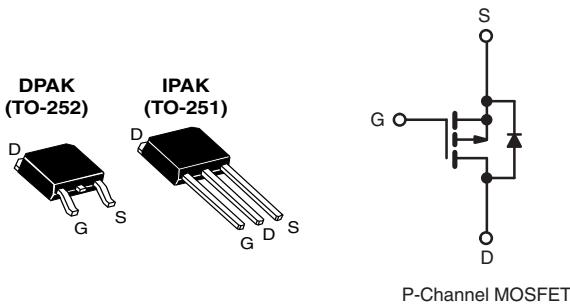


Power MOSFET

PRODUCT SUMMARY	
V _{DS} (V)	- 60
R _{DS(on)} (Ω)	V _{GS} = - 10 V 0.28
Q _g (Max.) (nC)	19
Q _{gs} (nC)	5.4
Q _{gd} (nC)	11
Configuration	Single



FEATURES

- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- Surface Mount (IRFR9024, SiHFR9024)
- Straight Lead (IRFU9024, SiHFU9024)
- Available in Tape and Reel
- P-Channel
- Fast Switching
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912



DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The DPAK is designed for surface mounting using vapor phase, infrared, or wave soldering techniques. The straight lead version (IRFU, SiHFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 W are possible in typical surface mount applications.

ORDERING INFORMATION					
Package	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	IPAK (TO-251)
Lead (Pb)-free and Halogen-free	SiHFR9024-GE3	SiHFR9024TR-GE3 ^a	SiHFR9024TRL-GE3 ^a	SiHFR9024TRR-GE3 ^a	SiHFU9024-GE3
Lead (Pb)-free	IRFR9024PbF	IRFR9024TRPbF ^a	IRFR9024TRLPbF ^a	IRFR9024TRRPbF ^a	IRFU9024PbF
	SiHFR9024-E3	SiHFR9024T-E3 ^a	SiHFR9024TL-E3 ^a	SiHFR9024TR-E3 ^a	SiHFU9024-E3

Note

a. See device orientation.

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

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-Source Voltage	V _{DS}	- 60	V
Gate-Source Voltage	V _{GS}	± 20	
Continuous Drain Current	I _D	- 8.8	A
		- 5.6	
Pulsed Drain Current ^a	I _{DM}	- 35	A
Linear Derating Factor		0.33	W/°C
Linear Derating Factor (PCB Mount) ^e		0.020	
Single Pulse Avalanche Energy ^b	E _{AS}	300	mJ
Repetitive Avalanche Current ^a	I _{AR}	- 8.8	A
Repetitive Avalanche Energy ^a	E _{AR}	5.0	mJ
Maximum Power Dissipation	P _D	42	W
Maximum Power Dissipation (PCB Mount) ^e		2.5	
Peak Diode Recovery dV/dt ^c	dV/dt	- 4.5	V/ns
Operating Junction and Storage Temperature Range	T _J , T _{stg}	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature) ^d	for 10 s	260	

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).

b. V_{DD} = - 25 V, starting T_J = 25 °C, L = 4.5 mH, R_g = 25 Ω, I_{AS} = - 8.8 A (see fig. 12).

c. I_{SD} ≤ - 11 A, dI/dt ≤ 140 A/μs, V_{DD} ≤ V_{DS}, T_J ≤ 150 °C.

d. 1.6 mm from case.

e. When mounted on 1" square PCB (FR-4 or G-10 material).

THERMAL RESISTANCE RATINGS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	-	110	°C/W
Maximum Junction-to-Ambient (PCB Mount) ^a	R_{thJA}	-	-	50	
Maximum Junction-to-Case (Drain)	R_{thJC}	-	-	3.0	

