

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

| PRODUCT SUMMARY                         |                        |
|---|------------------------|
| $V_{DS}$ (V) at $T_J$ max.              | 500                    |
| $R_{DS(on)}$ max. at 25 °C ( $\Omega$ ) | $V_{GS} = 10$ V   0.14 |
| $Q_g$ max. (nC)                         | 92                     |
| $Q_{gs}$ (nC)                           | 10                     |
| $Q_{gd}$ (nC)                           | 19                     |
| Configuration                           | Single                 |

### FEATURES

- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Reduced switching and conduction losses
- Low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)

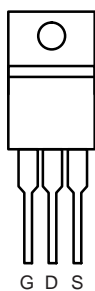


**RoHS**  
COMPLIANT

### APPLICATIONS

- Switch mode power supplies (SMPS)
- Server and telecom power supplies
- Power factor correction power supplies (PFC)

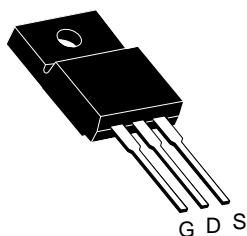
TO-220AB



G D S

Top View

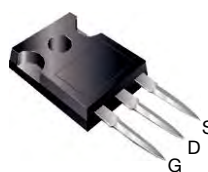
TO-220 FULLPAK



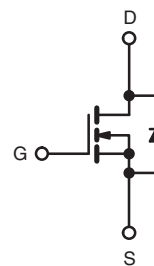
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Top View

TO-247AC



Top View




N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                  |                                 |      |      |
|---|------------------|---------------------------------|------|------|
| PARAMETER   | SYMBOL           | LIMIT                           | UNIT |      |
| Drain-Source Voltage  | $V_{DS}$         | 500                             | V    |      |
| Gate-Source Voltage   | $V_{GS}$         | $\pm 30$                        |      |      |
| Continuous Drain Current ( $T_J = 150$ °C)                        | $V_{GS}$ at 10 V | $T_C = 25$ °C                   | 20   | A    |
|   |                  | $T_C = 100$ °C                  | 12   |      |
| Pulsed Drain Current <sup>a</sup>                                 | $I_{DM}$         | 42                              |      |      |
| Linear Derating Factor  |                  | 1.4                             | W/°C |      |
| Single Pulse Avalanche Energy <sup>b</sup>                        | $E_{AS}$         | 204                             | mJ   |      |
| Maximum Power Dissipation   | $P_D$            | 179                             | W    |      |
| Operating Junction and Storage Temperature Range                  | $T_J, T_{stg}$   | -55 to +150                     | °C   |      |
| Drain-Source Voltage Slope  | $dV/dt$          | $V_{DS} = 0$ V to 80 % $V_{DS}$ | 70   | V/ns |
| Reverse Diode $dV/dt$ <sup>d</sup>                                |                  | 32                              |      |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>         | for 10 s         | 300                             | °C   |      |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 3.8$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.

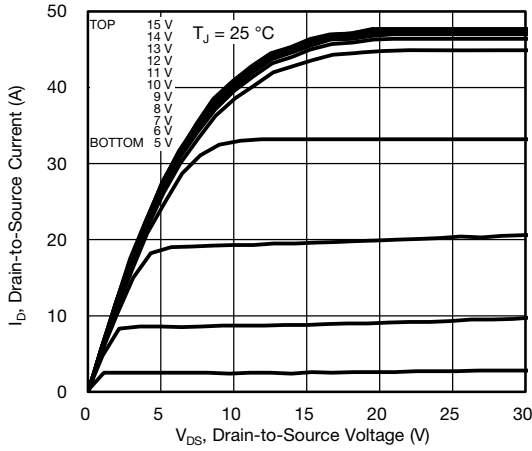
| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case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

