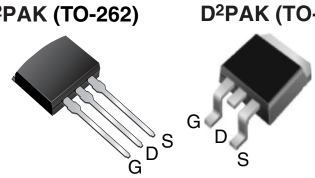
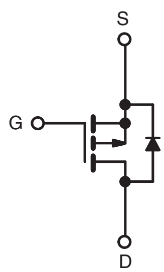
Power MOSFET

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	

I²PAK (TO-262) D²PAK (TO-263)





P-Channel MOSFET

FEATURES

- **Halogen-free According to IEC 61249-2-21 Definition**
- Advanced Process Technology
- Surface Mount (IRF9Z24S, SiHF9Z24S)
- Low-Profile Through-Hole (IRF9Z24L, SiHF9Z24L)
- 175 °C Operating Temperature
- Fast Switching
- P-Channel
- Fully Avalanche Rated
- Compliant to RoHS Directive 2002/95/EC

RoHS* COMPLIANT

HALOGEN FREE Available

DESCRIPTION

Third generation Power MOSFETs from Vishay utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that Power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The D²PAK is a surface mount power package capable of accommodating die size up to HEX-4. It provides the highest power capability and the lowest possible on-resistance in any existing surface mount package. The D²PAK is suitable for high current applications because of its low internal connection resistance and can dissipate up to 2.0 W in a typical surface mount application.

The through-hole version (IR9Z24L, SiH9Z24L) is available for low-profile applications.

ORDERING INFORMATION				
Package	D²PAK (TO-263)	D²PAK (TO-263)	D²PAK (TO-263)	I²PAK (TO-262)
Lead (Pb)-free and Halogen-free	SiHF9Z24S-GE3	SiHF9Z24STRL-GE3[a]	SiHF9Z24STRR-GE3[a]	-
Lead (Pb)-free	IRF9Z24SPbF	IRF9Z24STRLPbF[a]	IRF9Z24STRRPbF[a]	IRF9Z24LPbF
	SiHF9Z24S-E3	SiHF9Z24STL-E3[a]	SiHF9Z24STR-E3[a]	SiHF9Z24L-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[e]	V_{GS} at - 10 V	T_C = 25 °C	I_D	- 11	A
		T_C = 100 °C		- 7.7	
Pulsed Drain Current[a, e]			I_{DM}	- 44	
Linear Derating Factor				0.40	W/°C
Single Pulse Avalanche Energy[b, e]			E_{AS}	240	mJ
Repetitive Avalanche Current[a]			I_{AR}	- 11	A
Repetitive Avalanche Energy[a]			E_{AR}	6.0	mJ
Maximum Power Dissipation	T_A = 25 °C		P_D	3.7	W
	T_C = 25 °C			60	W
Peak Diode Recovery dV/dt[c, e]			dV/dt	- 4.5	V/ns
Operating Junction and Storage Temperature Range			T_J, T_{stg}	- 55 to + 175	°C
Soldering Recommendations (Peak Temperature)	for 10 s			300[d]	

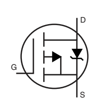
Notes
a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. V_{DD} = - 25 V, starting T_J = 25 °C, L = 2.3 mH, R_g = 25 Ω, I_{AS} = - 11 A (see fig. 12).
c. I_{SD} ≤ - 11 A, dI/dt ≤ 140 A/μs, V_{DD} ≤ V_{DS}, T_J ≤ 175 °C.
d. 1.6 mm from case.
e. Uses IRF9Z24, SiHF9Z24 data and test conditions.

* Pb containing terminations are not RoHS compliant, exemptions may apply

THERMAL RESISTANCE RATINGS					
PARAMETER	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Maximum Junction-to-Ambient (PCB Mount)[a]	R_{thJA}	-	-	40	°C/W
Maximum Junction-to-Case (Drain)	R_{thJC}	-	-	2.5	

