

## Power MOSFET

PRODUCT SUMMARY		
$V_{DS}$ (V)	- 400	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = - 10$ V	7.0
$Q_g$ (Max.) (nC)	13	
$Q_{gs}$ (nC)	3.2	
$Q_{gd}$ (nC)	5.0	
Configuration	Single	

### FEATURES

- P-Channel
- Surface Mount (IRFR9310/SiHFR9310)
- Straight Lead (IRFU9310/SiHFU9310)
- Advanced Process Technology
- Fast Switching
- Fully Avalanche Rated
- Lead (Pb)-free Available

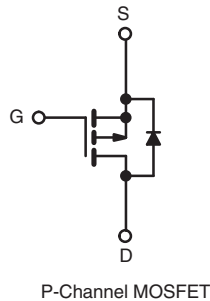
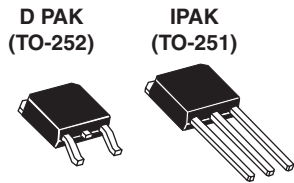


Available  
**RoHS\***  
COMPLIANT

### DESCRIPTION

Third generation Power MOSFETs from Vishay utilize advanced processing techniques to achieve 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 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.



ORDERING INFORMATION					
Package	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	DPAK (TO-252)	IPAK (TO-251)
Lead (Pb)-free	IRFR9310PbF	IRFR9310TRLPbF <sup>a</sup>	IRFR9310TRPbF <sup>a</sup>	IRFR9310TRRPbF <sup>a</sup>	IRFU9310PbF
	SiHFR9310-E3	SiHFR9310TLE3 <sup>a</sup>	SiHFR9310T-E3 <sup>a</sup>	SiHFR9310TR-E3 <sup>a</sup>	SiHFU9310-E3
SnPb	IRFR9310	IRFR9310TRL <sup>a</sup>	IRFR9310TR <sup>a</sup>	-	IRFU9310
	SiHFR9310	SiHFR9310TL <sup>a</sup>	SiHFR9310T <sup>a</sup>	-	SiHFU9310

#### Note

a. See device orientation.

ABSOLUTE MAXIMUM RATINGS $T_C = 25$ °C, unless otherwise noted					
PARAMETER			SYMBOL	LIMIT	UNIT
Drain-Source Voltage			$V_{DS}$	- 400	V
Gate-Source Voltage			$V_{GS}$	$\pm 20$	
Continuous Drain Current	$V_{GS}$ at - 10 V	$T_C = 25$ °C	$I_D$	- 1.8	A
		$T_C = 100$ °C		- 1.1	
Pulsed Drain Current <sup>a</sup>			$I_{DM}$	- 7.2	
Linear Derating Factor				0.40	W/°C
Single Pulse Avalanche Energy <sup>b</sup>			$E_{AS}$	92	mJ
Repetitive Avalanche Current <sup>a</sup>			$I_{AR}$	- 1.8	A
Repetitive Avalanche Energy <sup>a</sup>			$E_{AR}$	5.0	mJ
Maximum Power Dissipation	$T_C = 25$ °C		$P_D$	50	W
Peak Diode Recovery $dV/dt^c$			$dV/dt$	- 24	V/ns
Operating Junction and Storage Temperature Range			$T_J, T_{stg}$	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature)	for 10 s			300 <sup>d</sup>	

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting  $T_J = 25$  °C,  $L = 57$  mH,  $R_G = 25$   $\Omega$ ,  $I_{AS} = - 1.8$  A (see fig. 12).
- $I_{SD} \leq - 1.1$  A,  $dI/dt \leq 450$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150$  °C.
- 1.6 mm from case.