| <b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |   |  |      |           |                     |
|--|---------------------|---|--|------|-----------|---------------------|
| PARAMETER  | SYMBOL              | TEST CONDITIONS   | MIN.   | TYP. | MAX.      | UNIT                |
| <b>Static</b>  |                     |   |  |      |           |                     |
| Drain-Source Breakdown Voltage   | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$  | 500  | -    | -         | V                   |
| $V_{DS}$ Temperature Coefficient   | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$   | -  | 0.59 | -         | V/ $^\circ\text{C}$ |
| Gate-Source Threshold Voltage (N)  | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$  | 2.0  | -    | 4.0       | 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  | $I_{DSS}$           | $V_{DS} = 500\text{ V}$ , $V_{GS} = 0\text{ V}$   | -  | -    | 1         | $\mu\text{A}$       |
|  |                     | $V_{DS} = 400\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$   | -  | -    | 10        |                     |
| Drain-Source On-State Resistance   | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$   $I_D = 10\text{ A}$  | -  | 0.14 | -         | $\Omega$            |
| Forward Transconductance   | $g_{fs}$            | $V_{DS} = 30\text{ V}$ , $I_D = 10\text{ A}$  | -  | 4.4  | -         | S                   |
| <b>Dynamic</b>   |                     |   |  |      |           |                     |
| Input Capacitance  | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$  | -  | 1640 | -         | pF                  |
| Output Capacitance   | $C_{oss}$           |   | -  | 87   | -         |                     |
| Reverse Transfer Capacitance   | $C_{rss}$           |   | -  | 6    | -         |                     |
| Effective Output Capacitance, Energy Related <sup>a</sup>                          | $C_{o(er)}$         |   | $V_{DS} = 0\text{ V to } 400\text{ V}$ , $V_{GS} = 0\text{ V}$ | -    | 73        |                     |
| Effective Output Capacitance, Time Related <sup>b</sup>                            | $C_{o(tr)}$         |   | -  | 222  | -         |                     |
| Total Gate Charge  | $Q_g$               | $V_{GS} = 10\text{ V}$   $I_D = 10\text{ A}$ , $V_{DS} = 400\text{ V}$  | -  | 46   | 92        | nC                  |
| Gate-Source Charge   | $Q_{gs}$            |   | -  | 10   | -         |                     |
| Gate-Drain Charge  | $Q_{gd}$            |   | -  | 19   | -         |                     |
| Turn-On Delay Time   | $t_{d(on)}$         | $V_{DD} = 400\text{ V}$ , $I_D = 10\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_g = 9.1\text{ }\Omega$   | -  | 17   | 34        | ns                  |
| Rise Time  | $t_r$               |   | -  | 27   | 54        |                     |
| Turn-Off Delay Time  | $t_{d(off)}$        |   | -  | 48   | 96        |                     |
| Fall Time  | $t_f$               |   | -  | 25   | 50        |                     |
| Gate Input Resistance  | $R_g$               |   | $f = 1\text{ MHz}$ , open drain                                | -    | 0.83      |                     |
| <b>Drain-Source Body Diode Characteristics</b>                                     |                     |   |  |      |           |                     |
| Continuous Source-Drain Diode Current  | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode  | -  | -    | 20        | A                   |
| Pulsed Diode Forward Current   | $I_{SM}$            |   | -  | -    | 42        |                     |
| Diode Forward Voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = 10\text{ A}$ , $V_{GS} = 0\text{ V}$  | -  | -    | 1.2       | V                   |
| Reverse Recovery Time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = I_S = 10\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 25\text{ V}$                            | -  | 293  | -         | ns                  |
| Reverse Recovery Charge  | $Q_{rr}$            |   | -  | 4.0  | -         | $\mu\text{C}$       |
| Reverse Recovery Current   | $I_{RRM}$           |   | -  | 26   | -         | A                   |

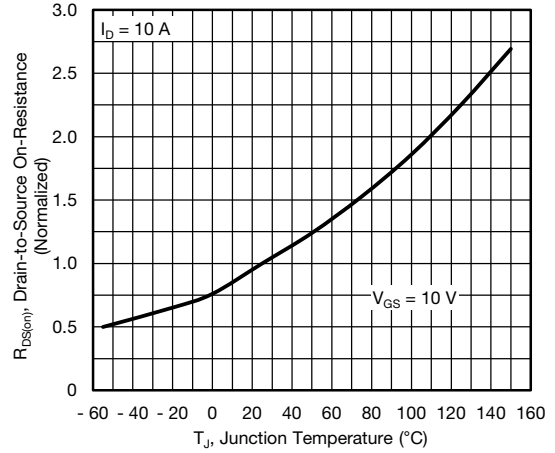
**Notes**

- 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 %  $V_{DSS}$ .

