

## D Series Power MOSFET



RoHS  
COMPLIANT  
HALOGEN  
**FREE**  
Available

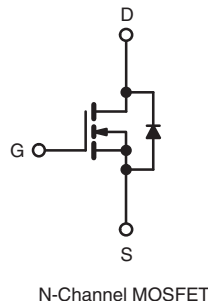
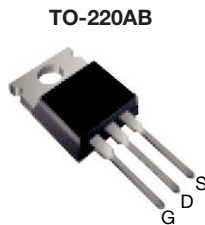
| PRODUCT SUMMARY                         |                 |     |
|-----------------------------------------|-----------------|-----|
| $V_{DS}$ (V) at $T_J$ max.              | 550             |     |
| $R_{DS(on)}$ max. at 25 °C ( $\Omega$ ) | $V_{GS} = 10$ V | 1.5 |
| $Q_g$ (max.) (nC)                       | 20              |     |
| $Q_{gs}$ (nC)                           | 3               |     |
| $Q_{gd}$ (nC)                           | 5               |     |
| Configuration                           | Single          |     |

### FEATURES

- Optimal Design
  - Low Area Specific On-Resistance
  - Low Input Capacitance ( $C_{iss}$ )
  - Reduced Capacitive Switching Losses
  - High Body Diode Ruggedness
  - Avalanche Energy Rated (UIS)
- Optimal Efficiency and Operation
  - Low Cost
  - Simple Gate Drive Circuitry
  - Low Figure-of-Merit (FOM):  $R_{on} \times Q_g$
  - Fast Switching
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### APPLICATIONS

- Consumer Electronics
  - Displays (LCD or Plasma TV)
- Server and Telecom Power Supplies
  - SMPS
- Industrial
  - Welding
  - Induction Heating
  - Motor Drives
- Battery Chargers




| ORDERING INFORMATION            |               |
|---------------------------------|---------------|
| Package                         | TO-220AB      |
| Lead (Pb)-free                  | SiHP5N50D-E3  |
| Lead (Pb)-free and Halogen-free | SiHP5N50D-GE3 |

| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                  |                |      |
|-------------------------------------------------------------------|------------------|----------------|------|
| PARAMETER                                                         | SYMBOL           | LIMIT          | UNIT |
| Drain-Source Voltage                                              | $V_{DS}$         | 500            | V    |
| Gate-Source Voltage                                               | $V_{GS}$         | $\pm 30$       |      |
| Gate-Source Voltage AC ( $f > 1$ Hz)                              |                  | 30             |      |
| Continuous Drain Current ( $T_J = 150$ °C)                        | $V_{GS}$ at 10 V | $T_C = 25$ °C  | A    |
|                                                                   |                  | $T_C = 100$ °C |      |
| Pulsed Drain Current <sup>a</sup>                                 | $I_{DM}$         | 10             |      |
| Linear Derating Factor                                            |                  | 0.83           | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                        | $E_{AS}$         | 23             | mJ   |
| Maximum Power Dissipation                                         | $P_D$            | 104            | W    |
| Operating Junction and Storage Temperature Range                  | $T_J, T_{stg}$   | - 55 to + 150  | °C   |
| Drain-Source Voltage Slope                                        | $dV/dt$          | $T_J = 125$ °C | V/ns |
| Reverse Diode $dV/dt$ <sup>(d)</sup>                              |                  | 0.28           |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>         | for 10 s         | 300            | °C   |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 2.3$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 4.5$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ , starting  $T_J = 25$  °C.

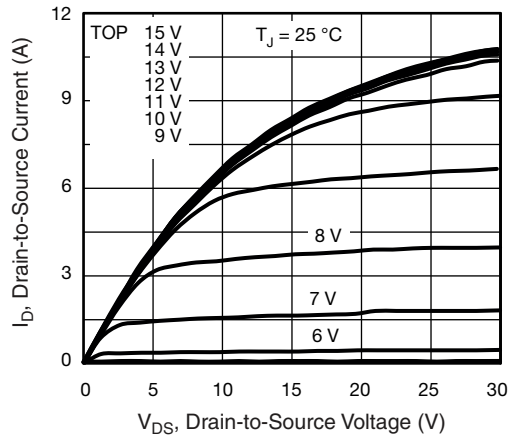
| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 1.2  |      |

