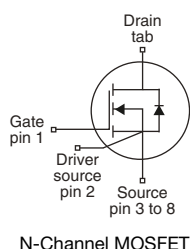


## EF Series Power MOSFET With Fast Body Diode



### FEATURES

- 4<sup>th</sup> generation E series technology
- Low figure-of-merit (FOM)  $R_{DS(on)} \times Q_g$
- 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 | 0.045 |
| $Q_g$ max. (nC)                         | 105             |       |
| $Q_{gs}$ (nC)                           | 29              |       |
| $Q_{gd}$ (nC)                           | 15              |       |
| Configuration                           | Single          |       |

### ORDERING INFORMATION

|                                 |                    |
|---------------------------------|--------------------|
| Package                         | PowerPAK 10 x 12   |
| Lead (Pb)-free and halogen-free | SiHK045N60EF-T1GE3 |

### 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>                | $I_{DM}$         | 133            |      |
| Linear derating factor                           |                  | 2.22           | W/°C |
| Single pulse avalanche energy <sup>b</sup>       | $E_{AS}$         | 261            | 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                       | $dv/dt$          | $T_J = 125$ °C | V/ns |
| Reverse diode $dv/dt$ <sup>d</sup>               |                  |                |      |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 120$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 4.3$  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**

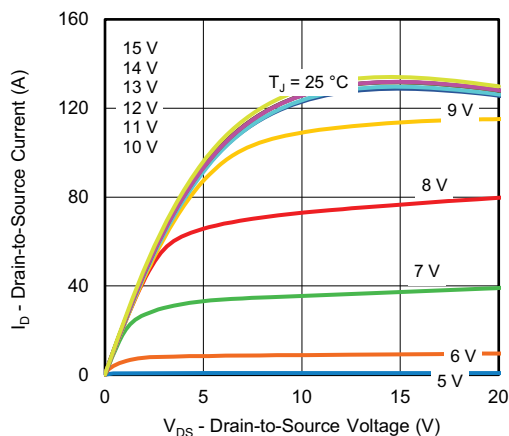
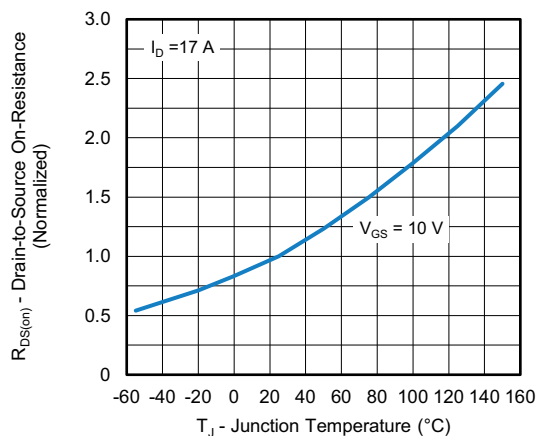
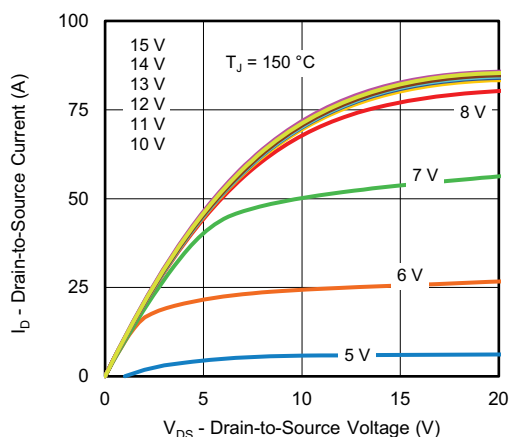
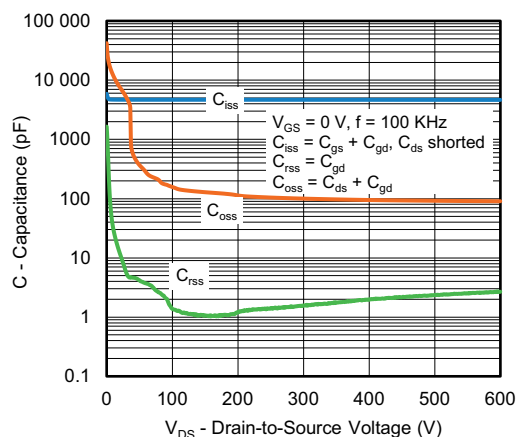
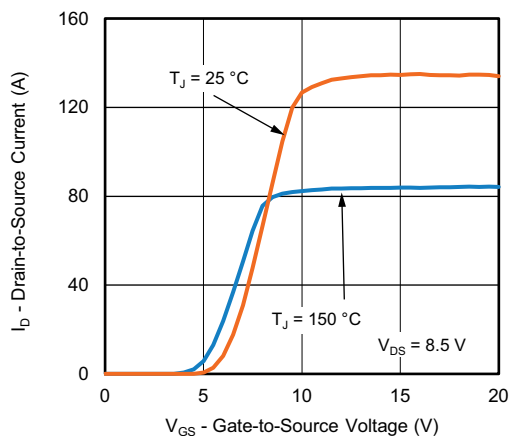
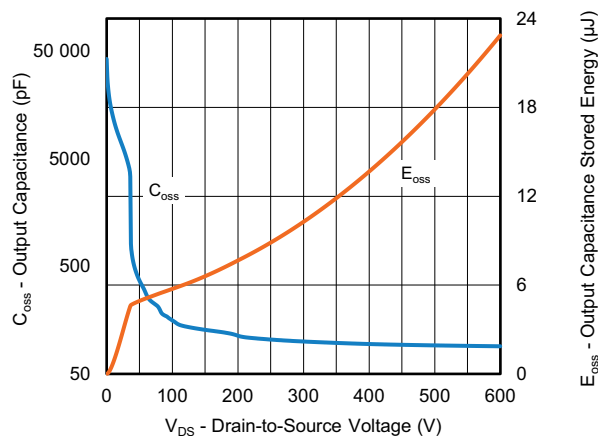
| PARAMETER                        | SYMBOL     | TYP. | MAX.  | UNIT |
|----------------------------------|------------|------|-------|------|
| Maximum junction-to-ambient      | $R_{thJA}$ | -    | 50 °C | °C/W |
| Maximum junction-to-case (drain) | $R_{thJC}$ | -    | 0.45  |      |