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

THERMAL RESISTANCE RATINGS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	$R_{thJA}$	-	-	110	°C/W
Maximum Junction-to-Ambient (PCB Mount) <sup>a</sup>	$R_{thJA}$	-	-	50	
Maximum Junction-to-Case (Drain)	$R_{thJC}$	-	-	2.5	

### Note

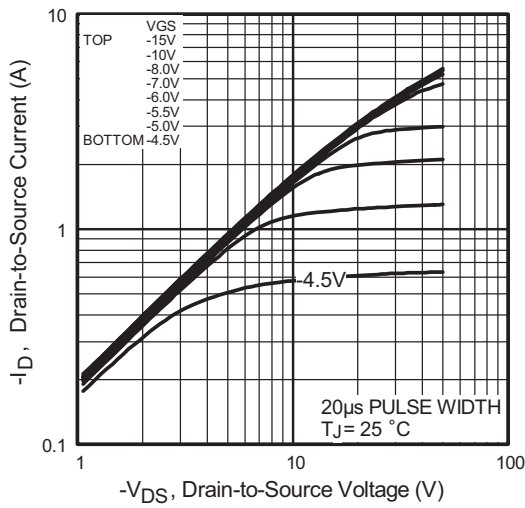
a. When mounted on 1" square PCB (FR-4 or G-10 material).

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 $25\text{ }^\circ\text{C}$ , $I_D = -1\text{ mA}$		-	-0.41	-	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	$I_{DSS}$	$V_{DS} = -400\text{ V}$ , $V_{GS} = 0\text{ V}$		-	-	-100	$\mu\text{A}$
		$V_{DS} = -320\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$		-	-	-500	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -1.1\text{ A}^b$	-	-	7.0	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS} = -50\text{ V}$ , $I_D = -1.1\text{ A}$		0.91	-	-	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		-	270	-	pF
Output Capacitance	$C_{oss}$			-	50	-	
Reverse Transfer Capacitance	$C_{rss}$			-	8.0	-	
Total Gate Charge	$Q_g$	$V_{GS} = -10\text{ V}$	$I_D = -1.1\text{ A}$ , $V_{DS} = -320\text{ V}$ , see fig. 6 and 13 <sup>b</sup>	-	-	13	nC
Gate-Source Charge	$Q_{gs}$			-	-	3.2	
Gate-Drain Charge	$Q_{gd}$			-	-	5.0	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -200\text{ V}$ , $I_D = -1.1\text{ A}$ , $R_G = 21\text{ }\Omega$ , $R_D = 180\text{ }\Omega$ , see fig. 10 <sup>b</sup>		-	11	-	ns
Rise Time	$t_r$			-	10	-	
Turn-Off Delay Time	$t_{d(off)}$			-	25	-	
Fall Time	$t_f$			-	24	-	
Internal Drain Inductance	$L_D$	Between lead, 6 mm (0.25") from package and center of die contact <sup>c</sup>		-	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		-	-	-1.9	A
Pulsed Diode Forward Current <sup>a</sup>	$I_{SM}$			-	-	-7.6	
Body Diode Voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_S = -1.1\text{ A}$ , $V_{GS} = 0\text{ V}^b$		-	-	-4.0	V
Body Diode Reverse Recovery Time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = -1.1\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}^b$		-	170	260	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			-	640	960	nC
Forward Turn-On Time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )					

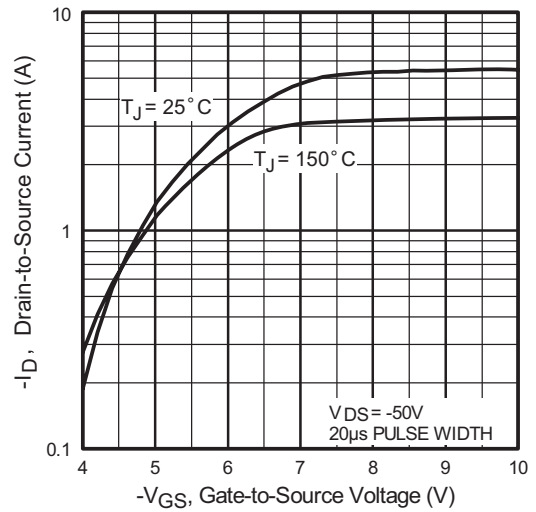
### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- This is applied for IPAK,  $L_S$  of DPAK is measured between lead and center of die contact.

