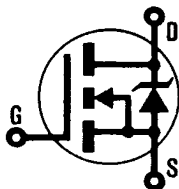


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T-39-11

INTERNATIONAL RECTIFIER **IR**REPETITIVE AVALANCHE AND dv/dt RATED***HEXFET® TRANSISTORS****N-CHANNEL****IRF610****IRF611****IRF612****IRF613****200 Volt, 1.5 Ohm HEXFET
TO-220AB Plastic Package**

The HEXFET® technology is the key to International Rectifier's advanced line of power MOSFET transistors. The efficient geometry and unique processing of this latest "State of the Art" design achieves: very low on-state resistance combined with high transconductance; superior reverse energy and diode recovery dv/dt capability.

The HEXFET transistors also feature all of the well established advantages of MOSFETs such as voltage control, very fast switching, ease of paralleling and temperature stability of the electrical parameters.

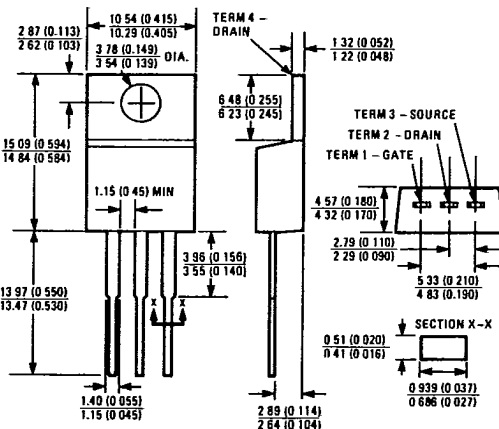
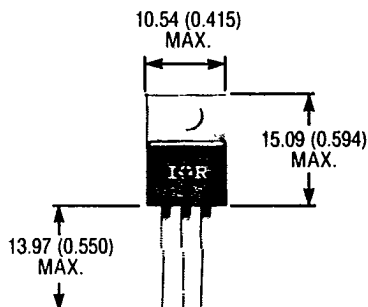
They are well suited for applications such as switching power supplies, motor controls, inverters, choppers, audio amplifiers and high energy pulse circuits.

Product Summary

Part Number	BVDSS	$R_{DS(on)}$	I_D
IRF610	200V	1.5Ω	3.3A
IRF611	150V	1.5Ω	3.3A
IRF612	200V	2.4Ω	2.6A
IRF613	150V	2.4Ω	2.6A

FEATURES:

- Repetitive Avalanche Ratings
- Dynamic dv/dt Rating
- Simple Drive Requirements
- Ease of Paralleling

CASE STYLE AND DIMENSIONS

Case Style TO-220AB
Dimensions in Millimeters and (Inches)

*This data sheet applies to product with batch codes that begin with a digit, i.e. 2A3B

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IRF610, IRF611, IRF612, IRF613 Devices

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Absolute Maximum Ratings

Parameter	IRF610, IRF611	IRF612, IRF613	Units
I_D @ $T_C = 25^\circ\text{C}$ Continuous Drain Current	3.3	2.6	A
I_D @ $T_C = 100^\circ\text{C}$ Continuous Drain Current	2.1	1.6	A
I_{DM} Pulsed Drain Current ^①	8.0	6.5	A
P_D @ $T_C = 25^\circ\text{C}$ Max. Power Dissipation	43		W
Linear Derating Factor	0.29		W/K ^②
V_{GS} Gate-to-Source Voltage	± 20		V
E_{AS} Single Pulse Avalanche Energy ^③	4.6 (See Fig. 14)		mJ
I_{AR} Avalanche Current ^④ (Repetitive or Non-Repetitive)	3.3 (See E_{AR})		A
E_{AR} Repetitive Avalanche Energy ^④	4.3 (See I_{AR})		mJ
dv/dt Peak Diode Recovery dv/dt ^⑤	5.0 (See Fig. 17)		V/ns
T_J Operating Junction Temperature Range	-55 to 150		$^\circ\text{C}$
T_{STG} Storage Temperature Range	-55 to 150		$^\circ\text{C}$
Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)		$^\circ\text{C}$

Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (Unless Otherwise Specified)

Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS} Drain-to-Source Breakdown Voltage	IRF610 IRF612	200	—	—	V	$V_{GS} = 0V, I_D = 250\mu\text{A}$
	IRF611 IRF613	150	—	—	V	
$R_{DS(on)}$ Static Drain-to-Source On-State Resistance ^①	IRF610 IRF611	—	1.2	1.5	Ω	$V_{GS} = 10V, I_D = 1.6A$
	IRF612 IRF613	—	1.5	2.4	Ω	
$I_{D(on)}$ On-State Drain Current ^②	IRF610 IRF611	3.3	—	—	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ Max. $V_{GS} = 10V$
	IRF612 IRF613	2.6	—	—	A	
$V_{GS(th)}$ Gate Threshold Voltage	ALL	2.0	—	4.0	V	$V_{DS} = V_{GS}, I_D = 250\mu\text{A}$
g_{fs} Forward Transconductance ^③	ALL	0.80	1.2	—	S(V)	$V_{DS} \geq 50V, I_{DS} = 1.6A$
I_{DSS} Zero Gate Voltage Drain Current	ALL	—	—	250	μA	$V_{DS} = \text{Max. Rating}, V_{GS} = 0V$
		—	—	1000	μA	$V_{DS} = 0.8 \times \text{Max. Rating}$ $V_{GS} = 0V, T_J = 125^\circ\text{C}$
I_{GSS} Gate-to-Source Leakage Forward	ALL	—	—	500	nA	$V_{GS} = 20V$
I_{GSS} Gate-to-Source Leakage Reverse	ALL	—	—	-500	nA	$V_{GS} = -20V$
Q_g Total Gate Charge	ALL	—	5.5	8.2	nC	$V_{GS} = 10V, I_D = 3.3A$
Q_{gs} Gate-to-Source Charge	ALL	—	1.2	1.8	nC	$V_{DS} = 0.8 \times \text{Max. Rating}$ See Fig. 16
Q_{gd} Gate-to-Drain ("Miller") Charge	ALL	—	3.0	4.5	nC	(Independent of operating temperature)
$t_{d(on)}$ Turn-On Delay Time	ALL	—	8.2	12	ns	$V_{DD} = 100V, I_D = 3.3A, R_G = 24\Omega$
t_r Rise Time	ALL	—	17	28	ns	$R_D = 30\Omega$
$t_{d(off)}$ Turn-Off Delay Time	ALL	—	14	21	ns	See Fig. 15
t_f Fall Time	ALL	—	8.9	13	ns	(Independent of operating temperature)
L_D Internal Drain Inductance	ALL	—	4.5	—	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S Internal Source Inductance	ALL	—	7.5	—	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.
C_{iss} Input Capacitance	ALL	—	140	—	pF	$V_{GS} = 0V, V_{DS} = 25V$
C_{oss} Output Capacitance	ALL	—	42	—	pF	$f = 1.0 \text{ MHz}$
C_{rss} Reverse Transfer Capacitance	ALL	—	8.8	—	pF	See Fig. 10



Source-Drain Diode Ratings and Characteristics

Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
I_S Continuous Source Current (Body Diode)	ALL	—	—	3.3	A	Modified MOSFET symbol showing the integral Reverse p-n junction rectifier. 
I_{SM} Pulsed Source Current (Body Diode) ①	ALL	—	—	8.0	A	
V_{SD} Diode Forward Voltage ②	ALL	—	—	2.0	V	$T_J = 25^{\circ}\text{C}$, $I_S = 3.3\text{A}$, $V_{GS} = 0\text{V}$
t_{rr} Reverse Recovery Time	ALL	75	150	310	ns	$T_J = 25^{\circ}\text{C}$, $I_F = 3.3\text{A}$, $dI/dt = 100\text{ A}/\mu\text{s}$
Q_{RR} Reverse Recovery Charge	ALL	0.33	0.68	1.4	μC	
t_{on} Forward Turn-On Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S + L_D$.				

