

# Power MOSFET

**TO-220AB**


N-Channel MOSFET

## FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- Fast switching
- Ease of paralleling
- Simple drive requirements
- 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

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220AB package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

## PRODUCT SUMMARY

|                           |                            |
|---------------------------|----------------------------|
| $V_{DS}$ (V)              | 600                        |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ 1.2 |
| $Q_g$ max. (nC)           | 60                         |
| $Q_{gs}$ (nC)             | 8.3                        |
| $Q_{gd}$ (nC)             | 30                         |
| Configuration             | Single                     |

## ORDERING INFORMATION

|                                 |                |
|---------------------------------|----------------|
| Package                         | TO-220AB       |
| Lead (Pb)-free                  | IRFBC40PbF     |
| Lead (Pb)-free and halogen-free | IRFBC40PbF-BE3 |

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

| PARAMETER                                                 | SYMBOL                           | LIMIT                         | UNIT                |
|-----------------------------------------------------------|----------------------------------|-------------------------------|---------------------|
| Drain-source voltage                                      | $V_{DS}$                         | 600                           | V                   |
| Gate-source voltage                                       | $V_{GS}$                         | $\pm 20$                      |                     |
| Continuous drain current                                  | $V_{GS} \text{ at } 10\text{ V}$ | $T_C = 25^\circ\text{C}$ 6.2  | A                   |
|                                                           |                                  | $T_C = 100^\circ\text{C}$ 3.9 |                     |
| Pulsed drain current <sup>a</sup>                         | $I_{DM}$                         | 25                            |                     |
| Linear derating factor                                    |                                  | 1.0                           | W/ $^\circ\text{C}$ |
| Single pulse avalanche energy <sup>b</sup>                | $E_{AS}$                         | 570                           | mJ                  |
| Repetitive avalanche current <sup>a</sup>                 | $I_{AR}$                         | 6.2                           | A                   |
| Repetitive avalanche energy <sup>a</sup>                  | $E_{AR}$                         | 13                            | mJ                  |
| Maximum power dissipation                                 | $T_C = 25^\circ\text{C}$ $P_D$   | 125                           | W                   |
| Peak diode recovery dV/dt <sup>c</sup>                    | dV/dt                            | 3.0                           | V/ns                |
| Operating junction and storage temperature range          | $T_J, T_{stg}$                   | -55 to +150                   | $^\circ\text{C}$    |
| Soldering recommendations (peak temperature) <sup>d</sup> | For 10 s                         | 300                           |                     |
| Mounting torque                                           | 6-32 or M3 screw                 | 10                            | lbf · in            |
|                                                           |                                  | 1.1                           | N · m               |

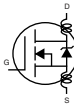
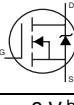
## Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 27\text{ mH}$ ,  $R_g = 25\ \Omega$ ,  $I_{AS} = 6.2\text{ A}$  (see fig. 12)
- $I_{SD} \leq 6.2\text{ A}$ ,  $dI/dt \leq 80\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150^\circ\text{C}$
- 1.6 mm from case

