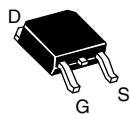
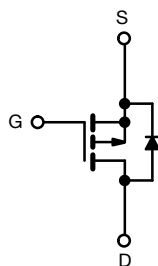
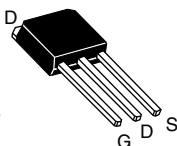


## Power MOSFET

**PAK (TO-252)**

**PAK (TO-251)**


P-Channel MOSFET

### FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- Surface mount (IRFR9014, SiHFR9014)
- Straight lead (IRFU9014, SiHFU9014)
- Available in tape and reel
- P-channel
- Fast switching
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### PRODUCT SUMMARY

V <sub>DS</sub> (V)	-60	
R <sub>DS(on)</sub> (Ω)	V <sub>GS</sub> = -10 V	0.50
Q <sub>g</sub> max. (nC)	12	
Q <sub>gs</sub> (nC)	3.8	
Q <sub>gd</sub> (nC)	5.1	
Configuration	Single	

### 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 PAK 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	PAK (TO-252)	PAK (TO-252)	PAK (TO-252)	PAK (TO-251)
Lead (Pb)-free and halogen-free	SiHFR9014-GE3	SiHFR9014TRL-GE3 <sup>a</sup>	SiHFR9014TR-GE3 <sup>a</sup>	SiHFU9014-GE3
	IRFR9014PbF-BE3	IRFR9014TRLPbF-BE3	IRFR9014TRPbF-BE3	-
Lead (Pb)-free	IRFR9014PbF	IRFR9014TRLPbF <sup>a</sup>	IRFR9014TRPbF <sup>a</sup>	IRFU9014PbF

#### Note

a. See device orientation

### ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25 °C, unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	V <sub>DS</sub>	-60	V
Gate-source voltage	V <sub>GS</sub>	± 20	
Continuous drain current	V <sub>GS</sub> at 5 V	T <sub>C</sub> = 25 °C	A
		T <sub>C</sub> = 100 °C	
Pulsed drain current <sup>a</sup>	I <sub>DM</sub>	-20	W/°C
Linear derating factor		0.20	
Linear derating factor (PCB mount) <sup>e</sup>		0.020	
Single pulse avalanche energy <sup>b</sup>	E <sub>AS</sub>	140	mJ
Repetitive avalanche current <sup>a</sup>	I <sub>AR</sub>	-5.1	A
Repetitive avalanche energy <sup>a</sup>	E <sub>AR</sub>	2.5	mJ
Maximum power dissipation	P <sub>D</sub>	T <sub>C</sub> = 25 °C	W
Maximum power dissipation (PCB mount) <sup>e</sup>		T <sub>A</sub> = 25 °C	
Peak diode recovery dV/dt <sup>c</sup>	dV/dt	-4.5	V/ns
Operating junction and storage temperature range	T <sub>J</sub> , T <sub>stg</sub>	-55 to +150	°C
Soldering recommendations (peak temperature) <sup>d</sup>	For 10 s	260	

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- V<sub>DD</sub> = - 25 V, starting T<sub>J</sub> = 25 °C, L = 6.3 mH, R<sub>g</sub> = 25 Ω, I<sub>AS</sub> = - 5.1 A (see fig. 12)
- I<sub>SD</sub> ≤ - 6.7 A, dI/dt ≤ 90 A/μs, V<sub>DD</sub> ≤ V<sub>DS</sub>, T<sub>J</sub> ≤ 150 °C
- 1.6 mm from case
- 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) <sup>a</sup>	$R_{thJA}$	-	-	50	
Maximum junction-to-case (drain)	$R_{thJC}$	-	-	5.0	

