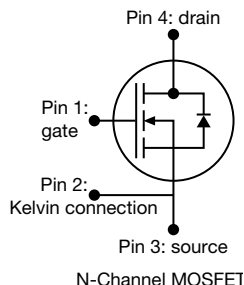
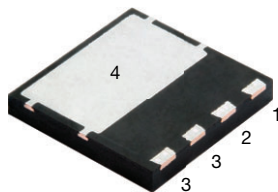


## EF Series Power MOSFET with Fast Body Diode

**PowerPAK® 8 x 8**


N-Channel MOSFET

### FEATURES

- Fast body diode MOSFET using E series technology
- Reduced  $t_{rr}$ ,  $Q_{rr}$ , and  $I_{RRM}$
- Completely lead (Pb)-free device
- Low figure-of-merit (FOM)  $R_{DS(on)} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Low switching losses due to reduced  $Q_{rr}$
- 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**  
**GREEN**  
(5-2008)

### PRODUCT SUMMARY

|                                         |                 |       |
|-----------------------------------------|-----------------|-------|
| $V_{DS}$ (V) at $T_J$ max.              | 650             |       |
| $R_{DS(on)}$ typ. ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V | 0.310 |
| $Q_g$ max. (nC)                         | 62              |       |
| $Q_{gs}$ (nC)                           | 7               |       |
| $Q_{gd}$ (nC)                           | 13              |       |
| Configuration                           | Single          |       |

### 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)

### ORDERING INFORMATION

|                                 |                    |
|---------------------------------|--------------------|
| Package                         | PowerPAK 8 x 8     |
| Lead (Pb)-free and Halogen-free | SiHH11N60EF-T1-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>                | $I_{DM}$         | 27             |      |
| Linear derating factor                           |                  | 0.9            | W/°C |
| Single pulse avalanche energy <sup>b</sup>       | $E_{AS}$         | 127            | mJ   |
| Maximum power dissipation                        | $P_D$            | 114            | 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>c</sup>               |                  | 28             |      |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DS} = 140$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 3$  A
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C

