

## Power MOSFET

**D<sup>2</sup>PAK (TO-263)**


N-Channel MOSFET

PRODUCT SUMMARY	
$V_{DS}$ (V)	250
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10\text{ V}$ 0.28
$Q_g$ max. (nC)	68
$Q_{gs}$ (nC)	11
$Q_{gd}$ (nC)	35
Configuration	Single

### FEATURES

- Surface-mount
- Available in tape and reel
- Dynamic  $dv/dt$  rating
- Repetitive avalanche rated
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

### 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 D<sup>2</sup>PAK (TO-263) 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 D<sup>2</sup>PAK (TO-263) 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.

ORDERING INFORMATION			
Package	D <sup>2</sup> PAK (TO-263)	D <sup>2</sup> PAK (TO-263)	D <sup>2</sup> PAK (TO-263)
Lead (Pb)-free and halogen-free	SiHF644S-GE3	SiHF644STRL-GE3 <sup>a</sup>	SiHF644STRR-GE3 <sup>a</sup>
Lead (Pb)-free	IRF644SPbF	IRF644STRLPbF <sup>a</sup>	IRF644STRRPbF <sup>a</sup>

### Note

a. See device orientation

ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)				
PARAMETER	SYMBOL		LIMIT	UNIT
Drain-source voltage	$V_{DS}$		250	V
Gate-source voltage	$V_{GS}$		$\pm 20$	
Continuous drain current	$V_{GS}$ at 10 V	$T_C = 25\text{ }^\circ\text{C}$	14	A
		$T_C = 100\text{ }^\circ\text{C}$	8.5	
Pulsed drain current <sup>a</sup>	$I_{DM}$		56	W/ $^\circ\text{C}$
Linear derating factor			1.0	
Linear derating factor (PCB mount) <sup>e</sup>			0.025	
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$		550	mJ
Avalanche current <sup>a</sup>	$I_{AR}$		14	A
Repetitive avalanche energy <sup>a</sup>	$E_{AR}$		13	mJ
Maximum power dissipation	$T_C = 25\text{ }^\circ\text{C}$		125	W
	$T_A = 25\text{ }^\circ\text{C}$		3.1	
Peak diode recovery $dv/dt$ <sup>c</sup>	$dv/dt$		4.8	V/ns
Operating junction and storage temperature range	$T_J, T_{stg}$		-55 to +150	$^\circ\text{C}$
Soldering recommendations (peak temperature) <sup>d</sup>	for 10 s		300	

### Notes

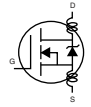

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 4.5\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 14\text{ A}$  (see fig. 12)
- $I_{SD} \leq 14\text{ A}$ ,  $di/dt \leq 150\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$
- 1.6 mm from case
- When mounted on 1" square PCB (FR-4 or G-10 material)



THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	$R_{thJA}$	-	62	°C/W
Maximum junction-to-ambient (PCB mount) <sup>a</sup>	$R_{thJA}$	-	40	
Maximum junction-to-case (drain)	$R_{thJC}$	-	1.0	

**Note**

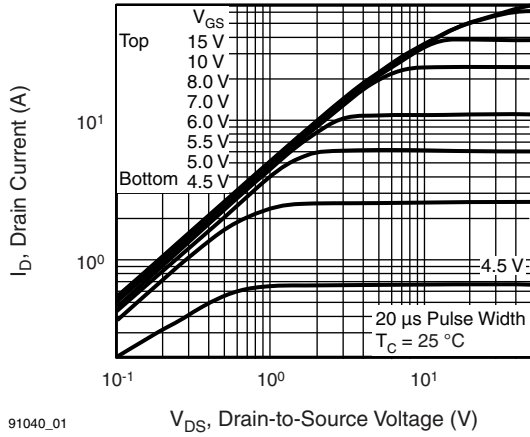
a. When mounted on 1" square PCB (FR-4 or G-10 material)

SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0, I_D = 250\ \mu\text{A}$		250	-	-	V
$V_{DS}$ temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\ \text{mA}$		-	0.34	-	V/°C
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$		2.0	-	4.0	V
Gate-source leakage	$I_{GSS}$	$V_{GS} = \pm 20\ \text{V}$		-	-	$\pm 100$	nA
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = 250\ \text{V}, V_{GS} = 0\ \text{V}$		-	-	25	$\mu\text{A}$
		$V_{DS} = 200\ \text{V}, V_{GS} = 0\ \text{V}, T_J = 125\text{ }^\circ\text{C}$		-	-	250	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\ \text{V}$	$I_D = 8.4\ \text{A}^b$	-	-	0.28	$\Omega$
Forward transconductance	$g_{fs}$	$V_{DS} = 50\ \text{V}, I_D = 8.4\ \text{A}^b$		6.7	-	-	S
<b>Dynamic</b>							
Input capacitance	$C_{iss}$	$V_{GS} = 0\ \text{V},$ $V_{DS} = 25\ \text{V},$ $f = 1.0\ \text{MHz},$ see fig. 5		-	1300	-	pF
Output capacitance	$C_{oss}$			-	330	-	
Reverse transfer capacitance	$C_{rss}$			-	85	-	
Total gate charge	$Q_g$	$V_{GS} = 10\ \text{V}$	$I_D = 7.9\ \text{A}, V_{DS} = 200\ \text{V},$ see fig. 6 and 13 <sup>b</sup>	-	-	68	nC
Gate-source charge	$Q_{gs}$			-	-	11	
Gate-drain charge	$Q_{gd}$			-	-	35	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 125\ \text{V}, I_D = 7.9\ \text{A},$ $R_g = 9.1\ \Omega, R_D = 8.7\ \Omega,$ see fig. 10 <sup>b</sup>		-	11	-	ns
Rise time	$t_r$			-	24	-	
Turn-off delay time	$t_{d(off)}$			-	53	-	
Fall time	$t_f$			-	49	-	
Gate input resistance	$L_D$	Between lead, 6 mm (0.25") from package and center of die contact 		-	4.5	-	nH
Internal drain inductance	$L_S$			-	7.5	-	
Internal source inductance	$R_g$	$f = 1\ \text{MHz},$ open drain		0.3	-	1.2	$\Omega$
<b>Drain-Source Body Diode Characteristics</b>							
Continuous source-drain diode current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	14	A
Pulsed diode forward current <sup>a</sup>	$I_{SM}$			-	-	56	
Body diode voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = 14\ \text{A}, V_{GS} = 0\ \text{V}^b$		-	-	1.8	V
Body diode reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}, I_F = 7.9\ \text{A}, di/dt = 100\ \text{A}/\mu\text{s}^b$		-	250	500	ns
Body diode reverse recovery charge	$Q_{rr}$			-	2.3	4.6	$\mu\text{C}$
Forward turn-on time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )					

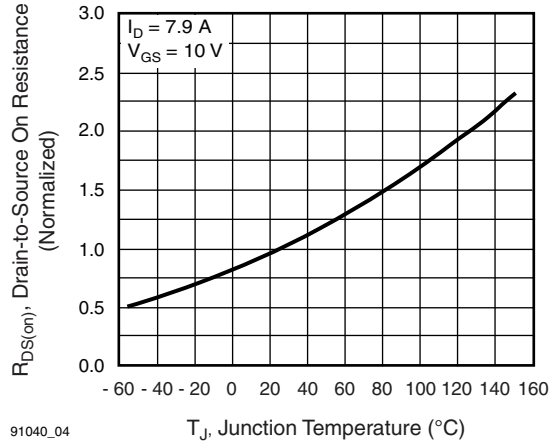
**Notes**

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

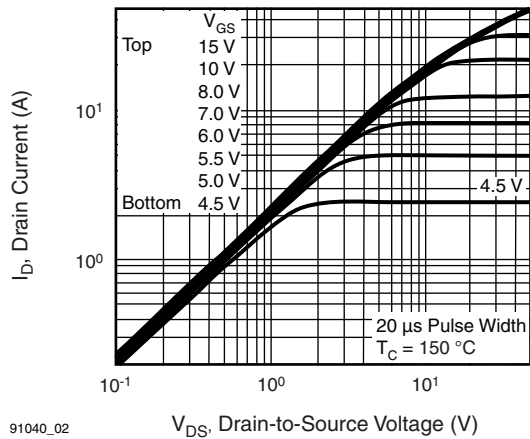
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



