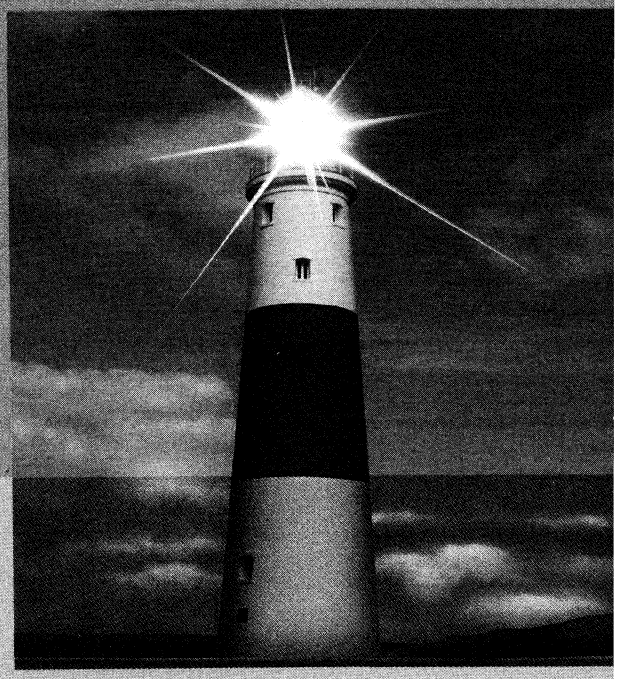
Melcher
Voedingen
Katalogus 1995

Algemene Informatie
Schakelende Regelaars
DC-DC Converters
AC-DC Converters
Toebehoren
Systeemintegratie
Toepassingen en hints



ISO 9001 Gecertificeerd

MELCHER

# Melcher produktklassen - gedefinieerd volgens omgevingsvoorwaarden

## Produktklasse voor strenge omgevingseisen (Rugged Environment)

Ideaal voor mobiele toepassingen of daar waar apparaten onderhevig zijn aan hoge niveaus van mechanische schokken of vibraties of extreme temperatuurgebieden.
De produkten zijn geschikt voor transport, quasi militair, marine, industriële, telemetry en kritieke toepassingen met betrekking tot de betrouwbaarheid zoals signalering en controle en monitor systemen. De produkten voldoen standaard aan veel militaire, ruimtevaart, transport, vermogensopwekking en industriële specificaties.
Voedingen in deze klasse bieden uitstekende immuniteit tegen zware transiënten, overspanningen, en geleidings- / stralingsemissies en bieden het hoogste niveau van dynamische kwaliteit, met een zeer breed ingangsbereik en hoge isolatieveiligheid.

| Kenmerkende prestaties | |
|---|---|
| Ingangsbereik: | 2:1 tot 10:1 |
| Isolatie: | tot 8 kV DC |
| Transiënt bescherming[1]: | 4 kV |
| EMC emissie[2]: | < B |
| EMC immuniteit[1]: | Vermogenklasse 3/4 |
| Temperatuurbereik: | −40°C tot 85°C |
| Vibratie: | 5 g |
| Schok: | 100 g |

## Produktklasse voor veeleisende industriële toepassingen (Industrial Environment)

Voor algemene industriële toepassingen waarbij het temperatuurbereik, mechanische duurzaamheid, goede dynamische prestaties en EMC belangrijk zijn.
Deze produkten zijn geschikt voor industriële produktie uitrustingen, procescontrole- en monitorsystemen, draagbare en handheld apparatuur, veiligheids-/ alarmsystemen, radio en televisie zendapparatuur, telecommunicatie en datatransmissie apparatuur. Voedingen in deze klasse beschikken over een compacte en solide constructie conform de telecommunicatie en industriële standaarden. Ze bieden een prima energie / volume verhouding.

| Kenmerkende prestaties | |
|---|---|
| Ingangsbereik: | 2:1 tot 5:1 |
| Isolatie: | tot 5.3 kV DC |
| Transiënt bescherming[1]: | 2 kV |
| EMC emissie[2]: | < B |
| EMC immuniteit[1]: | Vermogenklasse 2/3 |
| Temperatuurbereik: | −25°C tot 71°C |
| Vibratie: | 5 g |
| Schok: | 50 g |

## Produktklasse voor toepassingen in gecontroleerde omgevingen (Benign Environment)

Voor gebruik in toepassingen die meestal plaatsgebonden zijn en waar omgevingscondities zoals temperatuurbereik, EMC en mechanische duurzaamheid van gemiddeld niveau zijn.
Ideaal geschikt voor grote volumes en prijsniveau gevoelige toepassingen zoals instrumentatie, displays, commerciële apparatuur, etiketteer systemen, lichte industrie apparaten en test equipment.
Apparaten in deze klasse voldoen aan de internationale standaarden voor veiligheid en EMC, maar met lagere prestaties dan die in de Industrial en Rugged omgevingen. In het algemeen geldt dat produkten in deze klasse zich kenmerken door een smaller ingangsspanningsbereik, gelimiteerde transiënt en overspanningsbeveiligingen.

| Kenmerkende prestaties | |
|---|---|
| Ingangsbereik: | 2:1 tot 3:1 |
| Isolatie: | tot 5.3 kV DC |
| Transiënt bescherming[1]: | 0.5 kV |
| EMC emissie[2]: | < A |
| EMC immuniteit[1]: | Vermogenklasse 1/2 |
| Temperatuurbereik: | 0°C tot 50°C |
| Vibratie: | 2 g |
| Schok: | 15 g |

[1] Volgens IEC 801, IEC 1000-4
[2] Volgens EN 55022, CISPR 22 , CC J15

*Melcher produkt categorieën - Beschikbaar voor drie toepassingsbereiken*


| | | | |
|---|---|---|---|
| | *Algemene informatie* | Technisch<br>Standaards<br>Terminologie | 1 |
| *Schakelende Regelaars* | *< 5A* | | 2 |
| | *< 10A* | | 3 |
| | *> 10A* | | 4 |
| *DC-DC Converters* | *< 30W* | | 5 |
| | *< 100W* | | 6 |
| | *> 100W* | | 7 |
| *AC-DC Converters* | *< 30W* | | 8 |
| | *< 100W* | | 9 |
| | *> 100W* | | 10 |
| | *Toebehoren* | Konnektoren<br>Frontpanelen<br>Filters en spoelen | 11 |
| | *Systeem-integratie* | Transport<br>Telecommunicatie<br>Industrie | 12 |
| | *Toepassingen en hints* | Beveiligingsschakelingen<br>Sense lines<br>Verbindingen met systemen | 13 |

# Produktgerelateerde diensten verzorgt door Melcher

1. **Produkten en hun leverbaarheid**
   Melcher heeft meer dan 3000 verschillende voedingen waarvan er ±375 als voorraadtypes gedefinieerd zijn. Van deze types kan 95% met zekerheid uit voorraad geleverd worden.
2. **On-lineinformatie over de beschikbaarheid van produkten**
   Melcher stelt vanuit haar database informatie beschikbaar voor iedere klant en dit tegen een jaarlijkse vergoeding. Toegang wordt gegeven via een Modem en DEC Terminal Emulatie.
3. **Wereldwijde 48 uurs distributie**
   Het Melcher transportsysteem staat garant voor een wereldwijde levering binnen 48 uur. Kosten voor dit sneltransport zijn ten laste van de klant.
4. **Klant gemodificeerde voedingen**
   Voor de meeste produktfamilies kan Melcher modificaties aanbrengen binnen 6 tot 8 weken, afhankelijk van de complexiteit van het produkttype. Hiervoor kunt u contact opnemen met onze Field Sales Engineers om zodoende uw specifieke behoeften te bespreken alsmede voor het verkrijgen van een passende aanbieding.
5. **Verkrijgbaarheid op lange termijn**
   Melcher garandeert het op de lange termijn verkrijgen van de gehele produktlijn. De huidige produktfamilies zijn al meer dan 15 jaar leverbaar na de marktintroductie. Het geleidelijk uit produktie faseren van een produkttype wordt tenminste 8 maanden van te voren aangekondigd. Alle klanten die de desbetreffende produkten gekocht hebben gedurende de hieraan voorafgaande twee jaar worden gecontacteerd.
6. **Betrouwbaarheidsdata**
   Melcher controleert continu de bedrijfszekerheid van al haar produktlijnen en berekent jaarlijks het aantal "bedrijfsuren" (Zie bijgevoegde datasheets). Neemt u contact op met onze Field Sales Engineers voor nadere informatie.
7. **Garantie**
   Melcher garandeert alle zelf geproduceerde produkten welke defect bevonden zijn (te wijten aan materiaaldefecten of produktiefouten) indien deze zijn gebruikt binnen de grenzen van de opgegeven technische specifikaties en niet zijn bloot gesteld aan excessieve testen, binnen een periode van 24 maanden na aflevering aan de klant.

   Melchers verplichting en wettelijke aansprakelijkheid van bovengenoemde garanties worden gelimiteerd tot kosteloze vervanging of, naar Melchers inzicht, reparatie van om het even welk onderdeel. Melcher verplicht zich niet tot het honoreren van garantie, alsmede compensatie met betrekking tot schade, indien de goederen zijn beschadigd door de klant door onachtzaamheid, opzettelijk, gebruik van de goederen buiten de opgegeven specifikaties, gebruik maken van ongeschikte produkten, methode van transport en/of installatie.

   Met uitzondering van bovengenoemde garanties zal Melcher niet wettelijk aansprakelijk zijn voor iedere vorm van schade of nadeligheid, direct danwel indirect, veroorzaakt door of resulterend uit iedere handeling van verontachtzaamheid, ingebreke blijven of nalatigheid van personeel op welke wijze dan ook, voortkomend uit goederen die onderwerp zijn van gesprek. Een claim of actie voor hiervoor genoemde schade of nadeligheid zal niet geaccepteerd of aangespannen kunnen worden. Melcher is niet aansprakelijk voor enige reparatie verricht door een andere organisatie dan haar zelf.
8. **Gelijkvormigheidscertificaat**
   Een certificaat van gelijkvormigheid is verkrijgbaar voor ieder geleverd produkt. Deze certificaten kunnen uitgegeven worden zonder serienummer opgave of met serienummer opgave tegen een additionele vergoeding.
9. **Test certificaten**
   Melcher produkten kunnen besteld worden met gedetailleerde certificaten tegen een additionele vergoeding.
10. **Verpakking**
    Alle verpakkingsmaterialen zijn recycleerbaar, volledig ESD beschermend, vrij van CFK's en hebben dankzij de zorgvuldige constructie een zeer klein volume.
11. **CFK-vrije produktie**
    In geen enkele produktieplaats van Melcher AG worden CFK's (Chloor Fluor Koolwaterstoffen) gebruikt.
12. **Milieuvriendelijke PCB's**
    Alle door Melcher gebruikte PCB's (Print Circuit Boards) zijn milieuvriendelijk, gereinigd met CFK-vrije produkten en bedekt met een milieuvriendelijke beschermlaag.
13. **Accessoires**
    Voor alle Melcher produktlijnen zijn aparte accessoires verkrijgbaar. Deze zijn beschreven in sectie 12 van het databoek.
14. **Reparaties**
    Melcher repareert alle produkten ofwel tegen garantie ofwel op wens van de klant met berekening van de kosten. Defecte produkten dienen terug gestuurd te worden ofwel met een volledige verzendnota of met een "*Return Materials Acceptance Number*". Een volledige storingsomschrijving dient bijgevoegd te worden. Ingegoten converters worden niet hersteld maar vervangen door nieuwe.
15. **Kwalificaties**
    Alle gebruikte componenten zijn van de hoogste kwaliteit en worden ruim binnen de door de fabrikant opgegeven marges belast. Ruime veiligheidsmarges en component derating factoren zijn geïntegreerd in het elektronisch ontwerp om zodoende een lange levensduur te garanderen.
16. **Testen**
    Iedere Melcher voeding is elektronisch getest op functionaliteit en veiligheid om er voor te zorgen dat de prestaties overeenkomen met de gepubliceerde data. Er is een zeer ruime veiligheidsmarge tussen de gepubliceerde maximum specifikaties en de test limieten in produktie. Met deze toleranties werd rekening gehouden in de specifikaties om een normale componentveroudering toe te laten.
17. **Informatie op CD-rom**
    De inhoud van het databoek is verkrijgbaar op CD-rom of op een MO-disk (Magnetical Optical) tegen een vergoeding. Dit medium maakt het mogelijk gegevens eenvoudig en snel over een netwerk te distribueren, of snel bedrijfsspecifieke documentatie te creëren.

# 1 Algemene Informatie


| Topic | Bladzijde |
|---|---|
| Principes van Geschakelde Voedingen | 1 - 5 |
| Standaarden | 1 - 10 |
| AC Terminologie | 1 - 19 |
| Racking Systems | 1 - 20 |
| Produktbetrouwbaarheid, MTBF | 1 - 21 |
| Meten en Testen | 1 - 23 |
| Verklarende Woordenlijst | 1 - 25 |
| Produkt-Lijnen | 1 - 32 |

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Gedrukt in Zwitserland door: Druckerei Flawil AG

# Principes van Geschakelde Voedingen

## Spanningsregeling.

### Ferro-resonantie-regeling

De Ferro-resonantie techniek genereert een lijnregeling met behulp van een resonantie reservoir circuit en voorziet in een intrinsieke isolatie tussen de primaire en de secundaire windingen.
Ferro resonantie regeling is verkregen uit een hiervoor speciaal ontworpen constante spanningstransformator. De semi-blokgolf uitgangsspanning van de transformator is goed geschikt voor gelijkrichting en filtering. De inherente stroombeperking in Ferro-resonantie geregelde voedingen resulteert in het inzakken van de uitgangsspanning als de stroom door de belasting excessievelijk toeneemt.

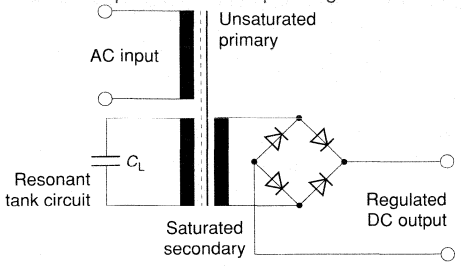



*Fig. 1*
*Ferro-resonantie regelaar met isolatie tussen in- en uitgang*

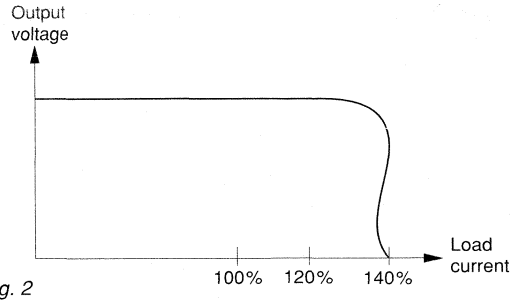



*Fig. 2*
*Inherente stroombegrenzing*

### Lineaire regeling.

Lineaire regeling is verkregen door de regeling van een spanningsval over een variabel weerstandselement, de doorlaattransistor. Het verschil tussen de onstabiele ingangsspanning en de gestabiliseerde uitgangsspanning wordt gegenereerd over de doorlaattransistor. Het vermogensverlies komt overeen met het produkt van collector-emitter spanning en de ingangsstroom. In de praktijk hebben de ingangsstroom en de uitgangsstroom een bijna dezelfde waarde.
Lineaire regelaars voorzien niet in enigerlei isolatie tussen in- en uitgangscircuits.

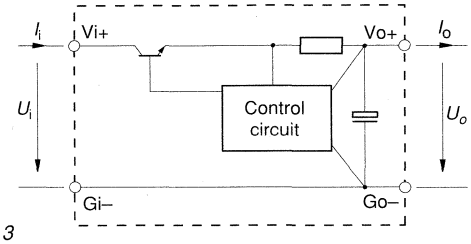



*Fig. 3*
*Lineaire regelaar zonder isolatie tussen in- en uitgang.*

### Schakelende regeling.

Schakelende regeling wordt verkregen door de regeling van de on- en de off-time verhouding van de doorlaattransistor maar dan in een snelle schakeltechniek. Voordelen hiervan zijn een hoog rendement, betrouwbaarheid en minimale warmte ontwikkeling.
Deze regeltechniek is bekend als puls-breedte-modulatie (PWM) en werkt gewoonlijk op schakelfrequenties boven de 20 kHz.
De actieve pulsbreedte is smal bij een hoge ingangsspanning en/of belasting en is breed voor een lage ingangsspanning en/of belasting, maar blijft altijd binnen het spectrum van de nagenoeg constante schakelfrequentie.
Geschakelde regelingen zijn niet voorzien van enige vorm van isolatie tussen in- en uitgangscircuits.

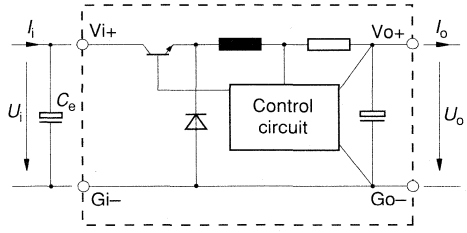



*Fig. 4*
*Geschakelde regelaar zonder isolatie tussen in- en uitgang*

### Rendement

(berekend voor regelingen zonder ingang-uitgang isolatie).
a) Lineaire regeling

$$\eta = P_o \div P_i = U_o \bullet I_o \div U_i \bullet I_i \text{ , (waarbij } I_o = I_i)$$

b) Geschakelde regeling 1 V:

$$P_{loss} = I_o \bullet 1\ V, \text{ (collector-emitter verzadigings spanning)}$$

$$\eta = P_o \div P_i = U_o \div (U_o + 1)$$

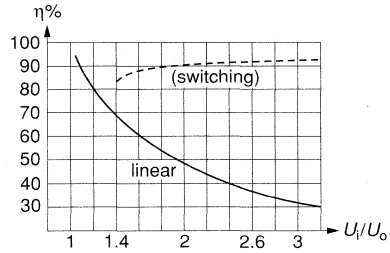



*Fig. 5*
*Rendement vs ingangsstroom*

## Standaard schakelconfiguraties

### Buck converter

Voordelen:
FET drain-source $U_{ds} \approx U_i$, gewone spoel. Geen problemen met magnetische koppeling. Lage belasting van de uitgangsondensator. Duty cycle van $T_{on}$ : $T$=1 is mogelijk.

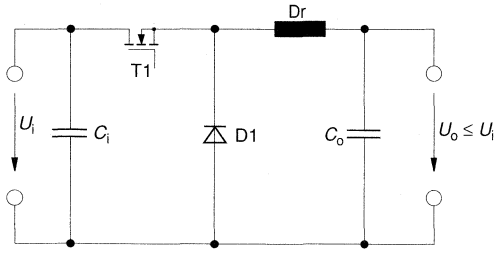
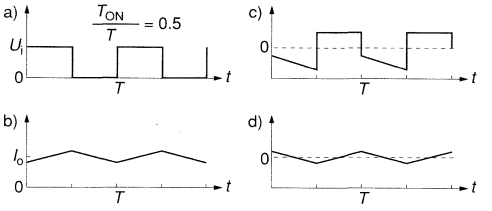



*Fig. 6*
*Buck converter*

Nadelen:
Geen isolatie tussen in- en uitgang. De ingang moet „zwevend" geconfigureerd zijn.




a) Spanningskarakteristiek van een transistor
b) Spoelstroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit

### Boost converter

Voordelen:
Gewone spoel. Geen problemen met magnetische koppeling.

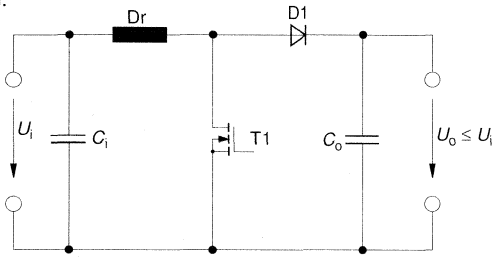
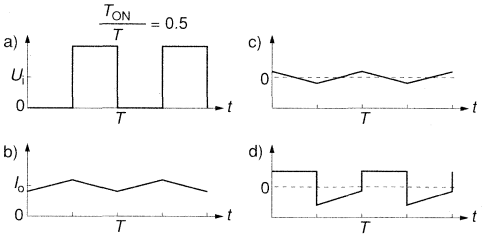



*Fig. 7*
*Boost converter*

Nadelen:
Vermogenstransistor drain-source spanning bereikt bij benadering $U_{ds} \approx U_0 > U_i$. Er is geen isolatie tussen in- en uitgang. Gemiddelde belasting van de uitgangscondensator.




a) Spanningskarakteristiek van een transistor
b) Spoelstroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit

### Buck-Boost converter

Voordelen:
Gewone spoel. Geen problemen met magnetische koppeling.

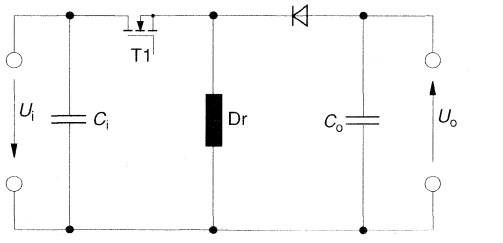
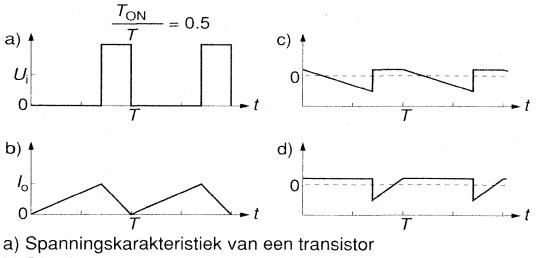



*Fig. 8*
*Buck-Boost converter*

Nadelen:
Vermogenstransistor drain-source spanning bereikt bij benadering $U_{ds} \approx U_0 + U_i$. Er is geen isolatie tussen in- en uitgang. Zware belasting van de uitgangscondensator. Het ingangscircuit moet „zwevend" geconfigureerd zijn. De polariteit van de uitgangsspanning is negatief in relatie tot de ingangsspanning.




a) Spanningskarakteristiek van een transistor
b) Spoelstroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit


MELCHER ISO 9001 certified

### Continuous flyback converter

Voordelen:

Groot ingangsspanningsbereik mogelijk (dankzij de constante transformator verhouding).

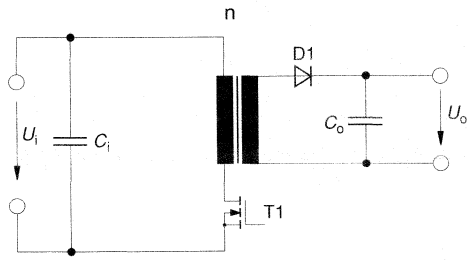
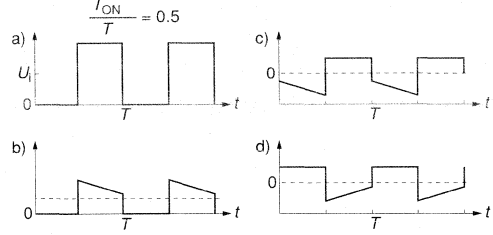



*Fig. 9*
*Continuous flyback converter*

Nadelen: Vermogenstransistor drain-source spanning bereikt bij benadering $U_{ds} > U_i + n \cdot U_o$. Zware belasting van de uitgangscondensator en diode Voor een goede magnetische koppeling heeft de transformator een kern met grote dwarsdoorsnede en luchtspleet nodig. Problemen met magnetische straling en wervelstromen.




(Trapezoidial current flow in transistor or primary winding)

a) Spanningskarakteristiek van een transistor
b) Diodestroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit

### Discontinuous flyback converter

Voordelen:

Galvanische scheiding tussen in- en uitgang. Andere kenmerken zijn identiek aan die van flyback type zoals hierboven beschreven.

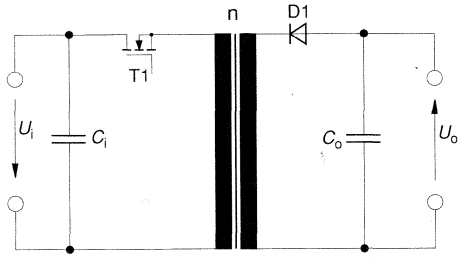
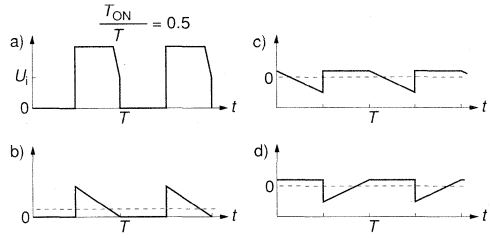



*Fig. 10*
*Discontinuous flyback converter*

Nadelen:

Vermogenstransistor drain-source spanning bereikt bij benadering $U_{ds} > U_i + n \cdot U_o$. Zware belasting van de uitgangscondensator en diode. Voor een goede magnetische koppeling heeft de transformator een kern met grote dwarsdoorsnede en luchtspleet nodig. Problemen met magnetische straling en wervelstromen.




(Sawtooth current flow in transistor or primary winding)

a) Spanningskarakteristiek van een transistor
b) Spoelstroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit

### Single-transistor forward converter

Voordelen:

Kern demagnetisatie is geen probleem. Eenvoudig ontwerp.

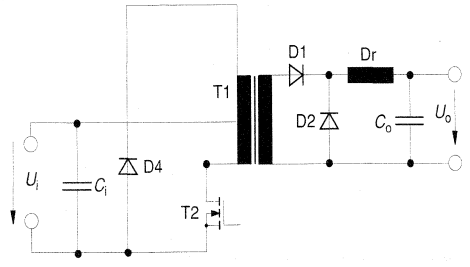
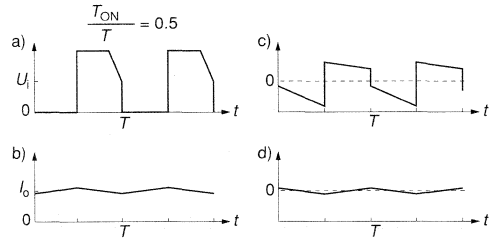



*Fig. 11*
*Single transistor forward converter*

Nadelen:

Vermogenstransistor drain-source spanning bereikt bij benadering $U_{ds} > 2 \cdot U_i$. Goede magnetische koppeling tussen de primaire en de demagnetisatie winding is noodzakelijk.




a) Spanningskarakteristiek van een transistor
b) Diodestroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit

### Push-pull converter

Voordelen:
De ingangsspanning naar beide transistoren is hetzelfde.

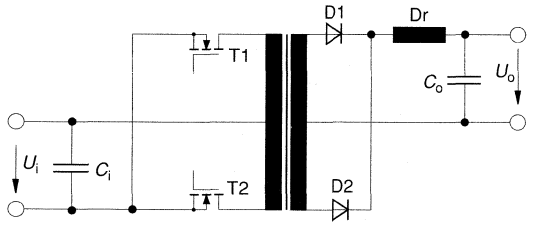
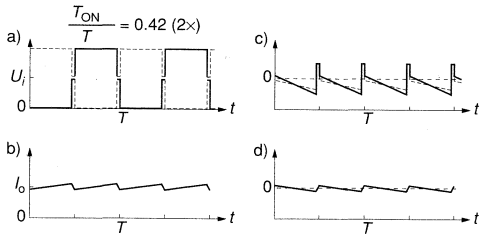



*Fig. 12*
*Push-Pull converter*

Nadelen:
Vermogenstransistoren drain-source spanning $U_{ds} > U_i + n \cdot U_o$ Correctie van symmetrie kan problemen opleveren. Goede magnetische koppeling tussen de twee primaire windingen is noodzakelijk. Gevaar dat beide transistoren gelijktijdig in geleiding komen.




a) Spanningskarakteristiek van een transistor
b) Spoelstroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit

### Single-ended push-pull converter

Voordelen:
FET drain-source spanning $U_{ds} \approx U_i$. De transformator mag een hoog niveau van strooi- inductie hebben.

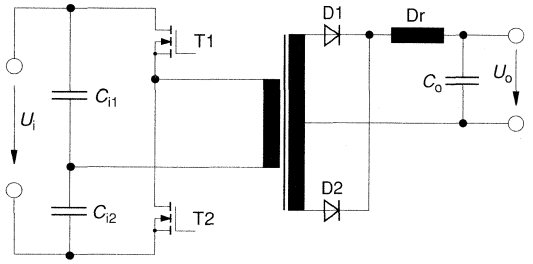
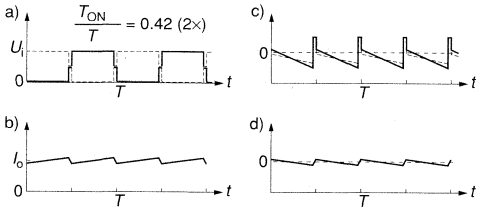



*Fig. 13*
*Single-ended push-pull converter*

Nadelen:
Correctie van symmetrie kan problemen opleveren. Gevaar dat beide transistoren gelijktijdig in geleiding komen. Een galvanisch gescheiden stuurcircuit is wenselijk.




a) Spanningskarakteristiek van een transistor
b) Spoelstroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit

### Two-transistor forward converter

Voordelen:
FET drain-source spanning $U_{ds} \approx U_i$. Kern demagnetisatie is geen probleem. De transformator mag een hoog niveau van strooi-inductie hebben.

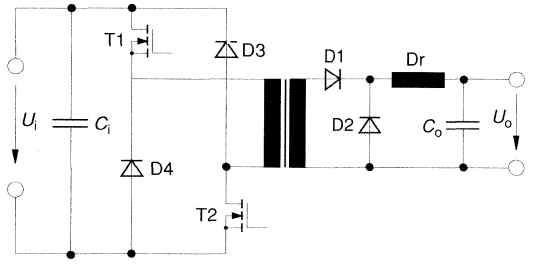
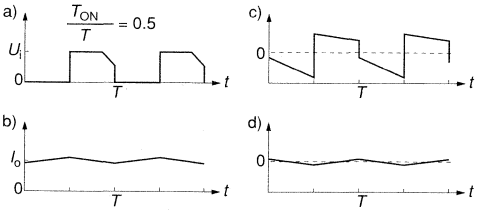



*Fig. 14*
*Two-transistor forward converter*

Nadelen:
Een galvanisch gescheiden stuurcircuit is wenselijk.




a) Spanningskarakteristiek van een transistor
b) Spoelstroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit


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**Full-bridge push-pull converter**

Voordelen:
FET drain-source spanning $U_{ds} \approx U_i$. De transformator mag een hoog niveau van strooi-indukties hebben.

Nadelen:
Correctie van symmetrie kan problemen geven. Gevaar dat beide transistoren tegelijkertijd in geleiding komen. Een galvanisch gescheiden stuurcircuit is wenselijk.

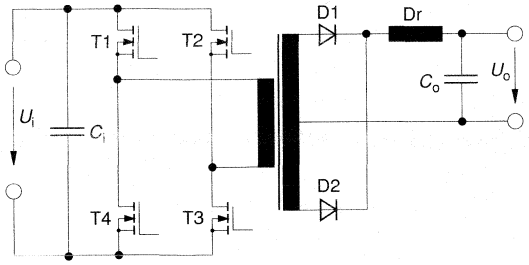
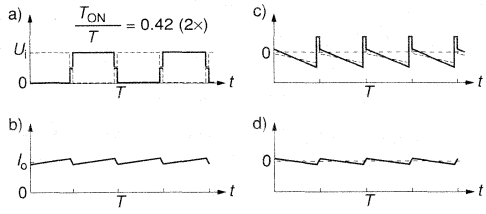



*Fig. 15*
*Full bridge push-pull converter*




a) Spanningskarakteristiek van een transistor
b) Spoelstroom
c) Stroomkarakteristiek van de ingangscapaciteit
d) Stroomkarakteristiek van de uitgangscapaciteit

**Enkele "recentere" topologieën**

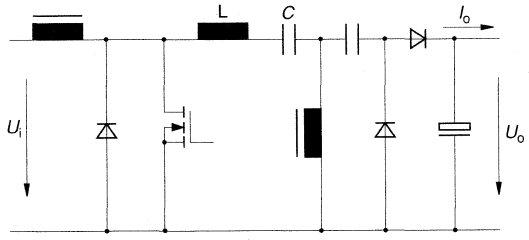



*Fig. 16*
*DC-DC converter (Energy pulse transfer).*

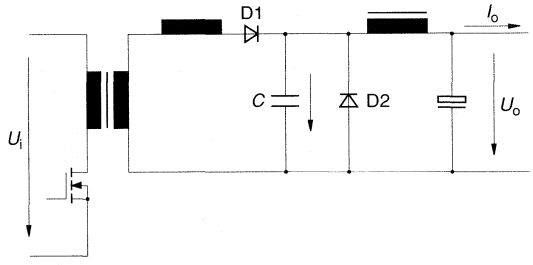
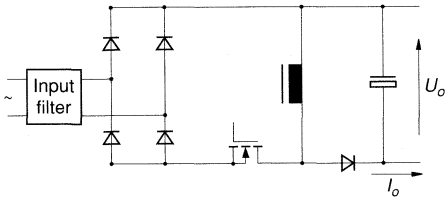



*Fig. 17*
*Pseudo-resonant forward converter*



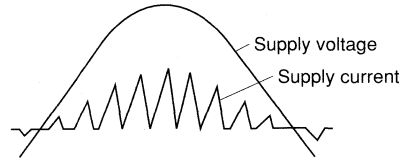




*Fig. 18*
*Buck-boost converter (acting as power factor corrector)*

# Standaarden

Deze lijst toont de belangrijkste nationale en internationale standaarden en reglementen met betrekking tot voedingen:

**BSI:**

British Standards Institution, de voornaamste instantie in Engeland. Deze standaarden zijn bij benadering gelijk aan UL/ IEC/VDE.

BS 7002 = IEC 950 (nationale vertaling)

BS 6301/87, Eisen voor apparaten die aangesloten zijn op het Britse elektriciteitsnet. Vervangen door EN 41003.

**CEE:**

Internationale commissie van regelgeving voor de goedkeuring van elektrische apparatuur.

**CSA:**

Canadian Standards Association

CS 22.2 nr. 143, kantoormachines. Van toepassing op kantoormachines gebruikt in bedrijfsomgevingen.
Gelijkaardig aan UL 114.

CSA 22.2 nr. 154, informatie verwerkingsapparatuur. Heeft betrekking op apparatuur ontworpen voor het ingeven, bewaren, zichtbaar maken of oversturen van informatie. Gelijkaardig aan UL 478.

CSA 22.2 nr. 950 M 85 = IEC 950

**EAMCL:**

Deze standaard betreft alle elektrische en elektronische systemen en machines die door Japan op de markt worden gebracht. Het is vergelijkbaar met de gecombineerde eisen van IEC 380 en IEC 435.

**ECMA:**

European Computer Manufacturers Association

ECMA 57, veiligheidseisen voor informatie verwerkingsapparatuur gebruikt in een bedrijfs- of industriële omgeving. Deze strikt Europese standaard is in essentie hetzelfde als IEC 435

**IEC**

International Electrotechnical Commission

IEC 380, Elektrische veiligheid van kantoormachines. Vervangen door IEC 950.

IEC 435, Veiligheid van informatieverwerkings apparaten. Geldig voor informatie- en datacommunicatie apparatuur .

IEC 950, Veiligheid van Informatie technologie, inclusief elektrische kantoor benodigdheden en aanverwante apparatuur. Voornamelijk vertaald naar EN 60950, CSA 22.2 no. 950 en UL 1950. Vervangt IEC 380 en UL 478.

**SEV:**

Schweizerischer Elektrotechnischer Verein. (Zwitserse Elektrotechnische Associatie)

**UL:**

Underwriter Laboratories.

UL 94: Kunststof materialen voor onderdelen in apparaten en hulpmiddelen. Bestrijkt de ontvlambaarheid van kunststof materialen gebruikt in huishoudelijke-, kantoor- en industriële omgevingen. Er is geen IEC of Europees equivalent.

UL 114, Standaard voor kantoorapparatuur en bedrijfshulpmiddelen. Omvat alle apparatuur die gebruikt wordt in kantoren. Gelijkaardig aan CSA 22.2 no. 143

UL 1950, vertaling van IEC 950. Het materiaal moet UL erkend zijn.

**VDE:**

Verband Deutscher Elektrotechniker (Duitse Elektrotechnische Commissie voor DIN en VDE)

VDE 0730, vervangen door VDE 0806.

VDE 0804, Telecommunicatie en informatieverwerkende apparatuur. Omvat alle EDP en Telecommunicatie apparatuur. Deze specifikatie was de oorspronkelijke basis voor IEC 435. Wordt vervangen door VDE 0805.

VDE 0805, herziene en toegelichte versie van VDE 0804; geen belangrijke veranderingen ten opzichte van VDE 0804. Het is de vertaling van IEC 950. (VDE 0805 uitgave 5.90)

VDE 0806, herziene en toegelichte versie van VDE 0730; geen belangrijke veranderingen ten opzichte van VDE 0730. Gelijkaardig aan IEC 380. Vervangen door VDE 0805 uitgave 5.90

**CE:**

Produkten verkocht in de EG moeten zich richten naar de Europese instructies die van toepassing zijn op de daartoe behorende produktcategorieën. Alhoewel de meeste voedingen als componenten beschouwd kunnen worden, zullen vele OEM 's het CE merkteken vereisen, dit om overeen te komen met de EMC- en laagspanningsrichtlijnen. Dit is echter geen garantie voor overeenkomstigheid van het uiteindelijke produkt.

## Standaarden van toepassing op voedingen

**Veiligheid:**

Principes van veiligheid zijn gebaseerd op dubbele veiligheid. De gewenste veiligheidsmaatregelen zijn afhankelijk van de toepassing (draagbaar, mobiel of vaste installaties), gebruikersgroepen of gebruik volgens ontwerpdoelstelling.

IEC 950 -> VDE 0805 / 5.90 -> EN 60950, EN 41003 (is een telecommunicatie veiligheidsstandaard die nagenoeg gelijk is aan IEC 950 met die uitzondering dat isolatietesten verricht mogen worden middels 3 verschillende methodes). UL 1950 (definieert veiligheidsmetingen voor elektrische apparaten met betrekking tot informatie systemen).

UL 1012 CSA. 950-M85.

SEV 1061/10.85, IEC 601-1, medisch, UL 544, medisch, CSA 22.2.1. medisch.

Niet langer geldig: VDE 380 -> VDE 0806/8.81, IEC 435.

Klasse I apparatuur:
Bescherming verkregen door eenvoudige isolatie en verbinding met massa voor die geleidende onderdelen die mogelijk onder gevaarlijke spanningen kunnen staan indien de isolatie faalt. (Meerderheid van Melcher DC-DC converters)

Klasse II apparatuur: ⧈
Bescherming is niet alleen gebaseerd op basis isolatie maar op additionele veiligheidsvoorzorgsmaatregelen, zoals dubbele of verstevigde isolatie. Deze apparatuur is niet voorzien van een aardaansluiting. (Melcher AC-DC en DC-DC converters van de C/D/LMZ series)

Klasse III apparatuur: ⧋
Bescherming tegen elektrische schokken berust op het voorzien van SELV circuits waarin gevaarlijke spanningen niet worden gegenereerd. (Melcher CQ-series; gebruikmakend van SELV circuits)

Aardaansluiting :
De aardaansluiting is een belangrijk beschermingselement voor klasse I apparatuur. Speciale eisen met betrekking tot mechanisch ontwerp, lage weerstand (kleiner dan 0,1 ohm), stroomvermogens (25 A DC gedurende 5 minuten), niet losmaakbaar en niet corroderend. Indicatie: blank metaal of een geel-groene kleur.

Openbaar elektriciteitsnet:
TN-S: Drie-draads: PH, N, PE
TN-C: Tweedraads: PH, PEN (aarding en N aan elkaar verbonden).
TT: Tweedraads: PH, N. N is verbonden met aarding, maar de behuizingen moeten apart geaard worden.
IT: Tweedraads: PH-N. N is geïsoleerd ten opzichte van de aarding. De behuizingen moeten apart geaard worden.
Nationale standaarden zijn ook van toepassing, (bv. in deScandinavische landen N, S, DK, SF).

Zekeringen:
Zekeringen moeten voorzien in het afschakelen van een defecte geleider. Een zekering in iedere fase en nul is gewenst als de nulgeleider niet juist geïdentificeerd kan worden.

Extra-low Voltage (ELV) Circuit:
Een bijkomende schakeling met spanningen tussen de geleiders of tussen geleiders en aarde, niet groter dan 42,2 V piek, of 60 V DC, onder normale werkingsvoorwaarden. Deze schakeling is door minstens een basis isolatie gescheiden van de gevaarlijke spanningen en voldoet niet aan de eisen van een SELV schakeling noch aan de eisen van een stroombegrenzingsschakeling.

Safety Extra-low Voltage (SELV) Circuit:
Een bijkomende schakeling die zo ontwikkeld en beveiligd is dat onder normale en enkelvoudige fout voorwaarden, de spanning tussen twee onderdelen van de SELV schakeling(en), en in geval van een klasse I toestel tussen ieder onderdeel en de aardingspen van het toestel, beneden een veilige waarde blijft.

Working Voltage:
De hoogste spanning die de isolatie kan weerstaan wanneer het toestel werkt bij nominale spanning en onder normale werkingscondities.

Creepage Distance:
De kortste weg tussen twee geleiders of tussen geleider en behuizing van het toestel, gemeten langs de isolatieoppervlakte.

Clearance:
De kortste afstand tussen twee geleiders of tussen geleider en behuizing van het toestel, gemeten via de lucht.

*Tabel 1: Safety relevant characteristics according to IEC 950*

| Characteristics | Isolation path with primary installation category II | | | | | | Unit |
|---|---|---|---|---|---|---|---|
| | Primary to earth Class I equipment | Primary to secondary Class II equipment | Primary to earth Class III equipment | Secondary to earth All equipment | | | |
| Nominal voltage | ≤300 rms | ≤300 rms | ≤60 DC | ≤60 DC | | | V |
| Transient rating | 2500 | 2500 | 1500 | 0 | 1500 | 2500 | |
| Maximum leakage current at $U_{i\,max}$ and $f_{line\,max}$ | 3.5 (up ot 5% of $I_i$ with warning label) | 0.25 | – | – | – | – | |
| Minimum clearance | 2.0 [1 3] | 4.0 [1 3] | 1.0 [1 7] | 0.7 [1] | 1 [1] | 2 [1] | mm |
| Minimum creepage distance | 2.0 [1 2 3] | 4.0 [1 2 3] | 1.0 [1 2 4] | 0.7 [1 2 5] | 1 [1 2 5] | 2 [1 2 5] | |
| Electric strength | 1500 [6] | 3000 [6] | 1000 [6] | No test | 978 [5] | | V AC |
| test voltage 1 min | 2121 [6] | 4243 [6] | 1414 [6] | [8] | 1383 [5] | | V DC |

[1] Valid for pollution degree 2
[2] Valid for material group I (CTI ≥600 V)
[3] Valid for insulation working voltage ≤300 $V_{rms}$
[4] Valid for insulation working voltage ≤200 $V_{rms}$
[5] Valid for insulation working voltage ≤100 $V_{rms}$
[6] Valid for insulation working voltage ≤250 $V_{rms}$
[7] Valid for insulation working voltage ≤150 $V_{rms}$
[8] Valid for insulation working voltage ≤60 V DC

**Lekstromen in medische toepassingen.**

De belangrijkste verschillen met gewone veiligheidsstandaarden (e.g. IEC 950) zijn kleinere lekstromen en grotere kruipafstanden, tussenruimtes en isolatiemateriaaldiktes. De minimale afstand tussen lichtnet spanning en massa (behuizing) is 4 mm!

In IEC 601-1 zijn drie types apparatuur gedefinieerd.

Type B:

Apparatuur met een interne voeding die voldoende beschermd is tegen elektrische impulsen, vooral met betrekking tot toelaatbare lekstromen en betrouwbare aarding. Met andere woorden; apparaten voor extern en intern gebruik bij een patiënt, maar geen directe hart-gerelateerde toepassingen.

Type BF:

Zelfde als type B apparatuur, maar met een van isolatiemateriaal voorzien op de patiënt toepasbaar onderdeel.

Type CF:

Apparatuur met een interne voeding met een hoge beschermingsgraad tegen massasluiting, speciaal in relatie tot toelaatbare lekstromen. Ze hebben hiervoor een op de patiënt toepasbaar, geïsoleerd onderdeel zodat deze apparaten geschikt zijn voor toepassing in direct contact met het hart van een patiënt.

*Tabel 2: Maximum toelaatbare lekstroom.*

| Stroom route | Type B | | Type BF | | Type CF | |
|---|---|---|---|---|---|---|
| Stroom waarde [mA] | NC | SFC | NC | SFC | NC | SFC |
| Lekstroom aarde | 0.5 | 1.0 | 0.5 | 1.0 | 0.5 | 1.0 |
| Lekstroom behuizing/aarde | 0.1 | 0.5 | 0.1 | 0.5 | 0.1 | 0.5 |
| Lekstroom behuizing/patiënt | 0.1 | 0.5 | 0.1 | 0.5 | 0.01 | 0.05 |

NC = normal condition SFC = single fault condition

**Elektromagnetische compatibiliteit (EMC):**

Emissies:

**VDE 0871, VDE 0875, VDE 0878, C.I.S.P.R. 11 = EN 55011**, (Industrieel, Wetenschappelijk en Medisch).

**C.I.S.P.R. 22 = EN 55022,** (Telecommunicatie),

**C.I.S.P.R. 14 = EN 55014,** (Huishoudelijk, deze voedingsstandaard is niet direct van toepassing, maar bevat meetmethodes met een MDS meetklem voor straling. De MDS aansluiting draagt zorg voor het eenvoudig meten van het door de storingen gegenereerde vermogen over een kabel met gedefinieerde lengte.)

**EN 50081**, (Algemene Emissie Standaard):
-1 = Utiliteit en lichte industrie;
-2 = Industriële omgeving.

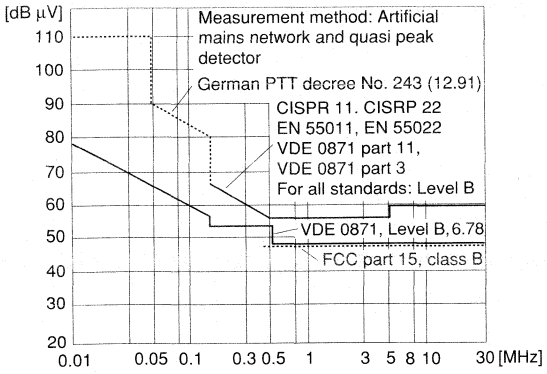
**MIL-STD-461C**, (Elektromagnetische Emissie).

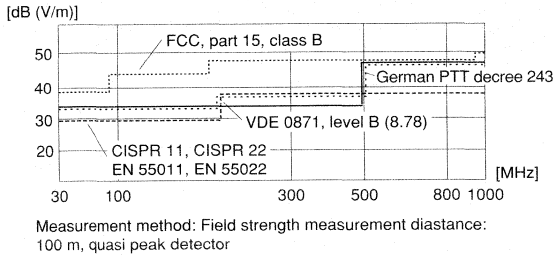
Radio frequente interferenties zijn storingen die gegenereerd worden door elektrische apparaten en ontvangen worden door andere apparaten. Deze storingen mogen geen frequenties en veldsterkten hebben die de correcte werking van andere apparaten verstoren.

In voedingen wordt RFI veroorzaakt door het schakelelement. Des te steiler de spanningsverschillen en hoger de schakelfrequenties des te groter wordt het gehalte aan harmonischen in de gegenereerde storingen. Deze storingen worden overgebracht op andere onderdelen in de voeding. Uiteindelijk zijn er meerdere storingsbronnen en wordt een breed spectrum van frequenties gegenereerd.

Laagfrequent storingen (tot 30 MHz) transporteren zich over leidingen en/of kabels. Hoogfrequent storingen (30...1000 MHz) worden uitgestraald.

De standaarden (sectie 3.1.2) zijn jammer genoeg zeer verschillend van elkaar. Een verdere coördinatie is niet in zicht zodat het vereiste RFI niveau bepaald moet worden per toepassing. De volgende tabellen geven een overzicht van de bestaande standaarden voor geleidings- en stralingsemissies.




Measurement method: Field strength measurement diastance: 100 m, quasi peak detector

*Fig.1a en b*
*RFI ruis niveaus*

**Immuniteit:**

De hierna volgende standaarden definiëren het testen van de bestendigheid van de voedingen met betrekking tot hoge spanningen en hoogfrequente transiënten aan de ingang. Zulke storingen worden in het algemeen veroorzaakt door schakelaars (niet ohms gedrag en vonkvorming), statische ontladingen, bliksem, filters, inkoppelen van hoogfrequente leidingen,...

**EN 50082**, (Algemene Immuniteit Standaard):

**-1** = Utiliteit en lichte industrie.

**-2** = industriële omgevingen.

**IEC 255.4 deel 1:** Voltage Burst test, apparaat niet werkend.

| Klasse | $U_{max}$ | Stijg tijd | Puls duur | Impedantie |
|---|---|---|---|---|
| Klasse II | 1 kV | 1.2 µs | 50 µs | 500 Ω |
| Klasse III | 5 kV | 1.2 µs | 50 µs | 500 Ω |

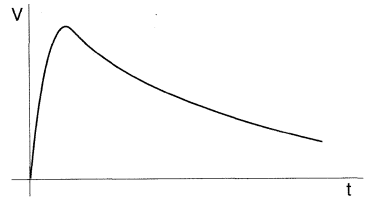



*Fig. 2*
*Spannings burst*

**IEC 255.4 deel 2:**

Hoogfrequente spanningsoscillatie, voeding in gebruik, storingen hetzij transversale of longitudinale oscillaties f = 1 MHz.

| Class | $U_{max}$ | Stijg tijd | Halfwaarde tijd | Impedantie |
|---|---|---|---|---|
| Klasse II longitudinaal | 1.0 kV | 75 ns | 6 µs | 200 Ω |
| Klasse II transversaal | 0.5 kV | 75 ns | 6 µs | 200 Ω |
| Klasse III longitudinaal | 2.5 kV | 75 ns | 6 µs | 200 Ω |
| Klasse III transversaal | 1.0 kV | 75 ns | 6 µs | 200 Ω |




*Fig. 3*
*Hoog frequente spannings oscillatie*

**IEC 801.2 (IEC 1000-4-2, EN 61000-4-2)**: Elektrostatische ontlading ten opzichte van de behuizing. Model gebaseerd op het veroorzaken van elektrische ontlading door het menselijk lichaam. De ontlading zal via direct contact of via een kleine afstand geschieden.

| Klasse | $U_{max}$ | Stijg tijd | Piek stroom | Impedantie |
|---|---|---|---|---|
| Niveau 1 | 2 kV | 1 ns | 7.5 A | 33 Ω |
| Niveau 2 | 4 kV | 1 ns | 15 A | 33 Ω |
| Niveau 3 | 6 kV | 1 ns | 22.5 A | 33 Ω |
| Niveau 4 | 8 (15) kV | 1 ns | 30 (75) A | 33 Ω |

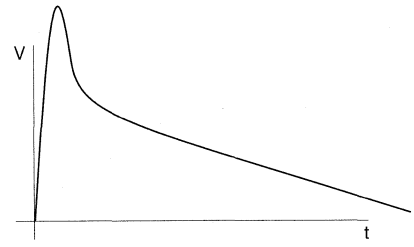



*Fig. 4*
*Elektrostatische ontladingspuls*

**IEC 801-3 (IEC 1000-4-3, EN 61000-4-3):**
Gevoeligheid voor elektrische velden; frequentie bereik : *f* = 10 kHz...500 MHz
Niveaus (veldsterkte): 1 V/m, 3V/m, 10 V/m,
(De meeste Melcher voedingen verdragen ook het hoogste niveau).

**IEC 801-4 (IEC 1000-4-4, EN 61000-4-4):**
Elektrisch snelle transiënten. Burst toegediend aan een werkende voeding. $f = 5$ kHz bij $U \leq 1$ kV, $f = 2.5$ kHz bij $U \leq 2$ kV.

Burst duur: 15 ms, burst periode: 300 ms.

| Test level | $U_{max}$ | Stijg tijd | Piek stroom | Impedantie |
|---|---|---|---|---|
| 1 | 0.5 kV | 5 ns | 10 A | 50 Ω |
| 2 | 1.0 kV | 5 ns | 20 A | 50 Ω |
| 3 | 2.0 kV | 5 ns | 40 A | 50 Ω |
| 4 | 4.0 kV | 5 ns | 80 A | 50 Ω |

Evaluatie klassen:
- Normaal gebruik;
- Tijdelijke afwijking van de specifikaties;
- Tijdelijke afwijking van de specifikaties en handmatige reset na een test;
- Volledige uitval

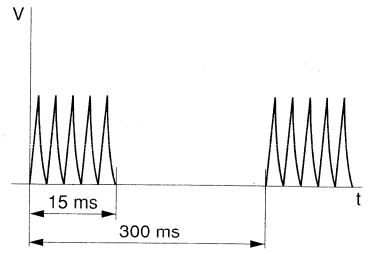



*Fig. 5*
*Elektrisch snelle transiënten*

**IEC 801-5 (EC 1000-4-5, EN 61000-4-5)**: Overspanning beveiligings eisen: stijgtijd 1.2 µs, halfwaardetijd 50 µs. Verschillende klasses voor energie- en datalijnen worden onderscheiden. Voedingsklassen met 1.2/50 µs golfvorm, bronimpedantie 12 Ω voor pieken tussen lijn en aarde:

| Klasse | $U_{max}$ | Piekstroom | Beschermings niveau |
|---|---|---|---|
| 0 | niet vereist | niet vereist | goed beschermde omgeving, |
| 1 | 0.5 kV | 42 A | Gedeeltlijk beschermt |
| 2 | 1 kV | 83 A | Kabels goed gescheiden |
| 3 | 2 kV | 167 A | Kabels parallel |
| 4 | 4 kV | 333 A | Meeraderige kabels |
| x | Afhankelijk van het lokale voedings systeem | | |

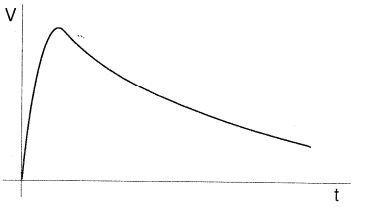



*Fig. 6*
*Surge puls*

**IEC 801-6 (IEC 1000-4-6, EN 61000-4-6).** Immuniteit voor door radiofrequente velden geïnduceerde storingen. Signalen die gegenereerd zijn door een testgenerator worden geïnduceerd via een klem naar de verschillende kabels die verbonden zijn met de te testen apparatuur (EUT).

| | |
|---|---|
| Frequentiebereik: | 150 kHz...80 MHz, 1 kHz modulated, 50 W |
| Spanningsniveau 1: | 120 dB/µV or 1 V |
| Spanningsniveau 2: | 130 dB/µV or 3 V |
| Spanningsniveau 3: | 140 dB/µV or10 V |

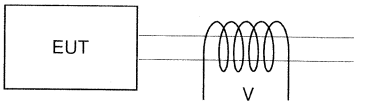



*Fig. 7*
*Elektrische storingen geïnduceerd door radiofrequente velden*

**IEC 1000-4-8, EN 61000-4-8:** Laagfrequent magnetische immuniteitstest;

| Test niveaus | Veldsterke |
|---|---|
| 1 | 1 A/m |
| 2 | 3 A/m |
| 3 | 10 A/m |
| 4 | 30 A/m |
| 5 | 100 A/m |
| x | speciaal |

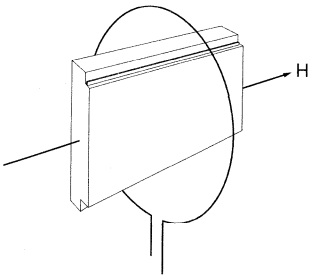



*Fig. 8*
*Laagfrequent magnetisch veld*


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**IEC 1000-4-9, EN 61000-4-9:** Magnetische puls immuniteitstest;

| Test niveaus | Veldsterke (piek) |
|---|---|
| 1 | n.a. |
| 2 | n.a. |
| 3 | 100 A/m |
| 4 | 300 A/m |
| 5 | 1000 A/m |
| x | speciaal |

**IEC 1000-4-10, EN 61000-4-10:** Gedempt oscillerend magnetische immuniteitstest.

| Test niveaus | Field strength (piek) |
|---|---|
| 1 | n.a. |
| 2 | n.a. |
| 3 | 10 A/m |
| 4 | 30 A/m |
| 5 | 100 A/m |
| x | speciaal |

**IEC 1000-4-11, EN 61000-4-11:** Spannings dips, korte interrupties en spanningsvariaties immuniteitstest.

Transiënte spanningen:

**VDE 160, DIN 57435 part 303/VDE 0435 part 30, VDE 0433 part 3.**

**MIL-STD-462,** Metingen van EMI immuniteit.

**IEC 555-2 (IEC 1000-3-2, EN 61000-3-2):** Harmonische storingen; beschrijft de maximale harmonische stromen van apparatuur met een ingangsstroom tot 16 A per fase. De harmonischen worden in vermogenapparatuur gegenereerd door schakelementen en gelijkrichtdiodes door snelle stijg- en daaltijden van de spanning over deze componenten. Het storingsfrequentiespectrum kan geanalyseerd worden met Fourier transformaties. De frequentie inhoud kan berekend worden voor even en oneven harmonischen van de netfrequentie.

In de meest recente voorstellen, zijn voedingen „andere apparatuur" met een „speciale golfvorm" (Klasse D).

Arbeidsfactor en harmonische inhoud van de stroom hebben niet dezelfde karakteristiek. Het is zeer aannemelijk dat voedingen met een arbeidsfactor naderend naar 1 minder harmonische storing veroorzaken.

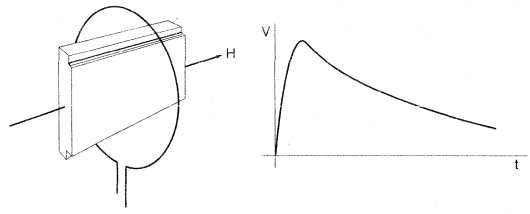



*Fig. 9*
*Magnetisch puls veld*

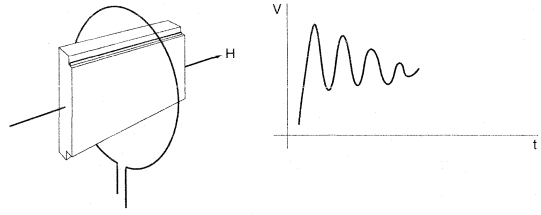



*Fig. 10*
*Gedempt oscillerend magnetisch veld*

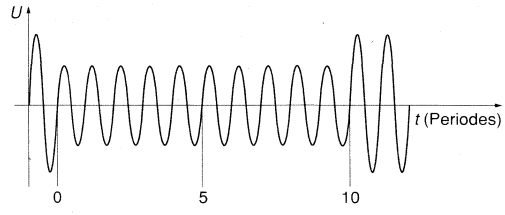



*Fig. 11*
*Spannings dips*

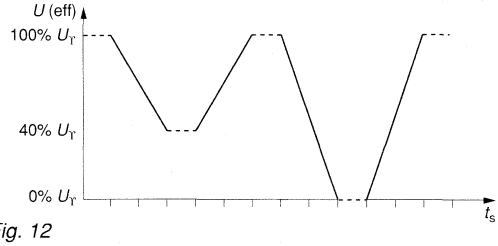



*Fig. 12*
*Spannings variaties*

*Tabel 3: Harmonische storingen*

| Harmonische orde | IEC 555-2 (uitgaave 1982) | IEC 1000-3-2 klasse D | |
|---|---|---|---|
| n | Limit [A] | Limit [mA/W] | Max. [A] |
| 2 | 1.08 | - | - |
| 3 | 2.3 | 3.4 | 2.3 |
| 4 | 0.43 | - | - |
| 5 | 1.14 | 1.9 | 1.14 |
| 6 | 0.3 | - | - |
| 7 | 0.77 | 1.0 | 0.77 |
| 8 | 1.84/n | - | - |
| 9 | 0.4 | 0.5 | 0.4 |
| 11 | 0.33 | 0.35 | 0.33 |
| >13 | 0.21 | 3.85/n | 2.25/n |
| >15 | 2.25/n | - | - |

**prETS 300132:** Voedings interface aan de ingang van telecommunicatie apparatuur.

Dit is een voorstel tot standaard door het Europee Telecommunicatie Standaard Instituut en beschrijft eisen voor AC-DC converters (ETS 300132-1) en DC-DC converters (ETS 300132-2).

ETS 300132-1:
- ingangsspanning: 207...253 V AC.
  (0...207 V AC geen schade)
- Lichtnet frequentie: 45...55 Hz
- Impuls test met speciale testgenerator $U_{max}$ = 2.5 kV
- Hold-up tijd: 20 ms
- Statische tolerantie van de ingang: ±10%
- Inschakelstroom moet gelimiteerd zijn.

ETS 300132-2
- Nominale ingangsspanning: –48 V DC
- Ingangsspanning bereik: –40.5...-57 V DC
  (0...–40.5 en –57...-60 V DC: geen schade)
- Spannings surge test volgens IEC 801-5 klasse 3 of met een speciale testgenerator
- Inschakelstroom moet gelimiteerd zijn.

Inschakelstroom

De inschakelstroom is de golfvorm van de ingangsstroom zoals deze wordt gemeten onmiddellijk na het aansluiten van de ingangsspanning.

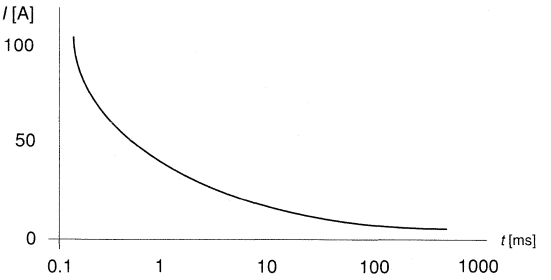



*Fig. 13*
*Inschakelstroom*

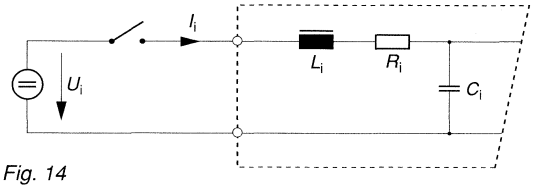



*Fig. 14*
*Ingangs circuit*

De inschakelstroom is afhankelijk van de externe ingangspannign $U_i$, de impedantie van bron en voedingskabel, de interne ingangsinductie $L_i$, de interne ingangsweerstand $R_i$ en de ESR van de interne ingangscapaciteit $C_i$ van de voeding.

De piekwaarde $I_{i\,m}$ van de inschakelstroom kan als volgt berekend worden:

$$I_{i\,m} = \frac{U_i}{R_i}$$

De stijgtijd $t_{i\,s}$ wordt gegeven door:

$$t_{i\,s} \approx \frac{L_i}{R_i}$$

De halfwaarde tijd $t_{i\,r}$ is:

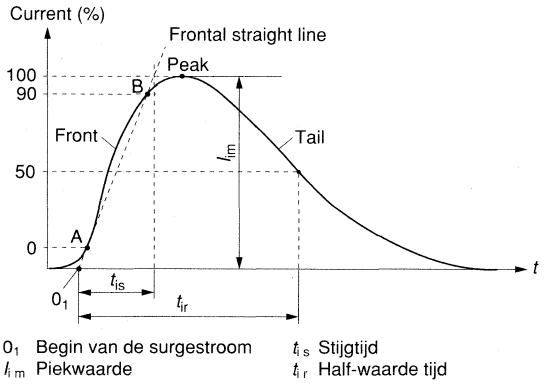
$$t_{i\,r} \approx 0.7 \cdot R_i \cdot C_i + t_{i\,s}$$

Basis principes:
De inschakelstroom bepaalt de waarde van de elektronische ingangsschakelaars, relais, en zekeringen.

De $\int I^2\,dt$ waarde van de inschakelstroom kan berekend worden met de volgende formule:

$$\int I^2\,dt \approx I_{i\,m}{}^2 \cdot (0.7 \cdot t_{i\,r} - 0.36 \cdot t_{i\,s})$$

De piekwaarde van de inschakelstroom kan gelimiteerd worden door middel van een NTC of een actief begrenzingscircuit (weerstand met relais, thyristor, transistor of optionele circuits zoals bijvoorbeeld optie E, verkrijgbaar op bepaalde Melcher voedingen).




$0_1$ Begin van de surgestroom
$I_m$ Piekwaarde
$t_s$ Stijgtijd
$t_r$ Half-waarde tijd

*Fig. 15*
*Definitie van de inschakelstroom*

**Omgevings tests:**

**MIL-STD-810C, DIN 40 046. IEC 68,** (basis test procedures), **EN 50125** (Spoorwegen).

**Vervuilingsgraad:**

De mate van bescherming tegen elektrische shock (beschermings klasses)

**MTBF berekening**

MIL-HDBK-217, Achtervoegsel C, D, E of F afhankelijk van de berekeningsdatum. Gedetailleerde waardes zijn vermeld in de betreffende produktdata sectie.


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*Tabel 4: Overeenkomstige MIL standaarden voor Melcher produkten*

| MIL-STD | Sectie | Onderwerp | Melcher product lijn |
|---|---|---|---|
| 810D | 501.2 | Temperatuur –25...71 °C | Alle produkten Klasse "rugged" |
| | 502.2 | Temperatuur –25...71 °C | Alle produkten Klasse "rugged" |
| | 503.2 | Temperatuur –25...71 °C | Alle produkten Klasse "rugged" |
| | 507.2 | Tropische hitte 40 °C, 93% r. H. 56 dagen | Alle produkten Klasse "rugged" |
| | 516.3 | Schock 100 g, 6 ms, 6 • 3 schocks | Alle produkten Klasse "rugged" |
| | 516.3 | Continue schock 40 g, 6 ms, 6 • 1000 schocks | Alle produkten Klasse "rugged" |
| | 514.3 | Sinus 5 g, 10...2000 Hz, 3 • 2.5 h | Alle produkten Klasse "rugged" |
| | 510.2 | Beschermingsgraad (stof) | Alle produkten Klasse "rugged"; Beschermingsgraad afhankelijk van het tape. |
| 461C | Gedeeltes IV, VI | Elektromagnetische emissies en gevoeligheid Vereisten CE 01, CE 03 | { BM 1000, BM 2000, BM 3000 series |
| | II, IV, V | Vereisten RE 01, RE 02 | { LM 1000, LM 2000, LM 3000 series |
| | IV, VI | Vereisten RS 01, RS 03 | |
| 1275A | | 28 V DC elektrische systemens in militaire voertuigen | AM, PSB, PSC, PSL, PSK, AK series |
| 704E | | Vliegtuig elektrische vermogenskarakteristieken | M, K series, type afhankelijk van de spanninsbron (115 V AC or 28 V DC) |
| 1399 | 300A Type I, II or III | Interface standard for shipborne systems | M, K series, type afhankelijk van de spanninsbron (115 V AC 60 Hz or 400 Hz), Volkoet niet aan de PF eisen. |

*Tabel 5: Standaarden Cross Reference*

| Uitgave | Standaard | | | | |
|---|---|---|---|---|---|
| | IEC (CISPR) | EN | DIN/VDE | MIL-STD 810D | BS |
| Isolatie, veiligheid | 950 | 60950 | 805 | | 7002 |
| Impuls spanningsgevoeligheid | 255.4 | | 435 | | |
| hoge frequentie gewoeligheid | 255.4 | | 435 | | |
| Trfansiënt ingangsspanningen | 571 | | | | |
| Elektrostatische ontladingen | 801-2/1000-4-2 | 61000-4-2 | | | |
| Elektrisch veld gevoeligheid | 801-3/1000-4-3 | 61000-4-3 | | | |
| Elektrisch snelle transiënten (bursts) | 801-4/1000-4-4 | 61000-4-4 | (843) | | 6667 |
| Overspanningsimmuniteit | 801-5/1000-4-5 | 61000-4-5 | | | |
| Immuniteit tegen storingen via geleiders | 801-6/1000-4-6 | 61000-4-6 | | | |
| Laagfrequente magneetveld immuniteit | 1000-4-8 | 61000-4-8 | | | |
| Puls Magneetveld Immuniteit | 1000-4-9 | 61000-4-9 | | | |
| Ged. oscill. Magneetveld Immuniteit | 1000-4-10 | 61000-4-10 | | | |
| Lekstromen | 601 | | 750 | | 5724 |
| RFI niveaus | (22/11) | 55022/55011 | 0871/0878 | | |
| Temperatuur | | | | 501.2/502.2/503.2 | |
| Vochtigheid/temperatuur | 68-2-3 | | 40046/5 | 507.2 | 2011 (2.1 Ca) |
| Schock | 68-2-27 | HD323 | 40046/7 | | 2011 (2.1 Ga) |
| Continue schock | 68-2-29 | HD323 | 40046/26 | 516.3 | 2011 (2.1 Eb) |
| Vibratie | 68-2-6 | HD323 | 40046/8 | 514.3 | 2011 (2.1 Fc) |
| Beschermings niveau (Stof) | 529 | | | 510.2 | 5490 |
| Kleur Indicatoren | 73 | HD493 | 0199 | | 4099 |
| Afmetingen van behuizing 19" rek syst. | 297 | | 41494 | | |

[1] aanvraag ingediend, proces lopende

*Tabel 6: Overeenkomstig met de luchtvaart Standaard RTCA DO 160 C*

| Onderwerp | Melcher produktlijnen |
|---|---|
| Geleidings emissies<br>Geleidings gevoeligheid<br>Stralings emissies<br>Stralingsgevoeligheid<br>Magnetich veld geïnduceerd in apparatuur<br>Magnetich veld geïnduceerd in bakebeling<br>Elektrisch veld geïnduceerd in bekabeling<br>Spikes geïnduceerd in bekabeling | BM 1000, BM 2000, BM 3000 series<br>LM 1000, LM 2000, LM 3000 series |

**Belangrijke opmerking:**

Als Melcher één van de boven genoemde standaarden specificeert dan behoren ze alleen toe aan die voeding. Zij hebben geen betrekking op het geïntegreerde systeem. Het is aan de gebruiker om systemen geheel overeenkomstig de standaarden te ontwikkelen.





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# AC Terminologie

**cos φ**

Voor onvervormde sinusvormige golfvormen is de cos φ de verschuivingsfaktor van de belastingsstroom tot de spanning (fig. 1).

Voor dit speciaal geval is φ ook gelijk aan de faseverschuiving tussen aktief en schijnbaar vermogen.

Schijnbaar vermogen: $U_{rms} \cdot I_{rms}$
Aktief vermogen: $U_{rms} \cdot I_{rms} \cdot \cos \varphi = S \cdot \cos \varphi$
Reaktief vermogen: $U_{rms} \cdot I_{rms} \cdot \sin \varphi$

Het schijnbaar vermogen is in het vektordiagram de resultante van het aktief en het reatkief vermogen (fig 2).

### Harmonische vervorming

Voor niet-lineaire belastingen (bv een gelijkrichter) zal de belastingsstroom geen sinsuvormig verloop hebben. Daar bij het aktief vermogen alleen rekening wordt gehouden met de basisfrequentie (frequentie van de voedingsspanning) kan de ontleding (Fourier analyse) van de stroom in basis en harmonischen berekend worden als:

$$I(t) = I_0 \cdot \sin(\omega_0 t + \varphi_0) + I_1 \cdot \sin(\omega_0 t + \varphi_i) + \ldots + I_n \cdot \sin(\omega_n t + \varphi_n)$$

| | | |
|---|---|---|
| $I_0$: | | amplitude van de baisgolfvorm |
| $I_i$: | i = 1...n | amplitude 1e harmonische |
| $\omega_0 = 2\pi \cdot f_0$ | $f_0$ = 50/60 Hz | frequentie van de baisgolfvorm |
| $\omega_i = i \cdot \omega_0$ | i = 1...n | frequentie van de 1e harmonische |
| $\varphi_0$ | | faseverschuiving van de basisgolfvorm |
| $\varphi_i$ | i = 1...n | faseverschuiving van de 1e haromische |

Gebaseerd op deze ontleding kan de vermormingsfaktor berekend worden als

$$K = \frac{\text{Inhoud van de harmonischen}}{\text{rms-waarde}}$$

$$K = \sqrt{\frac{\sum_{i=1}^{\infty} I_i^2}{\sum_{i=0}^{\infty} I_i^2}}$$

### Arbeidsfaktor

Voor éénfasige systemen wordt de arbeidsfaktor gedefiniëerd als de verhouding tussen het aktief vermogen geleverd aan de belasting en het schijnbaar vermogen. Daar golfvormen neit sinusvormig moeten zijn is de arbeidsfaktor bij benadering gelijk aan de cos φ. Voor die gevallen waar de golfvormen wel sinusvormig zijn is de arbeidsfaktor gelijk aan de cos φ.

$$PF = \frac{\text{Aktief vermogen}}{\text{schijnbaar}} = \frac{P}{S}$$

In de praktijk kan men ervan uitgaan dat de voedingsspanning sinusvormig is (fig. 3). Wat de vervorming betreft hangt de arbeidsfaktor alleen maar af van de belastingsstroom: hoe groter de vervorming hoe lager de arbeidsfatkor. Een ideale arbeidsfatkor is 1, waar in het slechtste geval de arbeidsfatkor 0 is.

$$PF = \frac{I_0 \cdot \cos \varphi_0}{I_{rms}}$$

$I_0$: basisgolfvorm van de belastingsstroom
cos $\varphi_0$: faseverschuiving van basisgolfvorm van de belastingsstroom
$I_{rms}$: rms-waarde van de belastingsstroom

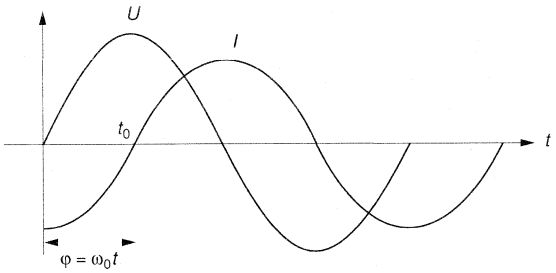



*Fig. 1*
*cos φ*

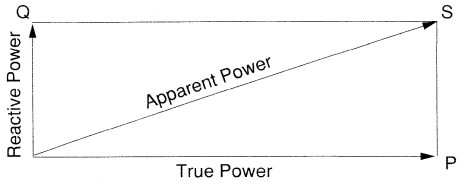



*Fig. 2*
*AC-power components*

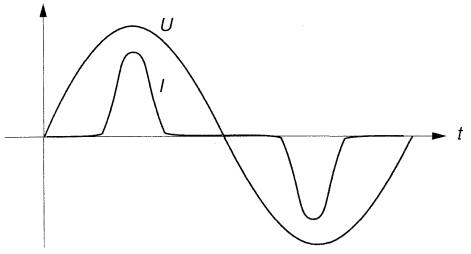



*Fig. 3*
*Harmonische vervorming*

1

# Racking Systems

**19" and 23" (IEC 297-1, -2 and -3)**

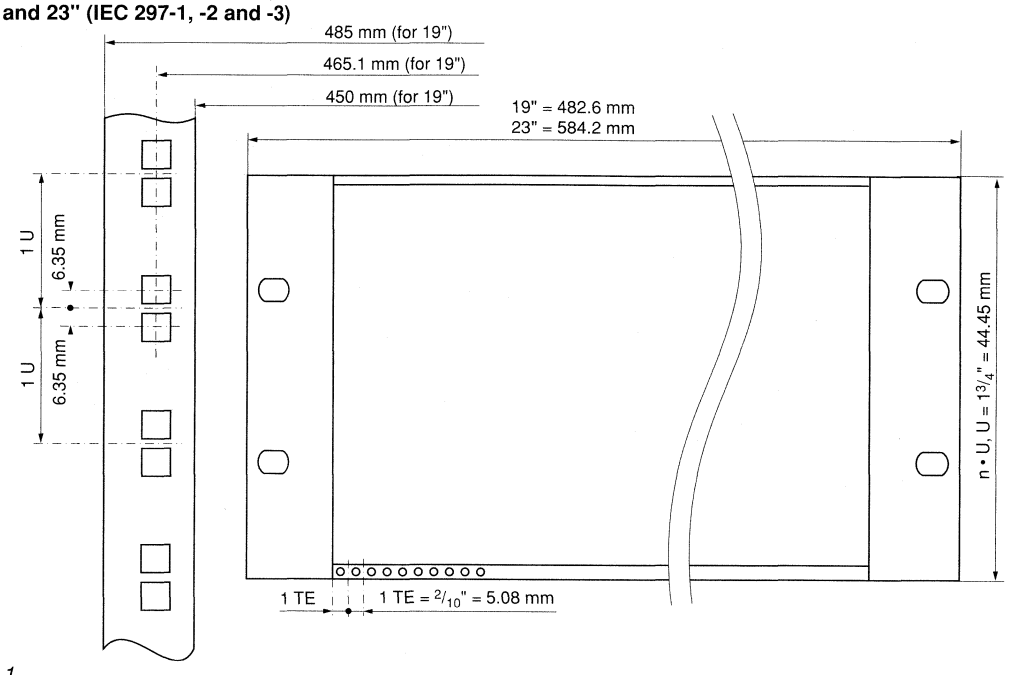



*Fig. 1*
*19" and 23" racking systems*

**Metric (IEC 917)**

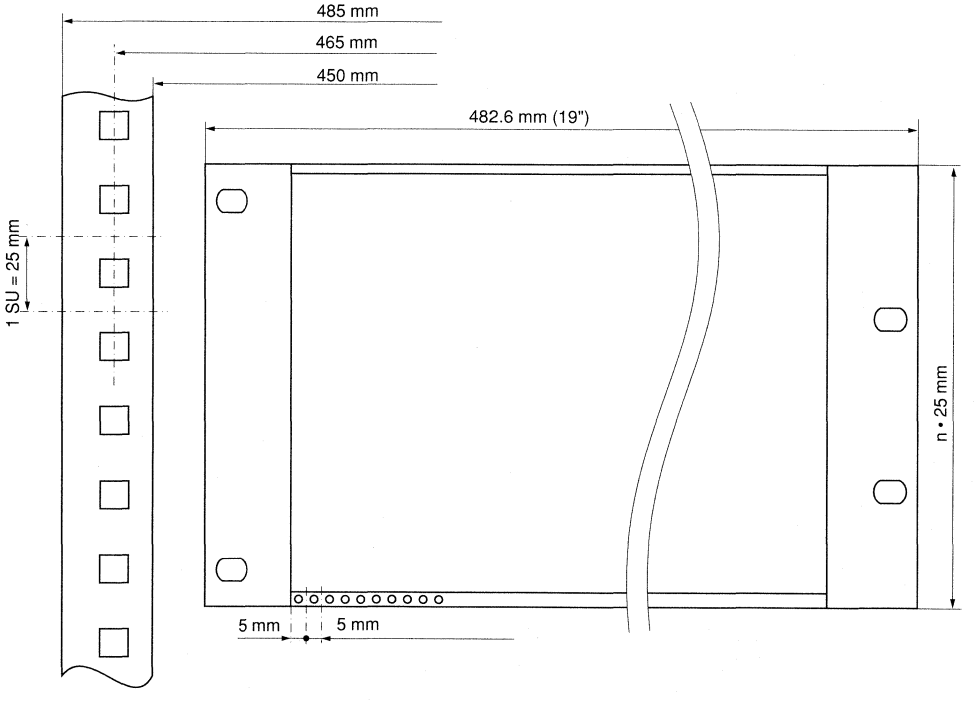



*Fig. 2*
*Metric racking systems*


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# Produktbetrouwbaarheid, MTBF

**Definities**

a) Kwaliteit
is de mate waarin een produkt tegemoet komt aan de behoeften van die specifieke toepassing.

b) Kwaliteitsborging
is het totaal van de activiteiten nodig voor het zekerstellen van de gewenste kwaliteit van een bepaald produkt

c) Projekt
is de wens tot het technisch realiseren van een behoeftenset die afgeleid is van een aantal gedefinieerde standaarden.

d) Configuratie
is het totaal van alle funktionele en fysieke kenmerken, beschikbaar per definitie in de datasheet en konstruktie.

e) Storing
van een specifieke eenheid is zijn onvermogen om te voldoen aan de gewenste eisen.

f) Fout
is het niet overeenkomen van een eenheid met de specifikaties als gevolg van een onvolmaaktheid tijdens het proces van ontwerp, ontwikkeling of produktie.

g) Onvolmaaktheid
is een klein gebrek dat niet of nauwelijks van invloed is op de eenheid in kwestie.

h) Defect
Een defect is een storing met gering effect op de vervulling van de gewenste funktie.

i) Toevallige fout
is een storing van een inherent zwak punt van een specifieke eenheid. Aanname: Het apparaat is niet overbelast. Toevallige storingen treden onregelmatig op en kunnen alleen voorspeld worden met kansberekening. In tegenstelling tot een toevallige storing wordt een storing veroorzaakt door een fout of slijtage onder invloed van veroudering.

j) Foutwaarde voor Elektronische Componenten
(vereenvoudigd model volgens MIL-HDBK 217).
Na een periode van kinderziektes neemt men een constante foutwaarde $\lambda$ aan.

$$\lambda = \frac{\text{aantal storingen [1/h]}}{\text{bedrijfsuren totaal}}$$

Opmerking: Mean Time Between Failure MTBF = $1/\lambda$ (uren) uitgaande van herstelbare apparaten en constante $\lambda$. Daarom is het zinvol te spreken over MTBF als de foutwaarde constant is en het toestel gerepareerd kan worden.
MTBF = horizontaal gedeelte van de bath-tube grafiek.
Andere definities:
MTTR = Mean Time To Repair
MTTF = Mean Time To Failure

k) Screening
Is een reeks van belastingen toegediend aan een voeding voor het opsporen van kinderziektes. Dit beschrijft het dalende gedeelte in de bath-tube grafiek.

l) Burn-in
Is het in bedrijf zijn van een voeding gedurende een vooraf bepaalde periode bij verhoogde temperatuur voor het stabiliseren van een aantal kenmerkende eigenschappen alsmede het opsporen van kinderziektes.

m) Derating
Is het opzettelijk onderbelasten van een in werking zijnde voeding of een component voor het reduceren van de storingskans.

n) Life time
Is de totale tijd van een niet repareerbare voeding totdat de eerste storing optreedt die aanleiding geeft tot reparatie. Beter bekend dan Levensduur is Mean Time To Failure.

o) Useful life
We verstaan onder useful life de totale levensduur van een te repareren voeding. Dit betreft het stijgende gedeelte in de grafiek.

p) Bath-tube grafiek
Deze beschrijft een empirisch model wat het storingsgedrag van (een of meerdere) te repareren voedingen laat zien of van een totaal van identieke niet repareerbare produkten.

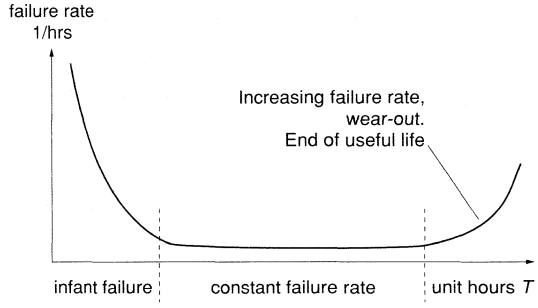



*Fig. 1*
*Levencyclus van storingsgradaties*

q) Betrouwbaarheid

De betrouwbaarheid van een specifiek produkt is de waarschijnlijkheid dat een bepaalde functie onder gegeven condities gedurende een voorspelde produkt bedrijfstijd haalbaar is.
Met de constante storingsgraad (voor elektronische componenten en systemen) kan de betrouwbaarheid $R$ voor tijdsduur $T$ als volgt worden berekend:

$R = e^{-\lambda T}$, (Exponentiële functie $\lambda$ = constant)
$= e^{-T/MTBF}$, ($T$ = bedrijfsuren)

De betrouwbaarheid vermindert exponentieel als functie van de tijd.

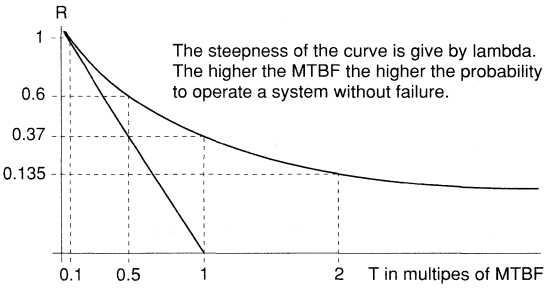



*Fig. 2*
*Betrouwbaarheid als functie van tijd*

r) Enkele elementen uit de Betrouwbaarheid theorie.
Zolang we gebruik maken van elektronische systemen (Melcher voedingen) kunnen we rekenen op een constante storingsgraad (na Burn-in)
Het MIL-handboek, wat een US-Army verzameling is van uitvalpercentages, beschouwt een constant uitvalspercentage l voor de beschreven componenten. Het is mogelijk om berekeningen te maken met niet constante storingsgraden. Dit is echter tijdrovend en gecompliceerd en algemene aannames zijn dan niet meer van toepassing.

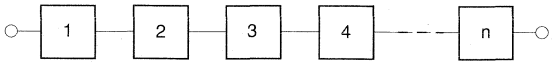
Uitvalpercentags:

| | |
|---|---|
| $\lambda$ (meest algemeen): | $10^{-6}$ [1/h], of |
| [FIT] (storing in tijd): | $10^{-9}$ [1/h], of |
| [%/1000]: | $10^{-5}$ [1/h] |

Voor niet herstelbare componenten:

$1/\lambda$ = MTTF (Mean Time to Failure)
= De statistisch bepaalde levensduur.

Voor systemen geldt:
$\lambda_{totaal}$ = de som van $\lambda$ voor alle componenten.




This means: Series model (non redundant)

$\lambda_{total} = \lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + ..... \lambda_n$

MTBF = (de empirisch bepaalde uitvalvrije periode)

De MTBF is een functie van belastingen, het aantal aan/uit schakelingen, complexiteit, enz...

**Omgevings en MTBF waarden voor Melcher produkten. (MIL-HDBK-217)**

Gb (Ground Benign):

Dit bevat laboratoriuminstrumenten, test apparatuur, medische apparaten, bedrijfsmachines, kantoorapparatuur en computersystemen.

Gf (Ground fixed) Betreft alle installaties zoals lucht verkeersleidingsystemen, radar en communicatie systemen in niet verwarmde gebouwen.

Gm (Ground mobile)

Hiertoe behoren mobiele communicatiesystemen, taktische geleideprojectiel ondersteunende apparatuur en vuurleidingssystemen geïnstalleerd op voertuigen met rupsband of voorzien van wielen.

Enkele redenen voor de hoge MTBF waarden voor Melcher produkten.

- continue selectie en evaluatie van eerste kwaliteit componenten;
- geoptimaliseerd ontwerp voor de laagst mogelijke belasting van de componenten;
- temperatuurverschil tussen behuizing en omgeving kleiner dan 24 °C

*Tabel 1: Produkt MTBF getallen volgens MIL-HDBK 217*

| Produkt | MIL-HDBK 217 | GB Ground Benign [hrs] | GF Ground Fixed [hrs] | | GM Ground Mobile [hrs] | | |
|---|---|---|---|---|---|---|---|
| | Issue | 40 °C | 40 °C | 70 °C | 40 °C | 50 °C | 70 °C |
| BSR 20 | C | | 100'000 | 46'000 | 28'000 | | 18'000 |
| P/NSR A01 40 V<br>80 V | D<br>D | | 160'000<br>150'000 | 70'000<br>65'000 | 45'000<br>41'000 | | 22'000<br>19'500 |
| PSB 80 V | F | 624'000 | 207'000 | 96'000 | | 46'000 | |
| PSC 80 V | D | 660'000 | 143'000 | 81'000 | | 68'000 | |
| PSK | E | | 138'000 | 35'000 | | 33'000 | |
| M 1000 -7R<br>D/EM 1000 -7R | E<br>E | 320'000<br>n.a. | 130'000<br>n.a. | 40'000<br>n.a. | | 35'000<br>39'000 | |
| M 2000 -7<br>D/EM 2000 -7 | E<br>E | 255'000<br>n.a. | 105'000<br>n.a. | 32'000<br>n.a. | | 28'000<br>31'000 | |
| M 3000-7 | E | 225'000 | 80'000 | 28'000 | | 25'000 | |
| K 1000 | F | 503'000 | 153'000 | 77'000 | | 51'000 | |
| CQ 1000, BQ 1000 | F | 588'000 | 196'000 | 96'000 | | 74'000 | |
| LT 1000 | F | 198'000 | 56'000 | 26'000 | | 20'000 | |
| ICR 1, IWR 1,<br>ICR 5, ICR 6 | | | 350'000<br>200'000 | | | | |
| ISR 5 | | | 250'000 | | | | |
| ISR 10 | | | 200'000 | | | | |

Voor details, zie ook de individuele produkt data.

# Meten en Testen

Dit hoofdstuk beschrijft de correcte meetopstelling voor de karakteristieken van een voeding

### Meet opstelling

In een juiste meetopstelling worden spanningsbron, belasting (-en) en meetapparatuur met aparte meetsnoeren uitgevoerd teneinde onderlinge beïnvloeding te voorkomen om aldus foutieve meetwaarden te vermijden. Het toepassen van de 4-punts meettechniek, ook wel de Kelvinmeting genoemd, wordt zeer aanbevolen.

**Men kan gebruik maken van een elektronische belasting of een variabele weerstand (rheostaat). Voor RFI-metingen is het gebruik van rheostaten verplicht.**

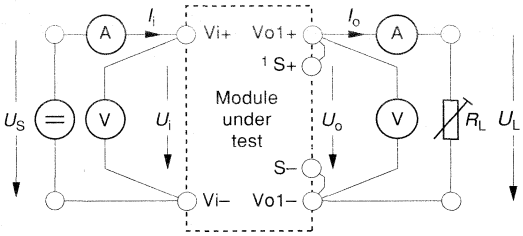
Men dient aandacht te besteden aan de inhibit-ingang van de module als er getest wordt omdat deze goed verbonden moet zijn met de relevante voedingspen om ervoor te zorgen dat de uitgang goed werkt.

De bron moet voldoende uitgangsvermogen kunnen leveren bij een laag niveau van de ingangsspanning van de voeding om de benodigde ingangsstroom te leveren. De negatieve ingangsweerstand van de voeding gedurende testen dient in beschouwing genomen te worden!

Alvorens met de metingen te starten dient men de ingangsspanning op de nominale waarde te brengen.

Spanningen en stromen kunnen het eenvoudigst gemeten worden door het volgen van de indexen van een van de metingsdocumenten, zoals op de volgende pagina staat afgebeeld. Alle waarden worden met 3 decimalen aangeduid.

De nauwkeurigheid van alle Volt- en Ampere meters moeten gelijk of beter zijn dan 0.1%.




[1] De sense-lijnen (indien aanwezig) moeten worden verbonden aan de daarbij behorende uitgangspennen of aan de belasting zoals beschreven in de overeenkomstige technische specifikaties.

*Fig. 1*
*Meetopstelling voor een voeding gedurende het testen.*

### Ingangsweerstanden $R_i$ en $r_i$

De ingangsweerstand $R_i$ is de verhouding tussen de ingangsspanning $U_i$ en de ingangstroom $I_i$ bij een uitgangsvermogen $P_o$:

$$R_i = \frac{U_i}{I_i}$$

De differentiële ingangsweerstand $r_i$ is de verhouding tussen de verandering van de ingangsspanning en ingangsstroom.

$$r_i = \frac{dU_i}{dI_i} = <0 \text{ (en daarom is } r_i \text{ negatief).}$$

Een negatieve ingangsimpedantie in combinatie met de impedantie van de voedingslijn kan aanleiding geven tot oscilleren.

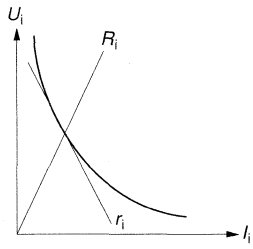



*Fig. 2*
*Definitie van de negatieve ingangsimpedantie.*

### IIngangsstroom.

De ingangsstroom $I_i$ neemt af bij verhoging van de ingangsspanning $U_i$ (bij constante belasting (-s) stroom $I_o$)

$$I_i = \frac{P_o}{\eta \cdot U_i}$$

Ruststroom bij nul-belasting $I_o = 0$

Geschakelde regelingen 5...20 mA (ingangsstroom van het control circuit)

DC-DC en AC-DC converters 5...20% van de maximum ingangsstroom. (interne elektronische voorbelasting)

Ingangsstromen bij geïnhibiteerde uitgangsspanning van voedingen met een hulpconverter:

$$I_i = \frac{2...7\ W}{U_i}$$

afhankelijk van het individuele type.

Ingangstromen met de uitgangen kortgesloten ($U_o = 0$):

Alle voedingen 5...20% van maximale ingangstroom bij $I_o$ = nominaal.

### Qualification measurements

The graphs on page 1 - 25 help to make qualification measurements for any power supply. Simply operate the unit at the several operating conditions for input voltage and output current as indicated in the graph. Take measurements for voltage and current and do the corresponding calculations.

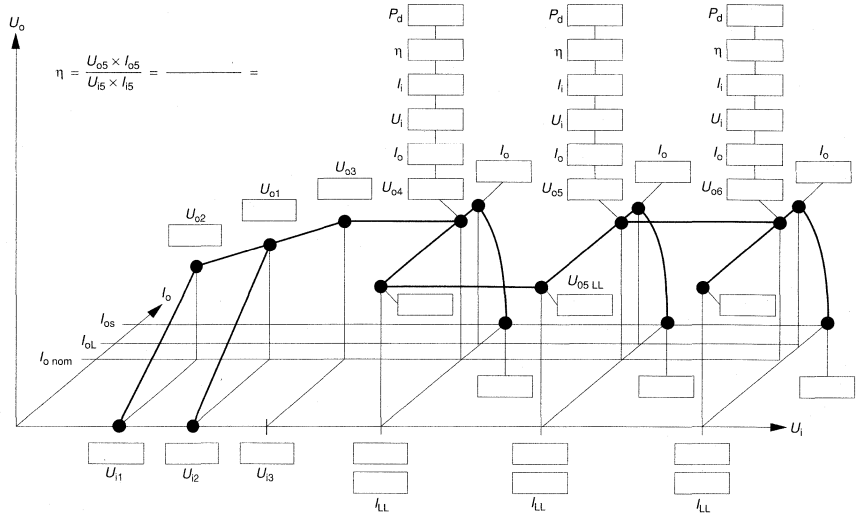



*Fig. 3*
*Statische metingen van een voeding met een uitgang.*

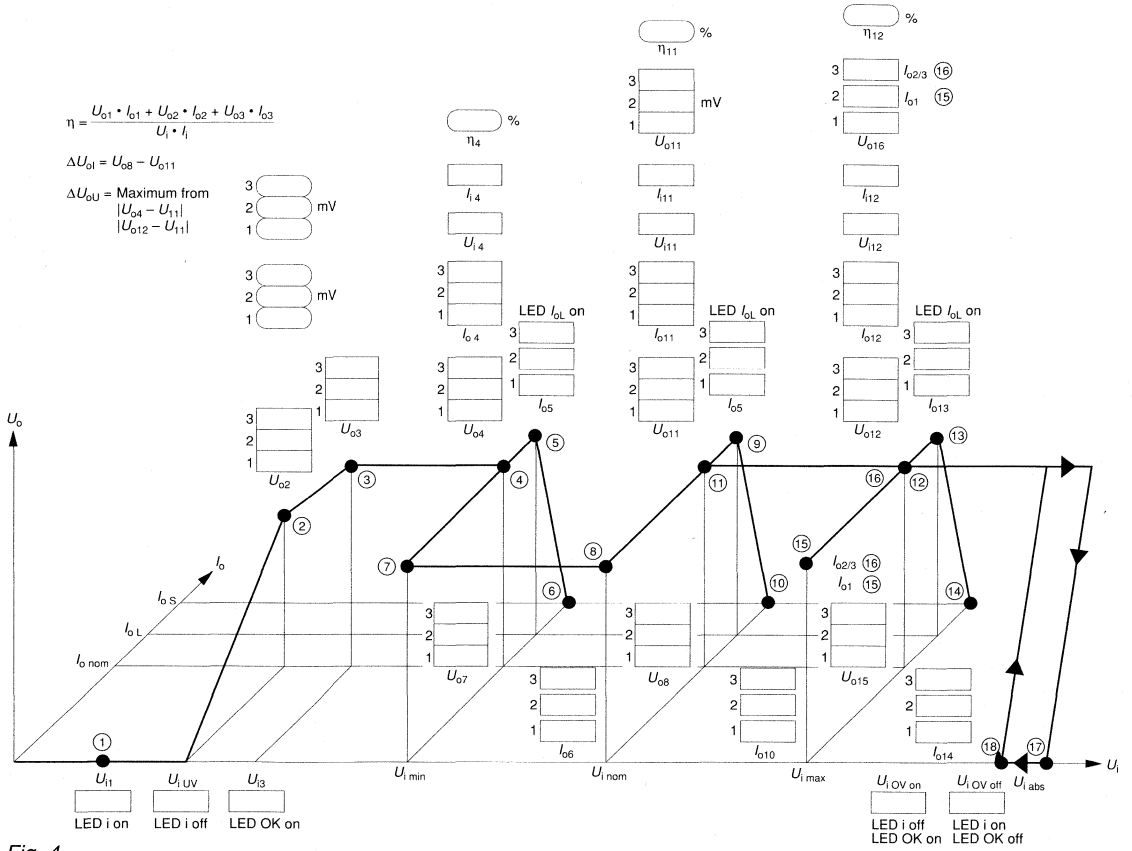



*Fig. 4*
*Statische metingen aan een voeding met meerdere uitgangen.*


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# Verklarende woordenlijst Voedingen



**Ambient temperature:**

De omgevingstemperatuur van een voeding, in het algemeen de kamertemperatuur.

**Bandwidth:**

Gebaseerd op de veronderstelling dat een voeding gezien kan worden als versterker, is de bandbreedte die frequentie waarbij de spanningsversterking met 3 dB gedaald is. De bandbreedte is een belangrijke bepalende faktor van transiëntgedrag en uitgangsimpedantie.

**Bleeder resistor:**

Een weerstand die parallel geschakeld is met een filtercircuit om capaciteiten te ontladen als de voeding is uitgeschakeld.

**Breakdown Voltage:**

Zie *Isolation*

**Brownout:**

De toestand gedurende periodes van piekbelasting waarbij elektrische voorzieningen de netspanning met 10 tot 15% kunnen verlagen.

**Brownout protection:**

De mogelijkheid van een voeding om te blijven werken binnen zijn specifikaties gedurende de brown-out tijd.

**Brug:**

(1) gelijkricht circuit met 2 (halve brug) of 4 diodes (volledige brug).

(2) Converter of schakelend element van een geschakelde voeding opgebouwd met 2 transistoren (halve brug) of 4 transistoren (volledige brug).

**Brute-force supply:**

De meest elementaire uitvoering van een voeding. Deze voeding levert een niet geregelde DC-uitgangspanning.

**Burn in:**

De periode direct nadat een voeding voor de eerste keer wordt aangezet. De periode is gekarakteriseerd door een relatief hoog en afnemend uitvalpercentage.

**Bus:**

(1) het systeem van geleiders (draad, kabel, koperen geleiders) dat wordt gebruikt voor het vermogenstransport van de voeding naar de belasting.

(2) Een communicatiestructuur gebruikt voor het beheersen van verscheidene instrumenten en subsystemen. (bijvoorbeeld, IEEE-488 bus)

**Carry-over:**

Zie *hold-up time*

**Centering:**

De afwijking van een uitgang van de nominale uitgangsspanning veroorzaakt door ontwerp limitaties en variaties in het produktieproces. Centering wordt uitgedrukt als verhouding tussen de spanningsverandering ten opzichte van de nominale spanning (in procenten).

**Chopper:**

Zie *Inverter.*

**Common-mode noise:**

Die ruis component gemeten tussen de uitgangsgeleider en een elektrisch referentiepunt meestal aarde.

**Constant current:**

Een voeding die ongeacht veranderingen in de belasting een constante stroom levert.

**Constant current limiting circuit:**

Stroom begrenzingscircuit dat er voor zorgt dat de uitgang op een bepaalde maximale stroom wordt vastgehouden wanneer er een overbelasting wordt waargenomen.

**Constant voltage:**

Een voeding die ongeacht veranderingen in de belasting een constante spanning levert.

**Convection:**

Het overbrengen van warmte energie in een gas of vloeistof door middel van stromen als resultaat van ongelijke temperaturen.

**Converter:**

(1) Een apparaat dat DC-vermogen levert als energie wordt toegevoegd uit een DC-bron.

(2) Gedeeltes van een schakelende voeding die de werkelijke vermogensconversie en uiteindelijke gelijkrichting bewerkstelligen.

**Cooling:**

Het verwijderen van hitte, die in een voeding gegenereerd wordt door transformeren, gelijkrichten, regelen en filteren. Het kan tot stand worden gebracht met behulp van radiatie, convectie en geforceerd koelen met lucht of vloeistof.

**Cross regulation:**

In een voeding met meerdere uitgangen kan een belastingsvariatie in één van de uitgangen een spanningsverandering in één van de andere doen ontstaan. De verhouding tussen de ingangsverandering en de nominale waarde heet cross regulation.

**Crowbar:**

Type overspanningsbeveiliging waarbij een SCR direct over de aansluitingen van de uitgangen geplaatst wordt.

**CSA (Canadian Standard Association):**

Een onafhankelijke Canadese organisatie die algemene veiligheidtesten verricht. Qua functie gelijk aan de Underwriters Laboratories in de Verenigde Staten.

**Current limiting circuit:**

Een op zichzelf staand circuit ontworpen om overbelasting van een constante spanningsvoeding te voorkomen. Het kan de vorm aannemen van constante, terugslag of cycle by cycle stroombegrenzing.

**Cycle-by-cycle current limiting circuit:**

Stroombegrenzingscircuit dat direct de uitgangstroom tot een bepaald minimum reduceert wanneer een overbelasting optreedt.

**Derating**

Een reductie van een bepaalde parameter voor het compenseren van een verandering in één of meer andere parameters. In voedingen, daalt het maximale uitgangsvermogen in het algemeen bij toenemende temperatuur.

**Diëlectrical withstand voltage:**

Zie *Isolation*

**Drift:**

Zie *Stability*

**Dynamic load:**

Een belasting die snel verandert van het ene naar het andere niveau. In een goede specifikatie wordt de totale verandering alsook de mate van verandering vermeld.

**Efficiency:**

De verhouding tussen uitgangs- en ingangsvermogen. In het algemeen gemeten bij volledige belasting en standaard lijncondities. Bij geschakelde voedingen met meerdere uitgangen kan het rendement een functie zijn van het totale uitgangsvermogen en de verdeling ervan over de uitgangen.

**EMI (Elektromagnetical interference)**

Ook wel radio-frequente interferentie genoemd (RFI), EMI is ongewenste hoog-frequent energie veroorzaakt door de schakelende transistoren, uitgangs-gelijkrichters en zenerdiodes in schakelende voedingen. EMI kan uitgestraald worden of overgedragen worden via de in- of uitgangslijnen.

**ESR (equivalent series resistor)**

De weerstandswaarde in serie met een ideale (verlieslose) condensator. In het algemeen geldt dat des te lager de ESR des te hoger de kwaliteit van de condensator en des te beter de geschiktheid als filtercomponent. ESR is een van de voornaamste (cq doorslaggevende) determinanten voor de bepaling van rimpelspanning in schakelende voedingen.

**Faraday shield :**

Een elektrostatische bescherming rond een transformator, ontworpen om capaciteiten tussen de windingen te verminderen. Dit resulteert in minder common- en differential noise aan de uitgang van de voeding.

**Federal Communications Commision (FCC):**

Amerikaanse federale organisatie waarvan de nieuwe EMI limieten, ontwerp en produktie van digitale elektrische systemen en daaraan gerelateerde halffabrikaten, zoals voedingen, beïnvloeden

**Ferro-resonance:**

Het principe gebruikt in een eenvoudige open-loop (non-feedback) spanning gestabiliseerde voeding.

**Filter:**

Een frequentie gevoelig netwerk dat ongewenste ruis en rimpel componenten van een gelijkgerichte voeding verzwakt.

**Flyback-converter:**

Configuratie van een schakelende voeding gebruikmakend van een transistor en een flyback-diode.

**Foldback current limiting circuit:**

Stroombegrenzingscircuit dat langzaam de uitgangsspanning tijdens overbelasting vermindert totdat een bepaald minimum niveau is bereikt tijdens een kortsluiting.

**Forward converter:**

Configuratie van een schakelende voeding gebruikmakende van een enkele transistor.

**Frequency changer:**

Vermogens-conversie-apparatuur die AC elektrisch vermogen transformeert van de ene naar de andere frequentie zonder andere karakteristieke eigenschappen te beïnvloeden.

**Full bridge converter:**

Configuratie van een geschakelde voeding met vier transistoren gebruikt om hoge vermogens te verwerken.

**Full wave rectifier:**

Gelijkrichtcircuit dat beide fases van een AC signaal gelijkricht.

**Ground loop:**

Een feedback probleem veroorzaakt door twee of meer circuits die samen gebruik maken van een gemeenschappelijke lijn, meestal een gemeenschappelijke massaleiding. Spanningsstijgingen of -dalingen in deze leiding veroorzaakt door een circuit kunnen capacitief, inductief of ohms gekoppeld worden naar andere circuits via de gemeenschappelijke lijn. Bij voedingen kan dit probleem gereduceerd worden door het gebruiken van single-point aarding.

**Half-bridge converters:**

Voedingsconfiguratie met twee transistoren gebruikt in toepassingen voor gemiddelde vermogens.

**Half-wave rectifier:**

Gelijkrichter met een diode die slechts één fase gelijkricht van het AC signaal.

**Head room:**

De „head room" in een lineaire regeling, is het verschil tussen de secundaire spanning toegediend door de vermogenstransformator bij nominale ingangsspanning en de geregelde uitgangspanning. Head Room is nodig om een correcte regeling te garanderen bij maximale belasting en lage ingangsspanning.

**Hi-pot (high potential voltage):**

De mogelijkheid van een voeding om een hoog spanningspotentiaal te weerstaan, tussen de ingangsaansluitingen en massa of tussen ieder paar ingangs- of uitgangsaansluitingen. Deze specifikatie is belangrijk met betrekking tot veiligheidseisen en is gedeeltelijk afhankelijk van de mechanische constructie van de voeding.

**Holdup time:**

De totale tijd dat iedere uitgang binnen zijn regelingsbereik blijft nadat de aangesloten ingangsspanning afgeschakeld is. Gekarakteriseerd bij volle belasting en nominale lijnspanning.

**Hybrid supplies:**

Een voeding die twee of meer type regeltechnieken combineert, zoals ferroresonantie in combinatie met lineaire resonantie of schakelend in combinatie met lineaire resonantie.

**Hybrid thermal design:**

Een voeding die gebruik maakt van de combinatie convectie en geforceerde luchtkoeling.

**Inhibit:**

De mogelijkheid om op afstand de uitgang van een voeding te schakelen.

**Input surge current:**

Zie *Inrush current*

**Input voltage range:**

Het bereik van lijnspanningen waarvoor de voeding gespecificeerd is.

**Inrush current:**

Een sterke toename van de ingangsstroom die voorkomt in schakelaars en nu en dan in lineaire regelingen, bij het voor de eerste maal aanzetten van een voeding.

**Instantaneous current limiting circuit:**

Zie *Cycle-by-cycle current limiting circuit.*

**Interaction:**

Totale statische regeling van een voeding wanneer lijn- en belastingsveranderingen tegelijkertijd optreden.

**International Commision on Rules for the Approval of Electric Equipment (CEE):**

Een Europese veiligheidsinstantie waar de Verenigde Staten alleen als observeerder participeert.

**International Electrotechnical Commision (IEC):**

Een internationale veiligheidsinstantie waarvan het hoofdkantoor gevestigd is in Géneve, Zwitserland.

**Inverter:**

(1) Een component die een AC-spanning levert wanneer een DC-spanning wordt toegediend. Inverters kunnen frequentie, amplitude of puls breedte gemoduleerd zijn voor het variëren van de uitgangsspanning.

(2) De chopper sectie van een geschakelde voeding.

**Isolation:**

De elektrische scheiding tussen twee punten. Het kan worden uitgedrukt in termen van spanning (breakdown), stroom (galvanisch) of weerstand en/of capaciteit (impedantie). In voedingen is het belangrijk de isolatie tussen in- en uitgang te maximaliseren.

**Koellichaam:**

Component gebruikt voor het afleiden en verspreiden van de door de elektronische componenten gegenereerde warmte.

**Leakage current:**

Stroom die vloeit tussen de uitgangsaansluitingen en chassis die toe te schrijven is aan het niet ideaal zijn van componenten en onvolmaaktheden in het elektrotechnisch ontwerp. Het moet zeer strak gecontroleerd worden om te blijven voldoen aan de veiligheidseisen zoals UL en VDE.

**Line frequency regulation:**

De variatie van een uitgangsspanning veroorzaakt door een verandering in de lijn ingangsspanning, waarbij alle andere factoren constant gehouden worden. Dit effect is verwaarloosbaar bij het schakelen van lineaire voedingen maar het is een kritieke specifikatie van ferro-resonantie voedingen.

**Line regulation:**

De variatie in een uitgangsspanning is te wijten aan een verandering in de ingangsspanning, waarbij alle ander factoren constant gehouden worden. Lijn-regeling wordt uitgedrukt als het maximum veranderings-percentage in de uitgangsspanning als de ingangsspanning varieert over zijn gespecificeerde bereik.

**Line regulator:**

Vermogens conversie-apparatuur die de mate van regeling, filterruis en/of spanningsfluctuaties bij toegediend AC vermogen verandert.

**Lineair regulator:**

Een algemene spanningsstabilisatietechniek waarbij de controlerende component (vaak een transistor) in serie of parallel geplaatst wordt met de voeding om de spanning te regelen over de belasting. De term 'lineair' is hier gebruikt omdat de spanningsval over het controlerende component continu varieert om niet gebruikt vermogen te dissiperen.

**Load:**

Voor spanningsgeregelde voedingen is de belasting de uitgangsstroom.

**Load regulation:**

Variatie van de uitgangsspanning is toe te schrijven aan een verandering in de uitgangsbelasting van nul naar maximale belasting waarbij alle factoren constant gehouden worden.

**Logic enable:**

Het vermogen om een voeding aan en uit te schakelen met een TTL-signaal. Een logisch 'laag' signaal schakelt de voeding uit; een logisch 'hoog' signaal schakelt de voeding in. Zie ook *Logic inhibit.*

**Logic high:**

Een TTL spanning hoger dan 2.3 Volt met een maximum van 5.5 Volt. Ook bekend als „logisch 1".

**Logic inhibit:**

De mogelijkheid om een voeding aan en uit te schakelen met behulp van TTL signalen. Logisch „laag" zet de voeding aan. Logisch „hoog" schakelt de voeding uit. Zie ook *Logic enable.*

**Logic low:**

TTL spanningen lager dan 0.8 volt. Ook bekend als logisch „0".

**Margining:**

Het vermogen om de uitgang handmatig aan te passen, gebruikelijk tot 5% van nominaal. Deze mogelijkheid wordt gebruikt bij systeem testen.

**Master:**

Het component in een systeem van onderling verbonden componenten dat controle uitoefent over de uitgangen van een of meer „slave" componenten. Een dergelijk systeem wordt algemeen toegepast om te zorgen voor gelijke verdeling van de belasting van parallel aangesloten voedingen.

**Modulair:**

Een fysische beschrijving van een voeding, samengesteld uit een aantal sub-secties, zoals een input-,vermogens- en filtermodule. Modulaire samenbouw neigt tot het verlagen van de MTBF.

**MTBF (Mean Time Between Failure):**

Een maatstaf van betrouwbaarheid. Het betrouwbaarheidinterval wordt berekend volgens de procedures van MIL-HDBK 217.

**MTTR (Mean Time to Repair):**

De gemiddelde tijd nodig voor het repareren van een voeding. Het is een resultaat van zowel elektrische als mechanische ontwerpfactoren.

**Multiple output supply:**

Een voeding die twee of meer uitgangsspanningen levert.

**Noise:**

Ruis is de niet periodieke, toevallige component van ongewenste deviaties in de uitgangsspanning. Meestal gespecificeerd in combinatie met een rimpelspanning. Zie *PARD* en ook *Rimple.*

**Nominal output voltage:**

De gewenste, ideale spanning van een uitgang.

**Off-line switcher:**

Een circuit configuratie vaak gebruikt in PWM schakelaars waarbij de ingangsgelijkrichter en filtersectie direct geplaatst is na de AC ingangslijn.

**Open-frame construction:**

Een constructietechniek vaak gebruikt in OEM voedingen waar de voeding niet is voorzien van een afscherming. Het kan eenvoudigweg een printplaat zijn of een printplaat gemonteerd aan een metalen chassis zonder behuizing.

**Operating temperature:**

Het temperatuurbereik waarbinnen een voeding moet functioneren binnen de gespecificeerde limieten.

**Opto-isolator:**

Onderdeel dat voorziet in elektrische isolatie en signaaloverdracht. Elektrische signalen worden omgezet naar optische, om daarna weer naar elektrische signalen getransformeerd te worden. Dit wordt bereikt met behulp van een licht -emitterende-diode in dichte nabijheid met een fototransistor. Opto isolatoren worden gebruikt in de feedback loop om op deze manier elektrischeisolatie te verkrijgen tussen in- en uitgang van de voeding.

**Output impedance:**

De waarde van een fictieve belasting in serie met een ideale spanningsbron die dezelfde AC-spanning zou leveren over de uitgangsaansluitingen als waargenomen bij een bepaalde amplitude en frequentie van een veranderende stroom.

**Overcurrent protection:**

Zie *Current Limiting circuit.*

**Overshoot:**

De mate waarin een uitgang boven zijn maximale waarde uitkomt als reactie op een snelle verandering in de belasting of ingangsspanning, gemeten als een percentage van de nominale waarde. Het is een belangrijke waarde bij turn-on alsook bij het volgen van een verandering van belastings- of lijnspanning.

**OVP (overvoltage protection):**

Een beschermingsmechanisme voor het belastingscircuit dat niet toelaat dat de uitgangsspanning een vooraf ingesteld niveau overschrijdt. In de meeste gevallen wordt de uitgangsspanning tijdelijk vermindert tot een lage waarde. Het ingangsvermogen wordt gebruikt om de uitgangsspanning terug te brengen op het vorige niveau.

**Parallel operation:**

Het vermogen van een voeding om op een dusdanige manier verbonden te worden dat de stroom van corresponderende uitgangen gecombineerd kan worden naar één belasting.

**PARD:**

Afkorting voor „periodic and random deviation" en gebruikt als specifikatie term voor rimpel en ruis. Rimpel is een ongewenste hoeveelheid uitgangs-harmonischen (periodiek) gerelateerd aan de ingangsfrequentie naar de ingangslijn en naar iedere intern gegenereerde schakelfrequentie. Ruis is de ongewenste niet periodieke uitgangs deviatie.

**Pass element:**

Het actieve circuitelement, typisch een transistor, dat het uitgangsvermogen van een lineaire voeding vormt.

**Peak-changing:**

Een verhoging van spanning over een condensator veroorzaakt door het opladen van de condensator tot het maximum in tegenstelling tot de rms waarde van de ingangsspanning. Dit gebeurt in het algemeen wanneer een condensator een hoge ontladingsweerstand over de aansluitingen heeft en zich veel rimpel en ruis of spikes op de ingangslijn bevindt. In een geschakelde regelaar, beïnvloedt deze parameter minimale belastingscondities (ontladings weerstand) op iedere uitgang. Dit is vereist om de regeling in stand te houden.

**Peak transient output current:**

De maximale piek-stroom die geleverd kan worden aan een belasting gedurende transiënt belastings condities, zoals het starten van een elektro-motor.

**Phase controlled modulation:**

Een circuit gebruikt in schakelende regelingen waar de werk-frequentie constant gehouden wordt (typisch 50 Hz lijnfrequentie). De fasehoek -waarbij de controlerende elementen aan staan is gevarieerd, waardoor zowel lijn- als belastingsveranderingen met minimale dissipatie worden gecontroleerd.

**Pin Fins:**

Type koellichaam dat gebruik maakt van pinnen in plaats van conventionele geëxtrudeerde vinnen.

**Post regulator:**

Meestal een lineaire regeling gebruikt aan de uitgang van een schakelende of ferro voeding om de algemene belastings-regeling te verbeteren.

**Power conversion:**

Het omzetten van elektrisch vermogen van gemiddelde kwaliteit geleverd door voorzieningen om het aan te passen naar de behoeftes van elektronische circuits.

**Power factor:**

De ratio van het werkelijk- tot het schijnbaar vermogen. De arbeidsfactor is dat gedeelte van de stroom dat in fase is met de spanning en de bijdraagt aan het gemiddelde vermogen.

**Power fail detect:**

Een circuit dat de DC-spanning over de ingangscondensatoren van een schakelende voeding controleert. Als de ingangslijn wegvalt detecteert het een abnormaal laag DC-niveau over de condensatoren en voorziet in een geïsoleeerd TTL uitgangssignaal dat waarschuwt bij dreigend inzakken van het vermogen.

**Power supply:**

De algemeen gebruikte term voor elektronische apparaten die DC-uitgangsspanningen leveren als ze op een AC-bron worden aangesloten.

**Pre-regulator:**

Een regelingscircuit (meestal een niet-dissipatief type) die in een lijn-geregelde uitgang voorziet die dan wordt bewerkt door een tweede regeling, de na-regeling, die de belastings regeling levert.

**Programming:**

De mogelijkheid de spanning van iedere uitgang te controleren

**Pulse width modulation (PWM):**

Een circuit gebruikt in geschakelde voedingen waar de schakelfrequentie constant gehouden wordt en de pulsbreedte varieert. De lijn en belastingsveranderingen worden tegelijkertijd gecontroleerd met minimale dissipatie.

**Push-pull converter:**

Gebruikt in schakelende voedingen waar het voornaamste schakelcircuit gebruik maakt van twee transistoren geschakeld in Push-Pull. Het belangrijkste voordeel is eenvoud van het ontwerp.

**Rated pulse power**

Het maximum piekvermogen dat kortstondig door een voeding geleverd kan worden door de voeding op basis van een puls. De Rated Pulse Power middelt gewoonlijk uit tot het maximale continue uitgangsvermogen.

**Recovery time:**

De door een over- of undershoot transiënt benodigde tijd, gebruikt bij een gestabiliseerde uitgang om binnen de gespecificeerde grenzen te komen.

**Redundance:**

De mogelijheid om voedingen in parallel te schakelen zodat als er één uitvalt de ander voldoende vermogen kan genereren aan de belasting. Deze methode wordt gebruikt in systemen wanneer uitval van een voeding niet mag voorkomen.

**Reference:**

Een bekende stabiele spanning waarmee de uitgangspanning vergeleken wordt om deze te stabiliseren.

**Regulator:**

Dat gedeelte van de voeding wat de uitgang controleert. In de meeste gevallen stabiliseert de regulator de uitgangspanning op een vooraf ingestelde waarde.

**Remote on-off:**

Zie *Inhibit.*

**Remote sensing:**

Een verschuivingsmethode waarbij het regelingspunt wordt verlegd van de uitgangsaansluitingen naar de belasting. Hierdoor worden spanningsvallen in de vermogens-bus gecompenseert

**Response time:**

De hoeveelheid tijd (ms) die benodigd is door de uitgang om zich binnen enige toleranties te stabiliseren, bij een verandering in de belasting.

**Return:**

Een arbitraire naam voor de gemeenschappelijke aansluitingen van alle uitgangen. Het geleidt de retourstromen van alle uitgangen.

**Reverse voltage protection:**

De mogelijkheid van een voeding om een tegengestelde polariteit te verdragen op de uitgangsaansluitingen.

**RFI (radio frequency interference):**

Zie *EMI*

**Ripple:**

De periodieke AC ruis component van de uitgangspanning. Zie *PARD*

**Schottky diode:**

Een halfgeleider met een kleine doorlaatspanning (0.6 Volt) en een snelle hersteltijd. Deze diode is vooral nuttig bij hoge stromen, lage spanningen (typisch 5 Volt), waar geringe verliezen en hoge schakelsnelheden belangrijk zijn.

**Second breakdown:**

De meest voorkomende storing in de vermogenstransistoren van schakelaars; het wordt veroorzaakt door het tegelijkertijd optreden van hoge spannings- en stroomniveaus als de transistoren uitgeschakeld worden. De invloeden zijn onomkeerbaar, bijna ogenblikkelijk en fataal. Het kan gecontroleerd worden door een goed systeemontwerp.

**Semi-regulated output:**

Een neven uitgang op een voeding met meerdere uitgangen die alleen lijn-regulatie heeft.

**Sequencing:**

Het tijd vertraagd aan en uit schakelen van meerdere voedingen.

**Series regulator:**

Een lineaire regelaar waarvan het actieve schakelement in serie staat met de belasting.

**Short-circuit protection:**

Zie *Current limiting circuit.*

**Shunt regulator:**

Een lineaire voeding waarbij het actieve schakelelement (transistor) parallel geschakeld is met de belasting.

**Slave:**

Het onderdeel in een master-slave schema dat door het master onderdeel gecontroleerd wordt. Zie *Master.*

**Snubber:**

Een netwerk dat bestaat uit een weerstand, condensator en een diode die in een schakelende voeding worden gebruikt om hoge energie transiënten op te vangen en gevoelige componenten te beschermen.

**Soft start:**

Inschakelen van een voeding waarbij de inschakelstroom vertraagd zijn maximale waarde bereikt.

**Stability:**

De verandering van de uitgangsspanning bij konstante belasting, ingangsspanning en temperatuur na een bepaalde tijd. Dit effect staat in relatie met de inwendige temperatuur en veroudering.

**Static load:**

Een belasting die constant blijft gedurende een bepaalde tijd. Meestal gespecificeerd als een percentage van de volledige belasting.

**Stefan-Boltzmann law:**

Een thermodynamische wet die de mate van emissie beschrijft, uitgestraald door het oppervlak van een lichaam.

**Stress-aging:**

Het proces waarbij een volledige voeding onderworpen wordt aan een verscheidenheid van belastingen ten einde burn-in fouten versneld te laten optreden.

**Switching frequency:**

De frequentie waarop de ingangsspanning van een geschakelde regelaar of DC-DC converter wordt geschakeld.

**Switching regulator:**

Een hoog rendement DC-DC converter bestaande uit: spoelen en condensatoren om energie op te slaan. Alsmede schakelelementen (meestal transistoren of SCR's) die openen en sluiten indien nodig om de spanning te regelen over een belasting. De schakelverhouding wordt gecontroleerd door een terugkoppelcircuit om de uitgang te stabiliseren.

**Temperature coefficient:**

Het gemiddelde percentage waarmee de uitgangsspanning verandert per graad temperatuursverandering bij gelijkblijvende belasting en ingangsspanning.

**Thermal protection:**

Beveiliging via een thermische schakelaar die de funktionaliteit van een voeding onderbreekt indien de inwendige temperatuur een vooraf ingestelde waarde overschrijdt.

**Thermal regulation:**

Zie *Temperature coefficient*

**Thermistor:**

Een component met een relatief hoge elektrische weerstand bij een lage temperatuur en bijna geen weerstand bij werkingstemperatuur. Thermistors worden soms gebruikt om de inschakelstroom van off-line regelaars te beperken.

**Transformer:**

Een magnetische component die AC spanningen omzet in willekeurige spanningen. Een ideale transformator is verliesloos. Er wordt geen energie in opgeslagen en hij vraagt geen magnetische stroom.

**Transient:**

Een tijdelijke en kortstondige verandering van een gegeven parameter. Meestral geassocieerd met ingangsspanning of belastingsparameters.

**Transient response time:**

De tijd nodig voor de uitgang om zich te herstellen binnen een bepaald tolerantiebereik, normaal volgend op een verandering van de belasting.

**UL (Underwriters Laboratories):**

Een onafhanklijke, non-profit organisatie voor het uitvoeren van veiligheidstesten in de Verenigde Staten. In sommige toepassingen is voor de apparatuur UL-erkenning vereist.

**Undershoot:**

De mate waarin een uitgangsspanning beneden een bepaalde waarde valt bij snelle verandering van de belasting.

**UPS (Uninterruptible Power Supply):**

Een toestel ontwikkelt om vermogen te leveren bij een kortstondige of langdurige onderbreking van de AC netspanning. Dikwijls werken deze toestellen met een AC netspanning of een DC (batterij) back-up ingang.

**VDE (Verband Deutscher Elektrotechniker):**

Een Duitse organisatie voor het uitvoeren van veiligheidstesten; gelijkaardig aan de UL in de Verenigde Staten.

**Warm up drift:**

De verandering van de uitgangsspanning die optreedt gedurende de tijd dat een koude voeding wordt ingeschakeld tot ongeveer 30 minuten na inschakeling. Warm-up drift wordt gemeten bij constante belasting, ingangs-spanning en omgevingstemperatuur. De oorzaak van de warm-up drift ligt bij de componenten die hun thermisch evenwicht moeten bereiken.

**Warm up time:**

De tijd die de voeding nodig heeft om, na inschakelen, zijn thermisch evenwicht te bereiken bij een constante belasting. Gewoonlijk is de warmup tijd 30 minuten.

1

# Terminologie en Produkt-Lijnen

Spanningsregelaars van Melcher zijn gebaseerd op de schakelende technologie. Omdat het produktpakket uit meer dan 3000 typen bestaat, heeft Melcher een specifieke terminologie om al deze produkten te benoemen.

Melcher verdeelt de DC-DC convertors in 2 klassen afhankelijk van een isolatie tussen ingang en uitgang :

- Schakelende regelaars staan algemeen bekend als DC-DC converters zonder isolatie tussen ingang en uitgang. Eén van de voedingslijnen is doorverbonden. Dit type converter heeft geen galvanische scheiding tussen de bron en de belasting.
- DC-DC converters voorzien in een volledige isolatie tussen ingang en uitgang en hebben dus geen doorverbinding. Sommige typen leveren klasse II dubbele isolatie. Deze hebben geen aarding nodig en garanderen volledige veiligheid volgens de internationale standaard IEC 950/EN 60950.

AC-DC converters voorzien in een volledige isolatie tussen ingang en uitgang en hebben dus geen doorverbinding. De meeste AC-DC converters hebben dezelfde mechanische constructie als DC-DC converters van hetzelfde vermogen. Hierdoor kan een identiek systeem worden gebouwd voor zowel AC als DC spanningen. Sommige typen leveren klasse II dubbele isolatie. Deze hebben geen aarding nodig en garanderen volledige veiligheid volgens de internationale standaard IEC 950/EN 60950.

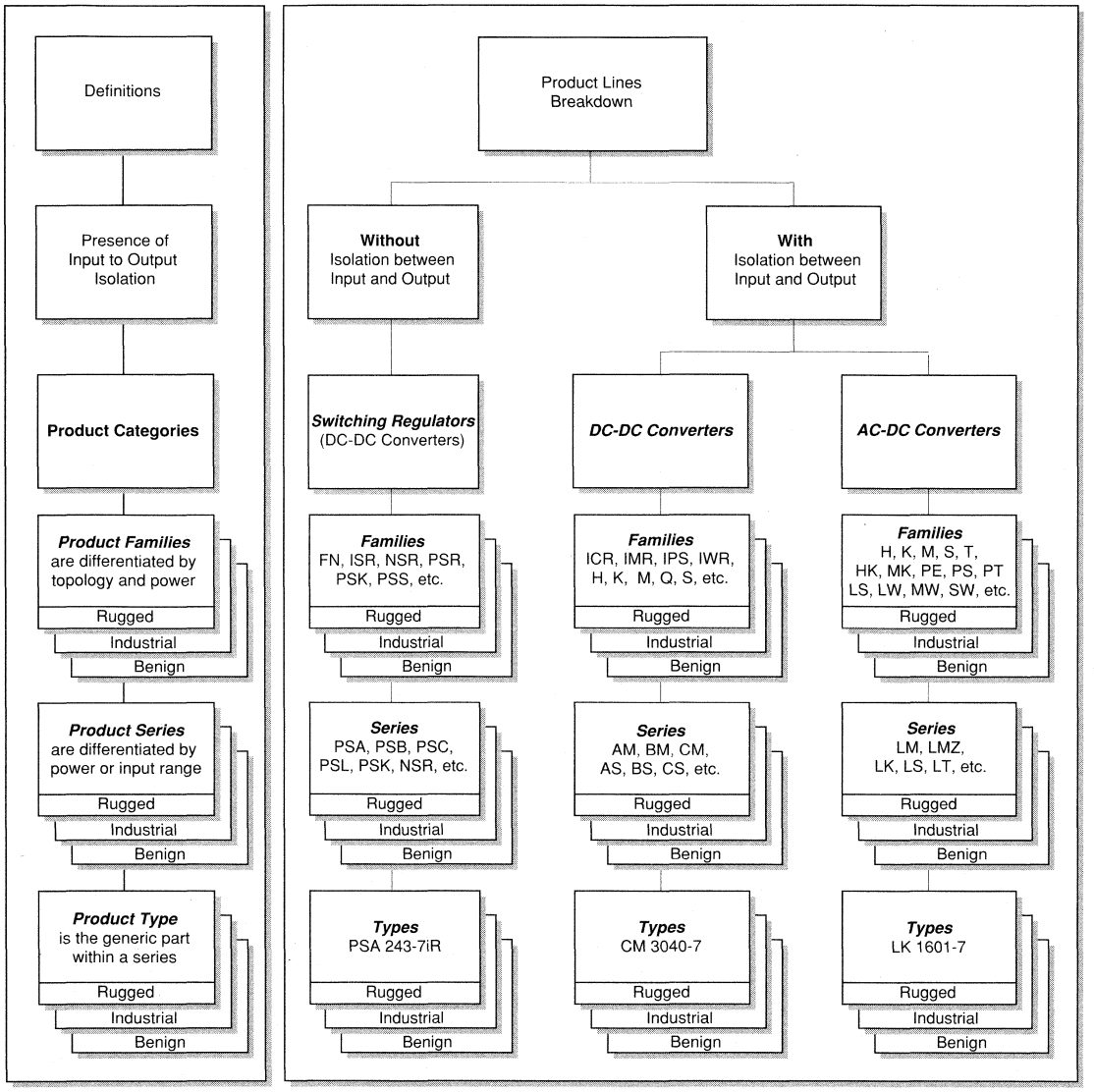



*Fig. 1*
*Produktlijnen*

# 2 Switching Regulators <5 A

## 2.1 Rugged Environment



## 2.2 Industrial Environment

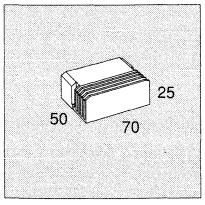
| Output [A] 1 1.5 2 3 4 5 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] ≤ 40 80 144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| ■ | ■ | ■ | ISR | various | 2 - 19 |
| ■ | ■ | ■ | PSR | A01 | 2 - 25 |
| ■ | ■ | ■ | PSB | B02 | 2 - 33 |

| Output [A] 1 1.5 2 3 4 5 | Output [V DC] –3 –5 –12 –15 –24 –36 –48 | Input [V DC] ≤ –40 –80 –144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| ■ | ■ | ■ | NSR | A01 | 2 - 40 |

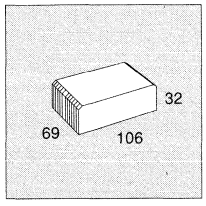
## 2.3 Benign Environment

| Output [A] 1 1.5 2 3 4 5 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] ≤ 40 80 144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| ■ | ■ | ■ | FN | various | 2 - 48 |
| ■ | ■ | ■ | PSA | A01 | 2 - 53 |

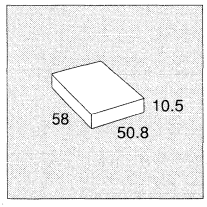
Case A01



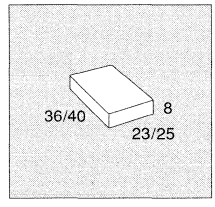

Case B02




Case 50.8x58




Case FN



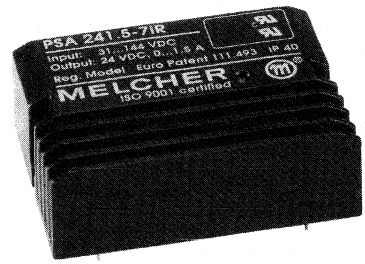
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# PSR: Positive Switching Regulators

# PSA-Family

**No input to output isolation**
**Single output of 12, 15, 24, 36 or 48 V DC/18...48 W**
**Input voltage up to 144 V DC**

- High efficiency up to 95%
- Extremely wide input voltage range
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Two temperature ranges
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




## Table of Contents

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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options |
|---|---|---|---|---|---|---|
| 12 V | 1.5 A | 18...144 V | 60 V | 86% | PSA 121.5-7iR | -9, P, Y, U |
| 15 V | | 22...144 V | | 89% | PSA 151.5-7iR | |
| 24 V | | 31...144 V | | 93% | PSA 241.5-7iR | |
| 36 V | 1.2 A | 44...144 V | 80 V | 94% | PSA 361-7iR | |
| 48 V | 1.0 A | 58...144 V | | 95% | PSA 481-7iR | |

[1] Surges up to 156 V for 2 sec. See also data $\Delta U_{io\,min}$.

## Description

The PSA family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 144 V are specially designed for battery driven mobile applications.
Case A01: Aluminium, black finish and self cooling.

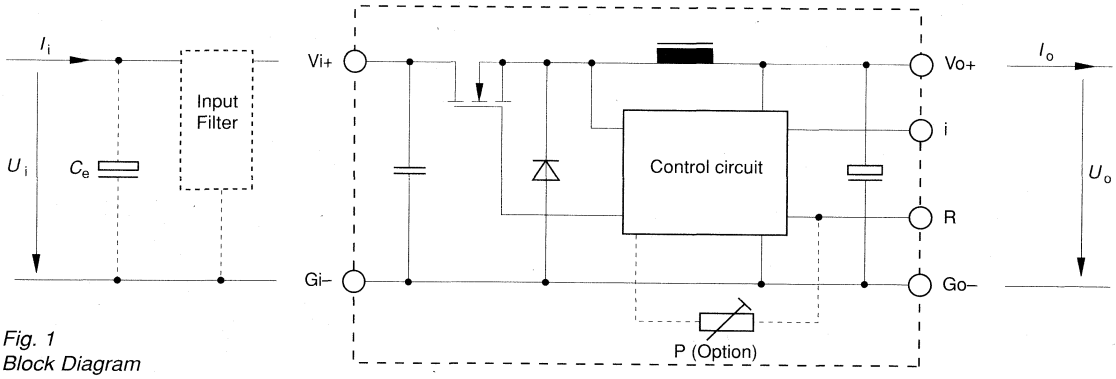



*Fig. 1*
*Block Diagram*

**External input circuitry**

An external input filter FP 144 (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 2.0 m (3 m twisted). For long connection lines the use of the external filter is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**i Inhibit**

**Note:** With open i-input, output is enabled ($U_o$ = on)

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur, when the units are switched on or off.

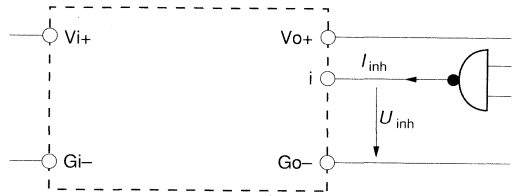



*Fig. 2*
*Definition of $I_{inh}$ and $U_{inh}$*

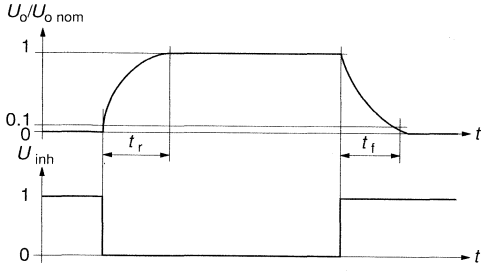



*Fig. 3*
*Output response as a function of inhibit signal*

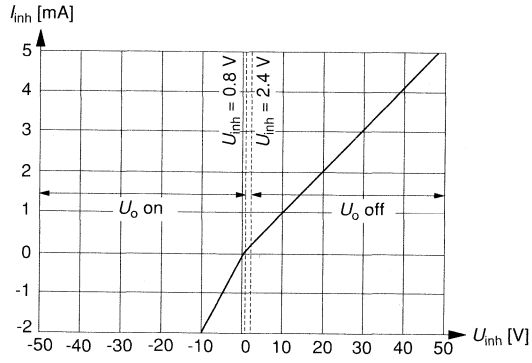



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

**Data**

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –10 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 2 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 4 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |



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### R External Output Voltage Adjustment

**Note:** With open R-input, $U_o = U_{o\,nom}$.

R-input and option P cannot be supported simultaneously.

The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

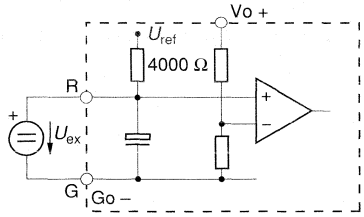



*Fig. 5*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±2%)

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V, nor be negative.

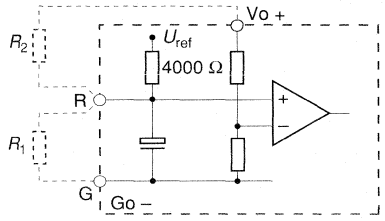



*Fig. 6*
*Voltage adjustment with extenal resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:

$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 2\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | $40^{+2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.7 mm (10...60 Hz)<br>10 $g_n$ = 98 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |
| Burst test | | IEC 801-4 | Level 4 | 4 kV (5/50 ns; 50 Ω) | Operating |
| Surge test | | IEC 571-1 | | 1.8 kV (1.2/50 µs; 100 Ω) | Operating |
| (Input filter FP 144 necessary) | | IEC 801-5 | Class II: | 1.0 kV (1.2/50 µs; 2 Ω) | Operating |

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF and device hours*

| MTBF, device hours | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 50 °C | |
| | 789'000 h | 199'000 h | 104'000 h | 76'000 h | 5'100'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Electrical Input and Output Data

General Conditions
– $T_A$ = +25°C, unless $T_C$ is specified.
– With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6a: Input and output data*

| Characteristics | | Conditions | PSA 121.5 min | PSA 121.5 typ | PSA 121.5 max | PSA 151.5 min | PSA 151.5 typ | PSA 151.5 max | PSA 241.5 min | PSA 241.5 typ | PSA 241.5 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 1.5 | | | 1.5 | | | 1.5 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$... $T_{C\,max}$ | 1.5 | | 1.88 | 1.5 | | 1.88 | 1.5 | | 1.88 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 30 | 60 | | 40 | 70 | | 80 | 160 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 40 | | | 40 | | | 40 | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0... $I_{o\,nom}$ | | 20 | | | 20 | | | 30 | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 50 | | | 50 | | | 50 | | |
| $t_d$ | Dynamic load transient time constant | | | 50 | | | 50 | | | 60 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$... $T_{C\,max}$ | | | ±2 | | | ±2 | | | ±3 | mV/K |
| | | $I_o$ = 0... $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage [2] | $I_o$ = 0... $I_{o\,nom}$ $T_{C\,min}$... $T_{C\,max}$ | 18 | | 144 | 22 | | 144 | 31 | | 144 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | | | 6 | | | 7 | | | 7 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 12.0 | | | 18.0 | | | 22.0 | | |
| $I_{i\,0}$ | No load Input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 20 | | | 20 | | | 20 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 150 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 2.5 | | | 2.5 | | | 2.5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 15 | | | 15 | | | 15 | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,min...max}$, $I_{o\,nom}$ | | | B | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 86 | | | 89 | | | 93 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 1500 | | | 1500 | | | 1500 | | V DC |

[1] See "Dynamic Characteristics".
[2] Surges up to 156 V for 2 sec. (Complying with LES-DB Standard for $U_N$ = 110 V)
[3] Definitions according to VDE 0433, part 3.
[4] With input filter FP 144 (see "Accessories") and 2 × 3.3 µF/250 V (MKT-Capacitors) connected between $U_{i\,i}$ and $G_i$.

*Table 6b: Input and output data*

| Characteristics | | Conditions | PSA 361 min | PSA 361 typ | PSA 361 max | PSA 481 min | PSA 481 typ | PSA 481 max | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 35.78 | | 36.22 | 47.71 | | 48.29 | | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 1.2 | | | 1.0 | | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 1.2 | | 1.5 | 1.0 | | 1.25 | | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 80 | 160 | | 100 | 200 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 80 | | | 90 | | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 40 | | | 60 | | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}\leftrightarrow$1/3 $I_{o\,nom}$ | | 60 | | | 60 | | | |
| $t_d$ | Dynamic load transient time constant | | | 60 | | | 60 | | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±5 | | | ±6 | | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage [2] | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 44 | | 144 | 58 | | 144 | | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | | | 8 | | | 10 | | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 31 | | | 44 | | | |
| $I_{i\,0}$ | No load Input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 25 | | | 25 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 150 | | | 150 | | | A |
| $t_{i\,s}$ | Rise time [3] | | | 2.5 | | | 2.5 | | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 15 | | | 15 | | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,min...max}$, $I_{o\,nom}$ | | | B | | | B | | dB (µV) |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 94 | | | 95 | | | % |
| **Isolation** | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnecte | | 1500 | | | 1500 | | | V DC |

[1] See "Dynamic Characteristics".
[2] Surges up to 156 V for 2 sec. (Complying with LES-DB Standard for $U_N$ = 110 V)
[3] Definitions according to VDE 0433, part 3.
[4] With input filter FP 144 (see "Accessories") and 2 × 3.3 µF/250 V (MKT-Capacitors) connected between $U_{i\,i}$ and $G_i$.

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

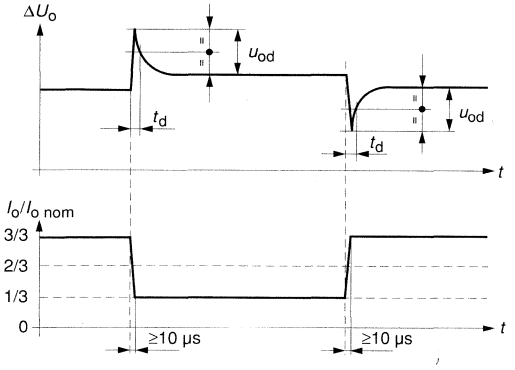



*Fig. 7*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 95 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 144 V DC which is far above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

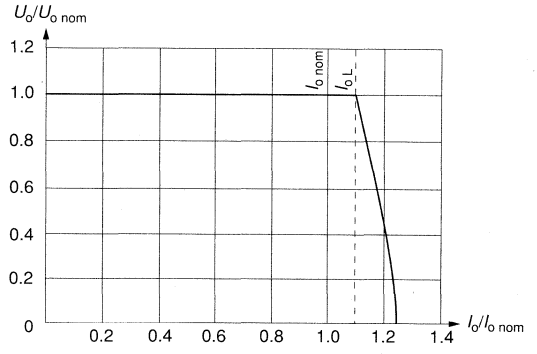



*Fig. 8*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90. SEV approval according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards are in progress.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 40. With option P this reduces to IP 20.

## Description of Options

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71\,°C$.

**Option P** Potentiometer

Option P excludes R function. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{io\,min}$ between input and output voltages as specified in "Electrical Input and Output Data", should be maintained.

**Option Y** PCB Soldering Pins

This option defines soldering pins of 1.0 × 0.5 × 6.5 mm, instead of the standard fast-on terminals of 2.8 × 0.5 × 6.5 mm. Modules with this option can be mounted onto printed circuit boards, providing through-plated finished hole size of Ø 1.3...1.5 mm.

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSA family as recognized components up to an ambient temperature of $T_{A\,max} - 10$ K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have, in contrast to UL, accepted the standard PCB material to be operated up to $T_{A\,max} = 71\,°C$ without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ± 0.3 mm unless otherwise specified.

European Projection

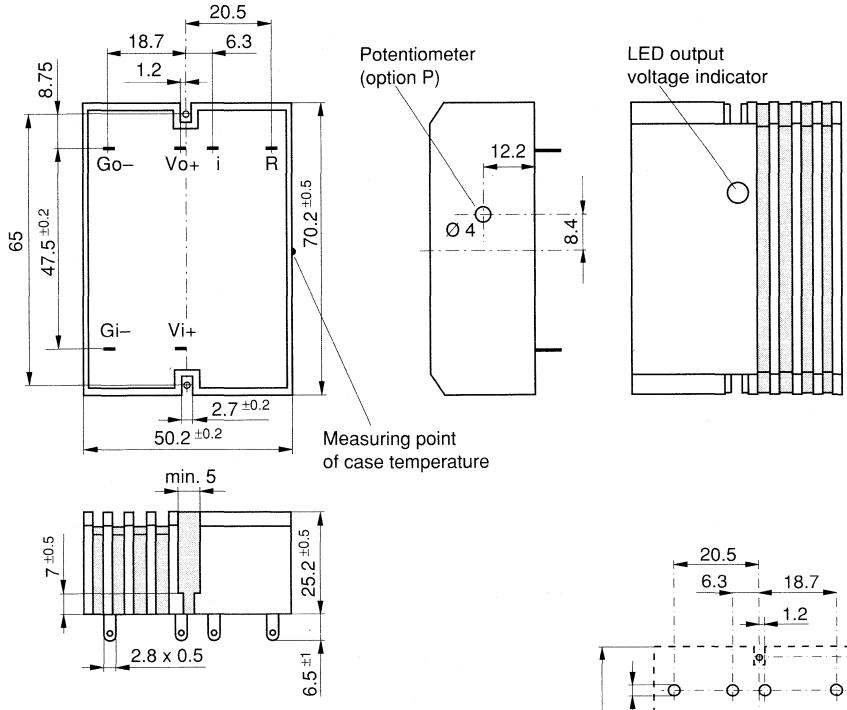



*Fig. 9*
*Case A01 (Weight 100 g)*

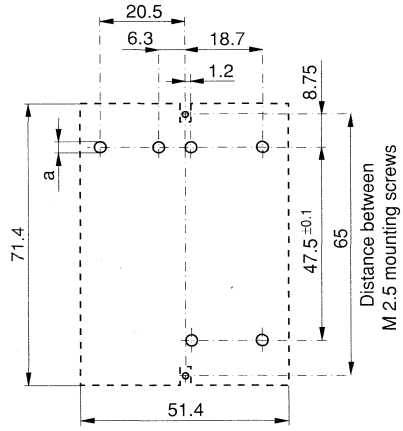
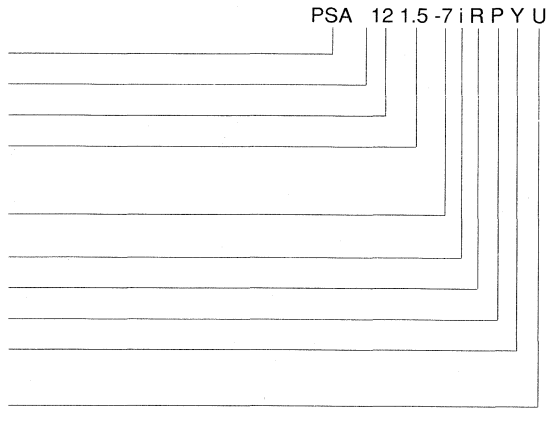



*Fig. 10*
*Case A01 hole locations for circuit board layout (component side view of PCB):*
*- - - = Space reserved for switching regulator*
*"a" = 3.0 mm x 0.7 mm slot or Ø 3.0 mm, through plated for hand or machine soldering (fast on)*
*"a" = Ø 1.3...1.5 mm with option Y pins*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case A01 ..... PSA
Blank .....
Nominal output voltage in volt ..... 12...48
Nominal output current in ampere ..... 1...1.5
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Small soldering pins 0.5 × 1.0 mm ..... Y
UL recognized component for $T_{A\,max}$ = 71 °C
(instead of 60 °C) ..... U

Example: PSA 121.5-7iPY = A positive switching regulator with a 12 V, 1.5 A output, ambient temperature range of –25...71 °C, inhibit input, potentiometer and small soldering pins.

### Product Marking

Main face: Specific type designation, input voltage range, nominal output voltage and current, applicable safety approval and recognition marks, degree of protection, Melcher patent nos. and company logo.

Cover: Pin allocation and warnings.

Side wall: Label with batch no., serial no. and data code comprising production site, modification status of main PCB and date of production.


MELCHER® ISO 9001 certified

# PSR: Positive Switching Regulators PSB-Family

**No input to output isolation**
**Single output of 5.1, 12, 15, 24, 36 or 48 V DC/20...192 W**
**Input voltage up to 144 V DC**

- High efficiency up to 96%
- Extremely wide input voltage range
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Two temperature ranges
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Output current $I_{o\,nom}$ | Output current $I_{o\,max}$ [1] | Input voltage range $U_i$ [2] | Input voltage nominal $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options |
|---|---|---|---|---|---|---|---|
| 5.1 V | 4 A | 5 A | 15...144 V | 60 V | 80% | PSB 5A4-7iR | -9, L, P, C, U |
| 12 V | 3 A | 4 A | 18...144 V | | 89% | PSB 123-7iR | |
| 15 V | | | 22...144 V | | 90% | PSB 153-7iR | |
| 24 V | | | 31...144 V | | 94% | PSB 243-7iR | |
| 36 V | | | 44...144 V | 80 V | 95% | PSB 363-7iR | |
| 48 V | | | 58...144 V | | 96% | PSB 483-7iR | |

[1] $I_{o\,max}$ for $U_i < 80$ V or reduced $T_A$
[2] See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSB family of positive switching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 144 V are specially designed for battery driven mobile applications.
Case B02: Aluminium, black finish and self cooling.

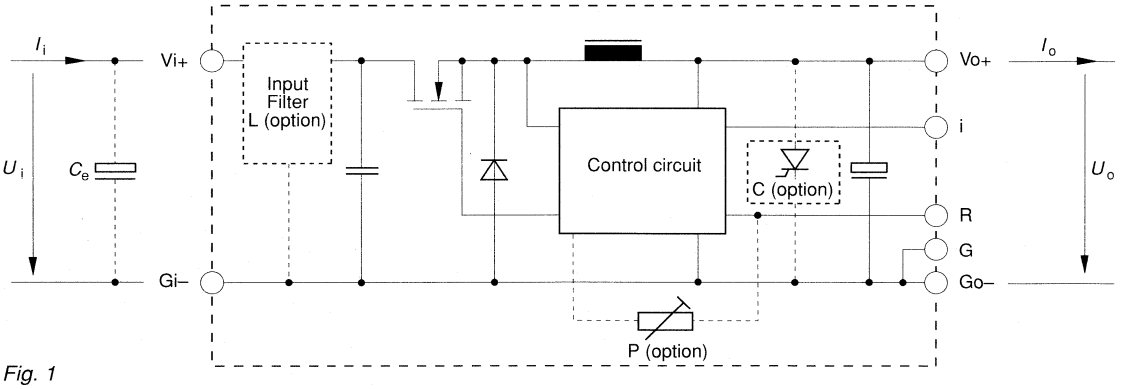



*Fig. 1*
*Block diagram*

**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**i Inhibit**

**Note:** With open i-input, output is enabled ($U_o$ = on)

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

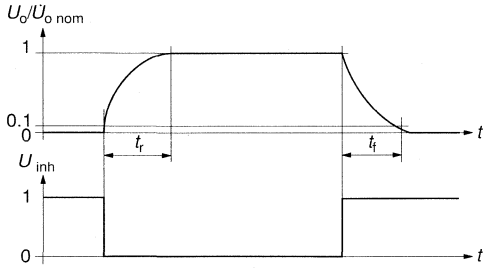



*Fig. 3*
*Output response as a function of inhibit signal*

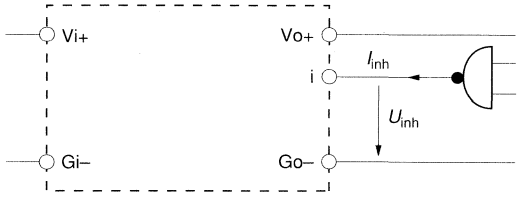



*Fig. 2*
*Definition of $I_{inh}$ and $U_{inh}$*

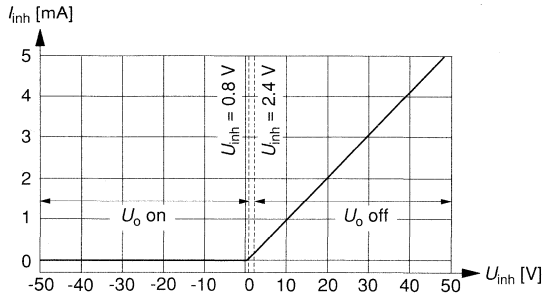



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

**Data**

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom} / I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |


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### R External Output Voltage Adjustment

**Note:** With open R input, $U_o = U_{o\,nom}$.

R-input and option P cannot be supported simultaneously. The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

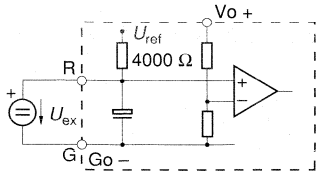



*Fig. 5*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±2%)

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V, nor be negative.

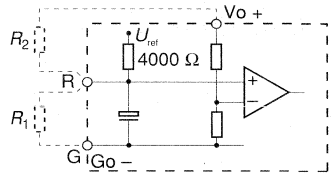



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:

$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 2\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | $40^{+2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |
| Electric field susceptibility | | IEC 801-3 | Level 3: | 10 V/m (1 MHz...1 GHz) | Operating |
| Burst test [1] | | IEC 801-4 | Level 4: | 4 kV (5/50 ns; 50 Ω) | Operating |
| Surge test [1] | | IEC 801-5 | Class II: | 1 kV (1.2/50 µs; 2 Ω) | Operating |
| | | IEC 571-1 | | 1.8 kV (1.2/50 µs; 100 Ω) | Operating |

[1] Option L necessary

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 50 °C | |
| | 624'000 | 207'000 h | 96'000 h | 46'000 h | 13'000'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Electrical Input and Output Data

General Conditions
– $T_A$ = +25°C, unless $T_C$ is specified
– With R or option P, output voltage $U_o$ = $U_{o\,nom}$ at $I_{o\,max}$

*Table 6a: Input and output data*

| Characteristics | | Conditions | PSB 5A4 | | | PSB 123 | | | PSB 153 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,max}$ | 5.07 | | 5.13 | 11.92 | | 12.07 | 14.91 | | 15.09 | V |
| $I_{o\,max}$ | Output current [5] | $U_{i\,min}$...$U_{i\,max}$ | | 5.0 | | | 4.0 | | | 4.0 | | A |
| $I_{oL}$ | Output current limitation response [5] | $T_{C\,min}$... $T_{C\,max}$ | 5.0 | | 6.5 | 4.0 | | 5.2 | 4.0 | | 5.2 | |
| $u_o$ | Output ripple voltage | $U_{i\,nom}$, $I_{o\,max}$ BW = 20 MHz | | 25 | 65 | | 40 | 75 | | 60 | 100 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,max}$ | | 20 | 45 | | 30 | 55 | | 50 | 75 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,max}$ | | 20 | 35 | | 25 | 40 | | 30 | 65 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ | | 100 | | | 100 | | | 100 | | |
| $t_d$ | Dynamic load transient time constant | $I_{o\,max} \leftrightarrow 1/3\ I_{o\,max}$ | | 50 | | | 60 | | | 60 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient | $U_{i\,min}$...$U_{i\,max}$ | | | ±1 | | | ±2 | | | ±3 | mV/K |
| | $\Delta U_o/\Delta T_C$ ($T_{C\,min}$... $T_{C\,max}$) | $I_o$ = 0...$I_{o\,max}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage [6] | $I_o$ = 0...$I_{o\,max}$ | 15 | | 144 | 18 | | 144 | 22 | | 144 | V DC |
| $\Delta U_{i\,o\,m}$ | Min. diff. voltage $U_i$ - $U_o$ [2] | $T_{C\,min}$... $T_{C\,max}$ | | 10 | | | 6 | | | 7 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 10 | | | 12 | | | 15 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0, $U_{i\,min}$...$U_{i\,max}$ | | | 40 | | | 35 | | | 35 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 150 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 180 | | | 180 | | | 180 | | A |
| $t_{i\,s}$ | Rise time [3] | with option L | | 15 | | | 15 | | | 15 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 100 | | | 100 | | | 100 | | |
| $u_{i\,RFI}$ | Input RFI level, VDE 0871 [4] | $I_{o\,max}$, $U_{i\,min}$...$U_{i\,max}$ | | | B | | | B | | | B | dB(µV) |
| **Efficiency** | | | | | | | | | | | | |
| η | Efficiency | $U_{i\,nom}$, $I_{o\,max}$ | | 80 | | | 89 | | | 90 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs and outputs interconnected | | 1500 | | | 1500 | | | 1500 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_C$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 470 µF/200 V (e.g. Chemicon, KME-series, or equivalent)
[5] See also "Temperature dependent current limit"
[6] Surges up to 156 V for 2 sec. (complying to LES-DB standard for $U_N$ = 110 V)

*Table 6b: Input and output data*

| Characteristics | | Conditions | PSB 243 | | | PSB 363 | | | PSB 483 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,max}$ | 23.86 | | 24.14 | 35.78 | | 36.22 | 47.70 | | 48.29 | V |
| $I_{o\,max}$ | Output current [5] | $U_{i\,min}$...$U_{i\,max}$ | | 4.0 | | | 4.0 | | | 4.0 | | A |
| $I_{oL}$ | Output current limitation response [5] | $T_{C\,min}$...$T_{C\,max}$ | 4.0 | | 5.2 | 4.0 | | 5.2 | 4.0 | | 5.2 | |
| $u_o$ | Output ripple voltage | $U_{i\,nom}$, $I_{o\,max}$ BW = 20 MHz | | 75 | 200 | | 120 | 280 | | 150 | 300 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,max}$ | | 70 | 150 | | 100 | 200 | | 150 | 300 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,max}$ | | 70 | 120 | | 120 | 160 | | 150 | 250 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ | | 120 | | | 140 | | | 150 | | |
| $t_d$ | Dynamic load transient time constant | $I_{o\,max} \leftrightarrow 1/3\ I_{o\,max}$ | | 80 | | | 100 | | | 100 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient | $U_{i\,min}$...$U_{i\,max}$ | | | ±5 | | | ±8 | | | ±10 | mV/K |
| | $\Delta U_o/\Delta T_C$ ($T_{C\,min}$...$T_{C\,max}$) | $I_o$ = 0...$I_{o\,max}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage [6] | $I_o$ = 0...$I_{o\,max}$ | 31 | | 144 | 44 | | 144 | 58 | | 144 | V DC |
| $\Delta U_{i\,o\,m}$ | Min. diff. voltage $U_i$ - $U_o$ [2] | $T_{C\,min}$...$T_{C\,max}$ | | 7 | | | 8 | | | 10 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 19 | | | 29 | | | 40 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0, $U_{i\,min}$...$U_{i\,max}$ | | | 35 | | | 40 | | | 45 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 150 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 180 | | | 180 | | | 180 | | A |
| $t_{i\,s}$ | Rise time [3] | with option L | | 15 | | | 15 | | | 15 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 100 | | | 100 | | | 100 | | |
| $u_{i\,RFI}$ | Input RFI level, VDE 0871 [4] | $I_{o\,max}$, $U_{i\,min}$...$U_{i\,max}$ | | | B | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| η | Efficiency | $U_{i\,nom}$, $I_{o\,max}$ | | 94 | | | 95 | | | 96 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs and outputs interconnected | | 1500 | | | 1500 | | | 1500 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_C$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 470 µF/200 V (e.g. Chemicon, KME-series, or equivalent)
[5] See also "Temperature dependent current limit"
[6] Surges up to 156 V for 2 sec. (complying to LES-DB standard for $U_N$ = 110 V)

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

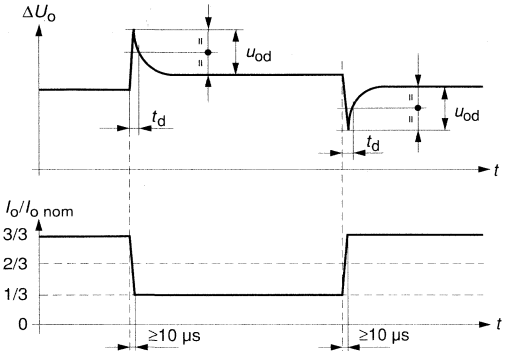



*Fig. 7*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C (see also "Temperature Dependent Current Limit").

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 144 V DC which is far above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

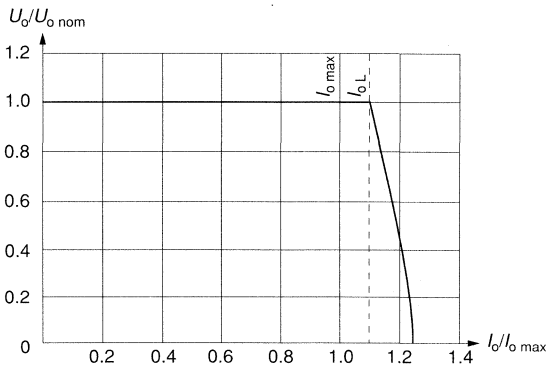



*Fig. 8*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.


MELCHER ISO 9001 certified

## Temperature Dependent Current Limit

These regulators withstand a continuous input voltage of up to 144 V DC (120 V +20%) with surges up to 156 V for 2 sec.

They also comply with LES-DB standard for $U_N$ = 110 V.

$I_{o\,max}$ is continuously available over the entire temperature range for an input voltage up to 80 V, or over the whole input voltage range at a reduced maximum ambient temperature of $T_{A\,max}$ = 45 °C.

Continuous operation within the shaded area is guaranteed ($T_{A\,max}$ = 71 °C). Short-term operation within the dashed area (e.g. current peaks, transients) is also possible, provided the case temperature remains at $T_{C\,max} \leq$ 95 °C.

For operation at $T_A$ = 45...71 °C together with an input voltage between 80...144 V the internal thermistor (PTC) starts to reduce the maximum available output current (according to fig.). Under the most extreme conditions this results in a reduction of $I_{o\,max}$ by 1 A to $I_{o\,nom}$.

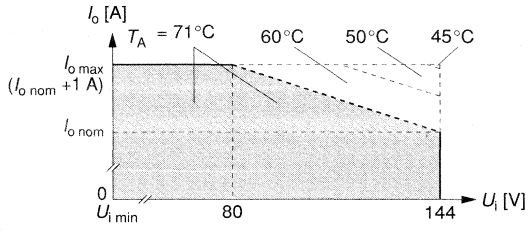



*Fig. 9*
*Output current characteristics for high input voltage range*

## Description of Options

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A$ = –40...71 °C.

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH, a maximum magnitude of 80 $mV_{rms}$. A reduction can be achieved by insertion of a capacitor across the input (e.g. plastic foil between Vi+ and Gi–).

The input impedance of the switching regulator at 120 kHz is about 17 Ω. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 10\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 1000\ Hz/f_i \cdot 1V$$

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSB family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max}$ = 71 °C without any further precautions.

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{oc}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | 5.1 V | | 12 V | | 15 V | | 24 V | | 36 V | | 48 V | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | min | max | min | max | min | max | min | max | |
| $U_{oc}$ | Trigger voltage | $U_{i\,min}$...$U_{i\,max}$ $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 5.8 | 6.8 | 13.5 | 16 | 16.5 | 19 | 27 | 31 | 40 | 45.5 | 55 | 61 | V |
| $t_s$ | Delay time | | | 1.5 | | 1.5 | | 1.5 | | 1.5 | | 1.5 | | 1.5 | µs |

## Mechanical Data

European Projection

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

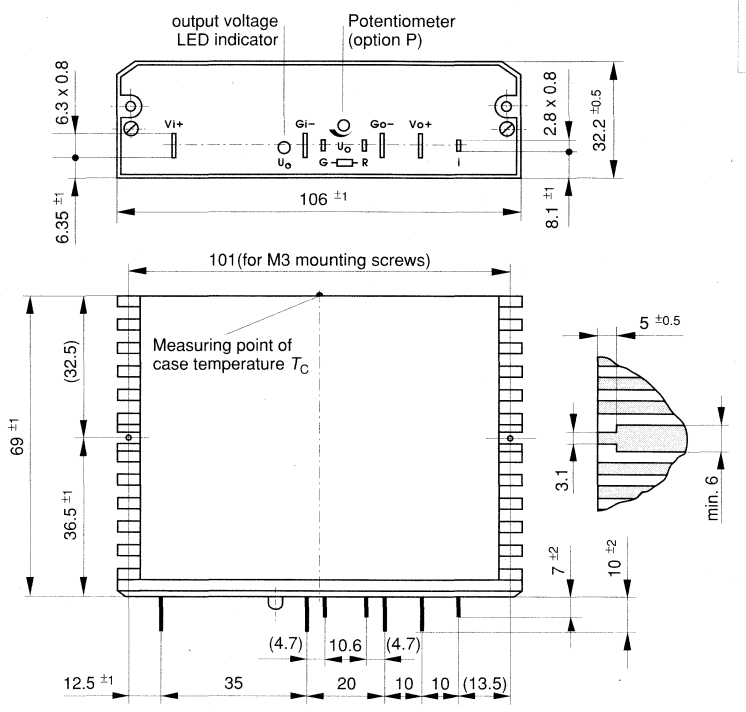



*Fig. 10*
*Case B02 (weight 230 g)*

## Type Key and Product Marking

### Type Key

PSB 12 3 -7 L i R P C U

| | |
|---|---|
| Positive switching regulator in case B02 | PSB |
| Blank | |
| Nominal output voltage in volt (5A –> 5.1) | 5.1...48 |
| Nominal output current in ampere | 3...4 |
| Ambient temperature range | |
| $T_A$ = –25...71 °C | -7 |
| $T_A$ = –40...71 °C | -9 |
| Input filter | L |
| Inhibit input | i |
| External output voltage adjustment | R |
| Potentiometer | P |
| Thyristor-Crowbar | C |
| UL recognized component for $T_{A\,max}$ = 71 °C (instead of 60 °C) | U |

Example: PSB 123-7LiPC = A positive switching regulator with a 12 V, 3 A output, ambient temperature range of –25...71 °C, input filter, inhibit input, potentiometer and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometer and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

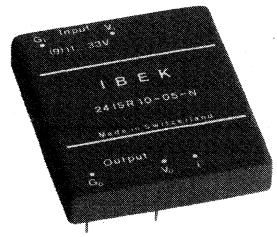

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Edition 1/05 - © Melcher AG

# IBEK, Positive Switching Regulators

# ISR-Family

**No input to output isolation**
**Single output of 5, 12 or 15 V DC/5...10 W**
**Input voltage up to 33 V DC**

**Attention:**
The regulators should never be operated without an external input capacitor, see "External Input Circuitry".
The input voltage should be maintained 4 V above the selected output voltage under all conditions.




- Wide input voltage range
- High efficiency up to 80%
- High reliability
- Very good dynamic response
- Two operational ambient temperature ranges
- Inhibit control input (optional)
- Continuous no-load and short-circuit proof
- Case height only 10.5 mm

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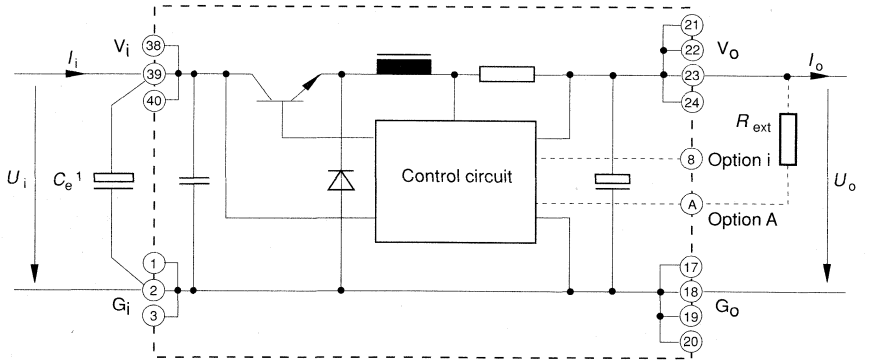
## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency (typ.) $\eta$ | Type designation | Case | Options |
|---|---|---|---|---|---|---|---|
| 5 V | 1 A | ($U_o$+4)...33 V | 24 V | 78% | 24ISR 5-05-N | DIL 40 | S, i, A |
| 12 V | 0.42 A | | | 80% | 24ISR 5-12-N | | |
| 15 V | 0.33 A | | | 80% | 24ISR 5-15-N | | |
| 5 V | 2 A | | | 78% | 24ISR 10-05-N | 50.8 × 58 | S, i |

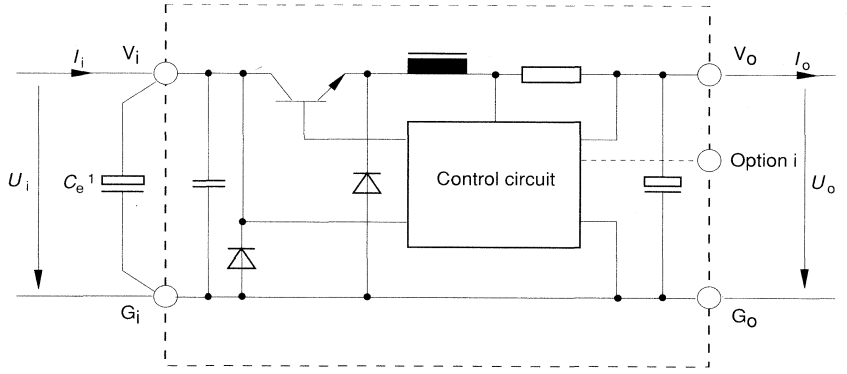
## Description

The ISR family of positive swiching regulators have been designed to power electronic systems. Their features include high efficiency, which remains virtually constant over the entire input voltage range, with the benefit of low thermal dissipation, high quality and reliability, low output ripple and excellent dynamic response. The regulators are continuously no-load and short-circuit proof. Inhibit and adjustable output voltage (both optional) make the regulators adaptable to individual applications. The modules are manufactured according to ISO 9001 quality standards.
Case ISR 5: DIL 40 package, grey coloured plastic, self cooling (free air convection).
Case ISR 10: metal, black anodized, self cooling (free air convection).




1 External input capacitor mandatory, see "External Input Circuitry"

*Fig. 1*
*Block diagram ISR 5*




1 External input capacitor mandatory, see "External Input Circuitry"

*Fig. 2*
*Block diagram ISR 10*

## Immunity to Environmental Conditions

*Table 2: Temperature specification values given are for air pressures in the range 800...1200 hPa (800...1200 mbar)*

| Temperature | | | Standard -N | | Option -S | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 71 | –40 | 85 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | 0 | 95 | –40 | 105 | |
| $T_S$ | Storage temperature | (Not operational) | –55 | 105 | –55 | 105 | |

The case temperature $T_C$ should not exceed the maximum value.In applications with limited air circulation, additional measures should be taken (either larger spacing or a fan) to avoid case temperatures above $T_{C\,max}$.

*Table 3: MTBF*

| Values at specified Case Temperature | Module Types | Ground Benign | Ground Fixed | | Ground Mobile | | Unit |
|---|---|---|---|---|---|---|---|
| | | 40°C | 40°C | 70°C | 40°C | 70°C | |
| MTBF according to MIL-HDBK-217F | ISR 5, ISR 10 | 2'150'000 | 570'000 | 270'000 | 190'000 | 90'000 | h |

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With option A, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 4: Input and output data*

| Characteristic | | Conditions | ISR 5-05 min | ISR 5-05 typ | ISR 5-05 max | ISR 5-12 min | ISR 5-12 typ | ISR 5-12 max | ISR 5-15 min | ISR 5-15 typ | ISR 5-15 max | ISR 10-05 min | ISR 10-05 typ | ISR 10-05 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | | | | |
| $U_o$ | Output voltage (std. -N) | $U_{i\,nom}$, $I_{o\,nom}$ | 4.90 | | 5.10 | 11.88 | | 12.12 | 14.85 | | 15.15 | 4.98 | | 5.08 | V |
| $U_o$ | Output voltage (opt. S) | $U_{i\,nom}$, $I_{o\,nom}$ | 4.85 | | 5.15 | 11.75 | | 12.25 | 14.70 | | 15.30 | 4.93 | | 5.10 | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 1.0 | | | 0.42 | | | 0.33 | | | 2.0 | | A |
| $I_{oL}$ | Output current limitation response | $U_{i\,nom}$ $U_o = 0.95 \cdot U_{o\,nom}$ | | 1.2 $I_{o\,nom}$ | | | 1.2 $I_{o\,nom}$ | | | 1.2 $I_{o\,nom}$ | | | 1.2 $I_{o\,nom}$ | | |
| $I_{oS}$ | Short circuit output current | $U_{i\,nom}$ $U_o$ = 0 V | | 1.3 $I_{o\,nom}$ | | | 1.3 $I_{o\,nom}$ | | | 1.3 $I_{o\,nom}$ | | | 1.3 $I_{o\,nom}$ | | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 40 | 80 | | 15 | 30 | | 10 | 20 | | 50 | 100 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±10 | | | ±25 | | | ±30 | | | ±10 | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | ±10 | | | ±25 | | | ±30 | | | ±10 | | |
| $u_{o\,u}$ | Dynamic undershoot level | $U_{i\,nom}$ $\Delta I_o$ = +1/3 $I_{o\,nom}$ | 4.80 | | | 11.85 | | | 14.85 | | | 4.78 | | | V |
| $u_{o\,o}$ | Dynamic overshoot level | $U_{i\,nom}$ $\Delta I_o$ = −1/3 $I_{o\,nom}$ | | | 5.2 | | | 12.15 | | | 15.15 | | | 5.22 | |
| $t_{rr}$ | Load transient recovery time | $U_{i\,nom}$ $\Delta I_o$ = ±1/3 $I_{o\,nom}$ | | 150 | | | 150 | | | 150 | | | 30 | | µs |
| $\alpha_{uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | ($U_o$+4) [1] | | 33 | ($U_o$+4) | | 33 | ($U_o$+4) | | 33 | ($U_o$+4) [1] | | 33 | V DC |
| $U_{i\,abs.}$ | Input voltage without any defect | max. 60 sec. | 0 | | 35 | 0 | | 35 | 0 | | 35 | 0 | | 35 | |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | $I_o$ = 0...$I_{o\,nom}$ | | 4 | | | 4 | | | 4 | | | 4 | | |
| $I_{i\,0}$ | No load input current | $U_{i\,nom}$, $I_o$ = 0 | | 9 | 14 | | 9 | 14 | | 9 | 14 | | 9 | 14 | mA |
| $I_{i\,inh}$ | Idle input current | Inhibit mode | | 11 | 12 | | 11 | 12 | | 11 | 12 | | 11 | 12 | |
| $f_s$ | Switching frequency | $U_{i\,nom}$, $I_{o\,nom}$ | | 100 | | | 100 | | | 100 | | | 100 | | kHz |
| **Efficiency** | | | | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | 74 | 78 | | 76 | 80 | | 76 | 80 | | 74 | 78 | | % |

[1] For $U_i$ = 11...9 V, linear derating of the output current $I_o$ from 100 to 80% of $I_{o\,nom}$ is required.

## Characteristics and Definitions



### External Input Circuitry

Important: The regulators should never be operated without an external input capacitor $C_e$!

Only a small input filter capacitor is incorporated. The AC component $i_C$ of the input current caused by the switching principle must be supplied by the external capacitor $C_e$, which is usually present in rectifier mode operation. The current through this capacitor is $i_C \approx 0.5\ I_o$. The component of the AC voltage should remain below 3 $V_{pp}$ at the regulators switching frequency of 100 kHz. The lenght of the connection between the capacitor $C_e$ and the input pins of the regulator should never exceed 2 × 75 = 150 mm.

| Regulator type | required input capacitor $C_e$ |
|---|---|
| 24 ISR 5-05 | 470 µF |
| 24 ISR 5-12 | 330 µF |
| 24 ISR 5-15 | 220 µF |
| 24 ISR 10-05 | 680 µF |

### Output Protection

In systems equipped with ISR regulators the user should ensure that an unsafe condition does not occur in the event of a failure. A voltage suppressor diode or a thyristor should be connected across the output to protect the load against overvoltages which could occur due to an internal failure of the control circuit or the switching transistor.

### Dynamic Characteristics

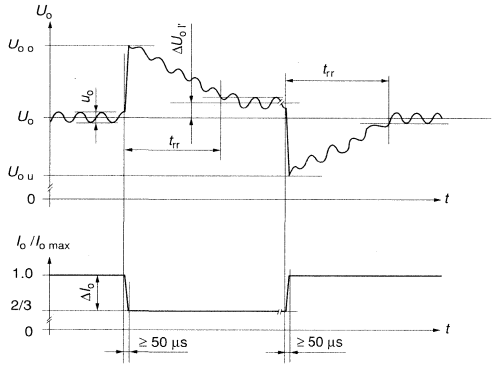



*Fig. 3:*
*Behaviour and characteristics under varying load conditions.*

### Short circuit behaviour

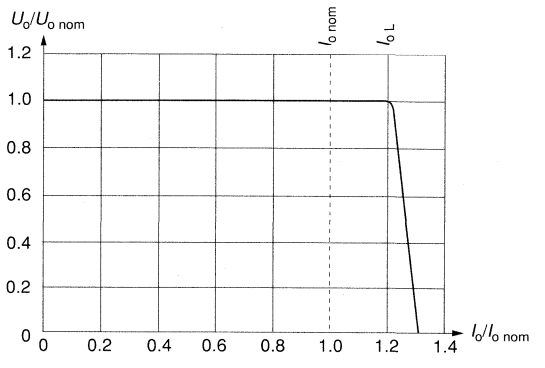



*Fig. 4:*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Connection in Parallel and Series

Parallel connection of these units is not permitted. The load distribution and the ripple voltage could not be controlled.

Outputs can be connected in series with any other module. Galvanically isolated source voltages are needed for each module. When connected in series, each individual output should be protected by a zener diode or preferably by a suppressor diode to avoid overvoltages or reverse polarity at the outputs, e.g.

– 1N5908 to protect 5 V outputs

– BZW04-11 to protect 12 V outputs

– BZW04-14 to protect 15 V outputs.

Such destructive voltages may occur at switch-on cycle of the converters, if the output voltages do not rise at the same time. The "slower" output(s) could be supplied and, as a result, destroyed by the "faster" output(s) via the load. The maximum output current is limited by the lowest current limitation.

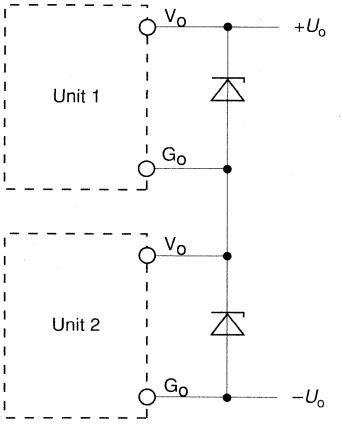



*Fig. 5:*
*Output connection in series with protection diodes*



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## Description of Options

**Option -S** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...85°C$.

**Option i** Inhibit

**Note:** With i open, the output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control with a logic signal (TTL, CMOS) the activation sequence of the regulators. An output voltage overshoot will not occur when the units are switched on or off.

*Table 5: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}...U_{i\,max}$ | –0.3 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{A\,min}...T_{A\,max}$ | +2.4 | | +5.5 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = +0.8 V | | | 100 | µA |
| | | | $U_{inh}$ = +2.4 V | | | 400 | |
| $R_{inh}$ | Inhibit input resistance | | | 4.7 | | 12 | kΩ |
| $I_{o\,0}$ | Output leakage current | | $U_{i\,nom}$, $R_L = U_{o\,nom}/I_{o\,nom}$ | | | 0.5 | mA |
| $t_r$ | Switch-on time after inhibit command | | $U_i$ = 11 V, $I_{o\,nom}$ | | 0.7 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 1 | | |

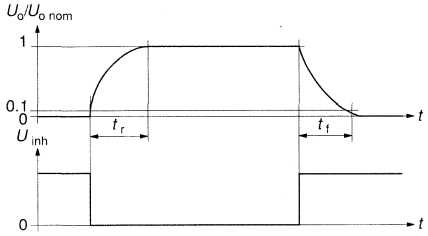



*Fig. 6:*
*Output response as a function of inhibit signal*

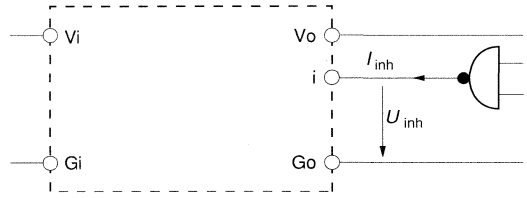



*Fig. 7:*
*Definition of $I_{inh}$ and $U_{inh}$*

**Option A** Output voltage adjustment (ISR 5 only)

The output voltage $U_o$ can be adjusted by means of an external resistor $R_{ext}$. The guaranteed adjustment range is $U_{o\,nom}$ ±5%.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified should be maintained.

*Table 6: $U_o$ adjustment range with $R_{ext}$.*

| Type | $R_{ext.}$ | $U_o$ |
|---|---|---|
| 24 ISR 5-05 | ≥100 kΩ (or open A pin)<br>0 Ω | 5.25...5.40 V<br>4.50...4.75 V |
| 24 ISR 5-12 | ≥100 kΩ (or open A pin)<br>0 Ω | 12.60...12.80 V<br>11.20...11.40 V |
| 24 ISR 5-15 | ≥100 kΩ (or open A pin)<br>0 Ω | 15.75...16.00 V<br>14.00...14.25 V |

**Cleaning**

Two cleaners free from FCHC have been tested and can be recommended:

Prozone from BP

Zestron from Dr. O.K.Wack Chemie GmbH, Germany.

Submersion of the units in water for rinsing is permitted. Drying should be done in the air.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

European Projection



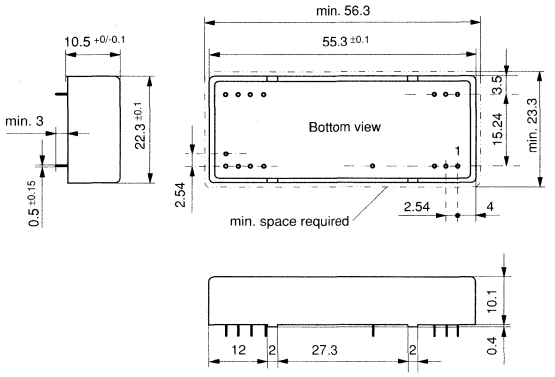



*Fig. 8:*
*DIL 40 plastic case,*
*Weight 23 g*

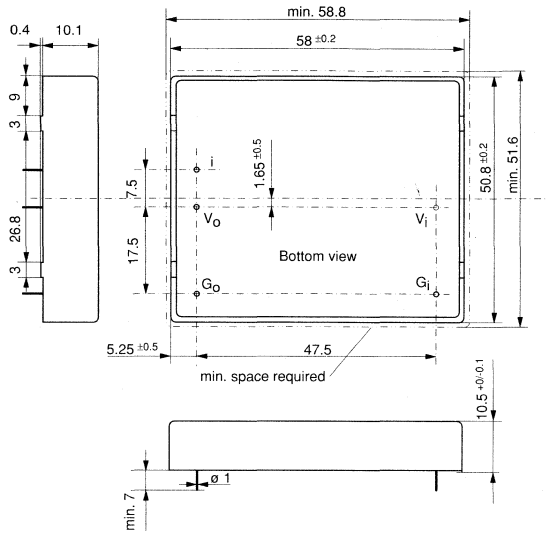



*Fig. 9:*
*50.8 × 58 mm metal case,*
*Weight 63 g*

## Type Key and Product Marking

### Type Key

24 ISR 5 - 05 - N i A

Nominal input voltage in volts ..... 24
Positive switching regulator family ..... ISR
Nominal output power in watts ..... 5...10
Nominal output voltage in volts ..... 5...15
Ambient temperature range
$T_A$ = 0...71°C ..... -N
$T_A$ = –40...85°C ..... -S
Inhibit input ..... i
External output voltage adjustment (ISR 5 only) ..... A

Example: 24ISR 10-05-Si = A positive switching regulator with 5 V, 2 A output, ambient temperature range of –40...85°C and including an inhibit input.

### Product Marking

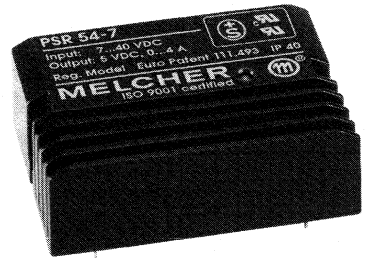
Main face: Manufacturer's name (IBEK), specific type designation, input voltage range, input and output pin allocation.
Bottom: Date code.

# PSR: Positive Switching Regulators

# PSR-Family

**No input to output isolation**
**Single output of 5, 12, 15, 24 or 36 V DC/15...72 W**
**Input voltage up to 80 V DC**

- High efficiency up to 94%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\ nom}$ | Nominal output current $I_{o\ nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\ nom}$ | Efficiency $\eta$ | Type designation | Options |
|---|---|---|---|---|---|---|
| 5 V | 4.0 A [2] | 7...40 V | 20 V | 82% | PSR 54-7 | -9, i, P, R, Y, U |
| | 3.0 A | 8...80 V | 40 V | 77% | PSR 53-7 | |
| 12 V | 2.5 A | 15...80 V | | 86% | PSR 122.5-7 | |
| 15 V | | 19...80 V | | 88% | PSR 152.5-7 | |
| 24 V | 2.0 A | 29...80 V | 50 V | 91% | PSR 242-7 | |
| 36 V | | 42...80 V | 60 V | 94% | PSR 362-7 | |

[1] See also data $\Delta U_{io\ min}$.
[2] Regulator with 5 V, 5 A (PSA 55) available on request. Ask for data.

## Description

The PSR family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 80 V are specially designed for secondary switched and battery driven applications.
Case size A01: Aluminium, black finish and self cooling.

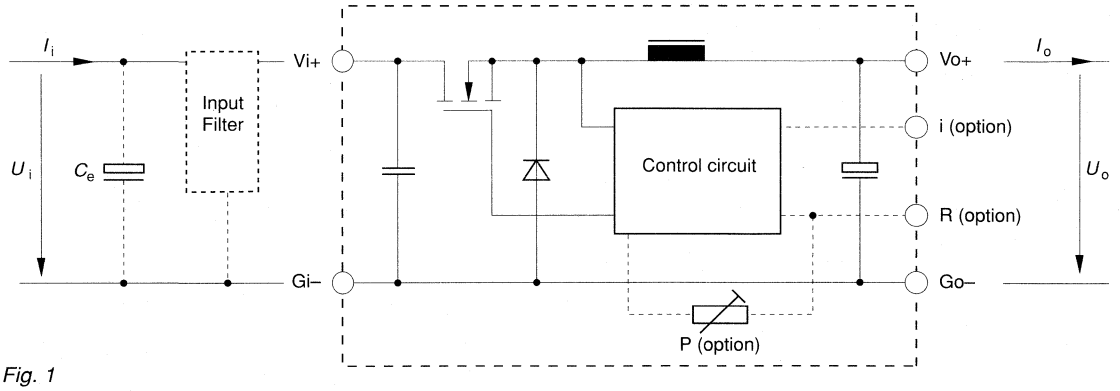



*Fig. 1*
*Block Diagram*

**External input circuitry**

An external input filter FP 38 or FP 80 (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 0.3 m (0.5 m twisted). For long connection lines the use of the external filter is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.7 mm (10...60 Hz)<br>10 $g_n$ = 98 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 4: MTBF and device hours*

| MTBF | Ground Fixed | | Ground Mobile | | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217D | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | |
| | 160'000 h | 70'000 h | 45'000 h | 22'000 h | 5'100'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use


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## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

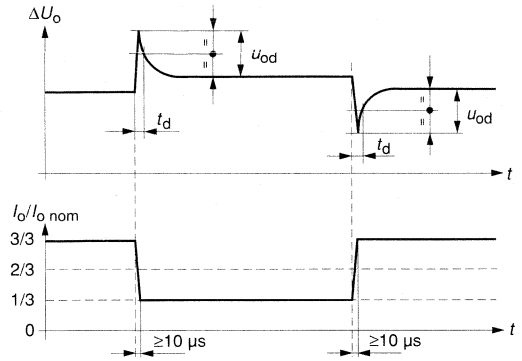



*Fig. 2*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 95 °C after the warm-up phase measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

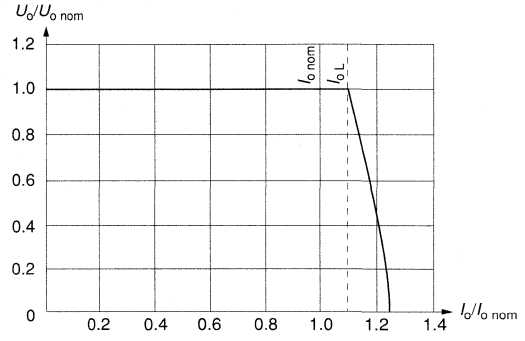



*Fig. 3*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 40. With option P this reduces to IP 20.

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With option P or R, output voltage $U_o$ = $U_{o\,nom}$ at $I_{o\,nom}$

*Table 5a: Input and output data*

| Characteristics | | Conditions | PSR 54 min | PSR 54 typ | PSR 54 max | PSR 53 min | PSR 53 typ | PSR 53 max | PSR 122.5 min | PSR 122.5 typ | PSR 122.5 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 4.97 | | 5.03 | 4.97 | | 5.03 | 11.92 | | 12.07 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 4.0 | | | 3.0 | | | 2.5 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$... $T_{C\,max}$ | 4.0 | | 5.2 | 3.0 | | 3.9 | 2.5 | | 3.25 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 25 | 45 | | 35 | 60 | | 50 | 75 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 30 | 45 | | 30 | 45 | | 50 | 75 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 20 | 25 | | 20 | 25 | | 35 | 45 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 200 | | | 100 | | | 180 | | |
| $t_r$ | Dynamic load transient time constant | | | 40 | | | 50 | | | 60 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$... $T_{C\,max}$ | | | ±1 | | | ±1 | | | ±2 | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$... $T_{C\,max}$ | 7 | | 40 | 8 | | 80 | 15 | | 80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 2 | | | 3 | | | 3 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 6.3 | | | 7.3 | | | 7.3 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 45 | | | 40 | | | 35 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 75 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 2.5 | | | 2.5 | | | 2.5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 15 | | | 15 | | | 15 | | |
| $u_{i\,rfi}$ | RFI level at input, 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A [5] | | | A [4] | | | A [4] | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 82 | | | 77 | | | 86 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 750 | | | 750 | | | 750 | | V DC |

[1] See "Dynamic Characteristics"
[2] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly by 1 V max between $T_A$ = 46°C and 71°C ($T_C$ = 70°C and 95°C)
[3] Definitions according to VDE 0433, part 3
[4] With input filter FP 80 and $C_e$ = 470 µF/100 V (see "Accessories") connected between $U_{i\,i}$ and $G_i$
[5] With input filter FP 38 and $C_e$ = 470 µF/40 V (see "Accessories") connected between $U_{i\,i}$ and $G_i$

*Table 5b: Input and output data*

| Characteristics | | Conditions | PSR 152.5 min | typ | max | PSR 242 min | typ | max | PSR 362 min | typ | max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 14.91 | | 15.09 | 23.85 | | 24.14 | 35.78 | | 36.22 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 2.5 | | | 2.0 | | | 2.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 2.5 | | 3.25 | 2.0 | | 2.6 | 2.0 | | 2.6 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 70 | 110 | | 100 | 175 | | 150 | 250 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 70 | 100 | | 150 | 220 | | 200 | 270 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 40 | 55 | | 120 | 160 | | 125 | 160 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 180 | | | 210 | | | 250 | | |
| $t_d$ | Dynamic load transient time constant | | | 60 | | | 80 | | | 100 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | ±3 | | | ±5 | | | ±8 | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 19 | | 80 | 29 | | 80 | 42 | | 80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 4 | | | 5 | | | 6 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 12 | | | 19 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 35 | | | 35 | | | 40 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 150 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 2.5 | | | 2.5 | | | 2.5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 15 | | | 15 | | | 15 | | |
| $u_{i\,rfi}$ | RFI level at input, 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A [4] | | | A [4] | | | A [4] | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 88 | | | 91 | | | 94 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 750 | | | 750 | | | 750 | | V DC |

[1] See "Dynamic Characteristics"
[2] The minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltage increases linearly by 1 V max. between $T_A$ = 46°C and 71°C ($T_C$ = 70°C and 95°C)
[3] Definitions according to VDE 0433, part 3
[4] With input filter FP 80 and $C_e$ = 470 µF/100 V (see "Accessories") connected between $U_{i\,i}$ and $G_i$

## Description of Options

**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, CMOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

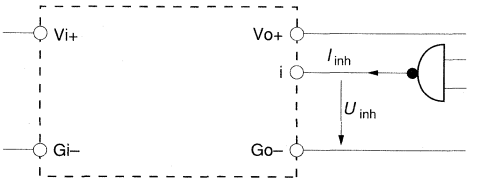



*Fig. 4*
*Definition of $I_{inh}$ and $U_{inh}$*

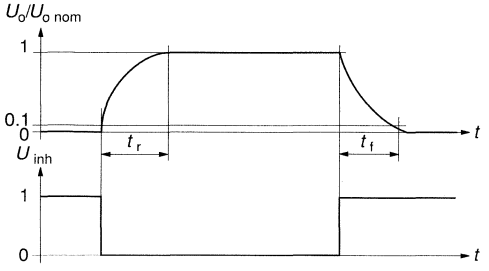



*Fig. 5*
*Output response as a function of inhibit signal*

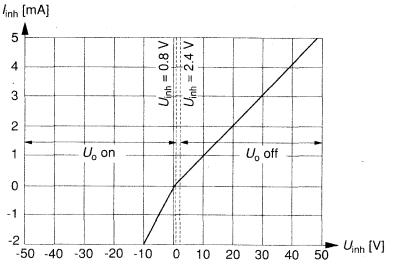



*Fig. 6*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 6: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}...U_{i\,max}$ | –10 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}...T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 2 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 4 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |

**Option R** Output Voltage Adjustment

**Note:** With open R-input, $U_o = 1.08\ U_{o\,nom}$ (Exception: With optipn Y, $U_o = 1.00\ U_{o\,nom}$)!

The output voltage $U_o$ can be adjusted either with an external resistor $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0...1.08 of $U_{o\,nom}$ (or 0...1.00 of $U_{o\,nom}$ with option Y). The minimum differential voltage $\Delta U_{io\,min}$ between input and output voltages as specified in relevant tables should be maintained.

Option R and P cannot be supported simultaneously.

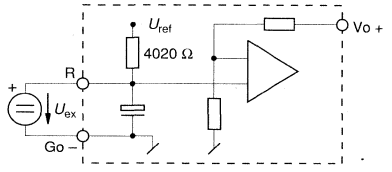



*Fig. 7*
*Voltage adjustment with $U_{ex}$*

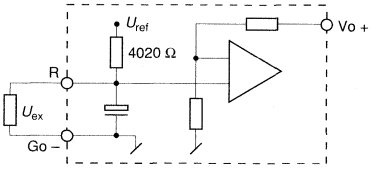



*Fig. 8*
*Voltage adjustment with $R_{ex}$*

**Voltage adjustment with $U_{ex}$** ($U_{ref}$ = 2.49 V ±4%)

Without option Y: $U_o \approx 1.08 \cdot U_{o\,nom} \cdot U_{ex} / U_{ref}$
With option Y: $U_o \approx U_{o\,nom} \cdot U_{ex} / U_{ref}$

**Caution:** $U_{ex}$ must neither exceed $U_{ref}$ (1.1 • $U_{ref}$ with option Y) nor be negative, or failure will occur!

**Voltage adjustment with $R_{ex}$ [Ω]**

Without option Y: $U_o \approx U_{o\,nom} \cdot 1.08 \cdot R_{ex} / (R_{ex} + 4020)$
$R_{ex} \approx 4020 \cdot U_o / (1.08 \cdot U_{o\,nom} - U_o)$

With option Y: $U_o \approx U_{o\,nom} \cdot R_{ex} / (R_{ex} + 4020)$
$R_{ex} \approx 4020 \cdot U_o / (U_{o\,nom} - U_o)$

All formulae give approximate values only.


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**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71\,°C$.

**Option P** Potentiometer

Option P excludes R function. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{io\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

**Option Y** PCB Soldering Pins

This option defines soldering pins of 1.0 × 0.5 × 6.5 mm, instead of the standard fast-on terminals of 2.8 × 0.5 × 6.5 mm. Modules with this option can be mounted onto printed circuit boards, providing through-plated finished hole size of Ø 1.3...1.5 mm.

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSR-family as recognized components up to an ambient temperature of $T_{A\,max} - 10$ K, given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have, in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71\,°C$ without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ± 0.3 mm unless otherwise specified.

European Projection

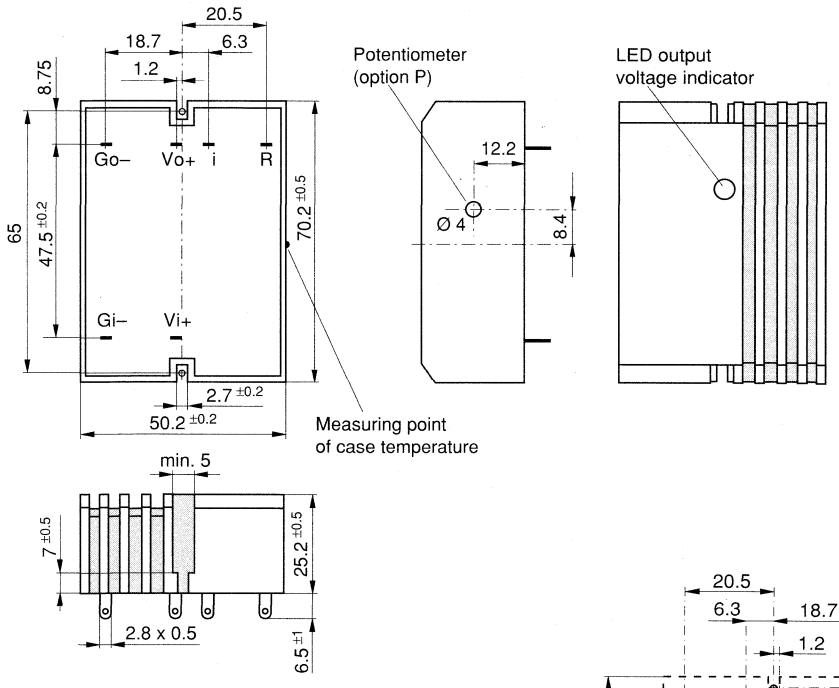



*Fig. 9*
*Case A01 (Weight 100 g)*

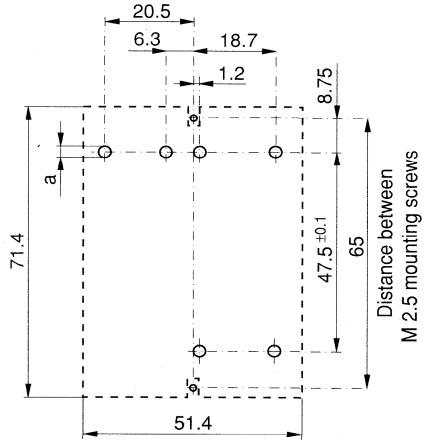
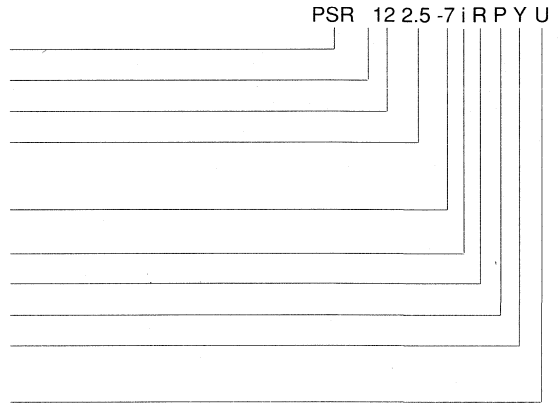



*Fig. 10*
*Case A01 hole locations for circuit board layout (component side view of PCB):*
*- - - = Space reserved for switching regulator*
*"a" = 3.0 mm x 0.7 mm slot or Ø 3.0 mm, through plated for hand or machine soldering (fast on)*
*"a" = Ø 1.3...1.5 mm with option Y pins*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case A01 ..... PSR
Blank .....
Nominal output voltage in volt ..... 5...36
Nominal output current in ampere ..... 2...4
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Small soldering pins 0.5 × 1.0 mm ..... Y
UL recognized component for $T_{A\,max}$ = 71 °C
(instead of 60 °C) ..... U

Example: PSR 122.5-7iPY = A positive switching regulator with a 12 V, 2.5 A output, ambient temperature range of –25...71 °C, inhibit input, potentiometer and small soldering pins.

### Product Marking

Main face: Specific type designation, input voltage range, nominal output voltage and current, applicable safety approval and recognition marks, degree of protection, Melcher patent nos. and company logo.

Cover: Pin allocation and warnings.

Side wall: Label with batch no., serial no. and data code comprising production site, modification status of main PCB and date of production.

# PSR: Positive Switching Regulators PSB-Family

**No input to output isolation**
**Single output of 12, 15, 24 or 36 V DC/60...180 W**
**Input voltage up to 80 V DC**

- High efficiency up to 96%
- Wide input voltage range
- Low input-to-output differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Two temperature ranges
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options | Superseded old type (phased-out) |
|---|---|---|---|---|---|---|---|
| 12 V | 5 A | 15...80 V | 40 V | 90% | PSB 125-7iR | -9, L, P, C, U | PSR 124-7 |
| 15 V | | 19...80 V | | 92% | PSB 155-7iR | | PSR 154-7 |
| 24 V | | 29...80 V | 50 V | 95% | PSB 245-7iR | | PSR 244-7 |
| 36 V | | 42...80 V | 60 V | 96% | PSB 365-7iR | | PSR 364-7 |

[1] See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSB family of positive switching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 80 V are specially designed for secondary switched and battery driven applications.
Case B02: Aluminium, black finish and self cooling.

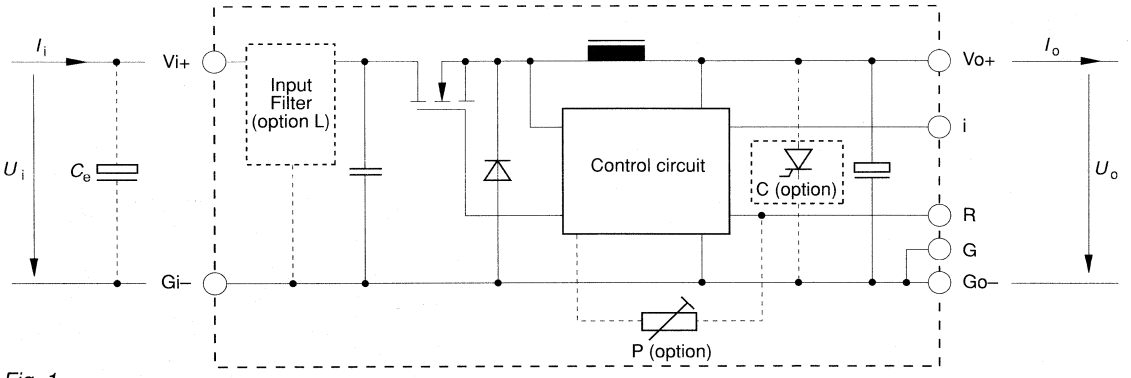



*Fig. 1*
*Block diagram*

**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**i Inhibit**

**Note:** With open i-input, output is enabled ($U_o$ = on)

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

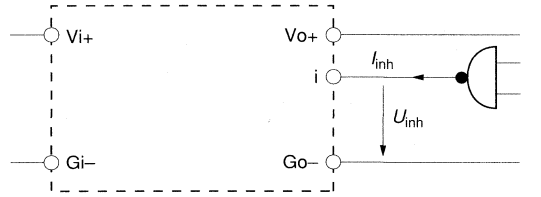



*Fig. 2*
*Definition of $I_{inh}$ and $U_{inh}$*

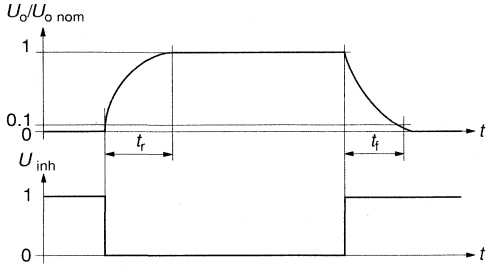



*Fig. 3*
*Output response as a function of inhibit signal*

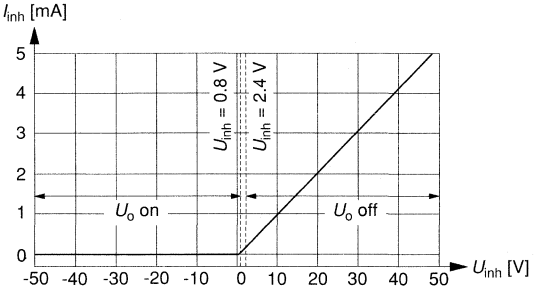



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

**Data**

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\ min}$...$U_{i\ max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\ min}$...$T_{C\ max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\ nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\ nom}/I_{o\ nom}$ | | 10 | | |
| $I_{i\ off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\ nom}$ | | 10 | | mA |





Edition 1/05 - © Melcher AG

### R External Output Voltage Adjustment

**Note:** With open R input, $U_o = U_{o\,nom}$.
(For superseded PSR types, $U_o = 1.08 \cdot U_{o\,nom}$)

R-input and option P cannot be supported simultaneously. The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

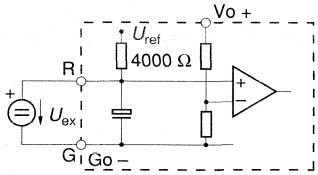



*Fig. 5*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±2%)

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V, nor be negative.

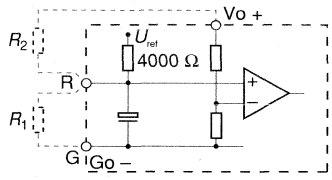



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:
$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \quad (U_{ref} = 2.5\ V \pm 2\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$°C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40°C | $T_C$ = 40°C | $T_C$ = 70°C | $T_C$ = 50°C | |
| | 624'000 h | 207'000 h | 96'000 h | 46'000 h | 13'000'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

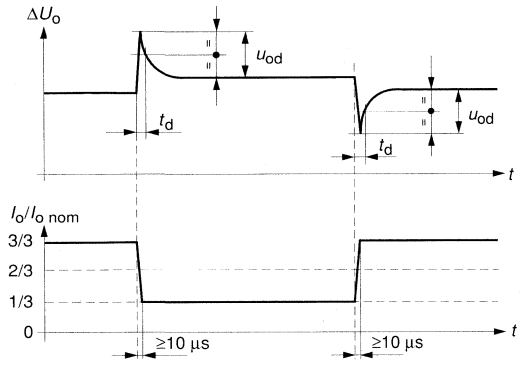



*Fig. 7*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

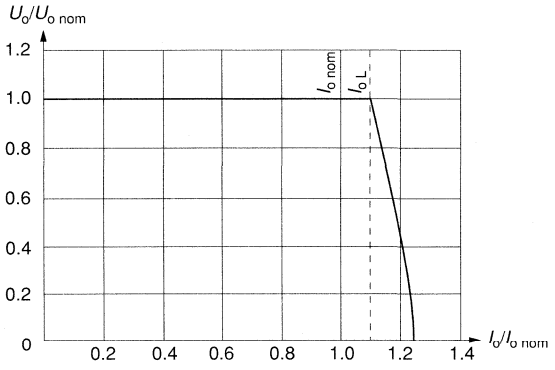



*Fig. 8*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Electrical Input and Output Data

General Conditions
– $T_A$ = +25°C, unless $T_C$ is specified
– With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSB 125 | | | PSB 155 | | | PSB 245 | | | PSB 365 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 11.92 | | 12.07 | 14.91 | | 15.09 | 23.85 | | 24.14 | 35.78 | | 36.22 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 5.0 | | | 5.0 | | | 5.0 | | | 5.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 5.0 | | 6.5 | 5.0 | | 6.5 | 5.0 | | 6.5 | 5.0 | | 6.5 | |
| $u_o$ | Output ripple voltage | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 40 | 75 | | 70 | 100 | | 100 | 220 | | 120 | 280 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 25 | 50 | | 40 | 75 | | 80 | 150 | | 110 | 200 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 20 | 35 | | 30 | 65 | | 80 | 120 | | 120 | 160 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ | | 100 | | | 100 | | | 120 | | | 180 | | |
| $t_d$ | Dynamic load transient time constant | $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 60 | | | 60 | | | 80 | | | 100 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient | $U_{i\,min}$...$U_{i\,max}$ | | | ±2 | | | ±3 | | | ±5 | | | ±8 | mV/K |
| | $\Delta U_o/\Delta T_C$ ($T_{C\,min}$...$T_{C\,max}$) | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ | 15 | | 80 | 19 | | 80 | 29 | | 80 | 42 | | 80 | V DC |
| $\Delta U_{i\,o\,m}$ | Min. diff. voltage $U_i$ - $U_o$ [2] | $T_{C\,min}$...$T_{C\,max}$ | | 3 | | | 4 | | | 5 | | | 6 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 7.3 | | | 12 | | | 19 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0, $U_{i\,min}$...$U_{i\,max}$ | | | 35 | | | 35 | | | 35 | | | 40 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 150 | | | 150 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 180 | | | 180 | | | 180 | | | 180 | | A |
| $t_{i\,s}$ | Rise time [3] | with option L | | 15 | | | 15 | | | 15 | | | 15 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 100 | | | 100 | | | 100 | | | 100 | | |
| $u_{i\,RFI}$ | Input RFI level, VDE 0871 [4] | $I_{o\,nom}$, $U_{i\,min}$...$U_{i\,max}$ | | | B | | | B | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 90 | | | 92 | | | 95 | | | 96 | | % |
| **Isolation** | | | | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs and outputs interconnected | | 750 | | | 750 | | | 750 | | | 750 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_C$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 120 µF/100 V e.g. Nichicon PF(M) series or equivalent

## Description of Options

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71\,°C$.

---

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 60 $mV_{rms}$. A reduction can be achieved by insertion of a capacitor across the input (e.g. plastic foil between Vi+ and Gi–).

The input impedance of the switching regulator at 120 kHz is about 17 Ω. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 22\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 2200\ Hz/f_i \cdot 1V$$

---

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

---

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | 12 V | | 15 V | | 24 V | | 36 V | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | min | max | min | max | |
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ | 13.5 | 16 | 16.5 | 19 | 27 | 31 | 40 | 45.5 | V |
| $t_s$ | Delay time | $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | | 1.5 | | 1.5 | | 1.5 | | 1.5 | µs |

---

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSB family as recognized components up to an ambient temperature of $T_{A\,max} - 10$ K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71\,°C$ without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

European Projection

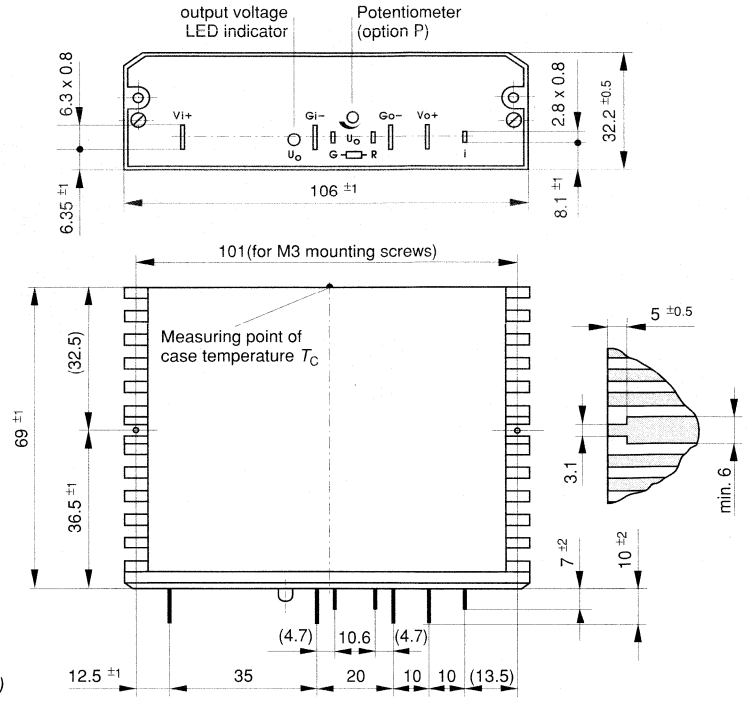



*Fig. 9*
*Case B02 (weight 230 g)*

## Type Key and Product Marking

### Type Key

PSB 12 5 -7 L i R P C U

| | |
|---|---|
| Positive switching regulator in case B02 | PSB |
| Blank | |
| Nominal output voltage in volt | 12...36 |
| Nominal output current in ampere | 5 |
| Ambient temperature range | |
| $T_A$ = –25...71°C | -7 |
| $T_A$ = –40...71°C | -9 |
| Input filter | L |
| Inhibit input | i |
| External output voltage adjustment | R |
| Potentiometer | P |
| Thyristor-Crowbar | C |
| UL recognized component for $T_{A\,max}$ = 71°C (instead of 60°C) | U |

Example: PSB 125-7LiPC = A positive switching regulator with a 12 V, 5 A output, ambient temperature range of –25...71°C, input filter, inhibit input, potentiometer and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometer and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

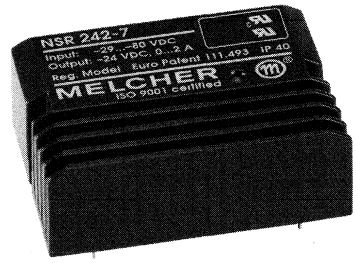
# NSR: Negative Switching Regulators

# NSR-Family

**No input to output isolation**
**Single output of –5, –12, –15, –24 or –36 V DC/15...72 W**
**Input voltage up to –80 V DC**



- High efficiency up to 94%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Continuous no-load and short-circuit proof
- Parallel configurations possible
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\ nom}$ | Nominal output current $I_{o\ nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\ nom}$ | Efficiency $\eta$ | Type designation | Options |
|---|---|---|---|---|---|---|
| –5 V | 4 A [2] | –7...–40 V | –20 V | 82% | NSR 54-7 | -9, i, P, R, Y, U |
| | 3 A | –8...–80 V | –40 V | 77% | NSR 53-7 | |
| –12 V | 2.5 A | –15...–80 V | | 86% | NSR 122.5-7 | |
| –15 V | | –19...–80 V | | 88% | NSR 152.5-7 | |
| –24 V | 2 A | –29...–80 V | –50 V | 91% | NSR 242-7 | |
| –36 V | | –42...–80 V | –60 V | 94% | NSR 362-7 | |

[1] See also data $\Delta U_{io\ min}$ (min. differential voltage $U_i - U_o$).
[2] Regulator with –5 V, 5 A (NSA 55) available on request. Ask for data.

## Description

The NSR family of negative switching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response.

The modules are specially designed for secondary switched and battery driven applications with positive system ground.
Case: Aluminium, black finish and self cooling.

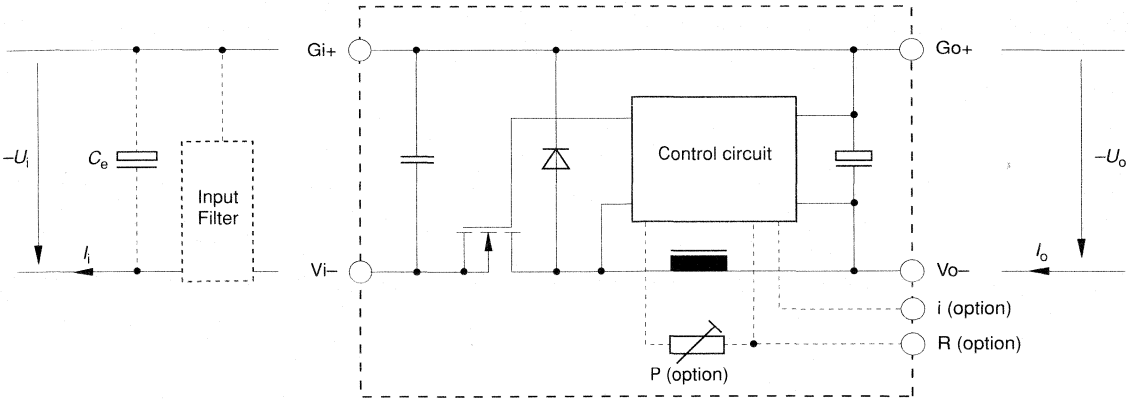



*Fig. 1*
*Block Diagram*

**External input circuitry**

An external input filter FN 38 or FN 80 (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 0.3 m (0.5 m twisted). For long connection lines the use of the external filter is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test | Method | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5 IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7 IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26 IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8 IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.7 mm (10...60 Hz)<br>10 $g_n$ = 98 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |

*Table 3: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 4: MTBF and device hours*

| MTBF | Ground Fixed | | Ground Mobile | | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217D | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | |
| | 160'000 h | 70'000 h | 45'000 h | 22'000 h | 1'300'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With option P or R, output voltage $U_o$ = $U_{o\,nom}$ at $I_{o\,nom}$

*Table 5a: Input and output data*

| Characteristics | | Conditions | NSR 54 min | NSR 54 typ | NSR 54 max | NSR 53 min | NSR 53 typ | NSR 53 max | NSR 122.5 min | NSR 122.5 typ | NSR 122.5 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | –4.97 | | –5.03 | –4.97 | | –5.03 | –11.92 | | –12.07 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 4.0 | | | 3.0 | | | 2.5 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$... $T_{C\,max}$ | 4.0 | | 5.2 | 3.0 | | 3.9 | 2.5 | | 3.25 | A |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 25 | 45 | | 35 | 65 | | 50<br>60 | 75<br>90 [1] | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 30 | 45 | | 30 | 45 | | 50<br>60 | 75<br>90 [1] | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0... $I_{o\,nom}$ | | 20 | 25 | | 20 | 25 | | 35<br>40 | 45<br>50 [1] | |
| $u_{o\,d}$ | Dynamic control deviation [2] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 200 | | | 100 | | | 180 | | |
| $t_d$ | Dynamic load transient time constant [2] | | | 40 | | | 50 | | | 60 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$... $T_{C\,max}$ | | | ±1 | | | ±1 | | | ±2 | mV/K |
| | | $I_o$ = 0... $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0... $I_{o\,nom}$ $T_{C\,min}$... $T_{C\,max}$ | –7 | | –40 | –8 | | –80 | –15 | | –80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [3] | | | –2 | | | –3 | | | –3 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | –6.3 | | | –7.3 | | | –7.3 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 45 | | | 40 | | | 35 | mA |
| $I_{i\,m}$ | Peak value of inrush current [4] | $U_{i\,nom}$ | | 75 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [4] | | | 2.5 | | | 2.5 | | | 2.5 | | µs |
| $t_{i\,r}$ | Tail half value time [4] | | | 15 | | | 15 | | | 15 | | |
| $u_{i\,rfi}$ | RFI level at input, 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A [6] | | | A [5] | | | A [5] | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 82 | | | 77 | | | 86 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | | 500 | | | 500 | | V DC |

[1] Lower row represents option -9 data only
[2] See "Dynamic Characteristics"
[3] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly by 1 V max between $T_A$ = 46°C and 71°C ($T_C$ = 70°C and 95°C)
[4] Definitions according to VDE 0433, part 3
[5] With FN 80 and $C_e$ = 470 µF (see "Accessories")
[6] With FN 38 and $C_e$ = 470 µF (see "Accessories")

*Table 5b: Input and output data*

| Characteristics | | Conditions | NSR 152.5 min | NSR 152.5 typ | NSR 152.5 max | NSR 242 min | NSR 242 typ | NSR 242 max | NSR 362 min | NSR 362 typ | NSR 362 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | –14.91 | | –15.09 | –23.85 | | –24.14 | –35.78 | | –36.22 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 2.5 | | | 2.0 | | | 2.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 2.5 | | 3.25 | 2.0 | | 2.6 | 2.0 | | 2.6 | A |
| $u_o$ [1] | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 70<br>140 | 110<br>220 | | 100<br>125 | 175<br>220 | | 150<br>160 | 250<br>270 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ [1] | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 70<br>150 | 100<br>220 | | 150<br>180 | 220<br>270 | | 200<br>275 | 270<br>370 | mV |
| $\Delta U_{o\,I}$ [1] | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0... $I_{o\,nom}$ | | 40<br>120 | 55<br>160 | | 120<br>170 | 160<br>220 | | 125<br>250 | 160<br>320 | mV |
| $u_{o\,d}$ | Dynamic control deviation [2] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3 \cdot I_{o\,nom}$ | | 180 | | | 210 | | | 250 | | mV |
| $t_d$ | Dynamic load transient time constant [2] | | | 60 | | | 80 | | | 100 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0... $I_{o\,nom}$ | | | ±3 | | | ±5 | | | ±8 | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0... $I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | –19 | | –80 | –29 | | –80 | –42 | | –80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [3] | | | –4 | | | –5 | | | –6 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | –7.3 | | | –12 | | | –19 | | V |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 35 | | | 35 | | | 40 | mA |
| $I_{i\,m}$ | Peak value of inrush current [4] | $U_{i\,nom}$ | | 150 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [4] | | | 2.5 | | | 2.5 | | | 2.5 | | µs |
| $t_{i\,r}$ | Tail half value time [4] | | | 15 | | | 15 | | | 15 | | µs |
| $u_{i\,rfi}$ | RFI level at input, 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A [5] | | | A [5] | | | A [5] | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 88 | | | 91 | | | 94 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | | 500 | | | 500 | | V DC |

[1] Lower row represtents option -9 data only
[2] See "Dynamic Characteristics"
[3] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly by 1 V max between $T_A$ = 46°C and 71°C ($T_C$ = 70°C and 95°C)
[4] Definitions according to VDE 0433, part 3
[5] With FN 80 and $C_e$ = 470 µF (see "Accessories")

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

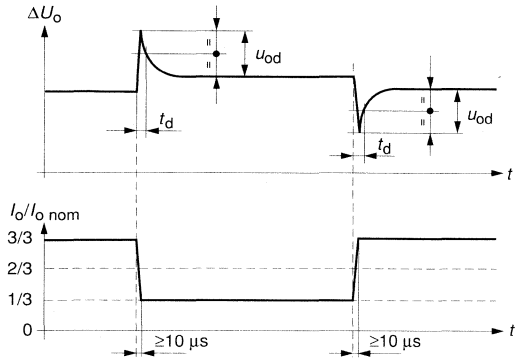



*Fig. 2*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase measured at the measuring point of case temperature $T_C$ (see "Mechanical Data).

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

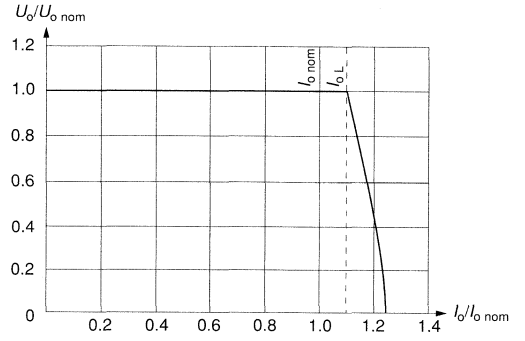



*Fig. 3*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 40. With option P this reduces to IP 20.

## Description of Options

**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

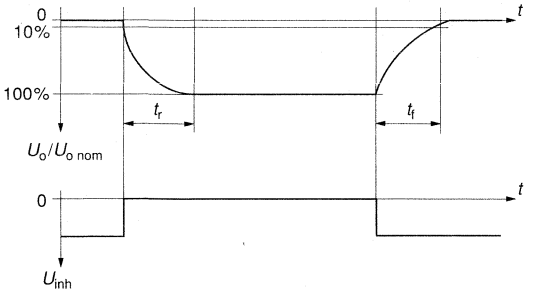



*Fig. 5*
*Output response as a function of inhibit signal*

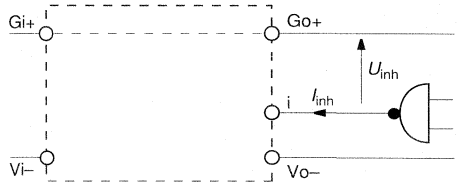



*Fig. 4*
*Definition of $I_{inh}$ and $U_{inh}$*

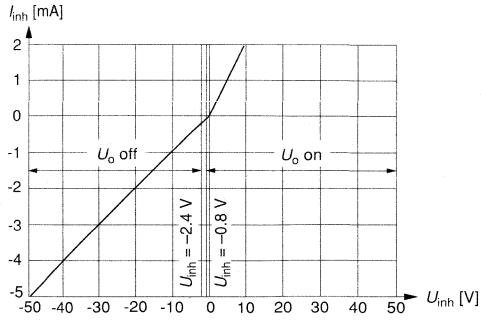



*Fig. 6*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 6: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –0.8 | | +10 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | –50 | | –2.4 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 2 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 4 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |

**Option R** Output voltage adjustment

**Note:** With open R-input, $U_o = 1.08\ U_{o\,nom}$ (Exception: With option Y, $U_o = 1.00\ U_{o\,nom}$)!

The output voltage $U_o$ can be adjusted either with an external resistor $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0.65...1.08 of $U_{o\,nom}$ (or 0.65...1.00 of $U_{o\,nom}$ with option Y). The minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in relevant tables must be maintained.

Option R and P cannot be supported simultaneously.

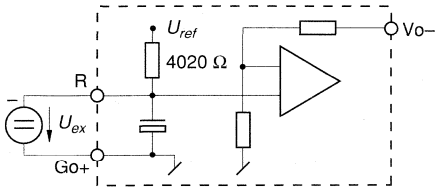



*Fig. 7*
*Voltage adjustment with $U_{ex}$ [V]*

Without option Y: $U_o \approx 1.08 \cdot U_{o\,nom} \cdot U_{ex} / U_{ref}$
With option Y: $U_o \approx U_{o\,nom} \cdot U_{ex} / U_{ref}$
($U_{ref}$ = –2.49 V ±4%)

**Caution:** $U_{ex}$ must neither exceed $U_{ref}$ (1.1 • $U_{ref}$ with option Y) nor be positive, or failure will occur!

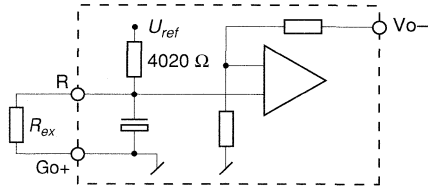



*Fig. 8*
*Voltage adjustment with $R_{ex}$ [Ω]*

Without option Y: $U_o \approx U_{o\,nom} \cdot 1.08 \cdot R_{ex} / (R_{ex} + 4020)$
$R_{ex} \approx 4020 \cdot U_o / (1.08 \cdot U_{o\,nom} - U_o)$
With option Y: $U_o \approx U_{o\,nom} \cdot R_{ex} / (R_{ex} + 4020)$
$R_{ex} \approx 4020 \cdot U_o / (U_{o\,nom} - U_o)$

All formulae give approximate values only.

2.2

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71\,°C$

**Option P** Potentiometer

Option P excludes R function. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

**Option Y** PCB Soldering Pins

This option defines soldering pins of 1.0 × 0.5 × 6.5 mm, instead of the standard fast-on terminals of 2.8 × 0.5 × 6.5 mm. Modules with this option can be mounted onto printed circuit boards, providing through-plated finished hole size of Ø 1.3...1.5 mm.

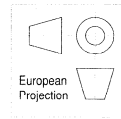
**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the NSR-family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 K, given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71\,°C$ without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.



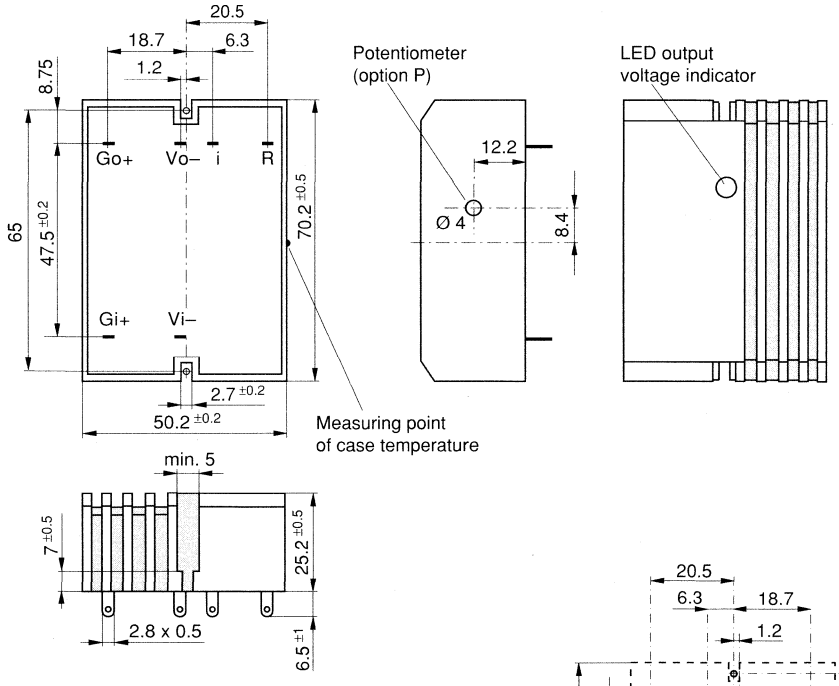




*Fig. 9*
*Case A01 (Weight 100 g)*

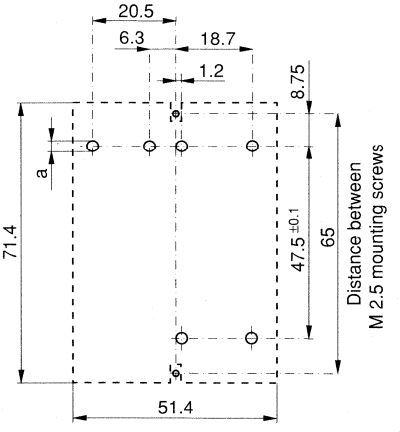
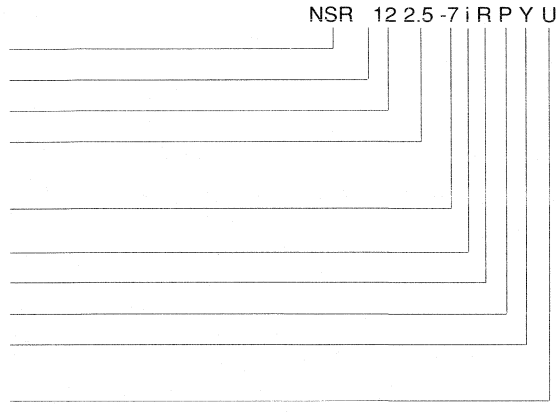



*Fig. 10*
*Case A01 hole locations for circuit board layout (component side view of PCB):*
*- - - = Space reserved for switching regulator*
*"a" = 3.0 mm × 0.7 mm slot or Ø 3.0 mm, through plated for hand or machine soldering (fast on)*
*"a" = Ø 1.3...1.5 mm with option Y pins*


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## Type Key and Product Marking

### Type Key




Negative switching regulator in case A01 ..... NSR
Blank .....
Nominal output voltage in volt ..... –5...–36
Nominal output current in ampere ..... 2...4
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Small soldering pins 0.5 × 1.0 mm ..... Y
UL recognized component for $T_{A\,max}$ = 71 °C
(instead of 60 °C) ..... U

Example: NSR 122.5-7iP = A negative switching regulator with a –12 V, 2.5 A output, ambient temperature range of –25...71 °C, inhibit input and potentiometer.

### Product Marking

Main face: Specific type designation, input voltage range, nominal output voltage and current, applicable safety approval and recognition marks, degree of protection, Melcher patent nos. and company logo.

Cover: Pin allocation and warnings.

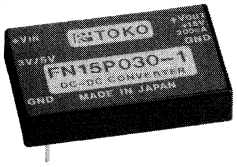
Side wall: Label with batch no., serial no. and data code comprising production site, modification status of main PCB and date of production.

# Positive/Negative Switching Regulators FN-Family

**No input to output isolation**
**Single output (positive or negative) of 5, 12 or 15 V DC/1.5...3 W**
**Double output (positive/negative) of ±12 or ±15 V DC/1.5...3 W**
**Input voltage from 2.7 V up to 7 V DC**

2.3

- 2.7...7 V input range
- High efficiency and low heat generation
- High reliability and long life
- Good output stability
- Silicon packed: high immunity against humidity
- No electrolytic capacitors used inside
- Choke coils for optimum EMI filtering (optional)
- Suitable for rack 3 TE (15.24 mm)




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## Type Survey

*Table 1a: Survey of 1.5 W types*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_o$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Rated output power $P_{o\,max}$ |
|---|---|---|---|---|---|---|
| +5 V | 3...300 mA | 2.7...4 V | 3 V | 79% | FN05P015-0 | 1.5 W |
| +12 V | 2...125 mA | 2.7...7 V | 5 V | | FN12P015-1 | |
| +15 V | 2...100 mA | | | | FN15P015-1 | |
| –5 V | 3...300 mA | | | 71% | FN05N015-1 | |
| –12 V | 2...125 mA | | | | FN12N015-1 | |
| –15 V | 2...100 mA | | | | FN15N015-1 | |
| ±12 V | ±18...±62 mA | | | | FN12D015-1 | |
| ±15 V | ±15...±50 mA | | | | FN15D015-1 | |

*Table 1b: Survey of 3.0 W types*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_o$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Rated output power $P_{o\,max}$ |
|---|---|---|---|---|---|---|
| +5 V | 6...600 mA | 2.7...4 V | 3 V | 79% | FN05P030-0 | 3.0 W |
| +12 V | 3...250 mA | 2.7...7 V | 5 V | | FN12P030-1 | |
| +15 V | 2...200 mA | | | | FN15P030-1 | |
| –5 V | 6...600 mA | | | 70% | FN05N030-1 | |
| –12 V | 3...250 mA | | | | FN12N030-1 | |
| –15 V | 2...200 mA | | | | FN15N030-1 | |
| ±12 V | ±37...±125 mA | | | | FN12D030-1 | |
| ±15 V | ±30...±100 mA | | | | FN15D030-1 | |

## Description

The FN family of swiching regulators (DC-DC converters) offers low profile, high stability and high reliability. The regulators are suited to all kind of applications in electronic systems, specially to control equipment, measuring instruments, telecommunications and general purpose, where high reliability is paramount. A full range of specifications and innovative optional choke coils are available to suit a wide variety of technical needs.






*Fig. 1*
*External circuitry without chokes*

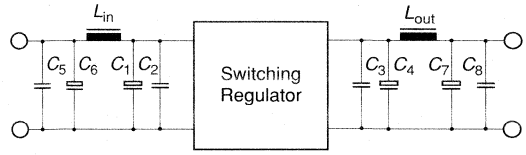



*Fig. 2*
*External circuitry including chokes*

### Filtering Recommendations

Two different design-in circuits can be recommended:

a) circuit design by means of adding just input and output capacitors in order to reduce ripple and noise to a moderate value

b) circuit design by adding input and output π-filtering by means of capacitors and filtering chokes (in series connection) in order to achieve enhanced ripple and noise behaviour

### Notes:

Capacitors and chokes should be within 20 mm of regulator terminals;
$C_2$ and $C_3$: 0.047 µF ceramic capacitors
$C_5$ and $C_8$: 0.01 µF ceramic capacitors
$C_6$ = 82 µF
$C_1$, $C_4$ and $C_7$: see table below
$L_{in}$ = 22 µH (TOKO 8RDB-220M),
$L_{out}$ = 33 µH (TOKO 8RDB-330M)

*Table 2a: External capacitors for 1.5 W types*

| $U_i$ = 3 V $C_i$ [µF] | $U_i$ = 5 V $C_i$ [µF] | Type | $I_{o\,max}$ [mA] | $C_4$ [µF] | $C_7$ [µF] |
|---|---|---|---|---|---|
| 1000 | 470 | FN 05P015-0 | 300 | 330 | 82 |
| | | FN 12P015-1 | 125 | 120 | 56 |
| | | FN 15P015-1 | 100 | 82 | 39 |
| | | FN 05N015-1 | 300 | 680 | 82 |
| | | FN 12N015-1 | 125 | 120 | 56 |
| | | FN 15N015-1 | 100 | 82 | 39 |
| | | FN 12D015-1 | ±62 | 2×120 | 2x56 |
| | | FN 15D015-1 | ±50 | 2×82 | 2x39 |

*Table 2b: External capacitors for 3.0 W types*

| $U_i$ = 3 V $C_i$ [µF] | $U_i$ = 5 V $C_i$ [µF] | Type | $I_{o\,max}$ [mA] | $C_4$ [µF] | $C_7$ [µF] |
|---|---|---|---|---|---|
| 2200 | 1000 | FN 05P030-0 | 600 | 680 | 82 |
| | | FN 12P030-1 | 250 | 330 | 56 |
| | | FN 15P030-1 | 200 | 270 | 39 |
| | | FN 05N030-1 | 600 | 1000 | 82 |
| | | FN 12N030-1 | 250 | 330 | 56 |
| | | FN 15N030-1 | 200 | 270 | 39 |
| | | FN 12D030-1 | ±125 | 2×330 | 2×56 |
| | | FN 15D030-1 | ±100 | 2×180 | 2×39 |

## Derating Characteristics

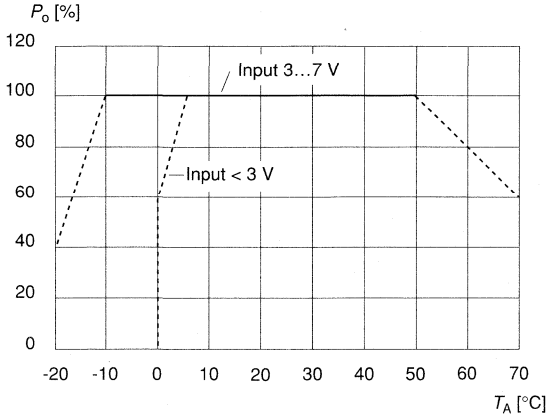



*Fig. 3*
*Output power vs. ambient temperature*

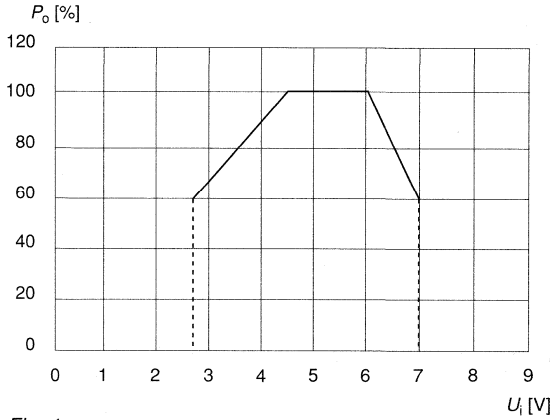



*Fig. 4*
*Output power vs. input voltage*

## Electrical Input and Output Data

General Condition; $T_A$ = +25°C, see also "Derating Characteristics"

*Table 3a: Input and output data 1.5 W types with positive output*

| Characteristics | | Conditions | FN 05P015-0 min | FN 05P015-0 typ | FN 05P015-0 max | FN 12P015-1 min | FN 12P015-1 typ | FN 12P015-1 max | FN 15P015-1 min | FN 15P015-1 typ | FN 15P015-1 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,min}$...$U_{i\,max}$ | 4.75 | | 5.25 | 11.40 | | 12.60 | 14.25 | | 15.75 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | 3 | | 300 | 2 | | 125 | 2 | | 100 | mA |
| $u_o$ | Output ripple and noise | $U_{i\,nom}$, with choke | | 120 | | | 120 | | | 120 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ | | ±1.5 | | | ±1.5 | | | ±1.5 | | % |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_{o\,min}$...$I_{o\,max}$ | | ±1 | | | ±1 | | | ±1 | | |
| $\Delta U_o/\Delta T$ | Thermal coefficient | $U_{i\,nom}$, $I_{o\,min}$...$I_{o\,max}$ | | ±1 | | | ±1 | | | ±1 | | |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_{o\,min}$...$I_{o\,max}$ | 2.7 | | 4.0 | 2.7 | | 7.0 | 2.7 | | 7.0 | V DC |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 79 | | | 79 | | | 79 | | % |

*Table 3b: Input and output data 1.5 W types with negative output*

| Characteristics | | Conditions | FN 05N015-1 min | FN 05N015-1 typ | FN 05N015-1 max | FN 12N015-1 min | FN 12N015-1 typ | FN 12N015-1 max | FN 15N015-1 min | FN 15N015-1 typ | FN 15N015-1 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,min}$...$U_{i\,max}$ | –4.75 | | –5.25 | –11.40 | | –12.60 | –14.25 | | –15.75 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | 3 | | 300 | 2 | | 125 | 2 | | 100 | mA |
| $u_o$ | Output ripple and noise | $U_{i\,nom}$, with choke | | 120 | | | 120 | | | 120 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ | | ±1.5 | | | ±1.5 | | | ±1.5 | | % |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_{o\,min}$...$I_{o\,max}$ | | ±1 | | | ±1 | | | ±1 | | |
| $\Delta U_o/\Delta T$ | Thermal coefficient | $U_{i\,nom}$, $I_{o\,min}$...$I_{o\,max}$ | | ±1 | | | ±1 | | | ±1 | | |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_{o\,min}$...$I_{o\,max}$ | 2.7 | | 7.0 | 2.7 | | 7.0 | 2.7 | | 7.0 | V DC |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 71 | | | 71 | | | 71 | | % |

*Table 3c: Input and output data 1.5 W types with double output*

| Characteristics | | Conditions | | FN 12D015-1 min | FN 12D015-1 typ | FN 12D015-1 max | FN 15D015-1 min | FN 15D015-1 typ | FN 15D015-1 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,min}$...$U_{i\,max}$ | | ±11.40 | | ±12.60 | ±14.25 | | ±15.75 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | ±18 | | ±62 | ±15 | | ±50 | mA |
| $u_o$ | Output ripple and noise | $U_{i\,nom}$, with choke | | | 120 | | | 120 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ | | | ±1.5 | | | ±1.5 | | % |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_{o\,min}$...$I_{o\,max}$ | | | ±1 | | | ±1 | | |
| $\Delta U_o/\Delta T$ | Thermal coefficient | $U_{i\,nom}$, $I_{o\,min}$...$I_{o\,max}$ | | | ±1 | | | ±1 | | |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage | $I_{o\,min}$...$I_{o\,max}$ | | 2.7 | | 7.0 | 2.7 | | 7.0 | V DC |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | | 71 | | | 71 | | % |

General condition: $T_A$ = +25°C, see also "Derating Characteristics"

*Table 4a: Input and output data 3.0 W types with positive output*

| Characteristics | | Conditions | FN 05P030-0 min | typ | max | FN 12P030-1 min | typ | max | FN 15P030-1 min | typ | max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,min}$...$U_{i\,max}$ | 4.75 | | 5.25 | 11.40 | | 12.60 | 14.25 | | 15.75 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | 6 | | 600 | 3 | | 250 | 2 | | 200 | mA |
| $u_o$ | Output ripple and noise | $U_{i\,nom}$, with choke | | 120 | | | 120 | | | 120 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ | | ±1.5 | | | ±1.5 | | | ±1.5 | | % |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_{o\,min}$...$I_{o\,max}$ | | ±1 | | | ±1 | | | ±1 | | |
| $\Delta U_o/\Delta T$ | Thermal coefficient | $U_{i\,nom}$, $I_{o\,min}$...$I_{o\,max}$ | | ±1 | | | ±1 | | | ±1 | | |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_{o\,min}$...$I_{o\,max}$ | 2.7 | | 4.0 | 2.7 | | 7.0 | 2.7 | | 7.0 | V DC |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 79 | | | 79 | | | 79 | | % |

*Table 4b: Input and output data 3.0 W types with negative output*

| Characteristics | | Conditions | FN 05N030-1 min | typ | max | FN 12N030-1 min | typ | max | FN 15N030-1 min | typ | max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,min}$...$U_{i\,max}$ | –4.75 | | –5.25 | –11.40 | | –12.60 | –14.25 | | –15.75 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | 6 | | 600 | 3 | | 250 | 2 | | 200 | mA |
| $u_o$ | Output ripple and noise | $U_{i\,nom}$, with choke | | 140 | | | 120 | | | 120 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ | | ±1.5 | | | ±1.5 | | | ±1.5 | | % |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_{o\,min}$...$I_{o\,max}$ | | ±1 | | | ±1 | | | ±1 | | |
| $\Delta U_o/\Delta T$ | Thermal coefficient | $U_{i\,nom}$, $I_{o\,min}$...$I_{o\,max}$ | | ±1 | | | ±1 | | | ±1 | | |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_{o\,min}$...$I_{o\,max}$ | 2.7 | | 7.0 | 2.7 | | 7.0 | 2.7 | | 7.0 | V DC |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 70 | | | 70 | | | 70 | | % |

*Table 4c: Input and output data 3.0 W types with double output*

| Characteristics | | Conditions | | FN 12D030-1 min | typ | max | FN 15D030-1 min | typ | max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,min}$...$U_{i\,max}$ | | ±11.40 | | ±12.60 | ±14.25 | | ±15.75 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | ±37 | | ±125 | ±30 | | ±100 | mA |
| $u_o$ | Output ripple and noise | $U_{i\,nom}$, with choke | | | 120 | | | 120 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ | | | ±1.5 | | | ±1.5 | | % |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_{o\,min}$...$I_{o\,max}$ | | | ±1 | | | ±1 | | |
| $\Delta U_o/\Delta T$ | Thermal coefficient | $U_{i\,nom}$, $I_{o\,min}$...$I_{o\,max}$ | | | ±1 | | | ±1 | | |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage | $I_{o\,min}$...$I_{o\,max}$ | | 2.7 | | 7.0 | 2.7 | | 7.0 | V DC |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | | 70 | | | 70 | | % |

2.3

## Immunity to Environmental Conditions

*Table 5: Temperature specifications*

| Temperature | | | Operating | | Storage | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature [1] | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,min}$...$I_{o\,max}$ | –10 | 50 | –25 | 85 | °C |
| *r.H.* | Relative humidity | | | 95 | | 95 | % |

[1] See also "Derating Characteristics"

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise stated

European Projection

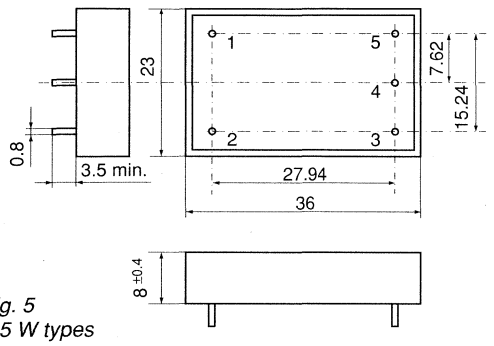



*Fig. 5*
*1.5 W types*

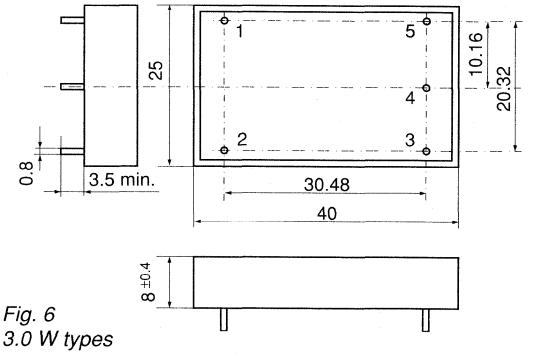



*Fig. 6*
*3.0 W types*

*Table 6: Pin assignments*

| Type of regulator | $P_o$ | Pin no. 1 | Pin no. 2 | Pin no. 3 | Pin no. 4 | Pin no. 5 |
|---|---|---|---|---|---|---|
| FN 05P015-0, FN 12P015-1, FN 15P015-1 | 1.5 W | GND | Vi+ | Vo+ | GND | n.a. |
| FN 05N015-1, FN 12N015-1, FN 15N015-1 | | GND | Vi+ | n.a. | GND | Vo- |
| FN 12D015-1, FN 12D015-1 | | GND | Vi+ | Vo+ | COMMON | Vo- |
| FN 05P030-0, FN 12P030-1, FN 15P030-1 | 3.0 W | GND | Vi+ | Vo+ | GND | n.a. |
| FN 05N030-1, FN 12N030-1, FN 15N030-1 | | GND | Vi+ | n.a. | GND | Vo- |
| FN 12D030-1, FN 15D030-1 | | GND | Vi+ | Vo+ | COMMON | Vo- |

n.a. –> not assembled

## Type Key and Product Marking

### Type Key

FN 05 P 015 - 1

Family, (DC-DC converter) ..... FN
Blank .....
Nominal output voltage in volt ..... 5...15
Output configuration: positive ..... P
negative ..... N
double (±, common ground) .... D
Nominal output power: 1.5 watts ..... 015
3.0 watts ..... 030
Dash .....
Version ..... 0...1

### Product Marking

Main face: Manufacturer, specific type designation, input and output pin designation, input and output voltage(s)

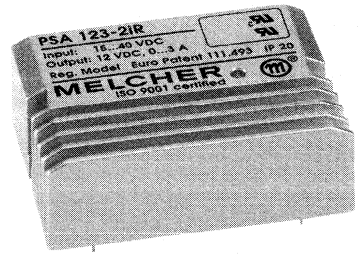

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# PSR: Positive Switching Regulators PSA-Family

**No input to output isolation**
**Single output of 5.1, 12, 15 or 24 V DC/10...60 W**
**Input voltage up to 60 V DC**



- High efficiency up to 91%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Option package |
|---|---|---|---|---|---|---|
| 5.1 V | 2.0 A | 8...40 V | 20 V | 74% | PSA 5A2-2 | iRY |
| | 5.0 A | 7...35 V | | 81% | PSA 5A5-2 | |
| 12 V | 3.0 A | 15...40 V | | 86% | PSA 123-2 | |
| 15 V | | 19...40 V | 30 V | 88% | PSA 153-2 | |
| 24 V | 2.5 A | 29...60 V | 40 V | 91% | PSA 242.5-2 | |

[1] See also data $\Delta U_{io\,min}$.

## Description

The PSA family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 60 V are specially designed for secondary switched and battery driven applications.
Case A01: Aluminium, self cooling.

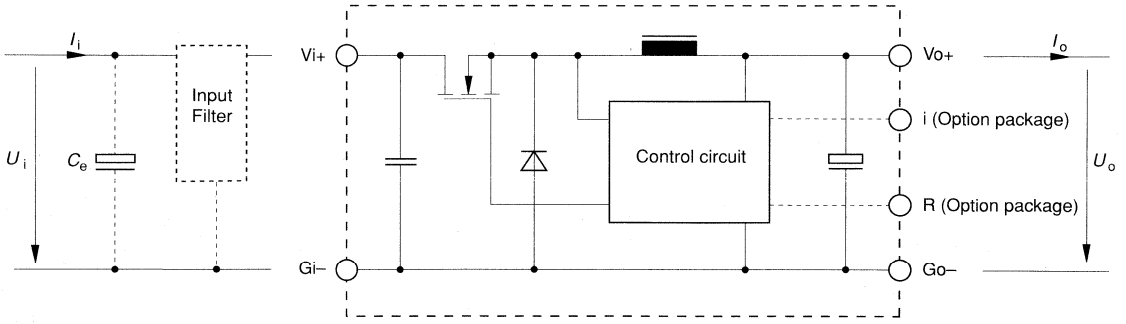



*Fig. 1*
*Block Diagram*

**External input circuitry**

An external input filter FP 38 or FP 80 (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 0.3 m (0.5 m twisted). For long connection lines the use of the external filter is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 in each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 in each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s² (60...150 Hz)<br>3.75 h (1.25 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 2: | 4 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 1: | 0.5 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperture specifications*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | (Not operational) | –25 | 100 | |

*Table 4: MTBF*

| MTBF | Ground Benign |
|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40 °C |
| | 580'000 h |





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## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

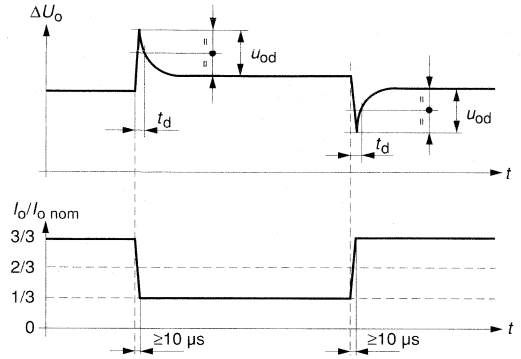



*Fig. 2*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 50 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 80 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data).

Under practical operating conditions, the ambient temperature $T_A$ may exceed 50 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 80 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages which are at the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

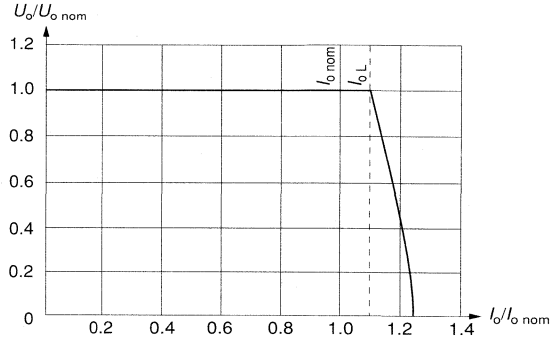



*Fig. 3*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Recognition

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With option package iRY, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 5a: Input and output data*

| Characteristics | | Conditions | PSA 5A2 min | PSA 5A2 typ | PSA 5A2 max | PSA 5A5 min | PSA 5A5 typ | PSA 5A5 max | PSA 123 min | PSA 123 typ | PSA 123 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.05 | | 5.15 | 5.05 | | 5.15 | 11.60 | | 12.40 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 2.0 | | | 5.0 | | | 3.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 2.0 | | 2.6 | 5.0 | | 6.5 | 3.0 | | 3.9 | A |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | | 75 | | | 75 | | | 240 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | | 100 | | | 100 | | | 240 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | | 100 | | | 100 | | | 180 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 150 | | | 300 | | | 360 | | |
| $t_d$ | Dynamic load transient time constant | | | 100 | | | 100 | | | 120 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | ±1 | | | ±1 | | | ±2 | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 8 | | 40 | 7 | | 35 | 15 | | 40 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | | | 3 | | | 2 | | | 3 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 6.3 | | | 7.3 | | |
| $I_{i\,0}$ | No load Input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 50 | | | 50 | | | 50 | mA |
| $I_{i\,m}$ | Peak value of inrush current [2] | $U_{i\,nom}$ | | 150 | | | 75 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [2] | | | 2.5 | | | 2.5 | | | 2.5 | | µs |
| $t_{i\,r}$ | Tail half value time [2] | | | 15 | | | 15 | | | 15 | | |
| $u_{i\,rfi}$ | RFI level at input, [3] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A | | | A | | | A | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 74 | | | 80 | | | 86 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | | 500 | | | 500 | | V DC |

[1] See "Dynamic Characteristics".
[2] Definitions according to VDE 0433, part 3.
[3] Additional external filter or capacitor necessary.

*Table 5b: Input and output data*

| Characteristics | | Conditions | PSA 153 min | PSA 153 typ | PSA 153 max | PSA 242.5 min | PSA 242.5 typ | PSA 242.5 max | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 14.50 | | 15.50 | 23.30 | | 24.70 | | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 3.0 | | | 2.5 | | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 3.0 | | 3.9 | 2.5 | | 3.25 | | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | | 300 | | | 480 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | | 300 | | | 480 | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | | 200 | | | 300 | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 450 | | | 720 | | | |
| $t_d$ | Dynamic load transient time constant | | | 120 | | | 160 | | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±3 | | | ±5 | | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 19 | | 40 | 29 | | 60 | | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | | | 4 | | | 5 | | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 12 | | | |
| $I_{i\,0}$ | No load Input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 50 | | | 50 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [2] | $U_{i\,nom}$ | | 150 | | | 150 | | | A |
| $t_{i\,s}$ | Rise time [2] | | | 2.5 | | | 2.5 | | | µs |
| $t_{i\,r}$ | Tail half value time [2] | | | 15 | | | 15 | | | |
| $u_{i\,rfi}$ | RFI level at input, [3] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A | | | A | | dB (µV) |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 88 | | | 91 | | | % |
| **Isolation** | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | | 500 | | | V DC |

[1] See "Dynamic Characteristics".
[2] Definitions according to VDE 0433, part 3.
[3] Additional external filter or capacitor necessary.

## Description of Option Package

With this family, the options i (inhibit), R (output voltage adjustment) and Y (PCB soldering pins) are defined as a package. Other combinations or parts of this package are not available.



**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, CMOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

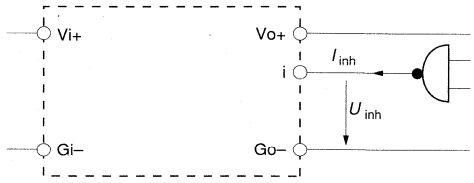



*Fig. 4*
*Definition of $I_{inh}$ and $U_{inh}$*

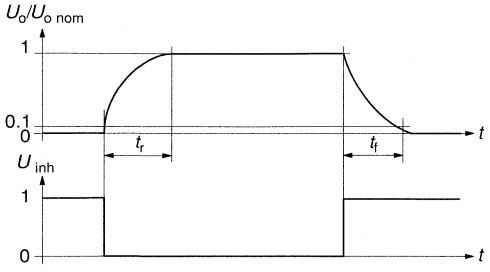



*Fig. 5*
*Output response as a function of inhibit signal*

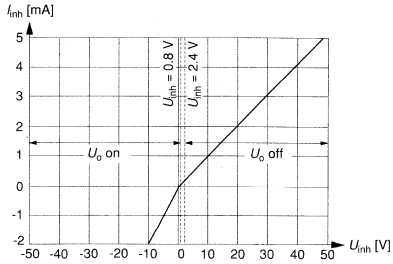



*Fig. 6*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 6: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –10 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 2 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 4 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |

**Option R** Output voltage adjustment

**Note:** with an open R-pin, $U_o = U_{o\,nom}$!
The output voltage $U_o$ can be adjusted either with an external resistor $R_{ex}$ or an external reference voltage $U_{ex}$.

The adjustment range is 0...1.00 of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{io\,min}$ between input and output voltages as specified in relevant tables should be maintained.

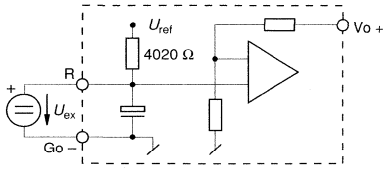



*Fig. 7*
*Voltage adjustment with $U_{ex}$*

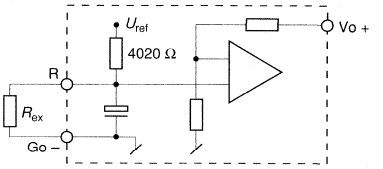



*Fig. 8*
*Voltage adjustment with $R_{ex}$*

**Voltage adjustment with $U_{ex}$** ($U_{ref}$ = 2.49 V ±4%)

$$U_o \approx U_{o\,nom} \cdot \frac{U_{ex}}{U_{ref}}$$

**Caution:** $U_{ex}$ must neither exceed 1.1 • $U_{ref}$ nor be negative, or failure will occure!

**Voltage adjustment with $R_{ex}$ [Ω]**

$$U_o \approx U_{o\,nom} \cdot \frac{R_{ex}}{R_{ex} + 4020}$$

$$R_{ex} \approx 4020 \cdot \frac{U_o}{U_{o\,nom} - U_o}$$

All formulae give approximate values only.



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**Option Y** PCB Soldering Pins

This option defines soldering pins of 1.0 × 0.5 × 6.5 mm, instead of the standard fast-on terminals of 2.8 × 0.5 × 6.5 mm. Modules with this option can be mounted onto printed circuit boards, providing through-plated finished hole size of Ø 1.3...1.5 mm.



## Mechanical Data

Dimensions in mm. Tolerances ± 0.3 mm unless otherwise specified.

European Projection

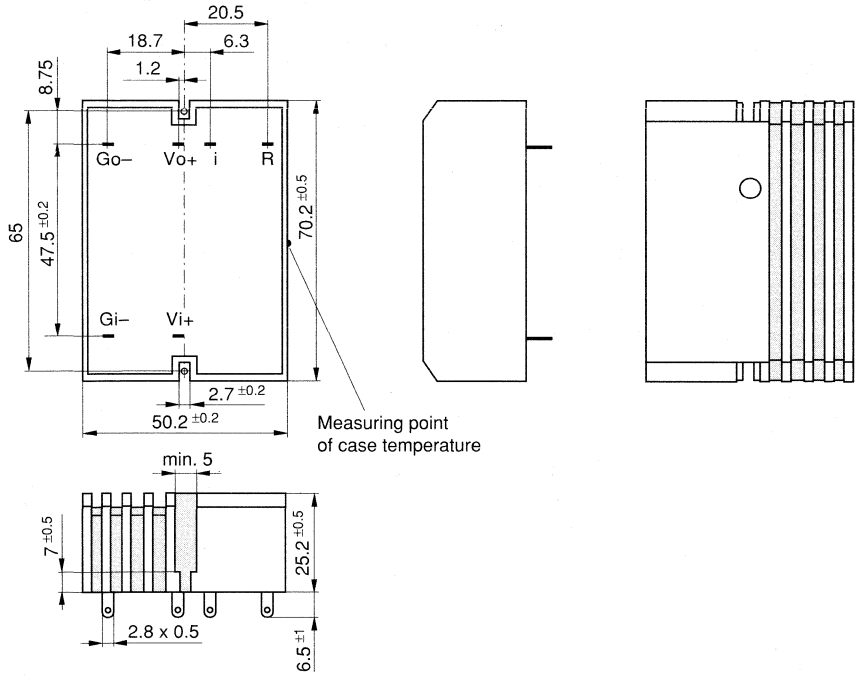



*Fig. 9*
*Case A01 without LED output voltage indicator (Weight 100 g)*

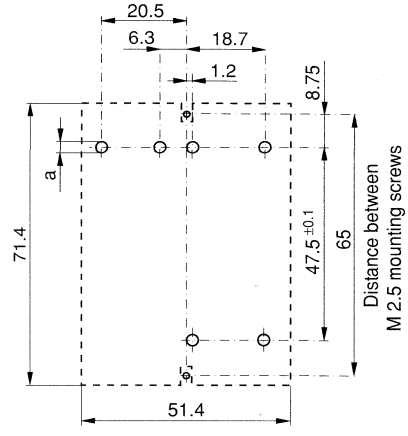
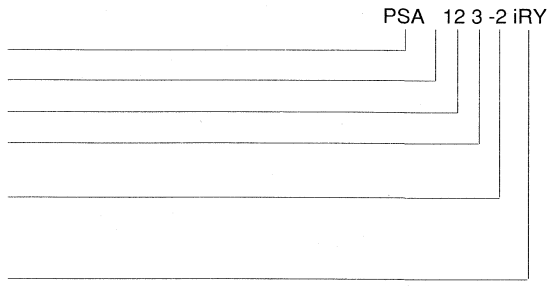



*Fig. 10*
*Case A01 hole locations for circuit board layout (component side view of PCB):*
*- - - = Space reserved for switching regulator*
*"a" = 3.0 mm × 0.7 mm slot or Ø 3.0 mm, through plated for hand or machine soldering (fast on)*
*"a" = Ø 1.3...1.5 mm with option Y pins*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case A01 ..... PSA
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1...24
Nominal output current in ampere ..... 2...5
Ambient temperature range
$T_A$ = 0...50 °C ..... -2
Option package:
– Inhibit input ..... i
– External output voltage adjustment ..... R
– Small soldering pins 0.5 × 1.0 mm ..... Y

Example: PSA 123-2iRY = A positive switching regulator with a 12 V, 3 A output, ambient temperature range of 0...50 °C, with option package: inhibit input, external output voltage adjustment and small soldering pins.

### Product Marking

Main face: Specific type designation, input voltage range, nominal output voltage and current, applicable safety approval and recognition marks, degree of protection, Melcher patent nos. and company logo.

Cover: Pin allocation and warnings.

Side wall: Label with batch no., serial no. and data code comprising production site, modification status of main PCB and date of production.


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# 3 Switching Regulators <10 A

## 3.1 Rugged Environment

## 3.2 Industrial Environment

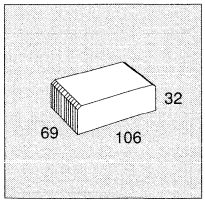
| Output [A] 5 6 7 8 9 10 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] ≤ 40 80 144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | PSB | B02 | 3 - 32 |
| | | | PSC | C03 | 3 - 39 |
| | | | PSL | L04 | 3 - 48 |

| Output [A] 5 6 7 8 9 10 | Output [V DC] −3 −5 −12 −15 −24 −36 −48 | Input [V DC] ≤ −40 −80 −144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | NSR | C03 | 3 - 58 |

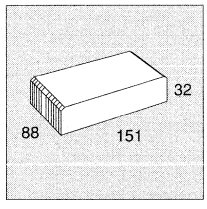
## 3.3 Benign Environment

| Output [A] 5 6 7 8 9 10 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] ≤ 40 80 144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | PSB | B02 | 3 - 66 |
| | | | PSC | C03 | 3 - 72 |
| | | | PSL | L04 | 3 - 78 |

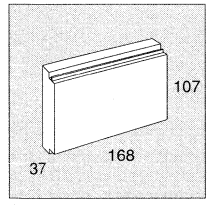
Case B02



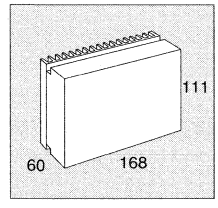

Case C03




Case L04




Case S01



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# PSR: Positive Switching Regulators PSC-Family

**No input to output isolation**
**Single output of 12, 15, 24, 36 or 48 V DC/72...288 W**
**Input voltage up to 144 V DC**

- High efficiency up to 96%
- Extremely wide input voltage range
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Two temperature ranges
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




## Table of Contents


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| Electrical Input and Output Data | 3 - 6 |
| Characteristics and Definitions | 3 - 8 |
| Description of Options | 3 - 9 |
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| Type Key and Product Marking | 3 - 11 |


## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options |
|---|---|---|---|---|---|---|
| 12 V | 6 A | 18...144 V | 60 V | 89% | PSC 126-7iR | -9, L, P, C, D, U |
| 15 V | | 22...144 V | | 90% | PSC 156-7iR | |
| 24 V | | 31...144 V | | 94% | PSC 246-7iR | |
| 36 V | | 44...144 V | 80 V | 95% | PSC 366-7iR | |
| 48 V | | 58...144 V | | 96% | PSC 486-7iR | |

[1] Surges up to 156 V for 2 sec. See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSC family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 144 V are specially designed for battery driven mobile applications.
Case C03: Aluminium, black finish and self cooling.

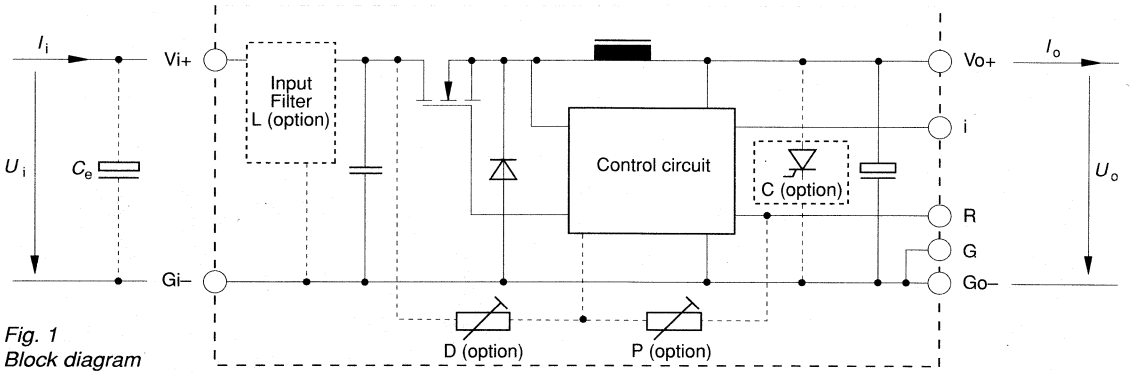



*Fig. 1*
*Block diagram*

**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**i Inhibit**

**Note:** With open i-input, output is enabled ($U_o$ = on)

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

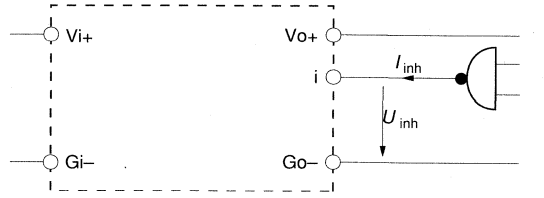



*Fig. 2*
*Definition of $I_{inh}$ and $U_{inh}$*

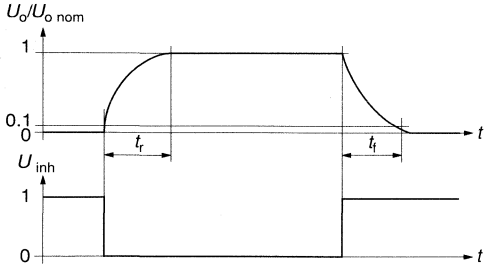



*Fig. 3*
*Output response as a function of inhibit signal*

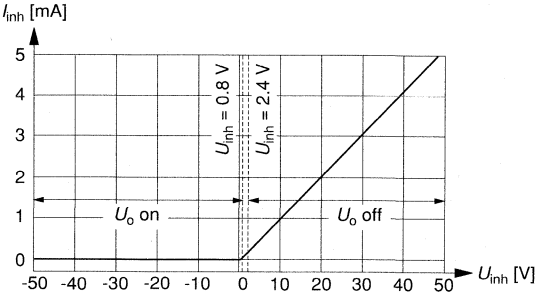



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

**Data**

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |


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### R External Output Voltage Adjustment

**Note:** With open R input, $U_o = U_{o\,nom}$.

R-input and option P cannot be supported simultaneously. The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

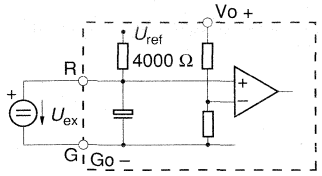



*Fig. 5*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±2%)

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V, nor be negative.

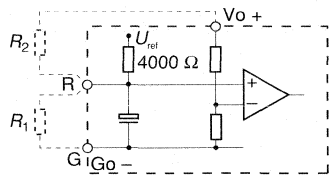



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:

$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1 - k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 2\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |
| Burst test [1] | | IEC 801-4 | Level 4: | 4 kV (5/50 ns; 50 Ω) | Operating |
| Surge test [1] | | IEC 801-5 | Class III: | 2 kV (1.2/50 µs; 2 Ω) | Operating |
| | | IEC 571-1 | | 1.8 kV (1.2/50 µs; 100 Ω) | Operating |

[1] Option L necessary

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 50 °C | |
| | 660'000 | 143'000 h | 81'000 h | 68'000 h | 2'800'00 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6a: Input and output data*

| Characteristics | | Conditions | PSC 126 min | PSC 126 typ | PSC 126 max | PSC 156 min | PSC 156 typ | PSC 156 max | PSC 246 min | PSC 246 typ | PSC 246 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 11.92 | | 12.07 | 14.91 | | 15.09 | 23.85 | | 24.14 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 6.0 | | | 6.0 | | | 6.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$... $T_{C\,max}$ | 6.0 | | 7.8 | 6.0 | | 7.8 | 6.0 | | 7.8 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 75 | | | 100 | | | 200 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 55 | | | 75 | | | 150 | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 40 | | | 65 | | | 120 | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 100 | | | 100 | | | 120 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 60 | | | 60 | | | 80 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$... $T_{C\,max}$ | | | ±2 | | | ±3 | | | ±5 | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage [5] | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$... $T_{C\,max}$ | 18 | | 144 | 22 | | 144 | 31 | | 144 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 6 | | | 7 | | | 7 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 12 | | | 15 | | | 19 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | 35 | | | 35 | | | 35 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 250 | | | 250 | | | 250 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | 350 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | | 25 | | | 25 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | | 125 | | | 125 | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,min...max}$, $I_{o\,nom}$ | | | B | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 89 | | | 90 | | | 94 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 1500 | | | 1500 | | | 1500 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 470 µF/200 V, e.g. Chemicon KME-series or equivalent
[5] Surges up to 156 V for 2 sec. (complying to LES-DB standard for $U_N$ = 110 V)

*Table 6b: Input and output data*

| Characteristics | | Conditions | PSC 366 min | PSC 366 typ | PSC 366 max | PSC 486 min | PSC 486 typ | PSC 486 max | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_{o\ nom}$ | Output voltage | $U_{i\ nom}$, $I_{o\ nom}$ | 35.78 | | 36.22 | 47.70 | | 48.29 | | V |
| $I_{o\ nom}$ | Output current | $U_{i\ min}$...$U_{i\ max}$ | | 6.0 | | | 6.0 | | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\ min}$...$T_{C\ max}$ | 6.0 | | 7.8 | 6.0 | | 7.8 | | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\ nom}$ $I_{o\ nom}$ | | 280 | | | 300 | | | $mV_{pp}$ |
| $\Delta U_{o\ U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\ min}$...$U_{i\ max}$ $I_{o\ nom}$ | | 200 | | | 300 | | | mV |
| $\Delta U_{o\ I}$ | Static control deviation versus output current $I_o$ | $U_{i\ nom}$ $I_o$ = 0...$I_{o\ nom}$ | | 160 | | | 250 | | | |
| $u_{o\ d}$ | Dynamic control deviation [1] | $U_{i\ nom}$ $I_{o\ nom} \leftrightarrow 1/3\ I_{o\ nom}$ | | 140 | | | 150 | | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 100 | | | 100 | | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\ min}$...$U_{i\ max}$ $T_{C\ min}$...$T_{C\ max}$ | | | ±8 | | | ±10 | | mV/K |
| | | $I_o$ = 0...$I_{o\ nom}$ | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage [5] | $I_o$ = 0...$I_{o\ nom}$ $T_{C\ min}$...$T_{C\ max}$ | 44 | | 144 | 58 | | 144 | | V DC |
| $\Delta U_{io\ min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 8 | | | 10 | | | V |
| $U_{i\ o}$ | Undervoltage cut-out | | | 29 | | | 40 | | | |
| $I_{i\ 0}$ | No load input current | $I_o$ = 0 $U_{i\ min}$...$U_{i\ max}$ | | 40 | | | 45 | | | mA |
| $I_{i\ m}$ | Peak value of inrush current [3] | $U_{i\ nom}$ | | 250 | | | 250 | | | A |
| $t_{i\ s}$ | Rise time [3] | | | 5 | | | 5 | | | µs |
| $t_{i\ r}$ | Tail half value time [3] | | | 40 | | | 40 | | | |
| $I_{i\ m}$ | Peak value of inrush current [3] | $U_{i\ nom}$ with option L | | 350 | | | 350 | | | A |
| $t_{i\ s}$ | Rise time [3] | | | 25 | | | 25 | | | µs |
| $t_{i\ r}$ | Tail half value time [3] | | | 125 | | | 125 | | | |
| $u_{i\ rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\ min...max}$, $I_{o\ nom}$ | | | B | | | B | | dB (µV) |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\ nom}$, $I_{o\ nom}$ | | 95 | | | 96 | | | % |
| **Isolation** | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 1500 | | | 1500 | | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\ o\ min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 470 µF/200 V, e.g. Chemicon KME-series or equivalent
[5] Surges up to 156 V for 2 sec. (complying to LES-DB standard for $U_N$ = 110 V)

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

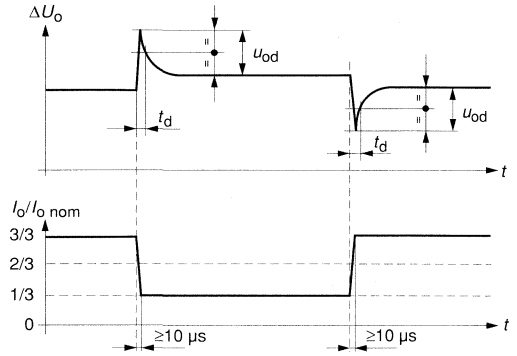



*Fig. 7*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 144 V DC which is far above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

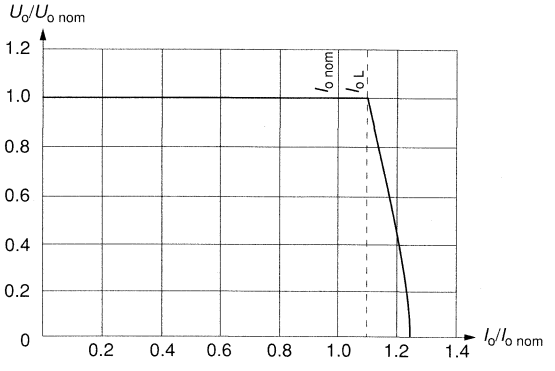



*Fig. 8*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90. SEV approval according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards are in progress.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Description of Options

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71°C$.

---

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 4 $mV_{rms}$.

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 10\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 1000\ Hz/f_i \cdot 1\ V$$

---

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

---

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | 12 V | | 15 V | | 24 V | | 36 V | | 48 V | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | min | max | min | max | min | max | |
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | 13.5 | 16 | 16.5 | 19 | 27 | 31 | 40 | 45.5 | 55 | 61 | V |
| $t_s$ | Delay time | | | 1.5 | | 1.5 | | 1.5 | | 1.5 | | 1.5 | µs |

---

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSC family as recognized components up to an ambient temperature of $T_{A\,max} - 25$ K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71°C$ without any further precautions.

**Option D** "Save Data", input undervoltage monitor

**Note:** Output instead of input undervoltage monitor is available on request (Option D1).

If the input voltage $U_i$ is below the adjustable threshold voltage $U_t$, the control circuit for terminal D has low impedance. Terminal D and Go– are connected to a self-conducting field effect transistor (FET). A 0.5 W Zener diode provides protection against overvoltages.

The voltage $U_t$ can be externally adjusted with a trim potentiometer by means of a screwdriver. The hystersis $U_H$ of $U_t$ is <2%. Terminal D stays low for a minimum time $t_{low\ min}$, in order to prevent any oscillation. $U_t$ can be set to a value between $U_{i\ min}$ and $U_{i\ max}$. 10. It is important to note that the FET can become conductive again when $U_D > U_i - 3V$.

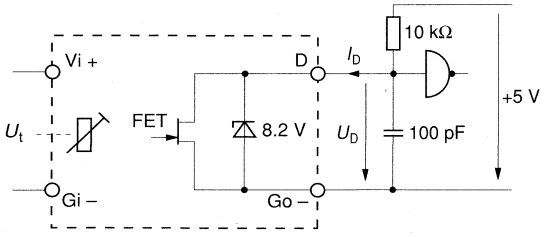



*Fig. 9*
*Test circuit with definition of voltage $U_D$ and current $I_D$ on Terminal D.*

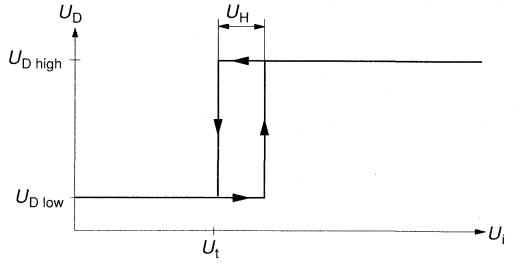



*Fig. 10*
*Definition of $U_t$ and $U_H$*

## Data

*Table 8: Option D data*

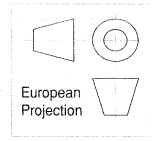
| Characteristics | | Conditions | PSC | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| $U_{D\ low}$ | Voltage - Terminal D at low impedance | $U_i < U_t$, $I_D \leq 2.5$ mA | | | 0.8 | V |
| $U_{D\ high}$ | Voltage - Terminal D at high impedance | $U_i > U_t + U_H$, $I_D > 25$ µA | 4.75 | | | |
| $t_{low\ min}$ | Minimum duration $U_{D\ low}$ | | | 30 | | ms |
| $t_{D\ f}$ | Response time to $U_{D\ low}$ | | | 1 | | µs |
| $I_{D\ max}$ | Maximum current - Terminal D | | | | 20 | mA |

Application examples

a) The signal $U_D$ can be utilized in battery powered systems to provide a warning in case of **low batteries**.
b) In case of power failure, the signal can serve to initiate **data save** routines.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.



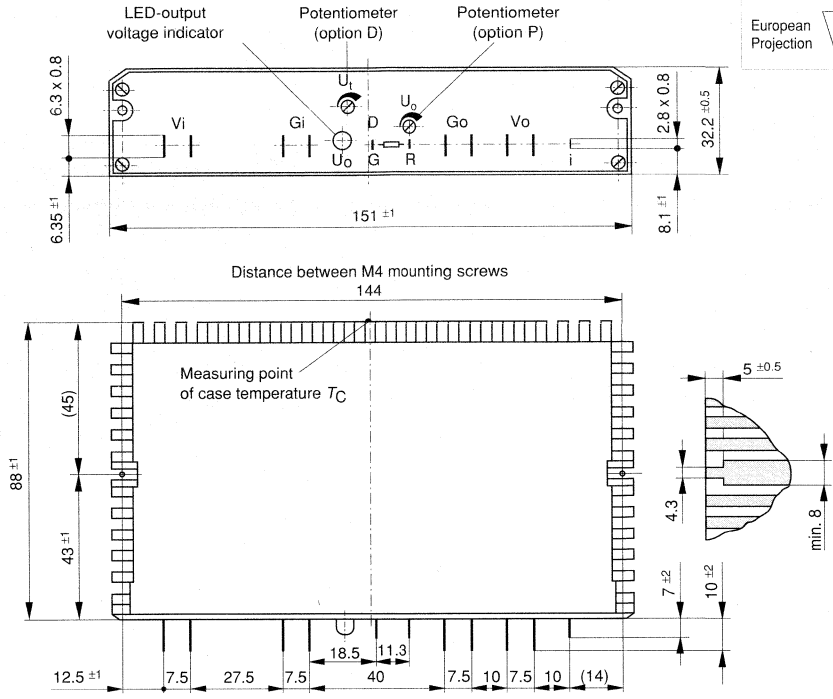




*Fig. 11*
*Case C03 (weight 440 g)*

## Type Key and Product Marking

### Type Key

PSC 12 6 -7 L i R P C D U

| | |
|---|---|
| Positive switching regulator in case C03 | PSC |
| Blank | |
| Nominal output voltage in volt | 12...48 |
| Nominal output current in ampere | 6 |
| Ambient temperature range | |
| $T_A$ = –25...71 °C | -7 |
| $T_A$ = –40...71 °C | -9 |
| Input filter | L |
| Inhibit input | i |
| External output voltage adjustment | R |
| Potentiometer | P |
| Thyristor-Crowbar | C |
| "Save Data" undervoltage monitor | D |
| UL recognized component for $T_{A\,max}$ = 71 °C | U |

Example: PSC 126-7LiPC = A positive switching regulator with a 12 V, 6 A output, ambient temperature range of –25...71°C, input filter, inhibit input, potentiometer and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometers and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

# PSR: Positive Switching Regulators PSL-Family

**No input to output isolation**
**Single output of 12, 15, 24, 36 or 48 V DC/72...288 W**
**Input voltage up to 144 V DC**

- High efficiency up to 96%
- Extremely wide input voltage range
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Two temperature ranges
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\ nom}$ | Nominal output current $I_{o\ nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\ nom}$ | Efficiency $\eta$ | Type designation | Options |
|---|---|---|---|---|---|---|
| 12 V | 6 A | 18...144 V | 60 V | 89% | PSL 126-7R | -9, L, i, P, C, D, A, U |
| 15 V | | 22...144 V | | 90% | PSL 156-7R | |
| 24 V | | 31...144 V | | 94% | PSL 246-7R | |
| 36 V | | 44...144 V | 80 V | 95% | PSL 366-7R | |
| 48 V | | 58...144 V | | 96% | PSL 486-7R | |

[1] Surges up to 156 V for 2 sec. See data $\Delta U_{io\ min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSL family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 144 V are specially designed for battery driven mobile applications.
Case L04: Aluminium, black finish and self cooling.

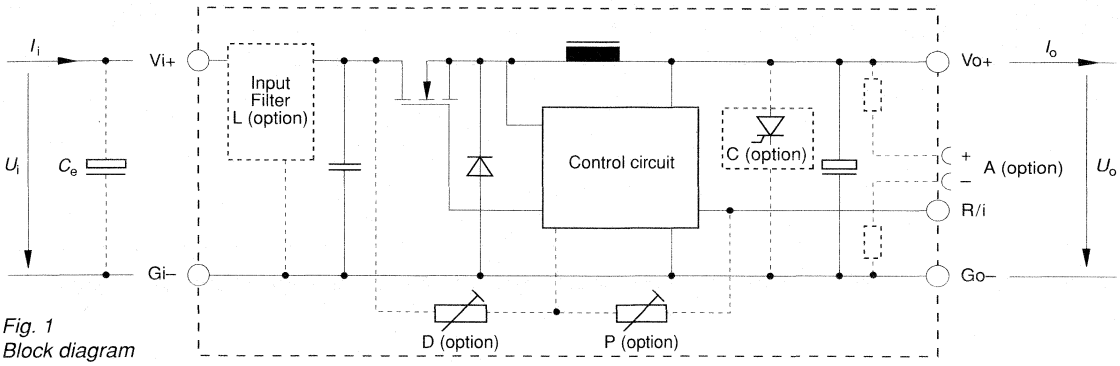



*Fig. 1*
*Block diagram*

**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**R External Output Voltage Adjustment**

**Note:** With open R input, $U_o = U_{o\,nom}$.
R-input together with option i or option P cannot be supported simultaneously.