**THERMAL RESISTANCE RATINGS**

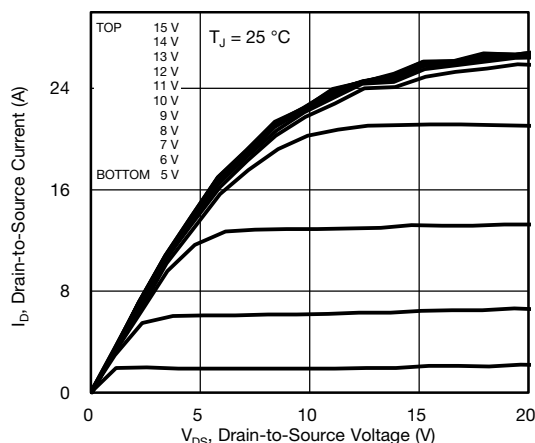
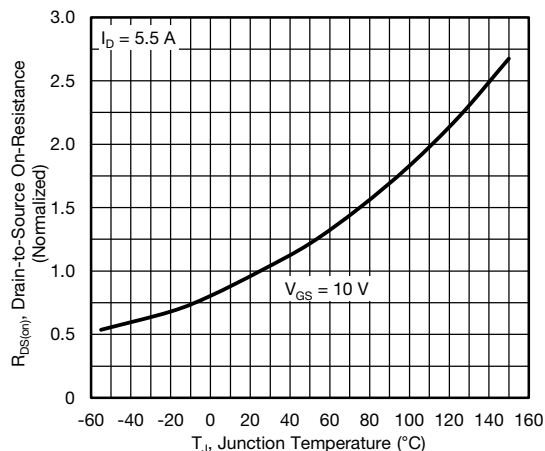
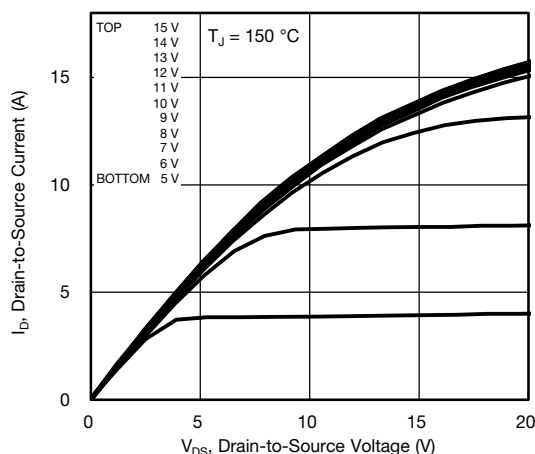
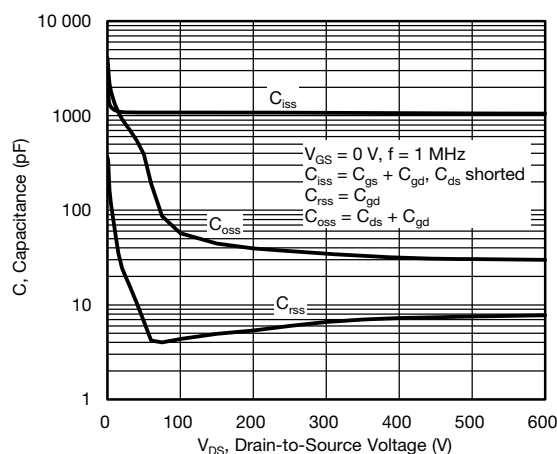
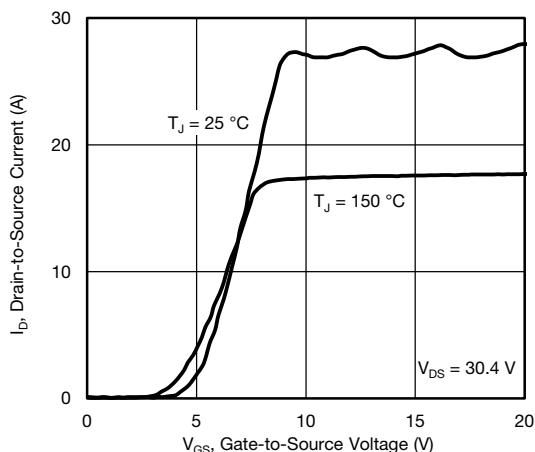
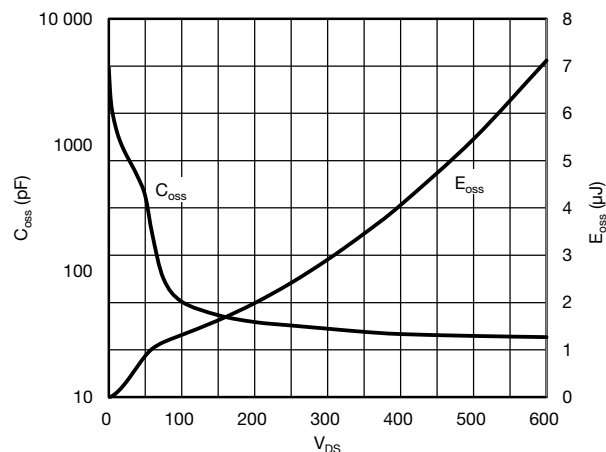
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | 42   | 55   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | 0.76 | 1.10 |      |

