

Power MOSFET

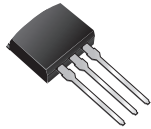
PRODUCT SUMMARY		
V_{DS} (V)	- 60	
$R_{DS(on)}$ (Ω)	$V_{GS} = -10$ V	0.28
Q_g (Max.) (nC)	19	
Q_{gs} (nC)	5.4	
Q_{gd} (nC)	11	
Configuration	Single	

FEATURES

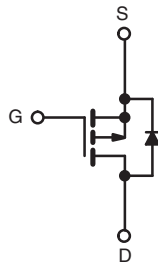
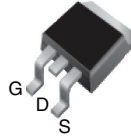
- Advanced Process Technology
- Surface Mount (IRF9Z24S/SiHF9Z24S)
- Low-Profile Through-Hole (IRF9Z24L/SiHF9Z24L)
- 175 °C Operating Temperature
- Fast Switching
- P-Channel
- Fully Avalanche Rated
- Lead (Pb)-free Available



I²PAK (TO-262)



D²PAK (TO-263)



P-Channel MOSFET

DESCRIPTION

Third 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 D²PAK is a surface mount power package capable of accommodating die size up to HEX-4. It provides the highest power capability and the lowest possible on-resistance in any existing surface mount package. The D²PAK 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.

The through-hole version (IR9Z24L/SiH9Z24L) is available for low-profile applications.

ORDERING INFORMATION

Package	D ² PAK (TO-263)	D ² PAK (TO-263)	D ² PAK (TO-263)	I ² PAK (TO-262)
Lead (Pb)-free	IRF9Z24SPbF	IRF9Z24STRLPbF ^a	IRF9Z24STRRPbF ^a	IRF9Z24LPbF
	SiHF9Z24S-E3	SiHF9Z24STL-E3 ^a	SiHF9Z24STR-E3 ^a	SiHF9Z24L-E3
SnPb	IRF9Z24S	IRF9Z24STRL ^a	IRF9Z24STRR ^a	IRF9Z24L
	SiHF9Z24S	SiHF9Z24STL ^a	SiHF9Z24STR ^a	SiHF9Z24L

Note

a. See device orientation.

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

PARAMETER	SYMBOL	LIMIT	UNIT	
Drain-Source Voltage	V_{DS}	- 60	V	
Gate-Source Voltage	V_{GS}	± 20		
Continuous Drain Current ^e	V_{GS} at - 10 V	$T_C = 25$ °C	- 11	A
		$T_C = 100$ °C	- 7.7	
Pulsed Drain Current ^{a, e}	I_{DM}	- 44		
Linear Derating Factor		0.40	W/°C	
Single Pulse Avalanche Energy ^{b, e}	E_{AS}	240	mJ	
Repetitive Avalanche Current ^a	I_{AR}	- 11	A	
Repetitive Avalanche Energy ^a	E_{AR}	6.0	mJ	

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

IRF9Z24S, IRF9Z24L, SiHF9Z24S, SiHF9Z24L

Vishay Siliconix



ABSOLUTE MAXIMUM RATINGS $T_C = 25\text{ }^\circ\text{C}$, unless otherwise noted				
PARAMETER		SYMBOL	LIMIT	UNIT
Maximum Power Dissipation	$T_A = 25\text{ }^\circ\text{C}$	P_D	3.7	W
	$T_C = 25\text{ }^\circ\text{C}$		60	W
Peak Diode Recovery dV/dt^c		dV/dt	- 4.5	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 ^d	


Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = -25\text{ V}$, starting $T_J = 25\text{ }^\circ\text{C}$, $L = 2.3\text{ mH}$, $R_G = 25\text{ }\Omega$, $I_{AS} = -11\text{ A}$ (see fig. 12).
- $I_{SD} \leq -11\text{ A}$, $dI/dt \leq 140\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{DS}$, $T_J \leq 175\text{ }^\circ\text{C}$.
- 1.6 mm from case.
- Uses IRF9Z24/SiHF9Z24 data and test conditions.

