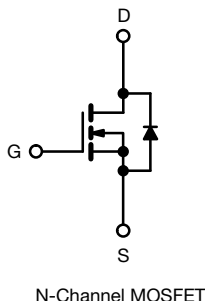


## E Series Power MOSFET

Thin-Lead TO-220 FULLPAK



### FEATURES

- 4<sup>th</sup> generation E series technology
- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low effective capacitance ( $C_{o(er)}$ )
- Reduced switching and conduction losses
- 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**

### 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
  - Solar (PV inverters)

### PRODUCT SUMMARY

|                                         |                 |      |
|-----------------------------------------|-----------------|------|
| $V_{DS}$ (V) at $T_J$ max.              | 650             |      |
| $R_{DS(on)}$ typ. ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V | 0.60 |
| $Q_g$ max. (nC)                         | 12              |      |
| $Q_{gs}$ (nC)                           | 3               |      |
| $Q_{gd}$ (nC)                           | 3               |      |
| Configuration                           | Single          |      |

### ORDERING INFORMATION

|                                 |                          |
|---------------------------------|--------------------------|
| Package                         | Thin-Lead TO-220 FULLPAK |
| Lead (Pb)-free and halogen-free | SiHA690N60E-GE3          |

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

| PARAMETER                                                       |                         |                         | SYMBOL                            | LIMIT       | UNIT |
|-----------------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|------|
| Drain-source voltage                                            |                         |                         | V <sub>DS</sub>                   | 600         | V    |
| Gate-source voltage                                             |                         |                         | V <sub>GS</sub>                   | ± 30        |      |
| Continuous drain current (T <sub>J</sub> = 150 °C) <sup>e</sup> | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 4.3         | A    |
|                                                                 |                         | T <sub>C</sub> = 100 °C |                                   | 2.7         |      |
| Pulsed drain current <sup>a</sup>                               |                         |                         | I <sub>DM</sub>                   | 11          |      |
| Linear derating factor                                          |                         |                         |                                   | 0.23        | W/°C |
| Single pulse avalanche energy <sup>b</sup>                      |                         |                         | E <sub>AS</sub>                   | 9           | mJ   |
| Maximum power dissipation                                       |                         |                         | P <sub>D</sub>                    | 29          | W    |
| Operating junction and storage temperature range                |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C   |
| Drain-source voltage slope                                      |                         | T <sub>J</sub> = 125 °C | dv/dt                             | 70          | V/ns |
| Reverse diode dv/dt <sup>d</sup>                                |                         |                         |                                   | 17          |      |
| Soldering recommendations (peak temperature) <sup>c</sup>       |                         | For 10 s                |                                   | 260         | °C   |
| Mounting torque, M3 screw                                       |                         |                         |                                   | 0.6         | Nm   |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 120$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 0.8$  A
- 1.6 mm from case
- $I_{SD} \leq I_D$ ,  $di/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C
- Limited by maximum junction temperature

