

INTERNATIONAL RECTIFIER

T-37-25

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REPETITIVE AVALANCHE AND dv/dt RATED

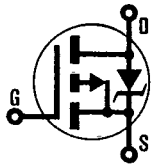
HEXFET® TRANSISTORS

IRFR9210

IRFR9212

IRFU9210

IRFU9212



P-CHANNEL

-200 Volt, 3.0 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 IRFR9210 is provided on 16mm tape. The straight lead option IRFU9210 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.

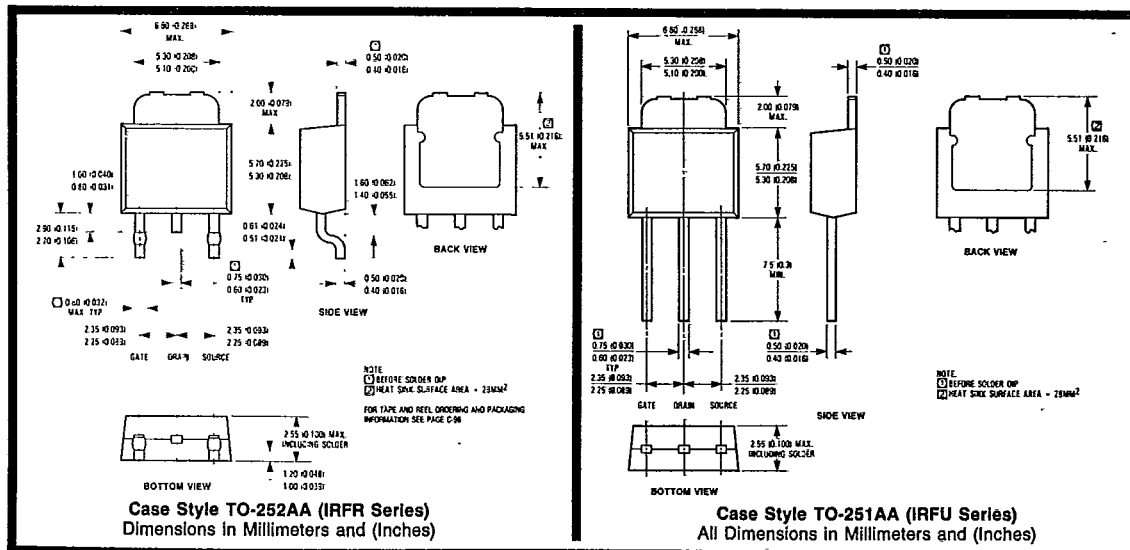
Product Summary

Part Number	BV_{DSS}	$R_{DS(on)}$	I_D
IRFR9210	-200V	3.0 Ω	-2.0A
IRFR9212	-200V	4.5 Ω	-1.6A
IRFU9210	-200V	3.0 Ω	-2.0A
IRFU9212	-200V	4.5 Ω	-1.6A

Features

- Surface Mountable (Order As IRFR9210)
- Straight Lead Option (Order As IRFU9210)
- Repetitive Avalanche Ratings
- Dynamic dv/dt Rating
- Simple Drive Requirements
- Ease of Paralleling

