



Power MOSFET

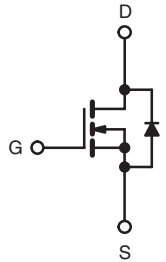
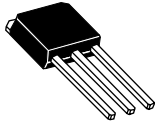
PRODUCT SUMMARY

V_{DS} (V)	600	
$R_{DS(on)}$ (Max.) (Ω)	$V_{GS} = 10\text{ V}$	7.0
Q_g (Max.) (nC)	14	
Q_{gs} (nC)	2.7	
Q_{gd} (nC)	8.1	
Configuration	Single	

PAK
(TO-252)



PAK
(TO-251)



N-Channel MOSFET

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
- Lead (Pb)-free Available



RoHS*
COMPLIANT

APPLICATIONS

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply
- Power Factor Correction

TYPICAL SMPS TOPOLOGIES

- Low Power Single Transistor Flyback

ORDERING INFORMATION

Package	PAK (TO-252)	PAK (TO-252)	PAK (TO-252)	PAK (TO-252)	PAK (TO-251)
Lead (Pb)-free	IRFR1N60APbF	IRFR1N60ATRLPbF ^a	IRFR1N60ATRPbF ^a	IRFR1N60ATRRPbF ^a	IRFU1N60APbF
	SiHFR1N60A-E3	SiHFR1N60ATL-E3 ^a	SiHFR1N60AT-E3 ^a	SiHFR1N60ATR-E3 ^a	SiHFU1N60A-E3
SnPb	IRFR1N60A	-	IRFR1N60ATR ^a	-	IRFU1N60A
	SiHFR1N60A	-	SiHFR1N60AT ^a	-	SiHFU1N60A

Note

a. See device orientation.

ABSOLUTE MAXIMUM RATINGS $T_C = 25^\circ\text{C}$, unless otherwise noted

PARAMETER			SYMBOL	LIMIT	UNIT
Drain-Source Voltage			V _{DS}	600	V
Gate-Source Voltage			V _{GS}	± 30	
Continuous Drain Current	V _{GS} at 10 V	T _C = 25 °C	I _D	1.4	A
		T _C = 100 °C		0.89	
Pulsed Drain Current ^a			I _{DM}	5.6	
Linear Derating Factor				0.28	W/°C
Single Pulse Avalanche Energy ^b			E _{AS}	93	mJ
Repetitive Avalanche Current ^a			I _{AR}	1.4	A
Repetitive Avalanche Energy ^a			E _{AR}	3.6	mJ
Maximum Power Dissipation	T _C = 25 °C		P _D	36	W
Peak Diode Recovery dV/dt ^c			dV/dt	3.8	V/ns
Operating Junction and Storage Temperature Range			T _J , T _{stg}	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature)	for 10 s			300 ^d	

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).

b. Starting $T_J = 25^\circ\text{C}$, $L = 95\text{ mH}$, $R_G = 25\ \Omega$, $I_{AS} = 1.4\text{ A}$ (see fig. 12).

c. $I_{SD} \leq 1.4\text{ A}$, $dI/dt \leq 180\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{DS}$, $T_J \leq 150^\circ\text{C}$.

d. 1.6 mm from case.

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

THERMAL RESISTANCE RATINGS

PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	110	°C/W
Maximum Junction-to-Ambient (PCB Mount) ^a	R_{thJA}	-	50	
Maximum Junction-to-Case (Drain)	R_{thJC}	-	3.5	

