HARRIS

IRF610/611/612/613
IRF610R/611R/612R/613R

N-Channel Power MOSFETs Avalanche Energy Rated*

August 1991

Features

- 2.6A and 3.3A, 150V - 200V
- $r_{DS}(on)$ = 1.5Ω and 2.4Ω
- Single Pulse Avalanche Energy Rated*
- SOA is Power-Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

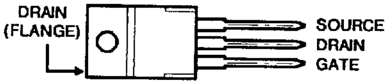
Description

The IRF610, IRF611, IRF612, and IRF613 are n-channel enhancement-mode silicon-gate power field-effect transistors. IRF610R, IRF611R, IRF612R and IRF613R types are advanced power MOSFETs designed, tested, and guaranteed to withstand a specified level of energy in the breakdown avalanche mode of operation. All of these power MOSFETs are designed for applications such as switching regulators, switching converters, motor drivers, relay drivers, and drivers for high-power bipolar switching transistors requiring high speed and low gate-drive power. These types can be operated directly from integrated circuits.

The IRF types are supplied in the JEDEC TO-220AB plastic package.

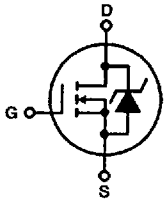
Package

TO-220AB
TOP VIEW



Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



Absolute Maximum Ratings (T_C = +25°C), Unless Otherwise Specified

		IRF610 IRF610R	IRF611 IRF611R	IRF612 IRF612R	IRF613 IRF613R	UNITS
Drain-Source Voltage (1)	V_{DS}	200	150	200	150	V
Drain-Gate Voltage (R_{GS} = 20kΩ) (1)	V_{DGR}	200	150	200	150	V
Continuous Drain Current						
T_C = +25°C	I_D	3.3	3.3	2.6	2.6	A
T_C = +100°C	I_D	2.1	2.1	1.6	1.6	A
Pulsed Drain Current (3)	I_{DM}	8	8	6.5	6.5	A
Gate-Source Voltage	V_{GS}	±20	±20	±20	±20	V
Maximum Power Dissipation						
T_C = +25°C	P_D	43	43	43	43	W
Linear Derating Factor		0.34	0.34	0.34	0.34	W/°C
Inductive Current, Clamped (See Figure 14, L = 100μH)	I_{LM}	10	10	8.0	8.0	A
Single Pulse Avalanche Energy Rating (4)	E_{AS}*	46	46	46	46	mJ
Operating and Storage Junction Temperature Range	T_J, T_{STG}	-55 to +150	-55 to +150	-55 to +150	-55 to +150	°C
Maximum Lead Temperature for Soldering (0.063" (1.6mm) from case for 10s)	T_L	300	300	300	300	°C

NOTES:

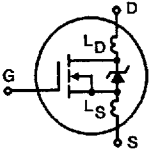
1. T_J = +25°C to +150°C.
2. Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%.
3. Repetitive rating: Pulse width limited by maximum junction temperature. See Transient Thermal Impedance Curve (Figure 5).
4. V_{DD} = 50V, starting T_J = +25°C, L = 6.4mH, R_{GS} = 25Ω, I_{PEAK} = 3.3A. See Figure 15.

*R Suffix Types Only

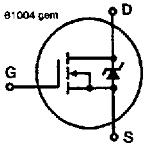
CAUTION: These devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

