HARRIS SEMICONDUCTOR

2N7331D, 2N7331R 2N7331H

REGISTRATION PENDING
Currently Available as FRE9260 (D, R, H)

April 1994

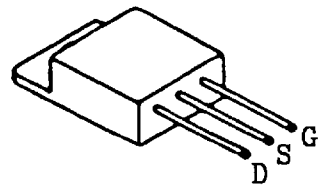
Radiation Hardened N-Channel Power MOSFETs

Features

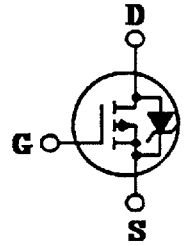
- 19A, -200V, RDS(on) = 0.210Ω
- Second Generation Rad Hard MOSFET Results From New Design Concepts
- Gamma
  - Meets Pre-Rad Specifications to 100KRAD(Si)
  - Defined End Point Specs at 300KRAD(Si) and 1000KRAD(Si)
  - Performance Permits Limited Use to 3000KRAD(Si)
- Gamma Dot
  - Survives 3E9RAD(Si)/sec at 80% BVDSS Typically
  - Survives 2E12 Typically If Current Limited to IDM
- Photo Current - 18.0nA Per-RAD(Si)/sec Typically
- Neutron
  - Pre-RAD Specifications for 1E13 Neutrons/cm^2
  - Usable to 1E14 Neutrons/cm^2
- Single Event - Typically Survives 1E5ions/cm^2 Having an LET ≤ 35MeV/mg/cm^2 and a Range ≥ 30μm at 80% BVDSS

Package

TO-258



Symbol



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 100KRAD(Si) and 1000KRAD(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. 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 (n°) 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.

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

		2N7331D, R, H	UNITS
Drain-Source Voltage	VDS	-200	V
Drain-Gate Voltage (RGS = 20kΩ)	VDGR	-200	V
Continuous Drain Current			
TC = +25°C	ID	19	A
TC = +100°C	ID	12	A
Pulsed Drain Current	IDM	57	A
Gate-Source Voltage	VGS	±20	V
Maximum Power Dissipation			
TC = +25°C	PT	150	W
TC = +100°C	PT	60	W
Derated Above +25°C		1.20	W/°C
Inductive Current, Clamped, L = 100μH, (See Test Figure)	ILM	57	A
Continuous Source Current (Body Diode)	IS	19	A
Pulsed Source Current (Body Diode)	ISM	57	A
Operating And Storage Temperature	TJC, TSTG	-55 to +150	°C
Lead Temperature (During Soldering)			
Distance > 0.063 in. (1.6mm) From Case, 10s Max.	TL	300	°C

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

File Number **3269.1**

Specifications 2N7331D, 2N7331R, 2N7331H - Registration Pending

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

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS MIN	LIMITS MAX	UNITS
Drain-Source Breakdown Volts	BVDSS	VGS = 0, ID = 1mA	-200	-	V
Gate-Treshold 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 = -200V, VGS = 0 VDS = -160V, VGS = 0 VDS = -160V, VGS = 0, TC = +125°C	- - -	1 0.025 0.25	mA
Rated Avalanche Current	IAR	Time = 20µs	-	57	A
Drain-Source On-State Volts	VDS(on)	VGS = -10V, ID = 19A	-	-4.19	V
Drain-Source On Resistance	RDS(on)	VGS = -10V, ID = 12A	-	0.210	Ω
Turn-On Delay Time	td(on)	VDD = -100V, ID = 19A Pulse Width = 3µs Period = 300µs Rg = 10Ω 0 ≤ VGS ≤ 10 (See Test Circuit)	-	100	ns
Rise Time	tr		-	700	
Turn-Off Delay Time	td(off)		-	400	
Fall Time	tf		-	300	
Gate-Charge Threshold	QG(th)	VDD = -100V, ID = 19A IGS1 = IGS2 0 ≤ VGS ≤ 20	4	16	nc
Gate-Charge On State	QG(on)		94	376	
Gate-Charge Total	QGM		182	728	
Plateau Voltage	VGP		-3	-16	V
Gate-Charge Source	QGS		21	86	nc
Gate-Charge Drain	QGD		52	210	
Diode Forward Voltage	VSD	ID = 19A, VGD = 0	-0.6	-1.8	V
Reverse Recovery Time	TT	I = 19A; di/dt = 100A/µs	-	1200	ns
Junction-To-Case	Rθjc		-	0.83	°C/W
Junction-To-Ambient	Rθja	Free Air Operation	-	48	

