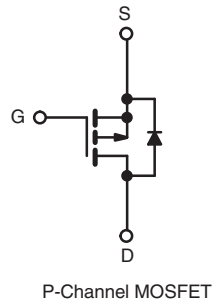


## Power MOSFET

| PRODUCT SUMMARY           |                  |      |
|---------------------------|------------------|------|
| $V_{DS}$ (V)              | - 100            |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = -10$ V | 0.20 |
| $Q_g$ (Max.) (nC)         | 61               |      |
| $Q_{gs}$ (nC)             | 14               |      |
| $Q_{gd}$ (nC)             | 29               |      |
| Configuration             | Single           |      |



### FEATURES

- Dynamic  $dV/dt$  Rating
- Repetitive Avalanche Rated
- P-Channel
- 175 °C Operating Temperature
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Compliant to RoHS Directive 2002/95/EC



Available  
**RoHS\***  
COMPLIANT

### 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.

| ORDERING INFORMATION |             |
|----------------------|-------------|
| Package              | TO-220AB    |
| Lead (Pb)-free       | IRF9540PbF  |
|                      | SiHF9540-E3 |
| SnPb                 | IRF9540     |
|                      | SiHF9540    |

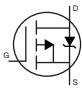
| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                    |                |                  |          |
|---|--------------------|----------------|------------------|----------|
| PARAMETER   | SYMBOL             | LIMIT          | UNIT             |          |
| Drain-Source Voltage  | $V_{DS}$           | - 100          | V                |          |
| Gate-Source Voltage   | $V_{GS}$           | $\pm 20$       |                  |          |
| Continuous Drain Current  | $V_{GS}$ at - 10 V | $T_C = 25$ °C  | - 19             | A        |
|   |                    | $T_C = 100$ °C | - 13             |          |
| Pulsed Drain Current <sup>a</sup>                                 | $I_{DM}$           | - 72           |                  |          |
| Linear Derating Factor  |                    | 1.0            | W/°C             |          |
| Single Pulse Avalanche Energy <sup>b</sup>                        | $E_{AS}$           | 640            | mJ               |          |
| Repetitive Avalanche Current <sup>a</sup>                         | $I_{AR}$           | - 19           | A                |          |
| Repetitive Avalanche Energy <sup>a</sup>                          | $E_{AR}$           | 15             | mJ               |          |
| Maximum Power Dissipation   | $T_C = 25$ °C      | $P_D$          | 150              | W        |
| Peak Diode Recovery $dV/dt^c$                                     |                    | $dV/dt$        | - 5.5            | V/ns     |
| Operating Junction and Storage Temperature Range                  |                    | $T_J, T_{stg}$ | - 55 to + 175    | °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

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = -25$  V, starting  $T_J = 25$  °C,  $L = 2.7$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = -19$  A (see fig. 12).
- $I_{SD} \leq -19$  A,  $dI/dt \leq 200$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175$  °C.
- 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         | $R_{thJA}$ | -    | 62   | °C/W |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.50 | -    |      |
| Maximum Junction-to-Case (Drain)    | $R_{thJC}$ | -    | 1.0  |      |

