

## P-Channel 40 V (D-S) MOSFET

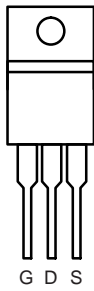
| PRODUCT SUMMARY     |                                    |                                 |
|---------------------|------------------------------------|---------------------------------|
| V <sub>DS</sub> (V) | R <sub>DS(on)</sub> (Ω)            | I <sub>D</sub> (A) <sup>a</sup> |
| - 40                | 0.012 at V <sub>GS</sub> = - 10 V  | ± 65                            |
|                     | 0.014 at V <sub>GS</sub> = - 4.5 V | ± 60                            |

### FEATURES

- Compliant to RoHS Directive 2002/95/EC



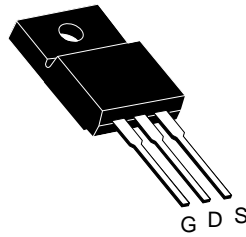
TO-220AB



Top View

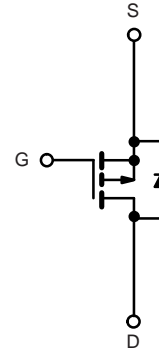
VBM2412

TO-220 FULLPAK



Top View

VBMB2412



P-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                                              |                         |                   |
|---------------------------------------------------------------------------|----------------------------------------------|-------------------------|-------------------|
| Parameter                                                                 | Symbol                                       | Limit                   | Unit              |
| Gate-Source Voltage                                                       | V <sub>GS</sub>                              | ± 40                    | V                 |
| Continuous Drain Current (T <sub>J</sub> = 175 °C)                        | I <sub>D</sub>                               | T <sub>C</sub> = 25 °C  | - 65 <sup>a</sup> |
|                                                                           |                                              | T <sub>C</sub> = 125 °C | - 62              |
| Pulsed Drain Current                                                      | I <sub>DM</sub>                              | - 60                    | A                 |
| Avalanche Current                                                         | I <sub>AR</sub>                              | - 60                    |                   |
| Repetitive Avalanche Energy <sup>b</sup>                                  | L = 0.1 mH                                   | E <sub>AR</sub>         | 180               |
| Power Dissipation                                                         | T <sub>C</sub> = 25 °C (TO-220AB and TO-263) | P <sub>D</sub>          | 187 <sup>d</sup>  |
|                                                                           | T <sub>A</sub> = 25 °C (TO-263) <sup>c</sup> |                         | 3.75              |
| Operating Junction and Storage Temperature Range                          | T <sub>J</sub> , T <sub>stg</sub>            | - 55 to 175             | °C                |

| THERMAL RESISTANCE RATINGS |                   |                                 |      |
|----------------------------|-------------------|---------------------------------|------|
| Parameter                  | Symbol            | Limit                           | Unit |
| Junction-to-Ambient        | R <sub>thJA</sub> | PCB Mount (TO-263) <sup>c</sup> | 40   |
|                            |                   | Free Air (TO-220AB)             | 62.5 |
| Junction-to-Case           | R <sub>thJC</sub> | 0.8                             | °C/W |

Notes:

- Package limited.
- Duty cycle ≤ 1 %.
- When mounted on 1" square PCB (FR-4 material).
- See SOA curve for voltage derating.