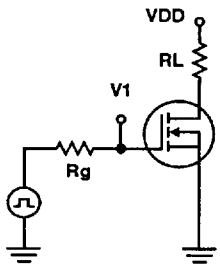


FIGURE 1. SWITCHING TIME TESTING

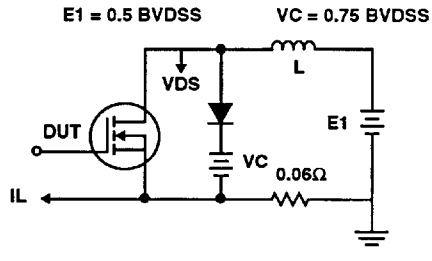


FIGURE 2. CLAMPED INDUCTIVE SWITCHING, ILM

Specifications 2N7331D, 2N7331R, 2N7331H - Registration Pending

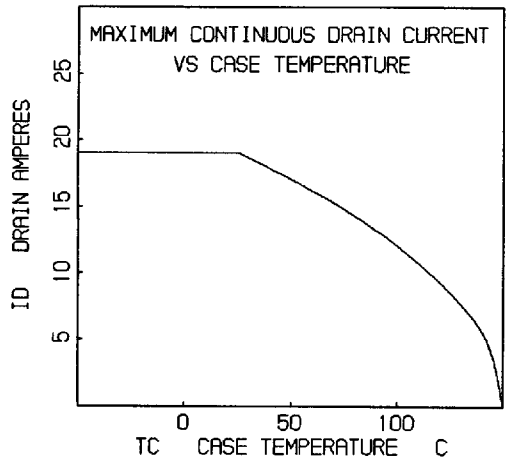
Post-Radiation Electrical Specifications TC = +25°C, Unless Otherwise Specified

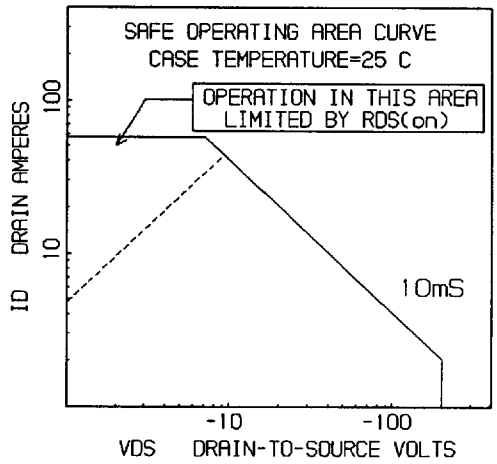
PARAMETER		SYMBOL	TYPE	TEST CONDITIONS	LIMITS		UNITS
					MIN	MAX	
Drain-Source Breakdown Volts	(Note 4, 6)	BVDSS	2N7331D, R	VGS = 0, ID = 1mA	-200	-	V
	(Note 5, 6)	BVDSS	2N7331H	VGS = 0, ID = 1mA	-190	-	V
Gate-Source Threshold Volts	(Note 4, 6)	VGS(th)	2N7331D, R	VGS = VDS, ID = 1mA	-2.0	-4.0	V
	(Note 3, 5, 6)	VGS(th)	2N7331H	VGS = VDS, ID = 1mA	-1.5	-4.5	V
Gate-Body Leakage Forward	(Note 4, 6)	IGSSF	2N7331D, R	VGS = - 20V, VDS = 0	-	100	nA
	(Note 5, 6)	IGSSF	2N7331H	VGS = - 20V, VDS = 0	-	200	nA
Gate-Body Leakage Reverse	(Note 2, 4, 6)	IGSSR	2N7331D, R	VGS = 20V, VDS = 0	-	100	nA
	(Note 2, 5, 6)	IGSSR	2N7331H	VGS = 20V, VDS = 0	-	200	nA
Zero-Gate Voltage Drain Current	(Note 4, 6)	IDSS	2N7331D, R	VGS = 0, VDS = -160V	-	25	µA
	(Note 5, 6)	IDSS	2N7331H	VGS = 0, VDS = -160V	-	100	µA
Drain-Source On-State Volts	(Note 1, 4, 6)	VDS(on)	2N7331D, R	VGS = -10V, ID = 19A	-	-4.19	V
	(Note 1, 5, 6)	VDS(on)	2N7331H	VGS = -16V, ID = 19A	-	-6.28	V
Drain-Source On Resistance	(Note 1, 4, 6)	RDS(on)	2N7331D, R	VGS = -10V, ID = 12A	-	.210	Ω
	(Note 1, 5, 6)	RDS(on)	2N7331H	VGS = -14V, ID = 12A	-	.315	Ω

