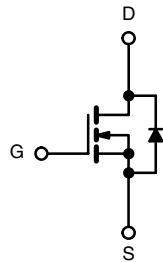
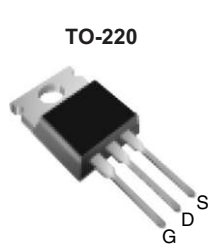


## Power MOSFET

| PRODUCT SUMMARY           |                        |      |
|---------------------------|------------------------|------|
| $V_{DS}$ (V)              | 500                    |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.21 |
| $Q_g$ (Max.) (nC)         | 110                    |      |
| $Q_{gs}$ (nC)             | 33                     |      |
| $Q_{gd}$ (nC)             | 54                     |      |
| Configuration             | Single                 |      |



N-Channel MOSFET

### FEATURES

- Low Gate Charge  $Q_g$  Results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic  $dV/dt$  Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Low  $R_{DS(on)}$
- Compliant to RoHS Directive 2002/95/EC



RoHS\*  
COMPLIANT

### APPLICATIONS

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply
- High Speed Power Switching
- Hard Switched and High Frequency Circuits

| ORDERING INFORMATION |                |
|----------------------|----------------|
| Package              | TO-220         |
| Lead (Pb)-free       | IRFB20N50KPbF  |
|                      | SiHFB20N50K-E3 |
| SnPb                 | IRFB20N50K     |
|                      | SiHFB20N50K    |


| ABSOLUTE MAXIMUM RATINGS $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted |                                  |                |                                   |                     |   |
|------------------------------------------------------------------------------------|----------------------------------|----------------|-----------------------------------|---------------------|---|
| PARAMETER                                                                          |                                  | SYMBOL         | LIMIT                             | UNIT                |   |
| Drain-Source Voltage                                                               |                                  | $V_{DS}$       | 500                               | V                   |   |
| Gate-Source Voltage                                                                |                                  | $V_{GS}$       | $\pm 30$                          |                     |   |
| Continuous Drain Current                                                           | $V_{GS}$ at 10 V                 | $I_D$          | $T_C = 25\text{ }^\circ\text{C}$  | 20                  | A |
|                                                                                    |                                  |                | $T_C = 100\text{ }^\circ\text{C}$ | 12                  |   |
| Pulsed Drain Current <sup>a</sup>                                                  |                                  | $I_{DM}$       | 80                                |                     |   |
| Linear Derating Factor                                                             |                                  |                | 2.2                               | W/ $^\circ\text{C}$ |   |
| Single Pulse Avalanche Energy <sup>b</sup>                                         |                                  | $E_{AS}$       | 330                               | mJ                  |   |
| Repetitive Avalanche Current <sup>a</sup>                                          |                                  | $I_{AR}$       | 20                                | A                   |   |
| Repetitive Avalanche Energy <sup>a</sup>                                           |                                  | $E_{AR}$       | 28                                | mJ                  |   |
| Maximum Power Dissipation                                                          | $T_C = 25\text{ }^\circ\text{C}$ | $P_D$          | 280                               | W                   |   |
| Peak Diode Recovery $dV/dt^c$                                                      |                                  | $dV/dt$        | 10                                | V/ns                |   |
| Operating Junction and Storage Temperature Range                                   |                                  | $T_J, T_{stg}$ | - 55 to + 150                     | $^\circ\text{C}$    |   |
| Soldering Recommendations (Peak Temperature)                                       | for 10 s                         |                | 300 <sup>d</sup>                  |                     |   |
| Mounting Torque                                                                    | 6-32 or M3 screw                 |                | 10                                |                     |   |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 1.6\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 20\text{ A}$ .
- $I_{SD} \leq 20\text{ A}$ ,  $dI/dt \leq 350\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

