

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

### PRODUCT SUMMARY

|                                         |                 |       |
|-----------------------------------------|-----------------|-------|
| $V_{DS}$ (V) at $T_J$ max.              | 500             |       |
| $R_{DS(on)}$ max. at 25 °C ( $\Omega$ ) | $V_{GS} = 10$ V | 0.243 |
| $Q_g$ max. (nC)                         | 66              |       |
| $Q_{gs}$ (nC)                           | 8               |       |
| $Q_{gd}$ (nC)                           | 14              |       |
| 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)

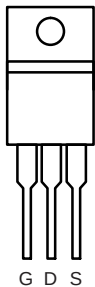


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### APPLICATIONS

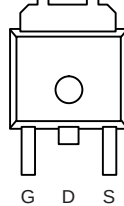
- Computing
  - PC silver box / ATX power supplies

TO-220AB



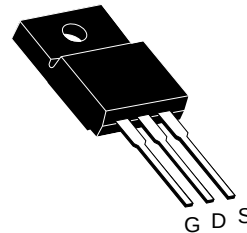
Top View

TO-252

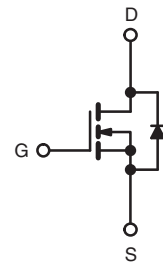


Top View

TO-220 FULLPAK



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 ( $T_J = 150\text{ }^{\circ}\text{C}$ ) | $V_{GS}$ at 10 V                             | $T_C = 25\text{ }^{\circ}\text{C}$  | $I_D$          | 14.5        | A                     |
|                                                                  |                                              | $T_C = 100\text{ }^{\circ}\text{C}$ |                | 9.2         |                       |
| Pulsed Drain Current <sup>a</sup>                                |                                              |                                     | $I_{DM}$       | 28          |                       |
| Linear Derating Factor                                           |                                              |                                     |                | 1.25        | W/ $^{\circ}\text{C}$ |
| Single Pulse Avalanche Energy <sup>b</sup>                       |                                              |                                     | $E_{AS}$       | 136         | mJ                    |
| Maximum Power Dissipation                                        |                                              |                                     | $P_D$          | 156         | W                     |
| Operating Junction and Storage Temperature Range                 |                                              |                                     | $T_J, T_{stg}$ | -55 to +150 | $^{\circ}\text{C}$    |
| Drain-Source Voltage Slope                                       | $V_{DS} = 0\text{ V to }80\text{ \% }V_{DS}$ |                                     | $dV/dt$        | 70          | V/ns                  |
| Reverse Diode $dV/dt$ <sup>d</sup>                               |                                              | 27                                  |                |             |                       |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>        | for 10 s                                     |                                     |                | 300         | $^{\circ}\text{C}$    |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 3.1$  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