**Note**

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

**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 <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = - 250 μA		-60	-	-	V
V <sub>DS</sub> temperature coefficient	ΔV <sub>DS</sub> /T <sub>J</sub>	Reference to 25 °C, I <sub>D</sub> = -1 mA		-	-0.059	-	V/°C
Gate-source threshold voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μA		-2.0	-	-4.0	V
Gate-source leakage	I <sub>GSS</sub>	V <sub>GS</sub> = ± 20 V		-	-	± 100	nA
Zero gate voltage drain current	I <sub>DSS</sub>	V <sub>DS</sub> = -60 V, V <sub>GS</sub> = 0 V		-	-	-100	μA
		V <sub>DS</sub> = -48 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C		-	-	-500	
Drain-source on-state resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = -10 V	I <sub>D</sub> = -3.1 A <sup>b</sup>	-	-	0.50	Ω
Forward transconductance	g <sub>fs</sub>	V <sub>DS</sub> = -25 V, I <sub>D</sub> = -3.1 A <sup>b</sup>		1.4	-	-	S
Dynamic							
Input capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = -25 V, f = 1.0 MHz, see fig. 5		-	270	-	pF
Output capacitance	C <sub>oss</sub>			-	170	-	
Reverse transfer capacitance	C <sub>rss</sub>			-	31	-	
Total gate charge	Q <sub>g</sub>	V <sub>GS</sub> = - 10 V	I <sub>D</sub> = -6.7 A, V <sub>DS</sub> = -48 V, see fig. 6 and 13 <sup>b</sup>	-	-	12	nC
Gate-source charge	Q <sub>gs</sub>			-	-	3.8	
Gate-drain charge	Q <sub>gd</sub>			-	-	5.1	
Turn-on delay time	t <sub>d(on)</sub>	V <sub>DD</sub> = -30 V, I <sub>D</sub> = -6.7 A, R <sub>g</sub> = 24 Ω, R <sub>D</sub> = 4.0 Ω, see fig. 10 <sup>b</sup>		-	11	-	ns
Rise time	t <sub>r</sub>			-	63	-	
Turn-off delay time	t <sub>d(off)</sub>			-	9.6	-	
Fall time	t <sub>f</sub>			-	31	-	
Internal drain inductance	L <sub>D</sub>	Between lead, 6 mm (0.25") from package and center of die contact <sup>c</sup>		-	4.5	-	nH
Internal source inductance	L <sub>S</sub>			-	7.5	-	
Drain-Source Body Diode Characteristics							
Continuous source-drain diode current	I <sub>S</sub>	MOSFET symbol showing the integral reverse p - n junction diode		-	-	-5.1	A
Pulsed diode forward current <sup>a</sup>	I <sub>SM</sub>			-	-	-20	
Body diode voltage	V <sub>SD</sub>	T <sub>J</sub> = 25 °C, I <sub>S</sub> = -5.1 A, V <sub>GS</sub> = 0 V <sup>b</sup>		-	-	-5.5	V
Body diode reverse recovery time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C, I <sub>F</sub> = -6.7 A, dI/dt = 100 A/μs <sup>b</sup>		-	80	160	ns
Body diode reverse recovery charge	Q <sub>rr</sub>			-	0.096	0.19	μC
Forward turn-on time	t <sub>on</sub>	Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )					

