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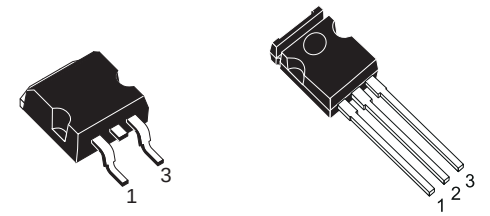
# VNB10N07/K10N07FM
# VNP10N07FI/VNV10N07

## "OMNIFET": FULLY AUTOPROTECTED POWER MOSFET

| TYPE | $V_{clamp}$ | $R_{DS(on)}$ | $I_{lim}$ |
|---|---|---|---|
| VNB10N07 | 70 V | 0.1 Ω | 10 A |
| VNK10N07FM | 70 V | 0.1 Ω | 10 A |
| VNP10N07FI | 70 V | 0.1 Ω | 10 A |
| VNV10N07 | 70 V | 0.1 Ω | 10 A |

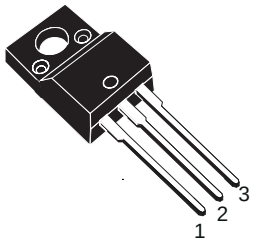
- LINEAR CURRENT LIMITATION
- THERMAL SHUT DOWN
- SHORT CIRCUIT PROTECTION
- INTEGRATED CLAMP
- LOW CURRENT DRAWN FROM INPUT PIN
- DIAGNOSTIC FEEDBACK THROUGH INPUT PIN
- ESD PROTECTION
- DIRECT ACCESS TO THE GATE OF THE POWER MOSFET (ANALOG DRIVING)
- COMPATIBLE WITH STANDARD POWER MOSFET



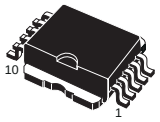

**D2PAK**
**TO-263**




**SOT82-FM**




**ISOWATT220**



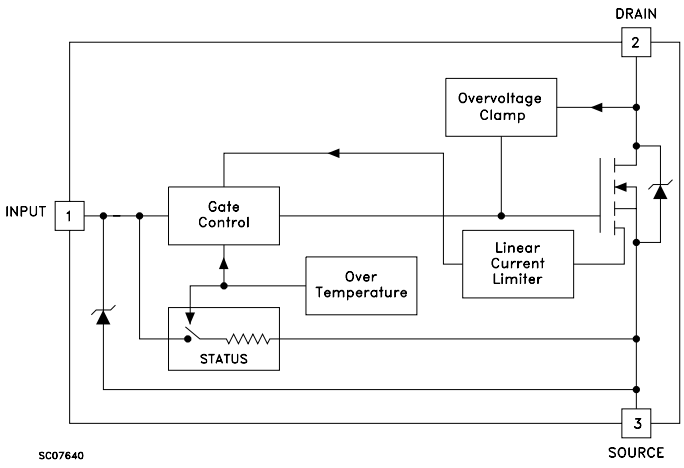

**PowerSO-10**

### DESCRIPTION

The VNB10N07, VNK10N07FM, VNP10N07FI and VNV10N07 are monolithic devices made using STMicroelectronics VIPower M0 Technology, intended for replacement of standard power MOSFETS in DC to 50 KHz applications. Built-in thermal shut-down, linear current limitation and overvoltage clamp protect the chip in harsh enviroments.

Fault feedback can be detected by monitoring the voltage at the input pin.

### BLOCK DIAGRAM (∗)




(∗) PowerSO-10 Pin Configuration : INPUT = 6,7,8,9,10; SOURCE = 1,2,4,5; DRAIN = TAB

## ABSOLUTE MAXIMUM RATING

| Symbol | Parameter | Value | | | Unit |
|---|---|---|---|---|---|
| | | PowerSO-10 D2PAK | SOT-82FM | ISOWATT220 | |
| $V_{DS}$ | Drain-source Voltage ($V_{in}$ = 0) | Internally Clamped | | | V |
| $V_{in}$ | Input Voltage | 18 | | | V |
| $I_D$ | Drain Current | Internally Limited | | | A |
| $I_R$ | Reverse DC Output Current | -14 | | | A |
| $V_{esd}$ | Electrostatic Discharge (C= 100 pF, R=1.5 KΩ) | 2000 | | | V |
| $P_{tot}$ | Total Dissipation at $T_c$ = 25 °C | 50 | 9.5 | 31 | W |
| $T_j$ | Operating Junction Temperature | Internally Limited | | | °C |
| $T_c$ | Case Operating Temperature | Internally Limited | | | °C |
| $T_{stg}$ | Storage Temperature | -55 to 150 | | | °C |

## THERMAL DATA

| | | ISOWATT220 | PowerSO-10 | SOT82-FM | D2PAK | |
|---|---|---|---|---|---|---|
| $R_{thj\text{-}case}$ | Thermal Resistance Junction-case Max | 4 | 2.5 | 13 | 2.5 | °C/W |
| $R_{thj\text{-}amb}$ | Thermal Resistance Junction-ambient Max | 62.5 | 50 | 100 | 62.5 | °C/W |

## ELECTRICAL CHARACTERISTICS ($T_{case}$ = 25 °C unless otherwise specified)

OFF

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{CLAMP}$ | Drain-source Clamp Voltage | $I_D$ = 200 mA $V_{in}$ = 0 | 60 | 70 | 80 | V |
| $V_{CLTH}$ | Drain-source Clamp Threshold Voltage | $I_D$ = 2 mA $V_{in}$ = 0 | 55 | | | V |
| $V_{INCL}$ | Input-Source Reverse Clamp Voltage | $I_{in}$ = -1 mA | -1 | | -0.3 | V |
| $I_{DSS}$ | Zero Input Voltage Drain Current ($V_{in}$ = 0) | $V_{DS}$ = 13 V $V_{in}$ = 0<br>$V_{DS}$ = 25 V $V_{in}$ = 0 | | | 50<br>200 | µA<br>µA |
| $I_{ISS}$ | Supply Current from Input Pin | $V_{DS}$ = 0 V $V_{in}$ = 10 V | | 250 | 500 | µA |

ON (∗)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{IN(th)}$ | Input Threshold Voltage | $V_{DS}$ = $V_{in}$ $I_D$ + $I_{in}$ = 1 mA | 0.8 | | 3 | V |
| $R_{DS(on)}$ | Static Drain-source On Resistance | $V_{in}$ = 10 V $I_D$ = 5 A<br>$V_{in}$ = 5 V $I_D$ = 5 A | | | 0.1<br>0.14 | Ω<br>Ω |