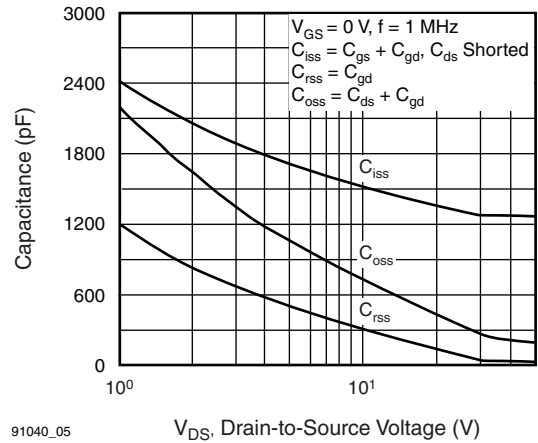
**Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$**



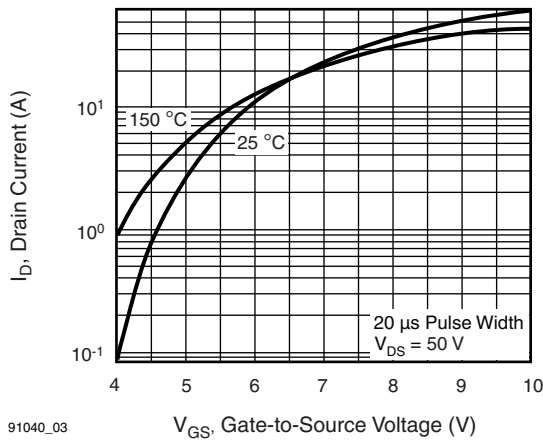
**Fig. 4 - Normalized On-Resistance vs. Temperature**



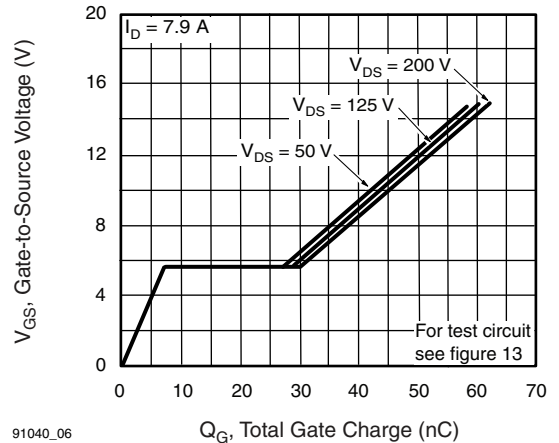
**Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^\circ\text{C}$**



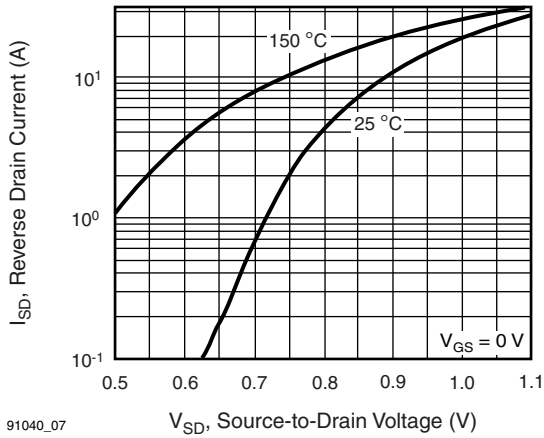
**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



