

# Power MOSFET

**TO-220AB**


N-Channel MOSFET

## FEATURES

- Extremely low  $R_{DS(on)}$
- Compact plastic package
- Fast switching
- Low drive current
- Ease of paralleling
- Excellent temperature stability
- Parts per million quality
- 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

## DESCRIPTION

The technology has expanded its product base to serve the low voltage, very low  $R_{DS(on)}$  MOSFET transistor requirements. Vishay's highly efficient geometry and unique processing have been combined to create the lowest on resistance per device performance. In addition to this feature all have documented reliability and parts per million quality!

The transistor also offer all of the well established advantages of MOSFETs such as voltage control, very fast switching, ease of paralleling, and temperature stability of the electrical parameters.

They are well suited for applications such as switching power supplies, motor controls, inverters, choppers, audio amplifiers, high energy pulse circuits, and in systems that are operated from low voltage batteries, such as automotive, portable equipment, etc.

## PRODUCT SUMMARY

|                           |                        |      |
|---------------------------|------------------------|------|
| $V_{DS}$ (V)              | 50                     |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.10 |
| $Q_g$ (Max.) (nC)         | 17                     |      |
| $Q_{gs}$ (nC)             | 9.0                    |      |
| $Q_{gd}$ (nC)             | 3.0                    |      |
| Configuration             | Single                 |      |

## ORDERING INFORMATION

|                                 |               |
|---------------------------------|---------------|
| Package                         | TO-220AB      |
| Lead (Pb)-free                  | IRFZ20PbF     |
| Lead (Pb)-free and halogen-free | IRFZ20PbF-BE3 |

## ABSOLUTE MAXIMUM RATINGS

| ABSOLUTE MAXIMUM RATINGS                         |                         |                         |                                   |                                 |      |
|--------------------------------------------------|-------------------------|-------------------------|-----------------------------------|---------------------------------|------|
| PARAMETER                                        |                         |                         | SYMBOL                            | LIMIT                           | UNIT |
| Drain-source voltage <sup>a</sup>                |                         |                         | V <sub>DS</sub>                   | 50                              | V    |
| Gate-source voltage <sup>a</sup>                 |                         |                         | 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>                    | 15                              | A    |
|                                                  |                         | T <sub>C</sub> = 100 °C |                                   | 10                              |      |
| Pulsed drain current <sup>b</sup>                |                         |                         | I <sub>DM</sub>                   | 60                              |      |
| Single pulse avalanche energy <sup>c</sup>       |                         |                         | E <sub>AS</sub>                   | 5                               | mJ   |
| Linear derating factor (see fig. 16)             |                         |                         |                                   | 0.32                            | W/°C |
| Maximum power dissipation (see fig. 16)          | T <sub>C</sub> = 25 °C  |                         | P <sub>D</sub>                    | 40                              | W    |
| 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 (0.063" (1.6 mm) from case) |      |

## Notes

a.  $T_J = 25\text{ }^\circ\text{C}$  to  $150\text{ }^\circ\text{C}$

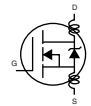
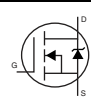
b. Repetitive rating: Pulse width limited by max. junction temperature. See transient temperature impedance curve (see fig. 11)

c. Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 0.07\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 12\text{ A}$

**THERMAL RESISTANCE RATINGS**

| PARAMETER                                                | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------------------------------|------------|------|------|------|
| Typical socket mount, junction-to-ambient                | $R_{thJA}$ | -    | 80   | °C/W |
| Case-to-sink, mounting surface flat, smooth, and greased | $R_{thCS}$ | 1.0  | -    |      |
| Junction-to-case                                         | $R_{thJC}$ | -    | 3.12 |      |