Thermal Resistance

$R_{\theta JC}$ Junction-to-Case	ALL	—	—	3.5	K/W⑤	Mounting surface flat, smooth, and greased Typical socket mount
$R_{\theta CS}$ Case-to-Sink	ALL	—	0.50	—	K/W⑤	
$R_{\theta JA}$ Junction-to-Ambient	ALL	—	—	80	K/W⑤	

- ① Repetitive Rating; Pulse width limited by maximum junction temperature (see figure 5)
Refer to current HEXFET reliability report
- ② $I_{SD} \leq 3.3\text{A}$, $dI/dt \leq 70\text{ A}/\mu\text{s}$,
 $V_{DD} \leq BV_{DSS}$, $T_J \leq 150^{\circ}\text{C}$
Suggested $R_G = 24\Omega$
- ③ $K/W = ^{\circ}\text{C}/W$
 $W/K = W/^{\circ}\text{C}$
- ④ @ $V_{DD} = 50\text{V}$, Starting $T_J = 25^{\circ}\text{C}$,
 $L = 6.4\text{ mH}$, $R_G = 25\Omega$, Peak $I_L = 3.3$
- ⑤ Pulse width $\leq 300\text{ }\mu\text{s}$; Duty Cycle $\leq 2\%$

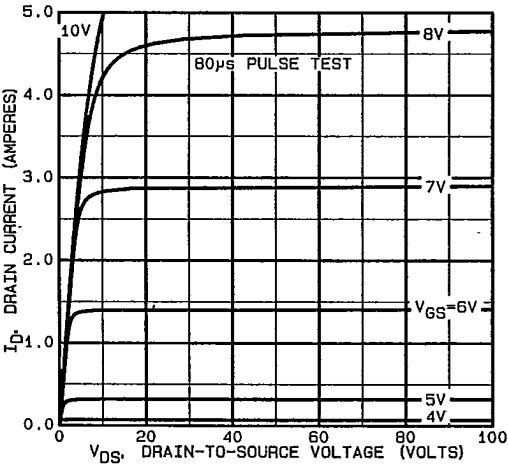


Fig. 1 — Typical Output Characteristics

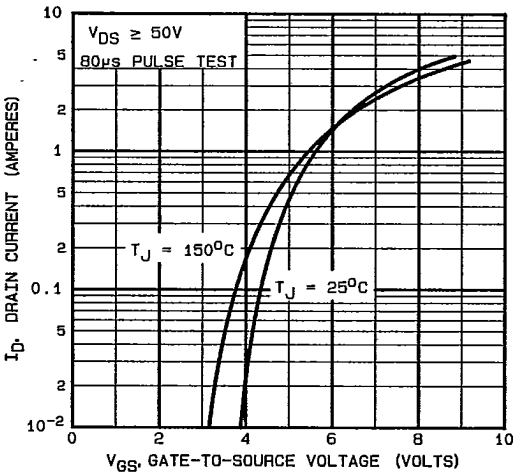


Fig. 2 — Typical Transfer Characteristics

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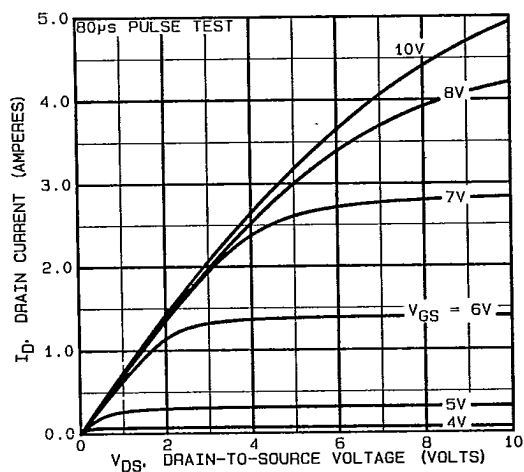


