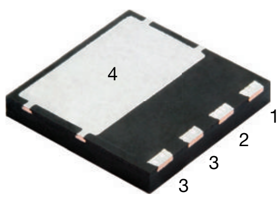
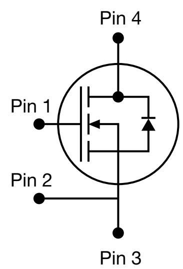
# E Series Power MOSFET with Fast Body Diode

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) at $T_J$ max. | 700 | |
| $R_{DS(on)}$ typ. (Ω) at 25 °C | $V_{GS}$ = 10 V | 0.157 |
| $Q_g$ max. (nC) | 102 | |
| $Q_{gs}$ (nC) | 15 | |
| $Q_{gd}$ (nC) | 28 | |
| Configuration | Single | |

PowerPAK® 8 x 8




N-Channel MOSFET

## FEATURES

- Completely lead (Pb)-free device
- Low figure-of-merit (FOM) $R_{on}$ x $Q_g$
- 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

Pb-free

**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
  - Renewable energy
  - Solar (PV inverters)

| ORDERING INFORMATION | |
|---|---|
| Package | PowerPAK 8 x 8 |
| Lead (Pb)-free and Halogen-free | SiHH21N65EF-T1-GE3 |

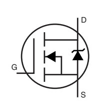
**ABSOLUTE MAXIMUM RATINGS** ($T_C$ = 25 °C, unless otherwise noted)

| PARAMETER | | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|---|
| Drain-Source Voltage | | | $V_{DS}$ | 650 | V |
| Gate-Source Voltage | | | $V_{GS}$ | ± 30 | |
| Continuous Drain Current ($T_J$ = 150 °C) | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 19.8 | A |
| | | $T_C$ = 100 °C | | 12.5 | |
| Pulsed Drain Current [a] | | | $I_{DM}$ | 53 | |
| Linear Derating Factor | | | | 1.47 | W/°C |
| Single Pulse Avalanche Energy [b] | | | $E_{AS}$ | 353 | mJ |
| Maximum Power Dissipation | | | $P_D$ | 156 | W |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | -55 to +150 | °C |
| Drain-Source Voltage Slope | $T_J$ = 125 °C | | dV/dt | 70 | V/ns |
| Reverse Diode dV/dt [c] | | | | 10 | |

**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature.
b. $V_{DD}$ = 140 V, starting $T_J$ = 25 °C, L = 28.2 mH, $R_g$ = 25 Ω, $I_{AS}$ = 5 A.
c. $I_{SD} \leq I_D$, dI/dt = 100 A/μs, starting $T_J$ = 25 °C.

| THERMAL RESISTANCE RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TYP.** | **MAX.** | **UNIT** |
| Maximum Junction-to-Ambient | $R_{thJA}$ | 39 | 51 | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | 0.51 | 0.68 | |