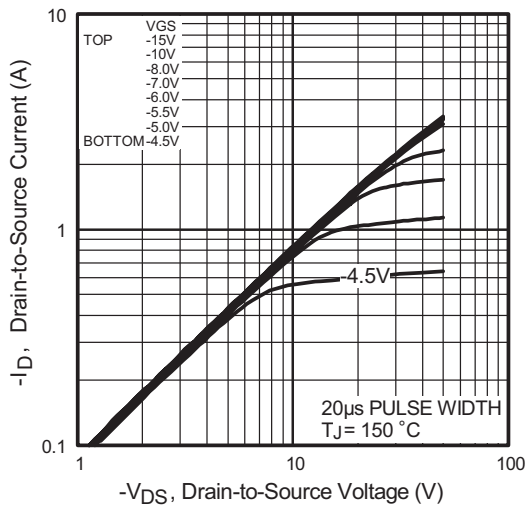
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



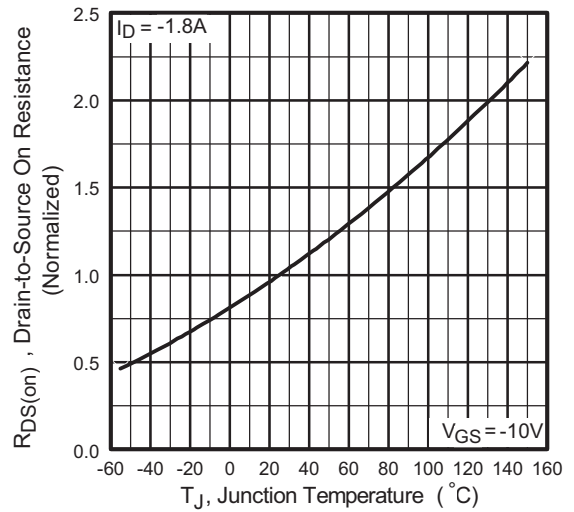
**Fig. 1 - Typical Output Characteristics**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics**



