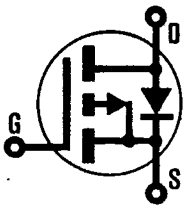
Data Sheet No. PD-9.421A
T-39-23

INTERNATIONAL RECTIFIER IOR

HEXFET® TRANSISTORS IRF9540 IRF9541 IRF9542 IRF9543

P-CHANNEL 100 VOLT POWER MOSFETs



TO-220

−100 Volt, 0.2 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 the HEXFET design achieve very low on-state resistance combined with high transconductance and extreme device ruggedness.

The P-Channel HEXFETs are designed for applications which require the convenience of reverse polarity operation. They retain all of the features of the more common N-Channel HEXFETs such as voltage control, very fast switching, ease of paralleling, and excellent temperature stability. The P-Channel IRF9540 device is an approximate electrical complement to the N-Channel IRF530 HEXFET.

P-Channel HEXFETs are intended for use in power stages where complementary symmetry with N-Channel devices offers circuit simplification. They are also very useful in drive stages because of the circuit versatility offered by the reverse polarity connection. Applications include motor control, audio amplifiers, switched mode converters, control circuits and pulse amplifiers.

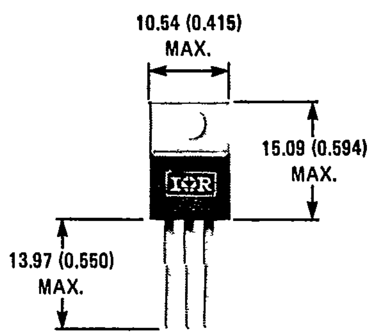
Product Summary

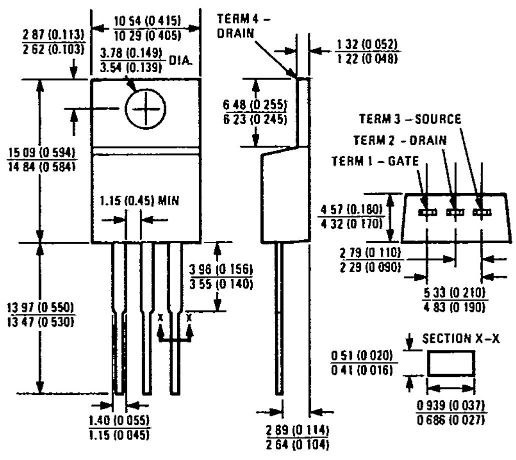
Part Number	V_{DS}	$R_{DS(on)}$	I_D
IRF9540	-100V	0.2Ω	-19A
IRF9541	-60V	0.2Ω	-19A
IRF9542	-100V	0.3Ω	-15A
IRF9543	-60V	0.3Ω	-15A

Features:

- P-Channel Versatility
- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- Excellent Temperature Stability

CASE STYLE AND DIMENSIONS





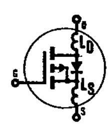
Case Style TO-220AB
Dimensions in Millimeters and (Inches)

IRF9540, IRF9541, IRF9542, IRF9543 Devices

Absolute Maximum Ratings

	Parameter	IRF9540	IRF9541	IRF9542	IRF9543	Units
V_{DS}	Drain - Source Voltage ①	-100	-60	-100	-60	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 20 KΩ) ①	-100	-60	-100	-60	V
I_D @ T_C = 25°C	Continuous Drain Current	-19	-19	-15	-15	A
I_D @ T_C = 100°C	Continuous Drain Current	-12	-12	-10	-10	A
I_{DM}	Pulsed Drain Current ③	-76	-76	-60	-60	A
V_{GS}	Gate - Source Voltage	±20				V
P_D @ T_C = 25°C	Max. Power Dissipation	125 (See Fig. 14)				W
	Linear Derating Factor	1.0 (See Fig. 14)				W/K④
I_{LM}	Inductive Current, Clamped	(See Fig. 15 and 16) L = 100μH -76	-76	-60	-60	A
T_J T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