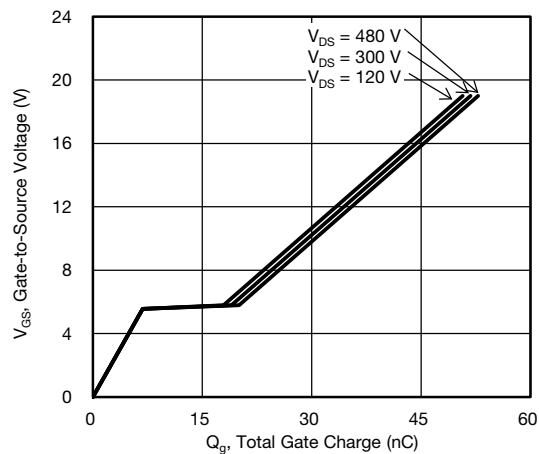
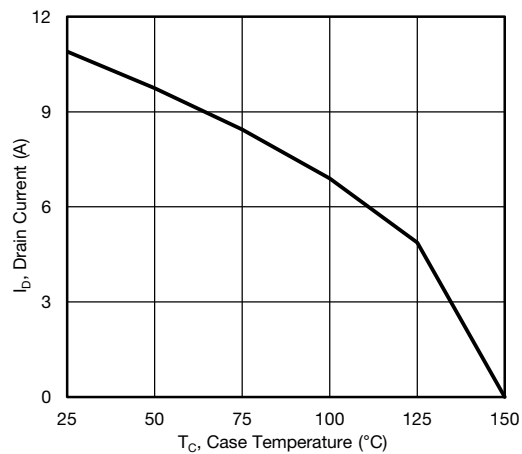
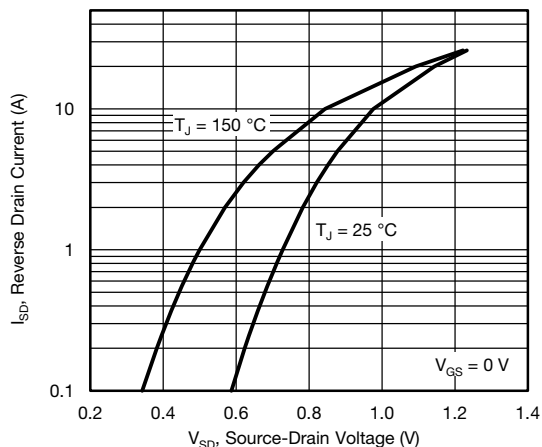
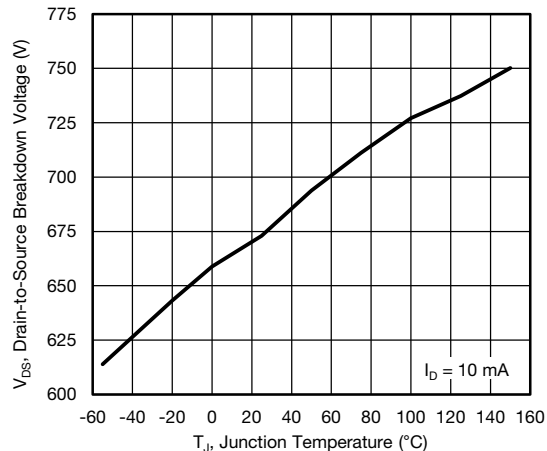
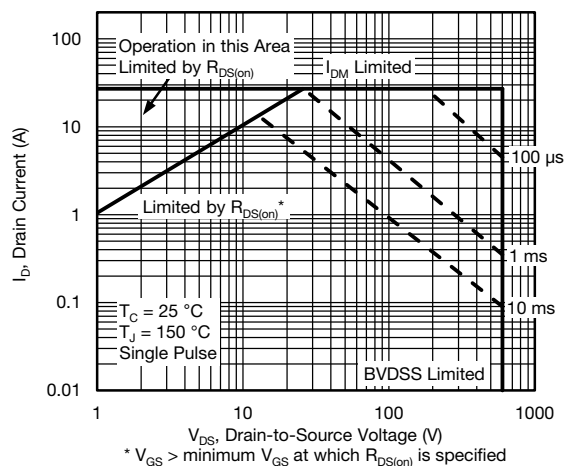
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