D-PAK



IRFR9210, IRFR9212, IRFU9210, IRFU9212 Devices

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Absolute Maximum Ratings

Parameter	IRFR9210, IRFU9210	IRFR9212, IRFU9212	Units
I_D @ $T_C = 25^\circ\text{C}$ Continuous Drain Current	-2.0	-1.6	A
I_D @ $T_C = 100^\circ\text{C}$ Continuous Drain Current	-1.2	-1.0	A
I_{DM} Pulsed Drain Current (1)	-8.0	-6.4	A
P_D @ $T_C = 25^\circ\text{C}$ Max. Power Dissipation	25		W
Linear Derating Factor	0.20		W/K (3)
V_{GS} Gate-to-Source Voltage	± 20		V
E_{AS} Single Pulse Avalanche Energy (2)	150 (See Fig. 14)		mJ
I_{AR} Avalanche Current (Repetitive or Non-Repetitive) (2)	-2.0 (See E_{AR})		A
E_{AR} Repetitive Avalanche Energy (1)	2.5 (See I_{AR})		mJ
dv/dt Peak Diode recovery dv/dt	5.0 (See Fig. 17)		V/ns
T_J Operating Junction Temperature	-55 to 150		$^\circ\text{C}$
T_{STG} Storage Temperature Range			$^\circ\text{C}$
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	All	-200	—	—	V	$V_{GS} = 0V, I_D = -250\mu A$
$R_{DS(on)}$ Static Drain-to-Source On-State Resistance (1)	IRFR9210 IRFU9210	—	2.3	3.0	Ω	$V_{GS} = 10V, I_D = -1.0A$
	IRFR9212 IRFU9212	—	3.0	4.5		
$I_{D(on)}$ On-State Drain Current (1)	IRFR9210 IRFU9210	-2.0	—	—	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ Max. $V_{GS} = -10V$
	IRFR9212 IRFU9212	-1.6	—	—		
$V_{GS(th)}$ Gate Threshold Voltage	All	-2.0	—	-4.0	V	$V_{DS} = V_{GS}, I_D = -250\mu A$
g_{fs} Forward Transconductance (4)	All	0.61	0.92	—	S(U)	$V_{DS} \leq 50V, I_{DS} = -1.0A$
I_{DSS} Zero Gate Voltage Drain Current	All	—	—	-250	μA	$V_{DS} = \text{Max. Rating}, V_{GS} = 0V$
		—	—	-1000		$V_{DS} = 0.8 \times \text{Max. Rating}$ $V_{GS} = 0V, T_J = 125^\circ\text{C}$
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	—	6.5	9.7	nC	$V_{GS} = -10V, I_D = -2.3A$
Q_{gs} Gate-to-Source Charge	All	—	1.4	2.2	nC	$V_{DS} = 0.8 \times \text{Max. Rating}$
Q_{gd} Gate-to-Drain ("Miller") Charge		—	3.3	5.7	nC	See Fig. 16 (Independent of operating temperature)
$t_{d(on)}$ Turn-On Delay Time	All	—	8.0	12	ns	$V_{DD} = -100V, I_D = -2.3A, R_G = 24\Omega$
t_r Rise Time	All	—	12	18	ns	$R_D = 39\Omega$
$t_{d(off)}$ Turn-Off Delay Time	All	—	11	17	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.
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	—	180	—	pF	$V_{GS} = 0V, V_{DS} = -25V$
C_{oss} Output Capacitance	All	—	53	—	pF	$f = 1.0 \text{ MHz}$
C_{rss} Reverse Transfer Capacitance	All	—	17	—	pF	See Fig. 10

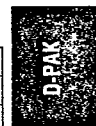


Source-Drain Diode Ratings and Characteristics

Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
I_S Continuous Source Current (Body Diode)	ALL	—	—	-2.0	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 (4)	ALL	—	—	-5.8	V	$T_J = 25^\circ\text{C}$, $I_S = -2.0\text{A}$, $V_{GS} = 0\text{V}$
t_{rr} Reverse Recovery Time	ALL	48	99	214	ns	$T_J = 25^\circ\text{C}$, $I_F = -2.3\text{A}$, $di/dt = 100\text{ A}/\mu\text{s}$
Q_{RR} Reverse Recovery Charge	ALL	0.19	0.40	0.92	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/W (5)	
R_{thCS} Case-to-Sink	ALL	—	1.7	—	K/W (5)	Typical solder mount (6)
R_{thJA} Junction-to-Ambient	ALL	—	—	110	K/W (5)	Typical socket mount



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

(2) @ $V_{DD} = -50\text{V}$, Starting $T_J = 25^\circ\text{C}$,
 $L = 59\text{ mH}$, $R_G = 25\Omega$,
Peak $I_L = 5.3\text{A}$

(3) $I_{SD} \leq -2.0\text{A}$, $di/dt \leq -70\text{A}/\mu\text{s}$,
 $V_{DD} \leq -50\text{V}$, $T_J \leq 150^\circ\text{C}$
Suggested $R_G = 24\Omega$

(4) Pulse width $\leq 300\mu\text{s}$; Duty Cycle $\leq 2\%$

(5) $\text{K/W} = ^\circ\text{C/W}$
 $\text{W/K} = \text{W}/^\circ\text{C}$

(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.

