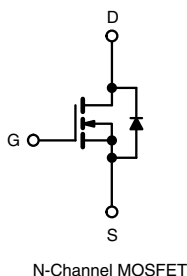
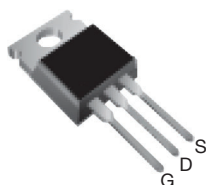


## Power MOSFET

### PRODUCT SUMMARY

|                           |                        |      |
|---------------------------|------------------------|------|
| $V_{DS}$ (V)              | 60                     |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.20 |
| $Q_g$ (Max.) (nC)         | 11                     |      |
| $Q_{gs}$ (nC)             | 3.1                    |      |
| $Q_{gd}$ (nC)             | 5.8                    |      |
| Configuration             | Single                 |      |

**TO-220AB**


### FEATURES

- Dynamic  $dV/dt$  Rating
- 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 provides 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 | IRFZ10PbF<br>SiHFZ10-E3 |
| SnPb           | IRFZ10<br>SiHFZ10       |

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

| PARAMETER                                        | SYMBOL           | LIMIT                 | UNIT  |
|--------------------------------------------------|------------------|-----------------------|-------|
| Drain-Source Voltage                             | $V_{DS}$         | 60                    | V     |
| Gate-Source Voltage                              | $V_{GS}$         | $\pm 20$              |       |
| Continuous Drain Current                         | $I_D$            | $T_C = 25\text{ °C}$  | A     |
|                                                  |                  | $T_C = 100\text{ °C}$ |       |
| Pulsed Drain Current <sup>a</sup>                | $I_{DM}$         | 40                    |       |
| Linear Derating Factor                           |                  | 0.29                  | W/°C  |
| Single Pulse Avalanche Energy <sup>b</sup>       | $E_{AS}$         | 47                    | mJ    |
| Maximum Power Dissipation                        | $P_D$            | 43                    | W     |
| Peak Diode Recovery $dV/dt$ <sup>c</sup>         | $dV/dt$          | 4.5                   | 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                    |       |
|                                                  |                  | 1.1                   | N · m |

#### Notes

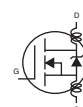
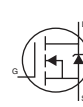
- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = 25\text{ V}$ , starting  $T_J = 25\text{ °C}$ ,  $L = 1.8\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 7.2\text{ A}$  (see fig. 12).
- $I_{SD} \leq 10\text{ A}$ ,  $dI/dt \leq 90\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ °C}$ .
- 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)    | $R_{thJC}$ | -    | 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 <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                                     |                                                                                  | 60   | -     | -     | V    |
| V <sub>DS</sub> Temperature Coefficient   | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA                                                                                                                          |                                                                                  | -    | 0.063 | -     | V/°C |
| Gate-Source Threshold Voltage             | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                                        |                                                                                  | 2.0  | -     | 4.0   | V    |
| Gate-Source Leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20                                                                                                                                             |                                                                                  | -    | -     | ± 100 | nA   |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V                                                                                                                      |                                                                                  | -    | -     | 25    | μA   |
|                                           |                                  | V <sub>DS</sub> = 48 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 150 °C                                                                                             |                                                                                  | -    | -     | 250   |      |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                             | I <sub>D</sub> = 6.0 A <sup>b</sup>                                              | -    | -     | 0.20  | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 25 V, I <sub>D</sub> = 6.0 A <sup>b</sup>                                                                                                        |                                                                                  | 2.4  | -     | -     | S    |
| Dynamic                                   |                                  |                                                                                                                                                                    |                                                                                  |      |       |       |      |
| Input Capacitance                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V<br>V <sub>DS</sub> = 25 V<br>f = 1.0 MHz, see fig. 5                                                                                         |                                                                                  | -    | 300   | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                                    |                                                                                  | -    | 160   | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                                                    |                                                                                  | -    | 29    | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                             | I <sub>D</sub> = 10 A, V <sub>DS</sub> = 48 V,<br>see fig. 6 and 13 <sup>b</sup> | -    | -     | 11    | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                                                    |                                                                                  | -    | -     | 3.1   |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                                                    |                                                                                  | -    | -     | 5.8   |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 30 V, I <sub>D</sub> = 10 A<br>R <sub>g</sub> = 24 Ω, R <sub>D</sub> = 2.7 Ω, see fig. 10 <sup>b</sup>                                           |                                                                                  | -    | 10    | -     | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                                                                    |                                                                                  | -    | 50    | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                                                                    |                                                                                  | -    | 13    | -     |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                                                                    |                                                                                  | -    | 19    | -     |      |
| Internal Drain Inductance                 | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact<br> |                                                                                  | -    | 4.5   | -     | nH   |
| Internal Source Inductance                | L <sub>S</sub>                   |                                                                                                                                                                    |                                                                                  | -    | 7.5   | -     |      |
| Drain-Source Body Diode Characteristics   |                                  |                                                                                                                                                                    |                                                                                  |      |       |       |      |
| Continuous Source-Drain Diode Current     | I <sub>S</sub>                   | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode<br>   |                                                                                  | -    | -     | 10    | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                                    |                                                                                  | -    | -     | 40    |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 10 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                                  |                                                                                  | -    | -     | 1.6   | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 10 A, di/dt = 100 A/μs <sup>b</sup>                                                                                       |                                                                                  | -    | 70    | 140   | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                                                                    |                                                                                  | -    | 0.20  | 0.40  | μC   |
| Forward Turn-On Time                      | t <sub>on</sub>                  | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )                                                                  |                                                                                  |      |       |       |      |