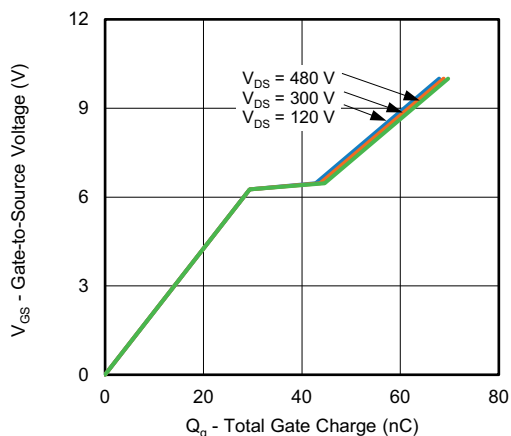
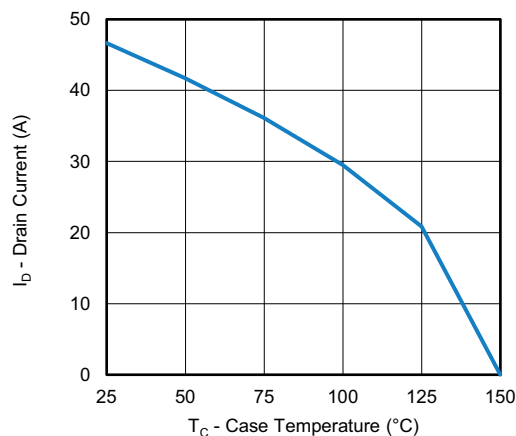
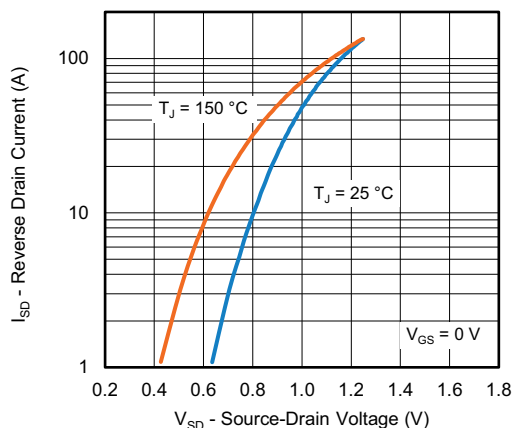
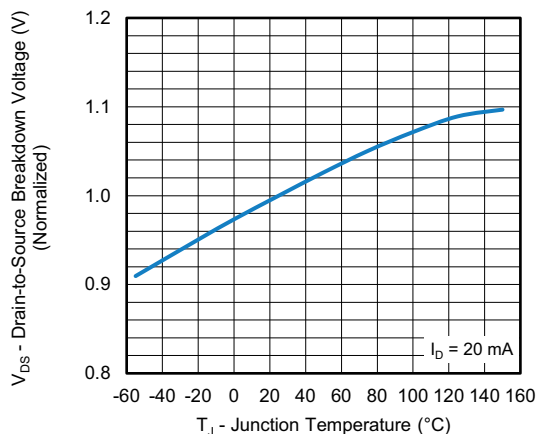
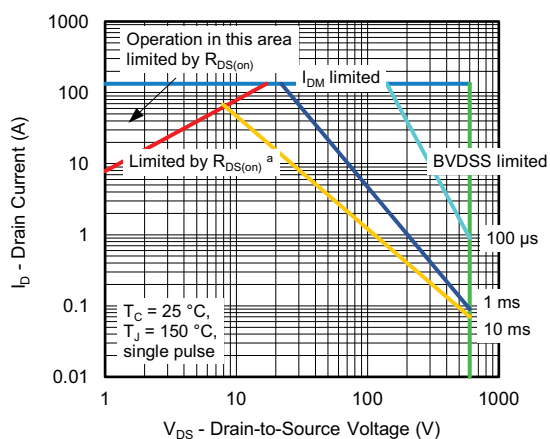
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