**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)

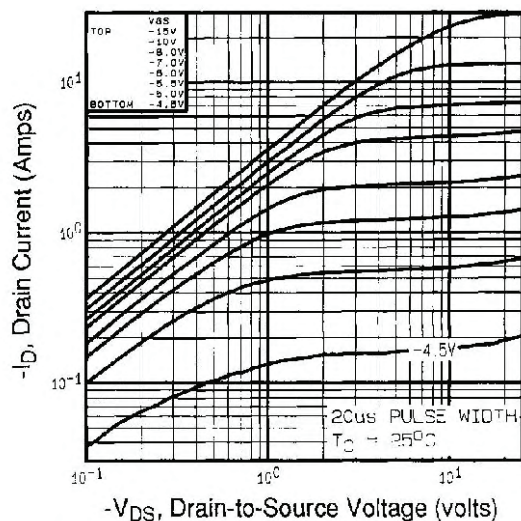


Fig. 1 - Typical Output Characteristics,  $T_C = 25^\circ\text{C}$

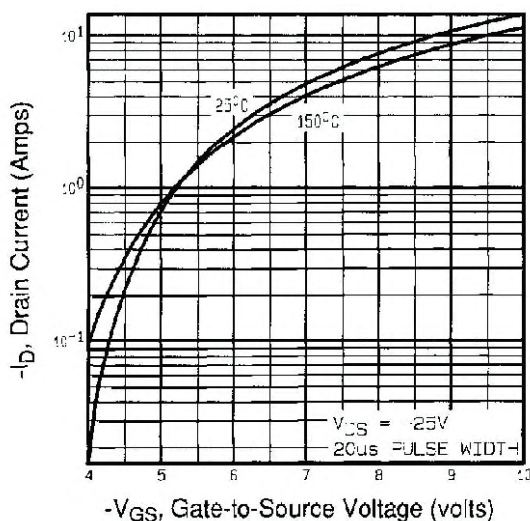


Fig. 3 - Typical Transfer Characteristics

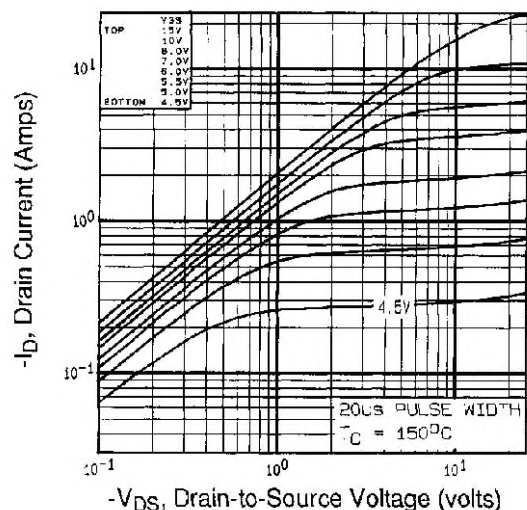


Fig. 2 - Typical Output Characteristics,  $T_C = 150^\circ\text{C}$

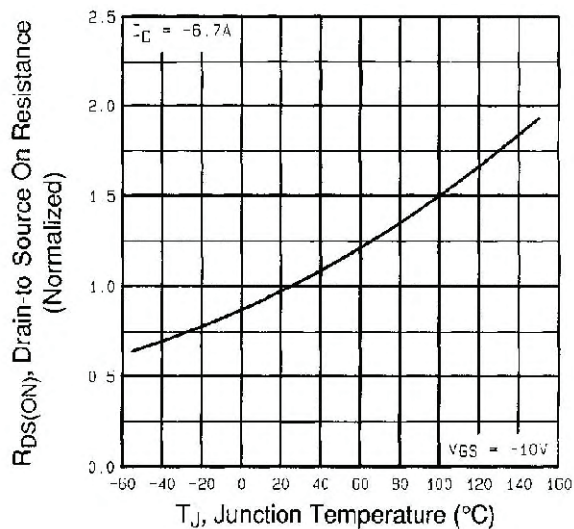


Fig. 4 - Normalized On-Resistance vs. Temperature