**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)

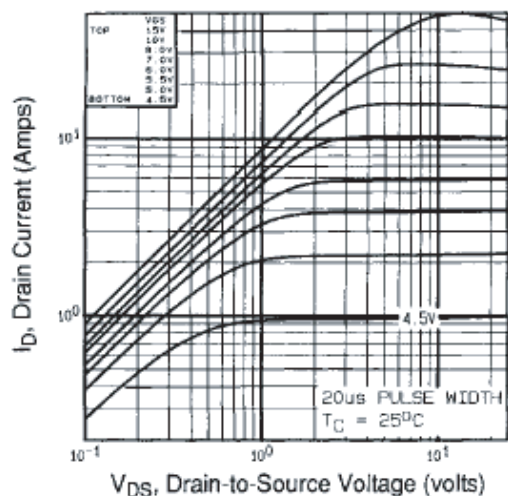


Fig. 1 - Typical Output Characteristics,  $T_C = 25^\circ\text{C}$

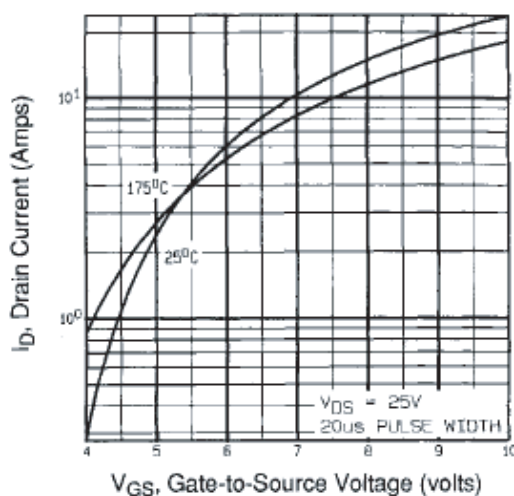


Fig. 3 - Typical Transfer Characteristics

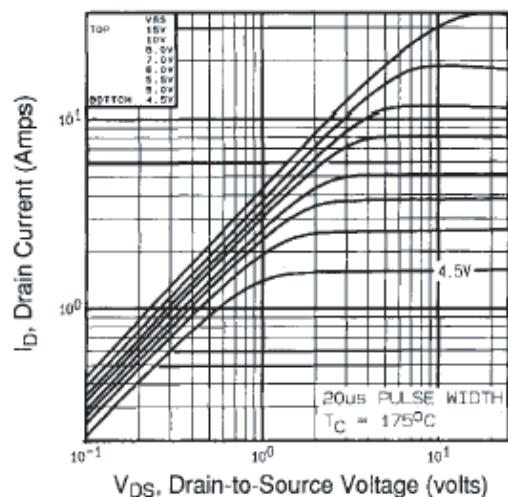


Fig. 2 - Typical Output Characteristics,  $T_C = 175^\circ\text{C}$

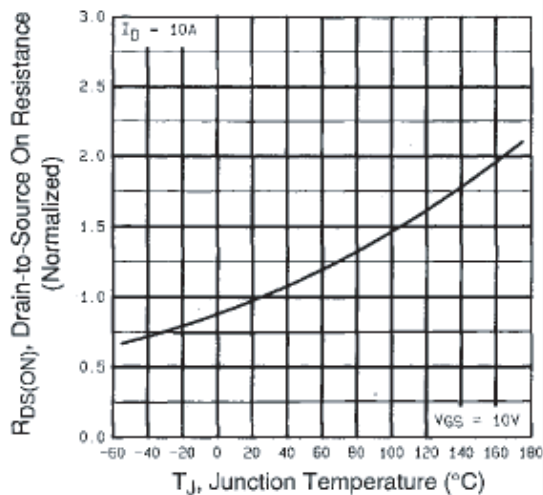