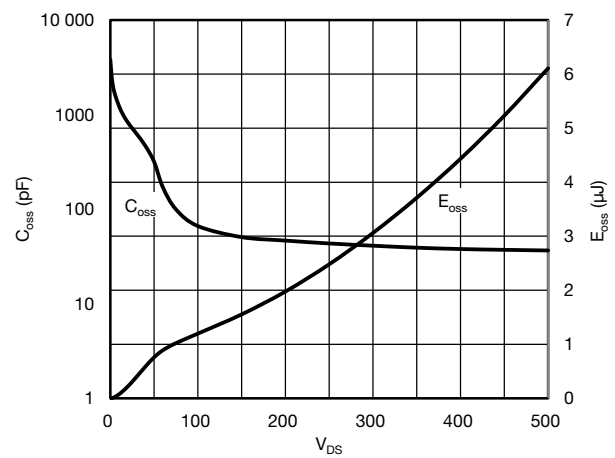
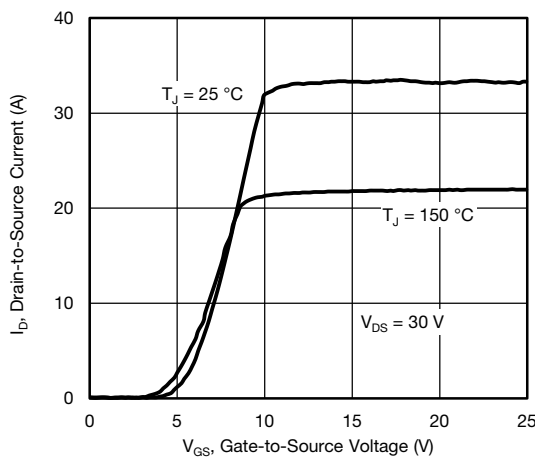
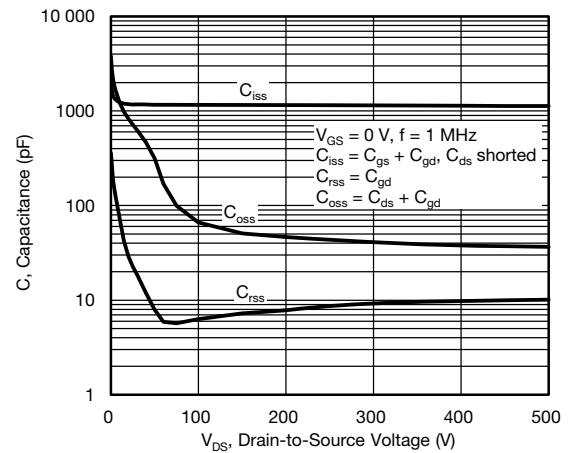
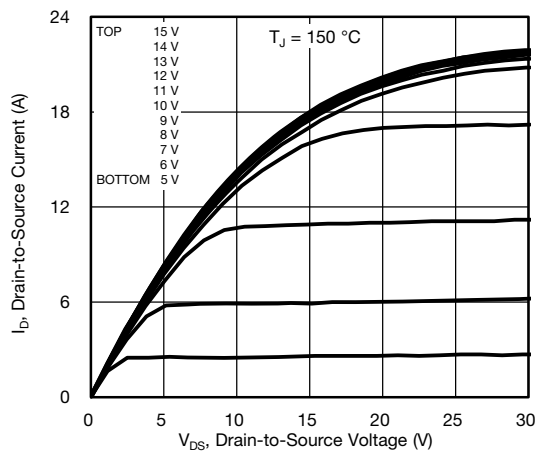
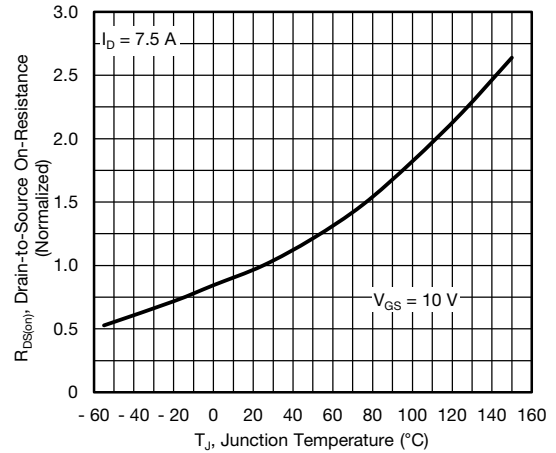
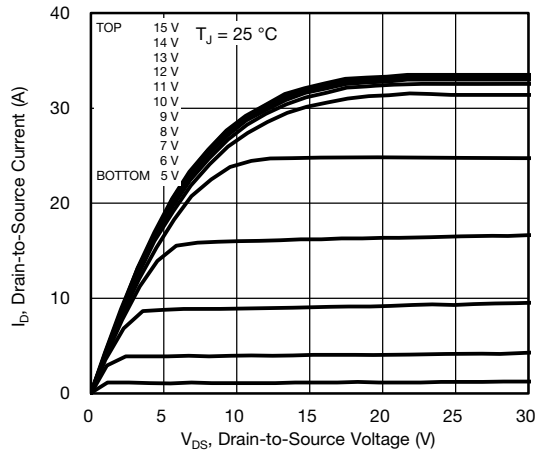
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.8  |      |

| SPECIFICATIONS (T <sub>J</sub> = 25 °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                                                                                                        |                                                 | 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> = 7.5 A                          | -    | 0.243 | -     | Ω    |
| Forward Transconductance                                        | g <sub>fs</sub>                  | V <sub>DS</sub> = 30 V, I <sub>D</sub> = 7.5 A                                                                                                        |                                                 | -    | 3.9   | -     | S    |
| Dynamic                                                         |                                  |                                                                                                                                                       |                                                 |      |       |       |      |
| 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>               | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                                                                                                 |                                                 | -    | 55    | -     |      |
| Effective Output Capacitance, Time Related <sup>b</sup>         | C <sub>o(tr)</sub>               |                                                                                                                                                       |                                                 | -    | 164   | -     |      |
| Total Gate Charge                                               | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                | I <sub>D</sub> = 7.5 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                                                                                                                                 |                                                 | -    | 0.85  | -     | Ω    |
| Drain-Source Body Diode Characteristics                         |                                  |                                                                                                                                                       |                                                 |      |       |       |      |
| 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> = 7.5 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> = 7.5 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)



