SGS-THOMSON MICROELECTRONICS

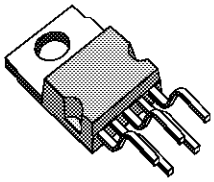
# VN220

## HIGH SIDE SMART POWER SOLID STATE RELAY

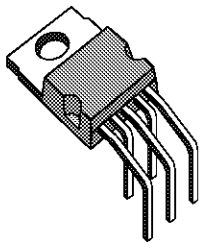
**ADVANCE DATA**

| TYPE | $V_{DSS}$ | $R_{DS(on)}$ | $I_{OUT}$ | $V_{CC}$ |
|---|---|---|---|---|
| VN220 | 60 V | 0.05 Ω | 28 A | 60 V |

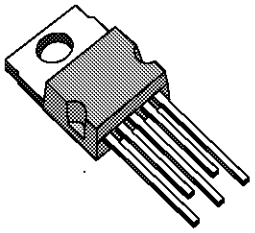
- OUTPUT CURRENT (CONTINUOUS): 28A @ $T_c$=25°C
- THERMAL SHUT-DOWN
- UNDER VOLTAGE SHUT-DOWN
- OPEN DRAIN DIAGNOSTIC OUTPUT
- VERY LOW STAND-BY POWER DISSIPATION



**PENTAWATT (vertical)**



**PENTAWATT (horizontal)**



**PENTAWATT (in-line)**

**ORDER CODES:**

| | |
|---|---|
| PENTAWATT vertical | VN220 |
| PENTAWATT horizontal | VN220 (011Y) |
| PENTAWATT in-line | VN220 (012Y) |

### DESCRIPTION

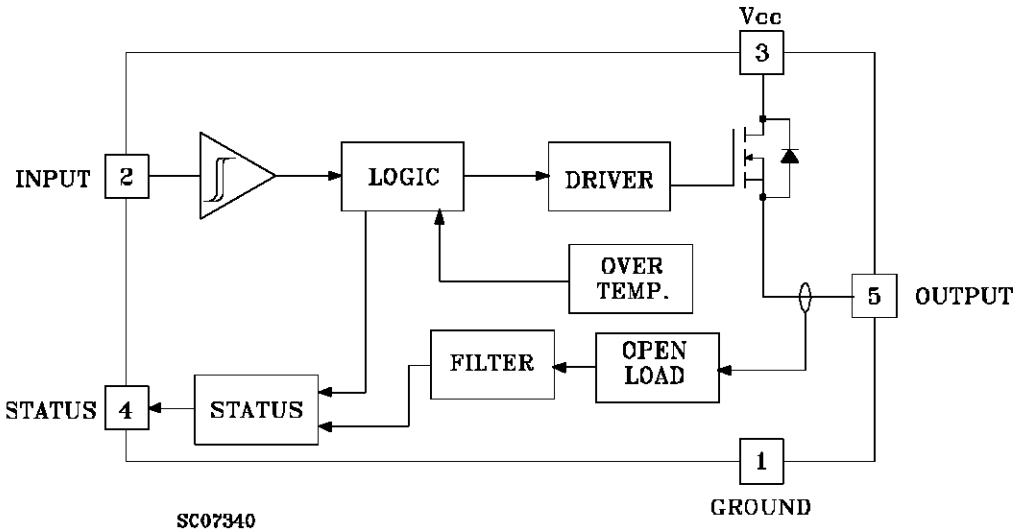
The VN220 is a monolithic device made using SGS-THOMSON Vertical Intelligent Power Technology, intended for driving resistive or inductive loads with one side grounded.

Built-in thermal shut-down protects the chip from over temperature and short circuit.

The input control is 5V logic level compatible.

The open drain diagnostic output indicates open circuit (no load) and over temperature status.

