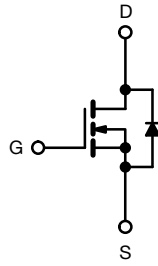
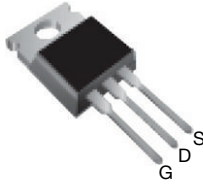


## Power MOSFET

**TO-220AB**


N-Channel 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                 |      |

### 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  $R_{DS(on)}$
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS\***  
Available

### Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

### APPLICATIONS

- Switch mode power supply (SMPS)
- Uninterruptible power supply
- High speed power switching
- Hard switched and high frequency circuits

### ORDERING INFORMATION

|                |                |
|----------------|----------------|
| Package        | TO-220AB       |
| Lead (Pb)-free | IRFB20N50KPbF  |
|                | SiHFB20N50K-E3 |

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

| PARAMETER                                                 |                         |                         | SYMBOL                            | LIMIT       | UNIT |
|-----------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|------|
| Drain-source voltage                                      |                         |                         | V <sub>DS</sub>                   | 500         | V    |
| Gate-source voltage                                       |                         |                         | V <sub>GS</sub>                   | ± 30        |      |
| Continuous drain current                                  | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 20          | A    |
|                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 12          |      |
| Pulsed drain current <sup>a</sup>                         |                         |                         | I <sub>DM</sub>                   | 80          |      |
| Linear derating factor                                    |                         |                         |                                   | 2.2         | W/°C |
| Single pulse avalanche energy <sup>b</sup>                |                         |                         | E <sub>AS</sub>                   | 330         | mJ   |
| Repetitive avalanche current <sup>a</sup>                 |                         |                         | I <sub>AR</sub>                   | 20          | A    |
| Repetitive avalanche energy <sup>a</sup>                  |                         |                         | E <sub>AR</sub>                   | 28          | mJ   |
| Maximum power dissipation                                 | T <sub>C</sub> = 25 °C  |                         | P <sub>D</sub>                    | 280         | W    |
| Peak diode recovery dV/dt <sup>c</sup>                    |                         |                         | dV/dt                             | 10          | V/ns |
| Operating junction and storage temperature range          |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C   |
| Soldering recommendations (peak temperature) <sup>d</sup> | For 10 s                |                         |                                   | 300         |      |
| Mounting torque                                           | 6-32 or M3 screw        |                         |                                   | 10          |      |
|                                                           |                         |                         |                                   | 10          | N    |