Fig. 4 - Normalized On-Resistance vs. Temperature

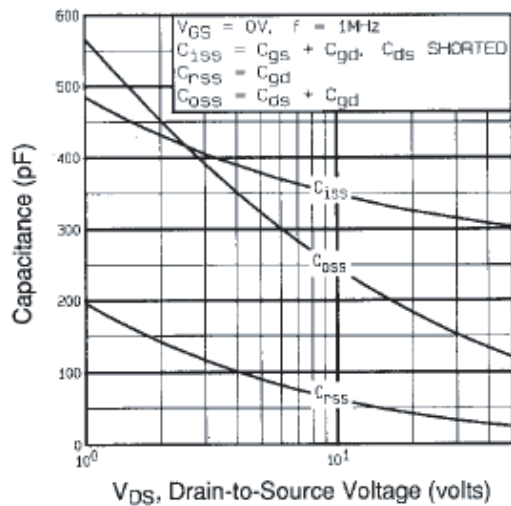


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

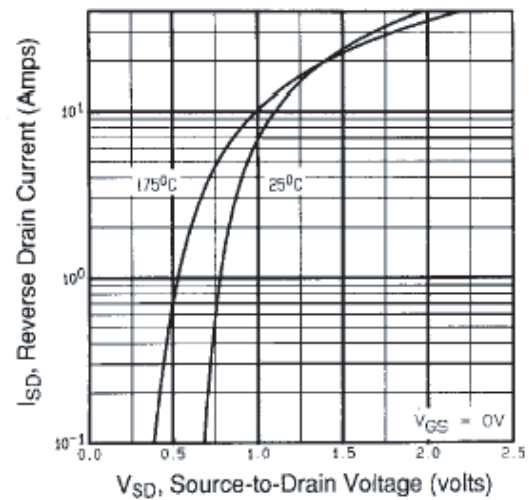


Fig. 7 - Typical Source-Drain Diode Forward Voltage

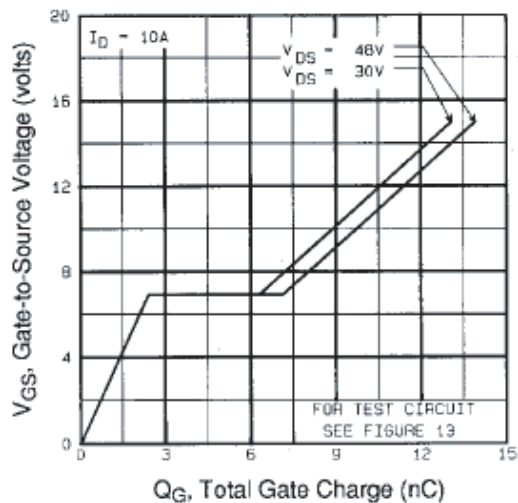


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

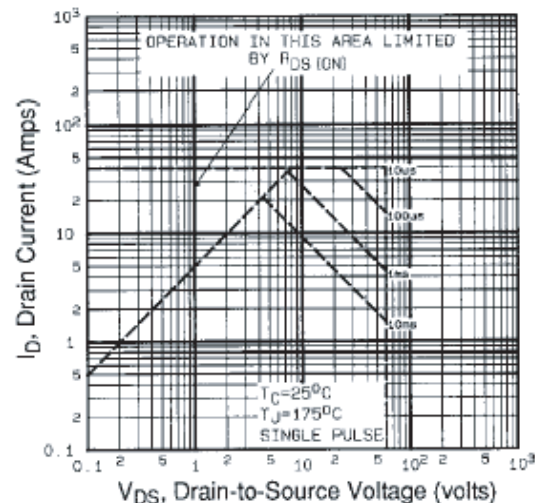


Fig. 8 - Maximum Safe Operating Area

