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INTERNATIONAL RECTIFIER

Data Sheet No. PD-9.516A

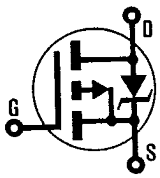
T-37-25

INTERNATIONAL RECTIFIER IOR

REPETITIVE AVALANCHE AND dv/dt RATED

HEXFET® TRANSISTORS

IRFR9010 IRFR9012 IRFU9010 IRFU9012



P-CHANNEL

D-PAK

−50 Volt, 0.50 Ohm HEXFET

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.

Surface mount packages enhance circuit performance by reducing stray inductances and capacitance. The D-Pak (TO-252AA) surface mount package brings the advantages of HEXFETs to high volume applications where PC Board surface mounting is desirable. The surface mount option IRFR9010 is provided on 16mm tape. The straight lead option IRFU9010 of the device is called the I-Pak (TO-251AA).

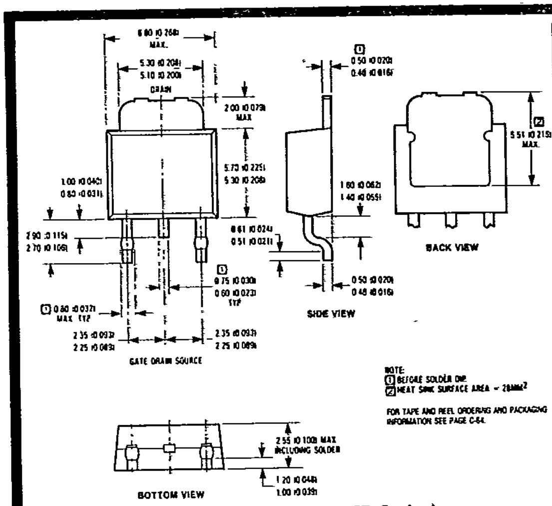
They are well suited for applications where limited heat dissipation is required such as, computers and peripherals, telecommunications equipment, DC/DC converters, and a wide range of consumer products.

Product Summary

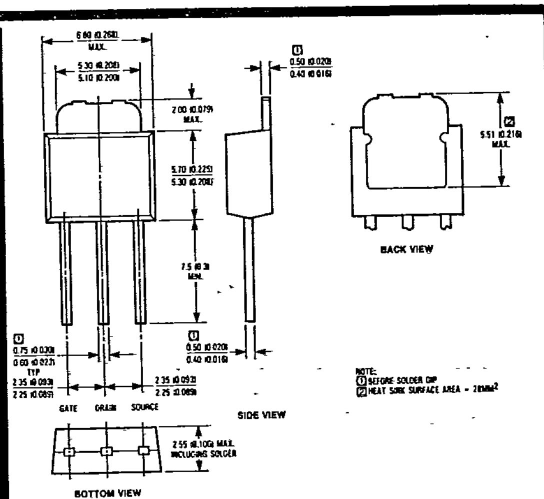
Part Number	BV_{DSS}	$R_{DS(on)}$	I_D
IRFR9010	−50V	0.50Ω	−5.3A
IRFR9012	−50V	0.70Ω	−4.5A
IRFU9010	−50V	0.50Ω	−5.3A
IRFU9012	−50V	0.70Ω	−4.5A

FEATURES:

- Surface Mountable (Order As IRFR9010)
- Straight Lead Option (Order As IRFU9010)
- Repetitive Avalanche Ratings
- Dynamic dv/dt Rating
- Simple Drive Requirements
- Ease of Paralleling



Case Style TO-252AA (IRFR Series)
Dimensions in Millimeters and (Inches)



Case Style TO-251AA (IRFU Series)
Dimensions in Millimeters and (Inches)

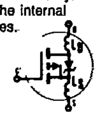
IRFR9010, IRFR9012, IRFU9010, IRFU9012 Devices