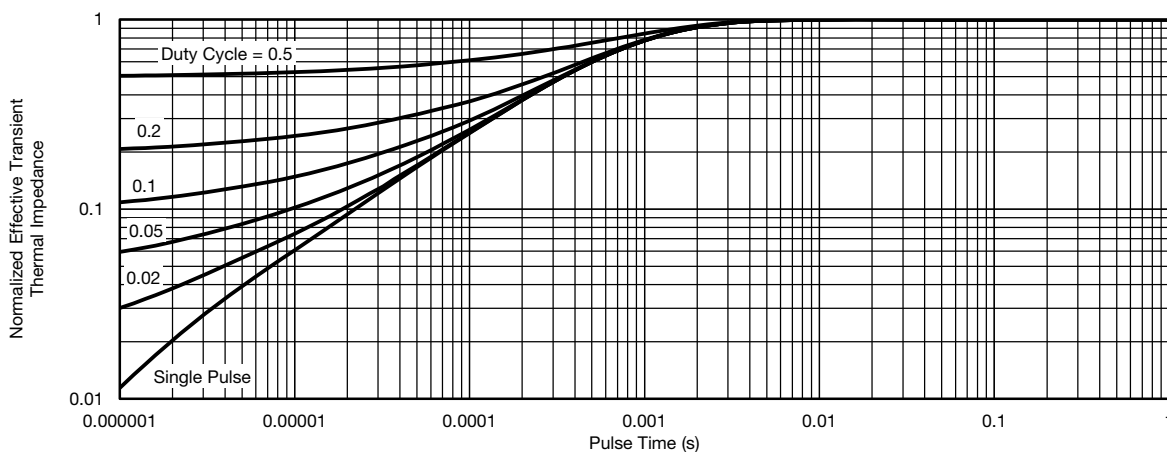
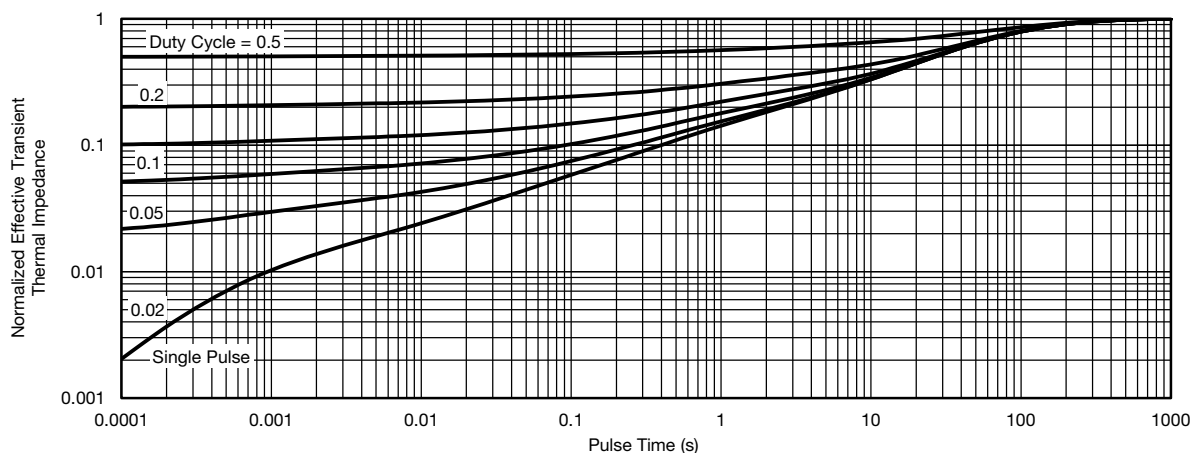
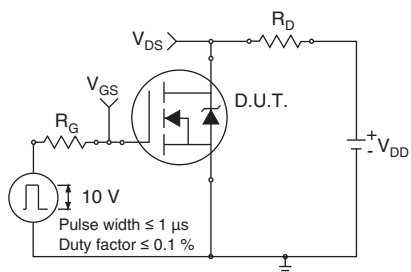
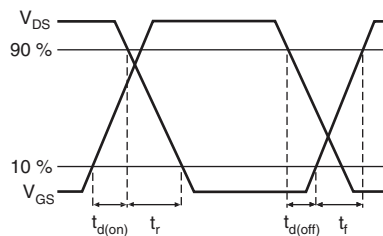
| PARAMETER                                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                          |                                                | MIN. | TYP.  | MAX.      | UNIT                  |
|-----------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|------|-------|-----------|-----------------------|
| Static                                                    |                     |                                                                                                                                                          |                                                |      |       |           |                       |
| Drain-Source Breakdown Voltage                            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                   |                                                | 600  | -     | -         | V                     |
| $V_{DS}$ Temperature Coefficient                          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^{\circ}\text{C}$ , $I_D = 10\text{ mA}$                                                                                         |                                                | -    | 0.66  | -         | V/ $^{\circ}\text{C}$ |
| Gate-Source Threshold Voltage (N)                         | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                       |                                                | 2.0  | -     | 4.0       | 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         | $\mu\text{A}$         |
|                                                           |                     | $V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}$                                                                    |                                                | -    | -     | 50        |                       |
| Drain-Source On-State Resistance                          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 5.5\text{ A}$                           | -    | 0.310 | 0.357     | $\Omega$              |
| Forward Transconductance                                  | $g_{fs}$            | $V_{DS} = 30\text{ V}$ , $I_D = 5.5\text{ A}$                                                                                                            |                                                | -    | 3.7   | -         | S                     |
| Dynamic                                                   |                     |                                                                                                                                                          |                                                |      |       |           |                       |
| Input Capacitance                                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                               |                                                | -    | 1078  | -         | pF                    |
| Output Capacitance                                        | $C_{oss}$           |                                                                                                                                                          |                                                | -    | 57    | -         |                       |
| Reverse Transfer Capacitance                              | $C_{rss}$           |                                                                                                                                                          |                                                | -    | 4     | -         |                       |
| Effective Output Capacitance, Energy Related <sup>a</sup> | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 480\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                           |                                                | -    | 35    | -         |                       |
| Effective Output Capacitance, Time Related <sup>b</sup>   | $C_{o(tr)}$         |                                                                                                                                                          |                                                | -    | 145   | -         |                       |
| Total Gate Charge                                         | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 5.5\text{ A}$ , $V_{DS} = 480\text{ V}$ | -    | 31    | 62        | nC                    |
| Gate-Source Charge                                        | $Q_{gs}$            |                                                                                                                                                          |                                                | -    | 7     | -         |                       |
| Gate-Drain Charge                                         | $Q_{gd}$            |                                                                                                                                                          |                                                | -    | 13    | -         |                       |
| Turn-On Delay Time                                        | $t_{d(on)}$         | $V_{DD} = 480\text{ V}$ , $I_D = 5.5\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_g = 9.1\text{ }\Omega$                                                   |                                                | -    | 16    | 32        | ns                    |
| Rise Time                                                 | $t_r$               |                                                                                                                                                          |                                                | -    | 21    | 42        |                       |
| Turn-Off Delay Time                                       | $t_{d(off)}$        |                                                                                                                                                          |                                                | -    | 39    | 68        |                       |
| Fall Time                                                 | $t_f$               |                                                                                                                                                          |                                                | -    | 21    | 42        |                       |
| Gate Input Resistance                                     | $R_g$               | $f = 1\text{ MHz}$ , open drain                                                                                                                          |                                                | 0.2  | 0.7   | 1.5       | $\Omega$              |
| Drain-Source Body Diode Characteristics                   |                     |                                                                                                                                                          |                                                |      |       |           |                       |
| Continuous Source-Drain Diode Current                     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                                | -    | -     | 11        | A                     |
| Pulsed Diode Forward Current                              | $I_{SM}$            |                                                                                                                                                          |                                                | -    | -     | 27        |                       |
| Diode Forward Voltage                                     | $V_{SD}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_S = 5.5\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                        |                                                | -    | 0.9   | 1.2       | V                     |
| Reverse Recovery Time                                     | $t_{rr}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_F = I_S = 5.5\text{ A}$ ,<br>$dI/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 25\text{ V}$                            |                                                | -    | 114   | 228       | ns                    |
| Reverse Recovery Charge                                   | $Q_{rr}$            |                                                                                                                                                          |                                                | -    | 0.56  | 1.12      | $\mu\text{C}$         |
| Reverse Recovery Current                                  | $I_{RRM}$           |                                                                                                                                                          |                                                | -    | 9.5   | -         | A                     |