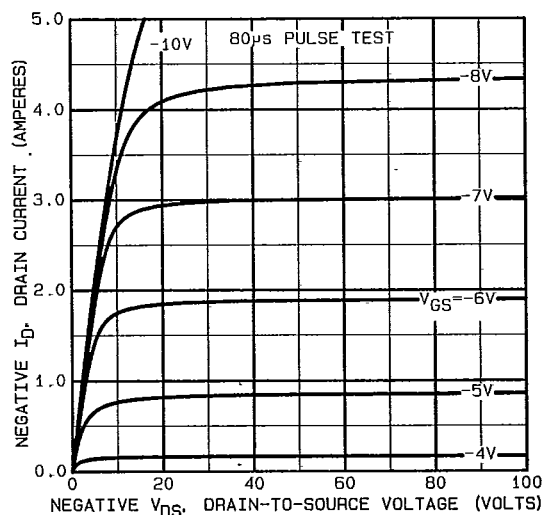


Fig. 1 — Typical Output Characteristics

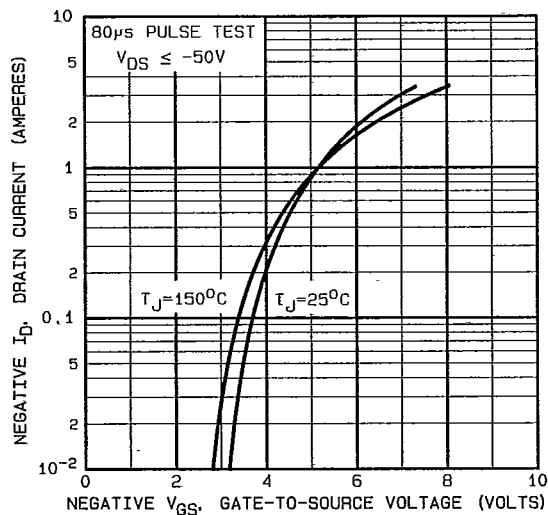


Fig. 2 — Typical Transfer Characteristics

IRFR9210, IRFR9212, IRFU9210, IRFU9212 Devices

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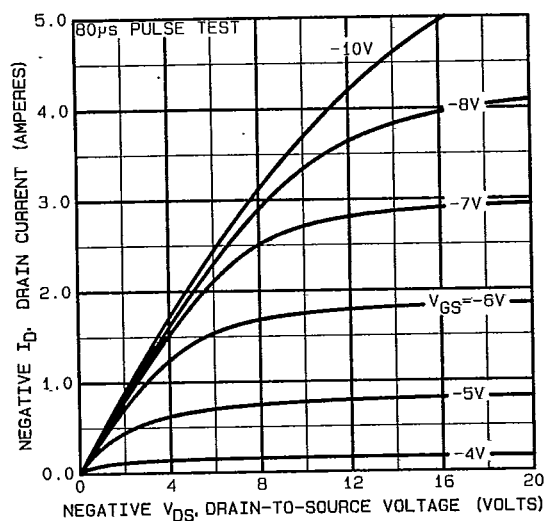