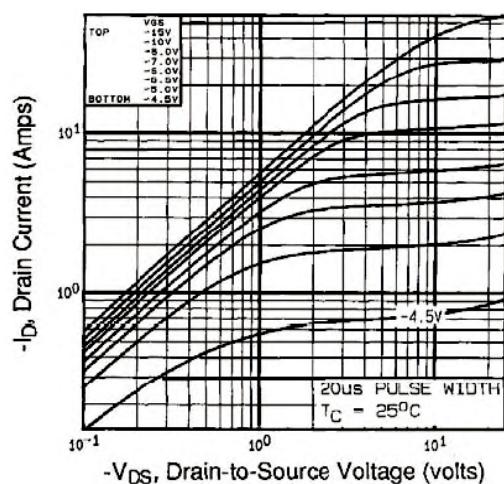
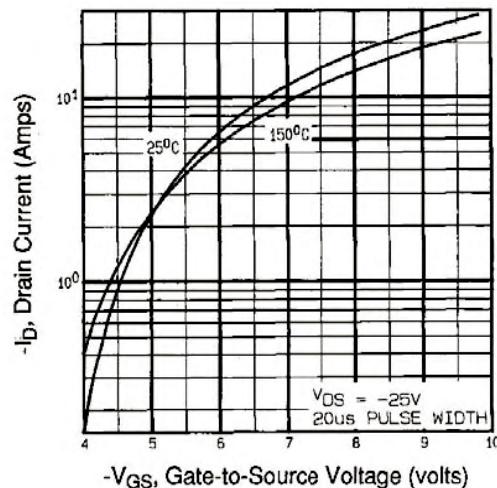
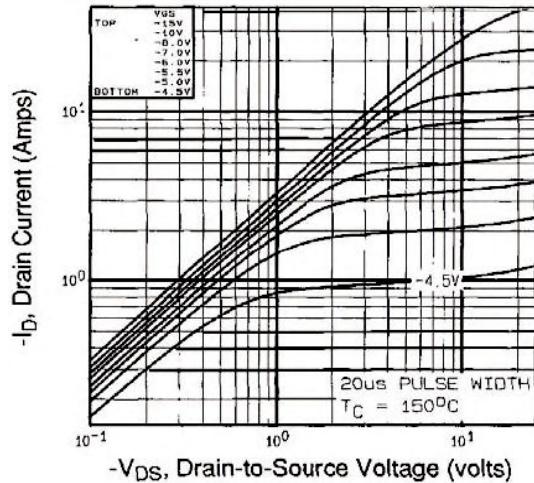
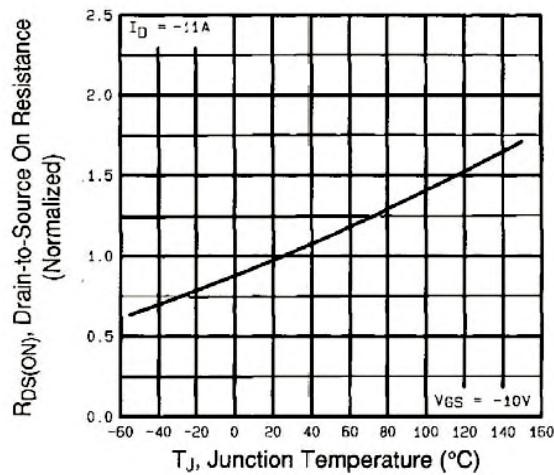
Note

a. When mounted on 1" square PCB (FR-4 or G-10 material).