**Fig. 3 - Typical Transfer Characteristics**

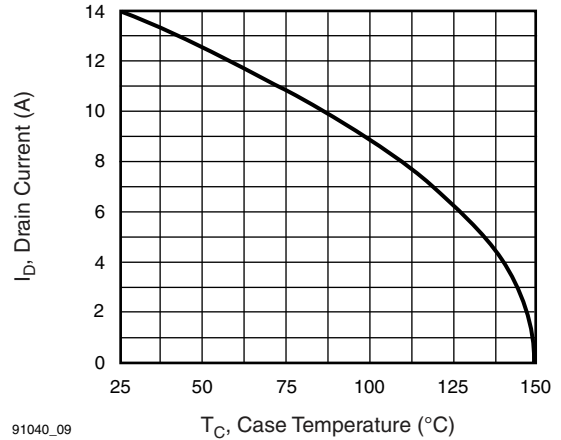


**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**



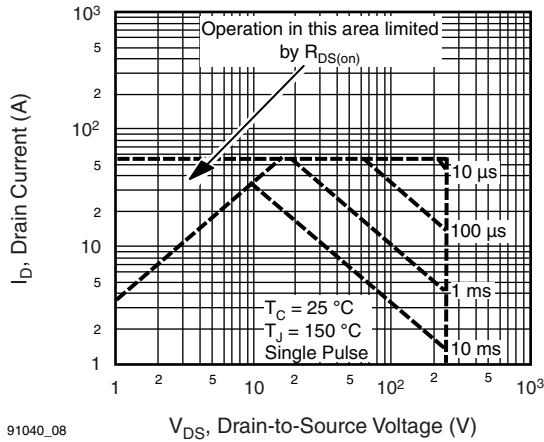
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Fig. 7 - Typical Source-Drain Diode Forward Voltage



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Fig. 9 - Maximum Drain Current vs. Case Temperature



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Fig. 8 - Maximum Safe Operating Area

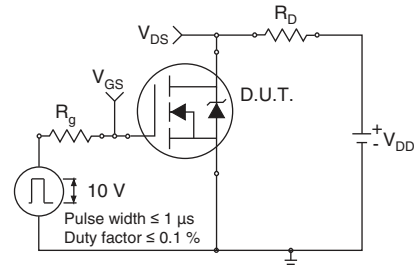


Fig. 10a - Switching Time Test Circuit

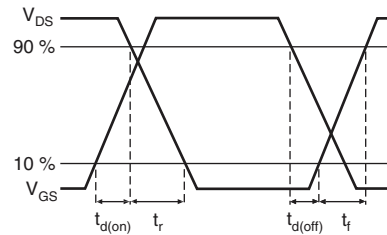
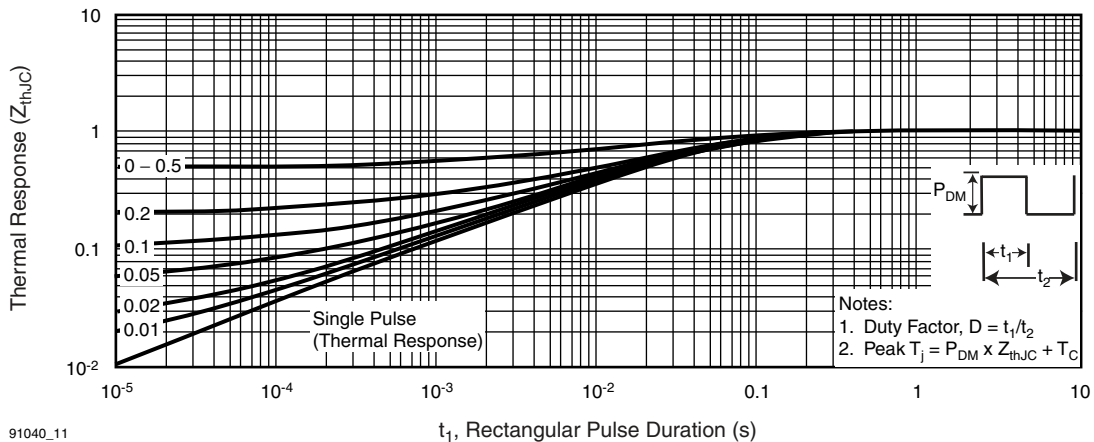