INTERNATIONAL RECTIFIER

Absolute Maximum Ratings

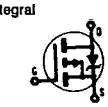
	Parameter	IRFR9010, IRFU9010	IRFR9012, IRFU9012	Units
I_D @ T_C = 25°C	Continuous Drain Current	−5.3	−4.5	A
I_D @ T_C = 100°C	Continuous Drain Current	−3.3	−2.8	A
I_{DM}	Pulsed Drain Current ①	−21	−18	A
P_D @ T_C = 25°C	Max. Power Dissipation	25		W
	Linear Derating Factor	0.20		W/K ⑤
V_{GS}	Gate-to-Source Voltage	±20		V
E_{AS}	Single Pulse Avalanche Energy ②	240 (See Fig. 14)		mJ
I_{AR}	Avalanche Current ① (Repetitive or Non-Repetitive)	−5.3 (See E_{AR})		A
E_{AR}	Repetitive Avalanche Energy ①	2.5 (See I_{AR})		mJ
dv/dt	Peak Diode recovery dv/dt ③	5.8 (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	All	−50			V	V_{GS} = 0V, I_D = −250μA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance ④	IRFR9010 IRFU9010	—	0.35	0.50	Ω	V_{GS} = −10V, I_D = −2.8A
		IRFR9012 IRFU9012	—	0.50	0.70		
$I_{D(on)}$	On-State Drain Current ④	IRFR9010 IRFU9010	−5.3	—	—	A	V_{DS} > $I_{D(on)}$ × $R_{DS(on)}$ Max. V_{GS} = −10V
		IRFR9012 IRFU9012	−4.5				
$V_{GS(th)}$	Gate Threshold Voltage	ALL	−2.0	—	−4.0	V	V_{DS} = V_{GS}, I_D = −250μA
g_{fs}	Forward Transconductance ④	ALL	1.1	1.7	—	S(℧)	V_{DS} ≤ −50V, I_{DS} = −2.8A
I_{DSS}	Zero Gate Voltage Drain Current	ALL	—	—	−250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			—	—	−1000		V_{DS} = 0.8 × 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	—	6.1	9.1	nC	V_{GS} = −10V, I_D = −4.7A
Q_{gs}	Gate-to-Source Charge	ALL	—	2.0	3.0	nC	V_{DS} = 0.8 × Max. Rating See Fig. 16
Q_{gd}	Gate-to-Drain ("Miller") Charge		—	3.9	5.9	nC	(Independent or operating temperature)
$t_{d(on)}$	Turn-On Delay Time	ALL	—	6.1	9.2	ns	V_{DD} = −25V, I_D = −4.7A, R_G = 24Ω
t_r	Rise Time	ALL	—	47	71	ns	R_D = 5.6Ω
$t_{d(off)}$	Turn-Off Delay Time	ALL	—	13	20	ns	See Fig. 15
t_f	Fall Time	ALL	—	35	59	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. Modifed 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	—	240	—	pF	V_{GS} = 0V, V_{DS} = −25V
C_{oss}	Output Capacitance	ALL	—	160	—	pF	f = 1.0 MHz
C_{rss}	Reverse Transfer Capacitance	ALL	—	30	—	pF	See Fig. 10

D-PAK

Source-Drain Diode Ratings and Characteristics

	Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	ALL	—	—	-5.3	A	Modified MOSFET symbol showing the integral Reverse p-n junction rectifier. 
I_{SM}	Pulsed Source Current (Body Diode) ①	ALL	—	—	-18	A	
V_{SD}	Diode Forward Voltage ④	ALL	—	—	-5.5	V	T_J = 25°C, I_S = -5.3A, V_{GS} = 0V
t_{rr}	Reverse Recovery Time	ALL	33	75	160	ns	T_J = 25°C, I_F = -4.7A, di/dt = 100 A/μs
Q_{RR}	Reverse Recovery Charge	ALL	0.090	0.22	0.52	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	—	—	5.0	K/W⑤	
R_{thCS}	Case-to-Sink	ALL	—	1.7	—	K/W⑤	Typical solder mount⑥
R_{thJA}	Junction-to-Ambient	ALL	—	—	110	K/W⑤	Typical socket mount

① Repetitive Rating; Pulse width limited by maximum junction temperature (see figure 5)

② @ V_{DD} = -25V, Starting T_J = 25°C, L = 9.7 mH, R_G = 25Ω, Peak I_L = -5.3A

③ I_{SD} ≤ -5.3A, di/dt ≤ -80A/μs, V_{DD} 40V, T_J ≤ 150°C Suggested R_G = 24Ω

④ Pulse width ≤ 300 μs; Duty Cycle ≤ 2%

⑤ K/W = °C/W W/K = W/°C

⑥ Mounting pad must cover heatsink surface area. See case style drawing on front page

The information shown on the following graphs applies also to the IRFU devices.

