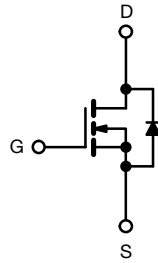
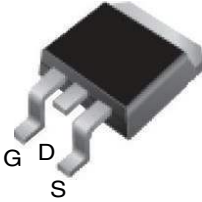


## EF Series Power MOSFET With Fast Body Diode

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


N-Channel MOSFET

### FEATURES

- 4<sup>th</sup> generation E series technology
- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low effective capacitance ( $C_{o(er)}$ )
- Reduced switching and conduction losses
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


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

### APPLICATIONS

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting
- Industrial
  - Welding
  - Motor drives
  - Battery chargers
  - Solar (PV inverters)

### PRODUCT SUMMARY

$V_{DS}$ (V) at $T_J$ max.	650	
$R_{DS(on)}$ typ. ( $\Omega$ ) at 25 °C	$V_{GS} = 10$ V	0.059
$Q_g$ max. (nC)	77	
$Q_{gs}$ (nC)	19	
$Q_{gd}$ (nC)	16	
Configuration	Single	

### ORDERING INFORMATION

Package	D <sup>2</sup> PAK (TO-263)
	SiHB068N60EF-GE3
Lead (Pb)-free and halogen-free	SiHB068N60EF-T1GE3 <sup>a</sup>
	SiHB068N60EF-T5GE3 <sup>a</sup>

#### Note

- a. See device orientation

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


PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	$V_{DS}$	600	V
Gate-source voltage	$V_{GS}$	$\pm 30$	
Continuous drain current ( $T_J = 150$ °C)	$V_{GS}$ at 10 V	$T_C = 25$ °C	A
		$T_C = 100$ °C	
Pulsed drain current <sup>a</sup>	$I_{DM}$	115	
Linear derating factor		2	W/°C
Single pulse avalanche energy <sup>b</sup>	$E_{AS}$	226	mJ
Maximum power dissipation	$P_D$	250	W
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +150	°C
Drain-source voltage slope	$dV/dt$	$T_J = 125$ °C	V/ns
Reverse diode $dV/dt$ <sup>d</sup>		50	
Soldering recommendations (peak temperature) <sup>c</sup>	For 10 s	260	°C

#### Notes

- a. Repetitive rating; pulse width limited by maximum junction temperature  
 b.  $V_{DD} = 120$  V, starting  $T_J = 25$  °C,  $L = 28.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 4$  A  
 c. 1.6 mm from case  
 d.  $I_{SD} \leq I_D$ ,  $di/dt = 210$  A/ $\mu$ s, starting  $T_J = 25$  °C



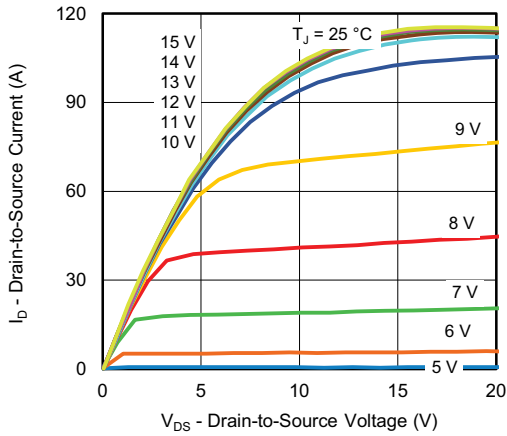
THERMAL RESISTANCE RATINGS			
PARAMETER	SYMBOL	LIMIT	UNIT
Maximum junction-to-ambient	R <sub>thJA</sub>	62	°C/W
Maximum junction-to-case (drain)	R <sub>thJC</sub>	0.5	

SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Static</b>						
Drain-source breakdown voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA	600	-	-	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	-	0.63	-	V/°C
Gate-source threshold voltage (N)	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	3	-	5	V
Gate-source leakage	I <sub>GSS</sub>	V <sub>GS</sub> = ± 20 V	-	-	± 100	nA
		V <sub>GS</sub> = ± 30 V	-	-	± 1	μA
Zero gate voltage drain current	I <sub>DSS</sub>	V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V	-	-	1	μA
		V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C	-	-	2	mA
Drain-source on-state resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 16 A	-	0.059	0.068	Ω
Forward transconductance	g <sub>fs</sub>	V <sub>DS</sub> = 30 V, I <sub>D</sub> = 16 A	-	9	-	S
<b>Dynamic</b>						
Input capacitance	C <sub>iSS</sub>	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 100 V, f = 1 MHz	-	2628	-	pF
Output capacitance	C <sub>oss</sub>		-	122	-	
Reverse transfer capacitance	C <sub>rSS</sub>		-	7	-	
Effective output capacitance, energy related <sup>a</sup>	C <sub>o(er)</sub>		-	87	-	
Effective output capacitance, time related <sup>b</sup>	C <sub>o(tr)</sub>	V <sub>DS</sub> = 0 V to 480 V, V <sub>GS</sub> = 0 V	-	543	-	
Total gate charge	Q <sub>g</sub>	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 16 A, V <sub>DS</sub> = 480 V	-	51	77	nC
Gate-source charge	Q <sub>gs</sub>		-	19	-	
Gate-drain charge	Q <sub>gd</sub>		-	16	-	
Turn-on delay time	t <sub>d(on)</sub>	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 16 A, V <sub>GS</sub> = 10 V, R <sub>g</sub> = 9.1 Ω	-	27	54	ns
Rise time	t <sub>r</sub>		-	55	83	
Turn-off delay time	t <sub>d(off)</sub>		-	53	80	
Fall time	t <sub>f</sub>		-	35	70	
Gate input resistance	R <sub>g</sub>		f = 1 MHz, open drain	0.3	0.7	
<b>Drain-Source Body Diode Characteristics</b>						
Continuous source-drain diode current	I <sub>S</sub>	MOSFET symbol showing the integral reverse p - n junction diode 	-	-	41	A
Pulsed diode forward current	I <sub>SM</sub>		-	-	115	
Diode forward voltage	V <sub>SD</sub>	T <sub>J</sub> = 25 °C, I <sub>S</sub> = 16 A, V <sub>GS</sub> = 0 V	-	-	1.2	V
Reverse recovery time	t <sub>rr</sub>	T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 16 A, di/dt = 100 A/μs, V <sub>R</sub> = 400 V	-	152	304	ns
Reverse recovery charge	Q <sub>rr</sub>		-	1	2	μC
Reverse recovery current	I <sub>RRM</sub>		-	14	-	A

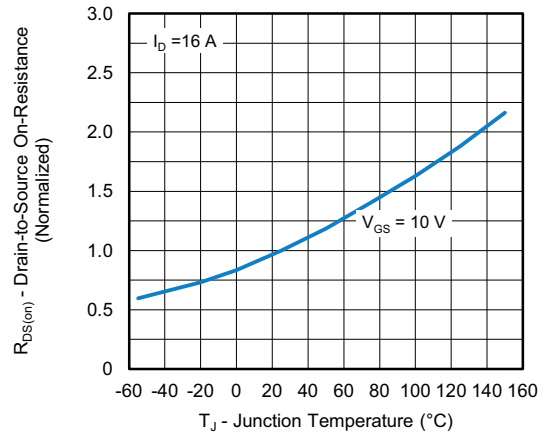
**Notes**

- a. C<sub>oss(er)</sub> is a fixed capacitance that gives the same energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 % to 80 % V<sub>DSS</sub>
- b. C<sub>oss(tr)</sub> is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 % to 80 % V<sub>DSS</sub>

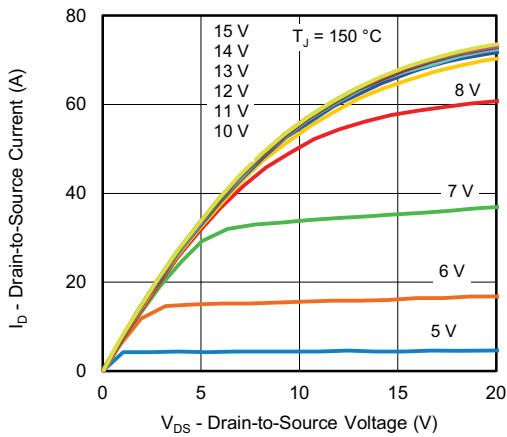
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