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

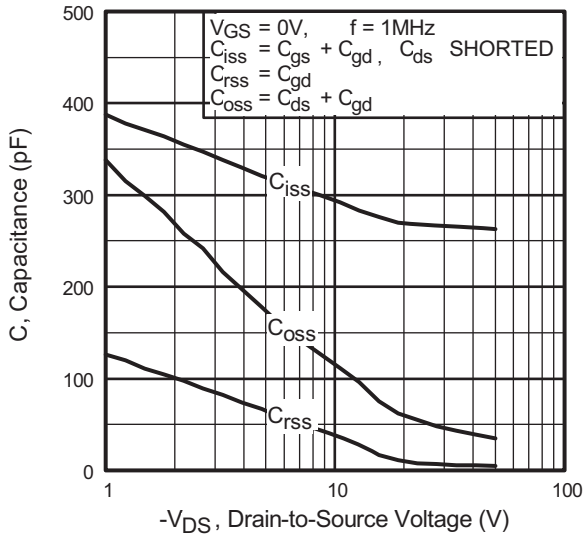


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

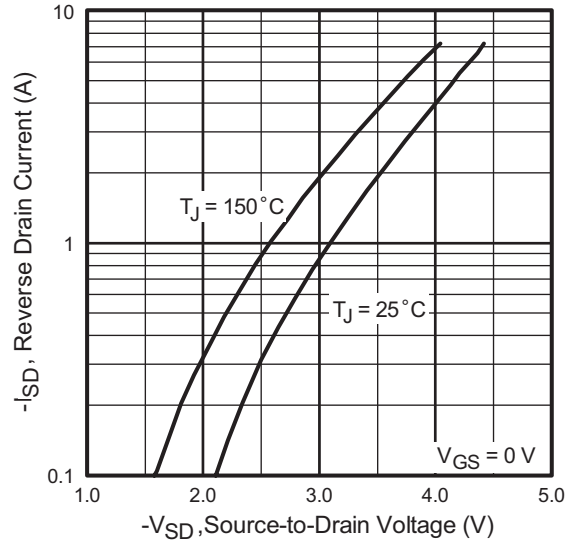


Fig. 7 - Typical Source-Drain Diode Forward Voltage

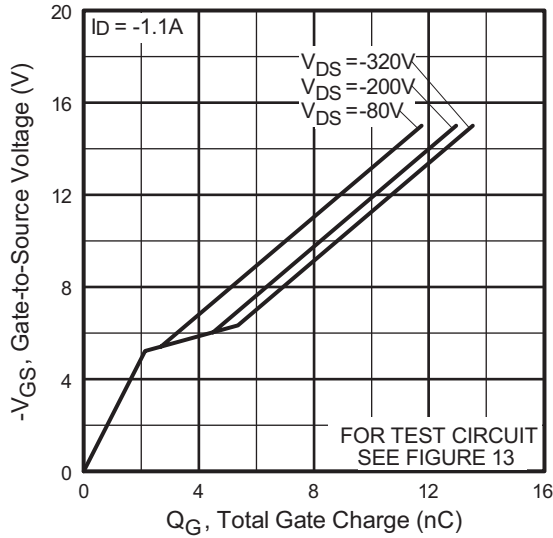


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

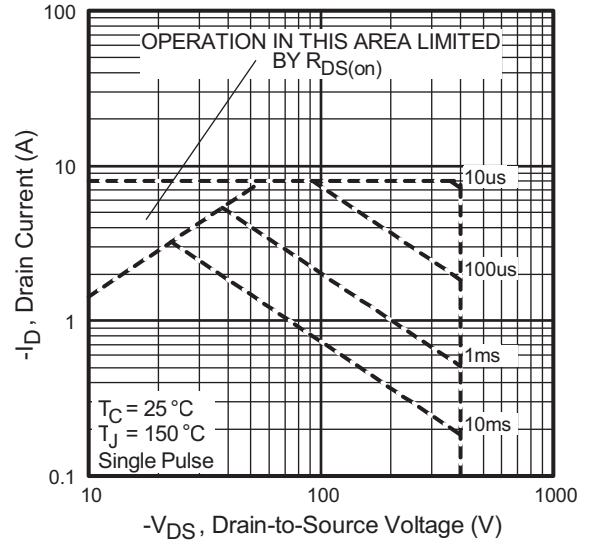
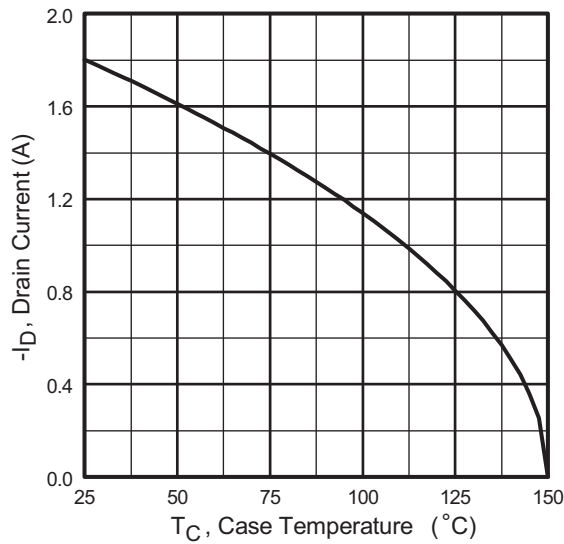
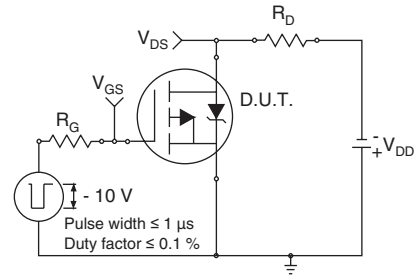