The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

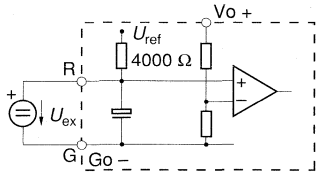



*Fig. 2*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±4%)

**Caution:** To prevent damage $U_{ex}$ should not exceed 2.7 V, nor be negative.

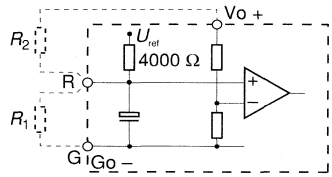



*Fig. 3*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom} \ldots U_{o\,max}$, using $R_2$ between R and Vo+:
$U_{o\,max} = U_{o\,nom}$ + 8%

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1\text{-}k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 4\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |
| Burst test [1] | | IEC 801-4 | Level 4: | 4 kV (5/50 ns; 50 Ω) | Operating |
| Surge test [1] | | IEC 801-5 | Class III: | 2 kV (1.2/50 µs; 2 Ω) | Operating |
| | | IEC 571-1 | | 1.8 kV (1.2/50 µs; 100 Ω) | Operating |

[1] Option L necessary

*Table 3: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 4: MTBF and device hours*

| MTBF | Ground Fixed | | Ground Mobile | | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217D | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | |
| | 130'000 h | 58'000 h | 36'000 h | 17'000 h | 3'900'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

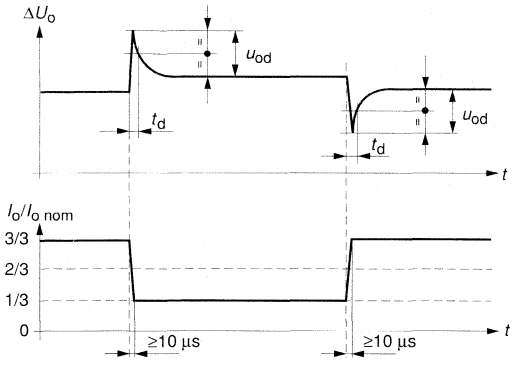



*Fig. 4*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 95 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 144 V DC which is far above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

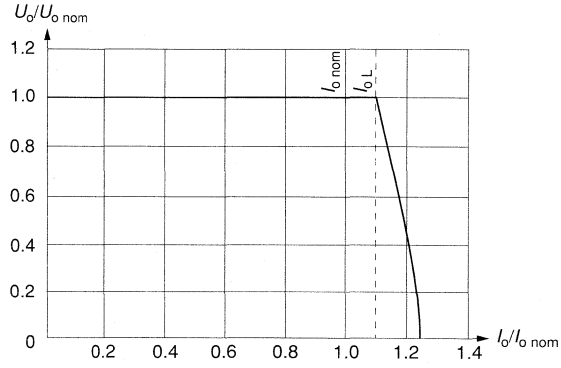



*Fig. 5*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90. SEV approval according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards are in progress.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30 (equipped with any potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 5a: Input and output data*

| Characteristics | | Conditions | PSL 126 min | PSL 126 typ | PSL 126 max | PSL 156 min | PSL 156 typ | PSL 156 max | PSL 246 min | PSL 246 typ | PSL 246 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 11.92 | | 12.07 | 14.91 | | 15.09 | 23.85 | | 24.14 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 6.0 | | | 6.0 | | | 6.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$... $T_{C\,max}$ | 6.0 | | 7.8 | 6.0 | | 7.8 | 6.0 | | 7.8 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 75 | | | 100 | | | 200 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 55 | | | 75 | | | 150 | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0... $I_{o\,nom}$ | | 40 | | | 65 | | | 120 | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 100 | | | 100 | | | 120 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 60 | | | 60 | | | 80 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$... $T_{C\,max}$ $I_o$ = 0... $I_{o\,nom}$ | | | ±2 | | | ±3 | | | ±5 | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage [5] | $I_o$ = 0... $I_{o\,nom}$ $T_{C\,min}$... $T_{C\,max}$ | 18 | | 144 | 22 | | 144 | 31 | | 144 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 6 | | | 7 | | | 7 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 12 | | | 15 | | | 19 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$... $U_{i\,max}$ | | 35 | | | 35 | | | 35 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 250 | | | 250 | | | 250 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | 350 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | | 25 | | | 25 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | | 125 | | | 125 | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,min...max}$, $I_{o\,nom}$ | | | B | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 89 | | | 90 | | | 94 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 1500 | | | 1500 | | | 1500 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 470 µF/200 V, e.g. Chemicon, KME-series or equivalent
[5] Surges up to 156 V for 2 sec. (complying to LES-DB standard for $U_N$ = 110 V)

*Table 5b: Input and output data*

| Characteristics | | Conditions | PSL 366 min | typ | max | PSL 486 min | typ | max | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 35.78 | | 36.22 | 47.70 | | 48.29 | | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 6.0 | | | 6.0 | | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$... $T_{C\,max}$ | 6.0 | | 7.8 | 6.0 | | 7.8 | | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 280 | | | 300 | | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 200 | | | 300 | | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 160 | | | 250 | | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}\leftrightarrow$1/3 $I_{o\,nom}$ | | 140 | | | 150 | | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 100 | | | 100 | | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$... $T_{C\,max}$ | | | ±8 | | | ±10 | | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage [5] | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$... $T_{C\,max}$ | 44 | | 144 | 58 | | 144 | | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 8 | | | 10 | | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 29 | | | 40 | | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | 40 | | | 45 | | | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 250 | | | 250 | | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | | 25 | | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | | 125 | | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | B | | | B | | dB (µV) |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,min...max}$, $I_{o\,nom}$ | | 95 | | | 96 | | | % |
| **Isolation** | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 1500 | | | 1500 | | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 470 µF/200 V, e.g. Chemicon, KME-series or equivalent
[5] Surges up to 156 V for 2 sec. (complying to LES-DB standard for $U_N$ = 110 V)

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 32 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H11 (according to DIN 41612) to ensure requested safety!

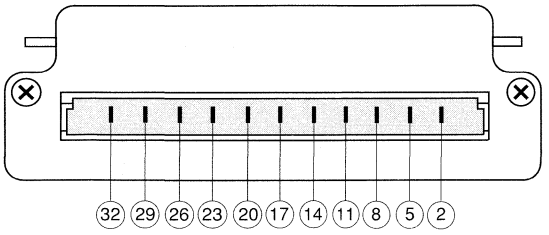



*Fig. 6*
*View of male H11 connector*

*Table 6: H11 connector pin allocation and designation*

| Electrical Determination | Type H11 Pin No. | Design. |
|---|---|---|
| R-input (or inhibit input) [1] | 2 | R (i) |
| Undervoltage monitor (Option D) | 5 | D |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 11 | Go– |
| Output voltage(positive) | 14 | Vo+ |
| Output voltage (positive) | 17 | Vo+ |
| Input voltage (negative) | 20 | Gi– |
| Input voltage (negative) | 23 | Gi– |
| Input voltage (positive) | 26 | Vi+ |
| Input voltage (positive) | 29 | Vi+ |
| Protective ground (protruding pin) | 32 | ⏚ |

[1] R-input (output voltage programming) not available with option P (potentiometer) or option i (inhibit)

## Description of Options

**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on)
Inhibit excludes R function.

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

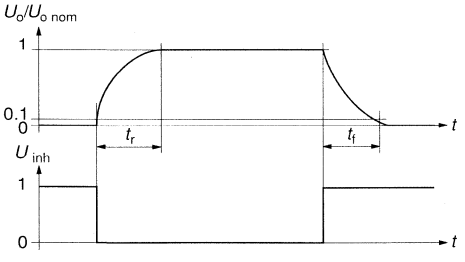



*Fig. 8*
*Output response as a function of inhibit signal*

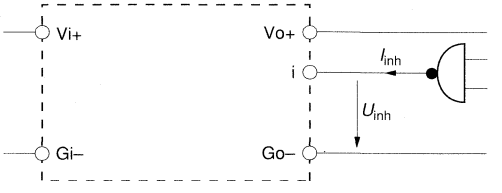



*Fig. 7*
*Definition of $I_{inh}$ and $U_{inh}$*

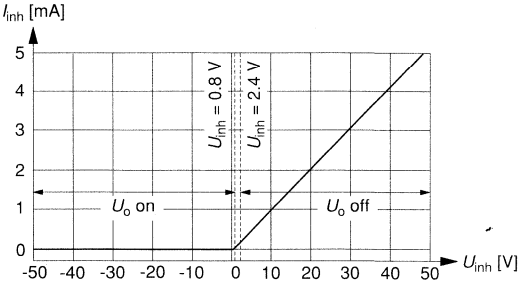



*Fig. 9*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

### Data

*Table 7: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom} / I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |


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**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71°C$.

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 4 $mV_{rms}$.

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 10\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 1000\ Hz/f_i \cdot 1\ V$$

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSL family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71°C$ without any further precautions.

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 8: Crowbar trigger levels*

| Characteristics | | Conditions | 12 V | | 15 V | | 24 V | | 36 V | | 48 V | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | min | max | min | max | min | max | |
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | 13.5 | 16 | 16.5 | 19 | 27 | 31 | 40 | 45.5 | 55 | 61 | V |
| $t_s$ | Delay time | | | 1.5 | | 1.5 | | 1.5 | | 1.5 | | 1.5 | µs |

**Option D** "Save Data", input undervoltage monitor

**Note:** Output instead of input undervoltage monitor is available on request (option D1).

If the input voltage $U_i$ is below the adjustable threshold voltage $U_t$, the control circuit for terminal D has low impedance. Terminal D and Go– are connected to a self-conducting field effect transistor (FET). A 0.5 W Zener diode provides protection against overvoltages.

The voltage $U_t$ can be externally adjusted with a trim potentiometer by means of a screwdriver. The hystersis $U_H$ of $U_t$ is <2%. Terminal D stays low for a minimum time $t_{low\,min}$, in order to prevent any oscillation. $U_t$ can be set to a value between $U_{i\,min}$ and $U_{i\,max}$ according to fig. 10. It is important to note that the FET can become conductive again when $U_D > U_i - 3V$.

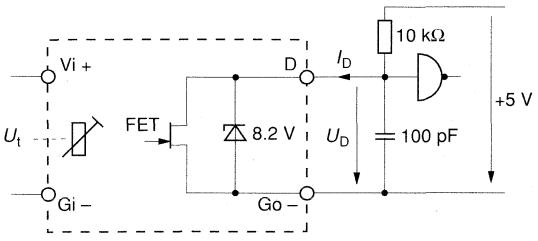



*Fig. 10*
*Test circuit with definition of voltage $U_D$ and current $I_D$ on Terminal D.*

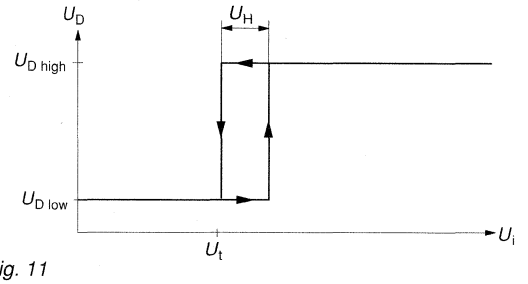



*Fig. 11*
*Definition of $U_t$ and $U_H$*

**Data**

*Table 9: Option D data*

| Characteristics | | Conditions | PSL | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| $U_{D\ low}$ | Voltage - Terminal D at low impedance | $U_i < U_t$, $I_D \leq 2.5$ mA | | | 0.8 | V |
| $U_{D\ high}$ | Voltage - Terminal D at high impedance | $U_i > U_t + U_H$, $I_D > 25$ µA | 4.75 | | | |
| $t_{low\ min}$ | Minimum duration $U_{D\ low}$ | | | 30 | | ms |
| $t_{D\ f}$ | Response time to $U_{D\ low}$ | | | 1 | | µs |
| $I_{D\ max}$ | Maximum current - Terminal D | | | | 20 | mA |

Application examples

a) The signal $U_D$ can be utilized in battery powered systems to provide a warning in case of **low batteries**.

b) In case of power failure, the signal can serve to initiate **data save** routines.

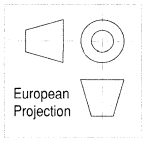
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**Option A** Test sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage are located at the front panel of the module. The output voltage is measured internally directly at the connector pins.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



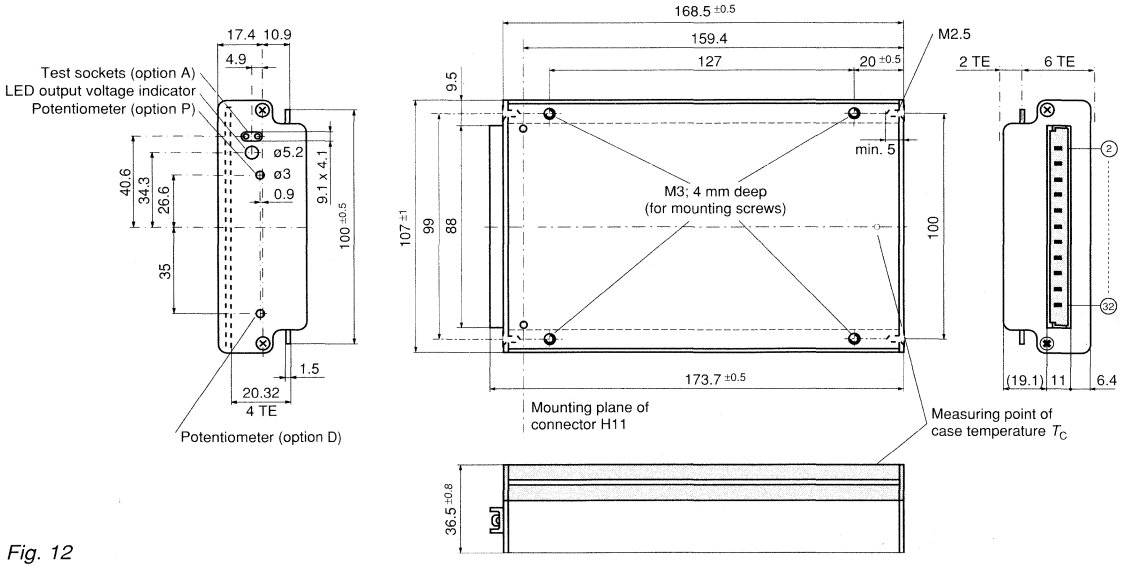




*Fig. 12*
*Case L04 (weight 550 g)*


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## Type Key and Product Marking

### Type Key




Positive switching regulator in case L04 ..... PSL
Blank .....
Nominal output voltage in volt ..... 12...48
Nominal output current in ampere ..... 6
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Input filter ..... L
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Thyristor-Crowbar ..... C
"Save Data" undervoltage monitor ..... D
Test sockets ..... A
UL recognized component for $T_{A\,max}$ = 71 °C ..... U

Example: PSL 126-7LiPC = A positive switching regulator with a 12 V, 6 A output, ambient temperature range of –25...71 °C, input filter, inhibit input, potentiometer and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

Front plate: Identification of LED, optional test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltage and current, pin allocation of options and auxiliary functions and degree of protection.

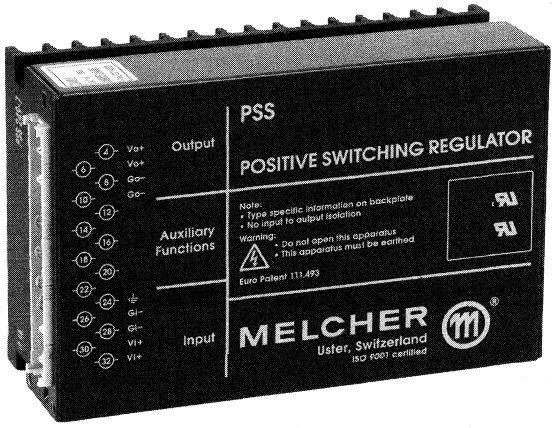
Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and production date.

# Positive Switching Regulators

# PSS-Family

**No input to output isolation**
**Single output of 12, 15[1], 24, 36 or 48 V DC/108...432 W**
**Input voltage up to 144 V DC**

- Extremely wide input voltage range
- High efficiency up to 96%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no load and short circuit proof
- Output current sharing
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$[2] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$[3] | Type designation | Options |
|---|---|---|---|---|---|---|
| 12 V[1] | 9 A | 18...144 V | 60 V | 90% | PSS 129-7 | -9, E, P, C, B, B1, U |
| 24 V | | 31...144 V | | 94% | PSS 249-7 | |
| 36 V | | 44...144 V | 80 V | | PSS 369-7 | |
| 48 V | | 58...144 V | | 96% | PSS 489-7 | |

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")
[2] Surges up to 156 V for maximum 2 s
[3] Including option E, $T_A$ = 25 °C

## Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. The maximum input voltage is as high as 144 V DC (120 V +20%) with surges up to 156 V for 2 sec. This allows operation in the majority of battery driven mobile applications. The basic type of regulators may be completed by various options to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case S01: Aluminium, black finish, fully enclosed. The basic model with heat sink is self cooling.

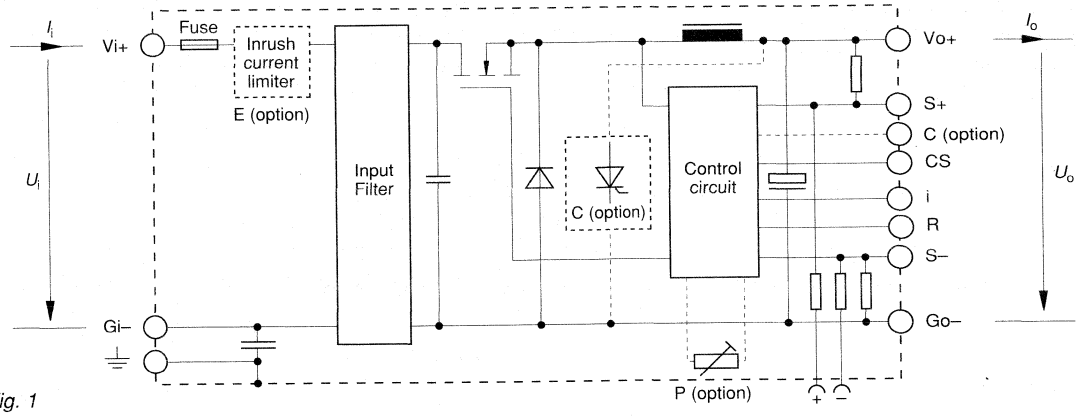



*Fig. 1*
*Block diagram*

## Standard Features

**Note:**
Additional information on input circuitry, grounding and parallel operation of units is given in section "Application Note"

**Inhibit (i)**

If the inhibit pin is not connected, the power supply is enabled ($U_o$ = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

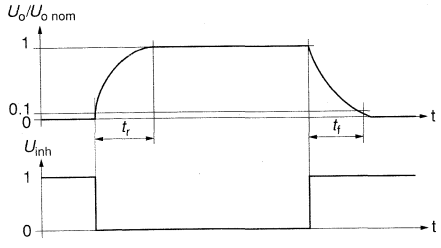



*Fig. 3*
*Output response as a function of inhibit signal*

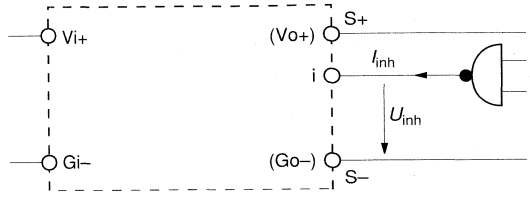



*Fig. 2*
*Definition of inhibit voltage and current*

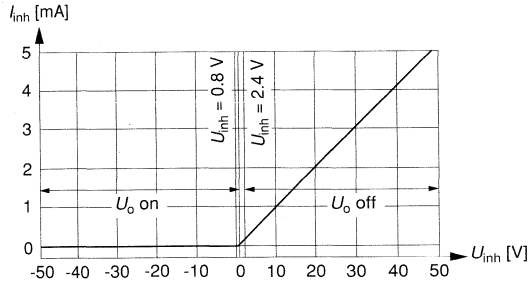



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | PSS 129 | | | PSS 249 | | | PSS 369 | | | PSS 489 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_{inh}$ | Inhibit input voltage to keep output voltage... | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | V DC |
| | | $U_o$ = off | | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,nom}$ (resistive load) | | 100 | | | 100 | | | 100 | | | 100 | | ms |
| $t_f$ | Switch-off time after inhibit command | | | | 15 | | | 20 | | | 15 | | | 40 | | |
| $I_{i\,off}$ | Input current with converter inhibited | | $I_o$ = 0 $U_{i\,nom}$ | | 25 | | | 25 | | | 25 | | | 25 | | mA |

### Input Filter and Fuse

An input filter and a fuse are incorporated in all PSS modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

If a reduction of the considerable high inrush current is required, refer to option E.

The maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$u_{i\,max}$ = 10 $V_{pp}$ at 100 Hz, or $V_{pp}$ = 1000 Hz/$f_i$ • 1 V

### Test Sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage $U_o$ internally at the connector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

### Current Sharing (CS)

**Note:** Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage ($U_i$) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

### Sense Lines (S)

**Note:** Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSS connector) should not exceed the following values:

| Output voltage | Total voltage difference between both sense lines and their respective output | Voltage difference between Go– and S– |
|---|---|---|
| 12 , 24, 36, 48 V | < 1.0 V | < 0.25 V |

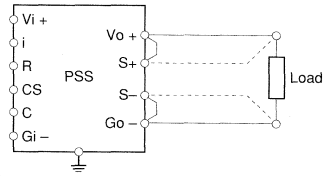



*Fig. 5*
*Sense lines connection*

### External Voltage Adjustment (R)

Note: With open R input, $U_o = U_{o\,nom}$. With option P, the R input must remain unconnected.

The output voltage $U_o$ can either be adjusted with an external resistor $R_1$ or $R_2$, or with an external voltage $U_{ex}$ referenced to S–. The adjustment range is 0...$U_{o\,max}$ depending on the nominal output voltage (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor ($R_1$ resp. $R_2$). Option P is not recommended for parallel operation mode.

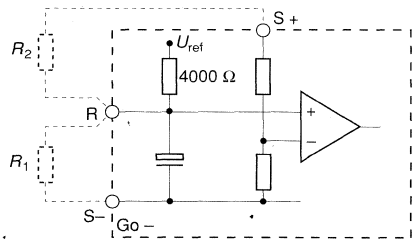



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$*

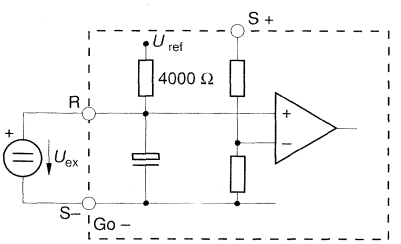



*Fig. 7*
*Voltage adjustment with external voltage $U_{ex}$ [V]*

a) $U_o = 0...U_{o\,nom}$, using $R_1$ [Ω] between R and S–:

$$U_o \approx U_{o\,nom} \bullet \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \bullet U_o}{U_{o\,nom} - U_o}$$

b) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \bullet \frac{R_2}{k \bullet (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \bullet \frac{U_o \bullet (1\text{-}k)}{k \bullet U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

c) $U_o = 0...U_{o\,max}$, using $U_{ex}$ [V] between R and S–:

$$U_o = U_{o\,nom} \bullet [\frac{U_{ex}}{U_{ref}} \bullet 0.98 + 0.02]$$

$(U_{ref} = 2.48\ V \pm 1\%)$

All formulae give approximate values only.

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V nor be negative!



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## Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3<br>MIL 810D sec.507.2 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL 810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL 810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL 810D sec.514.3 | Frequency (1 Oct/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Kb | Salt mist cyclic (Sodium chloride solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% relative humidity<br>3 | Not operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |
| Electric field suseptibility | | IEC 801-3 | Level 3: | 10 V/m (1 MHz...1 GHz) | Operating |
| Burst test | | IEC 801-4 | Level 4: | 4 kV (5/50 ns; 50 Ω) | Operating |
| Surge test | | IEC 801-5 | Class II: | 1 kV (1.2/50 µs; 2 Ω) | Operating |
| Voltage surge test | | IEC 571-1 | Capacitor discharge circ. | 1.8 kV (1/50 µs, 100 Ω) | Operating |

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF values and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF according to | $T_C$ = 40 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 50°C | |
| MIL-HDBK-217F | 335'000 h | 138'000 h | 35'000 h | 33'000 h | 2'100'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). This diode is not assembled in combination with option C (see also "Thyristor Crowbar").

### Dynamic Characteristics

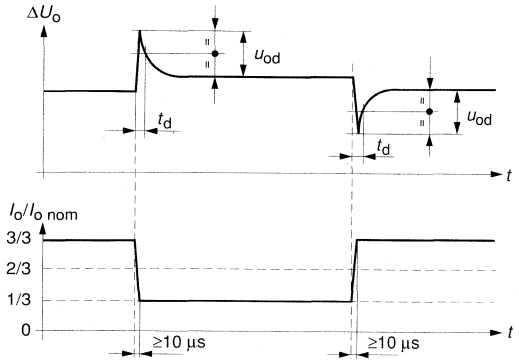



*Fig. 8*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules should only be wired via the female connector H15 (according to DIN 41612) in order to ensure compliance to national and international safety requirements. The modules accept input voltages up to 144 V DC which is far above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage of isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. Use the current sharing feature for even distribution of the output current (see "Standard Features": Current Sharing).

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

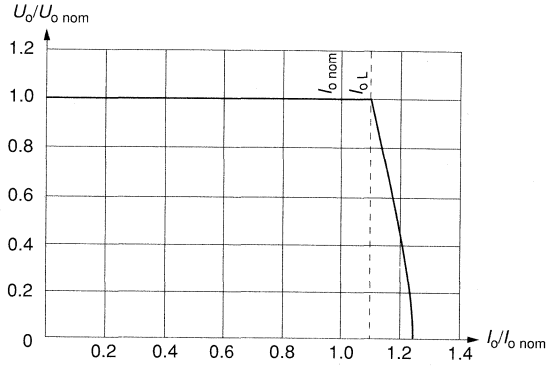



*Fig. 9*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30 (equipped with potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.


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## Electrical Input and Output Data

General Conditions
- $T_A$ = 25°C, unless $T_C$ is specified
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSS 129 | | | PSS 249 | | | PSS 369 | | | PSS 489 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 11.92 | | 12.07 | 23.85 | | 24.14 | 35.78 | | 36.22 | 47.71 | | 48.29 | V |
| $U_{o\,max}$ | Maximum adjustable output voltage utilizing R input | $U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector | | | 16.0 | | | 26.0 | | | 42.5 | | | 52.8 | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 9 | | | 9 | | | 9 | | | 9 | | A |
| $I_{o\,L}$ | Output current limitation response (% of $I_{o\,nom}$) | | 100 | | 125 | 100 | | 125 | 100 | | 125 | 100 | | 125 | % |
| $u_o$ | Ripple at Output (BW = 20 MHz) | $U_{i\,nom}$, $I_{o\,nom}$ | | 40 | 80 | | 50 | 110 | | 60 | 110 | | 60 | 100 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 40 | 70 | | 80 | 170 | | 120 | 250 | | 100 | 200 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 30 | 50 | | 50 | 120 | | 60 | 120 | | 40 | 120 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_o$ = $^2/_3$ $I_{o\,nom}$ $\pm^1/_3$ $I_{o\,nom}$ | | 140 | | | 180 | | | 200 | | | 200 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 60 | | | 60 | | | 70 | | | 70 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient $\Delta U_o$ / $\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | ±3 | | | ±5 | | | ±8 | | | ±10 | | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | | | | | | |
| $U_i$ | Input voltage range [2] | $T_{C\,min}$...$T_{C\,max}$ | 18 | | 144 | 31 | | 144 | 44 | | 144 | 58 | | 144 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | $I_o$ = 0...$I_{o\,nom}$ | | 6 | | | 7 | | | 8 | | | 10 | | |
| $U_{io}$ | Undervoltage cut-out | | | 12 | | | 24 | | | 36 | | | 48 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0 $U_{i\,nom}$ | | 36 | | | 36 | | | 36 | | | 36 | | mA |
| $I_{im}$ | Peak value of inrush current | $U_{i\,nom}$ with option E [3] | | | 60 | | | 60 | | | 80 | | | 80 | A |
| $u_{rfi}$ | RFI level at input, 0.01...30 MHz | VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$ | | | B | | | B | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | | | | | | | |
| η | Efficiency with option E | $U_{i\,nom}$, $I_{o\,nom}$ | | 90 | | | 94 | | | 94 | | | 96 | | % |
| **Isolation** | | | | | | | | | | | | | | | |
| $U_{i\,s}$ | Isolation test voltage electronic to case | All input and output terminals interconnected | | 1500 | | | 1500 | | | 1500 | | | 1500 | | V DC |

[1] See "Dynamic Characteristics"
[2] Surges up to 156 V for 2 s
[3] See also option E

## Description of Options

**Option -9** Extended Temperature Range

This option defines an extended operational ambient temperature range of $T_A$ = –40...71 °C.

**Option E** Inrush Current Limitation

**Note:** This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of $U_i$/1 Ω and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

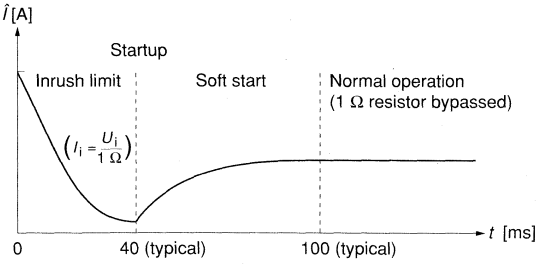



*Fig. 10*
*Option E: Inrush current versus time*

**Option P** Potentiometer

**Note:** Option P is not recommended if several modules are operated in parallel connection.

The potentiometer can be controlled with a screwdriver from the front side. The output voltage adjustment range is 90...110% of the nominal output voltage $U_{o\,nom}$.

The minimum differential voltage, $\Delta U_{io\,min}$ between input and output voltages should be maintained.

**Option C** Thyristor Crowbar

**Note**: The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage $U_o$ and when the trigger voltage $U_{o\,C}$ is reached, the thyristor crowbar triggers and disables the output.

An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

*Table 7: Crowbar trigger levels*

| Characteristics | | Condition | PSS 129 | PSS 249 | PSS 369 | PSS 489 | Unit |
|---|---|---|---|---|---|---|---|
| | | | min typ max | min typ max | min typ max | min typ max | |
| $U_{o\,C}$ | Crowbar trigger voltage | $T_{C\,min}...T_{C\,max}$<br>$U_{i\,min}...U_{i\,max}$ | 17.8 18.9<br>14.3 15.2 [1] | 28.89 30.6 | 47.0 50.0<br>43.0 45.5 [1] | 58.0 61.0 | V DC |
| $t_s$ | Delay time | $I_o$ = 0...$I_{o\,nom}$ | 1.5 | 1.5 | 1.5 | 1.5 | µs |

[1] Crowbar Trigger voltage with option P


MELCHER® ISO 9001 certified

**Option B, Option B1** Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output at 110°C approximately. The output is automatically enabled again after temperature has droped below $T_{C\,max}$.

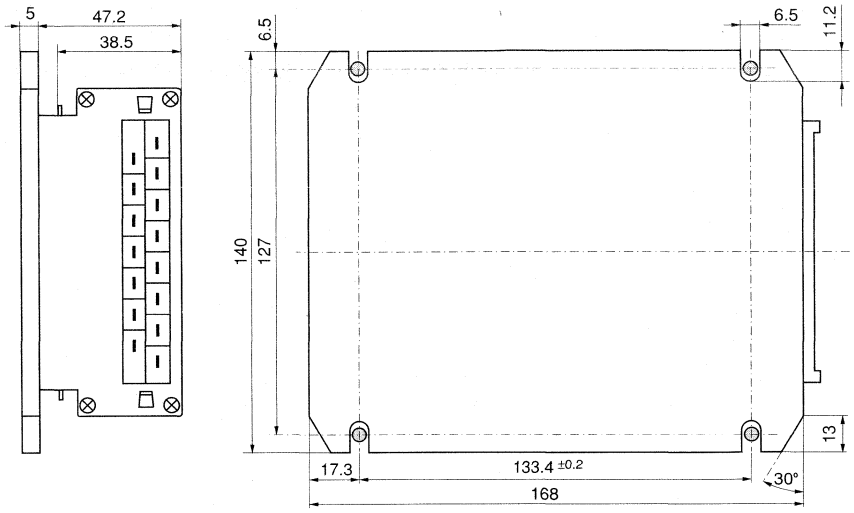



*Fig. 11*
*Case S01 with option B (cooling plate)*
*Weight: 1.1 kg*

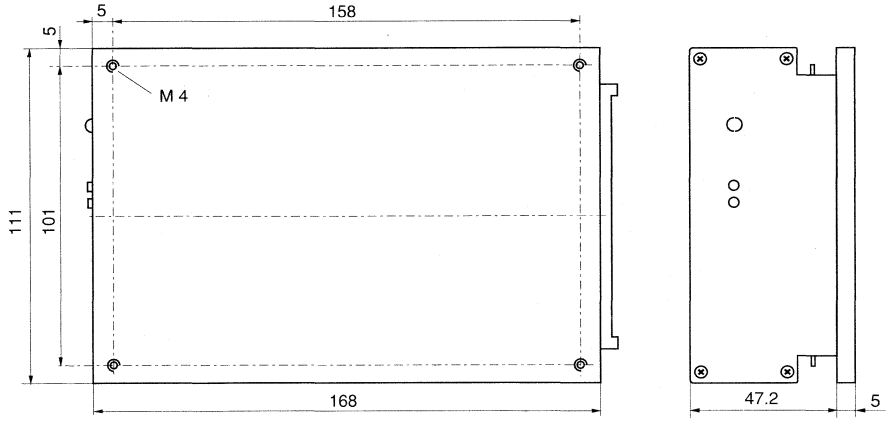



*Fig. 12*
*Case S01 with option B1 (cooling plate)*
*Weight: 1.1 kg*

**Option U** Ambient Temp. Range acc. UL Recognition

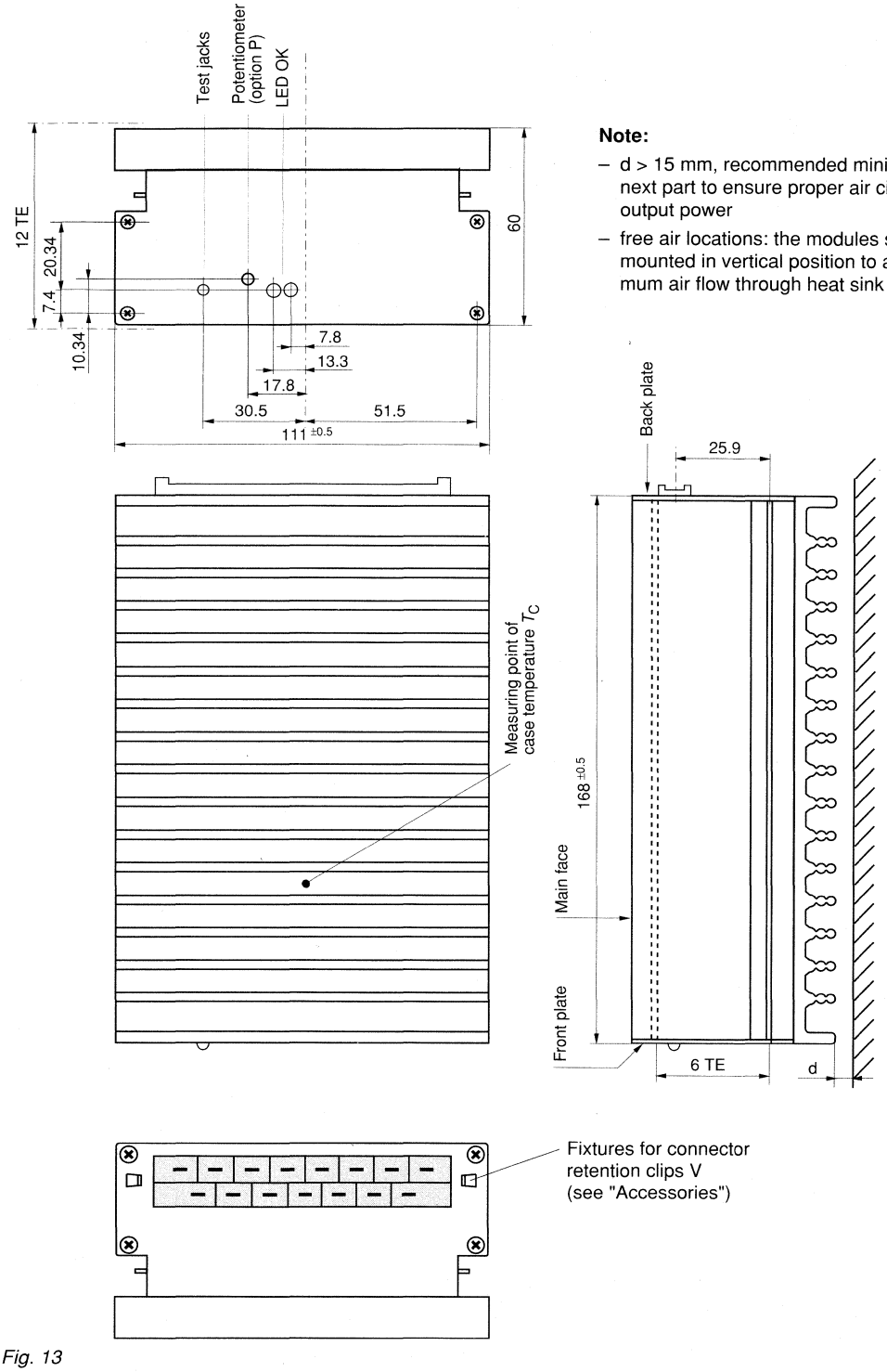
Underwriters Laboratories (UL) have approved the PSS family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max}$ = 71 °C without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

European Projection




**Note:**

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted in vertical position to achieve a maximum air flow through heat sink

*Fig. 13*
*Case S01 with heatsink*
*Weight: 1.45 kg*


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## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

*Table 8: H15 connector pin allocation*

| Electrical Determination | Type H15 | |
|---|---|---|
| | Pin No. | Ident. |
| Output voltage (positive) | 4 | Vo+ |
| Output voltage (positive) | 6 | Vo+ |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 10 | Go– |
| Crowbar trigger input (option C) | 12 | C |
| Inhibit input | 14 | i |
| R-input (output voltage programming) [1] | 16 | R |
| Sense line (negative) | 18 | S– |
| Sense line (positive) | 20 | S+ |
| Current sharing control input | 22 | CS |
| Protective ground (protruding pin) | 24 | ⏚ |
| Input voltage (negative) | 26 | Gi– |
| Input voltage (negative) | 28 | Gi– |
| Input voltage (positive) | 30 | Vi+ |
| Input voltage (positive) | 32 | Vi+ |

[1] Not available with option P

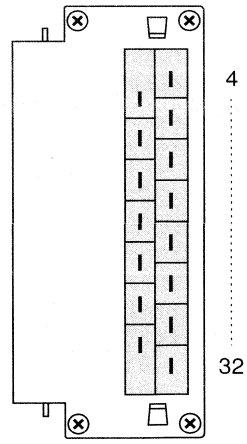
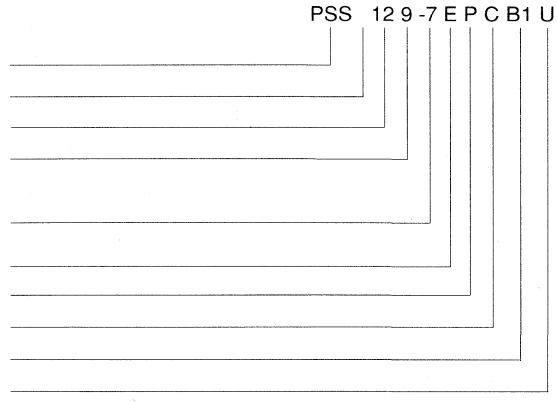



*Fig. 14*
*View of male connector H15*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case S01 ..... PSS
Blank .....
Nominal output voltage in volt ..... 12...48
Nominal output current in ampere ..... 9
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Inrush current limitation ..... E
Potentiometer ..... P
Thyristor-Crowbar ..... C
Cooling plate ..... B, B1
UL recognized component for $T_{A\,max}$ = 71 °C ..... U

Example: PSS 129-7EPCB = A positive switching regulator with a 12 V, 9 A output, ambient temperature range of –25...71 °C, inrush current limitation, potentiometer, crowbar, and cooling plate B.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LED, test sockets and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of option and auxiliary functions, fuse specification and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

# PSR: Positive Switching Regulators PSB-Family

**No input to output isolation**
**Single output of 5.1 V DC/30...35 W**
**Input voltage up to 80 V DC**



- High efficiency up to 84%
- Wide input voltage range
- Low input-to-output differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Two temperature ranges
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options | Superseded old type (phased-out) |
|---|---|---|---|---|---|---|---|
| 5.1 V | 7 A | 7...40 V | 20 V | 84% | PSB 5A7-7iR | -9, L, P, C, U | PSR 55-7 |
| | 6 A | 8...80 V | 40 V | 81% | PSB 5A6-7iR | | PSR 57-7 |

[1] See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSB family of positive switching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 80 V are specially designed for secondary switched and battery driven applications.
Case B02: Aluminium, black finish and self cooling.

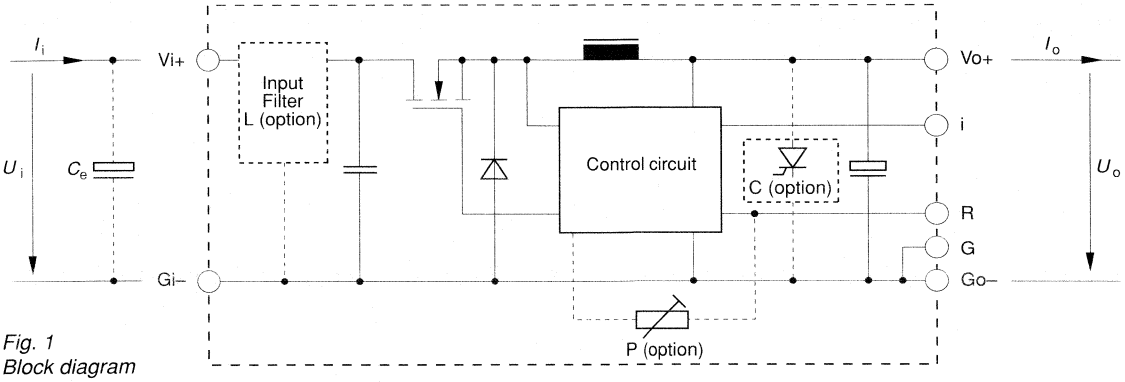



*Fig. 1*
*Block diagram*



**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without otion L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**i Inhibit**

**Note:** With open i-input, output is enabled ($U_o$ = on)

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

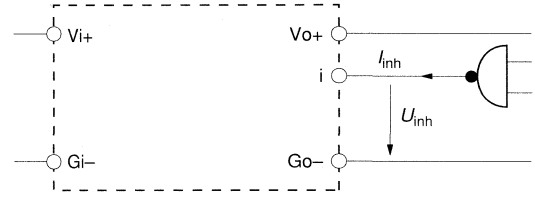



*Fig. 2*
*Definition of $I_{inh}$ and $U_{inh}$*

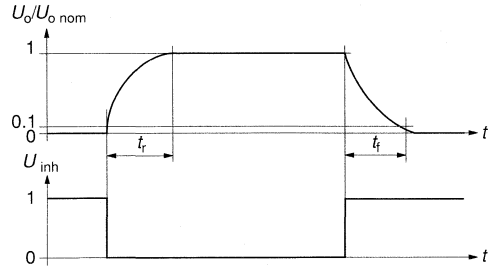



*Fig. 3*
*Output response as a function of inhibit signal*

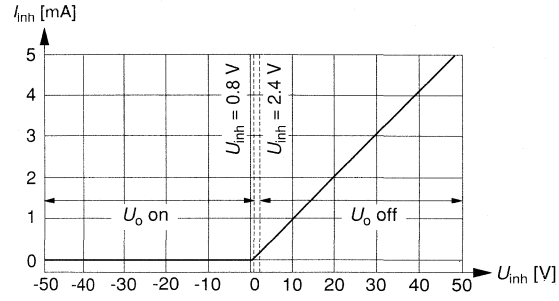



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

**Data**

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\ min}$...$U_{i\ max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\ min}$...$T_{C\ max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\ nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\ nom} / I_{o\ nom}$ | | 10 | | |
| $I_{i\ off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\ nom}$ | | 10 | | mA |

### R External Output Voltage Adjustment

**Note:** With open R-input, $U_o = U_{o\,nom}$.
(For superseded PSR types, $U_o = 1.08 \cdot U_{o\,nom}$)

R-input and option P cannot be supported simultaneously. The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

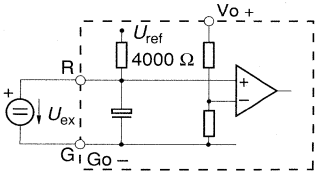



*Fig. 5*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±2%)

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V, nor be negative.

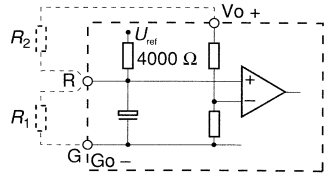



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:
$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 2\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 50 °C | |
| | 624'000 h | 207'000 h | 96'000 h | 46'000 h | 13'000'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Electrical Input and Output Data

General Conditions
– $T_A$ = +25°C, unless $T_C$ is specified
– With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSB 5A7 | | | PSB 5A6 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 5.07 | | 5.13 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 7.0 | | | 6.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 7.0 | | 9.1 | 6.0 | | 7.8 | |
| $u_o$ | Output ripple voltage | $U_{i\,nom}$, $I_{onom}$ BW = 20 MHz | | 25 | 45 | | 25 | 60 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 25 | 45 | | 25 | 45 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 10 | 25 | | 10 | 25 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ | | 120 | | | 100 | | |
| $t_d$ | Dynymic load transient time constant [1] | $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 40 | | | 50 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient | $U_{i\,min}$...$U_{i\,max}$ | | | ±1 | | | ±1 | mV/K |
| | $\Delta U_o/\Delta T_C$ ($T_{C\,min}$...$T_{C\,max}$) | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ | 7 | | 40 | 8 | | 80 | V DC |
| $\Delta U_{i\,o\,m}$ | Min. differential voltage $U_i$ - $U_o$ [2] | $T_{C\,min}$...$T_{C\,max}$ | | 2 | | | 3 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 6.3 | | | 7.3 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0, $U_{i\,min}$...$U_{i\,max}$ | | | 45 | | | 40 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 75 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 100 | | | 180 | | A |
| $t_{i\,s}$ | Rise time [3] | with option L | | 15 | | | 15 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 100 | | | 100 | | |
| $u_{i\,RFI}$ | Input RFI level, VDE 0871 [4] | $I_{o\,nom}$, $U_{i\,min}$...$U_{i\,max}$ | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 84 | | | 81 | | % |
| **Isolation** | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs and outputs interconnected | | 750 | | | 750 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_C$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 120 µF/100 V (e.g. Nichicon PF(M) series or equivalent)

# Characteristics and Definitions



### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

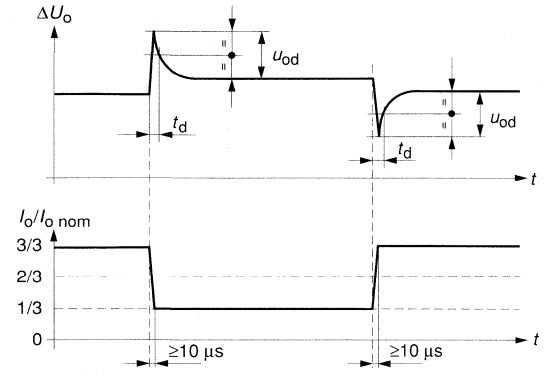



*Fig. 7*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

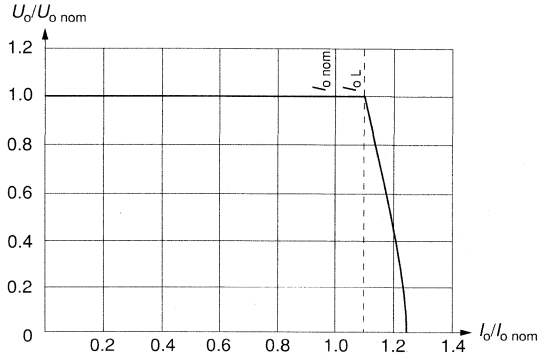



*Fig. 8*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV1061.1981, SEV 1085.1983 and EN 55014 standards.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Description of Options

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71\,°C$.

---

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 60 $mV_{rms}$. A reduction can be achieved by insertion of a capacitor across the input (e.g. plastic foil between Vi+ and Gi–).

The input impedance of the switching regulator at 120 kHz is about 17 Ω. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

Input voltage up to 40 V:

$u_{i\,max} = 12\ V_{pp}$ at 100 Hz or $V_{pp} = 1200\ Hz/f_i \cdot 1V$

Input voltage up to 80 V:

$u_{i\,max} = 22\ V_{pp}$ at 100 Hz or $V_{pp} = 2200\ Hz/f_i \cdot 1V$

---

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

---

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | 5.1 V | | Unit |
|---|---|---|---|---|---|
| | | | min | max | |
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$<br>$I_o = 0...I_{o\,nom}$<br>$T_{C\,min}...T_{C\,max}$ | 5.8 | 6.8 | V |
| $t_s$ | Delay time | | | 1.5 | µs |

---

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSB family as recognized components up to an ambient temperature of $T_{A\,max} - 10$ K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71\,°C$ without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

European Projection

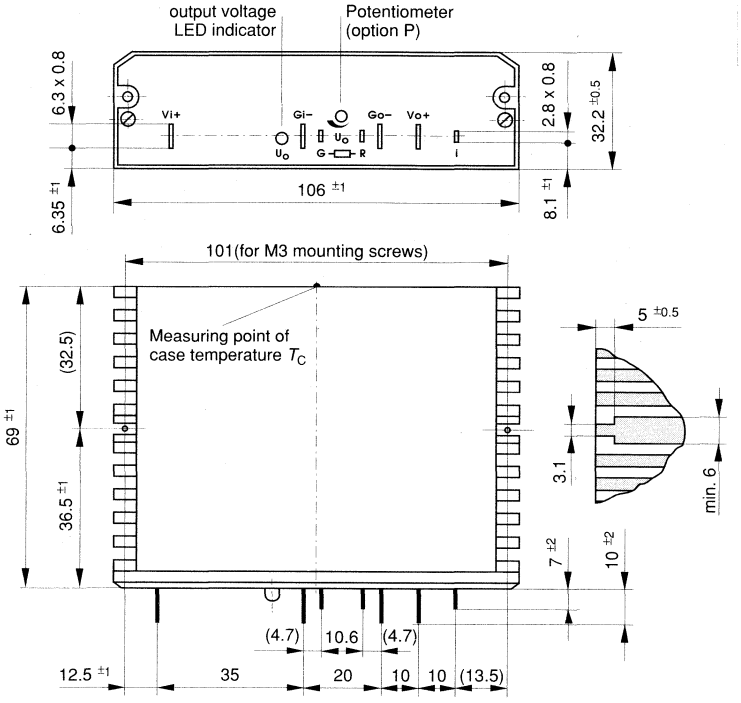



*Fig. 9*
*Case B02 (weight 230 g)*

## Type Key and Product Marking

### Type Key

PSB 5A 6 -7 L i R P C U

Positive switching regulator in case B02 ..... PSB
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1
Nominal output current in ampere ..... 6...7
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Input filter ..... L
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Thyristor-Crowbar ..... C
UL recognized component for $T_{A\,max}$ = 71 °C (instead of 60 °C) ..... U

Example: PSB 5A6-7LiPC = A positive switching regulator with a 5.1 V, 6 A output, ambient temperature range of –25...71 °C, input filter, inhibit input, potentiometer and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometer and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.


MELCHER ISO 9001 certified

# PSR: Positive Switching Regulators

# PSC-Family

**No input to output isolation**
**Single output of 5.1, 12, 15, 24 or 36 V DC/51...288 W**
**Input voltage up to 80 V DC**

- High efficiency up to 96%
- Wide input voltage range
- Low input-to-output differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\ nom}$ | Nominal output current $I_{o\ nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\ nom}$ | Efficiency $\eta$ | Type designation | Options | Superseded old type (phase-out) |
|---|---|---|---|---|---|---|---|
| 5.1 V | 10 A | 8...80 V | 40 V | 79% | PSC 5A10-7iR | -9, L, P, C, D, U | PSR 510-7 |
| 12 V | 8 A | 15...80 V | | 90% | PSC 128-7iR | | PSR 128-7 |
| 15 V | | 19...80 V | | 91% | PSC 158-7iR | | PSR 158-7 |
| 24 V | | 29...80 V | 50 V | 94% | PSC 248-7iR | | PSR 248-7 |
| 36 V | | 42...80 V | 60 V | 96% | PSC 368-7iR | | PSR 368-7 |

[1] See data $\Delta U_{io\ min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSC family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 80 V are specially designed for secondary switched and battery driven applications.
Case C03: Aluminium, black finish and self cooling.

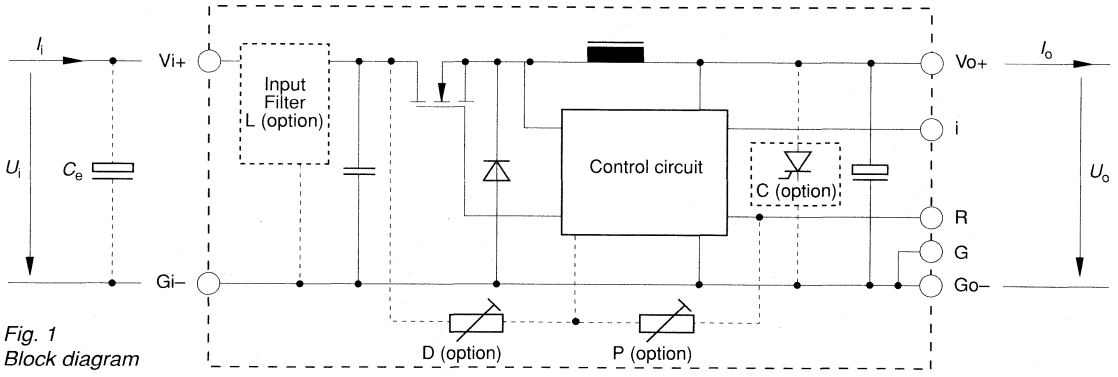



*Fig. 1*
*Block diagram*

3.2

**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**i Inhibit**

**Note:** With open i-input, output is enabled ($U_o$ = on)

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

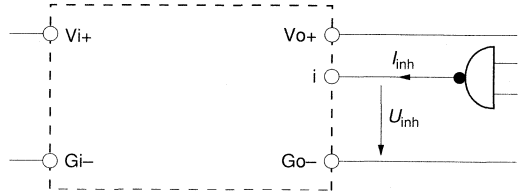



*Fig. 2*
*Definition of $I_{inh}$ and $U_{inh}$*

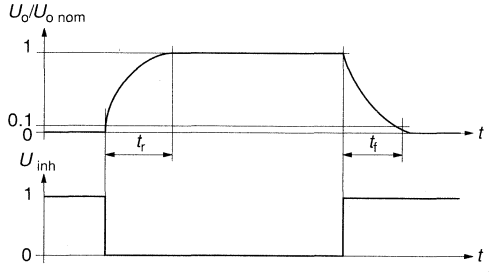



*Fig. 3*
*Output response as a function of inhibit signal*

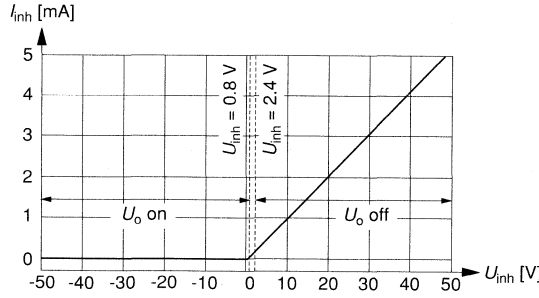



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

**Data**

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |


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### R External Output Voltage Adjustment

**Note:** With open R input, $U_o = U_{o\,nom}$.
(For superseded PSR types, $U_o = 1.08 \cdot U_{o\,nom}$)

R-input and option P cannot be supported simultaneously. The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage lock-out.

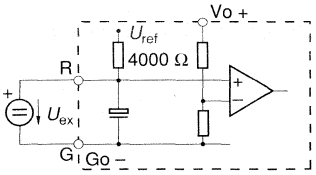



*Fig. 5*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±2%)

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V, nor be negative.

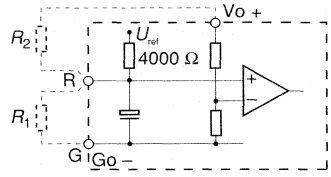



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:

$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 2\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40°C | $T_C$ = 40°C | $T_C$ = 70°C | $T_C$ = 50°C | |
| | 660'000 h | 143'000 h | 81'000 h | 68'000 h | 2'800'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6a: Input and output data*

| Characteristics | | Conditions | PSC 5A10 min | PSC 5A10 typ | PSC 5A10 max | PSC 128 min | PSC 128 typ | PSC 128 max | PSC 158 min | PSC 158 typ | PSC 158 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.92 | | 12.07 | 14.91 | | 15.09 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 10.0 | | | 8.0 | | | 8.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 10.0 | | 13.0 | 8.0 | | 10.4 | 8.0 | | 10.4 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 35 | 50 | | 80 | 150 | | 80 | 150 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 30 | 45 | | 50 | 75 | | 70 | 100 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 20 | 25 | | 30 | 35 | | 35 | 45 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow$ 1/3 $I_{o\,nom}$ | | 130 | | | 130 | | | 130 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 50 | | | 60 | | | 60 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | ±1 | | | ±2 | | | ±3 | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 8 | | 80 | 15 | | 80 | 19 | | 80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 3 | | | 3 | | | 4 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 7.3 | | | 7.3 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 40 | | | 35 | | | 35 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 250 | | | 250 | | | 250 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | 350 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | | 25 | | | 25 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | | 125 | | | 125 | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,min...max}$, $I_{o\,nom}$ | | | B | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 79 | | | 90 | | | 91 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 750 | | | 750 | | | 750 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 120 µF/100 V, e.g. Nichicon, PF(M) series, or equivalent

*Table 6b: Input and output data*

| Characteristics | | Conditions | PSC 248 min | PSC 248 typ | PSC 248 max | PSC 368 min | PSC 368 typ | PSC 368 max | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 23.85 | | 24.14 | 35.78 | | 36.22 | | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 8.0 | | | 8.0 | | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$... $T_{C\,max}$ | 8.0 | | 10.4 | 8.0 | | 10.4 | | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 100 | 250 | | 150 | 300 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 150 | 220 | | 200 | 270 | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0... $I_{o\,nom}$ | | 120 | 160 | | 125 | 160 | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow$ 1/3 $I_{o\,nom}$ | | 150 | | | 220 | | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 80 | | | 100 | | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$... $T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±5 | | | ±8 | | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0... $I_{o\,nom}$ $T_{C\,min}$... $T_{C\,max}$ | 29 | | 80 | 42 | | 80 | | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 5 | | | 6 | | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 12 | | | 19 | | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 35 | | | 40 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 250 | | | 250 | | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | | 25 | | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | | 125 | | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,min...max}$, $I_{o\,nom}$ | | | B | | | B | | dB (µV) |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 94 | | | 96 | | | % |
| **Isolation** | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 750 | | | 750 | | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 120 µF/100 V, e.g. Nichicon, PF(M) series, or equivalent

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

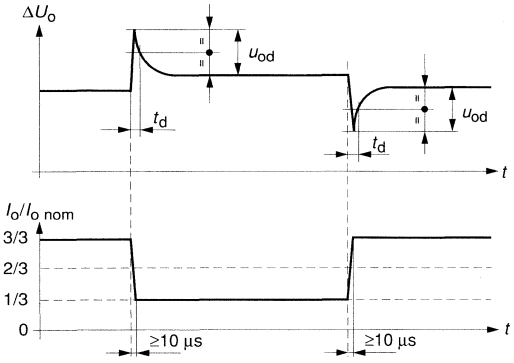



*Fig. 7*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 95 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

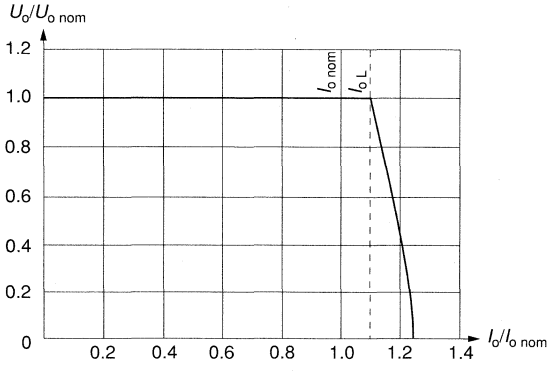



*Fig. 8*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90. SEV approval according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards are in progress.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Description of Options

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A$ = –40...71°C.

---

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 4 $mV_{rms}$.

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 22\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 2200\ Hz/f_i \bullet 1\ V$$

---

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

---

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | 5.1 | | 12 V | | 15 V | | 24 V | | 36 V | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | min | max | min | max | min | max | |
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | 5.8 | 6.8 | 13.5 | 16 | 16.5 | 19 | 27 | 31 | 40 | 45.5 | V |
| $t_s$ | Delay time | | | 1.5 | | 1.5 | | 1.5 | | 1.5 | | 1.5 | µs |

---

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSC family as recognized components up to an ambient temperature of $T_{A\,max}$ – 25 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max}$ = 71 °C without any further precautions.

**Option D** ("Save Data", input undervoltage monitor)

**Note:** Output instead of input undervoltage monitor is available on request (Option D1).

If the input voltage $U_i$ is below the adjustable threshold voltage $U_t$, the control circuit for terminal D has low impedance. Terminal D and Go– are connected to a self-conducting field effect transistor (FET). A 0.5 W Zener diode provides protection against overvoltages.

The voltage $U_t$ can be externally adjusted with a trim potentiometer by means of a screwdriver. The hystersis $U_H$ of $U_t$ is <2%. Terminal D stays low for a minimum time $t_{low\ min}$, in order to prevent any oscillation. $U_t$ can be set to a value between $U_{i\ min}$ and $U_{i\ max}$. It is important to note that the FET can become conductive again when $U_D > U_i - 3V$.



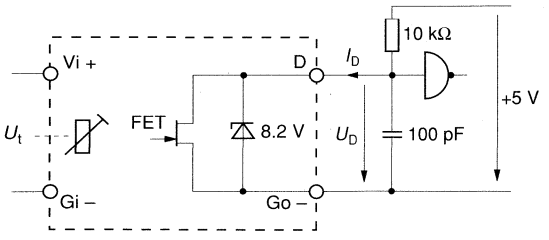



*Fig. 9*
*Test circuit with definition of voltage $U_D$ and current $I_D$ on Terminal D.*

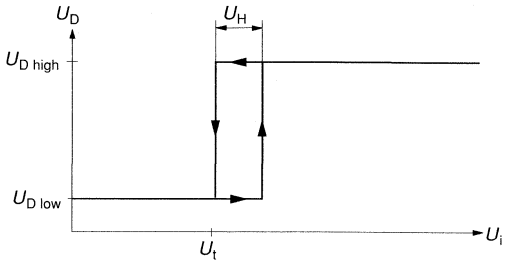



*Fig. 10*
*Definition of $U_t$ and $U_H$*

## Data

*Table 8: Option D data*

| Characteristics | | Conditions | PSC | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| $U_{D\ low}$ | Voltage - Terminal D at low impedance | $U_i < U_t$, $I_D \leq 2.5$ mA | | | 0.8 | V |
| $U_{D\ high}$ | Voltage - Terminal D at high impedance | $U_i > U_t + U_H$, $I_D > 25$ µA | 4.75 | | | |
| $t_{low\ min}$ | Minimum duration $U_{D\ low}$ | | | 30 | | ms |
| $t_{D\ f}$ | Response time to $U_{D\ low}$ | | | 1 | | µs |
| $I_{D\ max}$ | Maximum current - Terminal D | | | | 20 | mA |

Application examples

a) The signal $U_D$ can be utilized in battery powered systems to provide a warning in case of **low batteries**.
b) In case of power failure, the signal can serve to initiate **data save** routines.


MELCHER® ISO 9001 certified

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

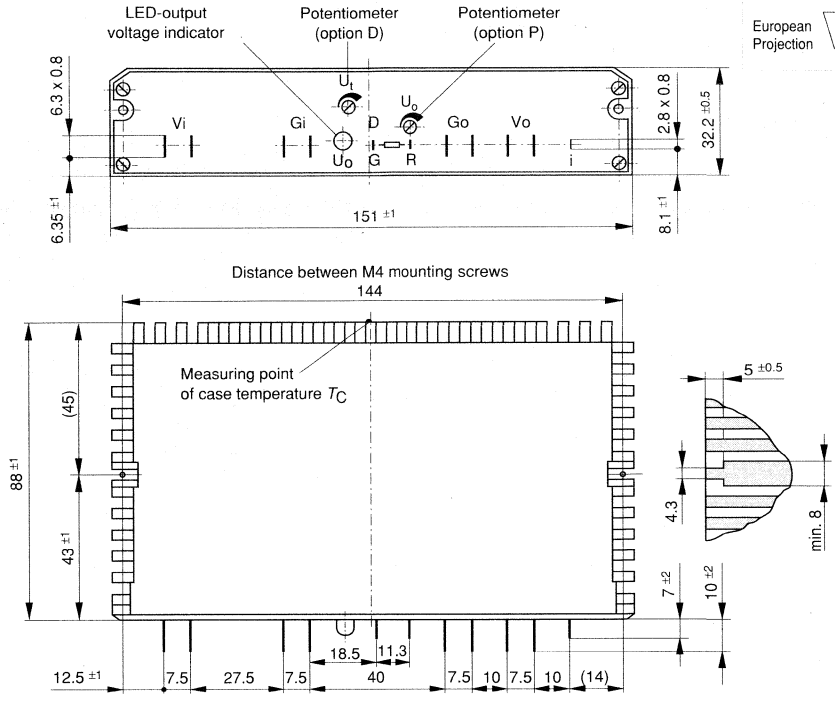



*Fig. 11*
*Case C03 (weight 440 g)*

## Type Key and Product Marking

### Type Key

PSC 12 8 -7 L i R P C D U

| | |
|---|---|
| Positive switching regulator in case C03 | PSC |
| Blank | |
| Nominal output voltage in volt (5A –> 5.1) | 5.1...36 |
| Nominal output current in ampere | 8...10 |
| Ambient temperature range | |
| $T_A$ = –25...71 °C | -7 |
| $T_A$ = –40...71 °C | -9 |
| Input filter | L |
| Inhibit input | i |
| External output voltage adjustment | R |
| Potentiometer | P |
| Thyristor-Crowbar | C |
| "Save Data" undervoltage monitor | D |
| UL recognized component for $T_{A\,max}$ = 71 °C | U |

Example: PSC 128-7LiPC = A positive switching regulator with a 12 V, 8 A output, ambient temperature range of –25...71 °C, input filter, inhibit input, potentiometer and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometers and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

# PSR: Positive Switching Regulators PSL-Family

**No input to output isolation**
**Single output of 5.1, 12, 15, 24 or 36 V DC/51...288 W**
**Input voltage up to 80 V DC**



- High efficiency up to 94%
- Wide input voltage range
- Low input-to-output differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options | Superseded old type (phase-out) |
|---|---|---|---|---|---|---|---|
| 5.1 V | 10 A | 8...80 V | 40 V | 76% | PSL 5A10-7R | -9, L, i, P, C, D, A, U | PSR 510E-7 |
| 12 V | 8 A | 15...80 V | | 89% | PSL 128-7R | | PSR 128E-7 |
| 15 V | | 19...80 V | | 90% | PSL 158-7R | | PSR 158E-7 |
| 24 V | | 29...80 V | 50 V | 92% | PSL 248-7R | | PSR 248E-7 |
| 36 V | | 42...80 V | 60 V | 94% | PSL 368-7R | | PSR 368E-7 |

[1] See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSL family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 80 V are specially designed for secondary switched and battery driven applications.
Case L04: Aluminium, black finish and self cooling.

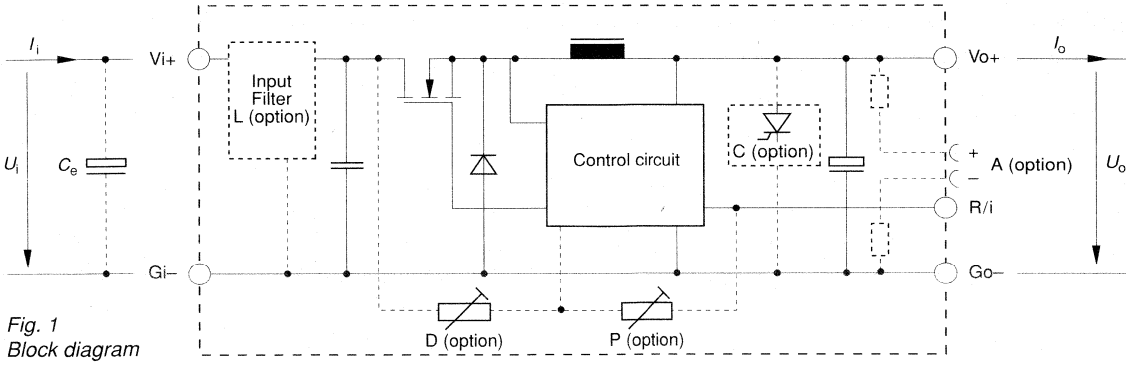



*Fig. 1*
*Block diagram*



**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**R External Output Voltage Adjustment**

**Note:** With open R input, $U_o = U_{o\,nom}$.
(For superseded PSR types, $U_o = 1.08 \cdot U_{o\,nom}$)
R-input together with option i or option P cannot be supported simultaneously.

The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

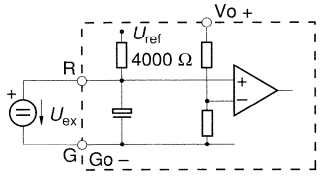



*Fig. 2*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±4%)

**Caution:** To prevent damage $U_{ex}$ should not exceed $U_{ref}$, nor be negative.

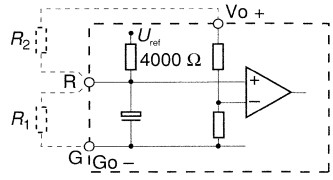



*Fig. 3*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:
$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 4\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 4: MTBF and device hours*

| MTBF | Ground Fixed | | Ground Mobile | | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217D | $T_C$ = 40°C | $T_C$ = 70°C | $T_C$ = 40°C | $T_C$ = 70°C | |
| | 130'000 h | 58'000 h | 36'000 h | 17'000 h | 3'900'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

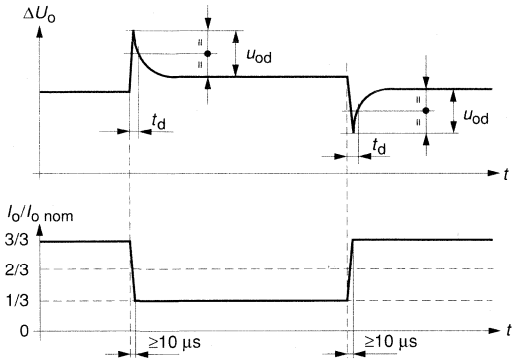



*Fig. 4*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 95 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

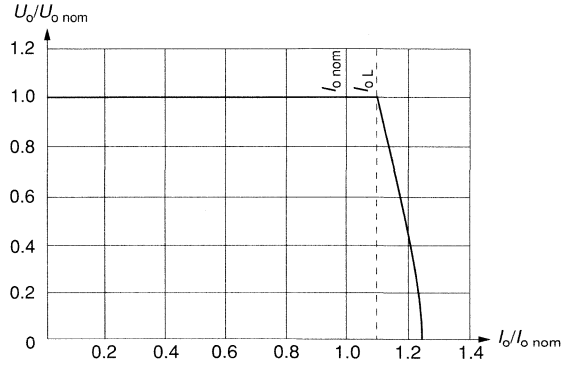



*Fig. 5*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90. SEV approval according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards are in progress.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30 (equipped with any potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 5a: Input and output data*

| Characteristics | | Conditions | PSL 5A10 min | PSL 5A10 typ | PSL 5A10 max | PSL 128 min | PSL 128 typ | PSL 128 max | PSL 158 min | PSL 158 typ | PSL 158 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.92 | | 12.07 | 14.91 | | 15.09 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 10.0 | | | 8.0 | | | 8.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 10.0 | | 13.0 | 8.0 | | 10.4 | 8.0 | | 10.4 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 35 | 50 | | 80 | 150 | | 80 | 150 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 30 | 45 | | 50 | 75 | | 70 | 100 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 20 | 25 | | 28 | 35 | | 33 | 45 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow$ 1/3 $I_{o\,nom}$ | | 130 | | | 130 | | | 130 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 50 | | | 60 | | | 60 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±1 | | | ±2 | | | ±3 | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 8 | | 80 | 15 | | 80 | 19 | | 80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 3 | | | 3 | | | 4 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 7.3 | | | 7.3 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 40 | | | 35 | | | 35 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 250 | | | 250 | | | 250 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | 350 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | | 25 | | | 25 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | | 125 | | | 125 | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | B | | | B | | | B | dB(µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 76 | | | 89 | | | 90 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 750 | | | 750 | | | 750 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 120 µF/100 V, e.g. Nichicon, PF(M) series, or equivalent

*Table 5b: Input and output data*

| Characteristics | | Conditions | PSL 248 min | PSL 248 typ | PSL 248 max | PSL 368 min | PSL 368 typ | PSL 368 max | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 23.85 | | 24.14 | 35.78 | | 36.22 | | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 8.0 | | | 8.0 | | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 8.0 | | 10.4 | 8.0 | | 10.4 | | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 100 | 250 | | 150 | 300 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 150 | 220 | | 200 | 270 | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 120 | 160 | | 125 | 160 | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}$↔ 1/3 $I_{o\,nom}$ | | 150 | | | 220 | | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 80 | | | 100 | | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±5 | | | ±8 | | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 29 | | 80 | 42 | | 80 | | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 5 | | | 6 | | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 12 | | | 19 | | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 35 | | | 40 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 250 | | | 250 | | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | | 5 | | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | | 40 | | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | | 25 | | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | | 125 | | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | B | | | B | | dB(µV) |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 92 | | | 94 | | | % |
| **Isolation** | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 750 | | | 750 | | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 120 µF/100 V, e.g. Nichicon, PF(M) series, or equivalent

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 32 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H11 (according to DIN 41612) to ensure requested safety!

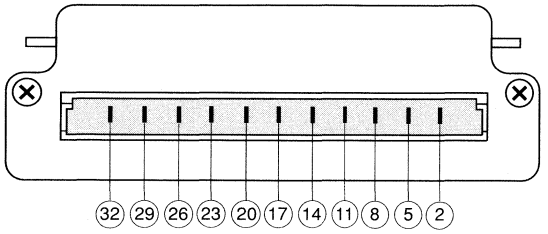



*Fig. 6*
*View of male H11 connector*

*Table 6: H11 connector pin allocation and designation*

| Electrical Determination | Type H11 Pin No. | Design. |
|---|---|---|
| R-input (or inhibit input) [1] | 2 | R (i) |
| Undervoltage monitor (Option D) | 5 | D |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 11 | Go– |
| Output voltage(positive) | 14 | Vo+ |
| Output voltage (positive) | 17 | Vo+ |
| Input voltage (negative) | 20 | Gi– |
| Input voltage (negative) | 23 | Gi– |
| Input voltage (positive) | 26 | Vi+ |
| Input voltage (positive) | 29 | Vi+ |
| Protective ground (protruding pin) | 32 | ⏚ |

[1] R-input (output voltage programming) not available with option P (potentiometer) or option i (inhibit)

## Description of Options

**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on). Inhibit excludes R function!

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

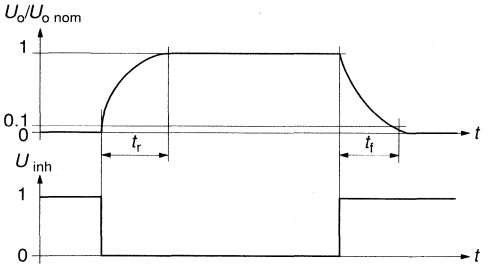



*Fig. 8*
*Output response as a function of inhibit signal*

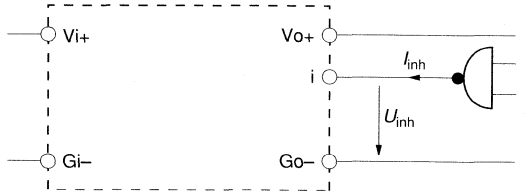



*Fig. 7*
*Definition of $I_{inh}$ and $U_{inh}$*

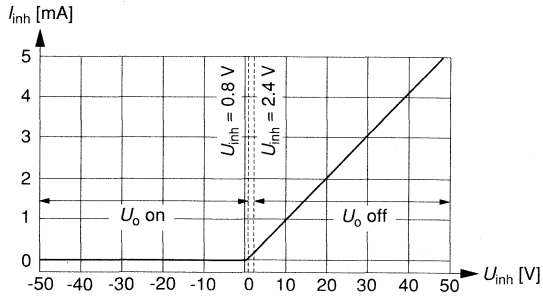



*Fig. 9*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

### Data

*Table 7: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom} / I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |


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**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71°C$.

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 4 $mV_{rms}$.

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 22\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 2200\ Hz/f_i \cdot 1\ V$$

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSL family as recognized components up to an ambient temperature of $T_{A\,max} - 10$ K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71°C$ without any further precautions.

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 8: Crowbar trigger levels*

| Characteristics | | Conditions | 5.1 V | | 12 V | | 15 V | | 24 V | | 36 V | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | min | max | min | max | min | max | |
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ | 5.8 | 6.8 | 13.5 | 16 | 16.5 | 19 | 27 | 31 | 40 | 45.5 | V |
| $t_s$ | Delay time | $T_{C\,min}...T_{C\,max}$ | | 1.5 | | 1.5 | | 1.5 | | 1.5 | | 1.5 | µs |

**Option D** ("Save Data", input undervoltage monitor)

**Note:** Output instead of input undervoltage monitor is available on request (option D1).

If the input voltage $U_i$ is below the adjustable threshold voltage $U_t$, the control circuit for terminal D has low impedance. Terminal D and Go– are connected to a self-conducting field effect transistor (FET). A 0.5 W Zener diode provides protection against overvoltages.

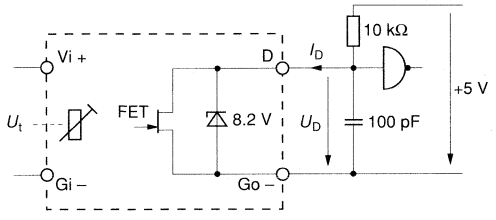



*Fig. 10*
*Test circuit with definition of voltage $U_D$ and current $I_D$ on Terminal D.*

The voltage $U_t$ can be externally adjusted with a trim potentiometer by means of a screwdriver. The hystersis $U_H$ of $U_t$ is <2%. Terminal D stays low for a minimum time $t_{low\ min}$, in order to prevent any oscillation. $U_t$ can be set to a value between $U_{i\,min}$ and $U_{i\,max}$ according to fig. 10. It is important to note that the FET can become conductive again when $U_D > U_i - 3V$.

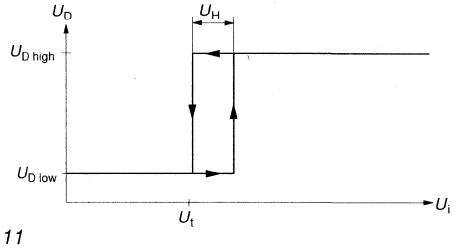



*Fig. 11*
*Definition of $U_t$ and $U_H$*

**Data**

*Table 9: Option D data*

| Characteristics | | Conditions | PSL | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| $U_{D\,low}$ | Voltage - Terminal D at low impedance | $U_i < U_t$, $I_D \leq 2.5$ mA | | | 0.8 | V |
| $U_{D\,high}$ | Voltage - Terminal D at high impedance | $U_i > U_t + U_H$, $I_D > 25$ µA | 4.75 | | | |
| $t_{low\,min}$ | Minimum duration $U_{D\,low}$ | | | 30 | | ms |
| $t_{D\,f}$ | Response time to $U_{D\,low}$ | | | 1 | | µs |
| $I_{D\,max}$ | Maximum current - Terminal D | | | | 20 | mA |



Application examples

a) The signal $U_D$ can be utilized in battery powered systems to provide a warning in case of **low batteries**.
b) In case of power failure, the signal can serve to initiate **data save** routines.

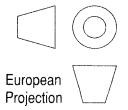
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**Option A** Test sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage are located at the front panel of the module. The output voltage is measured internally directly at the connector pins.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



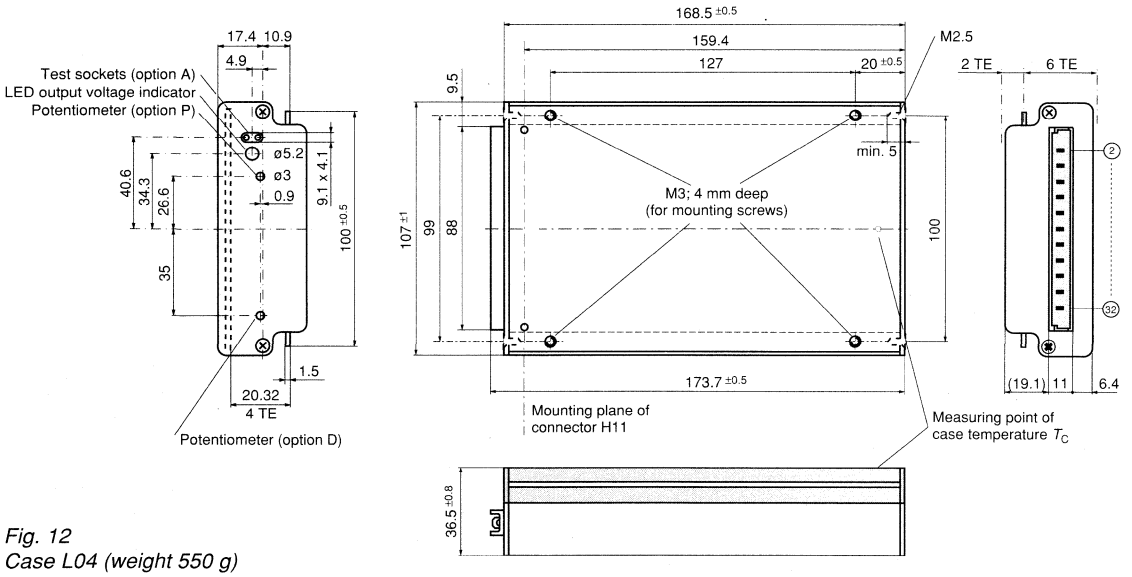




*Fig. 12*
*Case L04 (weight 550 g)*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case L04 ..... PSL
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1...36
Nominal output current in ampere ..... 8...10
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Input filter ..... L
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Thyristor-Crowbar ..... C
"Save Data" undervoltage monitor ..... D
Test sockets ..... A
UL recognized component for $T_{A\,max}$ = 71 °C ..... U

Example: PSL 128-7LiPC = A positive switching regulator with a 12 V, 8 A output, ambient temperature range of –25...71 °C, input filter, inhibit input, potentiometer and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

Front plate: Identification of LED, optional test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltage and current, pin allocation of options and auxiliary functions and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and production date.

# NSR: Negative Switching Regulators NSR-Family

**No input to output isolation**
**Single output of –5, –12, –15, –24 or –36 V DC/50...288 W**
**Input voltage up to –80 V DC**



- High efficiency up to 94%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options |
|---|---|---|---|---|---|---|
| –5 V | 10 A | –8...–80 V | –40 V | 70% | NSR 510-7 | -9, L, i, P, R, C, U |
| –12 V | 8 A | –15...–80 V | | 89% | NSR 128-7 | |
| –15 V | | –19...–80 V | | 89% | NSR 158-7 | |
| –24 V | | –29...–80 V | –50 V | 91% | NSR 248-7 | |
| –36 V | | –42...–80 V | –60 V | 94% | NSR 368-7 | -9, L, i, P, R, U |

[1] See also data $\Delta U_{io\,min}$. (Minimum differential voltage $U_i - U_o$)

## Description

The NSR family of negative switching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response.

The modules are specially designed for secondary switched and battery driven applications with positive system ground.

Case C03: Aluminium, black finish and self cooling.

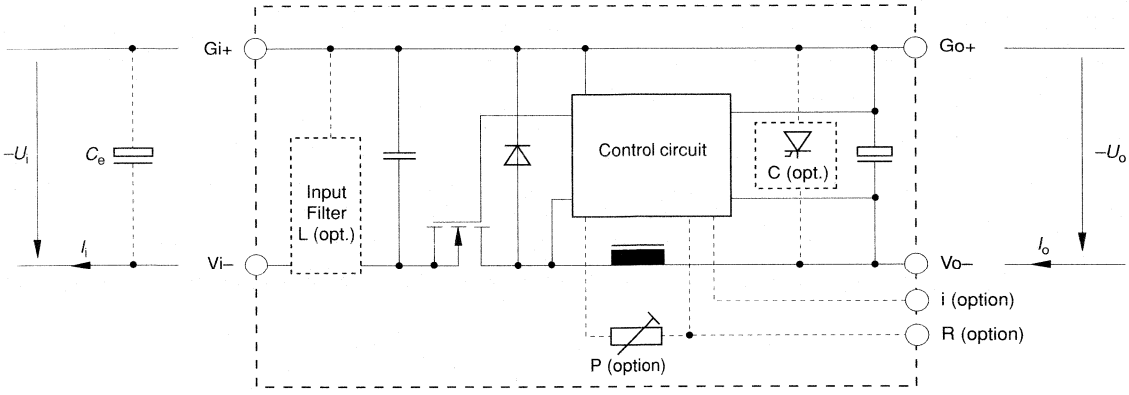



*Fig. 1*
*Block Diagram*

**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |

*Table 3: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 4: MTBF and device hours*

| MTBF | Ground Fixed | | Ground Mobile | | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217D | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | |
| | 130'000 h | 58'000 h | 36'000 h | 17'000 h | 1'050'000 h |

[1] Statistical values , based on an average of 4300 working hours per year and in general field use

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With option P or R, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 5a: Input and output data*

| Characteristics | | Conditions | NSR 510 min | NSR 510 typ | NSR 510 max | NSR 128 min | NSR 128 typ | NSR 128 max | NSR 158 min | NSR 158 typ | NSR 158 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | –4.97 | | –5.03 | –11.92 | | –12.07 | –14.91 | | –15.09 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 10.0 | | | 8.0 | | | 8.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 10.0 | | 13.0 | 8.0 | | 10.4 | 8.0 | | 10.4 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$<br>$I_{o\,nom}$ | | 35<br>60 | 50<br>85 [1] | | 80 | 150 | | 80 | 150 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$ | | 30 | 45 | | 50 | 85 | | 70 | 105 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$<br>$I_o$ = 0...$I_{o\,nom}$ | | 20 | 25 | | 28<br>45 | 35<br>55 [1] | | 33<br>48 | 45<br>65 [1] | |
| $u_{o\,d}$ | Dynamic control deviation [2] | $U_{i\,nom}$<br>$I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 130 | | | 130 | | | 130 | | |
| $t_d$ | Dynamic load transient time constant [2] | | | 50 | | | 60 | | | 60 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$<br>$T_{C\,min}$...$T_{C\,max}$ | | | ±1 | | | ±2 | | | ±3 | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$<br>$T_{C\,min}$...$T_{C\,max}$ | –8 | | –80 | –15 | | –80 | –19 | | –80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [3] | | | –3 | | | –3 | | | –4 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | –7.3 | | | –7.3 | | | –7.3 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0<br>$U_{i\,min}$...$U_{i\,max}$ | | | 40 | | | 35 | | | 35 | mA |
| $I_{i\,m}$ | Peak value of inrush current [4] | $U_{i\,nom}$ | | 250 | | | 250 | | | 250 | | A |
| $t_{i\,s}$ | Rise time [4] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [4] | | | 40 | | | 40 | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [4] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | 350 | | A |
| $t_{i\,s}$ | Rise time [4] | | | 25 | | | 25 | | | 25 | | µs |
| $t_{i\,r}$ | Tail half value time [4] | | | 125 | | | 125 | | | 125 | | |
| $u_{i\,rfi}$ | RFI level at input, 0.01...30 MHz | VDE 0871 (6.78)<br>$U_{i\,nom}$, $I_{o\,nom}$ | | | A | | | A | | | A | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 76 | | | 88 | | | 89 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | | 500 | | | 500 | | V DC |

[1] Lower row represents option -9 data only
[2] See "Dynamic Characteristics"
[3] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly by 1 V max between $T_A$ = 46°C and 71°C ($T_C$ = 70°C and 95°C)
[4] Definitions according to VDE 0433, part 3

*Table 5b: Input and output data*

| Characteristics | | Conditions | NSR 248 min | NSR 248 typ | NSR 248 max | NSR 368 min | NSR 368 typ | NSR 368 max | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | –23.85 | | –24.14 | –35.78 | | –36.22 | | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 8.0 | | | 8.0 | | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 8.0 | | 10.4 | 8.0 | | 10.4 | | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 100 | 250 | | 150 | 300 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 150 | 220 | | 200<br>270 | 270<br>370 [1] | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 120 | 160 | | 125<br>250 | 160<br>320 [1] | | |
| $u_{o\,d}$ | Dynamic control deviation [2] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 150 | | | 225 | | | |
| $t_d$ | Dynamic load transient time constant [2] | | | 80 | | | 100 | | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±5 | | | ±8 | | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | –29 | | –80 | –42 | | –80 | | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [3] | | | –5 | | | –6 | | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | –12 | | | –19 | | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 35 | | | 40 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [4] | $U_{i\,nom}$ | | 250 | | | 250 | | | A |
| $t_{i\,s}$ | Rise time [4] | | | 5 | | | 5 | | | µs |
| $t_{i\,r}$ | Tail half value time [4] | | | 40 | | | 40 | | | |
| $I_{i\,m}$ | Peak value of inrush current [4] | $U_{i\,nom}$ with option L | | 350 | | | 350 | | | A |
| $t_{i\,s}$ | Rise time [4] | | | 25 | | | 25 | | | µs |
| $t_{i\,r}$ | Tail half value time [4] | | | 125 | | | 125 | | | |
| $u_{i\,rfi}$ | RFI level at input, 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A | | | A | | dB (µV) |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 91 | | | 94 | | | % |
| **Isolation** | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | | 500 | | | V DC |

[1] Lower row represents option -9 data only
[2] See "Dynamic Characteristics"
[3] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly by 1 V max between $T_A$ = 46°C and 71°C ($T_C$ = 70°C and 95°C)
[4] Definitions according to VDE 0433, part 3

# Characteristics and Definitions



### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor crowbar).

### Dynamic Characteristics

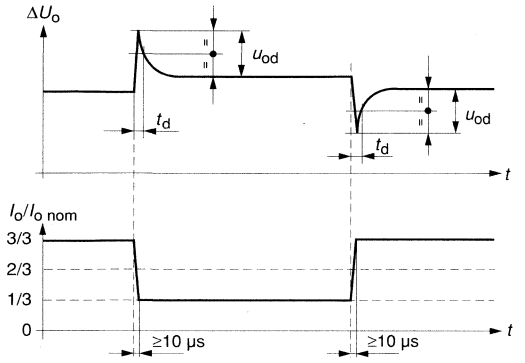



*Fig. 2*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase measured at the measuring point of case temperature $T_C$ (see "Mechanical Data).

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

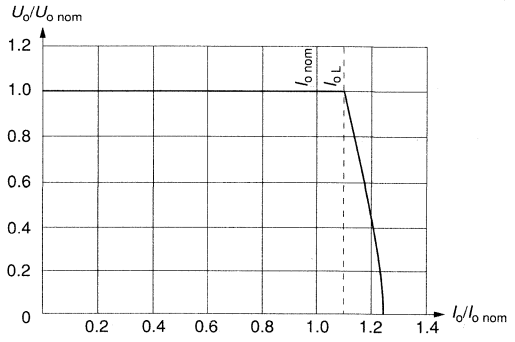



*Fig. 3*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Description of Options

**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

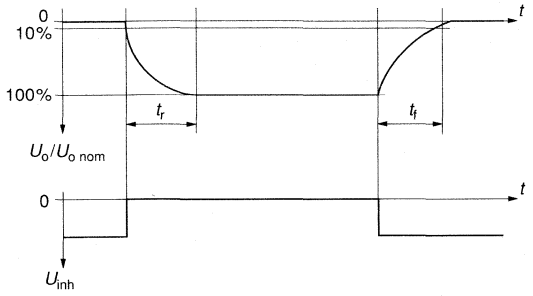



*Fig. 5*
*Output response as a function of inhibit signal*

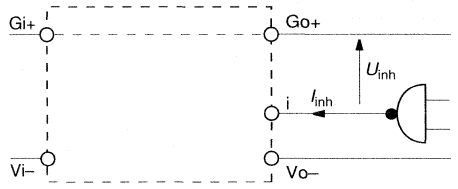



*Fig. 4*
*Definition of $I_{inh}$ and $U_{inh}$*

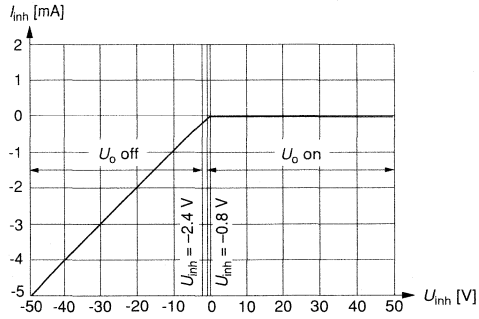



*Fig. 6*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 6: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –0.8 | | +50 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | –50 | | –2.4 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |

**Option R** Output voltage adjustment

**Note:** with an open R-pin, $U_o$ = 1.08 $U_{o\,nom}$!
The output voltage $U_o$ can be adjusted either with an external resistance $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0.65...1.08 of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in relevant tables must be maintained. Options R and P cannot be supported simultaneously.

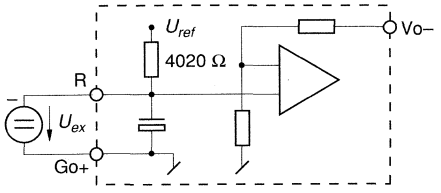



*Fig. 7*
*Voltage adjustment with $U_{ex}$ [V]*

$$U_o \approx 1.08 \cdot U_{ex} \cdot \frac{U_{o\,nom}}{U_{ref}} \qquad (U_{ref} = -2.49\ V \pm 4\%)$$

**Caution:** To prevent damage $U_{ex}$ should not exceed $U_{ref}$ nor be positive!

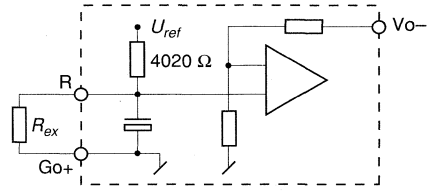



*Fig. 8*
*Voltage adjustment with $R_{ex}$ [Ω]*

$$U_o \approx 1.08 \cdot U_{o\,nom} \cdot \frac{R_{ex}}{R_{ex} + 4020}$$

$$R_{ex} \approx 4020 \cdot \frac{U_o}{1.08 \cdot U_{o\,nom} - U_o}$$

All formulae give approximate values only.

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71\,°C$.

---

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi– and Gi+ has, with an input line inductance of 5 µH a maximum magnitude of 4 $mV_{rms}$. A reduction can be achived by insertion of a capacitor across the input (e.g. plastic foil capacitor).

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 22\ V_{pp} \text{ at } 100\ Hz,$$

$$u_{i\,max} = \frac{2200\ Hz}{f} \cdot 1\ V_{pp} \text{ (at any frequency } f)$$

The rectifier circuit as described in "Application Notes" fulfils the above requirements.

---

**Option P** Potentiometer

Option P excludes R option. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{io\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

---

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

Option C is not available for NSR 368 type.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | –5 V | | –12 V | | –15 V | | –24 V | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | min | max | min | max | |
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | –5.8 | –6.8 | –13.5 | –16 | –16.5 | –19 | –27 | –31 | V |
| $t_s$ | Delay time | | | 1.5 | | 1.5 | | 1.5 | | 1.5 | µs |

---

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the NSR-family as recognized components up to an ambient temperature of $T_{A\,max} - 25$ K, given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71\,°C$ without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

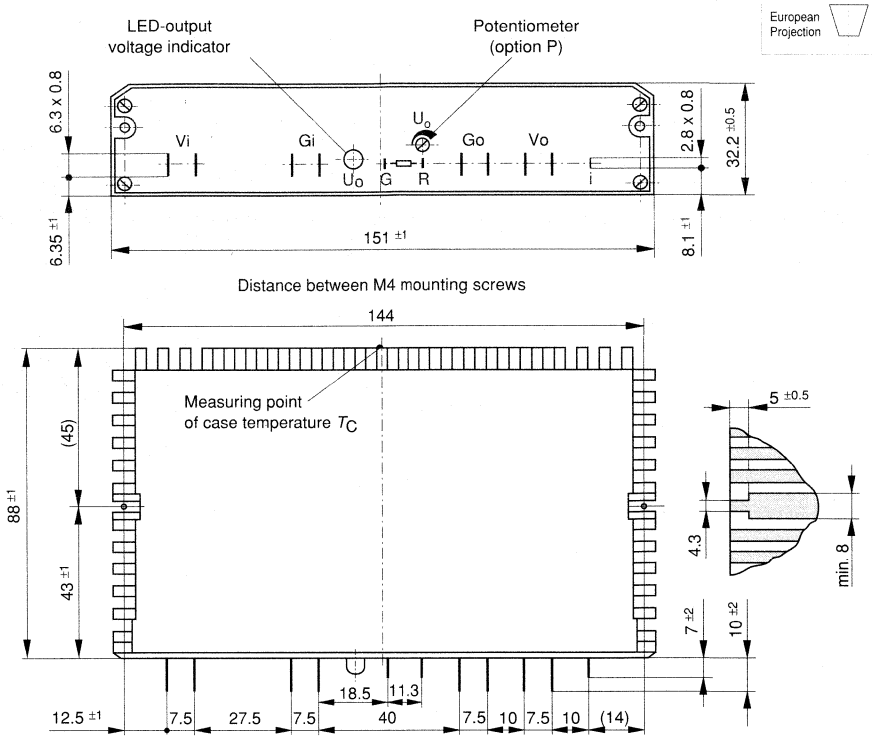
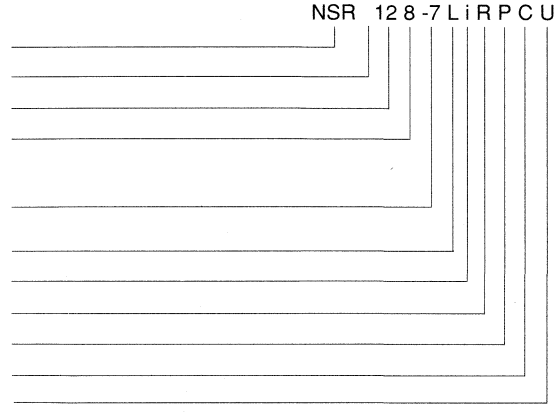



*Fig. 9*
*Case C03 (weight 440 g)*

## Type Key and Product Marking

### Type Key




Negative switching regulator in case C03 ..... NSR
Blank .....
Nominal output voltage in volt ..... –5...–36
Nominal output current in ampere ..... 8...10
Ambient temperature range
$T_A$ = –25...71°C ..... -7
$T_A$ = –40...71°C ..... -9
Input filter ..... L
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Thyristor-Crowbar ..... C
UL recognized component for $T_{A\,max}$ = 71°C ..... U

Example: NSR 128-7iP = A negative switching regulator with a –12 V, 8 A output, ambient temperature range of –25...71°C, inhibit input and potentiometer.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometers and degree of protection.

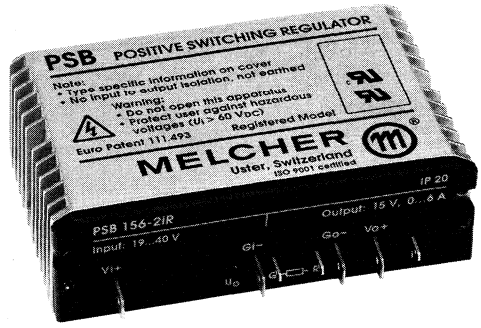
Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

# PSR: Positive Switching Regulators PSB-Family

**No input to output isolation**
**Single output of 5.1, 12, 15 or 24 V DC/40...144 W**
**Input voltage up to 60 V DC**



- High efficiency up to 95%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Option package |
|---|---|---|---|---|---|---|
| 5.1 V | 8 A | 7...40 V | 20 V | 81% | PSB 5A8-2 | iR |
| 12 V | 6 A | 15...40 V | | 90% | PSB 126-2 | |
| 15 V | | 19...40 V | 30 V | 92% | PSB 156-2 | |
| 24 V | | 29...60 V | 40 V | 95% | PSB 246-2 | |

[1] See also data $\Delta U_{io\,min}$.

## Description

The PSB family of positive switching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 60 V are specially designed for secondary switched and battery driven applications.
Case B02: Aluminium and self cooling.

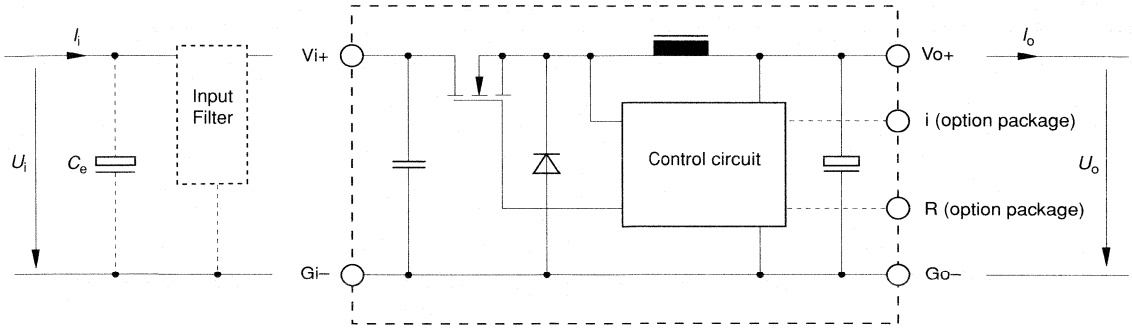



*Fig. 1*
*Block Diagram*



**External input circuitry**

An external input filter (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 5 m.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 in each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 in each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s² (60...150 Hz)<br>3.75 h (1.25 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 2: | 4 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 1: | 0.5 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperture specifications*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | (Not operational) | –25 | 100 | |

*Table 4: MTBF*

| MTBF | Ground Benign |
|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40 °C |
| | 450'000 h |

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

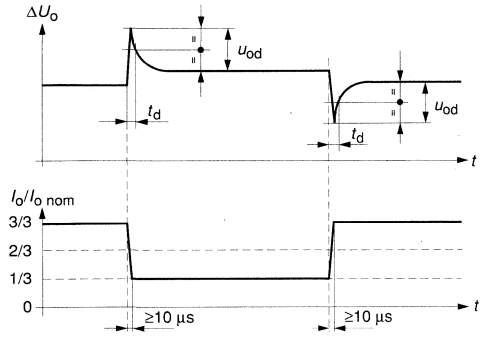



*Fig. 2*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 50 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 80 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 50 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 80 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages which are at the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

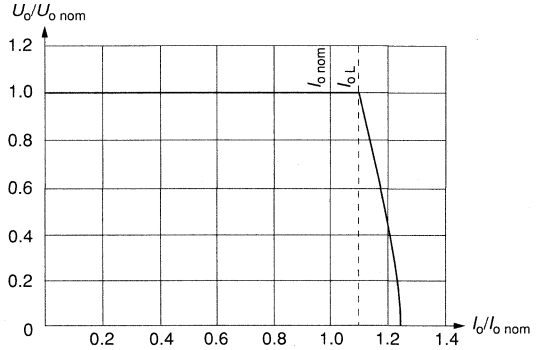



*Fig. 3*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Recognition

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Electrical Input and Output Data

General Conditions
– $T_A$ = +25°C, unless $T_C$ is specified
– With option package iR, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 5: Input and output data*

| Characteristics | | Conditions | PSB 5A8 | | | PSB 126 | | | PSB 156 | | | PSB 246 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.05 | | 5.15 | 11.60 | | 12.40 | 14.50 | | 15.50 | 23.30 | | 24.70 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$... $U_{i\,max}$ | | 8.0 | | | 6.0 | | | 6.0 | | | 6.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$... $T_{C\,max}$ | 8.0 | | 10.4 | 6.0 | | 7.8 | 6.0 | | 7.8 | 6.0 | | 7.8 | |
| $u_o$ | Output ripple voltage | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | | 75 | | | 240 | | | 300 | | | 480 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$... $U_{i\,max}$ $I_{o\,nom}$ | | | 100 | | | 240 | | | 300 | | | 480 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0... $I_{o\,nom}$ | | | 100 | | | 180 | | | 200 | | | 300 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ | | 150 | | | 360 | | | 450 | | | 700 | | |
| $t_d$ | Dynamic load transient time constant [1] | $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 100 | | | 120 | | | 120 | | | 160 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient | $U_{i\,min}$... $U_{i\,max}$ | | | ±2 | | | ±2 | | | ±3 | | | ±5 | mV/K |
| | $\Delta U_o/\Delta T_C$ ($T_{C\,min}$... $T_{C\,max}$) | $I_o$ = 0... $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0... $I_{o\,nom}$ | 7 | | 40 | 15 | | 40 | 19 | | 40 | 29 | | 60 | V DC |
| $\Delta U_{i\,o\,m}$ | Min. diff. voltage $U_i$ - $U_o$ | $T_{C\,min}$... $T_{C\,max}$ | | 2 | | | 3 | | | 4 | | | 5 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 7.3 | | | 7.3 | | | 12 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0, $U_{i\,min}$... $U_{i\,max}$ | | | 50 | | | 50 | | | 50 | | | 50 | mA |
| $I_{i\,m}$ | Peak value of inrush current [2] | $U_{i\,nom}$ | | 150 | | | 150 | | | 150 | | | 150 | | A |
| $t_{i\,s}$ | Rise time [2] | | | 5 | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [2] | | | 40 | | | 40 | | | 40 | | | 40 | | |
| $u_{i\,RFI}$ | Input RFI level, VDE 0871 [3] | $I_{o\,nom}$, $U_{i\,min}$... $U_{i\,max}$ | | A | | | A | | | A | | | A | | dB (µV) |
| **Efficiency** | | | | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 81 | | | 90 | | | 92 | | | 95 | | % |
| **Isolation** | | | | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs and outputs interconnected | | 500 | | | 500 | | | 500 | | | 500 | | V DC |

[1] See "Dynamic Characteristics"
[2] Definitions according to VDE 0433, part 3
[3] Additional external input filter or capacitor necessary

## Description of Option Package

With this family, the options i (inhibit) and R (output voltage adjustment) are defined as a package. Other combinations or parts of this package are not available.



**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, CMOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

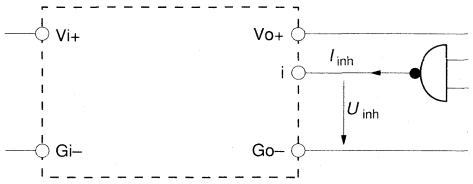



*Fig. 4*
*Definition of $I_{inh}$ and $U_{inh}$*

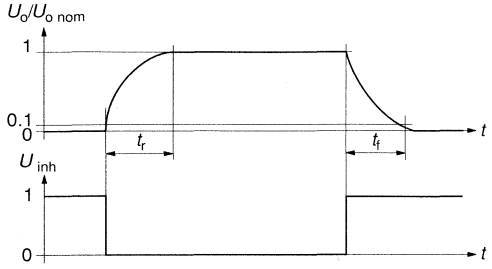



*Fig. 5*
*Output response as a function of inhibit signal*

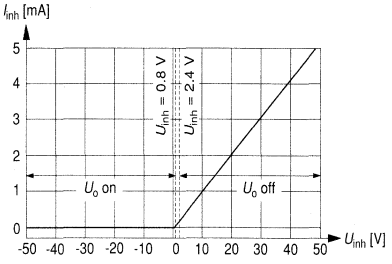



*Fig. 6*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 6: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |

**Option R** External Output voltage adjustment

**Note:** With an open R-pin, $U_o = U_{o\,nom}$!
The output voltage $U_o$ can be adjusted either with an external resistance $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0...1.00 of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in relevant tables must be maintained.

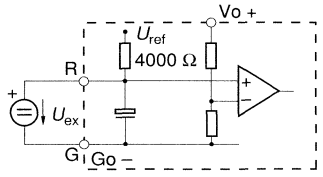



*Fig. 7*
*Voltage adjustment with $U_{ex}$*

**Voltage adjustment with $U_{ex}$** ($U_{ref}$ = 2.5 V ±2%)

$$U_o \approx U_{ex} \cdot \frac{U_{o\,nom}}{U_{ref}} \text{ [V]}$$

**Caution:** $U_{ex}$ must neither exceed 1.1 • $U_{ref}$ nor be negative, or failure will occure!

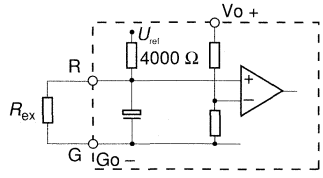



*Fig. 8*
*Voltage adjustment with $R_{ex}$*

**Voltage adjustment with $R_{ex}$**

$$U_o \approx U_{o\,nom} \cdot \frac{R_{ex}}{R_{ex} + 4000} \text{ [V]}$$

$$R_{ex} \approx 4000 \cdot \frac{U_o}{U_{o\,nom} - U_o} \text{ [Ω]}$$

All formulae give approximate values only.


MELCHER® ISO 9001 certified

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

European Projection

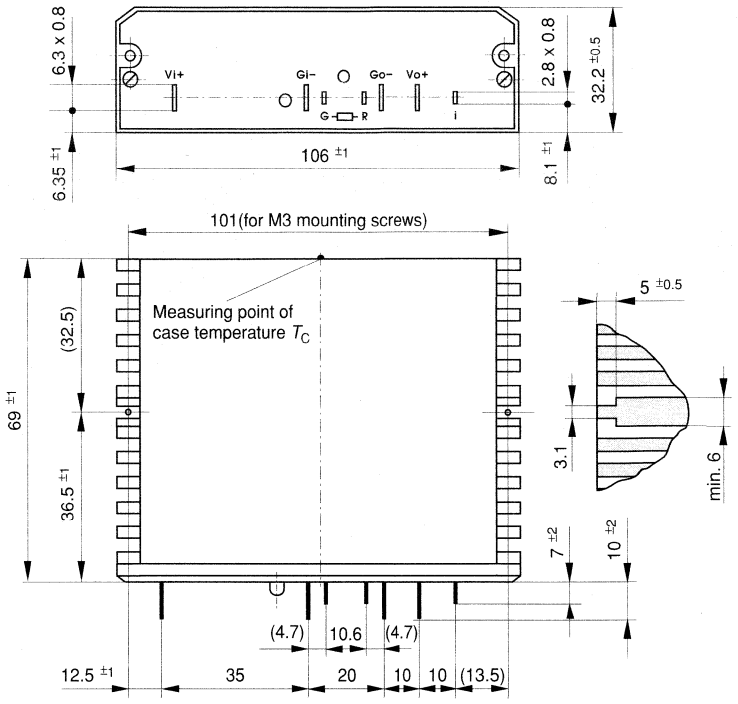
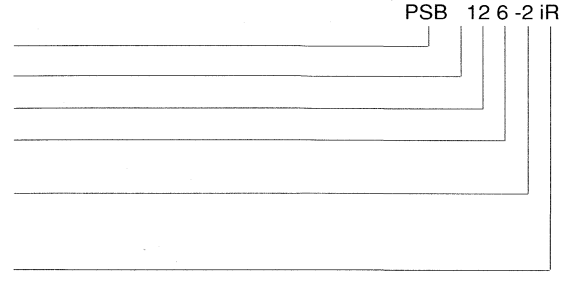



*Fig. 9*
*Case B02 (weight 230 g)*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case B02 ..... PSB
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1...24
Nominal output current in ampere ..... 6...8
Ambient temperature range
$T_A$ = 0...50°C ..... -2
Option package:
– Inhibit input ..... i
– External output voltage adjustment ..... R

Example: PSB 126-2iR = A positive switching regulator with a 12 V, 6 A output, ambient temperature range of 0...50°C, with option package inhibit input and external output voltage adjustment.

### Produkt Marking

Main face: Basic type designation, applicable safety approvals and recognition marks, warnings, Melcher patent nos. and company logo.

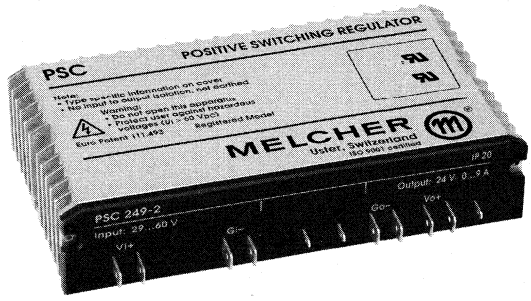
Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

# PSR: Positive Switching Regulators PSC-Family

**No input to output isolation**
**Single output of 12, 15 or 24 V DC/108...216 W**
**Input voltage up to 60 V DC**

- High efficiency up to 94%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




3.3

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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Option package |
|---|---|---|---|---|---|---|
| 12 V | 9 A | 15...40 V | 20 V | 90% | PSC 129-2 | iR |
| 15 V | | 19...40 V | 30 V | 91% | PSC 159-2 | |
| 24 V | | 29...60 V | 40 V | 94% | PSC 249-2 | |

## Description

The PSC family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 60 V are specially designed for secondary switched and battery driven applications.
Case C03: Aluminium and self cooling.

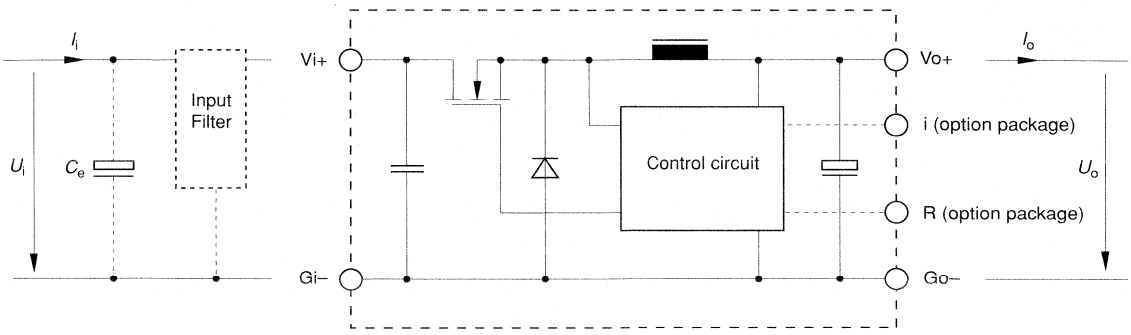



*Fig. 1*
*Block Diagram*



**External input circuitry**

An external input filter (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 5 m.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 in each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 in each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s² (60...150 Hz)<br>3.75 h (1.25 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 2: | 4 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 1: | 0.5 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperature specifications*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | (Not operational) | –25 | 100 | |

*Table 4: MTBF*

| MTBF | Ground Benign |
|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40°C |
| | 484'000 h |

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

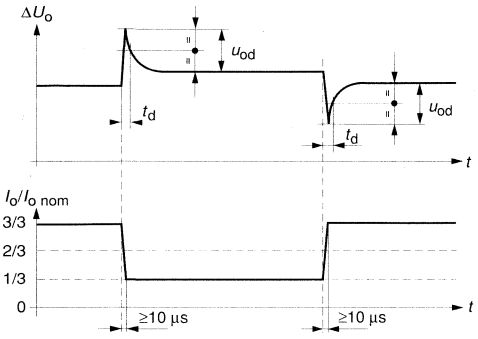



*Fig. 2*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 50 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 80 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 50 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 80 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages which are at the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

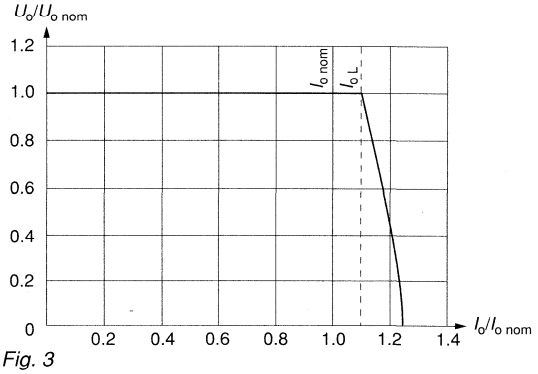



*Fig. 3*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Recognition

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90 ($T_{A\,max}$ reduced to 45°C).

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With option package iR, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 5: Input and output data*

| Characteristics | | Conditions | PSC 129 min | PSC 129 typ | PSC 129 max | PSC 159 min | PSC 159 typ | PSC 159 max | PSC 249 min | PSC 249 typ | PSC 249 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 11.60 | | 12.40 | 14.50 | | 15.50 | 23.30 | | 24.70 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}...U_{i\,max}$ | | 9.0 | | | 9.0 | | | 9.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}...T_{C\,max}$ | 9.0 | | 11.7 | 9.0 | | 11.7 | 9.0 | | 11.7 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | | 240 | | | 300 | | | 480 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}...U_{i\,max}$ $I_{o\,nom}$ | | | 240 | | | 300 | | | 480 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o = 0...I_{o\,nom}$ | | | 120 | | | 150 | | | 240 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 360 | | | 450 | | | 700 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 60 | | | 60 | | | 80 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ | | | ±2 | | | ±3 | | | ±5 | mV/K |
| | | $I_o = 0...I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | 15 | | 40 | 19 | | 40 | 29 | | 60 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i - U_o$ | | | 3 | | | 4 | | | 5 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 7.3 | | | 12.0 | | |
| $I_{i\,0}$ | No load Input current | $I_o = 0$ $U_{i\,min}...U_{i\,max}$ | | 35 | | | 35 | | | 35 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [2] | $U_{i\,nom}$ | | 250 | | | 250 | | | 250 | | A |
| $t_{i\,s}$ | Rise time [2] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [2] | | | 40 | | | 40 | | | 40 | | |
| $u_{i\,rfi}$ | RFI level at input, [3] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A | | | A | | | A | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 90 | | | 91 | | | 94 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | | 500 | | | 500 | | V DC |

[1] See "Dynamic Characteristics".
[2] Definitions according to VDE 0433, part 3.
[3] Additional external filter or capacitor necessary.

## Description of Option Package

With this family, the options i (inhibit) and R (output voltage adjustment) are defined as a package. Other combinations or parts of this package are not available.



**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, CMOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

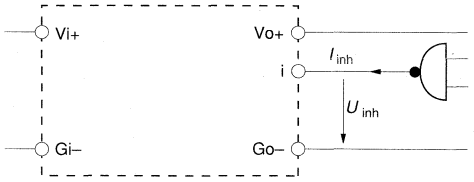



*Fig. 4*
*Definition of $I_{inh}$ and $U_{inh}$*

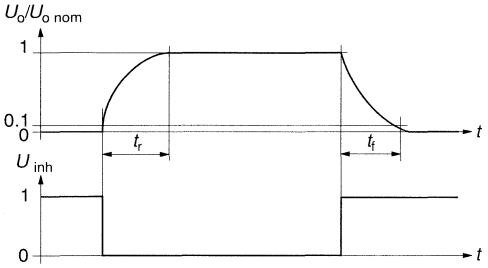



*Fig. 5*
*Output response as a function of inhibit signal*

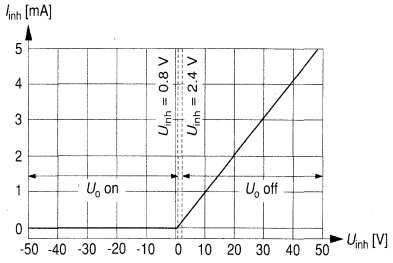



*Fig. 6*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 6: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |

**Option R** External Output voltage adjustment

**Note:** With an open R-pin, $U_o = U_{o\,nom}$!
The output voltage $U_o$ can be adjusted either with an external resistance $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0...1.00 of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in relevant tables must be maintained.

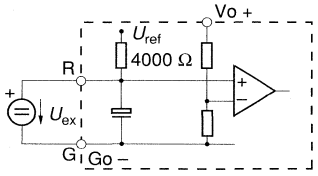



*Fig. 7*
*Voltage adjustment with $U_{ex}$*

**Voltage adjustment with $U_{ex}$** ($U_{ref}$ = 2.5 V ±4%)

$$U_o \approx U_{ex} \cdot \frac{U_{o\,nom}}{U_{ref}} \quad [V]$$

**Caution:** $U_{ex}$ must neither exceed 1.1 • $U_{ref}$ nor be negative, or failure will occure!

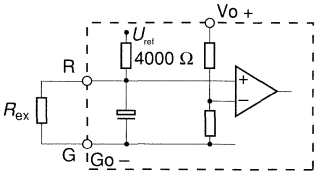



*Fig. 8*
*Voltage adjustment with $R_{ex}$*

**Voltage adjustment with $R_{ex}$**

$$U_o \approx U_{o\,nom} \cdot \frac{R_{ex}}{R_{ex} + 4000} \quad [V]$$

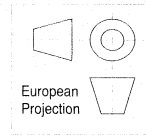
$$R_{ex} \approx 4000 \cdot \frac{U_o}{U_{o\,nom} - U_o} \quad [\Omega]$$

All formulae give approximate values only.


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## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.



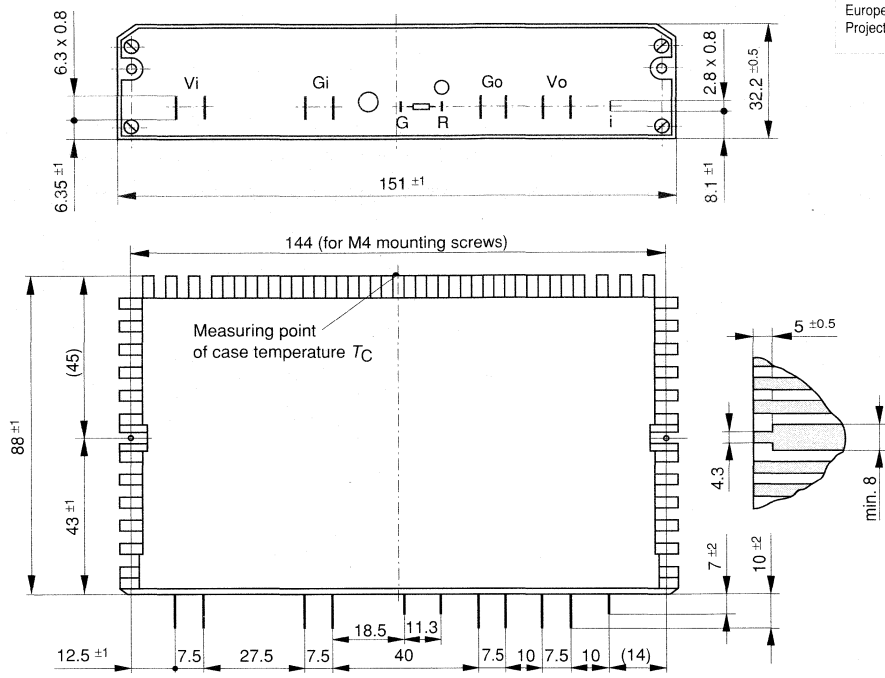
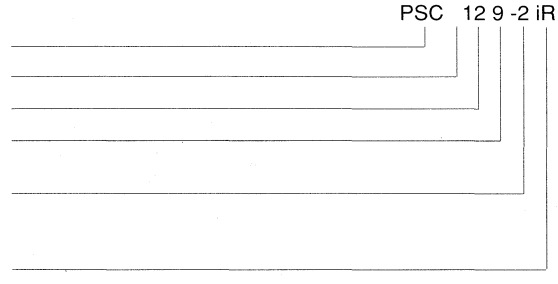




*Fig. 9*
*Case C03 (weight 440 g)*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case C03 ..... PSC
Blank .....
Nominal output voltage in volt ..... 12...24
Nominal output current in ampere ..... 9
Ambient temperature range
$T_A$ = 0...50°C ..... -2
Option package:
– Inhibit input ..... i
– External output voltage adjustment ..... R

Example: PSC 129-2iR = A positive switching regulator with a 12 V, 9 A output, ambient temperature range of 0...50°C, with option package inhibit input and external output voltage adjustment.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

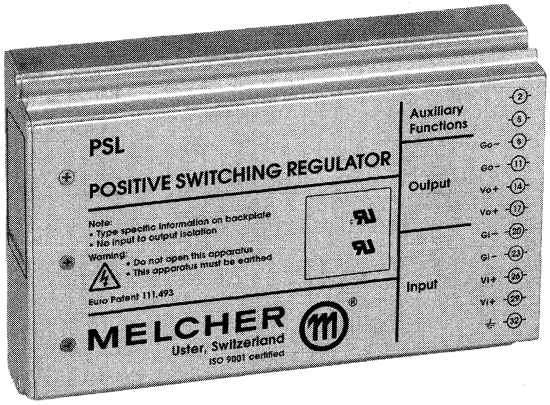
Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

# PSR: Positive Switching Regulators PSL-Family

**No input to output isolation**
**Single output of 12, 15 or 24 V DC/108...216 W**
**Input voltage up to 60 V DC**

- High efficiency up to 94%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation |
|---|---|---|---|---|---|
| 12 V | 9 A | 15...40 V | 20 V | 90% | PSL 129-2R |
| 15 V | | 19...40 V | 30 V | 91% | PSL 159-2R |
| 24 V | | 29...60 V | 40 V | 94% | PSL 249-2R |

## Description

The PSL family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 60 V are specially designed for secondary switched and battery driven applications.
Case L04: Aluminium and self cooling.

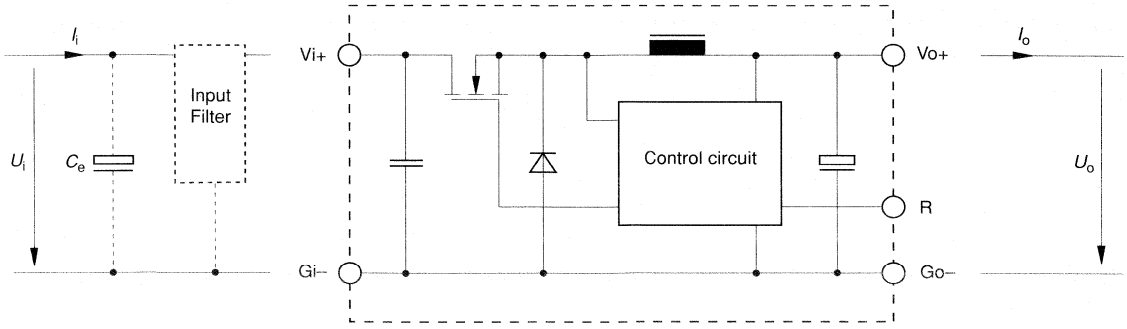



*Fig. 1*
*Block Diagram*



**External input circuitry**

An external input filter (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 5 m.

## Standard Features

**R External Output Voltage Adjustment**

**Note:** With an open R-pin, $U_o = U_{o\,nom}$!

The output voltage $U_o$ can be adjusted either with an external resistance $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0...1.00 of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{io\,min}$ between input and output voltages as specified in relevant tables must be maintained.

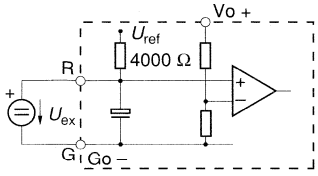



*Fig. 2*
*Voltage adjustment with $U_{ex}$*

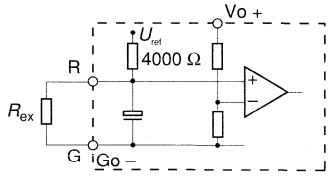



*Fig. 3*
*Voltage adjustment with $R_{ex}$*

**Voltage adjustment with $U_{ex}$** ($U_{ref}$ = 2.5 V ±4%)

$$U_o \approx U_{ex} \cdot \frac{U_{o\,nom}}{U_{ref}} \quad [V]$$

**Caution:** To prevent damage $U_{ex}$ should not exceed $U_{ref}$, nor be negative.

**Voltage adjustment with $R_{ex}$**

$$U_o \approx U_{o\,nom} \cdot \frac{R_{ex}}{R_{ex} + 4000} \quad [V]$$

$$R_{ex} \approx 4000 \cdot \frac{U_o}{U_{o\,nom} - U_o} \quad [\Omega]$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 in each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 in each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s² (60...150 Hz)<br>3.75 h (1.25 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 2: | 4 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 1: | 0.5 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperature specifications*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | (Not operational) | –25 | 100 | |

*Table 4: MTBF*

| MTBF | Ground Benign |
|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40°C |
| | 484'000 h |

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 32 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H11 (according to DIN 41612) to ensure requested safety!

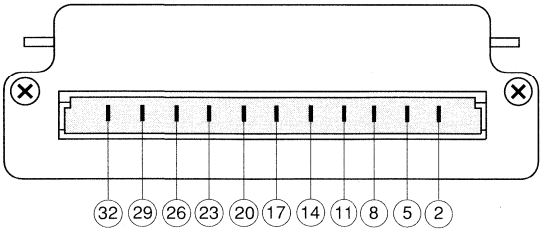



*Fig. 4*
*View of male H11 connector*

*Table 5: H11 connector pin allocation and designation*

| Electrical Determination | Type H11 Pin No. | Design. |
|---|---|---|
| R-input | 2 | R |
| Not connected | 5 | - |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 11 | Go– |
| Output voltage(positive) | 14 | Vo+ |
| Output voltage (positive) | 17 | Vo+ |
| Input voltage (negative) | 20 | Gi– |
| Input voltage (negative) | 23 | Gi– |
| Input voltage (positive) | 26 | Vi+ |
| Input voltage (positive) | 29 | Vi+ |
| Protective ground (protruding pin) | 32 | ⏚ |

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With R, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSL 129 min | PSL 129 typ | PSL 129 max | PSL 159 min | PSL 159 typ | PSL 159 max | PSL 249 min | PSL 249 typ | PSL 249 max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | | | | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 11.60 | | 12.40 | 14.50 | | 15.50 | 23.30 | | 24.70 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}...U_{i\,max}$ | | 9.0 | | | 9.0 | | | 9.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}...T_{C\,max}$ | 9.0 | | 11.7 | 9.0 | | 11.7 | 9.0 | | 11.7 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | | 240 | | | 300 | | | 480 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}...U_{i\,max}$ $I_{o\,nom}$ | | | 240 | | | 300 | | | 480 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o = 0...I_{o\,nom}$ | | | 120 | | | 150 | | | 240 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 360 | | | 450 | | | 700 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 60 | | | 60 | | | 80 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ | | | ±2 | | | ±3 | | | ±5 | mV/K |
| | | $I_o = 0...I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage | $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | 15 | | 40 | 19 | | 40 | 29 | | 60 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | | | 3 | | | 4 | | | 5 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | | 7.3 | | | 12.0 | | |
| $I_{i\,0}$ | No load Input current | $I_o = 0$ $U_{i\,min}...U_{i\,max}$ | | 35 | | | 35 | | | 35 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [2] | $U_{i\,nom}$ | | 250 | | | 250 | | | 250 | | A |
| $t_{i\,s}$ | Rise time [2] | | | 5 | | | 5 | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [2] | | | 40 | | | 40 | | | 40 | | |
| $u_{i\,rfi}$ | RFI level at input, [3] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A | | | A | | | A | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 90 | | | 91 | | | 94 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | | 500 | | | 500 | | V DC |

[1] See "Dynamic Characteristics".
[2] Definitions according to VDE 0433, part 3.
[3] Additional external input filter or capacitor necessary.

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

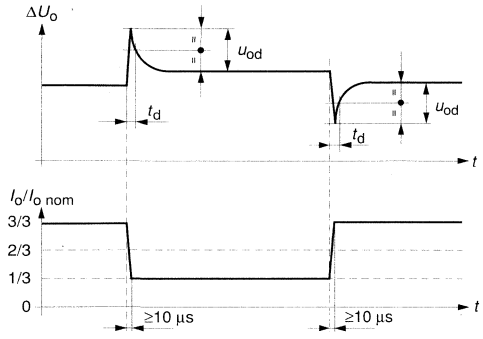



*Fig. 5*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 50°C and is operated at its nominal output power, the case temperature $T_C$ will be about 80°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 50°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 80°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages which are at the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

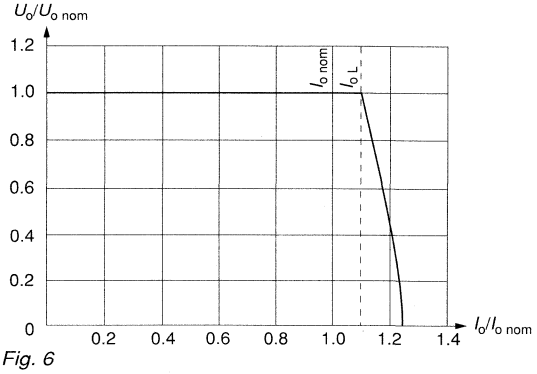



*Fig. 6*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Recognition

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20. It applies only if the female H11 connector is properly attached to the module.

## Mechanical Data

Dimensions are in mm. Tolerances are ±0.3 mm unless otherwise specified.

European Projection

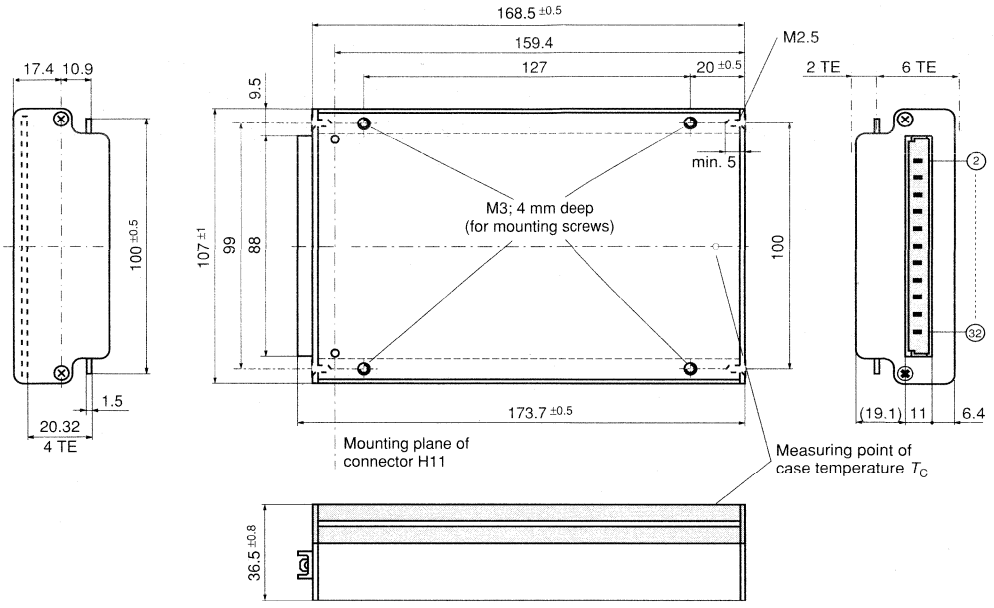



*Fig. 7*
*Case L04 (weight 550 g)*

## Type Key and Product Marking

### Type Key

PSL 12 9 -2 R

Positive switching regulator in case L04 ..... PSL
Blank .....
Nominal output voltage in volt ..... 12...24
Nominal output current in ampere ..... 9
Ambient temperature range
$T_A$ = 0...50°C ..... -2
External output voltage adjustment ..... R

Example: PSL 129-2R = A positive switching regulator with a 12 V, 9 A output; ambient temperature range of 0...50°C and external output voltage adjustment.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

Back plate: Specific type designation, input voltage range, nominal output voltage and current, pin allocation of auxiliary function and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and production date.

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# 4 Switching Regulators >10 A

## 4.1 Rugged Environment

## 4.2 Industrial Environment

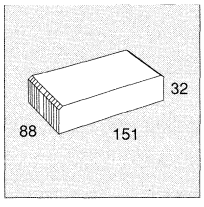
| Output [A] 10 12 16 18 20 25 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] ≤ 40 80 144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| ▬ | ▬ | ▬ | PSC | C03 | 4 - 13 |
| ▬ | ▬ | ▬ | PSL | L04 | 4 - 21 |
| ▬ | ▬▬▬ | ▬▬ | PSS | S01 | 4 - 30 |
| ▬▬▬ | ▬▬▬ | ▬▬ | PSK | K01 | 4 - 40 |

| Output [A] 10 12 16 18 20 25 | Output [V DC] −3 −5 −12 −15 −24 −36 −48 | Input [V DC] ≤ −40 −80 −144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| ▬ | ▬ | ▬ | NSR | C03 | 4 - 50 |

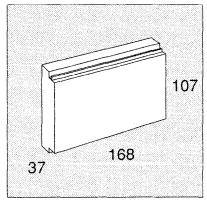
## 4.3 Benign Environment

| Output [A] 10 12 16 18 20 25 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] ≤ 40 80 144 | Product Family | Case | Page |
|---|---|---|---|---|---|
| ▬ | ▬ | ▬ | PSC | C03 | 4 - 57 |
| ▬ | ▬ | ▬ | PSL | L04 | 4 - 63 |
| ▬▬ | ▬▬▬ | ▬▬ | PSS | S01 | 4 - 69 |
| ▬▬▬ | ▬▬▬ | ▬▬ | PSK | K01 | 4 - 78 |

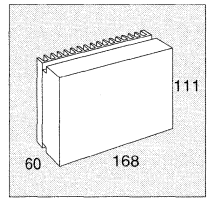
Case C03



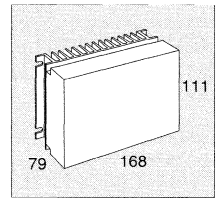

Case L04




Case S01




Case K01



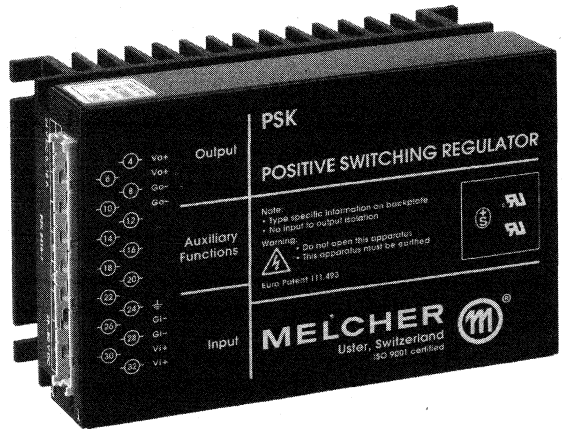
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# Positive Switching Regulators

# PSK-Family

**No input to output isolation**
**Single output of 12, 15[1], 24, 36 or 48 V DC/144...576 W**
**Input voltage up to 144 V DC**

- Extremely wide input voltage range
- High efficiency up to 96%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no load and short circuit proof
- Output current sharing
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$[2] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$[3] | Type designation | Options |
|---|---|---|---|---|---|---|
| 12 V[1] | 12 A | 18...144 V | 60 V | 90% | PSK 1212-7 | -9, E, P, C, B, B1, U |
| 24 V | | 31...144 V | | 94% | PSK 2412-7 | |
| 36 V | | 44...144 V | 80 V | | PSK 3612-7 | |
| 48 V | | 58...144 V | | 96% | PSK 4812-7 | |

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")
[2] Surges up to 156 V for maximum 2 s
[3] Including option E, $T_A$ = 25°C

## Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. The maximum input voltage is as high as 144 V DC (120 V +20%) with surges up to 156 V for 2 sec. This allows operation in the majority of battery driven mobile applications. The basic type of regulators may be completed by various options to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case K01: Aluminium, black finish, fully enclosed. The basic model with heat sink is self cooling.

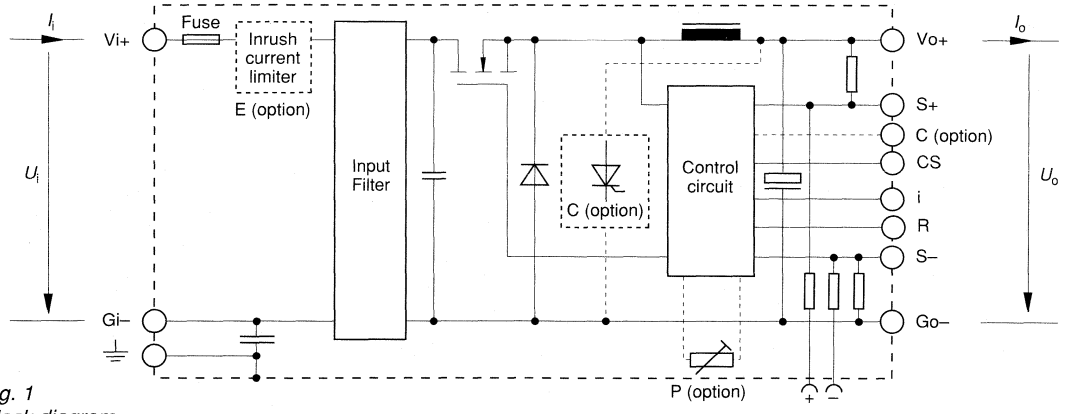



*Fig. 1*
*Block diagram*

## Standard Features

**Note:**
Additional information on input circuitry, grounding and parallel operation of units is given in section "Application Note"

**Inhibit (i)**

If the inhibit pin is not connected, the power supply is enabled ($U_o$ = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

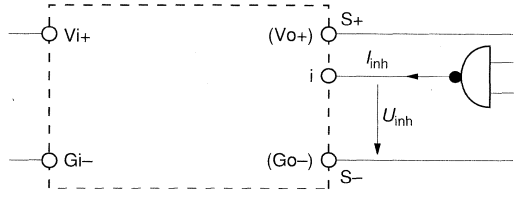



*Fig. 2*
*Definition of inhibit voltage and current*

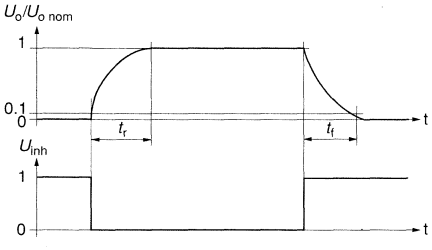



*Fig. 3*
*Output response as a function of inhibit signal*

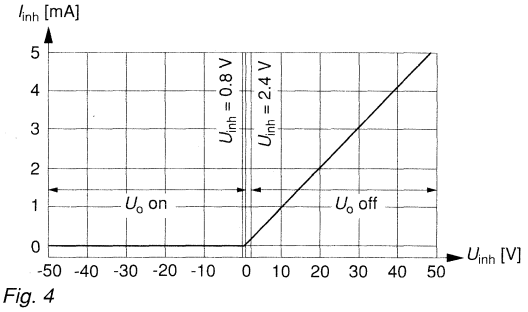



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | PSK 1212 | | | PSK 2412 | | | PSK 3612 | | | PSK 4812 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_{inh}$ | Inhibit input voltage to keep output voltage... | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | V DC |
| | | $U_o$ = off | | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,nom}$ | | 100 | | | 100 | | | 100 | | | 100 | | ms |
| $t_f$ | Switch-off time after inhibit command | | (resistive load) | | 15 | | | 20 | | | 15 | | | 40 | | |
| $I_{i\,off}$ | Input current with converter inhibited | | $I_o$ = 0 $U_{i\,nom}$ | | 25 | | | 25 | | | 25 | | | 25 | | mA |


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### Input Filter and Fuse

An input filter and a fuse are incorporated in all PSK modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

If a reduction of the considerable high inrush current is required, refer to option E.

The maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$u_{i\,max}$ = 10 $V_{pp}$ at 100 Hz, or $V_{pp}$ = 1000 Hz/$f_i$ • 1 V

### Test Sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage $U_o$ internally at the connector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

### Current Sharing (CS)

**Note:** Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage ($U_i$) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

### Sense Lines (S)

**Note:** Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSK connector) should not exceed the following values:

| Output voltage | Total voltage difference between both sense lines and their respective output | Voltage difference between Go– and S– |
|---|---|---|
| 12 , 24, 36, 48 V | < 1.0 V | < 0.25 V |

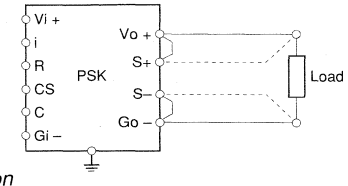



*Fig. 5*
*Sense lines connection*

### External Voltage Adjustment (R)

Note: With open R input, $U_o = U_{o\,nom}$. With option P, the R input must remain unconnected.

The output voltage $U_o$ can either be adjusted with an external resistor $R_1$ or $R_2$, or with an external voltage $U_{ex}$ referenced to S–. The adjustment range is 0...$U_{o\,max}$ depending on the nominal output voltage (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor ($R_1$ resp. $R_2$). Option P is not recommended for parallel operation mode.

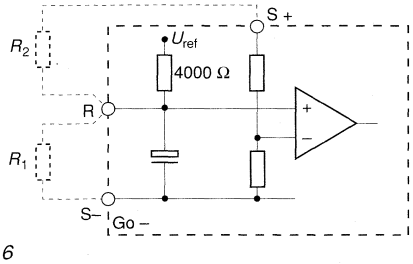



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$*

a) $U_o = 0...U_{o\,nom}$, using $R_1$ [Ω] between R and S–:

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

b) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

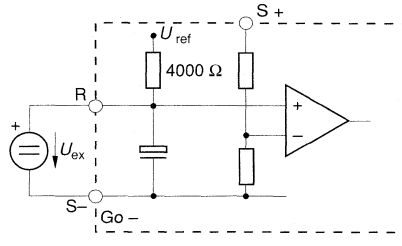



*Fig. 7*
*Voltage adjustment with external voltage $U_{ex}$ [V]*

c) $U_o = 0...U_{o\,max}$, using $U_{ex}$ [V] between R and S–:

$$U_o \approx U_{o\,nom} \cdot [\frac{U_{ex}}{U_{ref}} \cdot 0.98 + 0.02]$$

($U_{ref}$ = 2.48 V ±1%)

All formulae give approximate values only.

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V nor be negative!

## Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3<br>MIL 810D sec.507.2 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL 810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL 810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL 810D sec.514.3 | Frequency (1 Oct/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Kb | Salt mist cyclic (Sodium chloride solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% relative humidity<br>3 | Not operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |
| Electric field suseptibility | | IEC 801-3 | Level 3: | 10 V/m (1 MHz...1 GHz) | Operating |
| Burst test | | IEC 801-4 | Level 4: | 4 kV (5/50 ns; 50 Ω) | Operating |
| Surge test | | IEC 801-5 | Class II: | 1 kV (1.2/50 µs; 2 Ω) | Operating |
| Voltage surge test | | IEC 571-1 | Capacitor discharge circ. | 1.8 kV (1/50 µs, 100 Ω) | Operating |

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF values and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF according to | $T_C$ = 40 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 50°C | |
| MIL-HDBK-217F | 335'000 h | 138'000 h | 35'000 h | 33'000 h | 2'100'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Electrical Input and Output Data

General Conditions
- $T_A$ = 25°C, unless $T_C$ is specified
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSK 1212 | | | PSK 2412 | | | PSK 3612 | | | PSK 4812 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 11.92 | | 12.07 | 23.85 | | 24.14 | 35.78 | | 36.22 | 47.71 | | 48.29 | V |
| $U_{o\,max}$ | Maximum adjustable output voltage utilizing R input | $U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector | | | 16.0 | | | 26.0 | | | 42.5 | | | 52.8 | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 12 | | | 12 | | | 12 | | | 12 | | A |
| $I_{o\,L}$ | Output current limitation response (% of $I_{o\,nom}$) | | 100 | | 125 | 100 | | 125 | 100 | | 125 | 100 | | 125 | % |
| $u_o$ | Ripple at Output (BW = 20 MHz) | $U_{i\,nom}$, $I_{o\,nom}$ | | 40 | 80 | | 50 | 110 | | 60 | 110 | | 60 | 100 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 40 | 70 | | 80 | 170 | | 120 | 250 | | 100 | 200 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 30 | 50 | | 50 | 120 | | 60 | 120 | | 40 | 120 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_o$ = $^2/_3$ $I_{o\,nom}$ $\pm^1/_3$ $I_{o\,nom}$ | | 140 | | | 180 | | | 200 | | | 200 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 60 | | | 60 | | | 70 | | | 70 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient $\Delta U_o$ / $\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | ±3 | | | ±5 | | | ±8 | | | ±10 | | mV/K |
| | | | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | | | | | | |
| $U_i$ | Input voltage range [2] | $T_{C\,min}$...$T_{C\,max}$ | 18 | | 144 | 31 | | 144 | 44 | | 144 | 58 | | 144 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | $I_o$ = 0...$I_{o\,nom}$ | | 6 | | | 7 | | | 8 | | | 10 | | |
| $U_{io}$ | Undervoltage cut-out | | | 12 | | | 24 | | | 36 | | | 48 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0 $U_{i\,nom}$ | | 36 | | | 36 | | | 36 | | | 36 | | mA |
| $I_{im}$ | Peak value of inrush current | $U_{i\,nom}$ with option E [3] | | | 60 | | | 60 | | | 80 | | | 80 | A |
| $u_{rfi}$ | RFI level at input, 0.01...30 MHz | VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$ | | B | | | B | | | B | | | B | | dB (µV) |
| **Efficiency** | | | | | | | | | | | | | | | |
| η | Efficiency with option E | $U_{i\,nom}$, $I_{o\,nom}$ | | 90 | | | 94 | | | 94 | | | 96 | | % |
| **Isolation** | | | | | | | | | | | | | | | |
| $U_{i\,s}$ | Isolation test voltage electronic to case | All input and output terminals interconnected | | 1500 | | | 1500 | | | 1500 | | | 1500 | | V DC |

[1] See "Dynamic Characteristics"
[2] Surges up to 156 V for 2 s
[3] See also option E

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). This diode is not assembled in combination with option C (see also "Thyristor Crowbar").

### Dynamic Characteristics

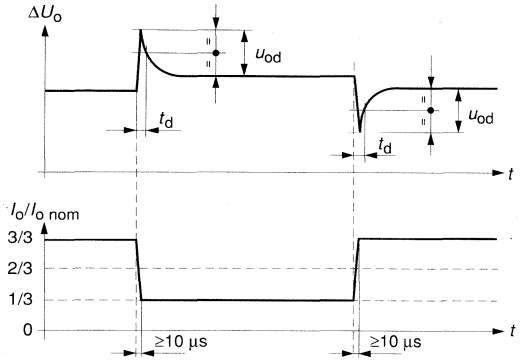



*Fig. 8*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules should only be wired via the female connector H15 (according to DIN 41612) in order to ensure compliance to national and international safety requirements. The modules accept input voltages up to 144 V DC which is far above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage of isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. Use the current sharing feature for even distribution of the output current (see "Standard Features": Current Sharing).

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

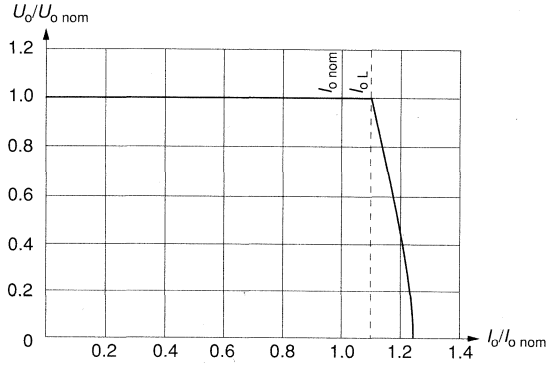



*Fig. 9*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30 (equipped with potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.


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## Description of Options

**Option -9** Extended Temperature Range

This option defines an extended operational ambient temperature range of $T_A = -40...71\,°C$.

---

**Option E** Inrush Current Limitation

**Note:** This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of $U_i/1\ \Omega$ and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

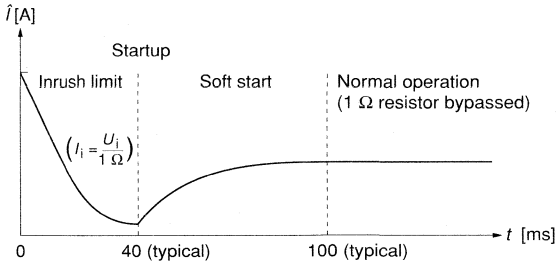



*Fig. 10*
*Option E: Inrush current versus time*

---

**Option P** Potentiometer

**Note:** Option P is not recommended if several modules are operated in parallel connection.

The potentiometer can be controlled with a screwdriver from the front side. The output voltage adjustment range is 90...110% of the nominal output voltage $U_{o\,nom}$.

The minimum differential voltage, $\Delta U_{io\,min}$ between input and output voltages should be maintained.

---

**Option C** Thyristor Crowbar

**Note**: The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage $U_o$ and when the trigger voltage $U_{o\,C}$ is reached, the thyristor crowbar triggers and disables the output.

An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

*Table 7: Crowbar trigger levels*

| Characteristics | | Condition | PSK 1212 | PSK 2412 | PSK 3612 | PSK 4812 | Unit |
|---|---|---|---|---|---|---|---|
| | | | min typ max | min typ max | min typ max | min typ max | |
| $U_{o\,C}$ | Crowbar trigger voltage | $T_{C\,min}...T_{C\,max}$<br>$U_{i\,min}...U_{i\,max}$ | 17.8 18.9<br>14.3 15.2 [1] | 28.89 30.6 | 47.0 50.0<br>43.0 45.5 [1] | 58.0 61.0 | V DC |
| $t_s$ | Delay time | $I_o = 0...I_{o\,nom}$ | 1.5 | 1.5 | 1.5 | 1.5 | µs |

[1] Crowbar Trigger voltage with option P

**Option B, Option B1** Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output at 110 °C approximately. The output is automatically enabled again after temperature has droped below $T_{C\,max}$.

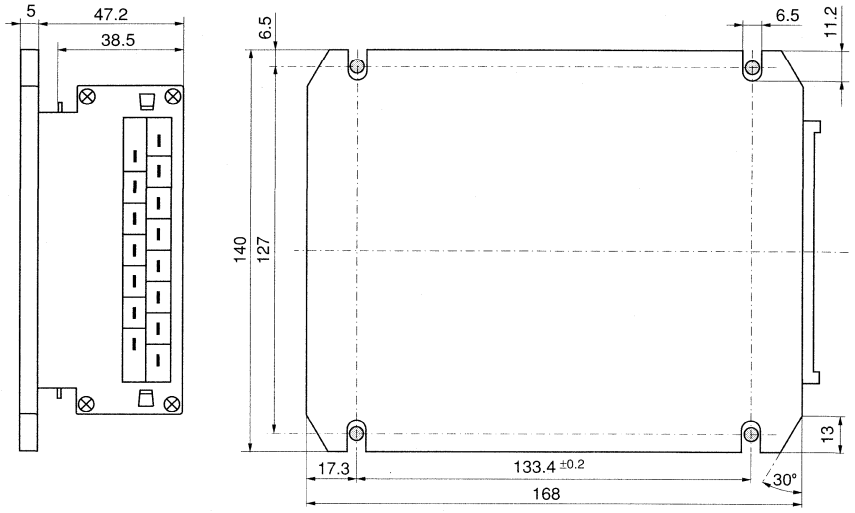



*Fig. 11*
*Case K01 with option B (cooling plate)*
*Weight: 1.1 kg*

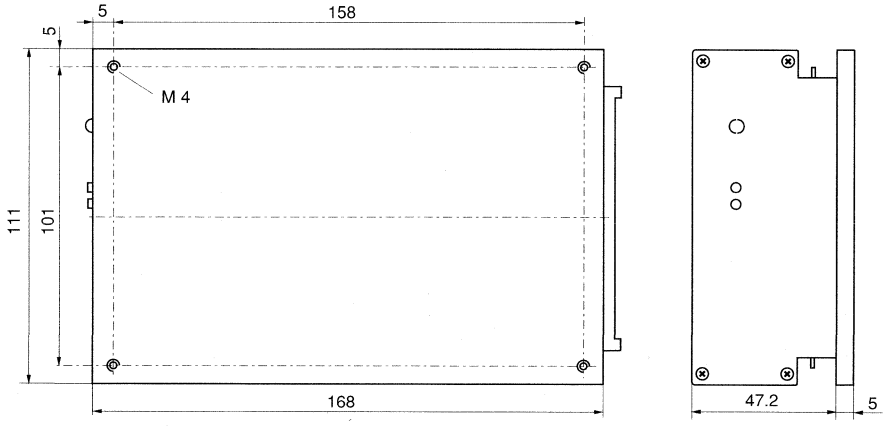



*Fig. 12*
*Case K01 with option B1 (cooling plate)*
*Weight: 1.1 kg*

**Option U** Ambient Temp. Range acc. UL Recognition

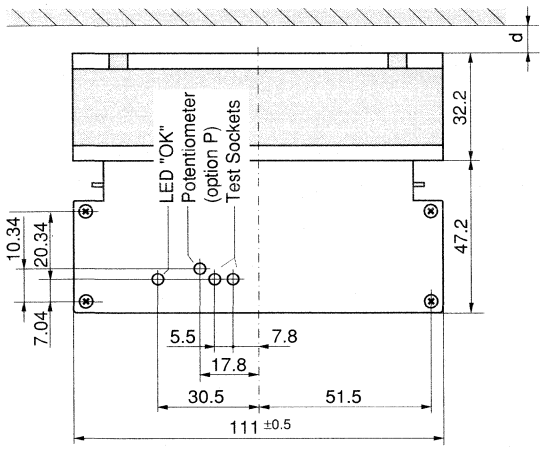
Underwriters Laboratories (UL) have approved the PSK family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

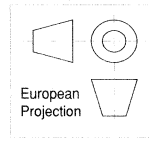
The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max}$ = 71 °C without any further precautions.


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## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.




**Note:**

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow through heat sink

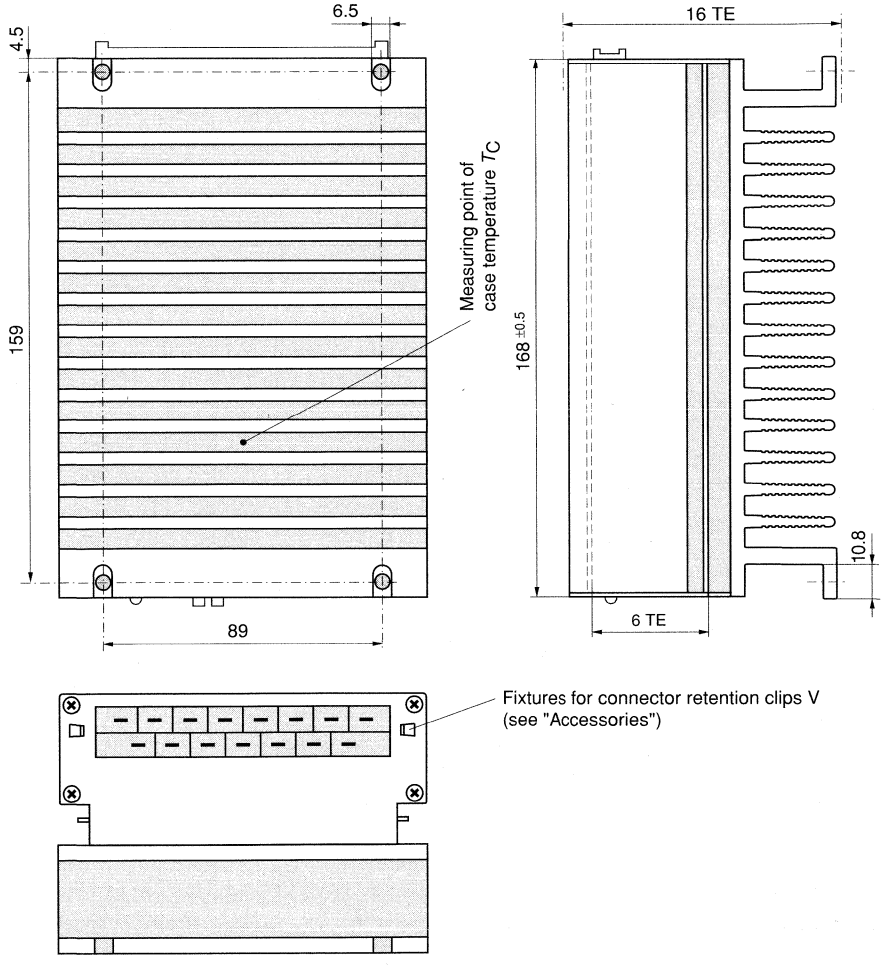



*Fig. 13*
*Case K01 with heatsink*
*Weight: 1.6 kg*

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

*Table 8: H15 connector pin allocation*

| Electrical Determination | Type H15 | |
|---|---|---|
| | Pin No. | Ident. |
| Output voltage (positive) | 4 | Vo+ |
| Output voltage (positive) | 6 | Vo+ |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 10 | Go– |
| Crowbar trigger input (option C) | 12 | C |
| Inhibit input | 14 | i |
| R-input (output voltage programming) [1] | 16 | R |
| Sense line (negative) | 18 | S– |
| Sense line (positive) | 20 | S+ |
| Current sharing control input | 22 | CS |
| Protective ground (protruding pin) | 24 | ⏚ |
| Input voltage (negative) | 26 | Gi– |
| Input voltage (negative) | 28 | Gi– |
| Input voltage (positive) | 30 | Vi+ |
| Input voltage (positive) | 32 | Vi+ |

[1] Not available with option P

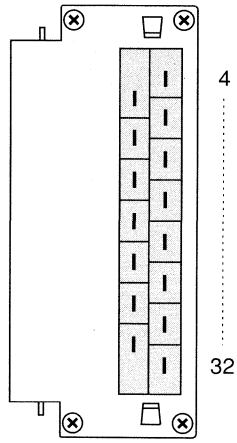
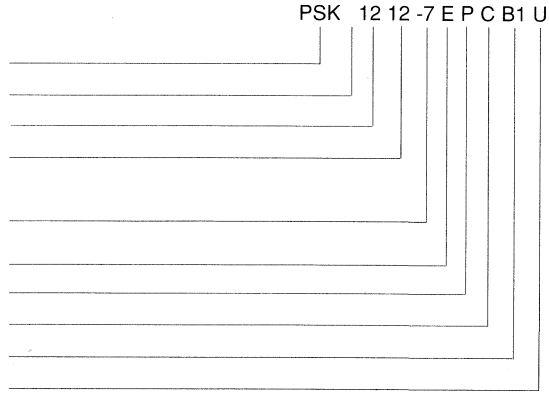



*Fig. 14*
*View of male connector H15*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case K01 ..... PSK
Blank .....
Nominal output voltage in volt ..... 12...48
Nominal output current in ampere ..... 12
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Inrush current limitation ..... E
Potentiometer ..... P
Thyristor-Crowbar ..... C
Cooling plate ..... B, B1
UL recognized component for $T_{A\,max}$ = 71 °C ..... U

Example: PSK 1212-7EPCB = A positive switching regulator with a 12 V, 12 A output, ambient temperature range of –25...71 °C, inrush current limitation, potentiometer, crowbar, and cooling plate B.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LED, test sockets and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of option and auxiliary functions, fuse specification and degree of protection.

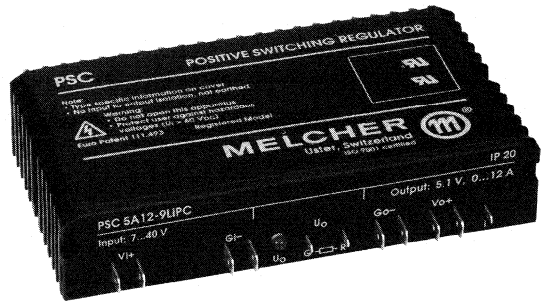
Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.


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# PSR: Positive Switching Regulators PSC-Family

**No input to output isolation**
**Single output of 5.1 V DC/61 W**
**Input voltage up to 40 V DC**

- High efficiency up to 83%
- Wide input voltage range
- Low input-to-output differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




4.2

## Table of Contents


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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options | Superseded old type (phase-out) |
|---|---|---|---|---|---|---|---|
| 5.1 V | 12 A | 7...40 V | 20 V | 83% | PSC 5A12-7iR | -9, L, P, C, D, U | PSR 512-7 |

[1] See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSC family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 40 V are specially designed for secondary switched and battery driven applications.
Case C03: Aluminium, black finish and self cooling.

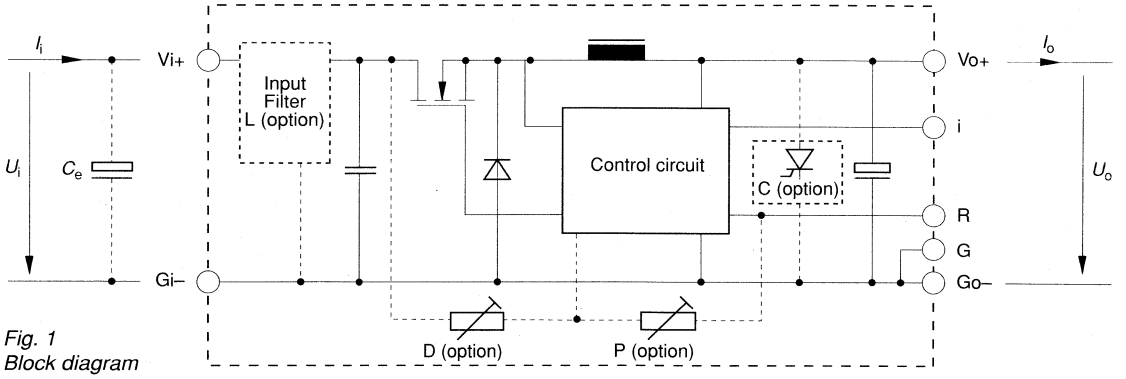



*Fig. 1*
*Block diagram*



**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**i Inhibit**

**Note:** With open i-input, output is enabled ($U_o$ = on)

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

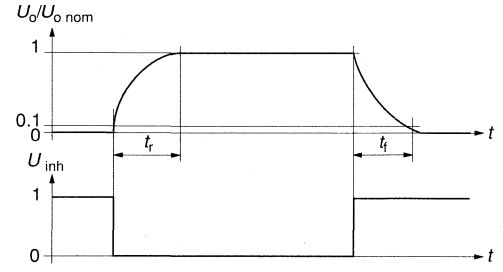



*Fig. 3*
*Output response as a function of inhibit signal*

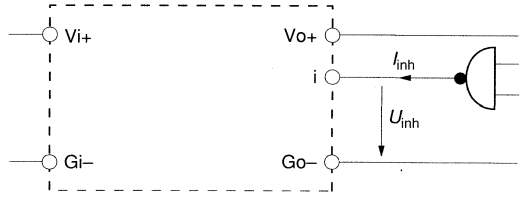



*Fig. 2*
*Definition of $I_{inh}$ and $U_{inh}$*

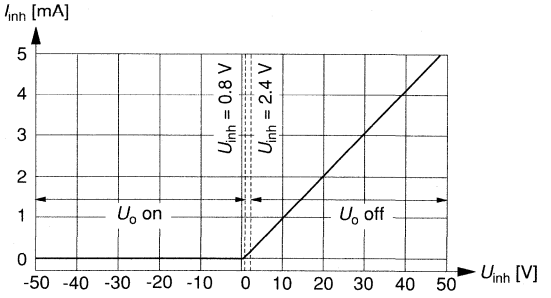



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

**Data**

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |



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### R External Output Voltage Adjustment

**Note:** With open R input, $U_o = U_{o\,nom}$.
(For superseded PSR types, $U_o = 1.08 \cdot U_{o\,nom}$)

R-input and option P cannot be supported simultaneously. The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage lock-out.

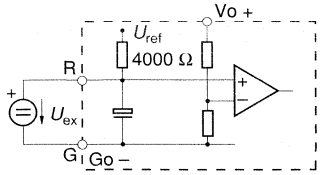



*Fig. 5*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±2%)

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V, nor be negative.

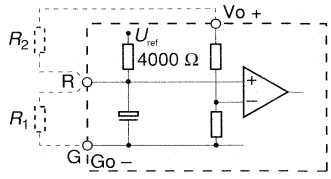



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:

$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 2\%)$$

All formulae give approximate values only.

## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40°C | $T_C$ = 40°C | $T_C$ = 70°C | $T_C$ = 50°C | |
| | 660'000 h | 143'000 h | 81'000 h | 68'000 h | 2'800'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

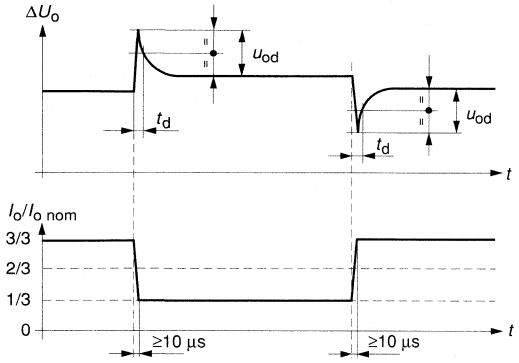



*Fig. 7*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 95 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 40 V DC which is below the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

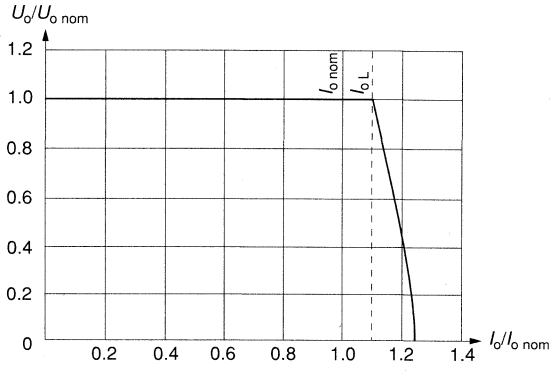



*Fig. 8*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90. SEV approval according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards are in progress.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSC 5A12 min | typ | max | Unit |
|---|---|---|---|---|---|---|
| **Output** | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 12.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 12.0 | | 15.6 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 35 | 50 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 30 | 45 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 20 | 25 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 130 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 40 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±1 | mV/K |
| | | | | | ±0.02 | %/K |
| **Input** | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 7 | | 40 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 2 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 6.3 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 45 | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 250 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,min...max}$, $I_{o\,nom}$ | | | B | dB(µV) |
| **Efficiency** | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 83 | | % |
| **Isolation** | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 750 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 120 µF/50 V, e.g. Nichicon PF(M) series, or equivalent

## Description of Options

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71°C$.

---

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 4 $mV_{rms}$.

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 12\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 1200\ Hz/f_i \cdot 1\ V$$

---

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

---

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$.

Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | 5.1 V min | 5.1 V max | Unit |
|---|---|---|---|---|---|
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | 5.8 | 6.8 | V |
| $t_s$ | Delay time | | | 1.5 | µs |

---

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSC family as recognized components up to an ambient temperature of $T_{A\,max} - 25$ K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71°C$ without any further precautions.

**Option D** ("Save Data", input undervoltage monitor)

**Note:** Output instead of input undervoltage monitor is available on request (Option D1).

If the input voltage $U_i$ is below the adjustable threshold voltage $U_t$, the control circuit for terminal D has low impedance. Terminal D and Go– are connected to a self-conducting field effect transistor (FET). A 0.5 W Zener diode provides protection against overvoltages.

The voltage $U_t$ can be externally adjusted with a trim potentiometer by means of a screwdriver. The hystersis $U_H$ of $U_t$ is <2%. Terminal D stays low for a minimum time $t_{low\ min}$, in order to prevent any oscillation. $U_t$ can be set to a value between $U_{i\ min}$ and $U_{i\ max}$. It is important to note that the FET can become conductive again when $U_D > U_i - 3V$.

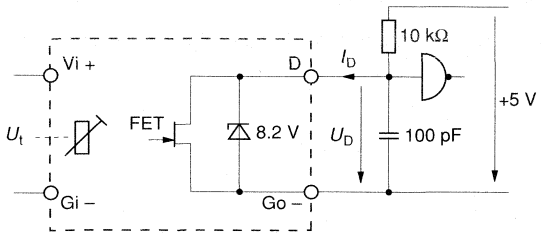



*Fig. 9*
*Test circuit with definition of voltage $U_D$ and current $I_D$ on Terminal D.*

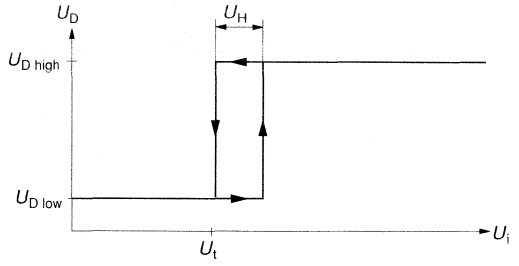



*Fig. 10*
*Definition of $U_t$ and $U_H$*

## Data

*Table 8: Option D data*

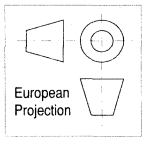
| Characteristics | | Conditions | PSC | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| $U_{D\ low}$ | Voltage - Terminal D at low impedance | $U_i < U_t$, $I_D \leq 2.5$ mA | | | 0.8 | V |
| $U_{D\ high}$ | Voltage - Terminal D at high impedance | $U_i > U_t + U_H$, $I_D > 25$ µA | 4.75 | | | |
| $t_{low\ min}$ | Minimum duration $U_{D\ low}$ | | | 30 | | ms |
| $t_{D\ f}$ | Response time to $U_{D\ low}$ | | | 1 | | µs |
| $I_{D\ max}$ | Maximum current - Terminal D | | | | 20 | mA |

Application examples

a) The signal $U_D$ can be utilized in battery powered systems to provide a warning in case of **low batteries**.
b) In case of power failure, the signal can serve to initiate **data save** routines.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.



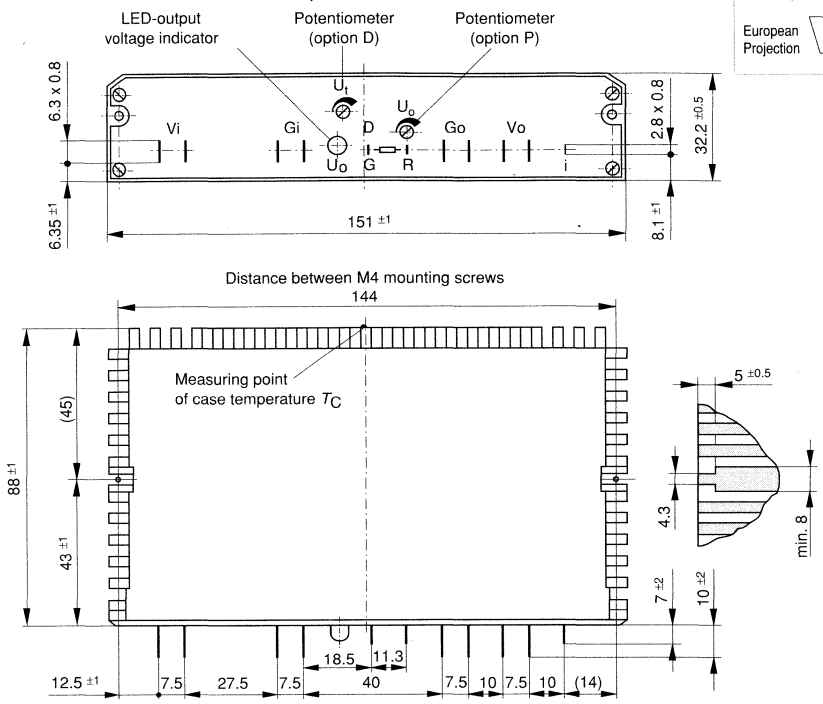
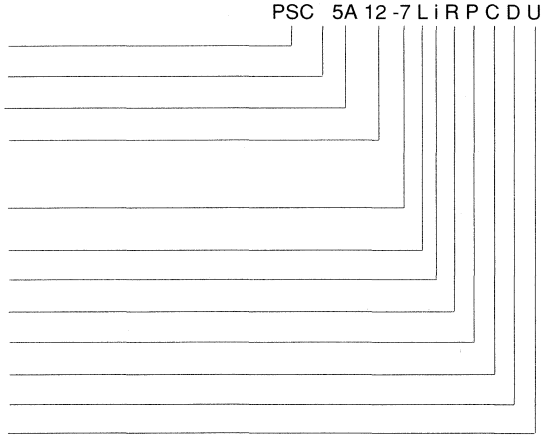




*Fig. 11*
*Case C03 (weight 440 g)*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case C03 ..... PSC
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1
Nominal output current in ampere ..... 12
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Input filter ..... L
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Thyristor-Crowbar ..... C
"Save Data" undervoltage monitor ..... D
UL recognized component for $T_{A\,max}$ = 71 °C ..... U

Example: PSC 5A12-7LiRC = A positive switching regulator with a 5.1 V, 12 A output, ambient temperature range of –25...71 °C, input filter, inhibit input, external output voltage adjustment and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

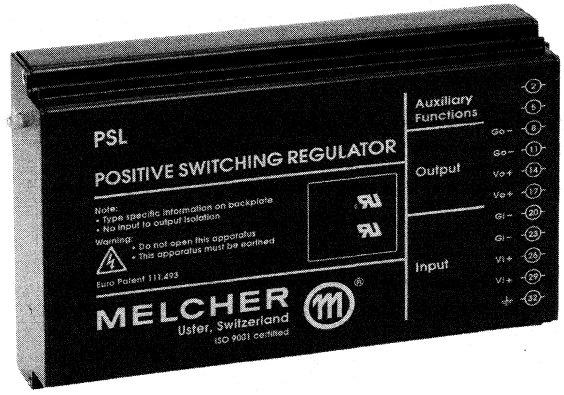
Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometers and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

# PSR: Positive Switching Regulators PSL-Family

**No input to output isolation**
**Single output of 5.1 V DC/61 W**
**Input voltage up to 80 V DC**

- High efficiency up to 83%
- Wide input voltage range
- Low input-to-output differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Continuous no-load and short circuit-proof
- No derating
- Safety according to IEC 950




4.2

## Table of Contents


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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options | Superseded old type (phase-out) |
|---|---|---|---|---|---|---|---|
| 5.1 V | 12 A | 7...40 V | 20 V | 83% | PSL 5A12-7R | -9, L, i, P, C, D, A, U | PSR 512E-7 |

[1] See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

## Description

The PSL family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 40 V are specially designed for secondary switched and battery driven applications.
Case L04: Aluminium, black finish and self cooling.

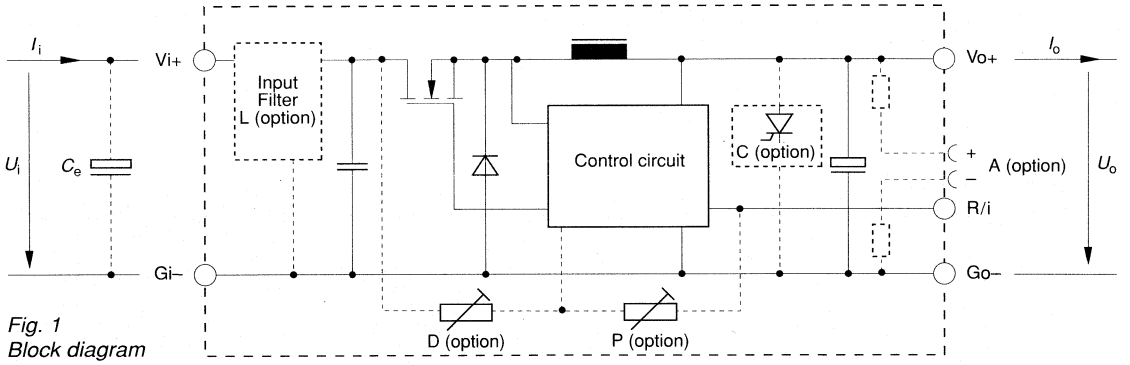



*Fig. 1*
*Block diagram*



**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Standard Features

**R External Output Voltage Adjustment**

**Note:** With open R input, $U_o = U_{o\,nom}$.
(For superseded PSR types, $U_o = 1.08 \cdot U_{o\,nom}$)

R-input together with option i or option P cannot be supported simultaneously.

The output voltage $U_o$ can either be adjusted with an external resistor ($R_1$ or $R_2$) or with an external voltage ($U_{ex}$). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

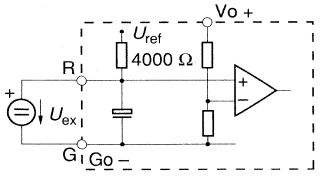



*Fig. 2*
*Voltage adjustment with $U_{ex}$ [V] between R and G (Go-):*

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ ($U_{ref}$ = 2.5 V ±4%)

**Caution:** To prevent damage $U_{ex}$ should not exceed $U_{ref}$, nor be negative.

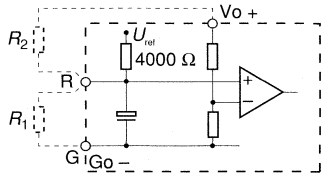



*Fig. 3*
*Voltage adjustment with external resistor $R_1$ or $R_2$ [Ω]*

b) $U_o$ = 0...100% $U_{o\,nom}$, using $R_1$ between R and G (Go-):

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

c) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ between R and Vo+:
$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ V \pm 4\%)$$

All formulae give approximate values only.


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## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 4: MTBF and device hours*

| MTBF | Ground Fixed | | Ground Mobile | | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217D | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | |
| | 130'000 h | 58'000 h | 36'000 h | 17'000 h | 3'900'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor Crowbar).

### Dynamic Characteristics

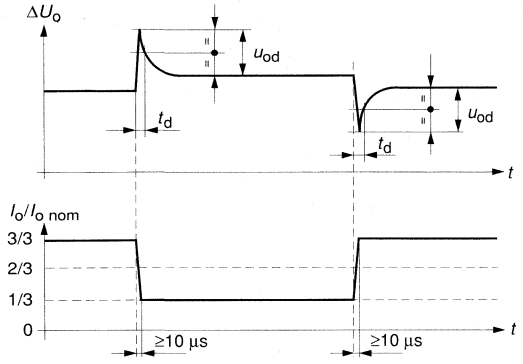



*Fig. 4*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 40 V DC which is below the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

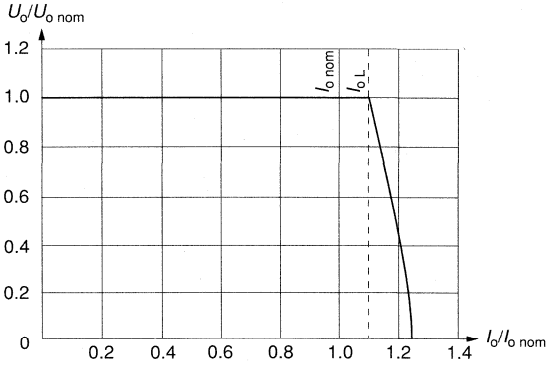



*Fig. 5*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90. SEV approval according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards are in progress.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30 (equipped with any potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSL 5A12 min | typ | max | Unit |
|---|---|---|---|---|---|---|
| **Output** | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 12.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 12.0 | | 15.6 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 50 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 45 | | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 25 | | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3\ I_{o\,nom}$ | | 130 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 40 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±1 | mV/K |
| | | | | | ±0.02 | %/K |
| **Input** | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 7 | | 40 | V DC |
| $\Delta U_{Io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [2] | | | 2 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 6.3 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | 45 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ | | 150 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [3] | $U_{i\,nom}$ with option L | | 250 | | A |
| $t_{i\,s}$ | Rise time [3] | | | 25 | | µs |
| $t_{i\,r}$ | Tail half value time [3] | | | 125 | | |
| $u_{i\,rfi}$ | RFI level at input, [4] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | B | dB(µV) |
| **Efficiency** | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 83 | | % |
| **Isolation** | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 750 | | V DC |

[1] See "Dynamic characteristics"
[2] The min. differential voltage $\Delta U_{i\,o\,min}$ between input/output voltage increases linearly by 0 to 1 V from $T_A$ = 46...71°C ($T_A$ = 71...95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor $C_e$ = 120 µF/50 V, e.g. Nichicon PF(M) series, or equivalent

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 32 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H11 (according to DIN 41612) to ensure requested safety!

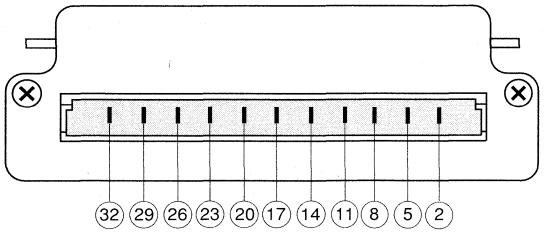



*Fig. 6*
*View of male H11 connector*

*Table 6: H11 connector pin allocation and designation*

| Electrical Determination | Type H11 Pin No. | Design. |
|---|---|---|
| R-input (or inhibit input) [1] | 2 | R (i) |
| Undervoltage monitor (Option D) | 5 | D |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 11 | Go– |
| Output voltage(positive) | 14 | Vo+ |
| Output voltage (positive) | 17 | Vo+ |
| Input voltage (negative) | 20 | Gi– |
| Input voltage (negative) | 23 | Gi– |
| Input voltage (positive) | 26 | Vi+ |
| Input voltage (positive) | 29 | Vi+ |
| Protective ground (protruding pin) | 32 | ⏚ |

[1] R-input (output voltage programming) not available with option P (potentiometer) or option i (inhibit)

## Description of Options

**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on). Inhibit excludes R function!

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

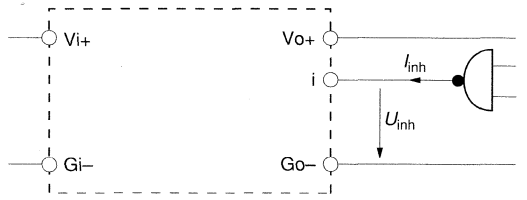



*Fig. 7*
*Definition of $I_{inh}$ and $U_{inh}$*

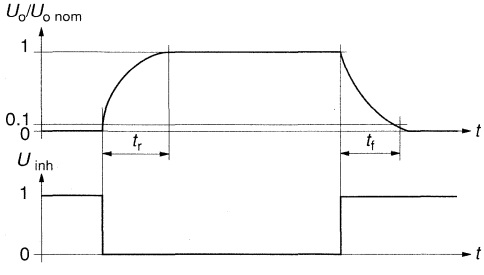



*Fig. 8*
*Output response as a function of inhibit signal*

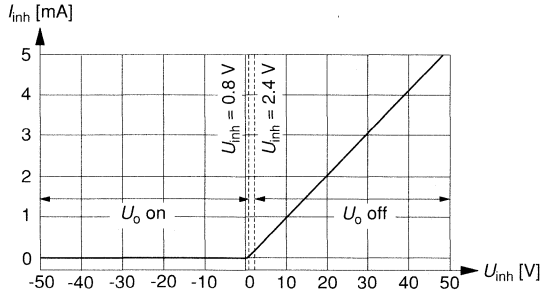



*Fig. 9*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

### Data

*Table 7: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\ min}$...$U_{i\ max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\ min}$...$T_{C\ max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\ nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\ nom} / I_{o\ nom}$ | | 10 | | |
| $I_{i\ off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\ nom}$ | | 10 | | mA |


MELCHER ISO 9001 certified

**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71°C$.

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 4 $mV_{rms}$.

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 12\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 1200\ Hz/f_i \cdot 1\ V$$

**Option P** Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSL family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71°C$ without any further precautions.

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$.

Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | 5.1 V | | Unit |
|---|---|---|---|---|---|
| | | | min | max | |
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | 5.8 | 6.8 | V |
| $t_s$ | Delay time | | | 1.5 | µs |

**Option D** ("Save Data", input undervoltage monitor)

**Note:** Output instead of input undervoltage monitor is available on request (option D1).

If the input voltage $U_i$ is below the adjustable threshold voltage $U_t$, the control circuit for terminal D has low impedance. Terminal D and Go– are connected to a self-conducting field effect transistor (FET). A 0.5 W Zener diode provides protection against overvoltages.

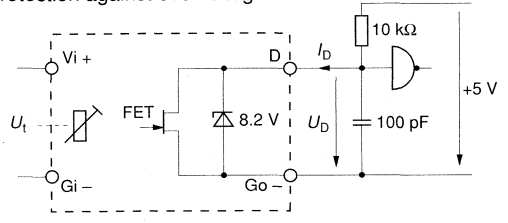



*Fig. 10*
*Test circuit with definition of voltage $U_D$ and current $I_D$ on Terminal D.*

The voltage $U_t$ can be externally adjusted with a trim potentiometer by means of a screwdriver. The hystersis $U_H$ of $U_t$ is <2%. Terminal D stays low for a minimum time $t_{low\,min}$, in order to prevent any oscillation. $U_t$ can be set to a value between $U_{i\,min}$ and $U_{i\,max}$ according to fig. 10. It is important to note that the FET can become conductive again when $U_D > U_i - 3V$.

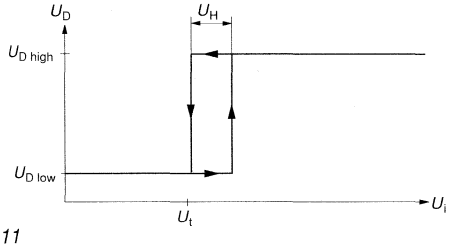



*Fig. 11*
*Definition of $U_t$ and $U_H$*

**Data**

*Table 9: Option D data*

| Characteristics | | Conditions | PSL | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| $U_{D\ low}$ | Voltage - Terminal D at low impedance | $U_i < U_t$, $I_D \leq 2.5$ mA | | | 0.8 | V |
| $U_{D\ high}$ | Voltage - Terminal D at high impedance | $U_i > U_t + U_H$, $I_D > 25$ µA | 4.75 | | | |
| $t_{low\ min}$ | Minimum duration $U_{D\ low}$ | | | 30 | | ms |
| $t_{D\ f}$ | Response time to $U_{D\ low}$ | | | 1 | | µs |
| $I_{D\ max}$ | Maximum current - Terminal D | | | | 20 | mA |

Application examples

a) The signal $U_D$ can be utilized in battery powered systems to provide a warning in case of **low batteries**.
b) In case of power failure, the signal can serve to initiate **data save** routines.

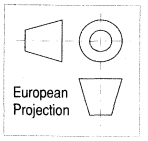
4.2

**Option A** Test sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage are located at the front panel of the module. The output voltage is measured internally directly at the connector pins.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



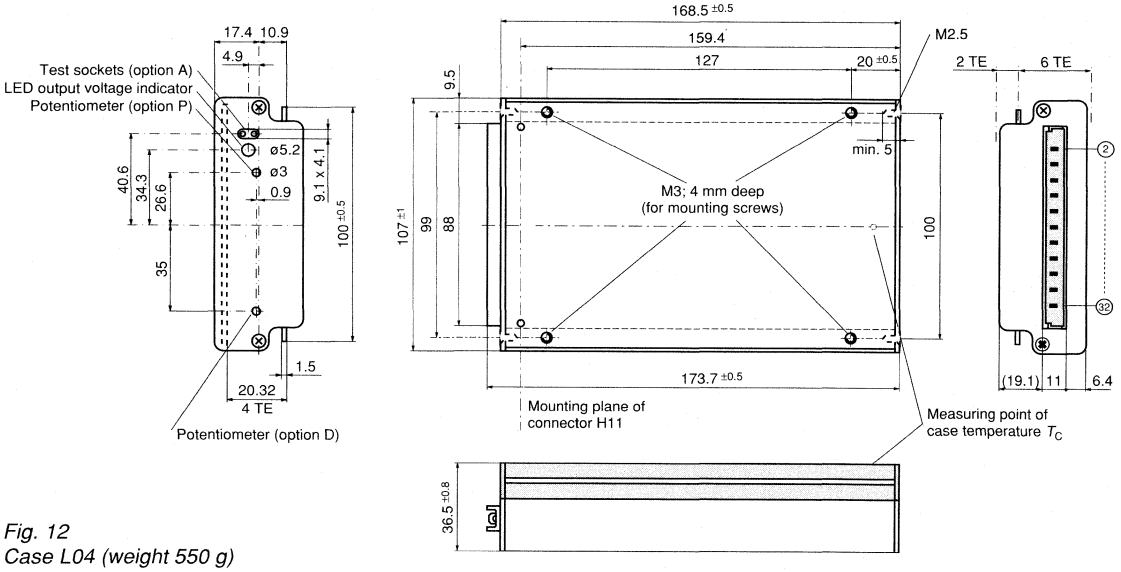
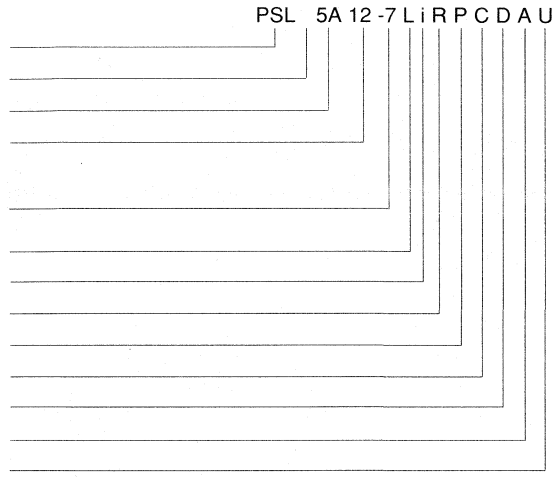




*Fig. 12*
*Case L04 (weight 550 g)*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case L04 ..... PSL
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1
Nominal output current in ampere ..... 12
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Input filter ..... L
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Thyristor-Crowbar ..... C
"Save Data" undervoltage monitor ..... D
Test sockets ..... A
UL recognized component for $T_{A\,max}$ = 71 °C ..... U

Example: PSL 5A12-7LiPC = A positive switching regulator with a 5.1 V, 12 A output, ambient temperature range of –25...71 °C, input filter, inhibit input, potentiometer and thyristor-crowbar.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

Front plate: Identification of LED, optional test sockets and potentiometers.

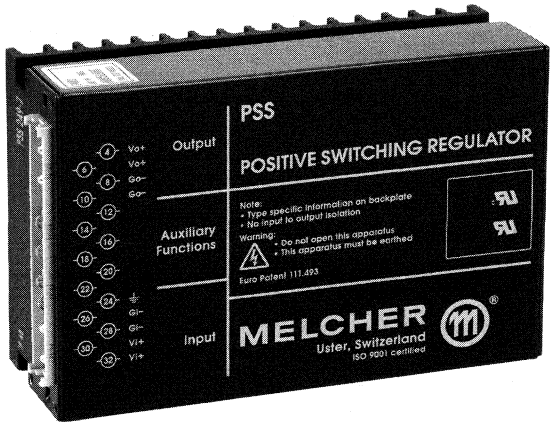
Back plate: Specific type designation, input voltage range, nominal output voltage and current, pin allocation of options and auxiliary functions and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and production date.

# Positive Switching Regulators PSS-Family

**No input to output isolation**
**Single output of 5.1, 12, 15[1], 24 or 36 V DC/60...432 W**
**Input voltage up to 80 V DC**

- Wide input voltage range
- High efficiency up to 96%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no load and short circuit proof
- Output current sharing
- No derating
- Safety according to IEC 950




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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ [2] | Type designation | Options |
|---|---|---|---|---|---|---|
| 5.1 V | 12 A | 8...80 V | 40 V | 80% | PSS 5A12-7 | -9, E, P, C, B, B1, U |
| 12 V [1] | | 15...80 V | | 90% | PSS 1212-7 | |
| 24 V | | 29...80 V | 50 V | 94% | PSS 2412-7 | |
| 36 V | | 42...80 V | 60 V | 96% | PSS 3612-7 | |

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")
[2] Including option E, $T_A$ = 25°C

## Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. This allows operation in the majority of battery driven or secondary switched applications. The basic type of regulators may be completed by various options to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case S01: Aluminium, black finish, fully enclosed. The basic model with heat sink is self cooling.

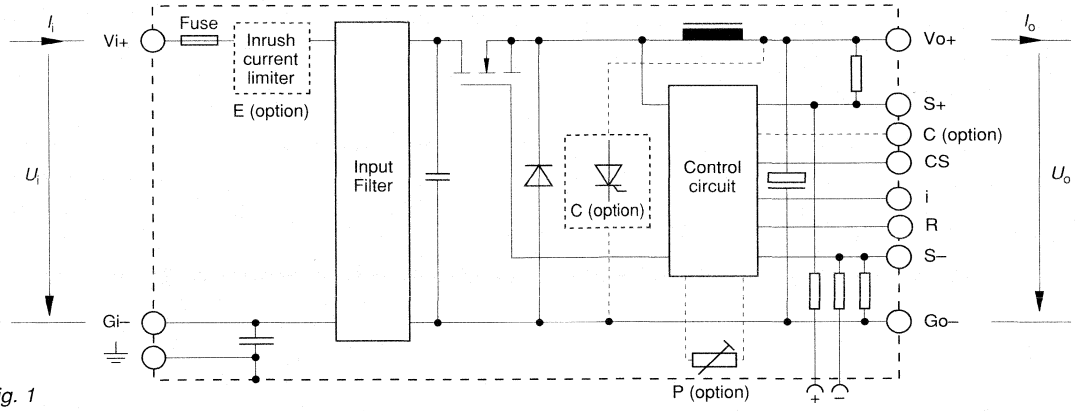



*Fig. 1*
*Block diagram*

## Standard Features

**Note:**
Additional information on input circuitry, grounding and parallel operation of units is given in section "Application Note"

**Inhibit (i)**

If the inhibit pin is not connected, the power supply is enabled ($U_o$ = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

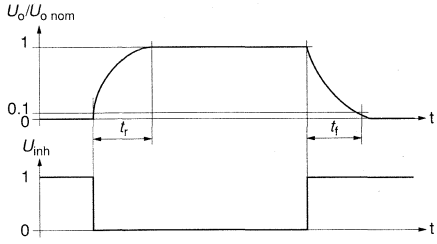



*Fig. 3*
*Output response as a function of inhibit signal*

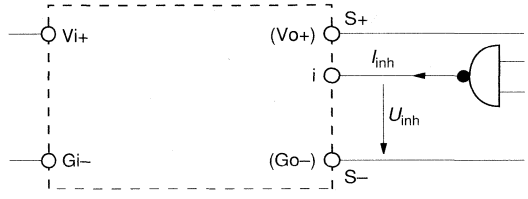



*Fig. 2*
*Definition of inhibit voltage and current*

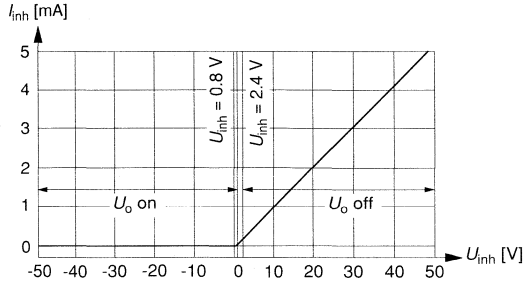



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | PSS 5A12 | | | PSS 1212 | | | PSS 2412 | | | PSS 3612 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_{inh}$ | Inhibit input voltage to keep output voltage... | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | V DC |
| | | $U_o$ = off | | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,nom}$ (resistive load) | | 100 | | | 100 | | | 100 | | | 100 | | ms |
| $t_f$ | Switch-off time after inhibit command | | | | 10 | | | 15 | | | 20 | | | 15 | | |
| $I_{i\,off}$ | Input current with converter inhibited | | $I_o$ = 0 $U_{i\,nom}$ | | 25 | | | 25 | | | 25 | | | 25 | | mA |

### Input Filter and Fuse

An input filter and a fuse are incorporated in all PSS modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

If a reduction of the considerable high inrush current is required, refer to option E.

The maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$u_{i\,max}$ = 10 $V_{pp}$ at 100 Hz, or $V_{pp}$ = 1000 Hz/$f_i$ • 1 V

### Test Sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage $U_o$ internally at the connector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

### Current Sharing (CS)

**Note:** Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage ($U_i$) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

### Sense Lines (S)

**Note:** Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSS connector) should not exceed the following values:

| Output voltage | Total voltage difference between both sense lines and their respective output | Voltage difference between Go– and S– |
|---|---|---|
| 5.1 V | <0.5 V | <0.25 V |
| 12 , 24, 36 V | <1.0 V | <0.25 V |

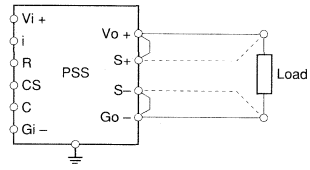



*Fig. 5*
*Sense lines connection*

### External Voltage Adjustment (R)

Note: With open R input, $U_o = U_{o\,nom}$. With option P, the R input must remain unconnected.

The output voltage $U_o$ can either be adjusted with an external resistor $R_1$ or $R_2$, or with an external voltage $U_{ex}$ referenced to S–. The adjustment range is 0...$U_{o\,max}$ depending on the nominal output voltage (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor ($R_1$ resp. $R_2$). Option P is not recommended for parallel operation mode.

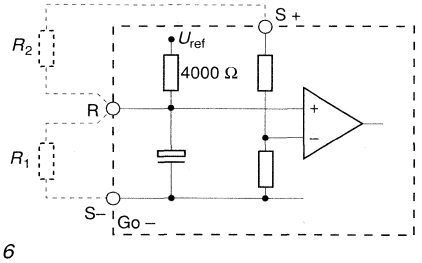



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$*

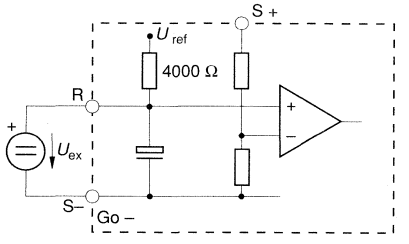



*Fig. 7*
*Voltage adjustment with external voltage $U_{ex}$ [V]*

a) $U_o = 0...U_{o\,nom}$, using $R_1$ [Ω] between R and S–:

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

b) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

c) $U_o = 0...U_{o\,max}$, using $U_{ex}$ [V] between R and S–:

$$U_o \approx U_{o\,nom} \cdot [\frac{U_{ex}}{U_{ref}} \cdot 0.98 + 0.02]$$

$(U_{ref} = 2.48\ V \pm 1\%)$

All formulae give approximate values only.

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V nor be negative!

## Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3<br>MIL 810D sec.507.2 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL 810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL 810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL 810D sec.514.3 | Frequency (1 Oct/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Kb | Salt mist cyclic (Sodium chloride solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Number of cycles: | 5% (30 °C)<br>2 h per cycle<br>40 °C, 93% relative humidity<br>3 | Not operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |
| Surge test | | IEC 801-5 | Class II: | 1 kV (1.2/50 µs; 2 Ω) | Operating |
| Voltage surge test | | IEC 571-1 | Capacitor discharge circ. | 1.8 kV (1/50 µs, 100 Ω) | Operating |

[1] Temporary deviation from specifications possible

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF values and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF according to | $T_C$ = 40 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 50°C | |
| MIL-HDBK-217F | 335'000 h | 138'000 h | 35'000 h | 33'000 h | 2'100'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). This diode is not assembled in combination with option C (see also "Thyristor Crowbar").

### Dynamic Characteristics

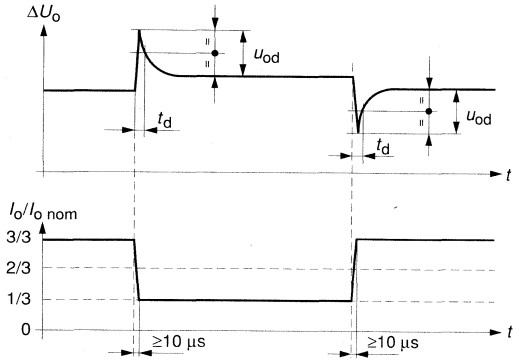



*Fig. 8*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules should only be wired via the female connector H15 (according to DIN 41612) in order to ensure compliance to national and international safety requirements. The modules accept input voltages up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage of isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. Use the current sharing feature for even distribution of the output current (see "Standard Features": Current Sharing).

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

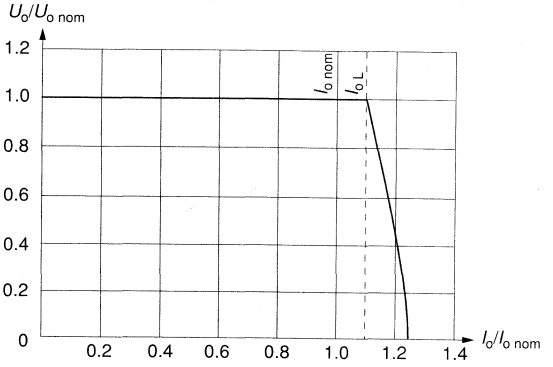



*Fig. 9*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30 (equipped with potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

## Electrical Input and Output Data

General Conditions
- $T_A$ = 25°C, unless $T_C$ is specified
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSS 5A12 | | | PSS 1212 | | | PSS 2412 | | | PSS 3612 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.92 | | 12.07 | 23.85 | | 24.14 | 35.78 | | 36.22 | V |
| $U_{o\,max}$ | Maximum adjustable output voltage utilizing R input | $U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector | | | 5.6 | | | 16.0 | | | 26.0 | | | 42.5 | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 12 | | | 12 | | | 12 | | | 12 | | A |
| $I_{o\,L}$ | Output current limitation response (% of $I_{o\,nom}$) | | 100 | | 125 | 100 | | 125 | 100 | | 125 | 100 | | 125 | % |
| $u_o$ | Ripple at Output (BW = 20 MHz) | $U_{i\,nom}$, $I_{o\,nom}$ | | 30 | 70 | | 40 | 80 | | 50 | 110 | | 60 | 110 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 15 | 35 | | 40 | 70 | | 80 | 170 | | 120 | 250 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 10 | 25 | | 30 | 50 | | 50 | 120 | | 60 | 120 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_o$ = $^2/_3$ $I_{o\,nom}$ $\pm^1/_3$ $I_{o\,nom}$ | | 70 | | | 140 | | | 180 | | | 200 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 40 | | | 60 | | | 60 | | | 70 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient $\Delta U_o$ / $\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | ±1 | | | ±3 | | | ±5 | | | ±8 | | mV/K |
| | | $I_o$ = 0...$I_{o\,nom}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | | | | | | |
| $U_i$ | Input voltage range | $T_{C\,min}$...$T_{C\,max}$ | 8 | | 80 | 15 | | 80 | 29 | | 80 | 42 | | 80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | $I_o$ = 0...$I_{o\,nom}$ | | 3 | | | 3 [3] | | | 5 | | | 6 | | |
| $U_{io}$ | Undervoltage cut-out | | | 6.5 | | | 7.3 | | | 12 | | | 19 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0 $U_{i\,nom}$ | | 36 | | | 36 | | | 36 | | | 36 | | mA |
| $I_{im}$ | Peak value of inrush current | $U_{i\,nom}$ with option E [2] | | | 40 | | | 60 | | | 60 | | | 80 | A |
| $u_{rfi}$ | RFI level at input, 0.01...30 MHz | VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$ | | | B | | | B | | | B | | | B | dB (µV) |
| **Efficiency** | | | | | | | | | | | | | | | |
| η | Efficiency with option E | $U_{i\,nom}$, $I_{o\,nom}$ | | 80 | | | 90 | | | 94 | | | 96 | | % |
| **Isolation** | | | | | | | | | | | | | | | |
| $U_{i\,s}$ | Isolation test voltage electronic to case | All input and output terminals interconnected | | 750 | | | 750 | | | 750 | | | 750 | | V DC |

[1] See "Dynamic Characteristics"
[2] See also option E
[3] For $U_o$ > 12 V, add 1 V

## Description of Options

**Option -9** Extended Temperature Range

This option defines an extended operational ambient temperature range of $T_A = -40...71\,°C$.

---

**Option E** Inrush Current Limitation

**Note:** This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of $U_i/1\ \Omega$ and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

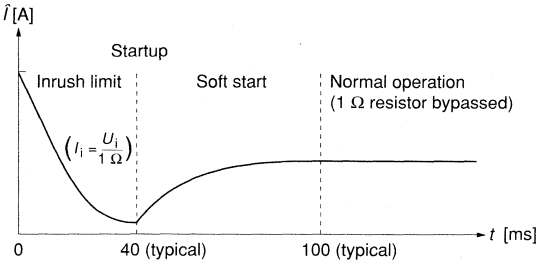



*Fig. 10*
*Option E: Inrush current versus time*

---

**Option P** Potentiometer

**Note:** Option P is not recommended if several modules are operated in parallel connection.

The potentiometer can be controlled with a screwdriver from the front side. The output voltage adjustment range is 90...110% of the nominal output voltage $U_{o\,nom}$.

The minimum differential voltage, $\Delta U_{io\,min}$ between input and output voltages should be maintained.

---

**Option C** Thyristor Crowbar

**Note**: The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage $U_o$ and when the trigger voltage $U_{o\,C}$ is reached, the thyristor crowbar triggers and disables the output.

An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

*Table 7: Crowbar trigger levels*

| Characteristics | | Condition | PSS 5A12 | PSS 1212 | PSS 2412 | PSS 3612 | Unit |
|---|---|---|---|---|---|---|---|
| | | | min typ max | min typ max | min typ max | min typ max | |
| $U_{o\,C}$ | Crowbar trigger voltage | $T_{C\,min}...T_{C\,max}$<br>$U_{i\,min}...U_{i\,max}$ | 6.3 6.7 | 17.8 18.9<br>14.3 15.2 [1] | 28.89 30.6 | 47.0 50.0<br>43.0 45.5 [1] | V DC |
| $t_s$ | Delay time | $I_o = 0...I_{o\,nom}$ | 1.5 | 1.5 | 1.5 | 1.5 | µs |

[1] Crowbar Trigger voltage with option P

**Option B, Option B1** Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output at 110 °C approximately. The output is automatically enabled again after temperature has droped below $T_{C\,max}$.

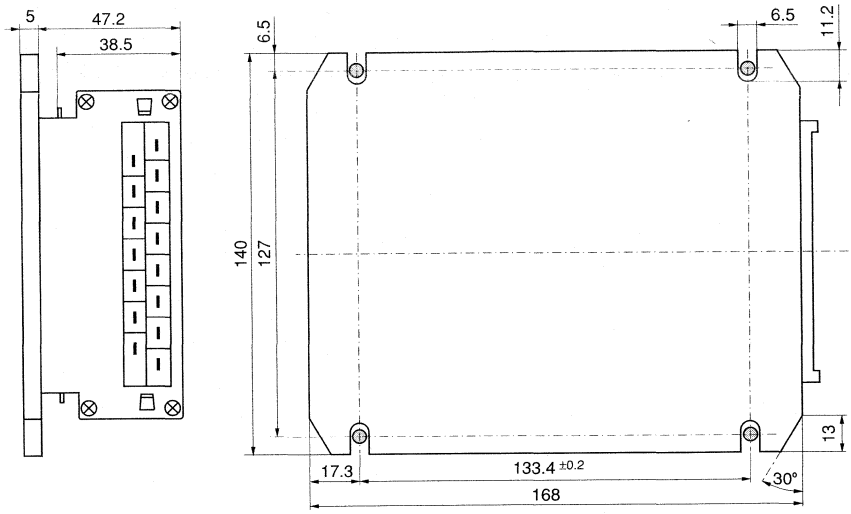



*Fig. 11*
*Case S01 with option B (cooling plate)*
*Weight: 1.1 kg*

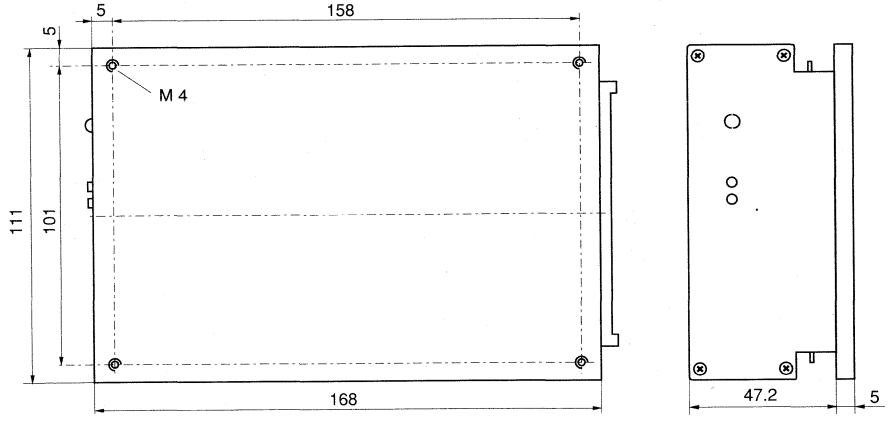



*Fig. 12*
*Case S01 with option B1 (cooling plate)*
*Weight: 1.1 kg*

**Option U** Ambient Temp. Range acc. UL Recognition

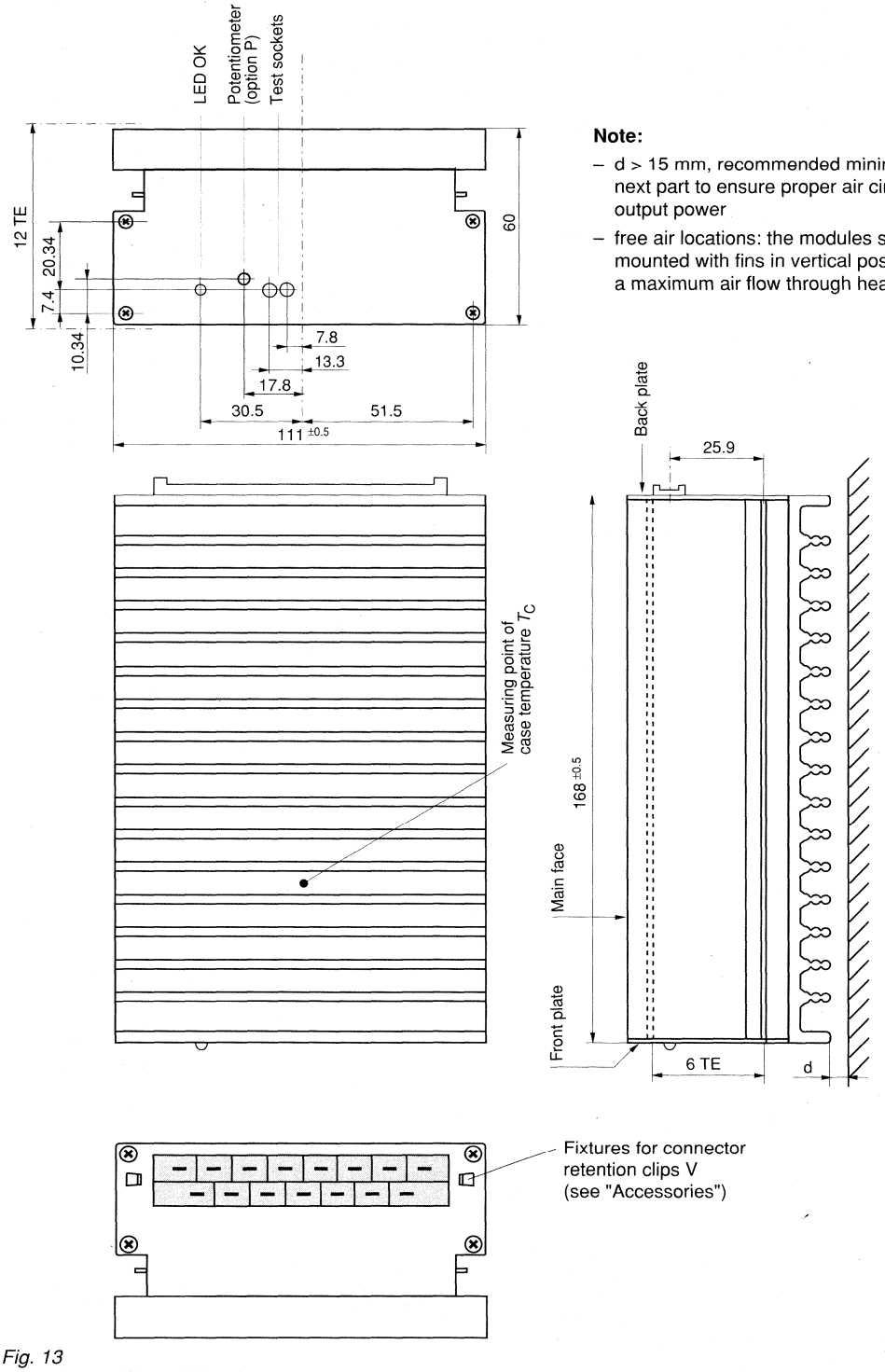
Underwriters Laboratories (UL) have approved the PSS family as recognized components up to an ambient temperature of $T_{A\,max} - 10$ K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71$ °C without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

European Projection




**Note:**

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow through heat sink

*Fig. 13*
*Case S01 with heatsink*
*Weight: 1.45 kg*

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

*Table 8: H15 connector pin allocation*

| Electrical Determination | Type H15 | |
|---|---|---|
| | Pin No. | Ident. |
| Output voltage (positive) | 4 | Vo+ |
| Output voltage (positive) | 6 | Vo+ |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 10 | Go– |
| Crowbar trigger input (option C) | 12 | C |
| Inhibit input | 14 | i |
| R-input (output voltage programming) [1] | 16 | R |
| Sense line (negative) | 18 | S– |
| Sense line (positive) | 20 | S+ |
| Current sharing control input | 22 | CS |
| Protective ground (protruding pin) | 24 | ⏚ |
| Input voltage (negative) | 26 | Gi– |
| Input voltage (negative) | 28 | Gi– |
| Input voltage (positive) | 30 | Vi+ |
| Input voltage (positive) | 32 | Vi+ |

[1] Not available with option P

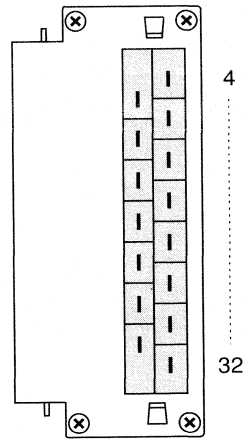
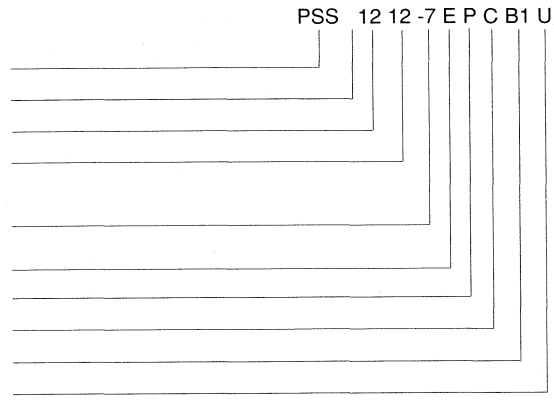



*Fig. 14*
*View of male H15 connector*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case S01 ..... PSS
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1...36
Nominal output current in ampere ..... 12
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Inrush current limitation ..... E
Potentiometer ..... P
Thyristor-Crowbar ..... C
Cooling plate ..... B, B1
UL recognized component for $T_{A\,max}$ = 71 °C ..... U

Example: PSS 1212-7EPCB = A positive switching regulator with a 12 V, 12 A output, ambient temperature range of –25...71 °C, inrush current limitation, potentiometer, crowbar, and cooling plate B.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LED, test sockets and potentiometer.

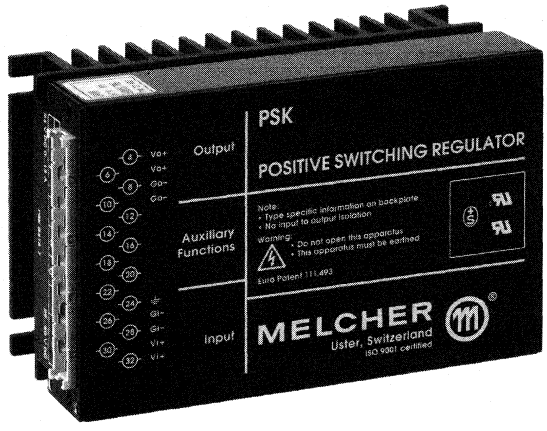
Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of option and auxiliary functions, fuse specification and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

# Positive Switching Regulators PSK-Family

**No input to output isolation**
**Single output of 5.1, 12, 15[1], 24 or 36 V DC/80...720 W**
**Input voltage up to 80 V DC**

- Wide input voltage range
- High efficiency up to 96%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- No derating
- Output no load and short circuit proof
- Output current sharing
- Safety according to IEC 950






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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ [2] | Type designation | Connector type | Options |
|---|---|---|---|---|---|---|---|
| 5.1 V | 25 A | 8...40 V | 20 V | 85% | PSK 5A25-7 | H15 S4 | -9, E, P, C, B, B1, U |
| | 20 A | 8...80 V | 40 V | 80% | PSK 5A20-7 | | |
| 12 V [1] | | 15...80 V | | 90% | PSK 1220-7 | | |
| 24 V | | 29...80 V | 50 V | 94% | PSK 2420-7 | | |
| 36 V | | 42...80 V | 60 V | 96% | PSK 3620-7 | | |
| 5.1 V | 16 A | 8...80 V | 40 V | 80% | PSK 5A16-7 | H15 | |
| 12 V [1] | | 15...80 V | | 90% | PSK 1216-7 | | |
| 24 V | | 29...80 V | 50 V | 94% | PSK 2416-7 | | |
| 36 V | | 42...80 V | 60 V | 96% | PSK 3616-7 | | |

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")
[2] Including option E, $T_A$ = 25°C

## Description

The switching regulators define power supply modules for industrial electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. This allows operation in the majority of battery driven or secondary switched applications. The basic type of regulators may be completed by various options to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.
Two different connectors according to DIN 41 612 are provided: H15 (standard) for current values up to 16 A or H15 S4 (containing 4 high current terminals, one pair each for input and output) supplying current values from 20 A up.
Case K01: Aluminium, black finish, fully enclosed. The basic model with heat sink is self cooling.

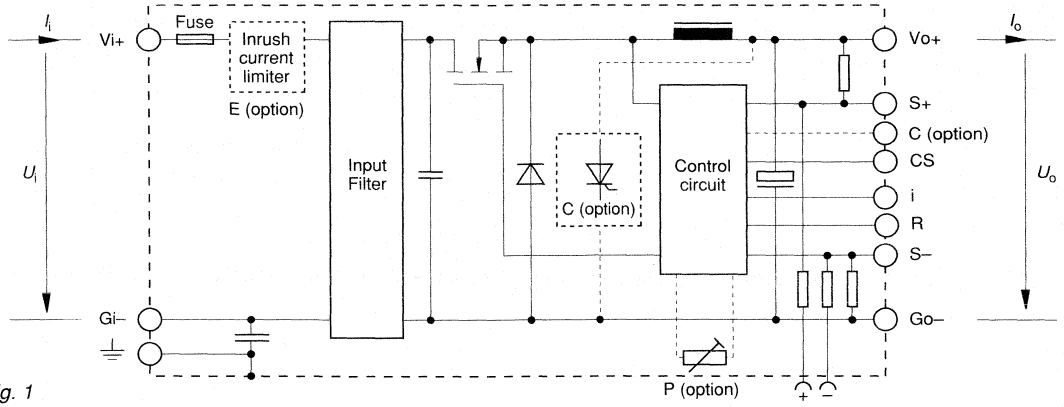



*Fig. 1*
*Block diagram*

## Standard Features

**Note:**
Additional information on input circuitry, grounding and parallel operation of units is given in section "Application Note"

**Inhibit (i)**

If the inhibit pin is not connected, the power supply is enabled ($U_o$ = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

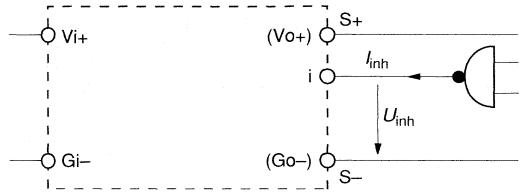



*Fig. 2*
*Definition of inhibit voltage and current*

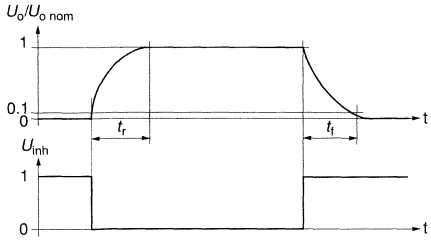



*Fig. 3*
*Output response as a function of inhibit signal*

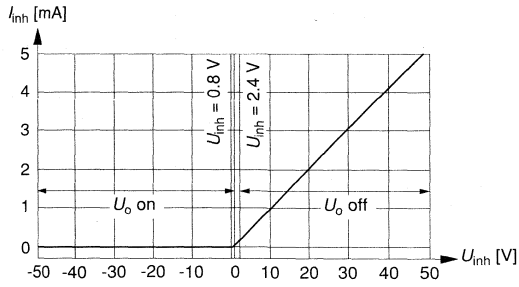



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 2: Inhibit characteristics*

| Characteristics | | | Conditions | PSK 5A.. | | | PSK 12.. | | | PSK 24.. | | | PSK 36.. | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_{inh}$ | Inhibit input voltage to keep output voltage... | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | V DC |
| | | $U_o$ = off | | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,nom}$ (resistive load) | | 100 | | | 100 | | | 100 | | | 100 | | ms |
| $t_f$ | Switch-off time after inhibit command | | | | 10 | | | 15 | | | 20 | | | 15 | | |
| $I_{i\,off}$ | Input current with converter inhibited | | $I_o$ = 0 $U_{i\,nom}$ | | 25 | | | 25 | | | 25 | | | 25 | | mA |

4.2

### Input Filter and Fuse

An input filter and a fuse are incorporated in all PSK modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

If a reduction of the considerable high inrush current is required, refer to option E.

The maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$u_{i\,max}$ = 10 $V_{pp}$ at 100 Hz, or $V_{pp}$ = 1000 Hz/$f_i$ • 1 V

### Test Sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage $U_o$ internally at the connector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

### Current Sharing (CS)

**Note:** Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage ($U_i$) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

### Sense Lines (S)

**Note:** Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSK connector) should not exceed the following values:

| Output voltage | Total voltage difference between both sense lines and their respective output | Voltage difference between Go– and S– |
|---|---|---|
| 5,1 V | < 0.5 V | < 0.25 V |
| 12 , 24, 36 V | < 1.0 V | < 0.25 V |

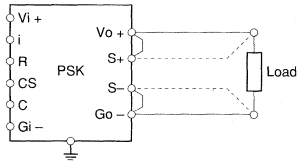



*Fig. 5*
*Sense lines connection*

### External Voltage Adjustment (R)

Note: With open R input, $U_o = U_{o\,nom}$. With option P, the R input must remain unconnected.

The output voltage $U_o$ can either be adjusted with an external resistor $R_1$ or $R_2$, or with an external voltage $U_{ex}$ referenced to S–. The adjustment range is 0...$U_{o\,max}$ depending on the nominal output voltage (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor ($R_1$ resp. $R_2$). Option P is not recommended for parallel operation mode.

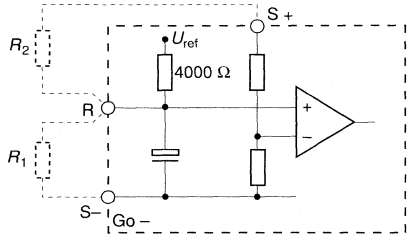



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$*

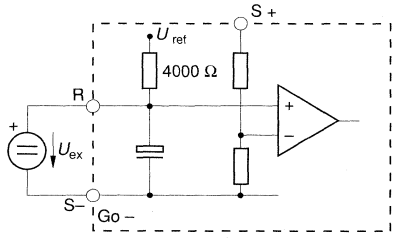



*Fig. 7*
*Voltage adjustment with external voltage $U_{ex}$ [V]*

a) $U_o = 0...U_{o\,nom}$, using $R_1$ [Ω] between R and S–:

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

b) $U_o = U_{o\,nom}...U_{o\,max}$, using $R_2$ [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1\text{-}k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

c) $U_o = 0...U_{o\,max}$, using $U_{ex}$ [V] between R and S–:

$$U_o \approx U_{o\,nom} \cdot [\frac{U_{ex}}{U_{ref}} \cdot 0.98 + 0.02]$$

($U_{ref}$ = 2.48 V ±1%)

All formulae give approximate values only.

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V nor be negative!


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## Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3<br>MIL 810D sec.507.2 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL 810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL 810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL 810D sec.514.3 | Frequency (1 Oct/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$ (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Kb | Salt mist, cyclic (Sodium chloride solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% relative humidity<br>3 | Not operating |
| Electrostatic discharge | | IEC 801-2 | Level 3: | 6 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 3: | 2 kV (5/50 ns, 50 Ω) | Operating [1] |
| Surge test | | IEC 801-5 | Class II: | 1 kV (1.2/50 µs; 2 Ω) | Operating |
| Voltage surge test | | IEC 571-1 | Capacitor discharge circ. | 1.8 kV (1/50 µs, 100 Ω) | Operating |

[1] Temporary deviation from specifications possible

*Table 4: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (not operational) | –40 | 100 | –55 | 100 | |

*Table 5: MTBF values and device hours*

| MTBF | Ground Benign | Ground Fixed | | Ground Mobile | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF according to | $T_C$ = 40 °C | $T_C$ = 40 °C | $T_C$ = 70 °C | $T_C$ = 50°C | |
| MIL-HDBK-217F | 335'000 h | 138'000 h | 35'000 h | 33'000 h | 2'100'000 h |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). This diode is not assembled in combination with option C (see also "Thyristor Crowbar").

### Dynamic Characteristics

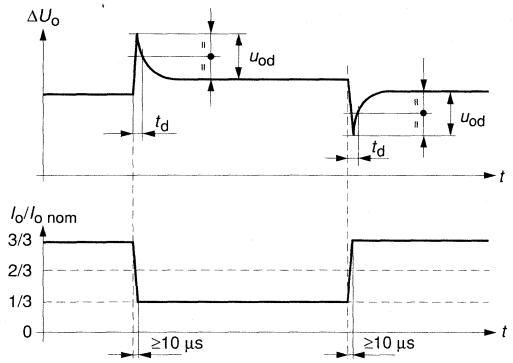



*Fig. 8*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 95 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95 °C.

### Safety

For safety reasons in all installations the modules should only be wired via the female connectors H15 or H15 S4 (according to DIN 41612) in order to ensure compliance to national and international safety requirements. The modules accept input voltages up to 80 V DC which is above the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage of isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. Use the current sharing feature for even distribution of the output current (see: Standard Features: "Current Sharing").

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

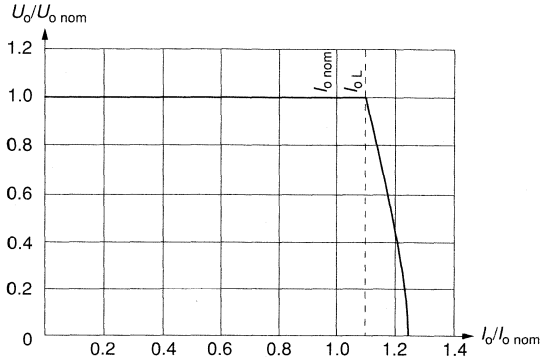



*Fig. 9*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30 (equipped with potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

## Electrical Input and Output Data

General Conditions
- $T_A$ = 25°C, unless $T_C$ is specified
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | | Conditions | PSK 5A16 PSK 5A20 PSK 5A25 | | | PSK 1216 PSK 1220 | | | PSK 2416 PSK 2420 | | | PSK 3616 PSK 3620 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_o$ | Output voltage | | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.92 | | 12.07 | 23.85 | | 24.14 | 35.78 | | 36.22 | V |
| $U_{o\,max}$ | Maximum adjustable output voltage utilizing R input | | $U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector | | | 5.6 | | | 16.0 | | | 26.0 | | | 42.5 | |
| $I_{o\,nom}$ | Output current | PSK ...16<br>PSK ...20<br>PSK 5A25 | $U_{i\,min}$...$U_{i\,max}$<br>$T_{C\,min}$...$T_{C\,max}$ | | 16<br>20<br>25 | | | 16<br>20<br>– | | | 16<br>20<br>– | | | 16<br>20<br>– | | A |
| $I_{o\,L}$ | Output current limitation response (% of $I_{o\,nom}$) | | | 100 | | 125 | 100 | | 125 | 100 | | 125 | 100 | | 125 | % |
| $u_o$ | Ripple at Output (BW = 20 MHz) | | $U_{i\,nom}$, $I_{o\,nom}$ | | 30 | 70 | | 40 | 80 | | 50 | 110 | | 60 | 110 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$ | | 15 | 35 | | 40 | 70 | | 80 | 170 | | 120 | 250 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | | $U_{i\,nom}$<br>$I_o$ = 0...$I_{o\,nom}$ | | 10 | 25 | | 30 | 50 | | 50 | 120 | | 60 | 120 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | | $U_{i\,nom}$<br>$I_o$ = $^2/_3$ $I_{o\,nom}$<br>$\pm^1/_3$ $I_{o\,nom}$ | | 70 | | | 140 | | | 180 | | | 200 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | | 40 | | | 60 | | | 60 | | | 70 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient $\Delta U_o$ / $\Delta T_C$ | | $U_{i\,min}$...$U_{i\,max}$<br>$T_{C\,min}$...$T_{C\,max}$<br>$I_o$ = 0...$I_{o\,nom}$ | | ±1 | | | ±3 | | | ±5 | | | ±8 | | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | | | | | | | |
| $U_i$ | Input voltage range | | $T_{C\,min}$...$T_{C\,max}$ | 8 | | 80 [2] | 15 | | 80 | 29 | | 80 | 42 | | 80 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | | $I_o$ = 0...$I_{o\,nom}$ | | 3 | | | 3 [3] | | | 5 | | | 6 | | |
| $U_{io}$ | Undervoltage cut-out | | | | 6.5 | | | 7.3 | | | 12 | | | 19 | | |
| $I_{i\,o}$ | No load input current | | $I_o$ = 0<br>$U_{i\,nom}$ | | 36 | | | 36 | | | 36 | | | 36 | | mA |
| $I_{im}$ | Peak value of inrush current | | $U_{i\,nom}$ with option E [4] | | | 40 | | | 60 | | | 60 | | | 80 | A |
| $u_{rfi}$ | RFI level at input, 0.01...30 MHz | | VDE0871, part 11 EN 55011/55022<br>$U_{i\,nom}$, $I_{o\,nom}$ | | B | | | B | | | B | | | B | | dB (µV) |
| **Efficiency** | | | | | | | | | | | | | | | | |
| h | Efficiency with option E | | $U_{i\,nom}$, $I_{o\,nom}$ | | 80 [5] | | | 90 | | | 94 | | | 96 | | % |
| **Isolation** | | | | | | | | | | | | | | | | |
| $U_{i\,s}$ | Isolation test voltage electronic to case | | All input and output terminals interconnected | | 750 | | | 750 | | | 750 | | | 7500 | | V DC |

[1] See "Dynamic Characteristics"
[2] PSK 5A25: $U_i$ = 8...40 V
[3] For $U_o$ > 12 V, add 1 V
[4] See also option E
[5] PSK 5A25: η = 85%

## Description of Options

**Option -9** Extended Temperature Range

This option defines an extended operational ambient temperature range of $T_A = -40...71\,°C$.

**Option E** Inrush Current Limitation

**Note:** This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of $U_i/1\,\Omega$ and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

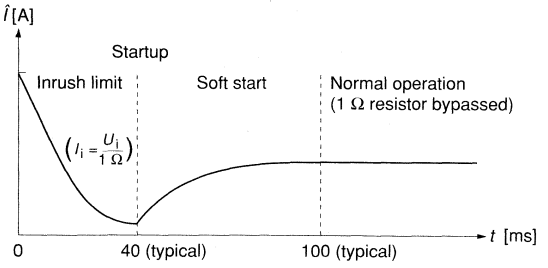



*Fig. 10*
*Option E: Inrush current versus time*

**Option P** Potentiometer

**Note:** Option P is not recommended if several modules are operated in parallel connection.

The potentiometer can be controlled with a screwdriver from the front side. The output voltage adjustment range is 90...110% of the nominal output voltage $U_{o\,nom}$.

The minimum differential voltage, $\Delta U_{io\,min}$ between input and output voltages should be maintained.

**Option C** Thyristor Crowbar

**Note:** The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage $U_o$ and when the trigger voltage $U_{o\,C}$ is reached, the thyristor crowbar triggers and disables the output. An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

*Table 7: Crowbar trigger levels*

| Characteristics | | Condition | PSK 5A.. | | | PSK 12.. | | | PSK 24.. | | | PSK 36.. | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,C}$ | Crowbar trigger voltage | $T_{C\,min}...T_{C\,max}$ $U_{i\,min}...U_{i\,max}$ | | 6.3 | 6.7 | | 17.8<br>14.3 | 18.9<br>15.2 [1] | | 28.8 | 30.6 | | 47.0<br>43.0 | 50.0<br>45.5 [1] | V DC |
| $t_s$ | Delay time | $I_o = 0...I_{o\,nom}$ | | 1.5 | | | 1.5 | | | 1.5 | | | 1.5 | | µs |

[1] Crowbar Trigger voltage with option P

**Option B, Option B1** Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output at 110 °C approximately. The output is automatically enabled again after temperature has droped below $T_{C\,max}$.

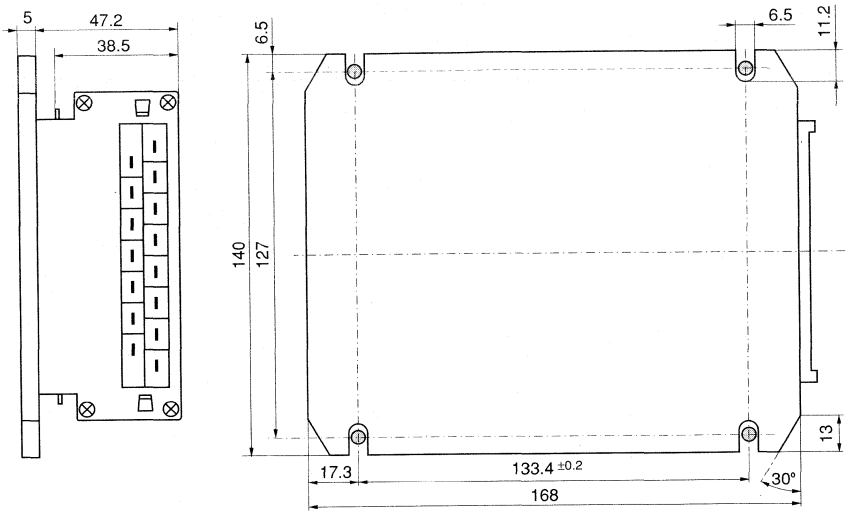



*Fig. 11*
*Case K01 with option B (cooling plate)*
*Weight: 1.1 kg*

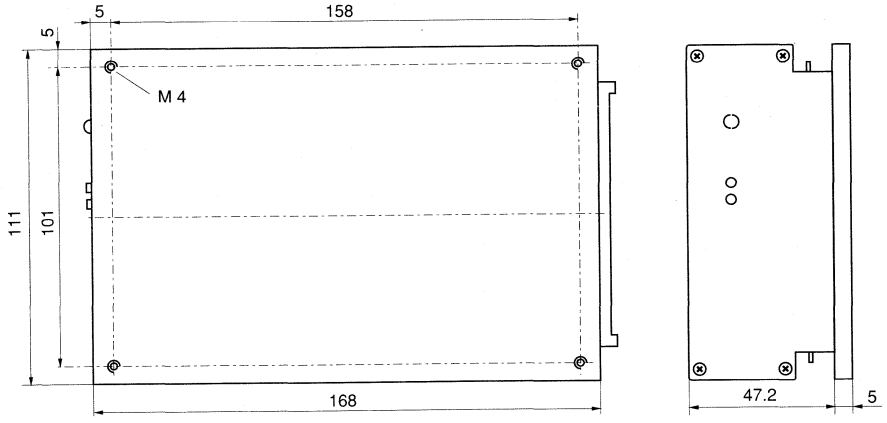



*Fig. 12*
*Case K01 with option B1 (cooling plate)*
*Weight: 1.1 kg*

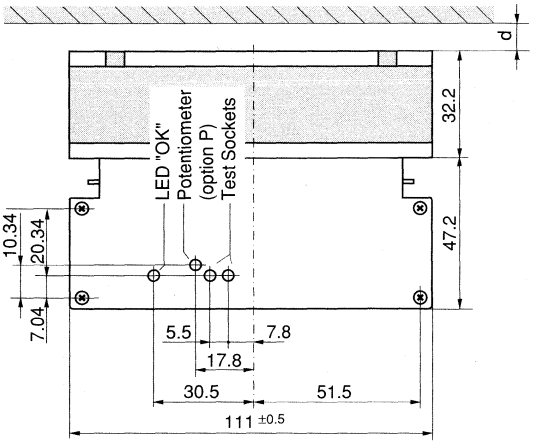
**Option U** Ambient Temp. Range acc. UL Recognition

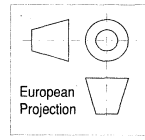
Underwriters Laboratories (UL) have approved the PSK family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max}$ = 71 °C without any further precautions.

## Mechanical Data

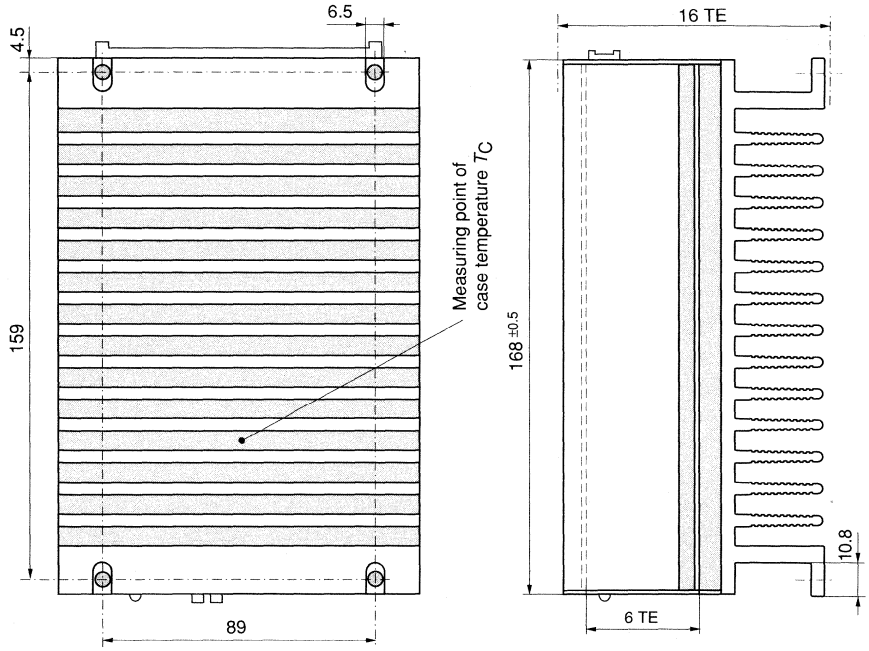
Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.




**Note:**

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow throught heat sink



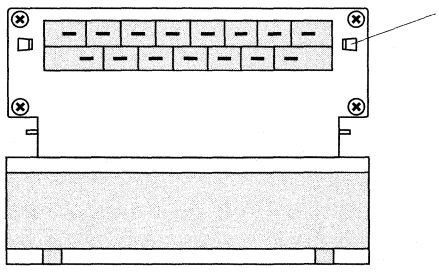




*Fig. 13*
*Case K01 with heatsink*
*Weight: 1.6 kg*


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## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 or H15 S4 (see "Accessories") to ensure requested safety!

*Table 8: H15 and H15 S4 connector pin allocation*

| Electrical Determination | Type H15 | | Type H15 S4 | |
|---|---|---|---|---|
| | Pin No. | Ident. | Pin No. | Ident. |
| Output voltage (positive) | 4 | Vo+ | 4/6 | Vo+ |
| Output voltage (positive) | 6 | Vo+ | | |
| Output voltage (negative) | 8 | Go– | 8/10 | Go– |
| Output voltage (negative) | 10 | Go– | | |
| Crowbar trigger input (option C) | 12 | C | 12 | C |
| Inhibit input | 14 | i | 14 | i |
| R-input (output voltage programming) [1] | 16 | R | 16 | R |
| Sense line (negative) | 18 | S– | 18 | S– |
| Sense line (positive) | 20 | S+ | 20 | S+ |
| Current sharing control input | 22 | CS | 22 | CS |
| Protective ground (protruding pin) | 24 | ⏚ | 24 | ⏚ |
| Input voltage (negative) | 26 | Gi– | 26/28 | Gi– |
| Input voltage (negative) | 28 | Gi– | | |
| Input voltage (positive) | 30 | Vi+ | 30/32 | Vi+ |
| Input voltage (positive) | 32 | Vi+ | | |

[1] Not available with option P

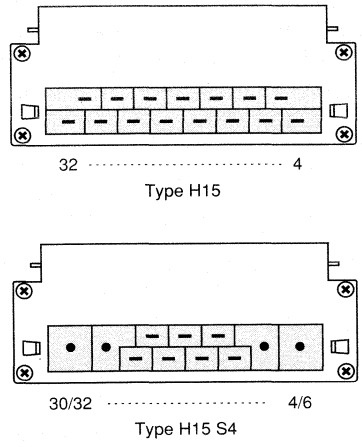



*Fig. 14*
*View of male H15 and H15 S4 connector*

## Type Key and Product Marking

### Type Key

PSK 12 16 -7 E P C B1 U

Positive switching regulator in case K01 ..... PSK
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1...36
Nominal output current in ampere ..... 16...25
Ambient temperature range
$T_A$ = –25...71 °C ..... -7
$T_A$ = –40...71 °C ..... -9
Inrush current limitation ..... E
Potentiometer ..... P
Thyristor-Crowbar ..... C
Cooling plate ..... B, B1
UL recognized component for $T_{A\,max}$ = 71 °C ..... U

Example: PSK 1216-7EPCB = A positive switching regulator with a 12 V, 16 A output, ambient temperature range of –25...71 °C, inrush current limitation, potentiometer, thyristor-crowbar, and cooling plate B.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LED, test sockets and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of option and auxiliary functions, fuse specification and degree of protection.

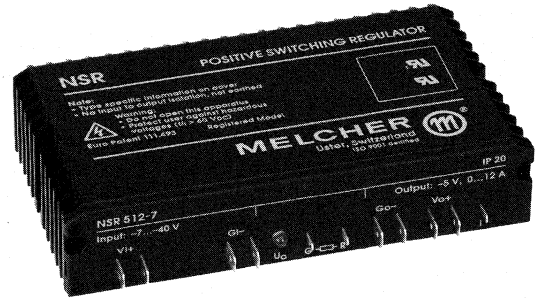
Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

# NSR: Negative Switching Regulators

# NSR-Family

**No input to output isolation**
**Single output of –5 V DC/60 W**
**Input voltage up to –40 V DC**

- High efficiency up to 81%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Inptt undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




4.2

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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ [1] | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Options |
|---|---|---|---|---|---|---|
| –5 V | 12 A | –7...–40 V | –20 V | 81% | NSR 512-7 | -9, L, i, P, R, C, U |

[1]See also data $\Delta U_{io\,min}$. (Minimum differential voltage $U_i - U_o$)

## Description

The NSR family of negative switching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response.

The modules are specially designed for secondary switched and battery driven applications with positive system ground.

Case C03: Aluminium, black finish and self cooling.





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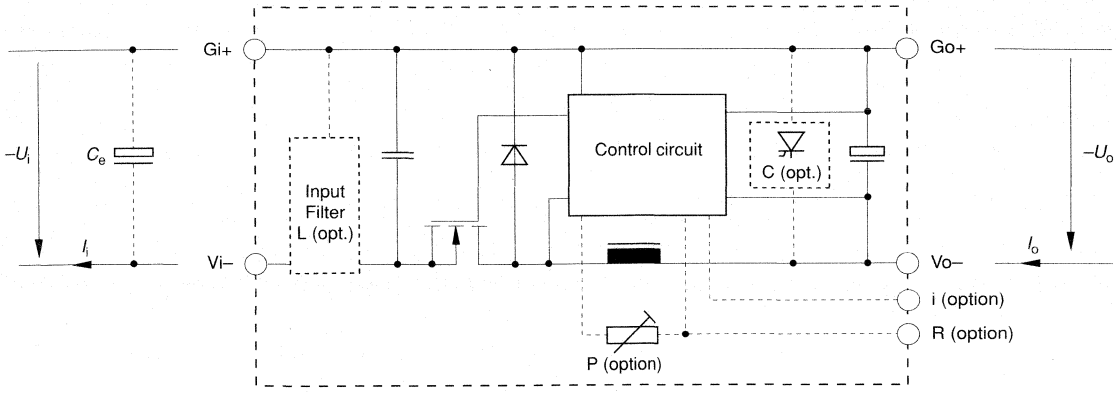



*Fig. 1*
*Block Diagram*

**External input circuitry**

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | $40^{+2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |

*Table 3: Temperature specifications*

| Temperature | | | Standard -7 | | Option -9 | | Unit |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | min | max | |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –25 | 95 | –40 | 95 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 100 | –55 | 100 | |

*Table 4: MTBF and device hours*

| MTBF | Ground Fixed | | Ground Mobile | | Device Hours [1] |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217D | $T_C$ = 40°C | $T_C$ = 70°C | $T_C$ = 40°C | $T_C$ = 70°C | |
| | 130'000 h | 58'000 h | 36'000 h | 17'000 h | 1'050'000 h |

[1] Statistical values , based on an average of 4300 working hours per year and in general field use

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe). See also option C (Thyristor crowbar).

### Dynamic Characteristics

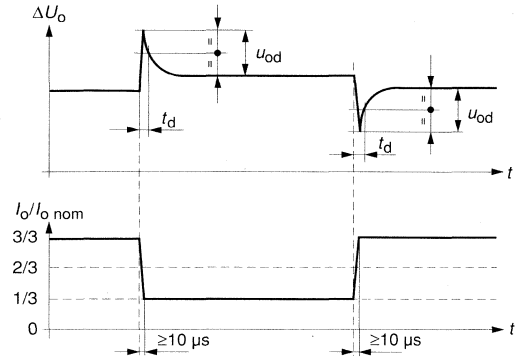



*Fig. 2*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 71°C and is operated at its nominal output power, the case temperature $T_C$ will be about 95°C after the warm-up phase measured at the measuring point of case temperature $T_C$ (see "Mechanical Data).

Under practical operating conditions, the ambient temperature $T_A$ may exceed 71°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 95°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages of up to 40 V DC which is below the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

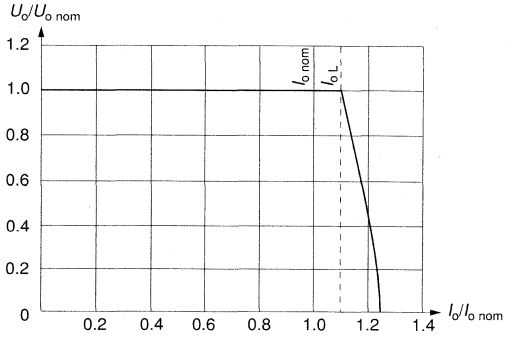



*Fig. 3*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With option P or R, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 5: Input and output data*

| Characteristics | | Conditions | NSR 512 min | typ | max | Unit |
|---|---|---|---|---|---|---|
| **Output** | | | | | | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | –4.97 | | –5.03 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 12.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 12.0 | | 15.6 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | 35<br>60 | 50<br>85 [1] | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 30<br>35 | 45<br>55 [1] | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | 20 | 25 | |
| $u_{o\,d}$ | Dynamic control deviation [2] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 135 | | |
| $t_d$ | Dynamic load transient time constant [2] | | | 40 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±1 | mV/K |
| | | | | | ±0.02 | %/K |
| **Input** | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | –7 | | –40 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ [3] | | | –2 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | –6.3 | | |
| $I_{i\,0}$ | No load input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | | 45 | mA |
| $I_{i\,m}$ | Peak value of inrush current [4] | $U_{i\,nom}$ | | 150 | | A |
| $t_{i\,s}$ | Rise time [4] | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [4] | | | 40 | | |
| $I_{i\,m}$ | Peak value of inrush current [4] | $U_{i\,nom}$ with option L | | 250 | | A |
| $t_{i\,s}$ | Rise time [4] | | | 25 | | µs |
| $t_{i\,r}$ | Tail half value time [4] | | | 125 | | |
| $u_{i\,rfi}$ | RFI level at input, 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A | dB (µV) |
| **Efficiency** | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 81 | | % |
| **Isolation** | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | V DC |

[1] Lower row represents option -9 data only
[2] See "Dynamic Characteristics"
[3] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly by 1 V max between $T_A$ = 46°C and 71°C ($T_C$ = 70°C and 95°C)
[4] Definitions according to VDE 0433, part 3

## Description of Options

**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

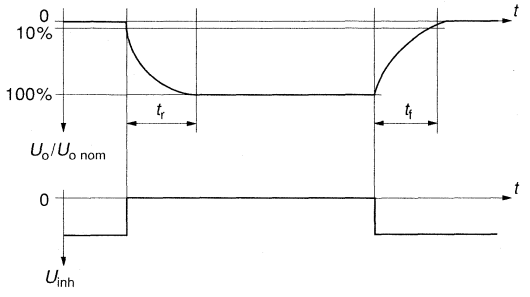



*Fig. 5*
*Output response as a function of inhibit signal*

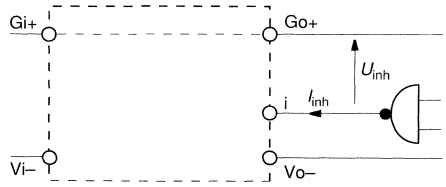



*Fig. 4*
*Definition of $I_{inh}$ and $U_{inh}$*

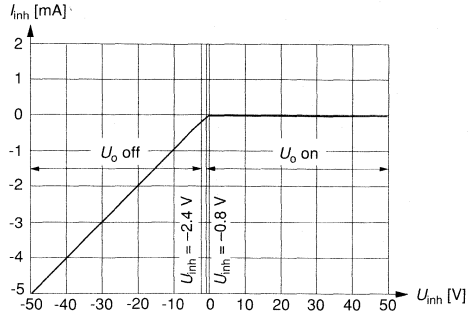



*Fig. 6*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 6: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –0.8 | | +50 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | –50 | | –2.4 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |

**Option R** Output voltage adjustment

**Note:** with an open R-pin, $U_o$ = 1.08 $U_{o\,nom}$!
The output voltage $U_o$ can be adjusted either with an external resistance $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0.65...1.08 of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in relevant tables must be maintained. Options R and P cannot be supported simultaneously.

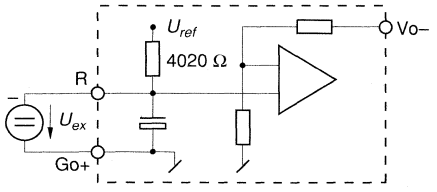



*Fig. 7*
*Voltage adjustment with $U_{ex}$ [V]*

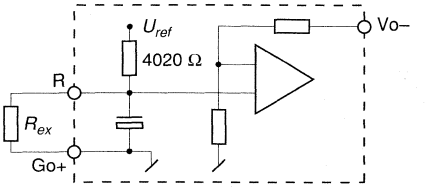



*Fig. 8*
*Voltage adjustment with $R_{ex}$ [Ω]*

$$U_o \approx 1.08 \cdot U_{ex} \cdot \frac{U_{o\,nom}}{U_{ref}} \qquad (U_{ref} = -2.49\ V \pm 4\%)$$

**Caution:** To prevent damage $U_{ex}$ should not exceed $U_{ref}$ nor be positive!

$$U_o \approx 1.08 \cdot U_{o\,nom} \cdot \frac{R_{ex}}{R_{ex} + 4020}$$

$$R_{ex} \approx 4020 \cdot \frac{U_o}{1.08 \cdot U_{o\,nom} - U_o}$$

All formulae give approximate values only.


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**Option -9** Extended Temperature Range

The operational ambient temperature range is extended to $T_A = -40...71\,°C$.

---

**Option L** Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi– and Gi+ has, with an input line inductance of 5 µH a maximum magnitude of 4 $mV_{rms}$. A reduction can be achived by insertion of a capacitor across the input (e.g. plastic foil capacitor).

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave.

With option L, the maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$$u_{i\,max} = 12\ V_{pp} \text{ at } 100\ Hz,$$

$$u_{i\,max} = \frac{1200\ Hz}{f} \cdot 1\ V_{pp} \text{ (at any frequency } f)$$

The rectifier circuit as described in "Application Notes" fulfils the above requirements.

---

**Option P** Potentiometer

Option P excludes R option. The output voltage $U_o$ can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{io\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

---

**Option C** Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage $U_o$. When the trigger voltage $U_{oc}$ is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excess current.

**Note:** As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$.

Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

*Table 7: Crowbar trigger levels*

| Characteristics | | Conditions | 5 V min | 5 V max | Unit |
|---|---|---|---|---|---|
| $U_{o\,c}$ | Trigger voltage | $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$ | 5.8 | 6.8 | V |
| $t_s$ | Delay time | | | 1.5 | µs |

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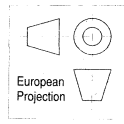
**Option U** Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the NSR-family as recognized components up to an ambient temperature of $T_{A\,max} - 25$ K, given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max} = 71\,°C$ without any further precautions.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.



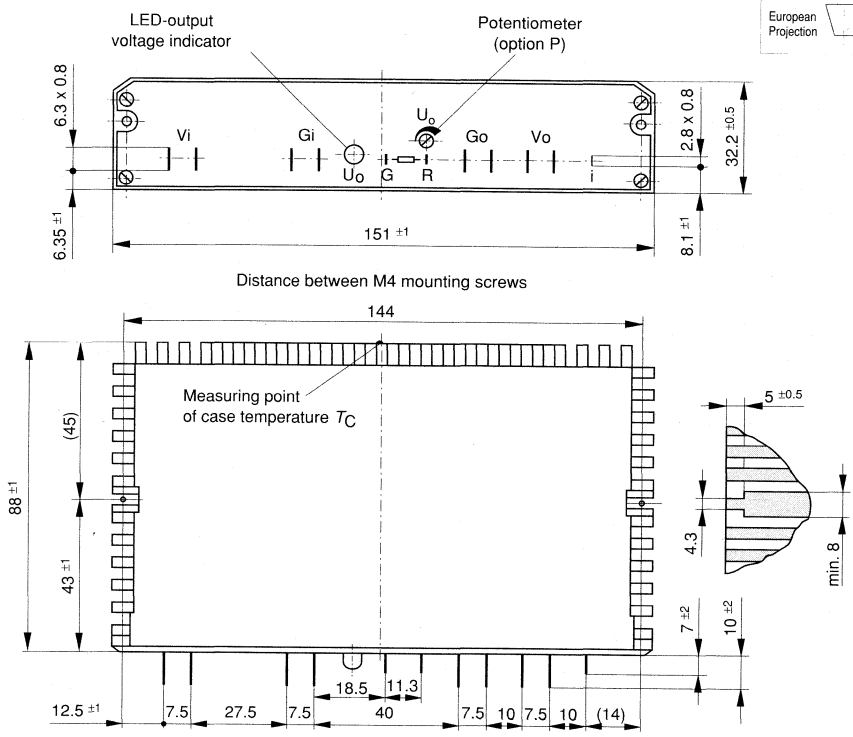
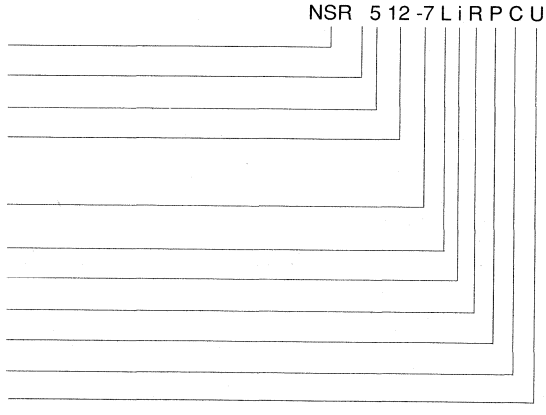




*Fig. 9*
*Case C03 (weight 440 g)*

## Type Key and Product Marking

### Type Key




Negative switching regulator in case C03 ..... NSR
Blank .....
Nominal output voltage in volt ..... –5
Nominal output current in ampere ..... 12
Ambient temperature range
$T_A$ = –25...71°C ..... -7
$T_A$ = –40...71°C ..... -9
Input filter ..... L
Inhibit input ..... i
External output voltage adjustment ..... R
Potentiometer ..... P
Thyristor-Crowbar ..... C
UL recognized component for $T_{A\,max}$ = 71°C ..... U

Example: NSR 512-7iP = A negative switching regulator with a –5 V, 12 A output, ambient temperature range of –25...71°C, inhibit input and potentiometer.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometer and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.


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# PSR: Positive Switching Regulators

# PSC-Family

**No input to output isolation**
**Single output of 5.1 V DC/55 W**
**Input voltage up to 40 V DC**

- High efficiency up to 79%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




4.3

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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Option package |
|---|---|---|---|---|---|---|
| 5.1 V | 11 A | 8...40 V | 20 V | 79% | PSC 5A11-2 | iR |

## Description

The PSC family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 40 V are specially designed for secondary switched and battery driven applications.
Case C03: Aluminium and self cooling.

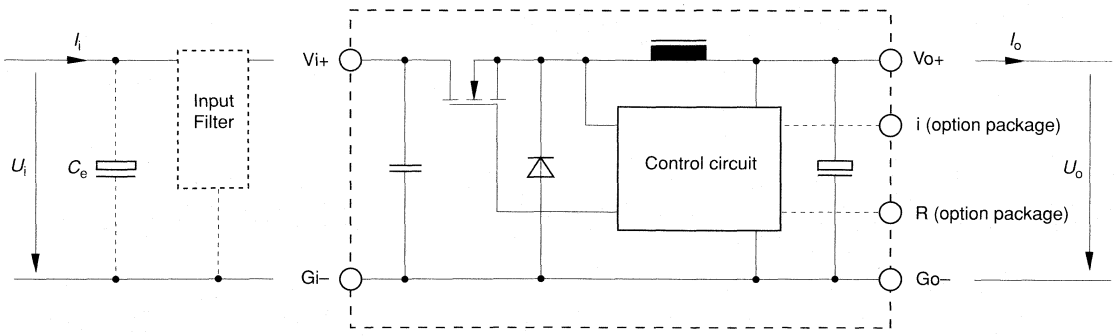



*Fig. 1*
*Block Diagram*



**External input circuitry**

An external input filter (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 5 m.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 in each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 in each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s² (60...150 Hz)<br>3.75 h (1.25 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 2: | 4 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 1: | 0.5 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperature specifications*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | (Not operational) | –25 | 100 | |

*Table 4: MTBF*

| MTBF | Ground Benign |
|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40°C |
| | 484'000 h |


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## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With option package iR, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 5: Input and output data*

| Characteristics | | Conditions | PSC 5A11 min | typ | max | Unit |
|---|---|---|---|---|---|---|
| **Output** | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.05 | | 5.15 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 11.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 11.0 | | 14.3 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | | 100 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | | 100 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | | 100 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 150 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 50 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±1 | mV/K |
| | | | | | ±0.02 | %/K |
| **Input** | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 8 | | 40 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | | | 3 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | |
| $I_{i\,0}$ | No load Input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | 40 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [2] | $U_{i\,nom}$ | | 250 | | A |
| $t_{i\,s}$ | Rise time [2] | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [2] | | | 40 | | |
| $u_{i\,rfi}$ | RFI level at input, [3] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A | dB (µV) |
| **Efficiency** | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 79 | | % |
| **Isolation** | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | V DC |

[1] See "Dynamic Characteristics".
[2] Definitions according to VDE 0433, part 3.
[3] Additional external input filter or capacitor necessary.

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

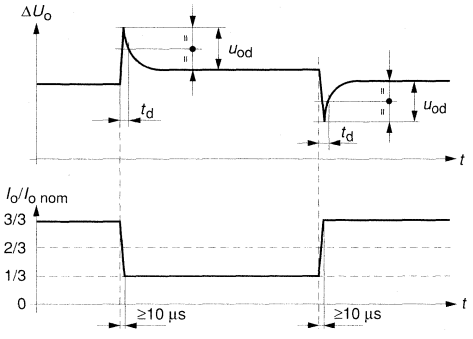



*Fig. 2*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 50 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 80 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 50 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 80 °C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages which are below the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

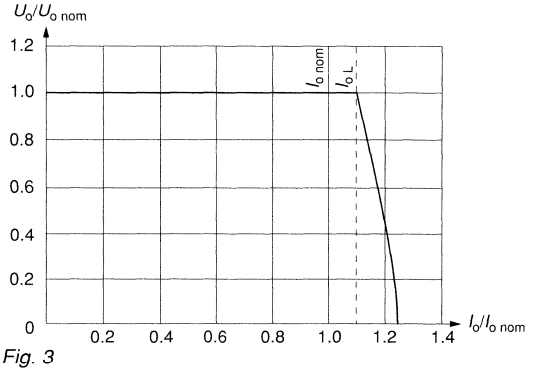



*Fig. 3*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Recognition

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90 ($T_{A\,max}$ reduced to 45 °C).

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20.

## Description of Option Package

With this family, the options i (inhibit) and R (output voltage adjustment) are defined as a package. Other combinations or parts of this package are not available.

**Option i** Inhibit

**Note:** With open i-input, output is enabled ($U_o$ = on).

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, CMOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

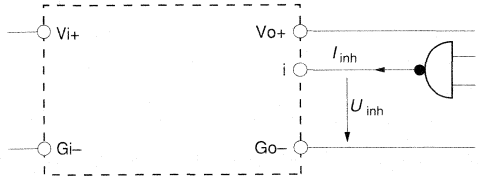



*Fig. 4*
*Definition of $I_{inh}$ and $U_{inh}$*

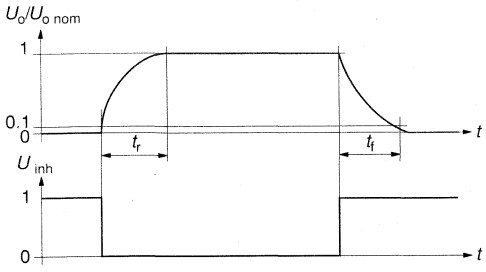



*Fig. 5*
*Output response as a function of inhibit signal*

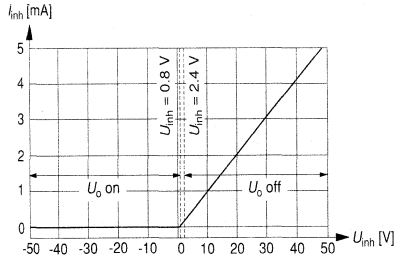



*Fig. 6*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 6: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage to keep | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | +0.8 | V DC |
| | regulator output voltage... | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_i = U_{i\,nom}$ | | 5 | | ms |
| $t_f$ | Switch-off time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ | | 10 | | |
| $I_{i\,off}$ | Input current when inhibited | | $I_o$ = 0, $U_i = U_{i\,nom}$ | | 10 | | mA |

**Option R** External Output voltage adjustment

**Note:** With an open R-pin, $U_o = U_{o\,nom}$!
The output voltage $U_o$ can be adjusted either with an external resistance $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0...1.00 of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in relevant tables must be maintained.

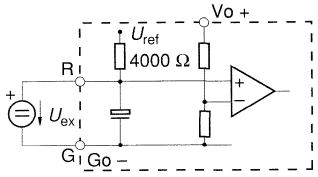



*Fig. 7*
*Voltage adjustment with $U_{ex}$*

**Voltage adjustment with $U_{ex}$** ($U_{ref}$ = 2.5 V ±4%)

$$U_o \approx U_{ex} \cdot \frac{U_{o\,nom}}{U_{ref}} \text{ [V]}$$

**Caution:** $U_{ex}$ must neither exceed 1.1 • $U_{ref}$ nor be negative, or failure will occure!

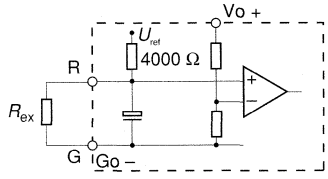



*Fig. 8*
*Voltage adjustment with $R_{ex}$*

**Voltage adjustment with $R_{ex}$**

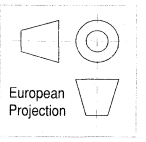
$$U_o \approx U_{o\,nom} \cdot \frac{R_{ex}}{R_{ex} + 4000} \text{ [V]}$$

$$R_{ex} \approx 4000 \cdot \frac{U_o}{U_{o\,nom} - U_o} \text{ [}\Omega\text{]}$$

All formulae give approximate values only.

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.



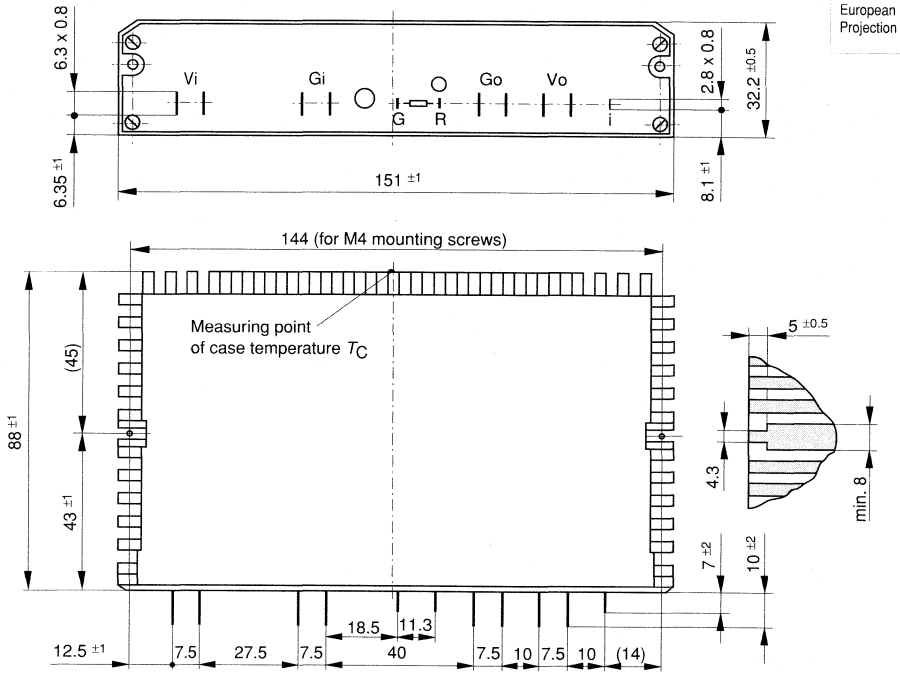




*Fig. 9*
*Case C03 (weight 440 g)*

## Type Key and Product Marking

### Type Key

PSC 5A 11 -2 iR

Positive switching regulator in case C03 ..... PSC
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1
Nominal output current in ampere ..... 11
Ambient temperature range
$T_A$ = 0...50°C ..... -2
Option package:
– Inhibit input ..... i
– External output voltage adjustment ..... R

Example: PSC 5A11-2iR = A positive switching regulator with a 5.1 V, 11 A output, ambient temperature range of 0...50°C, with option package inhibit input and external output voltage adjustment.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation and degree of protection.

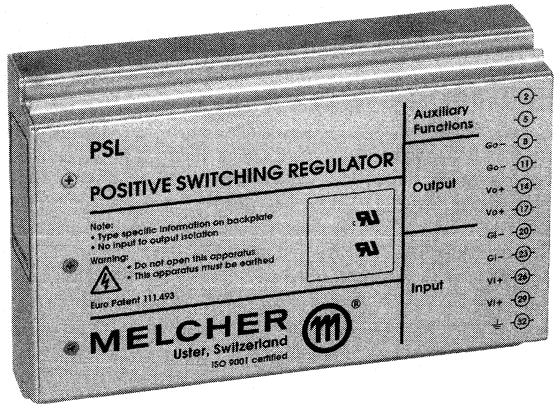
Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.

# PSR: Positive Switching Regulators

# PSL-Family

**No input to output isolation**
**Single output of 5.1 V DC/55 W**
**Input voltage up to 40 V DC**

- High efficiency up to 79%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950




## Table of Contents


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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\ nom}$ | Nominal output current $I_{o\ nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\ nom}$ | Efficiency $\eta$ | Type designation |
|---|---|---|---|---|---|
| 5.1 V | 11 A | 8...40 V | 20 V | 79% | PSL 5A11-2R |

## Description

The PSL family of positive swiching regulators are designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 40 V are specially designed for secondary switched and battery driven applications.
Case L04: Aluminium and self cooling.

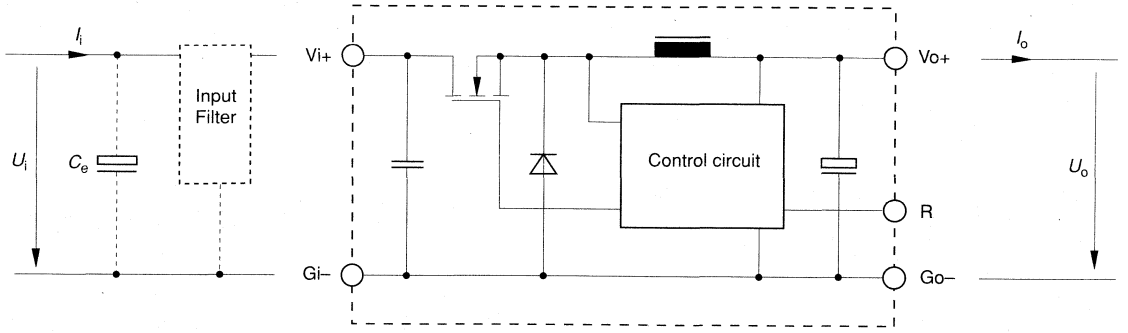



*Fig. 1*
*Block Diagram*



**External input circuitry**

An external input filter (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 5 m.

## Standard Features

**R External Output voltage adjustment**

**Note:** With an open R-pin, $U_o = U_{o\,nom}$!

The output voltage $U_o$ can be adjusted either with an external resistance $R_{ex}$ or an external reference voltage $U_{ex}$. The adjustment range is 0...1.00 of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in relevant tables must be maintained.

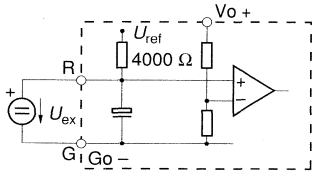



*Fig. 7*
*Voltage adjustment with $U_{ex}$*

**Voltage adjustment with $U_{ex}$** ($U_{ref}$ = 2.5 V ±4%)

$$U_o \approx U_{ex} \cdot \frac{U_{o\,nom}}{U_{ref}} \quad [V]$$

**Caution:** To prevent damage $U_{ex}$ should not exceed $U_{ref}$, nor be negative.

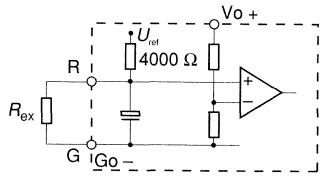



*Fig. 8*
*Voltage adjustment with $R_{ex}$*

**Voltage adjustment with $R_{ex}$**

$$U_o \approx U_{o\,nom} \cdot \frac{R_{ex}}{R_{ex} + 4000} \quad [V]$$

$$R_{ex} \approx 4000 \cdot \frac{U_o}{U_{o\,nom} - U_o} \quad [\Omega]$$

All formulae give approximate values only.



MELCHER ISO 9001 certified

## Electrical Input and Output Data

General Conditions
- $T_A$ = +25°C, unless $T_C$ is specified.
- With R, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSL 5A11 min | typ | max | Unit |
|---|---|---|---|---|---|---|
| **Output** | | | | | | |
| $U_{o\,nom}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.05 | | 5.15 | V |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | | 11.0 | | A |
| $I_{oL}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | 11.0 | | 14.3 | |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,nom}$ $I_{o\,nom}$ | | | 100 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | | 100 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | | 100 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_{o\,nom}$↔1/3 $I_{o\,nom}$ | | 150 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 50 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | | ±1 | mV/K |
| | | | | | ±0.02 | %/K |
| **Input** | | | | | | |
| $U_i$ | Input voltage | $I_o$ = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 8 | | 40 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i$ - $U_o$ | | | 3 | | V |
| $U_{i\,o}$ | Undervoltage cut-out | | | 7.3 | | |
| $I_{i\,0}$ | No load Input current | $I_o$ = 0 $U_{i\,min}$...$U_{i\,max}$ | | 40 | | mA |
| $I_{i\,m}$ | Peak value of inrush current [2] | $U_{i\,nom}$ | | 250 | | A |
| $t_{i\,s}$ | Rise time [2] | | | 5 | | µs |
| $t_{i\,r}$ | Tail half value time [2] | | | 40 | | |
| $u_{i\,rfi}$ | RFI level at input, [3] 0.01...30 MHz | VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$ | | | A | dB (µV) |
| **Efficiency** | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 79 | | % |
| **Isolation** | | | | | | |
| $U_{is}$ | Isolation test voltage electronics to case | Inputs/outputs interconnected | | 500 | | V DC |

[1] See "Dynamic Characteristics".
[2] Definitions according to VDE 0433, part 3.
[3] Additional external input filter or capacitor necessary.

## Immunity to Environmental Conditions

*Table 2: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 in each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 in each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s² (60...150 Hz)<br>3.75 h (1.25 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 2: | 4 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 1: | 0.5 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 3: Temperature specifications*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | (Not operational) | –25 | 100 | |

*Table 4: MTBF*

| MTBF | Ground Benign |
|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40°C |
| | 484'000 h |

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 32 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H11 (according to DIN 41612) to ensure requested safety!

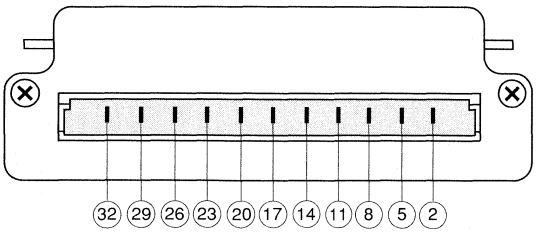



*Fig. 4*
*View of male H11 connector*

*Table 5: H11 connector pin allocation and designation*

| Electrical Determination | Type H11 Pin No. | Design. |
|---|---|---|
| R-input | 2 | R |
| Not connected | 5 | - |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 11 | Go– |
| Output voltage(positive) | 14 | Vo+ |
| Output voltage (positive) | 17 | Vo+ |
| Input voltage (negative) | 20 | Gi– |
| Input voltage (negative) | 23 | Gi– |
| Input voltage (positive) | 26 | Vi+ |
| Input voltage (positive) | 29 | Vi+ |
| Protective ground (protruding pin) | 32 | ⏚ |

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

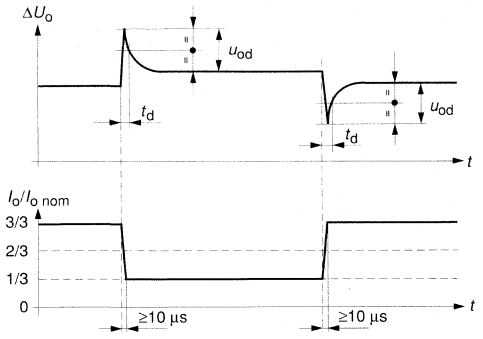



*Fig. 5*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 50°C and is operated at its nominal output power, the case temperature $T_C$ will be about 80°C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 50°C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 80°C.

### Safety

For safety reasons in all installations the modules are to be connected properly in order to ensure compliance to national and international safety requirements. The modules accept input voltages which are below the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage to the isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

### Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

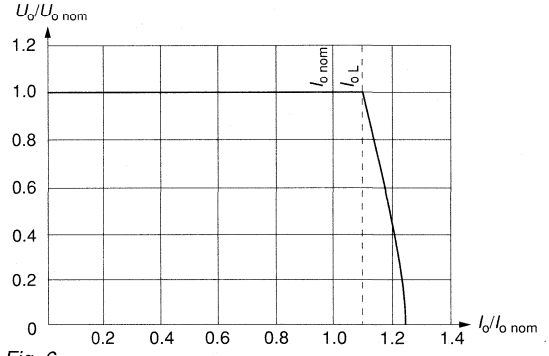



*Fig. 6*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Recognition

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 20. It applies only if the female H11 connector is properly attached to the module.

## Mechanical Data

Dimensions are in mm. Tolerances are ±0.3 mm unless otherwise specified.

European Projection

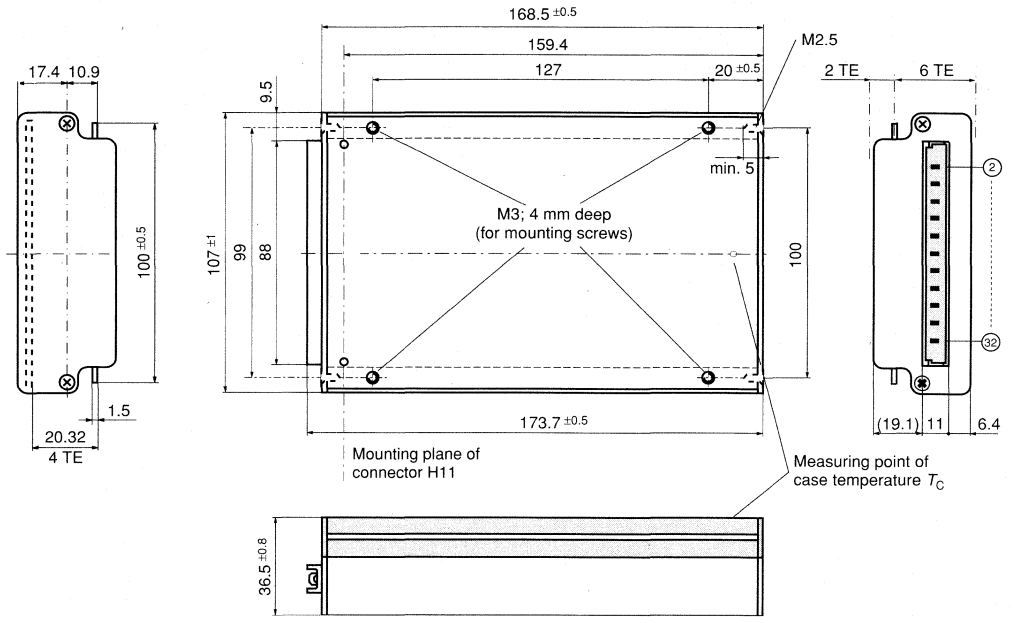
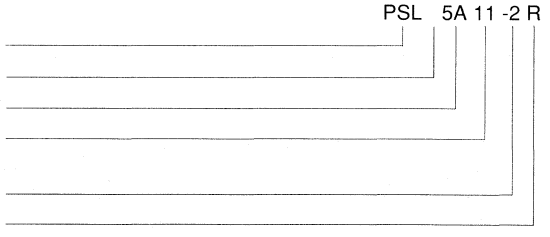



*Fig. 7*
*Case L04 (weight 550 g)*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case L04 ..... PSL
Blank .....
Nominal output voltage in volt ..... 5.1
Nominal output current in ampere ..... 11
Ambient temperature range
$T_A$ = 0...50 °C ..... -2
External output voltage adjustment ..... R

Example: PSL 5A11-2R = A positive switching regulator with a 5.1 V, 11 A output, ambient temperature range of 0...50 °C and external output voltage adjustment.

### Produkt Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

Back plate: Specific type designation, input voltage range, nominal output voltage and current, pin allocation of auxiliary function and degree of protection.

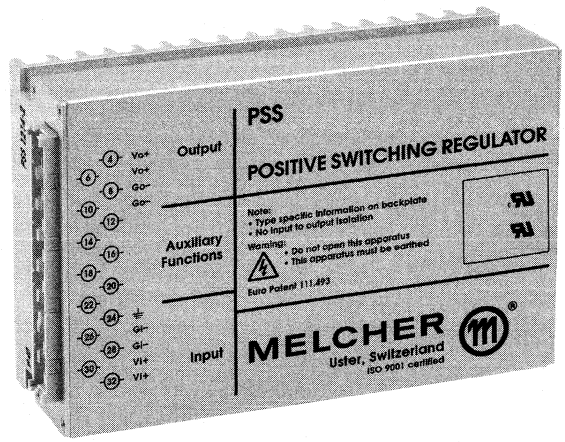
Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and production date.