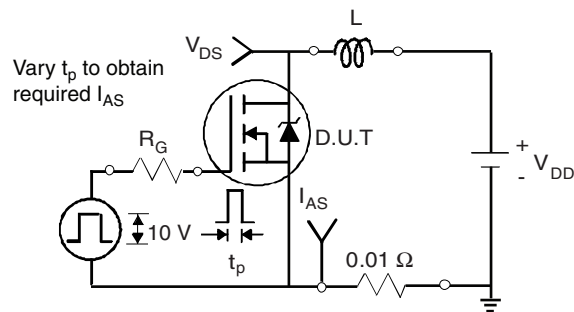
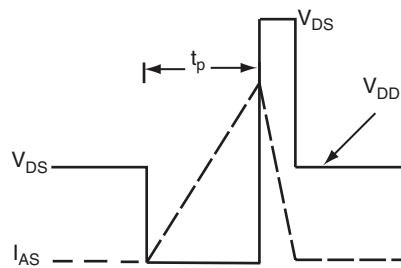
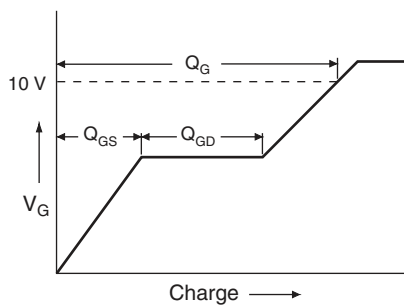
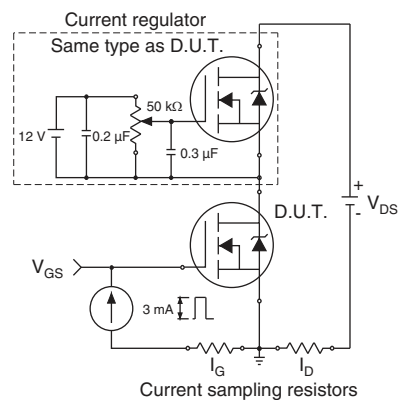
**Notes**