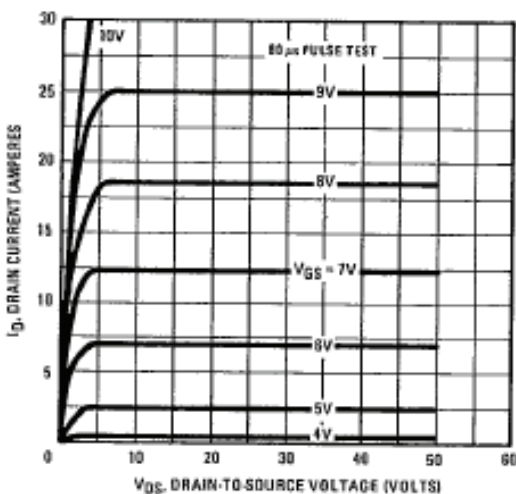
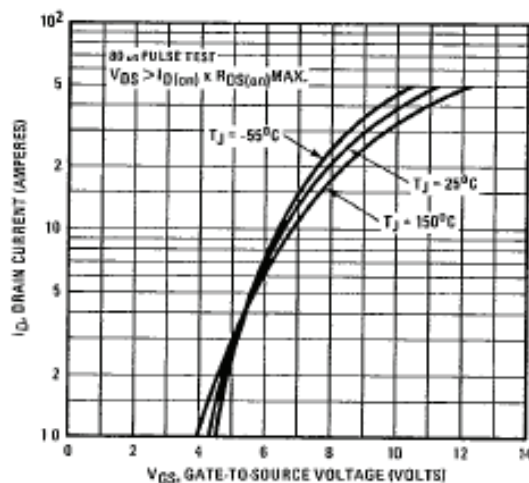
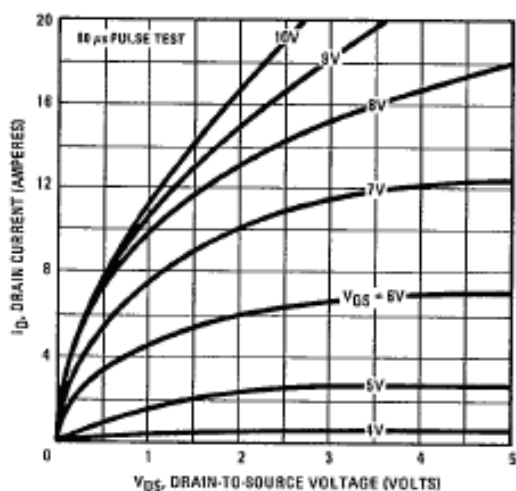
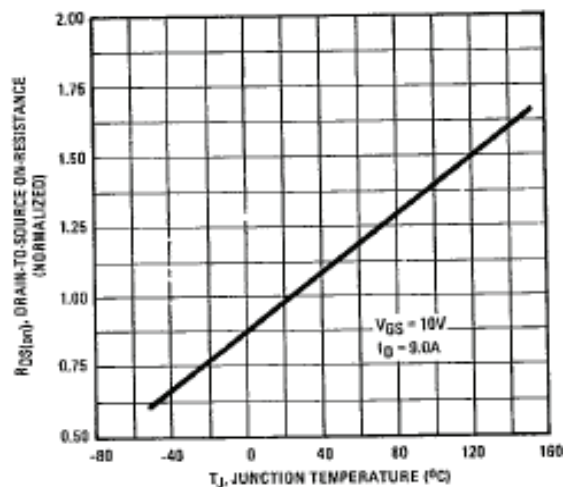
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| 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                                                                                                               |                                                                                                                                                          | 50                                                              | -     | -     | V    |
| V <sub>DS</sub> temperature coefficient       | 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 threshold voltage                 | I <sub>GSS</sub>    | V <sub>GS</sub> = ± 20 V                                                                                                                                     |                                                                                                                                                          | -                                                               | -     | ± 500 | nA   |
| Gate-source leakage                           | I <sub>DSS</sub>    | V <sub>DS</sub> > Max. Rating, V <sub>GS</sub> = 0 V                                                                                                         |                                                                                                                                                          | -                                                               | -     | 250   | μA   |
| Zero gate voltage drain current               |                     | V <sub>DS</sub> = Max. Rating x 0.8, V <sub>GS</sub> = 0 V, T <sub>C</sub> = 125 °C                                                                          |                                                                                                                                                          | -                                                               | -     | 1000  |      |
|                                               |                     | I <sub>D(on)</sub>                                                                                                                                           | V <sub>GS</sub> = 10 V                                                                                                                                   | V <sub>DS</sub> > I <sub>D(on)</sub> x R <sub>DS(on)</sub> max. | -     | -     | 15   |
| Drain-source on-state resistance <sup>b</sup> | R <sub>DS(on)</sub> | V <sub>GS</sub> = 10 V                                                                                                                                       | I <sub>D</sub> = 10 A                                                                                                                                    | -                                                               | 0.080 | 0.10  | Ω    |
| Forward transconductance <sup>b</sup>         | g <sub>fs</sub>     | V <sub>DS</sub> > I <sub>D(on)</sub> x R <sub>DS(on)</sub> max., I <sub>D</sub> = 9.0 A                                                                      |                                                                                                                                                          | 5.0                                                             | 6.0   | -     | 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. 11                                                                                |                                                                                                                                                          | -                                                               | 560   | 860   | pF   |
| Output capacitance                            | C <sub>oss</sub>    |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 250   | 350   |      |
| Reverse transfer capacitance                  | C <sub>rss</sub>    |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 60    | 100   |      |
| Total gate charge                             | Q <sub>g</sub>      | V <sub>GS</sub> = 10 V                                                                                                                                       | I <sub>D</sub> = 20 A, V <sub>DS</sub> = 0.8 max. rating, see fig. 18 for test circuit (Gate charge is essentially independent of operating temperature) | -                                                               | 12    | 17    | nC   |