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

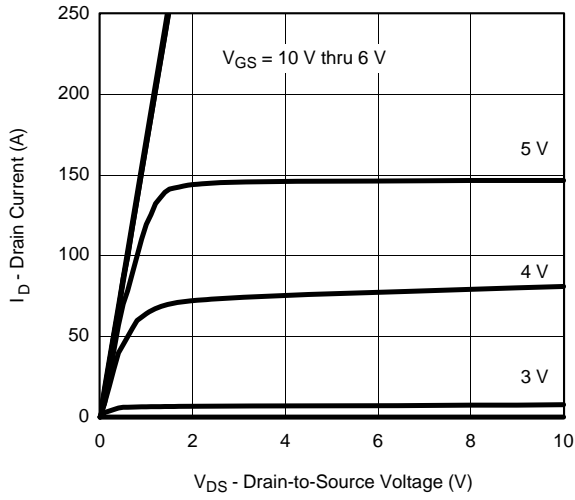
| <b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)                     |               |                                                                                                                                |      |       |           |               |
|--------------------------------------------------------------------------------------------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------|------|-------|-----------|---------------|
| Parameter                                                                                              | Symbol        | Test Conditions                                                                                                                | Min. | Typ.  | Max.      | Unit          |
| <b>Static</b>                                                                                          |               |                                                                                                                                |      |       |           |               |
| Drain-Source Breakdown Voltage                                                                         | $V_{DS}$      | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$                                                                           | -40  |       |           | V             |
| Gate Threshold Voltage                                                                                 | $V_{GS(th)}$  | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$                                                                               | -1.5 |       | -1.7      |               |
| Gate-Body Leakage                                                                                      | $I_{GSS}$     | $V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$                                                                                |      |       | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current                                                                        | $I_{DSS}$     | $V_{DS} = -30\text{ V}, V_{GS} = 0\text{ V}$                                                                                   |      |       | -1        | $\mu\text{A}$ |
|                                                                                                        |               | $V_{DS} = -30\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$                                                  |      |       | -50       |               |
|                                                                                                        |               | $V_{DS} = -30\text{ V}, V_{GS} = 0\text{ V}, T_J = 175\text{ }^\circ\text{C}$                                                  |      |       | -250      |               |
| On-State Drain Current <sup>a</sup>                                                                    | $I_{D(on)}$   | $V_{DS} = -5\text{ V}, V_{GS} = -10\text{ V}$                                                                                  | -120 |       |           | A             |
| Drain-Source On-State Resistance <sup>a</sup>                                                          | $R_{DS(on)}$  | $V_{GS} = -10\text{ V}, I_D = -30\text{ A}$                                                                                    |      | 0.012 |           | $\Omega$      |
|                                                                                                        |               | $V_{GS} = -10\text{ V}, I_D = -30\text{ A}, T_J = 125\text{ }^\circ\text{C}$                                                   |      | 0.018 |           |               |
|                                                                                                        |               | $V_{GS} = -10\text{ V}, I_D = -30\text{ A}, T_J = 175\text{ }^\circ\text{C}$                                                   |      | 0.025 |           |               |
|                                                                                                        |               | $V_{GS} = -4.5\text{ V}, I_D = -20\text{ A}$                                                                                   |      | 0.014 |           |               |
| Forward Transconductance <sup>a</sup>                                                                  | $g_{fs}$      | $V_{DS} = -15\text{ V}, I_D = -75\text{ A}$                                                                                    | 20   |       |           | S             |
| <b>Dynamic<sup>b</sup></b>                                                                             |               |                                                                                                                                |      |       |           |               |
| Input Capacitance                                                                                      | $C_{iss}$     | $V_{GS} = 0\text{ V}, V_{DS} = -25\text{ V}, f = 1\text{ MHz}$                                                                 |      | 9000  |           | $\mu\text{F}$ |
| Output Capacitance                                                                                     | $C_{oss}$     |                                                                                                                                |      | 1565  |           |               |
| Reverse Transfer Capacitance                                                                           | $C_{rss}$     |                                                                                                                                |      | 715   |           |               |
| Total Gate Charge <sup>c</sup>                                                                         | $Q_g$         | $V_{DS} = -15\text{ V}, V_{GS} = -10\text{ V}, I_D = -75\text{ A}$                                                             |      | 160   | 240       | nC            |
| Gate-Source Charge <sup>c</sup>                                                                        | $Q_{gs}$      |                                                                                                                                |      | 32    |           |               |
| Gate-Drain Charge <sup>c</sup>                                                                         | $Q_{gd}$      |                                                                                                                                |      | 30    |           |               |
| Turn-On Delay Time <sup>c</sup>                                                                        | $t_{d(on)}$   | $V_{DD} = -15\text{ V}, R_L = 0.2\text{ }\Omega$<br>$I_D \equiv -75\text{ A}, V_{GEN} = -10\text{ V}, R_g = 2.5\text{ }\Omega$ |      | 25    | 40        | ns            |
| Rise Time <sup>c</sup>                                                                                 | $t_r$         |                                                                                                                                |      | 225   | 360       |               |
| Turn-Off Delay Time <sup>c</sup>                                                                       | $t_{d(off)}$  |                                                                                                                                |      | 150   | 240       |               |
| Fall Time <sup>c</sup>                                                                                 | $t_f$         |                                                                                                                                |      | 210   | 340       |               |
| <b>Source-Drain Diode Ratings and Characteristics<sup>b</sup></b> ( $T_C = 25\text{ }^\circ\text{C}$ ) |               |                                                                                                                                |      |       |           |               |
| Continuous Current                                                                                     | $I_S$         |                                                                                                                                |      |       | -80       | A             |
| Pulsed Current                                                                                         | $I_{SM}$      |                                                                                                                                |      |       | -240      |               |
| Forward Voltage <sup>a</sup>                                                                           | $V_{SD}$      | $I_F = -75\text{ A}, V_{GS} = 0\text{ V}$                                                                                      |      | -1.2  | -1.5      | V             |
| Reverse Recovery Time                                                                                  | $t_{rr}$      | $I_F = -75\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$                                                                         |      | 55    | 100       | ns            |
| Peak Reverse Recovery Current                                                                          | $I_{RM(REC)}$ |                                                                                                                                |      | 2.5   | 5         | A             |
| Reverse Recovery Charge                                                                                | $Q_{rr}$      |                                                                                                                                |      | 0.07  | 0.25      | $\mu\text{C}$ |