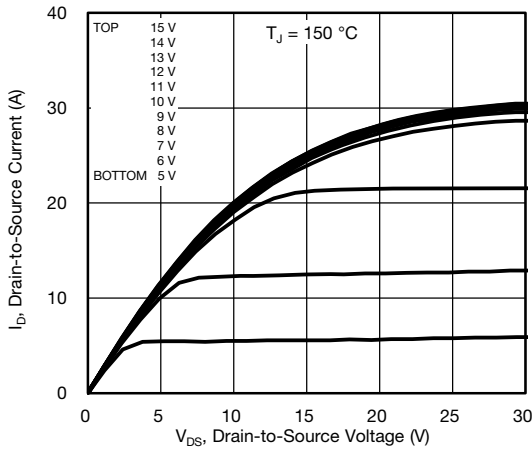
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



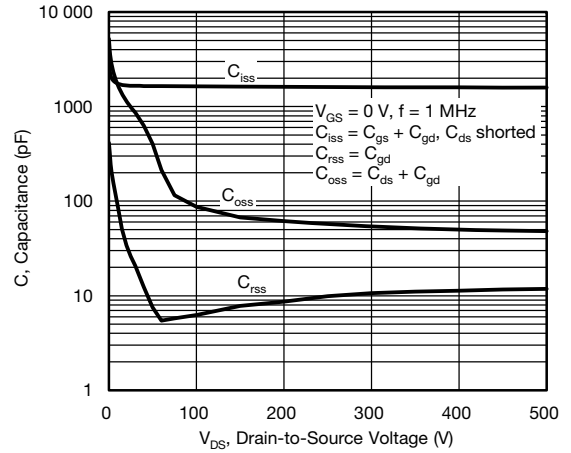
**Fig. 1 - Typical Output Characteristics**



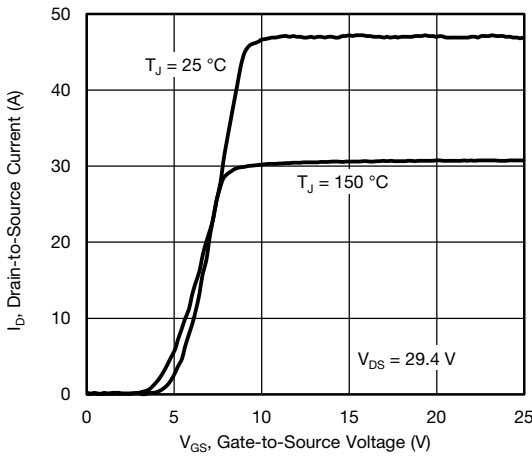
**Fig. 4 - Normalized On-Resistance vs. Temperature**



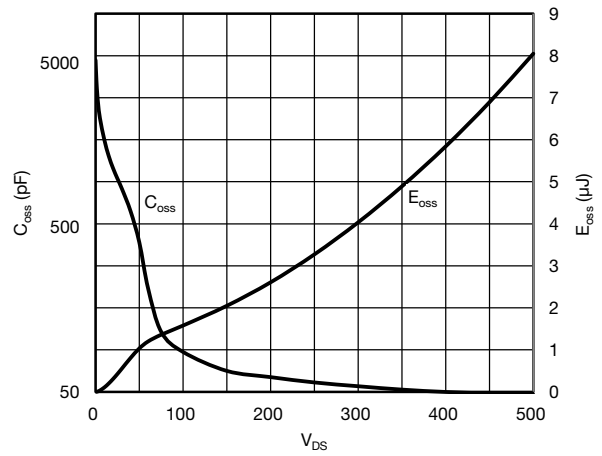
**Fig. 2 - Typical Output Characteristics**



