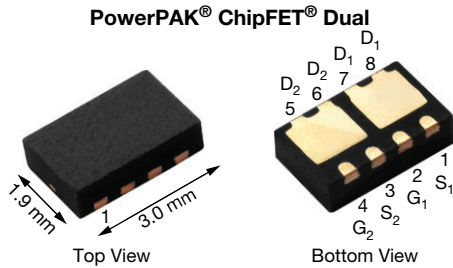


## N- and P-Channel 20 V (D-S) MOSFET



Marking code: EA

PRODUCT SUMMARY		
	N-CHANNEL	P-CHANNEL
$V_{DS}$ (V)	20	-20
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = \pm 4.5$ V	0.039	0.072
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = \pm 2.5$ V	0.045	0.100
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = \pm 1.8$ V	0.055	0.131
$Q_g$ typ. (nC)	6	5.5
$I_D$ (A) <sup>a</sup>	6	-6
Configuration	N- and p-pair	

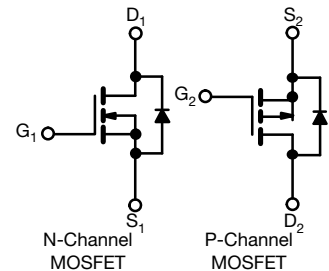
### FEATURES

- TrenchFET® power MOSFETs
- Thermally enhanced PowerPAK ChipFET package
  - Small footprint area
  - Low on-resistance
  - Thin 0.8 mm profile
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


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

### APPLICATIONS

- Complementary MOSFET for portable devices
  - Ideal for buck-boost circuits



ORDERING INFORMATION	
Package	PowerPAK ChipFET
Lead (Pb)-free and halogen-free	Si5517DU-T1-GE3

ABSOLUTE MAXIMUM RATINGS ( $T_A = 25$ °C, unless otherwise noted)					
PARAMETER	SYMBOL	N-CHANNEL	P-CHANNEL	UNIT	
Drain-source voltage	$V_{DS}$	20	-20	V	
Gate-source voltage	$V_{GS}$	$\pm 8$	$\pm 8$		
Continuous drain current ( $T_J = 150$ °C)	$I_D$	$T_C = 25$ °C	6 <sup>a</sup>	-6 <sup>a</sup>	A
		$T_C = 70$ °C	6 <sup>a</sup>	-6 <sup>a</sup>	
		$T_A = 25$ °C	7.2 <sup>b, c</sup>	-4.6 <sup>b, c</sup>	
		$T_A = 70$ °C	5.8 <sup>b, c</sup>	-3.7 <sup>b, c</sup>	
Pulsed drain current	$I_{DM}$	20	-15		
Source-drain current diode current	$I_S$	$T_C = 25$ °C	6.9	-6.9	
		$T_A = 25$ °C	1.9 <sup>b, c</sup>	-1.9 <sup>b, c</sup>	
Maximum power dissipation	$P_D$	$T_C = 25$ °C	8.3	8.3	W
		$T_C = 70$ °C	5.3	5.3	
		$T_A = 25$ °C	2.3 <sup>b, c</sup>	2.3 <sup>b, c</sup>	
		$T_A = 70$ °C	1.5 <sup>b, c</sup>	1.5 <sup>b, c</sup>	
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +150		°C	
Soldering recommendations (peak temperature) <sup>d, e</sup>		260			

THERMAL RESISTANCE RATINGS							
PARAMETER	SYMBOL	N-CHANNEL		P-CHANNEL		UNIT	
		TYP.	MAX.	TYP.	MAX.		
Maximum junction-to-ambient <sup>b, f</sup>	$t \leq 5$ s	$R_{thJA}$	45	55	45	55	°C/W
Maximum junction-to-case (drain)	Steady state	$R_{thJC}$	12	15	12	15	

### Notes

- Based on  $T_C = 25$  °C
- Surface mounted on 1" x 1" FR4 board
- $t = 5$  s
- See solder profile ([www.vishay.com/doc?73257](http://www.vishay.com/doc?73257)). The PowerPAK ChipFET is a leadless package. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper tip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection
- Rework conditions: manual soldering with a soldering iron is not recommended for leadless components
- Maximum under steady state conditions is 105 °C/W for both channels