# Positive Switching Regulators

# PSS-Family

**No input to output isolation**
**Single output of 5.1, 12, 15[1] or 24 V DC/70...336 W**
**Input voltage up to 60 V DC**

- Wide input voltage range
- High efficiency up to 94%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no load and short circuit proof
- Output current sharing
- No derating
- Safety according to IEC 950




4.3

## Table of Contents


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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Option |
|---|---|---|---|---|---|---|
| 5.1 V | 14 A | 8...40 V | 20 V | 80% | PSS 5A14-2 | B, B1 |
| 12 V[1] | | 16...40 V | 30 V | 90% | PSS 1214-2 | |
| 24 V | | 29...60 V | 40 V | 94% | PSS 2414-2 | |

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")

## Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. This allows operation in the majority of battery driven or secondary switched applications. The basic type of regulators incorporates various standard features to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case S01: Aluminium, fully enclosed. The basic model with heat sink is self cooling.

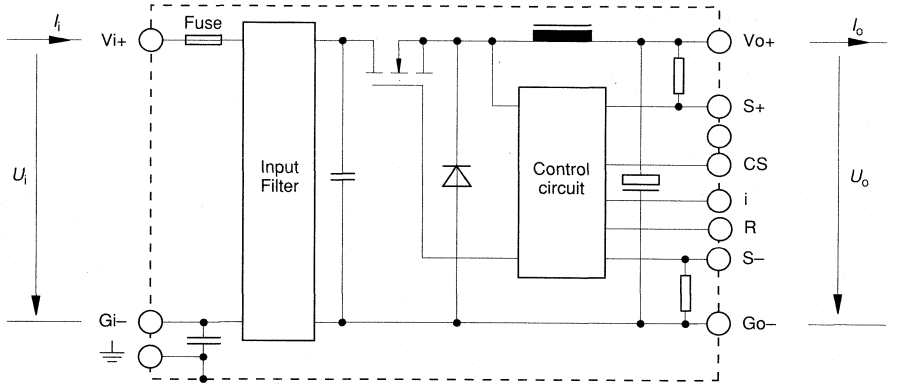



*Fig. 1*
*Block diagram*



## Standard Features

**Note:**
Additional information on input circuitry, grounding and parallel operation of units is given in section "Application Note"

**Inhibit (i)**

If the inhibit pin is not connected, the power supply is enabled ($U_o$ = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

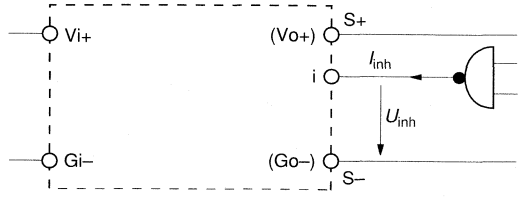



*Fig. 2*
*Definition of inhibit voltage and current*

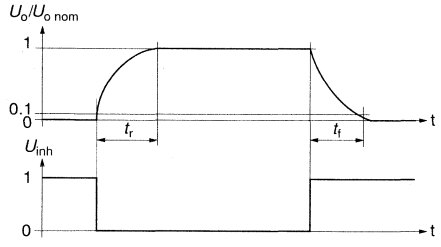



*Fig. 3*
*Output response as a function of inhibit signal*

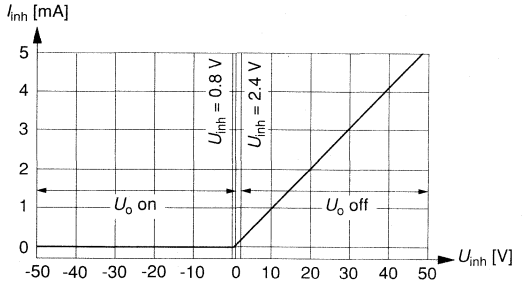



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 2: Inhibit charakteristics*

| Characteristic | | | Conditions | PSS 5A14 | | | PSS 1214 | | | PSS 2414 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{inh}$ | Inhibit input voltage to keep output voltage... | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | V DC |
| | | $U_o$ = off | | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,max}$ | | 100 | | | 100 | | | 100 | | ms |
| $t_f$ | Switch-off time after inhibit command | | (resistive load) | | 10 | | | 15 | | | 20 | | |
| $I_{i\,off}$ | Input current with converter inhibited | | $I_o = 0$ $U_{i\,nom}$ | | 25 | | | 25 | | | 25 | | mA |


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### Input Filter and Fuse

An input filter and a fuse are incorporated in all PSS modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

The maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$u_{i\,max}$ = 10 $V_{pp}$ at 100 Hz, or $V_{pp}$ = 1000 Hz/$f_i$ • 1 V

**Note:** Inrush current can reach very high values depending on the source and input line conditions. The inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. This input presents a very low impedance to such currents and when driven from a low impedance source, e.g. a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. To protect series elements such as switches or circuit brakers and rectifiers the use of additional external current limitation device is recommended.

### Current Sharing (CS)

**Note:** Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage ($U_i$) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

### Sense Lines (S)

**Note:** Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSS connector) should not exceed the following values:

| Output voltage | Total voltage difference between both sense lines and their respective output | Voltage difference between Go– and S– |
|---|---|---|
| 5.1 V | <0.5 V | <0.25 V |
| 12 , 24 V | <1.0 V | <0.25 V |

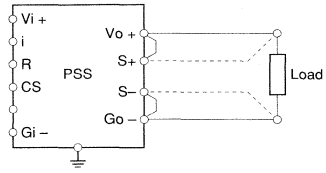



*Fig. 5*
*Sense lines connection*

### External Voltage Adjustment (R)

**Note:** With open R input, $U_o = U_{o\,nom}$.

The output voltage $U_o$ can either be adjusted with an external resistor $R_1$ or $R_2$, or with an external voltage $U_{ex}$ referenced to S–. The adjustment range is 0...$U_{o\,max}$ depending on the nominal output voltage (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor ($R_1$ resp. $R_2$).

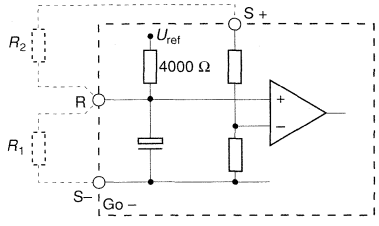



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$*

a) $U_o$ = 0...$U_{o\,nom}$, using $R_1$ [Ω] between R and S–:

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

b) $U_o = U_{o\,nom}$...$U_{o\,max}$, using $R_2$ [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1\text{-}k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

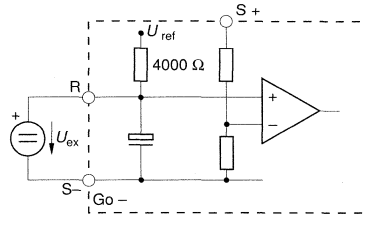



*Fig. 7*
*Voltage adjustment with external voltage $U_{ex}$ [V]*

c) $U_o$ = 0...$U_{o\,max}$, using $U_{ex}$ [V] between R and S–:

$$U_o \approx U_{o\,nom} \cdot [\frac{U_{ex}}{U_{ref}} \cdot 0.98 + 0.02]$$

($U_{ref}$ = 2.48 V ±1%)

All formulae give approximate values only.

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V nor be negative!

## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s$^2$<br>11 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s$^2$<br>16 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL810D sec.514.3 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s$^2$ (60...150 Hz)<br>3.75 h (1.25 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 2: | 4 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 1: | 0.5 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 4: Temperture specifications*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | (Not operational) | –25 | 100 | |

*Table 5: MTBF values*

| MTBF | Ground Benign |
|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40°C |
| | 335'000 h |

## Electrical Input and Output Data

General Conditions
- $T_A$ = 25°C, unless $T_C$ is specified
- With R, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSS 5A14 | | | PSS 1214 | | | PSS 2414 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.05 | | 5.15 | 11.60 | | 12.40 | 23.30 | | 24.70 | V |
| $U_{o\,max}$ | Maximum adjustable output voltage utilizing R input | $U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector | | | 5.6 | | | 16.0 | | | 26.0 | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 14 | | | 14 | | | 14 | | A |
| $I_{o\,L}$ | Output current limitation response (% of $I_{o\,nom}$) | | 100 | | 125 | 100 | | 125 | 100 | | 125 | % |
| $u_o$ | Ripple at Output (BW = 20 MHz) | $U_{i\,nom}$, $I_{o\,nom}$ | | | 100 | | | 240 | | | 480 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | | 100 | | | 240 | | | 480 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | | 100 | | | 120 | | | 240 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_o = {}^2/_3\ I_{o\,nom}$ $\pm{}^1/_3\ I_{o\,nom}$ | | 150 | | | 360 | | | 700 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 40 | | | 60 | | | 60 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | ±1 | | | ±3 | | | ±5 | | mV/K |
| | | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage range | $T_{C\,min}$...$T_{C\,max}$ | 8 | | 40 | 16 | | 40 | 29 | | 60 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i - U_o$ | $I_o$ = 0...$I_{o\,nom}$ | | 3 | | | 4 | | | 5 | | |
| $U_{io}$ | Undervoltage cut-out | | | 6.5 | | | 7.3 | | | 12 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0 $U_{i\,nom}$ | | 36 | | | 36 | | | 36 | | mA |
| $u_{rfi}$ | RFI level at input, 0.01...30 MHz | VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$ | | | A | | | A | | | A | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 80 | | | 90 | | | 94 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{i\,s}$ | Isolation test voltage electronic to case | All input and output terminals interconnected | | 500 | | | 500 | | | 500 | | V DC |

[1] See "Dynamic Characteristics"

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

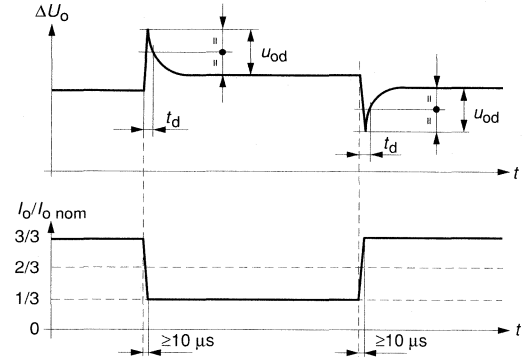



*Fig. 8*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 50 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 80 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 50 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 80 °C.

### Safety

For safety reasons in all installations the modules should only be wired via the female connector H15 (according to DIN 41612) in order to ensure compliance to national and international safety requirements. The modules accept input voltages up to 60 V DC which is at the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage of isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. Use the current sharing feature for even distribution of the output current (see "Standard Features": Current Sharing).

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

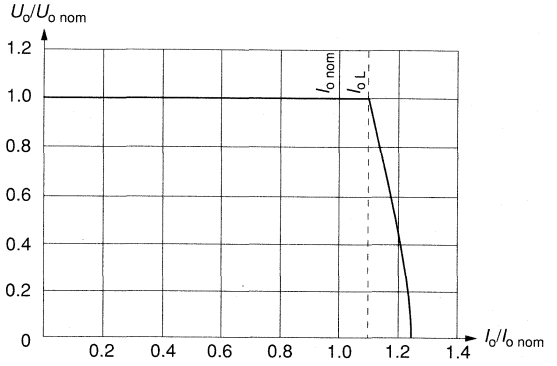



*Fig. 9*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30. The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

## Description of Options

**Option B, Option B1** Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output above $T_{C\,max}$. The output is automatically enabled again after temperature has droped below $T_{C\,max}$.

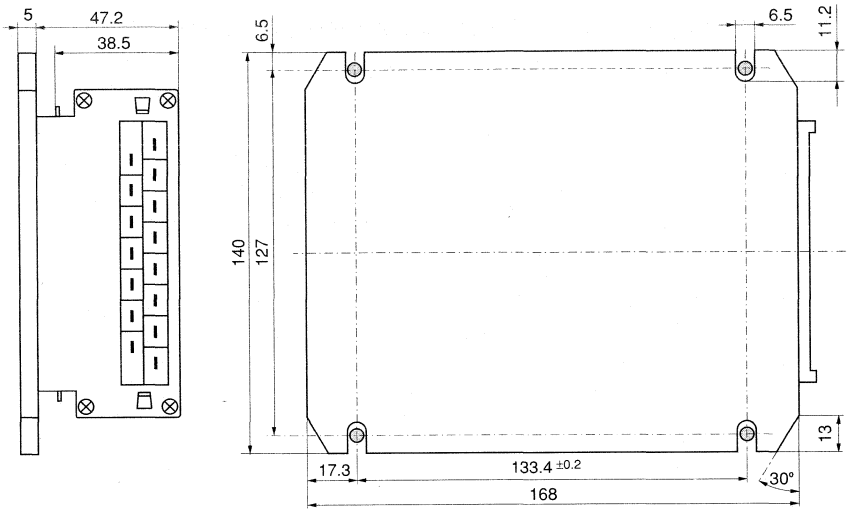



*Fig. 10*
*Case S01 with option B (cooling plate)*
*Weight: 1.1 kg*

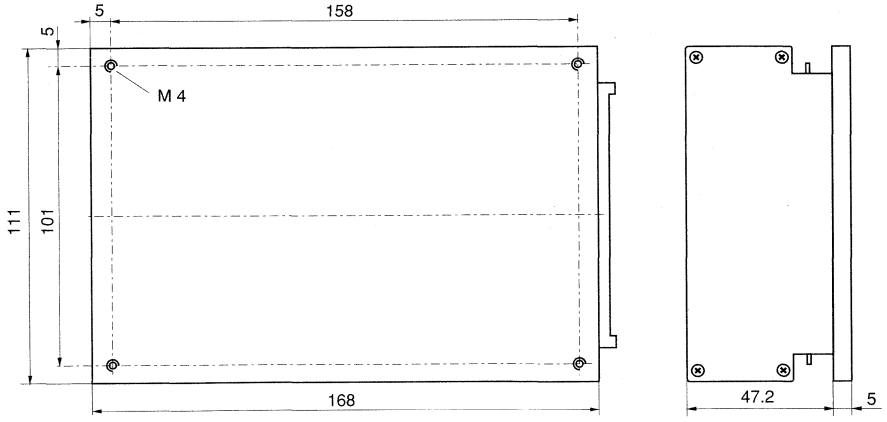



*Fig. 11*
*Case S01 with option B1 (cooling plate)*
*Weight: 1.1 kg*

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

European Projection

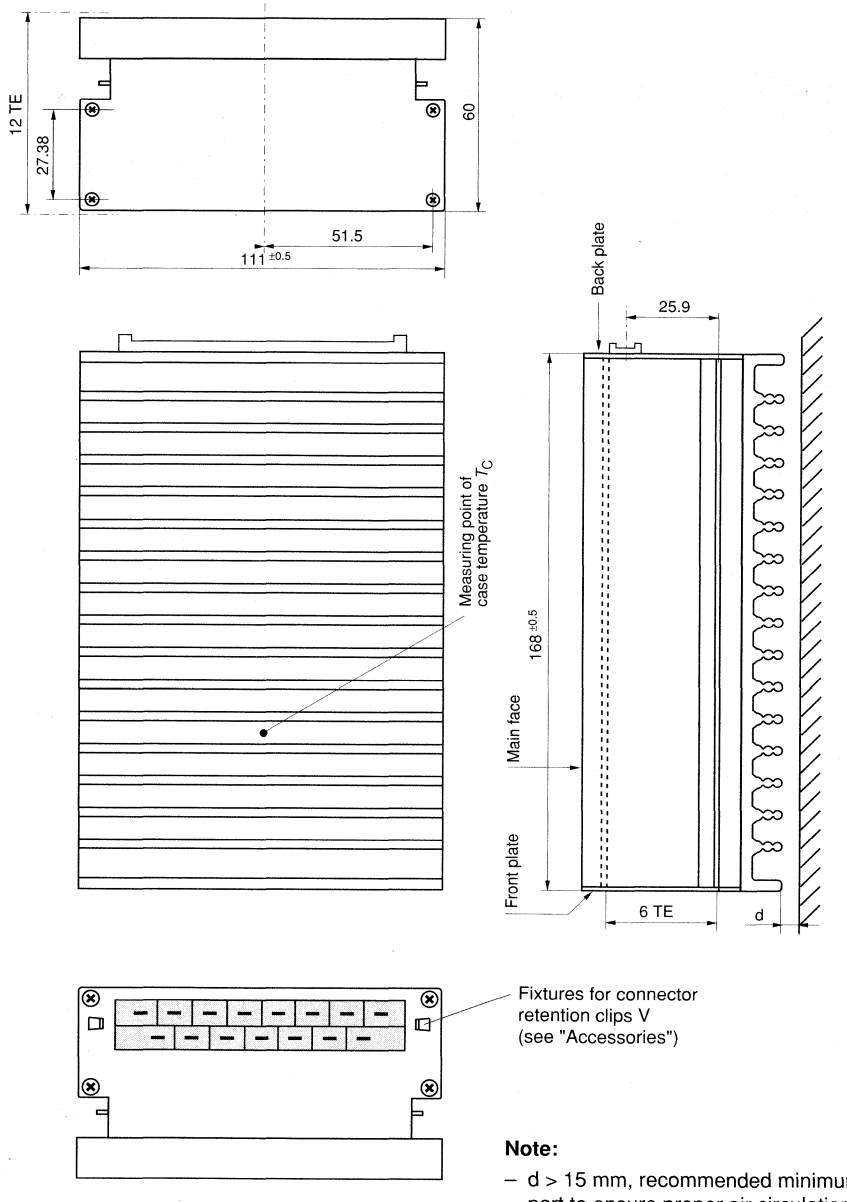



*Fig. 12*
*Case S01 with heatsink*
*Weight: 1.45 kg*

**Note:**

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow through heat sink



MELCHER ISO 9001 certified

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

*Table 7: H15 connector pin allocation*

| Electrical Determination | Type H15 | |
|---|---|---|
| | Pin No. | Ident. |
| Output voltage (positive) | 4 | Vo+ |
| Output voltage (positive) | 6 | Vo+ |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 10 | Go– |
| Not connected | 12 | n.c. |
| Inhibit input | 14 | i |
| R-input (output voltage programming) | 16 | R |
| Sense line (negative) | 18 | S– |
| Sense line (positive) | 20 | S+ |
| Current sharing control input | 22 | CS |
| Protective ground (protruding pin) | 24 | ⏚ |
| Input voltage (negative) | 26 | Gi– |
| Input voltage (negative) | 28 | Gi– |
| Input voltage (positive) | 30 | Vi+ |
| Input voltage (positive) | 32 | Vi+ |

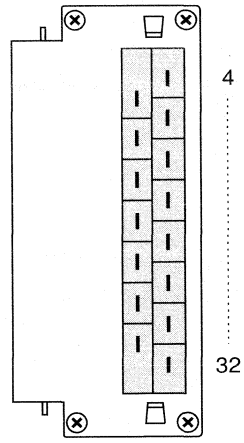
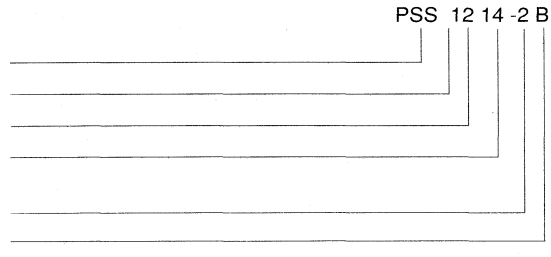



*Fig. 13*
*View of male H15 connector*

## Type Key and Product Marking

### Type Key




Positive switching regulator in case S01 ..... PSS
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1...24
Nominal output current in ampere ..... 14
Ambient temperature range
$T_A$ = 0...50°C ..... -2
Cooling plate ..... B, B1

Example: PSS 1214-2B = A positive switching regulator with a 12 V, 14 A output, ambient temperature range of 0...50°C and cooling plate B.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of auxiliary functions, fuse specification and degree of protection.

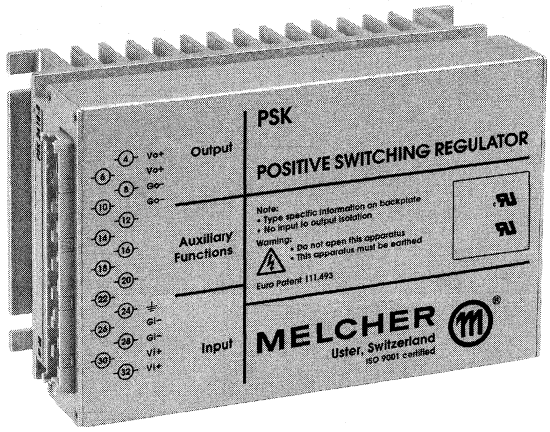
Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

# Positive Switching Regulators

# PSK-Family

**No input to output isolation**
**Single output of 5.1, 12, 15[1] or 24 V DC/90...432 W**
**Input voltage up to 60 V DC**

- Wide input voltage range
- High efficiency up to 94%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no load and short circuit proof
- Output current sharing
- No derating
- Safety according to IEC 950




4.3

## Table of Contents


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## Type Survey

*Table 1: Type survey*

| Nominal output voltage $U_{o\,nom}$ | Nominal output current $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Efficiency $\eta$ | Type designation | Option |
|---|---|---|---|---|---|---|
| 5.1 V | 18 A | 8...40 V | 20 V | 80% | PSK 5A18-2 | B, B1 |
| 12 V[1] | | 16...40 V | 30 V | 90% | PSK 1218-2 | |
| 24 V | | 29...60 V | 40 V | 94% | PSK 2418-2 | |

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")

## Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. This allows operation in the majority of battery driven or secondary switched applications. The basic type of regulators incorporates various standard features to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case K01: Aluminium, fully enclosed. The basic model with heat sink is self cooling.

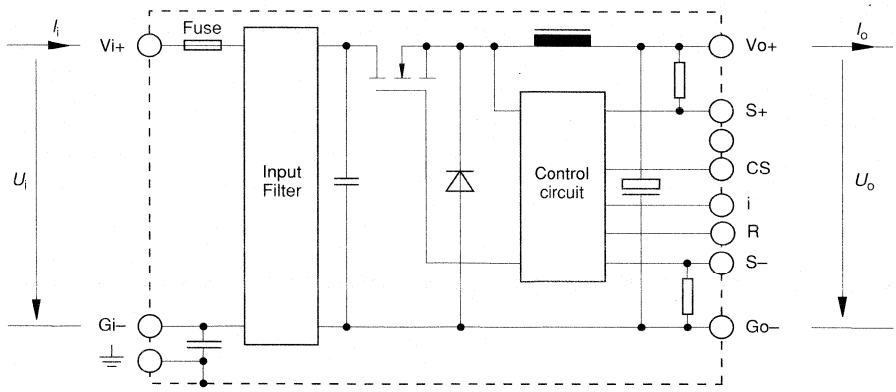



*Fig. 1*
*Block diagram*



## Standard Features

**Note:**
Additional information on input circuitry, grounding and parallel operation of units is given in section "Application Note"

**Inhibit (i)**

If the inhibit pin is not connected, the power supply is enabled ($U_o$ = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

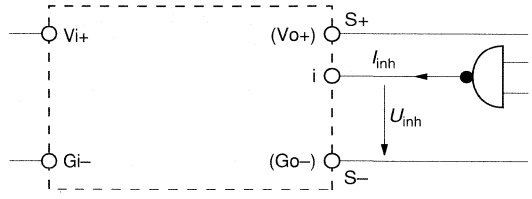



*Fig. 2*
*Definition of inhibit voltage and current*

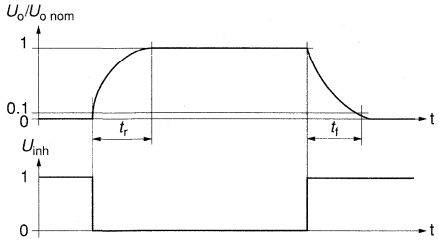



*Fig. 3*
*Output response as a function of inhibit signal*

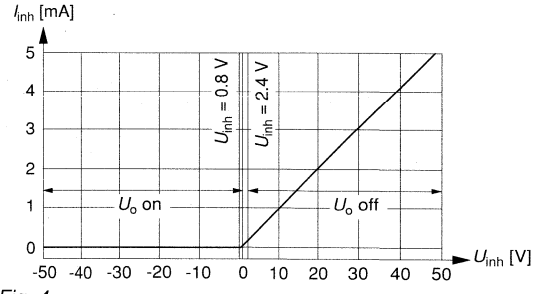



*Fig. 4*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 2: Inhibit charakteristics*

| Characteristic | | | Conditions | PSK 5A18 | | | PSK 1218 | | | PSK 2418 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{inh}$ | Inhibit input voltage to keep output voltage... | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | V DC |
| | | $U_o$ = off | | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | |
| $t_r$ | Switch-on time after inhibit command | | $U_{i\,nom}$, $R_L = U_{o\,nom}/I_{o\,max}$ | | 100 | | | 100 | | | 100 | | ms |
| $t_f$ | Switch-off time after inhibit command | | (resistive load) | | 10 | | | 15 | | | 20 | | |
| $I_{i\,off}$ | Input current with converter inhibited | | $I_o$ = 0, $U_{i\,nom}$ | | 25 | | | 25 | | | 25 | | mA |

### Input Filter and Fuse

An input filter and a fuse are incorporated in all PSK modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

The maximum permissible additionally superimposed ripple $u_i$ of the input voltage (rectifier mode) at a specified input frequency $f_i$ has the following values:

$u_{i\,max}$ = 10 $V_{pp}$ at 100 Hz, or $V_{pp}$ = 1000 Hz/$f_i$ • 1 V

**Note:** Inrush current can reach very high values depending on the source and input line conditions. The inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. This input presents a very low impedance to such currents and when driven from a low impedance source, e.g. a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. To protect series elements such as switches or circuit brakers and rectifiers the use of additional external current limitation device is recommended.

### Current Sharing (CS)

**Note:** Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage ($U_i$) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

### Sense Lines (S)

**Note:** Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSK connector) should not exceed the following values:

| Output voltage | Total voltage difference between both sense lines and their respective output | Voltage difference between Go– and S– |
|---|---|---|
| 5.1 V | <0.5 V | <0.25 V |
| 12 , 24 V | <1.0 V | <0.25 V |

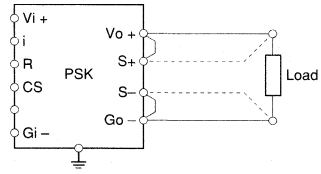



*Fig. 5*
*Sense lines connection*

### External Voltage Adjustment (R)

**Note:** With open R input, $U_o = U_{o\,nom}$.

The output voltage $U_o$ can either be adjusted with an external resistor $R_1$ or $R_2$, or with an external voltage $U_{ex}$ referenced to S–. The adjustment range is 0...$U_{o\,max}$ depending on the nominal output voltage (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor ($R_1$ resp. $R_2$).

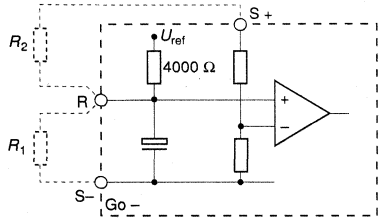



*Fig. 6*
*Voltage adjustment with external resistor $R_1$ or $R_2$*

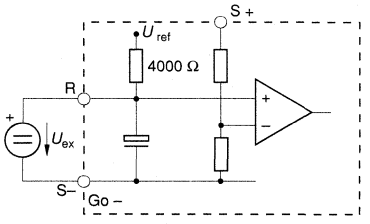



*Fig. 7*
*Voltage adjustment with external voltage $U_{ex}$ [V]*

a) $U_o$ = 0...$U_{o\,nom}$, using $R_1$ [Ω] between R and S–:

$$U_o \approx U_{o\,nom} \cdot \frac{R_1}{R_1 + 4000} \qquad R_1 \approx \frac{4000 \cdot U_o}{U_{o\,nom} - U_o}$$

b) $U_o = U_{o\,nom}$...$U_{o\,max}$, using $R_2$ [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

c) $U_o$ = 0...$U_{o\,max}$, using $U_{ex}$ [V] between R and S–:

$$U_o \approx U_{o\,nom} \cdot [\frac{U_{ex}}{U_{ref}} \cdot 0.98 + 0.02]$$

($U_{ref}$ = 2.48 V ±1%)

All formulae give approximate values only.

**Caution:** To prevent damage $U_{ex}$ should not exceed 20 V nor be negative!





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## Immunity to Environmental Conditions

*Table 3: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL810D sec.516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL810D sec.514.3 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s² (60...150 Hz)<br>3.75 h (1.25 h each axis) | Operating |
| Electrostatic discharge | | IEC 801-2 | Level 2: | 4 kV (contact, 1 ns, 330 Ω) | Operating [1] |
| Electric field susceptibility | | IEC 801-3 | Level 2: | 3 V/m (80 MHz...1 GHz) | Operating [1] |
| Electric fast transients | | IEC 801-4 | Level 1: | 0.5 kV (5/50 ns, 50 Ω) | Operating [1] |

[1] Temporary deviation from specifications possible

*Table 4: Temperture specifications*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | (Not operational) | –25 | 100 | |

*Table 5: MTBF values*

| MTBF | Ground Benign |
|---|---|
| MTBF acc. to MIL-HDBK-217F | $T_C$ = 40 °C |
| | 335'000 h |

## Characteristics and Definitions

### Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Dynamic Characteristics

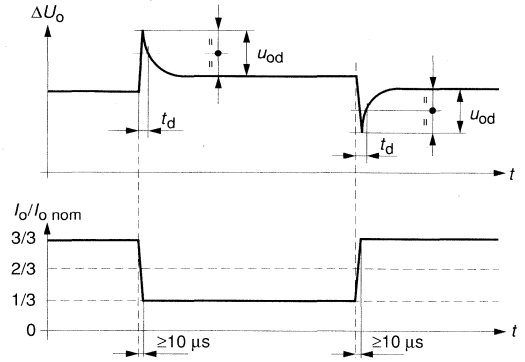



*Fig. 8*
*Behaviour and characteristics under varying load conditions.*

### Temperature

When a converter is located in free, quasi-stationary air at a temperature $T_A$ = 50 °C and is operated at its nominal output power, the case temperature $T_C$ will be about 80 °C after the warm-up phase, measured at the measuring point of case temperature $T_C$ (see "Mechanical Data").

Under practical operating conditions, the ambient temperature $T_A$ may exceed 50 °C, provided additional measures are taken to ensure that the case temperature $T_C$ does not exceed its maximum value of 80 °C.

### Safety

For safety reasons in all installations the modules should only be wired via the female connector H15 (according to DIN 41612) in order to ensure compliance to national and international safety requirements. The modules accept input voltages up to 60 V DC which is at the SELV limit of 60 V DC (Safety Extra Low Voltage)! Check for hazardous voltages before altering any connections. Do not open the module. Improper re-assembly may cause damage of isolation leading to electrical shock! The input and the output circuitry are not separated, i.e. the ground path is internally interconnected!

### Parallel and Series Connections

Outputs of equal nominal voltages can be parallel-connected. Use the current sharing feature for even distribution of the output current (see "Standard Features": Current Sharing).

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

### Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulators output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

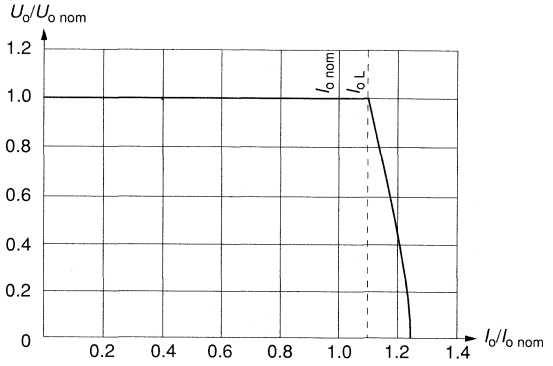



*Fig. 9*
*Overload, short-circuit behaviour $U_o$ versus $I_o$*

### Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

### Cleaning Agents

In order to avoid possible damage, any penetration of cleaning fluids is to be prevented, since the power supplies are not hermetically sealed.

### Protection Degree

The protection degree is defined by IP 30. The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

## Electrical Input and Output Data

General Conditions
- $T_A$ = 25°C, unless $T_C$ is specified
- With R, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 6: Input and output data*

| Characteristics | | Conditions | PSK 5A18 | | | PSK 1218 | | | PSK 2418 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.05 | | 5.15 | 11.60 | | 12.40 | 23.30 | | 24.70 | V |
| $U_{o\,max}$ | Maximum adjustable output voltage utilizing R input | $U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector | | | 5.6 | | | 16.0 | | | 26.0 | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 18 | | | 18 | | | 18 | | A |
| $I_{o\,L}$ | Output current limitation response (% of $I_{o\,nom}$) | | 100 | | 125 | 100 | | 125 | 100 | | 125 | % |
| $u_o$ | Ripple at Output (BW = 20 MHz) | $U_{i\,nom}$, $I_{o\,nom}$ | | | 100 | | | 240 | | | 480 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation versus input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | | 100 | | | 240 | | | 480 | mV |
| $\Delta U_{o\,I}$ | Static control deviation versus output current $I_o$ | $U_{i\,nom}$ $I_o$ = 0...$I_{o\,nom}$ | | | 100 | | | 120 | | | 240 | |
| $u_{o\,d}$ | Dynamic control deviation [1] | $U_{i\,nom}$ $I_o$ = $^2/_3$ $I_{o\,nom}$ $\pm^1/_3$ $I_{o\,nom}$ | | 150 | | | 360 | | | 700 | | |
| $t_d$ | Dynamic load transient time constant [1] | | | 40 | | | 60 | | | 60 | | µs |
| $\alpha_{Uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,nom}$ | | ±1 | | | ±3 | | | ±5 | | mV/K |
| | | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| **Input** | | | | | | | | | | | | |
| $U_i$ | Input voltage range | $T_{C\,min}$...$T_{C\,max}$ | 8 | | 40 | 16 | | 40 | 29 | | 60 | V DC |
| $\Delta U_{io\,min}$ | Minimum differential voltage $U_i - U_o$ | $I_o$ = 0...$I_{o\,nom}$ | | 3 | | | 4 | | | 5 | | |
| $U_{io}$ | Undervoltage cut-out | | | 6.5 | | | 7.3 | | | 12 | | |
| $I_{i\,o}$ | No load input current | $I_o$ = 0 $U_{i\,nom}$ | | 36 | | | 36 | | | 36 | | mA |
| $u_{rfi}$ | RFI level at input, 0.01...30 MHz | VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$ | | | A | | | A | | | A | dB (µV) |
| **Efficiency** | | | | | | | | | | | | |
| η | Efficiency | $U_{i\,nom}$, $I_{o\,nom}$ | | 80 | | | 90 | | | 94 | | % |
| **Isolation** | | | | | | | | | | | | |
| $U_{i\,s}$ | Isolation test voltage electronic to case | All input and output terminals interconnected | | 500 | | | 500 | | | 500 | | V DC |

[1] See "Dynamic Characteristics"

## Description of Options

**Option B, Option B1** Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output above $T_{C\,max}$. The output is automatically enabled again after temperature has droped below $T_{C\,max}$.



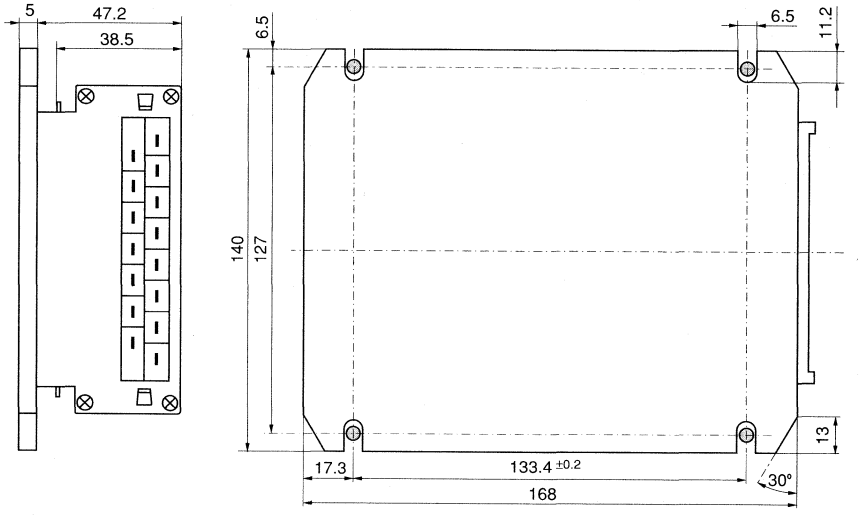



*Fig. 10*
*Case K01 with option B (cooling plate)*
*Weight: 1.1 kg*

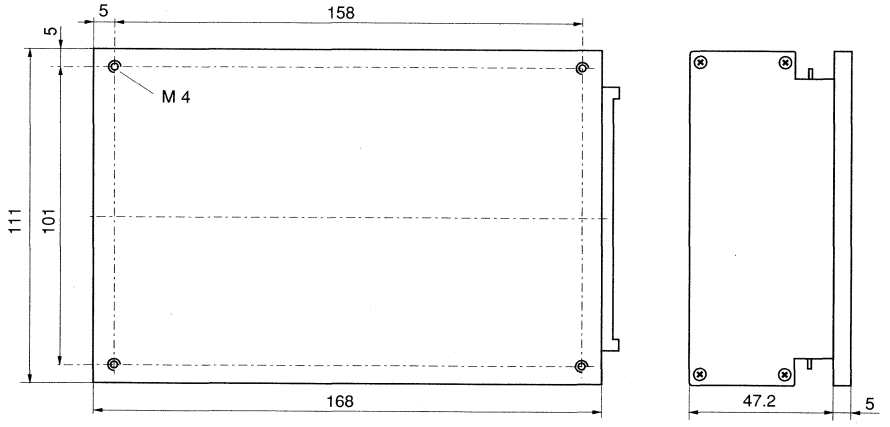


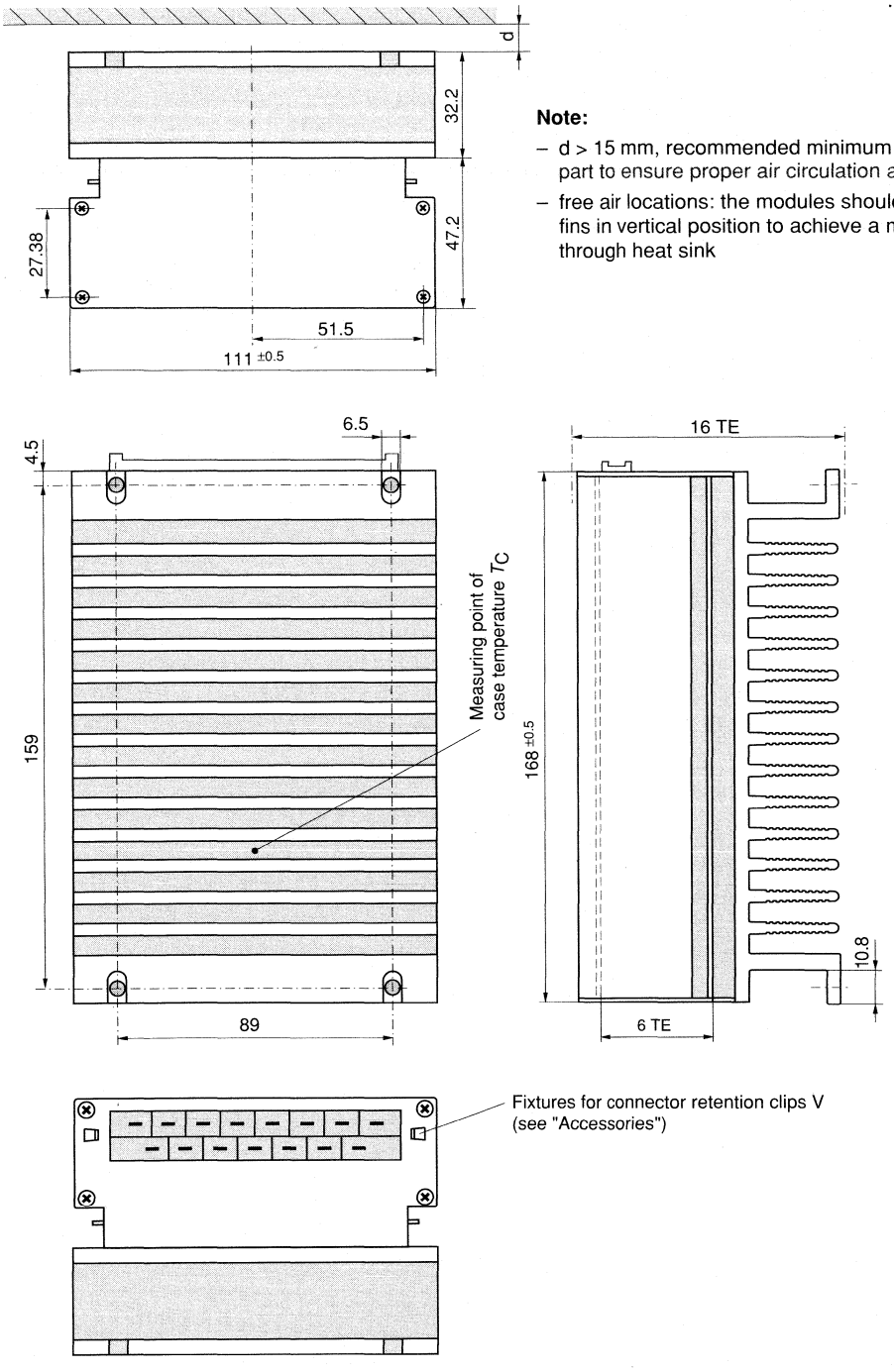

*Fig. 11*
*Case K01 with option B1 (cooling plate)*
*Weight: 1.1 kg*


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## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

European Projection




**Note:**

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow through heat sink

4.3

*Fig. 12*
*Case K01 with heatsink*
*Weight: 1.45 kg*

## Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

*Table 7: H15 connector pin allocation*

| Electrical Determination | Type H15 | |
|---|---|---|
| | Pin No. | Ident. |
| Output voltage (positive) | 4 | Vo+ |
| Output voltage (positive) | 6 | Vo+ |
| Output voltage (negative) | 8 | Go– |
| Output voltage (negative) | 10 | Go– |
| Not connected | 12 | n.c. |
| Inhibit input | 14 | i |
| R-input (output voltage programming) | 16 | R |
| Sense line (negative) | 18 | S– |
| Sense line (positive) | 20 | S+ |
| Current sharing control input | 22 | CS |
| Protective ground (protruding pin) | 24 | ⏚ |
| Input voltage (negative) | 26 | Gi– |
| Input voltage (negative) | 28 | Gi– |
| Input voltage (positive) | 30 | Vi+ |
| Input voltage (positive) | 32 | Vi+ |

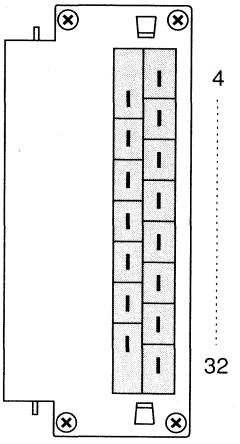



*Fig. 13*
*View of male H15 connector*

## Type Key and Product Marking

### Type Key

PSK 12 18 -2 B

Positive switching regulator in case K01 ..... PSK
Blank .....
Nominal output voltage in volt (5A –> 5.1) ..... 5.1...24
Nominal output current in ampere ..... 18
Ambient temperature range
$T_A$ = 0...50°C ..... -2
Cooling plate ..... B, B1

Example: PSK 1218-2B = A positive switching regulator with a 12 V, 18 A output, ambient temperature range of 0...50°C and cooling plate B.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of auxiliary functions, fuse specification and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

# 5 DC-DC Converters <30 W

## 5.1 Rugged Environment

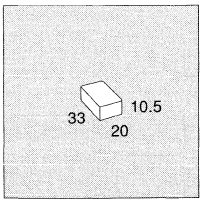
## 5.2 Industrial Environment

| Output [W] 1 2 3 10 20 30 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] 5 12 24 48 75 180 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | 1 Watt | DIL 24 | 5 - 3 |
| | | | 3 Watt | DIL 24 | 5 - 11 |
| | | | 6 Watt | 2"×2" | 5 - 25 |
| | | | 10 Watt | 2"×2" | 5 - 17 |
| | | | SR | C03 | 5 - 31 |

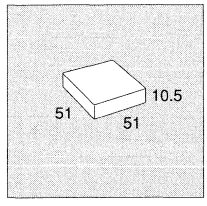
## 5.3 Benign Environment

| Output [W] 1 2 3 10 20 30 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] 5 12 24 48 75 180 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | IMR 3 | DIL 24 | 5 - 39 |
| | | | IMR 6 | DIL 24 | 5 - 43 |
| | | | IMR 15 | 2"×2" | 5 - 47 |

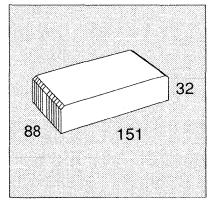
Case DIL 24




Case 2"×2"




Case C01

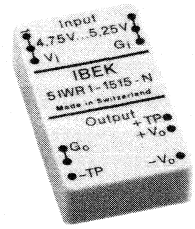


# IBEK DC-DC Converters

# 1 Watt-Family

**Input to output isolation test voltage up to 5 $kV_{rms}$**
**1 or 2 Outputs: ICR 1, IXR 1, IYR 1, IZR 1**
**1, 2 or 4 Outputs: IWR 1**

- Extremely high isolation test voltages
- Efficient Pi input filter
- Aluminium solid electrolytic capacitors (OS-CON)
- Outputs equipped with linear voltage regulators
- High reliability
- Optimal dynamic response
- Operating ambient temperature range up to –40...85°C (optional)
- Case height only 10.5 mm




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## Description

The DC-DC converters have been developed as a response to the increasing need for decentralised power supply systems. They are especially suitable for powering small loads on PCBs and for realising redundant systems. Five input to output isolation test voltage categories and three temperature ranges are available. The DC-DC converters feature low output ripple, low module height, high quality and reliability. To minimize feedback effects in the supply system, the modules are equipped with an efficient low-pass Pi input filter.

All modules are manufactured according to ISO 9001.

Case: DIL 24 package, grey colored plastic material, self cooling (free air convection).

## Type Survey

General Condition: $T_A$ = 25°C

*Table 1a: Type survey ICR 1 and IWR 1*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage [1] $U_i$ [V DC] | Group [2] | 700 V DC/500 $V_{rms}$ Isolation test voltage Type [1] | Group [2] | 1500 V DC/1060 $V_{rms}$ Isolation test voltage Type [1] | Option |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 200 | - | - | 5 (±5%) | 06 | .. ICR 1-05-N | 01 | .. IWR 1-05-N | T, S |
| 12 | 80 | - | - | or | | .. ICR 1-12-N | | .. IWR 1-12-N | |
| 15 | 66 | - | - | 12 (±10%) | | .. ICR 1-15-N | | .. IWR 1-15-N | |
| ±5 | ±50 | - | - | or | - | - | 02 | .. IWR 1-0505-N | |
| ±12 | ±40 | - | - | 15 (±10%) | 07 | .. ICR 1-1212-N [3 4] | | .. IWR 1-1212-N [3 4] | |
| ±15 | ±33 | - | - | or | | .. ICR 1-1515-N [3 4] | | .. IWR 1-1515-N [3 4] | |
| 5 | 100 | 5 | 100 | 24 (±10%) | - | - | 03 | .. IWR 1-05-05-N | |
| 5 | 100 | 12 | 40 | or | - | - | | .. IWR 1-05-12-N | |
| 5 | 100 | 15 | 33 | 28 (±10%) | - | - | | .. IWR 1-05-15-N | |
| 12 | 40 | 12 | 40 | or | 08 | .. ICR 1-12-12-N [3 4] | | .. IWR 1-12-12-N [3 4] | |
| 15 | 33 | 15 | 33 | 48 (±10%) [5] | | .. ICR 1-15-15-N [3 4] | | .. IWR 1-15-15-N [3 4] | |
| ±5 | ±50 | ±5 | ±50 | | - | - | 05 | .. IWR 1-2×0505-N | T |
| ±12 | ±20 | ±12 | ±20 | | - | - | | .. IWR 1-2×1212-N [3 4] | |
| ±15 | ±17 | ±15 | ±17 | | - | - | | .. IWR 1-2×1515-N [3 4] | |

*Table 1b: Type survey IXR 1 and IYR 1*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage [1] $U_i$ [V DC] | Group [2] | 3530 V DC/2500 $V_{rms}$ Isolation test voltage Type [1] | Group [2] | 5300 V DC/3750 $V_{rms}$ Isolation test voltage Type [1] | Option |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 200 | - | - | 5 (±5%) | 11 | .. IXR 1-05-N | 11 | .. IYR 1-05-N | T, S |
| 12 | 80 | - | - | or | | .. IXR 1-12-N | | .. IYR 1-12-N | |
| 15 | 66 | - | - | 12 (±10%) | | .. IXR 1-15-N | | .. IYR 1-15-N | |
| ±5 | ±50 | - | - | or | 12 | .. IXR 1-0505-N | | .. IIYR 1-0505-N | |
| ±12 | ±40 | - | - | 15 (±10%) | | .. IXR 1-1212-N [3 4] | 12 | .. IYR 1-1212-N [3 4] | |
| ±15 | ±33 | - | - | or | | .. IXR 1-1515-N [3 4] | | .. IYR 1-1515-N [3 4] | |
| 5 | 100 | 5 | 100 | 24 (±10%) | 13 | .. IXR 1-05-05-N | 13 | .. IYR 1-05-05-N | |
| 5 | 100 | 12 | 40 | or | | .. IXR 1-05-12-N | | .. IYR 1-05-12-N | |
| 5 | 100 | 15 | 33 | 28 (±10%) | | .. IXR 1-05-15-N | | .. IYR 1-05-15-N | |
| 12 | 40 | 12 | 40 | or | | .. IXR 1-12-12-N [3 4] | | .. IYR 1-12-12-N [3 4] | |
| 15 | 33 | 15 | 33 | 48 (±10%) [5] | | .. IXR 1-15-15-N [3 4] | | .. IYR 1-15-15-N [3 4] | |

*Table 1c: Type survey IZR 1*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage [1] $U_i$ [V DC] | Group [2] | Isolation test voltage 7070 V DC/5000 $V_{rms}$ Type [1] | Option |
|---|---|---|---|---|---|---|---|
| 5 | 200 | - | - | 5 (±5%) | 11 | .. IZR 1-05-N | T, S |
| 12 | 80 | - | - | or | | .. IZR 1-12-N | |
| 15 | 66 | - | - | 12 (±10%) | | .. IZR 1-15-N | |
| ±5 | ±50 | - | - | or | 12 | .. IIZR 1-0505-N | |
| ±12 | ±40 | - | - | 15 (±10%) | | .. IZR 1-1212-N [3 4] | |
| ±15 | ±33 | - | - | or | | .. IZR 1-1515-N [3 4] | |
| 5 | 100 | 5 | 100 | 24 (±10%) | 13 | .. IZR 1-05-05-N | |
| 5 | 100 | 12 | 40 | or | | .. IZR 1-05-12-N | |
| 5 | 100 | 15 | 33 | 28 (±10%) | | .. IZR 1-05-15-N | |
| 12 | 40 | 12 | 40 | or | | .. IZR 1-12-12-N [3 4] | |
| 15 | 33 | 15 | 33 | 48 (±10%) [5] | | .. IZR 1-15-15-N [3 4] | |

[1] The required input voltage value (e.g. 24 V) should be added to the type designation: .. ICR 1-1212-N changes to 24 ICR 1-1212-N

[2] See Block Diagrams

[3] The output current of one output may be increased by 25% if the output current of the other output is reduced by 25% simultaneously. Example for a 5 IWR 1-1515-N: The +15 V output current of 33 mA may be increased to 41 mA if the –15 V output current is reduced to 25 mA.

[4] The output current of both outputs of the 12, 24, 28 and 48 V input types may be increased by 20% of $I_{o\,nom}$. Note [3] is applicable at the same time. Example for a 24 IWR 1-2×1212-N: $I_{o1}$ = +29 mA/–19 mA, $I_{o2}$ = +19 mA/–29 mA or $I_{o1}$ = ±19 mA, $I_{o2}$ = ±29 mA

[5] Only standard temperature range N or option T available





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## Electrical Input and Output Data

General Conditions: $T_A$ = 25°C

*Table 2: Input Data*

| Input | | | | 5 V | 12 V | 15 V | 24 V | 28 V | 48 V | |
|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | | Conditions | | | | | | | Unit |
| $U_i$ | Input voltage range | min<br>nom<br>max | DC | 4.75<br>5<br>5.25 | 10.8<br>12<br>13.2 | 13.5<br>15<br>16.5 | 21.6<br>24<br>26.4 | 25.2<br>28<br>30.8 | 43.2<br>48<br>52.8 | V |
| $I_{i\,o}$ | No load input input current | typ<br>max | $U_{i\,nom}$, $I_o$ = 0 | 85<br>110 | 35<br>45 | 30<br>40 | 15<br>23 | 17<br>20 | 8<br>12 | mA |
| $u_{i\,rfi}$ | RFI voltage at the input | typ | $U_{i\,nom}$, $I_{o\,nom}$<br>$L_{source} \approx 1\ \mu H$ | 50 | 80 | 85 | 100 | 130 | 200 | $mV_{pp}$ |
| $i_{i\,rfi}$ | RFI current at the input | typ | | 10 | | | | | | $mA_{pp}$ |
| $U_{i\,abs}$ | Input voltage limits without any damage | min<br>max | max 60 s | 0<br>6.25 | 0<br>15 | 0<br>18.75 | 0<br>30 | 0<br>35 | 0<br>60 | V |
| $f_s$ | Switching frequency | typ | $U_{i\,nom}$, $I_{o\,nom}$ | 25 | | | | | | kHz |

*Table 3: Output Data*

| Output | | | | 5 V | | 12 V | | 15 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | | Conditions | | | | | | | Unit |
| $U_o$ | Output voltage | | $U_{i\,nom}$, $I_{o\,nom}$ | 5 | | 12 | | 15 | | V |
| $\Delta U_{o\,a}$ | Output voltage accuracy | typ<br>max | | ±1<br>±3 | | ±2<br>±5 | | ±2<br>±5 | | % |
| $u_o$ | Output ripple, $u_o$ = f ($U_i$) | | at $U_i$ = | 5 | 12 | 15 | 24 | 28 | 48 | V |
| | | typ | (BW = 20 MHz) | 25 | 35 | 40 | 45 | 50 | 55 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static line regulation | typ | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$ | ±0.3 | | ±0.2 | | ±0.2 | | % |
| $\Delta U_{o\,I}$ | Static load regulation | typ | $U_{i\,nom}$<br>$I_o$ = 0...$I_{o\,nom}$ | ±0.8 | | ±0.1 | | ±0.1 | | |
| $\alpha_{Uo}$ | Temperature coefficient | | $U_{i\,nom}$, $I_{o\,nom}$ | ±0.02 | | | | | | %/K |
| $C_{o\,ext}$ | Maximum admissible capacitive load | | | 22 | | 10 | | 10 | | µF |

*Table 4: Efficiency*

| Efficiency | | | | 5 V | 12 V | 15 V | |
|---|---|---|---|---|---|---|---|
| Characteristics | | | Conditions | | | | Unit |
| $\eta$ | Efficiency | min<br>typ | $U_{i\,nom}$, $I_{o\,nom}$ | 50<br>58 | | | % |

## Supplementary Data

### Isolation Tests

Input to output isolation voltage tests are performed as factory tests (100%) and should not be repeated in the field. Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests.

*Table 5: Isolation test voltage, coupling capacitance, insulation resistance, clearance and creepage distances*

| Characteristics | | Conditions | ICR | IWR [1] | IXR | IYR | IZR | Unit |
|---|---|---|---|---|---|---|---|---|
| $U_{is\ io}$ | Isolation test voltage Input to output | AC: 50 Hz, | 500 | 1060 | 2500 | 3750 | 5000 | $V_{rms}$ |
| | | 1 minute | 1400 | 3000 | 7070 | 10600 | 14100 | $V_{pp}$ |
| | | DC: 1 second [2] | 700 | 1500 | 3530 | 5300 | 7070 | V |
| | | DC: 1 second [3] | 800 | 1700 | 4000 | 6000 | 8000 | |
| $U_{is\ oo}$ | Isolation test voltage output to output [4] | AC: 50 Hz, | 500 | 1060 | 1060 | 1060 | 1060 | $V_{rms}$ |
| | | 1 minute | 1400 | 3000 | 3000 | 3000 | 3000 | $V_{pp}$ |
| | | DC: 1 second [2] | 700 | 1700 | 1500 | 1500 | 1500 | V |
| | | DC: 1 second [3] | 800 | 1500 | 1700 | 1700 | 1700 | |
| $C_{io}$ | Coupling capacitance typ | | 20 | 10 | 10 | 10 | 10 | pF |
| $R_{is}$ | Insulation resistance | at 100 V DC after 1 minute | ≥1000 | | | | | MΩ |
| $d_{io}$ | Clearance and creepage distances input to output | | ≥0.6 | ≥1 | ≥3 [5] | ≥3 [5] | ≥3 [5] | mm |

[1] According to EN 41003 (1993)
[2] For production test purposes in accordance with IEC 950/EN 60950
[3] Factory test procedure
[4] Groups 03, 05, 08 and 13
[5] In combination with the high isolation strength of the potting compound, isolation test voltages mentioned are guaranteed.

### Connection in Series

If the outputs of one or more units are connected in series each individual output should be protected by a zener diode or preferably by a suppressor diode to avoid overvoltages or reverse polarity at the individual outputs, e.g.:
– 1N5908 to protect 5 V outputs
– BZW04-11 to protect 12 V outputs
– BZW04-14 to protect 15 V outputs
(or equivalent types)

Such destructive voltages may occur at switch-on cycle of the converters, if the output voltages do not rise at the same time. The "slower" output(s) could be supplied and, as a result, destroyed by the "faster" output(s) via the load. The maximum output current is limited by the lowest current limitation.

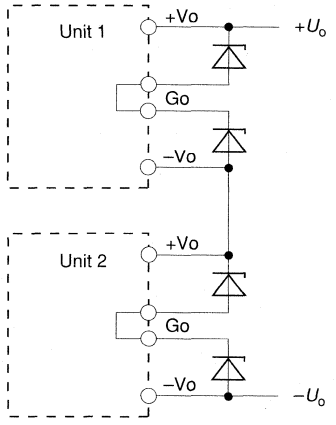



*Fig. 1*
*Outputs connected in series*

### Connection in Parallel

Connection of the outputs of one or more units in parallel is not permitted. The load distribution and the ripple values could not be controlled.

### Cleaning

Two CFC free cleaning solvents have been tested and can be recommended:
– Prozone from BP
– Zestron from Dr. O. K. Wack Chemie GmbH (Germany)

Submersion of the units in water for rinsing is permitted. Drying should be done in the air.


MELCHER® ISO 9001 certified

## Immunity to Environmental Conditions

### Thermal Considerations

*Table 6: Temp. specification values given are valid for air pressures in the range 800...1200 hPa (800...1200 mbar)*

| Characteristics | | Conditions | Standard -N | | Option -T | | Option -S | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | min | max | |
| $T_A$ | Ambient temperature | $U_{I\,min}...U_{I\,max}$ | 0 | 71 | –25 | 71 | –40 | 85 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | 0 | 91 | –25 | 91 | –40 | 105 | |
| $T_S$ | Storage temperature | not operational | | | –55 | 105 | | | |

The case temperature $T_C$ must not exceed the maximum value. In applications with limited air circulation, additional measures must be taken (either larger spacing or a fan) to avoid case temperatures higher than $T_{C\,max}$!

*Table 7: MTBF*

| Values at specified Case Temperature | Modules Types | Ground Benign | Ground Fixed | | Ground Mobile | | Unit |
|---|---|---|---|---|---|---|---|
| | | 40°C | 40°C | 70°C | 40°C | 70°C | |
| MTBF according to MIL-HDBK-217F | Single output | 7'400'000 | 3'200'000 | 260'000 | 880'000 | 60'000 | h |
| | Double and dual outputs | 5'700'000 | 2'500'000 | 200'000 | 670'000 | 45'000 | |

## Block Diagrams

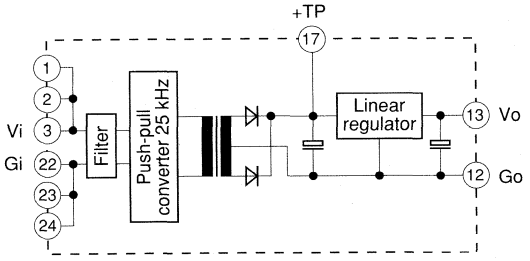



*Fig. 2*
*IWR, group 01*

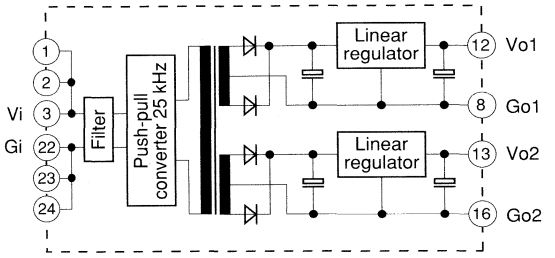



*Fig. 4*
*IWR, group 03*

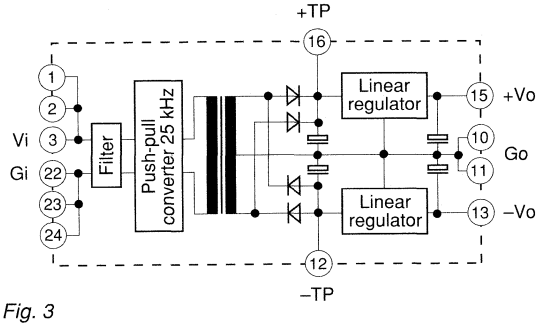



*Fig. 3*
*IWR, group 02*

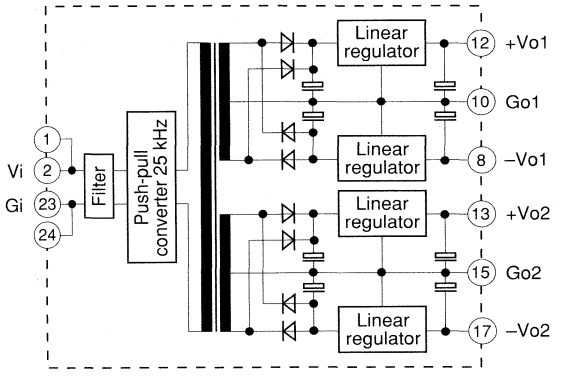



*Fig. 5*
*IWR, group 05*

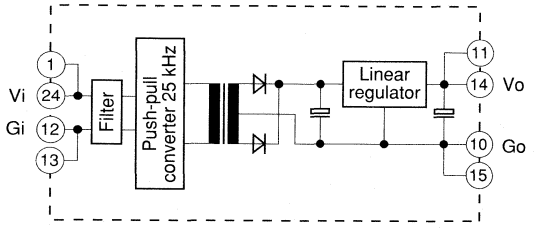



*Fig. 6*
*ICR, group 06*

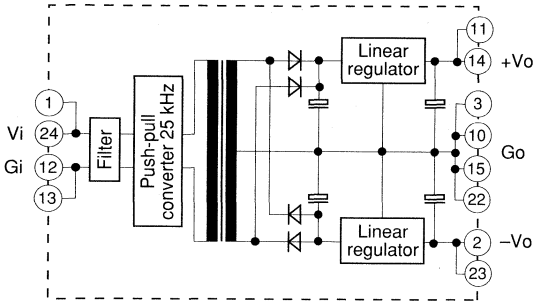



*Fig. 7*
*ICR, group 07*

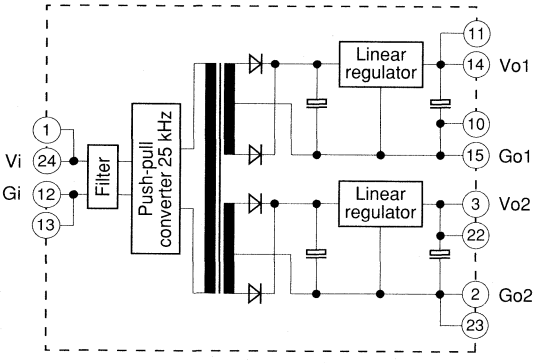



*Fig. 8*
*ICR, group 08*

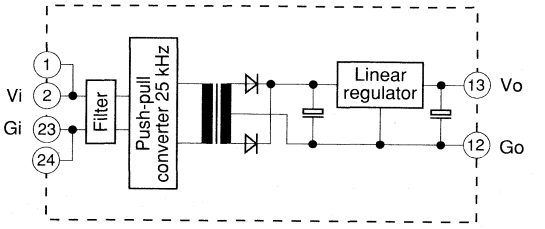



*Fig. 9*
*IXR, IYR, IZR, group 11*

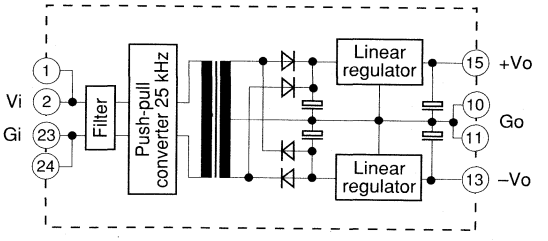



*Fig. 10*
*IXR, IYR, IZR, group 12*

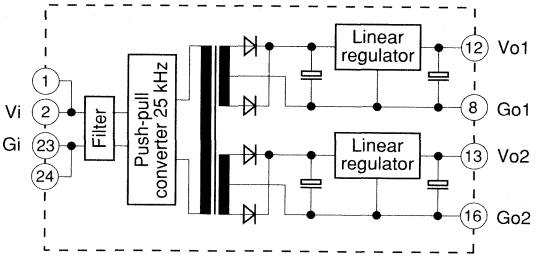
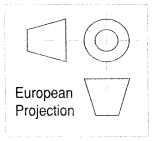



*Fig. 11*
*IXR, IYR, IZR, group 13*


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## Mechanical Data

Dimensions in mm. Tolerances ±0.2 mm, unless otherwise specified.



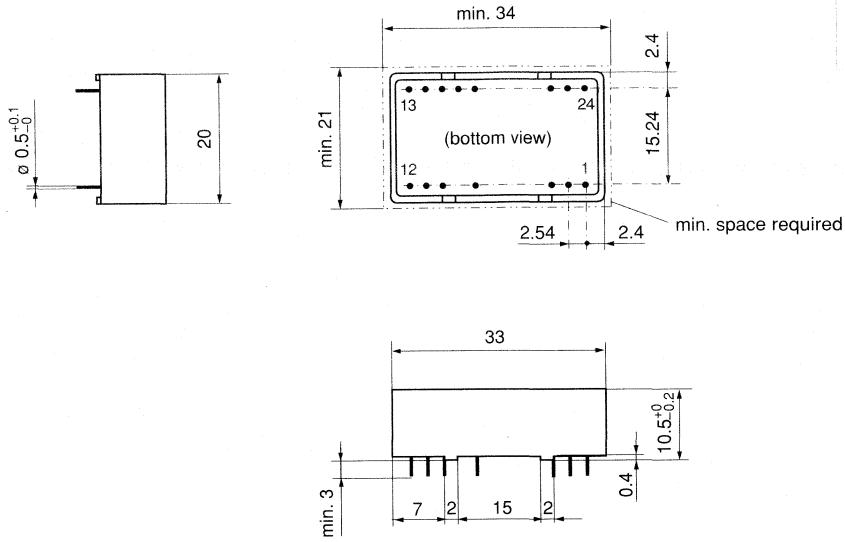




*Fig. 12*
*Case: DIL 24. Foot print shown for all pin configurations.*
*Hole diameter required in PCB: 0.8±0.1 mm*
*Weight: 13 g*

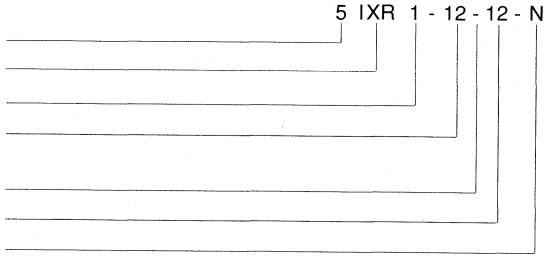
### Pin Configuration

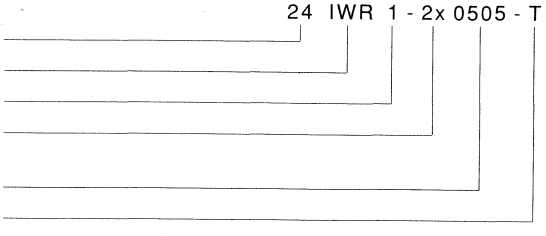
*Table 8: Pin configuration*

| Type | Group | 1 | 2 | 3 | 8 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IWR | 01 | Vi | Vi | Vi | - | - | - | Go | Vo | - | - | - | +TP | Gi | Gi | Gi |
| IWR | 02 | Vi | Vi | Vi | - | Go | Go | –TP | –Vo | - | +Vo | +TP | - | Gi | Gi | Gi |
| IWR | 03 | Vi | Vi | Vi | Go1 | - | - | Vo1 | Vo2 | - | - | Go2 | - | Gi | Gi | Gi |
| IWR | 05 | Vi | Vi | - | –Vo1 | Go1 | - | +Vo1 | +Vo2 | - | Go2 | - | –Vo2 | - | Gi | Gi |
| ICR | 06 | Vi | - | - | - | Go | Vo | Gi | Gi | Vo | Go | - | - | - | - | Vi |
| ICR | 07 | Vi | –Vo | Go | - | Go | +Vo | Gi | Gi | +Vo | Go | - | - | Go | –Vo | Vi |
| ICR | 08 | Vi | Go2 | Vo2 | - | Go1 | Vo1 | Gi | Gi | Vo1 | Go1 | - | - | Vo2 | Go2 | Vi |
| IXR, IYR, IZR | 11 | Vi | Vi | - | - | - | - | Go | Vo | - | - | - | - | - | Gi | Gi |
| IXR, IYR, IZR | 12 | Vi | Vi | - | - | Go | Go | - | –Vo | - | +Vo | - | - | - | Gi | Gi |
| IXR, IYR, IZR | 13 | Vi | Vi | - | Go1 | - | - | Vo1 | Vo2 | - | - | Go2 | - | - | Gi | Gi |

## Type Key and Product Marking

**Type Key:**




**Product Marking:**

Main face: Manufacturer's name (IBEK), specific type designation, input voltage range, input and output pin allocation.

Bottom: Date code.



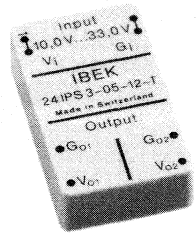
MELCHER® ISO 9001 certified

# IBEK DC-DC Converters

# 3 Watt-Family

**Input to output and output to output isolation test voltage 500 $V_{rms}$ or 1 $kV_{rms}$**
**Single, double and dual outputs**
**Input voltage ranges: 10...33 V DC and 18...72 V DC**

- Wide input voltage ranges of up to 1:4
- Efficient current compensated input filter
- SD-shutdown input
- High efficiency (typ. 80%)
- High reliability
- No-load and short-circuit proof
- Operating ambient temperature range up to −40...85°C (optional)
- No derating
- DIL 24 package size, height only 10.5 mm




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## Description

This series of DC-DC converters has been developed for powering electronic circuits, e.g. telephone system components, control modules and small appliances. They are also suitable for applications with variable input voltages or with input transients. The converters feature high efficiency, high reliability, and good dynamic response to load changes and at start-up. Efficiency is high and practically constant over the entire input voltage range. Two input to output isolation test voltage categories and two temperature ranges are available.

All modules are manufactured according to ISO 9001.

Case: DIL 24 package, grey coloured plastics, self cooling (free air convection).

## Type Survey

General Condition: TA = 25°C

*Table 1a: Type survey IPS 3*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage $U_i$ [V DC] | Group | 700 V DC/500 $V_{rms}$ Isolation test voltage Type | Option |
|---|---|---|---|---|---|---|---|
| 5 | 500 | - | - | 24 IPS .. 10...33 (nominal 24) | 01 | .. IPS 3-05-T | S |
| 12 | 250 | - | - | | | .. IPS 3-12-T | |
| 15 | 200 | - | - | | | .. IPS 3-15-T | |
| +5 | 250 | –5 | 250 | | 02 | .. IPS 3-0505-T | |
| +12 | 125 | –12 | 125 | | | .. IPS 3-1212-T | |
| +15 | 100 | –12 | 100 | | | .. IPS 3-1515-T | |
| 5 | 250 | 5 | 250 | 48 IPS .. 18...72 (nominal 48) | 03 [1] | .. IPS 3-05-05-T | |
| 5 | 250 | 12 | 125 | | | .. IPS 3-05-12-T | |
| 5 | 250 | 15 | 100 | | | .. IPS 3-05-15-T | |
| 12 | 125 | 12 | 125 | | | .. IPS 3-12-12-T | |
| 15 | 100 | 15 | 100 | | | .. IPS 3-15-15-T | |

*Table 1b: Type survey CPS 3*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage $U_i$ [V DC] | Group | 700 V DC/500 $V_{rms}$ Isolation test voltage Type | Option |
|---|---|---|---|---|---|---|---|
| 5 | 500 | - | - | 24 CPS .. 10...33 (nominal 24) | 04 [2] | .. CPS 3-05-T | S |
| 12 | 250 | - | - | | | .. CPS 3-12-T | |
| 15 | 200 | - | - | | | .. CPS 3-15-T | |
| +5 | 250 | –5 | 250 | 48 CPS .. 18...72 (nominal 48) | 05 [2] | .. CPS 3-0505-T | |
| +12 | 125 | –12 | 125 | | | .. CPS 3-1212-T | |
| +15 | 100 | –12 | 100 | | | .. CPS 3-1515-T | |

*Table 1c: Type survey IPW 3*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage $U_i$ [V DC] | Group | 1500 V DC/1060 $V_{rms}$ Isolation test voltage Type | Option |
|---|---|---|---|---|---|---|---|
| 5 | 500 | - | - | 24 IPW .. 10...33 (nominal 24) | 01 | .. IPW 3-05-T | S |
| 12 | 250 | - | - | | | .. IPW 3-12-T | |
| 15 | 200 | - | - | | | .. IPW 3-15-T | |
| +5 | 250 | –5 | 250 | | 02 | .. IPW 3-0505-T | |
| +12 | 125 | –12 | 125 | | | .. IPW 3-1212-T | |
| +15 | 100 | –12 | 100 | | | .. IPW 3-1515-T | |
| 5 | 250 | 5 | 250 | 48 IPW .. 18...72 (nominal 48) | 03 [1] | .. IPW 3-05-05-T | |
| 5 | 250 | 12 | 125 | | | .. IPW 3-05-12-T | |
| 5 | 250 | 15 | 100 | | | .. IPW 3-05-15-T | |
| 12 | 125 | 12 | 125 | | | .. IPW 3-12-12-T | |
| 15 | 100 | 15 | 100 | | | .. IPW 3-15-15-T | |

[1] Group 03 features two independent galvanically isolated outputs. For each unit, the output to output isolation test voltage is identical to that for input to output isolation.

[2] See Mechanical Data: "Alternative Pin Configuration"

Other types with different input and output specifications available upon request.

## Electrical Input and Output Data

General Conditions: $T_A$ = 25°C, unless otherwise specified

*Table 2: Input Data*

| Input | | | .. IPS/IPW 3-05 .. | | | .. IPS/IPW 3-12 .. | | | .. IPS/IPW 3-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range 24 IPS/IPW<br>48 IPS/IPW | $T_{A\,min}$...$T_{A\,max}$<br>$I_o$ = 0...$I_{o\,nom}$ | 10<br>18 | | 33<br>72 | 10<br>18 | | 33<br>72 | 10<br>18 | | 33<br>72 | V DC |
| $U_{i\,abs}$ | Input voltage limits without any damage 24 IPS/IPW [1]<br>48 IPS/IPW [2] | | 0<br>0 | | 45<br>75 | 0<br>0 | | 45<br>75 | 0<br>0 | | 45<br>75 | |
| $I_{i\,o}$ | No load input current | $U_{i\,nom}$ = 24 V, $I_o$ = 0<br>$U_{i\,nom}$ = 48 V, $I_o$ = 0 | | 5<br>3 | | | 5<br>3 | | | 5<br>3 | | mA |
| $I_{i\,SD}$ | Input current in shutdown condition | $U_{i\,min}$...$U_{i\,max}$<br>$T_{A\,min}$...$T_{A\,max}$ | | 1.3 | | | 1.3 | | | 1.3 | | |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}$...$U_{i\,max}$<br>$T_{A\,min}$...$T_{A\,max}$ | | 1.25 $I_{i\,max}$ | | | 1.25 $I_{i\,max}$ | | | 1.25 $I_{i\,max}$ | | |
| $I_{i\,rfi}$ | RFI current at the input | $I_o$ = 0...$I_{o\,max}$ | | 30 | | | 30 | | | 30 | | $mA_{pp}$ |
| $U_{SD}$ | Shutdown voltage for converter | operating<br>not operating | | open or 8...10<br>–0.3...+2 | | | open or 8...10<br>–0.3...+2 | | | open or 8...10<br>–0.3...+2 | | V DC |
| $I_{SD}$ | Shutdown current for converter | operating<br>not operating | | +1...+5<br>–25...–35 | | | +1...+5<br>–25...–35 | | | +1...+5<br>–25...–35 | | µA |
| $f_s$ | Switching frequency | $U_{i\,min}$...$_{max}$, $I_{o\,nom}$<br>$T_{A\,min}$...$T_{A\,max}$ | | 130 | | | 130 | | | 130 | | kHz |

[1] 35 V DC for 500 ms, repetition rate 50 s; 45 V DC for 10 ms repetition rate 10 s; according to Siemens standard SN 26555, section 9
[2] The applied minimum load must be 25% between 72.0...75.0 V DC

*Table 3: Output Data*

| Output | | | .. IPS/IPW 3-05 .. | | | .. IPS/IPW 3-12 .. | | | .. IPS/IPW 3-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 4.90 | | 5.10 | 11.76 | | 12.24 | 14.70 | | 15.30 | V DC |
| $I_{o\,nom}$ | Nominal output current Group 01<br>Group 02/03 | $U_{i\,min}$...$U_{i\,max}$<br>$T_{A\,min}$...$T_{A\,max}$ | | 500<br>250 | | | 250<br>125 | | | 200<br>100 | | mA |
| $u_o$ | Output ripple (BW = 20 MHz) | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$ | | 100 | | | 100 | | | 100 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static line regulation | | | ±10 | | | ±12 | | | ±15 | | mV |
| $\Delta U_{o\,I}$ | Static load regulation | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$...0.25 $I_{o\,nom}$ | | 0...5 | | | 0...2 [1] | | | 0...2 [1] | | % |
| $\alpha_{Uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | Output overvoltage clamping | | | 5.6 $^{+5/-0\%}$ | | | 13 $^{+5/-0\%}$ | | | 16 $^{+5/-0\%}$ | | V |
| $C_{o\,ext}$ | Maximum admissible capacitive load | | | 33 | | | 15 | | | 15 | | µF |

[1] 0...5% for the galvanically isolated second output of the types ..05-12.. and ..05-15..
Double and dual output units should have the same (%) load conditions at both outputs to comply with above specifications

*Table 4: Efficiency*

| Efficiency | | | .. IPS/IPW 10-05 .. | | | .. IPS/IPW 10-12 .. | | | .. IPS/IPW 10-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $\eta$ | Efficiency | $U_{i\,nom}$ = 24 V, $I_{o\,nom}$<br>$U_{i\,nom}$ = 48 V, $I_{o\,nom}$ | 78<br>80 | 80<br>82 | | 78<br>80 | 80<br>82 | | 78<br>80 | 80<br>82 | | % |

## Supplementary Data

### Isolation Tests

Input to output isolation voltage tests are performed as factory tests (100%) and should not be repeated in the field. Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests.

*Table 5: Isolation test voltage, coupling capacitance and insulation resistance*

| Characteristics | | Conditions | IPS | IPW [1] | Unit |
|---|---|---|---|---|---|
| $U_{is\ io}$ | Isolation test voltage Input to output | AC: 50 Hz, 1 minute | 500 | 1060 | $V_{rms}$ |
| | | | 1400 | 3000 | $V_{pp}$ |
| | | DC: 1 second [2] | 700 | 1500 | V |
| | | DC: 1 second [3] | 800 | 1700 | |
| $U_{is\ oo}$ | Isolation test voltage output to output [4] | AC: 50 Hz, 1 minute | 500 | 1060 | $V_{rms}$ |
| | | | 1400 | 3000 | $V_{pp}$ |
| | | DC: 1 second [2] | 700 | 1500 | V |
| | | DC: 1 second [3] | 800 | 1700 | |
| $C_{io}$ | Coupling capacitance typ | | 300 | external [5] | pF |
| $R_{is}$ | Insulation resistance | at 100 V DC after 1 minute | ≥2000 | | MΩ |

[1] According to EN 41003 (1993) [2] For production test purposes in accordance with IEC 950/EN 60950 [3] Factory test procedure
[4] Group 03 [5] Important: All IPW types need (an) external coupling capacitor(s) $C_{io}$ of min. 220 pF, 1 $kV_{rms}$

### Connection in Series

If the outputs of one or more units are connected in series each individual output should be protected by a zener diode or preferably by a suppressor diode to avoid overvoltages or reverse polarity at the individual outputs, e.g.: 1N5908 (5 V), BZW04-11 (12 V), BZW04-14 (15 V) or equivalent types.
Such destructive voltages may occur at switch-on cycle of the converters, if the output voltages do not rise at the same time. The "slower" output(s) could be supplied and, as a result, destroyed by the "faster" output(s) via the load. The maximum output current is limited by the lowest current limitation.

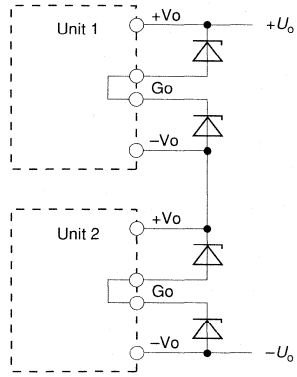



*Fig. 1*
*Outputs connected in series*

### Connection in Parallel

Connection of the outputs of one or more units in parallel is not permitted. The load distribution and the ripple values could not be controlled.

### Cleaning

Two CFC free cleaning solvents have been tested and can be recommended:
– Prozone from BP
– Zestron from Dr. O. K. Wack Chemie GmbH (Germany)

Submersion of the units in water for rinsing is permitted. Drying should be done in the air.

### Shutdown Description

The shutdown terminal is used to switch the converter output voltage $U_o$ on and off via a control signal (e.g. using an open collector drive). See "Electrical Input and Output Data".

The output voltage is switched on when the shutdown terminal is open circuit or +8...+10 V. The output voltage is switched off when a voltage of –0.3...+2 V is applied to the shutdown terminal. At the open shutdown pin 10...12 V will appear.

## Immunity to Environmental Conditions

### Thermal Considerations

*Table 6: Temp. specification values given are valid for air pressures in the range 800...1200 hPa (800...1200 mbar)*

| Characteristics | | Conditions | Standard -T | | Option -S | | Unit |
|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | |
| $T_A$ | Ambient temperature | $U_{i\ min}...U_{i\ max}$ | 0 | 71 | –40 | 85 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\ nom}$ | 0 | 91 | –40 | 105 | |
| $T_S$ | Storage temperature | not operational | –55 | 105 | –55 | 105 | |

The case temperature $T_C$ should not exceed the maximum value. In applications with limited air circulation, additional measures should be taken (either larger spacing or a fan) to avoid case temperatures higher than $T_{C\,max}$!

*Table 7: MTBF*

| Values at specified Case Temperature | Modules Types | Ground Benign | Ground Fixed | | Ground Mobile | | Unit |
|---|---|---|---|---|---|---|---|
| | | 40 °C | 40 °C | 70 °C | 40 °C | 70 °C | |
| MTBF according to MIL-HDBK-217F | Group 01 | 2'900'000 | 1'400'000 | 310'000 | 430'000 | 150'000 | h |
| | Group 02/03 | 2'300'000 | 1'000'000 | 270'000 | 310'000 | 110'000 | |

## Functional Description and Block Diagrams

These converters are primary controlled flyback converters using Pulse With Modulation (PWM). The output voltage is monitored via a separate transformer winding very close to the secondary winding(s) and fed back to the control circuit. This is the reason why double and dual output units should always have the same (%) load conditions at both outputs to comply with the specified data. The current limitation is located on the primary side, limiting the total output current.

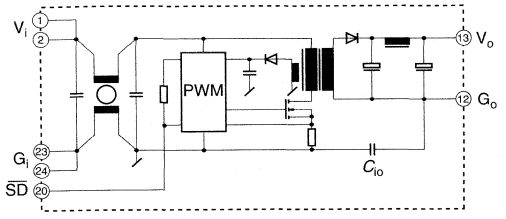



*Fig. 2*
*IPS 3, Group 01*

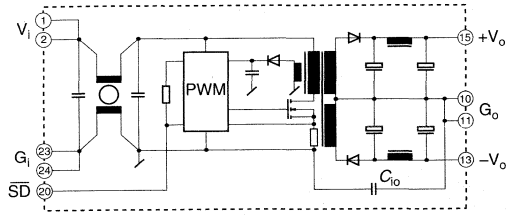



*Fig. 3*
*IPS 3, Group 02*

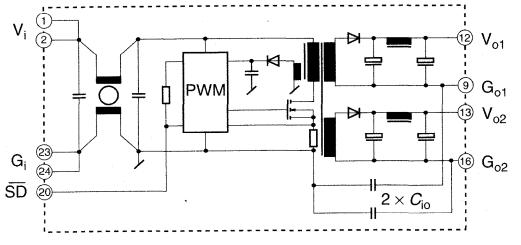



*Fig. 4*
*IPS 3, Group 03*

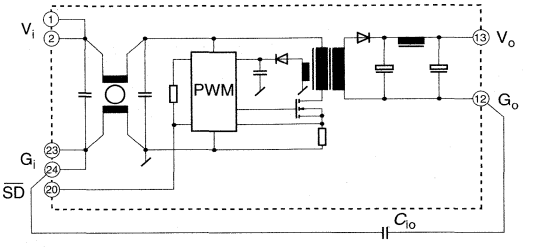



*Fig. 5*
*IPW 3, Group 01, external $C_{io}$ is required*

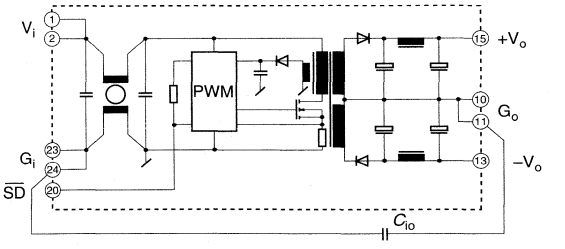



*Fig. 6*
*IPW 3, Group 02, external $C_{io}$ is required*

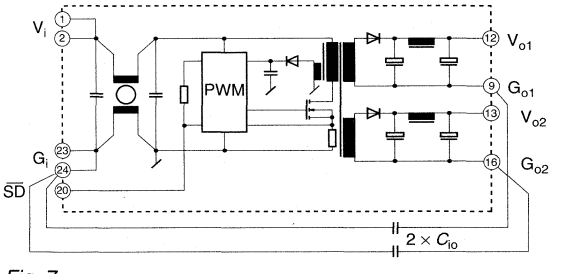
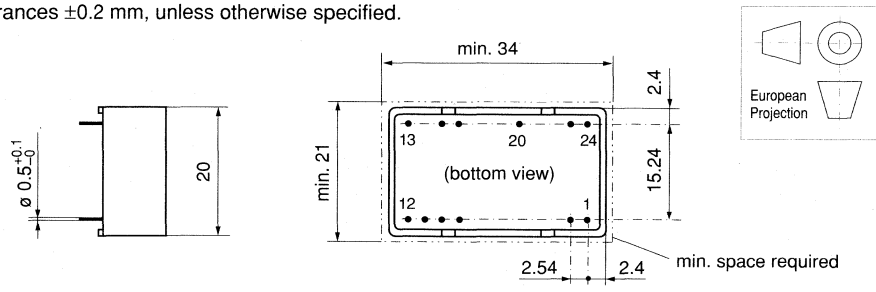



*Fig. 7*
*IPW 3, Group 03, external 2 × $C_{io}$ is required*

## Mechanical Data

Dimensions in mm. Tolerances ±0.2 mm, unless otherwise specified.



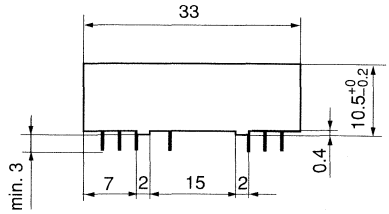




*Fig. 8*
*Case: DIL 24. Foot print shown for all pin configurations.*
*Hole diameter required in PCB: $0.8^{\pm 0.1}$ mm*
*Weight: 15 g*

### Pin Configuration

*Table 8: Pin configuration*

| Group | 1 | 2 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 20 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Vi | Vi | - | - | - | Go | Vo | - | - | SD | Gi | Gi |
| 02 | Vi | Vi | - | Go | Go | - | –Vo | +Vo | - | SD | Gi | Gi |
| 03 | Vi | Vi | Go1 | - | - | Vo1 | Vo2 | - | Go2 | SD | Gi | Gi |

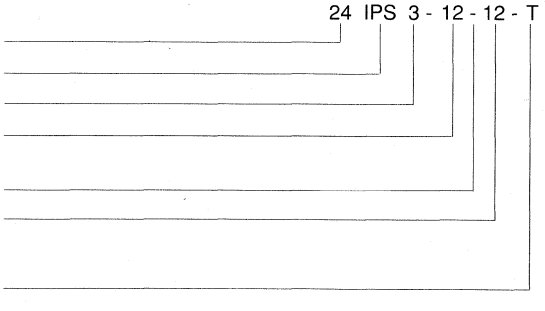
*Table 9: Alternative pin configuration*

| Group | 1 | 2 | 9 | 10 | 11 | 12 | 13 | 16 | 20 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04 | - | Gi | Gi | - | - | - | Vo | Go | - | Vi | Vi | - |
| 05 | - | Gi | Gi | Go | –Vo | - | +Vo | Go | - | Vi | Vi | - |

The converters of groups 04 and 05 are designated as CPS 3 types. The type variety and all specifications are the same as for the IPS 3 group 01 and 02 with the exception of the shutdown function which is not available.

## Type Key and Product Marking

### Type Key:




Nominal input voltage in volt ..... 24, 48
Family ..... IPS, IPW, CPS
Nominal output power in watt ..... 3
Nominal output voltage for output 1 in volt ..... 05, 12, 15
Dash: Designates dual output unit with two independent, galvanically isolated outputs ..... -
Nominal output voltage for output 2 in volt ..... 05, 12, 15
Operating ambient temperature range $T_A$
$T_A$ = –25...71 °C ..... -T
$T_A$ = –40...85 °C ..... -S

### Product Marking:

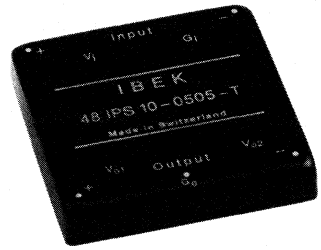
Main face: Manufacturer's name (IBEK), specific type designation, input voltage range, input and output pin allocation.
Bottom: Date code.

# IBEK DC-DC Converters

# 10 Watt-Family

**Input to output isolation test voltage up to 5 $kV_{rms}$**
**1 or 2 Outputs: IPS 10, IPW 10, IPZ 5**
**Input voltage ranges: 10...33 V DC and 18...72 V DC**

- Extremely high isolation test voltages
- Wide input voltage ranges of up to 1:4
- Efficient input Pi-filter
- SD-shutdown input (on request)
- High efficiency (typ. 80%)
- High reliability
- Continuous no-load and short-circuit proof
- Case height only 10.5 mm




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## Description

This series of DC-DC converters has been developed for powering electronic circuits and systems, e.g. telephone system components, control modules and small appliances. They are also suitable for applications with variable input voltages or with input transients. Input to output isolation test voltage categories up to 5 $kV_{rms}$ are available. The converters feature high efficiency, high reliability, low output voltage ripple and excellent dynamic response. Efficiency is high and practically constant over the entire input voltage range.

All modules are manufactured according to ISO 9001.

Case: IPS/IPW: 2"× 2" metal, black anodized, IPZ: black colored plastics, self cooling (free air convection).

## Type Survey

General Condition: $T_A$ = 25°C

*Table 1a: Type survey IPS 10*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage Range $U_i$ [V DC] | Group [1] | 700 V DC/500 $V_{rms}$ Isolation test voltage Type | Pin Configuration |
|---|---|---|---|---|---|---|---|
| 5 | 2000 | - | - | 24 IPS .. | 01 | .. IPS 10-05-T.. | C, B, G, F |
| 12 | 833 | - | - | 10...33 | | .. IPS 10-12-T.. | |
| 15 | 667 | - | - | (nominal 24) | | .. IPS 10-15-T.. | |
| +5 | 1000 | –5 | 1000 | 48 IPS .. | 02 | .. IPS 10-0505-T.. | |
| +12 | 417 | –12 | 417 | 18...72 | | .. IPS 10-1212-T.. | |
| +15 | 333 | –15 | 333 | (nominal 48) | | .. IPS 10-1515-T.. | |

*Table 1b: Type survey IPW 10*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage Range $U_i$ [V DC] | Group [1] | 1500 V DC/1060 $V_{rms}$ Isolation test voltage Type | Pin Configuration |
|---|---|---|---|---|---|---|---|
| 5 | 2000 | - | - | 24 IPW .. | 01 | .. IPW 10-05-T.. | C, G |
| 12 | 833 | - | - | 10...33 | | .. IPW 10-12-T.. | |
| 15 | 667 | - | - | (nominal 24) | | .. IPW 10-15-T.. | |
| +5 | 1000 | –5 | 1000 | 48 IPW .. | 02 | .. IPW 10-0505-T.. | |
| +12 | 417 | –12 | 417 | 18...72 | | .. IPW 10-1212-T.. | |
| +15 | 333 | –15 | 333 | (nominal 48) | | .. IPW 10-1515-T.. | |

*Table 1c: Type survey IPZ 5*

| Output 1 $U_{o\,nom}$ [V DC] | Output 1 $I_{o\,nom}$ [mA] | Output 2 $U_{o\,nom}$ [V DC] | Output 2 $I_{o\,nom}$ [mA] | Input Voltage Range $U_i$ [V DC] | Group [1] | 7070 V DC/5000 $V_{rms}$ Isolation test voltage Type | Pin Configuration |
|---|---|---|---|---|---|---|---|
| 5 | 1000 | - | - | 24 IPZ .. | 01 | .. IPZ 5-05-T.. | C |
| 12 | 417 | - | - | 10...33 | | .. IPZ 5-12-T.. | |
| 15 | 333 | - | - | (nominal 24) | | .. IPZ 5-15-T.. | |
| +5 | 500 | –5 | 500 | 48 IPZ .. | 02 | .. IPZ 5-0505-T.. | |
| +12 | 208 | –12 | 208 | 18...72 | | .. IPZ 5-1212-T.. | |
| +15 | 167 | –15 | 167 | (nominal 48) | | .. IPZ 5-1515-T.. | |

[1] See Block Diagrams

Other types with different input and output specifications available upon request.

## Supplementary Data

### Isolation Tests

Input to output isolation voltage tests are performed as factory tests (100%) and should not be repeated in the field. Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests.

*Table 5: Isolation test voltage coupling capacitance and insulation resistance*

| Characteristic | | Conditions | IPS | IPW [1] | IPZ | Unit |
|---|---|---|---|---|---|---|
| $U_{is\ io}$ | Isolation test voltage Input to output | AC: 50 Hz, 1 minute | 500 | 1060 | 5000 | $V_{rms}$ |
| | | | 1400 | 3000 | 14100 | $V_{pp}$ |
| | | DC: 1 second [2] | 700 | 1500 | 7070 | V |
| | | DC: 1 second [3] | 800 | 1700 | 8000 | |
| $C_{io}$ | Coupling capacitance typ | | 1000 | 1000 | 40 | pF |
| $R_{is}$ | Insulation resistance | at 100 V DC after 1 minute | ≥1000 | | | MΩ |

[1] According to EN 41003 (1993)
[2] For production test purposes in accordance with IEC 950/EN 60950
[3] Factory test procedure

### Connection in Series

If the outputs of one or more units are connected in series each individual output should be protected by a zener diode or preferably by a suppressor diode to avoid overvoltages or reverse polarity at the individual outputs, e.g.: 1N5908 (5 V), BZW04-11 (12 V), BZW04-14 (15 V) or equivalent types.
Such destructive voltages may occur at switch-on cycle of the converters, if the output voltages do not rise at the same time. The "slower" output(s) could be supplied and, as a result, destroyed by the "faster" output(s) via the load. The maximum output current is limited by the lowest current limitation.

### Connection in Parallel

Connection of the outputs of one or more units in parallel is not permitted. The load distribution and the ripple values could not be controlled.

### Cleaning

Two CFC free cleaning solvents have been tested and can be recommended:
– Prozone from BP
– Zestron from Dr. O. K. Wack Chemie GmbH (Germany)

Submersion of the units in water for rinsing is permitted. Drying should be done in air only.

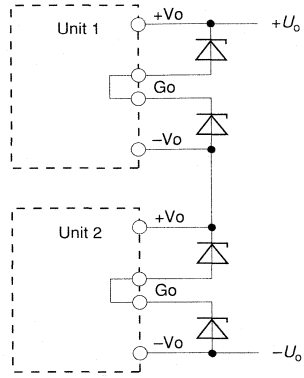



*Fig. 1*
*Outputs connected in series*

### Shutdown Description

The shutdown terminal is used to switch the converter output voltage $U_o$ on and off (e.g. using an open collector drive). See "Electrical Input and Output Data".

The output voltage is switched on when the shutdown terminal is open circuit. The output voltage is switched off when a voltage of –0.3...+2 V is applied to the shutdown terminal. At the open shutdown pin 10...12 V will appear.

## Electrical Input and Output Data

General Conditions: $T_A$ = 25°C, unless otherwise specified

*Table 2a: Input Data*

| Input | | | .. IPS/IPW 10-05 .. | | | .. IPS/IPW 10-12 .. | | | .. IPS/IPW 10-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range 24 IPS<br>48 IPS | $T_{A\,min}$...$T_{A\,max}$<br>$I_o$ = 0...$I_{o\,nom}$ | 10<br>18 | | 33<br>72 | 10<br>18 | | 33<br>72 | 10<br>18 | | 33<br>72 | V DC |
| $U_{i\,abs}$ | Input voltage limits without any damage 24 IPS [1]<br>48 IPS [2] | | 0<br>0 | | 45<br>75 | 0<br>0 | | 45<br>75 | 0<br>0 | | 45<br>75 | |
| $I_{i\,o}$ | No load input current Group 01<br>Group 02 | $U_{i\,nom}$, $I_o$ = 0 | | 25<br>25 | | | 25<br>45 | | | 25<br>45 | | mA |
| $I_{i\,SD}$ [3] | Input current in shutdown condition | $U_{i\,min}$...$U_{i\,max}$<br>$T_{A\,min}$...$T_{A\,max}$ | | 3 | | | 3 | | | 3 | | |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}$...$U_{i\,max}$<br>$T_{A\,min}$...$T_{A\,max}$ | | 1.2 $I_{i\,max}$ | | | 1.2 $I_{i\,max}$ | | | 1.2 $I_{i\,max}$ | | |
| $i_{i\,rfi}$ | RFI current at the input | $I_o$ = 0...$I_{o\,max}$ | | 30 | | | 30 | | | 30 | | $mA_{pp}$ |
| $U_{SD}$ [3] | Shutdown voltage for converter | operating<br>not operating | | open circuit<br>–0.3...+2 | | | open circuit<br>–0.3...+2 | | | open circuit<br>–0.3...+2 | | V DC |
| $I_{SD}$ [3] | Shutdown current for converter | operating<br>not operating | | -<br>3 | | | -<br>3 | | | -<br>3 | | µA |
| $f_s$ | Switching frequency | $U_{i\,min}$...$_{max}$, $I_{o\,nom}$<br>$T_{A\,min}$...$T_{A\,max}$ | | 145 | | | 145 | | | 145 | | kHz |

[1] 35 V for 500 ms, repetition rate 50 s; 45 V DC for 10 ms repetition rate 10 s; according to Siemens standard SN 26555, section 9
[2] The applied minimum load must be 10% between 72.0...75.0 V DC
[3] With shutdown facility: Pin configuration F and G for IPS-types, pin configuration G for IPW-types

*Table 3a: Output Data*

| Output | | | .. IPS/IPW 10-05 .. | | | .. IPS/IPW 10-12 .. | | | .. IPS/IPW 10-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 4.95 | | 5.05 | 11.88 | | 12.12 | 14.85 | | 15.15 | V DC |
| $I_{o\,nom}$ | Nominal output current Group 01<br>Group 02 | $U_{i\,min}$...$U_{i\,max}$<br>$T_{A\,min}$...$T_{A\,max}$ | | 2000<br>1000 | | | 833<br>417 | | | 667<br>333 | | mA |
| $u_o$ | Output ripple (BW = 20 MHz) | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$ | | 50 | 100 | | 120 | 240 | | 150 | 300 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static line regulation | | | 5 | 10 | | 12 | 24 | | 15 | 30 | mV |
| $\Delta U_{o\,I}$ | Static load regulation | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$...0 | | 0...50 | | | 0...50 | | | 0...50 | | |
| $\alpha_{Uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| | Output overvoltage clamping | | | 5.6 +10/–0% | | | 13 +10/–0% | | | 16 +10/–0% | | V |

*Table 4a: Efficiency*

| Efficiency | | | .. IPS/IPW 10-05 .. | | | .. IPS/IPW 10-12 .. | | | .. IPS/IPW 10-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $\eta$ | Efficiency | $U_{i\,nom}$ = 24 V, $I_{o\,nom}$<br>$U_{i\,nom}$ = 48 V, $I_{o\,nom}$ | 77<br>77 | 80<br>80 | | 77<br>77 | 80<br>80 | | 77<br>77 | 80<br>80 | | % |

Double output units should have the same (%) load conditions at both outputs to comply with above specifications.

*Table 2b: Input Data*

| **Input** | | | .. IPZ 10-05 .. | | | .. IPZ 10-12 .. | | | .. IPZ 10-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range 24 IPS<br>48 IPS | $T_{A\,min}$... $T_{A\,max}$<br>$I_o$ = 0... $I_{o\,nom}$ | 10<br>18 | | 33<br>72 | 10<br>18 | | 33<br>72 | 10<br>18 | | 33<br>72 | V DC |
| $U_{i\,abs}$ | Input voltage limits without any damage 24 IPS [1]<br>48 IPS [2] | | 0<br>0 | | 45<br>75 | 0<br>0 | | 45<br>75 | 0<br>0 | | 45<br>75 | |
| $I_{i\,o}$ | No load input current Group 01<br>Group 02 | $U_{i\,nom}$, $I_o$ = 0 | | 25<br>25 | | | 25<br>45 | | | 25<br>45 | | mA |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}$... $U_{i\,max}$<br>$T_{A\,min}$... $T_{A\,max}$ | | 1.2 $I_{i\,max}$ | | | 1.2 $I_{i\,max}$ | | | 1.2 $I_{i\,max}$ | | |
| $I_{i\,rfi}$ | RFI current at the input | $I_o$ = 0... $I_{o\,max}$ | | 30 | | | 30 | | | 30 | | $mA_{pp}$ |
| $f_s$ | Switching frequency | $U_{i\,min}$...$_{max}$, $I_{o\,nom}$<br>$T_{A\,min}$... $T_{A\,max}$ | | 145 | | | 145 | | | 145 | | kHz |

[1] 35 V for 500 ms, repetition rate 50 s; 45 V DC for 10 ms repetition rate 10 s; according to Siemens standard SN 26555, section 9
[2] The applied minimum load must be 10% between 72.0...75.0 V DC

*Table 3b: Output Data*

| **Output** | | | .. IPZ 10-05 .. | | | .. IPZ 10-12 .. | | | .. IPZ 10-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 4.95 | | 5.05 | 11.88 | | 12.12 | 14.85 | | 15.15 | V DC |
| $I_{o\,nom}$ | Nominal output current Group 01<br>Group 02 | $U_{i\,min}$... $U_{i\,max}$<br>$T_{A\,min}$... $T_{A\,max}$ | | 1000<br>500 | | | 417<br>208 | | | 333<br>167 | | mA |
| $u_o$ | Output ripple (BW = 20 MHz) | $U_{i\,min}$... $U_{i\,max}$<br>$I_{o\,nom}$ | | 50 | 100 | | 120 | 240 | | 150 | 300 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static line regulation | | | 5 | 10 | | 12 | 24 | | 15 | 30 | mV |
| $\Delta U_{o\,I}$ | Static load regulation | $U_{i\,min}$... $U_{i\,max}$<br>$I_{o\,nom}$...0 | | 0...50 | | | 0...50 | | | 0...50 | | |
| $\alpha_{Uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| | Output overvoltage clamping | | | 5.6 $^{+10/-0\%}$ | | | 13 $^{+10/-0\%}$ | | | 16 $^{+10/-0\%}$ | | V |

*Table 4b: Efficiency*

| **Efficiency** | | | .. IPZ 10-05 .. | | | .. IPZ 10-12 .. | | | .. IPZ 10-15 .. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $\eta$ | Efficiency | $U_{i\,nom}$ = 24 V, $I_{o\,nom}$<br>$U_{i\,nom}$ = 48 V, $I_{o\,nom}$ | 77<br>77 | 80<br>80 | | 77<br>77 | 80<br>80 | | 77<br>77 | 80<br>80 | | % |

Double output units should have the same (%) load conditions at both outputs to comply with above specifications.

## Immunity to Environmental Conditions

### Thermal Considerations

*Table 6: Temp. specification values given are valid for air pressures in the range 800...1200 hPa (800...1200 mbar)*

| Characteristics | | Conditions | Standard -T | | on request [1] | | Unit |
|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 71 | –40 | 85 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | 0 | 91 | –40 | 105 | |
| $T_S$ | Storage temperature | not operational | –55 | 105 | –55 | 105 | |

[1] Available on request as special types (custom designed units) with reduced output power

The case temperature $T_C$ should not exceed the maximum value. In applications with limited air circulation, additional measures must be taken (either larger spacing or a fan) to avoid case temperatures higher than $T_{C\,max}$!

*Table 7: MTBF*

| Values at specified Case Temperature | Modules Types | Ground Benign | Ground Fixed | | Ground Mobile | | Unit |
|---|---|---|---|---|---|---|---|
| | | 40°C | 40°C | 70°C | 40°C | 70°C | |
| MTBF according to MIL-HDBK-217F | Single output | 2'150'000 | 570'000 | 270'000 | 190'000 | 90'000 | h |
| | Double outputs | 1'850'000 | 510'000 | 250'000 | 150'000 | 70'000 | |

## Functional Description and Block Diagrams

These converters are primary controlled single transistor forward converters using Pulse With Modulation (PWM). The output voltage is fed back to the primary control circuit via a signal transformer. The second output voltage regulation relies on the close magnetic coupling of the output inductor together with the circuit symmetry. Therefore output 2 should have the same (%) load condition as output 1 to comply with the specified data. The current limitation is located on the primary side, limiting the total output current.

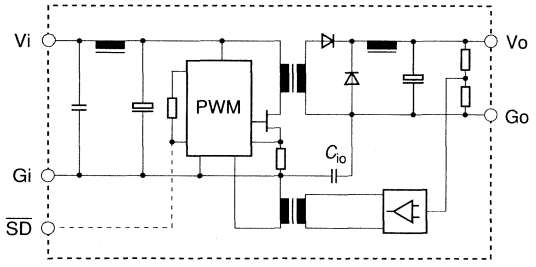



*Fig. 2*
*Group 01, single output*

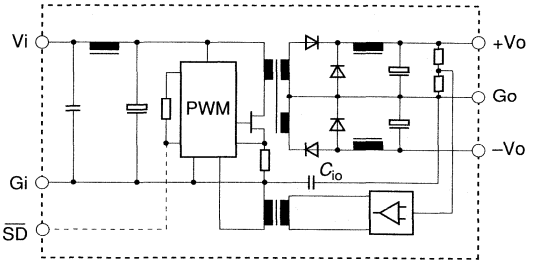



*Fig. 3*
*Group 02, double output*


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## Mechanical Data

Dimensions in mm. Tolerances ±0.2 mm, unless otherwise specified.

European Projection

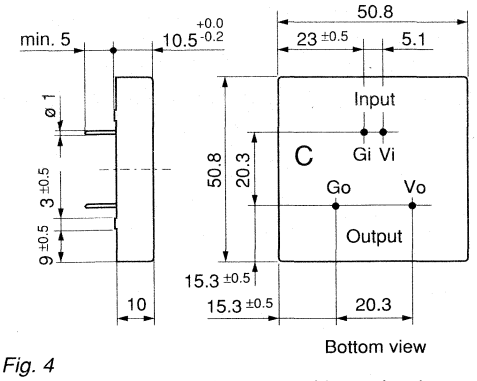



*Fig. 4*
*2"×2" metal case, single output without shutdown*
*Pin configuration C, available for IPS and IPW-types*

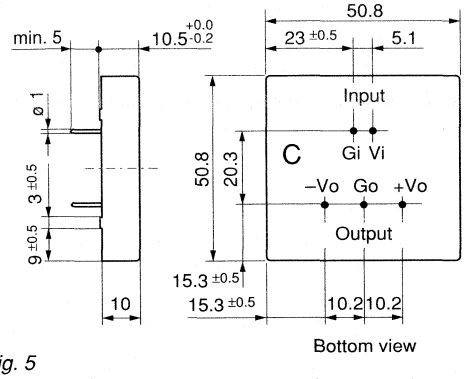



*Fig. 5*
*2"×2" metal case, double output without shutdown*
*Pin configuration C, available for IPS and IPW-types*

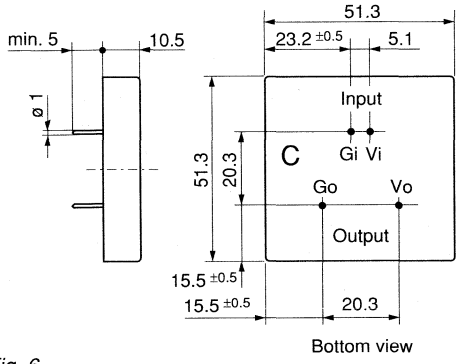



*Fig. 6*
*Plastic case, single output without shutdown*
*Pin configuration C, available for IPZ-types*

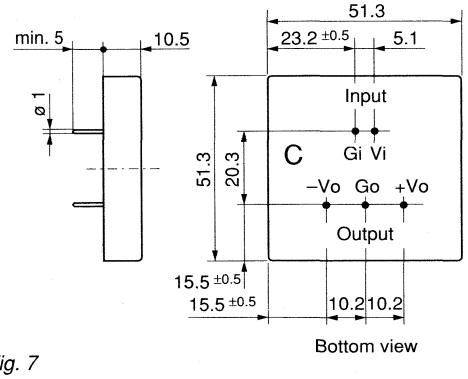



*Fig. 7*
*Plastic case, double output without shutdown*
*Pin configuration C, available for IPZ-types*

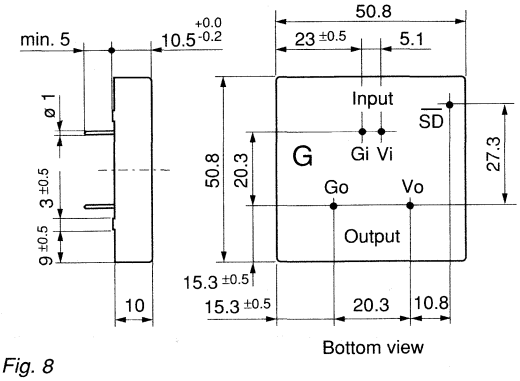



*Fig. 8*
*2"×2" metal case, single output with shutdown*
*Pin configuration G, available for IPS and IPW-types*

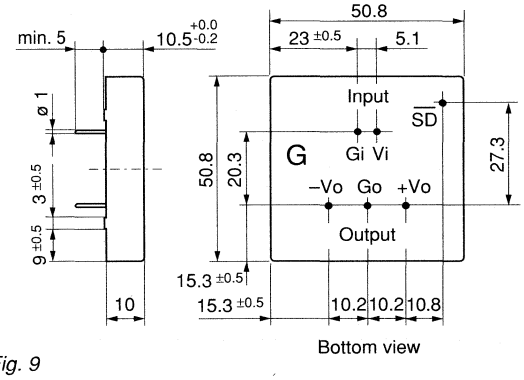



*Fig. 9*
*2"×2" metal case, double output with shutdown*
*Pin configuration G, available for IPS and IPW-types*

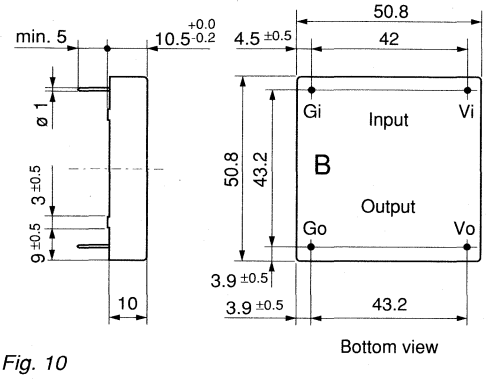



*Fig. 10*
*2"×2" metal case, single output without shutdown*
*Pin configuration B, available for IPS-types*

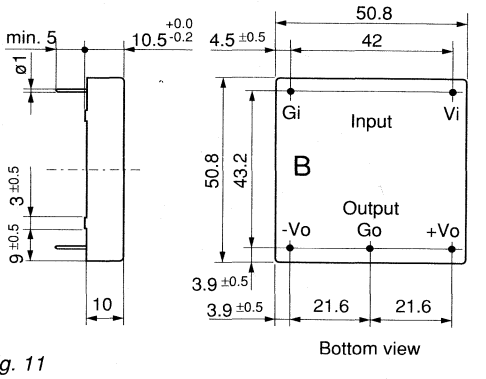



*Fig. 11*
*2"×2" metal case, double output without shutdown*
*Pin configuration B, available for IPS-types*

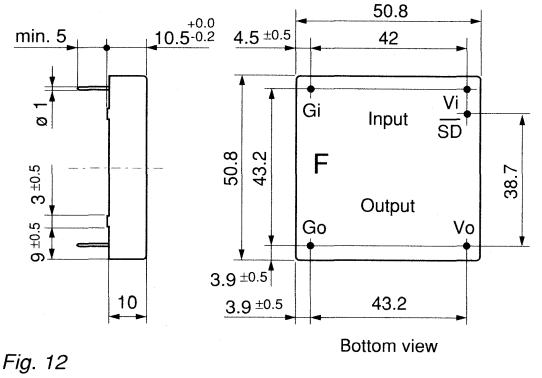



*Fig. 12*
*2"×2" metal case, single output with shutdown*
*Pin configuration F, available for IPS-types*

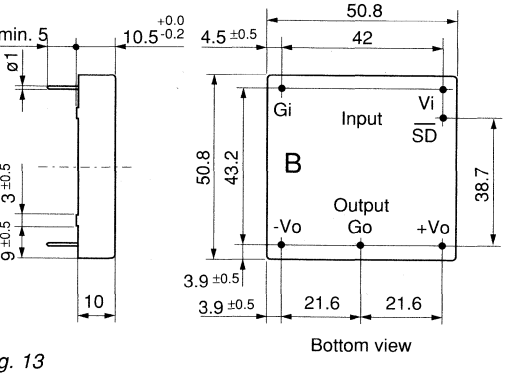
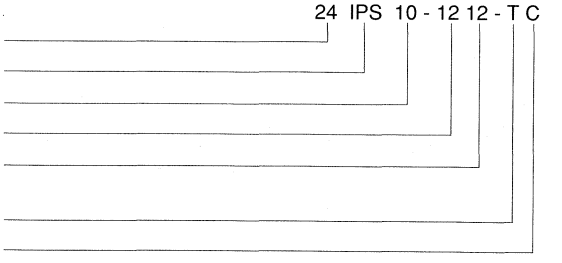



*Fig. 13*
*2"×2" metal case, double output with shutdown*
*Pin configuration F, available for IPS-types*

## Type Key and Product Marking

**Type Key:**

Nominal input voltage in volt ..... 24, 48
Family ..... IPS, IPW, IPZ
Nominal output power in watts ..... 5, 10
Nominal output voltage for output 1 in volt ..... 05, 12, 15
Nominal output voltage for output 2 in volt ..... 05, 12, 15
Operating ambient temperature range
$T_A$ = –21...71 °C ..... T
Pin configuration ..... C, B, G, F




**Product Marking:**

Main face: Manufacturer's name (IBEK), specific type designation, input voltage range, input and output pin allocation.
Bottom: Date code.

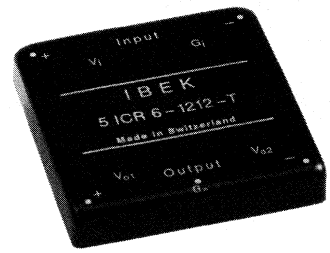

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# IBEK DC-DC Converters

# 6 Watt-Family

**Input to output isolation test voltage 500 $V_{rms}$**
**Single output of 5 V DC/5 W**
**Single and dual output of 12 V DC and 15 V DC/6 W**
**Input voltages of 5, 12, 15, 24, 28 and 48 V DC**

- Efficient Pi input filter
- Outputs equipped with linear voltage regulation
- High reliability
- Optimal dynamic response
- Continuous no-load and short-circuit proof
- Operating ambient temperature range up to −40...85°C (optional)
- Case height only 10.5 mm




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## Description

The DC-DC converters have been developed as a response to the increasing need for decentralised power supply systems. They are especially suitable for powering medium loads on PCBs and for realising redundant systems. The DC-DC converters feature high efficiency, low output ripple, low module height, high quality and reliability. To minimise feedback effects in the supply system, the modules are equipped with an efficient low-pass Pi input filter.

All modules are manufactured according to ISO 9001.

Case: 2"×2" metal, black anodized, self cooling (free air convection).

## Type Survey

General Condition: $T_A$ = 25°C

*Table 1: Type survey*

| Output $U_{o\,nom}$ [V DC] | Output $I_{o\,nom}$ [mA] | Input $U_{i\,nom}$ [V DC] | Typ. no load Input Current ($U_{i\,nom}$, $I_o$ = 0) [mA] | Efficiency η (typ.) [%] | Group [1] | 700 V DC/500 Vrms Isolation test voltage Type [2] | Pin-Config. | Option |
|---|---|---|---|---|---|---|---|---|
| 5 | 1000 | 5 | 32 | 68 | 01 | 5 ICR 5-05-T.. | C, B | S |
| 12 | 500 | | 46 | 72 | | 5 ICR 6-12-T.. | | |
| 15 | 400 | | 52 | 72 | | 5 ICR 6-15-T.. | | |
| ±12 | ±250 | | 125 | 68 | 02 | 5 ICR 6-1212-T.. | | |
| ±15 | ±200 | | 150 | 70 | | 5 ICR 6-1515-T.. | | |
| 5 | 1000 | 12 | 20 | 70 | 01 | 12 ICR 5-05-T.. | | |
| 12 | 500 | | 25 | 75 | | 12 ICR 6-12-T.. | | |
| 15 | 400 | | 30 | 75 | | 12 ICR 6-15-T.. | | |
| ±12 | ±250 | | 60 | 72 | 02 | 12 ICR 6-1212-T.. | | |
| ±15 | ±200 | | 63 | 73 | | 12 ICR 6-1515-T.. | | |
| 5 | 1000 | 15 | 18 | 72 | 01 | 15 ICR 5-05-T.. | | |
| 12 | 500 | | 19 | 75 | | 15 ICR 6-12-T.. | | |
| 15 | 400 | | 20 | 75 | | 15 ICR 6-15-T.. | | |
| 5 | 1000 | 24 | 18 | 72 | | 24 ICR 5-05-T.. | | |
| 12 | 500 | | 19 | 76 | | 24 ICR 6-12-T.. | | |
| 15 | 400 | | 20 | 76 | | 24 ICR 6-15-T.. | | |
| ±12 | ±250 | | 37 | 74 | 02 | 24 ICR 6-1212-T.. | | |
| ±15 | ±200 | | 39 | 75 | | 24 ICR 5-1515-T.. | | |
| 5 | 1000 | 28 | 18 | 72 | 01 | 28 ICR 5-05-T.. | | |
| 12 | 500 | | 19 | 76 | | 28 ICR 6-12-T.. | | |
| 15 | 400 | | 20 | 76 | | 28 ICR 6-15-T.. | | |
| ±12 | ±250 | | 34 | 75 | 02 | 28 ICR 6-1212-T.. | | |
| ±15 | ±200 | | 36 | 75 | | 28 ICR 6-1515-T.. | | |
| 5 | 1000 | 48 | 12 | 70 | 01 | 48 ICR 5-05-T.. | | |
| 12 | 500 | | 13 | 72 | | 48 ICR 6-12-T.. | | |
| 15 | 400 | | 14 | 72 | | 48 ICR 6-15-T.. | | |
| ±12 | ±250 | | 28 | 73 | 02 | 48 ICR 6-1212-T.. | | |
| ±15 | ±200 | | 30 | 73 | | 48 ICR 6-1515-T.. | | |

[1] See "Block Diagrams"
[2] Pin configuration has to be added to the type designation (e.g. 5 ICR 5-05-TC)




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## Electrical Input and Output Data

General Conditions: $T_A$ = 25 °C

*Table 2: Input Data*

| Input | | | | 5 V | 12 V | 15 V | 24 V | 28 V | 48 V | |
|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | | Conditions | | | | | | | Unit |
| $U_i$ | Input voltage range at 60% load | min<br>max | DC | 4.40<br>6.50 | 10.56<br>15.60 | 13.20<br>19.50 | 21.12<br>31.20 | 24.64<br>36.40 | 42.24<br>62.40 | V |
| | Input voltage range at 80% load | min<br>max | | 4.50<br>6.00 | 10.80<br>14.40 | 13.50<br>18.00 | 21.60<br>28.80 | 25.20<br>33.60 | 43.20<br>57.60 | |
| | Input voltage range at 100% load | min<br>max | | 4.65<br>5.50 | 11.16<br>13.20 | 13.95<br>16.50 | 22.32<br>26.40 | 26.04<br>30.80 | 44.64<br>52.80 | |
| $i_{i\,rfi}$ | RFI current at the input | typ<br>max | $U_{i\,nom}$, $I_{o\,nom}$<br>$L_{source}$ = 1 µH | 1% $_{pp}$ of $I_i$<br>3% $_{pp}$ of $I_i$ | | | | | | |
| $U_{i\,abs}$ | Input voltage limits without any damage | min<br>max | max 60 s | 0<br>6.75 | 0<br>6.20 | 0<br>20.25 | 0<br>32.40 | 0<br>37.80 | 0<br>64.80 | V |
| $f_s$ | Switching frequency | min<br>max | $U_{i\,nom}$, $I_{o\,nom}$ | 20<br>40 | | | | | | kHz |

*Table 3: Output Data*

| Output | | | | 5 V | 12 V | 15 V | |
|---|---|---|---|---|---|---|---|
| Characteristics | | | Conditions | | | | Unit |
| $U_o$ | Output voltage | | $U_{i\,nom}$, $I_{o\,nom}$ | 5 | 12 | 15 | V |
| $\Delta U_{o\,a}$ | Output voltage accuracy | max | | ±0.5 | | | % |
| $I_{oL}$ | Output current limitation response | typ | $U_{i\,nom}$ | 1.25 $I_{o\,nom}$ | | | |
| $I_{oS}$ | Short-circuit current of the output | typ<br>max | $U_{i\,nom}$, $U_o$ = 0 | 1.4 $I_{o\,nom}$<br>2.0 $I_{o\,nom}$ | | | |
| $u_o$ | Output voltage noise | max | $U_{i\,nom}$, $I_{o\,nom}$ | 1 | | | $mV_{rms}$ |
| | | | (BW = 20 MHz) | 35 | | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static line regulation | typ | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$ | ±0.05 | | | % |
| $\Delta U_{o\,I}$ | Static Load regulation | typ | $U_{i\,nom}$ | ±0.1 | | | |
| $u_{od}$ | Dynamic load regulation | max | $I_o$ = 0...$I_{o\,nom}$ | 50 | | | mV |
| $t_{rr}$ | Load transient recovery time | typ | | 20 | | | µs |
| $\alpha_{Uo}$ | Temperature coefficient | typ<br>max | $U_{i\,nom}$, $I_{o\,nom}$ | ±0.01<br>±0.03 | | | %/K |

*Table 4: Efficiency*

| Efficiency | | | | 5 V | 12 V | 15 V | |
|---|---|---|---|---|---|---|---|
| Characteristics | | | Conditions | | | | Unit |
| $\eta$ | Efficiency | min<br>typ | $U_{i\,nom}$, $I_{o\,nom}$ | 68<br>75 | | | % |

## Supplementary Data

### Isolation Tests

Input to output isolation voltage tests are performed as factory tests (100%) and should not be repeated in the field. Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests.

*Table 5: Isolation test voltage, coupling capacitance and insulation resistance*

| Characteristics | | Conditions | ICR | Unit |
|---|---|---|---|---|
| $U_{is\ io}$ | Isolation test voltage Input to output | AC: 50 Hz, 1 minute | 500 | $V_{rms}$ |
| | | | 1400 | $V_{pp}$ |
| | | DC: 1 second [1] | 700 | V |
| | | DC: 1 second [2] | 800 | |
| $C_{io}$ | Coupling capacitance typ | | 70 | pF |
| $R_{is}$ | Insulation resistance | at 100 V DC after 1 minute | ≥1000 | MΩ |

[1] For production test purposes in accordance with IEC 950/ EN 60950
[2] Factory test procedure

5.2

### Connection in Series

If the outputs of one or more units are connected in series each individual output should be protected by a zener diode or preferably by a suppressor diode to avoid overvoltages or reverse polarity at the individual outputs, e.g.:
– 1N5908 to protect 5 V outputs
– BZW04-11 to protect 12 V outputs
– BZW04-14 to protect 15 V outputs
(or equivalent types)

Such destructive voltages may occur at switch-on cycle of the converters, if the output voltages do not rise at the same time. The "slower" output(s) could be supplied and, as a result, destroyed by the "faster" output(s) via the load. The maximum output current is limited by the lowest current limitation.

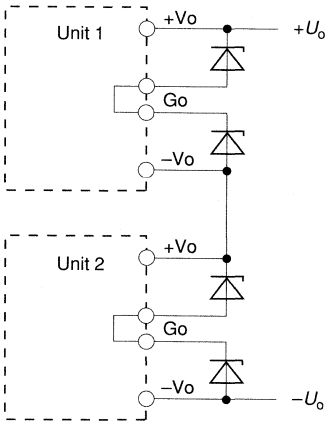



*Fig. 1*
*Outputs connected in series*

### Connection in Parallel

Connection of the outputs of one or more units in parallel is not permitted. The load distribution and the ripple values could not be controlled.

Exception: .. ICR 5-05 (all 5 V single output units)

### Cleaning

Two CFC free cleaning solvents have been tested and can be recommended:
– Prozone from BP
– Zestron from Dr. O. K. Wack Chemie GmbH (Germany)

Submersion of the units in water for rinsing is permitted. Drying should be done in the air.


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## Immunity to Environmental Conditions

### Thermal Considerations

*Table 6: Temp. specification values given are valid for air pressures in the range 800...1200 hPa (800...1200 mbar)*

| Characteristics | | Conditions | Standard -T | | Option -S [1] | | Unit |
|---|---|---|---|---|---|---|---|
| | | | min | max | min | max | |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –25 | 71 | –40 | 85 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | –25 | 91 | –40 | 105 | |
| $T_S$ | Storage temperature | not operational | –55 | 105 | –55 | 105 | |

[1] ICR 6: Linear derating of the output power from 6 to 5 watts for $T_A$ = 71°C to 85°C.

The case temperature $T_C$ must not exceed the maximum value. In applications with limited air circulation, additional measures must be taken (either larger spacing or a fan) to avoid case temperatures higher than $T_{C\,max}$!

*Table 7: MTBF*

| Values at specified Case Temperature | Modules Types | Ground Benign | Ground Fixed | | Ground Mobile | | Unit |
|---|---|---|---|---|---|---|---|
| | | 40°C | 40°C | 70°C | 40°C | 70°C | |
| MTBF according to MIL-HDBK-217F | Single output | 2'150'000 | 570'000 | 270'000 | 190'000 | 90'000 | h |
| | Double output | 1'850'000 | 510'000 | 250'000 | 150'000 | 70'000 | |

5.2

## Block Diagrams

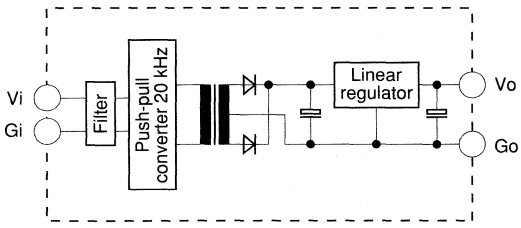



*Fig. 2*
*ICR 5/6, group 01 (single output)*

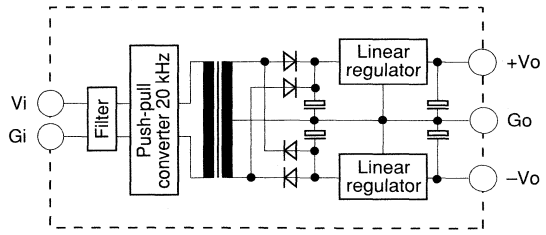



*Fig. 3*
*ICR 5/6, group 02 (double output)*

## Mechanical Data

Dimensions in mm. Tolerances ±0.2 mm, unless otherwise specified.

European Projection

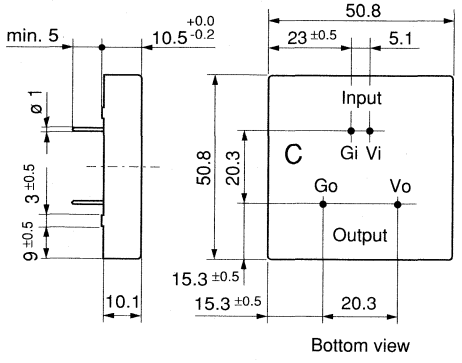



*Fig. 4*
*Single output, pin configuration C*

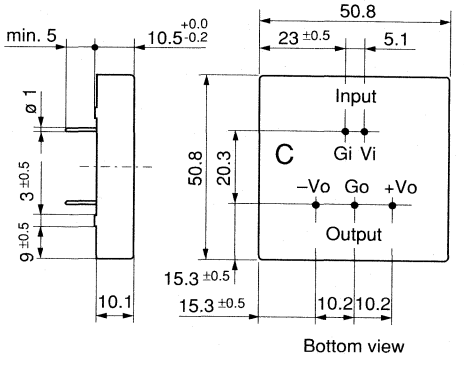



*Fig. 5*
*Double output, pin configuration C*

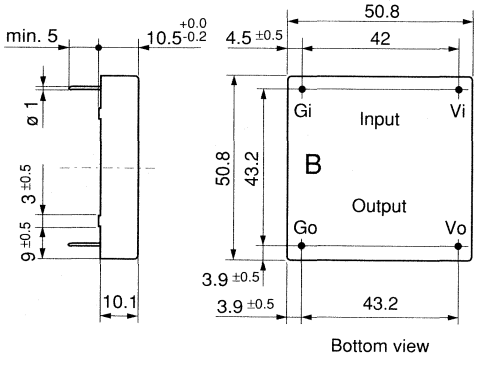



*Fig. 6*
*Single output, pin configuration B*

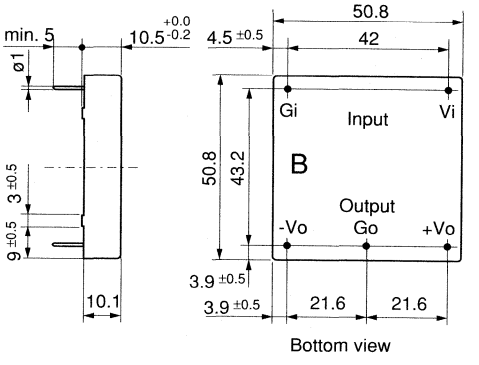



*Fig. 7*
*Double output, pin configuration B*

## Type Key and Product Marking

### Type Key

24 ICR 6 - 12 12 - T C

Nominal input voltage in volt ..... 5, 12, 15, 24, 28, 48
Family ..... ICR
Nominal output power in watt ..... 5, 6
Nominal output voltage for output 1 in volt ..... 05, 12, 15
Nominal output voltage for output 2 in volt ..... 12, 15
Ambient temperature range
TA = –25...71°C ..... T
TA = –40...85°C ..... S
Pin configuration ..... C, B

**Product Marking:**

Main face: Manufacturer's name (IBEK), specific type designation, input and output pin allocation.
Bottom: Date code.



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# 20 W DC-DC Converters

# SR-Family

**Single output of 5, 12, 15 or 24 V DC**
**Input voltage up to 180 V DC**

- Full input to output isolation 2.5 $kV_{rms}$
- Wide input voltage range
- High efficiency up to 81%
- Efficient input filter
- Very good dynamic characteristics
- Parallel and series compatible
- Continuous no-load and short circuit proof




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## Type Survey

*Table 1: Type survey*

| Output | | Input Voltage Range and Efficiency | | | | | | Options |
|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{i\,min}...U_{i\,max}$ **19...45 V DC** [1] | η % | $U_{i\,min}...U_{i\,max}$ **38...90 V DC** [1] | η % | $U_{i\,min}...U_{i\,max}$ **76...180 V DC** | η | |
| 5 | 4 | BSR 2005 | 73 | CSR 2005 | 77 | DSR 2005 | 77 | -6, R, i, P |
| 12 | 1.67 | BSR 2012 | 77 | CSR 2012 | 78 | DSR 2012 | 78 | |
| 15 | 1.34 | BSR 2015 | 78 | CSR 2015 | 79 | DSR 2015 | 79 | |
| 24 | 0.84 | BSR 2024 | 79 | CSR 2024 | 81 | DSR 2024 | 81 | |

[1] With option R for BSR: 16...38 V DC, for CSR: 32...76 V DC

Other output voltages and currents on request.

## Description

The DC-DC converters of the SR family are power supply modules for electronic systems. Their major advantages include a high efficiency that remains virtually constant over the entire input voltage range, high reliability, low ripple and excellent dynamic response. The converters are designed for chassis mounting.
Case: aluminium, black finish, fully enclosed, self cooling.

## Functional Description

After passing through a line interference filter, the DC voltage is chopped at a constant frequency of about 30 kHz. After transformer isolation and rectification, an output filter reduces ripple to a minimum without compromising the dynamic behaviour. The output voltage is routed to a control circuit with internal sense lines, where the output voltage is compared with a reference voltage. The voltage is regulated via a control transformer by varying the duty ratio of the forward converter.

The converters have input transient protection by means of a zinc oxide VDR and input reverse polarity protection by means of a protective diode and a fuse.

An internal inhibit signal keeps the output voltage switched off below approx. 0.7...0.9 $U_{i\,min}$.

The outputs are protected against continuous open circuit by means of an internal, electronically switched pre-load and against continuous short circuit by the current limiting circuit.

No output voltage overshoot will occur when plugging in or disconnecting the module, switching the input voltage on/off, inhibiting the unit or after reset.

In the event of a main control circuit failure, the maximum output voltage $U_o$ is restricted to 1.2 $U_{o\,nom}$ by means of an independent second control circuit.

When the converters are located in free, stationary air at a temperature $T_{A\,max}$ = 71 °C and are operated at nominal power, the case temperature $T_{C\,max}$ will reach approx. 85 °C after a certain warm-up time (Case temperature $T_C$ at the measuring point, see "Mechanical Data").

Under certain operating conditions the ambient temperature $T_{A\,max}$ may be allowed to exceed 71 °C provided that additional measures are taken to ensure the case temperature $T_{C\,max}$ remains below 85 °C.



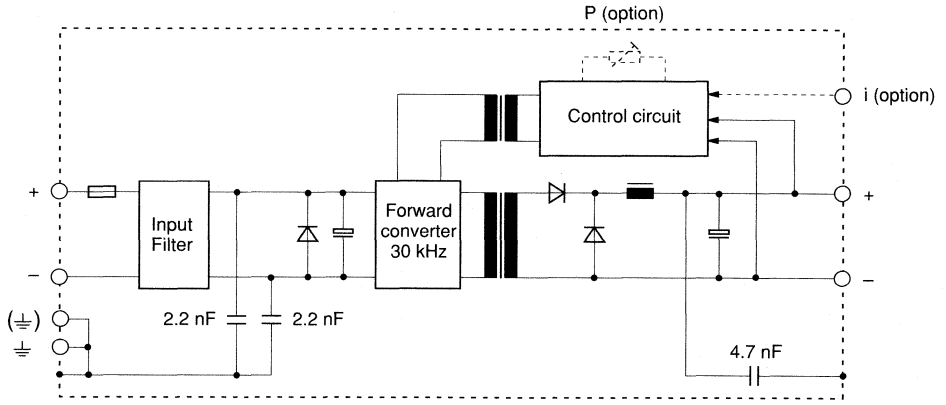



*Fig. 1*
*Block diagram*

## Safety and Installation Instructions

The converters correspond to safety class I equipment and comply with IEC 950, EN 60950, VDE 0805 Part 100, UL 1950 and CSA C 22.2 No.950. The input to output isolation test voltage is 2.5 $kV_{rms}$ at 50 Hz for 1 min.

Power and control transformers provide 8 mm isolation and air gaps between input and output. Creepage distances and air gaps between input and case and output and case are 4 mm.

**Installation:**

Installation must strictly follow the national safety regulations. The earthing pin (case) should be connected with protective ground.


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## Electrical Input and Output Data

General Conditions
- $T_A$ = 25°C, unless $T_C$ is specified
- With option i, pin i is connected with $-U_o$
- With option P, $U_o = U_{o\,nom}$ at $I_{o\,nom}$

*Table 2: Input data*

| Input | | | | BSR | | | CSR | | | DSR | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage | Standard | $I_o = 0...I_{o\,nom}$ | 19 | | 45 | 38 | | 90 | 76 | | 180 | V DC |
| | | Option R | $T_{C\,min}...T_{C\,max}$ | 16 | | 38 | 32 | | 76 | | n.a. | | |
| $I_{inr\,p}$ | Peak value of inrush current [2] | | $U_i$ = 30 V DC [1] | | 28 | | | 22 | | | 10 | | A |
| $t_{inr\,r}$ | Rise time [2] | | | | 0.2 | | | 0.3 | | | 0.4 | | ms |
| $t_{inr\,h}$ | Tail half value time [2] | | | | 1 | | | 0.7 | | | 1 | | |
| $u_{i\,RFI}$ | RFI level at input 0.01...30 MHz | | VDE 0871 50 Ω/50 µH $U_i$ = 30 V DC [1] | | | B | | | B | | | B | dB (µV) |
| *Si* | Primary fuse rating | | slow blow | | 3.15 | | | 2 | | | 1.6 | | A |
| $u_{i\,tr}$ | Input transient suppression | | 1.2/5 µs VDE 0433 | 0.8 | | | 1.5 | | | 2.5 | | | kV |
| $I_{i\,inh}$ | Residual input current with converter inhibited | | 5 min. after start | | 1...6 | | | 1...4 | | | 1...4 | | mA |
| $I_{i\,UV}$ | Input current undervoltage cut-off | | after 5 min. $U_i < 0.7\ U_{i\,min}$ | | 1 | | | 1 | | | 1 | | |

[1] With option R: $U_i$ = 24 V DC
[2] Definitions according to VDE 0433, part 3

*Table 3: Output data*

| Output | | | ..SR 2005 | | | ..SR 2012 | | | ..SR 2015 | | | ..SR 2024 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_i$ = 30 V DC [1] $I_{o\,nom}$ | 4.97 | | 5.03 | 11.92 | | 12.07 | 14.91 | | 15.09 | 23.85 | | 24.14 | V DC |
| $I_o$ | Output current | $U_{i\,min}...U_{i\,max}$ | 0 | | 4 | 0 | | 1.67 | 0 | | 1.34 | 0 | | 0.84 | A |
| $u_o$ | Ripple at output (BW = 20 MHz) | $U_{i\,min}...U_{i\,max}$ $I_{onom}$ | | 50 | 70 | | 20 | 30 | | 15 | 25 | | 15 | 25 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static line regulation | | | ±6 | ±12 | | ±8 | ±20 | | ±10 | ±20 | | ±12 | ±25 | mV |
| $\Delta U_{o\,I}$ | Static load regulation | $U_i$ = 30 V DC [1] $I_o = 0...I_{o\,max}$ | | 12 | 25 | | 20 | 40 | | 25 | 50 | | 30 | 60 | |
| $u_{o\,d}$ | Dynamic control deviation [2] | $U_i$ = 30 V DC [1] $\Delta I_o = \pm 0.8\ I_{o\,nom}$ | | ±70 | | | ±25 | | | ±25 | | | ±25 | | |
| $t_d$ | Dynamic load transient time constant [2] | | | 70 | | | 150 | | | 200 | | | 300 | | µs |
| $\alpha_{uo}$ | Temperature coefficient $\Delta U_o/\Delta T_C$ | $U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$ | | | ±1 | | | ±2 | | | ±3 | | | ±5 | mV/K |
| | | | | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| $I_{o\,L}$ | Output current limit | $U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ | | 4.4 | | | 1.84 | | | 1.47 | | | 0.92 | | A |
| $U_{o\,L}$ | Overvoltage limit with second control loop | Failure of main control circuit | 5.3 | | 6.8 | 13.5 | | 16.0 | 16.5 | | 19.0 | 27.0 | | 31.0 | V DC |
| **Efficiency** | | | | | | | | | | | | | | | |
| $\eta$ | Efficiency BSR | $U_{i\,nom}$ $I_{o\,nom}$ | 70 | 73 | | 74 | 77 | | 74 | 78 | | 75 | 79 | | % |
| | CSR | | 74 | 77 | | 75 | 78 | | 76 | 79 | | 77 | 81 | | |
| | DSR | | 74 | 77 | | 75 | 78 | | 76 | 79 | | 77 | 81 | | |

[1] With option R: $U_i$ = 24 V DC
[2] See "Dynamic Characteristics"

## Immunity to Environmental Conditions

*Table 4: Mechanical stress, impulse voltages, high frequency disturbances*

| Test Method | | Standard | Test Conditions | | Status |
|---|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{-3/+2}$ %<br>56 days | Not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction) | Operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction) | Operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Okt/min):<br>Max. vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s² (60...2000 Hz)<br>7.5 h (2.5 h each axis) | Operating |
| Impulse voltage withstand test | | IEC 255-4 | Class III: | 5 kV (1.2/50 µs; 500 Ω) | Not operating |
| High-frequency disturbance test | | Appendix E | Class III: | Long: 2.5 kV Trans: 1.0 kV (200 Ω) | Operating |

*Table 5: Temperature specifications*

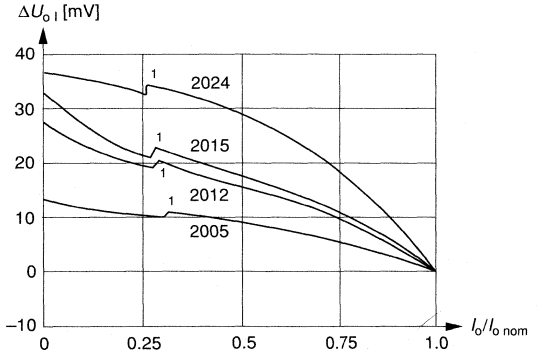
| Temperature | | | .. -6 | .. -7 | Standard | | Unit |
|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | | | min | max | |
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | Hermetic | Plastic | –25 | 71 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | semiconductor | semiconductor | –25 | 85 | |
| $T_S$ | Storage temperature | (Not operational) | devices [1] | devices | –40 | 85 | |

[1] Whenever possible

*Table 6: MTBF values*

| MTBF | | Ground Fixed | | Ground Mobile | |
|---|---|---|---|---|---|
| | | $T_C$ = 40°C | $T_C$ = 70°C | $T_C$ = 40°C | $T_C$ = 70°C |
| MTBF acc. to MIL-HDBK-217D | .. -6 | 155'000 h | 69'000 h | 31'500 h | 13'000 h |
| | .. -7 | 100'000 h | 46'000 h | 28'000 h | 18'000 h |

## Characteristics and Definitions




[1] Switch-off point of internal pre-load

*Fig. 2*
*Static load regulation.*
*Output voltage $U_o$ versus output current $I_o$*

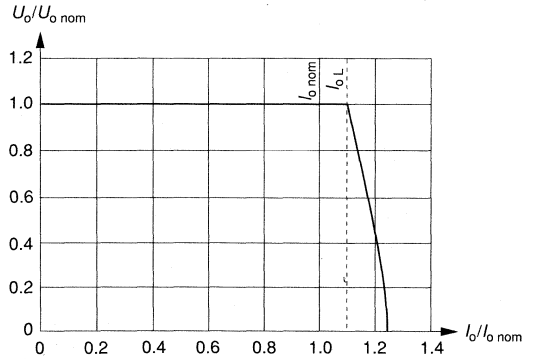



*Fig. 3*
*Short-circuit behaviour*
*Output voltage $U_o$ versus output current $I_o$*


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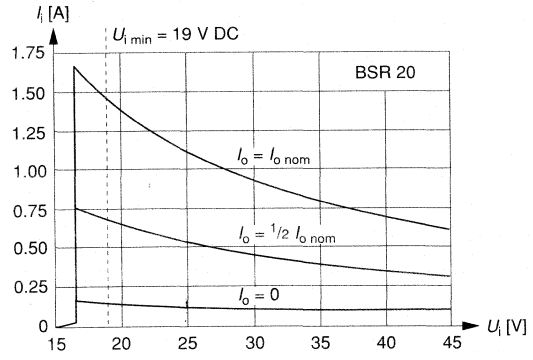



*Fig. 4*
*Input current $I_i$ versus input voltage $U_i$*

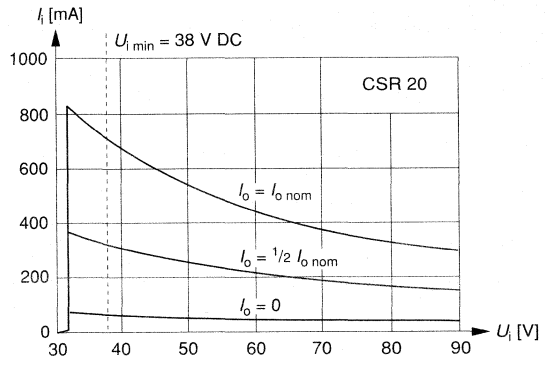



*Fig. 5*
*Input current $I_i$ versus input voltage $U_i$*

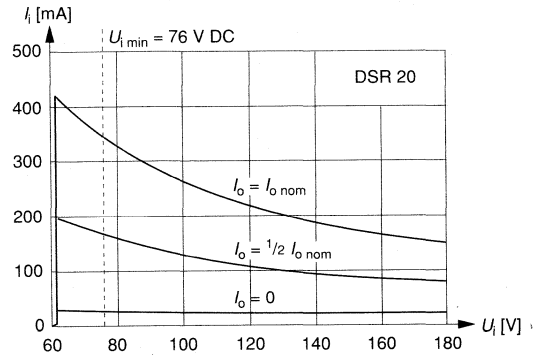
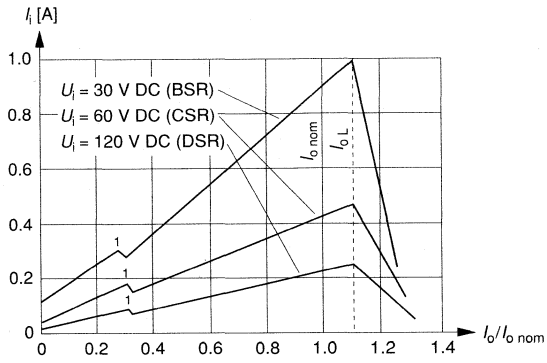



*Fig. 6*
*Input current $I_i$ versus input voltage $U_i$*




[1] Switch-off point of artificial pre-load

*Fig. 7*
*Input current $I_i$ versus input voltage $U_i$*

**Dynamic Characteristics**

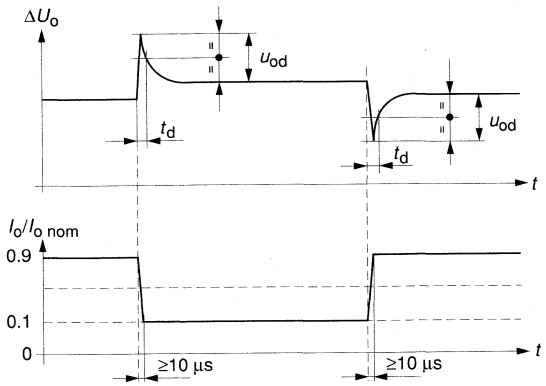



*Fig. 8*
*Behaviour and characteristics under dynamic load conditions*

## Description of Options

**Option -6** Hermetic semiconductor

The converters are equipped with hermetic semiconductors instead of the standard plastic ones as far as such components are electrically and mechanically compatible.

**Option R** Shifted input voltage range

Option R allows the operation of BSR and CSR DC-DC converter families from either 24 or 48 V input voltages. The input voltage tolerance is –30...+25% as required by IEC 571 "*Rules for Electronic Equipment used on Rail Vehicles*".

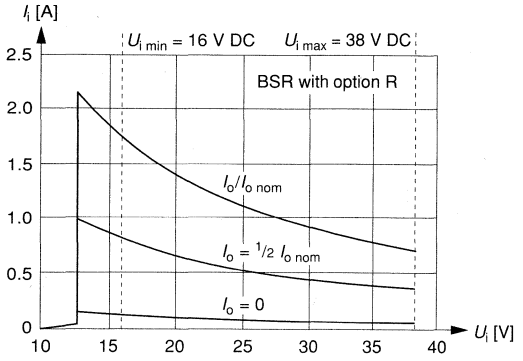



*Fig. 9*
*Input current $I_i$ versus input voltage $U_i$*

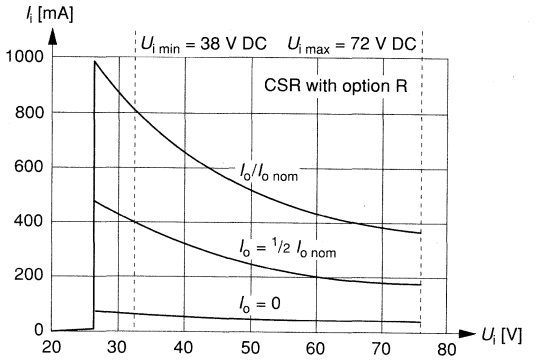



*Fig. 10*
*Input current $I_i$ versus input voltage $U_i$*

**Option i** Inhibit

The DC-DC converter can be switched on or off with a control signal via the inhibit input i. In systems with several units, this feature can be used, for example, to control the activation sequence of the units with a logic signal (TTL, C-MOS, etc.).

A non-used inhibit input should be connected to the negative output to enable the unit.

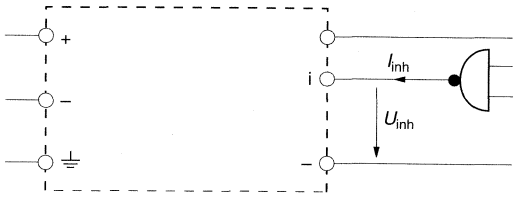



*Fig. 11*
*Definitions of $I_{inh}$ and $U_{inh}$*

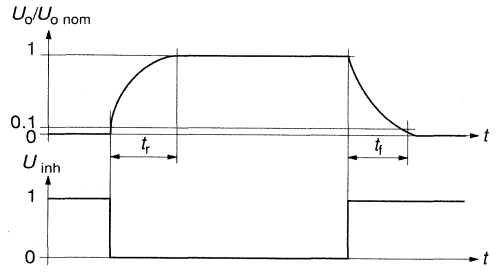



*Fig. 12*
*Output response as a function of inhibit signal*

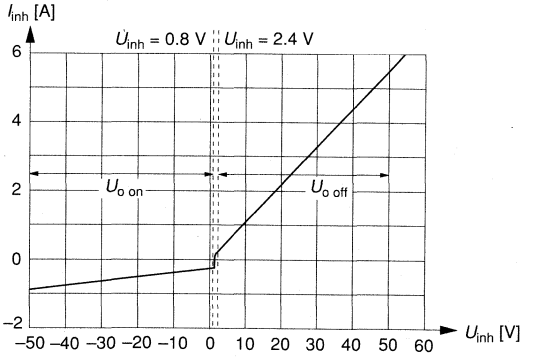



*Fig. 13*
*Inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*


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Edition 1/05 - © Melcher AG

*Table 7: Inhibit characteristics*

| Characteristics | | | Conditions | .. SR 2005 | | | .. SR 2012 | | | .. SR 2015 | | | .. SR 2024 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_{inh}$ | Inhibit input voltage to keep output voltage... | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $R_L = U_{o\,nom}/I_{o\,nom}$ ... ∞ | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | -50 | | +0.8 | V DC |
| | | $U_o$ = off | | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | +2.4 | | +50 | |
| $I_{inh}$ | Inhibit input current at $U_{inh}$ = 0 | | | | | –400 | | | –400 | | | –400 | | | –400 | µA |
| $t_r$ | Switch-on time after inhibit command | | $R_L = U_{o\,nom}/I_{o\,nom}$ BSR $U_i$ = 30 V DC | | 40 | | | 80 | | | 80 | | | 110 | | ms |
| $t_f$ | Switch-off time after inhibit command | | CSR $U_i$ = 60 V DC DSR $U_i$ = 120 V DC | | 2 | | | 75 | | | 75 | | | 80 | | |

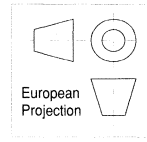
**Option P** Potentiometer

The potentiometer provides an output voltage adjustment range of ±5% from the nominal output voltage $U_{o\,nom}$ and is accessible from the connector side. This option can be used, for example, to compensate for voltage drops in the supply lines.

5.2

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



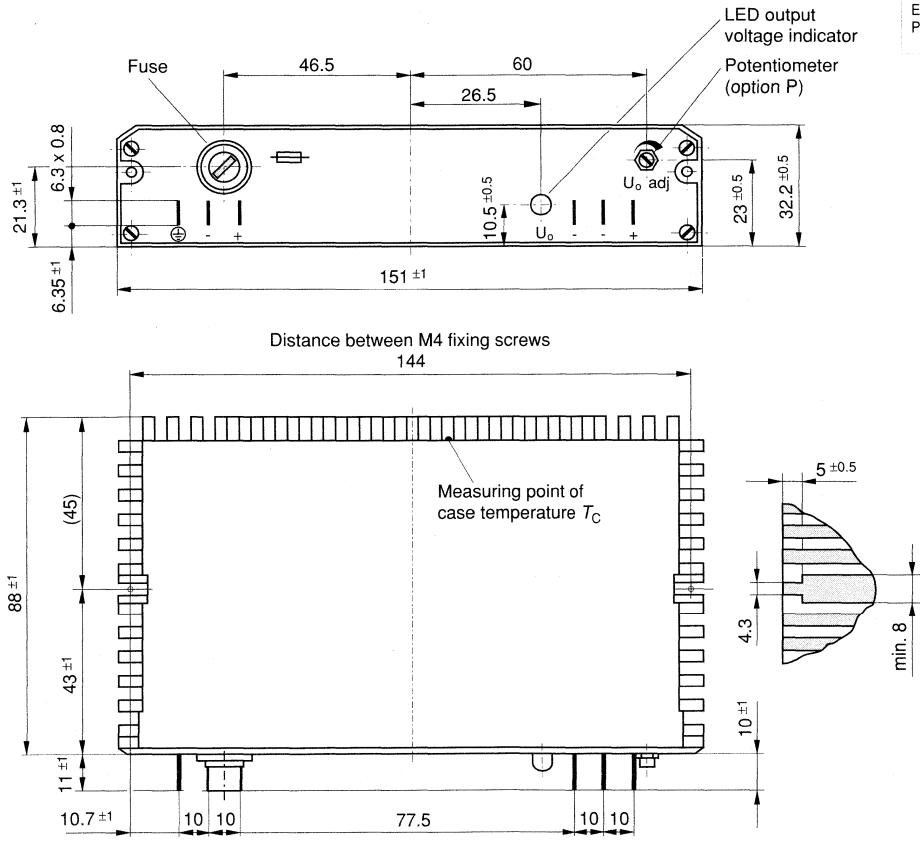
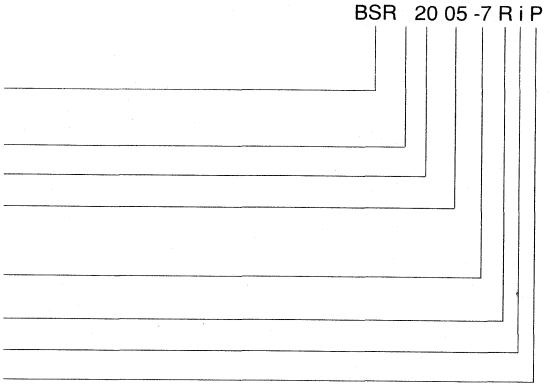




*Fig. 14*
*Case: C01 (weight: BSR 550 g, CSR and DSR 555 g)*

## Type Key and Product Marking

### Type Key




Input voltage range $U_i$
- 19...45 V DC ..... BSR
- 38...90 V DC ..... CSR
- 76...180 V DC ..... DSR

Blank .....

Nominal output power in watt ..... 20

Nominal output voltage in volt ..... 5...24

Ambient temperature range $T_A$ = –25...71 °C:
- Application of plastic semi-conductors ..... -7
- Application of hermetic semi-conductors ..... -6

Shifted input voltage range ..... R

Inhibit input ..... i

Potentiometer ..... P

Example: BSR 2005-7RiP = 20 watt DC-DC converter with a 5 V output, ambient temperature range of –25...71 °C, shifted input range of $U_i$ = 16...38 V DC, inhibit, and potentiometer.

### Produkt Marking

Main face: Basic type designation, input voltage range, nominal output voltage and current, Melcher company logo.

Cover: Specific type designation, pin allocation, identification of LED, potentiometers and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and date of production.



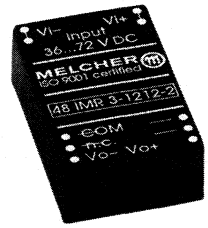
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# DC-DC Converters

# IMR 3-Family

**Input to output isolation test voltage 500 V DC**
**Single or double output**

- Input voltage range up to 3:1
- High efficiency up to 75%
- Short-circuit-proof
- No derating
- DIL 24 plastic package
- Low cost




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## Type Survey

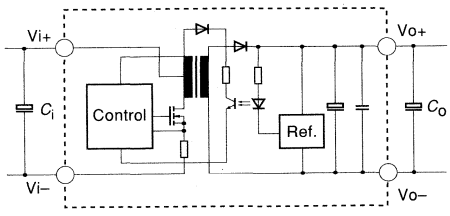
*Table 1: Type survey*

| Output $U_{o\,nom}$ | Output $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Input to output isolation | Type |
|---|---|---|---|---|---|
| 5 V | 500 mA | | | | .. IMR 3-05-2 |
| 12 V | 250 mA | 12 IMR 3: 9...18 V DC | 12 V DC | Test voltage: | .. IMR 3-12-2 |
| 15 V | 200 mA | 24 IMR 3: 18...36 V DC | 24 V DC | 500 V DC min. | .. IMR 3-15-2 |
| ±5 V | ±250 mA | 40 IMR 3: 20...60 V DC | 48 V DC | Resistance: | .. IMR 3-0505-2 |
| ±12 V | ±125 mA | 48 IMR 3: 36...72 V DC | 48 V DC | 10 MΩ min. | .. IMR 3-1212-2 |
| ±15 V | ±100 mA | | | | .. IMR 3-1515-2 |

## Description

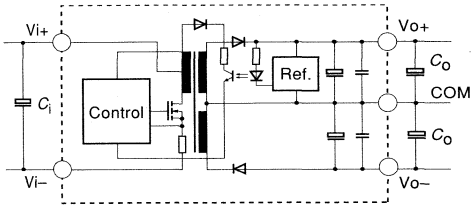
The IMR 3 family of DC-DC converters have been developed for powering commercial type of electronic circuits, e.g. telephone systems components, industrial controllers and small appliances. They are suitable for applications with standard battery voltages. The IMR 3 converters feature good efficiency and good dynamic response to load changes and at start-up. The IMR 3 modules are short-circuit-proof.

### Block Diagrams




$C_i$ = 4.7 µF/100 V must be added in any application
$C_o$= 10 µF to minimize ripple and noise to <100 $mV_{pp}$
(Capacitors should be of low ESR types)

*Fig. 1:*
*Single output converter block diagram*




$C_i$ = 4.7 µF/100 V must be added in any application
$C_o$=10 µF to minimize ripple and noise to <100 $mV_{pp}$
(Capacitors should be of low ESR types)

*Fig. 2:*
*Double output converter block diagram*

*Table 2: Pin assignment*

| Type | 2 | 3 | 9 | 10 | 11 | 14 | 15 | 16 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|
| Single output | Vi– | Vi– | – | n.c. | – | Vo+ | n.c. | Vo– | Vi+ | Vi+ |
| Double output | Vi– | Vi– | COM | n.c. | Vo– | Vo+ | n.c. | COM | Vi+ | Vi+ |

## Electrical Input and Output Data

General condition:
– $T_A$ = 25 °C unless otherwise specified

*Table 3a: Input data*

| Characteristics | | Conditions | 12 IMR 3 | | | 24 IMR 3 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| **Input** | | | min | typ | max | min | typ | max | |
| $U_i$ | Input voltage range | $T_{A\,min}...T_{A\,max}$, $I_o$ = 0...$I_{o\,nom}$ | 9 | | 18 | 18 | | 36 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | | | 12 | | | 24 | | |
| $I_{i\,0}$ | No load input current | $U_{i\,nom}$, $I_o$ = 0 | | 5 | | | 5 | | mA |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}...U_{i\,max}$<br>$T_{A\,min}...T_{A\,max}$ | | 1.25 $I_{onom}$ | | | 1.25 $I_{onom}$ | | |
| $I_{i\,rfi}$ | RFI input current | $I_o$ = 0...$I_{o\,nom}$ | | 30 | | | 30 | | $mA_{pp}$ |
| $U_{i\,rev}$ | Reverse input voltage protection | $U_i$ = negative or reverse polarity | | shunt diode use external fuse | | | shunt diode use external fuse | | |

*Table 3b: Input data*

| Characteristics | | Conditions | 40 IMR 3 | | | 48 IMR 3 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| **Input** | | | min | typ | max | min | typ | max | |
| $U_i$ | Input voltage range | $T_{A\,min}...T_{A\,max}$, $I_o$ = 0...$I_{o\,nom}$ | 20 | | 60 | 36 | | 72 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | | | 48 | | | 48 | | |
| $I_{i\,0}$ | No load input current | $U_{i\,nom}$, $I_o$ = 0 | | 5 | | | 5 | | mA |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}...U_{i\,max}$<br>$T_{A\,min}...T_{A\,max}$ | | 1.25 $I_{o\,nom}$ | | | 1.25 $I_{o\,nom}$ | | |
| $I_{i\,rfi}$ | RFI input current | $I_o$ = 0...$I_{o\,nom}$ | | 30 | | | 30 | | $mA_{pp}$ |
| $U_{i\,rev}$ | Reverse input voltage protection | $U_i$ = negative or reverse polarity | | shunt diode use external fuse | | | shunt diode use external fuse | | |

*Table 4a: Output data*

| Characteristics | | Conditions | .. IMR 3-05 | | | .. IMR 3-12 | | | .. IMR 3-15 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Nominal output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 4.90 | | 5.10 | 11.76 | | 12.24 | 14.70 | | 15.30 | V |
| $I_{o\,nom}$ | Nominal output current:<br>– 12 IMR 3 types<br>– other types | $U_{i\,min}$...$U_{i\,max}$ | | 400<br>500 | | | 200<br>250 | | | 150<br>200 | | mA |
| $u_o$ | Output ripple voltage:<br>– without $C_o$<br>– with $C_o$ | $U_{i\,min}$...$U_{i\,max}$,<br>$I_{o\,nom}$,<br>(BW=20 MHz) | | | 300<br>100 | | | 300<br>100 | | | 300<br>100 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation vs. input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$,<br>$I_{o\,nom}$ | | | ±1 | | | ±1 | | | ±1 | % |
| $\Delta U_{o\,I}$ | Static control deviation vs. output current $I_o$ | $U_{i\,nom}$,<br>$I_o$ = 0 ↔ $I_{o\,nom}$ | | ±2 | | | ±2 | | | ±2 | | |
| $\alpha_{uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| $f_s$ | Switching frequency | | 50 | | | 50 | | | 50 | | | kHz |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | – 12 IMR 3 types<br>– other types | $U_{i\,nom}$, $I_{o\,nom}$ | | 63<br>70 | | | 65<br>70 | | | 65<br>70 | | % |

*Table 4b: Output data*

| Characteristics | | Conditions | .. IMR 3-0505 | | | .. IMR 3-1212 | | | .. IMR 3-1515 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Nominal output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | ±4.90 | | ±5.10 | ±11.76 | | ±12.24 | ±14.70 | | ±15.30 | V |
| $I_{o\,nom}$ | Nominal output current:<br>– 12 IMR 3 types<br>– other types | $U_{i\,min}$...$U_{i\,max}$ | | ±200<br>±250 | | | ±100<br>±125 | | | ±80<br>±100 | | mA |
| $u_o$ | Output ripple voltage:<br>– without $C_o$<br>– with $C_o$ | $U_{i\,min}$...$U_{i\,max}$,<br>$I_{o\,nom}$,<br>(BW=20 MHz) | | | 300<br>100 | | | 300<br>100 | | | 300<br>100 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation vs. input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$,<br>$I_{o\,nom}$ | | | ±1 | | | ±1 | | | ±1 | % |
| $\Delta U_{o\,I}$ | Static control deviation vs. output current $I_o$ | $U_{i\,nom}$,<br>$I_o$ = 0.2↔$I_{o\,nom}$ | | ±5 | | | ±5 | | | ±5 | | |
| $\alpha_{uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| $f_s$ | Switching frequency | | 50 | | | 50 | | | 50 | | | kHz |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | – 12 IMR 3 types<br>– other types | $U_{i\,nom}$, $I_{o\,nom}$ | | 65<br>72 | | | 67<br>75 | | | 67<br>75 | | % |

5.3

## Immunity to Environmental Conditions

### Thermal Considerations

*Table 6: Temperature specification*

| Characteristics | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | not operational | –25 | 100 | |

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

European Projection

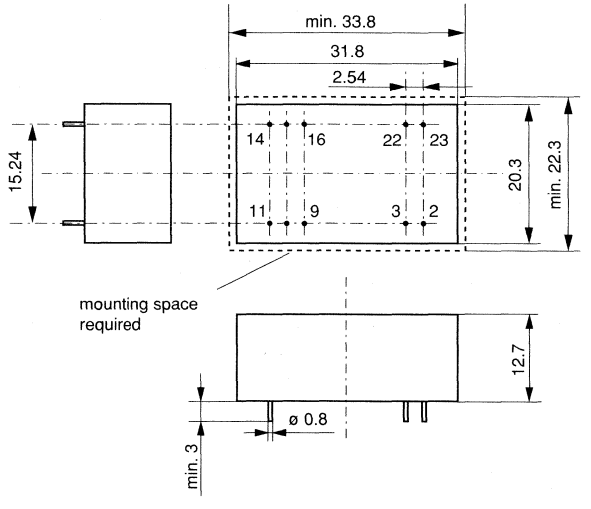



*Fig. 3:*
*Case: DIL 24*
*Weight: 16 g*

## Type Key and Product Marking

### Type Key

24 IMR 3 - 12 12 -2

Nominal input voltage in volt ..... 12...48
Blank .....
Family ..... IMR
Nominal output power in watt ..... 3
Nominal output voltage for output 1 in volt ..... 5...15
Nominal output voltage for output 2 in volt ..... 5...15
Operational ambient temperature range ..... -2

### Product Marking

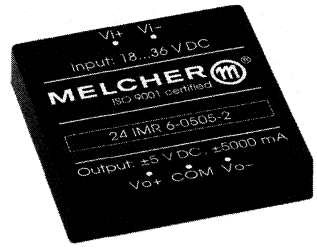
Main face: Melcher name, data code on separate label, type of converter, input voltage range, output voltage(s) and current(s) and pin assignment.

# DC-DC Converters

# IMR 6-Family

**Input to output isolation test voltage 500 V DC**
**Single or double output**

- Input voltage range up to 3:1
- Input filter
- High efficiency up to 75%
- Outputs short-circuit-proof
- No derating
- 2"×2" plastic case
- Low cost




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## Type Survey

*Table 1: Type survey*

| Output $U_{o\,nom}$ | Output $I_{o\,nom}$ | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Input to output isolation | Type |
|---|---|---|---|---|---|
| 5 V | 1000 mA | | | | .. IMR 6-05-2 |
| 12 V | 500 mA | 12 IMR 6: 9...18 V DC | 12 V DC | Test voltage: | .. IMR 6-12-2 |
| 15 V | 400 mA | 24 IMR 6: 18...36 V DC | 24 V DC | 500 V DC min. | .. IMR 6-15-2 |
| ±5 V | ±500 mA | 40 IMR 6: 20...60 V DC | 48 V DC | Resistance: | .. IMR 6-0505-2 |
| ±12 V | ±250 mA | 48 IMR 6: 36...72 V DC | 48 V DC | 1000 MΩ min. | .. IMR 6-1212-2 |
| ±15 V | ±200 mA | | | | .. IMR 6-1515-2 |

## Description

The IMR 6 family of DC-DC converters have been developed for powering commercial type of electronic circuits, e.g. telephone systems components, industrial controllers and small appliances. They are suitable for applications with standard battery voltages. The IMR 6 converters feature good efficiency and good dynamic response to load changes and at start-up. The IMR 6 modules are short-circuit-proof.

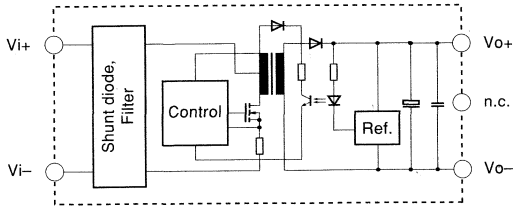



*Fig. 1:*
*Single output converter block diagram*

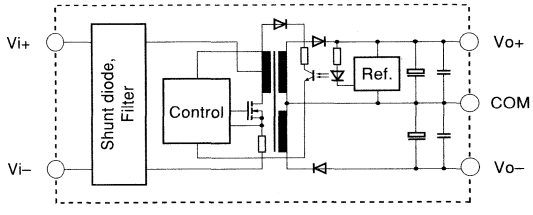



*Fig. 2:*
*Double output converter block diagram*

## Electrical Input and Output Data

General condition:
– $T_A$ = 25°C unless otherwise specified.

*Table 2a: Input data*

| Characteristics | | Conditions | 12 IMR 6 | | | 24 IMR 6 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| **Input** | | | min | typ | max | min | typ | max | |
| $U_i$ | Input voltage range | $T_{A\,min}$...$T_{A\,max}$, $I_o$ = 0...$I_{o\,nom}$ | 9 | | 18 | 18 | | 36 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | | | 12 | | | 24 | | |
| $I_{i\,0}$ | No load input current | $U_{i\,nom}$, $I_o$ = 0 | | 22 | | | 26 | | mA |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}$...$U_{i\,max}$ $T_{A\,min}$...$T_{A\,max}$ | | 1.25 $I_{o\,nom}$ | | | 1.25 $I_{o\,nom}$ | | |
| $I_{i\,rfi}$ | RFI input current | $I_o$ = 0...$I_{o\,nom}$ | | 30 | | | 30 | | $mA_{pp}$ |
| $U_{i\,rev}$ | Reverse input voltage protection | $U_i$ = negative or reverse polarity | | shunt diode use external fuse | | | shunt diode use external fuse | | |

*Table 2b: Input data*

| Characteristics | | Conditions | 40 IMR 6 | | | 48 IMR 6 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| **Input** | | | min | typ | max | min | typ | max | |
| $U_i$ | Input voltage range | $T_{A\,min}$...$T_{A\,max}$, $I_o$ = 0...$I_{o\,nom}$ | 20 | | 60 | 36 | | 72 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | | | 48 | | | 48 | | |
| $I_{i\,0}$ | No load input current | $U_{i\,nom}$, $I_o$ = 0 | | 26 | | | 26 | | mA |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}$...$U_{i\,max}$ $T_{A\,min}$...$T_{A\,max}$ | | 1.2 $I_{o\,nom}$ | | | 1.2 $I_{o\,nom}$ | | |
| $I_{i\,rfi}$ | RFI input current | $I_o$ = 0...$I_{o\,nom}$ | | 30 | | | 30 | | $mA_{pp}$ |
| $U_{i\,rev}$ | Reverse input voltage protection | $U_i$ = negative or reverse polarity | | shunt diode use external fuse | | | shunt diode use external fuse | | |

*Table 3a: Output data*

| Characteristics | | Conditions | .. IMR 6-05 | | | .. IMR 6-12 | | | .. IMR 6-15 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Nominal output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 4.90 | | 5.10 | 11.76 | | 12.24 | 14.70 | | 15.30 | V |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}...U_{i\,max}$ | | 1000 | | | 500 | | | 400 | | mA |
| $u_o$ | Output ripple voltage | $U_{i\,min}...U_{i\,max}$<br>$I_o = 0.2 \leftrightarrow I_{o\,nom}$<br>BW = 20 MHz | | 100 | 150 | | 100 | 150 | | 100 | 150 | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation vs. input voltage $U_i$ | $U_{i\,min}...U_{i\,max}$<br>$I_{o\,nom}$ | | | 1 | | | 1 | | | 1 | % |
| $\Delta U_{o\,I}$ | Static control deviation vs. output current $I_o$ | $U_{i\,nom}$<br>$I_o = 0 \leftrightarrow I_{o\,nom}$ | | 2 | | | 2 | | | 2 | | |
| $\alpha_{uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| $f_s$ | Switching frequency | | 50 | | | 50 | | | 50 | | | kHz |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | – 12 IMR 6 types<br>– other types | $U_{i\,nom}$, $I_{o\,nom}$ | | 63<br>72 | | | 68<br>72 | | | 68<br>72 | | % |

*Table 3b: Output data*

| Characteristics | | Conditions | .. IMR 6-0505 | | | .. IMR 6-1212 | | | .. IMR 6-1515 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Nominal output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | ±4.90 | | ±5.10 | ±11.76 | | ±12.24 | ±14.70 | | ±15.30 | V |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}...U_{i\,max}$ | | ±500 | | | ±250 | | | ±200 | | mA |
| $u_o$ | Output ripple voltage | $U_{i\,min}...U_{i\,max}$<br>$I_o = 0.2 \leftrightarrow I_{o\,nom}$<br>BW = 20 MHz | | 50 | | | 120 | | | 150 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation vs. input voltage $U_i$ | $U_{i\,min}...U_{i\,max}$<br>$I_{o\,nom}$ | | | ±1 | | | ±1 | | | ±1 | % |
| $\Delta U_{o\,I}$ | Static control deviation vs. output current $I_o$ | $U_{i\,nom}$,<br>$I_o = 0.2 \leftrightarrow I_{o\,nom}$ | | ±5 | | | ±5 | | | ±5 | | |
| $\alpha_{uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | | ±0.02 | | | ±0.02 | | | ±0.02 | %/K |
| $f_s$ | Switching frequency | | 50 | | | 50 | | | 50 | | | kHz |
| **Efficiency** | | | | | | | | | | | | |
| $\eta$ | – 12 IMR 6 types<br>– other types | $U_{i\,nom}$, $I_{o\,nom}$ | | 67<br>73 | | | 70<br>75 | | | 70<br>75 | | % |

## Immunity to Environmental Conditions

### Thermal Considerations

*Table 6: Temperature specification*

| Characteristics | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | not operational | –25 | 100 | |

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

European Projection

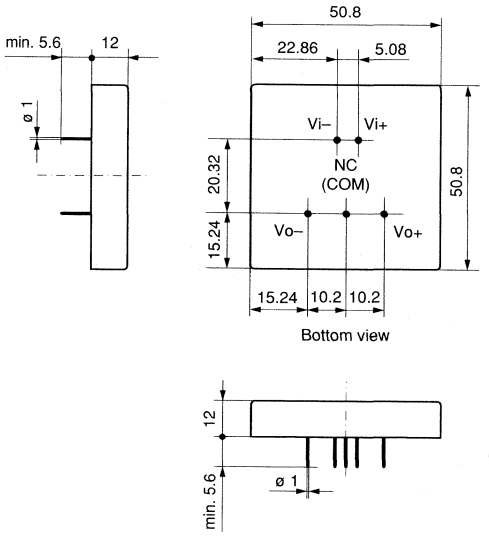



*Fig. 3:*
*Case 2"×2"*
*Weight: 50 g*

## Type Key and Product Marking

### Type Key

Nominal input voltage in volt ..... 12...48
Blank .....
Family ..... IMR
Nominal output power in watt ..... 6
Nominal output voltage for output 1 in volt ..... 5...15
Nominal output voltage for output 2 in volt ..... 5...15
Operational ambient temperature range ..... -2

24 IMR 6 - 12 12 -2

### Product Marking

Main face: Melcher name, data code on separate label, type of converter, input voltage range, output voltage(s) and current(s) and pin assignment.

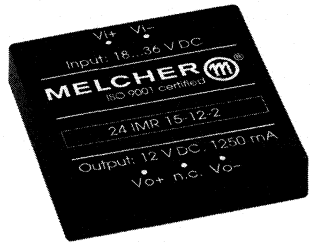

MELCHER ISO 9001 certified

# DC-DC Converters

# IMR 15-Family

**Input to output isolation test voltage 500 V DC**
**Single or double output**

- Input voltage range 2:1
- Input filter built-in
- High efficiency up to 82%
- Short-circuit-proof
- No derating
- 2"×2" metal case
- Low cost




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## Type Survey

*Table 1: Type survey*

| Output $U_{o\,nom}$ | Output $I_{o\,nom}$ [1] | Input voltage range $U_i$ | Nominal input voltage $U_{i\,nom}$ | Input to output isolation | Type |
|---|---|---|---|---|---|
| 5 V | 3000 mA | 12 IMR 15: 9...18 V DC<br>24 IMR 15: 18...36 V DC<br>48 IMR 15: 36...72 V DC | 12 V DC<br>24 V DC<br>48 V DC | Test voltage: 500 V DC min.<br>Resistance: 1000 MΩ min. | .. IMR 15-05-2 |
| 12 V | 1250 mA | | | | .. IMR 15-12-2 |
| 15 V | 1000 mA | | | | .. IMR 15-15-2 |
| ±12 V | ±625 mA | | | | .. IMR 15-1212-2 |
| ±15 V | ±500 mA | | | | .. IMR 15-1515-2 |

[1] 12 IMR 15: Output current $I_{o\,nom}$ = 67% of indicated values

## Description

The IMR 15 family of DC-DC converters have been developed for powering commercial type of electronic circuits, e.g. telephone systems components, industrial controllers and small appliances. They are suitable for applications with standard battery voltages. The IMR 15 converters feature good efficiency and good dynamic response to load changes and at start-up. The IMR 15 modules are short-circuit-proof.

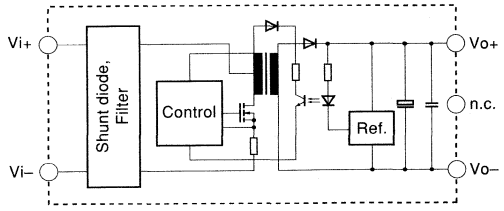



*Fig. 1:*
*Single output converter block diagram*

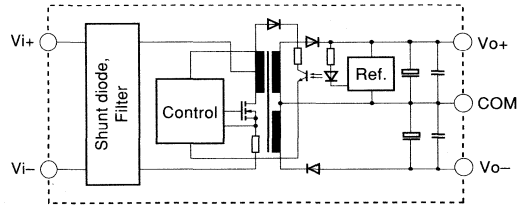



*Fig. 2:*
*Double output converter block diagram*

## Electrical Input and Output Data

General condition:
– $T_A$ = 25 °C unless otherwise specified.

*Table 2a: Input data*

| Characteristics | | Conditions | 12 IMR 15 | | | 24 IMR 15 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| **Input** | | | min | typ | max | min | typ | max | |
| $U_i$ | Input voltage range | $T_{A\,min}$... $T_{A\,max}$, $I_o$ = 0... $I_{o\,nom}$ | 9 | | 18 | 18 | | 36 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | | | 12 | | | 24 | | |
| $I_{i\,0}$ | No load input current | $U_{i\,nom}$, $I_o$ = 0 | | 35 | | | 26 | | mA |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}$... $U_{i\,max}$ $T_{A\,min}$... $T_{A\,max}$ | | 1.25 $I_{o\,nom}$ | | | 1.25 $I_{o\,nom}$ | | |
| $I_{i\,rfi}$ | RFI input current | $I_o$ = 0... $I_{o\,nom}$ | | 30 | | | 30 | | $mA_{pp}$ |
| $U_{i\,rev}$ | Reverse input voltage protection | $U_i$ = negative or reverse polarity | | shunt diode use external fuse | | | shunt diode use external fuse | | |

*Table 2b: Input data*

| Characteristics | | Conditions | | 48 IMR 15 | | | Unit |
|---|---|---|---|---|---|---|---|
| **Input** | | | | min | typ | max | |
| $U_i$ | Input voltage range | $T_{A\,min}$... $T_{A\,max}$, $I_o$ = 0... $I_{o\,nom}$ | | 36 | | 72 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | | | | 48 | | |
| $I_{i\,0}$ | No load input current | $U_{i\,nom}$, $I_o$ = 0 | | | 26 | | mA |
| $I_{i\,L}$ | Input current limitation response | $U_{i\,min}$... $U_{i\,max}$ $T_{A\,min}$... $T_{A\,max}$ | | | 1.2 $I_{o\,nom}$ | | |
| $I_{i\,rfi}$ | RFI input current | $I_o$ = 0... $I_{o\,nom}$ | | | 30 | | $mA_{pp}$ |
| $U_{i\,rev}$ | Reverse input voltage protection | $U_i$ = negative or reverse polarity | | | shunt diode use external fuse | | |

*Table 3a: Output data*

| Characteristics | | Conditions | .. IMR 15-05 | | .. IMR 15-12 | | .. IMR 15-15 | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min typ | max | min typ | max | min typ | max | |
| $U_{o\,nom}$ | Nominal output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 4.90 5.10 | | 11.76 12.24 | | 14.70 15.30 | | V |
| $I_{o\,nom}$ | Nominal output current:<br>– 12 IMR 15 types<br>– other types | $U_{i\,min}$...$U_{i\,max}$ | 2000<br>3000 | | 834<br>1250 | | 667<br>1000 | | mA |
| $u_{o<}$ | Output ripple voltage (BW = 20 MHz) | $U_{i\,min}$...$U_{i\,max}$<br>$I_o$ = 0.2↔$I_{o\,nom}$ | 100 | | 240 | | 300 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation vs. input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$<br>$I_{o\,nom}$ | ±1 | | ±1 | | ±1 | | % |
| $\Delta U_{o\,I}$ | Static control deviation vs. output current $I_o$ | $U_{i\,nom}$,<br>$I_o$ = 0 ↔ $I_{o\,nom}$ | ±2 | | ±2 | | ±2 | | |
| $t_r$ | Transient recovery time | $I_o$ =1↔0.5$I_{o\,nom}$ | 500 | | 500 | | 500 | | µs |
| $\alpha_{uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | ±0.02 | | ±0.02 | | ±0.02 | | %/K |
| $f_s$ | Switching frequency | | 200 | | 200 | | 200 | | kHz |
| **Efficiency** | | | | | | | | | |
| $\eta$ | – 12 IMR 15 types<br>– other types | $U_{i\,nom}$, $I_{o\,nom}$ | 63<br>70 | | 70<br>75 | | 70<br>75 | | % |

*Table 3b: Output data*

| Characteristics | | Conditions | | .. IMR 15-1212 | | | .. IMR 15-1515 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Nominal output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | | ±11.76 | | ±12.24 | ±14.70 | | ±15.30 | V |
| $I_{o\,nom}$ | Nominal output current:<br>– 12 IMR 15 types<br>– other types | $U_{i\,min}$...$U_{i\,max}$ | | | ±417<br>+625 | | | ±334<br>±500 | | mA |
| $I_{o\,min}$ | Minimum output current | | | | ±0.2 $I_{o\,nom}$ | | | ±0.2 $I_{o\,nom}$ | | |
| $u_o$ | Output ripple voltage: (BW = 20 MHz) | $U_{i\,min}$...$U_{i\,max}$,<br>$I_o$ = 0.2↔$I_{o\,nom}$ | | | 240 | | | 300 | | $mV_{pp}$ |
| $\Delta U_{o\,U}$ | Static control deviation vs. input voltage $U_i$ | $U_{i\,min}$...$U_{i\,max}$,<br>$I_{o\,nom}$ | | | | ±1 | | | ±1 | % |
| $\Delta U_{o\,I}$ | Static control deviation vs. output current $I_o$ | $U_{i\,nom}$,<br>$I_o$ = 0.2↔$I_{o\,nom}$ | | | | ±5 | | | ±5 | |
| $t_r$ | Transient recovery time | $I_o$ =1↔0.5$I_{o\,nom}$ | | | 500 | | | 500 | | µs |
| $\alpha_{uo}$ | Temperature coefficient | $U_{i\,nom}$, $I_{o\,nom}$ | | | | ±0.02 | | | ±0.02 | %/K |
| $f_s$ | Switching frequency | | | | 200 | | | 200 | | kHz |
| **Efficiency** | | | | | | | | | | |
| $\eta$ | – 12 IMR 15 types<br>– other types | $U_{i\,nom}$, $I_{o\,nom}$ | | | 75<br>80 | | | 75<br>80 | | % |

5.3

## Immunity to Environmental Conditions

### Thermal Considerations

*Table 6: Temperature specification*

| Characteristics | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | 0 | 80 | |
| $T_S$ | Storage temperature | not operational | –25 | 100 | |

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise specified.

European Projection

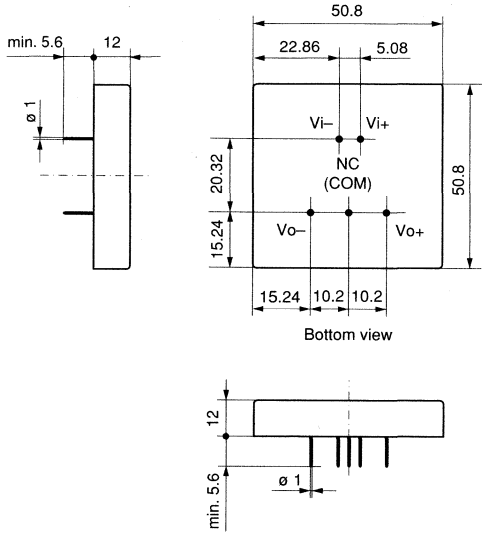
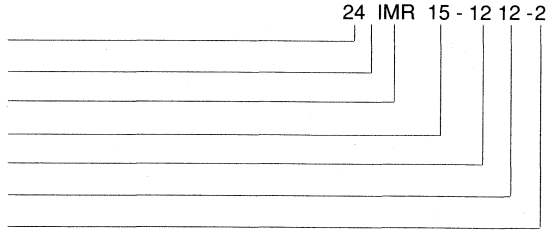



*Fig. 3:*
*Case 2"× 2"*
*Weight: 70 g*

## Type Key and Product Marking

### Type Key




### Product Marking

Main face: Melcher name, data code on separate label, type of converter, input voltage range, output voltage(s) and current(s) and pin assignment.

# 6 DC-DC Converters <100 W

## 6.1 Rugged Environment

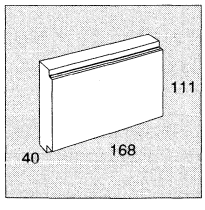
## 6.2 Industrial Environment

| Output [W] 10 20 40 60 80 100 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] 10 30 70 140 220 380 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | M | M02 | 6 - 3 |
| | | | Q | Q01 | 6 - 53 |

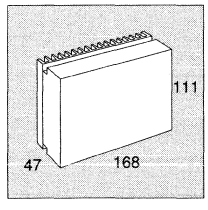
## 6.3 Benign Environment

| Output [W] 10 20 40 60 80 100 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] 10 30 70 140 220 380 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | H | M05 | 6 - 71 |
| | | | Q | Q01 | 6 - 86 |

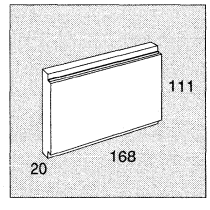
Case M02



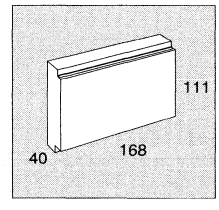

Case S01




Case Q01




Case M05



Edition 1/05 - © Melcher AG

# 50 W DC-DC (AC-DC) Converters

# M-Family

**Class I Equipment**

Single output: series AM...LM 1000
Dual output: series AM...LM 2000
Triple output: series AM...LM 3000

**Class II Equipment (double insulation)** ⧈

Single output: series CMZ/DMZ/LMZ 1000
Dual output: series CMZ/DMZ/LMZ 2000
Triple output: series CMZ/DMZ/LMZ 3000

- Extremely wide input voltage range suitable for battery (and AC) operation
- Efficient input filter and built-in surge and transient suppression circuitry
- 4 $kV_{rms}$ input to output electric strength test
- Outputs individually isolated and controlled
- Outputs fully protected against overload
- Safety according to IEC 950




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## Description

The M-family of DC-DC (AC-DC) converters represents a broad and flexible range of power supplies for use in advanced industrial electronic systems. Features include high efficiency, reliability, low output voltage noise and excellent dynamic response to load/line changes due to individual regulation of any output.

The converter inputs are protected against surges and transients occuring on the source lines. Input over- and undervoltage cut-out circuitry disables the outputs if the input voltage is outside the specified range. Certain types include an inrush current limitation preventing circuit breakers and fuses from being damaged at switch-on.

All outputs are open- and short-circuit proof and are protected against overvoltages by means of built-in suppressor diodes. The outputs can be inhibited by a logic signal applied to the connector pin i. If the inhibit function is not used pin 2 should be connected with pin 23 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case and output to output isolation is provided. The modules are designed and built according to the international safety standard IEC 950 and have been approved by the safety agencies VDE (Germany), SEV (Switzerland), UL (USA) and CSA (Canada).

The case design allows operation at nominal load up to 71°C in a free air ambient temperature. If forced cooling is provided, the ambient temperature may exceed 71°C but the case temperature should remain below 95°C under all conditions.

A temperature sensor generates an inhibit signal which disables the outputs if the case temperature $T_C$ exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Case: aluminium, black finish, self cooling.
Dimensions: 38.7 × 111.2 × 168.5 mm. Weight: 770 g.

# Type Survey

**Options see "Descriptions of Options"**

### General note

The type survey tables provide an overview of the basic input and output configurations. More than 500 different types have been manufactured providing different output configurations and customised specialities. Please consult Melcher's field sales engineers for specific requirements. The best technical solution will carefully be considered and a detailed proposal submitted.

*Table 1a: Class I equipment*

| Output 1 | | Output 2 | | Output 3 | | Input Voltage Range and Efficiency [1] | | | | | | Option |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{i\,min}...U_{i\,max}$ **8...35 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **14...70 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **20...100 V DC** | $\eta_{min}$ % | |
| 5.1 | 8.0 | | | | | AM 1001-7R | 72 | BM 1001-7R | 74 | FM 1001-7R | 74 | –9 |
| 12.0 | 4.0 | | | | | AM 1301-7R | 79 | BM 1301-7R | 80 | FM 1301-7R | 80 | P |
| 15.0 | 3.4 | | | | | AM 1501-7R | 79 | BM 1501-7R | 81 | FM 1501-7R | 81 | D0...D9 |
| 24.0 | 2.0 | | | | | AM 1601-7R | 81 | BM 1601-7R | 83 | FM 1601-7R | 82 | V0,V2,V3 |
| 48.0 | 1.0 | | | | | AM 1901-7R | 81 | BM 1901-7R | 83 | FM 1901-7R | 83 | A |
| 12.0 | 2.0 | 12.0 | 2.0 | | | AM 2320-7 | 77 | BM 2320-7 | 79 | FM 2320-7 | 80 | H |
| 15.0 | 1.7 | 15.0 | 1.7 | | | AM 2540-7 | 78 | BM 2540-7 | 80 | FM 2540-7 | 79 | F |
| 5.1 | 5.0 | 12.0 | 0.7 | 12.0 | 0.7 | AM 3020-7 | 75 | BM 3020-7 | 76 | FM 3020-7 | 76 | U |
| 5.1 | 5.0 | 15.0 | 0.6 | 15.0 | 0.6 | AM 3040-7 | 75 | BM 3040-7 | 76 | FM 3040-7 | 76 | |

*Table 1b: Class I equipment*

| Output 1 | | Output 2 | | Output 3 | | Input Voltage Range and Efficiency [1] | | | | | | Option |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{i\,min}...U_{i\,max}$ **28...140 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **44...220 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **88...372 V DC** (85...264 V AC) | $\eta_{min}$ % | |
| 5.1 | 8.0 | | | | | CM 1001-7R | 74 | DM 1001-7R | 74 | LM 1001-7R | 73 | –9 |
| 12.0 | 4.0 | | | | | CM 1301-7R | 80 | DM 1301-7R | 81 | LM 1301-7R | 79 | E |
| 15.0 | 3.4 | | | | | CM 1501-7R | 82 | DM 1501-7R | 82 | LM 1501-7R | 78 | P |
| 24.0 | 2.0 | | | | | CM 1601-7R | 82 | DM 1601-7R | 83 | LM 1601-7R | 81 | D0...D9 |
| 48.0 | 1.0 | | | | | CM 1901-7R | 82 | DM 1901-7R | 83 | LM 1901-7R | 81 | V0,V2,V3 |
| 12.0 | 2.0 | 12.0 | 2.0 | | | CM 2320-7 | 79 | DM 2320-7 | 80 | LM 2320-7 | 77 | A |
| 15.0 | 1.7 | 15.0 | 1.7 | | | CM 2540-7 | 80 | DM 2540-7 | 80 | LM 2540-7 | 78 | H |
| 5.1 | 5.0 | 12.0 | 0.7 | 12.0 | 0.7 | CM 3020-7 | 76 | DM 3020-7 | 77 | LM 3020-7 | 73 | F |
| 5.1 | 5.0 | 15.0 | 0.6 | 15.0 | 0.6 | CM 3040-7 | 76 | DM 3040-7 | 76 | LM 3040-7 | 71 | U |

*Table 2: Class II equipment (double insulation)* ⧈

| Output 1 | | Output 2 | | Output 3 | | Input Voltage Range and Efficiency [1] | | | | | | Option |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{i\,min}...U_{i\,max}$ **28...140 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **44...220 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **88...372 V DC** (85...264 V AC) | $\eta_{min}$ % | |
| 5.1 | 8.0 | | | | | CMZ 1001-7R | 74 | DMZ 1001-7R | 74 | LMZ 1001-7R | 73 | –9 |
| 12.0 | 4.0 | | | | | CMZ 1301-7R | 80 | DMZ 1301-7R | 81 | LMZ 1301-7R | 79 | E |
| 15.0 | 3.4 | | | | | CMZ 1501-7R | 82 | DMZ 1501-7R | 82 | LMZ 1501-7R | 78 | P |
| 24.0 | 2.0 | | | | | CMZ 1601-7R | 82 | DMZ 1601-7R | 83 | LMZ 1601-7R | 81 | D0...D9 |
| 48.0 | 1.0 | | | | | CMZ 1901-7R | 82 | DMZ 1901-7R | 83 | LMZ 1901-7R | 81 | V0,V2,V3 |
| 12.0 | 2.0 | 12.0 | 2.0 | | | CMZ 2320-7 | 79 | DMZ 2320-7 | 80 | LMZ 2320-7 | 77 | A |
| 15.0 | 1.7 | 15.0 | 1.7 | | | CMZ 2540-7 | 80 | DMZ 2540-7 | 80 | LMZ 2540-7 | 78 | H |
| 5.1 | 5.0 | 12.0 | 0.7 | 12.0 | 0.7 | CMZ 3020-7 | 76 | DMZ 3020-7 | 77 | LMZ 3020-7 | 73 | F |
| 5.1 | 5.0 | 15.0 | 0.6 | 15.0 | 0.6 | CMZ 3040-7 | 76 | DMZ 3040-7 | 76 | LMZ 3040-7 | 71 | U |

[1] Efficiency measured at $U_{i\,nom}$ and $I_{o\,nom}$

**Notes:** EM types with an input voltage range of 67...385 V DC are available upon request

Remarks: LM types may be operated in AC mode within a frequency range of 47...440 Hz and LMZ types within a frequency range of 47...65 Hz.



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## Safety and Installation Instructions

### Safety

**For safety reasons, the power supply modules must be wired via the female connector H11 (according to DIN 41612, see accessories) in order to meet national and international safety requirements!**

AM...LM types correspond to class I equipment, while the C/D/LMZ types correspond to class II equipment. All converters fully comply with IEC 950, EN 60950, DIN VDE 0805 (including manufacturing surveillance), UL 1950 and CSA/C22.2 No. 950-M89.

In class I equipment the connector protective earthing pin is leading while it is omitted in class II equipment (no protective earthing is required). Class II equipment requires reinforced insulation between input and output circuitry and also between input and case. There are two class II Y-capacitors connected in series between input and output circuitry instead of having Y-capacitors connected to the case.

During the production process, all transformers and each of the fully assembled modules are individually tested for electric strength and earth continuity (detailed values are shown in table 14). All electric strength tests are performed as factory tests.

The UL 1950 recognition limits the ambient operational temperature range of the standard modules to $T_A$ = $T_{A\,max}$ –15 K. Option U allows the operation in applications where the full operational temperature range according to the relevant data sheet and UL 1950 recognition is required.

*Table 3: Status of actual safety approvals*

| Types | Safety Standards | | | |
|---|---|---|---|---|
| | DIN VDE 0805/05.90 IEC 950/EN 60950 | SEV 1061/1085 | UL 1950 File E 143030 | CSA C.22.2 No.950 File LR 95850 [3] |
| AM 1000 | in progress [1] | in progress | recognized | recognized |
| AM 2000 | in progress [1] | in progress | recognized | recognized |
| AM 3000 | in progress [1] | in progress | recognized | recognized |
| BM 1000 | in progress [1] | in progress | recognized | recognized |
| BM 2000 | in progress [1] | in progress | recognized | recognized |
| BM 3000 | in progress [1] | in progress | recognized | recognized |
| CM 1000 | approved | approved | recognized | recognized |
| CM 2000 | approved | approved | recognized | recognized |
| CM 3000 | approved | in progress | recognized | recognized |
| DM 1000 | approved | in progress | recognized | recognized |
| DM 2000 | approved | in progress | recognized | recognized |
| DM 3000 | approved | in progress | recognized | recognized |
| EM 1000 | in progress [1] | in progress | in progress [2] | in progress |
| EM 2000 | in progress [1] | in progress | in progress [2] | in progress |
| EM 3000 | in progress [1] | in progress | in progress [2] | in progress |
| FM 1000 | in progress [1] | in progress | in progress [2] | in progress |
| FM 2000 | in progress [1] | in progress | in progress [2] | in progress |
| FM 3000 | in progress [1] | in progress | in progress [2] | in progress |
| LM 1000 | approved | approved | recognized | recognized |
| LM 2000 | approved | approved | recognized | recognized |
| LM 3000 | approved | approved | recognized | recognized |
| CMZ 1000 | in progress [1] | in progress | in progress [2] | in progress |
| CMZ 2000 | in progress [1] | in progress | in progress [2] | in progress |
| CMZ 3000 | in progress [1] | in progress | in progress [2] | in progress |
| DMZ 1000 | in progress [1] | in progress | in progress [2] | in progress |
| DMZ 2000 | in progress [1] | in progress | in progress [2] | in progress |
| DMZ 3000 | in progress [1] | in progress | in progress [2] | in progress |
| LMZ 1000 | in progress [1] | in progress | in progress [2] | in progress |
| LMZ 2000 | in progress [1] | in progress | in progress [2] | in progress |
| LMZ 3000 | in progress [1] | in progress | in progress [2] | in progress |

[1] Approval planned for March 1995
[2] Approval planned for July 1995
[3] Will be replaced by $UL_C$ in July 1995

### Important Advice

Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/µs, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher AG will not honour any guarantee/warranty claims resulting from high voltage field tests.

### Installation

Installation of the power supply must strictly follow the national safety regulations. To observe the safety requirements according to EN 60950/IEC 950, the module shall be connected via the female connector type H11. Other installation methods may not meet the safety requirements. A second fuse should be installed in the wiring to pin 29 if:

- Local requirements demand an individual fuse in each source line
- Input to earth impedance is high or undefined
- Phase and neutral of the mains are not defined (AC-DC converters)

Reverse polarity at the input of A...D/FM and C/DMZ types will cause the fuse to blow. In E/LM and LMZ types a series diode will protect the module. A series diode is not incorporated in A...D/FM and C/DMZ types to avoid unwanted power loss.

Whenever the inhibit function is not required, pin 2 should be connected to pin 23 to enable the output(s).

*Table 4: H11 connector pin allocation*

| Electrical Determination | A...LM 1000 | | C/D/LMZ 1000 | | A...LM 2000 | | C/D/LMZ 2000 | | A...LM 3000 | | C/D/LMZ 3000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pin | Ident | Pin | Ident | Pin | Ident | Pin | Ident | Pin | Ident | Pin | Ident |
| Inhibit control input | 2 | i | 2 | i | 2 | i | 2 | i | 2 | i | 2 | i |
| Safe Data or ACFAIL | 5 | D or V | 5 | D or V | 5 | D or V | 5 | D or V | 5 | D or V | 5 | D or V |
| Output voltage (positive) | 8 | Vo1+ | 8 | Vo1+ | 8 | | 8 | | 8 | Vo3+ | 8 | Vo3+ |
| Output voltage (negative) | 11 | Vo1– | 11 | Vo1– | 11 | | 11 | | 11 | Vo3– | 11 | Vo3– |
| Control input + [1] | 14 | R | 14 | R | | | | | | | | |
| Control input – | 17 | G | 17 | G | | | | | | | | |
| Output voltage (positive) | | | | | 14 | Vo2+ | 14 | Vo2+ | 14 | Vo2+ | 14 | Vo2+ |
| Output voltage (negative) | | | | | 17 | Vo2– | 17 | Vo2– | 17 | Vo2– | 17 | Vo2– |
| Output voltage (positive) | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ |
| Output voltage (negative) | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– |
| Protective earthing [2] | 26 | ⏚ | | | 26 | ⏚ | | | 26 | ⏚ | | |
| DC input voltage [3] | 29 | Vi+ | 29 | Vi+ | 29 | Vi+ | 29 | Vi+ | 29 | Vi+ | 29 | Vi+ |
| DC input voltage | 32 | Vi– | 32 | Vi– | 32 | Vi– | 32 | Vi– | 32 | Vi– | 32 | Vi– |
| AC input voltage [4] | 29 | N~ | 29 | N~ | 29 | N~ | 29 | N~ | 29 | N~ | 29 | N~ |
| AC input voltage | 32 | P~ | 32 | P~ | 32 | P~ | 32 | P~ | 32 | P~ | 32 | P~ |

[1] This function is not simultaneously available with option P
[2] Leading pin (pregrounding)
[3] A/B/C/D/E/FM and C/DMZ types
[4] LM/LMZ types

### Degree of Protection

Condition: Female connector fitted to the unit
IP 40: All units, except those with options P, A, K, D or V with potentiometer adjustment.
IP 30: All units, except those with option P, D or V with potentiometer adjustment.
IP 20: All units fitted with options which include potentiometer setting.

### Leakage Currents and Insulation

Please refer "Supplementary Data"

## Functional Description

The input voltage is fed via an input fuse, an input filter, a rectifier [3] and an inrush current limiter [4] to the input capacitor. This capacitor sources a single transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke and an output filter. The control logic senses the main output voltage $U_{o1}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor. This signal is fed back via a coupling transformer.

The auxiliary outputs $U_{o2}$ and $U_{o3}$ are individually regulated by means of secondary switching transistors. Each auxiliary output's current is sensed using a current transformer. If one of the outputs is driven into current limit, the other outputs will reduce their output voltages as well because all output currents are controlled by the same control circuit.

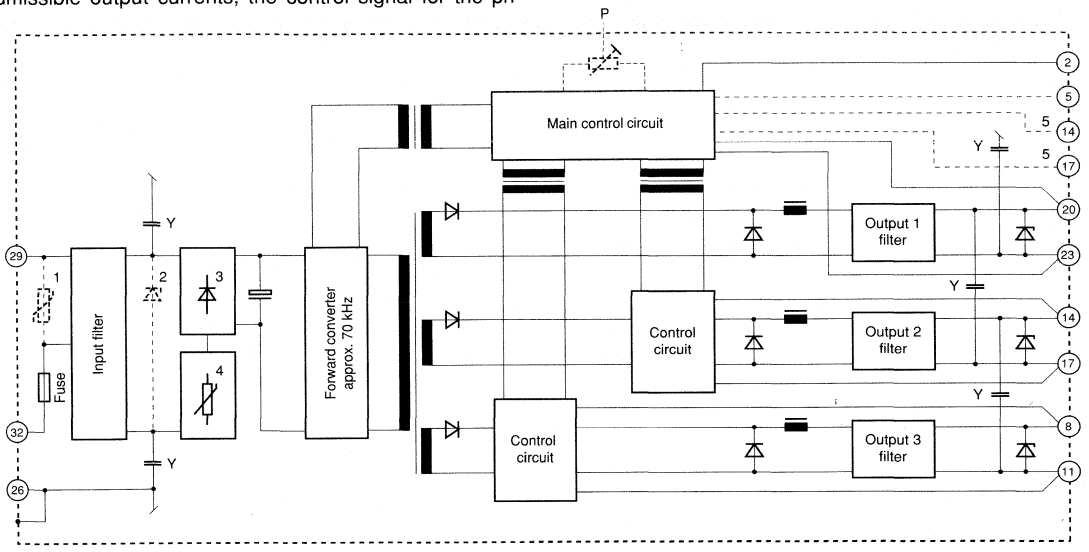



*Fig. 1a*
*DC-DC (AC-DC) converter block diagram, class I equipment*

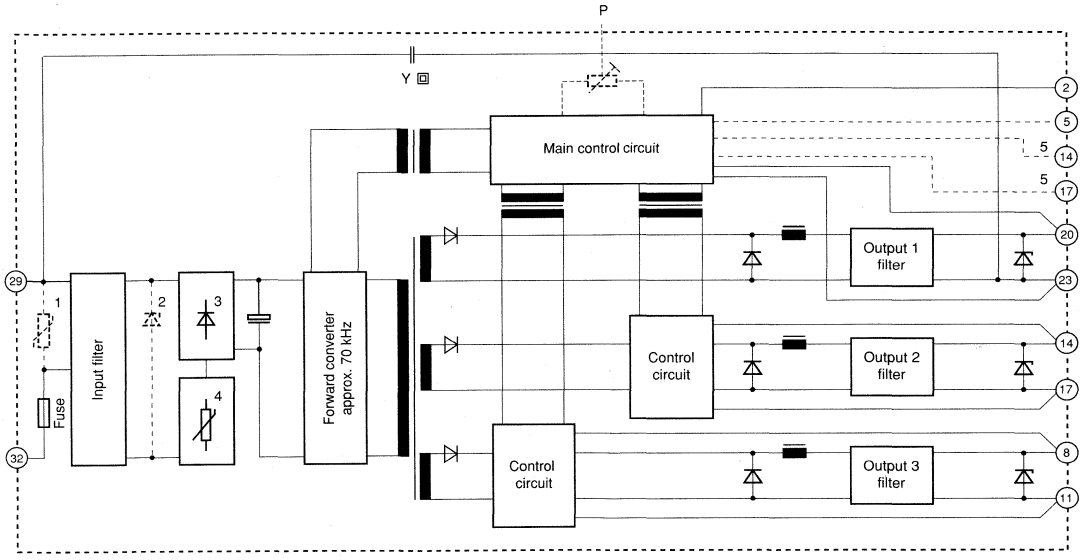



*Fig. 1b*
*DC-DC (AC-DC) converter block diagram, class II equipment (double insulation)*

[1] Transient suppressor (VDR) in C/D/E/F/LM and C/D/LMZ
[2] Transient suppressor diode in A/B/C/FM and CMZ types
[3] Bridge rectifier in LM/LMZ, series diode in EM types
[4] Inrush current limiter (NTC) in C/D/E/LM and C/D/LMZ types (option E: refer to the description of option E)
[5] Single output modules A...LM 1000 and C/D/LMZ 1000

## Electrical Input Data

General conditions:
– $T_A$ = 25°C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, with option P: $U_o = U_{o\,nom}$, R input not connected.

*Table 5a: Input data*

| Input | | | AM | | | BM | | | FM | | | CM/CMZ | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $U_i$ | Input voltage range | $I_o = 0 \ldots I_{o\,nom}$ | 8 | | 35 | 14 | | 70 | 20 | | 100 | 28 | | 140 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | $T_{C\,min} \ldots T_{C\,max}$ | | 15 | | | 30 | | | 50 | | | 60 | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [2] | | 4.0 | | | 2.0 | | | 2.0 | | | 1.0 | | A |
| $P_{i\,0}$ | No-load input power:<br>Single output<br>Double output<br>Triple output | $U_{i\,nom}$<br>$I_{o1,2,3} = 0$ | | <br>1<br>7<br>6 | <br>1.5<br>9<br>9 | | <br>1<br>7<br>6 | <br>1.5<br>9<br>9 | | <br>1<br>7<br>6 | <br>1.5<br>9<br>9 | | <br>1<br>7<br>6 | <br>1.5<br>9<br>9 | W |
| $P_{i\,inh}$ | Idle input power | inhibit mode | | | 1.5 | | | 1.5 | | | 1.5 | | | 1.5 | W |
| $I_{inr\,p}$ [6] | Peak inrush current | $U_i = U_{i\,max}$ | | | 400 | | | 500 | | | 400 | | | 170 [4] | A |
| $t_{inr\,r}$ | Rise time | $R_S = 0\ \Omega$ [3] | | 60 | | | 50 | | | 40 | | | 60 | | µs |
| $t_{inr\,h}$ | Trailing edge half-life | $T_C$ = 25°C | | 170 | | | 100 | | | 60 | | | 280 | | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 87.5 | | | 140 | | | 250 | | | 824 [4] | | | mΩ |
| $C_i$ | Input capacitance | | 2600 | | 4000 | 670 | | 1100 | 370 | | 600 | 370 | | 600 | µF |
| $U_{i\,abs}$ | Input voltage limits without any damage | | 0 | | 40 | 0 | | 80 | 0 | | 120 | 0 | | 160 | V DC |

*Table 5b: Input data*

| Input | | | DM/DMZ | | | EM | | | LM/LMZ | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | |
| $U_i$ | Input voltage range | $I_o = 0 \ldots I_{o\,nom}$ | | - | | | - | | 85 | | 264 | V AC [1] |
| | | $T_{C\,min} \ldots T_{C\,max}$ | 44 | | 220 | 67 | | 385 | 88 | | 372 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | | | 110 | | | 220 | | | 310 | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [2] | | 0.55 | | | 0.275 | | | 0.20 | | A |
| $P_{i\,0}$ | No-load input power:<br>Single output<br>Double output<br>Triple output | $U_{i\,nom}$<br>$I_{o1,2,3} = 0$ | | <br>1<br>7<br>6 | <br>1.5<br>9<br>9 | | <br>1<br>7<br>6 | <br>1.5<br>9<br>9 | | <br>1<br>7<br>6 | <br>1.5<br>9<br>9 | W |
| $P_{i\,inh}$ | Idle input power | inhibit mode | | | 1.5 | | | 1.5 | | | 1.5 | W |
| $I_{inr\,p}$ [6] | Peak inrush current | $U_i = U_{i\,max}$ | | | 110 [4] | | | 160 [4] | | | 60 [4] | A |
| $t_{inr\,r}$ | Rise time | $R_S = 0\ \Omega$ [3] | | 40 | | | 40 | | | 300 | | µs |
| $t_{inr\,h}$ | Trailing edge half-life | $T_C$ = 25°C | | 250 | | | 240 | | | 900 | | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 2000 [4] | | | 2400 [4] | | | 6200 [4] | | | mΩ |
| $C_i$ | Input capacitance | | 140 | | 270 | 140 | | 270 | 140 | | 270 | µF |
| $U_{i\,abs}$ | Input voltage limits without any damage | | 0 | | 400 [5] | -400 | | 400 | -400 | | 400 | V DC |
| | | | – | | – | – | | – | 0 | | 284 | V AC |

[1] In AC powered mode: LM types: 47...440 Hz; LMZ types: 47...65 Hz
[2] With multiple output modules, the same condition for each output applies.
[3] $R_S$ = source resistance.
[4] Value for initial switch-on cycle.
[5] 1 s max., duty cycle 1% max.
[6] $I_{inr\,p} = U_i/(R_s + R_i)$


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### Input fuse

A fuse holder containing a slow-blow type fuse (Dimension: 5 × 20 mm) is mounted in the converter's back plate. The fuse protects the module against severe defects. It may not fully protect the module at input voltages exceeding 200 V DC. In applications where the converters operate at DC source voltages above 200 V DC, an external fuse or a circuit breaker at system level should be installed.

Option F (built-in inaccessible fuse) cannot be provided for A/BM types since there is no suitable fuse type which fits into the available space (see option F).

*Table 6: Fuse types (slow-blow)*

| Series | Schurter type | Part number |
|---|---|---|
| AM 1000...3000 | SPT 10 A 250 V | 0001.2514 |
| BM 1000...3000 | SPT 8 A 250 V | 0001.2513 |
| FM 1000...3000<br>CM/CMZ 1000...3000 | SPT 3.15 A 250 V | 0001.2509 |
| DM/DMZ 1000...3000<br>EM 1000...3000<br>LM/LMZ 1000...3000 | SPT 2.5 A 250 V | 0001.2508 |

### Input Under-/Overvoltage Cut-out

If the input voltage remains below 0.8 $U_{i\,min}$ or exceeds 1.1 $U_{i\,max}$ (approx. values), an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ must be carefully considered (see tables 5a and 5b).

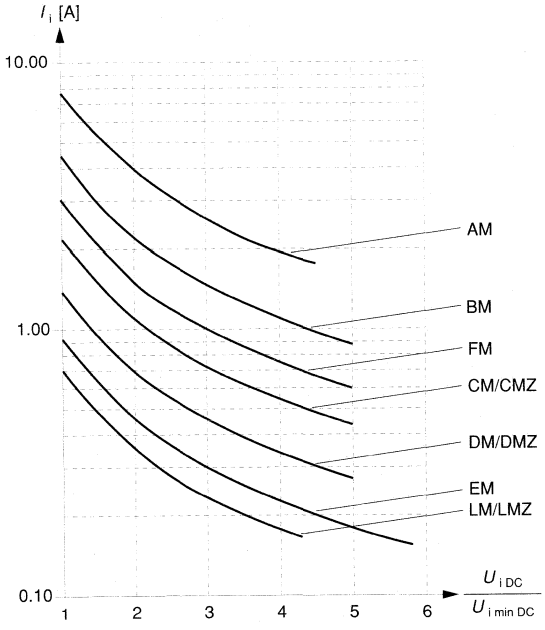



*Fig. 2*
*Typical input current versus relative input voltage at nominal output load*

### Inrush Current

The C...LM and C/D/LMZ (excluding FM) modules incorporate a NTC resistor in the input circuitry which (during the initial switch-on cycle) limits the peak inrush current to avoid damage to connectors and switching devices. Subsequent switch-on cycles within a short interval will cause an increase of the peak inrush current due to the warming up of the NTC resistor. Refer also to option E description.

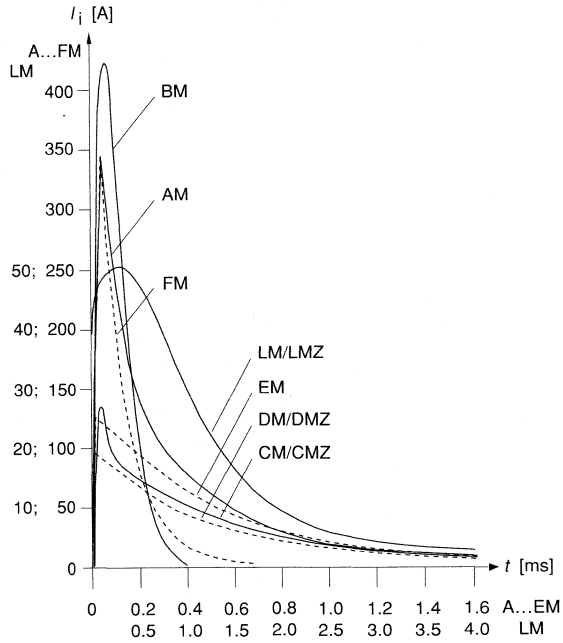



*Fig. 3*
*Typical inrush current at initial switch-on cycle and at $U_{i\,max}$ [DC] versus time*

## Electrical Output Data

General conditions
– $T_A$ = 25°C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, $U_o = U_{o\,nom}$ (option P), R input not connected.

*Table 7: Output data*

| Output | | $U_{o\,nom}$ | 5.1 V | | | 12 V | | | 15 V | | | 24 V | | | 48 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [1] | 5.07 | | 5.13 | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | 47.72 | | 48.28 | V |
| $U_{o\,L}$ | Overvoltage prot. | $I_{o\,nom}$ | | 7.5 | | | 20 | | | 24 | | | 40 | | | 76 | | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | see tables 1 and 2 | | | | | | | | | | | | | | | |
| $I_{o\,L}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | see fig. 4 | | | | | | | | | | | | | | | |
| $u_{o1/2/3}$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 2 | 4 | | 3 | 6 | | 3 | 6 | | 3 | 6 | | 4 | 8 | $mV_{rms}$ |
| $u_{o1}$ | | Bandwidth = | | 15 | 30 | | 25 | 50 | | 35 | 70 | | 40 | 80 | | 50 | 100 | $mV_{pp}$ |
| $u_{o2/3}$ | | 20 MHz | | 60 | 120 | | 40 | 80 | | 40 | 80 | | 40 | 80 | | - | | |
| $\Delta U_{o\,U}$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$<br>$U_{i\,nom}$...$U_{i\,max}$<br>$I_{o\,nom}$ [1] | | ±10 | ±30 | | ±12 | ±50 | | ±15 | ±60 | | ±15 | ±60 | | ±15 | ±60 | mV |
| $\Delta U_{o\,I}$ | Static load regulation | $U_{i\,nom}$<br>$I_o = I_{o\,nom}$...0 [2] | | 6 | 25 | | 13 | 50 | | 17 | 60 | | 30 | 80 | | 60 | 150 | |
| $\Delta U_{o\,Ic}$ | Static cross load regulation [4] | $U_{i\,nom}$<br>$I_o = I_{o\,nom}$...0 [3] | | 0 | ±15 | | 0 | ±20 | | 0 | ±30 | | 0 | ±40 | | - | | |
| $u_{o\,d}$ | Dynamic load regulation | $U_{i\,nom}$,<br>$I_o$ = | | ±220 | | | ±110 | | | ±150 | | | ±130 | | | ±150 | | |
| $t_d$ | Dynamic load regulation time constant | 1/0.33/1•$I_{o\,nom}$ [2]<br>fig. 5 | | 0.6 | | | 0.6 | | | 0.5 | | | 1 | | | 2 | | ms |
| $u_{o\,dc}$ | Dynamic cross load regulation [4] | $U_{i\,nom}$,<br>$I_o$ = | | +10<br>-100 | | | +10<br>-75 | | | +10<br>-140 | | | +20<br>-200 | | | -<br>- | | mV |
| $t_{dc}$ | Dynamic cross load reg. time constant [4] | 1/0.33/1•$I_{o\,nom}$ [3]<br>fig. 5 | | 0.05<br>0.5 | | | 0.2<br>0.3 | | | 0.5<br>0.7 | | | 1<br>2 | | | -<br>- | | ms |
| $\alpha_{Uo}$ | Output voltage deviation versus case temperature | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | | ±9.6 | | mV/K |

[1] With multiple output modules, the same condition for each output applies.
[2] Condition for specified output. With multiple output modules, other output(s) loaded with constant current $I_o = I_{o\,nom}$.
[3] Condition for non-specified output, individually tested, other output(s) loaded with constant current $I_o = I_{o\,nom}$.
[4] Multiple output modules.

### Output Protection

Each output is protected against overvoltages which could occur due to a failure of the internal control circuit. Voltage suppressor diodes (which under worst case condition may become a short circuit) provide the required protection. The suppressor diodes are not designed to withstand externally applied overvoltages. Overload at any of the outputs will cause a shut-down of all outputs. A red LED indicates the overload condition of the respective output.

### Parallel and Series Connection

Main outputs of equal nominal voltage can be connected in parallel. It is important to assure that the main output of a multiple output module is forced to supply a minimum current of 0.1 A to enable correct operation of its own auxiliary outputs.

In parallel operation, one or more of the main outputs may operate continuously in current limit which will cause an increase in case temperature. Consequently, a reduction of the max. ambient temperature by 10 K is recommended.

Main or auxiliary outputs can be connected in series with any other output of the same or another module. In series, the maximum output current is limited by the lowest current limit. Output ripple and regulation values are added. Connection wiring should be kept as short as possible.

If output terminals are connected together in order to establish multi-voltage configurations, e.g. +5.1 V, ±12 V etc. the common ground connecting point should be as close as possible to the connector to avoid excessive output ripple voltages.

Auxiliary outputs should never be connected in parallel!


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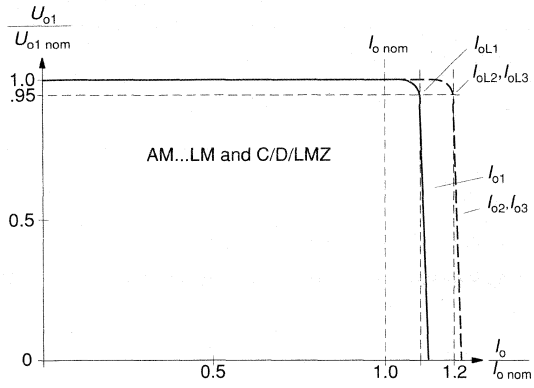



*Fig. 4*
*Typical output voltage $U_{o1}$ versus output currents $I_o$*

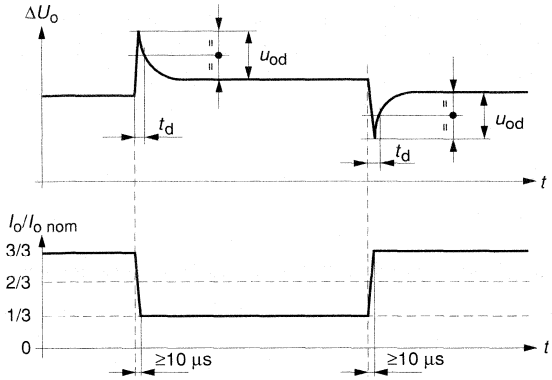



*Fig. 5*
*Control deviation of $U_o$ versus dynamic load change*

### Output Current Allocation for special Types

Output currents differing from those given for standard types (listed in tables 1 and 2) can be provided. A maximum output power of 50 W should be considered, if an ambient temperature range of –25...71 °C is required. The maximum permissible output currents are indicated in table 8. If (upon customer's request) output voltages are different from standard values, the relevant output currents have to be adapted accordingly.

With reduced maximum ambient temperature or with forced cooling, the total output power may exceed 50 W. Customised configurations always need to be checked by a feasibility study first. Please ask Melcher's sales engineers for a proposal appropriate to your specific needs.

*Table 8: Current allocation with special types*

| Output voltage all types $U_{o1/2/3\ nom}$ [V] | | Output 1 all types $I_{o1\ max}$ [A] | Output 2 A...LM 2000 $I_{o2\ max}$ [A] | Output 2 A...LM 3000 $I_{o2\ max}$ [A] | Output 3 A...LM 3000 $I_{o3\ max}$ [A] | Temperature $T_A$ [°C] | Temperature $T_C$ [°C] |
|---|---|---|---|---|---|---|---|
| 5.1 | | 8.0 | 4.0 | 1.8 (2.5 [1]) | 1.5 | –25...71 | –25...95 |
| 12 | | 4.0 | 2.0 | 1.5 | 1.2 | | |
| 15 | | 3.4 | 1.7 | 1.2 | 1.0 | | |
| 24 | | 2.0 | 1.0 | 0.7 | 0.5 | | |
| [2] | 5.1 | 10.0 | 4.5 | 2.1 (2.8 [1]) | 1.8 | –25...60 | –25...90 |
| | 12 | 5.0 | 2.5 | 1.7 | 1.5 | | |
| | 15 | 4.0 | 2.0 | 1.5 | 1.3 | | |
| | 24 | 2.5 | 1.3 | 0.9 | 0.7 | | |
| | 5.1 | 11.0 | 5.0 | 2.4 (3.0 [1]) | 2.0 | –25...50 | –25...85 |
| | 12 | 6.0 | 3.0 | 2.0 | 1.7 | | |
| | 15 | 4.6 | 2.3 | 1.7 | 1.5 | | |
| | 24 | 3.0 | 1.5 | 1.0 | 0.8 | | |

[1] Special high current components required, [2] $U_{i\ min}$ has to be increased

### Inhibit (i Input)

The outputs of the module may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to the inhibit input. If the inhibit function is not required, connect the inhibit pin 2 to pin 23 to enable the outputs (active low logic, fail safe).

The reference for the inhibit signal is the negative pin of output 1.

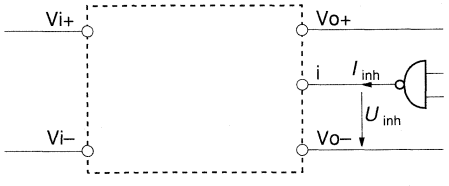



*Fig. 6*
*Definition of inhibit voltage and current*

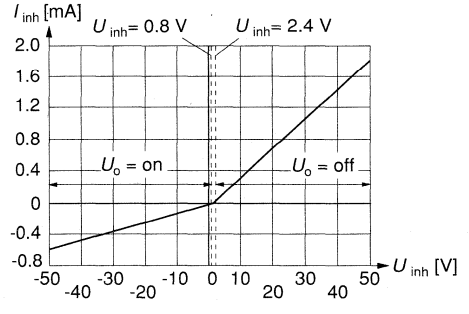



*Fig. 7*
*Typical inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 9: Inhibit data*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage causing | switched on | $U_{i\,min}...U_{i\,max}$ | –50 | | 0.8 | V DC |
| | output voltage being... | switched off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $U_{inh} = 0$ | –60 | –100 | –220 | µA |

### Hold-up Time and Output Response

When the input voltage is switched off the output voltage will remain high for a certain hold-up time $t_h$ (fig. 8) before the output voltage falls below 0.95 $U_{o\,nom}$. To achieve the hold-up times indicated in fig. 9, A/B/C/D/FM and C/DMZ modules require an external series diode in the input path. This is necessary to prevent the discharge of the input capacitor through the source impedance or other circuits connected to the same source. E/LM and LMZ modules have a built-in series diode. In A/B/C/D/FM and C/DMZ modules, a built-in series diode would generate up to 10 W of additional power loss inside the converter. Consequently the maximum operational ambient temperature would have to be reduced accordingly.

The behavior of the outputs is similar with either the input voltage applied or the inhibit switched low.

An output voltage overshoot will not occur when the module is turned on or off.

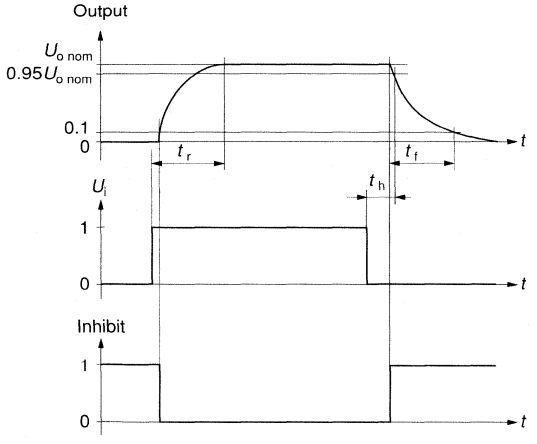



*Fig. 8*
*Output response as a function of input voltage (on/off switching) or inhibit control*

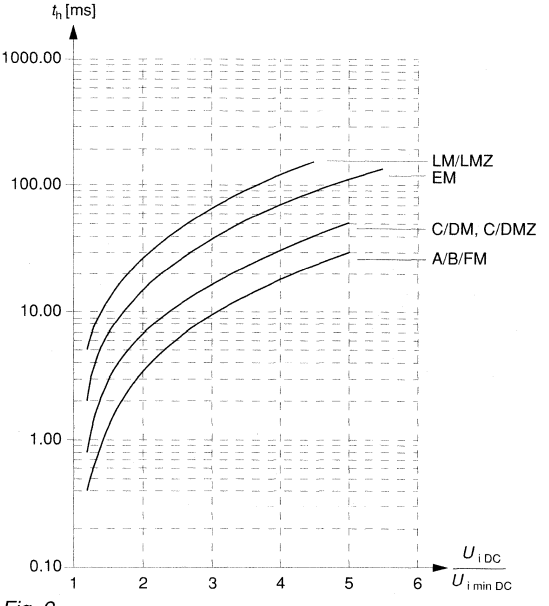



*Fig. 9*
*Typical hold-up time $t_h$ versus relative input voltage at $I_{o\,nom}$*

*Table 10: Output response time, $t_r$ values not applicable for modules equipped with option E*

| Type of Converter | $t_r$ at $P_o$ =0 and $t_f$ at $P_o = P_{o\,nom}$ typ | max | $t_r$ and $t_f$ at $P_o = {}^3/_4\,P_{o\,nom}$ typ | max | $t_r$ at $P_o = P_{o\,nom}$ typ | max | Unit |
|---|---|---|---|---|---|---|---|
| A...LM 1001-7R and C/D/LMZ 1001-7R | 5 | 10 | 5 | 10 | 10 | 20 | ms |
| A...LM 1301-7R and C/D/LMZ 1301-7R | 10 | 20 | 15 | 30 | 20 | 40 | |
| A...LM 1501-7R and C/D/LMZ 1501-7R | 5 | 10 | 10 | 20 | 30 | 60 | |
| A...LM 1601-7R and C/D/LMZ 1601-7R | 15 | 30 | 25 | 50 | 40 | 80 | |
| A...LM 1901-7R and C/D/LMZ 1901-7R | 65 | 130 | 100 | 200 | 165 | 330 | |
| A...LM 2320-7 and C/D/LMZ 2320-7 | 20 | 40 | 30 | 60 | 50 | 100 | |
| A...LM 2540-7 and C/D/LMZ 2540-7 | 15 | 30 | 20 | 40 | 35 | 70 | |
| A...LM 3020-7 and C/D/LMZ 3020-7 | 55 | 110 | 85 | 170 | 145 | 290 | |
| A...LM 3040-7 and C/D/LMZ 3040-7 | 40 | 80 | 60 | 120 | 100 | 200 | |

Conditions:
R input not used. For multiple output modules the figures indicated in the table above relate to the output which reacts slowest. All outputs are resistively loaded. Variation of the input voltage within $U_{i\,min}...U_{i\,max}$ does not influence the values.


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**Programmable Voltage** (R Input)

As a standard feature single output modules offer an adjustable output voltage indentified by letter R in the type designation. The control input R (pin 14) accepts either a control voltage $U_{ext}$ or a resistor $R_{ext}$ to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_o$ according to table 7. The control input is protected against external overvoltage up to 8 V max.

a) Adjustment by means of an external control voltage $U_{ext}$ between pin 14 (R) and pin 17 (G):
The control voltage range is 0...2.75 V and allows an adjustment in the range of approximately
$U_o$ = 0...110% $U_{o\,nom}$.

$$U_{ext} \approx \frac{U_o}{U_{o\,nom}} \cdot 2.5\ V$$

b) Adjustment by means of an external resistor:
Depending upon the value of the required output voltage, the resistor shall be connected
**either:** Between pin 14 and pin 17 ($U_o < U_{o\,nom}$) to achieve an output voltage adjustment range of approx.
$U_o$ = 0...100% $U_{o\,nom}$

$$R_{ext} \approx 4\ k\Omega \cdot \frac{U_o}{U_{o\,nom} - U_o}$$

**or:** Between pin 14 and pin 20 ($U_o > U_{o\,nom}$) to achieve an output voltage adjustment range of approximately
$U_o$ = 100...110% of $U_{o\,nom}$.

$$R'_{ext} \approx 4\ k\Omega \cdot \frac{(U_o - 2.5\ V)}{2.5\ V \cdot (U_o/U_{o\,nom} - 1)}$$

For output voltages $U_o > U_{o\,nom}$, the minimum input voltage according to "Electrical Input Data" increases proportionally to $U_o/U_{o\,nom}$.

**Warning**

The value of $R'_{ext}$ should never be less than 47 kΩ to avoid damage to the unit! R inputs may be parallel connected, but $1/R_{tot} = 1/R_1 + 1/R_2 + ....$ should be considered.

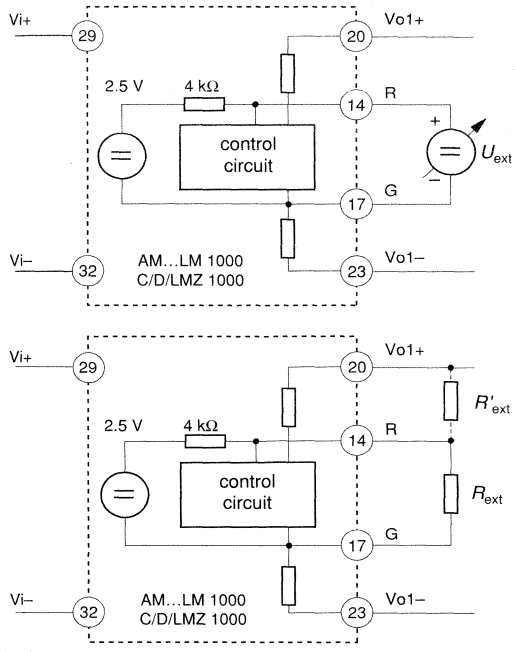



*Fig. 10*
*Output voltage control by means of the R input*

*Table 11a: $R_{ext}$ for $U_o < U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | $U_{o\,nom}$ = 15 V | | $U_{o\,nom}$ = 24 V | | $U_{o\,nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] |
| 0.5 | 0.432 | 2.0 | 0.806 | 2.0 | 0.619 | 4.0 | 0.806 | 8.0 | 0.806 |
| 1.0 | 0.976 | 3.0 | 1.33 | 4.0 | 1.47 | 6.0 | 1.33 | 12.0 | 1.33 |
| 1.5 | 1.65 | 4.0 | 2.0 | 6.0 | 2.67 | 8.0 | 2.0 | 16.0 | 2.0 |
| 2.0 | 2.61 | 5.0 | 2.87 | 8.0 | 4.53 | 10.0 | 2.87 | 20.0 | 2.87 |
| 2.5 | 3.83 | 6.0 | 4.02 | 9.0 | 6.04 | 12.0 | 4.02 | 24.0 | 4.02 |
| 3.0 | 5.76 | 7.0 | 5.62 | 10.0 | 8.06 | 14.0 | 5.62 | 28.0 | 5.62 |
| 3.5 | 8.66 | 8.0 | 8.06 | 11.0 | 11.0 | 16.0 | 8.06 | 32.0 | 8.06 |
| 4.0 | 14.7 | 9.0 | 12.1 | 12.0 | 16.2 | 18.0 | 12.1 | 36.0 | 12.1 |
| 4.5 | 30.1 | 10.0 | 20.0 | 13.0 | 26.1 | 20.0 | 20.0 | 40.0 | 20.0 |
| 5.0 | 200.0 | 11.0 | 44.2 | 14.0 | 56.2 | 22.0 | 44.2 | 44.0 | 44.2 |

*Table 11b: $R'_{ext}$ for $U_o > U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | $U_{o\,nom}$ = 15 V | | $U_{o\,nom}$ = 24 V | | $U_{o\,nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] |
| 5.15 | 464 | 12.1 | 1780 | 15.2 | 1470 | 24.25 | 3160 | 48.5 | 6810 |
| 5.20 | 215 | 12.2 | 909 | 15.4 | 750 | 24.50 | 1620 | 49.0 | 3480 |
| 5.25 | 147 | 12.3 | 619 | 15.6 | 511 | 24.75 | 1100 | 49.5 | 2370 |
| 5.30 | 110 | 12.4 | 464 | 15.8 | 383 | 25.00 | 825 | 50.0 | 1780 |
| 5.35 | 90.9 | 12.5 | 383 | 16.0 | 332 | 25.25 | 715 | 50.5 | 1470 |
| 5.40 | 78.7 | 12.6 | 316 | 16.2 | 274 | 25.50 | 590 | 51.0 | 1270 |
| 5.45 | 68.1 | 12.7 | 274 | 16.4 | 237 | 25.75 | 511 | 51.5 | 1100 |
| 5.50 | 61.9 | 12.8 | 249 | 16.5 | 226 | 26.00 | 453 | 52.0 | 953 |
| | | 13.0 | 200 | | | 26.25 | 402 | 52.5 | 845 |
| | | 13.2 | 169 | | | 26.40 | 383 | 52.8 | 806 |

## EMC and Immunity to Input Transients

A suppressor diode or a metal oxide VDR (depending upon the type) together with an input fuse and an input filter form an effective protection against high input transient voltages which typically occur in most installations, but especially in battery driven mobile applications. The Mk II series has been successfully tested to the following specifications:

### Electromagnetic Immunity

*Table 12: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [4] | Value applied | Waveform | Source impedance | Test procedure | In operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Impulse voltage | IEC 255-4 App. E4 [6] (1976) | III | i/o, i/c, o/c +i/–i, +o/–o | 5000 $V_p$ | 1.2/50 µs | 500 Ω | 3 pos. and 3 neg. impulses per coupling mode | no | |
| High frequency disturbance | IEC 255-4 App. E5 [6] (1976) | III | i/o, i/c, o/o, o/c | 2500 $V_p$ | 400 damped 1 MHz waves/s | 200 Ω | 2 s per coupling mode | yes | 1 |
| | | | +i/–i, +o/–o | 1000 $V_p$ | | | | | |
| Voltage surge | IEC 571-1 [3] (1990-07) | | i/c, +i/–i | 800 $V_p$ | 100 µs | 100 Ω | | yes | 1 |
| | | | | 1500 $V_p$ | 50 µs | | 1 pos. and 1 neg. voltage surge per coupling mode | | |
| | | | | 3000 $V_p$ | 5 µs | | | | |
| | | | | 4000 $V_p$ | 1 µs | | | | |
| | | | | 7000 $V_p$ | 100 ns | | | | |
| Supply related surge | RIA 12 (1984) | A [5] | +i/–i | 3.5• $U_{batt}$ | 20 ms | 0.2 Ω | 1 positive surge | yes | 1 |
| | | B | | 1.5• $U_{batt}$ | 1 s | | | | |
| Direct transient | | C | | 960 $V_p$ | 10/100 µs | 5 Ω | 5 pos. and 5 neg. impulses | | |
| | | D | | 1800 $V_p$ | 5/50 µs | | | | |
| | | E | | 3600 $V_p$ | 0.5/5 µs | 100 Ω | | | |
| | | F | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | G | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Indirect coupled transient | | H | i/c | 1800 $V_p$ | 5/50 µs | | | | |
| | | J | | 3600 $V_p$ | 0.5/5 µs | | | | |
| | | K | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | L | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Electrostatic discharge | IEC 801-2 (1991-04) | 4 | contact discharge to case, | 8000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | 1 |
| | | | air dischg. to case | 15000 $V_p$ | | | | | |
| Electric field | IEC 801-3 (1984) | 3 | antenna in 1m distance | 10 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | 2 |
| Fast transient/ burst | IEC 801-4 (1988) | 3 | i/c, +i/–i | 2000 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | 1 |
| | | 4 | | 4000 $V_p$ | | | | | 2 |
| Transient | IEC 801-5 (Draft 1993-01) | 4 | i/c | 4000 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | 1 |
| | | | +i/–i | 2000 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] Will be replaced by EN 50155
[4] i = input, o = output, c = case
[5] Only met with extended input voltage range of BM (24 V battery), CM (48 V battery) and EM (110 V battery) types. These units are available on customer's request. Standard DM units (110 V battery) will not be damaged, but overvoltage lock-out will occur during the surge
[6] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)


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**Electromagnetic Emissions**

*Table 13: Emissions at $U_{i\,nom}$ and $I_{o\,nom}$ (LM/LMZ at 230 V AC)*

| Types | Level: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | VDE 0871 6.78 | | VDE 0875 part 3 12.88 | | EN 55011, 1991 [1] EN 55022, 1987 [2] | | FCC: 47 CFR 15.xxx 15.107 | 15.103 |
| | ≤ 30 MHz | ≥30 MHz | ≤ 30 MHz | ≥30 MHz | ≤ 30 MHz | ≥30 MHz | ≤ 30 MHz | ≥30 MHz |
| AM 1000 | B | B | N | K | B | B | B | B |
| AM 2000 | B | B | N | K | B | B | B | B |
| AM 3000 | B | A | N | K | B | A | B | A |
| BM 1000 | B | B | N | K | B | B | B | B |
| BM 2000 | B | B | N | K | B | B | B | B |
| BM 3000 | B | A | N | K | B | A | B | A |
| CM 1000 | B | B | N | K | B | B | B | B |
| CM 2000 | B | B | N | K | B | B | B | B |
| CM 3000 | B | A | N | K | B | A | B | A |
| DM 1000 | B | B | N | K | B | B | B | B |
| DM 2000 | B | B | N | K | B | B | B | B |
| DM 3000 | B | A | N | K | B | A | B | A |
| EM 1000 | B | B | N | K | B | B | B | B |
| EM 2000 | B | B | N | K | B | B | B | B |
| EM 3000 | B | A | N | K | B | A | B | A |
| FM 1000 | A | B | N | K | B | B | A | B |
| FM 2000 | A | B | N | K | B | B | A | B |
| FM 3000 | A | A | N | K | B | A | A | A |
| LM 1000 | B | B | N | K | B | B | B | B |
| LM 2000 | B | B | N | K | B | B | B | B |
| LM 3000 | B | A | N | K | B | A | B | A |
| CMZ 1000 | B | A | N | K | B | A | B | A |
| CMZ 2000 | - | - | - | - | - | - | - | - |
| CMZ 3000 | >A | >A | G | G | A | >A | A | >A |
| DMZ 1000 | - | - | - | - | - | - | - | - |
| DMZ 2000 | - | - | - | - | - | - | - | - |
| DMZ 3000 | - | - | - | - | - | - | - | - |
| LMZ 1000 | >A | >A | G | K | A | >A | >A | >A |
| LMZ 2000 | - | - | - | - | - | - | - | - |
| LMZ 3000 | A | >A | N | N | B | >A | A | >A |

[1] Identical with CISPR 11 (1990-09) and VDE 0875 part 11 (1992-07)
[2] Identical with CISPR 22 (1985) and VDE 0878 part 3 (1989-11)

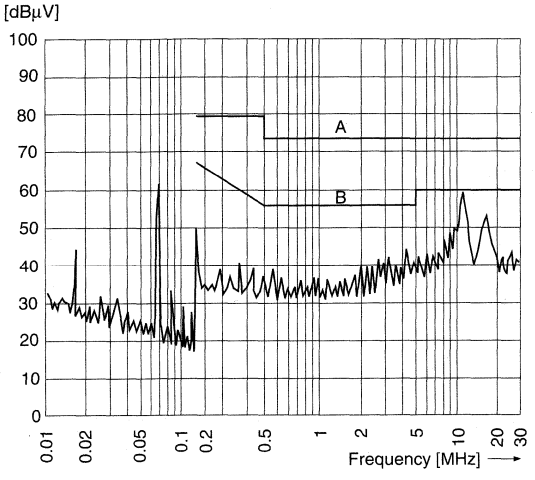



*Fig. 11a*
*Conducted RFI at input according to EN 55011 (quasi peak)*

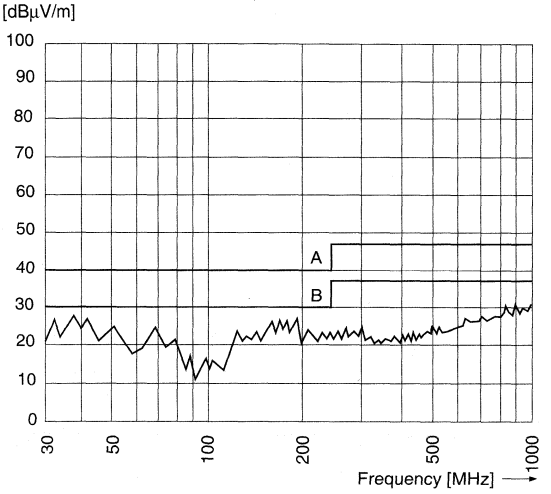



*Fig. 11b*
*Radiated RFI according to EN 55011 (Distance 10 m)*

## Supplementary Data

### Isolation

Input to output electric strength tests, in accordance with the safety standards IEC 950, EN 60950, VDE 0805 and EN 41003 are performed as factory tests and should not be repeated in the field.

### Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 1). Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests. Reference is also made to chapter: Safety and Installation Instructions.

*Table 14: Electric strength test voltage, insulation resistance, clearance and creepage distances*

| Characteristic<br>a) values according to IEC 950,<br>b) Product's performance | | I/O [1] | | I/C [1] Class I | | I/C [1] Class II | | O/C [1] | | O/O [1] | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a) | b) | a) | b) | a) | b) | a) | b) | a) | b) | |
| Electric strength | DC: 1 s | 4243 [2] | 5600 [2] | 2122 | 2800 | 4243 | 5600 | 707 | 1414 | – | 300 | V |
| test voltage | AC: 50 Hz, 1 min | 3000 [2] | 4000 [2] | 1500 | 2000 | 3000 | 4000 | 500 | 1000 | – | 200 | |
| Insulation resistance | at 500 V DC | – | ≥300 | – | ≥300 | – | ≥300 | – | ≥100 | – | – | MΩ |
| Clearance and | AM/BM | 4.0 | 5.0 | 2.0 | 4.0 | 4.0 | 5.0 | 1.0 | 2.0 | – | 0.9 | mm |
| Creepage distances | C...LM and C/D/LMZ | 4.0 | 8.0 | 2.0 | 4.0 | 4.0 | 5.0 | 1.0 | 2.0 | – | 0.9 | |

[1] I/O = Input to Output, I/C = Input to case, O/C = Output to Case, O/O = Output to Output
[2] Only subassemblies performance in accordance with IEC 950

### Leakage Currents in AC-DC operation

Leakage currents will flow due to internal leakage capacitances and RFI suppression Y-capacitors. The current values are proportional to the mains voltage and nearly proportional to the mains frequency and are specified at an input condition of 264 V/50 Hz where phase, neutral and protective earth are correctly connected as required for class I equipment. Under test conditions the leakage currents flow through a measurement circuit, consisting of a 1500 Ω resistance with a 150 nF capacitor connected in parallel. The voltage drop across this element is measured and the current value calculated from the measured voltage divided by 1500 Ω.

If inputs of M-units are connected in parallel, their individual leakage currents are added.

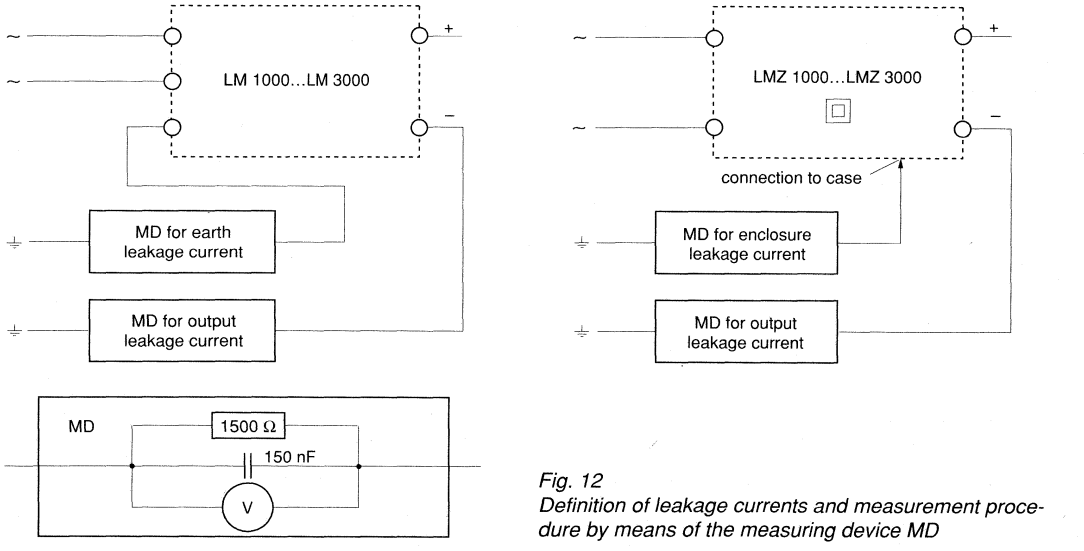



*Fig. 12*
*Definition of leakage currents and measurement procedure by means of the measuring device MD*

*Table 15: Leakage currents*

| Characteristic<br>a) permissible according to IEC 950<br>b) value at 264 V, 50 Hz | Class I (LM) a) max | Class I (LM) b) max | Class II (LMZ) a) max | Class II (LMZ) b) max | Unit |
|---|---|---|---|---|---|
| Earth leakage current | 3.5 | 1.4 | – | – | mA |
| Enclosure leakage current | – | – | 0.25 | 0.03 | |
| Output leakage current | 0.25 | 0.005 | 0.25 | 0.15 | |


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**Display Status of LEDs**

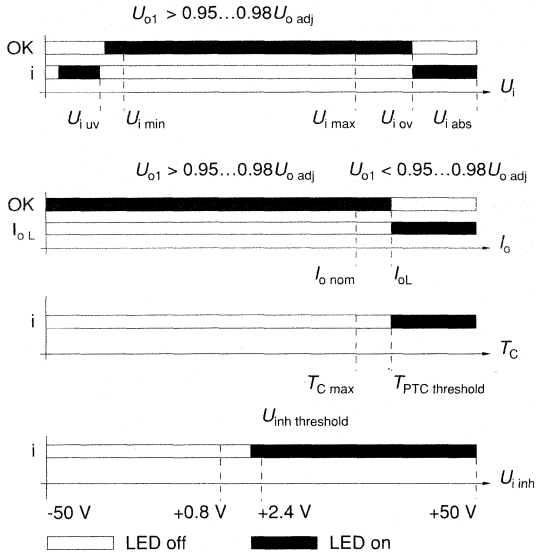



*Fig. 13*
*LEDs "OK" and "i" status versus input voltage*
*Conditions: $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*
*$U_{i\,uv}$ = undervoltage lock-out, $U_{i\,ov}$ = overvoltage lock-out*

*LED "OK" and "$I_{o\,L}$" status versus output current*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*

*LED "i" versus case temperature*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $U_{inh} \le 0.8$ V*

*LED "i" versus $U_{inh}$*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$*

## Description of Options

Table 16: Survey of options

| Option | Function of Option | Characteristic |
|---|---|---|
| –7 | Standard operational ambient temperature range | $T_A$ = –25...71 °C |
| –9 | Extended operational ambient temperature range | $T_A$ = –40...71 °C |
| E | Electronic inrush current limitation circuitry | improved inrush current limitation as per table 19 |
| R [1] | R input for external output voltage programming | Adjustment range 0...110% of $U_{o\,nom}$ (single output modules) |
| P [1] | Potentiometer for fine adjustment of output voltage | Adjustment range ±5% of $U_{o\,nom}$, excludes R input |
| D [2] | Input and/or output undervoltage monitoring circuitry | Safe data signal output (D0...D9) |
| V [2 3] | Input and/or output undervoltage monitoring circuitry | ACFAIL signal according to VME specifications (V0, V2, V3) |
| A | Test sockets at front panel for check of output voltage | $U_o$ internally measured at the connector terminals |
| H | Enhanced output to case electric strength test voltage | 2000 V AC (standard: 1000 V AC) |
| F | Input fuse built-in (not available for A/BM types) | Fuse not externally accessible |
| U | UL recognized full ambient temperature range | Full temperature range according to temperature suffix |

[1] Function R excludes option P and vice versa; [2] Option D excludes option V and vice versa; [3] With main output voltage $U_{o1}$ = 5.1 V available only

**Option -9**

Option -9 extends the operational ambient temperature range from –25...71 °C (standard) to –40...71 °C. The power supplies provide full nominal output power with convection cooling.

**Option A**

Test sockets (pin Ø = 2 mm, distance d = 5.08 mm) are located at the front of the module. The output voltage is sensed at the connector pins inside the module.

**Option P** (not recommended for mobile applications)

Optionally built-in multi-turn potentiometers provide an output voltage adjustment range of minimum ±5% of $U_{o\,nom}$ and are accessible through holes in the front cover. Compensation of voltage drop across connector and wiring is easily achievable. For output voltages $U_o > U_{o\,nom}$, the minimum input voltage according to "Electrical Input Data" increases proportionally to $U_o/U_{o\,nom}$.

*Table 17: Configuration of option A and option P*

| Type of option | AM...LM/CMZ...LMZ 1000 | AM...LM/CMZ...LMZ 2000 | | AM...LM/CMZ...LMZ 3000 | | |
|---|---|---|---|---|---|---|
| | Output 1 | Output 1 | Output 2 | Output 1 | Output 2 | Output 3 |
| Potentiometer [1] | yes | yes | yes | yes | no | no |
| Test sockets | yes | yes | yes | yes | no | no |

[1] AM...LM 1000 types equipped with option P do not provide the R input simultaneously, pins 14 and 17 are not connected.

**Option E**

The standard version of the modules C/D/E/LM as well as C/D/LMZ have a passive inrush current limitation in the form of a NTC resistor.

For applications which require an improved inrush current limitation, an active electronic circuit (option E) as shown in fig. 14 has been developed. Figures 15 and 16 show typical inrush current waveforms of units equipped with this option.

CM and CMZ units meet the CEPT/ETSI standards for 48 V DC supply voltage according to prETS 300132-2 (version 4.2, dated 931213) if fitted with option E (inrush current limitation) together with option D6 (input voltage monitoring). Option D6, externally adjustable via potentiometer, is necessary to disable the converter at input voltages below actual service ranges, avoiding an excessive input current when the input voltage is raised slowly according to prETS 300132-2. Option D6 threshold level $U_{t\,i}$ + $U_{h\,i}$ (refer to description of option D) should be adjusted to 36.0...40.5 V for 48 V DC nominal supply voltage (For 60 V DC systems, threshold should be set to 44.0...50.0 V DC). The D output (pin 5) should be connected to the inhibit (pin 2). For applications where potentiometers are not allowed please contact Melcher.

*Table 18: Inrush current characteristics with option E*

| Characteristic<br>CM/CMZ/EM at $U_i$ = 110 V DC<br>LM/LMZ at $U_i$ = 230 VAC | | CM/CMZ | | EM | | LM/LMZ | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | typ | max | typ | max | typ | max | |
| $I_{inr\,p}$ | Peak inrush current | 6.5 | 8 | 2.2 | 4 | 6 | 10 | A |
| $t_{inr}$ | Inrush current duration | 22 | 30 | 19 | 30 | 35 | 50 | ms |

Precautions:

In order to avoid overload of the series resistor $R_I$ the on/off switching cycle should be limited to 12 s if switched on/off continuously. There should not be more than 10 start-up cycles within 20 s at a case temperature of 25°C.

If CM and CMZ types are driven by input voltages below 35 V DC or LM and LMZ types below 100 V AC, the maximum case temperature should be derated by 10 K or the total output power should be derated by 20%. EM, LM and LMZ units driven by DC input voltages do not need to be derated within the full specified input voltage range.

Availability:

Option E is available for C/E/LM and CMZ/LMZ modules with a nominal output power of 51 W maximum.

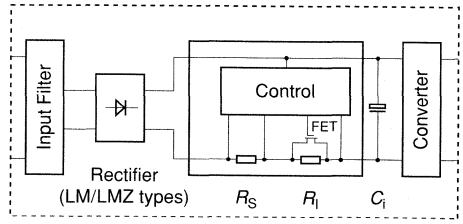



*Fig. 14*
*Option E block diagram*

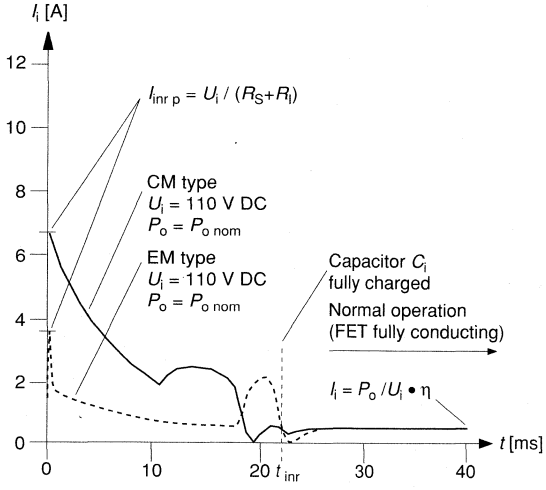



*Fig. 15*
*Typical inrush current waveforms of a CM and an EM type*

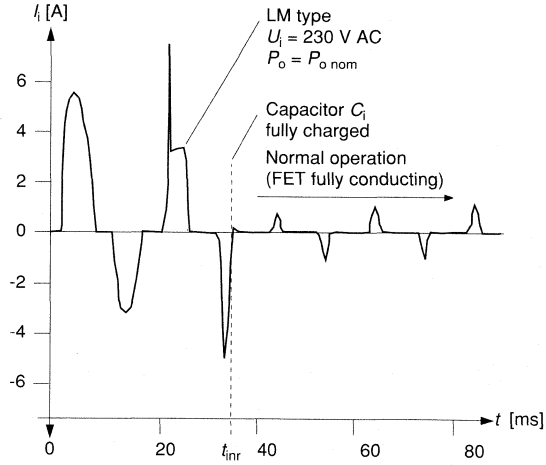



*Fig. 16*
*Typical inrush current waveform of a LM type*



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**Option D**

General description

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1– (pin 23). The D output recovers when the monitored voltage(s) exceed(s) $U_t+U_h$. The threshold level $U_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D0...D9 as shown in the following table.

*Table 19: Undervoltage monitor functions*

| Output type JFET | Output type NPN | Monitoring $U_i$ | Monitoring $U_{o1}$ | Minimum adjustment range of threshold level $U_{t\,i}$ | Minimum adjustment range of threshold level $U_{t\,o}$ | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] $U_{h\,i}$ | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] $U_{h\,o}$ |
|---|---|---|---|---|---|---|---|
| D1 | D5 | no | yes | – | 3.5 V...48 V [1] | – | 2.3...1 |
| D2 | D6 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | – | 3.0...0.5 | – |
| D3 | D7 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| D4 | D8 | no | yes | – | 0.95...0.98 $U_{o1}$ [2] | – | "0" |
| D0 | D9 | no | yes | – | 3.5 V...48 V [3] | – | 1.8...1 |
| | | yes | no | $U_{i\,min}...U_{i\,max}$ [3 4] | – | 2.2...0.4 | – |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | 0.95...0.98 $U_{o1}$ [2] | 2.2...0.4 | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications)
[2] Fixed value between 95% and 98% of $U_{o1}$ (tracking)
[3] Fixed value, resistor-adjusted according to customer's specifications ±2% at 25°C; individual type number is determined by Melcher
[4] Adjusted at $I_{o\,nom}$

JFET output (D0...D4):

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $U_D \leq 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) < $U_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_D \leq 0.4$ V at $I_D = 2.5$ mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_D \leq 25$ µA at $U_D = 5.25$ V |

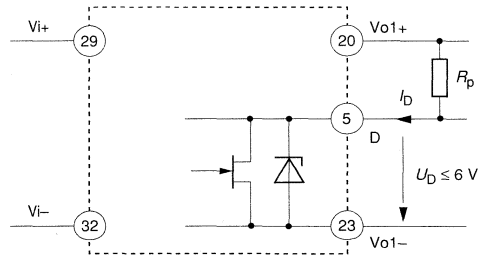



*Fig. 17*
*Options D0...D4, JFET output*

NPN output (D5...D9):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D < 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) > $U_t + U_h$. The current $I_D$ through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. $U_D$ should not exceed 40 V.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | high, H, $I_D \leq 25$ µA at $U_D = 40$ V |
| $U_i$ and $U_{o1} > U_t + U_h$ | low, L, $U_D \leq 0.4$ V at $I_D = 20$ mA |

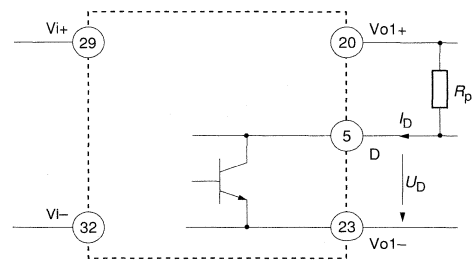



*Fig. 18*
*Options D5...D9, NPN output*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage after the input filter and rectifier (E/LM and LMZ types) is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold level of the D0 and D9 options is factory adjusted at nominal output current $I_{o\,nom}$ and at $T_A$ = 25°C. The value of $\Delta U_{t\,i}$ depends upon the input voltage range (AM, BM, ...), threshold level $U_t$, temperature and input current. The input current is a function of the input voltage and the output power.

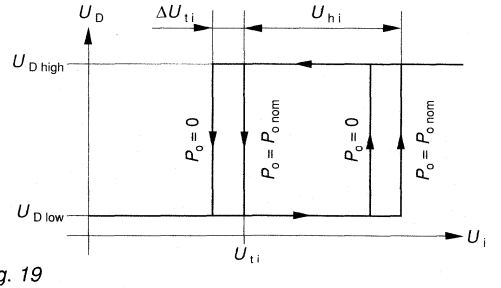
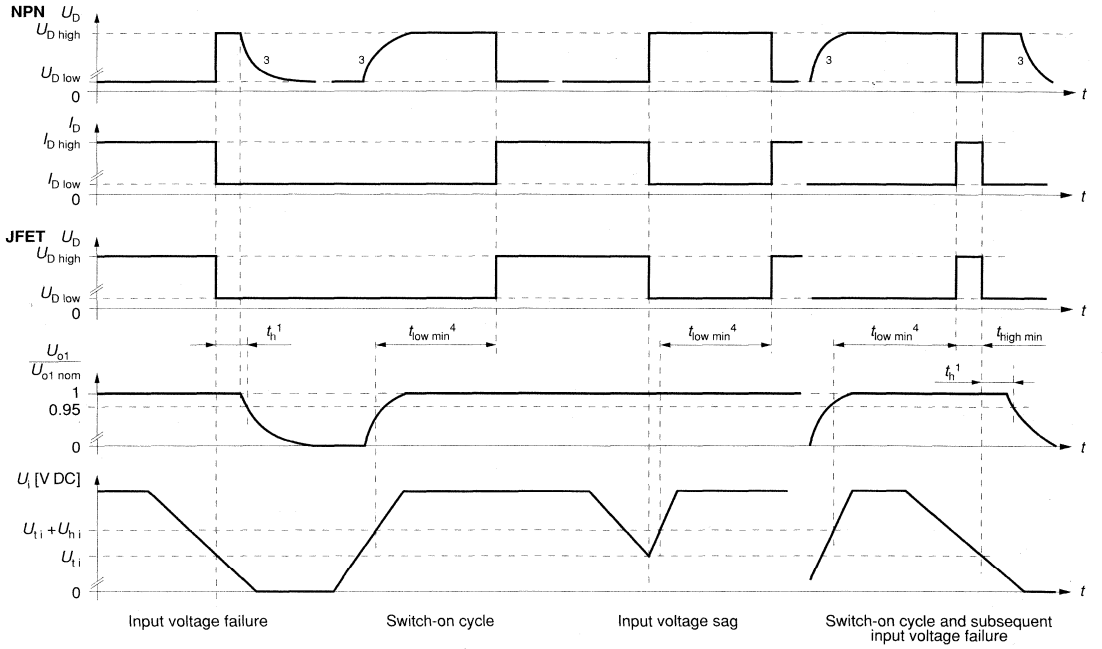
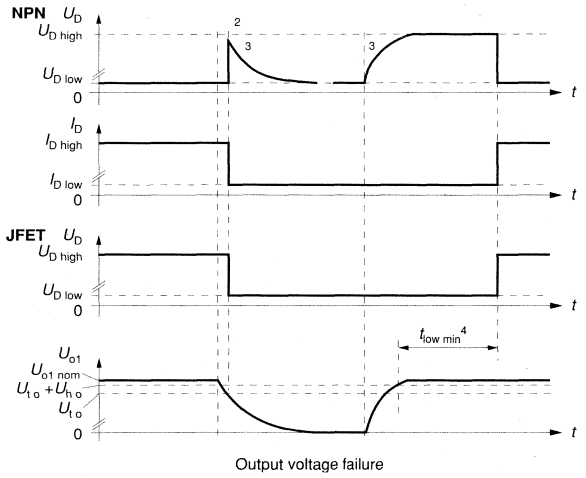



*Fig. 19*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$ (JFET output)*




[1] See fig. 9 for hold-up time.
[2] With output voltage monitoring the hold-up time $t_h$ = 0
[3] The D signal remains high if the D output is connected to an external source.
[4] $t_{low\,min}$ = 40...200 ms, typically 80 ms

*Fig. 20*
*Relationship between $U_i$, $U_{o1}$, $U_D$, $I_D$ and $U_{o1}/U_{o\,nom}$ versus time.*


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### Option V

This option defines an undervoltage monitoring circuit for the input and/or main output voltage ($U_{o1\ nom}$ = 5.1 V only) equivalent to option D and generates an ACFAIL signal (V signal) which conforms to the VME standard.

The low state level of the ACFAIL signal is specified at a sink current of $I_V$ = 48 mA to $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME motherboard.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V when the 5.1 V output is fully loaded. This hold-up time $t_h$ is provided by the internal input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\,min}$ of the converter so that enough energy is remaining in the input capacitance. If the input voltage is below the required level, an external hold-up capacitor ($C_{i\,ext}$) should be added.

Formula for threshold level for desired value of $t_h$:

$$U_{t\,i} = \sqrt{\frac{2 \cdot P_o \cdot (t_h + 0.3\ ms) \cdot 100}{C_{i\,min} \cdot \eta} + U_{i\,min}^2}$$

Formula for additional external input capacitor

$$C_{i\,ext} = \frac{2 \cdot P_o \cdot (t_h + 0.3\ ms) \cdot 100}{\eta \cdot (U_{t\,i}^2 - U_{i\,min}^2)} - C_{i\,min}$$

where as:

$C_{i\,min}$ = minimum internal input capacitance [mF], according to table 19 below
$C_{i\,ext}$ = external input capacitance [mF]
$P_o$ = output power [W]
$\eta$ = efficiency [%]
$t_h$ = hold-up time [ms]
$U_{i\,min}$ = minimum input voltage [V] [1]
$U_{t\,i}$ = threshold level [V]

[1] Min. input voltage according to "Electrical Input Data". For output voltages $U_o > U_{o\,nom}$, the minimum input voltage increases proportionally to $U_o/U_{o\,nom}$.

Remarks: The threshold level $U_{t\,i}$ of option V2 and V3 is adjusted during manufacture to a value according to table 20. A decoupling diode should be connected in series with the input of A...D/FM converters to avoid the input capacitance discharging through other loads connected to the same source voltage. If LM or LMZ units are AC powered, an external input capacitor cannot be applied unless an additional rectifier is provided.

*Table 20: Available internal input capacitance and factory potentiometer setting of $U_{t\,i}$ with resulting hold-up time*

| Types | AM | BM | FM | CM/CMZ | DM/DMZ | EM | LM/LMZ | Unit |
|---|---|---|---|---|---|---|---|---|
| $C_{i\,min}$ | 2.6 | 0.67 | 0.37 | 0.37 | 0.14 | 0.14 | 0.14 | mF |
| $U_{t\,i}$ | 9.5 | 19.5 | 39 | 39 | 61 | 104 | 120 | V DC |
| $t_h$ | 0.34 | 0.69 | 2.92 | 1.92 | 1.73 | 6.69 | 8.18 | ms |

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1– (pin 23). The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by potentiometer, accessible through a hole in the front cover, or is factory adjusted to a determined customer specified value.

Versions V0, V2 and V3 are available as shown below.

*Table 21: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level | | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] | |
|---|---|---|---|---|---|---|
| | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| V2 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | - | 3.0...0.5 | - |
| V3 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| V0 | yes | no | $U_{i\,min}...U_{i\,max}$ [3 4] | - | 2.2...0.4 | - |
| | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | 0.95...0.98 $U_{o1}$ [2] | 2.2...0.4 | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications); [2] Fixed value between 95% and 98% of $U_{o1}$ (tracking), output undervoltage monitoring is not a requirement of VME standard; [3] Adjusted at $I_{o\,nom}$;
[4] Fixed value, resistor-adjusted (±2% at 25°C) acc. to customer's specifications; individual type number is determined by Melcher

V output (V0, V2, V3):

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) < $U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $U_V$ should not exceed 80 V.

| $U_i$, $U_{o1}$ status | V output, $U_V$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_V \leq 0.6$ V at $I_V$ = 50 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_V \leq 25$ µA at $U_V$ = 5.1 V |

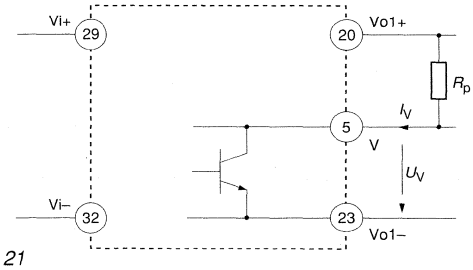



*Fig. 21*
*Output configuration of options V0, V2 and V3*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, t he internal input voltage is measured after the input filter and rectifier (E/LM and LMZ types). Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold level of option V0 is factory adjusted at $I_{o\,nom}$ and $T_A = 25°C$. The value of $\Delta U_{t\,i}$ depends upon the input voltage range (AM, BM, ...), threshold level $U_t$, temperature and input current. The input current is a function of input voltage and output power.

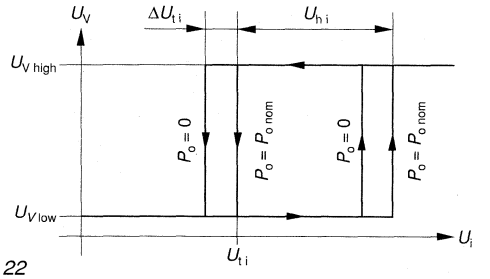
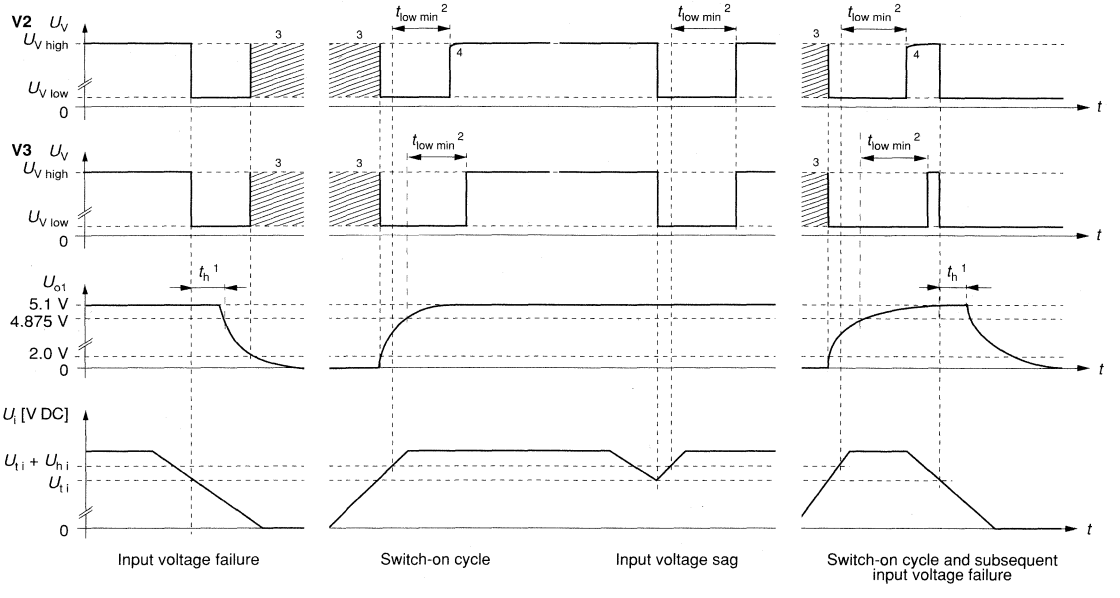
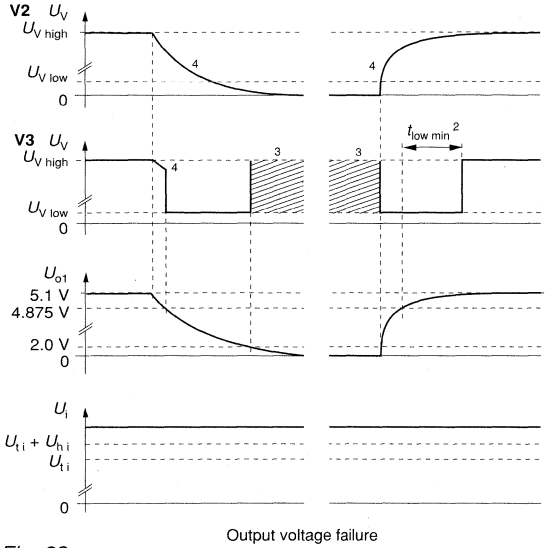



*Fig. 22*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$*




[1] VME request: minimum 4 ms
[2] $t_{low\,min}$ = 40...200 ms, typically 80 ms
[3] $U_V$ level not defined at $U_{o1} < 2.0$ V
[4] The V signal drops simultaneously with the output voltage, if the pull-up resistor $R_P$ is connected to Vo1+. The V signal remains high if $R_P$ is connected to an external source.

*Fig. 23*
*Relationship between $U_i$, $U_{o1}$, $U_V$, $I_V$ and $U_{o1}/U_{o\,nom}$ versus time.*


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**Option F**

The standard M units have a fuseholder containing a 5 × 20 mm fuse which is externally accessible and to be found in the back plate near the connector. Some applications require an inaccessible fuse. Option F provides a fuse mounted directly onto the main PCB inside the case. The full self-protecting functions of the module do not normally lead to broken fuses, except as a result of inverse polarity at the input of an A/B/C/D/FM or C/DMZ type or if a power component inside fails (switching transistor, freewheeling diode, etc). In such cases the defective unit has to be returned to Melcher for repair. Option F is not available with A/BM types.

**Option U**

Underwriters Laboratories (UL) have approved the M series converters as recognized components up to an ambient temperature of $T_{A\,max}$ – 15 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast accepted the converters with the standard PCB material to be operated up to $T_{A\,max}$ without any further precautions.

## Immunity to Environmental Conditions

*Table 22: Mechanical stress*

| Test Method | | Standard | Test Conditions | |
|---|---|---|---|---|
| Ca | Damp heat<br>steady state | DIN 40046 part<br>IEC 68-2-3<br>MIL-STD-810D section 507.2 | Temperature:<br>Relative humidity:<br>Duration: | 40 $^{\pm 2}$ °C<br>93 $^{+2/-3}$ %<br>56 days<br>Unit not operating |
| Ea | Shock<br>(half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock<br>(half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration<br>(sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL-STD-810D section 514.3 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$<br>7.5 h (2.5 h each axis)<br>Unit operating |
| Fda | Random vibration<br>wide band<br>reproducibility high | DIN 40046 part 23<br>IEC 68-2-35 | Frequency band:<br>Acceleration magnitude:<br>Test duration: | 10...2000 Hz<br>5 $g_{rms}$<br>3 h (1 h each axis)<br>Unit not operating |
| Kb | Salt mist<br>cyclic<br>(sodium chloride NaCl solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Storage duration:<br>Number of cycles: | 5% (30 °C)<br>2 h per cycle<br>40 °C, 93% rel. humidity<br>22 h per cycle<br>3<br>Unit not operating |

### Thermal considerations

*Table 23: Temperature specifications, values given are for an air pressure of 800...1200 hPa (800...1200 mbar)*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Standard operational ambient temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –25 | 71 | °C |
| $T_A$ | Extended operational ambient temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 71 | |
| $T_C$ | Standard operational case temperature range -7, overtemp. lock-out (PTC) at $T_C$ > 95°C | –25 | 95 | |
| $T_C$ | Extended operational case temperature range -9, overtemp. lock-out (PTC) at $T_C$ > 95°C | –40 | 95 | |
| $T_S$ | Storage temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 100 | |
| $T_S$ | Extended storage temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –55 | 100 | |

Basically the available output power is limited by thermal characteristics. Customer specific applications requiring slightly higher output power, i.e. increased voltages or currents are available on request. Usually the maximum ambient and case temperatures are reduced compared with standard types. Operation at higher temperatures with nominal output currents is also possible if forced cooling can be provided (heat sink, fan, etc.).

Example: Sufficient forced coolling allows $T_{A\,max}$ = 85°C. A simple check of the case temperature $T_C$ ($T_C \leq 95$°C) at full load ensures correct operation of the system (temperature measurement point on the case see fig. 25).

In general: For an ambient temperature of 85°C with only convection cooling, the maximum permissible current for each output is approx. 50% of it's nominal value for -7 or -9 units (see fig. 24).

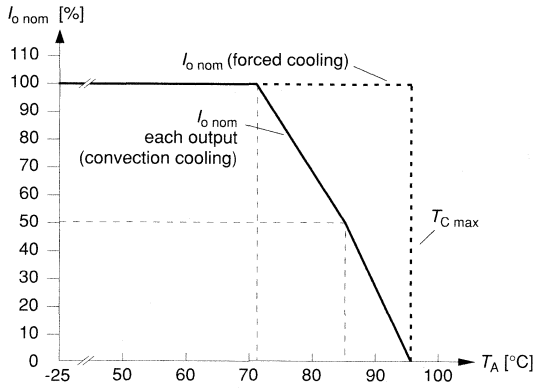



*Fig. 24*
*Output derating versus ambient temperature under convection and forced cooled conditions*

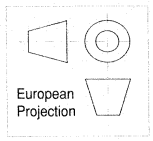
*Table 24: MTBF*

| Values at specified Case Temperature | Module Types | Ground Benign 40°C | Ground Fixed 40°C | Ground Fixed 70°C | Ground Mobile 50°C | Unit |
|---|---|---|---|---|---|---|
| MTBF [1] | A...LM 1000 and C/D/LMZ 1000 | 320'000 | 130'000 | 40'000 | 35'000 | h |
| | A...LM 2000 and C/D/LMZ 2000 | 255'000 | 105'000 | 32'000 | 28'000 | |
| | A...LM 3000 and C/D/LMZ 3000 | 225'000 | 80'000 | 28'000 | 25'000 | |
| Device hours [2] | A...LM 1000 and C/D/LMZ 1000 | 840'000 | | | | |
| | A...LM 2000 and C/D/LMZ 2000 | 740'000 | | | | |
| | A...LM 3000 and C/D/LMZ 3000 | 670'000 | | | | |

[1] Calculated in accordance with MIL-HDBK-217E (calculation according to edition F would show even better results)
[2] Statistical values, based on an average of 4300 working hours per year and in general field use, over 3 years

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



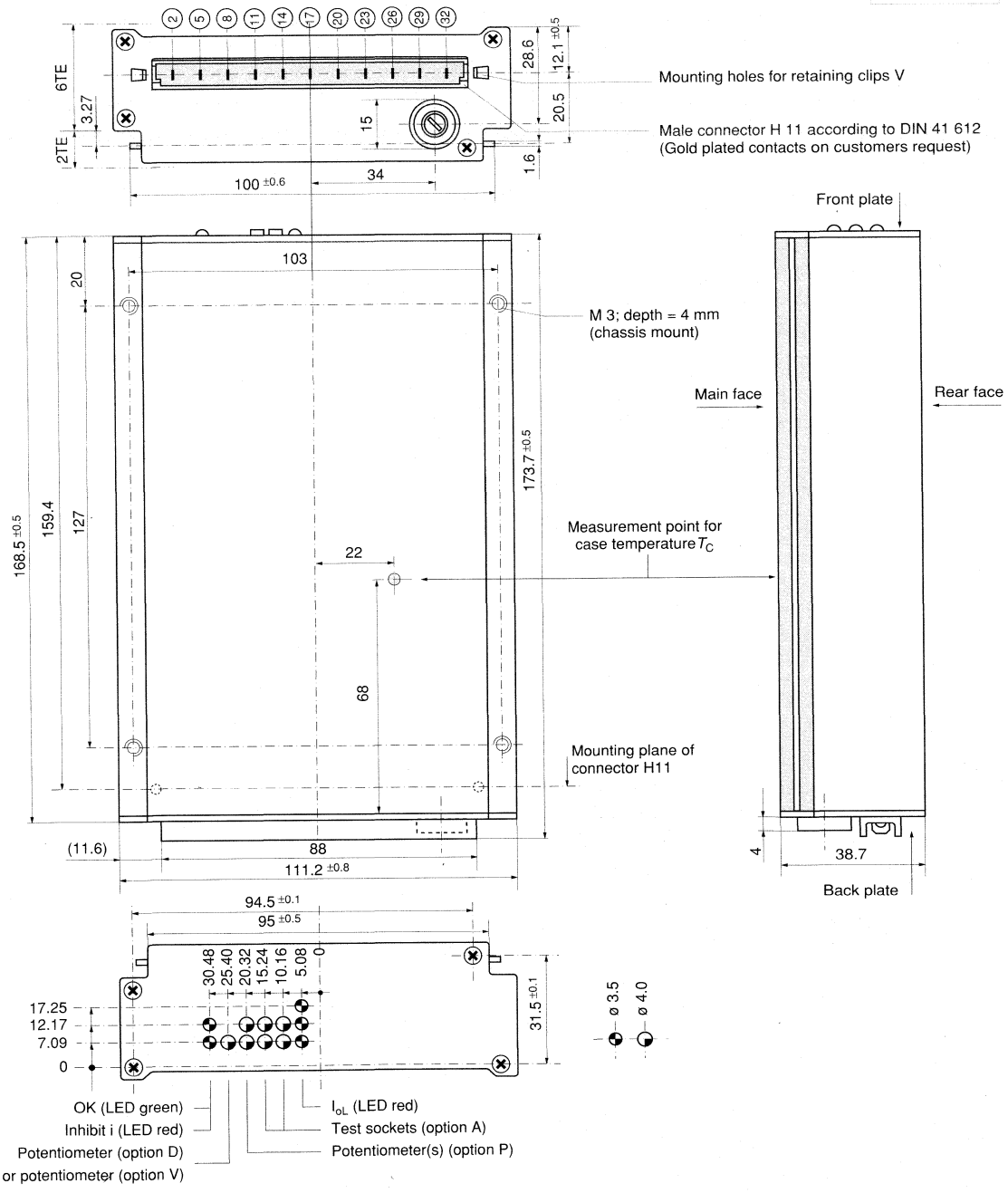
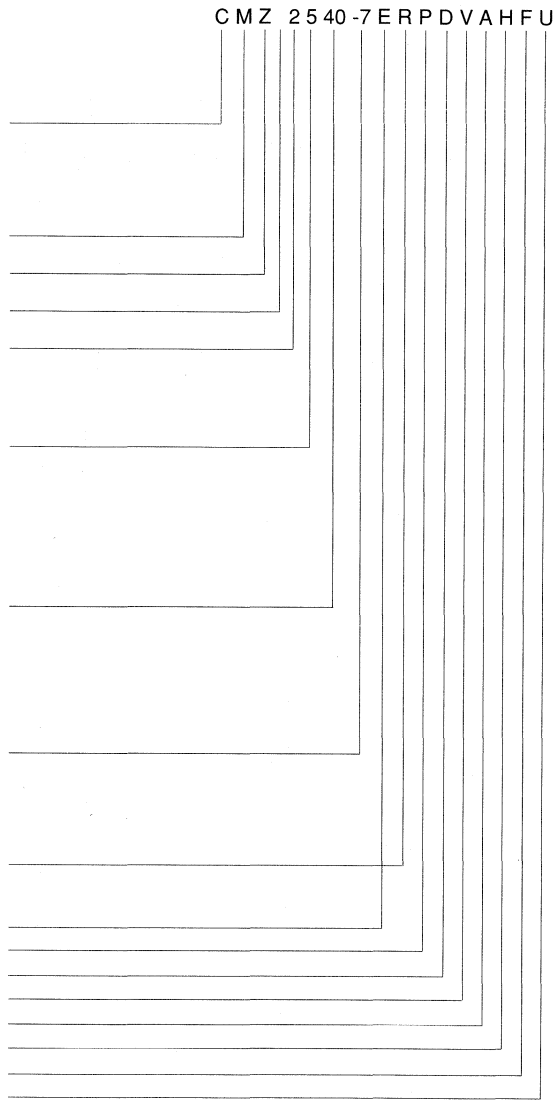




*Fig. 25*
*Case M02, weight 770 g (approx.)*

**Note:** An elongated case of 234 mm is available on request. Please consult Melcher's field sales engineer.

## Type Key and Product Marking

### Type Key




Input voltage range $U_i$:
- 8...35 V DC ..... A
- 14...70 V DC ..... B
- 20...100 V DC ..... F
- 28...140 V DC ..... C
- 44...220 V DC ..... D
- 67...385 V DC ..... E [1]
- 85...264 V AC, 88...372 V DC ..... L

Family ..... M

Class II Equipment ..... Z

Blank .....