**ELECTRICAL CHARACTERISTICS** (continued)

DYNAMIC

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$ (*) | Forward Transconductance | $V_{DS}$ = 13 V $I_D$ = 5 A | 6 | 8 | | S |
| $C_{oss}$ | Output Capacitance | VDS = 13 V f = 1 MHz $V_{in}$ = 0 | | 350 | 500 | pF |

SWITCHING (**)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on Delay Time<br>Rise Time<br>Turn-off Delay Time<br>Fall Time | $V_{DD}$ = 15 V $I_d$ = 5 A<br>$V_{gen}$ = 10 V $R_{gen}$ = 10 Ω<br>(see figure 3) | | 50<br>80<br>230<br>100 | 100<br>160<br>400<br>180 | ns<br>ns<br>ns<br>ns |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on Delay Time<br>Rise Time<br>Turn-off Delay Time<br>Fall Time | $V_{DD}$ = 15 V $I_d$ = 5 A<br>$V_{gen}$ = 10 V $R_{gen}$ = 1000 Ω<br>(see figure 3) | | 600<br>0.9<br>3.8<br>1.7 | 900<br>2<br>6<br>2.5 | ns<br>µs<br>µs<br>µs |
| $(di/dt)_{on}$ | Turn-on Current Slope | $V_{DD}$ = 15 V $I_D$ = 5 A<br>$V_{in}$ = 10 V $R_{gen}$ = 10 Ω | | 60 | | A/µs |
| $Q_i$ | Total Input Charge | $V_{DD}$ = 12 V $I_D$ = 5 A $V_{in}$ = 10 V | | 30 | | nC |

SOURCE DRAIN DIODE

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{SD}$ (*) | Forward On Voltage | $I_{SD}$ = 5 A $V_{in}$ = 0 | | | 1.6 | V |
| $t_{rr}$ (**)<br>$Q_{rr}$ (**)<br>$I_{RRM}$ (**) | Reverse Recovery Time<br>Reverse Recovery Charge<br>Reverse Recovery Current | $I_{SD}$ = 5 A di/dt = 100 A/µs<br>$V_{DD}$ = 30 V $T_j$ = 25 °C<br>(see test circuit, figure 5) | | 125<br>0.3<br>4.8 | | ns<br>µC<br>A |

PROTECTION

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{lim}$ | Drain Current Limit | $V_{in}$ = 10 V $V_{DS}$ = 13 V<br>$V_{in}$ = 5 V $V_{DS}$ = 13 V | 7<br>7 | 10<br>10 | 14<br>14 | A<br>A |
| $t_{dlim}$ (**) | Step Response Current Limit | $V_{in}$ = 10 V<br>$V_{in}$ = 5 V | | 20<br>50 | 30<br>80 | µs<br>µs |
| $T_{jsh}$ (**) | Overtemperature Shutdown | | 150 | | | °C |
| $T_{jrs}$ (**) | Overtemperature Reset | | 135 | | | °C |
| $I_{gf}$ (**) | Fault Sink Current | $V_{in}$ = 10 V $V_{DS}$ = 13 V<br>$V_{in}$ = 5 V $V_{DS}$ = 13 V | | 50<br>20 | | mA<br>mA |
| $E_{as}$ (**) | Single Pulse Avalanche Energy | starting $T_j$ = 25 °C $V_{DD}$ = 20 V<br>$V_{in}$ = 10 V $R_{gen}$ = 1 KΩ L = 10 mH | 0.4 | | | J |

(*) Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %

(**) Parameters guaranteed by design/characterization

## PROTECTION FEATURES

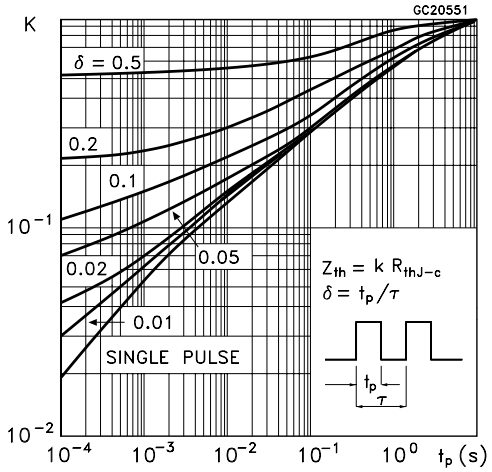
During normal operation, the Input pin is electrically connected to the gate of the internal power MOSFET. The device then behaves like a standard power MOSFET and can be used as a switch from DC to 50 KHz. The only difference from the user's standpoint is that a small DC current ($I_{iss}$) flows into the Input pin in order to supply the internal circuitry.

The device integrates:

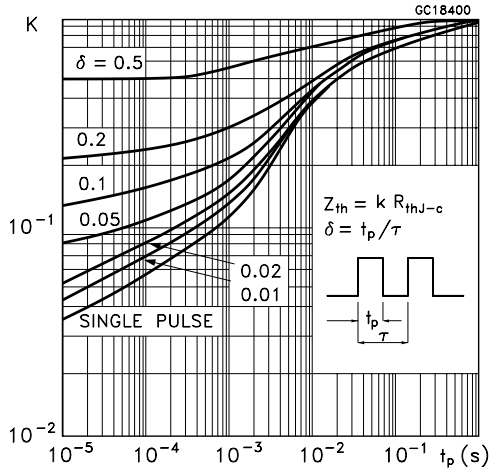
- OVERVOLTAGE CLAMP PROTECTION: internally set at 70V, along with the rugged avalanche characteristics of the Power MOSFET stage give this device unrivalled ruggedness and energy handling capability. This feature is mainly important when driving inductive loads.
- LINEAR CURRENT LIMITER CIRCUIT: limits the drain current Id to Ilim whatever the Input pin voltage. When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the capability of the heatsink. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold $T_{jsh}$.
- OVERTEMPERATURE AND SHORT CIRCUIT PROTECTION: these are based on sensing the chip temperature and are not dependent on the input voltage. The location of the sensing element on the chip in the power stage area ensures fast, accurate detection of the junction temperature. Overtemperature cutout occurs at minimum $150^{o}C$. The device is automatically restarted when the chip temperature falls below $135^{o}C$.
- STATUS FEEDBACK: In the case of an overtemperature fault condition, a Status Feedback is provided through the Input pin. The internal protection circuit disconnects the input from the gate and connects it instead to ground via an equivalent resistance of 100 Ω. The failure can be detected by monitoring the voltage at the Input pin, which will be close to ground potential.