<b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)									
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP. <sup>a</sup>	MAX.	UNIT			
<b>Static</b>									
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	N-Ch	20	-	-	V		
		$V_{GS} = 0\text{ V}, I_D = -1\text{ mA}$	P-Ch	-20	-	-			
$V_{DS}$ temperature coefficient	$\Delta V_{DS}/T_J$	$I_D = 250\text{ }\mu\text{A}$	N-Ch	-	17	-	mV/ $^\circ\text{C}$		
		$I_D = -250\text{ }\mu\text{A}$	P-Ch	-	-20	-			
$V_{GS(th)}$ temperature coefficient	$\Delta V_{GS(th)}/T_J$	$I_D = 250\text{ }\mu\text{A}$	N-Ch	-	-2.6	-	mV/ $^\circ\text{C}$		
		$I_D = -250\text{ }\mu\text{A}$	P-Ch	-	2.4	-			
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	N-Ch	0.4	-	1	V		
		$V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$	P-Ch	-0.4	-	-1			
Gate-body leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 8\text{ V}$	N-Ch	-	-	100	nA		
			P-Ch	-	-	-100			
Zero gate voltage drain current	$I_{BSS}$	$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}$	N-Ch	-	-	1	$\mu\text{A}$		
		$V_{DS} = -20\text{ V}, V_{GS} = 0\text{ V}$	P-Ch	-	-	-1			
		$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$	N-Ch	-	-	10			
		$V_{DS} = -20\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$	P-Ch	-	-	-10			
On-state drain current <sup>b</sup>	$I_{D(on)}$	$V_{DS} \leq 5\text{ V}, V_{GS} = 4.5\text{ V}$	N-Ch	20	-	-	A		
		$V_{DS} \leq -5\text{ V}, V_{GS} = -4.5\text{ V}$	P-Ch	-15	-	-			
Drain-source on-state resistance <sup>b</sup>	$R_{DS(on)}$	$V_{GS} = 4.5\text{ V}, I_D = 4.4\text{ A}$	N-Ch	-	0.0320	0.0390	$\Omega$		
		$V_{GS} = -4.5\text{ V}, I_D = -3.3\text{ A}$	P-Ch	-	0.0600	0.0720			
		$V_{GS} = 2.5\text{ V}, I_D = 4.1\text{ A}$	N-Ch	-	0.0370	0.0450			
		$V_{GS} = -2.5\text{ V}, I_D = -2.8\text{ A}$	P-Ch	-	0.0830	0.1000			
		$V_{GS} = 1.8\text{ V}, I_D = 1.8\text{ A}$	N-Ch	-	0.0455	0.0550			
		$V_{GS} = -1.8\text{ V}, I_D = -0.76\text{ A}$	P-Ch	-	0.1080	0.1310			
Forward transconductance <sup>b</sup>	$g_{fs}$	$V_{DS} = 10\text{ V}, I_D = 4.4\text{ A}$	N-Ch	-	22	-	S		
		$V_{DS} = -10\text{ V}, I_D = -3.3\text{ A}$	P-Ch	-	0.9	-			
<b>Dynamic <sup>a</sup></b>									
Input capacitance	$C_{iss}$	N-channel $V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$  P-channel $V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch	-	520	-	pF		
			P-Ch	-	455	-			
Output capacitance	$C_{oss}$		N-Ch	-	100	-			
			P-Ch	-	105	-			
Reverse transfer capacitance	$C_{rss}$		N-Ch	-	60	-			
			P-Ch	-	65	-			
Total gate charge	$Q_g$	$V_{DS} = 10\text{ V}, V_{GS} = 8\text{ V}, I_D = 4.4\text{ A}$	N-Ch	-	10.5	16	nC		
		$V_{DS} = -10\text{ V}, V_{GS} = -8\text{ V}, I_D = -4.6\text{ A}$	P-Ch	-	9.1	14			
		$V_{DS} = 10\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 4.4\text{ A}$	N-Ch	-	6	9			
		$V_{DS} = -10\text{ V}, V_{GS} = -4.5\text{ V}, I_D = -1.8\text{ A}$	P-Ch	-	5.5	8.5			
Gate-source charge	$Q_{gs}$	N-channel $V_{DS} = 10\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 4.4\text{ A}$  P-channel $V_{DS} = -10\text{ V}, V_{GS} = -4.5\text{ V}, I_D = -1.8\text{ A}$	N-Ch	-	0.91	-	nC		
			P-Ch	-	0.75	-			
Gate-drain charge	$Q_{gd}$		N-Ch	-	0.7	-			
			P-Ch	-	1.5	-			
Gate resistance	$R_g$		$f = 1\text{ MHz}$	N-Ch	-	1.9		-	$\Omega$
				P-Ch	-	8		-	



SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP. <sup>a</sup>	MAX.	UNIT	
<b>Dynamic<sup>a</sup></b>							
Turn-on delay time	t <sub>d(on)</sub>	N-channel V <sub>DD</sub> = 10 V, R <sub>L</sub> = 2.8 Ω, I <sub>D</sub> ≅ 3.6 A, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	-	20	30	ns
			P-Ch	-	8	15	
Rise time	t <sub>r</sub>	P-channel V <sub>DD</sub> = -10 V, R <sub>L</sub> = 2.7 Ω, I <sub>D</sub> ≅ -3.7 A, V <sub>GEN</sub> = -4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	-	65	100	
			P-Ch	-	35	55	
Turn-off delay time	t <sub>d(off)</sub>	N-channel V <sub>DD</sub> = 10 V, R <sub>L</sub> = 2.8 Ω, I <sub>D</sub> ≅ 3.6 A, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	-	40	60	
			P-Ch	-	40	60	
Fall time	t <sub>f</sub>	P-channel V <sub>DD</sub> = -10 V, R <sub>L</sub> = 2.7 Ω, I <sub>D</sub> ≅ -3.7 A, V <sub>GEN</sub> = -4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	-	10	15	
			P-Ch	-	55	85	
Turn-on delay time	t <sub>d(on)</sub>	N-channel V <sub>DD</sub> = 10 V, R <sub>L</sub> = 2.8 Ω, I <sub>D</sub> ≅ 3.6 A, V <sub>GEN</sub> = 8 V, R <sub>g</sub> = 1 Ω	N-Ch	-	5	10	
			P-Ch	-	5	10	
Rise time	t <sub>r</sub>	P-channel V <sub>DD</sub> = -10 V, R <sub>L</sub> = 2.7 Ω, I <sub>D</sub> ≅ -3.7 A, V <sub>GEN</sub> = -8 V, R <sub>g</sub> = 1 Ω	N-Ch	-	12	20	
			P-Ch	-	15	25	
Turn-off delay time	t <sub>d(off)</sub>	N-channel V <sub>DD</sub> = 10 V, R <sub>L</sub> = 2.8 Ω, I <sub>D</sub> ≅ 3.6 A, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	-	26	40	
			P-Ch	-	30	45	
Fall Time	t <sub>f</sub>	P-channel V <sub>DD</sub> = -10 V, R <sub>L</sub> = 2.7 Ω, I <sub>D</sub> ≅ -3.7 A, V <sub>GEN</sub> = -8 V, R <sub>g</sub> = 1 Ω	N-Ch	-	8	15	
			P-Ch	-	45	70	
<b>Drain-Source Body Diode Characteristics</b>							
Continuous source-drain diode current	I <sub>S</sub>	T <sub>C</sub> = 25 °C	N-Ch	-	-	6.9	A
			P-Ch	-	-	-6.9	
Pulse diode forward current <sup>a</sup>	I <sub>SM</sub>		N-Ch	-	-	20	A
			P-Ch	-	-	-15	
Body diode voltage	V <sub>SD</sub>	I <sub>S</sub> = 1.2 A, V <sub>GS</sub> = 0 V	N-Ch	-	0.8	1.2	V
		I <sub>S</sub> = -1.0 A, V <sub>GS</sub> = 0 V	P-Ch	-	-0.8	-1.2	
Body diode reverse recovery time	t <sub>rr</sub>	N-channel I <sub>F</sub> = 1.2 A, di/dt = 100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	-	45	70	ns
			P-Ch	-	30	60	
Body diode reverse recovery charge	Q <sub>rr</sub>	P-channel I <sub>F</sub> = -1 A, di/dt = -100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	-	21	32	nC
			P-Ch	-	15	30	
Reverse recovery fall time	t <sub>a</sub>	N-channel I <sub>F</sub> = 1.2 A, di/dt = 100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	-	29	-	ns
			P-Ch	-	11	-	
Reverse recovery rise time	t <sub>b</sub>	P-channel I <sub>F</sub> = -1 A, di/dt = -100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	-	16	-	
			P-Ch	-	19	-	