Note

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

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, I_D = - 250 μA	- 60	-	-	V
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = - 1 mA[c]	-	- 0.056	-	V/°C
Gate-Source Threshold Voltage	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = - 250 μA	- 2.0	-	- 4.0	V
Gate-Source Leakage	I_{GSS}	V_{GS} = ± 20 V	-	-	± 100	nA
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = - 60 V, V_{GS} = 0 V	-	-	- 100	μA
		V_{DS} = - 48 V, V_{GS} = 0 V, T_J = 150 °C	-	-	- 500	
Drain-Source On-State Resistance	$R_{DS(on)}$	V_{GS} = - 10 V; I_D = - 6.6 A[b]	-	-	0.28	Ω
Forward Transconductance	g_{fs}	V_{DS} = - 25 V, I_D = - 6.6 A[c]	1.4	-	-	S
Dynamic						
Input Capacitance	C_{iss}	V_{GS} = 0 V, V_{DS} = - 25 V, f = 1.0 MHz, see fig. 5[c]	-	570	-	pF
Output Capacitance	C_{oss}		-	360	-	
Reverse Transfer Capacitance	C_{rss}		-	65	-	
Total Gate Charge	Q_g	V_{GS} = - 10 V; I_D = - 11 A, V_{DS} = - 48 V, see fig. 6 and 13[b, c]	-	-	19	nC
Gate-Source Charge	Q_{gs}		-	-	5.4	
Gate-Drain Charge	Q_{gd}		-	-	11	
Turn-On Delay Time	$t_{d(on)}$	V_{DD} = - 30 V, I_D = - 11 A, R_g = 18 Ω, R_D = 2.5 Ω, see fig. 10[b]	-	13	-	ns
Rise Time	t_r		-	68	-	
Turn-Off Delay Time	$t_{d(off)}$		-	15	-	
Fall Time	t_f		-	29	-	
Drain-Source Body Diode Characteristics						
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p - n junction diode 	-	-	- 11	A
Pulsed Diode Forward Current[a]	I_{SM}		-	-	- 44	
Body Diode Voltage	V_{SD}	T_J = 25 °C, I_S = - 11 A, V_{GS} = 0 V[b]	-	-	- 6.3	V
Drain-Source Body Diode Characteristics						
Body Diode Reverse Recovery Time	t_{rr}	T_J = 25 °C, I_F = -11 A, dI/dt = 100 A/μs[b, c]	-	100	200	ns
Body Diode Reverse Recovery Charge	Q_{rr}		-	320	640	nC
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 ≤ 300 μs; duty cycle ≤ 2 %.
c. Uses IRF9Z24, SiHF9Z24 data and test conditions.

