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INTERNATIONAL RECTIFIER

Data Sheet No. PD-9.315I

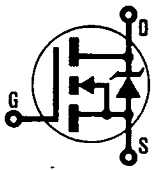
T-39-11

INTERNATIONAL RECTIFIER IOR

REPETITIVE AVALANCHE AND dv/dt RATED*

HEXFET® TRANSISTORS

IRF720
IRF721
IRF722
IRF723



N-CHANNEL

TO-220

400 Volt, 1.8 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.

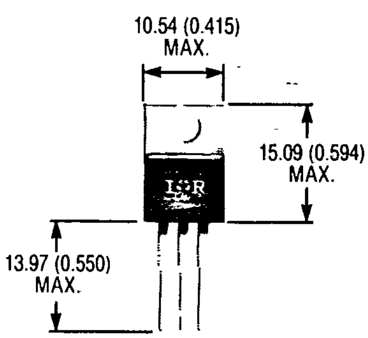
Product Summary

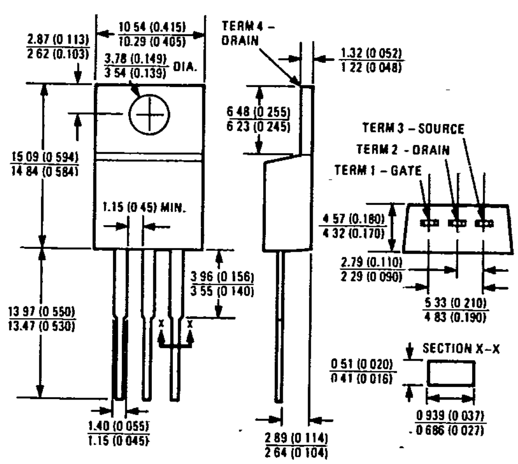
Part Number	BV_{DSS}	$R_{DS(on)}$	I_D
IRF720	400V	1.8Ω	3.3A
IRF721	350V	1.8Ω	3.3A
IRF722	400V	2.5Ω	2.8A
IRF723	350V	2.5Ω	2.8A

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, ie. 2A3B

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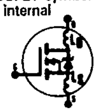
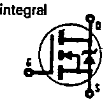
Absolute Maximum Ratings

	Parameter	IRF720, IRF721	IRF722, IRF723	Units
I_D @ T_C = 25°C	Continuous Drain Current	3.3	2.8	A
I_D @ T_C = 100°C	Continuous Drain Current	2.1	1.8	A
I_{DM}	Pulsed Drain Current ①	13	11	A
P_D @ T_C = 25°C	Max. Power Dissipation	50		W
	Linear Derating Factor	0.40		W/K ⑤
V_{GS}	Gate-to-Source Voltage	±20		V
E_{AS}	Single Pulse Avalanche Energy ②	190 (See Fig. 14)		mJ
I_{AR}	Avalanche Current ① (Repetitive or Non-Repetitive)	3.3 (See E_{AR})		A
E_{AR}	Repetitive Avalanche Energy ①	5.0 (See I_{AR})		mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.0 (See Fig. 17)		V/ns
T_J T_{STG}	Operating Junction Storage Temperature Range	−55 to 150		°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)		°C

Electrical Characteristics @ T_J = 25°C (Unless Otherwise Specified)

