HARRIS

IRF720/721/722/723
IRF720R/721R/722R/723R

N-Channel Power MOSFETs
Avalanche Energy Rated*

August 1991

Features

- 2.8A and 3.3A, 350V - 400V
- $r_{DS}(on)$ = 1.8Ω and 2.5Ω
- Single Pulse Avalanche Energy Rated*
- SOA is Power-Dissipation Limited
- Nanosecond Switching Speeds
- Linear Transfer Characteristics
- High Input Impedance

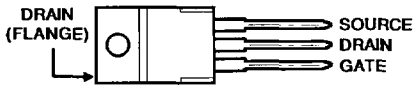
Description

The IRF720, IRF721, IRF722, and IRF723 are n-channel enhancement-mode silicon-gate power field-effect transistors. IRF720R, IRF721R, IRF722R and IRF723R 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.

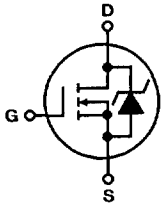
Package

TO-220AB
TOP VIEW



Terminal Diagram

N-CHANNEL ENHANCEMENT MODE



4 N-CHANNEL POWER MOSFETs

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

	IRF720 IRF720R	IRF721 IRF721R	IRF722 IRF722R	IRF723 IRF723R	UNITS
Drain-Source Voltage (1) ..... V_{DS}	400	350	400	350	V
Drain-Gate Voltage (R_{GS} = 20kΩ) (1) ..... V_{DGR}	400	350	400	350	V
Continuous Drain Current					
T_C = +25°C ..... I_D	3.3	3.3	2.8	2.8	A
T_C = +100°C ..... I_D	2.1	2.1	1.8	1.8	A
Pulsed Drain Current (3) ..... I_{DM}	13	13	11	11	A
Gate-Source Voltage ..... V_{GS}	±20	±20	±20	±20	V
Maximum Power Dissipation					
T_C = +25°C ..... P_D	50	50	50	50	W
Linear Derating Factor	0.4	0.4	0.4	0.4	W/°C
Inductive Current, Clamped ..... I_{LM} (See Figure 14, L = 100μH)	12	12	10	10	A
Single Pulse Avalanche Energy Rating (4) ..... E_{AS}*	190	190	190	190	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

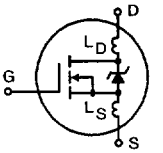
NOTES:

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).
   *R Suffix Types Only
4. V_{DD} = 50V, starting T_J = +25°C, L = 31mH, R_{GS} = 25Ω, I_{PEAK} = 3.3A. See Figure 15.

File Number **1579.1**

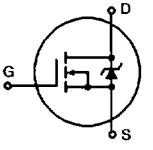
Electrical Characteristics T_C = 25°C, Unless Otherwise Specified

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	LIMITS MIN	LIMITS TYP	LIMITS MAX	UNITS
Drain-Source Breakdown Voltage IRF720/722, IRF720R/722R	BV_{DSS}	V_{GS} = 0V, I_D = 250µA	400	-	-	V
IRF721/723, IRF721R/723R			350	-	-	V
Gate Threshold Voltage	$V_{GS(TH)}$	V_{DS} = V_{GS}, I_D = 250µA	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°C	-	-	1000	µA
On-State Drain Current (Note 2) IRF720/721, IRF720R/721R	$I_{D(ON)}$	V_{DS} > $I_{D(ON)}$ x $R_{DS(ON)}$ Max, V_{GS} = 10V	3.3	-	-	A
IRF722/723, IRF722R/723R			2.8	-	-	A
Static Drain-Source On-State Resistance (Note 2) IRF720/721, IRF720R/721R	$r_{DS(ON)}$	V_{GS} = 10V, I_D = 1.8A	-	1.5	1.8	Ω
IRF722/723, IRF722R/723R			-	1.8	2.5	Ω
Forward Transconductance (Note 2)	g_{fs}	V_{DS} ≥ 50V, I_D = 1.8A	1.8	2.7	-	S(℧)
Input Capacitance	C_{ISS}	V_{GS} = 0V, V_{DS} = 25V, f = 1.0MHz See Figure 10	-	360	-	pF
Output Capacitance	C_{OSS}		-	55	-	pF
Reverse Transfer Capacitance	C_{RSS}		-	20	-	pF
Turn-On Delay Time	$t_{d(ON)}$	V_{DD} = 200V, I_D ≃ 3.3A, R_G = 18Ω See Figure 16. (MOSFET switching times are essentially independent of operating temperature)	-	10	15	ns
Rise Time	t_r		-	14	21	ns
Turn-Off Delay Time	$t_{d(OFF)}$		-	30	45	ns
Fall Time	t_f		-	13	20	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.)	-	12	20	nC
Gate-Source Charge	Q_{gs}		-	2.0	-	nC
Gate-Drain ("Miller") Charge	Q_{gd}		-	6.0	-	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	$R_{\theta JC}$		-	-	2.5	°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

