

June 1998

### Features

- 6A, 500V, RDS(on) = 1.40Ω
- 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
  - 12.0nA Per-RAD(Si)/sec Typically
- Neutron
  - Pre-RAD Specifications for 3E12 Neutrons/cm<sup>2</sup>
  - Usable to 3E13 Neutrons/cm<sup>2</sup>

### Description

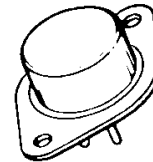
The Intersil Corporation has designed a series of SECOND GENERATION hardened power MOSFETs of both N and P channel enhancement types with ratings from 100V to 500V, 1A to 60A, and on resistance as low as 25mΩ. Total dose hardness is offered at 100K RAD(Si) and 1000KRAD(Si) with neutron hardness ranging from 1E13n/cm<sup>2</sup> for 500V product to 1E14n/cm<sup>2</sup> 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<sup>0</sup>) exposures. Design and processing efforts are also directed to enhance survival to heavy ion (SEE) and/or dose rate (GAMMA DOT) exposure.

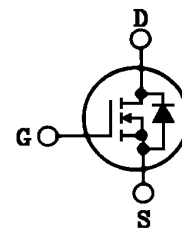
This part may be supplied as a die or in various packages other than shown above. Reliability screening is available as either non TX (commercial), TX equivalent of MIL-S-19500, TXV equivalent of MIL-S-19500, or space equivalent of MIL-S-19500. Contact the Intersil High-Reliability Marketing group for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

### Package

TO-204AA



### Symbol



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

	FRM440D, R, H	UNITS	
Drain-Source Voltage . . . . .	VDS	500	V
Drain-Gate Voltage (RGS = 20kΩ) . . . . .	VDGR	500	V
Continuous Drain Current			
TC = +25°C . . . . .	.ID	6	A
TC = +100°C . . . . .	.ID	4	A
Pulsed Drain Current . . . . .	IDM	18	A
Gate-Source Voltage . . . . .	VGS	±20	V
Maximum Power Dissipation			
TC = +25°C . . . . .	PT	125	W
TC = +100°C . . . . .	PT	50	W
Derated Above +25°C . . . . .		1.00	W/°C
Inductive Current, Clamped, L = 100μH, (See Test Figure) . . . . .	ILM	18	A
Continuous Source Current (Body Diode) . . . . .	.IS	6	A
Pulsed Source Current (Body Diode) . . . . .	ISM	18	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

# FRM440D, FRM440R, FRM440H

## Pre-Radiation Electrical Specifications $TC = +25^{\circ}C$ , Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS		UNITS
			MIN	MAX	
Drain-Source Breakdown Volts	BVDSS	$V_{GS} = 0, I_D = 1mA$	500	-	V
Gate-Threshold Volts	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 1mA$	2.0	4.0	V
Gate-Body Leakage Forward	IGSSF	$V_{GS} = +20V$	-	100	nA
Gate-Body Leakage Reverse	IGSSR	$V_{GS} = -20V$	-	100	nA
Zero-Gate Voltage Drain Current	IDSS1	$V_{DS} = 500V, V_{GS} = 0$	-	1	mA
	IDSS2	$V_{DS} = 400V, V_{GS} = 0$	-	0.025	
	IDSS3	$V_{DS} = 400V, V_{GS} = 0, TC = +125^{\circ}C$	-	0.25	
Rated Avalanche Current	IAR	Time = $20\mu s$	-	18	A
Drain-Source On-State Volts	$V_{DS(on)}$	$V_{GS} = 10V, I_D = 6A$	-	8.82	V
Drain-Source On Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 4A$	-	1.40	$\Omega$
Turn-On Delay Time	$t_d(on)$	$V_{DD} = 250V, I_D = 6A$	-	60	ns
Rise Time	$t_r$	Pulse Width = $3\mu s$	-	84	
Turn-Off Delay Time	$t_d(off)$	Period = $300\mu s, R_g = 25\Omega$	-	476	
Fall Time	$t_f$	$0 \leq V_{GS} \leq 10$ (See Test Circuit)	-	116	
Gate-Charge Threshold	$Q_G(th)$	$V_{DD} = 250V, I_D = 6A$ $I_{GS1} = I_{GS2}$ $0 \leq V_{GS} \leq 20$	2	8	nC
Gate-Charge On State	$Q_G(on)$		32	128	
Gate-Charge Total	$Q_{GM}$		65	250	
Plateau Voltage	VGP		3	12	V
Gate-Charge Source	QGS		6	24	nC
Gate-Charge Drain	QGD		11	46	
Diode Forward Voltage	VSD	$I_D = 6A, V_{GD} = 0$	0.6	1.8	V
Reverse Recovery Time	TT	$I = 6A; di/dt = 100A/\mu s$	-	1000	ns
Junction-To-Case	$R_{\theta jc}$		-	1.0	$^{\circ}C/W$
Junction-To-Ambient	$R_{\theta ja}$	Free Air Operation	-	30	