### 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

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

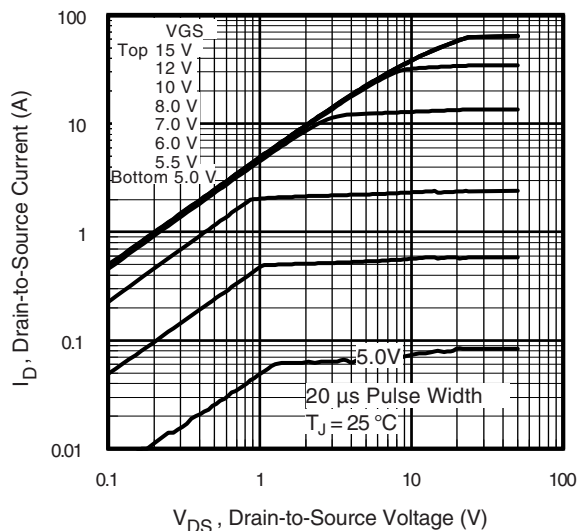
| = 25 °C,                                  | SYMBOL                           | TEST CONDITIONS                                                                                                                                       |                                                                                  | 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                                                                                                        |                                                                                  | 500  | -    | -     | 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                                                                                                             |                                                                                  | -    | 0.61 | -     | 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                                                                                           |                                                                                  | 3.0  | -    | 5.0   | V    |
| Gate-source leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 30 V                                                                                                                              |                                                                                  | -    | -    | ± 100 | nA   |
| Zero gate voltage drain current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V                                                                                                        |                                                                                  | -    | -    | 50    | μA   |
|                                           |                                  | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                               |                                                                                  | -    | -    | 250   |      |
| Drain-source on-state resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                | I <sub>D</sub> = 12 A <sup>b</sup>                                               | -    | 0.21 | 0.25  | Ω    |
| Forward transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 12 A                                                                                                         |                                                                                  | 11   | -    | -     | 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                                                                          |                                                                                  | -    | 2870 | -     | pF   |
| Output capacitance                        | C <sub>Oss</sub>                 |                                                                                                                                                       |                                                                                  | -    | 320  | -     |      |
| Reverse transfer capacitance              | C <sub>rss</sub>                 |                                                                                                                                                       |                                                                                  | -    | 34   | -     |      |
| Output capacitance                        | C <sub>Oss</sub>                 | V <sub>GS</sub> = 0 V                                                                                                                                 | V <sub>DS</sub> = 1.0 V, f = 1.0 MHz                                             | -    | 3480 | -     | nC   |
| Effective output capacitance              | C <sub>Oss</sub> eff.            |                                                                                                                                                       | V <sub>DS</sub> = 400 V, f = 1.0 MHz                                             | -    | 85   | -     |      |
| Total gate charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                | V <sub>DS</sub> = 0 V to 400 V                                                   | -    | 160  | -     |      |
| Gate-source charge                        | Q <sub>gs</sub>                  |                                                                                                                                                       | I <sub>D</sub> = 20 A, V <sub>DS</sub> = 400 V<br>see fig. 6 and 13 <sup>b</sup> | -    | -    | 110   |      |
| Gate-drain charge                         | Q <sub>gd</sub>                  |                                                                                                                                                       | -                                                                                | -    | 33   |       |      |
| Turn-on delay time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 250 V, I <sub>D</sub> = 20 A<br>R <sub>g</sub> = 7.5 Ω, V <sub>GS</sub> = 10 V, see fig. 10 <sup>b</sup>                            |                                                                                  | -    | 22   | -     | ns   |
| Rise time                                 | t <sub>r</sub>                   |                                                                                                                                                       |                                                                                  | -    | 74   | -     |      |
| Turn-off delay time                       | t <sub>d(off)</sub>              |                                                                                                                                                       |                                                                                  | -    | 45   | -     |      |
| Fall time                                 | t <sub>f</sub>                   |                                                                                                                                                       |                                                                                  | -    | 33   | -     |      |
| Gate input resistance                     | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                 |                                                                                  | 0.3  | -    | 2.9   | Ω    |
| Drain-Source Body Diode Characteristics   |                                  |                                                                                                                                                       |                                                                                  |      |      |       |      |
| Continuous source-drain diode current     | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode  |                                                                                  | -    | -    | 20    | A    |
| Pulsed diode forward current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                       |                                                                                  | -    | -    | 80    |      |
| Body diode voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 20 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                     |                                                                                  | -    | -    | 1.5   | V    |
| Body diode reverse recovery time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 20 A, dI/dt = 100 A/μs <sup>b</sup>                                                                          |                                                                                  | -    | 520  | 780   | ns   |
| Body diode reverse recovery charge        | Q <sub>rr</sub>                  |                                                                                                                                                       |                                                                                  | -    | 5.3  | 8.0   | 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**

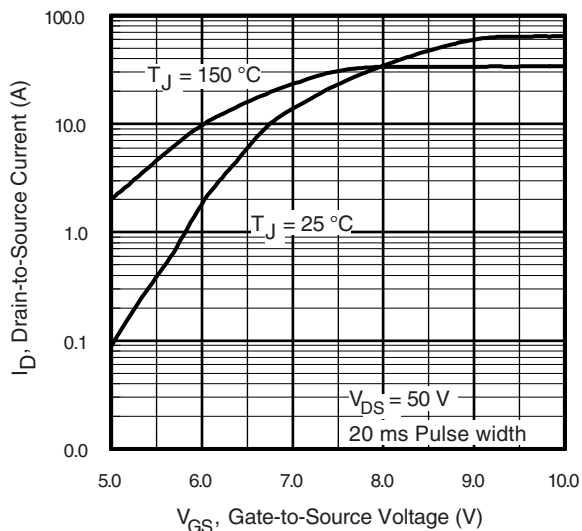
- a. Repetitive rating; pulse width limited by maximum junction temperature  
b. Pulse width  $\leq 400\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$



