HARRIS SEMICONDUCTOR

FRF9150D, FRF9150R, FRF9150H

23A, -100V, 0.140 Ohm, Rad Hard, P-Channel Power MOSFETs

June 1998

Features

- 23A, -100V, $r_{DS(ON)}$ = 0.140Ω
- Second Generation Rad Hard MOSFET Results From New Design Concepts
- Gamma
  - Meets Pre-RAD Specifications to 100K RAD (Si)
  - Defined End Point Specs at 300K RAD (Si) and 1000K RAD (Si)
  - Performance Permits Limited Use to 3000K RAD (Si)
- Gamma Dot
  - Survives 3E9 RAD (Si)/s at 80% BV_{DSS} Typically
  - Survives 2E12 Typically If Current Limited to IDM
- Photo Current
  - 7.0nA Per-RAD (Si)/s Typically
- Neutron
  - Pre-RAD Specifications for 3E13 Neutrons/cm^2
  - Usable to 3E14 Neutrons/cm^2

Description

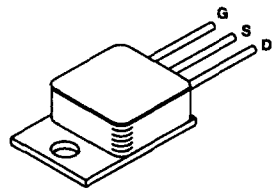
The Harris Semiconductor Sector has designed a series of SECOND GENERATION hardened power MOSFETs of both N and P channel enhancement types with ratings from 100V to 500V, 1A to 60A, and on resistance as low as 25mΩ. Total dose hardness is offered at 100K RAD (Si) and 1000K RAD (Si) with neutron hardness ranging from 1E13n/cm^2 for 500V product to 1E14n/cm^2 for 100V product. Dose rate hardness (GAMMA DOT) exists for rates to 1E9 without current limiting and 2E12 with current limiting.

This MOSFET is an enhancement-mode silicon-gate power field effect transistor of the vertical DMOS (VDMOS) structure. It is specially designed and processed to exhibit minimal characteristic changes to total dose (GAMMA) and neutron (n^0) exposures. Design and processing efforts are also directed to enhance survival to heavy ion (SEE) and/or dose rate (GAMMA DOT) exposure.

This part may be supplied as a die or in various packages other than shown above. Reliability screening is available as either non TX (commercial), TX equivalent of MIL-S-19500, TXV equivalent of MIL-S-19500, or space equivalent of MIL-S-19500. Contact the Harris Semiconductor High-Reliability Marketing group for any desired deviations from the data sheet.

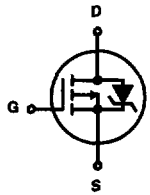
Package

TO-254AA



CAUTION: Beryllia Warning per MIL-S-19500 refer to package specifications.

Symbol



4 RAD HARD TRANSISTORS

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

		FRF9150D, R, H	UNITS
Drain-Source Voltage	V_{DS}	-100	V
Drain-Gate Voltage (R_{GS} = 20kΩ)	V_{DGR}	-100	V
Continuous Drain Current			
T_C = +25°C	I_D	23	A
T_C = +100°C	I_D	15	A
Pulsed Drain Current	I_{DM}	69	A
Gate-Source Voltage	V_{GS}	±20	V
Maximum Power Dissipation			
T_C = +25°C	PT	125	W
T_C = +100°C	PT	50	W
Derated Above +25°C		1.00	W/°C
Inductive Current, Clamped, L = 100μH, (See Test Figure)	I_{LM}	69	A
Continuous Source Current (Body Diode)	I_S	23	A
Pulsed Source Current (Body Diode)	I_{SM}	69	A
Operating And Storage Temperature	T_{JC}, T_{STG}	-55 to +150	°C
Lead Temperature (During Soldering)			
Distance > 0.063 in. (1.6mm) From Case, 10s Max	T_L	300	°C

CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.

File Number **3243.2**

Pre-Radiation Electrical Specifications T_C = +25°C, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS MIN	LIMITS MAX	UNITS
Drain-Source Breakdown Volts	BV_{DSS}	V_{GS} = 0, I_D = 1mA	-100	-	V
Gate-Threshold Volts	$V_{GS(TH)}$	V_{DS} = V_{GS}, I_D = 1mA	-2.0	-4.0	V
Gate-Body Leakage Forward	I_{GSSF}	V_{GS} = -20V	-	100	nA
Gate-Body Leakage Reverse	I_{GSSR}	V_{GS} = +20V	-	100	nA
Zero-Gate Voltage Drain Current	I_{DSS1} I_{DSS2} I_{DSS3}	V_{DS} = -100V, V_{GS} = 0 V_{DS} = -80V, V_{GS} = 0 V_{DS} = -80V, V_{GS} = 0, T_C = +125°C	- - -	1 0.025 0.25	mA
Rated Avalanche Current	I_{AR}	Time = 20µs	-	69	A
Drain-Source On-State Volts	$V_{DS(ON)}$	V_{GS} = -10V, I_D = 23A	-	-3.38	V
Drain-Source On Resistance	$r_{DS(ON)}$	V_{GS} = -10V, I_D = 15A	-	0.140	Ω
Turn-On Delay Time	$t_{D(ON)}$	V_{DD} = -50V, I_D = 23A	-	170	ns
Rise Time	t_R	Pulse Width = 3µs	-	620	
Turn-Off Delay Time	$t_{D(OFF)}$	Period = 300µs, R_G = 25Ω	-	600	
Fall Time	t_F	0 ≤ V_{GS} ≤ 10 (See Test Circuit)	-	242	
Gate-Charge Threshold	$Q_{G(TH)}$	V_{DD} = -50V, I_D = 23A I_{GS1} = I_{GS2} 0 ≤ V_{GS} ≤ 20	4	16	nc
Gate-Charge On State	$Q_{G(ON)}$		60	240	
Gate-Charge Total	Q_{GM}		126	504	
Plateau Voltage	V_{GP}		3	14	V
Gate-Charge Source	Q_{GS}		17	68	nc
Gate-Charge Drain	Q_{GD}		21	86	
Diode Forward Voltage	V_{SD}	I_D = 23A, V_{GD} = 0	-0.6	-1.8	V
Reverse Recovery Time	t_T	I = 23A; di/dt = 100A/µs	-	700	ns
Junction-To-Case	$R_{\theta JC}$		-	1.0	°C/W
Junction-To-Ambient	$R_{\theta JA}$	Free Air Operation	-	48	