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
Static							
Drain-Source Breakdown Voltage	V _{DS}	V _{GS} = 0 V, I _D = 250 μA		600	-	-	V
Gate-Source Threshold Voltage	V _{GS(th)}	V _{DS} = V _{GS} , I _D = 250 μA		2.0	-	4.0	
Gate-Source Leakage	I _{GSS}	V _{GS} = ± 30 V		-	-	± 100	nA
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = 600 V, V _{GS} = 0 V		-	-	25	μA
		V _{DS} = 480 V, V _{GS} = 0 V, T _J = 150 °C		-	-	250	
Drain-Source On-State Resistance	R _{DS(on)}	V _{GS} = 10 V	I _D = 0.84 A ^b	-	-	7.0	Ω
Forward Transconductance	g _{fs}	V _{DS} = 50 V, I _D = 0.84 A		0.88	-	-	S
Dynamic							
Input Capacitance	C _{iss}	V _{GS} = 0 V, V _{DS} = 25 V, f = 1.0 MHz, see fig. 5		-	229	-	pF
Output Capacitance	C _{oss}			-	32.6	-	
Reverse Transfer Capacitance	C _{rss}			-	2.4	-	
Output Capacitance	C _{oss}	V _{GS} = 0 V	V _{DS} = 1.0 V, f = 1.0 MHz	-	320	-	
			V _{DS} = 480 V, f = 1.0 MHz	-	11.5	-	
Effective Output Capacitance	C _{oss eff.}		V _{DS} = 0 V to 480 V ^c	-	130	-	
Total Gate Charge	Q _g	V _{GS} = 10 V	I _D = 1.4 A, V _{DS} = 400 V, see fig. 6 and 13 ^b	-	-	14	nC
Gate-Source Charge	Q _{gs}			-	-	2.7	
Gate-Drain Charge	Q _{gd}			-	-	8.1	
Turn-On Delay Time	t _{d(on)}	V _{DD} = 250 V, I _D = 1.4 A, R _G = 2.15 Ω, R _D = 178 Ω, see fig. 10 ^b		-	9.8	-	ns
Rise Time	t _r			-	14	-	
Turn-Off Delay Time	t _{d(off)}			-	18	-	
Fall Time	t _f			-	20	-	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I _S	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	1.4	A
Pulsed Diode Forward Current ^a	I _{SM}			-	-	5.6	
Body Diode Voltage	V _{SD}	T _J = 25 °C, I _S = 1.4 A, V _{GS} = 0 V ^b		-	-	1.6	V
Body Diode Reverse Recovery Time	t _{rr}	T _J = 25 °C, I _F = 1.4 A, dI/dt = 100 A/μs ^b		-	290	440	ns
Body Diode Reverse Recovery Charge	Q _{rr}			-	510	760	μC
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. $C_{oss\text{ eff.}}$ 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