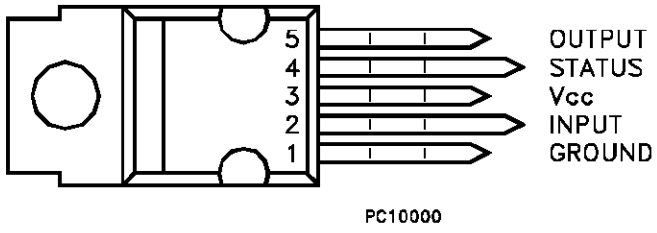
### BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATING

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | 60 | V |
| $V_{dsOFF}$ | Drain-Source Voltage (OFF STATE) | 60 | V |
| $V_{ds}$ | Drain-Source Voltage (Output Shorted to Ground) | 30 | V |
| $I_{OUT}$ | Output Current (cont.) | 28 | A |
| $I_R$ | Reverse Output Current | -28 | A |
| $I_{IN}$ | Input Current | ±10 | mA |
| $V_{in}$ | Input Voltage | 35 | V |
| $V_{diag}$ | Status Output Voltage | 35 | V |
| $-V_{CC}$ | Reverse Supply Voltage | -4 | V |
| $I_{STAT}$ | Status Current | ±10 | mA |
| $V_{ESD}$ | Electrostatic Discharge (1.5 kΩ, 100 pF) | 2000 | V |
| $P_{tot}$ | Power Dissipation at $T_c \leq 25\ ^oC$ | 60 | W |
| $T_j$ | Junction Operating Temperature | -40 to 150 | $^oC$ |
| $T_{stg}$ | Storage Temperature | -55 to 150 | $^oC$ |

## CONNECTION DIAGRAM

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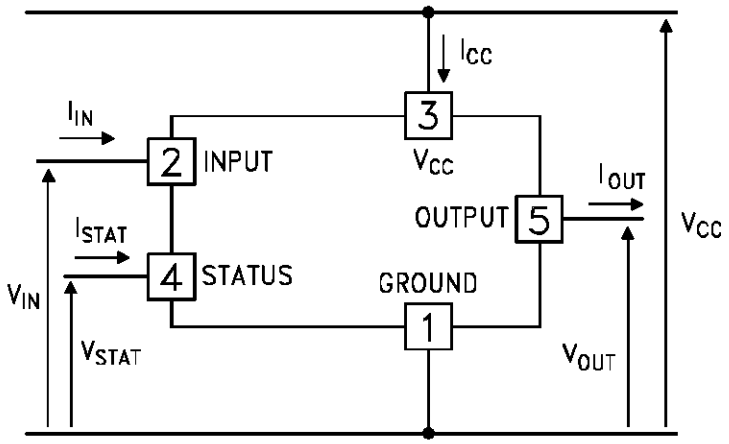
## CURRENT AND VOLTAGE CONVENTIONS

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## THERMAL DATA

| | | | | |
|---|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal Resistance Junction-case | Max | 2.08 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal Resistance Junction-ambient | Max | 60 | °C/W |

**ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = 13 V; -40 ≤ $T_j$ ≤ 125 °C unless otherwise specified)

POWER

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | 12 | | 30 | V |
| $R_{on}$ | On State Resistance | $I_{OUT}$ = 3.5 A<br>$I_{OUT}$ = 100 mA $T_j$ = 25 °C | | | 0.05<br>1.33 | Ω<br>Ω |
| $I_S$ | Supply Current | Off State<br>On State $T_j$ = 25 °C<br>On State $T_j$ = 100 °C | | | 1<br>8<br>6 | mA<br>mA<br>mA |

SWITCHING

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on Delay Time Of Output Current | $I_{OUT}$ = 3.5 A Resistive Load<br>Input Rise Time < 0.1 µs $T_j$ = 25 °C | | 20 | | µs |
| $t_r$ | Rise Time Of Output Current | $I_{OUT}$ = 3.5 A Resistive Load<br>Input Rise Time < 0.1 µs $T_j$ = 25 °C | | 200 | | µs |
| $t_{d(off)}$ | Turn-off Delay Time Of Output Current | $I_{OUT}$ = 3.5 A Resistive Load<br>Input Rise Time < 0.1 µs $T_j$ = 25 °C | | 30 | | µs |
| $t_f$ | Fall Time Of Output Current | $I_{OUT}$ = 3.5 A Resistive Load<br>Input Rise Time < 0.1 µs $T_j$ = 25 °C | | 5 | | µs |

LOGIC INPUT

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{IL}$ | Input Low Level Voltage | | | | 1.5 | V |
| $V_{IH}$ | Input High Level Voltage | | 6 | | | V |
| $V_{I(hyst.)}$ | Input Hysteresis Voltage | | | 1 | | V |
| $I_{IN}$ | Input Current | $V_{IN}$ = 5 V | | | 600 | µA |
| $V_{ICL}$ | Input Clamp Voltage | $I_{IN}$ = 1 mA | 31 | 36 | | V |