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

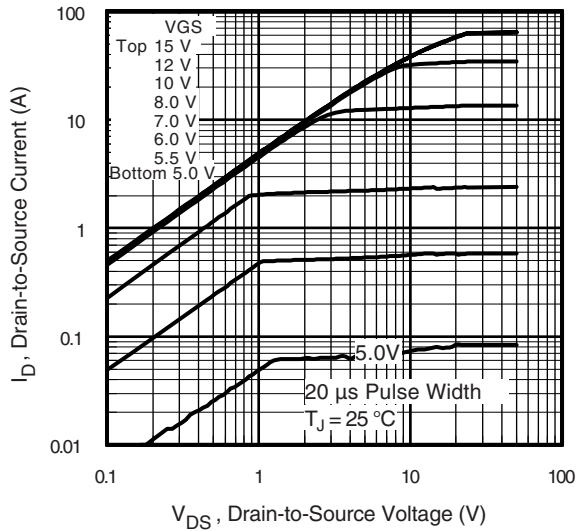
| THERMAL RESISTANCE RATINGS          |            |      |      |      |  |  |
|-------------------------------------|------------|------|------|------|--|--|
| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |  |  |
| Maximum Junction-to-Ambient         | $R_{thJA}$ | -    | 58   | °C/W |  |  |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.50 | -    |      |  |  |
| Maximum Junction-to-Case (Drain)    | $R_{thJC}$ | -    | 0.45 |      |  |  |

| 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 $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$                                                                                        | -                                           | 0.61 | -         | V/°C          |
| Gate-Source Threshold Voltage                                            | $V_{GS(th)}$          | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                                                                                                      | 3.0                                         | -    | 5.0       | V             |
| Gate-Source Leakage                                                      | $I_{GSS}$             | $V_{GS} = \pm 30\text{ V}$                                                                                                                           | -                                           | -    | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current                                          | $I_{DSS}$             | $V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$                                                                                                         | -                                           | -    | 50        | $\mu\text{A}$ |
|                                                                          |                       | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$                                                                        | -                                           | -    | 250       |               |
| Drain-Source On-State Resistance                                         | $R_{DS(on)}$          | $V_{GS} = 10\text{ V}, I_D = 12\text{ A}^b$                                                                                                          | -                                           | 0.21 | 0.25      | $\Omega$      |
| Forward Transconductance                                                 | $g_{fs}$              | $V_{DS} = 50\text{ V}, I_D = 12\text{ A}$                                                                                                            | 11                                          | -    | -         | 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                                                                         | -                                           | 2870 | -         | pF            |
| Output Capacitance                                                       | $C_{oss}$             |                                                                                                                                                      | -                                           | 320  | -         |               |
| Reverse Transfer Capacitance                                             | $C_{rss}$             |                                                                                                                                                      | -                                           | 34   | -         |               |
| Output Capacitance                                                       | $C_{oss}$             | $V_{GS} = 0\text{ V}$                                                                                                                                | $V_{DS} = 1.0\text{ V}, f = 1.0\text{ MHz}$ | -    | 3480      | -             |
| Effective Output Capacitance                                             | $C_{oss\text{ eff.}}$ |                                                                                                                                                      | $V_{DS} = 400\text{ V}, f = 1.0\text{ MHz}$ | -    | 85        | -             |
| Total Gate Charge                                                        | $Q_g$                 | $V_{GS} = 10\text{ V}, I_D = 20\text{ A}, V_{DS} = 400\text{ V}$<br>see fig. 6 and 13 <sup>b</sup>                                                   | -                                           | -    | 110       | nC            |
| Gate-Source Charge                                                       | $Q_{GS}$              |                                                                                                                                                      | -                                           | -    | 33        |               |
| Gate-Drain Charge                                                        | $Q_{GD}$              |                                                                                                                                                      | -                                           | -    | 54        |               |
| Turn-On Delay Time                                                       | $t_{d(on)}$           | $V_{DD} = 250\text{ V}, I_D = 20\text{ A}, R_g = 7.5\text{ }\Omega, V_{GS} = 10\text{ V}$ , see fig. 10 <sup>b</sup>                                 | -                                           | 22   | -         | ns            |
| Rise Time                                                                | $t_r$                 |                                                                                                                                                      | -                                           | 74   | -         |               |
| Turn-Off Delay Time                                                      | $t_{d(off)}$          |                                                                                                                                                      | -                                           | 45   | -         |               |
| Fall Time                                                                | $t_f$                 |                                                                                                                                                      | -                                           | 33   | -         |               |
| <b>Drain-Source Body Diode Characteristics</b>                           |                       |                                                                                                                                                      |                                             |      |           |               |
| Continuous Source-Drain Diode Current                                    | $I_S$                 | MOSFET symbol showing the integral reverse p - n junction diode  | -                                           | -    | 20        | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                | $I_{SM}$              |                                                                                                                                                      | -                                           | -    | 80        |               |
| Body Diode Voltage                                                       | $V_{SD}$              | $T_J = 25\text{ }^\circ\text{C}, I_S = 20\text{ A}, V_{GS} = 0\text{ V}^b$                                                                           | -                                           | -    | 1.5       | V             |
| Body Diode Reverse Recovery Time                                         | $t_{rr}$              | $T_J = 25\text{ }^\circ\text{C}, I_F = 20\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$                                                              | -                                           | 520  | 780       | ns            |
| Body Diode Reverse Recovery Charge                                       | $Q_{rr}$              |                                                                                                                                                      | -                                           | 5.3  | 8.0       | $\mu\text{C}$ |
| Forward Turn-On Time                                                     | $t_{on}$              | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )                                                                      |                                             |      |           |               |