| **SPECIFICATIONS** ($T_J$ = 25 °C, unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 μA | 650 | - | - | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 10 mA | - | 0.70 | - | V/°C |
| Gate-Source Threshold Voltage (N) | $V_{GS(th)}$ | $V_{DS} = V_{GS}$, $I_D$ = 250 μA | 2.0 | - | 4.0 | V |
| Gate-Source Leakage | $I_{GSS}$ | $V_{GS}$ = ± 20 V | - | - | ± 100 | nA |
| | | $V_{GS}$ = ± 30 V | - | - | ± 1 | μA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 520 V, $V_{GS}$ = 0 V | - | - | 1 | μA |
| | | $V_{DS}$ = 520 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | 100 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V   $I_D$ = 11 A | - | 0.157 | 0.180 | Ω |
| Forward Transconductance | $g_{fs}$ | $V_{DS}$ = 30 V, $I_D$ = 11 A | - | 7.8 | - | S |
| **Dynamic** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 100 V, f = 1 MHz | - | 2396 | - | pF |
| Output Capacitance | $C_{oss}$ | | - | 99 | - | |
| Reverse Transfer Capacitance | $C_{rss}$ | | - | 2 | - | |
| Effective Output Capacitance, Energy Related [a] | $C_{o(er)}$ | $V_{DS}$ = 0 V to 520 V, $V_{GS}$ = 0 V | - | 74 | - | |
| Effective Output Capacitance, Time Related [b] | $C_{o(tr)}$ | | - | 316 | - | |
| Total Gate Charge | $Q_g$ | $V_{GS}$ = 10 V   $I_D$ = 11 A, $V_{DS}$ = 520 V | - | 68 | 102 | nC |
| Gate-Source Charge | $Q_{gs}$ | | - | 15 | - | |
| Gate-Drain Charge | $Q_{gd}$ | | - | 28 | - | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = 520 V, $I_D$ = 11 A, $V_{GS}$ = 10 V, $R_g$ = 9.1 Ω | - | 24 | 48 | ns |
| Rise Time | $t_r$ | | - | 43 | 86 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 72 | 108 | |
| Fall Time | $t_f$ | | - | 46 | 92 | |
| Gate Input Resistance | $R_g$ | f = 1 MHz, open drain | 0.27 | 0.55 | 1.10 | Ω |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 19.8 | A |
| Pulsed Diode Forward Current | $I_{SM}$ | | - | - | 53 | |
| Diode Forward Voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 11 A, $V_{GS}$ = 0 V | - | 0.95 | 1.3 | V |
| Reverse Recovery Time | $t_{rr}$ | $T_J$ = 25 °C, $I_F = I_S$ = 11 A, dI/dt = 100 A/μs, $V_R$ = 25 V | - | 145 | 290 | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | - | 0.9 | 1.8 | μC |
| Reverse Recovery Current | $I_{RRM}$ | | - | 11.6 | - | 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)

