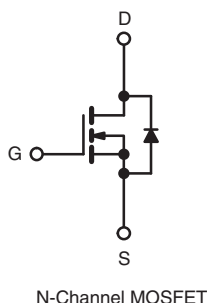
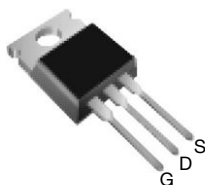


## Power MOSFET

### PRODUCT SUMMARY

|                           |                        |     |
|---------------------------|------------------------|-----|
| $V_{DS}$ (V)              | 400                    |     |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 3.6 |
| $Q_g$ (Max.) (nC)         | 17                     |     |
| $Q_{gs}$ (nC)             | 3.4                    |     |
| $Q_{gd}$ (nC)             | 8.5                    |     |
| Configuration             | Single                 |     |

**TO-220AB**


### FEATURES

- Dynamic  $dV/dt$  Rating
- Repetitive Avalanche Rated
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Compliant to RoHS Directive 2002/95/EC


**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 | IRF710PbF<br>SiHF710-E3 |
| SnPb           | IRF710<br>SiHF710       |

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| PARAMETER                                        |                         |                         | SYMBOL                            | LIMIT            | UNIT     |
|--------------------------------------------------|-------------------------|-------------------------|-----------------------------------|------------------|----------|
| Drain-Source Voltage                             |                         |                         | V <sub>DS</sub>                   | 400              | V        |
| Gate-Source Voltage                              |                         |                         | V <sub>GS</sub>                   | ± 20             |          |
| Continuous Drain Current                         | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 2.0              | A        |
|                                                  |                         | T <sub>C</sub> = 100 °C |                                   | 1.2              |          |
| Pulsed Drain Current <sup>a</sup>                |                         |                         | I <sub>DM</sub>                   | 6.0              |          |
| Linear Derating Factor                           |                         |                         |                                   | 0.29             | W/°C     |
| Single Pulse Avalanche Energy <sup>b</sup>       |                         |                         | E <sub>AS</sub>                   | 120              | mJ       |
| Repetitive Avalanche Current <sup>a</sup>        |                         |                         | I <sub>AR</sub>                   | 2.0              | A        |
| Repetitive Avalanche Energy <sup>a</sup>         |                         |                         | E <sub>AR</sub>                   | 3.6              | mJ       |
| Maximum Power Dissipation                        | T <sub>C</sub> = 25 °C  |                         | P <sub>D</sub>                    | 36               | W        |
| Peak Diode Recovery dV/dt <sup>c</sup>           |                         |                         | dV/dt                             | 4.0              | V/ns     |
| Operating Junction and Storage Temperature Range |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | - 55 to + 150    | °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

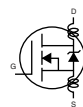
- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $L = 52\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 2.0\text{ A}$  (see fig. 12).
- $I_{SD} \leq 2.0\text{ A}$ ,  $dI/dt \leq 40\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^{\circ}\text{C}$ .
- 1.6 mm from case.

