

## Power MOSFET

PRODUCT SUMMARY	
V <sub>DS</sub> (V)	400
R <sub>DS(on)</sub> (Ω)	V <sub>GS</sub> = 10 V 3.6
Q <sub>g</sub> (Max.) (nC)	12
Q <sub>gs</sub> (nC)	1.9
Q <sub>gd</sub> (nC)	6.5
Configuration	Single

### FEATURES

- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- Surface Mount (IRFR310/SiHFR310)
- Straight Lead (IRFU310/SiHFU310)
- Available in Tape and Reel
- Fast Switching
- Fully Avalanche Rated
- Lead (Pb)-free Available



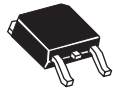
Available  
**RoHS\***  
COMPLIANT

### DESCRIPTION

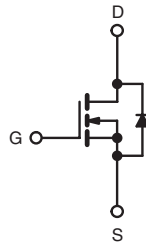
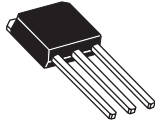
Third generation Power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The 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.

DPAK  
(TO-252)



IPAK  
(TO-251)



N-Channel MOSFET

ORDERING INFORMATION					
Package	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	IPAK (TO-251)
Lead (Pb)-free	IRFR310PbF	IRFR310TRLPbF <sup>a</sup>	IRFR310TRPbF <sup>a</sup>	IRFR310TRRPbF <sup>a</sup>	IRFU310PbF
	SiHFR310-E3	SiHFR310TL-E3 <sup>a</sup>	SiHFR310T-E3 <sup>a</sup>	SiHFR310TR-E3 <sup>a</sup>	SiHFU310-E3
SnPb	IRFR310	IRFR310TRL <sup>a</sup>	IRFR310TR <sup>a</sup>	-	IRFU310
	SiHFR310	SiHFR310TL <sup>a</sup>	SiHFR310T <sup>a</sup>	-	SiHFU310

#### Note

a. See device orientation.

ABSOLUTE MAXIMUM RATINGS T <sub>C</sub> = 25 °C, unless otherwise noted			
PARAMETER	SYMBOL	LIMIT	UNIT
Drain-Source Voltage	V <sub>DS</sub>	400	V
Gate-Source Voltage	V <sub>GS</sub>	± 20	
Continuous Drain Current	V <sub>GS</sub> at 10 V	T <sub>C</sub> = 25 °C	A
		T <sub>C</sub> = 100 °C	
Pulsed Drain Current <sup>a</sup>	I <sub>DM</sub>	6.0	W/°C
Linear Derating Factor		0.20	
Linear Derating Factor (PCB Mount) <sup>e</sup>		0.020	
Single Pulse Avalanche Energy <sup>b</sup>	E <sub>AS</sub>	86	mJ
Repetitive Avalanche Current <sup>a</sup>	I <sub>AR</sub>	1.7	A
Repetitive Avalanche Energy <sup>a</sup>	E <sub>AR</sub>	2.5	mJ
Maximum Power Dissipation	P <sub>D</sub>	T <sub>C</sub> = 25 °C	W
		T <sub>A</sub> = 25 °C	
Peak Diode Recovery dV/dt <sup>c</sup>	dV/dt	4.0	V/ns
Operating Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	- 55 to + 150	°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<sub>DD</sub> = 50 V, starting T<sub>J</sub> = 25 °C, L = 52 mH, R<sub>G</sub> = 25 Ω, I<sub>AS</sub> = 1.7 A (see fig. 12).
- I<sub>SD</sub> ≤ 1.7 A, di/dt ≤ 40 A/μs, V<sub>DD</sub> ≤ V<sub>DS</sub>, T<sub>J</sub> ≤ 150 °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	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient (PCB Mounted, steady-state) <sup>a</sup>	$R_{thJA}$	-	50	°C/W
Maximum Junction-to-Ambient	$R_{thJA}$	-	110	
Maximum Junction-to-Case	$R_{thJC}$	-	5.0	