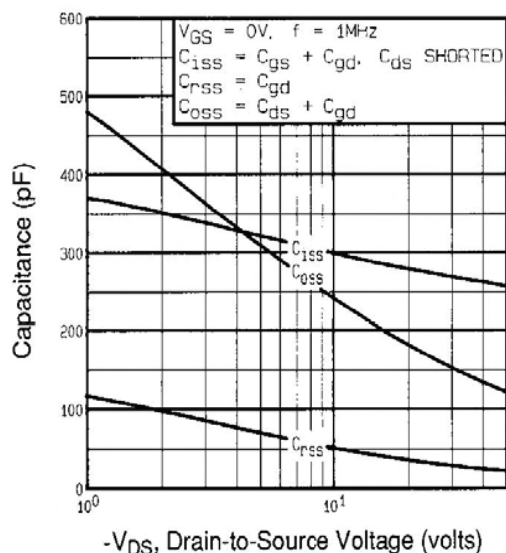


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

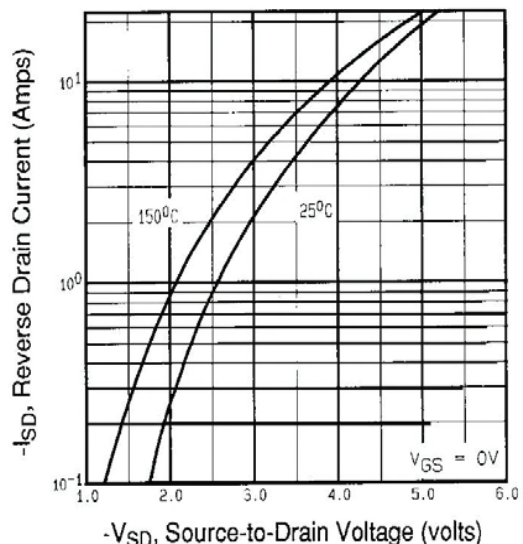


Fig. 7 - Typical Source-Drain Diode Forward Voltage

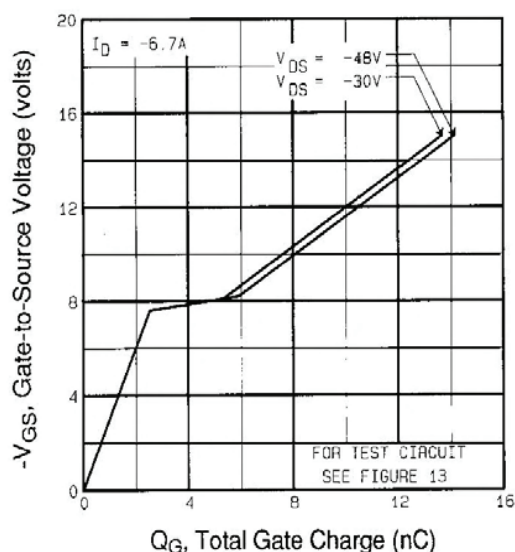


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

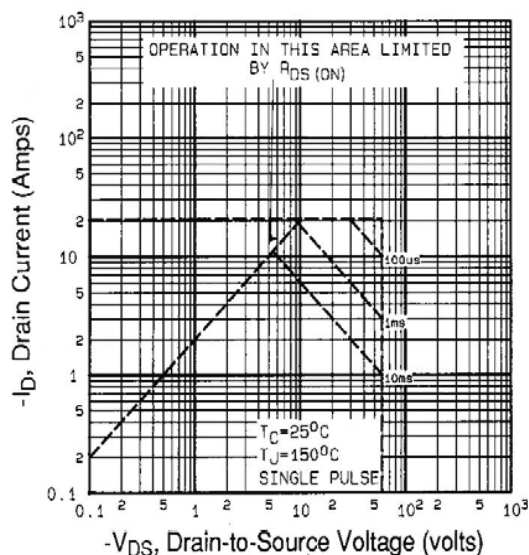


Fig. 8 - Maximum Safe Operating Area

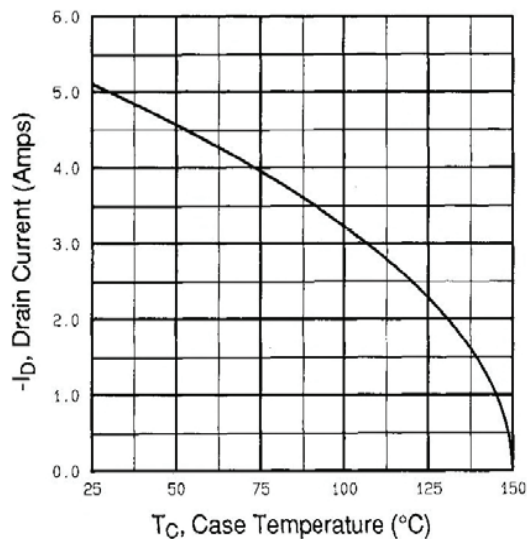


Fig. 9 - Maximum Drain Current vs. Case Temperature