Parameter		Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	IRF720 IRF722	400	—	—	V	V_{GS} = 0V, I_D = 250 μA
		IRF721 IRF723	350				
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance ④	IRF720 IRF721	—	1.6	1.8	Ω	V_{GS} = 10V, I_D = 1.8A
		IRF722 IRF723	—	1.8	2.5		
$I_{D(on)}$	On-State Drain Current ④	IRF720 IRF721	3.3	—	—	A	V_{DS} > $I_{D(on)}$ X $R_{DS(on)}$ Max. V_{GS} = 10V
		IRF722 IRF723	2.8				
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	—	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
g_{fs}	Forward Transconductance ④	ALL	1.8	2.7	—	S (Ʊ)	I_{DS} = 1.8A, V_{DS} ≥ 50V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	1000		V_{DS} = 0.8 x Max. Rating V_{GS} = 0V, T_J = 125°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	—	13	20	nC	V_{GS} = 10V, I_D = 3.3A
Q_{gs}	Gate-to-Source Charge	ALL	—	2.2	3.3	nC	V_{DS} = 0.8 x Max. Rating See Fig. 16
Q_{gd}	Gate-to-Drain ("Miller") Charge		—	7.2	11	nC	(Independent of operating temperature)
$t_{d(on)}$	Turn-On Delay Time	ALL	—	10	15	ns	V_{DD} = 200V, I_D ≈ 3.3A, R_G = 18Ω
t_r	Rise Time	ALL	—	14	21	ns	R_D = 56Ω
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	30	45	ns	See Fig. 15
t_f	Fall Time	ALL	—	13	20	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. — Modified MOSFET symbol showing the internal inductances. 
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	—	350	—	pF	V_{GS} = 0V, V_{DS} = 25V
C_{oss}	Output Capacitance	ALL	—	64	—	pF	f = 1.0 MHz
C_{rss}	Reverse Transfer Capacitance	ALL	—	8.1	—	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	–	–	13	A	
V_{SD}	Diode Forward Voltage ④	ALL	–	–	1.6	V	T_J = 25°C, I_S = 3.3A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	120	270	600	ns	T_J = 25°C, I_F = 3.3A, di/dt = 100 A/μs
Q_{RR}	Reverse Recovery Charge	ALL	0.64	1.4	3.0	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_{thJC}	Junction-to-Case	ALL	–	–	2.5	K/W ⑤	
R_{thCS}	Case-to-Sink	ALL	–	0.50	–	K/W ⑤	Mounting surface flat, smooth, and greased
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W ⑤	Typical socket mount

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Typical SPICE Computer Model Parameters (For More Information See Application Note AN-975)

Device	Level, SPICE MOSFET Model	W (m), Channel Width	L (μm), Channel Length	Theta (1/V), Mobility Modulation	UO (CM^2/V-S), Surface Mobility	VTO (V), Threshold Voltage	R1 (Ω), Drain Resistance	R2 (Ω), Source Resistance	RG (Ω), Gate Resistance
ALL	3	0.279	1.2	0.30	450	4.00	1.4	0.02	1.5

CGSO (pf), Gate-Source Capacitance	CGD (F) Gate-Drain Capacitance	E1 (V), Voltage Dependent Voltage Source	LD (nH), Drain Inductance	LS (nH), Source Inductance	LG (nH), Gate Inductance	IS (A), Diode Saturation Current	RS (Ω), Diode Bulk Resistance
770	C6	2 + 0.995 VDG	4.5	7.5	7.5	3.6×10^{-13}	0.026

C6 = 1500 pf + 1.8×10^{-22} $(V_{GE})^{48}$

① Repetitive Rating; Pulse width limited by maximum junction temperature (see figure 5) Refer to current HEXFET reliability report

② @ V_{DD} = 50V, Starting T_J = 25°C, L = 31 mH, R_G = 25Ω, Peak I_L = 3.3A.

③ $I_{SD} \leq$ 3.3A, di/dt $\leq$ 65A/μs, $V_{DD} \leq BV_{DSS}$, $T_J \leq$ 150°C Suggested R_G = 18Ω