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

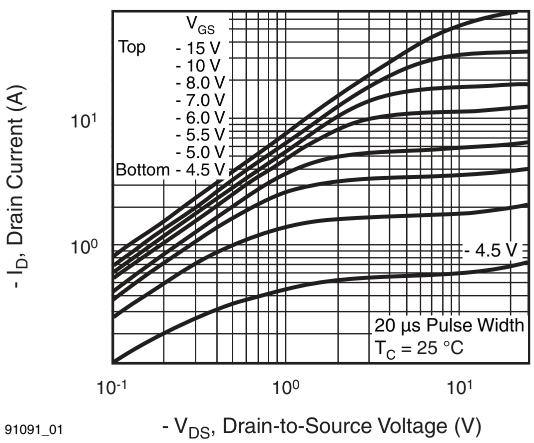


Fig. 1 - Typical Output Characteristics

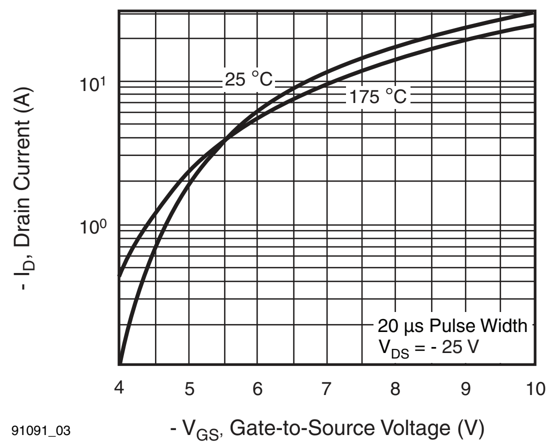


Fig. 3 - Typical Transfer Characteristics

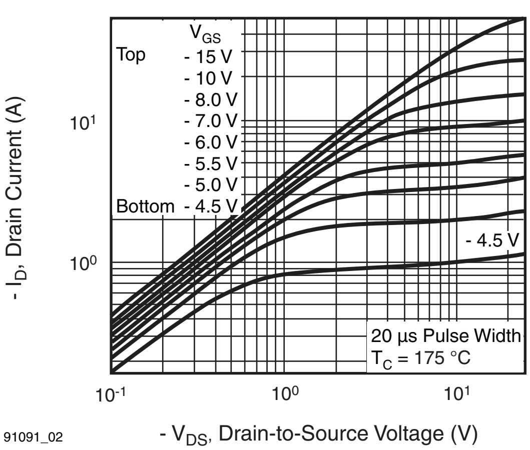


Fig. 2 - Typical Output Characteristics

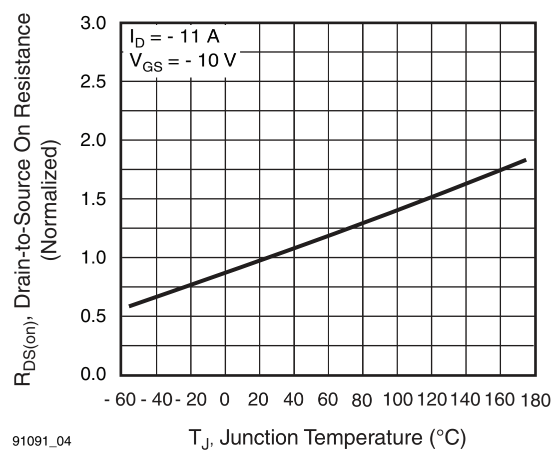


Fig. 4 - Normalized On-Resistance vs. Temperature