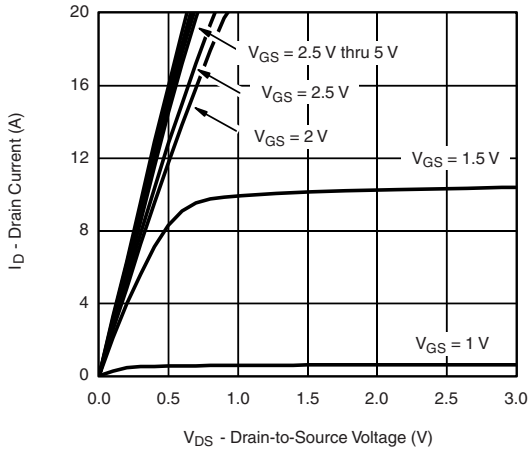
**Notes**

- a. Guaranteed by design, not subject to production testing
- b. Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 2 %

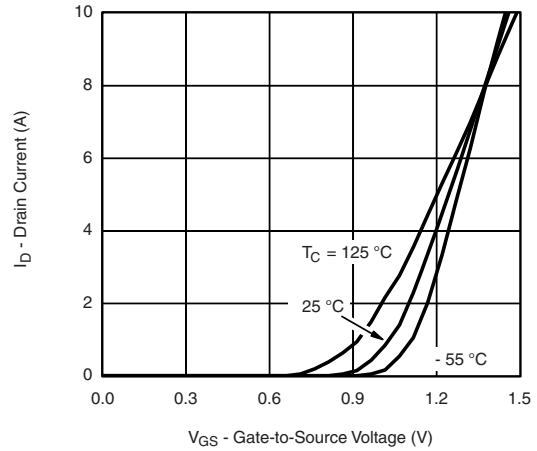
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



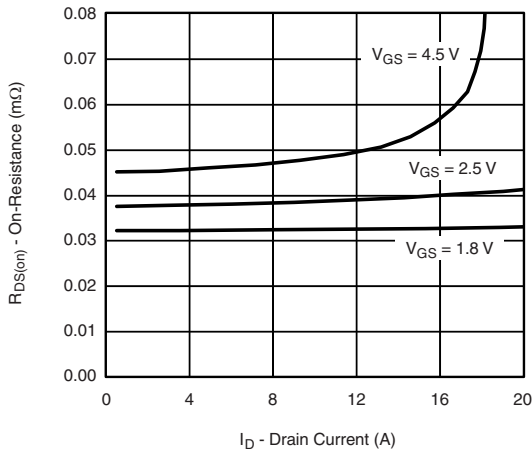
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



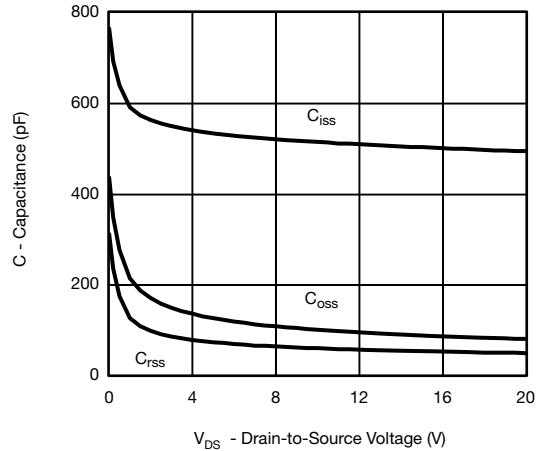
**Output Characteristics**



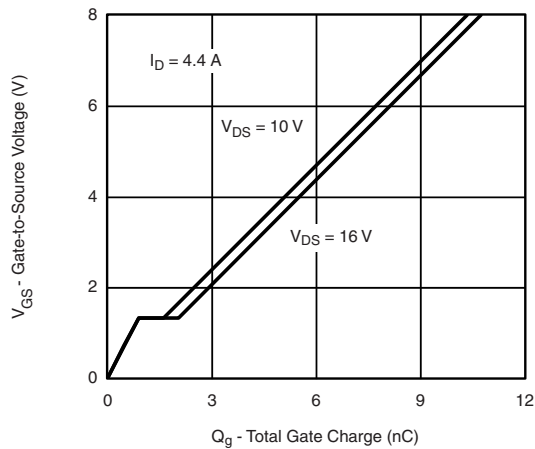
**Transfer Characteristics**



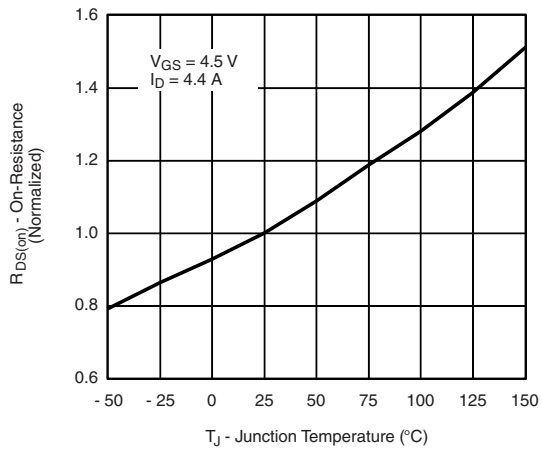
**On-Resistance vs. Drain Current and Gate Voltage**



