

## N-Channel 500-V (D-S) Super Junction MOSFET

| PRODUCT SUMMARY                            |                                |
|--|--------------------------------|
| V <sub>DS</sub> (V) at T <sub>J</sub> max. | 500                            |
| R <sub>DS(on)</sub> at 25 °C (Ω)           | V <sub>GS</sub> = 10 V   0.192 |
| Q <sub>g</sub> max. (nC)                   | 86                             |
| Q <sub>gs</sub> (nC)                       | 9                              |
| Q <sub>gd</sub> (nC)                       | 16                             |
| Configuration                              | Single                         |

### 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
- Low gate charge (Q<sub>g</sub>)
- Avalanche energy rated (UIS)

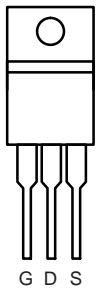


RoHS  
COMPLIANT  
HALOGEN  
FREE

### APPLICATIONS

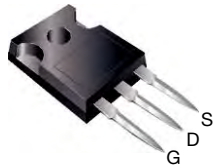
- Computing  
- PC silver box / ATX power supplies

TO-220AB



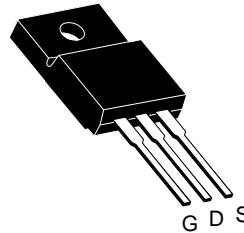
Top View

TO-247AC

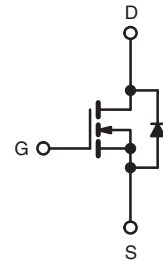


Top View

TO-220 FULLPAK



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>                   | 500   | 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                        | 18   | A    |
|   |                                   | T <sub>C</sub> = 100 °C                       | 12   |      |
| Pulsed Drain Current <sup>a</sup>   | I <sub>DM</sub>                   | 50  |      |      |
| Linear Derating Factor  |                                   | 1.25  | W/°C |      |
| Single Pulse Avalanche Energy <sup>b</sup>                                | E <sub>AS</sub>                   | 186   | mJ   |      |
| Maximum Power Dissipation   | P <sub>D</sub>                    | 206   | W    |      |
| Operating Junction and Storage Temperature Range                          | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150                                   | °C   |      |
| Drain-Source Voltage Slope  | dV/dt                             | V <sub>DS</sub> = 0 V to 80 % V <sub>DS</sub> | 70   | V/ns |
| Reverse Diode dV/dt <sup>d</sup>  |                                   | 27  |      |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>                 | for 10 s                          | 300   | °C   |      |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- V<sub>DD</sub> = 50 V, starting T<sub>J</sub> = 25 °C, L = 28.2 mH, R<sub>g</sub> = 25 Ω, I<sub>AS</sub> = 3.1 A.
- 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.

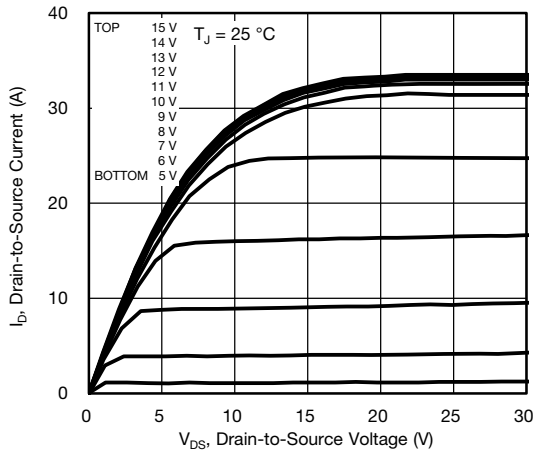
| THERMAL RESISTANCE RATINGS       |                   |      |      |      |
|----------------------------------|-------------------|------|------|------|
| PARAMETER                        | SYMBOL            | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | R <sub>thJA</sub> | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | R <sub>thJC</sub> | -    | 0.8  |      |

| SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted) |                                  |   |   |                       |       |       |      |
|---|----------------------------------|---|---|-----------------------|-------|-------|------|
| PARAMETER   | SYMBOL                           | TEST CONDITIONS   |   | MIN.                  | TYP.  | MAX.  | UNIT |
| <b>Static</b>   |                                  |   |   |                       |       |       |      |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA  |   | 500                   | -     | -     | V    |
| V <sub>DS</sub> Temperature Coefficient                         | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA   |   | -                     | 0.62  | -     | V/°C |
| Gate-Source Threshold Voltage (N)                               | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA   |   | 2.0                   | -     | 4.0   | V    |
| Gate-Source Leakage   | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V  |   | -                     | -     | ± 100 | nA   |
|   |                                  | V <sub>GS</sub> = ± 30 V  |   | -                     | -     | ± 1   | μA   |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>                 | V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V  |   | -                     | -     | 10    | μA   |
|   |                                  | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C   |   | -                     | -     | 25    |      |
| Drain-Source On-State Resistance                                | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V  | I <sub>D</sub> = 9.5 A                          | -                     | 0.192 | -     | Ω    |
| Forward Transconductance  | g <sub>fs</sub>                  | V <sub>DS</sub> = 30 V, I <sub>D</sub> = 9.5 A  |   | -                     | 3.9   | -     | S    |
| <b>Dynamic</b>  |                                  |   |   |                       |       |       |      |
| Input Capacitance   | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 100 V,<br>f = 1 MHz   |   | -                     | 1162  | -     | pF   |
| Output Capacitance  | C <sub>oss</sub>                 |   |   | -                     | 51    | -     |      |
| Reverse Transfer Capacitance                                    | C <sub>rss</sub>                 |   |   | -                     | 7     | -     |      |
| Effective Output Capacitance, Energy Related <sup>a</sup>       | C <sub>o(er)</sub>               |   |   | -                     | 55    | -     |      |
| Effective Output Capacitance, Time Related <sup>b</sup>         | C <sub>o(tr)</sub>               | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V   |   | -                     | 164   | -     |      |
| Total Gate Charge   | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V  | I <sub>D</sub> = 9.5 A, V <sub>DS</sub> = 400 V | -                     | 33    | 66    | nC   |
| Gate-Source Charge  | Q <sub>gs</sub>                  |   |   | -                     | 8     | -     |      |
| Gate-Drain Charge   | Q <sub>gd</sub>                  |   |   | -                     | 14    | -     |      |
| Turn-On Delay Time  | t <sub>d(on)</sub>               | V <sub>DD</sub> = 400 V, I <sub>D</sub> = 12 A,<br>V <sub>GS</sub> = 10 V, R <sub>g</sub> = 9.1 Ω   |   | -                     | 15    | 30    | ns   |
| Rise Time   | t <sub>r</sub>                   |   |   | -                     | 24    | 48    |      |
| Turn-Off Delay Time   | t <sub>d(off)</sub>              |   |   | -                     | 34    | 68    |      |
| Fall Time   | t <sub>f</sub>                   |   |   | -                     | 18    | 36    |      |
| Gate Input Resistance   | R <sub>g</sub>                   |   |   | f = 1 MHz, open drain |       | -     |      |
| <b>Drain-Source Body Diode Characteristics</b>                  |                                  |   |   |                       |       |       |      |
| Continuous Source-Drain Diode Current                           | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode  |   | -                     | -     | 14.5  | A    |
| Pulsed Diode Forward Current                                    | I <sub>SM</sub>                  |   |   | -                     | -     | 28    |      |
| Diode Forward Voltage   | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 9.5 A, V <sub>GS</sub> = 0 V   |   | -                     | -     | 1.2   | V    |
| Reverse Recovery Time   | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 9.5 A,<br>di/dt = 100 A/μs, V <sub>R</sub> = 25 V   |   | -                     | 265   | -     | ns   |
| Reverse Recovery Charge   | Q <sub>rr</sub>                  |   |   | -                     | 3.2   | -     | μC   |
| Reverse Recovery Current  | I <sub>RRM</sub>                 |   |   | -                     | 23    | -     | A    |

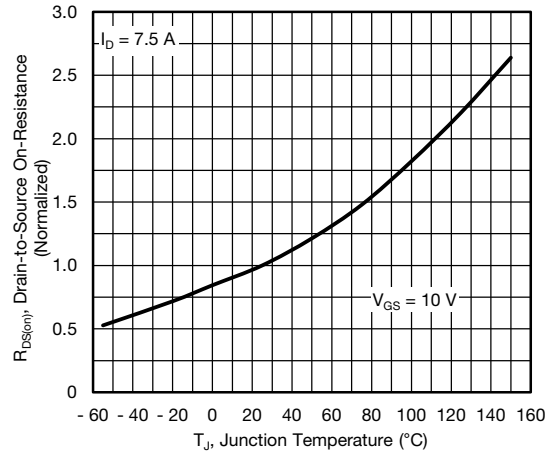
**Notes**

- a. C<sub>oss(er)</sub> is a fixed capacitance that gives the same energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 % to 80 % V<sub>DSS</sub>.
- b. C<sub>oss(tr)</sub> is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 % to 80 % V<sub>DSS</sub>.