SPECIFICATIONS ($T_J = 25^\circ\text{C}$, unless otherwise noted)								
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT	
Static								
Drain-Source Breakdown Voltage	V_{DS}	$V_{GS} = 0\text{ V}$, $I_D = 250\text{ }\mu\text{A}$		- 60	-	-	V	
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25°C , $I_D = 1\text{ mA}$		-	- 0.063	-	$\text{V}/^\circ\text{C}$	
Gate-Source Threshold Voltage	$V_{GS(\text{th})}$	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$		- 2.0	-	- 4.0	V	
Gate-Source Leakage	I_{GSS}	$V_{GS} = \pm 20\text{ V}$		-	-	± 100	nA	
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = - 60\text{ V}$, $V_{GS} = 0\text{ V}$		-	-	- 100	\mu A	
		$V_{DS} = - 48\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 125^\circ\text{C}$		-	-	- 500		
Drain-Source On-State Resistance	$R_{DS(\text{on})}$	$V_{GS} = - 10\text{ V}$	$I_D = - 5.3\text{ A}^b$	-	-	0.28	Ω	
Forward Transconductance	g_{fs}	$V_{DS} = - 25\text{ V}$, $I_D = - 5.3\text{ A}$		2.9	-	-	S	
Dynamic								
Input Capacitance	C_{iss}	$V_{GS} = 0\text{ V}$, $V_{DS} = - 25\text{ V}$, $f = 1.0\text{ MHz}$		-	570	-	pF	
Output Capacitance	C_{oss}			-	360	-		
Reverse Transfer Capacitance	C_{rss}			-	65	-		
Total Gate Charge	Q_g	$V_{GS} = - 10\text{ V}$	$I_D = - 11\text{ A}$, $V_{DS} = - 48\text{ V}$, see fig. 6 and 13 ^b	-	-	19	nC	
Gate-Source Charge	Q_{gs}			-	-	5.4		
Gate-Drain Charge	Q_{gd}			-	-	11		
Turn-On Delay Time	$t_{d(\text{on})}$			-	13	-		
Rise Time	t_r	$V_{DD} = - 30\text{ V}$, $I_D = - 11\text{ A}$, $R_g = 18\text{ }\Omega$, $R_D = 2.5\text{ }\Omega$, see fig. 10 ^b		-	68	-	ns	
Turn-Off Delay Time	$t_{d(\text{off})}$			-	15	-		
Fall Time	t_f			-	29	-		
Internal Drain Inductance	L_D			-	4.5	-		
Internal Source Inductance	L_S	Between lead, 6 mm (0.25") from package and center of die contact		-	7.5	-	nH	
Drain-Source Body Diode Characteristics								
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p - n junction diode		-	-	- 8.8	A	
Pulsed Diode Forward Current ^a	I_{SM}			-	-	- 35		
Body Diode Voltage	V_{SD}	$T_J = 25^\circ\text{C}$, $I_S = - 8.8\text{ A}$, $V_{GS} = 0\text{ V}^b$		-	-	- 6.3	V	
Body Diode Reverse Recovery Time	t_{rr}	$T_J = 25^\circ\text{C}$, $I_F = - 11\text{ A}$, $dI/dt = 100\text{ A}/\mu\text{s}^b$		-	100	200	ns	
Body Diode Reverse Recovery Charge	Q_{rr}			-	0.32	0.64	μC	
Forward Turn-On Time	t_{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L_S and L_D)						

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$.