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

	Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	IRF9540 IRF9542	-100	—	—	V	V_{GS} = 0V
		IRF9541 IRF9543	-60	—	—	V	I_D = -250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	-2.0	—	-4.0	V	$V_{DS} = V_{GS}$, I_D = -250μA
I_{GSS}	Gate - Source Leakage Forward	ALL	—	—	-500	nA	V_{GS} = -20V
I_{GSS}	Gate - Source Leakage Reverse	ALL	—	—	500	nA	V_{GS} = 20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	-250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	-1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	IRF9540 IRF9541	-19	—	—	A	$V_{DS} > I_{D(on)} \times R_{DS(on)max.}$, V_{GS} = -10V
		IRF9542 IRF9543	-15	—	—	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	IRF9540 IRF9541	—	0.15	0.2	Ω	V_{GS} = -10V, I_D = -10A
		IRF9542 IRF9543	—	0.22	0.3	Ω	
g_{fs}	Forward Transconductance ②	ALL	5.0	7.0	—	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)max.}$, I_D = -6.0A
C_{iss}	Input Capacitance	ALL	—	1100	1300	pF	V_{GS} = 0V, V_{DS} = -25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	—	550	700	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	—	250	400	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	—	20	30	ns	$V_{DD} \simeq 0.5\ BV_{DSS}$, I_D = -10A, Z_o = 4.7Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	—	10	15	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	13	20	ns	
t_f	Fall Time	ALL	—	8.0	12	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	70	90	nC	V_{GS} = -15V, I_D = -24A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	—	14	—	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	—	56	—	nC	
L_D	Internal Drain Inductance	ALL	—	3.5	—	nH	Measured from the contact screw on tab to center of die. / Modified MOSFET symbol showing the internal device inductances. 
			—	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.

Thermal Resistance

R_{thJC}	Junction-to-Case	ALL	—	—	1.0	K/W④	
R_{thCS}	Case-to-Sink	ALL	—	1.0	—	K/W④	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	—	—	80	K/W④	Typical socket mount

IRF9540, IRF9541, IRF9542, IRF9543 Devices

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Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	IRF9540 IRF9541	—	—	-19	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		IRF9542 IRF9543	—	—	-15	A	
I_{SM}	Pulse Source Current (Body Diode) ③	IRF9540 IRF9541	—	—	-76	A	
		IRF9542 IRF9543	—	—	-60	A	
V_{SD}	Diode Forward Voltage ②	IRF9540 IRF9541	—	—	-4.2	V	T_C = 25°C, I_S = -19A, V_{GS} = 0V
		IRF9542 IRF9543	—	—	-4.0	V	T_C = 25°C, I_S = -15A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	—	170	—	ns	T_J = 150°C, I_F = -19A, dI_F/dt = 100A/μs
Q_{RR}	Reverse Recovered Charge	ALL	—	0.8	—	μC	T_J = 150°C, I_F = -19A, dI_F/dt = 100A/μs
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S + L_D$.				

①T_J = 25°C to 150°C. ②Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

④K/W = °C/W
W/K = W/°C

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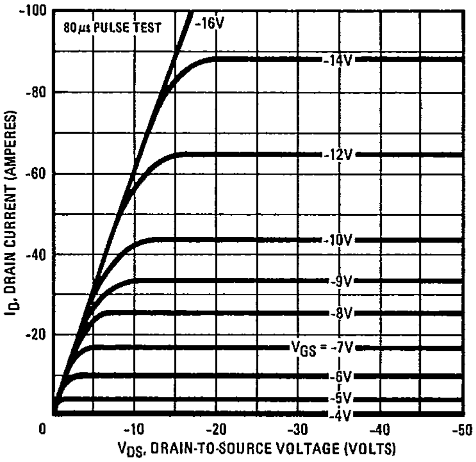

