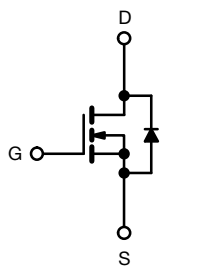
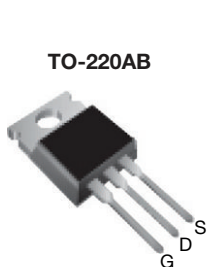


## E Series Power MOSFET



N-Channel MOSFET

### FEATURES

- Low figure-of-merit (FOM):  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Reduced switching and conduction losses
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**  
Available

### APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Industrial
  - Welding
  - Induction heating
  - Motor drives
  - Battery chargers
  - Renewable energy
  - Solar (PV inverters)

### PRODUCT SUMMARY

|                                         |                 |       |
|-----------------------------------------|-----------------|-------|
| $V_{DS}$ (V) at $T_J$ max.              | 650             |       |
| $R_{DS(on)}$ max. ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V | 0.099 |
| $Q_g$ max. (nC)                         | 150             |       |
| $Q_{gs}$ (nC)                           | 24              |       |
| $Q_{gd}$ (nC)                           | 42              |       |
| Configuration                           | Single          |       |

### ORDERING INFORMATION

|                                 |                |
|---------------------------------|----------------|
| Package                         | TO-220AB       |
| Lead (Pb)-free                  | SiHP33N60E-E3  |
| Lead (Pb)-free and Halogen-free | SiHP33N60E-GE3 |

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

| PARAMETER                                                 | SYMBOL           | LIMIT          | UNIT |
|-----------------------------------------------------------|------------------|----------------|------|
| Drain-Source Voltage                                      | $V_{DS}$         | 600            | V    |
| Gate-Source Voltage                                       | $V_{GS}$         | $\pm 30$       |      |
| Continuous Drain Current ( $T_J = 150$ °C)                | $V_{GS}$ at 10 V | $T_C = 25$ °C  | A    |
|                                                           |                  | $T_C = 100$ °C |      |
| Pulsed Drain Current <sup>a</sup>                         | $I_{DM}$         | 88             |      |
| Linear Derating Factor                                    |                  | 2.2            | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                | $E_{AS}$         | 793            | mJ   |
| Maximum Power Dissipation                                 | $P_D$            | 278            | W    |
| Operating Junction and Storage Temperature Range          | $T_J, T_{stg}$   | -55 to +150    | °C   |
| Drain-Source Voltage Slope                                | $dV/dt$          | 70             | V/ns |
| Reverse Diode $dV/dt$ <sup>d</sup>                        |                  | 12             |      |
| Soldering Recommendations (Peak temperature) <sup>c</sup> | for 10 s         | 300            | °C   |


#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 7.5$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.