④ Pulse width $\leq$ 300 μs; Duty Cycle $\leq$ 2%

⑤ K/W = °C/W W/K = W/°C

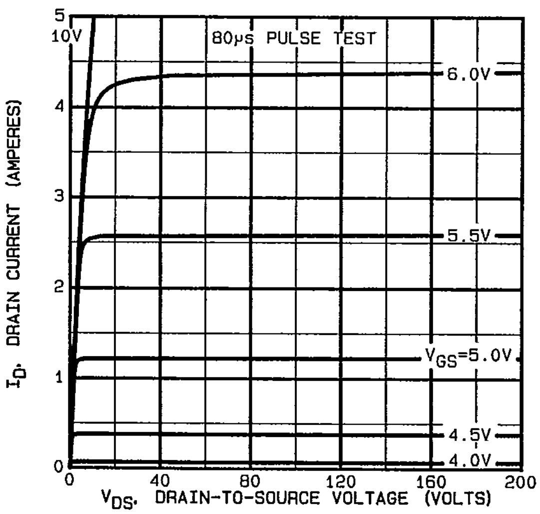

Fig. 1 — Typical Output Characteristics

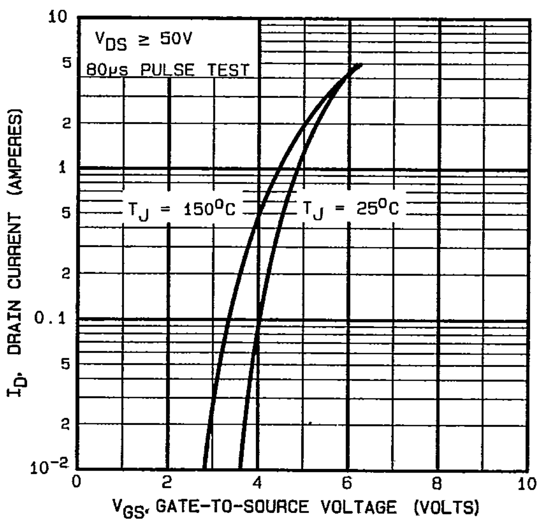

Fig. 2 — Typical Transfer Characteristics

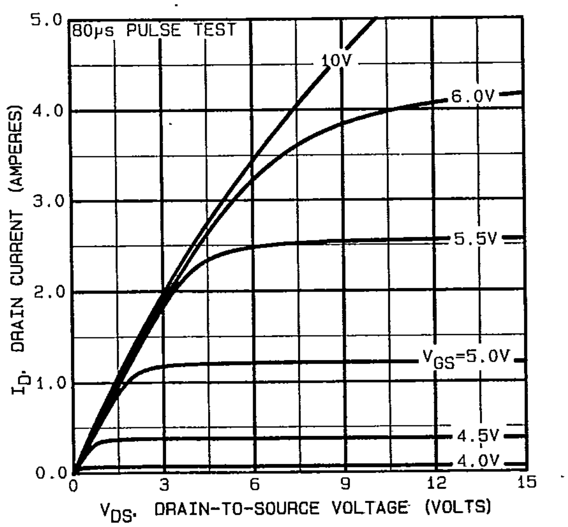

Fig. 3 — Typical Saturation Characteristics

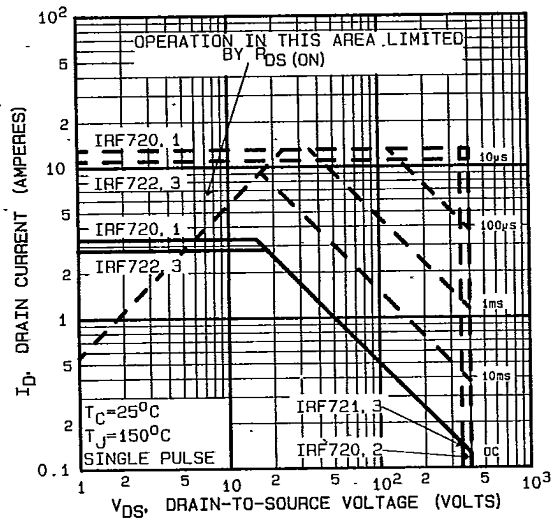

Fig. 4 — Maximum Safe Operating Area