Additional features of this device are ESD protection according to the Human Body model and the ability to be driven from a TTL Logic circuit (with a small increase in $R_{DS(on)}$).

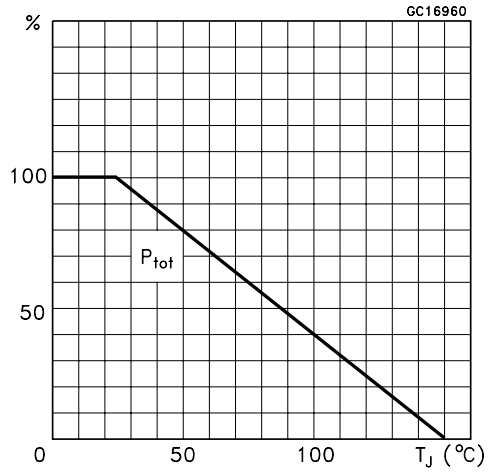
Thermal Impedance For ISOWATT220



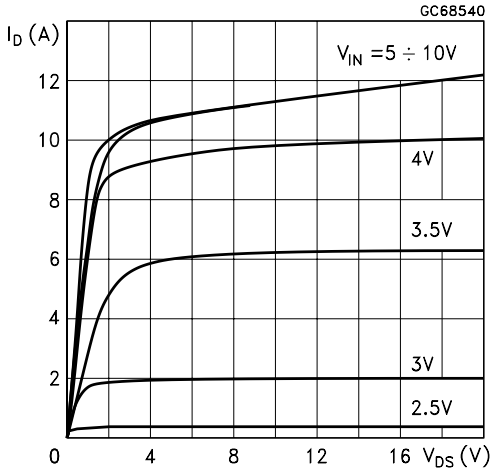

Thermal Impedance For D2PAK / PowerSO-10



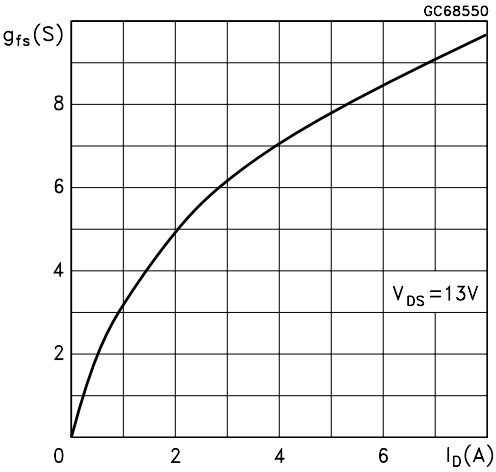

Derating Curve



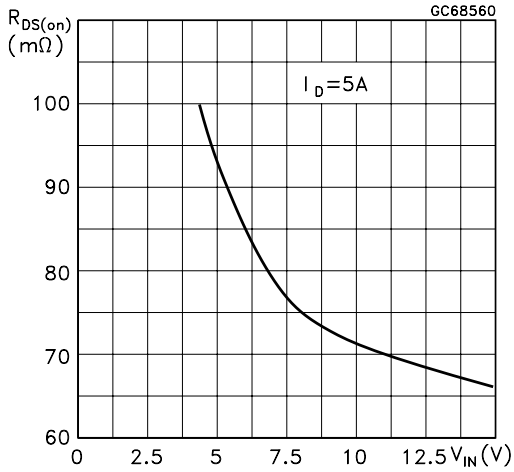

Output Characteristics



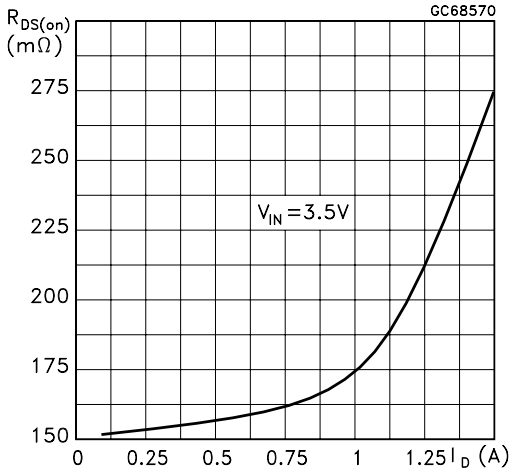

Transconductance



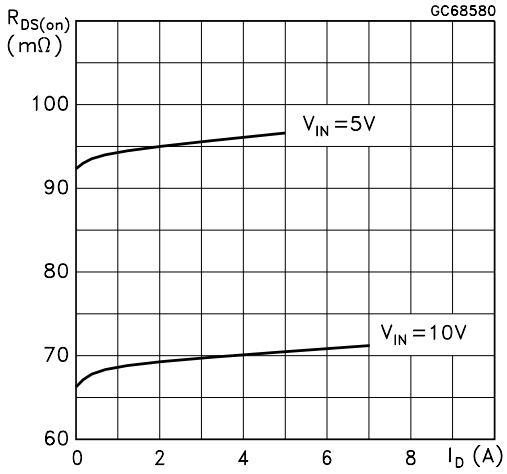

Static Drain-Source On Resistance vs Input Voltage