**Capacitance**



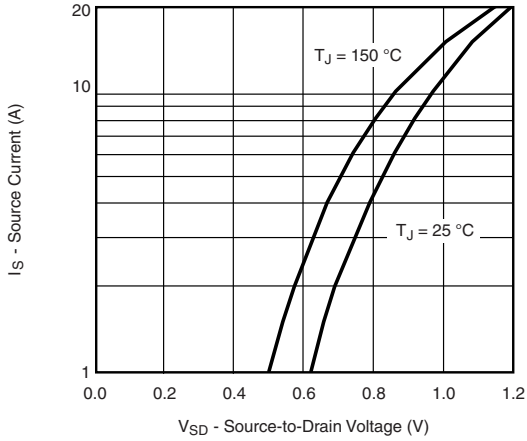
**Gate Charge**



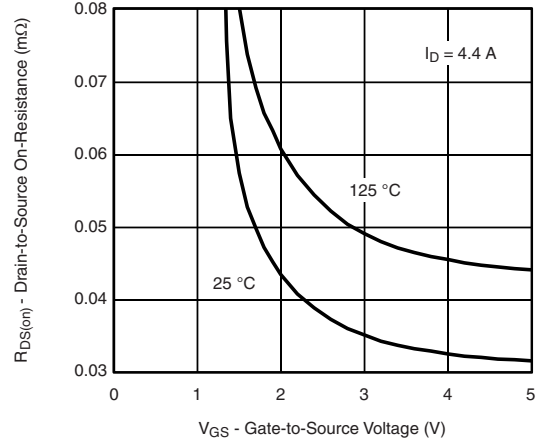
**On-Resistance vs. Junction Temperature**



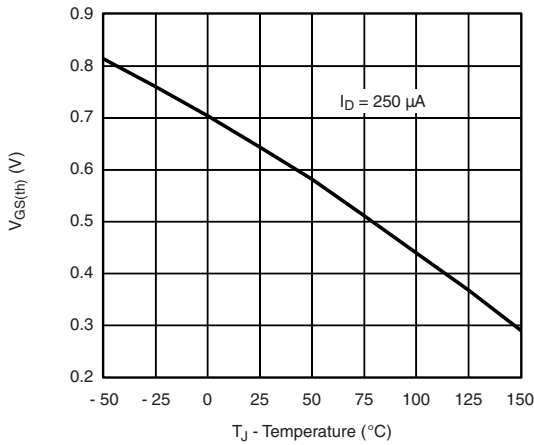
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



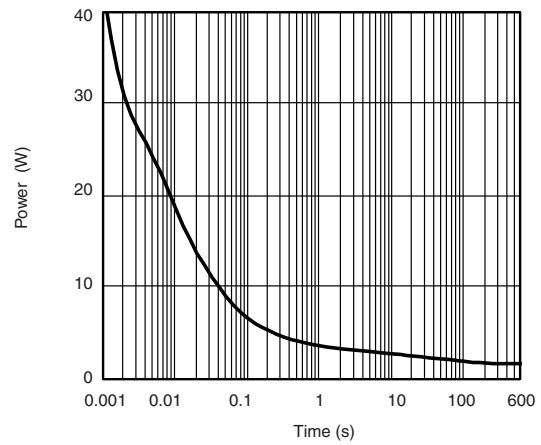
**Source-Drain Diode Forward Voltage**



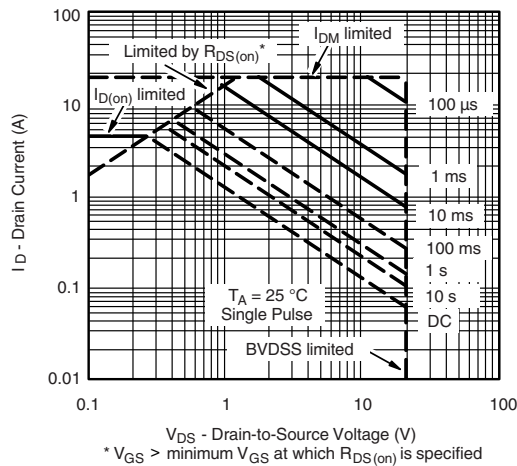
**On-Resistance vs. Gate-to-Source Voltage**



**Threshold Voltage**



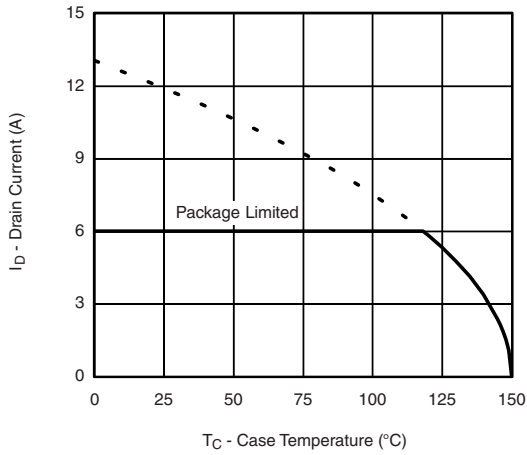
**Single Pulse Power, Junction-to-Ambient**



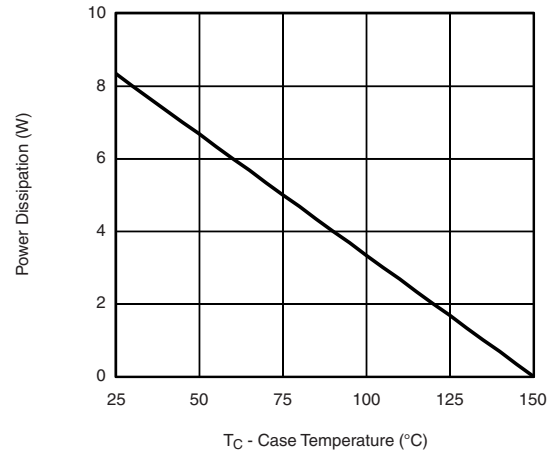
**Safe Operating Area, Junction-to-Ambient**



