

## N-Channel 800V (D-S) Super Junction Power MOSFET

### PRODUCT SUMMARY

|                           |                        |     |
|---------------------------|------------------------|-----|
| $V_{DS}$ (V)              | 800                    |     |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 1.2 |
| $Q_g$ (Max.) (nC)         | 200                    |     |
| $Q_{gs}$ (nC)             | 24                     |     |
| $Q_{gd}$ (nC)             | 110                    |     |
| Configuration             | Single                 |     |

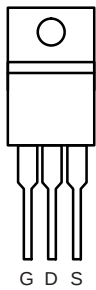
### FEATURES

- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- Isolated Central Mounting Hole
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Compliant to RoHS Directive 2002/95/EC



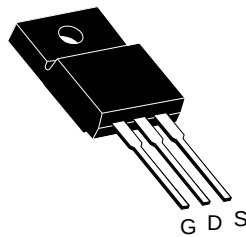
Available  
**RoHS\***  
 COMPLIANT

TO-220AB



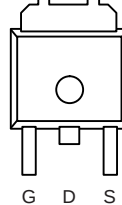
Top View

TO-220 FULLPAK



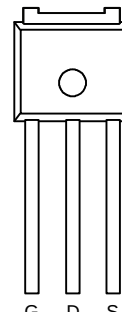
Top View

TO-252

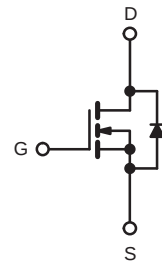


Top View

TO-251



Top View



N-Channel MOSFET

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)

| PARAMETER                                        |                                    |                                     | SYMBOL         | LIMIT            | UNIT                  |
|--------------------------------------------------|------------------------------------|-------------------------------------|----------------|------------------|-----------------------|
| Drain-Source Voltage                             |                                    |                                     | $V_{DS}$       | 800              | V                     |
| Gate-Source Voltage                              |                                    |                                     | $V_{GS}$       | $\pm 30$         |                       |
| Continuous Drain Current                         | $V_{GS}$ at 10 V                   | $T_C = 25\text{ }^{\circ}\text{C}$  | $I_D$          | 5                | A                     |
|                                                  |                                    | $T_C = 100\text{ }^{\circ}\text{C}$ |                | 3.9              |                       |
| Pulsed Drain Current <sup>a</sup>                |                                    |                                     | $I_{DM}$       | 21               |                       |
| Linear Derating Factor                           |                                    |                                     |                | 1.5              | W/ $^{\circ}\text{C}$ |
| Single Pulse Avalanche Energy <sup>b</sup>       |                                    |                                     | $E_{AS}$       | 770              | mJ                    |
| Repetitive Avalanche Current <sup>a</sup>        |                                    |                                     | $I_{AR}$       | 7.8              | A                     |
| Repetitive Avalanche Energy <sup>a</sup>         |                                    |                                     | $E_{AR}$       | 19               | mJ                    |
| Maximum Power Dissipation                        | $T_C = 25\text{ }^{\circ}\text{C}$ |                                     | $P_D$          | 190              | W                     |
| Peak Diode Recovery $dV/dt^c$                    |                                    |                                     | $dV/dt$        | 2.0              | V/ns                  |
| Operating Junction and Storage Temperature Range |                                    |                                     | $T_J, T_{stg}$ | - 55 to + 150    | $^{\circ}\text{C}$    |
| Soldering Recommendations (Peak Temperature)     |                                    | for 10 s                            |                | 300 <sup>d</sup> |                       |
| Mounting Torque                                  | 6-32 or M3 screw                   |                                     |                | 10               | lbf · in              |
|                                                  |                                    |                                     |                | 1.1              | N · m                 |

#### Notes

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).  
 b.  $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 23\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 7.8\text{ A}$  (see fig. 12).  
 c.  $I_{SD} \leq 7.8\text{ A}$ ,  $dI/dt \leq 140\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 600\text{ V}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .  
 d. 1.6 mm from case.