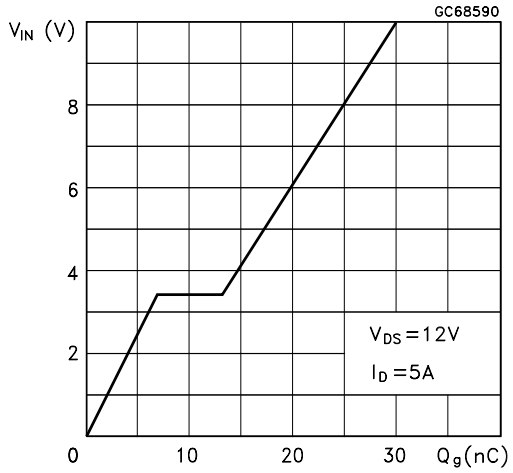
Static Drain-Source On Resistance



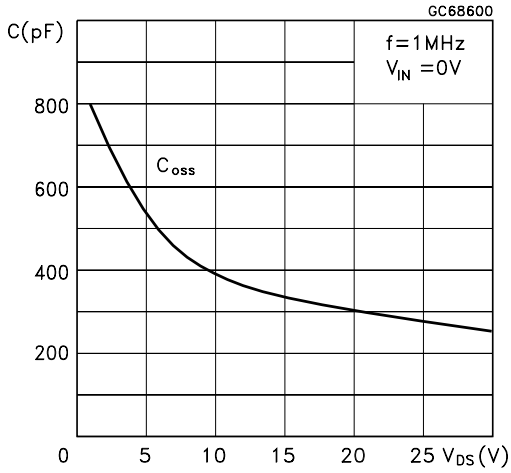

Static Drain-Source On Resistance



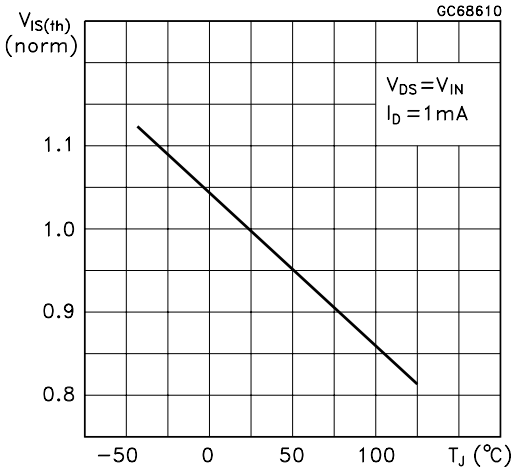

Input Charge vs Input Voltage



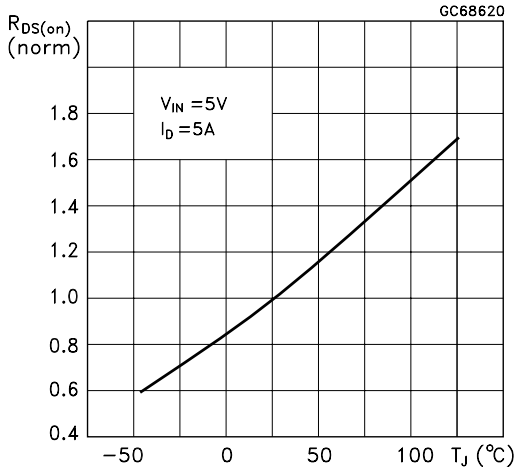

Capacitance Variations



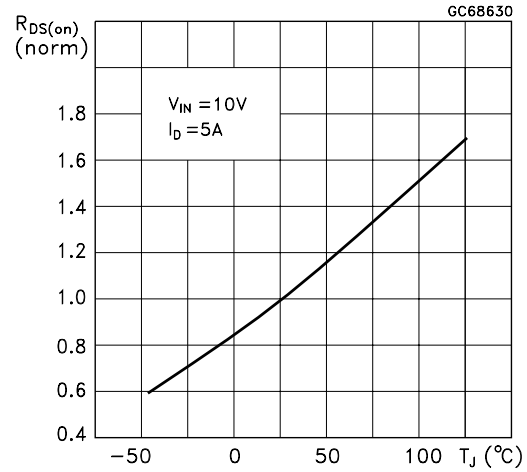

Normalized Input Threshold Voltage vs Temperature



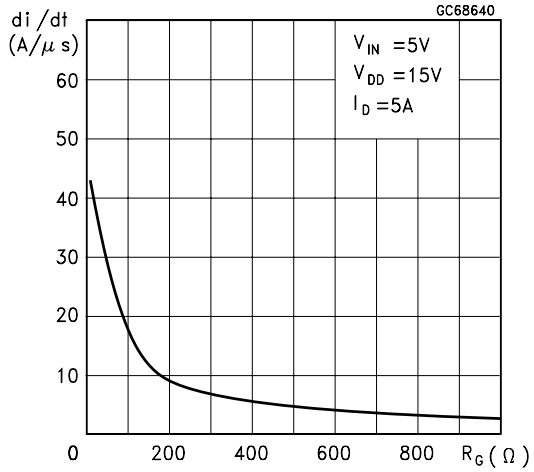

Normalized On Resistance vs Temperature



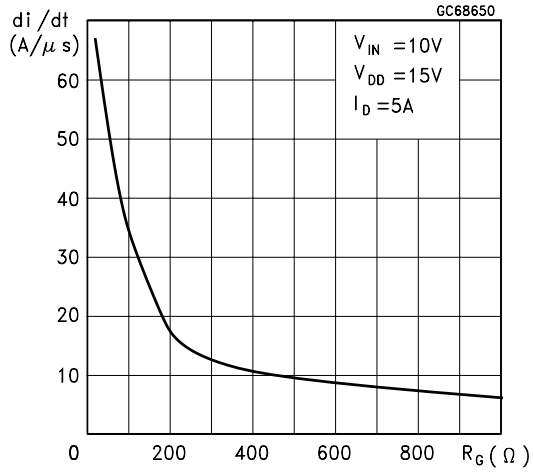
Normalized On Resistance vs Temperature



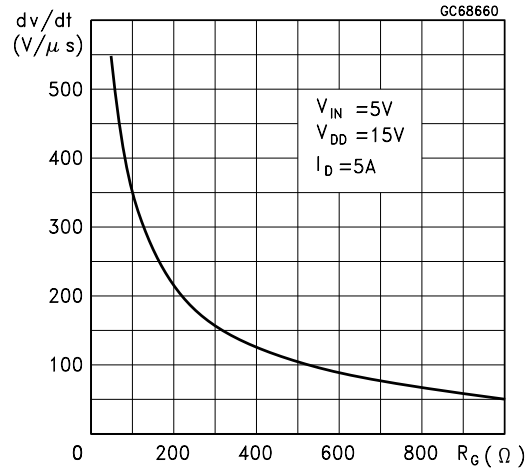