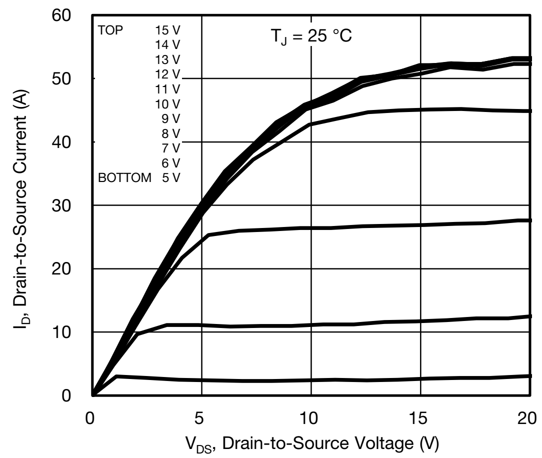



**Fig. 1 - Typical Output Characteristics**

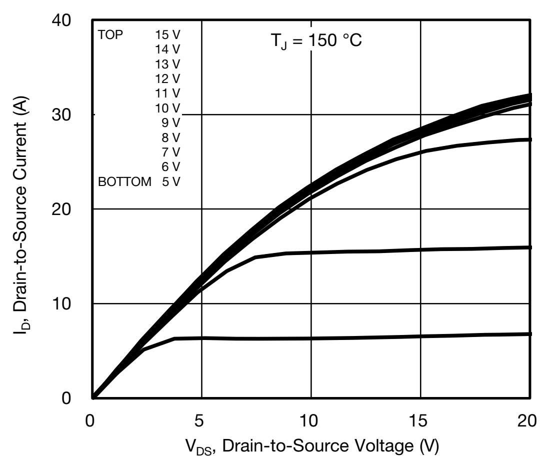



**Fig. 2 - Typical Output Characteristics**

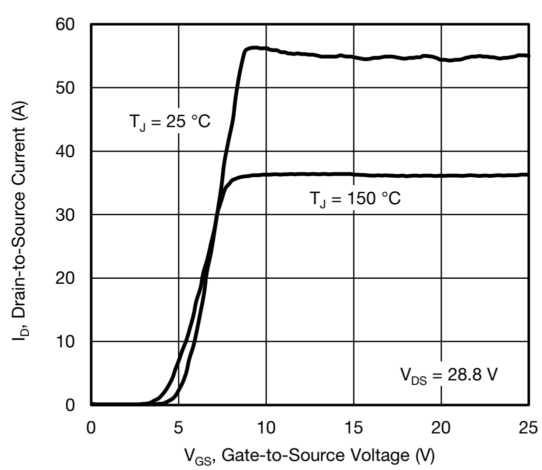



**Fig. 3 - Typical Transfer Characteristics**

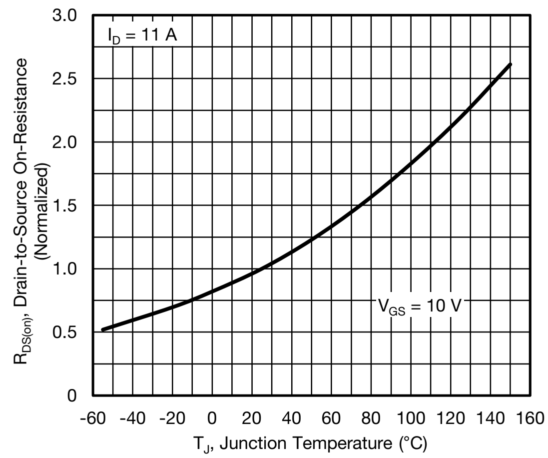