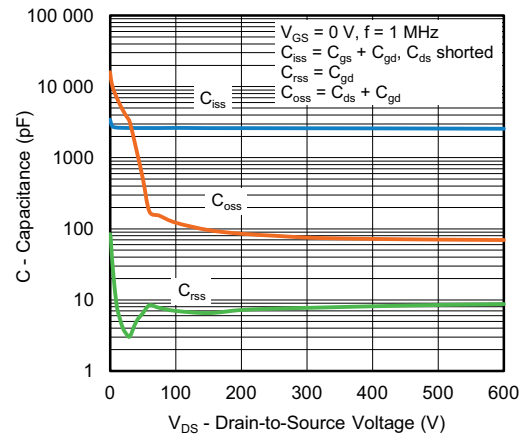
**Fig. 1 - Typical Output Characteristics**



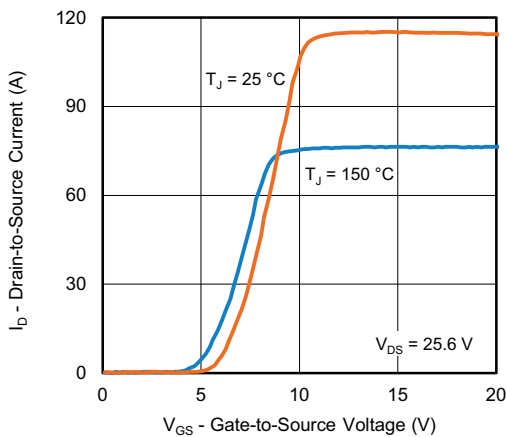
**Fig. 4 - Normalized On-Resistance vs. Temperature**



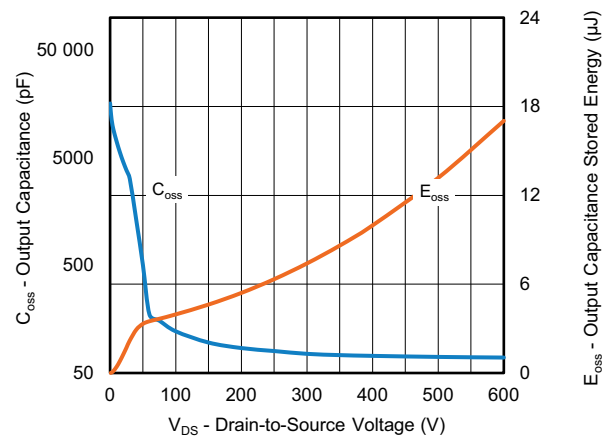
**Fig. 2 - Typical Output Characteristics**



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



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 - C<sub>oss</sub> and E<sub>oss</sub> vs. V<sub>DS</sub>**