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

Fig. 1 - Typical Output Characteristics, $T_c = 25\text{ }^{\circ}\text{C}$

Fig. 3 - Typical Transfer Characteristics

Fig. 2 - Typical Output Characteristics, $T_c = 150\text{ }^{\circ}\text{C}$

Fig. 4 - Normalized On-Resistance vs. Temperature

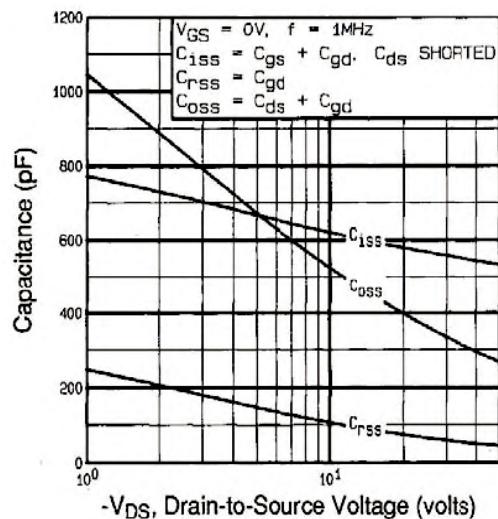


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

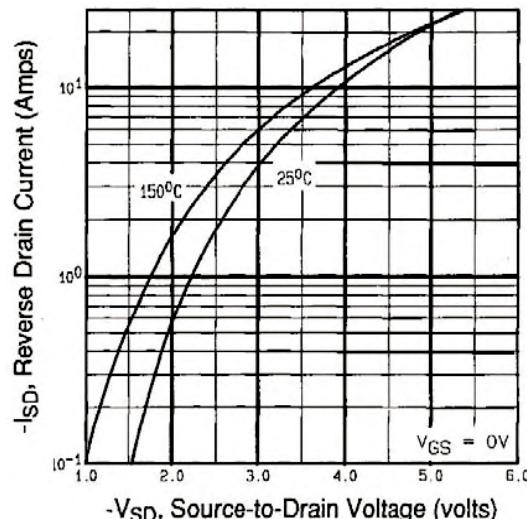


Fig. 7 - Typical Source-Drain Diode Forward Voltage

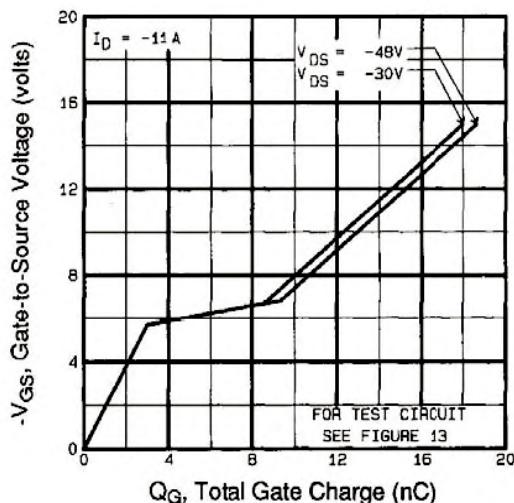


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