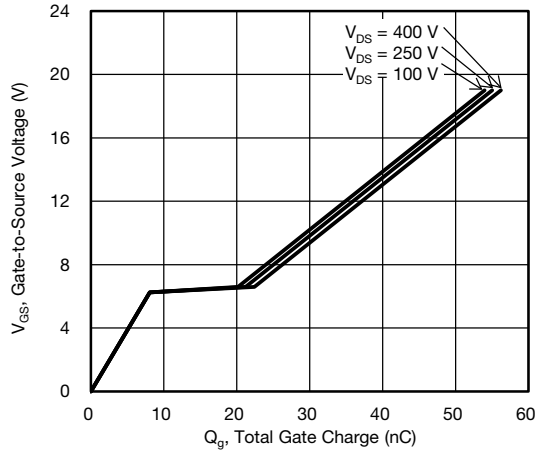


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

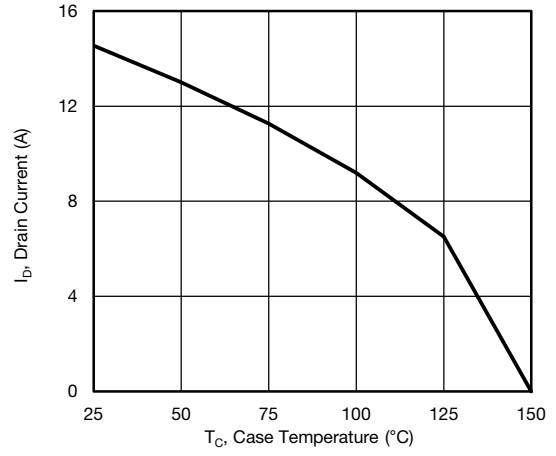


Fig. 10 - Maximum Drain Current vs. Case Temperature

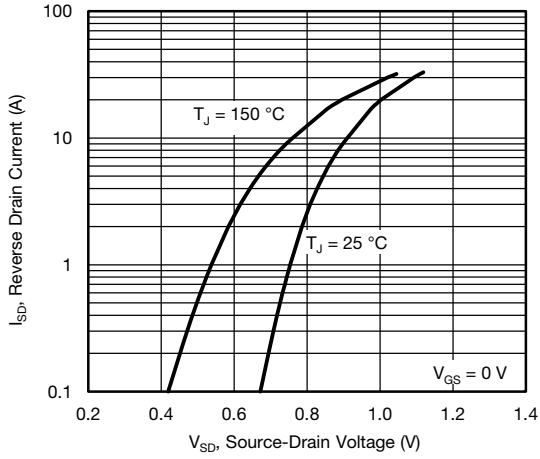


Fig. 8 - Typical Source-Drain Diode Forward Voltage

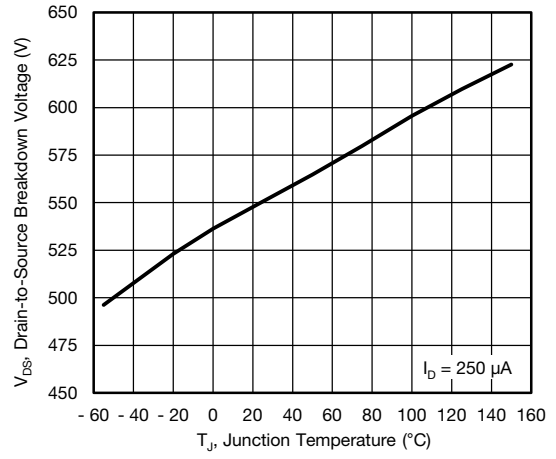


Fig. 11 - Temperature vs. Drain-to-Source Voltage