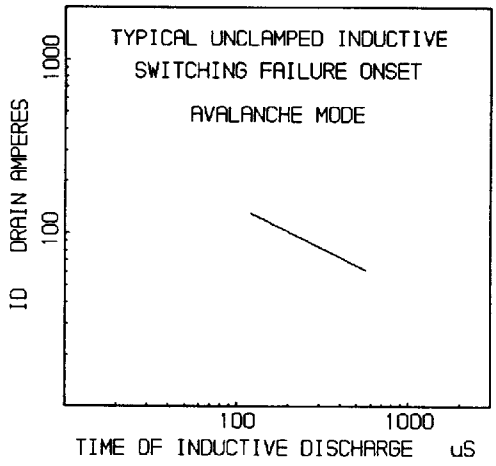
NOTES:

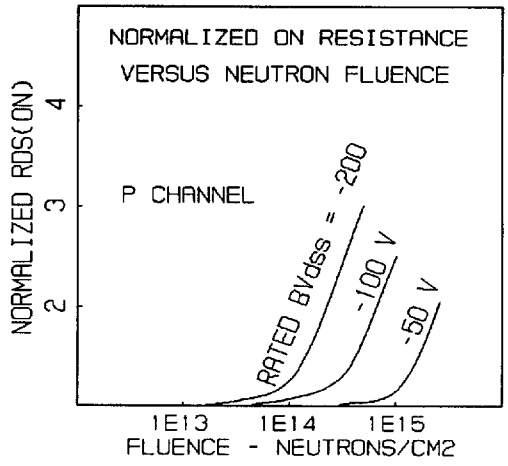
1. Pulse test, 300µs max
2. Absolute value-
3. Gamma = 300KRAD(Si)
4. Gamma = 10KRAD(Si) for "D", 100KRAD(Si) for "R" Neutron = 1E13
5. Gamma = 1000KRAD(Si) Neutron = 1E13
6. Insitu Gamma bias must be sampled for both VGS = -10V, VDS = 0V and VGS = 0V, VDS = 80% BVDSS
7. Gamma data taken 6/12/90 on TA 17762 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