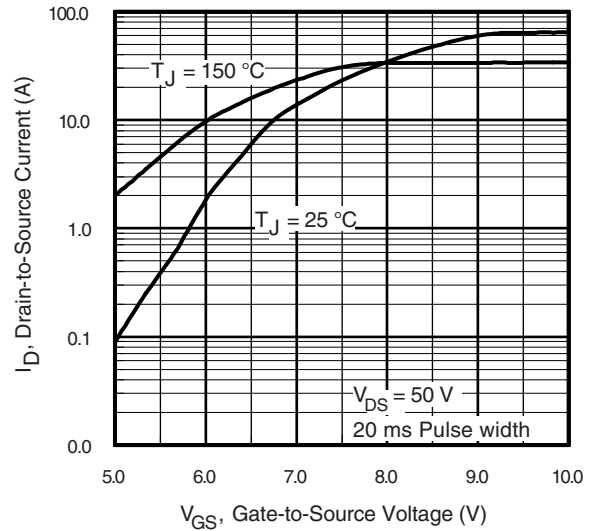
**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature.
- b. Pulse width  $\leq 400\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

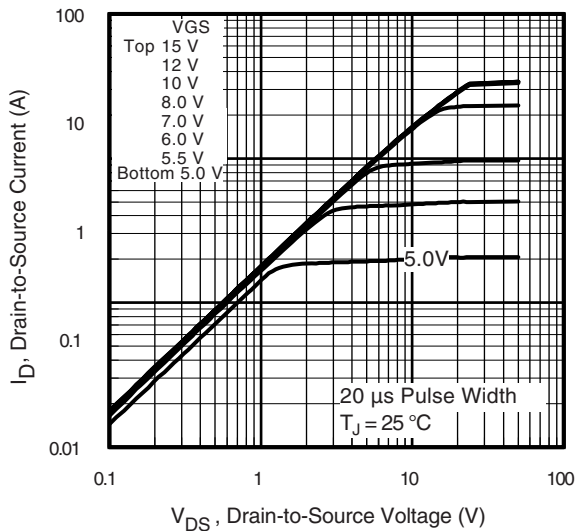
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



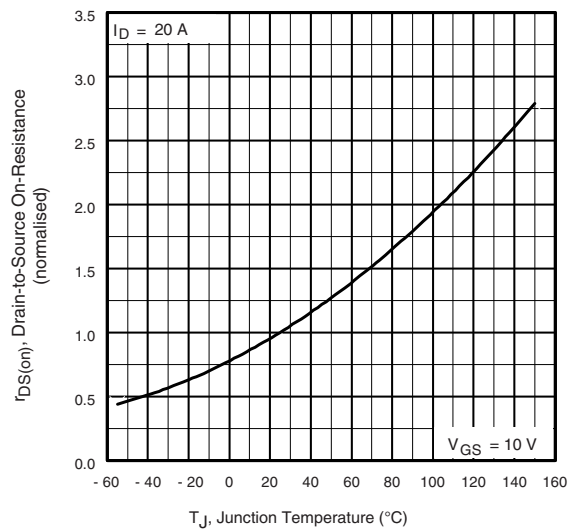
**Fig. 1 - Typical Output Characteristics**



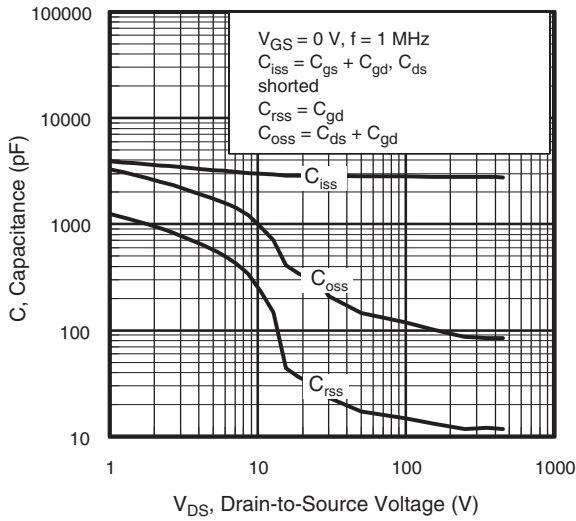
**Fig. 3 - Typical Transfer Characteristics**