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |  |      |        |           |               |
|---|---------------------|--|------|--------|-----------|---------------|
| PARAMETER   | SYMBOL              | TEST CONDITIONS  | MIN. | TYP.   | MAX.      | UNIT          |
| <b>Static</b>   |                     |  |      |        |           |               |
| Drain-Source Breakdown Voltage  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$   | -100 | -      | -         | V             |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = -1\text{ mA}$   | -    | -0.087 | -         | 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   | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$   | -    | -      | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current   | $I_{DSS}$           | $V_{DS} = -100\text{ V}, V_{GS} = 0\text{ V}$  | -    | -      | -100      | $\mu\text{A}$ |
|   |                     | $V_{DS} = -80\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$  | -    | -      | -500      |               |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = -10\text{ V}, I_D = -11\text{ A}^b$  | -    | -      | 0.20      | $\Omega$      |
| Forward Transconductance  | $g_{fs}$            | $V_{DS} = -50\text{ V}, I_D = -11\text{ A}^b$  | 6.2  | -      | -         | S             |
| <b>Dynamic</b>  |                     |  |      |        |           |               |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = -25\text{ V}, f = 1.0\text{ MHz}$ , see fig. 5  | -    | 1400   | -         | pF            |
| Output Capacitance  | $C_{oss}$           |  | -    | 590    | -         |               |
| Reverse Transfer Capacitance  | $C_{rss}$           |  | -    | 140    | -         |               |
| Total Gate Charge   | $Q_g$               | $V_{GS} = -10\text{ V}, I_D = -19\text{ A}, V_{DS} = -80\text{ V}$ , see fig. 6 and 13 <sup>b</sup>  | -    | -      | 61        | nC            |
| Gate-Source Charge  | $Q_{gs}$            |  | -    | -      | 14        |               |
| Gate-Drain Charge   | $Q_{gd}$            |  | -    | -      | 29        |               |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = -50\text{ V}, I_D = -19\text{ A}, R_g = 9.1\text{ }\Omega, R_D = 2.4\text{ }\Omega$ , see fig. 10 <sup>b</sup>                               | -    | 16     | -         | ns            |
| Rise Time   | $t_r$               |  | -    | 73     | -         |               |
| Turn-Off Delay Time   | $t_{d(off)}$        |  | -    | 34     | -         |               |
| Fall Time   | $t_f$               |  | -    | 57     | -         |               |
| 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    | -         |               |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |  |      |        |           |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse p-n junction diode      | -    | -      | -19       | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                   | $I_{SM}$            |  | -    | -      | -72       |               |
| Body Diode Voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = -19\text{ A}, V_{GS} = 0\text{ V}^b$  | -    | -      | -5.0      | V             |
| Body Diode Reverse Recovery Time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = -19\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$   | -    | 130    | 260       | ns            |
| Body Diode Reverse Recovery Charge  | $Q_{rr}$            |  | -    | 0.35   | 0.70      | $\mu\text{C}$ |
| Forward Turn-On Time  | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )  |      |        |           |               |

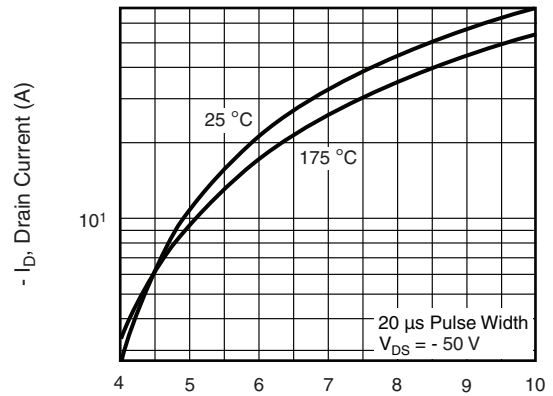
**Notes**

- 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)

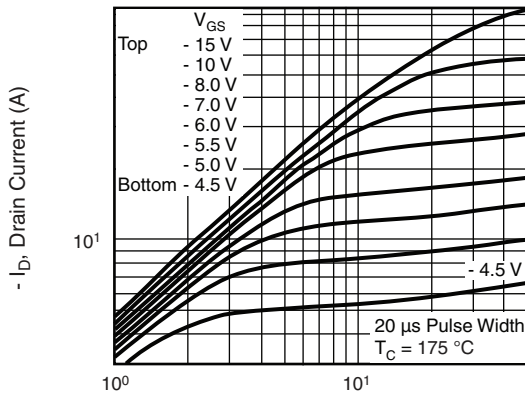

91078\_01

 $-V_{DS}$ , Drain-to-Source Voltage (V)

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


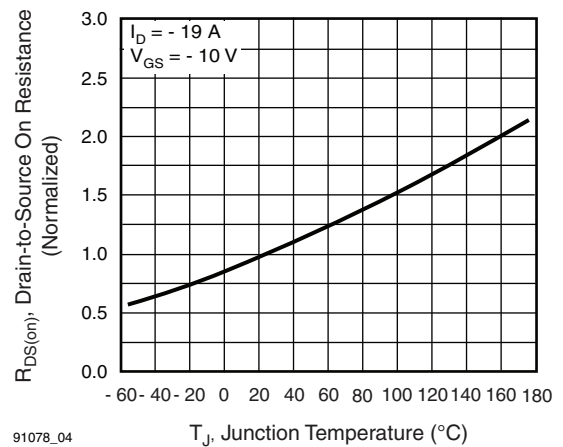
91078\_03

 $-V_{GS}$ , Gate-to-Source Voltage (V)