File Number **1576.1**

Electrical Characteristics $T_C = 25^oC$, Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	LIMITS MIN	LIMITS TYP	LIMITS MAX	UNITS
Drain-Source Breakdown Voltage IRF610/612, IRF610R/612R	BV_{DSS}	$V_{GS} = 0V, I_D = 250\mu A$	200	-	-	V
IRF611/613, IRF611R/613R			150	-	-	V
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	2.0	-	4.0	V
Gate-Source Leakage Forward	I_{GSS}	$V_{GS} = 20V$	-	-	500	nA
Gate-Source Leakage Reverse	I_{GSS}	$V_{GS} = -20V$	-	-	-500	nA
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = Max Rating, $V_{GS} = 0V$	-	-	250	µA
		V_{DS} = Max Rating x 0.8, $V_{GS} = 0V$, $T_J = +125^oC$	-	-	1000	µA
On-State Drain Current (Note 2) IRF610/611, IRF610R/611R	$I_{D(ON)}$	$V_{DS} > I_{D(ON)} \times r_{DS(ON)}$ Max, $V_{GS} = 10V$	3.3	-	-	A
IRF612/613, IRF612R/613R			2.6	-	-	A
Static Drain-Source On-State Resistance (Note 2) IRF610/611, IRF610R/611R	$r_{DS(ON)}$	$V_{GS} = 10V, I_D = 1.6A$	-	1.0	1.5	Ω
IRF612/613, IRF612R/613R			-	1.5	2.4	Ω
Forward Transconductance (Note 2)	g_{fs}	$V_{DS} \geq 50V, I_D = 1.6A$	0.8	1.3	-	S(℧)
Input Capacitance	C_{ISS}	$V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz$ See Figure 10	-	135	-	pF
Output Capacitance	C_{OSS}		-	60	-	pF
Reverse Transfer Capacitance	C_{RSS}		-	16	-	pF
Turn-On Delay Time	$t_{d(ON)}$	$V_{DD} = 100V, I_D \simeq 3.3A, R_G = 24\Omega$ See Figure 16. (MOSFET switching times are essentially independent of operating temperature)	-	8	12	ns
Rise Time	t_r		-	17	26	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	13	21	ns
Fall Time	t_f		-	9	13	ns
Total Gate Charge (Gate-Source + Gate-Drain)	Q_g	$V_{GS} = 10V, I_D = 3.3A, V_{DS} = 0.8V$ Max Rating. See Figure 17 for test circuit. (Gate charge is essentially independent of operating temperature.)	-	5.3	8.2	nC
Gate-Source Charge	Q_{gs}		-	1.2	-	nC
Gate-Drain ("Miller") Charge	Q_{gd}		-	3.0	-	nC
Internal Drain Inductance	L_D	Measured from the contact screw on tab to center of die Modified MOSFET symbol showing the internal device inductances. 	-	3.5	-	nH
		Measured from the drain lead, 6mm (0.25in.) from package to center of die	-	4.5	-	nH
Internal Source Inductance	L_S	Measured from the source lead, 6mm (0.25") from header and source bonding pad.	-	7.5	-	nH
Junction-to-Case	$R_{\theta JC}$		-	-	2.9	°C/W
Case-to-Sink	$R_{\theta CS}$	Mounting surface flat, smooth and greased	-	0.5	-	°C/W
Junction-to-Ambient	$R_{\theta JA}$	Free air operation	-	-	80	°C/W

Source Drain Diode Ratings and Characteristics

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Continuous Source Current (Body Diode)	I_S	Modified MOSFET symbol showing the integral reverse P-N junc. rectifier. 	-	-	3.3	A
Pulse Source Current (Body Diode) (Note 3)	I_{SM}		-	-	8	A
Diode Forward Voltage (Note 2)	V_{SD}	$T_J = +25^oC, I_S = 3.3A, V_{GS} = 0V$	-	-	2.0	V
Reverse Recovery Time	t_{rr}	$T_J = +25^oC, I_F = 3.3A, dI_F/dt = 100A/\mu s$	75	160	310	ns
Reverse Recovered Charge	Q_{RR}	$T_J = +25^oC, I_F = 3.3A, dI_F/dt = 100A/\mu s$	0.33	0.9	1.4	µC
Forward Turn-on Time	t_{ON}	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S + L_D$.	-	-	-	-

NOTES:
1. $T_J = +25^oC$ to $+150^oC$
2. Pulse Test: Pulse width $\leq 300\mu s$, Duty Cycle $\leq 2\%$
3. Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Figure 5)
4. $V_{DD} = 50V$, Start $T_J = +25^oC$, $L = 6.4mH$, $R_{GS} = 25\Omega$, $I_{PEAK} = 3.3A$ (See Figure 15)