Number of outputs ..... 1...3

Output 1, $U_{o1\ nom}$:
- 5.1 V ..... 0...2
- 12 V ..... 3
- 15 V ..... 4...5
- 24 V ..... 6
- other voltages ..... 7...8
- 48 V ..... 9

other specs for single output modules ..... 01...99

Output 2 and 3, $U_{o2\ nom}$, $U_{o3\ nom}$:
- 5.1 V ..... 01...19
- 12 V ..... 20...39
- 15 V ..... 40...59
- 24 V ..... 60...69

other voltages for multiple output modules ..... 70...99

Ambient temperature range $T_A$: (operational)
- –25...50 °C ..... -5
- –25...60 °C ..... -6
- –25...71 °C ..... -7
- –40...85 °C ..... -8
- –40...71 °C ..... -9
- custom specific ..... -0

Output voltage control input (single output modules) ..... R [2]

Options:
- Inrush current limitation (C/E/LM and C/LMZ) ..... E
- Potentiometers for fine adjustment of output voltages ..... P [2]
- Save data signal (D0...D9, to be specified) ..... D [3]
- ACFAIL signal (V0, V2, V3, to be specified) ..... V [3]
- Output voltage test sockets ..... A
- Increased electric strength test voltage (O/C) ..... H
- Input fuse built-in (not accessible) ..... F
- UL recognized component for $T_{A\ max}$ ..... U

[1] EM types upon custom specifications available
[2] Feature R excludes option P and vice versa
[3] Option D excludes option V and vice versa

Example: CM 2540-7PD3A: DC-DC converter, input voltage range 28...140 V, providing output 1 with 15 V/1.7 A and output 2 with 15 V/1.7 A; equipped with potentiometers, undervoltage monitor and test sockets.

**Product Marking** (refer also to "Mechanical Data")

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LEDs, optional test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltage(s) and current(s), pin allocation of options and auxiliary functions, fuse specification and degree of protection.

Rear face: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB, date of production. Confirmation of successfully passed final test.

# 100 W DC-DC (AC-DC) Converters

# S-Family

**Input to output isolation**
**Single output: AS...LS 1000**
**Double output: AS...LS 2000**

- Extremely wide input voltage range
- Input over- and undervoltage lock-out
- Efficient input filter and built-in surge and transient suppression circuitry
- 4 $kV_{rms}$ input to output isolation test voltage
- Fully isolated outputs
- Outputs open- and short-circuit proof
- No derating over entire operating temperature range
- CSA approval and UL recognition in progress
- Safety according to IEC 950




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## Description

The S-family of DC-DC (AC-DC) converters represents a broad and flexible range of power supplies for use in advanced electronic systems. Features include high efficiency, high reliability, low output voltage noise and excellent dynamic response to load/line changes.

The converter inputs are protected against surges and transients occuring on the source lines. Input over- and undervoltage lock-out circuitry disables the outputs if the input voltage is outside the specified ranges. Certain types include an inrush current limitation preventing circuit breakers and fuses from being damaged at switch-on.

All outputs are open- and short-circuit proof and are protected against overvoltages by means of a built-in suppressor diode. The outputs can be inhibited by a logic signal applied to the connector pin i. If the inhibit function is not used pin 18 must be connected with pin 14 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case and output to output isolation is provided. The modules are designed and built according to international safety standards (IEC 950, EN 60950 and VDE 0805).

The case design allows operation at nominal load up to 71 °C in a free air ambient temperature. If forced cooling is provided, the ambient temperature may exceed 71 °C but the case temperature must remain below 95 °C under all conditions.

A temperature sensor generates an inhibit signal which disables the outputs if the case temperature $T_C$ exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Case: Aluminium, black finish, self cooling.

## Type Survey

**Survey of Options see "Description of Options"**

Different output voltages and currents may be set in accordance with customer specifications.

*Table 1a: Type survey AS, BS, CS*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | | | | | Options |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{i\,min}...U_{i\,max}$ **8...35 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **14...70 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **128...140 V DC** | $\eta_{min}$ % | |
| 5.1 | 16.0 | | | AS 1001-7R | 72 | BS 1001-7R | 73 | CS 1001-7R | 77 | -9 |
| 12.0 | 8.0 | | | AS 1301-7R | 79 | BS 1301-7R | 80 | CS 1301-7R | 82 | E [3] |
| 15.0 | 6.5 | | | AS 1501-7R | 79 | BS 1501-7R | 80 | CS 1501-7R | 82 | D |
| 24.0 | 4.2 | | | AS 1601-7R | 80 | BS 1601-7R | 81 | CS 1601-7R | 84 | V [6] |
| 24.0 [4] | 4.0 | | | AS 2320-7R | 77 | BS 2320-7R | 79 | CS 2320-7R | 80 | P |
| 30.0 [4] | 3.2 | | | AS 2540-7R | 77 | BS 2540-7R | 79 | CS 2540-7R | 82 | T |
| 48.0 [4] | 2.0 | | | AS 2660-7R | 78 | BS 2660-7R | 80 | CS 2660-7R | 84 | B1 |
| 12.0 | 4.0 | 12.0 [5] | 4.0 | AS 2320-7R | 77 | BS 2320-7R | 79 | CS 2320-7R | 80 | |
| 15.0 | 3.2 | 15.0 [5] | 3.2 | AS 2540-7R | 77 | BS 2540-7R | 79 | CS 2540-7R | 82 | |
| 24.0 | 2.0 | 24.0 [5] | 2.0 | AS 2660-7R | 78 | BS 2660-7R | 80 | CS 2660-7R | 84 | |

*Table 1b: Type survey DS, FS, LS*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | | | | | Options |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{i\,min}...U_{i\,max}$ **44...220 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **20...100 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **88...372 V DC** (85...264 V AC) | $\eta_{min}$ % | |
| 5.1 | 16.0 | | | DS 1001-7R | 79 | FS 1001-7R | 77 | LS 1001-7R | 78 | -9 |
| 12.0 | 8.0 | | | DS 1301-7R | 83 | FS 1301-7R | 82 | LS 1301-7R | 84 | E [3] |
| 15.0 | 6.5 | | | DS 1501-7R | 84 | FS 1501-7R | 83 | LS 1501-7R | 84 | D |
| 24.0 | 4.2 | | | DS 1601-7R | 85 | FS 1601-7R | 84 | LS 1601-7R | 85 | V [6] |
| 24.0 [4] | 4.0 | | | DS 2320-7R | 81 | FS 2320-7R | 81 | LS 2320-7R | 81 | P |
| 30.0 [4] | 3.2 | | | DS 2540-7R | 82 | FS 2540-7R | 82 | LS 2540-7R | 83 | T |
| 48.0 [4] | 2.0 | | | DS 2660-7R | 85 | FS 2660-7R | 84 | LS 2660-7R | 84 | B1 |
| 12.0 | 4.0 | 12.0 [5] | 4.0 | DS 2320-7R | 81 | FS 2320-7R | 81 | LS 2320-7R | 81 | |
| 15.0 | 3.2 | 15.0 [5] | 3.2 | DS 2540-7R | 82 | FS 2540-7R | 82 | LS 2540-7R | 83 | |
| 24.0 | 2.0 | 24.0 [5] | 2.0 | DS 2660-7R | 85 | FS 2660-7R | 84 | LS 2660-7R | 84 | |

[1] Efficiency at $U_{i\,nom}$ and $I_{o\,nom}$.
[2] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents must be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[3] Option E for C/D/E/F/LS types.
[4] Series connection of output 1 and 2 see fig. 16a.
[5] Second output semi-regulated.
[6] Option V for A...LS 1001 types only

**Note:** ES types with an input voltage range of 67...385 V DC are available upon request.

## Safety and Installation Instructions

**Safety:**

For safety reasons, the power supplies should be wired via the female connector H15 (according to DIN 41612, see "Accessories") in order to meet national and international safety requirements

The converters correspond to safety class I equipment and comply with IEC 950, EN 60950, VDE 0805 Part 100 (including manufacturing surveillance), UL 1950, CSA/C22.2 No. 950-M89 and are VDE approved.

The connector has a leading earth connection pin which ensures earth connection prior to any other.

The UL 1950 recognition limits the ambient operational temperature range of the standard modules (-7) to –25...60°C. In applications where the full operational temperature range of –25...71°C under UL condition is required, forced cooling should be provided.

**Installation**

Installation must strictly follow the national safety regulations. Pin 24 has to be connected to earth. A second fuse should be installed in the wiring to pins 26/28 if:

- Local requirements demand an individual fuse in each source line
- Ui+ to earth impedance is high or undefined
- Phase and neutral of the mains are not defined (AC-DC converters).

In applications where the inhibit function is not used, the inhibit pin should be connected to the S– pin (S 1000) or the Vo1– pin (S 2000) to enable the outputs.

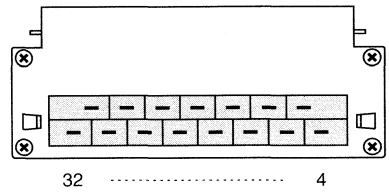
**Important Advice**

Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/µs, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher AG will not honour any guarantee/warranty claims resulting from high voltage field tests.

*Table 2: H15 and H15 S4 Connector pin allocation*

| Pin | Connector type H 15 | | | |
|---|---|---|---|---|
| No. | AS...LS 1000 | | AS...LS 2000 | |
| 4 | Vo1+ | Output 1 | Vo2+ | Output 2 |
| 6 | Vo1+ | | Vo2+ | |
| 8 | Vo1– | Output 1 | Vo2– | Output 2 |
| 10 | Vo1– | | Vo2– | |
| 12 | S+ | Sense | Vo1+ | Output 1 |
| 14 | S– | Sense | Vo1– | Output 1 |
| 16 | R [1] | Control of $U_{o1}$ | R [1] | Control of $U_{o1}$ |
| 18 | i | Inhibit | i | Inhibit |
| 20 | D [3] | Save data | D [3] | Save data |
| | V [3] | ACFAIL | V [3] | ACFAIL |
| 22 | T | Current sharing | T | Current sharing |
| 24 [2] | ⏚ | Protective earth | ⏚ | Protective earth |
| 26 | Vi+ or N~ | Input or Neutral | Vi+ or N~ | Input or Neutral |
| 28 | Vi+ or N~ | | Vi+ or N~ | |
| 30 | Vi– or P~ | Input or Phase | Vi– or P~ | Input or Phase |
| 32 | Vi– or P~ | | Vi– or P~ | |

[1] Function R is not simultaneously available with option P
[2] Leading pin (pregrounding)
[3] Option D is not simultaneously available with option V and vice versa.




Type H15

*Fig. 1*
*View of module's male connectors*

**Degree of Protection**

Condition: Female connector fitted to the unit.
IP 30: All units except those with options P, D or V with potentiometer adjustment.
IP 20: All units fitted with options which include potentiometer setting.

## Functional Description

The input voltage is fed via an input fuse, an input filter, a rectifier (LS types) and an inrush current limiter to the input capacitor. This capacitor sources a single transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke and output filter. The control logic senses the main output voltage $U_{o1}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor.

The second output of double output units is controlled by the main output but has independent current limiting. If the main output is taken into current limitation, the second output voltage will fall as well and vice versa.

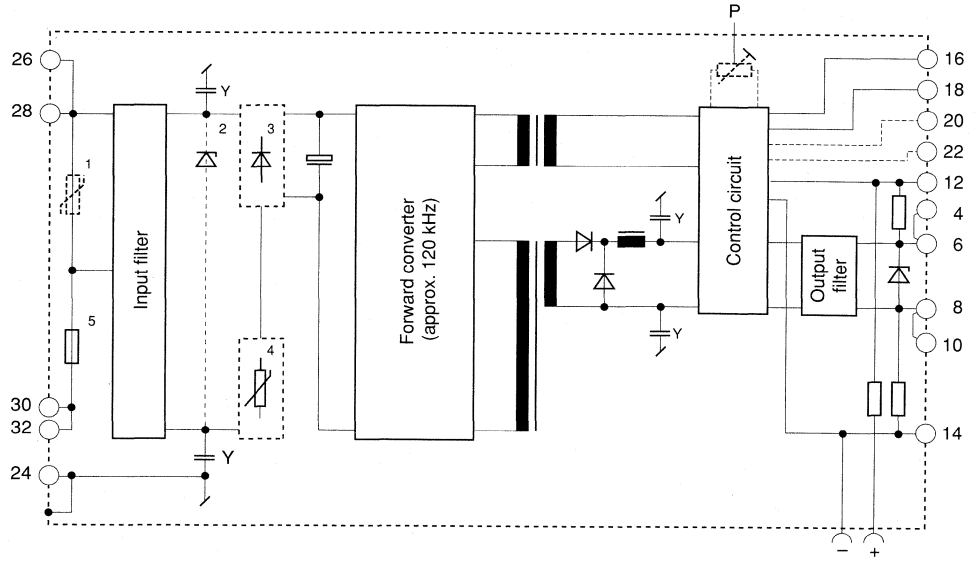
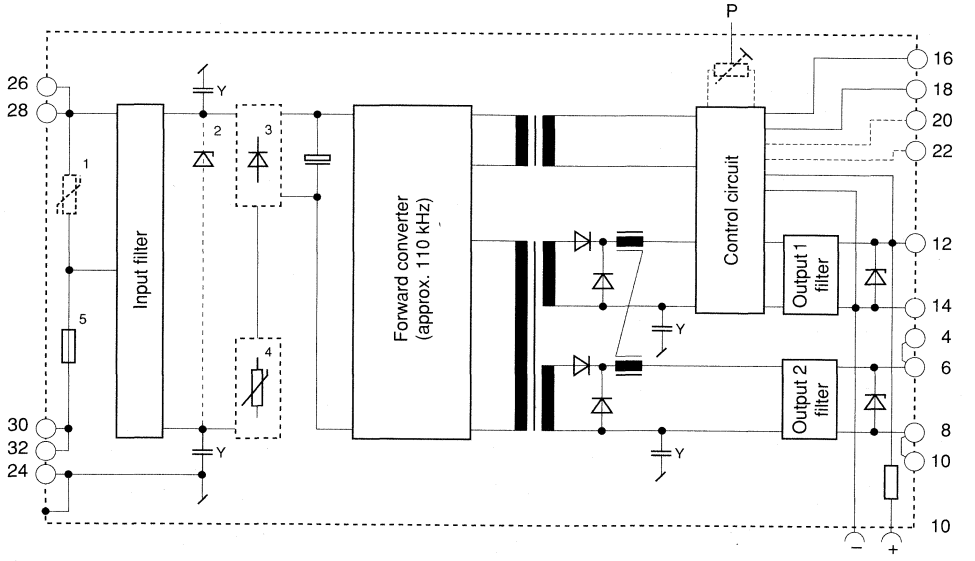



*Fig. 2*
*Block diagram of single output converters AS...LS 1000*




[1] Transient suppressor (VDR) in C/D/E/F/LS types
[2] Transient suppressor (diode) in A/B/C/FS types
[3] Bridge rectifier in LS types
[4] Inrush current limiter in C/D/E/F/LS types (NTC or Opt. E), -9 versions exclude the NTC
[5] Input fuse

*Fig. 3*
*Block diagram of symmetrical double output converters AS...LS 2000*


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## Electrical Input Data

General Conditions
– $T_A$ = 25°C, unless $T_C$ is specified.
– Pin 18 connected to pin 14, $U_o$ adjusted to $U_{o\,nom}$ (option P); R input not connected.
– Sense line pins S+ and S– connected to Vo+ and Vo– respectively.

*Table 3a: Input data*

| Input | | | AS | | | BS | | | CS | | | DS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0...$I_{o\,nom}$ | 8 | | 35 | 14 | | 70 | 28 | | 140 | 44 | | 220 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | $T_{C\,min}$...$T_{C\,max}$ | | 15 | | | 30 | | | 60 | | | 110 | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 7.5 | | | 4.3 | | | 2.1 | | | 1.1 | | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$...$U_{i\,max}$ | | | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | 1.5 | | | 1.5 | | | 1.5 | | | 1.5 | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 65 | | | 100 | | | 150 | | | 170 | | | mΩ |
| $R_{NTC}$ | NTC resistance [2] | | | –[3] | | | –[3] | | 800 | | | 1600 | | | |
| $C_i$ | Input capacitance | | 830 | | 1250 | 300 | | 450 | 660 | | 1000 | 260 | | 400 | µF |
| $U_{i\,RFI}$ | Conducted input RFI | EN 55022 | | | A | | | B | | | B | | | A | |
| | Radiated input RFI | | | | >A | | | >A | | | >A | | | >A | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | 0 | | 40 | 0 | | 80 | 0 | | 154 | 0 | | 400 [4] | V DC |
| F | Fuse rating (nominal) | see table 4 | | 30.0 | | | 25.0 | | | 12.5 | | | 8.0 | | A |

*Table 3b: Input data*

| Input | | | ES | | | FS | | | LS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0...$I_{o\,nom}$ | | – | | | – | | 85 | | 264 | V AC |
| | | $T_{C\,min}$...$T_{C\,max}$ | 67 | | 385 | 20 | | 100 | 88 | | 372 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | | | 220 | | | 48 | | | 310 | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 0.55 | | | 2.6 | | | 0.4 | | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$...$U_{i\,max}$ | | | 2.5 | | | 2.5 | | | 2.5 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | 1.5 | | | 1.5 | | | 1.5 | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 180 | | | 70 | | | 480 | | | mΩ |
| $R_{NTC}$ | NTC resistance [2] | | 3200 | | | | –[3] | | 3200 | | | |
| $C_i$ | Input capacitance | | 210 | | 400 | 1200 | | 1800 | 210 | | 400 | µF |
| $U_{i\,RFI}$ | Conducted input RFI | EN 55022 | | | | | | B | | | B | |
| | Radiated input RFI | | | | | | | >A | | | >A | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | 0 | | 400 | 0 | | 110 | –400 | | 400 | V DC |
| F | Fuse rating (nominal) | see table 4 | | 4.0 | | | 16.0 | | | 4.0 | | A |

[1] With double output modules, both outputs loaded with $I_{o\,nom}$.
[2] Valid for -7, -6, -5 versions with NTC, (-9 versions exclude the NTC). Initial switch-on cycle. Subsequent switch-on/off cycles increase the inrush current peak value.
[3] AS, BS and FS types have no NTC (inrush current limiter) fitted.
[4] 1 s max., duty cycle 1% max.

**Note:** ES types with an input voltage range of 67...385 V DC are available upon request.

Remarks: LS types may be operated in AC mode within a frequency range of 47...440 Hz. Above 70 Hz (at $U_i$ = 264 V AC) the earth leakage current may exceed 3.5 mA as specified in IEC 950. The built-in Y capacitors are specified for frequencies up to 100 Hz. Above 350 Hz the input voltage should not exceed 200 V AC, due to the built-in X capacitors.

### Input Fuse

A fuse mounted inside the converter protects the module against severe defects. This fuse may not fully protect the module when the input voltage exceeds 200 V DC! In applications where the converters operate at source voltages above 200 V DC an external fuse or a circuit breaker at system level should be installed!

*Table 4: Fuse Specification*

| Module | Fuse type | Fuse rating | |
|---|---|---|---|
| AS [1] | fast-blow | Little fuse 314 | 30.0 A, 125 V |
| BS [1] | fast-blow | Little fuse 314 | 25.0 A, 125 V |
| CS [2] | slow-blow | FTR | 12.5 A, 250 V |
| DS [2] | slow-blow | FTR | 8 A, 250 V |
| ES [2] | slow-blow | SP T | 4 A, 250 V |
| FS [2] | slow-blow | FTR | 16 A, 250 V |
| LS [2] | slow-blow | SP T | 4 A, 250 V |

[1] Fuse size 6.3 × 32 mm
[2] Fuse size 5 × 20 mm

### Input Under-/Overvoltage Cut-out

If the input voltage remains below approx. 0.8 $U_{i\,min}$ or exceeds approx. 1.1 $U_{i\,max}$, an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ should be considered!

### Input Transient Protection

A suppressor diode or a VDR (depending upon the input voltage range) together with the input fuse and a symmetrical input filter form an effective protection against high input transient voltages which typically occur in most installations, but especially in battery driven mobile applications.

Nominal battery voltages in use are: 12, 24, 36, 48, 60, 72, 110 and 220 V. In most cases each nominal value is specified to a tolerance of –30%/+25%.

In certain applications, surges according to RIA 12 are specified in addition to those defined in IEC 571-1. The power supply must not switch off during these surges and since their energy can not practically be absorbed an extremely wide input range is required. The EK input range for 110 V batteries has been designed to meet this requirement and is available upon customer request.

### Inrush Current Limitation

The C/D/E/LS modules of the versions -7, -6, -5 incorporate a NTC resistor in the input circuitry which - at initial turn on - reduces the peak inrush current value by a factor of 5...10 to protect connectors and switching devices from damage. Subsequent switch-on cycles within short periods will cause an increase of the peak inrush current value due to the warming-up of the NTC resistor. See also option E.

### Inrush Current Peak Value

The inrush current peak value/initial switch-on cycle) can be determined by following calculation: (Refer to fig. 6 also)

$$I_{inr\,p} = \frac{U_{i\,source}}{(R_{s\,ext} + R_i + R_{NTC})}$$

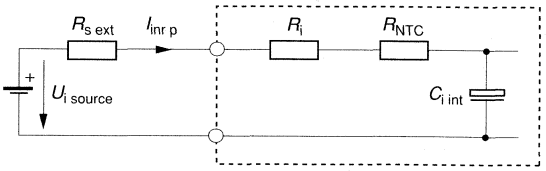



*Fig. 4*
*Replacement diagram for input impedance*


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**Electromagnetic Immunity**

*Table 5: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [4] | Value applied | Waveform | Source impedance | Test procedure | in operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Impulse voltage | IEC 255-4 App. E4 [6] (1976) | III | i/o, i/c, o/c +i/–i, +o/–o | 5000 $V_p$ | 1.2/50 µs | 500 Ω | 3 pos. and 3 neg. impulses per coupling mode | no | - |
| High frequency disturbance | IEC 255-4 App. E5 [6] (1976) | III | i/o, i/c, o/c | 2500 $V_p$ | 400 damped 1 MHz waves/s | 200 Ω | 2 s per coupling mode | yes | 8 |
| | | | i/o, +o/–o, o/c | 1000 $V_p$ | | | | | |
| Voltage surge | IEC 571-1 [3] (1990-07) | | i/c, +i/–i | 800 $V_p$ | 100 µs | 100 Ω | | yes | 1 |
| | | | | 1500 $V_p$ | 50 µs | | 1 pos. and 1 neg. voltage surge per coupling mode | | |
| | | | | 3000 $V_p$ | 5 µs | | | | |
| | | | | 4000 $V_p$ | 1 µs | | | | |
| | | | | 7000 $V_p$ | 100 ns | | | | |
| Supply related surge | RIA 12 (1984) | A [5] | +i/–i | 3.5 • $U_{batt}$ | 20 ms | 0.2 Ω | 1 positive surge | yes | 1 |
| | | B | | 1.5 • $U_{batt}$ | 1 s | | | | |
| Direct transient | | C | +i/c, –i/c | 960 $V_p$ | 10/100 µs | 5 Ω | 5 pos. and 5 neg. impulses | | 2 |
| | | D | | 1800 $V_p$ | 5/50 µs | | | | |
| | | E | | 3600 $V_p$ | 0.5/5 µs | 100 Ω | | | |
| | | F | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | G | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Indirect coupled transient | | H | +o/c, –o/c | 1800 $V_p$ | 5/50 µs | | | | 7 |
| | | J | | 3600 $V_p$ | 0.5/5 µs | | | | |
| | | K | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | L | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Electrostatic discharge | IEC 801-2 (1991-04) | 4 | contact discharge to case, | 8000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | 1 |
| | | | air disch. to case | 15000 $V_p$ | | | | | |
| Electric field | IEC 801-3 (1984) | 3 | antenna in 1m distance | 10 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | 8 |
| Fast transient/ burst | IEC 801-4 (1988) | 3 | i/c, +i/–i | 2000 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | 1 |
| | | 4 | | 4000 $V_p$ | | | | | |
| Transient | IEC 801-5 (Draft 1993-01) | 4 | i/c, | 4000 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | 1 |
| | | | +i/–i | 2000 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specifications possible
[3] Will be replaced by EN 50155
[4] i = input, o = output, c = case
[5] For 110 V batteries only met with extended input voltage range of ES types. These units are available upon customer's request. Standard DS units (110 V battery) will not be damaged, but overvoltage lock-out will occur during the surge. Under normal operation temporary deviation from specifications possible.
[6] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[7] Test in progress, please consult factory
[8] Not tested yet, please consult factory.

**Static Input Current Characteristic**

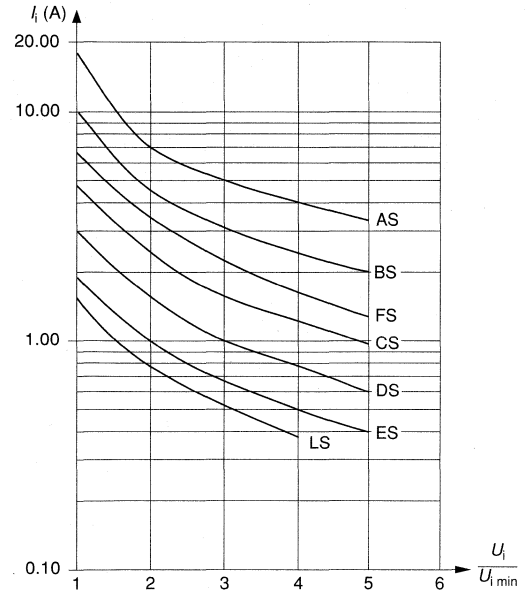



*Fig. 5*
*Input current versus relative input voltage*

**Input Inrush Current Characteristic**

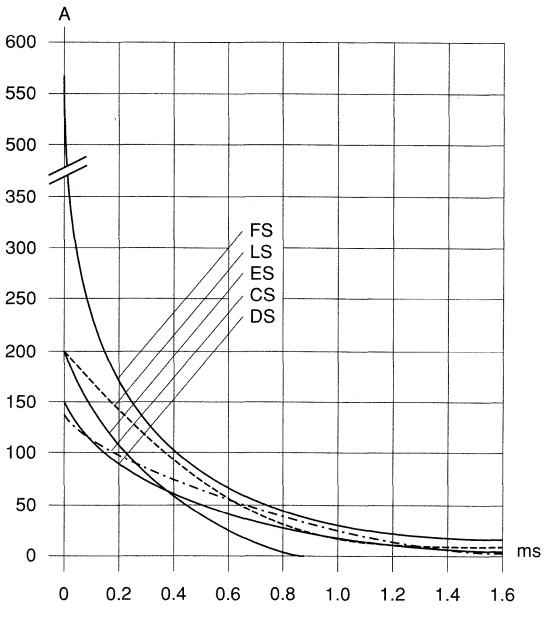



*Fig. 6*
*Inrush current versus time at $U_{i\,max}$, $R_{ext}$ = 0. For AS/BS as well as for application related values use the formula given in section "Inrush Current Peak Value" to get realistic results.*

**Hold-up Time versus relative Input Voltage**

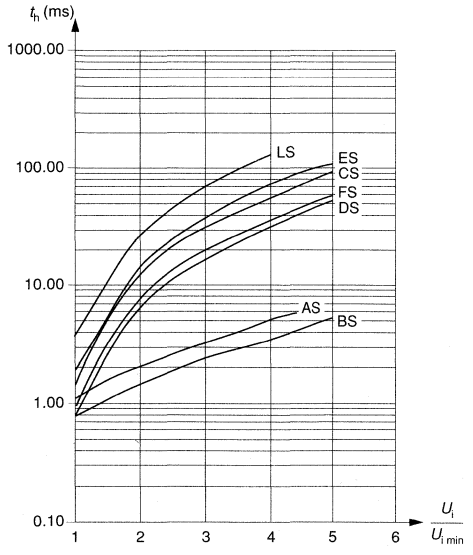



*Fig. 7*
*Hold-up time $t_h$ versus relative input voltage $U_i/U_{i\,min}$. With the exception of the LS, the DC-DC converters require an external series diode in the input path when other loads are connected to the same input supply lines.*

**RFI Noise at Input according to EN 55022**

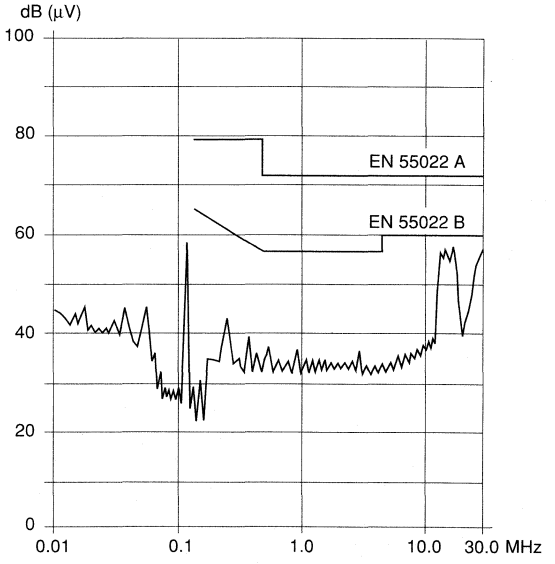



*Fig. 8*
*Typical radio frequency-interference voltage at $U_{i\,nom}$, $I_{o\,nom}$, measured with an artificial mains network and a quasi peak detector.*


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## Electrical Output Data

General Conditions, valid for all tables 6 and 7:
– $T_A$ = 25°C, unless $T_C$ is specified.
– Pin 18 connected to pin 14, $U_o$ adjusted to $U_{o\,nom}$ (option P), R input not connected.
– Sense line pins S+ and S– connected to Vo+ and Vo– respectively.

*Table 6a: Output data single output modules AS/BS*

| Output | | | AS/BS 1001 5.1 V | | | AS/BS 1301 12.0 V | | | AS/BS 1501 15.0 V | | | AS/BS 1601 24.0 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 7.6 | | | 21 | | | 26.5 | | | 43.5 | | |
| $I_{o\,nom}$ | Output current [1] | | | 16.0 | | | 8.0 | | | 6.5 | | | 4.2 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 16.2 | | | 8.2 | | | 6.7 | | | 4.4 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 5 | | | 5 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 75 | | | 40 | | | 60 | | | 90 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±15 | | | ±25 | | | ±30 | | | ±30 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1)$I_{o\,nom}$ | | 20 | | | 25 | | | 30 | | | 40 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±200 | | | ±250 | | | ±300 | | | ±200 | | |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1)$I_{o\,nom}$ | | 0.1 | | | 0.3 | | | 0.3 | | | 0.35 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | of output voltage [7] | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | mV/K |

*Table 6b: Output data double output modules AS/BS*

| Output (Outputs in Series Connection) | | | AS/BS 2320 24 V (2 × 12 V) | | | AS/BS 2540 30 V (2 × 15 V) | | | AS/BS 2660 48 V (2 × 24 V) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | | 24.0 [2] | | | 30.0 [2] | | | 48.0 [2] | | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 39 | | | 49 | | | 72 | | |
| $I_{o\,nom}$ | Output current [1] | | | 4.0 | | | 3.2 | | | 2.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 4.2 | | | 3.4 | | | 2.2 | | | |
| $u_o$ | Output voltage noise [3] | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 10 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 60 | | | 60 | | | 60 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±15 | | | ±15 | | | ±20 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1)$I_{o\,nom}$ | | 25 | | | 25 | | | 35 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±350 | | | ±350 | | | ±250 | | |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1)$I_{o\,nom}$ | | 0.2 | | | 0.2 | | | 0.3 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | of output voltage [7] | | | ±4.8 | | | ±6.0 | | | ±7.2 | | mV/K |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting, remote sensing or option T, the output current should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[2] Series connection for $U_{o\,nom}$ = 24 V, 30 V or 48 V, see fig. 16a.
[3] Shortest possible wiring for series connection at the connector.
[4] See fig. 10.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request

*Table 6c: Output data double output modules AS/BS*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **AS/BS 2320 12 V/12 V** | | | | | | **AS/BS 2540 15 V/15 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 11.93 | | 12.07 | 11.82 | | 12.18 | 14.91 | | 15.09 | 14.78 | | 15.22 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 21 | | | | | | 26.5 | | | | | |
| $I_{o\,nom}$ | Output current [3] | | | 4.0 | | | 4.0 | | | 3.2 | | | 3.2 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 4.2 | | | 4.2 | | | 3.4 | | | 3.4 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 10 | | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 20 | | | 20 | | | 25 | | | 25 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±30 | | | ±30 | | | ±30 | | | ±30 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 50 | | | Fig. 12 | | | 50 | | | Fig. 13 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±160 | | | | | | ±200 | | | | | mV |
| $t_d$ [7] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.2 | | | | | | 0.2 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | | | | ±0.02 | | | | | %/K |
| | | | | ±2.4 | | | | | | ±3.0 | | | | | mV/K |

*Table 6d: Output data double output modules AS/BS*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **AS/BS 2660 24 V/24 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 23.86 | | 24.14 | 23.64 | | 24.36 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 36 | | | 36 | | |
| $I_{o\,nom}$ | Output current [3] | | | 2.0 | | | 2.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 2.2 | | | 2.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 5 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 30 | | | 30 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±40 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 70 | | | Fig. 14 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±300 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.3 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | | | %/K |
| | | | | ±4.8 | | | | | mV/K |

[1] Depending upon the desired output configuration the wiring should be made as shown in fig. 16b, c, d or e.
[2] Same conditions for both outputs.
[3] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[4] See fig. 10.
[5] Condition for specified output. Other output loaded with constant current $I_o = I_{o\,nom}$
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.

*Table 7a: Output data single output modules CS...LS*

| **Output** | | | **CS...LS 1001 5.1 V** | | | **CS...LS 1301 12.0 V** | | | **CS...LS 1501 15.0 V** | | | **CS...LS 1601 24.0 V** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 7.6 | | | 20 | | | 26.5 | | | 39 | | |
| $I_{o\,nom}$ | Output current [1] | | | 16.0 | | | 8.0 | | | 6.5 | | | 4.2 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ | 16.2 | | | 8.2 | | | 6.7 | | | 4.4 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 5 | | | 5 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 75 | | | 40 | | | 60 | | | 90 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}...U_{i\,nom}$, $U_{i\,nom}...U_{i\,max}$, $I_{o\,nom}$ | | | ±15 | | | ±25 | | | ±30 | | | ±30 | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ | | | 20 | | | 25 | | | 30 | | | 40 | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±200 | | | ±250 | | | ±300 | | | ±200 | | |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.1 | | | 0.3 | | | 0.3 | | | 0.35 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}...T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | mV/K |

*Table 7b: Output data double output modules CS...LS*

| **Output** (Outputs in Series Connection) | | | **CS...LS 2320 24 V (2 × 12 V)** | | | **CS...LS 2540 30 V (2 × 15 V)** | | | **CS...LS 2660 48 V (2 × 24 V)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | | 24.0 [2] | | | 30.0 [2] | | | 48.0 [2] | | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 39 | | | 49 | | | 72 | | |
| $I_{o\,nom}$ | Output current [1] | | | 4.0 | | | 3.2 | | | 2.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ | 4.2 | | | 3.4 | | | 2.2 | | | |
| $u_o$ | Output voltage noise [3] | $U_{i\,nom}$, $I_{o\,nom}$ | | 15 | | | 15 | | | 20 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 400 | | | 500 | | | 500 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}...U_{i\,nom}$ $U_{i\,nom}...U_{i\,max}$ $I_{o\,nom}$ | | ±40 | | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ | | 40 | | | 30 | | | 40 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | +100/–300 | | | +200/–300 | | | +250/–250 | | |
| $t_d$ [6] | Time constant; dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.2 | | | 0.2 | | | 0.5 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}...T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±4.8 | | | ±6.0 | | | ±7.2 | | mV/K |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[2] Series connection for $U_{o\,nom}$ = 24 V, 30 V or 48 V, see fig. 16a.
[3] Shortest possible wiring for series connection at the connector.
[4] See fig. 10.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.

*Table 7c: Output data double output modules CS...LS*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **CS...LS 2320 12 V/12 V** | | | | | | **CS...LS 2540 15 V/15 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 11.93 | | 12.07 | 11.82 | | 12.18 | 14.91 | | 15.09 | 14.78 | | 15.22 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 19 | | | 19 | | | 25 | | | 25 | | |
| $I_{o\,nom}$ | Output current [3] | | | 4.0 | | | 4.0 | | | 3.2 | | | 3.2 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 4.2 | | | 4.2 | | | 3.4 | | | 3.4 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 10 | | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 150 | | | 75 | | | 200 | | | 100 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±30 | | | ±40 | | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 100 | | | Fig. 12 | | | 100 | | | Fig. 13 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$ | | +80/–250 | | | | | | +100/–250 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.4 | | | | | | 0.4 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | | | | ±0.02 | | | | | %/K |
| | | | | ±2.4 | | | | | | ±3.0 | | | | | mV/K |

*Table 7d: Output data double output modules CS...LS*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **CS...LS 2660 24 V/24 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 23.86 | | 24.14 | 23.64 | | 24.36 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 36 | | | 36 | | |
| $I_{o\,nom}$ | Output current [3] | | | 2.0 | | | 2.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$, $T_{C\,min}$...$T_{C\,max}$ | 2.2 | | | 2.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$, | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 200 | | | 100 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$, $U_{i\,nom}$...$U_{i\,max}$, $I_{o\,nom}$ | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 50 | | | Fig. 14 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | +100/–250 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.4 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | | | %/K |
| | | | | ±4.8 | | | | | mV/K |

[1] Depending upon the desired output configuration the wiring should be made as shown in fig. 16b, c, d or e.
[2] Same conditions for both outputs.
[3] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[4] See fig. 10.
[5] Condition for specified output. Other output loaded with constant current $I_o = I_{o\,nom}$.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.


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### Output Protection

Each output is protected against overvoltage which could occur due to a failure of the control circuit by means of a voltage suppressor diode which, under worst case conditions, may become a short circuit. The suppressor diode are not designed to withstand externally applied overvoltages. Overload at any of the two outputs will cause a shut-down of both outputs. A red LED indicates the overload condition.

### Test Sockets (Main output only [1])

Test sockets for measuring the output voltage $U_{o1}$ are located at the front of the module. The positive test socket is protected by a series resistor (see fig. 2 and 3). The voltage measured at the test sockets is approximately 30 mV lower than the value measured at the output terminals.

[1] In case of double output units externally connected in series for $U_o$ = 24 V, 30 V or 48 V the monitored output voltage is 12 V, 15 V or 24 V respectively.

### Inhibit Function

The outputs of a module may be enabled or disabled by means of a logic signal (TTL, CMOS etc.) applied to the inhibit input. If the inhibit function is not required, connect the inhibit pin 18 to pin 14 to enable the outputs (active low logic, fail safe).

*Table 8: Inhibit characteristics*

| Characteristic | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | 0.8 | V |
| | | $U_o$ = off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = 0 | | | –400 | µA |
| $t_r$ | Rise time | | | | 30 | | ms |
| $t_f$ | Fall time | | depending on $I_o$ | | | | |

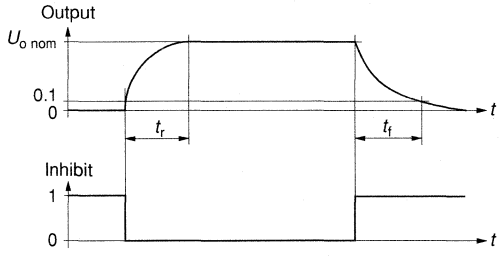



*Fig. 9*
*Output response as a function of inhibit control*

### Sense Lines

(Only for single output units 5.1 V, 12 V, 15 V, 24 V)

This feature enables compensation for voltage drops across the connector contacts and if necessary, across the load lines. If the sense lines are connected at the load rather than directly at the connector, the user should ensure that $U_{o\,max}$ (between Vo1+ and Vo1–) is not exceeded. We recommend connecting the sense lines directly at the female connector.

For further information, please refer to "Application Notes ".

To ensure correct operation, both sense lines should be connected to their respective power outputs and the voltage difference between any sense line and its respective power output pin (as measured on the connector) should not exceed the following values:

*Table 9: Voltage compensation allowed using sense lines*

| Output voltage | Total voltage difference between sense lines and their respective outputs | Voltage difference between Vo– and S– |
|---|---|---|
| 5.1 V | < 0.5 V | < 0.25 V |
| 12 V, 15 V | < 1.0 V | < 0.25 V |

If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents must be reduced accordingly so that $P_{o\,nom}$ is not exceeded.

### Parallel or Series Connection of Units

Single or double output units with equal nominal output voltage can be connected in parallel without any precautions using option T.

With **option T** (current sharing), all units share the current approximately equally.

Single output units and/or main and second outputs of double output units can be connected in series with any other (similar) output.

**Note:**

- Parallel connection of double output units should always include both, main **and** second output to maintain good regulation of both outputs.
- Series connection of second outputs without involving their main outputs should be avoided as regulation may be poor.
- The maximum output current is limited by the output with the lowest current limitation if several outputs are connected in series.
- Not more than 5 units should be connected in parallel.

**Output Voltage Regulation of Single or Double Output Modules with Outputs 1 and 2 Connected in Series**

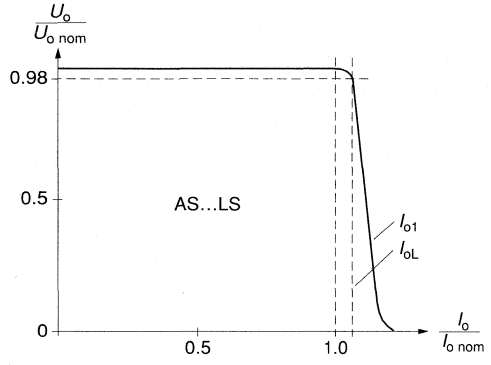



*Fig.10*
*$U_{o1}$ vs. $I_{o1}$ (typ.) of single output units*

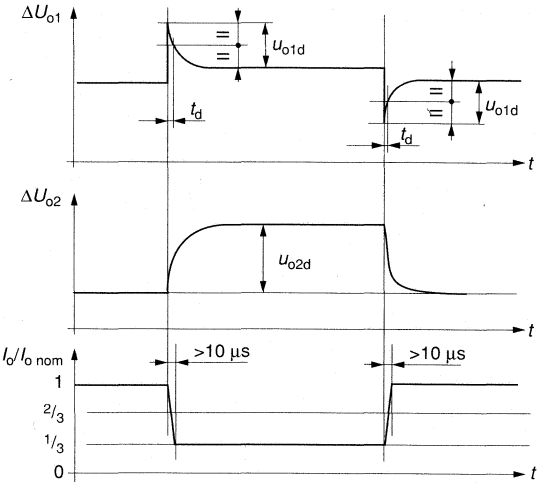



*Fig. 11*
*Control deviation of $u_{o1/2\,d}$ vs. dynamic load change*

**Output Voltage Regulation of Double Output Modules with Output 1 and 2 in Symmetrical Configuration**

Output 1 is under normal conditions regulated to $U_{o1\,nom}$, independent of the output currents.

$U_{o2}$ is dependent upon the load distribution. When both outputs are loaded with more than 10% of $I_{o\,nom}$, the deviation of $U_{o2}$ remains within ±5% of the value of $U_{o1}$. Figures 13, 14 and 15 show the regulation with varying load distribution. If $I_{o1} = I_{o2}$ or the two outputs are connected in series, the deviation of $U_{o2}$ remains within ±1% of the value of $U_{o1}$ provided that a total load of more than 10% of $I_{o\,nom}$ is applied.

Two outputs of a single S 2000 module connected in parallel will behave like the output of a S 1000 module; the paralleled output is fully regulated. No precautions are necessary in using the R-input and the test sockets.

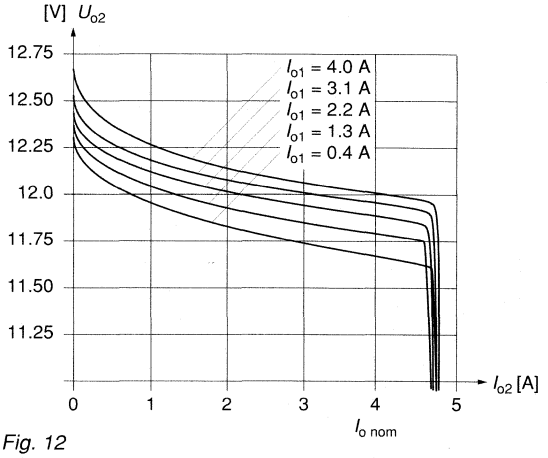



*Fig. 12*
*AS...LS 2320: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

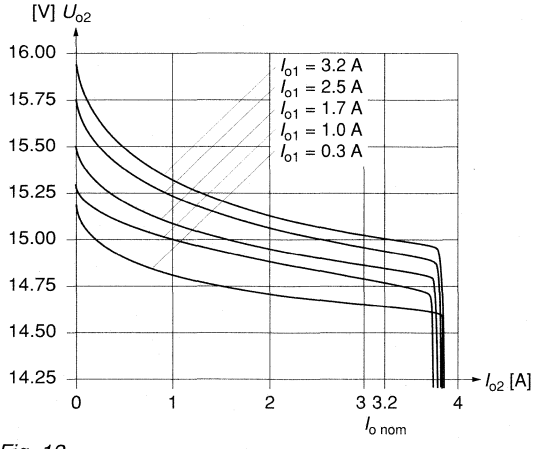



*Fig. 13*
*AS...LS 2540: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

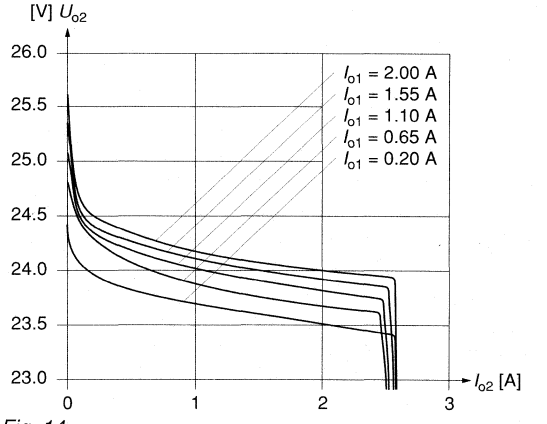



*Fig. 14*
*AS...LS 2660: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

**Programmable Output Voltage** (R-Function)

As a standard feature, the modules offer an adjustable output voltage, identified by letter R in the type designation. The control input R (pin 16) accepts either a control voltage $U_{ext}$ or a resistor $R_{ext}$ to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_{o\,nom}$.

a) Adjustment by means of an external control voltage $U_{ext}$ between pin 16 (R) and pin 14:

The control voltage range is 0...2.75 V DC and allows an output voltage adjustment in the range of approximately 0...110% $U_{o\,nom}$.

$$U_{ext} = \frac{U_o}{U_{o\,nom}} \cdot 2.5\ V \text{ (approximate formula)}$$

b) Adjustment by means of an external resistor:

Depending upon the value of the required output voltage the resistor shall be connected

**either:** Between pin 16 and pin 14 ($U_o < U_{o\,nom}$) to achieve an output voltage adjustment range of approximately 0...100% $U_{o\,nom}$

**or:** Between pin 16 and pin 12 ($U_o > U_{o\,nom}$) to achieve an output voltage adjustment range of approximately 100...110% $U_{o\,nom}$.

**Warning:**

- The value of $R'_{ext}$ shall never be less than the lowest value as indicated in table 10b to avoid damage to the unit!

**Remarks:**

- The R-Function excludes option P (output voltage adjustment by potentiometer).
- If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output current(s) should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
- The R-input (as well as option P) is related to the main output.
- With double output units the second output follows the value of the controlled main output. Resistor values as indicated for the single output units should be used.
- For correct output voltage adjustment of double output units the external wiring of the outputs should be according to fig. 16a, b, c, d or e depending upon the desired output configuration.
- In case of parallel connection the output voltages should be individually set within a tolerance of 1 - 2%.

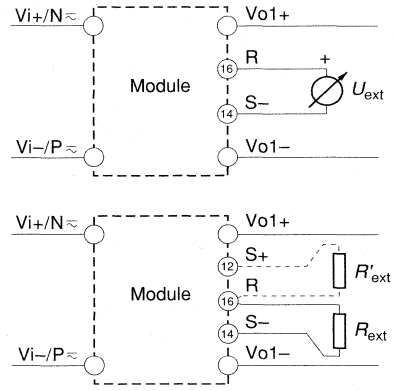



*Fig. 15*
*Output voltage control for single output units AS...LS 1000 by means of the R input*

*Table 10a: $R_{ext}$ for $U_o < U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ (V) | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] |
| 0.5 | 0.422 | 2 | 4 | 0.825 | 2 | 4 | 0.56 | 4 | 8 | 0.825 |
| 1.0 | 1.0 | 3 | 6 | 1.3 | 4 | 8 | 1.47 | 6 | 12 | 1.33 |
| 1.5 | 1.62 | 4 | 8 | 1.96 | 6 | 12 | 2.61 | 8 | 16 | 1.96 |
| 2.0 | 2.16 | 5 | 10 | 2.87 | 8 | 16 | 4.64 | 10 | 20 | 2.87 |
| 2.5 | 3.83 | 6 | 12 | 3.83 | 9 | 18 | 6.19 | 12 | 24 | 3.83 |
| 3.0 | 5.61 | 7 | 14 | 5.62 | 10 | 20 | 8.25 | 14 | 28 | 5.61 |
| 3.5 | 9.09 | 8 | 16 | 8.28 | 11 | 22 | 11.0 | 16 | 32 | 8.25 |
| 4.0 | 14.7 | 9 | 18 | 12.1 | 12 | 24 | 16.2 | 18 | 36 | 12.1 |
| 4.5 | 28.7 | 10 | 20 | 19.6 | 13 | 26 | 26.1 | 20 | 40 | 19.6 |
| 5.0 | 196 | 11 | 22 | 42.2 | 14 | 28 | 56.2 | 22 | 44 | 46.4 |

*Table 10b: $R'_{ext}$ for $U_o > U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] |
| 5.15 | 422 | 12.1 | 24.2 | 1780 | 15.2 | 30.4 | 1470 | 24.25 | 48.5 | 3160 |
| 5.2 | 215 | 12.2 | 24.4 | 909 | 15.4 | 30.8 | 750 | 24.5 | 49.0 | 1620 |
| 5.25 | 147 | 12.3 | 24.6 | 623 | 15.6 | 31.2 | 511 | 24.75 | 49.5 | 1100 |
| 5.3 | 110 | 12.4 | 24.8 | 464 | 15.8 | 31.6 | 383 | 25.0 | 50.0 | 825 |
| 5.35 | 90.9 | 12.5 | 25.0 | 383 | 16.0 | 32.0 | 316 | 25.25 | 50.5 | 681 |
| 5.4 | 75 | 12.6 | 25.2 | 316 | 16.2 | 32.4 | 261 | 25.5 | 51.0 | 562 |
| 5.45 | 61.9 | 12.7 | 25.4 | 286 | 16.4 | 32.8 | 237 | 25.75 | 51.5 | 511 |
| 5.5 | 56.2 | 12.8 | 25.6 | 234 | 16.5 | 32.0 | 215 | 26.0 | 52.0 | 464 |
| | | 13.0 | 26.0 | 196 | | | | 26.25 | 52.5 | 422 |
| | | 13.2 | 26.4 | 162 | | | | 26.4 | 52.8 | 383 |

[1] First column: single output units or double output units with separated outputs, second column: outputs in series connection

Programmable Output Voltage (R-Function) continued

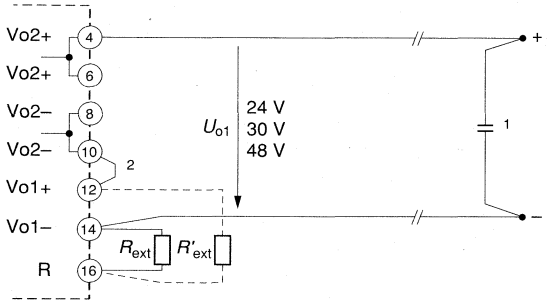



*Fig. 16a*
*AS...LS 2000 with H15 connector. R-input for output voltage control. Wiring for output voltage 24 V or 30 V or 48 V with main and second output connected in series.*

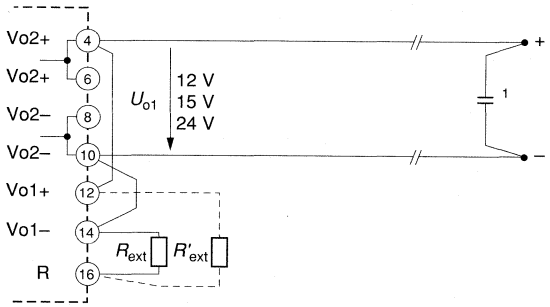



*Fig. 16b*
*AS...LS 2000 with H15 connector. R-input for output voltage control. Wiring for output voltage 12 V or 15 V or 24 V with main and second output connected in parallel.*

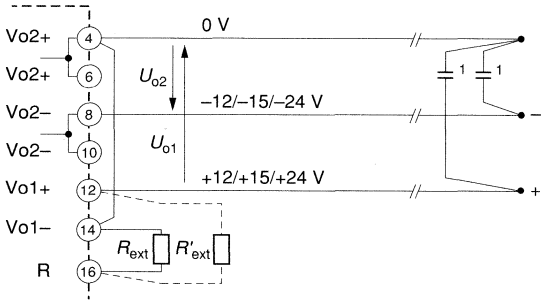



*Fig. 16c*
*AS...LS 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two symmetrical output voltages $U_{o1}$ and $U_{o2}$: ±12 V or ±15 V or ±24 V.*

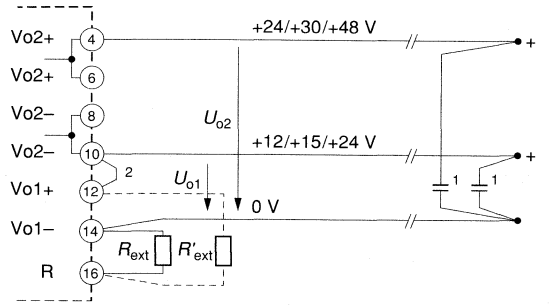



*Fig. 16d*
*AS...LS 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two output voltages $U_{o1}$ and $U_{o2}$: +12 V and +24 V or +15 V and +30 V or +24 V and +48 V.*

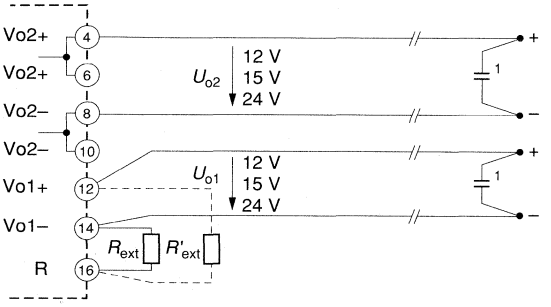



*Fig. 16e*
*AS...LS 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two output voltages $U_{o1}$ and $U_{o2}$: 12 V/12 V or 15 V/15 V or 24 V/24 V, the outputs are galvanically isolated.*

[1] A ceramic multilayer capacitor connected across the output lines reduces ripple and spikes.
[2] Shortest possible wiring for series connection at the female connector

**Remarks:**

Double output units fitted with H-15 connectors have the output pins of the second output, pins 4/6 and 8/10, internally paralleled.

It is recommended that pins 4/6 and 8/10 be directly paralleled at the female connector as well to reduce the voltage drop across the connector.

Please note: $U_{o2}$ varies depending upon its own load and the load on output 1.


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## Supplementary Data

### Isolation

Input to output isolation voltage tests in accordance with IEC 950, EN 60950, VDE 0805 and EN 41003 respectively are performed as factory tests and should not be repeated in the field.

### Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 2 and 3). Melcher will not honour any guarantee claims resulting from high voltage field tests.

*Table 11: Isolation test voltages, clearance and creepage distances*

| Characteristic | | Input to Output | Input to Case | Output to Case | Output to Output | Unit |
|---|---|---|---|---|---|---|
| Isolation test voltage | | 4.0 | 2.0 | 1.0 | 0.1 | $kV_{rms}$ |
| | | 5.6 | 2.8 | 1.4 | 0.15 | kV DC |
| Clearance and creepage distance on the print lay-out | AS/BS | 6.4 | 3.2 | 2.0 | 1.0 | mm |
| | CS...LS | 6.4 | 3.2 | 2.0 | 0.4 | |

### Display Status of LEDs

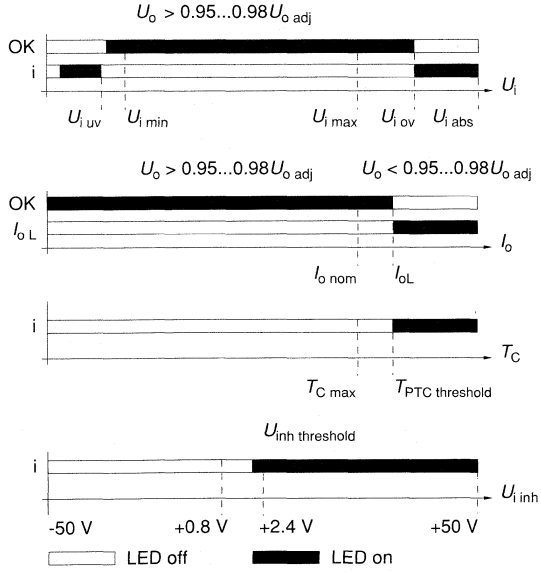



*Fig. 17*

*LEDs* "OK" *and* "i" *status versus input voltage*
*Conditions:* $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V
$U_{i\,uv}$ = *undervoltage lock-out,* $U_{i\,ov}$ = *overvoltage lock-out*

*LEDs* "OK" *and* "$I_{o\,L}$" *status versus output current*
*Conditions:* $U_{i\,min}...U_{i\,max}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V

*LED* "i" *versus case temperature*
*Conditions:* $U_{i\,min}...U_{i\,max}$, $I_o \le I_{o\,nom}$, $U_{inh} \le 0.8$ V

*LED* "i" *versus* $U_{inh}$
*Conditions:* $U_{i\,min}...U_{i\,max}$, $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$

## Description of Options

*Table 12: Survey of options*

| Option | Function of Option | Characteristics |
|---|---|---|
| -9 | Operational temperature range $T_A$ = –40 °C...71 °C | Extended operational temperature range |
| E [1] | Electronic inrush current limitation circuitry | Improved inrush current limitation as per table 12 |
| P | Potentiometer for $U_o$ adjustment | R-function is not available if option P is incorporated |
| D | Input and/or output undervoltage monitoring circuitry | Safe data signal output (Versions D0...DD) |
| V | Input (and output) undervoltage monitoring circuitry | ACFAIL signal according to VME specs (Versions V0, V2, V3) |
| T | Current sharing | Interconnect T-pins if paralleling outputs (5 units max.) |
| B1 | Cooling plate | Replaces standard heat sink, allowing direct chassis-mounting |

[1] Option E for C/D/E/LS types

**Option -9** Extended Temperature Range

Extension of the operating temperature range from standard –25...71 °C to –40...71 °C. The modules will provide full nominal output power with free air convection cooling. Option -9 excludes inrush current limitation by NTC.

**Option E** Inrush Current Limitation

CS/DS/ES/FS/LS types may be supplemented by an electronic circuit (option E, replacing the standard built-in NTC) to achieve an enhanced inrush current limiting function (not available with AS/BS/FS types).

If fitted with option E (inrush current limitation) together with option D6, input voltage monitoring, the CS units meet the CEPT/ETSI standards for 48 V DC supply voltages according to prETS 300132-2, version 4.2, date 9312. Option D6, externally adjustable via potentiometer, is necessary to disable the converter at input voltages below actual service voltage ranges, avoiding an excessive input current when the input voltage is raised slowly according to prETS 300132-2. Option D6 threshold level should be adjusted to 36.0...40.5 V for 48 V nominal supply systems or 44.0...50.0 V for 60 V nominal supply systems (refer also to description of option D). The D output should be connected to the inhibit input. Please contact Melcher if applications do not permit potentiometer setting.

*Table 13: Inrush current characteristics with option E*

| Characteristics | | CS | DS | ES/LS | Unit |
|---|---|---|---|---|---|
| $U_{i\,nom}$, $I_{o\,nom}$ | Input voltage | 60 | 110 | 220 | V |
| $I_{inr\,p}$ | Peak inrush current | 6.8 | 7.4 | 14.6 | A |
| $t_{inr}$ | Inrush current duration | 18 | 14 | 16 | ms |
| $U_{i\,nom}$, $I_{o\,nom}$ | Input voltage | 140 | 220 | 380 | V |
| $I_{inr\,p}$ | Peak inrush current | 9.3 | 14.5 | 25.3 | A |
| $t_{inr}$ | Inrush current duration | 20 | 14 | 12 | ms |

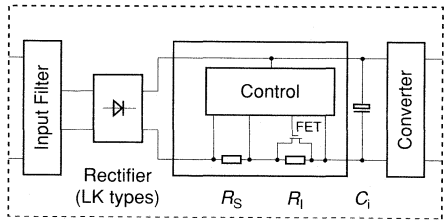
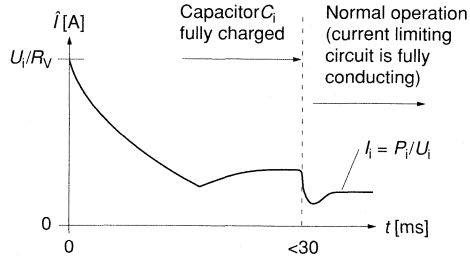



*Fig. 18*
*Option E block diagram*




$R_V$: *Current limiting resistance* = $R_S + R_I = 15\ \Omega$

*Fig. 19*
*Inrush current with option E*

**Precaution:**

Subsequent switch-on cycles at start-up are limited to max. 10 cycles during the first 20 seconds (cold unit) and at continuing on/off ($T_C$ = 95°C) max. 1 cycle every 8 sec.

**Option P** Potentiometer

The potentiometer provides an output voltage adjustment range of +10/–60% of $U_{o\,nom}$ and is accessible through a hole in the front cover. This feature enables compensation for voltage drops across the connector and wiring. Option P is not recommended if units are connected in parallel.

Option P excludes the R-function. With double output units both outputs are affected by the potentiometer setting (doubling the voltage setting if the outputs are in series).

If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output current(s) should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.

**Option T** Current Sharing

This option ensures that the output currents are approximately shared between all paralleled modules and increases system reliability. To use this facility, simply interconnect the T pins of all modules and make sure, that pins no. 14, the S– pins (S 1000) or the Vo1– pins (S 2000) are also connected together. The load leads should have equal length and cross section to ensure equal voltage drops. Not more than 5 units should be connected in parallel. If output voltage adjustment is requested we strongly recommend to use the R-input instead of option P, as with option P the required setting accuracy is difficult to achieve. The output voltages must be individually set prior to paralleling to within a tolerance of 1...2% or the R pins should be connected together.

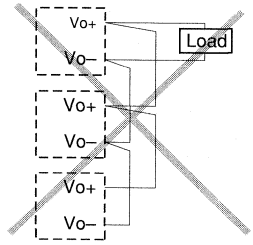
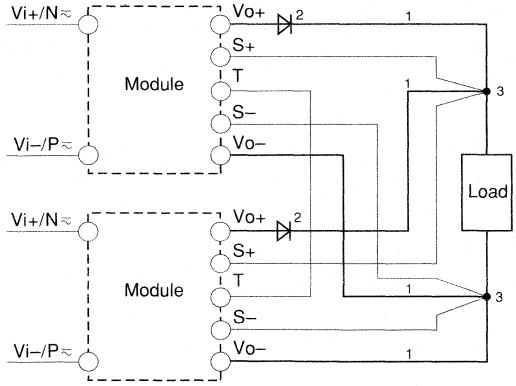



*Fig. 20*
*An example of poor wiring for connection in parallel*


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[1] Leads should have equal length and cross sections and should run in the same cable loom.
[2] Diodes recommended in redundant operation only
[3] DC common point

*Fig. 21*
*Paralleling of single output units using option T with the sense lines connected at the load*

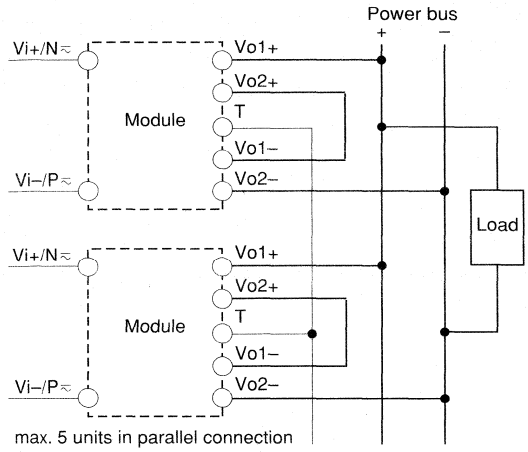



*Fig. 22*
*Paralleling of double output units using option T*

## Option D

General description

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 20 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1–. The D output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D0...DD as shown in the following table.

*Table 14: Undervoltage monitor functions*

| Output type JFET | Output type NPN | Monitoring $U_i$ | Monitoring $U_{o1}$ | Minimum adjustment range of threshold level $U_t$ $U_{t\,i}$ | Minimum adjustment range of threshold level $U_t$ $U_{t\,o}$ | Hysteresis $U_h$ typ [% of $U_t$] for $U_{t\,min}...U_{t\,max}$ $U_{h\,i}$ | Hysteresis $U_h$ typ [% of $U_t$] for $U_{t\,min}...U_{t\,max}$ $U_{h\,o}$ |
|---|---|---|---|---|---|---|---|
| D1 | D5 | no | yes | - | 3...40 V [1] | - | 2.5...0.6 |
| D2 | D6 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | - | 3.4...0.4 | - |
| D3 | D7 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | (0.95...0.985 $U_{o1}$) [2] | 3.4...0.4 | "0" |
| D4 | D8 | no | yes | - | (0.95...0.985 $U_{o1}$) [2] | - | "0" |
| D0 | D9 | no | yes | - | 3...40 V [3] | - | 2.5...0.6 |
| | | yes | no | $U_{i\,min}...U_{i\,max}$ [3 4] | - | 3.4...0.4 | - |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | 3...40 V [3] | 3.4...0.4 | 2.5...0.6 |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | (0.95...0.985 $U_{o1}$) [2] | 3.4...0.4 | "0" |
| - | DD | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 3...40 V [1] | 3.4...0.4 | 2.5...0.6 |

[1] Threshold level adjustable by potentiometer
[2] Fixed value (0.95...0.98 • $U_{o1}$). $U_{o1}$ adjustable via R-input, option P or sense lines.
[3] The threshold level permanently adjusted according to customer specification ±2% at 25°C. Any value within the specified range is basically possible but causes a special type designation in addition to the standard option designations (D0/D9 respectively)!
[4] Adjusted at $I_{o\,nom}$

JFET output (D0...D4):

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $U_D \leq 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $< U_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_D \leq 0.4$ V at $I_D = 2.5$ mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_D \leq 25$ µA at $U_D = 5.25$ V |

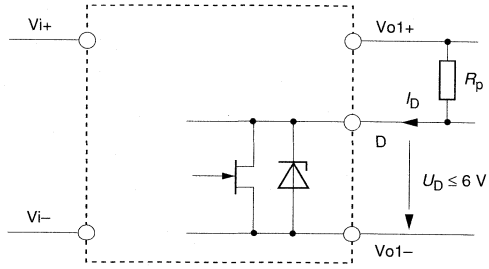



*Fig. 23*
*Option D1...D0: JFET output, $I_D \leq 2.5$ mA*

NPN output (D5...DD):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D < 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $> U_t + U_h$. The current $I_D$ through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. $U_D$ should not exceed 40 V.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | high, H, $I_D \leq 25$ µA at $U_D = 40$ V |
| $U_i$ and $U_{o1} > U_t + U_h$ | low, L, $U_D \leq 0.4$ V at $I_D = 20$ mA |

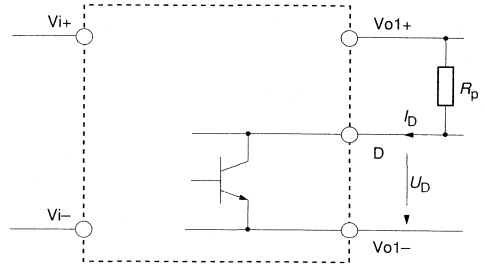



*Fig. 24*
*Option D5...DD: NPN output, $U_{o1} \leq 40$ V, $I_D \leq 20$ mA*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage after the input filter and rectifier (LS types) is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{ti}$ across input filter and rectifier. The threshold levels of the D0 and D9 options are factory adjusted at nominal output current $I_{o\,nom}$ and at $T_A = 25$°C. The value of $\Delta U_{ti}$ depends upon the input voltage range (CS, DS, ..), threshold level $U_t$, temperature and input current. The input current is a function of the input voltage and the output power.

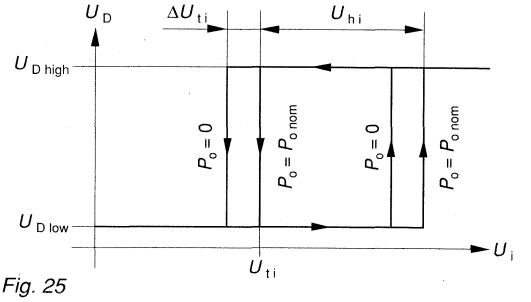


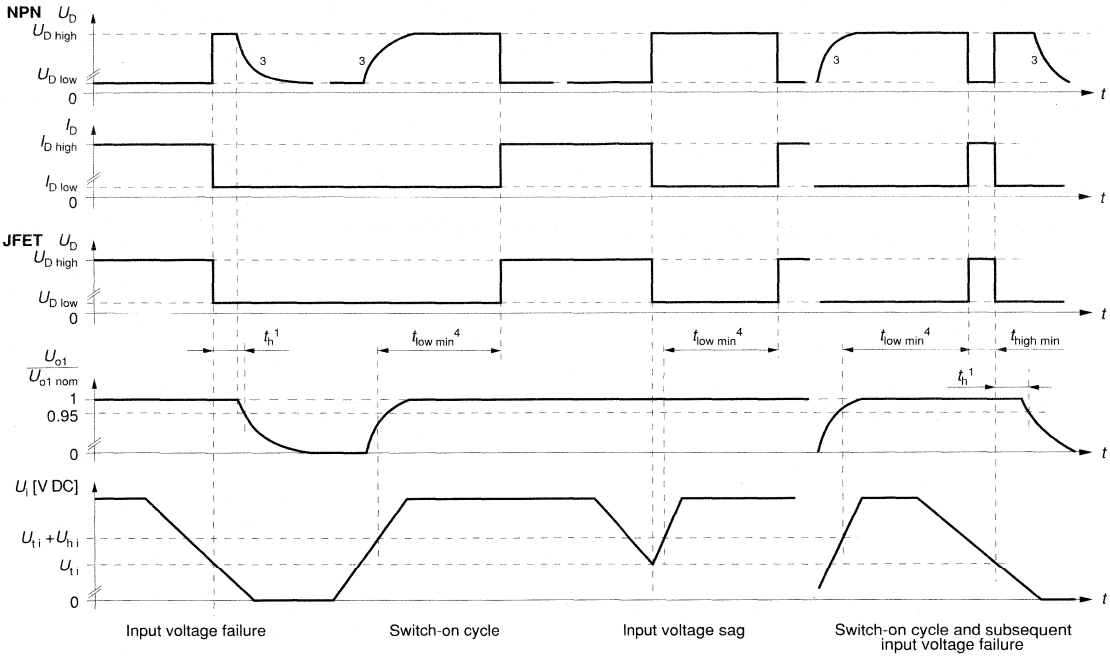

*Fig. 25*
*Definition of $U_{ti}$, $\Delta U_{ti}$ and $\Delta U_{hi}$ (JFET output)*

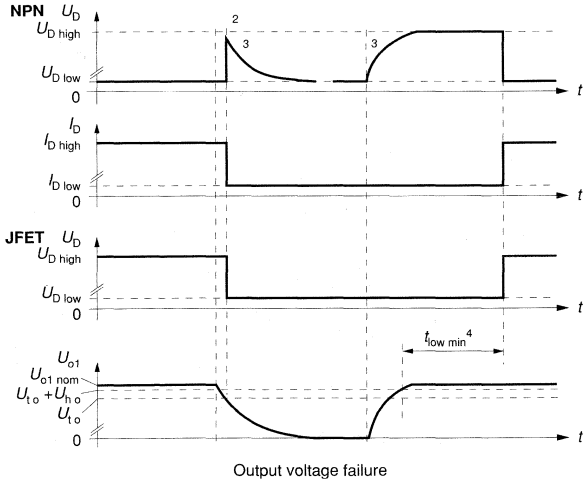
*Table 15: D-output logic signals*

| Version of D | $U_i < U_t$ resp. $U_o < U_t$ | $U_i > U_t + U_h$ resp. $U_o > U_t$ | Configuration |
|---|---|---|---|
| D1, D2, D3, D4, D0 | low | high | JFET |
| D5, D6, D7, D8, D9, DD | high | low | NPN |


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D-signal with respect to input and output voltage versus time:




[1] Hold-up time see fig. 7.
[2] With output voltage monitoring, hold-up time $t_h = 0$.
[3] The signal will remain high if the D output is connected to an external source.
[4] $t_{low\,min}$ = 100...170 ms, typically 130 ms.

*Fig. 26*
*Relationship between $U_i$, $U_{o1}$, $U_D$, $U_{o1}/U_{o\,nom}$ versus time*

### Option V

This option defines an undervoltage monitoring circuit for the input and/or main output voltage ($U_{o1\ nom}$ = 5.1 V only) equivalent to option D and generates an ACFAIL signal (V signal) which conforms to the VME standard.

The low state level of the ACFAIL signal is specified at a sink current of $I_V \leq 48$ mA to $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME motherboard.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V when the output is fully loaded. This hold-up time $t_h$ is provided by the internal input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\ min}$ of the converter so that enough energy is remaining in the input capacitance. If the input voltage is below the required level, an external hold-up capacitor ($C_{i\ ext}$) should be added.

Formula for threshold level for desired value of $t_h$:

$$U_{t\,i} = \sqrt{\frac{2 \cdot P_o \cdot (t_h + 0.3\ \text{ms}) \cdot 100}{C_{i\ min} \cdot \eta} + U_{i\ min}^2}$$

Formula for the external input capacitor:

$$C_{i\ ext} = \frac{2 \cdot P_o \cdot (t_h + 0.3\ \text{ms}) \cdot 100}{\eta \cdot (U_{t\,i}^2 - U_{i\ min}^2)} - C_{i\ min}$$

where as:

$C_{i\ min}$ = internal input capacitance [mF]
$C_{i\ ext}$ = external input capacitance [mF]
$P_o$ = output power [W]
$\eta$ = efficiency [%]
$t_h$ = hold-up time [ms]
$U_{i\ min}$ = minimum input voltage [V] [1]
$U_{t\,i}$ = threshold level [V]

[1] Min. input voltage according to "Electrical Input Data". For output voltages $U_o > U_{o\ nom}$, the minimum input voltage increases proportionally to $U_o/U_{o\ nom}$.

Remarks:

Option V2 and V3 can be adjustment by potentiometer to a threshold level between $U_{i\ min}$ and $U_{i\ max}$. A decoupling diode should be connected in series with the input of AS...FS converters to avoid the input capacitance discharging through other loads connected to the same source voltage. (An external input capacitor cannot be applied to AC powered LS units unless an additional rectifier is provided).

*Table 16: Available internal input capacitance and factory potentiometer setting of $U_{t\,i}$ with resulting hold-up time*

| Types | AS | BS | FS | CS | DS | ES | LS | Unit |
|---|---|---|---|---|---|---|---|---|
| $C_{i\ min}$ | 0.83 | 0.3 | 1.2 | 0.66 | 0.26 | 0.21 | 0.21 | mF |
| $U_{t\,i}$ | 9.5 | 19.5 | 39 | 39 | 61 | 97 | 120 | V DC |
| $t_h$ | 0.1 | 0.1 | 5.3 | 1.9 | 1.8 | 4.3 | 6.4 | ms |

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 20 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1–. The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by potentiometer, accessible through a hole in the front cover, or is adjusted during manufacture to a determined customer specified value.

Versions V0, V2 and V3 are available as shown below.

*Table 16: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level | | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] | |
|---|---|---|---|---|---|---|
| | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| V2 | yes | no | $U_{i\ min}...U_{i\ max}$ [1] | – | 3.0...0.5 | – |
| V3 | yes | yes | $U_{i\ min}...U_{i\ max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| V0 | yes | no | $U_{i\ min}...U_{i\ max}$ [3 4] | – | 2.2...0.4 | – |
| | yes | yes | $U_{i\ min}...U_{i\ max}$ [3 4] | 0.95...0.98 $U_{o1}$ [2] | 2.2...0.4 | "0" |

[1] Threshold level adjustable by potentiometer [2] Fixed value between 95% and 98% of $U_{o1}$ (tracking) [3] Adjusted at $I_{o\ nom}$
[4] Fixed value, resistor-adjusted (±2% at 25°C) acc. to customer's specifications; individual type number is determined by Melcher

V output (V0, V2, V3):

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $< U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $U_V$ should not exceed 80 V.

| $U_i$, $U_{o1}$ status | V output, $U_V$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_V \leq 0.6$ V at $I_V$ = 50 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_V \leq 25$ µA at $U_V$ = 5.1 V |

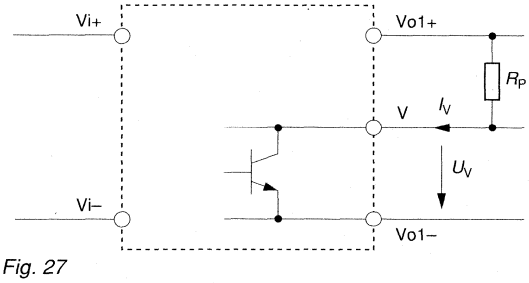



*Fig. 27*
*Output configuration of options V0, V2 and V3*


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Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage is measured after the input filter and rectifier (LS types). Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold level of option V0 is adjusted during manufacture at $I_{o\,nom}$ and $T_A = 25°C$. The value of $\Delta U_{t\,i}$ depends upon the input voltage range (AS, BS, ...), threshold level $U_t$, temperature and input current. The input current is a function of input voltage and output power.

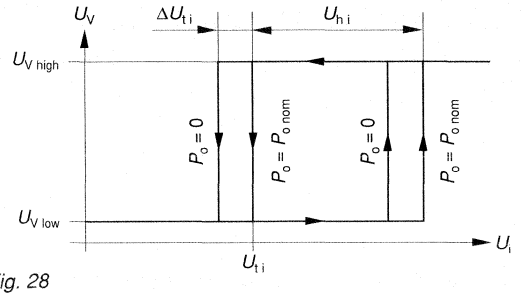
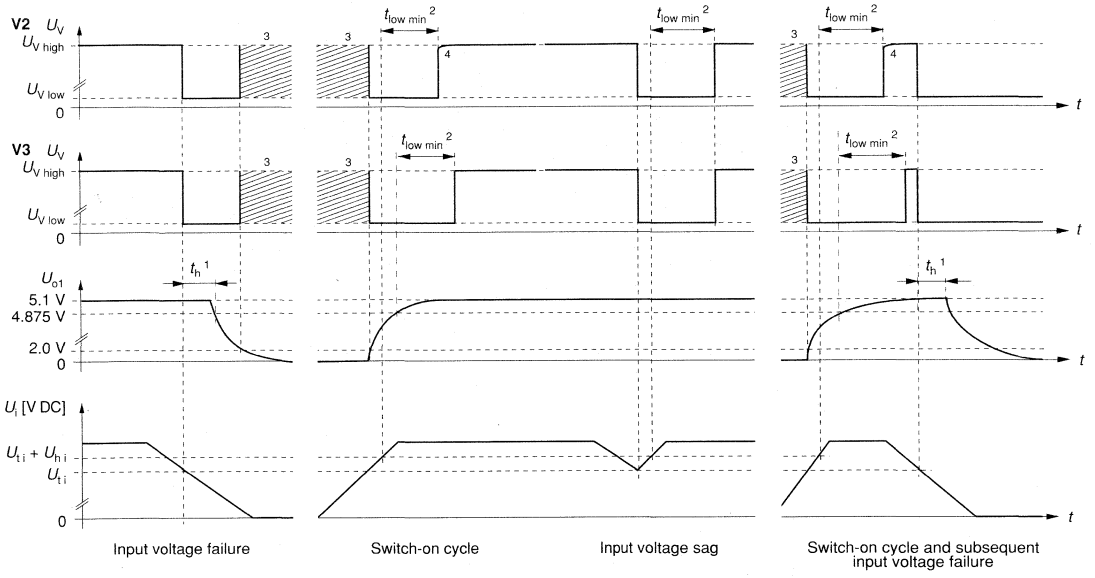
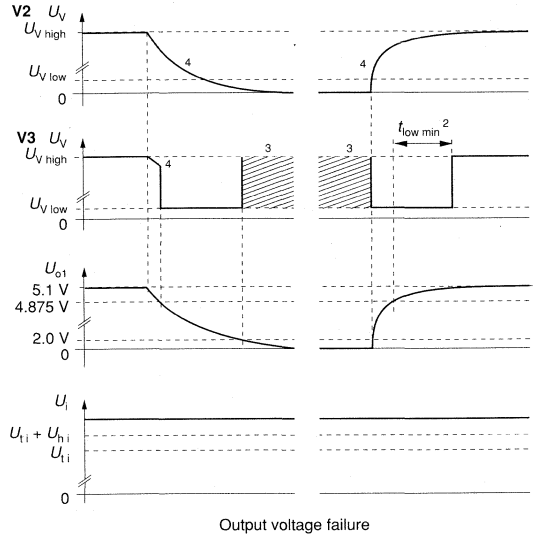



*Fig. 28*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$*




[1] VME request: minimum 4 ms
[2] $t_{low\,min}$ = 40...200 ms, typically 80 ms
[3] $U_V$ level not defined at $U_{o1} < 2.0$ V
[4] The V signal drops simultaneously with the output voltage. If the pull-up resistor $R_P$ is connected to Vo1+. The V signal remains high if $R_P$ is connected to an external source.

*Fig. 29*
*Relationship between $U_i$, $U_{o1}$, $U_V$, $I_V$ and $U_{o1}/U_{o\,nom}$ versus time.*

**Option B1** Cooling Plate (see "Mechanical Data")

Where a cooling surface is available, we recommend the use of a cooling plate (option B1) instead of the standard heatsink. The mounting system should ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The cooling capacity is calculated by:

$$P_{Loss} = \frac{(100\% - \eta)}{\eta} (U_o \bullet I_o)$$

Efficiency $\eta$ see tables 1a, b, c

## Immunity to Environmental Conditions

*Table 17: Mechanical stress*

| Test | | Standard | Test Parameters | |
|---|---|---|---|---|
| Ca | Damp heat<br>steady state | DIN 40046, part 5<br>IEC 68-2-3<br>MIL-STD 810D section 507.2 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{+2/-3}$ %<br>56 days<br>Unit not operating |
| Ea | Shock<br>(half-sinusoidal) | DIN 40046, part 7<br>IEC 68-2-27<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock<br>(half-sinusoidal) | DIN 40046, part 26<br>IEC 68-2-29<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration<br>(sinusoidal) | DIN 40046, part 8<br>IEC 68-2-6<br>MIL-STD 810D section 514.3 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$<br>7.5 h (2.5 h each axis)<br>Unit operating |
| Kb | Salt mist<br>cyclic<br>(sodium chloride NaCl solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Storage duration:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% rel. humidity<br>22 h per cycle<br>3<br>Unit not operating |

*Table 18: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Standard operational ambient temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –25 | 71 | °C |
| $T_A$ | Extended operational ambient temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 71 | |
| $T_C$ | Standard operational case temperature range -7, overtemp. lock-out (PTC) at $T_C$ > 95°C | –25 | 95 | |
| $T_C$ | Extended operational case temperature range -9, overtemp. lock-out (PTC) at TC > 95°C | –40 | 95 | |
| $T_S$ | Storage temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 100 | |
| $T_S$ | Extended storage temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –55 | 100 | |

### Thermal Considerations

Operation at ambient temperatures of 71...85°C with convection cooling will limit the maximum output power to 40% (approx.) of the nominal value. Forced cooling (additional heat sink, fan, etc.) allows operation of the power supply at nominal output power up to an ambient temperature of 85°C, as long as the maximum case temperature $T_{C\,max}$ (95°C) is not exceeded. The case temperature measuring point is shown on fig. 31.

In applications where modules operate in parallel, option T (current sharing) should be used.

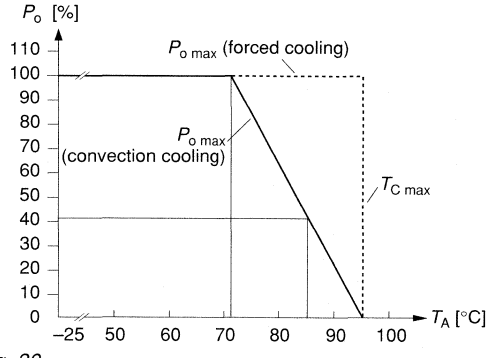



*Fig. 30*
*Output power derating versus $T_A$*

*Table 19: MTBF*

| Values at Specified Case Temperature | Type | Ground Benign 40°C | Ground Fixed 40°C | Ground Fixed 70°C | Ground Mobile 50°C | Unit |
|---|---|---|---|---|---|---|
| MIL-HDBK 217F, (CS 1301-7R) | CS...LS | 500'000 | 150'000 | 80'000 | 50'000 | h |


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## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

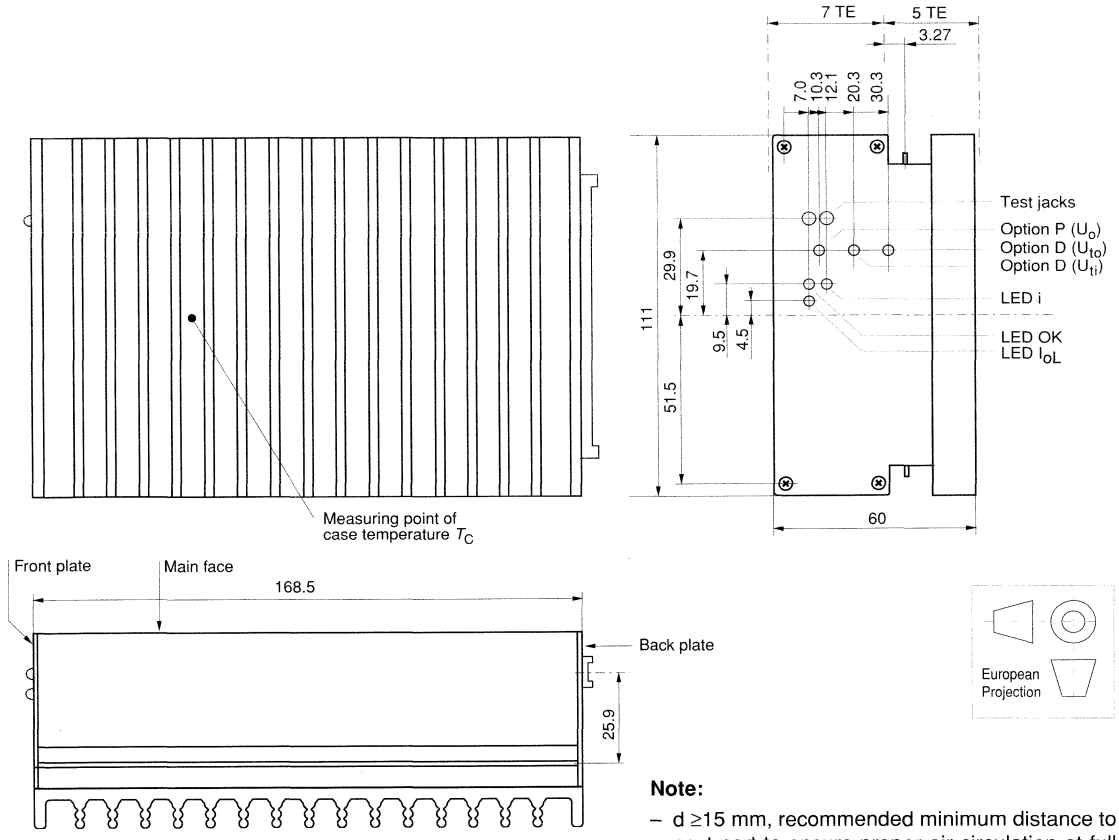



*Fig. 31*
*Case K02 with heatsink*
*Total weight: Approx. 1.55 kg*

**Note:**

- d ≥15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power.
- free air locations: the module should be mounted with fins in vertical position to achieve a maximum air flow through heat sink.

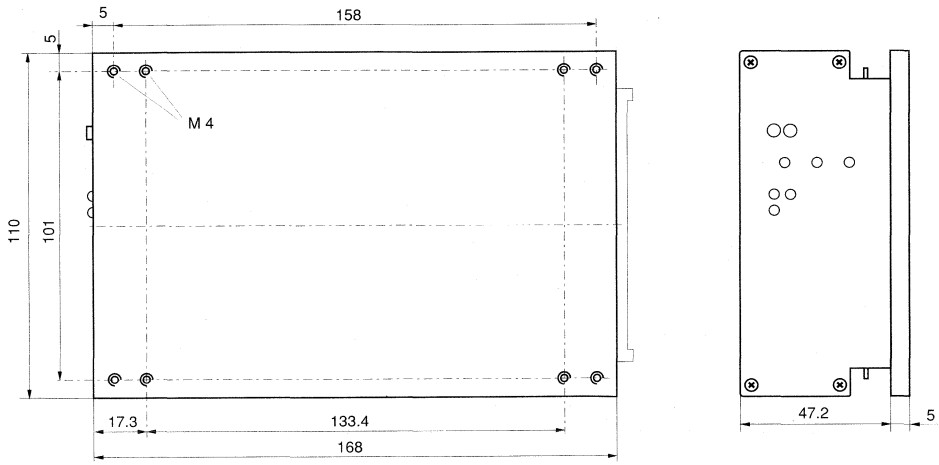
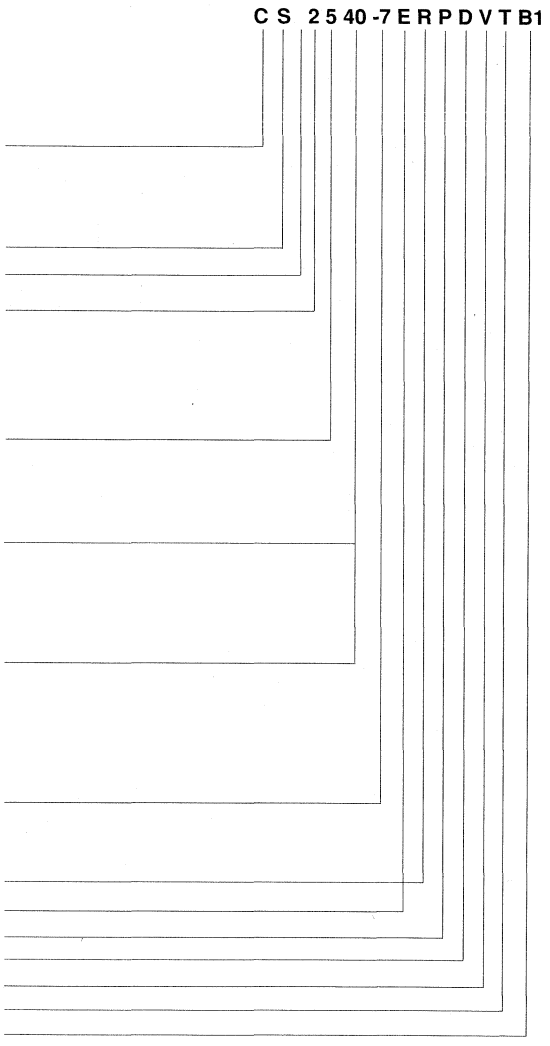



*Fig. 32*
*Case K02 with option B1 (cooling plate)*
*Total weight: Approx. 1.15 kg*

## Type Key and Product Marking

### Type Key




Input voltage range $U_I$:
- 8...35 V DC ..... A
- 14...70 V DC ..... B
- 28...140 V DC ..... C
- 44...220 V DC ..... D
- 67...385 V DC [1] ..... E
- 20...100 V DC ..... F
- 88...372 V DC (85...264 V AC) ..... L

Family ..... S

Blank .....

Number of outputs ..... 1...2

Single output units:

Nominal voltage output 1 (main output), $U_{o1\ nom}$
- 5.1 V ..... 0, 1, 2
- 12 V ..... 3
- 15 V ..... 4, 5
- 24 V ..... 6
- other voltages ..... 7, 8

Other specifications for single output modules ..... 01...99

Symmetrical double output units:

Nominal voltage output 1/output 2, $U_{o1/2\ nom}$
- 12 V/12 V [2] (24 V series conn. [3]) ..... 20
- 5 V/15 V [2] (30 V series conn. [3]) ..... 40
- 24 V/24 V [2] (48 V series conn. [3]) ..... 60
- other symmetrical voltages ..... 70...99

Operational ambient temperature range $T_A$:
- –25...50°C ..... -5
- –25...60°C ..... -6
- –25...71°C ..... -7
- –40...71°C (optional) ..... -9
- customer specific ..... -0

Feature: Output voltage control input [4] ..... R

Options:
- Inrush current limitation [5] ..... E
- Potentiometer (output voltage adjustment) [4] ... P
- Save data signal (D0...DD, to be specified) [6] . D
- ACFAIL signal (V0, V2, V3, to be specified) [6] . V
- Current sharing ..... T
- Cooling plate ..... B1

[1] ES types available upon customer request.
[2] External wiring of main and second output depending upon the desired output configuration (see fig. 16b, c, d or e).
[3] External wiring of main and second output (see fig.16a).
[4] Feature R excludes option P and vice versa.
[5] Option E available for CS, DS, ES, FS and LS types.
[6] Option D excludes option V and vice versa.

Example: CS 2540-7PD3: DC-DC converter, input voltage range 28...140 V, double output, each providing 15 V/3.2 A, equipped with potentiometer and undervoltage monitor option.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LED's, test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltages and output currents, pin allocation of options and auxiliary functions, fuse specification and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main PCB and date of production.

# 100 W DC-DC Converters

# Q-Family

**Input to output isolation**
**Single output: Series BQ...GQ 1000**
**Double output: Series BQ...GQ 2000**

- Extremely high efficiency of up to 91%
- Excellent protection, 2 $kV_{rms}$ input to output
- Safety according to IEC 950 and EN 41003
- Redundant operation (n+1), auto current sharing
- Extremely low inrush current, hot plug-in
- Externally adjustable output voltage and inhibit
- Very compact and fully functional unit (20 mm wide)
- Telecoms compatible input voltage range of CQ units according to prETS 300132-2 (35...75 V DC)




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## Description

These extremely compact DC-DC converters incorporate all necessary input and output filtering, signalling and protection features which are required in the majority of applications. The converters provide important advantages such as extremely high efficiency, excellent reliability, very low ripple and RFI noise levels, full input to output isolation, negligible inrush current, overtemperature protection and input over-/undervoltage cut-out. The converter inputs are protected against surges and transients occuring on the source lines.

The outputs are continuously open- and short-circuit proof.

As a stand-alone module or as part of a distributed power supply system, the low profile design significantly reduces the necessary power supply volume without sacrificing high reliability.

Full system flexibility and n+1 redundant operating mode are possible due to virtually unrestricted series or parallel connection capabilities of all outputs. In parallel connection of several units, automatic current sharing is provided by a single wire interconnection.

An isolated output power good signal and LEDs at the front panel indicate the status of the power supply modules. Test sockets at the front panel provide for a check of the main output voltage.

The fully enclosed, black coated aluminium case acts as heat sink and RFI shield. It is particularly suitable for 19" rack systems occupying 3 U/4 TE only, but can also be chassis-mount by means of four M 3 threads .

## Type Survey

**Survey of Options see "Description of Options"**

*Table 1a: Type survey BQ, GQ*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | | | | | Option |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ [2] A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ [2] A | $U_{i\,min}...U_{i\,max}$ **8...18 V DC** | $\eta$ % | $U_{i\,min}...U_{i\,max}$ **14.4...36 V DC** | $\eta$ % | $U_{i\,min}...U_{i\,max}$ **22...54 V DC** | $\eta$ % | |
| 5.1 | 16.0 | | | not available yet | | BQ 1001-7R | 86 | GQ 1001-7R | 87 | P |
| 12.0 [3] | 8.0 | | | | | BQ 2320-7R | 88.5 | GQ 2320-7R | 89 | |
| 15.0 [3] | 6.6 | | | | | BQ 2540-7R | 89 | GQ 2540-7R | 90.5 | |
| 24.0 [3] | 4.4 | | | | | BQ 2660-7R | 89.5 | GQ 2660-7R | 91 | |
| 24.0 [4] | 4.0 | | | | | BQ 2320-7R | 88.5 | GQ 2320-7R | 89 | |
| 30.0 [4] | 3.3 | | | | | BQ 2540-7R | 89 | GQ 2540-7R | 90.5 | |
| 48.0 [4] | 2.2 | | | | | BQ 2660-7R | 89.5 | GQ 2660-7R | 91 | |
| 12.0 | 4.0 | 12.0 [5] | 4.0 | | | BQ 2320-7R | 88.5 | GQ 2320-7R | 89 | |
| 15.0 | 3.3 | 15.0 [5] | 3.3 | | | BQ 2540-7R | 89 | GQ 2540-7R | 90.5 | |
| 24.0 | 2.2 | 24.0 [5] | 2.2 | | | BQ 2660-7R | 89.5 | GQ 2660-7R | 91 | |

*Table 1b: Type survey CQ, DQ*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | | | | | Option |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ [2] A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ [2] A | $U_{i\,min}...U_{i\,max}$ **35...75 V DC** | $\eta$ % | $U_{i\,min}...U_{i\,max}$ **43...108 V DC** [6] | $\eta$ % | $U_{i\,min}...U_{i\,max}$ **66...165 V DC** | $\eta$ % | |
| 5.1 | 16.0 | | | CQ 1001-7R | 85 | DQ 1001-7R | 85.5 | not available yet | | P |
| 12.0 [3] | 8.0 | | | CQ 2320-7R | 88 | DQ 2320-7R | 86.5 | | | |
| 15.0 [3] | 6.6 | | | CQ 2540-7R | 89 | DQ 2540-7R | 86.5 | | | |
| 24.0 [3] | 4.4 | | | CQ 2660-7R | 90 | DQ 2660-7R | 88.5 | | | |
| 24.0 [4] | 4.0 | | | CQ 2320-7R | 88 | DQ 2320-7R | 86.5 | | | |
| 30.0 [4] | 3.3 | | | CQ 2540-7R | 89 | DQ 2540-7R | 86.5 | | | |
| 48.0 [4] | 2.2 | | | CQ 2660-7R | 90 | DQ 2660-7R | 88.5 | | | |
| 12.0 | 4.0 | 12.0 [5] | 4.0 | CQ 2320-7R | 88 | DQ 2320-7R | 86.5 | | | |
| 15.0 | 3.3 | 15.0 [5] | 3.3 | CQ 2540-7R | 89 | DQ 2540-7R | 86.5 | | | |
| 24.0 | 2.2 | 24.0 [5] | 2.2 | CQ 2660-7R | 90 | DQ 2660-7R | 88.5 | | | |

[1] Typical efficiency at $U_{i\,nom}$, $I_{o\,nom}$ and $T_A$ = 25 °C
[2] See also $I_{o\,max}$ for operation with reduced ambient temperature ("Electrical Output Data")
[3] Parallel connection of output 1 and 2, see fig. 3
[4] Series connection of output 1 and 2, see fig. 4
[5] Symetrical configuration with second output semi-regulated, see fig. 5 and 6
[6] NFF 01-510 compatible

## Safety and Installation Instructions

### Safety

The modules correspond to the equipment class I specification and comply with EN 60950, IEC 950, VDE 0805 and EN 41003. For safety reasons the input circuit of the module must be electrically isolated from the mains. The earthing pin 26 is leading and should always be connected. Output voltages are below SELV (Safety Extra Low Voltage).

### Installation

The installation must follow the relevant safety specifications as well as the local regulations. Connection to the system shall be made via the matching female connector type DIN H 15. It is of major importance to wire the modules via this connector only in order to fulfill the safety requirements according to IEC 950, EN 60950, VDE 0805 and EN 41003.

Due to the high output current value, the BQ...GQ 1000 units provides for each the positive and the negative output path two internally parallel connected contacts (pins 4/6 and pins 8/10 respectively). It is recommended to connect the load to both female connector pins of each path in order to keep the voltage drop across the connector pins to an absolute minimum. See fig. 2.

Protection degree is defined by IP 30, but if equipped with option P, this reduces to IP 20. Protection degree applies only if the module is plugged-in, i.e. the female connector is properly attached to the module.

### Isolation Tests

All isolation voltage tests according to IEC 950, EN 60950, VDE 0805 and EN 41003 respectively are performed as factory tests and must not be repeated in field use. Improper test methods cause severe internal damage. In the production process all internal transformers as well as every final assembled module are fully isolation voltage tested. Details are given in section "Supplementary Data".

*Table 2: Pin allocation of the H 15 connector*

| Pin No. | Electrical determination | Q 1000 | Q 2000 |
|---|---|---|---|
| 4 | Output voltage (positive) | Vo1+ | Vo1+ |
| 6 | Output voltage (positive) | Vo1+ | Vo2+ |
| 8 | Output voltage (negative) | Vo1– | Vo1– |
| 10 | Output voltage (negative) | Vo1– | Vo2– |
| 12 | Sense line (positive) | S+ | S+ |
| 14 | Sense line (negative) | S– | S– |
| 16 | Output voltage control input [1] | R | R |
| 18 | Current sharing control input | T | T |
| 20 | Do not connect | - | - |
| 22 | Output good signal (positive) | Out OK+ | Out OK+ |
| 24 | Output good signal (negative) | Out OK– | Out OK– |
| 26 | Protective ground (protruding) | ⏚ | ⏚ |
| 28 | Inhibit control input [2] | i | i |
| 30 | Input voltage (positive) | Vi+ | Vi+ |
| 32 | Input voltage (negative) | Vi– | Vi– |

**Degree of Protection**

Condition: Female connector fitted to the unit

IP 30: All units except those with option P (potentiometer adjustment)

IP 20: All units fitted with option P (includes potentiometer)

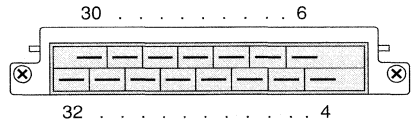



*Fig. 1*
*View of male H15 connector*

[1] With option P, R-input must remain unconnected
[2] If the inhibit function is not actively used, interconnect pins 28 and 32 in order to enable output

**Output Configuration**

The Q unit design allows high flexibility in output configuration to cover almost every individual requirement, by simply wiring the outputs in parallel, series or for symmetrical applications as per following figures. For further information and for parallel and series operation of several modules refer to "Electrical Output Data".

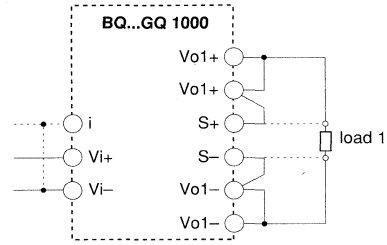



*Fig. 2*
*Single output configuration*

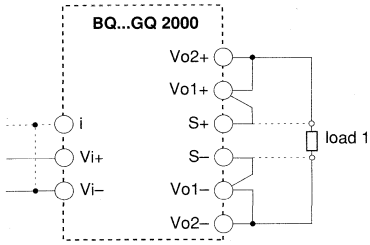



*Fig. 3*
*Parallel configuration of double output unit*

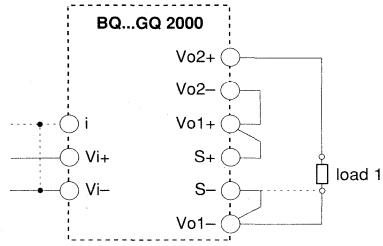



*Fig. 4*
*Series configuration of double output unit (neg. sense at load only)*

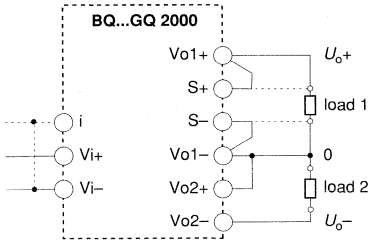



*Fig. 5*
*Symmetrical common ground configuration of double output unit*

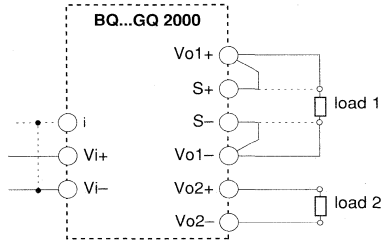



*Fig. 6*
*Independent symmetrical output configuration*

## Functional Description

The units are designed as forward converters using primary and secondary control circuits. The switching frequency is approximately 200 kHz under nominal operating conditions. The built-in high efficient input filter together with a minimum input capacitance generate very low inrush currents with short duration. After transformer isolation and rectification, the output filter reduces the ripple to a minimum without compromise to the dynamic ability. The output voltage is fed back to the secondary control circuit via the sense lines. The resultant error signal is sent to the primary control circuit via a signal transformer.

Double output modules have their voltage regulation of output 2 relying on the close magnetic coupling of the transformer and the output inductor together with the circuits symmetry. The current limitation is located at the primary side, thus limiting the total output current in overload conditions. In applications with large dynamic load changes it is recommended to connect such load to output 1 only. Output 1 and output 2 can either be series- or parallel-connected (see "Electrical Output Data").



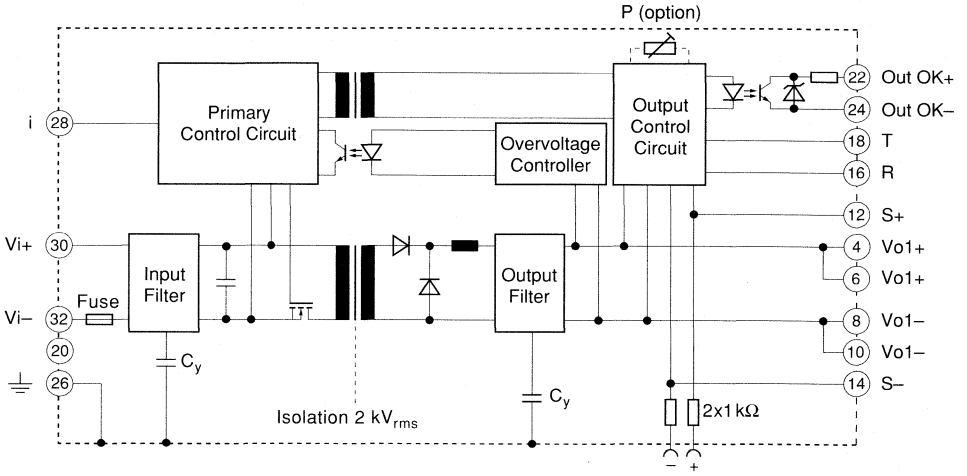



*Fig. 7*
*Block diagram of a single output converter*

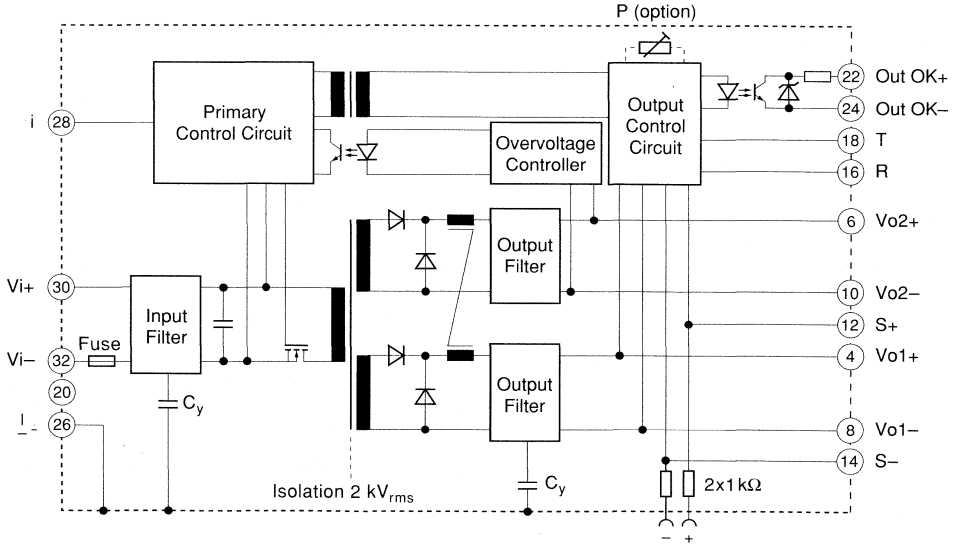



*Fig. 8*
*Block diagram of a double output converter*


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## Electrical Input Data

General Conditions
– $T_A$ = 25 °C, unless $T_C$ is specified
– Pin 28 connected to pin 32, pin 12 to pin 4 and pin 14 to pin 8
– R input not connected; with option P, $U_o$ set to $U_{o\,nom}$

*Table 3a: Input data*

| Input | | | AQ | | | BQ | | | CQ [2] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0…$I_{o\,nom}$ | | | | 14.4 | | 36 | 35 | | 75 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | $T_{C\,min}$…$T_{C\,max}$ | | | | | 24 | | | 48 | | |
| $I_i$ | Typical input current [1] | $U_{i\,nom}$, $I_{o\,nom}$ | | | | 3.9 | | 5.0 | 2.0 | | 2.4 | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$…$U_{i\,max}$ $I_o$ = 0 | | | | | | 2.5 | | | 2.5 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | | | | 1.0 | | | 1.5 | |
| $I_{inr\,p}$ | Peak inrush current [2] | $U_{i\,nom}$, $I_{o\,nom}$ | | | | | 35 | | | 35 | | A |
| $t_{inr\,r}$ | Rise time | | | | | | 50 | | | 40 | | µs |
| $t_{inr\,h}$ | Trailing edge half-life | | | | | | 170 | | | 100 | | |
| $u_{i\,RFI}$ | Input RFI level | VDE 0871-6.78<br>EN 55011/22<br>EN 55014 | | | | | | B<br>B<br>limit | | | B<br>B<br>limit | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | | | | 0 | | 50 | 0 | | 100 | V DC |
| F | Fuse rating | nominal | | | | | 14 | | | 7 | | A |

*Table 3b: Input data*

| Input | | | DQ | | | EQ | | | GQ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0…$I_{o\,nom}$ | 43 | | 108 | | | | 22 | | 54 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | $T_{C\,min}$…$T_{C\,max}$ | | 72 | | | | | | 36 | | |
| $I_i$ | Typical input current [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 1.3 | | 1.7 | | | | 2.6 | | 3.3 | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$…$U_{i\,max}$ $I_o$ = 0 | | | 5.5 | | | | | | 3.0 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | 3.5 | | | | | | 1.5 | |
| $I_{inr\,p}$ | Peak inrush current [2] | $U_{i\,nom}$, $I_{o\,nom}$ | | 25 | | | | | | 45 | | A |
| $t_{inr\,r}$ | Rise time | | | 20 | | | | | | 50 | | µs |
| $t_{inr\,h}$ | Trailing edge half-life | | | 60 | | | | | | 170 | | |
| $u_{i\,RFI}$ | Input RFI level | VDE 0871-6.78<br>EN 55011/22<br>EN 55014 | | | B<br>B<br>limit | | | | | | B<br>B<br>limit | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | 0 | | 115 | | | | 0 | | 63 | V DC |
| F | Fuse rating (nominal) | fast blow type | | 7 | | | | | | 14 | | A |

[1] Typical input current depends on individual module
[2] According to prETS 300132-2 (Ver. 3.1)

### Fuse

The fuse (normally fast blow type) is internally wired in the negative input path to protect the unit against severe defect. It cannot be made externally accessible because of the limited space at the back panel.

### Input Under-/Overvoltage Cut-Out

With input voltage below $U_{i\,min}$ or a above $U_{i\,max}$ an internally generated inhibit signal disables the output voltage. The maximum input voltage rating is to be considered (see also "Electrical Input Data": $U_{i\,abs}$).

### Inrush Current Limitation

The inherent inrush current value is lower than specified in the prETS 300132-2 (ver. 3.1) standard. The units operate with relatively small input capacitance resulting in low inrush current of short duration. As a direct consequence in a power-bus system the units can be hot plugged-in or disconnected causing negligible disturbance, at the input side.

### Inhibit (i Input)

**Note:** If this function is not actively used, the inhibit pin 28 must be interconnected with the negative input pin 32 to enable the output(s). A non-connected pin 28 will be interpreted by the internal logic as an active inhibit signal and therefore output(s) will remain disabled: Fail safe function.

An inhibit input enables (logic low, pull down) or disables (logic high, pull up) the output if a logic signal e.g. TTL, CMOS is applied. In systems consisting of several units, this feature may be used, for example, to control the activity sequence of the converters by means of logic signals, or to allow the unit's source for a proper start up before full load is applied.

*Table 4: Inhibit characteristics*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –200 | | 0.8 | V DC |
| | | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | 2.4 | | 200 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = –50 V<br>$U_{inh}$ = 0 V<br>$U_{inh}$ = 100 V<br>$U_{inh}$ = 200 V | | –520<br>–40<br>+1000<br>+2050 | | µA |
| $t_r$ | Rise time | | $U_{o\,nom}$, $I_{o\,nom}$ | | 3 | | ms |
| $t_f$ | Fall time | | | | 0.3 | | |

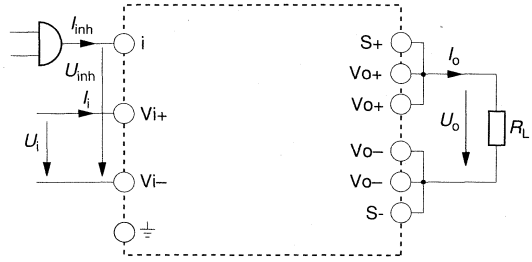



*Fig. 9*
*Definition of input and output parameters*

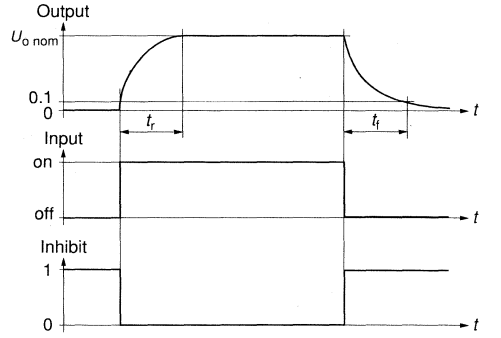



*Fig. 10*
*Inhibit Characteristic*

### Input Filter

Input filtering keeps the conducted noise of the units within the frequency range of 10 kHz to 30 MHz below level B according to VDE 0871 (6.78). (Newer standards have less stringent levels: For examle, the levels defined in the EN 55011 and EN 55022 standards, CISPR 11/22 respectively are 8 dB to 12 dB above the VDE specs.).

The input radiated noise >30 MHz is within the limits of EN 55011/22 and EN 55014 (12.88), measured by means of a MDS clamping device.

### EMC and Immunity to Input Transients

A suppressor diode and/or a metal oxide VDR (depending upon the type) together with an input fuse and a symmetrical input filter form an effective protection against high input transient voltages which typically occur in most installations. Specially in battery driven mobile applications surges according to IEC 571-1 (prEN 50155 respectively) are specified. The power supply must not switch off during these surges and since their energy can not practically be absorbed an adequate input range is required. The Q series has been successfully tested to the following specifications:

*Table 5: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [4] | Value applied | Waveform | Source impedance | Test procedure | In operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Impulse voltage | IEC 255-4 App. E4 [5] (1976) | III | i/o, i/c, o/c +i/–i | 5000 $V_p$ | 1.2/50 µs | 500 Ω | 3 pos. and 3 neg. impulses per coupling mode | no | - |
| High frequency disturbance | IEC 255-4 App. E5 [5] (1976) | III | i/o, i/c, o/c | 2500 $V_p$ | 400 damped 1 MHz waves/s | 200 Ω | 2 s per coupling mode | yes | 1 |
| | | | +i/–i | 1000 $V_p$ | | | | | |
| Voltage surge | IEC 571-1 (1990-07) | | i/c, +i/–i | 800 $V_p$ | 100 µs | 100 Ω | 1 pos. and 1 neg. voltage surge per coupling mode | yes | 2 |
| | | | | 1500 $V_p$ | 50 µs | | | | |
| | | | | 3000 $V_p$ | 5 µs | | | | |
| | | | | 4000 $V_p$ | 1 µs | | | | |
| | | | | 7000 $V_p$ | 100 ns | | | | |
| Electrostatic discharge | IEC 801-2 (1991-04) | 4 | contact discharge to case, | 8000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | 1 |
| | | | air dischg. to case | 15000 $V_p$ | | | | | |
| Electric field | IEC 801-3 (1984) | | antenna in 1m distance | | sine wave modulated w. 1 kHz | | 26...1000 MHz | | 6 |
| Fast transient/ burst | IEC 801-4 (1988) | 4 | i/c, +i/–i | 4000 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | 1 |
| Transient | IEC 801-5 (Draft 1993-01) | 3 | i/c | 2000 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | 2 3 |
| | | | +i/–i | 1000 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] For CQ modules only: Normal operation, no deviation from specs
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Not tested yet

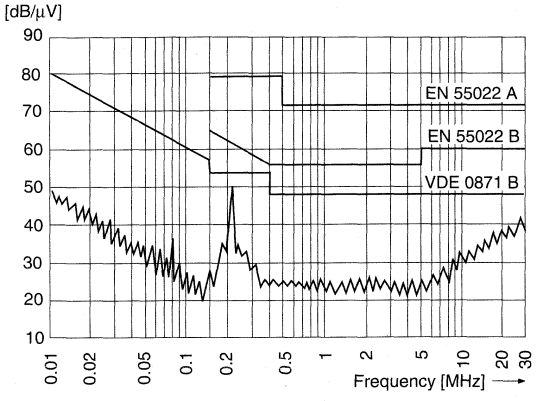



*Fig. 11*
*Conducted RFI at input according to VDE 0871 (6.78) (quasi peak): Typical measurment*

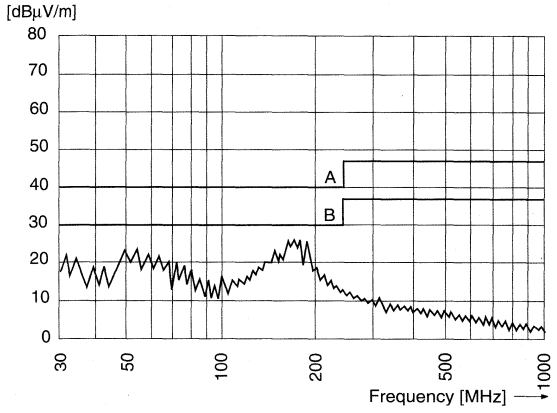



*Fig. 12*
*Radiated RFI according to EN 55011 (distance 10 m): Typical measurment*

## Electrical Output Data

General Conditions:
– $T_A$ = 25°C, unless $T_C$ is specified.
– $U_o$ adjusted to $U_{o\,nom}$ at $I_{o\,nom}$
– $U_i$ = $U_{i\,nom}$ sense line pins S+ and S– connected to Vo1+ and Vo1– respectively.

*Table 6a: Output data for single output modules and modules in parallel configuration (see fig. 2 and 3)*

| Output | | | BQ...GQ 1001 5.1 V | | | BQ...GQ 2320 12.0 V | | | BQ...GQ 2540 15.0 V | | | BQ...GQ 2660 24.0 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.94 | | 12.06 | 14.93 | | 15.08 | 23.88 | | 24.12 | V |
| $U_{ow}$ | Worstcase output voltage | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_o$ = 0...$I_{o\,max}$ | 5.02 | | 5.18 | 11.82 | | 12.18 | 14.78 | | 15.23 | 23.64 | | 24.36 | |
| $U_{oL}$ | Overvoltage limitation of second control loop | Incorrect con. sense lines | 5.9 | | 6.4 | 13.5 | | 15.0 | 17.0 | | 19.0 | 27.5 | | 30.0 | |
| $I_{o\,max}$ | Max. output current [2] | $T_{A\,max}$ = 50°C | | | 20.0 | | | 10.0 | | | 8.0 | | | 6.0 | A |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 16.0 | | | 8.0 | | | 6.6 | | | 4.4 | | |
| $I_{oL}$ | Output current limit [2] | $T_{C\,min}$...$T_{C\,max}$ | 21.0 | 22.0 | 25.0 | 10.5 | 11.0 | 12.5 | 8.4 | 8.8 | 10.0 | 6.3 | 6.6 | 7.5 | |
| $u_{or}$ | Output ripple voltage (acc. to IEC 1204) | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 15 | 30 | | 10 | 40 | | 15 | 50 | | 30 | 80 | $mV_{pp}$ |
| $P_{o\,max}$ | Max. output power | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | 110 | | | 130 | | | 130 | | | 150 | W |
| $u_{o\,d}$ [3] | Dynamic load regulation | $U_{i\,nom}$, $I_o$ = | | ±450 | | | ±450 | | | ±400 | | | ±600 | | mV |
| $t_d$ [3] | Time constant of dynamic load regulation | (1...1/4...1) $I_{o\,nom}$ | | 1.0 | | | 0.4 | | | 0.35 | | | 1.0 | | ms |
| $U_{o\,tr}$ | Output voltage trimming range [4] | $U_{i\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 4.0<br>4.6 | | 5.6<br>5.6 | 5.5<br>10.8 | | 13.2<br>13.2 | 8.0<br>13.5 | | 16.5<br>16.5 | 14.0<br>21.6 | | 26.4<br>26.4 | V |

*Table 6b: Output data for double output modules in series configuration (see fig. 4)*

| Output | | | BQ...GQ 2320 24 V (2 × 12 V) | | | BQ...GQ 2540 30 V (2 × 15 V) | | | BQ...GQ 2660 48 V (2 × 24 V) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 23.76 | | 24.24 | 29.70 | | 30.30 | 47.52 | | 48.48 | V |
| $U_{ow}$ | Worstcase output voltage | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_{o\,min}$...$I_{o\,max}$ [5] | 23.52 | | 24.48 | 29.40 | | 30.60 | 47.04 | | 48.96 | |
| $U_{oL}$ | Overvoltage limitation of second control loop | Incorrect conn. sense lines | 27.0 | | 30.0 | 34.0 | | 38.0 | 55.0 | | 60.0 | |
| $I_{o\,max}$ | Max. output current [2] | $T_{A\,max}$ = 50°C | | | 5.0 | | | 4.0 | | | 3.0 | A |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 4.0 | | | 3.3 | | | 2.2 | | |
| $I_{oL}$ | Output current limit [2] | $T_{C\,min}$...$T_{C\,max}$ | 5.25 | 5.50 | 6.25 | 4.20 | 4.40 | 5.00 | 3.15 | 3.30 | 3.75 | |
| $u_{or}$ | Output ripple voltage (acc. to IEC 1204) | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 20 | 80 | | 30 | 100 | | 60 | 160 | $mV_{pp}$ |
| $P_{o\,max}$ | Max. output power | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | 130 | | | 130 | | | 150 | W |
| $u_{o\,d}$ [3] | Dynamic load regulation | $U_{i\,nom}$, $I_o$ = | | ±450 | | | ±400 | | | ±600 | | mV |
| $t_d$ [3] | Time constant; dynamic load regulation | (1...1/4...1) $I_{o\,nom}$ | | 0.40 | | | 0.35 | | | 1.0 | | ms |
| $U_{o\,tr}$ | Output voltage trimming of output voltage [4] | $U_{i\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 11.0<br>21.6 | | 26.4<br>26.4 | 16.0<br>27.0 | | 33.0<br>33.0 | 28.0<br>43.2 | | 52.8<br>52.8 | V |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting or remote sensing, the output power should be reduced accordingly so that $P_{o\,max}$ and $T_{C\,max}$ are not exceeded (see fig. 25)
[2] See "Output Current Limitation", fig. 15 and 16
[3] Time constant until $U_o$ remains within 1% of $U_{o\,nom}$, see fig. 21
[4] Upper row represents setting via R-input, lower row option P range
[5] $I_{o\,min}$ = 10% of $I_{o\,nom}$ for each output necessary (see also "Output Regulation")

*Table 6c: Output data for double output modules in symmetrical configuration (see fig. 5 and 6)*

| Output | | | BQ...GQ 2320 12 V/12 V | | | | | | BQ...GQ 2540 15 V/15 V | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 11.94 | | 12.06 | 11.82 | | 12.18 | 14.93 | | 15.08 | 14.78 | | 15.23 | V |
| $U_{ow}$ | Worstcase output | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_{o\,min}$...$I_{o\,max}$ [5] | 11.82 | | 12.18 | Fig. 18 | | | 14.78 | | 15.23 | Fig. 19 | | | |
| $U_{oL}$ | Overvoltage limitation of second control loop | Incorrect conn. sense lines | | | | 13.5 | | 15.0 | | | | 17.0 | | 19.0 | |
| $I_{o\,max}$ | Max. output current [2] | $T_{A\,max}$ = 50 °C | | | 10.0 | | | 10.0 | | | 8.0 | | | 8.0 | A |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 4.0 | | | 4.0 | | | 3.3 | | | 3.3 | | |
| $I_{oL}$ | Output current limit [2] | $T_{C\,min}$...$T_{C\,max}$ | 10.5 | 11.0 | 12.5 | 10.5 | 11.0 | 12.5 | 8.4 | 8.8 | 10.0 | 8.4 | 8.8 | 10.0 | |
| $u_{or}$ | Output ripple voltage (acc. to IEC 1204) | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 10 | 40 | | 10 | 40 | | 15 | 50 | | 15 | 50 | $mV_{pp}$ |
| $P_{o\,max}$ | Max. output power ($P_{o1}$ + $P_{o2}$) | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | 130 | | | 130 | | | 130 | | | 130 | W |
| $u_{o\,d}$ [3] | Dynamic load regulation | $U_{i\,nom}$, $\Delta I_{o1}$ = | | ±450 | | | | | | ±400 | | | | | mV |
| $t_d$ [3] | Time constant of dynamic load regulation | (1...1/4...1) $I_{o\,nom}$ $I_{o2}$ = $I_{o\,nom}$ | | 0.4 | | | | | | 0.35 | | | | | ms |
| $U_{o\,tr}$ | Output voltage trimming range [4] | $U_{i\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 5.5<br>10.8 | | 13.2<br>13.2 | 5.5<br>10.8 | | 13.2<br>13.2 | 8.0<br>13.5 | | 16.5<br>16.5 | 8.0<br>13.5 | | 16.5<br>16.5 | V |

*Table 6d: Output data for double output modules in symmetrical configuration (see fig. 5 and 6)*

| Output | | | BQ...GQ 2660 24 V/24 V | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 23.88 | | 24.12 | 23.64 | | 24.36 | V |
| $U_{ow}$ | Worstcase output voltage | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_{o\,min}$...$I_{o\,max}$ [5] | 23.64 | | 24.36 | Fig. 20 | | | |
| $U_{oL}$ | Overvoltage limitation of second control loop | Incorrect conn. sense lines | | | | 27.5 | | 30.0 | |
| $I_{o\,max}$ | Output current [2] | $T_{A\,max}$ = 50 °C | | | 6.0 | | | 6.0 | A |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 2.2 | | | 2.2 | | |
| $I_{oL}$ | Output current limit [2] | $T_{C\,min}$...$T_{C\,max}$ | 6.3 | 6.6 | 7.5 | 6.3 | 6.6 | 7.5 | |
| $u_{or}$ | Output ripple voltage (acc. to IEC 1204) | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 30 | 80 | | 30 | 80 | $mV_{pp}$ |
| $P_{o\,max}$ | Max. output power ($P_{o1}$ + $P_{o2}$) | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | 150 | | | 150 | W |
| $u_{o\,d}$ [3] | Dynamic load regulation | $U_{i\,nom}$, $\Delta I_{o1}$ = | | ±600 | | | | | mV |
| $t_d$ [3] | Time constant of dynamic load regulation | (1...1/4...1) $I_{o\,nom}$ $I_{o2}$ = $I_{o\,nom}$ | | 1.0 | | | | | ms |
| $U_{o\,tr}$ | Output voltage trimming range [4] | $U_{i\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 14.0<br>21.6 | | 26.4<br>26.4 | 14.0<br>21.6 | | 26.4<br>26.4 | V |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting or remote sensing, the output power should be reduced accordingly so that $P_{o\,max}$ and $T_{C\,max}$ are not exceeded (see fig. 25). Same conditions for both outputs.
[2] Value of total current, $I_{o1}$ + $I_{o2}$. See "Output Current Limitation", fig. 15 and 16.
[3] Time constant until $U_o$ remains within 1% of $U_{o\,nom}$, see fig. 21
[4] Upper row represents setting via R-input, lower row option P range
[5] $I_{o\,min}$ = 10% of $I_{o\,nom}$ for each output necessary (see also "Output Regulation")

### Parallel or Series Connection of Outputs and/or Units

Single or double output units with equal nominal output voltage can be connected in parallel without any precaution by interconnecting the T-pins for approximate equal current sharing.

Any double output unit with its outputs in parallel behaves like a single output unit, i.e. is fully regulated. There is no inconvenience or restriction using the R-input, the sense lines and the test sockets.

Single output units and/or main and second outputs of double output units can be connected in series with any other (similar) output. For double output modules consider, that the effect via sense lines, R-input or option P is doubled and the test sockets monitor the main output only (i.e. $^1/_2\ U_o$).

**Note:**

- Parallel connection of several double output units should always include both, main and second output to maintain good regulation of all outputs.
- Series connection of second outputs without involving their main outputs should be avoided as regulation may be poor.
- The maximum output current is limited by the output with the lowest current limitation if several outputs are connected in series.
- Output voltages above 60 V (SELV = Safety Extra Low Voltage) need additional measures in order to comply with international safety requirements.

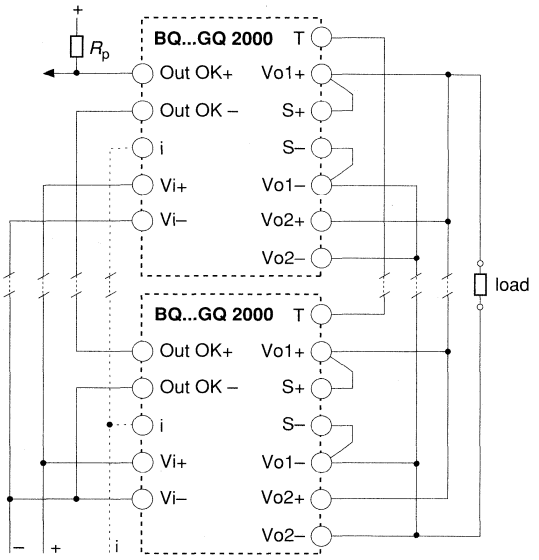



*Fig. 13*
*Parallel connection of several modules, sense lines connected at connector side*

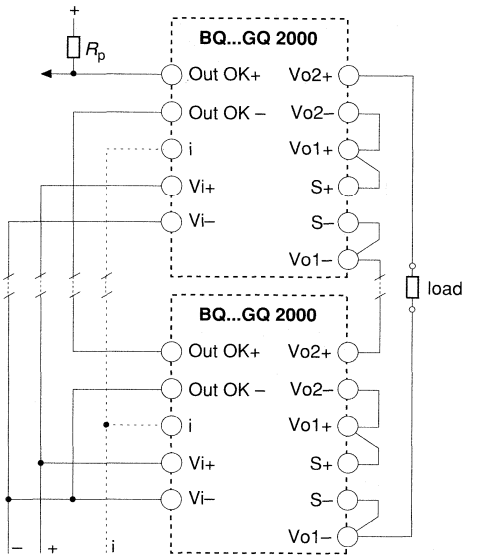



*Fig. 14*
*Series connection of several modules, sense lines connected at connector side only*

### Current Sharing (T-Function)

For higher power and n+1 high reliability systems, a current sharing facility allows several units to operate in parallel-connection with the assurance that a single fault will not lead to a system failure. Interconnection of the current sharing terminals T causes the units to share the load current, resulting in lower stress and further improved reliability. Parallel-connected modules with interconnected T pins share their output currents within a tolerance of approx. ±20% of $I_{o\ nom}$. BQ...GQ 2000 with outputs in series-connection can be paralleled with current sharing, if output 1 and 2 are connected in the same order. If the output voltages are programmed ($U_o$ is different from $U_{o\ nom}$), by means of the R-pin or option P, the outputs should be adjusted individually within a tolerance of ±1%. When operating with dynamic loads, the current sharing will be less accurate.

### Continuous Open-Circuit and Short-Circuit Proof

All outputs are fully protected against continuous open circuit, e.g. against no load condition (for the BQ...GQ 2000 characteristics refer to "Output Voltage Regulation of Double Output Modules").

All outputs of the units are fully protected against continuous short circuit condition by means of the electronic current limitation on the primary side (see "Output Current Limitation").


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### Output current limitation

Single output units and series- or parallel-connected double output units have a quasi rectangular constant current limitation characteristic.

In double output units, the total current is limited, allowing free choice of load distribution between the two outputs, up to a total $I_{o1} + I_{o2} \leq I_{o\,max}$ (see "Output Voltage Regulation of Double Output"). In overload ($I_{o1} + I_{o2} > I_{o\,max}$) both output voltages are simultaneously reduced.

Independent outputs with symmetrical current loads both have a rectangular current limitation characteristic.

Current distribution in overload is dependent upon the type of overload. A short-circuit in one output will cause the full current to flow into that output whereas a resistive overload results in more even distribution and in a reduced output voltage.

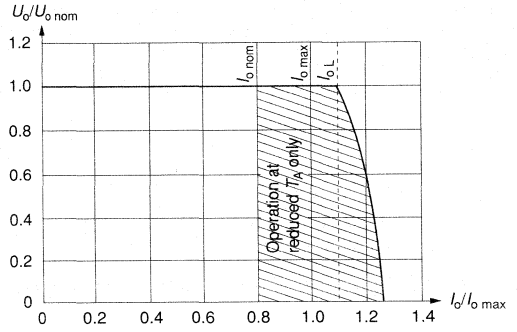



*Fig. 15*
*Current limitation behaviour of a single or a double output unit with series- or parallel-connected outputs*

### Increased Output Power at Reduced Temperature

Operating the units with output current from $I_{o\,nom}$...$I_{o\,max}$ requires a reduction of ambient temperature to $T_{A\,max}$ = 50°C or forced cooling in order to keep $T_C$ below 90°C. If $T_{C\,max}$ is exceeded, the unit runs into its thermal protection and switches off (e.g. $T_A > 50$°C and $P_o > P_{o\,nom}$).

Short-term operation within the shaded area (e.g. start-up current, peak current) is possible without additional measures, provided the case temperature remains below $T_{C\,max}$.

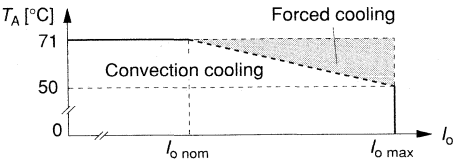



*Fig. 16*
*Output current versus ambient temperature*

### Sense Lines

**Note:** Sense lines must always be connected!

This feature enables compensation of voltage drop across the connector contacts and the load lines including the diode in true redundant wired-OR system configurations. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that Uo max (between Vo1+ and Vo1–) is not exceeded. (See fig. 2 to 6)

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines parallel or twisted. For unsymmetrical loads it is recommended to connect the sense lines directly at the female connector.

To ensure correct operation, both sense lines must be connected to their respective power output potential. With double output units the sense lines must be connected to output 1 only. Caution should be exercised when outputs are series-connected as the compensated voltage is effectively doubled (refer to fig. 4). The voltage difference between any sense line and its respective power output pin (as measured on the connector) should not exceed the following values at nominal output voltage.

*Table 7: Voltage compensation allowed using sense lines*

| Output voltage | Total voltage difference between sense lines and their respective outputs |
|---|---|
| 5.1 V | <0.5 V |
| 12, 15, 24 V | <1.0 V |

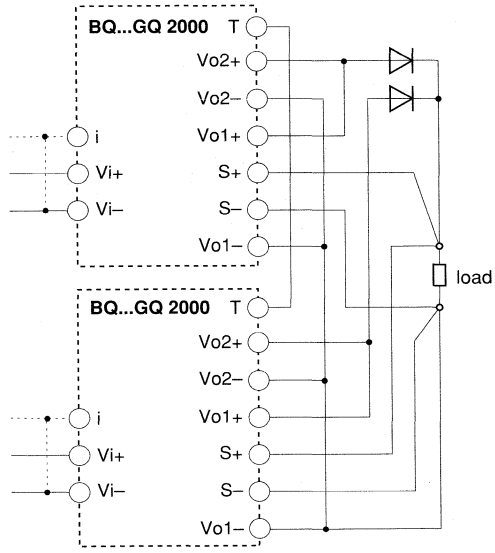



*Fig. 17*
*Sense lines connection for redundant (n+1) or parallel operation using wired-OR diodes*

### Output Voltage Regulation of Double Output Modules

In symmetrical configuration the main output 1 is under normal conditions regulated to $U_{o\,nom}$, independent of the output currents. Note that if the load on output 2 is too small (<0.1 • $I_{o\,nom}$), its voltage will rise, possibly activating the overvoltage protection, which will then reduce the voltage on both outputs.

$U_{o2}$ is dependent upon the load distribution: When each output is loaded with at least 10% of $I_{o\,nom}$, the deviation of $U_{o2}$ remains within ±5% of the value of $U_{o\,nom}$. Figures 18 to 20 explain the regulation with varying load distributions up to the current limit. If $I_{o1} = I_{o2}$ or the two outputs are in series-connection, the deviation of $U_{o2}$ remains within ±1% of the value of $U_{o\,nom}$ provided that the load is more than 10% of $I_{o\,nom}$.

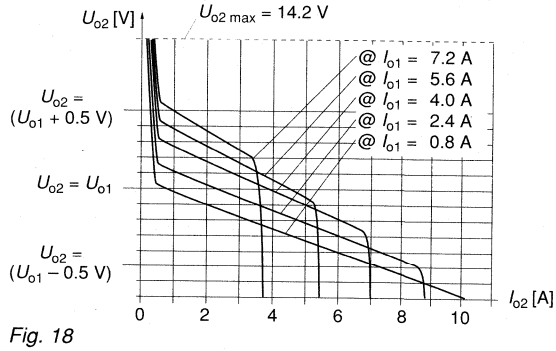



*Fig. 18*
*BQ...GQ 2320 output 2 voltage deviation vs. output 2 current with different currents on output 1*

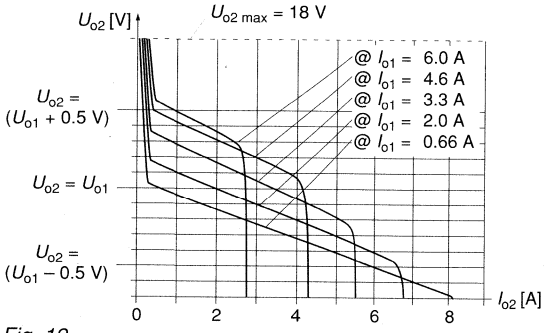



*Fig. 19*
*BQ...GQ 2540 output 2 voltage deviation vs. output 2 current with different currents on output 1*

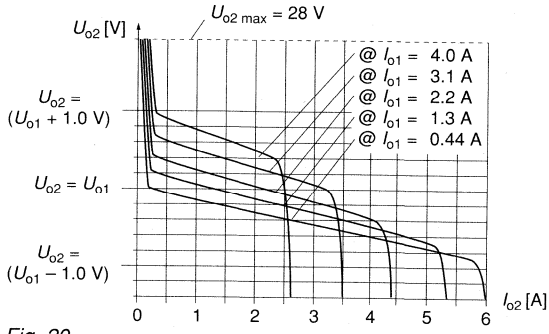



*Fig. 20*
*BQ...GQ 2660 output 2 voltage deviation vs. output 2 current with different currents on output 1*

### Output Voltage Overshoot Protection

Negligible output voltage overshoot may occur if the module is either hot plugged-in or disconnected, the input voltage is switched on or off, the module is switched with an inhibit signal, or after a reset of a short circuit and power failure.

### Second Control Loop

A fully independent second control loop limits the output voltage to approximately 1.25 • $U_{o\,nom}$ (see table 6, e.g. sense lines wired incorrectly). It further protects the load in the unlikely event of a malfunction of the main control circuit.

In double output modules output 1 is fully regulated with overvoltage protection on output 2, through this second control loop.

There is no specific built-in protection against externally applied overvoltages.

### Hold up Time

The modules provide virtually no hold up time. If hold up time is required, use external output capacitors or diodes and input capacitors of adequate size.

### Dynamic load regulation

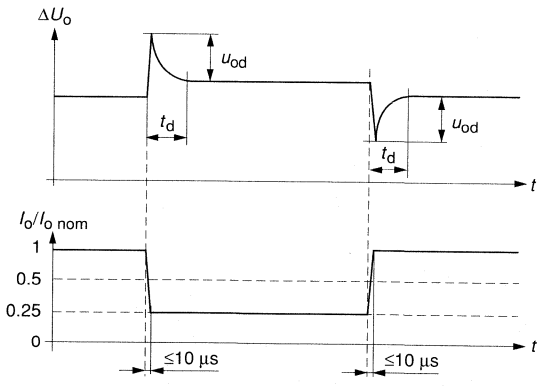



*Fig. 21*
*Control deviation of $U_o$ versus dynamic load change*


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**Programmable Output** (R-Function)

All modules offer a programmable output voltage feature. The programming is performed either by an external control voltage $U_{ext}$ or an external resistor $R_{ext}/R'_{ext}$, connected to the R-input. Trimming is limited to the values given in the table below. With a disconnected R-input, the output voltage is set to $U_{o\,nom}$.

Simultaneous use of the R-input function and option P is not possible. If option P is built-in, the R-input will remain active but its function must not be used; do not connect pin R at all!

With double output modules, both outputs are affected by the R-input settings.

If output voltages are set higher than $U_{o\,nom}$, the output currents should be reduced accordingly, so that the maximum specified output power is not exceeded.

**Caution:** The voltage at the R-input may not exceed 28 V DC under all circumstances in order to avoid damage.

a) Adjustment by means of an external control voltage $U_{ext}$ between R and S– ($U_o$ is dependent upon $U_{ext}$):

$U_o = U_{ext} \cdot U_{o\,nom} / 2.5$ V (approximative formula)

b) Adjustment by means of an external resistor:

The resistor can either be connected between the pins R and S– to set $U_o < U_{o\,nom}$, or between the pins R and S+ to set $U_o > U_{o\,nom}$.

R-inputs of several parallel operating modules can be parallel-connected, providing individual adjustment to $40^{\pm 1}$ %. For common adjustment the resulting resistor value is being calculated:

$1/R_{tot} = 1/R_1 + 1/R_2 + ... + 1/R_n$

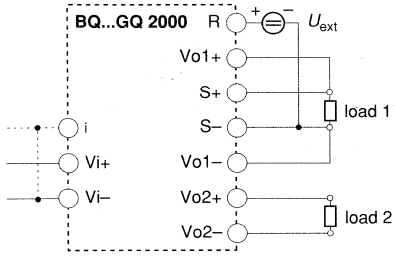



*Fig. 22*
*Output voltage programming using a control voltage $U_{ext}$*

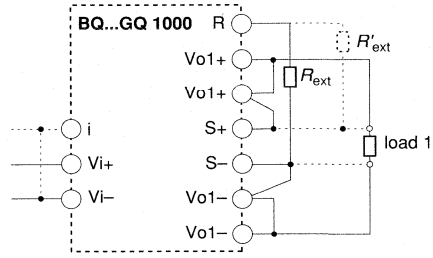



*Fig. 23*
*Output voltage programming using $R_{ext}$ or $R'_{ext}$*

*Table 8a: $R_{ext}$ for $U_o < U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ (V) | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] |
| 4.0 | 14.7 | 5.5 | 11.0 | 3.40 | 8.0 | 16.0 | 4.53 | 14.0 | 28.0 | 5.62 |
| 4.1 | 16.5 | 6.0 | 12.0 | 4.02 | 8.5 | 17.0 | 5.23 | 15.0 | 30.0 | 6.65 |
| 4.2 | 18.2 | 6.5 | 13.0 | 4.75 | 9.0 | 18.0 | 6.04 | 16.0 | 32.0 | 8.06 |
| 4.3 | 21.5 | 7.0 | 14.0 | 5.76 | 9.5 | 19.0 | 6.98 | 17.0 | 34.0 | 9.76 |
| 4.4 | 25.5 | 7.5 | 15.0 | 6.65 | 10.0 | 20.0 | 8.06 | 18.0 | 36.0 | 12.1 |
| 4.5 | 30.1 | 8.0 | 16.0 | 8.06 | 10.5 | 11.0 | 9.31 | 19.0 | 38.0 | 15.4 |
| 4.6 | 37.4 | 8.5 | 17.0 | 9.76 | 11.0 | 22.0 | 11.0 | 20.0 | 40.0 | 20.0 |
| 4.7 | 47.5 | 9.0 | 18.0 | 12.1 | 11.5 | 23.0 | 13.3 | 20.5 | 41.0 | 23.7 |
| 4.8 | 64.9 | 9.5 | 19.0 | 15.4 | 12.0 | 24.0 | 16.2 | 21.0 | 42.0 | 28.0 |
| 4.9 | 97.6 | 10.0 | 20.0 | 20.0 | 12.5 | 25.0 | 20.0 | 21.5 | 43.0 | 34.8 |
| 5.0 | 200.0 | 10.5 | 11.0 | 28.0 | 13.0 | 26.0 | 26.1 | 22.0 | 44.0 | 44.2 |
| | | 11.0 | 22.0 | 44.2 | 13.5 | 27.0 | 36.5 | 22.5 | 45.0 | 60.4 |
| | | 11.5 | 23.0 | 93.1 | 14.0 | 28.0 | 56.2 | 23.0 | 46.0 | 90.9 |
| | | | | | 14.5 | 29.0 | 115.0 | 23.5 | 47.0 | 190.0 |

*Table 8b: $R'_{ext}$ for $U_o > U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] |
| 5.2 | 215.0 | 12.2 | 24.4 | 931 | 15.3 | 30.6 | 1020 | 24.5 | 49.0 | 1690 |
| 5.3 | 110.0 | 12.4 | 24.8 | 475 | 15.5 | 31.0 | 619 | 25.0 | 50.0 | 866 |
| 5.4 | 75.0 | 12.6 | 25.2 | 316 | 15.7 | 31.4 | 453 | 25.5 | 51.0 | 590 |
| 5.5 | 57.6 | 12.8 | 25.6 | 243 | 16.0 | 32.0 | 324 | 26.0 | 52.0 | 453 |
| 5.6 | 46.4 | 13.0 | 26.0 | 196 | 16.2 | 32.4 | 274 | 26.4 | 52.8 | 383 |
| | | 13.2 | 26.4 | 169 | 16.5 | 33.0 | 221 | | | |

[1] First column: single output units or double output units with separated outputs, second column: outputs in series connection

## Supplementary Data

### Isolation

Input to output, input to case and output to case isolation voltage tests and clearance and creepage distances are in accordance with IEC 950, EN 60950, VDE 0805 and EN 41003 respectively. These test are performed as factory tests and should not be repeated in the field.

Attention:
Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 7 and 8). Melcher will not honour any guarantee claims resulting from high voltage field test damages.

*Table 9: Isolation test voltages, clearance and creepage distances*

| Characteristic | Input to Output | Input to Case | Output to Case | Output to Output [1] | Unit |
|---|---|---|---|---|---|
| Isolation test voltage | 2.0 | 1.0 | 1.0 | 0.2 | $kV_{rms}$ |
| | 2.8 | 1.4 | 1.4 | 0.3 | kV DC |
| Clearance and creepage distance on the print lay-out | 2.0 | 1.0 | 1.0 | 0.2 | mm |

[1] BQ...GQ 2000

### Output good signal

The galvanically isolated Out OK output gives a status indication of the module and the output voltage. It can be used for control functions such as data protection, central system monitoring or as a part of a self-testing system. It can be connected to get a centralized fault detection or may be used for other system specific applications at the primary or the secondary side of the converter.
In case of an error condition, the Out OK output shows a high impedance. During a system error or in an overload condition, the output good signal will disappear if the output voltage deviates approx. ±3% of $U_{o\,nom}$. Using the R-input or the option P, the supervision level is tracking the programmed output voltage.
The output is formed by a NPN transistor. The emitter (Out OK–) can be connected to primary Vi– or secondary Vo1– to get an open collector output. With several independent units the Out OK pins can be series-connected in order to get a system level signal. If one of the units fails the series-connected outputs rise to a high impedance. This series-connection can be completed by other transistors providing extended user specific error information.

Dimensioning of resistor value $R_p$ should be in accordance to the values given in table 10.

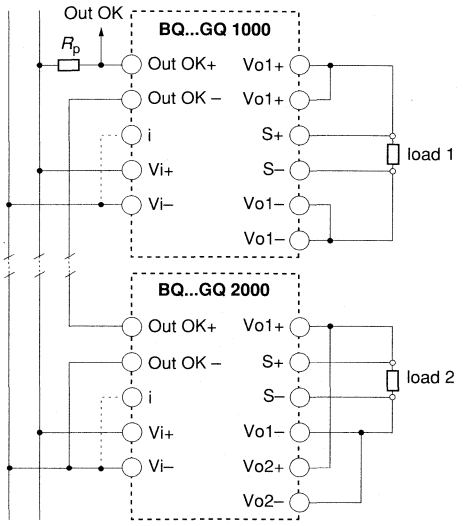



*Fig. 24*
*Series connection of the output good signal at the primary side of the converters for system supervision*

*Table 10: Output OK data*

| Characteristics | | Conditions | Output | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{OK\,low}$ | Voltage - Terminal OK at low impedance | $I_{OK} \leq 1.0$ mA | good | | 1.0 | | V |
| $U_{OK\,high}$ | Voltage - Terminal OK at high impedance | $I_{OK} > 25$ µA | failure | | 20.0 | | |

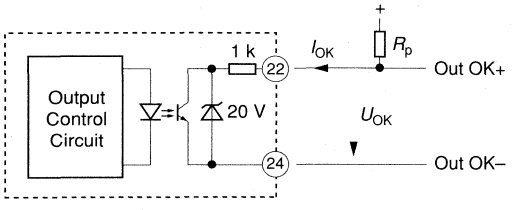



*Fig. 25*
*Output OK function*

**Caution:** The Out OK+ is protected by an internal series resistor and a Zener diode. To prevent damage the externally applied voltage should be limited to <25 V and the current to <20 mA respectively.


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### Test Sockets

Test sockets (pin diameter 2 mm) are located at the front of the module monitoring the main output voltage at the sense line terminals. The test sockets are short circuit protected by internal series resistors. Test sockets for monitoring output 2 are not available. Double output modules always show the sense line voltage of output 1 at the test sockets only.

If such outputs are series-connected, the measured voltage equals $^1/_2$ of $U_o$.

### Thermal Protection

An overtemperature monitor inhibits the unit, when the case temperature $T_C$ exceeds a nominal 100°C. Outputs are automatically enabled as the case temperature drops below the threshold temperature.

### Self Cooling Case

If a converter is located upright in free-flowing, quasi-stationary air at a temperature $T_A$ = 71°C (50°C only for operation between $I_{o\,nom}$...$I_{o\,max}$) and is operated at its nominal output power, the case temperature $T_C$ remains ≤95°C, (90°C for $I_{o\,max}$) measured at the case temperature measuring point.

### Additional Cooling

Cooling by a heat sink or a fan allows the operation at full output power and improves the reliability. The ambient temperature $T_A$ may exceed its max. value when additional measures are taken to ensure that the case temperature $T_C$ does not exceed 95°C. In rack systems without proper thermal management, the modules must not be packed too densely! In such cases the use of the 5 or 6 TE front panel is recommended.

Operation at ambient temperatures of 71...85°C with convection cooling will limit the maximum output power to 40% (approx.) of the nominal value. Forced cooling (additional heat sink, fan, etc.) allows operation of the power supply at nominal output power up to an ambient temperature of 85°C, as long as the maximum case temperature $T_{C\,max}$ is not exceeded.

### Display status of LED's

*Table 11: Display status of LED's*

| LED In OK | LED Out OK | Operating condition |
|---|---|---|
| on | on | normal operation |
| on | x | incorrect sense line connection |
| on | off | overtemperature<br>overload<br>output overvoltage<br>output undervoltage |
| off | on | not possible |
| off | off | no input voltage<br>input voltage too low<br>inhibit open / high<br>input voltage too high |

x = dependent on actual operating condition

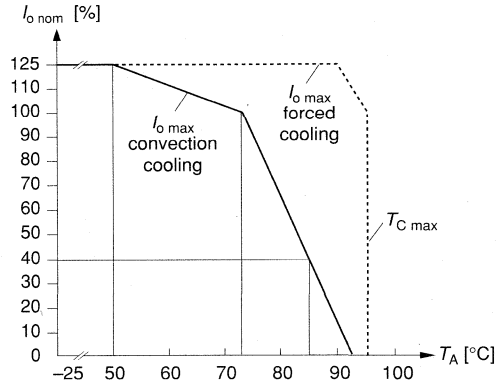



*Fig. 26*
*Output power uprating/derating versus $T_A$*

## Description of Option

**Option P** Output Voltage Adjustment

Option P is a built-in multi-turn potentiometer which provides an output voltage adjustment of ±10% of $U_{o\,nom}$. The potentiometer is accessible through a hole in the front cover. Static voltage drops across connectors and wires can easily be compensated.

With double output modules, both outputs are affected by the potentiometer settings. If different units are parallel-connected, their individual output voltages should be set within a tolerance of ±1%. If output voltages $U_o$ are set higher than $U_{o\,nom}$, the output currents should be reduced accordingly, so that the maximum specified output power is not exceeded.

## Immunity to Environmental Conditions

*Table 12: Mechanical stress*

| Test | | Standard | Test Parameters | |
|---|---|---|---|---|
| Ca | Damp heat<br>steady state | DIN 40046, part 5<br>IEC 68-2-3<br>MIL-STD 810D section 507.2 | Temperature:<br>Relative humidity:<br>Time: | 40 $^{\pm 2}$ °C<br>93 $^{+2/-3}$ %<br>56 days<br>Unit not operating |
| Ea | Shock<br>(half-sinusoidal) | DIN 40046, part 7<br>IEC 68-2-27<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 50 $g_n$ = 490.5 m/s$^2$<br>11 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock<br>(half-sinusoidal) | DIN 40046, part 26<br>IEC 68-2-29<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 25 $g_n$ = 245 m/s$^2$<br>11 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration<br>(sinusoidal) | DIN 40046, part 8<br>IEC 68-2-6<br>MIL-STD 810D section 514.3 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$<br>7.5 h (2.5 h each axis)<br>Unit operating |
| Kb | Salt mist<br>cyclic<br>(sodium chloride NaCl<br>solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Storage duration:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% rel. humidity<br>22 h per cycle<br>3<br>Unit not operating |

*Table 13: Temperature specifications for air pressure of 800...1200 hPa (800...1200 mbar)*

| Characteristics | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Ambient temperature range, start-up and operational [2] | –25 | 71 [1] | °C |
| $T_C$ | Case temperature range, operational | –25 | 95 | |
| $T_S$ | Storage temperature range, not operational [2] | –40 | 100 | |
| $T_{C\,max}$ | Overtemperature protection | 95 | 105 | |
| $R_{th\,C}$ | Temperature coefficient of case in still air | | 2 | K/W |

[1] Operation with $I_{o\,max}$ requires reduction to $T_{A\,max}$ = 50°C
[2] MIL-STD-810D sections 501.2 and 502.2

*Table 14: MTBF and device hours*

| Ratings at specified Case Temperature | Modules | Ground Benign 40 °C | Ground Fixed 40 °C | Ground Fixed 70 °C | Ground Mobile 50 °C | Device Hours [1] | Unit |
|---|---|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | CQ 1000 | 588'000 | 196'000 | 96'000 | 74'000 | Not available yet | h |
| | BQ 1000 | 594'000 | 194'000 | 94'000 | 74'000 | | |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

European Projection

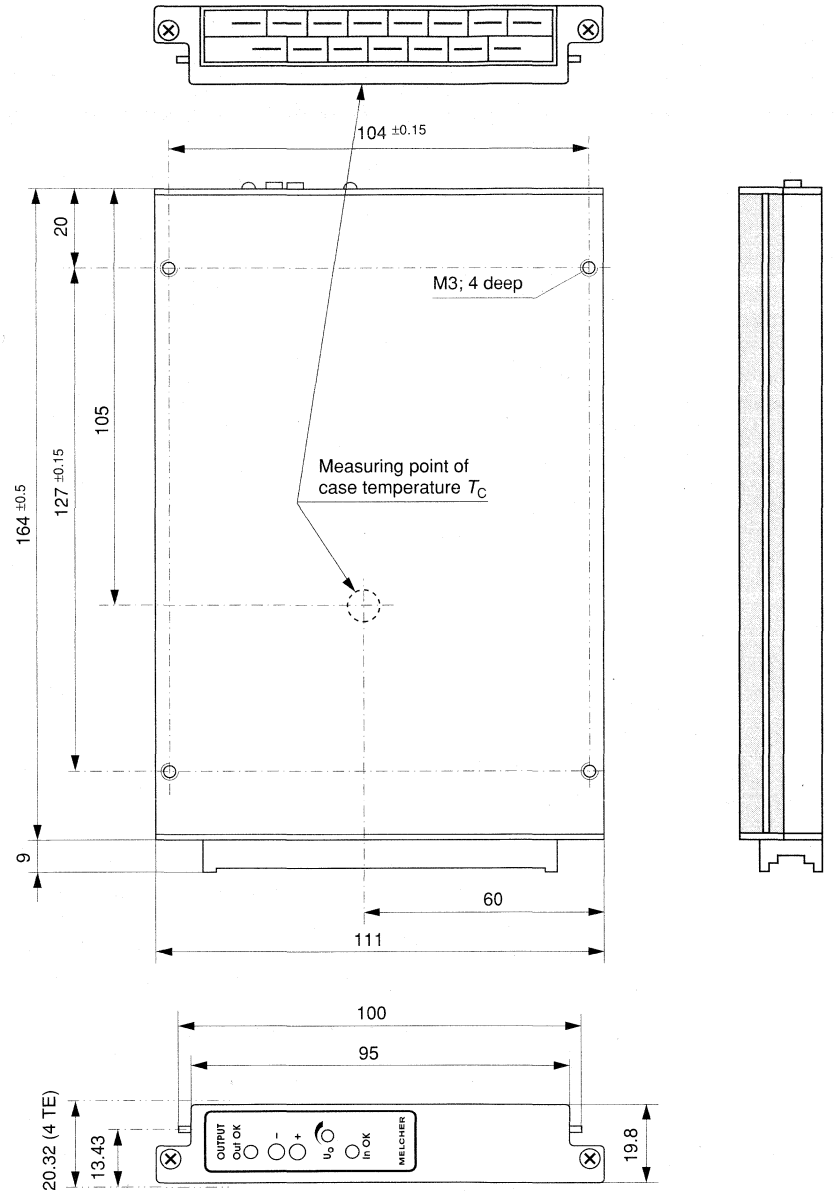
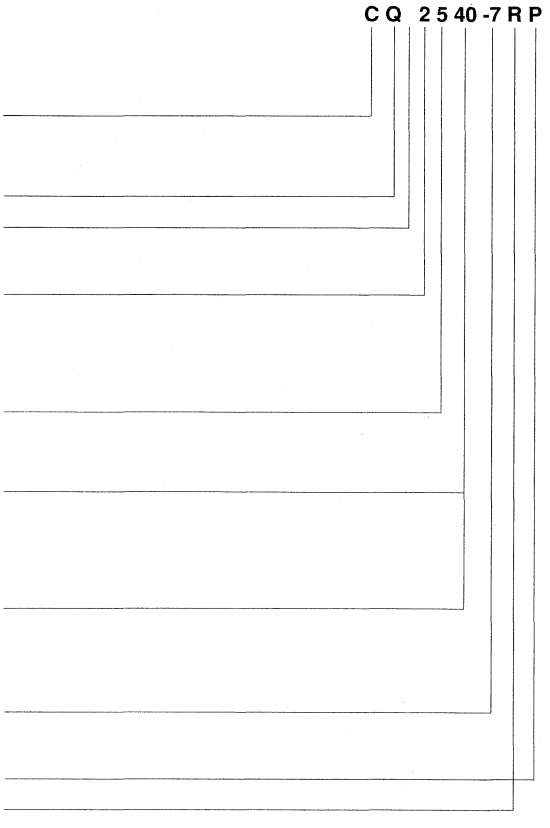



*Fig. 27*
*Case Q01, weight 480 g*

## Type Key and Product Marking

### Type Key




Input voltage range $U_I$:
- 14.4...36 V DC ..... B
- 35...75 V DC ..... C
- 43...108 V DC ..... D
- 66...165 V DC ..... E
- 22...54 V DC ..... G

Family ..... Q

Blank .....

Number of outputs:
- Single output ..... 1
- Double output ..... 2

Nominal voltage output 1 (main output), $U_{o1\ nom}$
- 5.1 V ..... 0, 1, 2
- 12 V ..... 3
- 15 V ..... 4, 5
- 24 V ..... 6
- other voltages ..... 7, 8

Other specifications for main output ..... 01...99

Symmetrical double output units:
Nominal voltage output 1/output 2, $U_{o1/2\ nom}$
- 12 V/12 V (24 V series conn.) ..... 20
- 15 V/15 V (30 V series conn.) ..... 40
- 24 V/24 V (48 V series conn.) ..... 60
- other symmetrical voltages ..... 70...99

Operational ambient temperature range $T_A$:
- –25...71 °C ..... -7
- –25...60 °C ..... -6
- customer specific ..... -0

Feature: Output voltage control input [1] ..... R

Option: Potentiometer (output voltage adjustment) [1] ... P

[1] Feature R excludes option P and vice versa

Example: CQ 2540-7P: DC-DC converter, input voltage range 35...75 V, double output, each providing 15 V/4 A, equipped with potentiometer and operating ambient temperature of –25...71 °C.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation of input, output and auxiliary functions, Melcher patents and company logo.

Front plate: Identification of LED's, test sockets and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, fuse specification and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main PCB and date of production.

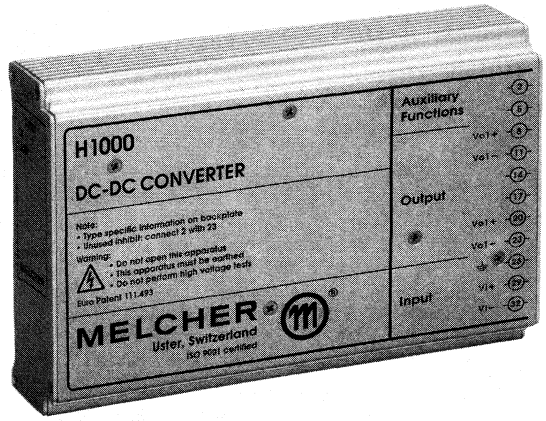
# 50 W DC-DC Converters

# H-Family

**Class I Equipment**

Single output: series 12H...48H1000
Dual output: series 12H...48H2000
Triple output: series 12H...48H3000

- Wide input voltage range suitable for battery operation
- Efficient input filter and built-in surge and transient suppression circuitry
- 3 $kV_{rms}$ input to output electric strength test
- Outputs individually isolated and controlled
- Outputs fully protected against overload
- Safety in accordance with IEC 950/EN 60950




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## Description

The H-family of DC-DC converters represents a broad and flexible range of power supplies for use in advanced electronic systems. Features include high efficiency, reliability and reasonable output voltage noise.

The converter inputs are protected against surges and transients occuring on the source lines. Input over- and undervoltage cut-out circuitry disables the outputs if the input voltage is outside the specified range.

All outputs are open- and short-circuit proof and are protected against overvoltages by means of built-in suppressor diodes. The outputs can be inhibited by a logic signal applied to the connector pin i. If the inhibit function is not used pin 2 should be connected with pin 23 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case and output to output isolation is provided. The modules are designed and built according to the international safety standard IEC 950.

The case design allows operation at nominal load up to 50 °C in a free air ambient temperature. If forced cooling is provided, the ambient temperature may exceed 50 °C but the case temperature should remain below 80 °C under all conditions.

A temperature sensor generates an inhibit signal which disables the outputs if the case temperature $T_C$ exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Case: aluminium, blank, self cooling.
Dimensions: 38.7 × 111.2 × 168.5 mm. Weight: 770 g

## Type Survey

**Options see "Descriptions of Options"**

*Table 1: Type survey*

| Output 1 | | Output 2 | | Output 3 | | Input Voltage Range and Efficiency [1] | | | | | | Option |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{i\,min}...U_{i\,max}$ **9...15 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **18...30 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **36...60 V DC** | $\eta_{min}$ % | |
| 5.1 | 8.0 | | | | | 12H1001-2R | 72 | 24H1001-2R | 74 | 48H1001-2R | 74 | V2, V3 |
| 12.0 | 4.0 | | | | | 12H1301-2R | 79 | 24H1301-2R | 80 | 48H1301-2R | 80 | D1...D8 |
| 15.0 | 3.4 | | | | | 12H1501-2R | 79 | 24H1501-2R | 81 | 48H1501-2R | 81 | |
| 24.0 | 2.0 | | | | | 12H1601-2R | 81 | 24H1601-2R | 83 | 48H1601-2R | 82 | |
| 48.0 | 1.0 | | | | | 12H1901-2R | 81 | 24H1901-2R | 83 | 48H1901-2R | 83 | |
| 12.0 | 2.0 | 12.0 | 2.0 | | | 12H2320-2 | 77 | 24H2320-2 | 79 | 48H2320-2 | 80 | |
| 15.0 | 1.7 | 15.0 | 1.7 | | | 12H2540-2 | 78 | 24H2540-2 | 80 | 48H2540-2 | 79 | |
| 5.1 | 5.0 | 12.0 | 0.7 | 12.0 | 0.7 | 12H3020-2 | 75 | 24H3020-2 | 76 | 48H3020-2 | 76 | |
| 5.1 | 5.0 | 15.0 | 0.6 | 15.0 | 0.6 | 12H3040-2 | 75 | 24H3040-2 | 76 | 48H3040-2 | 76 | |

1 Efficiency measured at $U_{i\,nom}$ and $I_{o\,nom}$

## Safety and Installation Instructions

### Safety

For safety reasons, the modules must be wired via the female connector H11 (according to DIN 41612) in order to meet national and international safety requirements!

All converters fully comply with IEC 950, EN 60950, UL 1950 and CSA/C22.2 No. 950-M89 standards. The connector protective earthing pin is leading. During the production process, all transformers and each of the fully assembled modules are individually tested for electric strength and earth continuity (see table 10). All electric strength tests are performed as factory tests.

### Installation

Installation of the power supply must strictly follow the national safety regulations. To observe the safety requirements according to EN 60950/IEC 950, the module shall be connected via the female connector type H11. Other installation methods may not meet the safety requirements. The modules do not incorporate any fuse(s). (An) external fuse(s) installed in the wiring to the input is essential!

Whenever the inhibit function is not required, pin 2 should be connected to pin 23 to enable the output(s).

### Important Advice

Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/µs, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher AG will not honour any guarantee/warranty claims resulting from high voltage field tests.

*Table 2: H11 connector pin allocation*

| Electrical Determination | H1000 | | H2000 | | H3000 | |
|---|---|---|---|---|---|---|
| | Pin | Ident | Pin | Ident | Pin | Ident |
| Inhibit control input | 2 | i | 2 | i | 2 | i |
| Safe Data or ACFAIL | 5 | D or V | 5 | D or V | 5 | D or V |
| Output voltage (positive) | 8 | Vo1+ | 8 | | 8 | Vo3+ |
| Output voltage (negative) | 11 | Vo1– | 11 | | 11 | Vo3– |
| Control input + | 14 | R | | | | |
| Control input – | 17 | G | | | | |
| Output voltage (positive) | | | 14 | Vo2+ | 14 | Vo2+ |
| Output voltage (negative) | | | 17 | Vo2– | 17 | Vo2– |
| Output voltage (positive) | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ |
| Output voltage (negative) | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– |
| Protective earthing [1] | 26 | ⏚ | 26 | ⏚ | 26 | ⏚ |
| DC input voltage | 29 | Vi+ | 29 | Vi+ | 29 | Vi+ |
| DC input voltage | 32 | Vi– | 32 | Vi– | 32 | Vi– |

[1] Leading pin (pregrounding)

### Degree of Protection

Condition: Female connector fitted to the unit
IP 40: All units, except those with options D or V incorporating potentiometer adjustment.
IP 20: Type fitted with options D or V incorporating potentiometer.

## Functional Description

The input voltage is fed via an input filter, to the input capacitor. This capacitor sources a single transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke. The control logic senses the main output voltage $U_{o1}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor. This signal is fed back via a coupling transformer.

The auxiliary outputs $U_{o2}$ and $U_{o3}$ are unregulated. Each auxiliary output's current is sensed using a current transformer. If one of the outputs is driven into current limit, the other outputs will reduce their output voltages as well because all output currents are controlled by the same control circuit.

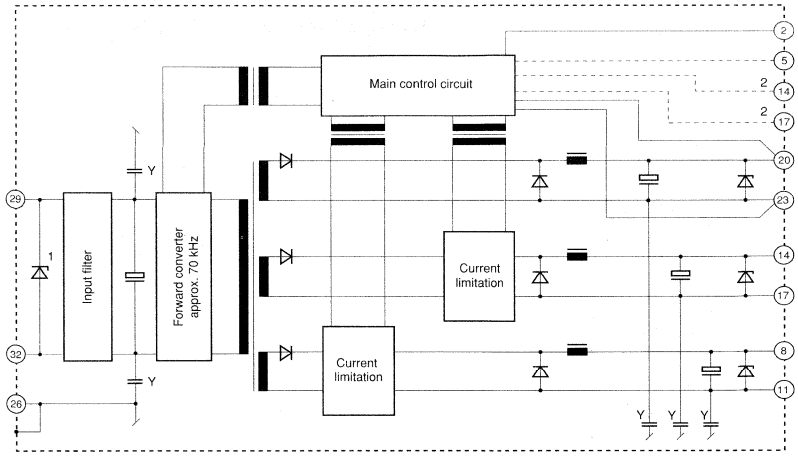



*Fig. 1*
*DC-DC converter block diagram, class I equipment*

[1] Transient suppressor diode
[2] Single output modules H1000

## Electrical Input Data

General conditions:
– $T_A$ = 25°C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, R input not connected.

*Table 3: Input data*

| Input | | | 12H | | | 24H | | | 48H | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | |
| $U_i$ | Input voltage range | $I_o$ = 0…$I_{o\,nom}$ | 9 | | 15 | 18 | | 30 | 36 | | 60 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | $T_{C\,min}$…$T_{C\,max}$ | | 12 | | | 24 | | | 48 | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 5.0 | | | 2.5 | | | 1.3 | | A |
| $P_{i\,0}$ | No-load input power:<br>Single output<br>Double output<br>Triple output | $U_{i\,nom}$<br>$I_{o1,2,3}$ = 0 | | <br>1<br>4<br>4 | <br>1.5<br>6<br>6 | | <br>1<br>4<br>4 | <br>1.5<br>6<br>6 | | <br>1<br>4<br>4 | <br>1.5<br>6<br>6 | W |
| $P_{i\,inh}$ | Idle input power | inhibit mode | | | 1.5 | | | 1.5 | | | 1.5 | W |
| $I_{inr\,p}$ [3] | Peak inrush current | $U_i$ = $U_{i\,max}$ | | | 250 | | | 300 | | | 400 | A |
| $t_{inr\,r}$ | Rise time | $R_S$ = 0 Ω [2] | | 60 | | | 50 | | | 20 | | µs |
| $t_{inr\,h}$ | Trailing edge half-life | $T_C$ = 25°C | | 130 | | | 75 | | | 30 | | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 78 | | | 100 | | | 150 | | | mΩ |
| $C_i$ | Input capacitance | | | | 3300 | | | 1200 | | | 300 | µF |
| $U_{i\,abs}$ | Input voltage limits without any damage | | 0 | | 20 | 0 | | 40 | 0 | | 80 | V DC |

[1] With multiple output modules, the same condition for each output applies. [2] $R_S$ = source resistance. [3] $I_{inr\,p} = U_i/(R_s + R_i)$

### Input Under-/Overvoltage Cut-out

If the input voltage remains below 0.6 $U_{i\,min}$ or exceeds 1.1 $U_{i\,max}$ (approx. values), an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ must be carefully considered (see table 5).

## Electrical Output Data

General conditions
– $T_A$ = 25°C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, R input not connected.

*Table 4a: Output data*

| Output | | $U_{o\,nom}$ | 5.1 V | | | 12 V | | | 15 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_{o1}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [1] | 5.00 | | 5.20 | 11.76 | | 12.24 | 14.70 | | 15.30 | V |
| $U_{o2/3}$ | | | | - | | 11.40 | | 12.60 | 14.25 | | 15.75 | |
| $U_{o\,L}$ | Overvoltage prot. | $I_{o\,nom}$ | | 7.5 | | | 20 | | | 24 | | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | see table 1 | | | | | | | | | |
| $I_{o\,L}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | see fig. 2 | | | | | | | | | |
| $u_{o1/2/3}$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | | 50 | | | 120 | | | 150 | $mV_{rms}$ |
| | | BW = 20 MHz | | | 200 | | | 360 | | | 450 | $mV_{pp}$ |
| $\Delta U_{o1\,U}$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ | | ±20 | ±50 | | ±25 | ±120 | | ±30 | ±150 | mV |
| $\Delta U_{o2/3\,U}$ | | $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ [1] | | - | | | ±80 | ±240 | | ±100 | ±300 | |
| $\Delta U_{o1\,I}$ | Static load regulation | $U_{i\,nom}$ $I_o$ = $I_{o\,nom}$...0 [2] | | 15 | 50 | | 35 | 120 | | 45 | 150 | |
| $\Delta U_{o2/3\,I}$ | | $U_{i\,nom}$, $I_o$ = (1...0.1) $I_{o\,nom}$ [2 3] | | - | | | 400 | 800 | | 500 | 1000 | |
| $\Delta U_{o1\,Ic}$ | Static cross load | $U_{i\,nom}$ | | ±5 | ±15 | | ±10 | ±30 | | ±15 | ±45 | |
| $\Delta U_{o2/3\,Ic}$ | regulation [4] | $I_o$ = $I_{o\,nom}$...0 [5] | | - | | | –1100 | –1500 | | –1400 | –2000 | |

*Table 4b: Output data*

| Output | | $U_{o\,nom}$ | 24 V | | | 48 V | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | Unit |
| $U_{o1}$ | Output voltage | $U_{i\,nom}$, $I_{o1\,nom}$ | 23.52 | | 24.48 | 47.04 | | 48.96 | V |
| $U_{o\,L}$ | Overvoltage prot. | $I_{o1\,nom}$ | | 40 | | | 76 | | |
| $I_{o1\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | see table 1 | | | | | | |
| $I_{o\,L}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | see fig. 2 | | | | | | |
| $u_{o1}$ | Output voltage noise | $U_{i\,nom}$, $I_{o1\,nom}$ | | | 240 | | | 480 | $mV_{rms}$ |
| | | BW = 20 MHz | | | 720 | | | 1440 | $mV_{pp}$ |
| $\Delta U_{o1\,U}$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o1\,nom}$ | | ±30 | ±240 | | ±30 | ±480 | mV |
| $\Delta U_{o1\,I}$ | Static load regulation | $U_{i\,nom}$ $I_{o1}$ = $I_{o1\,nom}$...0 | | 70 | 240 | | 150 | 480 | |

[1] With multiple output modules, the same condition for each output applies.
[2] Condition for specified output. With multiple output modules, other output(s) loaded with constant current $I_o$ = $I_{o\,nom}$.
[3] At $I_{o2/3}$ = 0, $U_{o2/3}$ may rise to approx. $U_{o2/3\,nom}$ + 20%
[4] Condition for non-specified output, individually tested, other output(s) loaded with constant current $I_o$ = $I_{o\,nom}$.
[5] Multiple output modules.

### Output Protection

Each output is protected against overvoltages which could occur due to a failure of the internal control circuit. Voltage suppressor diodes (which under worst case condition may become a short circuit) provide the required protection. The suppressor diodes are not designed to withstand externally applied overvoltages. Overload at any of the outputs will cause a shut-down of all outputs.

### Parallel and Series Connection

Outputs of equal nominal voltage can be connected in parallel. It is important to assure that the main output of a multiple output module is forced to supply a minimum current of 0.1 A to enable correct operation of its own auxiliary outputs. Outputs one and two of a dual output unit may be connected parallel without a minimum current requirement at the main output.

In parallel operation, one or more of the outputs may operate continuously in current limit which will cause an increase in case temperature. Consequently, a reduction of the max. ambient temperature by 10 K is recommended.

Main or auxiliary outputs can be connected in series with any other output of the same or another module. In series, the maximum output current is limited by the lowest current limit. Output ripple and regulation values are added. Connection wiring should be kept as short as possible.

If output terminals are connected together in order to establish multi-voltage configurations, e.g. +5.1 V, ±12 V etc. the common ground connecting point should be as close as possible to the connector to avoid excessive output ripple voltages.

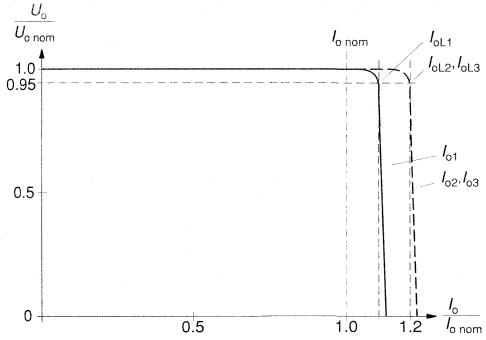



*Fig. 2*
*Typical output voltage $U_o$ versus output currents $I_o$*

### Inhibit (i Input)

The outputs of the module may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to the inhibit input. If the inhibit function is not required, connect the inhibit pin 2 to pin 23 to enable the outputs (active low logic, fail safe).

The reference for the inhibit signal is the negative pin of output 1.

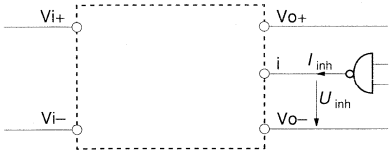



*Fig. 3*
*Definition of inhibit voltage and current*

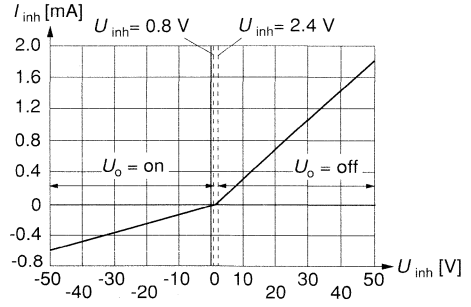



*Fig. 4*
*Typical inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 5: Inhibit data*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage causing | switched on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | 0.8 | V DC |
| | output voltage being... | switched off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = 0 | –60 | –100 | –220 | µA |

### Output Response

The reaction of the outputs is similar whether the input voltage is applied or the inhibit is switched low.

An output voltage overshoot will not occur when the module is turned on or off.

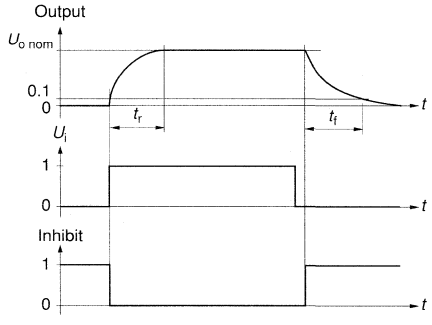



*Fig. 5*
*Output response as a function of input voltage (on/off switching) or inhibit control*

*Table 6: Output response time*

| Type of Converter | $t_r$ at $P_o = 0$ and $t_f$ at $P_o = P_{o\,nom}$ typ | max | $t_r$ and $t_f$ at $P_o = {}^3/_4\ P_{o\,nom}$ typ | max | $t_r$ at $P_o = P_{o\,nom}$ typ | max | Unit |
|---|---|---|---|---|---|---|---|
| H1001-2R | 3 | 7 | 3 | 7 | 5 | 15 | ms |
| H1301-2R | 5 | 15 | 8 | 20 | 10 | 30 | |
| H1501-2R | 3 | 7 | 5 | 15 | 15 | 40 | |
| H1601-2R | 8 | 20 | 15 | 35 | 20 | 60 | |
| H1901-2R | 35 | 90 | 50 | 140 | 85 | 220 | |
| H2320-2 | 10 | 30 | 15 | 40 | 25 | 70 | |
| H2540-2 | 8 | 20 | 10 | 30 | 20 | 50 | |
| H3020-2 | 30 | 75 | 45 | 120 | 75 | 200 | |
| H3040-2 | 20 | 60 | 30 | 80 | 50 | 140 | |

Conditions:
R input not used. For multiple output modules the figures indicated in the table above relate to the output which reacts slowest. All outputs are resistively loaded. Variation of the input voltage within $U_{i\,min}...U_{i\,max}$ does not influence the values.

6.3

### Programmable Voltage (R Input)

As a standard feature single output modules offer an adjustable output voltage indentified by letter R in the type designation. The control input R (pin 14) accepts either a control voltage $U_{ext}$ or a resistor $R_{ext}$ to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_o$ according to table 4a and 4b. The control input is protected against external overvoltage up to 8 V max.

a) Adjustment by means of an external control voltage $U_{ext}$ between pin 14 (R) and pin 17 (G):
The control voltage range is 0...2.75 V and allows an adjustment in the range of approximately
$U_o = 0...110\%\ U_{o\,nom}$.

$$U_{ext} \approx \frac{U_o}{U_{o\,nom}} \cdot 2.5\ V$$

b) Adjustment by means of an external resistor:
Depending upon the value of the required output voltage, the resistor shall be connected
**either:** Between pin 14 and pin 17 ($U_o < U_{o\,nom}$) to achieve an output voltage adjustment range of approx.
$U_o = 0...100\%\ U_{o\,nom}$

$$R_{ext} \approx 4\ k\Omega \cdot \frac{U_o}{U_{o\,nom} - U_o}$$

**or:** Between pin 14 and pin 20 ($U_o > U_{o\,nom}$) to achieve an output voltage adjustment range of approximately
$U_o = 100...110\%$ of $U_{o\,nom}$.

$$R'_{ext} \approx 4\ k\Omega \cdot \frac{(U_o - 2.5\ V)}{2.5\ V \cdot (U_o/U_{o\,nom} - 1)}$$

For output voltages $U_o > U_{o\,nom}$, the minimum input voltage according to "Electrical Input Data" increases proportionally to $U_o/U_{o\,nom}$.

### Warning

The value of $R'_{ext}$ should never be less than 47 kΩ to avoid damage to the unit! R inputs may be parallel connected, but $1/R_{tot} = 1/R_1 + 1/R_2 + ....$ should be considered.

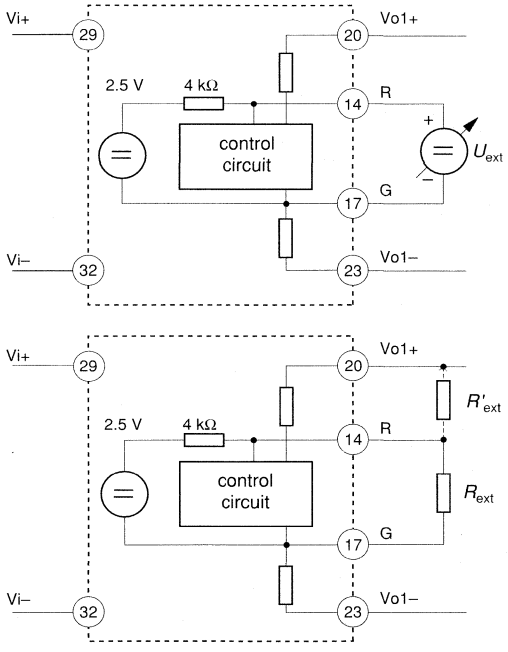



*Fig. 6*
*Output voltage control by means of the R input*


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*Table 7a: $R_{ext}$ for $U_o < U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | $U_{o\,nom}$ = 15 V | | $U_{o\,nom}$ = 24 V | | $U_{o\,nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] |
| 0.5 | 0.432 | 2.0 | 0.806 | 2.0 | 0.619 | 4.0 | 0.806 | 8.0 | 0.806 |
| 1.0 | 0.976 | 3.0 | 1.33 | 4.0 | 1.47 | 6.0 | 1.33 | 12.0 | 1.33 |
| 1.5 | 1.65 | 4.0 | 2.0 | 6.0 | 2.67 | 8.0 | 2.0 | 16.0 | 2.0 |
| 2.0 | 2.61 | 5.0 | 2.87 | 8.0 | 4.53 | 10.0 | 2.87 | 20.0 | 2.87 |
| 2.5 | 3.83 | 6.0 | 4.02 | 9.0 | 6.04 | 12.0 | 4.02 | 24.0 | 4.02 |
| 3.0 | 5.76 | 7.0 | 5.62 | 10.0 | 8.06 | 14.0 | 5.62 | 28.0 | 5.62 |
| 3.5 | 8.66 | 8.0 | 8.06 | 11.0 | 11.0 | 16.0 | 8.06 | 32.0 | 8.06 |
| 4.0 | 14.7 | 9.0 | 12.1 | 12.0 | 16.2 | 18.0 | 12.1 | 36.0 | 12.1 |
| 4.5 | 30.1 | 10.0 | 20.0 | 13.0 | 26.1 | 20.0 | 20.0 | 40.0 | 20.0 |
| 5.0 | 200.0 | 11.0 | 44.2 | 14.0 | 56.2 | 22.0 | 44.2 | 44.0 | 44.2 |

*Table 7b: $R'_{ext}$ for $U_o > U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | $U_{o\,nom}$ = 15 V | | $U_{o\,nom}$ = 24 V | | $U_{o\,nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] |
| 5.15 | 464 | 12.1 | 1780 | 15.2 | 1470 | 24.25 | 3160 | 48.5 | 6810 |
| 5.20 | 215 | 12.2 | 909 | 15.4 | 750 | 24.50 | 1620 | 49.0 | 3480 |
| 5.25 | 147 | 12.3 | 619 | 15.6 | 511 | 24.75 | 1100 | 49.5 | 2370 |
| 5.30 | 110 | 12.4 | 464 | 15.8 | 383 | 25.00 | 825 | 50.0 | 1780 |
| 5.35 | 90.9 | 12.5 | 383 | 16.0 | 332 | 25.25 | 715 | 50.5 | 1470 |
| 5.40 | 78.7 | 12.6 | 316 | 16.2 | 274 | 25.50 | 590 | 51.0 | 1270 |
| 5.45 | 68.1 | 12.7 | 274 | 16.4 | 237 | 25.75 | 511 | 51.5 | 1100 |
| 5.50 | 61.9 | 12.8 | 249 | 16.5 | 226 | 26.00 | 453 | 52.0 | 953 |
| | | 13.0 | 200 | | | 26.25 | 402 | 52.5 | 845 |
| | | 13.2 | 169 | | | 26.40 | 383 | 52.8 | 806 |

6.3

## EMC and Immunity to Input Transients

A suppressor diode or a metal oxide VDR together with an input filter form an effective protection against input transient voltages which typically occur in most installations, but especially in battery driven mobile applications. The H series has been successfully tested to the following specifications:

### Electromagnetic Immunity

*Table 8: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [3] | Value applied | Waveform | Source impedance | Test procedure | In operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Electrostatic discharge | IEC 801-2 (1991-04) | 2 | contact discharge to case, | 4000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative | yes | [2] |
| Electric field | IEC 801-3 (1984) | 2 | antenna in 1m distance | 3 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | [2] |
| Fast transient/ burst | IEC 801-4 (1988) | 1 | i/c, +i/–i | 500 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | [2] |
| Transient | IEC 801-5 (Draft 1993-01) | 1 | i/c | 500 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | [1] |
| | | | +i/–i | 500 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] i = input, o = output, c = case

### Electromagnetic Emissions

*Table 9: Emissions at $U_{i\,nom}$ and $I_{o\,nom}$*

| Standard | | | |
|---|---|---|---|
| EN 55011, 1991 [1] EN 55022, 1987 [2] | | FCC: 47 CFR 15.xx 15.107 | 15.103 |
| ≤30 MHz | ≥30 MHz | ≤30 MHz | ≥30 MHz |
| <A | <A | <A | <A |

[1] Identical with CISPR 11 (1990-09) and VDE 0875 part 11 (1992-07)
[2] Identical with CISPR 22 (1985) and VDE 0878 part 3 (1989-11)

## Supplementary Data

### Isolation

Input to output electric strength tests, in accordance with the safety standards IEC 950, EN 60950, VDE 0805 and EN 41003 are performed as factory tests and should not be repeated in the field.

### Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 1). Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests. Reference is also made to chapter: "Safety and Installation Instructions".

*Table 10: Electric strength test voltage, insulation resistance, clearance and creepage distances*

| Characteristic Values according to IEC 950 | | Input to output | Input to case | Output to case | Output to output | Unit |
|---|---|---|---|---|---|---|
| Electric strength | DC: 1 s | 4243 [1] | 2122 | 707 | 300 | V |
| test voltage | AC: 50 Hz, 1 min | 3000 [1] | 1500 | 500 | 200 | |
| Insulation resistance | at 500 V DC | ≥300 | ≥300 | ≥100 | – | MΩ |
| Clearance and creepage distances | | 4.0 | 2.0 | 1.0 | 0.9 | mm |

[1] Only subassemblies performance in accordance with IEC 950

### Display Status of LEDs

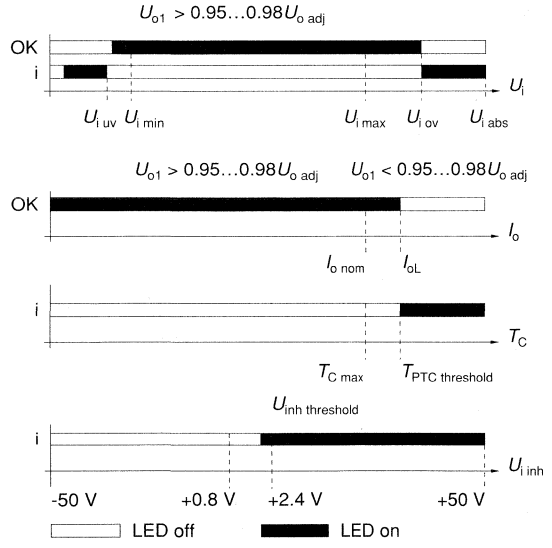



*Fig. 7*
*LEDs "OK" and "i" status versus input voltage*
*Conditions: $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*
*$U_{i\,uv}$ = undervoltage lock-out, $U_{i\,ov}$ = overvoltage lock-out*

*LED "OK" status versus output current*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*

*LED "i" versus case temperature*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $U_{inh} \le 0.8$ V*

*LED "i" versus $U_{inh}$*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$*

## Description of Options

*Table 11: Survey of options*

| Option | Function of Option | Characteristic |
|---|---|---|
| –2 | Standard operational ambient temperature range | $T_A$ = 0...50 °C |
| R | R input for external output voltage programming | Adjustment range 0...110% of $U_{o\,nom}$ (single output modules) |
| D [1] | Input and/or output undervoltage monitoring circuitry | Safe data signal output (D1...D8) |
| V [1 2] | Input and output undervoltage monitoring circuitry | ACFAIL signal according to VME specifications ( V2, V3) |

[1] Option D excludes option V and vice versa
[2] Only available with main output voltage $U_{o1}$ = 5.1 V

### Option D

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1– (pin 23). The D output recovers when the monitored voltage(s) exceed(s) $U_t+U_h$. The threshold level $U_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D1...D8 as shown in the following table.

*Table 12: Undervoltage monitor functions*

| Output type JFET | Output type NPN | Monitoring $U_i$ | Monitoring $U_{o1}$ | Minimum adjustment range of threshold level $U_{t\,i}$ | Minimum adjustment range of threshold level $U_{t\,o}$ | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] $U_{h\,i}$ | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] $U_{h\,o}$ |
|---|---|---|---|---|---|---|---|
| D1 | D5 | no | yes | – | 3.5 V...48 V [1] | – | 2.3...1 |
| D2 | D6 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | - | 3.0...0.5 | – |
| D3 | D7 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| D4 | D8 | no | yes | – | 0.95...0.98 $U_{o1}$ [2] | – | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications)
[2] Fixed value between 95% and 98% of $U_{o1}$ (tracking)

JFET output (D1...D4):

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $U_D \leq 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) < $U_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_D \leq 0.4$ V at $I_D$ = 2.5 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_D \leq 25$ µA at $U_D$ = 5.25 V |

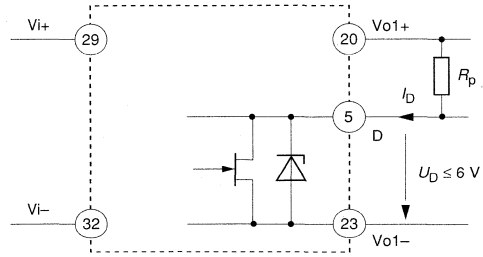



*Fig. 8*
*Options D1...D4, JFET output*

NPN output (D5...D8):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D < 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) > $U_t + U_h$. The current $I_D$ through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. $U_D$ should not exceed 40 V.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | high, H, $I_D \leq 25$ µA at $U_D$ = 40 V |
| $U_i$ and $U_{o1} > U_t + U_h$ | low, L, $U_D \leq 0.4$ V at $I_D$ = 20 mA |

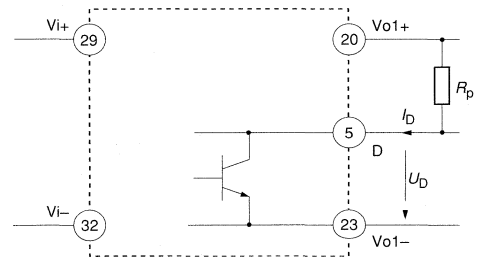



*Fig. 9*
*Options D5...D8, NPN output*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage after the input filter is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across the input filter. The value of $\Delta U_{t\,i}$ depends upon the input voltage range, threshold level $U_t$, temperature and input current. The input current is a function of the input voltage and the output power.

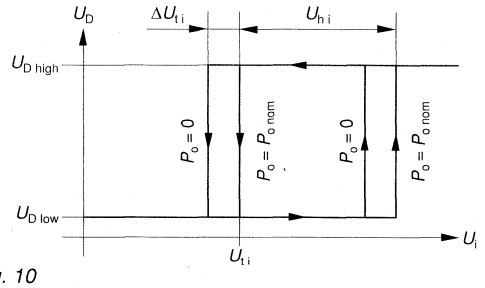
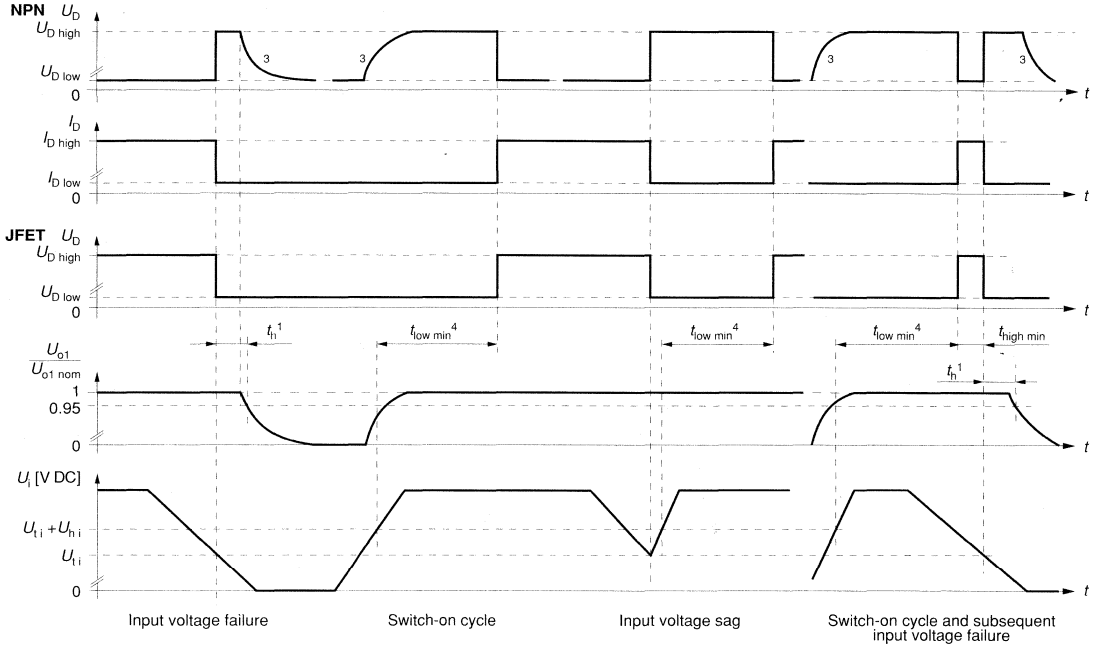
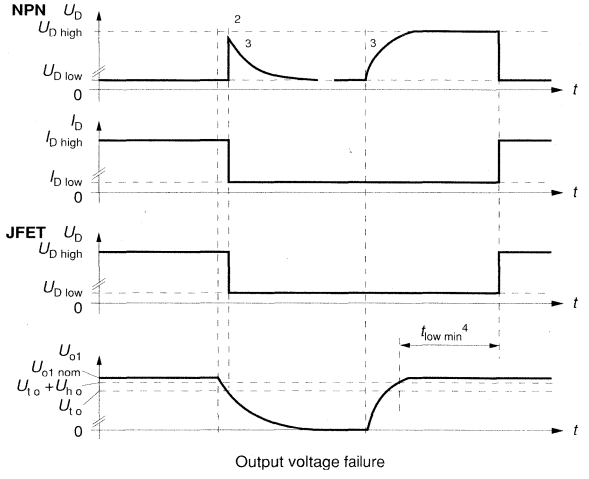



*Fig. 10*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$ (JFET output)*




[1] See fig. 9 for hold-up time.
[2] With output voltage monitoring the hold-up time $t_h = 0$
[3] The D signal remains high if the D output is connected to an external source.
[4] $t_{low\,min}$ = 40...200 ms, typically 80 ms

*Fig. 11*
*Relationship between $U_i$, $U_{o1}$, $U_D$, $I_D$ and $U_{o1}/U_{o\,nom}$ versus time.*

### Option V

This option defines an undervoltage monitoring circuit for the input and/or main output voltage ($U_{o1\ nom}$ = 5.1 V only) equivalent to option D and generates an ACFAIL signal (V signal) which conforms to the VME standard.

The low state level of the ACFAIL signal is specified at a sink current of $I_V$ = 48 mA to $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME motherboard.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V when the 5.1 V output is fully loaded. This hold-up time $t_h$ should be provided by an external input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\,min}$ of the converter so that enough energy is remaining in this capacitance.

*Table 13: Factory potentiometer setting of $U_{t\,i}$*

| Types | 12 H | 24 H | 48 H | Unit |
|---|---|---|---|---|
| $U_{t\,i}$ | 9.5 | 19.5 | 39 | V DC |

Formula for additional external input capacitor

$$C_{i\,ext} = \frac{2 \cdot P_o \cdot (t_h + 0.3\ ms) \cdot 100}{\eta \cdot (U_{t\,i}{}^2 - U_{i\,min}{}^2)}$$

where as:

$C_{i\,ext}$ = external input capacitance [mF]
$P_o$ = output power [W]
$\eta$ = efficiency [%]
$t_h$ = hold-up time [ms]
$U_{i\,min}$ = minimum input voltage [V] [1]
$U_{t\,i}$ = threshold level [V]

[1] Min. input voltage according to "Electrical Input Data". For output voltages $U_o > U_{o\,nom}$, the minimum input voltage increases proportionally to $U_o/U_{o\,nom}$.

Remarks:

The threshold level $U_{t\,i}$ of option V2 and V3 is adjusted during manufacture to a value according to table 13.

A decoupling diode should be connected in series with the input to avoid the input capacitance discharging through other loads connected to the same source voltage.

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1– (pin 23). The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is adjustable by potentiometer accessible through a hole in the front cover.

Versions V2 and V3 are available as shown below.

*Table 14: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level | | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] | |
|---|---|---|---|---|---|---|
| | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| V2 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | - | 3.0...0.5 | - |
| V3 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications)
[2] Fixed value between 95% and 98% of $U_{o1}$ (tracking), output undervoltage monitoring is not a requirement of VME standard

V output (V2, V3):

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) < $U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $U_V$ should not exceed 80 V.

| $U_i$, $U_{o1}$ status | V output, $U_V$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_V \leq 0.6$ V at $I_V$ = 50 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_V \leq 25$ µA at $U_V$ = 5.1 V |

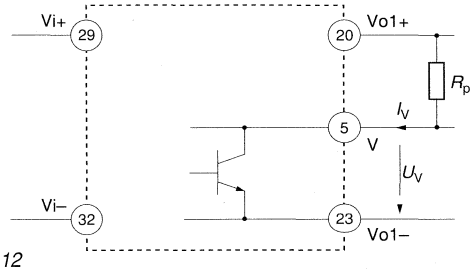



*Fig. 12*
*Output configuration of options V2 and V3*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, t he internal input voltage is measured after the input filter. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The value of $\Delta U_{t\,i}$ depends upon the input voltage range, threshold level $U_t$, temperature and input current. The input current is a function of input voltage and output power.

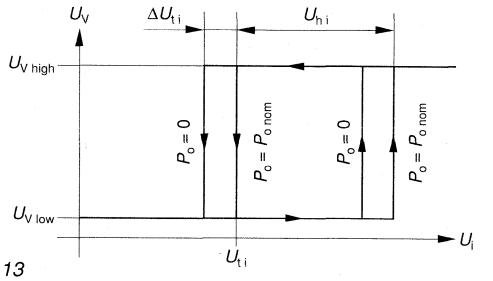
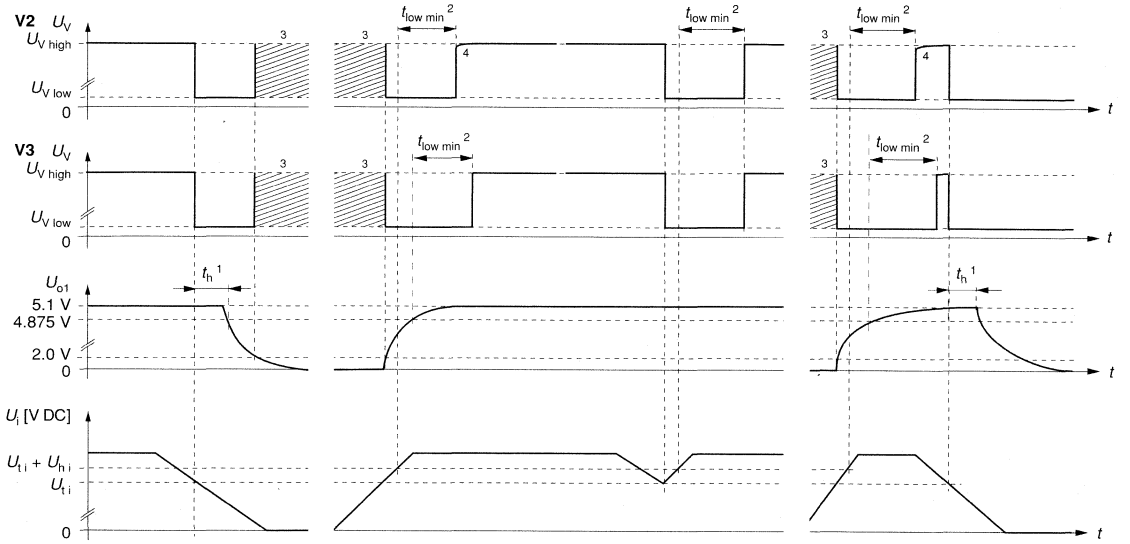
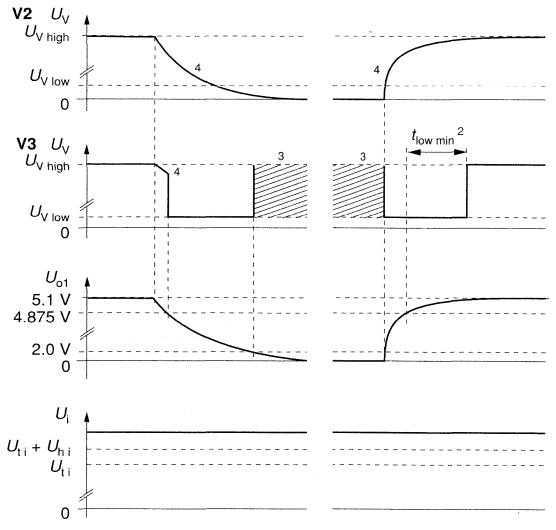



*Fig. 13*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$*




[1] VME request: minimum 4 ms
[2] $t_{low\,min}$ = 40...200 ms, typically 80 ms
[3] $U_V$ level not defined at $U_{o1}$ < 2.0 V
[4] The V signal drops simultaneously with the output voltage, if the pull-up resistor $R_P$ is connected to Vo1+. The V signal remains high if $R_P$ is connected to an external source.

*Fig. 14*
*Relationship between $U_i$, $U_{o1}$, $U_V$, $I_V$ and $U_{o1}/U_{o\,nom}$ versus time.*


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## Immunity to Environmental Conditions

*Table 15: Mechanical stress*

| Test Method | | Standard | Test Conditions | |
|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Duration: | $40^{\pm 2}$ °C<br>$93^{+2/-3}$ %<br>21 days<br>Unit not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL-STD-810D section 514.3 | Frequency (1 Oct/min):<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>2 $g_n$ = 20 m/s²<br>3.75 h (1.25 h each axis)<br>Unit operating |

### Thermal considerations

*Table 16: Temperature specifications, values given are for an air pressure of 800...1200 hPa (800...1200 mbar)*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Standard operational ambient temperature range -2 | 0 | 50 | °C |
| $T_C$ | Standard operational case temperature range -2, overtemp. lock-out (PTC) at $T_C$ > 95°C | 0 | 80 | |
| $T_S$ | Storage temperature range -2 | –25 | 100 | |

Basically the available output power is limited by thermal characteristics. Operation at higher temperatures with nominal output currents is also possible if forced cooling can be provided (heat sink, fan, etc.).

Example: Sufficient forced coolling allows $T_{A\,max}$ = 65°C. A simple check of the case temperature $T_C$ ($T_C \leq 80$°C) at full load ensures correct operation of the system (temperature measurement point on the case see fig. 16).

In general: For an ambient temperature of 65°C with only convection cooling, the maximum permissible current for each output is approx. 50% of it's nominal value.

*Table 17: MTBF*

| Values at specified Case Temperature | Module Types | Ground Benign 40°C | Unit |
|---|---|---|---|
| MTBF | H1000<br>H2000<br>H3000 | 384'000<br>306'000<br>270'000 | h |

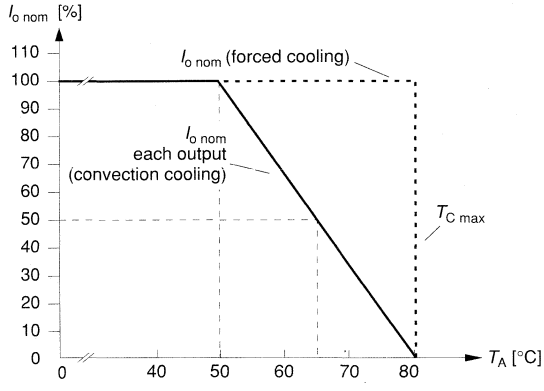
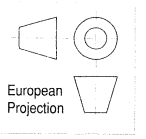



*Fig. 15*
*Output derating versus ambient temperature under convection and forced cooled conditions*

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



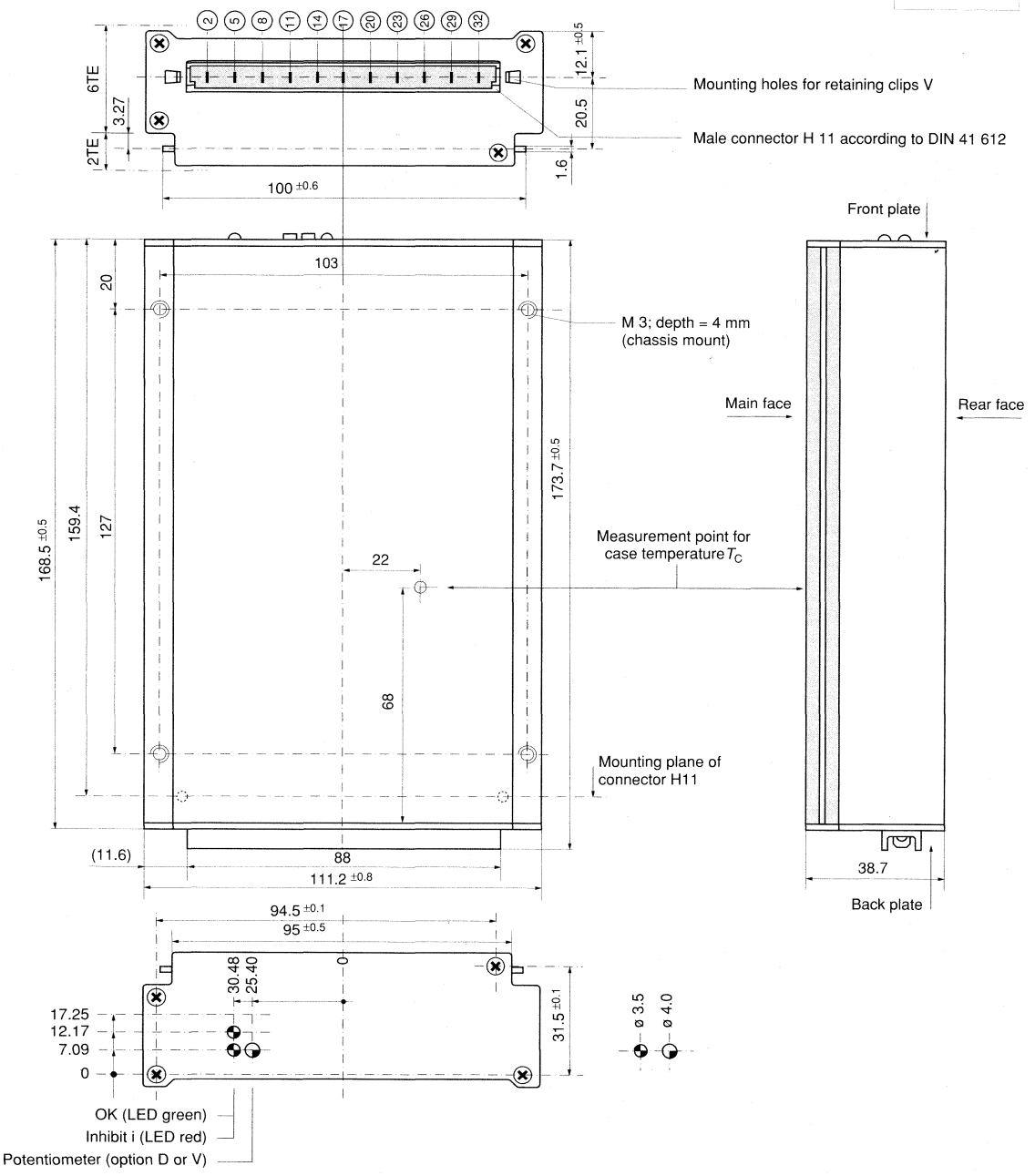
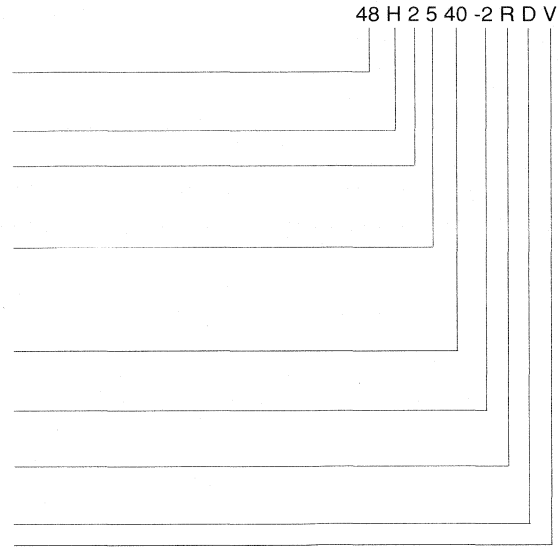




*Fig. 16*
*Case H02, weight 770 g (approx.)*


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## Type Key and Product Marking

### Type Key




Input voltage range $U_I$:
- 9...15 V DC ..... 12
- 18...30 V DC ..... 24
- 36...60 V DC ..... 48

Family ..... H

Number of outputs ..... 1...3

Output 1, $U_{o1\ nom}$:
- 5.1 V ..... 0
- 12 V ..... 3
- 15 V ..... 5
- 24 V ..... 6
- 48 V ..... 9

Single output modules ..... 01

Output 2 and 3, $U_{o2\ nom}$, $U_{o3\ nom}$:
- 12 V ..... 20
- 15 V ..... 40

Ambient temperature range $T_A$: (operational)
- 0...50 °C ..... -2

Output voltage control input (single output modules) ..... R

Options:
- Save data signal (D1...D8, to be specified) ..... D [1]
- ACFAIL signal (V2, V3, to be specified) ..... V [1]

[1] Option D excludes option V and vice versa

6.3

Example: 48H1501-2RD3: DC-DC converter, input voltage range 36...60 V, providing output with 15 V/3.4 A; equipped with an output voltage control input and undervoltage monitoring.

**Product Marking** (refer also to "Mechanical Data")

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LEDs and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage(s) and current(s), pin allocation of options and auxiliary functions, external fuse specification and degree of protection.

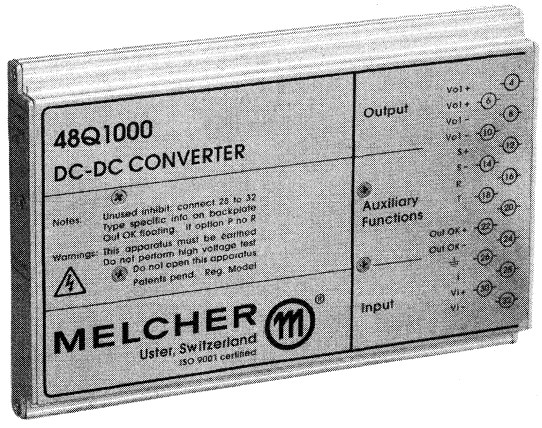
Rear face: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB, date of production. Confirmation of successfully passed final test.

# 100 W DC-DC Converters

# Q-Family

**Input to output isolation**
**Single output: Series 24Q...48Q1000**
**Double output: Series 24Q...48Q2000**

- Very high efficiency of up to 86%
- Excellent protection, 2 $kV_{rms}$ input to output
- Safety according to IEC 950 and EN 41003
- Redundant operation (n+1), auto current sharing
- Extremely low inrush current, hot plug-in
- Externally adjustable output voltage and inhibit
- Very compact and fully functional unit (20 mm wide)
- Telecoms compatible input voltage range of 48Q units according to prETS 300132-2 (38...75 V DC)




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## Description

These extremely compact DC-DC converters incorporate all necessary input and output filtering, signalling and protection features which are required in the majority of industrial applications. The converters provide important advantages such as very high efficiency, excellent reliability, very low ripple and RFI noise levels, full input to output isolation, negligible inrush current and input over-/undervoltage cut-out. The outputs are continuously open- and short-circuit proof.

As a stand-alone module or as part of a distributed power supply system, the low profile design significantly reduces the necessary power supply volume without sacrificing high reliability.

Full system flexibility and n+1 redundant operating mode are possible due to virtually unrestricted series or parallel connection capabilities of all outputs. In parallel connection of several units, automatic current sharing is provided by a single wire interconnection.

An isolated output power good signal and an output OK LED at the front panel indicate the status of the power supply modules.

The fully enclosed, blank aluminium case acts as heat sink and RFI shield. It is particularly suitable for 19" rack systems occupying 3 U/4 TE only, but can also be chassis-mount by means of four M 3 threads.

## Type Survey

**Survey of Option see "Description of Option"**

*Table 1a: Type survey*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | | | Options |
|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{i\,min}...U_{i\,max}$ **16...36 V DC** | $\eta$ % | $U_{i\,min}...U_{i\,max}$ **38...75 V DC** | $\eta$ % | |
| 5.1 | 16.0 | | | 24Q1001-7R | 82 | 48Q1001-7R | 82 | P |
| 12.0 [2] | 8.0 | | | 24Q2320-7R | 85 | 48Q2320-7R | 85 | |
| 15.0 [2] | 6.6 | | | 24Q2540-7R | 85 | 48Q2540-7R | 85 | |
| 24.0 [2] | 4.4 | | | 24Q2660-7R | 86 | 48Q2660-7R | 86 | |
| 24.0 [3] | 4.0 | | | 24Q2320-7R | 85 | 48Q2320-7R | 85 | |
| 30.0 [3] | 3.3 | | | 24Q2540-7R | 85 | 48Q2540-7R | 85 | |
| 48.0 [3] | 2.2 | | | 24Q2660-7R | 86 | 48Q2660-7R | 86 | |
| 12.0 | 4.0 | 12.0 [4] | 4.0 | 24Q2320-7R | 85 | 48Q2320-7R | 86 | |
| 15.0 | 3.3 | 15.0 [4] | 3.3 | 24Q2540-7R | 85 | 48Q2540-7R | 85 | |
| 24.0 | 2.2 | 24.0 [4] | 2.2 | 24Q2660-7R | 86 | 48Q2660-7R | 86 | |

[1] Typical efficiency at $U_{i\,nom}$, $I_{o\,nom}$ and $T_A$ = 25°C
[2] Parallel connection of output 1 and 2, see fig. 3
[3] Series connection of output 1 and 2, see fig. 4
[4] Symetrical configuration with second output semi-regulated, see fig. 5 and 6

## Safety and Installation Instructions

### Safety

The modules correspond to the equipment class I specification and are designed to meet EN 60950, IEC 950, VDE 0805 and EN 41003. For safety reasons the input circuit of the module must be electrically isolated from the mains. The earthing pin 26 is leading and should always be connected. Output voltages are below SELV (Safety Extra Low Voltage).

### Installation

The installation must follow the relevant safety specifications as well as the local regulations. Connection to the system shall be made via the matching female connector type DIN H 15. It is of major importance to wire the modules via this connector only in order to fulfill the safety requirements according to IEC 950, EN 60950, VDE 0805 and EN 41003.

Due to the high output current value, the 24Q...48Q1000 units provides for each the positive and the negative output path two internally parallel connected contacts (pins 4/6 and pins 8/10 respectively). It is recommended to connect the load to both female connector pins of each path in order to keep the voltage drop across the connector pins to an absolute minimum. See fig. 2.

Protection degree is defined by IP 30, but if equipped with option P, this reduces to IP 20. Protection degree applies only if the module is plugged-in, i.e. the female connector is properly attached to the module.

### Isolation Tests

All isolation voltage tests according to IEC 950, EN 60950, VDE 0805 and EN 41003 respectively are performed as factory tests and must not be repeated in field use. Improper test methods cause severe internal damage. In the production process all internal transformers as well as every final assembled module are fully isolation voltage tested. Details are given in section "Supplementary Data".

*Table 2: Pin allocation of the H 15 connector*

| Pin No. | Electrical determination | Q 1000 | Q 2000 |
|---|---|---|---|
| 4 | Output voltage (positive) | Vo1+ | Vo1+ |
| 6 | Output voltage (positive) | Vo1+ | Vo2+ |
| 8 | Output voltage (negative) | Vo1– | Vo1– |
| 10 | Output voltage (negative) | Vo1– | Vo2– |
| 12 | Sense line (positive) | S+ | S+ |
| 14 | Sense line (negative) | S– | S– |
| 16 | Output voltage control input [1] | R | R |
| 18 | Current sharing control input | T | T |
| 20 | Do not connect | - | - |
| 22 | Output good signal (positive) | Out OK+ | Out OK+ |
| 24 | Output good signal (negative) | Out OK– | Out OK– |
| 26 | Protective ground (protruding) | ⏚ | ⏚ |
| 28 | Inhibit control input [2] | i | i |
| 30 | Input voltage (positive) | Vi+ | Vi+ |
| 32 | Input voltage (negative) | Vi– | Vi– |

**Degree of Protection**

Condition: Female connector fitted to the unit

IP 30: All units except those with option P (potentiometer adjustment)

IP 20: All units fitted with option P (includes potentiometer)

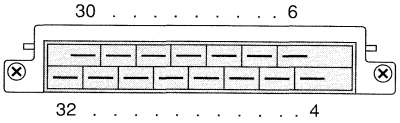



*Fig. 1*
*View of male H15 connector*

[1] With option P, R-input must remain unconnected
[2] If the inhibit function is not actively used, interconnect pins 28 and 32 in order to enable output

6.3

**Output Configuration**

The Q unit design allows high flexibility in output configuration to cover almost every individual requirement, by simply wiring the outputs in parallel, series or for symmetrical applications as per following figures. For further information and for parallel and series operation of several modules refer to "Electrical Output Data".

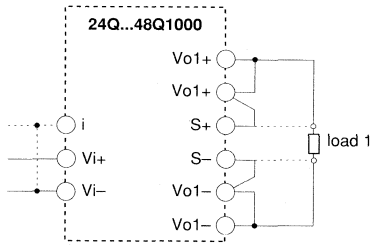



*Fig. 2*
*Single output configuration*

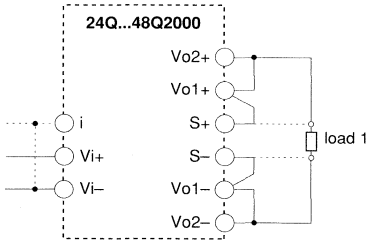



*Fig. 3*
*Parallel configuration of double output unit*

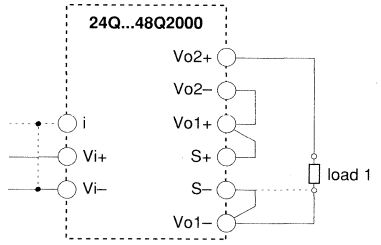



*Fig. 4*
*Series configuration of double output unit (neg. sense at load only)*

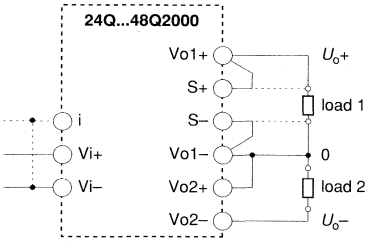



*Fig. 5*
*Symmetrical common ground configuration of double output unit*

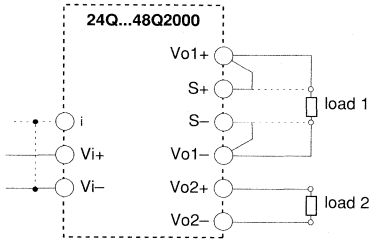



*Fig. 6*
*Independent symmetrical output configuration*


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## Functional Description

The units are designed as forward converters using primary and secondary control circuits. The switching frequency is approximately 200 kHz under nominal operating conditions. The built-in input filter together with a minimum input capacitance generate very low inrush currents with short duration. After transformer isolation and rectification, the output filter reduces the ripple to a minimum without compromise to the dynamic ability. The output voltage is fed back to the secondary control circuit via the sense lines. The resultant error signal is sent to the primary control circuit via a signal transformer.

Double output modules have their voltage regulation of output 2 relying on the close magnetic coupling of the transformer and the output inductor together with the circuits symmetry. The current limitation is located at the primary side, thus limiting the total output current in overload conditions. In applications with large dynamic load changes it is recommended to connect such load to output 1 only. Output 1 and output 2 can either be series- or parallel-connected (see "Electrical Output Data").

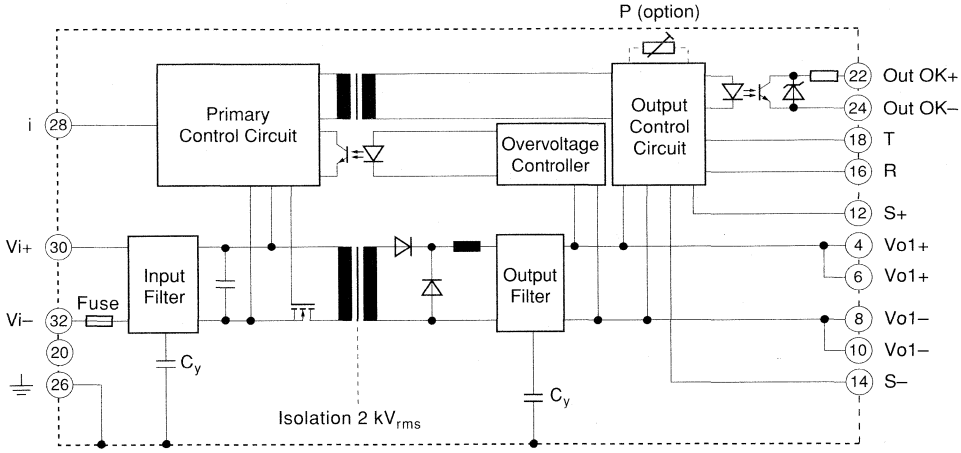



*Fig. 7*
*Block diagram of a single output converter*

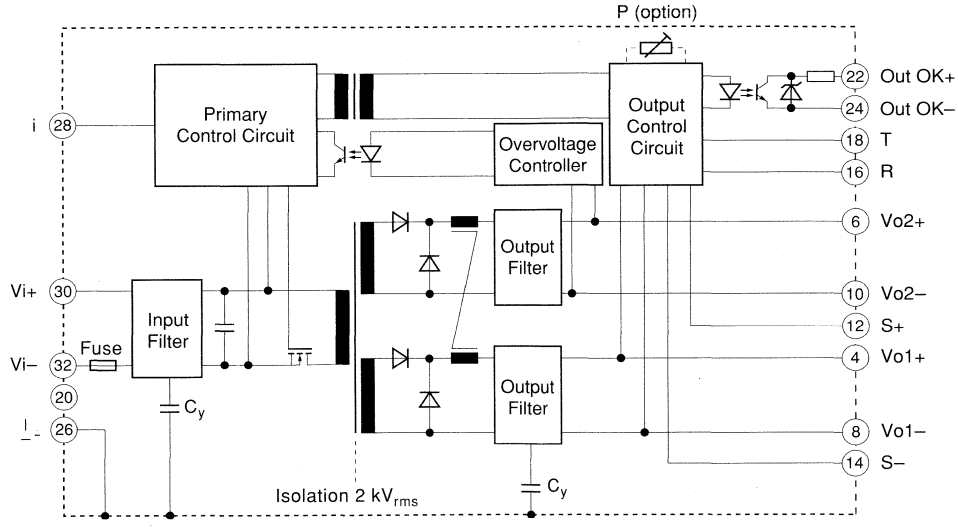



*Fig. 8*
*Block diagram of a double output converter*

## Electrical Input Data

General Conditions
– $T_A$ = 25°C, unless $T_C$ is specified
– Pin 28 connected to pin 32, pin 12 to pin 4 and pin 14 to pin 8
– R input not connected; with option P, $U_o$ set to $U_{o\,nom}$

*Table 3: Input data*

| Input | | | 24Q | | | 48Q | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0…$I_{o\,nom}$ | 16 | | 36 | 38 | | 75 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | $T_{C\,min}$…$T_{C\,max}$ | | 24 | | | 48 | | |
| $I_i$ | Typical input current [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 3.9 | | 5.0 | 2.0 | | 2.4 | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$…$U_{i\,max}$ $I_o$ = 0 | | | 2.5 | | | 2.5 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | 1.0 | | | 1.5 | |
| $I_{inr\,p}$ | Peak inrush current [2] | $U_{i\,nom}$, $I_{o\,nom}$ | | 35 | | | 35 | | A |
| $t_{inr\,r}$ | Rise time | | | 50 | | | 40 | | µs |
| $t_{inr\,h}$ | Trailing edge half-life | | | 170 | | | 100 | | |
| $u_{i\,RFI}$ | Input RFI level | EN 55011/22 EN 55014 | | | B limit | | | B limit | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | 0 | | 50 | 0 | | 100 | V DC |
| F | Fuse rating | nominal | | 14 | | | 7 | | A |

[1] Typical input current depends on individual module
[2] According to prETS 300132-2 (Ver. 3.1)

6.3

### Inhibit (i Input)

**Note:** If this function is not actively used, the inhibit pin 28 must be interconnected with the negative input pin 32 to enable the output(s). A non-connected pin 28 will be interpreted by the internal logic as an active inhibit signal and therefore output(s) will remain disabled: Fail safe function.

An inhibit input enables (logic low, pull down) or disables (logic high, pull up) the output if a logic signal e.g. TTL, CMOS is applied. In systems consisting of several units, this feature may be used, for example, to control the activity sequence of the converters by means of logic signals, or to allow the unit's source for a proper start up before full load is applied.

*Table 4: Inhibit characteristics*

| Characteristics | | | Conditions | min typ max | Unit |
|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$…$U_{i\,max}$ | –100 0.8 | V DC |
| | | $U_o$ = off | $T_{C\,min}$…$T_{C\,max}$ | 2.4 100 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = –50 V<br>$U_{inh}$ = 0 V<br>$U_{inh}$ = 50 V<br>$U_{inh}$ = 100 V | –500<br>–40<br>+500<br>+1000 | µA |
| $t_r$ | Rise time | | $U_{o\,nom}$, $I_{o\,nom}$ | 3 | ms |
| $t_f$ | Fall time | | | 0.3 | |

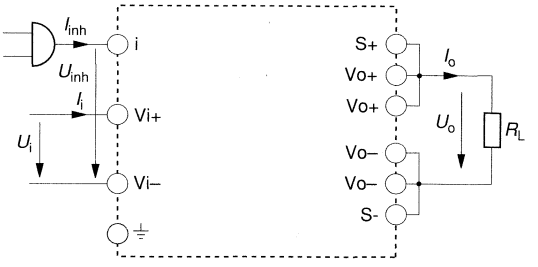



*Fig. 9*
*Definition of input and output parameters*

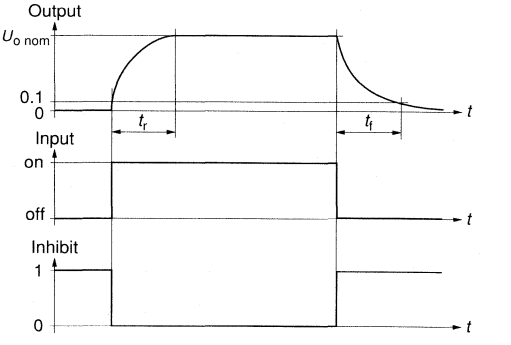



*Fig. 10*
*Inhibit Characteristic*

### Fuse

The fuse (normally fast blow type) is internally wired in the negative input path to protect the unit against severe defect. It cannot be made externally accessible because of the limited space at the back panel.

### Input Under-/Overvoltage Cut-Out

With input voltage below $U_{i\,min}$ or a above $U_{i\,max}$ an internally generated inhibit signal disables the output voltage. The maximum input voltage rating is to be considered (see also "Electrical Input Data": $U_{i\,abs}$).

### Input Filter

Input filtering keeps the conducted noise of the units within the frequency range of 10 kHz to 30 MHz below level B according to EN 55011 and EN 55022 standards (CISPR 11/22 respectively).

The input radiated noise >30 MHz is within the limits of EN 55011/22 and EN 55014 (12.88), measured by means of a MDS clamping device.

### Inrush Current Limitation

The inherent inrush current value is lower than specified in the prETS 300132-2 (ver. 3.1) standard. The units operate with relatively small input capacitance resulting in low inrush current of short duration. As a direct consequence in a power-bus system the units can be hot plugged-in or disconnected causing negligible disturbance at the input side.

### EMC and Immunity to Input Transients

A suppressor diode and/or a metal oxide VDR (depending upon the type) together with an input fuse and a symmetrical input filter form an effective protection against input transient voltages which typically occur in most installations in special applications surges according to IEC 801 are specified. The power supply must not switch off during these surges and since their energy can not practically be absorbed an adequate input range is required. The Q series has been successfully tested to the following specifications:

*Table 5: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [1] | Value applied | Waveform | Source impedance | Test procedure | In operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Electrostatic discharge | IEC 801-2 (1991-04) | 2 | contact discharge to case | 4000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative | yes | [2] |
| Electric field | IEC 801-3 (1984) | 2 | antenna in 1m distance | 3 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | [3] |
| Fast transient/ burst | IEC 801-4 (1988) | 1 | i/c, +i/–i | 500 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | [4] |
| Transient | IEC 801-5 (Draft 1993-01) | 1 | i/c | 500 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | [4] |
| | | | +i/–i | 500 $V_p$ | | 2 Ω | | | |

[1] i = input, o = output, c = case
[2] Normal operation, temporary deviation from specs possible
[3] Not tested yet
[4] Normal operation, no deviation from specifications

## Electrical Output Data

General Conditions:
- $T_A$ = 25°C, unless $T_C$ is specified.
- $U_o$ adjusted to $U_{o\,nom}$ at $I_{o\,nom}$
- $U_i$ = $U_{i\,nom}$ sense line pins S+ and S– connected to Vo1+ and Vo1– respectively.

*Table 6a: Output data for single output modules and modules in parallel configuration (see fig. 2 and 3)*

| Output | | | 24Q...48Q1001 5.1 V | | | 24Q...48Q2320 12.0 V | | | 24Q...48Q2540 15.0 V | | | 24Q...48Q2660 24.0 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.94 | | 12.06 | 14.93 | | 15.08 | 23.88 | | 24.12 | V |
| $U_{ow}$ | Worstcase output voltage | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_{o\,min}$...$I_{o\,max}$ | 5.02 | | 5.18 | 11.82 | | 12.18 | 14.78 | | 15.23 | 23.64 | | 24.36 | |
| $U_{oL}$ | Overvoltage limitation of second control loop | Incorrect con. sense lines | 5.9 | | 6.4 | 13.5 | | 15.0 | 17.0 | | 19.0 | 27.5 | | 30.0 | |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 16.0 | | | 8.0 | | | 6.6 | | | 4.4 | | A |
| $I_{oL}$ | Output current limit [2] | $T_{C\,min}$...$T_{C\,max}$ | 16.8 | | 20.0 | 8.4 | | 10.0 | 6.9 | | 8.3 | 4.6 | | 5.5 | |
| $u_{or}$ | Output ripple voltage (acc. to IEC 1204) | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 20 | | | 15 | | | 20 | | | 30 | | $mV_{pp}$ |
| $P_{o\,max}$ | Max. output power | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 90 | | | 100 | | | 100 | | | 105 | | W |
| $u_{o\,d}$ [3] | Dynamic load regulation | $U_{i\,nom}$, $I_o$ = | | ±500 | | | ±500 | | | ±500 | | | ±700 | | mV |
| $t_d$ [3] | Time constant of dynamic load regulation | (1...1/4...1) $I_{o\,nom}$ | | 0.15 | | | 0.30 | | | 0.30 | | | 0.35 | | ms |
| $U_{o\,tr}$ | Output voltage trimming range [4] | $U_{i\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 4.0<br>4.6 | | 5.6<br>5.6 | 5.5<br>10.8 | | 13.2<br>13.2 | 8.0<br>13.5 | | 16.5<br>16.5 | 14.0<br>21.6 | | 26.4<br>26.4 | V |

*Table 6b: Output data for double output modules in series configuration (see fig. 4)*

| Output | | | 24Q...48Q2320 24 V (2 × 12 V) | | | 24Q...48Q2540 30 V (2 × 15 V) | | | 24Q...48Q2660 48 V (2 × 24 V) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 23.76 | | 24.24 | 29.70 | | 30.30 | 47.52 | | 48.48 | V |
| $U_{ow}$ | Worstcase output voltage | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_{o\,min}$...$I_{o\,max}$ [5] | 23.52 | | 24.48 | 29.40 | | 30.60 | 47.04 | | 48.96 | |
| $U_{oL}$ | Overvoltage limitation of second control loop | Incorrect conn. sense lines | 27 | | 30 | 34 | | 38 | 55 | | 60 | |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 4.0 | | | 3.3 | | | 2.2 | | A |
| $I_{oL}$ | Output current limit [2] | $T_{C\,min}$...$T_{C\,max}$ | 4.2 | | 5.0 | 3.45 | | 4.2 | 2.3 | | 2.75 | |
| $u_{or}$ | Output ripple voltage (acc. to IEC 1204) | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 30 | | | 40 | | | 60 | | $mV_{pp}$ |
| $P_{o\,max}$ | Max. output power | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 100 | | | 100 | | | 105 | | W |
| $u_{o\,d}$ [3] | Dynamic load regulation | $U_{i\,nom}$, $I_o$ = | | | | | | | | | | mV |
| $t_d$ [3] | Time constant; dynamic load regulation | (1...1/4...1) $I_{o\,nom}$ | | | | | | | | | | ms |
| $U_{o\,tr}$ | Output voltage trimming range [4] | $U_{i\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 11.0<br>21.6 | | 26.4<br>26.4 | 16.0<br>27.0 | | 33.0<br>33.0 | 28.0<br>43.0 | | 52.8<br>52.8 | V |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting or remote sensing, the output power should be reduced accordingly so that $P_{o\,max}$ and $T_{C\,max}$ are not exceeded (see fig. 23)
[2] See "Output Current Limitation", fig. 13 and 14
[3] Time constant until $U_o$ remains within 1% of $U_{o\,nom}$, see fig. 19
[4] Upper row represents setting via R-input, lower row option P range
[5] $I_{o\,min}$ = 10% of $I_{o\,nom}$ for each output necessary (see also "Output Regulation")

*Table 6c: Output data for double output modules in symmetrical configuration (see fig. 5 and 6)*

| Output | | | 24Q...48Q2320 12 V/12 V | | | | | | 24Q...48Q2540 15 V/15 V | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage [2] | $U_{i\,nom}$, $I_{o\,nom}$ | 11.94 | | 12.06 | 11.82 | | 12.18 | 14.93 | | 15.08 | 14.78 | | 15.23 | V |
| $U_{ow}$ | Worstcase output | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_{o\,min}$...$I_{o\,max}$ [5] | 11.82 | | 12.18 | Fig. 18 | | | 14.78 | | 15.23 | Fig. 19 | | | |
| $U_{oL}$ | Overvoltage limitation of second control loop | Incorrect conn. sense lines | | | | 13.5 | | 15.0 | | | | 17.0 | | 19.0 | |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 4.0 | | | 4.0 | | | 3.3 | | | 3.3 | | A |
| $I_{oL}$ | Output current limit [2] | $T_{C\,min}$...$T_{C\,max}$ | 8.0 | | 10.0 | 8.0 | | 20.0 | 6.6 | | 8.3 | 6.6 | | 8.3 | |
| $u_{or}$ | Output ripple voltage (acc. to IEC 1204) | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 15 | | | 15 | | | 20 | | | 20 | | $mV_{pp}$ |
| $P_{o\,max}$ | Max. output power | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | 100 | | | 100 | | | 100 | | | 100 | W |
| $u_{o\,d}$ [3] | Dynamic load regulation | $U_{i\,nom}$, $I_o$ = | | | | | | | | | | | | | mV |
| $t_d$ [3] | Time constant of dynamic load regulation | (1...1/4...1) $I_{o\,nom}$ | | | | | | | | | | | | | ms |
| $U_{o\,tr}$ | Output voltage trimming range [4] | $U_{i\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 5.5<br>10.8 | | 13.2<br>13.2 | 5.5<br>10.8 | | 13.2<br>13.2 | 8.0<br>13.5 | | 16.5<br>16.5 | 8.0<br>13.5 | | 16.5<br>16.5 | V |

*Table 6d: Output data for double output modules in symmetrical configuration (see fig. 5 and 6)*

| Output | | | 24Q...48Q2660 24 V/24 V | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage [1] | $U_{i\,nom}$, $I_{o\,nom}$ | 23.85 | | 24.14 | 23.64 | | 24.36 | V |
| $U_{ow}$ | Worstcase output voltage | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ $I_{o\,min}$...$I_{o\,max}$ [5] | 23.64 | | 24.36 | Fig. 20 | | | |
| $U_{oL}$ | Overvoltage limitation of second control loop | Incorrect conn. sense lines | | | | 27.5 | | 30.0 | |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 2.2 | | | 2.2 | | A |
| $I_{oL}$ | Output current limit [2] | $T_{C\,min}$...$T_{C\,max}$ | 4.4 | | 5.5 | 4.4 | | 5.5 | |
| $u_{or}$ | Output ripple voltage (acc. to IEC 1204) | $U_{i\,nom}$, $I_{o\,nom}$ BW = 20 MHz | | 30 | | | 30 | | $mV_{pp}$ |
| $P_{o\,max}$ | Max. output power | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | | 105 | | | 105 | W |
| $u_{o\,d}$ [3] | Dynamic load regulation | $U_{i\,nom}$, $I_o$ = | | | | | | | mV |
| $t_d$ [3] | Time constant of dynamic load regulation | (1...1/4...1) $I_{o\,nom}$ | | | | | | | ms |
| $U_{o\,tr}$ | Output voltage trimming range [4] | $U_{i\,nom}$ $T_{C\,min}$...$T_{C\,max}$ | 14.0<br>21.6 | | 26.4<br>26.4 | 14.0<br>21.6 | | 26.4<br>26.4 | V |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting or remote sensing, the output power should be reduced accordingly so that $P_{o\,max}$ and $T_{C\,max}$ are not exceeded (see fig. 23). Same conditions for both outputs.
[2] Value of total current, $I_{o1}$ + $I_{o2}$. See "Output Current Limitation", fig. 13 and 14.
[3] Time constant until $U_o$ remains within 1% of $U_{o\,nom}$, see fig. 19
[4] Upper row represents setting via R-input, lower row option P range
[5] $I_{o\,min}$ = 10% of $I_{o\,nom}$ for each output necessary (see also "Output Regulation")

### Parallel or Series Connection of Outputs and/or Units

Single or double output units with equal nominal output voltage can be connected in parallel without any precaution by interconnecting the T-pins for approximate equal current sharing.

Any double output unit with its outputs in parallel behaves like a single output unit, i.e. is fully regulated. There is no inconvenience or restriction using the R-input and the sense lines .

Single output units and/or main and second outputs of double output units can be connected in series with any other (similar) output. For double output modules consider, that the effect via sense lines, R-input or option P is doubled.

**Note:**

- Parallel connection of several double output units should always include both, main and second output to maintain good regulation of all outputs.
- Series connection of second outputs without involving their main outputs should be avoided as regulation may be poor.
- The maximum output current is limited by the output with the lowest current limitation if several outputs are connected in series.
- Output voltages above 60 V (SELV = Safety Extra Low Voltage) need additional measures in order to comply with international safety requirements.

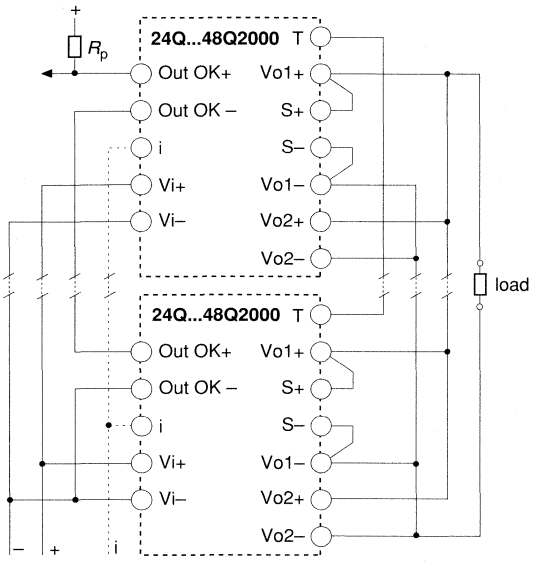



*Fig. 11*
*Parallel connection of several modules, sense lines connected at connector side*

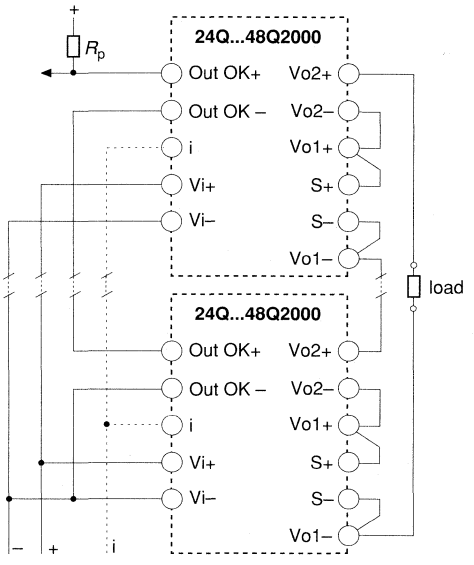



*Fig. 12*
*Series connection of several modules, sense lines connected at connector side only*

### Current Sharing (T-Function)

For higher power and n+1 high reliability systems, a current sharing facility allows several units to operate in parallel-connection with the assurance that a single fault will not lead to a system failure. Interconnection of the current sharing terminals T causes the units to share the load current, resulting in lower stress and further improved reliability. Parallel-connected modules with interconnected T pins share their output currents within a tolerance of approx. ±20% of $I_{o\,nom}$. 24Q...48Q2000 with outputs in series-connection can be paralleled with current sharing, if output 1 and 2 are connected in the same order. If the output voltages are programmed ($U_o$ is different from $U_{o\,nom}$), by means of the R-pin or option P, the outputs should be adjusted individually within a tolerance of ±1%. When operating with dynamic loads, the current sharing will be less accurate.

### Continuous Open-Circuit and Short-Circuit Proof

All outputs are fully protected against continuous open circuit, e.g. against no load condition (for the 24Q...48Q2000 characteristics refer to "Output Voltage Regulation of Double Output Modules").

All outputs of the units are fully protected against continuous short circuit condition by means of the electronic current limitation on the primary side (see "Output Current Limitation").


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### Output current limitation

Single output units and series- or parallel-connected double output units have a quasi rectangular constant current limitation characteristic.

In double output units, the total current is limited, allowing free choice of load distribution between the two outputs, up to a total $I_{o1} + I_{o2} \leq I_{o\,max}$ (see "Output Voltage Regulation of Double Output"). In overload ($I_{o1} + I_{o2} > I_{o\,max}$) both output voltages are simultaneously reduced.

Independent outputs with symmetrical current loads both have a rectangular current limitation characteristic.

Current distribution in overload is dependent upon the type of overload. A short-circuit in one output will cause the full current flow into that output whereas a resistive overload results in more even distribution and in a reduced output voltage.

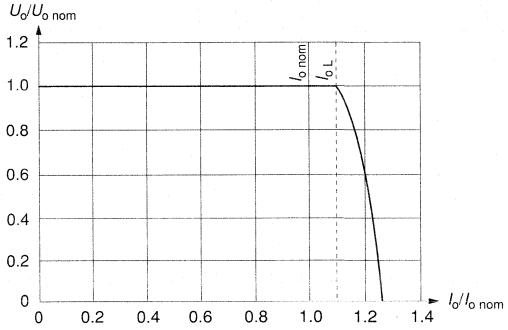



*Fig. 13*
*Current limitation behaviour of a single or a double output unit with series- or parallel-connected outputs*

### Sense Lines

**Note:** Sense lines must always be connected!

This feature enables compensation of voltage drop across the connector contacts and the load lines including the diode in true redundant wired-OR system configurations. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that Uo max (between Vo1+ and Vo1–) is not exceeded. (See fig. 2 to 6)

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines parallel or twisted. For unsymmetrical loads it is recommended to connect the sense lines directly at the female connector.

To ensure correct operation, both sense lines must be connected to their respective power output potential. With double output units the sense lines must be connected to output 1 only. Caution should be exercised when outputs are series-connected as the compensated voltage is effectively doubled (refer to fig. 4). The voltage difference between any sense line and its respective power output pin (as measured on the connector) should not exceed the following values at nominal output voltage.

*Table 7: Voltage compensation allowed using sense lines*

| Output voltage | Total voltage difference between sense lines and their respective outputs |
|---|---|
| 5.1 V | <0.5 V |
| 12, 15, 24 V | <1.0 V |

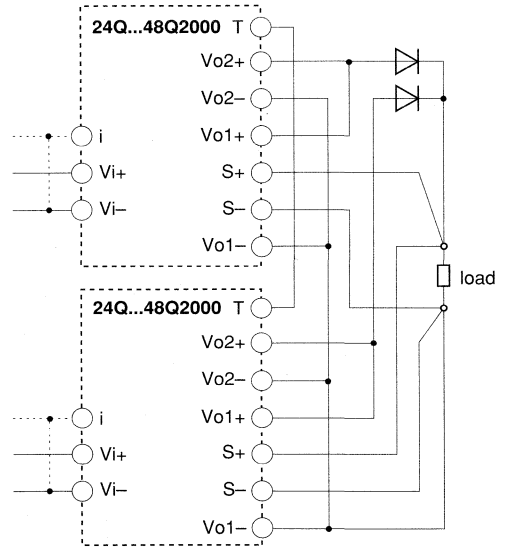



*Fig. 14*
*Sense lines connection for redundant (n+1) or parallel operation using wired-OR diodes*

### Output Voltage Regulation of Double Output Modules

In symmetrical configuration the main output 1 is under normal conditions regulated to $U_{o\,nom}$, independent of the output currents. Note that if the load on output 2 is too small (<0.1 • $I_{o\,nom}$), its voltage will rise, possibly activating the overvoltage protection, which will then reduce the voltage on both outputs.

$U_{o2}$ is dependent upon the load distribution: When each output is loaded with at least 10% of $I_{o\,nom}$, the deviation of $U_{o2}$ remains within ±5% of the value of $U_{o\,nom}$. Figures 15 to 17 explain the regulation with varying load distributions up to the current limit. If $I_{o1} = I_{o2}$ or the two outputs are in series-connection, the deviation of $U_{o2}$ remains within ±1% of the value of $U_{o\,nom}$ provided that the load is more than 10% of $I_{o\,nom}$.

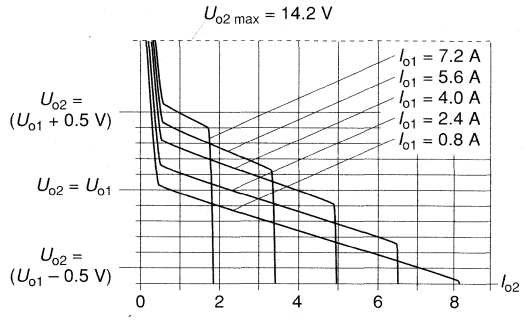



*Fig. 15*
*24Q...48Q2320 output 2 voltage deviation vs. output 2 current with different currents on output 1*

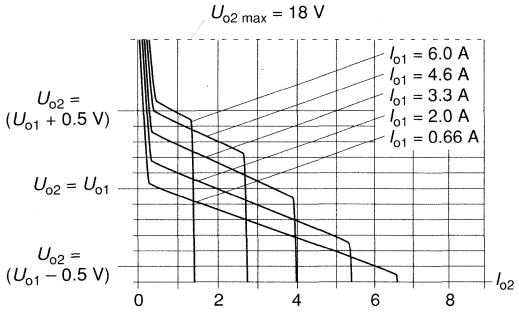



*Fig. 16*
*24Q...48Q2540 output 2 voltage deviation vs. output 2 current with different currents on output 1*

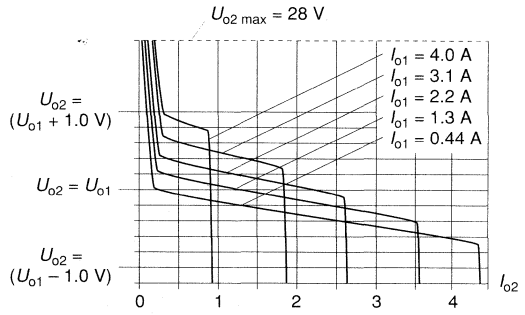



*Fig. 17*
*24Q...48Q2660 output 2 voltage deviation vs. output 2 current with different currents on output 1*

### Output Voltage Overshoot Protection

Negligible output voltage overshoot may occur if the module is either hot plugged-in or disconnected, the input voltage is switched on or off, the module is switched with an inhibit signal, or after a reset of a short circuit and power failure.

### Second Control Loop

A fully independent second control loop limits the output voltage to approximately 1.25 • $U_{o\,nom}$ (see table 6, e.g. sense lines wired incorrectly). It further protects the load in the unlikely event of a malfunction of the main control circuit.

In double output modules output 1 is fully regulated with overvoltage protection on output 2, through this second control loop.

There is no specific built-in protection against externally applied overvoltages.

### Hold up Time

The modules provide virtually no hold up time. If hold up time is required, use external output capacitors or diodes and input capacitors of adequate size.

### Dynamic load regulation

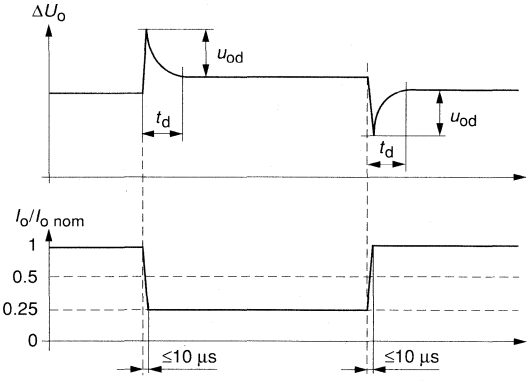



*Fig. 18*
*Control deviation of $U_o$ versus dynamic load change*

**Programmable Output** (R-Function)

All modules offer a programmable output voltage feature. The programming is performed either by an external control voltage $U_{ext}$ or an external resistor $R_{ext}/R'_{ext}$, connected to the R-input. Trimming is limited to the values given in the table below. With a disconnected R-input, the output voltage is set to $U_{o\,nom}$.

Simultaneous use of the R-input function and option P is not possible. If option P is built-in, the R-input will remain active but its function must not be used; do not connect pin R at all!

With double output modules, both outputs are affected by the R-input settings.

If output voltages are set higher than $U_{o\,nom}$, the output currents should be reduced accordingly, so that the maximum specified output power is not exceeded.

**Caution:** The voltage at the R-input may not exceed 28 V DC under all circumstances in order to avoid damage.

a) Adjustment by means of an external control voltage $U_{ext}$ between R and S– ($U_o$ is dependent upon $U_{ext}$):

$U_o = U_{ext} \cdot U_{o\,nom} / 2.5$ V (approximative formula)

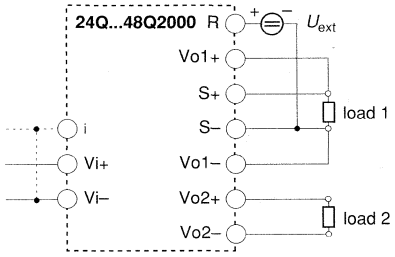



*Fig. 19*
*Output voltage programming using a control voltage $U_{ext}$*

b) Adjustment by means of an external resistor:

The resistor can either be connected between the pins R and S– to set $U_o < U_{o\,nom}$, or between the pins R and S+ to set $U_o > U_{o\,nom}$.

R-inputs of several parallel operating modules can be parallel-connected, providing individual adjustment to $U_o \pm 1\%$. For common adjustment the resulting resistor value is being calculated:

$1/R_{tot} = 1/R_1 + 1/R_2 + ... + 1/R_n$

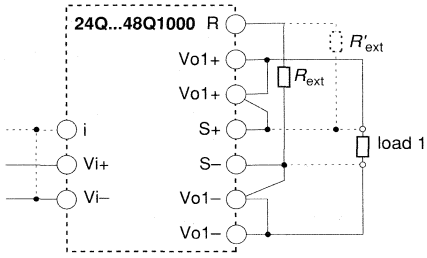



*Fig. 20*
*Output voltage programming using $R_{ext}$ or $R'_{ext}$*

*Table 8a: $R_{ext}$ for $U_o < U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ (V) | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] |
| 4.0 | 14.7 | 5.5 | 11.0 | 3.40 | 8.0 | 16.0 | 4.53 | 14.0 | 28.0 | 5.62 |
| 4.1 | 16.5 | 6.0 | 12.0 | 4.02 | 8.5 | 17.0 | 5.23 | 15.0 | 30.0 | 6.65 |
| 4.2 | 18.2 | 6.5 | 13.0 | 4.75 | 9.0 | 18.0 | 6.04 | 16.0 | 32.0 | 8.06 |
| 4.3 | 21.5 | 7.0 | 14.0 | 5.76 | 9.5 | 19.0 | 6.98 | 17.0 | 34.0 | 9.76 |
| 4.4 | 25.5 | 7.5 | 15.0 | 6.65 | 10.0 | 20.0 | 8.06 | 18.0 | 36.0 | 12.1 |
| 4.5 | 30.1 | 8.0 | 16.0 | 8.06 | 10.5 | 11.0 | 9.31 | 19.0 | 38.0 | 15.4 |
| 4.6 | 37.4 | 8.5 | 17.0 | 9.76 | 11.0 | 22.0 | 11.0 | 20.0 | 40.0 | 20.0 |
| 4.7 | 47.5 | 9.0 | 18.0 | 12.1 | 11.5 | 23.0 | 13.3 | 20.5 | 41.0 | 23.7 |
| 4.8 | 64.9 | 9.5 | 19.0 | 15.4 | 12.0 | 24.0 | 16.2 | 21.0 | 42.0 | 28.0 |
| 4.9 | 97.6 | 10.0 | 20.0 | 20.0 | 12.5 | 25.0 | 20.0 | 21.5 | 43.0 | 34.8 |
| 5.0 | 200.0 | 10.5 | 11.0 | 28.0 | 13.0 | 26.0 | 26.1 | 22.0 | 44.0 | 44.2 |
| | | 11.0 | 22.0 | 44.2 | 13.5 | 27.0 | 36.5 | 22.5 | 45.0 | 60.4 |
| | | 11.5 | 23.0 | 93.1 | 14.0 | 28.0 | 56.2 | 23.0 | 46.0 | 90.9 |
| | | | | | 14.5 | 29.0 | 115.0 | 23.5 | 47.0 | 190.0 |

*Table 8b: $R'_{ext}$ for $U_o > U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] |
| 5.2 | 215.0 | 12.2 | 24.4 | 931 | 15.3 | 30.6 | 1020 | 24.5 | 49.0 | 1690 |
| 5.3 | 110.0 | 12.4 | 24.8 | 475 | 15.5 | 31.0 | 619 | 25.0 | 50.0 | 866 |
| 5.4 | 75.0 | 12.6 | 25.2 | 316 | 15.7 | 31.4 | 453 | 25.5 | 51.0 | 590 |
| 5.5 | 57.6 | 12.8 | 25.6 | 243 | 16.0 | 32.0 | 324 | 26.0 | 52.0 | 453 |
| 5.6 | 46.4 | 13.0 | 26.0 | 196 | 16.2 | 32.4 | 274 | 26.4 | 52.8 | 383 |
| | | 13.2 | 26.4 | 169 | 16.5 | 33.0 | 221 | | | |

[1] First column: single output units or double output units with separated outputs, second column: outputs in series connection

## Supplementary Data

### Isolation

Input to output, input to case and output to case isolation voltage tests and clearance and creepage distances are in accordance with IEC 950, EN 60950, VDE 0805 and EN 41003 respectively. These test are performed as factory tests and should not be repeated in the field.

Attention:
Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 7 and 8). Melcher will not honour any guarantee claims resulting from high voltage field test damages.

*Table 9: Isolation test voltages, clearance and creepage distances*

| Characteristic | Input to Output | Input to Case | Output to Case | Output to Output [1] | Unit |
|---|---|---|---|---|---|
| Isolation test voltage | 2.0 | 1.0 | 1.0 | 0.2 | $kV_{rms}$ |
| | 2.8 | 1.4 | 1.4 | 0.3 | kV DC |
| Clearance and creepage distance on the print lay-out | 2.0 | 1.0 | 1.0 | appr. 0.2 | mm |

[1] 24Q...48Q2000

### Output good signal

The galvanically isolated Out OK output gives a status indication of the module and the output voltage. It can be used for control functions such as data protection, central system monitoring or as a part of a self-testing system. It can be connected to get a centralized fault detection or may be used for other system specific applications at the primary or the secondary side of the converter.
In case of an error condition, the Out OK output shows a high impedance. During a system error or in an overload condition, the output good signal will disappear if the output voltage deviates approx. ±3% of $U_{o\,nom}$. Using the R-input or the option P, the supervision level is tracking the programmed output voltage.
The output is formed by a NPN transistor. The emitter (Out OK–) can be connected to primary Vi– or secondary Vo1– to get an open collector output. With several independent units the Out OK pins can be series-connected in order to get a system level signal. If one of the units fails the series-connected outputs rise to a high impedance. This series-connection can be completed by other transistors providing extended user specific error information.

Dimensioning of resistor value $R_p$ should be in accordance to the values given in table 10.

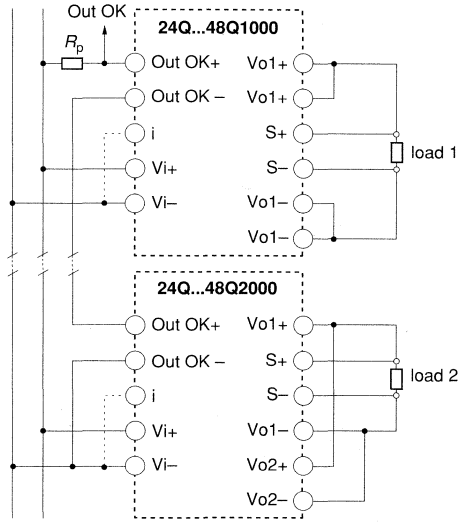



*Fig. 21*
*Series connection of the output good signal at the primary side of the converters for system supervision*

*Table 10: Output OK data*

| Characteristics | | Conditions | Output | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{OK\,low}$ | Voltage - Terminal OK at low impedance | $I_{OK} \leq 1.0$ mA | good | | 1.0 | | V |
| $U_{OK\,high}$ | Voltage - Terminal OK at high impedance | $I_{OK} > 25$ µA | failure | | 20.0 | | |

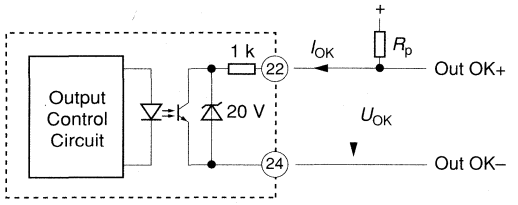



*Fig. 22*
*Output OK function*

**Caution:** The Out OK+ is protected by an internal series resistor and a Zener diode. To prevent damage the externally applied voltage should be limited to <25 V or the current to <20 mA respectively.


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### Self Cooling Case

If a converter is located upright in free-flowing, quasi-stationary air at a temperature $T_A = 50°C$ and is operated at its nominal output power, the case temperature $T_C$ remains ≤85°C, measured at the case temperature measuring point.

### Additional Cooling

Cooling by a heat sink or a fan allows the operation at full output power and improves the reliability. The ambient temperature $T_A$ may exceed its max. value when additional measures are taken to ensure that the case temperature $T_C$ does not exceed 85°C. In rack systems without proper thermal management, the modules must not be packed too densely! In such cases the use of the 5 or 6 TE front panel is recommended.

Operation at ambient temperatures of 50...65°C with convection cooling will limit the maximum output power to 40% (approx.) of the nominal value. Forced cooling (additional heat sink, fan, etc.) allows operation of the power supply at nominal output power up to an ambient temperature of 65°C, as long as the maximum case temperature $T_{C\,max}$ is not exceeded.

**Note:** $T_{C\,max}$ should not be exceeded in order to prevent damage. The unit does not provide for overtemperature protection.

### Display status of LED's

*Table 11: Display status of LED's*

| LED Out OK | Operating condition |
|---|---|
| on | normal operation |
| x | incorrect sense line connection |
| off | overtemperature<br>overload<br>output overvoltage<br>output undervoltage<br>no input voltage<br>input voltage too low<br>inhibit open / high<br>input voltage too high |

x = dependent on actual operating condition

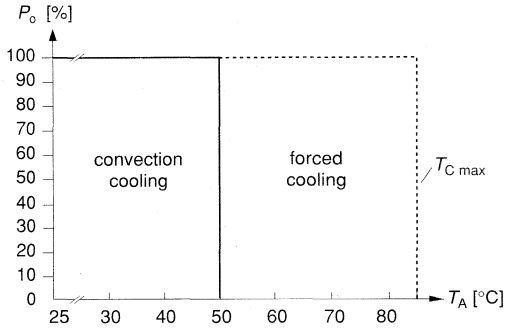



*Fig. 23*
*Output power uprating/derating versus $T_A$*

## Description of Option

**Option P** Output Voltage Adjustment

Option P is a built-in multi-turn potentiometer which provides an output voltage adjustment of ±10% of $U_{o\,nom}$. The potentiometer is accessible through a hole in the front cover. Static voltage drops across connectors and wires can easily be compensated.

With double output modules, both outputs are affected by the potentiometer settings. If different units are parallel-connected, their individual output voltages should be set within a tolerance of ±1%. If output voltages $U_o$ are set higher than $U_{o\,nom}$, the output currents should be reduced accordingly, so that the maximum specified output power is not exceeded.

## Immunity to Environmental Conditions

*Table 12: Mechanical stress*

| Test | | Standard | Test Parameters | |
|---|---|---|---|---|
| Ea | Shock<br>(half-sinusoidal) | DIN 40046, part 7<br>IEC 68-2-27<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock<br>(half-sinusoidal) | DIN 40046, part 26<br>IEC 68-2-29<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration<br>(sinusoidal) | DIN 40046, part 8<br>IEC 68-2-6<br>MIL-STD 810D section 514.3 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>0.15 mm (10...60 Hz)<br>2 $g_n$ = 20 m/s²<br>7.5 h (2.5 h each axis)<br>Unit operating |

*Table 13: Temperature specifications*

| Characteristics | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Ambient temperature range (start-up and operational) | 0 | 50 | °C |
| $T_C$ | Case temperature range (operational) | 0 | 85 | |
| $T_S$ | Storage temperature range (not operational) | –25 | 100 | |
| $R_{th\,C}$ | Temperature coefficient of case in still air | | 2 | K/W |

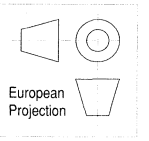
*Table 14: MTBF and device hours*

| Ratings at specified Case Temperature | Modules | Ground Benign 40 °C | Ground Fixed 40 °C | Device Hours [1] | Unit |
|---|---|---|---|---|---|
| MTBF acc. to MIL-HDBK-217F | 24Q1000 | 594'000 | 194'000 | Not yet available | h |
| | 48Q1000 | 594'000 | 194'000 | | |

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



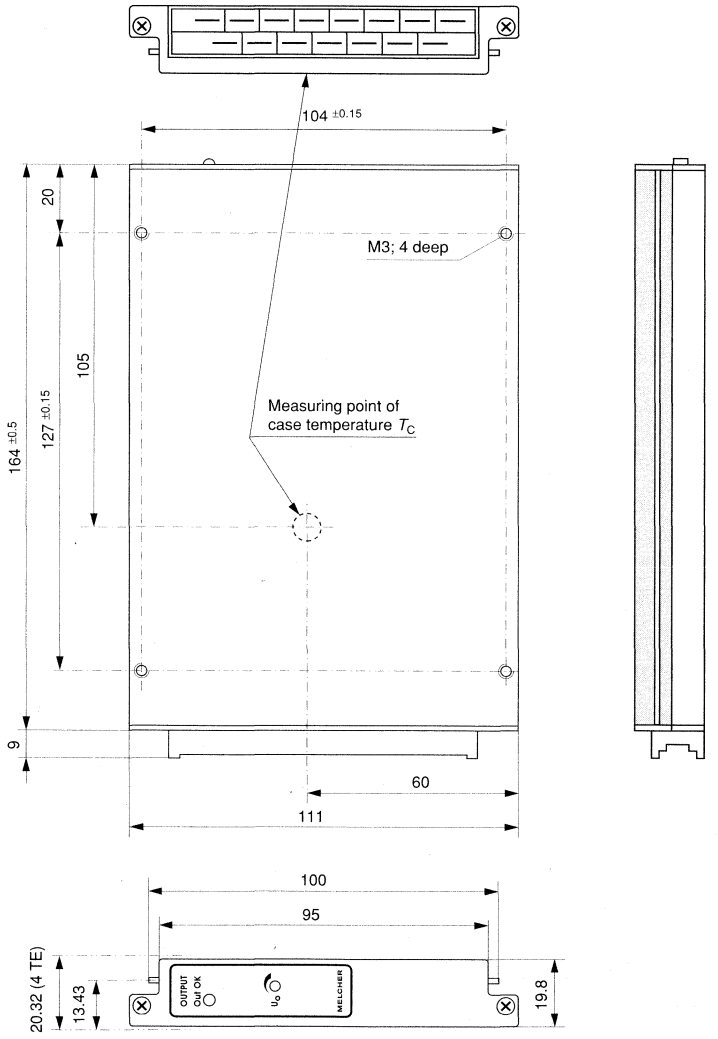
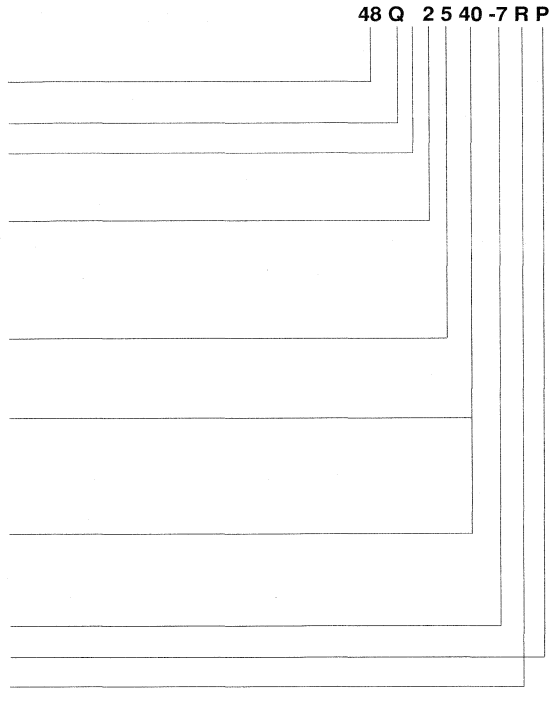




*Fig. 24*
*Case Q01, weight 480 g*


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## Type Key and Product Marking

### Type Key




Input voltage range $U_i$:
- 16...36 V DC ..... 24
- 38...75 V DC ..... 48

Family ..... Q

Blank .....

Number of outputs:
- Single output ..... 1
- Double output ..... 2

Nominal voltage output 1 (main output), $U_{o1\ nom}$
- 5.1 V ..... 0, 1, 2
- 12 V ..... 3
- 15 V ..... 4, 5
- 24 V ..... 6
- other voltages ..... 7, 8

Other specifications for main output ..... 01...99

Symmetrical double output units:
- Nominal voltage output 1/output 2, $U_{o1/2\ nom}$
- 12 V/12 V (24 V series conn. [1]) ..... 20
- 15 V/15 V (30 V series conn. [1]) ..... 40
- 24 V/24 V (48 V series conn. [1]) ..... 60
- other symmetrical voltages ..... 70...99

Operational ambient temperature range $T_A$:
- 0...50 °C ..... -2

Feature: Output voltage control input [1] ..... R

Option: Potentiometer (output voltage adjustment) [1] ... P

[1] Feature R excludes option P and vice versa

Example: 48Q2540-7P: DC-DC converter, input voltage range 38...75 V, double output, each providing 15 V/4 A, equipped with potentiometer and operating ambient temperature of 0...50 °C.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation of input, output and auxiliary functions, Melcher patents and company logo.

Front plate: Identification of LED and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, fuse specification and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main PCB and date of production.

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# 7 DC-DC Converters >100 W

## 7.1 Rugged Environment

[redacted]

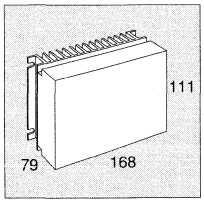
## 7.2 Industrial Environment

| Output [W] 20 40 60 100 120 150 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] 10 30 70 140 220 380 | Product Family | Case | Page |
|---|---|---|---|---|---|
| [redacted] | [redacted] | [redacted] | K | K02 | 7 - 3 |

## 7.3 Benign Environment

| Output [W] 20 40 60 100 120 150 | Output [V DC] 3 5 12 15 24 36 48 | Input [V DC] 10 30 70 140 220 380 | Product Family | Case | Page |
|---|---|---|---|---|---|
| to be launched soon – contact sales office | | | | | |

Case K01

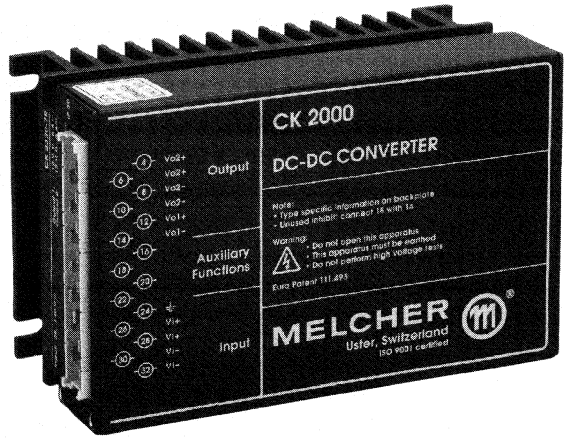


# 150 W DC-DC (AC-DC) Converters

# K-Family

**Input to output isolation**
**Single output: AK...LK 1000**
**Double output: AK...LK 2000**

- Extremely wide input voltage range
- Input over- and undervoltage lock-out
- Efficient input filter and built-in surge and transient suppression circuitry
- 4 $kV_{rms}$ input to output isolation test voltage
- Fully isolated outputs
- Outputs open- and short-circuit proof
- No derating over entire operating temperature range
- CSA approval and UL recognition in progress
- Safety according to IEC 950




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## Description

The K-family of DC-DC (AC-DC) converters represents a broad and flexible range of power supplies for use in advanced electronic systems. Features include high efficiency, high reliability, low output voltage noise and excellent dynamic response to load/line changes.

The converter inputs are protected against surges and transients occuring on the source lines. Input over- and undervoltage lock-out circuitry disables the outputs if the input voltage is outside the specified ranges. Certain types include an inrush current limitation preventing circuit breakers and fuses from being damaged at switch-on.

All outputs are open- and short-circuit proof and are protected against overvoltages by means of a built-in suppressor diode. The outputs can be inhibited by a logic signal applied to the connector pin i. If the inhibit function is not used pin 18 must be connected with pin 14 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case and output to output isolation is provided. The modules are designed and built according to international safety standards (IEC 950, EN 60950 and VDE 0805).

The case design allows operation at nominal load up to 71 °C in a free air ambient temperature. If forced cooling is provided, the ambient temperature may exceed 71 °C but the case temperature must remain below 95 °C under all conditions.

A temperature sensor generates an inhibit signal which disables the outputs if the case temperature $T_C$ exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Case: Aluminium, black finish, self cooling.

## Type Survey

**Survey of Options see "Description of Options"**

Different output voltages and currents may be set in accordance with customer specifications.

*Table 1a: Type survey AK*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | Options |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{i\,min}...U_{i\,max}$ **8...35 V DC** | $\eta_{min}$ % | |
| 5.1 | 20.0 | | | AK 1001-7R | 79 | -9 |
| 12.0 | 10.0 | | | AK 1301-7R | 80 | D |
| 15.0 | 8.0 | | | AK 1501-7R | 80 | V |
| 24.0 | 5.0 | | | AK 1601-7R | 81 | P |
| 24.0 [4] | 5.0 | | | AK 2320-7R | 78 | T |
| 30.0 [4] | 4.0 | | | AK 2540-7R | 79 | B1 |
| 48.0 [4] | 2.5 | | | AK 2660-7R | 79 | |
| 12.0 | 5.0 | 12.0 [5] | 5.0 | AK 2320-7R | 78 | |
| 15.0 | 4.0 | 15.0 [5] | 4.0 | AK 2540-7R | 79 | |
| 24.0 | 2.5 | 24.0 [5] | 2.5 | AK 2660-7R | 79 | |

*Table 1b: Type survey BK, CK*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | | | Options |
|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{i\,min}...U_{i\,max}$ **14...70 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **128...140 V DC** | $\eta_{min}$ % | |
| 5.1 | 25.0 | | | BK 1001-7R | 79 | CK 1001-7R | 79 | -9 |
| 12.0 | 12.0 | | | BK 1301-7R | 81 | CK 1301-7R | 82 | E [3] |
| 15.0 | 10.0 | | | BK 1501-7R | 82 | CK 1501-7R | 82 | D |
| 24.0 | 6.0 | | | BK 1601-7R | 82 | CK 1601-7R | 84 | V [6] |
| 24.0 [4] | 6.0 | | | BK 2320-7R | 80 | CK 2320-7R | 80 | P |
| 30.0 [4] | 5.0 | | | BK 2540-7R | 81 | CK 2540-7R | 82 | T |
| 48.0 [4] | 3.0 | | | BK 2660-7R | 82 | CK 2660-7R | 84 | B1 |
| 12.0 | 6.0 | 12.0 [5] | 6.0 | BK 2320-7R | 80 | CK 2320-7R | 80 | |
| 15.0 | 5.0 | 15.0 [5] | 5.0 | BK 2540-7R | 81 | CK 2540-7R | 82 | |
| 24.0 | 3.0 | 24.0 [5] | 3.0 | BK 2660-7R | 82 | CK 2660-7R | 84 | |

*Table 1c: Type survey DK, FK, LK*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | | | | | Options |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{i\,min}...U_{i\,max}$ **44...220 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **20...100 V DC** | $\eta_{min}$ % | $U_{i\,min}...U_{i\,max}$ **88...372 V DC** (85...264 V AC) | $\eta_{min}$ % | |
| 5.1 | 25.0 | | | DK 1001-7R | 79 | FK 1001-7R | 80 | LK 1001-7R | 80 | -9 |
| 12.0 | 12.0 | | | DK 1301-7R | 83 | FK 1301-7R | 82 | LK 1301-7R | 84 | E [3] |
| 15.0 | 10.0 | | | DK 1501-7R | 84 | FK 1501-7R | 83 | LK 1501-7R | 84 | D |
| 24.0 | 6.0 | | | DK 1601-7R | 85 | FK 1601-7R | 84 | LK 1601-7R | 85 | V [6] |
| 24.0 [4] | 6.0 | | | DK 2320-7R | 81 | FK 2320-7R | 81 | LK 2320-7R | 81 | P |
| 30.0 [4] | 5.0 | | | DK 2540-7R | 82 | FK 2540-7R | 82 | LK 2540-7R | 83 | T |
| 48.0 [4] | 3.0 | | | DK 2660-7R | 85 | FK 2660-7R | 84 | LK 2660-7R | 84 | B1 |
| 12.0 | 6.0 | 12.0 [5] | 6.0 | DK 2320-7R | 81 | FK 2320-7R | 81 | LK 2320-7R | 81 | |
| 15.0 | 5.0 | 15.0 [5] | 5.0 | DK 2540-7R | 82 | FK 2540-7R | 82 | LK 2540-7R | 83 | |
| 24.0 | 3.0 | 24.0 [5] | 3.0 | DK 2660-7R | 85 | FK 2660-7R | 84 | LK 2660-7R | 84 | |

[1] Efficiency at $U_{i\,nom}$ and $I_{o\,nom}$.
[2] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents must be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[3] Option E for C/D/E/LK types.
[4] Series connection of output 1 and 2 see fig. 16a.
[5] Second output semi-regulated.
[6] Option V for A...LK 1001 types only

**Note:** EK types with an input voltage range of 67...385 V DC are available upon request.


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## Safety and Installation Instructions

**Safety:**

For safety reasons, the power supplies should be wired via the female connector H15 or H15 S4 (according to DIN 41612, see "Accessories") in order to meet national and international safety requirements

The converters correspond to safety class I equipment and comply with IEC 950, EN 60950, VDE 0805 Part 100 (including manufacturing surveillance), UL 1950, CSA/C22.2 No. 950-M89 and are VDE approved.

The connector has a leading earth connection pin which ensures earth connection prior to any other.

The UL 1950 recognition limits the ambient operational temperature range of the standard modules (-7) to –25...60 °C. In applications where the full operational temperature range of –25...71 °C under UL condition is required, forced cooling should be provided.

**Installation**

Installation must strictly follow the national safety regulations. Pin 24 has to be connected to earth. A second fuse should be installed in the wiring to pins 26/28 if:

- Local requirements demand an individual fuse in each source line
- Ui+ to earth impedance is high or undefined
- Phase and neutral of the mains are not defined (AC-DC converters).

In applications where the inhibit function is not used, the inhibit pin should be connected to the S– pin (K 1000) or the Vo1– pin (K 2000) to enable the outputs.

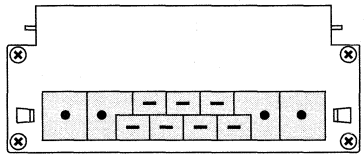
**Important Advice**

Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/µs, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher AG will not honour any guarantee/warranty claims resulting from high voltage field tests.

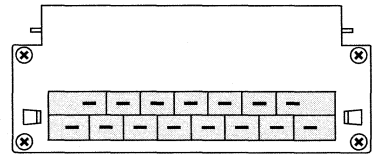
*Table 2: H15 and H15 S4 Connector pin allocation*

| Pin | Connector type H15 S4 | | | | Connector type H 15 | | | |
|---|---|---|---|---|---|---|---|---|
| No. | AK 1000 (all), BK...LK 1001 | | AK 2000 | | BK...LK 1301/1501/1601 | | BK...LK 2000 | |
| 4 | Vo1+ | Output 1 | Vo2+ | Output 2 | Vo1+ | Output 1 | Vo2+ | Output 2 |
| 6 | | | | | Vo1+ | | Vo2+ | |
| 8 | Vo1– | Output 1 | Vo2– | Output 2 | Vo1– | Output 1 | Vo2– | Output 2 |
| 10 | | | | | Vo1– | | Vo2– | |
| 12 | S+ | Sense | Vo1+ | Output 1 | S+ | Sense | Vo1+ | Output 1 |
| 14 | S– | Sense | Vo1– | Output 1 | S– | Sense | Vo1– | Output 1 |
| 16 | R [1] | Control of $U_{o1}$ | R [1] | Control of $U_{o1}$ | R [1] | Control of $U_{o1}$ | R [1] | Control of $U_{o1}$ |
| 18 | i | Inhibit | i | Inhibit | i | Inhibit | i | Inhibit |
| 20 | D [3] | Save data | D [3] | Safe data | D [3] | Save data | D [3] | Save data |
| | V [3] | ACFAIL | V [3] | ACFAIL | V [3] | ACFAIL | V [3] | ACFAIL |
| 22 | T | Current sharing | T | Current sharing | T | Current sharing | T | Current sharing |
| 24 [2] | ⏚ | Protective earth | ⏚ | Protective earth | ⏚ | Protective earth | ⏚ | Protective earth |
| 26 | Vi+ or N ≂ | Input or Neutral | Vi+ | Input or Neutral | Vi+ or N ≂ | Input or Neutral | Vi+ or N ≂ | Input or Neutral |
| 28 | | | | | Vi+ or N ≂ | | Vi+ or N ≂ | |
| 30 | Vi– or P ≂ | Input or Phase | Vi– | Input or Phase | Vi– or P ≂ | Input or Phase | Vi– or P ≂ | Input or Phase |
| 32 | | | | | Vi– or P ≂ | | Vi– or P ≂ | |

[1] Function R is not simultaneously available with option P; [2] Leading pin (pregrounding); [3] Option D is not simultaneously available with option V and vice versa.