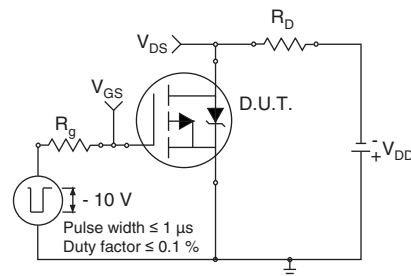


Fig. 10a - Switching Time Test Circuit

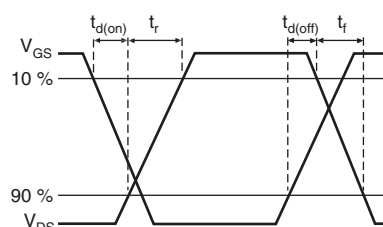


Fig. 10b - Switching Time Waveforms

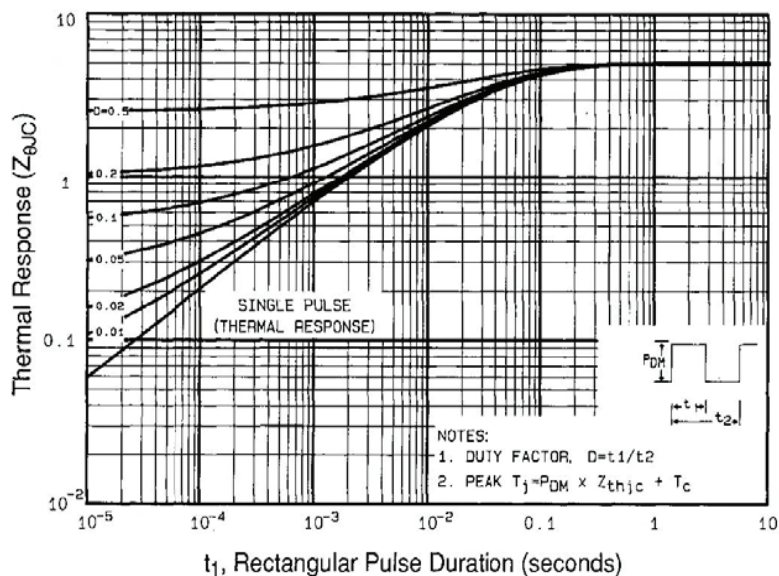
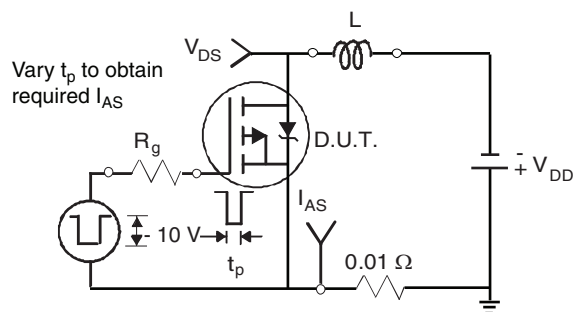
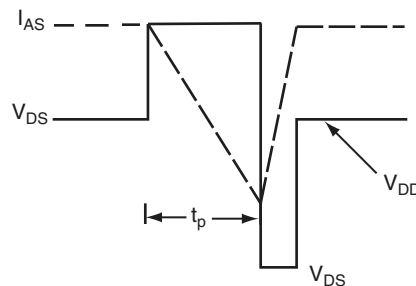
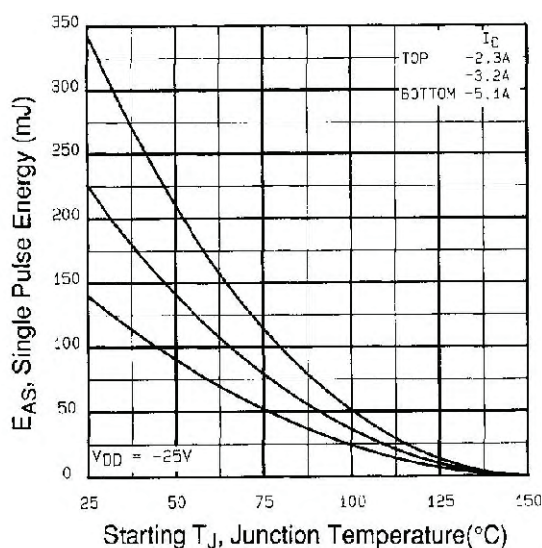
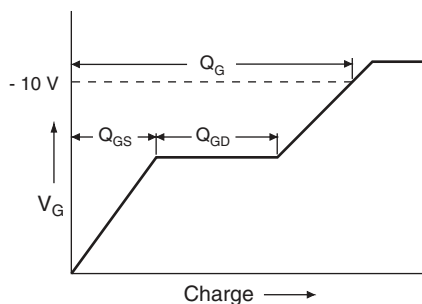
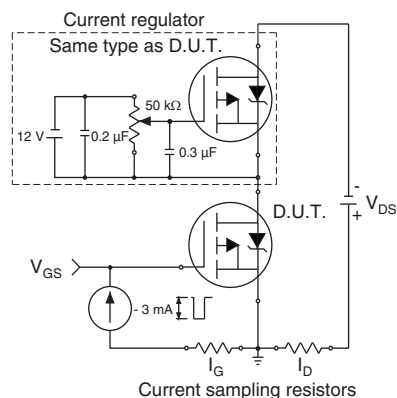
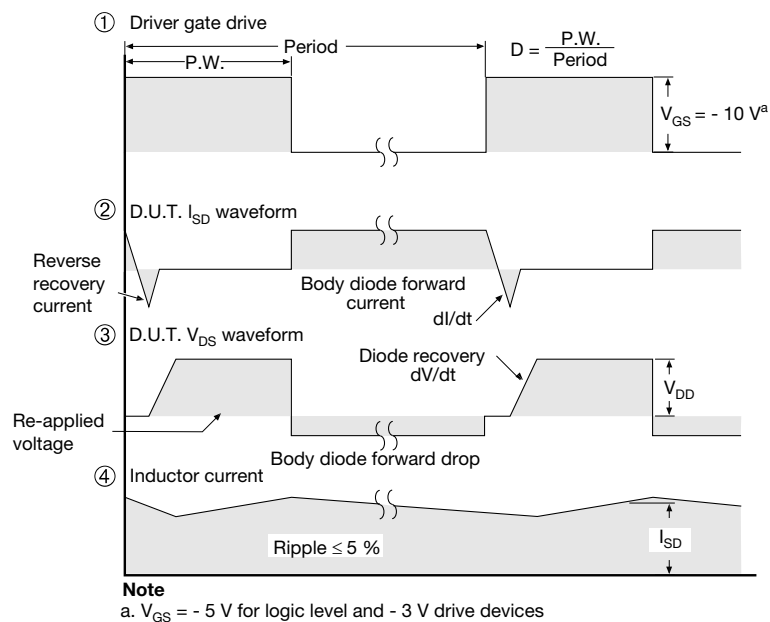
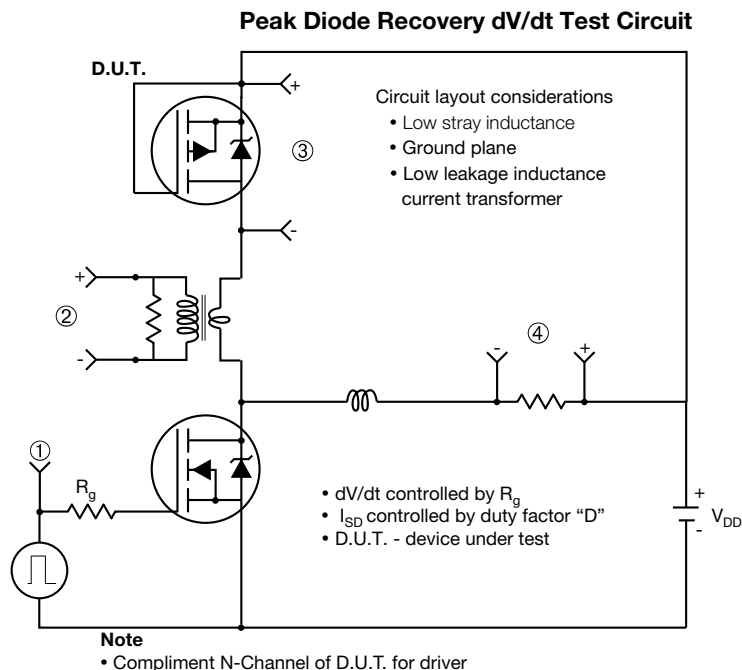