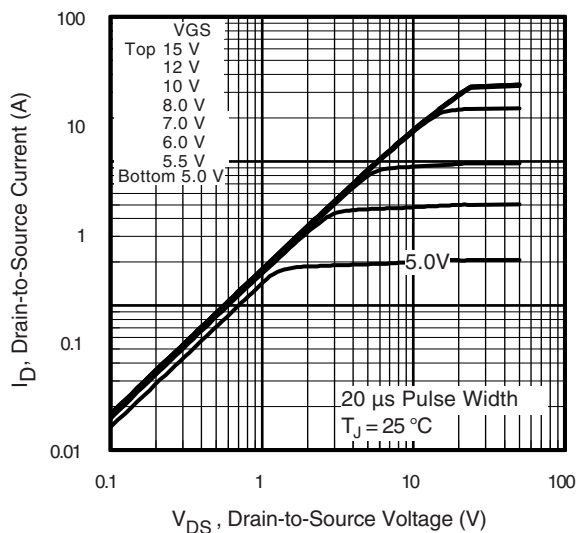
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



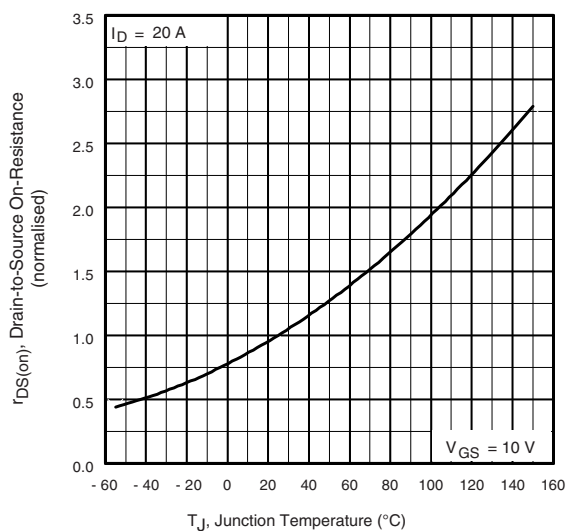
**Fig. 1 - Typical Output Characteristics**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics**