PROTECTIONS AND DIAGNOSTICS

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{diag}$ | Diagnostic Output Voltage | $I_{sink}$ = 5 mA (Fault Condition) | | 0.9 | 2.5 | V |
| $I_{diag}$ | Diagnostic Output Leakage Current | $V_{diag}$ = 30 V | | | 100 | µA |
| $I_{OL}$ | Open Load Current Level | | 3 | 9 | 20 | mA |

**ELECTRICAL CHARACTERISTICS** (continued)

PROTECTION AND DIAGNOSTICS (continued)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{ol}$ | Open Load Filtering Time | | 1 | | 10 | ms |
| $T_{TSD}$ | Thermal Shut-down Temperature | | 150 | | | $^{o}C$ |
| $T_R$ | Reset Temperature | | 125 | | | $^{o}C$ |
| $V_{diagCL}$ | Diagnostic Input Clamp Voltage | $I_{IN}$ = 1 mA | 31 | 36 | | V |

(*) The $V_{IH}$ is internally clamped at 6V about. It is possible to connect this pin to an higher voltage via an external resistor calculated to not exceed 10 mA at the input pin.
(•) Status determination > 100 µs after the switching edge.

**FUNCTIONAL DESCRIPTION**

The VN220 provides protection against a short circuit on the output and senses the output current to detect an open load. When one of these two faults is detected the diagnostic output is taken low.

OPEN LOAD DETECTION

When the device is first turned on, only the auxiliary DMOS device is turned on. If the load current remains below 9mA (typical), the open load signal is active and the diagnostic output is low. When the load current goes above 9 mA the open load detection becomes inactive and the diagnostic goes high. When the load current exceeds 300 mA, the main DMOS (50 mΩ) turns on. When the load current drops below 240 mA, the main DMOS is turned off but no open load signal is generated and the auxiliary DMOS is still turned on. If the load current drops below 9mA, again the open load signal is generated and the diagnostic output goes low.

NOTE: When an open load defect appears (or disappears) the state of the diagnostic output change only after the filtering time ($t_{ol}$). SEE open load waveforms diagrams.

SHORT CIRCUIT PROTECTION

Short circuit protection is achieved using the fast response of the thermal shut circuit. The only current limitation in this condition is the saturation current of the DMOS devices and the external wiring resistance. Under this condition the device can survive a short circuit up to 30V across DMOS devices.

THERMAL PROTECTION

The device is internally protected against over temperature by the thermal protection circuit. When the device junction temperature exceeds the protect limit, the output is latched off. To turn on the output again, the input signal must be taken low to reset the latch, then high again to turn on the output. If the junction temperature has not yet cooled below the lower limit set by the thermal sensing hysteresis, the devivce will remain latched off.

## TRUTH TABLE

| | INPUT | OUTPUT | DIAGNOSTIC |
|---|---|---|---|
| Normal Operation | L<br>H | L<br>H | H<br>H |
| Open Circuit (No Load) | H | H | L (*) |
| Over-temperature | H | L | L |

