



2N7328D, 2N7328R 2N7328H

Radiation Hardened
P-Channel Power MOSFETs

REGISTRATION PENDING
Currently Available as FRK9160(D, R, H)

December 1992

T-39-25

Features

- 40A, -100V, RDS(on) = 0.085Ω
- Second Generation Rad Hard MOSFET Results From New Design Concepts
- Gamma
 - Meets Pre-Rad Specifications to 100KRAD(Si)
 - Defined End Point Specs at 300KRAD(Si) and 1000KRAD(Si)
 - Performance Permits Limited Use to 3000KRAD(Si)
- Gamma Dot
 - Survives 3E9RAD(Si)/sec at 80% BVDS Typically
 - Survives 2E12 Typically If Current Limited to IDM
- Photo Current
 - 10.0nA Per-RAD(Si)/sec Typically
- Neutron
 - Pre-RAD Specifications for 3E13 Neutrons/cm²
 - Usable to 3E14 Neutrons/cm²
- Single Event
 - Typically Survives 1E5ions/cm² Having an LET ≤ 35MeV/mg/cm² and a Range ≥ 30μm at 80% BVDS

Package

TO-204AE



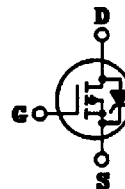
Description

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 1000KRAD(Si) with neutron hardness ranging from 1E13n/cm² for 500V product to 1E14n/cm² for 100V product. Dose rate hardness (GAMMA DOT) exists for rates to 1E9 without current limiting and 2E12 with current limiting. Heavy ion survival from signal event drain burn-out exists for linear energy transfer (LET) of 35 at 80% of rated voltage.

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 (n²) 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.

Symbol



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

	2N7328D, R, H	UNITS
Drain-Source Voltage.....	-100	V
Drain-Gate Voltage (RGS = 20kΩ).....	-100	V
Continuous Drain Current		
TC = +25°C.....	40	A
TC = +100°C.....	26	A
Pulsed Drain Current.....	100	A
Gate-Source Voltage.....	±20	V
Maximum Power Dissipation		
TC = +25°C.....	300	W
TC = +100°C.....	120	W
Derated Above +25°C.....	2.40	W/°C
Inductive Current, Clamped, L = 100μH, (See Test Figure).....	100	A
Continuous Source Current (Body Diode).....	40	A
Pulsed Source Current (Body Diode).....	100	A
Operating And Storage Temperature.....	-55 to +150	°C
Lead Temperature (During Soldering)		
Distance > 0.063 In. (1.6mm) From Case, 10s Max.....	300	°C

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

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS		UNITS	
			MIN	MAX		
Drain-Source Breakdown Volts	BVDSS	VGS = 0, ID = 1mA	-100	-	V	
Gate-Threshold Volts	VGS(th)	VDS = VGS, ID = 1mA	-2.0	-4.0	V	
Gate-Body Leakage Forward	IGSSF	VGS = -20V	-	100	nA	
Gate-Body Leakage Reverse	IGSSR	VGS = +20V	-	100	nA	
Zero-Gate Voltage Drain Current	IDSS1 IDSS2 IDSS3	VDS = -100V, VGS = 0 VDS = -80V, VGS = 0 VDS = -80V, VGS = 0, TC = +125°C	- - -	1 0.025 0.25	mA	
Rated Avalanche Current	IAR	Time = 20µs	-	100	A	
Drain-Source On-State Volts	VDS(on)	VGS = -10V, ID = 40A	-	-3.57	V	
Drain-Source On Resistance	RDS(on)	VGS = -10V, ID = 26A	-	0.085	Ω	
Turn-On Delay Time	td(on)	VDD = -50V, ID = 40A	-	150	ns	
Rise Time	tr	Pulse Width = 3µs	-	900		
Turn-Off Delay Time	td(off)	Period = 300µs, Rg = 10Ω	-	700		
Fall Time	tf	0 ≤ VGS ≤ 10 (See Test Circuit)	-	500		
Gate-Charge Threshold	QG(th)	VDD = -50V, ID = 40A IGS1 = IGS2 0 ≤ VGS ≤ 20	7	28	nC	
Gate-Charge On State	QG(on)		86	346		
Gate-Charge Total	QGM		158	632		
Plateau Voltage	VGP		0 ≤ VGS ≤ 20	-2	-11	V
Gate-Charge Source	QGS			19	78	nC
Gate-Charge Drain	QGD			34	138	
Diode Forward Voltage	VSD		ID = 40A, VGD = 0	-0.6	-1.8	V
Reverse Recovery Time	TT	I = 40A; di/dt = 100A/µs	-	TBD	ns	
Junction-To-Case	Rθjc		-	0.42	°C/W	
Junction-To-Ambient	Rθja	Free Air Operation	-	30		

