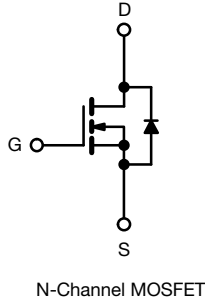
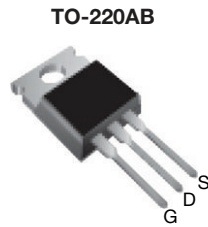


## Power MOSFET

PRODUCT SUMMARY		
$V_{DS}$ (V)	600	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10\text{ V}$	0.75
$Q_g$ max. (nC)	49	
$Q_{gs}$ (nC)	13	
$Q_{gd}$ (nC)	20	
Configuration	Single	



### FEATURES

- Low gate charge  $Q_g$  results in simple drive requirement
- Improved gate, avalanche and dynamic  $dV/dt$  ruggedness
- Fully characterized capacitance and avalanche voltage and current
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### APPLICATIONS

- Switch mode power supply (SMPS)
- Uninterruptible power supply
- High speed power switching

### APPLICABLE OFF LINE SMPS TOPOLOGIES

- Active clamped forward
- Main switch

ORDERING INFORMATION	
Package	TO-220AB
Lead (Pb)-free	IRFB9N60APbF
	SiHFB9N60A-E3
SnPb	IRFB9N60A
	SiHFB9N60A


ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)					
PARAMETER	SYMBOL		LIMIT	UNIT	
Drain-Source Voltage	$V_{DS}$		600	V	
Gate-Source Voltage	$V_{GS}$		$\pm 30$		
Continuous Drain Current	$V_{GS}$ at 10 V	$T_C = 25\text{ }^\circ\text{C}$	9.2	A	
		$T_C = 100\text{ }^\circ\text{C}$	5.8		
Pulsed Drain Current <sup>a</sup>	$I_{DM}$		37		
Linear Derating Factor			1.3	W/ $^\circ\text{C}$	
Single Pulse Avalanche Energy <sup>b</sup>	$E_{AS}$		290	mJ	
Repetitive Avalanche Current <sup>a</sup>	$I_{AR}$		9.2	A	
Repetitive Avalanche Energy <sup>a</sup>	$E_{AR}$		17	mJ	
Maximum Power Dissipation	$T_C = 25\text{ }^\circ\text{C}$		$P_D$	170	W
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) <sup>d</sup>	for 10 s		300		
Mounting Torque	6-32 or M3 screw		10	lbf · in	
			1.1	N · m	

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 6.8\text{ mH}$ ,  $R_g = 25\text{ }^\circ\Omega$ ,  $I_{AS} = 9.2\text{ A}$  (see fig. 12).
- $I_{SD} \leq 9.2\text{ A}$ ,  $dI/dt \leq 50\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.



THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	62	°C/W
Case-to-Sink, Flat, Greased Surface	$R_{thCS}$	0.50	-	
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	0.75	