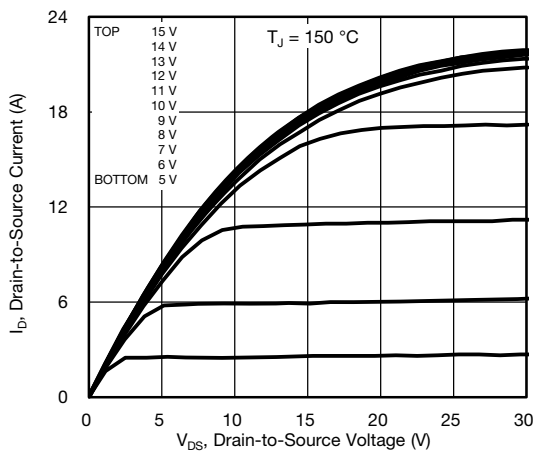
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



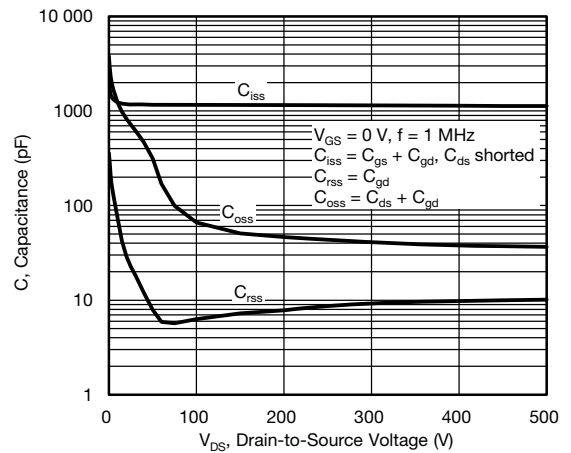
**Fig. 1 - Typical Output Characteristics**



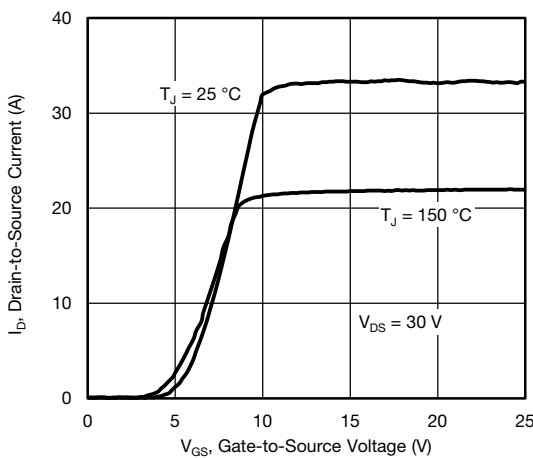
**Fig. 4 - Normalized On-Resistance vs. Temperature**



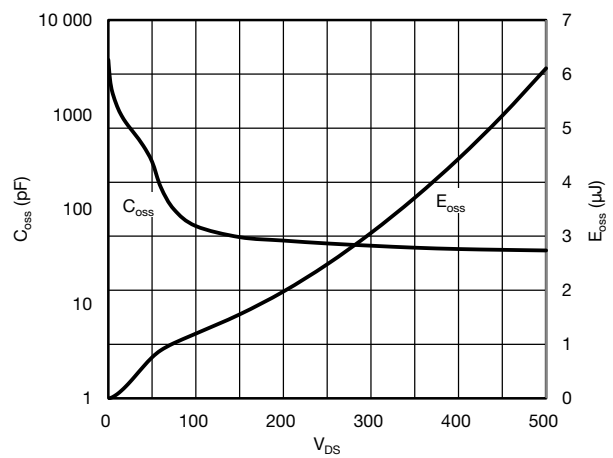
**Fig. 2 - Typical Output Characteristics**