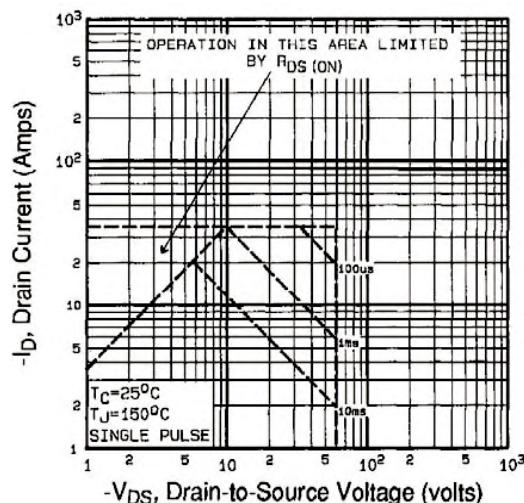


Fig. 8 - Maximum Safe Operating Area

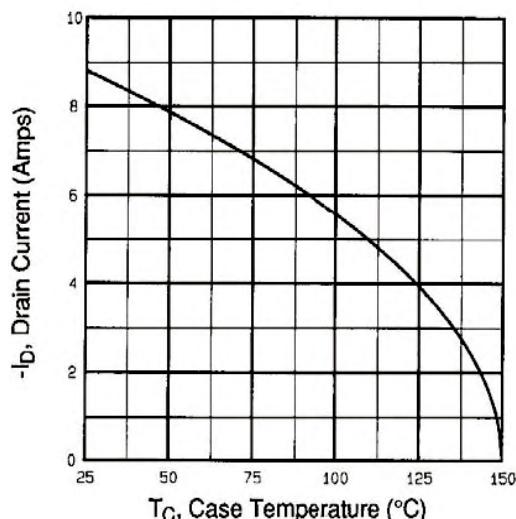


Fig. 9 - Maximum Drain Current vs. Case Temperature

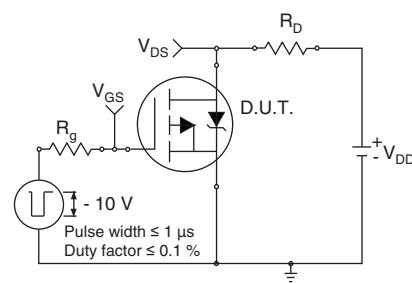


Fig. 10a - Switching Time Test Circuit

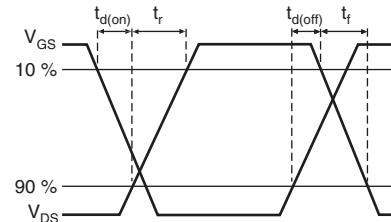


Fig. 10b - Switching Time Waveforms

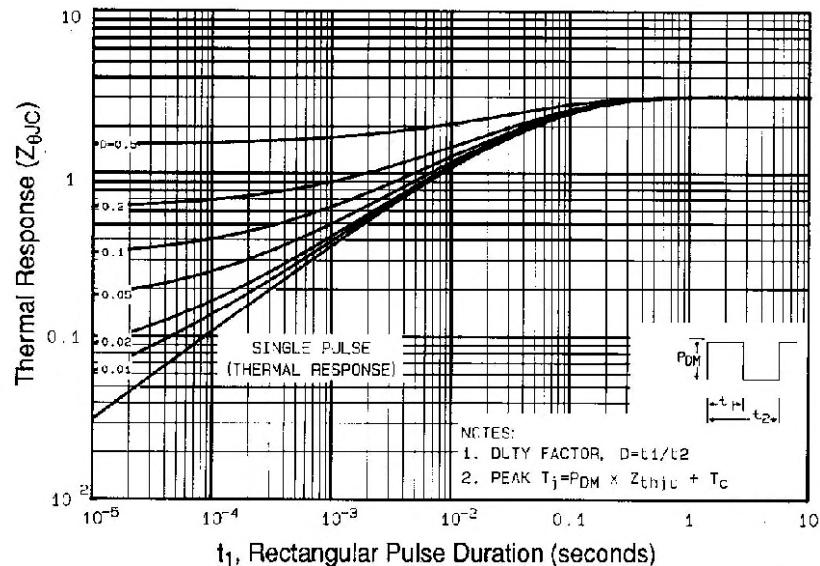
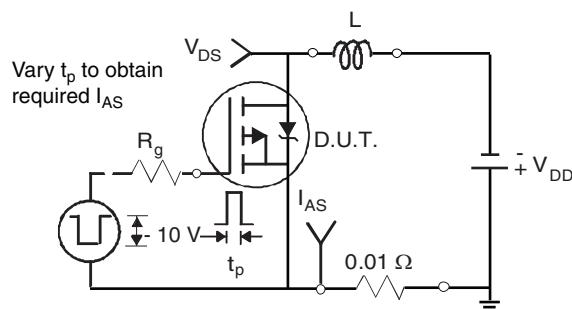
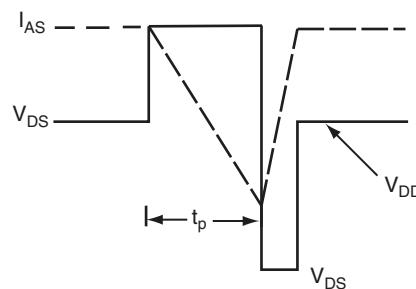
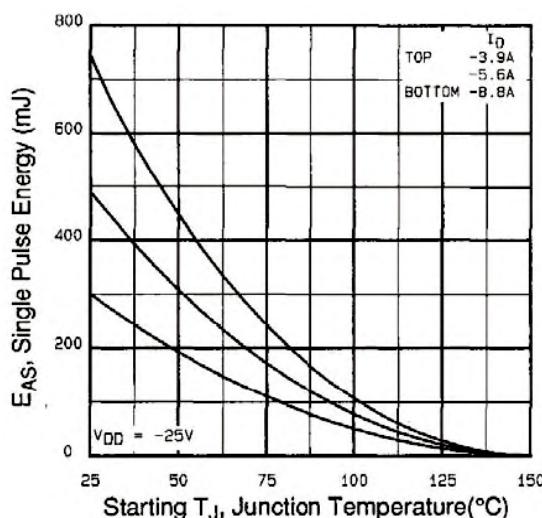
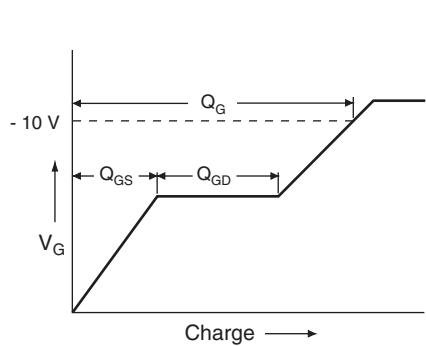
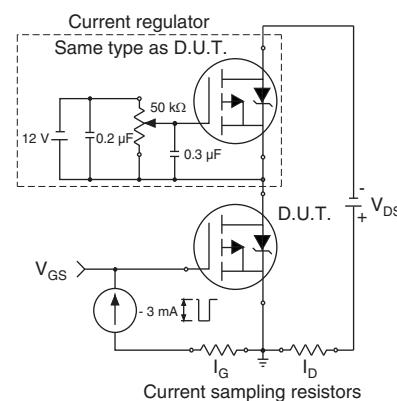