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

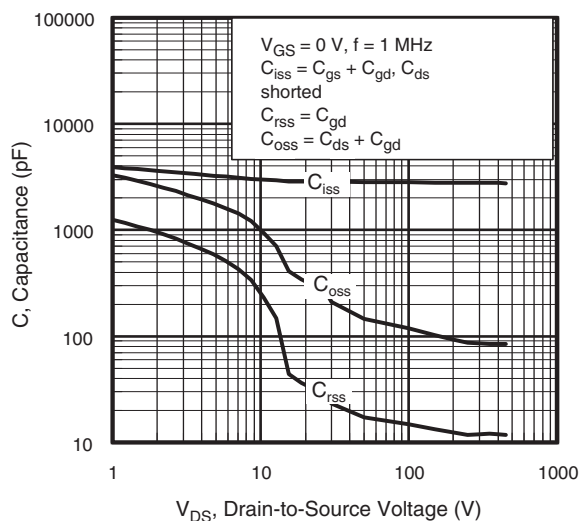


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

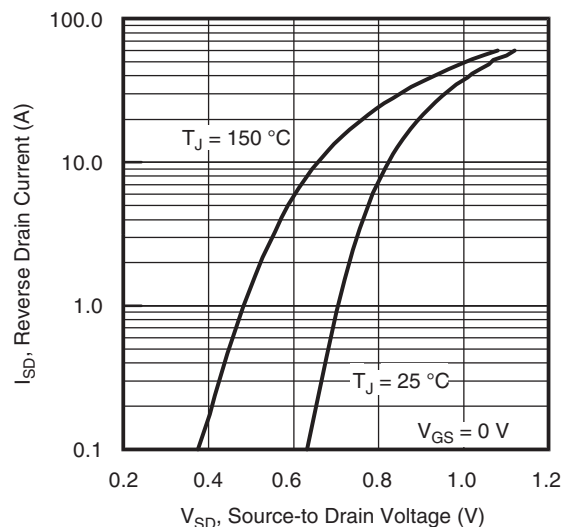


Fig. 7 - Typical Source-Drain Diode Forward Voltage

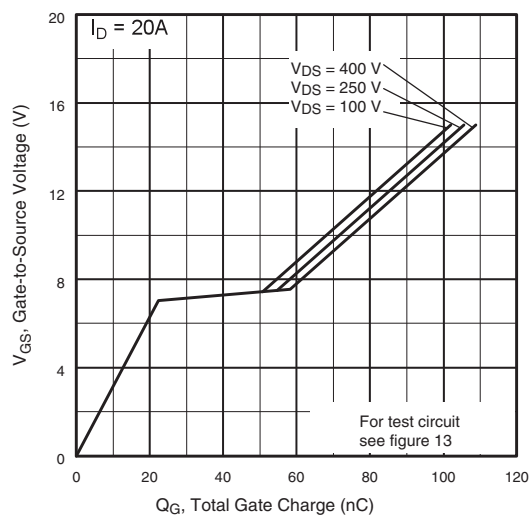


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

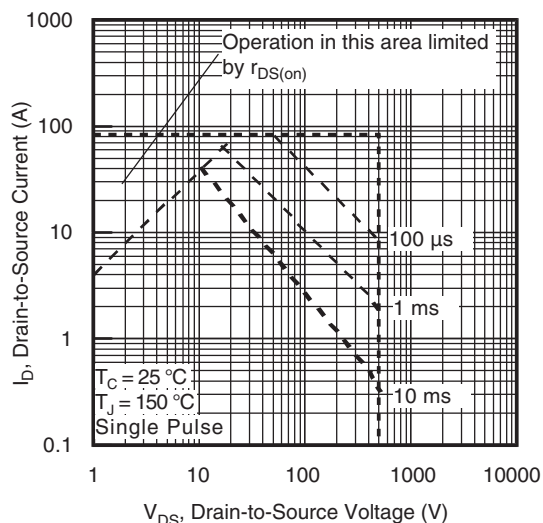
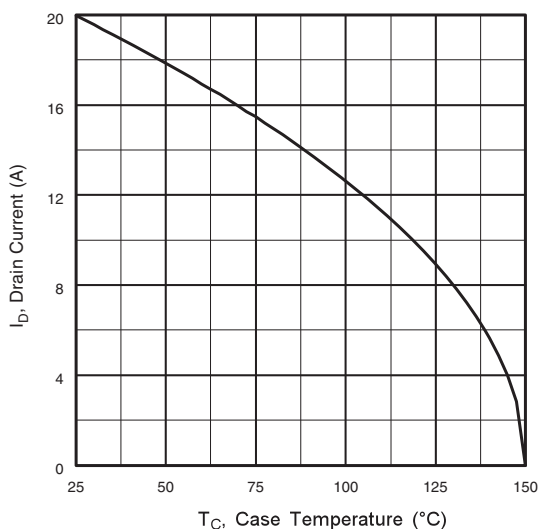