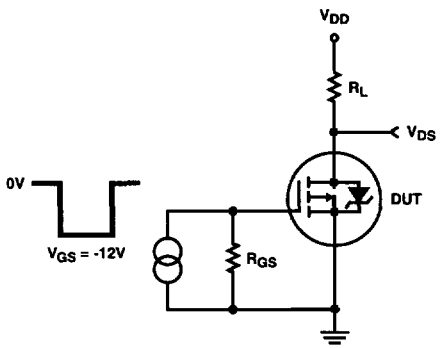


FIGURE 1. RESISTIVE SWITCHING TEST CIRCUIT

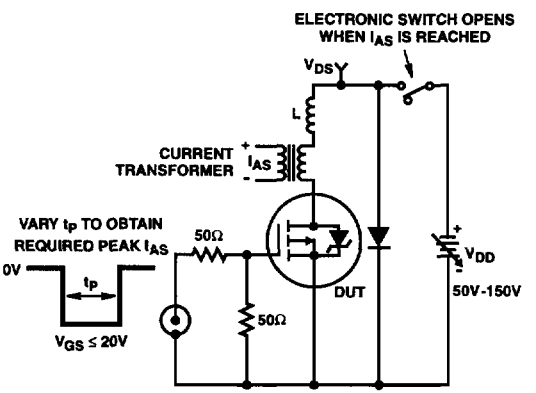


FIGURE 2. UNCLAMPED ENERGY TEST CIRCUIT

Post-Radiation Electrical Specifications T_C = +25°C, Unless Otherwise Specified

PARAMETER		SYMBOL	TYPE	TEST CONDITIONS	LIMITS MIN	LIMITS MAX	UNITS
Drain-Source Breakdown Volts	(Notes 4, 6)	BV_{DSS}	FRF9150D, R	V_{GS} = 0, I_D = 1mA	-100	-	V
	(Notes 5, 6)	BV_{DSS}	FRF9150H	V_{GS} = 0, I_D = 1mA	-95	-	V
Gate-Source Threshold Volts	(Notes 4, 6)	$V_{GS(TH)}$	FRF9150D, R	V_{GS} = V_{DS}, I_D = 1mA	-2.0	-4.0	V
	(Notes 3, 5, 6)	$V_{GS(TH)}$	FRF9150H	V_{GS} = V_{DS}, I_D = 1mA	-2.0	-6.0	V
Gate-Body Leakage Forward	(Notes 4, 6)	I_{GSSF}	FRF9150D, R	V_{GS} = -20V, V_{DS} = 0	-	100	nA
	(Notes 5, 6)	I_{GSSF}	FRF9150H	V_{GS} = -20V, V_{DS} = 0	-	200	nA
Gate-Body Leakage Reverse	(Notes 2, 4, 6)	I_{GSSR}	FRF9150D, R	V_{GS} = 20V, V_{DS} = 0	-	100	nA
	(Notes 2, 5, 6)	I_{GSSR}	FRF9150H	V_{GS} = 20V, V_{DS} = 0	-	200	nA
Zero-Gate Voltage Drain Current	(Notes 4, 6)	I_{DSS}	FRF9150D, R	V_{GS} = 0, V_{DS} = -80V	-	25	µA
	(Notes 5, 6)	I_{DSS}	FRF9150H	V_{GS} = 0, V_{DS} = -80V	-	100	µA
Drain-Source On-State Volts	(Notes 1, 4, 6)	$V_{DS(ON)}$	FRF9150D, R	V_{GS} = -10V, I_D = 23A	-	-3.38	V
	(Notes 1, 5, 6)	$V_{DS(ON)}$	FRF9150H	V_{GS} = -16V, I_D = 23A	-	-5.07	V
Drain-Source On Resistance	(Notes 1, 4, 6)	$r_{DS(ON)}$	FRF9150D, R	V_{GS} = -10V, I_D = 15A	-	0.140	Ω
	(Notes 1, 5, 6)	$r_{DS(ON)}$	FRF9150H	V_{GS} = -14V, I_D = 15A	-	0.210	Ω

NOTES:

1. Pulse test, 300µs (Max)
2. Absolute value
3. Gamma = 300K RAD (Si)
4. Gamma = 10K RAD (Si) for "D", 100K RAD (Si) for "R". Neutron = 3E13
5. Gamma = 1000K RAD (Si). Neutron = 3E13
6. In situ Gamma bias must be sampled for both V_{GS} = -10V, V_{DS} = 0V and V_{GS} = 0V, V_{DS} = 80% BV_{DSS}
7. Gamma data taken 1/18/91 on TA 17751 devices by GE ASTRO SPACE; EMC/SURVIVABILITY LABORATORY; KING OF PRUSSIA, PA 19401
8. Single event drain burnout testing by Titus, J.L., et al of NWSC, Crane, IN at Brookhaven Nat. Lab. Dec 11-14, 1989
9. Neutron derivation, HARRIS Application note AN-8831, Oct. 1988

Typical Performance Characteristics