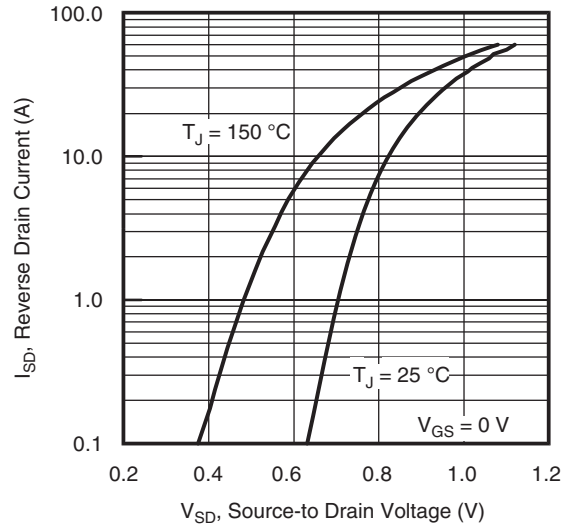
**Fig. 2 - Typical Output Characteristics**



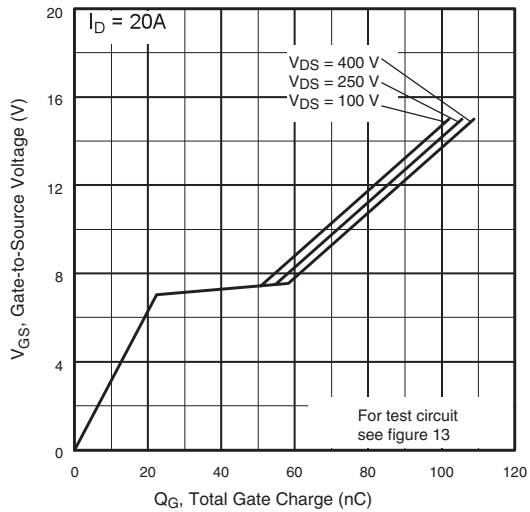
**Fig. 4 - Normalized On-Resistance vs. Temperature**



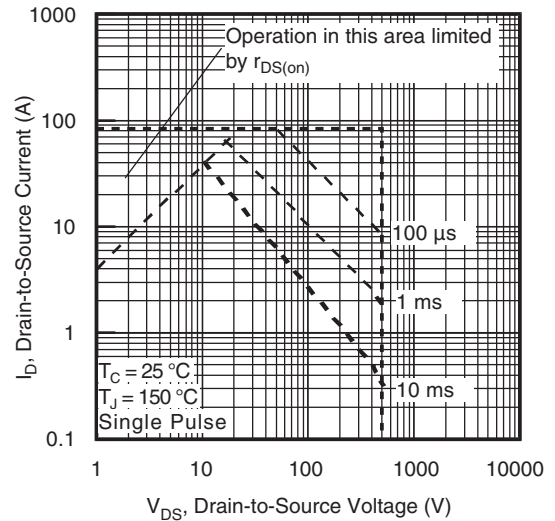
**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



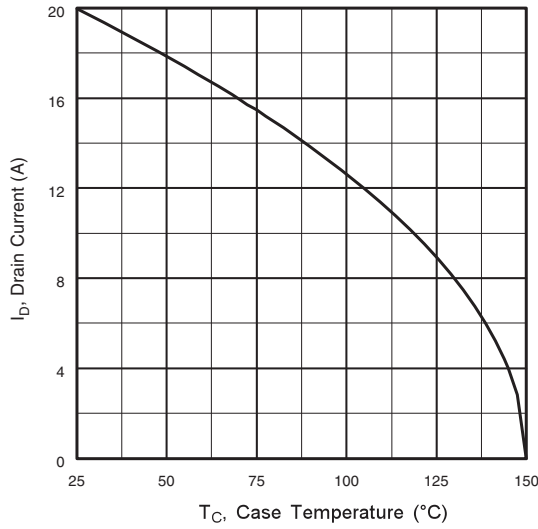
**Fig. 7 - Typical Source-Drain Diode Forward Voltage**