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case




**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**

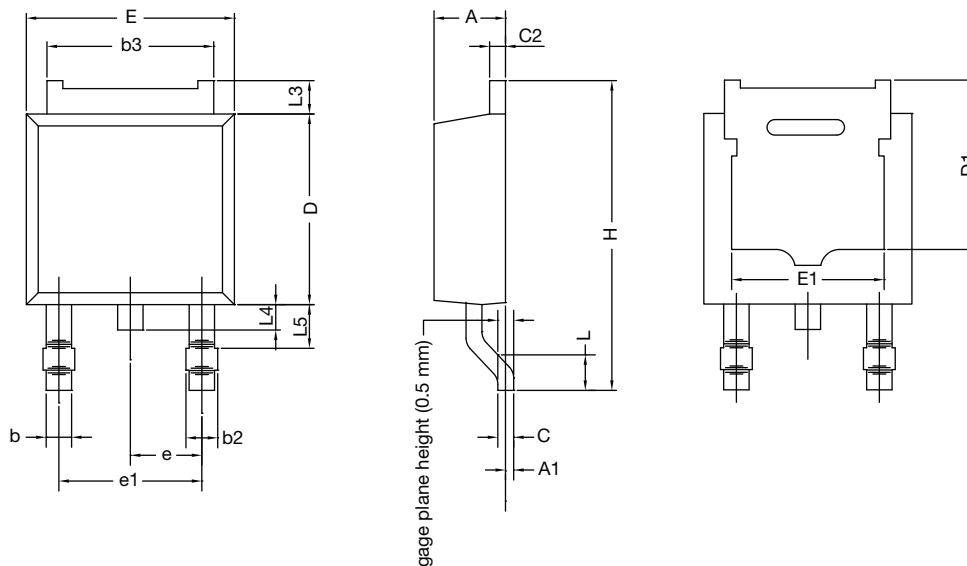


**Fig. 14 - For P-Channel**

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?91277](http://www.vishay.com/ppg?91277).

## TO-252AA Case Outline

### VERSION 1: FACILITY CODE = Y



MILLIMETERS		
DIM.	MIN.	MAX.
A	2.18	2.38
A1	-	0.127
b	0.64	0.88
b2	0.76	1.14
b3	4.95	5.46
C	0.46	0.61
C2	0.46	0.89
D	5.97	6.22
D1	4.10	-
E	6.35	6.73
E1	4.32	-
H	9.40	10.41
e	2.28 BSC	
e1	4.56 BSC	
L	1.40	1.78
L3	0.89	1.27
L4	-	1.02
L5	1.01	1.52

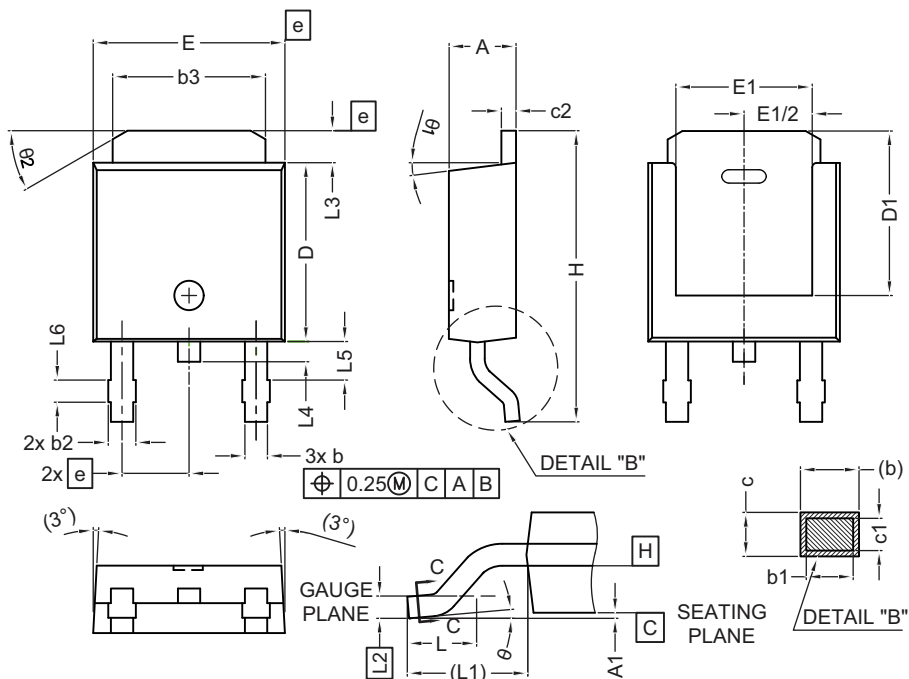
#### Note

- Dimension L3 is for reference only





## VERSION 2: FACILITY CODE = N



DIM.	MILLIMETERS	
	MIN.	MAX.
A	2.18	2.39
A1	-	0.13
b	0.65	0.89
b1	0.64	0.79
b2	0.76	1.13
b3	4.95	5.46
c	0.46	0.61
c1	0.41	0.56
c2	0.46	0.60
D	5.97	6.22
D1	5.21	-
E	6.35	6.73
E1	4.32	-
e	2.29 BSC	
H	9.94	10.34

DIM.	MILLIMETERS	
	MIN.	MAX.
L	1.50	1.78
L1	2.74 ref.	
L2	0.51 BSC	
L3	0.89	1.27
L4	-	1.02
L5	1.14	1.49
L6	0.65	0.85
theta	0°	10°
theta1	0°	15°
theta2	25°	35°

