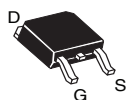


## Power MOSFET

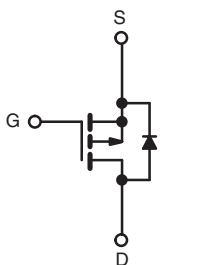
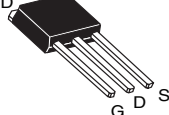
### PRODUCT SUMMARY

$V_{DS}$ (V)	- 200	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = - 10$ V	1.5
$Q_g$ (Max.) (nC)	20	
$Q_{gs}$ (nC)	3.3	
$Q_{gd}$ (nC)	11	
Configuration	Single	

DPAK  
(TO-252)



IPAK  
(TO-251)



P-Channel MOSFET

### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Dynamic  $dV/dt$  Rating
- Repetitive Avalanche Rated
- Surface Mount (IRFR9220, SiHFR9220)
- Straight Lead (IRFU9220, SiHFU9220)
- Available in Tape and Reel
- P-Channel
- Fast Switching
- Compliant to RoHS Directive 2002/95/EC



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

### DESCRIPTION

Third Power MOSFETs technology is the key to Vishay advanced line of Power MOSFET transistors. The efficient geometry and unique processing of the Power MOSFETs design achieve very low on-state resistance combined with high transconductance and extreme device ruggedness. 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	SiHFR9220-GE3	SiHFR9220TRL-GE3 <sup>a</sup>	SiHFR9220TRR-GE3 <sup>a</sup>	SiHFR9220TR-GE3 <sup>a</sup>	SiHFU9220-GE3
Lead (Pb)-free	IRFR9220PbF	IRFR9220TRLPbF <sup>a</sup>	IRFR9220TRRPbF <sup>a</sup>	IRFR9220TRPbF <sup>a</sup>	IRFU9220PbF
	SiHFR9220-E3	SiHFR9220TL-E3 <sup>a</sup>	SiHFR9220TR-E3 <sup>a</sup>	SiHFR9220T-E3 <sup>a</sup>	SiHFU9220-E3
SnPb	IRFR9220	IRFR9220TRL <sup>a</sup>	IRFR9220TRR <sup>a</sup>	IRFR9220TR <sup>a</sup>	IRFU9220
	SiHFR9220	SiHFR9220TL <sup>a</sup>	SiHFR9220TR <sup>a</sup>	SiHFR9220T <sup>a</sup>	SiHFU9220

#### Note

a. See device orientation.

### ABSOLUTE MAXIMUM RATINGS $T_C = 25^\circ\text{C}$ , unless otherwise noted

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-Source Voltage	$V_{DS}$	- 200	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	
Continuous Drain Current	$V_{GS}$ at - 10 V	$T_C = 25^\circ\text{C}$	A
		$T_C = 100^\circ\text{C}$	
Pulsed Drain Current <sup>a</sup>	$I_{DM}$	- 14	W/ $^\circ\text{C}$
Linear Derating Factor		0.33	
Linear Derating Factor (PCB Mount) <sup>e</sup>		0.020	
Single Pulse Avalanche Energy <sup>b</sup>	$E_{AS}$	310	mJ
Repetitive Avalanche Current <sup>a</sup>	$I_{AR}$	- 3.6	A
Repetitive Avalanche Energy <sup>a</sup>	$E_{AR}$	4.2	mJ
Maximum Power Dissipation	$P_D$	$T_C = 25^\circ\text{C}$	W
Maximum Power Dissipation (PCB Mount) <sup>e</sup>		$T_A = 25^\circ\text{C}$	
Peak Diode Recovery $dV/dt$ <sup>c</sup>	$dV/dt$	- 5.0	V/ns
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to + 150	$^\circ\text{C}$
Soldering Recommendations (Peak Temperature)		for 10 s	
		260 <sup>d</sup>	

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = - 50$  V, Starting  $T_J = 25^\circ\text{C}$ ,  $L = 35$  mH,  $R_g = 25\ \Omega$ ,  $I_{AS} = - 3.6$  A (see fig. 12).
- $I_{SD} \leq - 3.9$  A,  $dI/dt \leq 95$  A/ $\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150^\circ\text{C}$ .
- 1.6 mm from case.
- When mounted on 1" square PCB (FR-4 or G-10 material).