Fig. 3 — Typical Saturation Characteristics

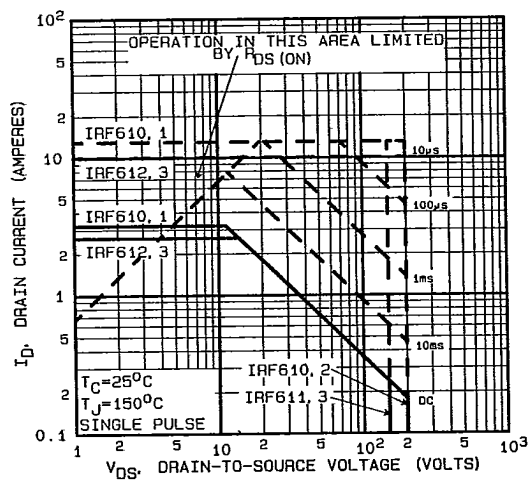


Fig. 4 — Maximum Safe Operating Area

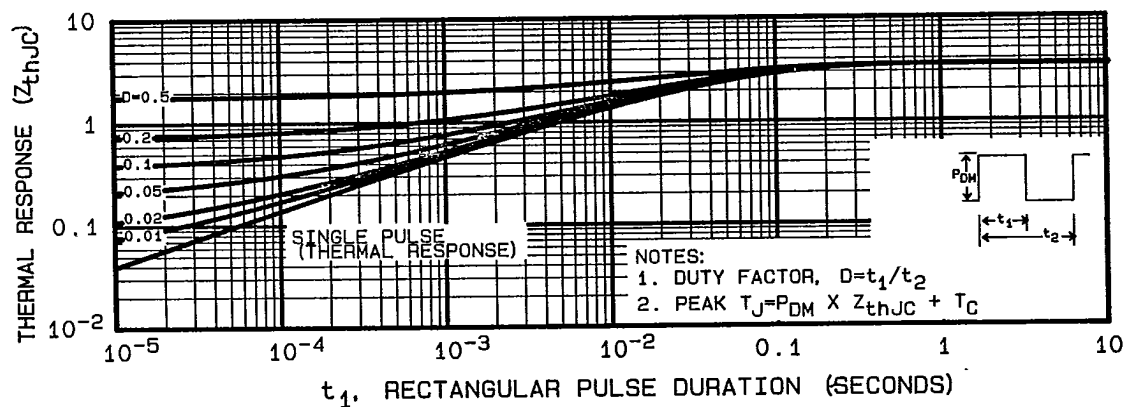


Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

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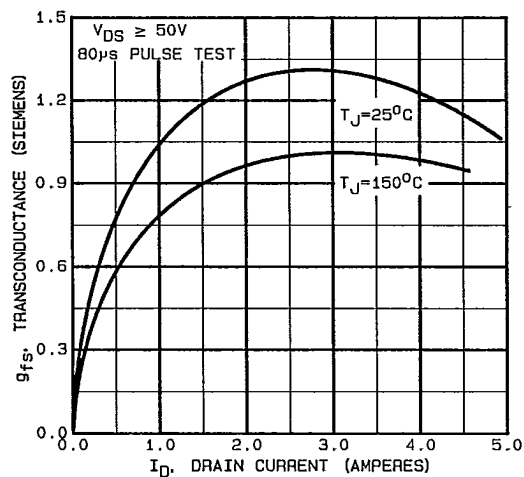