Turn-on Current Slope



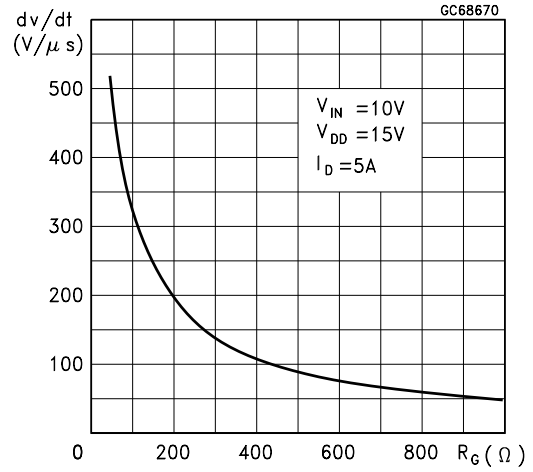

Turn-on Current Slope



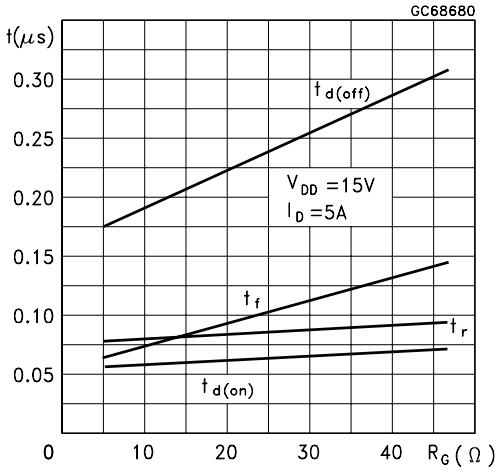

Turn-off Drain-Source Voltage Slope



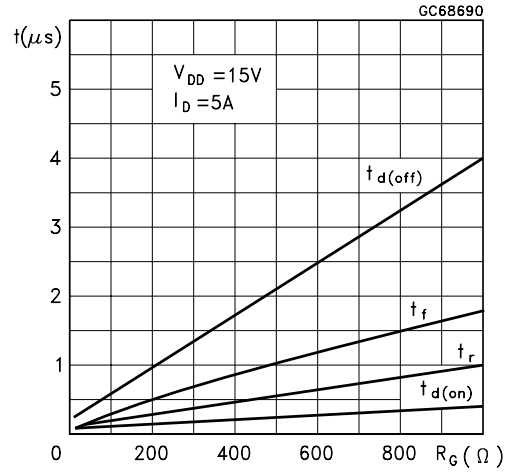

Turn-off Drain-Source Voltage Slope



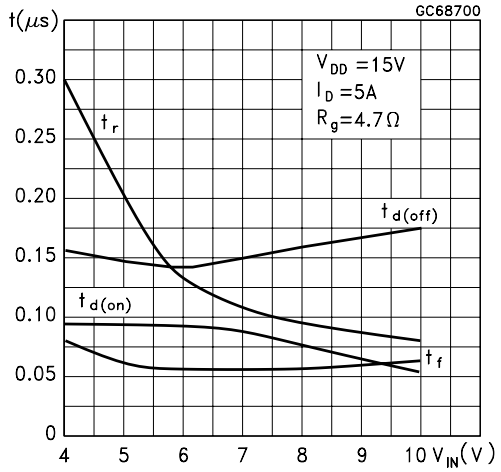

Switching Time Resistive Load



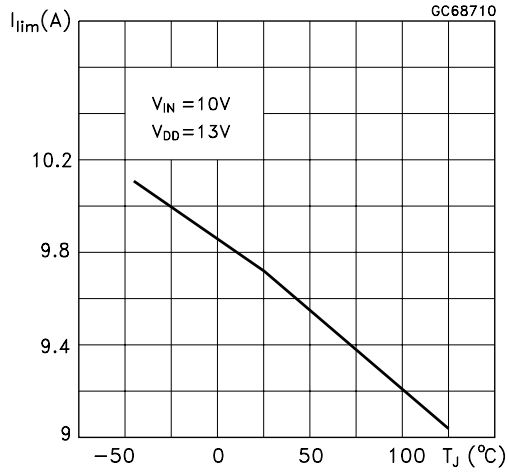
Switching Time Resistive Load



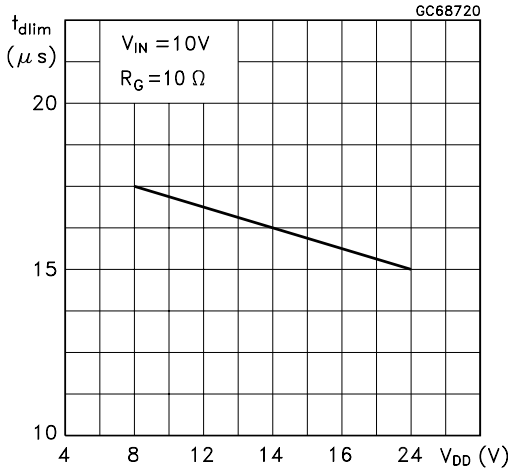

Switching Time Resistive Load




Current Limit vs Junction Temperature




Step Response Current Limit




Source Drain Diode Forward Characteristics