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

**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)	$R_{thJC}$	-	-	3.0	

**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		- 200	-	-	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		-	- 0.22	-	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> = - 200 V, V <sub>GS</sub> = 0 V		-	-	- 100	μA
		V <sub>DS</sub> = - 160 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> = - 2.2 A <sup>b</sup>	-	-	1.5	Ω
Forward Transconductance	g <sub>fs</sub>	V <sub>DS</sub> = - 50 V, I <sub>D</sub> = - 2.2 A		1.1	-	-	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		-	340	-	pF
Output Capacitance	C <sub>oss</sub>			-	110	-	
Reverse Transfer Capacitance	C <sub>rss</sub>			-	33	-	
Total Gate Charge	Q <sub>g</sub>	V <sub>GS</sub> = - 10 V	I <sub>D</sub> = - 3.9 A, V <sub>DS</sub> = - 160 V, see fig. 6 and 13 <sup>b</sup>	-	-	20	nC
Gate-Source Charge	Q <sub>gs</sub>			-	-	3.3	
Gate-Drain Charge	Q <sub>gd</sub>			-	-	11	
Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> = - 100 V, I <sub>D</sub> = - 3.9 A, R <sub>g</sub> = 18 Ω, R <sub>D</sub> = 24 Ω, see fig. 10 <sup>b</sup>		-	8.8	-	ns
Rise Time	t <sub>r</sub>			-	27	-	
Turn-Off Delay Time	t <sub>d(off)</sub>			-	7.3	-	
Fall Time	t <sub>f</sub>			-	19	-	
Internal Drain Inductance	L <sub>D</sub>	Between lead, 6 mm (0.25") from package and center of die contact		-	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		-	-	- 3.6	A
Pulsed Diode Forward Current <sup>a</sup>	I <sub>SM</sub>			-	-	- 14	
Body Diode Voltage	V <sub>SD</sub>	T <sub>J</sub> = 25 °C, I <sub>S</sub> = - 3.6 A, V <sub>GS</sub> = 0 V <sup>b</sup>		-	-	- 6.3	V
Body Diode Reverse Recovery Time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C, I <sub>F</sub> = - 3.9 A, dI/dt = 100 A/μs <sup>b</sup>		-	150	300	ns
Body Diode Reverse Recovery Charge	Q <sub>rr</sub>			-	0.97	2.0	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