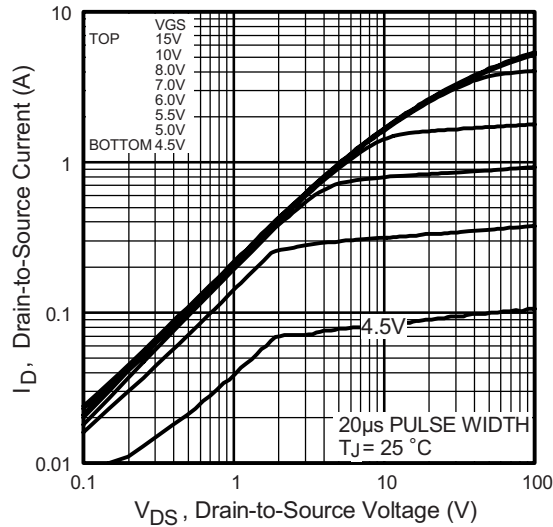


Fig. 1 - Typical Output Characteristics

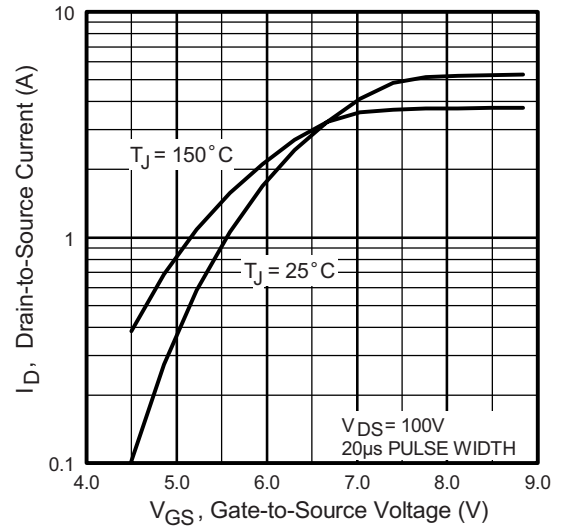


Fig. 3 - Typical Transfer Characteristics

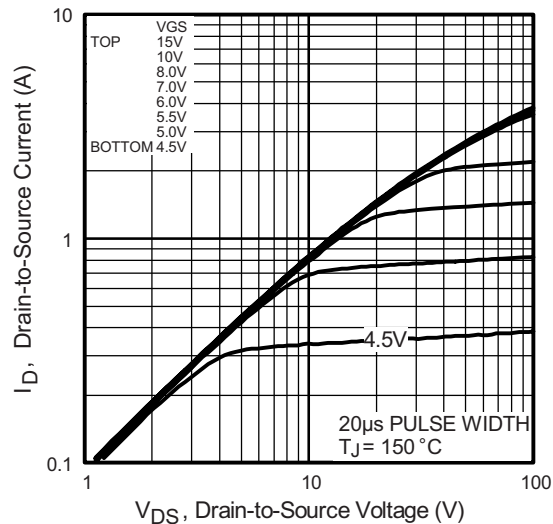


Fig. 2 - Typical Output Characteristics

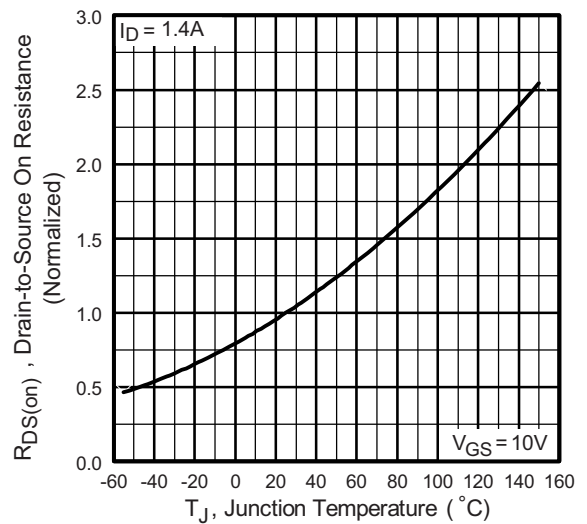


Fig. 4 - Normalized On-Resistance vs. Temperature

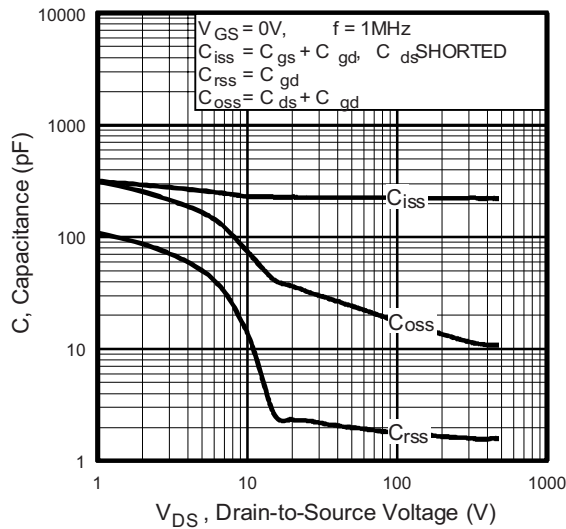


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