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}		-	-	13	A
Diode Forward Voltage (Note 2)	V_{SD}	T_J = +25°C, I_S = 3.3A, V_{GS} = 0V	-	-	1.6	V
Reverse Recovery Time	t_{rr}	T_J = +25°C, I_F = 3.3A, dI_F/dt = 100A/µs	120	-	600	ns
Reverse Recovered Charge	Q_{RR}	T_J = +25°C, I_F = 3.3A, dI_F/dt = 100A/µs	0.64	-	3.0	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°C to +150°C
2. Pulse Test: Pulse width ≤ 300µs, Duty Cycle ≤ 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°C, L = 31mH, R_{GS} = 25Ω, I_{PEAK} = 3.3A (See Figure 15)

Performance Curves

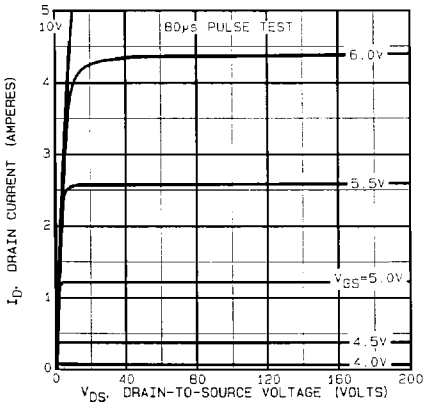


FIGURE 1. TYPICAL OUTPUT CHARACTERISTICS

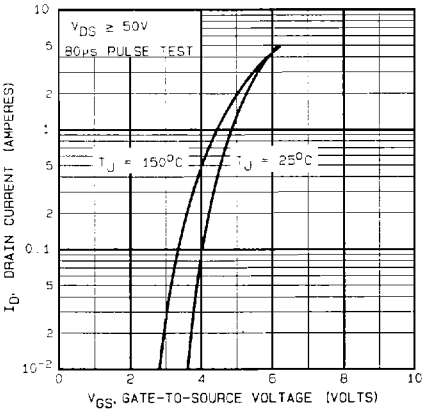


FIGURE 2. TYPICAL TRANSFER CHARACTERISTICS

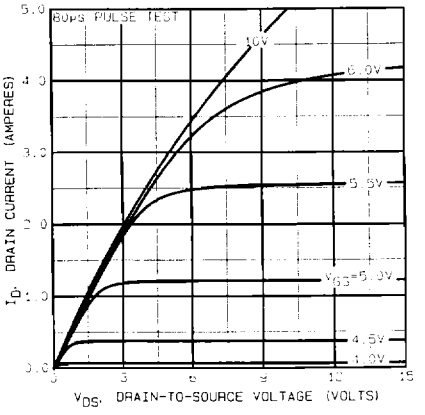


FIGURE 3. TYPICAL SATURATION CHARACTERISTICS

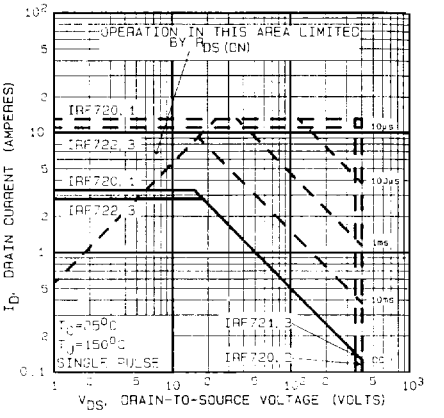


FIGURE 4. MAXIMUM SAFE OPERATING AREA

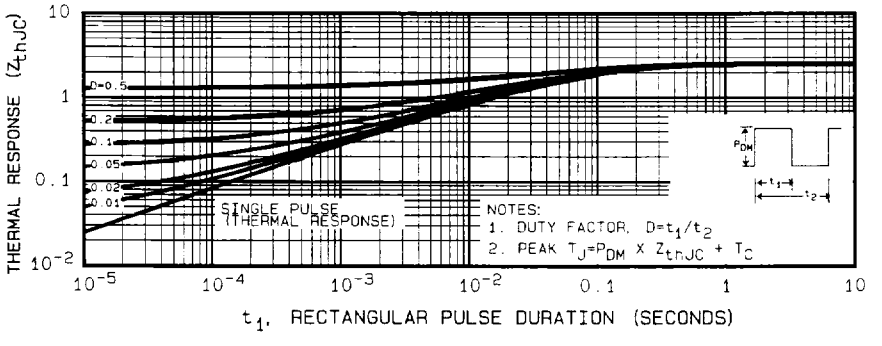


FIGURE 5. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs PULSE DURATION

Performance Curves (Continued)