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



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 - Coss and Eoss vs. Vds**

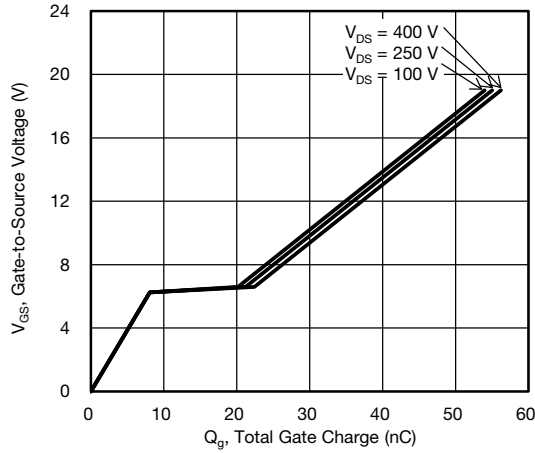


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

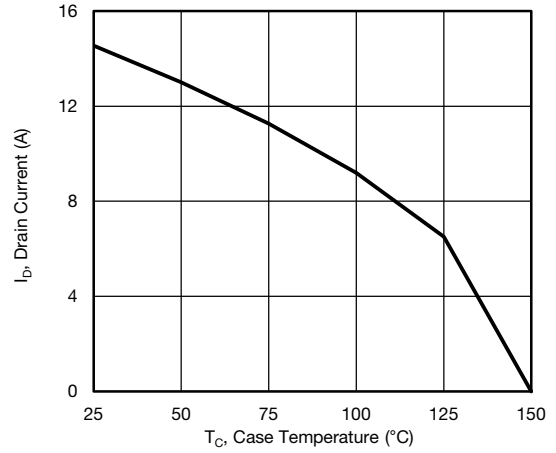


Fig. 10 - Maximum Drain Current vs. Case Temperature

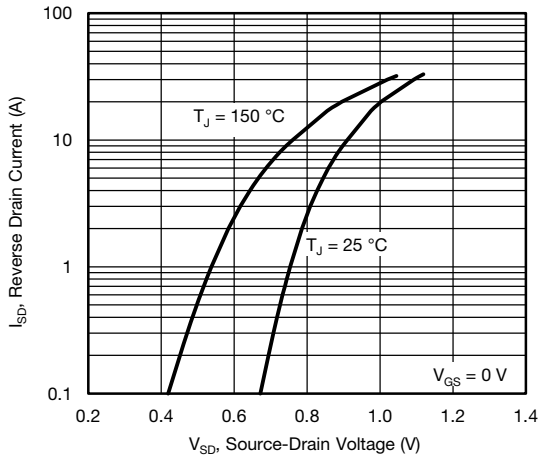


Fig. 8 - Typical Source-Drain Diode Forward Voltage

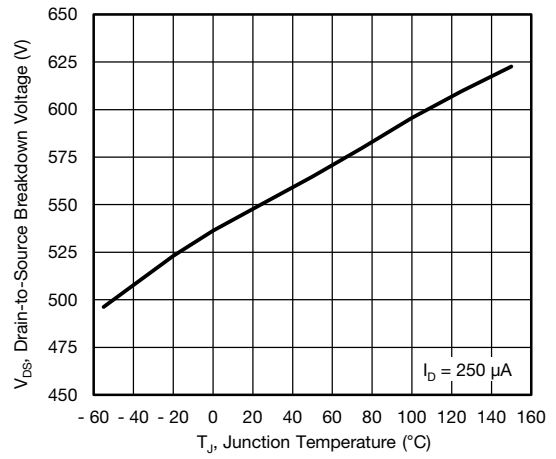


Fig. 11 - Temperature vs. Drain-to-Source Voltage

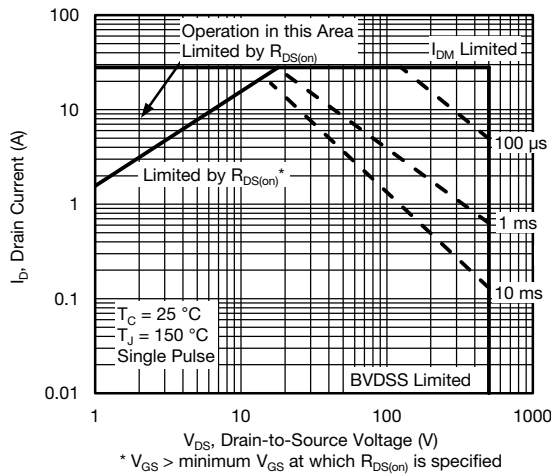


Fig. 9 - Maximum Safe Operating Area

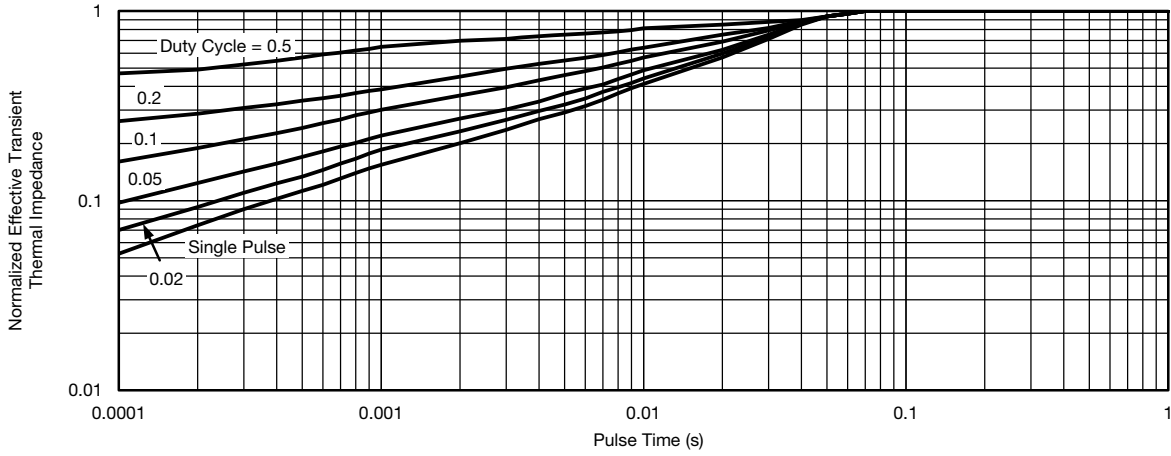


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

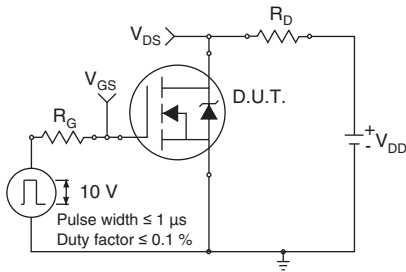


Fig. 13 - Switching Time Test Circuit