### 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	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$		400	-	- V	
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$		-	0.47	- V/°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	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}$		-	-	$\pm 100$ nA	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}$		-	-	25 $\mu\text{A}$	
		$V_{DS} = 320\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$		-	-	250 $\mu\text{A}$	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 1.0\text{ A}^b$	-	-	3.6 $\Omega$	
Forward Transconductance	$g_{fs}$	$V_{DS} = 50\text{ V}, I_D = 1.0\text{ A}^b$		0.97	-	- 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 <sup>c</sup>		-	170	-	pF
Output Capacitance	$C_{oss}$			-	34	-	
Reverse Transfer Capacitance	$C_{rss}$			-	6.3	-	
Total Gate Charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 2.0\text{ A}, V_{DS} = 320\text{ V}$ , see fig. 6 and 13 <sup>b, c</sup>	-	-	12	nC
Gate-Source Charge	$Q_{gs}$			-	-	1.9	
Gate-Drain Charge	$Q_{gd}$			-	-	6.5	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 200\text{ V}, I_D = 2.0\text{ A}, R_G = 24\text{ }\Omega, R_D = 95\text{ }\Omega$ , see fig. 10 <sup>b, c</sup>		-	7.9	-	ns
Rise Time	$t_r$			-	9.9	-	
Turn-Off Delay Time	$t_{d(off)}$			-	21	-	
Fall Time	$t_f$			-	11	-	
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		-	-	1.7	A
Pulsed Diode Forward Current <sup>a</sup>	$I_{SM}$			-	-	6.0	
Body Diode Voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = 1.7\text{ A}, V_{GS} = 0\text{ V}^b$		-	-	1.6	V
Body Diode Reverse Recovery Time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}, I_F = 2.0\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$		-	240	540	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			-	0.85	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