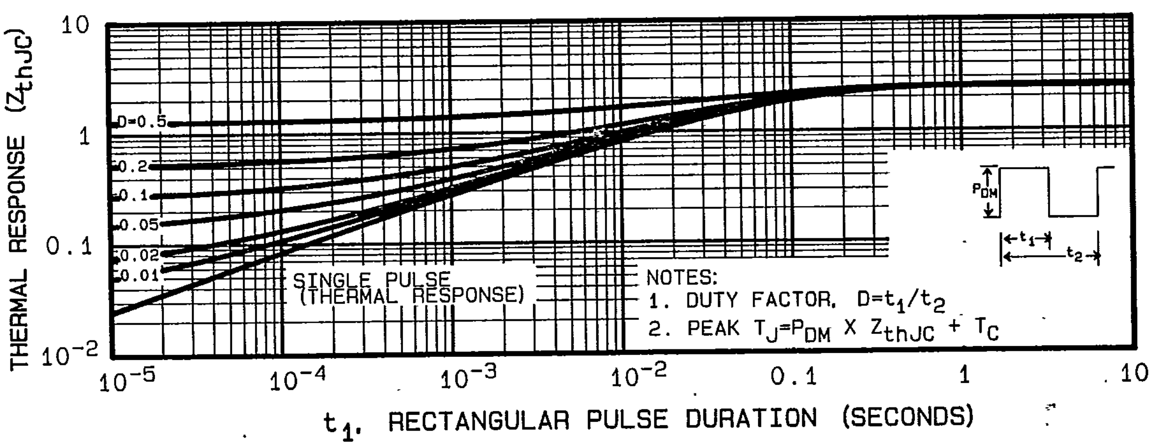

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

IRF720, IRF721, IRF722, IRF723 Devices

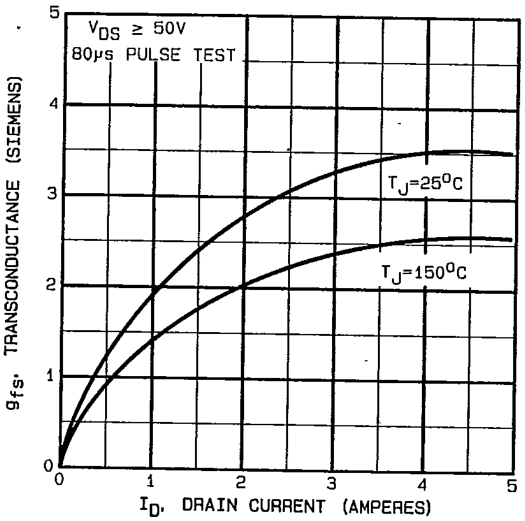

Fig. 6 — Typical Transconductance Vs. Drain Current

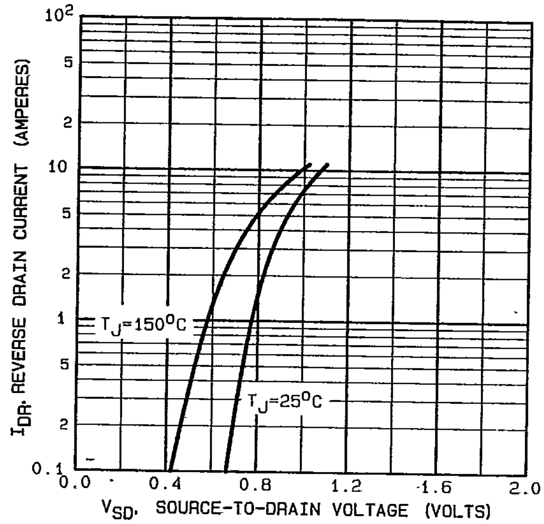

Fig. 7 — Typical Source-Drain Diode Forward Voltage

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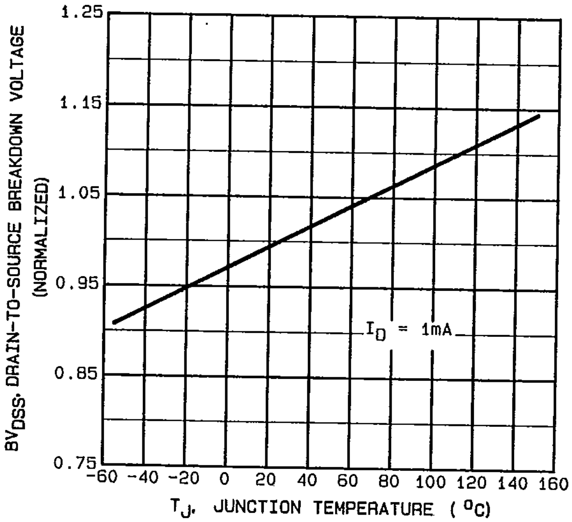