**THERMAL RESISTANCE RATINGS**

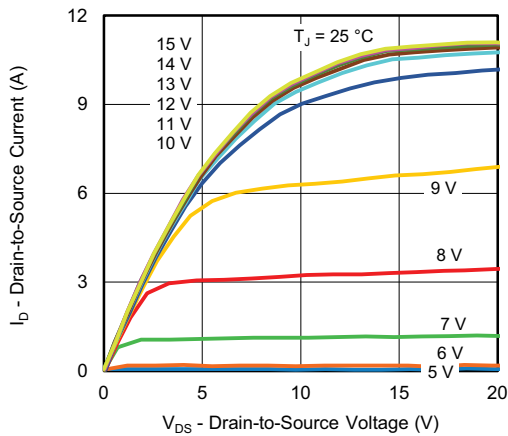
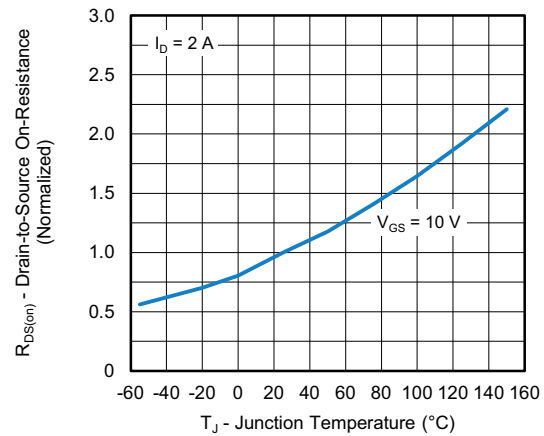
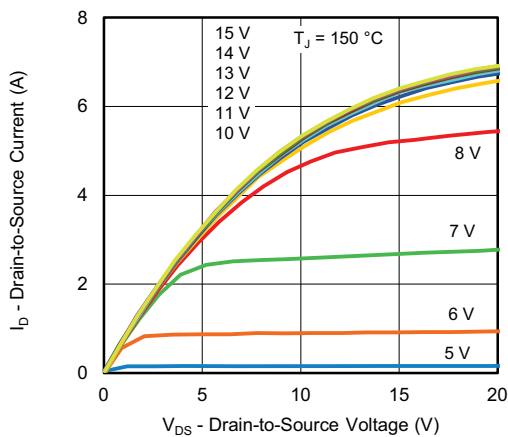
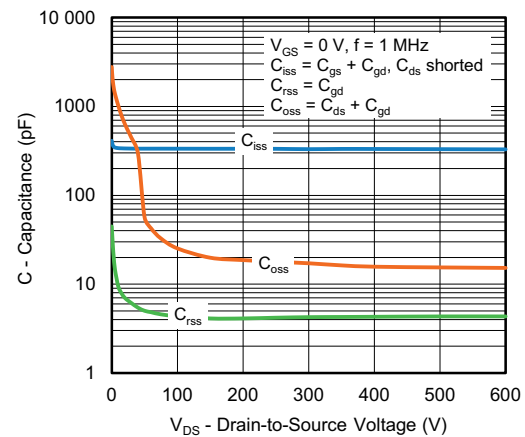
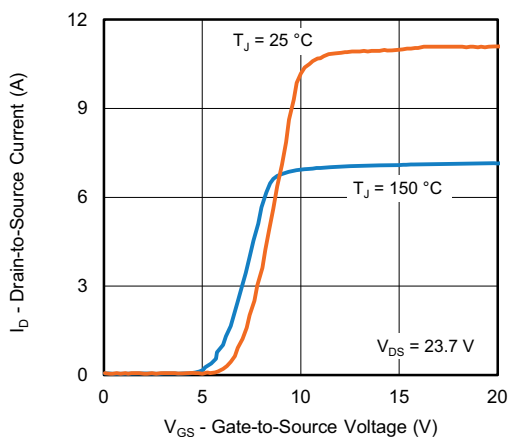
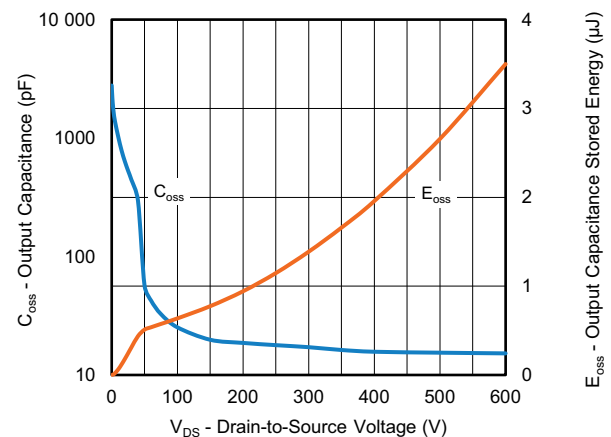
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum junction-to-ambient      | $R_{thJA}$ | -    | 65   | °C/W |
| Maximum junction-to-case (drain) | $R_{thJC}$ | -    | 4.3  |      |