THERMAL RESISTANCE RATINGS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient (PCB Mount) ^a	R_{thJA}	-	-	40	$^\circ\text{C}/\text{W}$
Maximum Junction-to-Case (Drain)	R_{thJC}	-	-	2.5	

Note

- 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
Static							
Drain-Source Breakdown Voltage	V_{DS}	$V_{GS} = 0\text{ V}$, $I_D = -250\text{ }\mu\text{A}$		- 60	-	-	V
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$, $I_D = -1\text{ mA}^c$		-	- 0.056	-	$\text{V}/^\circ\text{C}$
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}	$V_{GS} = \pm 20\text{ V}$		-	-	± 100	nA
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = -60\text{ V}$, $V_{GS} = 0\text{ V}$		-	-	- 100	μA
		$V_{DS} = -48\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$		-	-	- 500	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -6.6\text{ A}^b$	-	-	0.28	Ω
Forward Transconductance	g_{fs}	$V_{DS} = -25\text{ V}$, $I_D = -6.6\text{ A}^c$		1.4	-	-	S
Dynamic							
Input Capacitance	C_{iss}	$V_{GS} = 0\text{ V}$, $V_{DS} = -25\text{ V}$, $f = 1.0\text{ MHz}$, see fig. 5 ^c		-	570	-	pF
Output Capacitance	C_{oss}			-	360	-	
Reverse Transfer Capacitance	C_{riss}			-	65	-	
Total Gate Charge	Q_g	$V_{GS} = -10\text{ V}$	$I_D = -11\text{ A}$, $V_{DS} = -480\text{ V}$, see fig. 6 and 13 ^{b, c}	-	-	19	nC
Gate-Source Charge	Q_{gs}			-	-	5.4	
Gate-Drain Charge	Q_{gd}			-	-	11	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -30\text{ V}$, $I_D = -11\text{ A}$, $R_G = 18\text{ }\Omega$, $R_D = 2.5\text{ }\Omega$, see fig. 10 ^b		-	13	-	ns
Rise Time	t_r			-	68	-	
Turn-Off Delay Time	$t_{d(off)}$			-	15	-	
Fall Time	t_f			-	29	-	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	- 11	A
Pulsed Diode Forward Current ^a	I_{SM}			-	-	- 44	
Body Diode Voltage	V_{SD}	$T_J = 25\text{ }^\circ\text{C}$, $I_S = -11\text{ A}$, $V_{GS} = 0\text{ V}^b$		-	-	- 6.3	V



SPECIFICATIONS $T_J = 25^\circ\text{C}$, unless otherwise noted						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Drain-Source Body Diode Characteristics						
Body Diode Reverse Recovery Time	t_{rr}	$T_J = 25^\circ\text{C}$, $I_F = -11\text{ A}$, $dI/dt = 100\text{ A}/\mu\text{s}^{b,c}$	-	100	200	ns
Body Diode Reverse Recovery Charge	Q_{rr}		-	320	640	nC
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 $\leq 300\ \mu\text{s}$; duty cycle $\leq 2\%$.
- c. Uses IRF9Z24/SiHF9Z24 data and test conditions.