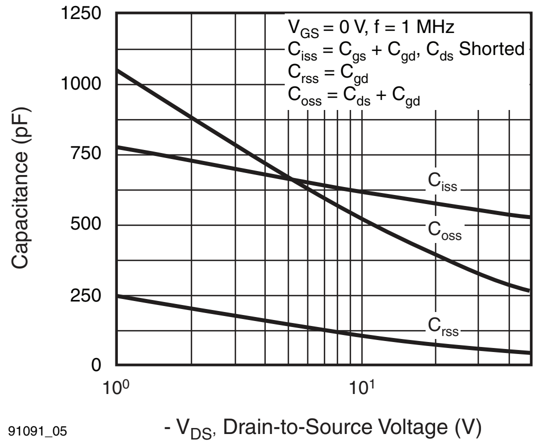


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

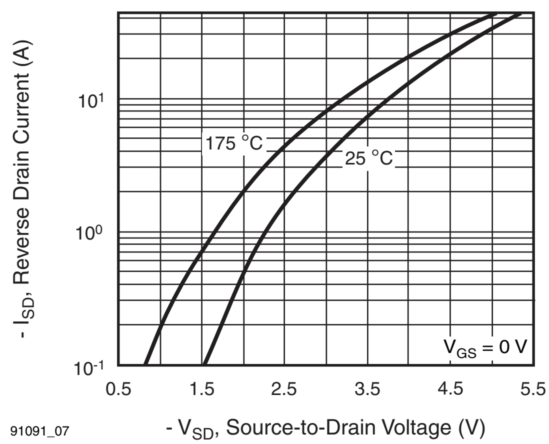


Fig. 7 - Typical Source-Drain Diode Forward Voltage

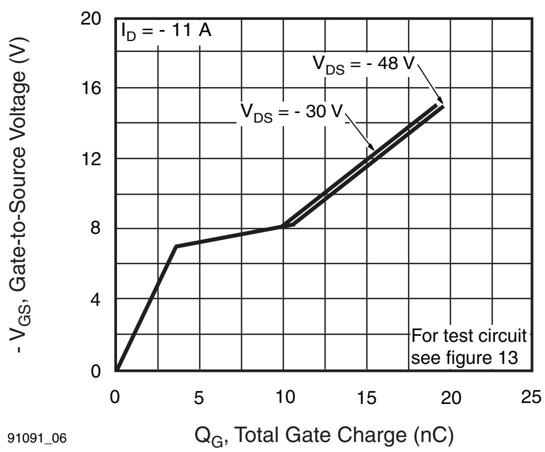


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

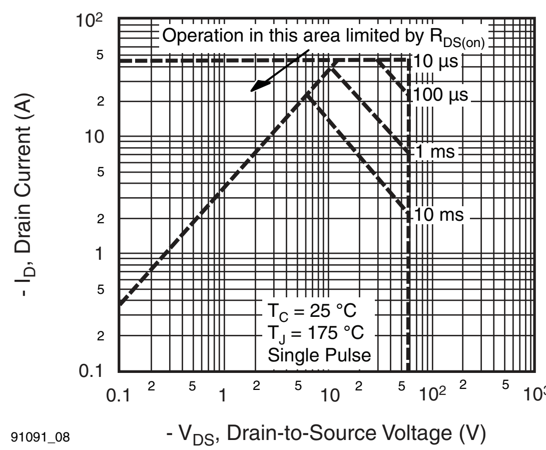


Fig. 8 - Maximum Safe Operating Area

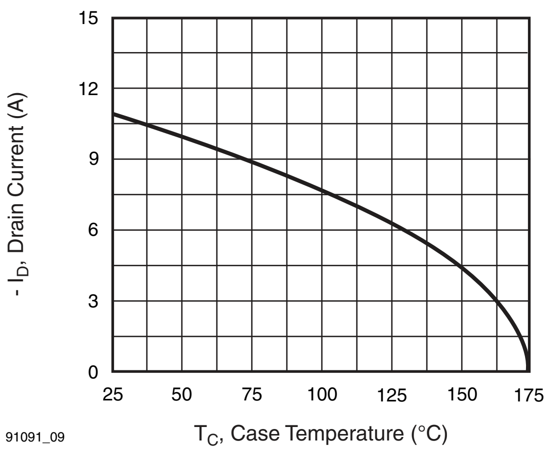