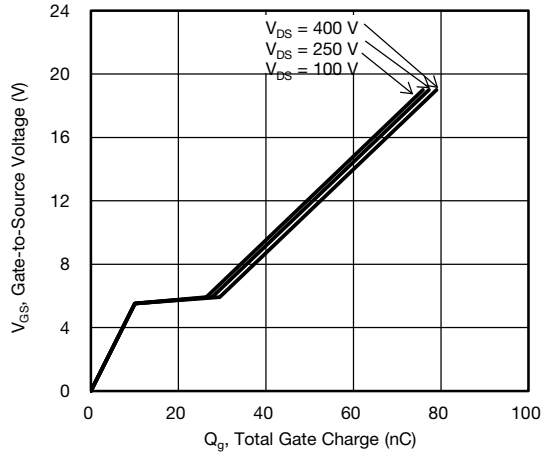
**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



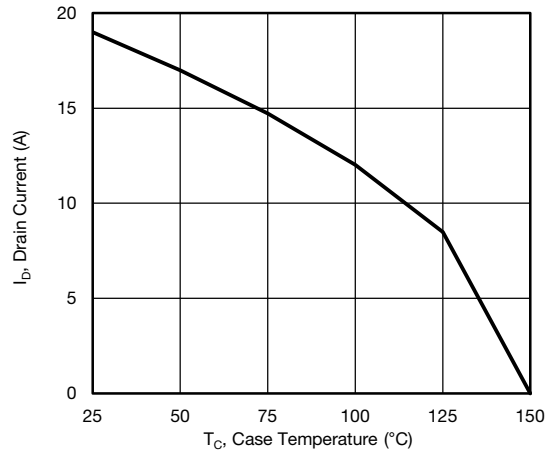
**Fig. 3 - Typical Transfer Characteristics**



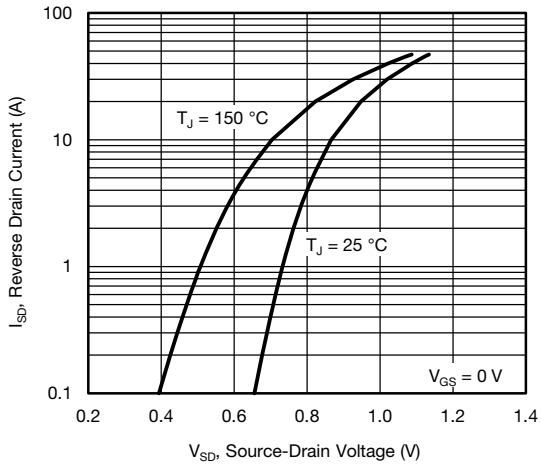
**Fig. 6 - C<sub>OSS</sub> and E<sub>OSS</sub> vs. V<sub>DS</sub>**



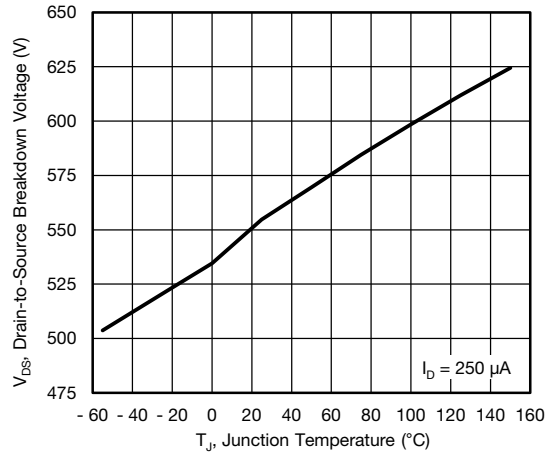
**Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage**