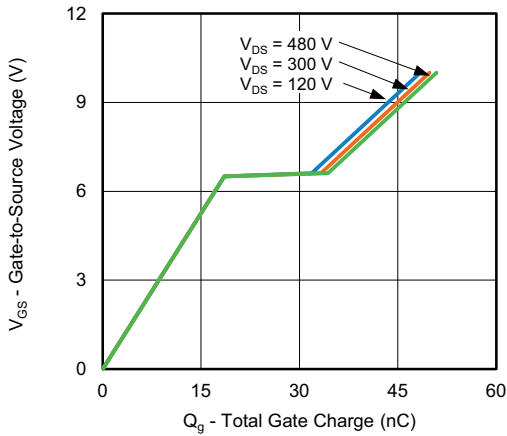


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

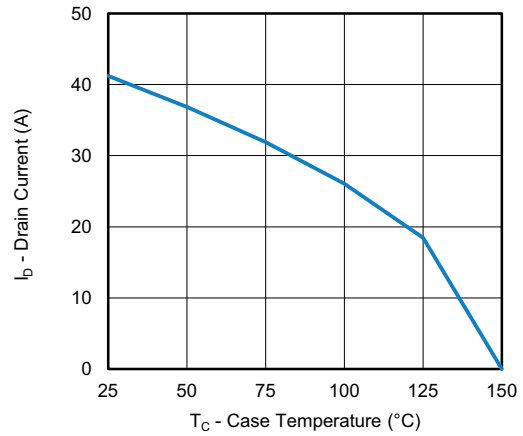


Fig. 10 - Maximum Drain Current vs. Case Temperature

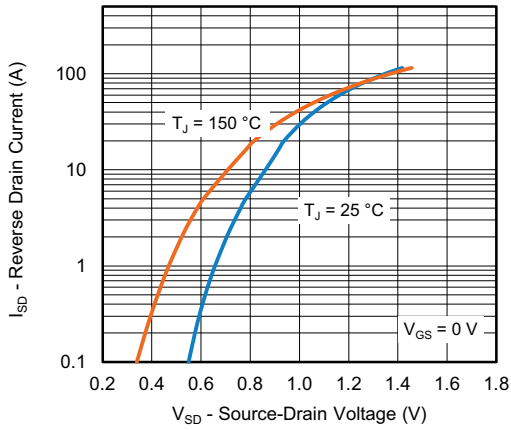


Fig. 8 - Typical Source-Drain Diode Forward Voltage

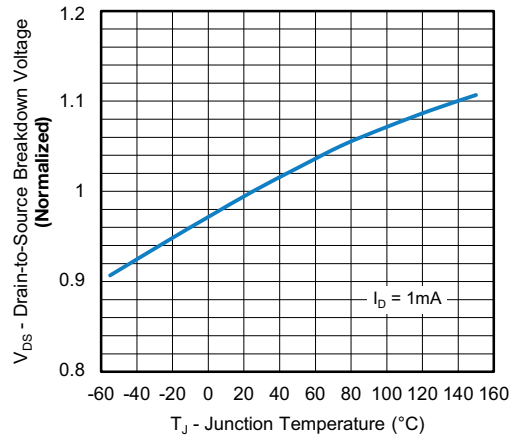


Fig. 11 - Temperature vs. Drain-to-Source Voltage

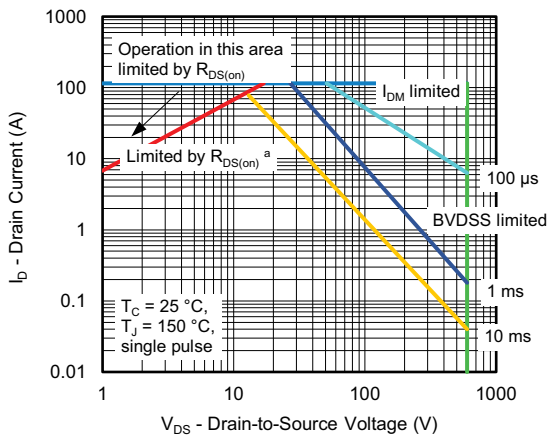


Fig. 9 - Maximum Safe Operating Area

**Note**

a.  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

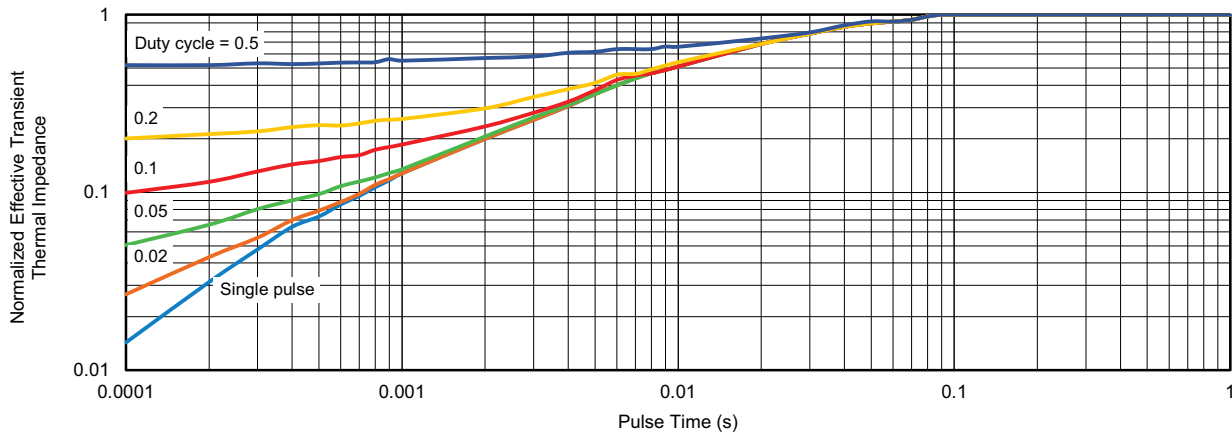


