DUAL TRACKING DC POWER SUPPLY

PDM35-3

INSTRUCTION MANUAL

KIKUSUI

Part No. Z1-609-920, IB002322

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Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

WARNING

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

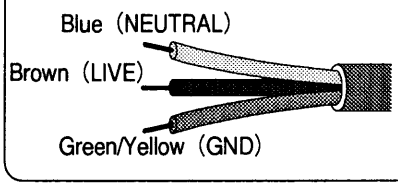
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

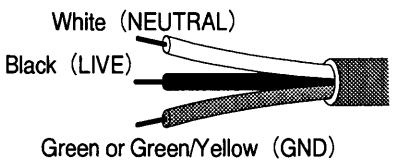
WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

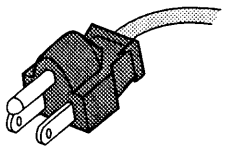
☐ Without a power plug



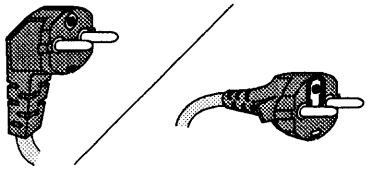
☐ Without a power plug



☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

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KIKUSUI

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1. GENERAL

Kikusui Model PDM 35-3 Tracking-type Dual Tracking DC Power Supply employs general-purpose monolithic IC's and silicon semiconductors and provides excellent electrical performances and operation reliability.
The rectifier circuit is a preregulator type which employs SCR's. The power supply is designed compact by supressing the loss of the series transistors.

The power supply provides a positive and a negative powers at the same time. That is, the power supply can be used as a dual power supply of 0 ~ +35 V and 0 ~ -35 V or as a single power supply of 0 ~ 70 V.

The output current rating is 3.0 A for both positive and negative powers. Each power supply circuit has a constant current transfer type of current limiting circuit in order to protect against overload and output shorting. The overload state is indicated by an LED light. When either one of the two output has become overloaded, the other one tracks the output voltage of the overload domain.

The power supply employs such a tracking system that the negative output voltage follows the positive output voltage. The setting of the negative output voltage is adjustable continuously-variably for a range of ±20% of the setting of the positive output voltage. (Note: When in this mode of operation, the maximum negative output voltage is limited at -37 V.)

The output voltage is finely adjustable with the 10-turn helical potentiometer. The output can be easily ON-OFF controlled with the OUTPUT switch on the equipment front panel. Other than in the single unit operation, the equipment can be used in one-control parallel operation and remote-control operation.

The width of the equipment front panel is a half of that of the standard 19-inch (500-mm) rack. Two equipment units can be installed in parallel on the rack. The outputs are available also at the rear terminal block.

2. SPECIFICATIONS

Input power:	100 V, 50/60 Hz single-phase AC; at full load: ±35 V, ±3A; approx. 590 VA
Ambient temperature:	0°C ~ 40°C
Dimensions: (Maximum dimensions):	210 W × 140 H × 360 D mm 215 W × 165 H × 415 D mm
Weight:	Approx. 14 kg
Accessories:	Shorting bar ..... 1 Instruction manual .... 1 Fuses, 8 A, (replacement spare) 2
Front terminals:	Binding posts, 19 mm spacing, inverted T-shape layout. Color code: Red (+), white (-), black (COM), black (GND)
Voltage to ground:	±150 V maximum
Output voltage:	(1) 0 ~ ±35 V (complimentary outputs) (2) 0 ~ 70 V (series output)
Output current:	3.0 A maximum

Ripple noize: (1) 0.5 mV rms (complimentary outputs)
(2) 1 mV rms (series output)
(5 Hz ~ 1 MHz)

Output regulation: Line voltage regulation (against ±10% change of AC line power)

(1) 0.005% + 1 mV (complimentary outputs)
(2) 0.005% + 2 mV (series output)

Load regulation (against 0 ~ 100% change of load)

(1) 0.005% + 1 mV (complimentary outputs)
(2) 0.005% + 2 mV (series output)

Transiential response: (Against 10% ~ 100% change of load)

50 μsec (typical)

Spec: Period for recovering to within 0.1% of output voltage

Temperature coefficient: 100 PPM (typical)

Dual tracking: 0 ~ ±35 V
with 10-turn helical potentiometer

Tracking adjustment:	Negative output voltage continuously-variably adjustable for ±20% with respect to positive output voltage
	Note: Negative output voltage is limited at -37 V.
Overload protection circuit:	Automatic constant-current transfer type (set current 3.2 A)
	Overload state is indicated by LED (red). When one of the two output is transferred into the constant-current domain, the other output follows the voltage of the output which is transferred.
Temperature detection circuit:	Cuts off the output when heat sink temperature has exceeded 110°C.
Indicating meters:	Voltmeter: 35 V DC, JIS class 2.5 (Positive/negative selection by switch)
	Ammeter: 3 A DC, JIS class 2.5 (Positive/negative selection by switch)
Insulation resistance:	Between input and GND: 500 V DC, 30 MΩ
	Between output and GND: 500 V DC, 20 MΩ