Fig. 1 — Typical Output Characteristics

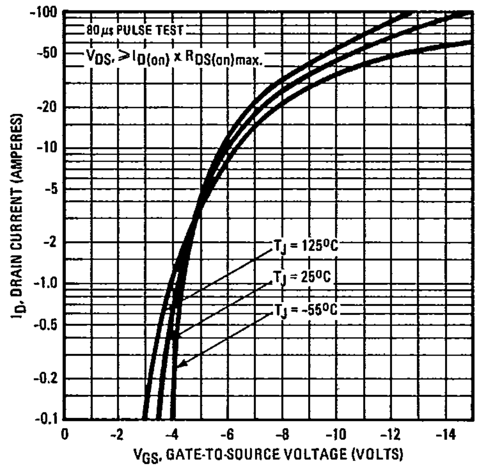

Fig. 2 — Typical Transfer Characteristics

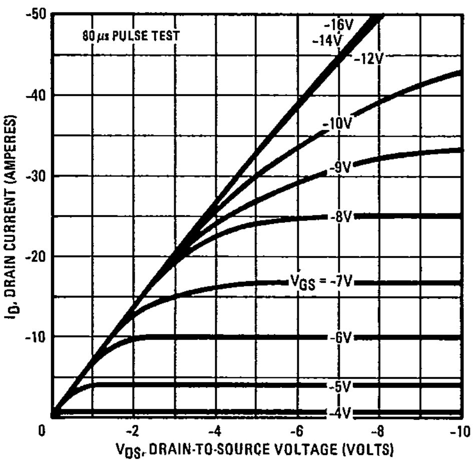

Fig. 3 — Typical Saturation Characteristics

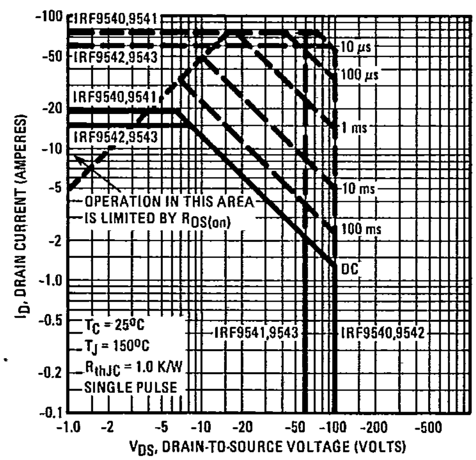

Fig. 4 — Maximum Safe Operating Area

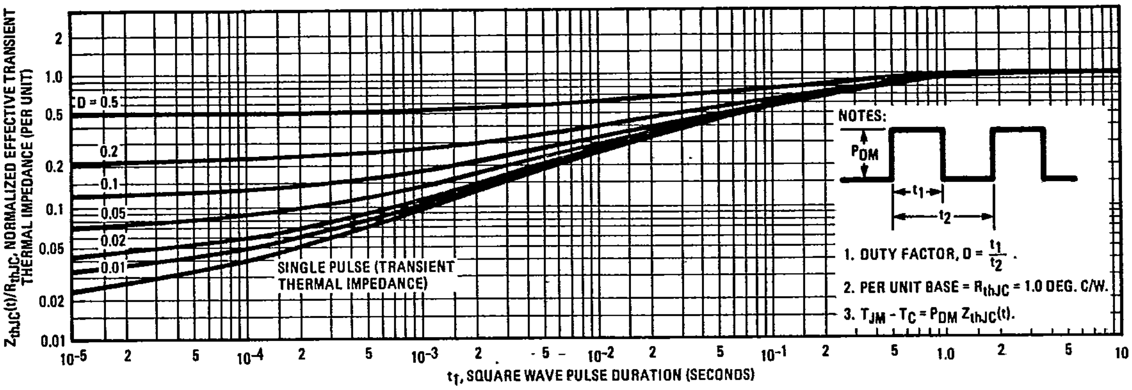

Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

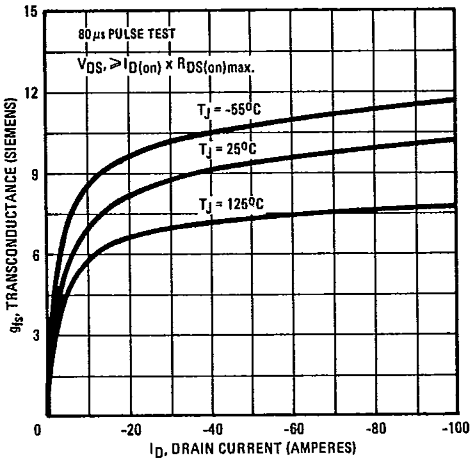

Fig. 6 — Typical Transconductance Vs. Drain Current

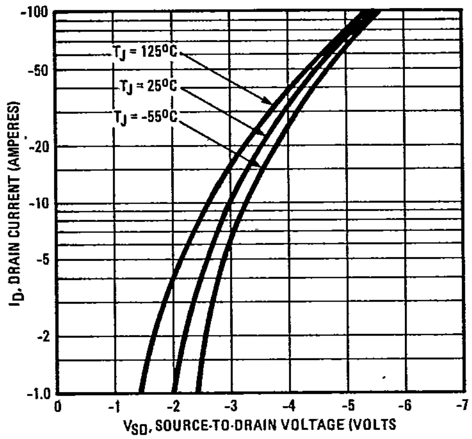

Fig. 7 — Typical Source-Drain Diode Forward Voltage

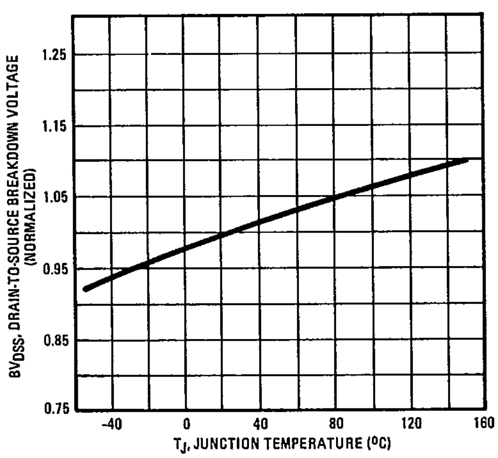