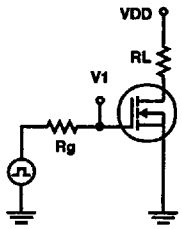


FIGURE 1. SWITCHING TIME TESTING

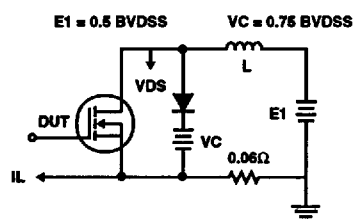


FIGURE 2. CLAMPED INDUCTIVE SWITCHING, ILM

Specifications 2N7328D, 2N7328R, 2N7328H - Registration Pending

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

PARAMETER	SYMBOL	TYPE	TEST CONDITIONS	LIMITS		UNITS	
				MIN	MAX		
Drain-Source Breakdown Volts	(Note 4, 6)	BVDSS	2N7328D, R	VGS = 0, ID = 1mA	-100	-	V
	(Note 5, 6)	BVDSS	2N7328H	VGS = 0, ID = 1mA	-95	-	V
Gate-Source Threshold Volts	(Note 4, 6)	VGS(th)	2N7328D, R	VGS = VDS, ID = 1mA	-2.0	-4.0	V
	(Note 3, 5, 6)	VGS(th)	2N7328H	VGS = VDS, ID = 1mA	-2.0	-6.0	V
Gate-Body Leakage Forward	(Note 4, 6)	IGSSF	2N7328D, R	VGS = -20V, VDS = 0	-	100	nA
	(Note 5, 6)	IGSSF	2N7328H	VGS = -20V, VDS = 0	-	200	nA
Gate-Body Leakage Reverse	(Note 2, 4, 6)	IGSSR	2N7328D, R	VGS = 20V, VDS = 0	-	100	nA
	(Note 2, 5, 6)	IGSSR	2N7328H	VGS = 20V, VDS = 0	-	200	nA
Zero-Gate Voltage Drain Current	(Note 4, 6)	IDSS	2N7328D, R	VGS = 0, VDS = -80V	-	25	µA
	(Note 5, 6)	IDSS	2N7328H	VGS = 0, VDS = -80V	-	100	µA
Drain-Source On-State Volts	(Note 1, 4, 6)	VDS(on)	2N7328D, R	VGS = -10V, ID = 40A	-	-3.57	V
	(Note 1, 5, 6)	VDS(on)	2N7328H	VGS = -16V, ID = 40A	-	-5.36	V
Drain-Source On Resistance	(Note 1, 4, 6)	RDS(on)	2N7328D, R	VGS = -10V, ID = 26A	-	0.85	Ω
	(Note 1, 5, 6)	RDS(on)	2N7328H	VGS = -14V, ID = 26A	-	0.128	Ω

NOTES:

1. Pulse test, 300µs max
2. Absolute value
3. Gamma = 300KRAD(Si)
4. Gamma = 10KRAD(Si) for "D", 100KRAD(Si) for "R". Neutron = 3E13
5. Gamma = 1000KRAD(Si). Neutron = 3E13
6. In situ Gamma bias must be sampled for both VGS = -10V, VDS = 0V and VGS = 0V, VDS = 80% BVDSS
7. Gamma data taken 6/8/90 on TA 17761 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

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Typical Performance Characteristics