| Gate-source charge                            | Q <sub>gs</sub>     |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 9.0   | -     |      |
| Gate-drain charge                             | Q <sub>gd</sub>     |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 3.0   | -     |      |
| Turn-on delay time                            | t <sub>d(on)</sub>  | V <sub>DD</sub> = 25 V, I <sub>D</sub> = 9.0 A,<br>Z <sub>0</sub> = 50 Ω, see fig. 5 <sup>b</sup>                                                            |                                                                                                                                                          | -                                                               | 15    | 30    | ns   |
| Rise time                                     | t <sub>r</sub>      |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 45    | 90    |      |
| Turn-off delay time                           | t <sub>d(off)</sub> |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 20    | 40    |      |
| Fall time                                     | t <sub>f</sub>      |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 15    | 30    |      |
| Internal drain inductance                     | L <sub>D</sub>      | Modified MOSFET symbol showing the internal device inductances<br>      |                                                                                                                                                          | -                                                               | 3.5   | -     | nH   |
| Internal source inductance                    | L <sub>S</sub>      |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 4.5   | -     |      |
| Drain-Source Body Diode Characteristics       |                     |                                                                                                                                                              |                                                                                                                                                          |                                                                 |       |       |      |
| Continuous source-drain diode current         | I <sub>S</sub>      | MOSFET symbol showing the integral reverse p - n junction rectifier<br> |                                                                                                                                                          | -                                                               | -     | 15    | A    |
| Pulsed diode forward current <sup>a</sup>     | I <sub>SM</sub>     |                                                                                                                                                              |                                                                                                                                                          | -                                                               | -     | 60    |      |
| Body diode voltage <sup>b</sup>               | V <sub>SD</sub>     | T <sub>C</sub> = 25 °C, I <sub>S</sub> = 15 A, V <sub>GS</sub> = 0 V                                                                                         |                                                                                                                                                          | -                                                               | -     | 1.5   | V    |
| Body diode reverse recovery time              | t <sub>rr</sub>     | T <sub>J</sub> = 150 °C, I <sub>F</sub> = 15 A, dI <sub>F</sub> /dt = 100 A/μs                                                                               |                                                                                                                                                          | -                                                               | 100   | -     | ns   |
| Body diode reverse recovery charge            | Q <sub>rr</sub>     |                                                                                                                                                              |                                                                                                                                                          | -                                                               | 0.4   | -     | 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 max. junction temperature. See transient temperature impedance curve (see fig. 5)