3. EXPLANATION OF PANELS AND OTHER ITEMS

3.1 Explanation of Front and Rear Panels

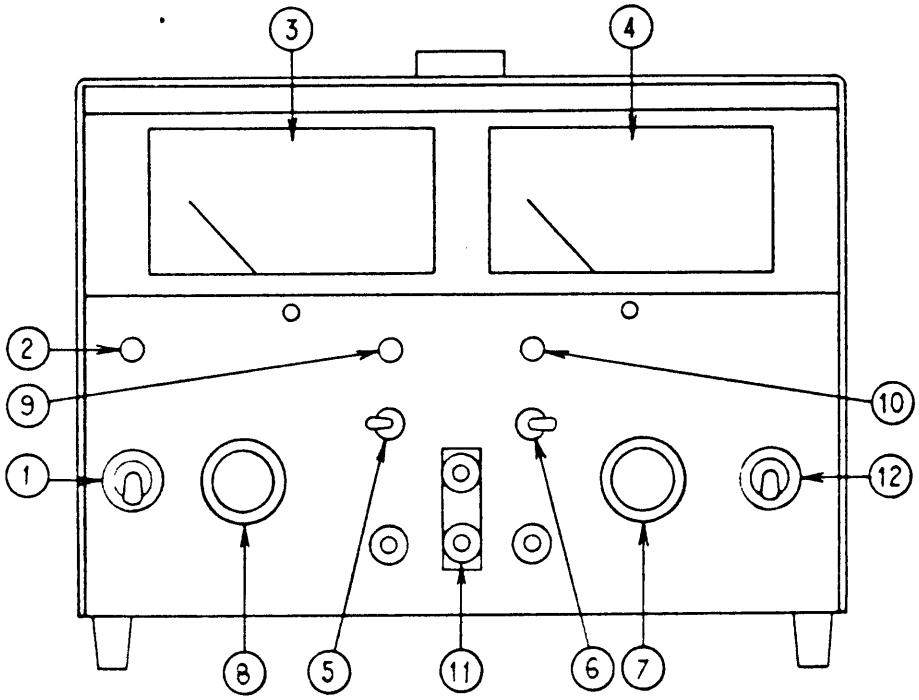

Figure 3-1 Front panel

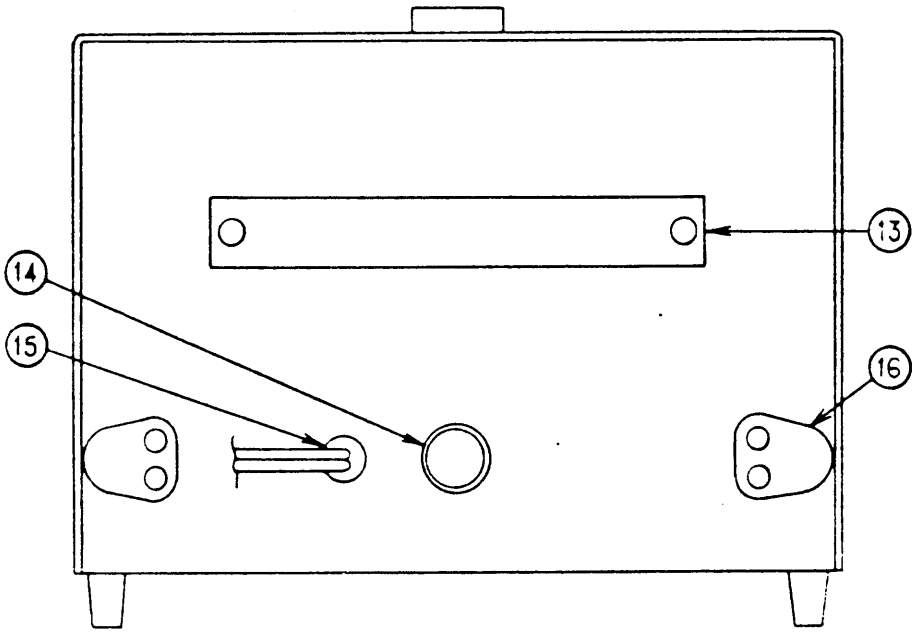

Figure 3-2 Rear panel

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(1) INPUT POWER switch: For ON-OFF control of input power. Top position is for ON, and LED (green) light turns-on.

(2) POWER LED: Turns-on to indicate that the input power is being applied. (green)

(3) AMMETER: Output ammeter, 3.0 A full scale. Accuracy: JIS Class 2.5

(4) VOLTMETER: Output voltmeter, 35 V full scale Accuracy: JIS Class 2.5

(5) AMMETER switch: Selects ammeter polarity between positive and negative.

(6) VOLTMETER switch: Selects voltmeter polarity between positive and negative.

(7) DUAL TRACKING potentiometer:

Adjusts the positive and negative output voltages at the same time. The output increases as this potentiometer (10-turn helical potentiometer) is turned clock-wise.

(8) NEGATIVE OUTPUT potentiometer:

Adjusts the negative output voltage within a range of ±20% of set value of positive output voltage.

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Note: When the positive output voltage is 31 V or over and this potentiometer is set at +20%, the negative output voltage is limited at -37 V.

(9) OVERLOAD LED: Turns-on when the negative output has become an overload state when transferred to the constant-current domain). Approx. 3.2 A (red LED)

(10) OVERLOAD LED Turns-on when the positive output voltage has become an overload state (when transferred to the constant-current domain). Approx. 3.2 A (red LED)

(11) OUTPUT terminals: Consist of NEGATIVE terminal (white), COM terminal (black), POSITIVE terminal (red), and GND terminal. Provide ±35 V outputs (complimentary) or 70 V output (series).

(12) OUTPUT switch: For ON-OFF control of output power.

Note: If this switch is ON-OFF operated with the output being shorted, the switch may be fused and it may become impossible to turn-off the power. Do not operate this switch under such state.

(13) Rear terminal block: Has OUTPUT terminals (negative, GND, COM, POSITIVE terminals), ONE-CONTROL PARALLEL-OPERATION terminals, and REMOTE CONTROL terminal.

(14) Input fuse holder: Has 8-ampere fuse.

(15) AC power cord

(16) Power cord takeup

3.2 Notes in Use

(1) Input power

Input voltage:	100/110/117 V ± 10%, AC
Frequency:	48 ~ 62 Hz
Standard:	100 V ± 10%, AC
Apparent power:	590 VA

(2) Output: Available at binding post terminals on front panel and at rear terminal block. Make sure that the jumper bar of rear terminal block is securely connected.

(3) Ambient temperature: 0°C ~ 40°C

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(4) Place of use: Do not use the equipment under any of the following conditions:

- o High humidity, dusty
- o Not well ventilated
- o Near a souce of heat

3.3 Items to be Checked Before Turning-on the Power

(1) Check that the AC line voltage is within the specified tolerance.

(2) Check that the fuse is of the correct rating (8 amperes).

3.4 Overshoots of Output Voltage

When the input power switch is turned on or off, no overshoot voltages higher than the set voltage are produced.