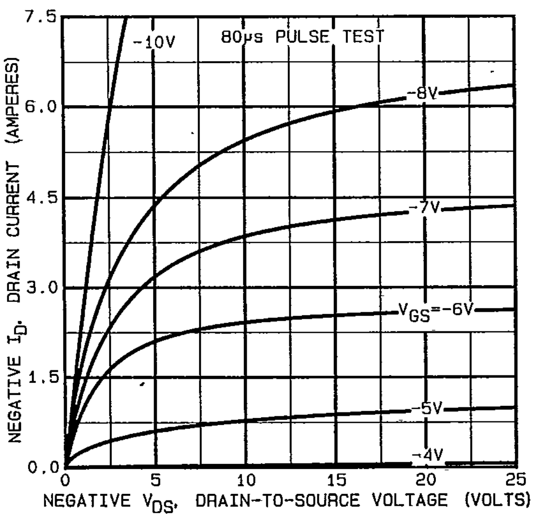


Fig. 1 — Typical Output Characteristics

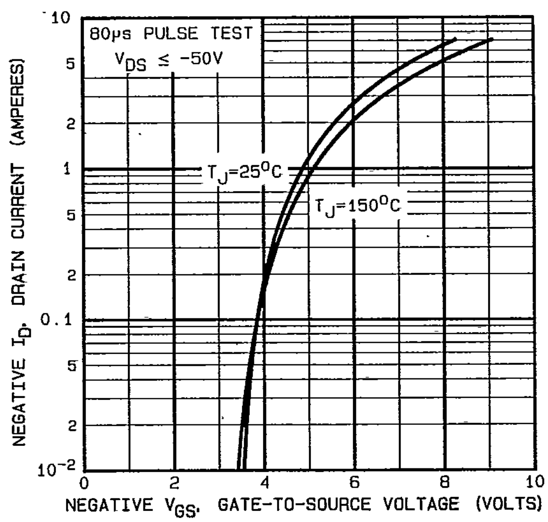


Fig. 2 — Typical Transfer Characteristics

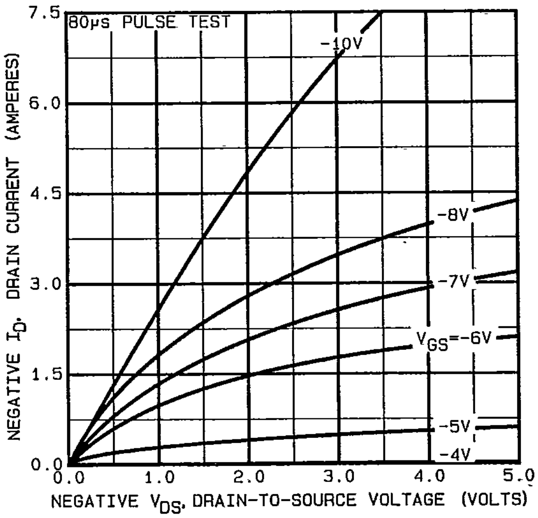


Fig. 3 — Typical Saturation Characteristics

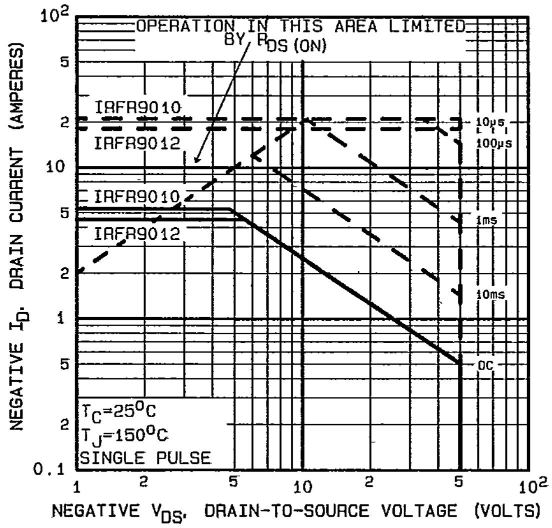


Fig. 4 — Maximum Safe Operating Area

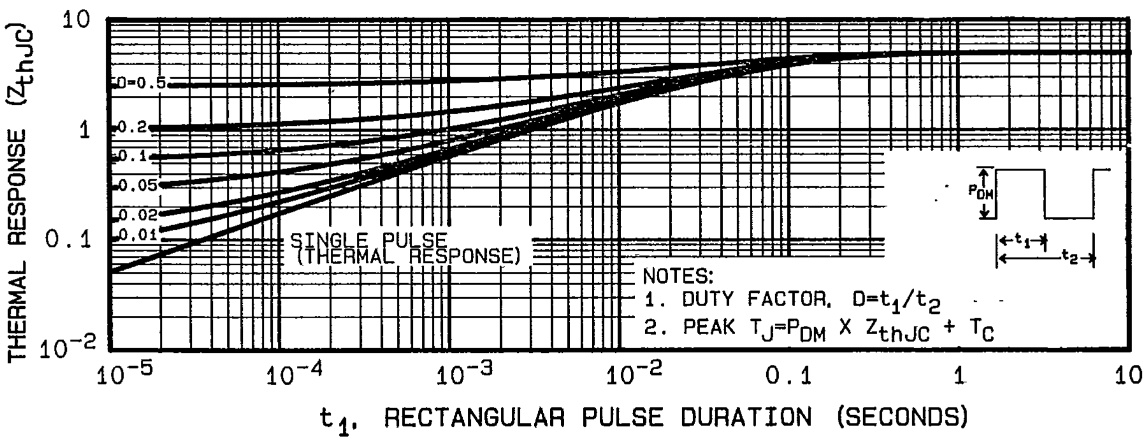


Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