b. Pulse test: Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$

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

**Fig. 1 - Typical Output Characteristics**

**Fig. 1 - Typical Transfer Characteristics**

**Fig. 2 - Typical Saturation Characteristics**

**Fig. 2 - Normalized On-Resistance vs. Temperature**

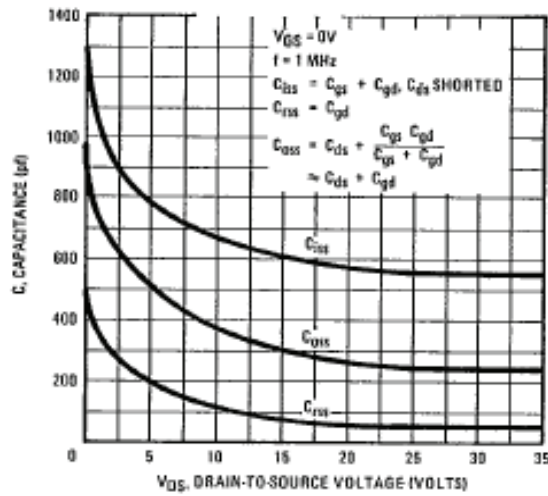


Fig. 3 - Typical Capacitance vs. Drain-to-Source Voltage

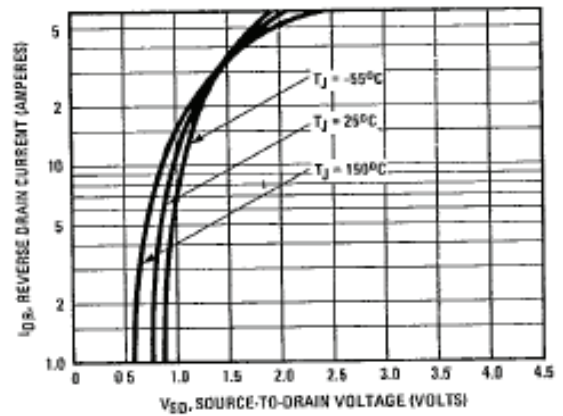


Fig. 5 - Typical Source-Drain Diode Forward Voltage

