



## Power MOSFET

PRODUCT SUMMARY	
$V_{DS}$ (V)	250 V
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10\text{ V}$ 0.240
$Q_g$ (Max.) (nC)	54
$Q_{gs}$ (nC)	9.2
$Q_{gd}$ (nC)	26
Configuration	Single

### FEATURES

- Advanced Process Technology
- Dynamic  $dV/dt$  Rating
- 175 °C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Ease of Paralleling
- Simple Drive Requirements
- Lead (Pb)-free Available

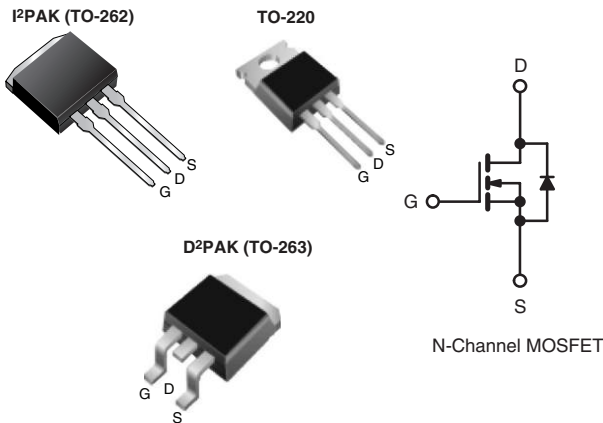


### DESCRIPTION

Fifth 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 TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.

The D<sup>2</sup>PAK is a surface mount power package capable of accommodating die sizes 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 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	TO-220	D <sup>2</sup> PAK (TO-263)	D <sup>2</sup> PAK (TO-263)	D <sup>2</sup> PAK (TO-263)	I <sup>2</sup> PAK (TO-262)
Lead (Pb)-free	IRF644NPbF	IRF644NSPbF	IRF644NSTRLPbF <sup>a</sup>	IRF644NSTRRPbF <sup>a</sup>	IRF644NLPbF
	SiHF644N-E3	SiHF644NS-E3	SiHF644NSTL-E3 <sup>a</sup>	SiHF644NSTR-E3 <sup>a</sup>	SiHF644NL-E3
SnPb	IRF644N	IRF644NS	IRF644NSTRL <sup>a</sup>	IRF644NSTR <sup>a</sup>	IRF644NL
	SiHF644N	SiHF644NS	SiHF644NSTL <sup>a</sup>	SiHF644NSTR <sup>a</sup>	SiHF644NL

**Note**

a. See device orientation.

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

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	$I_D$	$T_C = 25\text{ }^\circ\text{C}$	A
			$T_C = 100\text{ }^\circ\text{C}$	
Pulsed Drain Current <sup>a</sup>		$I_{DM}$	56	
Linear Derating Factor			1.0	W/ $^\circ\text{C}$
Single Pulse Avalanche Energy <sup>b</sup>		$E_{AS}$	180 <sup>e</sup>	mJ
Avalanche Current		$I_{AR}$	8.4	A
Repetitive Avalanche Energy		$E_{AR}$	15	mJ
Maximum Power Dissipation		$P_D$	150	W
Peak Diode Recovery $dV/dt$ <sup>c</sup>		$dV/dt$	7.9	V/ns
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	- 55 to + 175	$^\circ\text{C}$
Soldering Recommendations (Peak Temperature)		for 10 s	300 <sup>d</sup>	
Mounting Torque	6-32 or M3 screw		10	lbf · in
			1.1	N · m

**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- b. Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 5.0\text{ }\mu\text{H}$ ,  $R_G = 25\text{ }\Omega$ ,  $I_{AS} = 8.4\text{ A}$  (see fig. 12).
- c.  $I_{SD} \leq 8.4\text{ A}$ ,  $dl/dt \leq 378\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ }^\circ\text{C}$ .
- d. 1.6 mm from case.
- e. This is a calculated value limited to  $T_J = 175\text{ }^\circ\text{C}$ .