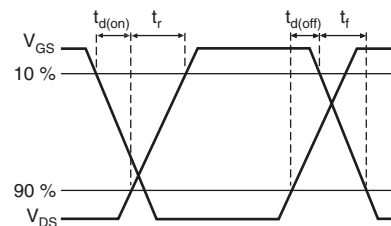
Fig. 8 - Maximum Safe Operating Area



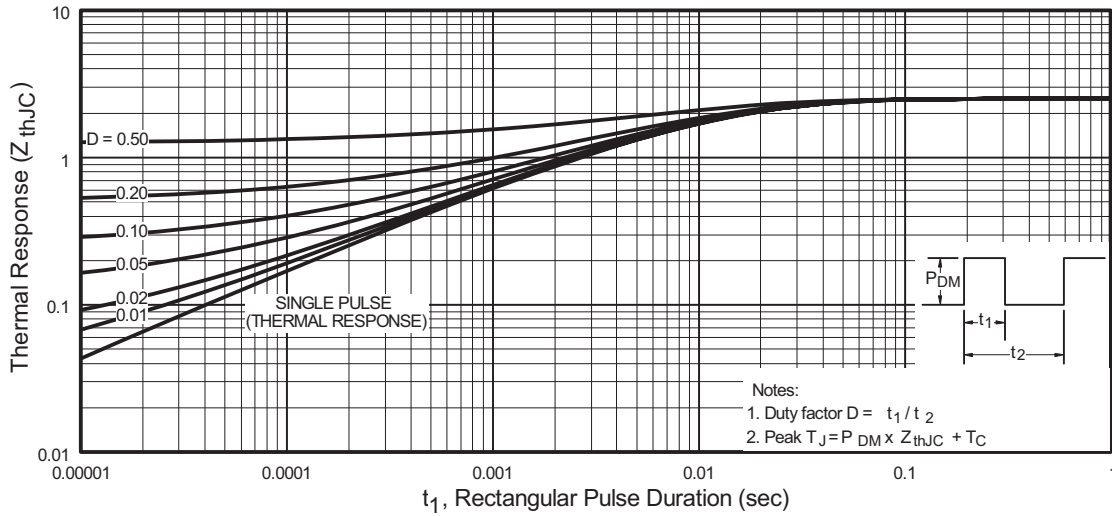
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