Type H15 S4




Type H15

*Fig. 1*
*View of module's male connectors*

**Degree of Protection**

Condition: Female connector fitted to the unit.

IP 30: All units except those with options P, D or V with potentiometer adjustment.

IP 20: All units fitted with options which include potentiometer setting.

## Functional Description

The input voltage is fed via an input fuse, an input filter, a rectifier (LK types) and an inrush current limiter to the input capacitor. This capacitor sources a single transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke and output filter. The control logic senses the main output voltage $U_{01}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor.

The second output of double output units is controlled by the main output but has independent current limiting. If the main output is taken into current limitation, the second output voltage will fall as well and vice versa.

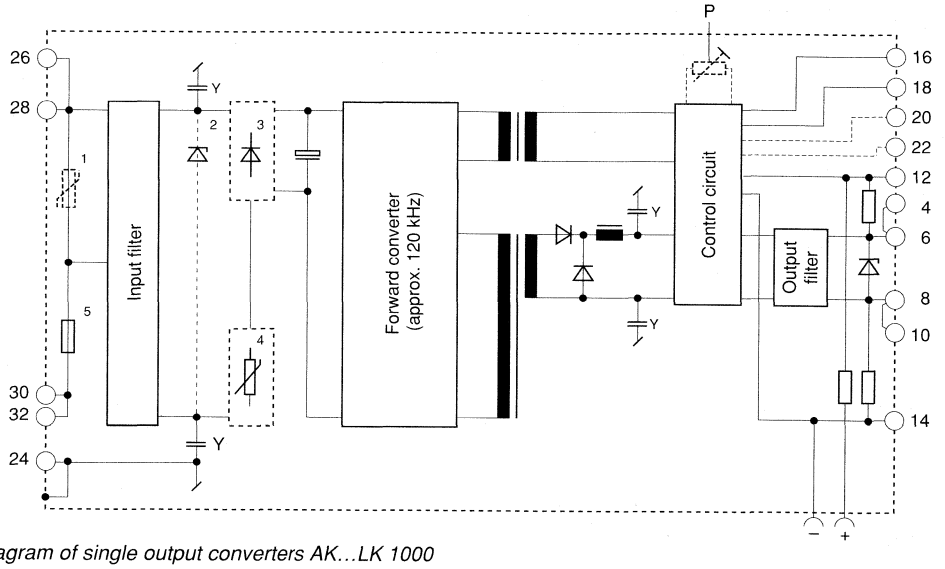
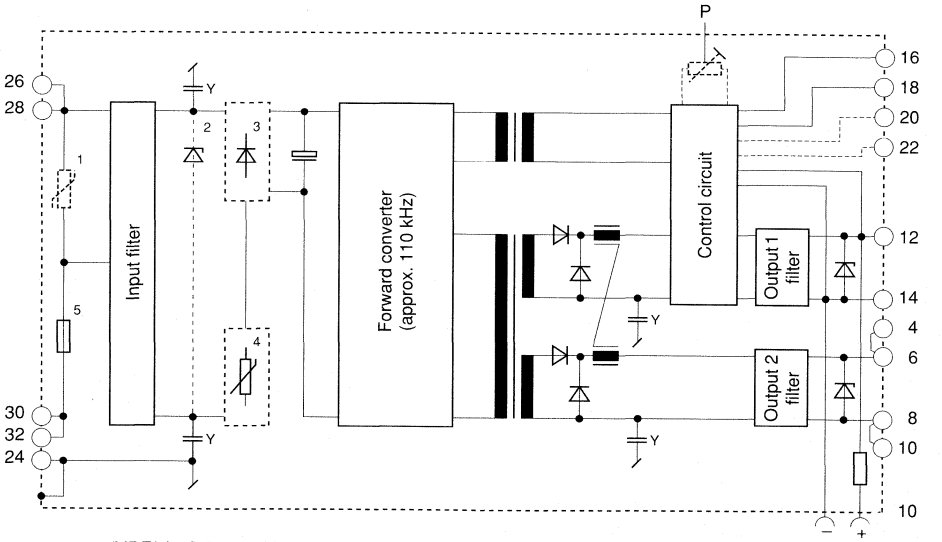



*Fig. 2*
*Block diagram of single output converters AK...LK 1000*




[1] Transient suppressor (VDR) in C/D/E/F/LK types
[2] Transient suppressor (diode) in A/B/C/FK types
[3] Bridge rectifier in LK types
[4] Inrush current limiter in C/D/E/LK types (NTC or Opt. E), -9 versions exclude the NTC
[5] Input fuse

*Fig. 3*
*Block diagram of symmetrical double output converters AK...LK 2000*


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## Electrical Input Data

General Conditions
– $T_A$ = 25 °C, unless $T_C$ is specified.
– Pin 18 connected to pin 14, $U_o$ adjusted to $U_{o\,nom}$ (option P); R input not connected.
– Sense line pins S+ and S– connected to Vo+ and Vo– respectively.

*Table 3a: Input data*

| Input | | | AK | | | BK | | | CK | | | DK | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0…$I_{o\,nom}$ | 8 | | 35 | 14 | | 70 | 28 | | 140 | 44 | | 220 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | $T_{C\,min}$…$T_{C\,max}$ | | 15 | | | 30 | | | 60 | | | 110 | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 9.0 | | | 6.0 | | | 3.0 | | | 1.6 | | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$…$U_{i\,max}$ | | | 2.5 | | | 2.5 | | | 2.5 | | | 2.5 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | 1.5 | | | 1.5 | | | 1.5 | | | 1.5 | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 65 | | | 100 | | | 150 | | | 170 | | | mΩ |
| $R_{NTC}$ | NTC resistance [2] | $T_C$ = 25°C | | – [3] | | | – [3] | | 800 | | | 1600 | | | |
| $C_i$ | Input capacitance | | 830 | | 1250 | 300 | | 450 | 660 | | 1000 | 260 | | 400 | µF |
| $U_{i\,RFI}$ | Conducted input RFI | EN 55022 | | | A | | | B | | | B | | | A | |
| | Radiated input RFI | | | | >A | | | >A | | | >A | | | >A | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | 0 | | 40 | 0 | | 80 | 0 | | 154 | 0 | | 400 [4] | V DC |
| F | Fuse rating (nominal) | see table 4 | | 30.0 | | | 25.0 | | | 12.5 | | | 8.0 | | A |

*Table 3b: Input data*

| Input | | | EK | | | FK | | | LK | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0…$I_{o\,nom}$ | | – | | | – | | 85 | | 264 | V AC |
| | | $T_{C\,min}$…$T_{C\,max}$ | 67 | | 385 | 20 | | 100 | 88 | | 372 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | | | 220 | | | 48 | | | 310 | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 0.8 | | | 3.75 | | | 0.6 | | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$…$U_{i\,max}$ | | | 2.5 | | | 2.5 | | | 2.5 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | 1.5 | | | 1.5 | | | 1.5 | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 180 | | | 70 | | | 480 | | | mΩ |
| $R_{NTC}$ | NTC resistance [2] | $T_C$ = 25°C | 3200 | | | | – [3] | | 3200 | | | |
| $C_i$ | Input capacitance | | 210 | | 400 | 1200 | | 1800 | 210 | | 400 | µF |
| $U_{i\,RFI}$ | Conducted input RFI | EN 55022 | | | | | | B | | | B | |
| | Radiated input RFI | | | | | | | >A | | | >A | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | 0 | | 400 | 0 | | 110 | –400 | | 400 | V DC |
| F | Fuse rating (nominal) | see table 4 | | 4.0 | | | 16.0 | | | 4.0 | | A |

[1] With double output modules, both outputs loaded with $I_{o\,nom}$.
[2] Valid for -7, -6, -5 versions with NTC, (-9 versions exclude the NTC). Initial switch-on cycle. Subsequent switch-on/off cycles increase the inrush current peak value.
[3] AK, BK and FK types have no NTC (inrush current limiter) fitted.
[4] 1 s max., duty cycle 1% max.

**Note:** EK types with an input voltage range of 67...385 V DC are available upon request.

Remarks: LK types may be operated in AC mode within a frequency range of 47...440 Hz. Above 70 Hz (at $U_i$ = 264 V AC) the earth leakage current may exceed 3.5 mA as specified in IEC 950. The built-in Y capacitors are specified for frequencies up to 100 Hz. Above 350 Hz the input voltage should not exceed 200 V AC, due to the built-in X capacitors.

### Input Fuse

A fuse mounted inside the converter protects the module against severe defects. This fuse may not fully protect the module when the input voltage exceeds 200 V DC! In applications where the converters operate at source voltages above 200 V DC an external fuse or a circuit breaker at system level should be installed!

*Table 4: Fuse Specification*

| Module | Fuse type | Fuse rating | |
|---|---|---|---|
| AK [1] | fast-blow | Little fuse 314 | 30.0 A, 125 V |
| BK [1] | fast-blow | Little fuse 314 | 25.0 A, 125 V |
| CK [2] | slow-blow | FTR | 12.5 A, 250 V |
| DK [2] | slow-blow | FTR | 8 A, 250 V |
| EK [2] | slow-blow | SP T | 4 A, 250 V |
| FK [2] | slow-blow | FTR | 16 A, 250 V |
| LK [2] | slow-blow | SP T | 4 A, 250 V |

[1] Fuse size 6.3 × 32 mm
[2] Fuse size 5 × 20 mm

### Input Under-/Overvoltage Cut-out

If the input voltage remains below approx. 0.8 $U_{i\,min}$ or exceeds approx. 1.1 $U_{i\,max}$, an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ should be considered!

### Input Transient Protection

A suppressor diode or a VDR (depending upon the input voltage range) together with the input fuse and a symmetrical input filter form an effective protection against high input transient voltages which typically occur in most installations, but especially in battery driven mobile applications.

Nominal battery voltages in use are: 12, 24, 36, 48, 60, 72, 110 and 220 V. In most cases each nominal value is specified to a tolerance of –30%/+25%.

In certain applications, surges according to RIA 12 are specified in addition to those defined in IEC 571-1. The power supply must not switch off during these surges and since their energy can not practically be absorbed an extremely wide input range is required. The EK input range for 110 V batteries has been designed to meet this requirement and is available upon customer request.

### Inrush Current Limitation

The C/D/E/LK modules of the versions -7, -6, -5 incorporate a NTC resistor in the input circuitry which - at initial turn on - reduces the peak inrush current value by a factor of 5...10 to protect connectors and switching devices from damage. Subsequent switch-on cycles within short periods will cause an increase of the peak inrush current value due to the warming-up of the NTC resistor. See also option E.

### Inrush Current Peak Value

The inrush current peak value/initial switch-on cycle) can be determined by following calculation: (Refer to fig. 6 also)

$$I_{inr\,p} = \frac{U_{i\,source}}{(R_{s\,ext} + R_i + R_{NTC})}$$

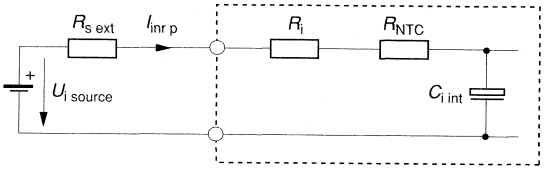



*Fig. 4*
*Replacement diagram for input impedance*


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## Electromagnetic Immunity

*Table 5: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [4] | Value applied | Waveform | Source impedance | Test procedure | in operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Impulse voltage | IEC 255-4 App. E4 [6] (1976) | III | i/o, i/c, o/c +i/–i, +o/–o | 5000 $V_p$ | 1.2/50 µs | 500 Ω | 3 pos. and 3 neg. impulses per coupling mode | no | - |
| High frequency disturbance | IEC 255-4 App. E5 [6] (1976) | III | i/o, i/c, o/c | 2500 $V_p$ | 400 damped 1 MHz waves/s | 200 Ω | 2 s per coupling mode | yes | [8] |
| | | | i/o, +o/–o, o/c | 1000 $V_p$ | | | | | |
| Voltage surge | IEC 571-1 [3] (1990-07) | | i/c, +i/–i | 800 $V_p$ | 100 µs | 100 Ω | | yes | [1] |
| | | | | 1500 $V_p$ | 50 µs | | 1 pos. and 1 neg. voltage surge per coupling mode | | |
| | | | | 3000 $V_p$ | 5 µs | | | | |
| | | | | 4000 $V_p$ | 1 µs | | | | |
| | | | | 7000 $V_p$ | 100 ns | | | | |
| Supply related surge | RIA 12 (1984) | A [5] | +i/–i | 3.5 • $U_{batt}$ | 20 ms | 0.2 Ω | 1 positive surge | yes | [1] |
| | | B | | 1.5 • $U_{batt}$ | 1 s | | | | |
| Direct transient | | C | +i/c, –i/c | 960 $V_p$ | 10/100 µs | 5 Ω | 5 pos. and 5 neg. impulses | | [2] |
| | | D | | 1800 $V_p$ | 5/50 µs | | | | |
| | | E | | 3600 $V_p$ | 0.5/5 µs | 100 Ω | | | |
| | | F | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | G | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Indirect coupled transient | | H | +o/c, –o/c | 1800 $V_p$ | 5/50 µs | | | | [7] |
| | | J | | 3600 $V_p$ | 0.5/5 µs | | | | |
| | | K | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | L | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Electrostatic discharge | IEC 801-2 (1991-04) | 4 | contact discharge to case, | 8000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | [1] |
| | | | air disch. to case | 15000 $V_p$ | | | | | |
| Electric field | IEC 801-3 (1984) | 3 | antenna in 1m distance | 10 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | [8] |
| Fast transient/ burst | IEC 801-4 (1988) | 3 | i/c, +i/–i | 2000 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | [1] |
| | | 4 | | 4000 $V_p$ | | | | | |
| Transient | IEC 801-5 (Draft 1993-01) | 4 | i/c, | 4000 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | [1] |
| | | | +i/–i | 2000 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specifications possible
[3] Will be replaced by EN 50155
[4] i = input, o = output, c = case
[5] For 110 V batteries only met with extended input voltage range of EK types. These units are available upon customer's request. Standard DK units (110 V battery) will not be damaged, but overvoltage lock-out will occur during the surge. Under normal operation temporary deviation from specifications possible.
[6] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[7] Test in progress, please consult factory
[8] Not tested yet, please consult factory

### Static Input Current Characteristic

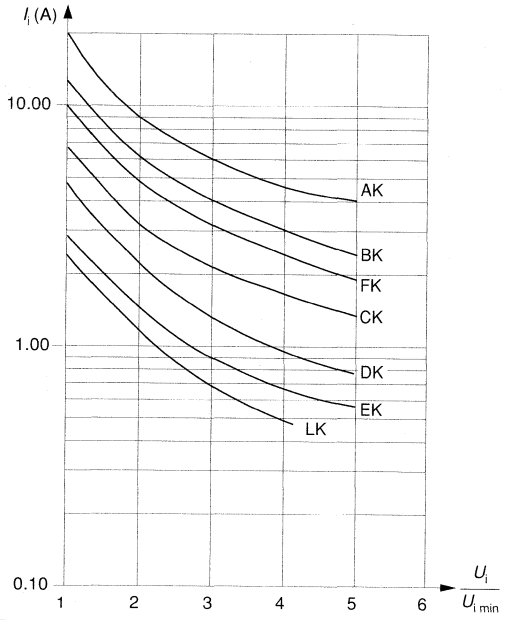



*Fig. 5*
*Input current versus relative input voltage*

### Input Inrush Current Characteristic

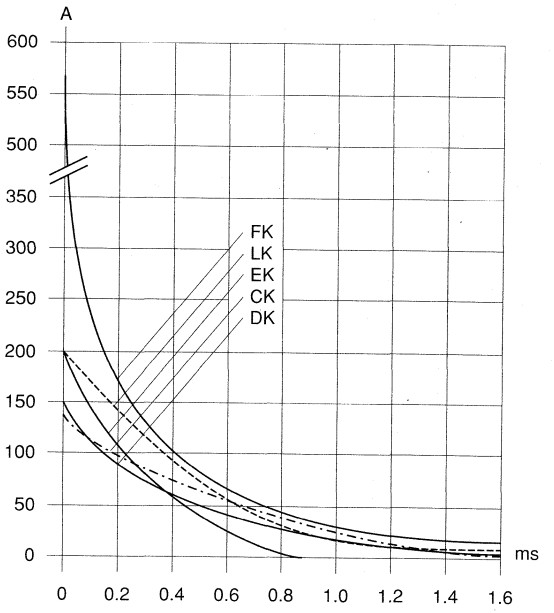



*Fig. 6*
*Inrush current versus time at $U_{i\,max}$, $R_{ext}$ = 0. For AK/BK as well as for application related values use the formula given in section "Inrush Current Peak Value" to get realistic results.*

### Hold-up Time versus relative Input Voltage

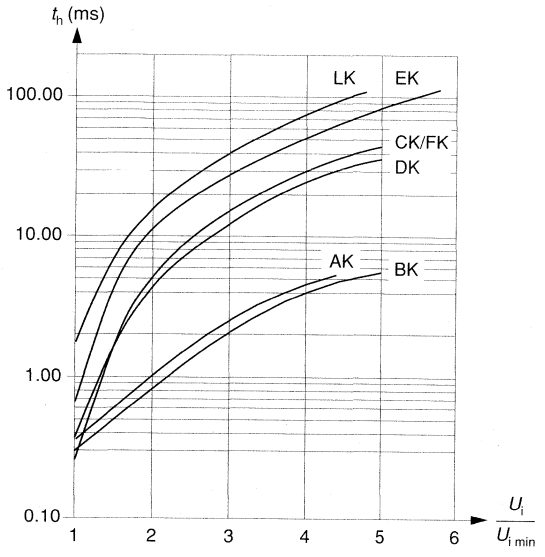



*Fig. 7*
*Hold-up time $t_h$ versus relative input voltage $U_i/U_{i\,min}$. With the exception of the LK, the DC-DC converters require an external series diode in the input path when other loads are connected to the same input supply lines.*

### RFI Noise at Input according to EN 55022

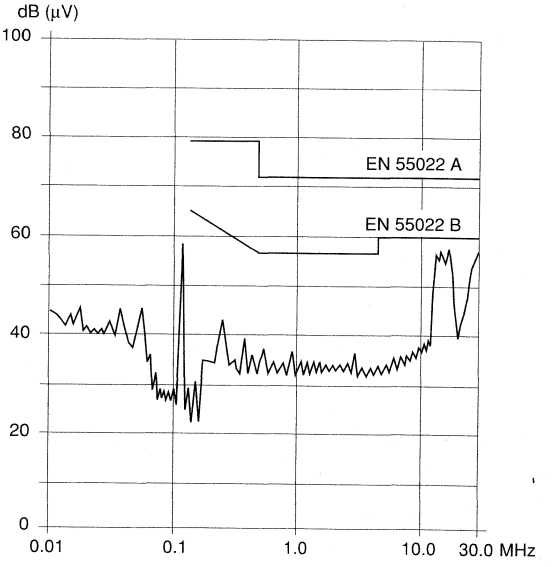



*Fig. 8*
*Typical radio frequency-interference voltage at $U_{i\,nom}$, $I_{o\,nom}$, measured with an artificial mains network and a quasi peak detector.*


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## Electrical Output Data

General Conditions, valid for all tables 6 and 7:
– $T_A$ = 25 °C, unless $T_C$ is specified.
– Pin 18 connected to pin 14, $U_o$ adjusted to $U_{o\,nom}$ (option P), R input not connected.
– Sense line pins S+ and S– connected to Vo+ and Vo– respectively.

*Table 6a: Output data single output modules AK/BK*

| **Output** | | | **AK/BK 1001 5.1 V** | | | **AK/BK 1301 12.0 V** | | | **AK/BK 1501 15.0 V** | | | **AK/BK 1601 24.0 V** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 7.6 | | | 21 | | | 26.5 | | | 43.5 | | |
| $I_{o\,nom}$ | Output current [1] AK/BK | | | 20.0/25.0 | | | 10.0/12.0 | | | 8.0/10.0 | | | 5.0/6.0 | | A |
| $I_{oL}$ | Output current AK/BK limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 21/26 | | | 10.2/12.2 | | | 8.2/10.2 | | | 5.2/6.2 | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 5 | | | 5 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 75 | | | 40 | | | 60 | | | 90 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±15 | | | ±25 | | | ±30 | | | ±30 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1)$I_{o\,nom}$ | | 20 | | | 25 | | | 30 | | | 40 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±200 | | | ±250 | | | ±300 | | | ±200 | | |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1)$I_{o\,nom}$ | | 0.1 | | | 0.3 | | | 0.3 | | | 0.35 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | of output voltage [7] | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | mV/K |

*Table 6b: Output data double output modules AK/BK*

| **Output** (Outputs in Series Connection) | | | **AK/BK 2320 24 V (2 × 12 V)** | | | **AK/BK 2540 30 V (2 × 15 V)** | | | **AK/BK 2660 48 V (2 × 24 V)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | | 24.0 [2] | | | 30.0 [2] | | | 48.0 [2] | | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 39 | | | 49 | | | 72 | | |
| $I_{o\,nom}$ | Output current [1] AK/BK | | | 5.0/6.0 | | | 4.0/5.0 | | | 2.5/3.0 | | A |
| $I_{oL}$ | Output current AK/BK limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | | 5.2/6.2 | | | 4.2/5.2 | | | 2.7/3.2 | | |
| $u_o$ | Output voltage noise [3] | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 10 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 60 | | | 60 | | | 60 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±15 | | | ±15 | | | ±20 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1)$I_{o\,nom}$ | | 25 | | | 25 | | | 35 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±350 | | | ±350 | | | ±250 | | |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1)$I_{o\,nom}$ | | 0.2 | | | 0.2 | | | 0.3 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | of output voltage [7] | | | ±4.8 | | | ±6.0 | | | ±7.2 | | mV/K |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting, remote sensing or option T, the output current should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[2] Series connection for $U_{o\,nom}$ = 24 V, 30 V or 48 V, see fig. 16a.
[3] Shortest possible wiring for series connection at the connector.
[4] See fig. 10.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request

*Table 6c: Output data double output modules AK/BK*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **AK/BK 2320 12 V/12 V** | | | | | | **AK/BK 2540 15 V/15 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 11.93 | | 12.07 | 11.82 | | 12.18 | 14.91 | | 15.09 | 14.78 | | 15.22 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 21 | | | | | | 26.5 | | | | | |
| $I_{o\,nom}$ | Output current [3] AK/BK | | | 5.0/6.0 | | | 5.0/6.0 | | | 4.0/5.0 | | | 4.0/5.0 | | A |
| $I_{oL}$ | Output current AK/BK limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 5.2/6.2 | | | 5.2/6.2 | | | 4.2/5.2 | | | 4.2/5.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 10 | | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 20 | | | 20 | | | 25 | | | 25 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±30 | | | ±30 | | | ±30 | | | ±30 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 50 | | | Fig. 12 | | | 50 | | | Fig. 13 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±160 | | | | | | ±200 | | | | | mV |
| $t_d$ [7] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.2 | | | | | | 0.2 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | | | | ±0.02 | | | | | %/K |
| | | | | ±2.4 | | | | | | ±3.0 | | | | | mV/K |

*Table 6d: Output data double output modules AK/BK*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **AK/BK 2660 24 V/24 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 23.86 | | 24.14 | 23.64 | | 24.36 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 36 | | | 36 | | |
| $I_{o\,nom}$ | Output current [3] AK/BK | | | 2.5/3.0 | | | 2.5/3.0 | | A |
| $I_{oL}$ | Output current AK/BK limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 2.7/3.2 | | | 2.7/3.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 5 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 30 | | | 30 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±40 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 70 | | | Fig. 14 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±300 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.3 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | | | %/K |
| | | | | ±4.8 | | | | | mV/K |

[1] Depending upon the desired output configuration the wiring should be made as shown in fig. 16b, c, d or e.
[2] Same conditions for both outputs.
[3] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[4] See fig. 10.
[5] Condition for specified output. Other output loaded with constant current $I_o = I_{o\,nom}$
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.


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*Table 7a: Output data single output modules CK...LK*

| **Output** | | | **CK...LK 1001 5.1 V** | | | **CK...LK 1301 12.0 V** | | | **CK...LK 1501 15.0 V** | | | **CK...LK 1601 24.0 V** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 7.6 | | | 20 | | | 26.5 | | | 39 | | |
| $I_{o\,nom}$ | Output current [1] | | | 25.0 | | | 12.0 | | | 10.0 | | | 6.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ | 26 | | | 12.2 | | | 10.2 | | | 6.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 5 | | | 5 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 75 | | | 40 | | | 60 | | | 90 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}...U_{i\,nom}$, $U_{i\,nom}...U_{i\,max}$, $I_{o\,nom}$ | | | ±15 | | | ±25 | | | ±30 | | | ±30 | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ | | | 20 | | | 25 | | | 30 | | | 40 | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±200 | | | ±250 | | | ±300 | | | ±200 | | |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.1 | | | 0.3 | | | 0.3 | | | 0.35 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}...T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | mV/K |

*Table 7b: Output data double output modules CK...LK*

| **Output** (Outputs in Series Connection) | | | **CK...LK 2320 24 V (2 × 12 V)** | | | **CK...LK 2540 30 V (2 × 15 V)** | | | **CK...LK 2660 48 V (2 × 24 V)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | | 24.0 [2] | | | 30.0 [2] | | | 48.0 [2] | | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 39 | | | 49 | | | 72 | | |
| $I_{o\,nom}$ | Output current [1] | | | 6.0 | | | 5.0 | | | 3.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ | 6.2 | | | 5.2 | | | 3.2 | | | |
| $u_o$ | Output voltage noise [3] | $U_{i\,nom}$, $I_{o\,nom}$ | | 15 | | | 15 | | | 20 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 400 | | | 500 | | | 500 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}...U_{i\,nom}$ $U_{i\,nom}...U_{i\,max}$ $I_{o\,nom}$ | | ±40 | | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ | | 40 | | | 30 | | | 40 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | +100/–300 | | | +200/–300 | | | +250/–250 | | |
| $t_d$ [6] | Time constant; dynamic load regulation | $I_o$ = (1...1/3...1)$I_{o\,nom}$ | | 0.2 | | | 0.2 | | | 0.5 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}...T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±4.8 | | | ±6.0 | | | ±7.2 | | mV/K |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.

[2] Series connection for $U_{o\,nom}$ = 24 V, 30 V or 48 V, see fig. 16a.

[3] Shortest possible wiring for series connection at the connector.

[4] See fig. 10.

[6] See fig. 11.

[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.

*Table 7c: Output data double output modules CK...LK*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **CK...LK 2320 12 V/12 V** | | | | | | **CK...LK 2540 15 V/15 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 11.93 | | 12.07 | 11.82 | | 12.18 | 14.91 | | 15.09 | 14.78 | | 15.22 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 19 | | | 19 | | | 25 | | | 25 | | |
| $I_{o\,nom}$ | Output current [3] | | | 6.0 | | | 6.0 | | | 5.0 | | | 5.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 6.2 | | | 6.2 | | | 5.2 | | | 5.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 10 | | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 150 | | | 75 | | | 200 | | | 100 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | | ±30 | | | ±40 | | | ±30 | | | ±40 | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | | 100 | | Fig. 12 | | | | 100 | | Fig. 13 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$ | | +80/–250 | | | | | | +100/–250 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.4 | | | | | | 0.4 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | | | | ±0.02 | | | | | %/K |
| | | | | ±2.4 | | | | | | ±3.0 | | | | | mV/K |

*Table 7d: Output data double output modules CK...LK*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **CK...LK 2660 24 V/24 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 23.86 | | 24.14 | 23.64 | | 24.36 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 36 | | | 36 | | |
| $I_{o\,nom}$ | Output current [3] | | | 3.0 | | | 3.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$, $T_{C\,min}$... $T_{C\,max}$ | 3.2 | | | 3.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$, | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 200 | | | 100 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$, $U_{i\,nom}$...$U_{i\,max}$, $I_{o\,nom}$ | | | ±30 | | | ±40 | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | | 50 | | Fig. 14 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | +100/–250 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.4 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | | | %/K |
| | | | | ±4.8 | | | | | mV/K |

[1] Depending upon the desired output configuration the wiring should be made as shown in fig. 16b, c, d or e.
[2] Same conditions for both outputs.
[3] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[4] See fig. 10.
[5] Condition for specified output. Other output loaded with constant current $I_o = I_{o\,nom}$.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.


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### Output Protection

Each output is protected against overvoltage which could occur due to a failure of the control circuit by means of a voltage suppressor diode which, under worst case conditions, may become a short circuit. The suppressor diode are not designed to withstand externally applied overvoltages. Overload at any of the two outputs will cause a shut-down of both outputs. A red LED indicates the overload condition.

### Test Sockets (Main output only [1])

Test sockets for measuring the output voltage $U_{o1}$ are located at the front of the module. The positive test socket is protected by a series resistor (see fig. 2 and 3). The voltage measured at the test sockets is approximately 30 mV lower than the value measured at the output terminals.

[1] In case of double output units externally connected in series for $U_o$ = 24 V, 30 V or 48 V the monitored output voltage is 12 V, 15 V or 24 V respectively.

### Inhibit Function

The outputs of a module may be enabled or disabled by means of a logic signal (TTL, CMOS etc.) applied to the inhibit input. If the inhibit function is not required, connect the inhibit pin 18 to pin 14 to enable the outputs (active low logic, fail safe).

*Table 8: Inhibit characteristics*

| Characteristic | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | 0.8 | V |
| | | $U_o$ = off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = 0 | | | –400 | µA |
| $t_r$ | Rise time | | | | 30 | | ms |
| $t_f$ | Fall time | | depending on $I_o$ | | | | |

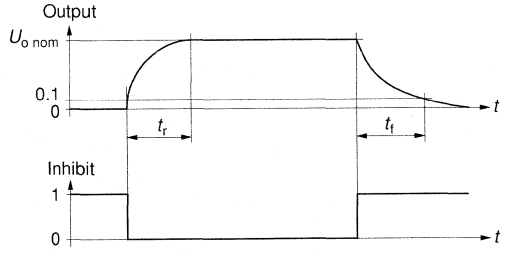



*Fig. 9*
*Output response as a function of inhibit control*

### Sense Lines

(Only for single output units 5.1 V, 12 V, 15 V, 24 V)

This feature enables compensation for voltage drops across the connector contacts and if necessary, across the load lines. If the sense lines are connected at the load rather than directly at the connector, the user should ensure that $U_{o\,max}$ (between Vo1+ and Vo1–) is not exceeded. We recommend connecting the sense lines directly at the female connector.

For further information, please refer to "Application Notes ".

To ensure correct operation, both sense lines should be connected to their respective power outputs and the voltage difference between any sense line and its respective power output pin (as measured on the connector) should not exceed the following values:

*Table 9: Voltage compensation allowed using sense lines*

| Output voltage | Total voltage difference between sense lines and their respective outputs | Voltage difference between Vo– and S– |
|---|---|---|
| 5.1 V | < 0.5 V | < 0.25 V |
| 12 V, 15 V | < 1.0 V | < 0.25 V |

If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents must be reduced accordingly so that $P_{o\,nom}$ is not exceeded.

### Parallel or Series Connection of Units

Single or double output units with equal nominal output voltage can be connected in parallel without any precautions using option T.

With **option T** (current sharing), all units share the current approximately equally.

Single output units and/or main and second outputs of double output units can be connected in series with any other (similar) output.

**Note:**

- Parallel connection of double output units should always include both, main **and** second output to maintain good regulation of both outputs.
- Series connection of second outputs without involving their main outputs should be avoided as regulation may be poor.
- The maximum output current is limited by the output with the lowest current limitation if several outputs are connected in series.
- Not more than 5 units should be connected in parallel.

### Output Voltage Regulation of Single or Double Output Modules with Outputs 1 and 2 Connected in Series

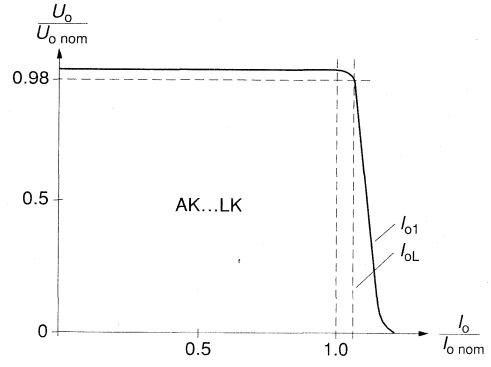



*Fig. 10*
*$U_{o1}$ vs. $I_{o1}$ (typ.) of single output units*

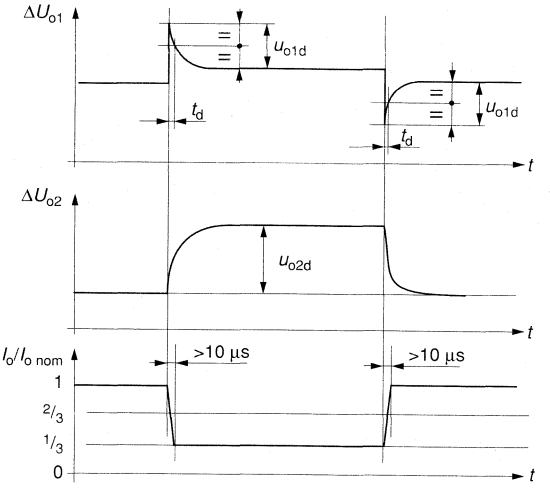



*Fig. 11*
*Control deviation of $u_{o1/2\,d}$ vs. dynamic load change*

### Output Voltage Regulation of Double Output Modules with Output 1 and 2 in Symmetrical Configuration

Output 1 is under normal conditions regulated to $U_{o1\,nom}$, independent of the output currents.

$U_{o2}$ is dependent upon the load distribution. When both outputs are loaded with more than 10% of $I_{o\,nom}$, the deviation of $U_{o2}$ remains within ±5% of the value of $U_{o1}$. Figures 13, 14 and 15 show the regulation with varying load distribution. If $I_{o1} = I_{o2}$ or the two outputs are connected in series, the deviation of $U_{o2}$ remains within ±1% of the value of $U_{o1}$ provided that a total load of more than 10% of $I_{o\,nom}$ is applied.

Two outputs of a single K 2000 module connected in parallel will behave like the output of a K 1000 module; the paralleled output is fully regulated. No precautions are necessary in using the R-input and the test sockets.

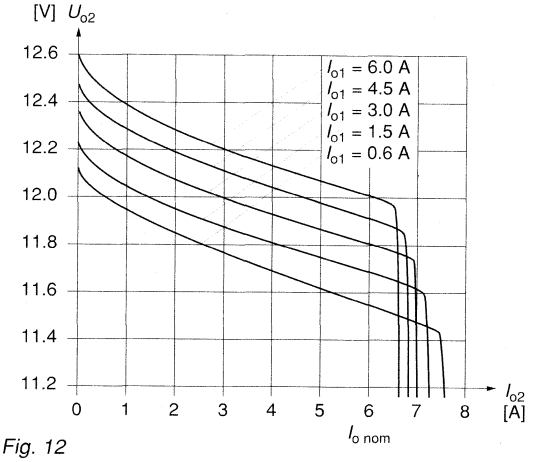



*Fig. 12*
*AK...LK 2320: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

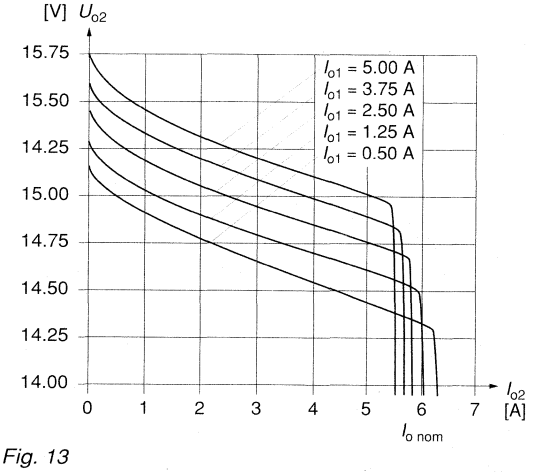



*Fig. 13*
*AK...LK 2540: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

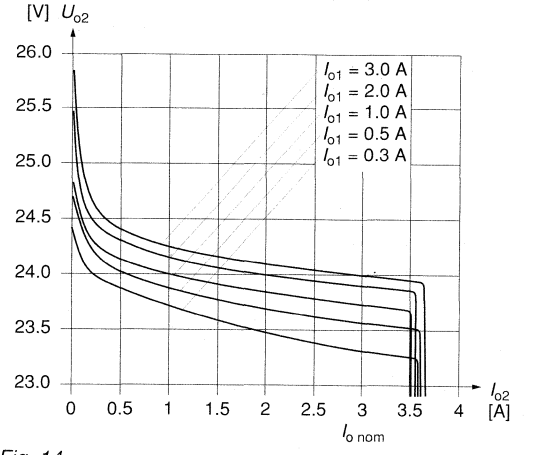



*Fig. 14*
*AK...LK 2660: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*


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**Programmable Output Voltage** (R-Function)

As a standard feature, the modules offer an adjustable output voltage, identified by letter R in the type designation. The control input R (pin 16) accepts either a control voltage $U_{ext}$ or a resistor $R_{ext}$ to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_{o\,nom}$.

a) Adjustment by means of an external control voltage $U_{ext}$ between pin 16 (R) and pin 14:

The control voltage range is 0...2.75 V DC and allows an output voltage adjustment in the range of approximately 0...110% $U_{o\,nom}$.

$$U_{ext} = \frac{U_o}{U_{o\,nom}} \cdot 2.5\ V \text{ (approximate formula)}$$

b) Adjustment by means of an external resistor:

Depending upon the value of the required output voltage the resistor shall be connected

**either:** Between pin 16 and pin 14 ($U_o < U_{o\,nom}$) to achieve an output voltage adjustment range of approximately 0...100% $U_{o\,nom}$

**or:** Between pin 16 and pin 12 ($U_o > U_{o\,nom}$) to achieve an output voltage adjustment range of approximately 100...110% $U_{o\,nom}$.

**Warning:**

- The value of $R'_{ext}$ shall never be less than the lowest value as indicated in table 10b to avoid damage to the unit!

**Remarks:**

- The R-Function excludes option P (output voltage adjustment by potentiometer).
- If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output current(s) should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
- The R-input (as well as option P) is related to the main output.
- With double output units the second output follows the value of the controlled main output. Resistor values as indicated for the single output units should be used.
- For correct output voltage adjustment of double output units the external wiring of the outputs should be according to fig. 16a, b, c, d or e depending upon the desired output configuration.
- In case of parallel connection the output voltages should be individually set within a tolerance of 1 - 2%.

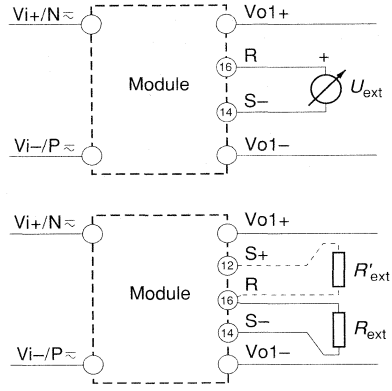



*Fig. 15*
*Output voltage control for single output units AK...LK 1000 by means of the R input*

*Table 10a: $R_{ext}$ for $U_o < U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ (V) | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] |
| 0.5 | 0.422 | 2 | 4 | 0.825 | 2 | 4 | 0.56 | 4 | 8 | 0.825 |
| 1.0 | 1.0 | 3 | 6 | 1.3 | 4 | 8 | 1.47 | 6 | 12 | 1.33 |
| 1.5 | 1.62 | 4 | 8 | 1.96 | 6 | 12 | 2.61 | 8 | 16 | 1.96 |
| 2.0 | 2.16 | 5 | 10 | 2.87 | 8 | 16 | 4.64 | 10 | 20 | 2.87 |
| 2.5 | 3.83 | 6 | 12 | 3.83 | 9 | 18 | 6.19 | 12 | 24 | 3.83 |
| 3.0 | 5.61 | 7 | 14 | 5.62 | 10 | 20 | 8.25 | 14 | 28 | 5.61 |
| 3.5 | 9.09 | 8 | 16 | 8.28 | 11 | 22 | 11.0 | 16 | 32 | 8.25 |
| 4.0 | 14.7 | 9 | 18 | 12.1 | 12 | 24 | 16.2 | 18 | 36 | 12.1 |
| 4.5 | 28.7 | 10 | 20 | 19.6 | 13 | 26 | 26.1 | 20 | 40 | 19.6 |
| 5.0 | 196 | 11 | 22 | 42.2 | 14 | 28 | 56.2 | 22 | 44 | 46.4 |

*Table 10b: $R'_{ext}$ for $U_o > U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] |
| 5.15 | 422 | 12.1 | 24.2 | 1780 | 15.2 | 30.4 | 1470 | 24.25 | 48.5 | 3160 |
| 5.2 | 215 | 12.2 | 24.4 | 909 | 15.4 | 30.8 | 750 | 24.5 | 49.0 | 1620 |
| 5.25 | 147 | 12.3 | 24.6 | 623 | 15.6 | 31.2 | 511 | 24.75 | 49.5 | 1100 |
| 5.3 | 110 | 12.4 | 24.8 | 464 | 15.8 | 31.6 | 383 | 25.0 | 50.0 | 825 |
| 5.35 | 90.9 | 12.5 | 25.0 | 383 | 16.0 | 32.0 | 316 | 25.25 | 50.5 | 681 |
| 5.4 | 75 | 12.6 | 25.2 | 316 | 16.2 | 32.4 | 261 | 25.5 | 51.0 | 562 |
| 5.45 | 61.9 | 12.7 | 25.4 | 286 | 16.4 | 32.8 | 237 | 25.75 | 51.5 | 511 |
| 5.5 | 56.2 | 12.8 | 25.6 | 234 | 16.5 | 32.0 | 215 | 26.0 | 52.0 | 464 |
| | | 13.0 | 26.0 | 196 | | | | 26.25 | 52.5 | 422 |
| | | 13.2 | 26.4 | 162 | | | | 26.4 | 52.8 | 383 |

[1] First column: single output units or double output units with separated outputs, second column: outputs in series connection

Programmable Output Voltage (R-Function) continued

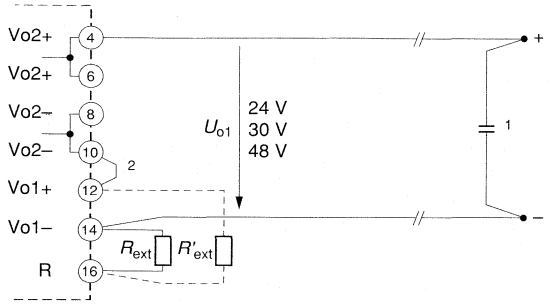



*Fig. 16a*
*AK...LK 2000 with H15 connector. R-input for output voltage control. Wiring for output voltage 24 V or 30 V or 48 V with main and second output connected in series.*

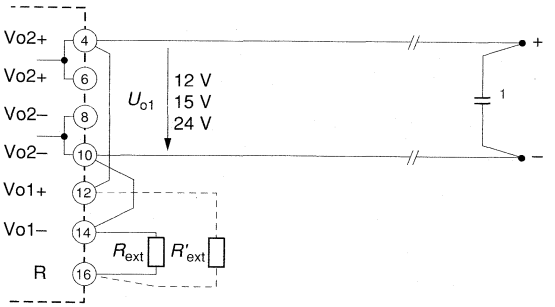



*Fig. 16b*
*AK...LK 2000 with H15 connector. R-input for output voltage control. Wiring for output voltage 12 V or 15 V or 24 V with main and second output connected in parallel.*

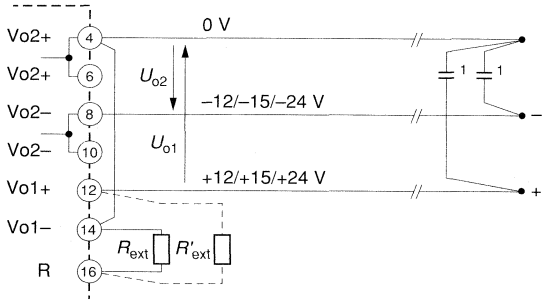



*Fig. 16c*
*AK...LK 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two symmetrical output voltages $U_{o1}$ and $U_{o2}$: ±12 V or ±15 V or ±24 V.*

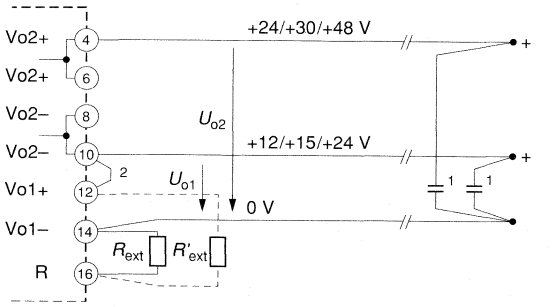



*Fig. 16d*
*AK...LK 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two output voltages $U_{o1}$ and $U_{o2}$: +12 V and +24 V or +15 V and +30 V or +24 V and +48 V.*

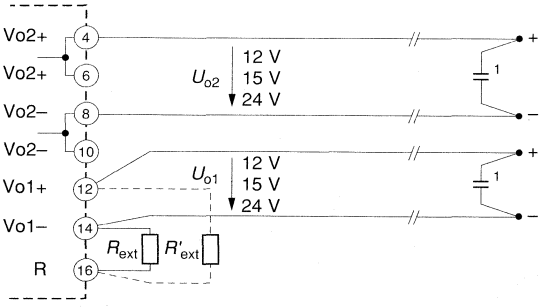



*Fig. 16e*
*AK...LK 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two output voltages $U_{o1}$ and $U_{o2}$: 12 V/12 V or 15 V/15 V or 24 V/24 V, the outputs are galvanically isolated.*

[1] A ceramic multilayer capacitor connected across the output lines reduces ripple and spikes.
[2] Shortest possible wiring for series connection at the female connector

**Remarks:**

Double output units fitted with H-15 connectors have the output pins of the second output, pins 4/6 and 8/10, internally paralleled.

It is recommended that pins 4/6 and 8/10 be directly paralleled at the female connector as well to reduce the voltage drop across the connector.

Please note: $U_{o2}$ varies depending upon its own load and the load on output 1.


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## Supplementary Data

### Isolation

Input to output isolation voltage tests in accordance with IEC 950, EN 60950, VDE 0805 and EN 41003 respectively are performed as factory tests and should not be repeated in the field.

### Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 2 and 3). Melcher will not honour any guarantee claims resulting from high voltage field tests.

*Table 11: Isolation test voltages, clearance and creepage distances*

| Characteristic | | Input to Output | Input to Case | Output to Case | Output to Output | Unit |
|---|---|---|---|---|---|---|
| Isolation test voltage | | 4.0 | 2.0 | 1.0 | 0.1 | $kV_{rms}$ |
| | | 5.6 | 2.8 | 1.4 | 0.15 | kV DC |
| Clearance and creepage distance on the print lay-out | AK/BK | 6.4 | 3.2 | 2.0 | 1.0 | mm |
| | CK...LK | 6.4 | 3.2 | 2.0 | 0.4 | |

### Display Status of LEDs

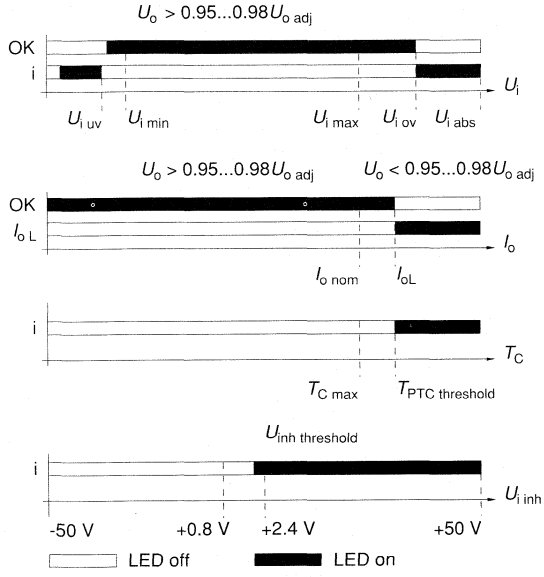



*Fig. 17*

*LEDs "OK" and "i" status versus input voltage*
*Conditions: $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*
*$U_{i\,uv}$ = undervoltage lock-out, $U_{i\,ov}$ = overvoltage lock-out*

*LEDs "OK" and "$I_{o\,L}$" status versus output current*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*

*LED "i" versus case temperature*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $U_{inh} \le 0.8$ V*

*LED "i" versus $U_{inh}$*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$*

## Description of Options

*Table 12: Survey of options*

| Option | Function of Option | Characteristics |
|---|---|---|
| -9 | Operational temperature range $T_A$ = –40 °C...71 °C | Extended operational temperature range |
| E [1] | Electronic inrush current limitation circuitry | Improved inrush current limitation as per table 12 |
| P | Potentiometer for $U_o$ adjustment | R-function is not available if option P is incorporated |
| D | Input and/or output undervoltage monitoring circuitry | Safe data signal output (Versions D0...DD) |
| V | Input (and output) undervoltage monitoring circuitry | ACFAIL signal according to VME specs (Versions V0, V2, V3) |
| T | Current sharing | Interconnect T-pins if paralleling outputs (5 units max.) |
| B1 | Cooling plate | Replaces standard heat sink, allowing direct chassis-mounting |

[1] Option E for C/D/E/LK types

**Option -9** Extended Temperature Range

Extension of the operating temperature range from standard –25...71 °C to –40...71 °C. The modules will provide full nominal output power with free air convection cooling. Option -9 excludes inrush current limitation by NTC.

**Option E** Inrush Current Limitation

CK/DK/EK/LK types may be supplemented by an electronic circuit (option E, replacing the standard built-in NTC) to achieve an enhanced inrush current limiting function (not available with AK/BK/FK types).

If fitted with option E (inrush current limitation) together with option D6, input voltage monitoring, the CK units meet the CEPT/ETSI standards for 48 V DC supply voltages according to prETS 300132-2, version 4.2, date 9312. Option D6, externally adjustable via potentiometer, is necessary to disable the converter at input voltages below actual service voltage ranges, avoiding an excessive input current when the input voltage is raised slowly according to prETS 300132-2. Option D6 threshold level should be adjusted to 36.0...40.5 V for 48 V nominal supply systems or 44.0...50.0 V for 60 V nominal supply systems (refer also to description of option D). The D output should be connected to the inhibit input. Please contact Melcher if applications do not permit potentiometer setting.

*Table 13: Inrush current characteristics with option E*

| Characteristics | | CK | DK | EK/LK | Unit |
|---|---|---|---|---|---|
| $U_{i\,nom}$, $I_{o\,nom}$ | Input voltage | 60 | 110 | 220 | V |
| $I_{inr\,p}$ | Peak inrush current | 6.8 | 7.4 | 14.6 | A |
| $t_{inr}$ | Inrush current duration | 18 | 14 | 16 | ms |
| $U_{i\,nom}$, $I_{o\,nom}$ | Input voltage | 140 | 220 | 380 | V |
| $I_{inr\,p}$ | Peak inrush current | 9.3 | 14.5 | 25.3 | A |
| $t_{inr}$ | Inrush current duration | 20 | 14 | 12 | ms |

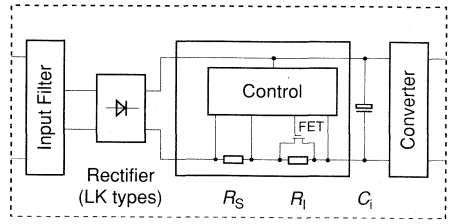
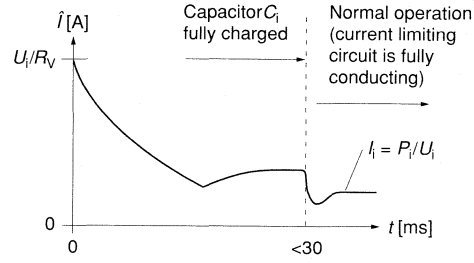



*Fig. 18*
*Option E block diagram*




$R_V$: *Current limiting resistance* = $R_S + R_I = 15\ \Omega$

*Fig. 19*
*Inrush current with option E*

**Precaution:**
Subsequent switch-on cycles at start-up are limited to max. 10 cycles during the first 20 seconds (cold unit) and at continuing on/off ($T_C$ = 95°C) max. 1 cycle every 8 sec.

**Option P** Potentiometer

The potentiometer provides an output voltage adjustment range of +10/–60% of $U_{o\,nom}$ and is accessible through a hole in the front cover. This feature enables compensation for voltage drops across the connector and wiring. Option P is not recommended if units are connected in parallel.

Option P excludes the R-function. With double output units both outputs are affected by the potentiometer setting (doubling the voltage setting if the outputs are in series).

If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output current(s) should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.

**Option T** Current Sharing

This option ensures that the output currents are approximately shared between all paralleled modules and increases system reliability. To use this facility, simply interconnect the T pins of all modules and make sure, that pins no. 14, the S– pins (K 1000) or the Vo1– pins (K 2000) are also connected together. The load leads should have equal length and cross section to ensure equal voltage drops. Not more than 5 units should be connected in parallel. If output voltage adjustment is requested we strongly recommend to use the R-input instead of option P, as with option P the required setting accuracy is difficult to achieve. The output voltages must be individually set prior to paralleling to within a tolerance of 1...2% or the R pins should be connected together.

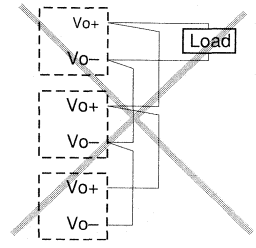
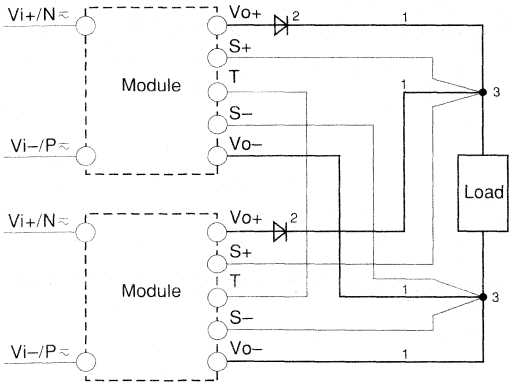



*Fig. 20*
*An example of poor wiring for connection in parallel*


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[1] Leads should have equal length and cross sections and should run in the same cable loom.
[2] Diodes recommended in redundant operation only
[3] DC common point

*Fig. 21*
*Paralleling of single output units using option T with the sense lines connected at the load*

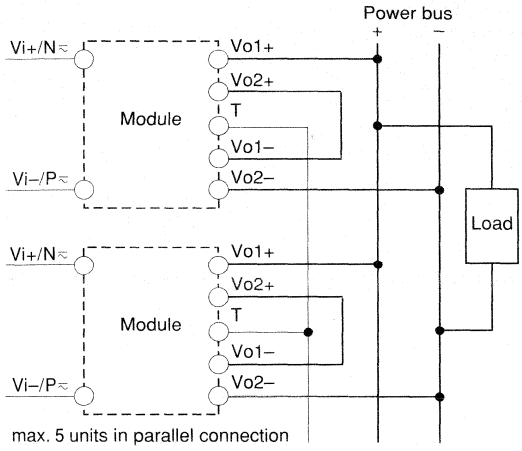



*Fig. 22*
*Paralleling of double output units using option T*

## Option D

General description

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 20 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1–. The D output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D0...DD as shown in the following table.

*Table 14: Undervoltage monitor functions*

| Output type | | Monitoring | | Minimum adjustment range of threshold level $U_t$ | | Hysteresis $U_h$ typ [% of $U_t$] for $U_{t\,min}...U_{t\,max}$ | |
|---|---|---|---|---|---|---|---|
| JFET | NPN | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| D1 | D5 | no | yes | - | 3...40 V [1] | - | 2.5...0.6 |
| D2 | D6 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | - | 3.4...0.4 | - |
| D3 | D7 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | (0.95...0.985 $U_{o1}$) [2] | 3.4...0.4 | "0" |
| D4 | D8 | no | yes | - | (0.95...0.985 $U_{o1}$) [2] | - | "0" |
| D0 | D9 | no | yes | - | 3...40 V [3] | - | 2.5...0.6 |
| | | yes | no | $U_{i\,min}...U_{i\,max}$ [3 4] | - | 3.4...0.4 | - |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | 3...40 V [3] | 3.4...0.4 | 2.5...0.6 |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | (0.95...0.985 $U_{o1}$) [2] | 3.4...0.4 | "0" |
| - | DD | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 3...40 V [1] | 3.4...0.4 | 2.5...0.6 |

[1] Threshold level adjustable by potentiometer
[2] Fixed value (0.95...0.98 • $U_{o1}$). $U_{o1}$ adjustable via R-input, option P or sense lines.
[3] The threshold level permanently adjusted according to customer specification ±2% at 25°C. Any value within the specified range is basically possible but causes a special type designation in addition to the standard option designations (D0/D9 respectively)!
[4] Adjusted at $I_{o\,nom}$

JFET output (D0...D4):

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $U_D \leq 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $< U_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_D \leq 0.4$ V at $I_D = 2.5$ mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_D \leq 25$ µA at $U_D = 5.25$ V |

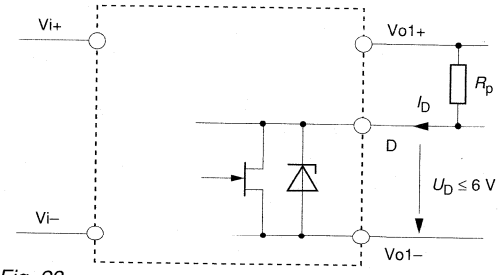



*Fig. 23*
*Option D1...D0: JFET output, $I_D \leq 2.5$ mA*

NPN output (D5...DD):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D < 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $> U_t + U_h$. The current $I_D$ through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. $U_D$ should not exceed 40 V.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | high, H, $I_D \leq 25$ µA at $U_D = 40$ V |
| $U_i$ and $U_{o1} > U_t + U_h$ | low, L, $U_D \leq 0.4$ V at $I_D = 20$ mA |

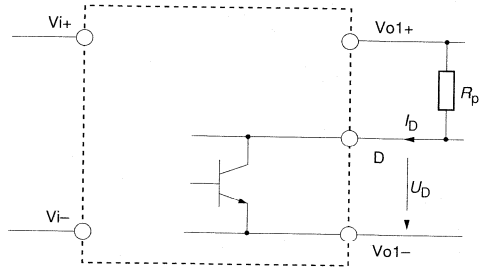



*Fig. 24*
*Option D5...DD: NPN output, $U_{o1} \leq 40$ V, $I_D \leq 20$ mA*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage after the input filter and rectifier (LK types) is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold levels of the D0 and D9 options are factory adjusted at nominal output current $I_{o\,nom}$ and at $T_A = 25$°C. The value of $\Delta U_{t\,i}$ depends upon the input voltage range (CK, DK, ..), threshold level $U_t$, temperature and input current. The input current is a function of the input voltage and the output power.

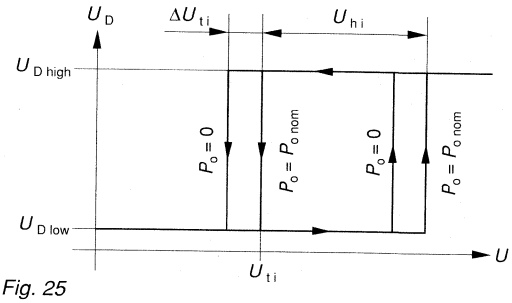


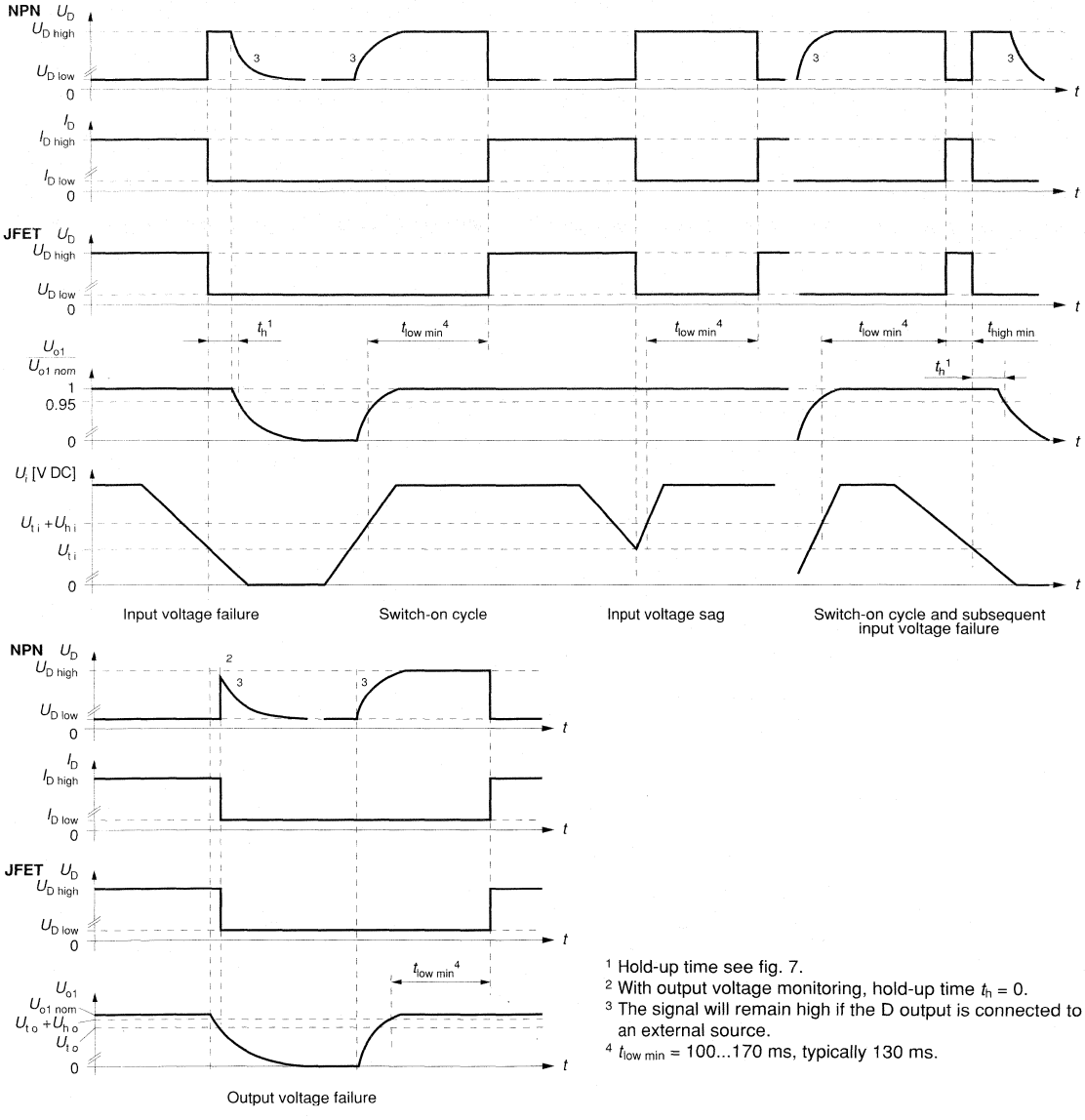

*Fig. 25*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $\Delta U_{h\,i}$ (JFET output)*

*Table 15: D-output logic signals*

| Version of D | $U_i < U_t$ resp. $U_o < U_t$ | $U_i > U_t + U_h$ resp. $U_o > U_t$ | Configuration |
|---|---|---|---|
| D1, D2, D3, D4, D0 | low | high | JFET |
| D5, D6, D7, D8, D9, DD | high | low | NPN |


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D-signal with respect to input and output voltage versus time:




[1] Hold-up time see fig. 7.
[2] With output voltage monitoring, hold-up time $t_h = 0$.
[3] The signal will remain high if the D output is connected to an external source.
[4] $t_{low\,min}$ = 100...170 ms, typically 130 ms.

*Fig. 26*
*Relationship between $U_i$, $U_{o1}$, $U_D$, $U_{o1}/U_{o\,nom}$ versus time*

### Option V

This option defines an undervoltage monitoring circuit for the input and/or main output voltage ($U_{o1\ nom}$ = 5.1 V only) equivalent to option D and generates an ACFAIL signal (V signal) which conforms to the VME standard.

The low state level of the ACFAIL signal is specified at a sink current of $I_V \leq 48$ mA to $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME motherboard.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V when the output is fully loaded. This hold-up time $t_h$ is provided by the internal input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\ min}$ of the converter so that enough energy is remaining in the input capacitance. If the input voltage is below the required level, an external hold-up capacitor ($C_{i\ ext}$) should be added.

Formula for threshold level for desired value of $t_h$:

$$U_{t\,i} = \sqrt{\frac{2 \cdot P_o \cdot (t_h + 0.3\ \text{ms}) \cdot 100}{C_{i\ min} \cdot \eta} + U_{i\ min}^2}$$

Formula for the external input capacitor:

$$C_{i\ ext} = \frac{2 \cdot P_o \cdot (t_h + 0.3\ \text{ms}) \cdot 100}{\eta \cdot (U_{t\,i}^2 - U_{i\ min}^2)} - C_{i\ min}$$

where as:

$C_{i\ min}$ = internal input capacitance [mF]
$C_{i\ ext}$ = external input capacitance [mF]
$P_o$ = output power [W]
$\eta$ = efficiency [%]
$t_h$ = hold-up time [ms]
$U_{i\ min}$ = minimum input voltage [V] [1]
$U_{t\,i}$ = threshold level [V]

[1] Min. input voltage according to "Electrical Input Data". For output voltages $U_o > U_{o\ nom}$, the minimum input voltage increases proportionally to $U_o/U_{o\ nom}$.

Remarks:

Option V2 and V3 can be adjusted by potentiometer to a threshold level between $U_{i\ min}$ and $U_{i\ max}$. A decoupling diode should be connected in series with the input of AK...FK converters to avoid the input capacitance discharging through other loads connected to the same source voltage. (An external input capacitor cannot be applied to AC powered LK units unless an additional rectifier is provided).

*Table 16: Available internal input capacitance and factory potentiometer setting of $U_{t\,i}$ with resulting hold-up time*

| Types | AK | BK | FK | CK | DK | EK | LK | Unit |
|---|---|---|---|---|---|---|---|---|
| $C_{i\ min}$ | 0.83 | 0.3 | 1.2 | 0.66 | 0.26 | 0.21 | 0.21 | mF |
| $U_{t\,i}$ | 9.5 | 19.5 | 39 | 39 | 61 | 97 | 120 | V DC |
| $t_h$ | 0.1 | 0.1 | 3.4 | 1.1 | 1.1 | 2.7 | 4.2 | ms |

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 20 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1–. The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by potentiometer, accessible through a hole in the front cover, or is adjusted during manufacture to a determined customer specified value.

Versions V0, V2 and V3 are available as shown below.

*Table 17: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level | | Typical hysteresis for $U_{t\ min}...U_{t\ max}$ [% of $U_t$] | |
|---|---|---|---|---|---|---|
| | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| V2 | yes | no | $U_{i\ min}...U_{i\ max}$ [1] | – | 3.0...0.5 | – |
| V3 | yes | yes | $U_{i\ min}...U_{i\ max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| V0 | yes | no | $U_{i\ min}...U_{i\ max}$ [3 4] | – | 2.2...0.4 | – |
| | yes | yes | $U_{i\ min}...U_{i\ max}$ [3 4] | 0.95...0.98 $U_{o1}$ [2] | 2.2...0.4 | "0" |

[1] Threshold level adjustable by potentiometer [2] Fixed value between 95% and 98% of $U_{o1}$ (tracking) [3] Adjusted at $I_{o\ nom}$
[4] Fixed value, resistor-adjusted (±2% at 25°C) acc. to customer's specifications; individual type number is determined by Melcher

V output (V0, V2, V3):

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $< U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $U_V$ should not exceed 80 V.

| $U_i$, $U_{o1}$ status | V output, $U_V$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_V \leq 0.6$ V at $I_V$ = 50 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_V \leq 25$ µA at $U_V$ = 5.1 V |

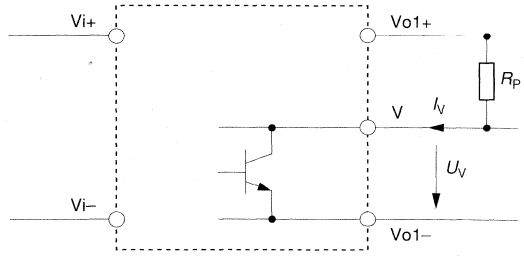



*Fig. 27*
*Output configuration of options V0, V2 and V3*


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Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage is measured after the input filter and rectifier (LK types). Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold level of option V0 is adjusted during manufacture at $I_{o\,nom}$ and $T_A = 25°C$. The value of $\Delta U_{t\,i}$ depends upon the input voltage range (AK, BK, ...), threshold level $U_t$, temperature and input current. The input current is a function of input voltage and output power.

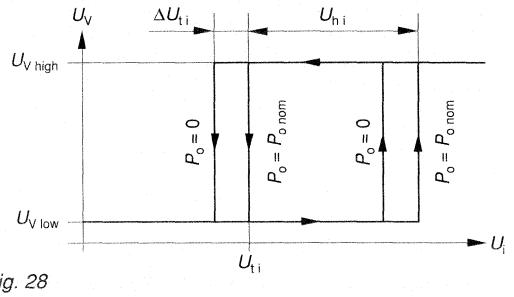
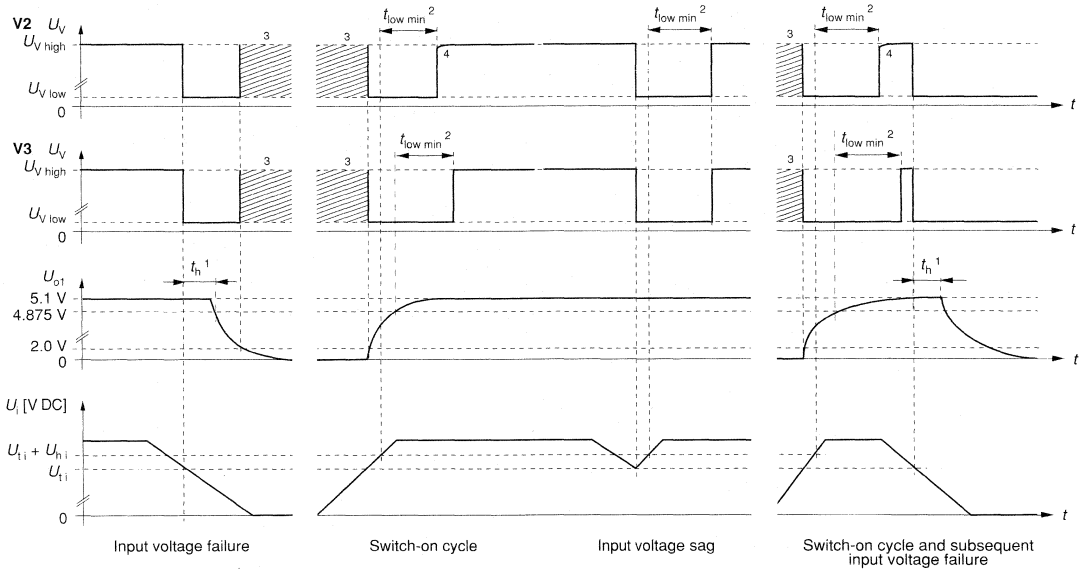
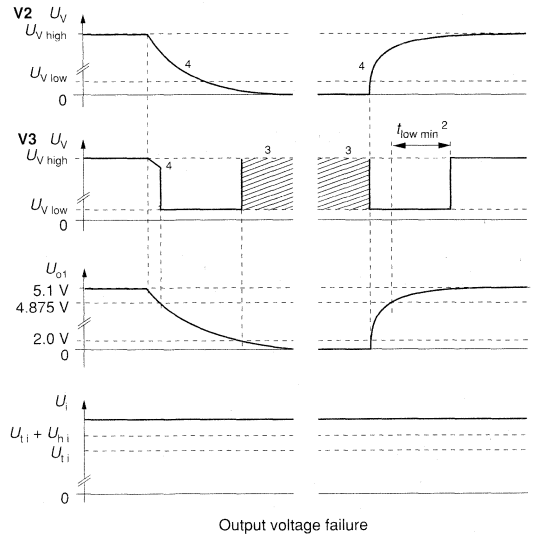



*Fig. 28*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$*




[1] VME request: minimum 4 ms
[2] $t_{low\,min}$ = 40...200 ms, typically 80 ms
[3] $U_V$ level not defined at $U_{o1} < 2.0$ V
[4] The V signal drops simultaneously with the output voltage. If the pull-up resistor $R_P$ is connected to Vo1+. The V signal remains high if $R_P$ is connected to an external source.

*Fig. 29*
*Relationship between $U_i$, $U_{o1}$, $U_V$, $I_V$ and $U_{o1}/U_{o\,nom}$ versus time.*

**Option B1** Cooling Plate (see "Mechanical Data")

Where a cooling surface is available, we recommend the use of a cooling plate (option B1) instead of the standard heatsink. The mounting system should ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The cooling capacity is calculated by:

$$P_{Loss} = \frac{(100\% - \eta)}{\eta} (U_o \bullet I_o)$$

Efficiency $\eta$ see tables 1a, b, c

## Immunity to Environmental Conditions

*Table 18: Mechanical stress*

| Test | | Standard | Test Parameters | |
|---|---|---|---|---|
| Ca | Damp heat<br>steady state | DIN 40046, part 5<br>IEC 68-2-3<br>MIL-STD 810D section 507.2 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{+2/-3}$ %<br>56 days<br>Unit not operating |
| Ea | Shock<br>(half-sinusoidal) | DIN 40046, part 7<br>IEC 68-2-27<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock<br>(half-sinusoidal) | DIN 40046, part 26<br>IEC 68-2-29<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration<br>(sinusoidal) | DIN 40046, part 8<br>IEC 68-2-6<br>MIL-STD 810D section 514.3 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s²<br>7.5 h (2.5 h each axis)<br>Unit operating |
| Kb | Salt mist<br>cyclic<br>(sodium chloride NaCl<br>solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Storage duration:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% rel. humidity<br>22 h per cycle<br>3<br>Unit not operating |

*Table 19. Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Standard operational ambient temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –25 | 71 | °C |
| $T_A$ | Extended operational ambient temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 71 | |
| $T_C$ | Standard operational case temperature range -7, overtemp. lock-out (PTC) at $T_C$ > 95°C | –25 | 95 | |
| $T_C$ | Extended operational case temperature range -9, overtemp. lock-out (PTC) at TC > 95°C | –40 | 95 | |
| $T_S$ | Storage temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 100 | |
| $T_S$ | Extended storage temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –55 | 100 | |

### Thermal Considerations

Operation at ambient temperatures of 71...85°C with convection cooling will limit the maximum output power to 40% (approx.) of the nominal value. Forced cooling (additional heat sink, fan, etc.) allows operation of the power supply at nominal output power up to an ambient temperature of 85°C, as long as the maximum case temperature $T_{C\,max}$ (95°C) is not exceeded. The case temperature measuring point is shown on fig. 31.

In applications where modules operate in parallel, option T (current sharing) should be used.

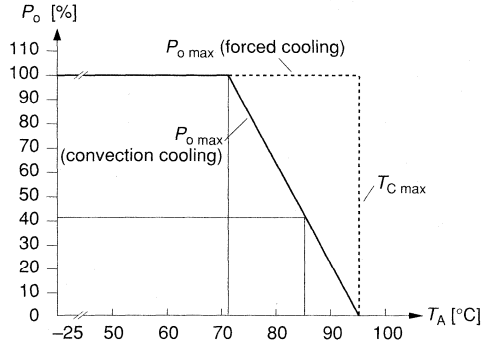



*Fig. 30*
*Output power derating versus $T_A$*

*Table 20: MTBF*

| Values at Specified Case Temperature | Type | Ground Benign 40°C | Ground Fixed 40°C | Ground Fixed 70°C | Ground Mobile 50°C | Unit |
|---|---|---|---|---|---|---|
| MIL-HDBK 217F, (CK 1301-7R) | CK...LK | 500'000 | 150'000 | 80'000 | 50'000 | h |


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## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

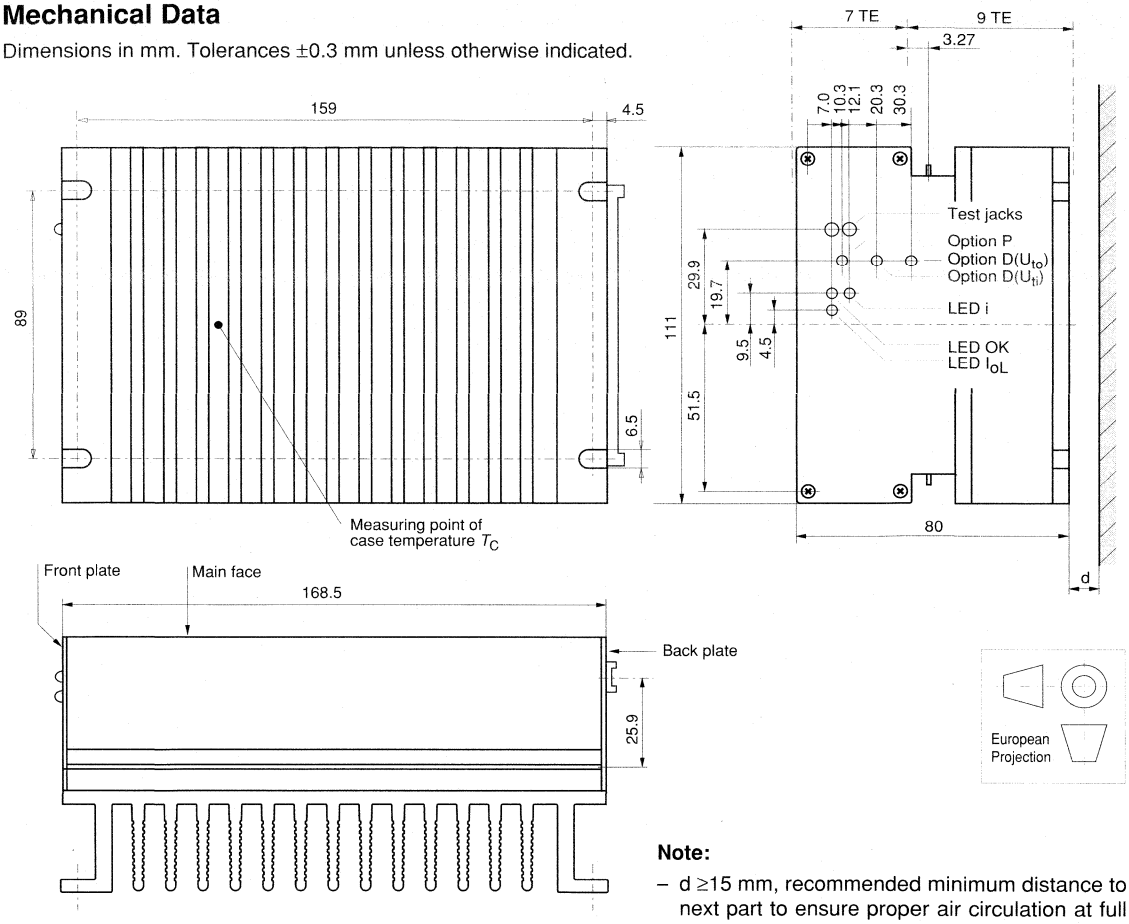



*Fig. 31*
*Case K02 with heatsink*
*Total weight: Approx. 1.55 kg*

**Note:**

- d ≥15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power.
- free air locations: the module should be mounted with fins in vertical position to achieve a maximum air flow through heat sink.

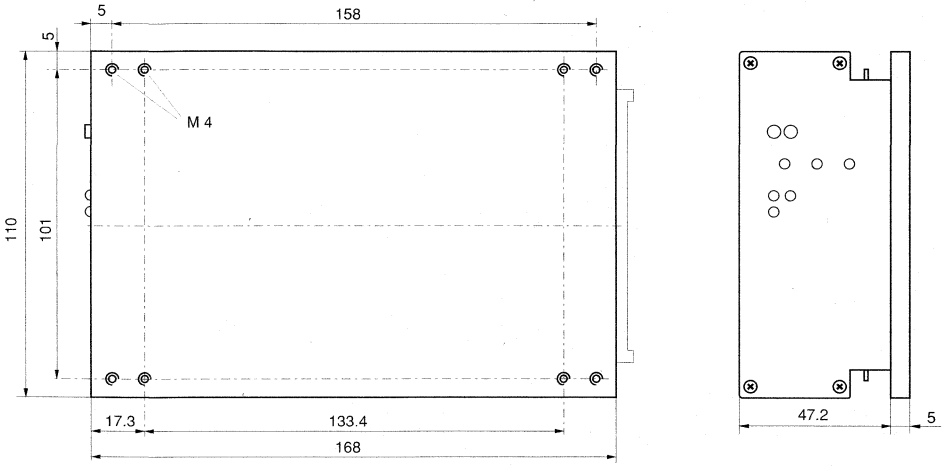
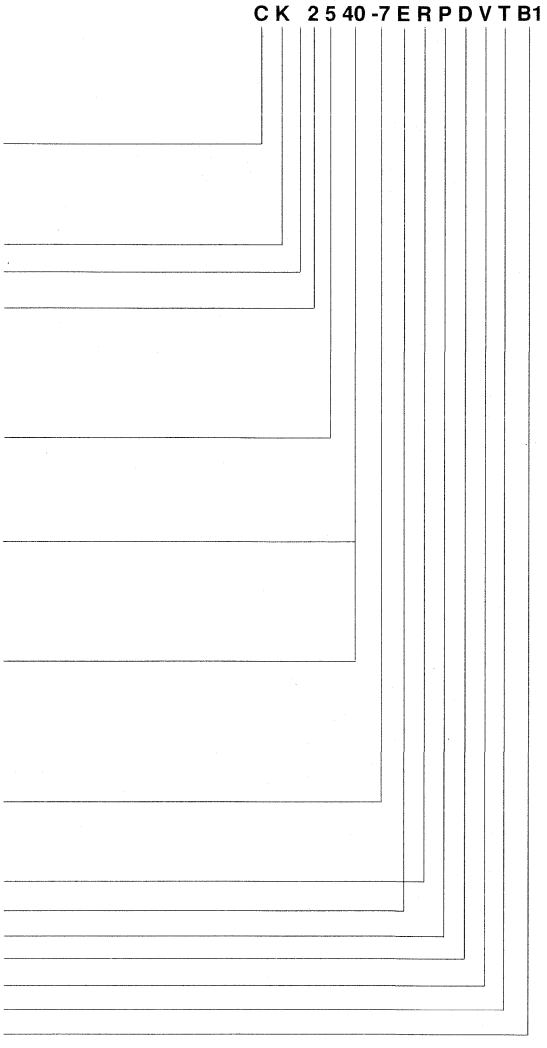



*Fig. 32*
*Case K02 with option B1 (cooling plate)*
*Total weight: Approx. 1.15 kg*

## Type Key and Product Marking

### Type Key




Input voltage range $U_i$:
- 8...35 V DC ..... A
- 14...70 V DC ..... B
- 28...140 V DC ..... C
- 44...220 V DC ..... D
- 67...385 V DC [1] ..... E
- 20...100 V DC ..... F
- 88...372 V DC (85...264 V AC) ..... L

Family ..... K

Blank .....

Number of outputs ..... 1...2

Single output units:

Nominal voltage output 1 (main output), $U_{o1\ nom}$
- 5.1 V ..... 0, 1, 2
- 12 V ..... 3
- 15 V ..... 4, 5
- 24 V ..... 6
- other voltages ..... 7, 8

Other specifications for single output modules ..... 01...99

Symmetrical double output units:

Nominal voltage output 1/output 2, $U_{o1/2\ nom}$
- 12 V/12 V [2] (24 V series conn. [3]) ..... 20
- 5 V/15 V [2] (30 V series conn. [3]) ..... 40
- 24 V/24 V [2] (48 V series conn. [3]) ..... 60
- other symmetrical voltages ..... 70...99

Operational ambient temperature range $T_A$:
- –25...50°C ..... -5
- –25...60°C ..... -6
- –25...71°C ..... -7
- –40...71°C (optional) ..... -9
- customer specific ..... -0

Feature: Output voltage control input [4] ..... R

Options:
- Inrush current limitation [5] ..... E
- Potentiometer (output voltage adjustment) [4] ... P
- Save data signal (D0...DD, to be specified) [6] . D
- ACFAIL signal (V0, V2, V3, to be specified) [6] . V
- Current sharing ..... T
- Cooling plate ..... B1

[1] EK- types available upon customer request.
[2] External wiring of main and second output depending upon the desired output configuration (see fig. 16b, c, d or e).
[3] External wiring of main and second output (see fig.16a).
[4] Feature R excludes option P and vice versa.
[5] Option E available for C, D, E and LK types.
[6] Option D excludes option V and vice versa.

Example: CK 2540-7PD3: DC-DC converter, input voltage range 28...140 V, double output, each providing 15 V/5 A, equipped with potentiometer and undervoltage monitor option.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LED's, test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltages and output currents, pin allocation of options and auxiliary functions, fuse specification and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main PCB and date of production.

# 8 AC-DC Converters <30 W

## 8.1 Rugged Environment



## 8.2 Industrial Environment

| Output [W] 5 7.5 10 15 20 30 | Output [V DC] 5 6 12 15 18 24 48 | Input [V DC] 85 110 135 180 220 264 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | VEW | various | 8 - 10 |

## 8.3 Benign Environment

| Output [W] 5 7.5 10 15 20 30 | Output [V DC] 5 6 12 15 18 24 48 | Input [V DC] 85 110 135 180 220 264 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | (multiple) | | LW | various | 8 - 15 |
| | (multiple) | | MW | various | 8 - 21 |
| | | | PE | various | 8 - 27 |
| | | | PS | various | 8 - 31 |
| | (multiple) | | PT | various | 8 - 37 |
| | | | SW | various | 8 - 43 |
| | | | VRW | various | 8 - 50 |

(Several power ranges available)

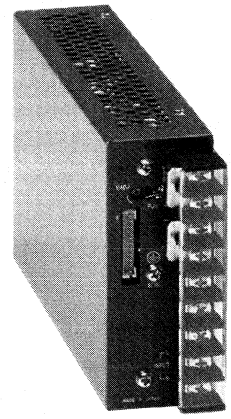
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# 20/30 W AC-DC Converters

# VSR-Family

**Single output**

- 110 V AC and 230 V AC input (auto selectable)
- 3750 $V_{rms}$ input to output isolation
- Wide power range up to 2 • $P_{o\,nom}$ temporarily
- Excellent line/load regulation
- High level of electromagnetic compatibility
- Safety standards: UL 478, CSA 22.2, TUV approved



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## Type Survey

*Table 1: Type survey*

| Output $U_{o\,nom}$ V DC | Output $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 71°C$ | Type designation |
|---|---|---|---|---|
| 5 | 4.0 | 85...132 V AC/47...440 Hz or 170...264 V AC/47...440 Hz 230...330 V DC manually or auto selectable | 20 W | VSR 20-5 |
| | 6.0 | | 30 W | VSR 30-5 |
| 12 | 1.67 | | 20 W | VSR 20-12 |
| | 2.5 | | 30 W | VSR 30-12 |
| 15 | 1.33 | | 20 W | VSR 20-15 |
| | 2.0 | | 30 W | VSR 30-15 |
| 24 | 0.83 | | 20 W | VSR 20-24 |
| | 1.25 | | 30 W | VSR 30-24 |
| 48 | 0.42 | | 20 W | VSR 20-48 |
| | 0.63 | | 30 W | VSR 30-48 |

## Description

The VSR series of switching power supplies is a single output series of AC-DC converters. Compact size and high reliability make the VSR series an excellent choice. The units provide sense lines, inhibit, output undervoltage monitor, output voltage adjustment and output overvoltage protection. Five standard single output ratings are available. Several units can be connected in parallel with current sharing facility.

**Key applications**

Factory automation, off-site test and measurement, and communications equipment.

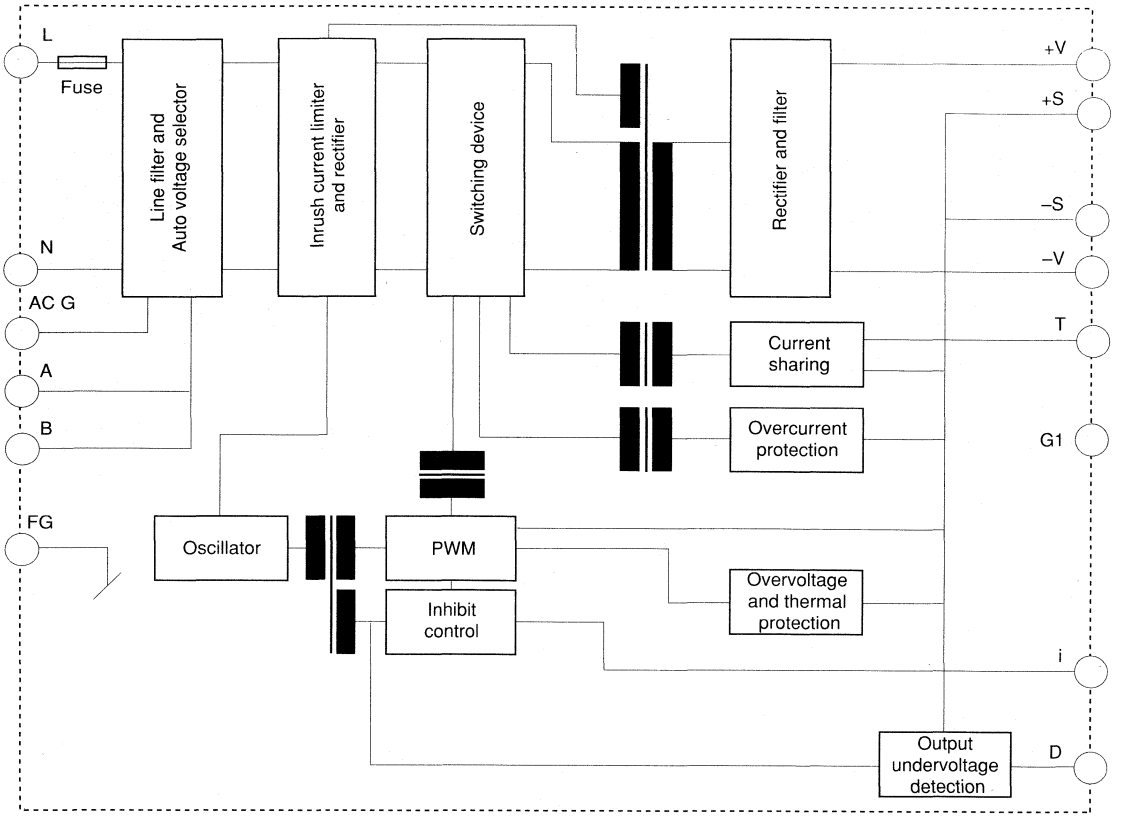



*Fig. 1*
*Block diagram VSR 20/30*

## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | VSR 20- .. | VSR 30- .. | Unit |
|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 100-120/200-240 | | V AC |
| $U_i$ | Input voltage range | | 85...132/170...265 [1] | | |
| | | | 230...330 [2] | | V DC |
| $f_i$ | Line frequency | | 47...440 | | Hz |
| $I_i$ | Input current [3] | typ. | 0.6/0.3 | 0.75/0.42 | A |
| $I_{inr}$ | Inrush current | max. | 4.5/9.0 | 6.8/13.5 | |
| $I_{i\ leak}$ | Leakage current | max. | 0.11/0.3 | 0.2/0.35 | mA |

[1] Manually or auto selectable
[2] Refer to table 4 also
[3] At rated input and output


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General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3a: Output data 20 W types*

| Type | | VSR 20-05 | VSR 20-12 | VSR 20-15 | VSR 20-24 | VSR 20-48 | |
|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\,adj}$ | Adjustable voltage range | ±10 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 3.5 | 1.5 | 1.3 | 0.9 | 0.4 | A |
| $I_o$ | Output current range min./max. | 0...200 | | | | | % |
| $u_o$ | Ripple-noise [1] max. | 50 | 60 | 60 | 80 | 100 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation $U_{i\,min}...U_{i\,max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±0.4 | | | | | |
| $\alpha u_o$ | Temperature coefficient max. | ±0.03 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 260 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.0...6.5 | 14.4...15.6 | 18.0...19.5 | 28.8...31.2 | 57.6...62.4 | V |
| $t_{Uo\,r}$ | Rise time [1] typ. | 50 | | | | | ms |
| $t_h$ | Hold-up time [1] typ. | 20 | | | | | |
| $\eta$ | Effciency [1] typ. | 68 | 70 | 70 | 73 | 73 | % |
| +S/–S | Remote sensing | provided | | | | | |
| i | Inhibit, remote on/off | provided | | | | | |
| V | DC power fail signal (open collector) | 30 V/20 mA | | | | | |
| | Output indicator | LED | | | | | |
| | Outputs connected in series | possible | | | | | |
| | Outputs connnected in parallel | possible, with current sharing facility | | | | | |

*Table 3b: Output data 30 W types*

| Type | | VSR 30-05 | VSR 30-12 | VSR 30-15 | VSR 30-24 | VSR 30-48 | |
|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\,adj}$ | Adjustable voltage range | ±10 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 6 | 2.5 | 2.0 | 1.25 | 0.63 | A |
| $I_o$ | Output current range min./max. | 0...200 | | | | | % |
| $u_o$ | Ripple-noise [1] max. | 50 | 60 | 60 | 80 | 100 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation $U_{i\,min}...U_{i\,max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±0.4 | | | | | |
| $\alpha u_o$ | Temperature coefficient typ. | ±0.03 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 260 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.0...6.5 | 14.4...15.6 | 18.0...19.5 | 28.8...31.2 | 57.6...62.4 | V |
| $t_{Uo\,r}$ | Rise time [1] typ. | 80 | | | | | ms |
| $t_h$ | Hold-up time [1] typ. | 20 | | | | | |
| $\eta$ | Effciency [1] typ. | 68 | 70 | 70 | 73 | 73 | % |
| +S/–S | Remote sensing | provided | | | | | |
| i | Inhibit, remote on/off | provided | | | | | |
| V | DC power fail signal (open collector) | 30 V/20 mA | | | | | |
| | Output indicator | LED | | | | | |
| | Outputs connected in series | possible | | | | | |
| | Outputs connnected in parallel | possible, with current sharing facility | | | | | |

[1] At rated input and output
[2] Operating in constant current method, automatic recovery. The unit will switch-off if overcurrent with output voltage below threshold level occurs for more than 5 s. Turn-on by brief removal of the input voltage
[3] Shut down of output. Turn-on by brief removal of the input voltage

# Operation Instructions

### AC Input Voltage Range Selection

The AC input voltage range can be selected by means of wiring, a relay contact or a TTL signal on the main connector barrier as per the following table:

*Table 4: Input voltage range selection*

| Input voltage range | Terminals A and B |
|---|---|
| 85...132 V AC | interconnected |
| 170...265 V AC<br>230...330 V DC | open<br>(not connected) |

### Input Undervoltage Cut-out

Input voltages lower than 65...75 or 130...150 V AC respectively will shut down the power supply. If the input voltage level returns to the specified range, the power supply resets automatically.

### Output Power Rating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 2. If the power supply is used at an ambient temperature of 0...40°C, the output power may be increased up to 200% of the rated value.

### Output Voltage Adjustment

The output voltage may be adjusted within ±10% of $U_{o\ nom}$ by means of the internal potentiometer. If the output voltage setting should be excessively high, the overvoltage protection circuit may shut-down the output.

### Sense Lines (S)

Remote sensing provides compensation of voltage drops between power supply and load, caused by connectors and load feeding wires. The sense lines should consist of shielded cables or be twisted. If remote sensing is not required, the +S should be connected to the +V and the –S to the –V terminals respectively applying shortest possible links. The compensation range is 10% of $U_{o\ nom}$.

### Output Undervoltage Monitor (D)

If the output voltage drops below 75...80% of its nominal value, the monitoring circuit consisting of an opto-coupler with an open collector output ($V_{CE\ max}$ = 30 V, $I_{C\ max}$ = 20 mA), generates across an external pull-up resistor a power fail signal (a logic "H", high signal).

### Output Overvoltage Protection

If the built-in overvoltage protection circuit becomes active, the output is shut down and a reset can only be achieved by brief removal of the input voltage after a minimum interval time.

### Output Overload Protection

An overload condition at the output of more than 5 seconds duration will cause a shut-down of the output. A reset can only be achieved by brief removal of the input voltage after a minimum interval time.

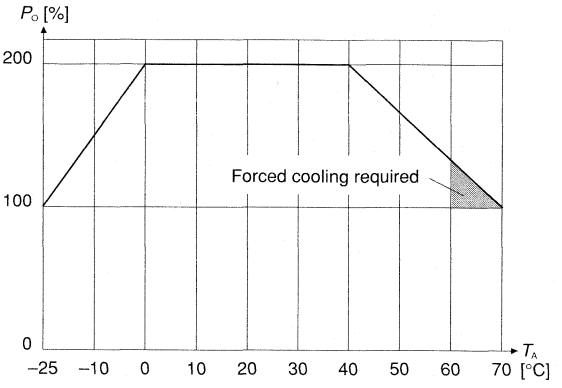



*Fig. 2:*
*Output power vs. ambient temperature*

### Inhibit (i)

The output may be enabled or disabled by means of a logic signal (TTL, CMOS etc.) or a mechanical contact applied to the inhibit input which is isolated from input and output by means of an opto-coupler. This provides independency from other voltages polarity. If the inhibit function is not required, connect the inhibit input i (pins 3/4) to return pin G1 (pins 1/2) to enable the output (active low logic, fail safe).

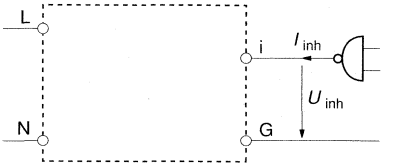



*Fig. 3:*
*Definition of inhibit voltage and current*

*Table 5: Inhibit characteristics*

| Characteristic | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\ min}$...$U_{i\ max}$ | –0.7 | | 0.8 | V |
| | | $U_o$ = off | | 2.0 | | 7 | |
| $I_{inh}$ | Inhibit sink curr. | | $U_{inh}$ = 0 | | 3.5 | | mA |

### Thermal Protection

If the temperature inside the module should exceed approx. 85...95°C, the thermal protection circuit will shut down the power supply. Having turned-off and cooled down the power supply, it will automatically reset when re-powering the input.


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### Outputs Connected in Series

Two or more units supplying the same or different output voltages may be connected in series. The value of the maximum output current to be taken is defined by that unit providing the lowest current limiting value. It should be assured that the outputs do not feed backwards into each other caused by their different rise/fall times at switch-on/off cycles by adding reverse polarity diodes across each output.

### Outputs Connected in Parallel, Current Sharing (T)

Two or more units supplying equivalent output voltages may be connected in parallel to enhance the total output power. It has to be assured that all output voltages are set to identical values before parallel wiring takes place. The load feeding lines should all be of identical specification. One each of the two T pins (current sharing facility) of each unit should be interconnected with one each of the two T pins of the parallel connected units. The units then show approximately equal load currents.

In back-up (redundant) operation, the T pins should not be interconnected. Each output should be decoupled by application of a series diode connected in the positive output path.

### Grounding Recommendations

A single power supply should be wired to the AC input by interconnecting the ACG (AC Ground) terminal with the FG (Frame Ground) terminal and both together to the protective earth.

With several modules connected in parallel, EMC and leakage currents in accordance with safety standard recommendations may no longer be met. In such cases, an external noise filter should be added in order to minimize RFI noise and to avoid summarization of the individual leakage currents caused by each module's filter. Therefore the ACG terminals (AC Ground) should not be connected. The FG terminals (Frame Ground) but must be connected directly to the protective earth (see fig. 4).

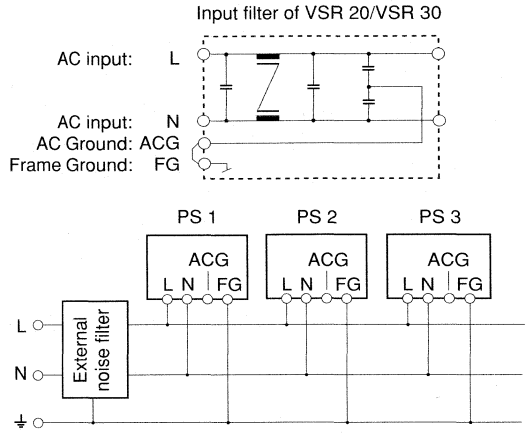
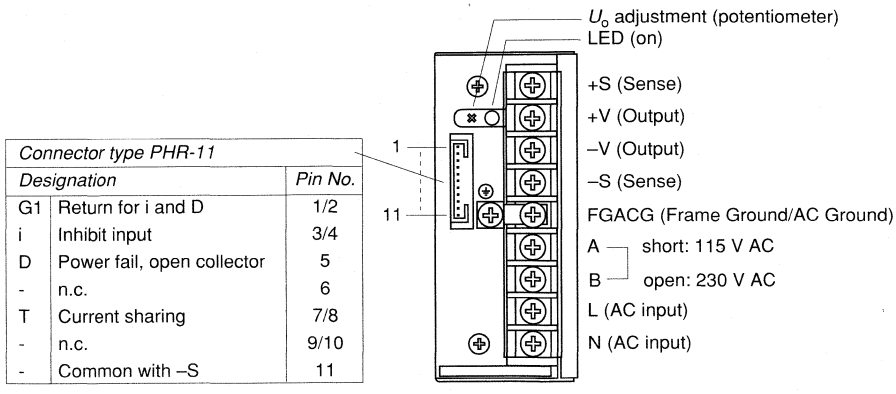



*Fig. 4:*
*Block diagram of input filter and input wiring of parallel connected modules using an external noise filter*

## Input and Output Terminals




| *Connector type PHR-11* | | |
|---|---|---|
| *Designation* | | *Pin No.* |
| G1 | Return for i and D | 1/2 |
| i | Inhibit input | 3/4 |
| D | Power fail, open collector | 5 |
| - | n.c. | 6 |
| T | Current sharing | 7/8 |
| - | n.c. | 9/10 |
| - | Common with –S | 11 |

*Fig. 5:*
*Terminal designation of VSR 20/30 types*

## Immunity to Environmental Conditions

*Table 6: Mechanical Stress, Impulse Votages, High Frequency Disturbances,*

| Test Method | Test conditions | | Status |
|---|---|---|---|
| Damp heat steady state | Temperature:<br>Relative himidity: | 40 $^{\pm 2}$ °C<br>30...95 $^{-3/+2}$ % | Operating |
| Shock (half-sinusoidal) | Acceleration amplitude: | 20 $g_n$ = 981 m/s$^2$ | Operating |
| Vibration (sinusoidal) | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...55 Hz<br>0.83 mm (55 Hz)<br>5 $g_n$ = 49 m/s$^2$<br>3 h (1 h each axis) | Operating |
| Electrostatic discharge | | 15 kV | Not operating |
| Electrical fast transient | | 2 kV (50...100 µs) | Operating |
| Surge immunity | | 5 kV (1,2/50 µs; 3 times) | Operating |
| Damped oscillating wave (IEEE 472) | | 2.5 kV (50/sec; 1 MHz; 150 Ω) | Operating |

*Table 7: Temperature*

| Characterisitcs | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –20 | 71 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | –20 | 85 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 85 | |

*Table 8: MTBF Values*

| MTBF | Ground Benign | Ground Fixed |
|---|---|---|
| MTBF according to MIL-HDBK-217E | $T_C$ = 40°C | $T_C$ = 40°C |
| VSR 20 types | 479'000 h | 155'000 h |
| VSR 30 types | 435'000 h | 134'000 h |

*Table 9: Isolation*

| Test | Input to output | Input to case | Output to case | Unit |
|---|---|---|---|---|
| Electric strenght test voltage (1 min) | 3750 | 2500 | 500 | V AC |
| Isolation resistance (500 V DC) | >100 | >100 | >100 | MΩ |

*Table 10: Electromagnetic Emmission*

| Standard | Maintained level |
|---|---|
| VDE 0871 | < A |
| FCC 20880 (VCCI) | < A |

*Table 11: Safety Approvals*

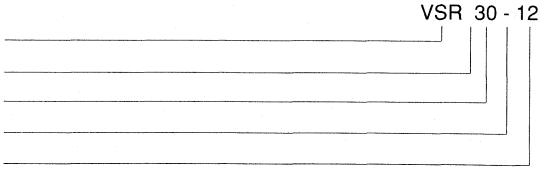
| Safety Approvals | UL 478 | CSA [1] | TÜV |
|---|---|---|---|
| VSR 30-5...VSR 30-24 | x | level 3 | x |
| VSR 20-48 | x | level 1 | x |
| VSR 30-5...VSR 30-24 | x | level 3 | x |
| VSR 30-48 | x | level 1 | x |

[1] CSA 22.2 No. 0-M 1982

## Type Key and Product Marking

### Type Key

Family ..... VSR
Blank .....
Nominal output power [W] ..... 20/30
Dash .....
Nominal output voltage [V] ..... 5...48




Example: VSR 30-12 = AC-DC converter providing 12 V/2.5 A, 30 W output, output undervoltage monitor and inhibit control.

### Produkt Marking

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.


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## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated

European Projection

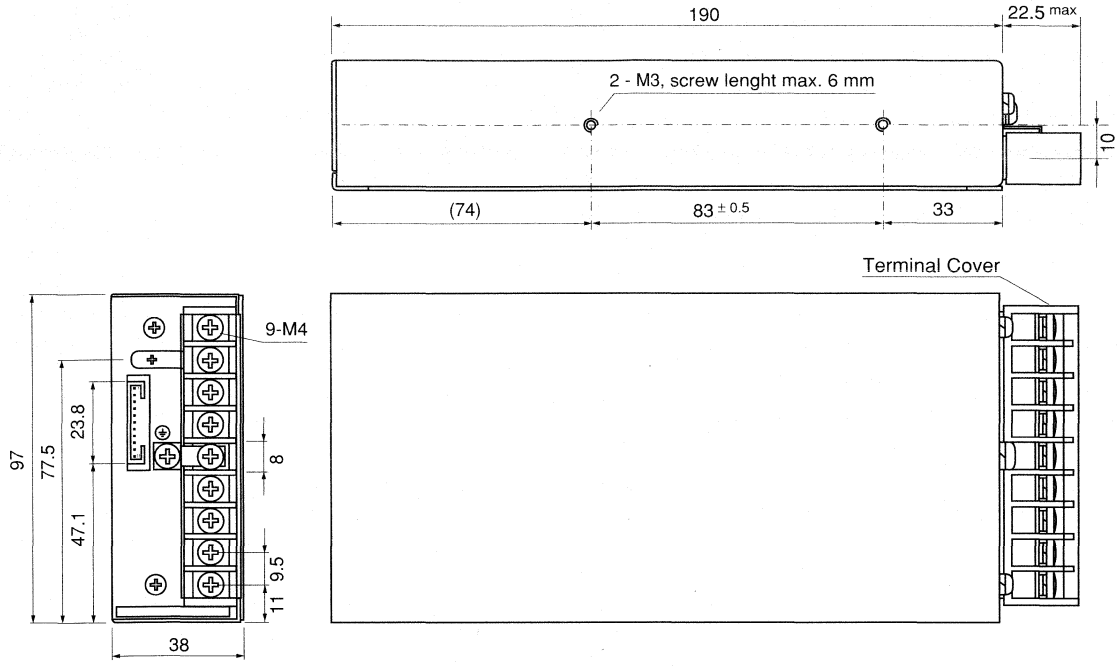



*Fig. 6:*
*VSR 20 types*

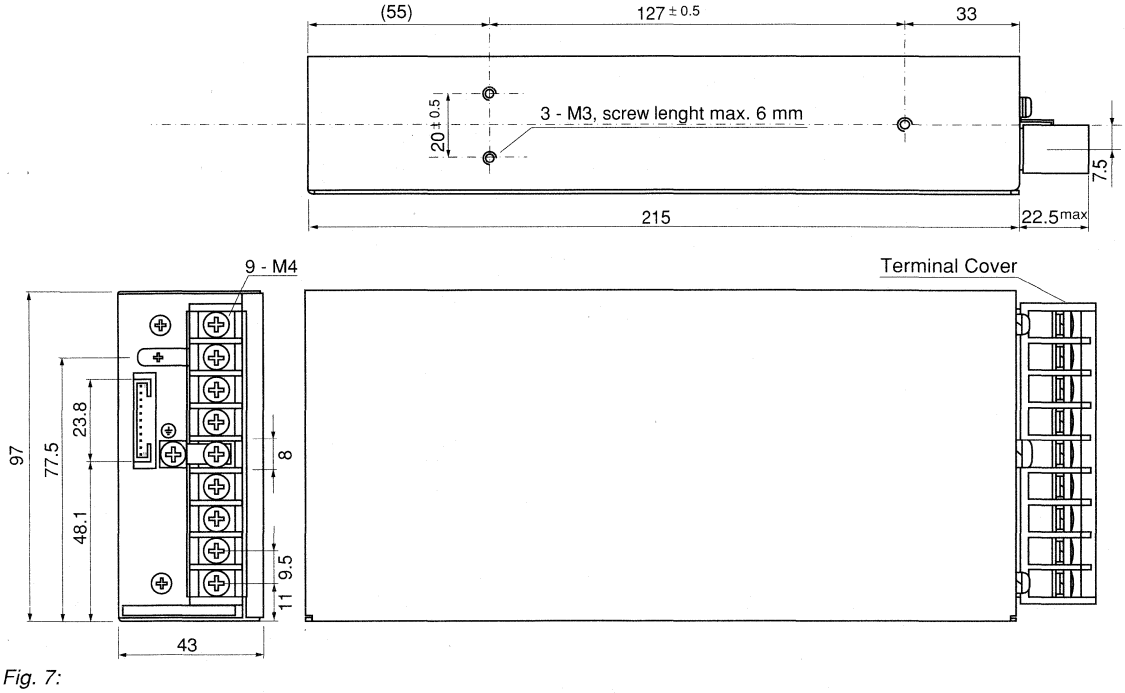



*Fig. 7:*
*VSR 30 types*

# 25 W AC-DC Converters

# VEW-Family

**Single output**

- 110 V AC and 230 V AC input (auto selectable)
- 3750 $V_{rms}$ input to output isolation
- Wide power range up to 2 • $P_{o\,nom}$ temporarily
- Excellent line/load regulation
- High level of electromagnetic compatibility
- Safety standards: UL, CSA and TUV approved



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## Type Survey

*Table 1: Type survey*

| Output $U_{o\,nom}$ V DC | Output $I_{o\,nom}$ A | Input voltage range $U_{i\,min}$...$U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 71°C | Type designation |
|---|---|---|---|---|
| 5 | 5.0 | 85...264 V AC<br>47...440 Hz<br>110...330 V DC | 25 W | VEW 25-5 |
| 12 | 2.1 | | | VEW 25-12 |
| 15 | 1.67 | | | VEW 25-15 |
| 24 | 1.05 | | | VEW 25-24 |
| 48 | 0.52 | | | VEW 25-48 |

8.2

## Description

The VEW series of switching power supplies is a single output series of AC-DC converters. Compact size and high reliability make the VEW series an excellent choice when a compact design is required. Five standard single output ratings are available.

**Key applications**

Factory automation, off-site test and measurement, and communications equipment.

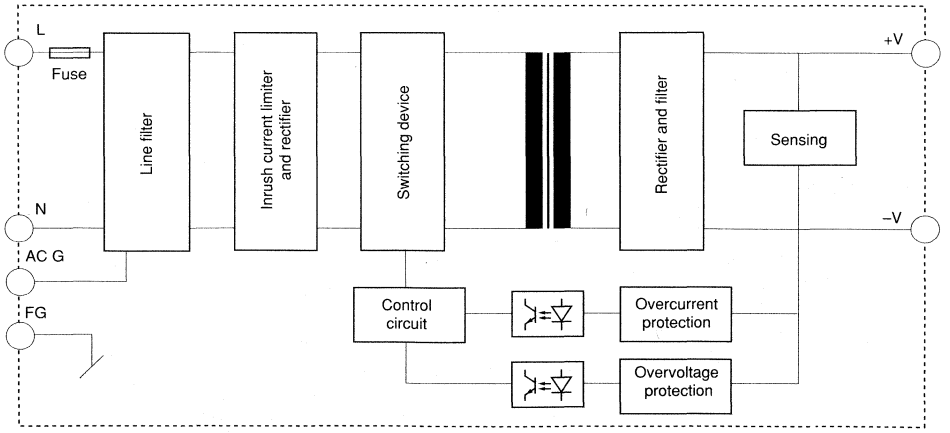



*Fig. 1*
*Block diagram VEW 25*



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## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | VEW 25- .. | Unit |
|---|---|---|---|---|
| $U_{i\,rated}$ | Rated input voltage | | 100/200 | V AC |
| $U_i$ | Input voltage range | | 85...265 | |
| | | | 110...330 | V DC |
| $f_i$ | Line frequency | | 47...440 | Hz |
| $I_i$ | Input current [1] | typ. | 1.2/0.6 | A |
| $I_{inr}$ | Inrush current | max. | 6.8/13.5 | |
| $I_{i\,leak}$ | Leakage current | max. | 0.25/0.5 | mA |

[1] At rated input and output

*Table 3: Output data*

| Type | | | VEW 25-05 | VEW 25-12 | VEW 25-15 | VEW 25-24 | VEW 25-48 | |
|---|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage | nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\,adj}$ | Adjustable voltage range | | ±10 | | | | | % |
| $I_{o\,nom}$ | Rated output current | | 5 | 2.1 | 1.67 | 1.05 | 0.52 | A |
| $I_o$ | Output current range | min./max. | 0...200 | | | | | % |
| $u_o$ | Ripple-noise [1] | max. | 120 | 150 | 150 | 200 | 250 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | $U_{i\,min}$...$U_{i\,max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±0.8 | | | | | |
| $\alpha u_o$ | Temperature coefficient | max. | ±1.5 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | | 260 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | | 5.75...6.75 | 13.8...16.2 | 17.3...20.3 | 27.6...32.4 | 55.2...64.8 | V |
| $t_{Uo\,r}$ | Rise time [1] | typ. | 50 | | | | | ms |
| $t_h$ | Hold-up time [1] | min. | 20 | | | | | |
| $\eta$ | Effciency [1] | typ. | 75 | 76 | 77 | 78 | 80 | % |
| +S/–S | Remote sensing | | not provided | | | | | |
| i | Inhibit, remote on/off | | not provided | | | | | |
| | Output indicator | | LED | | | | | |
| | Outputs connected in series | | possible | | | | | |
| | Outputs connnected in parallel | | not possible | | | | | |

[1] At rated input and output
[2] Foldback current method, automatic recovery.
[3] Shut down of output. Turn-on by brief removal of the input voltage

## Operation Instructions

### Output Power Rating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 2. If the power supply is used at an ambient temperature of 0...50°C, the output power may be increased up to 200% of the rated value.

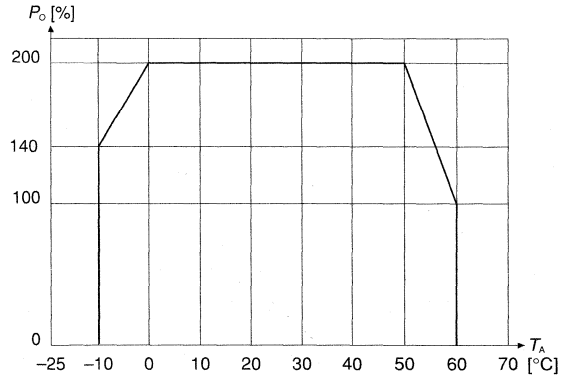



*Fig. 2*
*Output power vs. ambient temperature*

### Output Voltage Adjustment

The output voltage may be adjusted within ±10% of $U_{o\,nom}$ by means of the internal potentiometer. If the output voltage setting should be excessively high, the overvoltage protection circuit may shut-down the output.

### Output Overvoltage Protection

If the built-in overvoltage protection circuit becomes active, the output is shut down and a reset can only be achieved by brief removal of the input voltage after a minimum interval time.

### Output Overload Protection

An overload condition at the output will cause the protection circuit to turn into its foldback characteristic. After removal of overload, the unit wil return to normal operation automatically.

### Grounding Recommendations

A single power supply should be wired to the AC input by interconnecting the ACG (AC Ground) terminal with the FG (Frame Ground) terminal and both together to the protective earth.

With several modules connected in parallel, EMC and leakage currents in accordance with safety standard recommendations may no longer be met. In such cases, an external noise filter should be added in order to minimize RFI noise and to avoid summarization of the individual leakage currents caused by each module's filter. Therefore the ACG terminals (AC Ground) should not be connected. The FG terminals (Frame Ground) but have to be connected directly to the protective earth (see fig. 5).

### Outputs Connected in Series

Two or more units supplying the same or different output voltages may be connected in series. The value of the maximum output current to be taken is defined by that unit providing the lowest current limiting value. It should be assured that the outputs do not feed backwards into each other caused by their different rise/fall times at switch-on/off cycles by adding reverse polarity diodes across each output.

### Outputs Connected in Parallel

Parallel connection of several identical modules is not possible.

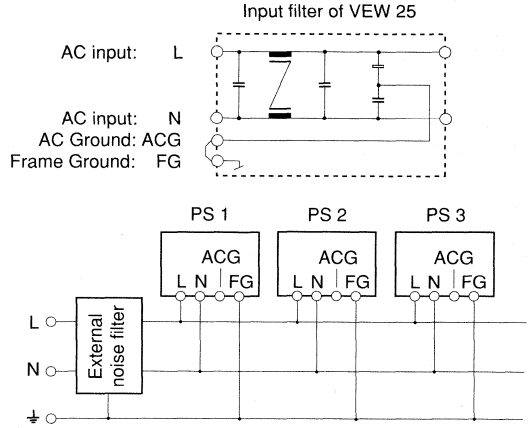



*Fig. 3:*
*Block diagram of input filter and input wiring of parallel connected modules using an external noise filter*

## Input and Output Terminals

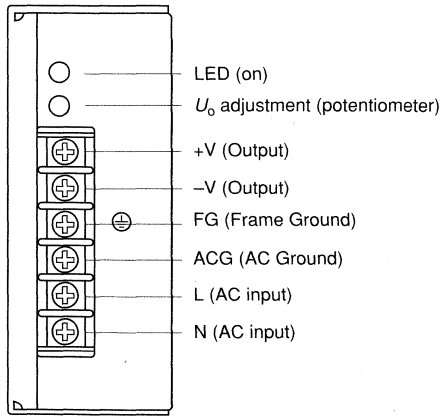



*Fig. 4:*
*Terminal designation of VEW 25 types*


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## Immunity to Environmental Conditions

*Table 4: Mechanical Stress, Impulse Votages, High Frequency Disturbances,*

| Test Method | Test conditions | | Status |
|---|---|---|---|
| Damp heat steady state | Temperature:<br>Relative himidity: | 40 $^{\pm 2}$ °C<br>30...90 $^{-3/+2}$ % | Operating |
| Shock (half-sinusoidal) | Acceleration amplitude: | 20 $g_n$ = 981 m/s$^2$ | Operating |
| Vibration (sinusoidal) | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...55 Hz<br>constant<br>2 $g_n$ = 19 m/s$^2$<br>3 h (1 h each axis) | Operating |
| Electrostatic discharge | | 15 kV | Not operating |
| Electrical fast transient | | 2 kV (50...100 µs) | Operating |
| Surge immunity | | 5 kV (1,2/50 µs; 3 times) | Operating |
| Damped oscillating wave (IEEE 472) | | 2.5 kV (50/sec; 1 MHz; 150 Ω) | Operating |

*Table 5: Temperature*

| Characterisitcs | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | –10 | 60 | °C |
| $T_C$ | Case temperature | $I_o = 0...I_{o\,nom}$ | –10 | 85 | |
| $T_S$ | Storage temperature | (Not operational) | –30 | 85 | |

*Table 6: MTBF Values*

| MTBF | Ground Benign |
|---|---|
| MTPF according to MIL-HDBK-217D | $T_C$ = 40 °C |
| VEW 25 types | 104'000 h |

*Table 7: Isolation*

| Test | Input to output | Input to case | Output to case | Unit |
|---|---|---|---|---|
| Electric strenght test voltage (1 min) | 3750 | 2500 | 500 | V AC |
| Isolation resistance (500 V DC) | >100 | >100 | >100 | MΩ |

*Table 8: Electromagnetic Emmission*

| Standard | Maintained level |
|---|---|
| VCCI | < 1 |
| FCC 20880 | < A |

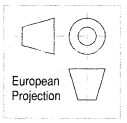
*Table 9: Safety Approvals*

| Safety Approvals | UL 478 | CSA [1] | TÜV |
|---|---|---|---|
| VEW 25-5...VEW 25-24 | x | level 3 | x |
| VEW 25-48 | x | level 1 | x |

[1] C 22.2 No. 0-M 1982

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated



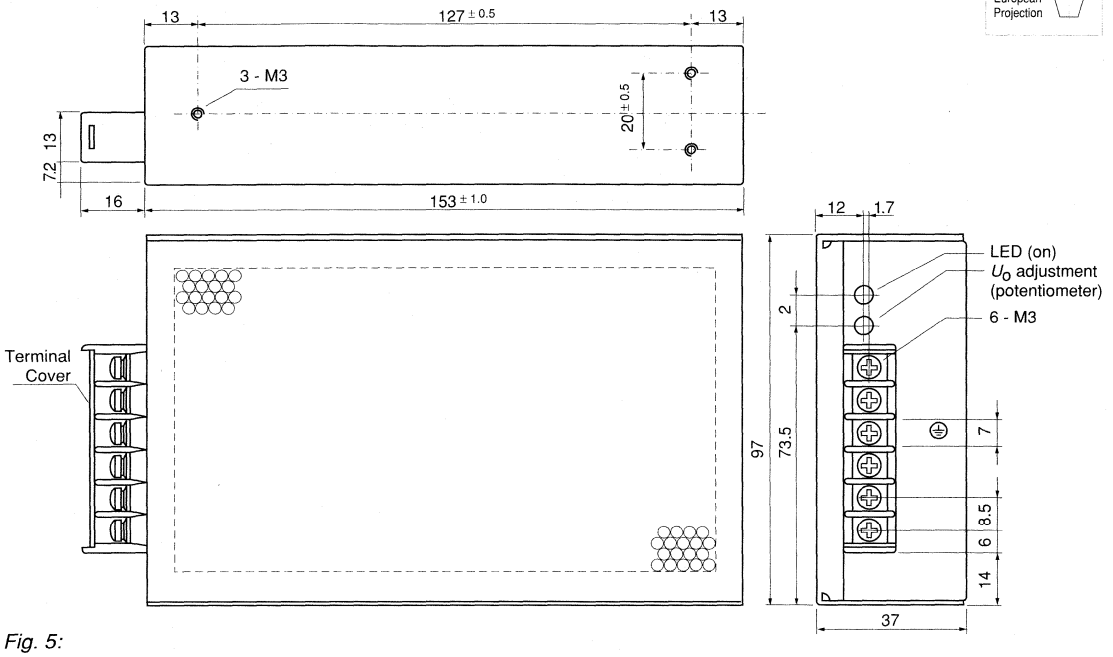
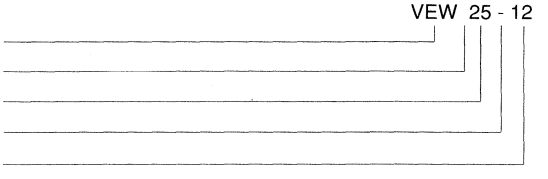




*Fig. 5:*
*VEW 25, weight 450 g*

## Type Key and Product Marking

**Type Key**

Family ..... VEW
Blank .....
Nominal output power [W] ..... 25
Dash .....
Nominal output voltage [V] ..... 5...48




Example: VEW 25-12 = AC-DC converter providing 12 V/2.1 A, 25 W output

**Produkt Marking**

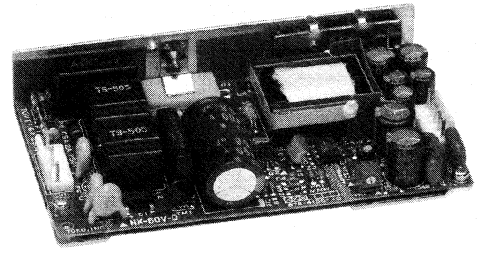
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 15/30 W AC-DC Converters

# LW-Family

**Input to output isolation**
**Triple output**

- Universal AC input
- Flex power topology
- Noise levels: In accordance with FCC class B, VDE 0871 class B
- Low profile: 25.5 mm
- Safety according to IEC 950



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## Type Survey

*Table 1: Type survey*

| Output 1 $U_{o\,nom}$ V DC | Output 1 $I_{omax}$ A | Output 2 $U_{o\,nom}$ V DC | Output 2 $I_{o\,max}$ A | Output 3 $U_{o\,mom}$ V DC | Output 3 $I_{o\,max}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation |
|---|---|---|---|---|---|---|---|---|
| 5 | 3.0 | 12 | 0.5 | –12 | 0.5 | 85...264 V AC | 15 | LW 15-01 |
| 5 | 3.0 | 15 | 0.5 | –15 | 0.5 | 47...63 Hz | | LW 15-11 |
| 5 | 5.0 | 12 | 1.2 | –12 | 0.5 | (110...350 V DC) | 30 | LW 30-01 |
| 5 | 5.0 | 15 | 1.2 | –15 | 0.5 | | | LW 30-11 |

## Description

Innovative design and attention to detail make the LW series the choice of many design engineers. These compact power supplies feature a total volume of nearly three times less than conventional switchers in the same power range. MOSFET switching technology and component derating further assure high reliability. The LW's flex power output design easily accommodates changing design needs and power requirements. Universal AC input is standard on all 15 and 30 W rated triple output models. Safety approvals according to UL 1950, CSA 950 (EB 1420C) and EN 60950 (IEC 950).

**Key applications**

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

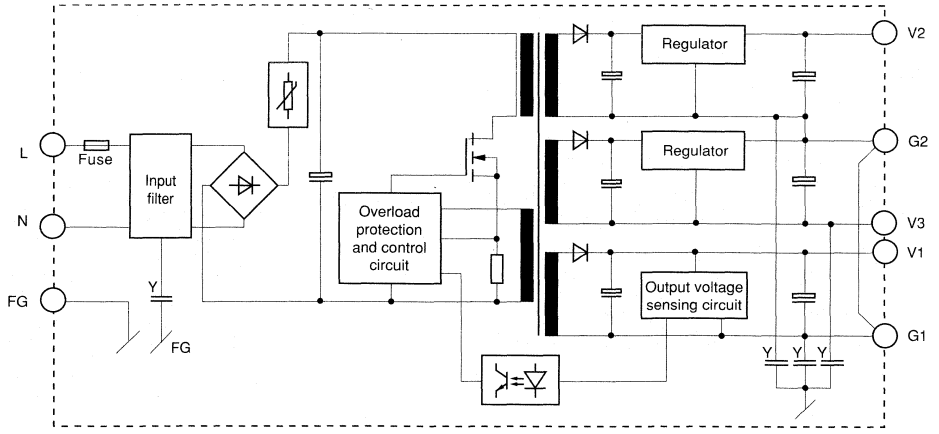



*Fig. 1*
*Block diagram LW 15*

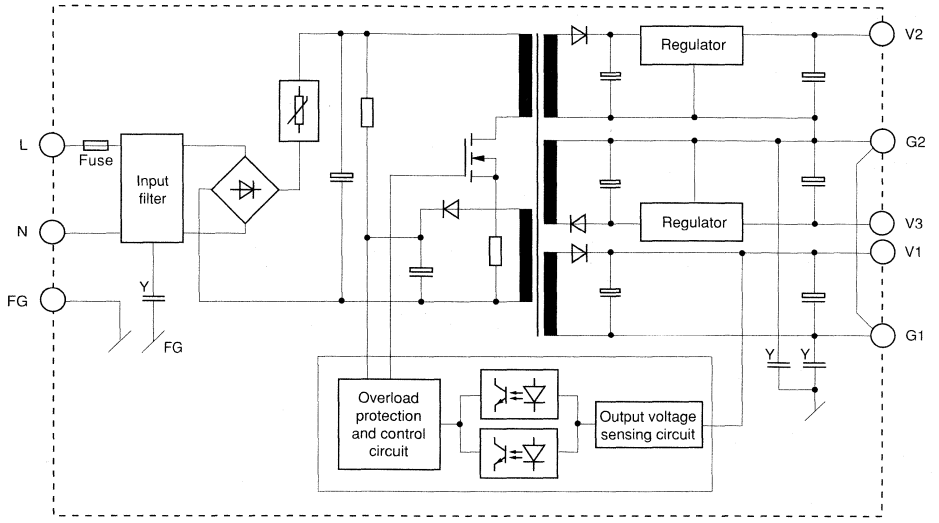



*Fig. 2*
*Block diagram LW 30*

## Electrical Input and Output Data

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | LW 15-... | LW 30-... | Unit |
|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 100, 120, 200, 220, 240 | | V AC |
| $U_i$ | Input voltage range | | 85...264 | | |
| | | | 110...350 | | V DC |
| $f_i$ | Line frequency | | 47...63 | | Hz |
| $I_i$ | Input current [1] | 100/200 V AC | 0.45/0.25 | 0.85/0.45 | A |
| $I_{i\ m}$ | Inrush current (max.) | 100 V AC | 30 | | |
| $I_{i\ leak}$ | Leakage current (max.) | 100 V AC | 0.5 | | mA |

[1] At rated input and output

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3a: Output data 15 W types*

| Type | | | LW 15-01 | | | LW 15-11 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | | V1 | V2 | V3 | V1 | V2 | V3 | |
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | –12 | 5 | 15 | –15 | V |
| $\Delta U_o$ | Voltage setting tolerance | | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | % |
| $I_{o\,set}$ | set at a load of | | 1.25 | 0.15 | 0.1 | 1.25 | 0.15 | 0.1 | A |
| $U_{oL}$ | Overvoltage protection | | - | - | - | - | - | - | V |
| $I_o$ | Output current | min. | 0.5 | 0 | 0 | 0.5 | 0 | 0 | A |
| | | typ. | 2 | 0.3 | 0.2 | 2 | 0.3 | 0.2 | |
| | | max. | 3 | 0.5 | 0.5 | 3 | 0.5 | 0.5 | |
| $I_{o\,L}$ | Overcurrent protection [2] | | 105 | | | | | | % |
| $P_{o\,tot}$ | Total output power | | 15 | | | | | | W |
| $P_{o\,max}$ | Max. power/output | | 15 | 6 | 6 | 15 | 7.5 | 7.5 | |
| $u_o$ | Ripple [1] | max. | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [1] | max. | 100 | 150 | 150 | 100 | 150 | 150 | |
| $\Delta U_{o\,U}$ | Line regulation | 85...264 V | ±2.0 | ±0.5 | ±0.5 | ±2.0 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±2.0 | ±1.0 | ±0.5 | ±2.0 | ±1.0 | ±0.5 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) | typ. | 0.3 | | | | | | |
| $\alpha U_o$ | Change in temp. | 0...50 °C | ±1 | | | | | | |
| $t_{o\,r}$ | Rise time [1] | max. | 100 | | | | | | ms |
| $t_{o\,h\,min}$ | Hold up time [1] 100/200 V AC | | 10/20 | | | | | | |
| $\eta$ | Efficiency [1] | typ. | 65 | | | | | | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3b: Output data 30 W types*

| | | | LW 30-01 | | | LW 30-11 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | | V1 | V2 | V3 | V1 | V2 | V3 | |
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | –12 | 5 | 15 | –15 | V |
| $\Delta U_o$ | Voltage setting tolerance | | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | % |
| $I_{o\,set}$ | set at a load of | | 1.85 | 0.5 | 0.15 | 1.85 | 0.5 | 0.15 | A |
| $U_{oL}$ | Overvoltage protection [3] | | yes | - | - | yes | - | - | |
| $I_o$ | Output current | min. | 1 | 0 | 0 | 1 | 0 | 0 | A |
| | | typ. | 3 | 1 | 0.3 | 3 | 0.8 | 0.2 | |
| | | max. | 5 | 1.2 | 0.5 | 5 | 1.2 | 0.5 | |
| $I_{o\,L}$ | Overcurrent protection [2] | | 105 | | | | | | % |
| $P_{o\,tot}$ | Rated output power | tot. | 30 | | | | | | W |
| $P_{o\,max}$ | Max power/output | | 25 | 14 | 6 | 25 | 18 | 7.5 | |
| $u_o$ | Ripple [1] | max. | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [1] | max. | 100 | 150 | 150 | 100 | 150 | 150 | |
| $\Delta U_{o\,U}$ | Line regulation | 85...264 V | ±2.0 | ±0.5 | ±0.5 | ±2.0 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±2.0 | ±1.0 | ±0.5 | ±2.0 | ±1.0 | ±0.5 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) | typ. | 0.3 | | | | | | |
| $\alpha U_o$ | Change in temp. | 0...50 °C | ±1 | | | | | | |
| $t_{o\,r}$ | Rise time [1] | max. | 100 | | | | | | ms |
| $t_{o\,h}$ | Hold up time [1] 100/200 V AC | | 10/20 | | | | | | |
| $\eta$ | Efficiency [1] | typ. | 65 | | | | | | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery
[3] For V1 only, overall voltage cutoff, recovery at power on

# Operation Instructions

### Input and Output Terminals

*Table 4: Input and output terminals*

| Terminal | Function | Explanation |
|---|---|---|
| L<br>N | Line input<br>Neutral input | 1. Connect to a sine wave 47...63 Hz, 85...264 V AC, single phase.<br>2. Use a double or triple core cable for the input line.<br>3. Space the AC input line as far as possible from the DC output line. |
| FG | Frame ground terminal | Connect with low impedance to ground line of equipment on which the power supply is mounted. |
| V1 | Output Terminal 1 | Stabilized output of 5 V DC |
| V2 | Output Terminal 2 | Stabilized output of 12 or 5 V DC |
| V3 | Output Terminal 3 | Stabilized output of –12 or –15 V DC |
| G1, G2 | Ground Terminals | G1: ground terminal for V1, G2: ground terminal for V2 and V3.<br>G1 and G2 are internally interconnected. |

### Proper Method of Operation

To achieve the proper output voltage from each of the three outputs, the individual load currents must remain within the minimum-maximum ratings. If the load current may drop below the minimum value specified, add a pre-load.

### Overcurrent Protection

Each output provides its own built-in overload protection at approx. 105% of the rated currents. In case of overload, the circuit operates to avoid excessive current. After removal of overload, the circuit automatically resets.

### Inrush Current

All models feature inrush current limitation circuits by means of power thermistors. Switching the AC input on/off repeatedly in rapid succession (less than 2 minutes waiting time) should be avoided. An appropriate AC switch for each model based on its specifications should be provided.

### Series or Parallel Operation

The outputs cannot be operated in series or parallel connection with other type of sources.

### Derating Characteristics

The relation between the ambient temperature $T_A$ and the rated output power is shown in fig. 3. Operating the power supply at 60°C, each output current should remain below 60% of its maximum rated value.

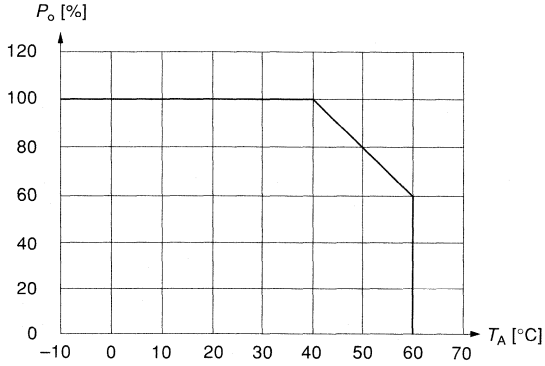



*Fig. 3*
*Output power vs. ambient temperature*

*Table 5: Connector types (JST)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | LW 15, LW 30 | B3P5-VH | VHR 5N | SVH-21T-P1.1 | 3 |
| DC output side | LW 15 | B5P-VH | VHR 5N | SVH-21T-P1.1 | 5 |
| | LW 30 | B7P-VH | VHR 7N | SVH-21T-P1.1 | 7 |

*Table 6: Cable kits (to be ordered seperately from power supply)*

| Position at | Type of cable kit | Power supply | Material / Length<br>Cross section | Wire color | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | V1 | V2 | V3 | G | AC (L) | AC (N) | FG |
| AC input side | CB11 | LW 15<br>LW 30 | UL 1015 / 60 cm<br>AWG 20 ≈ 0.50 mm² | – | – | – | – | Brown | Blue | Green-Yellow |
| DC output side | CB12 | LW15 | UL 1007 / 60 cm<br>AWG 18 ≈ 1 mm² | Red | Brown | Blue | Black x2 | – | – | – |
| | CB13 | LW 30 | UL 1007 / 60 cm<br>AWG 18 ≈ 1 mm² | Red | Brown x2 | Blue | Black | – x3 | – | – |



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## Immunity to Environmental Conditions

*Table 7: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | –10 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | –10 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 8: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s²)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 9: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 3000 V AC, 1 minute | –<br>leakage current <15 mA. | – |
| Insulation resistance [1] | – | – | > 100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mounting Instructions

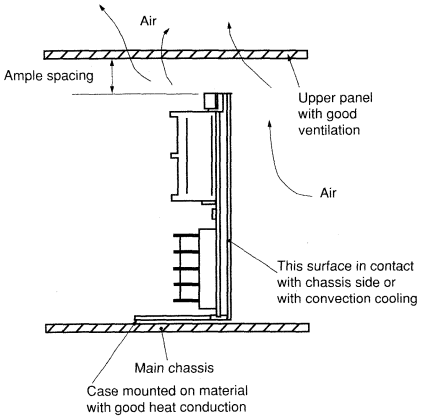



*Fig. 4*
*Horizontal mounting*

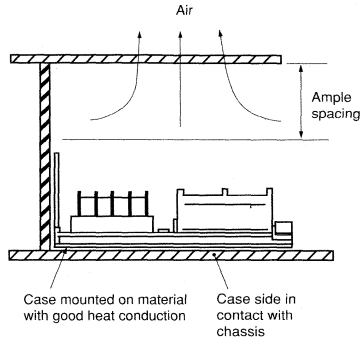



*Fig. 5*
*Vertical mounting*

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

European Projection

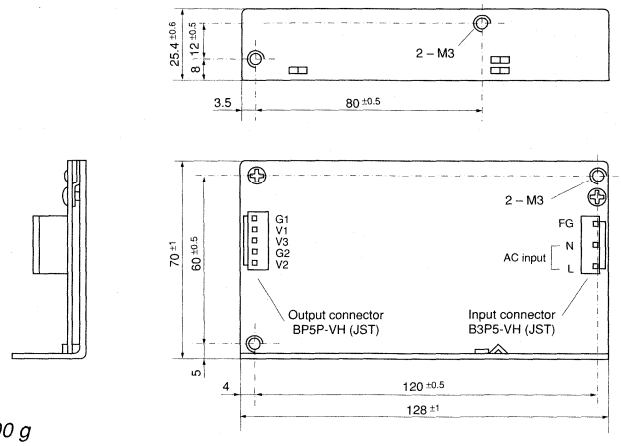



*Fig. 6*
*LW 15, weight: 200 g*

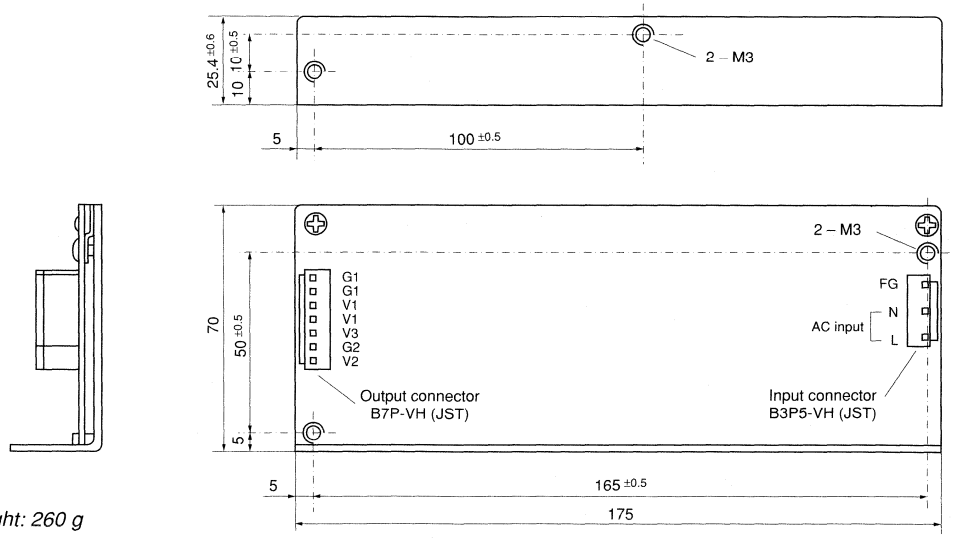



*Fig. 7*
*LW 30, weight: 260 g*

8.3

## Type Key and Product Marking

**Type Key**

LW 15 - 01

Family ..... LW
Blank .....
Nominal output power [W] ..... 15/30
Dash .....
Output configuration ..... 01/11

Example: LW 15-01 = AC-DC converter providing 15 W on 3 outputs of 5 V/3A, 12 V/0.5 A and –12 V/0.5 A

**Produkt Marking**

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

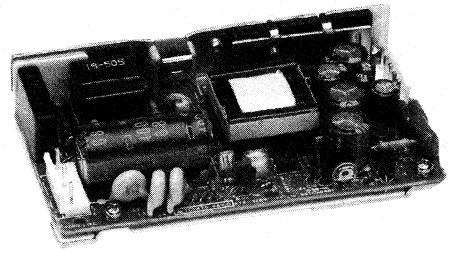

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# TOKO 15/30 W AC-DC Converters

# MW-Family

**Input to output isolation**
**Triple output**

- Universal AC input
- Flex power topology
- MTBF >144,000 hours
- Convection cooled
- High switching frequency (>100 KHz)
- State-of-the-art wireless transformer design
- Component derating for high reliability
- Meets FCC Class B, VCCI-2
- Safety according to IEC 950



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## Type Survey

*Table 1: Type survey*

| Output 1 $U_{o\,nom}$ V DC | Output 1 $I_{omax}$ A | Output 2 $U_{o\,nom}$ V DC | Output 2 $I_{o\,max}$ A | Output 3 $U_{o\,mom}$ V DC | Output 3 $I_{o\,max}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation |
|---|---|---|---|---|---|---|---|---|
| 5 | 3.0 | 12 | 0.5 | –12 | 0.5 | 85...264 V AC 47...63 Hz | 15 W | MW 15-01 |
| 5 | 3.0 | 15 | 0.5 | –15 | 0.5 | | | MW 15-11 |
| 5 | 5.0 | 12 | 1.2 | –12 | 0.5 | | 30 W | MW 30-01 |
| 5 | 5.0 | 15 | 1.2 | –15 | 0.5 | | | MW 30-11 |

## Description

The MW series strikes the right balance between size and performance right off the drawing board. These ultra compact switchers satisfy the design engineer's demand for less space without sacrificing power and efficiency. Very low profile of one inch is maintained on most models. Choice of 15 and 30 W ratings. Universal AC input on all models. The modules are UL 1950 (D3) and CSA C22.2/ 143, 154 approved.

**Key applications**

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

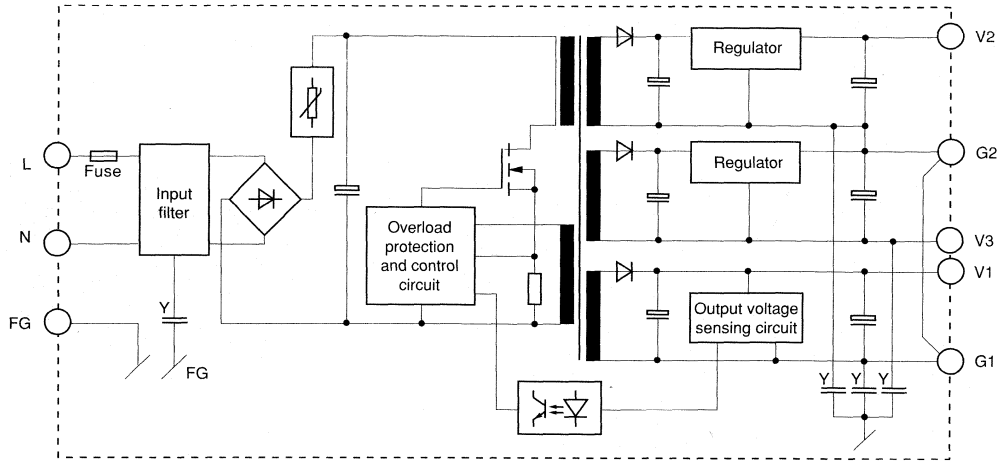



*Fig. 1*
*Block diagram MW 15*

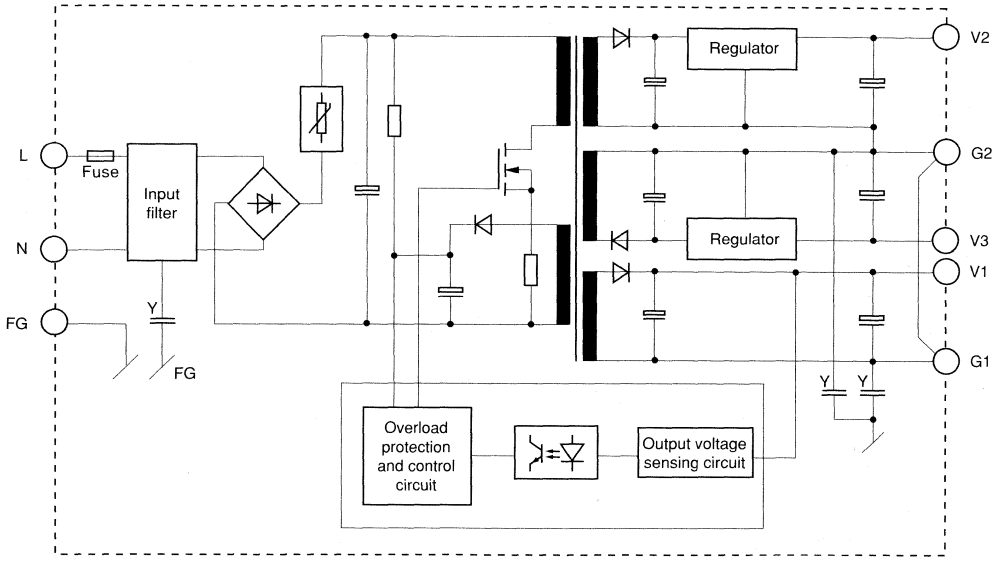



*Fig. 2*
*Block diagram MW 30*

8.3

## Electrical Input and Output Data

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | MW 15-... | MW 30-... | Unit |
|---|---|---|---|---|---|
| $U_{i\,rated}$ | Rated input voltage | | 115, 120, 220, 230, 240 | | V AC |
| $U_i$ | Input voltage range | | 85...264 | | |
| $f_i$ | Line frequency | | 47...63 | | Hz |
| $I_i$ | Input current [2] (typ.) | 115/230 V AC | 0.45/0.25 | 0.85/0.45 | A |
| $I_{i\,m}$ | Inrush current [2] (max.) | 115 V AC | 30 | | |
| $I_{leak}$ | Leakage current (max.) | 115 V AC | 0.5 | | mA |

[1] At rated input and output
[2] At rated input and output and normal temperature


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General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3a: Output data 15 W types*

| Type | | MW 15-01 | | | MW 15-11 | | | |
|---|---|---|---|---|---|---|---|---|
| Characteristics | | V1 | V2 | V3 | V1 | V2 | V3 | Unit |
| $U_{o\,nom}$ | Output voltage | 5 | 12 | –12 | 5 | 15 | –15 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | % |
| $I_{o\,set}$ | set at a load of | 1.25 | 0.15 | 0.1 | 1.25 | 0.15 | 0.1 | A |
| $U_{oL}$ | Overvoltage protection | Not provided | | | | | | V |
| $I_o$ | Output current min. | 0.5 | 0 | 0 | 0.5 | 0 | 0 | A |
| | typ. | 2 | 0.3 | 0.2 | 2 | 0.3 | 0.2 | |
| | max. | 3 | 0.5 | 0.5 | 3 | 0.5 | 0.5 | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 15 | | | | | | W |
| $P_{o\,max}$ | Output power | 15 | 6 | 6 | 15 | 7.5 | 7.5 | |
| $u_o$ | Ripple [1] max. | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [1] max. | 100 | 150 | 150 | 100 | 150 | 150 | |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±2.0 | ±0.5 | ±0.5 | ±2.0 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±2.0 | ±1.0 | ±0.5 | ±2.0 | ±1.0 | ±0.5 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | 0.3 | | | | | | |
| $\alpha U_o$ | Change in temp., 0...50 °C | ±1 | | | | | | |
| $t_{o\,r}$ | Rise time [1] max. | 100 | | | | | | ms |
| $t_{o\,h\,min}$ | Hold up time [1] 115/230 VAC | 10/20 | | | | | | |
| $\eta$ | Efficiency [1] typ. | 65 | | | | | | % |

[1] At rated input and output and normal temperature
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3b: Output data 30 W types*

| Type | | MW 30-01 | | | MW 30-11 | | | |
|---|---|---|---|---|---|---|---|---|
| Characteristics | | V1 | V2 | V3 | V1 | V2 | V3 | Unit |
| $U_{o\,nom}$ | Output voltage | 5 | 12 | –12 | 5 | 15 | –15 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | % |
| $I_{o\,set}$ | set at a load of | 1.85 | 0.5 | 0.5 | 1.85 | 0.5 | 0.5 | A |
| $U_{oL}$ | Overvoltage protection | Not provided | | | | | | V |
| $\mu$ | Output current min. | 1 | 0 | 0 | 1 | 0 | 0 | A |
| | typ. | 3 | 1 | 0.33 | 3 | 0.8 | 0.21 | |
| | max. | 5 | 1.2 | 0.5 | 5 | 1.2 | 0.5 | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 30 | | | | | | W |
| $P_{o\,max}$ | Output power | 25 | 14 | 6 | 25 | 18 | 7.5 | |
| $u_o$ | Ripple [1] max. | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [1] max. | 100 | 150 | 150 | 100 | 150 | 150 | |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±2.0 | ±0.5 | ±0.5 | ±2.0 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±2.0 | ±1.0 | ±0.5 | ±2.0 | ±1.0 | ±0.5 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | 0.3 | | | | | | |
| $\alpha U_o$ | Change in temp., 0...50 °C | ±1 | | | | | | |
| $t_{o\,r}$ | Rise time [1] max. | 100 | | | | | | ms |
| $t_{o\,h}$ | Hold up time [1] 115/230 V | 10/20 | | | | | | |
| $\eta$ | Efficiency [1] typ. | 65 | | | | | | % |

[1] At rated input and output and normal temperature.
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

# Operation Instructions

### Input and Output Terminals

*Table 4: Input and output terminals*

| Terminal | Function | Explanation |
|---|---|---|
| L<br>N | Line input<br>Neutral input | 1. Connect to a sine wave of 47...63 Hz, 85...264 VAC, single phase.<br>2. Use a double or triple core cable fo the input line.<br>3. Space the AC input line as far as possible from the DC output line. |
| FG | Frame ground terminal | Connect with low impedance to ground line of equipment on which the power supply is mounted. |
| V1 | Output Terminal 1 | Stabilized output of 5 VDC. |
| V2 | Output Terminal 2 | Stabilized output of 12 or 15 V DC. |
| V3 | Output Terminal 3 | Stabilized output of –12, or –15 V DC. |
| G1, G2 | Ground Terminals | G1: ground terminal for V1, G2: ground terminal for V2 and V3.<br>G1 and G2 are internally interconnected. |

### Proper Method of Operation

To achieve the proper output voltage from each of the three output channels, the load currents must be within the minimum-maximum ratings. If the load current is below the minimum, use a pre-load.

### Overcurrent Protection

Each channel has its own built-in overload protection at approx. 105% of the rated currents. In the case of overloading, the circuit operates to avoid excessive current. After removal of the overload, the circuit automatically resets.

### Inrush Current

All models feature inrush current limitation circuits by means of power thermistors. Switching the AC input on/off repeatedly in rapid succession (less than 2 minutes waiting) should be avoided. An appropriate AC switch for each model based on its specifications should be provided.

### Series or Parallel Operation

The outputs cannot be operated in series or parallel connection with other type of sources.

### Derating Characteristics

The relation between the ambient temperature $T_A$ and the rated output power is shown in fig. 3. Operating the power supply at 60°C, each output current should remain below 60% of its maximum rated value.

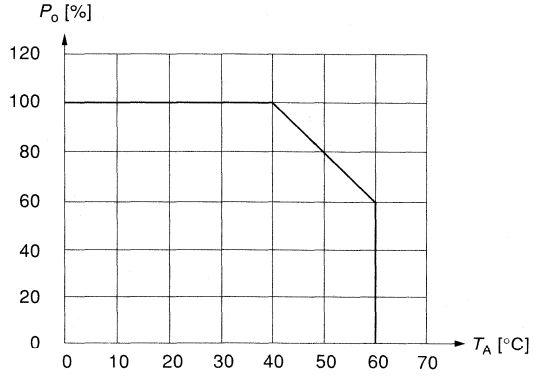



*Fig. 3*
*Output power vs. ambient temperature*

8.3


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*Table 5: Connector types (JST)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector types | Mating housing | Terminals | Quantity |
| AC input side | MW 15, 30 | B3P5-VH | VHR 5N | SVH-21T-P1.1 | 3 |
| DC output side | MW 15 | B5P-VH | VHR 5N | SVH-21T-P1.1 | 5 |
| | MW 30 | B7P-VH | VHR 7N | SVH-21T-P1.1 | 7 |

*Table 6: Cable kit (to be ordered separately from power supply)*

| Position at | Name of cable kit | Power supply | Material / Length / Cross section | Wire color | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | V1 | V2 | V3 | G | AC (L) | AC (N) | FG |
| AC input side | CB11 | MW 13<br>MW 30 | UL 1015 / 60 cm<br>AWG 20 ≈ 0.50 mm² | – | – | – | – | Black | White | Green |
| DC output side | CB12 | MW 15 | UL 1007 / 60 cm<br>AWG 18 ≈ 1 mm² | Red | Brown | Blue | Black<br>×2 | – | – | – |
| | CB13 | MW 30 | UL 1007 / 60 cm<br>AWG 18 ≈ 1 mm² | Red<br>×2 | Brown | Blue | Black<br>×3 | – | – | – |

## Immunity to Environmental Conditions

*Table 7: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 8: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s², 10...55 Hz)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 9: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 3750 V AC, 1 minute | 2500 V AC, 1 minute<br>leakage current <15 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

European Projection

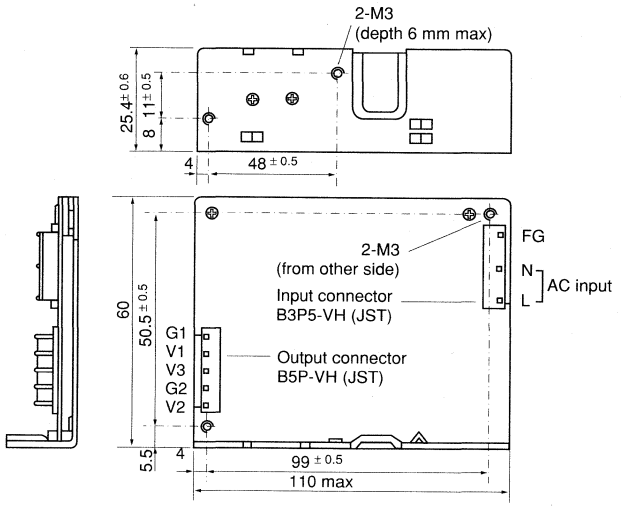



*Fig. 4*
*MW 15, weight: 150 g*

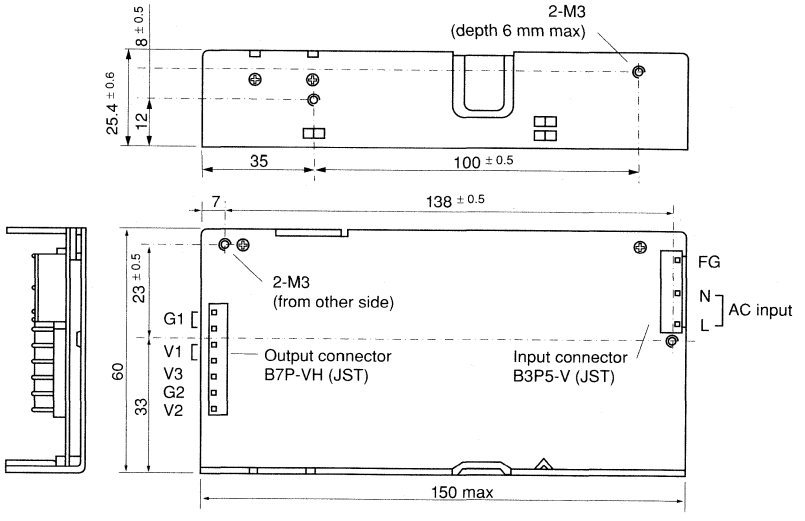



*Fig. 5*
*MW 30, weight: 230 g*

8.3

## Type Key and Product Marking

**Type Key**

| | |
|---|---|
| Family | MW |
| Blank | |
| Nominal output power [W] | 15/30 |
| Dash | |
| Output configuration | 01/11 |

MW 15 - 01

Example: MW 15-01 = AC-DC converter providing 15 W on 3 outputs of 5 V/3A; 12 V/0.5 A and –12 V/0.5 A

**Produkt Marking**

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.



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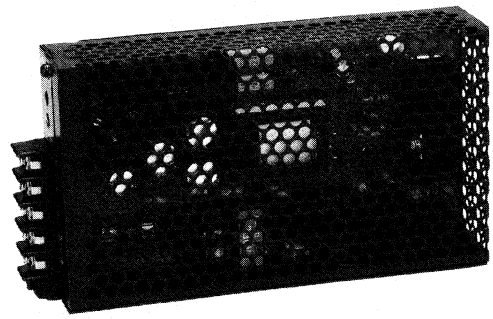
Edition 1/05 - © Melcher AG

# TOKO 30 W AC-DC Converters

# PE-Family

**Input to output isolation**
**Single output**

- Small Size
- Superb quality and reliability
- 115/230 V AC input, jumper selectable
- Noise: Meets FCC Class A
- Safety according to VDE 0806



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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 40°C | Type designation Case Terminal strip | Open frame Terminal strip | Open frame Connector |
|---|---|---|---|---|---|---|
| 5 | 5.5 | 85...132/170...264 V AC | 30 W | PE 30-05C | PE 30-05F | PE 30-05FC |
| 12 | 2.5 | 47...440 Hz | | PE 30-12C | PE 30-12F | PE 30-12FC |
| 24 | 1.3 | jumper selectable | | PE 30-24C | PE 30-24F | PE 30-24FC |

## Description

The PE Series can be operated at nominal line voltages from 100 to 240 V AC, suitable for worldwide usage. Single outputs with three different output voltages and a power rating of 30 W are available. The units are designed in the configurations open frame or enclosed in a case. VDE approved.

**Key applications**

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

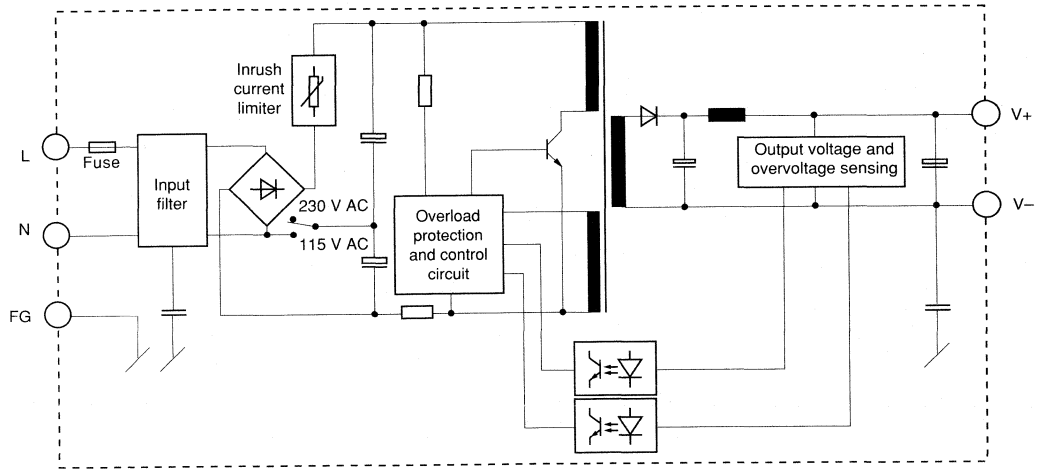



*Fig. 1*
*Block diagram PE 30*

## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | PE 30-05 | PE 30-12 | PE 30-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 115 or 230 | | | V AC |
| $U_i$ | Input voltage range | | 85...132 or 170...264; jumper selectable | | | |
| $f_i$ | Line frequency | | 47...440 | | | Hz |
| $I_i$ | Input current [1] | 115/230 V AC | 0.7/0.5 | | | A |
| $I_{i\ m}$ | Inrush current (max.) | 115/230 V AC | 30 | | | |
| $I_{i\ leak}$ | Leakage current (max.) | 60 Hz, 240 V AC | 0.7 | | | mA |

[1] At rated input and output

*Table 3: Output data*

| Characteristics | | | PE 30-05 | PE 30-12 | PE 30-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{o\ nom}$ | Output voltage | | 5 | 12 | 24 | V |
| | Adjustable output voltage range | | ±10 | | | % |
| $U_{oL}$ | Overvoltage protection | | 6.9 | 15.5 | 31.0 | V |
| $I_o$ | Rated output current | | 5.5 | 2.5 | 1.3 | A |
| | Output current range | | 0...100 | | | % |
| $I_{o\ L}$ | Overcurrent protection [2] | | 105 | | | |
| $u_o$ | Ripple-noise [1] | max. | 120 | 120 | 200 | mVpp |
| $\Delta U_{o\ U}$ | Line regulation | 85...132 V<br>170...264 V | ±3 | | | % |
| $\Delta U_{o\ I}$ | Load regulation | 0...100% | ±3 | | | |
| $\Delta U_{o\ t}$ | Drift (t = 0.5...8 h) | typ. | ±3 | | | |
| $\alpha U_o$ | Change in temperature | 0...50°C | ±3 | | | |
| $t_{o\ r}$ | Rise time [1] | max. | 30 | 100 | 200 | ms |
| $t_{o\ h\ min}$ | Hold up time [1] | | 20 | | | |
| $\eta$ | Efficiency [1] | typ. | 66 | 72 | 76 | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

8.3

## Operation Instructions

### Input Voltage Selection

The input voltage range is set for 230 V AC when shipped. For 115 V AC application, the jumper has to be changed.

### Derating of Output Power

The output power derating depends on the structure of the power supply. The derating characteristics are shown in fig. 2.

### Output Voltage Adjustment

The output voltage adjustment range ($V_{ACJ}$ at the front panel) is ±10% of $U_{o\ nom}$. The actual output power should not exceed the spedified maximum output power.

### Overcurrent Protection

When the output current exceeds 105% of the rated current the overcurrent protection circuit operates (see fig. 3). The output will recover automatically as soon as the overload condition is removed. The overload condition should remain as short as possible.

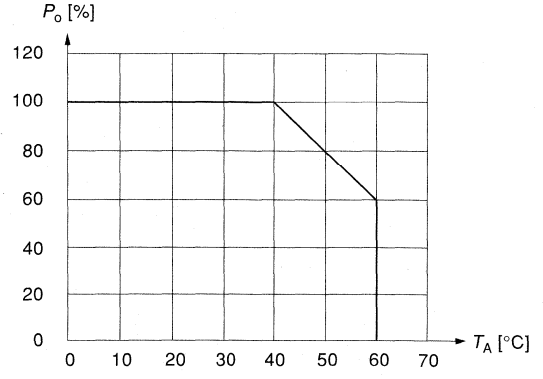



*Fig. 2*
*Output power vs. ambient temperature*


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### Overvoltage Protection

When there is an overvoltage condition at the output, the internal latch circuit will operate and the output will be cut off. In this instance, turn off the input. At least 90 seconds should be allowed as recovery time.

### Inrush Current

A power thermistor is built-in to protect against excessive inrush current. Appropriate selection of the AC input switch is recommended. Repeating switching cycles should be avoided i.e. permit at least two minutes recovery time.

### Insulation and Dielectric Strength Test

Preshipment tests have been applied at the factory and further testes are not necessary.

### Series Operation

Two power supplies, PS-1 and PS-2 for example, may be operated in series connection as shown in fig. 4a and 4b.

### Parallel Operation

**Do not connect the power supplies for parallel operation.**

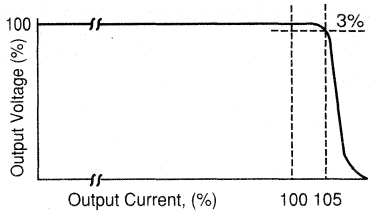



*Fig. 3*
*Output voltage vs. output current*

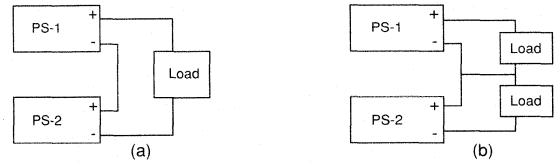



*Fig. 4*
*Power supplies connected in series*

*Table 4: Connector types (Molex)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | PE 30 | 5277-03A | 5196-03 | 5194 | 2 |
| DC output side | PE 30 | 5285-03A | 5198-03 | 5194 | 3 |

*Table 5: Cable kit (to be ordered separately from power supply)*

| Position at | Type of cable kit | Power supply | Material / Length / Cross section | Wire color | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | +V | –V | FG | AC | AC |
| AC input side | CB01 | PE 30 | UL 1015 / 60 cm / AWG 22 ≈ 0.34 mm² | – | – | – | Black | White |
| DC output side | CB02 | PE 30 | UL 1007 / 60 cm / AWG 22 ≈ 0.34 mm² | Red | Black | Green | – | – |

## Immunity to Environmental Conditons

*Table 6: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | –10 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | –10 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 7: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s²)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 8: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 3750 V AC, 1 minute | 3750 V AC, 1 minute leakage current <10 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

European Projection

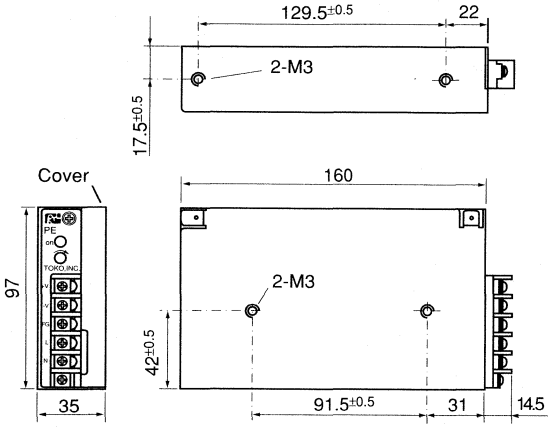



*Fig. 5*
*PE 30 covered, weight: 440 g*

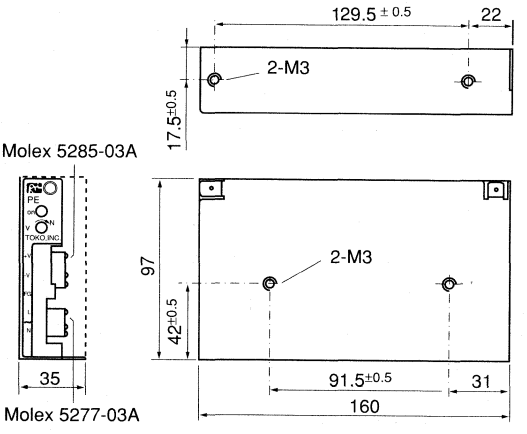
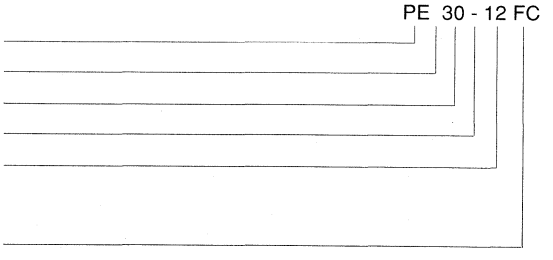



*Fig. 6*
*PE 30 open frame, weight: 440 g*

## Type Key and Product Marking

**Type Key**

Family ..... PE
Blank .....
Nominal output power [W] ..... 30
Dash .....
Nominal output voltage [V] ..... 5...24
Structure and connections:
- Case with terminal strip ..... C
- Open frame with terminal strip ..... F
- Open frame with connector ..... FC




Example: PE 30-12C = AC-DC converter providing 12 V/2.5 A and configured as case (covered) with terminal strip

**Produkt Marking**

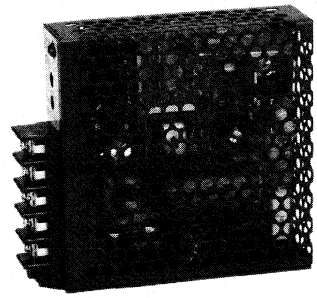
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 10/15/30 W AC-DC Converters

# PS-Family

**Single output**

- Ultra thin and compact
- High reliabiltiy
- Noise Standard: Meets FCC Class A
- Case or open frame structure
- Safety according to UL 1950 (D3)



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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}$...$U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 40 °C | Type designation Case Terminal strip | Open frame Terminal strip | Open frame Connector |
|---|---|---|---|---|---|---|
| 5 | 2.0 | 85...132 V AC<br>47...440 Hz<br>or<br>110...175 V DC | 10 W | PS 10-05C | PS 10-05F | PS 10-05FC |
| 5 | 3.0 | | 15 W | PS 15-05C | PS 15-05F | PS 15-05FC |
| 5 | 5.5 | | 30 W | PS 30-05C | PS 30-05F | PS 30-05FC |
| 12 | 0.9 | | 10 W | PS 10-12C | PS 10-12F | PS 10-12FC |
| 12 | 1.3 | | 15 W | PS 15-12C | PS 15-12F | PS 15-12FC |
| 12 | 2.5 | | 30 W | PS 30-12C | PS 30-12F | PS 30-12FC |
| 24 | 0.5 | | 10 W | PS 10-24C | PS 10-24F | PS 10-24FC |
| 24 | 0.7 | | 15 W | PS 15-24C | PS 15-24F | PS 15-24FC |
| 24 | 1.3 | | 30 W | PS 30-24C | PS 30-24F | PS 30-24FC |

## Description

The switiching power supplies of the PS series were designed to meet the demand for high performance characteristics in a single output at low cost. All the models in this series have the UL recognition. Their low profile and compact structure, together with high reliability, has found many uses in various electronic equiment. Additionally, the refined exterior black finish will enhance the image of the final product.

**Key applications**

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection, and medical.

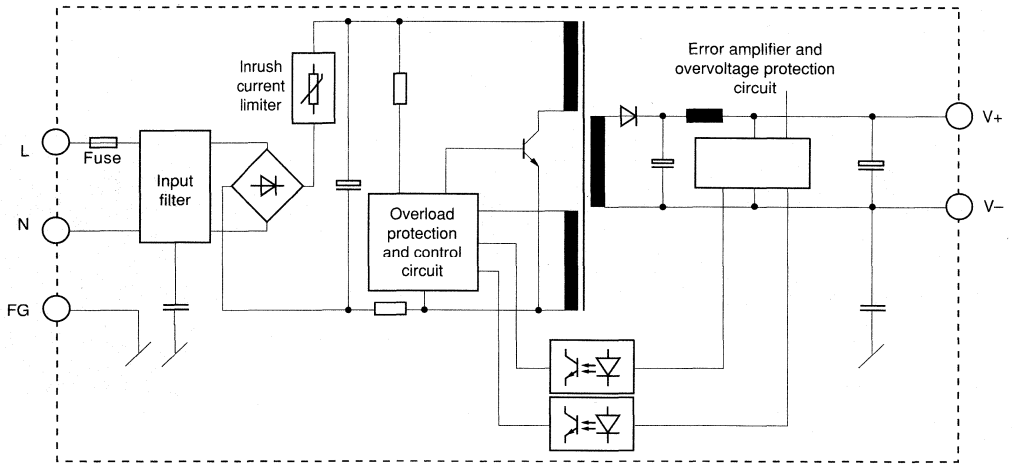



*Fig. 1*
*Block diagram PS 10/15/30*

## Electrical Input and Output Data

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | PS 10-.. | PS 15-.. | PS 30-.. | Unit |
|---|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 115 or 130 | | | V AC |
| $U_i$ | Input voltage range | | 85...132 | | | |
| $f_i$ | Line frequency | | 47...440 | | | Hz |
| $U_i$ | Input voltage range | | 110...175 | | | V DC |
| $I_i$ | Input current [1] | 115 V AC | 0.27 | 0.36 | 0.7 | A |
| $I_{i\ m}$ | Inrush current (max.) | 115 V AC | 20 | 25 | 30 | |
| $I_{i\ leak}$ | Leakage current (max.) | | 1 | | | mA |

[1] At rated input and output

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3a: Output data 10 W types*

| Characteristics | | | PS 10-05 | PS 10-12 | PS 10-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{o\ nom}$ | Output voltage | | 5 | 12 | 24 | V |
| | Adjustable output voltage range | | ±10 | | | % |
| $U_{oL}$ | Overvoltage protection | | not provided | | | |
| $I_o$ | Rated output current | | 2.0 | 0.9 | 0.5 | A |
| | Output current range | | 0...100 | | | % |
| $I_{o\ L}$ | Overcurrent protection [2] | | 105 | | | |
| $u_o$ | Ripple-noise [1] max. | | 120 | 120 | 200 | mVpp |
| $\Delta U_{o\ U}$ | Line regulation | 85...132 V | ±3 | | | % |
| $\Delta U_{o\ I}$ | Load regulation | 0...100% | ±3 | | | |
| $\Delta U_{o\ t}$ | Drift (t = 0.5...8 h) | typ. | ±3 | | | |
| $\alpha U_o$ | Change in temperature | 0...50 °C | ±3 | | | |
| $t_{o\ r}$ | Rise time [1] | max. | 30 | 100 | 200 | ms |
| $t_{o\ h\ min}$ | Hold up time [1] | | 20 | | | |
| $\eta$ | Efficiency [1] | typ. | 67 | 72 | 74 | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3b: Output data 15 W types*

| Characteristics | | | PS 15-05 | PS 15-12 | PS 15-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | 24 | V |
| | Adjustable output voltage range | | ±10 | | | % |
| $U_{oL}$ | Overvoltage protection | | not provided | | | |
| $I_o$ | Rated output current | | 3.0 | 1.3 | 0.7 | A |
| | Output current range | | 0...100 | | | % |
| $I_{o\,L}$ | Overcurrent protection [2] | | 105 | | | |
| $u_o$ | Ripple-noise [1] max. | | 120 | 120 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | 85...132 V | ±3 | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±3 | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) | typ. | ±3 | | | |
| $\alpha U_o$ | Change in temperature | 0...50°C | ±3 | | | |
| $t_{o\,r}$ | Rise time [1] | max. | 30 | 100 | 200 | ms |
| $t_{o\,h\,min}$ | Hold up time [1] | | 20 | | | |
| $\eta$ | Efficiency [1] | typ. | 70 | 72 | 76 | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3c: Output data 30 W types*

| Characteristics | | | PS 30-05 | PS 30-12 | PS 30-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | 24 | V |
| | Adjustable output voltage range | | ±10 | | | % |
| $U_{oL}$ | Overvoltage protection | | 6.9 | 15.5 | 31 | |
| $I_o$ | Rated output current | | 5.5 | 2.5 | 1.3 | A |
| | Output current range | | 0...100 | | | % |
| $I_{o\,L}$ | Overcurrent protection [2] | | 105 | | | |
| $u_o$ | Ripple-noise [1] max. | | 120 | 120 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | 85...132 V | ±3 | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±3 | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) | typ. | ±3 | | | |
| $\alpha U_o$ | Change in temperature | 0...50°C | ±3 | | | |
| $t_{o\,r}$ | Rise time [1] | max. | 30 | 100 | 200 | ms |
| $t_{o\,h\,min}$ | Hold up time [1] | | 20 | | | |
| $\eta$ | Efficieny [1] | typ. | 68 | 73 | 77 | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

8.3

## Operation Instructions

### Derating of Output Power

The output power derating depends on the structure of the power supply. The derating characteristics are shown in fig. 2.

### Output Voltage Adjustment

The output voltage adjustment range ($V_{ADJ}$ at the front panel) is ±10% of $U_{o\ nom}$. The actual output power should not exceed the spedified maximum output power.

### Overcurrent Protection

When the output current exceeds 105% of the rated current the overcurrent protection circuit operates (see fig. 3). The output will recover automatically as soon as the overload condition is removed. The overload condition should remain as short as possible.

### Overvoltage Protection

When there is an overvoltage condition at the output, the internal latch circuit will operate and the output will be cut off. In this instance, turn off the input. At least 90 seconds should be allowed as recovery time.

### Inrush Current

A resistor (PS 10 and PS 15) or a power thermistor (PS 30) is built-in to protect against excessive inrush current. Appropriate selection of the AC input switch is recommended. Repeating switching cycles should be avoided i.e. permit at least two minutes recovery time.

### Insulation and Dielectric Strength Test

Preshipment tests have been applied at the factory and further testes are not necessary.

### Series Operation

Two power supplies, PS-1 and PS-2 for example, may be operated in series connection as shown in fig. 4a and 4b.

### Parallel Operation

**Do not connect the power supplies for parallel operation.**

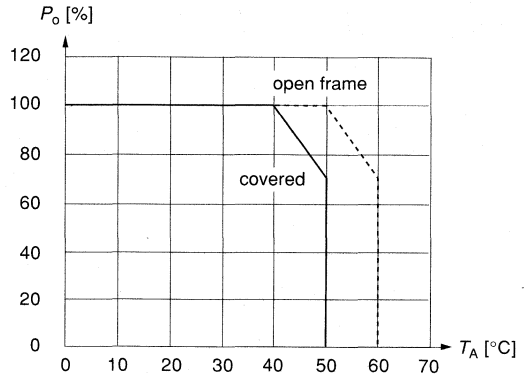



*Fig. 2*
*Output power vs. ambient temperature*

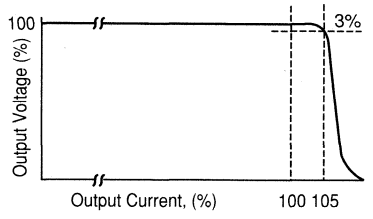



*Fig. 3*
*Output voltage vs. output current*

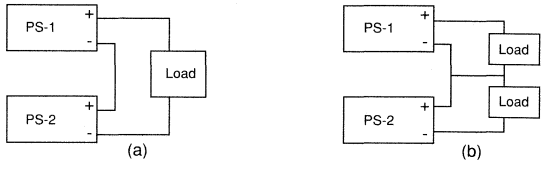



*Fig. 4*
*Power supplies connected in series*

*Table 4: Connector types (Molex)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | all | 5277-03A | 5196-03 | 5194 | 2 |
| DC output side | all | 5285-03A | 5198-03 | 5194 | 3 |

*Table 5: Cable kit (to be ordered separately from power supply)*

| Position at | Type of cable kit | Power supply | Material / Length / Cross section | Wire color | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | +V | –V | FG | AC | AC |
| AC input side | CB01 | all | UL 1015 / 60 cm / AWG 22 ≈ 0.34 mm² | – | – | – | Black | White |
| DC output side | CB02 | all | UL 1007 / 60 cm / AWG 18 ≈ 1 mm² | Red | Black | Green | – | – |


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## Immunity to Environmental Conditons

*Table 6: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 2) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 7: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s²)<br>3 h (1 h each axis)<br>Unit not operating |

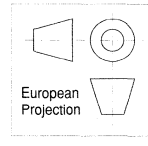
*Table 8: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 1500 V AC, 1 minute | 1500 V AC, 1 minute<br>leakage current <10 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.



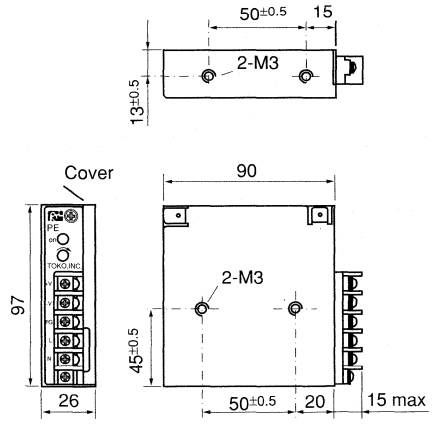




*Fig. 5*
*PS 10, weight 410 g*

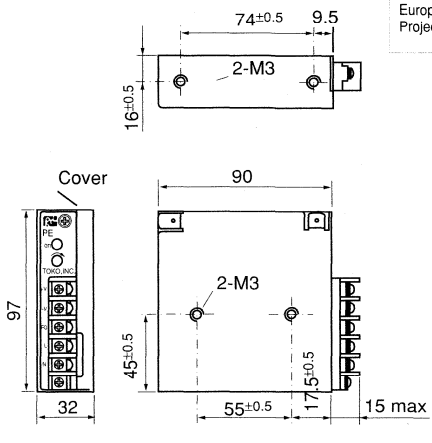



*Fig. 6*
*PS 15, weight 410 g*

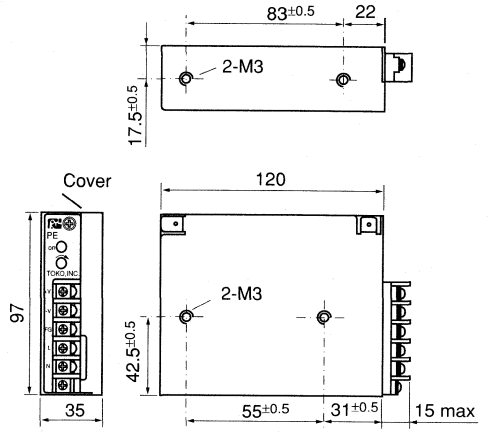



*Fig. 7*
*PS 30, weight 880 g*

## Type Key and Product Marking

### Type Key

PS 30 - 12 C

Family ..... PS
Blank .....
Nominal output power [W] ..... 10...30
Dash .....
Nominal output voltage [V] ..... 5...24
Structure and connections:
– Case with terminal strip ..... C
– Open frame with terminal strip ..... F
– Open frame with connector ..... FC

8.3

Example: PS 30-12C = AC-DC converter providing 12 V/2.5 A, 30 W and configured as open case with terminal strip

### Produkt Marking

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

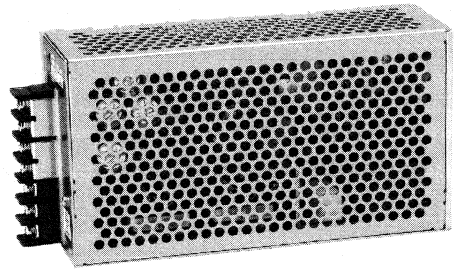

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# TOKO 15/30 W AC-DC Converters

# PT-Family

**Triple output**

- Wide range of Power ratings available
- Designed for high perfomance in operation
- Available with variations in structure (option)
- Designed to meet with regulations relative to FCC
- Wide input voltage range
- Safety according to UL 1950 (D3)



## Table of Contents


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## Type Survey

*Table 1: Type survey*

| Output 1 $U_{o\,nom}$ V DC | Output 1 $I_{o\,nom}$ A | Output 2 $U_{o\,nom}$ V DC | Output 2 $I_{o\,nom}$ A | Output 3 $U_{o\,nom}$ V DC | Output 3 $I_{o\,nom}$ A | Input voltage range $U_{i\,min}$...$U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40\,°C$ | Type designation Case Terminal strip | Open frame Terminal strip | Open frame Connector |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 2.0 | 12 | 0.3 | –12 | 0.2 | 85...132 V AC 47...63 Hz or 110...175 V DC | 15 W | PT 15-01C | PT 15-01F | PT 15-01FC |
| 5 | 2.0 | 12 | 0.3 | –12 | 0.2 | | | PT 15-02C | PT 15-02F | PT 15-02FC |
| 5 | 2.0 | 12 | 0.2 | –15 | 0.2 | | | PT 15-11C | PT 15-11F | PT 15-11FC |
| 5 | 2.0 | 12 | 0.3 | –5 | 0.2 | | | PT 15-21C | PT 15-21F | PT 15-21FC |
| 5 | 3.0 | 12 | 1.0 | –12 | 0.3 | | 30 W | PT 30-01C | PT 30-01F | PT 30-01FC |
| 5 | 3.0 | 12 | 1.0 | –12 | 0.3 | | | PT 30-02C | PT 30-02F | PT 30-02FC |
| 5 | 3.0 | 15 | 0.7 | –15 | 0.3 | | | PT 30-11C | PT 30-11F | PT 30-11FC |
| 5 | 3.0 | 12 | 1.0 | –5 | 0.3 | | | PT 30-21C | PT 30-21F | PT 30-21FC |

## Description

The PT series is UL approved, suitable for various applications and available in different packaging structures. The units provide three channel output where by different versions of current setting and regulation precision are available. Highest degree of circuit engineering has been applied to meet critical demands for high efficiency, small size, light weight, safety regulations and low cost.

**Key applications**

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

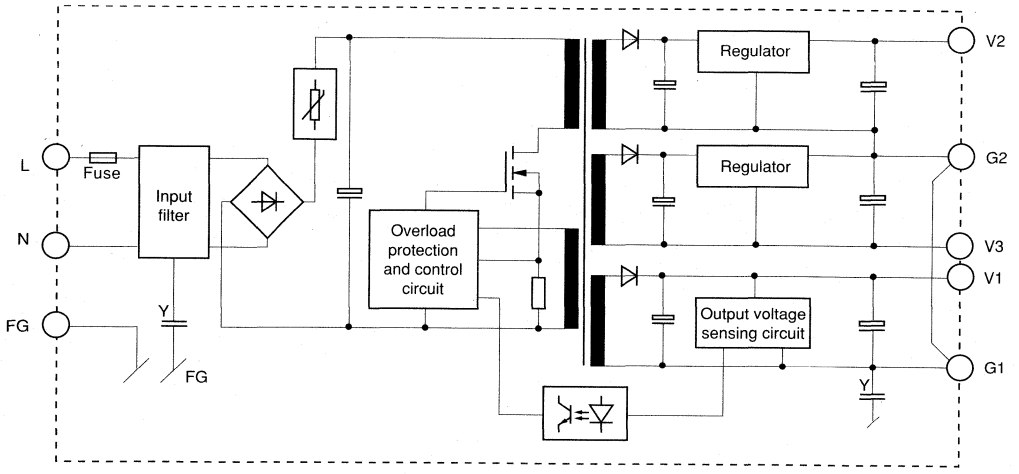



*Fig. 1*
*Block diagram PT 15/30*

## Electrical Input and Output Data

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 2: Input data*

| Characteristics | | PT 15-.. | PT 30-.. | Unit |
|---|---|---|---|---|
| $U_{i\,nom}$ | Nominal input voltage | 115, 120, 130 | | V AC |
| $U_i$ | Input voltage range | 85...132 | | V AC |
| | | 110...175 | | V DC |
| $f_i$ | Line frequency | 47...63 | | Hz |
| $I_i$ | Input current[1] | 0.37/0.35 | 0.65/0.7 | A |
| $I_{i\,m}$ | Inrush current (max.) [1] | 40 | 30 | A |
| $I_{i\,leak}$ | Leakage current (max.) | 1 | | mA |

[1] At rated input and output


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General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3a: Output data 15 W types*

| Characteristics | | PT 15-01 V1 | PT 15-01 V2 | PT 15-01 V3 | PT 15-02 V1 | PT 15-02 V2 | PT 15-02 V3 | PT 15-11 V1 | PT 15-11 V2 | PT 15-11 V3 | PT 15-21 V1 | PT 15-21 V2 | PT 15-21 V3 | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Onput voltage | +5 | +12 | −12 | +5 | +12 | −12 | +5 | +15 | −15 | +5 | +12 | −5 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±4 | ±4 | ±1 | ±5 | ±5 | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | % |
| $I_{o\,set}$ | set at a load of [1] | 1.25 | 0.15 | 0.1 | 1.35 | 0.15 | 0.1 | 1.25 | 0.15 | 0.1 | 1.25 | 0.15 | 0.1 | A |
| $U_{oL}$ | Overvoltage protection | not provided | | | | | | | | | | | | |
| $I_o$ | Rated output current min. | 0.5 | 0 | 0 | 0.7 | 0 | 0 | 0.5 | 0 | 0 | 0.5 | 0 | 0 | A |
| | typ. | 2 | 0.3 | 0.2 | 2 | 0.3 | 0.2 | 2 | 0.3 | 0.2 | 2 | 0.3 | 0.2 | |
| | max. | 2 | 0.3 | 0.2 | 2 | 0.3 | 0.2 | 2 | 0.3 | 0.2 | 2 | 0.3 | 0.2 | |
| $I_{o\,L}$ | Overcurrent protection [4] | 105 | | | | | | | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 15 | | | | | | | | | | | | W |
| $P_{o\,max}$ | Output power | 10 | 3.6 | 2.4 | 10 | 3.6 | 2.4 | 10 | 4.5 | 3.0 | 10 | 3.6 | 1.0 | |
| $u_o$ | Ripple [2] max. | 80 | 100 | 100 | 80 | 150 | 150 | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [2] max. | 120 | 150 | 150 | 100 | 150 | 150 | 120 | 150 | 150 | 120 | 150 | 150 | |
| $\Delta U_{o\,U}$ | Line regulation [3] 85...132 V | ±2 | ±0.5 | ±0.5 | ±2 | ±10 | ±10 | ±2 | ±0.5 | ±0.5 | ±2 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation [3] 0...100% | ±2 | ±1 | ±0.5 | ±2 | ±5 | ±5 | ±2 | ±1 | ±0.5 | ±2 | ±1 | ±0.5 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 hours) typ. | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | |
| $\alpha U_o$ | Change in Temp. 0...50°C | ±1 | ±1 | ±1 | ±1 | ±1.5 | ±1.5 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | |
| $t_{o\,r}$ | Rise time [2] max. | 30 | | | | | | | | | | | | ms |
| $t_{o\,h}$ | Hold up time [2] min. | 20 | | | | | | | | | | | | |
| $\eta$ | Efficiency [2] typ. | 60 | | | 75 | | | 60 | | | 60 | | | % |

*Table 3b: Output data 30 W types*

| Characteristics | | PT 30-01 V1 | PT 30-01 V2 | PT 30-01 V3 | PT 30-02 V1 | PT 30-02 V2 | PT 30-02 V3 | PT 30-11 V1 | PT 30-11 V2 | PT 30-11 V3 | PT 30-21 V1 | PT 30-21 V2 | PT 30-21 V3 | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Onput voltage | +5 | +12 | −12 | +5 | +12 | −12 | +5 | +15 | −15 | +5 | +12 | −5 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±4 | ±4 | ±1 | ±5 | ±5 | ±1 | ±4 | ±4 | ±1 | ±5 | ±5 | % |
| $I_{o\,set}$ | set at a load of [1] | 1.85 | 0.5 | 0.15 | 2 | 0.6 | 0.18 | 1.85 | 0.35 | 0.15 | 1.85 | 0.5 | 0.5 | A |
| $U_{oL}$ | Overvoltage protection | Not provided | | | | | | | | | | | | V |
| $I_o$ | Rated output current min. | 0.7 | 0 | 0 | 1 | 0.2 | 0.06 | 0.7 | 0 | 0 | 0.7 | 0 | 0 | A |
| | typ. | 3 | 1 | 0.3 | 3 | 1 | 0.3 | 3 | 0.7 | 0.3 | 3 | 1 | 0.3 | |
| | max. | 3 | 1 | 0.3 | 3 | 1 | 0.3 | 3 | 0.7 | 0.3 | 3 | 1 | 0.3 | |
| $I_{o\,L}$ | Overcurrent protection [4] | 105 | | | | | | | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 30 | | | | | | | | | | | | W |
| $P_{o\,max}$ | Output power | 15 | 12 | 3.6 | 15 | 12 | 3.6 | 15 | 10.5 | 4.5 | 15 | 12 | 1.5 | |
| $u_o$ | Ripple [2] max. | 80 | 100 | 100 | 80 | 100 | 100 | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [2] max. | 120 | 150 | 150 | 100 | 150 | 150 | 120 | 150 | 150 | 120 | 150 | 150 | |
| $\Delta U_{o\,U}$ | Line regulation [3] 85...132 V | ±2 | ±0.5 | ±0.5 | ±2 | ±8 | ±8 | ±2 | ±0.5 | ±0.5 | ±2 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation [3] 0...100% | ±2 | ±1 | ±0.5 | ±2 | ±8 | ±8 | ±2 | ±1 | ±0.5 | ±2 | ±1 | ±0.5 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 hours) typ. | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | |
| $\alpha U_o$ | Change in Temp. 0...50°C | ±1 | ±1 | ±1 | ±1 | ±1.5 | ±1.5 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | |
| $t_{o\,r}$ | Rise time [2] max. | 30 | | | | | | | | | | | | ms |
| $t_{o\,h}$ | Hold up time [2] min. | 20 | | | | | | | | | | | | |
| $\eta$ | Efficiency [2] typ. | 60 | | | 75 | | | 60 | | | 60 | | | % |

[1] Output voltages are set at factory for the load condition, as indicated, at the terminals or connector
[2] At rated input and output and normal temperature
[3] For each useable range as follows • Line regulation: Within the input voltage range • Load regulation: Within the output current range
[4] Operating at approx. 105% of rated power, constant current method, automatic recovery

# Operation Instructions

### Input and Output Terminals

*Table 4: Input and output terminals*

| Marking | Use | Remarks |
|---|---|---|
| AC 1<br>AC 2 | AC Input | 1. For AC input 85...132 V, single phase; 47...63 Hz sine wave.<br>2. Use a 2-conductor or twisted wires<br>3. Keep the AC input and DC output leads well separated |
| FG | Frame ground terminal | For connection to equipment; use a low impedance lead<br>Note: This terminal is omitted; for gounding connect directly to the frame or land pattern on the circuit board |
| V1 | Output Terminal 1 | For 5 V DC |
| V2 | Output Terminal 2 | For 12 V DC or 15 V DC |
| V3 | Output Terminal 3 | For –12 V DC, –15 V DC or –5 V DC |
| G1<br>G2 | Ground Terminals | G1 for V1<br>G2 for V2, V3 (G1 and G2 are internally interconnected) |

### Proper Method of Operation

To supply the proper voltages from each of the three ouput channels, the load currents must be within the minimum-maximum ratings. If the load current is below the minimum, connect a dummy load.

### Output Voltage Settings

The output voltages for all PT types are factory set.

### Overcurrent Protection

Each channel has its own built-in overload protection at approx. 105% of the rated currents. In event of overloading, the load should be removed immediately and the circuit re-sets automatically.

### Inrush Current

Each type is provided with inrush current protection namely a resistor for PT 15 and a power thermistor for PT 30. The AC power switch should be of ample rating to meet with in-rush current requirements. Quick turn on and off operating should be avoided. The recovery time of the thermistor is min. 2 minutes.

### Series or Parallel Operation

The outputs cannot be operated in series or parallel with other sources.

### Derating Characteristics

The relation between the ambient temperature ($T_A$) and the rated output power is shown in fig. 3. Operating the power supply at 40°C or 50°C respectively, each output current should remain below 40% of its maximum rated value.

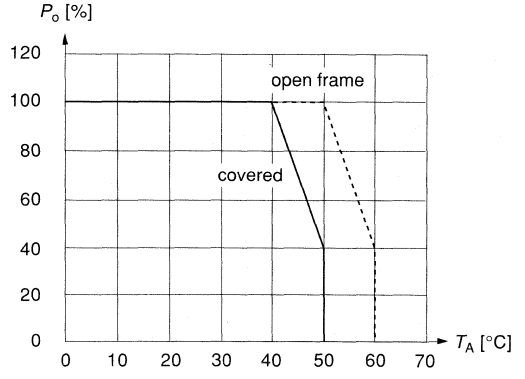



*Fig. 2*
*Output power vs. ambient temperature*

*Table 5: Connector types*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | PT 15, 30 | 5277-03A | 5196-03 | 5194 | 2 |
| DC output side | PT 15, 30 | 5289-05A | 5199-05 | 5194 | 5 |

*Table 6: Cable kit (to be ordered separately from power supply)*

| Position at | Type of cable kit | Power supply | Material / Length<br>Cross section | Wire color | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | V1 | V2 | V3 | G | AC (L) | AC (N) | FG |
| AC input side | CB01 | PT 15<br>PT 30 | UL 1015 / 60 cm<br>AWG 22 ≈ 0.34 mm² | – | – | – | – | Black | White | – |
| DC output side | CB05 | PT 15<br>PT 30 | UL 1007 / 60 cm<br>AWG 18 ≈ 1 mm² | Red | Brown | Blue | Black<br>×2 | – | – | – |


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## Immunity to Environmental Conditions

*Table 7: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 2) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 8: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s²)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 9: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 1500 V AC, 1 minute | 1500 V AC, 1 minute<br>leakage current <10 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mounting Instructions

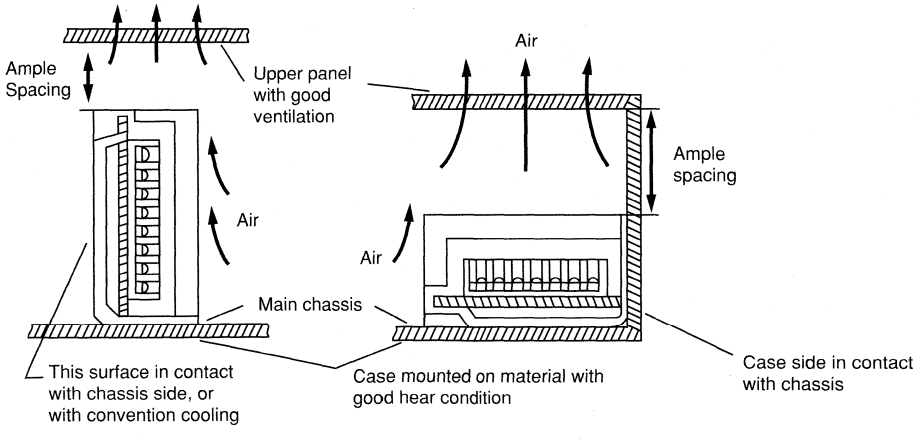



*Fig. 3a*
*Vertical positioning*

*Fig. 3b*
*Horizontal positioning*

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

European Projection

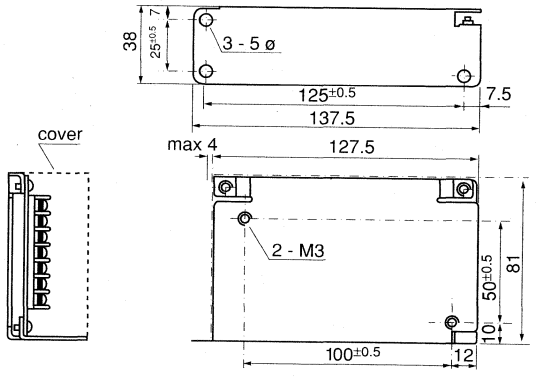



*Fig. 4*
*PT 15, weight 380 g*

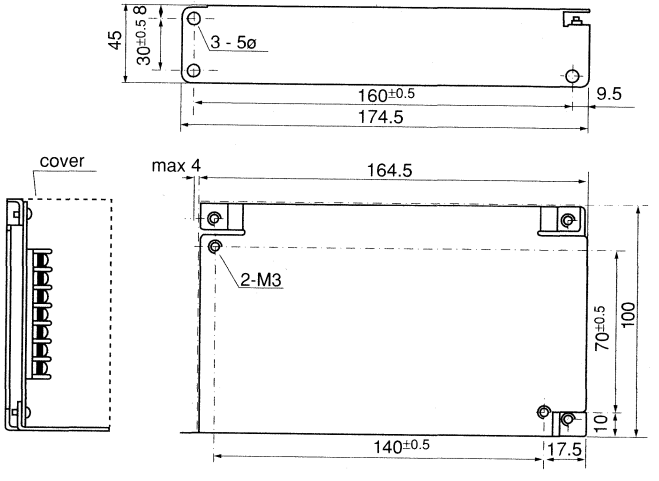



*Fig. 5*
*PT 30, weight 580 g*

## Type Key and Product Marking

### Type Key

PT 15 – 11 FC

Family ..... PT
Blank .....
Nominal output power [W] ..... 15/30
Dash .....
Output configuration ..... 01...21
Structure and connections
– Case with terminal strip ..... C
– Open frame with terminal strip ..... F
– Open frame with connector ..... FC

Example: PT 15-11 FC = AC-DC converter providing 15 W on three outputs: 5 V/2 A, 15 V/0.2 A, –15 V/0.2 A and configured as open frame with connectors

### Produkt Marking

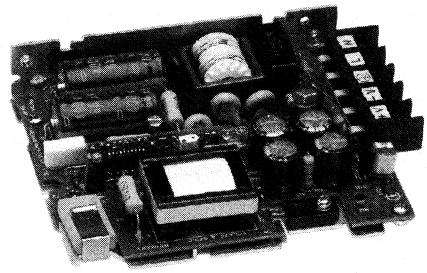
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 5/10/15/30 W AC-DC Converters

# SW-Family

**Input to output isolation**
**Single output**

- Ultra thin and compact
- High isolation
- Universal input (85...264 V AC)
- Noise standard: meets FCC class B (VCCI-2)
- Safety standard: UL 1950 (D3) approved, CSA 22.2 No. 950 (D3) approved



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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation Case Terminal strip | Open frame Terminal strip | Open frame Connector |
|---|---|---|---|---|---|---|
| 5 | 1.0 | 85...264 V AC 47...63 Hz | 5 W | – | - | SW 05-05FC |
| 5 | 2.0 | | 10 W | – | SW 10-05F | SW 10-05FC |
| 5 | 3.0 | | 15 W | SW 15-05C | SW 15-05F | SW 15-05FC |
| 5 | 6.0 | | 30 W | SW 30-05C | SW 30-05F | SW 30-05FC |
| 12 | 0.42 | | 5 W | – | - | SW 05-12FC |
| 12 | 0.83 | | 10 W | – | SW 10-12F | SW 10-12FC |
| 12 | 1.30 | | 15 W | SW 15-12C | SW 15-12F | SW 15-12FC |
| 12 | 2.50 | | 30 W | SW 30-12C | SW 30-12F | SW 30-12FC |
| 15 | 0.67 | | 10 W | – | SW 10-15F | SW 10-15FC |
| 15 | 1.00 | | 15 W | SW 15-15C | SW 15-15F | SW 15-15FC |
| 15 | 2.00 | | 30 W | SW 30-15C | SW 30-15F | SW 30-15FC |
| 24 | 0.42 | | 10 W | – | SW 10-24F | SW 10-24FC |
| 24 | 0.63 | | 15 W | SW 15-24C | SW 15-24F | SW 15-24FC |
| 24 | 1.33 | | 30 W | SW 30-24C | SW 30-24F | SW 30-24FC |

## Description

The new SW series ultra compact switchers satisfy the design engineer's demand for less space without sacrificing power and efficiency. Very low profile of one inch is maintained on most models. Choice of 5, 10, 15, and 30 Watt ratings with single output, open frame or covered models are available. Universal AC input on all models and UL1950 and CSA22.2 No. 950 (D) approvals, meeting FCC class B noise standards.

**Key applications**

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

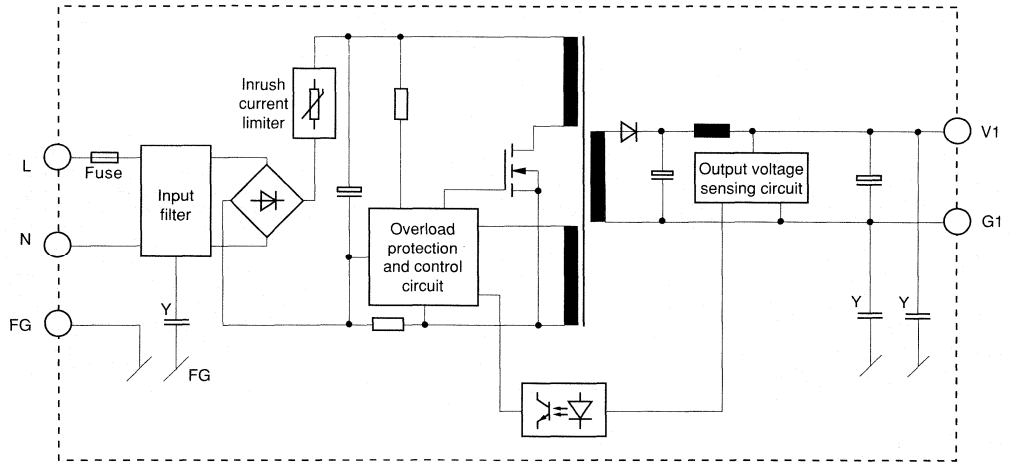



*Fig. 1*
*Block diagram SW 05/10/15*

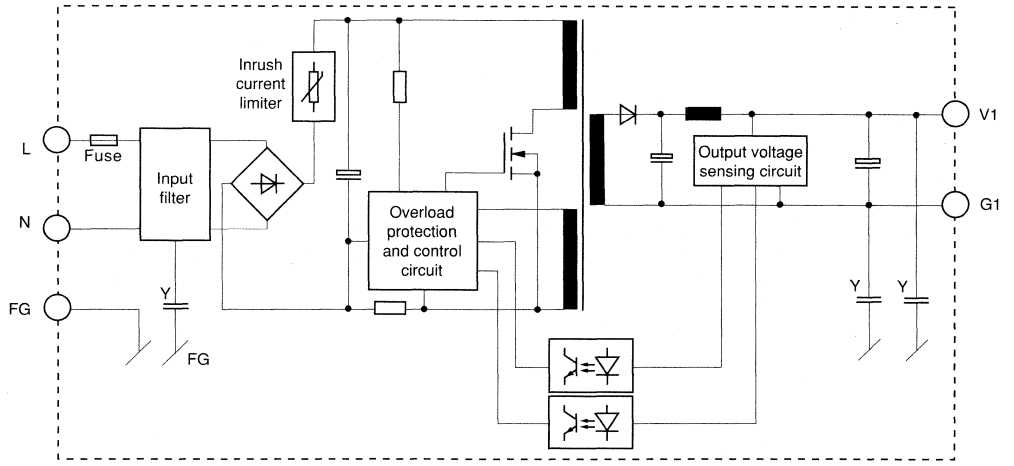



*Fig. 2*
*Block diagram SW 30*

8.3

## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | SW 05-.. | SW 10-.. | SW 15-.. | SW 30-.. | Unit |
|---|---|---|---|---|---|---|---|
| $U_{i\,rated}$ | Rated input voltage | | 100-120/200-240 | | | | V AC |
| $U_i$ | Input range voltage | | 85...264 | | | | |
| $f_i$ | Line frequency | | 47...63 | | | | Hz |
| $I_i$ | Input current [1] | 100/200 V AC | 0.12/0.06 | 0.24/0.12 | 0.36/0.17 | 0.7/0.5 | A |
| $I_{inr}$ | Inrush current (max.) [1] | 100/200 V AC | 30/60 | 30/60 | 30/60 | 45/90 | |
| $I_{i\,leak}$ | Leakage current (max.) | 120/240 V AC | 0.5/0.75 | | | | mA |

[1] At rated input and output


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General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3a: Output data 5 W types*

| Characteristics | | SW 05-05.. | SW 05-12.. | Unit |
|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | 5 | 12 | V |
| | Adjustable voltage range | ±10 | | % |
| $I_{o\,nom}$ | Rated output current | 1 | 0.42 | A |
| $I_o$ | Output current min./max. | 0...100 | | % |
| $U_o$ | Ripple-noise [1] max. | 120 | | mVpp |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±3 | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±3 | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | ±3 | | |
| $\alpha U_o$ | Change in temp. 0...50 °C | ±3 | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | |
| $U_{o\,L}$ | Overvoltage protection, max. | (optional) | | V |
| | Remote sensing | Not provided | | |
| | Output indicator | LED on PCB | | |
| $t_{o\,r}$ | Rise time [1] max. | 30 | 100 | ms |
| $t_{o\,h\,min}$ | Hold up time [1] 100 V AC | 15 | | |
| $\eta$ | Efficiency [1] typ. | 70 | 75 | % |

[1] At rated input and output
[2] Constant current method, automatic recovery

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3b: Output data 10 W types*

| Characteristics | | SW 10-05.. | SW 10-12.. | SW 10-15.. | SW 10-24.. | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | 5 | 12 | 15 | 24 | V |
| | Adjustable voltage range | ±10 | | | | % |
| $I_{o\,nom}$ | Rated output current | 2.0 | 0.83 | 0.67 | 0.42 | A |
| $I_o$ | Output current min./max. | 0...100 | | | | % |
| $U_o$ | Ripple-noise [1] max. | 120 | 120 | 150 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±3 | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±3 | | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | ±3 | | | | |
| $\alpha U_o$ | Change in temp. 0...50 °C | ±3 | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | |
| $U_{o\,L}$ | Overvoltage protection, max. | (optional) | | | | V |
| | Remote sensing | Not provided | | | | |
| | Output indicator | LED on PCB | | | | |
| $t_{o\,r}$ | Rise time [1] max. | 30 | 100 | 150 | 200 | ms |
| $t_{o\,h\,min}$ | Hold up time [1] 100 V AC | 15 | | | | |
| $\eta$ | Efficiency [1] typ. | 70 | 75 | 75 | 75 | % |

[1] At rated input and output
[2] Constant current method, automatic recovery

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3c: Output data 15 W types*

| Characteristics | | SW 15-05.. | SW 15-12.. | SW 15-15.. | SW 15-24.. | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | 5 | 12 | 15 | 24 | V |
| | Adjustable voltage range | ±10 | | | | % |
| $I_{o\,nom}$ | Rated output current | 3 | 1.3 | 1 | 0.63 | A |
| $I_o$ | Output current min./max. | 0...100 | | | | % |
| $U_o$ | Ripple-noise [1] max. | 120 | 120 | 150 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±3 | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±3 | | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | ±3 | | | | |
| $\alpha U_o$ | Change in temp. 0...50°C | ±3 | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | |
| $U_{o\,L}$ | Overvoltage protection, max. | (optional) | | | | V |
| | Remote sensing | Not provided | | | | |
| | Output indicator | LED on PCB | | | | |
| $t_{o\,r}$ | Rise time [1] max. | 30 | 100 | 150 | 200 | ms |
| $t_{h\,min}$ | Hold up time [1] 100 V AC | 15 | | | | |
| $\eta$ | Efficiency [1] typ. | 70 | 75 | 75 | 75 | % |

[1] At rated input and output
[2] Constant current method, automatic recovery

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3d: Output data 30 W types*

| Characteristics | | SW 30-05.. | SW 30-12.. | SW 30-15.. | SW 30-24.. | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | 5 | 12 | 15 | 24 | V |
| | Adjustable voltage range | ±10 | | | | % |
| $I_{o\,nom}$ | Rated output current | 6 | 2.5 | 2 | 1.3 | A |
| $I_o$ | Output current min./max. | 0...100 | | | | % |
| $U_o$ | Ripple-noise [1] max. | 120 | 120 | 150 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±3 | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±3 | | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | ±3 | | | | |
| $\alpha U_o$ | Change in temp. 0....50°C | ±3 | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | |
| $U_{o\,L}$ | Overvoltage protection, max. | 6.9 | 15.5 | 20 | 31 | V |
| | Remote sensing | Not provided | | | | |
| | Output indicator | LED on PCB | | | | |
| $t_{o\,r}$ | Rise time [1] max. | 30 | 100 | 150 | 200 | ms |
| $t_{o\,h\,min}$ | Hold up time [1] 100 V AC | 15 | | | | |
| $\eta$ | Efficiency [1] typ. | 70 | 75 | 75 | 75 | % |

[1] At rated input and output
[2] Constant current method, automatic recovery

# Operation Instructions

### Input and Output Terminals

*Table 4: Input and output terminals*

| Terminal | Function | Explanation |
|---|---|---|
| L (line)<br>N (neutral) | Input terminal | • Connect to AC of 85 to 264 V, sine wave, single phase<br>• Space the AC input line as far as possible from the DC output line. |
| FG | Frame ground terminal | • For frame grounding, connect to ground of main chassis. |
| +V<br>-V | Output Terminal<br>Output Terminal | • Output voltage. |

### Output Power Derating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 3. When the power supply is used at an ambient temperature of 60 °C, the output power has to be reduced to 60% of the rated maximum value.

### Series and Parallel Connection

The outputs of the SW modules cannot be operated in series or parallel connection.

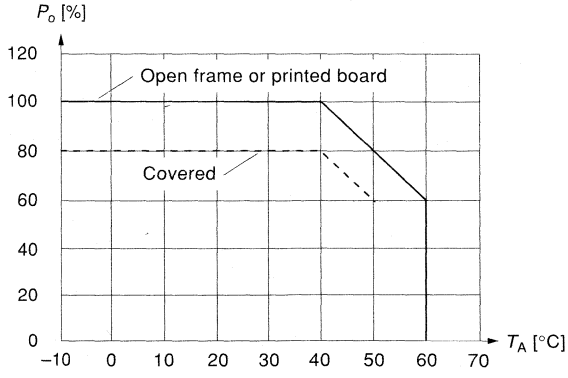



*Fig. 3*
*Output power vs. ambient temperature*

*Table 5: Connector types*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | SW 05, SW 10 | B3 (5-2,4) B-XH-A | XHP-5 | SXH-001T-P0.6 | 3 |
| | SW 15, SW 30 | B4P (6-2,4) -VH | VHR-6N | SVH-21T-P1.1 | 4 |
| DC output side | SW 05 | B2B-XH-A | XHP-2 | SXH-001T-P0.6 | 2 |
| | SW 10 | B4B-XH-A | XHP-4 | | 4 |
| | SW 15, SW 30 | B4P-VH | VHR-4N | SVH-21T-P1.1 | 4 |

*Table 6: Cable kit (to be ordered seperatly from power supply)*

| Position at | Name of cable kit | Power supply | Material \| Length<br>Cross section | Wire color | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | +V | –V | FG | L | N |
| AC input side | CB-19 | SW 05<br>SW 10 | UL 1430 \| 60 cm<br>AWG 22 ≈ 0.34 mm² | – | – | Green | Black | White |
| | CB-24 | SW 15<br>SW 30 | UL 1015 \| 60 cm<br>AWG 20 ≈ 0.5 mm² | – | – | Green | Black | White |
| DC output side | CB-20 | SW 05 | UL 1430 \| 60 cm<br>AWG 22 ≈ 0.34 mm² | Red | Black | – | – | – |
| | CB-21 | SW 15<br>SW 30 | UL 1430 \| 60 cm<br>AWG 18 ≈ 1 mm² | Red<br>×2 | Black<br>×2 | – | – | – |
| | CB-25 | SW 10 | UL 1430 \| 60 cm<br>AWG 22 ≈ 0.34 mm² | Red<br>×2 | Black<br>×2 | – | – | – |

### Mounting Methods

Care should be taken that there is sufficient air convection around the power supply unit.

Whenever possible, forced air cooling is recommended to obtain a higher reliability.

For open frame or covered structures:

a) Horizontal mounting: Use tapped holes at bottom side of the frame for fastening to the chassis. Use M3 screws with torque at less than 5 kpcm. Screw length should not damage the insulation.

b) Vertical mounting: Holes are provided on the flange; M3 screws should be used.

## Immunity to Environmental Conditions

*Table 7: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 4) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 8: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s²)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 9: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 2000 V AC, 1 minute | –<br>leakage current <10 mA. | – |
| Insulation resistance [1] | >100 MΩ at 500 V DC | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerance: ±1mm unless otherwise indicated.

European Projection

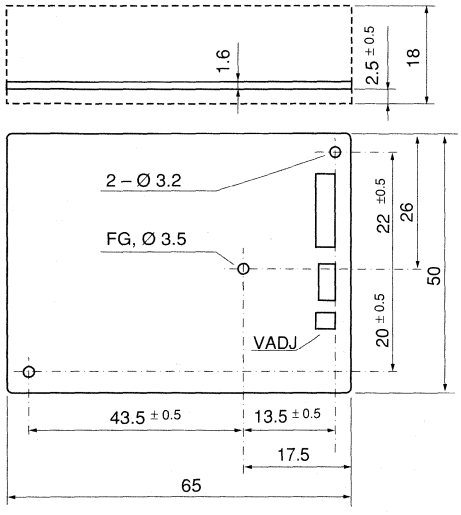



*Fig. 4*
*SW 05 (PCB), weight: 50 g*

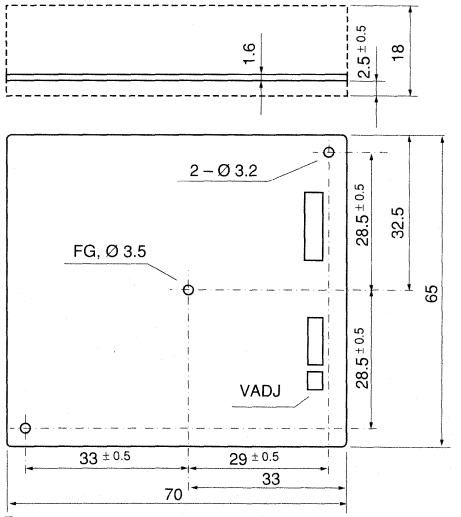



*Fig. 5*
*SW 10 (PCB), weight: 60 g*

**Note:**
When a SW power supply is mounted from bottom side, the screw shall not be longer than 6 mm.


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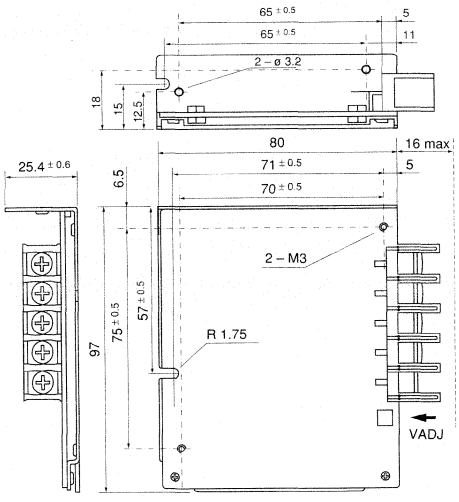



*Fig. 6*
*SW 15, weight: 220 g*

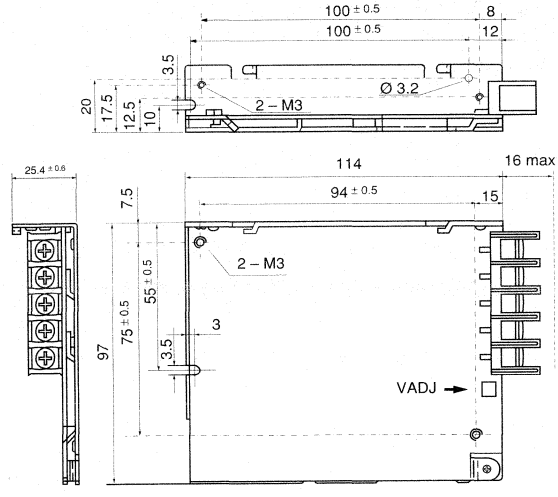



*Fig. 7*
*SW 30, weight: 250 g*

**Note:**
When a SW power supply is mounted from bottom side, the screw shall not be longer than 6 mm.

## Type Key and Product Marking

### Type Key

SW 15 – 12 FC

| | |
|---|---|
| Family | SW |
| Blank | |
| Nominal output power [W] | 5...30 |
| Dash | |
| Nominal output voltage [V] | 5...24 |
| Structure and connections | |
| – Case with terminal strip | C |
| – Open frame with terminal strip | F |
| – Open frame with connector | FC |

Example: SW 15-12 F = AC-DC converter providing 12 V/1.3 A and configured as open frame with terminal strip

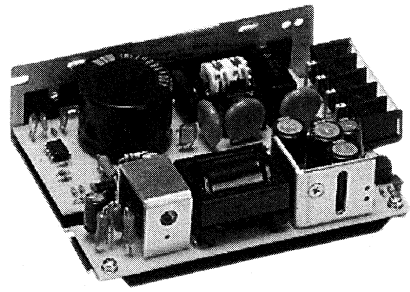
### Produkt Marking

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# 25 W AC-DC Converters VRW-Family

**Single output**

- Universal AC input
- 3000 $V_{rms}$ input to output isolation
- Compact design
- Excellent line/load regulation
- High efficiency
- Safety standards: UL, CSA, TUV approved



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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 50\,°C$ | Type designation Open frame Terminal block | Chassis cover Terminal block | Open frame Connector | Chassis cover Connector |
|---|---|---|---|---|---|---|---|
| 5 | 5.0 | 85...265 V AC 47...440 Hz 110...330 V DC | 25 W | VRW 25-5 | VRW 25-5A | VRW 25-5B | VRW 25-5C |
| 12 | 2.1 | | | VRW 25-12 | VRW 25-12A | VRW 25-12B | VRW 25-12C |
| 15 | 1.67 | | | VRW 25-15 | VRW 25-15A | VRW 25-15B | VRW 25-15C |
| 24 | 1.0 | | | VRW 25-24 | VRW 25-24A | VRW 25-24B | VRW 25-24C |
| 48 | 0.52 | | | VRW 25-48 | VRW 25-48A | VRW 25-48B | VRW 25-48C |

8.3

## Description

The VRW series of switching power supplies is a single output series of AC-DC converters. Compact size and high reliability make the VRW series an excellent choice. Five standard single output ratings are available. The units are UL 1950 (D3), CSA 234 und EN 60950 approved.

**Key applications**

Factory automation, test and measurement, point-of-sales and communications equipment.

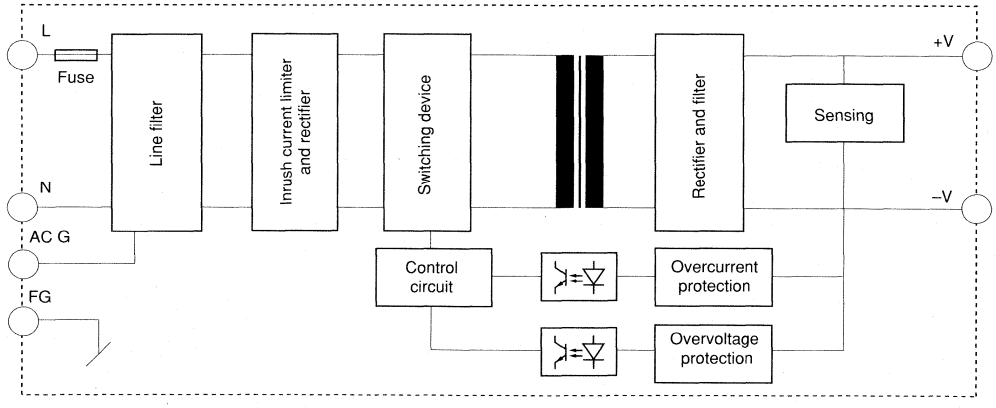



*Fig. 1*
*Block diagram VRW 25*

## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | VRW 25- .. | Unit |
|---|---|---|---|---|
| $U_{i\,rated}$ | Rated input voltage | | 100-120/200-240 | V AC |
| $U_i$ | Input voltage range | | 85...265 | |
| | | | 110...330 | V DC |
| $f_i$ | Line frequency | | 47...440 | Hz |
| $I_i$ | Input current [1] | 100/200 V AC | 0.55/0.3 | A |
| $I_{inr}$ | Inrush current | 100/200 V AC | 20/40 | |
| $I_{i\,leak}$ | Leakage current | 100/200 V AC | 0.25/0.5 | mA |

[1] At rated input and output

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3: Output data*

| Type / Characteristics | | | VRW 25-05 | VRW 25-12 | VRW 25-15 | VRW 25-24 | VRW 25-48 | Unit |
|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\,adj}$ | Adjustable voltage range | | ±10 | | | | | % |
| $I_{o\,nom}$ | Rated output current | | 5.0 | 2.1 | 1.67 | 1.0 | 0.52 | A |
| $I_o$ | Output current range | min./max. | 0...100 | | | | | % |
| $u_o$ | Ripple-noise [1] | max. | 120 | 150 | 150 | 200 | 300 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | $U_{i\,min}$...$U_{i\,max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±0.8 | | | | | |
| $\alpha u_o$ | Temperature coefficient | max. | ±1 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | | 125 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | | 5.75...6.75 | 13.8...16.2 | 17.3...20.3 | 27.6...32.4 | 55.2...64.8 | V |
| $t_{Uo\,r}$ | Rise time [1] | typ. | 20 | | | | | ms |
| $t_h$ | Hold-up time [1] | typ. | 20 | | | | | |
| $\eta$ | Effciency [1] | typ. | 72 | 77 | 79 | 81 | 81 | % |
| | Output indicator | | LED | | | | | |
| | Outputs connected in series | | possible | | | | | |
| | Outputs connnected in parallel | | not possible | | | | | |

[1] At rated input and output.
[2] Operating in foldback method, automatic recovery. Overload for more than 30 seconds should be avoided.
[3] Shut down of output. Turn-on by brief removal of the input voltage. Overvoltage protection is not adjustable.

## Operation Instructions

### Output Power Rating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 1.

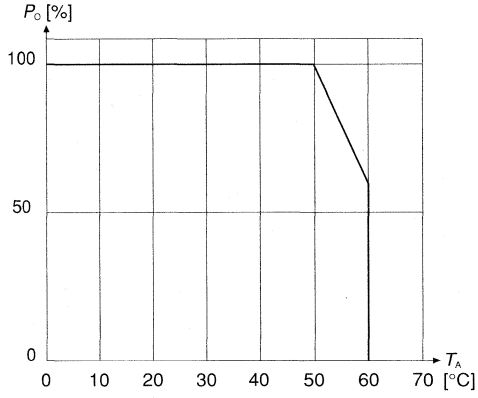



*Fig. 2*
*Output power vs. ambient temperature*

### Output Voltage Adjustment

The output voltage may be adjusted within ±10% of $U_{o\,nom}$ by means of the internal potentiometer. If the output voltage setting should be excessively high, the overvoltage protection circuit may shut-down the output.

### Output Overvoltage Protection

If the built-in overvoltage protection circuit becomes active, the output is shut down and a reset can only be achieved by brief removal of the input voltage after a minimum interval time. The overvoltage threshold level is not adjustable.

### Output Overload Protection

An overload condition at the output should not last for more than 30 seconds. After removal of the overload, the overload protection circuit will automatically recover.

### Outputs Connected in Series

Two or more units supplying the same or different output voltages may be connected in series. The value of the maximum output current to be taken is defined by that unit providing the lowest current limiting value. It should be assured that the outputs do not feed backwards into each other caused by their different rise/fall times at switch-on/off cycles by adding reverse polarity diodes across each output.

### Outputs Connected in Parallel

Parallel connection of several identical modules is not possible.

## Immunity to Environmental Conditions

*Table 4: Mechanical Stress*

| Test Method | Test conditions | | Status |
|---|---|---|---|
| Damp heat steady state | Temperature:<br>Relative himidity: | 40 $^{\pm 2}$ °C<br>30...90 $^{-3/+2}$ % | Operating |
| Shock (half-sinusoidal) | Acceleration amplitude: | 20 $g_n$ = 981 m/s$^2$ | Operating |
| Vibration (sinusoidal) | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...55 Hz<br>0.83 mm (55 Hz)<br>2 $g_n$ = 49 m/s$^2$<br>3 h (1 h each axis) | Operating |

*Table 5: Temperature*

| Characterisitcs | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 60 | |
| $T_S$ | Storage temperature | (Not operational) | –20 | 75 | |

*Table 6: MTBF Values*

| MTBF | Ground Benign |
|---|---|
| MTBF according to MIL-HDBK-217D | $T_C$ = 40 °C |
| VRW 25 types | 132'900 h |

*Table 7: Isolation*

| Test | Input to output | Input to case | Output to case | Unit |
|---|---|---|---|---|
| Electric strenght test voltage (1 min) | 3000 | 2000 | 500 | V AC |
| Isolation resistance (500 V DC) | >100 | >100 | >100 | MΩ |

*Table 8: Electromagnetic Emmission*

| Standard | Maintained level |
|---|---|
| FCC | < B |

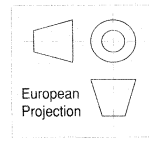
*Table 9: Safety Approvals*

| Safety Approvals | UL 1950 | CSA 234 | TÜV [1] |
|---|---|---|---|
| VRW 25- .. | x | x | x |

[1] EN 60 950

## Mechanical Data, Input and Output Terminals

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated



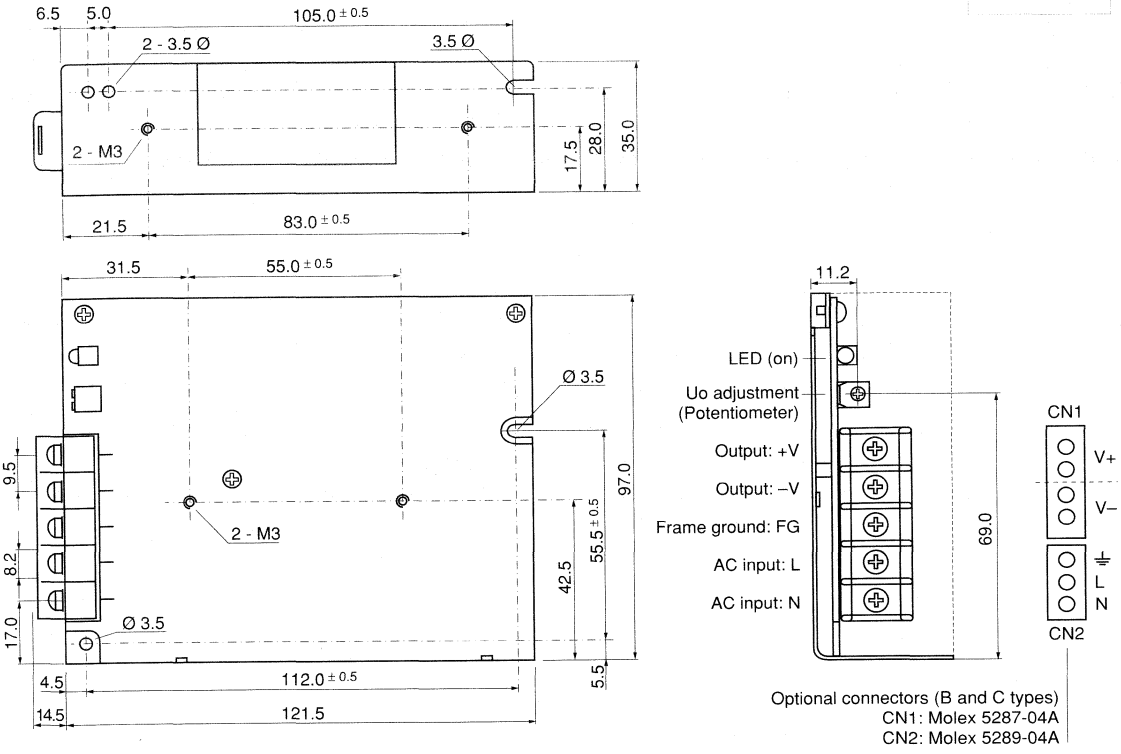




*Fig. 3*
*VRW 25, weight 310 g*

## Type Key and Product Marking

**Type Key**

VRW 25 - 12 A

Family ..... VRW
Blank .....
Nominal output power [W] ..... 25
Dash .....
Nominal output voltage [V] ..... 5...48
Structure and connectors:
– Open frame with terminal block .....
– Chassis cover with terminal block ..... A
– Open frame with connector ..... B
– Chassis cover with connector ..... C

Example: VRW 30-12A = AC-DC converter providing 12 V/2.1 A, 25 W output, module with chassis cover and terminal block

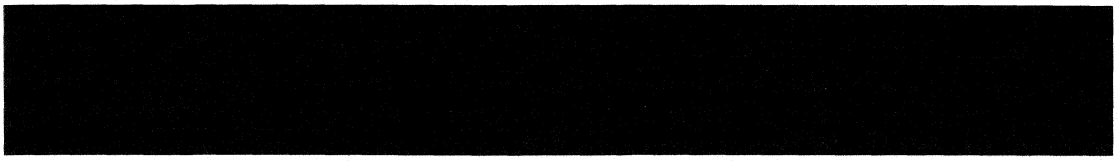
**Produkt Marking**

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

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# 9 AC-DC Converters <100 W

## 9.1 Rugged Environment



## 9.2 Industrial Environment

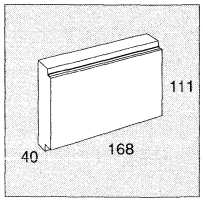
| Output [W] 30 40 50 60 80 100 | Output [V DC] 5 6 12 15 18 24 48 | Input [V DC] 85 110 135 180 220 264 | Product Family | Case | Page |
|---|---|---|---|---|---|
| ■ | ■ | ■ | LM | M02 | 9 - 3 |
| ■ | ■ | ■ | LS | S01 | 9 - 24 |
| ■ | ■ | ■ | VEW | various | 9 - 46 |

## 9.3 Benign Environment

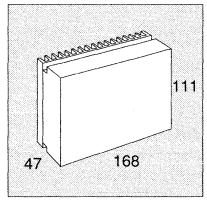
| Output [W] 30 40 50 60 80 100 | Output [V DC] 5 6 12 15 18 24 48 | Input [V DC] 85 110 135 180 220 264 | Product Family | Case | Page |
|---|---|---|---|---|---|
| ■ | ■ | ■ | LH | H01 | 9 - 51 |
| ■ | ■ ■ ■ (multiple) | ■ | LW | various | 9 - 66 |
| ■ | ■ ■ ■ (multiple) | ■ | MW | various | 9 - 72 |
| ■ | ■ | ■ ■ | PE | various | 9 - 78 |
| ■ | ■ | ■ | PS | various | 9 - 85 |
| ■ | ■ ■ ■ (multiple) | ■ | PT | various | 9 - 92 |
| ■ | ■ | ■ | SW | various | 9 - 99 |
| ■ | ■ | ■ ■ | VRW | various | 9 - 106 |

(Several power ranges available)

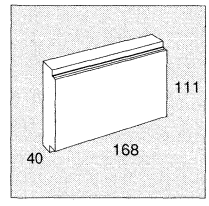
Case M02




Case S01




Case H02



Edition 1/05 - © Melcher AG

# 50 W AC-DC (DC-DC) Converters

# M-Family

**Class I Equipment**

Single output: series LM 1000
Dual output: series LM 2000
Triple output: series LM 3000

**Class II Equipment (double insulation)** ⧈

Single output: series LMZ 1000
Dual output: series LMZ 2000
Triple output: series LMZ 3000

- Extremely wide input voltage range suitable for most AC mains around the world
- Efficient input filter and built-in surge and transient suppression circuitry
- 4 $kV_{rms}$ input to output electric strength test
- Outputs individually isolated and controlled
- Outputs fully protected against overload
- Safety according to IEC 950




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## Description

The M-family of AC-DC (DC-DC) converters represents a broad and flexible range of power supplies for use in advanced industrial electronic systems. Features include high efficiency, reliability, low output voltage noise and excellent dynamic response to load/line changes due to individual regulation of any output.

The converter inputs are protected against surges and transients occuring on the source lines. Input over- and undervoltage cut-out circuitry disables the outputs if the input voltage is outside the specified range. These types include an inrush current limitation preventing circuit breakers and fuses from being damaged at switch-on.

All outputs are open- and short-circuit proof and are protected against overvoltages by means of built-in suppressor diodes. The outputs can be inhibited by a logic signal applied to the connector pin i. If the inhibit function is not used pin 2 should be connected with pin 23 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case and output to output isolation is provided. The modules are designed and built according to the international safety standard IEC 950 and have been approved by the safety agencies VDE (Germany), SEV (Switzerland), UL (USA) and CSA (Canada).

The case design allows operation at nominal load up to an ambient temperature of 71 °C in free air. If forced cooling is provided, the ambient temperature may exceed 71°C but the case temperature should remain below 95°C under all conditions.

A temperature sensor generates an inhibit signal which disables the outputs if the case temperature $T_C$ exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Case: aluminium, black finish, self cooling.
Dimensions: 38.7 × 111.2 × 168.5 mm. Weight: 770 g

## Type Survey

**Options see "Descriptions of Options"**

### General note

The type survey tables provide an overview of the basic input and output configurations. More than 500 different types have been manufactured providing different output configurations and customised specialities. Please consult Melcher's field sales engineers for specific requirements. The best technical solution will carefully be considered and a detailed proposal submitted.

*Table 1: Class I equipment*

| Output 1 | | Output 2 | | Output 3 | | Input Voltage Range and Efficiency [1] | | Option |
|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{i\,min}...U_{i\,max}$ **85...264 V AC/47...440 Hz** (88...372 V DC) | $\eta_{min}$ % | |
| 5.1 | 8.0 | | | | | LM 1001-7R | 73 | –9 |
| 12.0 | 4.0 | | | | | LM 1301-7R | 79 | E |
| 15.0 | 3.4 | | | | | LM 1501-7R | 78 | P |
| 24.0 | 2.0 | | | | | LM 1601-7R | 81 | D0...D9 |
| 48.0 | 1.0 | | | | | LM 1901-7R | 81 | V0,V2,V3 |
| 12.0 | 2.0 | 12.0 | 2.0 | | | LM 2320-7 | 77 | A |
| 15.0 | 1.7 | 15.0 | 1.7 | | | LM 2540-7 | 78 | H |
| 5.1 | 5.0 | 12.0 | 0.7 | 12.0 | 0.7 | LM 3020-7 | 73 | F |
| 5.1 | 5.0 | 15.0 | 0.6 | 15.0 | 0.6 | LM 3040-7 | 71 | U |

*Table 2: Class II equipment (double insulation)* ⧈

| Output 1 | | Output 2 | | Output 3 | | Input Voltage Range and Efficiency [1] | | Option |
|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | $U_{i\,min}...U_{i\,max}$ **85...264 V AC/47...65 Hz** (88...372 V DC) | $\eta_{min}$ % | |
| 5.1 | 8.0 | | | | | LMZ 1001-7R | 73 | –9 |
| 12.0 | 4.0 | | | | | LMZ 1301-7R | 79 | E |
| 15.0 | 3.4 | | | | | LMZ 1501-7R | 78 | P |
| 24.0 | 2.0 | | | | | LMZ 1601-7R | 81 | D0...D9 |
| 48.0 | 1.0 | | | | | LMZ 1901-7R | 81 | V0,V2,V3 |
| 12.0 | 2.0 | 12.0 | 2.0 | | | LMZ 2320-7 | 77 | A |
| 15.0 | 1.7 | 15.0 | 1.7 | | | LMZ 2540-7 | 78 | H |
| 5.1 | 5.0 | 12.0 | 0.7 | 12.0 | 0.7 | LMZ 3020-7 | 73 | F |
| 5.1 | 5.0 | 15.0 | 0.6 | 15.0 | 0.6 | LMZ 3040-7 | 71 | U |

[1] Efficiency measured at $U_{i\,nom}$ and $I_{o\,nom}$

## Safety and Installation Instructions

### Safety

For safety reasons, the power supply modules must be wired via the female connector H11 (according to DIN 41612, see accessories) in order to meet national and international safety requirements!

LM types correspond to class I equipment, while the LMZ types correspond to class II equipment. All converters fully comply with IEC 950, EN 60950, DIN VDE 0805 (including manufacturing surveillance), UL 1950 and CSA/C22.2 No. 950-M89.

In class I equipment the connector protective earthing pin is leading while it is omitted in class II equipment (no protective earthing is required). Class II equipment requires reinforced insulation between input and output circuitry and also between input and case. There are two class II Y-capacitors connected in series between input and output circuitry instead of having Y-capacitors connected to the case.

During the production process, all transformers and each of the fully assembled modules are individually tested for electric strength and earth continuity (detailed values are shown in table 14). All electric strength tests are performed as factory tests.

The UL 1950 recognition limits the ambient operational temperature range of the standard modules to $T_A$ = $T_{A\,max}$ –15 K. Option U allows the operation in applications where the full operational temperature range according to the relevant data sheet and UL 1950 recognition is required.

*Table 3: Status of actual safety approvals*

| Types | Safety Standards | | | |
|---|---|---|---|---|
| | DIN VDE 0805/05.90 IEC 950/EN 60950 | SEV 1061/1085 | UL 1950 File E 143030 | CSA C.22.2 No.950 File LR 95850 [3] |
| LM 1000 | approved | approved | recognized | recognized |
| LM 2000 | approved | approved | recognized | recognized |
| LM 3000 | approved | approved | recognized | recognized |
| LMZ 1000 | in progress [1] | in progress | in progress [2] | in progress |
| LMZ 2000 | in progress [1] | in progress | in progress [2] | in progress |
| LMZ 3000 | in progress [1] | in progress | in progress [2] | in progress |

[1] Approval planned for March 1995
[2] Approval planned for July 1995
[3] Will be replaced by $UL_C$ in July 1995

### Important Advice

Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/µs, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher AG will not honour any guarantee/warranty claims resulting from high voltage field tests.

### Installation

Installation of the power supply must strictly follow the national safety regulations. To observe the safety requirements according to EN 60950/IEC 950, the module shall be connected via the female connector type H11. Other installation methods may not meet the safety requirements. A second fuse should be installed in the wiring to pin 29 if:

- Local requirements demand an individual fuse in each source line
- Neutral to earth impedance is high or undefined
- Phase and neutral of the mains are not defined

Whenever the inhibit function is not required, pin 2 should be connected to pin 23 to enable the output(s).

*Table 4: H11 connector pin allocation*

| Electrical Determination | LM 1000 | | LMZ 1000 | | LM 2000 | | LMZ 2000 | | LM 3000 | | LMZ 3000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pin | Ident | Pin | Ident | Pin | Ident | Pin | Ident | Pin | Ident | Pin | Ident |
| Inhibit control input | 2 | i | 2 | i | 2 | i | 2 | i | 2 | i | 2 | i |
| Safe Data or ACFAIL | 5 | D or V | 5 | D or V | 5 | D or V | 5 | D or V | 5 | D or V | 5 | D or V |
| Output voltage (positive) | 8 | Vo1+ | 8 | Vo1+ | 8 | | 8 | | 8 | Vo3+ | 8 | Vo3+ |
| Output voltage (negative) | 11 | Vo1– | 11 | Vo1– | 11 | | 11 | | 11 | Vo3– | 11 | Vo3– |
| Control input + [1] | 14 | R | 14 | R | | | | | | | | |
| Control input – | 17 | G | 17 | G | | | | | | | | |
| Output voltage (positive) | | | | | 14 | Vo2+ | 14 | Vo2+ | 14 | Vo2+ | 14 | Vo2+ |
| Output voltage (negative) | | | | | 17 | Vo2– | 17 | Vo2– | 17 | Vo2– | 17 | Vo2– |
| Output voltage (positive) | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ |
| Output voltage (negative) | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– |
| Protective earthing [2] | 26 | ⏚ | | | 26 | ⏚ | | | 26 | ⏚ | | |
| AC input voltage [3] | 29 | N ≂ | 29 | N ≂ | 29 | N ≂ | 29 | N ≂ | 29 | N ≂ | 29 | N ≂ |
| AC input voltage | 32 | P ≂ | 32 | P ≂ | 32 | P ≂ | 32 | P ≂ | 32 | P ≂ | 32 | P ≂ |

[1] This function is not simultaneously available with option P
[2] Leading pin (pregrounding)
[3] In DC-DC operation pin 29 should be connected to the earth related potential of the input voltage

### Degree of Protection

Condition: Female connector fitted to the unit
IP 40: All units, except those with options P, A, K, D or V with potentiometer adjustment.
IP 30: All units, except those with option P, D or V with potentiometer adjustment.
IP 20: All units fitted with options which include potentiometer setting.

### Leakage Currents and Insulation

Please refer "Supplementary Data"

## Functional Description

The input voltage is fed via an input fuse, an input filter, a rectifier and an inrush current limiter to the input capacitor. This capacitor sources a single transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke and an output filter. The control logic senses the main output voltage $U_{o1}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor. This signal is fed back via a coupling transformer.

The auxiliary outputs $U_{o2}$ and $U_{o3}$ are individually regulated by means of secondary switching transistors. Each auxiliary output's current is sensed using a current transformer. If one of the outputs is driven into current limit, the other outputs will reduce their output voltages as well because all output currents are controlled by the same control circuit.

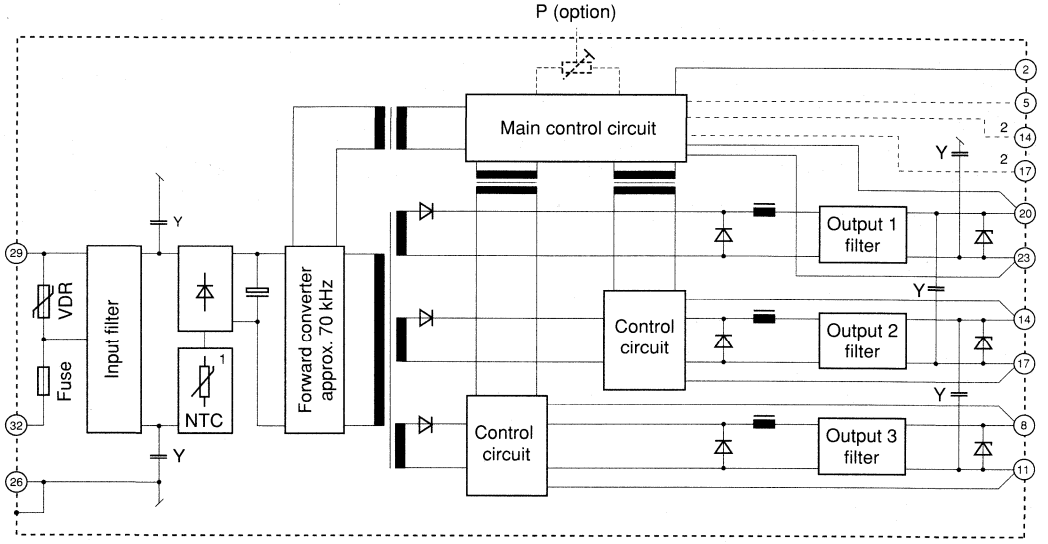



*Fig. 1a*
*AC-DC (DC-DC) converter block diagram, class I equipment*

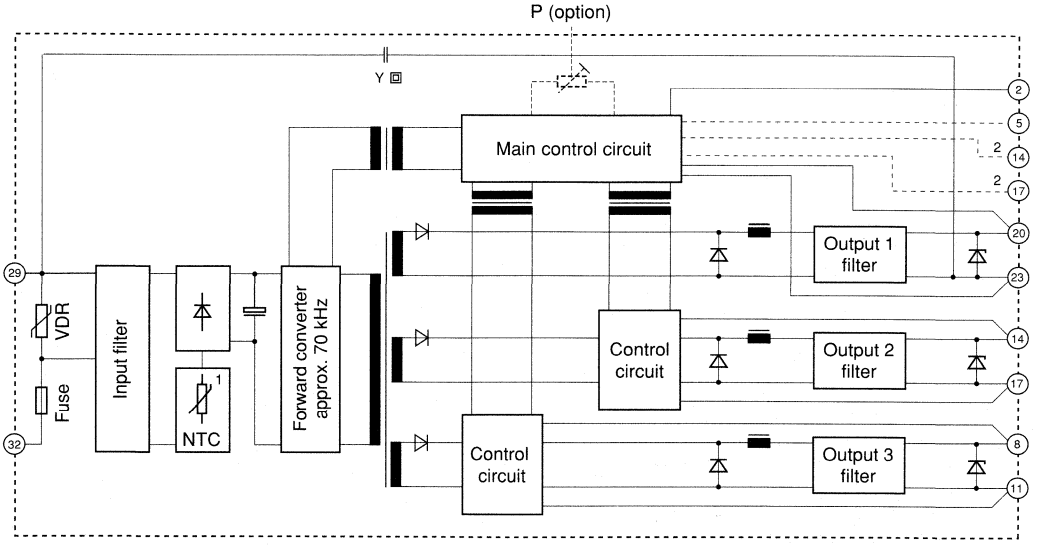



*Fig. 1b*
*AC-DC (DC-DC) converter block diagram, class II equipment (double insulation)*

[1] Inrush current limiter (option E: refer to the description of option E)
[2] Single output modules LM 1000 and LMZ 1000


MELCHER® ISO 9001 certified

## Electrical Input Data

General conditions:
– $T_A$ = 25°C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, with option P: $U_o = U_{o\,nom}$, R input not connected.

*Table 5: Input data*

| Input | | | LM/LMZ | | | |
|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0...$I_{o\,nom}$ | 85 | | 264 | V AC [1] |
| | | $T_{C\,min}$...$T_{C\,max}$ | 88 | | 372 | V DC |
| $U_{i\,nom}$ | Nominal input voltage | | | 310 [2] | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [3] | | 0.20 | | A |
| $P_{i\,0}$ | No-load input power:<br>Single output<br>Double output<br>Triple output | $U_{i\,nom}$<br>$I_{o1,2,3}$ = 0 | | <br>1<br>7<br>6 | <br>1.5<br>9<br>9 | W |
| $P_{i\,inh}$ | Idle input power | inhibit mode | | | 1.5 | W |
| $I_{inr\,p}$ [4] | Peak inrush current | $U_i = U_{i\,max}$ | | | 60 [6] | A |
| $t_{inr\,r}$ | Rise time | $R_S$ = 0 Ω [5] | | 300 | | µs |
| $t_{inr\,h}$ | Trailing edge half-life | $T_C$ = 25°C | | 900 | | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 6200 [6] | | | mΩ |
| $C_i$ | Input capacitance | | 140 | | 270 | µF |
| $U_{i\,abs}$ | Input voltage limits without any damage | | –400 | | 400 | V DC |
| | | | 0 | | 284 | V AC |

[1] In AC powered mode: LM types: 47...440 Hz; LMZ types: 47...65 Hz
[2] 310 V DC corresponds with 220 V AC
[3] With multiple output modules, the same condition for each output applies.
[4] $I_{inr\,p} = U_i/(R_S + R_i)$
[5] $R_S$ = source resistance.
[6] Value for initial switch-on cycle.

### Input fuse

A fuse holder containing a slow-blow type fuse (Dimension: 5 × 20 mm) is mounted in the converter's back plate. The fuse protects the module against severe defects. It may not fully protect the module at input voltages exceeding 200 V DC. In applications where the converters operate at DC source voltages above 200 V DC, an external fuse or a circuit breaker at system level should be installed.

*Table 6: Fuse type (slow-blow)*

| Series | Schurter type | Part number |
|---|---|---|
| LM/LMZ 1000...3000 | SPT 2.5 A 250 V | 0001.2508 |

### Input Under-/Overvoltage Cut-out

If the input voltage remains below 0.8 $U_{i\,min}$ or exceeds 1.1 $U_{i\,max}$ (approx. values), an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ must be carefully considered (see table 5).

### Inrush Current

The modules incorporate a NTC resistor in the input circuitry which (during the initial switch-on cycle) limits the peak inrush current to avoid damage to connectors and switching devices. Subsequent switch-on cycles within a short interval will cause an increase of the peak inrush current due to the warming up of the NTC resistor. Refer also to option E description.

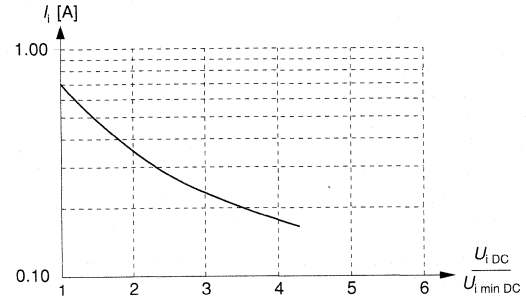



*Fig. 2*
*Typical input current versus relative input voltage at nominal output load*

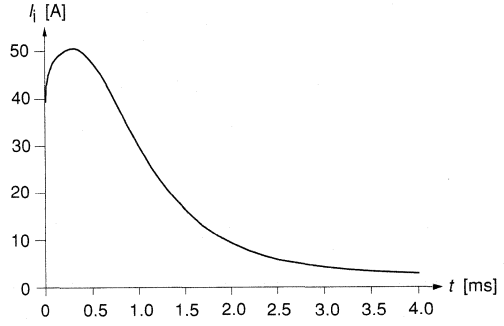



*Fig. 3*
*Typical inrush current at initial switch-on cycle and at $U_{i\,max}$ (DC) versus time*

## Electrical Output Data

General conditions
– $T_A$ = 25°C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, $U_o = U_{o\,nom}$ (option P), R input not connected.

*Table 7: Output data*

| Output | | $U_{o\,nom}$ | 5.1 V | | | 12 V | | | 15 V | | | 24 V | | | 48 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [1] | 5.07 | | 5.13 | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | 47.72 | | 48.28 | V |
| $U_{o\,L}$ | Overvoltage prot. | $I_{o\,nom}$ | | 7.5 | | | 20 | | | 24 | | | 40 | | | 76 | | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | see tables 1 and 2 | | | | | | | | | | | | | | | |
| $I_{o\,L}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | see fig. 4 | | | | | | | | | | | | | | | |
| $u_{o1/2/3}$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 2 | 4 | | 3 | 6 | | 3 | 6 | | 3 | 6 | | 4 | 8 | $mV_{rms}$ |
| $u_{o1}$ | | Bandwidth = | | 15 | 30 | | 25 | 50 | | 35 | 70 | | 40 | 80 | | 50 | 100 | $mV_{pp}$ |
| $u_{o2/3}$ | | 20 MHz | | 60 | 120 | | 40 | 80 | | 40 | 80 | | 40 | 80 | | - | | |
| $\Delta U_{o\,U}$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ [1] | | ±10 | ±30 | | ±12 | ±50 | | ±15 | ±60 | | ±15 | ±60 | | ±15 | ±60 | mV |
| $\Delta U_{o\,I}$ | Static load regulation | $U_{i\,nom}$ $I_o = I_{o\,nom}$...0 [2] | | 6 | 25 | | 13 | 50 | | 17 | 60 | | 30 | 80 | | 60 | 150 | |
| $\Delta U_{o\,Ic}$ | Static cross load regulation [4] | $U_{i\,nom}$ $I_o = I_{o\,nom}$...0 [3] | | 0 | ±15 | | 0 | ±20 | | 0 | ±30 | | 0 | ±40 | | - | | |
| $u_{o\,d}$ | Dynamic load regulation | $U_{i\,nom}$, $I_o$ = | | ±220 | | | ±110 | | | ±150 | | | ±130 | | | ±150 | | |
| $t_d$ | Dynamic load regulation time constant | 1/0.33/1•$I_{o\,nom}$ [2] fig. 5 | | 0.6 | | | 0.6 | | | 0.5 | | | 1 | | | 2 | | ms |
| $u_{o\,dc}$ | Dynamic cross load regulation [4] | $U_{i\,nom}$, $I_o$ = | | +10<br>-100 | | | +10<br>-75 | | | +10<br>-140 | | | +20<br>-200 | | | -<br>- | | mV |
| $t_{dc}$ | Dynamic cross load reg. time constant [4] | 1/0.33/1•$I_{o\,nom}$ [3] fig. 5 | | 0.05<br>0.5 | | | 0.2<br>0.3 | | | 0.5<br>0.7 | | | 1<br>2 | | | -<br>- | | ms |
| $\alpha_{Uo}$ | Output voltage deviation versus case temperature | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | | ±9.6 | | mV/K |

[1] With multiple output modules, the same condition for each output applies.
[2] Condition for specified output. With multiple output modules, other output(s) loaded with constant current $I_o = I_{o\,nom}$.
[3] Condition for non-specified output, individually tested, other output(s) loaded with constant current $I_o = I_{o\,nom}$.
[4] Multiple output modules.

### Output Protection

Each output is protected against overvoltages which could occur due to a failure of the internal control circuit. Voltage suppressor diodes (which under worst case condition may become a short circuit) provide the required protection. The suppressor diodes are not designed to withstand externally applied overvoltages. Overload at any of the outputs will cause a shut-down of all outputs. A red LED indicates the overload condition of the respective output.

### Parallel and Series Connection

Main outputs of equal nominal voltage can be connected in parallel. It is important to assure that the main output of a multiple output module is forced to supply a minimum current of 0.1 A to enable correct operation of its own auxiliary outputs.

In parallel operation, one or more of the main outputs may operate continuously in current limit which will cause an increase in case temperature. Consequently, a reduction of the max. ambient temperature by 10 K is recommended.

Main or auxiliary outputs can be connected in series with any other output of the same or another module. In series, the maximum output current is limited by the lowest current limit. Output ripple and regulation values are added. Connection wiring should be kept as short as possible.

If output terminals are connected together in order to establish multi-voltage configurations, e.g. +5.1 V, ±12 V etc. the common ground connecting point should be as close as possible to the connector to avoid excessive output voltage noise.

Auxiliary outputs should never be connected in parallel!

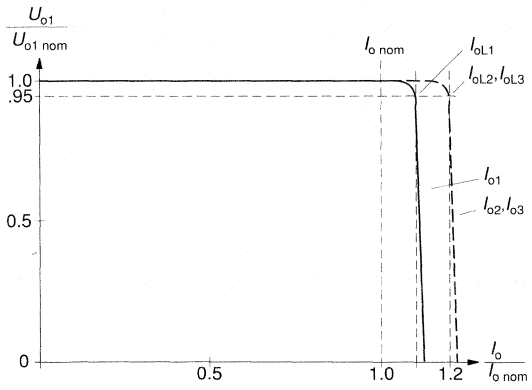



*Fig. 4*
*Typical output voltage $U_{o1}$ versus output currents $I_o$*

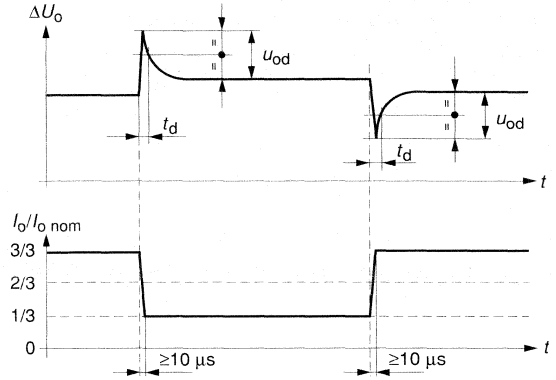



*Fig. 5*
*Control deviation of $U_o$ versus dynamic load change*

### Output Current Allocation for special Types

Output currents differing from those given for standard types (listed in tables 1 and 2) can be provided. A maximum output power of 50 W should be considered, if an ambient temperature range of –25...71 °C is required. The maximum permissible output currents are indicated in table 8. If (upon customer's request) output voltages are different from standard values, the relevant output currents have to be adapted accordingly.

With reduced maximum ambient temperature or with forced cooling, the total output power may exceed 50 W. Customised configurations always need to be checked by a feasibility study first. Please ask Melcher's sales engineers for a proposal appropriate to your specific needs.

*Table 8: Current allocation with special types*

| | Output voltage all types $U_{o1/2/3\ nom}$ [V] | Output 1 all types $I_{o1\ max}$ [A] | Output 2 LM/LMZ 2000 $I_{o2\ max}$ [A] | Output 2 LM/LMZ 3000 $I_{o2\ max}$ [A] | Output 3 LM/LMZ 3000 $I_{o3\ max}$ [A] | Temperature $T_A$ [°C] | Temperature $T_C$ [°C] |
|---|---|---|---|---|---|---|---|
| | 5.1 | 8.0 | 4.0 | 1.8 (2.5 [1]) | 1.5 | –25...71 | –25...95 |
| | 12 | 4.0 | 2.0 | 1.5 | 1.2 | | |
| | 15 | 3.4 | 1.7 | 1.2 | 1.0 | | |
| | 24 | 2.0 | 1.0 | 0.7 | 0.5 | | |
| [2] | 5.1 | 10.0 | 4.5 | 2.1 (2.8 [1]) | 1.8 | –25...60 | –25...90 |
| | 12 | 5.0 | 2.5 | 1.7 | 1.5 | | |
| | 15 | 4.0 | 2.0 | 1.5 | 1.3 | | |
| | 24 | 2.5 | 1.3 | 0.9 | 0.7 | | |
| | 5.1 | 11.0 | 5.0 | 2.4 (3.0 [1]) | 2.0 | –25...50 | –25...85 |
| | 12 | 6.0 | 3.0 | 2.0 | 1.7 | | |
| | 15 | 4.6 | 2.3 | 1.7 | 1.5 | | |
| | 24 | 3.0 | 1.5 | 1.0 | 0.8 | | |

[1] Special high current components required, [2] $U_{i\ min}$ has to be increased

### Inhibit (i Input)

The outputs of the module may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to the inhibit input. If the inhibit function is not required, connect the inhibit pin 2 to pin 23 to enable the outputs (active low logic, fail safe).

The reference for the inhibit signal is the negative pin of output 1.

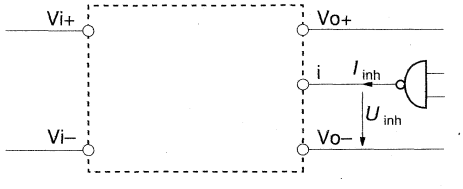



*Fig. 6*
*Definition of inhibit voltage and current*

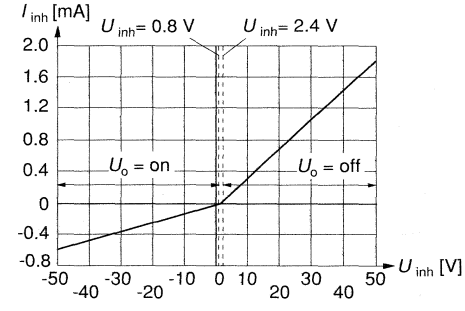



*Fig. 7*
*Typical inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 9: Inhibit data*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage causing | switched on | $U_{i\,min}...U_{i\,max}$ | –50 | | 0.8 | V DC |
| | output voltage being... | switched off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = 0 | –60 | –100 | –220 | µA |

### Hold-up Time and Output Response

When the input voltage is switched off, the output voltage will remain high for a certain hold-up time $t_h$ before the output voltage falls below 0.95 $U_{o\,nom}$.

The behavior of the outputs is similar with either the input voltage applied or the inhibit switched low.

An output voltage overshoot will not occur when the module is turned on or off.

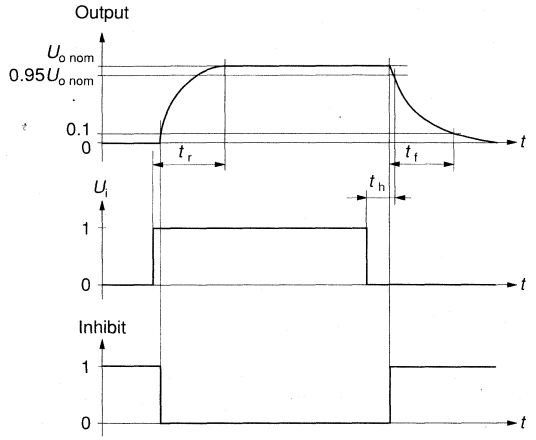



*Fig. 8*
*Output response as a function of input voltage (on/off switching) or inhibit control*

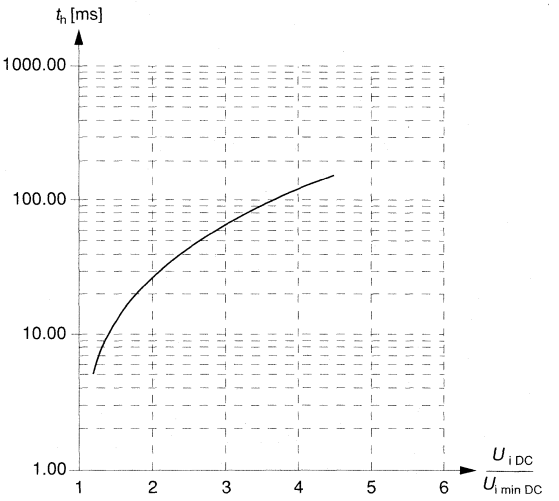



*Fig. 9*
*Typical hold-up time $t_h$ versus relative input voltage at $I_{o\,nom}$*

*Table 10: Output response time, $t_r$ values not applicable for modules equipped with option E*

| Type of Converter | $t_r$ at $P_o$ =0 and $t_f$ at $P_o = P_{o\,nom}$ typ | max | $t_r$ and $t_f$ at $P_o = {}^3/_4\,P_{o\,nom}$ typ | max | $t_r$ at $P_o = P_{o\,nom}$ typ | max | Unit |
|---|---|---|---|---|---|---|---|
| LM/LMZ 1001-7R | 5 | 10 | 5 | 10 | 10 | 20 | ms |
| LM/LMZ 1301-7R | 10 | 20 | 15 | 30 | 20 | 40 | |
| LM/LMZ 1501-7R | 5 | 10 | 10 | 20 | 30 | 60 | |
| LM/LMZ 1601-7R | 15 | 30 | 25 | 50 | 40 | 80 | |
| LM/LMZ 1901-7R | 65 | 130 | 100 | 200 | 165 | 330 | |
| LM/LMZ 2320-7 | 20 | 40 | 30 | 60 | 50 | 100 | |
| LM/LMZ 2540-7 | 15 | 30 | 20 | 40 | 35 | 70 | |
| LM/LMZ 3020-7 | 55 | 110 | 85 | 170 | 145 | 290 | |
| LM/LMZ 3040-7 | 40 | 80 | 60 | 120 | 100 | 200 | |

Conditions:
R input not used. For multiple output modules the figures indicated in the table above relate to the output which reacts slowest. All outputs are resistively loaded. Variation of the input voltage within $U_{i\,min}...U_{i\,max}$ does not influence the values.


MELCHER® ISO 9001 certified

**Programmable Voltage** (R Input)

As a standard feature single output modules offer an adjustable output voltage indentified by letter R in the type designation. The control input R (pin 14) accepts either a control voltage $U_{ext}$ or a resistor $R_{ext}$ to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_o$ according to table 7. The control input is protected against external overvoltage up to 8 V max.

a) Adjustment by means of an external control voltage $U_{ext}$ between pin 14 (R) and pin 17 (G):
The control voltage range is 0...2.75 V and allows an adjustment in the range of approximately
$U_o = 0...110\%\ U_{o\,nom}$.

$$U_{ext} \approx \frac{U_o}{U_{o\,nom}} \cdot 2.5\ V$$

b) Adjustment by means of an external resistor:
Depending upon the value of the required output voltage, the resistor shall be connected
**either:** Between pin 14 and pin 17 ($U_o < U_{o\,nom}$) to achieve an output voltage adjustment range of approx.
$U_o = 0...100\%\ U_{o\,nom}$

$$R_{ext} \approx 4\ k\Omega \cdot \frac{U_o}{U_{o\,nom} - U_o}$$

**or:** Between pin 14 and pin 20 ($U_o > U_{o\,nom}$) to achieve an output voltage adjustment range of approximately
$U_o = 100...110\%$ of $U_{o\,nom}$.

$$R'_{ext} \approx 4\ k\Omega \cdot \frac{(U_o - 2.5\ V)}{2.5\ V \cdot (U_o/U_{o\,nom} - 1)}$$

For output voltages $U_o > U_{o\,nom}$, the minimum input voltage according to "Electrical Input Data" increases proportionally to $U_o/U_{o\,nom}$.

**Warning**

The value of $R'_{ext}$ should never be less than 47 kΩ to avoid damage to the unit! R inputs may be parallel connected, but $1/R_{tot} = 1/R_1 + 1/R_2 + ....$ should be considered.

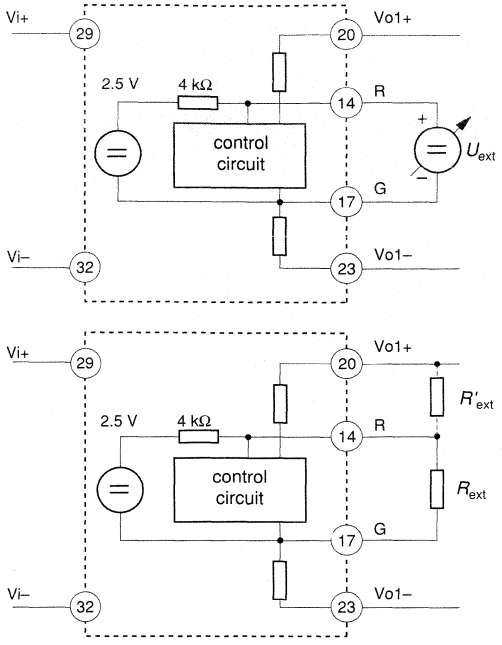



*Fig. 10*
*Output voltage control by means of the R input*

*Table 11a: $R_{ext}$ for $U_o < U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | $U_{o\,nom}$ = 15 V | | $U_{o\,nom}$ = 24 V | | $U_{o\,nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] |
| 0.5 | 0.432 | 2.0 | 0.806 | 2.0 | 0.619 | 4.0 | 0.806 | 8.0 | 0.806 |
| 1.0 | 0.976 | 3.0 | 1.33 | 4.0 | 1.47 | 6.0 | 1.33 | 12.0 | 1.33 |
| 1.5 | 1.65 | 4.0 | 2.0 | 6.0 | 2.67 | 8.0 | 2.0 | 16.0 | 2.0 |
| 2.0 | 2.61 | 5.0 | 2.87 | 8.0 | 4.53 | 10.0 | 2.87 | 20.0 | 2.87 |
| 2.5 | 3.83 | 6.0 | 4.02 | 9.0 | 6.04 | 12.0 | 4.02 | 24.0 | 4.02 |
| 3.0 | 5.76 | 7.0 | 5.62 | 10.0 | 8.06 | 14.0 | 5.62 | 28.0 | 5.62 |
| 3.5 | 8.66 | 8.0 | 8.06 | 11.0 | 11.0 | 16.0 | 8.06 | 32.0 | 8.06 |
| 4.0 | 14.7 | 9.0 | 12.1 | 12.0 | 16.2 | 18.0 | 12.1 | 36.0 | 12.1 |
| 4.5 | 30.1 | 10.0 | 20.0 | 13.0 | 26.1 | 20.0 | 20.0 | 40.0 | 20.0 |
| 5.0 | 200.0 | 11.0 | 44.2 | 14.0 | 56.2 | 22.0 | 44.2 | 44.0 | 44.2 |

*Table 11b: $R'_{ext}$ for $U_o > U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | $U_{o\,nom}$ = 15 V | | $U_{o\,nom}$ = 24 V | | $U_{o\,nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] |
| 5.15 | 464 | 12.1 | 1780 | 15.2 | 1470 | 24.25 | 3160 | 48.5 | 6810 |
| 5.20 | 215 | 12.2 | 909 | 15.4 | 750 | 24.50 | 1620 | 49.0 | 3480 |
| 5.25 | 147 | 12.3 | 619 | 15.6 | 511 | 24.75 | 1100 | 49.5 | 2370 |
| 5.30 | 110 | 12.4 | 464 | 15.8 | 383 | 25.00 | 825 | 50.0 | 1780 |
| 5.35 | 90.9 | 12.5 | 383 | 16.0 | 332 | 25.25 | 715 | 50.5 | 1470 |
| 5.40 | 78.7 | 12.6 | 316 | 16.2 | 274 | 25.50 | 590 | 51.0 | 1270 |
| 5.45 | 68.1 | 12.7 | 274 | 16.4 | 237 | 25.75 | 511 | 51.5 | 1100 |
| 5.50 | 61.9 | 12.8 | 249 | 16.5 | 226 | 26.00 | 453 | 52.0 | 953 |
| | | 13.0 | 200 | | | 26.25 | 402 | 52.5 | 845 |
| | | 13.2 | 169 | | | 26.40 | 383 | 52.8 | 806 |

## EMC and Immunity to Input Transients

A metal oxide VDR together with an input fuse and an input filter form an effective protection against high input transient voltages which typically occur in most installations, but especially in battery driven mobile applications. The Mk II series has been successfully tested to the following specifications:

### Electromagnetic Immunity

*Table 12: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [4] | Value applied | Waveform | Source impedance | Test procedure | In operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Impulse voltage | IEC 255-4 App. E4 [5] (1976) | III | i/o, i/c, o/c +i/–i, +o/–o | 5000 $V_p$ | 1.2/50 µs | 500 Ω | 3 pos. and 3 neg. impulses per coupling mode | no | |
| High frequency disturbance | IEC 255-4 App. E5 [5] (1976) | III | i/o, i/c, o/o, o/c | 2500 $V_p$ | 400 damped 1 MHz waves/s | 200 Ω | 2 s per coupling mode | yes | 1 |
| | | | +i/–i, +o/–o | 1000 $V_p$ | | | | | |
| Voltage surge | IEC 571-1 [3] (1990-07) | | i/c, +i/–i | 800 $V_p$ | 100 µs | 100 Ω | | yes | 1 |
| | | | | 1500 $V_p$ | 50 µs | | 1 pos. and 1 neg. voltage surge per coupling mode | | |
| | | | | 3000 $V_p$ | 5 µs | | | | |
| | | | | 4000 $V_p$ | 1 µs | | | | |
| | | | | 7000 $V_p$ | 100 ns | | | | |
| Supply related surge | RIA 12 (1984) | B | +i/–i | 1.5• $U_{batt}$ | 1 s | 0.2 Ω | 1 positive surge | yes | 1 |
| Direct transient | | C | | 960 $V_p$ | 10/100 µs | 5 Ω | 5 pos. and 5 neg. impulses | | |
| | | D | | 1800 $V_p$ | 5/50 µs | | | | |
| | | E | | 3600 $V_p$ | 0.5/5 µs | 100 Ω | | | |
| | | F | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | G | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Indirect coupled transient | | H | i/c | 1800 $V_p$ | 5/50 µs | | | | |
| | | J | | 3600 $V_p$ | 0.5/5 µs | | | | |
| | | K | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | L | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Electrostatic discharge | IEC 801-2 (1991-04) | 4 | contact discharge to case, | 8000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | 1 |
| | | | air dischg. to case | 15000 $V_p$ | | | | | |
| Electric field | IEC 801-3 (1984) | 3 | antenna in 1m distance | 10 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | 2 |
| Fast transient/ burst | IEC 801-4 (1988) | 3 | i/c, +i/–i | 2000 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | 1 |
| | | 4 | | 4000 $V_p$ | | | | | 2 |
| Transient | IEC 801-5 (Draft 1993-01) | 4 | i/c | 4000 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | 1 |
| | | | +i/–i | 2000 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] Will be replaced by EN 50155
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)

### Electromagnetic Emissions

*Table 13: Emissions at $U_{i\,nom}$ and $I_{o\,nom}$ at 230 V AC*

| Types | Level: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | VDE 0871 6.78 | | VDE 0875 part 3 12.88 | | EN 55011, 1991 [1] EN 55022, 1987 [2] | | FCC: 47 CFR 15.xxx 15.107 | 15.103 |
| | ≤ 30 MHz | ≥30 MHz | ≤ 30 MHz | ≥30 MHz | ≤ 30 MHz | ≥30 MHz | ≤ 30 MHz | ≥30 MHz |
| LM 1000 | B | B | N | K | B | B | B | B |
| LM 2000 | B | B | N | K | B | B | B | B |
| LM 3000 | B | A | N | K | B | A | B | A |
| LMZ 1000 | >A | >A | G | K | A | >A | >A | >A |
| LMZ 2000 | - | - | - | - | - | - | - | - |
| LMZ 3000 | A | >A | N | N | B | >A | A | >A |

[1] Identical with CISPR 11 (1990-09) and VDE 0875 part 11 (1992-07)
[2] Identical with CISPR 22 (1985) and VDE 0878 part 3 (1989-11)

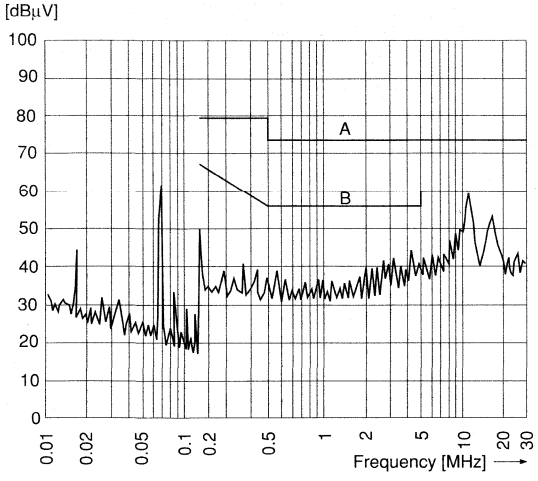



*Fig. 11a*
*Conducted RFI at input according to EN 55011 (quasi peak)*

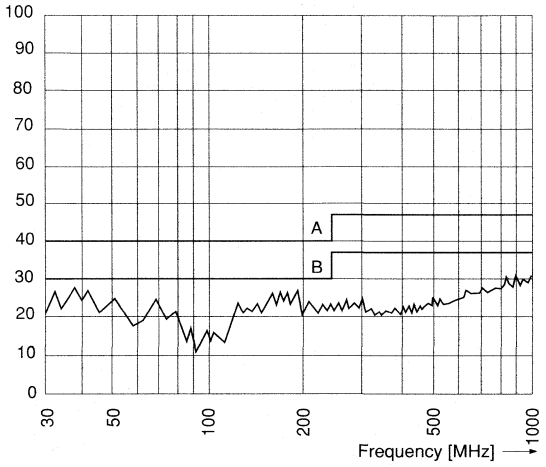



*Fig. 11b*
*Radiated RFI according to EN 55011 (Distance 10 m)*

## Supplementary Data

### Isolation

Input to output electric strength tests, in accordance with the safety standards IEC 950, EN 60950, VDE 0805 and EN 41003 are performed as factory tests and should not be repeated in the field.

### Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 1). Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests. Reference is also made to chapter: "Safety and Installation Instructions".

*Table 14: Electric strength test voltage, insulation resistance, clearance and creepage distances*

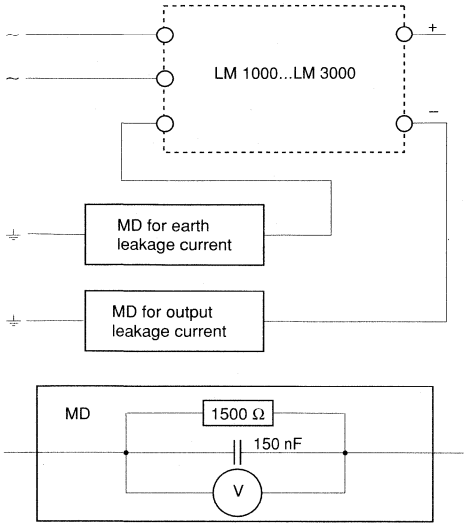
| Characteristic a) values according to IEC 950, b) Product's performance | | I/O [1] | | I/C [1] Class I | | I/C [1] Class II | | O/C [1] | | O/O [1] | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a) | b) | a) | b) | a) | b) | a) | b) | a) | b) | |
| Electric strength | DC: 1 s | 4243 [2] | 5600 [2] | 2122 | 2800 | 4243 | 5600 | 707 | 1414 | – | 300 | V |
| test voltage | AC: 50 Hz, 1 min | 3000 [2] | 4000 [2] | 1500 | 2000 | 3000 | 4000 | 500 | 1000 | – | 200 | |
| Insulation resistance | at 500 V DC | – | ≥300 | – | ≥300 | – | ≥300 | – | ≥100 | – | – | MΩ |
| Clearance and Creepage distances | | 4.0 | 8.0 | 2.0 | 4.0 | 4.0 | 5.0 | 1.0 | 2.0 | – | 0.9 | mm |

[1] I/O = Input to Output, I/C = Input to case, O/C = Output to Case, O/O = Output to Output
[2] Only subassemblies performance in accordance with IEC 950

### Leakage Currents in AC-DC operation

Leakage currents will flow due to internal leakage capacitances and RFI suppression Y-capacitors. The current values are proportional to the mains voltage and nearly proportional to the mains frequency and are specified at an input condition of 264 V/50 Hz where phase, neutral and protective earth are correctly connected as required for class I equipment. Under test conditions the leakage currents flow through a measurement circuit, consisting of a 1500 Ω resistance with a 150 nF capacitor connected in parallel. The voltage drop across this element is measured and the current value calculated from the measured voltage divided by 1500 Ω.

If inputs of M-units are connected in parallel, their individual leakage currents are added.



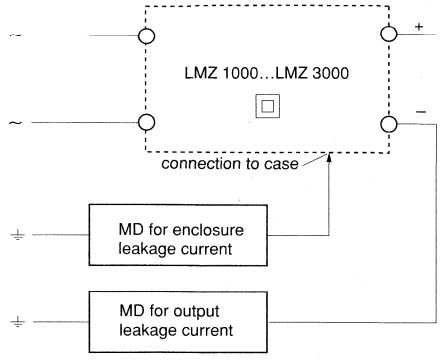




*Fig. 12*
*Definition of leakage currents and measurement procedure by means of the measuring device MD*

*Table 15: Leakage currents*

| **Characteristic**<br>a) permissible according to IEC 950<br>b) value at 264 V, 50 Hz | **Class I (LM)** a) max | **Class I (LM)** b) max | **Class II (LMZ)** a) max | **Class II (LMZ)** b) max | **Unit** |
|---|---|---|---|---|---|
| Earth leakage current | 3.5 | 1.4 | – | – | mA |
| Enclosure leakage current | – | – | 0.25 | 0.03 | |
| Output leakage current | 0.25 | 0.005 | 0.25 | 0.15 | |

### Display Status of LEDs

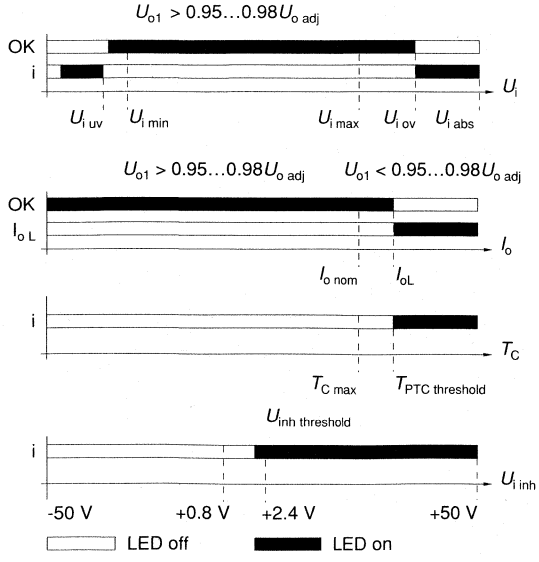



*Fig. 13*
*LEDs "OK" and "i" status versus input voltage*
*Conditions: $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*
*$U_{i\,uv}$ = undervoltage lock-out, $U_{i\,ov}$ = overvoltage lock-out*

*LED "OK" and "$I_{o\,L}$" status versus output current*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*

*LED "i" versus case temperature*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $U_{inh} \le 0.8$ V*

*LED "i" versus $U_{inh}$*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$*


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## Description of Options

Table 16: Survey of options

| Option | Function of Option | Characteristic |
|---|---|---|
| –7 | Standard operational ambient temperature range | $T_A$ = –25...71 °C |
| –9 | Extended operational ambient temperature range | $T_A$ = –40...71 °C |
| E | Electronic inrush current limitation circuitry | improved inrush current limitation as per table 19 |
| R [1] | R input for external output voltage programming | Adjustment range 0...110% of $U_{o\,nom}$ (single output modules) |
| P [1] | Potentiometer for fine adjustment of output voltage | Adjustment range ±5% of $U_{o\,nom}$, excludes R input |
| D [2] | Input and/or output undervoltage monitoring circuitry | Safe data signal output (D0...D9) |
| V [2 3] | Input and/or output undervoltage monitoring circuitry | ACFAIL signal according to VME specifications (V0, V2, V3) |
| A | Test sockets at front panel for check of output voltage | $U_o$ internally measured at the connector terminals |
| H | Enhanced output to case electric strength test voltage | 2000 V AC (standard: 1000 V AC) |
| F | Input fuse built-in (not available for A/BM types) | Fuse not externally accessible |
| U | UL recognized full ambient temperature range | Full temperature range according to temperature suffix |

[1] Function R excludes option P and vice versa
[2] Option D excludes option V and vice versa
[3] Only available with main output voltage $U_{o1}$ = 5.1 V

*Table 17: Configuration of option A and option P*

| Type of option | LM/LMZ 1000 Output 1 | LM/LMZ 2000 Output 1 | LM/LMZ 2000 Output 2 | LM/LMZ 3000 Output 1 | LM/LMZ 3000 Output 2 | LM/LMZ 3000 Output 3 |
|---|---|---|---|---|---|---|
| Potentiometer [1] | yes | yes | yes | yes | no | no |
| Test sockets | yes | yes | yes | yes | no | no |

[1] LM/LMZ 1000 types equipped with option P do not provide the R input simultaneously, pins 14 and 17 are not connected.