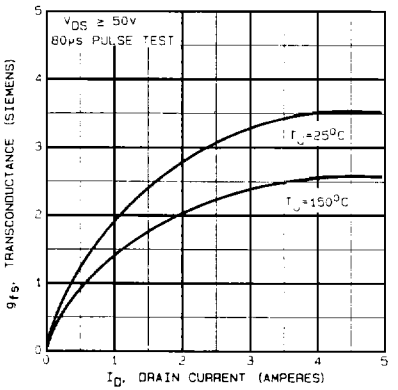


FIGURE 6. TYPICAL TRANSCONDUCTANCE vs DRAIN CURRENT

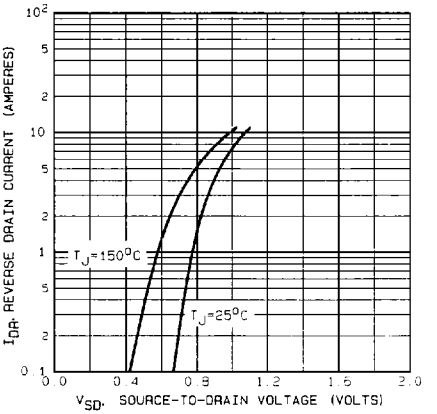


FIGURE 7. TYPICAL SOURCE-DRAIN DIODE FORWARD VOLTAGE

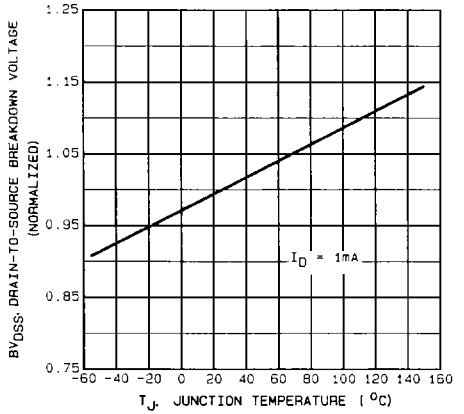


FIGURE 8. BREAKDOWN VOLTAGE vs TEMPERATURE

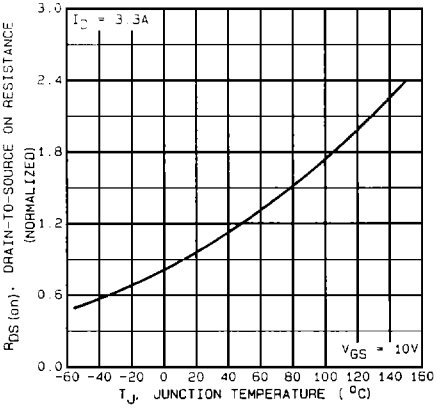


FIGURE 9. NORMALIZED ON-RESISTANCE vs TEMPERATURE

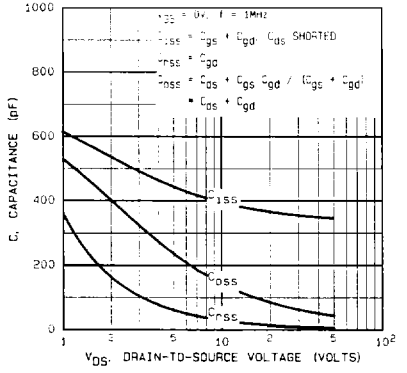


FIGURE 10. TYPICAL CAPACITANCE vs DRAIN-TO-SOURCE VOLTAGE

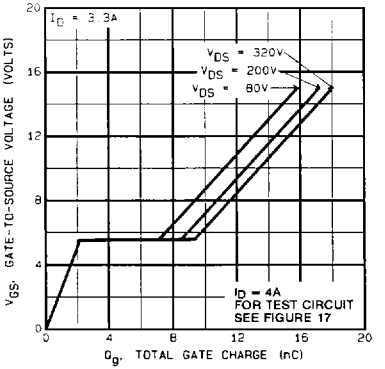


FIGURE 11. TYPICAL GATE CHARGE vs GATE-TO-SOURCE VOLTAGE

Performance Curves (Continued)