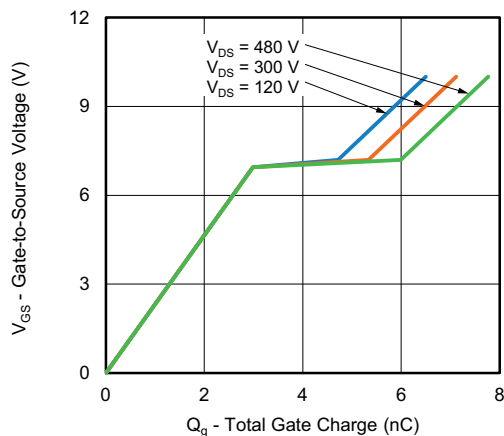
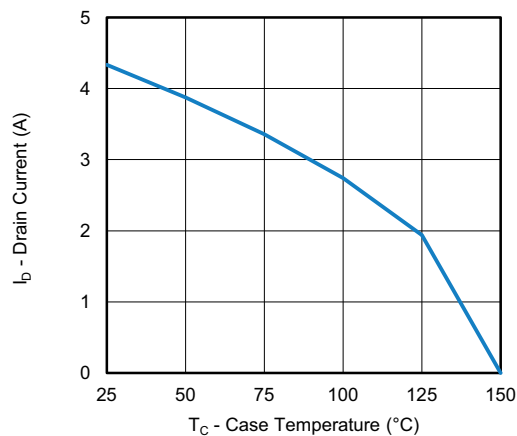
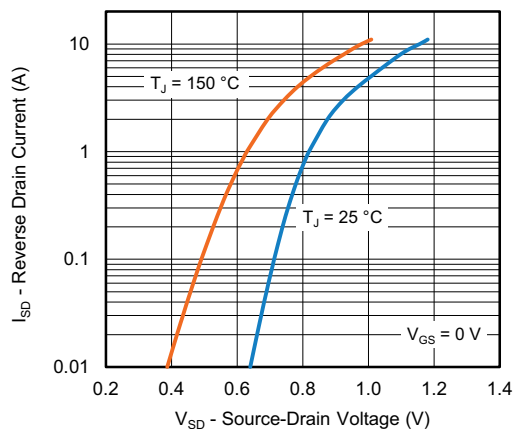
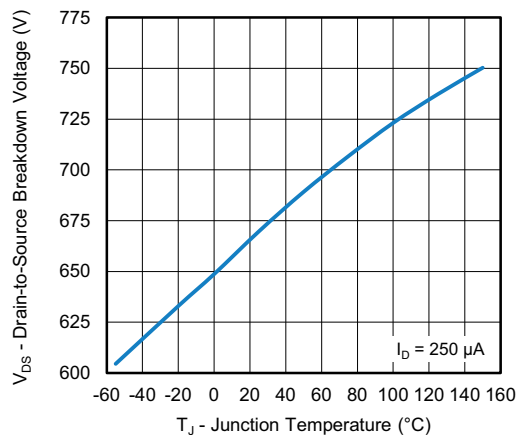
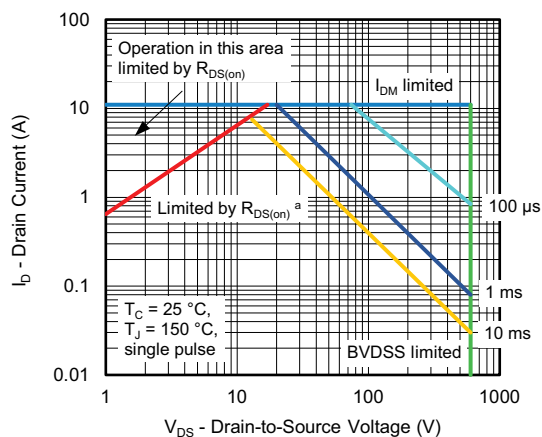
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