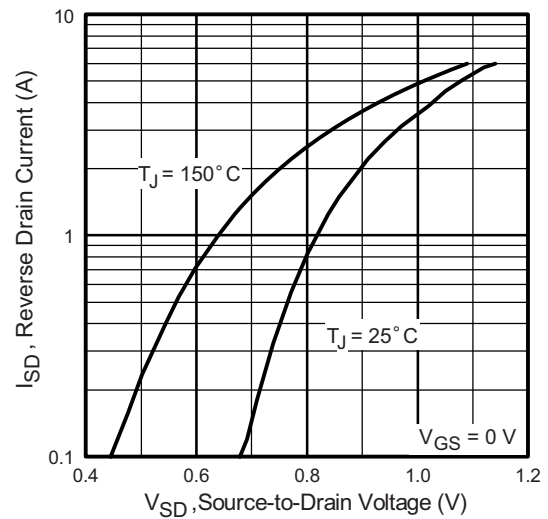


Fig. 7 - Typical Source-Drain Diode Forward Voltage

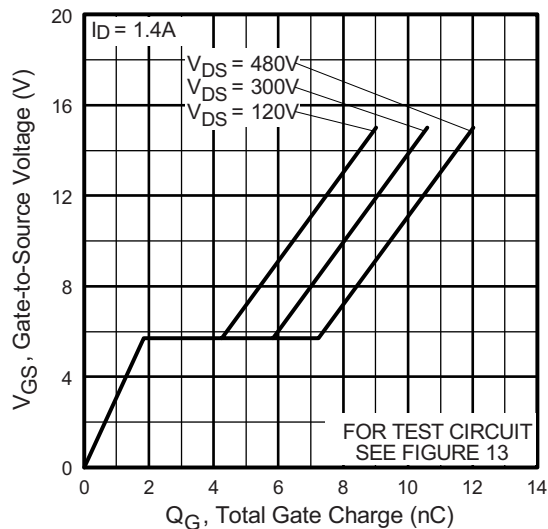


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

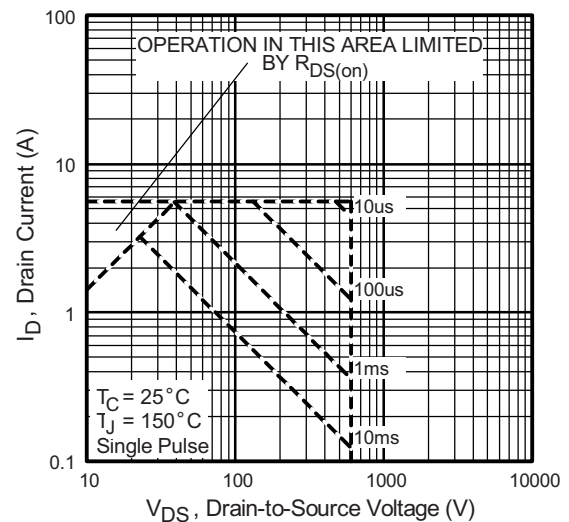


Fig. 8 - Maximum Safe Operating Area

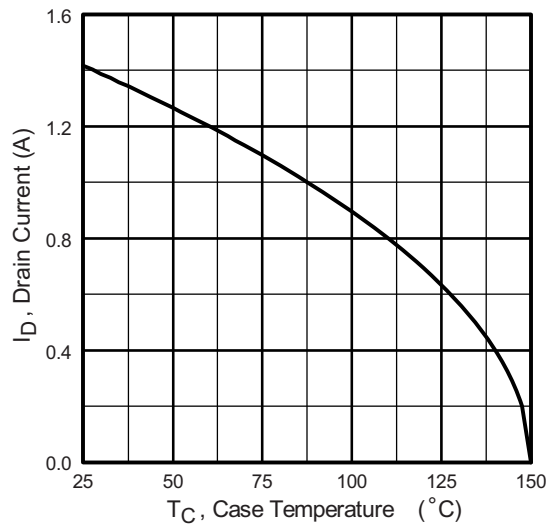


Fig. 9 - Maximum Drain Current vs. Case Temperature

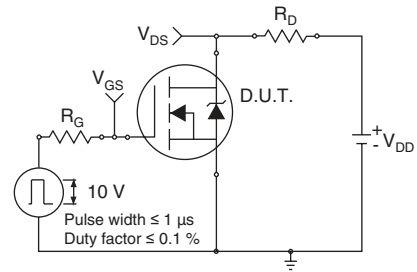


Fig. 10a - Switching Time Test Circuit

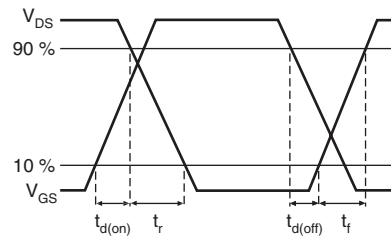