Performance Curves

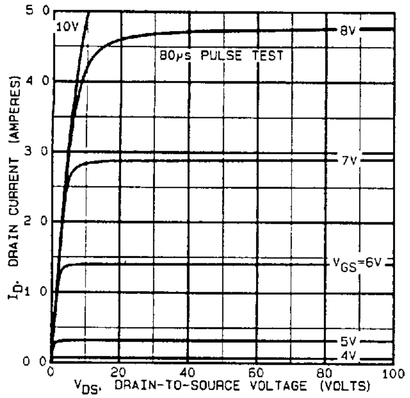


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

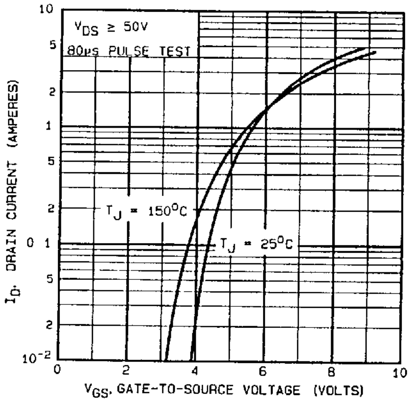


FIGURE 2. TYPICAL TRANSFER CHARACTERISTICS

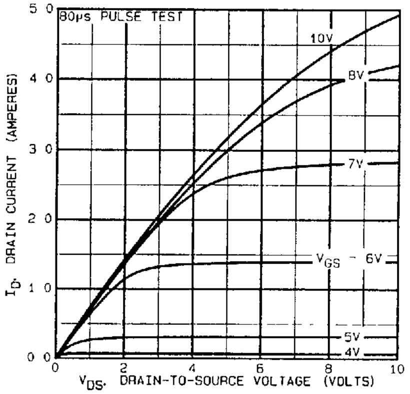


FIGURE 3. TYPICAL SATURATION CHARACTERISTICS

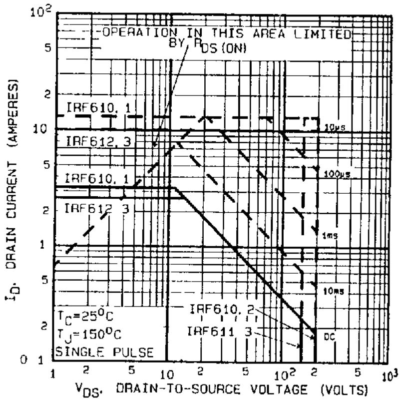


FIGURE 4. MAXIMUM SAFE OPERATING AREA

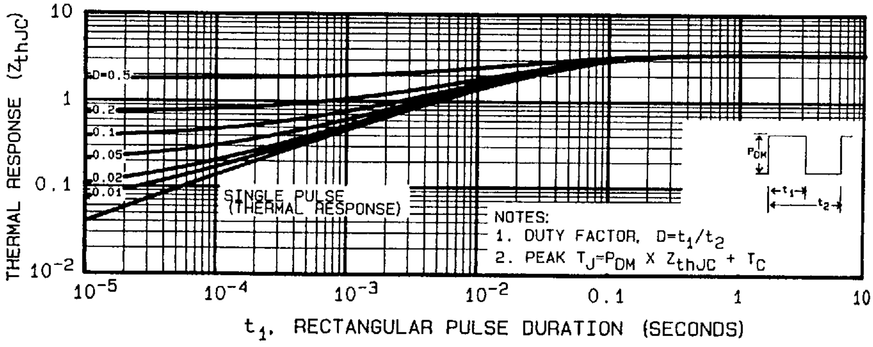


FIGURE 5. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs PULSE DURATION

Performance Curves (Continued)