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



**Current Derating <sup>a</sup>**



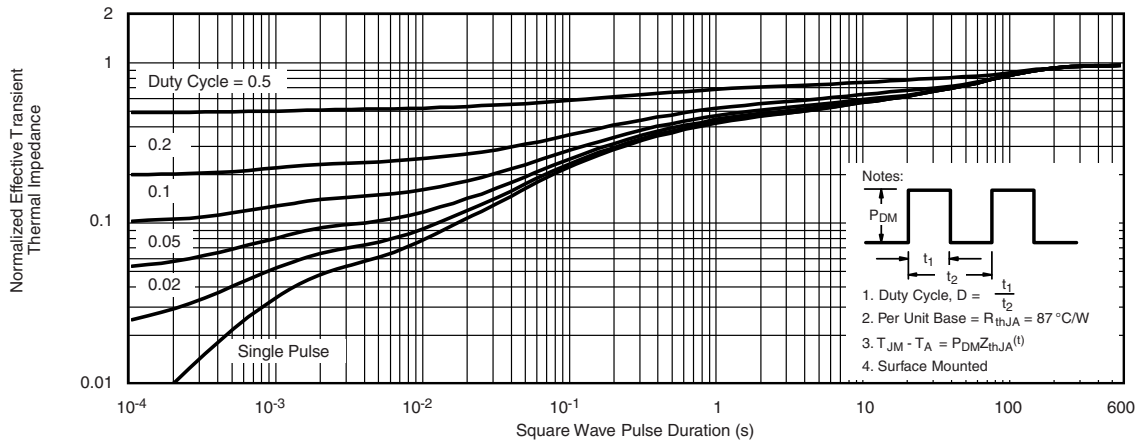
**Power Derating**

**Note**

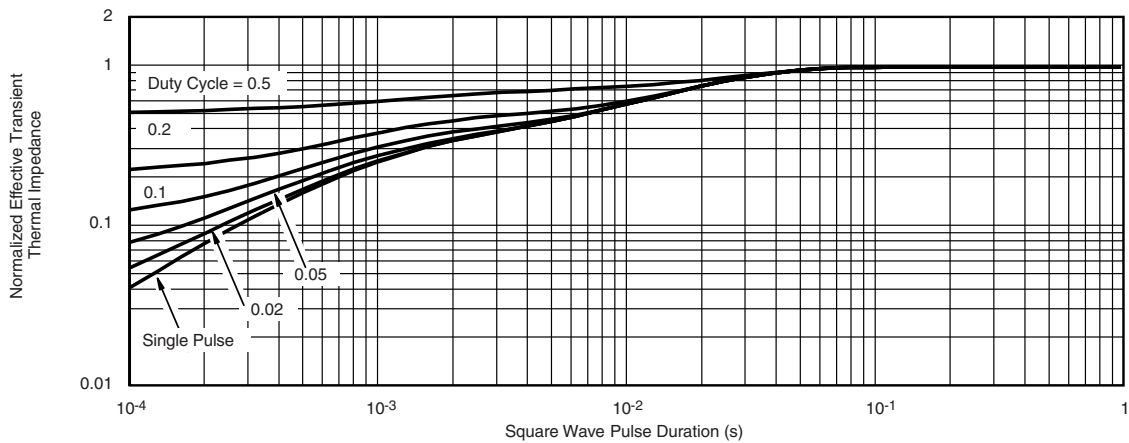
- a. The power dissipation  $P_D$  is based on  $T_J \text{ max.} = 150 \text{ }^\circ\text{C}$ , using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit



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



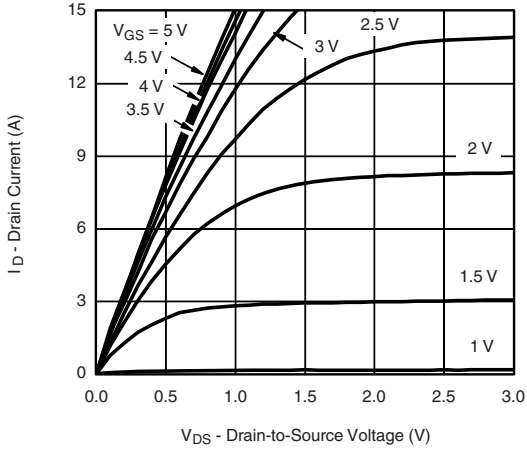
**Normalized Thermal Transient Impedance, Junction-to-Ambient**



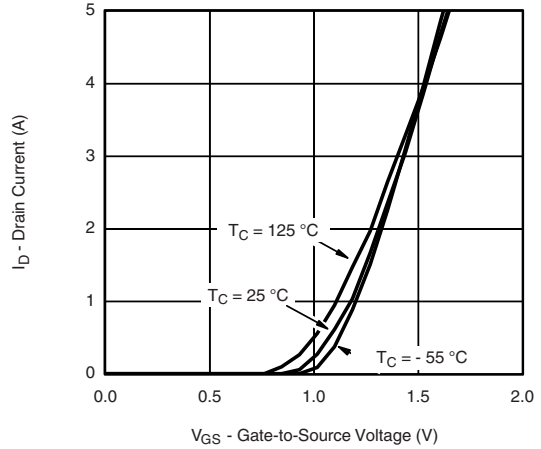
**Normalized Thermal Transient Impedance, Junction-to-Case**



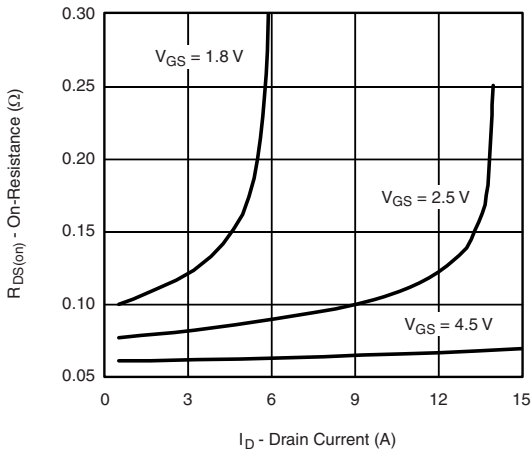
**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