| 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                                              | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$                                                                                                   | 500                                                         | -    | -         | V             |
| $V_{DS}$ Temperature Coefficient                                            | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 250\text{ }\mu\text{A}$                                                                              | -                                                           | 0.58 | -         | V/°C          |
| Gate-Source Threshold Voltage (N)                                           | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                                                                                                       | 3                                                           | -    | 5         | V             |
| Gate-Source Leakage                                                         | $I_{GSS}$           | $V_{GS} = \pm 30\text{ V}$                                                                                                                            | -                                                           | -    | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current                                             | $I_{DSS}$           | $V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$                                                                                                          | -                                                           | -    | 1         | $\mu\text{A}$ |
|                                                                             |                     | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$                                                                         | -                                                           | -    | 10        |               |
| Drain-Source On-State Resistance                                            | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}, I_D = 2.5\text{ A}$                                                                                                            | -                                                           | 1.2  | 1.5       | $\Omega$      |
| Forward Transconductance <sup>a</sup>                                       | $g_{fs}$            | $V_{DS} = 20\text{ V}, I_D = 2.5\text{ A}$                                                                                                            | -                                                           | 1.8  | -         | S             |
| <b>Dynamic</b>                                                              |                     |                                                                                                                                                       |                                                             |      |           |               |
| Input Capacitance                                                           | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$                                                                                        | -                                                           | 325  | -         | pF            |
| Output Capacitance                                                          | $C_{oss}$           |                                                                                                                                                       | -                                                           | 34   | -         |               |
| Reverse Transfer Capacitance                                                | $C_{rss}$           |                                                                                                                                                       | -                                                           | 6    | -         |               |
| Effective Output Capacitance, Energy Related <sup>b</sup>                   | $C_{o(er)}$         |                                                                                                                                                       | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$ | -    | 31        |               |
| Effective Output Capacitance, Time Related <sup>c</sup>                     | $C_{o(tr)}$         | -                                                                                                                                                     |                                                             | 41   | -         |               |
| Total Gate Charge                                                           | $Q_g$               | $V_{GS} = 10\text{ V}, I_D = 2.5\text{ A}, V_{DS} = 400\text{ V}$                                                                                     | -                                                           | 10   | 20        | nC            |
| Gate-Source Charge                                                          | $Q_{gs}$            |                                                                                                                                                       | -                                                           | 3    | -         |               |
| Gate-Drain Charge                                                           | $Q_{gd}$            |                                                                                                                                                       | -                                                           | 5    | -         |               |
| Turn-On Delay Time                                                          | $t_{d(on)}$         | $V_{DD} = 400\text{ V}, I_D = 2.5\text{ A}, R_g = 9.1\text{ }\Omega, V_{GS} = 10\text{ V}$                                                            | -                                                           | 12   | 24        | ns            |
| Rise Time                                                                   | $t_r$               |                                                                                                                                                       | -                                                           | 11   | 22        |               |
| Turn-Off Delay Time                                                         | $t_{d(off)}$        |                                                                                                                                                       | -                                                           | 14   | 28        |               |
| Fall Time                                                                   | $t_f$               |                                                                                                                                                       | -                                                           | 11   | 22        |               |
| Gate Input Resistance                                                       | $R_g$               |                                                                                                                                                       | $f = 1\text{ MHz}, \text{open drain}$                       | -    | 1.7       |               |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |                                                                                                                                                       |                                                             |      |           |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol showing the integral reverse P - N junction diode  | -                                                           | -    | 5         | A             |
| Pulsed Diode Forward Current                                                | $I_{SM}$            |                                                                                                                                                       | -                                                           | -    | 20        |               |
| Diode Forward Voltage                                                       | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 4\text{ A}, V_{GS} = 0\text{ V}$                                                                               | -                                                           | -    | 1.2       | V             |
| Reverse Recovery Time                                                       | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 2.5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, V_R = 20\text{ V}$                                       | -                                                           | 320  | -         | ns            |
| Reverse Recovery Charge                                                     | $Q_{rr}$            |                                                                                                                                                       | -                                                           | 1.2  | -         | $\mu\text{C}$ |
| Reverse Recovery Current                                                    | $I_{RRM}$           |                                                                                                                                                       | -                                                           | 8    | -         | A             |