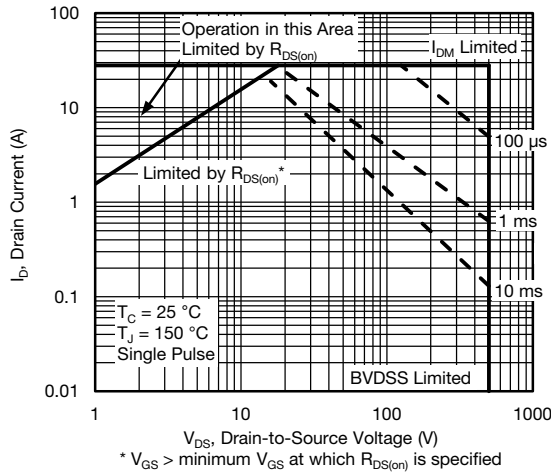
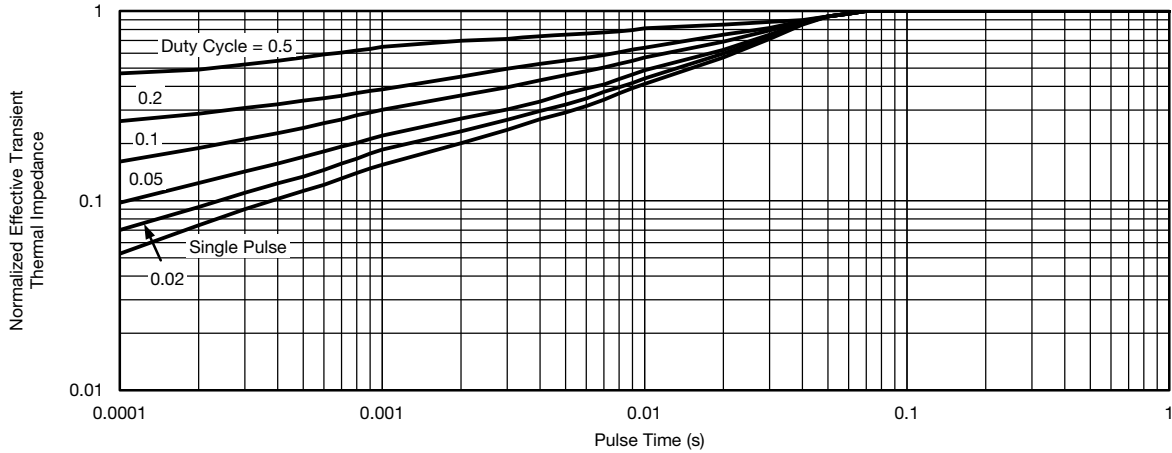
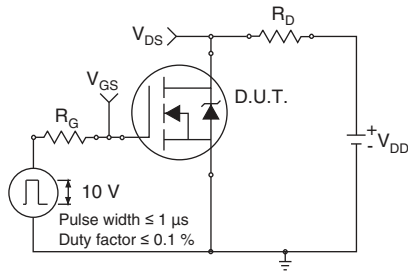


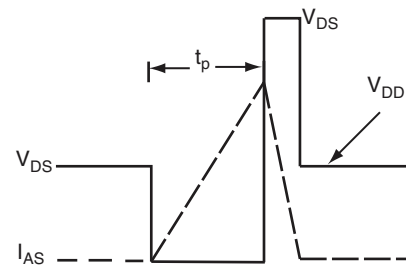
Fig. 9 - Maximum Safe Operating Area



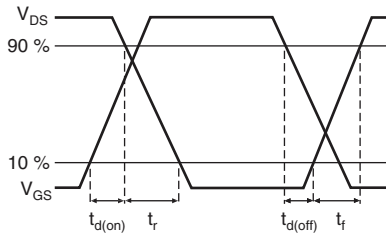
**Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case**



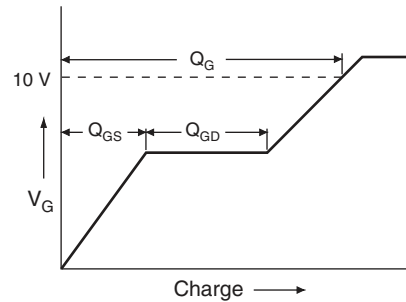
**Fig. 13 - Switching Time Test Circuit**