TYPICAL CHARACTERISTICS 25°C , unless otherwise noted

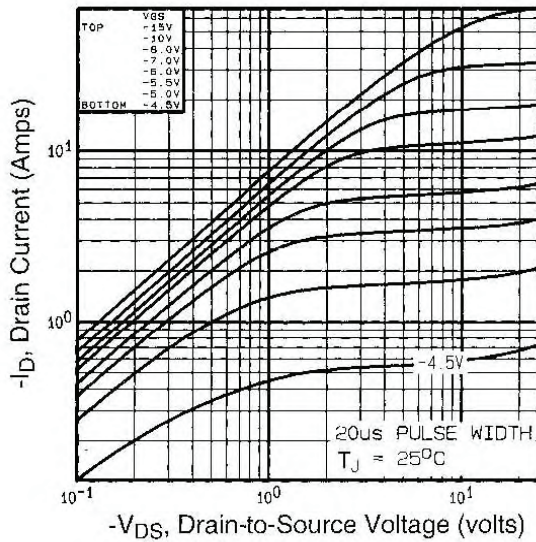


Fig. 1 - Typical Output Characteristics

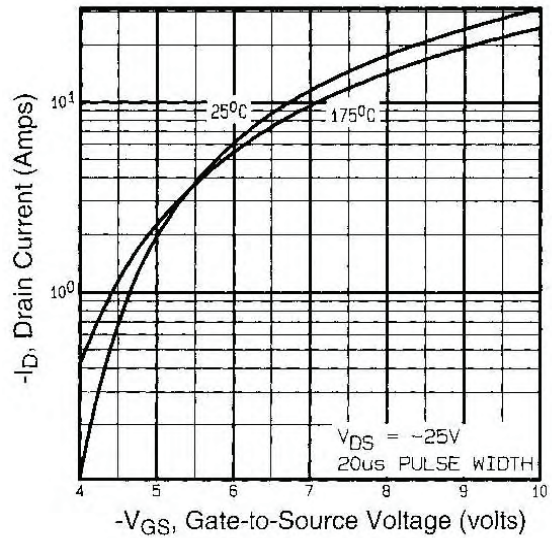


Fig. 3 - Typical Transfer Characteristics

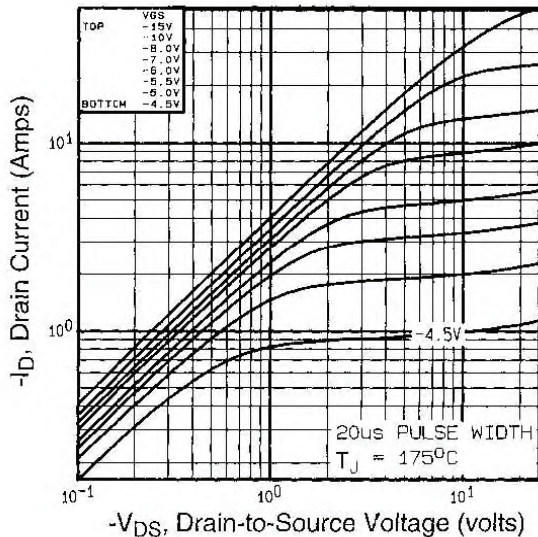


Fig. 2 - Typical Output Characteristics

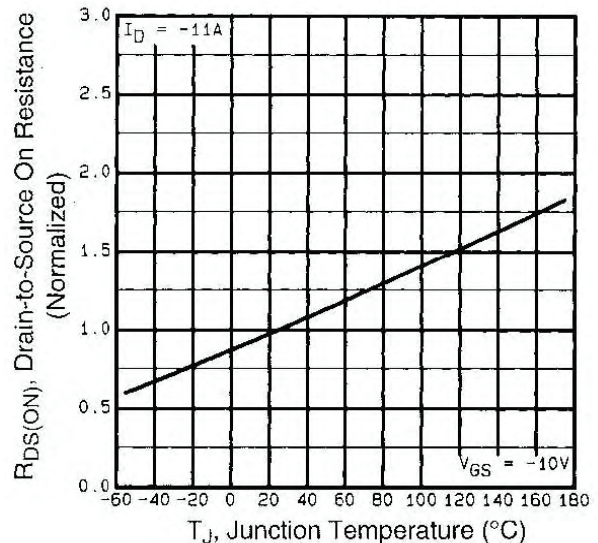


Fig. 4 - Normalized On-Resistance vs. Temperature

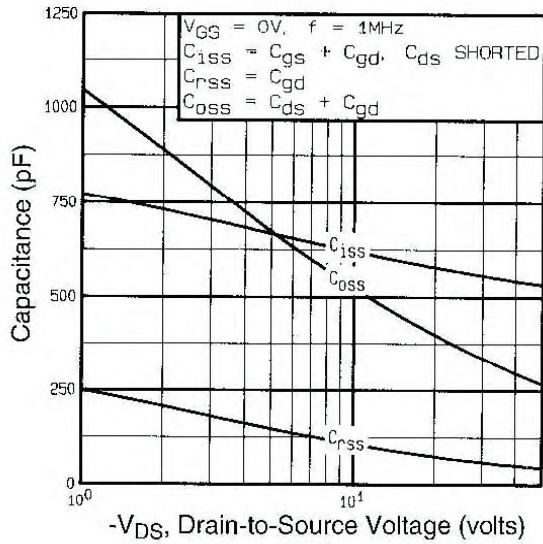