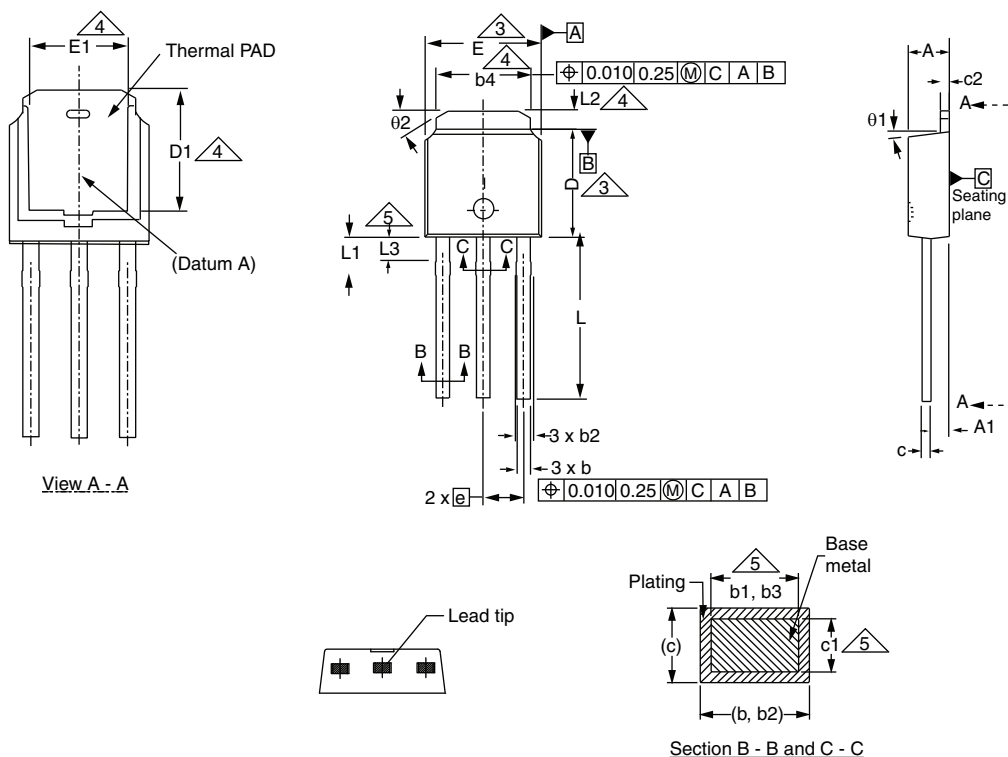
### Notes

- Dimensioning and tolerance confirm to ASME Y14.5M-1994
- All dimensions are in millimeters. Angles are in degrees
- Heat sink side flash is max. 0.8 mm
- Radius on terminal is optional

ECN: E22-0399-Rev. R, 03-Oct-2022  
DWG: 5347

## Case Outline for TO-251AA (High Voltage)

### OPTION 1:



DIM.	MILLIMETERS		INCHES	
	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

DIM.	MILLIMETERS		INCHES	
	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
θ1	0°	15°	0°	15°
θ2	25°	35°	25°	35°

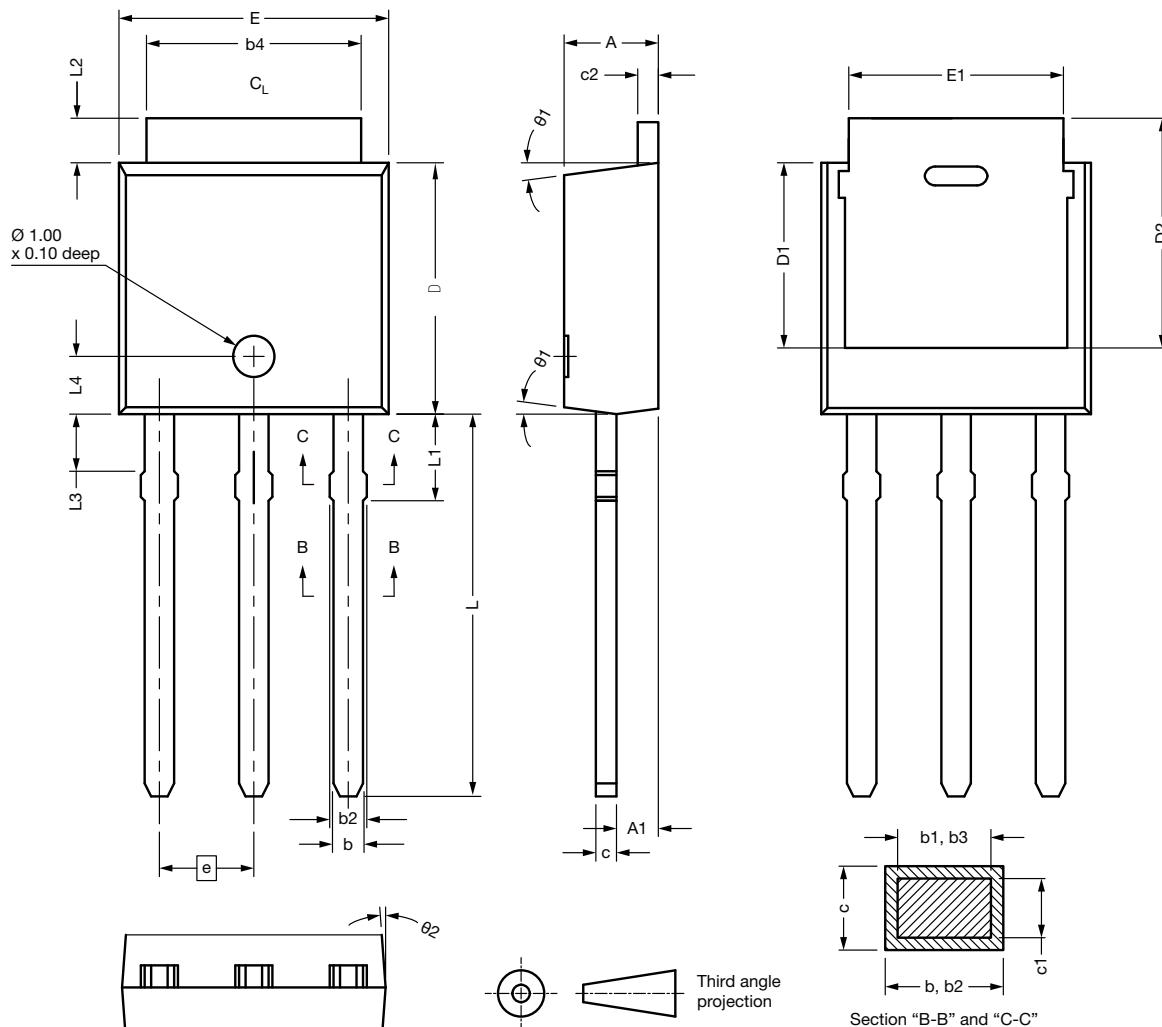
ECN: E21-0682-Rev. C, 27-Dec-2021  
DWG: 5968

