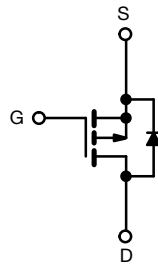


Power MOSFET

TO-220AB


P-Channel MOSFET

FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- P-channel
- 175 °C operating temperature
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



Available
RoHS*
 Available
HALOGEN
FREE
 Available

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220AB package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

PRODUCT SUMMARY

| | | |
|---------------------------|------------------|------|
| V_{DS} (V) | -60 | |
| $R_{DS(on)}$ (Ω) | $V_{GS} = -10$ V | 0.50 |
| Q_g max. (nC) | 12 | |
| Q_{gs} (nC) | 3.8 | |
| Q_{gd} (nC) | 5.1 | |
| Configuration | Single | |

ORDERING INFORMATION

| | |
|---------------------------------|----------------|
| Package | TO-220AB |
| Lead (Pb)-free | IRF9Z10PbF |
| Lead (Pb)-free and halogen-free | IRF9Z10PbF-BE3 |

ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C, unless otherwise noted)

| PARAMETER | SYMBOL | LIMIT | UNIT |
|---|------------------|---------------------------------|-------|
| Drain-source voltage | V_{DS} | -60 | V |
| Gate-source voltage | V_{GS} | ± 20 | |
| Continuous drain current | I_D | V_{GS} at -10 V $T_C = 25$ °C | -6.7 |
| | | $T_C = 100$ °C | -4.7 |
| Pulsed drain current ^a | I_{DM} | -27 | A |
| Linear derating factor | | 0.29 | W/°C |
| Single pulse avalanche energy ^b | E_{AS} | 140 | mJ |
| Repetitive avalanche current ^a | I_{AR} | -6.7 | A |
| Repetitive avalanche energy ^a | E_{AR} | 4.3 | mJ |
| Maximum power dissipation | P_D | 43 | W |
| Peak diode recovery dV/dt ^c | dV/dt | -4.5 | V/ns |
| Operating junction and storage temperature range | T_J, T_{stg} | -55 to +175 | °C |
| Soldering recommendations (peak temperature) ^d | For 10 s | 300 | |
| Mounting torque | 6-32 or M3 screw | 10 | |
| | | 1.1 | N · m |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = -25$ V, starting $T_J = 25$ °C, $L = 6.23$ mH, $R_g = 25$ Ω , $I_{AS} = -6.7$ A (see fig. 12)
- $I_{SD} \leq -6.7$ A, $dI/dt \leq 90$ A/ μ s, $V_{DD} \leq V_{DS}$, $T_J \leq 175$ °C
- 1.6 mm from case

| THERMAL RESISTANCE RATINGS | | | | |
|-------------------------------------|------------|------|------|------|
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
| Maximum junction-to-ambient | R_{thJA} | - | 62 | °C/W |
| Case-to-sink, flat, greased surface | R_{thCS} | 0.50 | - | |
| Maximum junction-to-case (drain) | R_{thJC} | - | 3.5 | |