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient <sup>c</sup>	$R_{thJA}$	-	62	$^\circ\text{C}/\text{W}$
Case-to-Sink, Flat, Greased Surface <sup>c</sup>	$R_{thCS}$	0.50	-	
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	1.0	
Maximum Junction-to-Ambient (PCB Mount) <sup>d</sup>	$R_{thJA}$	-	40	

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	$V_{DS}$	$V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$	250	-	-	V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$	-	0.33	-	V/ $^\circ\text{C}$
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	$I_{GSS}$	$V_{GS} = 20\text{ V}$	-	-	$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 250\text{ V}$ , $V_{GS} = 0\text{ V}$	-	-	25	$\mu\text{A}$
		$V_{DS} = 200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$	-	-	250	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$ , $I_D = 8.4\text{ A}^b$	-	-	0.240	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS} = 50\text{ V}$ , $I_D = 8.4\text{ A}^b$	8.8	-	-	S



SPECIFICATIONS $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX. UNIT	
<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		-	1060	-	pF
Output Capacitance	$C_{oss}$			-	140	-	
Reverse Transfer Capacitance	$C_{rss}$			-	38	-	
Total Gate Charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 8.4\text{ A}$ , $V_{DS} = 200\text{ V}$ , see fig. 6 and 13 <sup>b</sup>	-	-	54	nC
Gate-Source Charge	$Q_{gs}$			-	-	9.2	
Gate-Drain Charge	$Q_{gd}$			-	-	26	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 125\text{ V}$ , $I_D = 8.4\text{ A}$ , $R_G = 6.2\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ , see fig. 10 <sup>b</sup>		-	10	-	ns
Rise Time	$t_r$			-	21	-	
Turn-Off Delay Time	$t_{d(off)}$			-	30	-	
Fall Time	$t_f$			-	17	-	
Internal Drain Inductance	$L_D$	Between lead, 6 mm (0.25") from package and center of die contact		-	4.5	-	nH
Internal Source Inductance	$L_S$			-	7.5	-	
<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	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_S = 14\text{ A}$ , $V_{GS} = 0\text{ V}$ <sup>b</sup>		-	-	1.3	V
Body Diode Reverse Recovery Time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = 14\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}$ <sup>b</sup>		-	165	250	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			-	1.0	1.6	$\mu\text{C}$
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  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- c. This is only applied to TO-220 package.
- d. When mounted on 1" square PCB (fr-4 or G-10 material).