#### Notes

- Dimensioning and tolerancing per ASME Y14.5M-1994
- Dimension are shown in inches and millimeters
- 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
- Thermal pad contour optional with dimensions b4, L2, E1 and D1
- Lead dimension uncontrolled in L3
- Dimension b1, b3 and c1 apply to base metal only
- Outline conforms to JEDEC® outline TO-251AA



## OPTION 2: FACILITY CODE = N



DIM.	MIN.	NOM.	MAX.
A	2.180	2.285	2.390
A1	0.890	1.015	1.140
b	0.640	0.765	0.890
b1	0.640	0.715	0.790
b2	0.760	0.950	1.140
b3	0.760	0.900	1.040
b4	4.950	5.205	5.460
c	0.460	-	0.610
c1	0.410	-	0.560
c2	0.460	-	0.610
D	5.970	6.095	6.220
D1	4.300	-	-

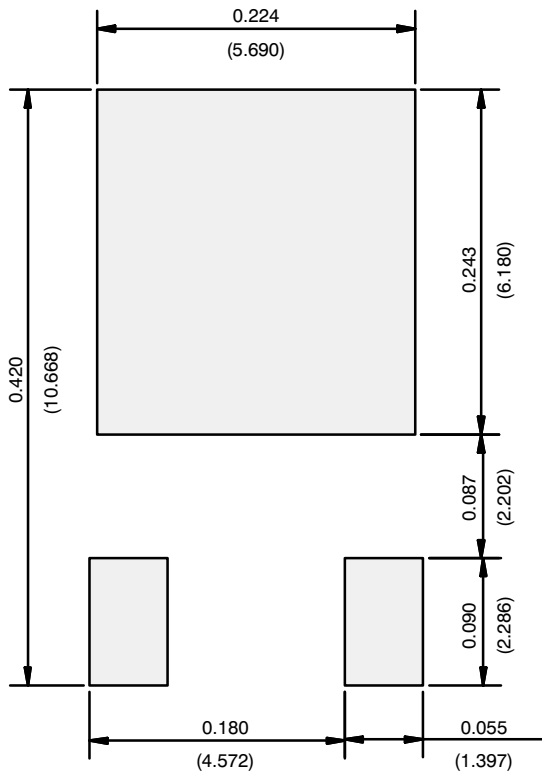
DIM.	MIN.	NOM.	MAX.
D2	5.380	-	-
E	6.350	6.540	6.730
E1	4.32	-	-
e	2.29 BSC		
L	8.890	9.270	9.650
L1	1.910	2.100	2.290
L2	0.890	1.080	1.270
L3	1.140	1.330	1.520
L4	1.300	1.400	1.500
θ1	0°	7.5°	15°
θ2	4°	-	-

ECN: E21-0682-Rev. C, 27-Dec-2021  
DWG: 5968

### Notes

- Dimensioning and tolerancing per ASME Y14.5M-1994
- All dimension are in millimeters, angles are in degrees
- Heat sink side flash is max. 0.8 mm

## RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads  
Dimensions in Inches/(mm)

[Return to Index](#)



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