

## N-Channel 600V (D-S) Super Junction Power MOSFET

| PRODUCT SUMMARY                            |                        |       |
|--------------------------------------------|------------------------|-------|
| V <sub>DS</sub> (V) at T <sub>J</sub> max. | 600                    |       |
| R <sub>DS(on)</sub> at 25 °C (Ω)           | V <sub>GS</sub> = 10 V | 0.330 |

### FEATURES

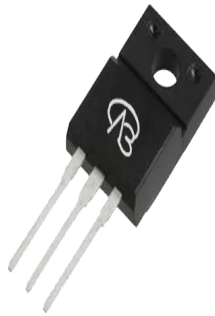
- Low figure-of-merit (FOM) R<sub>on</sub> x Q<sub>g</sub>
- Low input capacitance (C<sub>iss</sub>)
- Reduced switching and conduction losses
- Ultra low gate charge (Q<sub>g</sub>)
- Avalanche energy rated (UIS)



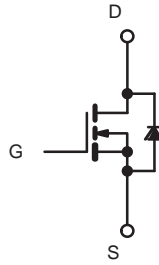
### APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Industrial

TO-220F



Top View



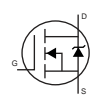
N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                                   |                         |             |      |
|---------------------------------------------------------------------------|-----------------------------------|-------------------------|-------------|------|
| PARAMETER                                                                 | SYMBOL                            |                         | LIMIT       | UNIT |
| Drain-Source Voltage                                                      | V <sub>DS</sub>                   |                         | 600         | V    |
| Gate-Source Voltage                                                       | V <sub>GS</sub>                   |                         | ± 30        |      |
| Continuous Drain Current (T <sub>J</sub> = 150 °C)                        | V <sub>GS</sub> at 10 V           | T <sub>C</sub> = 25 °C  | 12          | A    |
|                                                                           |                                   | T <sub>C</sub> = 100 °C | 7           |      |
| Pulsed Drain Current <sup>a</sup>                                         | I <sub>DM</sub>                   |                         | 36          |      |
| Linear Derating Factor                                                    |                                   |                         | 1.67        | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                                | E <sub>AS</sub>                   |                         | 590         | mJ   |
| Maximum Power Dissipation                                                 | P <sub>D</sub>                    |                         | 200         | W    |
| Operating Junction and Storage Temperature Range                          | T <sub>J</sub> , T <sub>stg</sub> |                         | -55 to +150 | °C   |
| Drain-Source Voltage Slope                                                | T <sub>J</sub> = 125 °C           |                         | 50          | V/ns |
| Reverse Diode dV/dt <sup>d</sup>                                          |                                   |                         | 15          |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>                 | for 10 s                          |                         | 260         | °C   |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- V<sub>DD</sub> = 100 V, starting T<sub>J</sub> = 25 °C, L = 28.2 mH, R<sub>g</sub> = 25 Ω, I<sub>AS</sub> = 6A.
- 1.6 mm from case.
- I<sub>SD</sub> ≤ I<sub>D</sub>, dI/dt = 100 A/μs, starting T<sub>J</sub> = 25 °C.

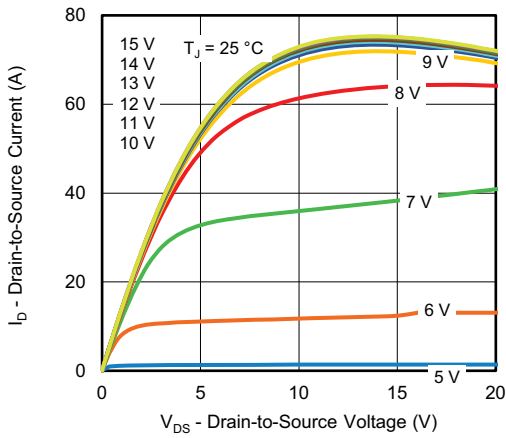
| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.7  |      |