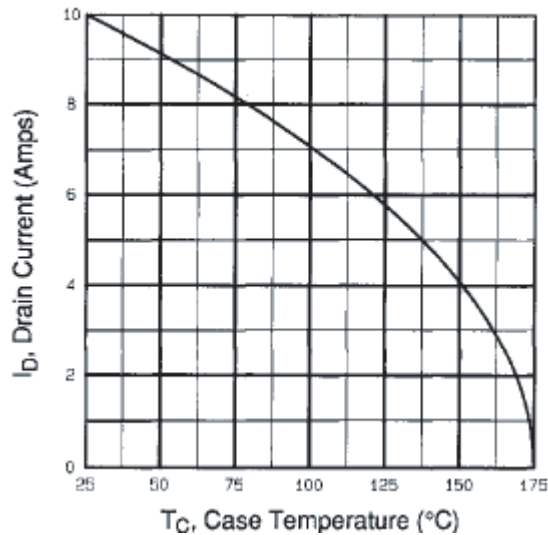


Fig. 9 - Maximum Drain Current vs. Case Temperature

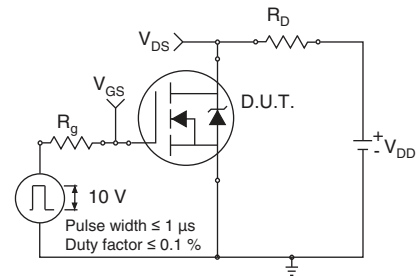


Fig. 10a - Switching Time Test Circuit

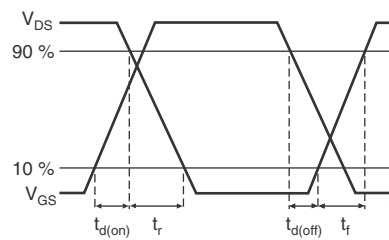


Fig. 10b - Switching Time Waveforms

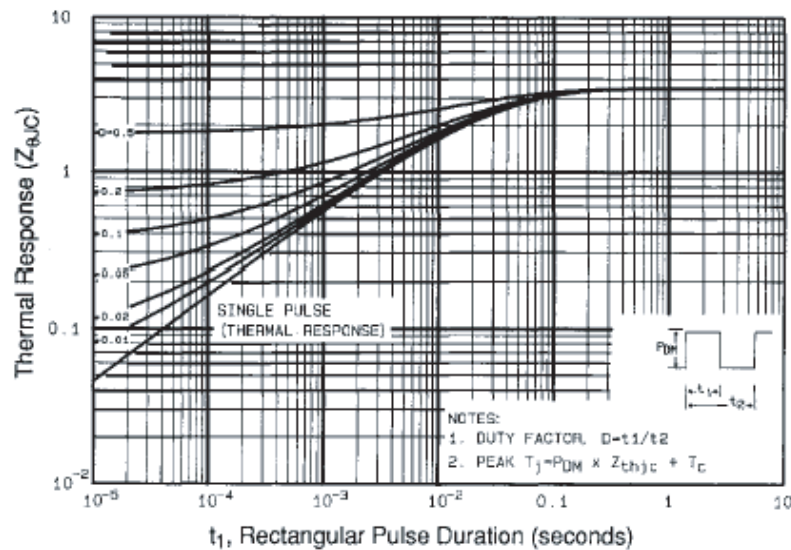


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

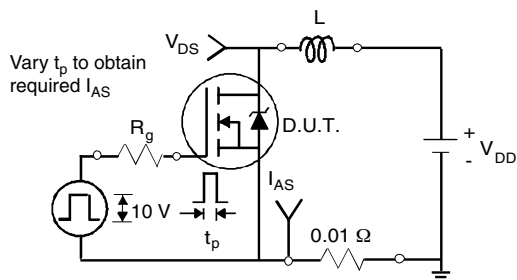