Notes:

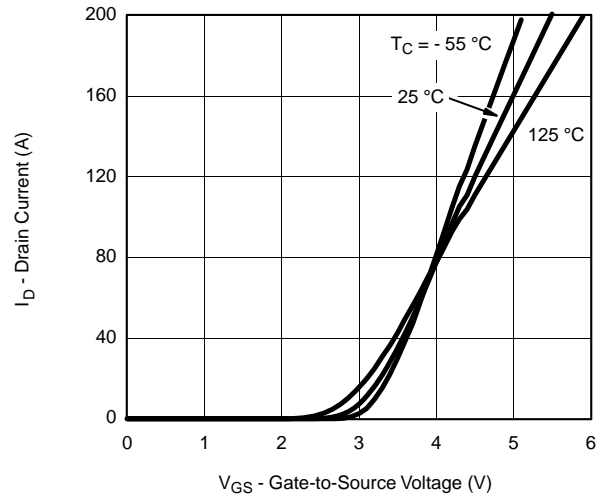
- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .  
 b. Guaranteed by design, not subject to production testing.  
 c. Independent of operating temperature.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

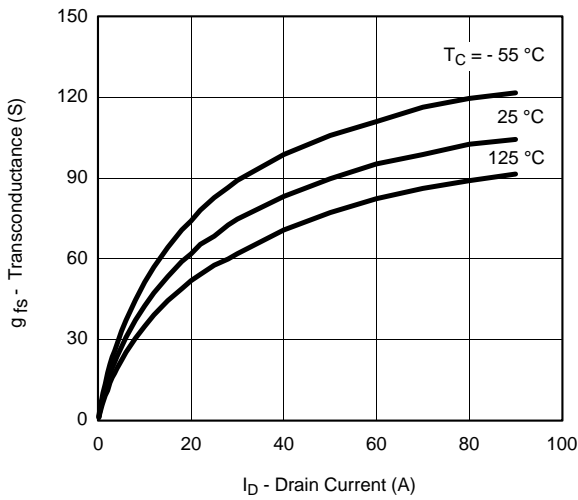
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