Fig. 8 — Breakdown Voltage Vs. Temperature

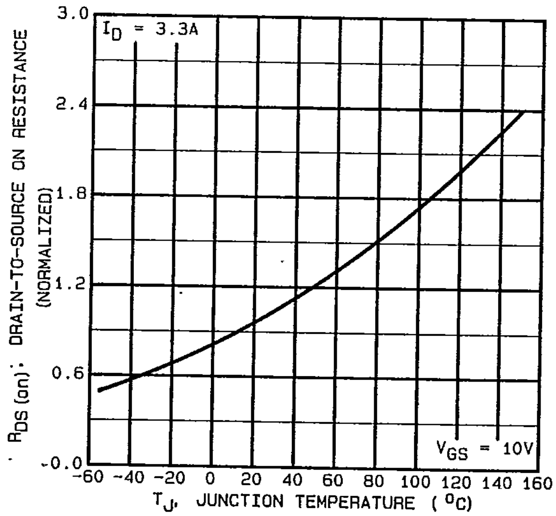

Fig 9 — Normalized On-Resistance Vs. Temperature

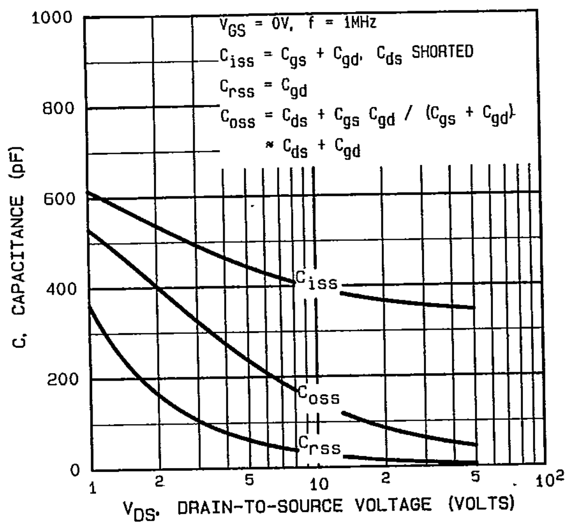

Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

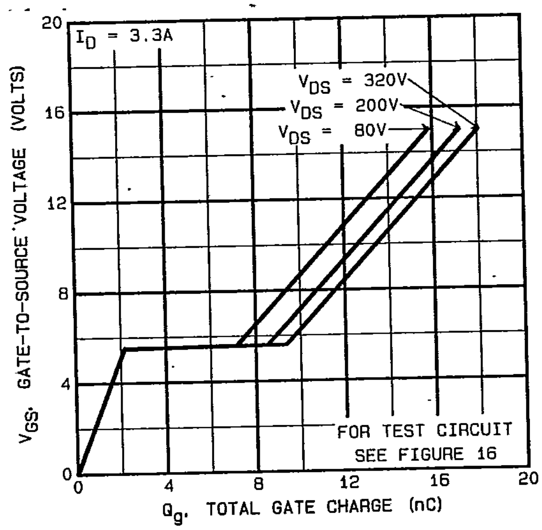

Fig. 11 — Typical Gate Charge Vs. Gate-to-Source Voltage

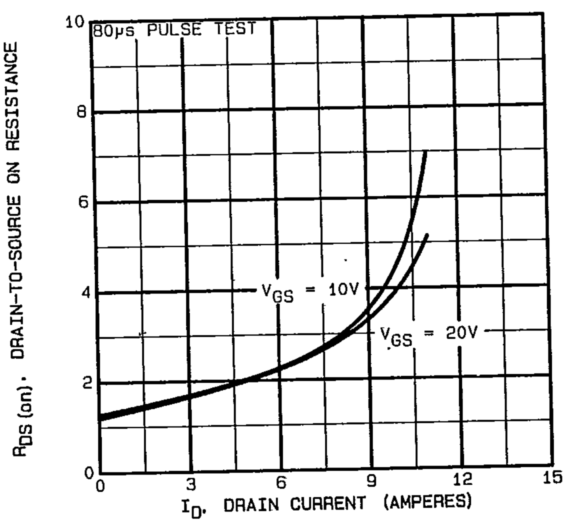

Fig. 12 — Typical On-Resistance Vs. Drain Current

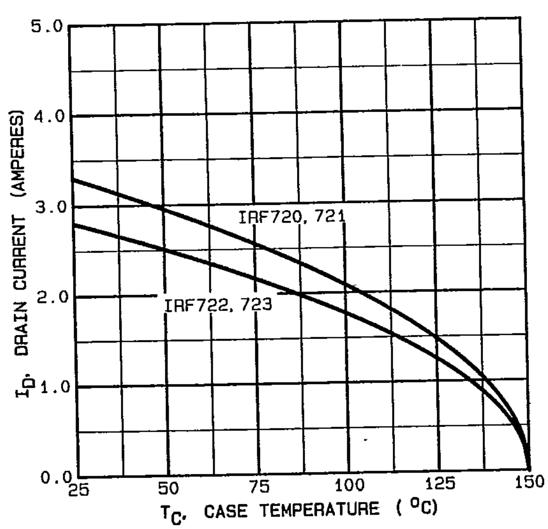