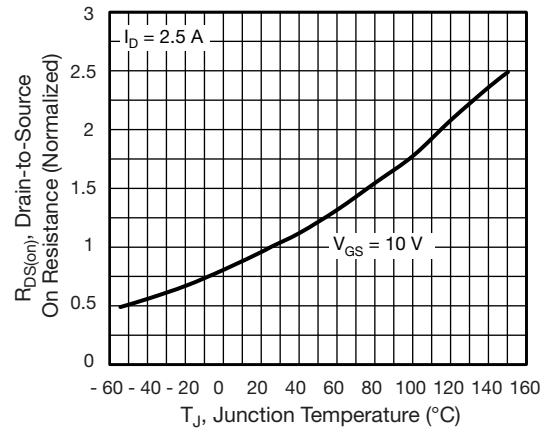
**Notes**

- Repetitive rating; pulse width limited by maximum junction temperature.
- $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .
- $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

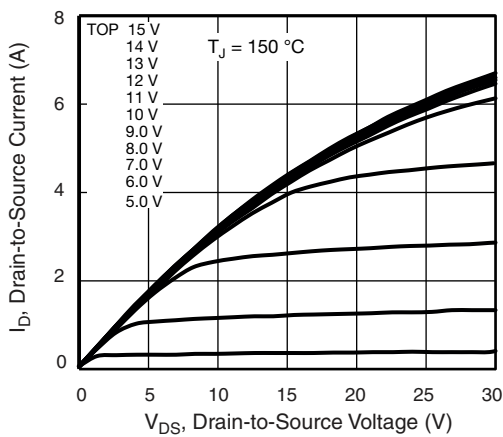
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



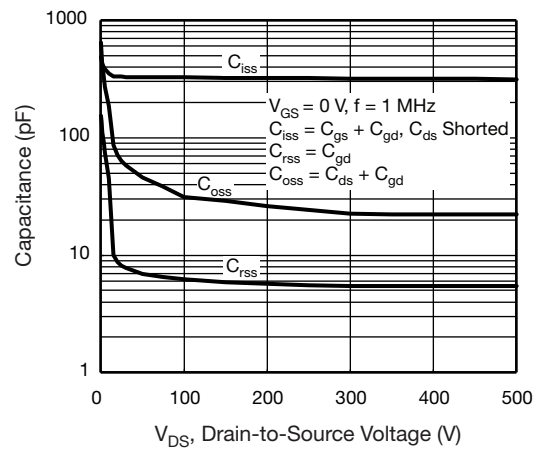
**Fig. 1 - Typical Output Characteristics**



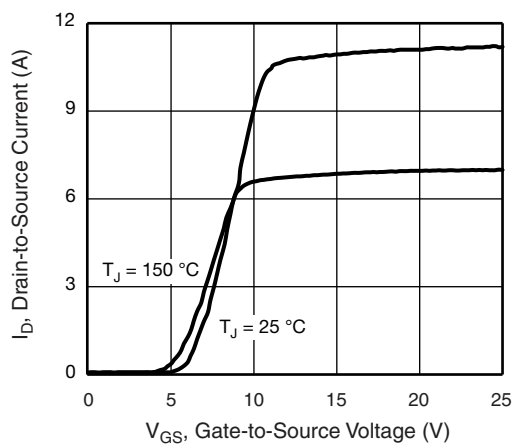
**Fig. 4 - Normalized On-Resistance vs. Temperature**



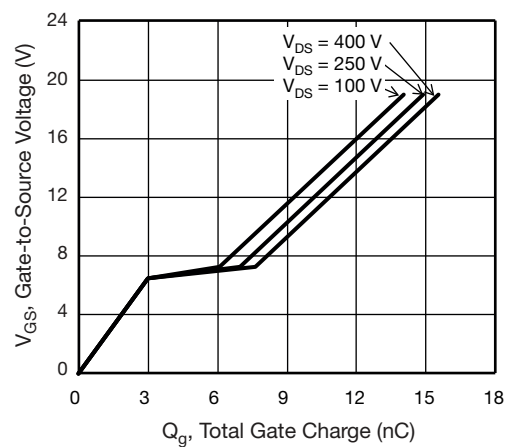
**Fig. 2 - Typical Output Characteristics**