| 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_{DS} | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$ | | -60 | - | - | V |
| V_{DS} temperature coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$, $I_D = -1\text{ mA}$ | | - | -0.060 | - | V/°C |
| Gate-source threshold voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$ | | -2.0 | - | -4.0 | V |
| Gate-source leakage | I_{GSS} | $V_{GS} = \pm 20\text{ V}$ | | - | - | ± 100 | nA |
| Zero gate voltage drain current | I_{DSS} | $V_{DS} = -60\text{ V}, V_{GS} = 0\text{ V}$ | | - | - | -100 | μA |
| | | $V_{DS} = -48\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$ | | - | - | -500 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS} = -10\text{ V}$ | $I_D = -4.0\text{ A}^b$ | - | - | 0.50 | Ω |
| Forward transconductance | g_{fs} | $V_{DS} = -25\text{ V}, I_D = -4.0\text{ A}^b$ | | 1.4 | - | - | S |
| Dynamic | | | | | | | |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{ V},$ $V_{DS} = -25\text{ V},$ $f = 1.0\text{ MHz},$ see fig. 5 | | - | 270 | - | pF |
| Output capacitance | C_{oss} | | | - | 170 | - | |
| Reverse transfer capacitance | C_{rss} | | | - | 31 | - | |
| Total gate charge | Q_g | $V_{GS} = -10\text{ V}$ | $I_D = -6.7\text{ A}, V_{DS} = -48\text{ V},$ see fig. 6 and 13 ^b | - | - | 12 | nC |
| Gate-source charge | Q_{gs} | | | - | - | 3.8 | |
| Gate-drain charge | Q_{gd} | | | - | - | 5.1 | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = -30\text{ V}, I_D = -6.7\text{ A},$ $R_g = 24\text{ }\Omega, R_D = 4.0\text{ }\Omega,$ see fig. 10 ^b | | - | 11 | - | ns |
| Rise time | t_r | | | - | 63 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 10 | - | |
| Fall time | t_f | | | - | 31 | - | |
| Gate input resistance | R_g | $f = 1\text{ MHz},$ open drain | | 1.4 | - | 8.7 | Ω |
| Internal drain inductance | L_D | Between lead, 6 mm (0.25") from package and center of die contact | | - | 4.5 | - | nH |
| Internal source inductance | L_S | | | - | 7.5 | - | |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous source-drain diode current | I_S | MOSFET symbol showing the integral reverse p - n junction diode | | - | - | -6.7 | A |
| Pulsed diode forward current ^a | I_{SM} | | | - | - | -27 | |
| Body diode voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}, I_S = -6.7\text{ A}, V_{GS} = 0\text{ V}^b$ | | - | - | -5.5 | V |
| Body diode reverse recovery time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}, I_F = -6.7\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$ | | - | 80 | 160 | ns |
| Body diode reverse recovery charge | Q_{rr} | | | - | 0.096 | 0.19 | μC |
| Forward turn-on time | t_{on} | Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D) | | | | | |

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)