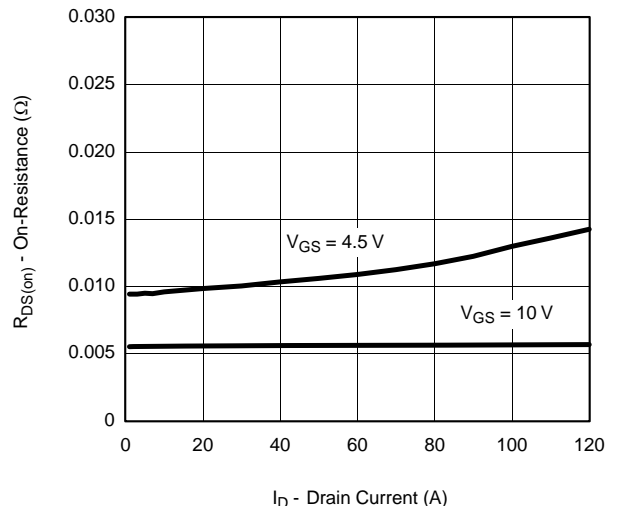
**Output Characteristics**



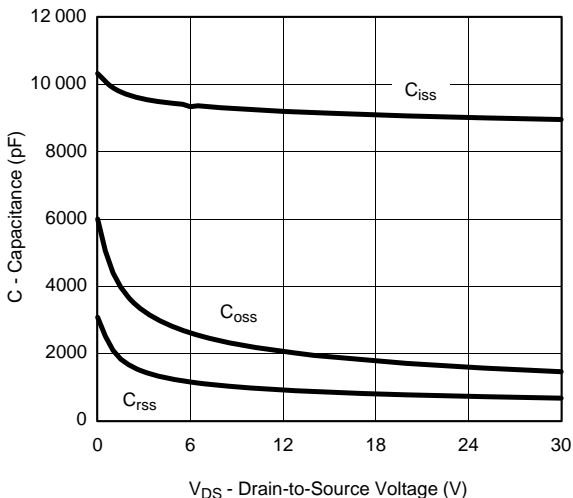
**Transfer Characteristics**



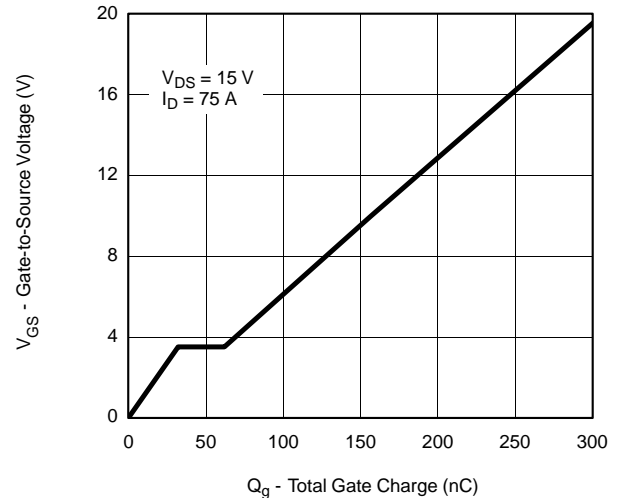
**Transconductance**



**On-Resistance vs. Drain Current**

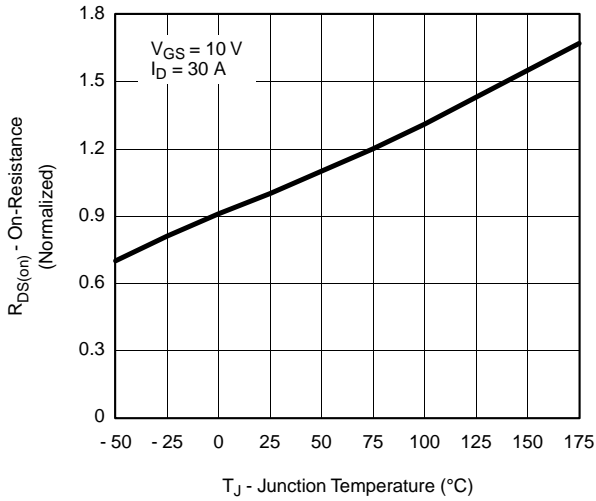