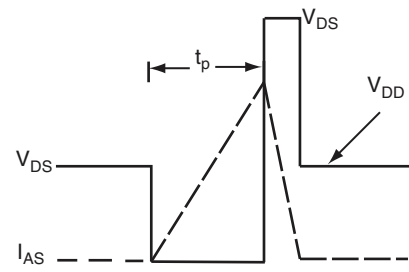


Fig. 16 - Unclamped Inductive Waveforms

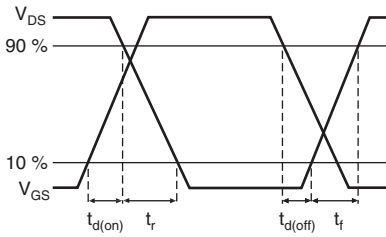


Fig. 14 - Switching Time Waveforms

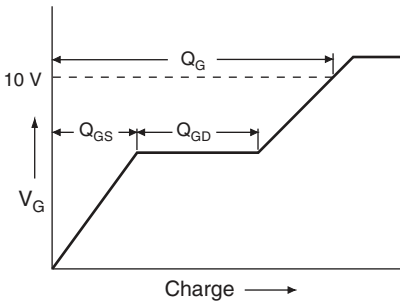


Fig. 17 - Basic Gate Charge Waveform

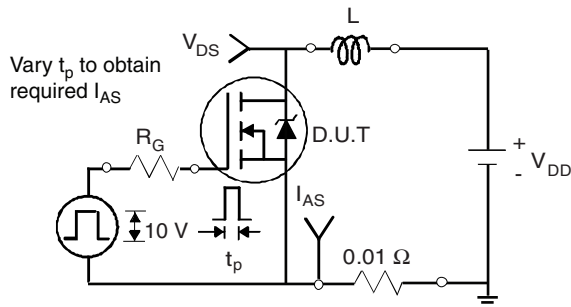


Fig. 15 - Unclamped Inductive Test Circuit

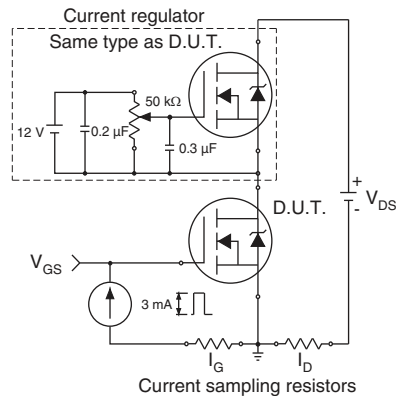
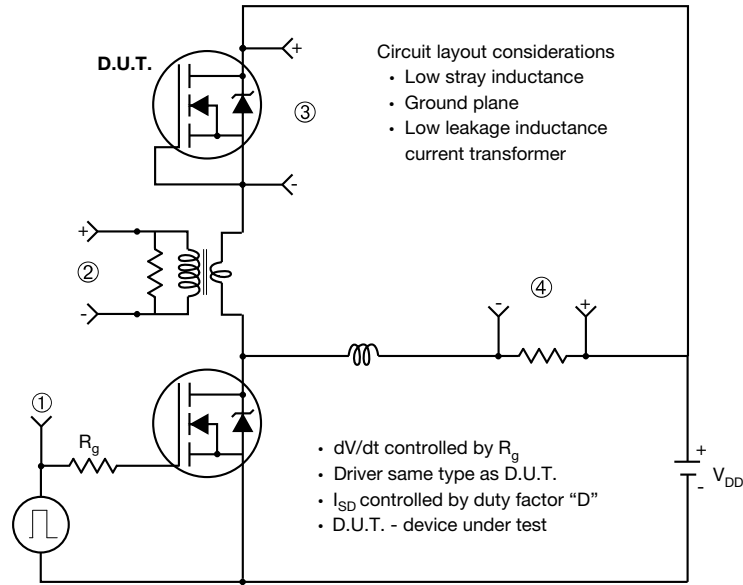


Fig. 18 - Gate Charge Test Circuit

**Peak Diode Recovery dV/dt Test Circuit**



**Note**

a.  $V_{GS} = 5 V$  for logic level devices

**Fig. 19 - For N-Channel**

### TO-220AB



| DIM. | MILLIMETERS |       | INCHES |       |
|------|-------------|-------|--------|-------|
|      | MIN.        | MAX.  | MIN.   | MAX.  |
| A    | 4.25        | 4.65  | 0.167  | 0.183 |
| b    | 0.69        | 1.01  | 0.027  | 0.040 |
| b(1) | 1.20        | 1.73  | 0.047  | 0.068 |
| c    | 0.36        | 0.61  | 0.014  | 0.024 |
| D    | 14.85       | 15.49 | 0.585  | 0.610 |
| E    | 10.04       | 10.51 | 0.395  | 0.414 |
| e    | 2.41        | 2.67  | 0.095  | 0.105 |
| e(1) | 4.88        | 5.28  | 0.192  | 0.208 |
| F    | 1.14        | 1.40  | 0.045  | 0.055 |
| H(1) | 6.09        | 6.48  | 0.240  | 0.255 |
| J(1) | 2.41        | 2.92  | 0.095  | 0.115 |
| L    | 13.35       | 14.02 | 0.526  | 0.552 |
| L(1) | 3.32        | 3.82  | 0.131  | 0.150 |
| Ø P  | 3.54        | 3.94  | 0.139  | 0.155 |
| Q    | 2.60        | 3.00  | 0.102  | 0.118 |

ECN: X12-0208-Rev. N, 08-Oct-12  
DWG: 5471

**Notes**

\* M = 1.32 mm to 1.62 mm (dimension including protrusion)  
Heatsink hole for HVM