Fig. 8 — Breakdown Voltage Vs. Temperature

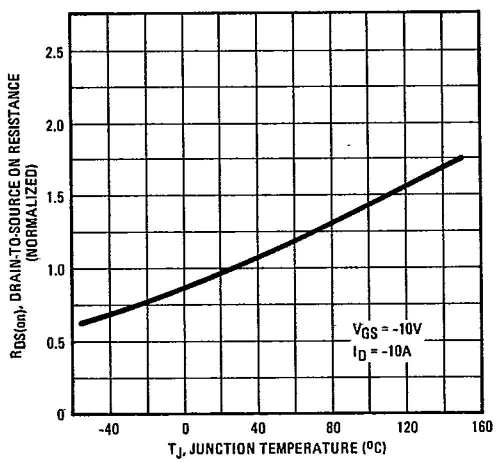

Fig. 9 — Normalized On-Resistance Vs. Temperature

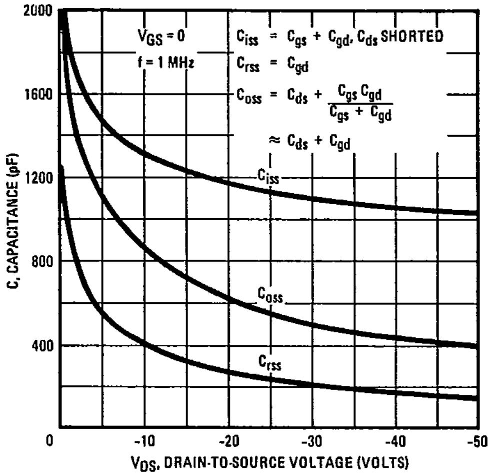

Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

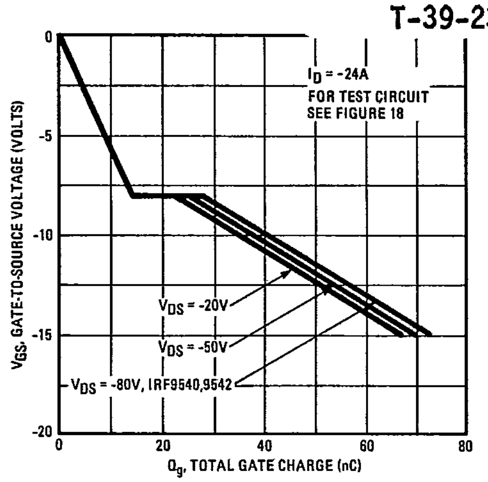

Fig. 11 — Typical Gate Charge Vs. Gate-to-Source Voltage

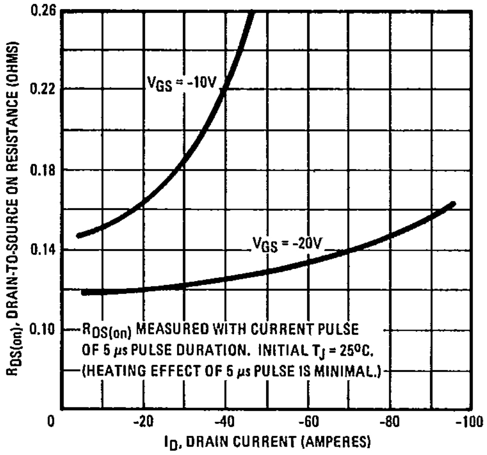

Fig. 12 — Typical On-Resistance Vs. Drain Current

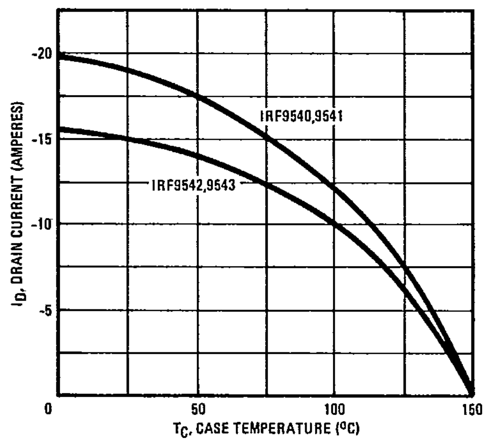

Fig. 13 — Maximum Drain Current Vs. Case Temperature

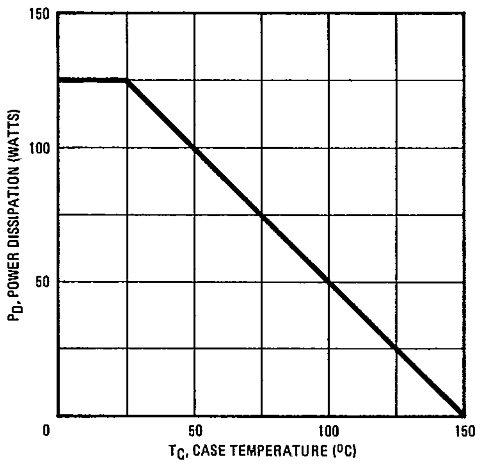

Fig. 14 — Power Vs. Temperature Derating Curve

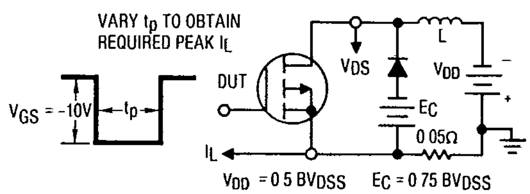