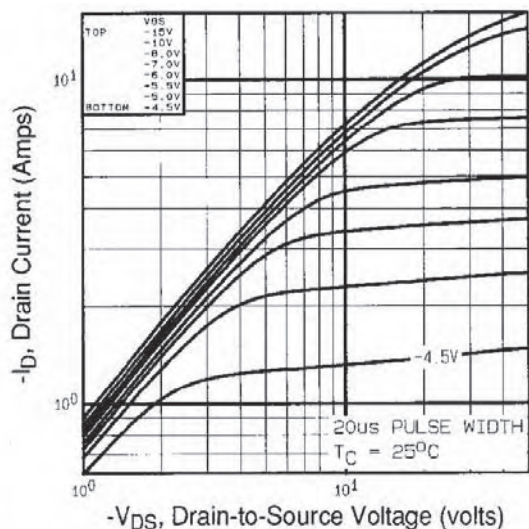


Fig. 1 - Typical Output Characteristics,  $T_C = 25^\circ\text{C}$

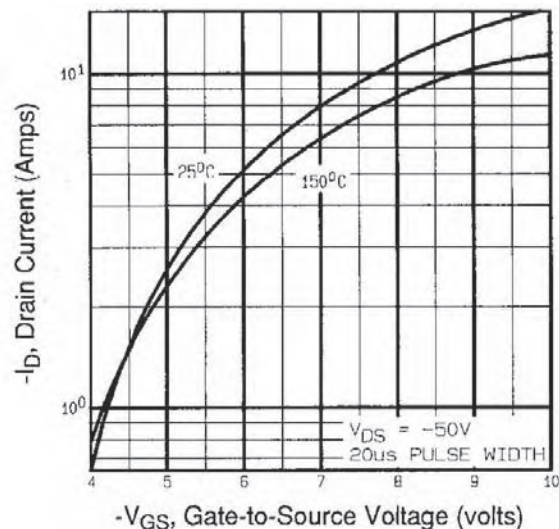


Fig. 3 - Typical Transfer Characteristics

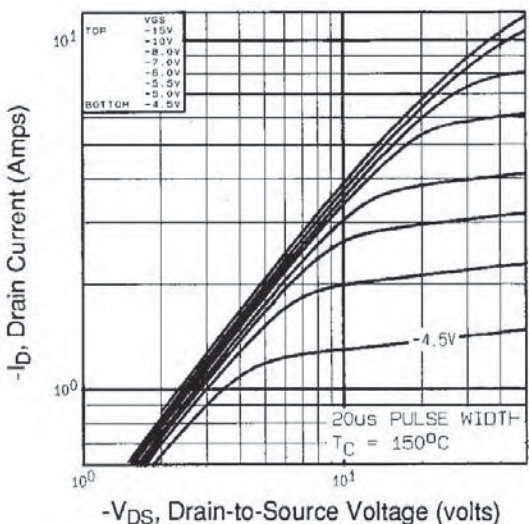


Fig. 2 - Typical Output Characteristics,  $T_C = 150^\circ\text{C}$

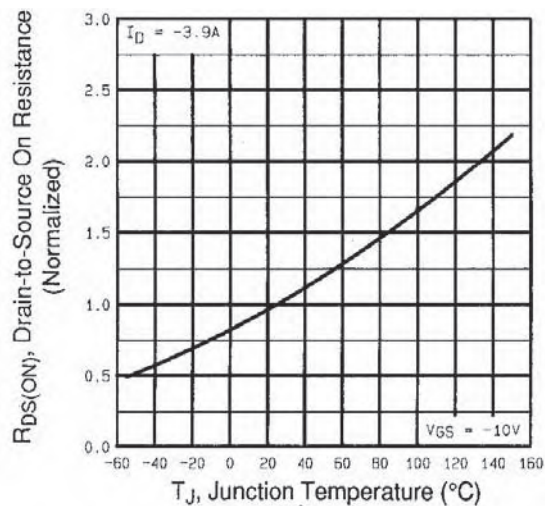


Fig. 4 - Normalized On-Resistance vs. Temperature

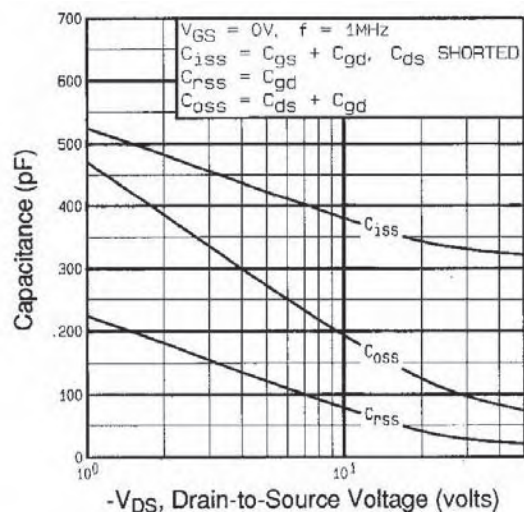