**Fig. 4 - Normalized On-Resistance vs. Temperature**

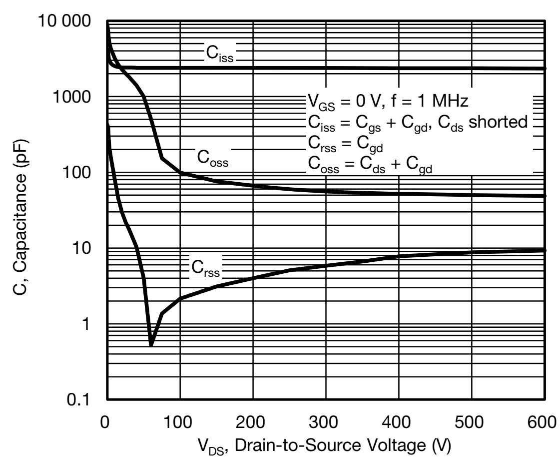



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

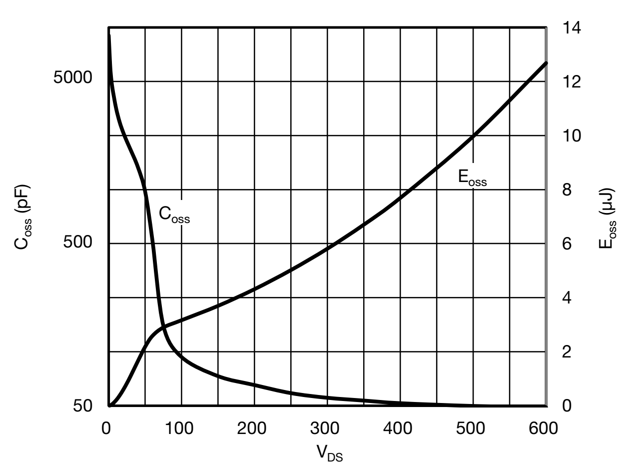



**Fig. 6 - $C_{OSS}$ and $E_{OSS}$ vs. $V_{DS}$**


For technical questions, contact: hvm@vishay.com

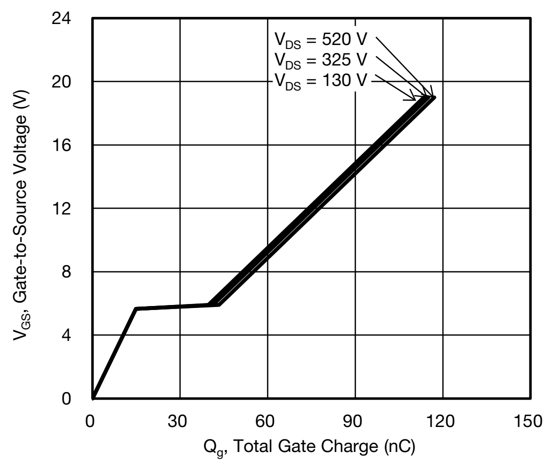



**Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage**

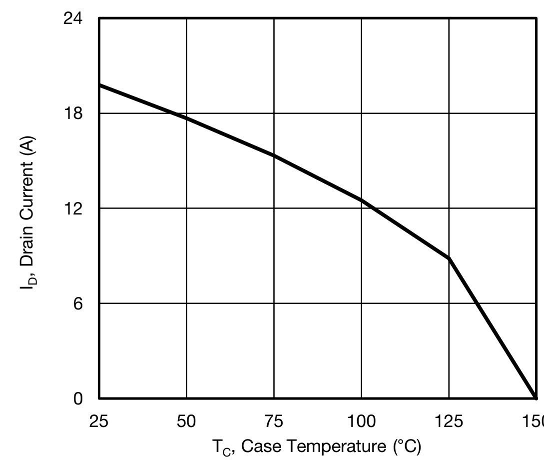



**Fig. 10 - Maximum Drain Current vs. Case Temperature**

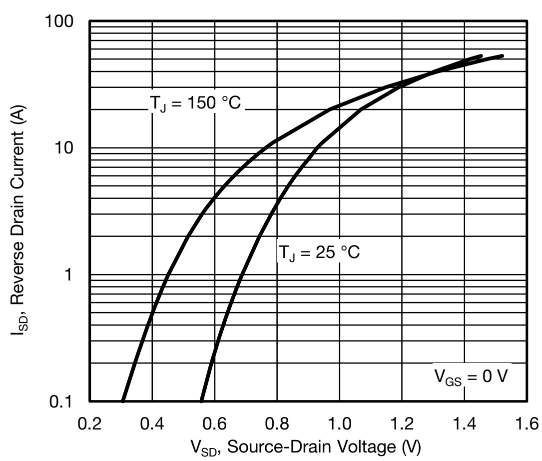



**Fig. 8 - Typical Source-Drain Diode Forward Voltage**

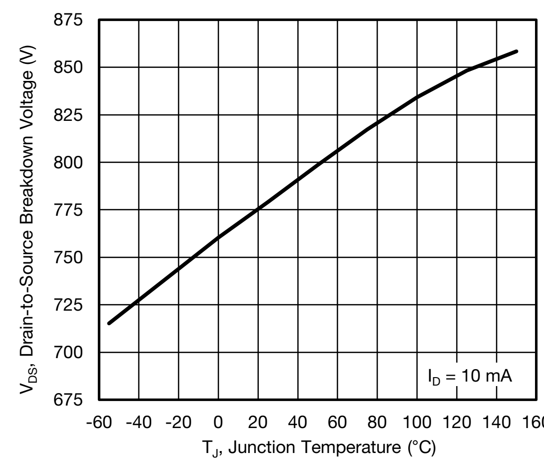
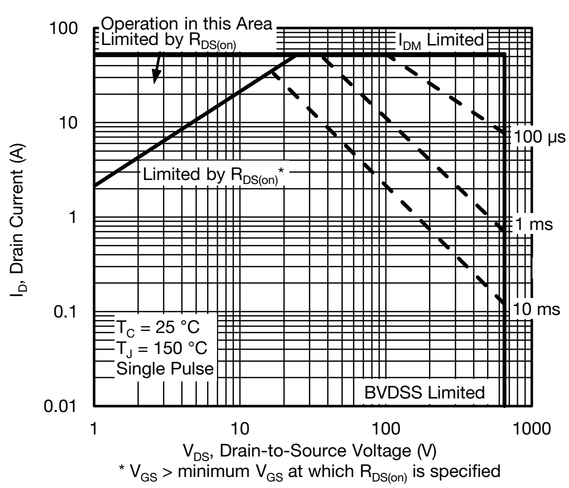