**THERMAL RESISTANCE RATINGS**

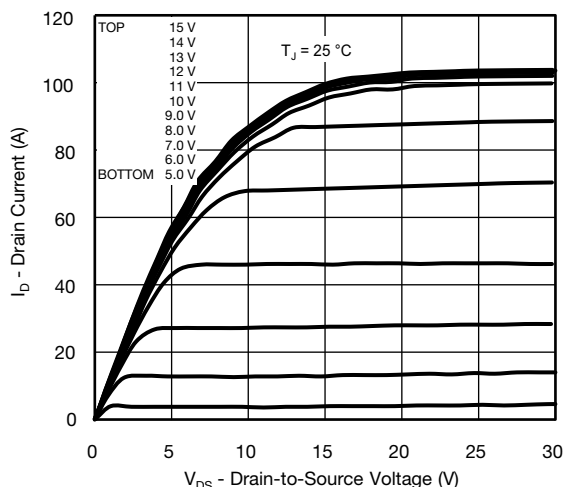
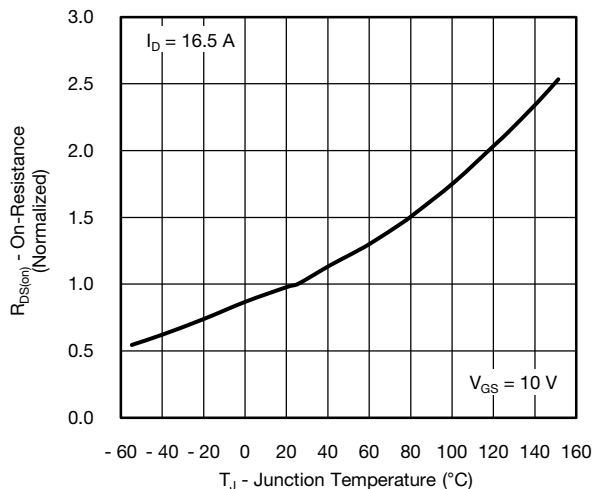
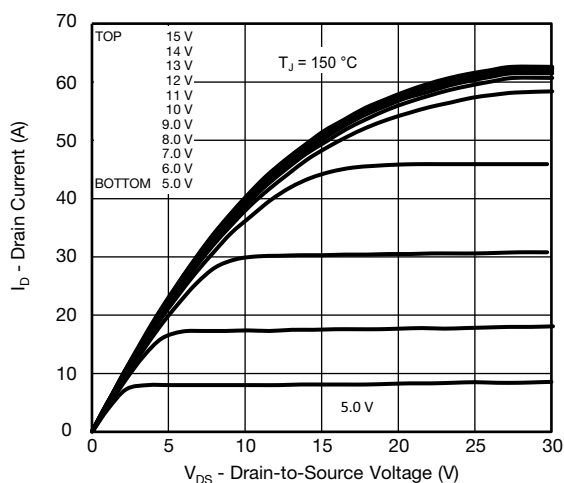
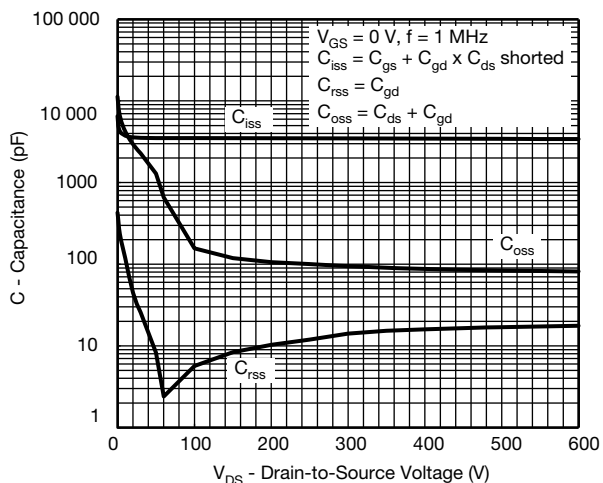
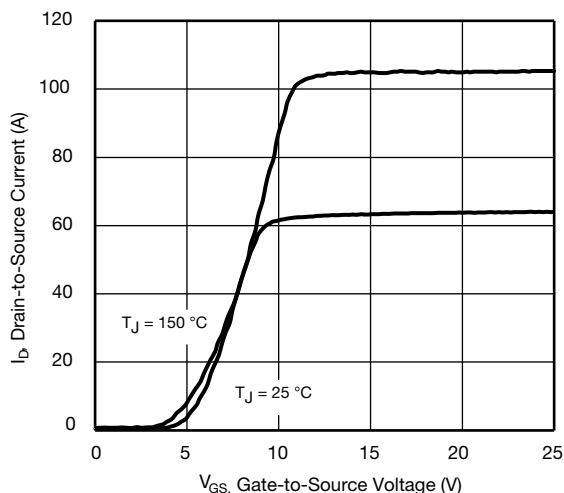
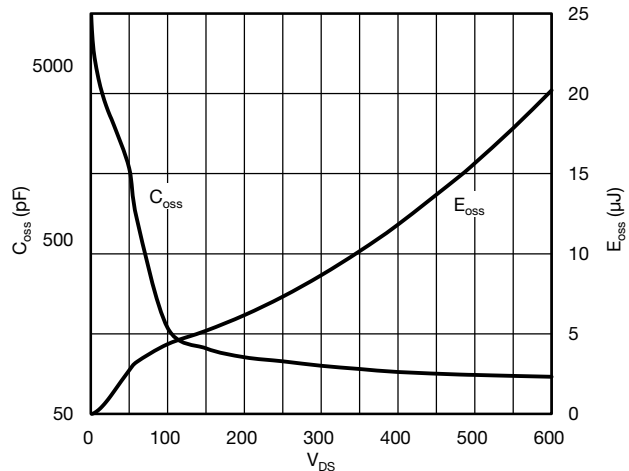
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.45 |      |