**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 |

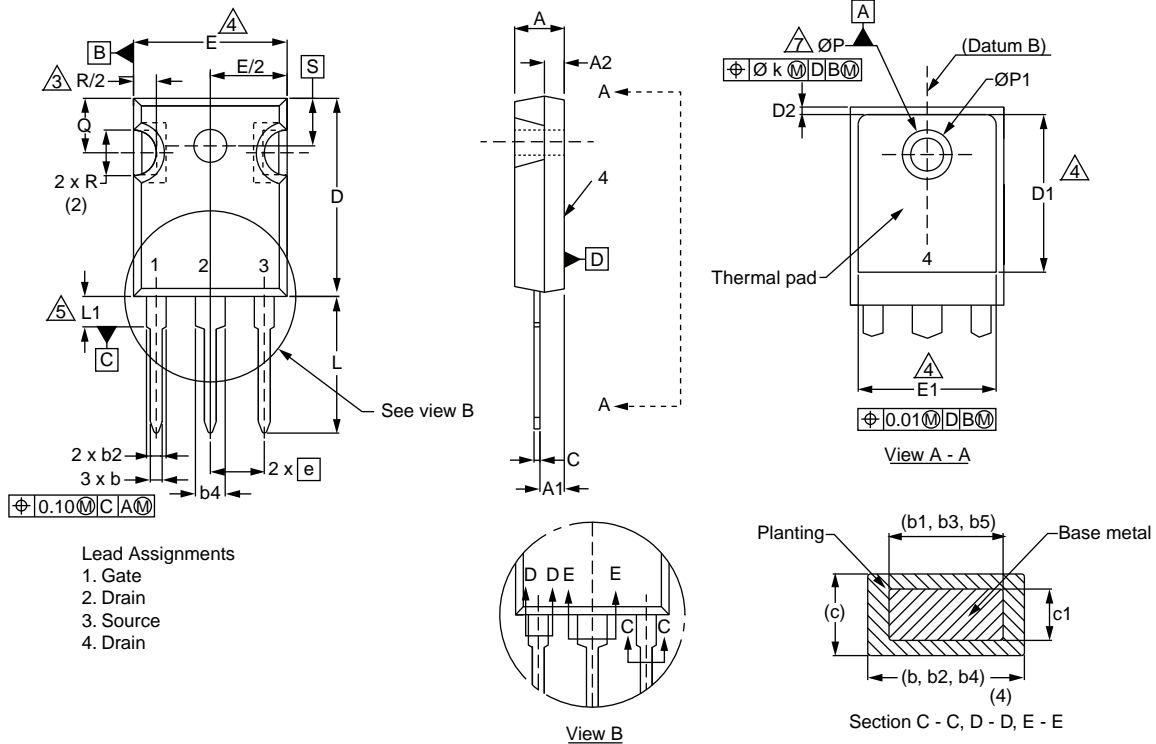
ECN: X09-0126-Rev. B, 26-Oct-09  
DWG: 5972

**Notes**

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



## TO-247AC (High Voltage)



| DIM. | MILLIMETERS |       | INCHES |       |
|------|-------------|-------|--------|-------|
|      | MIN.        | MAX.  | MIN.   | MAX.  |
| A    | 4.58        | 5.31  | 0.180  | 0.209 |
| A1   | 2.21        | 2.59  | 0.087  | 0.102 |
| A2   | 1.17        | 2.49  | 0.046  | 0.098 |
| b    | 0.99        | 1.40  | 0.039  | 0.055 |
| b1   | 0.99        | 1.35  | 0.039  | 0.053 |
| b2   | 1.53        | 2.39  | 0.060  | 0.094 |
| b3   | 1.65        | 2.37  | 0.065  | 0.093 |
| b4   | 2.42        | 3.43  | 0.095  | 0.135 |
| b5   | 2.59        | 3.38  | 0.102  | 0.133 |
| c    | 0.38        | 0.86  | 0.015  | 0.034 |
| c1   | 0.38        | 0.76  | 0.015  | 0.030 |
| D    | 19.71       | 20.82 | 0.776  | 0.820 |
| D1   | 13.08       | -     | 0.515  | -     |

| DIM. | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
|      | MIN.        | MAX.  | MIN.      | MAX.  |
| D2   | 0.51        | 1.30  | 0.020     | 0.051 |
| E    | 15.29       | 15.87 | 0.602     | 0.625 |
| E1   | 13.72       | -     | 0.540     | -     |
| e    | 5.46 BSC    |       | 0.215 BSC |       |
| Ø k  | 0.254       |       | 0.010     |       |
| L    | 14.20       | 16.25 | 0.559     | 0.640 |
| L1   | 3.71        | 4.29  | 0.146     | 0.169 |
| N    | 7.62 BSC    |       | 0.300 BSC |       |
| Ø P  | 3.51        | 3.66  | 0.138     | 0.144 |
| Ø P1 | -           | 7.39  | -         | 0.291 |
| Q    | 5.31        | 5.69  | 0.209     | 0.224 |
| R    | 4.52        | 5.49  | 0.178     | 0.216 |
| S    | 5.51 BSC    |       | 0.217 BSC |       |

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