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

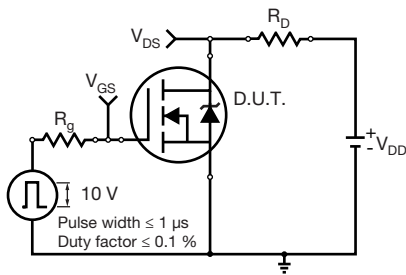


Fig. 13 - Switching Time Test Circuit

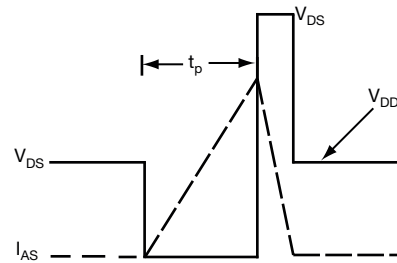


Fig. 16 - Unclamped Inductive Waveforms

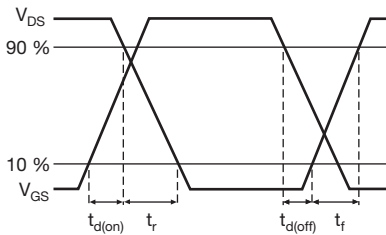


Fig. 14 - Switching Time Waveforms

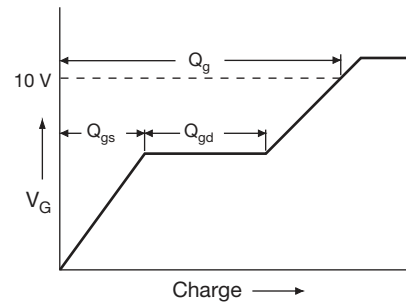


Fig. 17 - Basic Gate Charge Waveform

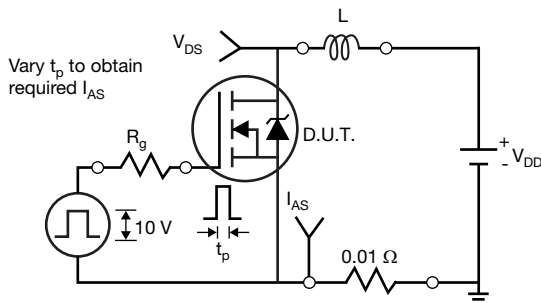


Fig. 15 - Unclamped Inductive Test Circuit

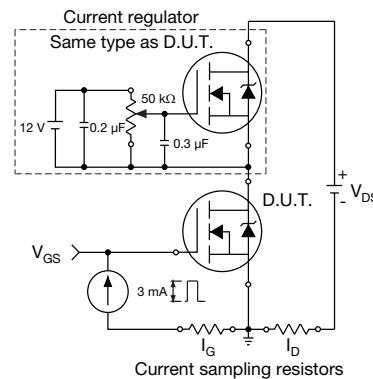
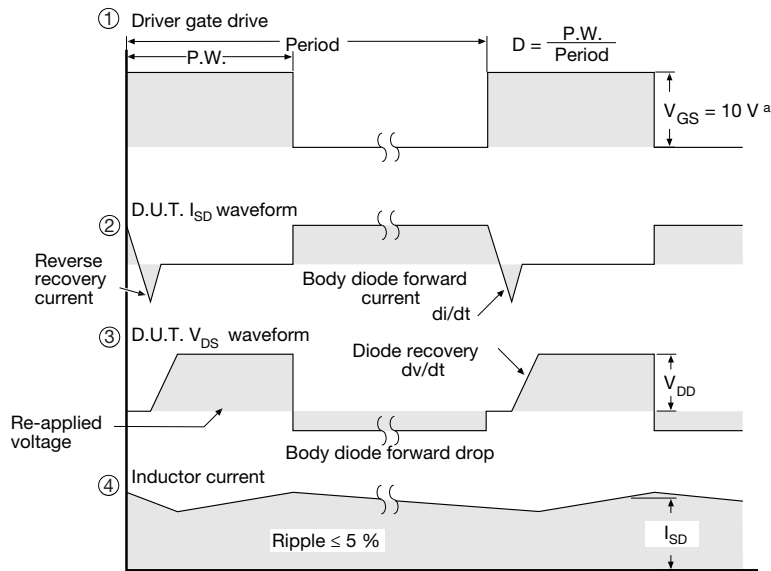
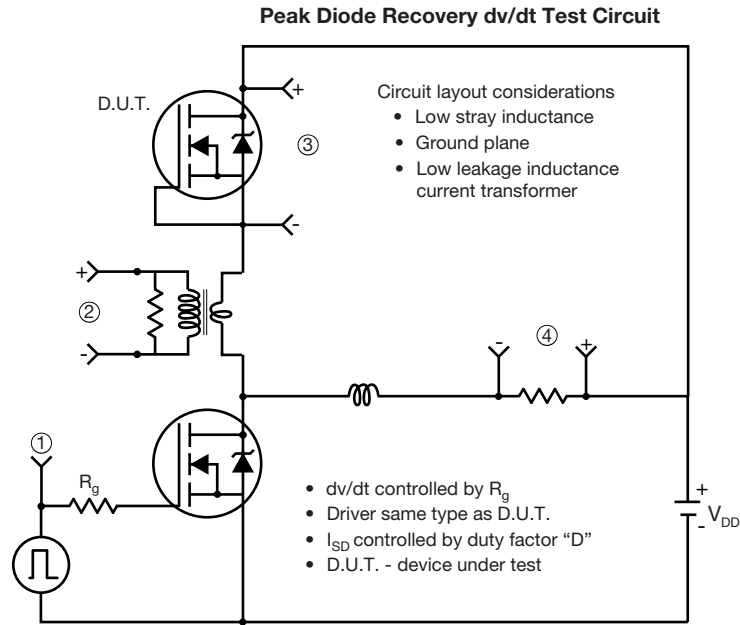