Fig. 12a - Unclamped Inductive Test Circuit

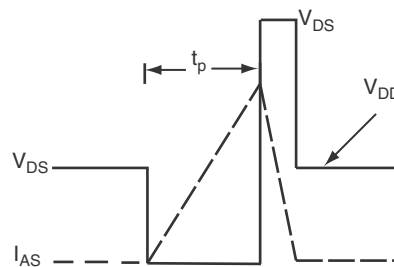


Fig. 12b - Unclamped Inductive Waveforms

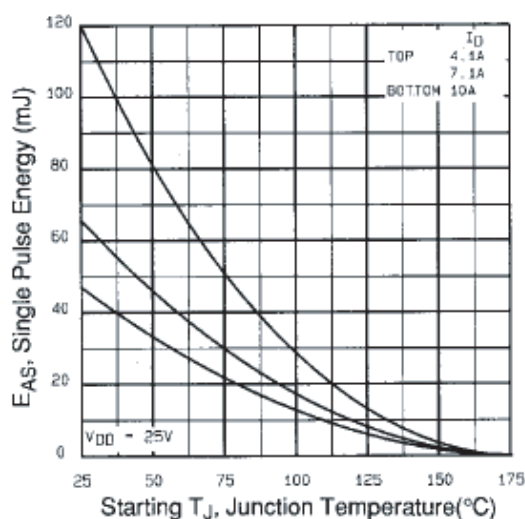


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

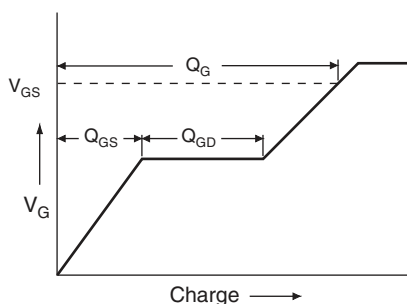


Fig. 13a - Basic Gate Charge Waveform

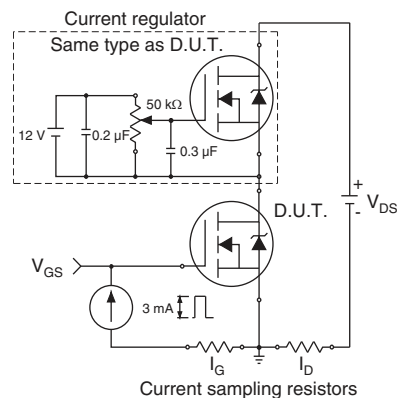
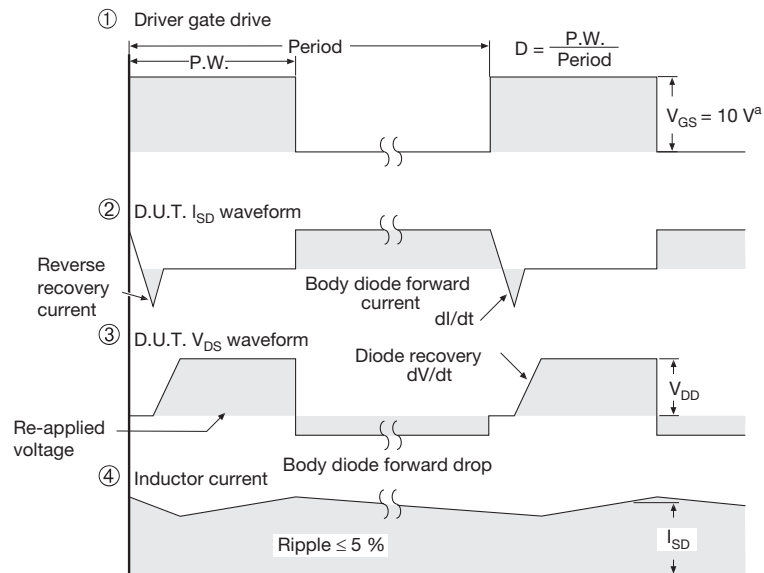
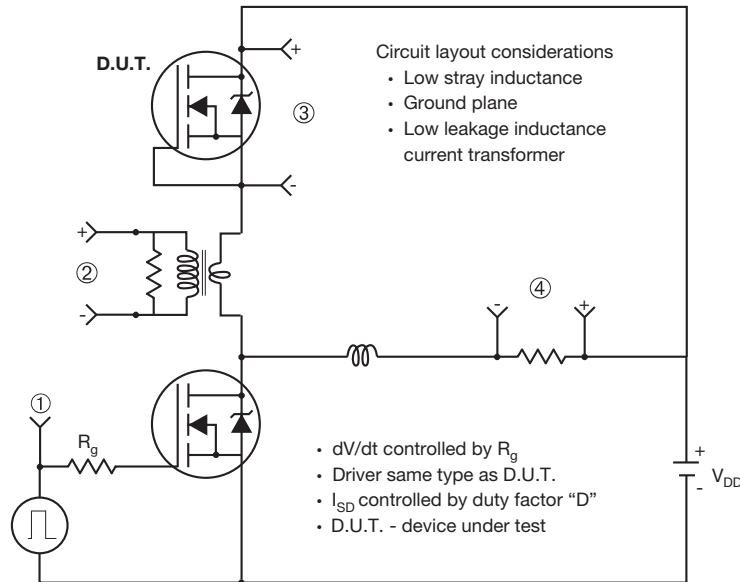