**Fig. 11 - Temperature vs. Drain-to-Source Voltage**




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

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

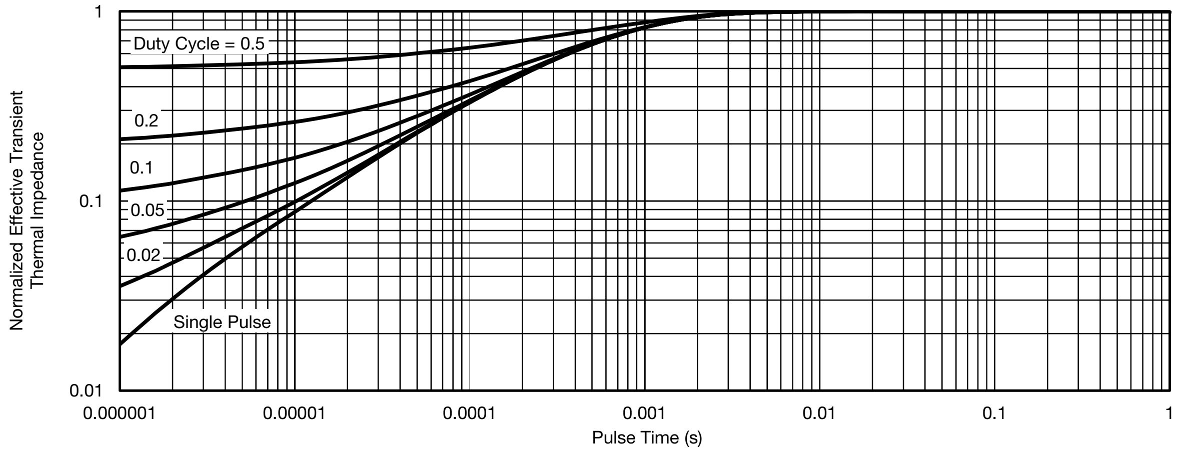



**Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case**

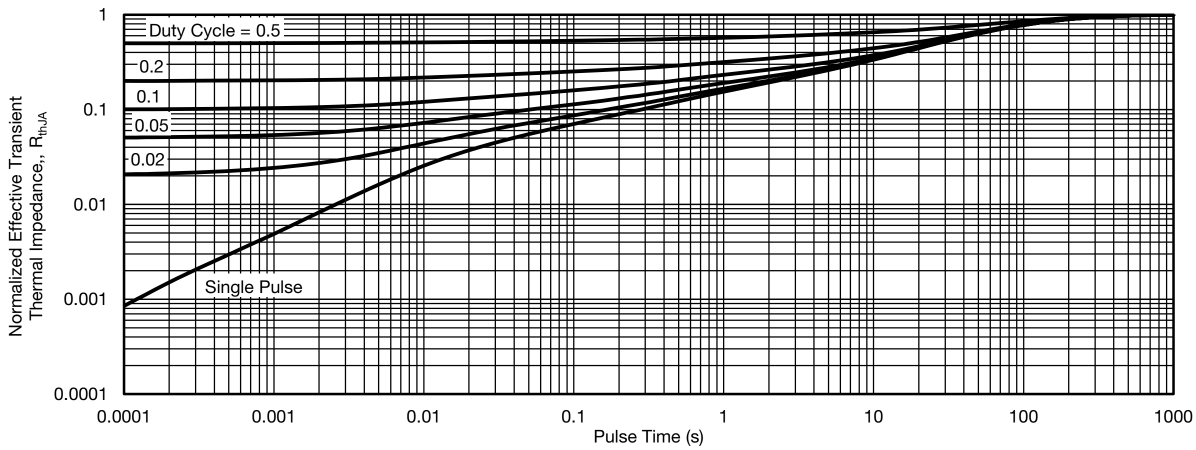



**Fig. 13 - Normalized Thermal Transient Impedance, Junction-to-Ambient**

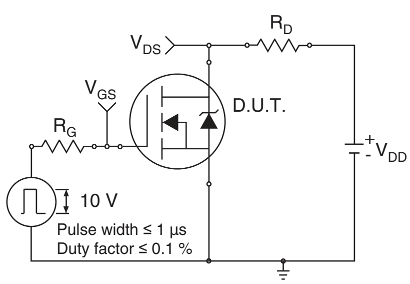