### Option E

The standard versions have a passive inrush current limitation in the form of a NTC resistor.

For applications which require an improved inrush current limitation, an active electronic circuit (option E) as shown in fig. 14 has been developed. Figure 15 shows typical inrush current waveforms of units equipped with this option.

Precautions:

In order to avoid overload of the series resistor $R_I$ the on/off switching cycle should be limited to 12 s if switched on/off continuously. There should not be more than 10 start-up cycles within 20 s at a case temperature of 25 °C.

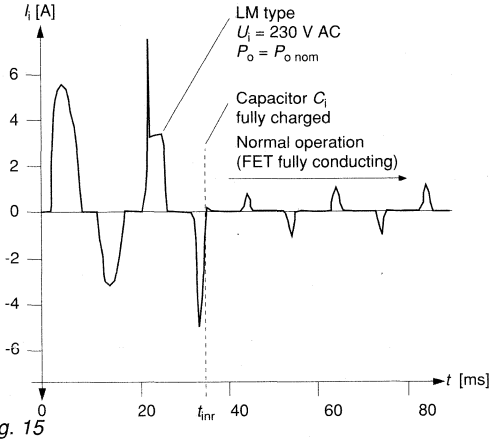



*Fig. 15*
*Typical inrush current waveform of a LM type*

If the modules are driven by an input voltage below 100 V AC, the maximum case temperature should be derated by 10 K or the total output power should be derated by 20%. Units driven by DC input voltages do not need to be derated within the full specified input voltage range.

Availability:

Option E is available with a nominal output power of 51 W maximum.

*Table 18: Inrush current characteristics with option E*

| Characteristic $U_i$ = 230 VAC | | LM/LMZ typ | LM/LMZ max | Unit |
|---|---|---|---|---|
| $I_{inr\,p}$ | Peak inrush current | 6 | 10 | A |
| $t_{inr}$ | Inrush current duration | 35 | 50 | ms |

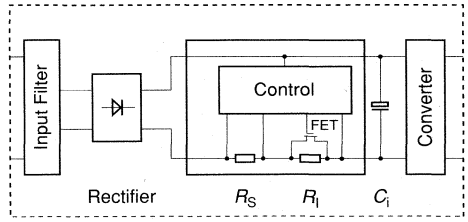



*Fig. 14*
*Option E block diagram*

### Option -9

Option -9 extends the operational ambient temperature range from –25...71 °C (standard) to –40...71 °C. The power supplies provide full nominal output power with convection cooling.

### Option A

Test sockets (pin Ø = 2 mm, distance d = 5.08 mm) are located at the front of the module. The output voltage is sensed at the connector pins inside the module.

### Option D

General description

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1– (pin 23). The D output recovers when the monitored voltage(s) exceed(s) $U_t+U_h$. The threshold level $U_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D0...D9 as shown in the following table.

*Table 19: Undervoltage monitor functions*

| Output type JFET | Output type NPN | Monitoring $U_i$ | Monitoring $U_{o1}$ | Minimum adjustment range of threshold level $U_{t\,i}$ | Minimum adjustment range of threshold level $U_{t\,o}$ | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] $U_{h\,i}$ | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] $U_{h\,o}$ |
|---|---|---|---|---|---|---|---|
| D1 | D5 | no | yes | – | 3.5 V...48 V [1] | – | 2.3...1 |
| D2 | D6 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | – | 3.0...0.5 | – |
| D3 | D7 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| D4 | D8 | no | yes | – | 0.95...0.98 $U_{o1}$ [2] | – | "0" |
| D0 | D9 | no | yes | – | 3.5 V...48 V [3] | – | 1.8...1 |
| | | yes | no | $U_{i\,min}...U_{i\,max}$ [3 4] | – | 2.2...0.4 | – |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | 0.95...0.98 $U_{o1}$ [2] | 2.2...0.4 | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications)
[2] Fixed value between 95% and 98% of $U_{o1}$ (tracking)
[3] Fixed value, resistor-adjusted according to customer's specifications ±2% at 25 °C; individual type number is determined by Melcher
[4] Adjusted at $I_{o\,nom}$

JFET output (D0...D4):

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $U_D \leq 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) < $U_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_D \leq 0.4$ V at $I_D = 2.5$ mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_D \leq 25$ µA at $U_D = 5.25$ V |

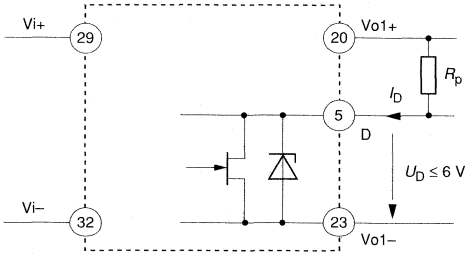



*Fig. 16*
*Options D0...D4, JFET output*

NPN output (D5...D9):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D < 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) > $U_t + U_h$. The current $I_D$ through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. $U_D$ should not exceed 40 V.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | high, H, $I_D \leq 25$ µA at $U_D = 40$ V |
| $U_i$ and $U_{o1} > U_t + U_h$ | low, L, $U_D \leq 0.4$ V at $I_D = 20$ mA |

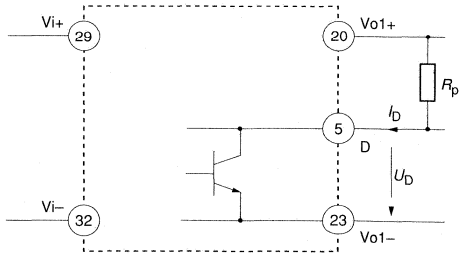



*Fig. 17*
*Options D5...D9, NPN output*


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Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage after the input filter and rectifier is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold level of the D0 and D9 options is factory adjusted at nominal output current $I_{o\,nom}$ and at $T_A$ = 25°C. The value of $\Delta U_{t\,i}$ depends upon the threshold level $U_t$, temperature and input current. The input current is a function of the input voltage and the output power.

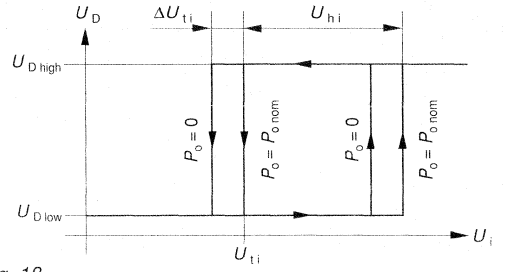
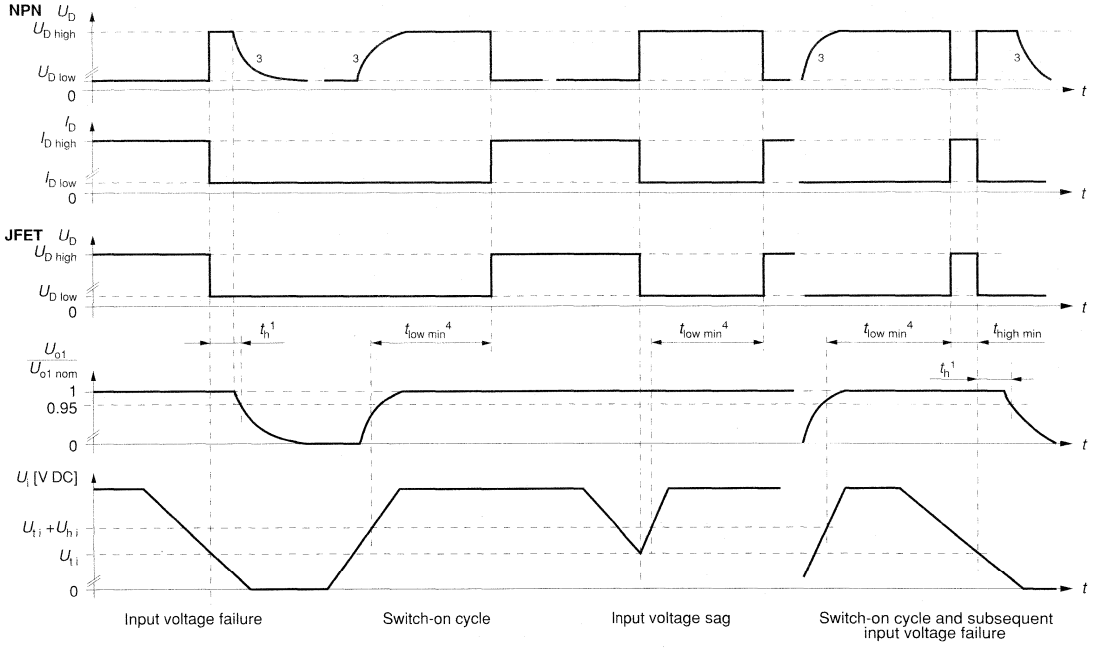
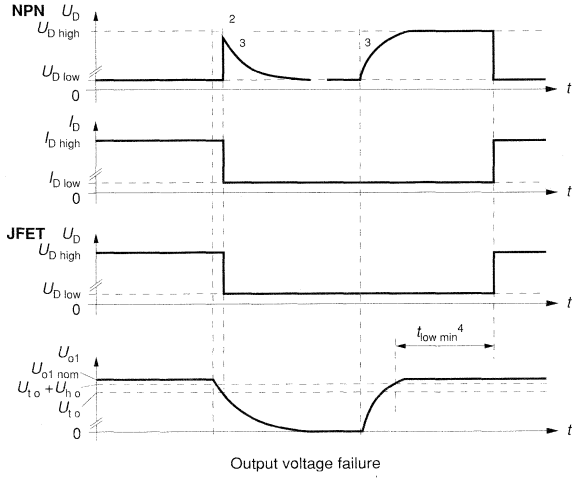



*Fig. 18*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$ (JFET output)*




[1] See fig. 9 for hold-up time.
[2] With output voltage monitoring the hold-up time $t_h$ = 0
[3] The D signal remains high if the D output is connected to an external source.
[4] $t_{low\,min}$ = 40...200 ms, typically 80 ms

*Fig. 19*
*Relationship between $U_i$, $U_{o1}$, $U_D$, $I_D$ and $U_{o1}/U_{o\,nom}$ versus time.*

### Option V

This option defines an undervoltage monitoring circuit for the input or the input and main output voltage ($U_{o1\ nom}$ = 5.1 V only) equivalent to option D and generates an ACFAIL signal (V signal) which conforms to the VME standard.

The low state level of the ACFAIL signal is specified at a sink current of $I_V$ = 48 mA to $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME motherboard.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V when the 5.1 V output is fully loaded. This hold-up time $t_h$ is provided by the internal input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\,min}$ of the converter so that enough energy is remaining in the input capacitance.

Formula for threshold level for desired value of $t_h$:

$$U_{t\,i} = \sqrt{\frac{2 \cdot P_o \cdot (t_h + 0.3\ ms) \cdot 100}{C_{i\,min} \cdot \eta} + U_{i\,min}^2}$$

*Table 20: Available internal input capacitance and factory potentiometer setting of $U_{t\,i}$ with resulting hold-up time*

| Types | LM/LMZ | Unit |
|---|---|---|
| $C_{i\,min}$ | 0.14 | mF |
| $U_{t\,i}$ | 120 | V DC |
| $t_h$ | 8.18 | ms |

If the input voltage is below the required level, an external hold-up capacitor ($C_{i\,ext}$) should be added. If the units are AC powered, an external input capacitor cannot be applied unless an additional rectifier is provided.

Formula for additional external input capacitor

$$C_{i\,ext} = \frac{2 \cdot P_o \cdot (t_h + 0.3\ ms) \cdot 100}{\eta \cdot (U_{t\,i}^2 - U_{i\,min}^2)} - C_{i\,min}$$

where as:

$C_{i\,min}$ = minimum internal input capacitance [mF], according to table 19 below
$C_{i\,ext}$ = external input capacitance [mF]
$P_o$ = output power [W]
$\eta$ = efficiency [%]
$t_h$ = hold-up time [ms]
$U_{i\,min}$ = minimum input voltage [V] [1]
$U_{t\,i}$ = threshold level [V]

[1] Min. input voltage according to "Electrical Input Data". For output voltages $U_o > U_{o\,nom}$, the minimum input voltage increases proportionally to $U_o/U_{o\,nom}$.

Remarks:

The threshold level $U_{t\,i}$ of option V2 and V3 is adjusted during manufacture to a value according to table 20.

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1– (pin 23). The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by potentiometer, accessible through a hole in the front cover, or is factory adjusted to a determined customer specified value.
Versions V0, V2 and V3 are available as shown below.

*Table 21: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level | | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] | |
|---|---|---|---|---|---|---|
| | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| V2 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | – | 3.0...0.5 | - |
| V3 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| V0 | yes | no | $U_{i\,min}...U_{i\,max}$ [3 4] | - | 2.2...0.4 | - |
| | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | 0.95...0.98 $U_{o1}$ [2] | 2.2...0.4 | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications); [2] Fixed value between 95% and 98% of $U_{o1}$ (tracking), output undervoltage monitoring is not a requirement of VME standard; [3] Adjusted at $I_{o\,nom}$;
[4] Fixed value, resistor-adjusted (±2% at 25°C) acc. to customer's specifications; individual type number is determined by Melcher

V output (V0, V2, V3):

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) < $U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $U_V$ should not exceed 80 V.

| $U_i$, $U_{o1}$ status | V output, $U_V$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_V \leq 0.6$ V at $I_V$ = 50 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_V \leq 25$ µA at $U_V$ = 5.1 V |

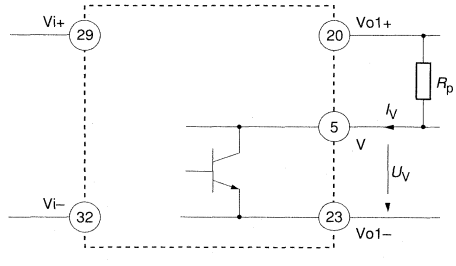



*Fig. 20*
*Output configuration of options V0, V2 and V3*


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Threshold tolerances and hysteresis:

If $U_i$ is monitored, t he internal input voltage is measured after the input filter and rectifier. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold level of option V0 is factory adjusted at $I_{o\,nom}$ and $T_A = 25°C$. The value of $\Delta U_{t\,i}$ depends upon the threshold level $U_t$, temperature and input current. The input current is a function of input voltage and output power.

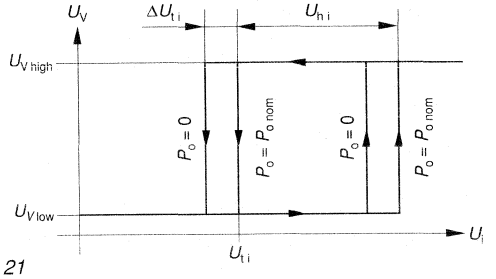
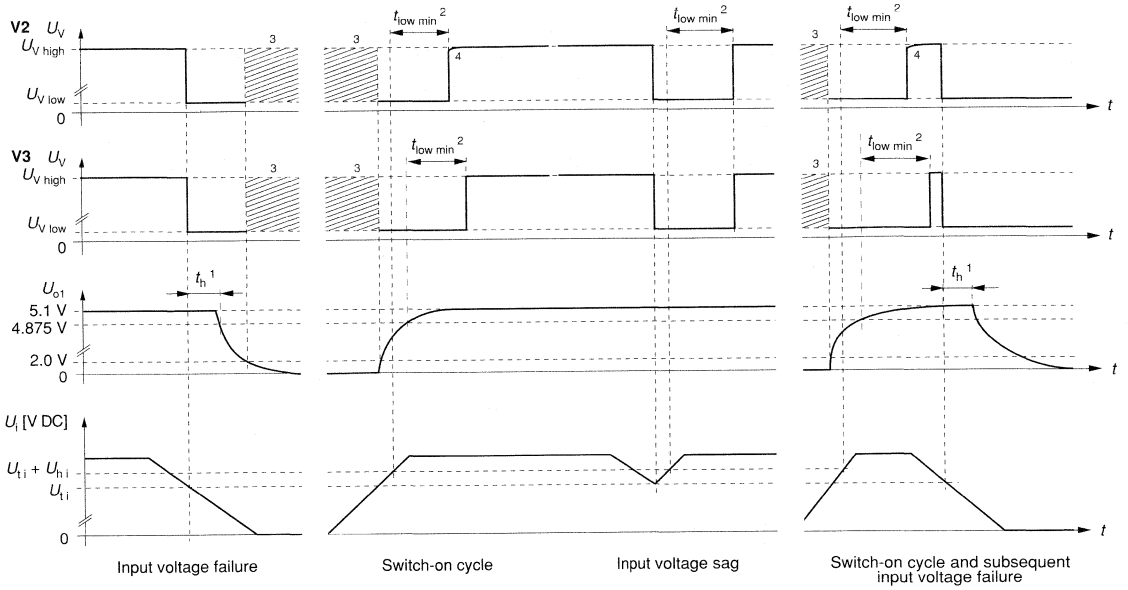
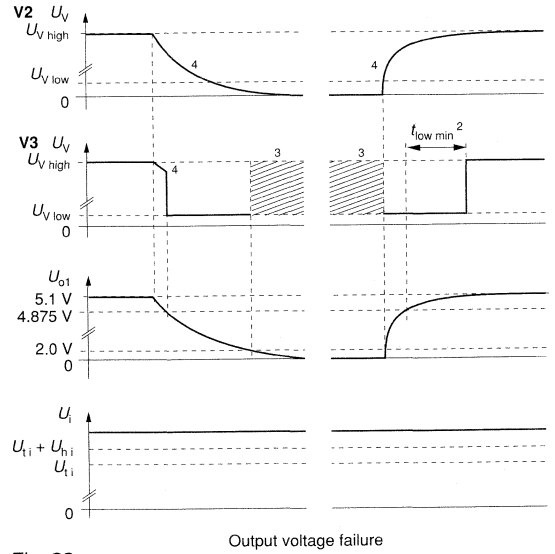



*Fig. 21*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$*




[1] VME request: minimum 4 ms
[2] $t_{low\,min}$ = 40...200 ms, typically 80 ms
[3] $U_V$ level not defined at $U_{o1} < 2.0$ V
[4] The V signal drops simultaneously with the output voltage, if the pull-up resistor $R_p$ is connected to Vo1+. The V signal remains high if $R_p$ is connected to an external source.

*Fig. 22*
*Relationship between $U_i$, $U_{o1}$, $U_V$, $I_V$ and $U_{o1}/U_{o\,nom}$ versus time.*

### Option F

The standard M units have a fuseholder containing a 5 × 20 mm fuse which is externally accessible and to be found in the back plate near the connector. Some applications require an inaccessible fuse. Option F provides a fuse mounted directly onto the main PCB inside the case. The full self-protecting functions of the module do not normally lead to broken fuses, except a power component inside fails (switching transistor, freewheeling diode, etc). In such cases the defective unit has to be returned to Melcher for repair.

### Option U

Underwriters Laboratories (UL) have approved the M series converters as recognized components up to an ambient temperature of $T_{A\,max}$ – 15 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\,max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast accepted the converters with the standard PCB material to be operated up to $T_{A\,max}$ without any further precautions.

## Immunity to Environmental Conditions

*Table 22: Mechanical stress*

| Test Method | | Standard | Test Conditions | |
|---|---|---|---|---|
| Ca | Damp heat<br>steady state | DIN 40046 part<br>IEC 68-2-3<br>MIL-STD-810D section 507.2 | Temperature:<br>Relative humidity:<br>Duration: | $40^{\pm 2}$ °C<br>$93^{+2/-3}$ %<br>56 days<br>Unit not operating |
| Ea | Shock<br>(half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s$^2$<br>6 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock<br>(half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s$^2$<br>6 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration<br>(sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL-STD-810D section 514.3 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s$^2$<br>7.5 h (2.5 h each axis)<br>Unit operating |
| Fda | Random vibration<br>wide band<br>reproducibility high | DIN 40046 part 23<br>IEC 68-2-35 | Frequency band:<br>Acceleration magnitude:<br>Test duration: | 10...2000 Hz<br>5 $g_{rms}$<br>3 h (1 h each axis)<br>Unit not operating |
| Kb | Salt mist<br>cyclic<br>(sodium chloride NaCl solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Storage duration:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% rel. humidity<br>22 h per cycle<br>3<br>Unit not operating |

### Thermal considerations

*Table 23: Temperature specifications, values given are for an air pressure of 800...1200 hPa (800...1200 mbar)*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Standard operational ambient temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –25 | 71 | °C |
| $T_A$ | Extended operational ambient temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 71 | |
| $T_C$ | Standard operational case temperature range -7, overtemp. lock-out (PTC) at $T_C$ > 95°C | –25 | 95 | |
| $T_C$ | Extended operational case temperature range -9, overtemp. lock-out (PTC) at $T_C$ > 95°C | –40 | 95 | |
| $T_S$ | Storage temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 100 | |
| $T_S$ | Extended storage temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –55 | 100 | |

Basically the available output power is limited by thermal characteristics. Customer specific applications requiring slightly higher output power, i.e. increased voltages or currents are available on request. Usually the maximum ambient and case temperatures are reduced compared with standard types. Operation at higher temperatures with nominal output currents is also possible if forced cooling can be provided (heat sink, fan, etc.).

Example: Sufficient forced coolling allows $T_{A\,max}$ = 85°C. A simple check of the case temperature $T_C$ ($T_C \leq 95$°C) at full load ensures correct operation of the system (temperature measurement point on the case see fig. 24).

In general: For an ambient temperature of 85°C with only convection cooling, the maximum permissible current for each output is approx. 50% of it's nominal value for -7 or -9 units (see fig. 23).

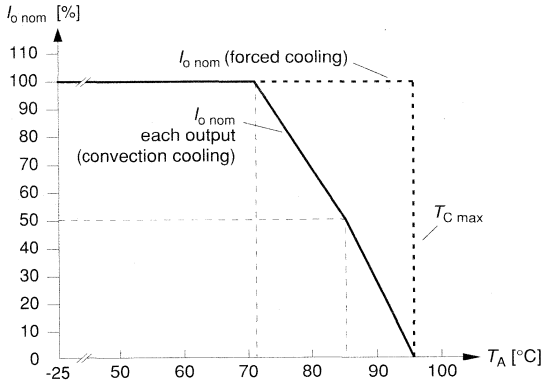



*Fig. 23*
*Output derating versus ambient temperature under convection and forced cooled conditions*

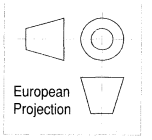
*Table 24: MTBF*

| Values at specified Case Temperature | Module Types | Ground Benign 40°C | Ground Fixed 40°C | Ground Fixed 70°C | Ground Mobile 50°C | Unit |
|---|---|---|---|---|---|---|
| MTBF [1] | LM/LMZ 1000<br>LM/LMZ 2000<br>LM/LMZ 3000 | 320'000<br>255'000<br>225'000 | 130'000<br>105'000<br>80'000 | 40'000<br>32'000<br>28'000 | 35'000<br>28'000<br>25'000 | h |
| Device hours [2] | LM/LMZ 1000<br>LM/LMZ 2000<br>LM/LMZ 3000 | 840'000<br>740'000<br>670'000 | | | | |

[1] Calculated in accordance with MIL-HDBK-217E (calculation according to edition F would show even better results)
[2] Statistical values, based on an average of 4300 working hours per year and in general field use, over 3 years

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



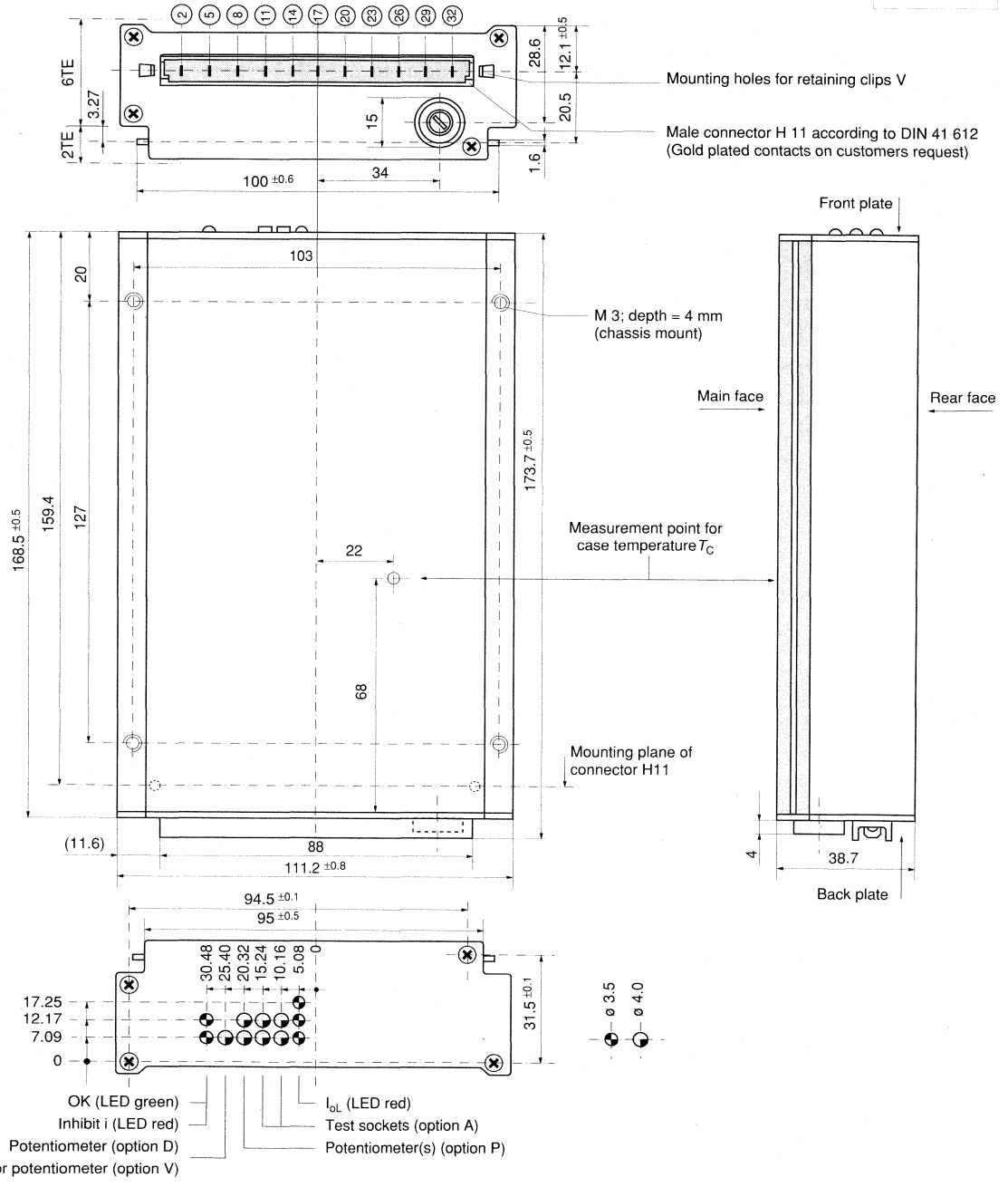
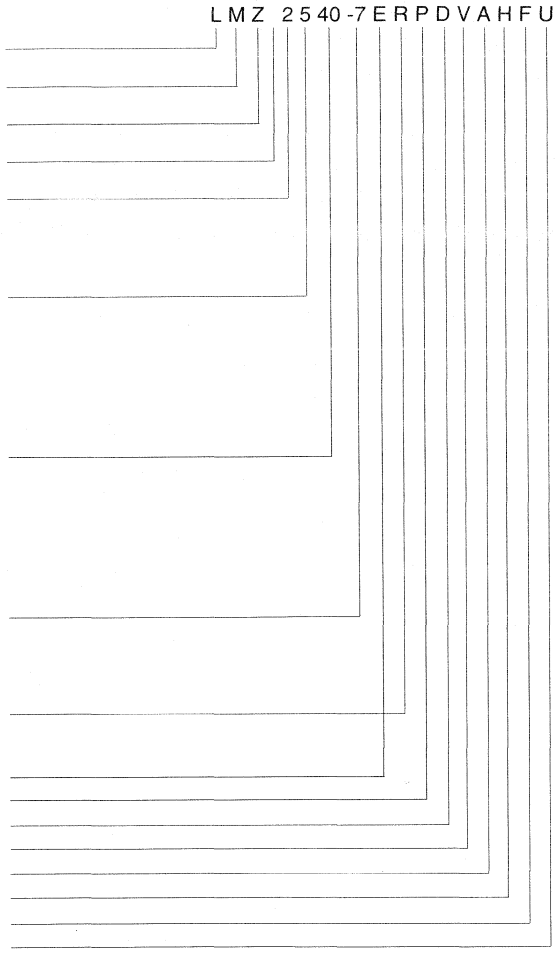




*Fig. 24*
*Case M02, weight 770 g (approx.)*

**Note:** An elongated case of 234 mm is available on request. Please consult Melcher's field sales engineer.

## Type Key and Product Marking

### Type Key




Input voltage range $U_I$ :85...264 V AC, 88...372 V DC .... L

Family ..... M

Class II Equipment ..... Z

Blank .....

Number of outputs ..... 1...3

Output 1, $U_{o1\ nom}$:
- 5.1 V ..... 0...2
- 12 V ..... 3
- 15 V ..... 4...5
- 24 V ..... 6
- other voltages ..... 7...8
- 48 V ..... 9

other specs for single output modules ..... 01...99

Output 2 and 3, $U_{o2\ nom}$, $U_{o3\ nom}$:
- 5.1 V ..... 01...19
- 12 V ..... 20...39
- 15 V ..... 40...59
- 24 V ..... 60...69

other voltages for multiple output modules ..... 70...99

Ambient temperature range $T_A$: (operational)
- –25...50 °C ..... -5
- –25...60 °C ..... -6
- –25...71 °C ..... -7
- –40...85 °C ..... -8
- –40...71 °C ..... -9
- custom specific ..... -0

Output voltage control input (single output modules) ..... R [1]

Options:
- Inrush current limitation ..... E
- Potentiometers for fine adjustment of output voltages ..... P [1]
- Save data signal (D0...D9, to be specified) ..... D [2]
- ACFAIL signal (V0, V2, V3, to be specified) ..... V [2]
- Output voltage test sockets ..... A
- Increased electric strength test voltage (O/C) ..... H
- Input fuse built-in (not accessible) ..... F
- UL recognized component for $T_{A\ max}$ ..... U

[1] Feature R excludes option P and vice versa
[2] Option D excludes option V and vice versa

Example: LM 2540-7PD3A: AC-DC converter, input voltage range 85...264 V, providing output 1 with 15 V/1.7 A and output 2 with 15 V/1.7 A; equipped with potentiometers, undervoltage monitoring and test sockets.

**Product Marking** (refer also to "Mechanical Data")

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LEDs, optional test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltage(s) and current(s), pin allocation of options and auxiliary functions, fuse specification and degree of protection.

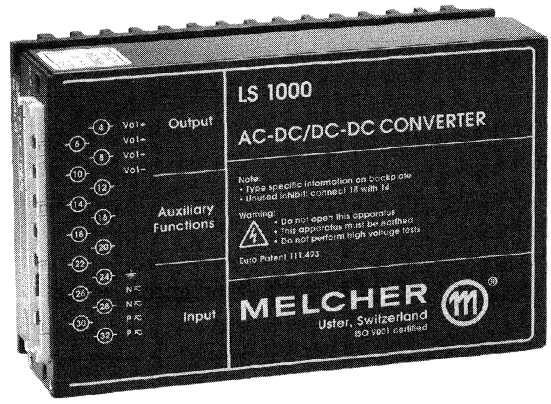
Rear face: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB, date of production. Confirmation of successfully passed final test.

# 100 W AC-DC (DC-DC) Converters

# S-Family

**Input to output isolation**
**Single output: LS 1000**
**Double output: LS 2000**

- Extremely wide input voltage range
- Input over- and undervoltage lock-out
- Efficient input filter and built-in surge and transient suppression circuitry
- 4 $kV_{rms}$ input to output isolation test voltage
- Fully isolated outputs
- Outputs open- and short-circuit proof
- No derating over entire operating temperature range
- CSA approval and UL recognition in progress
- Safety according to IEC 950




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## Description

The S-family of AC-DC (DC-DC) converters represents a flexible range of power supplies for use in advanced electronic systems. Features include high efficiency, high reliability, low output voltage noise and excellent dynamic response to load/line changes.

The converter inputs are protected against surges and transients occuring on the source lines. Input over- and undervoltage lock-out circuitry disables the outputs if the input voltage is outside the specified ranges. Certain types include an inrush current limitation preventing circuit breakers and fuses from being damaged at switch-on.

All outputs are open- and short-circuit proof and are protected against overvoltages by means of a built-in suppressor diode. The outputs can be inhibited by a logic signal applied to the connector pin i. If the inhibit function is not used pin 18 must be connected with pin 14 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case and output to output isolation is provided. The modules are designed and built according to international safety standards (IEC 950, EN 60950 and VDE 0805).

The case design allows operation at nominal load up to 71 °C in a free air ambient temperature. If forced cooling is provided, the ambient temperature may exceed 71 °C but the case temperature must remain below 95 °C under all conditions.

A temperature sensor generates an inhibit signal which disables the outputs if the case temperature $T_C$ exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Case: Aluminium, black finish, self cooling.

## Type Survey

*Table 1: Type survey LS*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | Options |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{i\,min}...U_{i\,max}$ **85...264 V AC** (88...372 V DC) | $\eta_{min}$ % | |
| 5.1 | 16.0 | | | LS 1001-7R | 78 | -9 |
| 12.0 | 8.0 | | | LS 1301-7R | 84 | E |
| 15.0 | 6.5 | | | LS 1501-7R | 84 | D |
| 24.0 | 4.2 | | | LS 1601-7R | 85 | V [6] |
| 24.0 [3] | 4.0 | | | LS 2320-7R | 81 | P |
| 30.0 [3] | 3.2 | | | LS 2540-7R | 83 | T |
| 48.0 [3] | 2.0 | | | LS 2660-7R | 84 | B1 |
| 12.0 | 4.0 | 12.0 [4] | 4.0 | LS 2320-7R | 81 | |
| 15.0 | 3.2 | 15.0 [4] | 3.2 | LS 2540-7R | 83 | |
| 24.0 | 2.0 | 24.0 [4] | 2.0 | LS 2660-7R | 84 | |

**Survey of Options see "Description of Options"**

Different output voltages and currents may be set in accordance with customer specifications.

[1] Efficiency at $U_{i\,nom}$ and $I_{o\,nom}$.
[2] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents must be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[3] Series connection of output 1 and 2 see fig. 16a.
[4] Second output semi-regulated.
[5] Option V for LS 1001 types only

## Safety and Installation Instructions

**Safety:**
For safety reasons, the power supplies should be wired via the female connector H15 (according to DIN 41612, see "Accessories") in order to meet national and international safety requirements

The converters correspond to safety class I equipment and comply with IEC 950, EN 60950, VDE 0805 Part 100 (including manufacturing surveillance), UL 1950, CSA/C22.2 No. 950-M89 and are VDE approved.

The connector has a leading earth connection pin which ensures earth connection prior to any other.

The UL 1950 recognition limits the ambient operational temperature range of the standard modules (-7) to –25...60°C. In applications where the full operational temperature range of –25...71°C under UL condition is required, forced cooling should be provided.

*Table 2: H15 Connector pin allocation*

| Pin | Connector type H 15 | | | |
|---|---|---|---|---|
| No. | LS 1000 | | LS 2000 | |
| 4 | Vo1+ | Output 1 | Vo2+ | Output 2 |
| 6 | Vo1+ | | Vo2+ | |
| 8 | Vo1– | Output 1 | Vo2– | Output 2 |
| 10 | Vo1– | | Vo2– | |
| 12 | S+ | Sense | Vo1+ | Output 1 |
| 14 | S– | Sense | Vo1– | Output 1 |
| 16 | R [1] | Control of $U_{o1}$ | R [1] | Control of $U_{o1}$ |
| 18 | i | Inhibit | i | Inhibit |
| 20 | D [3] | Save data | D [3] | Save data |
| | V [3] | ACFAIL | V [3] | ACFAIL |
| 22 | T | Current sharing | T | Current sharing |
| 24 [2] | ⏚ | Protective earth | ⏚ | Protective earth |
| 26 | N ≂ | Neutral | N ≂ | Neutral |
| 28 | N ≂ | | N ≂ | |
| 30 | P ≂ | Phase | P ≂ | Phase |
| 32 | P ≂ | | P ≂ | |

### Installation

Installation must strictly follow the national safety regulations. Pin 24 has to be connected to earth. A second fuse should be installed in the wiring to pins 26/28 if:
- Local requirements demand an individual fuse in each source line
- $U_i$+ to earth impedance is high or undefined
- Phase and neutral of the mains are not defined.

In applications where the inhibit function is not used, the inhibit pin should be connected to the S– pin (S 1000) or the Vo1– pin (S 2000) to enable the outputs.

**Important Advice**
Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/µs, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests.

### Degree of Protection

Condition: Female connector fitted to the unit.
IP 30: All units except those with options P, D or V with potentiometer adjustment.
IP 20: All units fitted with options which include potentiometer setting.

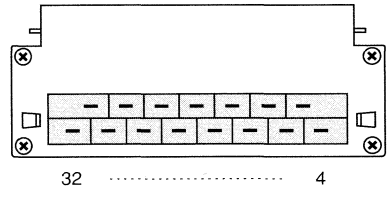



*Fig. 1*
*View of module's male connectors*

[1] Function R is not simultaneously available with option P
[2] Leading pin (pregrounding)
[3] Option D is not simultaneously available with option V and vice versa.

## Functional Description

The input voltage is fed via an input fuse, an input filter, a rectifier and an inrush current limiter to the input capacitor. This capacitor sources a single transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke and output filter. The control logic senses the main output voltage $U_{o1}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor.

The second output of double output units is controlled by the main output but has independent current limiting. If the main output is taken into current limitation, the second output voltage will fall as well and vice versa.

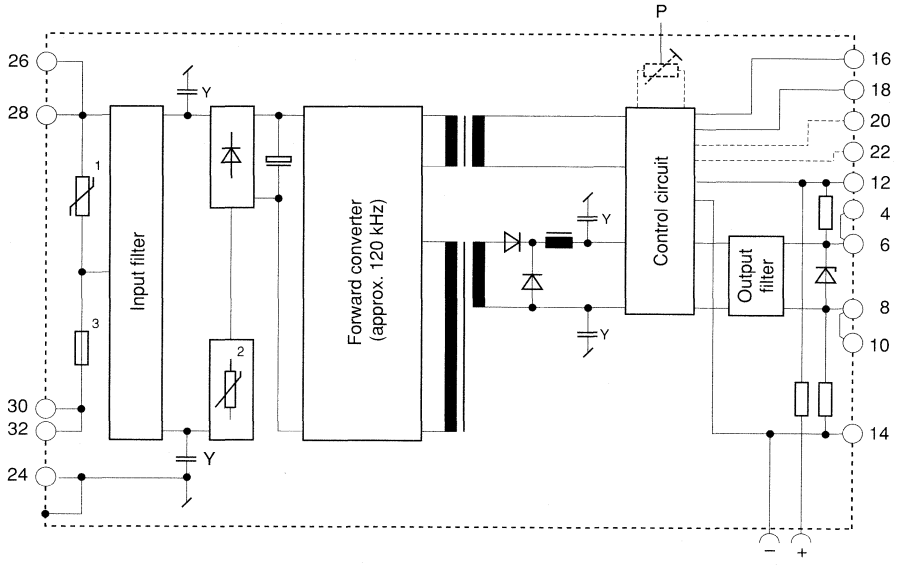
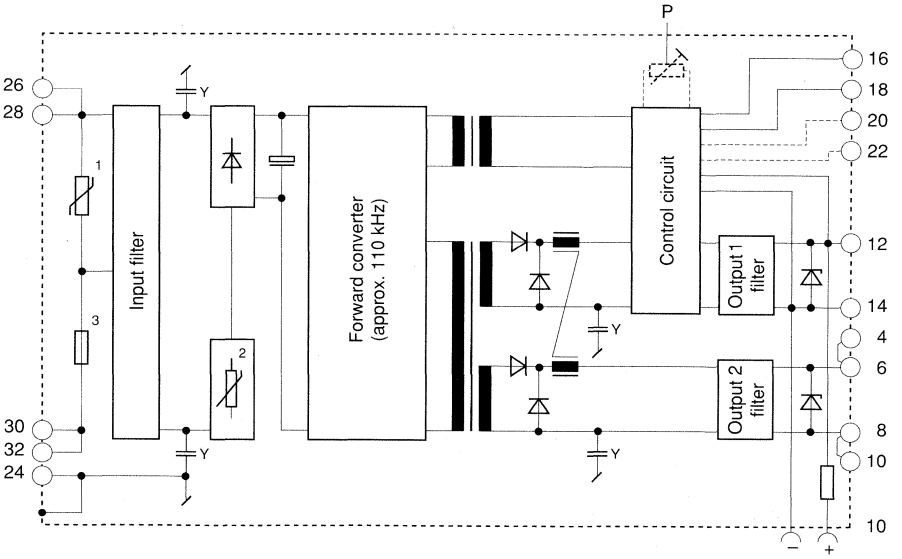



*Fig. 2*
*Block diagram of single output converters LS 1000*




[1] Transient suppressor (VDR)
[2] Inrush current limiter (NTC or option E), -9 version exclude the NTC
[3] Input fuse

*Fig. 3*
*Block diagram of symmetrical double output converters LS 2000*


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## Electrical Input Data

General Conditions
– $T_A$ = 25°C, unless $T_C$ is specified.
– Pin 18 connected to pin 14, $U_o$ adjusted to $U_{o\,nom}$ (option P); R input not connected.
– Sense line pins S+ and S– connected to Vo+ and Vo– respectively.

*Table 3: Input data*

| Input | | | LS | | | |
|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0...$I_{o\,nom}$ | 85 | | 264 | V AC |
| | | $T_{C\,min}$...$T_{C\,max}$ | 88 | | 372 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | | | 310 | | [3] |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 0.4 | | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$...$U_{i\,max}$ | | | 2.5 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | 1.5 | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 480 | | | mΩ |
| $R_{NTC}$ | NTC resistance [2] | | 3200 | | | |
| $C_i$ | Input capacitance | | 210 | | 400 | µF |
| $U_{i\,RFI}$ | Conducted input RFI | EN 55022 | | | B | |
| | Radiated input RFI | | | | >A | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | –400 | | 400 | V DC |
| F | Fuse rating (nominal) | see table 4 | | 4.0 | | A |

[1] With double output modules, both outputs loaded with $I_{o\,nom}$
[2] Valid for -7, -6, -5 versions with NTC, (-9 versions exclude the NTC). Initial switch-on cycle. Subsequent switch-on/off cycles increase the inrush current peak value.
[3] LS types may also be operated in DC mode. (See "S-Family, DC-DC Converters")

AC frequency range 47...440 Hz.
Above 70 Hz (at $U_i$ = 264 V AC) the earth lekage current may exceed 3.5 mA, specified in IEC 950. The built-in Y capacitors are specified for ≤100 Hz. Above 350 Hz the input voltage may not exceed 200 V AC.

### Input Fuse

A fuse mounted inside the converter protects the module against severe defects. If operated from a DC source this fuse may not fully protect the module when the input voltage exceeds 200 V DC! In applications where the converters operate at source voltages above 200 V DC an external fuse or a circuit breaker at system level should be installed!

*Table 4: Fuse Specification*

| Module | Fuse type | Fuse rating |
|---|---|---|
| LS [1] | slow-blow | SP T 4 A, 250 V |

[1] Fuse size 5 × 20 mm

### Inrush Current Limitation

The modules of the versions -7, -6, -5 incorporate a NTC resistor in the input circuitry which - at initial turn on - reduces the peak inrush current value by a factor of 5...10 to protect connectors and switching devices from damage. Subsequent switch-on cycles within short periods will cause an increase of the peak inrush current value due to the warming-up of the NTC resistor. See also option E.

### Inrush Current Peak Value

The inrush current peak value/initial switch-on cycle) can be determined by following calculation: (Refer to fig. 6 also)

$$I_{inr\,p} = \frac{U_{i\,source}}{(R_{s\,ext} + R_i + R_{NTC})}$$

### Input Under-/Overvoltage Cut-out

If the input voltage remains below approx. 0.8 $U_{i\,min}$ or exceeds approx. 1.1 $U_{i\,max}$, an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ should be considered!

### Input Transient Protection

A suppressor diode or a VDR (depending upon the input voltage range) together with the input fuse and a symmetrical input filter form an effective protection against high input transient voltages.

### Reserve Polarity Protection

The built-in rectifier provides reverse polarity protection at the input.

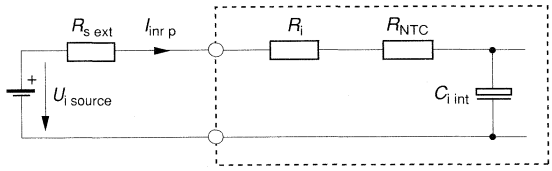



*Fig. 4*
*Replacement diagram for input impedance*

**Electromagnetic Immunity**

*Table 5: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [4] | Value applied | Waveform | Source impedance | Test procedure | in operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Impulse voltage | IEC 255-4 App. E4 [5] (1976) | III | i/o, i/c, o/c +i/–i, +o/–o | 5000 $V_p$ | 1.2/50 µs | 500 Ω | 3 pos. and 3 neg. impulses per coupling mode | no | - |
| High frequency disturbance | IEC 255-4 App. E5 [5] (1976) | III | i/o, i/c, o/c | 2500 $V_p$ | 400 damped 1 MHz waves/s | 200 Ω | 2 s per coupling mode | yes | 7 |
| | | | i/o, +o/–o, o/c | 1000 $V_p$ | | | | | |
| Voltage surge | IEC 571-1 [3] (1990-07) | | i/c, +i/–i | 800 $V_p$ | 100 µs | 100 Ω | | yes | 1 |
| | | | | 1500 $V_p$ | 50 µs | | 1 pos. and 1 neg. voltage surge per coupling mode | | |
| | | | | 3000 $V_p$ | 5 µs | | | | |
| | | | | 4000 $V_p$ | 1 µs | | | | |
| | | | | 7000 $V_p$ | 100 ns | | | | |
| Supply related surge | RIA 12 (1984) | B | +i/–i | 1.5 • $U_{batt}$ | 1 s | 0.2 Ω | 1 positive surge | yes | 1 |
| Direct transient | | C | +i/c, –i/c | 960 $V_p$ | 10/100 µs | 5 Ω | 5 pos. and 5 neg. impulses | | 2 |
| | | D | | 1800 $V_p$ | 5/50 µs | | | | |
| | | E | | 3600 $V_p$ | 0.5/5 µs | 100 Ω | | | |
| | | F | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | G | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Indirect coupled transient | | H | +o/c, –o/c | 1800 $V_p$ | 5/50 µs | | | | 6 |
| | | J | | 3600 $V_p$ | 0.5/5 µs | | | | |
| | | K | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | L | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Electrostatic discharge | IEC 801-2 (1991-04) | 4 | contact discharge to case, | 8000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | 1 |
| | | | air disch. to case | 15000 $V_p$ | | | | | |
| Electric field | IEC 801-3 (1984) | 3 | antenna in 1m distance | 10 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | 7 |
| Fast transient/ burst | IEC 801-4 (1988) | 3 | i/c, +i/–i | 2000 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | 1 |
| | | 4 | | 4000 $V_p$ | | | | | |
| Transient | IEC 801-5 (Draft 1993-01) | 4 | i/c, | 4000 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | 1 |
| | | | +i/–i | 2000 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specifications possible
[3] Will be replaced by EN 50155
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Test in progress, please consult factory
[7] Not tested yet, please consult factory.

**Static Input Current Characteristic**

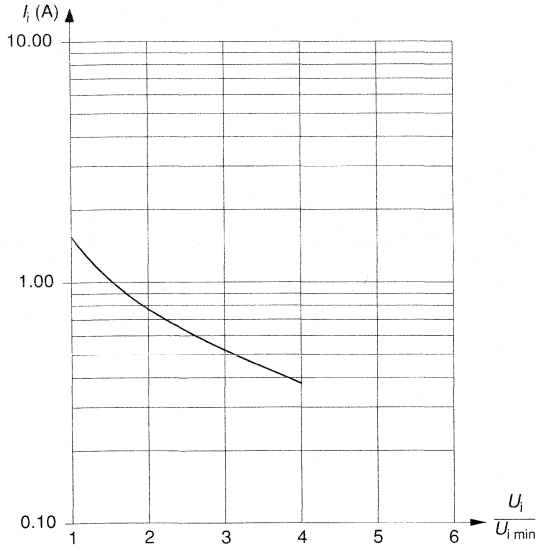



*Fig. 5*
*Input current versus relative input voltage*

**RFI Noise at Input according to EN 55022**

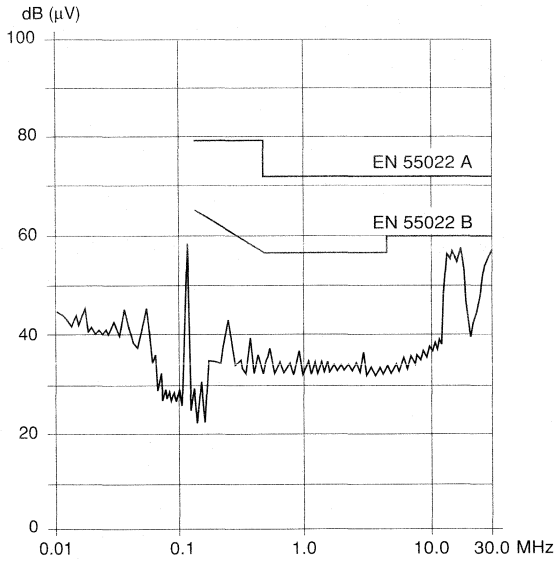



*Fig. 6*
*Typical radio frequency-interference voltage at $U_{i\,nom}$, $I_{o\,nom}$, measured with an artificial mains network and a quasi peak detector.*

**Hold-up Time versus relative Input Voltage**

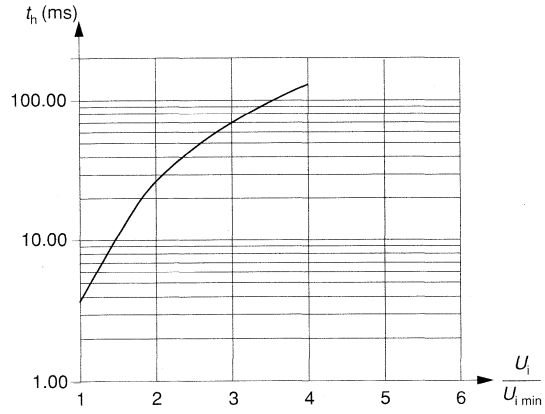



*Fig. 7*
*Hold-up time $t_h$ versus relative input voltage $U_i/U_{i\,min}$.*

**Input Inrush Current Characteristic**

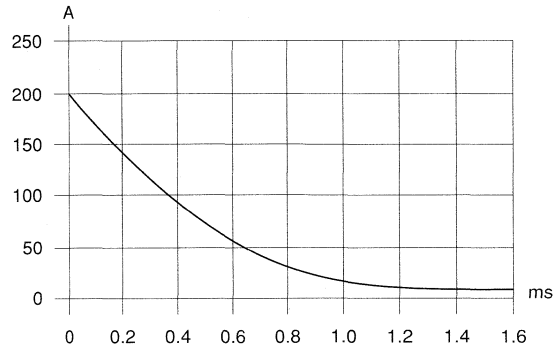



*Fig. 8*
*Inrush current versus time at $U_{i\,max}$, $R_{ext}$ = 0*

## Electrical Output Data

General Conditions, valid for all tables 6:
– $T_A$ = 25°C, unless $T_C$ is specified.
– Pin 18 connected to pin 14, $U_o$ adjusted to $U_{o\,nom}$ (option P), R input not connected.
– Sense line pins S+ and S– connected to Vo+ and Vo– respectively.

*Table 6a: Output data single output modules*

| **Output** | | | **LS 1001 5.1 V** | | | **LS 1301 12.0 V** | | | **LS 1501 15.0 V** | | | **LS 1601 24.0 V** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 7.6 | | | 20 | | | 26.5 | | | 39 | | |
| $I_{o\,nom}$ | Output current [1] | | | 16.0 | | | 8.0 | | | 6.5 | | | 4.2 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 16.2 | | | 8.2 | | | 6.7 | | | 4.4 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 5 | | | 5 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 75 | | | 40 | | | 60 | | | 90 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$, $U_{i\,nom}$...$U_{i\,max}$, $I_{o\,nom}$ | | | ±15 | | | ±25 | | | ±30 | | | ±30 | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ | | | 20 | | | 25 | | | 30 | | | 40 | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±200 | | | ±250 | | | ±300 | | | ±200 | | |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.1 | | | 0.3 | | | 0.3 | | | 0.35 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | mV/K |

*Table 6b: Output data double output modules*

| **Output** (Outputs connected in series) | | | **LS 2320 24 V (2 × 12 V)** | | | **LS 2540 30 V (2 × 15 V)** | | | **LS 2660 48 V (2 × 24 V)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | | 24.0 [2] | | | 30.0 [2] | | | 48.0 [2] | | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 39 | | | 49 | | | 72 | | |
| $I_{o\,nom}$ | Output current [1] | | | 4.0 | | | 3.2 | | | 2.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 4.2 | | | 3.4 | | | 2.2 | | | |
| $u_o$ | Output voltage noise [3] | $U_{i\,nom}$, $I_{o\,nom}$ | | 15 | | | 15 | | | 20 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 400 | | | 500 | | | 500 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±40 | | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ | | 40 | | | 30 | | | 40 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | +100/–300 | | | +200/–300 | | | +250/–250 | | |
| $t_d$ [6] | Time constant; dynamic load regulation | $I_o$ = (1...1/3...1)$I_{o\,nom}$ | | 0.2 | | | 0.2 | | | 0.5 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±4.8 | | | ±6.0 | | | ±7.2 | | mV/K |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[2] Series connection for $U_{o\,nom}$ = 24 V, 30 V or 48 V, see fig. 16a.
[3] Shortest possible wiring for series connection at the connector.
[4] See fig. 10.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.

*Table 6c: Output data double output modules*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **LS 2320 12 V/12 V** | | | | | | **LS 2540 15 V/15 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 11.93 | | 12.07 | 11.82 | | 12.18 | 14.91 | | 15.09 | 14.78 | | 15.22 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 19 | | | 19 | | | 25 | | | 25 | | |
| $I_{o\,nom}$ | Output current [3] | | | 4.0 | | | 4.0 | | | 3.2 | | | 3.2 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 4.2 | | | 4.2 | | | 3.4 | | | 3.4 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 10 | | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 150 | | | 75 | | | 200 | | | 100 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±30 | | | ±40 | | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 100 | | | Fig. 12 | | | 100 | | | Fig. 13 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$ | | +80/–250 | | | | | | +100/–250 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.4 | | | | | | 0.4 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | | | | ±0.02 | | | | | %/K |
| | | | | ±2.4 | | | | | | ±3.0 | | | | | mV/K |

*Table 6d: Output data double output modules*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **LS 2660 24 V/24 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 23.86 | | 24.14 | 23.64 | | 24.36 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 36 | | | 36 | | |
| $I_{o\,nom}$ | Output current [3] | | | 2.0 | | | 2.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$, $T_{C\,min}$...$T_{C\,max}$ | 2.2 | | | 2.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$, | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 200 | | | 100 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$, $U_{i\,nom}$...$U_{i\,max}$, $I_{o\,nom}$ | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 50 | | | Fig. 14 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | +100/–250 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.4 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$...$T_{C\,max}$ | | ±0.02 | | | | | %/K |
| | | | | ±4.8 | | | | | mV/K |

[1] Depending upon the desired output configuration the wiring should be made as shown in fig. 16b, c, d or e.
[2] Same conditions for both outputs.
[3] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[4] See fig. 10.
[5] Condition for specified output. Other output loaded with constant current $I_o = I_{o\,nom}$.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.

### Output Protection

Each output is protected against overvoltage which could occur due to a failure of the control circuit by means of a voltage suppressor diode which, under worst case conditions, may become a short circuit. The suppressor diode are not designed to withstand externally applied overvoltages. Overload at any of the two outputs will cause a shut-down of both outputs. A red LED indicates the overload condition.

### Test Sockets (Main output only [1])

Test sockets for measuring the output voltage $U_{o1}$ are located at the front of the module. The positive test socket is protected by a series resistor (see fig. 2 and 3). The voltage measured at the test sockets is approximately 30 mV lower than the value measured at the output terminals.

[1] In case of double output units externally connected in series for $U_o$ = 24 V, 30 V or 48 V the monitored output voltage is 12 V, 15 V or 24 V respectively.

### Inhibit Function

The outputs of a module may be enabled or disabled by means of a logic signal (TTL, CMOS etc.) applied to the inhibit input. If the inhibit function is not required, connect the inhibit pin 18 to pin 14 to enable the outputs (active low logic, fail safe).

*Table 8: Inhibit characteristics*

| Characteristic | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | 0.8 | V |
| | | $U_o$ = off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = 0 | | | –400 | µA |
| $t_r$ | Rise time | | | | 30 | | ms |
| $t_f$ | Fall time | | depending on $I_o$ | | | | |

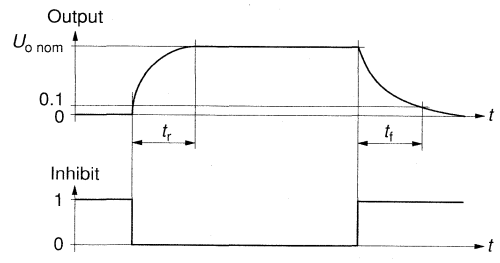



*Fig. 9*
*Output response as a function of inhibit control*

### Sense Lines

(Only for single output units 5.1 V, 12 V, 15 V, 24 V)

This feature enables compensation for voltage drops across the connector contacts and if necessary, across the load lines. If the sense lines are connected at the load rather than directly at the connector, the user should ensure that $U_{o\,max}$ (between Vo1+ and Vo1–) is not exceeded. We recommend connecting the sense lines directly at the female connector.

For further information, please refer to "Application Notes ".

To ensure correct operation, both sense lines should be connected to their respective power outputs and the voltage difference between any sense line and its respective power output pin (as measured on the connector) should not exceed the following values:

*Table 9: Voltage compensation allowed using sense lines*

| Output voltage | Total voltage difference between sense lines and their respective outputs | Voltage difference between Vo– and S– |
|---|---|---|
| 5.1 V | < 0.5 V | < 0.25 V |
| 12 V, 15 V | < 1.0 V | < 0.25 V |

If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents must be reduced accordingly so that $P_{o\,nom}$ is not exceeded.

### Parallel or Series Connection of Units

Single or double output units with equal nominal output voltage can be connected in parallel without any precautions using option T.

With **option T** (current sharing), all units share the current approximately equally.

Single output units and/or main and second outputs of double output units can be connected in series with any other (similar) output.

**Note:**

- Parallel connection of double output units should always include both, main **and** second output to maintain good regulation of both outputs.
- Series connection of second outputs without involving their main outputs should be avoided as regulation may be poor.
- The maximum output current is limited by the output with the lowest current limitation if several outputs are connected in series.
- Not more than 5 units should be connected in parallel.

**Output Voltage Regulation of Single or Double Output Modules with Outputs 1 and 2 Connected in Series**

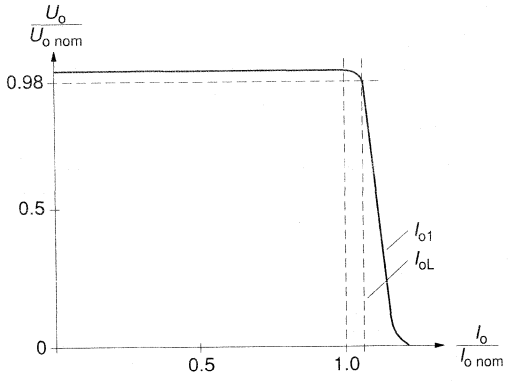



*Fig.10*
*$U_{o1}$ vs. $I_{o1}$ (typ.) of single output units*

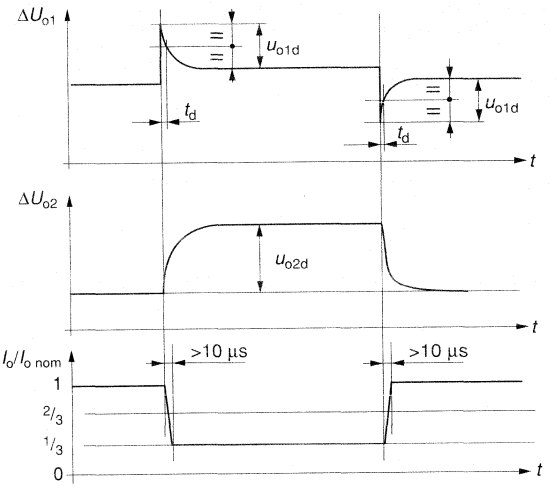



*Fig. 11*
*Control deviation of $u_{o1/2\,d}$ vs. dynamic load change*

**Output Voltage Regulation of Double Output Modules with Output 1 and 2 in Symmetrical Configuration**

Output 1 is under normal conditions regulated to $U_{o1\,nom}$, independent of the output currents.

$U_{o2}$ is dependent upon the load distribution. When both outputs are loaded with more than 10% of $I_{o\,nom}$, the deviation of $U_{o2}$ remains within ±5% of the value of $U_{o1}$. Figures 13, 14 and 15 show the regulation with varying load distribution. If $I_{o1} = I_{o2}$ or the two outputs are connected in series, the deviation of $U_{o2}$ remains within ±1% of the value of $U_{o1}$ provided that a total load of more than 10% of $I_{o\,nom}$ is applied.

Two outputs of a single S 2000 module connected in parallel will behave like the output of a S 1000 module; the paralleled output is fully regulated. No precautions are necessary in using the R-input and the test sockets.

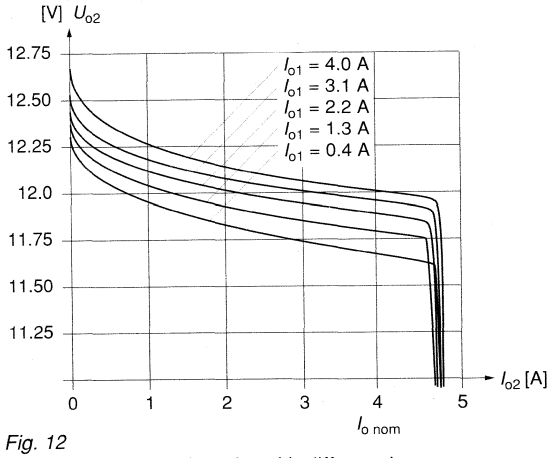



*Fig. 12*
*LS 2320: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

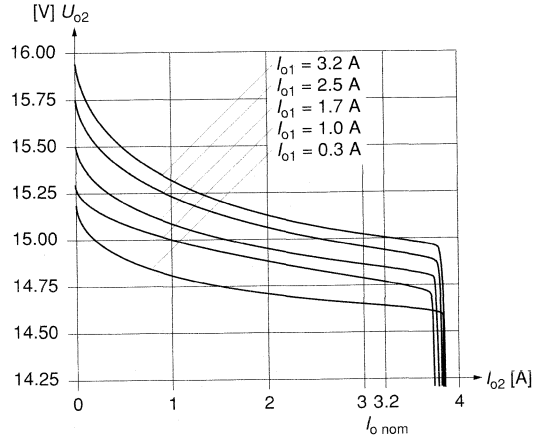



*Fig. 13*
*LS 2540: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

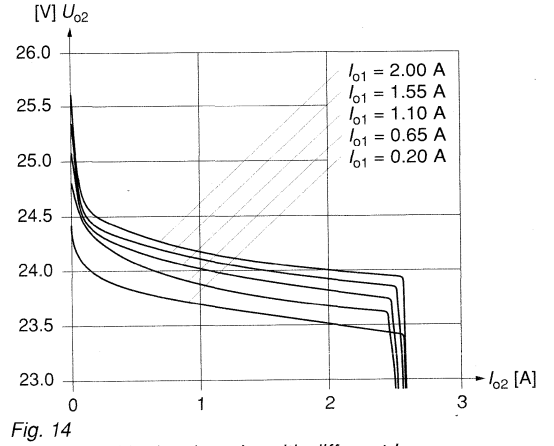



*Fig. 14*
*LS 2660: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

**Programmable Output Voltage** (R-Function)

As a standard feature, the modules offer an adjustable output voltage, identified by letter R in the type designation. The control input R (pin 16) accepts either a control voltage $U_{ext}$ or a resistor $R_{ext}$ to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_{o\,nom}$.

a) Adjustment by means of an external control voltage $U_{ext}$ between pin 16 (R) and pin 14:

The control voltage range is 0...2.75 V DC and allows an output voltage adjustment in the range of approximately 0...110% $U_{o\,nom}$.

$$U_{ext} = \frac{U_o}{U_{o\,nom}} \cdot 2.5\ V \text{ (approximate formula)}$$

b) Adjustment by means of an external resistor:

Depending upon the value of the required output voltage the resistor shall be connected

**either:** Between pin 16 and pin 14 ($U_o < U_{o\,nom}$) to achieve an output voltage adjustment range of approximately 0...100% $U_{o\,nom}$

**or:** Between pin 16 and pin 12 ($U_o > U_{o\,nom}$) to achieve an output voltage adjustment range of approximately 100...110% $U_{o\,nom}$.

**Warning:**

- The value of $R'_{ext}$ shall never be less than the lowest value as indicated in table 10b to avoid damage to the unit!

**Remarks:**

- The R-Function excludes option P (output voltage adjustment by potentiometer).
- If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output current(s) should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
- The R-input (as well as option P) is related to the main output.
- With double output units the second output follows the value of the controlled main output. Resistor values as indicated for the single output units should be used.
- For correct output voltage adjustment of double output units the external wiring of the outputs should be according to fig. 16a, b, c, d or e depending upon the desired output configuration.
- In case of parallel connection the output voltages should be individually set within a tolerance of 1 - 2%.

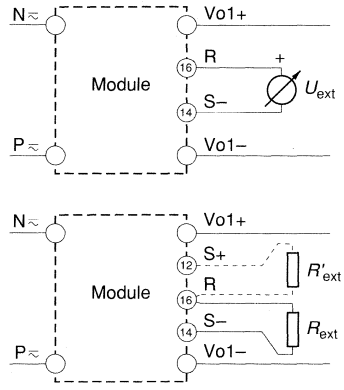



*Fig. 15*
*Output voltage control for single output units AS...LS 1000 by means of the R input*

*Table 10a: $R_{ext}$ for $U_o < U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ (V) | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] |
| 0.5 | 0.422 | 2 | 4 | 0.825 | 2 | 4 | 0.56 | 4 | 8 | 0.825 |
| 1.0 | 1.0 | 3 | 6 | 1.3 | 4 | 8 | 1.47 | 6 | 12 | 1.33 |
| 1.5 | 1.62 | 4 | 8 | 1.96 | 6 | 12 | 2.61 | 8 | 16 | 1.96 |
| 2.0 | 2.16 | 5 | 10 | 2.87 | 8 | 16 | 4.64 | 10 | 20 | 2.87 |
| 2.5 | 3.83 | 6 | 12 | 3.83 | 9 | 18 | 6.19 | 12 | 24 | 3.83 |
| 3.0 | 5.61 | 7 | 14 | 5.62 | 10 | 20 | 8.25 | 14 | 28 | 5.61 |
| 3.5 | 9.09 | 8 | 16 | 8.28 | 11 | 22 | 11.0 | 16 | 32 | 8.25 |
| 4.0 | 14.7 | 9 | 18 | 12.1 | 12 | 24 | 16.2 | 18 | 36 | 12.1 |
| 4.5 | 28.7 | 10 | 20 | 19.6 | 13 | 26 | 26.1 | 20 | 40 | 19.6 |
| 5.0 | 196 | 11 | 22 | 42.2 | 14 | 28 | 56.2 | 22 | 44 | 46.4 |

*Table 10b: $R'_{ext}$ for $U_o > U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] |
| 5.15 | 422 | 12.1 | 24.2 | 1780 | 15.2 | 30.4 | 1470 | 24.25 | 48.5 | 3160 |
| 5.2 | 215 | 12.2 | 24.4 | 909 | 15.4 | 30.8 | 750 | 24.5 | 49.0 | 1620 |
| 5.25 | 147 | 12.3 | 24.6 | 623 | 15.6 | 31.2 | 511 | 24.75 | 49.5 | 1100 |
| 5.3 | 110 | 12.4 | 24.8 | 464 | 15.8 | 31.6 | 383 | 25.0 | 50.0 | 825 |
| 5.35 | 90.9 | 12.5 | 25.0 | 383 | 16.0 | 32.0 | 316 | 25.25 | 50.5 | 681 |
| 5.4 | 75 | 12.6 | 25.2 | 316 | 16.2 | 32.4 | 261 | 25.5 | 51.0 | 562 |
| 5.45 | 61.9 | 12.7 | 25.4 | 286 | 16.4 | 32.8 | 237 | 25.75 | 51.5 | 511 |
| 5.5 | 56.2 | 12.8 | 25.6 | 234 | 16.5 | 32.0 | 215 | 26.0 | 52.0 | 464 |
| | | 13.0 | 26.0 | 196 | | | | 26.25 | 52.5 | 422 |
| | | 13.2 | 26.4 | 162 | | | | 26.4 | 52.8 | 383 |

[1] First column: single output units or double output units with separated outputs, second column: outputs in series connection


MELCHER ISO 9001 certified

Programmable Output Voltage (R-Function) continued

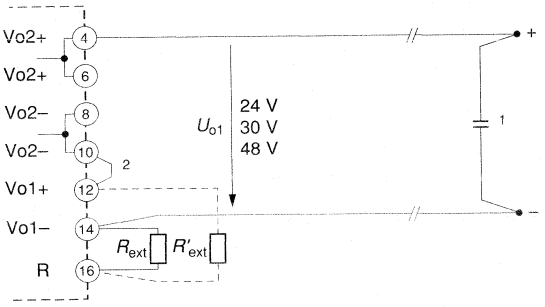



*Fig. 16a*
*LS 2000 with H15 connector. R-input for output voltage control. Wiring for output voltage 24 V or 30 V or 48 V with main and second output connected in series.*

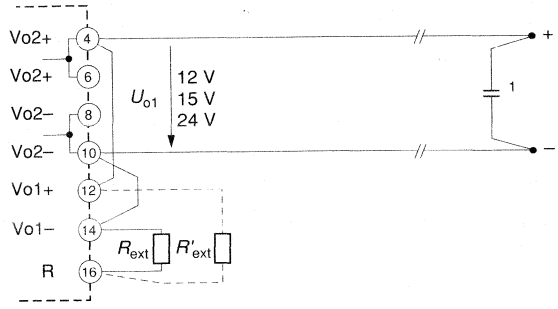



*Fig. 16b*
*LS 2000 with H15 connector. R-input for output voltage control. Wiring for output voltage 12 V or 15 V or 24 V with main and second output connected in parallel.*

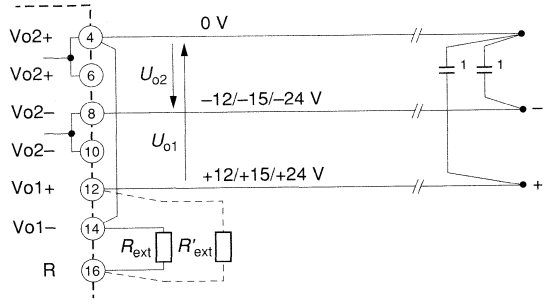



*Fig. 16c*
*LS 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two symmetrical output voltages $U_{o1}$ and $U_{o2}$: ±12 V or ±15 V or ±24 V.*

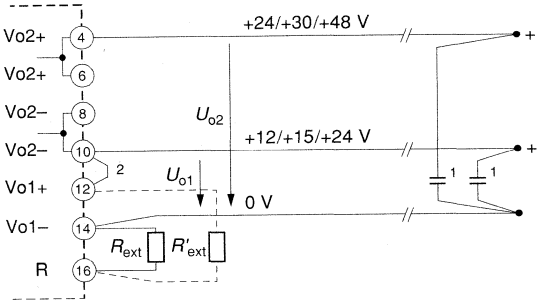



*Fig. 16d*
*LS 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two output voltages $U_{o1}$ and $U_{o2}$: +12 V and +24 V or +15 V and +30 V or +24 V and +48 V.*

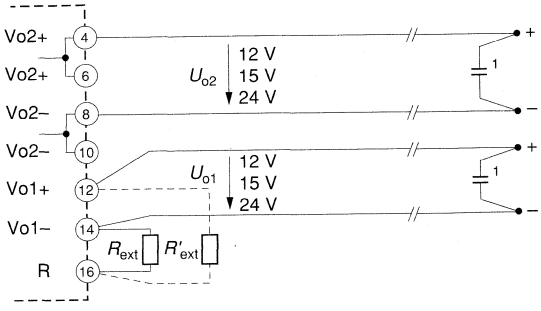



*Fig. 16e*
*LS 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two output voltages $U_{o1}$ and $U_{o2}$: 12 V/12 V or 15 V/15 V or 24 V/24 V, the outputs are galvanically isolated.*

[1] A ceramic multilayer capacitor connected across the output lines reduces ripple and spikes.
[2] Shortest possible wiring for series connection at the female connector

**Remarks:**

Double output units fitted with H-15 connectors have the output pins of the second output, pins 4/6 and 8/10, internally paralleled.

It is recommended that pins 4/6 and 8/10 be directly paralleled at the female connector as well to reduce the voltage drop across the connector.

Please note: $U_{o2}$ varies depending upon its own load and the load on output 1.

## Supplementary Data

### Isolation

Input to output isolation voltage tests in accordance with IEC 950, EN 60950, VDE 0805 and EN 41003 respectively are performed as factory tests and should not be repeated in the field.

### Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 2 and 3). Melcher will not honour any guarantee claims resulting from high voltage field tests.

*Table 11: Isolation test voltages, clearance and creepage distances*

| Characteristic | Input to Output | Input to Case | Output to Case | Output to Output | Unit |
|---|---|---|---|---|---|
| Isolation test voltage | 4.0 | 2.0 | 1.0 | 0.1 | $kV_{rms}$ |
| | 5.6 | 2.8 | 1.4 | 0.15 | kV DC |
| Clearance and creepage distance on the print lay-out | 6.4 | 3.2 | 2.0 | 0.4 | mm |

### Display Status of LEDs

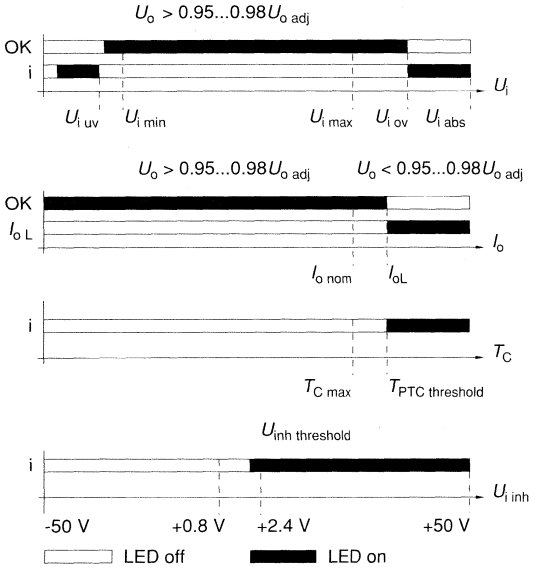



*Fig. 17*

*LEDs "OK" and "i" status versus input voltage*
*Conditions: $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*
*$U_{i\,uv}$ = undervoltage lock-out, $U_{i\,ov}$ = overvoltage lock-out*

*LEDs "OK" and "$I_{o\,L}$" status versus output current*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*

*LED "i" versus case temperature*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $U_{inh} \le 0.8$ V*

*LED "i" versus $U_{inh}$*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$*

## Description of Options

*Table 12: Survey of options*

| Option | Function of Option | Characteristics |
|---|---|---|
| -9 | Operational temperature range $T_A$ = –40 °C...71 °C | Extended operational temperature range |
| E | Electronic inrush current limitation circuitry | Improved inrush current limitation as per table 12 |
| P | Potentiometer for $U_o$ adjustment | R-function is not available if option P is incorporated |
| D | Input and/or output undervoltage monitoring circuitry | Safe data signal output (Versions D0...DD) |
| V | Input (and output) undervoltage monitoring circuitry | ACFAIL signal according to VME specs (Versions V0, V2, V3) |
| T | Current sharing | Interconnect T-pins if paralleling outputs (5 units max.) |
| B1 | Cooling plate | Replaces standard heat sink, allowing direct chassis-mounting |

**Option -9** Extended Temperature Range

Extension of the operating temperature range from standard –25...71 °C to –40...71 °C. The modules will provide full nominal output power with free air convection cooling. Option -9 excludes inrush current limitation by NTC.

**Option E** Inrush Current Limitation

The converters may be supplemented by an electronic circuit (option E, replacing the standard built-in NTC) to achieve an enhanced inrush current limiting function.

*Table 13: Inrush current characteristics with option E*

| **Characteristics** $U_i$ = 230 V AC | | LS typ | LS max | **Unit** |
|---|---|---|---|---|
| $I_{inr\ p}$ | Peak inrush current | – | 25.3 | A |
| $t_{inr}$ | Inrush current duration | 35 | 50 | ms |

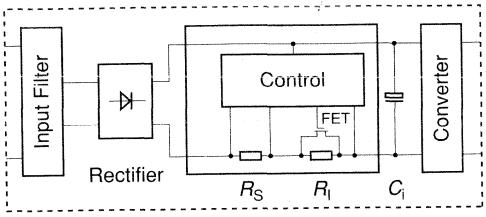



*Fig. 18*
*Option E block diagram*

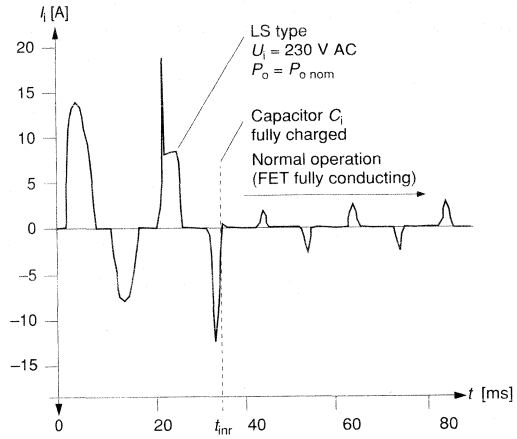



*Fig. 19*
*Inrush current with option E*

**Precaution:**
Subsequent switch-on cycles at start-up are limited to max. 10 cycles during the first 20 seconds (cold unit) and at continuing on/off ($T_C$ = 95°C) max. 1 cycle every 8 sec.

**Option P** Potentiometer

The potentiometer provides an output voltage adjustment range of +10/–60% of $U_{o\ nom}$ and is accessible through a hole in the front cover. This feature enables compensation for voltage drops across the connector and wiring. Option P is not recommended if units are connected in parallel.

Option P excludes the R-function. With double output units both outputs are affected by the potentiometer setting (doubling the voltage setting if the outputs are in series).

If the output voltages are increased above $U_{o\ nom}$ via R-input control, option P setting, remote sensing or option T, the output current(s) should be reduced accordingly so that $P_{o\ nom}$ is not exceeded.

**Option T** Current Sharing

This option ensures that the output currents are approximately shared between all paralleled modules and increases system reliability. To use this facility, simply interconnect the T pins of all modules and make sure, that pins no. 14, the S– pins (S 1000) or the Vo1– pins (S 2000) are also connected together. The load leads should have equal length and cross section to ensure equal voltage drops. Not more than 5 units should be connected in parallel. If output voltage adjustment is requested we strongly recommend to use the R-input instead of option P, as with option P the required setting accuracy is difficult to achieve. The output voltages must be individually set prior to paralleling to within a tolerance of 1...2% or the R pins should be connected together.

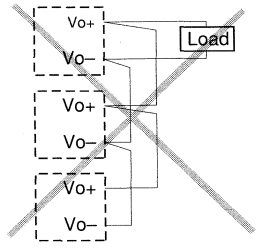
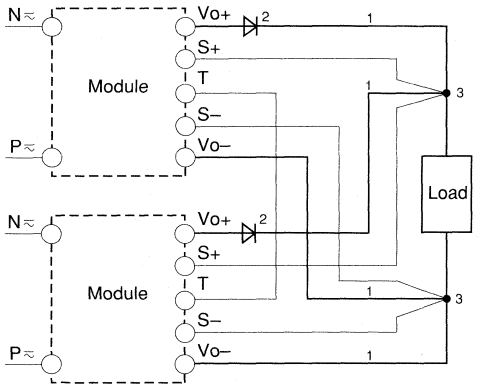


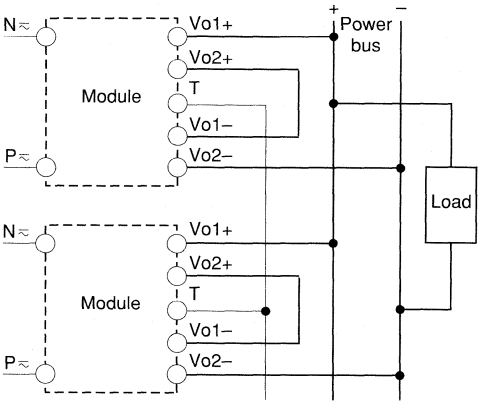

*Fig. 20*
*An example of poor wiring for connection in parallel*




max. 5 units connected in parallel

[1] Leads should have equal length and cross sections and should run in the same cable loom.
[2] Diodes recommended in redundant operation only
[3] DC common point

*Fig. 21*
*Paralleling of single output units using option T with the sense lines connected at the load*




max. 5 units connected in parallel

*Fig. 22*
*Paralleling of double output units using option T*

**Option D**

General description

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 20 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1–. The D output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D0...DD as shown in the following table.

*Table 14: Undervoltage monitor functions*

| Output type | | Monitoring | | Minimum adjustment range of threshold level $U_t$ | | Hysteresis $U_h$ typ [% of $U_t$] for $U_{t\,min}...U_{t\,max}$ | |
|---|---|---|---|---|---|---|---|
| JFET | NPN | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| D1 | D5 | no | yes | - | 3...40 V [1] | - | 2.5...0.6 |
| D2 | D6 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | - | 3.4...0.4 | - |
| D3 | D7 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | (0.95...0.985 $U_{o1}$) [2] | 3.4...0.4 | "0" |
| D4 | D8 | no | yes | - | (0.95...0.985 $U_{o1}$) [2] | - | "0" |
| D0 | D9 | no | yes | - | 3...40 V [3] | - | 2.5...0.6 |
| | | yes | no | $U_{i\,min}...U_{i\,max}$ [3 4] | - | 3.4...0.4 | - |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | 3...40 V [3] | 3.4...0.4 | 2.5...0.6 |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | (0.95...0.985 $U_{o1}$) [2] | 3.4...0.4 | "0" |
| - | DD | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 3...40 V [1] | 3.4...0.4 | 2.5...0.6 |

[1] Threshold level adjustable by potentiometer
[2] Fixed value (0.95...0.98 • $U_{o1}$). $U_{o1}$ adjustable via R-input, option P or sense lines.
[3] The threshold level permanently adjusted according to customer specification ±2% at 25°C. Any value within the specified range is basically possible but causes a special type designation in addition to the standard option designations (D0/D9 respectively)!
[4] Adjusted at $I_{o\,nom}$

JFET output (D0...D4):

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $U_D \leq 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $< U_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_D \leq 0.4$ V at $I_D = 2.5$ mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_D \leq 25$ µA at $U_D = 5.25$ V |

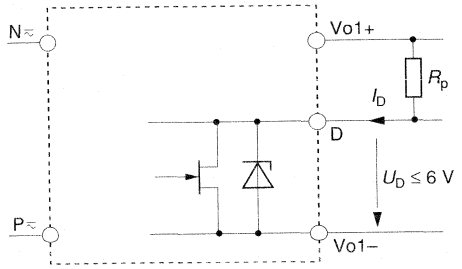



*Fig. 23*
*Option D1...D0: JFET output, $I_D \leq 2.5$ mA*

NPN output (D5...DD):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D < 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $> U_t + U_h$. The current $I_D$ through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. $U_D$ should not exceed 40 V.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | high, H, $I_D \leq 25$ µA at $U_D = 40$ V |
| $U_i$ and $U_{o1} > U_t + U_h$ | low, L, $U_D \leq 0.4$ V at $I_D = 20$ mA |

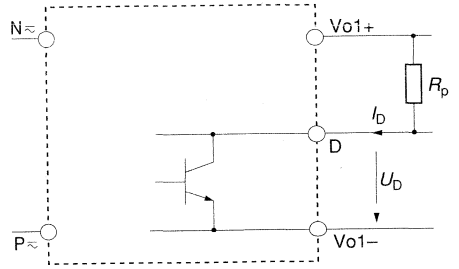



*Fig. 24*
*Option D5...DD: NPN output, $U_{o1} \leq 40$ V, $I_D \leq 20$ mA*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage after the input filter and rectifier is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{ti}$ across input filter and rectifier. The threshold levels of the D0 and D9 options are factory adjusted at nominal output current $I_{o\,nom}$ and at $T_A = 25$ °C. The value of $\Delta U_{ti}$ depends upon the threshold level $U_t$, temperature and input current. The input current is a function of the input voltage and the output power.

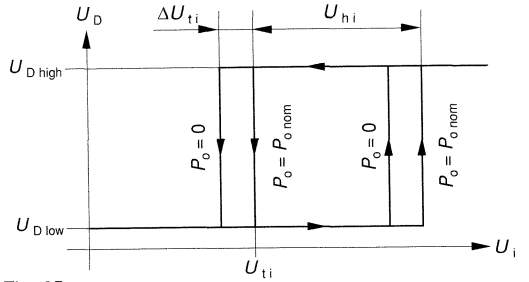
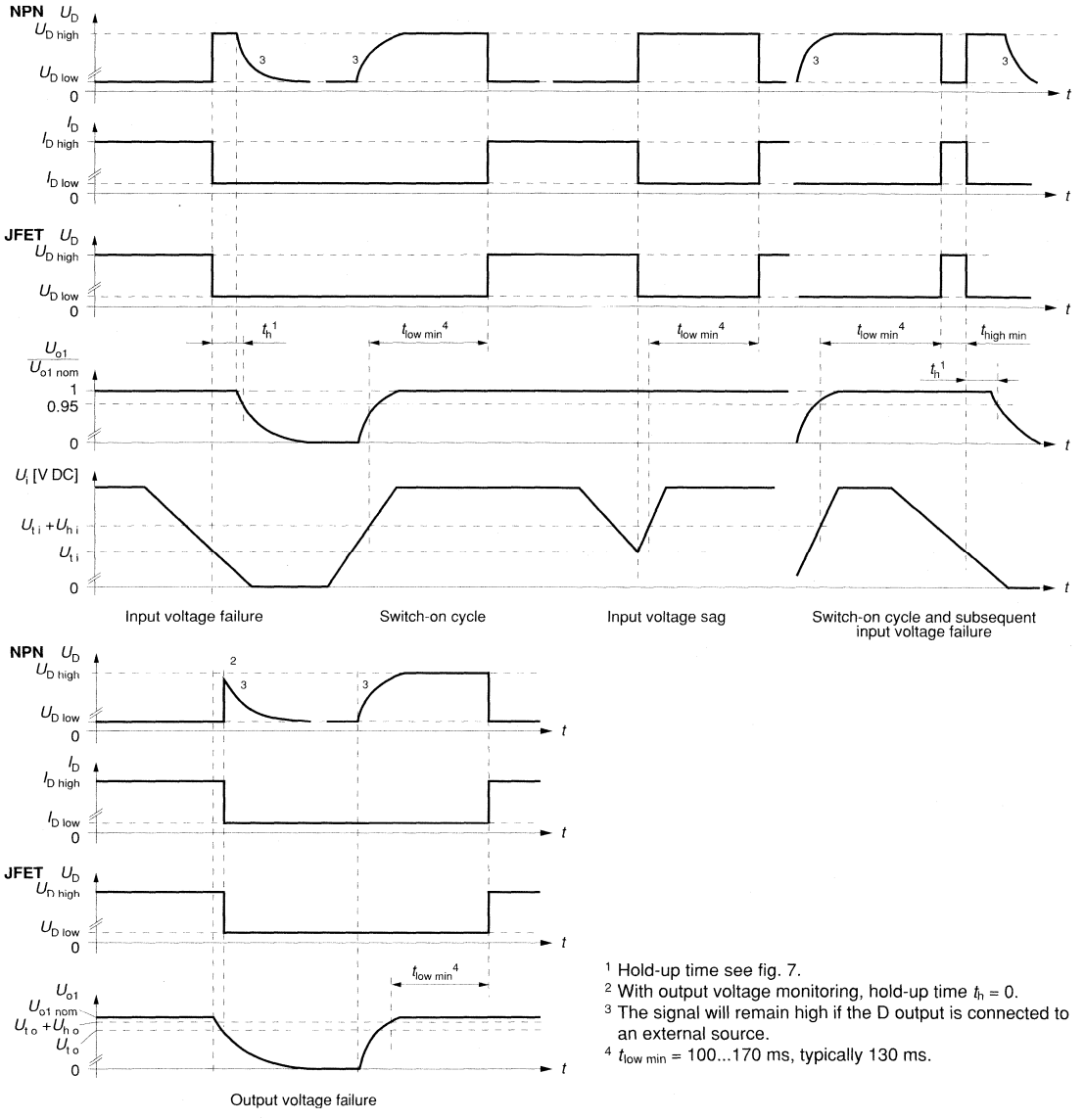



*Fig. 25*
*Definition of $U_{ti}$, $\Delta U_{ti}$ and $\Delta U_{hi}$ (JFET output)*

*Table 15: D-output logic signals*

| Version of D | $U_i < U_t$ resp. $U_o < U_t$ | $U_i > U_t + U_h$ resp. $U_o > U_t$ | Configuration |
|---|---|---|---|
| D1, D2, D3, D4, D0 | low | high | JFET |
| D5, D6, D7, D8, D9, DD | high | low | NPN |

D-signal with respect to input and output voltage versus time:




[1] Hold-up time see fig. 7.
[2] With output voltage monitoring, hold-up time $t_h = 0$.
[3] The signal will remain high if the D output is connected to an external source.
[4] $t_{low\,min}$ = 100...170 ms, typically 130 ms.

*Fig. 26*
*Relationship between $U_i$, $U_{o1}$, $U_D$, $U_{o1}/U_{o\,nom}$ versus time*

### Option V

This option defines an undervoltage monitoring circuit for the input and/or main output voltage ($U_{o1\ nom}$ = 5.1 V only) equivalent to option D and generates an ACFAIL signal (V signal) which conforms to the VME standard.

The low state level of the ACFAIL signal is specified at a sink current of $I_V \leq 48$ mA to $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME motherboard.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V when the output is fully loaded. This hold-up time $t_h$ is provided by the internal input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\ min}$ of the converter so that enough energy is remaining in the input capacitance.

Formula for threshold level for desired value of $t_h$:

$$U_{t\,i} = \sqrt{\frac{2 \cdot P_o \cdot (t_h + 0.3\ \text{ms}) \cdot 100}{C_{i\ min} \cdot \eta} + U_{i\ min}^2}$$

where as:

$C_{i\ min}$ = internal input capacitance [mF]
$P_o$ = output power [W]
$\eta$ = efficiency [%]
$t_h$ = hold-up time [ms]
$U_{i\ min}$ = minimum input voltage [V] [1]
$U_{t\,i}$ = threshold level [V]

[1] Min. input voltage according to "Electrical Input Data". For output voltages $U_o > U_{o\ nom}$, the minimum input voltage increases proportionally to $U_o/U_{o\ nom}$.

Remarks:

Option V2 and V3 can be adjustment by potentiometer to a threshold level between $U_{i\ min}$ and $U_{i\ max}$.

*Table 16: Available internal input capacitance and factory potentiometer setting of $U_{t\,i}$ with resulting hold-up time*

| Types | LS | Unit |
|---|---|---|
| $C_{i\ min}$ | 0.21 | mF |
| $U_{t\,i}$ | 120 | V DC |
| $t_h$ | 6.4 | ms |

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 20 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1–. The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by potentiometer, accessible through a hole in the front cover, or is adjusted during manufacture to a determined customer specified value.

Versions V0, V2 and V3 are available as shown below.

*Table 16: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level | | Typical hysteresis for $U_{t\ min}...U_{t\ max}$ [% of $U_t$] | |
|---|---|---|---|---|---|---|
| | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| V2 | yes | no | $U_{i\ min}...U_{i\ max}$ [1] | – | 3.0...0.5 | – |
| V3 | yes | yes | $U_{i\ min}...U_{i\ max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| V0 | yes | no | $U_{i\ min}...U_{i\ max}$ [3 4] | – | 2.2...0.4 | – |
| | yes | yes | $U_{i\ min}...U_{i\ max}$ [3 4] | 0.95...0.98 $U_{o1}$ [2] | 2.2...0.4 | "0" |

[1] Threshold level adjustable by potentiometer [2] Fixed value between 95% and 98% of $U_{o1}$ (tracking) [3] Adjusted at $I_{o\ nom}$
[4] Fixed value, resistor-adjusted (±2% at 25°C) acc. to customer's specifications; individual type number is determined by Melcher

V output (V0, V2, V3):

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) <$U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $U_V$ should not exceed 80 V.

| $U_i$, $U_{o1}$ status | V output, $U_V$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_V \leq 0.6$ V at $I_V$ = 50 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_V \leq 25$ µA at $U_V$ = 5.1 V |

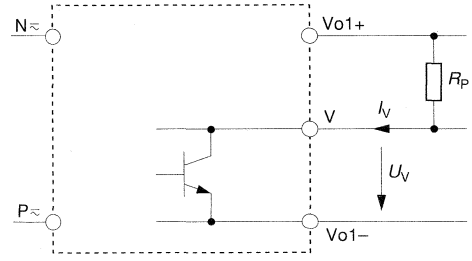



*Fig. 27*
*Output configuration of options V0, V2 and V3*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage is measured after the input filter and rectifier. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold level of option V0 is adjusted during manufacture at $I_{o\,nom}$ and $T_A = 25°C$. The value of $\Delta U_{t\,i}$ depends upon the threshold level $U_t$, temperature and input current. The input current is a function of input voltage and output power.

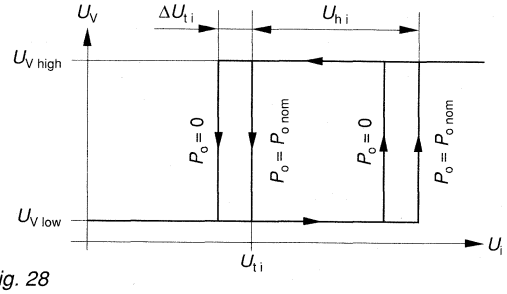
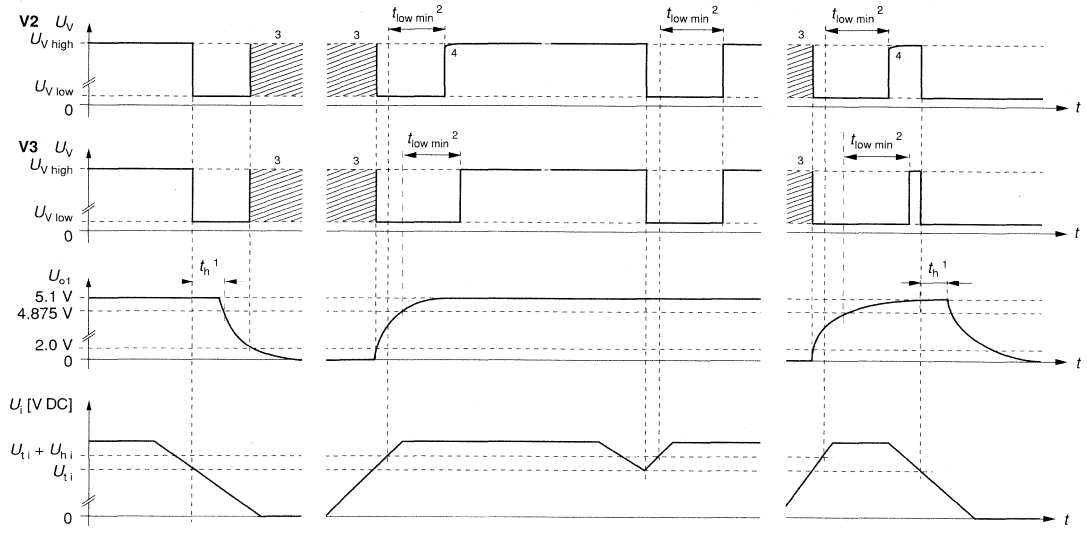
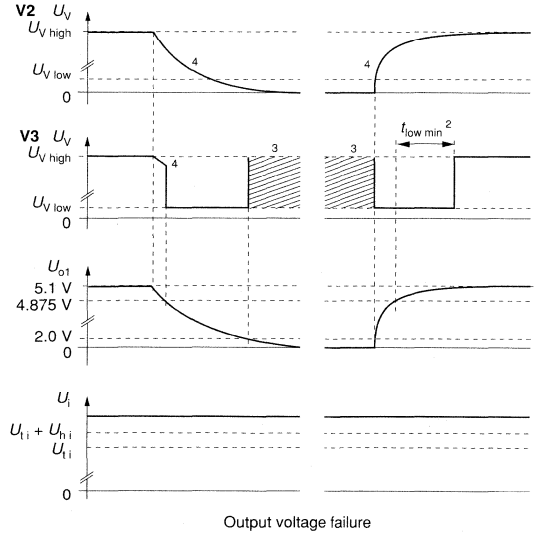



*Fig. 28*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$*




[1] VME request: minimum 4 ms
[2] $t_{low\,min}$ = 40...200 ms, typically 80 ms
[3] $U_V$ level not defined at $U_{o1} < 2.0$ V
[4] The V signal drops simultaneously with the output voltage. If the pull-up resistor $R_P$ is connected to Vo1+. The V signal remains high if $R_P$ is connected to an external source.

*Fig. 29*
*Relationship between $U_i$, $U_{o1}$, $U_V$, $I_V$ and $U_{o1}/U_{o\,nom}$ versus time.*

**Option B1** Cooling Plate (see "Mechanical Data")

Where a cooling surface is available, we recommend the use of a cooling plate (option B1) instead of the standard heatsink. The mounting system should ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The cooling capacity is calculated by:

$$P_{Loss} = \frac{(100\% - \eta)}{\eta} (U_o \bullet I_o)$$

Efficiency $\eta$ see tables 1a, b, c

## Immunity to Environmental Conditions

*Table 17: Mechanical stress*

| Test | | Standard | Test Parameters | |
|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046, part 5<br>IEC 68-2-3<br>MIL-STD 810D section 507.2 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{+2/-3}$ %<br>56 days<br>Unit not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046, part 7<br>IEC 68-2-27<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046, part 26<br>IEC 68-2-29<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration (sinusoidal) | DIN 40046, part 8<br>IEC 68-2-6<br>MIL-STD 810D section 514.3 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s²<br>7.5 h (2.5 h each axis)<br>Unit operating |
| Kb | Salt mist cyclic (sodium chloride NaCl solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Storage duration:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% rel. humidity<br>22 h per cycle<br>3<br>Unit not operating |

*Table 18: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Standard operational ambient temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –25 | 71 | °C |
| $T_A$ | Extended operational ambient temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 71 | |
| $T_C$ | Standard operational case temperature range -7, overtemp. lock-out (PTC) at $T_C$ > 95°C | –25 | 95 | |
| $T_C$ | Extended operational case temperature range -9, overtemp. lock-out (PTC) at TC > 95°C | –40 | 95 | |
| $T_S$ | Storage temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 100 | |
| $T_S$ | Extended storage temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –55 | 100 | |

### Thermal Considerations

Operation at ambient temperatures of 71...85°C with convection cooling will limit the maximum output power to 40% (approx.) of the nominal value. Forced cooling (additional heat sink, fan, etc.) allows operation of the power supply at nominal output power up to an ambient temperature of 85°C, as long as the maximum case temperature $T_{C\,max}$ (95°C) is not exceeded. The case temperature measuring point is shown on fig. 31.

In applications where modules operate in parallel, option T (current sharing) should be used.

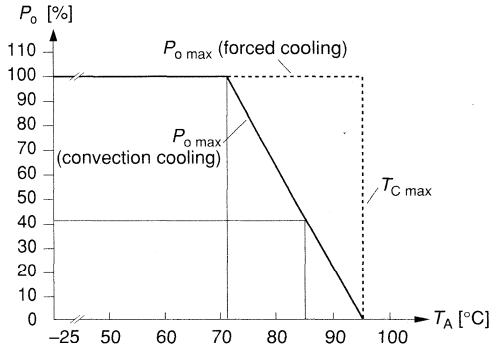


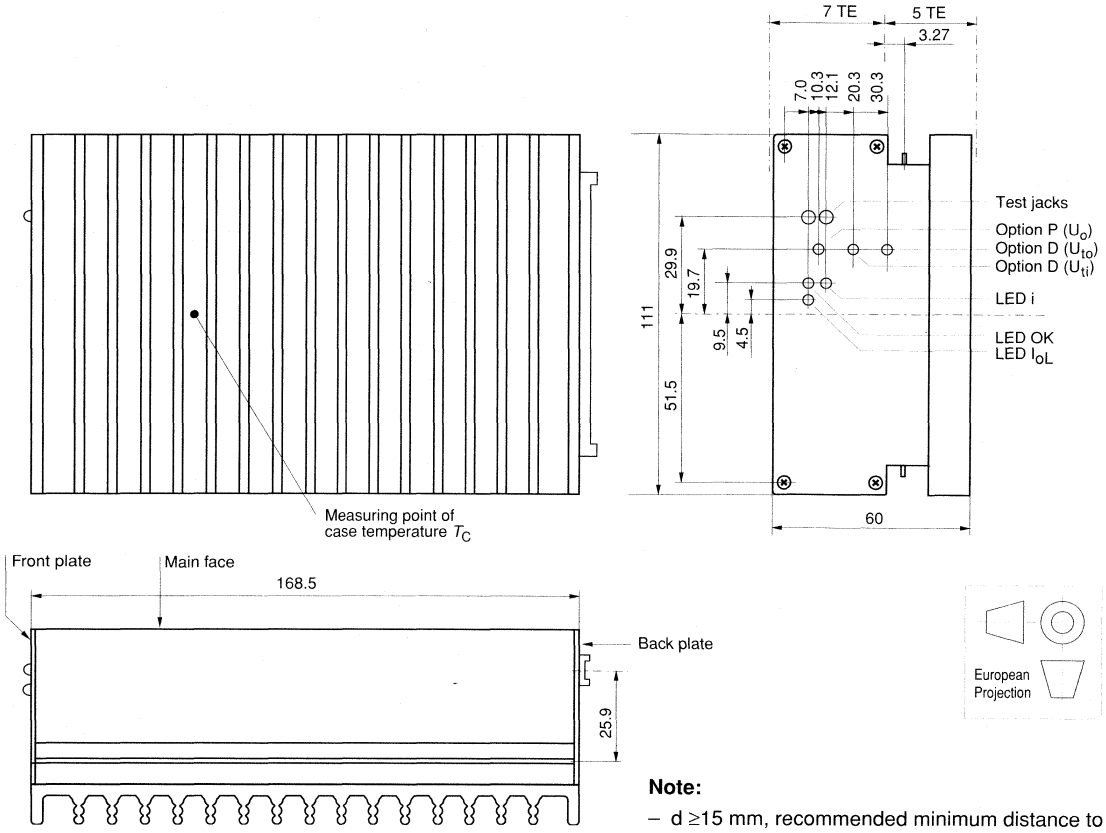

*Fig. 30*
*Output power derating versus $T_A$*

*Table 19: MTBF*

| Values at Specified Case Temperature | Type | Ground Benign 40°C | Ground Fixed 40°C | Ground Fixed 70°C | Ground Mobile 50°C | Unit |
|---|---|---|---|---|---|---|
| MIL-HDBK 217F | LS 1000/2000 | 500'000 | 150'000 | 80'000 | 50'000 | h |

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.




**Note:**

- d ≥15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power.
- free air locations: the module should be mounted with fins in vertical position to achieve a maximum air flow through heat sink.

*Fig. 31*
*Case K02 with heatsink*
*Total weight: Approx. 1.55 kg*

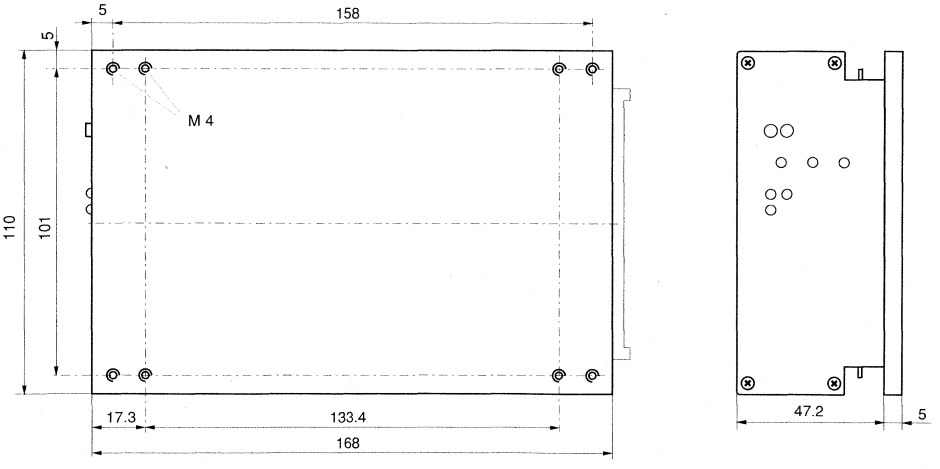
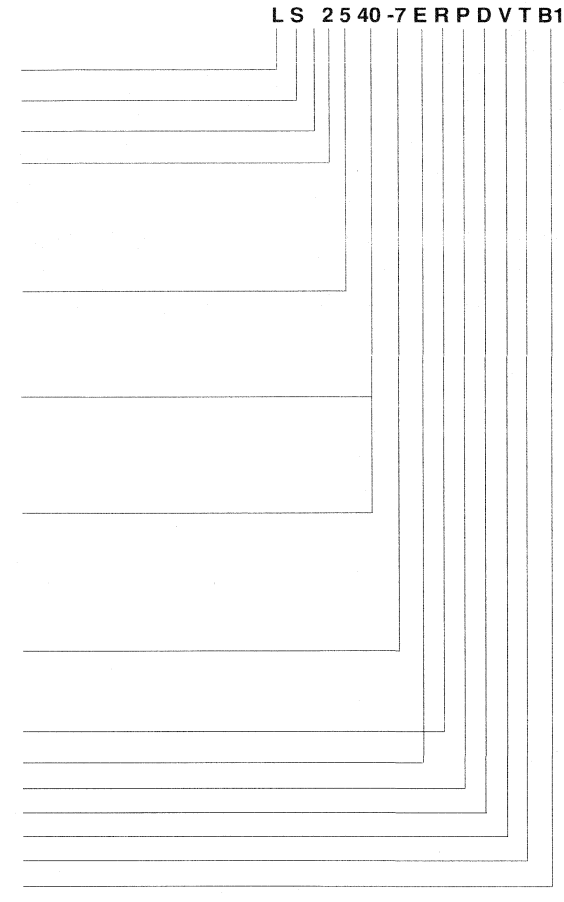



*Fig. 32*
*Case K02 with option B1 (cooling plate)*
*Total weight: Approx. 1.15 kg*


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## Type Key and Product Marking

### Type Key




Input voltage range $U_i$:
85...264 V AC (88...372 V DC) . L

Family ..... S

Blank .....

Number of outputs ..... 1...2

Single output units:
Nominal voltage output 1 (main output), $U_{o1\ nom}$
5.1 V ..... 0, 1, 2
12 V ..... 3
15 V ..... 4, 5
24 V ..... 6
other voltages ..... 7, 8

Other specifications for
single output modules ..... 01...99

Symmetrical double output units:
Nominal voltage output 1/output 2, $U_{o1/2\ nom}$
12 V/12 V [1] (24 V series conn. [2]) ..... 20
5 V/15 V [1] (30 V series conn. [2]) ..... 40
24 V/24 V [1] (48 V series conn. [2]) ..... 60
other symmetrical voltages ..... 70...99

Operational ambient temperature range $T_A$:
–25...50 °C ..... -5
–25...60 °C ..... -6
–25...71 °C ..... -7
–40...71 °C (optional) ..... -9
customer specific ..... -0

Feature: Output voltage control input [3] ..... R

Options: Inrush current limitation ..... E
Potentiometer (output voltage adjustment) [3] ... P
Save data signal (D0...DD, to be specified) [4] . D
ACFAIL signal (V0, V2, V3, to be specified) [4] . V
Current sharing ..... T
Cooling plate ..... B1

[1] External wiring of main and second output depending upon the desired output configuration (see fig. 16b, c, d or e).
[2] External wiring of main and second output (see fig.16a).
[3] Feature R excludes option P and vice versa.
[4] Option D excludes option V and vice versa.

Example: LS 2540-7PD3: AC-DC converter, input voltage range 85...264 V AC, double output, each providing 15 V/3.2 A, equipped with potentiometer and undervoltage monitor option.

### Product Marking

Main face: Basic type designation, applicable safety approvals and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LED's, test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltages and output currents, pin allocation of options and auxiliary functions, fuse specification and degree of protection.

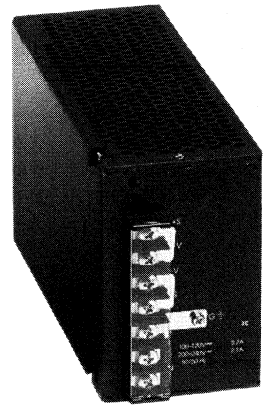
Label: Batch No., serial No. and data code including production site, modification status of main PCB and date of production.

# 70 W AC-DC Converters

# VEW-Family

**Single output**

- 110 V AC and 230 V AC input (auto select)
- 3750 $V_{rms}$ input to output isolation
- Wide power range up to 2 • $P_{o\,nom}$ temporarily
- Excellent line/load regulation
- High level of electromagnetic compatibility
- Safety standards: UL, CSA and TUV approved



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## Type Survey

*Table 1: Type survey*

| Output $U_{o\,nom}$ V DC | Output $I_{o\,nom}$ A | Input voltage range $U_{i\,min}$...$U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 71 °C | Type designation |
|---|---|---|---|---|
| 5 | 14.0 | 85...132 V AC/47...440 Hz | 70 W | VEW 70-5 |
| 12 | 5.83 | or | | VEW 70-12 |
| 15 | 4.67 | 170...265 V AC/47...440 Hz | | VEW 70-15 |
| 24 | 2.92 | 230...330 V DC | | VEW 70-24 |
| 48 | 1.46 | auto select | | VEW 70-48 |

## Description

The VEW series of switching power supplies is a single output series of AC-DC converters. Compact size and high reliability make the VEW series an excellent choice when a compact design is required. Five standard single output ratings are available.

**Key applications**

Factory automation, off-site test and measurement, and communications equipment.

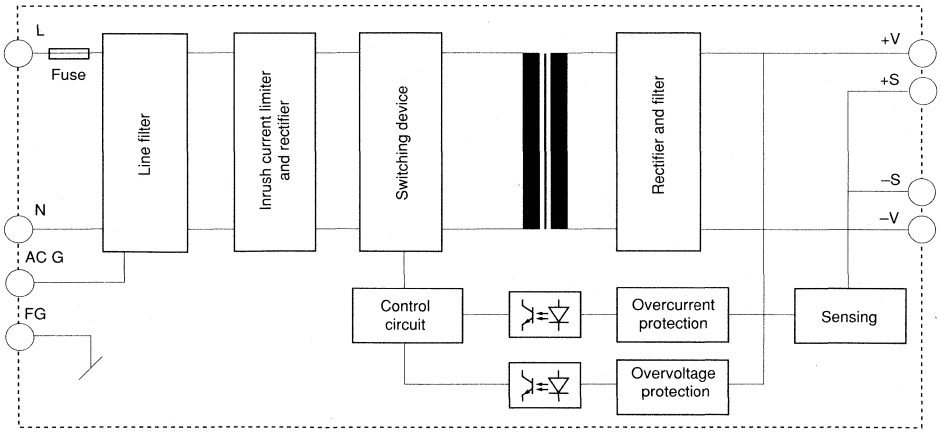



*Fig. 1:*
*Block diagram VEW 70*

## Electrical Input and Output Data

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | VEW 70- .. | Unit |
|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 100/200 | V AC |
| $U_i$ | Input voltage range | | 85...132/170...265 [1] | |
| | | | 230...330 [1] | V DC |
| $f_i$ | Line frequency | | 47...440 | Hz |
| $I_i$ | Input current [2] | typ. | 1.8/3.6 | A |
| $I_{inr}$ | Inrush current | max. | 14/28 | |
| $I_{i\ leak}$ | Leakage current [2] | max. | 0.25/0.5 | mA |

[1] Auto selected, [2] At rated input and output

*Table 3: Output data*

| Type | | | VEW 70-05 | VEW 70-12 | VEW 70-15 | VEW 70-24 | VEW 70-48 | |
|---|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | | Unit |
| $U_{o\ nom}$ | Output voltage | nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\ adj}$ | Adjustable voltage range | | ±10 | | | | | % |
| $I_{o\ nom}$ | Rated output current | | 14.0 | 5.83 | 4.67 | 2.92 | 1.46 | A |
| $I_o$ | Output current range | min./max. | 0...200 | | | | | % |
| $u_o$ | Ripple-noise [1] | max. | 150 | 200 | 200 | 250 | 250 | mVpp |
| $\Delta U_{o\ U}$ | Line regulation | $U_{i\ min}$...$U_{i\ max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\ I}$ | Load regulation | 0...100% | ±0.8 | | | | | |
| $\alpha u_o$ | Temperature coefficient | max. | ±1.5 | | | | | |
| $I_{o\ L}$ | Overcurrent protection [2] | | 260 | | | | | |
| $U_{o\ L}$ | Overvoltage protection [3] | | 5.75...6.75 | 13.8...16.2 | 17.2...20.2 | 27.6...32.4 | 55.2...64.8 | V |
| $t_{Uo\ r}$ | Rise time [1] | typ. | 150 | | | | | ms |
| $t_h$ | Hold-up time [1] | typ. | 20 | | | | | |
| $\eta$ | Effciency [1] | typ. | 78 | 80 | 80 | 82 | 84 | % |
| +S/–S | Remote sensing | | provided | | | | | |
| | Output indicator | | LED | | | | | |
| | Outputs connected in series | | possible | | | | | |
| | Outputs connnected in parallel | | not possible | | | | | |

[1] At rated input and output
[2] Foldback current method, automatic recovery
[3] Shut down of output. Turn-on by brief removal of the input voltage

## Operation Instructions

### AC Input Voltage Range Selection

The AC or DC input voltage will be detected and automatically selected by means of the internal circuitry.

### Output Power Rating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 2. If the power supply is used at an ambient temperature of 0...50 °C, the output power may be increased up to 200% of the rated value.

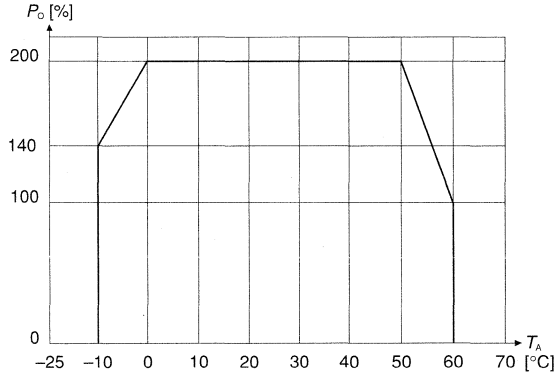



*Fig. 2:*
*Output power vs. ambient temperature*

### Output Voltage Adjustment

The output voltage may be adjusted within ±10% of $U_{o\ nom}$ by means of the internal potentiometer. If the output voltage setting should be excessively high, the overvoltage protection circuit may shut-down the output.

### Sense Lines (S)

Remote sensing provides compensation of voltage drops between power supply and load, caused by connectors and load feeding wires. The sense lines should consist of shielded cables or be twisted. If remote sensing is not reqiured, the +S should be connected to the +V and the –S to the –V terminals respectively applying shortest possible links. The compensation range is 10% of $U_{o\ nom}$.

### Output Overvoltage Protection

If the built-in overvoltage protection circuit becomes active, the output is shut down and a reset can only be achieved by brief removal of the input voltage after a minimum interval time.

### Output Overload Protection

An overload condition at the output will cause the protection cicuit to turn into its foldback characteristic. After removal of overload, the unit will return to normal operation automatically.

### Outputs Connected in Series

Two or more units supplying the same or different output voltages may be connected in series. The value of the maximum output current to be taken is defined by that unit providing the lowest current limiting value. It should be assured that the outputs do not feed backwards into each other caused by their different rise/fall times at switch-on/off cycles by adding reverse polarity diodes across each output.

### Outputs Connected in Parallel

Parallel connection of several identical modules is not possible.

### Grounding Recommendations

A single power supply should be wired to the AC input by interconnecting the ACG (AC Ground) terminal with the FG (Frame Ground) terminal and both together to the protective earth.

With several modules connected in parallel, EMC and leakage currents in accordance with safety standard recommendations may no longer be met. In such cases, an external noise filter should be added in order to minimize RFI noise and to avoid summarization of the individual leakage currents caused by each module's filter. Therefore the ACG terminals (AC Ground) should not be connected. The FG terminals (Frame Ground) but have to be connected directly to the protective earth (see fig. 3).

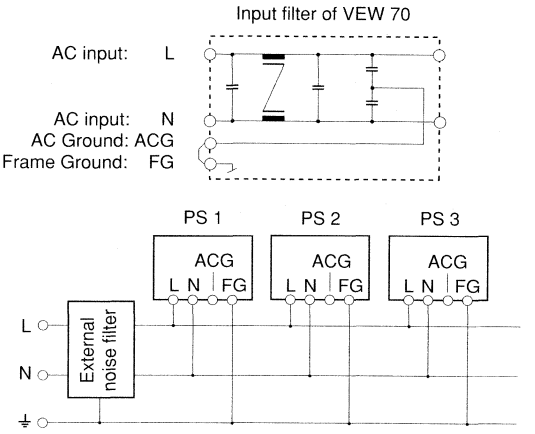



*Fig. 3:*
*Block diagram of input filter and input wiring of parallel connected modules using an external noise filter*

9.2

## Input and Output Terminals

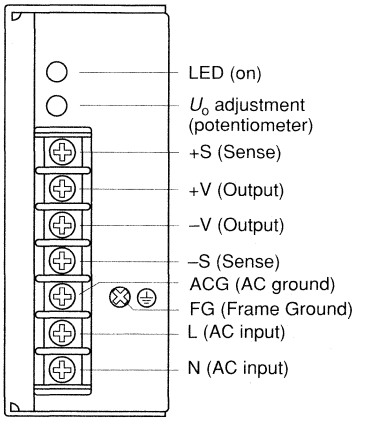



*Fig. 4:*
*Terminal designation of VEW 70 types*

## Immunity to Environmental Conditions

*Table 6: Mechanical Stress, Impulse Votages, High Frequency Disturbances,*

| Test Method | Test conditions | | Status |
|---|---|---|---|
| Damp heat steady state | Temperature:<br>Relative himidity: | 40 $^{\pm 2}$ °C<br>30...90 $^{-3/+2}$ % | Operating |
| Shock (half-sinusoidal) | Acceleration amplitude: | 20 $g_n$ = 981 m/s$^2$ | Operating |
| Vibration (sinusoidal) | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...55 Hz<br>constant<br>2 $g_n$ = 49 m/s$^2$<br>3 h (1 h each axis) | Operating |
| Electrostatic discharge | | 15 kV | Not operating |
| Electrical fast transient | | 2 kV (50...100 µs) | Operating |
| Surge immunity | | 5 kV (1,2/50 µs; 3 times) | Operating |
| Damped oscillating wave (IEEE 472) | | 2.5 kV (50/sec; 1 MHz; 150 Ω) | Operating |

*Table 7: Temperature*

| Characterisitcs | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | –10 | 60 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –10 | 85 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 85 | |

*Table 6: MTBF Values*

| MTBF | Ground Benign |
|---|---|
| MTPF according to MIL-HDBK-217D | $T_C$ = 40°C |
| VEW 70 types | 106'000 h |

*Table 9: Isolation*

| Test | Input to output | Input to case | Output to case | Unit |
|---|---|---|---|---|
| Electric strenght test voltage (1 min) | 3750 | 2500 | 500 | V AC |
| Isolation resistance (500 V DC) | >100 | >100 | >100 | MΩ |

*Table 10: Electromagnetic Emmission*

| Standard | Maintained level |
|---|---|
| VDE 0871 | <A |
| FCC 20880 (VCCI) | <A |

*Table 11: Safety Approvals*

| Safety Approvals | UL 478 | CSA [1] | TÜV |
|---|---|---|---|
| VEW 70-5...VEW 70-24 | x | level 3 | x |
| VEW 70-48 | x | level 1 | x |

[1] C 22.2 No. 0-M 1982

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

European Projection

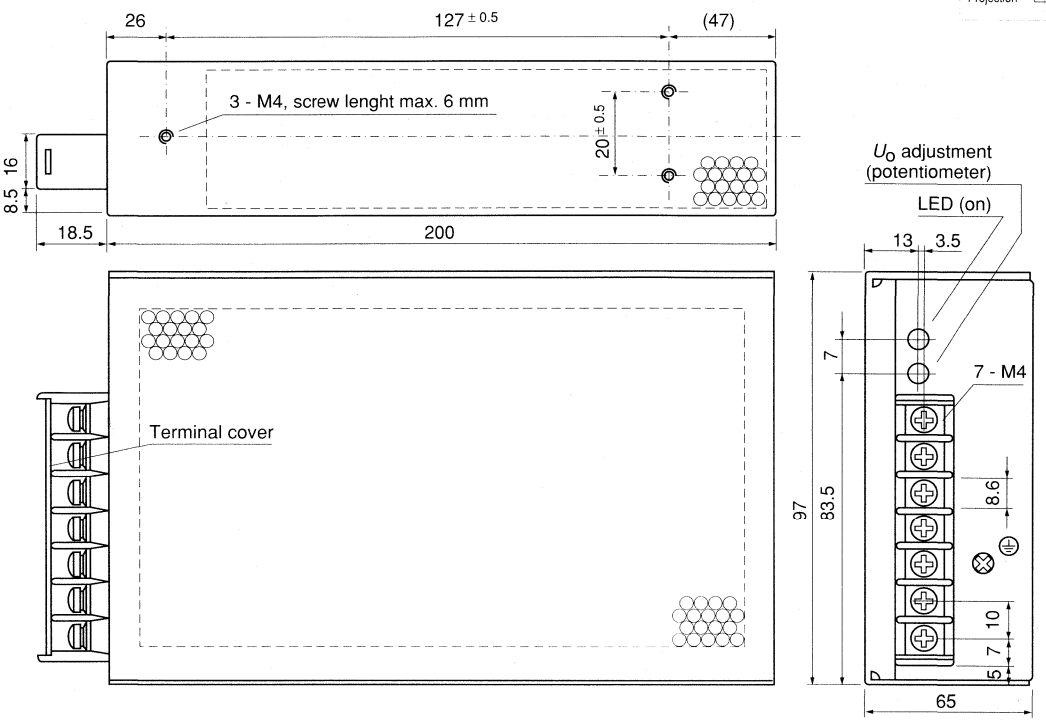



*Fig. 5*
*VEW 70, weight 1000 g*

9.2

## Type Key and Product Marking

**Type Key**

| | |
|---|---|
| Family | VEW |
| Blank | |
| Nominal output power [W] | 70 |
| Dash | |
| Nominal output voltage [V] | 5...48 |

VEW 70 - 12

Example: VEW 70-12 = AC-DC converter providing 12 V/5.83 A, 70 W output.

**Produkt Marking**

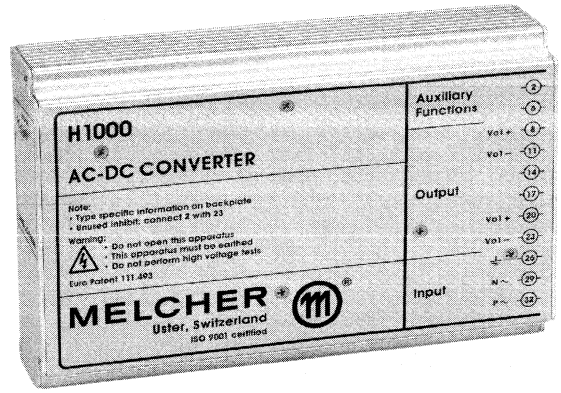
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# 50 W AC-DC Converters

# H-Family

**Single output: series 110H/230H1000**
**Dual output: series 110H/230H2000**
**Triple output: series 110H/230H3000**

- Two input voltage ranges suitable for most AC mains
- Efficient input filter and built-in surge and transient suppression circuitry
- 3 $kV_{rms}$ input to output electric strength test
- Outputs individually isolated and controlled
- Outputs fully protected against overload
- Safety in accordance with IEC 950/EN 60950




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## Description

The H-family of AC-DC converters represents a broad and flexible range of power supplies for use in advanced electronic systems. Features include high efficiency, reliability and reasonable output voltage noise.

The converter inputs are protected against surges and transients occuring on the source lines. Input over- and undervoltage cut-out circuitry disables the outputs if the input voltage is outside the specified range.

All outputs are open- and short-circuit proof and are protected against overvoltages by means of built-in suppressor diodes. The outputs can be inhibited by a logic signal applied to the connector pin i. If the inhibit function is not used pin 2 should be connected with pin 23 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case and output to output isolation is provided. The modules are designed and built according to the international safety standard IEC 950.

The case design allows operation at nominal load up to 50°C in a free air ambient temperature. If forced cooling is provided, the ambient temperature may exceed 50°C but the case temperature should remain below 80°C under all conditions.

A temperature sensor generates an inhibit signal which disables the outputs if the case temperature $T_C$ exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Case: aluminium, blank, self cooling.
Dimensions: 38.7 × 111.2 × 168.5 mm. Weight: 770 g

## Type Survey

**Options see "Descriptions of Options"**

*Table 1: Type survey*

| Output 1 | Output 2 | Output 3 | Input Voltage Range and Efficiency [1] | | | | Option |
|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ $I_{o\,nom}$ V DC A | $U_{o\,nom}$ $I_{o\,nom}$ V DC A | $U_{o\,nom}$ $I_{o\,nom}$ V DC A | $U_{i\,min}$...$U_{i\,max}$ **85...132 V AC 47...63 Hz** | $\eta_{min}$ % | $U_{i\,min}$...$U_{i\,max}$ **187...255 V AC 47...63 Hz** | $\eta_{min}$ % | |
| 5.1 8.0 | | | 110H1001-2R | 69 | 230H1001-2R | 71 | V2, V3 |
| 12.0 4.0 | | | 110H1301-2R | 75 | 230H1301-2R | 77 | D1...D8 |
| 15.0 3.4 | | | 110H1501-2R | 74 | 230H1501-2R | 76 | |
| 24.0 2.0 | | | 110H1601-2R | 77 | 230H1601-2R | 79 | |
| 48.0 1.0 | | | 110H1901-2R | 77 | 230H1901-2R | 79 | |
| 12.0 2.0 | 12.0 2.0 | | 110H2320-2 | 73 | 230H2320-2 | 75 | |
| 15.0 1.7 | 15.0 1.7 | | 110H2540-2 | 74 | 230H2540-2 | 76 | |
| 5.1 5.0 | 12.0 0.7 | 12.0 0.7 | 110H3020-2 | 69 | 230H3020-2 | 71 | |
| 5.1 5.0 | 15.0 0.6 | 15.0 0.6 | 110H3040-2 | 67 | 230H3040-2 | 69 | |

Universal input voltage range on request.

1 Efficiency measured at $U_{i\,nom}$ and $I_{o\,nom}$

## Safety and Installation Instructions

### Safety

For safety reasons, the modules must be wired via the female connector H11 (according to DIN 41612) in order to meet national and international safety requirements!

All converters fully comply with IEC 950, EN 60950, UL 1950 and CSA/C22.2 No. 950-M89 standards. The connector protective earthing pin is leading. During the production process, all transformers and each of the fully assembled modules are individually tested for electric strength and earth continuity (see table 10). All electric strength tests are performed as factory tests.

### Installation

Installation of the power supply must strictly follow the national safety regulations. To observe the safety requirements according to EN 60950/IEC 950, the module shall be connected via the female connector type H11. Other installation methods may not meet the safety requirements. The modules do not incorporate any fuse(s). (An) external fuse(s) installed in the wiring to the input is essential!

Whenever the inhibit function is not required, pin 2 should be connected to pin 23 to enable the output(s).

### Important Advice

Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/µs, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher AG will not honour any guarantee/warranty claims resulting from high voltage field tests.

*Table 2: H11 connector pin allocation*

| Electrical Determination | H1000 | | H2000 | | H3000 | |
|---|---|---|---|---|---|---|
| | Pin | Ident | Pin | Ident | Pin | Ident |
| Inhibit control input | 2 | i | 2 | i | 2 | i |
| Safe Data or ACFAIL | 5 | D or V | 5 | D or V | 5 | D or V |
| Output voltage (positive) | 8 | Vo1+ | 8 | | 8 | Vo3+ |
| Output voltage (negative) | 11 | Vo1– | 11 | | 11 | Vo3– |
| Control input + | 14 | R | | | | |
| Control input – | 17 | G | | | | |
| Output voltage (positive) | | | 14 | Vo2+ | 14 | Vo2+ |
| Output voltage (negative) | | | 17 | Vo2– | 17 | Vo2– |
| Output voltage (positive) | 20 | Vo1+ | 20 | Vo1+ | 20 | Vo1+ |
| Output voltage (negative) | 23 | Vo1– | 23 | Vo1– | 23 | Vo1– |
| Protective earthing [1] | 26 | ⏚ | 26 | ⏚ | 26 | ⏚ |
| AC input voltage | 29 | N~ | 29 | N~ | 29 | N~ |
| AC input voltage | 32 | P~ | 32 | P~ | 32 | P~ |

1 Leading pin (pregrounding)

### Degree of Protection

Condition: Female connector fitted to the unit

IP 40: All units, except those with options D or V incorporating potentiometer adjustment.

IP 20: Type fitted with options D or V incorporating potentiometer.

## Functional Description

The input voltage is fed via an input filter and bridge rectifier to the input capacitor. This capacitor sources a single transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke. The control logic senses the main output voltage $U_{o1}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor. This signal is fed back via a coupling transformer.

The auxiliary outputs $U_{o2}$ and $U_{o3}$ are unregulated. Each auxiliary output's current is sensed using a current transformer. If one of the outputs is driven into current limit, the other outputs will reduce their output voltages as well because all output currents are controlled by the same control circuit.

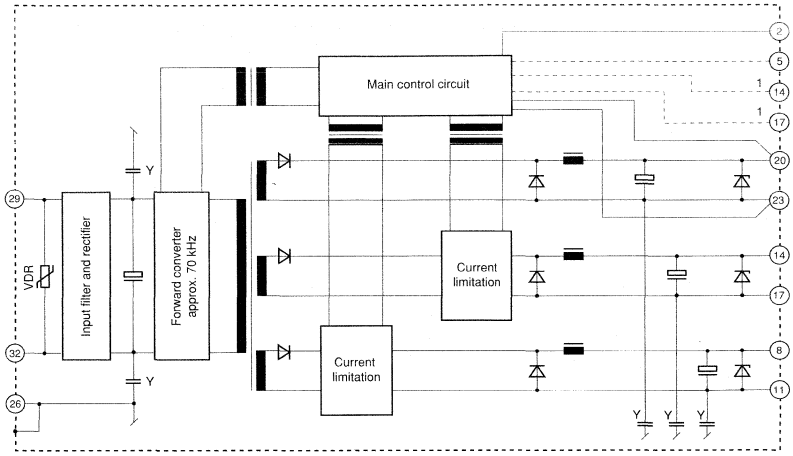



*Fig. 1*
*AC-DC converter block diagram, class I equipment*

[1] Single output modules H1000

## Electrical Input Data

General conditions:
– $T_A$ = 25°C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, R input not connected.

*Table 3: Input data*

| Input | | | 110H | | | 230H | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0…$I_{o\,nom}$ | 85 | | 132 | 187 | | 255 | V AC |
| $U_{i\,nom}$ | Nominal input voltage | $T_{C\,min}$…$T_{C\,max}$ | | 110 | | | 230 | | |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 0.78 | | | 0.44 | | $A_{rms}$ |
| $S_{i\,0}$ | No-load apparent input power: | $U_{i\,nom}$ | | | | | | | VA |
| | Single output | $I_{o1,2,3}$ = 0 | | 1 | 1.5 | | 1 | 1.5 | |
| | Double output | | | 7 | 9 | | 7 | 9 | |
| | Triple output | | | 7 | 9 | | 7 | 9 | |
| $S_{i\,inh}$ | Idle apparent input power | inhibit mode | | | 2.5 | | | 2.5 | |
| $I_{inr\,p}$ [3] | Peak inrush current | $U_i$ = $U_{i\,max}$ | | | 240 | | | 460 | A |
| $t_{inr\,r}$ | Rise time | $R_S$ = 0 Ω [2] | | 30 | | | 30 | | µs |
| $t_{inr\,h}$ | Trailing edge half-life | $T_C$ = 25°C | | 370 | | | 120 | | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 800 | | | 800 | | | mΩ |
| $C_i$ | Input capacitance | | 250 | | 570 | 50 | | 270 | µF |
| $U_{i\,abs}$ | Input voltage limits without any damage | | 0 | | 142 | 0 | | 284 | V AC |

[1] With multiple output modules, the same condition for each output applies. [2] $R_S$ = source resistance. [3] $I_{inr\,p} = U_i/(R_s + R_i)$

### Input Under-/Overvoltage Cut-out

If the input voltage remains below 0.6 $U_{i\,min}$ or exceeds 1.1 $U_{i\,max}$ (approx. values), an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ must be carefully considered (see table 5).

## Electrical Output Data

General conditions
– $T_A$ = 25°C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, R input not connected.

*Table 4a: Output data*

| Output | | $U_{o\,nom}$ | 5.1 V | | | 12 V | | | 15 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_{o1}$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [1] | 5.00 | | 5.20 | 11.76 | | 12.24 | 14.70 | | 15.30 | V |
| $U_{o2/3}$ | | | | - | | 11.40 | | 12.60 | 14.25 | | 15.75 | |
| $U_{o\,L}$ | Overvoltage prot. | $I_{o\,nom}$ | | 7.5 | | | 20 | | | 24 | | |
| $I_{o\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | see table 1 | | | | | | | | | |
| $I_{o\,L}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | see fig. 2 | | | | | | | | | |
| $u_{o1/2/3}$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | | 50 | | | 120 | | | 150 | $mV_{rms}$ |
| | | BW = 20 MHz | | | 200 | | | 360 | | | 450 | $mV_{pp}$ |
| $\Delta U_{o1\,U}$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ | | ±20 | ±50 | | ±25 | ±120 | | ±30 | ±150 | mV |
| $\Delta U_{o2/3\,U}$ | | $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ [1] | | - | | | ±80 | ±240 | | ±100 | ±300 | |
| $\Delta U_{o1\,I}$ | Static load regulation | $U_{i\,nom}$ $I_o$ = $I_{o\,nom}$...0 [2] | | 15 | 50 | | 35 | 120 | | 45 | 150 | |
| $\Delta U_{o2/3\,I}$ | | $U_{i\,nom}$, $I_o$ = (1...0.1) $I_{o\,nom}$ [2 3] | | - | | | 400 | 800 | | 500 | 1000 | |
| $\Delta U_{o1\,Ic}$ | Static cross load | $U_{i\,nom}$ | | ±5 | ±15 | | ±10 | ±30 | | ±15 | ±45 | |
| $\Delta U_{o2/3\,Ic}$ | regulation [4] | $I_o$ = $I_{o\,nom}$...0 [5] | | - | | | –1100 | –1500 | | –1400 | –2000 | |

*Table 4b: Output data*

| Output | | $U_{o\,nom}$ | 24 V | | | 48 V | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | Unit |
| $U_{o1}$ | Output voltage | $U_{i\,nom}$, $I_{o1\,nom}$ | 23.52 | | 24.48 | 47.04 | | 48.96 | V |
| $U_{o\,L}$ | Overvoltage prot. | $I_{o1\,nom}$ | | 40 | | | 76 | | |
| $I_{o1\,nom}$ | Output current | $U_{i\,min}$...$U_{i\,max}$ | see table 1 | | | | | | |
| $I_{o\,L}$ | Output current limitation response | $T_{C\,min}$...$T_{C\,max}$ | see fig. 2 | | | | | | |
| $u_{o1}$ | Output voltage noise | $U_{i\,nom}$, $I_{o1\,nom}$ | | | 240 | | | 480 | $mV_{rms}$ |
| | | BW = 20 MHz | | | 720 | | | 1440 | $mV_{pp}$ |
| $\Delta U_{o1\,U}$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o1\,nom}$ | | ±30 | ±240 | | ±30 | ±480 | mV |
| $\Delta U_{o1\,I}$ | Static load regulation | $U_{i\,nom}$ $I_{o1}$ = $I_{o1\,nom}$...0 | | 70 | 240 | | 150 | 480 | |

[1] With multiple output modules, the same condition for each output applies.
[2] Condition for specified output. With multiple output modules, other output(s) loaded with constant current $I_o$ = $I_{o\,nom}$.
[3] At $I_{o2/3}$ = 0, $U_{o2/3}$ may rise to approx. $U_{o2/3\,nom}$ + 20%
[4] Condition for non-specified output, individually tested, other output(s) loaded with constant current $I_o$ = $I_{o\,nom}$.
[5] Multiple output modules.

### Output Protection

Each output is protected against overvoltages which could occur due to a failure of the internal control circuit. Voltage suppressor diodes (which under worst case condition may become a short circuit) provide the required protection. The suppressor diodes are not designed to withstand externally applied overvoltages. Overload at any of the outputs will cause a shut-down of all outputs.

### Parallel and Series Connection

Outputs of equal nominal voltage can be connected in parallel. It is important to assure that the main output of a multiple output module is forced to supply a minimum current of 0.1 A to enable correct operation of its own auxiliary outputs. Outputs one and two of a dual output unit may be connected parallel without a minimum current requirement at the main output.

In parallel operation, one or more of the outputs may operate continuously in current limit which will cause an increase in case temperature. Consequently, a reduction of the max. ambient temperature by 10 K is recommended.

Main or auxiliary outputs can be connected in series with any other output of the same or another module. In series, the maximum output current is limited by the lowest current limit. Output ripple and regulation values are added. Connection wiring should be kept as short as possible.

If output terminals are connected together in order to establish multi-voltage configurations, e.g. +5.1 V, ±12 V etc. the common ground connecting point should be as close as possible to the connector to avoid excessive output ripple voltages.

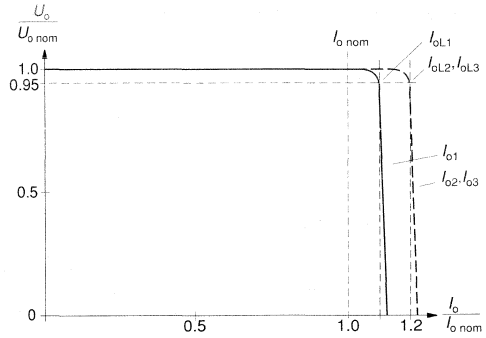



*Fig. 2*
*Typical output voltage $U_o$ versus output currents $I_o$*

### Inhibit (i Input)

The outputs of the module may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to the inhibit input. If the inhibit function is not required, connect the inhibit pin 2 to pin 23 to enable the outputs (active low logic, fail safe).

The reference for the inhibit signal is the negative pin of output 1.

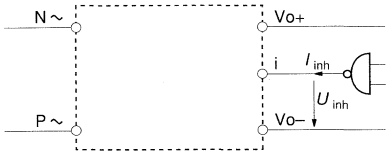



*Fig. 3*
*Definition of inhibit voltage and current*

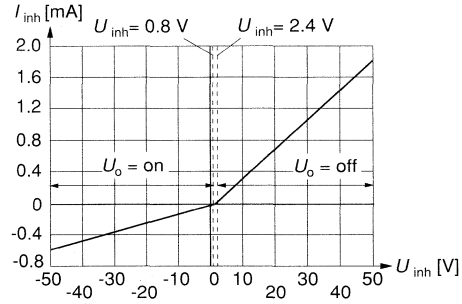



*Fig. 4*
*Typical inhibit current $I_{inh}$ versus inhibit voltage $U_{inh}$*

*Table 5: Inhibit data*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit input voltage causing | switched on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | 0.8 | V DC |
| | output voltage being... | switched off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = 0 | –60 | –100 | –220 | µA |

### Output Response

The reaction of the outputs is similar whether the input voltage is applied or the inhibit is switched low.

An output voltage overshoot will not occur when the module is turned on or off.

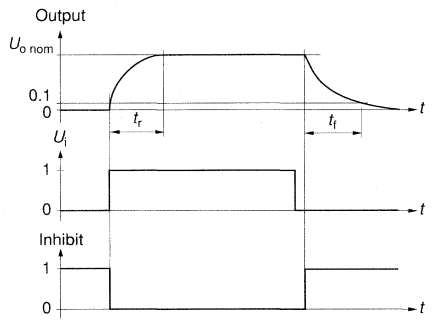



*Fig. 5*
*Output response as a function of input voltage (on/off switching) or inhibit control*

*Table 6: Output response time*

| Type of Converter | $t_r$ at $P_o = 0$ and $t_f$ at $P_o = P_{o\,nom}$ typ | max | $t_r$ and $t_f$ at $P_o = {}^3/_4\ P_{o\,nom}$ typ | max | $t_r$ at $P_o = P_{o\,nom}$ typ | max | Unit |
|---|---|---|---|---|---|---|---|
| H1001-2R | 3 | 17 | 3 | 17 | 5 | 25 | ms |
| H1301-2R | 5 | 25 | 8 | 30 | 10 | 40 | |
| H1501-2R | 3 | 17 | 5 | 25 | 15 | 50 | |
| H1601-2R | 8 | 30 | 15 | 45 | 20 | 70 | |
| H1901-2R | 35 | 100 | 50 | 150 | 85 | 230 | |
| H2320-2 | 10 | 40 | 15 | 50 | 25 | 80 | |
| H2540-2 | 8 | 30 | 10 | 40 | 20 | 60 | |
| H3020-2 | 30 | 85 | 45 | 130 | 75 | 210 | |
| H3040-2 | 20 | 70 | 30 | 90 | 50 | 150 | |

Conditions:
R input not used. For multiple output modules the figures indicated in the table above relate to the output which reacts slowest. All outputs are resistively loaded. Variation of the input voltage within $U_{i\,min}$...$U_{i\,max}$ does not influence the values.

### Programmable Voltage (R Input)

As a standard feature single output modules offer an adjustable output voltage indentified by letter R in the type designation. The control input R (pin 14) accepts either a control voltage $U_{ext}$ or a resistor $R_{ext}$ to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_o$ according to table 4a and 4b. The control input is protected against external overvoltage up to 8 V max.

a) Adjustment by means of an external control voltage $U_{ext}$ between pin 14 (R) and pin 17 (G):
The control voltage range is 0...2.75 V and allows an adjustment in the range of approximately
$U_o = 0...110\%\ U_{o\,nom}$.

$$U_{ext} \approx \frac{U_o}{U_{o\,nom}} \cdot 2.5\ V$$

b) Adjustment by means of an external resistor:
Depending upon the value of the required output voltage, the resistor shall be connected
**either:** Between pin 14 and pin 17 ($U_o < U_{o\,nom}$) to achieve an output voltage adjustment range of approx.
$U_o = 0...100\%\ U_{o\,nom}$

$$R_{ext} \approx 4\ k\Omega \cdot \frac{U_o}{U_{o\,nom} - U_o}$$

**or:** Between pin 14 and pin 20 ($U_o > U_{o\,nom}$) to achieve an output voltage adjustment range of approximately
$U_o = 100...110\%$ of $U_{o\,nom}$.

$$R'_{ext} \approx 4\ k\Omega \cdot \frac{(U_o - 2.5\ V)}{2.5\ V \cdot (U_o/U_{o\,nom} - 1)}$$

For output voltages $U_o > U_{o\,nom}$, the minimum input voltage according to "Electrical Input Data" increases proportionally to $U_o/U_{o\,nom}$.

### Warning

The value of $R'_{ext}$ should never be less than 47 kΩ to avoid damage to the unit! R inputs may be parallel connected, but $1/R_{tot} = 1/R_1 + 1/R_2 + ....$ should be considered.

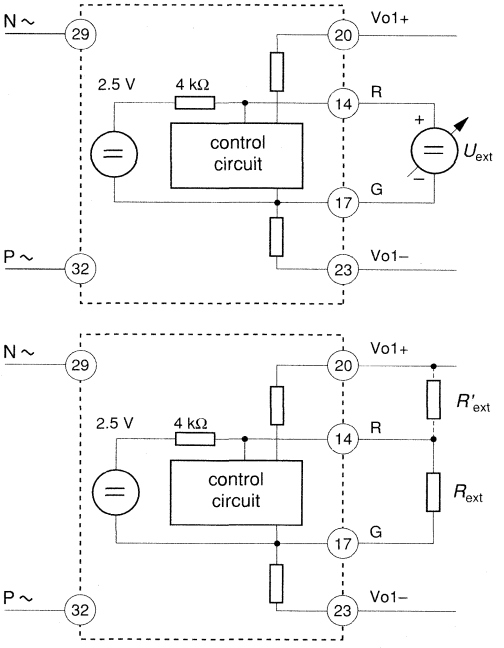



*Fig. 6*
*Output voltage control by means of the R input*

*Table 7a: $R_{ext}$ for $U_o < U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | $U_{o\,nom}$ = 15 V | | $U_{o\,nom}$ = 24 V | | $U_{o\,nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] | $U_o$ [V] | $R_{ext}$ [kΩ] |
| 0.5 | 0.432 | 2.0 | 0.806 | 2.0 | 0.619 | 4.0 | 0.806 | 8.0 | 0.806 |
| 1.0 | 0.976 | 3.0 | 1.33 | 4.0 | 1.47 | 6.0 | 1.33 | 12.0 | 1.33 |
| 1.5 | 1.65 | 4.0 | 2.0 | 6.0 | 2.67 | 8.0 | 2.0 | 16.0 | 2.0 |
| 2.0 | 2.61 | 5.0 | 2.87 | 8.0 | 4.53 | 10.0 | 2.87 | 20.0 | 2.87 |
| 2.5 | 3.83 | 6.0 | 4.02 | 9.0 | 6.04 | 12.0 | 4.02 | 24.0 | 4.02 |
| 3.0 | 5.76 | 7.0 | 5.62 | 10.0 | 8.06 | 14.0 | 5.62 | 28.0 | 5.62 |
| 3.5 | 8.66 | 8.0 | 8.06 | 11.0 | 11.0 | 16.0 | 8.06 | 32.0 | 8.06 |
| 4.0 | 14.7 | 9.0 | 12.1 | 12.0 | 16.2 | 18.0 | 12.1 | 36.0 | 12.1 |
| 4.5 | 30.1 | 10.0 | 20.0 | 13.0 | 26.1 | 20.0 | 20.0 | 40.0 | 20.0 |
| 5.0 | 200.0 | 11.0 | 44.2 | 14.0 | 56.2 | 22.0 | 44.2 | 44.0 | 44.2 |

*Table 7b: $R'_{ext}$ for $U_o > U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | $U_{o\,nom}$ = 15 V | | $U_{o\,nom}$ = 24 V | | $U_{o\,nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] | $R'_{ext}$ [kΩ] |
| 5.15 | 464 | 12.1 | 1780 | 15.2 | 1470 | 24.25 | 3160 | 48.5 | 6810 |
| 5.20 | 215 | 12.2 | 909 | 15.4 | 750 | 24.50 | 1620 | 49.0 | 3480 |
| 5.25 | 147 | 12.3 | 619 | 15.6 | 511 | 24.75 | 1100 | 49.5 | 2370 |
| 5.30 | 110 | 12.4 | 464 | 15.8 | 383 | 25.00 | 825 | 50.0 | 1780 |
| 5.35 | 90.9 | 12.5 | 383 | 16.0 | 332 | 25.25 | 715 | 50.5 | 1470 |
| 5.40 | 78.7 | 12.6 | 316 | 16.2 | 274 | 25.50 | 590 | 51.0 | 1270 |
| 5.45 | 68.1 | 12.7 | 274 | 16.4 | 237 | 25.75 | 511 | 51.5 | 1100 |
| 5.50 | 61.9 | 12.8 | 249 | 16.5 | 226 | 26.00 | 453 | 52.0 | 953 |
| | | 13.0 | 200 | | | 26.25 | 402 | 52.5 | 845 |
| | | 13.2 | 169 | | | 26.40 | 383 | 52.8 | 806 |

## EMC and Immunity to Input Transients

A metal oxide VDR together with an input filter form an effective protection against input transient voltages which typically occur in most installations. The H-Family has been successfully tested to the following specifications:

### Electromagnetic Immunity

*Table 8: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [3] | Value applied | Waveform | Source impedance | Test procedure | In operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Electrostatic discharge | IEC 801-2 (1991-04) | 2 | contact discharge to case, | 4000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative | yes | [2] |
| Electric field | IEC 801-3 (1984) | 2 | antenna in 1m distance | 3 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | [2] |
| Fast transient/ burst | IEC 801-4 (1988) | 1 | i/c, +i/–i | 500 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | [2] |
| Transient | IEC 801-5 (Draft 1993-01) | 1 | i/c | 500 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | [1] |
| | | | +i/–i | 500 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] i = input, o = output, c = case

### Electromagnetic Emissions

*Table 9: Emissions at $U_{i\ nom}$ and $I_{o\ nom}$*

| Standard | | | |
|---|---|---|---|
| EN 55011, 1991 [1] EN 55022, 1987 [2] | | FCC: 47 CFR 15.xx 15.107 | 15.103 |
| ≤30 MHz | ≥30 MHz | ≤30 MHz | ≥30 MHz |
| <A | <A | <A | <A |

[1] Identical with CISPR 11 (1990-09) and VDE 0875 part 11 (1992-07)
[2] Identical with CISPR 22 (1985) and VDE 0878 part 3 (1989-11)

## Supplementary Data

### Isolation

Input to output electric strength tests, in accordance with the safety standards IEC 950, EN 60950, VDE 0805 and EN 41003 are performed as factory tests and should not be repeated in the field.

### Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 1). Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests. Reference is also made to chapter: "Safety and Installation Instructions".

*Table 10: Electric strength test voltage, insulation resistance, clearance and creepage distances*

| Characteristic Values according to IEC 950 | | Input to output | Input to case | Output to case | Output to output | Unit |
|---|---|---|---|---|---|---|
| Electric strength | DC: 1 s | 4243 [1] | 2122 | 707 | 300 | V |
| test voltage | AC: 50 Hz, 1 min | 3000 [1] | 1500 | 500 | 200 | |
| Insulation resistance | at 500 V DC | ≥300 | ≥300 | ≥100 | – | MΩ |
| Clearance and creepage distances | | 4.0 | 2.0 | 1.0 | 0.9 | mm |

[1] Only subassemblies performance in accordance with IEC 950

### Display Status of LEDs

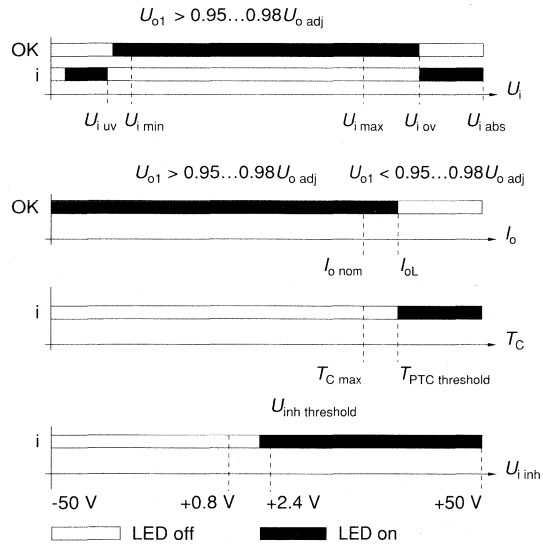



*Fig. 7*
*LEDs "OK" and "i" status versus input voltage*
*Conditions: $I_o \le I_{o\ nom}$, $T_C \le T_{C\ max}$, $U_{inh} \le 0.8$ V*
*$U_{i\ uv}$ = undervoltage lock-out, $U_{i\ ov}$ = overvoltage lock-out*

*LED "OK" status versus output current*
*Conditions: $U_{i\ min}$...$U_{i\ max}$, $T_C \le T_{C\ max}$, $U_{inh} \le 0.8$ V*

*LED "i" versus case temperature*
*Conditions: $U_{i\ min}$...$U_{i\ max}$, $I_o \le I_{o\ nom}$, $U_{inh} \le 0.8$ V*

*LED "i" versus $U_{inh}$*
*Conditions: $U_{i\ min}$...$U_{i\ max}$, $I_o \le I_{o\ nom}$, $T_C \le T_{C\ max}$*




MELCHER ISO 9001 certified

## Description of Options

*Table 11: Survey of options*

| Option | Function of Option | Characteristic |
|---|---|---|
| –2 | Standard operational ambient temperature range | $T_A$ = 0...50 °C |
| R | R input for external output voltage programming | Adjustment range 0...110% of $U_{o\,nom}$ (single output modules) |
| D [1] | Input and/or output undervoltage monitoring circuitry | Safe data signal output (D1...D8) |
| V [1 2] | Input and output undervoltage monitoring circuitry | ACFAIL signal according to VME specifications ( V2, V3) |

[1] Option D excludes option V and vice versa
[2] Only available with main output voltage $U_{o1}$ = 5.1 V

### Option D

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1– (pin 23). The D output recovers when the monitored voltage(s) exceed(s) $U_t$+$U_h$. The threshold level $U_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D1...D8 as shown in the following table.

*Table 12: Undervoltage monitor functions*

| Output type JFET | Output type NPN | Monitoring $U_i$ | Monitoring $U_{o1}$ | Minimum adjustment range of threshold level $U_{t\,i}$ | Minimum adjustment range of threshold level $U_{t\,o}$ | Typical hysteresis for $U_{t\,min}$...$U_{t\,max}$ [% of $U_t$] $U_{h\,i}$ | Typical hysteresis for $U_{t\,min}$...$U_{t\,max}$ [% of $U_t$] $U_{h\,o}$ |
|---|---|---|---|---|---|---|---|
| D1 | D5 | no | yes | – | 3.5 V...48 V [1] | – | 2.3...1 |
| D2 | D6 | yes | no | $U_{i\,min}$...$U_{i\,max}$ [1] | – | 3.0...0.5 | – |
| D3 | D7 | yes | yes | $U_{i\,min}$...$U_{i\,max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| D4 | D8 | no | yes | – | 0.95...0.98 $U_{o1}$ [2] | – | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications)
[2] Fixed value between 95% and 98% of $U_{o1}$ (tracking)

JFET output (D1...D4):

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $U_D \leq 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) < $U_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1}$ < $U_t$ | low, L, $U_D \leq 0.4$ V at $I_D$ = 2.5 mA |
| $U_i$ and $U_{o1}$ > $U_t$ + $U_h$ | high, H, $I_D \leq 25$ µA at $U_D$ = 5.25 V |

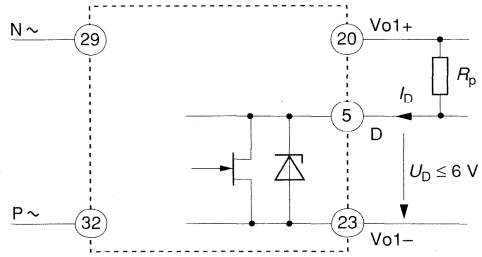



*Fig. 8*
*Options D1...D4, JFET output*

NPN output (D5...D8):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D$ < 0.4 V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) > $U_t$ + $U_h$. The current $I_D$ through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. $U_D$ should not exceed 40 V.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1}$ < $U_t$ | high, H, $I_D \leq 25$ µA at $U_D$ = 40 V |
| $U_i$ and $U_{o1}$ > $U_t$ + $U_h$ | low, L, $U_D \leq 0.4$ V at $I_D$ = 20 mA |

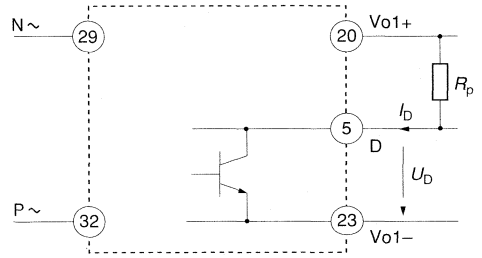



*Fig. 9*
*Options D5...D8, NPN output*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage after the input filter and rectifier is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{ti}$ across the input filter. The value of $\Delta U_{ti}$ depends upon the input voltage range, threshold level $U_t$, temperature and input current. The input current is a function of the input voltage and the output power.

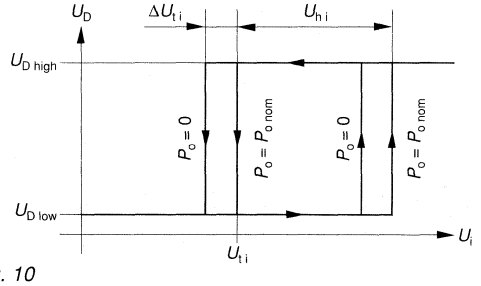
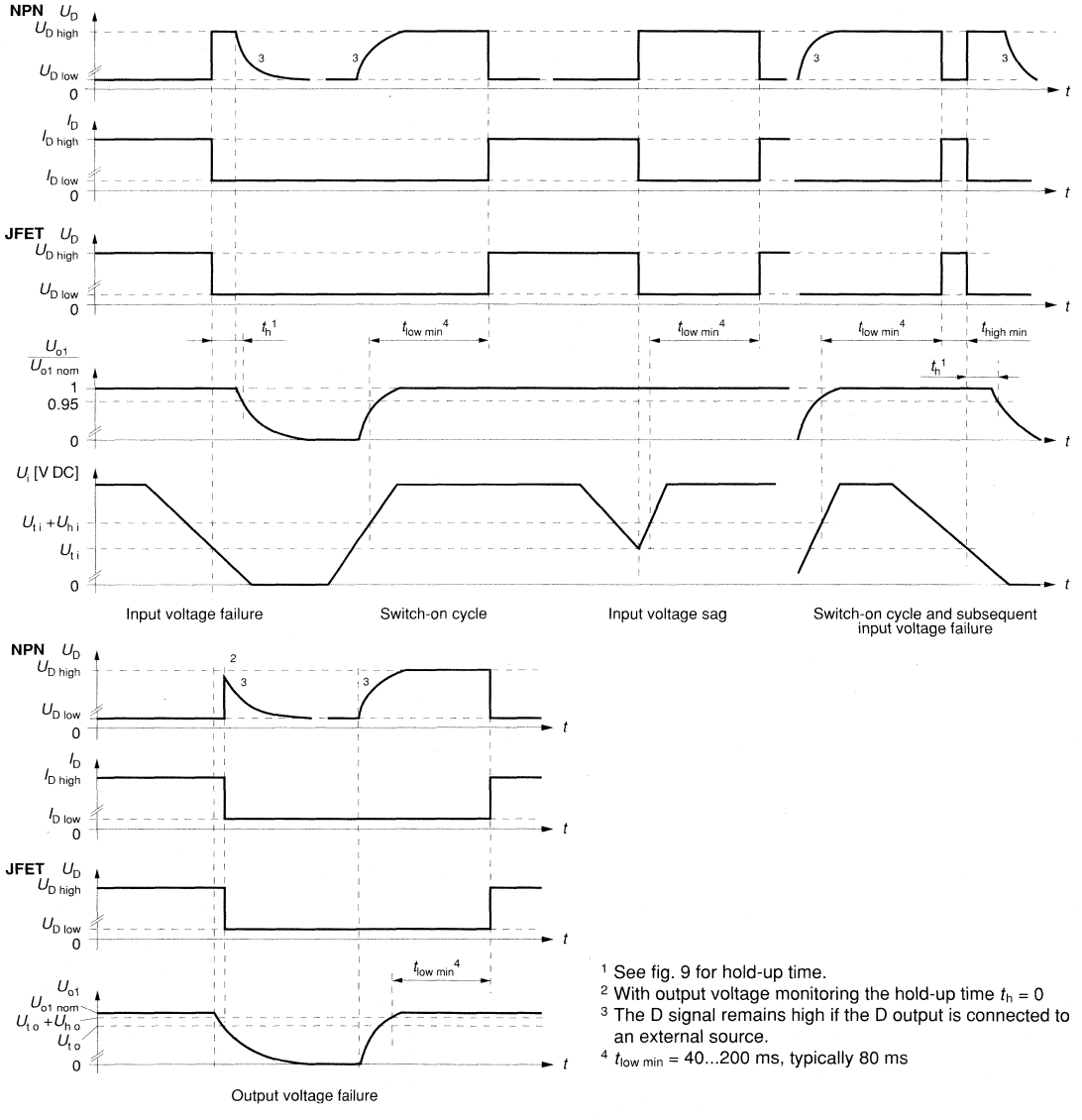



*Fig. 10*
*Definition of $U_{ti}$, $\Delta U_{ti}$ and $U_{hi}$ (JFET output)*




[1] See fig. 9 for hold-up time.
[2] With output voltage monitoring the hold-up time $t_h = 0$
[3] The D signal remains high if the D output is connected to an external source.
[4] $t_{low\,min}$ = 40...200 ms, typically 80 ms

*Fig. 11*
*Relationship between $U_i$, $U_{o1}$, $U_D$, $I_D$ and $U_{o1}/U_{o\,nom}$ versus time.*

### Option V

This option defines an undervoltage monitoring circuit for the input and/or main output voltage ($U_{o1\ nom}$ = 5.1 V only) equivalent to option D and generates an ACFAIL signal (V signal) which conforms to the VME standard.

The low state level of the ACFAIL signal is specified at a sink current of $I_V$ = 48 mA to $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME motherboard.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V when the 5.1 V output is fully loaded. This hold-up time $t_h$ is provided by the internal input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\ min}$ of the converter so that enough energy is remaining in the input capacitance.

*Table 13: Factory potentiometer setting of $U_{t\,i}$*

| Types | 110H | 230H | Unit |
|---|---|---|---|
| $C_{i\ min}$ | 0.25 | 0.05 | mF |
| $U_{t\,i}$ | 94 | 200 | V DC |
| $t_h$ | 5 | 5 | ms |

Formula for threshold level for desired value of $t_h$:

$$U_{t\,i} = \sqrt{\frac{2 \cdot P_o \cdot (t_h + 0.3\ ms) \cdot 100}{C_{i\ min} \cdot \eta}} + U_{i\ min}{}^2$$

where as:

$C_{i\ min}$ = minimum internal input capacitance [mF], according to table 13 below
$P_o$ = output power [W]
$h$ = efficiency [%]
$t_h$ = hold-up time [ms]
$U_{i\ min}$ = minimum input voltage [V] [1]
$U_{t\,i}$ = threshold level [V]

[1] Min. input voltage according to "Electrical Input Data". For output voltages $U_o > U_{o\ nom}$, the minimum input voltage increases proportionally to $U_o/U_{o\ nom}$.

Remarks:

The threshold level $U_{t\,i}$ of option V2 and V3 is adjusted during manufacture to a value according to table 13.

A decoupling diode should be connected in series with the input to avoid the input capacitance discharging through other loads connected to the same source voltage.

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1– (pin 23). The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is adjustable by potentiometer accessible through a hole in the front cover.
Versions V2 and V3 are available as shown below.

*Table 14: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level | | Typical hysteresis for $U_{t\,min}...U_{t\,max}$ [% of $U_t$] | |
|---|---|---|---|---|---|---|
| | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| V2 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | - | 3.0...0.5 | - |
| V3 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications)
[2] Fixed value between 95% and 98% of $U_{o1}$ (tracking), output undervoltage monitoring is not a requirement of VME standard

V output (V2, V3):

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) < $U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $U_V$ should not exceed 80 V.

| $U_i$, $U_{o1}$ status | V output, $U_V$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_V \leq 0.6$ V at $I_V$ = 50 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_V \leq 25$ µA at $U_V$ = 5.1 V |

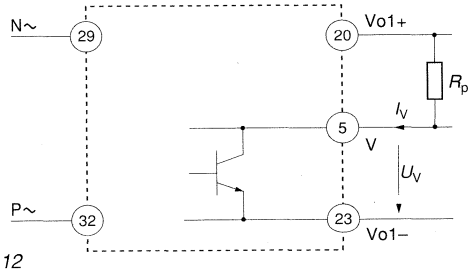



*Fig. 12*
*Output configuration of options V2 and V3*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage is measured after the input filter and rectifier. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The value of $\Delta U_{t\,i}$ depends upon the input voltage range, threshold level $U_t$, temperature and input current. The input current is a function of input voltage and output power.

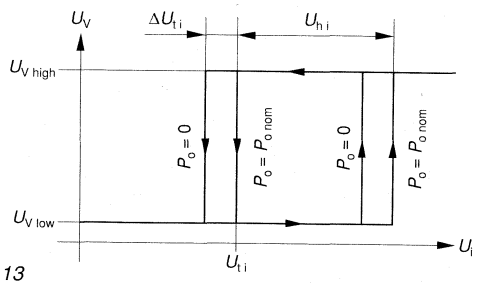
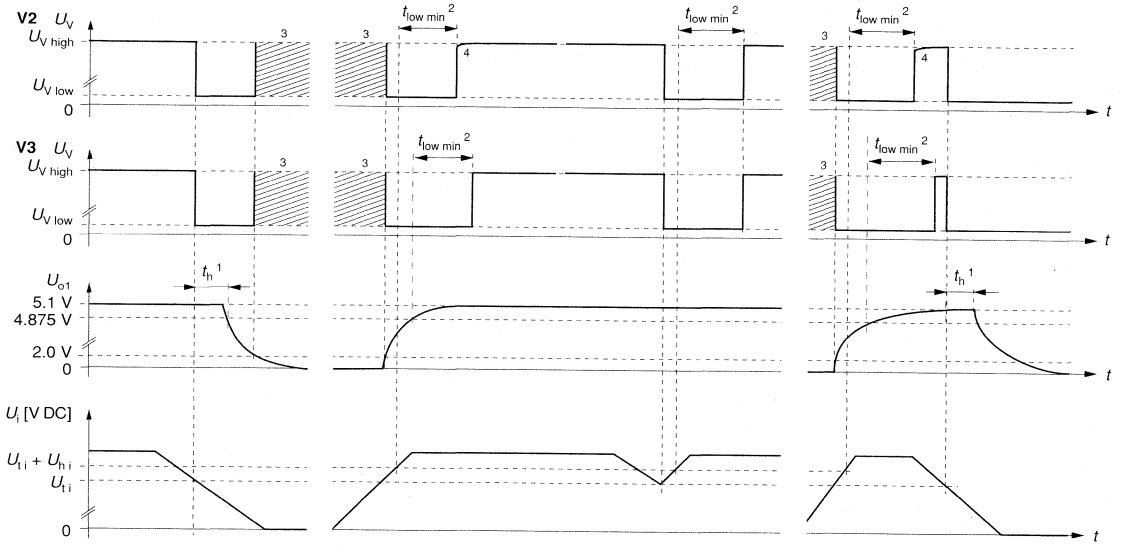
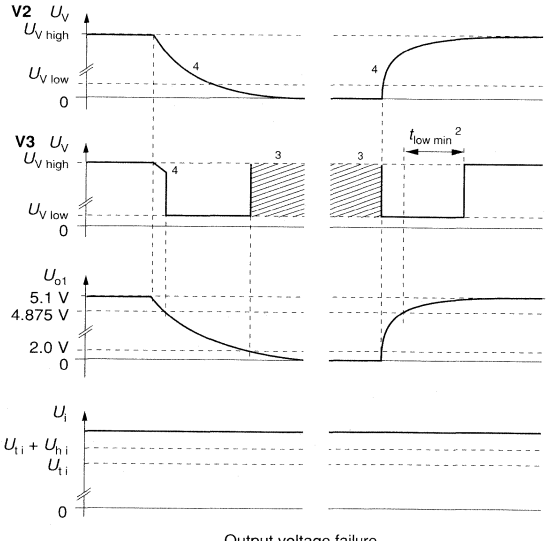



*Fig. 13*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$*




[1] VME request: minimum 4 ms
[2] $t_{low\,min}$ = 40...200 ms, typically 80 ms
[3] $U_V$ level not defined at $U_{o1}$ < 2.0 V
[4] The V signal drops simultaneously with the output voltage, if the pull-up resistor $R_P$ is connected to Vo1+. The V signal remains high if $R_P$ is connected to an external source.

*Fig. 14*
*Relationship between $U_i$, $U_{o1}$, $U_V$, $I_V$ and $U_{o1}/U_{o\,nom}$ versus time.*

## Immunity to Environmental Conditions

*Table 15: Mechanical stress*

| Test Method | | Standard | Test Conditions | |
|---|---|---|---|---|
| Ca | Damp heat steady state | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Duration: | $40^{\pm 2}$ °C<br>$93^{+2/-3}$ %<br>21 days<br>Unit not operating |
| Ea | Shock (half-sinusoidal) | DIN 40046 part 7<br>IEC 68-2-27<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s²<br>11 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock (half-sinusoidal) | DIN 40046 part 26<br>IEC 68-2-29<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s²<br>16 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6<br>MIL-STD-810D section 514.3 | Frequency (1 Oct/min):<br>Acceleration amplitude:<br>Test duration: | 10...150 Hz<br>2 $g_n$ = 20 m/s²<br>3.75 h (1.25 h each axis)<br>Unit operating |

### Thermal considerations

*Table 16: Temperature specifications, values given are for an air pressure of 800...1200 hPa (800...1200 mbar)*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Standard operational ambient temperature range -2 | 0 | 50 | °C |
| $T_C$ | Standard operational case temperature range -2, overtemp. lock-out (PTC) at $T_C$ > 95°C | 0 | 80 | |
| $T_S$ | Storage temperature range -2 | –25 | 100 | |

Basically the available output power is limited by thermal characteristics. Operation at higher temperatures with nominal output currents is also possible if forced cooling can be provided (heat sink, fan, etc.).

Example: Sufficient forced coolling allows $T_{A\,max}$ = 65°C. A simple check of the case temperature $T_C$ ($T_C \leq 80$°C) at full load ensures correct operation of the system (temperature measurement point on the case see fig. 16).

In general: For an ambient temperature of 65°C with only convection cooling, the maximum permissible current for each output is approx. 50% of it's nominal value.

*Table 17: MTBF*

| Values at specified Case Temperature | Module Types | Ground Benign 40°C | Unit |
|---|---|---|---|
| MTBF | H1000<br>H2000<br>H3000 | 384'000<br>306'000<br>270'000 | h |

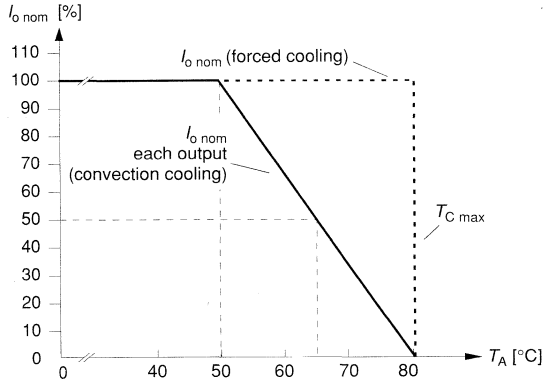
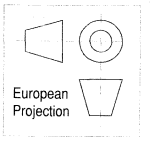



*Fig. 15*
*Output derating versus ambient temperature under convection and forced cooled conditions*

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.



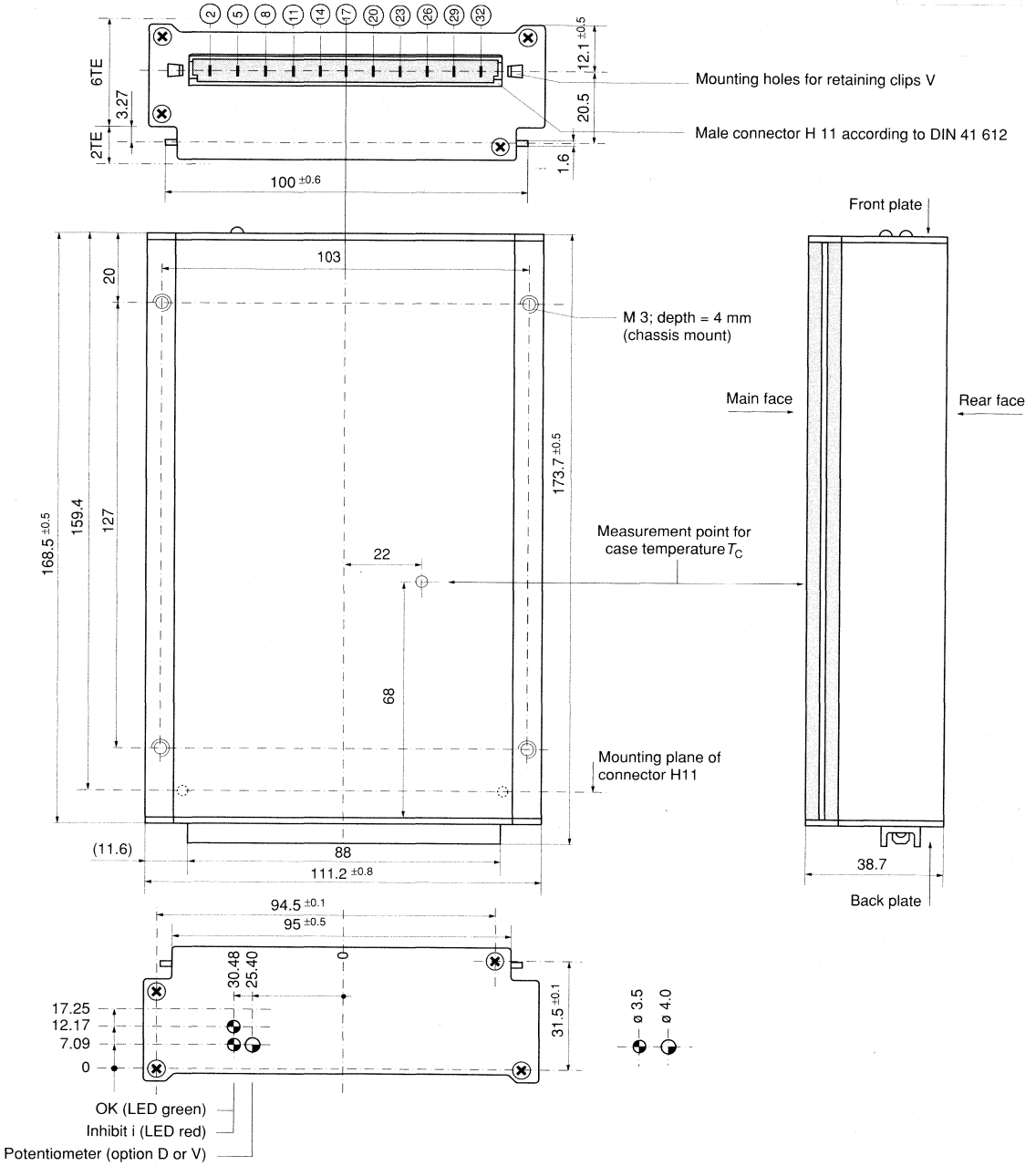
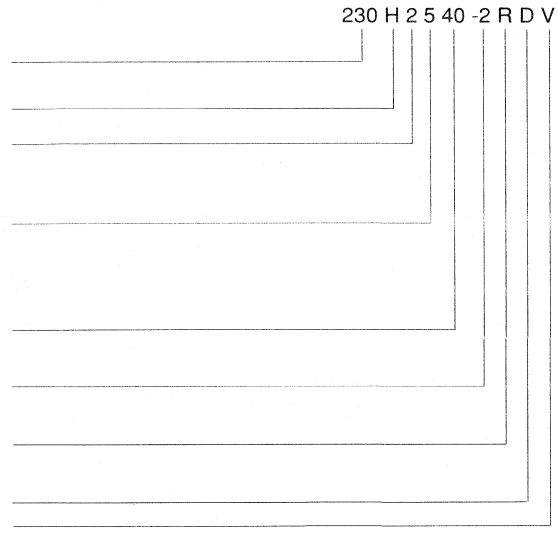




*Fig. 16*
*Case H02, weight 770 g (approx.)*

## Type Key and Product Marking

### Type Key




Input voltage range $U_i$:
85...132 V AC ..... 110
187...255 V AC ..... 230

Family ..... H

Number of outputs ..... 1...3

Output 1, $U_{o1\ nom}$:
5.1 V ..... 0
12 V ..... 3
15 V ..... 5
24 V ..... 6
48 V ..... 9

Single output modules ..... 01
Output 2 and 3, $U_{o2\ nom}$, $U_{o3\ nom}$:
12 V ..... 20
15 V ..... 40

Ambient temperature range $T_A$: 0...50 °C ..... -2
(operational)

Output voltage control input (single output modules) ..... R

Options:
Save data signal (D1...D8, to be specified) ..... D [1]
ACFAIL signal (V2, V3, to be specified) ..... V [1]

[1] Option D excludes option V and vice versa

Example: 230H1501-2RD3: AC-DC converter, input voltage range 187...255 V AC, providing output with 15 V/3.4 A; equipped with an output voltage control input and undervoltage monitoring.

**Product Marking** (refer also to "Mechanical Data")

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LEDs and potentiometer.

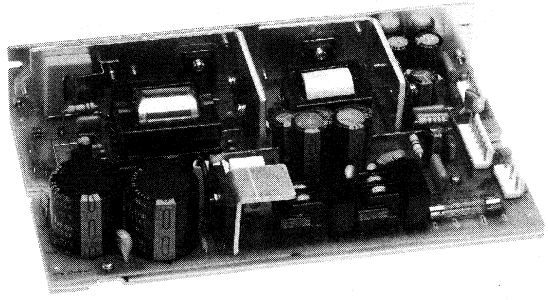
Back plate: Specific type designation, input voltage range, nominal output voltage(s) and current(s), pin allocation of options and auxiliary functions, external fuse specification and degree of protection.

Rear face: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB, date of production. Confirmation of successfully passed final test.

# TOKO 50/100 W AC-DC Converters LW-Family

**Input to output isolation**
**Triple output (50 W)**
**Triple and quadruple output (100 W)**

- Universal AC Input for 50 Watt models
- Selectable AC Input for 100 Watt models
- Triple output for 50 Watt models
- Triple and quadruple output for 100 Watt models
- Flex power topology
- Component derating for high reliability
- Noise Standard: Meets FCC Class A/B, VDE Class A/B
- Safety standards



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## Type Survey

*Table 1a: Survey of 50 W types*

| Output 1 $U_{o\,nom}$ V DC | Output 1 $I_{o\,max}$ A | Output 2 $U_{o\,nom}$ V DC | Output 2 $I_{o\,max}$ A | Output 3 $U_{o\,nom}$ V DC | Output 3 $I_{o\,max}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation |
|---|---|---|---|---|---|---|---|---|
| 5 | 8.0 | 12 | 1.5 | –12 | 1.0 | 85...264 V AC | 50 W | LW 50-01 |
| 5 | 8.0 | 15 | 1.5 | –15 | 1.0 | 47...63 Hz | | LW 50-11 |
| 5 | 8.0 | 12 | 1.5 | –5 | 1.0 | (110...350 V DC) | | LW 50-21 |

*Table 1b: Survey of 100 W types*

| Output 1 $U_{o\,nom}$ V DC | Output 1 $I_{o\,max}$ A | Output 2 $U_{o\,nom}$ V DC | Output 2 $I_{o\,max}$ A | Output 3 $U_{o\,nom}$ V DC | Output 3 $I_{o\,max}$ A | Output 4 $U_{o\,nom}$ V DC | Output 4 $I_{o\,max}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ V AC | Rated Power $P_{o\,tot}$ $T_A = 40°C$ | Type designation |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 12 | 24 | 2.0 | 12 | 2.0 | –12 | 1.0 | 85...132/170...264 | 100 W | LW 100-01 |
| 5 | 12 | 12 | 2.0 | 12 | 2.0 | –12 | 1.0 | 47...63 Hz | | LW 100-02 |
| 5 | 12 | 12 | 2.0 | –12 | 2.0 | – | – | jumper selectable | | LW 100-03 |
| 24 | 3 | 12 | 2.0 | 5 | 2.0 | –12 | 1.0 | | | LW 100-04 |

## Description

Innovative design and attention to detail make the LW series the choice of many design engineers. These ultra compact power supplies feature a total volume of nearly three times less than conventional switchers in the same power range. The LW's flex power output design easily accommodates changing design needs and power requirements. 50 and 100 W ratings, triple output on 50 W models, choice of triple or quad output for 100 W models. Universal AC input standard on both models, jumper selectable on 100 W models. UL 1950, CSA EB1402C and TÜV EN 60950 approved.

### Key applications

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

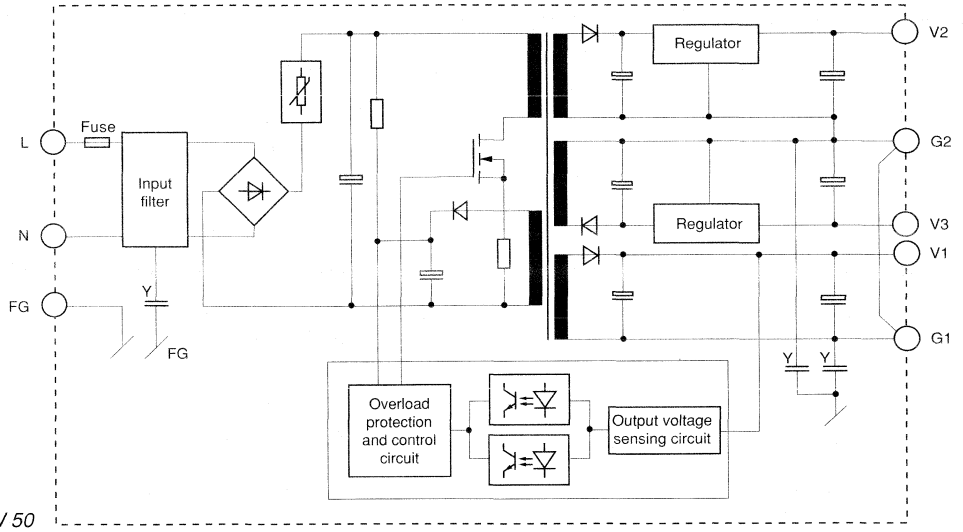



*Fig. 1*
*Block diagram LW 50*

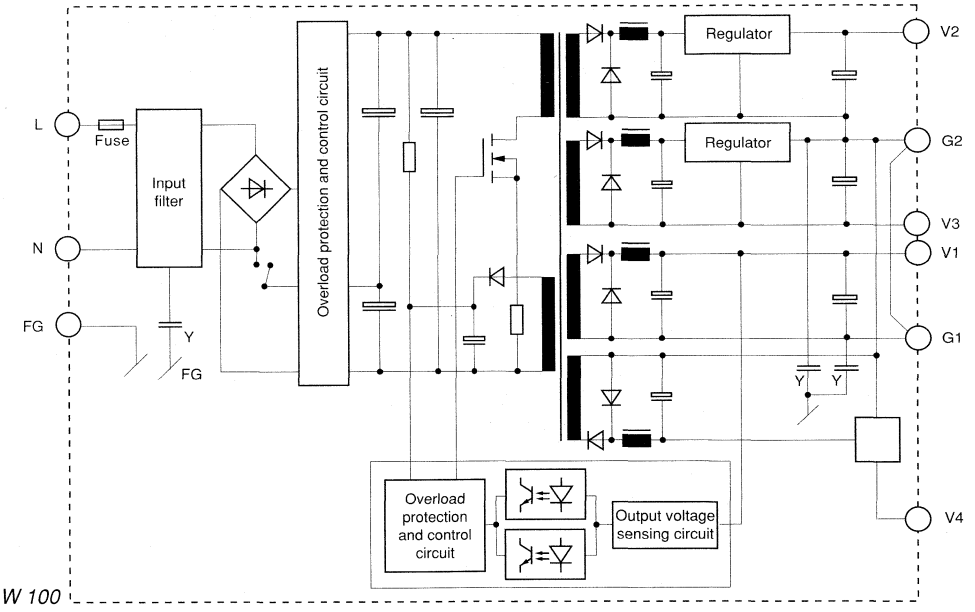



*Fig. 2*
*Block diagram LW 100*

## Electrical Input and Output Data

General Coindition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | LW 50-.. | LW 100-.. | Unit |
|---|---|---|---|---|---|
| $U_{i\ Rated}$ | Rated input voltage | | 100, 120, 200, 220, 240 | | V AC |
| $U_i$ | Input voltage range | | 85...264 | 85...132/170...264 [1] | |
| | | | 110...350 | – | V DC |
| $f_i$ | Line frequency | | 47...63 | | Hz |
| $I_i$ | Input current [2] | 100/200 V AC | 1.5/0.9 | 2.4/1.5 | A |
| $I_{i\ m}$ | Inrush current [2] (max.) | 100 V AC | 30 | | |
| $I_{i\ leak}$ | Leakage current (max.) | 100 V AC | 0.5 | 1.0 | mA |

[1] jumper selectable; [2] at rated input and output

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3a: Output data 50 W types*

| Characteristics | | LW 50-01 V1 | LW 50-01 V2 | LW 50-01 V3 | LW 50-11 V1 | LW 50-11 V2 | LW 50-11 V3 | LW 50-21 V1 | LW 50-21 V2 | LW 50-21 V3 | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | 5 | 12 | –12 | 5 | 15 | –15 | 5 | 12 | –5 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | % |
| $I_{o\,set}$ | Voltage setting load | 3.25 | 0.7 | 0.5 | 3.25 | 0.7 | 0.5 | 3.25 | 0.7 | 0.5 | A |
| $U_{oL}$ | Overvoltage protection | For +5 V only, overall voltage cut-off, recovery at power on | | | | | | | | | V |
| $I_o$ | Output current min. | 1.5 | 0 | 0 | 1.5 | 0 | 0 | 1.5 | 0 | 0 | A |
| | typ. | 6.6 | 1 | 0.5 | 5.7 | 1 | 0.5 | 6.8 | 1 | 0.5 | |
| | max. | 8 | 1.5 | 1 | 8 | 1.5 | 1 | 8 | 1.5 | 1 | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 51 | | | | | | | | | W |
| $P_{o\,max}$ | Output power | 40 | 18 | 12 | 40 | 22 | 15 | 40 | 18 | 5 | |
| $u_o$ | Ripple [1] max. | 80 | 100 | 100 | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [1] max. | 120 | 200 | 200 | 120 | 200 | 200 | 120 | 200 | 200 | |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±2.0 | ±0.5 | ±0.5 | ±2.0 | ±0.5 | ±0.5 | ±2.0 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±2.0 | ±1.0 | ±1.0 | ±2.0 | ±1.0 | ±1.0 | ±2.0 | ±1.0 | ±1.0 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | 0.3 | | | | | | | | | |
| $\alpha U_o$ | Change in temp. 0...50°C | ±1.0 | | | | | | | | | |
| $t_{o\,r}$ | Rise time [1] max. | 100 | | | | | | | | | ms |
| $t_{o\,h\,min}$ | Hold up time [1] 100/200 V AC | 20 | | | | | | | | | |
| $\eta$ | Efficiency [2] typ. | 65 | | | | | | | | | % |

[1] At rated input and output and normal temperature
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3b: Output data 100 W types*

| Characteristics | | LW 100-01 V1 | LW 100-01 V2 | LW 100-01 V3 | LW 100-01 V4 | LW 100-02 V1 | LW 100-02 V2 | LW 100-02 V3 | LW 100-02 V4 | LW 100-03 V1 | LW 100-03 V2 | LW 100-03 V3 | LW 100-04 V1 | LW 100-04 V2 | LW 100-04 V3 | LW 100-04 V4 | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | 5 | 24 | 12 | –12 | 5 | 12 | 12 | –12 | 5 | 12 | –12 | 24 | 12 | 5 | –12 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±4.2 | ±4 | ±4 | ±1 | ±4 | ±4 | ±4 | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | ±4 | % |
| $I_{o\,set}$ | Voltage setting load | 6 | 1 | 1 | 1 | 6 | 1 | 1 | 0.5 | 6 | 1 | 1 | 1.5 | 1 | 1 | 0.5 | A |
| $U_{oL}$ | Overvoltage protection | For V1 only, overall voltage cut-off, recovery at power on | | | | | | | | | | | | | | | V |
| $I_o$ | Output current min. | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | A |
| | typ. | 10.4 | 1 | 1.5 | 0.67 | 10 | 1.8 | 1.8 | 0.6 | 10.4 | 2 | 2 | 2.8 | 1.5 | 1.5 | 0.6 | |
| | max. | 12 | 2 | 2 | 1 | 12 | 2 | 2 | 1 | 12 | 2 | 2 | 3 | 2 | 2 | 1 | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | | | | | | | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 100 | | | | | | | | | | | | | | | W |
| $P_{o\,max}$ | Output power | 60 | 48 | 24 | 12 | 60 | 24 | 24 | 12 | 60 | 24 | 24 | 72 | 24 | 10 | 12 | |
| $u_o$ | Ripple [1] max. | 80 | 100 | 100 | 100 | 80 | 100 | 100 | 100 | 80 | 100 | 100 | 100 | 100 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [1] max. | 150 | 250 | 250 | 250 | 150 | 250 | 250 | 250 | 150 | 250 | 250 | 250 | 250 | 250 | 250 | |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±1 | ±0.5 | ±0.5 | ±0.5 | ±1 | ±0.5 | ±0.5 | ±0.5 | ±1 | ±0.5 | ±0.5 | ±1 | ±0.5 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±1 | ±1.5 | ±1.5 | ±1 | ±1 | ±1.5 | ±1.5 | ±1 | ±1 | ±1.5 | ±1.5 | ±1 | ±1.5 | ±1.5 | ±1.5 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | 0.3 | | | | | | | | | | | | | | | |
| $\alpha U_o$ | Change in temp., 0...50°C | ±1 | | | | | | | | | | | | | | | |
| $t_{o\,r}$ | Rise time[1] max. | 150 | | | | | | | | | | | | | | | ms |
| $t_{o\,h\,min}$ | Hold up time[1] 100/200 V AC | 20 | | | | | | | | | | | | | | | |
| $\eta$ | Efficiency [2] typ. | 65 | | | | | | | | | | | | | | | % |

[1] At rated input and output and normal temperature
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

# Operation Instructions

## Input and Output Terminals

*Table 4: Input and output terminals*

| Terminal | Function | Explanation |
|---|---|---|
| L<br>N | Input terminals | 1. Connect to AC with sine wave of 47...63 Hz, 85...132 V AC/180...264 V AC, single phase.<br>2. Use a double or triple core cable for an input line.<br>3. Space the AC input line as far as possible from the DC output line. |
| FG | Frame ground terminal | Connect with low impedance to ground line of equipment on which the power supply is mounted. |
| V1 | Output Terminal 1 | Supplies stabilized output of 5 V DC. |
| V2 | Output Terminal 2 | Supplies stabilized output of 12 or 15 V DC. |
| V3 | Output Terminal 3 | Supplies stabilized output of –12, –15 or –5 V DC. |
| V4 | Output Terminal 4 | Supplies stabilized output of –12 V DC. |
| G1, G2 | Ground Terminals | G1: ground terminal for V1, G2: ground terminal for V2 and V3.<br>G1 and G2 are internally interconnected. |

### Proper Method of Operation

To achieve the proper output voltage from each of the three output channels, the load currents must be within the minimum-maximum ratings. If the load current is below the minimum, add a pre-load.

### Overcurrent Protection

Each channel has its own built-in overload protection at above 105% of the rated currents. In the case of overloading, the circuit operates to eliminate the excess current. The circuit then automatically resets.

### Overvoltage Protection

The LW 50 and LW 100 have an overvoltage sensing circuit built into their V1 (+5 V) output.

### Inrush Current

All models in this series feature circuits to limit in-rush current. The LW 50 has a power thermistor, and the LW 100 has a thyristor circuit. Choose an appropriate AC switch for each model based on specifications. Avoid switching the AC input on and off repeatedly in rapid succession. (Wait approximately 2 minutes for models with thermistors and approximately 10 seconds for models with thyristors.)

### Series or Parallel Operation

The outputs cannot be operated in series or parallel connection with other sources.

### Derating Characteristics

The relation between the ambient temperature ($T_A$) and the rated output power is shown in the diagram below. When using your power supply at an ambient temperature of 60°C, keep the output current for each channel under 60% of maximum rated value.

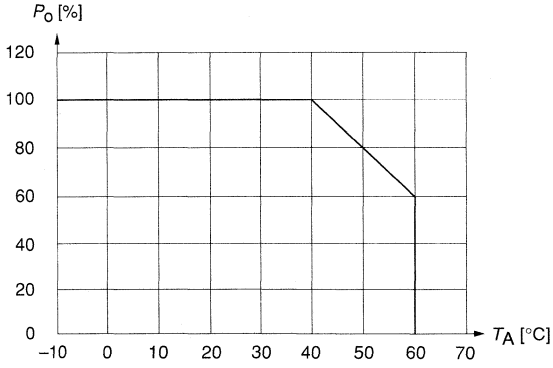



*Fig. 3*
*Output power vs. ambient temperature*

*Table 5: Connector types (JST)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | LW 50, 100 | B3P5-VH | VHR 5N | SVH-21T-P1.1 | 3 |
| DC output side | LW 50 | B7P-VH | VHR 7N | SVH-21T-P1.1 | 7 |
| | LW 100 | B5P-VH | VHR 5N | SVH-21T-P1.1 | 5 |
| | LW 100 | B7P-VH | VHR 7N | SVH-21T-P1.1 | 7 |

*Table 6: Cable kit (to be ordered separately from power supply)*

| Position at | Type of cable kit | Power supply | Material \| Length<br>Cross section | Wire color | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | V1 | V2 | V3 | V4 | G | AC (L) | AC (N) | FG |
| AC input side | CB11 | LW 50<br>LW 100 | UL 1015 \| 60 cm<br>AWG 20 ≈ 0.50 mm² | – | – | – | – | – | Black | White | Green |
| DC output side | CB13 | LW50 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | Red<br>×2 | Brown | Blue | – | Black<br>×3 | – | – | – |
| | CB14 | LW 100 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | – | Brown | Orange | Blue | Black<br>×2 | – | – | – |
| | CB15 | LW 100 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | Red<br>×3 | – | – | – | Black<br>×4 | – | – | – |

## Immunity to Environmental Conditions

*Table 7: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | –10 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | –10 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 8: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s²)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 9: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 3000 V AC, 1 minute | –<br>leakage current <15 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mounting Instructions

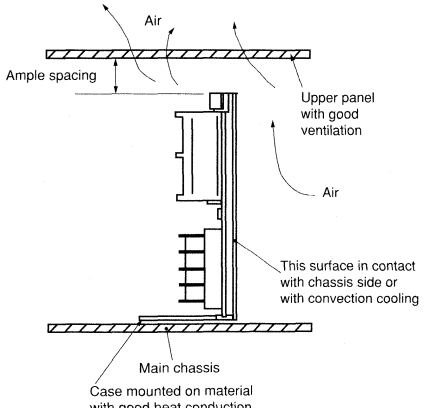



*Fig. 4*
*Vertical mounting*

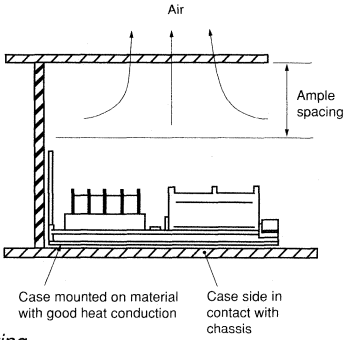



*Fig. 5*
*Horizontal mounting*


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## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

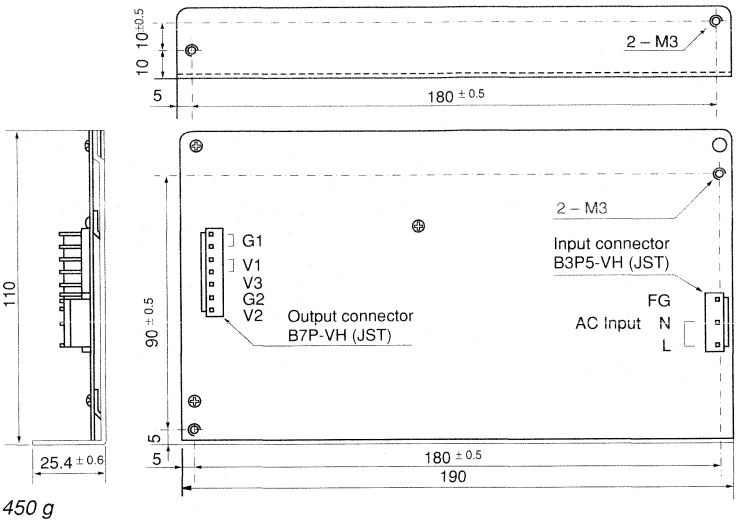



*Fig. 6*
*LW 50, Weight: 450 g*

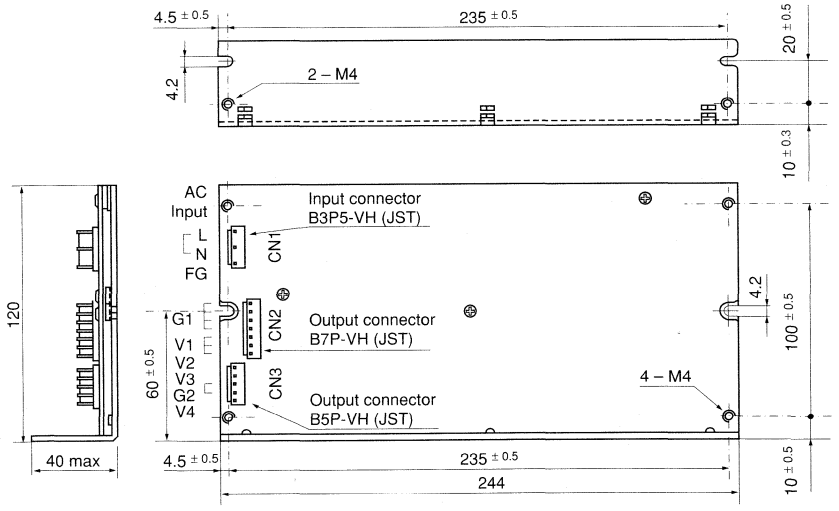



*Fig. 7*
*LW 100, Weight: 1050 g*

## Type Key and Product Marking

**Type Key**

| | |
|---|---|
| Family | LW |
| Blank | |
| Nominal output power [W] | 50/100 |
| Dash | |
| Output configuration | 01...21 |

LW 50 - 01

Example: LW 50-01 = AC-DC converter providing 50 W on 3 outputs of 5 V/8A, 12 V/1.5 A and –12 V/1.0 A

**Produkt Marking**

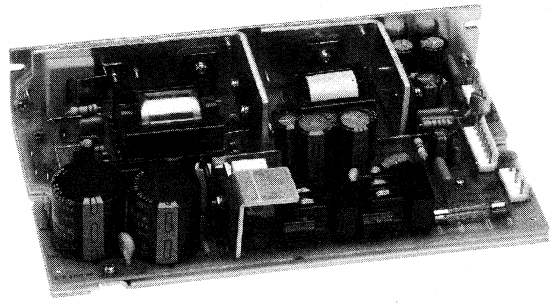
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 50/100 W AC-DC Converters

# MW-Family

**Input to output isolation**
**Triple output (50 W)**
**Triple and quadruple output (100 W)**

- AC Input jumper selectable
- Flex power topology
- Convection cooled
- High switching frequency (>100 KHz)
- State-of-the-art wireless transformer design
- Component derating for high reliability
- Meets FCC Class A or B
- Safety stanards



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## Type Survey

*Table 1a: Type survey 50 W*

| Output 1 $U_{o\,nom}$ V DC | Output 1 $I_{o\,max}$ A | Output 2 $U_{o\,nom}$ V DC | Output 2 $I_{o\,max}$ A | Output 3 $U_{o\,mom}$ V DC | Output 3 $I_{o\,max}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation |
|---|---|---|---|---|---|---|---|---|
| 5 | 8.0 | 12 | 1.5 | –12 | 1.0 | 85...132/170...264 | 51 W | MW 50-01 |
| 5 | 8.0 | 15 | 1.5 | –15 | 1.0 | jumper selectable | | MW 50-11 |
| 5 | 8.0 | 12 | 1.5 | –5 | 1.0 | | | MW 50-21 |

*Table 1b: Type survey 100 W*

| Output 1 $U_{o\,nom}$ V DC | Output 1 $I_{o\,max}$ A | Output 2 $U_{o\,nom}$ V DC | Output 2 $I_{o\,max}$ A | Output 3 $U_{o\,mom}$ V DC | Output 3 $I_{o\,max}$ A | Output 4 $U_{o\,mom}$ V DC | Output 4 $I_{o\,max}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ V AC | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 12 | 24 | 2.0 | 12 | 2.0 | –12 | 1.0 | | 100 W | MW 100-01 |
| 5 | 12 | 12 | 2.0 | 12 | 2.0 | –12 | 1.0 | 85...132/170...264 | | MW 100-02 |
| 5 | 12 | 12 | 2.0 | –12 | 2.0 | – | – | jumper selectable | | MW 100-03 |
| 24 | 3.0 | 12 | 2.0 | 5 | 2.0 | –12 | 1.0 | | | MW 100-04 |

## Description

The MW series strikes the right balance between size and performance right off the drawing board. These ultra compact switchers satisfy the design engineer's demand for less space without sacrificing power and efficiency. Very low profile of one inch is maintained on most models. Choice of 50 and 100 W ratings, triple or quad output, 11 open frame models available. Jumper selectable wide input range. The modules are UL 1950 (D3) and CSA C22.2/143, 154 approved.

### Key applications

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

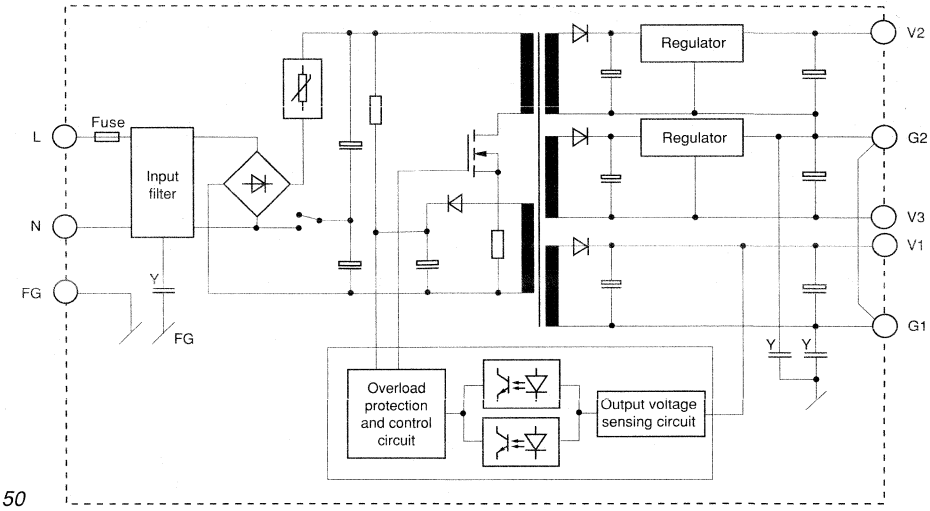



*Fig. 1*
*Block diagram MW 50*

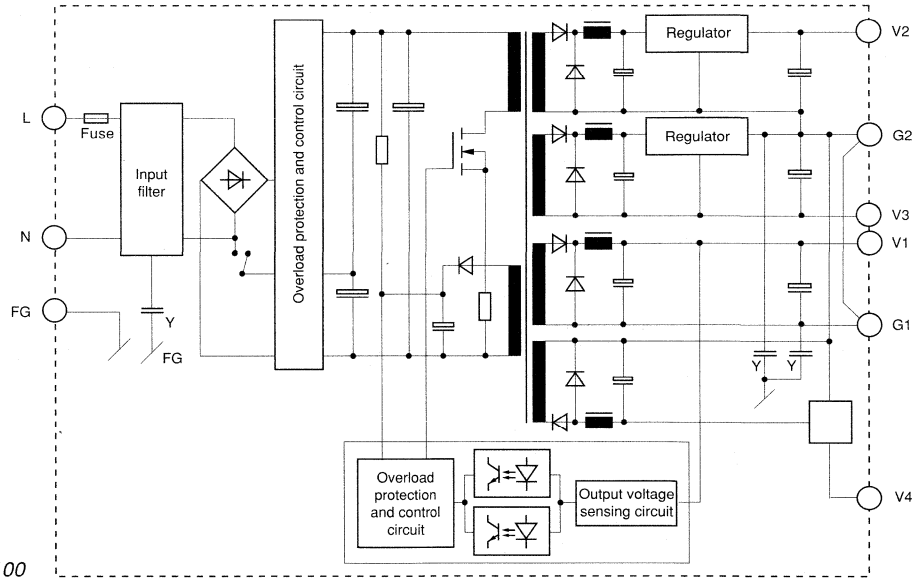



*Fig. 2*
*Block diagram MW 100*

## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | MW 50-.. | MW 100-.. | Unit |
|---|---|---|---|---|---|
| $U_{i\,Rated}$ | Rated input voltage | | 115, 120, 220, 230, 240 | | V AC |
| $U_i$ | Input voltage range | | 85...132/170...264 | | |
| $f_i$ | Line frequency | | 47...63 | | Hz |
| $I_i$ | Input current [1] | 115/230 V AC | 1.5/0.9 | 2.4/1.5 | A |
| $I_{i\,m}$ | Inrush current [1] (max.) | 115 V AC | 30 | | |
| $I_{i\,leak}$ | Leakage current (max.) | 115 V AC | 0.5 | 1.0 | mA |

[1] At rated input and output

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3a: Output data 50 W types*

| Type | | MW 50-01 | | | MW 50-11 | | | MW 50-21 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | V1 | V2 | V3 | V1 | V2 | V3 | V1 | V2 | V3 | |
| $U_{o\,nom}$ | Output voltage | 5 | 12 | –12 | 5 | 15 | –15 | 5 | 12 | –5 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | % |
| $I_{o\,set}$ | Voltage setting load | 3.25 | 0.7 | 0.5 | 3.25 | 0.7 | 0.5 | 3.25 | 0.7 | 0.5 | A |
| $U_{oL}$ | Overvoltage protection [2] | 7 | – | – | 7 | – | – | 7 | – | – | V |
| $I_o$ | Output current min. | 1.5 | 0 | 0 | 1.5 | 0 | 0 | 1.5 | 0 | 0 | A |
| | typ. | 6.6 | 1 | 0.5 | 5.7 | 1 | 0.5 | 6.8 | 1 | 0.5 | |
| | max. | 8 | 1.5 | 1 | 8 | 1.5 | 1 | 8 | 1.5 | 1 | |
| $I_{o\,L}$ | Overcurrent protection [3] | 105 | | | | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 51 | | | | | | | | | W |
| $P_{o\,max}$ | Output power | 40 | 18 | 12 | 40 | 22 | 15 | 40 | 18 | 5 | |
| $u_o$ | Ripple [1] max. | 80 | 100 | 100 | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [1] max. | 120 | 200 | 200 | 120 | 200 | 200 | 120 | 200 | 200 | |
| $\Delta U_{o\,U}$ | Line regulation max. 85...132 V/170...264 V | ±11.0 | ±0.5 | ±0.5 | ±11.0 | ±0.5 | ±0.5 | ±11.0 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation max. 0...100% | ±11.0 | ±1.0 | ±1.0 | ±11.0 | ±1.0 | ±1.0 | ±11.0 | ±1.0 | ±1.0 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | 0.3 | | | | | | | | | |
| $\alpha U_o$ | Change in temp., 0...50°C | ±1 | | | | | | | | | |
| $t_{o\,r}$ | Rise time [1] max. | 100 | | | | | | | | | ms |
| $t_{o\,h\,min}$ | Hold up time [1] | 20 | | | | | | | | | |
| $\eta$ | Efficiency [1] typ. | 65 | | | | | | | | | % |

[1] At rated input and output and normal temperature, [2] Output voltage hold off, reset by recycling
[3] Operating at approx. 105% of rated power, V1: fold-back, V2, V3: constant current method, automatic recovery

*Table 3b: Output data 100 W types*

| Type | | MW 100-01 | | | | MW 100-02 | | | | MW 100-03 | | | MW 100-04 | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | V1 | V2 | V3 | V4 | V1 | V2 | V3 | V4 | V1 | V2 | V3 | V1 | V2 | V3 | V4 | |
| $U_{o\,nom}$ | Output voltage | 5 | 24 | 12 | –12 | 5 | 12 | 12 | –12 | 5 | 12 | –12 | 24 | 12 | 5 | –12 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±4.2 | ±4 | ±4 | ±1 | ±4 | ±4 | ±4 | ±1 | ±4 | ±4 | ±1 | ±4 | ±4 | ±4 | % |
| $I_{o\,set}$ | Voltage setting load | 6 | 1 | 1 | 1 | 6 | 1 | 1 | 0.5 | 6 | 1 | 1 | 1.5 | 1 | 1 | 0.5 | A |
| $U_{oL}$ | Overvoltage protection [2] | 7 | – | – | – | 7 | – | – | – | 7 | – | – | 32 | – | – | – | V |
| $I_o$ | Rated output current min. | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | A |
| | typ. | 10.4 | 1 | 1.5 | 0.67 | 10 | 1.8 | 1.8 | 0.6 | 10.4 | 2 | 2 | 2.8 | 1.5 | 1.5 | 0.6 | |
| | max. | 12 | 2 | 2 | 1 | 12 | 2 | 2 | 1 | 12 | 2 | 2 | 3 | 2 | 2 | 1 | |
| $I_{o\,L}$ | Overcurrent protection [3] | 105 | | | | | | | | | | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 100 | | | | | | | | | | | | | | | W |
| $P_{o\,max}$ | Output power | 60 | 48 | 24 | 12 | 60 | 24 | 24 | 12 | 60 | 24 | 24 | 72 | 24 | 10 | 12 | |
| $u_o$ | Ripple [1] max. | 80 | 100 | 100 | 100 | 80 | 100 | 100 | 100 | 80 | 100 | 100 | 180 | 100 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [1] max. | 150 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 150 | 250 | 250 | 250 | 250 | 250 | 250 | |
| $\Delta U_{o\,U}$ | Line regulation 85...132 V/170...264 V | ±11 | ±0.5 | ±0.5 | ±0.5 | ±11 | ±0.5 | ±0.5 | ±0.5 | ±11 | ±0.5 | ±0.5 | ±11 | ±0.5 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±11 | ±1.5 | ±1.5 | ±1 | ±11 | ±1.5 | ±1.5 | ±1 | ±11 | ±1.5 | ±1.5 | ±11 | ±1.5 | ±1.5 | ±1.5 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | 0.3 | | | | | | | | | | | | | | | |
| $\alpha U_o$ | Change in temp., 0...50°C | ±1 | | | | | | | | | | | | | | | |
| $t_{o\,r}$ | Rise time [1] max. | 150 | | | | | | | | | | | | | | | ms |
| $t_{o\,h\,min}$ | Hold up time [1] | 20 | | | | | | | | | | | | | | | |
| $\eta$ | Efficiency [1] typ. | 65 | | | | | | | | | | | | | | | % |

[1] At rated input and output and normal temperature, [2] Output voltage hold off, reset by recycling
[3] Operating at approx. 105% of rated power, V1: fold-back, V2, V3: constant current method, automatic recovery


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## Operation Instructions

### Input and Output Terminals

*Table 4: Input and output terminals*

| Terminal | Function | Explanation |
|---|---|---|
| L<br>N | Input terminals | 1. Connect to AC with sine wave of 47...63 Hz, 85...132 V AC/180...264 V AC, single phase.<br>2. Use a double or triple core cable for an input line.<br>3. Space the AC input line as far as possible from the DC output line. |
| FG | Frame ground terminal | Connect with low impedance to ground line of equipment on which the power supply is mounted. |
| V1 | Output Terminal 1 | Stabilized output of 5 V DC (The MW 100 also has 24 V). |
| V2 | Output Terminal 2 | Stabilized output of 12 or 15 V DC (The MW 100 also has 24 V). |
| V3 | Output Terminal 3 | Stabilized output of –12, –15, or –5 V DC (The MW 100 also has 12 V). |
| V4 | Output Terminal 4 | Stabilized output of –12 V DC (MW 100 only). |
| G1, G2 | Ground Terminals | G1: ground terminal for V1, G2: ground terminal for V2 and V3.<br>G1 and G2 are internally interconnected. |

### Proper Method of Supplying Power

To achieve the proper output voltage from each of the three output channels, the load currents must be within the minimum-maximum ratings. If the load current is below the minimum, use a pre-load.

### Overcurrent Protection

Each channel has its own built-in overload protection at above 105% of the rated currents. In the case of overloading, the circuit operates to eliminate the excess current. After removal of the overload the circuit automatically resets.

### Overvoltage Protection

The MW 50 and MW 100 have an overvoltage sensing circuit built into their V1 output (5 V and 24 V).

### Inrush Current

All models feature inrush current limitation. The MW 50 provide a power thermistor and the MW 100 a thyristor circuit. Switching the AC input on and off repeatedly in rapid succession (less than 2 minutes for models with thermistors and 10 seconds for models with thyristors) should be avoided. An appropriate AC switch for each model based on specifications should be provided.

### Series or Parallel Operation

The outputs cannot be operated in series or parallel with other sources.

### Derating Characteristics

The relation between the ambient temperature ($T_A$) and the rated output power is shown in the diagram below. When using your power supply at an ambient temperature of 60°C, keep the output current for each channel under 60% of maximum rated value.

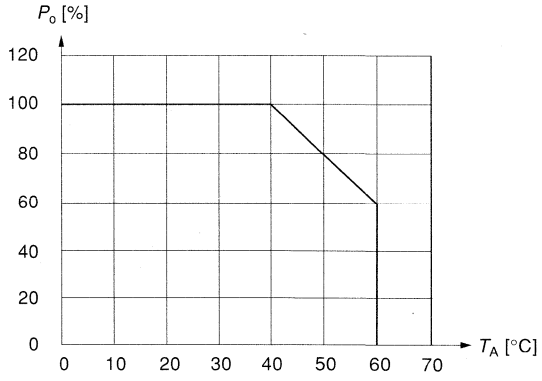



*Fig. 3*
*Output power vs. ambient temperature*

*Table 5: Connector Types (JST)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | MW 50, 100 | B3P5-VH | VHR 5N | SVH-21T-P1.1 | 3 |
| DC output side | MW 50 | B7P-VH | VHR 7N | SVH-21T-P1.1 | 7 |
| | MW 100 | B5P-VH | VHR 5N | SVH-21T-P1.1 | 5 |
| | MW 100 | B7P-VH | VHR 7N | SVH-21T-P1.1 | 7 |

*Table 6: Cable kit (to be ordered separately from power supply)*

| Position at | Type of cable kit | Power supply | Material \| Length<br>Cross section | Wire color | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | V1 | V2 | V3 | V4 | G | AC (L) | AC (N) | FG |
| AC input side | CB11 | MW 50<br>MW 100 | UL 1015 \| 60 cm<br>AWG 20 ≈ 0.50 mm² | – | – | – | – | – | Black | White | Green |
| DC output side | CB13 | MW 50 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | Red<br>×2 | Brown | Blue | – | Black<br>×3 | – | – | – |
| | CB14 | MW 100 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | – | Brown | Orange | Blue | Black<br>×2 | – | – | – |
| | CB15 | MW 100 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | Red<br>×3 | – | – | – | Black<br>×4 | – | – | – |

## Immunitiy to Environmental Conditions

*Table 7: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 8: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s², 10...55 Hz)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 9: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 3750 V AC, 1 minute | 2500 V AC, 1 minute<br>leakage current <15 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm.
Tolerances ±1 mm
unless otherwise indicated.

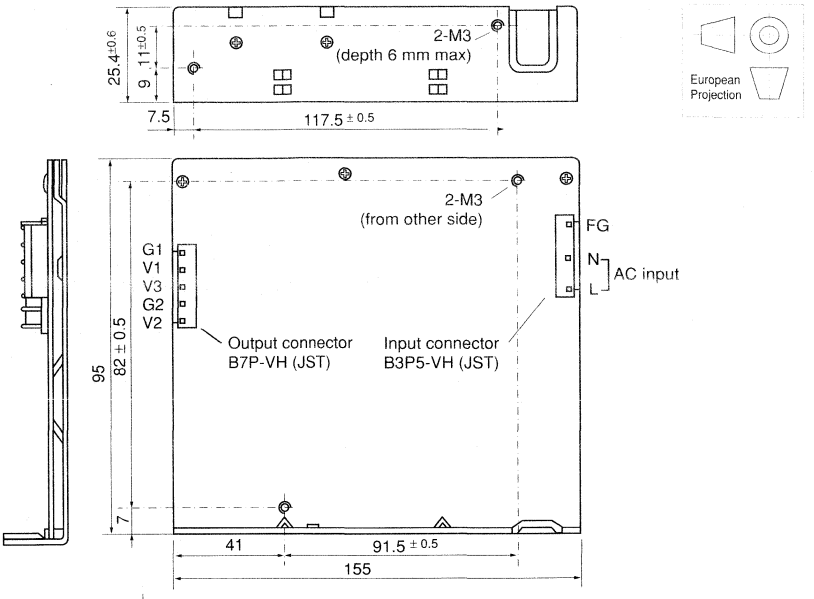



*Fig. 4*
*MW 50, weight: 330 g*

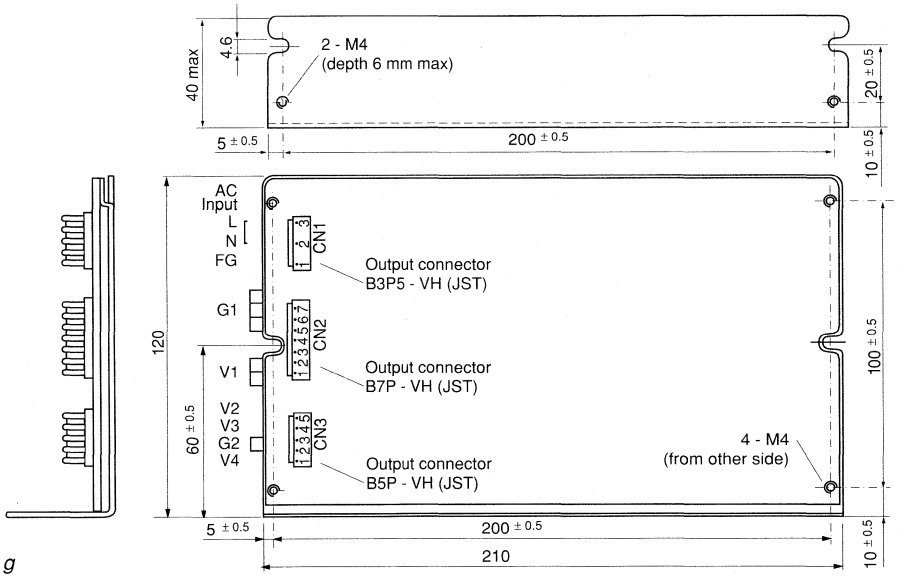



*Fig. 5*
*MW 100, weight: 1000 g*

## Type Key and Product Marking

**Type Key**

| | |
|---|---|
| Family | MW |
| Blank | |
| Nominal output power [W] | 50/100 |
| Dash | |
| Output configuration | 01...21 |

MW 50 - 01

Example: MW 100-04 = AC-DC converter providing 100 W on 4 outputs of 24 V/3A, 12 V/2 A, 5 V/2 A and –12 V/1 A

**Produkt Marking**

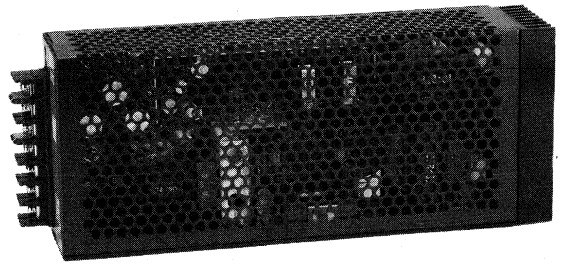
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 50/100 W AC-DC Converters

# PE-Family

**Input to output isolation**
**Single output**

- Small Size
- Superb quality and reliability
- 115/230 V AC input, jumper selectable
- Noise: Meets FCC Class A
- Safety according to VDE 0806



## Table of Contents


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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation Case Terminal strip | Open frame Terminal strip | Open frame Connector |
|---|---|---|---|---|---|---|
| 5 | 10.0 | 85...132 V AC | 50 W | PE 50-05C | PE 50-05F | PE 50-05FC |
| 5 | 20.0 | or | 100 W | PE 100-05C | PE 100-05F | – |
| 12 | 4.2 | 170...264 V AC | 50 W | PE 50-12C | PE 50-12F | PE 50-12FC |
| 12 | 8.3 | 47...440 Hz | 100 W | PE 100-12C | PE 100-12F | – |
| 24 | 2.1 | jumper selectable | 50 W | PE 50-24C | PE 50-24F | PE 50-24FC |
| 24 | 4.2 | | 100 W | PE 100-24C | PE 100-24F | – |

## Description

The PE series can be operated at nominal line voltages from 100 to 240 V AC, jumper selectable for worldwide usage. Single outputs with three different output voltages and power ratings of 50 W and 100 W are available. The units are designed in two configurations, namely open frame or enclosed. VDE approved.

### Key applications

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

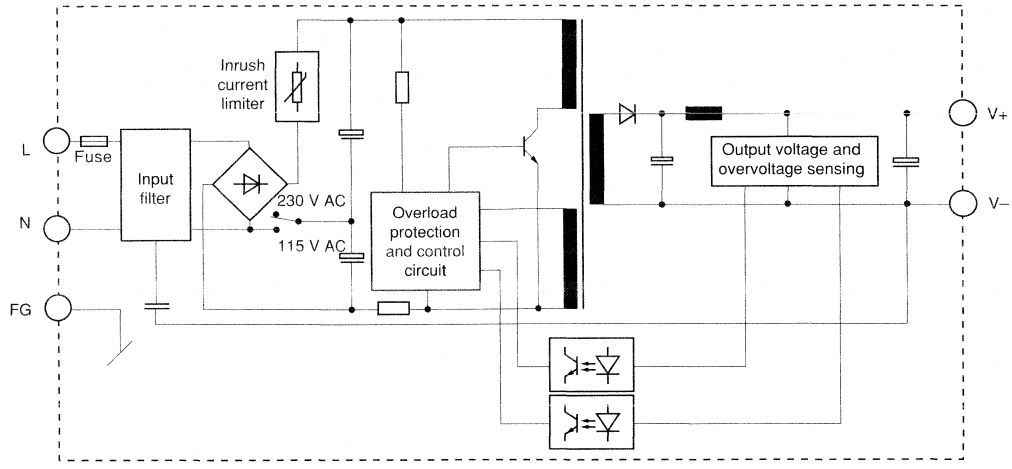



*Fig. 1*
*Block diagram PE 50*

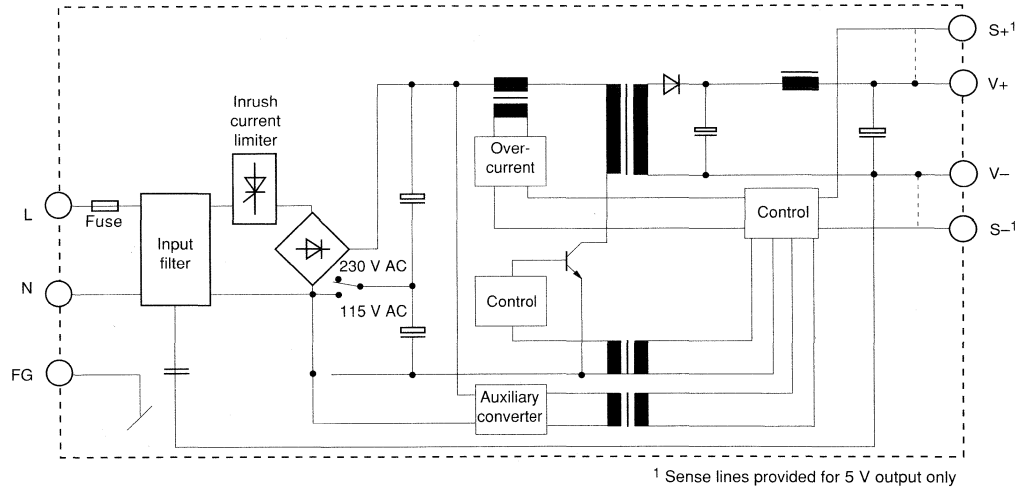



*Fig. 2*
*Block diagram PE 100*

## Electrical Input and Output Data

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | PE 50- .. | PE 50- .. | PE 50- .. | PE 100- .. | Unit |
|---|---|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 115, 230 | | | | V AC |
| $U_i$ | Input voltage range | | 85...132/170...264 [2] | | | | |
| $f_i$ | Line frequency | | 47...440 | | | | Hz |
| $I_i$ | Input current [1] | 115/230 V AC | 0.7/0.5 | | | 2/1.2 | A |
| $I_{i\ m}$ | Inrush current (max.) | 115/230 V AC | 30 | | | | |
| $I_{i\ leak}$ | Leakage current (max.) | 60 Hz, 240 V AC | 0.7 | | | 0.9 | mA |

[1] At rated input and output
[2] Jumper selectable

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3a: Output data 50 W types*

| Characteristics | | | PE 50-05 | PE 50-12 | PE 50-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | 24 | V |
| | Adjustable output voltage range | | | ±10 | | % |
| $U_{oL}$ | Overvoltage protection | max. | 6.9 | 15.5 | 31.0 | V |
| $I_o$ | Rated output current | | 10.0 | 4.2 | 2.1 | A |
| | Output current range | | | 0...100 | | % |
| $I_{o\,L}$ | Overcurrent protection [2] | | | 105 | | |
| $u_o$ | Ripple-noise [1] | max. | 120 | 120 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | 85...132 V<br>170...264 V | | ±3 | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | | ±3 | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) | typ. | | ±3 | | |
| $\alpha U_o$ | Change in temperature | 0...50 °C | | ±3 | | |
| $t_{o\,r}$ | Rise time [1] | max. | 30 | 100 | 200 | ms |
| $t_{o\,h\,min}$ | Hold up time [1] | | | 20 | | |
| $\eta$ | Efficiency [1] | typ. | 68 | 73 | 78 | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3b: Output data 100 W types*

| Characteristics | | | PE 100-05 | PE 100-12 | PE 100-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | 24 | V |
| | Adjustable output voltage range | | | ±10 | | % |
| $U_{oL}$ | Overvoltage protection | max. | 6.9 | 15.5 | 31.0 | V |
| $I_o$ | Rated output current | | 20.0 | 8.3 | 4.2 | A |
| | Output current range | | | 0...100 | | % |
| $I_{o\,L}$ | Overcurrent protection [2] | | | 105 | | |
| $u_o$ | Ripple-noise [1] | max. | 120 | 120 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | 85...132 V<br>170...264 V | | ±3 | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | | ±3 | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) | typ. | | ±3 | | |
| $\alpha U_o$ | Change in temperature | 0...50 °C | | ±3 | | |
| $t_{o\,r}$ | Rise time [1] | max. | | 100 | | ms |
| $t_{o\,h\,min}$ | Hold up time [1] | | | 20 | | |
| $\eta$ | Efficiency [1] | typ. | 75 | 78 | 80 | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery


MELCHER® ISO 9001 certified

## Operation Instructions

### Input Voltage Selection

The input voltage range is set for 230 V AC when shipped. For 115 V AC application, the jumper has to be changed.

### Derating of Output Power

The output power derating depends on the structure of the power supply. The derating characteristics are shown in fig. 3.

### Output Voltage Adjustment

The output voltage adjustment range ($V_{ADJ}$ at the front panel) is ±10% of $U_{o\ nom}$. The actual output power should not exceed the spedified maximum output power.

### Sense Lines

The sense lines should be connected at the load. The sense line wires should be twisted to minimize pick-up of noise (see fig. 4).

### Overcurrent Protection

When the output current exceeds 105% of the rated current the overcurrent protection circuit operates (see fig. 5). The output will recover automatically as soon as the overload condition is removed. The overload condition should remain as short as possible.

### Overvoltage Protection

When there is an overvoltage condition at the output, the internal latch circuit will operate and the output will be cut off. In this instance, turn off the input. At least 90 seconds should be allowed as recovery time.

### Inrush Current

A power thermistor (PE 50) or a thyristor (PE 100) is built-in to protect against excessive inrush current. Appropriate selection of the AC input switch is recommended. Repeating switching cycles should be avoided i.e. permit at least two minutes recovery time.

### Insulation and Dielectric Strength Test

Preshipment tests have been applied at the factory and further testes are not necessary.

### Series Operation

Two power supplies, PS-1 and PS-2 for example, may be operated in series connection as shown in fig. 6a and 6b.

### Parallel Operation

**Do not connect the power supplies for parallel operation.**

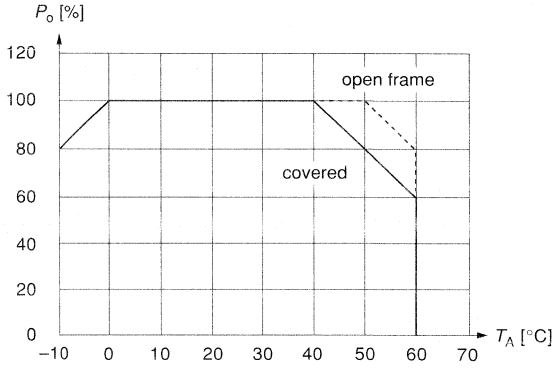



*Fig. 3*
*Output power vs. ambient temperature*

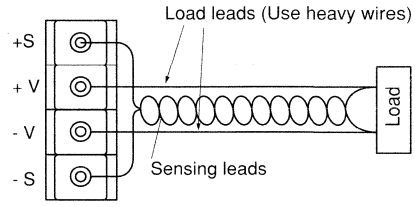



*Fig. 4*
*Sense line connection*

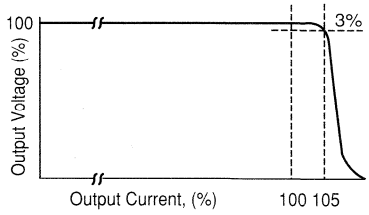



*Fig. 5*
*Output voltage vs. output current*

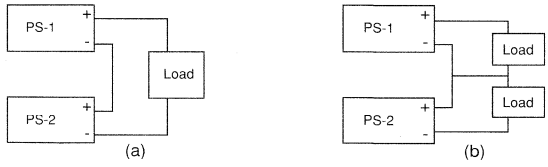



*Fig. 6*
*Power supplies connected in series*

9.3

*Table 4: Connector types (Molex)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | PE 50 | 5277-03A | 5196-03 | 5194 | 2 |
| DC output side | PE 50 | 5285-05A | 5198-03 | 5194 | 5 |

*Table 5: Cable kit (to be ordered separately from power supply)*

| Position at | Type of cable kit | Power supply | Material / Length / Cross section | Wire color | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | +V | –V | FG | AC | AC |
| AC input side | CB01 | PE 50 | UL 1015 / 60 cm / AWG 22 ≈ 0.34 mm² | – | – | – | Black | White |
| DC output | CB03 | PE 50 | UL 1007 / 60 cm / AWG 18 ≈ 1 mm² | Red x2 | Black x2 | Green | – | – |

## Immunity to Environmental Conditons

*Table 6: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | –10 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | –10 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 7: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity (no dew condensation) | Relative humidity: | 30...85% Unit operating/storage |
| Ea | Shock | Acceleration: Bump duration: Number of bumps: | 20 g (198 m/s²) 11 ms, ±5 ms 9 (3 each axis) Unit not operating |
| Fc | Vibration | Frequency: Maximum vibration amplitude: Acceleration: Duration: | 5...55 Hz 10 mm (5...10 Hz) 2 g (19.8 m/s²) 3 h (1 h each axis) Unit not operating |

*Table 8: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 3750 V AC, 1 minute | 3750 V AC, 1 minute leakage current <10 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

European Projection

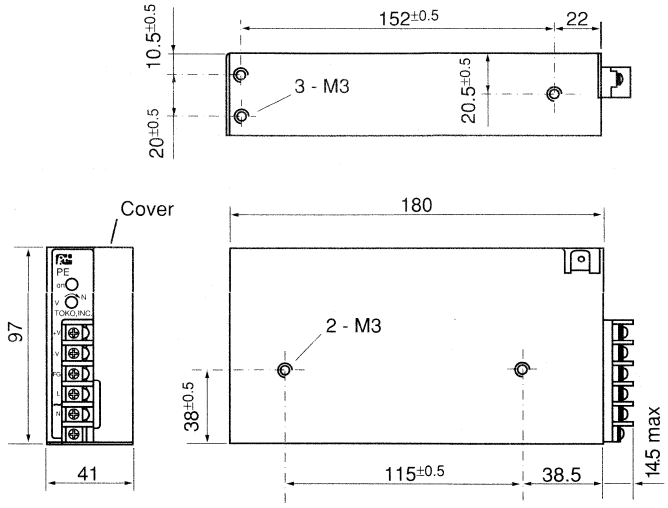



*Fig. 7*
*PE 50 covered or open frame with terminal strip, weight: 500 g*

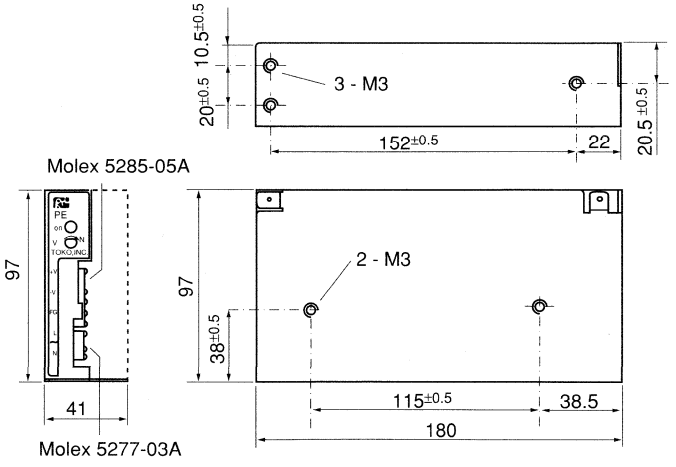



*Fig. 8*
*PE 50 open frame with connectors, weight: 500 g*

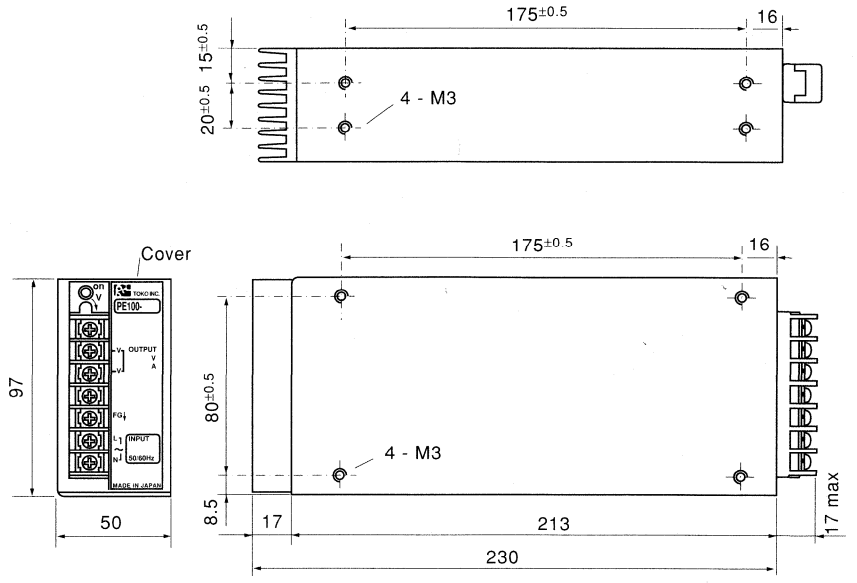



*Fig. 9*
*PE 100 covered or open frame with terminal strip, weight: 950 g*

## Type Key and Product Marking

**Type Key**

Family ..... PE
Blank .....
Nominal output power [W] ..... 50/100
Dash .....
Nominal output voltage [V] ..... 5...24
Structure and connections:
– Case with terminal strip ..... C
– Open frame with terminal strip ..... F

PE 100 - 12 C

Example: PE 100-12C = AC-DC converter providing 12 V/8.3 A, 100 W and configured as open case with terminal strip

**Produkt Marking**

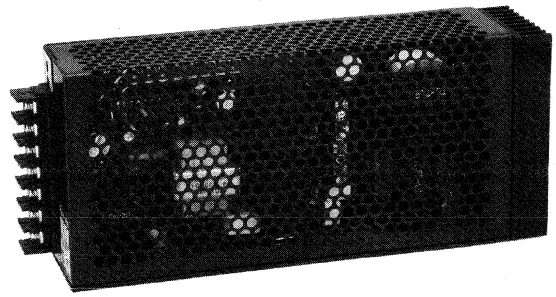
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 50/100 W AC-DC Converters

# PS-Family

**Single output**

- Ultra thin and compact
- High reliabiltiy
- Noise Standard: Meets FCC Class A
- Case or open frame structure
- Saftey according to UL 1950 (D3)



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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation Case Terminal strip | Open frame Terminal strip | Open frame Connector |
|---|---|---|---|---|---|---|
| 5 | 10.0 | 85...132 V AC 47...440 Hz or 110...175 V DC (PS 50) | 50 W | PS 50-05C | PS 50-05F | PS 50-05FC |
| 5 | 20.0 | | 100 W | PS 100-05C | PS 100-05F | – |
| 12 | 4.2 | | 50 W | PS 50-12C | PS 50-12F | PS 50-12FC |
| 12 | 8.3 | | 100 W | PS 100-12C | PS 100-12F | – |
| 24 | 2.1 | | 50 W | PS 50-24C | PS 50-24F | PS 50-24FC |
| 24 | 4.2 | | 100 W | PS 100-24C | PS 100-24F | – |

## Description

The switiching power supplies of the PS series were designed to meet the demand for high performance characteristics in a single output at low cost. All the models in this series have the UL recognition. Their low profile and compact structure, together with high reliability, has found many uses in various electronic equiment. Additionally, the refined exterior black finish will enhance the image of the final product.

**Key applications**

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection, and medical.

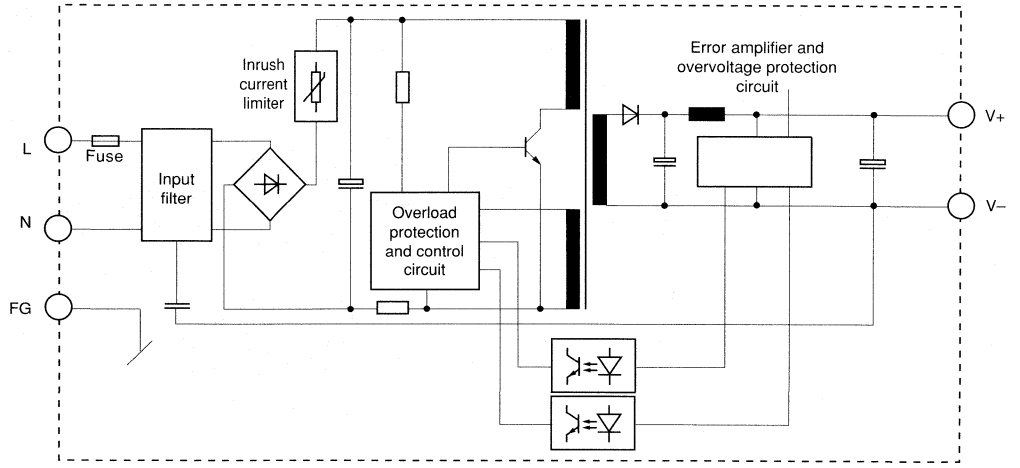
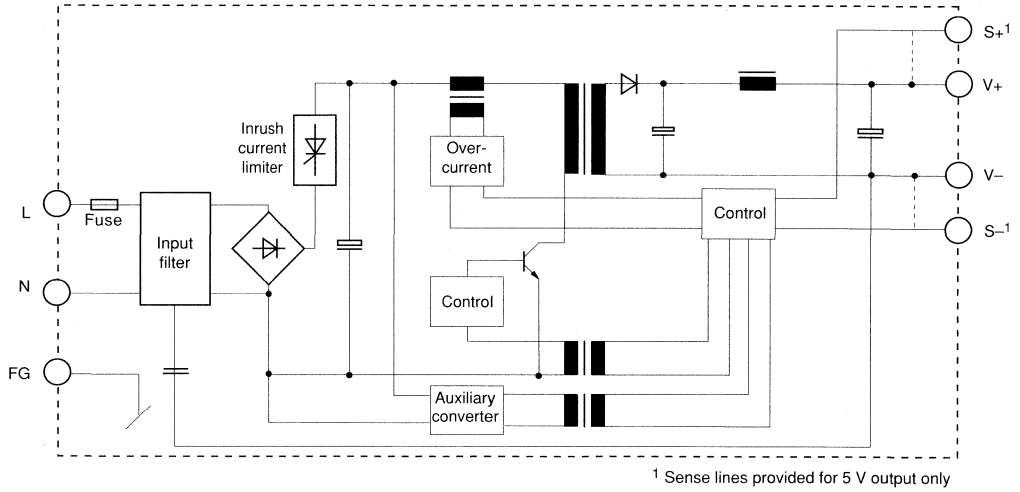



*Fig. 1*
*Block diagram PS 50*




[1] Sense lines provided for 5 V output only

*Fig. 2*
*Block diagram PS 100*

## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2a: Input data 50 W types*

| Characteristics | | | PS 50-05 | PS 50-12 | PS 50-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{i\,rated}$ | Rated input voltage | | 115 or 130 | | | V AC |
| $U_i$ | Input voltage range | | 85...132 | | | |
| $f_i$ | Line frequency | | 47...440 | | | Hz |
| $U_i$ | Input voltage range | | 110...175 | | | V DC |
| $I_i$ | Input current [1] | 115 V AC | 1.2 | | | A |
| $I_{i\,m}$ | Inrush current (max.) | 115 V AC | 30 | | | |
| $I_{i\,leak}$ | Leakage current (max.) | | 1 | | | mA |

[1] At rated input and output


MELCHER ISO 9001 certified

*Table 2b: Input data 100 W types*

| Characteristics | | | PS 100-05 | PS 100-12 | PS 100-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{i\,rated}$ | Rated input voltage | | 115 | | | V AC |
| $U_i$ | Input voltage range | | 85...132 | | | |
| $f_i$ | Line frequency | | 47...440 | | | Hz |
| $I_i$ | Input current [1] | 115 V AC | 2.0 | | | A |
| $I_{i\,m}$ | Inrush current (max.) | 115 V AC | 15 | | | |
| $I_{i\,leak}$ | Leakage current (max.) | | 1 | | | mA |

[1] At rated input and output

*General Condition:* $T_A$ = 25 °C *unless otherwise specified*

*Table 3a: Output data 50 W types*

| Characteristics | | | PS 50-05 | PS 50-12 | PS 50-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | 24 | V |
| | Adjustable output voltage range | | ±10 | | | % |
| $U_{oL}$ | Overvoltage protection | | 6.9 | 15.5 | 31.0 | V |
| $I_o$ | Rated output current | | 10.0 | 4.2 | 2.1 | A |
| | Output current range | | 0...100 | | | % |
| $I_{o\,L}$ | Overcurrent protection [2] | | 105 | | | |
| $u_o$ | Ripple-noise [1] | max. | 120 | 120 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | 85...132 V | ±3 | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±3 | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) | typ. | ±3 | | | |
| $\alpha U_o$ | Change in temperature | 0...50 °C | ±3 | | | |
| $t_{o\,r}$ | Rise time [1] | max. | 30 | 100 | 200 | ms |
| $t_{o\,h\,min}$ | Hold up time [1] | | 20 | | | |
| $\eta$ | Efficiency [1] | typ. | 69 | 73 | 78 | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3b: Output data 100 W types*

| Characteristics | | | PS 100-05 | PS 100-12 | PS 100-24 | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | 24 | V |
| | Adjustable output voltage range | | ±10 | | | % |
| $U_{oL}$ | Overvoltage protection | | 6.9 | 15.5 | 31.0 | V |
| $I_o$ | Rated output current | | 20.0 | 8.3 | 4.2 | A |
| | Output current range | | 0...100 | | | % |
| $I_{o\,L}$ | Overcurrent protection [2] | | 105 | | | |
| $u_o$ | Ripple-noise [1] | max. | 120 | 120 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | 85...132 V | ±3 | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±3 | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) | typ. | ±3 | | | |
| $\alpha U_o$ | Change in temperature | 0...50 °C | ±3 | | | |
| $t_{o\,r}$ | Rise time [1] | max. | 100 | | | ms |
| $t_{o\,h\,min}$ | Hold up time [1] | | 20 | | | |
| $\eta$ | Efficiency [1] | typ. | 75 | 78 | 80 | % |

[1] At rated input and output
[2] Operating at approx. 105% of rated power, constant current method, automatic recovery

## Operation Instructions

### Derating of Output Power

The output power derating depends on the structure of the power supply. The derating characteristics are shown in fig. 3.

### Output Voltage Adjustment

The output voltage adjustment range ($V_{ADJ}$ at the front panel) is ±10% of $U_{o\ nom}$. The actual output power should not exceed the spedified maximum output power.

### Sense Lines

The sense lines should be connected at the load. The sense line wires should be twisted to minimize pick-up of noise (see fig. 4).

### Overcurrent Protection

When the output current exceeds 105% of the rated current the overcurrent protection circuit operates (see fig. 5). The output will recover automatically as soon as the overload condition is removed. The overload condition should remain as short as possible.

### Overvoltage Protection

When there is an overvoltage condition at the output, the internal latch circuit will operate and the output will be cut off. In this instance, turn off the input. At least 90 seconds should be allowed as recovery time.

### Inrush Current

A power thermistor (PS 50) or a thyristor (PS 100) is built-in to protect against excessive inrush current. Appropriate selection of the AC input switch is recommended. Repeating switching cycles should be avoided i.e. permit at least two minutes recovery time.

### Insulation and Dielectric Strength Test

Preshipment tests have been applied at the factory and further testes are not necessary.

### Series Operation

Two power supplies, PS-1 and PS-2 for example, may be operated in series connection as shown in fig. 6a and 6b.

### Parallel Operation

**Do not connect the power supplies for parallel operation.**

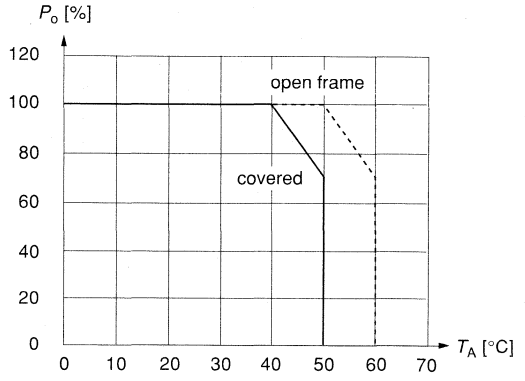



*Fig. 3*
*Output power vs. ambient temperature*

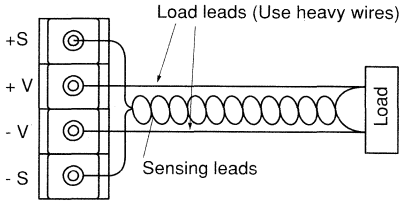



*Fig. 4*
*Sense line connection*

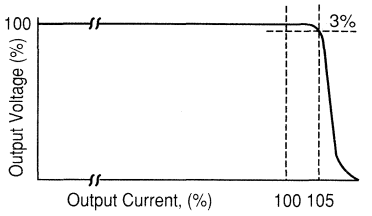



*Fig. 5*
*Output voltage vs. output current*

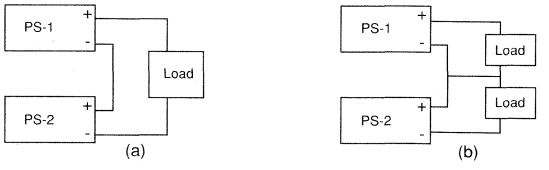



*Fig. 6*
*Power supplies connected in series*


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*Table 4: Connector types (Molex)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | PS 50 | 5277-03A | 5196-03 | 5194 | 2 |
| DC output side | PS 50 | 5285-05A | 5198-05 | 5194 | 5 |

*Table 5: Cable kit (to be ordered separately from power supply)*

| Position at | Type of cable kit | Power supply | Material / Length / Cross section | Wire color | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | +V | –V | FG | AC | AC |
| AC input side | CB01 | PS 50 | UL 1015 / 60 cm / AWG 22 ≈ 0.34 mm² | – | – | – | Black | White |
| DC output side | CB03 | PS 50 | UL 1007 / 60 cm / AWG 18 ≈ 1 mm² | Red ×2 | Black ×2 | Green | – | – |

## Immunity to Environmental Conditons

*Table 6: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 7: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity (no dew condensation) | Relative humidity: | 30...85% Unit operating/storage |
| Ea | Shock | Acceleration: Bump duration: Number of bumps: | 20 g (198 m/s²) 11 ms, ±5 ms 9 (3 each axis) Unit not operating |
| Fc | Vibration | Frequency: Maximum vibration amplitude: Acceleration: Duration: | 5...55 Hz 10 mm (5...10 Hz) 2 g (19.8 m/s²) 3 h (1 h each axis) Unit not operating |

*Table 8: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 1500 V AC, 1 minute | 1500 V AC, 1 minute leakage current <10 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

European Projection

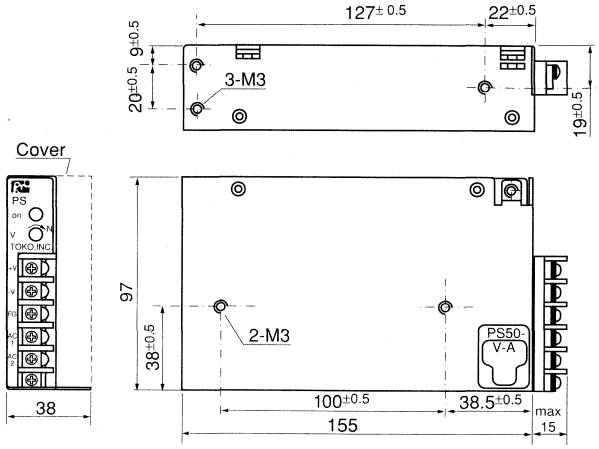



*Fig. 4*
*PS 50, weight 410 g*

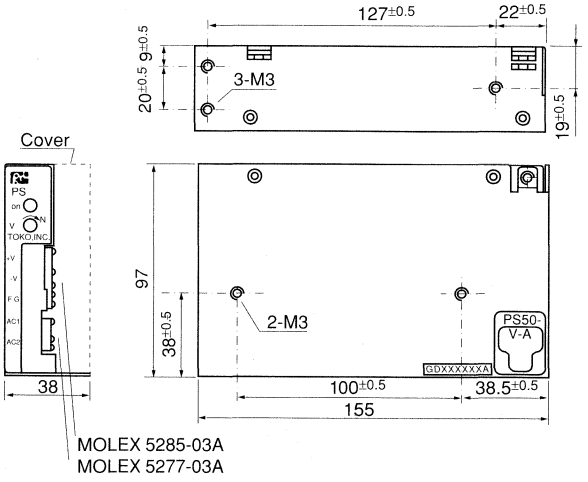



*Fig. 5*
*PS 50, weight 410 g*


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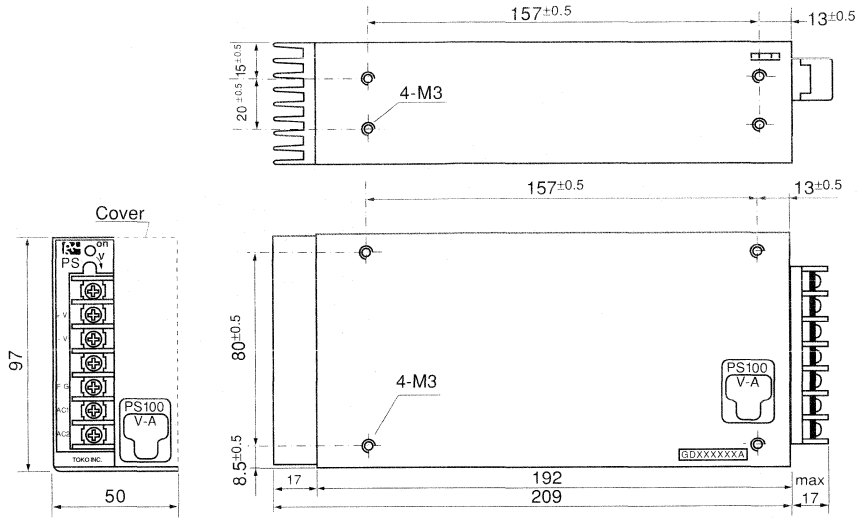



*Fig. 6*
*PS 100, weight 880 g*

## Type Key and Product Marking

**Type Key**

| | |
|---|---|
| Family | PS |
| Blank | |
| Nominal output power [W] | 50/100 |
| Dash | |
| Nominal output voltage [V] | 5...24 |
| Structure and connections: | |
| – Case with terminal strip | C |
| – Open frame with terminal strip | F |
| – Open frame with connector [1] | FC |

PS 100 - 12 C

[1] PS 50 models only

Example: PS 100-12C = AC-DC converter providing 12 V/8.3 A, 100 W and configured as open case with terminal strip

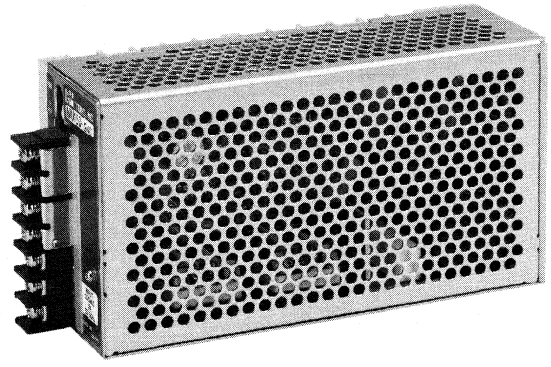
**Produkt Marking**

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 50/75/100 W AC-DC Converters PT-Family

**Triple output**

- Wide range of power ratings available
- Designed for high perfomance in operation
- Available with variations in structure (option)
- Designed to meet with regulations relative to FCC
- Wide input voltage range
- Safety according to UL 1950 (D3)



## Table of Contents


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## Type Survey

*Table 1: Type survey*

| Output 1 $U_{o\,nom}$ V DC | Output 1 $I_{o\,nom}$ A | Output 2 $U_{o\,nom}$ V DC | Output 2 $I_{o\,nom}$ A | Output 3 $U_{o\,nom}$ V DC | Output 3 $I_{o\,nom}$ A | Input voltage range $U_{i\,min}$...$U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 40 °C | Type designation Case Terminal strip | Open frame Terminal strip | Open frame Connector |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 5.0 | 12 | 1.0 | –12 | 1.0 | 90...132 V AC 47...63 Hz | 50 W | PT 50-01C | PT 50-01F | PT 50-01FC |
| 5 | 5.0 | 12 | 1.0 | –12 | 1.0 | | | PT 50-02C | PT 50-02F | PT 50-02FC |
| 5 | 6.0 | 12 | 1.2 | –12 | 0.3 | | | PT 50-03C | PT 50-03F | PT 50-03FC |
| 5 | 10.0 | 12 | 1.0 | –12 | 1.0 | | 75 W | PT 75-01C | PT 75-01F | PT 75-01FC |
| 5 | 10.0 | 12 | 1.0 | –12 | 1.0 | | | PT 75-02C | PT 75-02F | PT 75-02FC |
| 5 | 12.0 | 12 | 0.5 | –12 | 0.5 | | | PT 75-03C | PT 75-03F | PT 75-03FC |
| 5 | 9.0 | 12 | 2.0 | –12 | 0.5 | | | PT 75-04C | PT 75-04F | PT 75-04FC |
| 5 | 9.0 | 15 | 1.0 | –15 | 1.0 | | | PT 75-11C | PT 75-11F | PT 75-11FC |
| 5 | 12.0 | 12 | 3.0 | –12 | 0.5 | | 100 W | PT 100-01C | PT 100-01F | PT 100-01FC |
| 5 | 12.0 | 12 | 3.0 | –12 | 0.5 | | | PT 100-02C | PT 100-02F | PT 100-02FC |

9.3

## Description

The PT series is UL approved, suitable for various applications and available in different packaging structures. The units provide three channel where by different versions of current setting and regulation precision are available. Highest degree of circuit engineering has been applied to meet critical demands for high efficiency, small size, light weight, safety regulations and low cost.

### Key applications

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

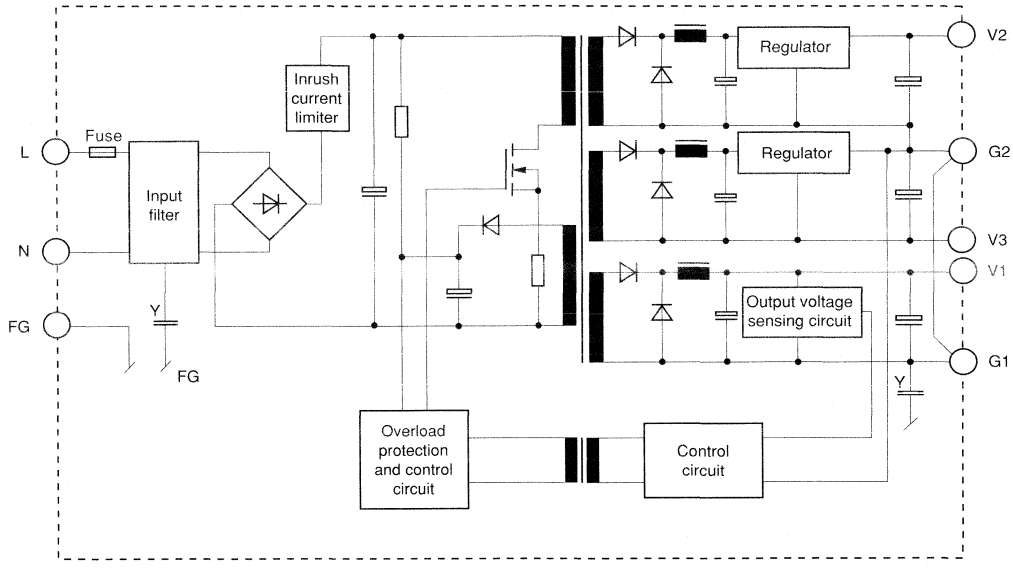



*Fig. 1*
*Block diagram PT 50/75/100*

## Electrical Input and Output Data

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 2: Input data*

| Characteristics | | PT 50- .. | PT 75- .. | PT 100- .. | Unit |
|---|---|---|---|---|---|
| $U_{i\,nom}$ | Nominal input voltage | 115, 120 | | | V AC |
| $U_i$ | Input voltage range | 90...132 | | | |
| $f_i$ | Line frequency | 47...63 | | | Hz |
| $I_i$ | Input current (typ.) [1] | 1.1 | 1.6 | 2.3 | A |
| $I_{i\,m}$ | Inrush current (max.) [1] | 30 | 15 | 15 | |
| $I_{i\,leak}$ | Leakage current (max.) | 1 | | | mA |

[1] At rated input and output

*Table 3a: Output data 50 W types*

| Type | | PT 50-01 | | | PT 50-02 | | | PT 50-03 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | V1 | V2 | V3 | V1 | V2 | V3 | V1 | V2 | V3 | Unit |
| $U_{o\,nom}$ | Onput voltage | +5 | +12 | −12 | +5 | +12 | −12 | +5 | +12 | −12 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±5 | ±5 | ±1 | ±5 | ±5 | ±1 | ±2 | ±5 | % |
| $I_{o\,set}$ | set at a load of [1] | 3.25 | 0.5 | 0.5 | 3.5 | 0.6 | 0.6 | 3.9 | 1.0 | 0.15 | A |
| $U_{oL}$ | Overvoltage protection | 7 | - | - | 7 | - | - | 7 | - | - | V |
| $I_o$ | Rated output current min. | 1.5 | 0 | 0 | 2 | 0.2 | 0.2 | 1.8 | 0 | 0 | A |
| | typ. | 5 | 1 | 1 | 5 | 1 | 1 | 6 | 1.2 | 0.3 | |
| | max. | 5 | 1 | 1 | 5 | 1 | 1 | 6 | 1.2 | 0.3 | |
| $I_{o\,L}$ | Overcurrent protection [4] | 105 | | | | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 49 | | | 48 | | | 49 | | | W |
| $P_{o\,max}$ | Output power | 25 | 12 | 12 | 25 | 12 | 12 | 30 | 14.4 | 3.6 | |
| $u_o$ | Ripple [2] max. | 80 | 100 | 100 | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [2] max. | 150 | 200 | 200 | 150 | 200 | 200 | 150 | 200 | 200 | |
| $\Delta U_{o\,U}$ | Line regulation [3] 85...264 V | ±2 | ±0.5 | ±0.5 | ±2 | ±8 | ±8 | ±2 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation [3] 0...100% | ±2 | ±1 | ±1 | ±2 | ±8 | ±8 | ±2 | ±1 | ±0.6 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 hours) typ. | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | |
| $\alpha U_o$ | Change in Temp. 0...50°C | ±1 | ±1 | ±1 | ±1 | ±1.5 | ±1.5 | ±1 | ±1 | ±1 | |
| $t_{o\,r}$ | Rise time [2] max. | 150 | | | | | | | | | ms |
| $t_{o\,h}$ | Hold up time [2] min. | 20 | | | | | | | | | |
| $\eta$ | Efficiency [1] typ. | 65 | | | 70 | | | 65 | | | % |

*Table 3b: Output data 75 W types*

| Type | | PT 75-01 | | | PT 75-02 | | | PT 75-03 | | | PT 75-04 | | | PT 75-11 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | V1 | V2 | V3 | V1 | V2 | V3 | V1 | V2 | V3 | V1 | V2 | V3 | V1 | V2 | V3 | Unit |
| $U_{o\,nom}$ | Onput voltage | +5 | +12 | −12 | +5 | +12 | −12 | +5 | +12 | −12 | +5 | +12 | −12 | +5 | +15 | −15 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±5 | ±5 | ±1 | ±5 | ±5 | ±1 | ±5 | ±5 | ±1 | ±2 | ±5 | ±1 | ±5 | ±5 | % |
| $I_{o\,set}$ | set at a load of [1] | 6.5 | 0.5 | 0.5 | 7 | 0.6 | 0.6 | 7.8 | 0.25 | 0.25 | 5.85 | 1 | 0.25 | 5.85 | 0.5 | 0.5 | A |
| $U_{oL}$ | Overvoltage protection | 7 | - | - | 7 | - | - | 7 | - | - | 7 | - | - | 7 | - | - | V |
| $I_o$ | Rated output current min. | 3 | 0 | 0 | 4 | 0.2 | 0.2 | 3.6 | 0 | 0 | 2.7 | 0 | 0 | 2.7 | 0 | 0 | A |
| | typ. | 10 | 1 | 1 | 10 | 1 | 1 | 12 | 0.5 | 0.5 | 9 | 2 | 0.5 | 9 | 1 | 1 | |
| | max. | 10 | 1 | 1 | 10 | 1 | 1 | 12 | 0.5 | 0.5 | 9 | 2 | 0.5 | 9 | 1 | 1 | |
| $I_{o\,L}$ | Overcurrent protection [4] | 105 | | | | | | | | | | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 74 | | | 74 | | | 72 | | | 75 | | | 75 | | | W |
| $P_{o\,max}$ | Output power | 50 | 12 | 12 | 50 | 12 | 12 | 60 | 6 | 6 | 45 | 24 | 6 | 45 | 15 | 15 | |
| $u_o$ | Ripple [2] max. | 80 | 100 | 100 | 80 | 100 | 100 | 80 | 100 | 100 | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [2] max. | 150 | 200 | 200 | 150 | 200 | 200 | 150 | 200 | 200 | 150 | 200 | 200 | 150 | 200 | 200 | |
| $\Delta U_{o\,U}$ | Line regulation [3] 85...264 V | ±2 | ±0.5 | ±0.5 | ±2 | ±8 | ±8 | ±2 | ±0.5 | ±0.5 | ±2 | ±0.5 | ±0.5 | ±2 | ±0.5 | ±0.5 | % |
| $\Delta U_{o\,I}$ | Load regulation [3] 0...100% | ±2 | ±1 | ±1 | ±2 | ±8 | ±8 | ±2 | ±1 | ±1 | ±2 | ±1 | ±1 | ±2 | ±1 | ±1 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 hours) typ. | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | |
| $\alpha U_o$ | Change in temp. 0...50°C | ±1 | ±1 | ±1 | ±1 | ±1.5 | ±1.5 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | ±1 | |
| $t_{o\,r}$ | Rise time [2] max. | 150 | | | | | | | | | | | | | | | ms |
| $t_{o\,h}$ | Hold up time [2] min. | 20 | | | | | | | | | | | | | | | |
| $\eta$ | Efficiency [1] typ. | 70 | | | 75 | | | 70 | | | 70 | | | 70 | | | % |

[1] Output voltages are set at factory for the load condition, as indicated, at the terminals or connectors
[2] At rated input and output and normal temperature
[3] For each useable range as follows • Line regulation: Within the input voltage range • Load regulation: Within the output current range
[4] Operating at approx. 105% of rated power, constant current method, automatic recovery





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*Table 3c: Output data 100 W types*

| Type | | PT 100-01 | | | PT 100-02 | | | Unit |
|---|---|---|---|---|---|---|---|---|
| Characteristics | | V1 | V2 | V3 | V1 | V2 | V3 | |
| $U_{o\,nom}$ | Onput voltage | 5 | 12 | –12 | 5 | 12 | –12 | V |
| $\Delta U_o$ | Voltage setting tolerance | ±1 | ±1 | ±5 | ±1 | ±5 | ±5 | % |
| $I_{o\,set}$ | set at a load of [1] | 7.8 | 1.5 | 0.25 | 8.25 | 1.8 | 0.3 | A |
| $U_{oL}$ | Overvoltage protection | 7 | - | - | 7 | - | - | V |
| $I_o$ | Rated output current min. | 3.6 | 0 | 0 | 4.5 | 0.6 | 0.1 | A |
| | typ. | 12 | 3 | 0.5 | 12 | 3 | 0.5 | |
| | max. | 12 | 3 | 0.5 | 12 | 3 | 0.5 | |
| $I_{o\,L}$ | Overcurrent protection [4] | 105 | | | | | | % |
| $P_{o\,tot}$ | Total rated output | 102 | | | 102 | | | W |
| $P_{o\,max}$ | Output power | 60 | 36 | 6 | 60 | 36 | 6 | |
| $u_o$ | Ripple [2] max. | 80 | 100 | 100 | 80 | 100 | 100 | mVpp |
| $u_o$ | Ripple-noise [2] max. | 150 | 250 | 250 | 150 | 250 | 250 | |
| $\Delta U_{o\,U}$ | Line regulation [3] 85...264 V | ±2 | ±2 | ±0.5 | ±2 | ±8 | ±8 | % |
| $\Delta U_{o\,I}$ | Load regulation [3] 0...100% | ±2 | ±2 | ±1 | ±2 | ±8 | ±8 | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 hours) typ. | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 | |
| $\alpha U_o$ | Change in Temp. 0...50°C | ±1 | ±1 | ±1 | ±1 | ±1.5 | ±1.5 | |
| $t_{o\,r}$ | Rise time [2] max. | 150 | | | | | | ms |
| $t_{o\,h}$ | Hold up time [2] min. | 20 | | | | | | |
| $\eta$ | Efficiency [1] typ. | 65 | | | 75 | | | % |

[1] Output voltages are set at factory for the load condition, as indicated, at the terminals or connectors
[2] At rated input and output and normal temperature
[3] For each useable range as follows • Line regulation: Within the input voltage range • Load regulation: Within the output current range
[4] Operating at approx. 105% of rated power, constant current method, automatic recovery

## Operation Instructions

### Input and Output Terminals

*Table 4: Input and output terminals*

| Marking | Use | Remarks |
|---|---|---|
| AC 1<br>AC 2 | AC Input | 1. For AC input 85...132 V, single phase; 47...63 Hz sine wave.<br>2. Use a 2-conductor or twisted wires<br>3. Keep the AC input and DC output leads well separated |
| FG | Frame ground terminal | For connection to equipment; use a low impedance lead |
| V1 | Output Terminal 1 | For 5 V DC |
| V2 | Output Terminal 2 | For 12 V DC or 15 V DC |
| V3 | Output Terminal 3 | For –12 V DC, –15 V DC or –5 V DC |
| G1<br>G2 | Ground Terminals | G1 for V1<br>G2 for V2 and V3 (G1 and G2 are internally interconnected) |

### Proper Method of Supplying Power

To supply the proper voltages from each of the three ouput channels, the load currents must be within the minimum-maximum ratings. If the load current is below the minimum, connect a dummy load.

### Output Voltage Settings

The output voltages for all PT types are factory set.

### Overcurrent Protection

Each channel has its own built-in overload protection at approx. 105% of the rated currents. In event of overloading, the load should be removed immediately and the circuit resets automatically.The V2 and V3 outputs for PT 50, PT 75 and PT 100-02 are provided with a fuse as overload protection. Should a fuse have blown and the defect has been remedied, replace only with fuse of same type and rating.

### Overvoltage Protection

The 5 V output V1 is equipped with an internal overvoltage sensing circuit. It acts as a latch circuit above 7 V and after the defect has been remedied, the reset is made by off/on switching the input voltage.

### Inrush Current

Each type is provided with inrush current protection namely, power thermistor for PT 50, and thyristor for PT 75 and PT 100. The AC power switch should be of ample rating to meet with inrush current requirements. Quick turn on and off operating should be avoided. Recovery times of thermistor min. 2 minutes and of thyristor min. 10 seconds.

### Series or Parallel Operation

The outputs cannot be operated in series or parallel with other sources.

### Derating Characteristics

The relation between the ambient temperature ($T_A$) and the rated output power is shown in fig. 2. Operating the power supply at 40°C or 50°C respectively, each output current should remain below 40% of its maximum rated value.

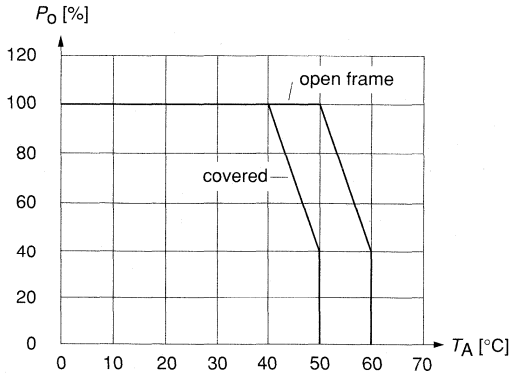



*Fig. 2*
*Output power vs. ambient temperature*

*Table 5: Connector types (Molex)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | PT 50, 75, 100 | 5277-04A | 5196-04 | 5194 | 3 |
| DC output side | PT 50<br>PT 75, 100 | 5285-07A<br>5285-03A, 06A | 5198-07<br>5198-03, 06 | 5194<br>5194 | 7<br>9 |

*Table 6: Cable kit (to be ordered separately from power supply)*

| Position at | Type of cable kit | Power supply | Material \| Length<br>Cross section | Wire color | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | V1 | V2 | V3 | G1/G2 | AC (L) | AC (N) | FG |
| AC input side | CB04 | PT 50, 75 100 | UL 1015 \| 60 cm<br>AWG 22 ≈ 0.34 mm² | – | – | – | – | Black | White | Green |
| DC output side | CB06 | PT 50 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | Red ×2 | Brown | Blue | Black ×2/×1 | – | – | – |
| | CB07 | PT 75 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | Red ×3 | Brown | Blue | Black ×2/×1 | – | – | – |
| | CB07 | PT 100 | UL 1007 \| 60 cm<br>AWG 18 ≈ 1 mm² | Red ×3 | Brown | Blue | Black ×3 | – | – | – |

## Immunity to Environmental Conditions

*Table 7: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 2) | 0 | 50 | |
| $T_A$ | Storage temperature range | –20 | 75 | |

*Table 8: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (198 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.8 m/s²)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 9: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 1500 V AC, 1 minute | 1500 V AC, 1 minute leakage current <10 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

European Projection

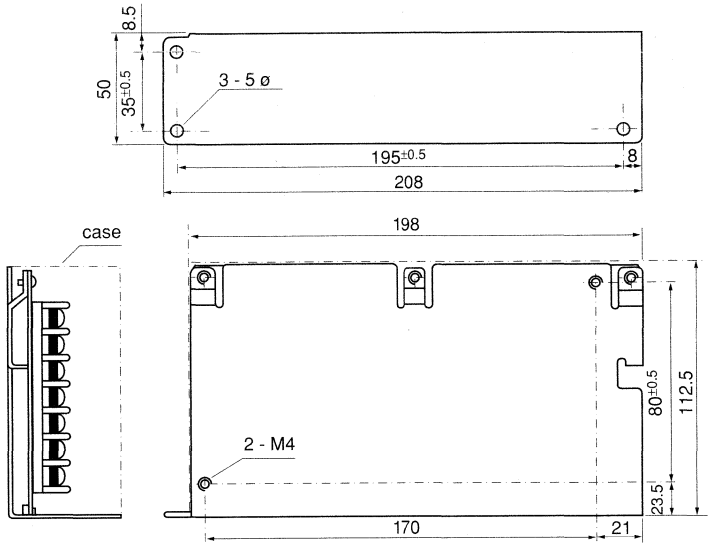



*Fig. 3*
*PT 50, weight 880 g*

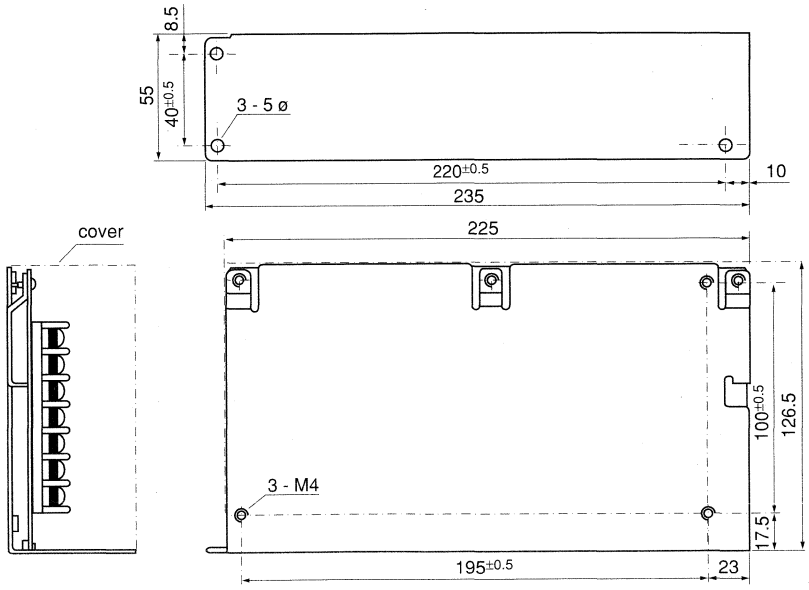



*Fig. 4*
*PT 75, weight: 1150 g*

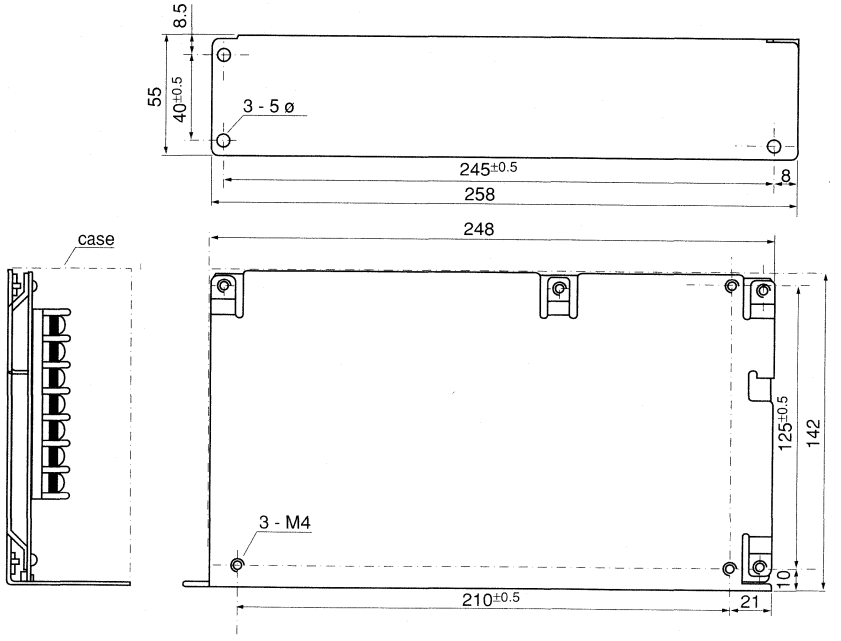



*Fig. 5*
*PT 100, weight: 1350 g*

## Type Key and Product Marking

### Type Key

PT 75 – 11 FC

Family ..... PT
Blank .....
Nominal output power [W] ..... 50...100
Dash .....
Output configuration ..... 01...11
Structure and connections
– Case with terminal strip ..... C
– Open frame with terminal strip ..... F
– Open frame with connector ..... FC

Example: PT 75-11 FC = AC-DC converter providing 75 W on three outputs: 5 V/9 A, 15 V/1.0 A, –15 V/1.0 A and configured as open frame with connectors

### Produkt Marking

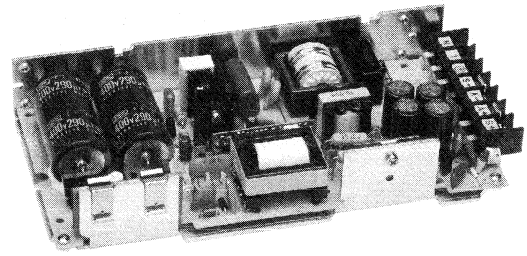
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 50/75/100 W AC-DC Converters

# SW-Family

**Input to output isolation**
**Singie output**

- Ultra thin and compact
- High isolation
- Universal input (85...264 V AC)
- Noise standard: meets FCC class A or B
- Safety standard: UL 1950 (D3) approved, CSA 22.2 No.950 (D3) approved



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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 40 °C | Type designation Case Terminal strip | Open frame Terminal strip | Open frame Connector |
|---|---|---|---|---|---|---|
| 5 | 10.0 | 85...264 V AC 47...63 Hz | 50 W | SW 50-05C | SW 50-05F | SW 50-05FC |
| 5 | 20.0 | | 100 W | SW 100-05C | SW 100-05F | SW 100-05FC |
| 12 | 4.2 | | 50 W | SW 50-12C | SW 50-12F | SW 50-12FC |
| 12 | 6.3 | | 75 W | SW 75-12C | SW 75-12F | SW 75-12FC |
| 12 | 8.3 | | 100 W | SW 100-12C | SW 100-12F | SW 100-12FC |
| 15 | 3.4 | | 50 W | SW 50-15C | SW 50-15F | SW 50-15FC |
| 15 | 5.0 | | 75 W | SW 75-15C | SW 75-15F | SW 75-15FC |
| 15 | 6.7 | | 100 W | SW 100-15C | SW 100-15F | SW 100-15FC |
| 24 | 2.1 | | 50 W | SW 50-24C | SW 50-24F | SW 50-24FC |
| 24 | 3.1 | | 75 W | SW 75-24C | SW 75-24F | SW 75-24FC |
| 24 | 4.2 | | 100 W | SW 100-24C | SW 100-24F | SW 100-24FC |
| 48 | 1.6 | | 75 W | SW 75-48C | SW 75-48F | SW 75-48FC |
| 48 | 2.1 | | 100 W | SW 100-48C | SW 100-48F | SW 100-48FC |

## Description

The SW series is a new single ouptut series of AC-DC converters. Compact size and high reliability make the SW series an excellent choice when a very low profile is required. Three standard single output ratings are available, all with universal AC input.

**Key applications**

Equipment for office automation, factory automation, peripheral, communication, security, display, test and measurement, inspection and medical.