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

**THERMAL RESISTANCE**

| 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  |      |

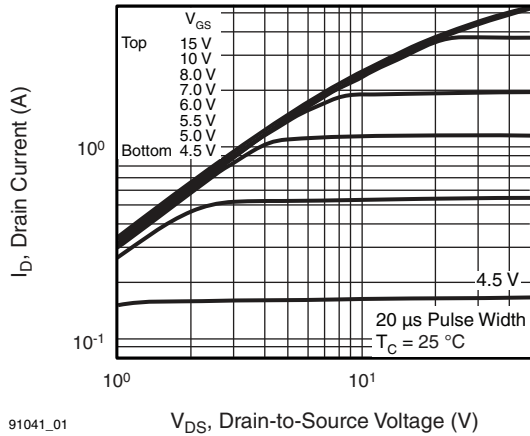
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| PARAMETER                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                                    |                                                                                  | MIN. | TYP. | MAX.      | UNIT                  |
|-------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------|------|-----------|-----------------------|
| Static                                    |                     |                                                                                                                                                                    |                                                                                  |      |      |           |                       |
| Drain-Source Breakdown Voltage            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                             |                                                                                  | 400  | -    | -         | V                     |
| $V_{DS}$ Temperature Coefficient          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^{\circ}\text{C}$ , $I_D = 1\text{ mA}$                                                                                                    |                                                                                  | -    | 0.47 | -         | V/ $^{\circ}\text{C}$ |
| 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           | $I_{DSS}$           | $V_{DS} = 400\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                                    |                                                                                  | -    | -    | 25        | $\mu\text{A}$         |
|                                           |                     | $V_{DS} = 320\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}$                                                                              |                                                                                  | -    | -    | 250       |                       |
| Drain-Source On-State Resistance          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                             | $I_D = 1.2\text{ A}^b$                                                           | -    | -    | 3.6       | $\Omega$              |
| Forward Transconductance                  | $g_{fs}$            | $V_{DS} = 50\text{ V}$ , $I_D = 1.2\text{ A}^b$                                                                                                                    |                                                                                  | 1.0  | -    | -         | S                     |
| Dynamic                                   |                     |                                                                                                                                                                    |                                                                                  |      |      |           |                       |
| Input Capacitance                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 25\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ , see fig. 5                                                                           |                                                                                  | -    | 170  | -         | pF                    |
| Output Capacitance                        | $C_{oss}$           |                                                                                                                                                                    |                                                                                  | -    | 34   | -         |                       |
| Reverse Transfer Capacitance              | $C_{rss}$           |                                                                                                                                                                    |                                                                                  | -    | 6.3  | -         |                       |
| Total Gate Charge                         | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                             | $I_D = 2.0\text{ A}$ , $V_{DS} = 320\text{ V}$<br>see fig. 6 and 13 <sup>b</sup> | -    | -    | 17        | nC                    |
| Gate-Source Charge                        | $Q_{gs}$            |                                                                                                                                                                    |                                                                                  | -    | -    | 3.4       |                       |
| Gate-Drain Charge                         | $Q_{gd}$            |                                                                                                                                                                    |                                                                                  | -    | -    | 8.5       |                       |
| Turn-On Delay Time                        | $t_{d(on)}$         | $V_{DD} = 200\text{ V}$ , $I_D = 2.0\text{ A}$ ,<br>$R_g = 24\text{ }\Omega$ , $R_D = 95\text{ }\Omega$<br>see fig. 10 <sup>b</sup>                                |                                                                                  | -    | 8.0  | -         | ns                    |
| Rise Time                                 | $t_r$               |                                                                                                                                                                    |                                                                                  | -    | 9.9  | -         |                       |
| Turn-Off Delay Time                       | $t_{d(off)}$        |                                                                                                                                                                    |                                                                                  | -    | 21   | -         |                       |
| Fall Time                                 | $t_f$               |                                                                                                                                                                    |                                                                                  | -    | 11   | -         |                       |
| Internal Drain Inductance                 | $L_D$               | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact<br> |                                                                                  | -    | 4.5  | -         | nH                    |
| Internal Source Inductance                | $L_S$               |                                                                                                                                                                    |                                                                                  | -    | 7.5  | -         |                       |
| Drain-Source Body Diode Characteristics   |                     |                                                                                                                                                                    |                                                                                  |      |      |           |                       |
| Continuous Source-Drain Diode Current     | $I_S$               | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode<br>   |                                                                                  | -    | -    | 2.0       | A                     |
| Pulsed Diode Forward Current <sup>a</sup> | $I_{SM}$            |                                                                                                                                                                    |                                                                                  | -    | -    | 6.0       |                       |
| Body Diode Voltage                        | $V_{SD}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_S = 2.0\text{ A}$ , $V_{GS} = 0\text{ V}^b$                                                                                |                                                                                  | -    | -    | 1.6       | V                     |
| Body Diode Reverse Recovery Time          | $t_{rr}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_F = 2.0\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}^b$                                                                |                                                                                  | -    | 240  | 540       | ns                    |
| Body Diode Reverse Recovery Charge        | $Q_{rr}$            |                                                                                                                                                                    |                                                                                  | -    | 0.85 | 1.6       | $\mu\text{C}$         |
| Forward Turn-On Time                      | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )                                                                                    |                                                                                  |      |      |           |                       |