| PARAMETER                                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                       | MIN. | TYP. | MAX.      | UNIT          |
|-----------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|-----------|---------------|
| <b>Static</b>                                             |                     |                                                                                                                                                       |      |      |           |               |
| Drain-source breakdown voltage                            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                | 600  | -    | -         | V             |
| $V_{DS}$ temperature coefficient                          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ °C}$ , $I_D = 1\text{ mA}$                                                                                                     | -    | 0.73 | -         | V/°C          |
| Gate-source threshold voltage (N)                         | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                    | 3.0  | -    | 5.0       | V             |
| Gate-source leakage                                       | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                                            | -    | -    | $\pm 100$ | nA            |
|                                                           |                     | $V_{GS} = \pm 30\text{ V}$                                                                                                                            | -    | -    | $\pm 1$   | $\mu\text{A}$ |
| Zero gate voltage drain current                           | $I_{DSS}$           | $V_{DS} = 600\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                       | -    | -    | 1         | $\mu\text{A}$ |
|                                                           |                     | $V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ °C}$                                                                               | -    | -    | 10        |               |
| Drain-source on-state resistance                          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$ , $I_D = 2.0\text{ A}$                                                                                                         | -    | 0.60 | 0.70      | $\Omega$      |
| Forward transconductance <sup>a</sup>                     | $g_{fs}$            | $V_{DS} = 20\text{ V}$ , $I_D = 2.0\text{ A}$                                                                                                         | -    | 1.2  | -         | S             |
| <b>Dynamic</b>                                            |                     |                                                                                                                                                       |      |      |           |               |
| Input capacitance                                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                            | -    | 347  | -         | pF            |
| Output capacitance                                        | $C_{oss}$           |                                                                                                                                                       | -    | 24   | -         |               |
| Reverse transfer capacitance                              | $C_{rss}$           |                                                                                                                                                       | -    | 4    | -         |               |
| Effective output capacitance, energy related <sup>a</sup> | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                        | -    | 17   | -         |               |
| Effective output capacitance, time related <sup>b</sup>   | $C_{o(tr)}$         |                                                                                                                                                       | -    | 86   | -         |               |
| Total gate charge                                         | $Q_g$               | $V_{GS} = 10\text{ V}$ , $I_D = 2.0\text{ A}$ , $V_{DS} = 480\text{ V}$                                                                               | -    | 8    | 12        | nC            |
| Gate-source charge                                        | $Q_{gs}$            |                                                                                                                                                       | -    | 3    | -         |               |
| Gate-drain charge                                         | $Q_{gd}$            |                                                                                                                                                       | -    | 3    | -         |               |
| Turn-on delay time                                        | $t_{d(on)}$         | $V_{DD} = 480\text{ V}$ , $I_D = 2.0\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_g = 9.1\text{ }\Omega$                                                | -    | 12   | 24        | ns            |
| Rise time                                                 | $t_r$               |                                                                                                                                                       | -    | 9    | 18        |               |
| Turn-off delay time                                       | $t_{d(off)}$        |                                                                                                                                                       | -    | 19   | 38        |               |
| Fall time                                                 | $t_f$               |                                                                                                                                                       | -    | 22   | 44        |               |
| Gate input resistance                                     | $R_g$               | $f = 1\text{ MHz}$ , open drain                                                                                                                       | 1.1  | 2.3  | 4.6       | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b>            |                     |                                                                                                                                                       |      |      |           |               |
| Continuous source-drain diode current                     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode  | -    | -    | 6.4       | A             |
| Pulsed diode forward current                              | $I_{SM}$            |                                                                                                                                                       | -    | -    | 11        |               |
| Diode forward voltage                                     | $V_{SD}$            | $T_J = 25\text{ °C}$ , $I_S = 2.0\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                                   | -    | -    | 1.2       | V             |
| Reverse recovery time                                     | $t_{rr}$            | $T_J = 25\text{ °C}$ , $I_F = I_S = 2.0\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 25\text{ V}$                                       | -    | 146  | 292       | ns            |
| Reverse recovery charge                                   | $Q_{rr}$            |                                                                                                                                                       | -    | 1.0  | 2.0       | $\mu\text{C}$ |
| Reverse recovery current                                  | $I_{RRM}$           |                                                                                                                                                       | -    | 13   | -         | A             |