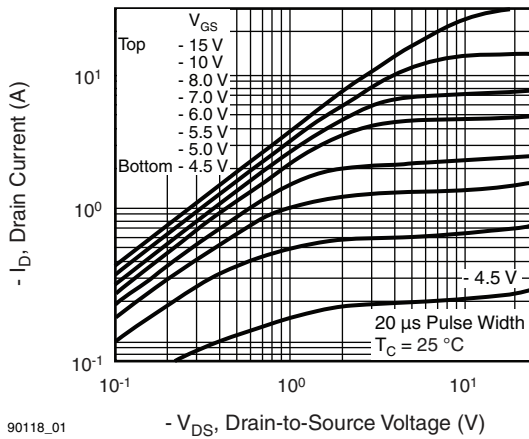


Fig. 1 - Typical Output Characteristics, $T_C = 25\text{ }^\circ\text{C}$

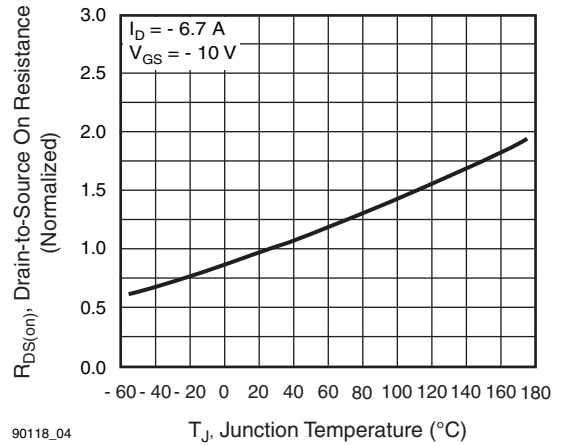


Fig. 4 - Normalized On-Resistance vs. Temperature

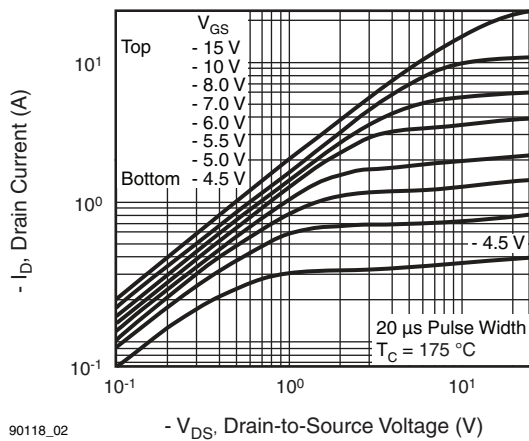


Fig. 2 - Typical Output Characteristics, $T_C = 175\text{ }^\circ\text{C}$

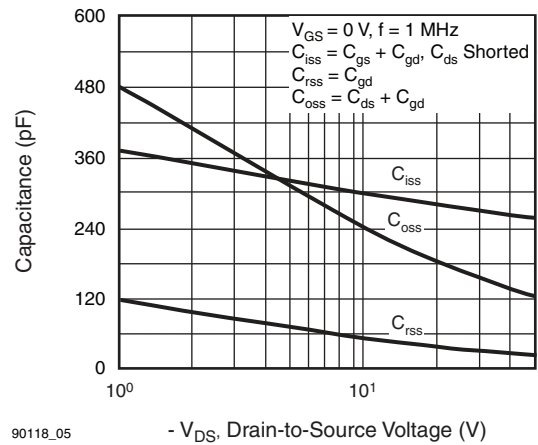


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

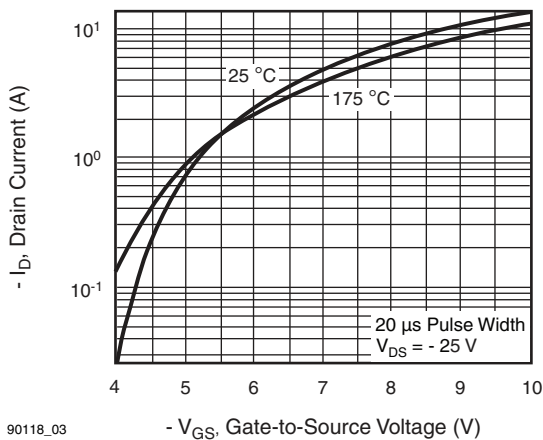


Fig. 3 - Typical Transfer Characteristics

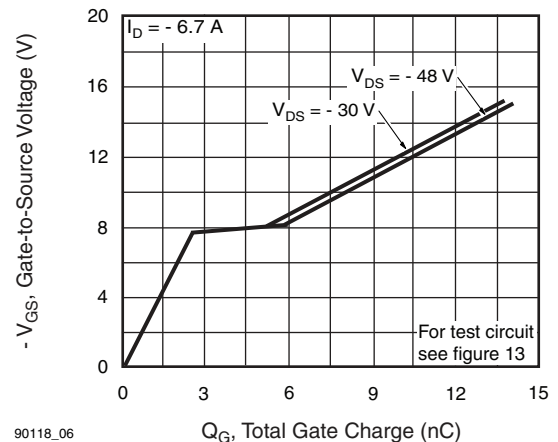
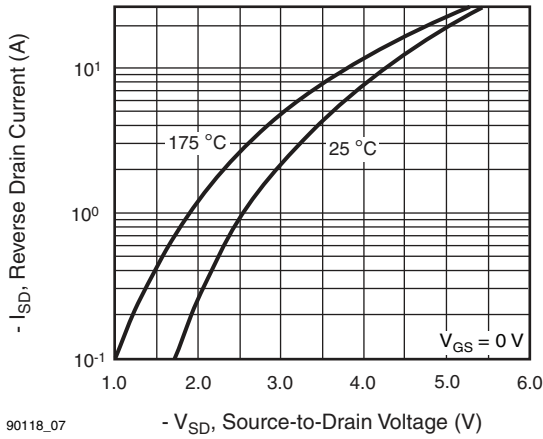
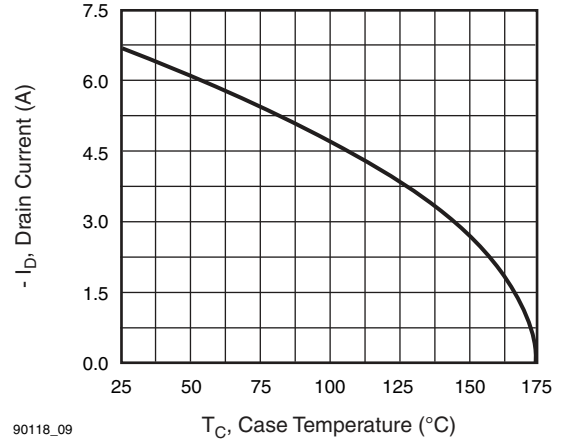