Fig. 3 — Typical Saturation Characteristics

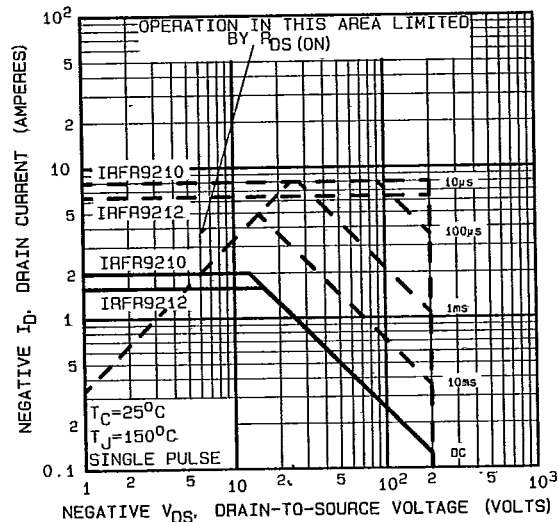


Fig. 4 — Maximum Safe Operating Area

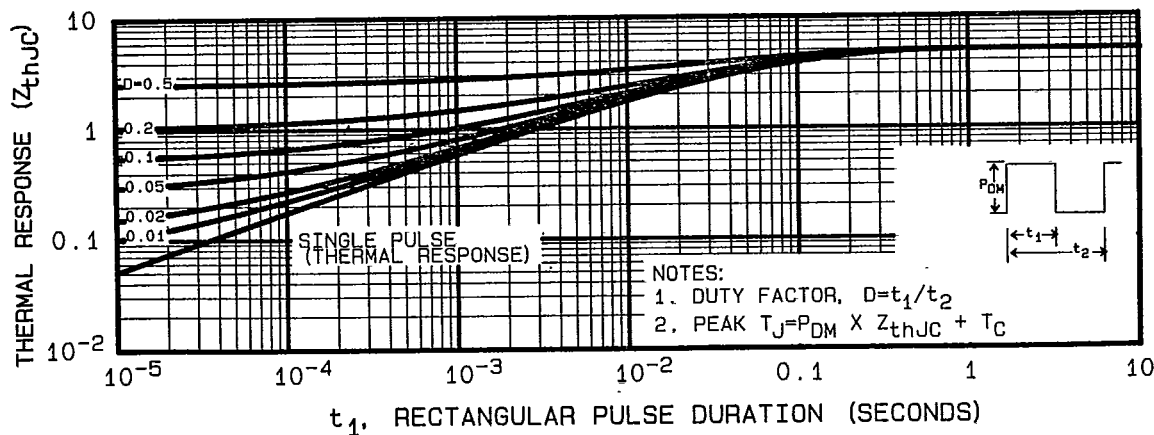


Fig. 5 — Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

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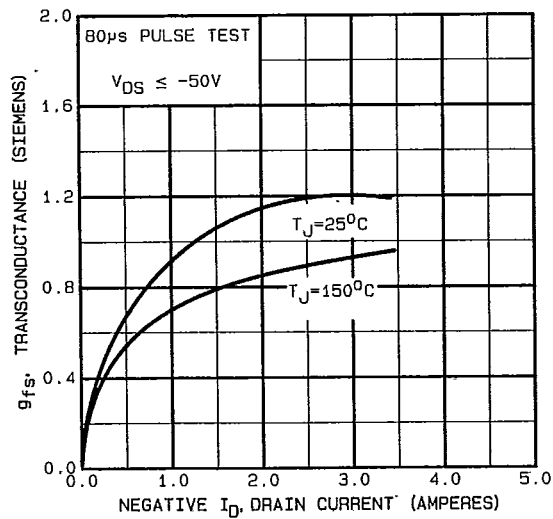