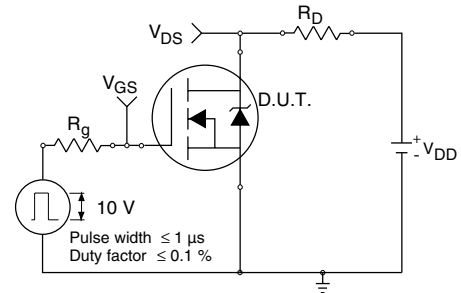
**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**



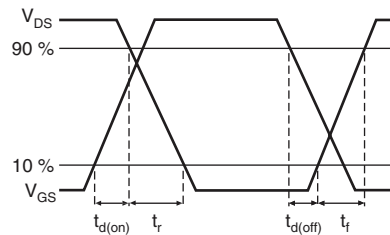
**Fig. 8 - Maximum Safe Operating Area**



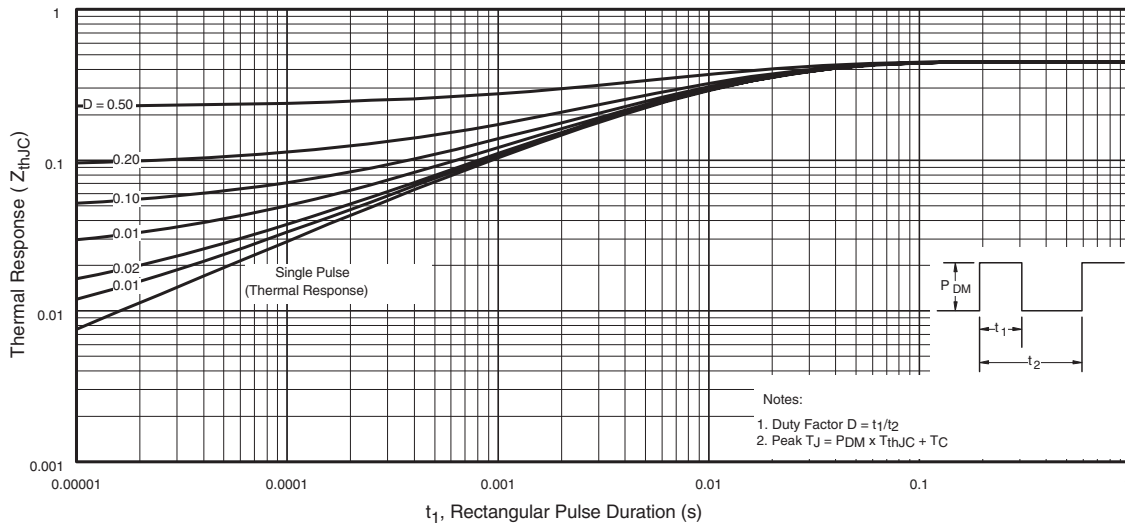
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



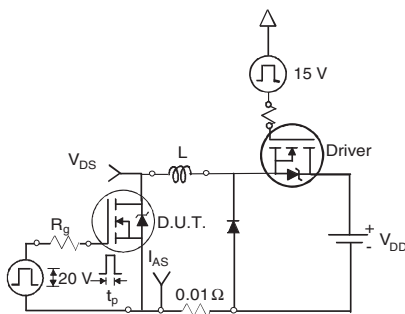
**Fig. 10a - Switching Time Test Circuit**



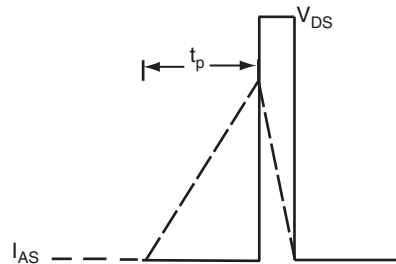
**Fig. 10b - Switching Time Waveforms**



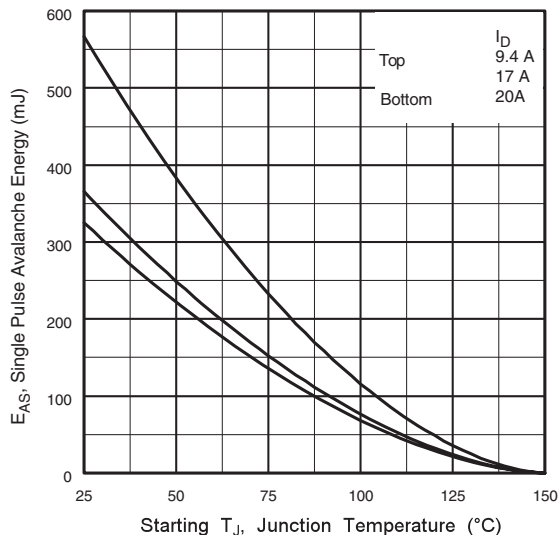
**Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**