Fig. 10b - Switching Time Waveforms

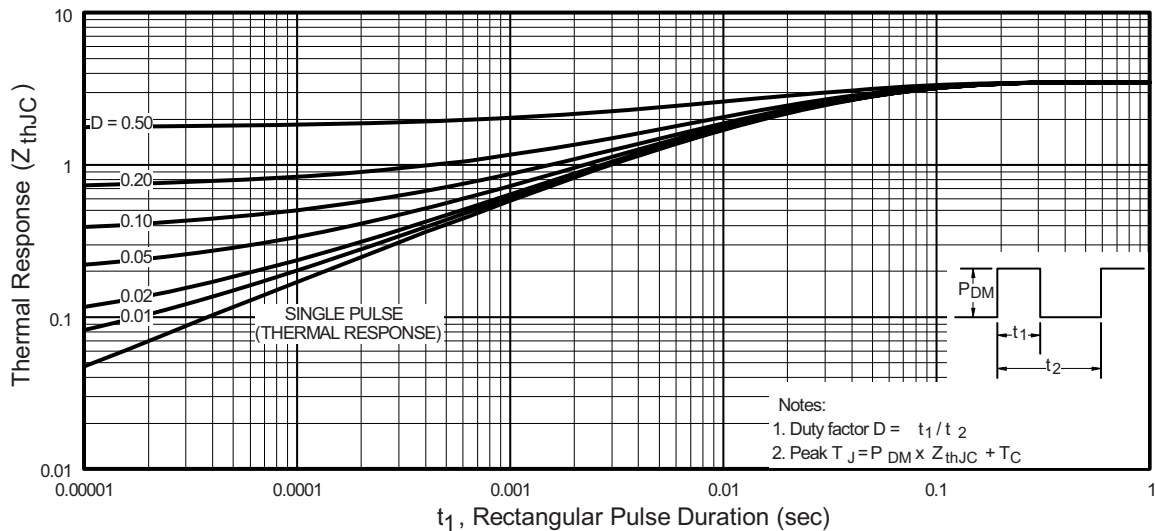


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

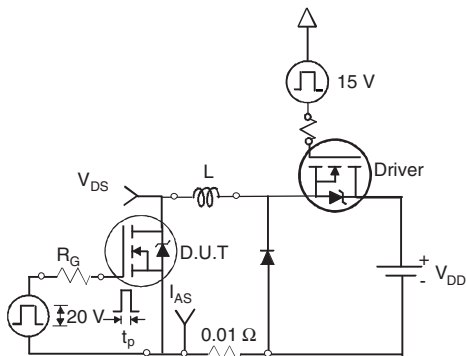


Fig. 12a - Unclamped Inductive Test Circuit

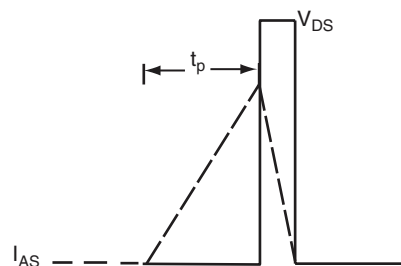


Fig. 12b - Unclamped Inductive Waveforms

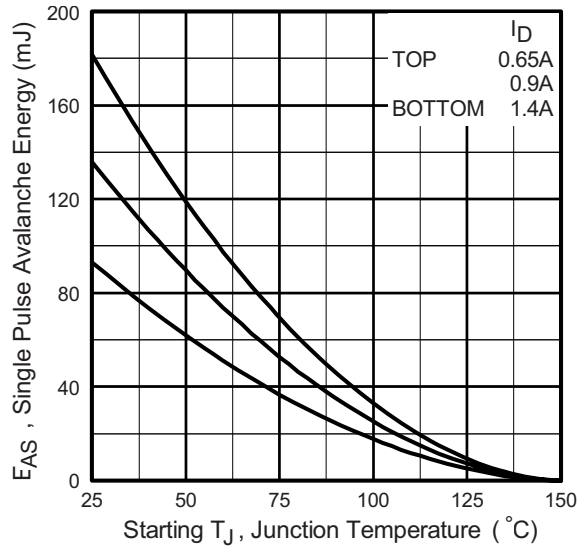


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

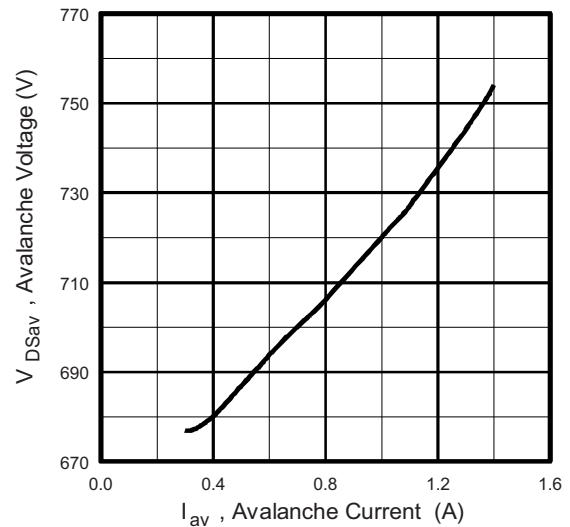