**Fig. 14 - Switching Time Test Circuit**

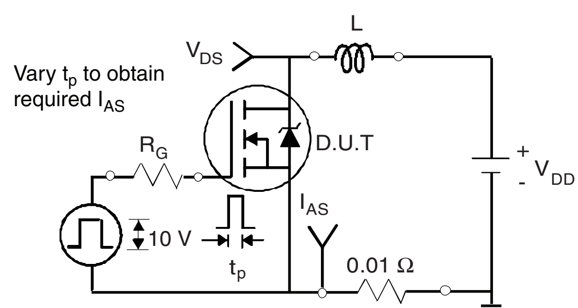



**Fig. 16 - Unclamped Inductive Test Circuit**

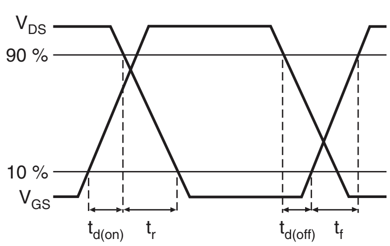



**Fig. 15 - Switching Time Waveforms**

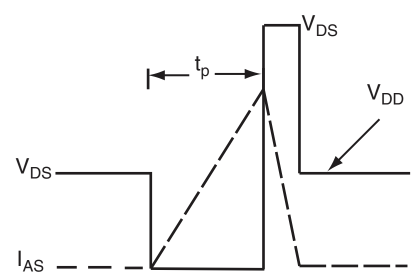



**Fig. 17 - Unclamped Inductive Waveforms**

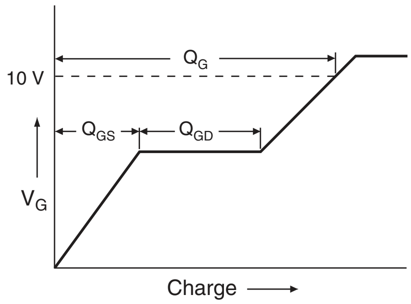



Fig. 18 - Basic Gate Charge Waveform

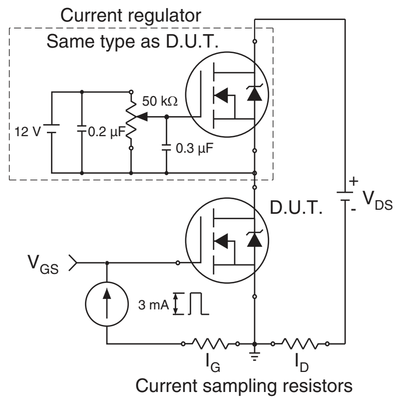
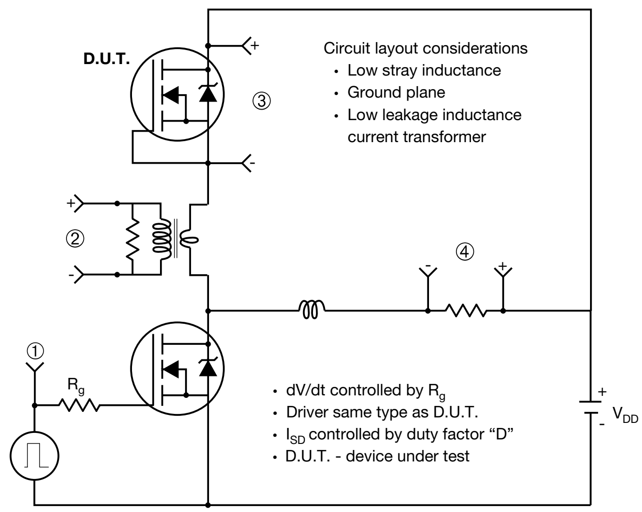
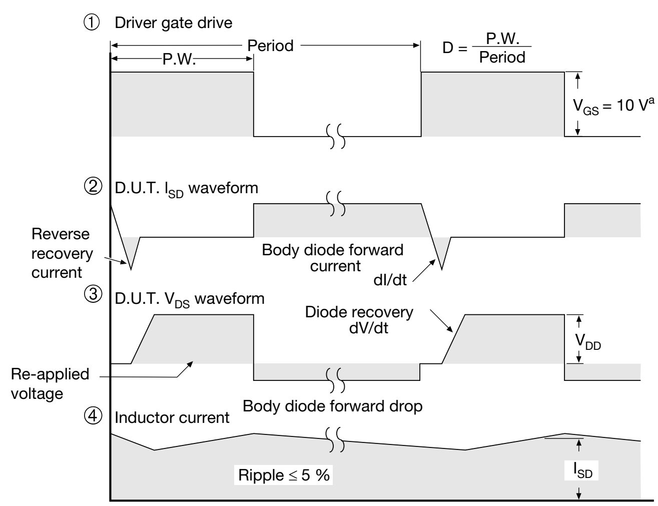