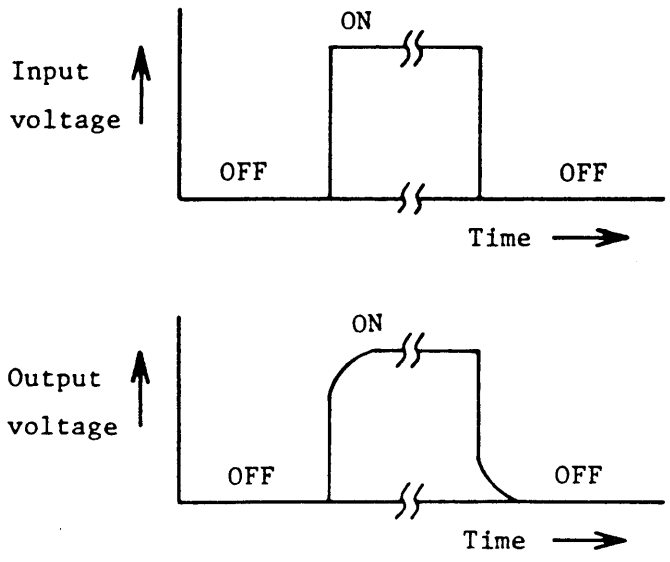


Figure 3-3

3.5 Transiential Response

This equipment responds sufficiently rapidly to transiential changes. It can handle such load as digital circuit the loading effect of which changes rapidly and transientially. This rapid response signifies also that the equipment can handle a wide range of frequencies and also that the circuit is a readily oscillatable state or not.

The transiential response speed (see ranges or less) depends on the characteristics of the capacitor connected in parallel to the output terminals of the voltage regulating circuit and on the wiring length.

The length meant in the above is that of the wires only to the output terminals. When the wires which connect this equipment to the load is long, the inductance of these wires becomes not negligible. In such a case, connect capacitors between the output wires (in a position as close to the load as possible) in order to make up a filter circuit as a typical example shown in Figure 3-4.

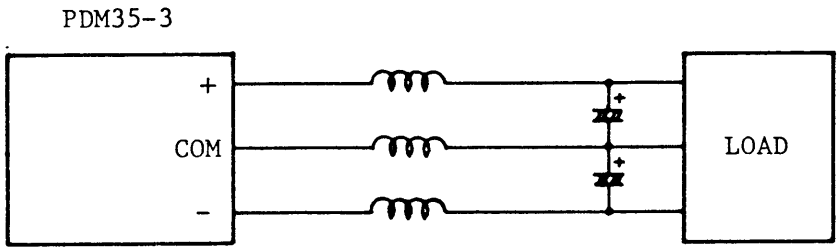


Figure 3-4

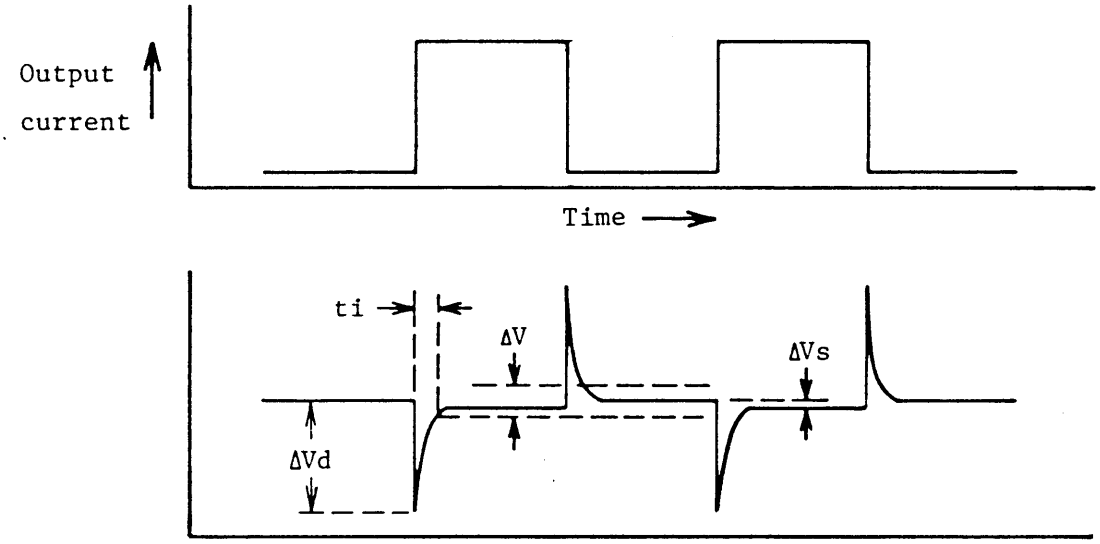


Figure 3-5

ΔV : Output variation range (specification value)

ΔVs: Actual static variation (load variation)