**THERMAL RESISTANCE RATINGS**

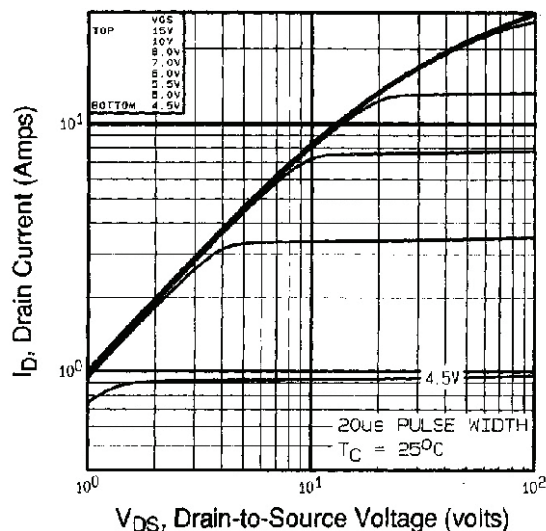
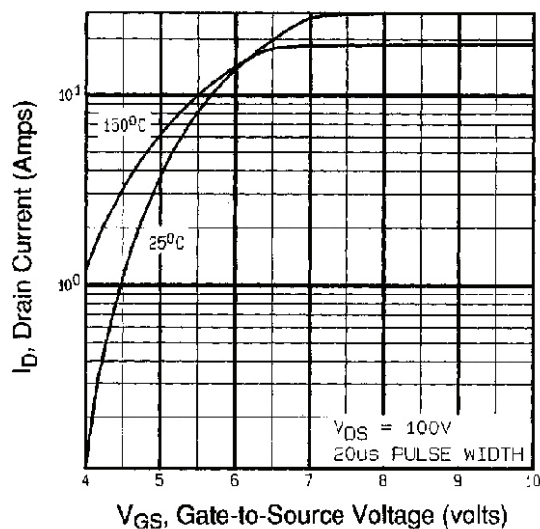
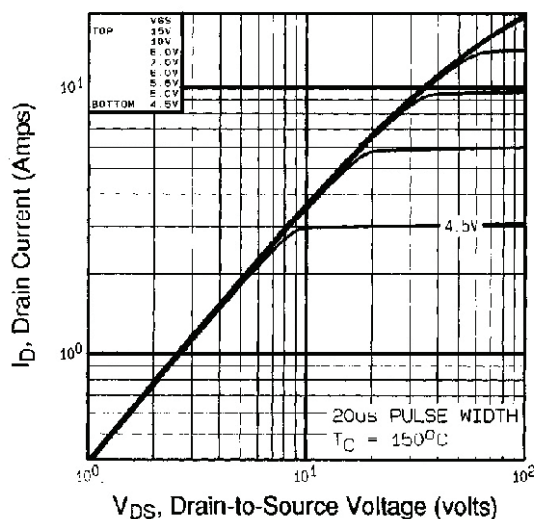
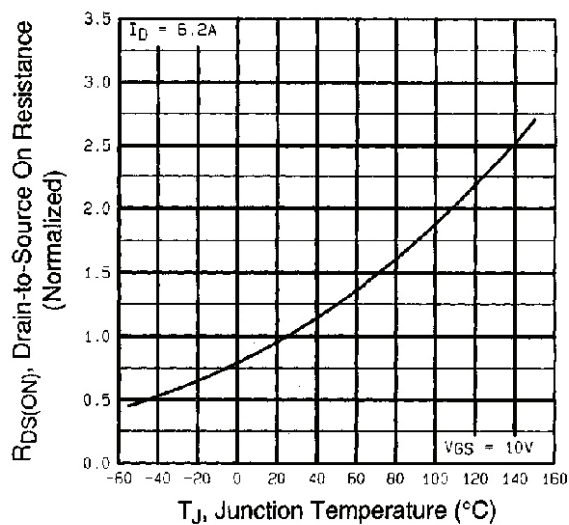
| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------|------------|------|------|------|
| Maximum junction-to-ambient         | $R_{thJA}$ | -    | 62   | °C/W |
| Case-to-sink, flat, greased surface | $R_{thCS}$ | 0.50 | -    |      |
| Maximum junction-to-case (drain)    | $R_{thJC}$ | -    | 1.0  |      |