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

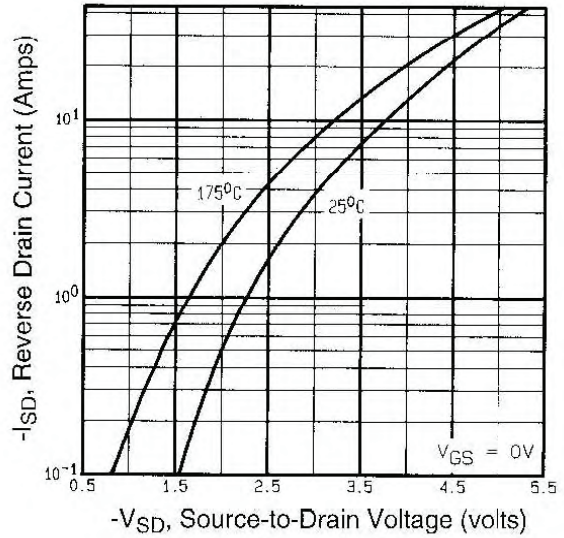


Fig. 7 - Typical Source-Drain Diode Forward Voltage

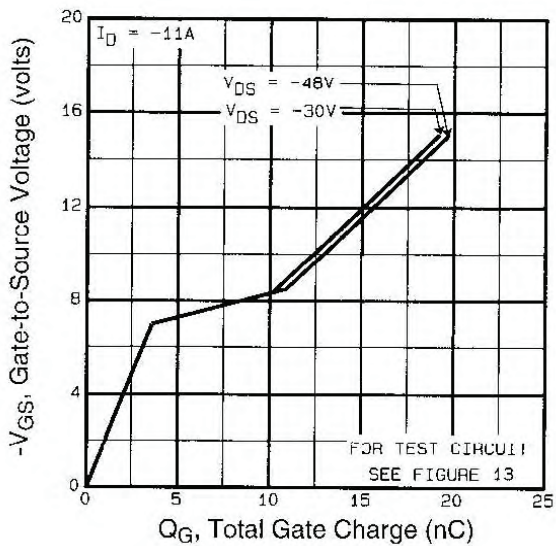


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

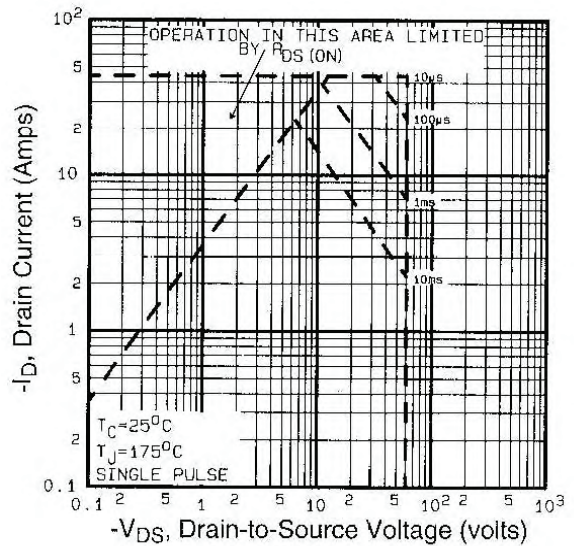


Fig. 8 - Maximum Safe Operating Area

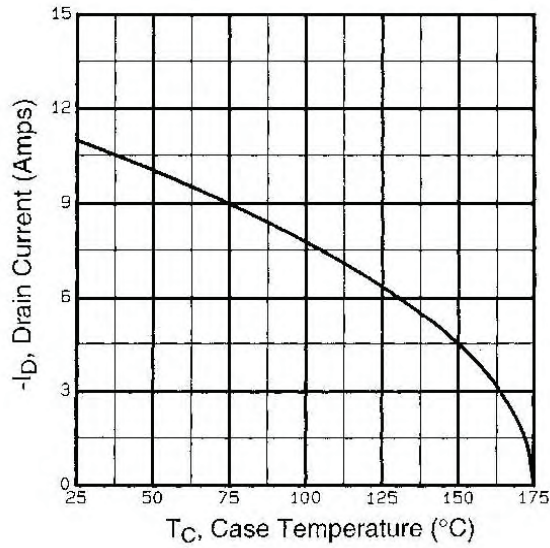


Fig. 9 - Maximum Drain Current vs. Case Temperature

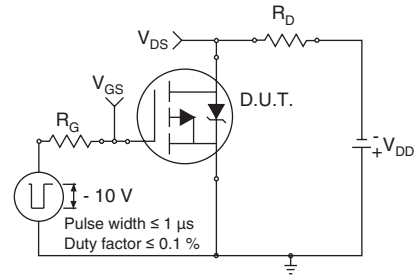