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |                                                                                                                                                       |                                           |      |       |           |               |
|-----------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|------|-------|-----------|---------------|
| PARAMETER                                                                   | SYMBOL              | TEST CONDITIONS                                                                                                                                       |                                           | MIN. | TYP.  | MAX.      | UNIT          |
| <b>Static</b>                                                               |                     |                                                                                                                                                       |                                           |      |       |           |               |
| Drain-Source Breakdown Voltage                                              | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$                                                                                                              |                                           | 600  | -     | -         | V             |
| $V_{DS}$ Temperature Coefficient                                            | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$                                                                                         |                                           | -    | 0.70  | -         | V/°C          |
| Gate-Source Threshold Voltage (N)                                           | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                                                                                                       |                                           | 2.5  | -     | 4.5       | V             |
| Gate-Source Leakage                                                         | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                                            |                                           | -    | -     | $\pm 100$ | nA            |
|                                                                             |                     | $V_{GS} = \pm 30\text{ V}$                                                                                                                            |                                           | -    | -     | $\pm 1$   | $\mu\text{A}$ |
| Zero Gate Voltage Drain Current                                             | $I_{DSS}$           | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                                                                                                          |                                           | -    | -     | 1         | $\mu\text{A}$ |
|                                                                             |                     | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$                                                                         |                                           | -    | -     | 100       |               |
| Drain-Source On-State Resistance                                            | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                | $I_D = 4\text{ A}$                        | -    | 0.330 | -         | $\Omega$      |
| Forward Transconductance                                                    | $g_{fs}$            | $V_{DS} = 30\text{ V}, I_D = 4\text{ A}$                                                                                                              |                                           | -    | 5.6   | -         | S             |
| <b>Dynamic</b>                                                              |                     |                                                                                                                                                       |                                           |      |       |           |               |
| Input Capacitance                                                           | $C_{iss}$           | $V_{GS} = 0\text{ V},$<br>$V_{DS} = 100\text{ V},$<br>$f = 1\text{ MHz}$                                                                              |                                           | -    | 1350  | -         | pF            |
| Output Capacitance                                                          | $C_{oss}$           |                                                                                                                                                       |                                           | -    | 80    | -         |               |
| Reverse Transfer Capacitance                                                | $C_{rss}$           |                                                                                                                                                       |                                           | -    | 4     | -         |               |
| Effective Output Capacitance, Energy Related <sup>a</sup>                   | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 520\text{ V}, V_{GS} = 0\text{ V}$                                                                                           |                                           | -    | 63    | -         |               |
| Effective Output Capacitance, Time Related <sup>b</sup>                     | $C_{o(tr)}$         |                                                                                                                                                       |                                           | -    | 213   | -         |               |
| Total Gate Charge                                                           | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                | $I_D = 8\text{ A}, V_{DS} = 520\text{ V}$ | -    | 9.8   | -         | nC            |
| Gate-Source Charge                                                          | $Q_{gs}$            |                                                                                                                                                       |                                           | -    | 15    | -         |               |
| Gate-Drain Charge                                                           | $Q_{gd}$            |                                                                                                                                                       |                                           | -    | 1.9   | -         |               |
| Turn-On Delay Time                                                          | $t_{d(on)}$         | $V_{DD} = 520\text{ V}, I_D = 8\text{ A},$<br>$V_{GS} = 10\text{ V}, R_g = 9.1\text{ }\Omega$                                                         |                                           | -    | 18    | 25        | ns            |
| Rise Time                                                                   | $t_r$               |                                                                                                                                                       |                                           | -    | 24    | 55        |               |
| Turn-Off Delay Time                                                         | $t_{d(off)}$        |                                                                                                                                                       |                                           | -    | 8.0   | -         |               |
| Fall Time                                                                   | $t_f$               |                                                                                                                                                       |                                           | -    | 1.2   | -         |               |
| Gate Input Resistance                                                       | $R_g$               | $f = 1\text{ MHz}, \text{ open drain}$                                                                                                                |                                           | -    | 0.8   | -         | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |                                                                                                                                                       |                                           |      |       |           |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode  |                                           | -    | -     | 12        | A             |
| Pulsed Diode Forward Current                                                | $I_{SM}$            |                                                                                                                                                       |                                           | -    | -     | 36        |               |
| Diode Forward Voltage                                                       | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 8\text{ A}, V_{GS} = 0\text{ V}$                                                                               |                                           | -    | -     | 1.5       | V             |
| Reverse Recovery Time                                                       | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 8\text{ A},$<br>$di/dt = 100\text{ A}/\mu\text{s}, V_R = 400\text{ V}$                                   |                                           | -    | 475   | -         | ns            |
| Reverse Recovery Charge                                                     | $Q_{rr}$            |                                                                                                                                                       |                                           | -    | 5.8   | -         | $\mu\text{C}$ |
| Reverse Recovery Current                                                    | $I_{RRM}$           |                                                                                                                                                       |                                           | -    | 35    | -         | A             |