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

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

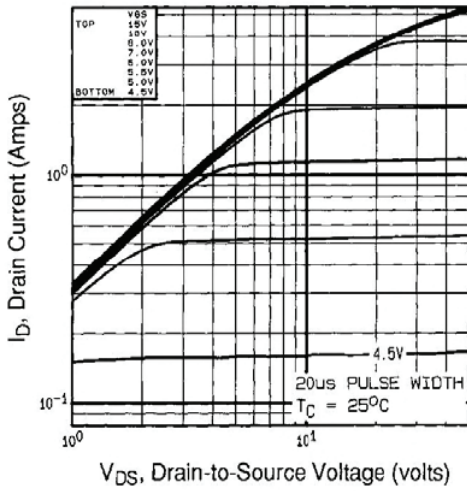


Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$

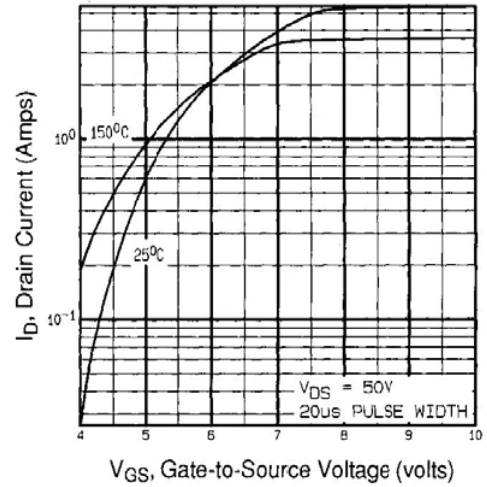


Fig. 3 - Typical Transfer Characteristics

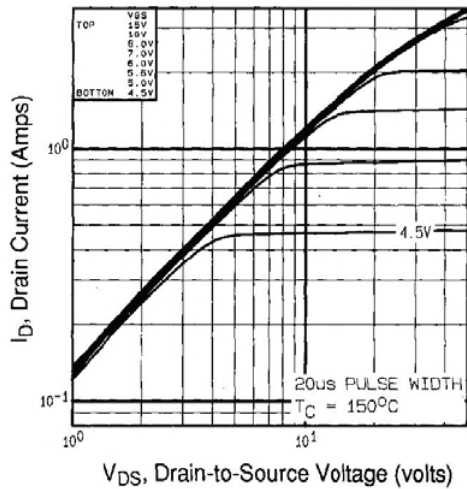


Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^\circ\text{C}$

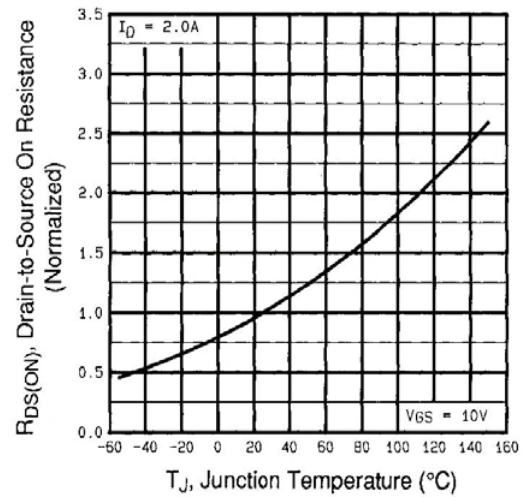


Fig. 4 - Normalized On-Resistance vs. Temperature

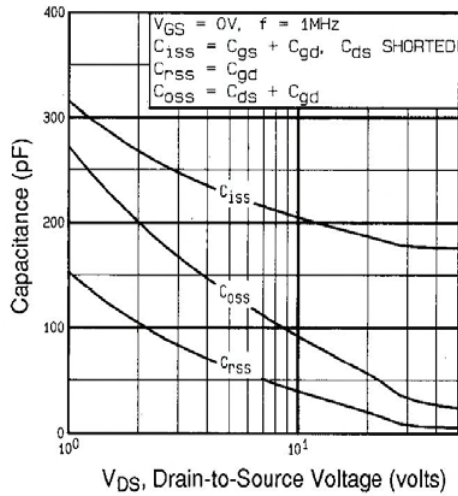


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

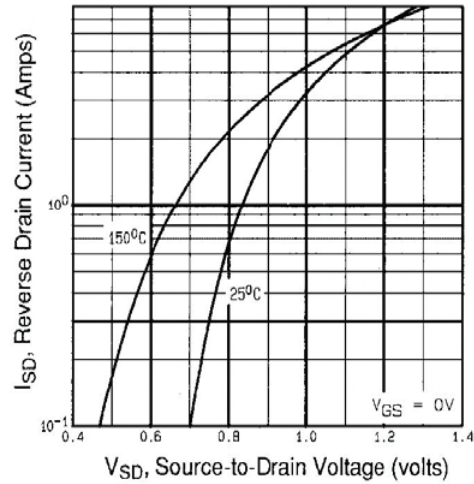