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

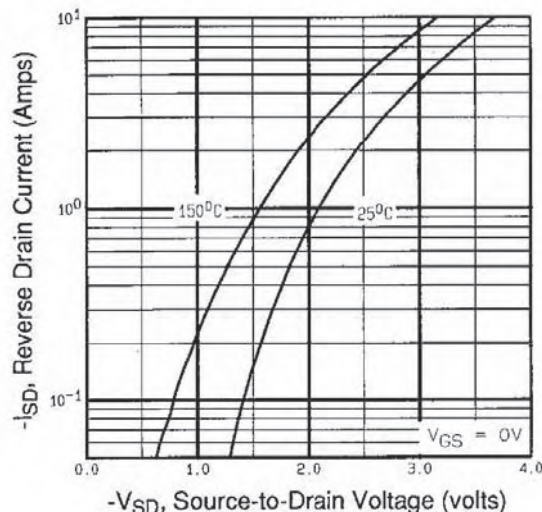


Fig. 7 - Typical Source-Drain Diode Forward Voltage

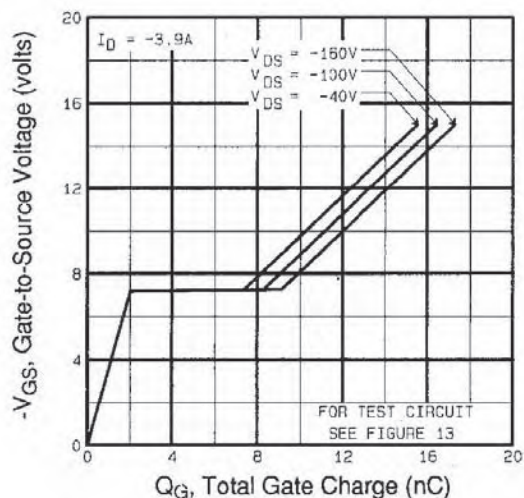


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

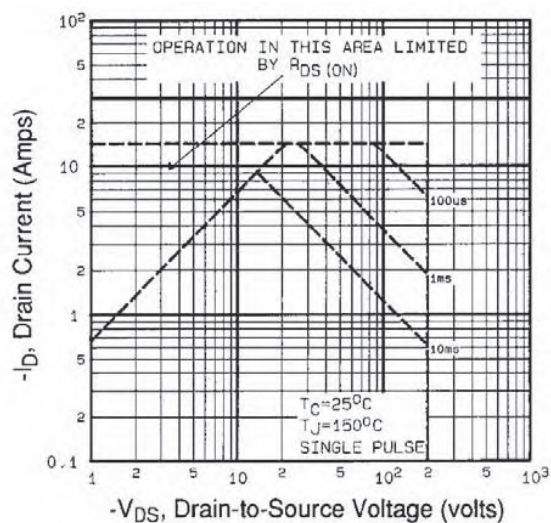


Fig. 8 - Maximum Safe Operating Area



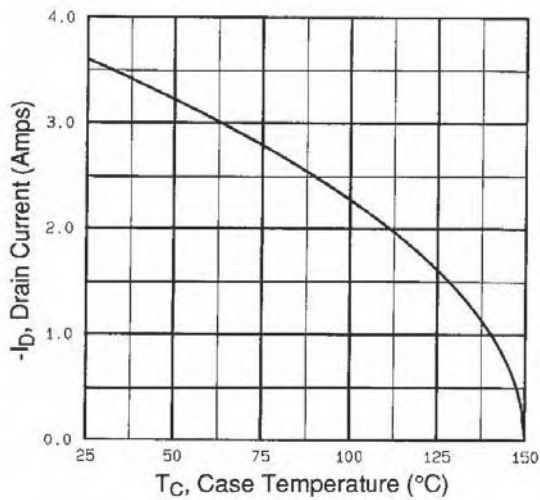


Fig. 9 - Maximum Drain Current vs. Case Temperature

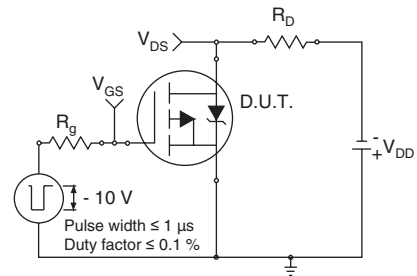