ΔVd: Dynamic variation

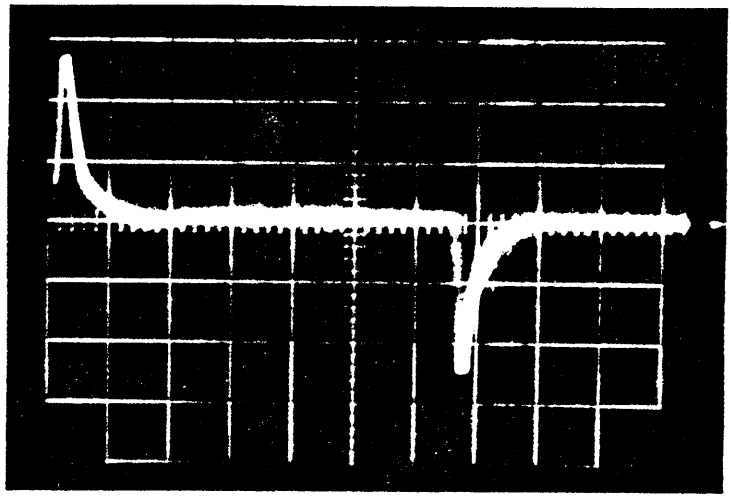
ti: Transiential response time

ΔV: 0.1% of output voltage

Typical value (transiential response time)
..... 50 μsec

Output current variation range: ..... 10%~100%

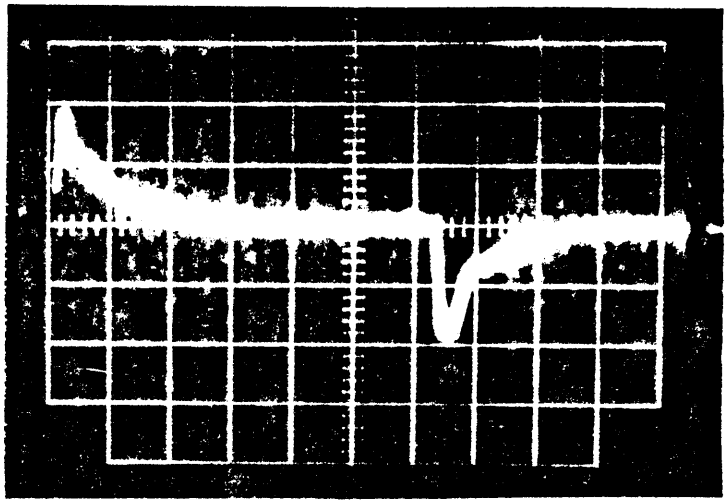
Transiential response of +35 V circuit



VERT: 50 mV/DIV
HOR: 50 µsec/DIV

Figure 3-6

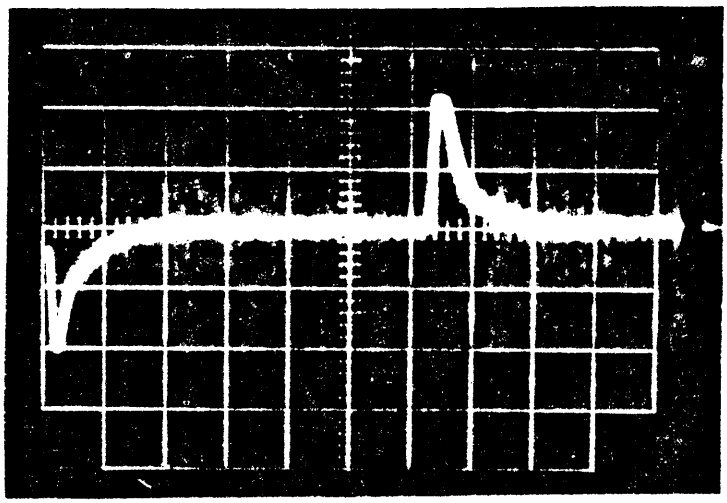
Transiential response of -35 V circuit



VERT: 50 mV/DIV
HOR 50 µsec/DIV

Figure 3-7

Transiential response of 70 V circuit



VERT: 100 mV/DIV
HOR: 50 µsec/DIV

Figure 3-8

7 C 3 4

3.6 Complimentary Output and Series Output

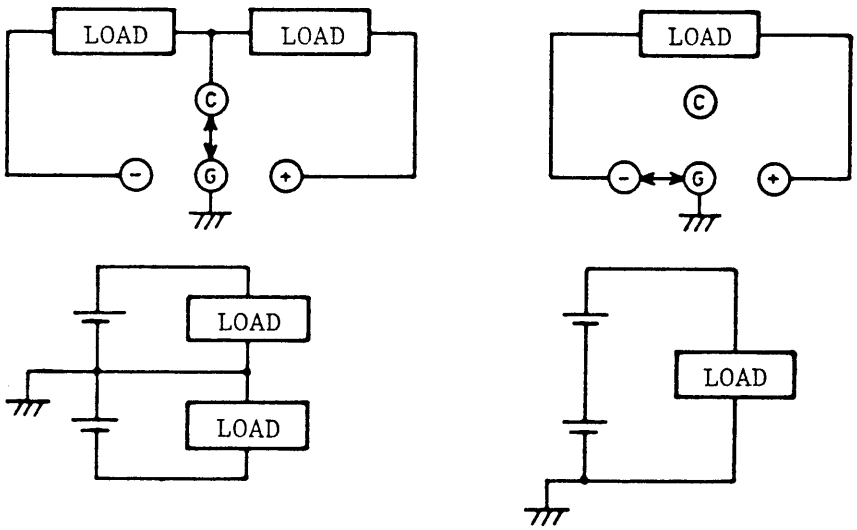
The two major methods in which the output of PDM 35-3 are available are as follows:

(1) Complimentary output:

The COM terminal is grounded and the positive and negative outputs of 0 ~ -35 V are used.

(2) Series output:

The positive or negative terminal is grounded and the 0 ~ +70 V or 0 ~ -70 V is used.

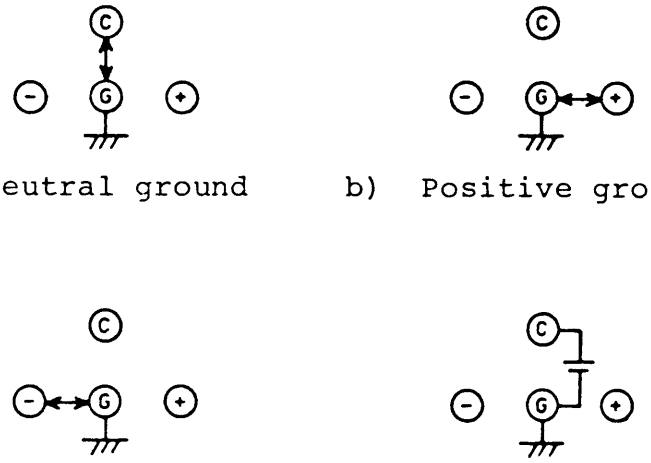


+: Positive output terminal
-: Negative output terminal
C: COM output
G: GND

a) Complimentary output b) Series output

Figure 3-9

Normally, the COM, positive or negative output terminal is connected with the shorting bar to the GND terminal (which is electrically connected to the chassis and panel). It also is possible to apply a DC bias voltage up to ±150 V.



a) Neutral ground b) Positive ground

c) Negative ground d) With DC bias

Figure 3-10

3.7 Use of Negative Output ±20% Variable Knob

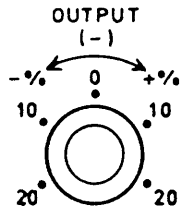


Figure 3-11

With this knob the negative voltage is adjustable for ±20% of the positive voltage. To set the positive and negative voltages at the same value, this variable

knob should be set in the 0% position. When this is done, the output voltages (the same for positive and negative) are adjustable with the DUAL TRACKING knob.

If the positive voltage become higher than 31 V while the negative output variable knob is set at +20%, the negative output voltage is limited at 37 V.

Note: When the negative voltage is limited at 37 V, if the negative output variable knob can be turned further in the +% direction, the positive output voltage decreases. This is not an abnormal indication.

3.8 Use of VOLTAGE DUAL TRACKING Knob

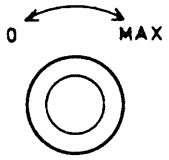


Figure 3-12

When in the complimentary mode, both positive and negative voltages are adjustable with the DUAL TRACKING knob at the same rate. The extremely counterclockwise position of the knob is for 0 vlolt. With this 10-turn helical potentiometer, the output voltages are finely and smoothly adjustable.