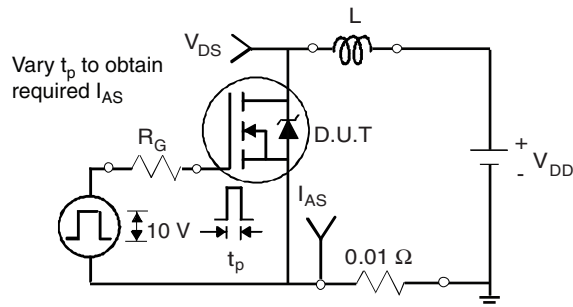
**Fig. 16 - Unclamped Inductive Waveforms**



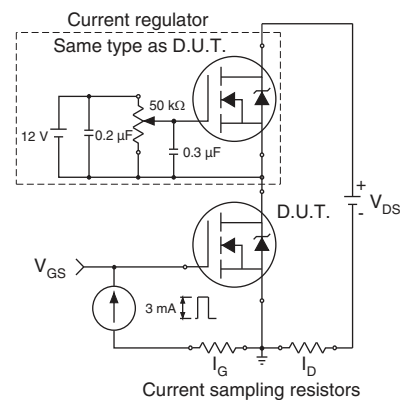
**Fig. 14 - Switching Time Waveforms**



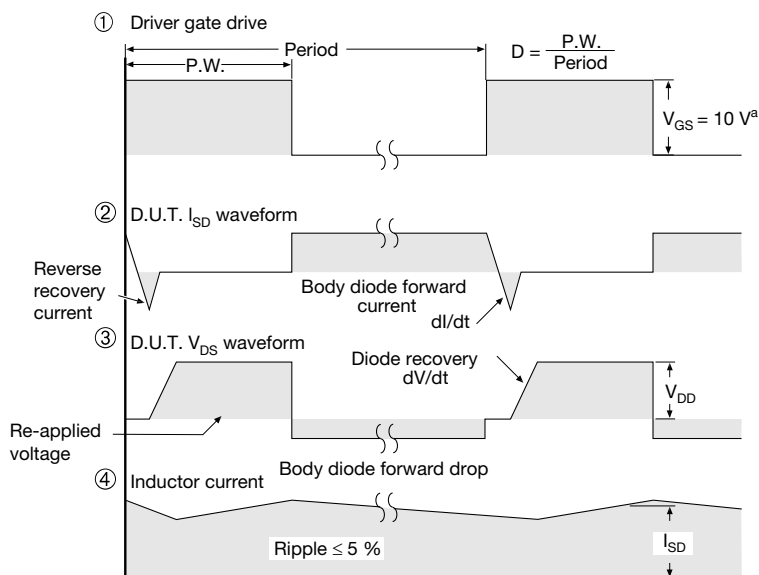
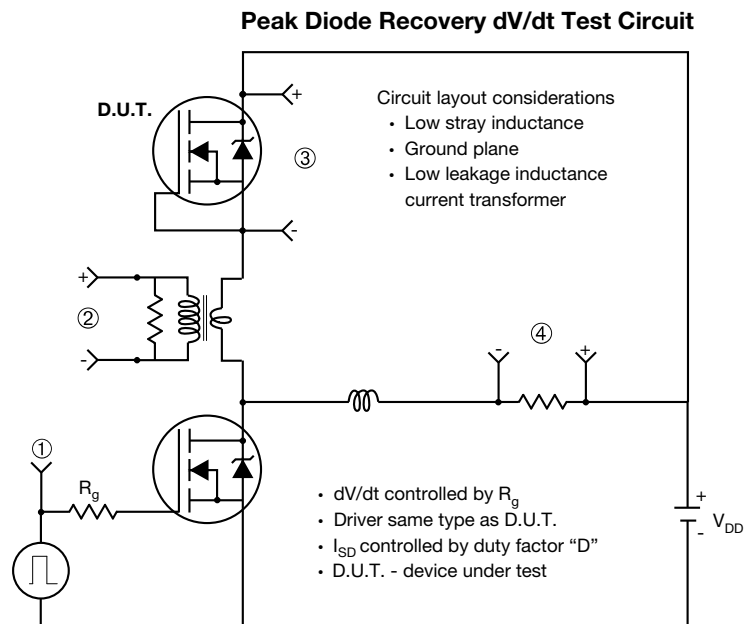
**Fig. 17 - Basic Gate Charge Waveform**