Fig. 13 — Maximum Drain Current Vs. Case Temperature

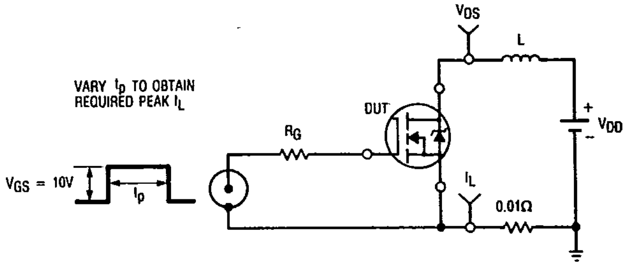

Fig. 14a — Unclamped Inductive Test Circuit

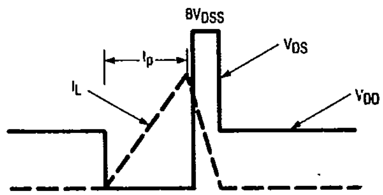

Fig. 14b — Unclamped Inductive Waveforms

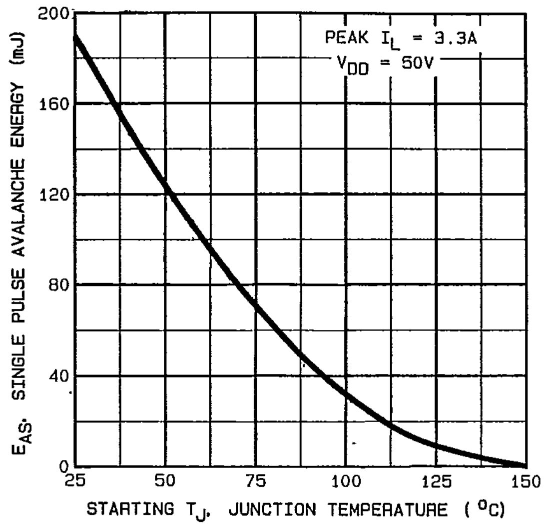

Fig. 14c — Maximum Avalanche Energy Vs. Starting Junction Temperature

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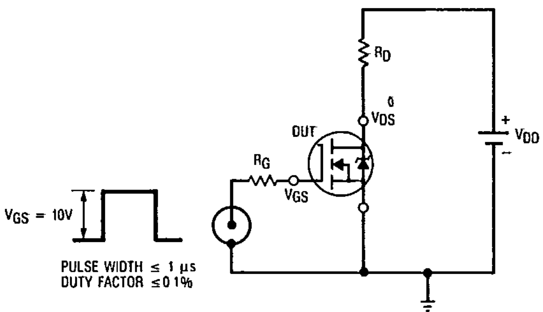