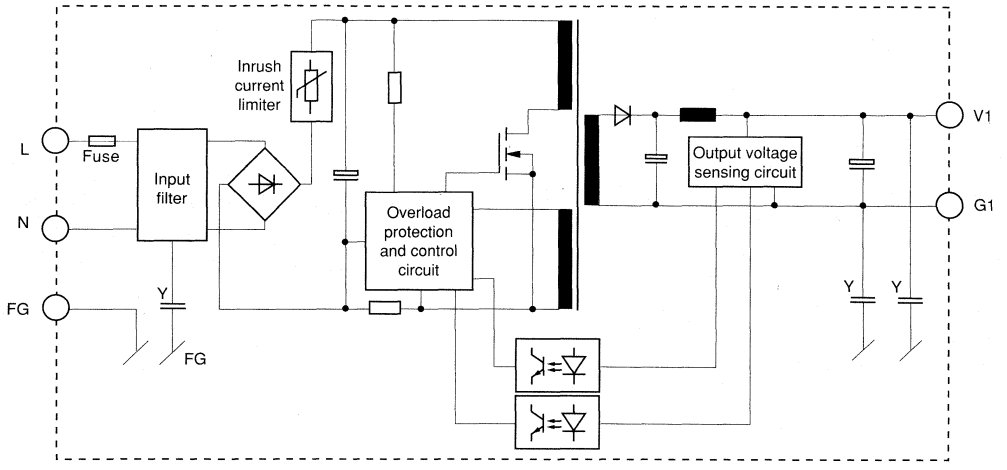



*Fig. 1*
*Block diagram SW 50*

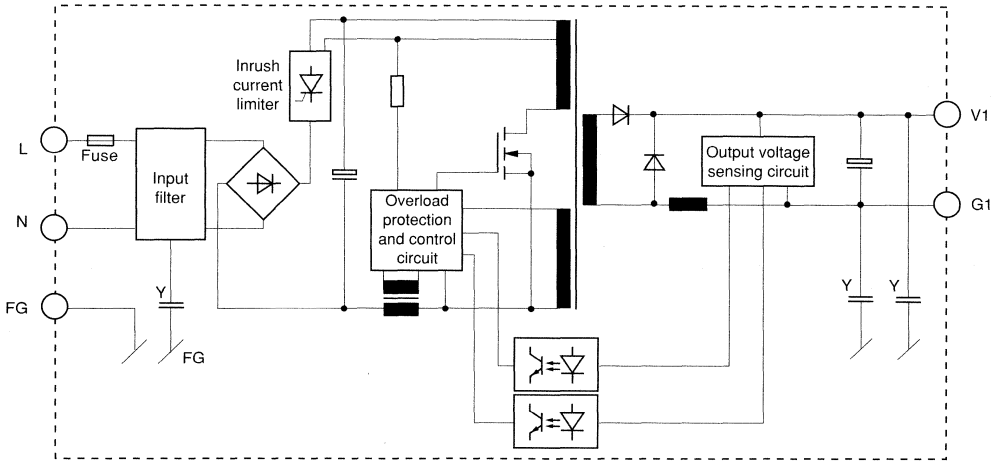



*Fig. 2*
*Block diagram SW 75/100*

## Electrical Input and Output Data

General condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | SW 50-.. | SW 75-.. | SW 100-.. | Unit |
|---|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 100-120/200-240 | | | V AC |
| $U_i$ | Input voltage range | | 85...264 | | | |
| $f_i$ | Line frequency | | 47...63 | | | Hz |
| $I_i$ | Input current [1] | 100/200 V AC | 1.2/0.7 | 1.8/1.0 | 2.0/1.2 | A |
| $I_{inr}$ | Inrush current (max.) | 100/200 V AC | 45/90 | | | |
| $I_{i\ leak}$ | Leakage current (max.) | 120/240 V AC | 0.5/0.75 | | | mA |

[1] At rated input and output

General condition: $T_A$ = 25°C unless otherwise specified

*Table 3a: Output data 50 W types*

| Characteristics | | SW 50-05.. | SW 50-12.. | SW 50-15.. | SW 50-24.. | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Nominal output voltage | 5 | 12 | 15 | 24 | V |
| $U_o$ | Adjustment range | ±10 | | | | % |
| $I_{o\,nom}$ | Rated output current | 10 | 4.2 | 3.4 | 2.1 | A |
| $I_o$ | Output current min./max. | 0...100 | | | | % |
| $u_o$ | Ripple-noise [1] max. | 120 | 120 | 150 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±3 | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±3 | | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | ±3 | | | | |
| $\alpha_{Uo}$ | Change in temp. 0...50°C | ±3 | | | | |
| $I_{o\,L}$ | Overcurrent protection | 105 | | | | |
| $U_{o\,L}$ | Overvoltage protection, max. | 6.9 | 15.5 | 20 | 31 | V |
| | Remote sensing | Not provided | | | | |
| | Output indicator | LED on PCB | | | | |
| $t_{o\,r}$ | Rise time [1] | 30 | 100 | 150 | 200 | ms |
| $t_{h\,min}$ | Hold-up time [1] 100 V AC | 15 | | | | |
| $\eta$ | Efficiency [1] typ. | 70 | 75 | 75 | 75 | % |

[1] At rated input and output
[2] Constant current method, automatic recovery

General condition: $T_A$ = 25°C unless otherwise specified

*Table 3b: Output data 75 W types*

| Characteristics | | SW 75-12.. | SW 75-15.. | SW 75-24.. | SW 75-48.. | Unit |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | 12 | 15 | 24 | 48 | V |
| $U_o$ | Adjustment range | ±10 | | | | % |
| $I_{o\,nom}$ | Rated output current | 6.3 | 5 | 3.1 | 1.5 | A |
| $I_o$ | Output current min./max. | 0...100 | | | | % |
| $u_o$ | Ripple-noise [1] max. | 120 | 150 | 200 | 400 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±3 | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±3 | | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 h) typ. | ±3 | | | | |
| $\alpha_{Uo}$ | Change in temp. 0...50°C | ±3 | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | |
| $U_{o\,L}$ | Overvoltage protection, max. | 15.5 | 20 | 31 | 59 | V |
| | Remote sensing | Not provided | | | | |
| | Output indicator | LED on PCB | | | | |
| $t_{o\,r}$ | Rise time [1] | 100 | 150 | 200 | 400 | ms |
| $t_{h\,min}$ | Hold-up time [1] 100 V AC | 15 | | | | |
| $\eta$ | Efficiency [1] typ. | 75 | 75 | 80 | 80 | % |

[1] At rated input and output
[2] Constant current method, automatic recovery

General condition: $T_A$ = 25°C unless otherwise specified

*Table 3c: Output data 100 W types*

| Characteristics | | SW 100-05.. | SW 100-12.. | SW 100-15.. | SW 100-24.. | SW 100-48.. | Unit |
|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | 5 | 12 | 15 | 24 | 48 | V |
| $U_o$ | Adjustment range | ±10 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 20 | 8.3 | 6.7 | 4.2 | 2.1 | V |
| $I_o$ | Output current min./max. | 0...100 | | | | | % |
| $U_o$ | Ripple-noise [1] max. | 150 | 150 | 200 | 200 | 400 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±3 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±3 | | | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8) typ. | ±3 | | | | | |
| $\alpha_{Uo}$ | Change in temp. 0...50°C | ±3 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105 | | | | | |
| $U_{o\,L}$ | Overvoltage protection max. | 6.9 | 15.5 | 20 | 31 | 59 | V |
| | Remote sensing | 5 V only, not provided with other outputs | | | | | |
| | Output indicator | LED on PCB | | | | | |
| $t_{o\,r}$ | Rise time [1] | 30 | 100 | 150 | 200 | 400 | ms |
| $t_{h\,min}$ | Hold up time [1] 100 V AC | 15 | | | | | |
| $\eta$ | Efficiency [1] typ. | 75 | 75 | 75 | 80 | 80 | % |

[1] At rated input and output, [2] Constant current method, automatic recovery

## Operation Instructions

### Input and Output Terminals

*Table 4: Input and output terminals*

| Terminal | Function | Explanation |
|---|---|---|
| L (line)<br>N (neutral) | Input terminal | • Connect to AC of 85 to 264 V, 47...63 Hz, sine wave, single phase<br>• Space the AC input line as far as possible from the DC output line. |
| FG | Frame ground terminal | • Frame grounding, connect with min. impedance to ground of main chassis. |
| +V | Output Terminal | • Output voltage. |

### Output Power Derating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 3. When the power supply is used at an ambient temperature of 60°C, the output power has to be reduced to 60% of the rated maximum value.

### Series and Parallel Connection

The outputs of the SW modules cannot be operated in series or parallel connection.

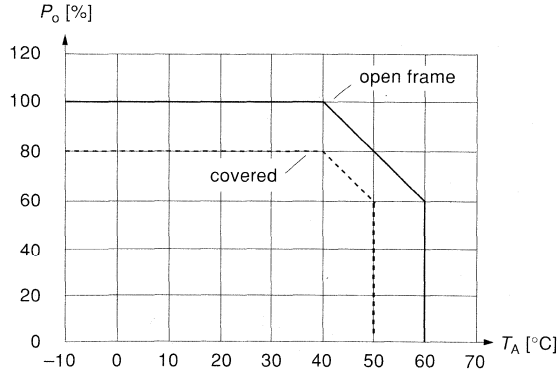



*Fig. 3*
*Output power vs. ambient temperature*

*Table 5: Connector types (JST)*

| Used at | Power supply side | | Opposite side | | |
|---|---|---|---|---|---|
| | Power supply type | Connector type | Mating housing | Terminals | Quantity |
| AC input side | SW 50, 75, 100 | B4P (6-2.4)-VH | VHR-6N | SVH-21T-P1.1 | 4 |
| DC output side | SW 50 | B4P-VH | VHR-4N | SVH-21T-P1.1 | 4 |
| | SW 75 | B7P-VH | VHR-7N | SVH-21T-P1.1 | 7 |
| | SW 100 | B8P-VH | VHR-8N | SVH-21T-P1.1 | 8 |

*Table 6: Cable kit*

| Position at | Type of cable kit | Power supply | Material / Length / Cross section | Wire color | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | +V | -V | FG | LN |
| AC input side | CB-24 | SW 50, 75, 100 | UL 1015 / 60 cm / AWG 22 ≈ 0.34 mm² | – | – | Green | Black | White |
| DC output side | CB-21 | SW 50 | UL 1430 / 60 cm / AWG 18 ≈ 1 mm² | Red ×2 | Black ×2 | – | – | – |
| | CB-22 | SW 75 | UL 1430 / 60 cm / AWG 18 ≈ 1 mm² | Red ×3 | Black ×4 | – | – | – |
| | CB-23 | SW 100 | UL 1430 / 60 cm / AWG 18 ≈ 1 mm² | Red ×4 | Black ×4 | – | – | – |

**Mounting Methods**

Care should be taken that there is sufficient air convection around the power supply unit.

Whenever possible, forced air cooling is recommended to obtain a higher reliability.

For open frame or covered structures:

a) Horizontal mounting: Use tapped holes at bottom side of the frame for fastening to the chassis. Use M3 screws with torque at less than 5 kpcm. Screw length should not damage the insulation.

b) Vertical mounting: Holes are provided on the flange; M3 screws should be used.

## Immunity to Environmental Conditions

*Table 7: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 8: Humidity, shock and vibration*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity (no dew condensation) | Relative humidity: | 30...85% Unit operating/storage |
| Ea | Shock | Acceleration: Bump duration: Number of bumps: | 20 g (198 m/s²) 11 ms, ±5 ms 9 (3 each axis) Unit not operating |
| Fc | Vibration | Frequency: Maximum vibration amplitude: Acceleration: Duration: | 5...55 Hz 10 mm (5...10 Hz) 2 g (19.8 m/s², 10...55 Hz) 3 h (1 h each axis) Unit not operating |

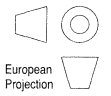
*Table 9: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 2000 V AC, 1 minute | – leakage current <10 mA. | – |
| Insulation resistance [1] | >100 MΩ at 500 V DC | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.



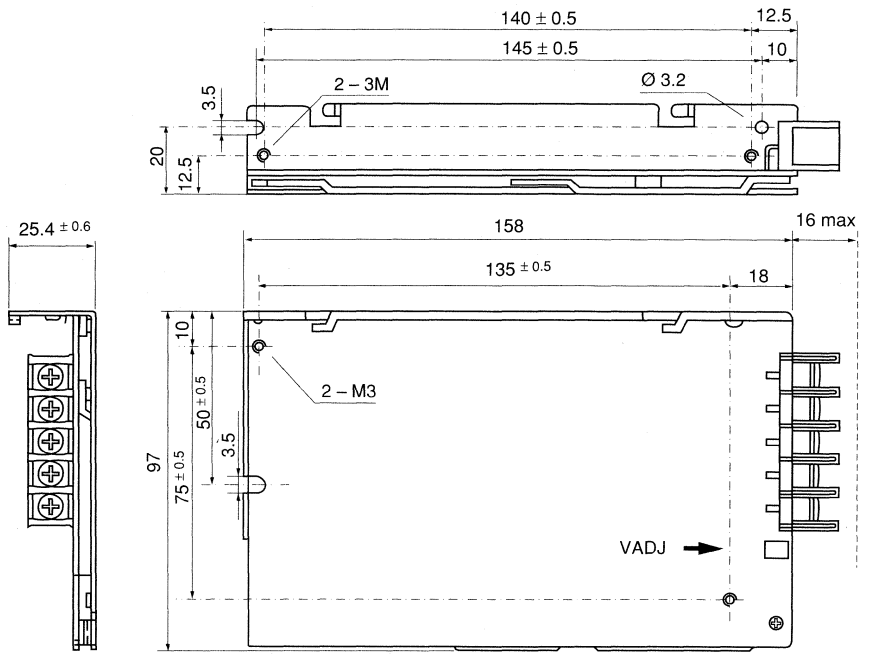




*Fig. 5*
*SW 50, weight: 400 g*

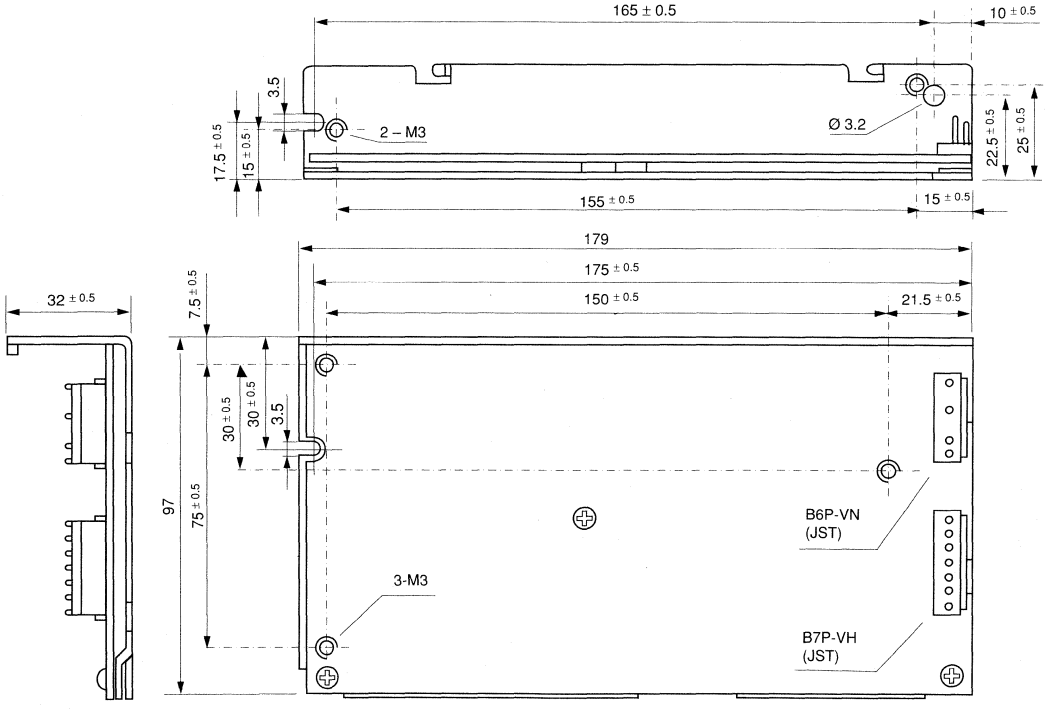



*Fig. 6*
*SW 75, weight: 550 g*

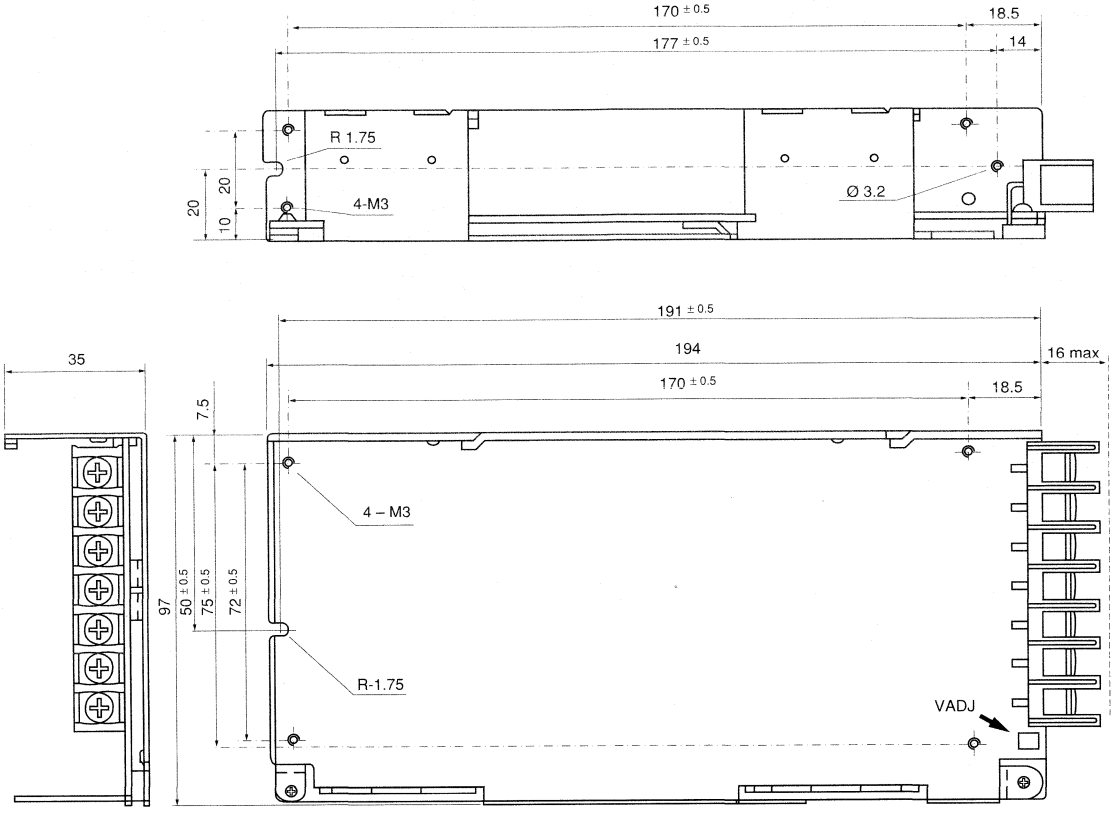



*Fig. 7*
*SW 100, weight: 600 g*

## Type Key and Product Marking

**Type Key**

SW 50 – 12 FC

Family ..... SW
Blank .....
Nominal output power [W] ..... 50...100
Dash .....
Nominal output voltage [V] ..... 5...48
Structure and connections:
– Case with terminal strip ..... C
– Open frame with terminal strip ..... F
– Open frame with connector ..... FC

Example: SW 50-12 F = AC-DC converter providing 12 V/4.2 A and configured as open frame with terminal strip

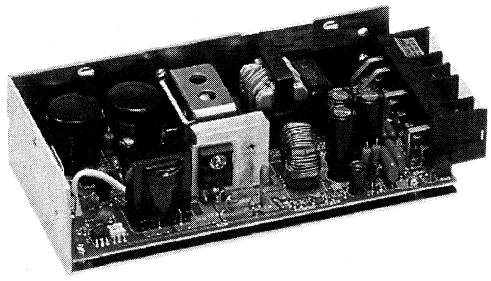
**Produkt Marking**

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# 50/100 W AC-DC Converters VRW-Family

**Single output**

- Universal AC input
- 3000 $V_{rms}$ input to output isolation
- Compact design
- Excellent line/load regulation
- High efficiency
- Safety standards: UL, CSA, TÜV approved



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## Description

The VRW series of switching power supplies is a single output series of AC-DC converters. Compact size and high reliability make the VRW series an excellent choice. Five standard single output ratings are available. The units are UL 1950 (D3), CSA 234 und EN 60950 approved.

### Key applications

Factory automation, off-site test and measurement, point-of-sales and communications equipment.

## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 50°C$ | Type designation Open frame Terminal block | Chassis cover Terminal block | Open frame Connector | Chassis cover Connector |
|---|---|---|---|---|---|---|---|
| 5 | 10.0 | 85...132 V AC or 170...265 V AC 47...440 Hz 230...330 V DC jumper selectable | 50 W | VRW 50-5 | VRW 50-5A | VRW 50-5B | VRW 50-5C |
| | 20.0 | | 100 W | VRW 100-5 | VRW 100-5A | - | - |
| 12 | 4.2 | | 50 W | VRW 50-12 | VRW 50-12A | VRW 50-12B | VRW 50-12C |
| | 8.5 | | 100 W | VRW 100-12 | VRW 100-12A | - | - |
| 15 | 3.4 | | 50 W | VRW 50-15 | VRW 50-15A | VRW 50-15B | VRW 50-15C |
| | 7.0 | | 100 W | VRW 100-15 | VRW 100-15A | - | - |
| 24 | 2.1 | | 50 W | VRW 50-24 | VRW 50-24A | VRW 50-24B | VRW 50-24C |
| | 4.5 | | 100 W | VRW 100-24 | VRW 100-24A | - | - |
| 48 | 1.0 | | 50 W | VRW 50-48 | VRW 50-48A | VRW 50-48B | VRW 50-48C |
| | 2.1 | | 100 W | VRW 100-48 | VRW 100-48A | - | - |

## Electrical Input and Output Data

General Condition: $T_A = 25°C$ unless otherwise specified

*Table 2: Input data*

| Characteristics | | | VRW 50- .. | VRW 100- .. | Unit |
|---|---|---|---|---|---|
| $U_{i\,rated}$ | Rated input voltage | | 100-120/200-240 | | V AC |
| $U_i$ | Input voltage range | | 85...132/170...265 [1] | | |
| | | | 230...330 [3] | | V DC |
| $f_i$ | Line frequency | | 47...440 | | Hz |
| $I_i$ | Input current [2] | 100/200 V AC | 1.2/0.61 | 2.2/1.2 | A |
| $I_{inr}$ | Inrush current [2] | 100/200 V AC | 16/32 | 15/30 | |
| $I_{i\,leak}$ | Leakage current [2] | 100/200 V AC | 0.30/0.45 | 0.20/0.35 | mA |

[1] Jumper selectable. [2] At rated input and output. [3] Terminals A and B not interconnected.

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3a: Output data 50 W types*

| Type | | | VRW 50-05 | VRW 50-12 | VRW 50-15 | VRW 50-24 | VRW 50-48 | |
|---|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage | nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\,adj}$ | Adjustable voltage range | | ±10 | | | | | % |
| $I_{o\,nom}$ | Rated output current | | 10.0 | 4.2 | 3.4 | 2.1 | 1.0 | A |
| $I_o$ | Output current range | min./max. | 0...100 | | | | | % |
| $u_o$ | Ripple-noise [1] | max. | 120 | 150 | 150 | 200 | 300 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | $U_{i\,min}$...$U_{i\,max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±0.8 | | | | | |
| $\alpha u_o$ | Temperature coefficient | max. | ±1 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | | 125 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | | 5.75...6.75 | 13.8...16.2 | 17.3...20.3 | 27.6...32.4 | 55.2...64.8 | V |
| $t_{Uo\,r}$ | Rise time [1] | typ. | 20 | | | | | ms |
| $t_h$ | Hold-up time [1] | typ. | 20 | | | | | |
| $\eta$ | Effciency [1] | typ. | 74 | 77 | 78 | 81 | 81 | % |
| | Output indicator | | LED | | | | | |
| | Outputs connected in series | | possible | | | | | |
| | Outputs connnected in parallel | | not possible | | | | | |

[1] At rated input and output.
[2] Operating in foldback method, automatic recovery. Overload for more than 30 seconds should be avoided.
[3] Shut down of output. Turn-on by brief removal of the input voltage. Overvoltage protection is not adjustable.

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3b: Output data 100 W types*

| Type | | | VRW 100-05 | VRW 100-12 | VRW 100-15 | VRW 100-24 | VRW 100-48 | |
|---|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage | nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\,adj}$ | Adjustable voltage range | | ±10 | | | | | % |
| $I_{o\,nom}$ | Rated output current | | 20.0 | 8.5 | 7.0 | 4.5 | 2.1 | A |
| $I_o$ | Output current range | min./max. | 0...100 | | | | | % |
| $u_o$ | Ripple-noise [1] | max. | 120 | 150 | 150 | 150 | 200 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | $U_{i\,min}$...$U_{i\,max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±0.8 | | | | | |
| $\alpha u_o$ | Temperature coefficient | max. | ±1 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | | 105 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | | 5.75...6.75 | 13.8...16.2 | 17.3...20.3 | 27.6...32.4 | 55.2...64.8 | V |
| $t_{Uo\,r}$ | Rise time [1] | typ. | 50 | | | | | ms |
| $t_h$ | Hold-up time [1] | typ. | 20 | | | | | |
| $\eta$ | Effciency [1] | typ. | 78 | 80 | 82 | 84 | 84 | % |
| | Output indicator | | LED | | | | | |
| | Outputs connected in series | | possible | | | | | |
| | Outputs connnected in parallel | | not possible | | | | | |

[1] At rated input and output.
[2] Operating in foldback method, automatic recovery. Overload for more than 30 seconds should be avoided.
[3] Shut down of output. Turn-on by brief removal of the input voltage. Overvoltage protection is not adjustable.

## Operation Instructions

### AC Input Voltage Range Selection

The AC input voltage range can be selected by means of wiring or a relay contact on the connector barrier as per the following table:

*Table 4: Input voltage range selection*

| Input voltage range | Terminals A and B |
|---|---|
| 85...132 V AC | interconnected |
| 170...265 V AC<br>230...330 V DC | open<br>(not connected) |

### Output Power Rating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 2.

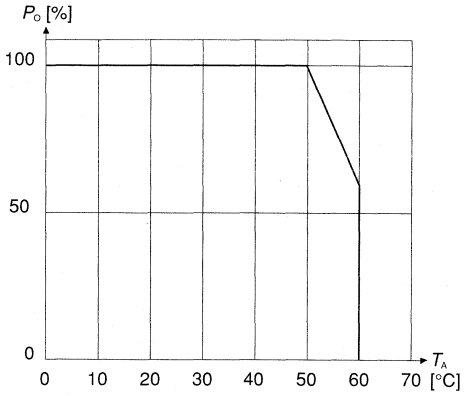



*Fig. 1*
*Output power vs. ambient temperature*

### Output Voltage Adjustment

The output voltage may be adjusted within ±10% of $U_{o\,nom}$ by means of the internal potentiometer. If the output voltage setting should be excessively high, the overvoltage protection circuit may shut-down the output.

### Output Overvoltage Protection

If the built-in overvoltage protection circuit becomes active, the output is shut down and a reset can only be achieved by brief removal of the input voltage after a minimum interval time. The overvoltage threshold level is not adjustable.

### Output Overload Protection

An overload condition at the output should not last for more than 30 seconds. After removal of the overload, the overload protection circuit will automatically recover.

### Outputs Connected in Series

Two or more units supplying the same or different output voltages may be connected in series. The value of the maximum output current to be taken is defined by that unit providing the lowest current limiting value. It should be assured that the outputs do not feed backwards into each other caused by their different rise/fall times at switch-on/off cycles by adding reverse polarity diodes across each output.

### Outputs Connected in Parallel

Parallel connection of several identical modules is not possible

## Immunity to Environmental Conditions

*Table 5: Mechanical Stress*

| Test Method | Test conditions | | Status |
|---|---|---|---|
| Damp heat<br>steady state | Temperature:<br>Relative himidity: | 40 $^{\pm 2}$ °C<br>30...90 $^{-3/+2}$ % | Operating |
| Shock (half-sinusoidal) | Acceleration amplitude: | 20 $g_n$ = 981 m/s$^2$ | Operating |
| Vibration (sinusoidal) | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...55 Hz<br>0.83 mm (55 Hz)<br>2 $g_n$ = 49 m/s$^2$<br>3 h (1 h each axis) | Operating |

*Table 6: Temperature*

| Characterisitcs | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 60 | |
| $T_S$ | Storage temperature | (Not operational) | –20 | 75 | |

*Table 7: MTBF Values*

| MTBF | Ground Benign |
|---|---|
| MTBF according to MIL-HDBK-217D | $T_C$ = 40°C |
| VRW 50 types | 132'900 h |
| VRW 100 types | 132'300 h |

*Table 8: Isolation*

| Test | Input to output | Input to case | Output to case | Unit |
|---|---|---|---|---|
| Electric strenght test voltage (1 min) | 3000 | 2000 | 500 | V AC |
| Isolation resistance (500 V DC) | >100 | >100 | >100 | MΩ |

*Table 9: Electromagnetic Emmission*

| Standard | Maintained level |
|---|---|
| FCC | <B |

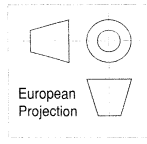
*Table 10: Safety Approvals*

| Safety Approvals | UL 1950 | CSA 234 | TÜV [1] |
|---|---|---|---|
| VRW 50- .. | x | x | x |
| VRW 100- .. | x | x | x |

[1] EN 60 950

## Mechanical Data, Input and Output Terminals

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.



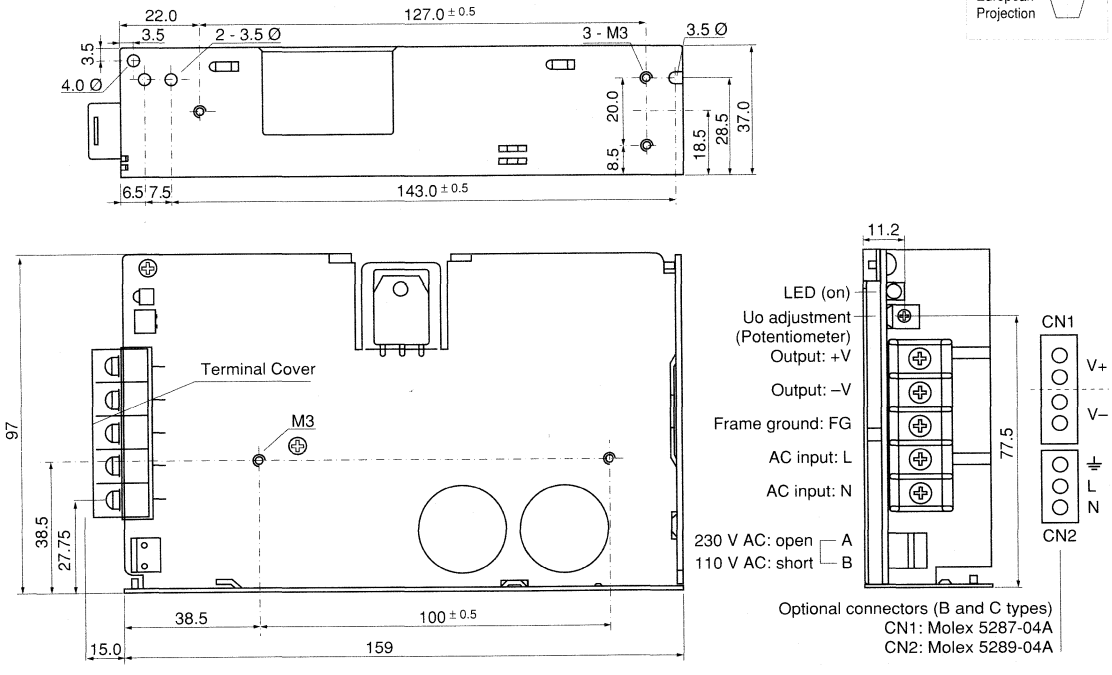




*Fig. 2*
*VRW 50, weight 380 g*

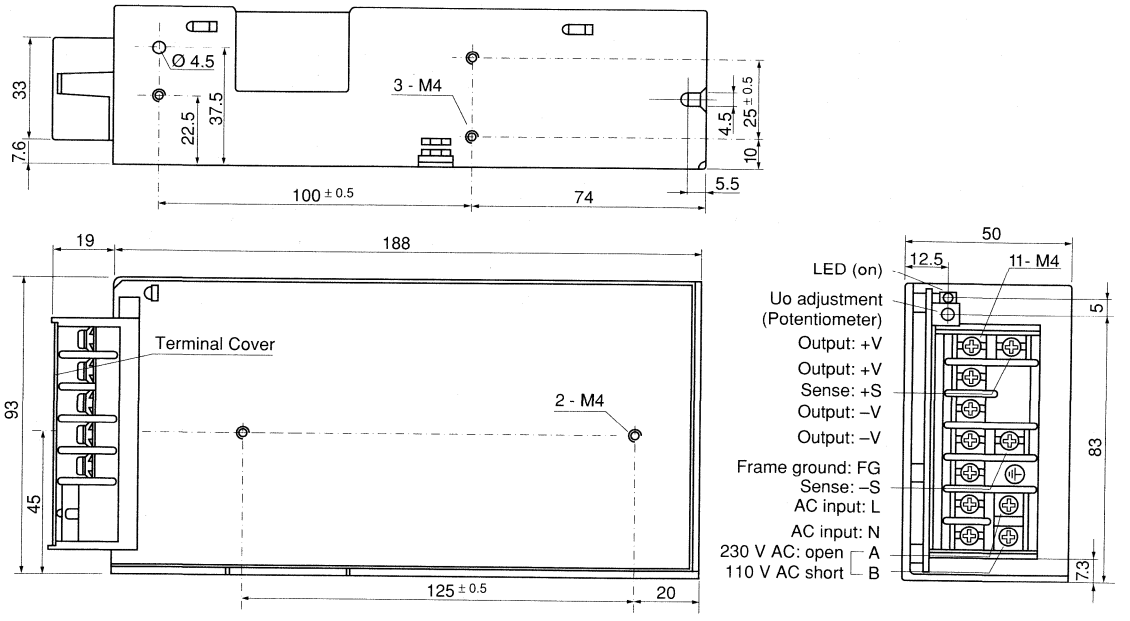



*Fig. 3*
*VRW 100, weight 690 g*

## Type Key and Product Marking

### Type Key

Family ..... VRW
Blank .....
Nominal output power [W] ..... 50, 100
Dash .....
Nominal output voltage [V] ..... 5...48
Structure and connectors:
– Open frame with terminal block .....
– Chassis cover with terminal block ..... A
– Open frame with connector ..... B
– Chassis cover with connector ..... C

VRW 50 - 12 A

Example: VRW 50-12A = AC-DC converter providing 12 V/4.2 A, 50 W output, module with chassis cover and terminal block

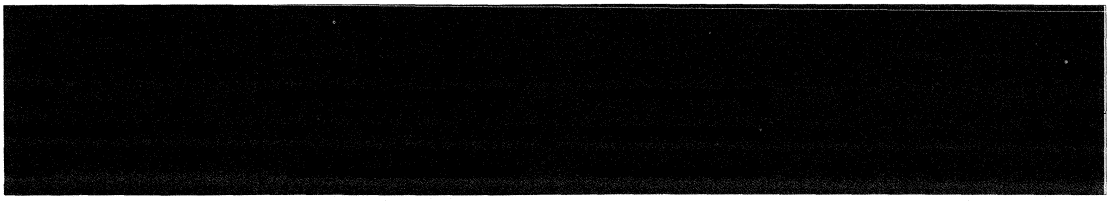
### Produkt Marking

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.


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# 10 AC-DC Converters >100 W

## 10.1 Rugged Environment



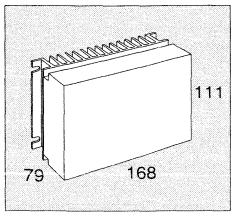
## 10.2 Industrial Environment

| Output [W]<br>100 300 550 1000 2100 | Output [V DC]<br>5 6 12 15 18 24 48 | Input [V DC]<br>85 110 135 180 220 264 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | LK | K02 | 10 - 3 |
| | | | LT | T01 | 10 - 26 |
| | | | VEW | various | 10 - 61 |

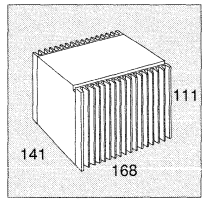
## 10.3 Benign Environment

| Output [W]<br>100 300 550 1000 2100 | Output [V DC]<br>5 6 12 15 18 24 48 | Input [V DC]<br>85 110 135 180 220 264 | Product Family | Case | Page |
|---|---|---|---|---|---|
| | | | MK | various | 10 - 72 |
| | | | HK | various | 10 - 76 |
| | | | VRW | various | 10 - 80 |

Case K02




Case T01



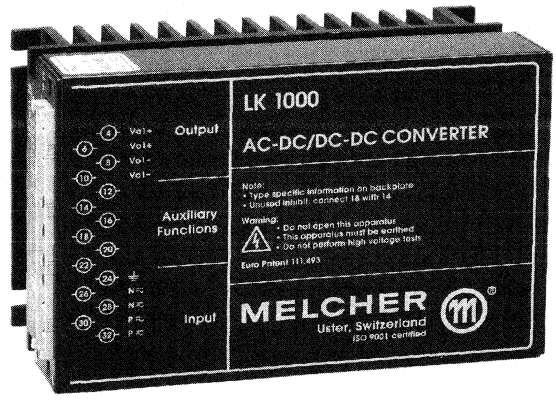
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# 150 W AC-DC (DC-DC) Converters

# K-Family

**Input to output isolation**
**Single output: LK 1000**
**Double output: LK 2000**

- Extremely wide input voltage range
- Input over- and undervoltage lock-out
- Efficient input filter and built-in surge and transient suppression circuitry
- 4 $kV_{rms}$ input to output isolation test voltage
- Fully isolated outputs
- Outputs open- and short-circuit proof
- No derating over entire operating temperature range
- CSA approval and UL recognition in progress
- Safety according to IEC 950




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## Description

The K-family of AC-DC (DC-DC) converters represents a flexible range of power supplies for use in advanced electronic systems. Features include high efficiency, high reliability, low output voltage noise and excellent dynamic response to load/line changes.

The converter inputs are protected against surges and transients occuring on the source lines. Input over- and undervoltage lock-out circuitry disables the outputs if the input voltage is outside the specified ranges. The LK types include an inrush current limitation preventing circuit breakers and fuses from being damaged at switch-on.

All outputs are open- and short-circuit proof and are protected against overvoltages by means of a built-in suppressor diode. The outputs can be inhibited by a logic signal applied to the connector pin i. If the inhibit function is not used pin 18 must be connected with pin 14 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case and output to output isolation is provided. The modules are designed and built according to international safety standards (IEC 950, EN 60950 and VDE 0805).

The case design allows operation at nominal load up to 71 °C in a free air ambient temperature. If forced cooling is provided, the ambient temperature may exceed 71 °C but the case temperature must remain below 95 °C under all conditions.

A temperature sensor generates an inhibit signal which disables the outputs if the case temperature $T_C$ exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Case: Aluminium, black finish, self cooling.

## Type Survey

**Survey of Options see "Description of Options"**

Different output voltages and currents may be set in accordance with customer specifications.

*Table 1: Type survey LK*

| Output 1 | | Output 2 | | Input Voltage Range and Efficiency [1] | | Options |
|---|---|---|---|---|---|---|
| $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{o\,nom}$ V DC | $I_{o\,nom}$ A [2] | $U_{i\,min}...U_{i\,max}$ **85...264 V AC** (88...372 V DC) | $\eta_{min}$ % | |
| 5.1 | 25.0 | | | LK 1001-7R | 80 | -9 |
| 12.0 | 12.0 | | | LK 1301-7R | 84 | E |
| 15.0 | 10.0 | | | LK 1501-7R | 84 | D |
| 24.0 | 6.0 | | | LK 1601-7R | 85 | V [5] |
| 24.0 [3] | 6.0 | | | LK 2320-7R | 81 | P |
| 30.0 [3] | 5.0 | | | LK 2540-7R | 83 | T |
| 48.0 [3] | 3.0 | | | LK 2660-7R | 84 | B1 |
| 12.0 | 6.0 | 12.0 [4] | 6.0 | LK 2320-7R | 81 | |
| 15.0 | 5.0 | 15.0 [4] | 5.0 | LK 2540-7R | 83 | |
| 24.0 | 3.0 | 24.0 [4] | 3.0 | LK 2660-7R | 84 | |

[1] Efficiency at $U_{i\,nom}$ and $I_{o\,nom}$.
[2] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents must be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[3] Series connection of output 1 and 2 see fig. 16a.
[4] Second output semi-regulated.
[5] Option V for LK 1001 types only

## Safety and Installation Instructions

**Safety:**

For safety reasons, the power supplies should be wired via the female connector H15 or H15 S4 (according to DIN 41612, see "Accessories") in order to meet national and international safety requirements

The converters correspond to safety class I equipment and comply with IEC 950, EN 60950, VDE 0805 Part 100 (including manufacturing surveillance), UL 1950, CSA/C22.2 No. 950-M89 and are VDE approved.

The connector has a leading earth connection pin which ensures earth connection prior to any other.

The UL 1950 recognition limits the ambient operational temperature range of the standard modules (-7) to –25...60°C. In applications where the full operational temperature range of –25...71°C under UL condition is required, forced cooling should be provided.

**Installation**

Installation must strictly follow the national safety regulations. Pin 24 has to be connected to earth. A second fuse should be installed in the wiring to pins 26/28 if:

- Local requirements demand an individual fuse in each source line
- Ui+ to earth impedance is high or undefined
- Phase and neutral of the mains are not defined.

In applications where the inhibit function is not used, the inhibit pin should be connected to the S– pin (K 1000) or the Vo1– pin (K 2000) to enable the outputs.

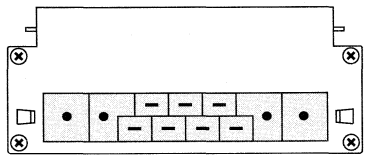
**Important Advice**

Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/µs, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher AG will not honour any guarantee/warranty claims resulting from high voltage field tests.

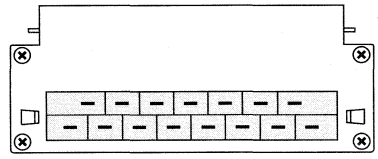
*Table 2: H15 and H15 S4 Connector pin allocation*

| Pin | Connector type H15 S4 | | Connector type H 15 | | | |
|---|---|---|---|---|---|---|
| No. | LK 1001 | | LK 1301/1501/1601 | | LK 2000 | |
| 4 | Vo1+ | Output 1 | Vo1+ | Output 1 | Vo2+ | Output 2 |
| 6 | | | Vo1+ | | Vo2+ | |
| 8 | Vo1– | Output 1 | Vo1– | Output 1 | Vo2– | Output 2 |
| 10 | | | Vo1– | | Vo2– | |
| 12 | S+ | Sense | S+ | Sense | Vo1+ | Output 1 |
| 14 | S– | Sense | S– | Sense | Vo1– | Output 1 |
| 16 | R [1] | Control of $U_{o1}$ | R [1] | Control of $U_{o1}$ | R [1] | Control of $U_{o1}$ |
| 18 | i | Inhibit | i | Inhibit | i | Inhibit |
| 20 | D [3] | Save data | D [3] | Save data | D [3] | Save data |
| | V [3] | ACFAIL | V [3] | ACFAIL | V [3] | ACFAIL |
| 22 | T | Current sharing | T | Current sharing | T | Current sharing |
| 24 [2] | ⏚ | Protective earth | ⏚ | Protective earth | ⏚ | Protective earth |
| 26 | N~ | Neutral | N~ | Neutral | N~ | Neutral |
| 28 | | | N~ | | N~ | |
| 30 | P~ | Phase | P~ | Phase | P~ | Phase |
| 32 | | | P~ | | P~ | |

[1] Function R is not simultaneously available with option P
[2] Leading pin (pregrounding)
[3] Option D is not simultaneously available with option V and vice versa.




Type H15 S4




Type H15

*Fig. 1*
*View of module's male connectors*

**Degree of Protection**

Condition: Female connector fitted to the unit.

IP 30: All units except those with options P, D or V with potentiometer adjustment.

IP 20: All units fitted with options which include potentiometer setting.

## Functional Description

The input voltage is fed via an input fuse, an input filter, a rectifier and an inrush current limiter to the input capacitor. This capacitor sources a single transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke and output filter. The control logic senses the main output voltage $U_{o1}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor.

The second output of double output units is controlled by the main output but has independent current limiting. If the main output is taken into current limitation, the second output voltage will fall as well and vice versa.

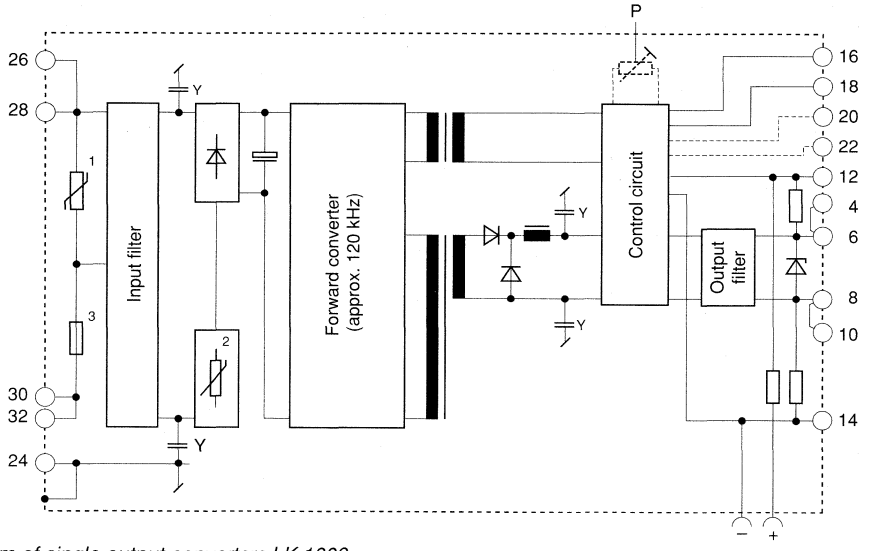
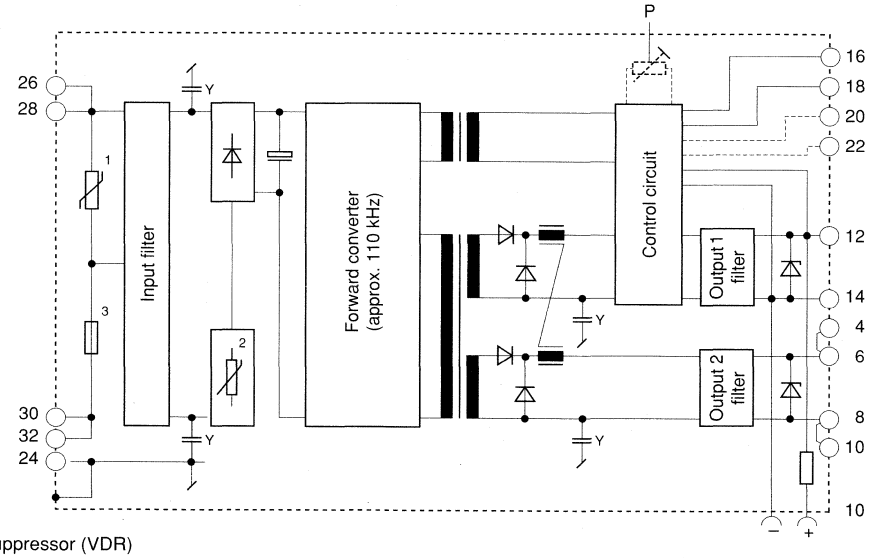



*Fig. 2*
*Block diagram of single output converters LK 1000*




[1] Transient suppressor (VDR)
[2] Inrush current limiter (NTC or Opt. E), -9 versions exclude the NTC
[3] Input fuse

*Fig. 3*
*Block diagram of symmetrical double output converters LK 2000*


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## Electrical Input Data

General Conditions
– $T_A$ = 25°C, unless $T_C$ is specified.
– Pin 18 connected to pin 14, $U_o$ adjusted to $U_{o\,nom}$ (option P); R input not connected.
– Sense line pins S+ and S– connected to Vo+ and Vo– respectively.

*Table 3: Input data*

| Input | | | LK | | | |
|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | Unit |
| $U_i$ | Input voltage range | $I_o$ = 0...$I_{o\,nom}$ | 85 | | 264 | V AC |
| | | $T_{C\,min}$...$T_{C\,max}$ | 88 | | 372 | V DC |
| $U_{i\,nom}$ | Input voltage (nominal) | | | 310 | | [3] |
| $I_i$ | Input current | $U_{i\,nom}$, $I_{o\,nom}$ [1] | | 0.6 | | A |
| $P_{i0}$ | No-load input power | $U_{i\,min}$...$U_{i\,max}$ | | | 2.5 | W |
| $P_{i\,inh}$ | Idle input power | unit inhibited | | | 1.5 | |
| $R_i$ | Input resistance | $T_C$ = 25°C | 480 | | | mΩ |
| $R_{NTC}$ | NTC resistance [2] | $T_C$ = 25°C | 3200 | | | |
| $C_i$ | Input capacitance | | 210 | | 400 | µF |
| $U_{i\,RFI}$ | Conducted input RFI | EN 55022 | | | B | |
| | Radiated input RFI | | | | >A | |
| $U_{i\,abs}$ | Input voltage limits (without damage) | | –400 | | 400 | V DC |
| F | Fuse rating (nominal) | see table 4 | | 4.0 | | A |

[1] With double output modules, both outputs loaded with $I_{o\,nom}$. [2] Valid for -7, -6, -5 versions with NTC, (-9 versions exclude the NTC). Initial switch-on cycles. Subsequent switch-on/off cycles increase the inrush current peak value.
[3] LK types may also be operated in DC mode. (See "K-Family, DC-DC Converters")

AC frequency range 47...440 Hz.
Above 70 Hz (at $U_i$ = 264 V AC) the earth lekage current may exceed 3.5 mA, specified in IEC 950. The built-in Y capacitors are specified for ≤100 Hz. Above 350 Hz the input voltage may not exceed 200 V AC.

### Input Fuse

A fuse mounted inside the converter protects the module against severe defects. If operated from a DC-source this fuse may not fully protect the module when the input voltage exceeds 200 V DC! In applications where the converters operate at source voltages above 200 V DC an external fuse or a circuit breaker at system level should be installed!

*Table 4: Fuse Specification*

| Module | Fuse type | Fuse rating |
|---|---|---|
| LK [1] | slow-blow | SP T 4 A, 250 V |

[1] Fuse size 5 × 20 mm

### Inrush Current Limitation

The modules of the versions -7, -6, -5 incorporate a NTC resistor in the input circuitry which - at initial turn on - reduces the peak inrush current value by a factor of 5...10 to protect connectors and switching devices from damage. Subsequent switch-on cycles within short periods will cause an increase of the peak inrush current value due to the warming-up of the NTC resistor. See also option E.

### Inrush Current Peak Value

The inrush current peak value/initial switch-on cycle) can be determined by following calculation: (Refer to fig. 6 also)

$$I_{inr\,p} = \frac{U_{i\,source}}{(R_{s\,ext} + R_i + R_{NTC})}$$

### Input Under-/Overvoltage Cut-out

If the input voltage remains below approx. 0.8 $U_{i\,min}$ or exceeds approx. 1.1 $U_{i\,max}$, an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ should be considered!

### Input Transient Protection

A suppressor diode or a VDR (depending upon the input voltage range) together with the input fuse and a symmetrical input filter form an effective protection against high input transient voltages.

### Reverse Polarity Protection

The built-in bridge rectifier provides reverse polarity protection at the input.

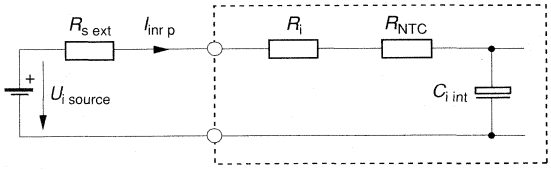



*Fig. 4*
*Replacement diagram for input impedance*

### Electromagnetic Immunity

*Table 5: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [4] | Value applied | Waveform | Source impedance | Test procedure | in operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Impulse voltage | IEC 255-4 App. E4 [5] (1976) | III | i/o, i/c, o/c +i/–i, +o/–o | 5000 $V_p$ | 1.2/50 µs | 500 Ω | 3 pos. and 3 neg. impulses per coupling mode | no | - |
| High frequency disturbance | IEC 255-4 App. E5 [5] (1976) | III | i/o, i/c, o/c | 2500 $V_p$ | 400 damped 1 MHz waves/s | 200 Ω | 2 s per coupling mode | yes | 7 |
| | | | i/o, +o/–o, o/c | 1000 $V_p$ | | | | | |
| Voltage surge | IEC 571-1 [3] (1990-07) | | i/c, +i/–i | 800 $V_p$ | 100 µs | 100 Ω | | yes | 1 |
| | | | | 1500 $V_p$ | 50 µs | | 1 pos. and 1 neg. voltage surge per coupling mode | | |
| | | | | 3000 $V_p$ | 5 µs | | | | |
| | | | | 4000 $V_p$ | 1 µs | | | | |
| | | | | 7000 $V_p$ | 100 ns | | | | |
| Supply related surge | RIA 12 (1984) | B | +i/–i | 1.5 • $U_{batt}$ | 1 s | 0.2 Ω | 1 positive surge | yes | 1 |
| Direct transient | | C | +i/c, –i/c | 960 $V_p$ | 10/100 µs | 5 Ω | 5 pos. and 5 neg. impulses | | 2 |
| | | D | | 1800 $V_p$ | 5/50 µs | | | | |
| | | E | | 3600 $V_p$ | 0.5/5 µs | 100 Ω | | | |
| | | F | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | G | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Indirect coupled transient | | H | +o/c, –o/c | 1800 $V_p$ | 5/50 µs | | | | 6 |
| | | J | | 3600 $V_p$ | 0.5/5 µs | | | | |
| | | K | | 4800 $V_p$ | 0.1/1 µs | | | | |
| | | L | | 8400 $V_p$ | 0.05/0.1 µs | | | | |
| Electrostatic discharge | IEC 801-2 (1991-04) | 4 | contact discharge to case, | 8000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | 1 |
| | | | air disch. to case | 15000 $V_p$ | | | | | |
| Electric field | IEC 801-3 (1984) | 3 | antenna in 1m distance | 10 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | 7 |
| Fast transient/ burst | IEC 801-4 (1988) | 3 | i/c, +i/–i | 2000 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | 1 |
| | | 4 | | 4000 $V_p$ | | | | | |
| Transient | IEC 801-5 (Draft 1993-01) | 4 | i/c, | 4000 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | 1 |
| | | | +i/–i | 2000 $V_p$ | | 2 Ω | | | |

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specifications possible
[3] Will be replaced by EN 50155
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Test in progress, please consult factory
[7] Not tested yet, please consult factory

### Static Input Current Characteristic

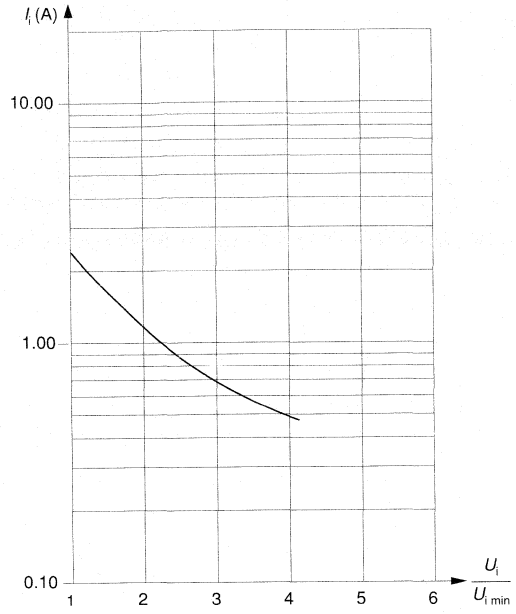



*Fig. 5*
*Input current versus relative input voltage*

### RFI Noise at Input according to EN 55022

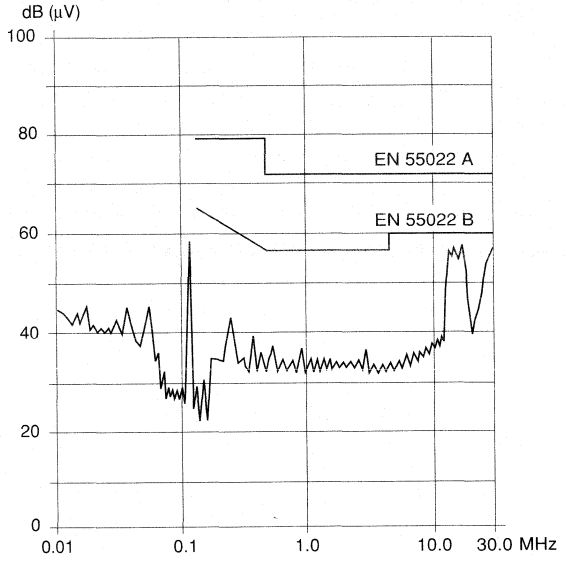



*Fig. 6*
*Typical radio frequency-interference voltage at $U_{i\,nom}$, $I_{o\,nom}$, measured with an artificial mains network and a quasi peak detector.*

### Hold-up Time versus relative Input Voltage

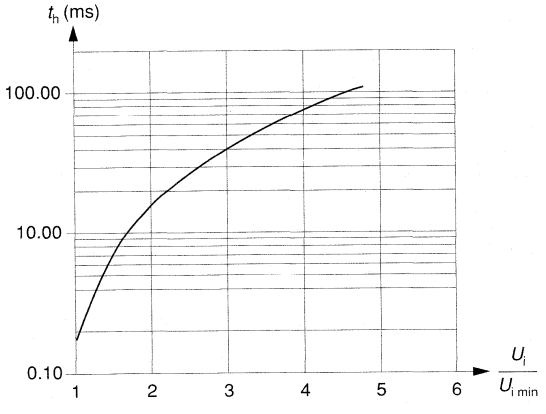



*Fig. 7*
*Hold-up time $t_h$ versus relative input voltage $U_i/U_{i\,min}$.*

### Input Inrush Current Characteristic

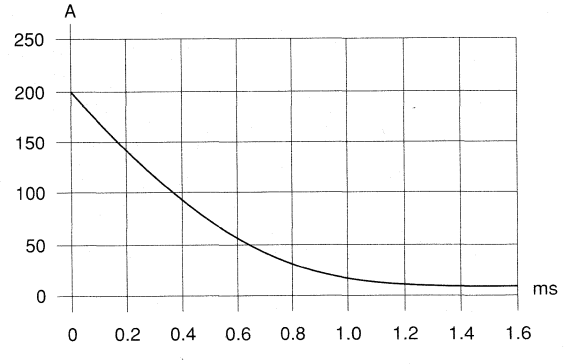



*Fig. 8*
*Inrush current versus time at $U_{i\,max}$, $R_{ext}$ = 0*

## Electrical Output Data

General Conditions, valid for all tables 6:
– $T_A$ = 25 °C, unless $T_C$ is specified.
– Pin 18 connected to pin 14, $U_o$ adjusted to $U_{o\,nom}$ (option P), R input not connected.
– Sense line pins S+ and S– connected to Vo+ and Vo– respectively.

*Table 6a: Output data single output modules*

| Output | | | LK 1001 5.1 V | | | LK 1301 12.0 V | | | LK 1501 15.0 V | | | LK 1601 24.0 V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 5.07 | | 5.13 | 11.93 | | 12.07 | 14.91 | | 15.09 | 23.86 | | 24.14 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 7.6 | | | 20 | | | 26.5 | | | 39 | | |
| $I_{o\,nom}$ | Output current [1] | | | 25.0 | | | 12.0 | | | 10.0 | | | 6.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 26 | | | 12.2 | | | 10.2 | | | 6.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 5 | | | 5 | | | 5 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 75 | | | 40 | | | 60 | | | 90 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$, $U_{i\,nom}$...$U_{i\,max}$, $I_{o\,nom}$ | | | ±15 | | | ±25 | | | ±30 | | | ±30 | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ | | | 20 | | | 25 | | | 30 | | | 40 | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | ±200 | | | ±250 | | | ±300 | | | ±200 | | |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.1 | | | 0.3 | | | 0.3 | | | 0.35 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | mV/K |

*Table 6b: Output data double output modules*

| Output (Outputs connected in series) | | | LK 2320 24 V (2 × 12 V) | | | LK 2540 30 V (2 × 15 V) | | | LK 2660 48 V (2 × 24 V) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | | 24.0 [2] | | | 30.0 [2] | | | 48.0 [2] | | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 39 | | | 49 | | | 72 | | |
| $I_{o\,nom}$ | Output current [1] | | | 6.0 | | | 5.0 | | | 3.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$... $T_{C\,max}$ | 6.2 | | | 5.2 | | | 3.2 | | | |
| $u_o$ | Output voltage noise [3] | $U_{i\,nom}$, $I_{o\,nom}$ | | 15 | | | 15 | | | 20 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 400 | | | 500 | | | 500 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±40 | | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ | | 40 | | | 30 | | | 40 | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | +100/–300 | | | +200/–300 | | | +250/–250 | | |
| $t_d$ [6] | Time constant; dynamic load regulation | $I_o$ = (1...1/3...1)$I_{o\,nom}$ | | 0.2 | | | 0.2 | | | 0.5 | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | ±4.8 | | | ±6.0 | | | ±7.2 | | mV/K |

[1] If the output voltages are increased above $U_{o\,nom}$ through R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[2] Series connection for $U_{o\,nom}$ = 24 V, 30 V or 48 V, see fig. 16a.
[3] Shortest possible wiring for series connection at the connector.
[4] See fig. 10.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.


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*Table 6c: Output data double output modules*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **LK 2320 12 V/12 V** | | | | | | **LK 2540 15 V/15 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 11.93 | | 12.07 | 11.82 | | 12.18 | 14.91 | | 15.09 | 14.78 | | 15.22 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 19 | | | 19 | | | 25 | | | 25 | | |
| $I_{o\,nom}$ | Output current [3] | | | 6.0 | | | 6.0 | | | 5.0 | | | 5.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$ | 6.2 | | | 6.2 | | | 5.2 | | | 5.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$ | | 10 | | | 10 | | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 150 | | | 75 | | | 200 | | | 100 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ | | ±30 | | | ±40 | | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 100 | | Fig. 12 | | | | 100 | | Fig. 13 | | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$ | | +80/–250 | | | | | | +100/–250 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.4 | | | | | | 0.4 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | | | | ±0.02 | | | | | %/K |
| | | | | ±2.4 | | | | | | ±3.0 | | | | | mV/K |

*Table 6d: Output data double output modules*

| **Output** (Outputs in Symmetrical Configuration) [1] | | | **LK 2660 24 V/24 V** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Characteristics | | Conditions | Output 1 | | | Output 2 | | | |
| | | | min | typ | max | min | typ | max | Unit |
| $U_o$ | Output voltage | $U_{i\,nom}$, $I_{o\,nom}$ [2] | 23.86 | | 24.14 | 23.64 | | 24.36 | V |
| $U_{oL}$ | Overvoltage protection | Failure in control circuit | | 36 | | | 36 | | |
| $I_{o\,nom}$ | Output current [3] | | | 3.0 | | | 3.0 | | A |
| $I_{oL}$ | Output current limit [4] | $U_{i\,min}$...$U_{i\,max}$, $T_{C\,min}$...$T_{C\,max}$ | 3.2 | | | 3.2 | | | |
| $u_o$ | Output voltage noise | $U_{i\,nom}$, $I_{o\,nom}$, | | 10 | | | 10 | | $mV_{rms}$ |
| | | BW = 20 MHz | | 200 | | | 100 | | $mV_{pp}$ |
| $\Delta U_o$ | Static line regulation | $U_{i\,min}$...$U_{i\,nom}$, $U_{i\,nom}$...$U_{i\,max}$, $I_{o\,nom}$ | | ±30 | | | ±40 | | mV |
| | Static load regulation | $U_{i\,nom}$, $I_o$ = (0.1...1) $I_{o\,nom}$ [5] | | 50 | | Fig. 14 | | | |
| $u_{o\,d}$ [6] | Dynamic load regulation | $U_{i\,nom}$, | | +100/–250 | | | | | mV |
| $t_d$ [6] | Time constant of dynamic load regulation | $I_o$ = (1...1/3...1) $I_{o\,nom}$ | | 0.4 | | | | | ms |
| $\alpha_{Uo}$ | Temperature coefficient of output voltage [7] | $T_{C\,min}$... $T_{C\,max}$ | | ±0.02 | | | | | %/K |
| | | | | ±4.8 | | | | | mV/K |

[1] Depending upon the desired output configuration the wiring should be made as shown in fig. 16b, c, d or e.
[2] Same conditions for both outputs.
[3] If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
[4] See fig. 10.
[5] Condition for specified output. Other output loaded with constant current $I_o = I_{o\,nom}$.
[6] See fig. 11.
[7] Negative temperature coefficient (0...3 mV/cell and K) available on request.

### Output Protection

Each output is protected against overvoltage which could occur due to a failure of the control circuit by means of a voltage suppressor diode which, under worst case conditions, may become a short circuit. The suppressor diode are not designed to withstand externally applied overvoltages. Overload at any of the two outputs will cause a shut-down of both outputs. A red LED indicates the overload condition.

### Test Sockets (Main output only [1])

Test sockets for measuring the output voltage $U_{o1}$ are located at the front of the module. The positive test socket is protected by a series resistor (see fig. 2 and 3). The voltage measured at the test sockets is approximately 30 mV lower than the value measured at the output terminals.

[1] In case of double output units externally connected in series for $U_o$ = 24 V, 30 V or 48 V the monitored output voltage is 12 V, 15 V or 24 V respectively.

### Inhibit Function

The outputs of a module may be enabled or disabled by means of a logic signal (TTL, CMOS etc.) applied to the inhibit input. If the inhibit function is not required, connect the inhibit pin 18 to pin 14 to enable the outputs (active low logic, fail safe).

*Table 7: Inhibit characteristics*

| Characteristic | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –50 | | 0.8 | V |
| | | $U_o$ = off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $U_{inh}$ = 0 | | | –400 | µA |
| $t_r$ | Rise time | | | | 30 | | ms |
| $t_f$ | Fall time | | depending on $I_o$ | | | | |

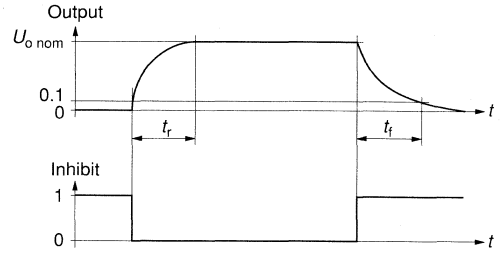



*Fig. 9*
*Output response as a function of inhibit control*

### Sense Lines

(Only for single output units 5.1 V, 12 V, 15 V, 24 V)

This feature enables compensation for voltage drops across the connector contacts and if necessary, across the load lines. If the sense lines are connected at the load rather than directly at the connector, the user should ensure that $U_{o\,max}$ (between Vo1+ and Vo1–) is not exceeded. We recommend connecting the sense lines directly at the female connector.

For further information, please refer to "Application Notes ".

To ensure correct operation, both sense lines should be connected to their respective power outputs and the voltage difference between any sense line and its respective power output pin (as measured on the connector) should not exceed the following values:

*Table 8: Voltage compensation allowed using sense lines*

| Output voltage | Total voltage difference between sense lines and their respective outputs | Voltage difference between Vo– and S– |
|---|---|---|
| 5.1 V | < 0.5 V | < 0.25 V |
| 12 V, 15 V | < 1.0 V | < 0.25 V |

If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output currents must be reduced accordingly so that $P_{o\,nom}$ is not exceeded.

### Parallel or Series Connection of Units

Single or double output units with equal nominal output voltage can be connected in parallel without any precautions using option T.

With **option T** (current sharing), all units share the current approximately equally.

Single output units and/or main and second outputs of double output units can be connected in series with any other (similar) output.

**Note:**

- Parallel connection of double output units should always include both, main **and** second output to maintain good regulation of both outputs.
- Series connection of second outputs without involving their main outputs should be avoided as regulation may be poor.
- The maximum output current is limited by the output with the lowest current limitation if several outputs are connected in series.
- Not more than 5 units should be connected in parallel.


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**Output Voltage Regulation of Single or Double Output Modules with Outputs 1 and 2 Connected in Series**

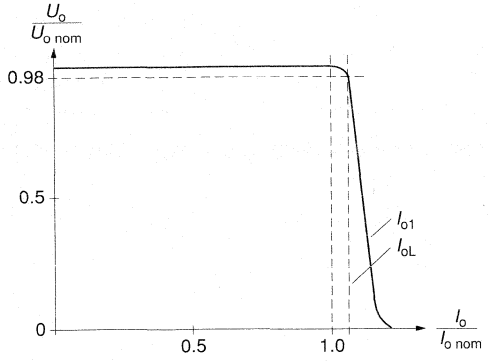



*Fig.10*
*$U_{o1}$ vs. $I_{o1}$ (typ.) of single output units*

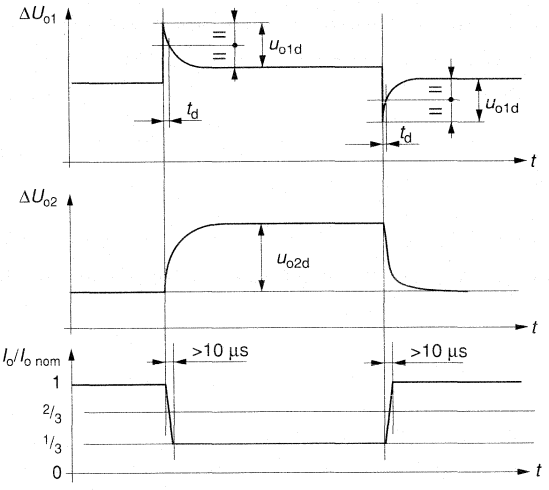



*Fig. 11*
*Control deviation of $u_{o1/2\,d}$ vs. dynamic load change*

**Output Voltage Regulation of Double Output Modules with Output 1 and 2 in Symmetrical Configuration**

Output 1 is under normal conditions regulated to $U_{o1\,nom}$, independent of the output currents.

$U_{o2}$ is dependent upon the load distribution. When both outputs are loaded with more than 10% of $I_{o\,nom}$, the deviation of $U_{o2}$ remains within ±5% of the value of $U_{o1}$. Figures 13, 14 and 15 show the regulation with varying load distribution. If $I_{o1} = I_{o2}$ or the two outputs are connected in series, the deviation of $U_{o2}$ remains within ±1% of the value of $U_{o1}$ provided that a total load of more than 10% of $I_{o\,nom}$ is applied.

Two outputs of a single K 2000 module connected in parallel will behave like the output of a K 1000 module; the paralleled output is fully regulated. No precautions are necessary in using the R-input and the test sockets.

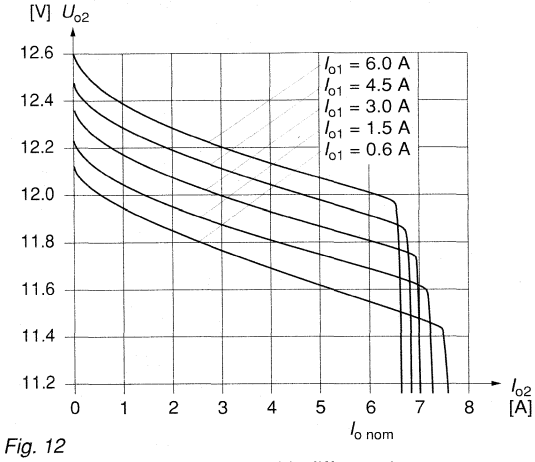



*Fig. 12*
*LK 2320: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

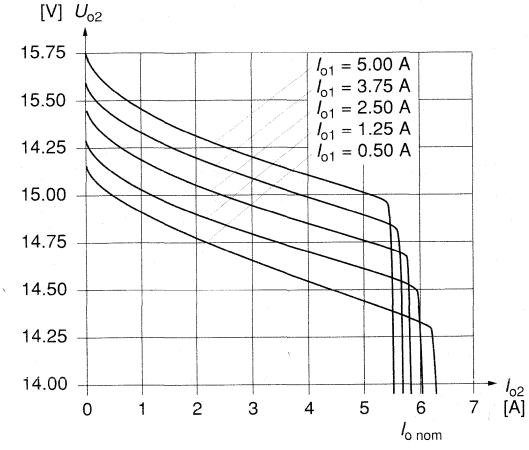



*Fig. 13*
*LK 2540: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

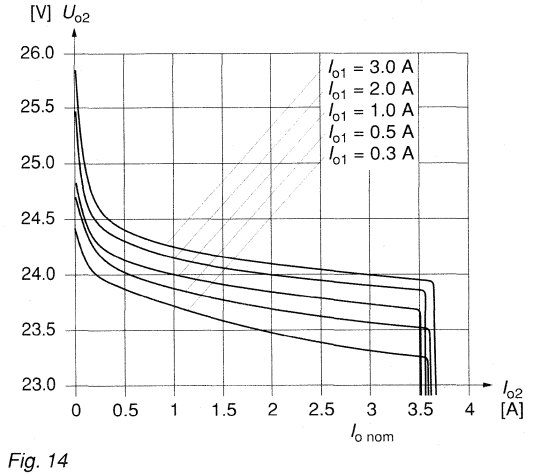



*Fig. 14*
*LK 2660: Δ $U_{02}$ (typ.) vs. $I_{02}$ with different $I_{01}$*

**Programmable Output Voltage** (R-Function)

As a standard feature, the modules offer an adjustable output voltage, identified by letter R in the type designation. The control input R (pin 16) accepts either a control voltage $U_{ext}$ or a resistor $R_{ext}$ to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_{o\,nom}$.

a) Adjustment by means of an external control voltage $U_{ext}$ between pin 16 (R) and pin 14:

The control voltage range is 0...2.75 V DC and allows an output voltage adjustment in the range of approximately 0...110% $U_{o\,nom}$.

$$U_{ext} = \frac{U_o}{U_{o\,nom}} \cdot 2.5\ V \text{ (approximate formula)}$$

b) Adjustment by means of an external resistor:

Depending upon the value of the required output voltage the resistor shall be connected

**either:** Between pin 16 and pin 14 ($U_o < U_{o\,nom}$) to achieve an output voltage adjustment range of approximately 0...100% $U_{o\,nom}$

**or:** Between pin 16 and pin 12 ($U_o > U_{o\,nom}$) to achieve an output voltage adjustment range of approximately 100...110% $U_{o\,nom}$.

**Warning:**

- The value of $R'_{ext}$ shall never be less than the lowest value as indicated in table 10b to avoid damage to the unit!

**Remarks:**

- The R-Function excludes option P (output voltage adjustment by potentiometer).
- If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output current(s) should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.
- The R-input (as well as option P) is related to the main output.
- With double output units the second output follows the value of the controlled main output. Resistor values as indicated for the single output units should be used.
- For correct output voltage adjustment of double output units the external wiring of the outputs should be according to fig. 16a, b, c, d or e depending upon the desired output configuration.
- In case of parallel connection the output voltages should be individually set within a tolerance of 1 - 2%.

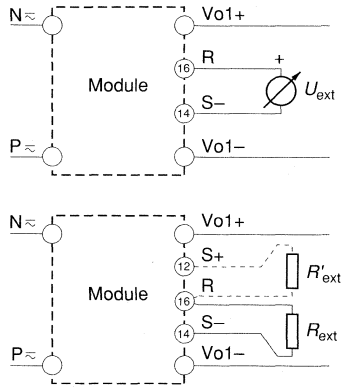



*Fig. 15*
*Output voltage control for single output units LK 1000 by means of the R input*

*Table 9a: $R_{ext}$ for $U_o < U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ (V) | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R_{ext}$ [kΩ] |
| 0.5 | 0.422 | 2 | 4 | 0.825 | 2 | 4 | 0.56 | 4 | 8 | 0.825 |
| 1.0 | 1.0 | 3 | 6 | 1.3 | 4 | 8 | 1.47 | 6 | 12 | 1.33 |
| 1.5 | 1.62 | 4 | 8 | 1.96 | 6 | 12 | 2.61 | 8 | 16 | 1.96 |
| 2.0 | 2.16 | 5 | 10 | 2.87 | 8 | 16 | 4.64 | 10 | 20 | 2.87 |
| 2.5 | 3.83 | 6 | 12 | 3.83 | 9 | 18 | 6.19 | 12 | 24 | 3.83 |
| 3.0 | 5.61 | 7 | 14 | 5.62 | 10 | 20 | 8.25 | 14 | 28 | 5.61 |
| 3.5 | 9.09 | 8 | 16 | 8.28 | 11 | 22 | 11.0 | 16 | 32 | 8.25 |
| 4.0 | 14.7 | 9 | 18 | 12.1 | 12 | 24 | 16.2 | 18 | 36 | 12.1 |
| 4.5 | 28.7 | 10 | 20 | 19.6 | 13 | 26 | 26.1 | 20 | 40 | 19.6 |
| 5.0 | 196 | 11 | 22 | 42.2 | 14 | 28 | 56.2 | 22 | 44 | 46.4 |

*Table 9b: $R'_{ext}$ for $U_o > U_{o\,nom}$; approximate values ($U_{i\,nom}$, $I_{o\,nom}$, series E 96 resistors)*

| $U_{o\,nom}$ = 5.1 V | | $U_{o\,nom}$ = 12 V | | | $U_{o\,nom}$ = 15 V | | | $U_{o\,nom}$ = 24 V | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $U_o$ [V] | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] | $U_o$ [V] [1] | | $R'_{ext}$ [kΩ] |
| 5.15 | 422 | 12.1 | 24.2 | 1780 | 15.2 | 30.4 | 1470 | 24.25 | 48.5 | 3160 |
| 5.2 | 215 | 12.2 | 24.4 | 909 | 15.4 | 30.8 | 750 | 24.5 | 49.0 | 1620 |
| 5.25 | 147 | 12.3 | 24.6 | 623 | 15.6 | 31.2 | 511 | 24.75 | 49.5 | 1100 |
| 5.3 | 110 | 12.4 | 24.8 | 464 | 15.8 | 31.6 | 383 | 25.0 | 50.0 | 825 |
| 5.35 | 90.9 | 12.5 | 25.0 | 383 | 16.0 | 32.0 | 316 | 25.25 | 50.5 | 681 |
| 5.4 | 75 | 12.6 | 25.2 | 316 | 16.2 | 32.4 | 261 | 25.5 | 51.0 | 562 |
| 5.45 | 61.9 | 12.7 | 25.4 | 286 | 16.4 | 32.8 | 237 | 25.75 | 51.5 | 511 |
| 5.5 | 56.2 | 12.8 | 25.6 | 234 | 16.5 | 32.0 | 215 | 26.0 | 52.0 | 464 |
| | | 13.0 | 26.0 | 196 | | | | 26.25 | 52.5 | 422 |
| | | 13.2 | 26.4 | 162 | | | | 26.4 | 52.8 | 383 |

[1] First column: single output units or double output units with separated outputs, second column: outputs in series connection


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Programmable Output Voltage (R-Function) continued

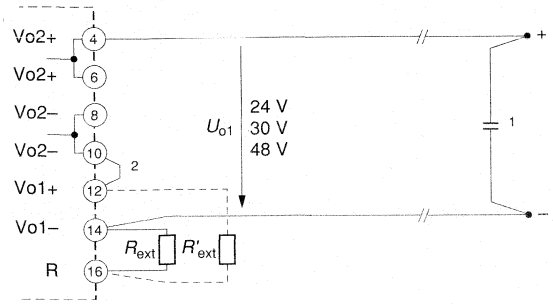



*Fig. 16a*
*LK 2000 with H15 connector. R-input for output voltage control. Wiring for output voltage 24 V or 30 V or 48 V with main and second output connected in series.*

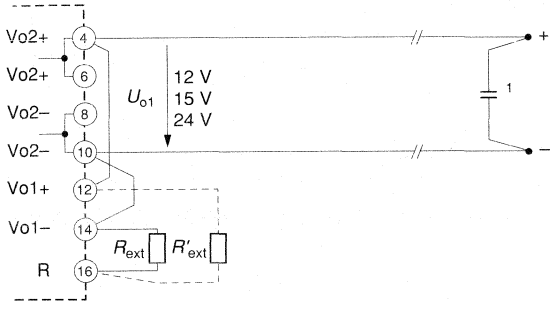



*Fig. 16b*
*LK 2000 with H15 connector. R-input for output voltage control. Wiring for output voltage 12 V or 15 V or 24 V with main and second output connected in parallel.*

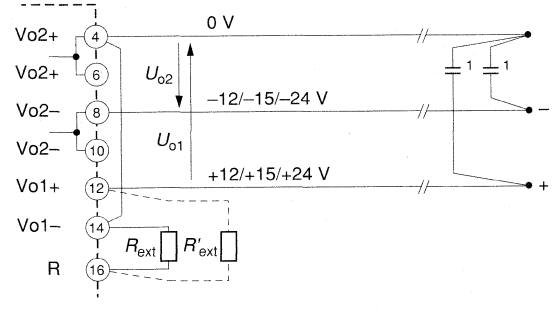



*Fig. 16c*
*LK 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two symmetrical output voltages $U_{o1}$ and $U_{o2}$: ±12 V or ±15 V or ±24 V.*

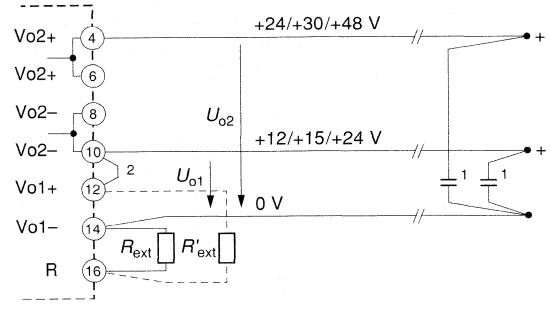



*Fig. 16d*
*LK 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two output voltages $U_{o1}$ and $U_{o2}$: +12 V and +24 V or +15 V and +30 V or +24 V and +48 V.*

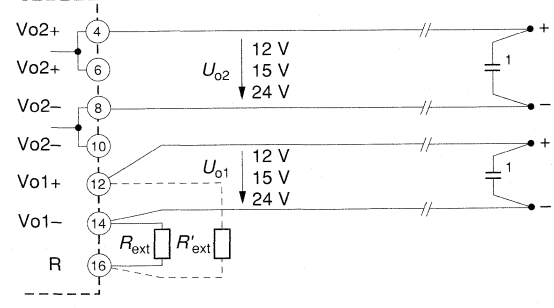



*Fig. 16e*
*LK 2000 with H15 connector. R-input for output voltage control. Wiring of main and second output for two output voltages $U_{o1}$ and $U_{o2}$: 12 V/12 V or 15 V/15 V or 24 V/24 V, the outputs are galvanically isolated.*

[1] A ceramic multilayer capacitor connected across the output lines reduces ripple and spikes.
[2] Shortest possible wiring for series connection at the female connector

**Remarks:**

Double output units fitted with H-15 connectors have the output pins of the second output, pins 4/6 and 8/10, internally paralleled.

It is recommended that pins 4/6 and 8/10 be directly paralleled at the female connector as well to reduce the voltage drop across the connector.

Please note: $U_{o2}$ varies depending upon its own load and the load on output 1.

## Supplementary Data

### Isolation

Input to output isolation voltage tests in accordance with IEC 950, EN 60950, VDE 0805 and EN 41003 respectively are performed as factory tests and should not be repeated in the field.

### Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 2 and 3). Melcher will not honour any guarantee claims resulting from high voltage field tests.

*Table 10: Isolation test voltages, clearance and creepage distances*

| Characteristic | Input to Output | Input to Case | Output to Case | Output to Output | Unit |
|---|---|---|---|---|---|
| Isolation test voltage | 4.0 | 2.0 | 1.0 | 0.1 | $kV_{rms}$ |
| | 5.6 | 2.8 | 1.4 | 0.15 | kV DC |
| Clearance and creepage distance on the print lay-out | 6.4 | 3.2 | 2.0 | 0.4 | mm |

### Display Status of LEDs

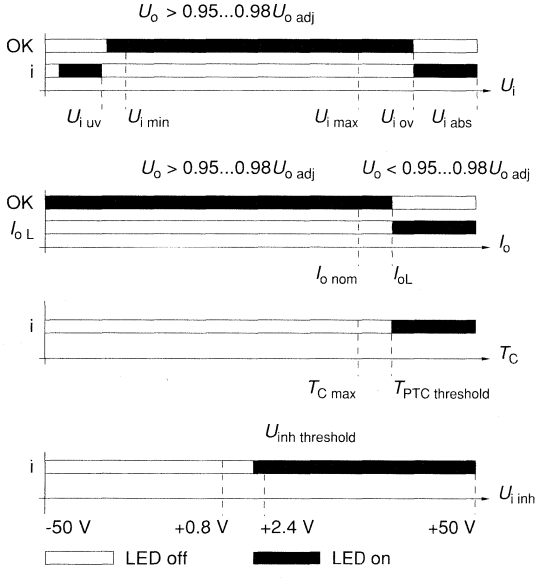



*Fig. 17*

*LEDs "OK" and "i" status versus input voltage*
*Conditions: $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*
*$U_{i\,uv}$ = undervoltage lock-out, $U_{i\,ov}$ = overvoltage lock-out*

*LEDs "OK" and "$I_{o\,L}$" status versus output current*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V*

*LED "i" versus case temperature*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $U_{inh} \le 0.8$ V*

*LED "i" versus $U_{inh}$*
*Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$*

## Description of Options

*Table 11: Survey of options*

| Option | Function of Option | Characteristics |
|---|---|---|
| -9 | Operational temperature range $T_A$ = –40 °C...71 °C | Extended operational temperature range |
| E | Electronic inrush current limitation circuitry | Improved inrush current limitation as per table 12 |
| P | Potentiometer for $U_o$ adjustment | R-function is not available if option P is incorporated |
| D | Input and/or output undervoltage monitoring circuitry | Safe data signal output (Versions D0...DD) |
| V | Input (and output) undervoltage monitoring circuitry | ACFAIL signal according to VME specs (Versions V0, V2, V3) |
| T | Current sharing | Interconnect T-pins if paralleling outputs (5 units max.) |
| B1 | Cooling plate | Replaces standard heat sink, allowing direct chassis-mounting |

**Option -9** Extended Temperature Range

Extension of the operating temperature range from standard –25...71 °C to –40...71 °C. The modules will provide full nominal output power with free air convection cooling. Option -9 excludes inrush current limitation by NTC.

**Option E** Inrush Current Limitation

The converters may be supplemented by an electronic circuit (option E, replacing the standard built-in NTC) to achieve an enhanced inrush current limiting function.

*Table 12: Inrush current characteristics with option E*

| Characteristics $U_i$ = 230 V AC | | LK typ | LK max | Unit |
|---|---|---|---|---|
| $I_{inr\,p}$ | Peak inrush current | – | 25.3 | A |
| $t_{inr}$ | Inrush current duration | 35 | 50 | ms |

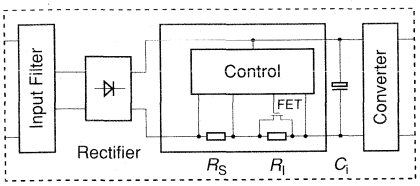



*Fig. 18*
*Option E block diagram*

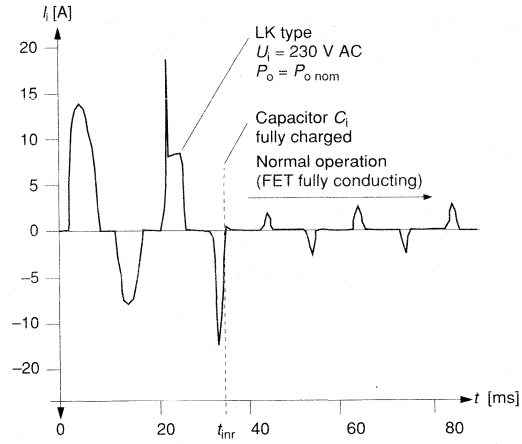



*Fig. 19*
*Inrush current with option E*

**Precaution:**
Subsequent switch-on cycles at start-up are limited to max. 10 cycles during the first 20 seconds (cold unit) and at continuing on/off ($T_C$ = 95°C) max. 1 cycle every 8 sec.

**Option P** Potentiometer

The potentiometer provides an output voltage adjustment range of +10/–60% of $U_{o\,nom}$ and is accessible through a hole in the front cover. This feature enables compensation for voltage drops across the connector and wiring. Option P is not recommended if units are connected in parallel.

Option P excludes the R-function. With double output units both outputs are affected by the potentiometer setting (doubling the voltage setting if the outputs are in series).

If the output voltages are increased above $U_{o\,nom}$ via R-input control, option P setting, remote sensing or option T, the output current(s) should be reduced accordingly so that $P_{o\,nom}$ is not exceeded.

**Option T** Current Sharing

This option ensures that the output currents are approximately shared between all paralleled modules and increases system reliability. To use this facility, simply interconnect the T pins of all modules and make sure, that pins no. 14, the S– pins (K 1000) or the Vo1– pins (K 2000) are also connected together. The load leads should have equal length and cross section to ensure equal voltage drops. Not more than 5 units should be connected in parallel. If output voltage adjustment is requested we strongly recommend to use the R-input instead of option P, as with option P the required setting accuracy is difficult to achieve. The output voltages must be individually set prior to paralleling to within a tolerance of 1...2% or the R pins should be connected together.

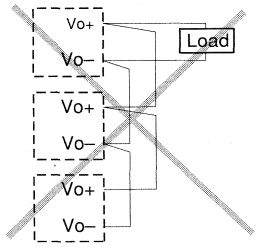
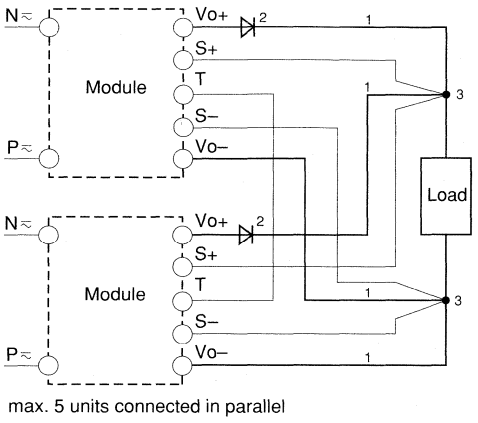



*Fig. 20*
*An example of poor wiring for connection in parallel*




[1] Leads should have equal length and cross sections and should run in the same cable loom.
[2] Diodes recommended in redundant operation only
[3] DC common point

*Fig. 21*
*Paralleling of single output units using option T with the sense lines connected at the load*

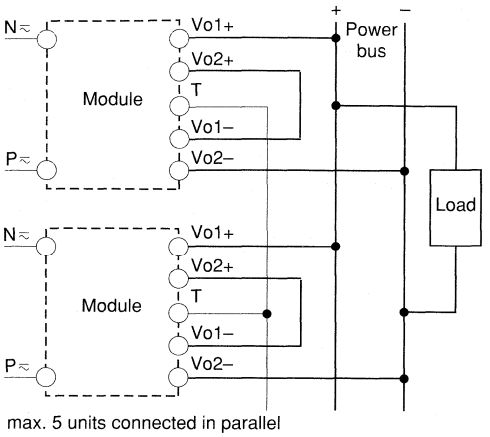



*Fig. 22*
*Paralleling of double output units using option T*

## Option D

General description

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 20 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1–. The D output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D0...DD as shown in the following table.

*Table 13: Undervoltage monitor functions*

| Output type JFET | Output type NPN | Monitoring $U_i$ | Monitoring $U_{o1}$ | Minimum adjustment range of threshold level $U_t$ $U_{t\,i}$ | Minimum adjustment range of threshold level $U_t$ $U_{t\,o}$ | Hysteresis $U_h$ typ [% of $U_t$] for $U_{t\,min}...U_{t\,max}$ $U_{h\,i}$ | Hysteresis $U_h$ typ [% of $U_t$] for $U_{t\,min}...U_{t\,max}$ $U_{h\,o}$ |
|---|---|---|---|---|---|---|---|
| D1 | D5 | no | yes | - | 3...40 V [1] | - | 2.5...0.6 |
| D2 | D6 | yes | no | $U_{i\,min}...U_{i\,max}$ [1] | - | 3.4...0.4 | - |
| D3 | D7 | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | (0.95...0.985 $U_{o1}$) [2] | 3.4...0.4 | "0" |
| D4 | D8 | no | yes | - | (0.95...0.985 $U_{o1}$) [2] | - | "0" |
| D0 | D9 | no | yes | - | 3...40 V [3] | - | 2.5...0.6 |
| | | yes | no | $U_{i\,min}...U_{i\,max}$ [3 4] | - | 3.4...0.4 | - |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | 3...40 V [3] | 3.4...0.4 | 2.5...0.6 |
| | | yes | yes | $U_{i\,min}...U_{i\,max}$ [3 4] | (0.95...0.985 $U_{o1}$) [2] | 3.4...0.4 | "0" |
| - | DD | yes | yes | $U_{i\,min}...U_{i\,max}$ [1] | 3...40 V [1] | 3.4...0.4 | 2.5...0.6 |

[1] Threshold level adjustable by potentiometer
[2] Fixed value (0.95...0.98 • $U_{o1}$). $U_{o1}$ adjustable via R-input, option P or sense lines.
[3] The threshold level permanently adjusted according to customer specification ±2% at 25°C. Any value within the specified range is basically possible but causes a special type designation in addition to the standard option designations (D0/D9 respectively)!
[4] Adjusted at $I_{o\,nom}$


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JFET output (D0...D4):

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $U_D \leq 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $< U_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_D \leq 0.4$ V at $I_D = 2.5$ mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_D \leq 25$ µA at $U_D = 5.25$ V |

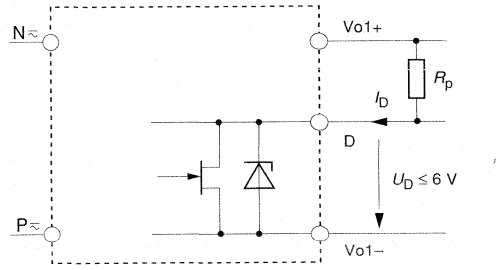



*Fig. 23*
*Option D1...D0: JFET output, $I_D \leq 2.5$ mA*

NPN output (D5...DD):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D < 0.4$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $> U_t + U_h$. The current $I_D$ through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. $U_D$ should not exceed 40 V.

| $U_i$, $U_{o1}$ status | D output, $U_D$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | high, H, $I_D \leq 25$ µA at $U_D = 40$ V |
| $U_i$ and $U_{o1} > U_t + U_h$ | low, L, $U_D \leq 0.4$ V at $I_D = 20$ mA |

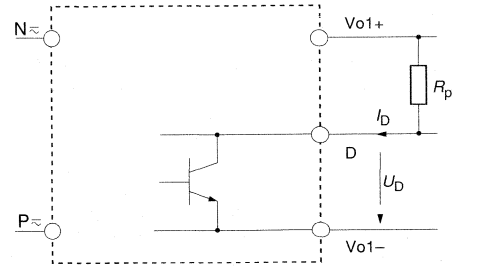



*Fig. 24*
*Option D5...DD: NPN output, $U_{o1} \leq 40$ V, $I_D \leq 20$ mA*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage after the input filter and rectifier is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{ti}$ across input filter and rectifier. The threshold levels of the D0 and D9 options are factory adjusted at nominal output current $I_{o\,nom}$ and at $T_A = 25$°C. The value of $\Delta U_{ti}$ depends upon the threshold level $U_t$, temperature and input current. The input current is a function of the input voltage and the output power.

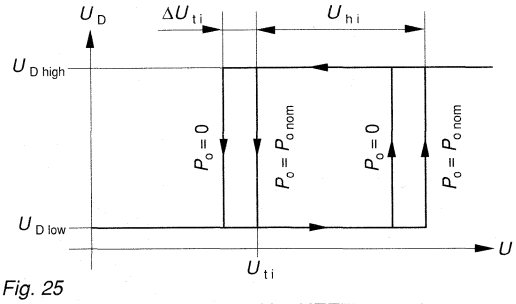
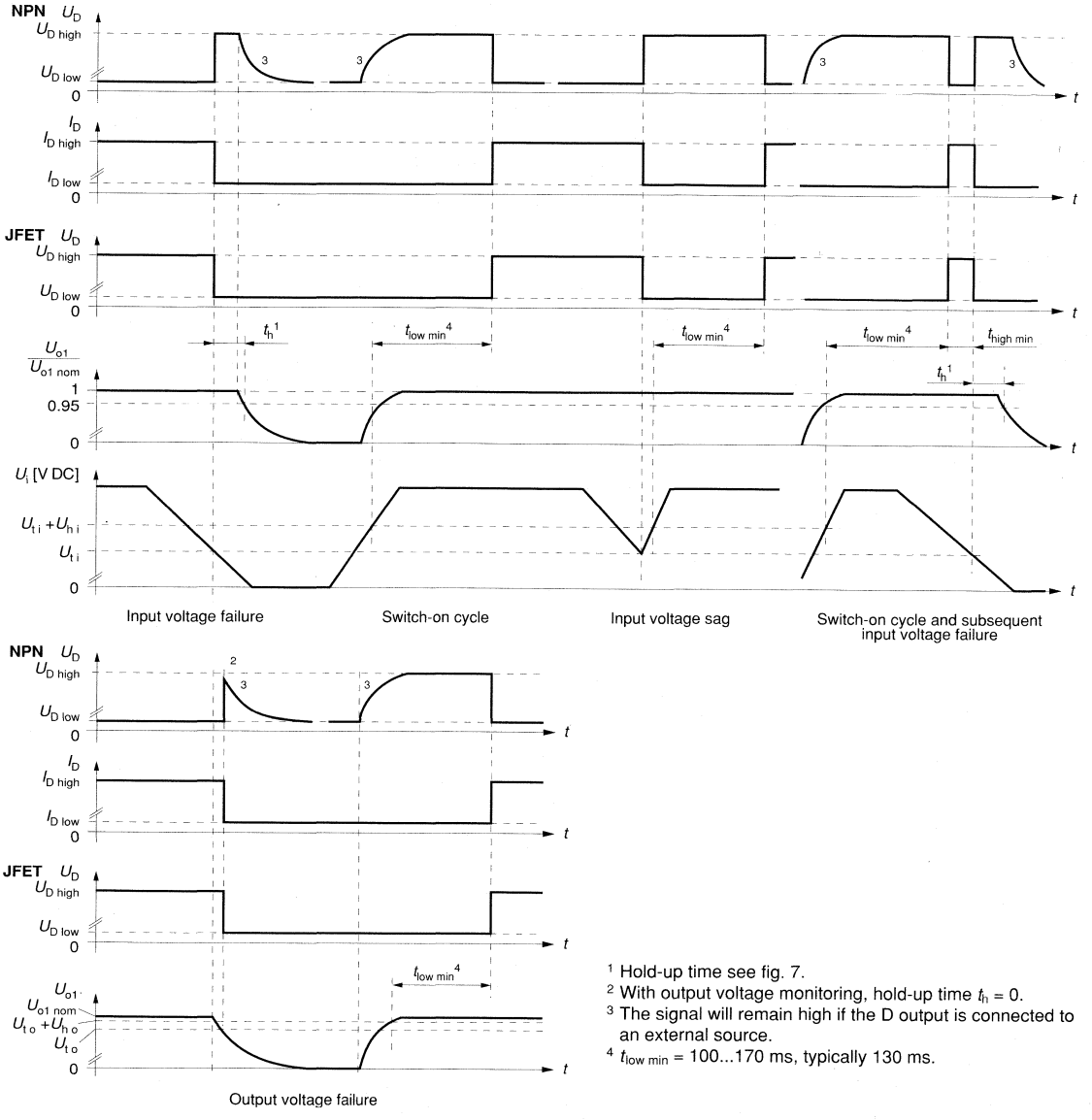



*Fig. 25*
*Definition of $U_{ti}$, $\Delta U_{ti}$ and $\Delta U_{hi}$ (JFET output)*

*Table 14: D-output logic signals*

| Version of D | $U_i < U_t$ resp. $U_o < U_t$ | $U_i > U_t + U_h$ resp. $U_o > U_t$ | Configuration |
|---|---|---|---|
| D1, D2, D3, D4, D0 | low | high | JFET |
| D5, D6, D7, D8, D9, DD | high | low | NPN |

D-signal with respect to input and output voltage versus time:




[1] Hold-up time see fig. 7.
[2] With output voltage monitoring, hold-up time $t_h = 0$.
[3] The signal will remain high if the D output is connected to an external source.
[4] $t_{low\,min}$ = 100...170 ms, typically 130 ms.

*Fig. 26*
*Relationship between $U_i$, $U_{o1}$, $U_D$, $U_{o1}/U_{o\,nom}$ versus time*

### Option V

This option defines an undervoltage monitoring circuit for the input and/or main output voltage ($U_{o1\ nom}$ = 5.1 V only) equivalent to option D and generates an ACFAIL signal (V signal) which conforms to the VME standard.

The low state level of the ACFAIL signal is specified at a sink current of $I_V \leq 48$ mA to $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME motherboard.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V when the output is fully loaded. This hold-up time $t_h$ is provided by the internal input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\ min}$ of the converter so that enough energy is remaining in the input capacitance.

Formula for threshold level for desired value of $t_h$:

$$U_{t\,i} = \sqrt{\frac{2 \cdot P_o \cdot (t_h + 0.3\ ms) \cdot 100}{C_{i\ min} \cdot \eta} + U_{i\ min}^2}$$

where as:

$C_{i\ min}$ = internal input capacitance [mF]
$P_o$ = output power [W]
$\eta$ = efficiency [%]
$t_h$ = hold-up time [ms]
$U_{i\ min}$ = minimum input voltage [V] [1]
$U_{t\,i}$ = threshold level [V]

[1] Min. input voltage according to "Electrical Input Data". For output voltages $U_o > U_{o\ nom}$, the minimum input voltage increases proportionally to $U_o/U_{o\ nom}$.

Remarks:

Option V2 and V3 can be adjusted by potentiometer to a threshold level between $U_{i\ min}$ and $U_{i\ max}$.

*Table 15: Available internal input capacitance and factory potentiometer setting of $U_{t\,i}$ with resulting hold-up time*

| Types | LK | Unit |
|---|---|---|
| $C_{i\ min}$ | 0.21 | mF |
| $U_{t\,i}$ | 120 | V DC |
| $t_h$ | 4.2 | ms |

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 20 as soon as one of the monitored voltages drops below the preselected threshold level $U_t$. The return for this signal is Vo1–. The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level $U_t$ is either adjustable by potentiometer, accessible through a hole in the front cover, or is adjusted during manufacture to a determined customer specified value.

Versions V0, V2 and V3 are available as shown below.

*Table 16: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level | | Typical hysteresis for $U_{t\ min}...U_{t\ max}$ [% of $U_t$] | |
|---|---|---|---|---|---|---|
| | $U_i$ | $U_{o1}$ | $U_{t\,i}$ | $U_{t\,o}$ | $U_{h\,i}$ | $U_{h\,o}$ |
| V2 | yes | no | $U_{i\ min}...U_{i\ max}$ [1] | – | 3.0...0.5 | – |
| V3 | yes | yes | $U_{i\ min}...U_{i\ max}$ [1] | 0.95...0.98 $U_{o1}$ [2] | 3.0...0.5 | "0" |
| V0 | yes | no | $U_{i\ min}...U_{i\ max}$ [3 4] | – | 2.2...0.4 | – |
| | yes | yes | $U_{i\ min}...U_{i\ max}$ [3 4] | 0.95...0.98 $U_{o1}$ [2] | 2.2...0.4 | "0" |

[1] Threshold level adjustable by potentiometer [2] Fixed value between 95% and 98% of $U_{o1}$ (tracking) [3] Adjusted at $I_{o\ nom}$
[4] Fixed value, resistor-adjusted (±2% at 25°C) acc. to customer's specifications; individual type number is determined by Melcher

V output (V0, V2, V3):

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level ($U_i$ and/or $U_{o1}$) $< U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $U_V$ should not exceed 80 V.

| $U_i$, $U_{o1}$ status | V output, $U_V$ |
|---|---|
| $U_i$ or $U_{o1} < U_t$ | low, L, $U_V \leq 0.6$ V at $I_V$ = 50 mA |
| $U_i$ and $U_{o1} > U_t + U_h$ | high, H, $I_V \leq 25$ µA at $U_V$ = 5.1 V |

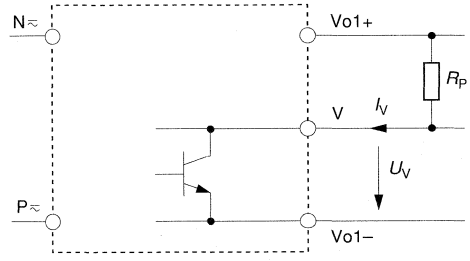



*Fig. 27*
*Output configuration of options V0, V2 and V3*

Threshold tolerances and hysteresis:

If $U_i$ is monitored, the internal input voltage is measured after the input filter and rectifier. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across input filter and rectifier. The threshold level of option V0 is adjusted during manufacture at $I_{o\,nom}$ and $T_A = 25\,°C$. The value of $\Delta U_{t\,i}$ depends upon the threshold level $U_t$, temperature and input current. The input current is a function of input voltage and output power.

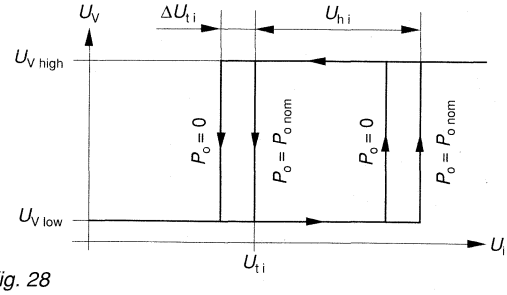
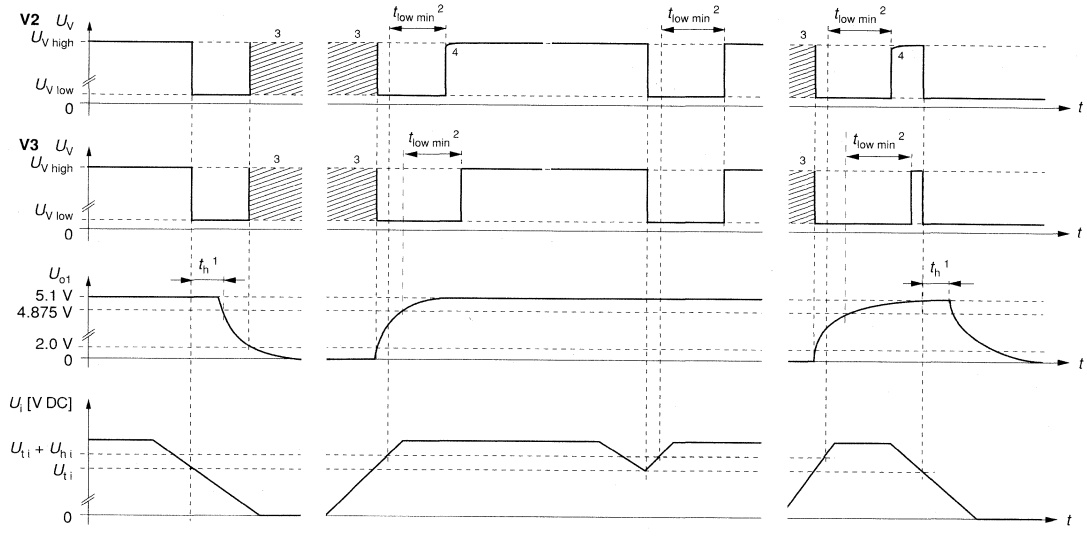
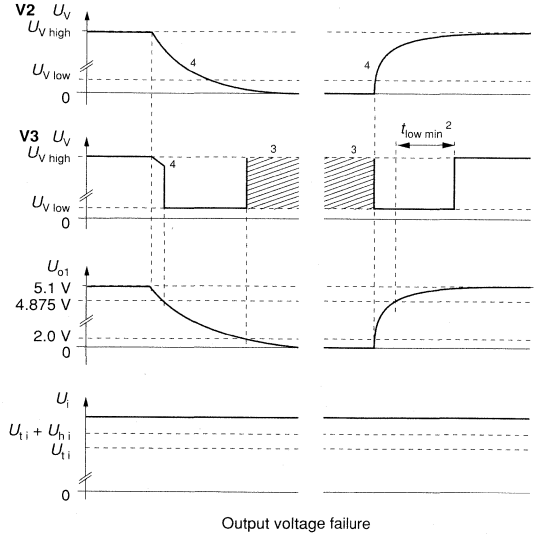



*Fig. 28*
*Definition of $U_{t\,i}$, $\Delta U_{t\,i}$ and $U_{h\,i}$*




[1] VME request: minimum 4 ms
[2] $t_{low\,min}$ = 40...200 ms, typically 80 ms
[3] $U_V$ level not defined at $U_{o1} < 2.0$ V
[4] The V signal drops simultaneously with the output voltage. If the pull-up resistor $R_P$ is connected to Vo1+. The V signal remains high if $R_P$ is connected to an external source.

*Fig. 29*
*Relationship between $U_i$, $U_{o1}$, $U_V$, $I_V$ and $U_{o1}/U_{o\,nom}$ versus time.*

**Option B1** Cooling Plate (see "Mechanical Data")

Where a cooling surface is available, we recommend the use of a cooling plate (option B1) instead of the standard heatsink. The mounting system should ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The cooling capacity is calculated by:

$$P_{Loss} = \frac{(100\% - \eta)}{\eta} (U_o \cdot I_o)$$

Efficiency $\eta$ see tables 1a, b, c


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## Immunity to Environmental Conditions

*Table 17: Mechanical stress*

| Test | | Standard | Test Parameters | |
|---|---|---|---|---|
| Ca | Damp heat<br>steady state | DIN 40046, part 5<br>IEC 68-2-3<br>MIL-STD 810D section 507.2 | Temperature:<br>Relative humidity:<br>Time: | $40^{\pm 2}$ °C<br>$93^{+2/-3}$ %<br>56 days<br>Unit not operating |
| Ea | Shock<br>(half-sinusoidal) | DIN 40046, part 7<br>IEC 68-2-27<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>18 (3 each direction)<br>Unit operating |
| Eb | Continuous shock<br>(half-sinusoidal) | DIN 40046, part 26<br>IEC 68-2-29<br>MIL-STD 810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (1000 each direction)<br>Unit operating |
| Fc | Vibration<br>(sinusoidal) | DIN 40046, part 8<br>IEC 68-2-6<br>MIL-STD 810D section 514.3 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...2000 Hz<br>0.35 mm (10...60 Hz)<br>5 $g_n$ = 49 m/s²<br>7.5 h (2.5 h each axis)<br>Unit operating |
| Kb | Salt mist<br>cyclic<br>(sodium chloride NaCl<br>solution) | DIN 40046 part 105<br>IEC 68-2-51 | Concentration:<br>Duration:<br>Storage:<br>Storage duration:<br>Number of cycles: | 5% (30°C)<br>2 h per cycle<br>40°C, 93% rel. humidity<br>22 h per cycle<br>3<br>Unit not operating |

*Table 18. Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Standard operational ambient temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –25 | 71 | °C |
| $T_A$ | Extended operational ambient temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 71 | |
| $T_C$ | Standard operational case temperature range -7, overtemp. lock-out (PTC) at $T_C$ > 95°C | –25 | 95 | |
| $T_C$ | Extended operational case temperature range -9, overtemp. lock-out (PTC) at TC > 95°C | –40 | 95 | |
| $T_S$ | Storage temperature range -7, (MIL-STD-810D sections 501.2 and 502.2) | –40 | 100 | |
| $T_S$ | Extended storage temperature range -9, (MIL-STD-810D sections 501.2 and 502.2) | –55 | 100 | |

### Thermal Considerations

Operation at ambient temperatures of 71...85°C with convection cooling will limit the maximum output power to 40% (approx.) of the nominal value. Forced cooling (additional heat sink, fan, etc.) allows operation of the power supply at nominal output power up to an ambient temperature of 85°C, as long as the maximum case temperature $T_{C\,max}$ (95°C) is not exceeded. The case temperature measuring point is shown on fig. 31.

In applications where modules operate in parallel, option T (current sharing) should be used.

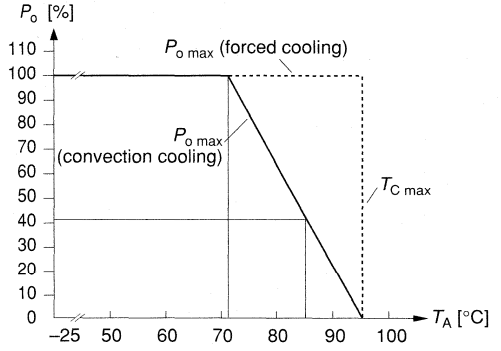



*Fig. 30*
*Output power derating versus $T_A$*

*Table 19: MTBF*

| Values at Specified Case Temperature | Type | Ground Benign 40°C | Ground Fixed 40°C | Ground Fixed 70°C | Ground Mobile 50°C | Unit |
|---|---|---|---|---|---|---|
| MIL-HDBK 217F | LK 1000/2000 | 500'000 | 150'000 | 80'000 | 50'000 | h |

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

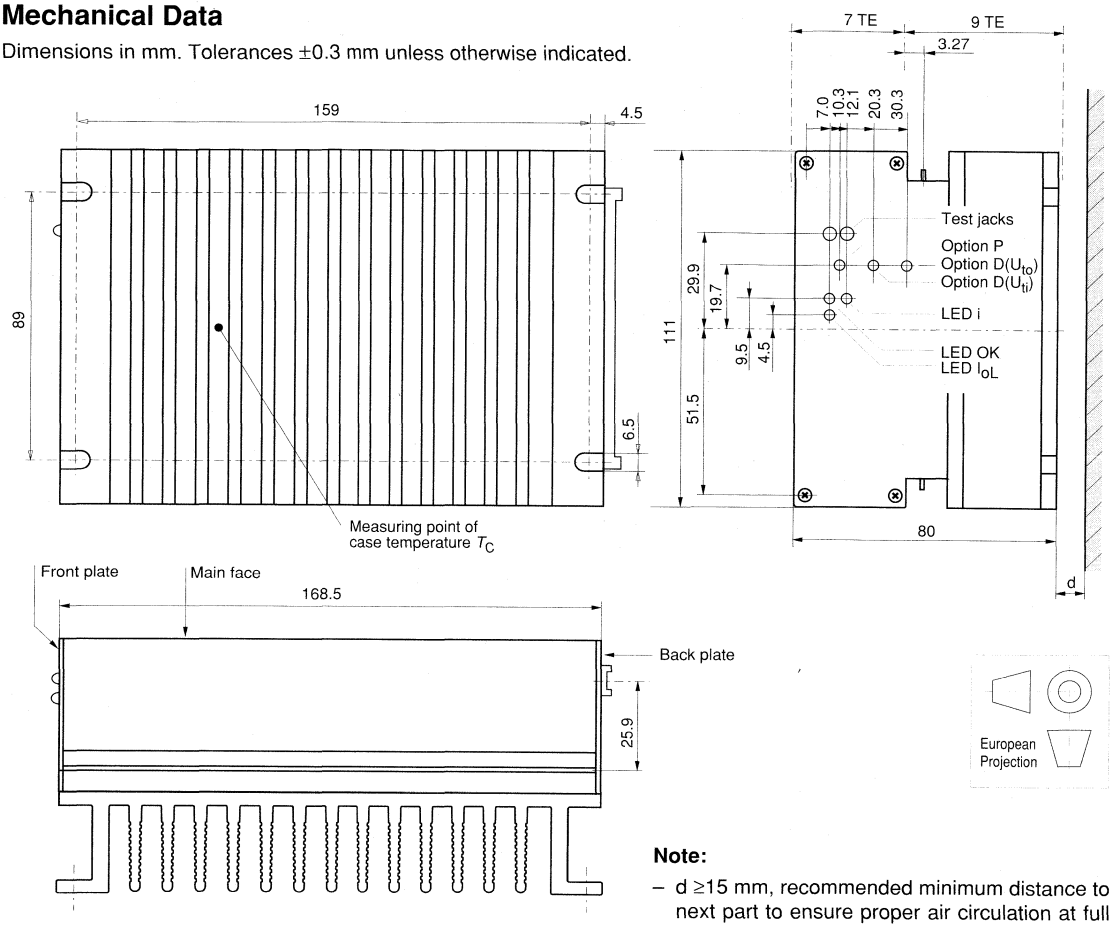



*Fig. 31*
*Case K02 with heatsink*
*Total weight: Approx. 1.55 kg*

**Note:**

- d ≥15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power.
- free air locations: the module should be mounted with fins in vertical position to achieve a maximum air flow through heat sink.

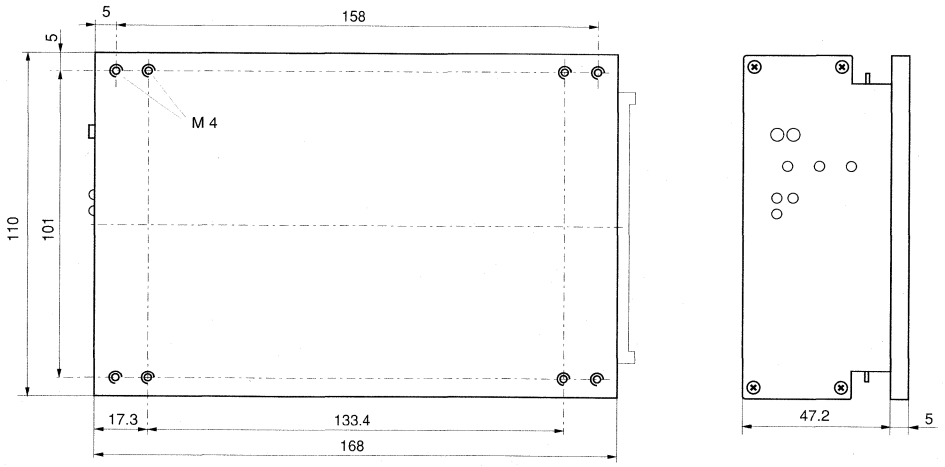
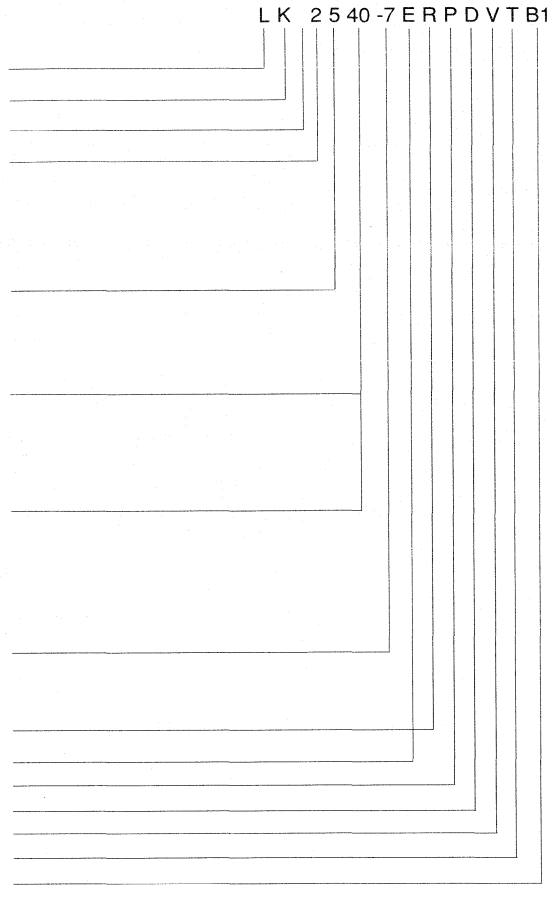



*Fig. 32*
*Case K02 with option B1 (cooling plate)*
*Total weight: Approx. 1.15 kg*


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## Type Key and Product Marking

### Type Key




Input voltage range $U_i$:
85...264 V AC (88...372 V DC) ..... L

Family ..... K

Blank .....

Number of outputs ..... 1...2

Single output units:
Nominal voltage output 1 (main output), $U_{o1\ nom}$
5.1 V ..... 0, 1, 2
12 V ..... 3
15 V ..... 4, 5
24 V ..... 6
other voltages ..... 7, 8

Other specifications for
single output modules ..... 01...99

Symmetrical double output units:
Nominal voltage output 1/output 2, $U_{o1/2\ nom}$
12 V/12 V [1] (24 V series conn. [2]) ..... 20
5 V/15 V [1] (30 V series conn. [2]) ..... 40
24 V/24 V [1] (48 V series conn. [2]) ..... 60
other symmetrical voltages ..... 70...99

Operational ambient temperature range $T_A$:
–25...50 °C ..... -5
–25...60 °C ..... -6
–25...71 °C ..... -7
–40...71 °C (optional) ..... -9
customer specific ..... -0

Feature: Output voltage control input [3] ..... R

Options: Inrush current limitation ..... E
Potentiometer (output voltage adjustment) [3] ... P
Save data signal (D0...DD, to be specified) [4] . D
ACFAIL signal (V0, V2, V3, to be specified) [4] . V
Current sharing ..... T
Cooling plate ..... B1

[1] External wiring of main and second output depending upon the desired output configuration (see fig. 16b, c, d or e).
[2] External wiring of main and second output (see fig.16a).
[3] Feature R excludes option P and vice versa.
[4] Option D excludes option V and vice versa.

Example: LK 2540-7PD3: AC-DC converter, input voltage range 85...264 V AC, double output, each providing 15 V/5 A, equipped with potentiometer and undervoltage monitor option.

### Product Marking

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LED's, test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltages and output currents, pin allocation of options and auxiliary functions, fuse specification and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main PCB and date of production.

# 500 W AC-DC Converters

# T-Family

**Input to output isolation**
**Single output: LT 1000**

- Universal AC input range
- 54.5 V DC output voltage for 48 V loads
- Battery charging with internal or remote temperature control
- Safety according to IEC 950. 3 kV input-to-output isolation
- Immune to transients and disturbances according to VDE 160 and IEC 801-2,3,4,5,6
- Very high efficiency, typically 93%
- Power factor >0.99, harmonics <IEC 555-2, low RFI
- No inrush current, hot plug-in capability
- High power density, 210 W/dm$^3$, rugged mechanical design
- Very compact 19" cassette (28 TE, 3 U, 160 mm)




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## Description

The LT 1000 is a galvanically isolated AC-DC converter, battery charger and telecom rectifier with an output power of 550 W. For higher power requirements several units may be connected in parallel.

The input of the LT 1000 is ideally adapted to the mains: Full power factor correction, no inrush current, low RFI level and low transient and surge susceptibility are key design features. The LT 1000 behaves similarly to a resistive load.

The output delivers a galvanically isolated Safety Extra Low Voltage (SELV) of 54.5 V DC. The output is short circuit and no-load proof. A constant output power of 550 W is available down to $U_o$ = 38 V DC; below this value, the output current is limited to 14.5 A.

The output can drive various 48 V loads and is especially suited to powering Melcher DC-DC converters of the CQ series which have matching signalling capabilities. Also non isolated switching regulators of the PSR-line or other Melcher converters may be applied. Such modularity allows application specific power supply systems with central or distributed architecture to be assembled. Distributed systems have the advantage of lower power loss over load lines and fewer regulation problems.

The DC-power bus can be supported by a 48 V lead acid battery allowing the simple configuration of uninterruptable power supply systems. The LT 1000 series can either directly charge such batteries thanks to its output characteristics with negative temperature coefficient (LT 1720/30) or by remote temperature sensing (LT 1740) with a trickle charge voltage from 50.5 V up to 56.5 V.

True redundant systems are also possible since both, the LT 1000 front-end and the secondary DC-DC converters of the CQ-series may be connected in parallel. (See also "System Integration").

## Type Survey

*Table 1a: Type Survey (All typical values at 20 °C)*

| Output Voltage at 0.5 • $I_{o\,nom}$ [1] [V] | Temperature Coefficient of Output [mV/K] | Maximum Output Power [W] | Output Current Limit [A] | Input Voltage [2] Range (47...63 Hz) [$V_{rms}$] | Efficiency η [%] | Type |
|---|---|---|---|---|---|---|
| 54.5 | –5 | 550 | 14.5 | 85...255 | 93 | LT 1701-7 |
| 54.5 | –72 | 550 | 14.5 | 85...255 | 93 | LT 1720-7 [3 5] |
| 54.5 | –72 | 550 | 14.5 | 85...255 | 93 | LT 1730-7 [4 5 7] |
| 53.52...55.68 | –72 | 550 | 14,5 | 85...255 | 93 | LT 1730-7Z [4 5 7] |
| 53.5 | –48...–108 | 550 | 14.5 | 85...255 | 93 | LT 1740-7 [6 7] |
| 53.52...55.68 | –48...–108 | 550 | 14.5 | 85...255 | 93 | LT 1740-7Z [6 7] |

[1] Definition see fig. 8.
[2] For $U_i$ 85...155 $V_{rms}$ reduced output power: $P_o$ [W] = $U_i$ [$V_{rms}$] • 3.6 [$A_{rms}$].
[3] Internal temperature sensor fitted to the front panel. For battery charging of 24 cell lead acid batteries with a fixed internal negative temperature coefficient of –3 mV/K per cell and 2.27 V trickle charge voltage at 20 °C. Different cell voltages on request.
[4] Internal temperature sensor fitted to the rear of the converter. For battery charging of 24 cell lead acid batteries with a fixed negative temperature coefficient of typically –3 mV/K per cell and 2.27 V trickle charge voltage at 20 °C. Optionally the LT 1730-7 is available with a cell voltage selector switch for external adjustment of the trickle charge voltage from 2.23 V up to 2.32 V per cell (LT 1730-7Z).
[5] The LT 1720/1730 battery chargers are suitable for battery systems located within buildings with an ambient temperature range of 0...50 °C. The LT units should experience the same ambient temperature conditions as the batteries. If the batteries are located in the same cubicle, forced cooling may be required. (See also "Battery charging with LT 1720/1730")
[6] For battery charging of 24 cell lead acid batteries with a control input for remote temperature sensing. Temperature sensors with different temperature coefficients from –2 mV/K up to –4.5 mV/K per cell are available on request. (See also "Battery charging with LT 1740"). Optionally the LT 1740-7 is available with a selector switch (LT 1740-7Z) for external adjustment of the trickle charge voltage from 2.23 V to 2.32 V per cell at 20 °C, together with the use of a standard Melcher sensor.
[7] Preliminary data

*Table 1b: Survey of options*

| Option | Function of option |
|---|---|
| Z [1 2] | Cell voltage selector switch |
| P [1 2] | Potentiometer for fine adjustment of the output voltage |
| W [1] | Electronically switched preload |
| G [1] | Galvanically isolated system |
| B1 | Mounting plate |

[1] Only for LT 1730/40
[2] Option P exludes option Z and vice versa

## Safety and Installation Instructions

### Safety

Connection to the system shall be made via the matching female connector type DIN H15, pinning according to table 2 below. It is of major importance to wire the modules via this connector in order to fulfill the safety requirements of IEC 950!

The LT 1000 series corresponds to the equipment class I specification and complies with IEC 950 for a 3 kV isolation test voltage. The earthing pins 8 and 10 are leading and separate input pins from output pins. Earth connection is mandatory.

After disconnecting the unit energy remains stored in the output capacitors, this is indicated by the red LED. (Internal discharging time: Approximately 3 minutes.) To prevent an unwanted short circuit across the output of a disconnected unit pins 16 and 18 are leading as well.

LT units are no load proof. However for safety reasons a minimum load of >5 W or an external voltage clamp is required. This prevents the output voltage exceeding the SELV limit for any single fault condition in the second output voltage control loop.

### Isolation Voltage Testing

An isolation voltage test in accordance with IEC 950, EN 60950, VDE 0805 and EN 41003 is performed in the factory. During the production process, all transformers and each fully assembled unit are individually tested.

### Insulation Resistance Testing

The insulation resistance $R_{ins}$ between input and output is tested in the factory with the output connected to the case. Test voltage: 500 V DC, $R_{ins} \geq 300$ MΩ.

**Important advice**

High voltage tests should not be repeated in the field. Improper test methods may cause severe damage to the unit and Melcher will refuse any guarantee/warranty claims resulting from high voltage field tests.

For safety reasons do not open the unit.

The LT 1720 types are fitted with an internal temperature sensor bolted to the front panel. To maintain proper earth connection as well as good thermal coupling to the temperature sensor the front panel should not be removed.

For all other LT types Melcher front panels are available as an accessory and can be mounted or removed without any restrictions.

The installation must strictly follow the national safety regulations. Pins 8/10 should be connected to earth.

A second fuse should be installed in the wiring to pin 6 if:
- Local requirements demand an individual fuse in each source line
- Phase and neutral of the mains are not defined

Connection to the system shall be made via the matching female connector type DIN H 15, pinning according to table 2 below.

The LT 1000 provides two contacts for both, the positive and the negative output path (pins 12/14 and pins 20/22 respectively) which are internally connected in parallel. It is recommended that the respective female connector pins of each path are also connected in parallel to keep the voltage drop across the connector pins to an absolute minimum.

In case of remote temperature control the temperature sensor should be connected according to its wiring diagram. Wrong connection may damage the sensor.

LT units correspond to protection degree IP 30, defined with the female connector fitted to the unit.

**Audible Noise**

Under certain operating conditions, the LT 1000 converter generates a slight audible noise due to magnetostriction in the transformer. This noise does not affect the function of the unit nor is it detrimental to its performance over time.

*Table 2a: H15 connector pin allocation*

| Pin No. | LT 1000 | |
|---|---|---|
| 4 | P~ | Phase |
| 6 | N~ | Neutral |
| 8 [1] | ⏚ | Protective earth |
| 10 [1] | | |
| 12 | Vo+ | Output/sensor positive supply, LT 1740 |
| 14 | | |
| 16 [1 3] | HC+ | Hot plug-in contacts |
| 18 [1 3] | HC– | |
| 20 | Vo– | Output/sensor negative supply, LT 1740 |
| 22 | | |
| 24 | Sys In | System Good signal |
| 26 | Sys Out | |
| 28 [2] | i/$U_{cr}$ | Inhibit/remote control input, LT 1740 |
| 30 | D | Power Down signal |
| 32 | D set | Power Down signal threshold of $U_o$ |

[1] Leading pin
[2] Unit operates with open inhibit
[3] External connections see fig. 30

*Table 2b: H15 connector pin allocation with option G, galvanically isolated signals System Good/Power Down*

| Pin No. | LT 1000-7G | |
|---|---|---|
| 4 | P~ | Phase |
| 6 | N~ | Neutral |
| 8 [1] | ⏚ | Protective earth |
| 10 [1] | | |
| 12 | Vo+ | Output/sensor positive supply, LT 1740 |
| 14 | | |
| 16 [1] | Sys Out– | System Good output – |
| 18 [1] | D Out– | Power Down output – |
| 20 | Vo– | Output/sensor negative supply, LT 1740 |
| 22 | | |
| 24 | Sys In | System Good input |
| 26 | Sys Out+ | System Good output + |
| 28 [2] | i/$U_{cr}$ | Inhibit/remote control input, LT 1740 |
| 30 | D Out+ | Power Down output + |
| 32 | D set | Power Down signal threshold of $U_o$ |

[1] Leading pin
[2] Unit operates with open inhibit

## Functional Description

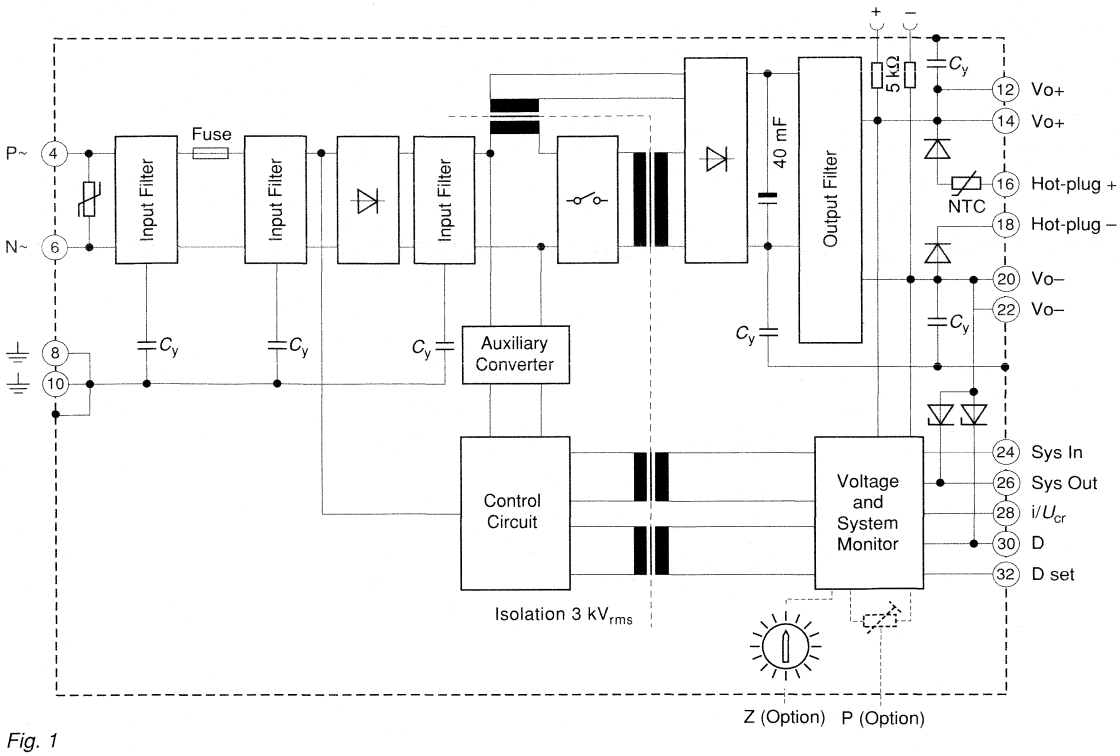



*Fig. 1*
*Block diagram*

The LT 1700 unit is a primary controlled AC-DC converter with a constant switching frequency of 65.5 kHz. The power factor corrected single step conversion of the line input voltage to a low output voltage results in extremely high efficiency.

The input voltage is fed via an input fuse, filter and rectifier to the main transformer. The wideband input filter with small input capacitance generates virtually no inrush current. Transient suppressors protect the unit against high voltage peaks and surges. An auxiliary converter generates an internal supply voltage for the primary control logic. The input voltage waveform is sensed by the primary control logic to allow power factor correction.

The main transformer is connected to a rectifier, large output capacitors and an efficient output filter which ensures low output ripple and spikes as well as providing the necessary hold-up time. The output voltage is fed back to the primary control logic via a signal transformer.

The inhibit signal and the LT failure signal are transferred by a second signal transformer (no opto-couplers!).

System Good and Output voltage OK are each indicated by a green LED. Inhibit and LT System Failure are indicated by a red LED.

System Good and Power Down are available as open collector signals at the connector. The threshold level of the Power Down signal can be externally adjusted at the D set input.

Test sockets allow measurement of the output voltage at the front panel.

The LT 1730/40 can either be fitted with option P (potentiometer) or with option Z, a 16-step selector switch, for setting the output voltage to different battery trickle charge voltages.

The LT 1740 features a control input for remote output voltage adjustment, available on the multifunctional inhibit/$U_{cr}$ control pin. A trim-potentiometer allows for fine adjustment of the output voltage.

## Electrical Input Data

General conditions:
– $T_A$ = 20 °C, unless $T_C$ is specified.

*Table 3: Input Characteristics*

| Input | | | LT 1000 | | | |
|---|---|---|---|---|---|---|
| Characteristic | | Conditions | min | typ | max | Unit |
| $U_i$ | Input voltage range with full output power [1] | AC (47...63 Hz) | 155 | | 255 | $V_{rms}$ |
| $U_{i\,red}$ | Input voltage range with reduced output power [2] | | 85 | | 155 | |
| $U_{i\,nom}$ | Nominal input voltage | | | 230 | | |
| $I_{i\,nom}$ | Nominal input current | $U_{i\,nom}$, $P_{o\,nom}$ | | 2.6 | | $A_{rms}$ |
| $I_{i\,L}$ | Input current limit | | | 4.0 | | |
| $P_{io}$ | No-load input power | $U_{i\,min}$...$U_{i\,max}$, $I_o$ = 0 | | 8 | | W |
| $P_{i\,inh}$ | Idle input power | $U_{i\,min}$...$U_{i\,max}$, inhibit = low | | 2.5 | | |
| PF | Power factor [3] | $U_{i\,nom}$, $I_{o\,nom}$ | 99 | | | % |
| $C_i$ | Input capacity [4] | $U_{i\,nom}$ | | 4 | | µF |
| $t_{on}$ | Switch on delay | $U_{i\,nom}$, $U_o$ > 39 V | | 400 | | ms |
| $U_{i\,RFI}$ | Input RFI level [5] | $I_o$ = $I_{o\,nom}$ EN 55014, EN 55011/022 | | | B | |
| $U_{i\,p}$ | Input overvoltage protection [6] | | | | 264 | $V_{rms}$ |
| $U_{i\,L}$ | Input undervoltage lock-out | | 75 | | | |
| F | Fuse fast blow 5 × 20 mm | | | 6.3 | | A |
| $f_{tr}$ | Switching frequency | | | 65.536 | | kHz |

[1] 550 W maximum output power.
[2] The input current is limited to approximately 4 $A_{rms}$, causing a linear output power derating to approximately $P_o$ [W] = $U_i$ [$V_{rms}$] • 3.6 $A_{rms}$ if operated in the low input voltage range.
[3] Power factor as a function of the input voltage and load (see fig. 5). Harmonic distortion (see fig. 6).
[4] Inrush current stays factor 10 below prETS 300132-1.
[5] 150 kHz...30 MHz: EN 55011/22-B, 30...300 MHz: EN 55014
[6] In case of overvoltage the LT 1000 switches off for short periods only when $|u_i| > 255 \cdot \sqrt{2}$ [V], resulting in reduced output power and increased RFI.

### Input Filter

The conducted noise emitted at the input of the LT units within the frequency range of 10 kHz to 30 MHz is below level B according to EN 55011/55022 under all operating conditions.

For system applications additional external input filtering is available. (See also: "Backplane")

The radiated noise in the frequency range of 30 MHz to 300 MHz on the input- and the output-side of the LT units stays below the limit of EN 55014 measured with an MDS-clamp and below level A, according to EN 55011/22 measured with an antenna.

The radiated noise of the LT between 30 MHz to 1 GHz will be reduced if the unit is built into a conductive chromatized 19" rack, fitted with a Melcher front panel. For units mounted otherwise, e.g. for wall mounting with option B1 (base plate) the radiated noise may be above level B.

Depending upon the system set-up additional RFI measurements may be necessary since noise may also be generated by the load.

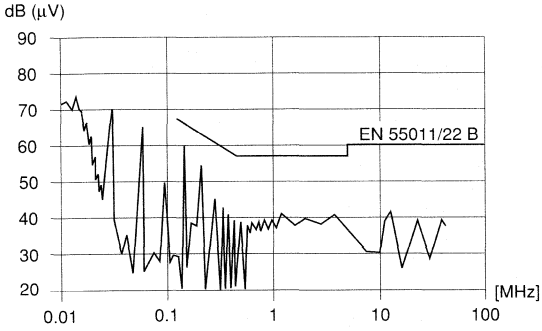



*Fig. 2*
*Typical radio frequency interference voltage at $U_{i\,nom}$, $I_{o\,nom}$, measured with an artificial mains network and a quasi peak detector.*

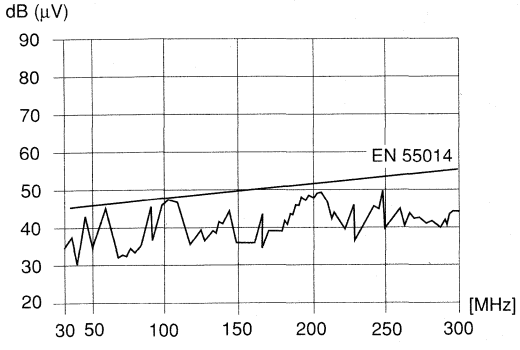



*Fig. 3*
*Typical radiated noise at the input and output of a LT 1701 measured with a MDS clamp at $P_{o\,nom}$*

### Inrush Current

The LT units operate with 4 µF input capacitance resulting in a low peak current of short duration when the unit is connected to the mains. The large output capacitors cause no inrush current because they are charged with the maximum input current (4 $A_{rms}$) as soon as the unit has started. As a direct result of the low and short inrush current and controlled charging procedure of the output capacitors, the unit can be hot plugged to the mains causing only negligible disturbances. The LT inrush current is a factor of 10 smaller than defined in the prETS 300 132-1 standard for Telecom Systems.

### Efficiency

The extremely high efficiency of the LT 1000 series is achieved by using a single step power factor corrected converter topology with low output voltage together with the most advanced technology in power conversion.

It allows a very compact design in a fully enclosed case without forced cooling.

**Note:** At output voltages >55 V the efficiency of the LT 1720/30/40 is 0.5% to 1% below the typical values of fig. 4 measured with an LT 1701. This should be considered in the thermal management for systems being operated at high ambient temperatures.

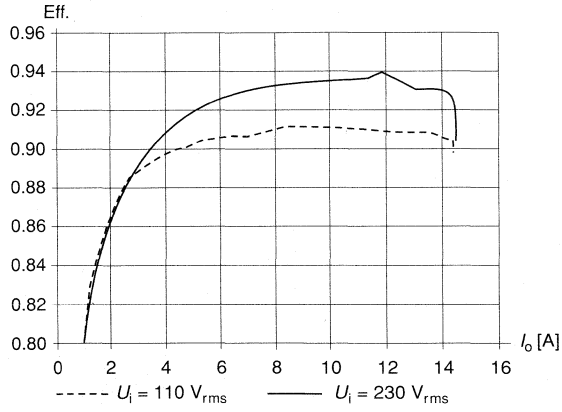



*Fig. 4*
*Efficiency versus load*

### Input Fuse

A fuse holder containing a fast blow type fuse (5 × 20 mm) is mounted in the converters back plate. The fuse is fitted in the line (P) path. (See also "Safety and Installation Instructions")

*Table 4: Fuse Type*

| Series | Schurter type [1] | Part number |
|---|---|---|
| LT 1000 | SP F 6.3 A, 250 V | 0001.1012 |

[1] fast blow type with high breaking capacity; other equivalent products permitted

### Power Factor, Harmonics

The LT power factor correction is achieved by controlling the input current waveform synchronously with the input voltage waveform. The power factor control is active in all operating conditions (voltage regulation, output power limitation, current limitation). The power factor control also works with different input voltage waveforms and frequencies. Operation at frequencies above 60 Hz will result in higher leakage currents. For special applications with different frequencies or non-sinusoidal wave shapes, please contact Melcher.

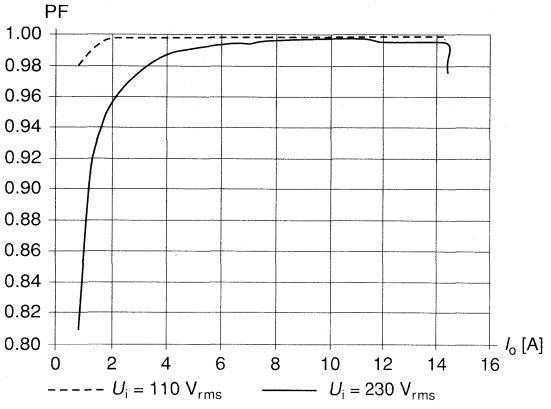



*Fig. 5*
*Power factor*

### Input Undervoltage Lock-Out

An internal signal inhibits the LT unit when the input voltage $U_i$ stays below typically 75 $V_{rms}$ for a sinusoidal wave shape.

The harmonic distortion at the input is far below the limits as requested by IEC 555-2, class D.

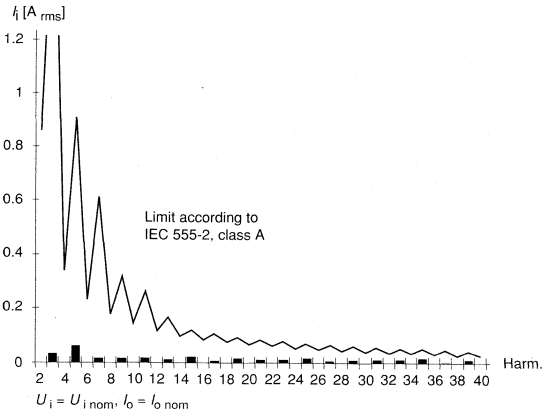



*Fig. 6*
*Harmonic distortion at input (IEC 555-2)*

### Input Overvoltage, Surges and Transients

An internal inhibit signal stops operation temporarily when the value of $U_{i(t)}$ exceeds $\sqrt{2} \cdot 255$ V. The power supply reduces in this way the available output power.

The units withstand transients according to VDE 160 class II ($U_{ip} = 2.3 \cdot U_{i\,nom}$; 1.3 ms), fast transient and bursts as per IEC 801-4 (level 4), electrostatic discharge up to 8 kV according IEC 801-2 (level 4), 4 kV lightning overvoltages, transients and surges according to IEC 801-5 (level 4), severe electromagnetic fields (10 V/m) per IEC 801-3 (level 3) and electromagnetic discharge IEC 801-6 (level 3).
Maximum permissible overvoltage up to 400 $V_{rms}$ for max. 0.5 seconds.

### Electromagnetic Immunity

*Table 5: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [2] | Value applied | Waveform | Source impedance | Test procedure | in operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Electrostatic discharge | IEC 801-2 (1991-04) | 4 | contact discharge to case, | 8000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | [1] |
| | | | air disch. to case | 15000 $V_p$ | | | | | |
| Electric field | IEC 801-3 (1984) | 3 | antenna in 1 m distance | 10 V/m | sine wave modulated w. 1 kHz | | 26...1000 MHz | yes | |
| Fast transient/ burst | IEC 801-4 (1988) | 3 | i/c, +i/–i | 2000 $V_p$ | bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period | 50 Ω | 1 min positive 1 min negative bursts per coupling mode | yes | [1] |
| | | 4 | | 4000 $V_p$ | | | | | |
| Transient | IEC 801-5 (Draft 1993-01) | 4 | i/c, | 4000 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. impulses per coupling mode | yes | [1] |
| | | | +i/–i | 2000 $V_p$ | | 2 Ω | | | |
| Electric field susceptibility | IEC 801-6 | 3 | | 14 dBµV | | | | | |

[1] Normal operation, no deviation from specifications

[2] i = input, o = output, c = case



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## Electrical Output Data

General conditions:
– $T_A$ = 20 °C, unless $T_C$ is specified.
– $U_i$ = $U_{i\,nom}$ (230 $V_{rms}$), f = 50 Hz

*Table 6: Output data*

| Output | | | LT 1701-7 | | | LT 1720-7 | | | LT 1730-7 | | | LT 1740-7 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristic | | Conditions | min | typ | max | min | typ | max | min | typ | max | min | typ | max | Unit |
| $U_{o\,set}$ | Output voltage adjustment, see fig. 8 | $U_{i\,nom}$, $T_C$ = $T_A$ $I_o$ = 0.5 • $I_{o\,nom}$ | | 54.5 | | | 54.5 | | | 54.5 | | | 53.5 | | V |
| | with option Z/sensor | | | – | | | – | | | 53.5...55.7 | | | 53.5...55.7 | | |
| $U_{o\,set\,tol}$ | $U_o$ setting tolerance | | | ±0.5 | | | ±0.25 | | | ±0.1 | | | ±0.1 | | |
| $U_o$ | Output voltage [1] over input voltage and load | $U_{i\,min}$...$U_{i\,max}$ $I_o$ = 0.01 • $I_{o\,nom}$ ...$I_{o\,nom}$ | 54.0 | | 55.0 | 54.0 | | 55.0 | 54.0 | | 55.0 | 53.0 | | 54.0 | |
| $U_{o\,range}$ | Output voltage range | $T_C$ = $T_A$ [2] | | | | | 50...58 [6] | | | 50.5...56.5 [7] | | | 50.5...56.5 [7] | | |
| $U_{o\,L}$ | $U_o$ overvoltage protection | | | 58.0 | | | 58.0 | | | 59.0 | | | 59.0 | | |
| $TC_{Uo}$ | Temperature coefficient of output voltage | *TC* fixed value | | –5 | 0 | | –72 | | | –72 | | | –3 | 0 | mV/K |
| | | *TC* def. by sensor | | | | | | | | | | | –40...–108 [9] | | |
| $I_{o\,nom}$ | Nominal output current | $U_o$ fixed value | | 10 | | | 10 | | | 10 | | | 10.2 | | A |
| | | $U_o$ by sel. switch | | | | | | | | 550/$U_{o\,set}$ [8] | | | 550/$U_{o\,set}$ [8] | | |
| $I_{o\,L}$ | Current limit [3] | $U_o$ = 20 V | | 14.5 | | | 14.5 | | | 14.5 | | | 14.5 | | |
| $P_{o\,L}$ | Output power limit [3] | $U_{i\,nom}$ | | 550 | | | 550 | | | 550 | | | 550 | | W |
| $U_{o\,r}$ | Output voltage ripple | $I_{o\,nom}$ | | 0.28 | 0.35 | | 0.28 | 0.35 | | 0.28 | 0.35 | | 0.28 | 0.35 | $V_{rms}$ |
| | (100 Hz) see fig. 7 | $I_{o\,L}$ | | 0.45 | 0.55 | | 0.45 | 0.55 | | 0.45 | 0.55 | | 0.45 | 0.55 | |
| $\Delta U_{o\,L}$ | Static load regulation see fig. 7 and fig. 8 | $I_o$ = 0.01 • $I_{o\,nom}$ ...$I_{o\,nom}$ | | 0.6 | 0.8 | | | 0.1 | | | 0.1 | | | 0.6 | V |
| $\Delta U_{o\,l}$ | Static line regulation see fig. 8 | $U_i$ = $U_{i\,min}$...$U_{i\,max}$ $I_{o\,nom}$ | | 0.3 | 0.4 | | | 0.1 | | | 0.1 | | | 0.1 | |
| $\Delta U_{o\,d}$ | Dynamic load reg. [4] see fig. 7 | $I_o$ = 10...90% $I_o$ = 90...10% | | 2.2<br>1.2 | | | 2.2<br>1.2 | | | 2.2<br>1.2 | | | 2.2<br>1.2 | | |
| $t_d$ | Dynamic load reg. time, see fig. 7 | $I_o$ = 10...90% $I_o$ = 90...10% | | 250<br>300 | | | 250<br>300 | | | 250<br>300 | | | 250<br>300 | | ms |
| $I_{o\,PL}$ | Continuous output [5] pulse loading | $f$ < 300 Hz $T_C$ = $T_{C\,max}$ | | | 8 | | | 8 | | | 8 | | | 8 | $A_{rms}$ |

[1] The output voltage deviation over load of the LT units at 20°C stays within the tolerance band of fig 8.
[2] The typical output voltage deviation over temperature of the LT 1740 with external sensor stays within the limits of fig 8. The output voltage deviation over temperature of the LT 1720/30 with internal sensor depends upon the cooling conditions. With convection cooling and 50% of the nominal load it does not exceed +1% of $U_{o\,set}$, compensated with –3 mV/K/cell. With inadequate cooling, the charging voltage may be below –1%. (see: "Battery charging with LT 1730").
[3] Due to the large output capacitors the maximum transient output current and power can be much higher than $I_{o\,L}$ respectively $P_{o\,L}$.
[4] Deviation limited by output overvoltage protection.
[5] For high current repetitive pulse loads external capacitors are recommended. See also fig. 13.
[6] Defined by case temperature.
[7] Defined by sensor or by remote control.
[8] Defined by cell voltage selector switch.
[9] Defined by sensor type.

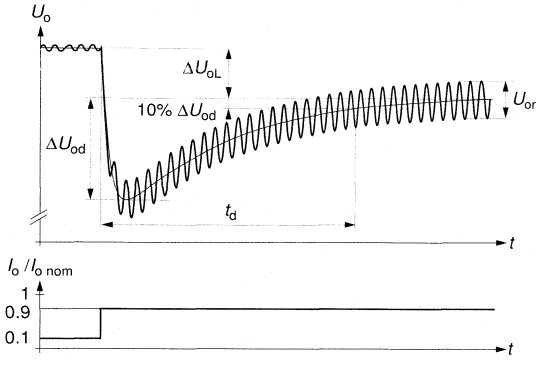



*Fig. 7*
*Dynamic characteristics under varying load conditions*

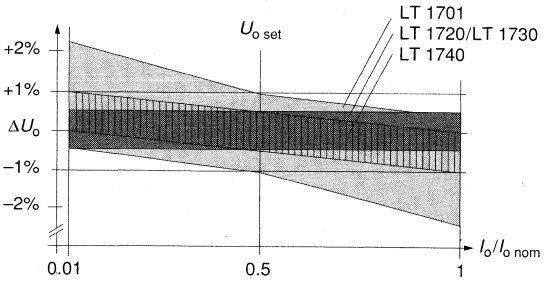



*Fig. 8*
*Output voltage tolerance over input voltage and output current ($T_C = T_A$)*

The LT 1700 series can be operated in 3 different modes:
- Output voltage regulation
- Output power limitation
- Output current limitation

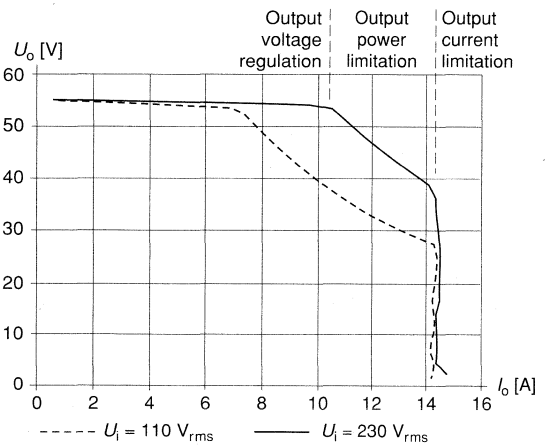



*Fig. 9*
*Output characteristics LT 1701-7*

- In output voltage regulation mode the LT 1000 can be operated within the full temperature range –25...71 °C.
- In output power or current limitation mode the max. ambient temperature $T_A$ should not exceed 65 °C with free air convection cooling.

**Output Voltage Regulation**

In normal operation mode (unit neither in power limitation nor in current limitation) the output voltage of the LT 1000 series is regulated by a feedback loop.

The output voltage of the LT 1701 is adjusted to a fixed value of 54.5 V at $U_{i\,nom}$ and 50% of $I_{o\,nom}$. A resistor in the control loop provides for an output voltage load dependency which ensures current sharing without further precautions when several units are connected in parallel.

The LT 1720/LT 1730 are adjusted to a fixed value of 54.5 V. To protect the battery from thermal runaway both types have a negative temperature coefficient (–3 mV/K per cell) adapted to the negative temperature coefficient of the trickle charge voltage for lead acid batteries. To avoid the LT 1720/30 running into output overvoltage protection below $T_A$ approximately 0 °C, the negative temperature coefficient is reduced to zero at low temperature (see fig. 11).

Current sharing of LT 1720/LT 1730 units is ensured through their negative temperature coefficient. There is no output voltage load dependency built in.

The LT 1740 is adjusted to 53.5 V and features a control input (pin 28) for remote output voltage adjustment either by a voltage source, a temperature sensor or an external potential devider. (See "Inhibit/$U_{cr}$ remote control")

Current sharing is ensured through the output voltage load dependency with a programmed resistance of 60 mΩ. For fine tuning of the output voltage (e.g. for improved current sharing) the LT 1740 is fitted with a trim-potentiometer accessible from the rear of the converter.

The output voltage of the LT 1730/LT 1740 can alternatively be set by a cell voltage selector switch (option Z) for 48 V battery systems with different cell voltages.


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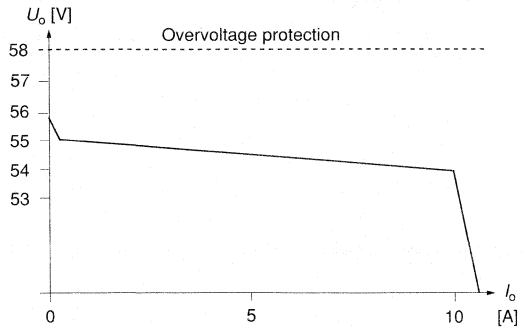



*Fig. 10a*
*Output voltage regulation LT 1701*

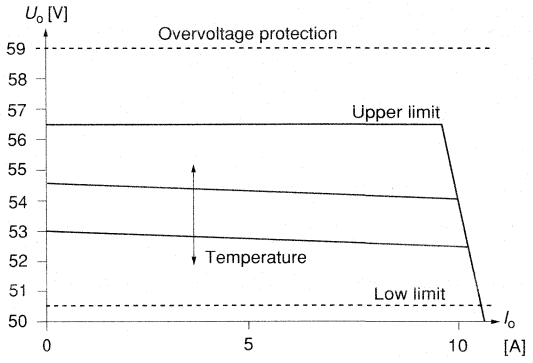



*Fig. 10b*
*Output voltage regulation LT 1740*

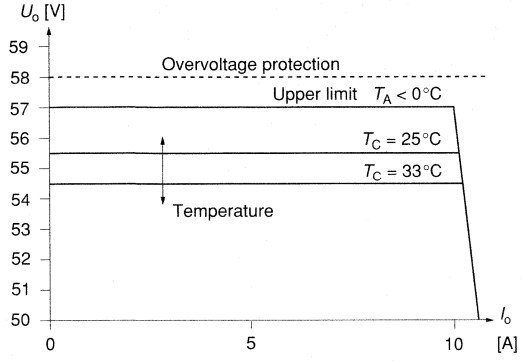



*Fig. 10c*
*Output voltage regulation LT 1720*

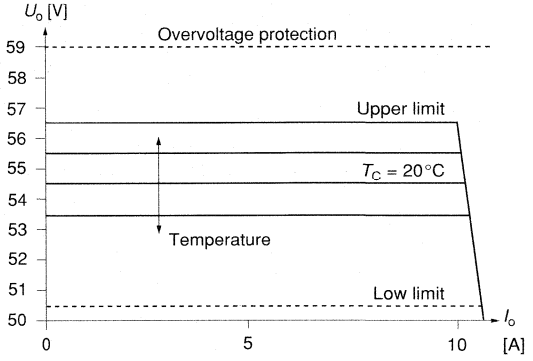



*Fig. 10d*
*Output voltage regulation LT 1730*

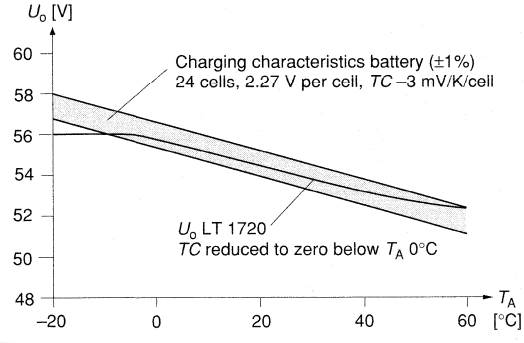



*Fig. 11*
*LT 1720/30 output voltage control over temperature. Temperature offset $T_C$ to $T_A$ approximately 13 K.*

### Output Power Limitation

Especially for power systems including batteries and/or Melcher CQ units the LT 1000 series features a further mode of operation. If the output current exceeds 10 A the output power is kept constant, down to an output voltage of approximately 38 V. This allows direct charging of deep discharged batteries or starting a power system with Melcher CQT units, a telecom version of the Melcher Q family, at maximum load without the need for a special start-up procedure.

Since the LT 1000 series has large output capacitors and only the average output power is limited it can buffer high transient loads. E.g. hot plug-in of Melcher CQ units to the power bus causes only a small and short voltage deviation. For repetitive puls loads the maximum rms value of the output ripple current should be considered. (See fig. 13).

Over the input voltage range $U_i$ = 155...255 $V_{rms}$ the output power is limited to typically 550 W. If the LT 1000 is operated from a low input voltage the output power limit is reduced to approximately $P_o$ [W] = 3.6 [$A_{rms}$] • $U_i$ [$V_{rms}$], providing 400 W at $U_i$ = 110 $V_{rms}$.

### Output Current Limitation

If the output voltage sinks below 38 V the LT 1000 operates in current limitation mode with a constant current of 14.5 A, until practically zero output voltage is reached. Because the LEDs are driven from the output voltage, in short circuit all the LED's will go out.

The output of the LT unit is fully protected against continuous short circuit.

**Note:** When selecting a different output voltage, available with LT 1730/40 types, the input current limit, the output current limit and the output power limit are not affected.

### Output Overvoltage Protection, Preload

A slight output voltage overshoot may occur at turn on, inhibit release or during fast load changes. A second independent control loop interrupts operation when the output voltage reaches approximately 58 V indicated by the red LED. The output voltage remains below 60 V (SELV) under all operating conditions.

With no load the output voltage of the LT 1000 units rises slightly up to the monitoring level. The red LED switches slowly on and off. The voltage rise can be avoided if a minimum load of >5 W is provided.

The LT 1730/1740 are available with an internal electronically switched preload as an option. The internal preload is switched on below an output current of $I_o$ =1 A. If the LT is not operating, for example in the case of a mains failure, the preload is switched off to avoid dischgarging batteries connected to the output.

**Note:** There is no specific built-in protection against externally applied overvoltage or a transient source as e.g. a motor. Never apply voltages >60 V to the output. Otherwise the unit may be damaged.

### Connection in Parallel and Series

The LT 1000 units may either be connected in series or in parallel.

Connection in parallel:
For the LT 1701 and LT 1740 current sharing between paralleled units is ensured by the output characteristic, for the LT 1720 and LT 1730 by the negative temperature coefficient of the output voltage.

Connection in series:
A maximum of 2 LT units may be connected in series, however the resulting output voltage of 110 V would no longer be SELV. For safety reasons the installation at the output should be protected with supplementary insulation (IEC 950). With the LT 1720 and LT 1730 the properties for battery charging remain, as the same negative temperature compensation is provided. With tow LT 1740 connected in series one temperature sensor per unit is required.

### Hold up Time

The hold up time depends upon the output voltage at the time of failure, the minimum usable output voltage and the load according to the following formula:

$$t_{hold} = \frac{U_o^2 - U_{o\,min\,u}^2}{P_o} \cdot 20.5\ [ms]$$

where:
$U_o$ = Output voltage at the moment of mains failure
$U_{o\,min\,u}$ = Minimum usable output voltage
$P_o$ = Average output power during hold up time

Some values of $t_{hold}$ are given in table 7:

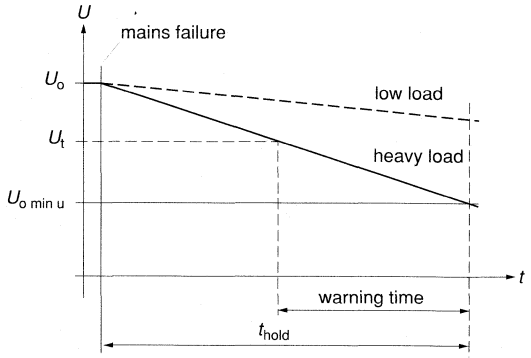



*Fig. 12*
*Hold up and warning time*

*Table 7: Hold up time $t_{hold}$*

| $U_o$ = 54 V | $U_{o\,min\,u}$ | | | | Unit |
|---|---|---|---|---|---|
| $P_o$ [W] | 46 V | 43 V | 40 V | 38 V | |
| 100 | 164 | 219 | 270 | 302 | ms |
| 200 | 82 | 109 | 135 | 151 | |
| 300 | 55 | 73 | 90 | 101 | |
| 400 | 41 | 55 | 67 | 75 | |
| 500 | 33 | 44 | 54 | 60 | |
| 550 | 30 | 40 | 49 | 55 | |

### Warning Time

Table 7 also gives information about the warning time of the power down signal. If for example the threshold level $U_t$ of the power down signal is set to 43 V and the minimum voltage of the load is 38 V the time between the activation of the power down signal and the switch-off of the load (550 W) will be 15 ms (55 ms - 40 ms).

### Pulse Loading

To prevent an overload of the output and filter capacitors the superimposed AC ripple current at the output should be limited according to fig. 13. For high current pulse loads external capacitors are recommended.

For other pulse loads than stated in fig. 13, e.g. $U_i < U_{i\,nom}$, $I_o > I_{o\,nom}$, please contact Melcher.

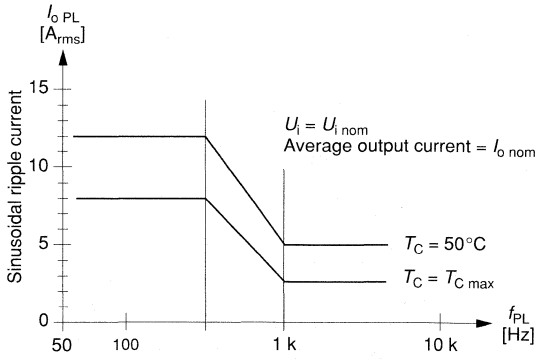



*Fig. 13*
*Maximum allowable AC ripple output current superimposed on the average output current $I_{o\,nom}$.*


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## Functional Features

### Available Signals and Status Monitoring

The LT series features an inhibit function as well as several voltage monitors and indicators for easy control and surveillance of a complete custom specific power supply system. All the surveillance functions are driven from the LT output and also operate in case of a mains failure down to an output voltage of 5 V. The power consumption of the surveillance circuit is typically 10 mA for LT 1701/1720 and 20 mA for LT 1730/1740 types.

Available functions:

| | | |
|---|---|---|
| – Power Down | D | pin 30 |
| | D set | pin 32 |
| – System Good | Sys In | pin 24 |
| | Sys Out | pin 26 |
| – Inhibit/$U_o$ control input [1] | i/$U_{cr}$ | pin 28 |

[1] LT 1740: Pin 28 has a dual function (see "Inhibit/$U_{cr}$ remote control")

Optical status monitoring is indicated by 3 LEDs on the front panel:

| | | |
|---|---|---|
| – System | (OK) | green |
| – $U_o$ | (OK) | green |
| – Error | | red |

Test sockets in the front panel allow easy measurement of the output voltage.

### Power Down

The power down circuitry monitors the output voltage and changes its output signal status from low to high impedance when the output voltage falls below the threshold level which is externally adjustable at the D set pin 32. Power Down can for example be used as a save data signal, for surveillance and protection of a battery system, for low voltage warning or to prevent connected converters from starting-up at a low bus voltage. For application examples see fig. 15a, b, c, d.

As it is driven from the output, power down operates independently of the input voltage and load conditions, even if the unit is inhibited.

**Signal input:** If pin D set is left open the threshold level of the power down signal is 43 V with a hysteresis of 1 V for LT 1701/1720 and a switch-on level of >49 V for LT 1730/1740. This prevents subsequently controlled equipment from possible oscillation.

The 43 V threshold level provides a warning time of approximately 15 ms (at $P_{o\ nom}$) for a system using Melcher CQT units before the CQT units turn off. The power down threshold level can be adjusted individually. With a resistor connected to D set and Vo– or Vo+ the threshold level can be increased or decreased respectively. (See fig. 15a)

The approximate resistor values for given threshold levels can be calculated from the following formula; ($U_t$ in V):

| $U_t > 43$ V ($R_{ext.}$ connected to Vo–) | $U_t < 43$ V ($R_{ext.}$ connected to Vo+) |
|---|---|
| $R_{ext} = \frac{936}{U_t - 42.8}$ [kΩ] | $R_{ext} = \frac{43.22\ U_t - 935}{42.8 - U_t}$ [kΩ] |

### Power Down, low battery

The power down signal can be used as a low battery signal to avoid deep discharge of the battery during long term mains failures. After disconnection from the load the battery voltage will recover slowly up to its chemical equilibrium voltage of 48 V. To allow direct control of a circuit breaker the power down signal of the LT 1730 and LT 1740 has a larger hysteresis to avoid oscillating switch on/off of the load.

*Table 8: Characteristics of Power Down functions*

| Characteristics | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| $U_t$ | Power Down threshold level set by $R_{ext.}$ | 74 kΩ to Vo+ | | 35 | | V |
| | | 115 kΩ to Vo+ | | 37 | | |
| | | 284 kΩ to Vo+ | | 40 | | |
| | | left open | | 43 | | |
| | | 293 kΩ to Vo– | | 46 | | |
| | | 151 kΩ to Vo– | | 49 | | |
| | | 102 kΩ to Vo– | | 52 | | |
| $I_D$ | Output sink current | $T_{C\ min}$... $T_{C\ max}$ | | | 50 [1] | mA |
| $U_{sat}$ | $U$ saturation | $I_D$ = 50 mA | | | 0.2 | V |
| $U_z$ | Zener voltage | | | 67 | | |
| $P_z$ | Z-diode $P_{Loss}$ | $T_C$ (LT) 95°C | | | 500 | mW |

[1] To be limited to 50 mA by the external circuitry.

**Signal output:** The power down output D is an open collector transistor referenced to Vo–, protected by a 68 V zener diode, and is well suited to driving an external relay. Optionally Power Down is available as a galvanically isolated signal.

Under normal operating conditions ($U_o > U_t$) the power down output D is low impedance. If the output voltage drops below the power down threshold level, the signal output becomes high impedance.

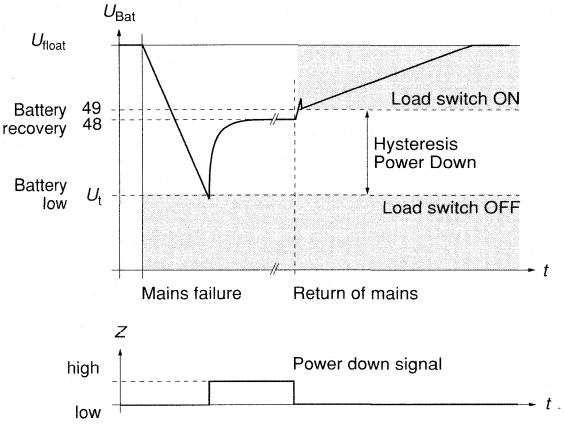



*Fig. 14*
*Hysteresis of power down signal for LT 1730/40, with corresponding level of power down signal*

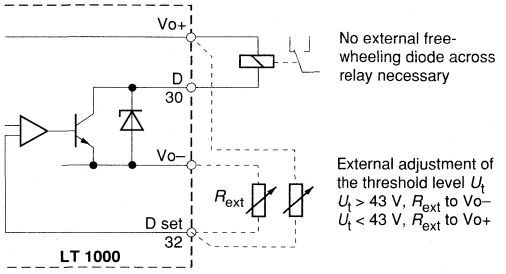



*Fig. 15a*
*Power Down*
*– External adjustment of threshold level $U_t$*
*– Signal galvanically isolated by an ext. relay*

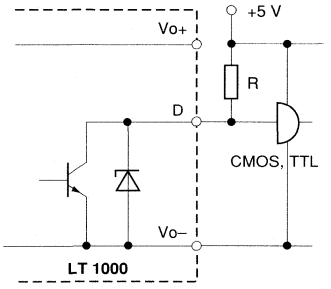



*Fig. 15b*
*Remote indication of the output voltage status by CMOS/ TTL interface for e.g. Save Data*

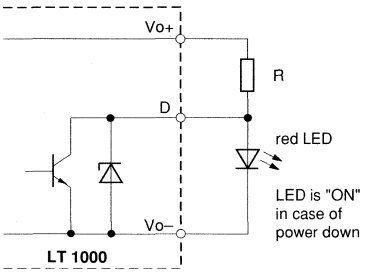



*Fig. 15c*
*Remote indication of Power Down by LED*

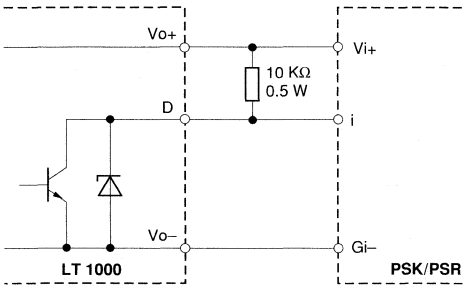



*Fig. 15d*
*Power Down used as inhibit to enable a system start-up in case of subsequently connected step-down converters PKS/PSR with low start-up voltage. (For CQ units no pull-up resistor is required.)*

**System Good**

The system good signal provides information about the general function of the LT 1000.

It can be used to monitor the status of a single LT unit or can be combined with any other signal within a power system consisting out of LT units and CQ units to derive one single logic signal for the status of the whole system. (See also fig. 20)

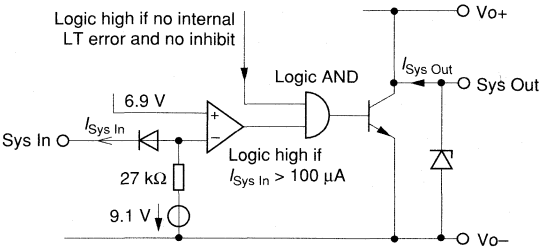



*Fig. 16*
*Equivalent circuit of system good input and output*

Signal input:

The system good input (Sys In) can be voltage or current driven (see table 9). To trigger the internal comparator, the voltage at the Sys In pin has to be <6.9 V if voltage driven. If current driven, the sink current to Vo– has to be >100 µA. An easy way to drive the system good input is achieved by means of an open collector transistor, or a 10 V CMOS interface. (See fig. 17 and 18)

Note: If only the internal status of a LT unit is to be monitored, Sys In has to be connected to Vo–.

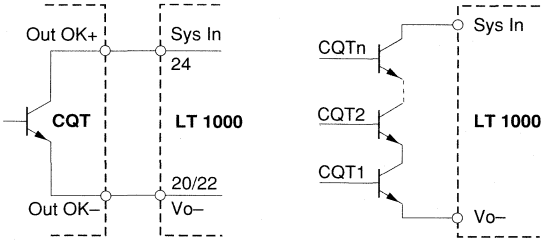



*Fig. 17/18*
*Open collector transistor (e.g. Out OK of CQ units) wired to the system good input of the LT 1000*

Signal output:

The system good signal output (Sys Out) is an open collector transistor referenced to Vo–, protected by a 68V zener diode. The output is well suited for relay applications.

Optionally System Good is available as a galvanically isolated signal (see also fig. 28).


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The signal is activated (low impedance) if the following conditions are met:

No external fault
– the signal input is low
(sink current >100 µA or voltage <6.9 V)

AND

No LT fault condition
– no inhibit
– no internal overtemperature
– no input under-/overvoltage
– no output short circuit
– no output overvoltage
– no internal circuit fault
– no sensor/control error (LT 1740)

The system good output of the LT 1740 has an additional fault condition: Sensor/control error
– open control input
– control voltage to low: $U_{cr} < 5$ V
– control voltage to high: $U_{cr} > 12$ V

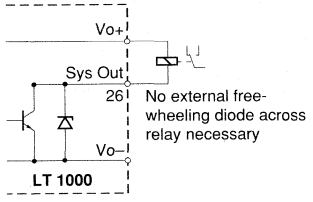



*Fig. 19*
*System status signal galvanically isolated by an external relay*

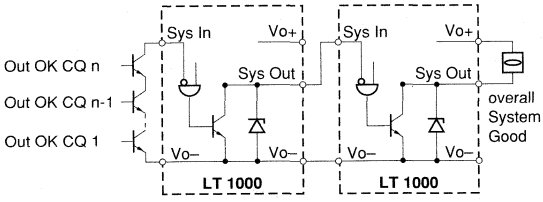



*Fig. 20*
*Wired AND of galvanically isolated open collector signals (e.g. the OUT OK signal of CQ units) with the system good signals of LT units in series to achieve one signal about the status of the whole system*

**Connection of Power Down and System Good in Series and Parallel**

Connection in series

To achieve a logic OR function of the system good and power down signal connect the D output to Sys In. The desired function is then obtained from the system good output. The output signal becomes high if the output voltage is lower than the threshold of the power down circuit, inhibit is applied or an internal error has occurred.

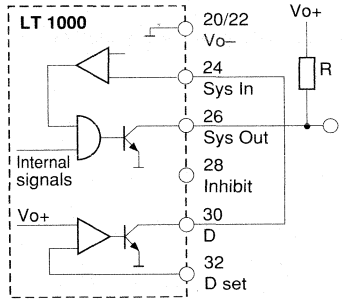



*Fig. 21*
*System Good and Power Down connected in series.*
*Note: Output signal will indicate error at start-up.*

Connection in parallel

To achieve a logic AND function of the System Good and Power Down connect the D output with the system good output. This combination generates an output signal only in case of severe system errors. Only an LT system fault together with a simultaneous Power Down of the output voltage will cause this output signal to become high impedance.

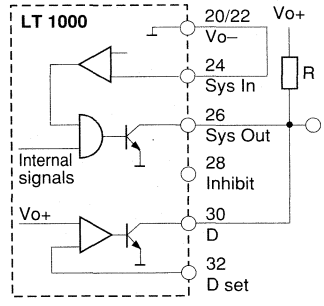



*Fig. 22*
*System Good and Power Down connected in parallel.*

*Table 9: Characteristics of the system good input and output*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{Trig}$ | Trigger level for logic | current driven | $U_{i\,min}...U_{i\,max}$ | | 100 | | µA |
| $U_{Trig}$ | low input (= Sys OK) | voltage driven | $T_{c\,min}...T_{c\,max}$ | –0.7 | 6.9 | | V |
| $I_{Trig}$ | Trigger level for logic | current driven | | | 0 | | A |
| $U_{Trig}$ | high input (= Sys Failure) | voltage driven | | | >7 | 60 | V |
| $I_{sys}$ | Output sink current [1] | | | | | 50 | mA |
| $U_{sat}$ | Saturation voltage | | $I_{Sys\,Out}$ = 50 mA | | | 0.2 | V |
| $U_Z$ | Zener voltage protection diode | | | | 67 | | V |
| $P_Z$ | Power disipation Zener diode | | $T_C$ (LT) 95°C | | | 500 | mW |

[1] To be limited to 50 mA by the external circuitry.

### Inhibit/$U_{cr}$ remote control

The output of an LT 1701/1720/1730 may be enabled or disabled by means of a TTL/CMOS compatible logic signal applied to the inhibit or simply by a low ohmic resistor or a switch connected between inhibit and Vo–. The unit is enabled by a logic high signal and disabled by a logic low signal. An open inhibit pin (pin 28) enables the unit. A resistor <50 Ω disables the unit. The inhibit signal can be used in battery buffered systems to perform a battery voltage test or to initialize Power Down on the power bus without disconnecting the mains. The fall time of the output voltage after inhibit depends upon the load (see "Hold up time").

With an inhibited output the true input power of the LT 1000 is typically 2.5 W.

The LT 1740 has remote output voltage control capability. Inhibit and remote control function are available at the same pin (pin 28).

*Table 10b: Characteristics of the inhibit/$U_{cr}$ remote control input of LT 1740*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | 2 | | 4.5 | V |
| | | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | –0.7 | | 0.4 | |
| $t_r$ | Switch-on time | | $P_{o\,nom}$, $U_o$ > 38 V | | 100 | | ms |
| $P_{inh}$ | Input power inhibited | | $U_{i\,nom}$ | | 3 | | W |
| $U_0$ | Remote control $U_{cr}$<br>Inhibit 2...5.5 V<br>$U_{cr}$ 5.5...11.5 V<br>$U_{cr}$ clamp 11.5...14 V<br>$U_{cr}$ fail >14...60 V | | $U_{i\,min}$...$U_{i\,max}$<br>$T_{C\,min}$...$T_{C\,max}$ | | 50.5<br>45 + $U_{cr}$<br>56.5<br>50.5 | | V |
| $R_{cr}$ | Input impedance | | | | 1 | | MΩ |
| $f_{cr}$ | $U_{cr}$ frequency limit | | | | | 1 | Hz |

The control range of the remote control input (pin 28)is limited to >5.5 V and <11.5 V to protect the battery in case of a sensor failure. Different control ranges on request. Outside of the control range a sensor monitoring circuit generates a system error signal (see also: "System Good", LT 1740).

In the case of an excessively high control voltage, the output of the LT 1740 is reduced to 50.5 V. The remote control input is protected against DC overvoltage up to 60 V.

**Note:** With the LT 1740 an open inhibit leads to a sensor error signal indicated by the Error LED with the output voltage reduced to 50.5 V. If fitted with option Z the output voltage is regulated between 50.5 V and 54.1 V depending upon the pre-selected cell voltage.

The inhibit of the LT 1740 is not TTL/CMOS compatible and should be triggerd by a switch, a relais or an open collector transistor.

### Remote control input

The remote control input of the LT 1740 can be used for temperature compensated charging of lead acid batteries with a Melcher temperature sensor. (See "Sensors for LT 1740".)

The remote control input can also be connected to an external voltage source with the voltage $U_{cr}$ to set the output voltage using the control function: $U_o$ = 45 V + $U_{cr}$.

*Table 10a: Characteristics of the inhibit signal of LT 1701/20/30*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | 2 | | 4.5 | V |
| | | $U_o$ = off | $T_{C\,min}$...$T_{C\,max}$ | –0.7 | | 0.4 | |
| $R_{inh}$ | Resistance to Vo– | $U_o$ = on | | | 30 k | | Ω |
| | | $U_o$ = off | | | | 50 | |
| $t_r$ | Switch-on time | | $P_{o\,nom}$, $U_o$ > 38 V | | 100 | | ms |
| $P_{inh}$ | Input power, inhibited | | $U_{i\,nom}$ | | 2.5 | | W |

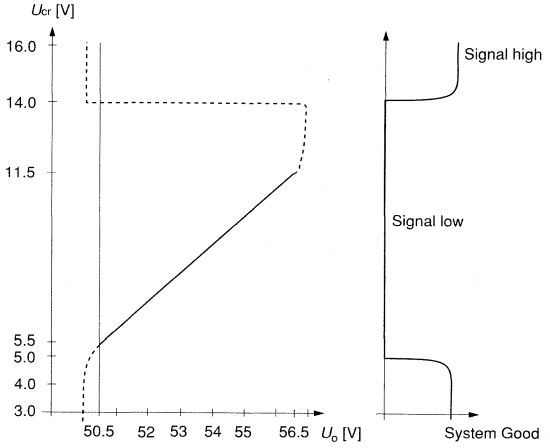



*Fig. 23*
*Control voltage $U_{cr}$ versus output voltage $U_o$, LT 1740 with corresponding system good signal*

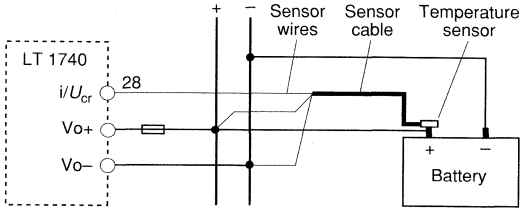



*Fig. 24a:*
*Voltage setting by a sensor*

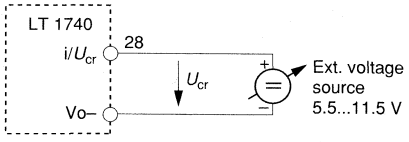



*Fig. 24b:*
*Voltage setting by an external voltage source*
*$U_o$ = 45 V + $U_{cr}$*


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With a resistive potential divider or a potentiometer connected to the remote control input a fixed output voltage can be programmed:

$U_{cr} = U_o \cdot R_2/(R_1 + R_2)$, $U_o = 45V \cdot (R2 + R1)/R1 = 45\ V \cdot k$

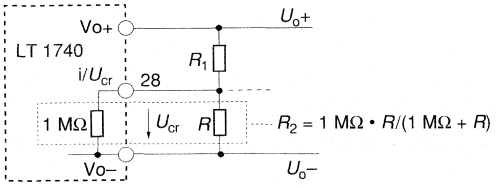



*Fig. 24c:*
*Voltage setting by a resistive potential devider*
*$U_{cr} = U_o \cdot R_2/(R_1 + R_2)$; $R_2$: Value with 1 MΩ internal resistance in parallel with R.*

**Note:** In case of external output voltage adjustment below 50 V or in power limit with $U_o < 50$ V, a system error will be indicated by the $U_{cr}$-input monitoring circuit.

The internally programmed output resistance of $R_o$ = 60 mΩ for the output load dependancy changes with the factor k. For example with a programmed output voltage of 54 V (54 V = 45 V • 1.2), $R_o$ will be 72 mΩ (60 mΩ • 1.2).

Optical Indicators

LED Sys OK (green) corresponds to the system good signal. The LED is ON if no internal or external error is detected.

LED $U_o$ OK (green) indicates the output voltage status of the LT . The LED is ON as long as $U_o$ is above the threshold level $U_t$ of the power down signal.

LED Error (red) is ON when one of the following conditions is detected:
- inhibit or
- internal overtemperature or
- input under/overvoltage or
- output overvoltage or
- internal circuit fault or
- Power Down or
- sensor/control error (LT 1740)

With the LT 1740 a sensor error is indicated by the red Error LED.

Sensor/control error conditions:
- Sensor not connected, open remote control input
- Control voltage out of range (5.5 V < $U_{cr}$ >11.5 V)

Note: After disconnecting the unit the red LED indicates stored energy in the output capacitors. Therefore caution should be taken especially at the output pins.

If an input voltage is applied to the unit but no LED turns on this indicates that the LT unit is inhibited or there is a short circuit across the output.

*Table 11: System monitoring*

Signal status and LED status display depending on the situation of the various system elements

| Possible Situation | | Open collector output | | LED | | |
|---|---|---|---|---|---|---|
| | | System Good | Power Down | Sys OK | $U_o$ OK | Error |
| All OK | | low | low | on | on | off |
| No mains and battery OK or no mains and $U_o > U_t$ | 2 | high | low | off | on | on |
| Unit inhibited and battery OK or unit inhibited and $U_o > U_t$ | 2 | | | | | |
| Internal error | 2 | | | | | |
| System good input interrupted | 4 | high | low | off | on | off |
| No mains and battery low or no mains and $U_o < U_t$ | | high | high | off | off | on [1] |
| Short circuit on LT output, $U_o < 4$ V | | high | high | off | off | off |
| Current limit LT output, $U_o > 4$ V, $U_o < U_t$ | 2 | low | high | on | off | on |
| | 3 | high | high | off | off | on |

[1] LED is on until the output capacitors are discharged
[2] Sys In connected to Vo–
[3] Sys In connected to CQT Out OK or connected to Power Down
[4] Sys In not connected to Vo– (single LT status monitoring) or failure on a Melcher CQ unit with its Out OK signal connected in series with Sys In. (See "System Integration")

**Potentiometer**

LT 1740 units are fitted with a one-turn potentiometer for fine tuning the output voltage to within ±200 mV. The potentiometer is protected by a plastic cover. To adjust the output voltage for improved current sharing or compensation for voltage drops over the load lines, each of the LT units in a system should be unplugged and adjusted individually to the same output voltage at equal load; otherwise current sharing may adversely be affected. The output voltage is adjusted during manufacture to within ±100 mV. In case of a faulty potentiometer the output voltage deviation is limited to +0.2 V, –0.6 V.

**Note:** To avoid a possible short circuit when adjusting the potentiometer tuning should only be done by using an insulated screw driver.

Tuning the output with the potentiometer changes the control function to 45 V + $U_{cr}$ + $U_{pot}$.

Compensation for voltage drops over the load lines is not recommended. Cabling to the load should have adequately dimensioned cross section to reduce load depending voltage drops and to avoid overtemperature in the cables.

## Description of Options

**Option Z** Cell voltage selector switch

The LT 1730 and LT 1740 types are optionally available with a cell voltage selector switch for external adjustment to a specific trickle charge voltage for battery types with cell voltages from 2.23 V (switch position 0) up to 2.32 V (switch position 9) defined at 20°C. Each switch position gives a step in the output voltage of 0.24 V.

The cell voltage selector switch allows the use of the same LT and sensor types for battery systems with different cell voltages.

Conditions for LT 1740-7Z:
Selector switch in the correct cell voltage position and Melcher temperature sensor with 2.23 V cell voltage.

Sensors are available with six different temperature coefficients between –2 and –4.5 mV/K/cell. For applications where no switch is allowed, battery specific sensors with different cell voltages and temperature coefficients are available on request. (See table 13 "Type survey".)

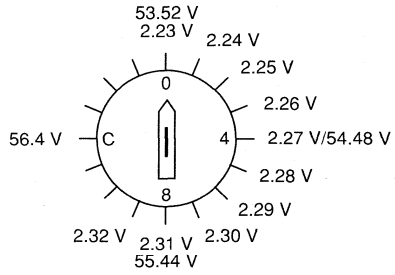



*Fig. 25*
*Cell voltage selector switch*

**Important advise:**
Setting the switch to the correct battery cell voltage is vital for the proper operation of a battery system. Check whether the switch position corresponds to the required battery cell voltage prior to put a system into operation.

Note: Switching to a different cell voltage while the LT unit is in operation may cause a small and short distortion of the output voltage.

**Option P** Potentiometer

Potentiometers for an adjustment range of the output voltage between 51.5 V and 55.0 V are optionally available for LT 1730/40 units.

The P option is not recommended for parallel or redundant configurations of LT 1730 units. Operation of LT 1740 units in parallel fitted with option P is possible, however each of the LT units in a system should be unplugged and adjusted individually to the same output voltage; otherwise current sharing may adversely be affected.

Option P excludes Option Z, cell selector switch.

**Option G** Galvanically isolated signals

The LT 1730/1740 types are optionally available with the System Good and the Power Down galvanically isolated by means of opto-couplers. With option G hot plug-in is no longer possible since the leading pins are used for signalling. Option G is not intended for being-wired to the primary side of the converter.

**Option W** Preload

In battery buffered systems where the system may be operated under no-load conditions for long periods of time with the battery connected to the system, a minimum load of >5 W is required. The LT 1730/1740 are available with an internal electronically switched preload. The internal preload is switched on below an output current of $I_o$ = 1 A. If the LT is not operating, for example in the case of a mains failure, the preload is switched off avoiding discharge of batteries connected to the output.

**Option B1**

If a cooling surface is available the LT 1000 units can be provided with a mounting plate (option B1) instead of the standard heat sink fitted to the right hand side of the unit. Since approximately 50% of the losses have to be dissipated through the heat sink on the left hand side sufficient free air flow has still to be provided.

*Table 12: System Good, Power Down (option G)*

| Characteristics | | Conditions | Output | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| Signal low | Sys Good, Power Down low impedance | $I_{signal} \leq 1.0$ mA | good | | 1.0 | | V |
| Signal high | Sys Good, Power Down high impedance | $I_{signal} > 25$ µA | failure | | 20.0 | | |
| $I_{signal\ max}$ | Maximum current, terminals option G | | | | | 20.0 | mA |

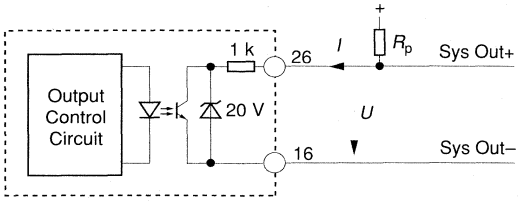



*Fig. 26*
*Galvanically isolated System Good*

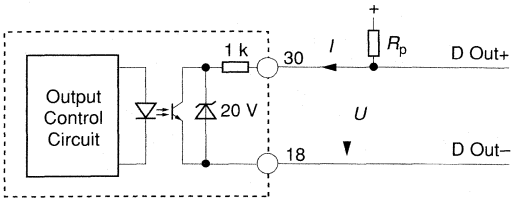



*Fig. 27*
*Galvanically isolated Power Down*

## Battery charging

According to the recommendations of battery manufacturers the trickle charge voltage of a lead acid battery should be temperature compensated. Depending upon the battery type and size charging with different temperature coefficients may be required. An excessive trickle charge voltage may damage the battery through overcharging.

If there is good thermal coupling between the battery and the charger unit the LT 1720 or LT 1730 types with an internal temperature sensor can be used. In applications where the battery and the charger experience different temperatur conditions the use of the LT 1740 with remote temperature sensing is recommended.

Most sealed lead acid batteries are manufactured with cell voltages between 2.23 V and 2.32 V and temperature coefficients between –3 and –4 mV/K/cell, with the nominal cell voltage normally defined at 20°C.

With option Z, available with LT 1730/1740 types the required cell voltage can be adjusted at the rear. The negative temperature coefficient, a fixed value, is either related to the charger (LT 1720/1730 types) or to the sensor (LT 1740).

### Battery charging with LT 1720/30

LT 1720/1730 units are adjusted for charging 48 V batteries with 2.27 V/cell and a temperature coefficient of –3 mV/K/cell. Because the case temperature is referenced, the trickle charge voltage of both charger types depends upon the cooling conditions and the load.

Note 1:
$U_o$ is defined at 50% of nominal load with convection cooling in an open rack. Load changes can lead to a slight variation of the trickle charge voltage due to changes in the case temperature of the battery charger. Fast load changes are averaged by the thermal time constant of the case. Slow changes within a period of a day are not averaged but do not reduce battery life if the mean value of the charging voltage during that period is correct. Battery life is influenced only by excessive and long term deviations from the correct charging voltage.

Note 2:
For LT 1720/30 good and constant thermal coupling between charger and battery is required. If possible the battery and the charger should be located in the same cabinet and placed in such a way that the charger does not heat up the batteries. The load should be mounted outside of the cabinet as the power dissipated by the load would generate an additional temperature rise and load depency and therefore adversely affect the trickle charge voltage. For optimal battery and charger life as well as for good thermal coupling forced cooling is recommended.

Note 3:
With LT 1730 units fitted with option Z corrective output voltage adjustment can be done, should the trickle charge voltage at nominal load be out of ±1% of the required trickle charge voltage. The voltage step per switch position is 0.24 V, approx. 0.5% of the actual trickle charge voltage.

In parallel operation all cell voltage selector switches should be set to the same value to assure current sharing.

Note 4:
With a built-in temperature sensor overcharging of the battery is very unlikely in normal operation. In case of a fan failure or system overtemperature the trickle charge voltage is reduced automatically. However battery systems with LT 1720/30 types should not be operated for long periods of time in no-load and the battery connected to the system, since under no-load condition the case temperature of the charger units and consequently the built-in temperature sensors may cool down, thus providing an excessively high trickle charge voltage.

The LT 1730/1740 units feature an output voltage range from 50.5 V to 56.5 V. At excessive low or high temperature the trickle charge voltage may be limited.

To be considered with all battery charger types:
The final trickle charge voltage is only reached with a fully loaded battery. Since new batteries directly supplied by the manufacturer are only charged to 70...80% of their capacity, the battery system should be operated for min. 24 h prior to checking the trickle charge voltage.

### Battery charging with LT 1740

In applications where the batteries and chargers are exposed to different temperature conditions the use of the LT 1740 with remote temperature sensing is recommended.

With the LT 1740 it is possible to use the same type of converter for most of the commercially available battery types. Adjustment to a specific cell voltage is either done by using a battery specific sensor type or if fitted with option Z (cell voltage selector switch) by using a 2.23 V/cell sensor and setting the required cell voltage with the cell voltage selector switch at the rear of the battery charger.

## Temperature Sensors for LT 1740

The active LT sensors are of robust construction, mounted into a sealed aluminium tube, 12 mm outer diameter and 50 mm length. The sensors are water proof (IP 66) and high voltage tested with 1.4 kV DC. Correct connection to the LT should be done via the 3-wire cable to the LT output (Uo+ and Uo-) and the remote control input. Wrong connection may damage the sensor.

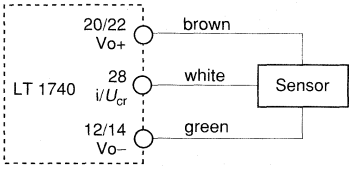



*Fig. 28*
*Wiring diagram sensor*

*Table 13: Type survey*

| Sensor types | Options | Battery voltage nominal [V] | Trickle charge voltage (20°C) [V] | Cell voltage (20°C) [V/cell] | Temp. coefficient [mV/K/cell] | Cable length [m] [4] |
|---|---|---|---|---|---|---|
| S48-2.23-30-01 [1 3] | X, P | 48 | 53.52 | 2.23 | –3.0 | 1 |
| S48-2.23-35-01 [1 3] | X, P | 48 | 53.52 | 2.23 | –3.5 | 1 |
| S48-2.27-30-01 [2] | X, P | 48 | 54.48 | 2.27 | –3.0 | 1 |
| S48-2.27-35-01 [2] | X, P | 48 | 54.48 | 2.27 | –3.5 | 1 |

[1] Standard types for conventional tubular lead acid batteries.
[2] Standard types for sealed lead acid batteries for LT 1740 without option Z.
[3] For use in applications with LT 1740 fitted with option Z (cell voltage selector switch). The same sensor can be used for battery systems with different cell voltages within the selectable range of option Z. Each step on the selector switch changes the cell voltage by 10 mV in the range from 2.23 V up to 2.32 V, changing the output voltage by 240 mV per step in the range from 53.52 V up to 55.68 V 20°C.
[4] Different cable lengths (5 or 10 m) are available on request.

Battery specific sensors with cell voltages from 2.23 up to 2.32 V and temperature coefficients from –2 up to –4.5 mV/K/cell are available on request.

### Description of options

Option P:
A potentiometer fitted to the sensor allows for remote fine adjustment of the output voltage of the LT 1740 types to within ±200 mV.

Option X:
A green LED fitted to the sensor head indicates operation of the sensor

**Note:** Option P excludes option X and vice versa.

Note 1:
By choosing a battery with a large temperature coefficient or with a high cell voltage, the required temperature range may be limited by the output voltage control range of the LT unit(s).

Note 2:
The temperature sensor should be mounted as close as possible to the battery, if possible to one of the metallic battery poles. Through their chemical activity batteries may be warmer than ambient temperature. Battery banks heat up if they are mounted too close together thus blocking free air flow. Since battery life is halved with every 10°C temperature increase it is recommended that the batteries be mounted at the bottom of the cabinet or in a separate, cool area.

Note 3:
The sensor commun supply wire should be refered to the LT output pin 12/14. If the sensor commun supply wire is connected to the power bus, resistive voltage drops or voltage drops across decoupling diodes in the Vo– supply line will be compensated by the sensor.

Please note: Decoupling diodes or fuses in the Vo– supply line are not recommendened as in case of a short circuit across the output of a LT unit status signalling of the system is affected.

Note 4:
For installation of batteries see also VDE 510 as well as the recommendations of the battery manufacturers.

*Table 14: Sensor data*

| Characteristics | | | Condition | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{source}$ | Sensor output current | | $U_{cr}$: 5.5...11.5 V | | | 0.2 | mA |
| | | | $U_{cr}$ = 0 V, act. inhibit | | | 0.6 | |
| $U_{cr\ sens\ tol}$ | Control voltage tolerance | 1 | $T_{sensor}$ = 20°C | | ±0.1 | | V |
| $P_i$ | Power consumption | | $U_{cr}$: 5.5...11.5 V | | 30 | | mW |
| $I_{sink}$ | Sensor sink current | 2 | $T_{sensor}$ ($T_{min}$... $T_{max}$) | | | 10 | mA |
| $U_z$ | Zener voltage protection diode | 3 | | | | 15 | V |

[1] Tolerance to be added to the LT tolerance: 45 V $^{\pm 0.1\ V}$ + $U_{cr}$ $^{\pm 0.1\ V}$ = $U_o$ $^{\pm 0.2\ V}$
[2] Sensor wrongly connected
[3] With a potential above 15 V and $I_{sink}$ >10 mA at the $U_{cr}$ output, the sensor will be damaged


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## System Integration

**Power boosting, Redundant Configuration, Hot Plug-in.**

Several LT 1000 units may be connected in parallel.

For redundant configurations the outputs should be decoupled to protect the DC-bus in case of an internal short circuit at the output of any of the paralleled LT units.

Decoupling may either be done using series diodes (fig. 29) or using appropriate fuses in the output path of each LT unit (fig. 30).

Decoupling diodes provide reverse polarity protection with no reverse current in case of hot plug-in but have the disadvantage of the forward voltage drop over the diode and higher power loss.

For battery applications with LT units decoupling with fuses is recommended since the voltage drop over the decoupling diodes would decrease the trickle charge voltage of the battery. In case of an internal short circuit at the output of a charger unit the battery will deliver a very large current causing the appropriate fuse to blow. The fuse should be mounted in the positive power path of the converter since the monitoring signals of the LT are referenced to the negative path. The fuse type should be suitable for DC application having a current rating of 20 A with high breaking capability, e.g. Littlefuse, series 314.

Several LT 1740 units connected in parallel can be controlled by a single voltage source or a single sensor wired to the remote control input. If sensors are connected in parallel, they should be decoupled by 200 kΩ resistors. (See fig. 31.) By using an individual sensor for each paralleled LT unit current sharing is affected by the sensor tolerance.

The remote control input of the LT1740 units allows hot plug-in to an operating battery system with a single sensor without affecting the trickle charge voltage.

To enable hot plug-in also in systems decoupled with fuses the LT 1000 series is fitted with a NTC resistor limiting the reverse current flowing into the discharged output capacitors (see fig. 1).

For this purpose the pins 16 and 18 have to be connected to Vo+ and Vo– respectively (see fig. 30).

Since pins 16 and 18 are leading pins, the output capacitors are precharged through the internal NTC resistor prior to any other pin making contact. This protects the connector and prevents the DC bus voltage from dropping during hot plug-in. Hot plugging should be done gently. Subsequent hot plug-out/plug-in of a unit with a hot NTC should be avoided as current limiting will be poor. After disconnecting an operating unit it should be cooled down prior to reconnecting to the bus to avoid damage of the fuse or the converter.

Note:
The internal NTC limits the reverse charge current flowing into the output capacitors of a LT when the unit is plugged into a battery buffered bus. Should however the LT unit already be connected when the battery is switched to the bus, the resulting charge current will not be limited. To avoid the fuse to blow or a possible arc across the circuit breaker, the LT units should be switched on to the mains prior to connecting the battery. With decoupling diodes, no reverse charge current flows from the power bus to the LT output capacitors.

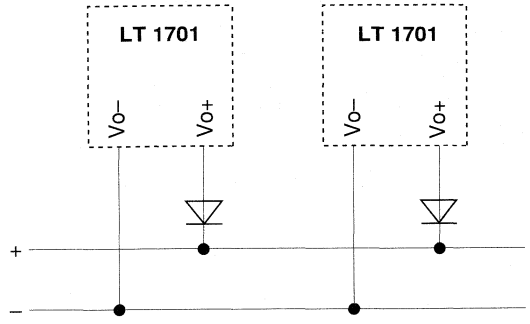



*Fig. 29*
*LT 1701 without battery back-up*

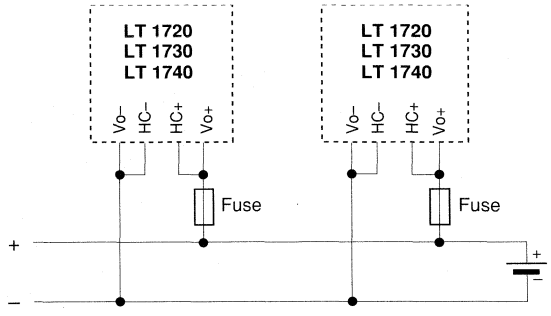



*Fig. 30*
*LT 1720/30/40 with battery connected to the output*

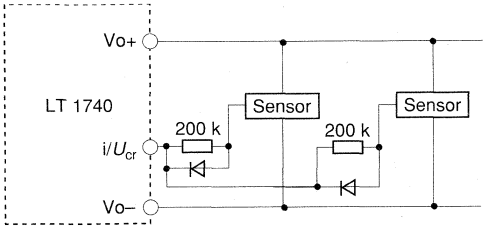



*Fig. 31*
*Sensors connected in parallel.*
*Sensors in parallel provide redundant voltage adjustment in case of one of the sensors in open circuit or short circuit (add. external components required)*

### Battery Size and Ripple Current

Some consideration should be given to the selection of the battery size. According to VDE 0510 part 2, the low frequency ripple current of the trickle charge current should not exceed 5 $A_{rms}$ per 100 Ah capacity (0.05 C). The power factor correction at the input of the LT 1000 generates a ripple voltage at the output of twice the input frequency, causing a ripple current into the connected battery.

For systems where only a small battery back-up time is required battery charging by one LT unit may be sufficient (see also fig. 32).

For systems with more than one LT charging the battery please refer to the "Back Plane".

The ripple current for a system set-up with one LT can be calculated using the following formula assuming.

$$I_{ripple\ rms} = \frac{I_{Load}}{\sqrt{1334 \cdot R_{Sys}^2 + (50.6 \cdot R_{Sys}) + 25}}$$

$I_{load}$ = Average LT output current (A)
$R_{Sys}$ = Wiring resistance and internal AC resistance of the battery at 2× times the mains frequency [Ω]

Example: $R_{Sys}$ = 60 mΩ, $I_{load}$ = 8 A, $I_{rms\ permissible}$ ≤0.05 C resulting $I_{Ripple\ rms}$ ~ 1.39 A:

The battery capacity should now be choosen with a value that the above mentioned condition is met.

$$Q_{Batt}\ [Ah] = \frac{1.39\ [A_{rms}]}{5\ [A_{rms}]} \cdot 100\ [Ah] = 28\ [Ah]$$

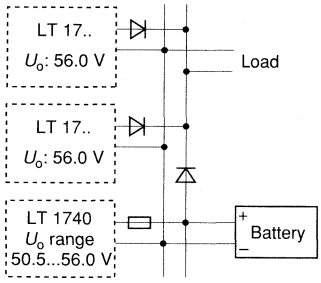



*Fig. 32*
*Alternative configuration for a larger system with a small battery*

If the ripple current is to high e.g. in the case of a smaller battery to be connected to the system, a large capacitor can be connected in parallel with the battery. Another possibility is to connect an additional impedance to the battery load line, e.g. a chocke or a NTC-resistor. Further considerations for the selection of battery size include desired back-up time, required battery life, temperature range and maximum permissible discharge current. Consult the manufacturers of lead-acid batteries for the final selection.

Note 1:
The permissible ripple current is limited because it increases the battery temperature. The temperature rise depends upon the battery technology. Some manufacturers with newer designs allow up to 10 $A_{rms}$ per 100 Ah (0.1 C).

Note 2:
Most manufacturers specify the battery DC-resistance which is useful for calculating the battery short circuit current but not the rms-ripple current. To estimate the rms-ripple current, the 100 Hz AC-resistance of the battery is required.

**Warning:**
Lead-acid batteries can generate certain amounts of $H_2$ and $O_2$ gas which can form explosive gas mixtures. Sufficient ventilation must be provided in battery cabinets and installation rooms.

Local regulations must be observed. Further information about designing battery systems is contained in VDE 0510 part 2.

### Combination of LT Units and Melcher CQ Units without Battery

In a complete power system consisting of two or more LT units in parallel combined with Melcher CQ units it may be desirable to have one common signal indicating the status of the whole system.

The Melcher CQ units provide a galvanically isolated signal Out OK. To obtain a logic AND all CQ Out OK signals should be connected in series (see also fig. 20). Out OK– of the first CQ unit should be connected to Vo–, Out OK+ of the last CQ unit should be connected to pin Sys In of one of the LT units. Sys Out should be connected to Sys In of the next LT unit. If one of the units fails (LT or CQ ) it will be indicated by the overall System Good (fig. 33).

With option G, Power Down and Sys Good as galvanically isolated signals further flexibility is provided for signal combinations e.g. a matrix connection.

If in a system with 2 redundant LT units Power Down is desired as one commun signal, independent of a possible failure of one of the two LT units, simply interconnect the D pins of the two LT units. In this way Power Down only becomes active if both LT units fail which would result in the bus voltage falling (fig. 33).

**Note:** Consider the behaviour of the signalling in a system with decoupling diodes or fuses in the case of a LT-failure, with the secondary in short circuit.

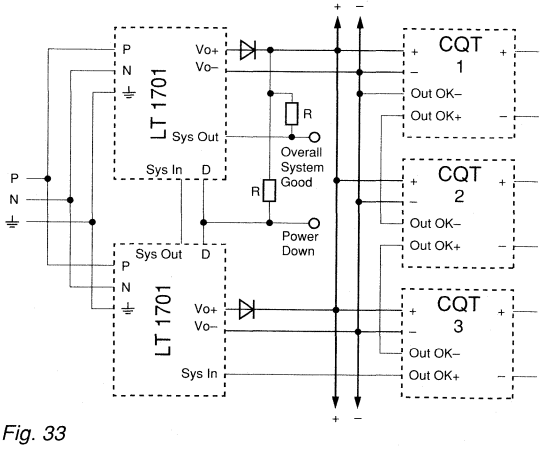



*Fig. 33*
*Monitoring of overall System Good and Power Bus Down in a redundant system*


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### Low Battery Discharge Protection

Since all monitoring functions are powered by the LT output or the battery in the case of a mains failure, Power Down can be used to monitor the status of the battery and to disconnect the load or part of it via the inhibit of the CQ units when the battery voltage drops below the threshold level of the Power Down. This prevents further discharge of the battery. See also "Low Battery".

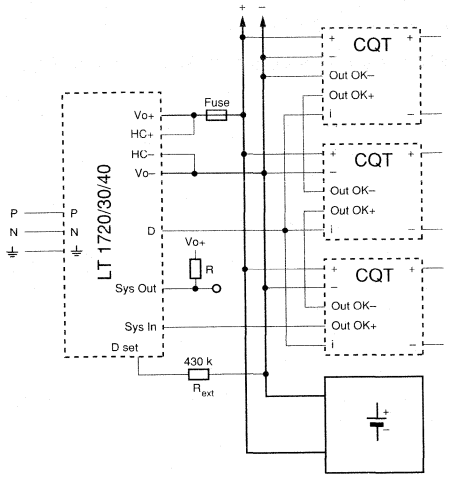



*Fig. 34*
*Disconnecting the loads at low battery voltage in case of mains failure*

### Storing the System Good Signal

For battery back-up systems located in inaccessible areas it could be of interest to know whether there has been a Power Fail (interruption of the mains). To obtain this information Sys Out should be connected to Sys In with a reset button connected to Vo–. In this way a system failure like an interruption to the mains will be stored at Sys Out until the reset button is pressed.

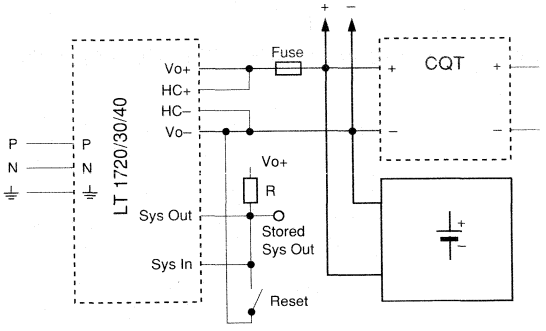



*Fig. 35*
*Storing the System Good signal*

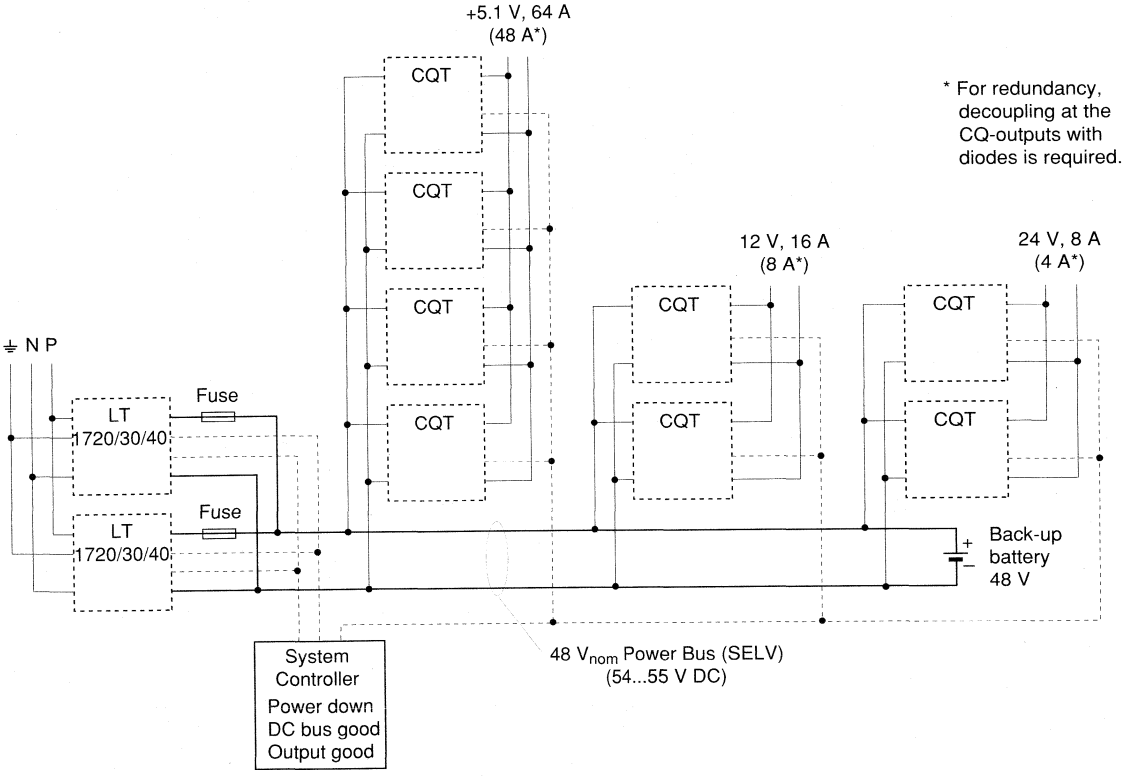



*Fig. 36*
*UPS uninteruptable power supply system*

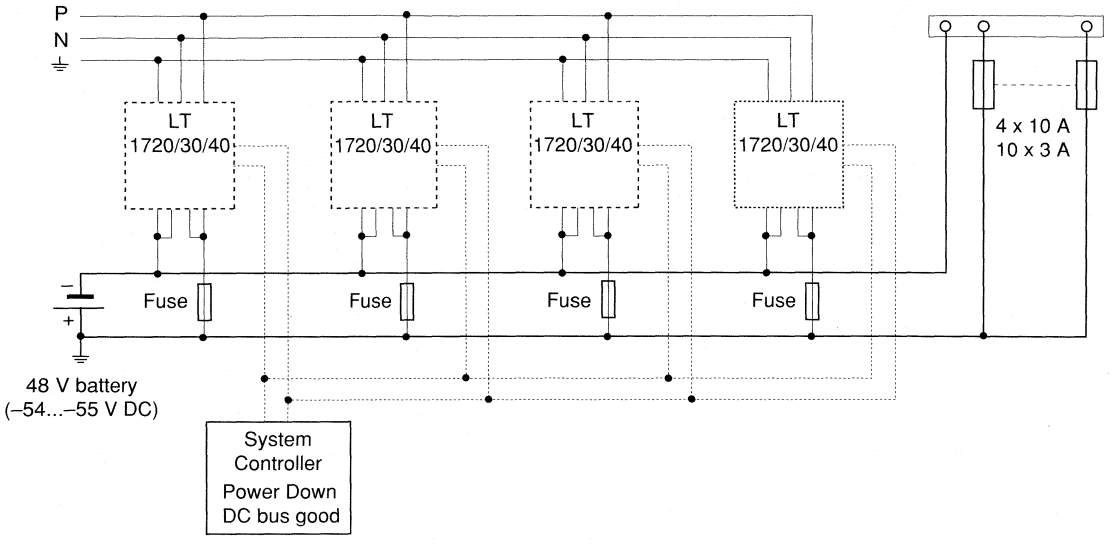



*Fig. 37*
*n + 1 redundancy*

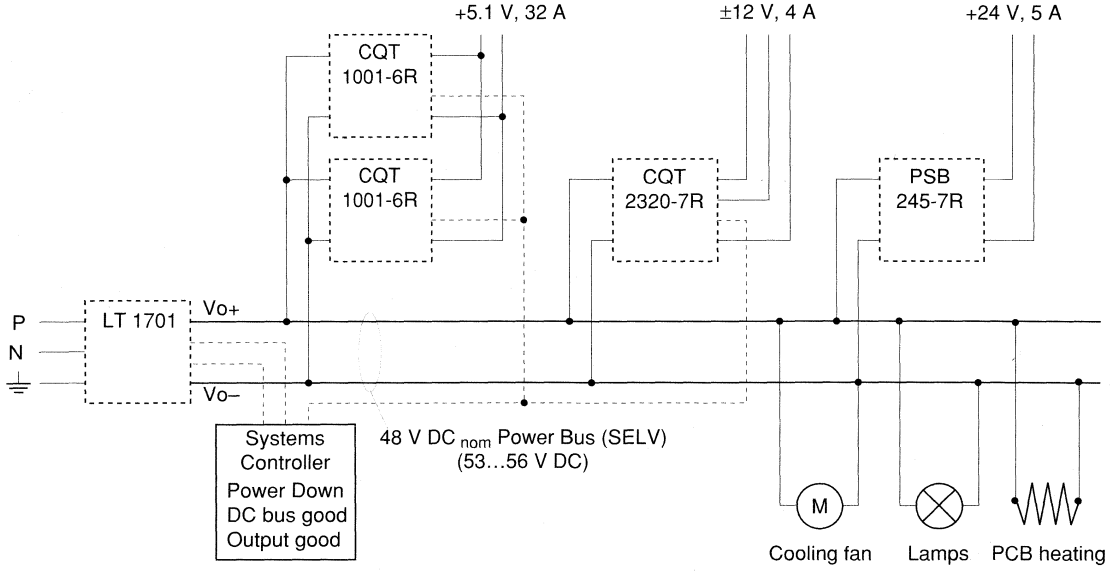



*Fig. 38*
*Front end with various loads*


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## Supplementary Data

*Table 15: Isolation test voltages, clearance and creepage distances (case connected to ground)*

| Characteristic | LT 1000 Input - Output | LT 1000 Input - Case | LT 1000 Output - Case | LT/Option G Output - Case | Sensor Output-Ground | Unit |
|---|---|---|---|---|---|---|
| AC isolation test voltage | 3000 | 2000 | 1000 | 1000 | 1000 | V |
| DC isolation test voltage | 4200 | 2800 | 1400 | 1400 | 1400 | |
| Clearance and Creepage distances | 4.0 | 2.0 | 1.0 | 1.0 | – | mm |
| Transients according to IEC 950 Installation category II | | ≤2500 | ≤1500 | ≤1500 | ≤1500 | V |

### Measurements

To check the performance of an AC-DC converter it is very important to distinguish the apparent from the true input power. For efficiency measurement only the true power is relevant:

$P_i$ [W] = PF • $I_{i\,rms}$ • $U_{i\,rms}$, (PF: Power factor)

Input and output voltage must be measured directly at the connector terminals of the power supply by applying the 4-wire technique, i.e. separate lead pairs for the load and for the digital voltmeters. This prevents incorrect results caused by voltage drops across connector and load leads. Accuracy of Volt- and Ampèremeters better than 0.1%

For correct measurements pins 12 and 14 as well as pins 20 and 22 should be wired together. See also "How to measure".

## Environmental Conditions

### Thermal Considerations

Despite the fact that the LT series has a very high efficiency the operating losses of the unit will heat the case. The heat sinks are designed to dissipate the power losses at maximum output power (550 W) over the specified temperature range with convection cooling with sufficient air volume, without obstructions for vertical air exchange below and above the units.

Because of the slightly higher power losses in output power and current limitation mode (fig. 40) the maximum admissible ambient and case temperature is lower than in output voltage regulation mode. See also "Efficiency".

The LT series has a built-in overtemperature shut down to protect the internal circuitry.

Derating is required for applications with higher operational ambient temperature. Fig. 39 shows the derating of the output power versus operational temperature above the specified ambient temperature of 71 °C. Two different conditions are shown:

a) Unit operating with convection cooling (solid line).
For example if the operational ambient temperature reaches 80 °C, the maximum output power should be limited to approx. 290 W. In this case steady operation in output power or current limitation mode is not possible.

b) Unit operating with forced cooling (dotted line).
Under these conditions, the case temperature of the LT unit is decisive. With sufficient cooling provided (air flow!), the unit still delivers 550 Watts output power in voltage regulation mode even at 85 °C ambient temperature, provided that the maximum case temperature of 95 °C is not exceeded (temperature measuring point on case, see fig. 41). If the case temperature does not exceed 90 °C, steady operation in output power or current limitation mode is still possible. Never the less it is not recommended to operate the units continuously close to the maximum case temperature since life time will be reduced.

Since the operating temperature of a power supply is of major importance to reliability the following conditions should be considered:

1. Do not cover heat sinks
2. Do not obstruct air flow around the heat sinks
3. Maximize free space around the units
4. In a system where the power supplies as well as the loads are located in the same enclosure, forced cooling is recommended. The LT units should be placed in the lower section of the enclosure.
5. In a closed system heat may build up causing excessive temperatures
6. Always check the maximum ambient and case temperature after system integration.

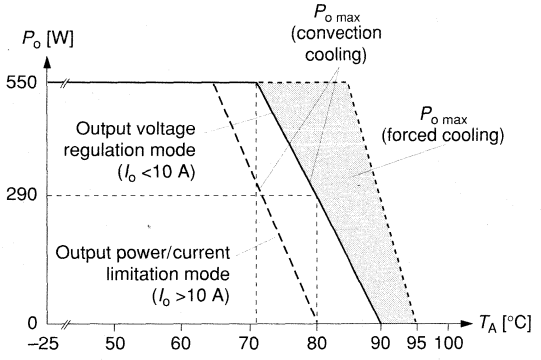



*Fig. 39*
*Output power versus ambient temperature*

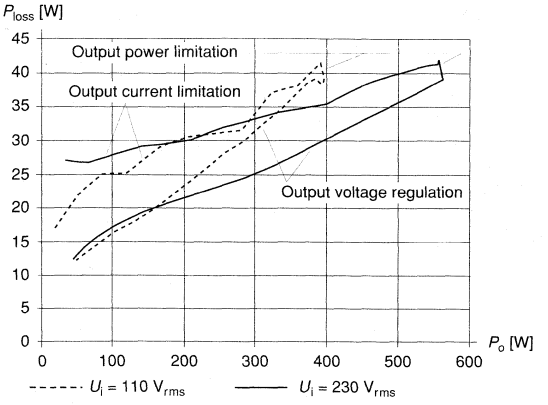



*Fig. 40*
*Internal power losses versus nominal output power*

*Table 16: Environmental conditions*

| Characteristic | | Conditions | LT 1701-7 | | | LT 1720/30-7 | | | LT 1740-7 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | typ | max | min | typ | max | min | typ | max | |
| $T_A$ | Ambient operational temperature range | $I_o = 0...I_{o\,nom}$ | –25 | | 71 | –25 | | 71 | –25 | | 71 | °C |
| | | $I_o > I_{o\,nom}$ | –25 | | 65 | –25 | | 65 | –25 | | 65 | |
| $T_A$ | Temperature range for battery charging | | | | | 0 | | 60 | 0 limited by $U_{cr}$ range | | 60 | |
| $T_C$ | Case operational temperature range (see measurement point on case fig. 28) | $I_o = 0...I_{o\,nom}$ | –25 | | 95 | –25 | | 95 | –25 | | 95 | |
| | | $I_o > I_{o\,nom}$ | –25 | | 90 | –25 | | 90 | –25 | | 90 | |
| $T_S$ | Storage temperature range (not operating) | | –40 | | 100 | –40 | | 100 | –40 | | 100 | |
| $T_{Cs}$ | Shut down case temperature | | | 100 | | | 100 | | | 100 | | |
| $P_d$ | Output power derating for $T_A$ > 71°C | $T_C$ < 95°C $I_o < I_{o\,nom}$ | | 29 | | | 29 | | | 29 | | W/K |
| $R_{th\,ca}$ | Thermal resistance (case to ambient.) | convection cooling | | 0.4 | | | 0.4 | | | 0.4 | | K/W |
| $\tau_C$ | Thermal time constant of case | | | 1 | | | 1 | | | 1 | | h |

*Table 17: Mechanical Stress*

| Test Method | | Standard | Test Conditions | |
|---|---|---|---|---|
| Ca | Damp heat steady state<br><br>to be tested | DIN 40046 part 5<br>IEC 68-2-3 | Temperature:<br>Relative humidity:<br>Duration: | $40^{\pm 2}$ °C<br>$93^{(+2/-3)}$ %<br>56 days<br>Unit not operating |
| Ea | Shock (half-sinusoidal)<br><br>to be tested | DIN 40046 part 7<br>IEC 68-2-27 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 100 $g_n$ = 981 m/s²<br>6 ms<br>9 (3 each axis)<br>Unit operating |
| Eb | Continuous shock (half-sinusoidal)<br><br>to be tested | DIN 40046 part 26<br>IEC 68-2-29 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 40 $g_n$ = 392 m/s²<br>6 ms<br>6000 (2000 each axis)<br>Unit operating |
| Fc | Vibration (sinusoidal) | DIN 40046 part 8<br>IEC 68-2-6 | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10…2000 Hz<br>0.35 mm (10…60 Hz)<br>5 $g_n$ = 49 m/s²<br>7.5 h (2.5 h each axis)<br>Unit operating |


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*Table 18: MTBF Ratings and Device Hours*

| Values at specified Case Temperature | | Module Types | Ground Benign 40°C | Ground Fixed 40°C | Ground Fixed 70°C | Ground Mobile 50°C | Unit |
|---|---|---|---|---|---|---|---|
| MTBF | [1] | LT 1701-7 | 198'770 | 56'390 | 26'140 | 20'200 | h |

[1]Calculated in accordance with MIL-Hdbk 217 F

## Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

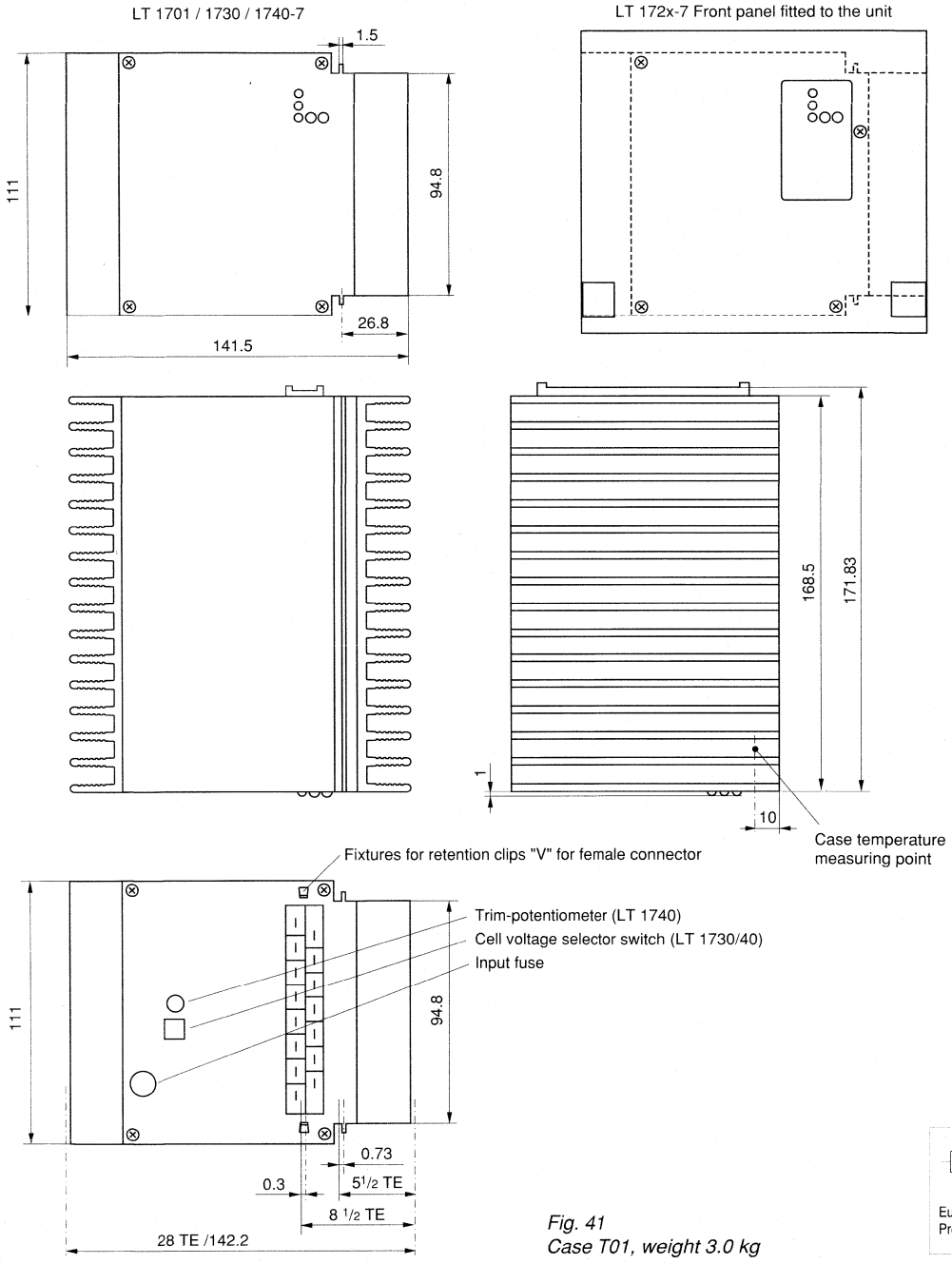



*Fig. 41*
*Case T01, weight 3.0 kg*

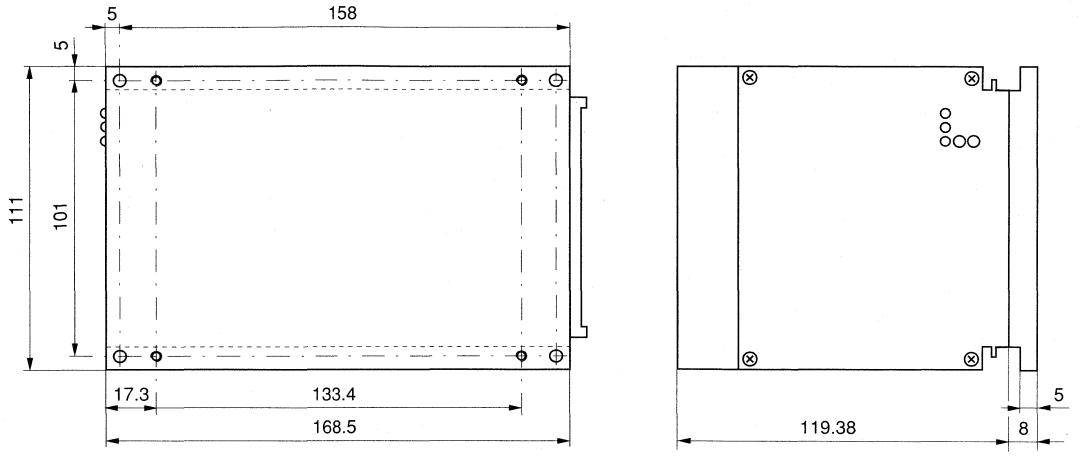



*Fig. 42*
*Option B1 for LT 1701, LT 1730 and LT 1740 (front panels available as accessories)*

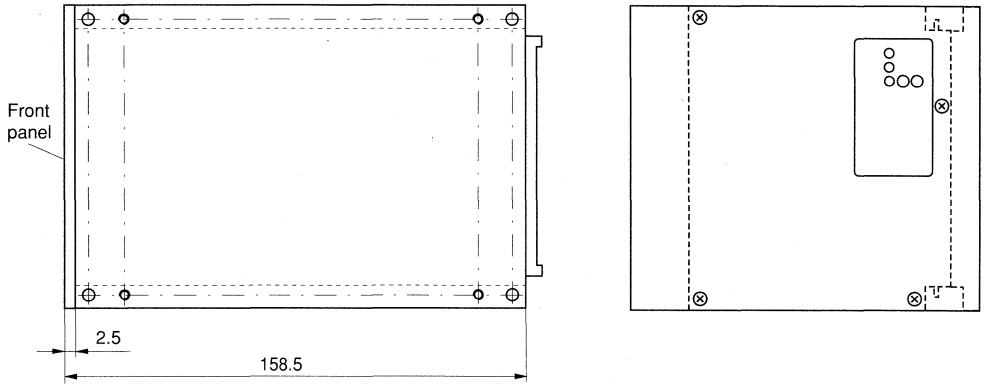



*Fig. 43*
*Option B1 for LT 172x, front panel factory mounted to the unit*

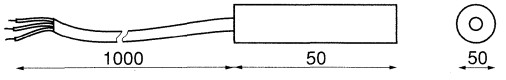
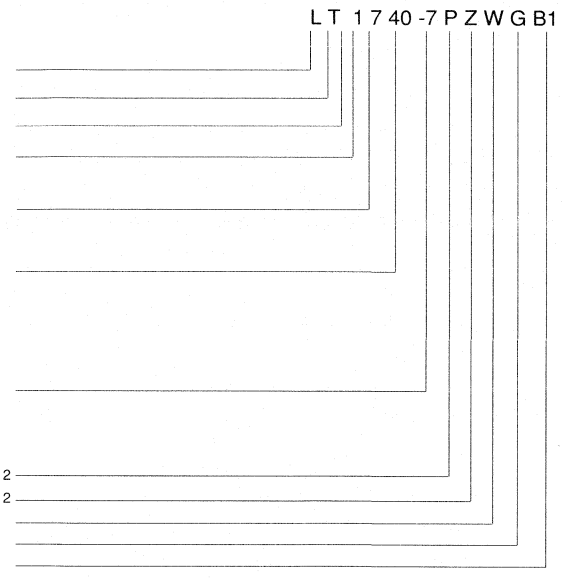



*Fig. 44*
*Temperature sensor (active element)*


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## LT Type Key and Product Identification

**Type Key**




Input voltage range $U_i$ :
- 85...255 V, 47...63 Hz ..... L

Family ..... T

Blank .....

Number of outputs: ..... 1

Output $U_{o\ nom}$:
- 52...56 V ..... 7

Without temperature sensor ..... 01
Temperature sensor mounted to the front ..... 20
Temperature sensor mounted to the rear ..... 30
With input for remote temperature sensor ..... 40

Ambient temperature range $T_A$:
- –25...50 °C ..... -5
- –25...60 °C ..... -6
- –25...71 °C ..... -7
- Custom defined ..... 0

Options:
- Potentiometer ..... P [1] [2]
- Cell voltage selector switch ..... Z [1] [2]
- Preload ..... W [1]
- Galanically isolated output signal ..... G [1]
- Baseplate ..... B1

[1] Only for LT 1730/40 [2] Option P excludes option Z and vica versa

Example: LT 1740-7Z: AC-DC converter, input voltage range 85...255 $V_{rms}$, single output 53.52...55.68 V DC, 10 A, operational ambient temperature –25...71 °C with cell selector voltage switch.

**Product Marking**

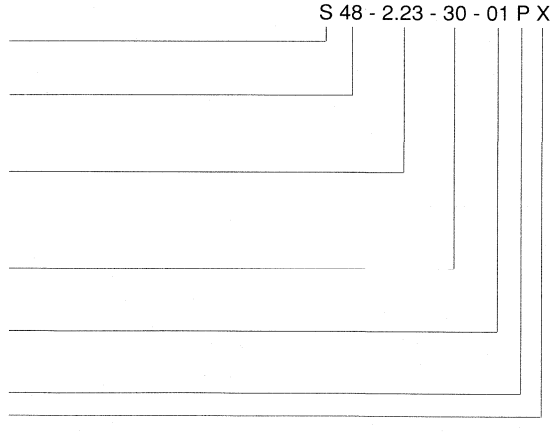
Front panel: Basic type designation with operating input voltage range, applicable approvals and input voltage range according to IEC 950, identification of LEDs and test sockets, company logo.

Back plate: Specific type designation, operating input voltage range, output voltage and current, applicable approvals with input voltage range according to IEC 950, warnings, pin allocation, degree of protection, fuse rating, company logo.

Label: Batch No.; Serial No.; Data code comprising production site, modification status of motherboard, date of production.

## Sensor Type Key and Product Identification

**Type Key**




Family ..... S [1]

Battery nominal voltage
- 48 V ..... 48

Cell voltage (at 20 °C)
- 2.23 V ..... 2.23
- 2.27 V ..... 2.27
- other cell voltages on request ..... 2.23...2.32

Temperature coefficient
- –3.0 mV/K/cell ..... 30
- –3.5 mV/K/cell ..... 35
- other temperature coefficients on request .....

Cable length ..... 01
other cable length on request .....

Option:
- Potentiometer ..... P [2]
- OK LED ..... X [2]

[1] Only together with LT 1740 [2] Option P excludes option X and vica versa

**Product Marking**

Label: Company logo, type designation, wiring diagram and data code

# 170/330 W AC-DC Converters

# VSR-Family

**Single output**

- 110 V AC and 230 V AC input (auto selectable)
- 3750 $V_{rms}$ input to output isolation
- Wide power range up to 2 • $P_{o\,nom}$ temporarily
- Excellent line/load regulation
- High level of electromagnetic compatibility
- Safety standards: UL 478, CSA 22.2, TUV approved



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## Type Survey

*Table 1: Type survey*

| Output $U_{o\,nom}$ V DC | Output $I_{o\,nom}$ A | Input voltage range $U_{i\,min}$...$U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 71°C | Type designation |
|---|---|---|---|---|
| 5 | 34.0 | 85...132 V AC/47...440 Hz or 170...264 V AC/47...440 Hz 230...330 V DC manually or auto selectable | 170 W | VSR 170-5 |
| | 66.0 | | 330 W | VSR 330-5 |
| 12 | 14.2 | | 170 W | VSR 170-12 |
| | 27.5 | | 330 W | VSR 330-12 |
| 15 | 11.3 | | 170 W | VSR 170-15 |
| | 22.0 | | 330 W | VSR 330-15 |
| 24 | 7.0 | | 170 W | VSR 170-24 |
| | 13.8 | | 330 W | VSR 330-24 |
| 48 | 3.6 | | 170 W | VSR 170-48 |
| | 7.0 | | 330 W | VSR 330-48 |

## Description

The VSR series of switching power supplies is a single output series of AC-DC converters. Compact size and high reliability make the VSR series an excellent choice. The units provide sense lines, inhibit, output undervoltage monitor, output voltage adjustment and output overvoltage protection. Five standard single output ratings are available. Several units can be connected in parallel with current sharing facility.

**Key applications**

Factory automation, off-site test and measurement, and communications equipment.



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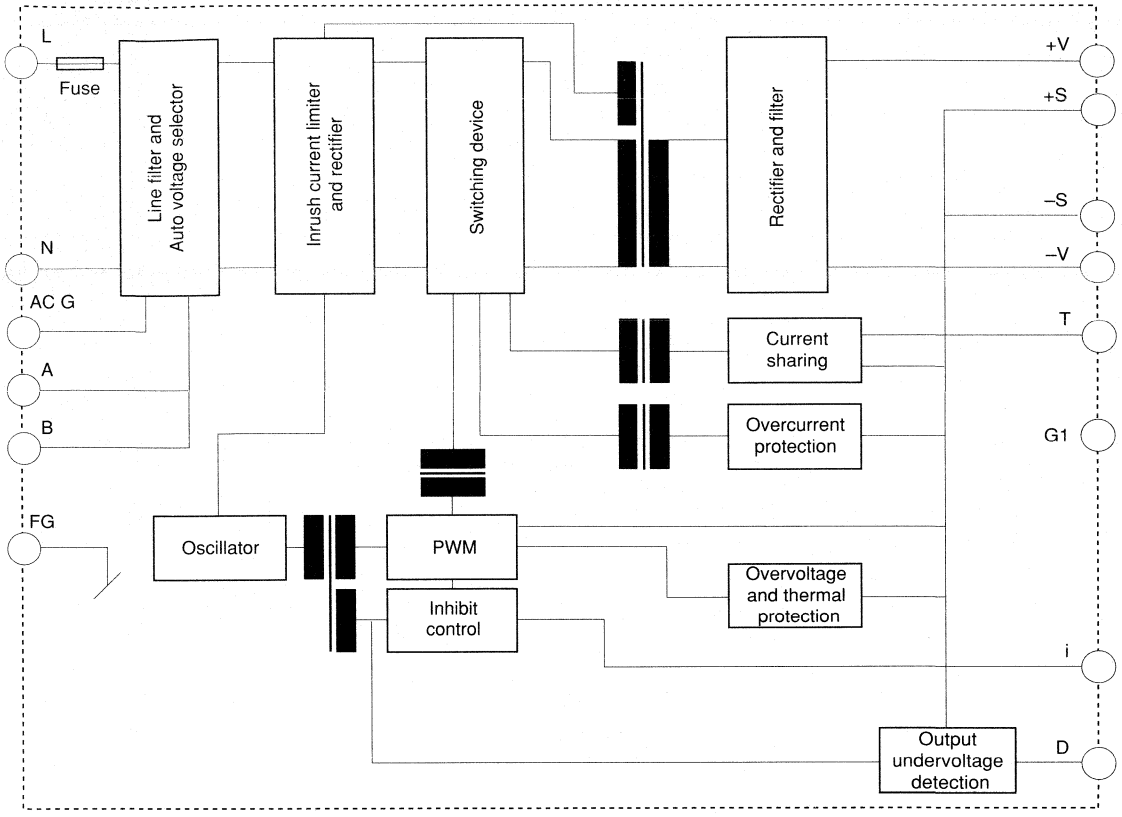



*Fig. 1*
*Block diagram VSR 170/330*

## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | VSR 170-... | VSR 330-... | Unit |
|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 100-120/200-240 | | V AC |
| $U_i$ | Input voltage range | | 85...132/170...265 [1] | | |
| | | | 230...330 [2] | | V DC |
| $f_i$ | Line frequency | | 47...440 | | Hz |
| $I_i$ | Input current [3] | typ. | 4.2/2.1 | 8.0/4.0 | A |
| $I_{inr}$ | Inrush current | max. | 15/30 | 30/60 | |
| $I_{i\ leak}$ | Leakage current | max. | 0.2/0.35 | 0.3/0.5 | mA |

[1] Manually or auto selectable
[2] Refer to table 4 also
[3] At rated input and output

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3a: Output data 170 W types*

| Type | | VSR 170-05 | VSR 170-12 | VSR 170-15 | VSR 170-24 | VSR 170-48 | |
|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\,adj}$ | Adjustable voltage range | ±20 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 34.0 | 14.2 | 11.3 | 7.0 | 3.6 | A |
| $I_o$ | Output current range min./max. | 0...200 | | | | | % |
| $u_o$ | Ripple-noise [1] max. | 100 | 200 | 200 | 200 | 400 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation $U_{i\,min}...U_{i\,max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±0.4 | | | | | |
| $\alpha u_o$ | Temperature coefficient max. | ±0.03 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 260 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.0...7.0 | 15.6...18.0 | 19.5...22.5 | 31.2...36.0 | 62.4...72.0 | V |
| $t_{Uo\,r}$ | Rise time [1] typ. | 50 | | | | | ms |
| $t_h$ | Hold-up time [1] typ. | 20 | | | | | |
| $\eta$ | Effciency [1] typ. | 75 | 82 | 82 | 84 | 84 | % |
| +S/–S | Remote sensing | provided | | | | | |
| i | Inhibit, remote on/off | provided | | | | | |
| V | DC power fail signal (open collector) | 30 V/20 mA | | | | | |
| $F_{alm}$ | Fan alarm signal (open collector) | 30 V/20 mA | | | | | |
| | Outputs connected in series | possible | | | | | |
| | Outputs connnected in parallel | possible, with current sharing facility | | | | | |

*Table 3b: Output data 330 W types*

| Type | | VSR 330-05 | VSR 330-12 | VSR 330-15 | VSR 330-24 | VSR 330-48 | |
|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\,adj}$ | Adjustable voltage range | ±20 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 66.0 | 27.5 | 22.0 | 13.8 | 7.0 | A |
| $I_o$ | Output current range min./max. | 0...200 | | | | | % |
| $u_o$ | Ripple-noise [1] max. | 100 | 200 | 200 | 200 | 400 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation $U_{i\,min}...U_{i\,max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100 % | ±0.4 | | | | | |
| $\alpha u_o$ | Temperature coefficient typ. | ±0.03 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 260 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.0...7.0 | 15.6...18.0 | 19.5...22.5 | 31.2...36.0 | 62.4...72.0 | V |
| $t_{Uo\,r}$ | Rise time [1] typ. | 50 | | | | | ms |
| $t_h$ | Hold-up time [1] typ. | 20 | | | | | |
| $\eta$ | Effciency [1] typ. | 76 | 82 | 82 | 84 | 84 | % |
| +S/–S | Remote sensing | provided | | | | | |
| i | Inhibit, remote on/off | provided | | | | | |
| V | DC power fail signal (open collector) | 30 V/20 mA | | | | | |
| $F_{alm}$ | Fan alarm signal (open collector) | 30 V/20 mA | | | | | |
| | Outputs connected in series | possible | | | | | |
| | Outputs connnected in parallel | possible, with current sharing facility | | | | | |

[1] At rated input and output
[2] Operating in constant current method, automatic recovery. The unit will switch-off if overcurrent with output voltage below threshold level occurs for more than 30 s. Turn-on by brief removal of the input voltage
[3] Shut down of output. Turn-on by brief removal of the input voltage

## Operation Instructions

### AC Input Voltage Range Selection

The AC input voltage range can be selected by means of wiring, a relay contact or a TTL signal on the main connector barrier as per the following table:

*Table 4: Input voltage range selection*

| Input voltage range | Terminals A and B |
|---|---|
| 85...132 V AC | interconnected |
| 170...265 V AC<br>230...330 V DC | open<br>(not connected) |

### Input Undervoltage Cut-out

Input voltages lower than 65...75 or 130...150 V AC respectively will shut down the power supply. If the input voltage level returns to the specified range, the power supply resets automatically.

### Output Power Rating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 2. If the power supply is used at an ambient temperature of 0...40 °C, the output power may be increased up to 200 % of the rated value.

### Output Voltage Adjustment

The output voltage may be adjusted within ±20% of $U_{o\ nom}$ by means of the internal potentiometer. If the output voltage setting should be excessively high, the overvoltage protection circuit may shut-down the output.

### Sense Lines (S)

Remote sensing provides compensation of voltage drops between power supply and load, caused by connectors and load feeding wires. The sense lines should consist of shielded cables or be twisted. If remote sensing is not reqiured, the +S should be connected to the +V and the –S to the –V terminals respectively applying shortest possible links. The compensation range is 20 % of $U_{o\ nom}$.

### Output Undervoltage Monitor (D)

If the output voltage drops below 75...80% of its nominal value, the monitoring circuit consisting of an opto-coupler with an open collector output ($V_{CE\ max}$ = 30 V, $I_{C\ max}$ = 20 mA), generates across an external pull-up resistor a power fail signal (a logic "H", high signal).

### Output Overvoltage Protection

If the built-in overvoltage protection circuit becomes active, the output is shut down and a reset can only be achieved by brief removal of the input voltage after a minimum interval time.

### Output Overload Protection

An overload condition at the output of more than 30 seconds duration will cause a shut-down of the output. A reset can only be achieved by brief removal of the input voltage after a minimum interval time.

### Inhibit (i)

The output may be enabled or disabled by means of a logic signal (TTL, CMOS etc.) or a mechanical contact applied to the inhibit input which is isolated from input and output by means of an opto-coupler. This provides independency from other voltages polarity. If the inhibit function is not required, connect the inhibit input i (pins 3/4) to return pin G1 (pins 1/2) to enable the output (active low logic, fail safe).

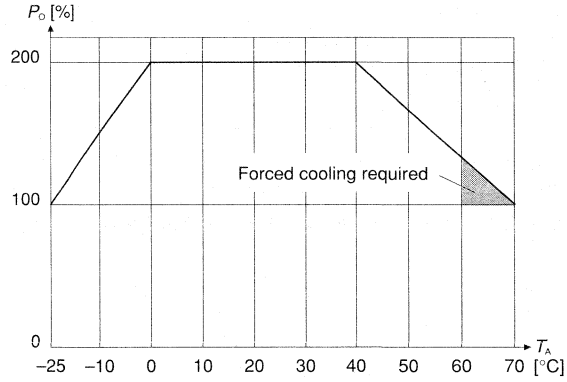



*Fig. 2*
*Output power vs. ambient temperature*

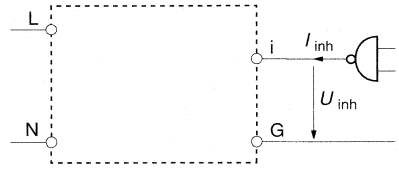



*Fig. 3*
*Definition of inhibit voltage and current*

*Table 5: Inhibit characteristics*

| Characteristic | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\ min}$...$U_{i\ max}$ | –0.7 | | 0.8 | V |
| | | $U_o$ = off | | 2.0 | | 7 | |
| $I_{inh}$ | Inhibit sink curr. | | $U_{inh}$ = 0 | | 3.5 | | mA |

### Thermal Protection

If the temperature inside the module should exceed approx. 85...95 °C, the thermal protection circuit will shut down the power supply. Having turned-off and cooled down the power supply, it will automatically reset when re-powering the input.

### Fan Alarm Signal

This circuit consisting of an opto-coupler with an open collector output continuously monitors the number of revolutions of the built-in fan. Should the number of revolutions drop below the preset value (1700 rpm), a fan alarm signal is generated (active low logic, fail safe, $V_{CE\ max}$ = 30 V, $I_{C\ max}$ = 20 mA).

### Outputs Connected in Series

Two or more units supplying the same or different output voltages may be connected in series. The value of the maximum output current to be taken is defined by that unit providing the lowest current limiting value. It should be assured that the outputs do not feed backwards into each other caused by their different rise/fall times at switch-on/off cycles by adding reverse polarity diodes across each output.

### Outputs Connected in Parallel, Current Sharing (T)

Two or more units supplying equivalent output voltages may be connected in parallel to enhance the total output power. It has to be assured that all output voltages are set to identical values before parallel wiring takes place. The load feeding lines should all be of identical specification. One each of the two T pins (current sharing facility) of each unit should be interconnected with one each of the two T pins of the parallel connected units. The units then show approximately equal load currents.

In back-up (redundant) operation, the T pins should not be interconnected. Each output should be decoupled by application of a series diode connected in the positive output path.

### Grounding Recommendations

A single power supply should be wired to the AC input by interconnecting the ACG (AC Ground) terminal with the FG (Frame Ground) terminal and both together to the protective earth.

With several modules connected in parallel, EMC and leakage currents in accordance with safety standard recommendations may no longer be met. In such cases, an external noise filter should be added in order to minimize RFI noise and to avoid summarization of the individual leakage currents caused by each module's filter. Therefore the ACG terminals (AC Ground) should not be connected. The FG terminals (Frame Ground) but must be connected directly to the protective earth (see fig. 4).

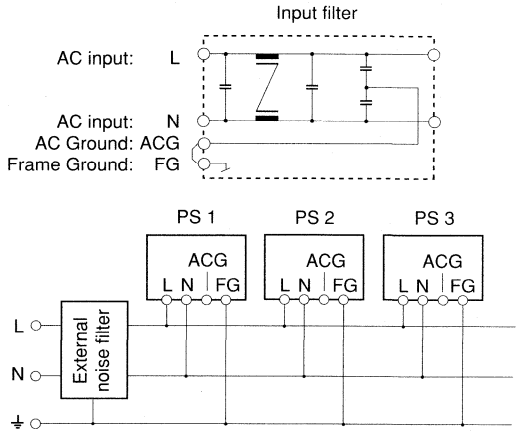



*Fig. 4*
*Block diagram of input filter and input wiring of parallel connected modules using an external noise filter*

## Input and Output Terminals

| *Connector type PHR-11* | | |
|---|---|---|
| *Designation* | | *Pin No.* |
| G1 | Return for i, D and $F_{alm}$ | 1/2 |
| i | Inhibit input | 3/4 |
| D | Power fail, open collector | 5 |
| $F_{alm}$ | Fan alarm, open collector | 6 |
| T | Current sharing | 7/8 |
| - | n.c. | 9/10 |
| - | Common with –S | 11 |

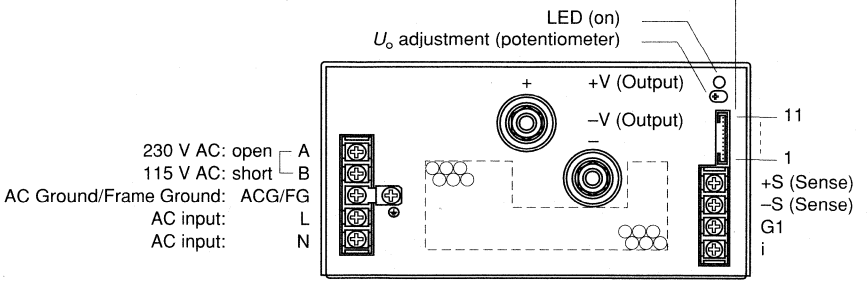



*Fig. 5*
*Terminal designation of VSR 170/330 types*


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## Immunity to Environmental Conditions

*Table 6: Mechanical Stress, Impulse Votages, High Frequency Disturbances,*

| Test Method | Test conditions | | Status |
|---|---|---|---|
| Damp heat steady state | Temperature:<br>Relative himidity: | 40 $^{\pm 2}$ °C<br>30...95 $^{-3/+2}$ % | Operating |
| Shock (half-sinusoidal) | Acceleration amplitude: | 20 $g_n$ = 981 m/s$^2$ | Operating |
| Vibration (sinusoidal) | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...55 Hz<br>0.83 mm (55 Hz)<br>5 $g_n$ = 49 m/s$^2$<br>3 h (1 h each axis) | Operating |
| Electrostatic discharge | | 15 kV | Not operating |
| Electrical fast transient | | 2 kV (50...100 µs) | Operating |
| Surge immunity | | 5 kV (1,2/50 µs; 3 times) | Operating |
| Damped oscillating wave (IEEE 472) | | 2.5 kV (50/sec; 1 MHz; 150 Ω) | Operating |

*Table 7: Temperature*

| Characterisitcs | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | –20 | 71 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –20 | 85 | |
| $T_S$ | Storage temperature | (Not operational) | –40 | 85 | |

*Table 8: MTBF Values*

| MTBF | Ground Benign | Ground Fixed |
|---|---|---|
| MTBF according to MIL-HDBK-217E | $T_C$ = 40 °C | $T_C$ = 40 °C |
| VSR 170 types | 239'000 h | 76'000 h |
| VSR 330 types | 188'000 h | 60'000 h |

*Table 9: Isolation*

| Test | Input to output | Input to case | Output to case | Unit |
|---|---|---|---|---|
| Electric strenght test voltage (1 min) | 3750 | 2500 | 500 | V AC |
| Isolation resistance (500 V DC) | >100 | >100 | >100 | MΩ |

*Table 10: Electromagnetic Emmission*

| Standard | Maintained level |
|---|---|
| VDE 0871 | <A |
| FCC 20880 (VCCI) | <A |

*Table 11: Safety Approvals*

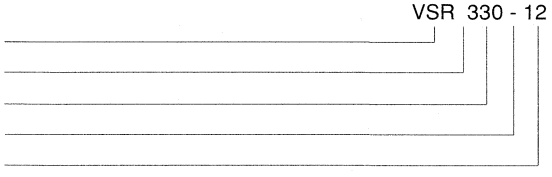
| Safety Approvals | UL 478 | CSA [1] | TÜV |
|---|---|---|---|
| VSR 170-5...VSR 170-24 | x | level 5 | x |
| VSR 170 -48 | x | level 1 | x |
| VSR 330-5...VSR 330-24 | x | level 5 | x |
| VSR 330-48 | x | level 1 | x |

[1] CSA 22.2 No. 0-M 1982

## Type Key and Product Marking

### Type Key

Family ..... VSR
Blank .....
Nominal output power [W] ..... 170, 330
Dash .....
Nominal output voltage [V] ..... 5...48



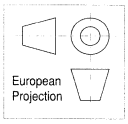

Example: VSR 330-12 = AC-DC converter providing 12 V/27.5 A, 330 W output, output undervoltage monitor and inhibit control.

### Produkt Marking

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.



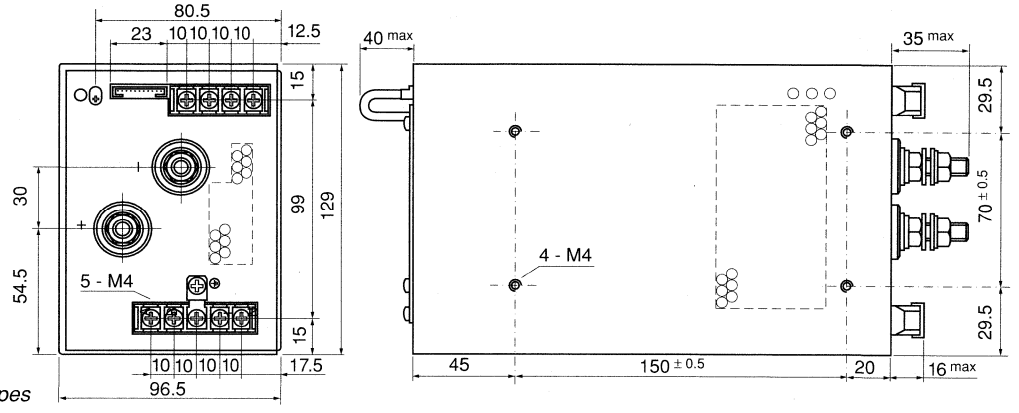




*Fig. 6*
*VSR 170 types*

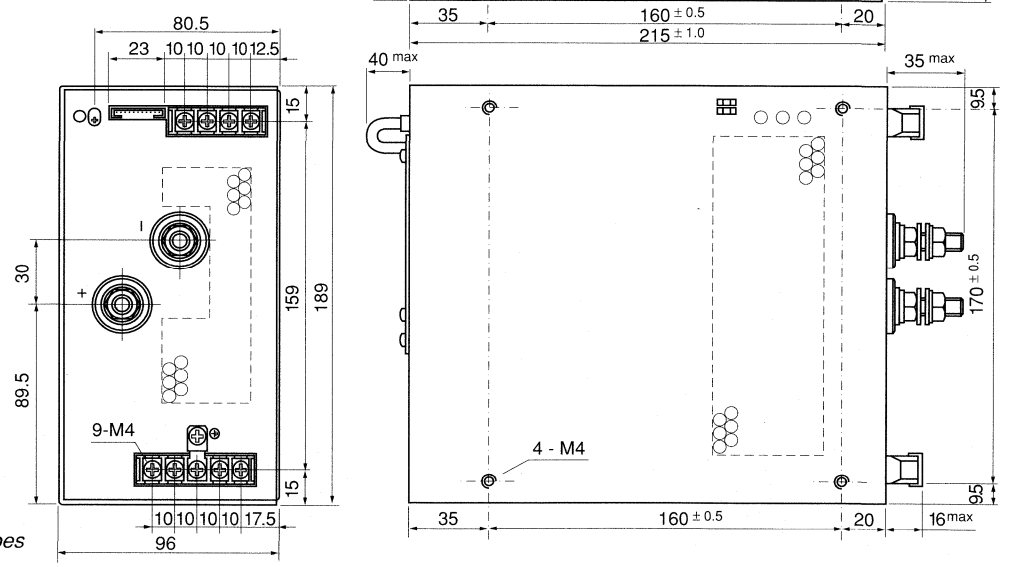



*Fig. 7*
*VSR 330 types*



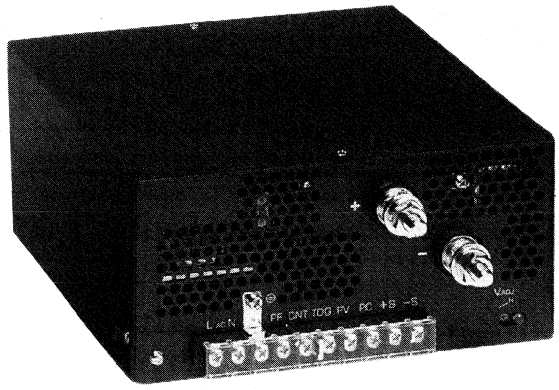
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# 200/400/1000/2100 W AC-DC Converters VEW-Family

**Single output**

- 110 V AC and 230 V AC input (auto select)
- 3750 $V_{rms}$ input to output isolation
- Power flexibility up to 2 • $P_{o\,nom}$ temporarily
- Excellent line/load regulation
- High level of electromagnetic compatibility
- Safety standards: UL, CSA and TÜV approved



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## Type Survey

*Table 1: Type survey*

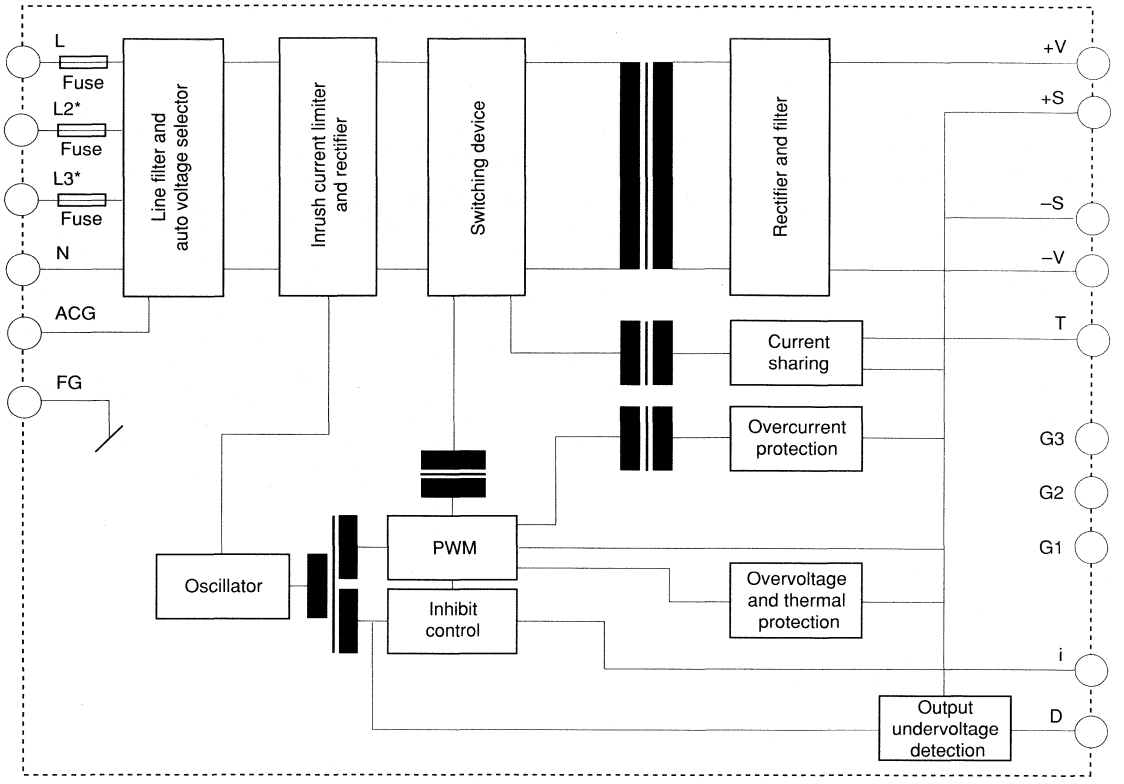
| Output $U_{o\,nom}$ V DC | Output $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 71°C | Type designation |
|---|---|---|---|---|
| 5 | 40 | VEW 200/VEW 440/VEW 1000: 85...132/170...265 V AC 47...63 Hz auto select | 200 W | VEW 200-5 |
| | 88 | | 440 W | VEW 440-5 |
| | 200 | | 1000 W | VEW 1000-5 |
| | 420 | | 2100 W | VEW 2100-5 |
| 12 | 16.7 | | 200 W | VEW 200-12 |
| | 36.7 | | 440 W | VEW 440-12 |
| | 83.3 | | 1000 W | VEW 1000-12 |
| | 175 | | 2100 W | VEW 2100-12 |
| 15 | 13.3 | | 200 W | VEW 200-15 |
| | 29.3 | | 440 W | VEW 440-15 |
| | 66.7 | | 1000 W | VEW 1000-15 |
| | 140 | | 2100 W | VEW 2100-15 |
| 24 | 8.3 | VEW 2100: 170...265 V AC 3-phases only 47...63 Hz PF = 0.95 | 200 W | VEW 200-24 |
| | 18.3 | | 440 W | VEW 440-24 |
| | 41.7 | | 1000 W | VEW 1000-24 |
| | 87.5 | | 2100 W | VEW 2100-24 |
| 48 | 4.2 | | 200 W | VEW 200-48 |
| | 9.2 | | 440 W | VEW 440-48 |
| | 20.8 | | 1000 W | VEW 1000-48 |
| | 43.8 | | 2100 W | VEW 2100-48 |

## Description

The VEW series of switching power supplies is a single output series of AC-DC converters. Compact size and high reliability make the VEW series an excellent choice when a very low profile is required. Five standard single output ratings are available, all with universal input (auto selectable). The units are provided with inhibit control, programmable output voltage, sense lines and output undervoltage monitor.

### Key applications

Factory automation, technical equipment, measuring apparatus, computer, display and communications equipment.




* Only with VEW 2100

*Fig. 1*
*Block diagram*

## Electrical Input and Output Data

General Condition: $T_A$ = 25 °C unless otherwise specified.

*Table 2: Input data*

| Characteristics | | | VEW 200 | VEW 440 | VEW 1000 | VEW 2100 | Unit |
|---|---|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 100-120/200-240 [1] | | | 200-240 [2] | V AC |
| $U_i$ | Input voltage range | | 85...132/170...265 [1] | | | 170...265 [2] | |
| $f_i$ | Line frequency | | 47...63 | | | | Hz |
| $I_i$ | Input current [3] | 100/200 V AC | 4.7/2.5 | 10.5/5.3 | 22/11 | –/8.4 | A |
| $I_{inr}$ | Inrush current (max.) | 100/200 V AC | 25/50 | 30/60 | 30/60 | –/40 | |
| $I_{i\ leak}$ | Leakage current (max.) | 100/200 V AC | 0.2/0.3 | 0.3/0.7 | 0.6/0.8 | –/1.0 | mA |

[1] VEW 200/VEW 440/VEW 1000: single phase, auto select;
[2] VEW 2100: three phases mains supply
[3] At rated input and output

General Condition: $T_A$ = 25°C unless otherwise specified.

*Table 3a: Output data 200 W types*

| Type | | VEW 200-05 | VEW 200-12 | VEW 200-15 | VEW 200-24 | VEW 200-48 | Unit |
|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | |
| $U_{o\,nom}$ | Output voltage | 5 | 12 | 15 | 24 | 48 | V |
| | Adjustable voltage range | ±20 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 40.0 | 16.7 | 13.3 | 8.3 | 4.2 | A |
| $I_o$ | Output current min./max. | 0...140 | | | | | % |
| $U_o$ | Ripple-noise [1] max. | 100 | 200 | 200 | 200 | 400 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100 % | ±0.6 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 185 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.3...7.3 | 15.0...17.4 | 18.8...21.8 | 30.0...34.8 | 60.0...69.6 | V |
| $t_{o\,r}$ | Rise time [1] max. | 20 | | | | | ms |
| $t_h$ | Hold-up time [1] (min.) 100/200 V AC | 20/20 | | | | | |
| $\eta$ | Efficiency [1] (typ.) | 74 | 80 | 80 | 82 | 82 | % |
| S | Remote sensing | provided | | | | | |
| i | Inhibit control (remote on/off) | provided | | | | | |
| D | DC power fail signal | provided | | | | | |
| | Outputs in series connection | possible | | | | | |
| | Outputs in parallel connection | possible, with current sharing facility | | | | | |

[1] At rated input and output
[2] Constant current limiting with automatic recovery. However, after 30 sec overcurrent with output voltage below output voltage monitor threshold, the unit switches off and can only be turned on again by brief removal of the input voltage
[3] Output will be shut down. Turn-on only by brief removal of the input voltage

General Condition: $T_A$ = 25°C unless otherwise specified.

*Table 3b: Output data 440 W types*

| Type | | VEW 440-05 | VEW 440-12 | VEW 440-15 | VEW 440-24 | VEW 440-48 | Unit |
|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | |
| $U_{o\,nom}$ | Output voltage | 5 | 12 | 15 | 24 | 48 | V |
| | Adjustable voltage range | ±20 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 88.0 | 36.7 | 29.3 | 18.3 | 9.2 | A |
| $I_o$ | Output current min./max. | 0...140 | | | | | % |
| $U_o$ | Ripple-noise [1] max. | 100 | 200 | 200 | 200 | 400 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±0.6 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 185 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.3...7.3 | 15.0...17.4 | 18.8...21.8 | 30.0...34.8 | 60.0...69.6 | V |
| $t_{o\,r}$ | Rise time [1] max. | 50 | | | | | ms |
| $t_h$ | Hold-up time [1] (min.) 100/200 V AC | | | 20/20 | | | |
| $\eta$ | Efficiency [1] (typ.) | 75 | 75 | 80 | 83 | 83 | % |
| S | Remote sensing | provided | | | | | |
| i | Inhibit control (remote on/off) | provided | | | | | |
| D | DC power fail signal | provided | | | | | |
| | Outputs in series connection | possible | | | | | |
| | Outputs in parallel connection | possible, with current sharing facility | | | | | |

[1] At rated input and output
[2] Constant current limiting with automatic recovery. However, after 30 sec overcurrent with output voltage below output voltage monitor threshold, the unit switches off and can only be turned on again by brief removal of the input voltage
[3] Output will be shut down. Turn-on only by brief removal of the input voltage

General Condition: $T_A$ = 25 °C unless otherwise specified.

*Table 3c: Output data 1000 W types*

| Type | | VEW 1000-05 | VEW 1000-12 | VEW 1000-15 | VEW 1000-24 | VEW 1000-48 | Unit |
|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | |
| $U_{o\,nom}$ | Output voltage | 5 | 12 | 15 | 24 | 48 | V |
| | Adjustable voltage range | ±20 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 200 | 83.3 | 66.7 | 41.7 | 20.8 | A |
| $I_o$ | Output current min./max. | 0...140 | | | | | % |
| $U_o$ | Ripple-noise [1] max. | 100 | 200 | 200 | 200 | 400 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±0.6 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 185 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.3...7.3 | 15.0...17.4 | 18.8...21.8 | 30.0...34.8 | 60.0...69.6 | V |
| $t_{o\,r}$ | Rise time [1] max. | 20 | | | | | ms |
| $t_{h\,min}$ | Hold-up time [1] 100/200 V AC | 20/20 | | | | | |
| $\eta$ | Efficiency [1] (typ.) | 80 | 81 | 82 | 83 | 84 | % |
| S | Remote sensing | provided | | | | | |
| i | Inhibit control (remote on/off) | provided | | | | | |
| D | DC power fail signal | provided | | | | | |
| | Outputs in series connection | possible | | | | | |
| | Outputs in parallel connection | possible, with current sharing facility | | | | | |

[1] At rated input and output
[2] Constant current limiting with automatic recovery. However, after 30 sec overcurrent with output voltage below output voltage monitor threshold, the unit switches off and can only be turned on again by brief removal of the input voltage
[3] Output will be shut down. Turn-on only by brief removal of the input voltage

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3d: Output data 2100 W types*

| Type | | VEW 2100-05 | VEW 2100-12 | VEW 2100-15 | VEW 2100-24 | VEW 2100-48 | Unit |
|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | |
| $U_{o\,nom}$ | Output voltage | 5 | 12 | 15 | 24 | 48 | V |
| | Adjustable voltage range | ±20 | | | | | % |
| $I_{o\,nom}$ | Rated output current | 420 | 175 | 140 | 87.5 | 43.8 | A |
| $I_o$ | Output current min./max. | 0...140 | | | | | % |
| $U_o$ | Ripple-noise [1] max. | 100 | 200 | 200 | 200 | 400 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation 85...264 V | ±0.4 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±0.6 | | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 185 | | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.3...7.3 | 15.0...17.4 | 18.8...21.8 | 30.0...34.8 | 60.0...69.6 | V |
| $t_{o\,r}$ | Rise time [1] max. | 50 | | | | | ms |
| $t_{h\,min}$ | Hold-up time [1] 100/200 V AC | 20/20 | | | | | |
| $\eta$ | Efficiency [1] (typ.) | 80 | 81 | 82 | 83 | 84 | % |
| S | Remote sensing | provided | | | | | |
| i | Inhibit control (remote on/off) | provided | | | | | |
| D | DC power fail signal | provided | | | | | |
| | Outputs in series connection | possible | | | | | |
| | Outputs in parallel connection | possible, with current sharing facility | | | | | |

[1] At rated input and output
[2] Constant current limiting with automatic recovery. However, after 30 sec overcurrent with output voltage below output voltage monitor threshold, the unit switches off and can only be turned on again by brief removal of the input voltage
[3] Output will be shut down. Turn-on only by brief removal of the input voltage


MELCHER ISO 9001 certified

## Operation Instructions

### AC Input Voltage Range Selection

With VEW 200, VEW 440 and VEW 1000 models, the AC input voltage will be detected and automatically selected by means of the internal circuitry. The VEW 2100 models require three phases mains of 3 × 170...265 V AC.

### Input Open Phase Detection (VEW 2100)

If one of the the three input line phases becomes open, or falls below 160 V AC, the output will be shut down within 5 seconds. The unit is reactivated by short removal of the input lines.

### Inrush Current Limiting Device

This series is provided with an inrush current limiting device. However it will not be operating if activated more than once in any 5 seconds.

### Output Power Rating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 2. If the power supply is used at an ambient temperature of 0...50 °C, the output power may be increased to 140% of the rated value.

### Output Voltage Adjustment

The output voltage may be adjusted within ±20% of $U_{o\,nom}$ by means of the internal potentiometer. If the output voltage setting should be excessively high, the overvoltage protection circuit may shut-down the output.

### Sense Lines (S)

Remote sensing provides compensation of voltage drops between power supply and load, caused by connectors and load feeding wires. The sense lines should consist of shielded cables or be twisted. If remote sensing is not reqiured, the +S should be connected to the +V and the –S to the –V terminals respectively applying shortest possible links. The compensation range is 20% of $U_{o\,nom}$.

### Output Undervoltage Monitor (D)

If the output voltage drops below 75...80% of its set value, the monitoring circuit consisting of an opto-coupler with an open collector output ($V_{CE\,max}$ = 30 V, $I_{C\,max}$ = 20 mA), generates across an external pull-up resistor a power fail signal (a logic "H", high signal).

### Output Overvoltage Protection, Fan Monitor

If the built-in overvoltage protection circuit becomes active, the output is shut down and a reset can only be achieved by brief removal of the input voltage after a minimum interval time. VEW 2100: Should one of this built-in fans stop, the output is shut down and the output undervoltage monitor (D) activated.

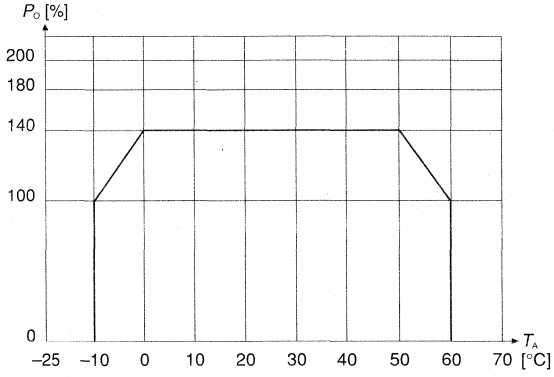



*Fig. 2*
*Output power vs. ambient temperature*

### Output Overload Protection

An overload condition at the output will cause the protection cicuit to turn into its foldback characteristic. After removal of overload, the unit will return to normal operation automatically.

### Thermal Protection

If the temperature inside the module should exceed approx. 85...95°C, the thermal protection circuit will shut down the power supply. Having turned-off and cooled down the power supply, it will automatically reset when re-powering the input.

### Inhibit (i)

signal (TTL, CMOS etc.) or a mechanical contact applied to the inhibit input which is isolated from input and output by means of an opto-coupler. This provides independency from other voltages polarity. If the inhibit function is not required, connect the inhibit input i to return pin G1 to enable the output (active low logic, fail safe).

*Table 4: Inhibit characteristics*

| Characteristic | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}$...$U_{i\,max}$ | –0.7 | | 0.8 | V |
| | | $U_o$ = off | | 2.0 | | 7 | |
| $I_{inh}$ | Inhibit sink curr. | | $U_{inh}$ = 0 | | 3.5 | | mA |

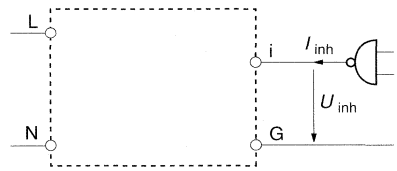



*Fig. 3*
*Definition of inhibit voltage and current*

### Outputs Connected in Series

Two or more units supplying the same or different output voltages may be connected in series. The value of the maximum output current to be taken is defined by that unit providing the lowest current limiting value. It should be assured that the outputs do not feed backwards into each other caused by their different rise/fall times at switch-on/off cycles by adding reverse polarity diodes across each output.

### Outputs Connected in Parallel, Current Sharing (T2)

Two or more units supplying equivalent output voltages may be connected in parallel to enhance the total output power. It has to be assured that all output voltages are set to identical values before parallel wiring takes place. The load feeding lines should all be of identical specification. One of the T pins of each unit should be interconnected with a T pin of the parallel connected units. The units then show approximately equal load currents.

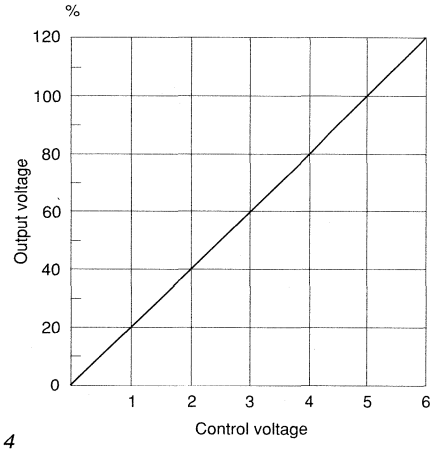



*Fig. 4*
*Programmable output voltage function*

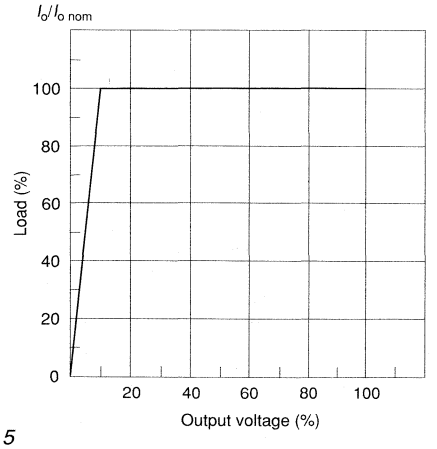



*Fig. 5*
*Derating curve for programmable output voltage*

### Programmable Output Voltage (R) (VEW 1000 and VEW2100)

Control by an external voltage:
The output voltage can be externally controlled between zero and 120% of rated output voltage (0...120% regulation range) by applying an external control voltage between pins R and G3. The relationship between control voltage and output voltage can be found in figure 4. Setting accuracy is within ±2%. If the output voltage is regulated to below of 10% of nominal voltage, the output power has to be derated linearily to zero according to figure 5. Response time to control voltage changes is between 200...300 ms depending on load. The maximum control voltage change over time should stand below 1 V/ms.

Attention: If this function is not used, short R and G2 pin!

Control by an external resistor:
The output voltage can be controlled by an external potentiometer connected to the pins R, G2 and G3 as shown in figure 7. The pin G2 is hereby feeding a control voltage. The regulation range is 0...100%. Should a range of 0...120% be necessary, then the output voltage must be set to the maximum by using the adjustment potentiometer (short R and G2 pin before doing so!)

Attention: If this function is not used, short R and G2 pin!

### Master-Slave operation:

One unit can control the voltage of the other units by interconnecting them as shown in figure 8.

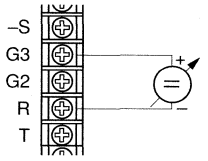



*Fig. 6*
*Output voltage control by an external voltage*

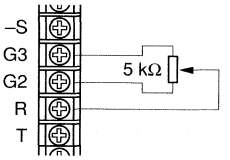



*Fig. 7*
*Output voltage control by an external variable resistor*

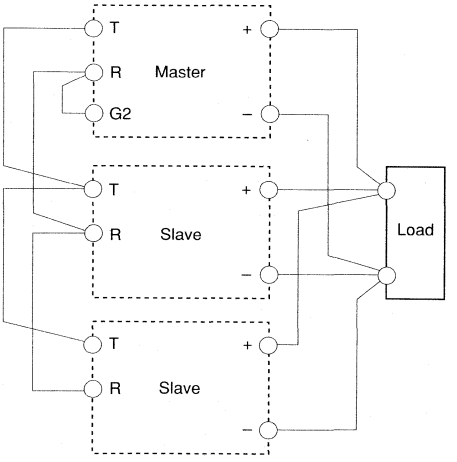



*Fig. 8*
*Master slave operation*


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**Grounding Recommendations**

A single power supply should be wired to the AC input by interconnecting the ACG (AC Ground) terminal with the FG (Frame Ground) terminal and both together to the protective earth.

With several modules connected in parallel, EMC and leakage currents in accordance with safety standard recommendations may no longer be met. In such cases, an external noise filter should be added in order to minimize RFI noise and to avoid summarization of the individual leakage currents caused by each module's filter. Therefore the ACG terminals (AC Ground) should not be connected. The FG terminals (Frame Ground) must be connected directly to the protective earth (see fig. 3a and 3b).

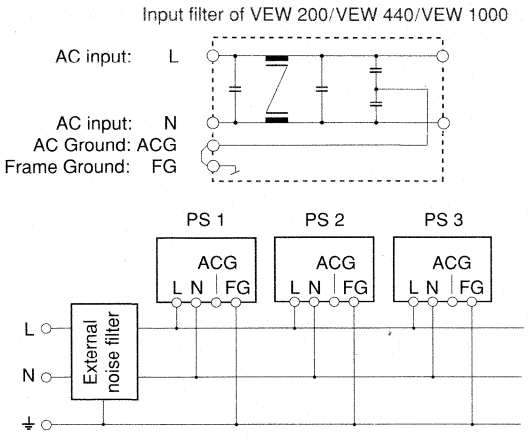



*Fig. 9a*
*Block diagram of VEW 200/VEW 440/VEW 1000 input filter and input wiring of parallel connected modules using an external noise filter*

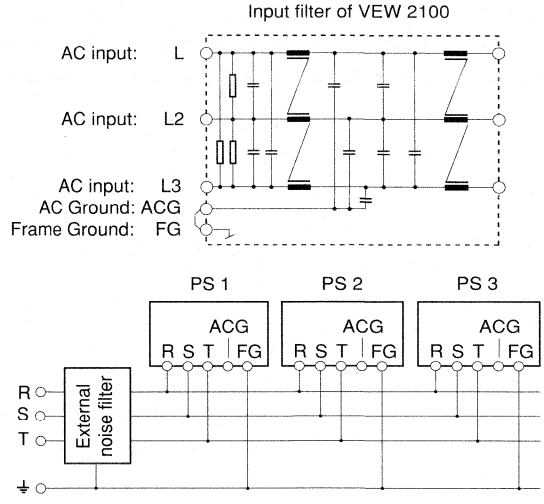



*Fig. 9b*
*Block diagram of VEW 2100 3-phase input filter and input wiring of parallel connected modules using an external noise filter*

## Input and Output Terminals

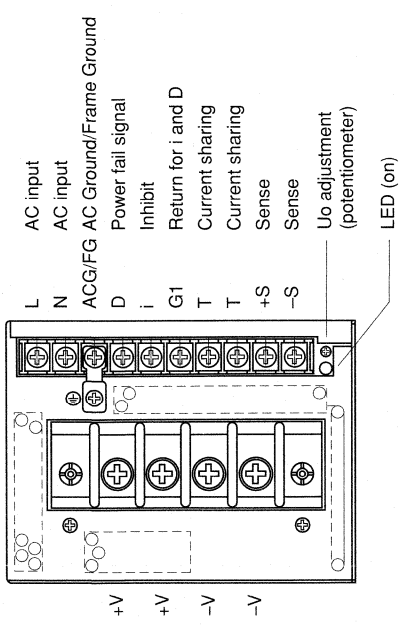



*Fig. 10*
*Terminal designation of VEW 200*

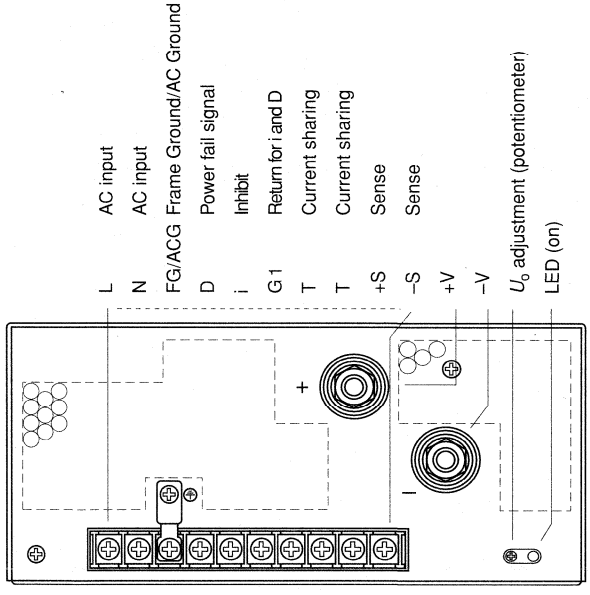



*Fig. 11*
*Terminal designation of VEW 440*

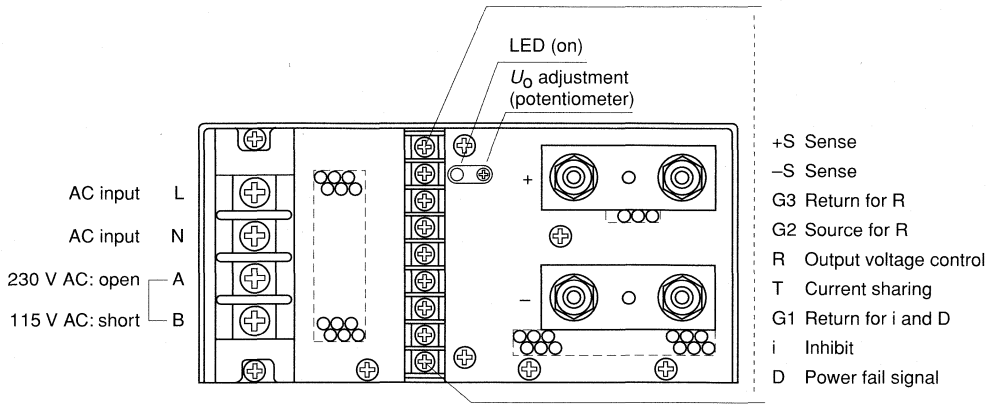



*Fig. 12*
*Terminal designation of VEW 1000*

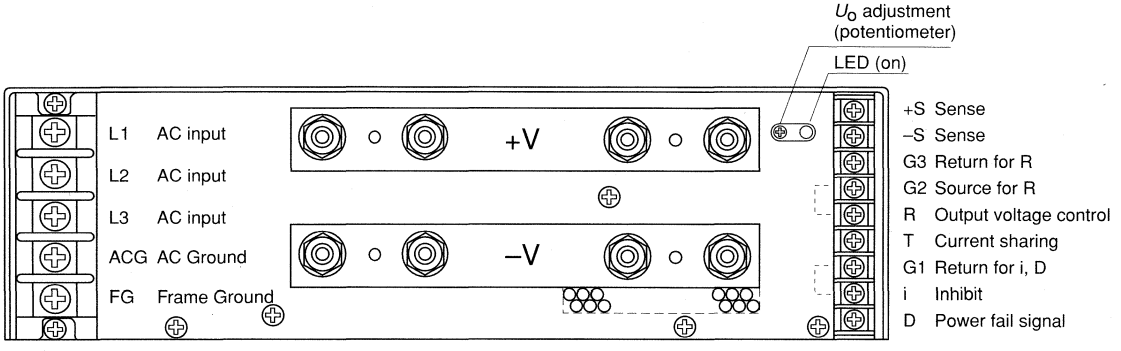



*Fig. 13*
*Terminal designation of VEW 2100*

## Immunity to Environmental Conditions

*Table 5: Mechanical Stress, Impulse Votages, High Frequency Disturbances,*

| Test Method | Test conditions | | Status |
|---|---|---|---|
| Damp heat<br>steady state | Temperature:<br>Relative himidity: | 40 $^{\pm 2}$ °C<br>30...95 $^{-3/+2}$ % | Operating |
| Shock (half-sinusoidal) | Acceleration amplitude: | 20 $g_n$ = 198 m/s$^2$ | Operating |
| Vibration (sinusoidal) | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...55 Hz<br>0.83 mm (55 Hz)<br>2 $g_n$ = 19.6 m/s$^2$<br>3 h (1 h each axis) | Operating |
| Electrostatic discharge | | 15 kV | Operating |
| Electrical fast transient | | 2 kV (50...100 µs) | Operating |
| Surge immunity | | 5 kV (1,2/50 µs; 3 times) | Operating |
| Damped oscillating wave (IEEE 472) | | 2.5 kV (50/sec; 1 MHz; 150 Ω) | Operating |

*Table 6: Temperature*

| Characterisitcs | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}$...$U_{i\,max}$ | –10 | +60 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | –10 | +85 | |
| $T_S$ | Storage temperature | (Not operational) | –30 | +85 | |

*Table 7: MTBF Values*

| MTBF | Ground Benign |
|---|---|
| MTBF according to MIL-HDBK-217E | $T_C$ = 40 °C |
| VEW 200 types | 30'000 h |
| VEW 440 types | 24'000 h |
| VEW 1000 types | 48'000 h |
| VEW 2100 types | 33'000 h |

*Table 8: Isolation*

| Test | | Input to output | Input to case | Output to case | Unit |
|---|---|---|---|---|---|
| Electric strenght test voltage (1 min) | VEW 200/440/1000 | 3750 | 2500 | 500 | V AC |
| Electric strenght test voltage (1 min) | VEW 2100 | 2500 | 2500 | 500 | |
| Isolation resistance (500 V DC) | all types | >100 | >100 | >100 | MΩ |

*Table 9: Electromagnetic Emmission*

| Standard | Maintained level |
|---|---|
| VDE 0871 | <A |
| FCC 20880 (VCCI) | <A |

*Table 10: Safety Approvals*

| Safety Approvals | UL 478 | CSA 22.2 [1] | TÜV |
|---|---|---|---|
| VEW 200 | x | x [1] | x |
| VEW 440 | x | x [1] | x |
| VEW 1000 (only 5 V type) | x [2] | x | x |
| VEW 2100 (only 48 V type) | – | x | – |

[1] Level 5 for 5, 12, 15, 24 V output, Level 1 for 48 V output
[2] Also 48 V type

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.