**Fig. 3 - Typical Transfer Characteristics**


91078\_02

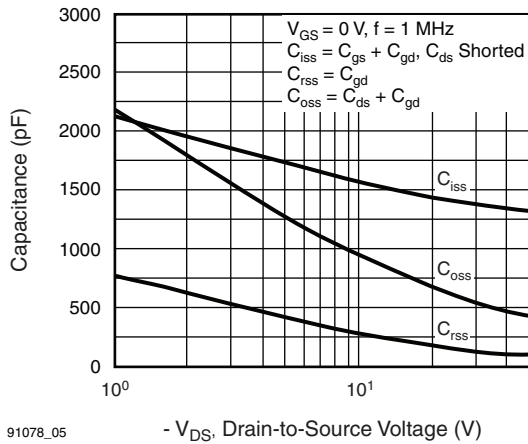
 $-V_{DS}$ , Drain-to-Source Voltage (V)

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


91078\_04

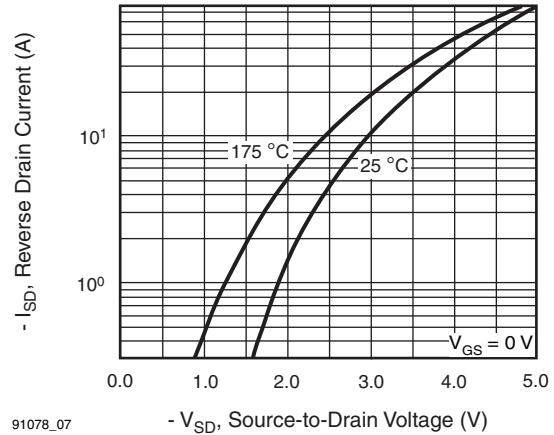
 $T_J$ , Junction Temperature (°C)