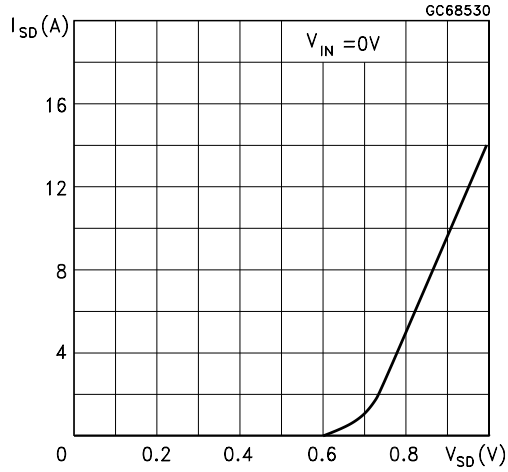


**Fig. 1:** Unclamped Inductive Load Test Circuits

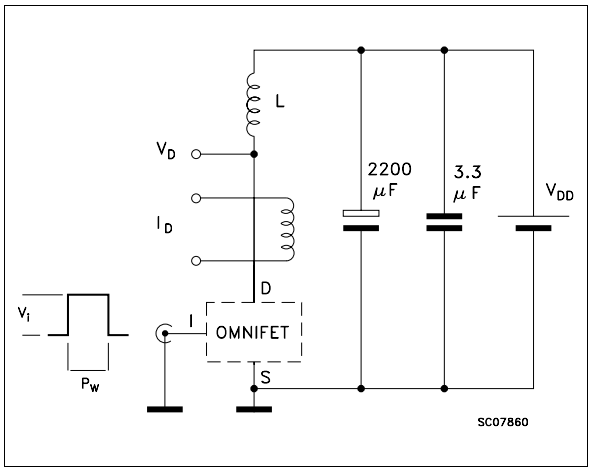



**Fig. 2:** Unclamped Inductive Waveforms

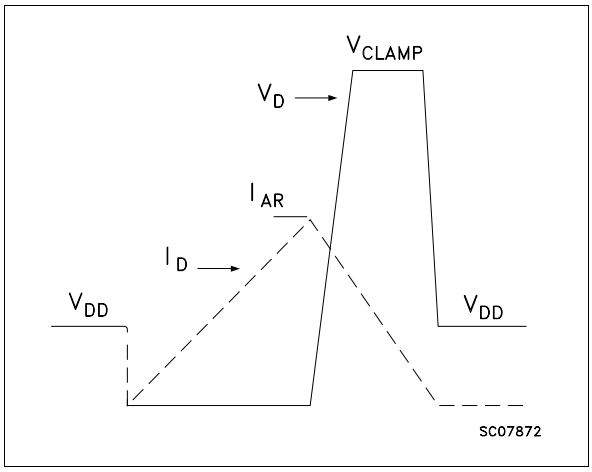



**Fig. 3:** Switching Times Test Circuits For Resistive Load

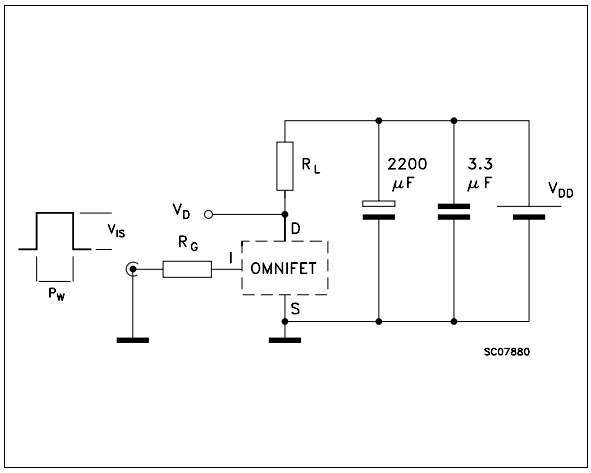



**Fig. 4:** Input Charge Test Circuit

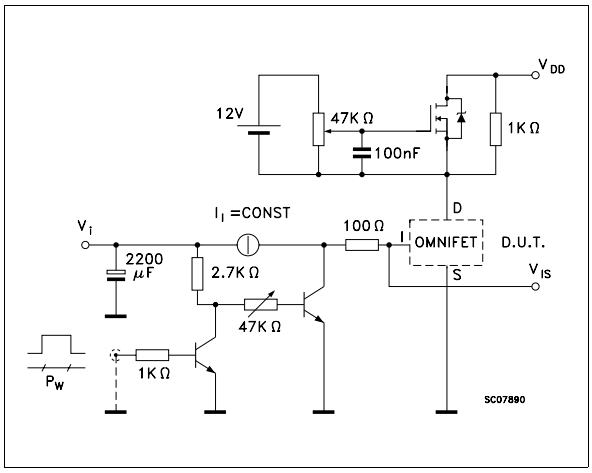



**Fig. 5:** Test Circuit For Inductive Load Switching And Diode Recovery Times

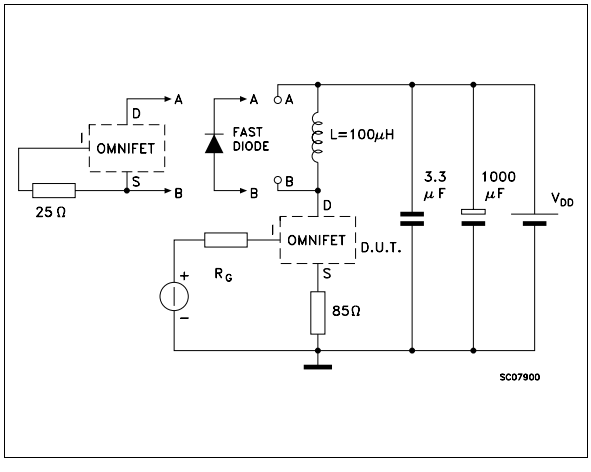
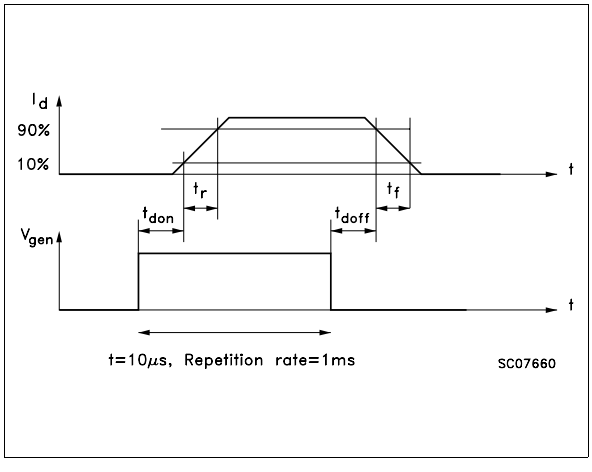
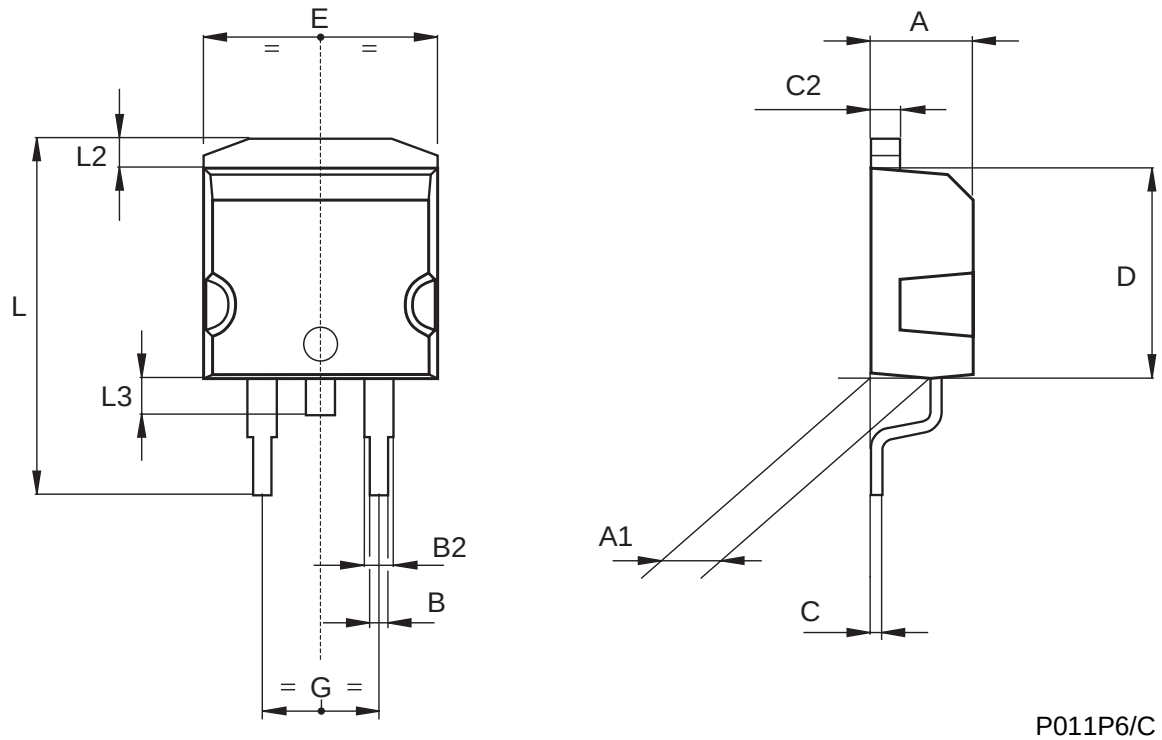