**Notes**

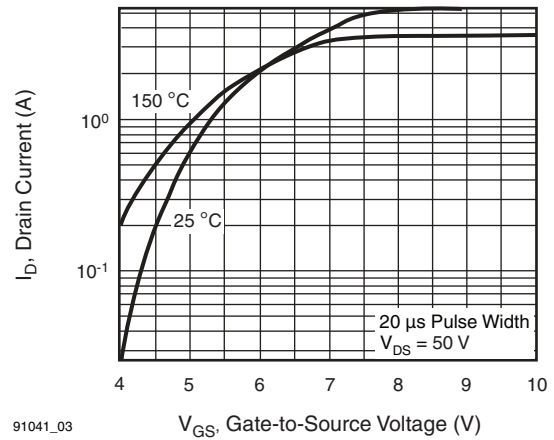
- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).  
b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

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



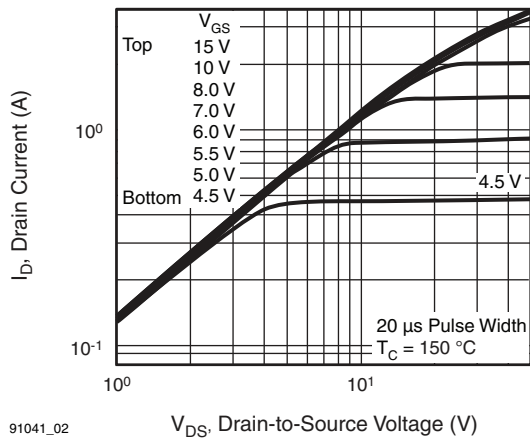
91041\_01

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



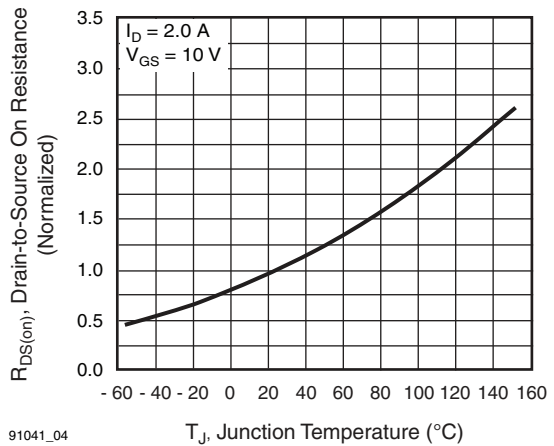
91041\_03

Fig. 3 - Typical Transfer Characteristics



91041\_02

Fig. 2 - Typical Output Characteristics,  $T_C = 150^\circ\text{C}$



91041\_04

Fig. 4 - Normalized On-Resistance vs. Temperature

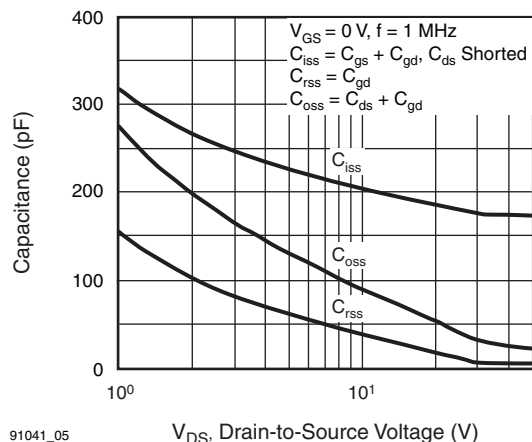