When in the series output mode, the output is adjustable from zero to the maximum voltage (70 V) with this potentiometer.

Note: When in the series output mode, set the negative output $\pm$20% variable knob at the 0% position or a lower position.

(Due to the action of the negative output limiting circuit, the specification values of ripples and regulations may not be satisfied.)

3.9 Complimentary Output

Positive output	Negative output $\pm$20% variable knob
+35 V	0%: -35 V
+35 V	+10%: Limited at -37 V
+35 V	-20%: -28 V
Reduced to lower than +35 V (set at +35 V)	+20% Limited at -37 V

4. OPERATION METHOD

4.1 Single operation

Layout of the rear terminals and connections of the shorting bars are as shown in Figure 4-1.

As shown there, the output is available at the rear terminals also.

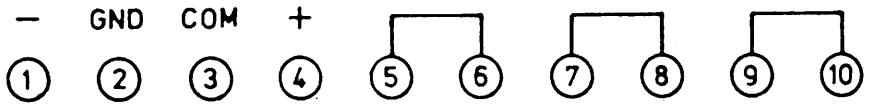


Figure 4-1

To operate the equipment as a single independent unit, proceed as follows:

(1) Connect the power cord and turn-on the power switch. The green LED will light and the equipment will start operating.

(2) Set the negative voltage ±20% knob in the 0% position.

(3) Set the output at the required voltage with the DUAL TRACKING knob.

(4) Turn-off the output switch and connect the load to the output terminals.

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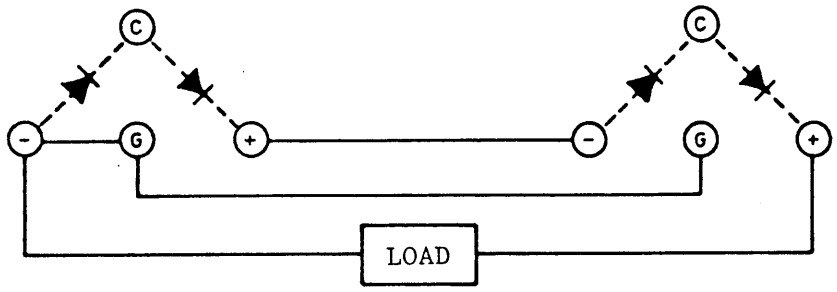
(5) Turn-on the output switch. The power will be supplied to the load.

Note: The overcurrent setting is fixed at 3.2 A and not adjustable.

4.2 Series Operation

(1) By using two units in series, an output up to 140 V can be obtained. For output connections, refer to Figure 4-2. Do not connect the COM terminals.



(negative ground)

Figure 4-2

When overload is caused in the above series operation, the output of the unit the protecting circuit of which trips later is applied to the other unit the protecting circuit of which trips sooner, and the series transistors of the latter unit are overloaded and damaged. In order to prevent this, diodes are connected between output terminals.

(2) Biased complimentary outputs:

When this equipment is used in the complimentary mode, the outputs are ±35 V maximum. When voltages higher than ±35 V are required, a DC bias voltage should be connected in series to each output voltage as shown in Figure 4-3.

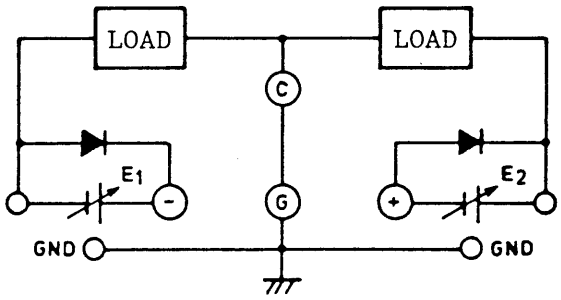


Figure 4-3

When bias voltages are connected as above, the available maximum voltages become $-(35 + E_1)$ V, $(35 + E_2)$ V.

In the above case, sources E_1 and E_2 must have a sufficient current rating for the load and must be provided with protecting diodes against overloading. (All of Kikusui Transistorized Regulated DC Power Supplies are incorporated with protection diodes.)

Note that the voltage against the ground must not exceed the specification value.

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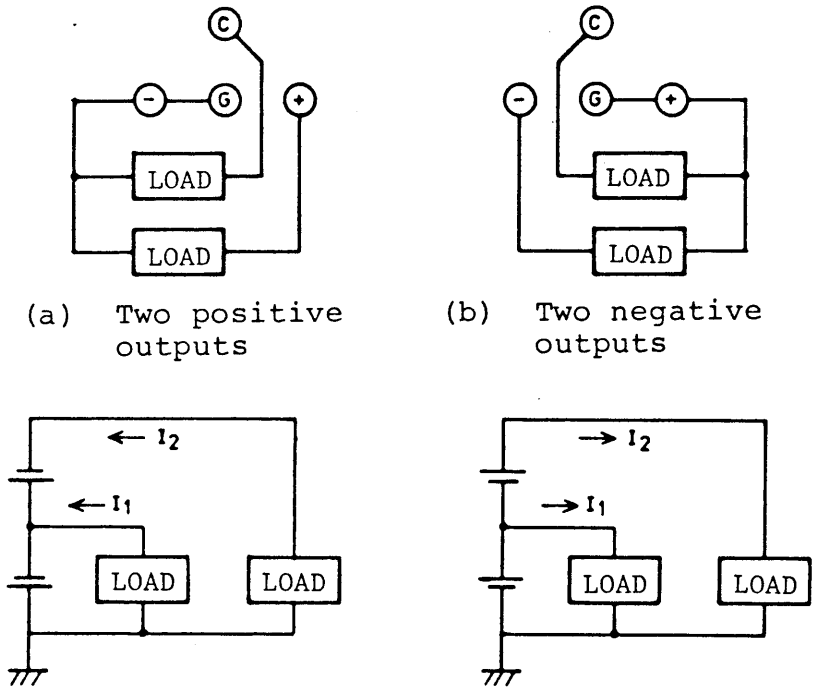
(3) Other uses

This equipment normally is used in the complimentary output mode or series output mode. However, if it is required to use both outputs in the positive or negative polarity, this can be done in the methods as shown in Figure 4-4 although the currents are not available up to the rated values in this case.



(a) Two positive outputs

(b) Two negative outputs

Note: Pay attention so that the sum of the two currents does not exceed 3.0 A.