| PARAMETER                                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                          |                                               | MIN. | TYP.  | MAX.      | UNIT          |
|-----------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------|-------|-----------|---------------|
| Static                                                    |                     |                                                                                                                                                          |                                               |      |       |           |               |
| 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 °C, $I_D = 1\text{ mA}$                                                                                                                  |                                               | -    | 0.64  | -         | 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                           | $I_{DSS}$           | $V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                          |                                               | -    | -     | 1         | $\mu\text{A}$ |
|                                                           |                     | $V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$                                                                      |                                               | -    | -     | 2         | mA            |
| Drain-source on-state resistance                          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 17\text{ A}$                           | -    | 0.042 | 0.052     | $\Omega$      |
| Forward transconductance <sup>a</sup>                     | $g_{fs}$            | $V_{DS} = 10\text{ V}$ , $I_D = 17\text{ A}$                                                                                                             |                                               | -    | 21    | -         | S             |
| Dynamic                                                   |                     |                                                                                                                                                          |                                               |      |       |           |               |
| Input capacitance                                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 100\text{ KHz}$                                                                             |                                               | -    | 4685  | -         | pF            |
| Output capacitance                                        | $C_{oss}$           |                                                                                                                                                          |                                               | -    | 160   | -         |               |
| Reverse transfer capacitance                              | $C_{rss}$           |                                                                                                                                                          |                                               | -    | 1     | -         |               |
| Effective output capacitance, energy related <sup>a</sup> | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 400\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                           |                                               | -    | 171   | -         | pF            |
| Effective output capacitance, time related <sup>b</sup>   | $C_{o(tr)}$         |                                                                                                                                                          |                                               | -    | 1069  | -         |               |
| Total gate charge                                         | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 17\text{ A}$ , $V_{DS} = 480\text{ V}$ | -    | 70    | 105       | nC            |
| Gate-source charge                                        | $Q_{gs}$            |                                                                                                                                                          |                                               | -    | 29    | -         |               |
| Gate-drain charge                                         | $Q_{gd}$            |                                                                                                                                                          |                                               | -    | 15    | -         |               |
| Turn-on delay time                                        | $t_{d(on)}$         | $V_{DD} = 480\text{ V}$ , $I_D = 17\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_g = 9.1\text{ }\Omega$                                                    |                                               | -    | 39    | 78        | ns            |
| Rise time                                                 | $t_r$               |                                                                                                                                                          |                                               | -    | 66    | 99        |               |
| Turn-off delay time                                       | $t_{d(off)}$        |                                                                                                                                                          |                                               | -    | 64    | 96        |               |
| Fall time                                                 | $t_f$               |                                                                                                                                                          |                                               | -    | 37    | 74        |               |
| Gate input resistance                                     | $R_g$               | $f = 1\text{ MHz}$                                                                                                                                       |                                               | 0.6  | 1.2   | 2.4       | $\Omega$      |
| Drain-Source Body Diode Characteristics                   |                     |                                                                                                                                                          |                                               |      |       |           |               |
| Continuous source-drain diode current                     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                               | -    | -     | 47        | A             |
| Pulsed diode forward current                              | $I_{SM}$            |                                                                                                                                                          |                                               | -    | -     | 133       |               |
| Diode forward voltage                                     | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = 17\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                           |                                               | -    | -     | 1.2       | V             |
| Reverse recovery time                                     | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = I_S = 17\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 400\text{ V}$                              |                                               | -    | 127   | 254       | ns            |
| Reverse recovery charge                                   | $Q_{rr}$            |                                                                                                                                                          |                                               | -    | 0.8   | 1.6       | $\mu\text{C}$ |
| Reverse recovery current                                  | $I_{RRM}$           |                                                                                                                                                          |                                               | -    | 12    | -         | A             |