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case


Fig. 12a - Unclamped Inductive Test Circuit

Fig. 12b - Unclamped Inductive Waveforms

Fig. 12c - Maximum Avalanche Energy vs. Drain Current

Fig. 13a - Basic Gate Charge Waveform

Fig. 13b - Gate Charge Test Circuit

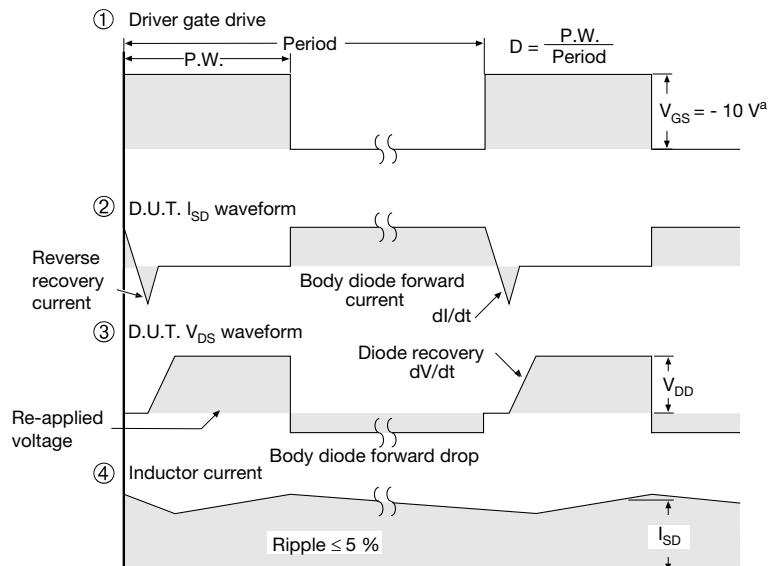
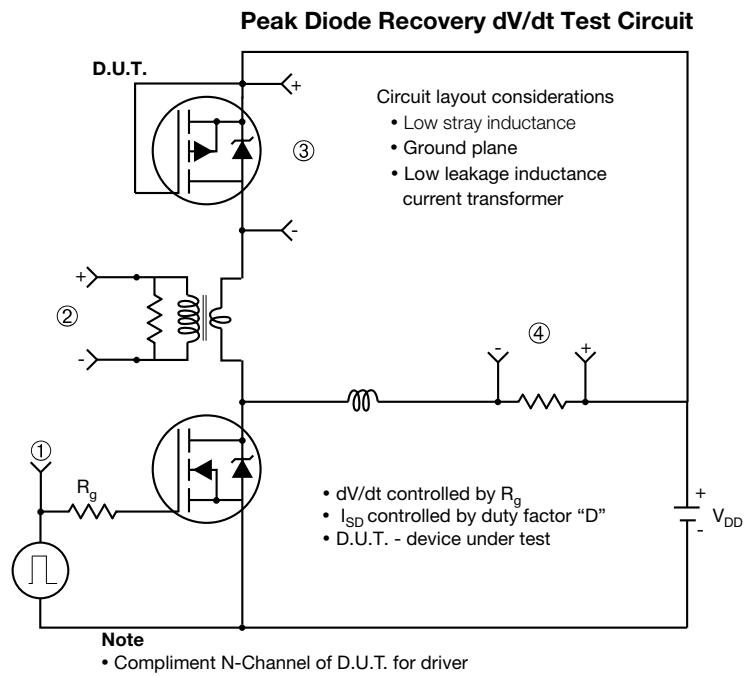
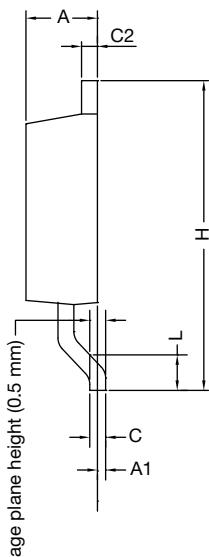
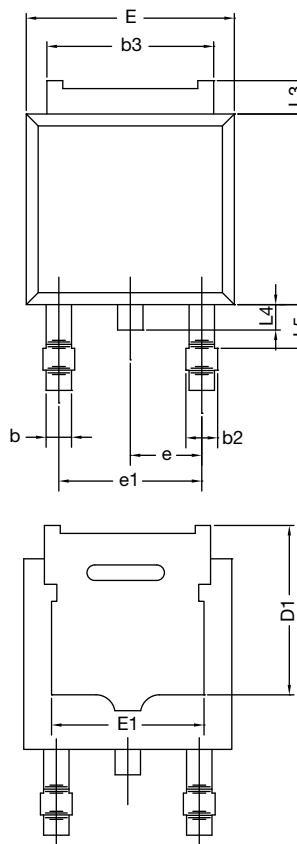