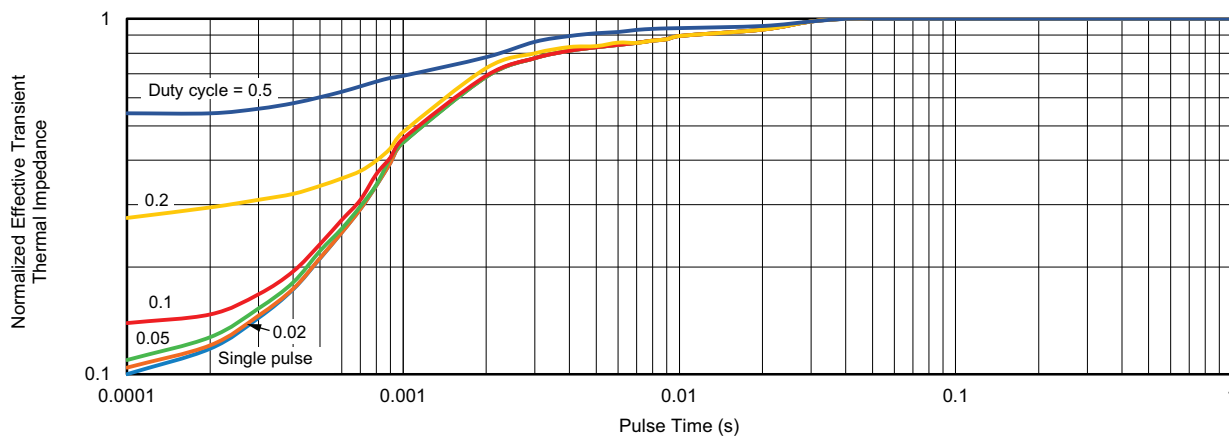
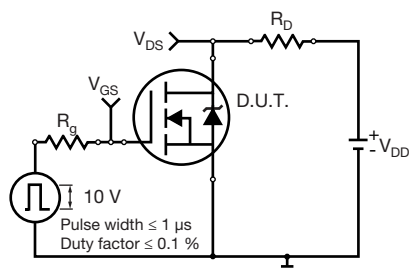
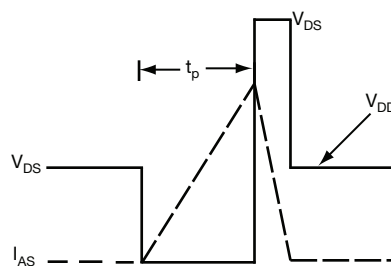
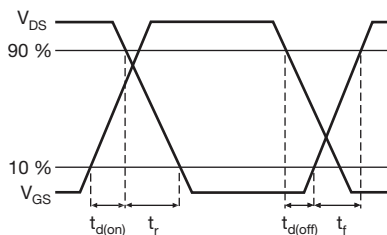
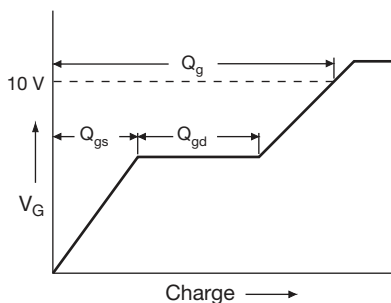
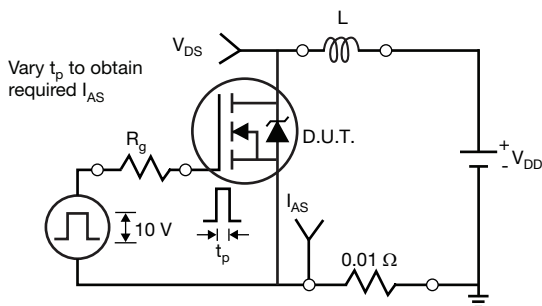
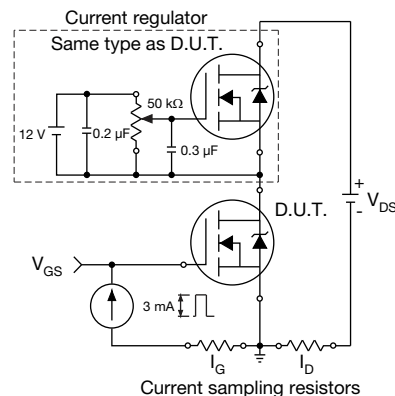
**Notes**