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

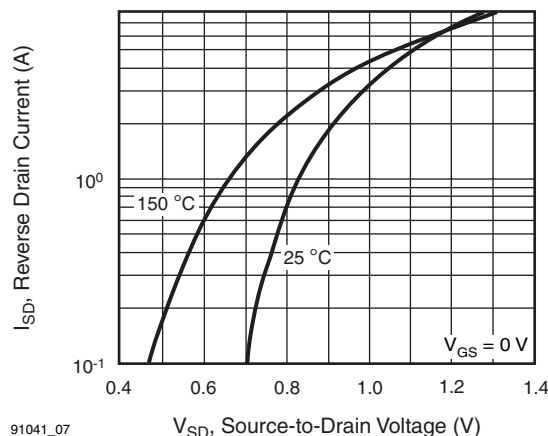


Fig. 7 - Typical Source-Drain Diode Forward Voltage

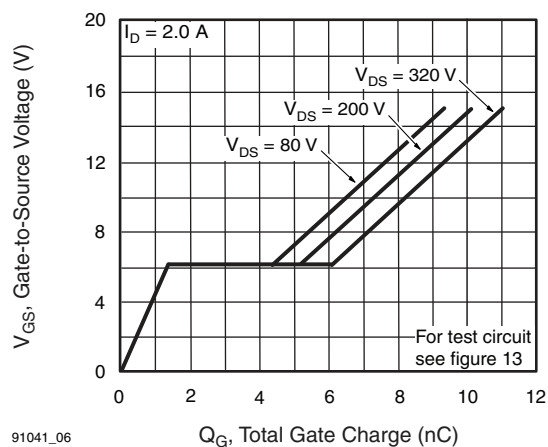


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

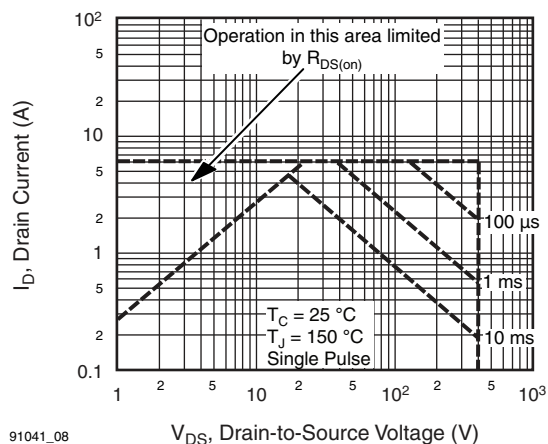
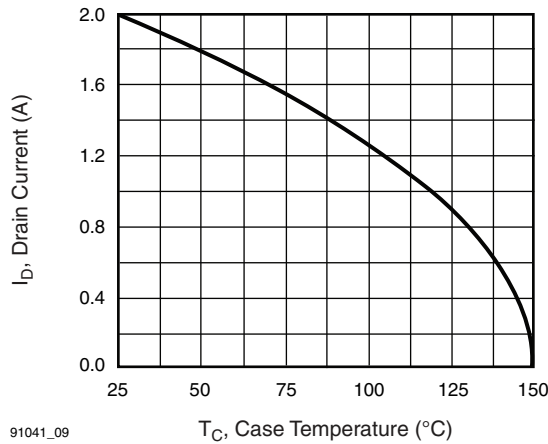


Fig. 8 - Maximum Safe Operating Area



91041\_09

Fig. 9 - Maximum Drain Current vs. Case Temperature

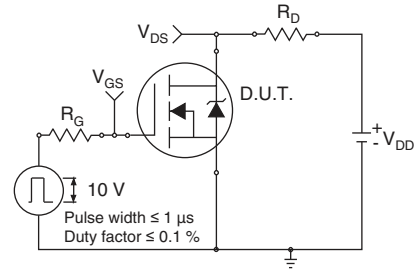


Fig. 10a - Switching Time Test Circuit

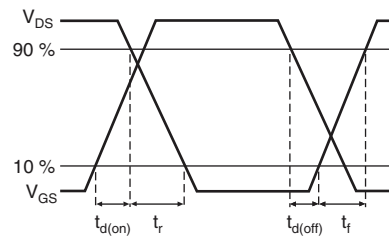
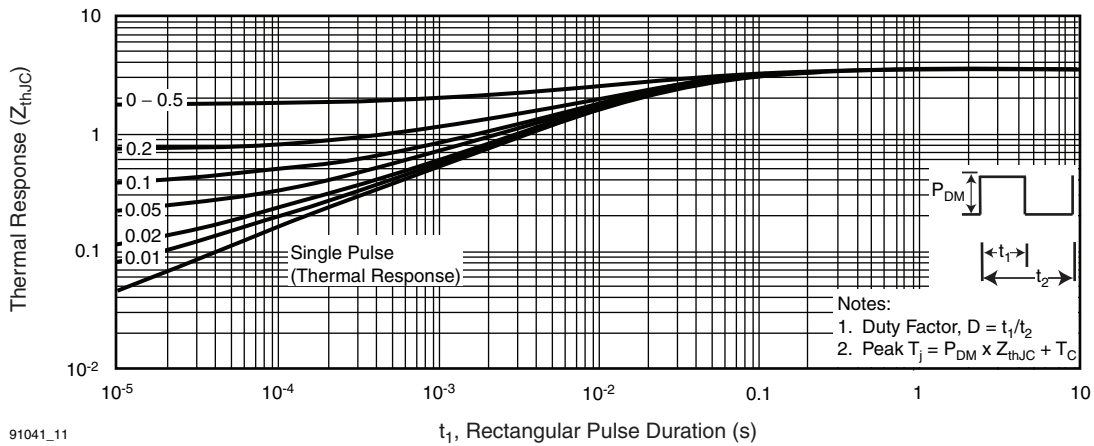