**Fig. 6:** Waveforms



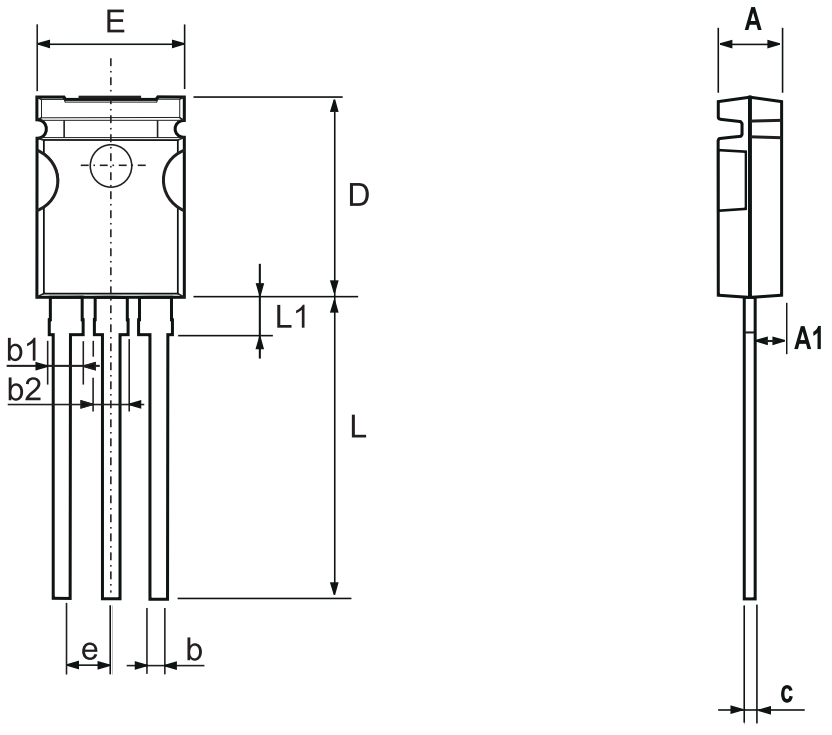
## TO-263 (D2PAK) MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.3 | | 4.6 | 0.169 | | 0.181 |
| A1 | 2.49 | | 2.69 | 0.098 | | 0.106 |
| B | 0.7 | | 0.93 | 0.027 | | 0.036 |
| B2 | 1.25 | | 1.4 | 0.049 | | 0.055 |
| C | 0.45 | | 0.6 | 0.017 | | 0.023 |
| C2 | 1.21 | | 1.36 | 0.047 | | 0.053 |
| D | 8.95 | | 9.35 | 0.352 | | 0.368 |
| E | 10 | | 10.28 | 0.393 | | 0.404 |
| G | 4.88 | | 5.28 | 0.192 | | 0.208 |
| L | 15 | | 15.85 | 0.590 | | 0.624 |
| L2 | 1.27 | | 1.4 | 0.050 | | 0.055 |
| L3 | 1.4 | | 1.75 | 0.055 | | 0.068 |



## SOT82-FM MECHANICAL DATA

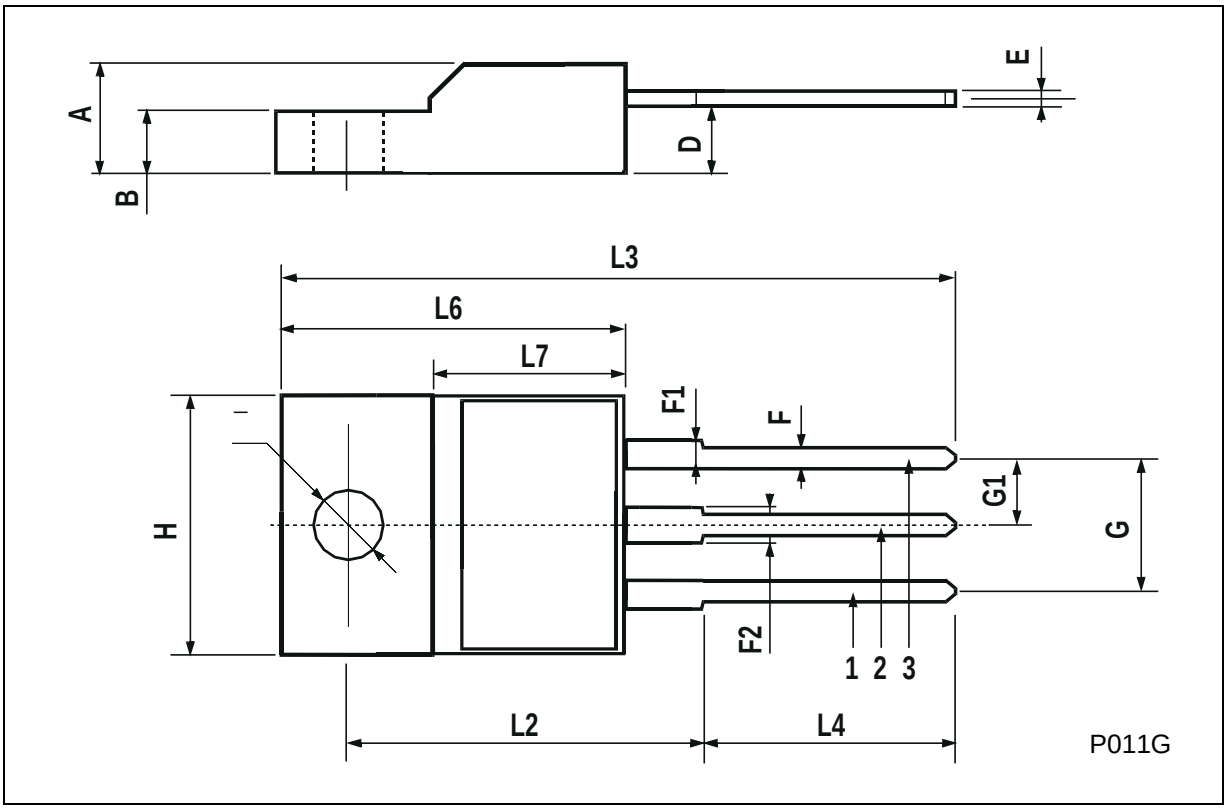
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 2.85 | | 3.05 | 1.122 | | 1.200 |
| A1 | 1.47 | | 1.67 | 0.578 | | 0.657 |
| b | 0.40 | | 0.60 | 0.157 | | 0.236 |
| b1 | 1.4 | | 1.6 | 0.551 | | 0.630 |
| b2 | 1.3 | | 1.5 | 0.511 | | 0.590 |
| c | 0.45 | | 0.6 | 0.177 | | 0.236 |
| D | 10.5 | | 10.9 | 4.133 | | 4.291 |
| e | 2.2 | | 2.8 | 0.866 | | 1.102 |
| E | 7.45 | | 7.75 | 2.933 | | 3.051 |
| L | 15.5 | | 15.9 | 6.102 | | 6.260 |
| L1 | 1.95 | | 2.35 | 0.767 | | 0.925 |