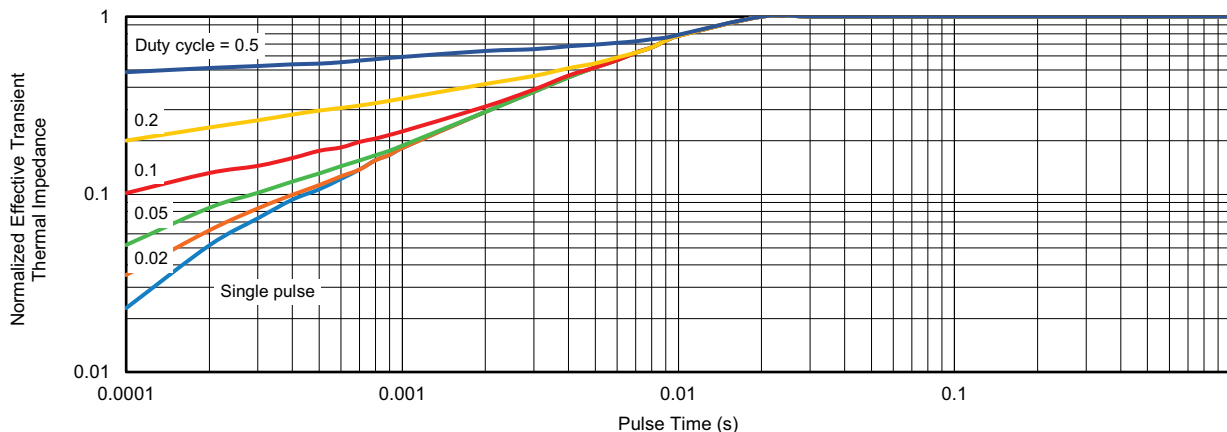
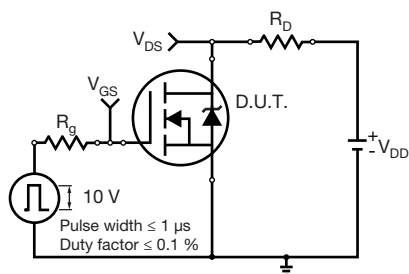
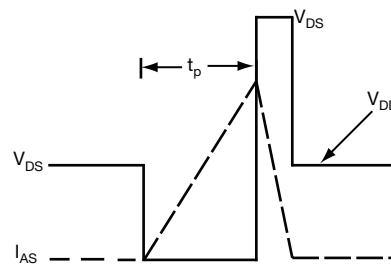
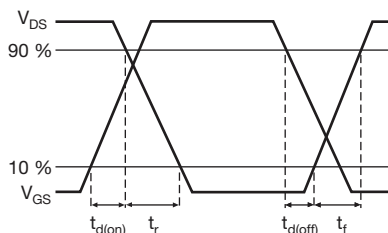
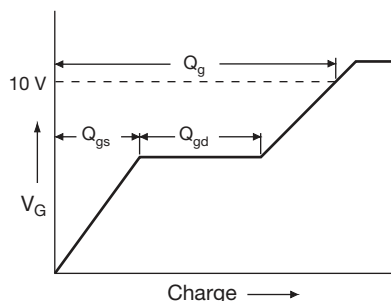
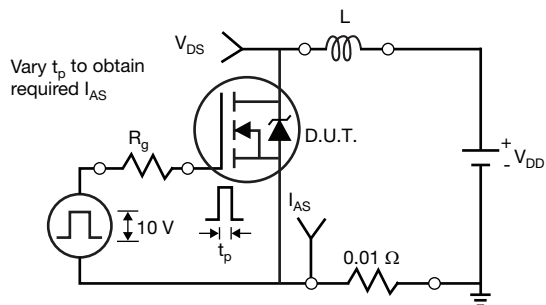
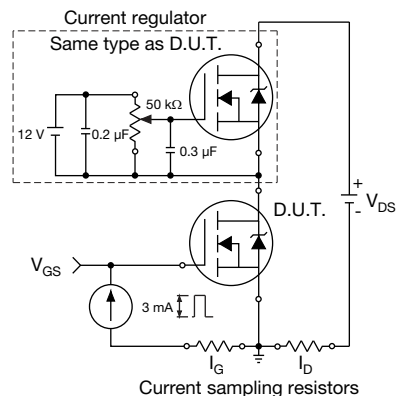
**Notes**