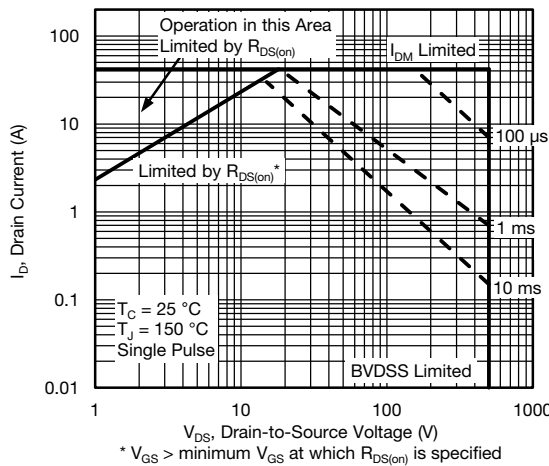
**Fig. 10 - Maximum Drain Current vs. Case Temperature**



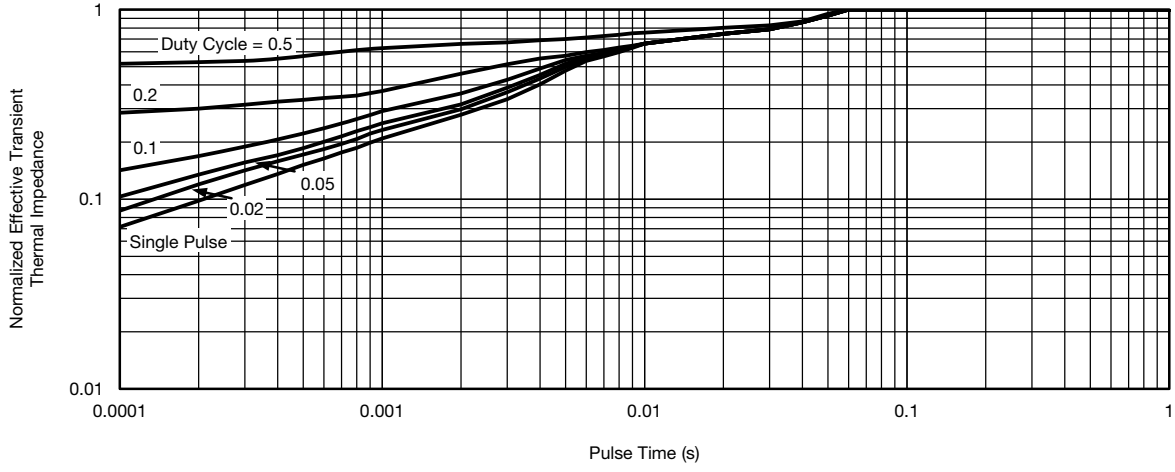
**Fig. 8 - Typical Source-Drain Diode Forward Voltage**



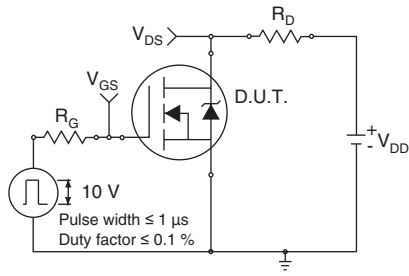
**Fig. 11 - Temperature vs. Drain-to-Source Voltage**



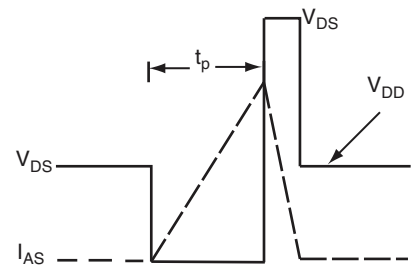
**Fig. 9 - Maximum Safe Operating Area**



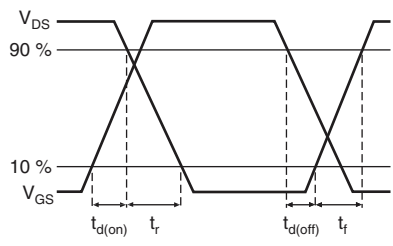
**Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case**