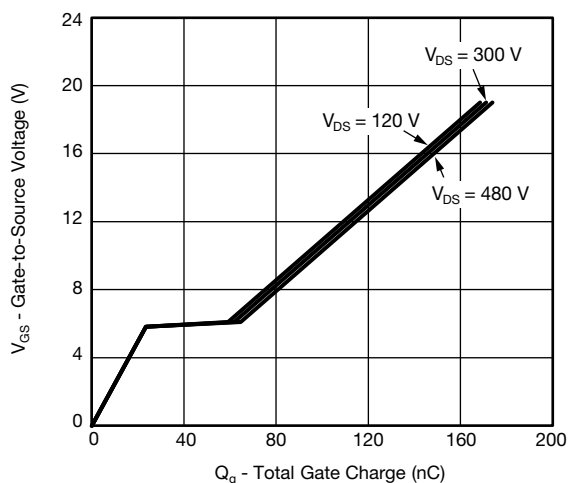
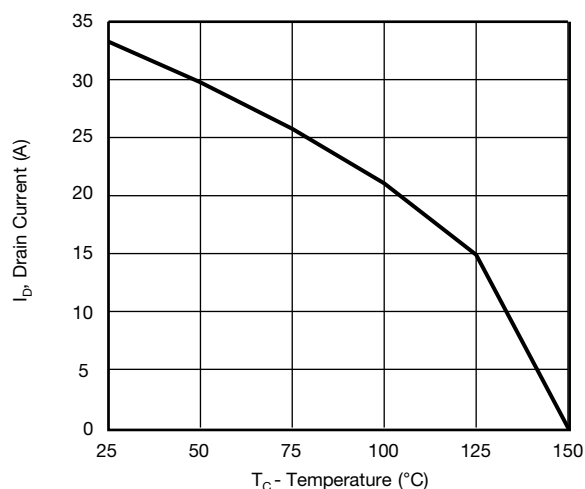
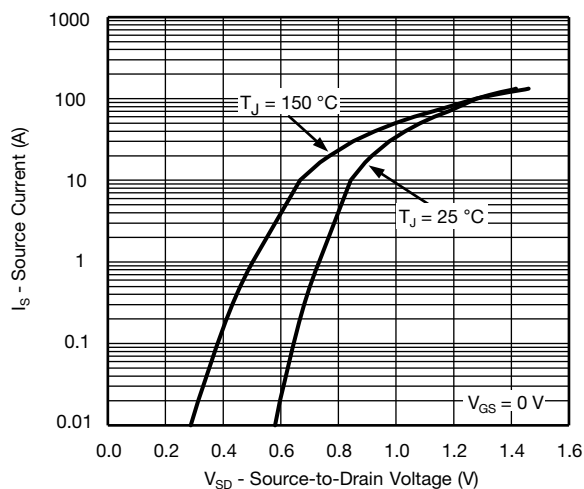
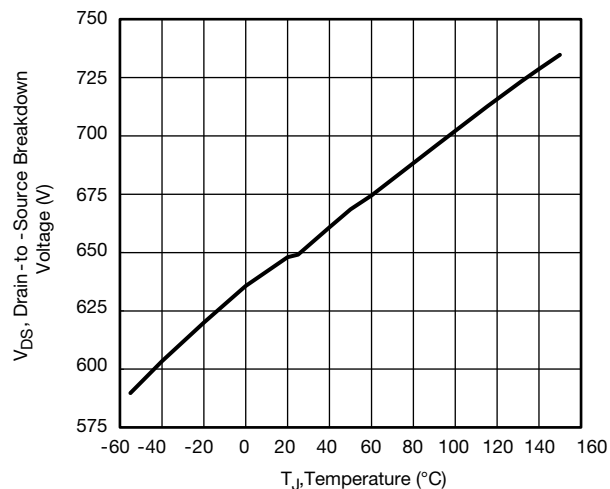
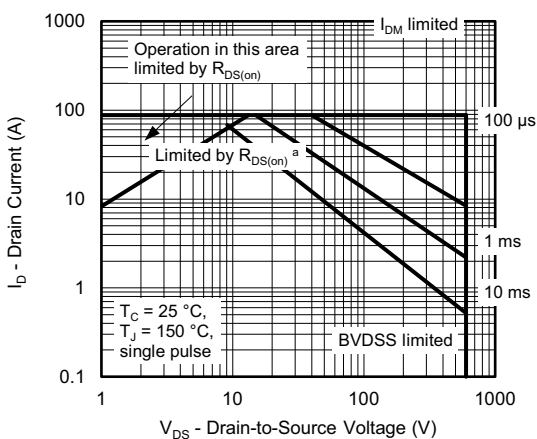
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