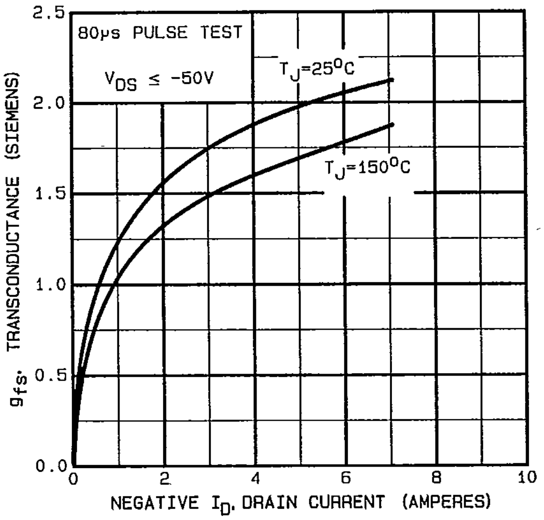


Fig. 6 — Typical Transconductance Vs. Drain Current

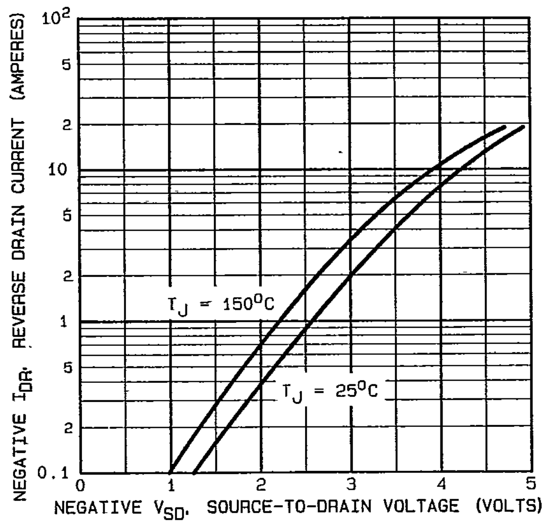


Fig. 7 — Typical Source-Drain Diode Forward Voltage

D-PAK

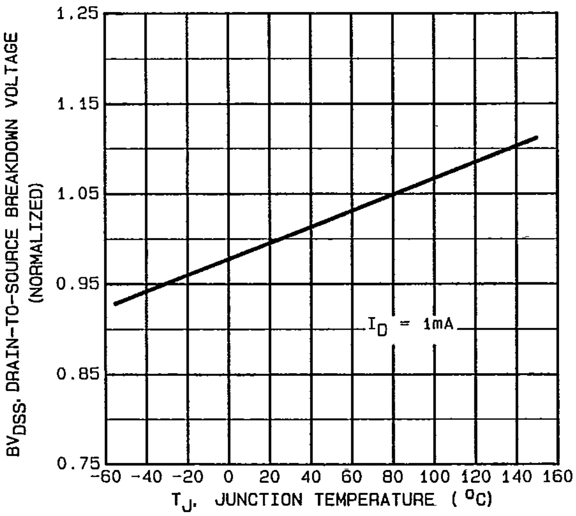


Fig. 8 — Breakdown Voltage Vs. Temperature

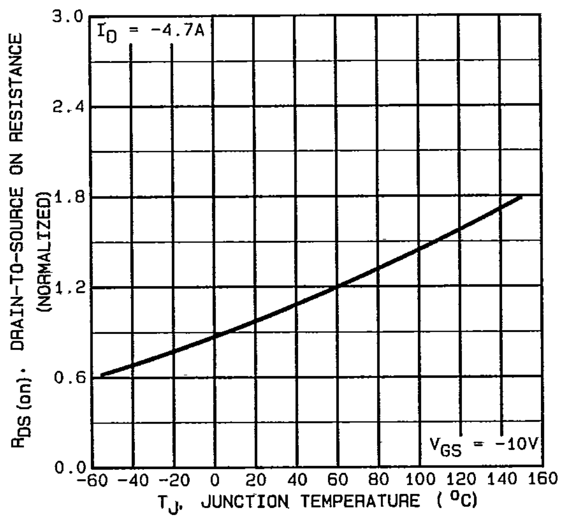


Fig 9 — Normalized On-Resistance Vs. Temperature

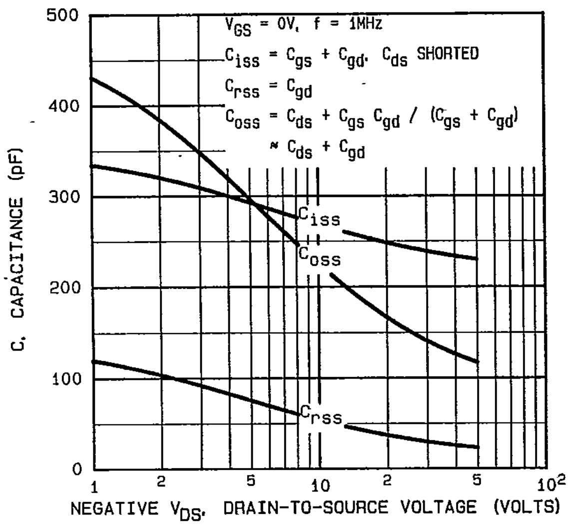