Fig. 19 - Gate Charge Test Circuit

**Peak Diode Recovery dV/dt Test Circuit**



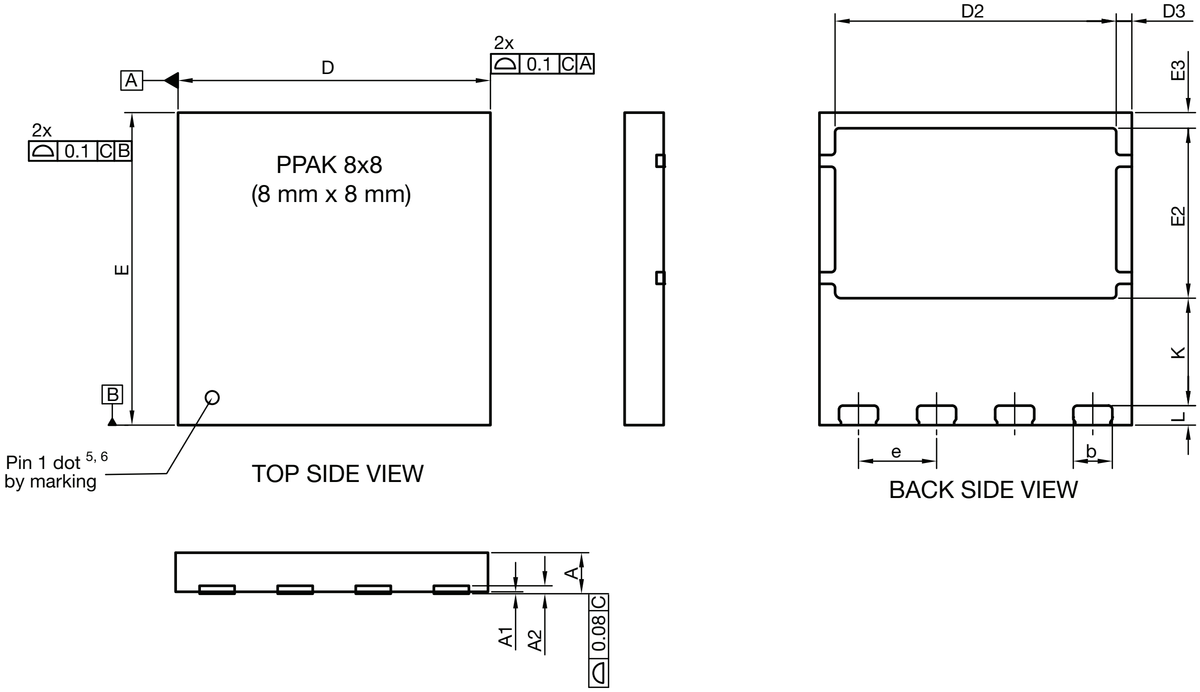

**Note**

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

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

*Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see www.vishay.com/ppg?91739.*

# PowerPAK® 8 x 8 Case Outline



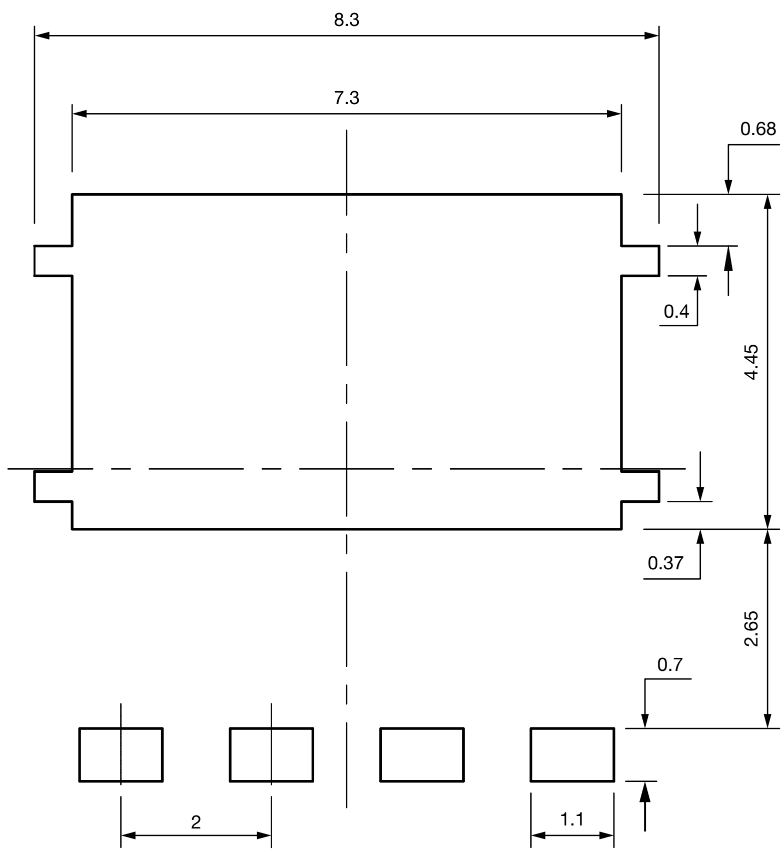

| DIM. | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A [8] | 0.95 | 1.00 | 1.05 | 0.037 | 0.039 | 0.041 |
| A1 | 0.00 | - | 0.05 | 0.000 | - | 0.002 |
| A2 | | 020 ref. | | | 0.008 ref. | |
| b [4] | 0.95 | 1.00 | 1.05 | 0.037 | 0.039 | 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 [3] | | 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. Package warpage max. 0.08 mm.
5. The pin 1 identifier must be existed on the top surface of the package by using indentation mark or other feature of package body.
6. Exact shape and size of this feature is optional.

ECN: T15-0225-Rev. A, 18-May-15
DWG: 6041

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




Dimensions in millimeters

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