Fig. 10a - Switching Time Test Circuit

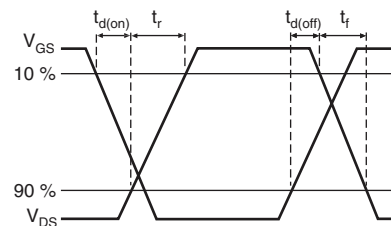


Fig. 10b - Switching Time Waveforms

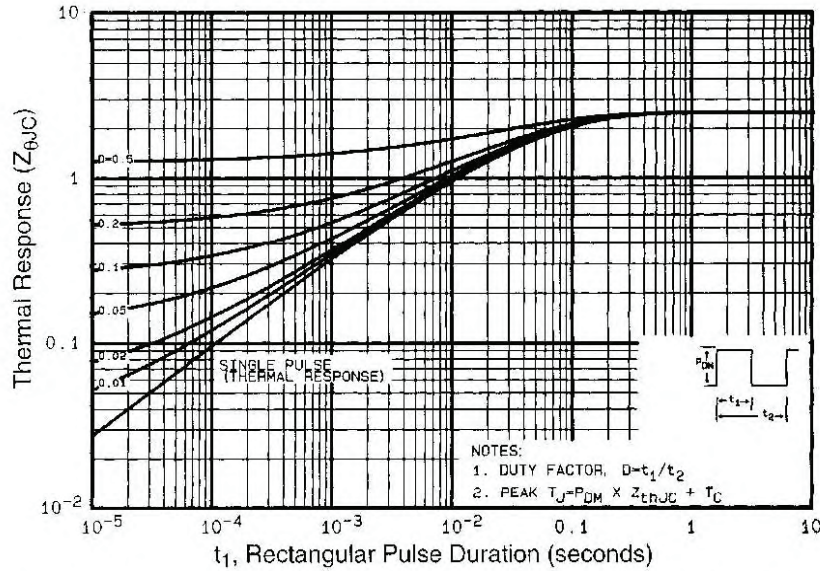


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

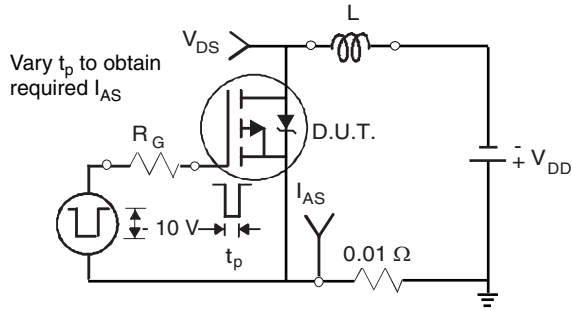


Fig. 12a - Unclamped Inductive Test Circuit

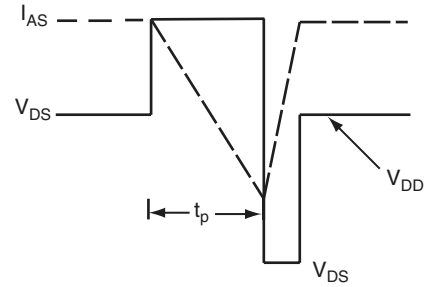


Fig. 12b - Unclamped Inductive Waveforms

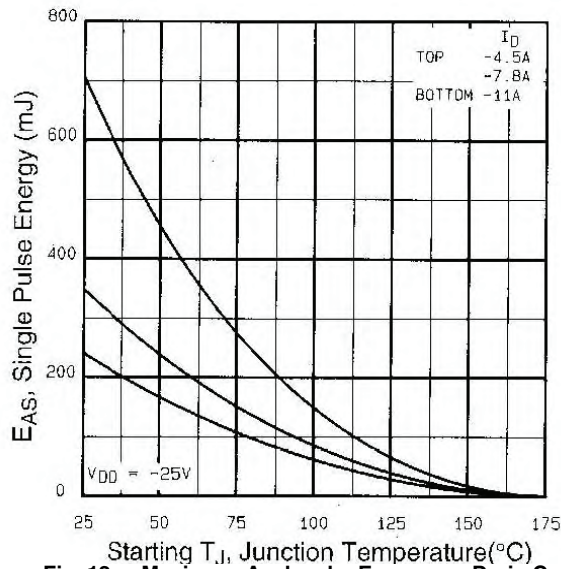