Fig. 12d - Basic Gate Charge Waveform

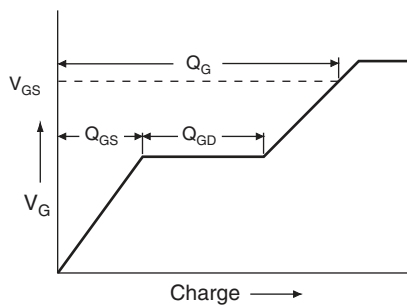


Fig. 13a - Maximum Avalanche Energy vs. Drain Current

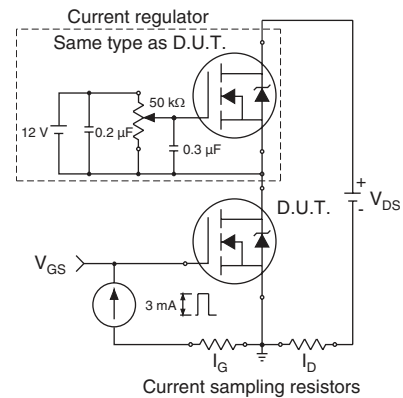
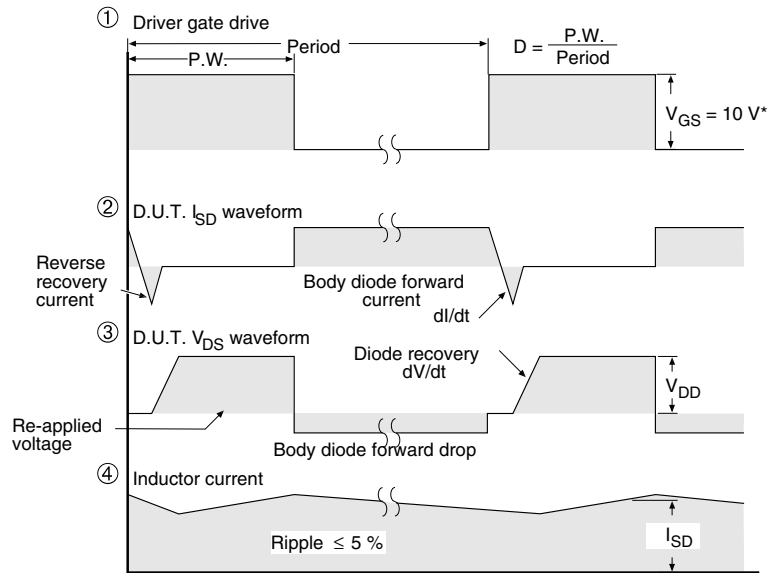
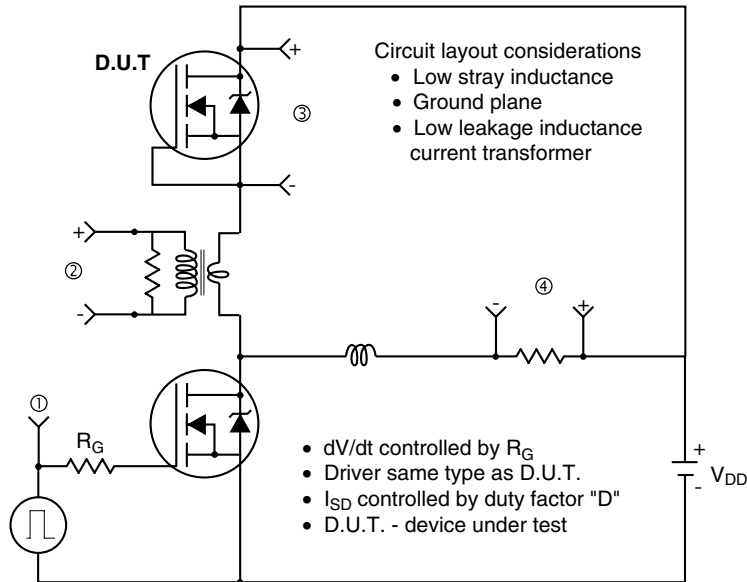


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



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

Fig. 14 - For N-Channel



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