(*): with filtering operation

**Figure 1:** Waveforms

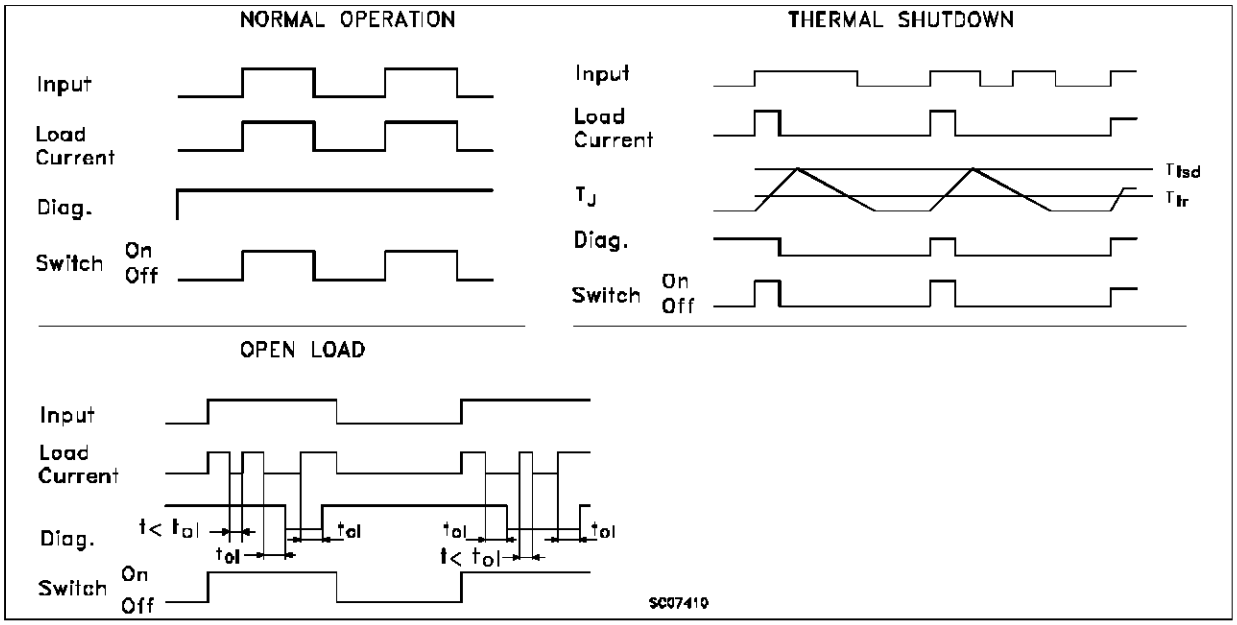



**Figure 2:** Over Current Test Circuit

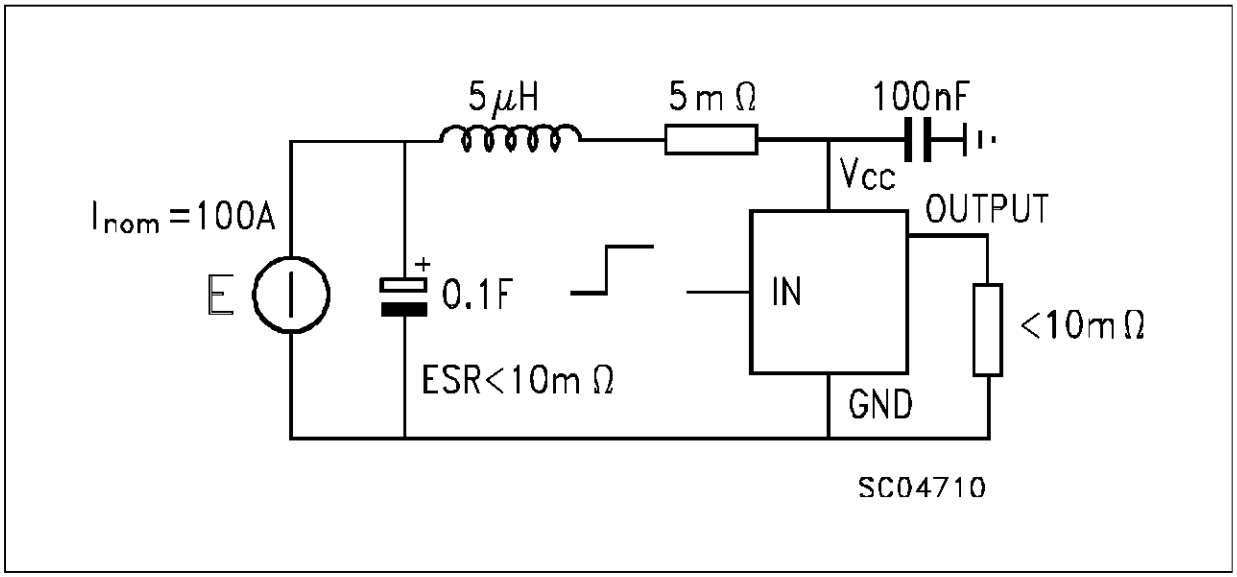