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	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$	600	-	-	V	
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$	-	660	-	mV/°C	
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	2.0	-	4.0	V	
Gate-Source Leakage	$I_{GSS}$	$V_{GS} = \pm 30\text{ V}$	-	-	$\pm 100$	nA	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$	-	-	25	$\mu\text{A}$	
		$V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	-	250		
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 5.5\text{ A}^b$	-	-	0.75	$\Omega$	
Forward Transconductance	$g_{fs}$	$V_{DS} = 50\text{ V}, I_D = 5.5\text{ A}$	5.5	-	-	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	-	1400	-	pF	
Output Capacitance	$C_{oss}$		-	180	-		
Reverse Transfer Capacitance	$C_{rss}$		-	7.1	-		
Output Capacitance	$C_{oss}$	$V_{GS} = 0\text{ V}$	$V_{DS} = 1.0\text{ V}, f = 1.0\text{ MHz}$	-	1957	-	
Effective Output Capacitance	$C_{oss\text{ eff.}}$		$V_{DS} = 480\text{ V}, f = 1.0\text{ MHz}$	-	49	-	
			$V_{DS} = 0\text{ V to } 480\text{ V}$	-	96	-	
Total Gate Charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 9.2\text{ A}, V_{DS} = 400\text{ V}$ see fig. 6 and 13 <sup>b</sup>	-	-	49	nC
Gate-Source Charge	$Q_{gs}$			-	-	13	
Gate-Drain Charge	$Q_{gd}$			-	-	20	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 300\text{ V}, I_D = 9.2\text{ A}$ $R_g = 9.1\text{ }\Omega, R_D = 35.5\text{ }\Omega,$ see fig. 10 <sup>b</sup>	-	13	-	ns	
Rise Time	$t_r$		-	25	-		
Turn-Off Delay Time	$t_{d(off)}$		-	30	-		
Fall Time	$t_f$		-	22	-		
Gate Input Resistance	$R_g$		$f = 1\text{ MHz},$ open drain	0.5	-		3.2
<b>Drain-Source Body Diode Characteristics</b>							
Continuous Source-Drain Diode Current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode 	-	-	9.2	A	
Pulsed Diode Forward Current <sup>a</sup>	$I_{SM}$		-	-	37		
Body Diode Voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = 9.2\text{ A}, V_{GS} = 0\text{ V}^b$	-	-	1.5	V	
Body Diode Reverse Recovery Time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}, I_F = 9.2\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$	-	530	800	ns	
Body Diode Reverse Recovery Charge	$Q_{rr}$		-	3.0	4.4	$\mu\text{C}$	
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  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- c.  $C_{oss\text{ effective}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .



TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

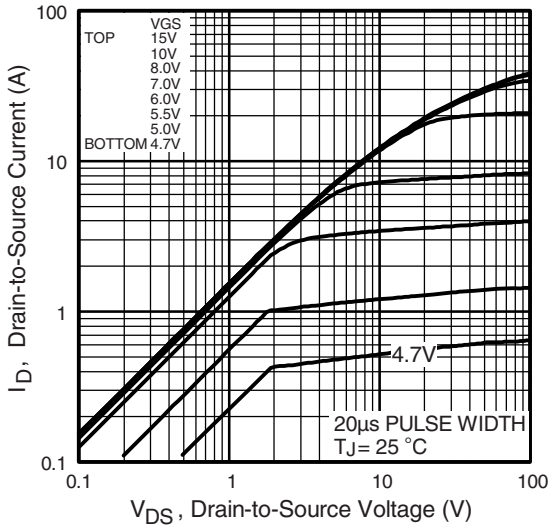


Fig. 1 - Typical Output Characteristics

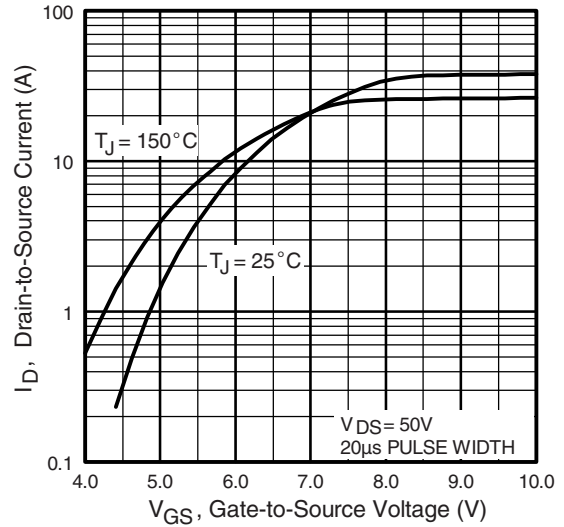


Fig. 3 - Typical Transfer Characteristics

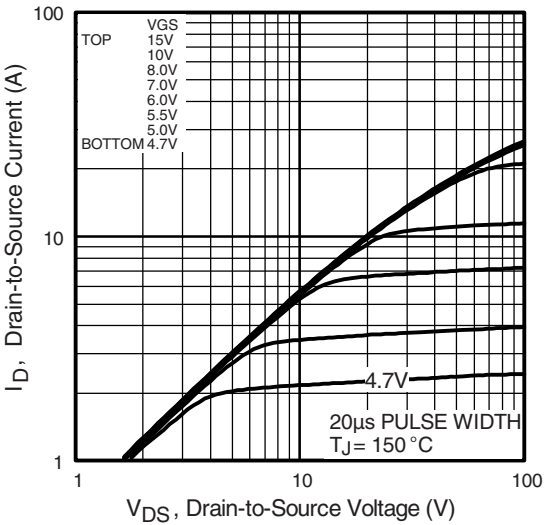


Fig. 2 - Typical Output Characteristics

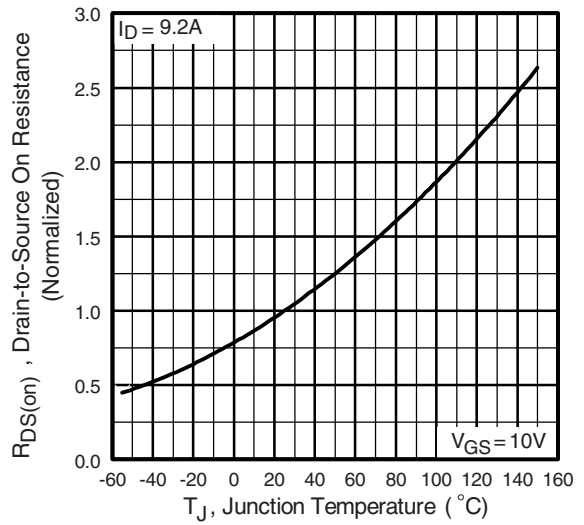


Fig. 4 - Normalized On-Resistance vs. Temperature

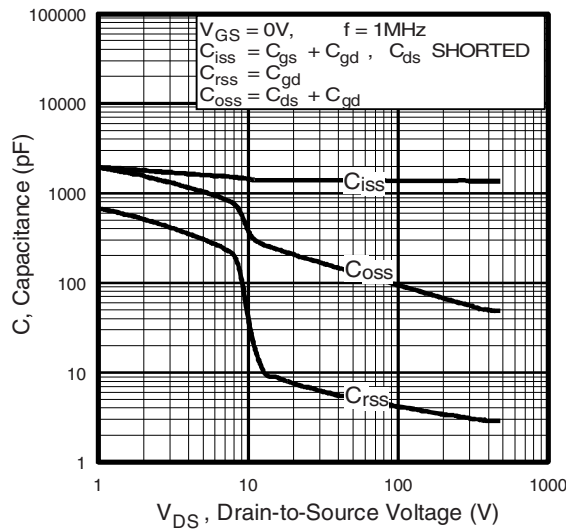


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

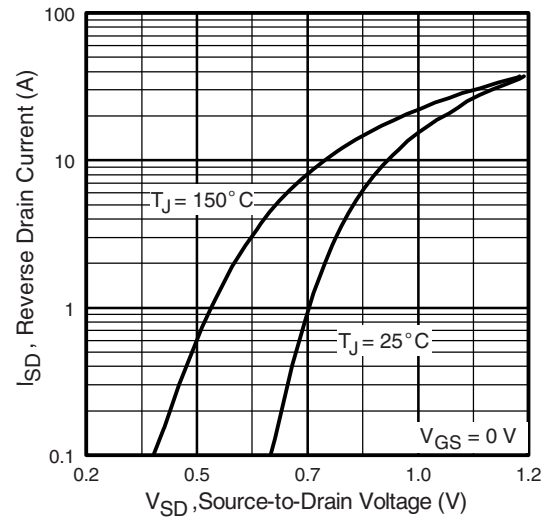


Fig. 7 - Typical Source-Drain Diode Forward Voltage