Figure 4-4

4.3 Parallel Operation

When a current more than can be supplied by a single unit is required, two units can be operated in parallel simply by connecting their outputs in parallel.

(1) Set the output voltages of the parallel-operated units as close to the required voltage (load voltage) as possible. (The difference of set voltages is directly reflected on load variation.)

(2) Connect together the output terminals of the same polarity, and connect the load to the output terminals. Also make the ground polarities the same. (For series operation)

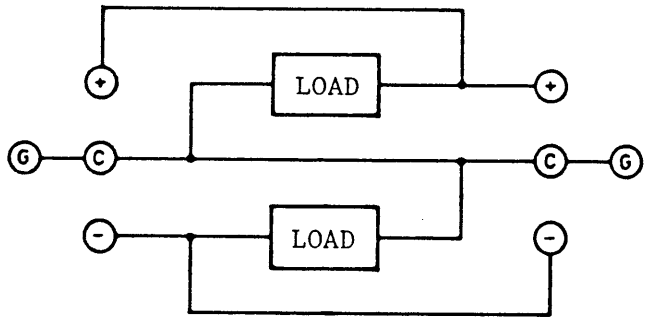


Figure 4-5 Connection for parallel operation (Complimentary outputs)

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Voltage and current characteristics when in parallel operation:

The voltage and current characteristics when in the parallel operation is as shown in Figure 4-6. Unit A (the output voltage of which is higher than that of other unit B) operates until it becomes overloaded. When the current of unit A has entered the constant-current domain, its output voltage drops. When the voltage has fallen to the set voltage of unit B, the output terminal of unit B is driven into the normal state from the reverse-voltage state and unit B starts operating in the constant-voltage mode. Thus, the difference (ΔV) of the set voltages is directly reflected on load regulation. If ΔV is large, voltage regulation is poor and ripples and other characteristics are degraded.

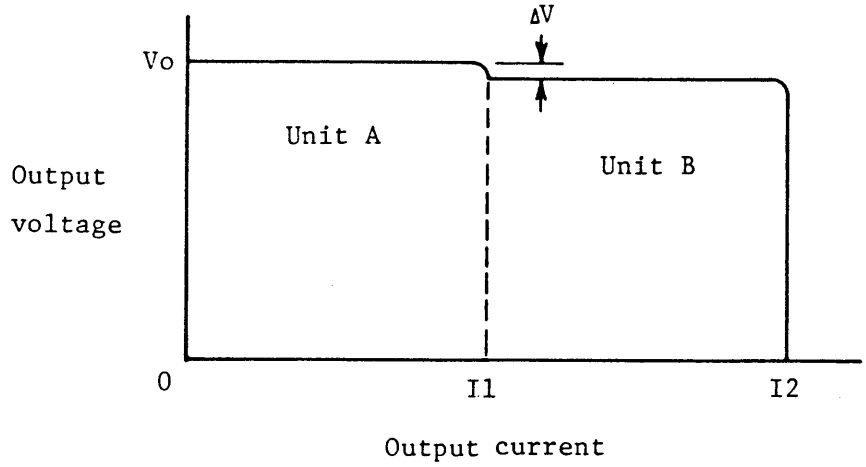

Figure 4-6 Voltage and current characteristics when in parallel operation

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4.4 One-control Parallel Operation

The one-control parallel operation method is used when a current larger than available with a single unit is required and degradiation of characteristics is undesirable.

(1) Connect as shown in Figure 4-7 the rear terminals of the master unit (which controls the output voltage) and the slave unit (of which output voltage is controlled).

(2) Connect the load to the rear output terminals. To turn-on the system, turn-on the power switch (output switch) of the master unit first and that of the slave unit next; to turn-off the system, turn-off the power switch of the slave unit first and that of the master unit next.

Notes: (1) The load may be connected to the front terminals. In this case, however, load regulation is slightly degrated and the current balance between master and slave units becomes poor.

(2) Keep the DUAL TRACKING knob of the slave unit in the extremely clock-wise position.

(3) When in the one-control parallel operation, up to two slave units can be used.

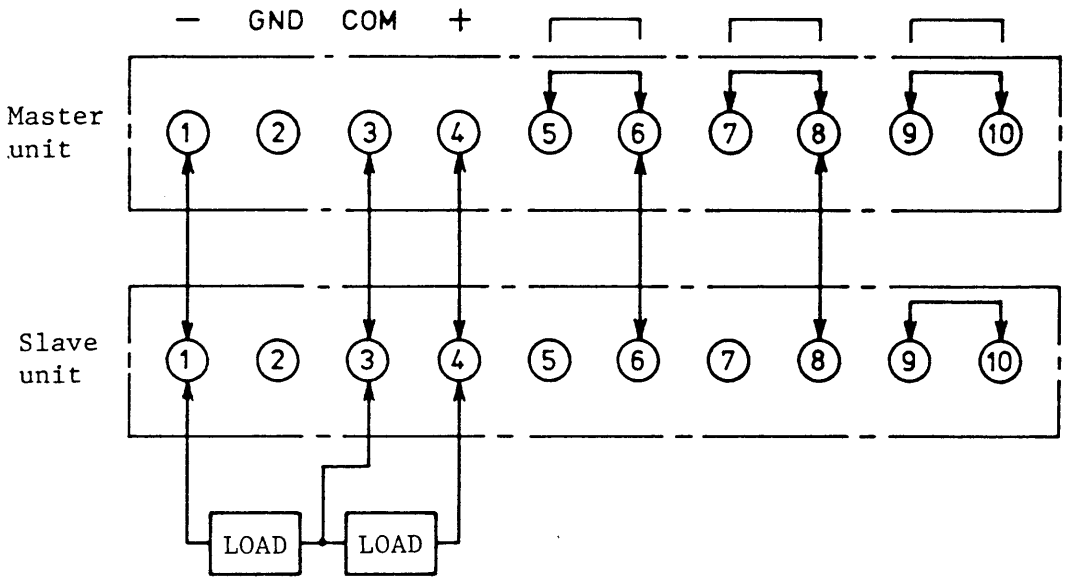


Figure 4-7 One-control parallel operation

4.5 Remote Control Operation

The remote control operation is for externally controlling the output voltage.

(1) Turn-off the power switch. (Be sure to turn-off the power switch when handling the rear terminal.)