**Figure 3:** Typical Application Circuit With A Schottky Diode For Reverse Supply Protection

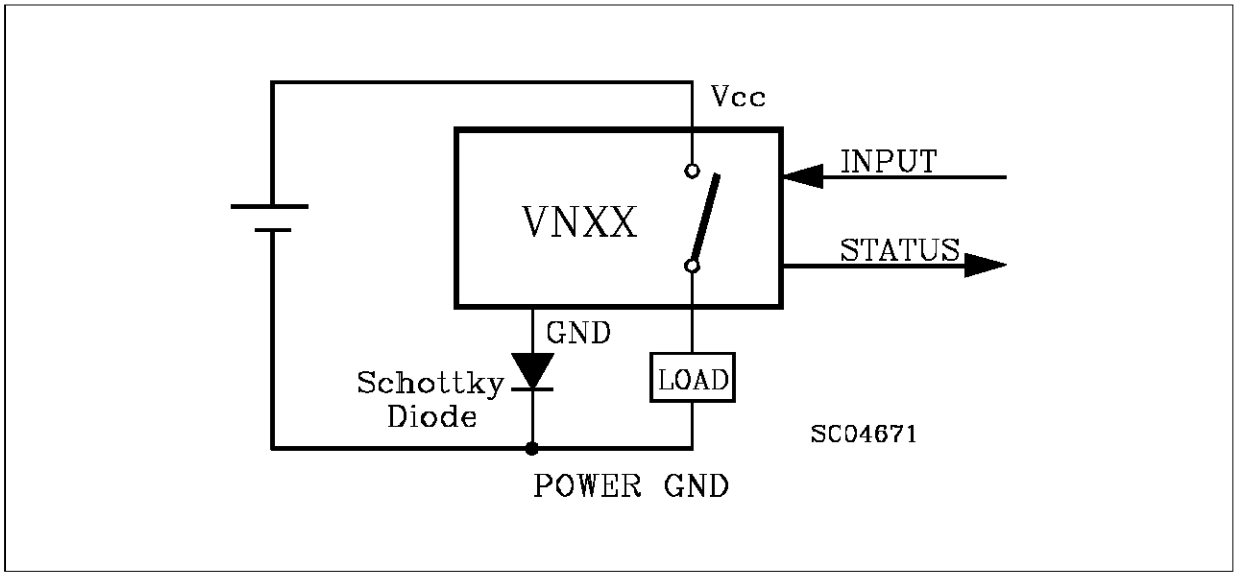
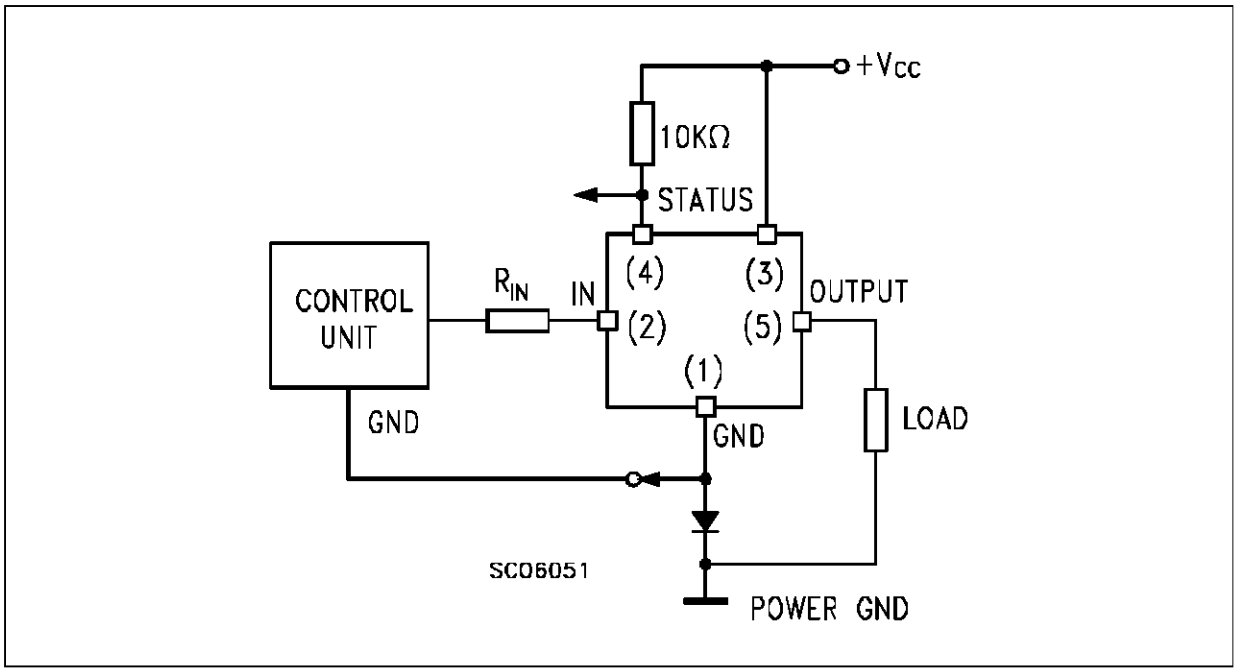
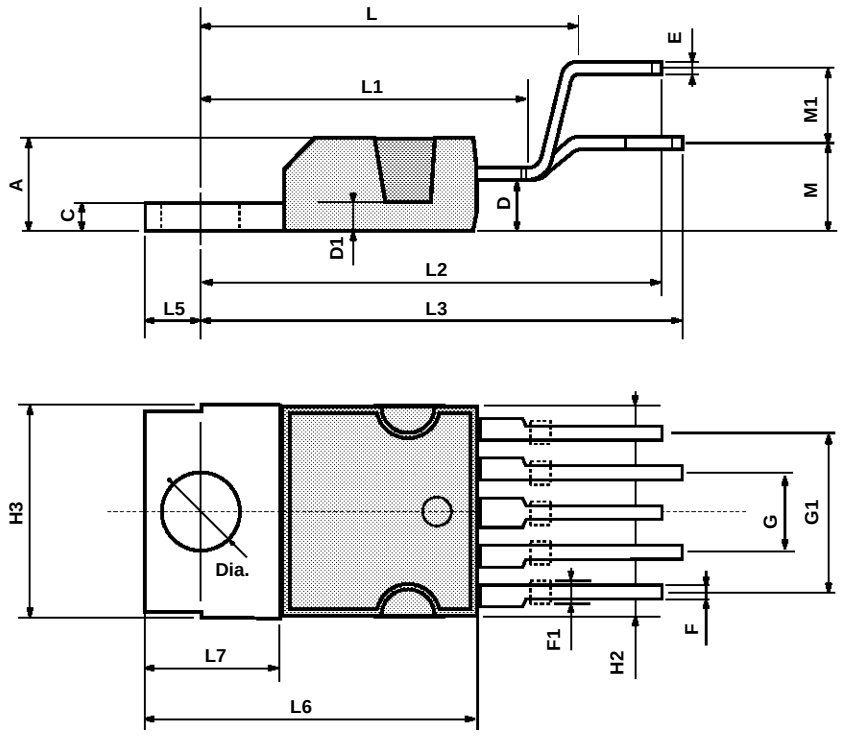