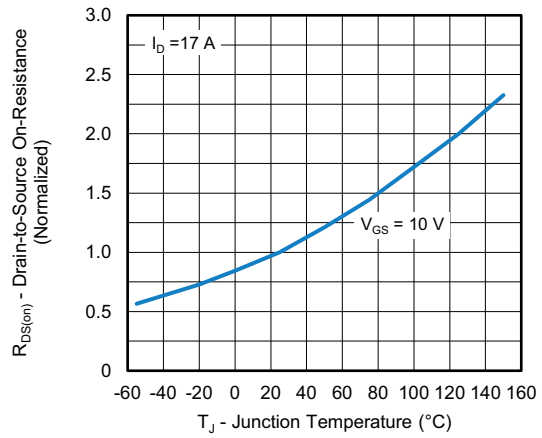
**Notes**

- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .
- b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

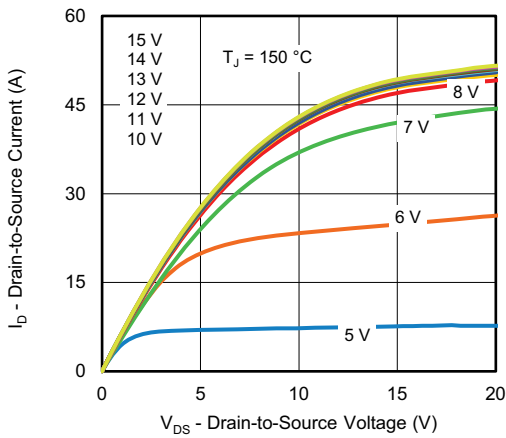
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



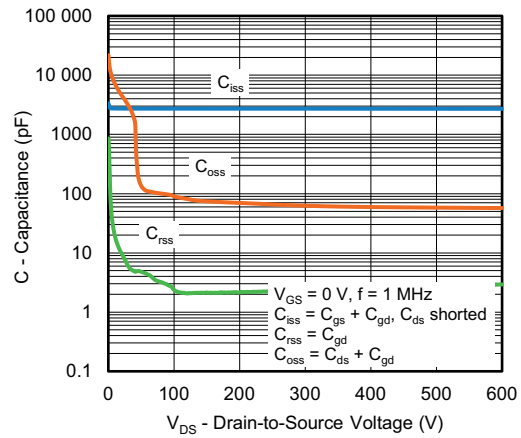
**Fig. 1 - Typical Output Characteristics**



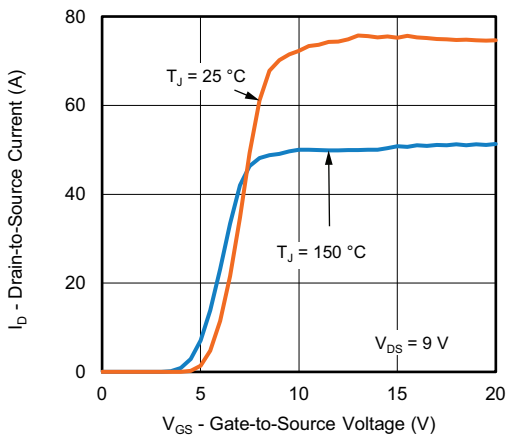
**Fig. 4 - Normalized On-Resistance vs. Temperature**



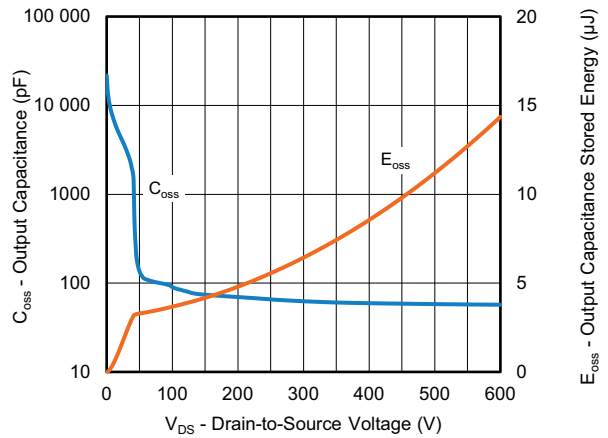
**Fig. 2 - Typical Output Characteristics**



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 -  $C_{oss}$  and  $E_{oss}$  vs.  $V_{DS}$**