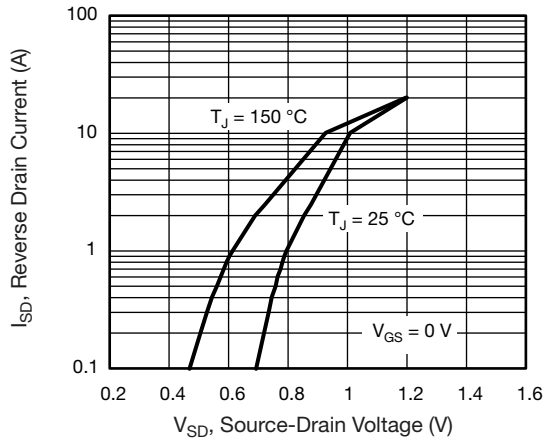
**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



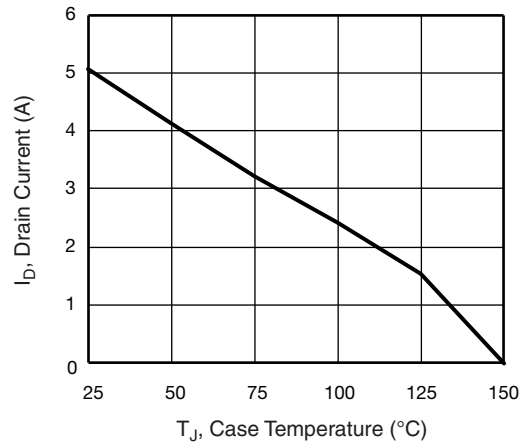
**Fig. 3 - Typical Transfer Characteristics**



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



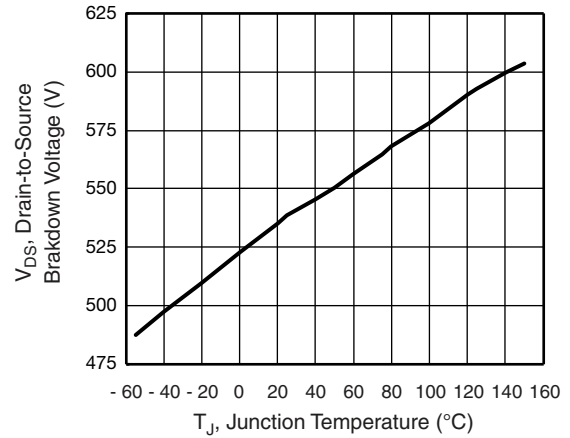
**Fig. 7 - Typical Source-Drain Diode Forward Voltage**



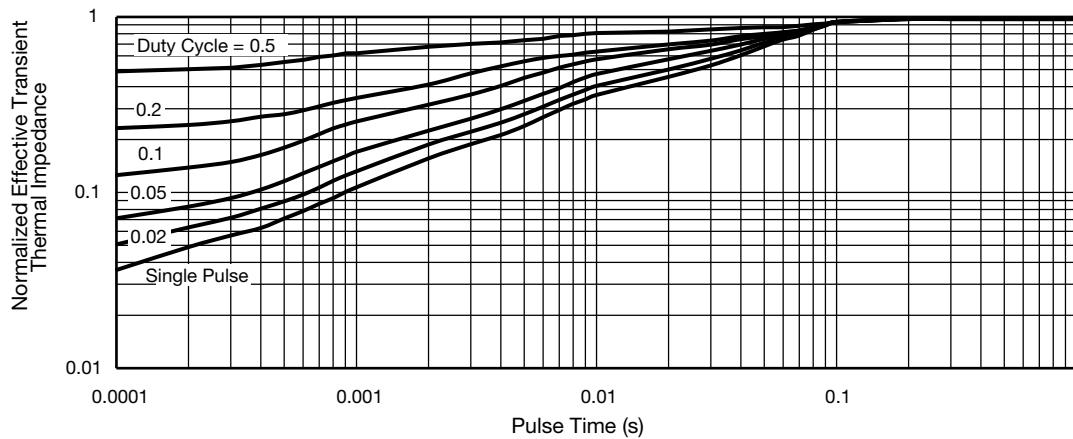
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