**Figure 4:** Typical Application Circuit With Separate Signal Ground



## Pentawatt (vertical) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 4.8 | | | 0.189 |
| C | | | 1.37 | | | 0.054 |
| D | 2.4 | | 2.8 | 0.094 | | 0.110 |
| D1 | 1.2 | | 1.35 | 0.047 | | 0.053 |
| E | 0.35 | | 0.55 | 0.014 | | 0.022 |
| F | 0.8 | | 1.05 | 0.031 | | 0.041 |
| F1 | 1 | | 1.4 | 0.039 | | 0.055 |
| G | 3.2 | 3.4 | 3.6 | 0.126 | 0.134 | 0.142 |
| G1 | 6.6 | 6.8 | 7 | 0.260 | 0.268 | 0.276 |
| H2 | | | 10.4 | | | 0.409 |
| H3 | 10.05 | | 10.4 | 0.396 | | 0.409 |
| L | | 17.85 | | | 0.703 | |
| L1 | | 15.75 | | | 0.620 | |
| L2 | | 21.4 | | | 0.843 | |
| L3 | | 22.5 | | | 0.886 | |
| L5 | 2.6 | | 3 | 0.102 | | 0.118 |
| L6 | 15.1 | | 15.8 | 0.594 | | 0.622 |
| L7 | 6 | | 6.6 | 0.236 | | 0.260 |
| M | | 4.5 | | | 0.177 | |
| M1 | | 4 | | | 0.157 | |
| Dia | 3.65 | | 3.85 | 0.144 | | 0.152 |