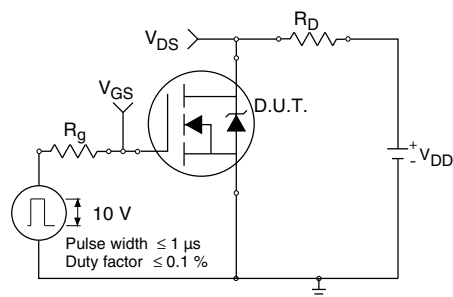
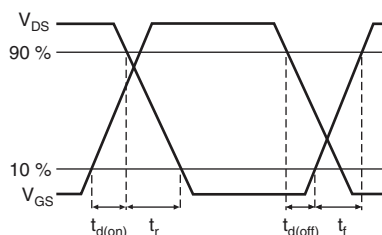
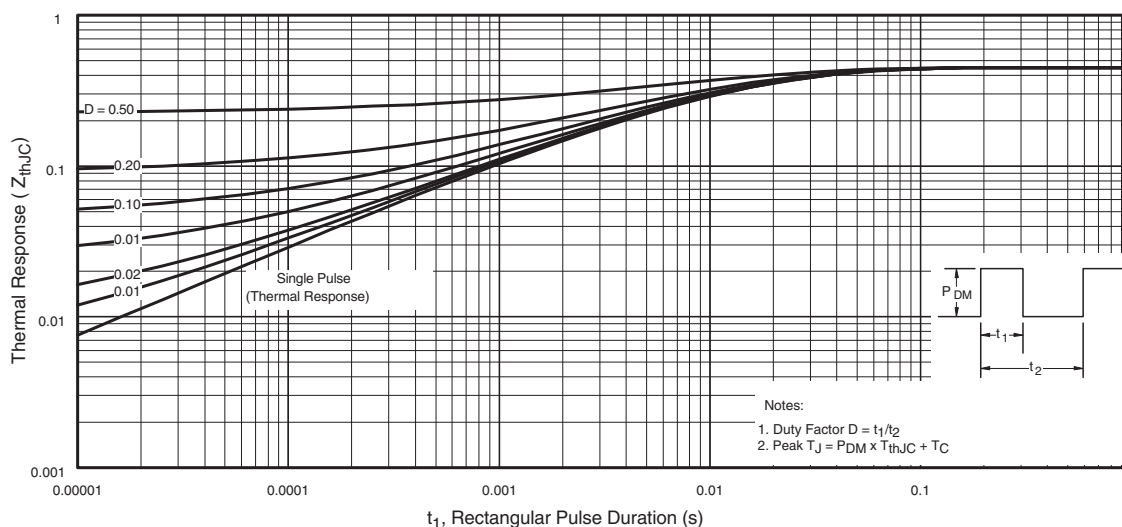
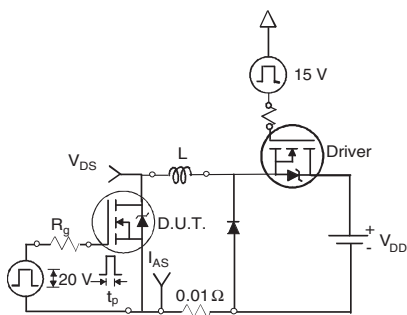
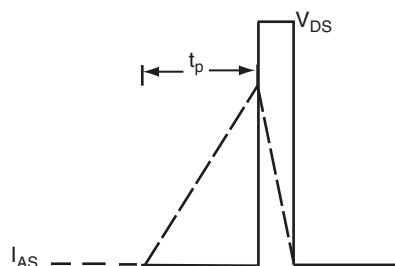
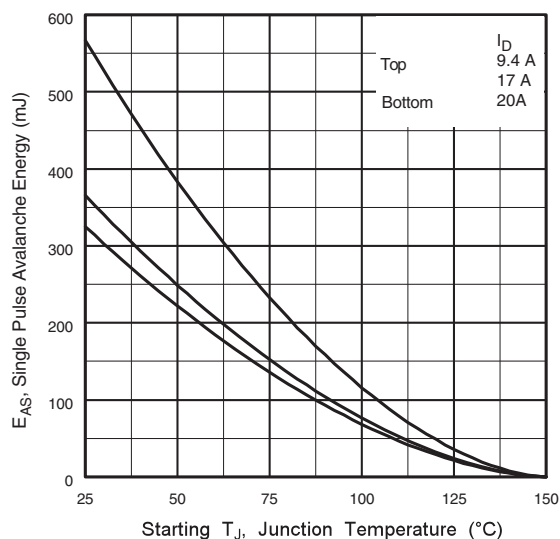
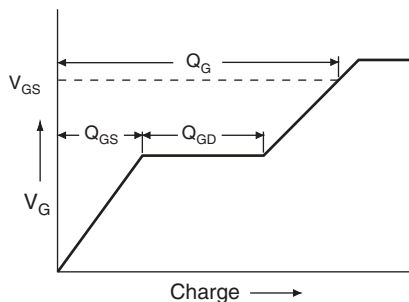
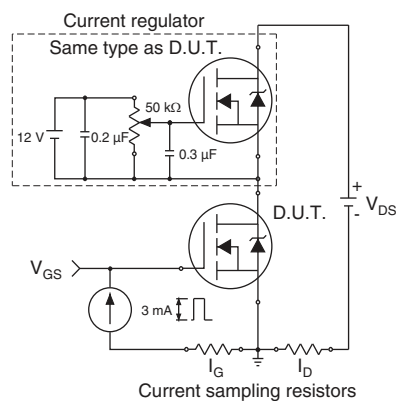
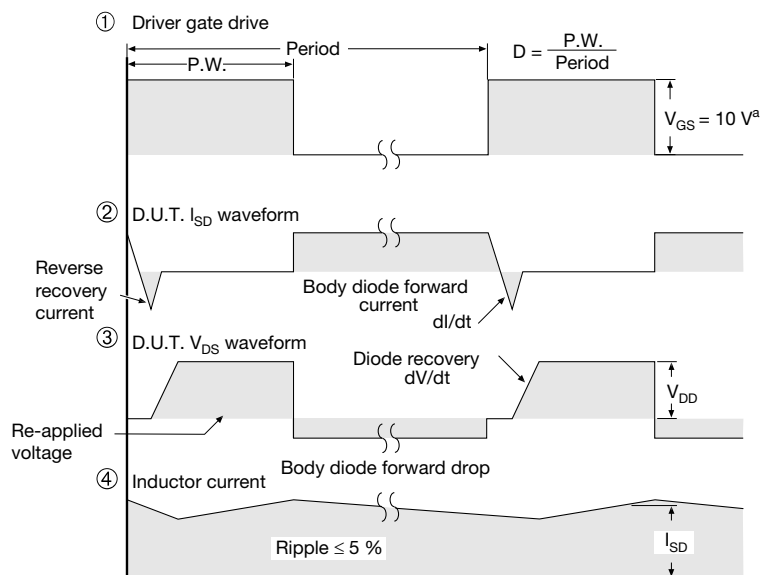
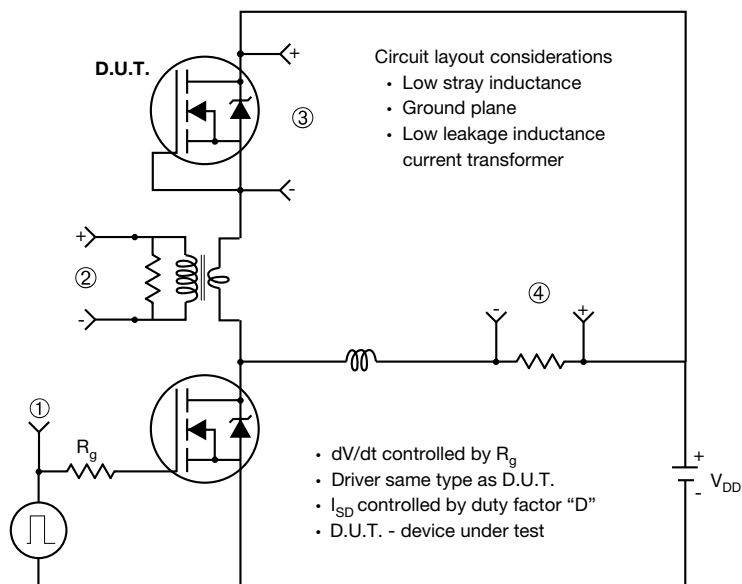