Fig. 10a - Switching Time Test Circuit

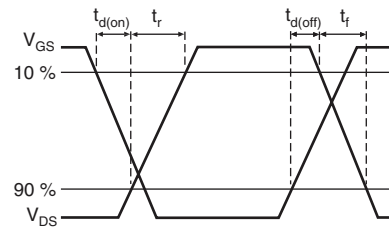


Fig. 10b - Switching Time Waveforms

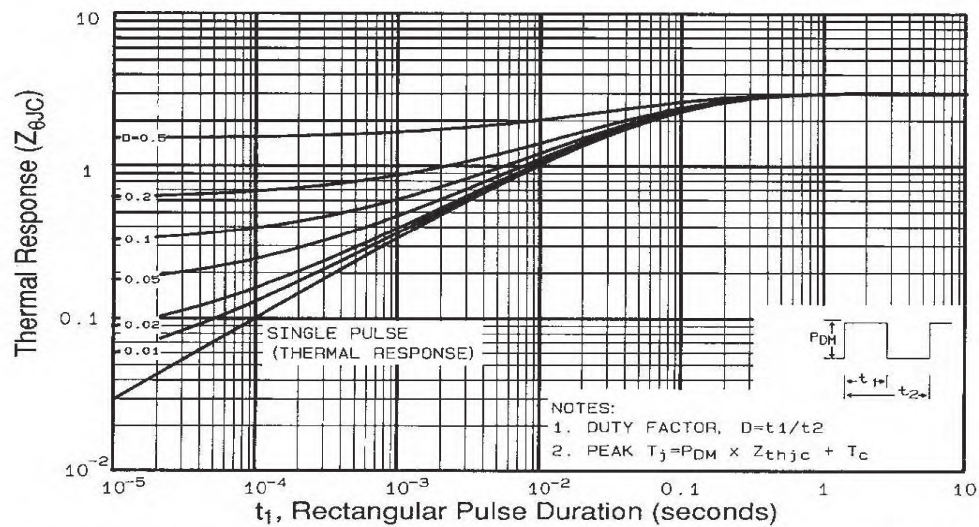


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

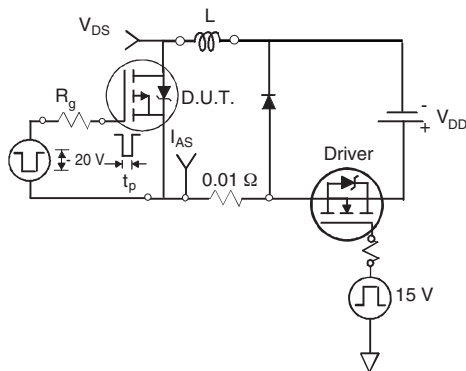


Fig. 12a - Unclamped Inductive Test Circuit

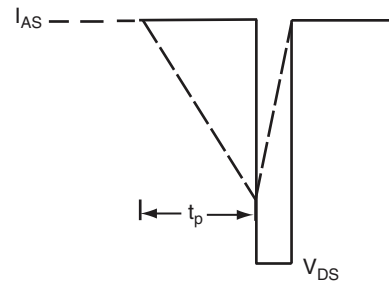


Fig. 12b - Unclamped Inductive Waveforms

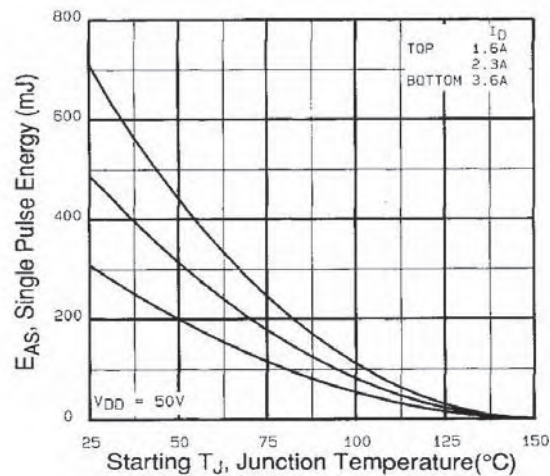