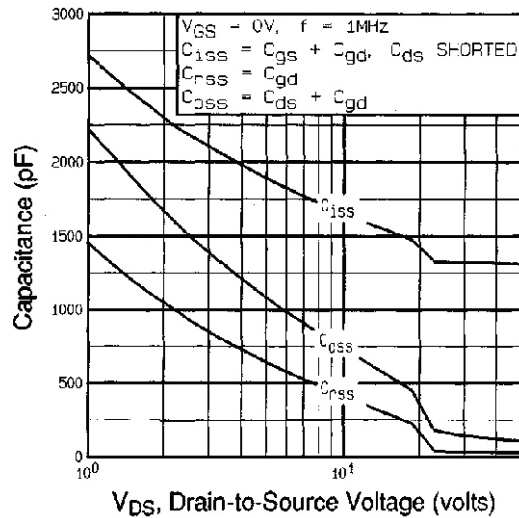
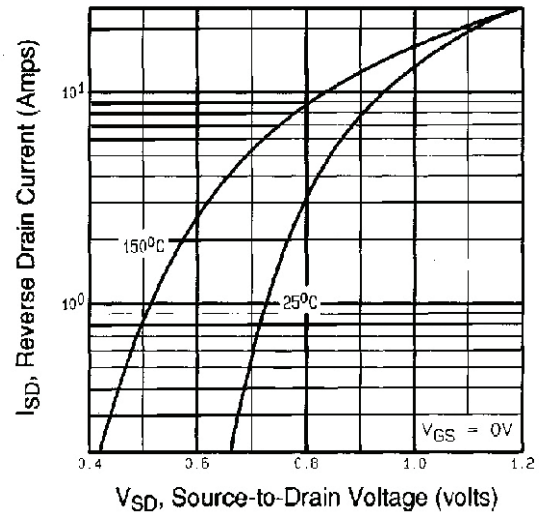
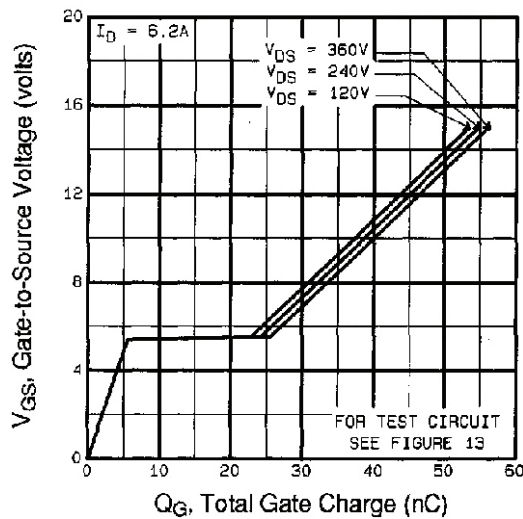
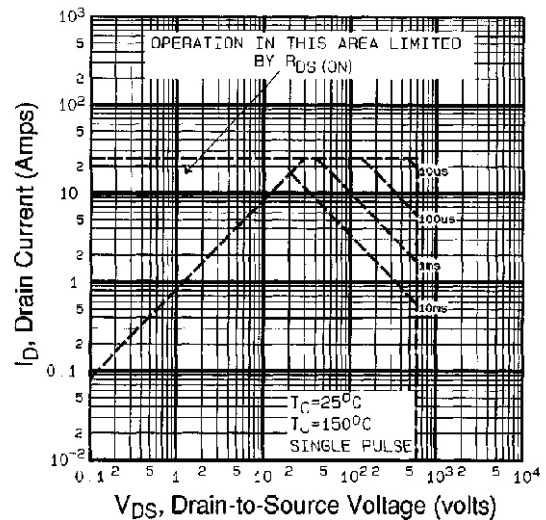
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