Fig. 9 - Maximum Drain Current vs. Case Temperature

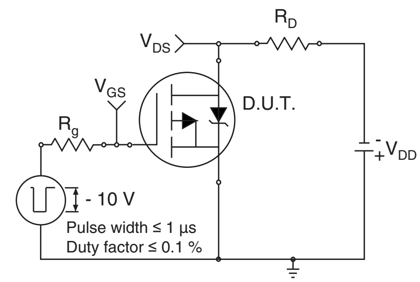


Fig. 10a - Switching Time Test Circuit

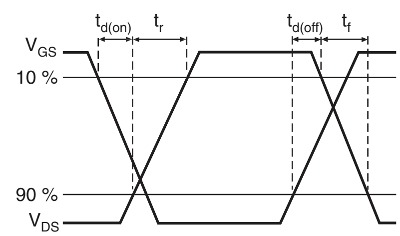


Fig. 10b - Switching Time Waveforms

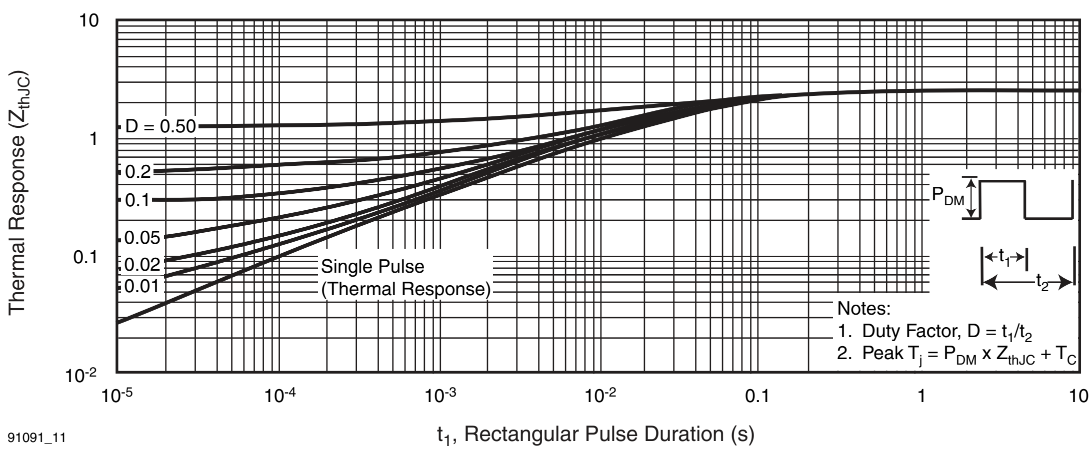


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

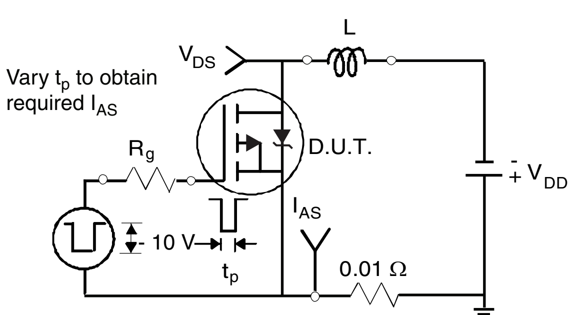


Fig. 12a - Unclamped Inductive Test Circuit