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



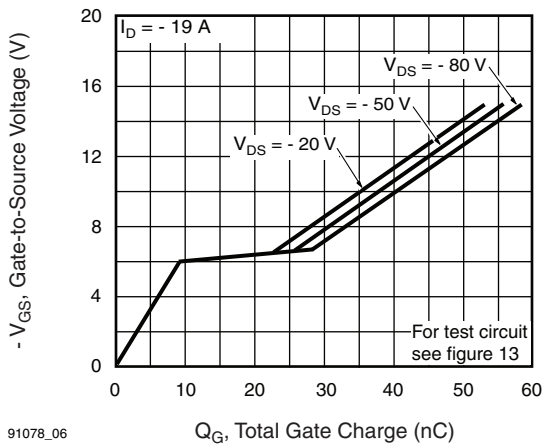
91078\_05

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



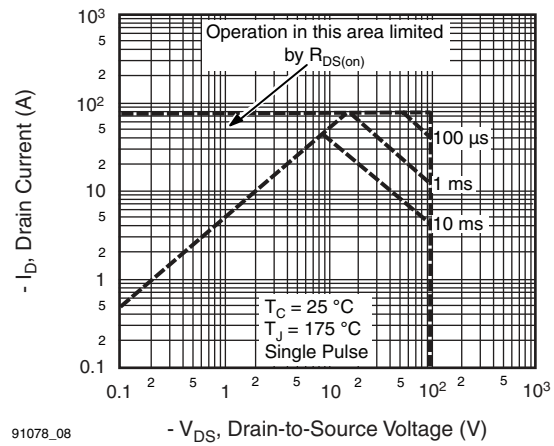
91078\_07

**Fig. 7 - Typical Source-Drain Diode Forward Voltage**



91078\_06

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



91078\_08

**Fig. 8 - Maximum Safe Operating Area**



91078\_09

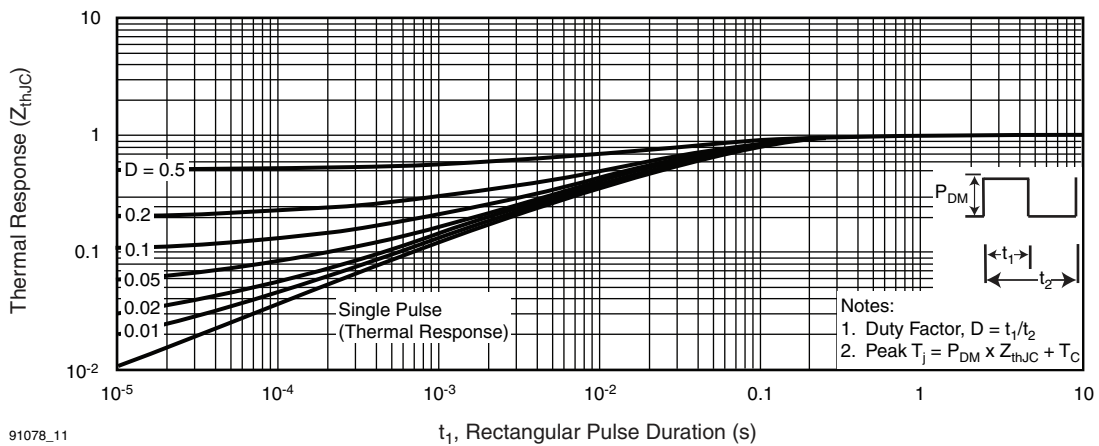
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



**Fig. 10a - Switching Time Test Circuit**



**Fig. 10b - Switching Time Waveforms**



91078\_11

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

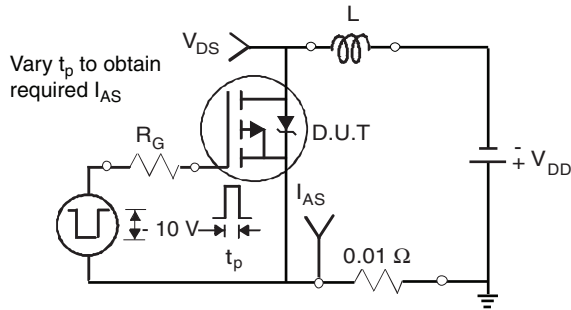


Fig. 12a - Unclamped Inductive Test Circuit

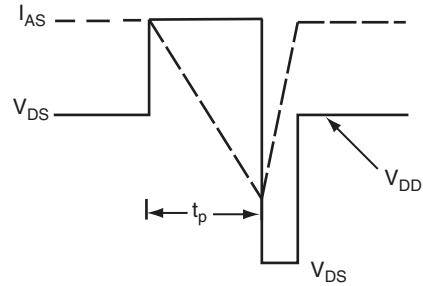
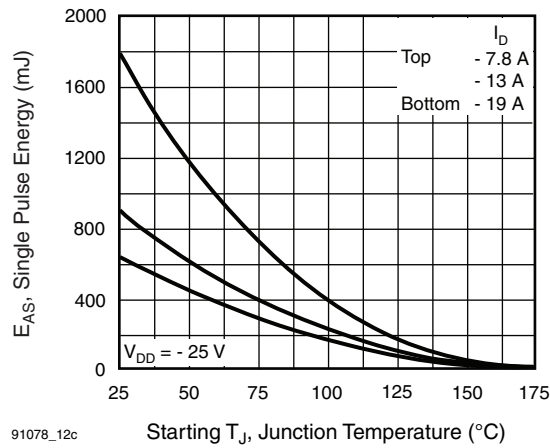