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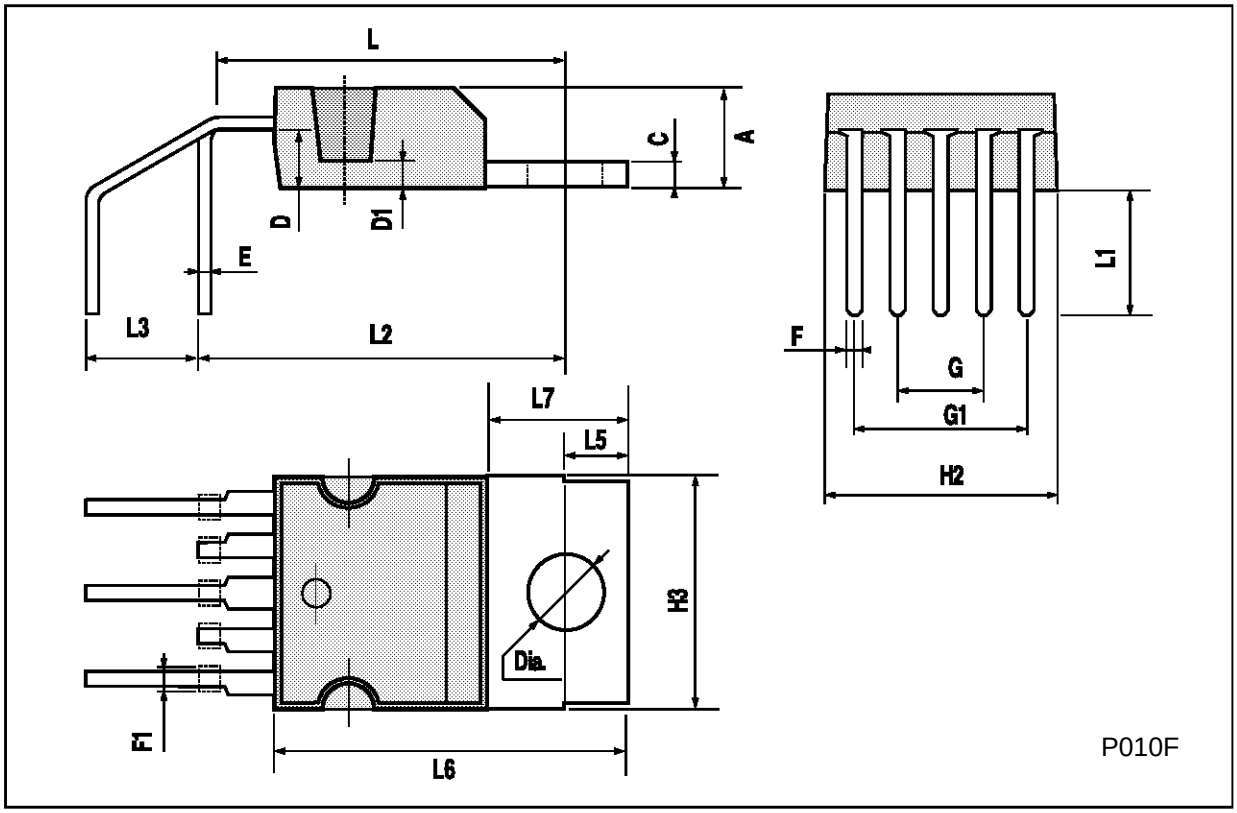
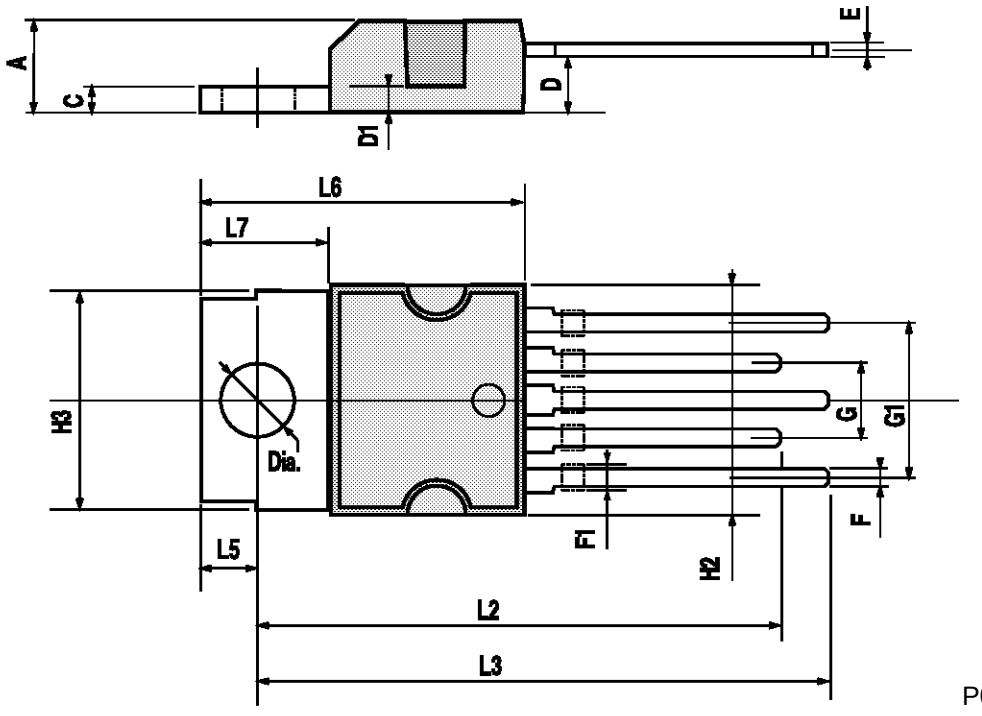
## Pentawatt (horizontal) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 4.8 | | | 0.189 |
| C | | | 1.37 | | | 0.054 |
| D | 2.4 | | 2.8 | 0.094 | | 0.110 |
| D1 | 1.2 | | 1.35 | 0.047 | | 0.053 |
| E | 0.35 | | 0.55 | 0.014 | | 0.022 |
| F | 0.8 | | 1.05 | 0.031 | | 0.041 |
| F1 | 1 | | 1.4 | 0.039 | | 0.055 |
| G | 3.2 | 3.4 | 3.6 | 0.126 | 0.134 | 0.142 |
| G1 | 6.6 | 6.8 | 7 | 0.260 | 0.268 | 0.276 |
| H2 | | | 10.4 | | | 0.409 |
| H3 | 10.05 | | 10.4 | 0.396 | | 0.409 |
| L | 14.2 | | 15 | 0.559 | | 0.590 |
| L1 | 5.7 | | 6.2 | | | 0244 |
| L2 | 14.6 | | 15.2 | | | 0.598 |
| L3 | 3.5 | | 4.1 | 0.137 | | 0.161 |
| L5 | 2.6 | | 3 | 0.102 | | 0.118 |
| L6 | 15.1 | | 15.8 | 0.594 | | 0.622 |
| L7 | 6 | | 6.6 | 0.236 | | 0.260 |
| Dia | 3.65 | | 3.85 | 0.144 | | 0.152 |