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



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

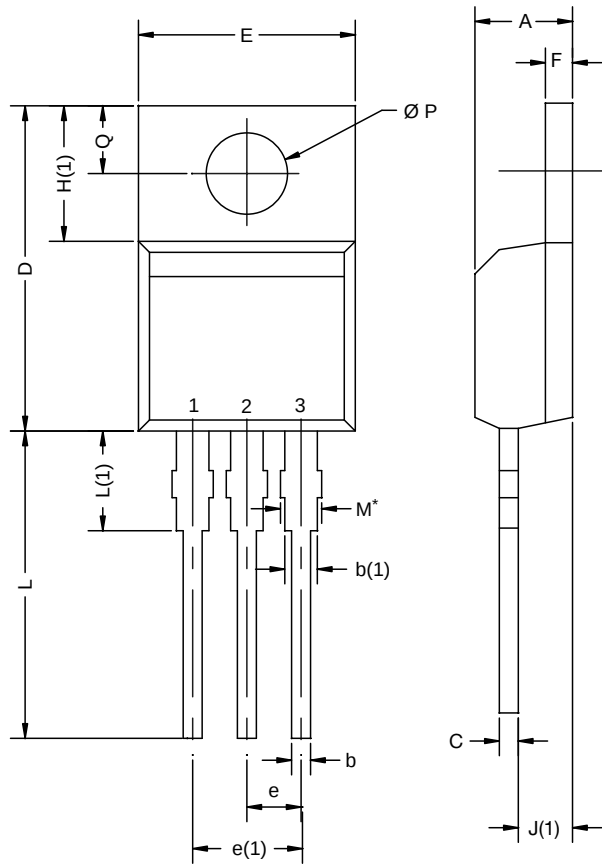


**Note**

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

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

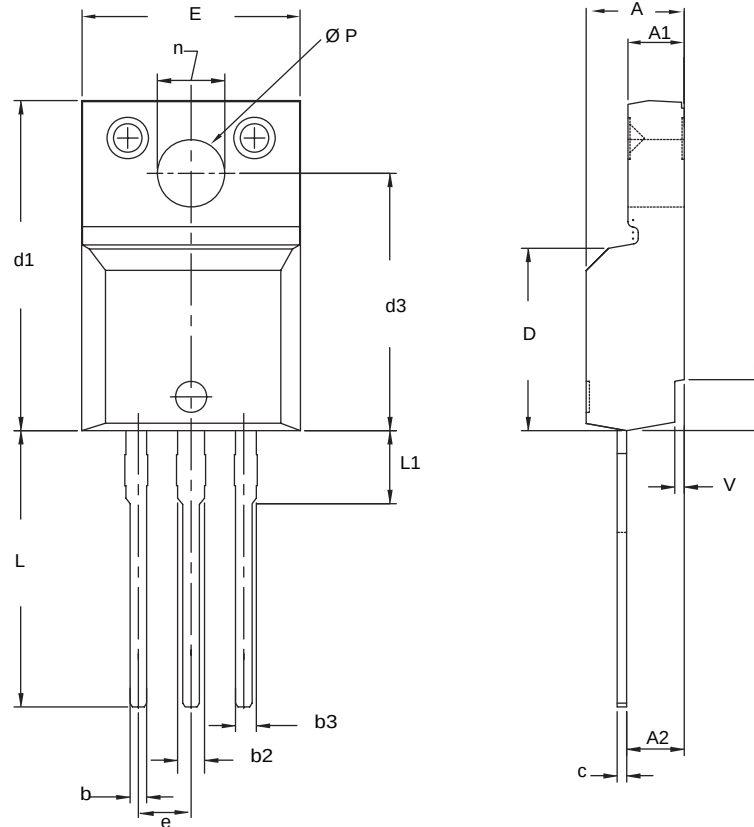
## TO-220AB



| 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<br>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 |