Fig. 12b - Unclamped Inductive Waveforms



91078\_12c

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

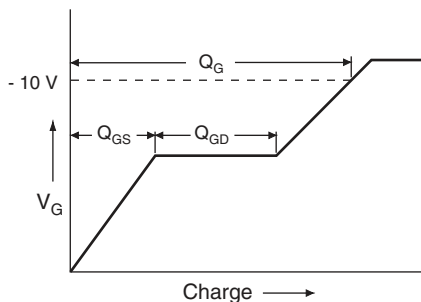


Fig. 13a - Basic Gate Charge Waveform

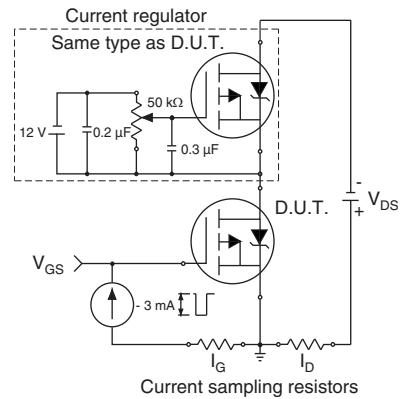
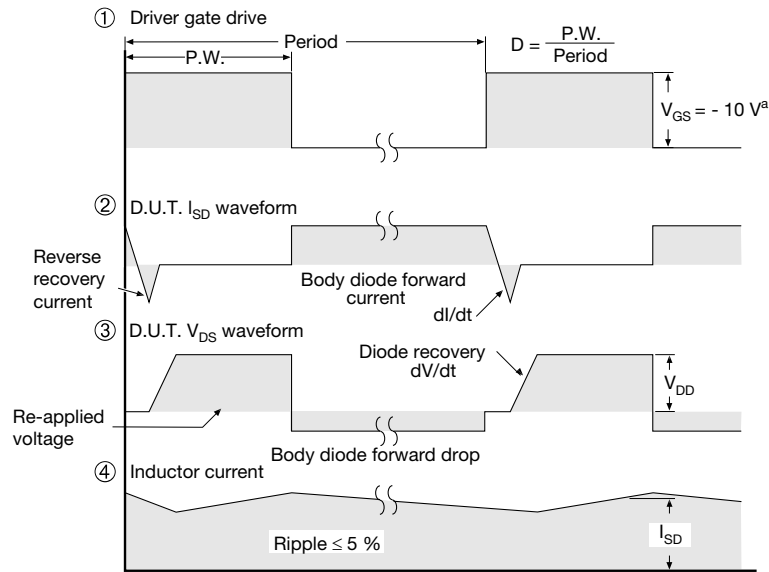


Fig. 13b - Gate Charge Test Circuit

### Peak Diode Recovery dV/dt Test Circuit



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



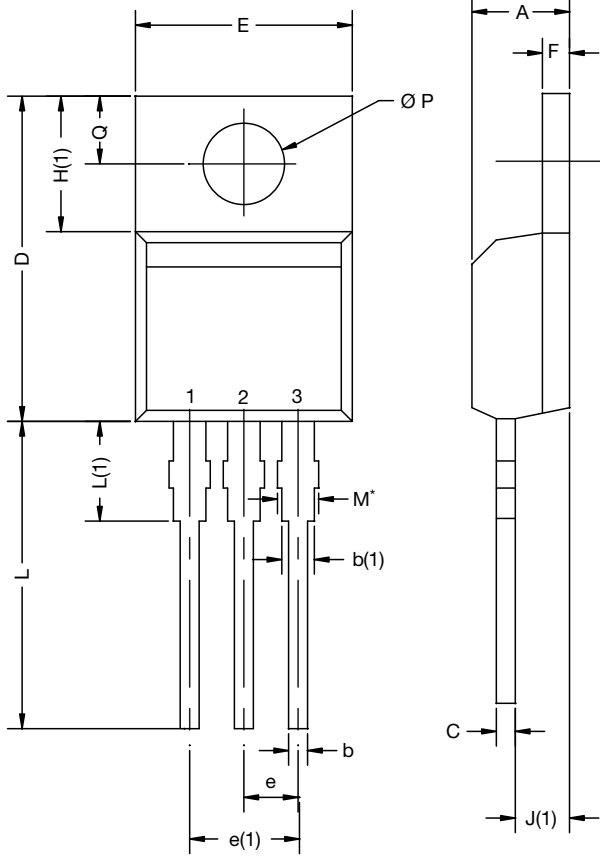
**Note**  
a.  $V_{GS} = -5V$  for logic level and  $-3V$  drive devices

**Fig. 14 - For P-Channel**

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see [www.vishay.com/ppg?91078](http://www.vishay.com/ppg?91078).



### TO-220-1



| DIM. | MILLIMETERS |       | INCHES |       |
|------|-------------|-------|--------|-------|
|      | MIN.        | MAX.  | MIN.   | MAX.  |
| A    | 4.14        | 4.70  | 0.163  | 0.185 |
| b    | 0.69        | 1.02  | 0.027  | 0.040 |
| b(1) | 1.14        | 1.73  | 0.045  | 0.068 |
| 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    | 0.43        | 1.40  | 0.017  | 0.055 |
| H(1) | 6.10        | 6.48  | 0.240  | 0.255 |
| 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    | 2.59        | 3.00  | 0.102  | 0.118 |

ECN: X15-0003-Rev. A, 19-Jan-15  
DWG: 6031

#### Notes

- M\* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM
- Outline conforms to JEDEC® outline TO-220AB with exception of dimension F







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