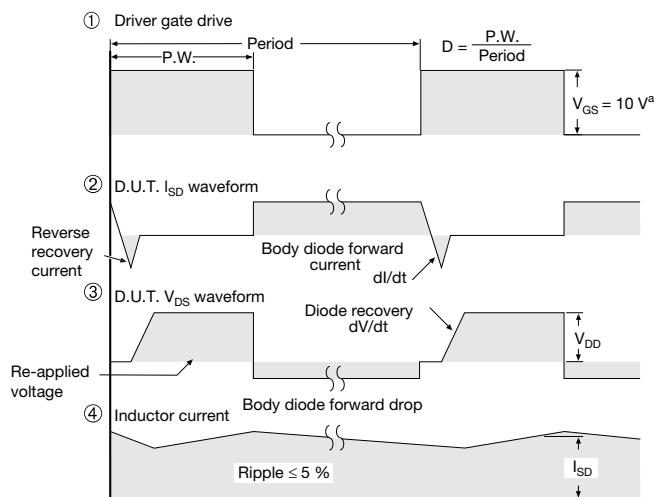
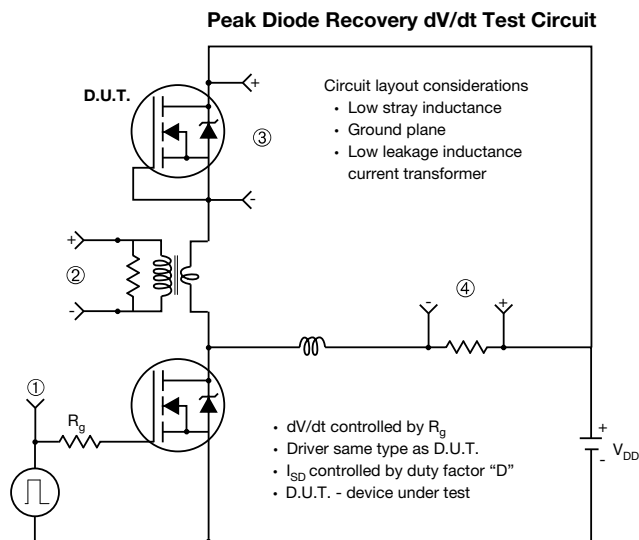
- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$   
b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$