**Fig. 12a - Unclamped Inductive Test Circuit**



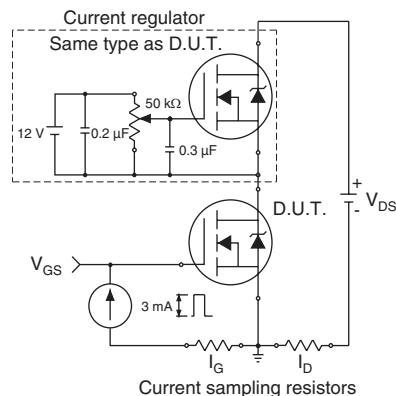
**Fig. 12b - Unclamped Inductive Waveforms**



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

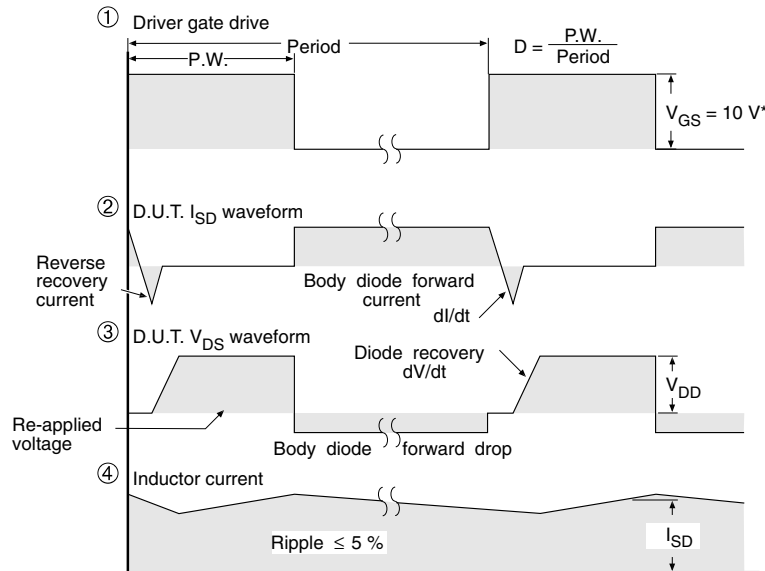
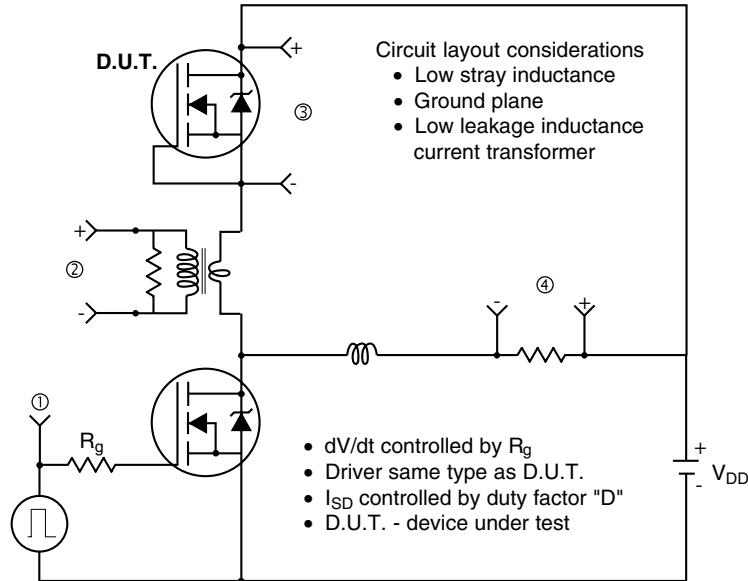


**Fig. 13a - Basic Gate Charge Waveform**



**Fig. 13b - Gate Charge Test Circuit**

## Peak Diode Recovery dV/dt Test Circuit



\*  $V_{GS} = 5 V$  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







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**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

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