Fig. 10 — Typical Capacitance Vs. Drain-to-Source Voltage

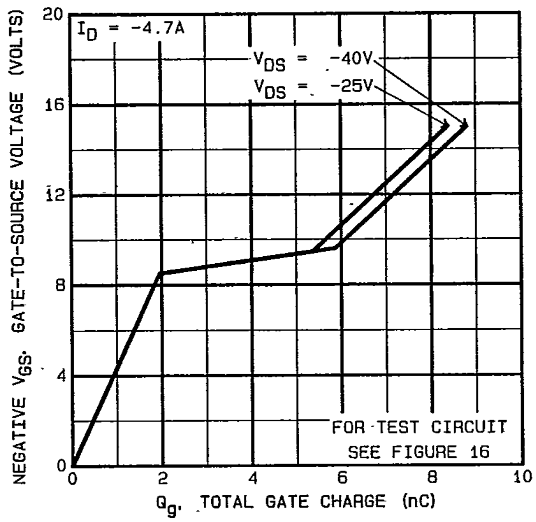


Fig. 11 — Typical Gate Charge Vs. Gate-to-Source Voltage

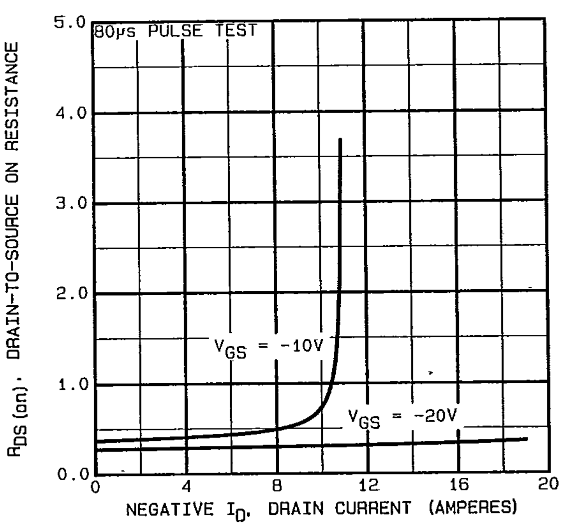


Fig. 12 — Typical On-Resistance Vs. Drain Current

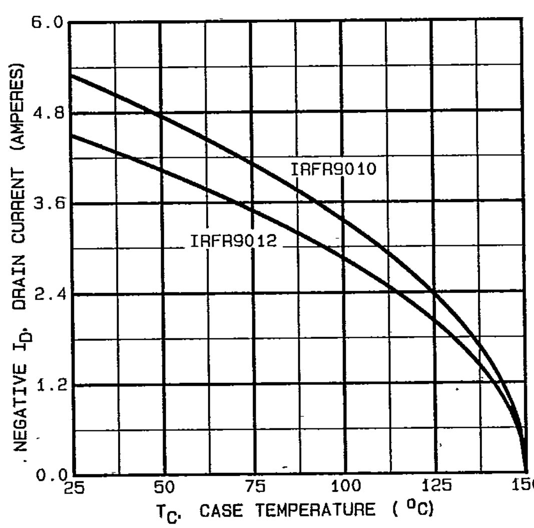


Fig. 13 — Maximum Drain Current Vs. Case Temperature

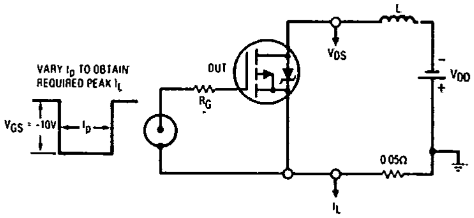