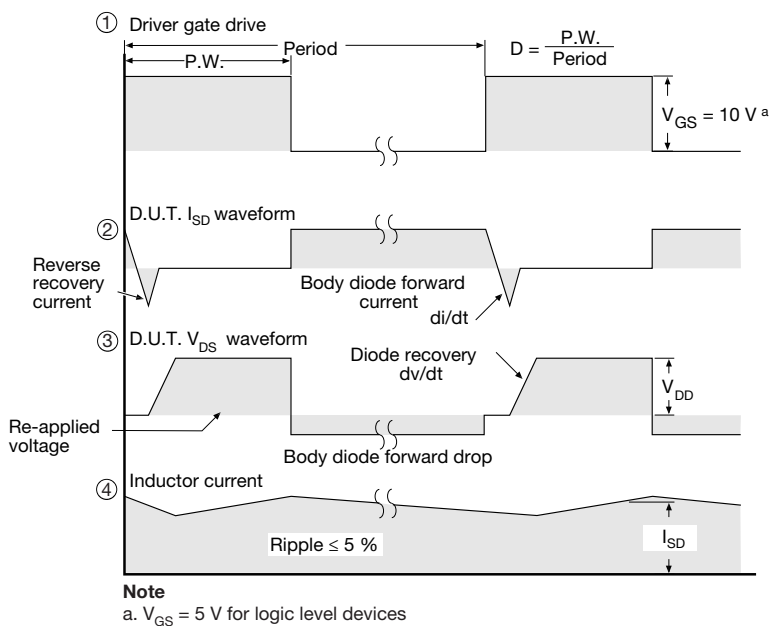
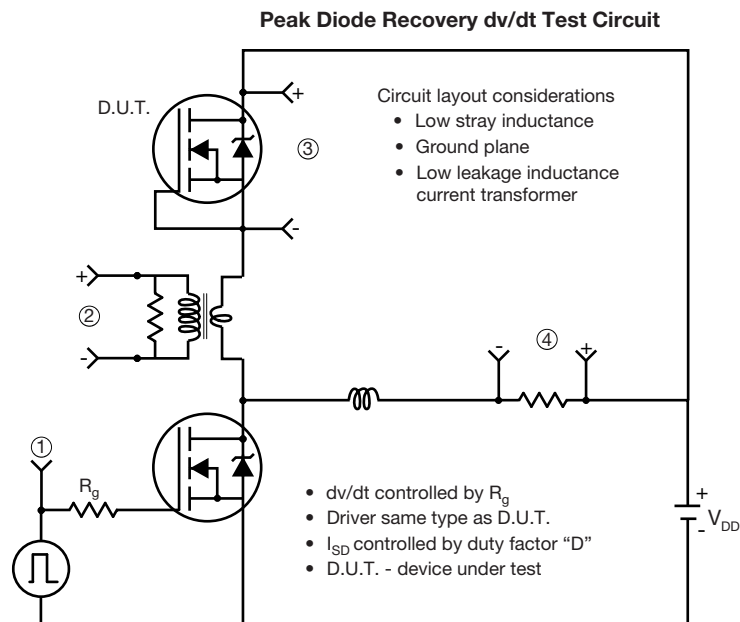
- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$   
b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$   
c. When mounted on 1" x 1" FR4 board