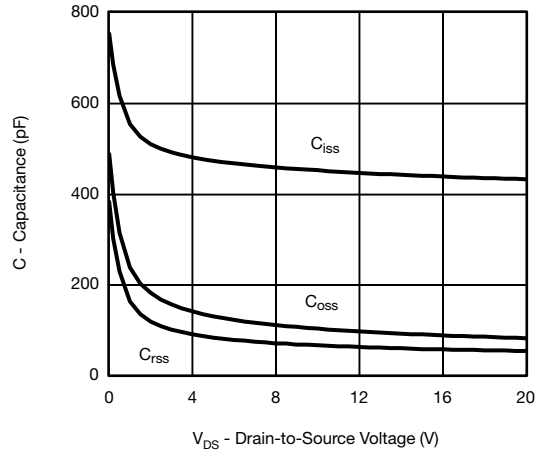
**Output Characteristics**



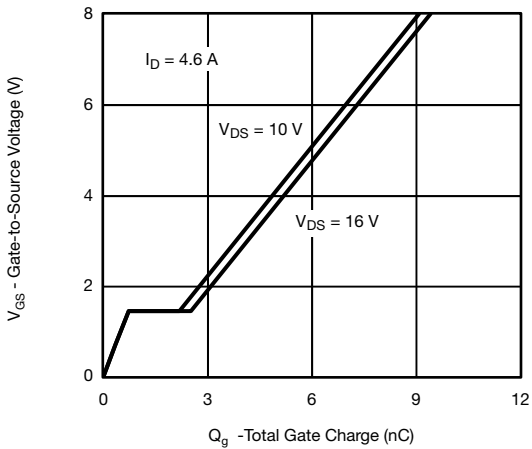
**Transfer Characteristics**



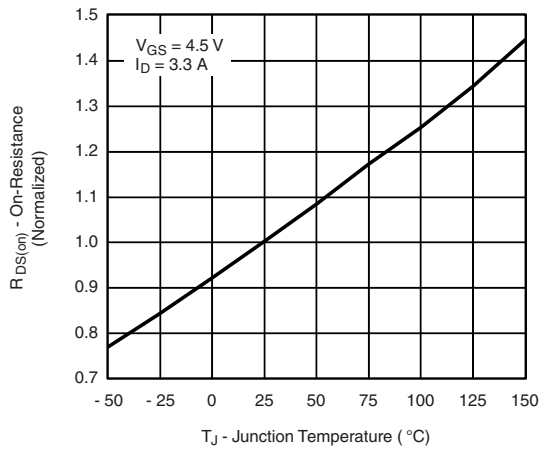
**On-Resistance vs. Drain Current and Gate Voltage**



**Capacitance**



**Gate Charge**

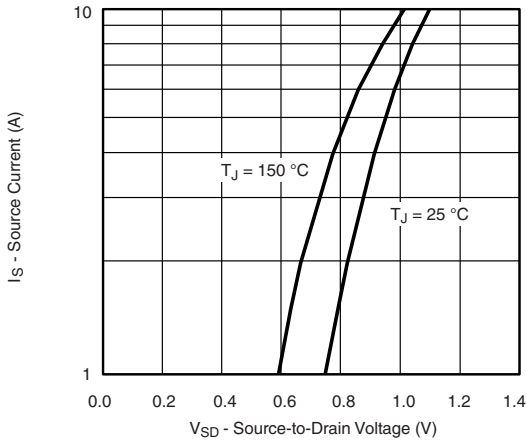


**On-Resistance vs. Junction Temperature**

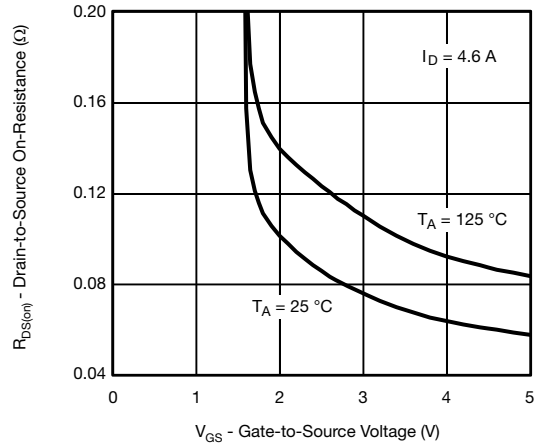




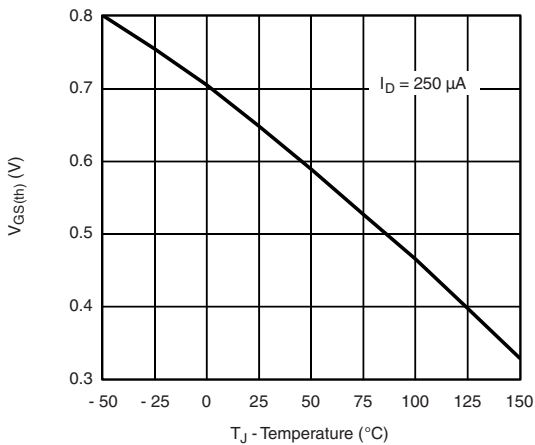
**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



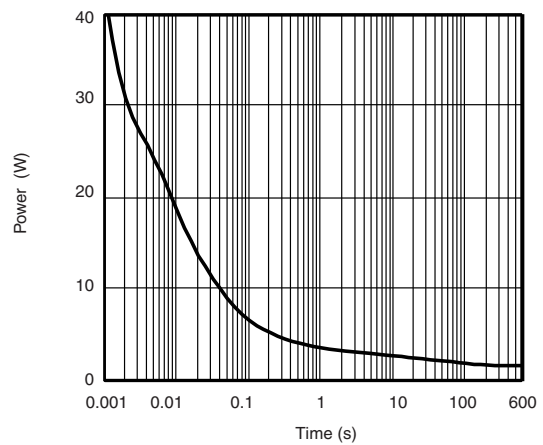
**Source-Drain Diode Forward Voltage**



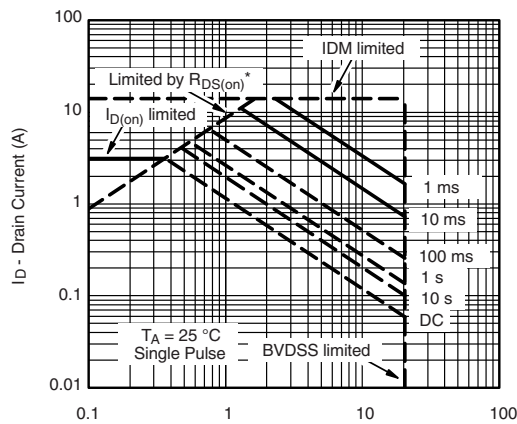
**On-Resistance vs. Gate-to-Source Voltage**