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

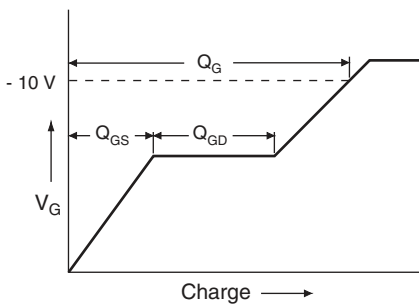


Fig. 13a - Basic Gate Charge Waveform

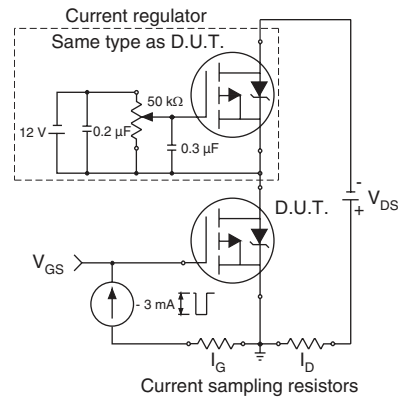
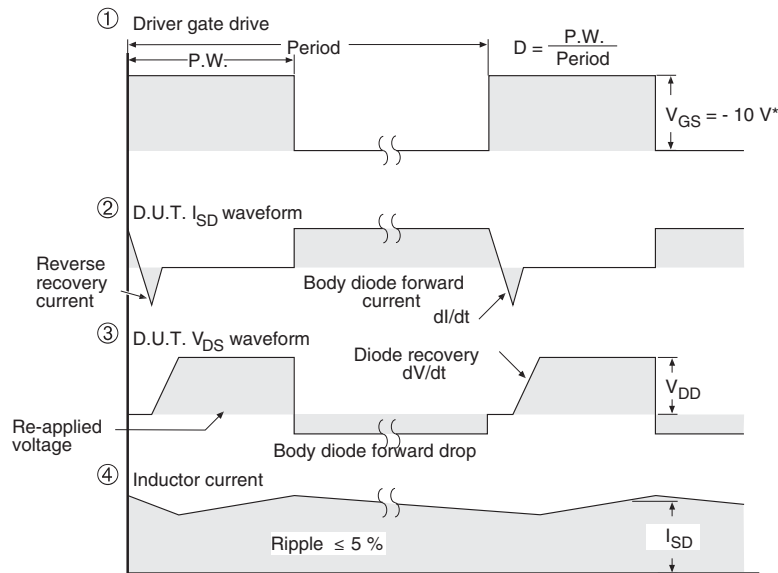
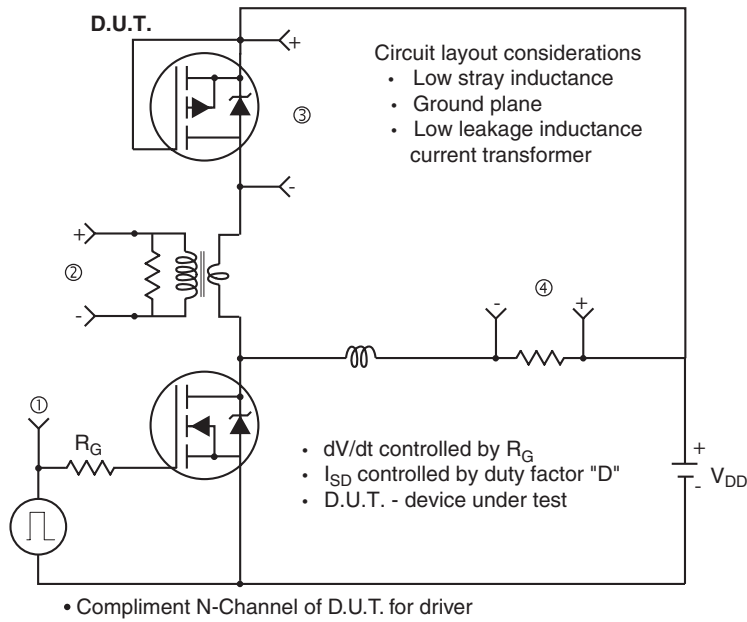


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



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

Fig. 14 - For P-Channel

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