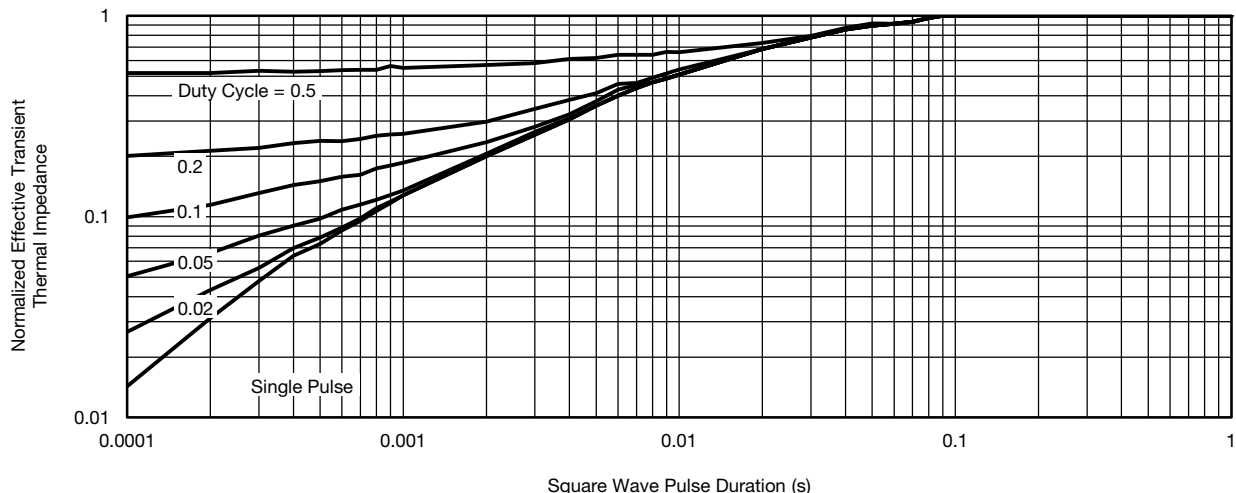
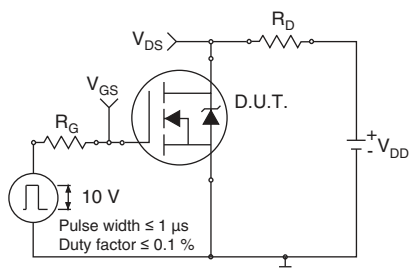
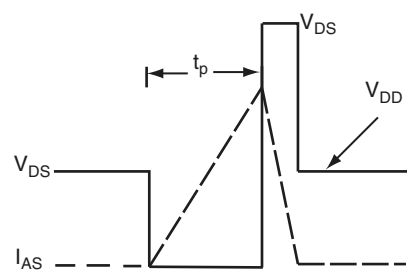
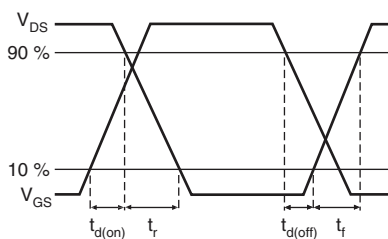
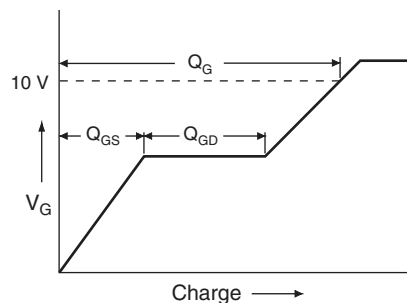
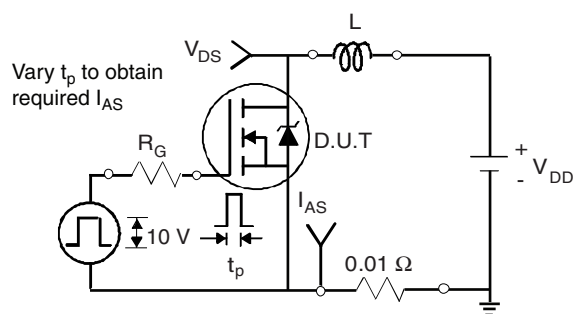
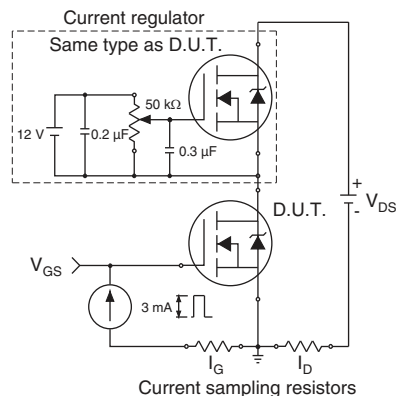
| PARAMETER                                                 | SYMBOL                           | TEST CONDITIONS                                                                                                                                          |                                                  | MIN. | TYP.  | MAX.  | UNIT |
|-----------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|------|-------|-------|------|
| 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                                                                                                                |                                                  | -    | 0.71  | -     | V/°C |
| Gate-Source Threshold Voltage (N)                         | 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   |
|                                                           |                                  | V <sub>GS</sub> = ± 30 V                                                                                                                                 |                                                  | -    | -     | ± 1   | μA   |
| Zero Gate Voltage Drain Current                           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V                                                                                                           |                                                  | -    | -     | 1     | μA   |
|                                                           |                                  | V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                  |                                                  | -    | -     | 10    |      |
| Drain-Source On-State Resistance                          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 16.5 A                          | -    | 0.083 | 0.099 | Ω    |
| Forward Transconductance <sup>a</sup>                     | g <sub>fs</sub>                  | V <sub>DS</sub> = 30 V, I <sub>D</sub> = 16.5 A                                                                                                          |                                                  | -    | 11    | -     | S    |
| Dynamic                                                   |                                  |                                                                                                                                                          |                                                  |      |       |       |      |
| Input Capacitance                                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 100 V,<br>f = 1 MHz                                                                                          |                                                  | -    | 3508  | -     | pF   |
| Output Capacitance                                        | C <sub>oss</sub>                 |                                                                                                                                                          |                                                  | -    | 156   | -     |      |
| Reverse Transfer Capacitance                              | C <sub>rss</sub>                 |                                                                                                                                                          |                                                  | -    | 6     | -     |      |
| Effective Output Capacitance, Energy Related <sup>b</sup> | C <sub>o(er)</sub>               | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 0 V to 480 V                                                                                                    |                                                  | -    | 136   | -     | pF   |