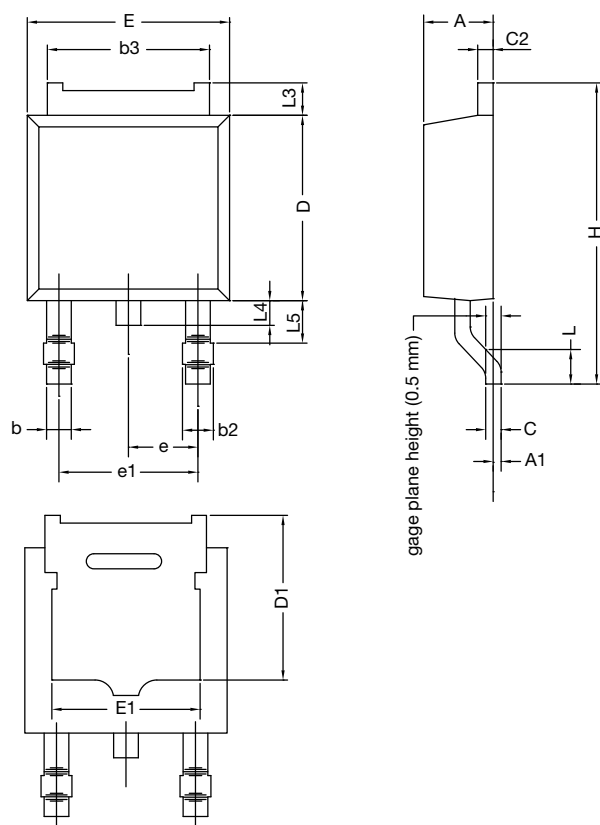
ECN: X09-0126-Rev. B, 26-Oct-09  
 DWG: 5972

**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-252AA CASE OUTLINE



| DIM.                            | MILLIMETERS |       | INCHES    |       |
|---------------------------------|-------------|-------|-----------|-------|
|                                 | MIN.        | MAX.  | MIN.      | MAX.  |
| A                               | 2.18        | 2.38  | 0.086     | 0.094 |
| A1                              | -           | 0.127 | -         | 0.005 |
| b                               | 0.64        | 0.88  | 0.025     | 0.035 |
| b2                              | 0.76        | 1.14  | 0.030     | 0.045 |
| b3                              | 4.95        | 5.46  | 0.195     | 0.215 |
| C                               | 0.46        | 0.61  | 0.018     | 0.024 |
| C2                              | 0.46        | 0.89  | 0.018     | 0.035 |
| D                               | 5.97        | 6.22  | 0.235     | 0.245 |
| D1                              | 5.21        | -     | 0.205     | -     |
| E                               | 6.35        | 6.73  | 0.250     | 0.265 |
| E1                              | 4.32        | -     | 0.170     | -     |
| H                               | 9.40        | 10.41 | 0.370     | 0.410 |
| e                               | 2.28 BSC    |       | 0.090 BSC |       |
| e1                              | 4.56 BSC    |       | 0.180 BSC |       |
| L                               | 1.40        | 1.78  | 0.055     | 0.070 |
| L3                              | 0.89        | 1.27  | 0.035     | 0.050 |
| L4                              | -           | 1.02  | -         | 0.040 |
| L5                              | 1.14        | 1.52  | 0.045     | 0.060 |
| ECN: X12-0247-Rev. M, 24-Dec-12 |             |       |           |       |
| DWG: 5347                       |             |       |           |       |

### Note

- Dimension L3 is for reference only.

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**Taiwan VBsemi Electronics Co., Ltd., hereby certify that all of the products are determined to be oHS compliant and meets the definition of restrictions under Directive of the European Parliament 2011/65 / EU, 2011 Nian. 6. 8 Ri Yue restrict the use of certain hazardous substances in electrical and electronic equipment (EEE) - modification, unless otherwise specified as inconsistent.(www.VBsemi.com)**

**Please note that some documents may still refer to Taiwan VBsemi RoHS Directive 2002/95 / EC. We confirm that all products identified as consistent with the Directive 2002/95 / EC European Directive 2011/65 /.**

**Taiwan VBsemi Electronics Co., Ltd. hereby certify that all of its products comply identified as halogen-free halogen-free standards required by the JEDEC JS709A. Please note that some Taiwanese VBsemi documents still refer to the definition of IEC 61249-2-21, and we are sure that all products conform to confirm compliance with IEC 61249-2-21 standard level JS709A.**