Fig. 6 — Typical Transconductance Vs. Drain Current

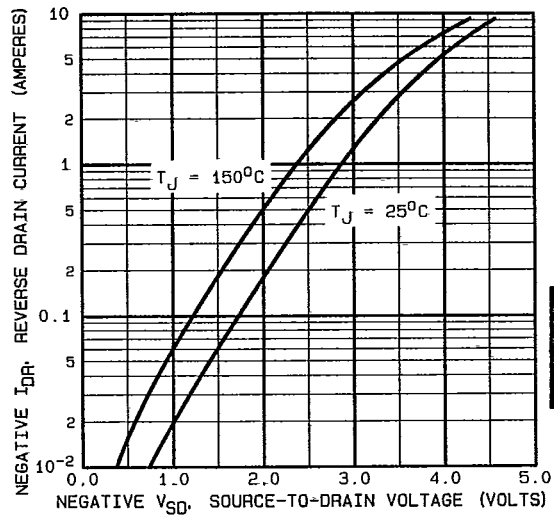


Fig. 7 — Typical Source-Drain Diode Forward Voltage

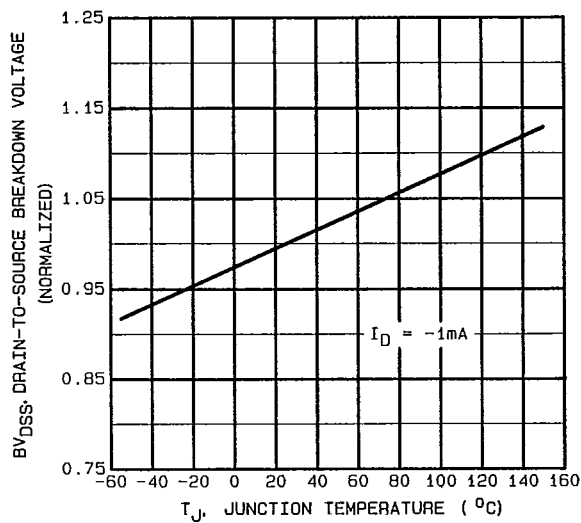


Fig. 8 — Breakdown Voltage Vs. Temperature