| Effective Output Capacitance, Time Related <sup>c</sup>   | C <sub>o(tr)</sub>               |                                                                                                                                                          |                                                  | -    | 468   | -     |      |
| Total Gate Charge                                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 16.5 A, V <sub>DS</sub> = 480 V | -    | 100   | 150   | nC   |
| Gate-Source Charge                                        | Q <sub>gs</sub>                  |                                                                                                                                                          |                                                  | -    | 24    | -     |      |
| Gate-Drain Charge                                         | Q <sub>gd</sub>                  |                                                                                                                                                          |                                                  | -    | 42    | -     |      |
| Turn-On Delay Time                                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 480 V, I <sub>D</sub> = 16.5 A<br>R <sub>g</sub> = 9.1 Ω, V <sub>GS</sub> = 10 V                                                       |                                                  | -    | 28    | 56    | ns   |
| Rise Time                                                 | t <sub>r</sub>                   |                                                                                                                                                          |                                                  | -    | 60    | 90    |      |
| Turn-Off Delay Time                                       | t <sub>d(off)</sub>              |                                                                                                                                                          |                                                  | -    | 99    | 150   |      |
| Fall Time                                                 | t <sub>f</sub>                   |                                                                                                                                                          |                                                  | -    | 54    | 80    |      |
| Gate Input Resistance                                     | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                    |                                                  | 0.2  | 0.7   | 1.0   | 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<br> |                                                  | -    | -     | 33    | A    |
| Pulsed Diode Forward Current                              | I <sub>SM</sub>                  |                                                                                                                                                          |                                                  | -    | -     | 88    |      |
| Diode Forward Voltage                                     | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 16.5 A, V <sub>GS</sub> = 0 V                                                                                   |                                                  | -    | 0.9   | 1.2   | V    |
| Reverse Recovery Time                                     | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> ,<br>dI/dt = 100 A/μs, V <sub>R</sub> = 20 V                                                     |                                                  | -    | 503   | 1006  | ns   |
| Reverse Recovery Charge                                   | Q <sub>rr</sub>                  |                                                                                                                                                          |                                                  | -    | 8.5   | 17    | μC   |
| Reverse Recovery Current                                  | I <sub>RRM</sub>                 |                                                                                                                                                          |                                                  | -    | 26    | -     | A    |