## Pentawatt (In- Line) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 4.8 | | | 0.189 |
| C | | | 1.37 | | | 0.054 |
| D | 2.4 | | 2.8 | 0.094 | | 0.110 |
| D1 | 1.2 | | 1.35 | 0.047 | | 0.053 |
| E | 0.35 | | 0.55 | 0.014 | | 0.022 |
| F | 0.8 | | 1.05 | 0.031 | | 0.041 |
| F1 | 1 | | 1.4 | 0.039 | | 0.055 |
| G | 3.2 | 3.4 | 3.6 | 0.126 | 0.134 | 0.142 |
| G1 | 6.6 | 6.8 | 7 | 0.260 | 0.268 | 0.276 |
| H2 | | | 10.4 | | | 0.409 |
| H3 | 10.05 | | 10.4 | 0.396 | | 0.409 |
| L2 | 23.05 | 23.4 | 23.8 | 0.907 | 0.921 | 0.937 |
| L3 | 25.3 | 25.65 | 26.1 | 0.996 | 1.010 | 1.028 |
| L5 | 2.6 | | 3 | 0.102 | | 0.118 |
| L6 | 15.1 | | 15.8 | 0.594 | | 0.622 |
| L7 | 6 | | 6.6 | 0.236 | | 0.260 |
| Dia | 3.65 | | 3.85 | 0.144 | | 0.152 |

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