P032R

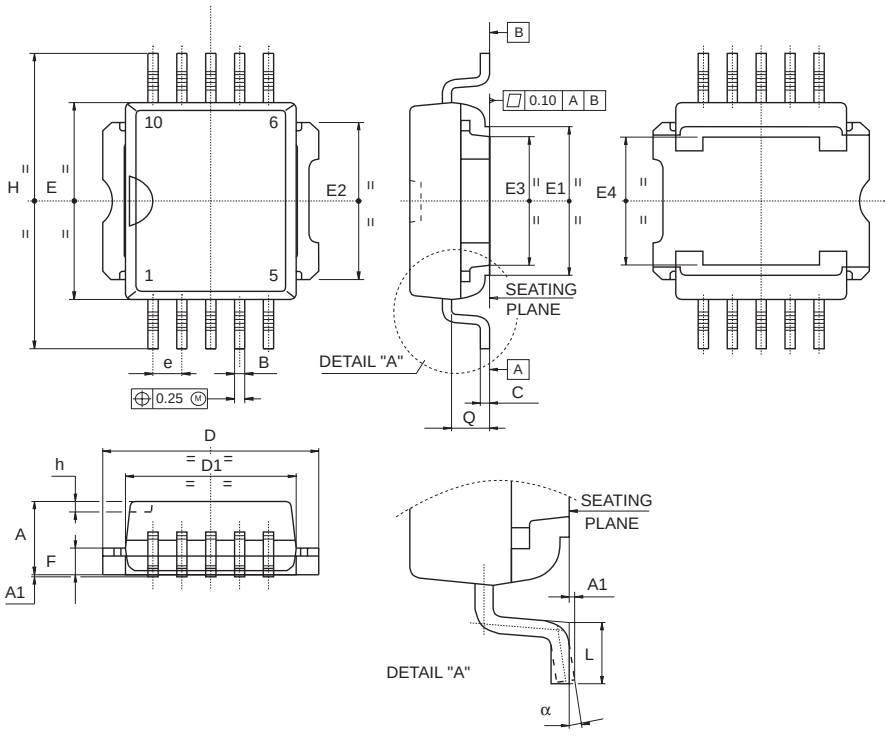
## ISOWATT220 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 4.4 | | 4.6 | 0.173 | | 0.181 |
| B | 2.5 | | 2.7 | 0.098 | | 0.106 |
| D | 2.5 | | 2.75 | 0.098 | | 0.108 |
| E | 0.4 | | 0.7 | 0.015 | | 0.027 |
| F | 0.75 | | 1 | 0.030 | | 0.039 |
| F1 | 1.15 | | 1.7 | 0.045 | | 0.067 |
| F2 | 1.15 | | 1.7 | 0.045 | | 0.067 |
| G | 4.95 | | 5.2 | 0.195 | | 0.204 |
| G1 | 2.4 | | 2.7 | 0.094 | | 0.106 |
| H | 10 | | 10.4 | 0.393 | | 0.409 |
| L2 | | 16 | | | 0.630 | |
| L3 | 28.6 | | 30.6 | 1.126 | | 1.204 |
| L4 | 9.8 | | 10.6 | 0.385 | | 0.417 |
| L6 | 15.9 | | 16.4 | 0.626 | | 0.645 |
| L7 | 9 | | 9.3 | 0.354 | | 0.366 |
| Ø | 3 | | 3.2 | 0.118 | | 0.126 |



## PowerSO-10 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 3.35 | | 3.65 | 0.132 | | 0.144 |
| A1 | 0.00 | | 0.10 | 0.000 | | 0.004 |
| B | 0.40 | | 0.60 | 0.016 | | 0.024 |
| c | 0.35 | | 0.55 | 0.013 | | 0.022 |
| D | 9.40 | | 9.60 | 0.370 | | 0.378 |
| D1 | 7.40 | | 7.60 | 0.291 | | 0.300 |
| E | 9.30 | | 9.50 | 0.366 | | 0.374 |
| E1 | 7.20 | | 7.40 | 0.283 | | 0.291 |
| E2 | 7.20 | | 7.60 | 0.283 | | 0.300 |
| E3 | 6.10 | | 6.35 | 0.240 | | 0.250 |
| E4 | 5.90 | | 6.10 | 0.232 | | 0.240 |
| e | | 1.27 | | | 0.050 | |
| F | 1.25 | | 1.35 | 0.049 | | 0.053 |
| H | 13.80 | | 14.40 | 0.543 | | 0.567 |
| h | | 0.50 | | | 0.002 | |
| L | 1.20 | | 1.80 | 0.047 | | 0.071 |
| q | | 1.70 | | | 0.067 | |
| α | $0^o$ | | $8^o$ | | | |

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