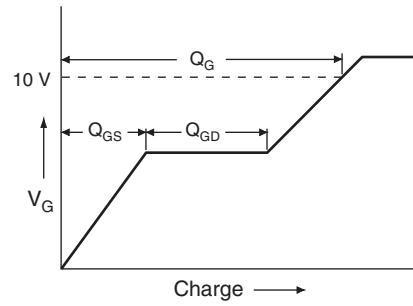
**Fig. 13 - Switching Time Test Circuit**



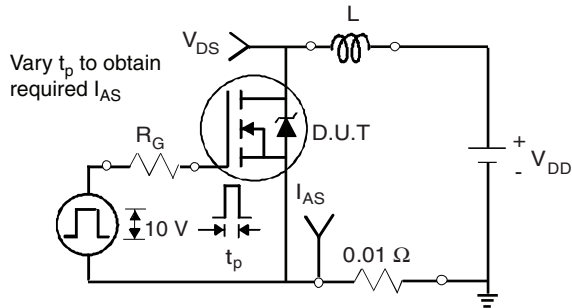
**Fig. 16 - Unclamped Inductive Waveforms**



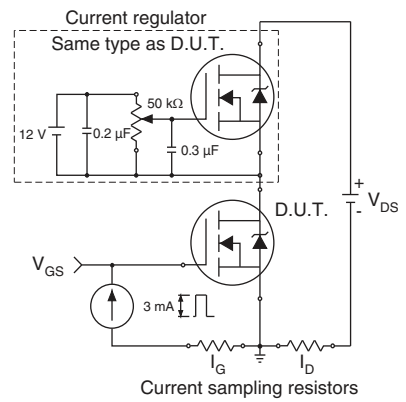
**Fig. 14 - Switching Time Waveforms**



**Fig. 17 - Basic Gate Charge Waveform**

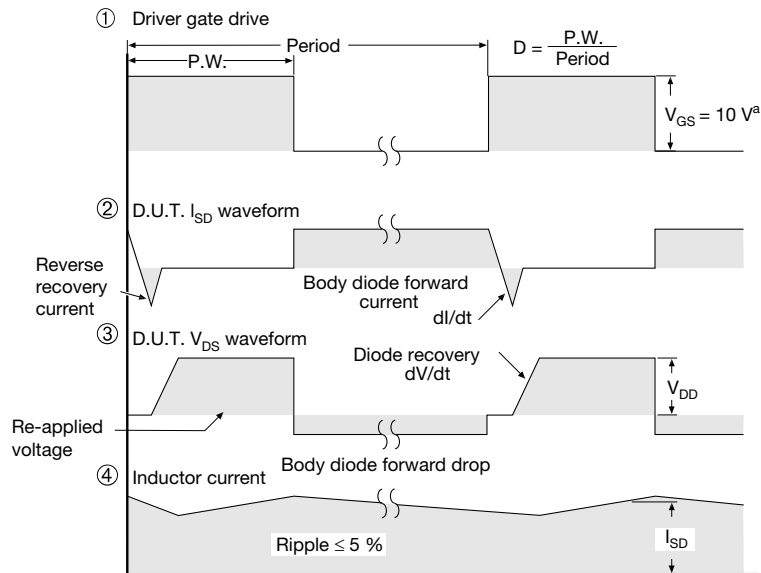
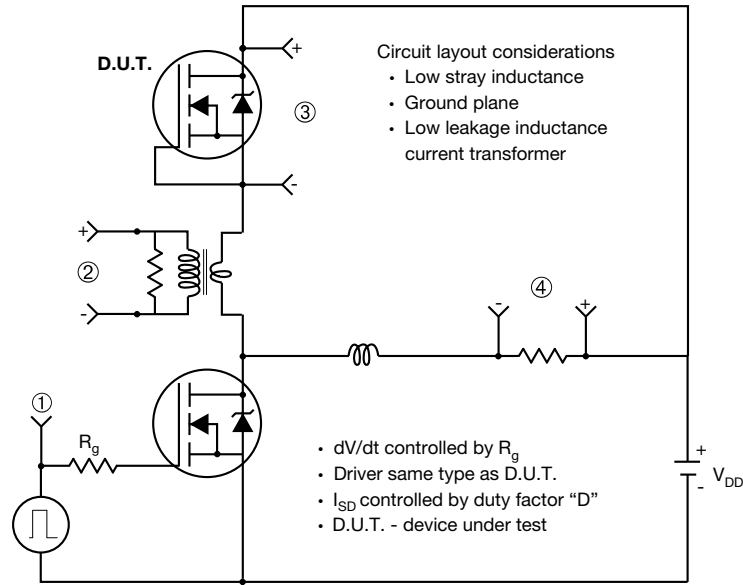