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



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



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

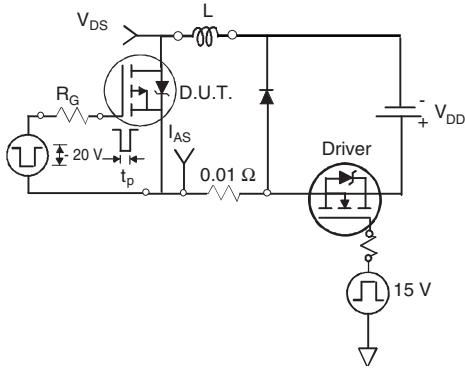


Fig. 12a - Unclamped Inductive Test Circuit

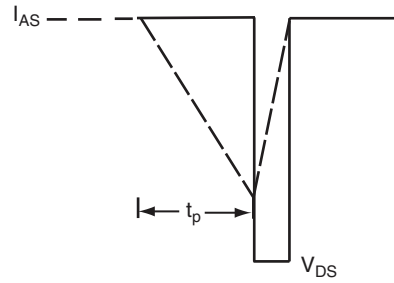


Fig. 12b - Unclamped Inductive Waveforms

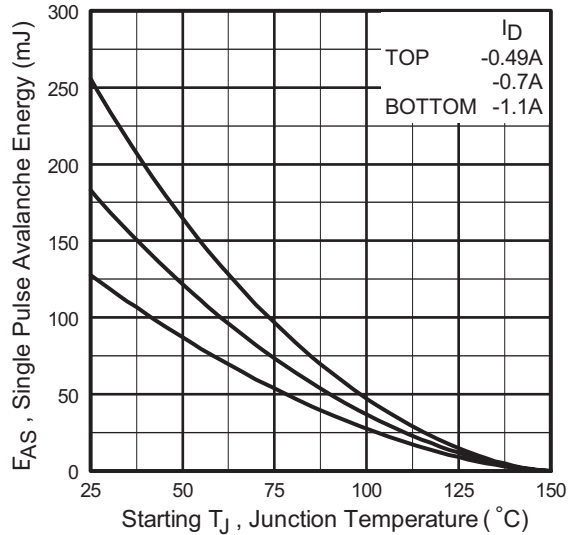


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

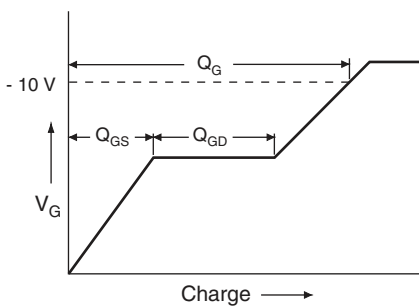


Fig. 13a - Basic Gate Charge Waveform

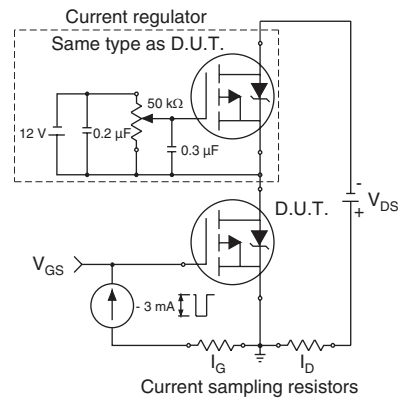
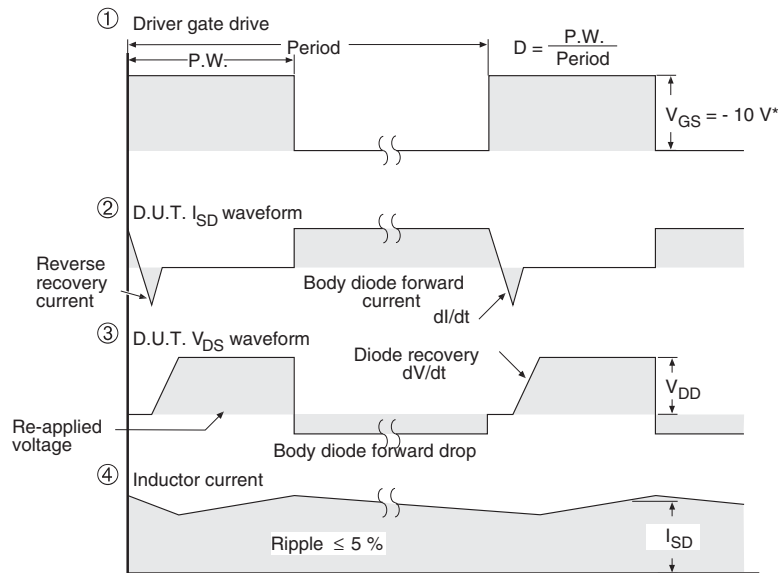
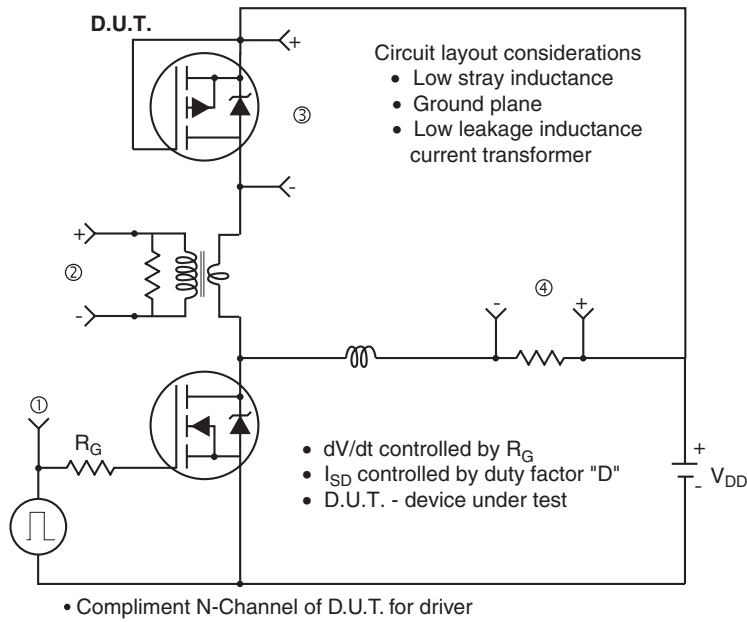


Fig. 13b - Gate Charge Test Circuit

## Peak Diode Recovery dV/dt Test Circuit



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

**Fig. 14 - For P-Channel**

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