**Capacitance**

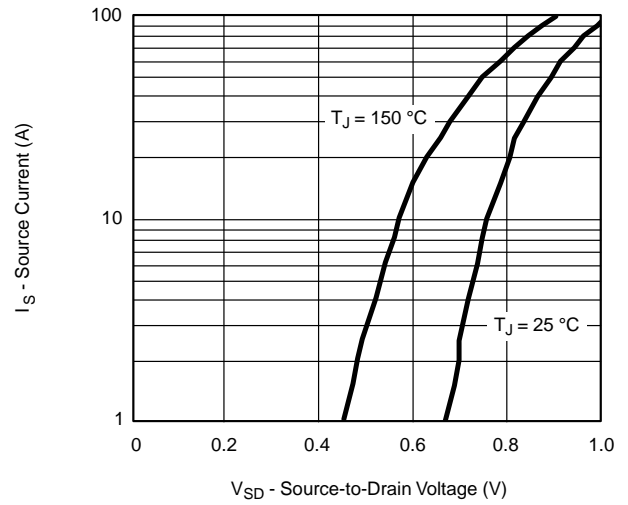


**Gate Charge**

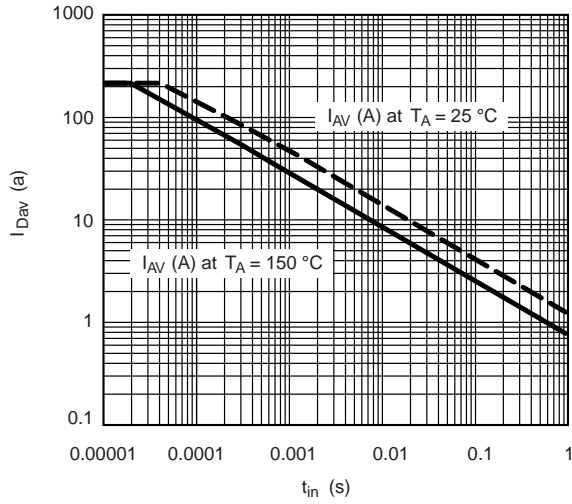
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



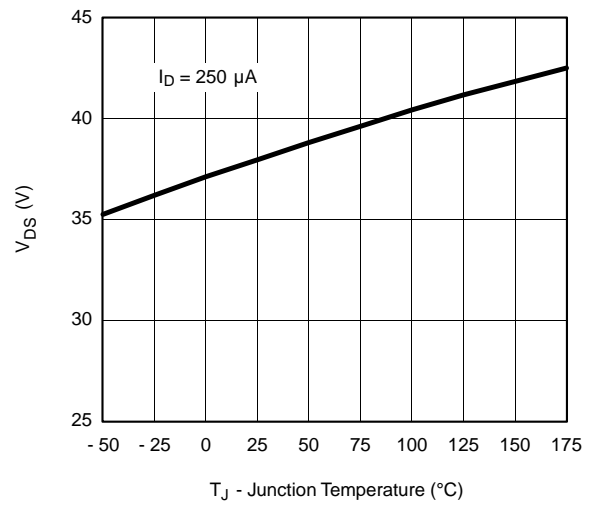
**On-Resistance vs. Junction Temperature**