Fig. 14a — Unclamped Inductive Test Circuit

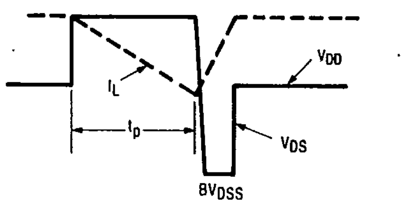


Fig. 14b — Unclamped Inductive Waveforms

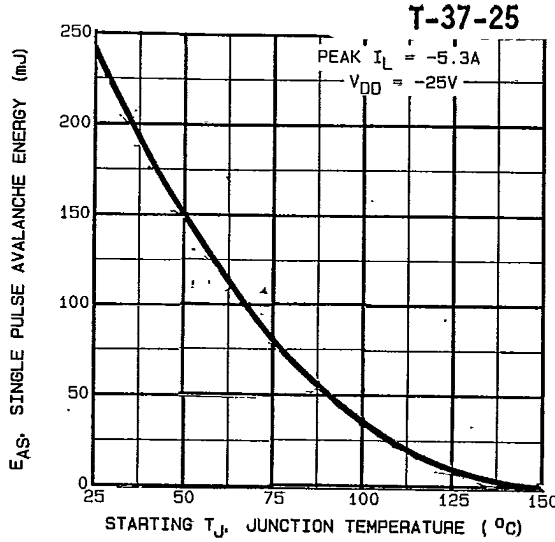


Fig. 14c — Maximum Avalanche Vs. Starting Junction Temperature

D-PAK

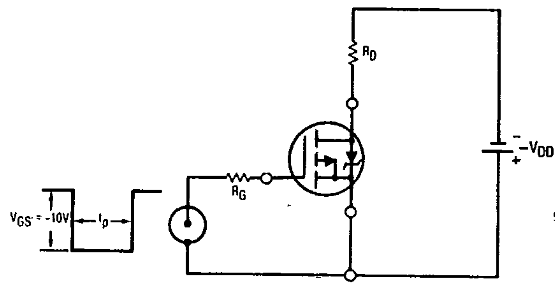


Fig. 15a — Switching Time Test Circuit

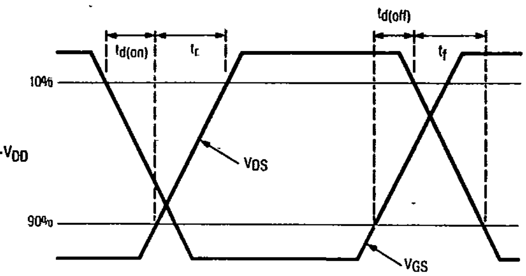


Fig. 15b — Switching Time Waveforms

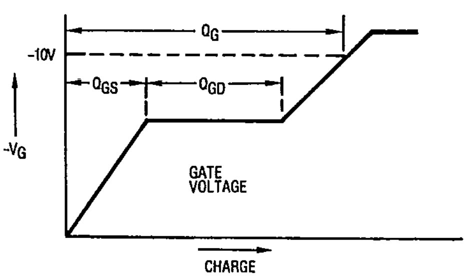