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

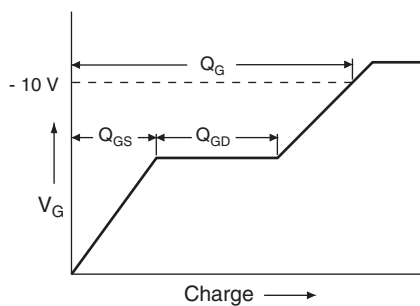


Fig. 13a - Basic Gate Charge Waveform

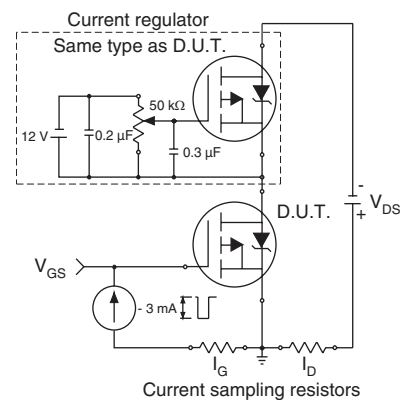
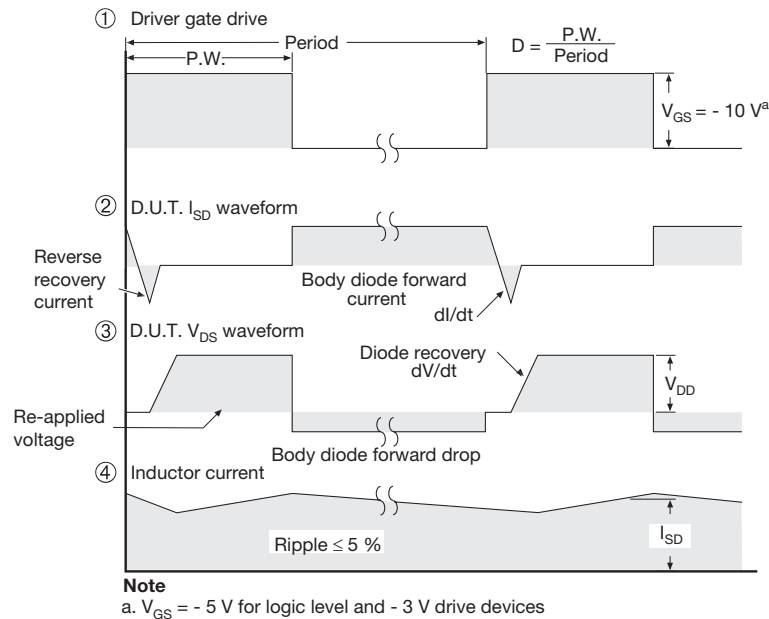
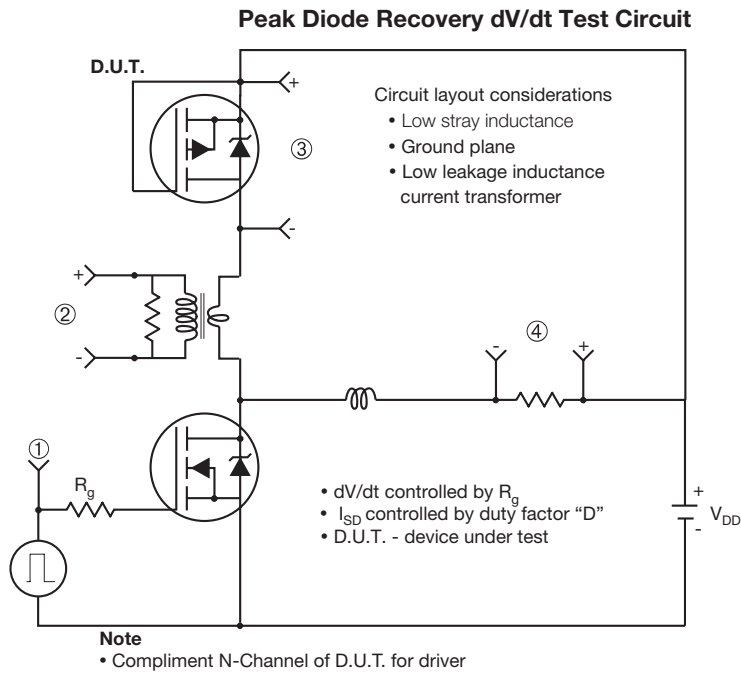


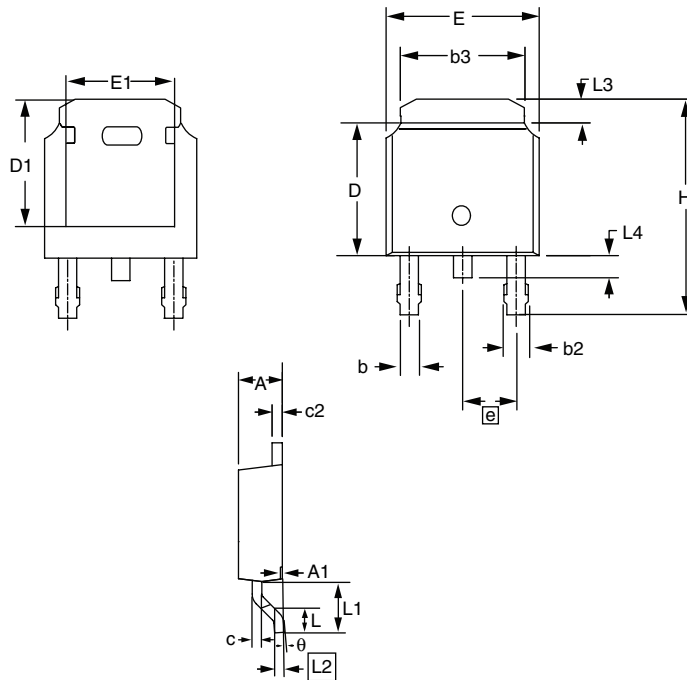
Fig. 13b - Gate Charge Test Circuit



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

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## TO-252AA (HIGH VOLTAGE)