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage



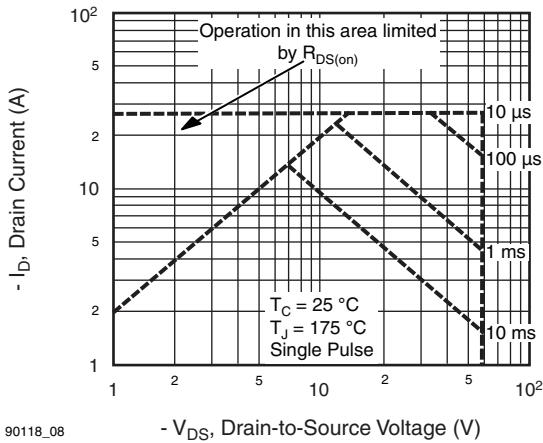
90118_07

Fig. 7 - Typical Source-Drain Diode Forward Voltage



90118_09

Fig. 9 - Maximum Drain Current vs. Case Temperature



90118_08

Fig. 8 - Maximum Safe Operating Area

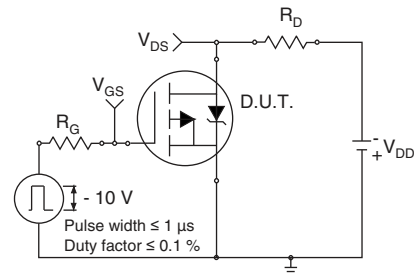


Fig. 10a - Switching Time Test Circuit

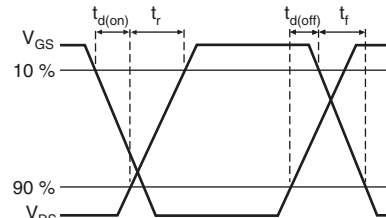
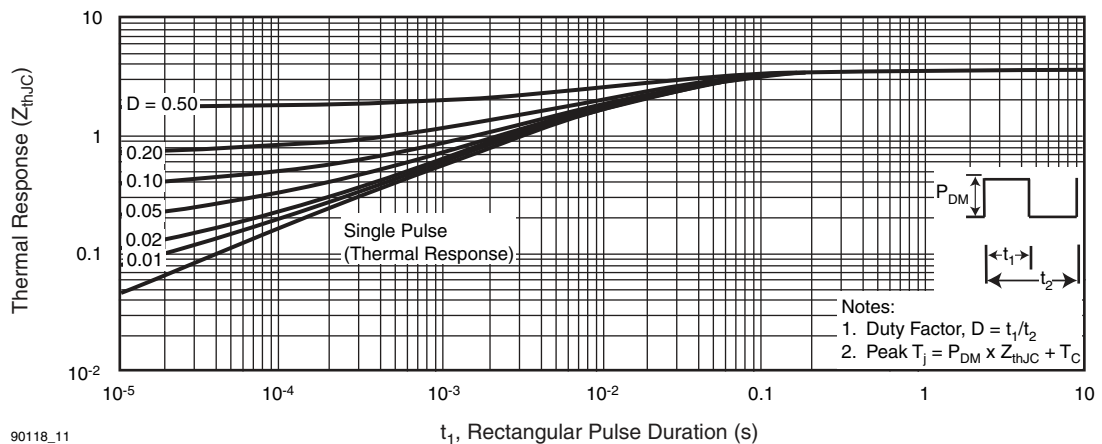