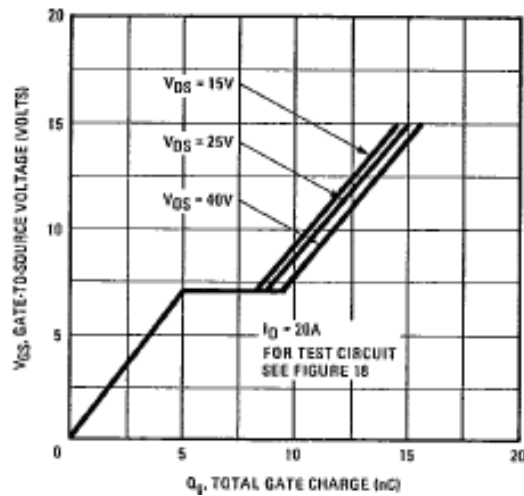


Fig. 4 - Typical Gate Charge vs. Gate-to-Source Voltage

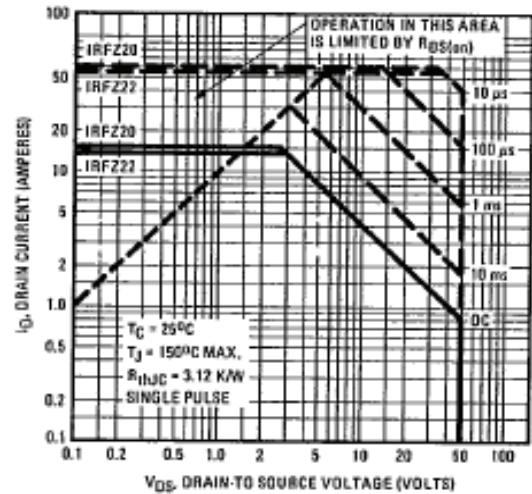


Fig. 6 - Maximum Safe Operating Area

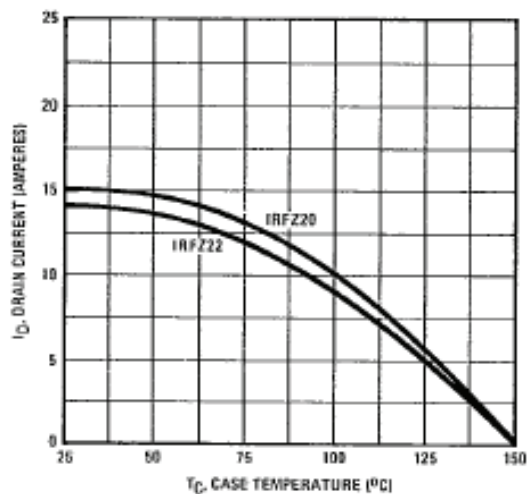


Fig. 7 - Maximum Drain Current vs. Case Temperature

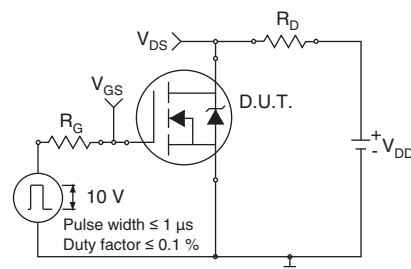


Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms

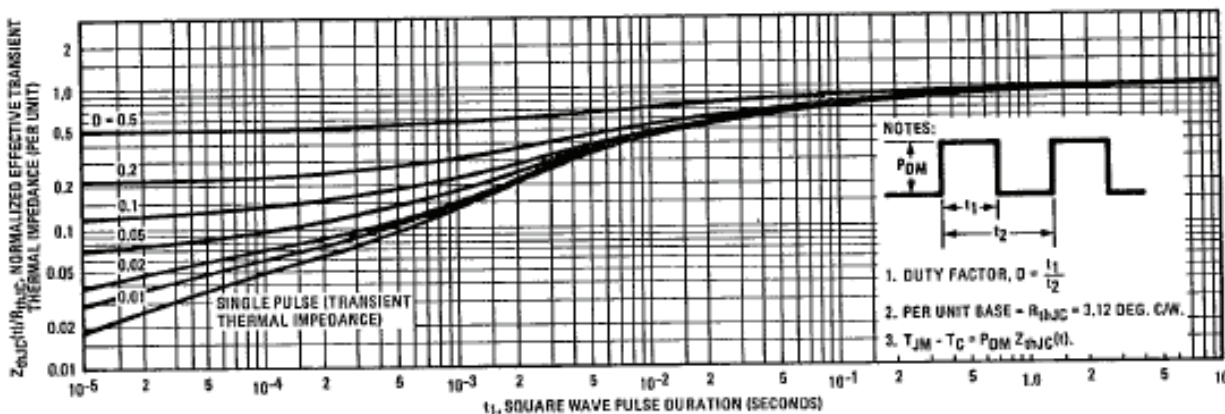


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case vs. Pulse Duration

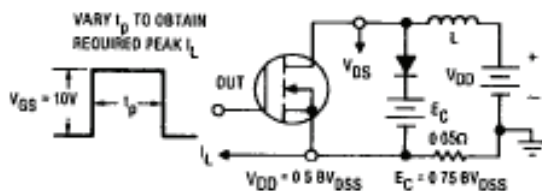