Fig. 14 - For P-Channel

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?91278.

TO-252AA Case Outline



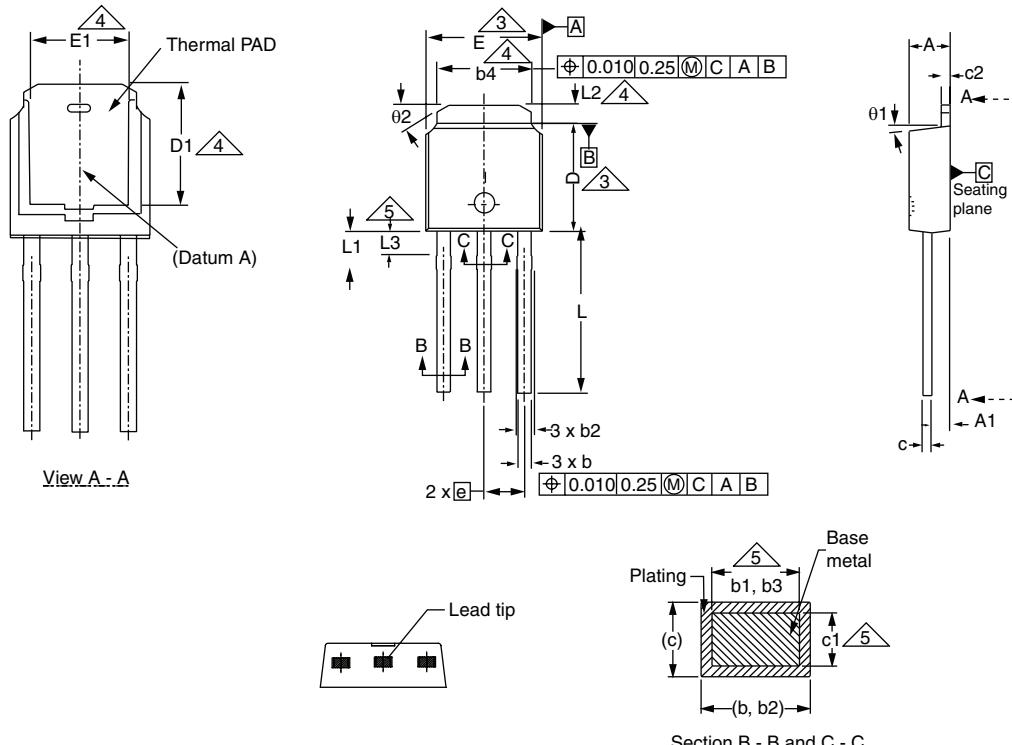
DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	2.18	2.38	0.086	0.094
A1	-	0.127	-	0.005
b	0.64	0.88	0.025	0.035
b2	0.76	1.14	0.030	0.045
b3	4.95	5.46	0.195	0.215
C	0.46	0.61	0.018	0.024
C2	0.46	0.89	0.018	0.035
D	5.97	6.22	0.235	0.245
D1	4.10	-	0.161	-
E	6.35	6.73	0.250	0.265
E1	4.32	-	0.170	-
H	9.40	10.41	0.370	0.410
e	2.28 BSC		0.090 BSC	
e1	4.56 BSC		0.180 BSC	
L	1.40	1.78	0.055	0.070
L3	0.89	1.27	0.035	0.050
L4	-	1.02	-	0.040
L5	1.01	1.52	0.040	0.060