**Source-Drain Diode Forward Voltage**

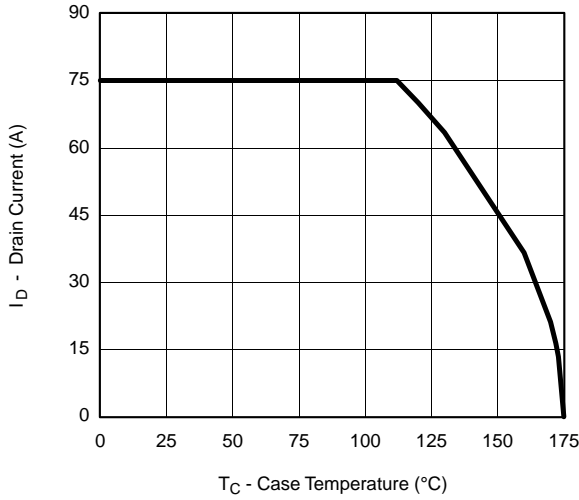


**Avalanche Current vs. Time**

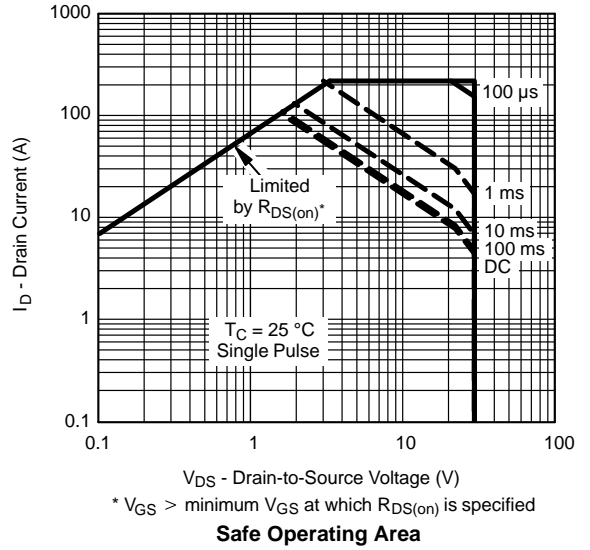


**Drain Source Breakdown vs. Junction Temperature**

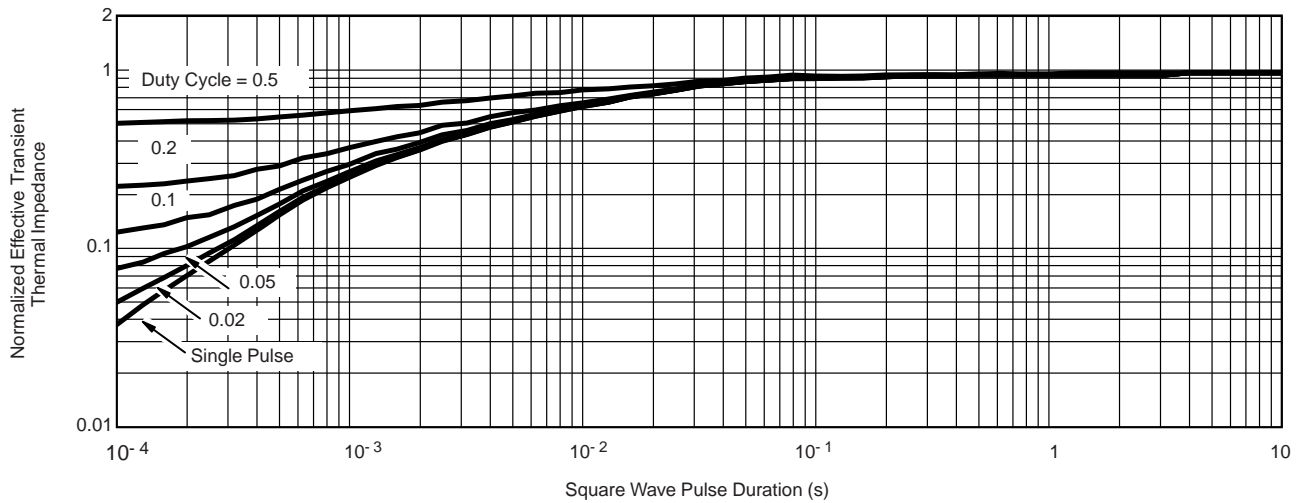
**THERMAL RATINGS**



**Maximum Avalanche and Drain Current vs. Case Temperature**

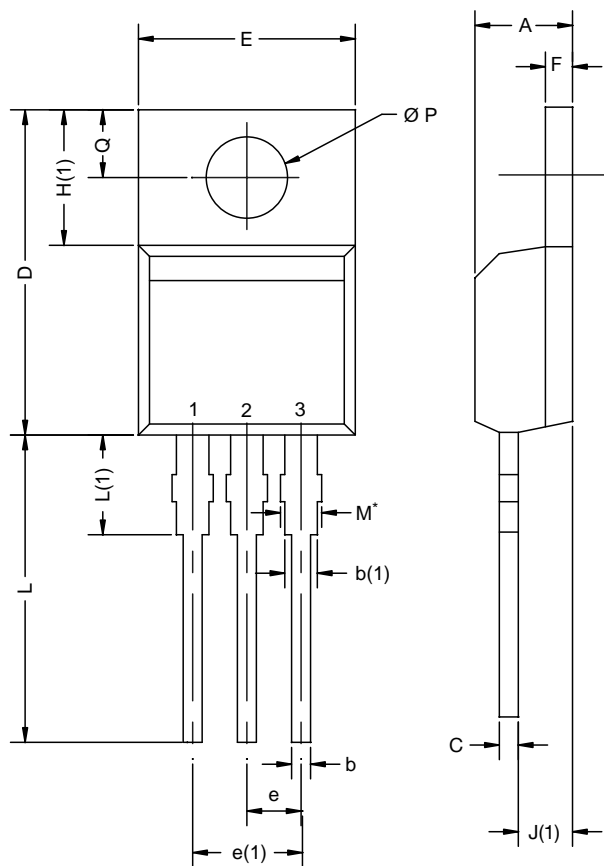


**Safe Operating Area**



**Normalized Thermal Transient Impedance, Junction-to-Case**

### TO-220AB



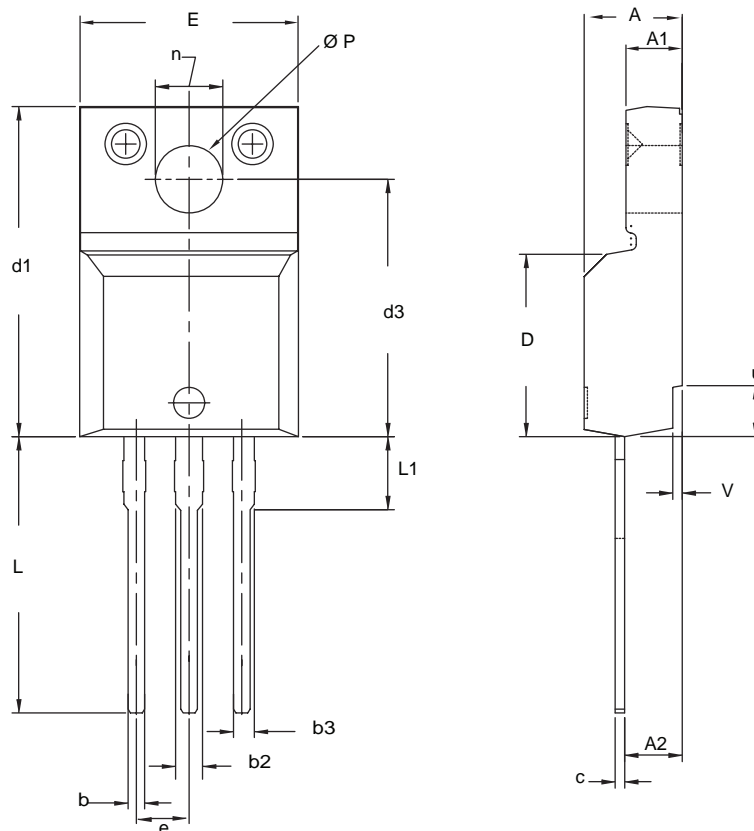
| DIM.            | MILLIMETERS |       | INCHES |       |
|-----------------|-------------|-------|--------|-------|
|                 | MIN.        | MAX.  | MIN.   | MAX.  |
| A               | 4.25        | 4.65  | 0.167  | 0.183 |
| b               | 0.69        | 1.01  | 0.027  | 0.040 |
| b(1)            | 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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