**Threshold Voltage**



**Single Pulse Power, Junction-to-Ambient**

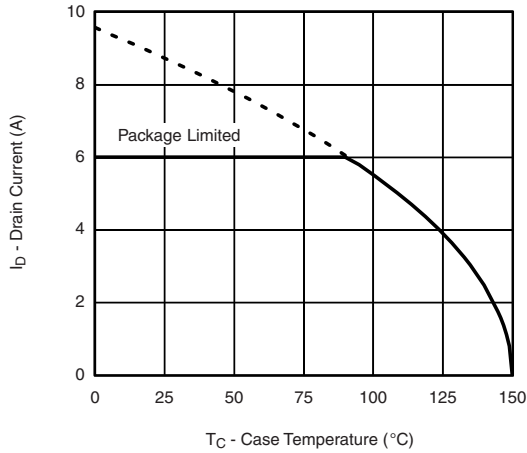


\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

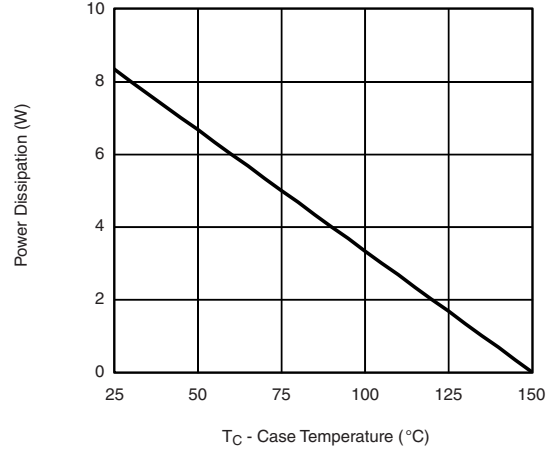
**Safe Operating Area, Junction-to-Case**



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



**Current Derating <sup>a</sup>**



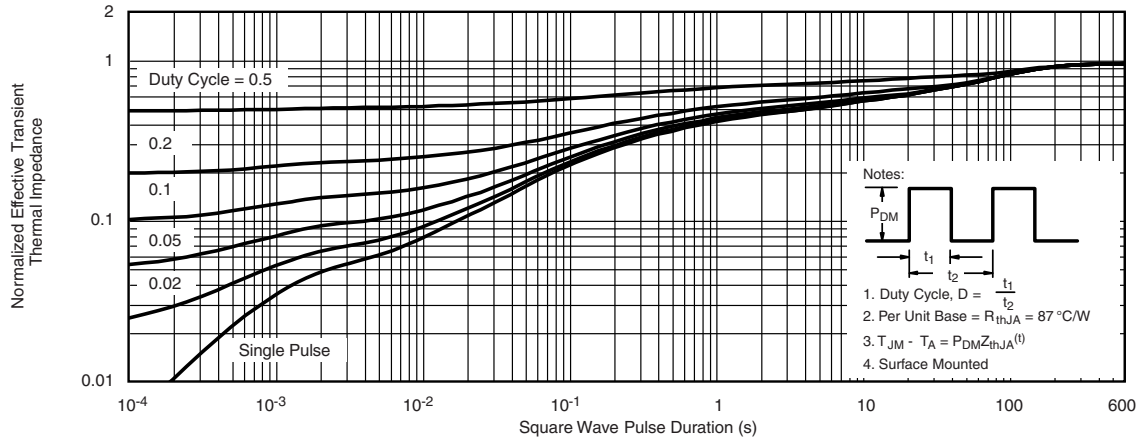
**Power Derating**

**Note**

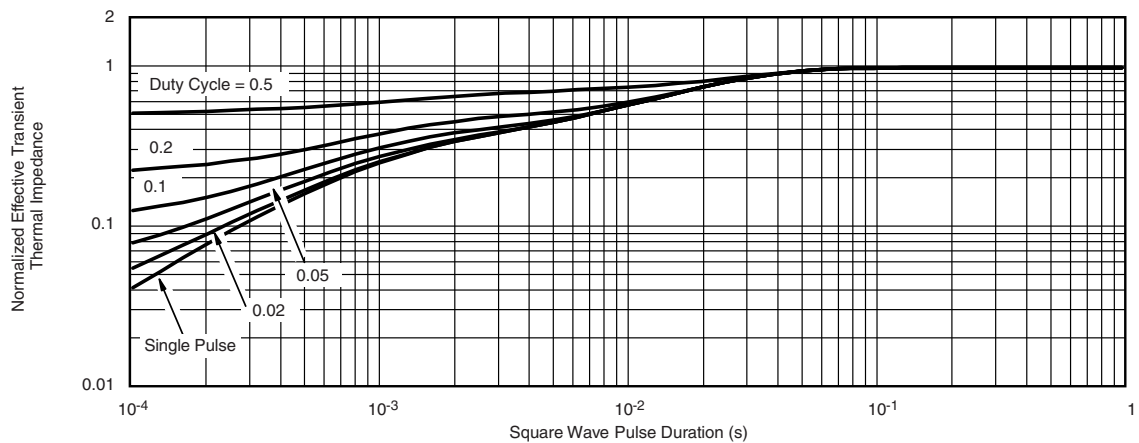
- a. The power dissipation  $P_D$  is based on  $T_J \text{ max.} = 150 \text{ °C}$ , using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit



P-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



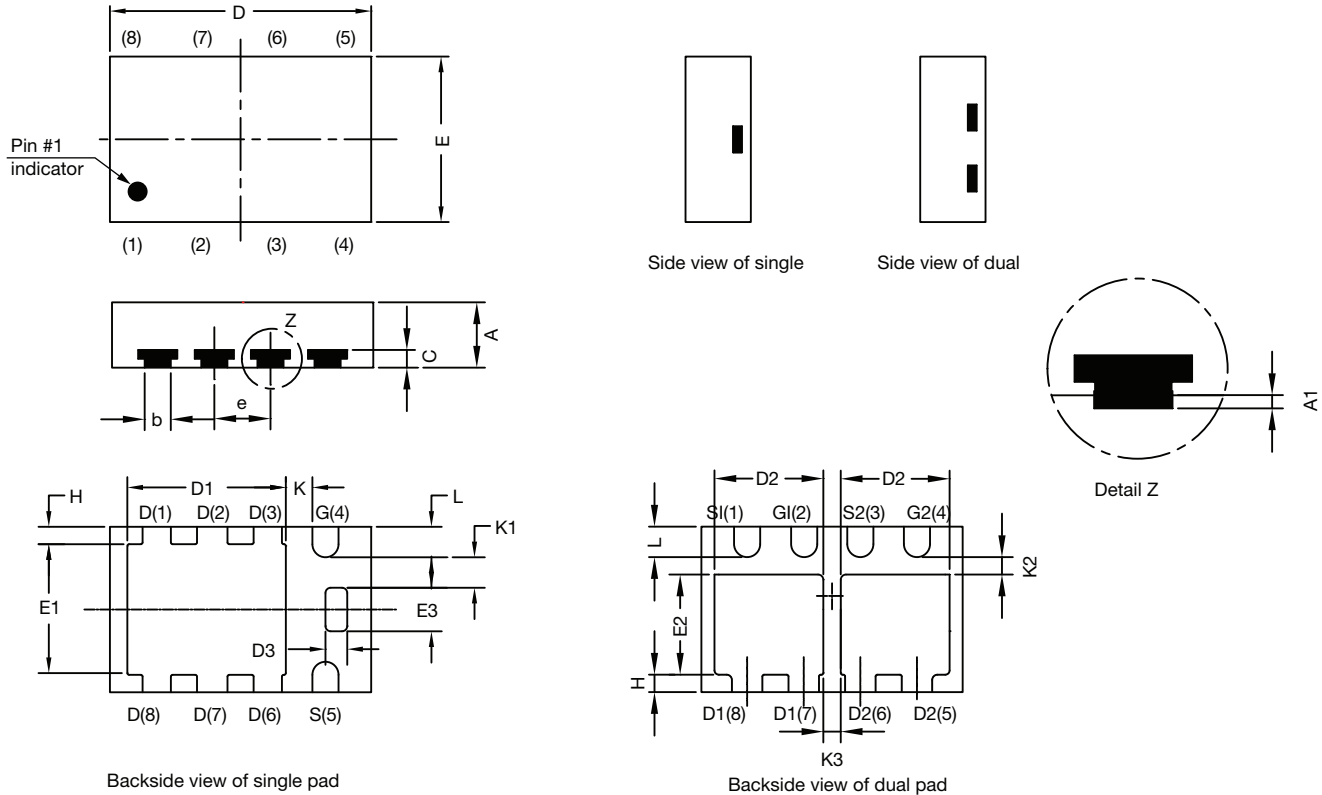
Normalized Thermal Transient Impedance, Junction-to-Ambient