**TYPICAL CHARACTERISTICS**  $25\text{ }^\circ\text{C}$ , unless otherwise noted

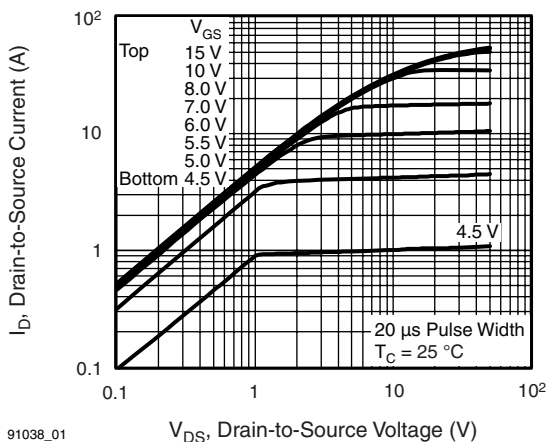


Fig. 1 - Typical Output Characteristics

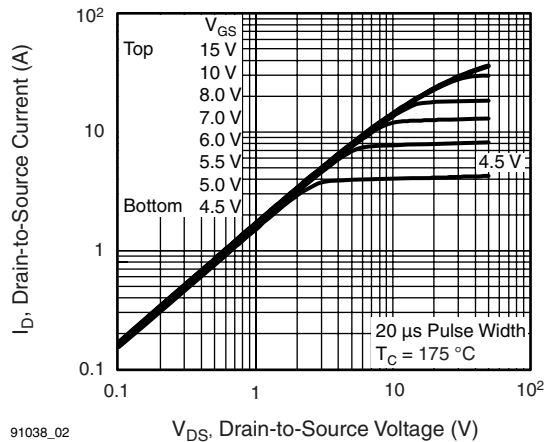


Fig. 2 - Typical Output Characteristics

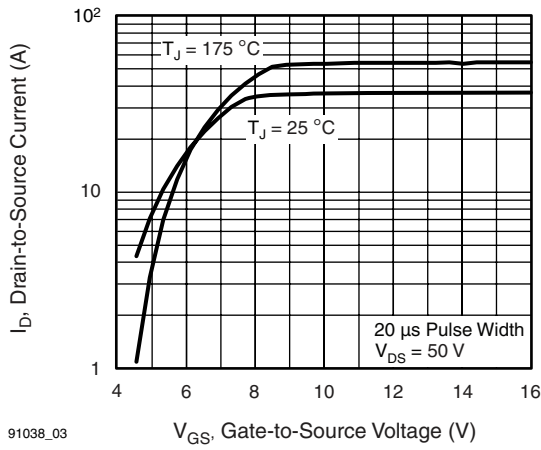


Fig. 3 - Typical Transfer Characteristics

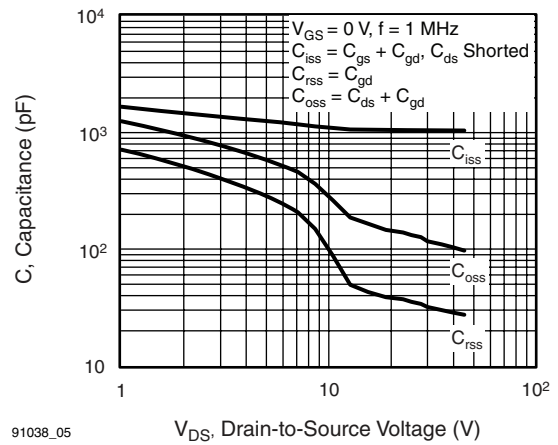


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

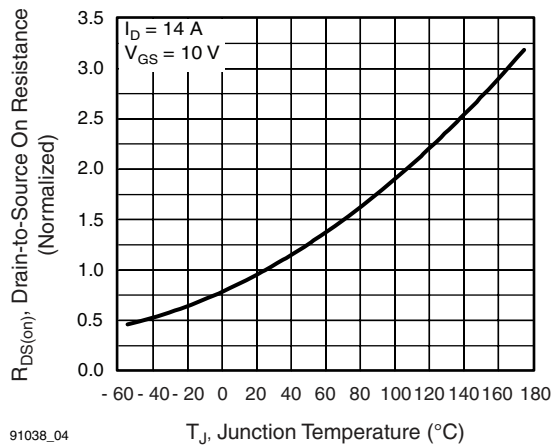


Fig. 4 - Normalized On-Resistance vs. Temperature

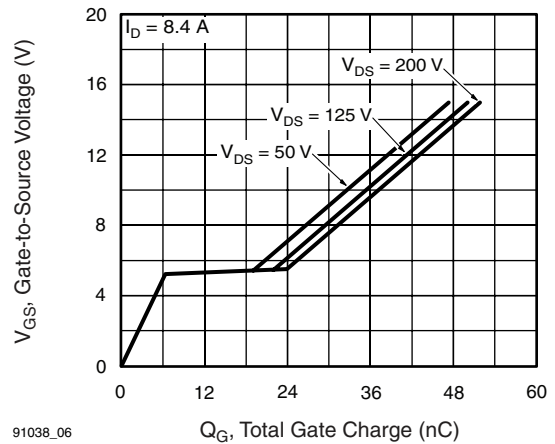
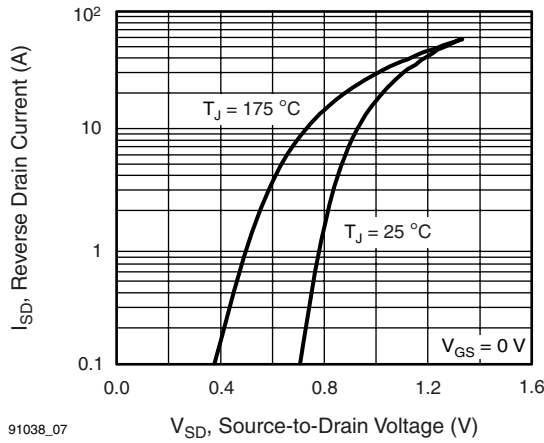
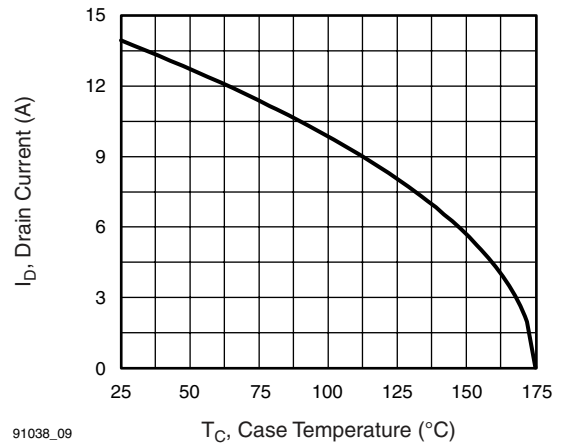