Fig. 6 — Typical Transconductance Vs. Drain Current

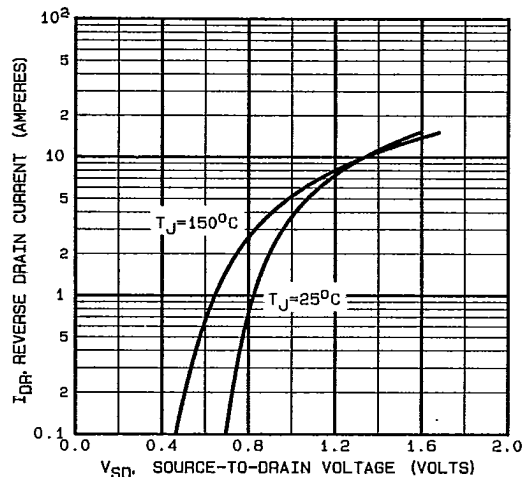


Fig. 7 — Typical Source-Drain Diode Forward Voltage

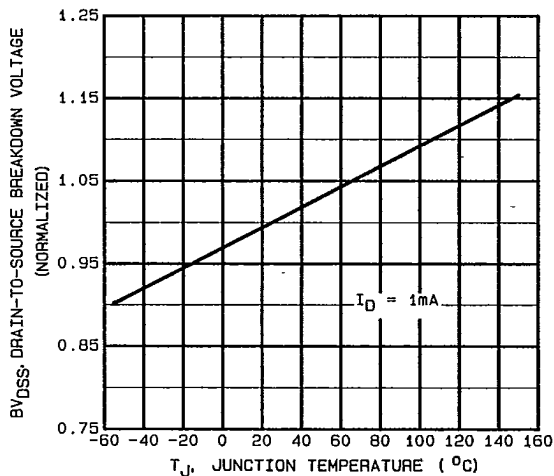


Fig. 8 — Breakdown Voltage Vs. Temperature

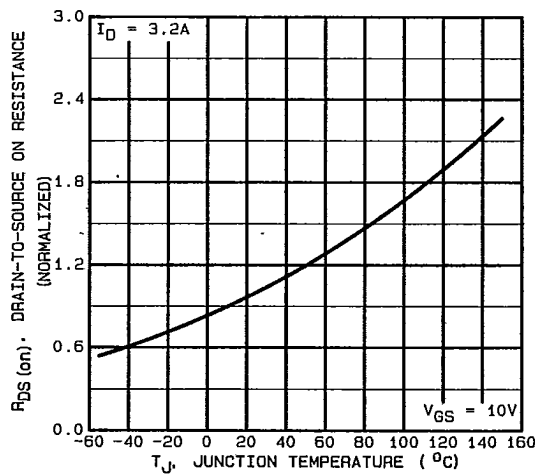


Fig. 9 — Normalized On-Resistance Vs. Temperature

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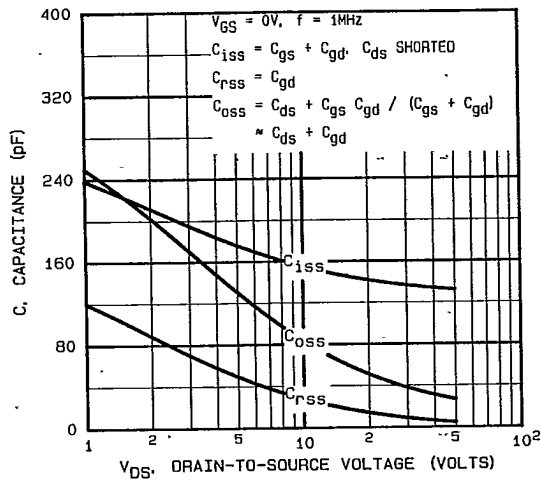