Normalized Thermal Transient Impedance, Junction-to-Case

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?73529](http://www.vishay.com/ppg?73529).

### PowerPAK<sup>®</sup> ChipFET<sup>®</sup> Case Outline



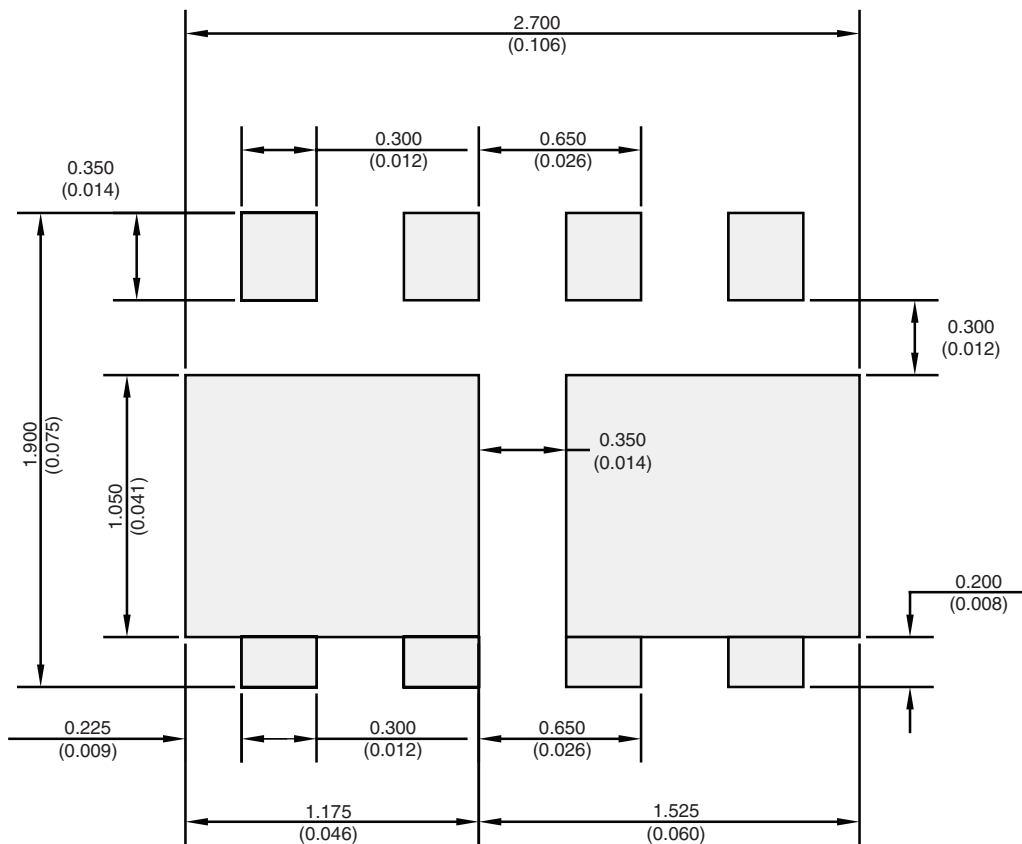
DIM.	MILLIMETERS			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.85	0.028	0.030	0.033
A1	0	-	0.05	0	-	0.002
b	0.25	0.30	0.35	0.010	0.012	0.014
C	0.15	0.20	0.25	0.006	0.008	0.010
D	2.92	3.00	3.08	0.115	0.118	0.121
D1	1.75	1.87	2.00	0.069	0.074	0.079
D2	1.07	1.20	1.32	0.042	0.047	0.052
D3	0.20	0.25	0.30	0.008	0.010	0.012
E	1.82	1.90	1.98	0.072	0.075	0.078
E1	1.38	1.50	1.63	0.054	0.059	0.064
E2	0.92	1.05	1.17	0.036	0.041	0.046
E3	0.45	0.50	0.55	0.018	0.020	0.022
e	0.65 BSC			0.026 BSC		
H	0.15	0.20	0.25	0.006	0.008	0.010
K	0.25	-	-	0.010	-	-
K1	0.30	-	-	0.012	-	-
K2	0.20	-	-	0.008	-	-
K3	0.20	-	-	0.008	-	-
L	0.30	0.35	0.40	0.012	0.014	0.016

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DWG: 5940

**Note**

- Millimeters will govern

## RECOMMENDED MINIMUM PADS FOR PowerPAK® ChipFET® Dual



Recommended Minimum Pads  
Dimensions in mm/(Inches)

Note: This is Flipped Mirror Image  
Pin #1 Location is Top Left Corner



## Disclaimer

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