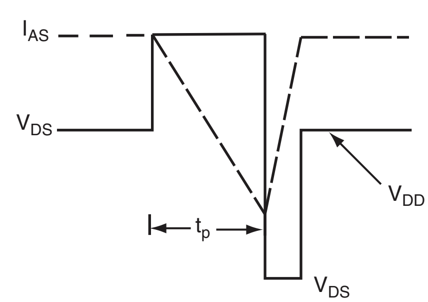


Fig. 12b - Unclamped Inductive Waveforms

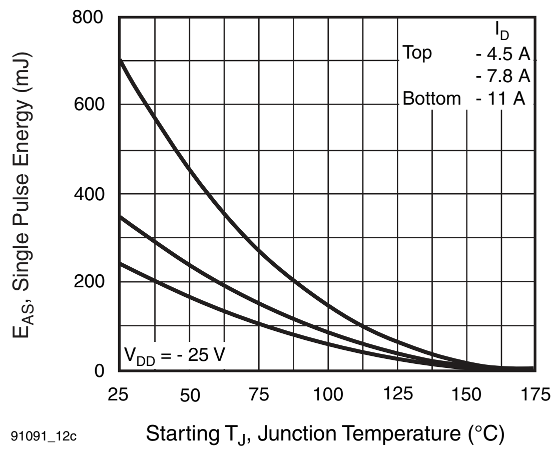


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

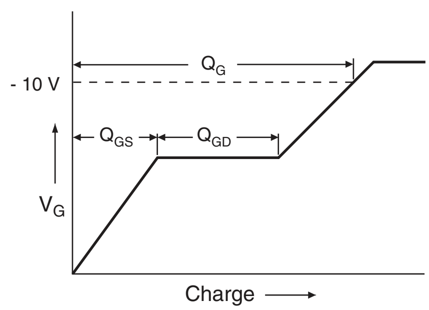


Fig. 13a - Basic Gate Charge Waveform

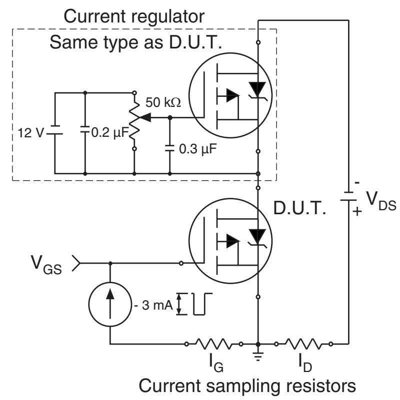
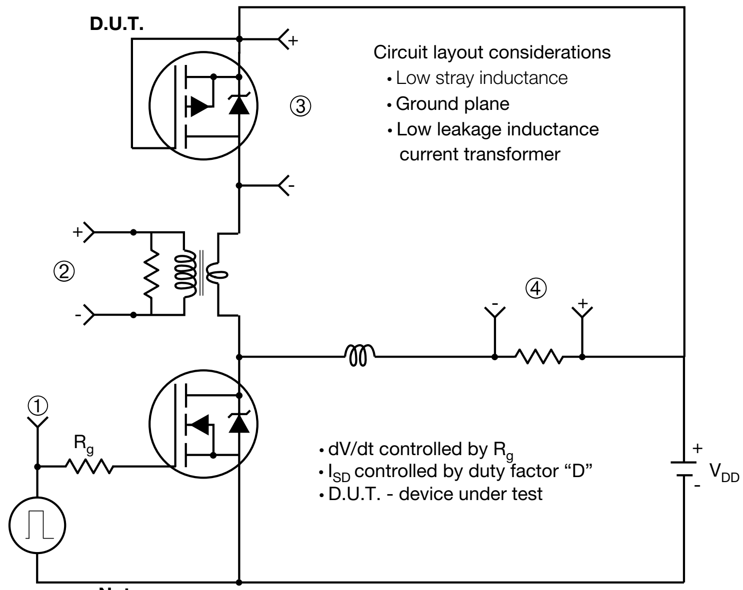
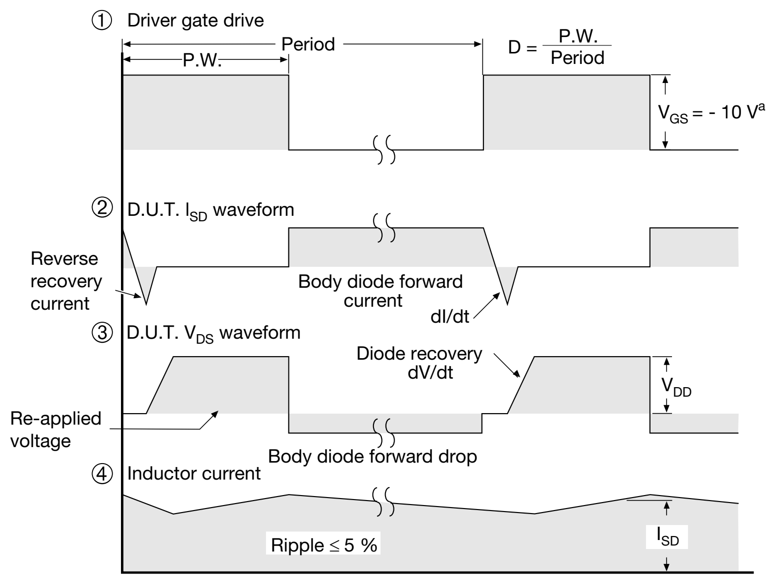