Fig. 7 - Typical Source-Drain Diode Forward Voltage

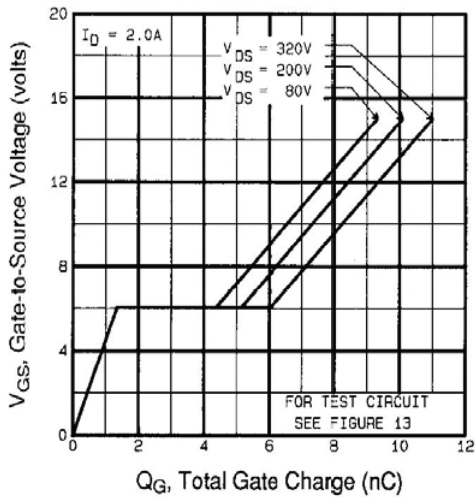


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

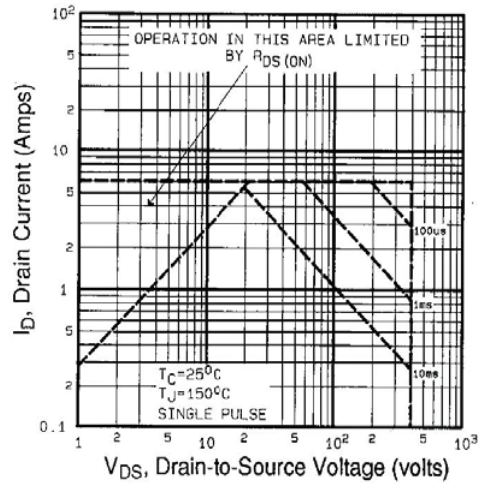


Fig. 8 - Maximum Safe Operating Area

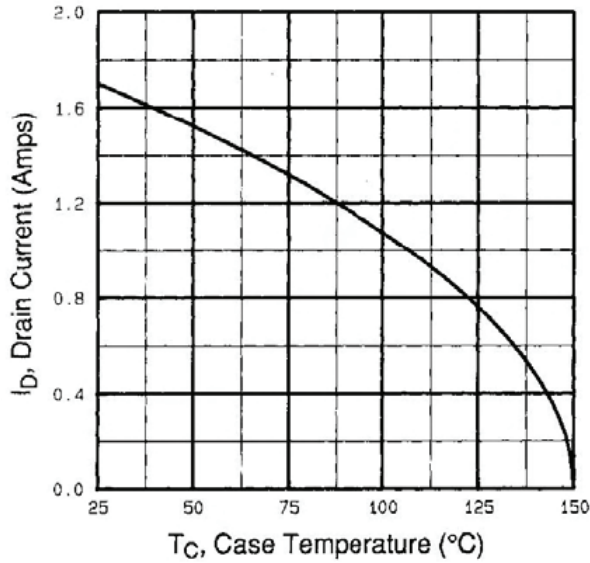


Fig. 9 - Maximum Drain Current vs. Case Temperature

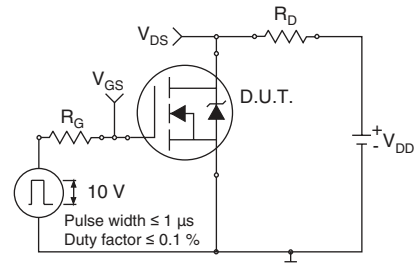


Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms

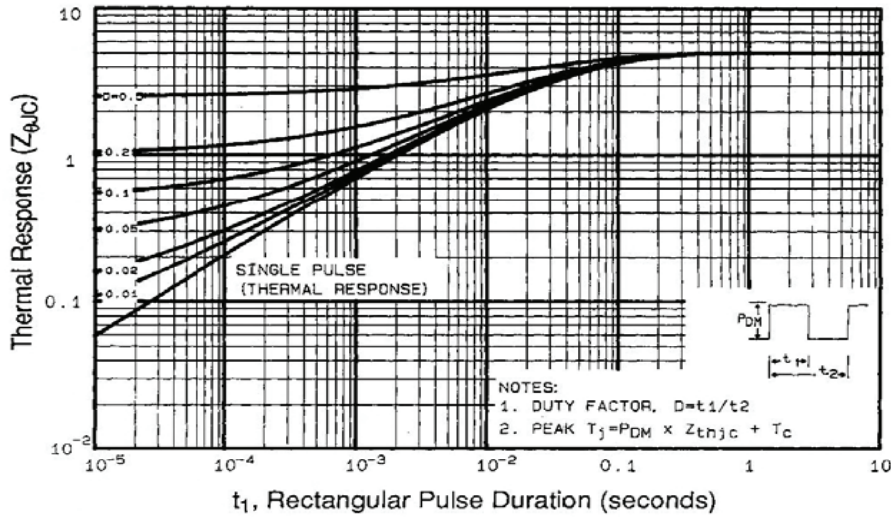


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

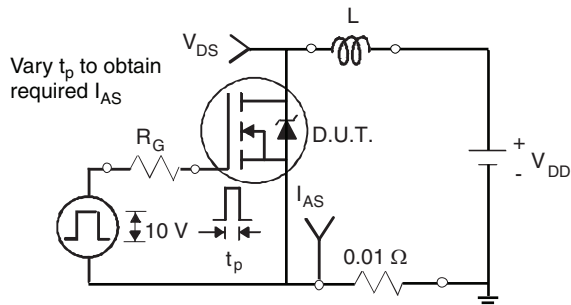


Fig. 12a - Unclamped Inductive Test Circuit