**Fig. 15 - Unclamped Inductive Test Circuit**



**Fig. 18 - Gate Charge Test Circuit**

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

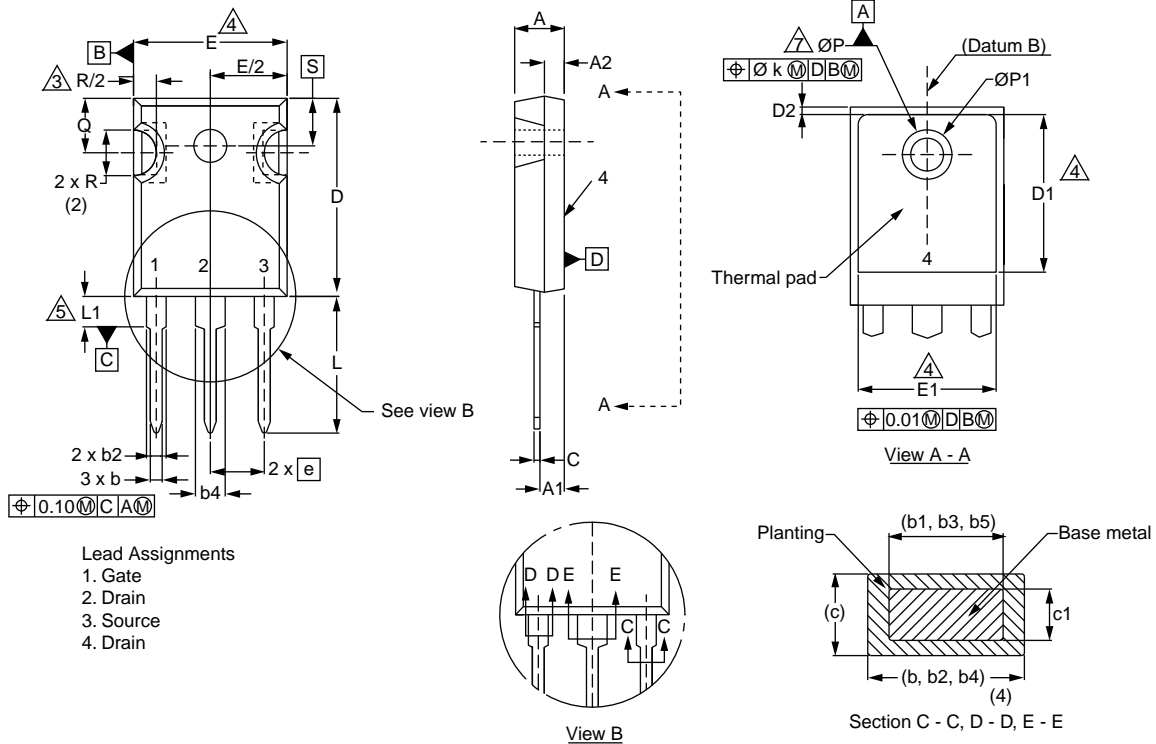


**Note**

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

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

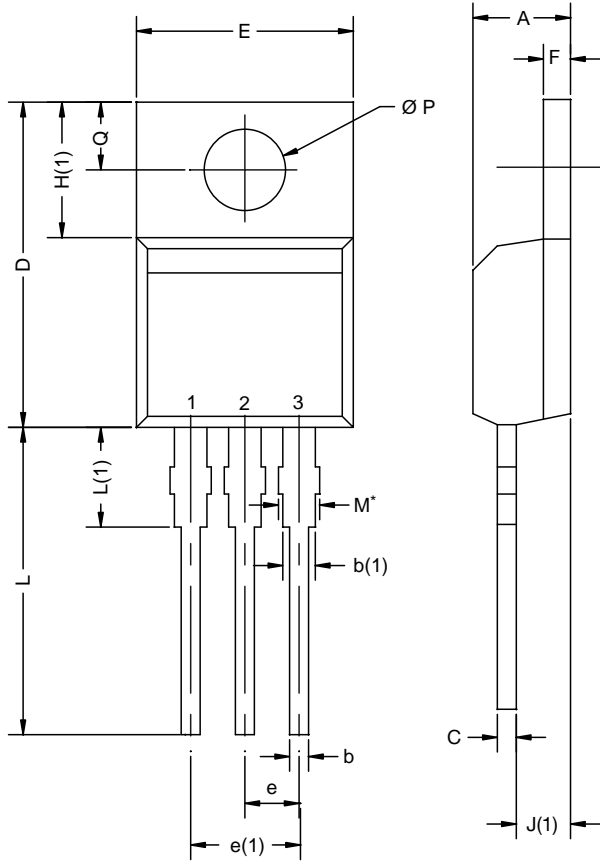
## TO-247AC (High Voltage)



| 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 |       |
| $\phi k$  | 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 |       |