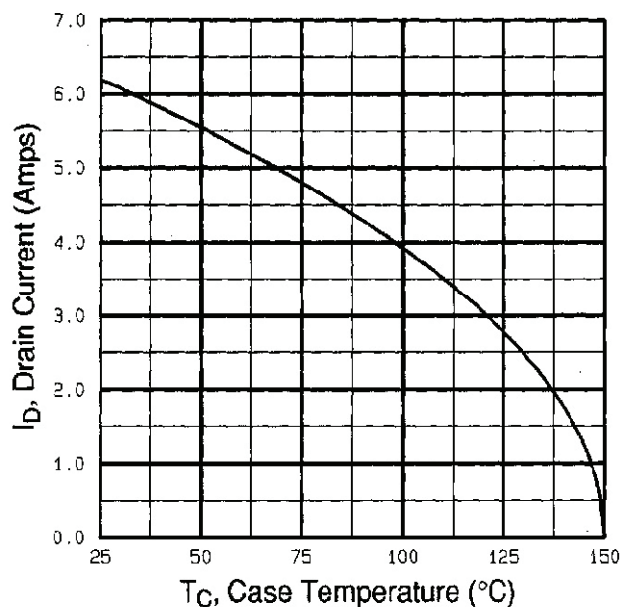
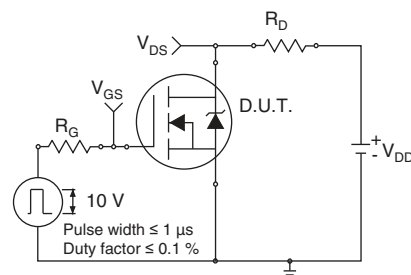
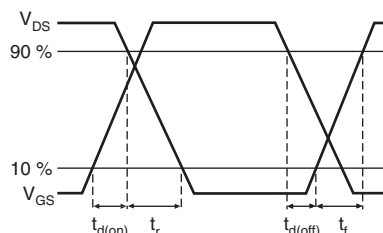
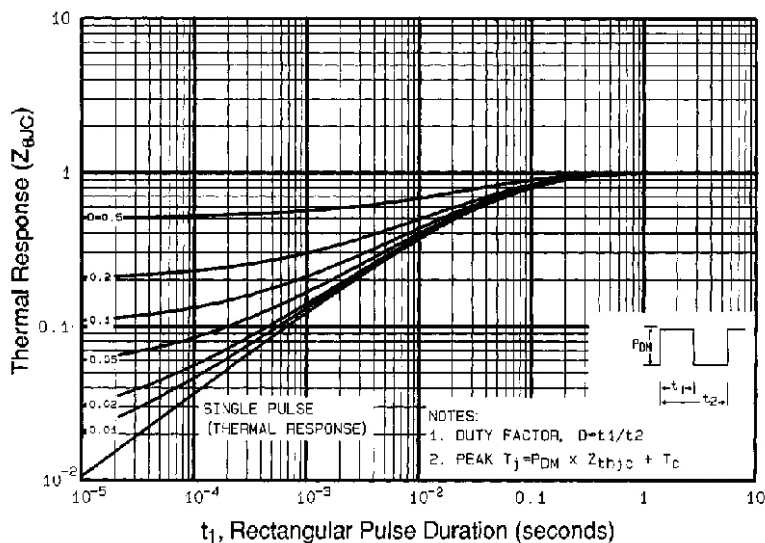
| PARAMETER                                 | SYMBOL                           | TEST CONDITIONS                                                                                                                                                  |                                                                                    | 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                                                                                                                   |                                                                                    | 600  | -    | -     | 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                                                                                                                        |                                                                                    | -    | 0.7  | -     | 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 V                                                                                                                                         |                                                                                    | -    | -    | ± 100 | nA   |
| Zero gate voltage drain current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V                                                                                                                   |                                                                                    | -    | -    | 100   | μA   |
|                                           |                                  | V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                          |                                                                                    | -    | -    | 500   |      |
| Drain-source on-state resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                           | I <sub>D</sub> = 3.7A <sup>b</sup>                                                 | -    | -    | 1.2   | Ω    |
| Forward transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 100 V, I <sub>D</sub> = 3.7 A <sup>b</sup>                                                                                                     |                                                                                    | 4.7  | -    | -     | 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                                                                                     |                                                                                    | -    | 1300 | -     | pF   |
| Output capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                                  |                                                                                    | -    | 160  | -     |      |
| Reverse transfer capacitance              | C <sub>rss</sub>                 |                                                                                                                                                                  |                                                                                    | -    | 30   | -     |      |
| Total gate charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                           | I <sub>D</sub> = 6.2 A, V <sub>DS</sub> = 360 V,<br>see fig. 6 and 13 <sup>b</sup> | -    | -    | 60    | nC   |
| Gate-source charge                        | Q <sub>gs</sub>                  |                                                                                                                                                                  |                                                                                    | -    | -    | 8.3   |      |
| Gate-drain charge                         | Q <sub>gd</sub>                  |                                                                                                                                                                  |                                                                                    | -    | -    | 30    |      |
| Turn-on delay time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 300 V, I <sub>D</sub> = 6.2 A,<br>R <sub>g</sub> = 9.1 Ω, R <sub>D</sub> = 47 Ω, see fig. 10 <sup>b</sup>                                      |                                                                                    | -    | 13   | -     | ns   |
| Rise time                                 | t <sub>r</sub>                   |                                                                                                                                                                  |                                                                                    | -    | 18   | -     |      |
| Turn-off delay time                       | t <sub>d(off)</sub>              |                                                                                                                                                                  |                                                                                    | -    | 55   | -     |      |
| Fall time                                 | t <sub>f</sub>                   |                                                                                                                                                                  |                                                                                    | -    | 20   | -     |      |
| Gate input resistance                     | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                            |                                                                                    | 0.3  | -    | 3.9   | Ω    |
| Internal drain inductance                 | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact  |                                                                                    | -    | 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    |                                                                                    | -    | -    | 6.2   | A    |
| Pulsed diode forward current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                                  |                                                                                    | -    | -    | 25    |      |
| Body diode voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 6.2 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> = 6.2 A, dI/dt = 100 A/μs <sup>b</sup>                                                                                    |                                                                                    | -    | 450  | 940   | ns   |
| Body diode reverse recovery charge        | Q <sub>rr</sub>                  |                                                                                                                                                                  |                                                                                    | -    | 3.8  | 7.9   | 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> )                                                                |                                                                                    |      |      |       |      |