Fig. 10b - Switching Time Waveforms



91041\_11

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

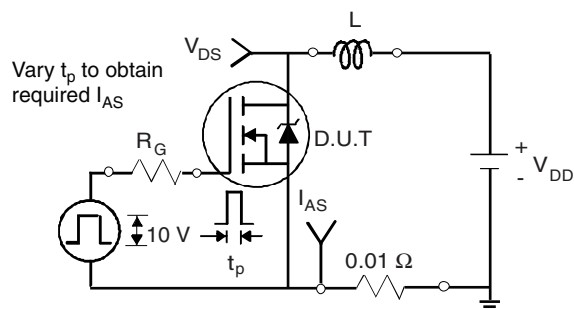


Fig. 12a - Unclamped Inductive Test Circuit

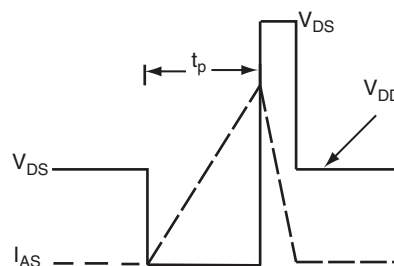
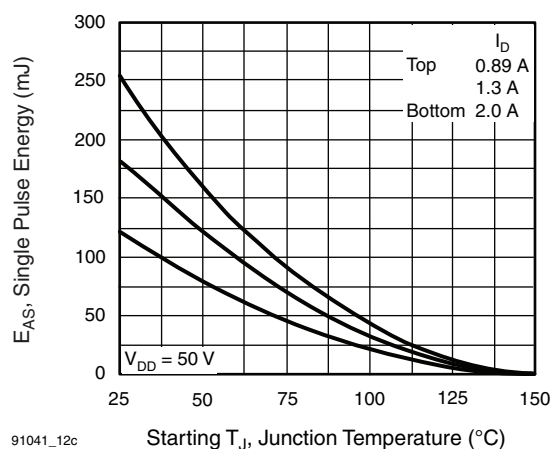


Fig. 12b - Unclamped Inductive Waveforms



91041\_12c

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

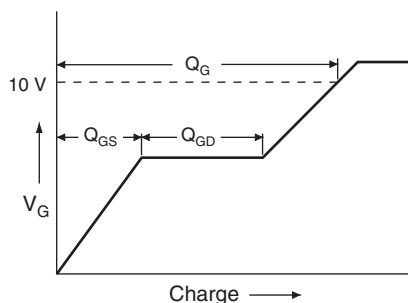


Fig. 13a - Basic Gate Charge Waveform

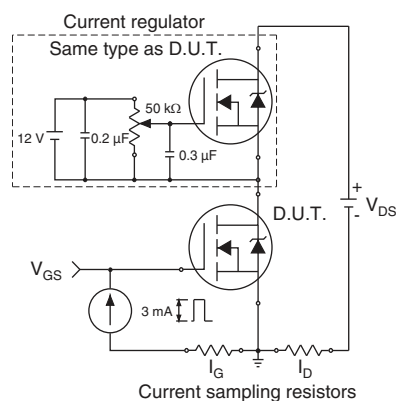


Fig. 13b - Gate Charge Test Circuit



**Note**

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

**Fig. 14 - For N-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

## Package Picture





## Disclaimer

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