Fig. 10b - Switching Time Waveforms



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

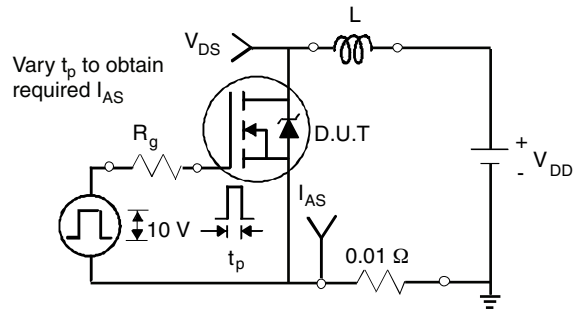


Fig. 12a - Unclamped Inductive Test Circuit

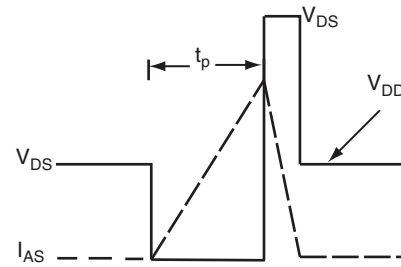


Fig. 12b - Unclamped Inductive Waveforms

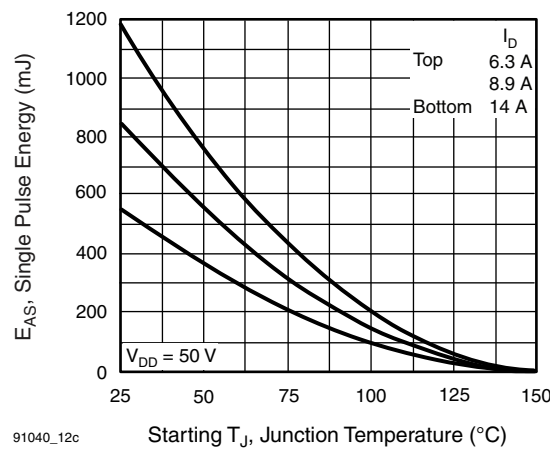


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

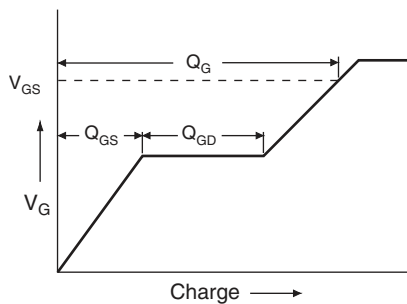


Fig. 13a - Basic Gate Charge Waveform

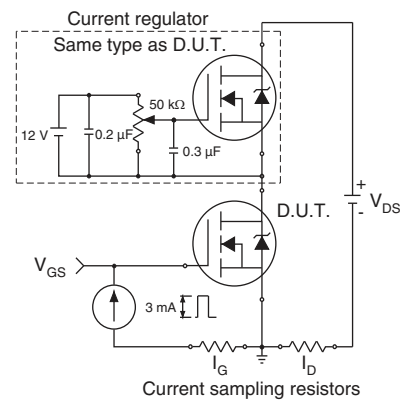
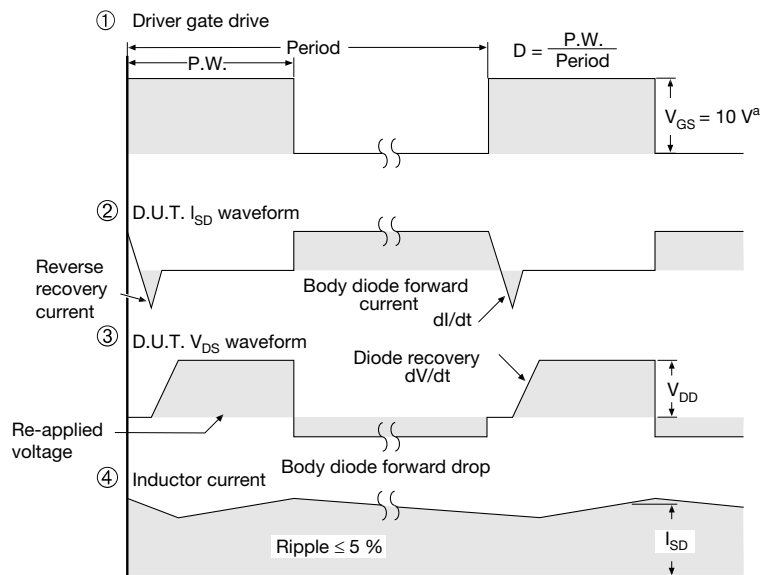
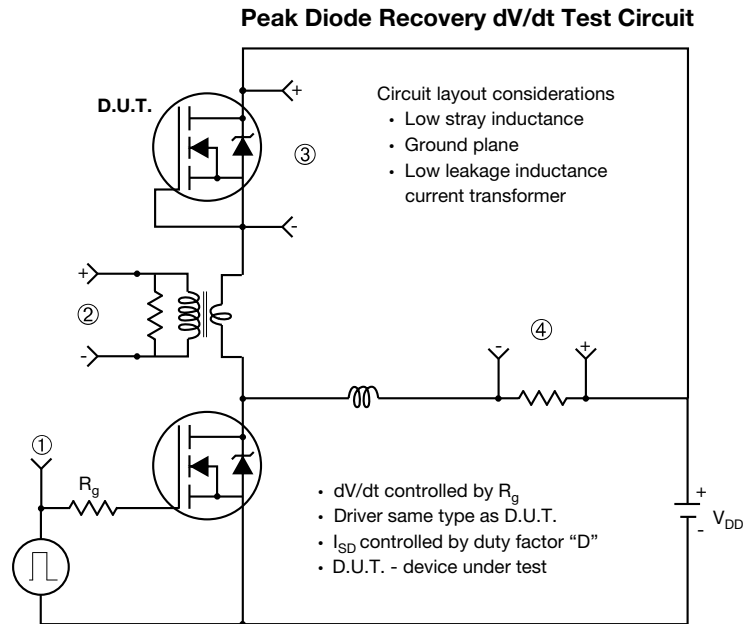


Fig. 13b - Gate Charge Test Circuit



**Note**

a.  $V_{GS} = 5 V$  for logic level devices

**Fig. 14 - For N-Channel**

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### TO-263AB (HIGH VOLTAGE)



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.06	4.83	0.160	0.190
A1	0.00	0.25	0.000	0.010
b	0.51	0.99	0.020	0.039
b1	0.51	0.89	0.020	0.035
b2	1.14	1.78	0.045	0.070
b3	1.14	1.73	0.045	0.068
c	0.38	0.74	0.015	0.029
c1	0.38	0.58	0.015	0.023
c2	1.14	1.65	0.045	0.065
D	8.38	9.65	0.330	0.380

DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
D1	6.86	-	0.270	-
E	9.65	10.67	0.380	0.420
E1	6.22	-	0.245	-
e	2.54 BSC		0.100 BSC	
H	14.61	15.88	0.575	0.625
L	1.78	2.79	0.070	0.110
L1	-	1.65	-	0.066
L2	-	1.78	-	0.070
L3	0.25 BSC		0.010 BSC	
L4	4.78	5.28	0.188	0.208