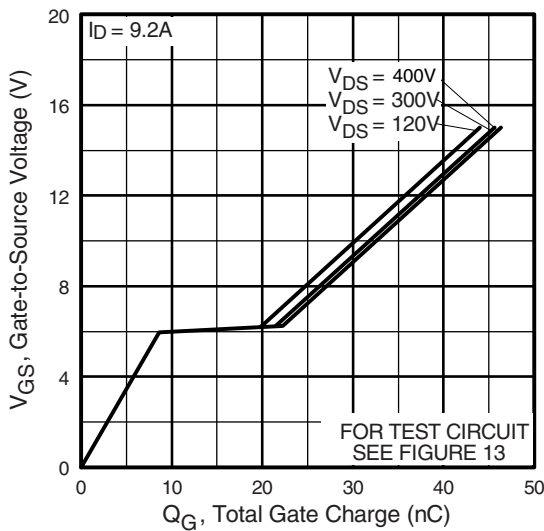


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

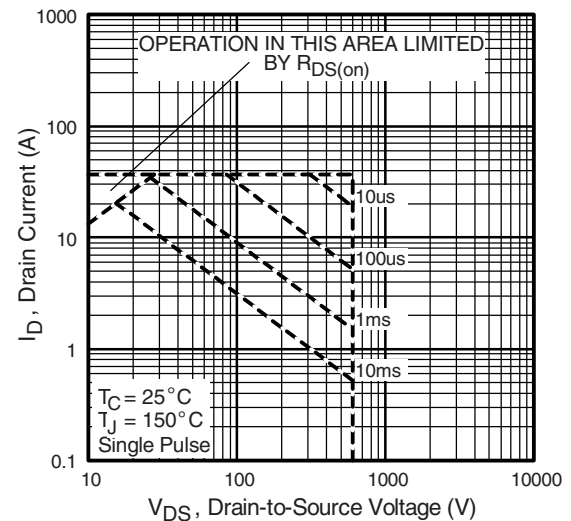


Fig. 8 - Maximum Safe Operating Area

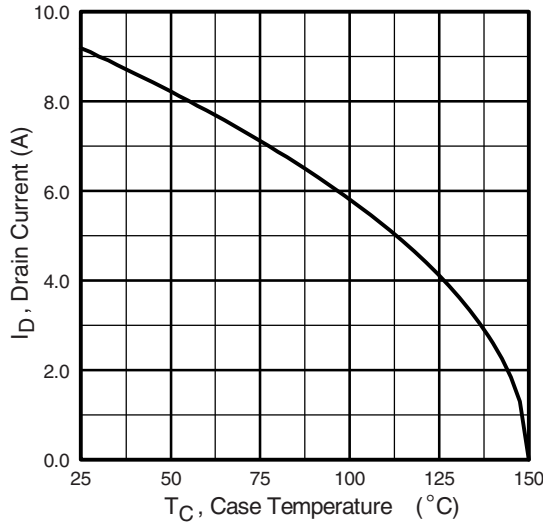


Fig. 9 - Maximum Drain Current vs. Case Temperature

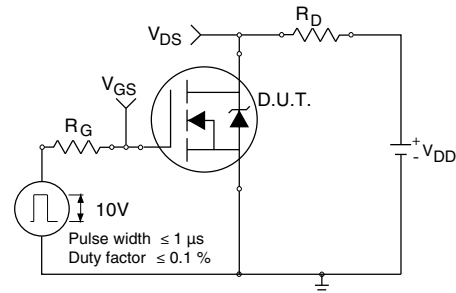


Fig. 10a - Switching Time Test Circuit

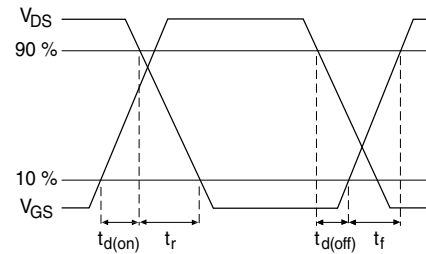


Fig. 10b - Switching Time Waveforms

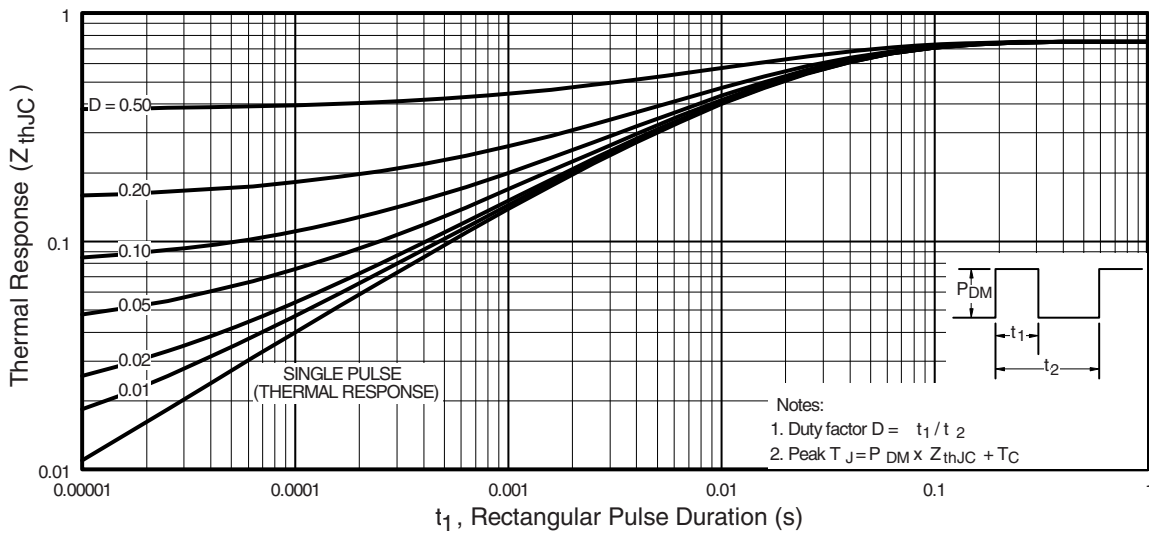


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

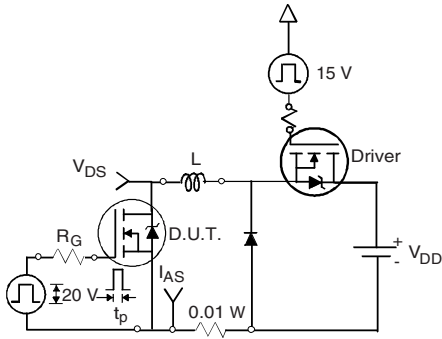


Fig. 12a - Unclamped Inductive Test Circuit