Fig. 8 - Maximum Safe Operating Area


**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**

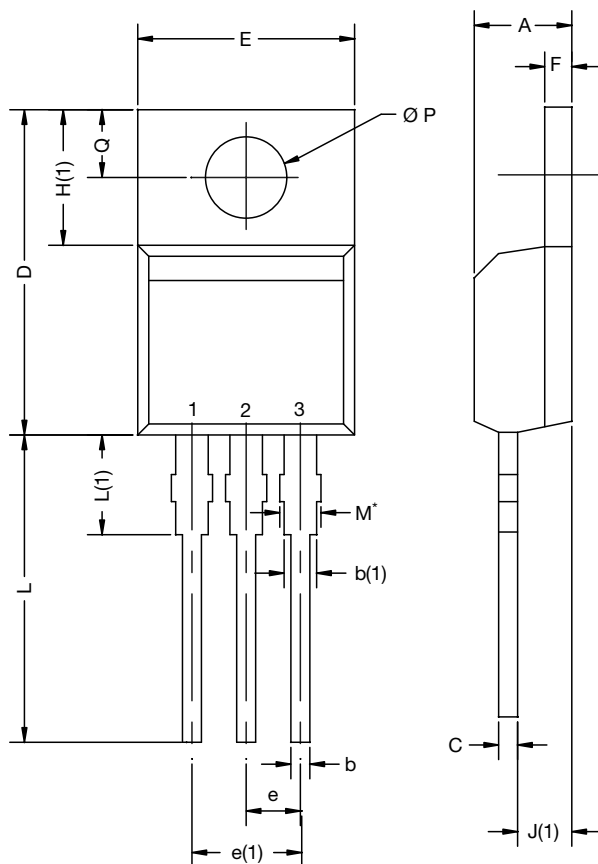
**Peak Diode Recovery dV/dt Test Circuit**

**Note**

a.  $V_{GS} = 5\text{ V}$  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 |
| $\varnothing P$ | 3.53        | 3.94  | 0.139  | 0.155 |
| Q               | 2.54        | 3.00  | 0.100  | 0.118 |

ECN: E21-0621-Rev. D, 04-Nov-2021  
DWG: 6031

### Note

- $M^*$  = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM



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