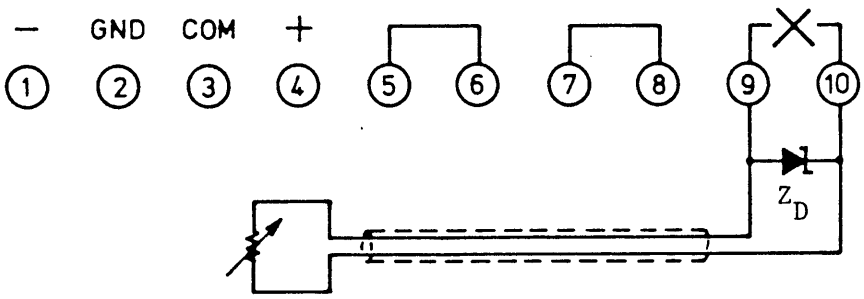
(2) Turn-off the output switch.

(3) Be sure to turn the DUAL TRACKING knob the front panel to the extremely counterclockwise position.

Note: Be sure to do the above. If not, an unnecessary large voltage is produced.

(4) Disconnect the jumper from between terminals (9) and (10).

(5) Connect a resistor between terminals (9) and (10).



(Connect the shield wire of the 2-core cable to the negative output terminal.)

Figure 4-8

The function of the remote control resistor is similar to that of the DUAL TRACKING resistor and the negative output voltage can be set with the negative output ±20% variable knob.

(Note: Negative output limiting voltage = -37 V)

When the positive and negative outputs at the same value are reauired to be controlled with an external resistor, the negative output ±20% variable knob must be set in the 0% position. In this case, the output voltage is as follows:

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$\pm$ E_{OUT} (complimentary output) = 0.0035 R

$R(\Omega) \leqq 10\ k\Omega$

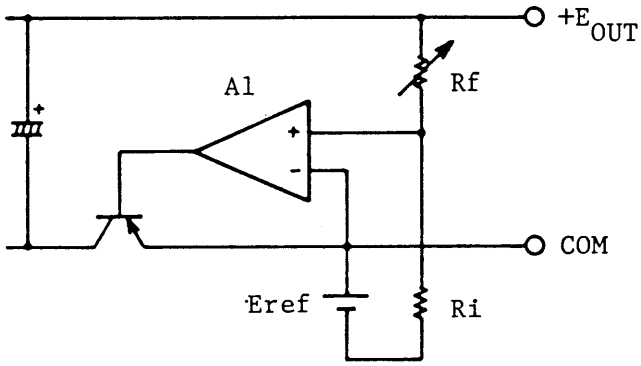
To protect the load, a zener diode (Z_D) may be connected between terminals (9) and (10) so that the output voltage does not become higher than the zener voltage.

* Application of remote control:

  By using a fixed resistor and a variable resistor, the output voltage is adjustable for several percent of the set voltage for the full span of the variable resistor. That is, as the resolution of the output voltage depends on fixed resistor R, any required resolution can be obtained. A programmed voltage output also can be obtained by changing the preset resistors with a switch (use a closed-circuit switch which provides constantly a closed circuit when switching).

5. OPERATING PRINCIPLE

Basic Circuit



Eref:
Reference voltage

Ri: Input resistance

Rf: Feedback resistance

Figure 5-1

The positive output voltage (E_{OUT}) when in the complimentary operation is expressed as follows (denoting by A1 and ideal amplifier):

$$E_{OUT} = -\frac{Rf}{Ri} \times Eref \qquad (1)$$

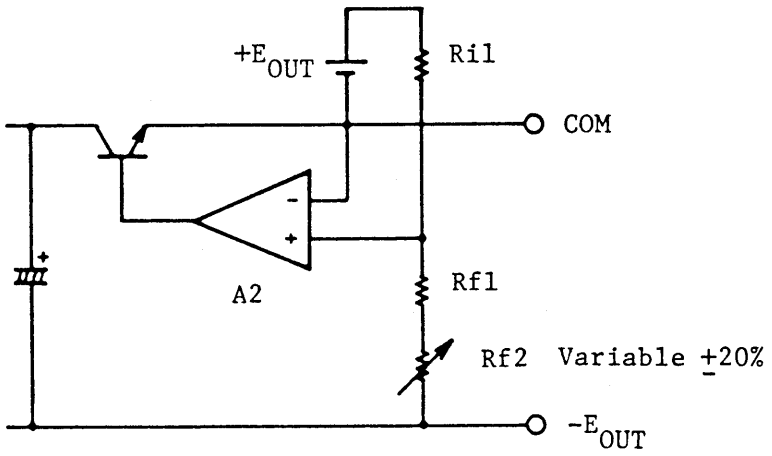


Figure 5-2

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The negative output ($-E_{OUT}$) when in the complimentary operation is expressed as follows:

$$-E_{OUT} = -\frac{Rf1 + Rf2}{Ri1} \times (+E_{OUT}) \qquad (2)$$

Substituting equation (1) into equation (2), the folling equation can be written.

$$-E_{OUT} = -\frac{Rf1 + Rf2}{Ri1} \times (-\frac{Rf}{Ri} \times Eref) \qquad (3)$$

(A2 denotes an ideal amplifier.)

Equation (1), (2) and (3) indicate that the output voltage depends only on Eref, Ri and Rf.

As can be known from the above, to stabilize the positive and negative output voltages, Eref, Ri and Rf must be stabilized by protecting them against external changes in voltage and environment. Error amplifiers A1 and A2 also must be as close to ideal ones as possible. For the reference voltage source, 50 PPM zener diodes are used. For input resistor Ri and feedback resistor Rf, a metallic film resistor and wound-wire resistor of excellent temperature characteristics and less aging changes are used. General-purpose monolithic ICs are used for the error amplifiers.

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6. MAINTENANCE AND ADJUSTMENTS

To operate the equipment always in the best conditions, provides maintenance and adjustment service at regular intervals.

6.1 Clean the Equipment

When the panel and cover have become dirty, clean them with a cloth moistened with alcohol or diluted neutral soap solution and, then, wipe with a clean, dry cloth. Do not use thinner or benzine. Remove dust collected in the ventilation holes of the casing and inside the equipment, use a compressed air or a vacuum cleaner.

6.2 Check of Power Cord

Check that the power cord and its plug are in a good state.

Adjustments

6.3 Calibration of Voltmeter

Calibrate the voltmeter by connecting to the output terminals a voltmeter of an accuracy of 0.5% or better, setting the output voltage at 35.0 V (complimentary output) and adjusting potentiometer R144.