Fig. 12a - Clamped Inductive Test Circuit

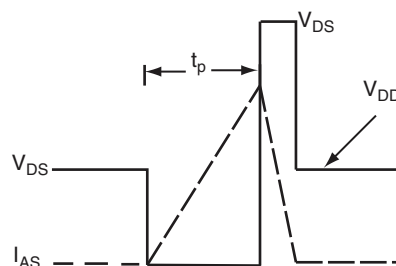


Fig. 12b - Unclamped Inductive Waveforms

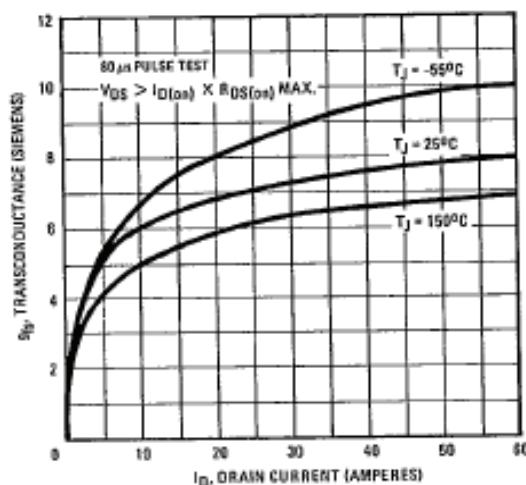


Fig. 13 - Typical Transconductance vs. Drain Current

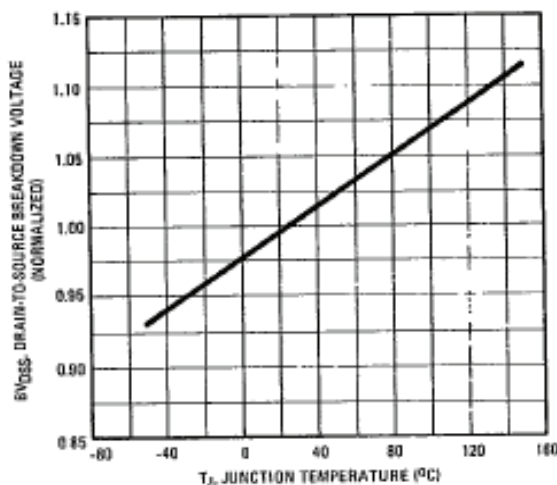


Fig. 14 - Breakdown Voltage vs. Temperature

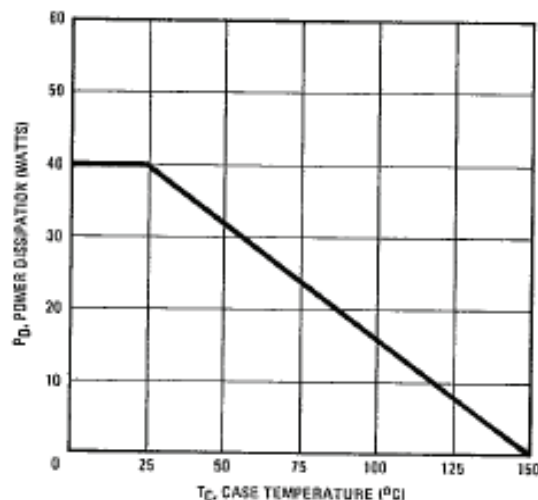


Fig. 16 - Power vs. Temperature Derating Curve

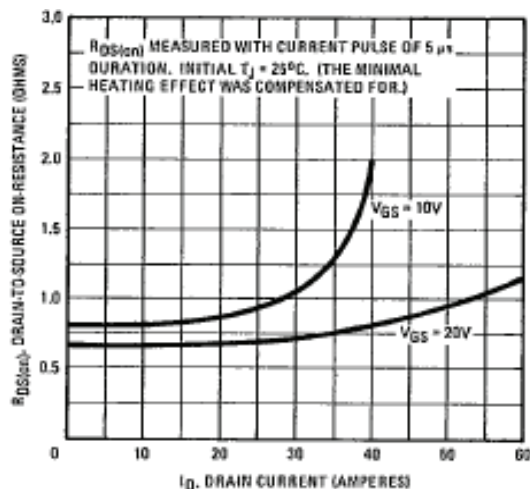


Fig. 15 - Typical On-Resistance vs. Drain Current