Fig. 15 — Clamped Inductive Test Circuit

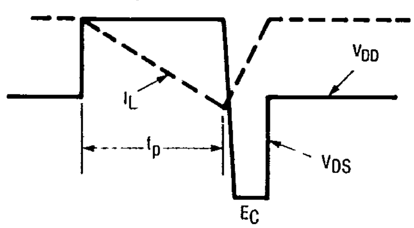

Fig. 16 — Clamped Inductive Waveforms

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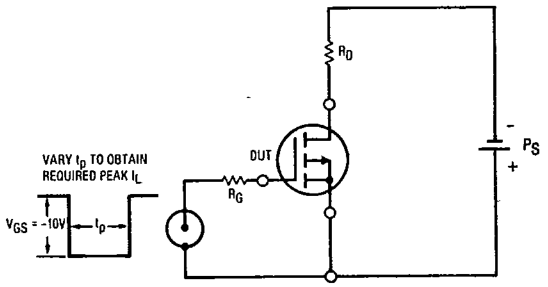

Fig. 17 — Switching Time Test Circuit

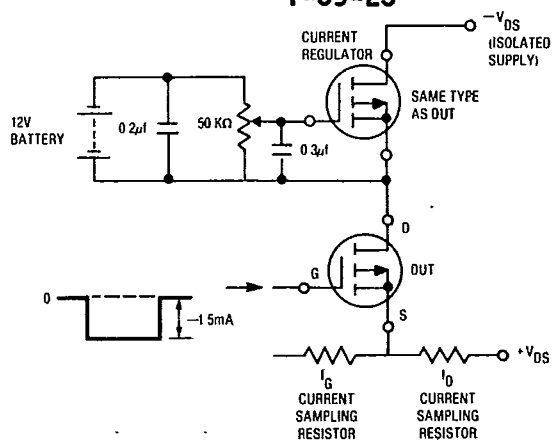

Fig. 18 — Gate Charge Test Circuit

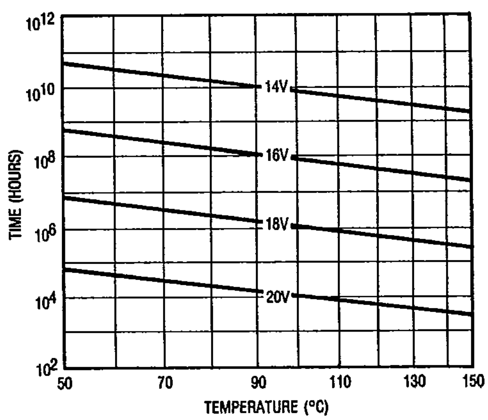

*Fig. 19 — Typical Time to Accumulated 1% Gate Failure

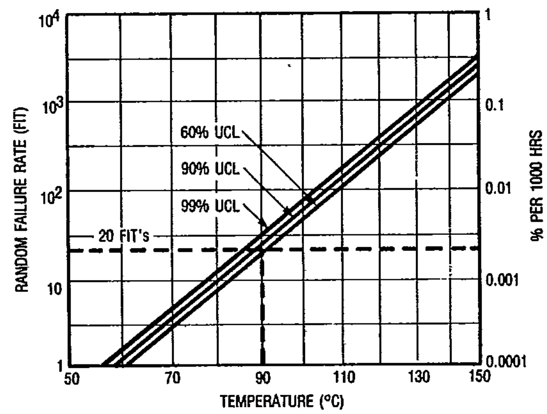

*Fig. 20 — Typical High Temperature Reverse Bias (HTRB) Failure Rate

*The data shown in 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.