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**THERMAL RESISTANCE RATINGS**

| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient         | $R_{thJA}$ | -    | 40   | °C/W |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.24 | -    |      |
| Maximum Junction-to-Case (Drain)    | $R_{thJC}$ | -    | 0.65 |      |

**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| PARAMETER                                 | SYMBOL                           | TEST CONDITIONS                                                                                                                                                    |                                                                                    | MIN. | TYP. | MAX.  | UNIT |
|-------------------------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------|------|-------|------|
| Static                                    |                                  |                                                                                                                                                                    |                                                                                    |      |      |       |      |
| Drain-Source Breakdown Voltage            | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                                     |                                                                                    | 800  | -    | -     | 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                                                                                                                          |                                                                                    | -    | 0.98 | -     | V/°C |
| Gate-Source Threshold Voltage             | 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   |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 800 V, V <sub>GS</sub> = 0 V                                                                                                                     |                                                                                    | -    | -    | 100   | μA   |
|                                           |                                  | V <sub>DS</sub> = 640 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                            |                                                                                    | -    | -    | 500   |      |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                             | I <sub>D</sub> = 3.7 A <sup>b</sup>                                                | -    | 1.2  | -     | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 100 V, I <sub>D</sub> = 3.7 A <sup>b</sup>                                                                                                       |                                                                                    | 5.6  | -    | -     | S    |
| Dynamic                                   |                                  |                                                                                                                                                                    |                                                                                    |      |      |       |      |
| Input Capacitance                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 25 V,<br>f = 1.0 MHz, see fig. 5                                                                                       |                                                                                    | -    | 3100 | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                                    |                                                                                    | -    | 800  | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                                                    |                                                                                    | -    | 490  | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                             | I <sub>D</sub> = 3.8 A, V <sub>DS</sub> = 400 V,<br>see fig. 6 and 13 <sup>b</sup> | -    | -    | 200   | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                                                    |                                                                                    | -    | -    | 24    |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                                                    |                                                                                    | -    | -    | 110   |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 400 V, I <sub>D</sub> = 3.8 A,<br>R <sub>g</sub> = 6.2 Ω, R <sub>D</sub> = 52 Ω<br>see fig. 10 <sup>b</sup>                                      |                                                                                    | -    | 19   | -     | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                                                                    |                                                                                    | -    | 38   | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                                                                    |                                                                                    | -    | 120  | -     |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                                                                    |                                                                                    | -    | 39   | -     |      |
| Internal Drain Inductance                 | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact<br> |                                                                                    | -    | 5.0  | -     | nH   |
| Internal Source Inductance                | L <sub>S</sub>                   |                                                                                                                                                                    |                                                                                    | -    | 13   | -     |      |
| Drain-Source Body Diode Characteristics   |                                  |                                                                                                                                                                    |                                                                                    |      |      |       |      |
| Continuous Source-Drain Diode Current     | I <sub>S</sub>                   | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode<br>   |                                                                                    | -    | -    | 5.0   | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                                    |                                                                                    | -    | -    | 21    |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 3.8 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                                 |                                                                                    | -    | -    | 1.8   | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 3.8 A,<br>di/dt = 100 A/μs <sup>b</sup>                                                                                   |                                                                                    | -    | 650  | 980   | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                                                                    |                                                                                    | -    | 3.8  | 5.7   | μC   |
| Forward Turn-On Time                      | t <sub>on</sub>                  | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )                                                                  |                                                                                    |      |      |       |      |