Fig. 15a — Switching Time Test Circuit

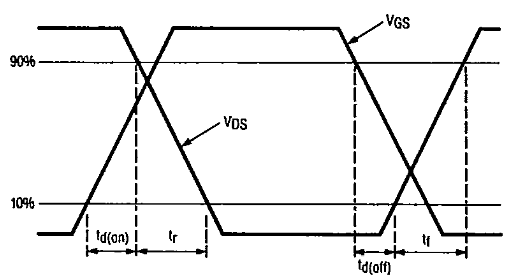

Fig. 15b — Switching Time Waveforms

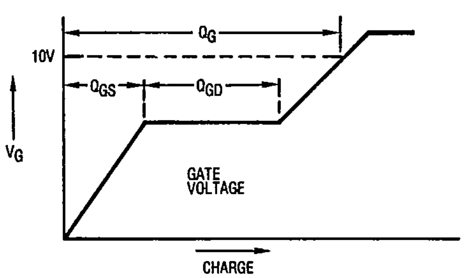

Fig. 16a — Basic Gate Charge Waveform

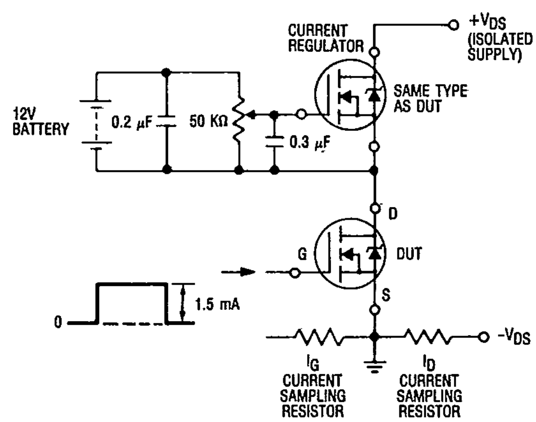

Fig. 16b — Gate Charge Test Circuit

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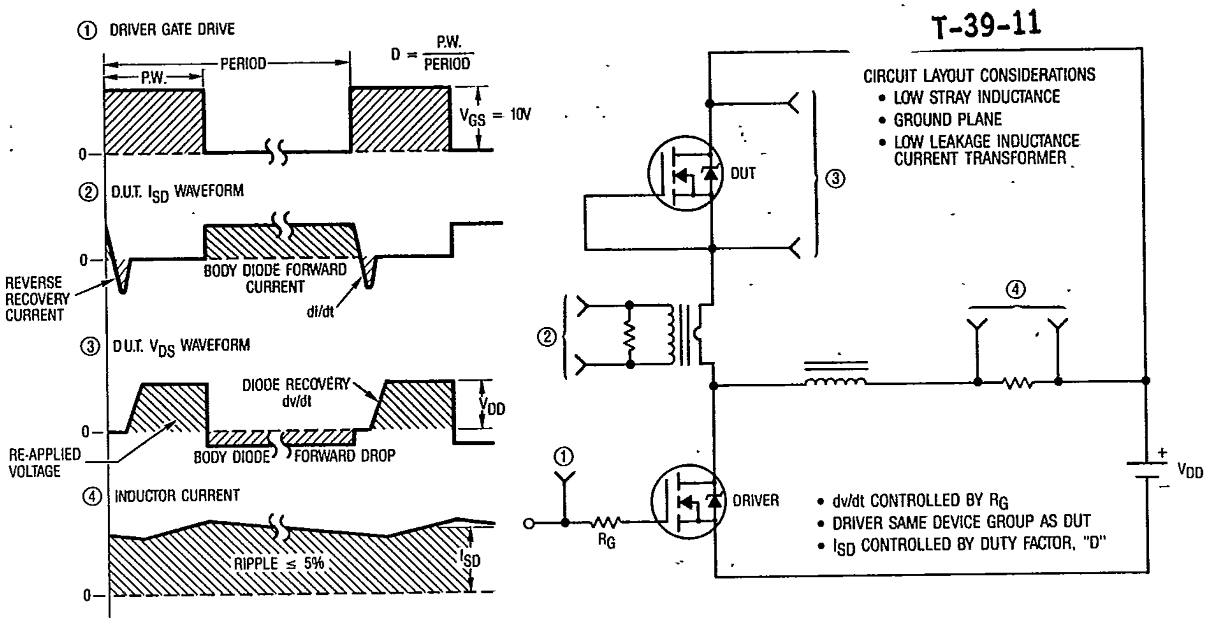

Fig. 17 — Peak Diode Recovery dv/dt Test Circuit

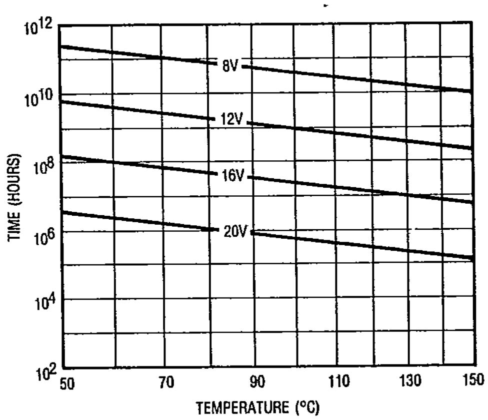

***Fig. 18 — Typical Time to Accumulated 1% Gate Failure**

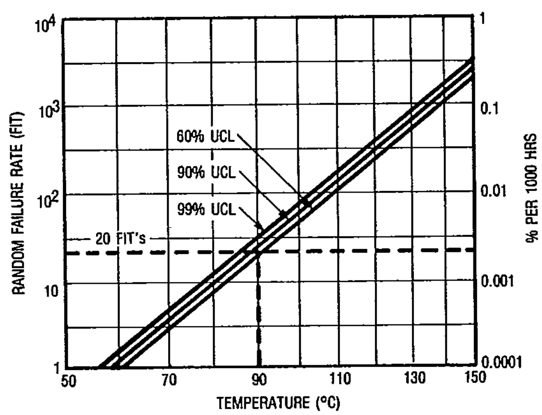

***Fig. 19 — Typical High Temperature Reverse Bias (HTRB) Failure Rate**

*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.