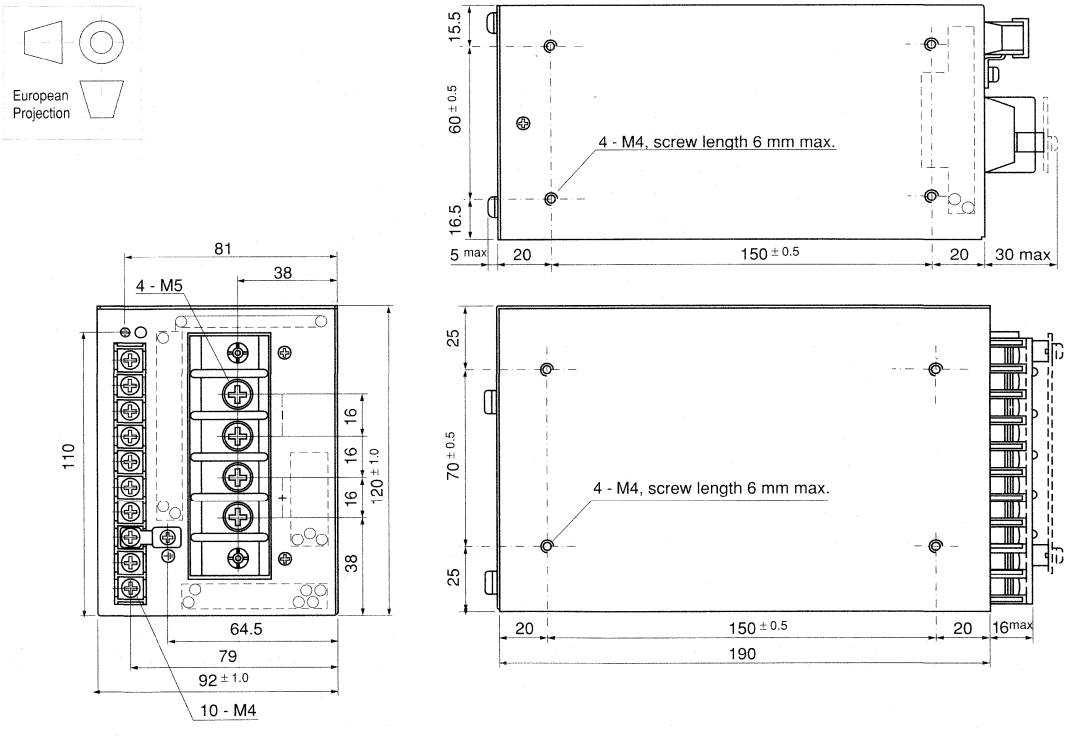



*Fig. 14*
*VEW 200*

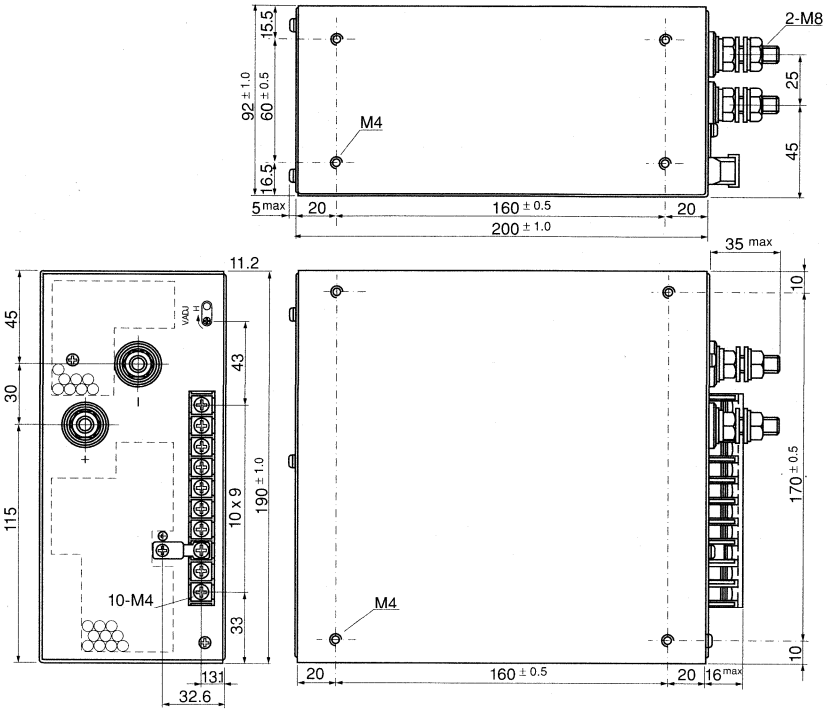



*Fig. 15*
*VEW 440*

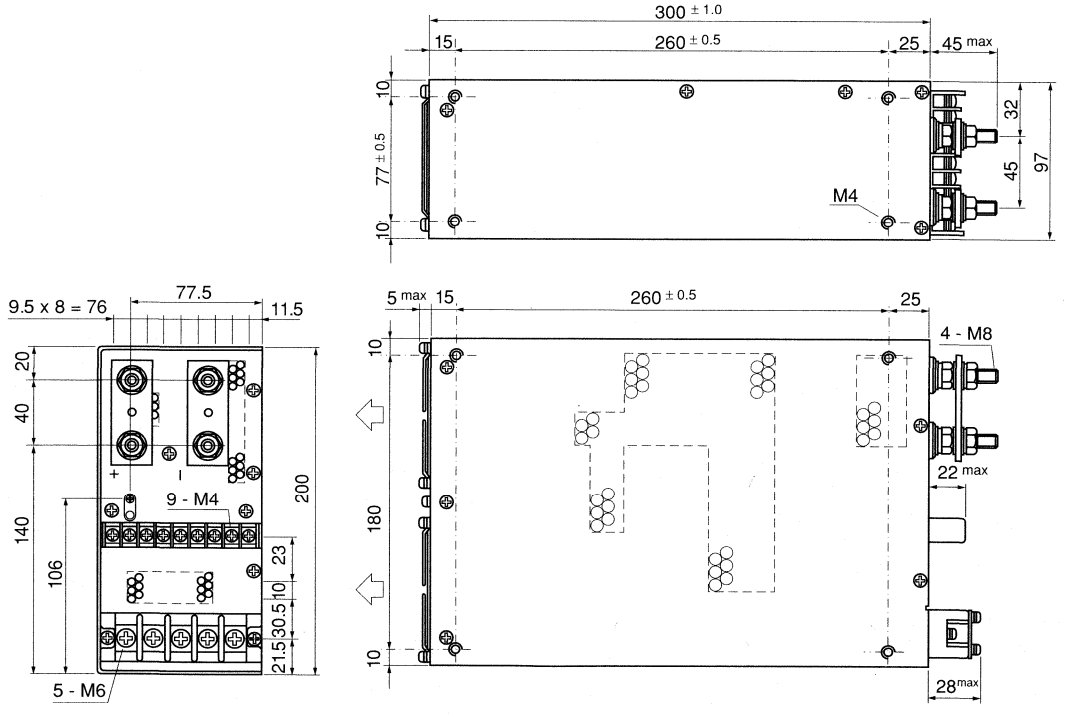



*Fig. 16*
*VEW 1000*


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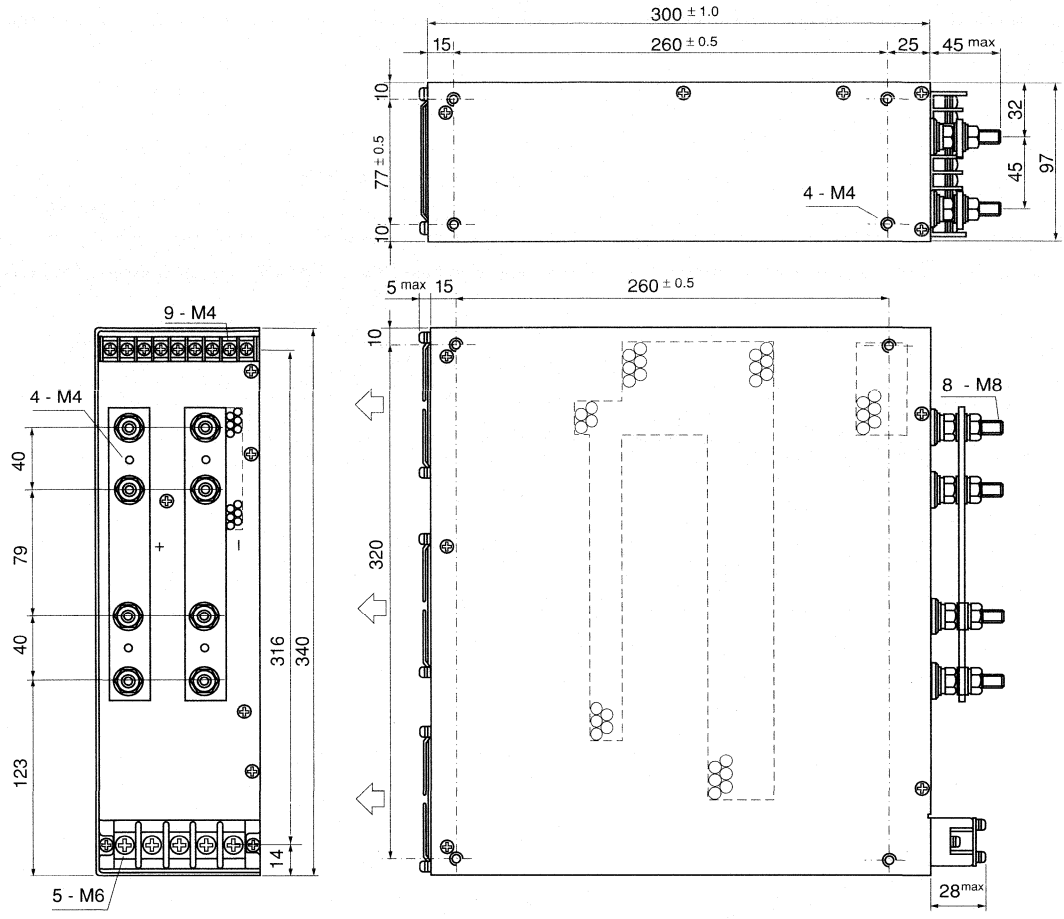



*Fig. 17*
*VEW 2100*

## Type Key and Product Marking

**Type Key**

VEW 440 - 12

| | |
|---|---|
| Family | VEW |
| Blank | |
| Nominal output power [W] | 200/440/1000/2100 |
| Dash | |
| Nominal output voltage [V] | 5...48 |

Example: VEW 440-12 = AC-DC converter providing 12 V/36.7 A, 440 W output, output undervoltage monitor and inhibit control.

**Produkt Marking**

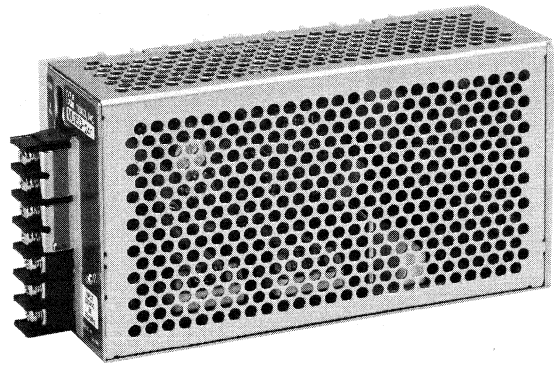
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 150 W AC-DC Converters

# MK-Family

**Single output**

- Ultra compact, high power density
- High efficiency up to 80%
- Overload and overvoltage protection
- Highest grade components for highest reliability
- Surge protection
  – Lightning 4 KV
  – Strong electric fields 50 V/m
- Noise standards: Meets FCC Class B and VCCI, Class 2
- Saftey standards: UL 478 approved, designed to meet CSA C22.2/N220



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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 40°C$ | Type designation |
|---|---|---|---|---|
| 5 | 30.0 | 90...132 V AC<br>47...440 Hz<br>or<br>120...175 V DC | 150 W | MK 150-05 |
| 6 | 25.0 | | | MK 150-06 |
| 12 | 12.5 | | | MK 150-12 |
| 15 | 10.0 | | | MK 150-15 |
| 18 | 8.4 | | | MK 150-18 |
| 24 | 6.3 | | | MK 150-24 |

## Description

Modules to application of new inductive technology the switching fequency of the MK 150 has been boosted to 250 kHz. The design allows for the use of smaller inductive components and filtering circuitry. The use of power MOSFET technology also reduces size and increases power density. For a new generation product or as a running design change, a manufacturer can replace a conventional 100-watt supply with a 150-watt type MK 150. This permits the use of more power-intensive peripherals without mechanical design changes.

### Key applications

The smaller-than-usual size of the MK 150 series makes them well suited to newer, smaller footprint personal computers as well as telecommunications equipment, instrumentation and control systems.



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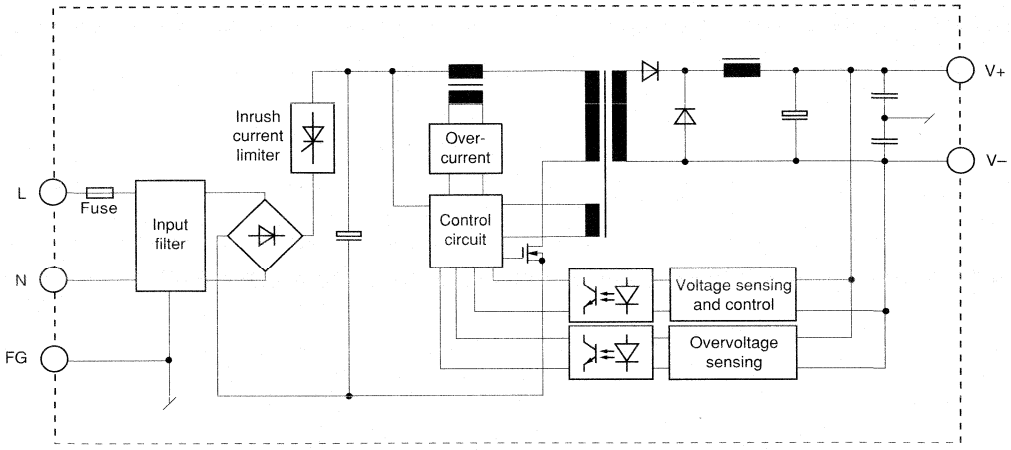



*Fig. 1*
*Block diagram MK 150*

## Electrical Input and Output Data

General condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input Data*

| Characteristics | | | MK 150 | Unit |
|---|---|---|---|---|
| $U_i$ | Rated input voltage | | 115 | V AC |
| | Input voltage range | | 90...132 | |
| | | | 120...175 | V DC |
| $f_i$ | Line frequency | | 47...440 | Hz |
| $I_{i\,leak}$ | Leakage current (max.) | 115 V AC, 50 Hz | 0.5 | mA |

General condition: $T_A$ = 25°C unless otherwise specified

*Table 3: Output data*

| Characteristics | | | MK 150-05 | MK150-06 | MK150-12 | MK150-15 | MK150-18 | MK150-24 | Unit |
|---|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | | 5 | 6 | 12 | 15 | 18 | 24 | V |
| | Adjustable output range | | ±10 | | | | | | % |
| $U_{oL}$ | Overvoltage protection | | 6.9 | 8.0 | 15.5 | 20.0 | 24.0 | 31.0 | V |
| $I_o$ | Output current | | 30.0 | 25.0 | 12.5 | 10.0 | 8.4 | 6.3 | A |
| $I_{o\,L}$ | Overcurrent protection [1] | | 105 | | | | | | % |
| $u_o$ | Ripple-noise | max. | 120 | 120 | 120 | 150 | 180 | 200 | mVp |
| $\Delta U_{o\,U}$ | Line regulation | | ±3 | | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±3 | | | | | | |
| $t_{o\,r}$ | Rise time | max. | 150 | | | | | | ms |
| $t_{o\,h}$ | Hold up time | min. | 20 | | | | | | |
| $\eta$ | Efficiency [2] | typ. | 78 | 78 | 80 | 80 | 82 | 82 | % |

[1] Operate at 105% of rated current, CC method, automatic reset
[2] At rated input and output

## Operating Instructions

### Derating of Output Power

The output power derating depends on the structure of the power supply. The derating characteristics are shown in fig. 2.

### Output Voltage Adjustment

The output voltage adjustment range ($V_{ADJ}$ at the front panel) is ±10% of $U_{o\ nom}$. The actual output power should not ecxeed the spedified maximum output power.

### Overcurrent Protection

When the output current exceeds 105% of the rated current the overcurrent protection circuit operates (see fig. 3). The output will recover automatically as soon as the overload condition is removed. The overload condition should remain as short as possible.

### Overvoltage Protection

When there is an overvoltage condition at the output, the internal latch circuit will operate and the output will be cut off. In this instance, turn off the input. At least 90 seconds should be allowed as recovery time.

### Inrush Current

A thyristor is built-in to protect against excessive inrush current. Appropriate selection of the AC input switch is recommended. Repeating switching cycles should be avoided i.e. permit at least two minutes recovery time.

### Insulation and Dielectric Strength Test

Preshipment tests have been applied at the factory and further testes are not necessary.

### Series Operation

Two power supplies, PS-1 and PS-2 for example, may be operated in series connection as shown in fig. 4a and 4b.

### Parallel Operation

**Do not connect the power supplies for parallel operation.**

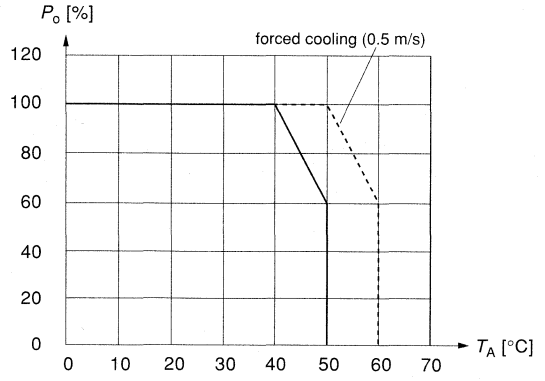



*Fig. 2*
*Output power vs. ambient temperature*

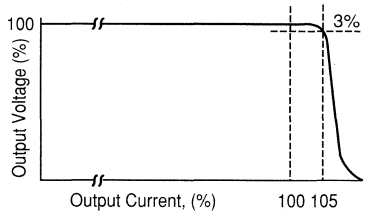



*Fig. 3*
*Output voltage vs. output current*

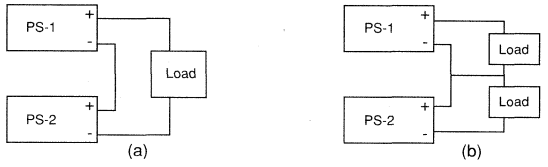



*Fig. 4*
*Power supplies connected in series*

## Immunity to Environmental Conditons

*Table 4: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 40 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 3) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 5: Humidity*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity (no dew condensation) | Relative humidity: | 30...85% Unit operating/storage |


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*Table 6: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 1500 V AC, 1 minute | 1500 V AC, 1 minute leakage current <10 mA. | – |
| Insulation resistance [1] | – | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ⊥1 mm unless otherwise indicated.

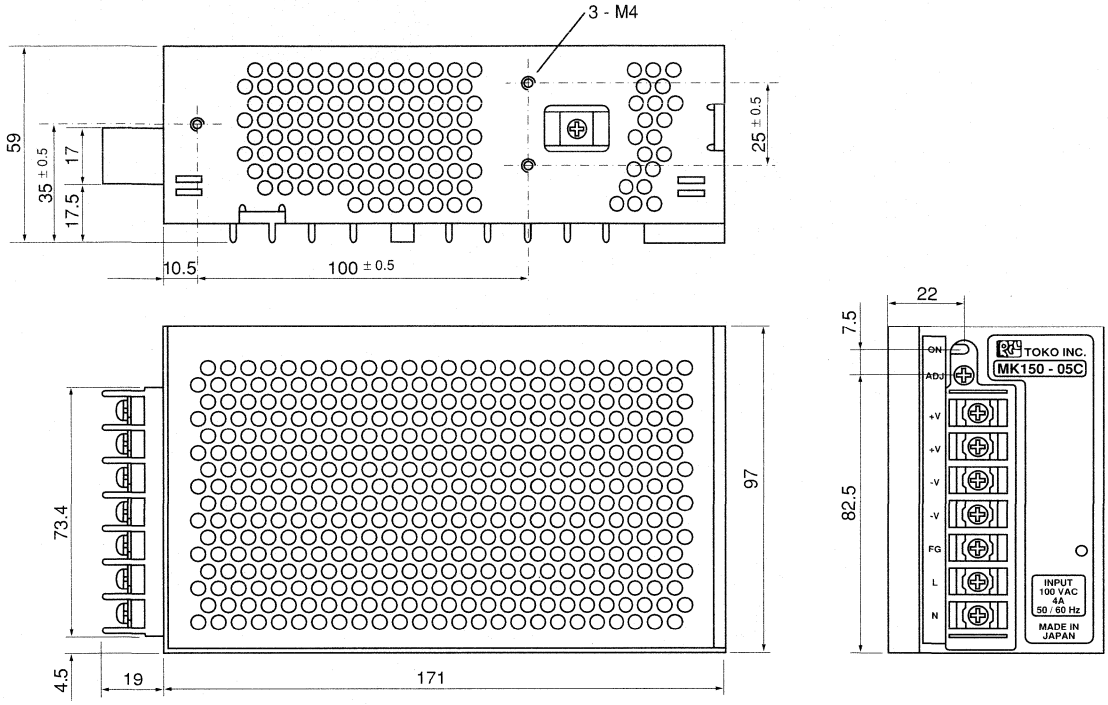



*Fig. 5*
*MK 150: For vertical installation only. Maximum lenght of M4 mounting screws inside the power supply 6 mm.*

## Type Key and Product Marking

**Type Key**

MK 150 - 12

Family ..... MK
Blank .....
Nominal output power [W] ..... 150
Dash .....
Nominal output voltage [V] ..... 5...24

Example: MK 150-12 = AC-DC converter providing 12 V/12.5 A, 150 W in a case with terminal strip

**Produkt Marking**

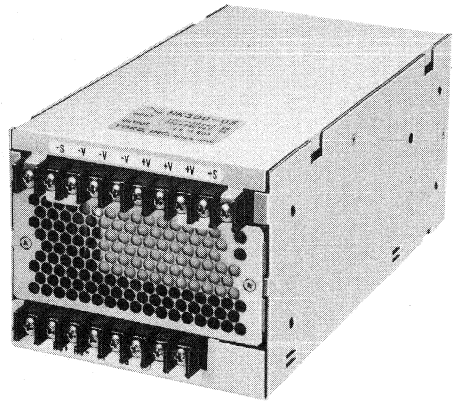
Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# TOKO 300 W AC-DC Converters

# HK-Family

**Single output**

- Universal input: (85...264 V AC)
- Power factor corrected
- Special functions, as current sharing, power fail signal, remote control and sense lines
- Safety standards: designed to meet UL, CSA, VDE
- Noise standards: meets FCC-A and VDE 0871-A



## Description

This design of the HK 300 allows for the use of smaller inductive components and filtering circuitry. The power MOSFET technology also reduces size and increases power density. For a new generation product or as a running design change, a manufacturer can replace a conventional power supply with a HK 300.

### Key applications

The smaller-than-usual size of the HK 300 series makes them well suited to newer, smaller footprint personal computers as well as telecommunications equipment, instrumentation and control systems.

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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}...U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A = 50°C$ | Power factor correction | Type designation |
|---|---|---|---|---|---|
| 5 | 60.0 | 85...264 V AC 47...63 Hz | 300 W | 0.98 (100 V AC) 0.95 (230 V AC) | HK 300-05 |
| 12 | 25.0 | | | | HK 300-12 |
| 15 | 20.0 | | | | HK 300-15 |
| 24 | 12.5 | | | | HK 300-24 |
| 48 | 6.3 | | | | HK 300-48 |

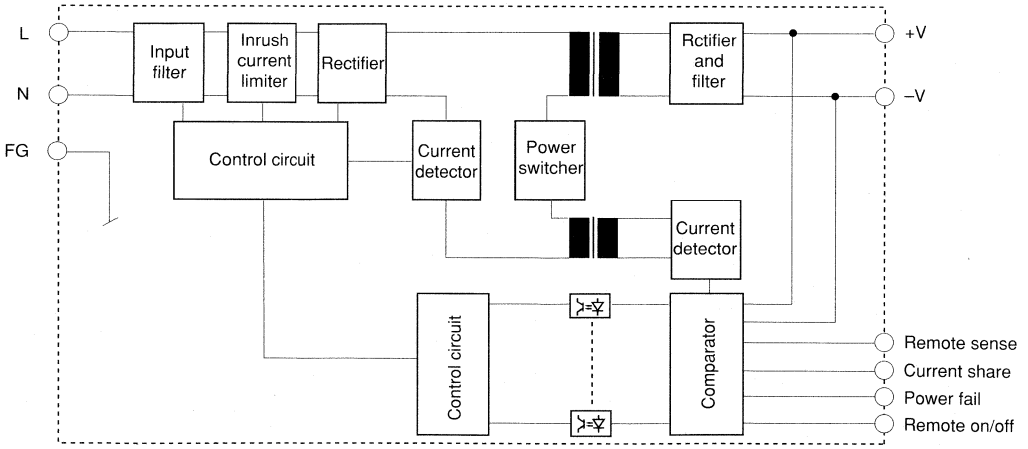



*Fig. 1*
*Block diagram HK 300*



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## Electrical Input and Output Data

General condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input Data*

| Characteristics | | | HK 300-.. | Unit |
|---|---|---|---|---|
| $U_i$ | Input voltage range | | 85...264 | V AC |
| $f_i$ | Line frequency | | 47...63 | Hz |
| $I_i$ | Input current (max.) | 100/200 V AC | 8/4 | A |
| $I_{inr}$ | Inrush current (max.) | 100/200 V AC | 15/30 | |
| $I_{i\,leak}$ | Leakage current (max.) | 100/200 V AC | 0.5/0.75 | mA |
| *PF* | Power factor correction | min. | 0.95 | |

General condition: $T_A$ = 25°C unless otherwise specified

*Table 3: Output data*

| Characteristics | | | HK 300-05 | HK300-12 | HK300-15 | HK300-24 | HK300-48 | Unit |
|---|---|---|---|---|---|---|---|---|
| $U_{o\,nom}$ | Output voltage | | 5 | 12 | 15 | 24 | 48 | V |
| | Adjustable output range | | ±10 | | | | | % |
| $U_{oL}$ | Overvoltage protection | | 6.0...6.9 | 13.5...15.5 | 17...20.0 | 27...31 | 53...59 | V |
| $I_o$ | Output current | | 60 | 25 | 20 | 12.5 | 6.3 | A |
| $I_{o\,L}$ | Overcurrent protection [1] | | 105 | | | | | % |
| $u_o$ | Ripple-noise | max. | 120 | 150 | 150 | 200 | 400 | mVp |
| $\Delta U_{o\,U}$ | Line regulation | | ±3 | | | | | % |
| $\Delta U_{o\,I}$ | Load regulation | 0...100% | ±3 | | | | | |
| $\Delta U_{o\,t}$ | Drift (t = 0.5...8 hours) | typ. | ±3 | | | | | |
| $\alpha U_o$ | Change in temp. 0...50°C | typ. | ±3 | | | | | |
| | Remote sensing | | standard | | | | | |
| | Remote on/off | | standard | | | | | |
| | Current sharing | | standard | | | | | |
| | Output indicator | | LED on front panel | | | | | |
| | Power fail | | standard | | | | | |
| $t_{o\,r}$ | Rise time [2] | max. | 500 | | | | | ms |
| $t_{o\,h}$ | Hold up time [2] | min. | 20 | | | | | |
| $\eta$ | Efficiency [2] | typ. | 74 | 76 | 78 | 80 | 81 | % |

[1] Operate at 105% of rated current, CC method, automatic recovery
[2] At rated input and output

## Operating Instructions

### Derating of Output Power

The derating characteristic of the output power is shown in fig. 2.

### Output Voltage Adjustment

The output voltage adjustment range ($V_{ADJ}$ at the front panel) is ±10% of $U_{o\,nom}$. The actual output power should not exceed the spedified maximum output power.

### Overcurrent Protection

When the output current exceeds 105% of the rated current the overcurrent protection circuit operates (see fig. 3). The output will recover automatically as soon as the overload condition is removed (constant current method).

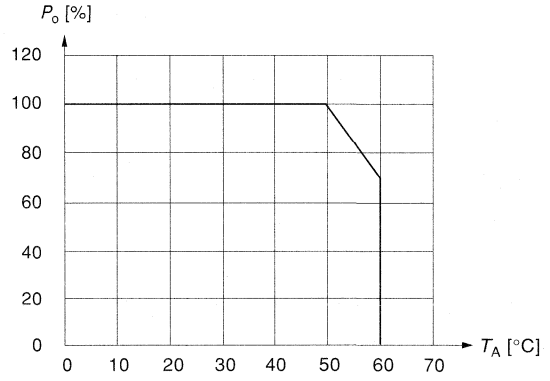



*Fig. 2*
*Output power vs. ambient temperature*

### Overvoltage Protection

If there is an overvoltage condition at the output, the internal latch circuit will operate and the output will be cut off. In this instance, turn off the input. At least 90 seconds should be allowed as recovery time.

### Inrush Current

A thyristor is built-in to protect against excessive inrush current. Appropriate selection of the AC input switch is recommended. Repeating switching cycles within short period should be avoided.

### Insulation and Dielectric Strength Test

Preshipment tests have been applied at the factory and further tests are not necessary.

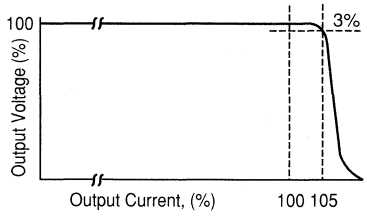



*Fig. 3*
*Output voltage vs. output current*

## Immunity to Environmental Conditons

*Table 4: Temperature specifications*

| Characteristic | | min | max | Unit |
|---|---|---|---|---|
| $T_A$ | Operating ambient temperature range without derating | 0 | 50 | °C |
| $T_A$ | Operating ambient temperature range with derating (see fig. 2) | 0 | 60 | |
| $T_S$ | Storage temperature range | –20 | 75 | |

*Table 5: Humidity*

| Test | | Parameters | |
|---|---|---|---|
| Ca | Humidity<br>(no dew condensation) | Relative humidity: | 30...85%<br>Unit operating/storage |
| Ea | Shock | Acceleration:<br>Bump duration:<br>Number of bumps: | 20 g (196 m/s²)<br>11 ms, ±5 ms<br>9 (3 each axis)<br>Unit not operating |
| Fc | Vibration | Frequency:<br>Maximum vibration amplitude:<br>Acceleration:<br>Duration: | 5...55 Hz<br>10 mm (5...10 Hz)<br>2 g (19.6 m/s², 10...55 Hz)<br>3 h (1 h each axis)<br>Unit not operating |

*Table 6: MTBF*

| Ratings at specified Ambient temperature | HK 300<br>40°C | Fan (Life time)<br>25°C | Unit |
|---|---|---|---|
| MTBF | 38'000 | 30'000 | h |

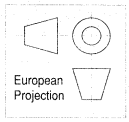
*Table 6: Isolation*

| Test | Input to output | Input to frame | Output to frame |
|---|---|---|---|
| Dielectric strength test [1] | 3000 V AC, 1 minute | 3000 V AC, 1 minute<br>leakage current <10 mA. | – |
| Insulation resistance [1] | >100 MΩ at 500 V DC | – | >100 MΩ at 500 V DC |

[1] At normal temperature and humidity

## Mechanical Data

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated.



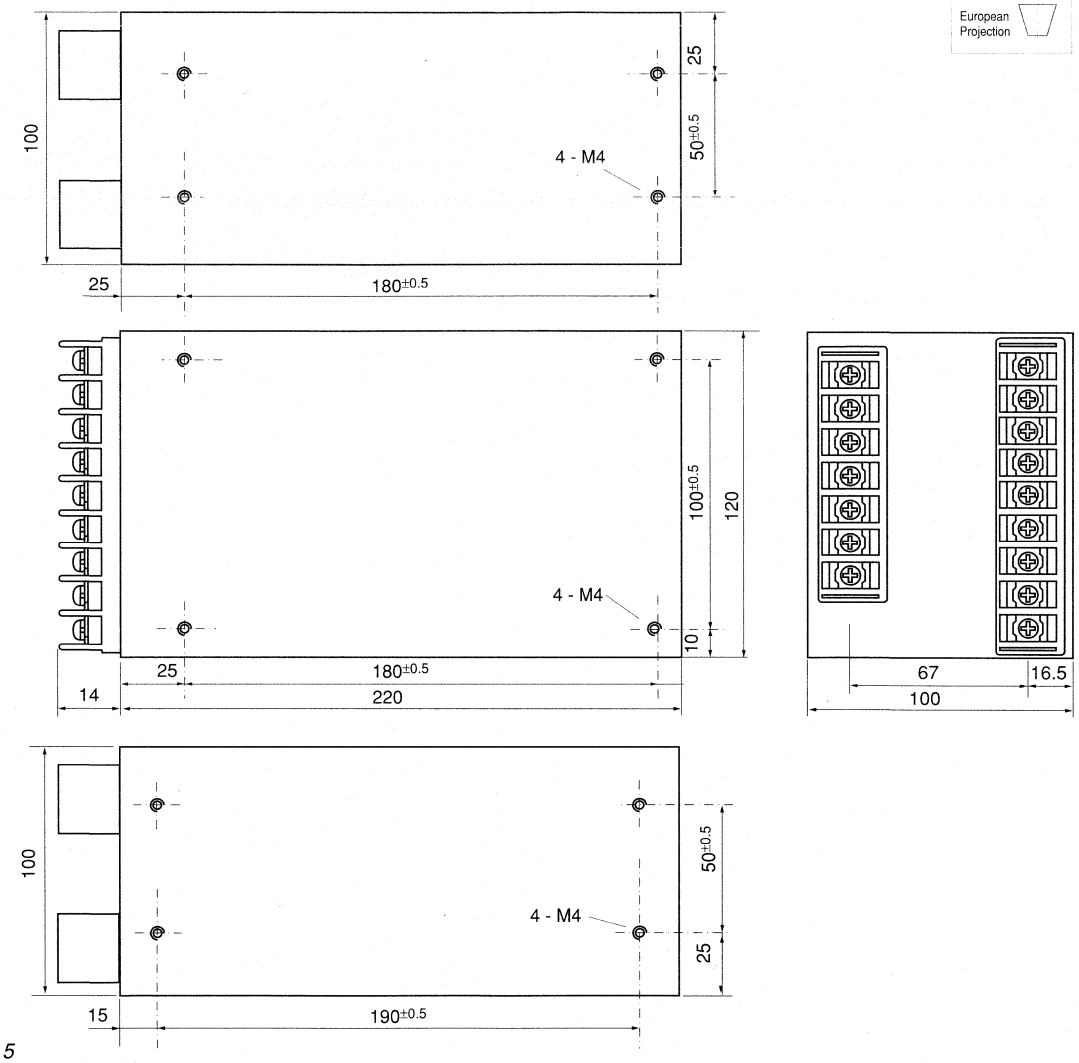




*Fig. 5*
*HK 300, weight 2600 g*

## Type Key and Product Marking

**Type Key**

HK 300 - 12

Family ..... HK
Blank .....
Nominal output power [W] ..... 300
Dash .....
Nominal output voltage [V] ..... 5...48

Example: HK 300-12 = AC-DC converter providing 12 V/25 A, 300 W in a case with terminal strips.

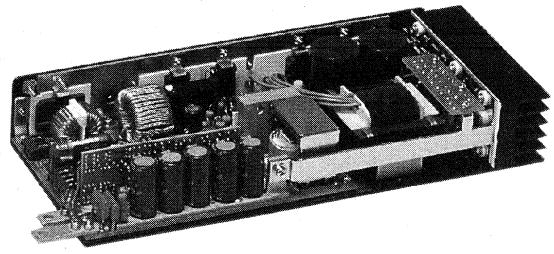
**Produkt Marking**

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.

# 150/300/450 W AC-DC Converters VRW-Family

**Single output**

- Universal AC input
- 3000 $V_{rms}$ input to output isolation
- Compact design
- Excellent line/load regulation
- High efficiency
- Safety standards: UL, CSA, TUV approved



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## Type Survey

*Table 1: Type survey*

| Output configuration $U_{o\,nom}$ V DC | $I_{o\,nom}$ A | Input voltage range $U_{i\,min}$...$U_{i\,max}$ | Rated power $P_{o\,tot}$ $T_A$ = 50 °C | Type designation Open frame | Chassis cover |
|---|---|---|---|---|---|
| 5 | 30 | VRW 150: 85...132 V AC or 170...265 V AC 47...440 Hz | 150 W | VRW 150-5 | VRW 150-5A |
| | 60 | | 300 W | VRW 300-5 | VRW 300-5A |
| | 90 | | 450 W | VRW 450-5 | VRW 450-5A |
| 12 | 13 | | 150 W | VRW 150-12 | VRW 150-12A |
| | 26 | | 300 W | VRW 300-12 | VRW 300-12A |
| | 40 | | 450 W | VRW 450-12 | VRW 450-12A |
| 15 | 10 | 230...330 V DC jumper selectable | 150 W | VRW 150-15 | VRW 150-15A |
| | 21 | | 300 W | VRW 300-15 | VRW 300-15A |
| | 32 | | 450 W | VRW 450-15 | VRW 450-15A |
| 24 | 6.5 | VRW 300/VRW 450: 85...265 V AC 47...63 Hz | 150 W | VRW 150-24 | VRW 150-24A |
| | 13 | | 300 W | VRW 300-24 | VRW 300-24A |
| | 20 | | 450 W | VRW 450-24 | VRW 450-24A |
| 48 | 3.2 | | 150 W | VRW 150-48 | VRW 150-48A |

## Description

The VRW series of switching power supplies is a single output series of AC-DC converters. Compact size and high reliability make the VRW series an excellent choice. Five standard single output ratings are available. All types have sense lines, the VRW 300 and VRW 450 provide also for inhibit function. The units are UL 1950 (D3), CSA 234 und EN 60950 approved.

**Key applications**

Factory automation, test and measurement, piont-of-sales and communications equipment.



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## Electrical Input and Output Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Input data*

| Characteristics | | | VRW 150-.. | VRW 300-.. | VRW 450-.. | Unit |
|---|---|---|---|---|---|---|
| $U_{i\ rated}$ | Rated input voltage | | 100-120/200-240 | 100-120/200-240 | | V AC |
| $U_i$ | Input voltage range | | 85...132/170...265 [1] | 85...265 | | |
| | | | 230...330 [3] | – | | V DC |
| $f_i$ | Line frequency | | 47...440 | 47...63 | | Hz |
| $I_i$ | Input current [2] | 100/200 V AC | 3.2/1.7 | 4.0/2.0 | 6.2/3.1 | A |
| $I_{inr}$ | Inrush current [2] | 100/200 V AC | 15/30 | 14/28 | 14/28 | |
| $I_{i\ leak}$ | Leakage current [2] | 100/200 V AC | 0.25/0.40 | 0.6/0.4 | 0.8/0.4 | mA |

[1] Jumper selectable. [2] At rated input and output. [3] Terminals A and B not connected.

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 3a: Output data 150 W types*

| Type | | | VRW 150-05 | VRW 150-12 | VRW 150-15 | VRW 150-24 | VRW 150-48 | |
|---|---|---|---|---|---|---|---|---|
| Characteristics | | | | | | | | Unit |
| $U_{o\ nom}$ | Output voltage | nom. | 5 | 12 | 15 | 24 | 48 | V |
| $U_{o\ adj}$ | Adjustable voltage range | | ±10 | | | | | % |
| $I_{o\ nom}$ | Rated output current | | 30 | 13 | 10 | 6.5 | 3.2 | A |
| $I_o$ | Output current range | min./max. | 0...100 | | | | | % |
| $u_o$ | Ripple-noise [1] | max. | 120 | 150 | 150 | 150 | 300 | mVpp |
| $\Delta U_{o\ U}$ | Line regulation | $U_{i\ min}...U_{i\ max}$ | ±0.4 | | | | | % |
| $\Delta U_{o\ I}$ | Load regulation | 0...100% | ±0.8 | | | | | |
| $\alpha u_o$ | Temperature coefficient | max. | ±1 | | | | | |
| $I_{o\ L}$ | Overcurrent protection [2] | | 105 | | | | | |
| $U_{o\ L}$ | Overvoltage protection [3] | | 5.75...6.75 | 13.8...16.2 | 17.3...20.3 | 27.6...32.4 | 55.2...64.8 | V |
| $t_{Uo\ r}$ | Rise time [1] | typ. | 20 | | | | | ms |
| $t_h$ | Hold-up time [1] | typ. | 20 | | | | | |
| $\eta$ | Effciency [1] | typ. | 78 | 80 | 82 | 84 | 84 | % |
| | Output indicator | | not provided | | | | | |
| | Outputs connected in series | | possible | | | | | |
| | Outputs connnected in parallel | | not possible | | | | | |

[1] At rated input and output.
[2] Operating in foldback method, automatic recovery. Overload for more than 30 seconds should be avoided.
[3] Shut down of output. Turn-on by brief removal of the input voltage. Overvoltage protection is not adjustable.

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3b: Output data 300 W types*

| Type | | VRW 300-05 | VRW 300-12 | VRW 300-15 | VRW 300-24 | |
|---|---|---|---|---|---|---|
| Characteristics | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage nom. | 5 | 12 | 15 | 24 | V |
| $U_{o\,adj}$ | Adjustable voltage range | ±10 | | | | % |
| $I_{o\,nom}$ | Rated output current | 60 | 26 | 21 | 13 | A |
| $I_o$ | Output current range min./max. | 0...100 | | | | % |
| $u_o$ | Ripple-noise [1] max. | 150 | 180 | 180 | 240 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation $U_{i\,min}...U_{i\,max}$ | ±0.4 | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±0.8 | | | | |
| $\alpha u_o$ | Temperature coefficient max. | ±1 | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105...125 | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.0...7.0 | 14.4...16.8 | 18.0...21.0 | 28.0...32.0 | V |
| $t_{Uo\,r}$ | Rise time [1] typ. | 50 | | | | ms |
| $t_h$ | Hold-up time [1] typ. | 20 | | | | |
| $\eta$ | Effciency [1] typ. | 76 | 78 | 78 | 82 | % |
| | Output indicator | not provided | | | | |
| | Outputs connected in series | possible | | | | |
| | Outputs connnected in parallel | not possible | | | | |

[1] At rated input and output.
[2] Operating in foldback method, automatic recovery. Overload for more than 30 seconds should be avoided.
[3] Shut down of output. Turn-on by brief removal of the input voltage. Overvoltage protection is not adjustable.

General Condition: $T_A$ = 25 °C unless otherwise specified

*Table 3c: Output data 450 W types*

| Type | | VRW 450-05 | VRW 450-12 | VRW 450-15 | VRW 450-24 | |
|---|---|---|---|---|---|---|
| Characteristics | | | | | | Unit |
| $U_{o\,nom}$ | Output voltage nom. | 5 | 12 | 15 | 24 | V |
| $U_{o\,adj}$ | Adjustable voltage range | ±10 | | | | % |
| $I_{o\,nom}$ | Rated output current | 90 | 40 | 32 | 20 | A |
| $I_o$ | Output current range min./max. | 0...100 | | | | % |
| $u_o$ | Ripple-noise [1] max. | 120 | 150 | 150 | 150 | mVpp |
| $\Delta U_{o\,U}$ | Line regulation $U_{i\,min}...U_{i\,max}$ | ±0.4 | | | | % |
| $\Delta U_{o\,I}$ | Load regulation 0...100% | ±0.8 | | | | |
| $\alpha u_o$ | Temperature coefficient max. | ±1 | | | | |
| $I_{o\,L}$ | Overcurrent protection [2] | 105...125 | | | | |
| $U_{o\,L}$ | Overvoltage protection [3] | 6.0...7.0 | 14.4...16.8 | 18.0...21.0 | 28.0...32.0 | V |
| $t_{Uo\,r}$ | Rise time [1] typ. | 50 | | | | ms |
| $t_h$ | Hold-up time [1] typ. | 20 | | | | |
| $\eta$ | Effciency [1] typ. | 76 | 78 | 78 | 82 | % |
| | Output indicator | not provided | | | | |
| | Outputs connected in series | possible | | | | |
| | Outputs connnected in parallel | not possible | | | | |

[1] At rated input and output.
[2] Operating in foldback method, automatic recovery. Overload for more than 30 seconds should be avoided.
[3] Shut down of output. Turn-on by brief removal of the input voltage. Overvoltage protection is not adjustable.

## Operation Instructions

### VRW 150: AC Input Voltage Range Selection

The AC input voltage range can be selected by means of wiring or a relay contact on the connector barrier as per the following table:

*Table 4: Input voltage range selection*

| Input voltage range | Terminals A and B |
|---|---|
| 85...132 V AC | interconnected |
| 170...265 V AC<br>230...330 V DC | open<br>(not connected) |

### Output Power Rating

The relation between the rated output power $P_o$ and the ambient temperature $T_A$ is shown in fig. 1.

### Output Voltage Adjustment

The output voltage may be adjusted within ±10% of $U_{o\,nom}$ by means of the internal potentiometer. If the output voltage setting should be excessively high, the overvoltage protection circuit may shut-down the output.

### Output Overvoltage Protection

If the built-in overvoltage protection circuit becomes active, the output is shut down and a reset can only be achieved by brief removal of the input voltage after a minimum interval time. The overvoltage threshold level is not adjustable.

### Output Overload Protection

An overload condition at the output should not last for more than 30 seconds. After removal of the overload, the overload protection circuit will automatically recover.

### Sense Lines (S, VRW 300 and VRW 450 series)

Remote sensing provides compensation of voltage drops between power supply and load, caused by connectors and load feeding wires. The sense lines should consist of shielded cables or be twisted. If remote sensing is not reqiured, the +S should be connected to the +V and the –S to the –V terminals respectively applying shortest possible links. The compensation range is 20% of $U_{o\,nom}$.

### Outputs Connected in Series

Two or more units supplying the same or different output voltages may be connected in series. The value of the maximum output current to be taken is defined by that unit providing the lowest current limiting value. It should be assured that the outputs do not feed backwards into each other caused by their different rise/fall times at switch-on/off cycles by adding reverse polarity diodes across each output.

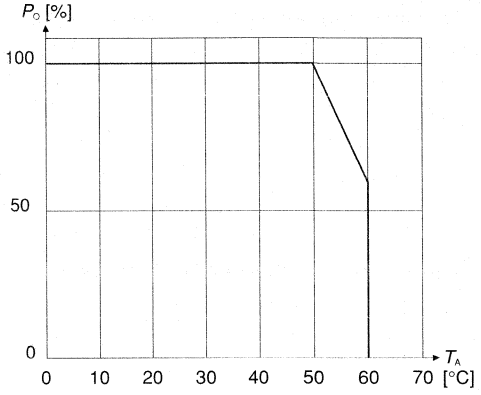



*Fig. 1:*
*Output power vs. ambient temperature*

### Outputs Connected in Parallel

Parallel connection of several identical modules is not possible.

### Inhibit (i, VRW 300 and VRW 450 series)

The output may be enabled or disabled by means of a logic signal (TTL, CMOS etc.) or a mechanical contact applied to the inhibit input which is isolated from input and output by means of an opto-coupler. This provides independency from other voltages polarity. If the inhibit function is not required, connect the inhibit input i (pins 3/4) to return pin G1 (pins 1/2) to enable the output (active low logic, fail safe).

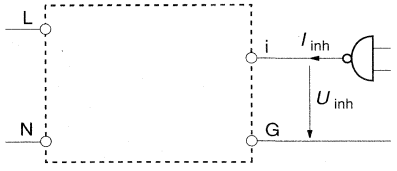



*Fig. 2*
*Definition of inhibit voltage and current*

*Table 5: Inhibit characteristics*

| Characteristic | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $U_{inh}$ | Inhibit voltage | $U_o$ = on | $U_{i\,min}...U_{i\,max}$ | –0.7 | | 0.8 | V |
| | | $U_o$ = off | | 2.0 | | 7 | |
| $I_{inh}$ | Inhibit sink curr. | | $U_{inh}$ = 0 | | 3.5 | | mA |

## Immunity to Environmental Conditions

*Table 6: Temperature*

| Characterisitcs | | Conditions | min | max | Unit |
|---|---|---|---|---|---|
| $T_A$ | Ambient temperature | $U_{i\,min}...U_{i\,max}$ | 0 | 50 | °C |
| $T_C$ | Case temperature | $I_o$ = 0...$I_{o\,nom}$ | 0 | 60 | |
| $T_S$ | Storage temperature | (Not operational) | –20 | 75 | |

*Table 7: Mechanical Stress*

| Test Method | Test conditions | | Status |
|---|---|---|---|
| Damp heat<br>steady state | Temperature:<br>Relative himidity: | 40 $^{\pm 2}$ °C<br>30...90 $^{-3/+2}$ % | Operating |
| Shock (half-sinusoidal) | Acceleration amplitude: | 20 $g_n$ = 196 m/s$^2$ | Operating |
| Vibration (sinusoidal) | Frequency (1 Oct/min):<br>Maximum vibration amplitude:<br>Acceleration amplitude:<br>Test duration: | 10...55 Hz<br>0.83 mm (55 Hz)<br>2 $g_n$ = 19.6 m/s$^2$<br>3 h (1 h each axis) | Operating |

*Table 8: MTBF Values*

| MTBF | Ground Benign |
|---|---|
| MTBF according to MIL-HDBK-217D | $T_C$ = 40°C |
| VRW 150 types | 121'850 h |
| VRW 300 | 60'350 h |
| VRW 450 types | 52'400 h |

*Table 9: Isolation*

| Test | Input to output | Input to case | Output to case | Unit |
|---|---|---|---|---|
| Electric strenght test voltage (1 min) | 3000 | 2000 | 500 | V AC |
| Isolation resistance (500 V DC) | >100 | >100 | >100 | MΩ |

*Table 10: Electromagnetic Emmission*

| Standard | Maintained level |
|---|---|
| FCC | VRW 150 types: <A |

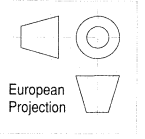
*Table 10: Safety Approvals*

| Safety Approvals | UL 1950 | CSA 234 | TÜV [1] |
|---|---|---|---|
| VRW 150 | x | x | x |
| VRW 300/VRW 450 | x | x | x |

[1] EN 60 950

## Mechanical Data, Input and Output Terminals

Dimensions in mm. Tolerances ±1 mm unless otherwise indicated



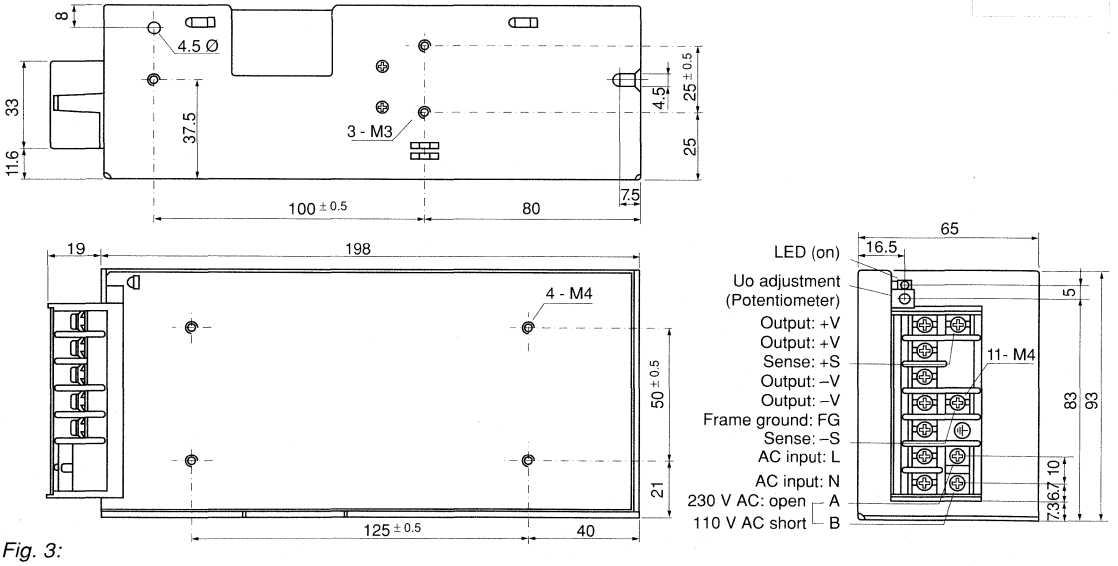




*Fig. 3:*
*VRW 150, weight 890 g*

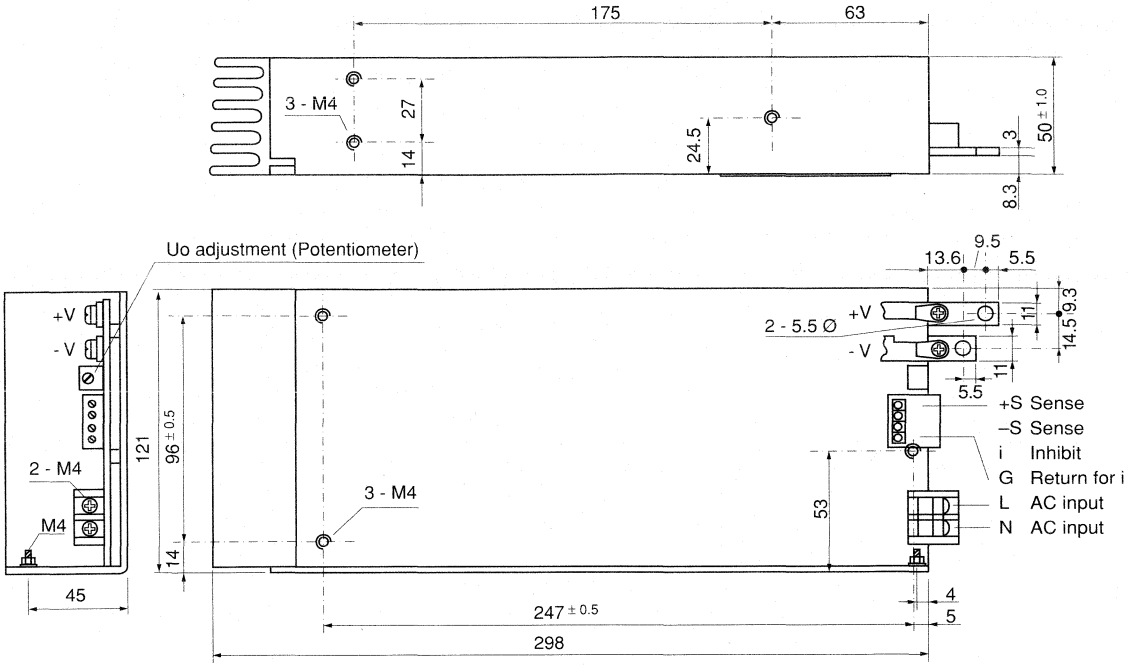



*Fig. 4:*
*VRW 300, weight 2200 g, with cover 2450 g*

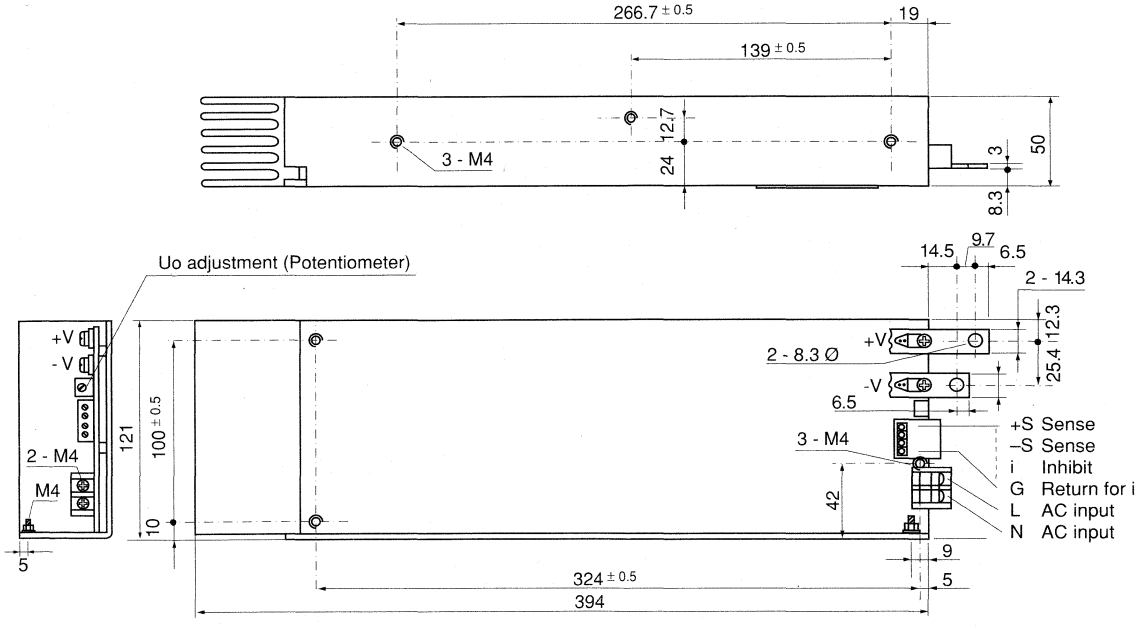
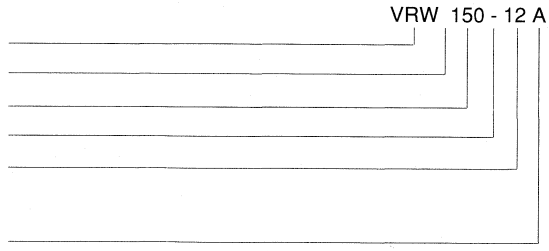



*Fig. 5:*
*VRW 450, weight 2800 g, with cover 3060 g*

## Type Key and Product Marking

**Type Key**

Family ..... VRW
Blank .....
Nominal output power [W] ..... 150, 300, 450
Dash .....
Nominal output voltage [V] ..... 5...48
Structure and connectors:
– Open frame .....
– With chassis cover ..... A




Example: VRW 450-12A = AC-DC converter providing 12 V/40 A, 480 W output, open frame with chassis cover

**Produkt Marking**

Label: Type designation, applicable safety approvals and recognition marks, specific type designation, input voltage range, nominal output voltage and current and pin allocation.




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# 11 Accessories

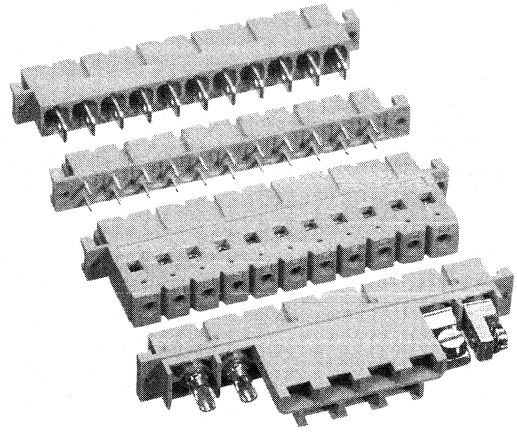

| Topic | Page |
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| Filter and Ring Core Chokes | 11 - 13 |
| Mounting Supports for Chassis-, DIN-Rail- and PCB Mounting | 11 - 18 |
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# Mating Connectors H11/H15/H15 S4

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## Description

All Melcher 19" cassette type converters are equipped with either H11-, H15- or H15 S4 male connectors. Mating female connectors are available as accessories according to the following tables. The three H-type connector versions are specially designed for power supply applications, capable of handling high operating currents. The connectors have an integrated code key system allowing many coding possibilities. Modules with high output current normally use two contacts in parallel to keep the voltage drop across the connector as low as possible.

## H11 Connector

This connector has eleven contacts in one vertical column marked 2 to 32. Mating- and mounting conditions are according to DIN 41612. The connector contacts are hard-silver-plated and correspond to quality class 1, with respect to electrical and mechanical life time.

*Table 1: H11 Connector Survey*

| Female Connector Part No. | Description of Terminals | Integrated Coding |
|---|---|---|
| STV-H11-F/CO | Faston straight 6.3 × 0.8 mm | yes |
| STV-H11-FS/CO | Faston straight 6.3 × 0.8 mm, solderable | yes |
| STV-H11-FSR/CO | Screw terminals, 90°, 2.5 mm² (AWG 13) max, | yes |
| STV-H11-FB/CO [1] | Solder pin 5.2 mm, ∅ 1.6 mm | yes |
| STV-H11-FBER/CO | Solder pin 4.3 mm, ∅ 1.0 mm | yes |
| STV-H11-FP/CO [2] | Press fit 6.5 mm, ∅ 1.0 mm | yes |
| STV-H11-FBG/CO [2] | Solder pin 5.2 mm, ∅ 1.6 mm, gold-plated contacts | yes |

[1] Also matching Flexi-PCB for PCB mounting of converters (see Mounting Supports)
[2] Available on request

This connector is used in the following converter families (case size):

H (H02), M (M02), SR (L01) and PSL (L04).

**Mechanical Dimensions**

All dimensions in mm, tolerances ±0.2 mm unless otherwise specified

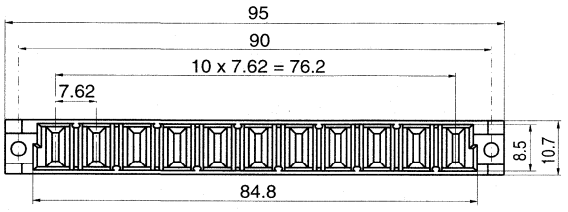



*Fig. 1*
*H11 frontal view, relating to figures 2 to 5*

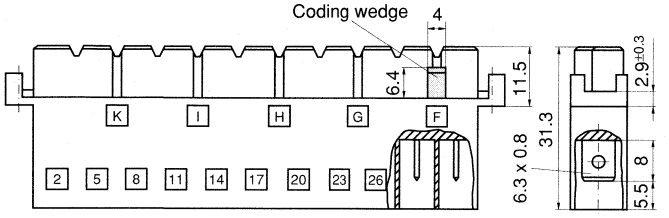



*Fig. 2*
*STV-H11-F/CO,*
*Faston cable terminals 6.3 × 0.8 mm*

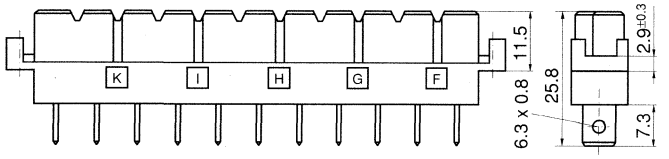



*Fig. 3*
*STV-H11-FS/CO,*
*Faston cable terminals 6.3 × 0.8 mm,*
*solderable (short moulding)*

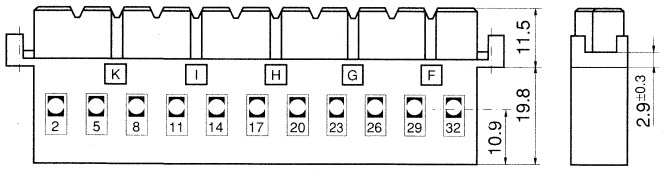



*Fig. 4*
*STV-H11-FSR/CO,*
*screw terminals (max. 2.6 mm²/AWG 13)*

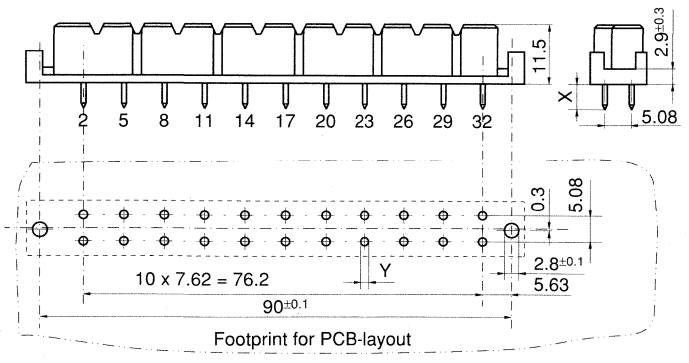



*Fig. 5*

| | | |
|---|---|---|
| *STV-H11-FB/CO,* | | |
| *soldering pins* | *X = 5.2* | *Y = Ø 1.6* |
| *STV-H11-FBG/CO,* | | |
| *soldering pins* | *X = 5.2* | *Y = Ø 1.6* |
| *STV-H11-FBER/CO,* | | |
| *soldering pins* | *X = 4.3* | *Y = Ø 1.0* |
| *STV-H11-FP/CO,* | | |
| *press insert pins* | *X = 6.5* | *Y = Ø 1.0* |



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## H15 Connector

This connector has fifteen contacts in two vertical columns marked 4 to 32 and is designed to meet DIN 41612. The connector contacts are hardsilver-plated and correspond to quality class 1, with respect to electrical and mechanical life time.

This connector is used in the following converter families (case size):

PSS (S01), S (S02), Q (Q01) and for PSK (K01) and K (K02) only for output current ≤18 A.

*Table 2: H15 Connector Survey*

| Female Connector Part No. | Description of Terminals | Integrated Coding |
|---|---|---|
| STV-H15-F/CO | Faston straight 6.3 × 0.8 mm | yes |
| STV-H15-FSR | Screw terminals, 90°, 2.5 mm² (AWG 13) max. | no |
| STV-H15-FB/CO | Solder pin 4.0 mm, ∅ 1.6 mm | yes |
| STV-H15-FP/CO [1] | Press fit 6.5 mm, ∅ 1.0 mm | yes |
| STV-H15-FBG/CO [1] | Solder pin 4.0 mm, ∅ 1.6 mm, gold-plated contacts | yes |

[1] Available on request

### Mechanical Dimensions

All dimensions in mm, tolerances ±0.2 mm unless otherwise specified

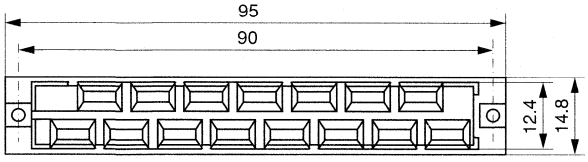



*Fig. 6*
*H15 frontal view,*
*relating to figures 7 and 8*

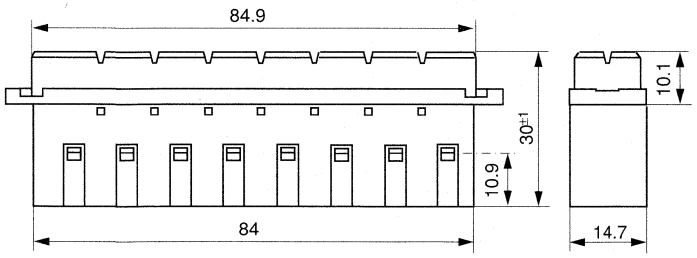
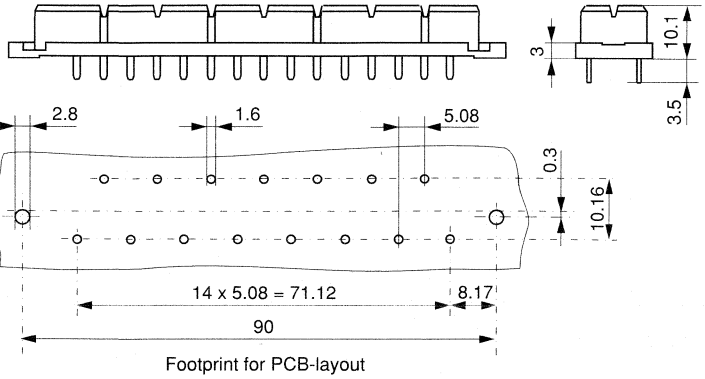



*Fig. 7*
*STV-H15-FSR,*
*Screw terminals, no coding*
*STV-H15-F/CO,*
*Faston cable terminals 6.3 × 0.8 mm*
*(identical dimensions, not shown)*




Footprint for PCB-layout

*Fig. 8*
*STV-H15-FB/CO,*
*soldering pins*

11

## H15 S4 Connector

This special connector is a derivative of the H15, having seven standard contacts as above combined with four High Current Contacts according to DIN 41626. The high current contacts are specially designed to handle currents from 20 A up to 50 A. They correspond to quality class 1, with respect to electrical and mechanical life time. The socket contact material is high quality Beryllium-Copper (CuBe treated) with a gold-plated surface.

To install the high current contacts carefully follow the assembly instructions. It is extremely important to solder cables, screw cable terminals or heat shrink sleeves to high current jacks first, before inserting them into the moulding. Paralleled converters should preferably be interconnected on current bars or at a star point.

Using screw versions, the two outer high current jacks may be inserted at a 90° angle in order to prevent, possible short circuits between the cable terminals, especially in applications with high vibration environment. Heat shrink sleeves might be necessary for further isolation purposes or to keep clearance and creepage distances at specified levels.

An Extraction Tool allows removal of the high current contacts for replacement (see Extraction Tool).

**Caution:** The use of an adequate cable strain relief device (e.g. Cable Hood etc.) is essential in order to protect the high current contact jacks from damage. Never screw, solder or manipulate S4-contacts when the connector is plugged into the male connector!

This connector is used in the following converter families (case size):

PSK (K01) and K (K02) with output current ≥20 A.

*Table 3: H15 S4 Connector Survey*

| Female Connector Part No. | Description of Terminals | Integrated Coding |
|---|---|---|
| STV-H15 S4-F/CO | 7 Faston straight 6.3 × 0.8 mm, set of 4 solder jacks [1] | yes |
| STV-H15 S4-FSF/CO | 7 Faston straight 6.3 × 0.8 mm, set of 4 screw jacks [1] | yes |
| STV-H15 S4-FLS/CO | 7 screw terminals, 90°, 2.5 mm², set of 4 solder jacks [1] | yes |
| STV-H15 S4-FSR/CO | 7 screw terminals, 90°, 2.5 mm², set of 4 screw jacks [1] | yes |

[1] Spare set of high current jacks available on request

**Delivery content:** H15 S4-moulding, four high current jacks and assembly instructions. Screw versions also include four M4 screws with washers and heat shrink sleeve.

### Mechanical Dimensions

All dimensions in mm, tolerances ±0.2 mm unless otherwise specified

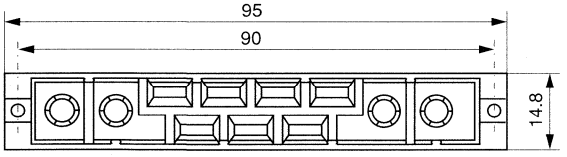



*Fig. 9*
*H15 S4 frontal view, relating to figures 10 and 11*

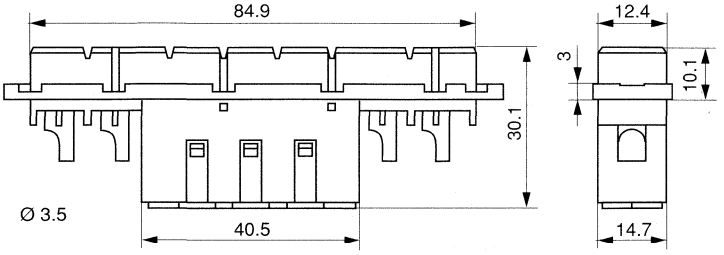



*Fig. 10*
*STV-H15 S4-FLS/CO, screw terminals and four high current soldering terminals*

*STV-H15 S4-FSR/CO, screw terminals and four high current screw terminals (not shown)*

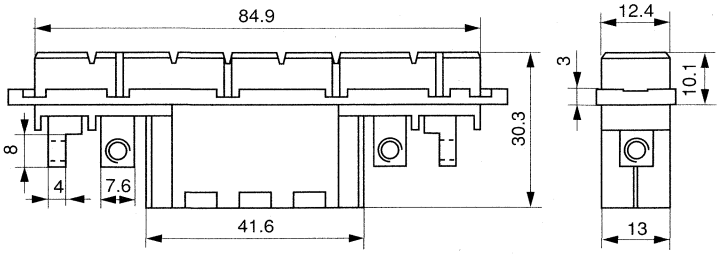



*Fig. 11*
*STV-H15 S4-FSF/CO, Faston cable terminals and four high current screw terminals*

*STV-H15 S4-F/CO Faston cable terminals and four high current soldering terminals (not shown)*


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## Technical Data

*Table 4: Connector data*

| Type | H11 | H15 | H15 S4 Standard | H15 S4 High current |
|---|---|---|---|---|
| **Mechanical data** | | | | |
| Number of poles | 11 | 15 | 7 | 4 |
| Mating cycles | 500 | 500 | 500 | 500 |
| Insertion/withdrawal forces max. | 80 N | 90 N | 90 N | 10/1.6 N |
| **Electrical data** | | | | |
| Clearance distance contact/ground | ≥4.5 mm | ≥4.5 mm | ≥4.5 mm | |
| Creepage distance contact/contact | ≥8.0 mm | ≥8.0 mm | ≥8.0 mm | |
| Test voltage Vrms | 3100 | 3100 | 3100 | |
| Operation voltage V AC | 500 | 500 | 500 | |
| Operation current per contact $T_A$ 20°C<br>$T_A$ 70°C<br>$T_A$ 95°C | 20 A<br>17 A<br>14 A | 15 A<br>12 A<br>9 A | 15 A<br>12 A<br>9 A | 40 A<br>35 A<br>25 A |
| Contact resistance | ≤8 mΩ | ≤8 mΩ | ≤8 mΩ | ≤1 mΩ |
| Isolation resistance at 100 V DC | $\geq 10^{12}$ Ω | $\geq 10^{12}$ Ω | $\geq 10^{12}$ Ω | |
| **Miscellaneous data** | | | | |
| Operating temperature | –55...125°C | –55...125°C | –55...125°C | |
| Contact surface | 6 µm Ag | 6 µm Ag | 6 µm Ag | 1.3 µm Au |
| Moulding material | PBTP/PC | PBTP/PC | PBTP | |
| Flammability | UL 94V-0/UL 94 V-1 | UL 94 V-0/UL 94 V-1 | UL 94 V-0 | |
| Approvals | | | | |

## Code Key System

An efficient coding system is of great importance and cannot be valued highly enough in complex electronic systems. Since power supplies handle high currents and voltages any false connection could not only be extremely dangerous but also quite costly.

This integrated polarizing system allows effortless coding by the simple insertion of Coding Wedges into the female connector mouldings. The corresponding counter-parts, i.e. the coding tabs of the male moulding just have to be broken off to match the right female part. Major advantages are high mechanical stability and ease of handling. The H11 connectors have 10 and the H15 connectors have 8 coding positions. Using 4 coding wedges, this results in 210 (H11) respectively 70 (H15) different coding possibilities. Coding wedges are available as accessories to female connectors with the following part number:

**Part No.:** Coding Wedge (Codierkeil)
**Delivery content:** 5 pcs.

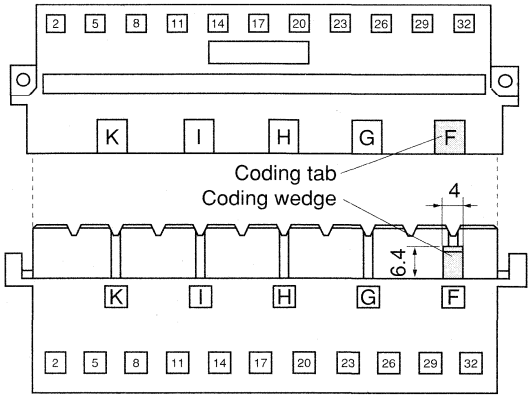



*Fig. 12*
*Integrated code key system*

## Extraction Tool for High Current Contacts

High current plugs and jacks can be disassembled from the moulding by means of a special Extraction Tool (H15 S4). Holding the extraction tool ower the centre of the connector's female contact the outer part of the extraction tool should be fed into the moulding outside the female contact itself. This allows release of the spring clip fixing the contacts, in order to pull the contacts out of their moulding for replacement. If the operation is performed correctly very little force is required, Extreme care should be taken since incorrect procedure and excessive force could damage the tool and/or connector.

This tool is available as an accessory for both types, screw- or solder version of high current contacts.

**Note:** In order to avoid damage never manipulate high current contacts when plugged-in!

**Part No.:** Extraction Tool

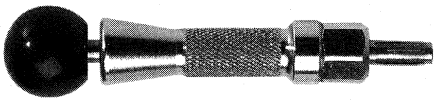


*Fig. 13*
*Extraction tool*

## Connector Retention Clip

The retention clip V is an accessory for field assembly into regulator back plates. They guarantee secure connection even under severe vibration, as for example in mobile applications. One connector retention system for almost all units and all the forementioned connector types.

The following converter families are delivered with prepunched holes in back plates for the field- mounting of retention clips:

H, M, K, PSK, S and PSS (Q family only in combination with Mounting Plate Q, see Mounting Supports)

**Part No.:** Retention Clips (V)

**Delivery content:** 2 pcs.

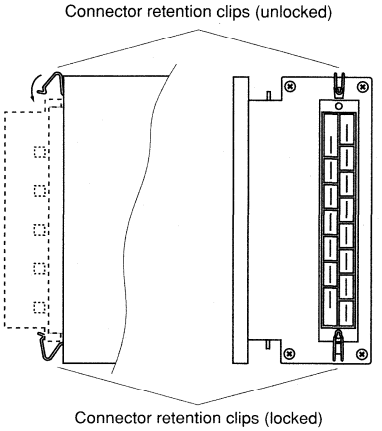



*Fig. 14*
*Connector retention clip*

## Cable Hood

A kind of cable connector housing or Cable Hood is available for all female H15- and H15 S4 type connectors. It serves as a strain relief, isolates connections and protects cables.

In order to use a cable hood together with retention clips, both sides of the hood have to be slightly modified by removing a small plastic piece in order to allow insertion of the clips. The hood with retention clips has been tested to withstand vibrations according to IEC 86-2-6: 5 g, 6 directions, 2.5 hours per axis.

**Part No.:** KSG-H15/H15S4

**Delivery content:** Housing shell, cable duct with covers, cable clip, cable boot and screws

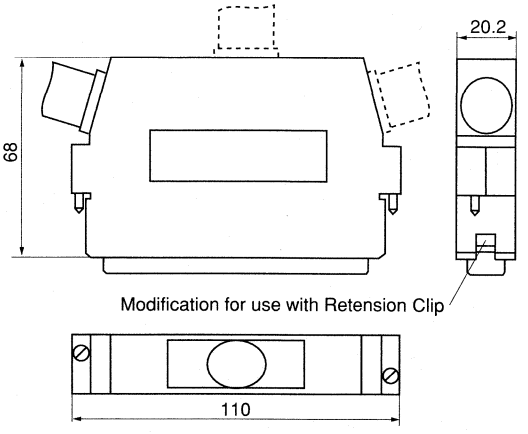



*Fig. 15*
*Cable hood for H15 and H15 S4 connectors*

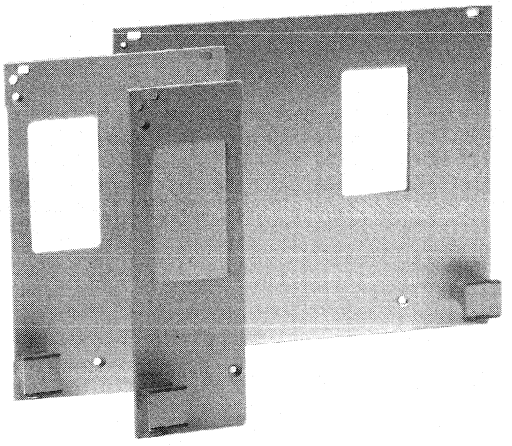

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# Front Panels for Melcher Power Supplies

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## Description

Front panels are available for 19" rack mounting of 3 U cassette type power supplies in *"Schroff"* system version (*"Intermas"* on request) and may be attached to the converter by means of countersunk screws.

An assembly kit, consisting of a front panel and a support bracket, enables arrangement of two standard cassettes with up to six output voltages in 6 U configuration.

All front panels are of colourless anodised aluminium and delivered with one or two grey plastic handles of 3 TE for easy pull-out and two or four hand-press insertable plastic retainers with captive screws for fixing to the rack.

**Note:** Front panel mounting or custom specific front panels are available on request.

Dimensions in accordance to DIN 41494-1 (IEC 297):
Height: 1 U = 44.45 mm (1.750 in)
Width: 1 TE = 5.08 mm (0.20 in)
Tolerances ±0.2 mm, unless otherwise specified

## Schroff System for 3 U Rack

### Q-Family Front Panels in 4, 5 or 6 TE

This front panel in three versions fits to all 100 Watt DC-DC converters of the 24...48Q and B...DQ Family with case size Q01.

*Table 1: Q01 case front panel selection*

| X | | Case size | Converter family | Part No. |
|---|---|---|---|---|
| TE | mm | | | |
| 4 | 20.0 | Q01 | Q | G04-Q01 |
| 5 | 25.1 | Q01 | Q | G05-Q01 |
| 6 | 30.2 | Q01 | Q | G06-Q01 |

**Note:** For use of several Q-units next to each other, do not pack them too densely in order to assure good thermal management (see also Q-data sheet)

Delivery contents:
Front panel, grey plastic handle, three countersunk screws, set of two plastic retainers with captive screws and assembly instructions.

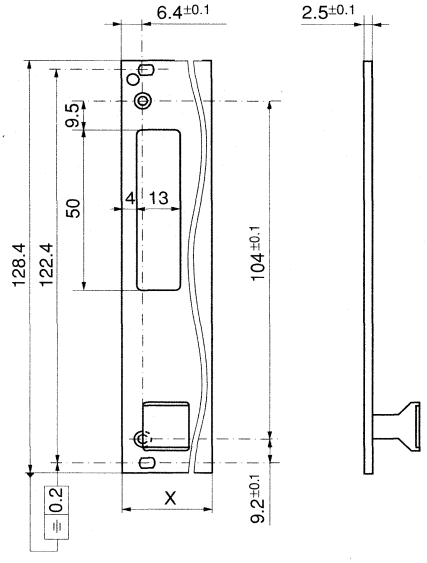



*Fig. 1*
*Front panel for Q01 case size*

### H- and M-Family Front Panel in 8 TE

This front panel fits to all 50 Watt DC-DC and AC-DC converters of the 12...230H-Family with case size H02 as well as to all AM...LM- and CMZ...LMZ-Family versions with case size M02.

*Table 2: H and M case front panel selection*

| X TE | X mm | Case size | Converter family | Part No. |
|---|---|---|---|---|
| 8 | 40.3 | M02 | M | G08-M02 |
| 8 | 40.3 | H02 | H | G08-M02 |

**Note:** Front panels for the superseded M-Mk I version are available on request.

Delivery contents:
Front panel with grey plastic handle, two countersunk screws, set of two plastic retainers with captive screws and assembly instructions

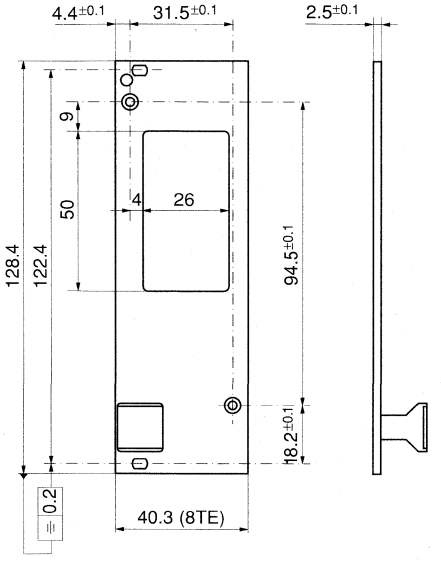



*Fig. 2*
*Front panel for H02 and M02 case size*

### PSL- and SR 20E-Family Front Panel in 8 TE

This front panel fits to all Switching Regulators of the PSL-Family with case size L04 and to all 20 Watt DC-DC and AC-DC converters of the B...LSR-Family with case size L01.

*Table 3: L case front panel selection*

| X TE | X mm | Case size | Converter family | Part No. |
|---|---|---|---|---|
| 8 | 40.3 | L04 | PSL | G08-L [1] |
| 8 | 40.3 | L01 | SR20E | G08-L |

[1] Exception: PSL with option D is Part no. G08-L04-D

**Note:** This front panel is a compatible replacement for all earlier versions of the same size, published in a previous front panel data sheet.

Delivery contents:
Front panel with grey plastic handle, two countersunk screws, set of two plastic retainers with captive screws and assembly instructions.

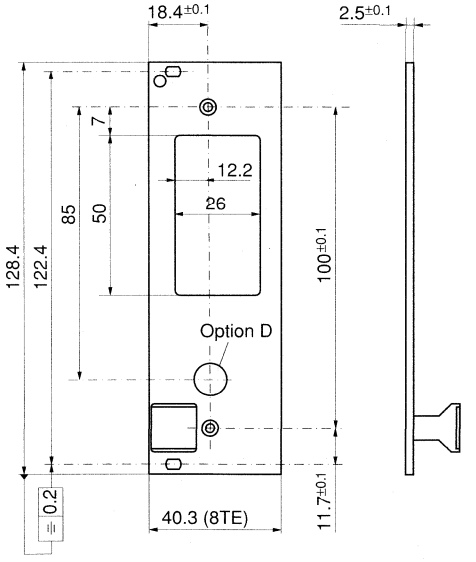



*Fig. 3*
*Front panel for L01 and L04 case size*


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**PSS- and S-Family Front Panels in 12 TE**
**PSK- and K-Family Front Panels in 16 TE**

This front panel fits to all Switching Regulators of the PSS- and PSK-Family with case size S01 or K01 as well as to all 100...150 Watt DC-DC and AC-DC converters of the A...LS- and A...LK-Family with case size S02 or K02 according to following selection table:

*Table 4: S and K case front panel selection*

| X TE | X mm | Case size | Converter family | Part No. |
|---|---|---|---|---|
| 12 | 60.6 | S01<br>S02 | PSS<br>S | G12-S |
| 16 | 81.0 | K01<br>K02 | PSK<br>K | G16-K |

Delivery contents:
Front panel with grey plastic handle, two countersunk screws, set of four plastic retainers with captive screws and assembly instructions.

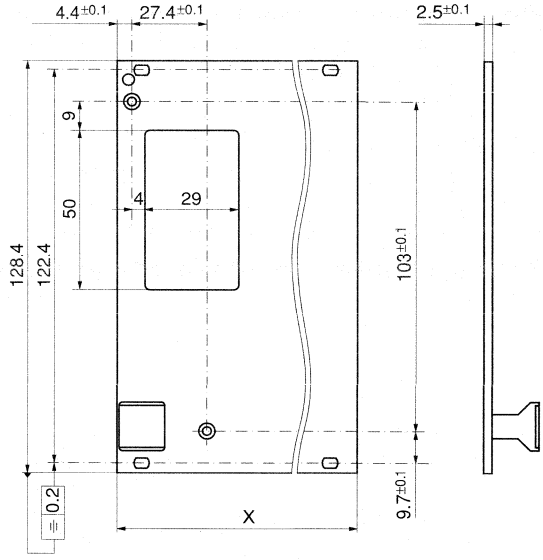



*Fig. 4*
*Front panel for S01, S02, K01 and K02 case size*

**T-Family Front Panel in 28 and 25 TE**

This front panel fits to all 500 Watt AC-DC converters of the LT-Family with case size T01.

*Table 5: T case front panel selection*

| X TE | X mm | Case size | Converter family | Part No. |
|---|---|---|---|---|
| 28 | 141.9 | T01 | T | G28-T01 |
| 26 | 131.7 | T01, option B1 | | G26-T01 |

Delivery contents:
Front panel with two grey plastic handles, three countersunk screws, set of four plastic retainers with captive screws and assembly instructions.

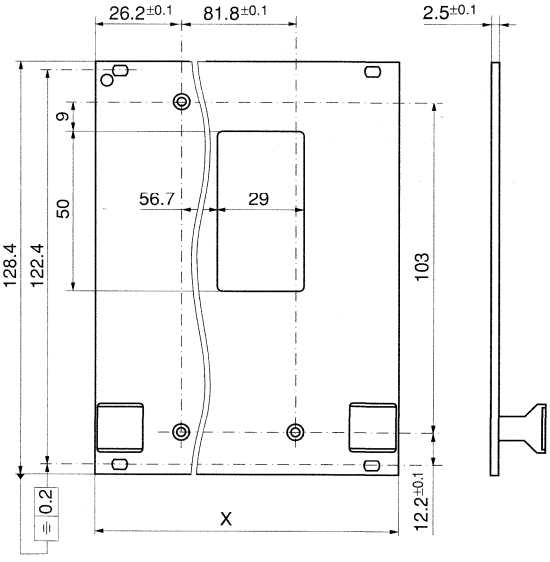



*Fig. 5*
*Front panel for T01 case size*

## Intermas System for 3 U Rack

The major differences between the Intermas and the Schroff system front panels are the thickness (2 mm instead of 2.5 mm), the hole size for the plastic retainers and a small cut-out on each side (see figure 6). All other dimensions are given in the relevant Schroff front panel drawings.

The following Intermas front panels are available on request:

*Table 6: Intermas front panel selection*

| X TE | X mm | Case size | Converter family | Part No. |
|---|---|---|---|---|
| 8 | 40.3 | H02, M02 | H, M | F08-M02 |
| 8 | 40.3 | L01, L04 | PSL, SR20E | F08-L |
| 12 | 60.6 | S01, S02 | PSS, S | F12-S |
| 16 | 81.0 | K01, K02 | PSK, K | F16-K |

Delivery contents:
Front panel with grey plastic handle, two countersunk screws and assembly instructions.

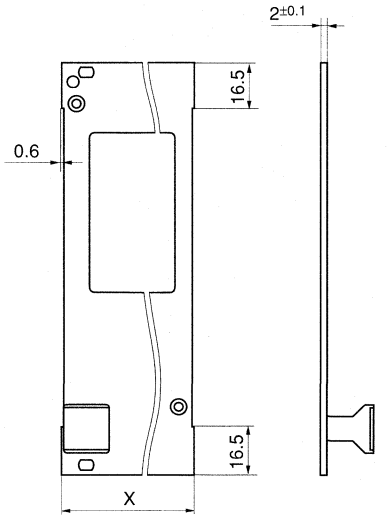



*Fig. 6*
*Intermas system front panel (various case sizes)*

## Schroff System Kit for 6 U Rack

To configure Melcher Power Supplies for use in 6 U racks a special assembly kit has been created consisting of a double front panel together with a support bracket for two converters as shown in figure 7.

All other dimensions are given in the relevant 3 U front panel drawings according to their case size. The assembly kit is available with its part number according to the following table:

*Table 7: 6 U assembly kit selection*

| X TE | X mm | Case size | Converter family | Part No. |
|---|---|---|---|---|
| 5 | 25.1 | Q01 | Q | Kit-G05-6HE-Q01 |
| 8 | 40.3 | H02, M02 | H, M | Kit-G08-6HE-M02 |
| 12 | 60.6 | S01, S02 | PSS, S | Kit-G12-6HE-S |
| 16 | 81.0 | K01, K02 | PSK, K | Kit-G16-6HE-K |

Delivery contents:
Double front panel with two grey plastic handles, four countersunk screws, set of two plastic retainers with captive screws, a support bracket and assembly instructions.

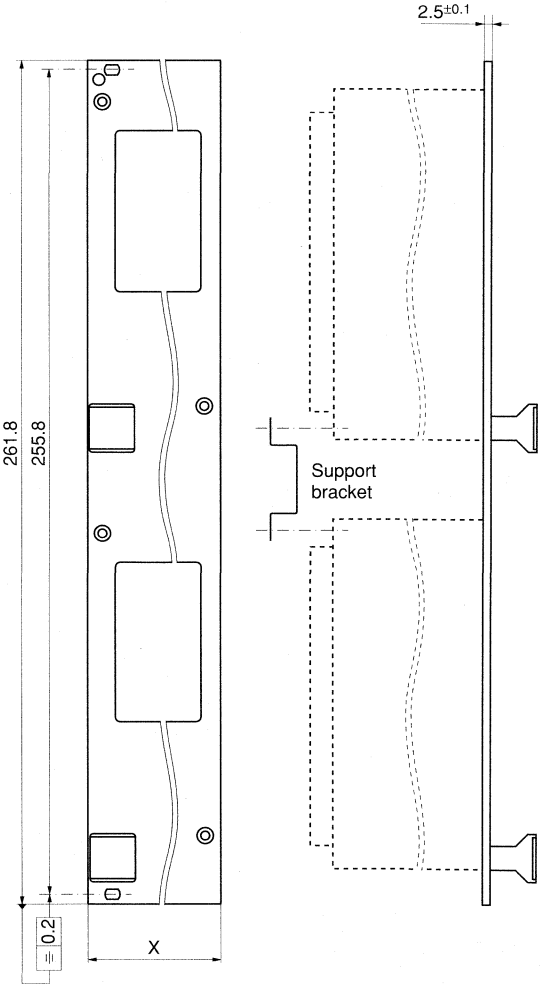



*Fig. 7*
*Front panel for 6 U configuration (various case sizes)*


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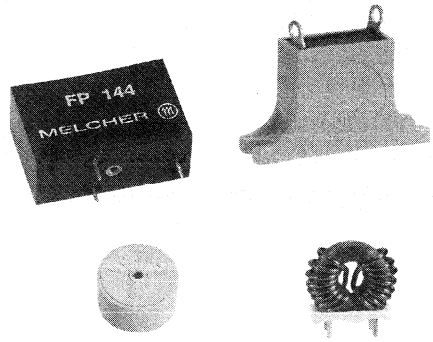
# Filters and Ring Core Chokes

# FN/FP/L/LP-Series

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## Description

Filters and chokes are designed to reduce input interference and/or output ripple voltages occurring in applications with switched mode power supplies. Since all filters contain a Moly Permalloy Powder (MPP) ring core they feature very low DC losses as well as high DC magnetisation and operate perfectly at the input and/or output of switching regulators ensuring effective filtering even at elevated DC current levels. These special characteristics allow the chokes to be operated (unlike ferrite core chokes where inductance rapidly decreases above a certain DC magnetising level) at direct currents which considerably exceed the rated current, by accepting a corresponding gradual loss of inductance.

In applications where switching regulators have long supply lines, filters and chokes are used in order to prevent oscillations caused by their negative input impedance. For further information refer also to switching regulator data "Option L", and to section "Application Notes, Supplementary Data for Switching Regulators".

## Filter Blocks FN/FP Types

The filter blocks contain, apart from the MPP ring core, a capacitor and an attenuation resistor, capable of handling the high ripple currents seen at the input of switching regulators. This forms an entire external filter system optimised to prevent oscillations and to reduce superimposed interference voltages and currents, specially designed for use in PCB applications together with switching regulators in A01 case sizes. For selection of filters refer to the following table:

*Table 1a: Type survey of FP filter blocks*

| Filter Type | Matching Switching Regulator Type |
|---|---|
| FP 38 | PSR 54<br>PSA 55<br>PSA 5A2<br>PSA 5A5<br>PSA 123<br>PSA 153 |
| FP 80 | PSR 53<br>PSR 122.5<br>PSR 152.5<br>PSR 242<br>PSR 362<br>PSA 242.5 |
| FP 144 | PSA 121.5<br>PSA 151.5<br>PSA 241.5<br>PSA 361<br>PSA 481 |

*Table 1b: Type survey of FN filter blocks*

| Filter Type | Matching Switching Regulator Type |
|---|---|
| FN 38 | NSR 54<br>NSA 55 |
| FN 80 | NSR 53<br>NSR 122.5<br>NSR 152.5<br>NSR 242<br>NSR 362 |

*Table 1c: Type survey ring core chokes*

| Type | Inductivity | $I_{Ln}$ | Single coil | Symm. coil | Mounting |
|---|---|---|---|---|---|
| L 20-7 | 20 µH | 7 A | • | | chassis |
| LP 20-7 | 20 µH | 7 A | • | | PCB |
| LP 34-3 | 34 µH | 3 A | • | | PCB |
| LP 183 | 2 × 183 µH | 8 A | | • | PCB |

### Electrical Data Filter Blocks

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 2: Filter blocks FP/FN*

| Characteristics | | Conditions | FP 38/FN 38 | | | FP 80/FN 80 | | | FP 144 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | min | typ | max | min | typ | max | min | typ | max | |
| $I_{Fn}$ | Rated current | $L$ = 0.75 $L_o$ | | 4 | | | 4 | | | 2 | | A DC |
| $U_{Fn}$ | Rated voltage | $T_{C\,min}$... $T_{C\,max}$ | 5 | | 40 | 5 | | 40 | 15 | | 144 | V DC |
| $R_F$ | Ohmic resistance | | 18 | 20 | 22 | 18 | 20 | 22 | 90 | 95 | 100 | mΩ |
| $L_o$ | No load inductance | $I_L$ = 0, $T_{C\,min}$... $T_{C\,max}$ | 30 | 34 | 38 | 30 | 34 | 38 | 88 | 100 | 112 | µH |
| $T_A$ | Ambient temperature | $I_F$ = $I_{Fn}$ | –40 | | 80 | –40 | | 80 | –40 | | 95 | °C |
| $T_C$ | Case temperature | | –40 | | 92 | –40 | | 92 | –40 | | 98 | |
| $T_S$ | Storage temperature | | –40 | | 100 | –40 | | 100 | –55 | | 100 | |

For currents $I_F$ > 4 A the following derating takes place: $T_{A\,max}$ = 100 – 1.3 • $I_F^2$ [°C], $T_{C\,max}$ = 100 – 0.49 • $I_F^2$ [°C]

### Input Interference Reduction

An AC ripple current can be measured at the input of any switching regulator, even if they are equipped with an input filter. Depending on the types of filters used, common and/or differential mode interferences can be reduced. They will also help to further increase the surge and burst immunity of the power supplies.

The FN/FP filters increase the source impedance of regulators superimposed interference considerably, to a value which is normally high in comparison to the impedance of the source ($Z_{Line}$). The interference currents are therefore practically independent of their source impedance. The filter will reduce these currents by approximately 25 dB at a frequency of 150 kHz.

The interference voltages at the filter input are due to the remaining interference currents flowing through the source impedance. The resulting interference voltage reduction can be seen in the following figure. For frequencies above the regulator switching frequency the attenuation will increase (up to 2 MHz approx.).

Parallel operation: When several switching regulator inputs are connected in parallel, each regulator should be equipped with a separate input filter. Interconnections should only be made in front of the filter or at its input Uii (i. e. the central ground point should be before or at the filter and under no circumstances at the regulator input).

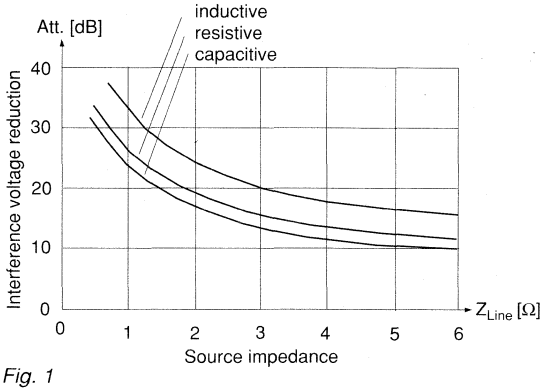



*Fig. 1*
*Interference voltage reduction with FN/FP filters at f = 150 kHz*

### Reduction of Output Ripple

Even though Melcher switching regulators have an inherently low output ripple, certain sensitive applications need even further reduction. In such cases, the filters designed to reduce disturbances at the input, can also be used for reducing the ripple on the output voltage. (Even better results with regard to the ripple and dynamic control deviation can be achieved by using Melcher low-loss ring core chokes in combination with an external capacitor, see below)

The output ripple can be reduced by the use of Melcher filter blocks by about 24 dB. The formula for the ripple $u_R$ at the load $R_L$ is as follows:

$$u_R = 0.063 \cdot u_o$$

(Ripple voltage $u_o$ is given for specific regulators in the corresponding data section).

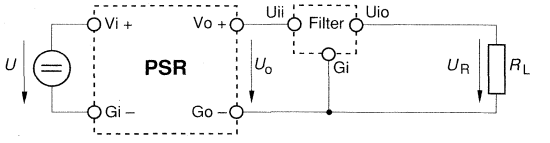



*Fig. 2*
*Reduction of voltage interference by FN/FP filters*

Consider, that the filter not only effects the output ripple but can also influence the voltage across the load $R_L$ in the event of load changes. The static load regulation increases with the ohmic resistance of the choke i.e. 24 mV/A for the FP/FN 38 and FP/FN 80 filters and 95 mV/A for the FP 144 filter.


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**Typical Application:**

The example in figure 2 shows a switching regulator operating from a battery ($R_i < 0.5\ \Omega$) with long supply lines (e.g. 2 m). The resulting superimposed interference voltage $U_{SL}$ may be measured at the regulators input. The connection of a filter in front of the power supply will reduce this interference accordingly:

1. The regulator's source impedance is mainly inductive because of the low battery impedance and the long supply lines. It can be calculated as follows:

   $|Z_{Line}| \cong 2\pi \cdot f_S \cdot L_{Line} \cdot 2l$

   $|Z_{Line}| \cong 2\pi \cdot (150 \cdot 10^3) \cdot 10^{-6} \cdot 2 \cdot 2 \cong 3.8\ \Omega$

   $f_S$: Switching frequency (150 kHz)

   $L_{Line}$: Supply line inductance (1µH/m)

   l: Length of single supply line (twice for positive and negative path)

2. This example shows, that with an inductive source impedance of 3.8 Ω, the insertion of the filter results in an interference voltage reduction of approx. 18 dB (see fig. 1).

3. The original superimposed interference voltage will be reduced by a factor of approx. 8:

   $U_{SF} = U_{SL} \cdot 10^{-18/20}$ [V]

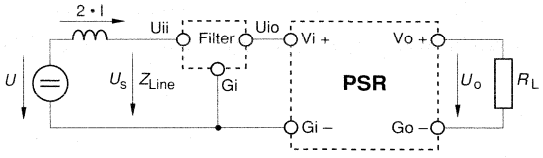



*Fig. 3*
*Reduction of voltage interference by FN/FP filters*

## Low-Loss Ring Core Chokes L/LP-Series

The ring core chokes, in combination with a capacitor, may easily be used for application specific LC filters at the input or output of switched mode power supplies. All chokes are suitable for PCB mounting. They are either moulded into plastic cases or isolated from the PCB by means of an isolation pad.

Series L/LP 20-7 and LP 34-3 are intended for use as differential mode filters and the current compensated choke LP 183 enables attenuation of common mode interference.

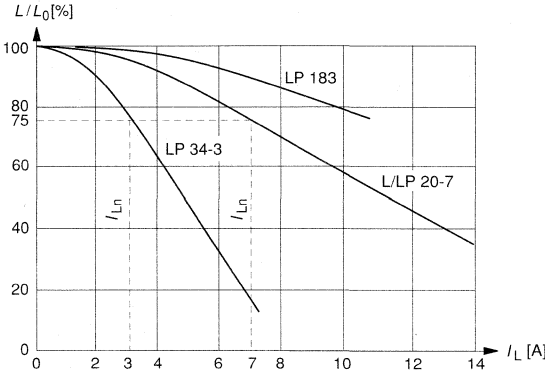



*Fig. 4*
*Choke inductivity vs. current*

**Electrical Data Ring Core Chokes**

General Condition: $T_A = 25°C$ unless otherwise specified

*Table 3: Ring core chokes*

| Characteristics | | Conditions | L 20-7/LP 20-7 min | typ | max | LP 34-3 min | typ | max | LP 183 min | typ | max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $I_{Ln}$ | Rated current [1] | $L = 0.75\ L_o$ | | 7 | | | 3 | | | 8 | | A DC |
| $R_L$ | Ohmic resistance | | 5 | 5.5 | 6 | 18 | 20 | 22 | 2×2.9 | 2×4.2 | 2×5.5 | mΩ |
| $L_o$ | No load inductance | $I_L = 0$, $T_{C\,min}...T_{C\,max}$ | 18 | 20 | 22 | 30 | 34 | 38 | 2×95 | 2×183 | 2×245 | µH |
| $\Delta_{TI}$ | Current specific case temp. increase [1] | | | 0.082 | | | 0.68 | | | 0.19 | | K/A² |
| $T_A$ | Amb. temperature [1] | $I_L = I_{Ln}$ | –40 | | 106 | –40 | | 104 | –40 | | 98 | °C |
| $T_C$ | Case temperature | | –40 | | 110 | –40 | | 110 | –40 | | 110 | |
| $T_S$ | Storage temperature | | –40 | | 110 | –40 | | 110 | –40 | | 110 | |

[1] If the choke is not operating at the rated current $I_{Ln}$, the maximum ambient temperature $T_{A\,max}$ and the maximum direct current $I_{L\,max}$ change according to the following equations: $I_{L\,max} = \sqrt{\frac{T_{C\,max} - T_{A\,max}}{\Delta_{TI}}}$ $\quad T_{A\,max} = T_{C\,max} - I_L^2{}_{max} \cdot \Delta_{TI}$

### Input Interference Reduction

Using L- or LP-series chokes together with an additional external capacitor a similar attenuation can be achieved as with filter blocks. The capacitor between the choke and the converter input is necessary in order to avoid possible oscillations caused by the negative input impedance of the regulator. This phenomenon could cause the input voltage to leave the specified regulator input range. The relatively high ripple current flowing through the capacitor must be considered for the design. Refer also to Application Notes.

The current compensated choke LP 183 has a high permeability ring core with two identical separate windings.

The normal operating current will only see the small stray inductance between the windings. However common mode interference will be blocked by the full inductance of the choke.

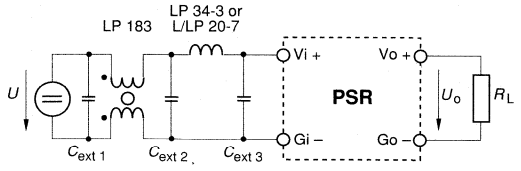



*Fig. 5*
*L/LP type chokes and capacitors used as input filter*

### Reduction of Output Ripple

Even though Melcher switching regulators have an inherently low output ripple, certain sensitive applications need even further reduction. In such cases, the Melcher low-loss ring core chokes designed to reduce disturbances at the input, can also be used for reducing the ripple on the output voltage. The chokes in combination with an external capacitor can achieve even better results than the Filter Blocks with regard to the ripple and dynamic regulation.

The formula for the remaining output ripple at the load $R_L$ is calculated as follows:

$U_R = u_o \cdot Z_{Cex} / Z_{LD}$

$u_o$: Output ripple of the regulator

$Z_{Cex}$: The impedance of the capacitor at the regulator's switching frequency (150 kHz) corresponds to the equivalent series resistance (ESR) of the capacitor (please refer to the corresponding data sheet).

$Z_{LD} = 2\pi \cdot f_S \cdot L_D$

$f_S$: 150 kHz (regulator switching frequency)

$L_D$: Defined in fig. 6

Through the use of a common mode choke LP 183, the common mode noise at the output can also be further reduced.

Consider that the filter not only effects the output ripple but can also influence the voltage across the load $R_L$ in the event of load changes. The static regulation increases with the ohmic resistance of the choke, i.e. 6 mV/A for the choke L/LP 20-7 and 20 mV/A for the LP 34-3.

The dynamic regulation is dependent on the size of the capacitor. Generally, the bigger $C_{ex}$ the smaller is the dynamic, however, recovery will be slower.

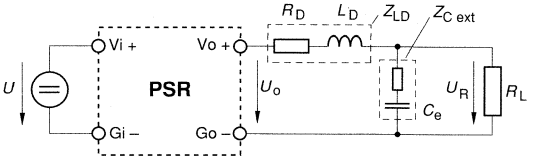



*Fig. 6*
*Melcher low-loss ring core choke with external capacitor ($C_{ex}$ approx. 1000 µF) used as output filter*

### Typical Application

A voltage drop $U_{rGo} = r_{Go} \cdot (I_o - I_i)$ is produced across the ground loop resistance $r_{Go}$. It is superimposed upon the regulator output voltage $U_o$ and generates the voltage $U_R = U_o - U_{r\,Go}$ across the load resistance $R_L$. Without an input inductance $L_e$ the current $I_i$ in the input circuit has a relatively high AC component with a basic frequency $f_s$ (regulator's switching frequency of approx. 150 kHz). This alternating current produces an AC voltage component across $r_{Go}$ which is superimposed upon $U_{RL}$.

To prevent this phenomenon, an inductance $L_e$ is inserted into the input circuit. This causes the AC component of the input current to be supplied entirely from the input capacitor $C_e$; thus, $I_i$ is a pure direct current. $C_e$ should be wired as close as possible to the regulator's input terminals Vi+ and Gi–.

$L_e$ and $C_e$ additionally provide protection against input transients and reduce radio interference voltages.

External connection of Gi– and Go– or connection via a common ground is not recommended. The internal voltage drop $U_{rG}$ in the regulator would be superimposed on the output voltage.

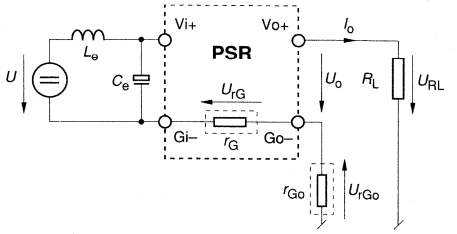



*Fig. 7*
*Decrease of superimposed interference voltages in grounded power supply systems, caused by ground loops*


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## Mechanical Dimensions

Dimensions in mm. Tolerances ±0.2 mm unless otherwise specified

European Projection

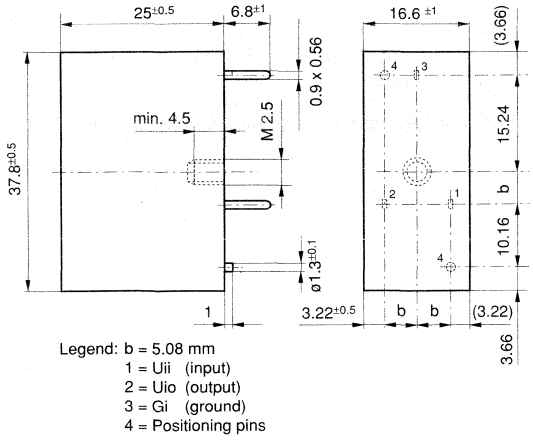



*Fig. 8*
*Filter blocks FP/FN, weight 30 g*

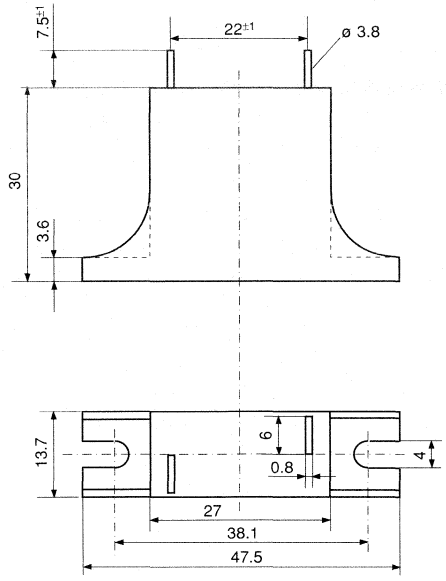



*Fig. 9*
*Ring core choke L 20-7, weight 30 g*

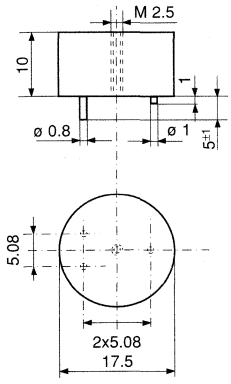



*Fig. 10*
*Ring core choke LP 34-3, weight 7 g*

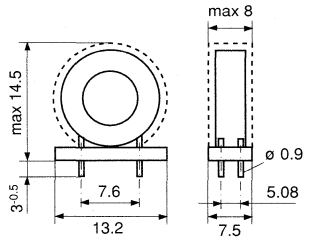



*Fig. 11*
*Ring core choke LP 183, weight 7 g*

# Mounting Supports for Chassis-, DIN-Rail- and PCB Mounting

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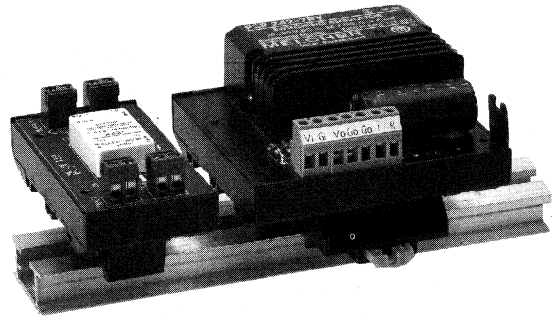
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Chassis Mounting Plates ..... 11 - 18
DIN- and Chassis Mounting Brackets ..... 11 - 20
PCB Mounting Supports ..... 11 - 23

## Description

Special mounting supports have been designed for the integration of Melcher power supplies into switch boards, control panels, printed wiring boards, etc. using adapters for Chassis-, DIN-Rail or PCB mounting.

The 19 inch cassette type DC-DC and AC-DC converters can also be frontal chassis mounted by means of a special Mounting Plate, attached to the converters threaded holes. The Universal Mounting Bracket fits to most of these cassettes too, allowing either vertical chassis- or DIN-Rail mounting facilities.

A bracket kit, consisting of a PCB with screw terminal connectors and a socket suitable for either Chassis- or DIN-Rail mounting, is available either for PCB mountable PSR and PSA Switching Regulators with option "Y" pins or for small DC-DC converters 1...15 W.



To isolate the PCB-mountable converters from a double sided wiring board, the use of Isolations Pads is recommended.

A flexible H11 PCB allows connection of casette type converters which are mounted on top of a printed wiring board.

**Note:** All dimensions are in mm, with tolerances of ±0.2 mm unless otherwise specified.

## Chassis Mounting Plates

For chassis mounting of 19" cassette type converters, special chassis mounting plate adapters with frontal access to mounting screws are available according to the following table and figures 1 to 3.

*Table 1: Mounting Plate survey*

| Case size | Converter family | Part. No. | Delivery content |
|---|---|---|---|
| K02 | K | Mounting plate K02 | Mounting plate and 4 countersunk screws |
| S02 | S | | |
| Q01 | Q | Mounting plate Q | |
| | | Mounting plate M | Mounting plate, 4 sountersunk screws including washers |
| M02 | M | | |
| H02 | H | | |

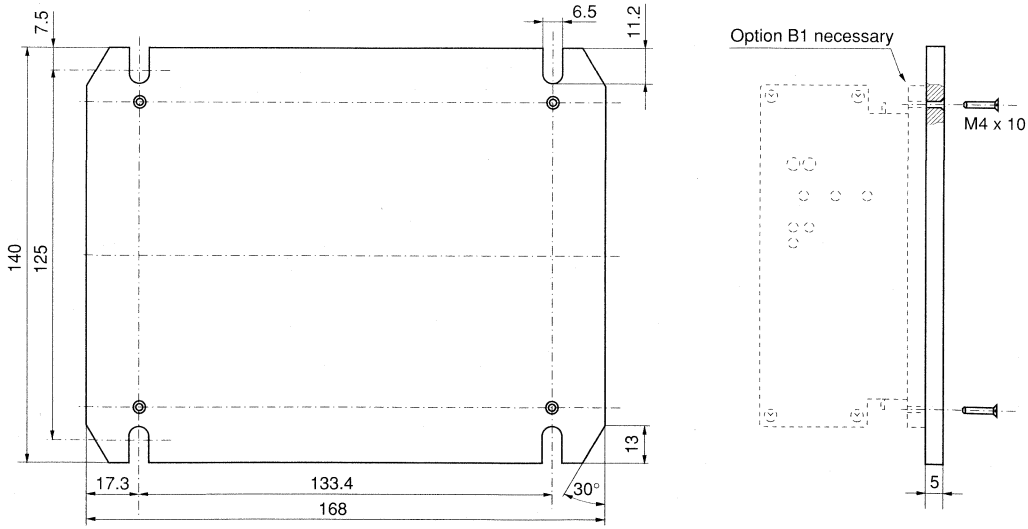



*Fig. 1*
*Mountig plate K02*



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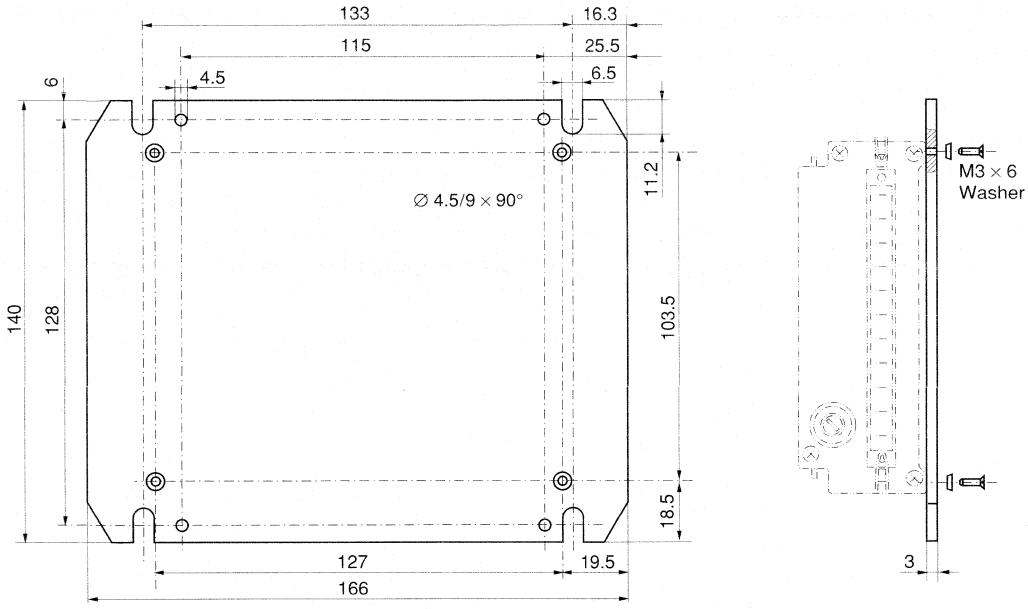



*Fig. 2*
*Mounting plate M*

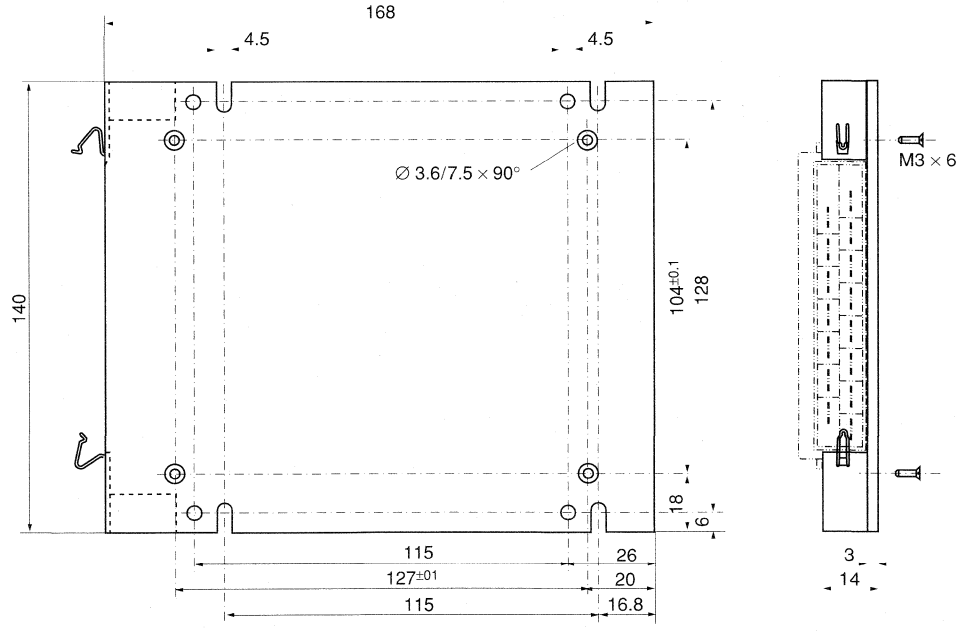



*Fig. 3*
*Mounting plate Q with integrated connector retension facility*

**Note:** Details on retension Clip V are given in section "Female Connectors"

## DIN- and Chassis Mounting Brackets

PCB mountable as well as cassette type converters can as an alternative be chassis- and/or DIN-Rail mounted by means of Mounting Bracket adapters. For selection and part numbers refer to table 2.

*Table 2: Mounting Bracket survey*

| X [mm] | Y [mm] | Case size | Converter family | Part No. Chassis-mounting | Part No. DIN-mounting | Delivery content |
|---|---|---|---|---|---|---|
| 95.0 | 90.0 | A01 | PSR | CMB A01-iRY/80 | DMB A01-iRY/80 | PCB, screw teminal blocks, 4 diodes, capacitor C1 and C- or D-socket with screws |
| | | | PSA | CMB A01-iRY/144 | DMB A01-iRY/144 | |
| 72.5 | 67.5 | 2"×2" | IBEK 6/10 Watt IMR 6...IMR 15 | CMB 2×2-BCFG | DMB 2×2-BCFG | PCB, screw teminal blocks, and C- or D-socket |
| 50.0 | 45.0 | DIL 24 | IBEK 3 Watt | CMB 3W-123 | DMB 3W-123 | |
| – | – | L01, L04 H02, M02 Q01 | SR, PSL H, M Q | UMB-LHMQ | UMB-LMHQ | Alu-profil, two screws and DIN-rail socket with screw |

**Note:** Custom adapters for other case size are available on request.

Each part number gives a direct indication of the kind of mounting, the type of converter, i.e. the case size or the output power as well as the possible pinnings and options according to the relevant converter data. The adapters are divided into three mechanical types: CMB, DMB and UMB.

### CMB: Chassis Mounting Bracket

The kit consists of a PCB for the converter, a set of screw terminals allowing easy electrical connection and two aluminium profiles which, attached to the PCB by means of four screws, serve as the chassis mountable socket. Four different versions according to table 2 are available.

Details on layout of PCB's and diagrams are given in the description below.

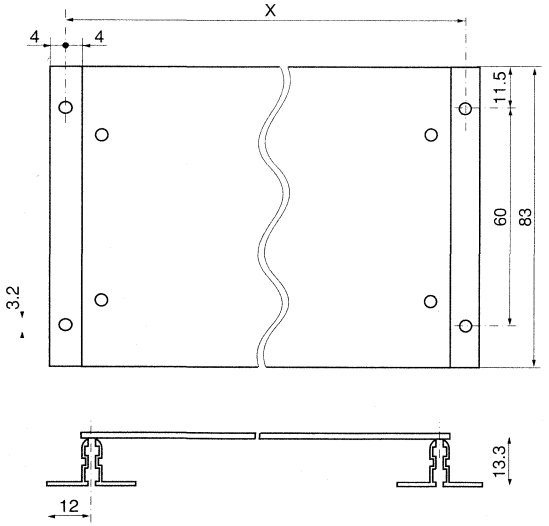



*Fig. 4*
*Chassis Mounting Bracket dimensions "CMB"*

### DMB: DIN-Rail Mounting Bracket

The DMB kit differs only from the "CMB" version in that it has another socket. It contains a black plastic body with the socket fitting to DIN-Rail configurations (according to EN 50022, including Hat- and C-rail). The plastic body holds the PCB by means of a snap-in device. Four different versions according to table 2 are available.

Details on layout of PCB's and diagrams are given in the description below.

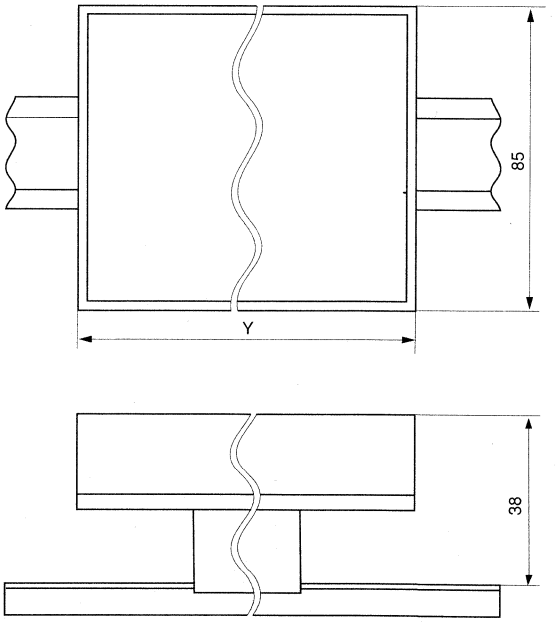
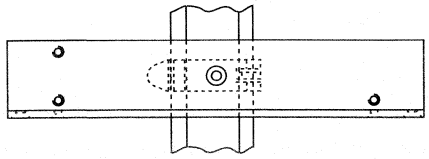



*Fig. 5*
*DIN-rail mounting bracket dimensions "DMB"*


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### UMB-LHMQ: Universal Mounting Bracket

A special Universal Mounting Bracket has been designed for vertical or upright Chassis- and DIN-Rail mounting of the 19" cassette type converters shown in table 2.



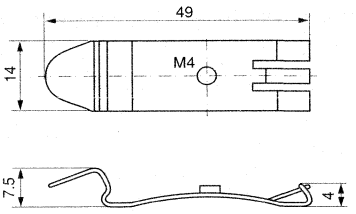



*Fig. 6a*
*DIN-rail socket*

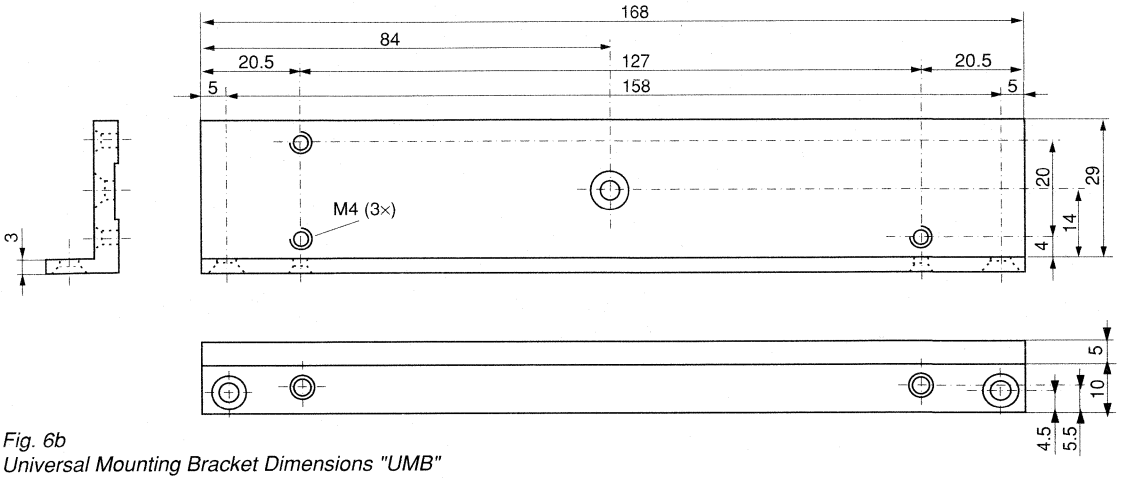



*Fig. 6b*
*Universal Mounting Bracket Dimensions "UMB"*

### C/DMBA01- .. Description

This bracket is designed for non-isolated Melcher Switching Regulators of the PSR and PSA families in the A01 case size, equipped with "Option Y" pins and giving output voltages between 5 V and 48 V. Pin configuration and technical details, i.e. max. input voltage etc. are described in the relevant PSR and PSA data and further information is given in the application notes. The use of optional inhibit- and R-functions (external output voltage adjustment with R1) is possible and the device can be driven from either a DC-source or from a transformer secondary voltage:

– DC-input: Consider the forward voltage drop across the rectifier diodes (also providing reverse polarity protection). Capacitor C1 compensates the negative converter input impedance in case of long connection leads.

– AC-input: The recommended transformer secondary voltage is 48 $V_{rms}$ for PSR and 72 $V_{rms}$ for PSA.

Exeption: Input voltage for PSR 54 (PSA 55) is 20 $V_{rms}$. PSR 54 (PSA 55) and PSR 362 require an additional capacitor (C2) of at least 470 mF.

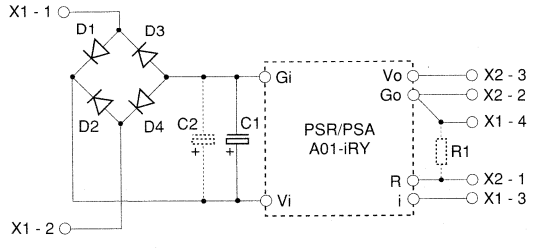



*Fig. 7a*
*.. MB A01- .. circuit diagram*

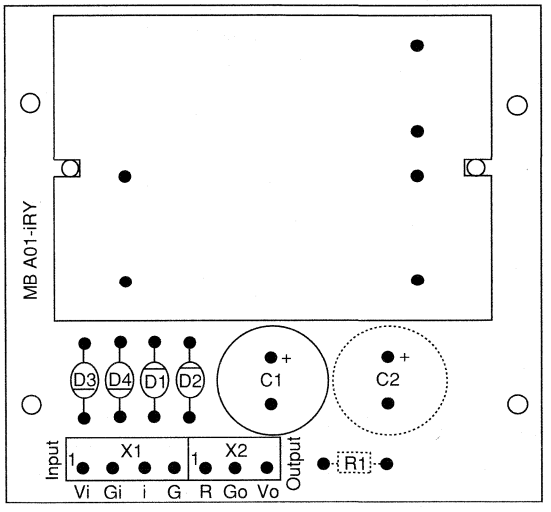



*Fig. 7b*
*.. MB A01- .. print layout*

### C/DMB2×2-BCFG Description

This bracket allows conficuration of isolated DC-DC converters of Melcher families IMR 6 and IMR 15 and of IBEK families IPS 10 (10 watt) and ICR 5 or ICR 6 (5/6 watt) in 2" by 2" cases with either one or two output voltages of 5, 12 or 15 V. The possible pin configurations (B, C, F, G) as well as all technical details are given in the relevant IMR 6, IMR 15 and IBEK 10 Watt or 6 Watt data.

Depending on the application an input transient protection may be incorporated (e.g. an appropriately dimensioned Transzorb diode D1).

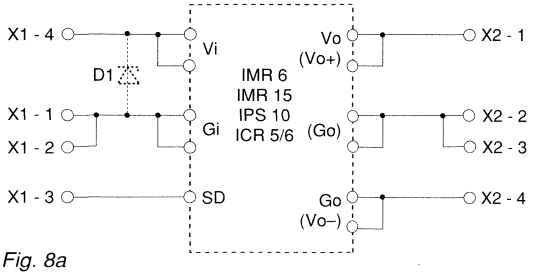



*Fig. 8a*
*.. MB2×2-BCGF circuit diagram*

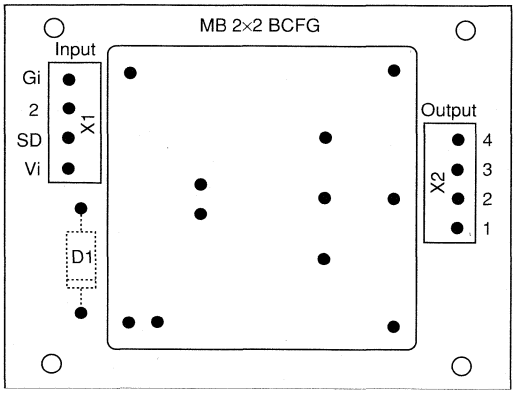



*Fig. 8b*
*.. MB2×2-BCGF print layout*

### C/DMB3W-123 Description

This bracket is designed for configuration of isolated DC-DC converters of the IBEK IPS 3 and IPW 3 families in DIL24 cases with one or two output voltages of 5, 12 or 15 V. The pin configuration of the converter groups 01, 02 and 03 and all technical converter details are described in the relevant IBEK 3 Watt data.

Depending on the application an input transient protection may be incorporated (e.g. an appropriately dimensioned Transzorb diode D1) .

IPW 3 type converters require additional external coupling capacitors because of the increased isolation voltage (at least 220 pF/1 kV). They should be installed as follows:

- IPW 3 with group 01 pinning require capacitor C1 only
- IPW 3 with group 02 pinning require capacitor C2 only
- IPW 3 with group 03 pinning require both capacitor C2 and C3

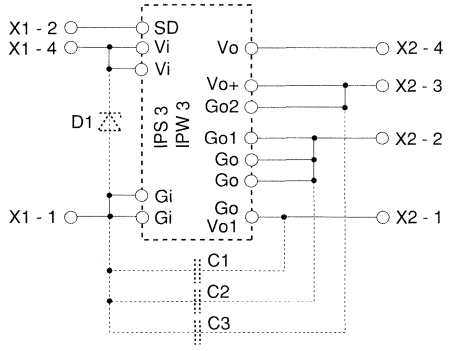



*Fig. 9a*
*.. MB3W-123 circuit diagram*

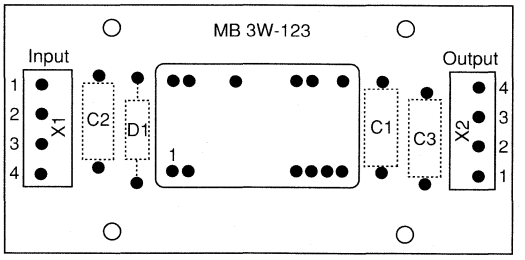



*Fig. 9b*
*.. MB3W-123 print layout*


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# PCB Mounting Supports

### Isolation Pads for PCB Mounting

In applications where PCB mountable converters are placed on top of double sided wiring boards, the use of Isolation Pads is recommendable. These cardboard pads avoid short circuits and provide excellent protection against possible damage to tracks. For selection and part numbers refer to table 3:

*Table 3: Isolation Pad survey*

| Case size | Converter family | Isolation pad Part. No. | Dimensions [mm] |
|---|---|---|---|
| A01 | PSR, PSA | Isolation A | 70 × 50 × 0.3 |
| B02 | PSB | Isolation B | 107 × 71 × 0.3 |
| C01 | xSR 20 | Isolation C | 152 × 86 × 0.3 |
| C03 | PSC | | |
| 2"×2" | IMR 6/15<br>IBEK 6/10 W | Isolation 2"×2" | 53 × 53 × 0.3 |
| DIL24 | IBEK 1 W<br>IBEK 3 W | Isolation DIL24 | 33.8 × 21 × 0.3 |

### PCB-Tags for PCB Mounting

DC-DC and AC-DC converters in C01 case and Switching Regulators either in B02 or C03 cases may also be mounted directly onto PCB's. The connection between the converters fast-on pins and the wiring board can be made easily by means of PCB-Tags as shown in figure 10.

Part No.: PCB Tag
Delivery content: 10 pieces

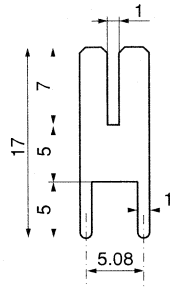



*Fig. 10*
*PCB-Tag*

### Flexible H11 PCB

If cassette type converters with male H11 connectors (used for example in H- or M- Families) are mounted on wiring boards, the connection between the wiring board and the male converter connector may be made using the special H11 Flexi-PCB together with the female STV-H11-FB/CO connector (see also female connector data).

Part No: H11 Flexi-PCB

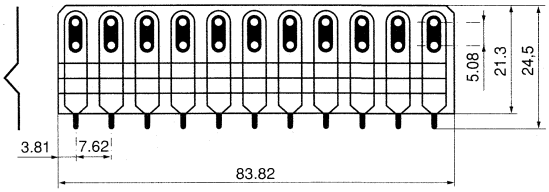
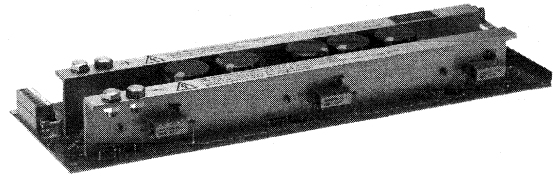



*Fig. 11*
*H11 Flexi-PCB*

# Back Planes for the T-Family BPD/BPF-Series

**19"/3U Rack-Systems**

- Easy configuration of telecom rectifiers, battery charges and power bus systems
- Provides controller function
- 1.6 kW power maximum
- Single or triple phase connection
- Redundant configuration possible



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## Description

The back plane types BPF 1000 and BPD 1000 have been designed for fast and simple set-up of 19" rack mounted power supply systems powered by Melcher AC-DC converters of the family LT 1000. Battery charger systems, telecom rectifiers and modular power bus systems can be easily configured with n+1 redundancy if required. Three LT units can be plugged into one back plane providing up to 1.6 kW output power.

The back plane concept allows system assembly in next to no time. When fitted in the rack all input and output terminals are readily accessible from the rear. The AC input is designed for single or 3-phase operation. The LT system monitoring signals and the control signal inputs and outputs are available from a screw terminal strip. System specific signal combination is possible with different jumper settings. The back plane fulfills in this way the function of a controller unit.

The layout of the back plane and the hot plug-in capability of the LT 1000 AC-DC converters allow for system expansion under load (e.g. from 550 W up to 1.6 kW) by simply inserting further LT units into the rack. Larger system power extension is just a matter of interlinking the DC output rails and signal outputs of two or more racks.

The back planes are available in 2 basic versions:

- BPD 1000
  A front-end version, fitted with decoupling diodes in each positive line to the DC bus, for systems with 2 or more LT units in parallel or n+1 redundancy.
- BPF 1000
  A battery charger version, in which each output is fitted with a preload and a fuse in the positive line to the DC bus, for battery charging or rectifier systems with two or more LT units in parallel or n+1 redundancy.

Should project specific requirements demand lower input EMI emission and/or lower low frequency output ripple than specified for the individual AC-DC converters LT 1000, each of the 2 basic back plane versions are available with additional input and/or output filters.

A cardboard cover over the live parts of the input on the back plane prevents accidental contact during installation and start-up of a system.

## Type Survey

*Table 1: Type survey*

| AC Input 85...255 V AC 1 or 3 phase (Y) | Input filters (reduced EMC) [1] | Output capacitors (reduced 100Hz output ripple) [2] | Preload | Application |
|---|---|---|---|---|
| BPD 1001 | – | – | – | Front-end, fitted with diodes |
| BPD 1002 | x | – | – | |
| BPD 1003 | x | 90 mF | – | |
| BPF 1004 | x | – | x | Battery charger, fitted with fuses |
| BPF 1005 | x | 50 mF | x | |
| BPF 1006 | x | 90 mF | x | |
| 19" Rack, 3 U | | | | Rack for systems with up to 3 LT units |

[1] See fig. 6, 7 as well as LT data section
[2] Please refer to fig. 10 and 11

## Functional Description

The back plane is divided into 3 sections, each one fitted with a H15 female connector for one LT, with the mains input section and the DC output section separated from each other.

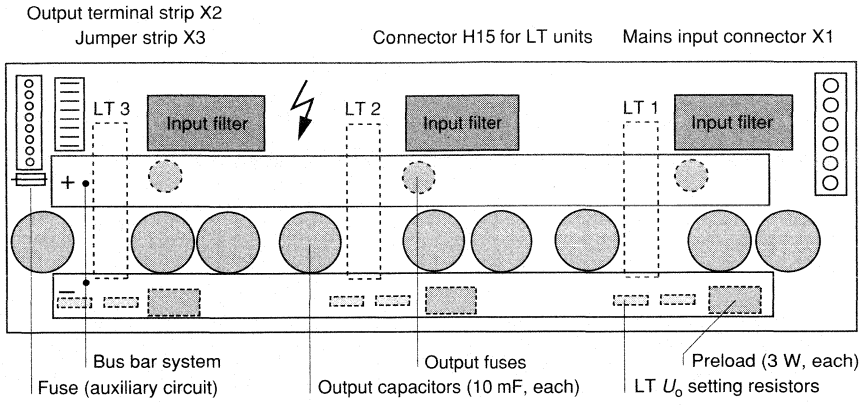



*Fig. 1*
*Back plane, configuration BPF 1006, view from the back*

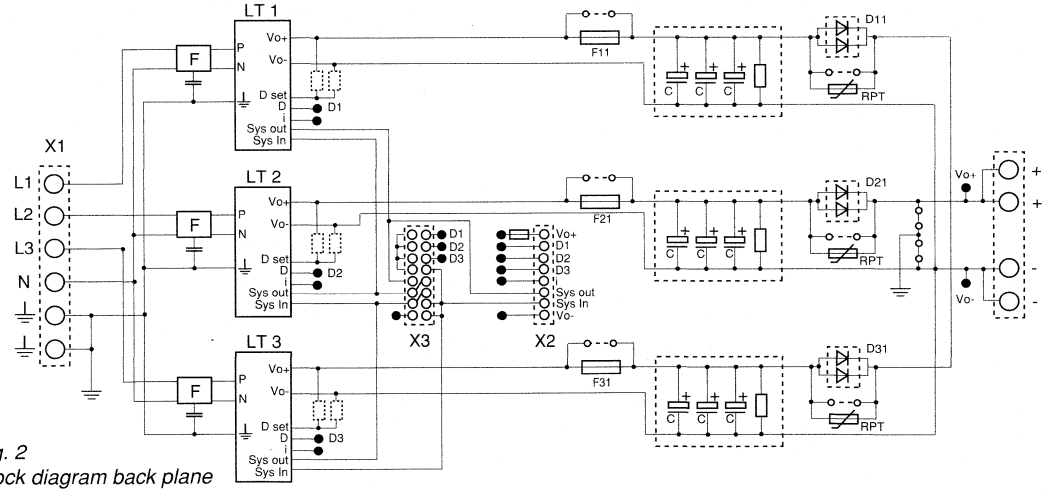



*Fig. 2*
*Block diagram back plane*

## Mains input section

### Connection to the Mains

Connection to the mains shall be made via the 6-pole screw terminal connector (X1), located on the right hand side of the back plane (view from the back).

For single phase operation the terminals (L1, L2 and L3) at the female should be connected together.

*Table 2: Mains input arrangement*

| Mains voltage 1-ph/3-ph (Y) | Single phase L, N | Phase - phase (Δ) L1, L2 | 3-phase (Y) L1, L2, L3, N | 3-phase (Δ) L1, L2. L3 |
|---|---|---|---|---|
| 230 V/400 V | L, N, ⏚ | not allowed | L1, L2, L3, N, ⏚ | not allowed |
| 115 V/230 V | L, N, ⏚ | L1, L2, ⏚ external fuses | L1, L2, L3, N, ⏚ | with special back plane (consult Melcher) |

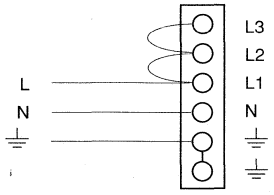



*Fig. 3*
*Single phase connection*
*230 V or 115 V*

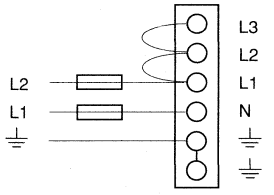



*Fig. 4*
*2-phase connection (e.g. USA),*
*230 V (external fuse in each line)*

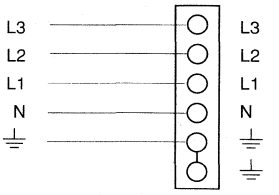



*Fig. 3*
*3-phase connection*

**Safety precautions:**

- Connection to the system ground is mandatory (leakage current exceeds 3.5 mA)
- The back planes are designed for connection to the mains 230/115 V. In 3-phase systems connection to the neutral line is mandatory.
- Integration into 3-phase systems with a Δ-connection (115/230 V) is only possible together with a special back plane.
- For single phase connection where the neutral is not definded an additional external fuse should be provided in the phase and the neutral line.
- For safety reasons a mains switch for line interruption is required.
- Prior to handling the back plane the system should be disconnected from the mains and all of the LT's LEDs should be OFF.
- Back planes fitted with output filter capacitors or connected to a battery may still be under voltage even with the mains interrupted.
- In the case of a short circuit across the LT outputs the LEDs will be OFF, eventhough the mains is present.
- Avoid short circuits at the power bus. The energy either supplied by the battery or by the output filter capacitors will generate an arc.
- See also below

## RFI

### Conducted noise

The LT units can be operated in 3 different modes, depending on the load:
- Output voltage regulation ($I_{o\,LT} \leq 10$ A)
- Output power limitation (10 A < $I_{o\,LT}$ < 14.5 A)
- Output current limitation ($I_{o\,LT} \leq 14.5$ A)

In output voltage regulation mode the conducted noise at the input of the LT units is below level B according to EN 55011/55022.

In output power and output current limitation mode, e.g. in the case of charging heavily discharged batteries, the conducted noise may be above level B.

For EMI sensitive applications the back planes are available with additional input filters.

### Radiated noise

To keep the radiated noise of the LT 1000 units as low as possible the LT units should be mounted into a conductive chromatized 19" rack, fitted with Melcher front panels and the back plane earth connected to the rack.

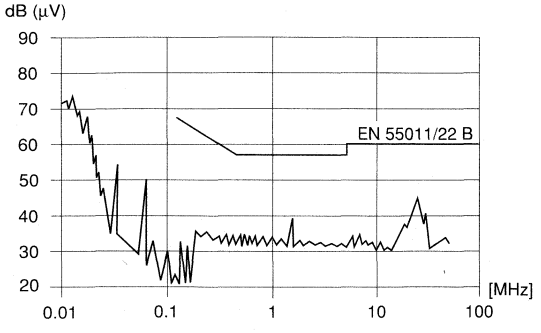



*Fig.6*
*Typical RFI voltage in output voltage regulation mode ($U_{i\,nom}$, $I_{i\,nom}$) back plane fitted with 3 LT units, input filters and 5 additional output capacitors (10 mF each)*

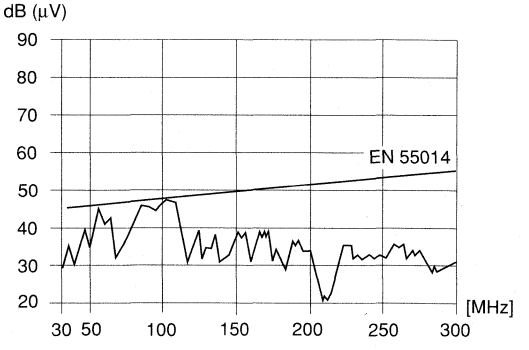



*Fig.7*
*Typical radiated noise at system input and output ($U_{i\,nom}$, $I_{i\,nom}$) back plane fitted with 3 LT units, input filters and 5 additional output capacitors (10 mF each)*

## Output section

### Power bus

The back plane is fitted with a generously dimensioned bus bar system. Each bus bar (4 mm thick Alu alloy profile, identified with its polarity) is fitted with 2 captive nuts (M 6) serving as connection points to the load as well as to the battery system. Depending upon the application either the positive or the negative pole of the battery may be earthed.

For application specific requirements such as reduced ripple current, reduced low frequency ripple voltage, enhanced hold-up time or heavy puls loads, the back planes are available with additional output capacitors. The output capacitors are mounted between the positive and the negative bus rail.

### Front-end version

To provide maximum system reliability especially with n+1 redundant systems, each positive output path is fitted with a decoupling diode mounted onto the positive bus rail. The diodes D11, 21 and 31 prevent a possible Power Down on the power bus in the case of a short circuit across the output of one of the LT units. To maintain the signalling functions of the LT unit(s) in the case of a single inhibit or a single mains phase failure, a PTC in parallel to the decoupling diode allows a small reverse current from the DC bus powering the control functions of the affected LT unit.

### Battery charger version

Direct battery charging or powering battery buffered systems requires an adequate trickle charge voltage over the specified temperature range. Decoupling diodes should be avoided due to their voltage drop, affecting the trickle charge voltage of the battery. To maintain system redundancy adequately rated fuses (F11, 21 and 31) are mounted in each positive output line. In the case of a short circuit across the output of one of the LT units the relevant fuse will blow, interrupting the reverse short circuit current supplied by the battery and the remaining LT units.

Under no-load conditions the output voltage of LT units without an internal preload may rise up to the overvoltage switch-off level. To avoid a fully charged battery being exposed to excessive trickle charge voltages a preload is fitted to each output. The preloads (power consumption 3 W each) are mounted onto the negative bus bar which at the same time serves as a heat sink.

**Note:** Systems fitted with LT 1720 or LT 1730 types should not be operated for long periods of time with no-load and the battery connected to the system, since under no-load condition the case temperature of the charger units and consequently the built-in temperature sensors may cool down, thus providing an excessively high trickle charge voltage.

LT 1730/1740 units are optionally available with an internal, electronically switched preload.

### Interface for remote signalling and control

A signal terminal strip (X2) allows interfacing with the customer's control system.

*Table 3: Terminal strip*

| Connector X3 | Signal allocation | Description |
|---|---|---|
| 1 | Vo– | Supply V– |
| 2 | Sys In | Sys Good input |
| 3 | Sys Out | Sys Good output |
| 4 | i | Inhibit |
| 5 | D3 | Power Down LT3 |
| 6 | D2 | Power Down LT2 |
| 7 | D1 | Power Down LT1 |
| 8 | Vo+ | Supply Vo+ (1 A fuse) |

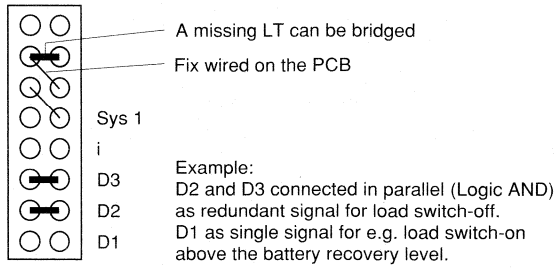



*Fig. 8*
*Jumper strip X3*

The Power Down signal of each LT unit is available as an individual single signal.

The System Good signals of all 3 LTs are connected in series on the backplane and available as one commun input and output signal.

## System Integration

Mains input voltage monitoring:

The LT unit interprets a mains failure as a system error, indicated by the red Error LED together with a System Good failure signal. Should a dedicated mains failure identification be required this signal would have to be established externally.

Available signals/signal combinations (Please also refer to the LT data sheet):

The LT unit provides two open collector signals, System Good and Power Down.

The System Good signal monitors the operational function of a single LT unit. In case of reduced output power due to a mains failure, a LT internal failure or inhibit, the signal changes from low to high impedance.

In systems with battery back-up or with n+1 redundancy the failure of one single unit does not cause a failure of the system as the required output power is still available either from the battery or from the remaining LTs. To indicate the status of the whole system, the System Good signals of all 3 LT units are connected in series on the back plane.

The System Good output can be combined with other DC-DC converters such as Melcher CQT units, integrating this additional information into the overall system status signal.

If only the system status of the LTs is be monitored, Sys In should be wired to Vo-.

The Power Down signal monitors the output voltage level of the bus bar system. The threshold levels of the 3 possible signals can be individually adjusted by means of resistors R 13/14...R 33/34 and used for:

- Save data
- disconnecting the load or part of it
- performing a battery test

In systems with battery back-up it may be desirable to extend system operation in case of long term mains failures by disconnecting an uncritical part of the load at a certain bus voltage level, triggered by one of the 3 possible power down signals. The 2 remaining signals can be set to the low battery discharge level to get a redundant signal (wired AND) for finally disconnecting the critical part of the load.

**Note:** The Power Down signal of the LT 1730 and LT 1740 types has an enlarged hysteresis of approximately 6 V. The LT 1720 types have only a small built-in hysteresis which may cause the load to switch off and on if switch-on is triggered by the same threshold value. (See also LT 1000 data sheet; Power Down, low battery).

The Power Down signal(s) can be combined with the System Good signal to give a wired AND. In such cases the resulting alarm only becomes active as a result of a mains failure or a LT failure together with a heavily discharged battery.

**To be considered in Battery Charger Systems**

When installing a LT system with back planes the relevant national and local safety standards must be adhered to. In battery charger systems safety standards demand that a battery can be completely disconnected from the power system including the battery system ground.

Depending upon the project specific requirements disconnecting may either occur by a manually operated switch with fuses, or automatically by means of a circuit breaker.

Care should be taken during system set-up or after maintenance when connecting a battery to the power bus of a back plane (BPF types) fitted with fuses. The LT system with the back planes should be switched to the mains prior to connecting the battery to the power bus, since the reverse current from the battery into the uncharged output capacitors of the LTs and the back plane may damage the fuses.

Selecting the right battery and back plane configuration:
As mentioned in the LT data sheet the power factor corrrection at the input of the LT 1000 unit generates a ripple voltage at the output of twice the input frequency, causing a ripple current into the connected battery.

For most battery types the low frequency ripple current should not exceed 5 $A_{rms}$ per 100 Ah (0.05 C). Some manufacturers (with newer battery technology) specify 10 $A_{rms}$ per 100 Ah (0.1 C).

Excessive ripple current can increase the battery temperature and reduces the battery life time. For a single phase system additional output capacitors may be necessary depending upon the selected battery.

**Note:** With the LTs symmetrically connected to a 3-phase (Y) mains supply the low frequency output ripple is virtually zero, only a high frequency ripple and noise of <100 $mV_{pp}$ at the switching frequency of 65.5 kHz remains.

When selecting a battery the following aspects should be considered:

1. Batteries are normally specified at 20°C.

   Steady operation at higher temperatures will shorten the life time of a battery. For every 10°C temperature increase the battery life is halved.

2. Worst case considerations with regard to the necessary battery capacity should include operation at the lowest possible temperature and highest possible discharge current, since under such conditions a substantial capacity drop has to be expected.

3. The capacity of a battery deteriorates with time. Therefore decisions on battery capacity should be based upon 20% ageing loss.

4. Battery manufacturers normally specify the DC resistance which can be used to calculate the short circuit current of the battery. However in order to estimate the ripple current to the battery, the AC resistance of the battery at 2 times the mains frequency (100 or 120 Hz ) needs to be known.

5. Consult the battery manufacturer for correct layout of the battery system.

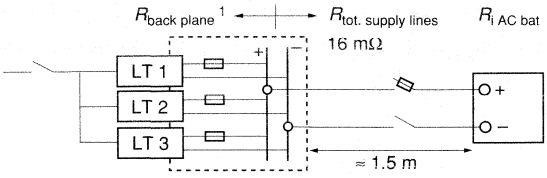
**Battery size, permissible ripple current**

Example1 :

Battery charger system in single phase connection: 230 V, 50 Hz, Load: 1kW, Battery back-up: 3 h

Battery charger:
3 LT 1000 , n+1 redundant configuration, 1.6kW

Conditions: $T_A$ = –10...40°C for both, charger and battery




[1] The resistor on the back plane ( $R_{back\ plane}$) is already taken into account in fig. 10 and 11

*Fig. 9*
*System set-up*

**Calculation of battery size**

Battery ( at 20°C):
- 24 cells, 2.23 V/cell, trickle charge voltage 53.5V
- permissible ripple current $I_{rms}$: 0.05C (5% of battery capacity)
- temperature coefficient –3 mV/K per cell
- max. discharge current 20 A
- capacity at –10°C and 0.2 C discharge: 70%

Battery size:
Load 20 A , back-up 3 h, ageing loss 20% therefore ageing factor 0.8, derating factor for temperature and discharge current 0.7

$Q_{bat}$ [Ah] = $I_{load} \cdot t_{back\text{-}up} / (f_{ageing} \cdot f_{TA/discharge})$
= 20 [A] • 3 [h] /(0.8 • 0.7) = 107 [Ah]
next closest battery configuration: 120 Ah or 95 Ah

Decision: Battery with 95 Ah ($R_{i\ DC}$: *28 mΩ*)
permissible ripple current $I_{rms}$ (0.05C), 4.75 $A_{rms}$
$R_{i\ AC\ bat}$ (measured): 16 mΩ

$R_{sys}$ [mΩ] = $R_{supply\ lines} + R_{i\ AC\ bat}$
= 16 [mΩ] + 16 [mΩ] = 32 [mΩ]

**Selection of Back plane, necessary filter capacitors**

To calculate the ripple current to the battery the average current drawn by the load in trickle charge condition is decisive.

Permissible ripple current

$I_{rms}$ = 0.05C = 0.05 • 95 Ah = 4.75 $A_{rms}$

$I_{rms\ bat} = I_{load}$ • factor y = 19 A • 0.198 = 3.76 $A_{rms}$

As the ripple current stays below the permitted value of 4.5 $A_{rms}$, additional output capacitors on the back plane are not necessary.

Example 2:

Same system set up, load 1.6 kW, without redundancy

$I_{load}$ [A] = $P_o/U_o$ = 1600 [W] / 53.2 [V] = 30.0 [A]

$I_{rms\ bat}$ [A] = $I_{load}$ • factor y = 30.0 [A] • 0.198 = 5.94 [$A_{rms}$]

As the ripple current is greater then the maximum acceptable value of 4.5 Arms, additional output capacitors on the back plane are necessary.

Fig. 10 and Fig.11 give an indication of the available ripple current attenuation with or without additional output capacitors.

Permissible ripple current $I_{rms} = I_{load}$ • factor y

factor y ≤ $I_{rms\ bat} / I_{load}$ = 4.5 [$A_{rms}$] / 30.0 [A] = 0.16

Fig. 11 shows that a factor ≤0.16 can be achieved with a back plane fitted with 50 mF capacitance.

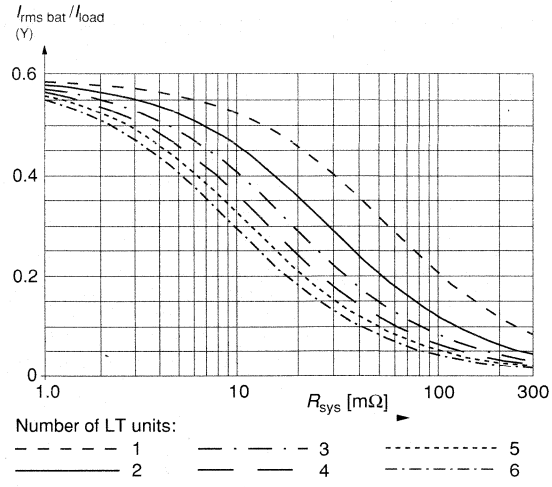



*Fig. 10*
*$I_{rms}/I_{load}$ versus system resistance ($R_{sys}$). Up to 6 LT units in parallel, without additional output capacitors*

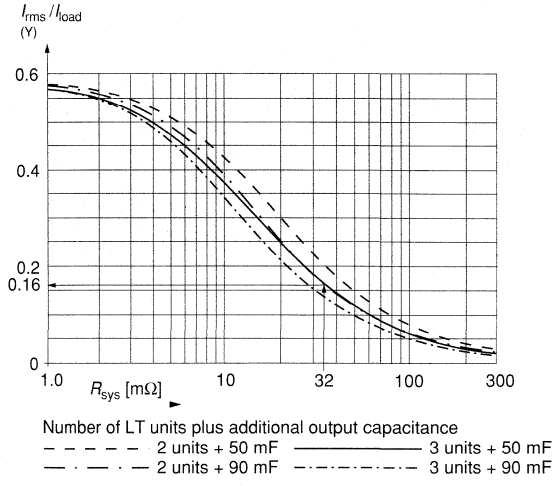



*Fig. 11*
*$I_{rms}/I_{load}$ versus system resistance ($R_{sys}$). 2 and 3 LT units in parallel, with additional output capacitors*

### Handling

1. Reverse polarity connection of the battery may damage the battery, the back plane(s) and the battery chargers.
2. For battery maintenance please contact the battery manufacturer.
3. Exchanging a battery should always include the whole battery bank. New batteries should be of the same type, with the same cell voltage and temperature coefficient.
4. For expansion of battery system contact the battery manufacturer.
5. For battery location and connection please refer to IEC 510 part 2.
6. For transportation use standard Melcher packaging material.
7. Racks fitted with back planes are not designed for transportation with the LT's fitted into the racks.

### Safety

1. Consult the LT series data section prior to connecting the system to the mains.
2. Prior to handling the back plane, disconnect the system from the mains. Be careful, live parts are accessible when the cardboard cover is removed. Service should be carried out by qualified personnel only.
3. Fuses should be replaced by the same types.
4. The leakage current of the LT 1000 units exceeds 0.5 mA. Earth terminals on the back plane should be connected to safety ground.
5. Connection to the mains: With three phase (Y) input, connection to the neutral line is mandatory. (See also "Mains input section")
5. High energy may be stored in the output capacitors. Do not cause a short circuit across the output.
6. Output voltage is present until all the battery charger LEDs are off.

   This also applies to LT units when removed.
7. In case of a short circuit across a LT output all LEDs at the battery charger will be off, eventhough the mains may be present.
8. Empty spaces in a LT rack should be covered by a dummy front plate.

### Possible failures during system set up/Trouble shooting

(See also LT data sheet, System Monitoring)

All LTs are operating, all Sys OK LEDs are OFF.
- Sys In is not referenced to Vo– or
- the first of the Out OK signals of the Melcher CQT converters connected in series with the Sys Good signal of the LTs not referenced to Vo–. (Please also refer to the LT data sheet.)

3-phase AC input. One LT unit indicates Error
- single LT failure or
- single LT inhibit or
- single phase mains failure

All System OK LEDs are OFF, all LTs indicate Error.
- mains failure or
- all LTs inhibited, e.g. battery test or lesslikely
- all LTs have a failure

The red Error LED at one of the LTs turns periodically ON and OFF.
- LT with Error LED ON has an overtemperature

One of the LTs has all LEDs OFF.
- short circuit across the LT ouptut.

At one LT unit the $U_o$ OK LED is ON. The remaining LTs are in current limitation with the LED $U_o$ OK OFF.
- a fuse on the back plane damaged, relevant LT with $U_o$ OK ON.

All LEDs at the LT units are OFF, mains is apparent
- short circuit across the power bus

Single phase AC input. Only one LT unit is in operation
- wire jumpers on mains input connector not connected to L2/L3 input terminals

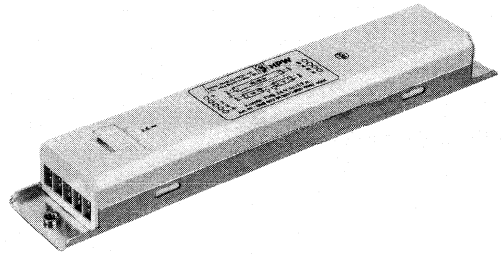
All Sys Good and $U_o$ OK LEDs are ON, no output power
- output not connected to the system

# HPW Electronic Ballasts

# TVG-Family

**Input voltage $U_{i\,nom}$: 18, 24, 36, 48, 72 or 110 V DC**
**Input voltage tolerance: $U_{i\,nom}$ ±30%**

- High efficiency up to 85%
- Wide operating temperature range
- High immunity against shock and vibration
- Higher switching frequency for greater light yield
- Consistent pre-heating time
- Flicker-free starting and operation
- In conformance with international standards



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## Description

TVG electronic ballasts have been designed to obtain comfortable light and improved security especially in public transportation vehicles, but in any other battery-powered application.

Fluorescent lamps require alternating current and high starting voltages and cannot be powered directly from the locally installed battery. Starting and operating characteristics of fluorescent lamps vary as the ambient temperature changes. In the roof area of public transportation vehicles, temperatures can vary from –30 °C up to 80 °C. TVG electronic ballasts provide the required starting and operating voltages over the entire temperature range.

To ensure maximum reliability, a high shock and vibration immunity is a basic requirement. It is an important task in the mechanical design process. All components used in TVG ballasts have been carefully selected and designed, and every ballast undergoes specific inspections and intensive tests before delivery takes place.

## Characteristics and Definitions

### Electronic ballasts for interior vehicle lighting

TVG electronic ballasts have given reliable service since many years in more than 10'000 vehicles. Their carefully engineered design offers important advantages:

- Higher frequency for greater light yield, which is 10 - 15% higher compaired with 50 Hz operation.
  The light yield is the ratio between the light flux (in lumens, lm) generated by a light source and the power (in watts) it consumes. This ratio indicates the cost-effectiveness of the light source.
- Flicker-free starting and operation.
- Consistent pre-heating times extend the fluorescent lamp life.
- Higher efficiency (typ. 85%) resulting in low heat generation and consequently in a longer component life.
- Markable maintenance cost reduction: lamps last longer which also means a reduced environmental impact.
- Easy access for servicing and repairs.

### Standards

TVG-05 Kombi/-06 electronic ballasts meet the following standards:

| | |
|---|---|
| Type: | UIC 555-1 |
| Input voltage: | Primary RIA 12 |
| EMC: | EN 55011, class B V-NNB (FTZ 1046)<br>EN 55022, class B (FTZ 1046)<br>Decree Nr. 1046 |
| Interference resistance: | IEC 801-4, IEC 801-2 |
| Vibration test: | as per DIN 40046 |

Dimmable versions available upon request.

*Table 1: Standard lamps configuration*

| Configuration | Standard fluorescent lamp Lenghts without contact pins [mm] ø 38 mm | ø 26 mm | ø 16 mm | TVG Type |
|---|---|---|---|---|
| 1 × 4 W | | | 136 | -06 |
| 2 × 4 W | | | 136 | -06 |
| 1 × 6 W | | | 212 | -06 |
| 2 × 6 W | | | 212 | -06 |
| 1 × 8 W | | | 288 | -06 |
| 2 × 8 W | | | 288 | -05/-06 |
| 1 × 13 W | | | 517 | -05/-06 |
| 2 × 13 W | | | 517 | -05 |
| 1 × 16 W | | 720 | | -05/-06 |
| 1 × 18 W | | 590 | | -05/-06 |
| 2 × 18 W | | 590 | | -05 |
| 1 × 20 W | 590 | | | -05/-06 |
| 2 × 20 W | 590 | | | -05 |
| 1 × 36 W | | 1200 | | -05 |
| 1 ×36 W-1 | | 968 | | -05 |
| 1 × 30 W | | 895 | | -05 |
| 1 × 40 W | 1200 | | | -05 |
| 1 × 58 W | | 1500 [1] | | -05 |
| 1 × 65 W | 1500 [1] | | | -05 |

[1] optional

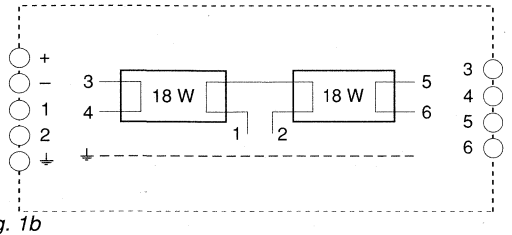



*Fig. 1b*
*Connecting diagram Kombi TVG–05*

*Table 2: Energy saver lamps configuration*

| Configuration | Energy saver fluorescent lamp Base | Lenght without contact pins [mm] | TVG Type |
|---|---|---|---|
| 1 × 5 W | 2 G7 | 85 | -06 |
| 2 × 5 W | 2 G7 | 85 | -06 |
| 1 × 7 W | 2 G7 | 115 | -06 |
| 2 × 7 W | 2 G7 | 115 | -06 |
| 1 × 9 W | 2 G7 | 145 | -06 |
| 2 × 9 W | 2 G7 | 145 | -06 |
| 1 × 11 W | 2 G7 | 215 | -06 |
| 1 × 10 W | G24 q-1 | 95 | -06 |
| 1 × 13 W | G24 q-1 | 130 | -06 |

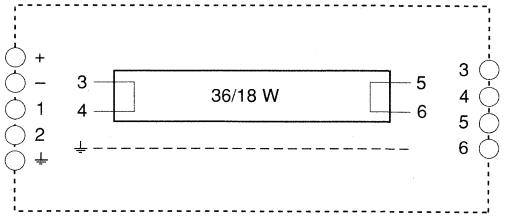



*Fig. 1a*
*Connecting diagram Kombi TVG–05*

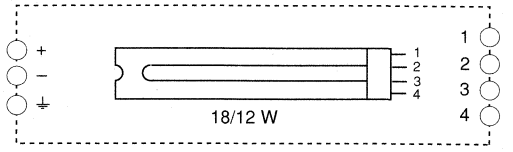


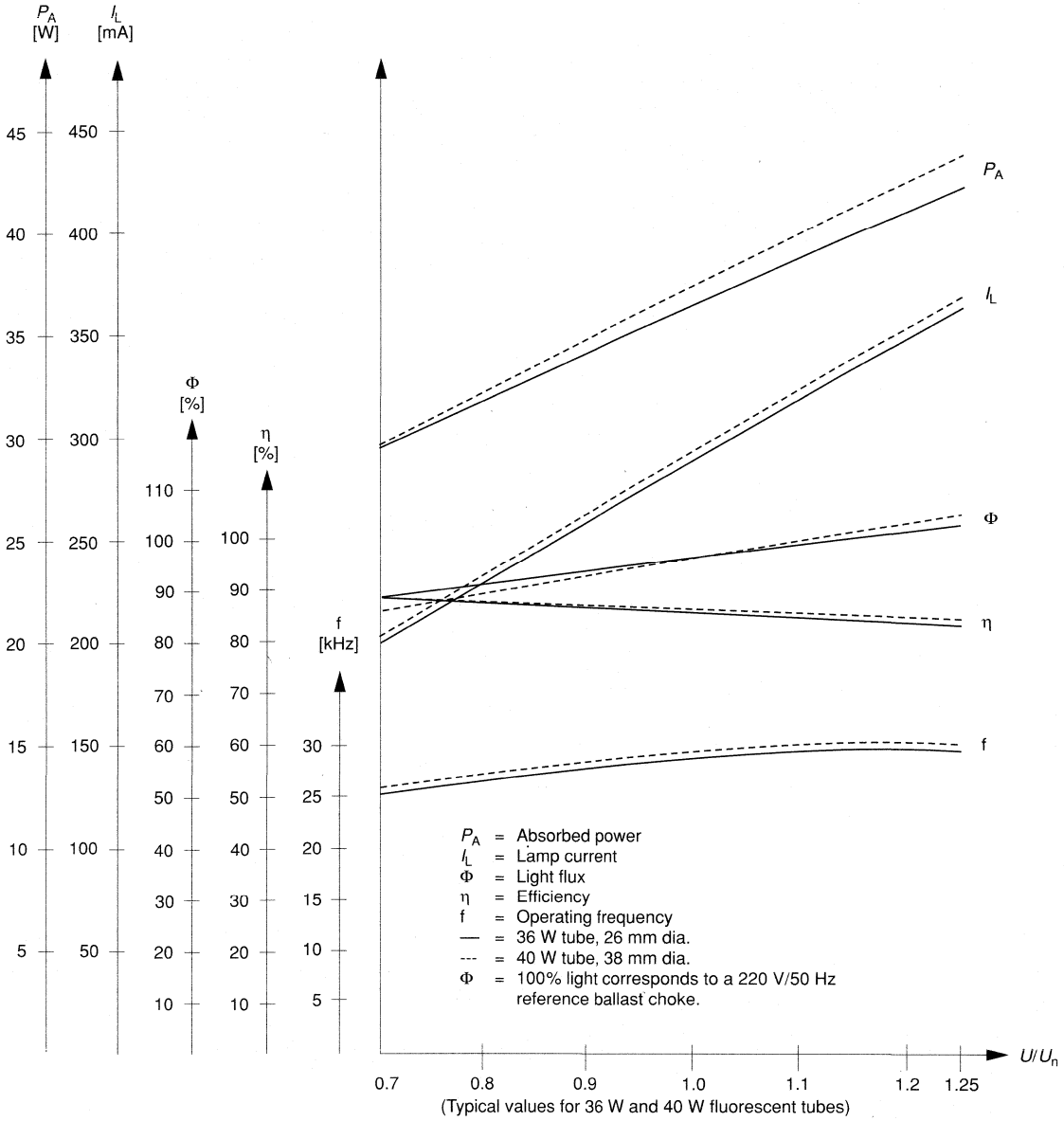

*Fig. 2*
*Connecting diagram TVG–06*


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## Electrical Data

| | |
|---|---|
| Input voltage $U_{nom}$: | 18, 24, 36, 48, 72, 110 V |
| Input voltage range: | ±30% (e.g. 16.8...32 V DC for a 24 V battery) |
| Maximum input voltage: | 1.5 × $U_{nom}$ during 10 min. |
| Operating frequency: | 26 kHz (approx.) |
| Lamp current peak factor: | 1.4 |
| Output voltage: | Sinusoidal wave form |
| Efficiency (typ.): | 85% |
| Pre-heating time: | – 1 s (UIC 555-1)<br>– 2 s (std. Swiss setting) |
| Switching life time (typ.): | 300'000 on-off cycles (36 W) |

| | |
|---|---|
| Ambient temp. range: | –30 °C...80 °C |
| Vibration test: | 5 g (as per DIN 40046-8) |
| Fuse: | Built-in and externally accessible |
| Connectors: | – Faston 6.3 mm tabs<br>– Screw terminals<br>– Connector, type WAGO |
| Protection degree: | IP 50 |
| Weight: | 255 g |
| Cable lenght: | Maximum 5 m from TVG to lamp |
| Installation: | In or on the lamp housing possible. Installation outside the housing requests for a suitable grounding. |




(Typical values for 36 W and 40 W fluorescent tubes)

*Fig. 3*
*Ballast data diagram*

## Mechanical Data

Dimensions in mm. Tolerances ±0.3mm unless otherwise specified.

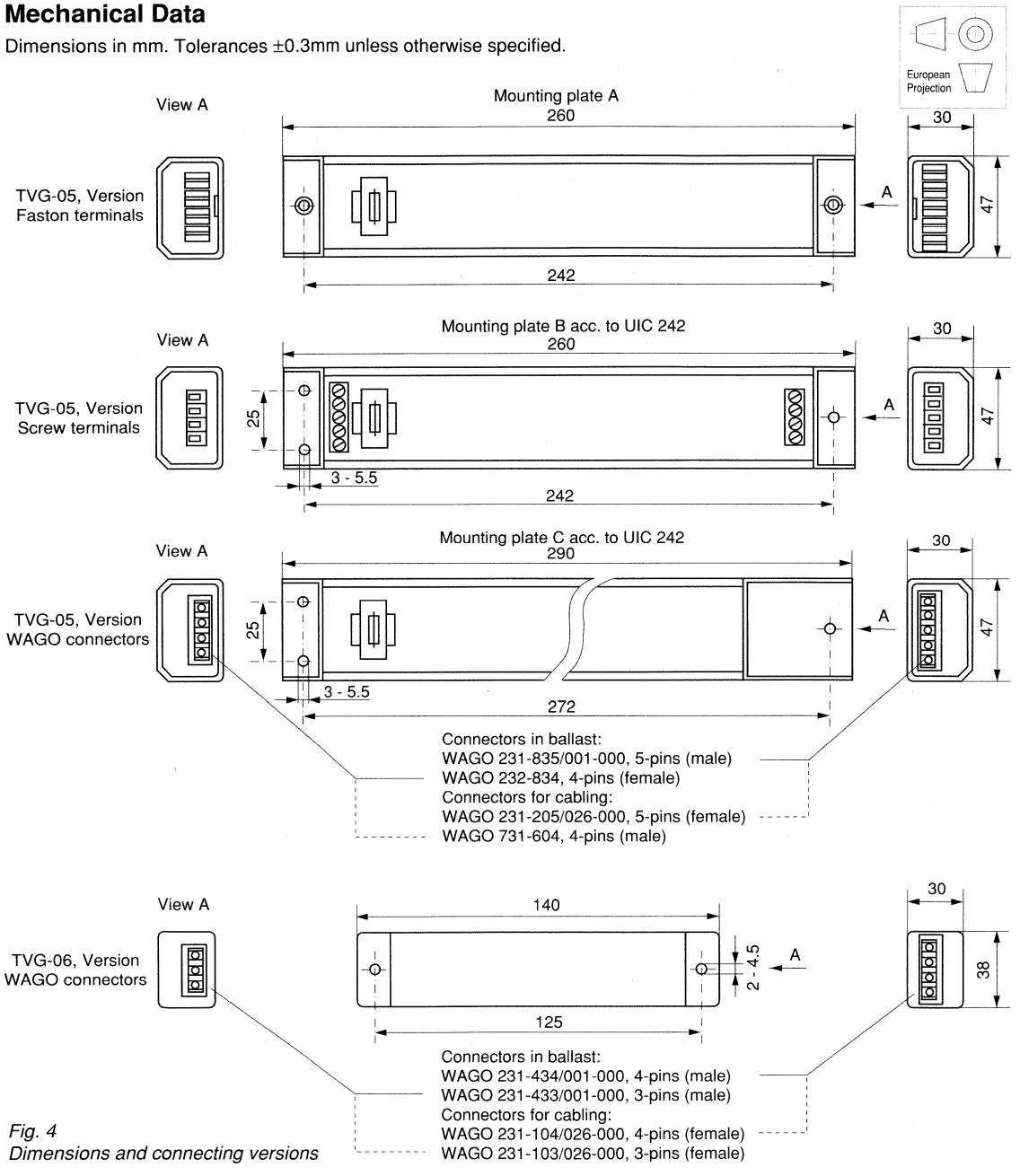



*Fig. 4*
*Dimensions and connecting versions*

## Type Key

36 TVG - 05 - F B

| | |
|---|---|
| Nominal input voltage | 18...110 |
| Product family | |
| Type | 05...06 |
| Faston terminals | F |
| Screw terminals | S |
| WAGO connectors | W |
| Mounting plate | A, B, C |


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# Electronic Load

# Mestro 300

**Load capacity up to 300 W**
**Load input voltage up to 50 V**
**Load input current up to 20 A**

- Selectable constant current or resistive load
- Precise adjustment of load values by two 10-turn potentiometers
- 3 1/2 digit load current display
- Internal pulse generator for dynamic load characteristic measurements
- Fully protected against overloads
- Parallel connection of several units possible




## Table of Contents


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## Description

The electronic load Mestro 300 covers a wide range of applications in development laboratories, production monitoring, quality control, test facilities, goods inwards inspection, etc.

This measuring equipment is idealy suited for development and testing of power supply modules, generators, storage batteries, dry batteries, etc.

The wide setting range, high resolution and accuracy of the Mestro 300 allows the replacement of an entire bank of rheostats to simplify test set-ups.

Operating in resistive mode, the Mestro 300 regulates the load current to a value which is proportional to the applied voltage.

Operating in constant current mode, the current drawn by the Mestro 300 is independent of the applied voltage. The static output deviation of a power supply module - due to load changes - can easily be determined by switching back and forth between two preset current values.

The dynamic behaviour of power supply modules in response to load changes can be tested by means of the built-in square wave pulse generator.

Any desired time dependent load variation can be set via the control input. Typical applications include the determination of the output impedance of a source versus frequency or storage battery testing with varying loads.

## Electrical Data

General Condition: $T_A$ = 25°C unless otherwise specified

*Table 1: Load input characteristics*

| Characteristics | | Range I min | Range I typ | Range I max | Range II min | Range II typ | Range II max | Unit |
|---|---|---|---|---|---|---|---|---|
| $I_L$ | Load current control range | 0 | | 20 | 0 | | 5.0 | A DC |
| $I_{L\,max}$ | Load current limit | | | 22 | | | 5.5 | |
| $\alpha_{IL}$ | Temperature drift | | –4 | | | –1 | | mA/K |
| $I_{L\,set}$ | Resolution (manual setting) | | 3.2 | | | 0.8 | | mA |
| $D_{set}$ | 3 1/2 Digit LED Display resolution (±1 digit) | | ±0.5 | | | ±0.5 | | % |
| $R_L$ | Load resistance | 0.16 | | 1000 | 0.6 | | 1000 | Ω |
| $U_L$ | Load voltage | 1.75 | | 50 | 1.75 | | 50 | V DC |
| $U_{L\,max}$ | Overvoltage prot. (disconnection of load) | | 62 | | | 62 | | |
| $U_{i\,max}$ | Overvoltage prot. (Crowbar triggering) | | 82 | | | 82 | | |
| $P_{max}$ | Power rating (continuous) | | | 300 | | | | W |
| $P_{pulse}$ | Pulse rating (electronically limited) | | | Fig. 1 | | | | |
| $U_{L\,reverse}$ | Reverse polarity protection | | | Reverse polarity diode | | | | |
| $U_{ctr}$ | Control input voltage range ($I_{L\,min}$...$I_{L\,max}$) | 0 | | 10 | 0 | | 10 | V |
| $U_{ctr\,max}$ | Max. control input voltage (without damage) | | | 100 | | | 100 | V DC |
| $R_{ctr}$ | Control resistance | | | External potentiometer | | | | |
| $f_{ctr}$ | Control input frequency (–3 dB) | | | 40 | | | | kHz |
| $Z_{ctr}$ | Control input impedance | | | 250 | | | | kΩ |
| $I_{pulse}$ | Individually adjustable | 0 | | $I_{L\,max}$ | 0 | | $I_{L\,max}$ | A |
| $f_{pulse}$ | Pulse repetition frequency | 200 | | 1800 | 200 | | 1800 | Hz |
| $t_{r,f}$ | Rise/fall time 0.1...0.9 $U_{pulse}$ | | | 9 | | | | µs |
| $T_{pulse}$ | Pulse duty cycle | | | 50 | | | | % |
| $U_{iso}$ | Isolation voltage: input to ground and control input to ground | | | ±500 | | | | V DC |

### Mains Input Data

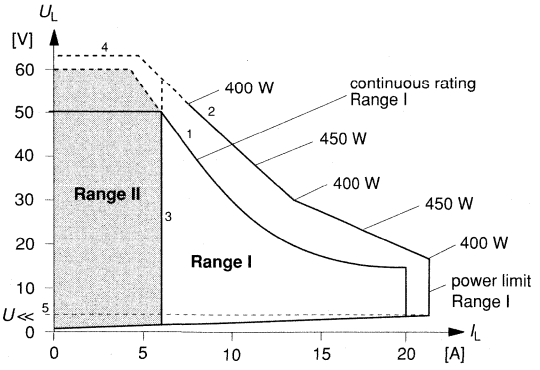
Mains voltage 230 V AC, 50...60 Hz, 25 VA,
**Note:**
Mains voltage 110 V AC, 50...60 Hz, 25 VA is available on request.

### Safety:

The Mestro 300 is a class I equipment according to IEC 950/EN 60950, i.e. a protective earth connection is provided.

### Environmental Conditions:

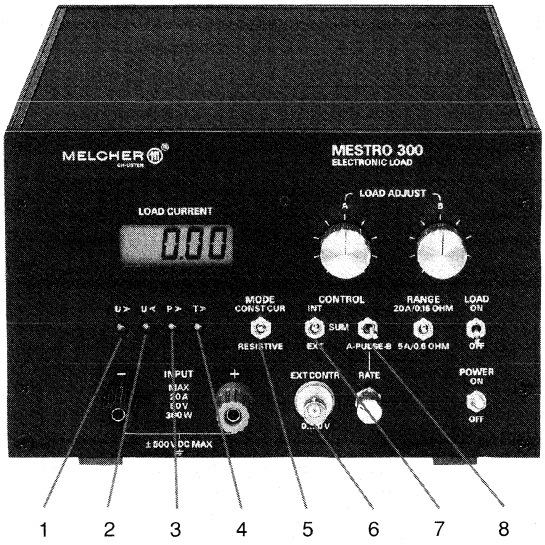
Ambient temperature range: 0...40°C
Automatically controlled cooling fan built-in
Automatic disconnection of load at a heat sink temperature of approx. 80°C.




[1] Specified continuous rating at $T_A$ = 25°C
[2] Typical power limitation (Range I), indicated by the LED power limit (red)
[3] Typical current limitation (Range II), potentiometer adjusted to the upper limit
[4] Typical voltage limitation (upper limit), indicated by the red LED (≫U)
[5] Typical undervoltage condition (low limit), indicated by the red LED (U≪)

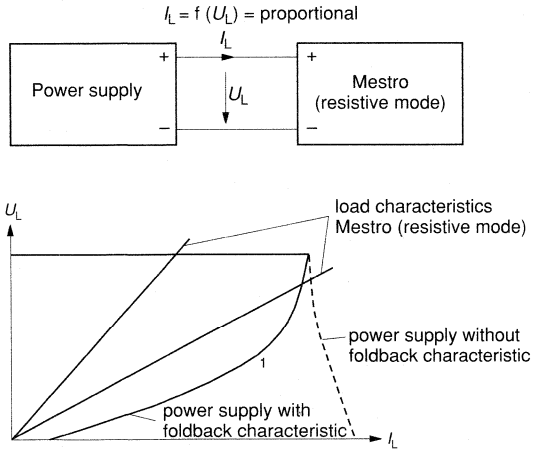
*Fig. 1*
*Load ranges of Mestro 300*


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1 Overvoltage indiocator
2 Undervoltage indicator
3 Overload indicator
4 Overtemperature indicator
5 Selector switch for constant current load or resistive load
6 Socket for external control; not isolated from load circuit. A connected generator must be electrically isolated from the load circuit.
7 Selector switch for internal or external control
8 Selector switch for potentiometer A, potentiometer B or pulse load. The minimum and maximum value of the pulse load can be independently preset with the two potentiometers.

**Resistive Load:**




[1] With a Mestro 300 a power supply can be operated in this region. With a constant current load characteristic this would not be possible

*Fig. 2*
*Resistive mode*

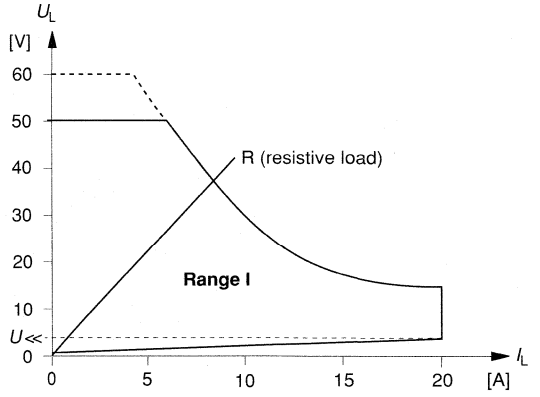



*Fig. 3*
*Resistive mode*

The Mestro behaves like a power rheostat but provides easier handling, better resolution, a wide setting range and a remote control input.

**Constant Current Load (Current Sink):**

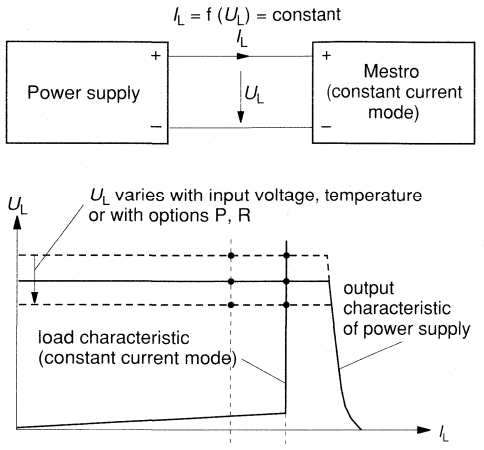



*Fig. 4*
*Constant current mode*

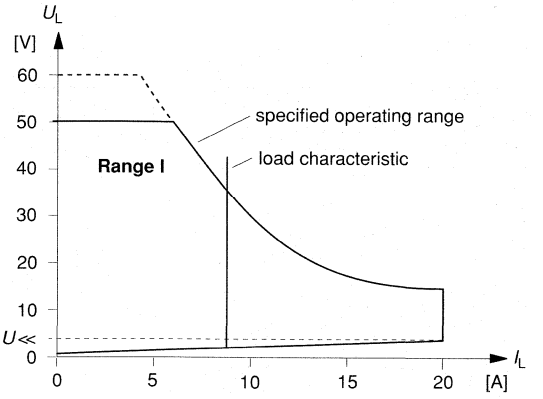



*Fig. 5*
*Constant current load (current sink)*

**Constant Voltage Load (Voltage Sink):**

Voltage sink consisting of a Mestro and a voltage source, basic set-up:

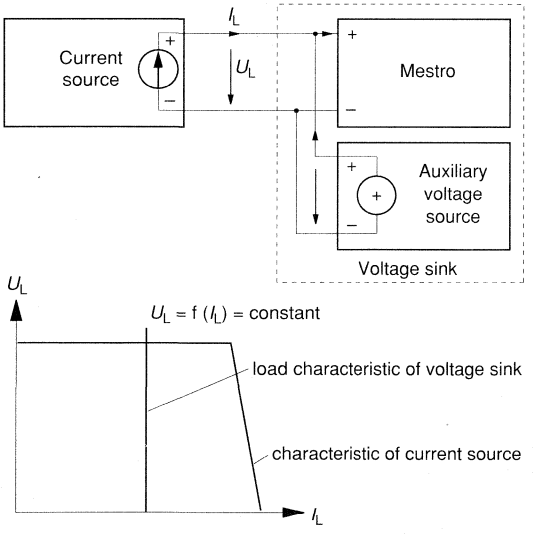



*Fig. 6*
*Constant voltage mode*

**Pulse Mode Operation:**

Measuring the dynamic response of a power supply or testing the pulse load behaviour

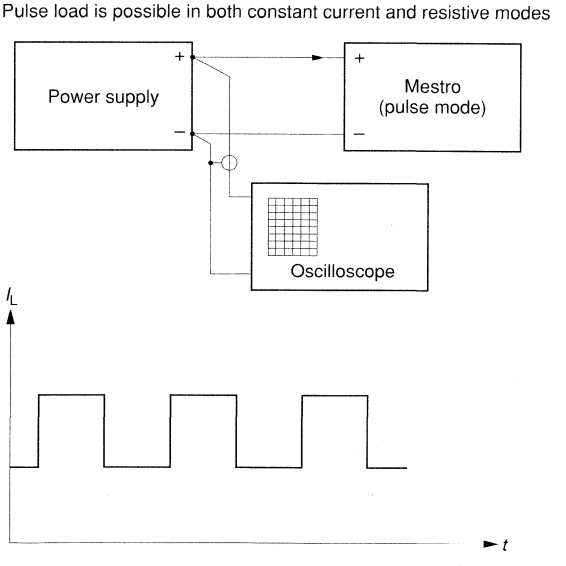
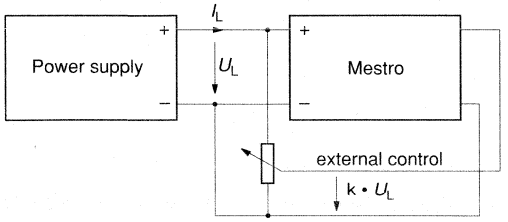



*Fig. 7*
*Pulse mode*


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**Externally Controlled Load in Resistive Mode:**




$$I_L = U_{ctr} \cdot \frac{20\ A}{10\ V}, \qquad U_{ctr} = k \cdot U_L$$

$$I_L = U_L \cdot k \cdot \frac{20\ A}{10\ V}, \qquad R_L = I_L = \frac{10\ V}{k \cdot 20\ A} = \frac{1}{2 \cdot k}\ [\Omega]$$

$k = 0...1$, $R_L = 0.5...\infty\ \Omega$

*Fig. 8*
*External control of resistive load*

**Time Varying Load:**

Remote control operating mode via control input:

In this mode, the 2 potentiometers, the constant current and/or resistive mode switch and the internal oscillator are not operating.

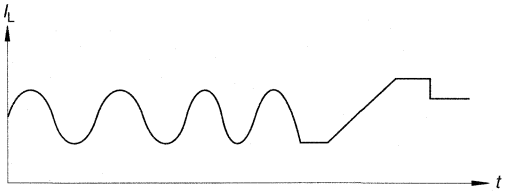



*Fig. 9*
*Varying load versus time*

**Remote Control:**

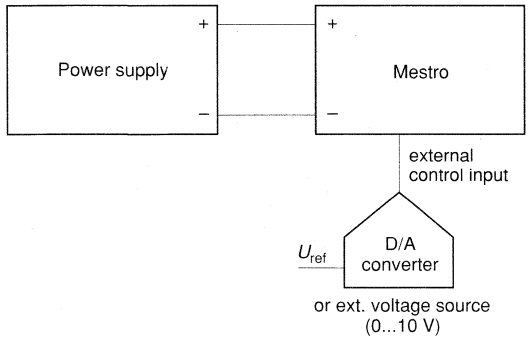



*Fig. 10*
*Remote control operation*

**Connection in Parallel:**

Several Mestros can be connected in parallel.

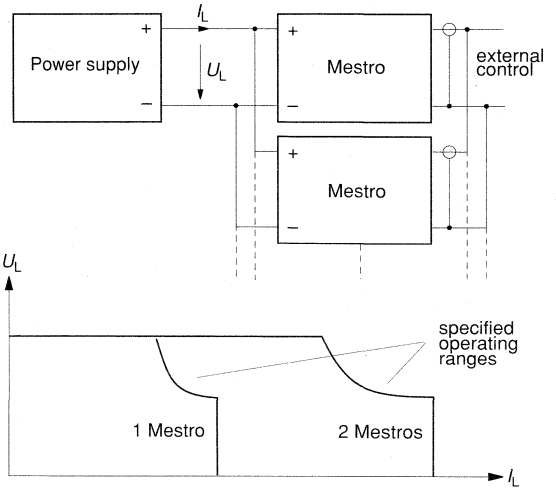



*Fig. 11*
*Several Mestros connected in parallel*

**Connection in series is not permitted!**

## Mechanical Data

Case width: 214 m, case hight: 147 mm, case depth: 294 mm, overall depth: 318 mm

Weight: approx. 5 kg

**Accessories:**

Assembly kit for installation of one or two Mestros into 19 inch 3 U rack systems (on request).

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# 12 Systems Solutions


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| Decentralized Power Distribution | 12 - 7 |
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# Systems Solutions

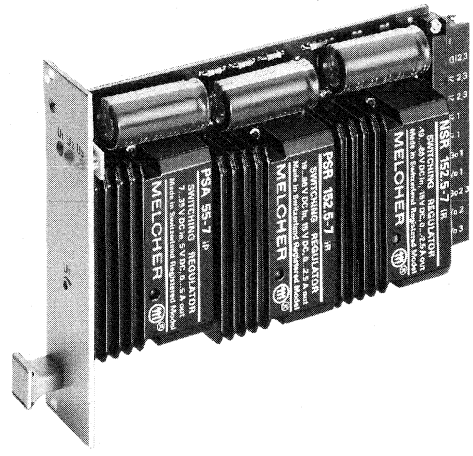
## 19" Cassettes of 220 (232) mm Length

AC-DC and DC-DC converters in standard 19 inch cassettes are also available in extended cases for specific application requirements. These cases are nominal 220 mm (232 mm) long and 3 U high according to DIN 41494. The extra space allows the integration of additional monitoring or filtering functions. Some of the power supply modules can be operated at increased output power or over an extended ambient temperature range because of the enlarged heat dissipating area of the case.



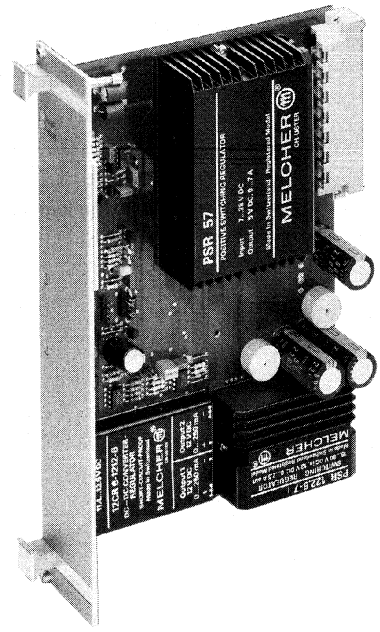

## 3 U Multi Voltage Card

Eurocard equipped with regulators providing three or four output voltages and powered either from a mains transformer with three secondary windings or from DC voltage sources. The card features programmable output voltages and can be configured with regulators built into A01- or G-cases, with rectifier diodes and support capacitors. The maximum output power rating is 130 W. The connector is a H 11-type (DIN 41612) which can be coded.



## VME Compatible Power Supply

A 6 U Double-Eurocard with rectifiers and support capacitors providing three outputs powered from a mains transformer. The card also contains a monitoring circuit for the input and output voltages plus an LED indicating the current mode of operation. The output power rating is 96 W maximum. The connector is an H 15 (DIN 41612) which can be coded. This module generates VME-bus compatible signals. Detailed information is given in a separate description.




## Multi Voltage Power Supply Modules

This 6 U printed circuit board carries one or two identical M-series modules, each providing one, two or three outputs. It is further equipped with a front plate and an H 15 connector (DIN 41612), which can be coded. The module is available in the following two versions:

The single module version provides its outputs with diode isolation to the connector and may be wired for redundancy externally. The dual module version provides redundancy on the assembly itself.

Both versions have monitoring circuitry which controls the output voltages and the operating status of the power supply system.




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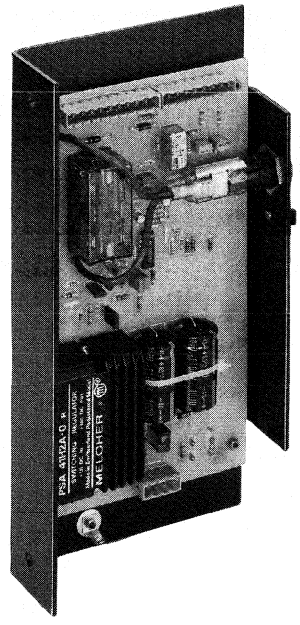


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## 24 V DC Power Supply System with Battery Back-up

This power supply was developed for microprocessor control units in production equipment. The unit is powered from a mains transformer backed-up by a 36 V battery. During normal operation the battery is trickle charged by a separate circuit. The system generates various control signals which are fed to the microprocessor in order to guarantee safe operating conditions.

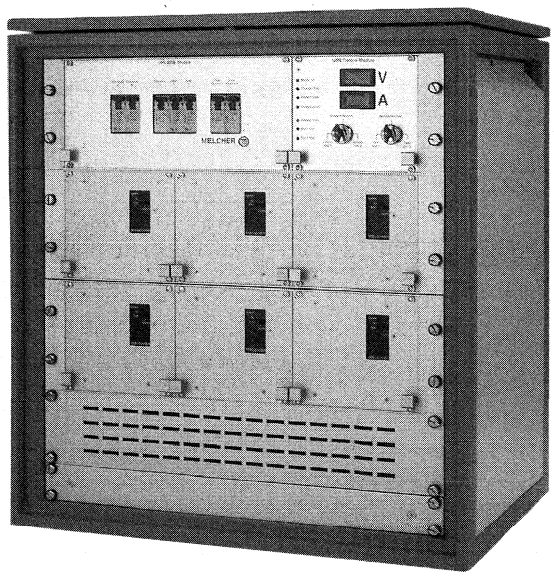



## Intelligent UPS Providing 48 V, 3 kW

A 12 U 19 inch cabinet containing six LT-series AC-DC converters providing a battery backed 48 V 3 kW supply divided into seven independently MCB protected outputs. Designed to meet the requirements of the forthcoming EMC directive, the unit is compliant with EN 60555 and EN 55022 level B.

A sophisticated lead acid battery charging facility provides full temperature compensation which coupled with a key operated battery health test and monitoring ensures maximum battery life. An LCD display provides voltage and current readings supported by extensive status LED indication.

Input and outpus are via MIL 38999 connectors, with battery terminations via M 8 studs.



## "n + 2" Redundant DC-DC Converter Providing 24 V, 900 W

Available in various DC input versions to meet the demands of the stringent trainborne voltage transient and surge specifications RIA 12, EN 55015 and IEC 571.

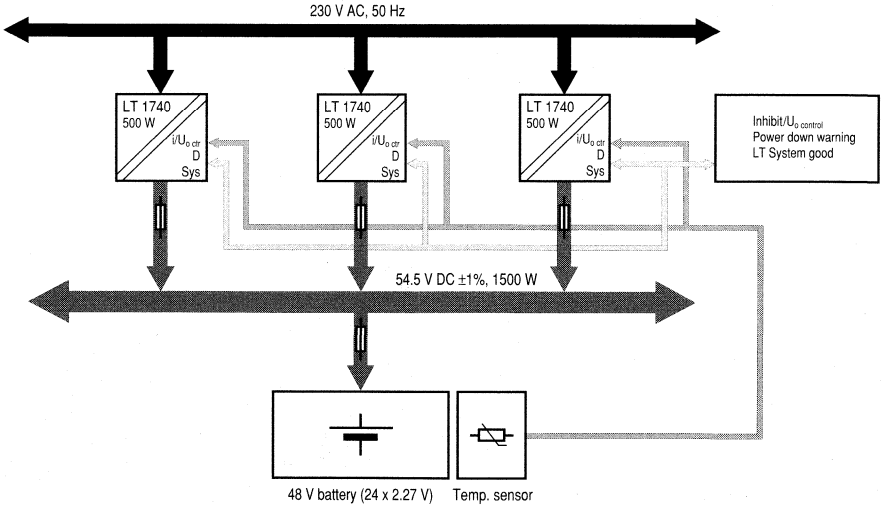
Six K-series modules are mounted on heatsinks and provide up to 900 W with diode isolation to offer full redundancy. All connections are made via MIL38999 connectors.

Voltage free contacts and full LED status indication allow the user to monitor the performance both remotely and locally.

A rugged IP 65 steel enclosure protects against the vigours of a mobile environment.




## 1500 Watt Telecom Rectifier for 48 V Battery Charging



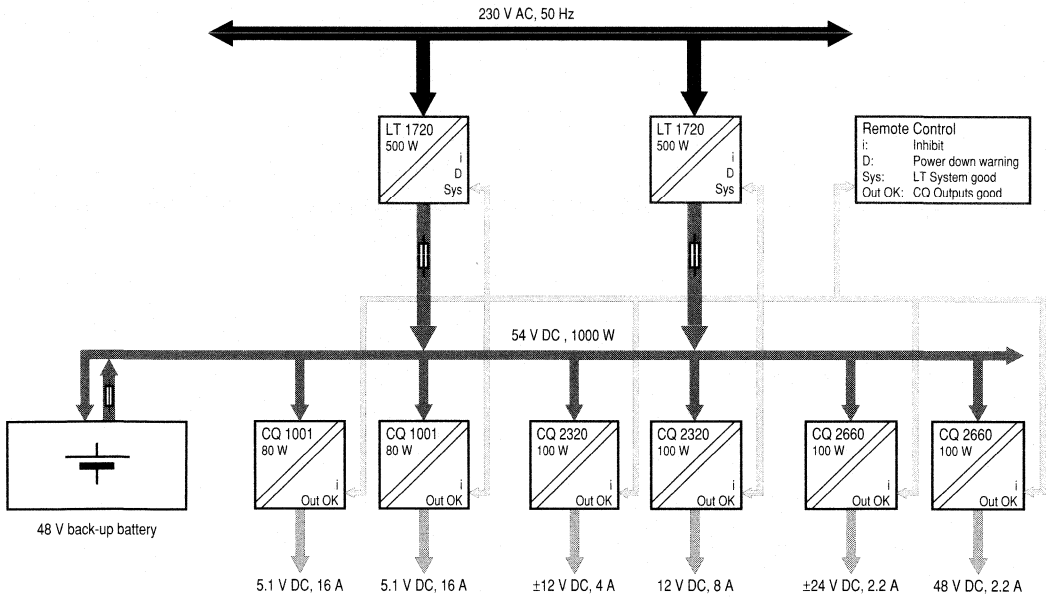

This system configuration features:

- Safety according to IEC 950/EN 60950
- Virtually no inrush current at start up
- Different types of LT units providing output voltages of 54.5 V (±1%) for 24 element or 52.2 V (±1%) for 23 element batteries (2.27 V trickle charge voltage, $T_A$ = 22°C)
- Trickle charge voltage characteristic with negative temperature coefficient according to VDE 0510/DIN 41773
- Ideally adapted voltage, current and power limitation characteristics in battery charging mode



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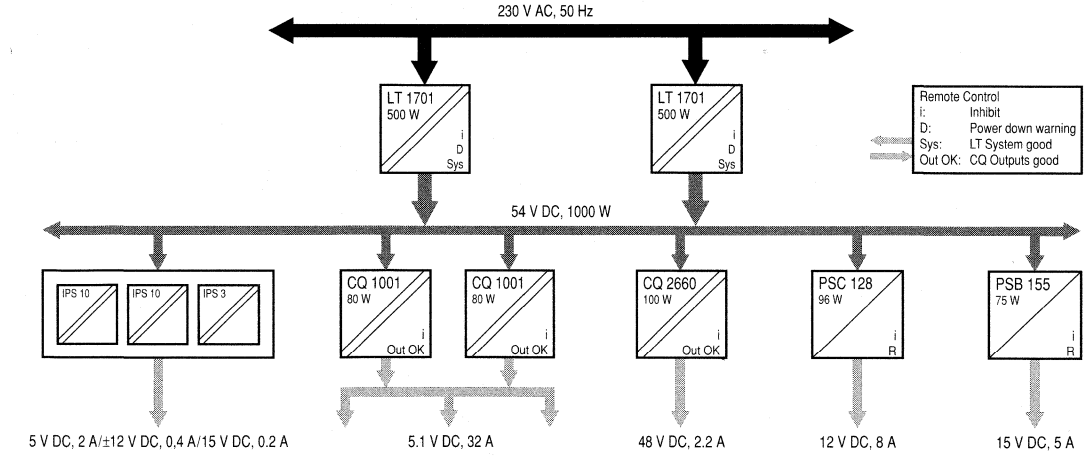
## 48 V Parallel Battery Back-up




This system features:

- Safety reqirements in accordance with IEC 950/ EN 60950/VDE 0805 part 100
- Full galvanic isolation at each distribution level and from the back-up battery
- Protection of the battery against heavy discharge by means of undervoltage monitoring and a cut-out facility
- A simple realization of a UPS including full signalling and a virtually free choice of battery capacity

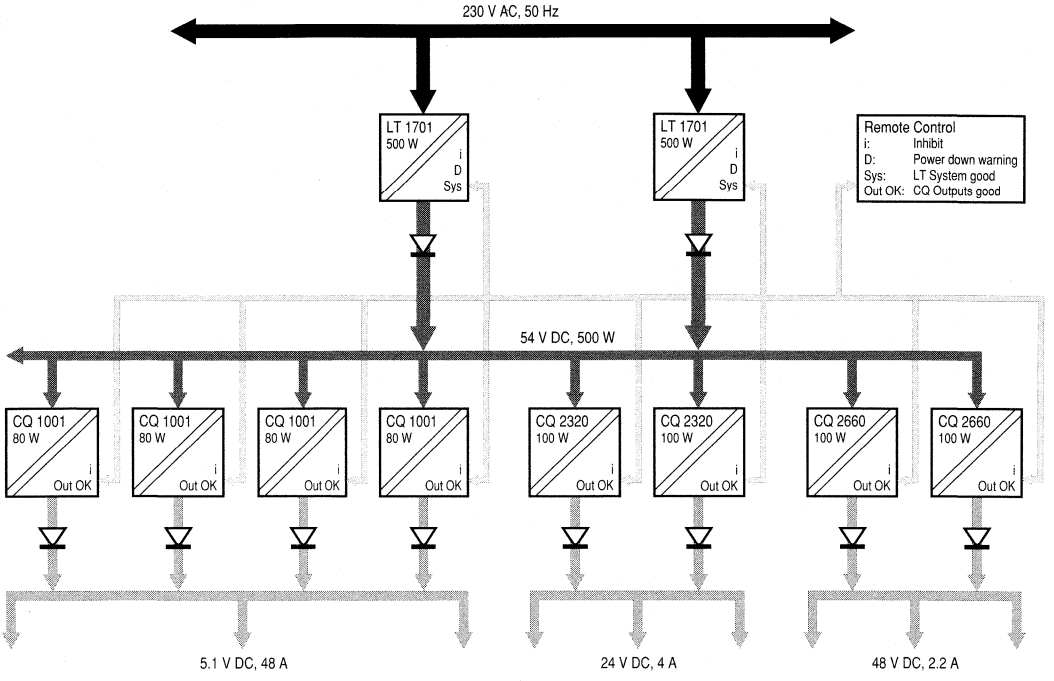
## Decentralized Power Distribution




This system features:

- Harmonic currents well below the limits defined by IEC 1000-3-2/EN 61000-3-2
- System bus voltage of 54 V, i. e. Safety Extra Low Voltage (SELV) according to IEC 950/EN 60950
- Any combination of galvanically isolated or non isolated second stage converters, depending on the customers needs
- Possible later expansion by adding supplementary modules according to future power requirements

## True n+1 Redundant Power Supply




This system features:

- Power factor PF = 0.99 in accordance with IEC 1000-3-2/ EN 61000-3-2
- N+1 redundancy provided at each power distribution level, i.e. the redundancy may be selected for every power group according to customer needs
- System bus voltage of 54 V, i.e. Safety Extra Low Voltage (SELV) according to IEC 950/EN 60950
- Signals for the operating status of each module allowing easy monitoring of the system.
- Servicing at full power without system interruption is possible, since hot plugging is allowed


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# 13 Application Notes


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# Protection Circuits

## input Fusing

If an external fuse is essential the user should consider the following:

1. The fuse should have an $I^2t$ rating capable of withstanding the turn on inrush current but it should also be fast enough to blow before the components it is intended to protect.
2. It should be rated to carry more than the maximum continuous input current. The maximum input current can be calculated as follows:

$$I_{max} = \frac{P_{out}}{\eta \cdot U_{i\,min}}$$

3. Fuse mounting and termination should be carefully considered to reduce the temperature rise due to contact resistance and thermally insulating fuse holders (Any additional heating of the fuse will reduce it's effective current rating).

## Reverse Polarity Protection

**Switching Regulators:**

- PSR, PSA, PSB, PSC, PSL and NSR units are fitted with an internal Zener diode «guaranty diode». This diode goes into short circuit in case of reversed polarity or overvoltage.
  (If the source energy is unlimited, the Zener diode vaporises and then the power supply is unprotected.)
- PSK and PSS units are fitted with an internal fuse and a suppressor diode. The diode goes into short circuit in case of reversed polarity or overvoltage and will cause the fuse to blow.

**DC-DC Converters:**

- A...DM, FM and SR units are protected with an externally accessible fuse. Reverse polarity will cause the fuse to blow. The fuse can be replaced by the customer.
- In EM types a series diode will protect the unit.
- H units are fitted with an internal suppressor diode «guaranty diode». The diode fails into short circuit in case of reversed polarity or overvoltage.
- A...CK, E/FK, A...CS and E/FS units are protected with an internal fuse. Reverse polarity will cause the fuse to blow.
- On DK and DS units the switching transistor fails before the fuse blows.
- Q units are fitted with an internal fuse. The fuse only blows if the source energy is very high. If not, the input capacitor and the switching transistor will fail.

**AC-DC Converters:**

- Due to the internal bridge rectifier reversed polarity protection is not required.

**Conclusion:**

If reversed polarity were applied, such units have to be sent back to Melcher for repair, except the M and SR units.

## Output Protection

Overvoltage at the output can damage the power supply!

In Melcher power supplies, a voltage suppressor diode or a second independent control circuit protects the output(s) and the load against an internally generated overvoltage. Overvoltage could occur for example due to a failure of the control circuit or unconnected sense lines. In the worst case condition, the suppressor diode fails into a short circuit.

The units fitted with a second independent control circuit are the SR, Q and LT's. These units are not protected at all against externally applied overvoltage or transient source, e.g. motors, etc. On other units, the suppressor diode is not designed to withstand externally applied overvoltages, but it protects them against further damage. The diode does not protect the load against overvoltage.

The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

### Crow Bar

Switching regulators (except those in case A01) can be provided with a thyristor crowbar. (Option C)

The thyristor crowbar acts as a protection against internally as well as externally caused overvoltages, but it is not designed to sink external currents.

The current rating of a thyristor crowbar is limited, e.g.:

| | | |
|---|---|---|
| PSB | case B02 | $I_{SC}$ = 8 A |
| PSC, PSL | case C03/L04 | $I_{SC}$ = 15 A |
| PSK, PSS | case K01/S01 | $I_{SC}$ = 15 A |

This has to be taken into consideration when a powerful external source is fed into the output of the power supply or when power supplies are connected in parallel, as the unit with the lowest overvoltage trigger level will have to sink all currents, the maximum current supplied from the external source and/or the currents of the other paralleled units.

On PSK and PSS units, when the crowbar option is used with two or more power supplies in parallel, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits trigger simultaneously in order to disable all outputs together. The crowbar trigger voltage is monitored between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\ max}$ (between Vo+ and Go–) is not exceeded.

The crowbar trigger threshold is internally defined and not adjustable. However, just as each interconnected unit is able to trigger every other via the C terminal, it is possible to drive the crowbar trigger from external circuitry (fig.1). In this way, the user can define thresholds at any voltage **lower** than that internally programmed.

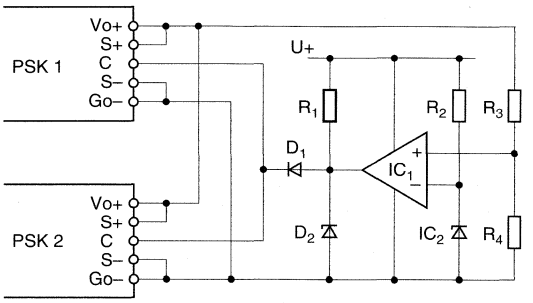
### Input Characteristics of Terminal C

(per unit, with respect to Go–):

| | |
|---|---|
| Input impedance (resistive) | 700 Ω |
| Parallel capacitance | 100 nF |
| Input voltage $U_c$ (no crowbar trigger) | 0 V ≤ $U_c$ ≤ 0.4 V |
| Input voltage $U_c$ (crowbar trigger) | 2.0 V ≤ $U_c$ ≤ 15 V |
| Maximum input voltage ($U_{c\ max}$) | 15 V |

**Note:**

The C inputs must be driven via a series diode ($D_1$) as shown in fig. 1.




U+: Suitable voltage source (assumed +12 V)
$R_1$: 1k5 for 1 PSK, 750R for 2 PSK's in parallel connection, etc.
$R_3$ /$R_4$: 1k00/4k99 respectively for a threshold of 15 V
$D_1$: 1N4148 (pull up diode)
$D_2$: BZX79C12 (only necessary for higher U+ voltages when $U_c$ may otherwise exceed +15 V)

*Fig. 1*
*Typical application of an external crowbar trigger circuit*

# Sense Lines

Sense terminals are provided for the PSK, PSS, S, K and Q families. Sense lines in general may cause trouble!

(Refer also to "Voltage Regulators/Converters: With or Without Sense Lines" below)

**Caution:** Incorrectly connected sense terminals will cause internally generated overvoltage!

## Sense Line Connections

Normally a power supply operating in a constant voltage mode achieves optimum line and load regulation, lowest output impedance, lowest drift and fastest transient recovery performance at the power supply output terminals. If the load is separated from the output terminals by any line length, some of these performance characteristics will be degraded at the load terminals by an amount proportional to the impedance of the load leads.

With remote error sensing it is possible to connect the sense terminals - defining the input of the voltage feedback amplifier - directly to the load so that the power supply regulates at the load rather than at the power supply output terminals. Thus, the voltage at the power supply output terminals shifts by up to the maximum allowed voltage per load line (see corresponding regulator data section) to compensate the voltage drop in the load leads, thereby maintaining a constant voltage at the load terminals. Higher compensation may damage the protection resistors or malfunction. However, the dynamic behaviour of such a configuration will be degraded.

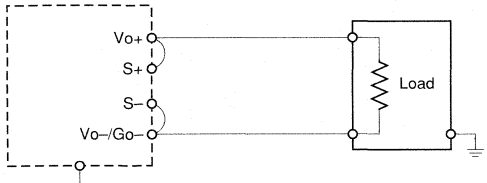



*Fig. 1*
*Sense lines linked at the connector terminals*

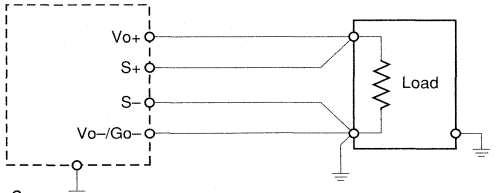



*Fig. 2*
*Remote error sensing*

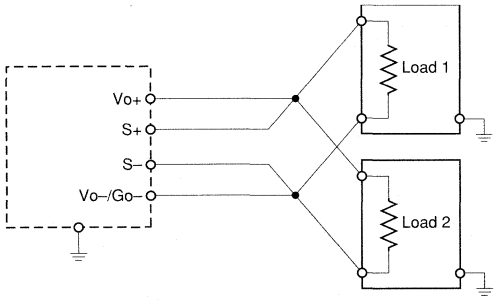



*Fig. 3*
*Remote error sensing of multiple loads*

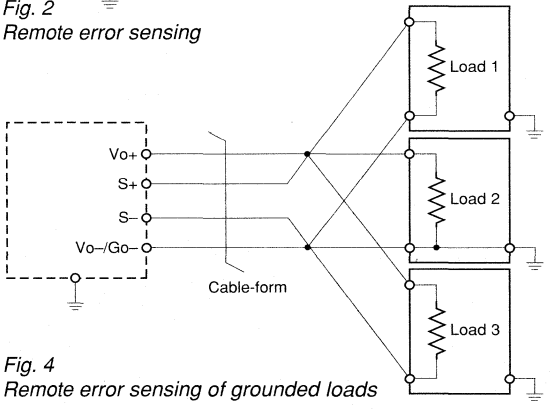



*Fig. 4*
*Remote error sensing of grounded loads*

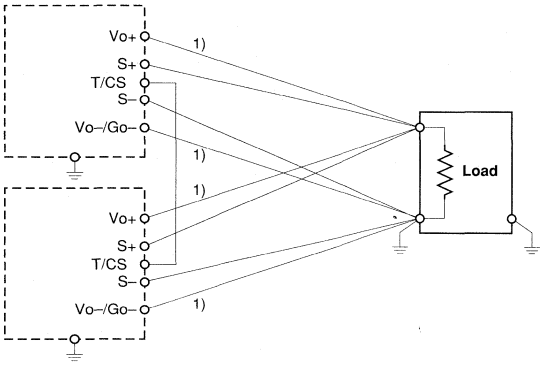
It is recommended to connect the sense lines directly at the power supply's connector and to compensate for any loss in output voltage with input R or option P (fig. 1).

In cases where very slow changes in the load occur the sense lines can be connected at the loads. The following rules have to be observed:

- Sense line should **always** be connected
- The DC-common point should be as close as possible at the load(s) end, see fig. 3 and fig. 4.
- Special consideration has to be taken to more than one grounded load. Here, only one load shall be grounded and the DC-common point selected at this load (fig. 4).
- Eliminating all switch, relay or connector contacts from the remote sensing paths will help to minimize the possibility of any loss of regulation. However, the loss of one sense line connection will result in an output voltage increase.
- Arrange sense and power lines in the same cable form (fig. 4). To minimize noise pick-up. Sense line wires should run parallel or be twisted.
- In noisy environments or when the sense lines are long (> 1m) it is recommended to use shielded cables to protect the sense signals from external noise.
- The maximum voltage drop which can be compensated by remote sensing is limited (see corresponding regulator's data section). This limitation sometimes dictates the use of a larger wire cross section than such would be required by current rating or impedance considerations. Bear in mind that a compensation of 0.5 V means loosing 10% of overall efficiency of a 5 V power supply. This equates to a power loss of 12.5 W at 25 A!
- Although DC and low frequency performance is improved by remote sensing, over-/under-compensation associated with long load and sense leads can affect the stability of the feed back loops seriously enough to cause oscillation. This problem cannot be overcome directly. The only measure to prevent oscillation is the reduction of voltage drops and line impedances.

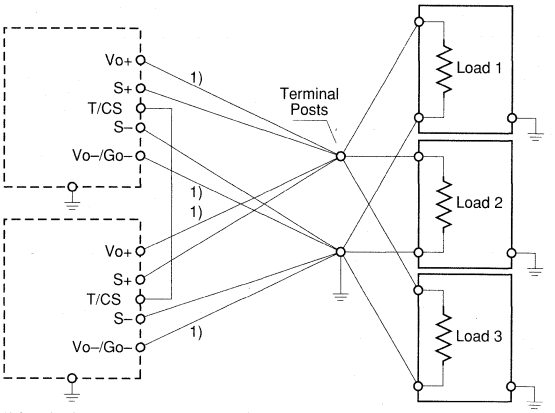
### Sense Line Connections in Parallel Operation

In most applications the sense lines will be linked at the connector terminals. However, when the sense lines are linked to a load they shall be connected to the DC distribution terminals as shown in fig. 6. The DC distribution terminals shall be placed as close as possible to the loads.




1) Leads should have equal length and cross sections, and should run in the same cable form

*Fig. 5*
*Single load configuration*




1) Leads should have equal length and cross sections, and should run in the same cable form

*Fig. 6*
*Multiple arrangement*

## Remote Sensing Operation of Power Supplies without Sense Lines

The R input (external output voltage programming) of the Melcher power supply units can generally be used for remote error sensing by adding an external circuitry. Some examples are given below:

### Switching Regulators

If the application calls for a compensation of the voltage drops in the connection lines between the switching regulator and the load, a single sense line S can be installed according to fig. 7. A reference diode D1 of 2.5 V is powered from input Vi+ via a constant current diode D2. The voltage divider $P_1/R_1$ defines the adjustment range with output voltage $U_o$.

The voltage drop across the ground line $R_{Go}$ is routed to voltage divider $R_2/P_2$ via sense line S and causes an increase of the reference voltage which is amplified by the switching regulator with its gain factor K.

If the divider $R_2/P_2$ is dimensioned such that the resulting increase of the output voltage between terminals Vo+ and Go– is equal to the sum of the voltage drops across $R_{Vo}$ and $R_{Go}$ as caused by $I_o$, the nominal voltage $U_o$ will be applied across the load. The internal resistance of the source is then exactly zero. The setting of $P_2$ can also be used to obtain over-compensation. The source will then necessarily have a negative internal resistance.

For 5 V devices, if approximately identical voltage drops across $R_{Vo}$ and $R_{Go\ are}$ are given, the cathode of D1 can be connected directly with S (fig. 8).

Generally, the introduction of the remote sensing method should be carefully considered with switching regulators. Although the static voltage drops of the power lines can be compensated, the result is a substantial deterioration of the dynamic characteristics as opposed to the parameters given in the specification.

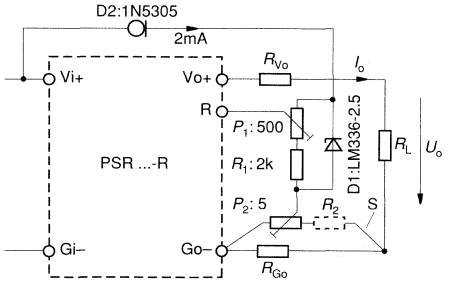



*Fig. 7*
*Remote sensing mode*
*$P_1$: Adjustement of output voltage*
*$P_2$: Adjustement of internal resistance*

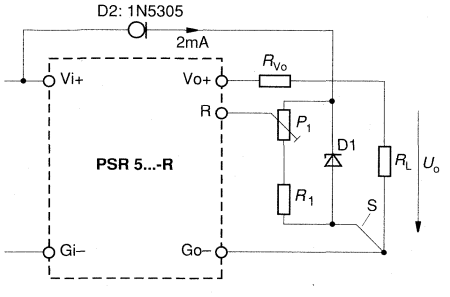



*Fig. 8*
*Simplified remote sensing operation for 5 V devices*

### A...LM 1001-7R

Both, the positive and the negative load wires should have equal length (equal Rw+ and Rw–). The maximum voltage drop (ΔU+ and ΔU–) which can be compensated is limitted to 0.25 V in each line.

**Note:** Set $U_R$ to 2.50 V by means of the potentiometer $P_1$.

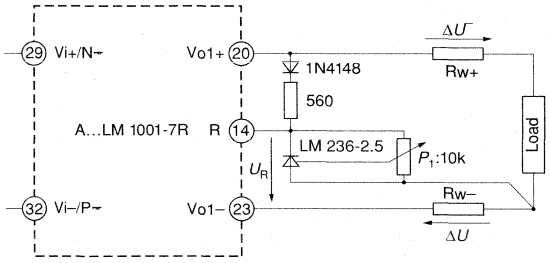



*Fig. 9*
*Remote sensing operation of an A...LM 1001-7R*

## Voltage Regulators/Converters: With or Without Sense Lines?

A discussion under particular consideration of switching regulators

### Control Principles

Fig. 10 shows the basic configuration of a switching regulator. It consists of the converter W which is responsilbe for the active control function, and of the passive part of the regulator formed by *L* and *C*. The output voltage $U_o$ of the switching regulator - the controlled variable - is internally routed back to the actual controller R via two short sampler lines +S and –S. Comparing this sampler feedback (controlled variable) with the possibly adjustable reference value(see "Without sense lines but with compensated mean voltage drop"), the controller generates the correction value and feeds it to the converter W.

If a switching mode regulator is used for power supply control purposes, the application will often involve long supply lines which inherently and obviously cause resistive and inductive voltage drops. This is illustrated in fig. 11.

In general, power consumption in the load will vary with time; thus, its input voltage will also vary by the voltage drop attributable to line impedance.

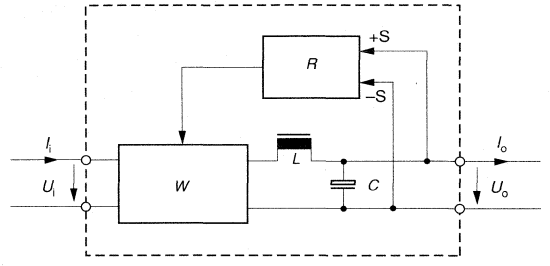



*Fig. 10*
*Block diagram of a switching regulator*

### Sense Lines

Such an effect is often undesirable and can be corrected by measuring the output voltage (controlled variable) directly at the load as shown in fig. 12. It should be noted however, that all control functions are still contained in the regulator. The resistive component of the sense line impedance is negligible due to the small currents involved and was therefore not shown in fig. 12.

### Dynamic Behavior

If a regulator is subject to transient loads from a consumer, this will result in a voltage drop with resistive and inductive components across the supply lines. This phenomenon occurs irrespective of whether sense lines are used. The behavior of the two circuits according to fig. 11 and fig. 12 can be distingushed in the reaction of the controller to this load change.

The static control deviation has been neglected in the following considerations.

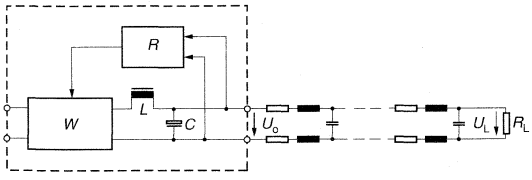



*Fig. 11*
*Switching regulator*
*Diagramm shows equivalent circuit of line impedance,*
*$R_L$ = load resistance (consumer),*
*$U_L$ = voltage across load resistance*

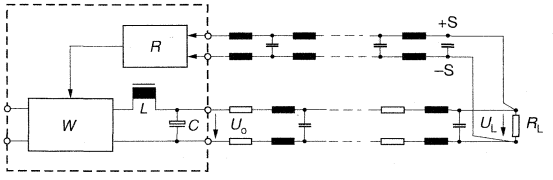



*Fig. 12*
*Switching regulator with sense lines*

**Without Sense Lines** (fig. 11)

When connecting a load, a charge deficit $\Delta Q$ occurs in capacitor $C$ and produces a control deviation

$$u_{od} = \frac{\Delta Q}{C}$$

at the output of the controller (see fig. 13. $\Delta Q$ depends on the current transient and on the reaction time of the controller).

The recharging cycle is governed by the time constant

$$\tau_{LC} = \frac{\pi}{2} = \sqrt{LC}$$

which corresponds to about one fourth of the period of resonance frequency

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Sometimes the dynamic control deviation caused by a current transient form 10% to 90% of it's maximum current is specified.

It is the responsibilty of the user to minimize the resistive and inductive voltage drop by using adequately wiring for the supply lines and by keeping them as short as possible.

A similar result is obtained if we observe the discontinuous current reduction from 90% to 10% (fig. 13). The voltage across the output capacitor follows Lenz' law in that it briefly rises due to the energy stored in self-inductance L and then also drops to the desired value within

$$\tau_{LC} \approx \frac{\pi}{2}\sqrt{LC}$$

A suitable selection of the elements $L$ and $C$ will keep $u_{od}$ and $\tau_{LC}$ small. However, a reduction of $u_{od}$ can be obtained only at the expense of a longer reponse time $\tau_{LC}$.

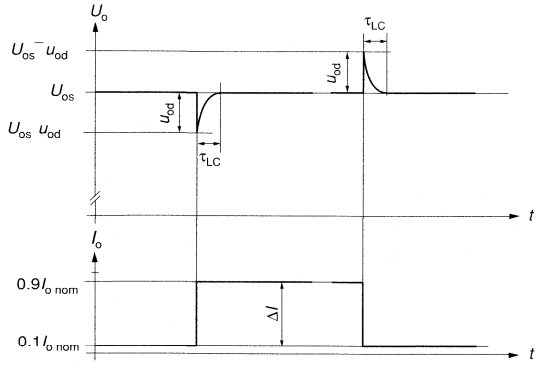



*Fig. 13*
*Dynamic behavior of controller without sense lines.*
*Voltages measured across capacitor C (output of controller).*
*$U_{os}$ = desired controller voltage*
*$I_{o\,nom}$ = specified maximum output current of the controller*

**With Sense Lines** (fig. 12)

In addition to the dynamic control deviation $u_{od}$ as described above, a load increase also produces a deviation $\Delta U$ at the consumer due to the voltage drop in the supply lines. This new dynamic control deviation $u_{sd} = u_{od} + \Delta U$ is sent to controller $R$ via the sense lines. The charge deficit $\Delta Q$ of capacitor $C$ interpreted from this information is so large that the controller passes into the short-circuit mode to recharge the capacitor with its short-circuit current $I_{oL}$ until the voltage at the consumer has risen to the desired value $U_{LS}$ again. Fig. 14 illustrates this behavior.

When recharging, the voltage across the capacitor rises with a rate of

$$\left(\frac{dU}{dt}\right)_r = \frac{1}{C} \cdot \frac{dQ}{dt} = \frac{1}{C} \cdot I_{oL}$$

until it reaches $U_{ss} + \Delta U$, i.e. a value which is higher than the desired voltage $U_{LS}$ across the consumer. The voltage will remain at this level until the next load change occurs (fig. 15).

When the load is decreased, the voltage drop across the supply lines is reduced instantaneously and the still existing overvoltage across capacitor $C$ produces a voltage $U_{LS} + \Delta U$ across the consumer, i.e. a voltage exceeding the desired value $U_{LS}$ by the reduction of the voltage drop $\Delta U$. This process also involves the dynamic control deviation $u_{od}$ (fig. 14). The voltage across the sense lines is now higher than the desired voltage; this causes the controller to stop supplying any further energy to capacitor $C$. Instead, the access charge in $C$ must be removed - basically, this can only take place via the residual load.

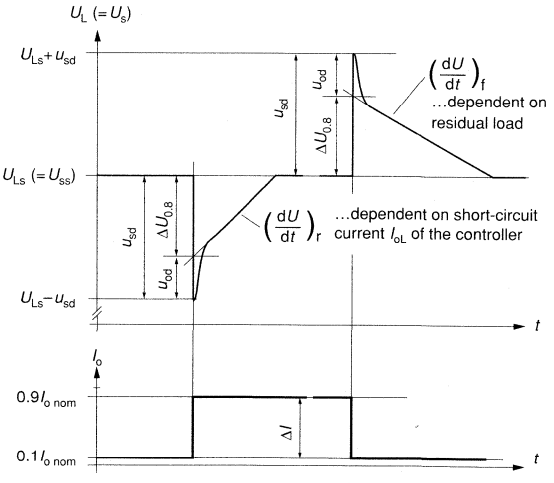



*Fig. 14*
*Dynamic behavior of controller with sense lines.*
*Voltages measured at sense line connection to consumer.*
*$U_s$ = $U_L$ = voltage across the sense lines*
*$\Delta U_{0.8}$ = change of voltage drop across sense lines caused by a current transient $\Delta I$ from 0.8 $I_{o\,nom}$ (inductive voltage drop neglected).*

During the entire discharge period, the consumer is operating with a voltage which exceeds the desired voltage $U_{LS}$. The capacitor is discharged with a rate of

$$\left(\frac{dU}{dt}\right)_f = \frac{1}{C} \cdot \frac{dQ}{dt} \approx \frac{U_0}{R_L C} e^{-t/R_L C}$$

wherein $R_L C >> \tau_{LC}$.

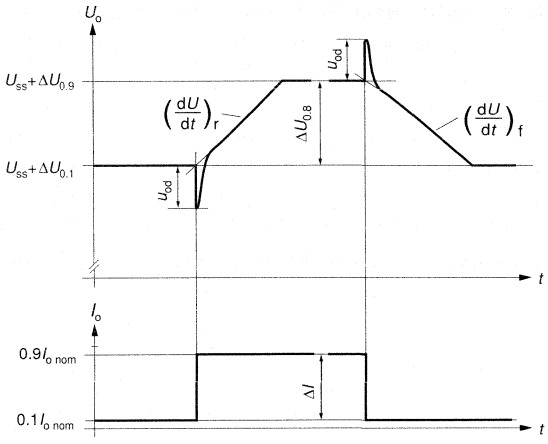



*Fig. 15*
*Dynamic behavior of controller with sense lines. Voltages measured across Capacitor C (output of controller).*
*$\Delta U_{0.1}$ = voltage drop across supply lines caused by a current of $0.1 I_{o\,nom}$*
*$\Delta U_{0.9}$ = voltage drop across supply lines caused by a current of $0.9 I_{o\,nom}$*

**Without Sense Lines, but with Compensated Mean Voltage Drop** (fig. 16)

The smallest peak voltage deviations across the consumer are obtained if the output voltage $U_o$ of the controller without the use of sense lines is increased by changing the reference value (i.e. a potentiometer) to such an extent that the input voltage $U_L$ of the consumer corresponds to the desired voltage $U_{LS}$ for a mean load ($\hat{=} I_{o\,m}$). This generally produces a (load-dependent) static deviation $\Delta U$ at the input of the consumer, but the maximum occurring deviation from the desired value is 0.5 $\Delta U_{max}$ smaller than in a circuit with sense lines! $\Delta U_{max}$ is the change of the resistive voltage drop in the supply lines caused by the maximum operational current change $\Delta I_{max}$. Fig. 17 shows the response in both cases for $\Delta I_{max} = 0.8\ I_{o\,nom}$.

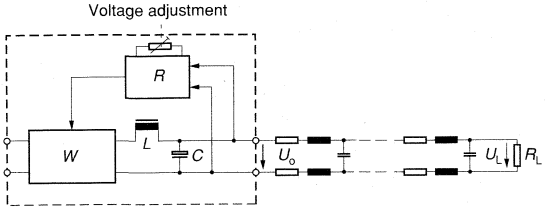



*Fig. 16*
*Switching regulator with permanently adjusted output voltage.*

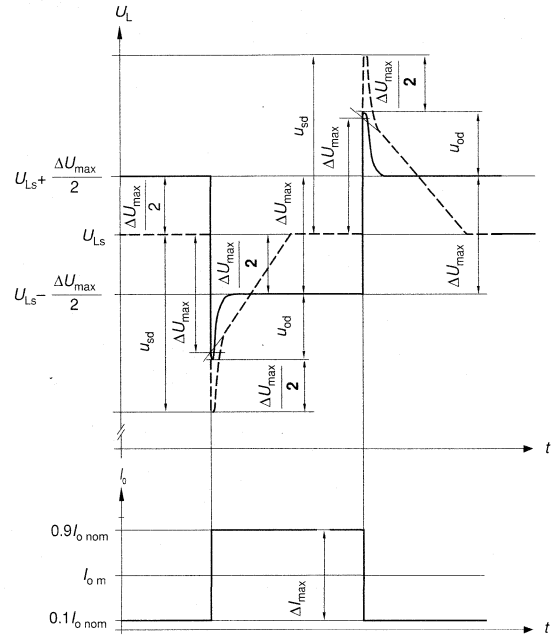



*Fig. 17*
*Dynamic behavior. Comparison of circuit with sense lines to circuit with compensated mean voltage drop*
———— *with sense lines*
— — — *with compensated mean voltage drop*
$I_{o\,m}$ = *mean operational current*
*(in the illustration: $I_{o\,m} = 0.5\ I_{o\,nom}$)*

### Final Considerations

The following conclusions can be derived from the statements above and from experience:

- Sense lines result in a compensation of the static voltage drop. This may encourage the user to employ smaller cross section supply lines. Although the static characteristics comply with the specifications, the dynamic behavior will change considerably. As mentioned above, the control loop is stretched and the voltage is no longer measured at the place where it is produced. To be specific:
- The storage capacity $C$ is at the wrong place; it would have to be removed from the controller and relocated at the connection points of the sense lines. For switching regulators, this can hardly be implemented for the following reason:

  The current in the feed line to the capacitor has a high AC content attributable to the basic circuit-principles. This produces electromagnetic interference fields which can only be sufficiently reduced with a relatively large shielding effort.
- The total deviation $u_{sd}$ of the input voltage $U_L$ of the consumer from the desird value $U_{Ls}$ is the sum of the dynamic control deviation $u_{od}$ and of the resistive voltage drop change $\Delta U$ produced by the load transient in both supply lines.
- If an additional storage capacity identical in size to the one incorporated in the controller is wired across the load, the value of the new dynamic control deviation $u_{sd}$ introduced by the sense lines is reduced only to half of its original size at the consumer.
- In all cases - even if several consumers are powered by one controller (normal case, because each transistor and each IC represents a consumer) - static conditions are only obtained for the voltage at the sense line connection point. Current distribution at least from this point onwards should therefore be handled with sufficiently sized conductors (voltage drop between connection point and consumers).
- In appliances with relatively low output voltages, the power loss attributable to the voltage drop $\Delta U$ across the lines rapidly reaches a magnitude which can no longer be neglected within the overall output power rating. Example: $U_L = 5$ V, $\Delta U = 0.5$ V per supply line wire. Power loss $P_V = 20\%$ of rated power!
- Fig. 12 shows that the existence of sense lines is equivalent to stretching the switching regulator; this produces a loop. Sense lines not only transmit the voltage level at the connection point to controller R but also crosstalk from the electromagnetically active environment. Under certain circumstances, this may cause uncontrollable oscillations.
- The input of controller R is exposed; unfavorable wiring concepts and insulation flaws can have serious consequences.

### Conclusion

An increase of conductor cross sections and if possible the use of shorter supply lines are more effective measures against voltage drops than the application of sense lines.

For logic applications, it is generally recommended to use a bus system with wide, large-area conductors. For mechanically movable connections, it is possible to use highly flexible cable which is still practical even if relatively large cross sections are needed. A cable with a cross section of 6 mm$^2$ can still be bent to a radius of 1 cm. The voltage drop at 6 A and in an overall length of 2 m is only 34 mV.

# Connection to System

## Cabling

The high currents associated with power supply applications can cause relatively high voltage drops in the system wiring. The most effective measures against these voltage drops are to increase the wire cross-section and if possible shorten the supply lines. For permanent connections it is generally recommended to use a bus system with wide, large-area conductors. For mechanically moveable connections it is possible to use highly flexible cables, which is still practical even if relatively large cross sections are used. Such a cable with 6 mm² allows a bending radius of 1 cm.

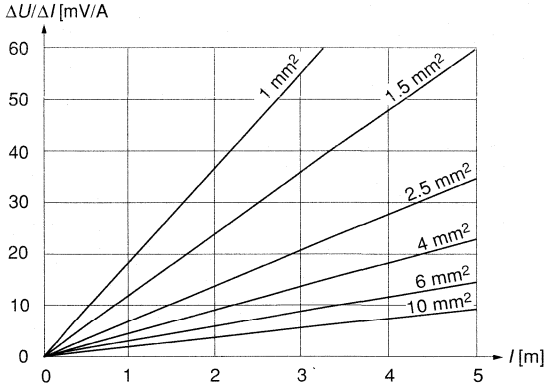



*Fig. 1*
*Voltage drop per ampere in copper lines versus the total line length I*

## Ground Connection and DC Common Point

Examples shown with switching Regulator PSK

The standard configurations are shown in fig. 2: The cases of the power supplies and the loads are separately connected to earth (star point to prevent idling currents). The Go– terminal shall be connected to ground if a grounded circuit is desired. Otherwise the Go– terminal is left open to provide a floating circuit.

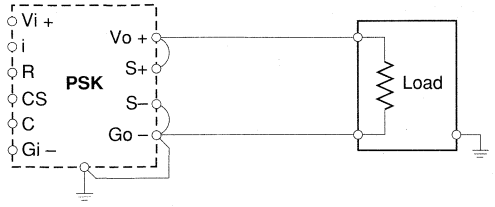



*Fig. 2a*
*Grounded circuit*

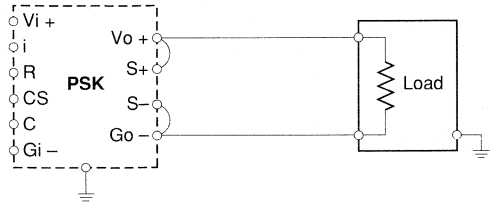



*Fig. 2b*
*Floating circuit*

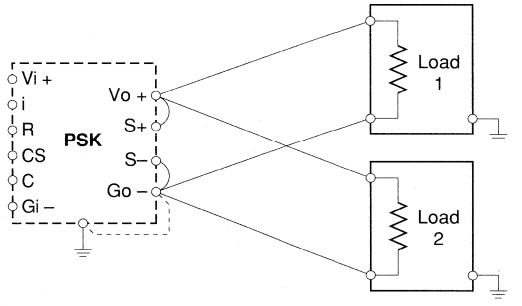



*Fig. 3*
*Connection of several single isolated loads*

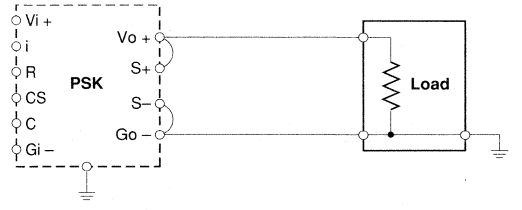



*Fig. 4*
*Load internal grounded circuit*

When connecting several seperate loads, all the power lines shall be connected at the power supply (star point, fig. 3).

Attention has to be given to loads which have internal connections to chassis and ground as in fig. 4. The load terminals of the grounded load must be designated the DC common ground. Ground loops must be avoided!

Individual ground connections for multiple loads must be avoided if at all possible. Ground loop currents circulating through the load wiring cannot be avoided if the loads have separate ground returns as shown in fig. 5.

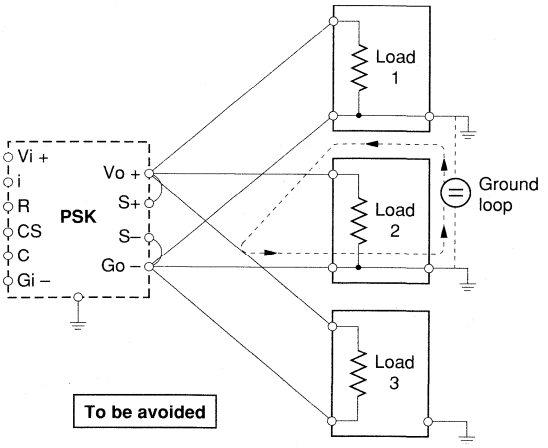
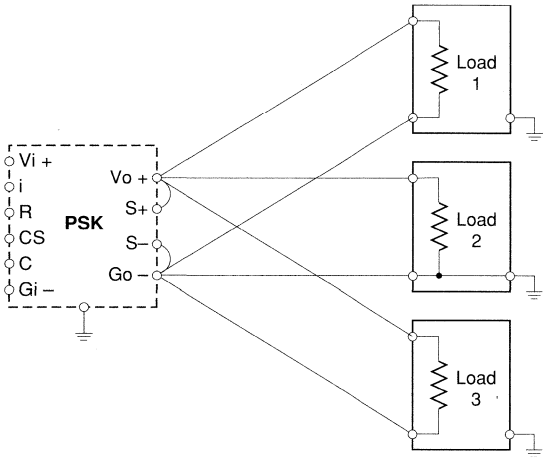



*Fig. 5*
*Individual ground connection*




One possible solution is to break the ground connection in all of the loads and then select the DC common point at the power supply using the multiple isolated load alternative as in fig. 3. Another solution would be to break the ground connection in all but one of the loads and select the DC common point as in fig. 6.

If there are two or more loads with ground connections that can not be removed and the system is susceptible to ground loop problems, then the only satisfactory solution is to increase the number of power supplies and to operate each grounded load from a separate supply. Each combination of power supply and grounded load would be treated as in fig. 4.

*Fig. 6*
*Ground connection at the load for multiple loads*

## Ground Connection and DC Common Point in parallel operation

Example shown with switching Regulator PSK:

The same decisions as above have to be taken on where to ground the system and where to choose the DC common point. There can only be one DC common point allowed in a system.

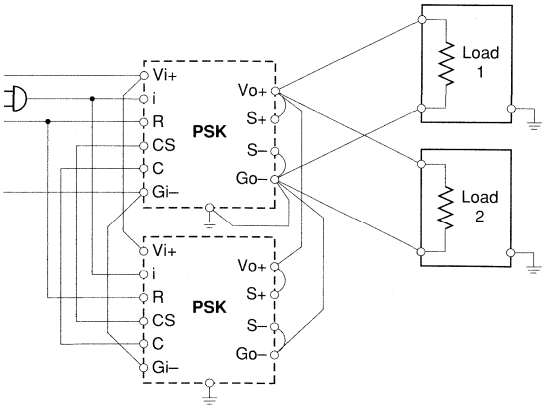



*Fig. 11*
*DC common point and ground connection of single isolated loads*

## Prevention of Ground Loops in Switching Regulator applications

A switching regulator amplifies the voltage between terminals R (external voltage adjustment) and G (Go) with its gain factor K. For the actual circuit, it is therefore necessary to consider the normal precautions which apply to amplifier technology: prevention of ground loops and injections from an electromagnetically active environments.

To reduce the interference voltages generated by the switching regulator itself, it is recommend to install a regulator with input filter (option L, included as standard in PSK).

For regulator types in case A01, for which option L is not available, a FP 38, FP 80 or FP 144 input filter can be used, depending on the input voltage.

Fig. 7 shows a line powered system. To prevent 100 Hz interference (hum), the input capacitor is floating. The minus line of load $R_L$ and the system reference ground are separately wired and all meet at terminal Go (case A01 does not have a separate G terminal if option R is installed). The ground line from Go to system reference ground does not carry current.

In DC-powered systems, a reference is frequently already defined, such as the minus pole on the vehicle chassis. Since the switching regulators do not have input to output isolation, the return line from Go to the system reference ground in this case will carry current. Depending on the way the load is wired, there are two possibilities (figs. 8 and 9).

Fig. 8 shows that the input current $I_i$ flows back to ground through the connection $R_{Go}$. To keep high-frequency components as small as possible, option L is used and Gi is not connected. The voltage drop $U_{R\,Go}$ is caused only by $I_i$ itself and appears as a common-mode signal at Go and Vo.

In fig. 9, both the battery and the load $R_L$ are connected directly to ground. In addition to the input current $I_i$, the load current $I_o$ also flows through the connection from Go to ground, but in the other direction. The voltage drop $U_{R\,Go}$ is caused by the difference between these two currents and appears superimposed across load $R_L$.

The user must decide whether version A or version B is to be selected for the given application. In both cases, a short line with the smallest possible resistance will keep $U_{R\,Go}$ small. Whenever possible, G (Go) should be selected as the reference point for $U_{ex}$. If this is not possible because of the application, and if the interference produced by voltage drop $U_{R\,Go}$ is not tolerable for the application, the only remedy is to isolate the control signal $U_{ex}$, for example with aid of an isolation amplifier (fig. 10).

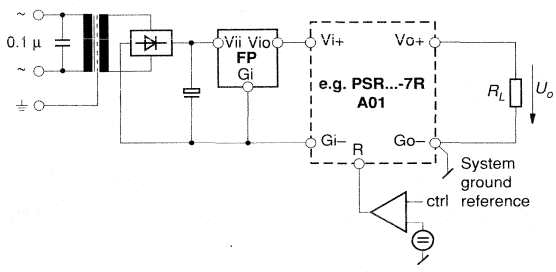



*Fig. 7*
*Line-powered supply system with analog control and override protection*

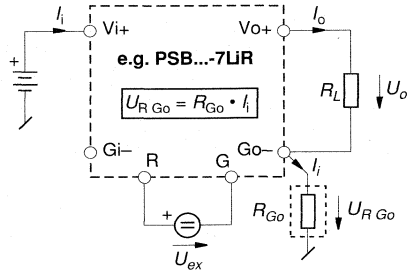



*Fig. 8*
*Battery-operated power supply version A*

*Fig. 9*
*Battery-operated power supply version B*

## Parallel Operation

All Melcher units can generally be used in parallel operation. Exception: IBEK and IMR families.

**Important note: Never disconnect any module while in operation!**

The terminals i and R (when used), C (when ever option C is installed) and CS/T (active current sharing) shall be interconnected. This provides for simultaneous operation of the crowbar, voltage adjustment and logical inhibit functions. Furtherr the output currents are shared between the units. For further details see the following paragraphs.

**Units without active current sharing.**

Suppose output voltage of device 1 is 5.2 V, of device 2 is 5.0 V.

If the total current $I_{o\,tot}$ is lower than $I_{o1\,L}$ device 2 will not operate because the output voltage is higher than its internal reference voltage.

If the current $I_{o\,tot}$ increases, it reaches the current limitation value $I_{o1\,L}$ of device 1. The voltage decreases to 5.0 V, which will cause device 2 to operate.

If $I_{o\,tot}$ is higher than $I_{o1\,L}$ both devices are operating, with device 1 continuously at its current limiting point $I_{o\,L}$ up to $1.3 \cdot I_{o\,nom}$.

In parallel operation, the increased power dissipation demands a reduction of the specified case temperature $T_C$ by 10 K.

The 20 W DC-DC converters, 20 W-LSR's/USR's AC-DC power supplies require a start up time of approx 20 ms. This can produce a voltage sag at the output if the current increase is fast. All other Melcher power supplies have no starting delay in parallel operation.

In parallel operation, each power supply works with its individual switching frequency, resulting in a superimposed ripple voltage. The beat frequency seen can vary between 0 Hz and the maximum frequency tolerance of the units.This depends on the various families. Worst case ripple voltage may be up to 1.5 times of the normal ripple voltage value.

In case of a short circuit [1] at one of the outputs of paralleled units, all units are short-circuited.

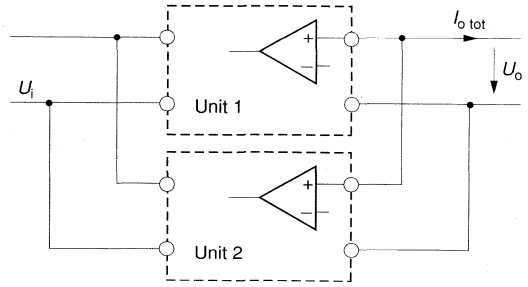
A diode in each positive output supply line prevents the remaining paralleled units being affected by this short circuit (voltage drop!):

However, if the short circuit is at the load [2], which is actually more often the case, they obviously don't help. Therefore it is advisable to split the load if ever possible.

If one of the units is a double or triple output unit, then the diodes ensure that the auxiliary outputs will continue to work, even if the main output does not deliver any current.

Measures which can be taken to improve parallel operation behaviour:

a) Insert a series resistor on each positive load line between supply output and connection point. If a continuous minimal current is required, the voltage drop will cause both devices to work . However, static control deviation at the load will be inferior (see following calculation example).



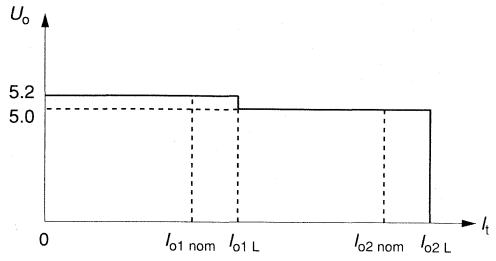




*Fig. 12*
*Parallel operation*

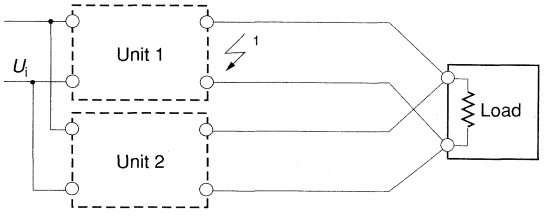



*Fig. 13*
*Short circuit in parallel operation*

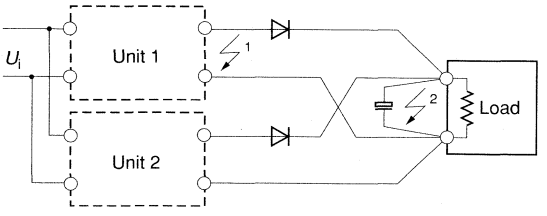



*Fig. 14*
*Short circuit protection*

b) Insert a series diode (Schottky diodes are recommended) in each positive load line. Both devices will work even without output current flow. Be sure to select a diode with a reverse-blocking voltage at least 50% higher than the nominal DC-voltage being supplied to the load and the forward current rating at least 25% higher than the modules current rating. (For 5.1 V units we recommend the double diode 62CNQ025 from International Rectifier). If desired, increase the output voltage by the forward voltage drop of the diodes by means of the potentiometer of "option P" or by ordering special output voltage, e.g. 5.5 V. Here too, control deviation will increase, but sense terminals could improve it.

However, an electrolyte capacitor accross the load will help to improve dynamic control deviation.

Example of paralleled units: The following example (Fig. 15) shows 2 BM 1301-7 in parallel and the calculation of their series resistors. The current limitation is $I_{oL} = 1.1 \cdot I_{o\,nom}$.

BM 1: $U_o = 12.07$ V  BM 2: $U_o = 11.93$ V

BM 1 with the higher ref. voltage will operate in current limitation

$I_{oL} = 1.1 \cdot I_{o\,nom}$  $I_{o1} = 1.1 \cdot 4$ A $= 4.4$ A.

BM 2 will take the remaining current

$I_{o2} = 8 - 4.4 = 3.6$ A.

$U_{R1} = R_1 \cdot I_{o1} = R_1 \cdot 4.4$ A
$U_{R2} = R_2 \cdot I_{02} = R_2 \cdot 3.6$ A
$U_{R1} - U_{R2} = \Delta U = 12.07 - 11.93 = 0.140$ V $= 140$ mV

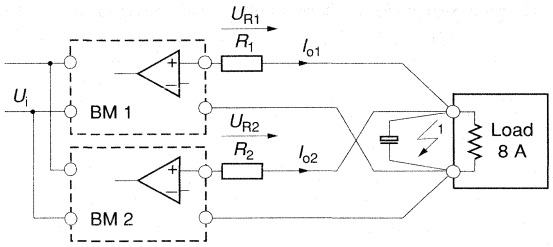



*Fig. 15*
*Parallel operation with series resistor*

$4.4 \cdot R_1 - 3.6 \cdot R_2 = 140$ mV
$R_1 = R_2 = R$  $R\,(4.4 - 3.6) = 140$ mV
$0.8\,R = 140$ mV

$$R = \frac{140\text{ mV}}{0.8\text{ A}} = 175\text{ m}\Omega$$

$U_{R1} = 4.4 \cdot 0.175\ \Omega = 0.77$ V
$U_{R2} = 3.6 \cdot 0.175\ \Omega = 0.63$ V
Voltage at the load $= U_{o1} - U_{R1} = U_{o2} - U_{R2}$

12.07 V – 0.77 V = 11.30 V
11.93 V – 0.63 V = 11.30 V

**Units with active Current Sharing**

The Melcher power supplies of the families PSK, PSS, K, S and Q are available with active current sharing circuitry. Active current sharing ensures that the output currents are approximately shared between all paralleled units by interconnecting the current sharing terminals (CS or T) of all units.

Whenever possible, units shall be interconnected in parallel directly at the connector via the shortest possible leads. Longer leads would create voltage differentials between the units and thus an unequal share of the load on each power supply.

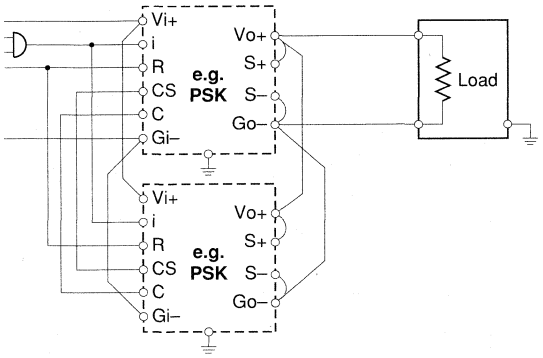
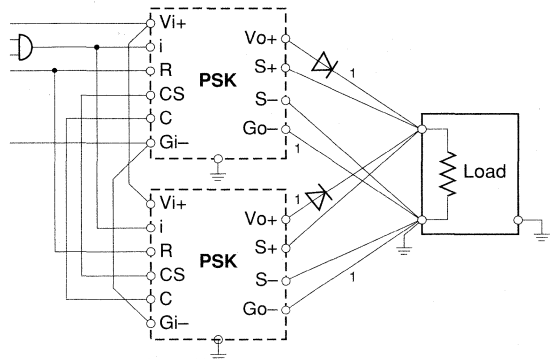



*Fig. 16*
*Paralleling of units with active current sharing*

**N+1 Redundancy**

True n+1 redundancy is defined as the parallel connection of power modules so that the total number of power modules is one greater than that required at full load. The power modules share the full load, and failure of any one module will not affect the remaining modules from supplying full load power.

In contrast to the above, a load failure will affect all power supplies. Split loads could avoid this behaviour.




[1] Leads should have equal length and cross sections and should run in the same cable loom

*Fig. 17*
*1 + 1 redundancy with two PSK in parallel*

## Supplementary Information to the data of Switching Regulators

These application notes provide supplementary information to the basic data sheets of the PSR (PSA, PSB, PSC, PSL) and NSR series of switching regulators and represents a helpful tool for succesful design-in. Figure 26 at the end of this chapter shows the capacitor $C_L$ rating for the PSK and PSS series.

### Negative Input Resistance $r_i$

The efficiency $\eta$ of a switching regulator is almost constant over it's entire operating input voltage range $U_i$. This results in a large input current $I_i$ at a low input voltage $U_i$ and a small input current $I_i$ at high input voltage $U_i$. This corresponds dynamically to a negative input impedance $r_i$, in terms of alternating current (see also "Long Supply Lines").

### Basic Requirements

The following basic requirements must be complied with to ensure correct operation of all PSR switching regulator families:
The specified input voltage range must be strictly adhered to. If the output is adjusted by using the R or P functions, the specified minimum differential voltage $\Delta U_{io\ min}$ between input and output must be maintained. The extreme values of any superimposed AC voltages should be taken into consideration, e.g. line ripple or ripple caused by reactive currents. The alternating voltage component of a switching regulator can achieve a maximum value of 0.8 $V_{pp}$ (CRO measuring bandwidth at 20 MHz) at $U_{i\ min}$ and $I_{o\ nom}$, assuming a line inductance of at least 2 µH (no option L and no external input capacitor). With a short circuited output, this alternating voltage component must never exceed 2 $V_{pp}$, within a frequency range of approx. 10...100 kHz.

### External Input Circuitry

**A01 Case:** Without additional external circuitry these regulators can be operated at input line length of a + b ≤ 0.5 m twisted, or ≤0.3 m untwisted (i.e. max. line inductance 0.5 µH, see fig. 1). For longer input lines an input filter is mandatory (see fig. 18 and "Long Supply Lines").

When several switching regulator inputs are connected in parallel, each regulator must be provided with a separate input filter. FP- and FN-filters for A01 modules are available as an accessory and are described in a separate data sheet for filters. Their performance is similar to that of option L.

In some cases an electrolytic capacitor $C_e$, connected close to the regulator input (e.g. 100 µF, length a + b as above, see fig. 19), might replace the filter, but consideration must be given to the high ripple current $i_{Ce}$ passing through this capacitor. The capacitor may also be combined with a choke (see "Filter and Chokes").

If the filter is to reduce interference voltages and currents simultaneously, the shortest possible connection between filter and regulator input has to be achieved. An additional capacitor $C_F$ will further reduce these interferences (see fig. 20).

**B02, C03 and L04 case:** These switching regulators can be operated without additional external circuitry for input line length of a + b ≤ 5 m (i.e. line inductance less than approx. 5 µH, see fig. 18), providing the input voltage $U_i$ is below 0.7 • $U_{i\ max}$. For longer input lines and/or $U_i$ > 0.7 • $U_{i\ max}$, option L is essential (see "Long Supply Lines").

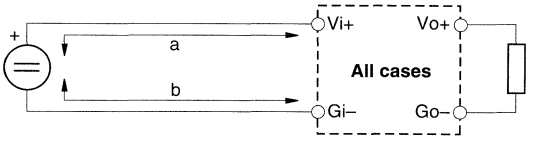



*Fig. 18*
*Switching regulator without external input circuitry*

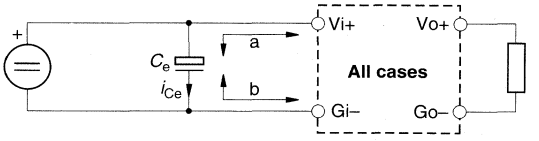



*Fig. 19*
*Switching regulator with external capacitor $C_e$ at the input*

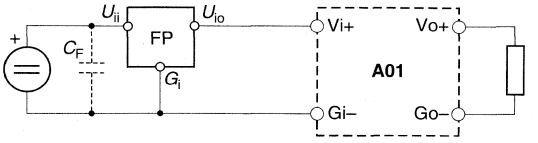



*Fig. 20*
*Switching regulator without external input circuitry*

### Long Supply Lines

When operating B02, C03 and L04 modules without input filter (option L), special measures may be necessary if the input lines between the switching regulator and the source (or the nearest capacitor of at least 100 µF) are longer than 5 m approx. (a + b as per fig. 18: connecting line inductance above 5 µH). The regulator's negative input resistance $-r_i$ together with the input line inductance $L_L$ and the internal capacitor $C_i$ form a parallel resonant circuit (fig. 21). If the resonant frequency of this circuit is significantly lower than the regulator's switching frequency (this is the case with a large $L_L$), the circuit may be excited by $r_i$. This can cause the input voltage to leave the switching regulator's specified range. Any resonant condition must therefore be avoided by adopting suitable means. Therefore consider:

$$-r_i = \frac{(U_{i\,min})^2}{P_{o\,max}} \bullet \frac{\eta}{100} \qquad (1)$$

$U_{i\,min}$ = min. regulator input voltage at normal operation
$P_{o\,max}$ = max. output power at normal operation
$\eta$ = regulator efficiency

The circuit does not oscillate under the following condition:

$$\frac{L_L}{R_L} < |\, C_i \bullet r_i \,| \qquad (2)$$

$L_L$ = Input line inductance to the nearest voltage source (a + b, see fig. 21). An inductance of approx. 1 µH/m input line length can be assumed for calculation. Any capacitor larger than 100 µF can be treated as a voltage source.

$R_L$ = Total resistance of input lines and source or input lines and the series resistance of the capacitor resp.

$C_i$ = 6.8 µF for A01, 13.6 µF for B02 and 27.2 µF for C03 and L04 cases

If the calculation shows inequality (2) one or several of the following measures must be taken:

- Use of regulators with input filter (built-in as option L, available in cases B02, C03 and L04).
- Reduction of input line inductance $L_L$ (twisting the two lines reduces line inductance by 30% approx.).
- Increase of resistance $R_L$ in the input lines (smaller cross section), although not recommended due to associated additional losses.
- Introduction of an external capacitor $C_e$ between Vi+ and Gi– (fig. 19) with following capacitance (observe also section "External Input Circuity" for determining the capacitor characteristics):

$$C_{e\,min} = \frac{L_L}{|\, R_L \bullet r_i \,|} \qquad (3)$$

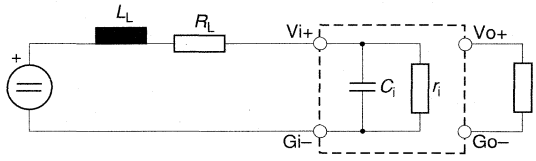



*Fig. 21*
*Regulator without input filter and with long input lines*

### Operation in Rectifier Mode

Switching regulators operated in rectifier mode, neither tolerate an underride nor an override of the specified input voltage range (full-load condition at the lowest line voltage or no-load condition at the highest line voltage respectively). Therefore an external charging capacitor $C_L$ (fig. 22 and 23) is in this case always required. Transformer, rectifier and capacitor dimensioning are given below.

### Rectifier Rating

In circuits configured with bridge type or centre-tapped rectifiers, every diode conducts a pulsating direct current with a peak value reaching about three times the current $i_{CL}$ through the capacitor. The mean value of current passing through each diode is approximately half the regulator's input current.

A considerable peak inrush current appears at system switch-on. This peak value can vary from about seven times (centre-tapped rectifiers) up to twenty times (bridge rectifiers) the value of the pulsating peak current. The diode's cutoff voltage for bridges has to be at least twice the nominal value of the transformer's secondary voltage and four times this value for a centre-tapped rectifier configuration.

### Single Phase Transformer Rating

If a transformer is operated with rectifier and charging capacitor at it's secondary output, it cannot supply any current during the relatively long lasting non-conducting phase of the rectifier but is then exposed to a correspondingly higher load during the diode's conducting phase. The root mean square value of this pulsating current is nearly twice as high as it's average value. The rated transformer power in VA must be at least twice the regulator's input rating, assuming a mains voltage tolerance of –15% to +10%. The regulator's input power is calculated by it's output power and efficiency $\eta$.

For example PSC 5A12-7iR: Output power $P_o$ = 5.1 V • 12 A ≈ 60 W, efficiency $\eta$ = 81%, thus resulting in an input power of $P_i$ = 60 W/0.81 = 74 W and in a minimum transformer power rating of 150 VA. Transformer ratings are usually valid for a maximum ambient temperature of 40°C. Many applications require operation at higher temperatures, thus, thermal considerations must be taken into account, e.g. by consulting the manufacturer for transformer rating calculation.

Assuming a mains tolerance from –15% to +10%, the nominal value of the transformer secondary voltage is recommendet to be either 20 $V_{rms}$ for units with $U_{i\,max}$ = 35...40 V, or 48 $V_{rms}$ for units with $U_{i\,max}$ = 80 V.

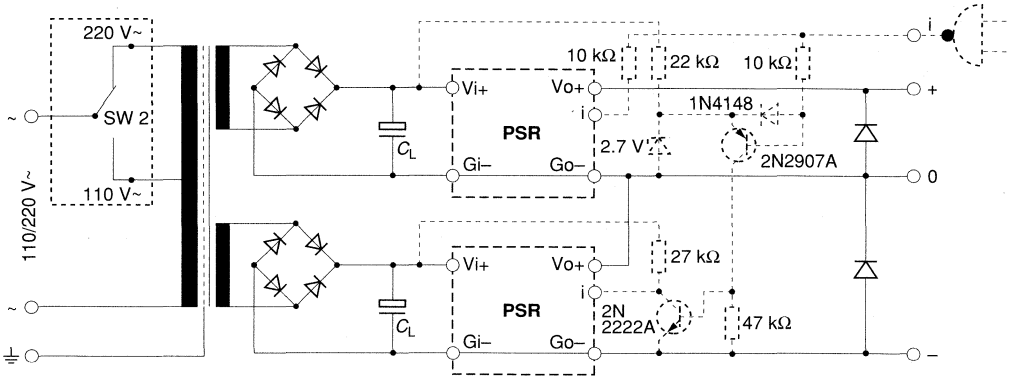



*Fig. 22*
*Symmetrical power supply consisting of two PSR modultes in bridge type rectifier mode*

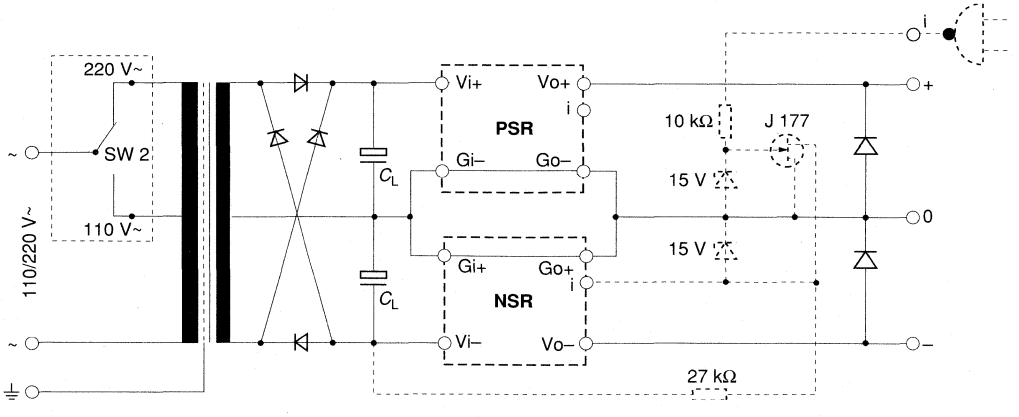



*Fig. 23*
*Symmetrical power supply consisting of one PSR and one NSR module in centre-tapped rectifier mode*

### Capacitor $C_L$ Rating

The capacitance $C_L$ and the current $i_{CL}$ of the charging capacitor can be determined from the diagrams below. These diagrams are based on a bridge type or centre-tapped rectifier circuit configurations, a mains voltage tolerance from –15% to +10% and a mains frequency of 50 or 60 Hz, in combination with above mentioned transformer ratings.

With several switching regulator inputs connected in parallel, the sum of the output power $P_{o\,tot}$ (addition of each regulator's individual $P_o$) must be utilized to determine capacitance $C_L$ from the diagrams.

Configurations without option L and without an external input filter will have an additional ripple current flowing through the capacitor (see also "External Input Circuitry"). This current must be taken into account when the capacitor rating is determined. Generally rating the capacitor for the higher of the two current values should be sufficient.

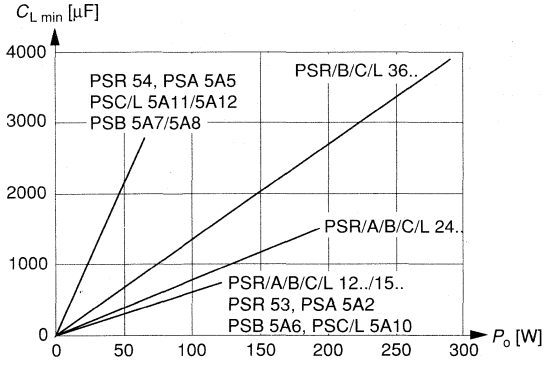



*Fig. 24*
*Minimum capacitance $C_{L\,min}$ versus regulator's output power $P_o$*

Using option L, the input line length becomes irrelevant. However, under no circumstances must the maximum input voltage $U_{i\,max}$ be exceeded.

### Application Examples

Two different symmetrical power supply configurations with line voltage selector (SW 2), transformer, rectifier, capacitor and output protection through suppressor diodes (preferably schottky) are shown in fig. 22 and 23. Additionally a circuit for inhibit level shifting is suggested with dashed lines. Careful attention must be paid to the PCB lay-out, in order to avoid ground loops or to keep them as small as possible.

**Note:** Eurocards of 3HE/7TE with up to three output voltages in similar configurations to those above are available as Multi-Voltage-Cards. Also PCB's for DIN rail mounting are available as Mounting Brackets. Please ask for detailed information.

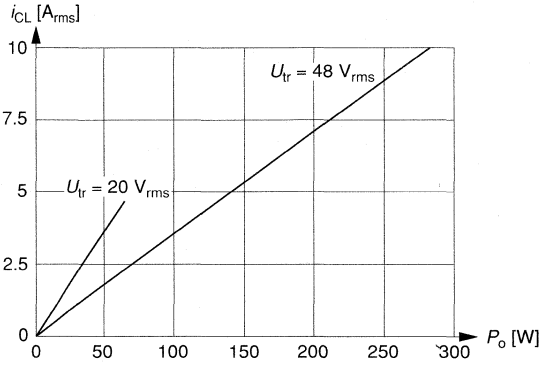



*Fig. 25*
*Current $i_{CL}$ of the capacitor $C_L$ verrsus regulator's output power $P_o$*

### Capacitors $C_L$ Rating for PSK and PSS series

When operating PSK's from a transformed and full-wave rectified AC voltage, the ripple voltage component at the PSK's input terminals must be considered. The external capacitance $C_{L\,min}$ (between rectifier and PSK input) has to maintain the ripple voltage below 10 $V_{pp}$ at full load. The ripple current through $C_L$ can achieve rather high values and careful consideration in the selection of $C_L$ must take place.

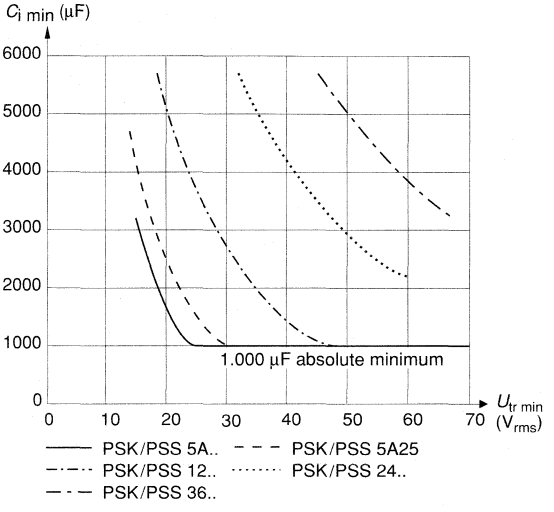



*Fig. 26*
*Minimum capacitance $C_{L\,min}$ versus transformer AC voltage (single unit operation)*

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# Melcher Power Supplies Data Book 1995
# Errata

**Page 1 - 6**

Fig. 7: Change $U_o \leq U_i$ to $U_o \geq U_i$

**Page 1 - 12**

*Table 1: Safety relevant characteristics according to IEC 950*

| Characteristics | Isolation path with primary installation category II | | | | | | Unit |
|---|---|---|---|---|---|---|---|
| | Primary to earth Class I equipment | Primary to secondary Class II equipment | Primary to earth Class III equipment | Secondary to earth All equipment | | | |
| Nominal voltage | ≤300 rms | ≤300 rms | ≤60 DC | ≤60 DC | | | V |
| Transient rating | 2500 | 2500 | 1500 | 0 | 1500 | 2500 | $V_p$ |
| Maximum leakage current at $U_{i\,max}$ and $f_{line\,max}$ | 3.5 (up ot 5% of $I_i$ with warning label) | 0.25 | – | – | – | – | mA |

**Page 1 - 14**

Change unit dB/µV to dBµV

**Page: 4 - 45**

Table 6: Change $U_{is}$ from 7500 to 750 V DC for PSK 3616/PSK 3620

**Page: 5 - 1**

Change case type of IMR 6 from DIL 24 to 2"× 2"

**Page: 5 - 14**

Table 6: Change temperature range of -T for $T_A$ from 0...71 to –25...71°C and for $T_C$ from 0...91 to –25...91°C.

**Page 2 - 24**

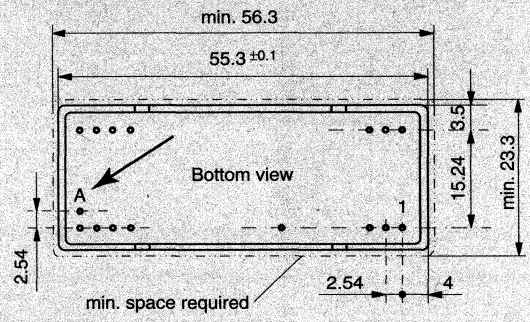



*Fig. 8:*
*DIL 40 plastic case,*
*Weight 23 g*

**Page 5 - 16**

Table 9: Alternative pin configuration group has changed to following:

*Table 9: Alternative pin configuration*

| Group | 1 | 2 | 3 | 9 | 11 | 12 | 14 | 16 | 20 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04 | - | Gi | Gi | - | - | - | Vo | Go | - | Vi | Vi | - |
| 05 | - | Gi | Gi | Go | –Vo | - | +Vo | Go | - | Vi | Vi | - |

The converters of groups 04 and 05 are designated as CPS 3 types. The type variety and all specifications are the same as for the IPS 3 group 01 and 02 with the exception of the shutdown function which is not available.

**Page 5 - 21**

Change in all table heads the type definitions
from .. IPZ 10-05 to .. IPZ 5-05
from .. IPZ 10-12 to .. IPZ 5-12
from .. IPZ 10-15 to .. IPZ 5-15

**Page: 5 - 22**

Table 6: Change temperature range of -T
for $T_A$ from 0...71 to –25...71°C and
for $T_C$ from 0...91 to –25...95°C.

**Page 5 - 24**

Fig. 13: Change pin configuration in drawing from B to F

**Page 5 - 26**

Change type: 24 ICR 5-1515-T to 24 ICR 6-1515-T

**Page 5 - 45**

Table 3a and 3b: $u_o$ output noise voltage values changed as per following tables:

*Table 3a: Output data*

| Characteristics | | Conditions | .. IMR 6-05 | | | .. IMR 6-12 | | | .. IMR 6-15 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Nominal output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | 4.90 | | 5.10 | 11.76 | | 12.24 | 14.70 | | 15.30 | V |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | 1000 | | | 500 | | | 400 | | mA |
| $u_o$ | Output noise voltage | $U_{i\,min}$...$U_{i\,max}$<br>$I_o = 0.2 \leftrightarrow I_{o\,nom}$<br>BW = 20 MHz | | 100 | | | 240 | | | 300 | | $mV_{pp}$ |

*Table 3b: Output data*

| Characteristics | | Conditions | .. IMR 6-0505 | | | .. IMR 6-1212 | | | .. IMR 6-1515 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Output** | | | min | typ | max | min | typ | max | min | typ | max | |
| $U_{o\,nom}$ | Nominal output voltage | $U_{i\,nom}$, $I_{o\,nom}$ | ±4.90 | | ±5.10 | ±11.76 | | ±12.24 | ±14.70 | | ±15.30 | V |
| $I_{o\,nom}$ | Nominal output current | $U_{i\,min}$...$U_{i\,max}$ | | ±500 | | | ±250 | | | ±200 | | mA |
| $u_o$ | Output noise voltage | $U_{i\,min}$...$U_{i\,max}$<br>$I_o = 0.2 \leftrightarrow I_{o\,nom}$<br>BW = 20 MHz | | 100 | | | 240 | | | 300 | | $mV_{pp}$ |

**Page 6 - 28**

Table 1a: Change input voltage range of CS types from 128...140 V DC to 28...140 V DC

**Page 6 - 29**

Table 2: Change title from H15 and H15 S4 connector pin allocation to H15 connector pin allocation

**Page 6 - 87**

Table 1a: Change all type definitions from ....-7R to ....-2R

**Page 6 - 101**

Type Key: Change type definition of 48Q2540-7RP (top right corner) to 48Q2540-2RP and in
Example: 48Q2540-7P to 48Q2540-2P (center of page).

**Page 7 - 4**

Table 1b: Change input voltage range of CK types from 128...140 V DC to 28...140 V DC

**Page 8 - 1, 9 - 1 and 10 - 1**

Change in all tables the input voltage definition from V DC to V AC

**Page 8 - 5**

Table 3a: Change rated output currents from 3.5 to 4.0, 1.5 to 1.67, 1.3 to 1.33, 0.9 to 0.83 and 0.4 to 0.42 A

**Page 9 - 46**

Table 1: Change at $P_{o\,tot}$ $T_A$ = 71°C to $T_A$ = 60°C

**Page 10 - 27**

Complete as follows

*Table 1a: Type Survey (All typical values at 20°C)*

| Output Voltage at 0.5 • $I_{O\,nom}$ [1] [V] | Temperature Coefficient of Output [mV/K] | Maximum Output Power [W] | Output Current Limit [A] | Input Voltage [2] Range (47...63 Hz) [$V_{rms}$] | Efficiency $\eta$ [%] | Type |
|---|---|---|---|---|---|---|
| 53.5 | –48...–108 [8] | 550 | 14.5 | 85...255 | 93 | LT 1740-7 [6 7] |
| 53.52...55.68 | –48...–108 [8] | 550 | 14.5 | 85...255 | 93 | LT 1740-7Z [6 7] |

[1...7]

[8] Defined by external sensor

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**Page 10 - 27**

Complete as follows

*Table 1b: Survey of options*

| Option | Function of option |
|---|---|
| G [1] | Galvanically isolated System Good and Power Down signal |

---

**Page 10 - 32**

Complete last row as follows

*Table 5: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [2] | Value applied | Waveform | Source impedance | Test procedure | in operation | Performance |
|---|---|---|---|---|---|---|---|---|---|
| Electric field susceptibility | IEC 801-6 | 3 | i, o, signal wires | 10 V | Sine wave modulated w. 1 kHz | 50 Ω | AM 0.15...80 MHz | yes | [1] |

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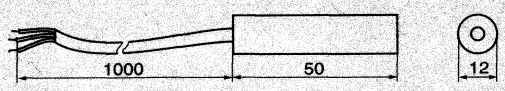
**Pages 10 - 37 to 10 - 48**

Change in text and figures all type definitions from CQT units to CQ units.

---

**Page 10 - 52**

Fig. 44: Change diameter from 50 to 12 mm




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**Page 10 - 69, Fig. 14**
**Page 10 - 70, Fig. 15 and Fig. 16**
**Page 10 - 71, Fig. 17**

All top views: The 4 - M4 threads are actually on bottom side.

---

**Page 10 - 41**

Change text (center right of page) from
– Control voltage out of range (5.5 V < $U_{cr}$ > 11.5 V) to
– Control voltage out of range (5.5 V > $U_{cr}$ > 11.5 V)

---

**Page 10 - 60**

Fig. 6 and Fig. 7 top view: the 4 - M4 threads are actually on bottom side.

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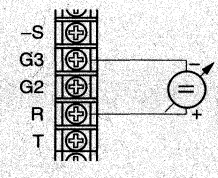
**Page 11 - 12**

Text center right:
Change .. at least 470 mF
to .. at least 470 µF

---

**Page 10 - 66**

Fig. 6: The polarity of the external voltage is inverse, e.g. negative to G3 and positive to R connected.




**Page 13 - 13**

Ad Fig. 9 and Fig. 10 as follows

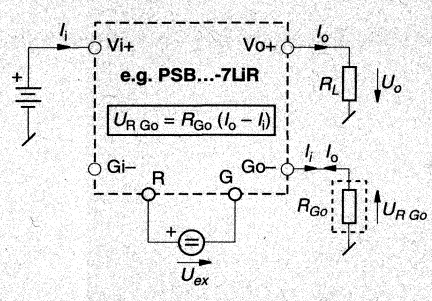



*Fig. 9*
*Battery-operated power supply version B*

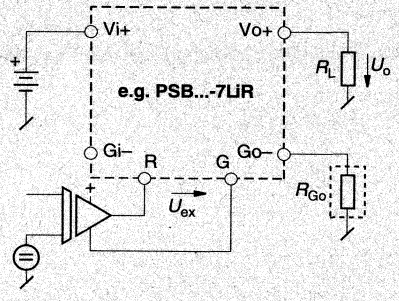



*Fig. 10*
*Battery-operated power supply with ground referenced control circuit and buffer amplifier*

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