**Notes**

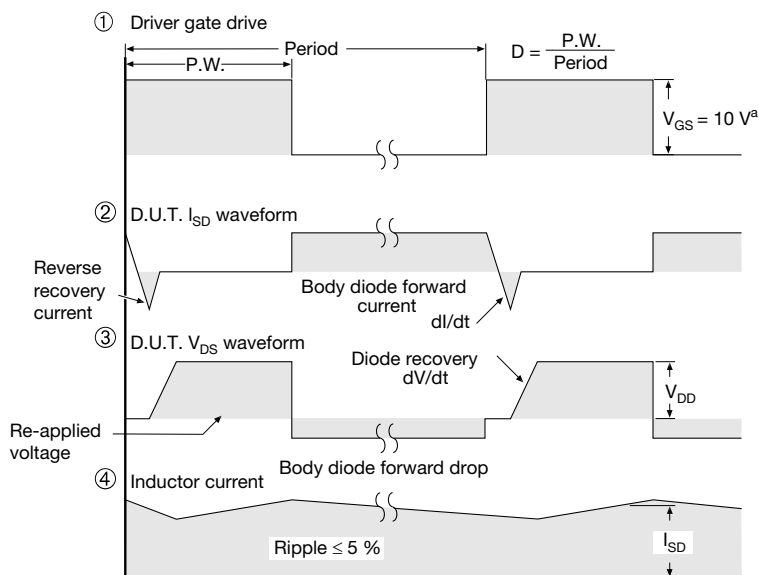
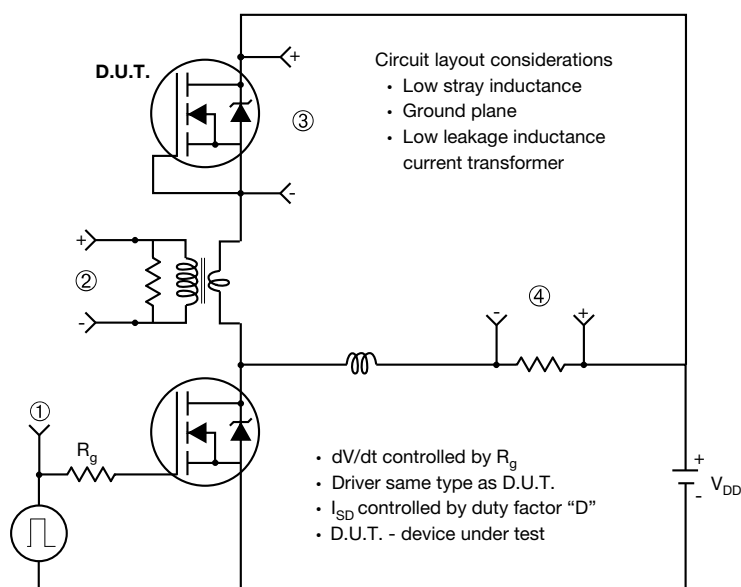
- a. Repetitive rating; pulse width limited by maximum junction temperature.  
b.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .  
c.  $C_{oss(tr)}$  is a fixed capacitance that gives the charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

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

**Fig. 1 - Typical Output Characteristics**

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

**Fig. 2 - Typical Output Characteristics**

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

**Fig. 3 - Typical Transfer Characteristics**

**Fig. 6 -  $C_{oss}$  and  $E_{oss}$  vs.  $V_{DS}$**


**Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage**

**Fig. 10 - Maximum Drain Current vs. Case Temperature**

**Fig. 8 - Typical Source-Drain Diode Forward Voltage**

**Fig. 11 - Typical Drain-to-Source Voltage vs. Temperature**

**Fig. 9 - Maximum Safe Operating Area**


**Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case**

**Fig. 13 - Switching Time Test Circuit**

**Fig. 16 - Unclamped Inductive Waveforms**

**Fig. 14 - Switching Time Waveforms**

**Fig. 17 - Basic Gate Charge Waveform**

**Fig. 15 - Unclamped Inductive Test Circuit**

**Fig. 18 - Gate Charge Test Circuit**

### Peak Diode Recovery dV/dt Test Circuit



### Note

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

**Fig. 19 - For N-Channel**

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