**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).  
 b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

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

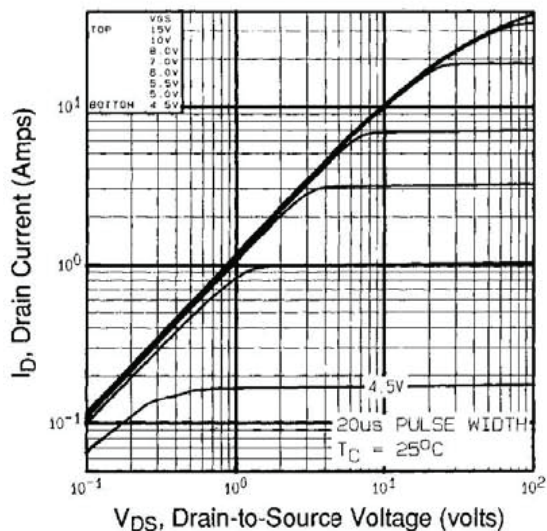


Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^{\circ}\text{C}$

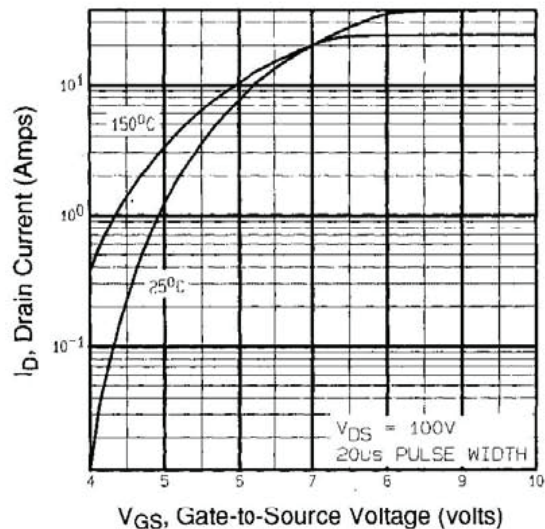


Fig. 3 - Typical Transfer Characteristics

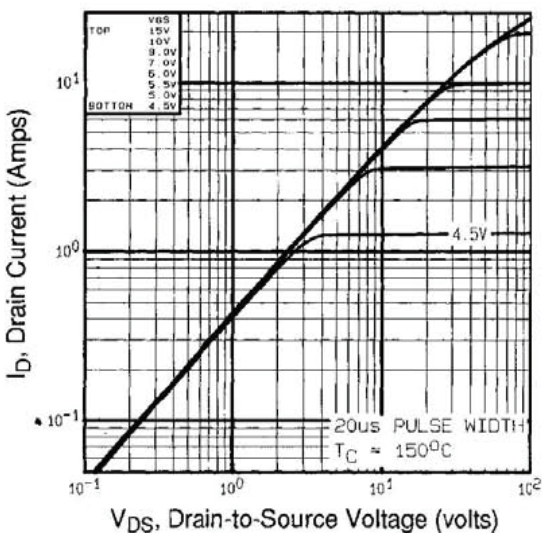


Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^{\circ}\text{C}$

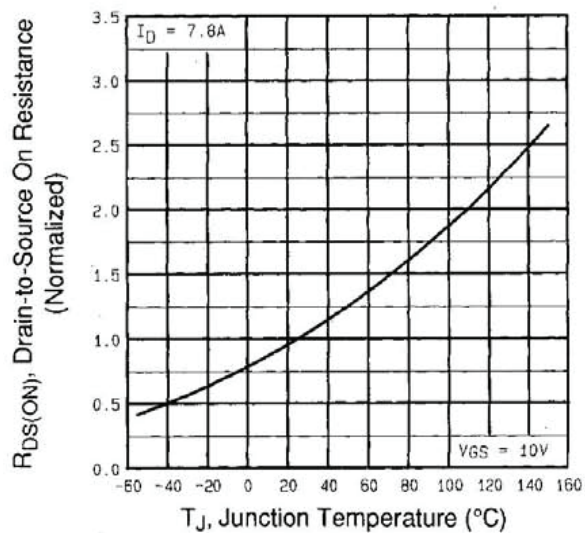


Fig. 4 - Normalized On-Resistance vs. Temperature



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

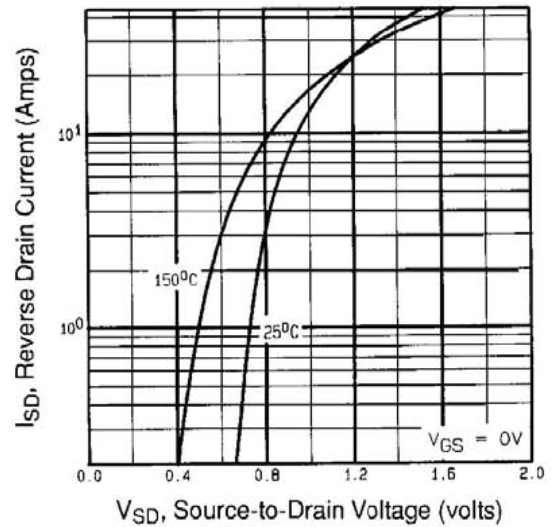