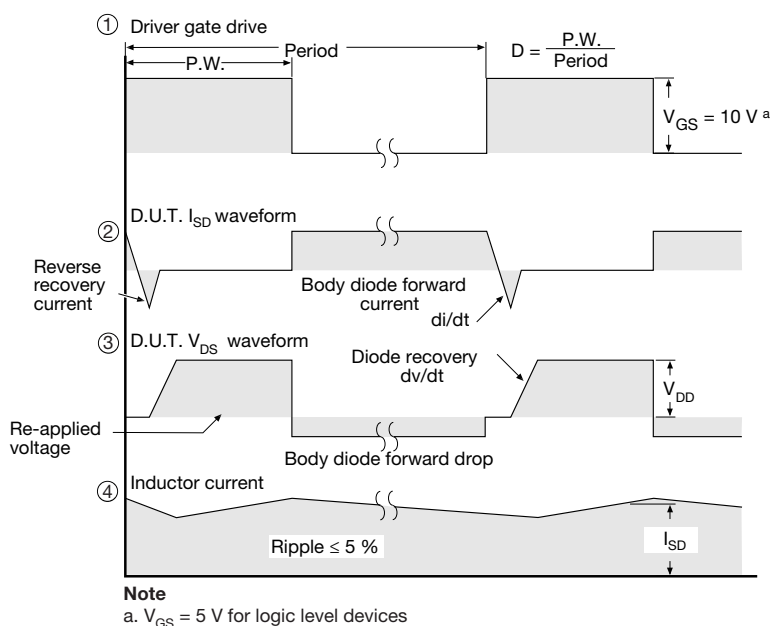
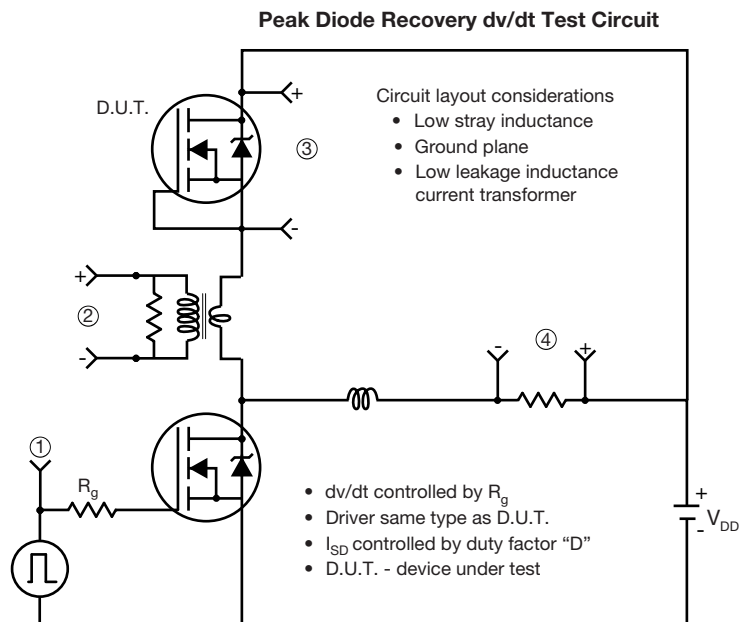
- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$   
b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$

**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 - Temperature vs. Drain-to-Source Voltage**

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

a.  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified


**Fig. 12 - Normalized Transient Thermal 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**


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

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Электрон  
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