6.4 Calibration of Ammeter

Calibrate the ammeter by connecting to the output terminals an ammeter of an accuracy of 0.5% or better, setting the output current at 2.5 A (complimentary output), and adjusting potentiometer R101 for the positive output and potentiometer R104 for the negative output.

6.5 Adjustment of Maximum Positive Output Voltage

Connect a voltmeter of an accuracy of 0.5% or better between positive output terminal and COM terminal and so adjust potentiometer R12 that the output voltage when the DUAL TRACKING knob is turned to the extremely clockwise position becomes 18.5 V.

Set the positive output voltage at 18.0 V and the OUTPUT (-) knob at 0%, connect to the negative output terminals a voltmeter of an accuracy of 0.5% or better, and so adjust potentiometer R38 that the negative output voltage becomes 18.0 V.

6.8 Adjustment of Maximum Positive and Negative Currents

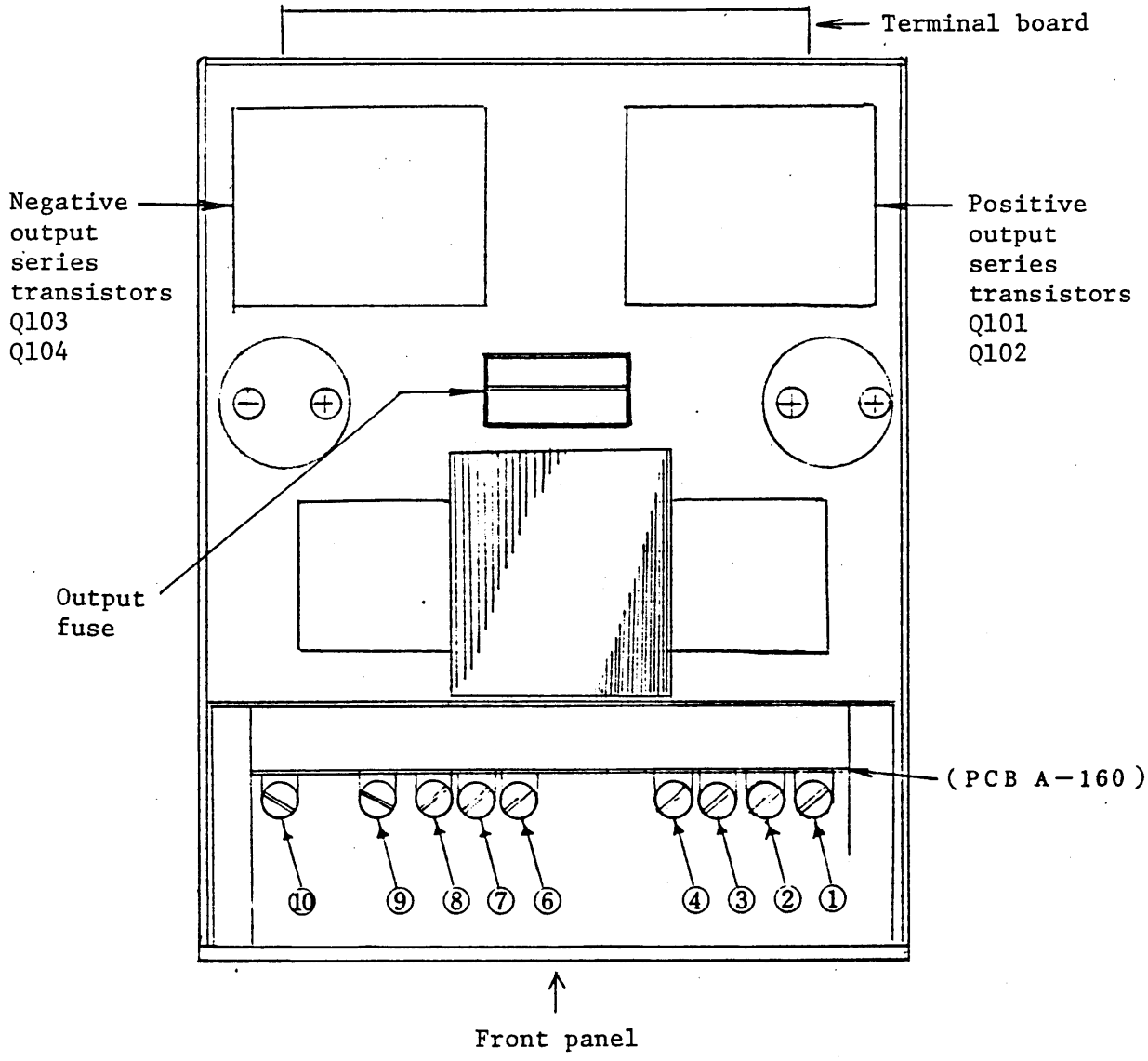
Connect to the positive output terminal an ammeter of an accuracy of 0.5% or better and so adjust potentiometer R163 that the current becomes 3.2 A. Connect to the negative output terminals an ammeter of an accuracy of 0.5% or better and so adjust potentiometer R164 that the current becomes 3.2 A.

6.9 Adjustment of Series Transistor Voltage (V_{CE}) of Positive Output

Connect an ammeter of an accuracy of 0.5% or better between collector and emitter of the series transistor mounted on the heat sink of the positive output circuit and so adjust potentiometer R127 that the voltmeter reads 7.0 V. (Conditions: Output voltage 35 V, output current 3 A, input voltage 100 V AC).

6.10 Adjustment of Series Transistor Voltage (V_{CE}) of Negative Output

Connect an ammeter of an accuracy of 0.5% or better between collector and emitter of the series transistor mounted on the heat sink of the negative output circuit and so adjust potentiometer R166 that the voltmeter reads 7.0 V. (Conditions: Output voltage 35 V, output current 3 A, input voltage 100 V AC)



(1) R199: Adjustment of variable range of negative output
(2) R202: Adjustment of maximum positive output voltage
(3) R164: Adjustment of maximum negative output voltage
(4) R163: Adjustment of maximum positive output

(6) R142: Adjustment of negative output ammeter
(7) R140: Adjustment of positive output ammeter
(8) R144: Adjustment of positive and negative voltmeter
(9) R116: Adjustment of negative output voltage V_{CE}
(10) R127: Adjustment of positive output voltage V_{CE}

Figure 6-1