**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.  $V_{DS}$**

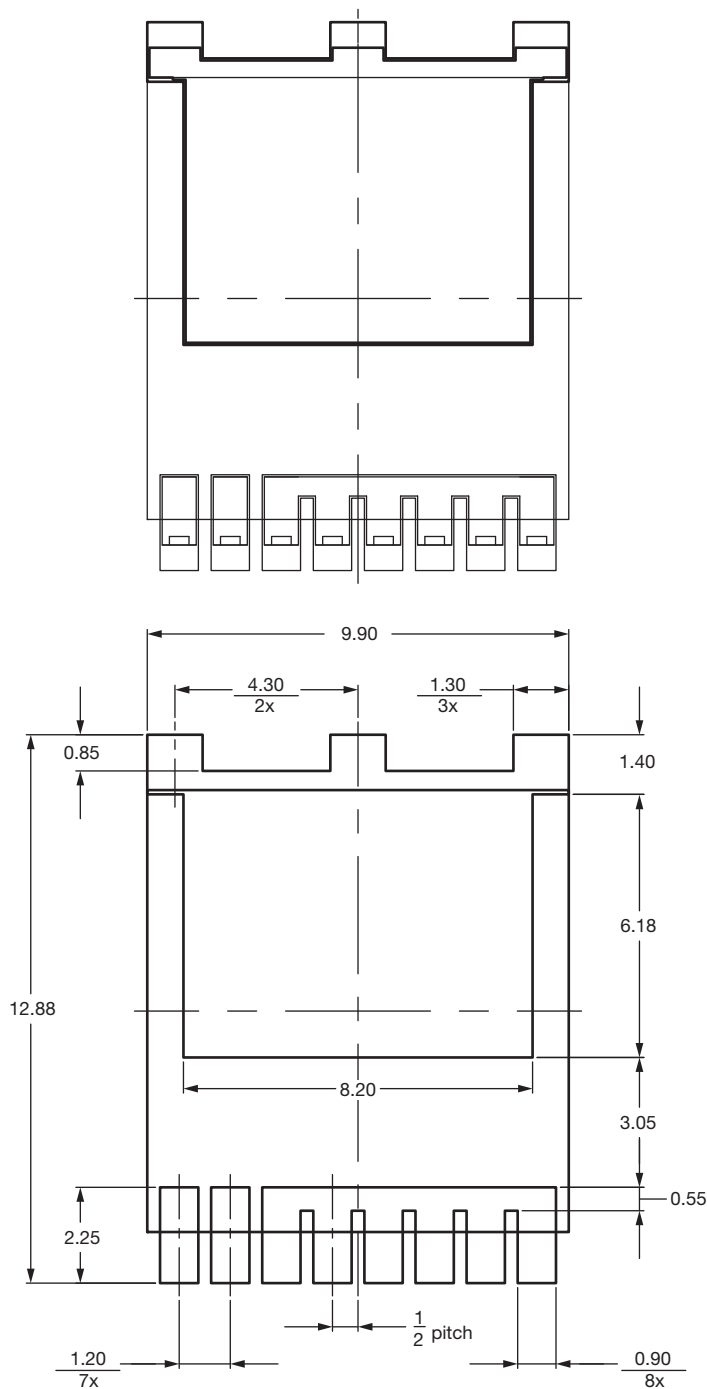

**Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage**

**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**

## Recommended Land Pattern PowerPAK® 10 x 12 (TOLL) (High Voltage)


**Note**

- Dimensions in mm

ECN: S22-1061-Rev. C, 26-Dec-2022  
DWG: 3013



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