| $\phi P$  | 3.51        | 3.66  | 0.138     | 0.144 |
| $\phi P1$ | -           | 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 |       |

**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 |

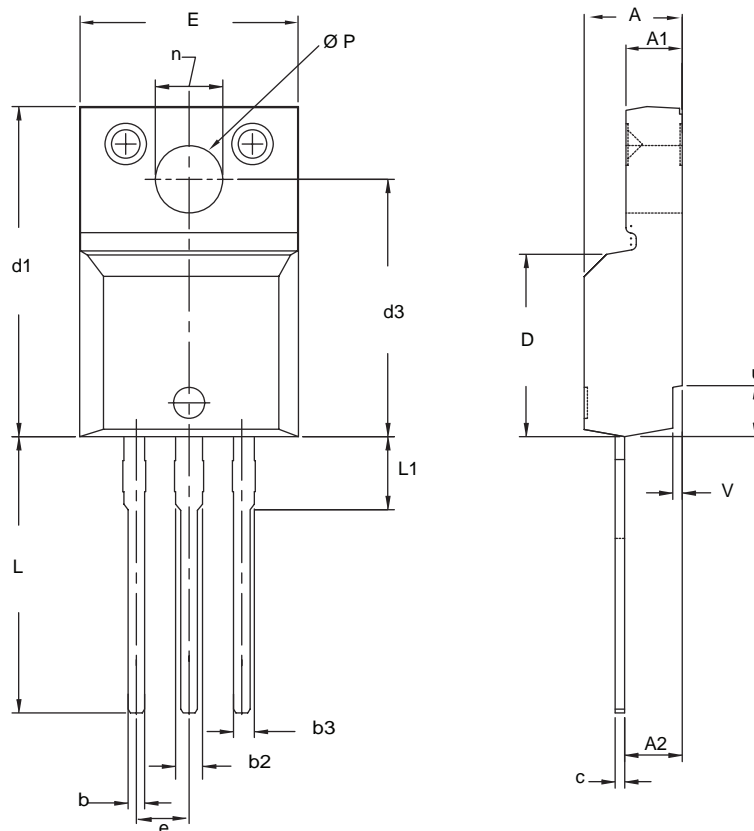
ECN: X12-0208-Rev. N, 08-Oct-12  
DWG: 5471

**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 |
| $\varnothing P$ | 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.

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