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

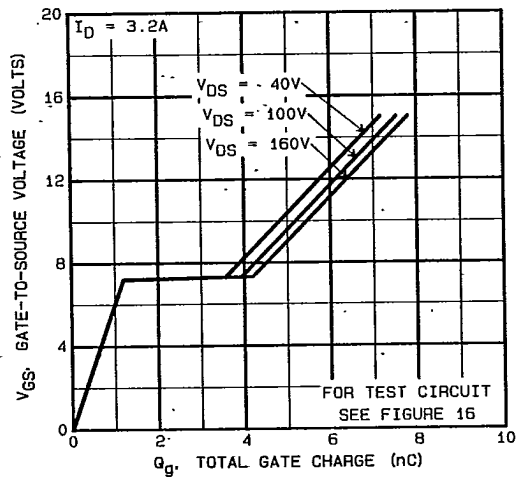


Fig. 11 — Typical Gate Charge Vs. Gate-to-Source Voltage

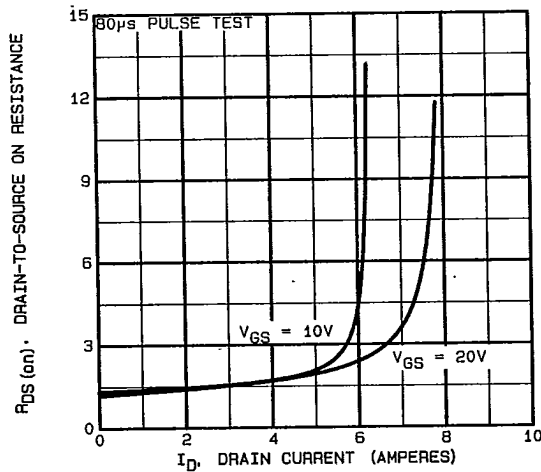


Fig. 12 — Typical On-Resistance Vs. Drain Current

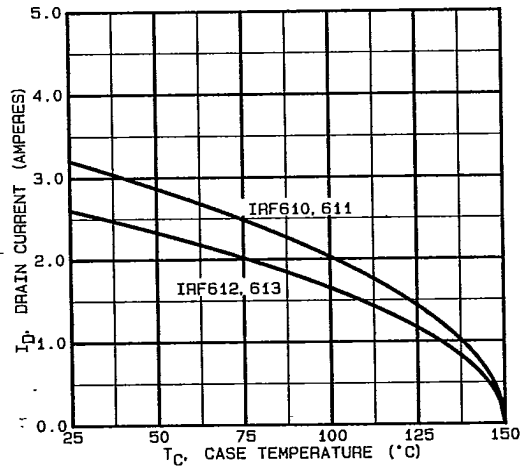


Fig. 13 — Maximum Drain Current Vs. Case Temperature

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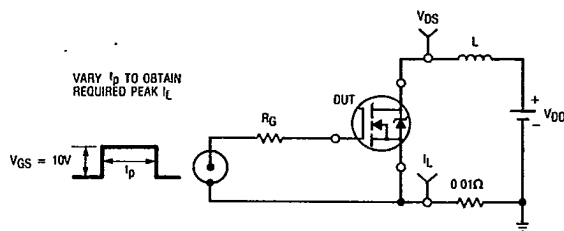