ECN: T16-0236-Rev. P, 16-May-16
DWG: 5347

Notes

- Dimension L3 is for reference only.

TO-251AA (HIGH VOLTAGE)



	MILLIMETERS		INCHES	
DIM.	MIN.	MAX.	MIN.	MAX.
A	2.18	2.39	0.086	0.094
A1	0.89	1.14	0.035	0.045
b	0.64	0.89	0.025	0.035
b1	0.65	0.79	0.026	0.031
b2	0.76	1.14	0.030	0.045
b3	0.76	1.04	0.030	0.041
b4	4.95	5.46	0.195	0.215
c	0.46	0.61	0.018	0.024
c1	0.41	0.56	0.016	0.022
c2	0.46	0.86	0.018	0.034
D	5.97	6.22	0.235	0.245

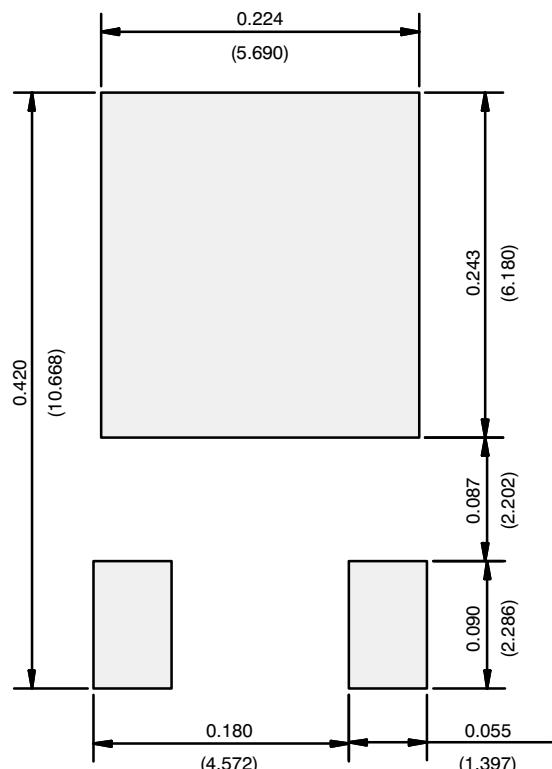
ECN: S-82111-Rev. A, 15-Sep-08
DWG: 5968

	MILLIMETERS		INCHES	
DIM.	MIN.	MAX.	MIN.	MAX.
D1	5.21	-	0.205	-
E	6.35	6.73	0.250	0.265
E1	4.32	-	0.170	-
e	2.29 BSC		2.29 BSC	
L	8.89	9.65	0.350	0.380
L1	1.91	2.29	0.075	0.090
L2	0.89	1.27	0.035	0.050
L3	1.14	1.52	0.045	0.060
01	0'	15'	0'	15'
02	25'	35'	25'	35'

Notes

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimension are shown in inches and millimeters.
3. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.13 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body.
4. Thermal pad contour optional with dimensions b4, L2, E1 and D1.
5. Lead dimension uncontrolled in L3.
6. Dimension b1, b3 and c1 apply to base metal only.
7. Outline conforms to JEDEC outline TO-251AA.

RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



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APPLICATION NOTE

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Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.

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