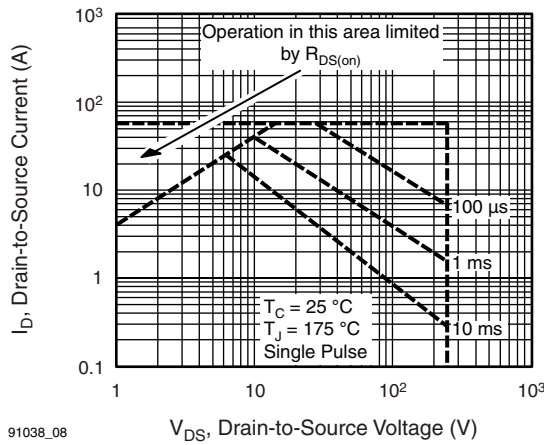
Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage



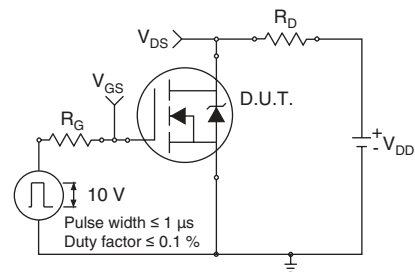
**Fig. 7 - Typical Source-Drain Diode Forward Voltage**



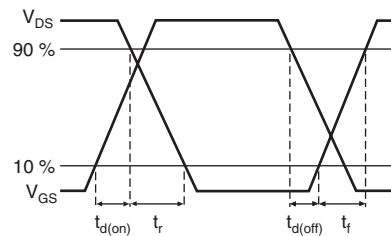
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