Fig. 18 - Gate Charge Test Circuit

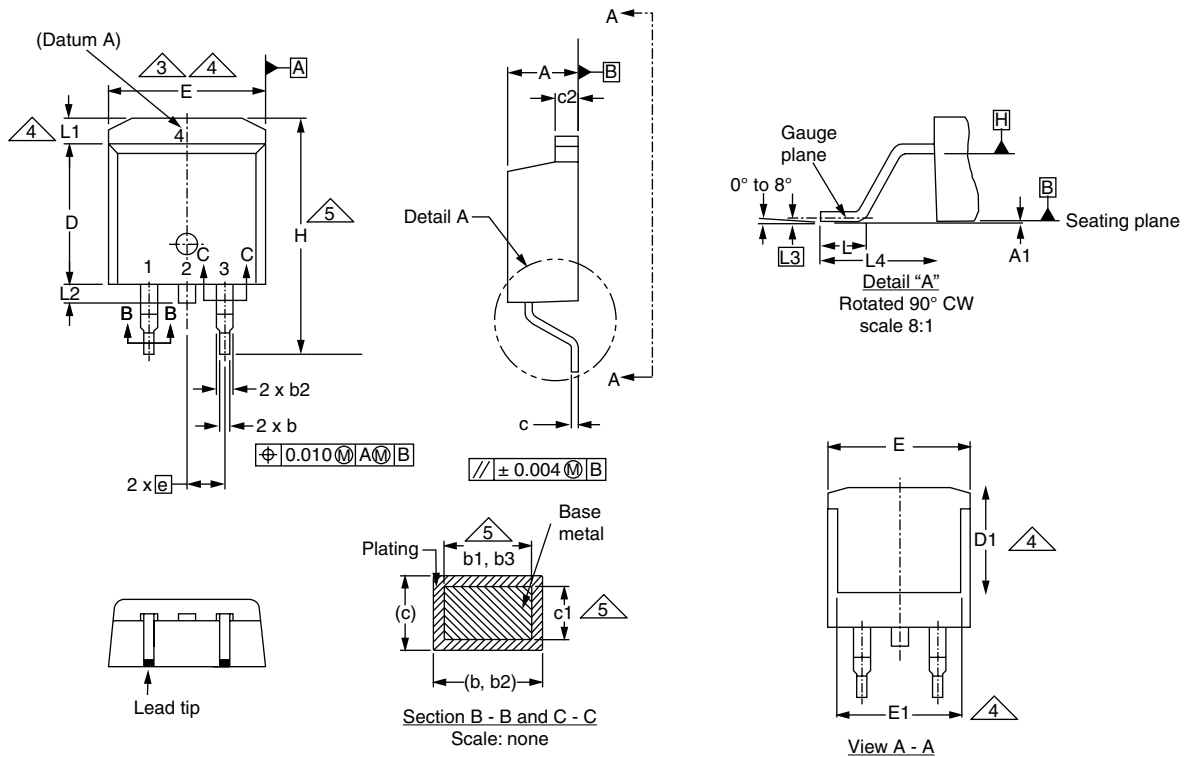


**Note**  
 a.  $V_{GS} = 5 V$  for logic level devices

**Fig. 19 - 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.

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



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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