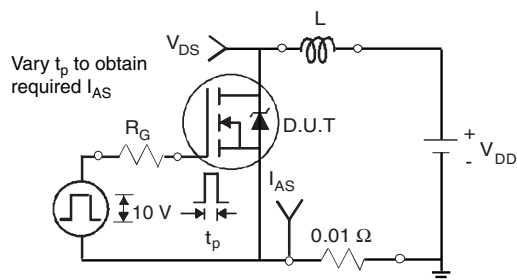
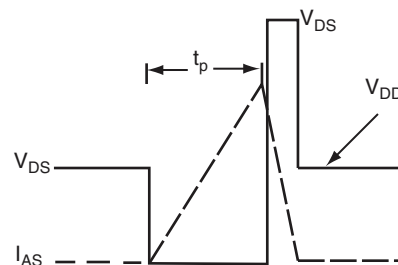
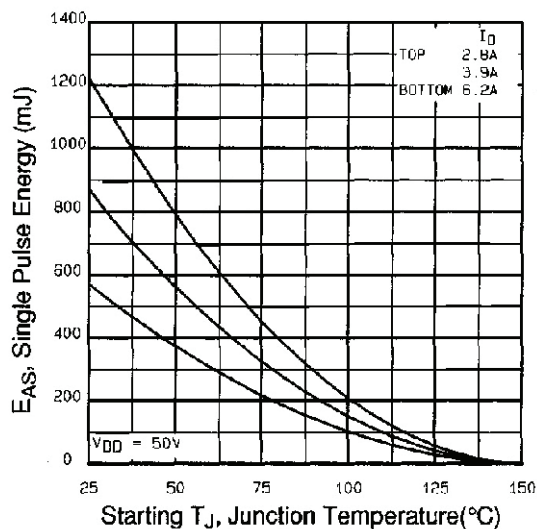
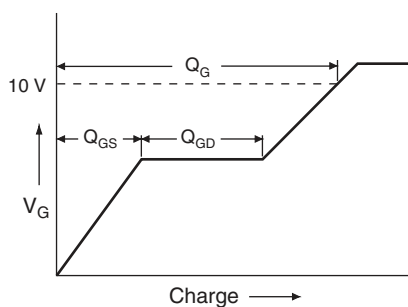
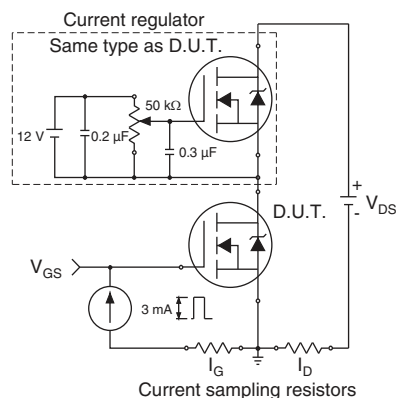
**Notes**

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

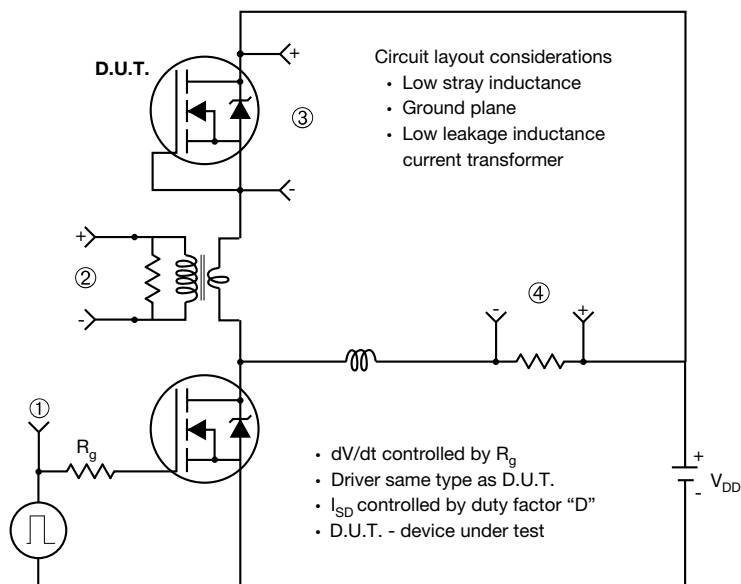
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

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

**Fig. 3 - Typical Transfer Characteristics**

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

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

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

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