Fig. 16a — Basic Gate Charge Waveform

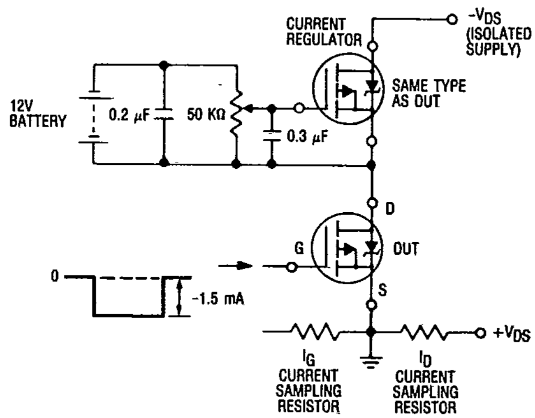


Fig. 16b — Gate Charge Test Circuit

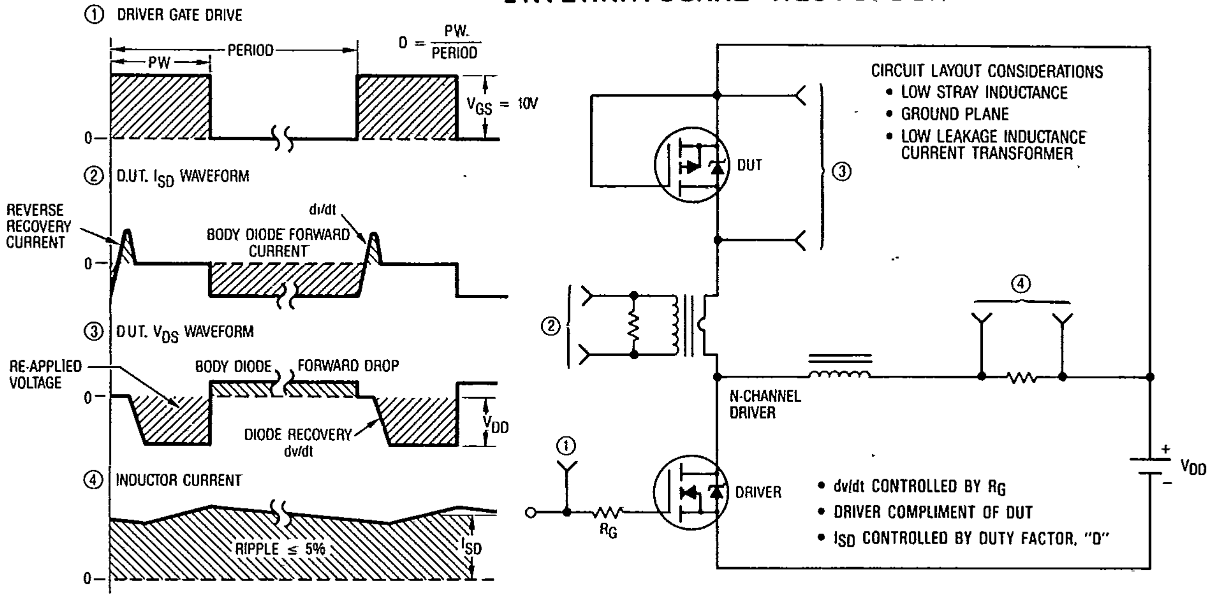


Fig. 17 — Peak Diode Recovery dv/dt Test Circuit

ORDERING INFORMATION

IRFR Series — Tape and reel
when ordering, add TR after the part number and the quantity
(order in multiples of 3,000 pieces).

Example: IRFR9010TR — 15,000 pieces

PACKAGING