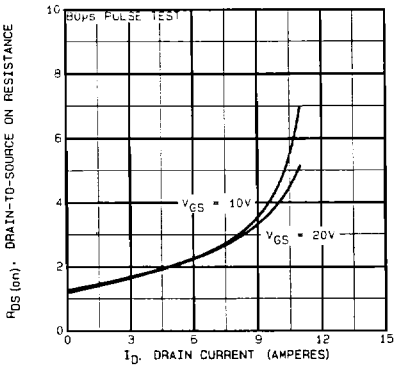


FIGURE 12. TYPICAL ON-RESISTANCE VS. DRAIN CURRENT

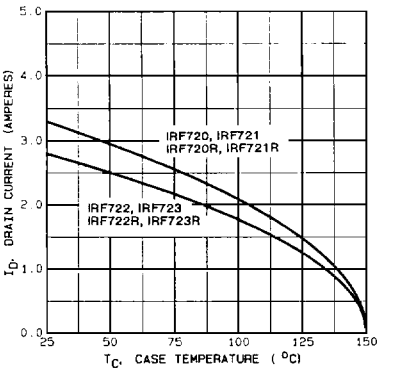


FIGURE 13. MAXIMUM DRAIN CURRENT VS. CASE TEMPERATURE

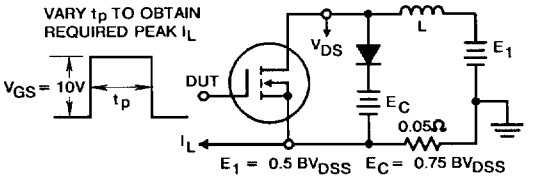


FIGURE 14a. CLAMPED INDUCTIVE TEST CIRCUIT

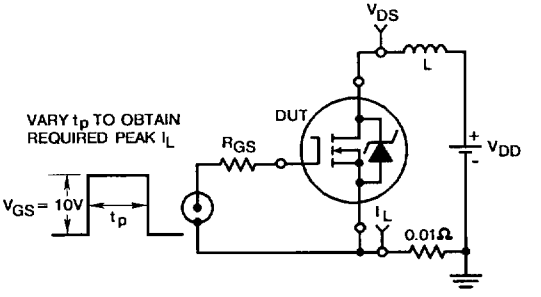


FIGURE 15a. UNCLAMPED ENERGY TEST CIRCUIT

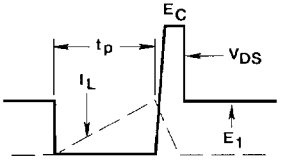


FIGURE 14b. CLAMPED INDUCTIVE WAVEFORMS

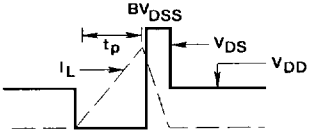


FIGURE 15b. UNCLAMPED ENERGY WAVEFORMS

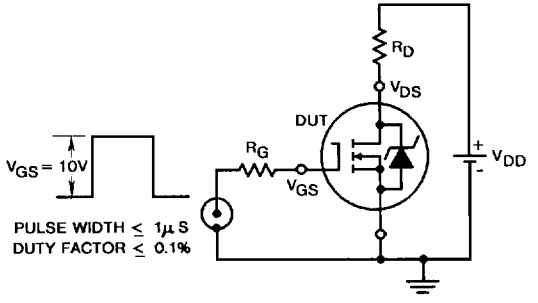


FIGURE 16. SWITCHING TIME TEST CIRCUIT

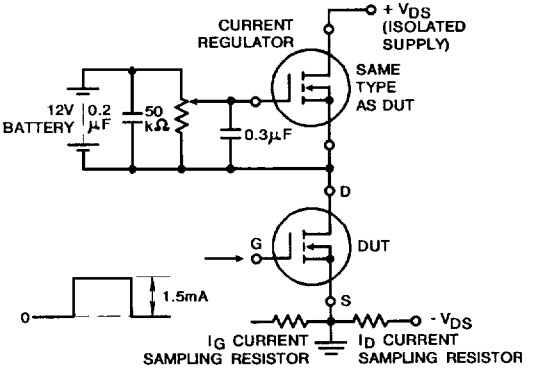


FIGURE 17. GATE CHARGE TEST CIRCUIT

4 N-CHANNEL POWER MOSFETs