Fig. 13b - Gate Charge Test Circuit

## Peak Diode Recovery dV/dt Test Circuit



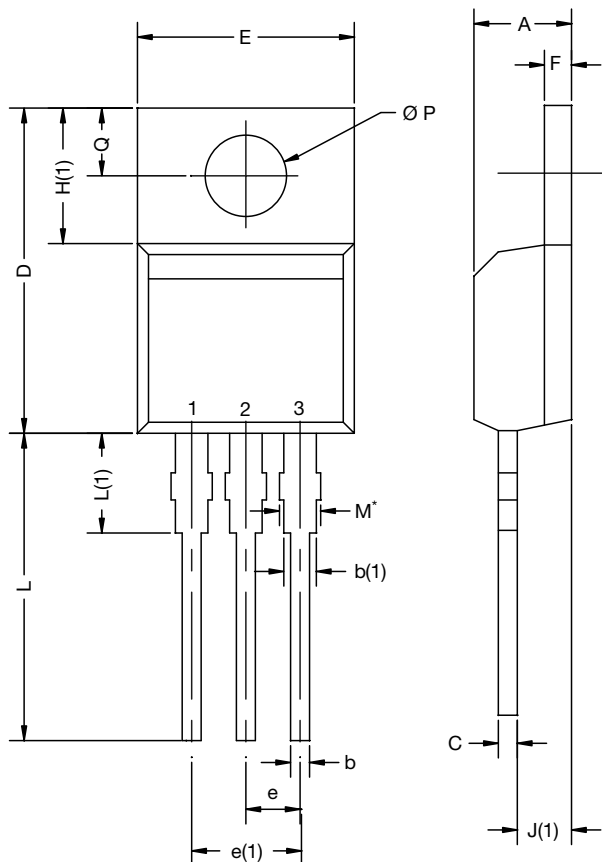
### Note

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

**Fig. 14 - For N-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?90363](http://www.vishay.com/ppg?90363).

## TO-220-1

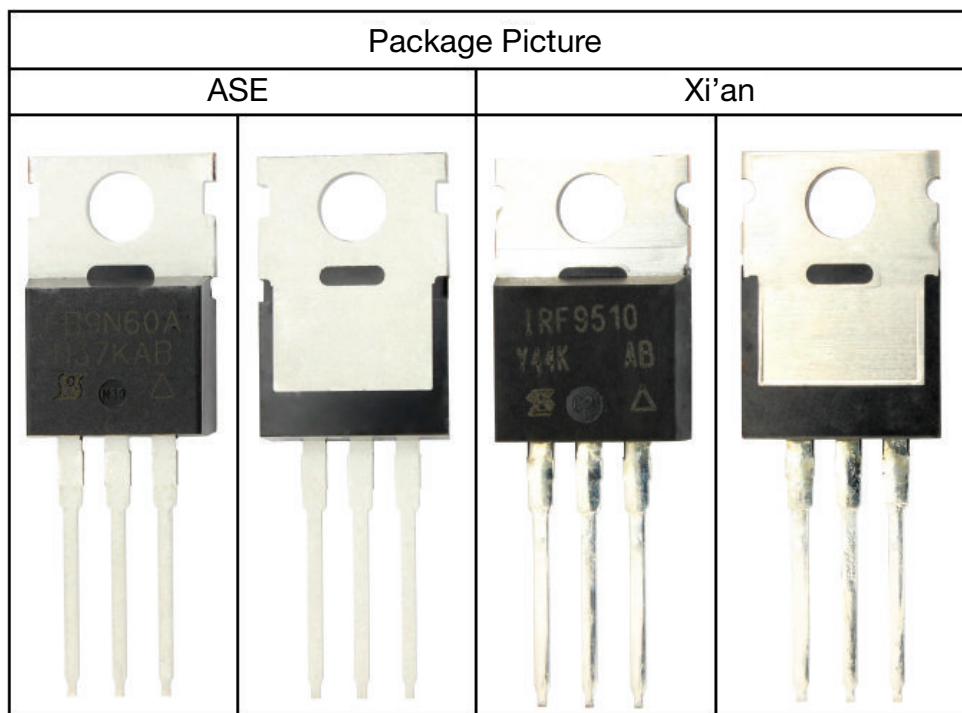


| DIM. | MILLIMETERS |       | INCHES |       |
|------|-------------|-------|--------|-------|
|      | MIN.        | MAX.  | MIN.   | MAX.  |
| A    | 4.24        | 4.65  | 0.167  | 0.183 |
| b    | 0.69        | 1.02  | 0.027  | 0.040 |
| b(1) | 1.14        | 1.78  | 0.045  | 0.070 |
| c    | 0.36        | 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







## Disclaimer

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