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

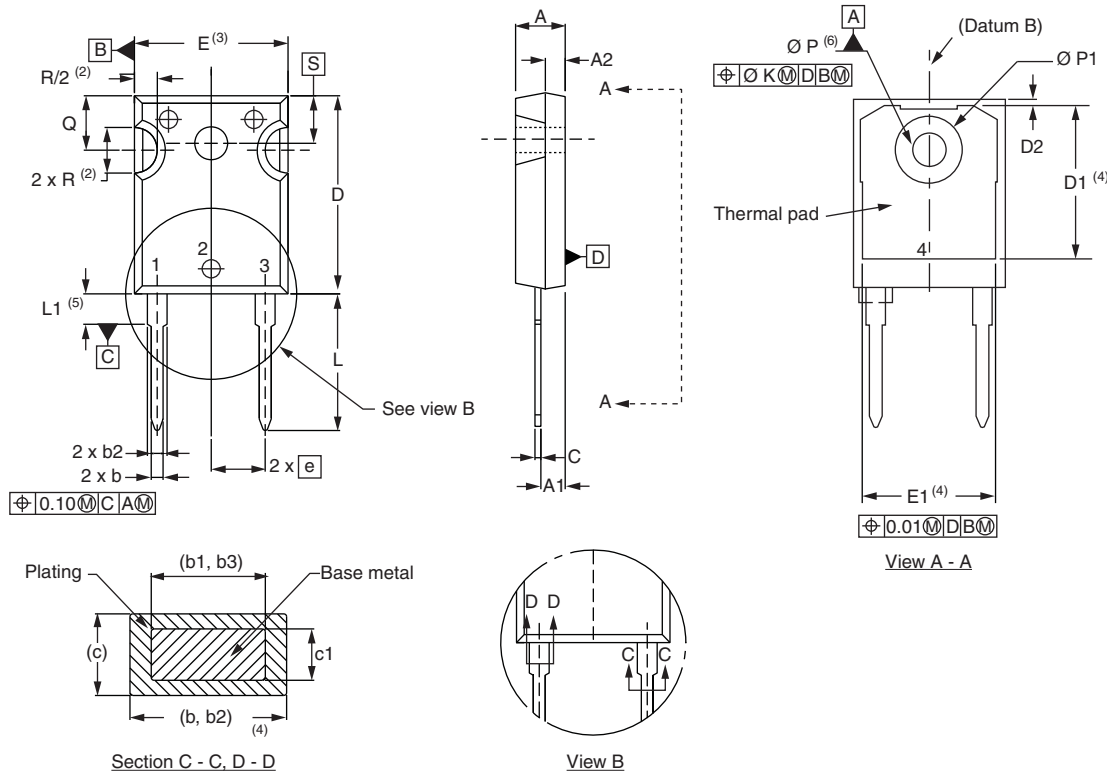
#### Notes

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.



## TO-247AC 2L

**DIMENSIONS** in millimeters and inches



SYMBOL	MILLIMETERS		INCHES		NOTES	SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.			MIN.	MAX.	MIN.	MAX.	
A	4.65	5.31	0.183	0.209		E	15.29	15.87	0.602	0.625	3
A1	2.21	2.59	0.087	0.102		E1	13.46	-	0.53	-	
A2	1.17	1.37	0.046	0.054		e	5.46 BSC		0.215 BSC		
b	0.99	1.40	0.039	0.055		$\text{ (M) } K$	0.254		0.010		
b1	0.99	1.35	0.039	0.053		L	14.20	16.10	0.559	0.634	
b2	1.65	2.39	0.065	0.094		L1	3.71	4.29	0.146	0.169	
b3	1.65	2.34	0.065	0.092		$\text{ (M) } P$	3.56	3.66	0.14	0.144	
c	0.38	0.89	0.015	0.035		$\text{ (M) } P1$	-	7.39	-	0.291	
c1	0.38	0.84	0.015	0.033		Q	5.31	5.69	0.209	0.224	
D	19.71	20.70	0.776	0.815	3	R	4.52	5.49	0.178	0.216	
D1	13.08	-	0.515	-	4	S	5.51 BSC		0.217 BSC		
D2	0.51	1.35	0.020	0.053							

**Notes**

- (1) Dimensioning and tolerancing per ASME Y14.5M-1994
- (2) Contour of slot optional
- (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 outermost extremes of the plastic body
- (4) Thermal pad contour optional with dimensions D1 and E1
- (5) Lead finish uncontrolled in L1
- (6)  $\text{ (M) } P$  to have a maximum draft angle of 1.5 to the top of the part with a maximum hole diameter of 3.91 mm (0.154")
- (7) Outline conforms to JEDEC® outline TO-247 with exception of dimension Q



**RECOMMENDED MINIMUM PADS FOR D<sup>2</sup>PAK: 3-Lead**



Recommended Minimum Pads  
Dimensions in Inches/(mm)

[Return to Index](#)



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