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



Note
• Compliment N-Channel of D.U.T. for driver

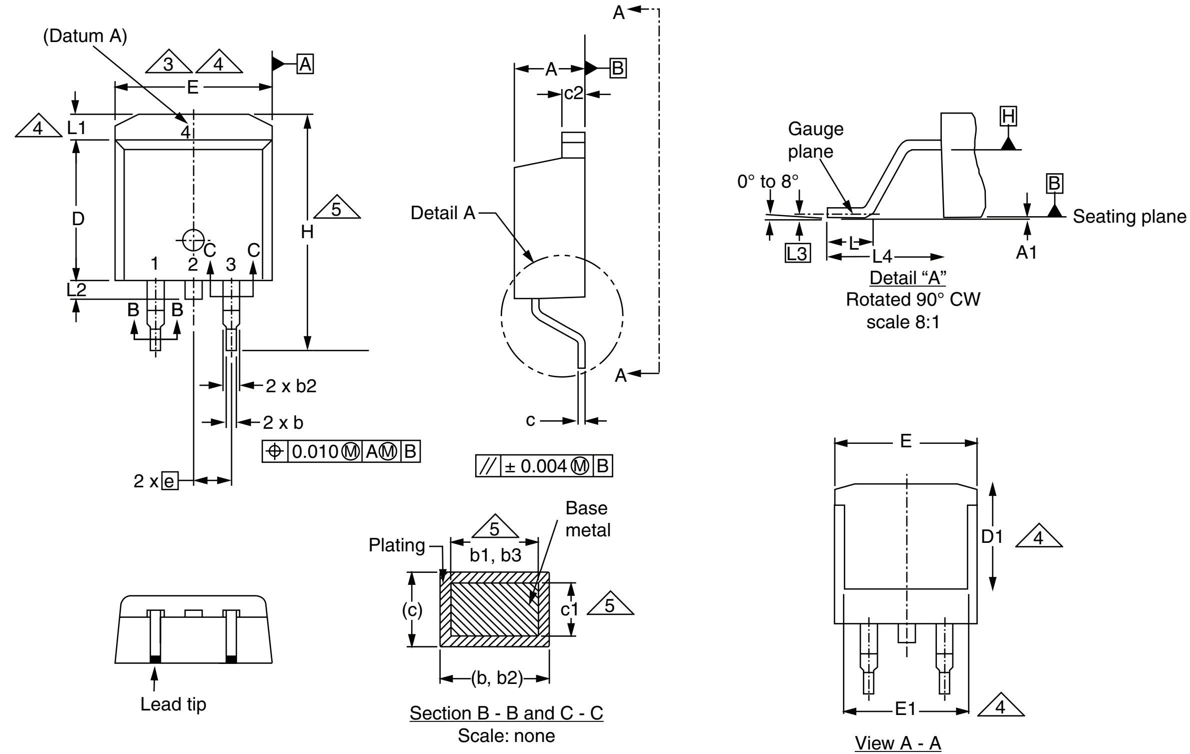


Note
a. V_{GS} = - 5 V for logic level and - 3 V drive devices

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?91091.

TO-263AB (HIGH VOLTAGE)



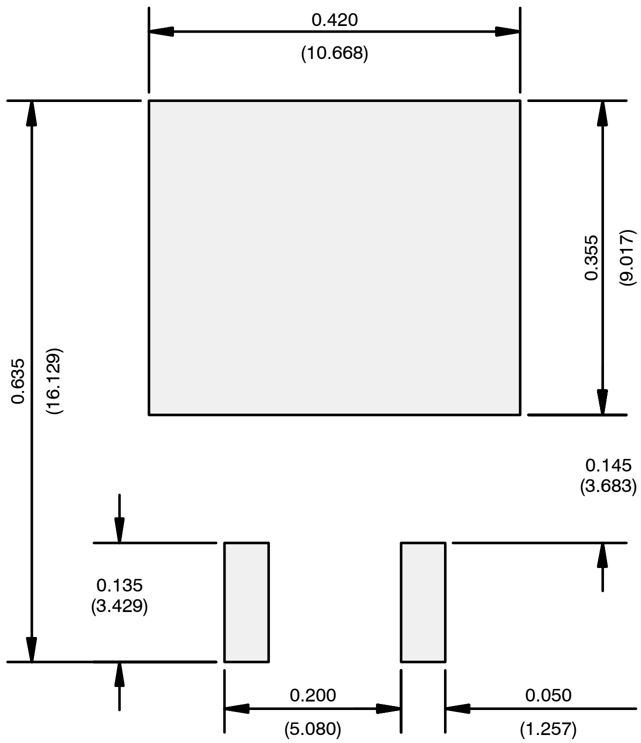
	MILLIMETERS		INCHES				MILLIMETERS		INCHES	
DIM.	MIN.	MAX.	MIN.	MAX.		DIM.	MIN.	MAX.	MIN.	MAX.
A	4.06	4.83	0.160	0.190		D1	6.86	-	0.270	-
A1	0.00	0.25	0.000	0.010		E	9.65	10.67	0.380	0.420
b	0.51	0.99	0.020	0.039		E1	6.22	-	0.245	-
b1	0.51	0.89	0.020	0.035		e	2.54 BSC		0.100 BSC	
b2	1.14	1.78	0.045	0.070		H	14.61	15.88	0.575	0.625
b3	1.14	1.73	0.045	0.068		L	1.78	2.79	0.070	0.110
c	0.38	0.74	0.015	0.029		L1	-	1.65	-	0.066
c1	0.38	0.58	0.015	0.023		L2	-	1.78	-	0.070
c2	1.14	1.65	0.045	0.065		L3	0.25 BSC		0.010 BSC	
D	8.38	9.65	0.330	0.380		L4	4.78	5.28	0.188	0.208

ECN: S-82110-Rev. A, 15-Sep-08
DWG: 5970

Notes

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimensions are shown in millimeters (inches).
3. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outmost extremes of the plastic body at datum A.
4. Thermal PAD contour optional within dimension E, L1, D1 and E1.
5. Dimension b1 and c1 apply to base metal only.
6. Datum A and B to be determined at datum plane H.
7. Outline conforms to JEDEC outline to TO-263AB.

RECOMMENDED MINIMUM PADS FOR D²PAK: 3-Lead



Recommended Minimum Pads
Dimensions in Inches/(mm)

Return to Index

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