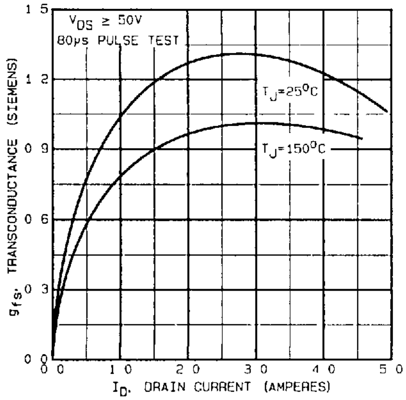


FIGURE 6. TYPICAL TRANSCONDUCTANCE vs DRAIN CURRENT

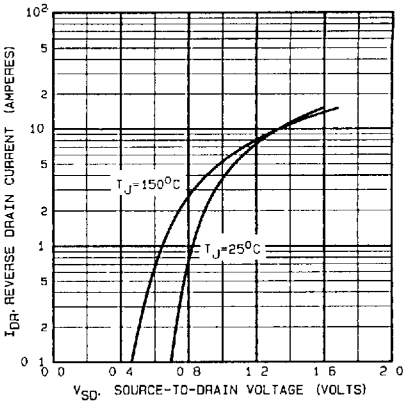


FIGURE 7. TYPICAL SOURCE-DRAIN DIODE FORWARD VOLTAGE

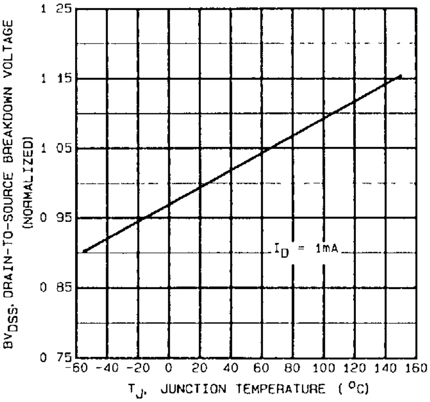


FIGURE 8. BREAKDOWN VOLTAGE vs TEMPERATURE

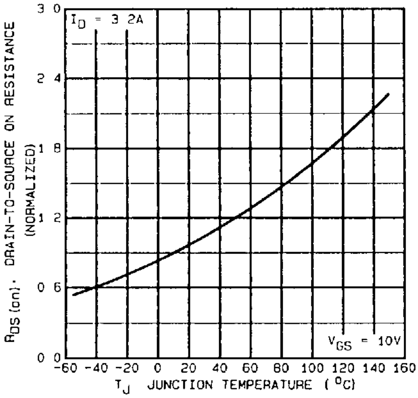


FIGURE 9. NORMALIZED ON-RESISTANCE vs TEMPERATURE

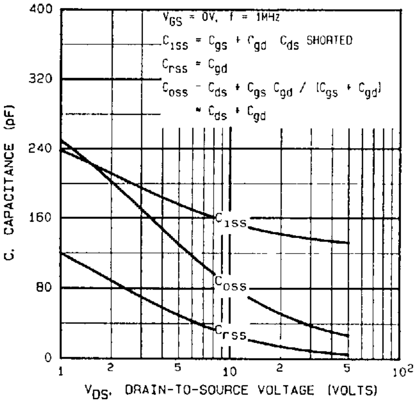


FIGURE 10. TYPICAL CAPACITANCE vs DRAIN-TO-SOURCE VOLTAGE

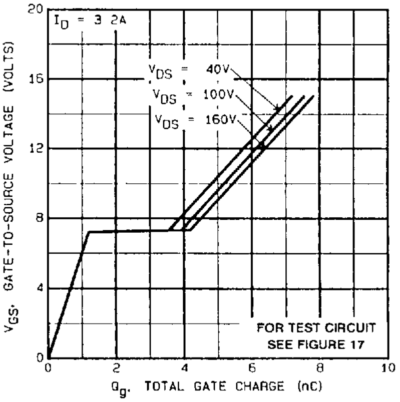


FIGURE 11. TYPICAL GATE CHARGE vs GATE-TO-SOURCE VOLTAGE

Performance Curves (Continued)