Fig. 10b - Switching Time Waveforms



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

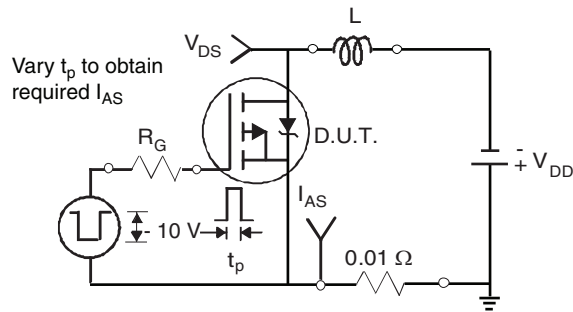


Fig. 12a - Unclamped Inductive Test Circuit

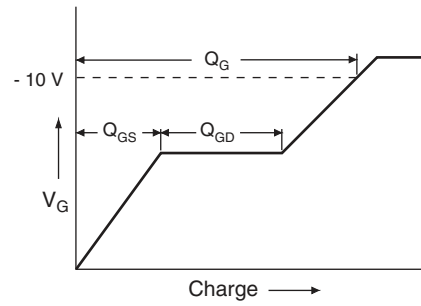


Fig. 13a - Basic Gate Charge Waveform

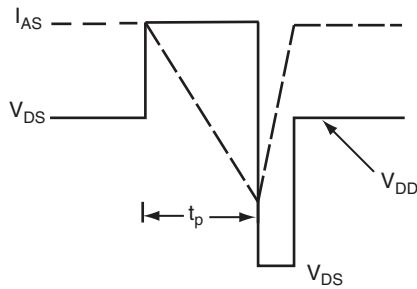


Fig. 12b - Unclamped Inductive Waveforms

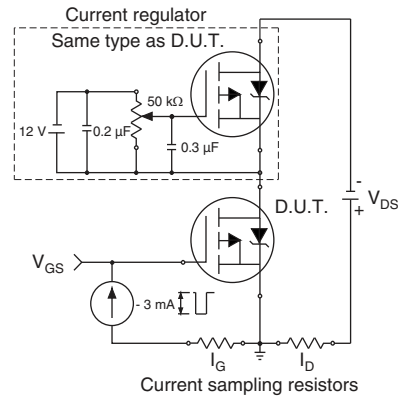


Fig. 13b - Gate Charge Test Circuit

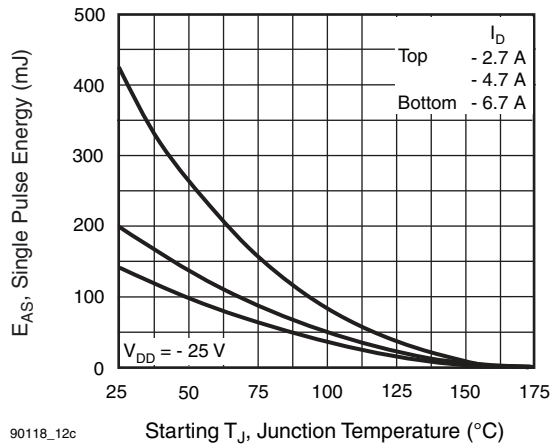
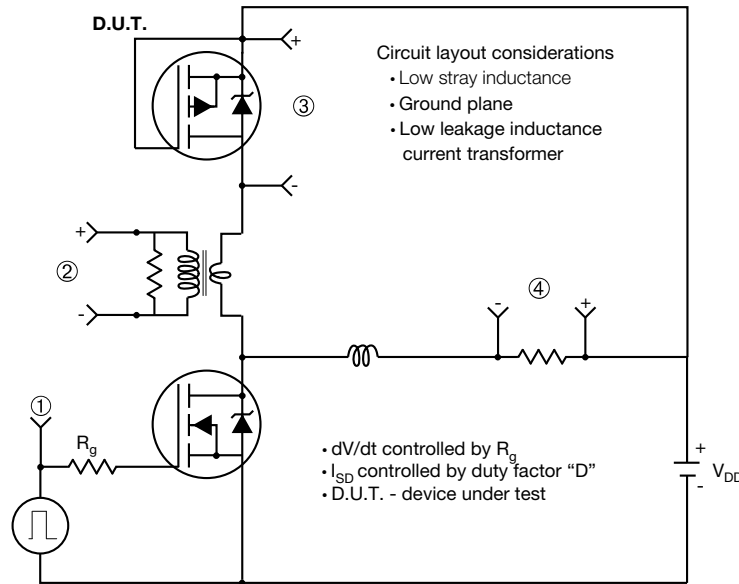
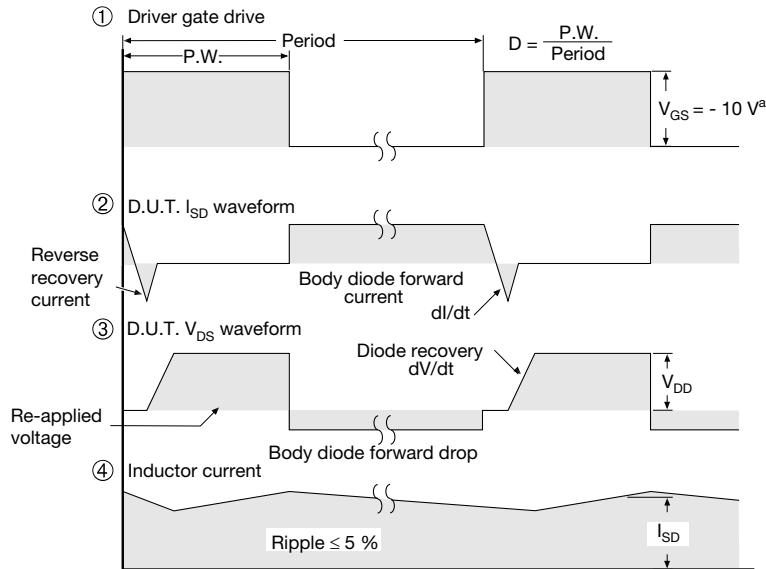


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

Peak Diode Recovery dV/dt Test Circuit



Note
 • Compliment N-Channel of D.U.T. for driver



Note
 a. $V_{GS} = -5\text{ V}$ for logic level and -3 V drive devices

Fig. 14 - For P-Channel

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TO-220-1



| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|-------|--------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.24 | 4.65 | 0.167 | 0.183 |
| b | 0.69 | 1.02 | 0.027 | 0.040 |
| b(1) | 1.14 | 1.78 | 0.045 | 0.070 |
| c | 0.36 | 0.61 | 0.014 | 0.024 |
| D | 14.33 | 15.85 | 0.564 | 0.624 |
| E | 9.96 | 10.52 | 0.392 | 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) | 6.10 | 6.71 | 0.240 | 0.264 |
| J(1) | 2.41 | 2.92 | 0.095 | 0.115 |
| L | 13.36 | 14.40 | 0.526 | 0.567 |
| L(1) | 3.33 | 4.04 | 0.131 | 0.159 |
| Ø P | 3.53 | 3.94 | 0.139 | 0.155 |
| Q | 2.54 | 3.00 | 0.100 | 0.118 |

ECN: X15-0364-Rev. C, 14-Dec-15
DWG: 6031

Note

- M* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM





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