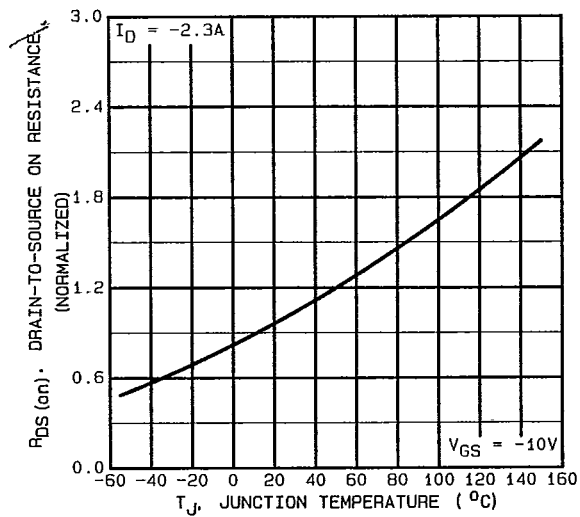
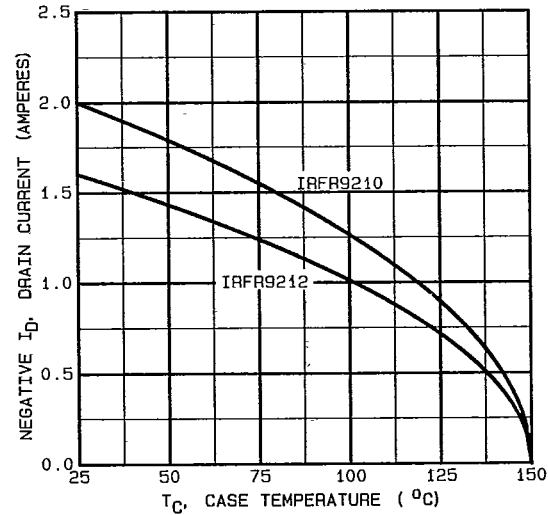
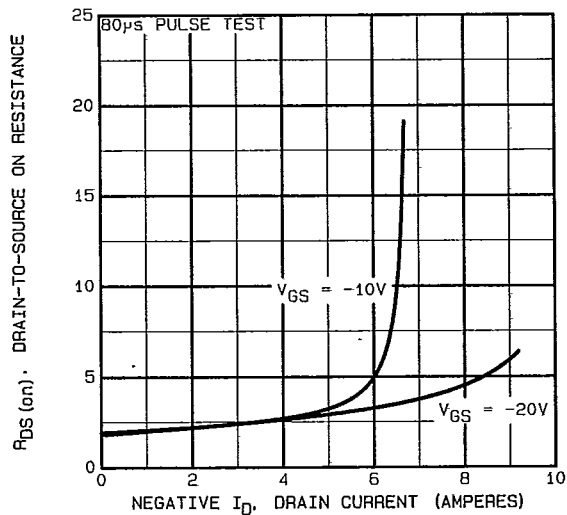
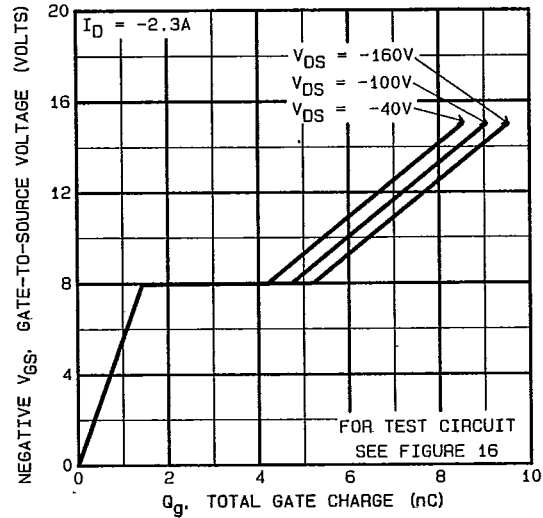
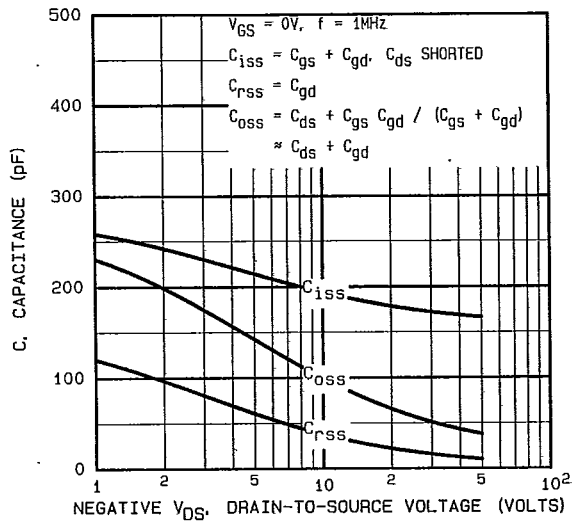