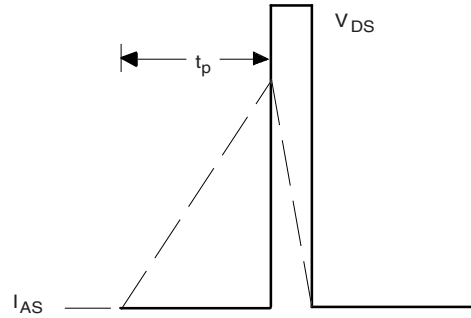


Fig. 12b - Unclamped Inductive Waveforms

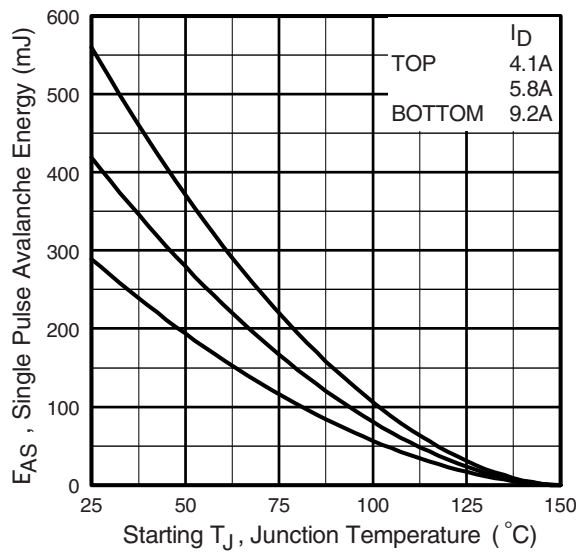


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

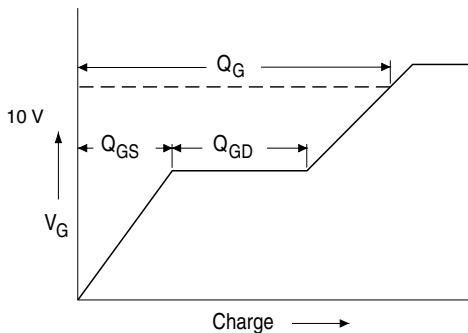


Fig. 13a - Basic Gate Charge Waveform

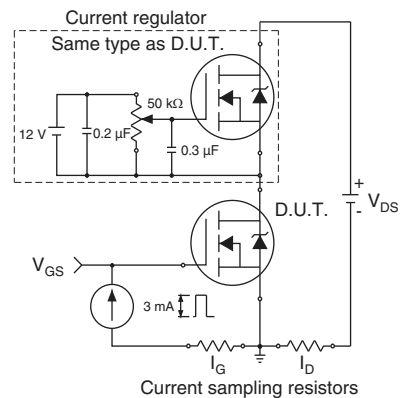
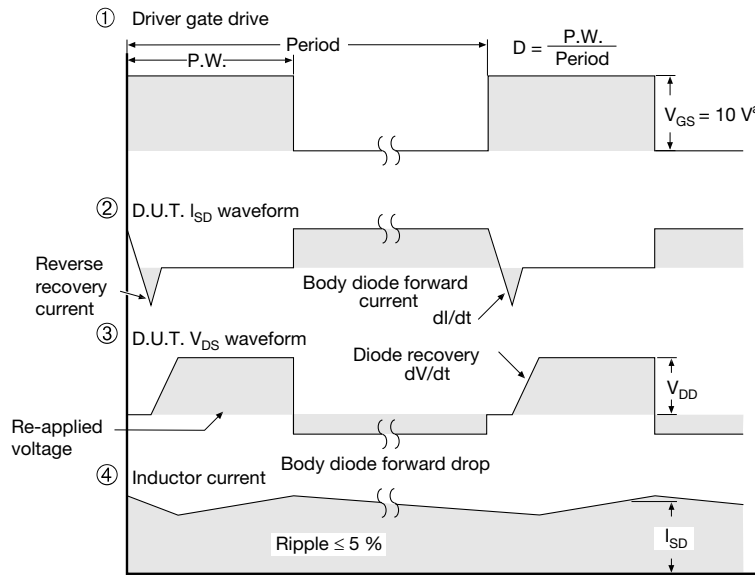
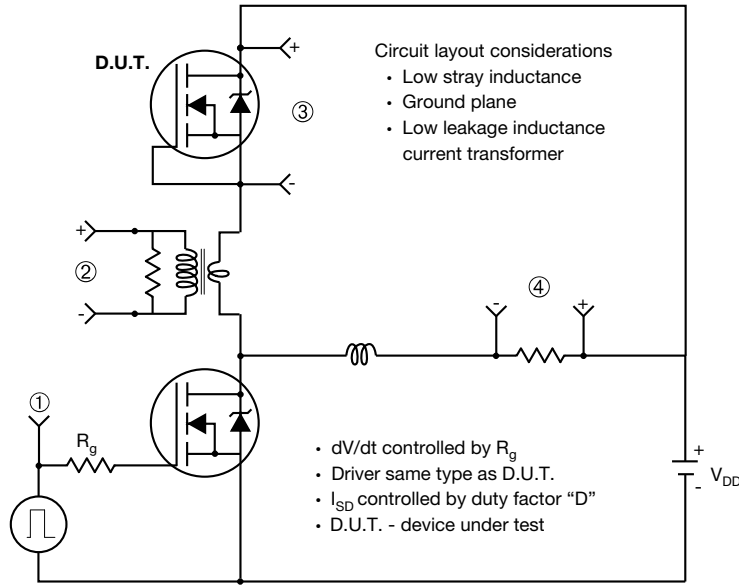


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



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

Fig. 14 - For N-Channel

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TO-220-1



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.24	4.65	0.167	0.183
b	0.69	1.02	0.027	0.040
b(1)	1.14	1.78	0.045	0.070
c	0.36	0.61	0.014	0.024
D	14.33	15.85	0.564	0.624
E	9.96	10.52	0.392	0.414
e	2.41	2.67	0.095	0.105
e(1)	4.88	5.28	0.192	0.208
F	1.14	1.40	0.045	0.055
H(1)	6.10	6.71	0.240	0.264
J(1)	2.41	2.92	0.095	0.115
L	13.36	14.40	0.526	0.567
L(1)	3.33	4.04	0.131	0.159
Ø P	3.53	3.94	0.139	0.155
Q	2.54	3.00	0.100	0.118

ECN: X15-0364-Rev. C, 14-Dec-15  
DWG: 6031

Note

- M\* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM







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