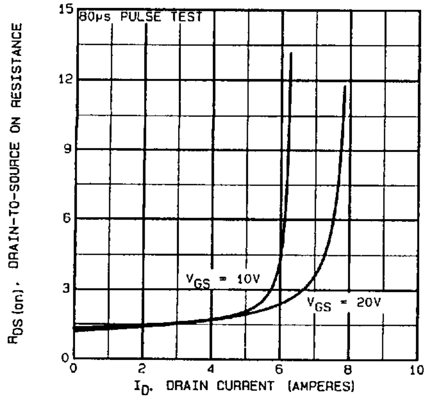


FIGURE 12. TYPICAL ON RESISTANCE vs DRAIN CURRENT

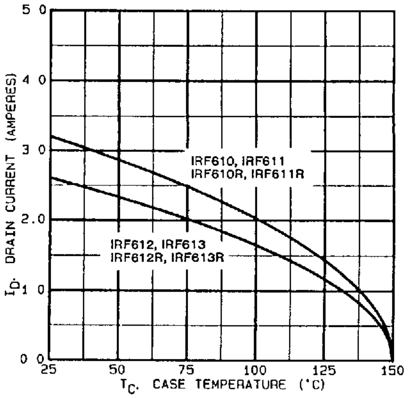


FIGURE 13. MAXIMUM DRAIN CURRENT vs CASE TEMPERATURE

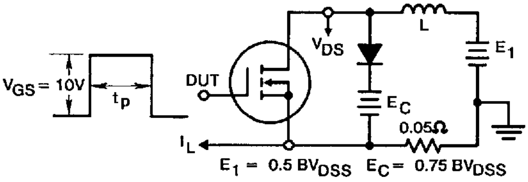


FIGURE 14a. CLAMPED INDUCTIVE TEST CIRCUIT

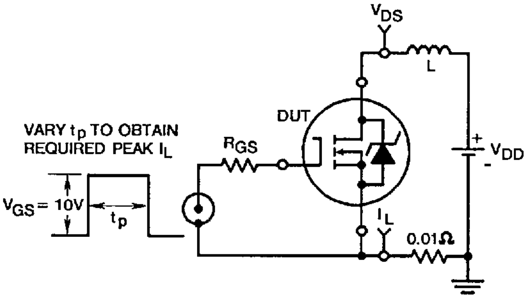


FIGURE 15a. UNCLAMPED ENERGY TEST CIRCUIT

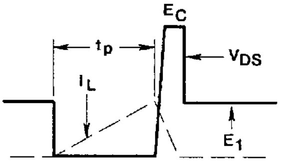


FIGURE14b. CLAMPED INDUCTIVE WAVEFORMS

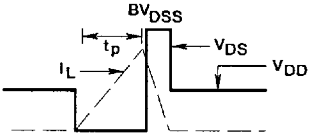


FIGURE 15b. UNCLAMPED ENERGY WAVEFORMS

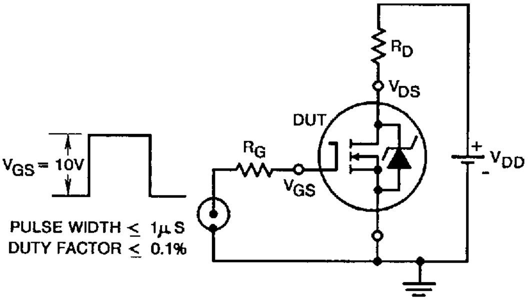


FIGURE 16. SWITCHING TIME TEST CIRCUIT

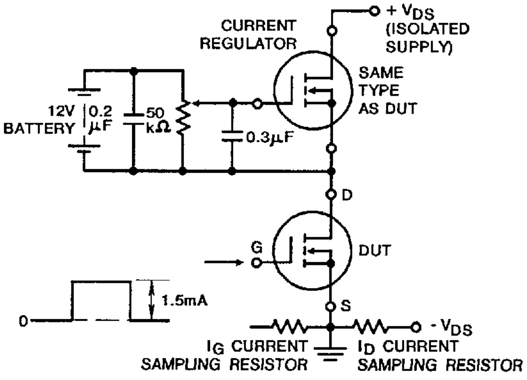


FIGURE 17. GATE CHARGE TEST CIRCUIT