Fig. 14a — Unclamped Inductive Test Circuit

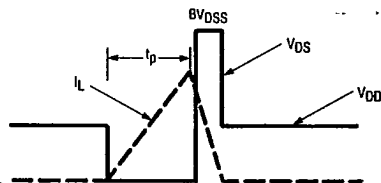


Fig. 14b — Unclamped Inductive Waveforms

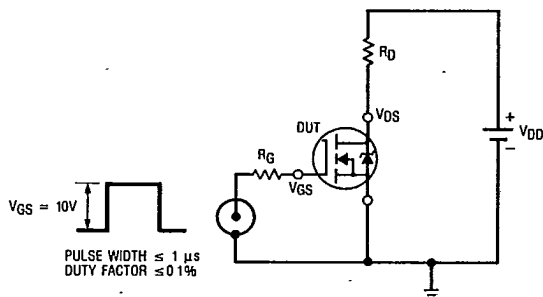


Fig. 15a — Switching Time Test Circuit

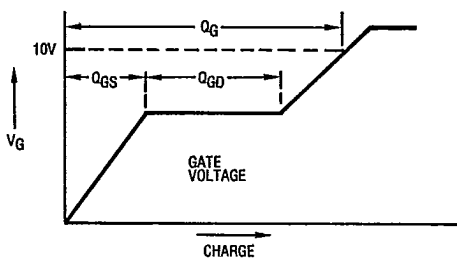


Fig. 16a — Basic Gate Charge Waveform

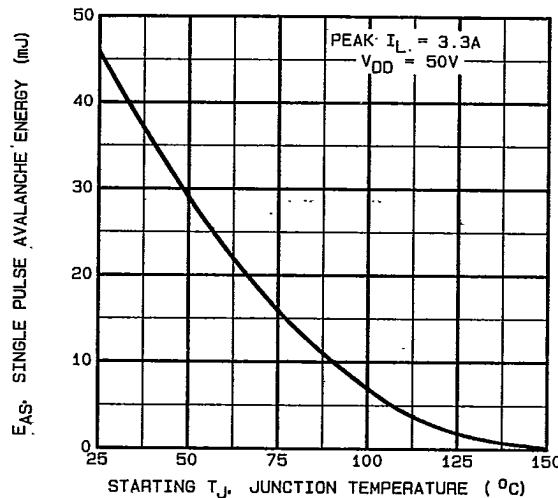


Fig. 14c — Maximum Avalanche Energy Vs. Starting Junction Temperature

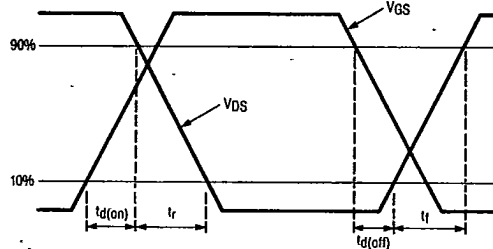


Fig. 15b — Switching Time Waveforms

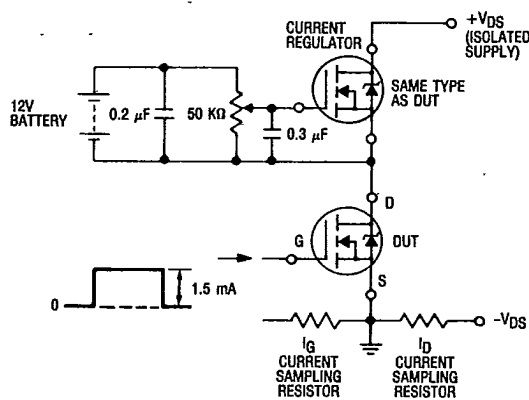


Fig. 16b — Gate Charge Test Circuit

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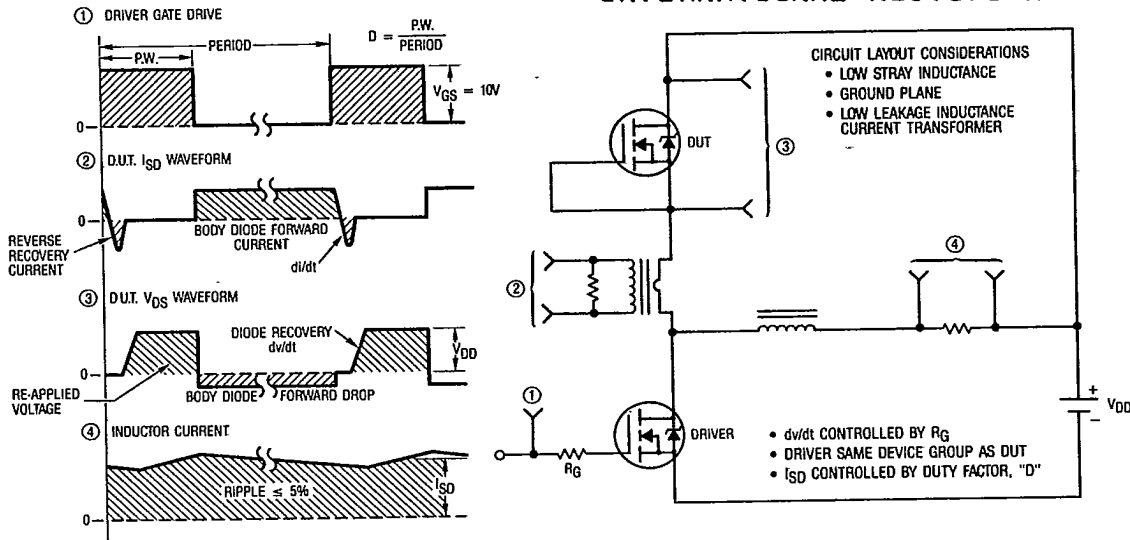
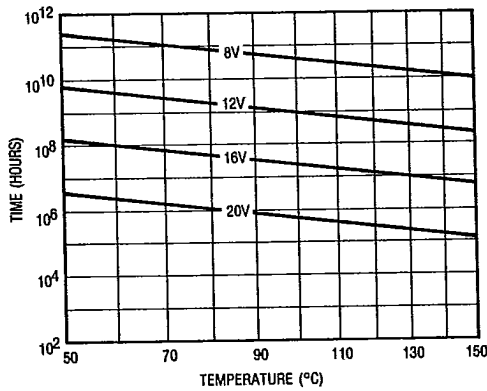
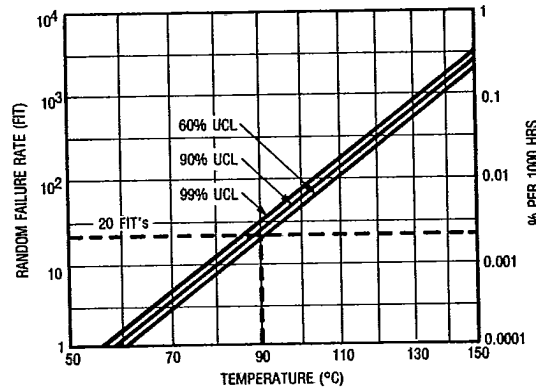


Fig. 17 — Peak Diode Recovery dv/dt Test Circuit



*Fig. 18 — Typical Time to Accumulated 1% Gate Failure



*Fig. 19 — Typical High Temperature Reverse Bias (HTRB) Failure Rate

*The data shown is correct as of April 15, 1987. This information is updated on a quarterly basis; for the latest reliability data, please contact your local IR field office.