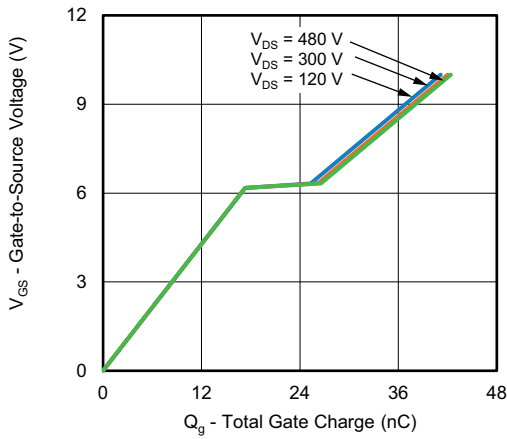


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

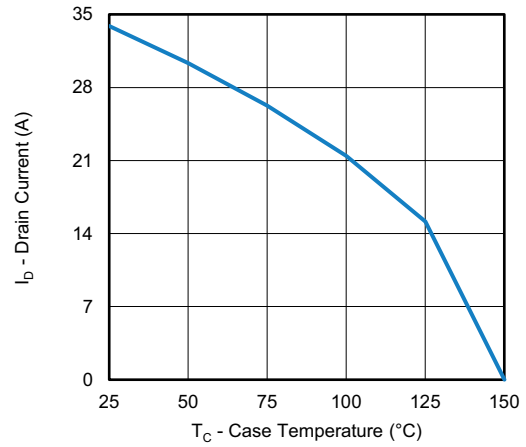


Fig. 10 - Maximum Drain Current vs. Case Temperature

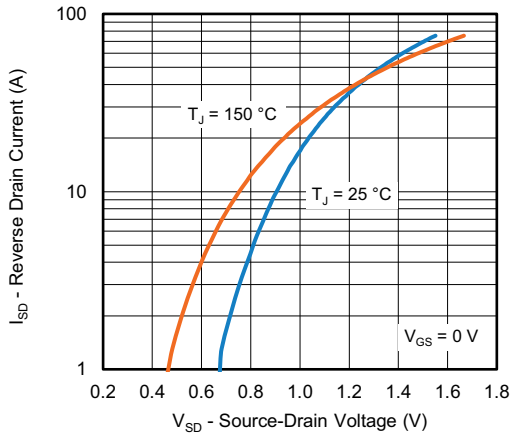


Fig. 8 - Typical Source-Drain Diode Forward Voltage

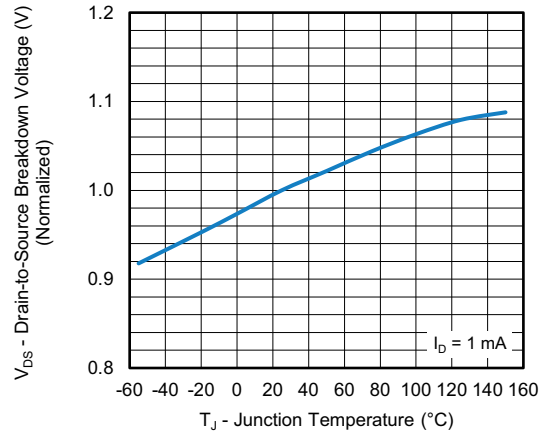


Fig. 11 - Temperature vs. Drain-to-Source Voltage

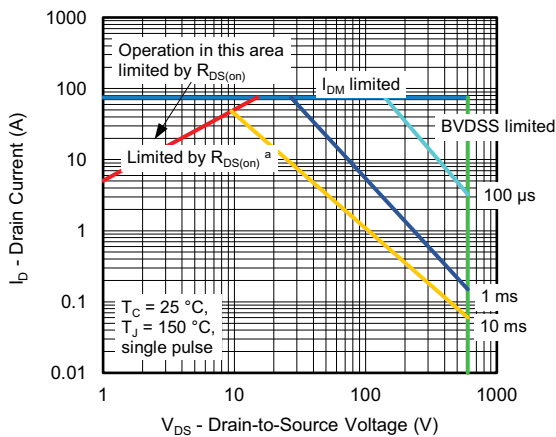


Fig. 9 - Maximum Safe Operating Area

**Note**

a.  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

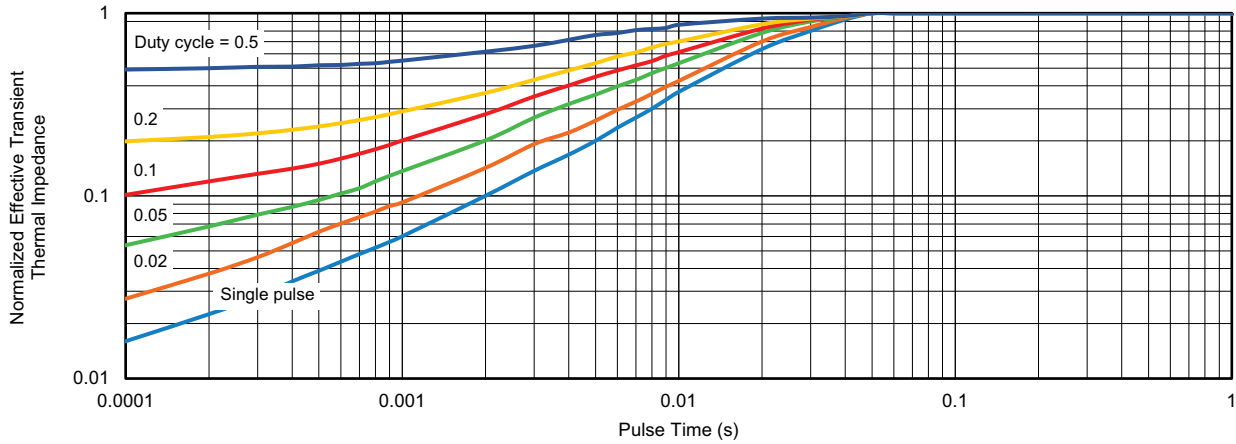


Fig. 12 - Normalized Transient Thermal Impedance, Junction-to-Case

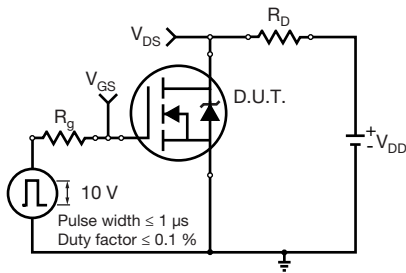


Fig. 13 - Switching Time Test Circuit

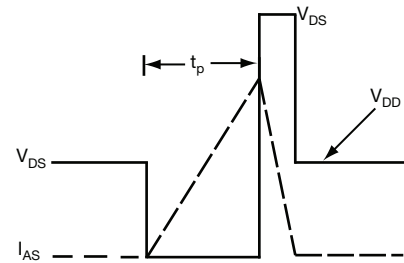


Fig. 16 - Unclamped Inductive Waveforms

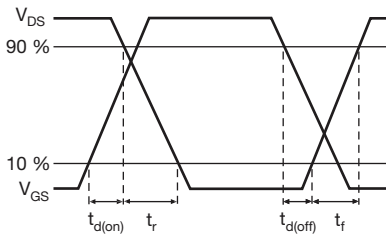


Fig. 14 - Switching Time Waveforms