Fig. 7 - Typical Source-Drain Diode Forward Voltage



Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

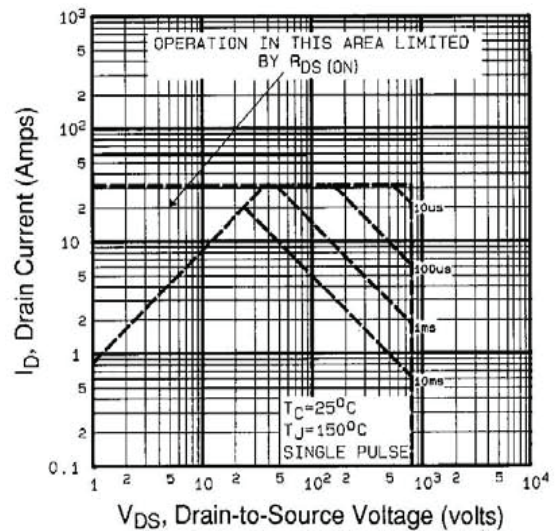


Fig. 8 - Maximum Safe Operating Area

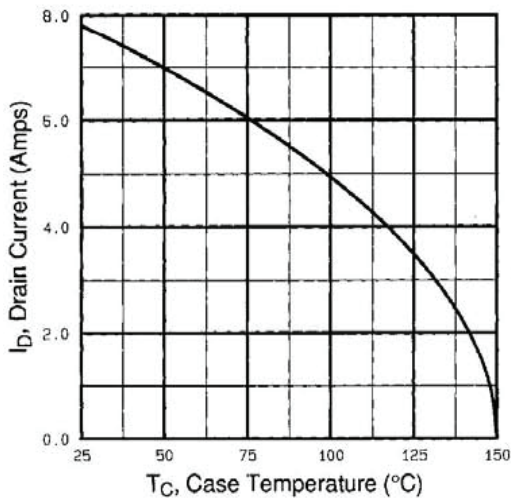


Fig. 9 - Maximum Drain Current vs. Case Temperature

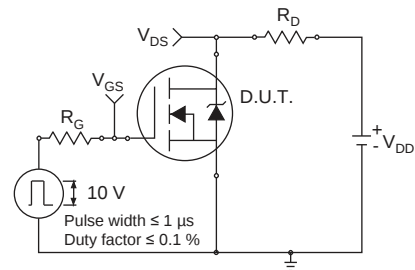


Fig. 10a - Switching Time Test Circuit

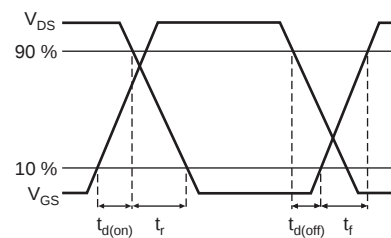


Fig. 10b - Switching Time Waveforms

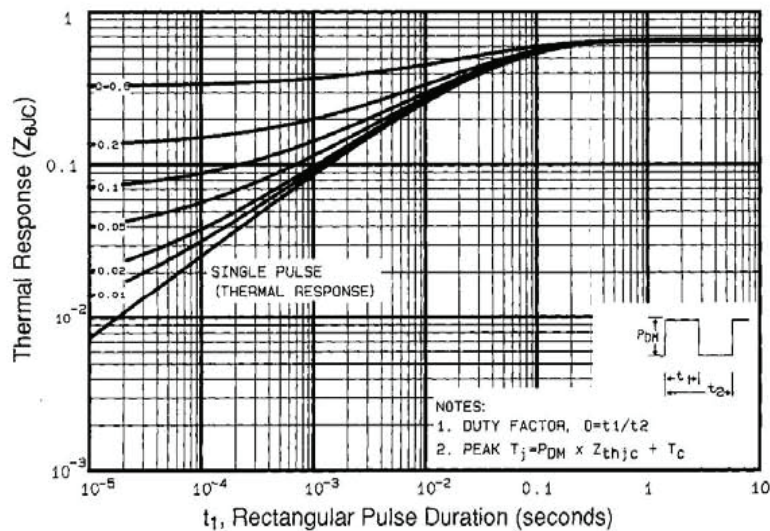


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



Fig. 12a - Unclamped Inductive Test Circuit

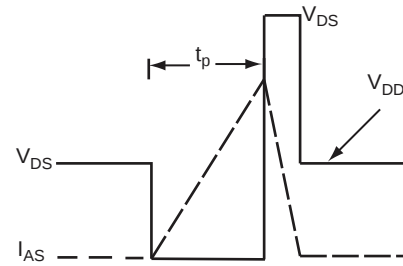