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



**Fig. 10 - Typical Drain-to-Source Voltage vs. Temperature**



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



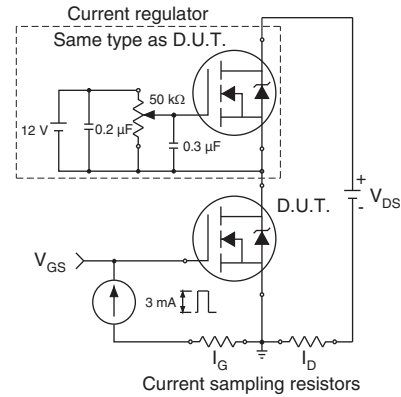
**Fig. 12 - Switching Time Test Circuit**



**Fig. 16 - Basic Gate Charge Waveform**



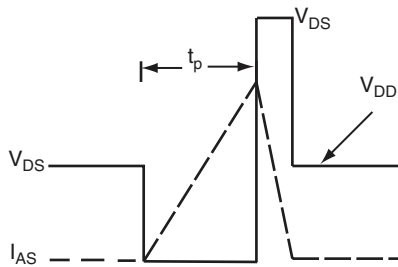
**Fig. 13 - Switching Time Waveforms**



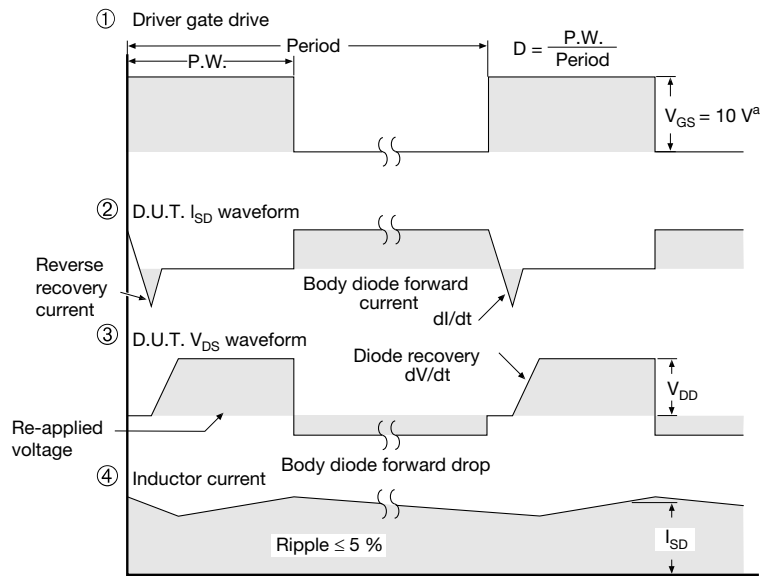
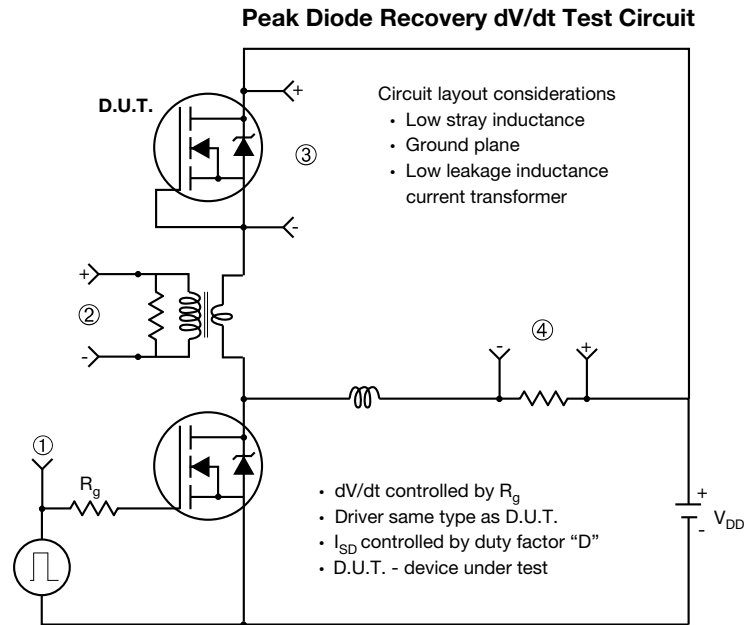
**Fig. 17 - Gate Charge Test Circuit**



**Fig. 14 - Unclamped Inductive Test Circuit**



**Fig. 15 - Unclamped Inductive Waveforms**



**Note**

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

**Fig. 18 - For N-Channel**

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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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