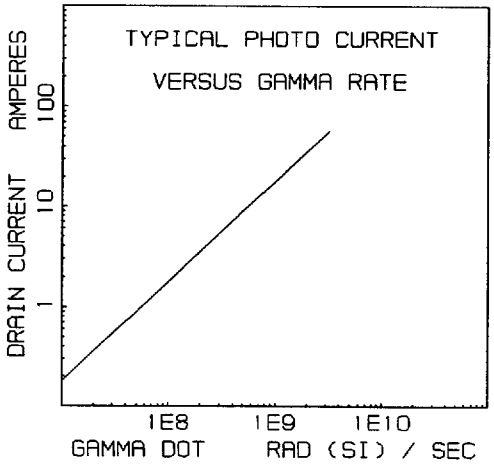
Typical Performance Characteristics

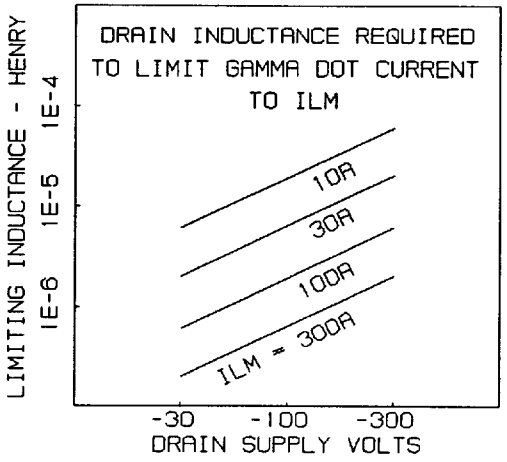




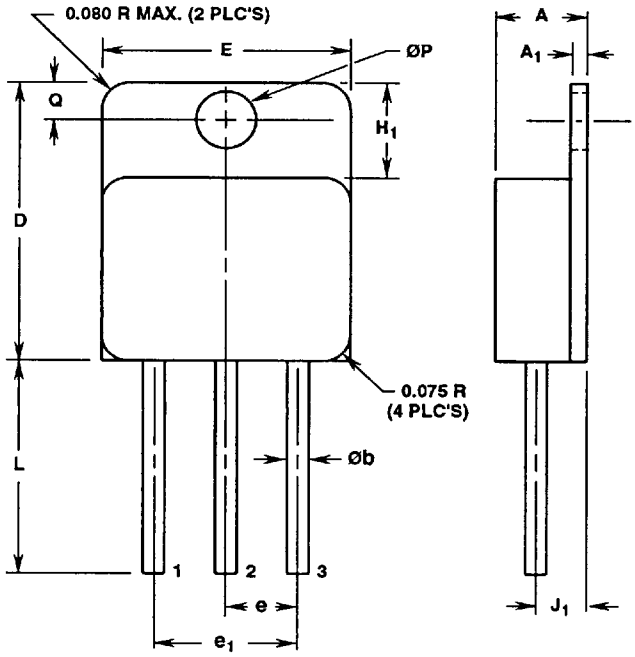








Packaging



TO-258AA

3 LEAD JEDEC TO-258AA HERMETIC METAL PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.250	0.270	6.35	6.85	-
A_1	0.035	0.045	0.89	1.14	-
Øb	0.055	0.065	1.40	1.65	2, 3
D	0.815	0.830	20.71	21.08	-
E	0.685	0.695	17.40	17.65	-
e	0.200 TYP		5.08 TYP		4
e_1	0.400 BSC		10.16 BSC		4
H_1	0.270	0.290	6.86	7.36	-
J_1	0.130	0.150	3.31	3.81	4
L	0.600	0.650	15.24	16.51	-
ØP	0.155	0.165	3.94	4.19	-
Q	0.115	0.125	2.93	3.17	-

NOTES:

1. These dimensions are within allowable dimensions of Rev. A of JEDEC TO-258AA outline dated 2-88.
2. Add typically 0.002 inches (0.05mm) for solder coating.
3. Lead dimension (without solder).
4. Position of lead to be measured 0.250 inches (6.35mm) from bottom of dimension D.
5. Die to base BeO isolated, terminals to case ceramic isolated.
6. Controlling dimension: Inch.
7. Revision 1 dated 1-93.