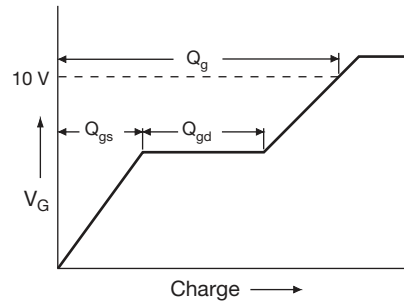


Fig. 17 - Basic Gate Charge Waveform

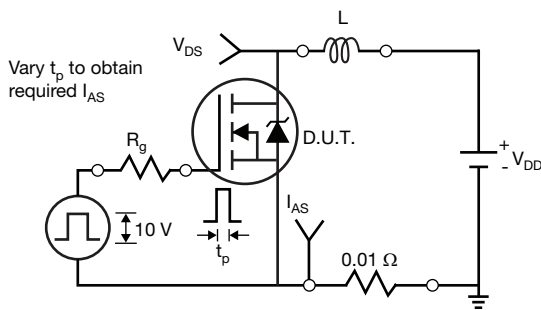


Fig. 15 - Unclamped Inductive Test Circuit

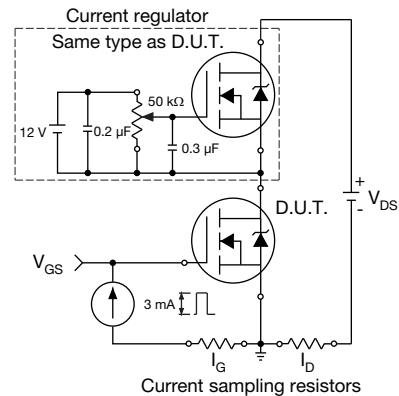
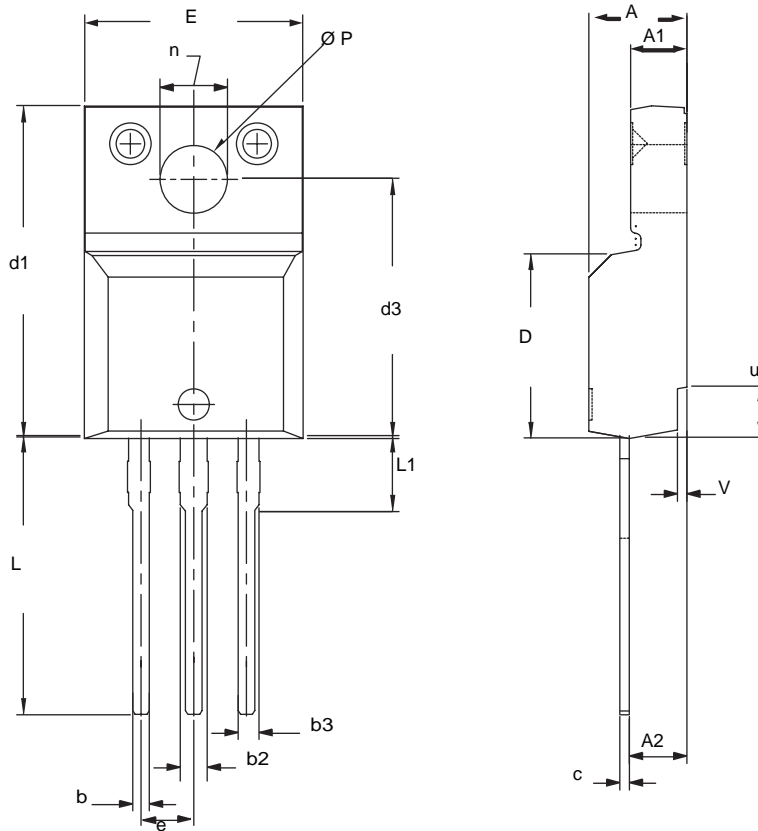


Fig. 18 - Gate Charge Test Circuit

**TO-220 FULLPAK (HIGH VOLTAGE)**



| DIM. | MILLIMETERS |        | INCHES    |       |
|------|-------------|--------|-----------|-------|
|      | MIN.        | MAX.   | MIN.      | MAX.  |
| A    | 4.570       | 4.830  | 0.180     | 0.190 |
| A1   | 2.570       | 2.830  | 0.101     | 0.111 |
| A2   | 2.510       | 2.850  | 0.099     | 0.112 |
| b    | 0.622       | 0.890  | 0.024     | 0.035 |
| b2   | 1.229       | 1.400  | 0.048     | 0.055 |
| b3   | 1.229       | 1.400  | 0.048     | 0.055 |
| c    | 0.440       | 0.629  | 0.017     | 0.025 |
| D    | 8.650       | 9.800  | 0.341     | 0.386 |
| d1   | 15.88       | 16.120 | 0.622     | 0.635 |
| d3   | 12.300      | 12.920 | 0.484     | 0.509 |
| E    | 10.360      | 10.630 | 0.408     | 0.419 |
| e    | 2.54 BSC    |        | 0.100 BSC |       |
| L    | 13.200      | 13.730 | 0.520     | 0.541 |
| L1   | 3.100       | 3.500  | 0.122     | 0.138 |
| n    | 6.050       | 6.150  | 0.238     | 0.242 |
| Ø P  | 3.050       | 3.450  | 0.120     | 0.136 |
| u    | 2.400       | 2.500  | 0.094     | 0.098 |
| v    | 0.400       | 0.500  | 0.016     | 0.020 |

ECN: X09-0126-Rev. B, 26-Oct-09  
 DWG: 5972

**Notes**

1. To be used only for process drawing.
2. These dimensions apply to all TO-220, FULLPAK leadframe versions 3 leads.3
3. All critical dimensions should C meet  $C_{pk} > 1.33$ .
4. All dimensions include burrs and plating thickness.
5. No chipping or package damage.

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