**Fig. 8 - Maximum Safe Operating Area**



**Fig. 10a - Switching Time Test Circuit**



**Fig. 10b - Switching Time Waveforms**

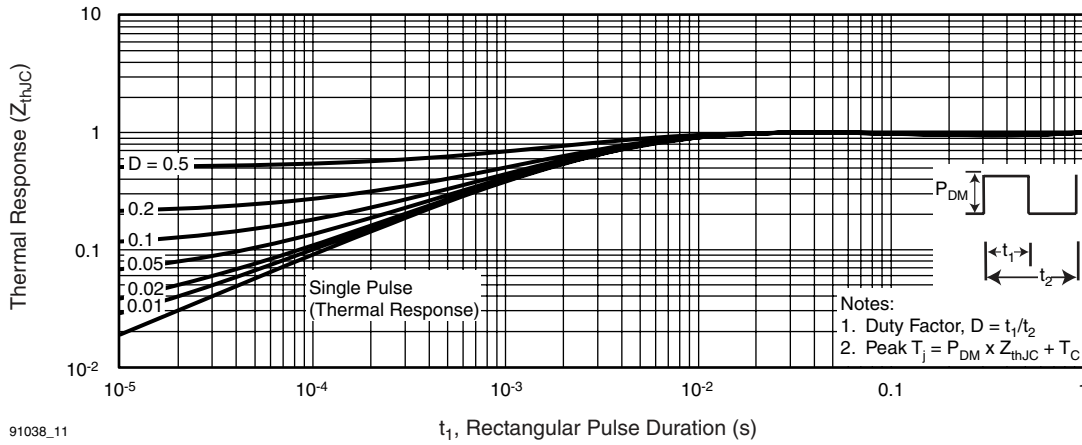


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

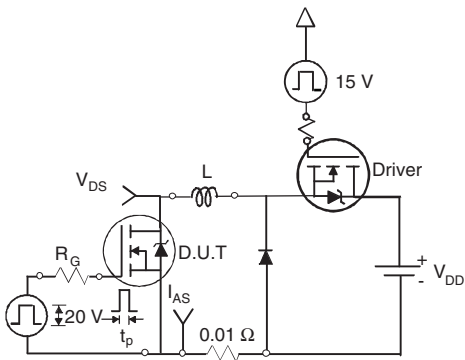


Fig. 12a - Unclamped Inductive Test Circuit

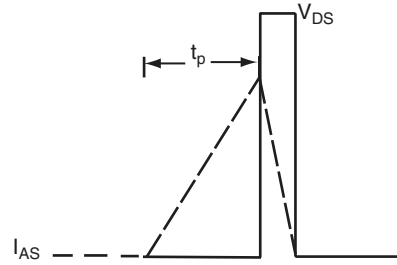


Fig. 12b - Unclamped Inductive Waveforms

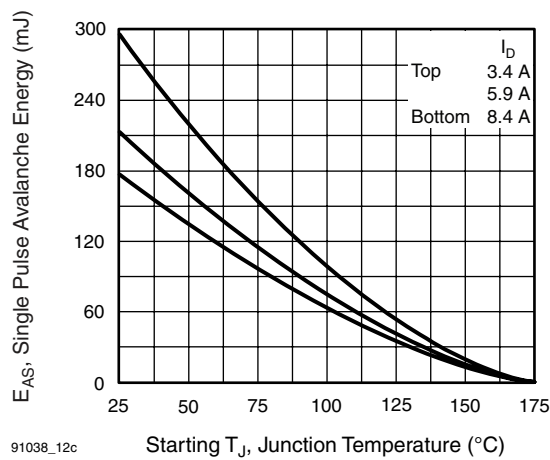


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

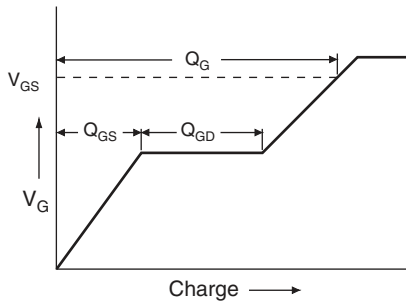


Fig. 13a - Basic Gate Charge Waveform

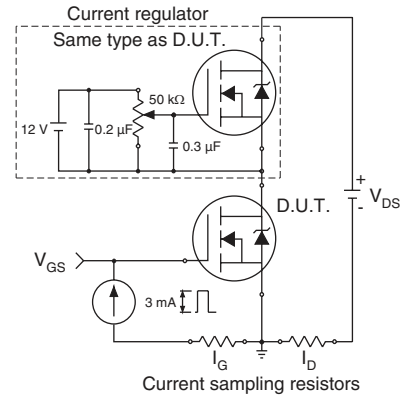
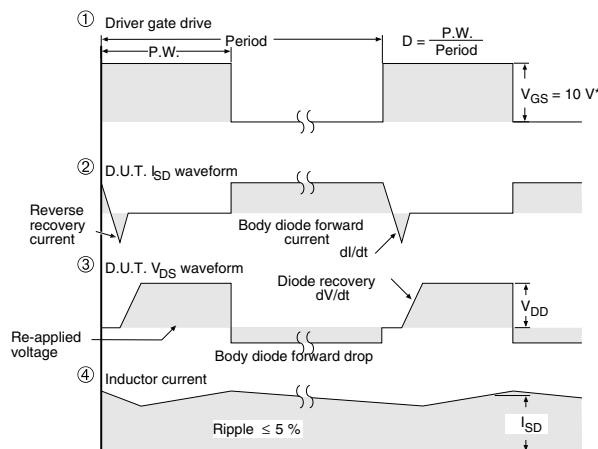
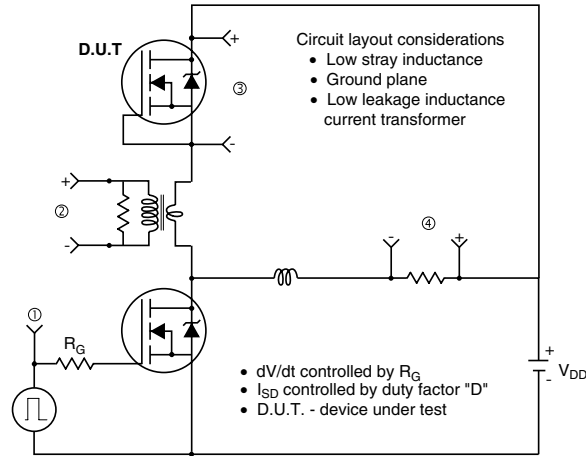


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



\*  $V_{GS} = 5V$  for logic level devices and  $3V$  drive devices

Fig. 14 - For N-Channel

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