Fig. 12b - Unclamped Inductive Waveforms



Fig. 12c - Maximum Avalanche Energy vs. Drain Current



Fig. 13a - Basic Gate Charge Waveform



Fig. 13b - Gate Charge Test Circuit

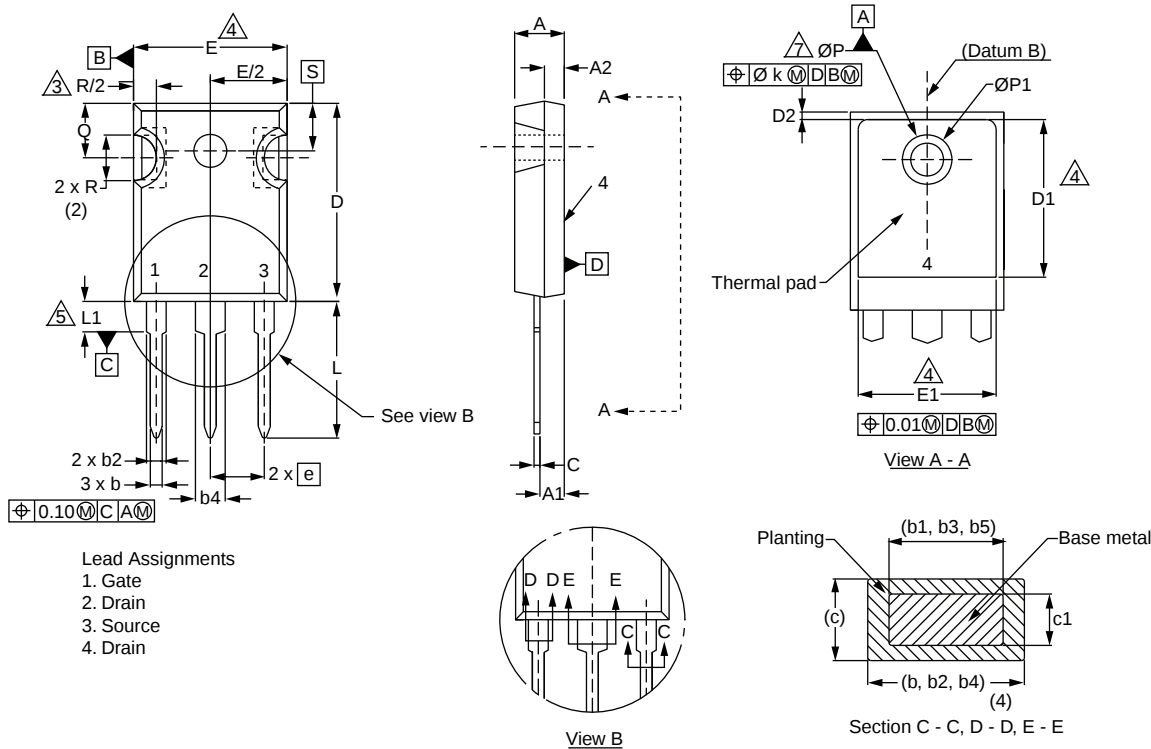


**Note**

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

**Fig. 14 - 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 |       |
| 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 |       |

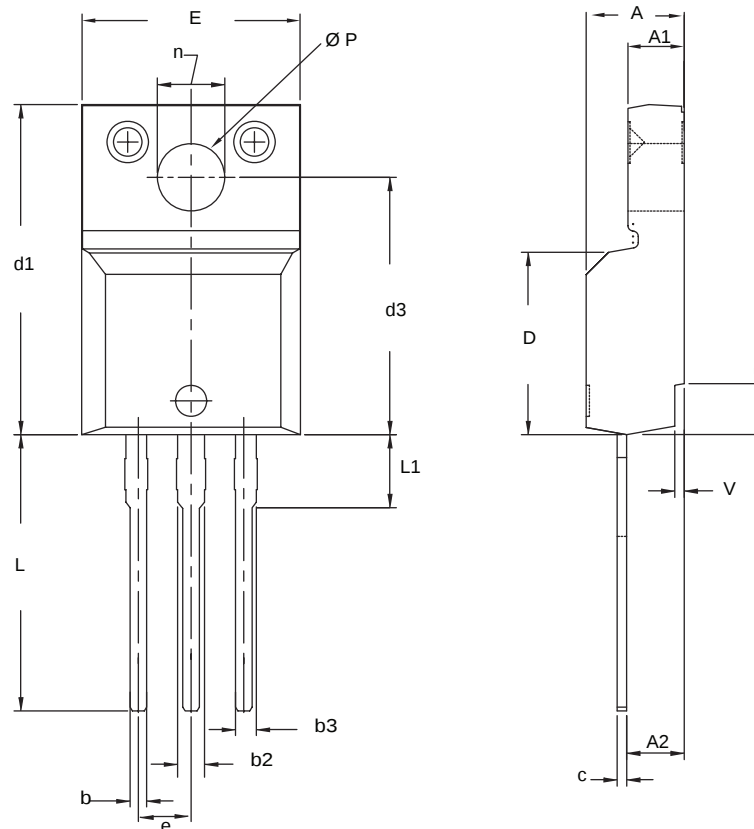
TO-220AB



| 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 |
| $\varnothing P$ | 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.

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