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
E	6.40	6.73	0.252	0.265
L	1.40	1.77	0.055	0.070
L1	2.743 REF		0.108 REF	
L2	0.508 BSC		0.020 BSC	
L3	0.89	1.27	0.035	0.050
L4	0.64	1.01	0.025	0.040
D	6.00	6.22	0.236	0.245
H	9.40	10.40	0.370	0.409
b	0.64	0.88	0.025	0.035
b2	0.77	1.14	0.030	0.045
b3	5.21	5.46	0.205	0.215
e	2.286 BSC		0.090 BSC	
A	2.20	2.38	0.087	0.094
A1	0.00	0.13	0.000	0.005
c	0.45	0.60	0.018	0.024
c2	0.45	0.58	0.018	0.023
D1	5.30	-	0.209	-
E1	4.40	-	0.173	-
θ	0°	10°	0°	10°

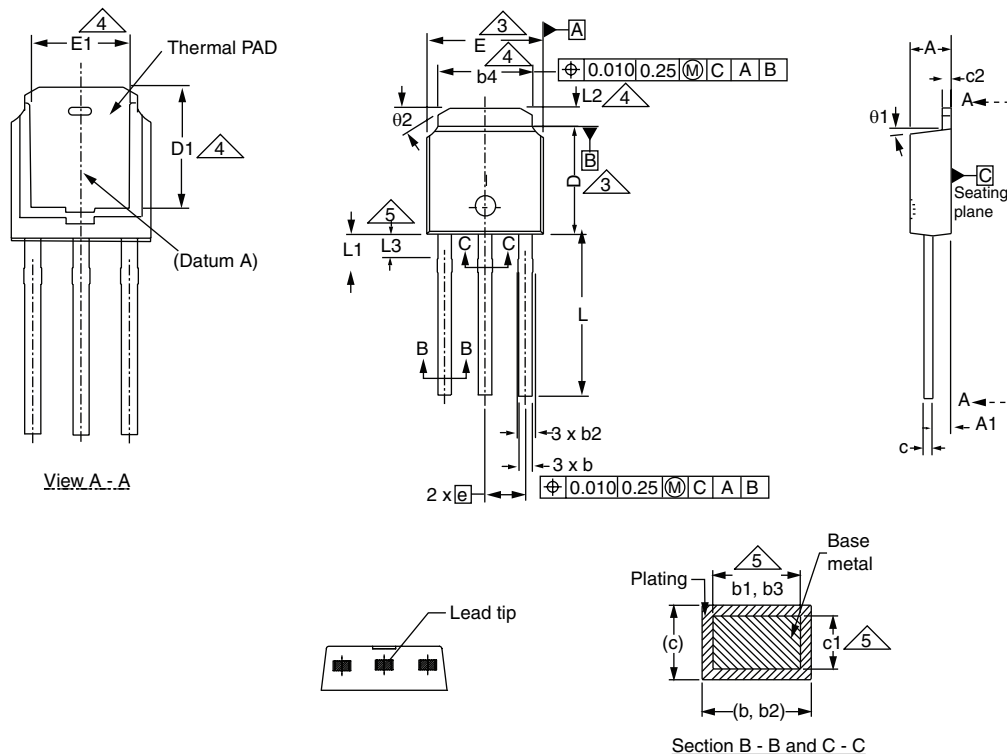
ECN: S-81965-Rev. A, 15-Sep-08  
DWG: 5973

### Notes

1. Package body sizes exclude mold flash, protrusion or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 0.10 mm per side.
2. Package body sizes determined at the outermost extremes of the plastic body exclusive of mold flash, gate burrs and interlead flash, but including any mismatch between the top and bottom of the plastic body.
3. The package top may be smaller than the package bottom.
4. Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall be 0.10 mm total in excess of "b" dimension at maximum material condition. The dambar cannot be located on the lower radius of the foot.



## TO-251AA (HIGH VOLTAGE)



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

### 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.



## Disclaimer

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**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.**

**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.**