Fig. 9 — Normalized On-Resistance Vs. Temperature



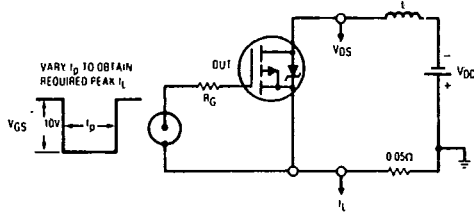


Fig. 14a — Unclamped Inductive Test Circuit

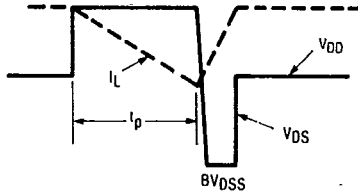


Fig. 14b — Unclamped Inductive Waveforms

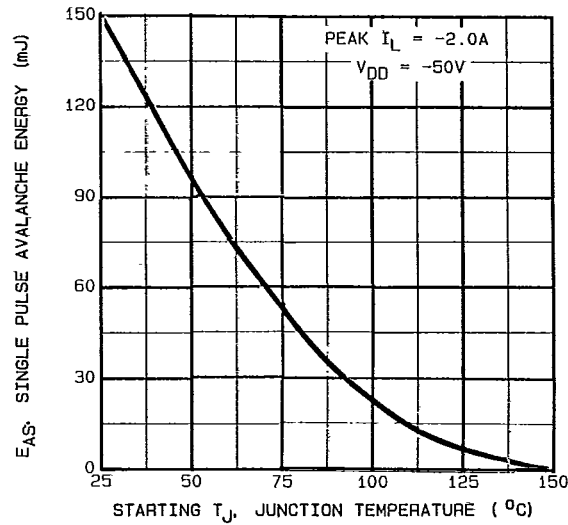


Fig. 14c — Maximum Avalanche Vs. Starting Junction Temperature

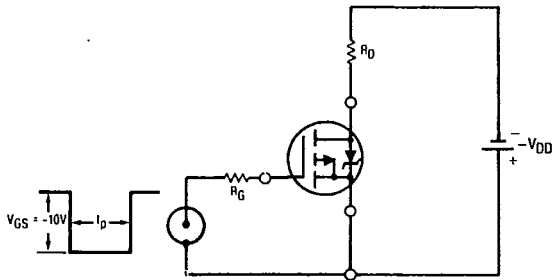


Fig. 15a — Switching Time Test Circuit

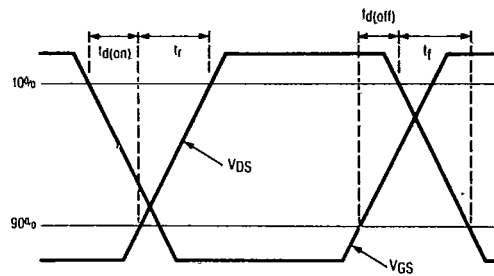


Fig. 15b — Switching Time Waveforms

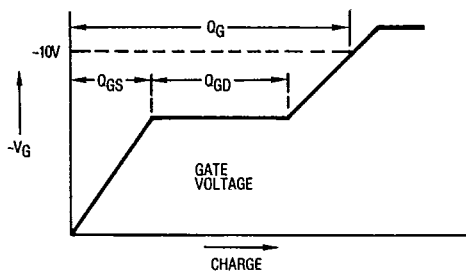


Fig. 16a — Basic Gate Charge Waveform

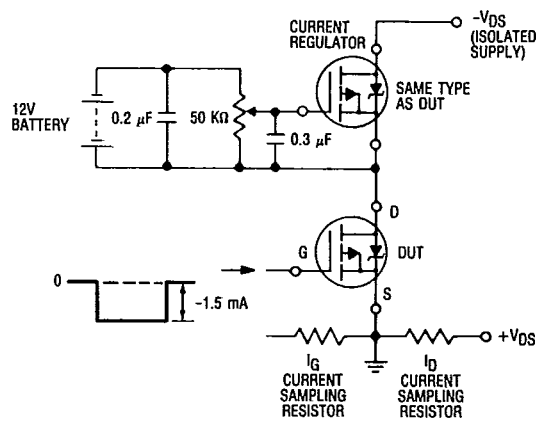


Fig. 16b — Gate Charge Test Circuit

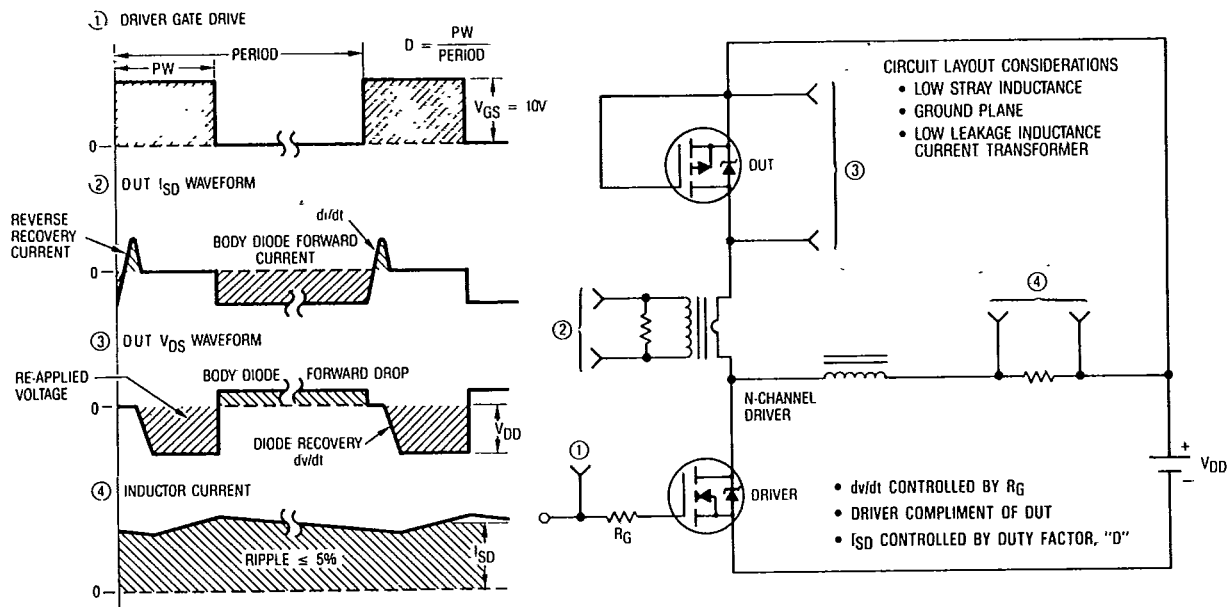


Fig. 17 — Peak Diode Recovery dv/dt Test Circuit

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: IRFR9210TR — 15,000 pieces.

PACKAGING