**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**


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

**Fig. 13 - Normalized Thermal Transient Impedance, Junction-to-Ambient**

**Fig. 14 - Switching Time Test Circuit**

**Fig. 15 - Switching Time Waveforms**


**Fig. 16 - Unclamped Inductive Test Circuit**

**Fig. 17 - Unclamped Inductive Waveforms**

**Fig. 18 - Basic Gate Charge Waveform**

**Fig. 19 - Gate Charge Test Circuit**


**Note**

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

**Fig. 20 - For N-Channel**

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## PowerPAK® 8 x 8 Case Outline



| DIM.             | MILLIMETERS |      |      | INCHES     |       |       |
|------------------|-------------|------|------|------------|-------|-------|
|                  | MIN.        | NOM. | MAX. | MIN.       | NOM.  | MAX.  |
| A                | 0.95        | 1.00 | 1.05 | 0.037      | 0.039 | 0.041 |
| A1               | 0.00        | -    | 0.05 | 0.000      | -     | 0.002 |
| A2               | 020 ref.    |      |      | 0.008 ref. |       |       |
| b                | 0.95        | 1.00 | 1.05 | 0.037      | 0.039 | 0.041 |
| D                | 7.90        | 8.00 | 8.10 | 0.311      | 0.315 | 0.319 |
| D2               | 7.10        | 7.20 | 7.30 | 0.280      | 0.283 | 0.287 |
| D3               | 0.40 BSC    |      |      | 0.016 BSC  |       |       |
| e                | 2.00 BSC    |      |      | 0.079 BSC  |       |       |
| E                | 7.90        | 8.00 | 8.10 | 0.311      | 0.315 | 0.319 |
| E2               | 4.30        | 4.35 | 4.40 | 0.169      | 0.171 | 0.173 |
| E3               | 0.40 BSC    |      |      | 0.016 BSC  |       |       |
| K                | 2.75 BSC    |      |      | 0.108 BSC  |       |       |
| L                | 0.45        | 0.50 | 0.55 | 0.018      | 0.020 | 0.022 |
| N <sup>(3)</sup> | 8           |      |      | 8          |       |       |

### Notes

- (1) Use millimeters as the primary measurement
- (2) Dimensioning and tolerances conform to ASME Y14.5 M - 1994
- (3) N is the number of terminals
- (4) The pin 1 identifier must be existed on the top surface of the package by using indentation mark or other feature of package body
- (5) Exact shape and size of this feature is optional

ECN: E20-0518-Rev. B, 28-Sep-2020  
DWG: 6041



## Recommended Minimum PADs for PowerPAK® 8 mm x 8 mm



Dimensions in millimeters



## Disclaimer

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