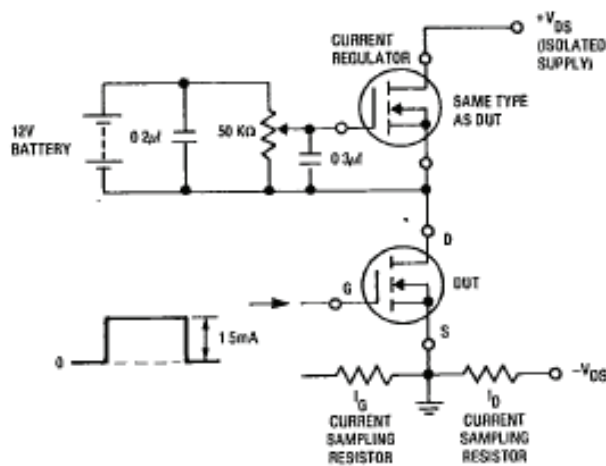
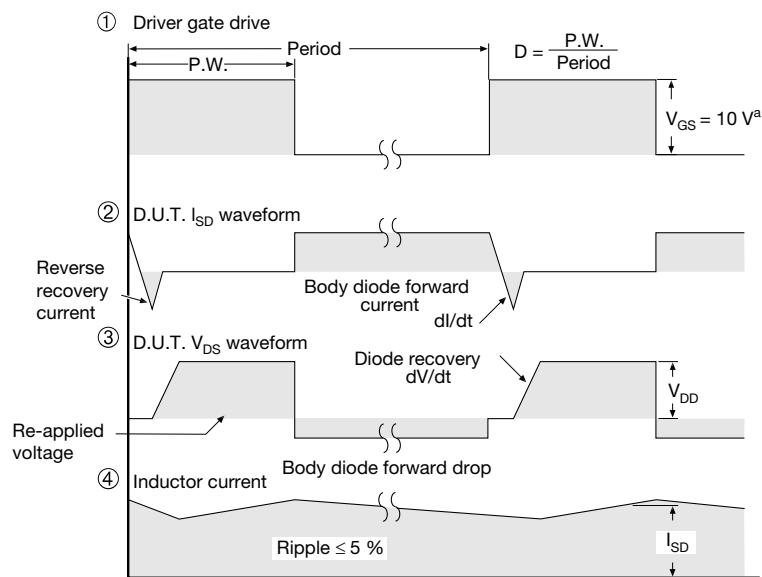
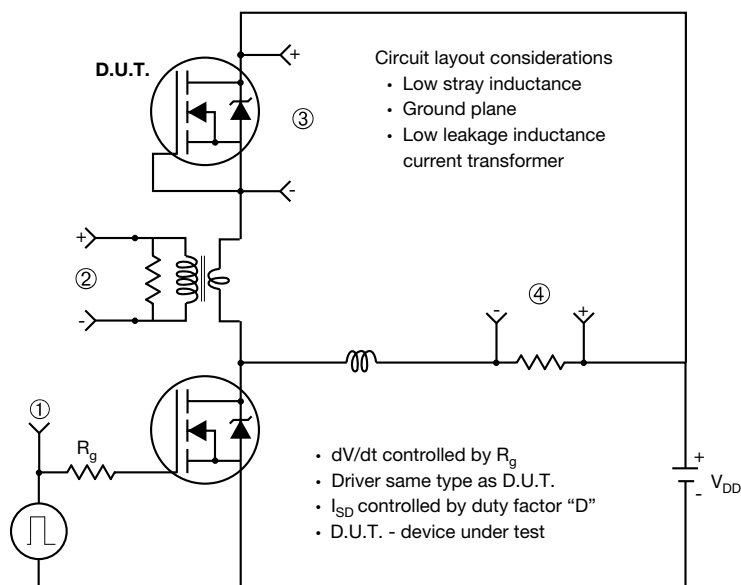


Fig. 17 - Gate Charge Test Circuit

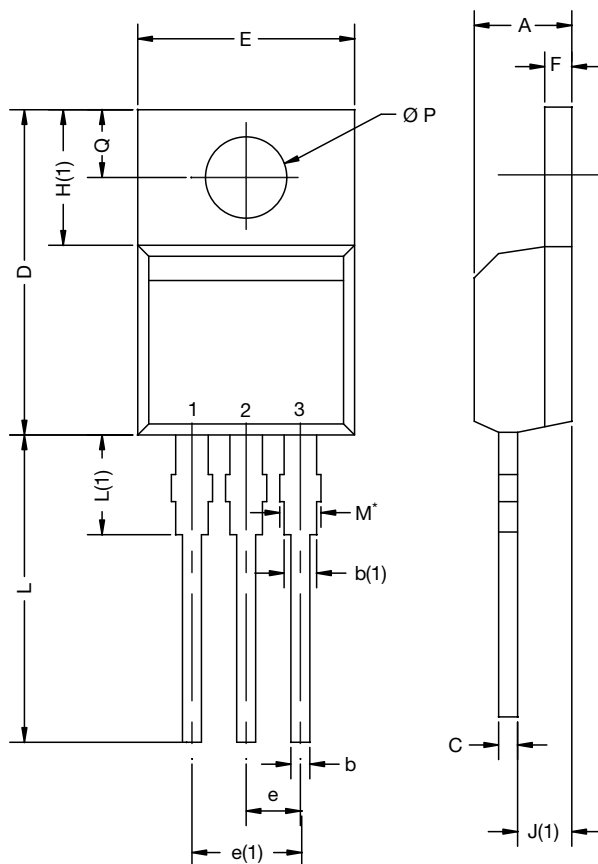
**Peak Diode Recovery dV/dt Test Circuit**

**Note**

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

**Fig. 14 - For N-Channel**

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 <http://www.vishay.com/ppg?91340>.

## 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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