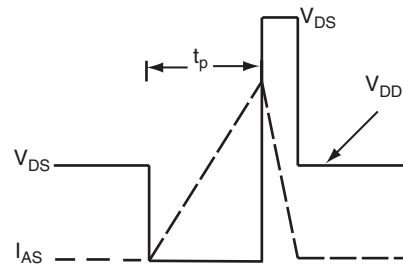


Fig. 12b - Unclamped Inductive Waveforms

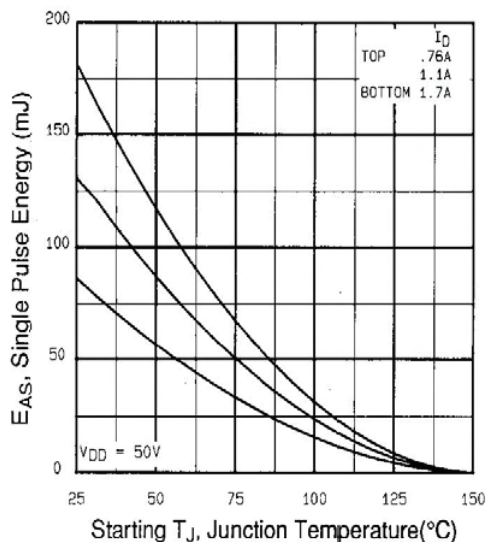


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

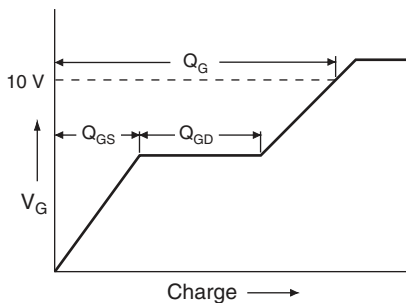


Fig. 13a - Basic Gate Charge Waveform

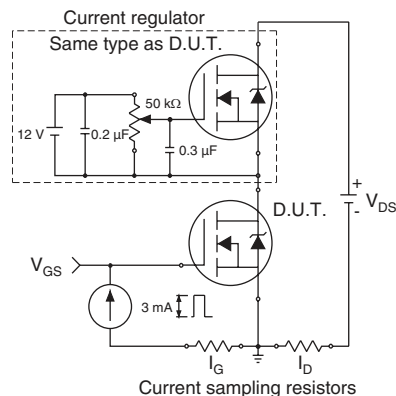
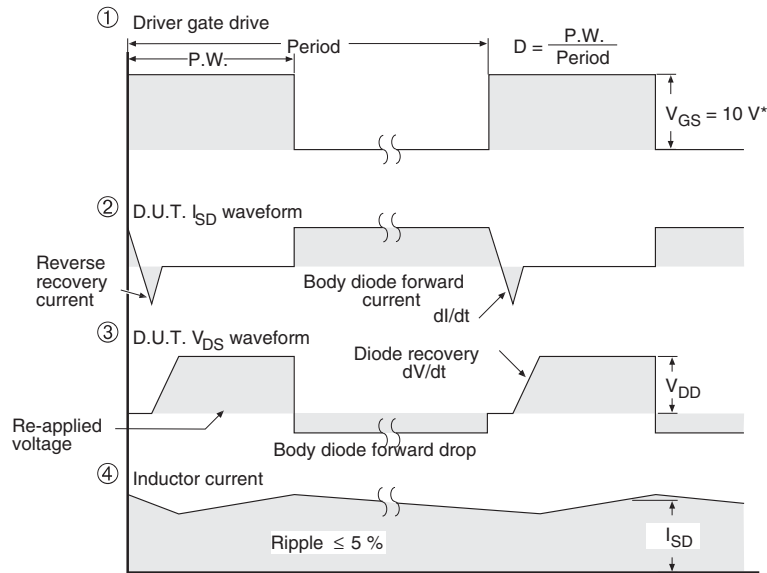
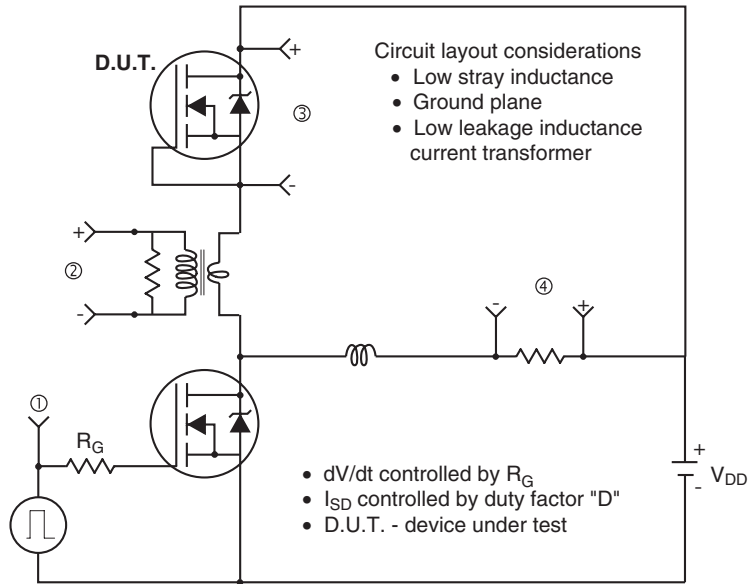


Fig. 13b - Gate Charge Test Circuit

## Peak Diode Recovery $dV/dt$ Test Circuit



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

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

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