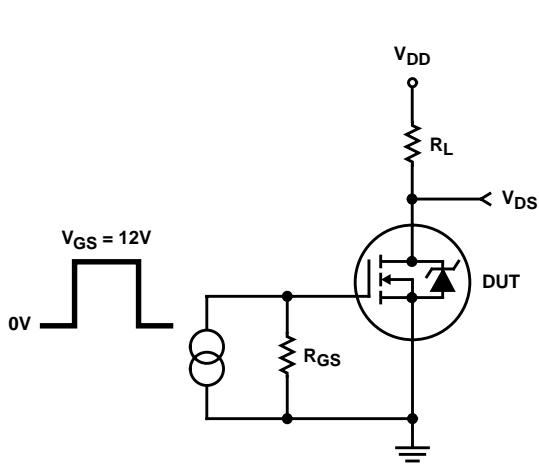


FIGURE 1. RESISTIVE SWITCHING TEST CIRCUIT

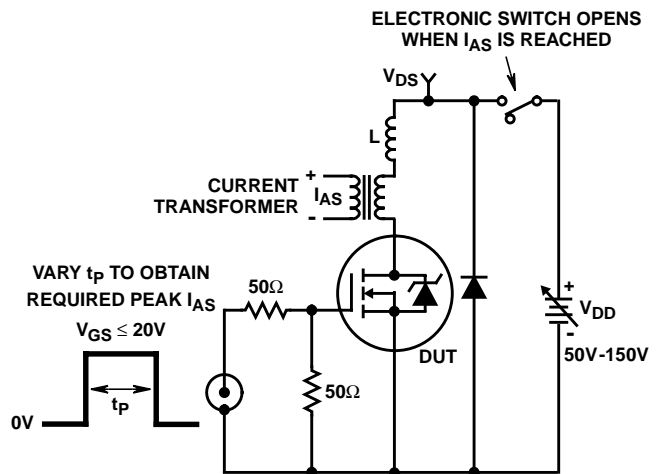


FIGURE 2. UNCLAMPED ENERGY TEST CIRCUIT

**FRM440D, FRM440R, FRM440H**

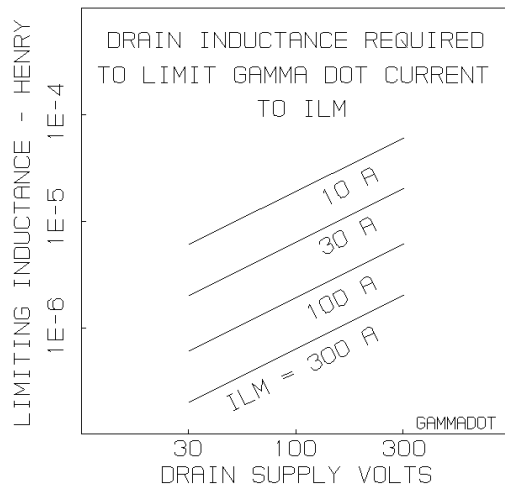
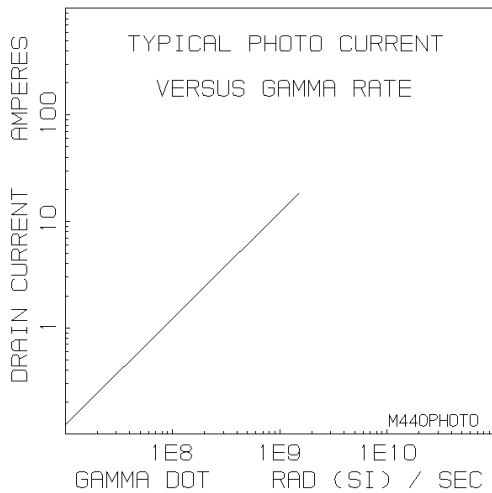
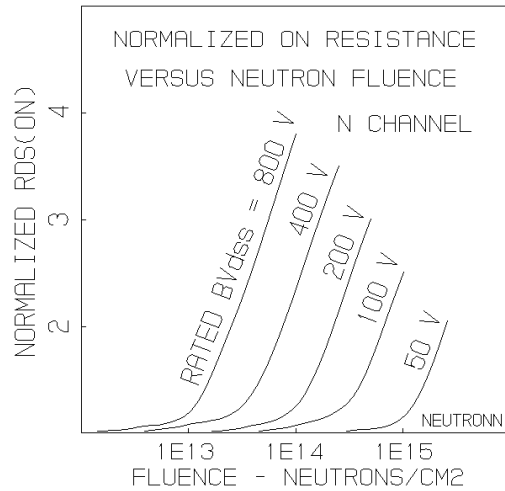
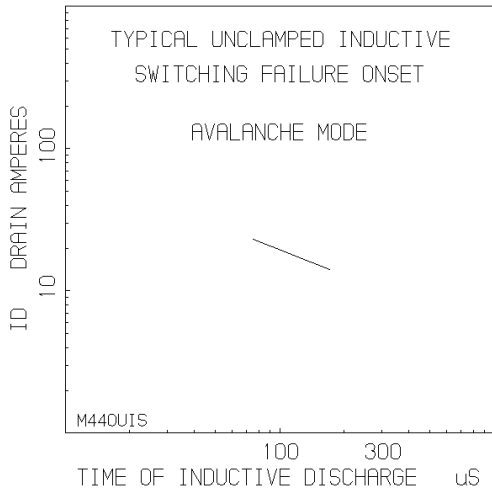
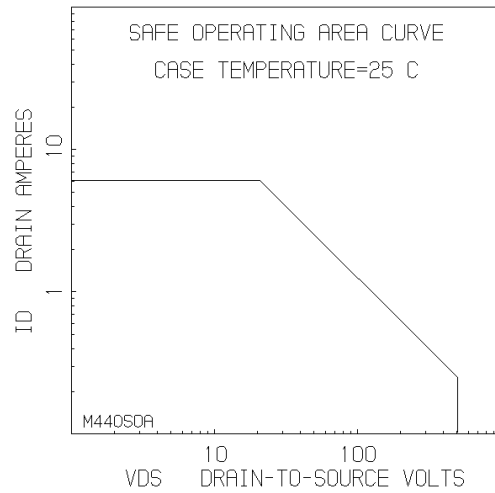
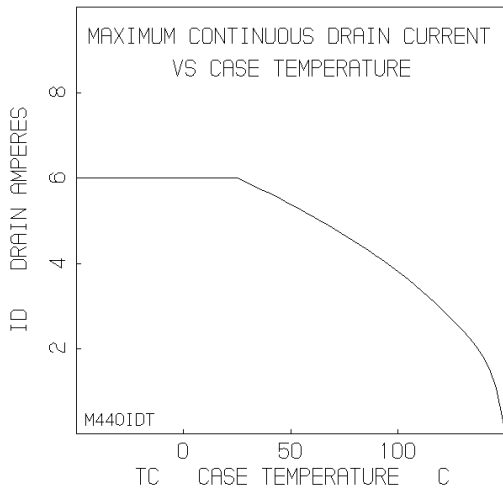
**Post-Radiation Electrical Specifications** TC = +25°C, Unless Otherwise Specified

PARAMETER	SYMBOL	TYPE	TEST CONDITIONS	LIMITS		UNITS	
				MIN	MAX		
Drain-Source Breakdown Volts	(Note 4, 6)	BVDSS	FRM440D, R	VGS = 0, ID = 1mA	500	-	V
	(Note 5, 6)	BVDSS	FRM440H	VGS = 0, ID = 1mA	475	-	V
Gate-Source Threshold Volts	(Note 4, 6)	VGS(th)	FRM440D, R	VGS = VDS, ID = 1mA	2.0	4.0	V
	(Note 3, 5, 6)	VGS(th)	FRM440H	VGS = VDS, ID = 1mA	1.5	4.5	V
Gate-Body Leakage Forward	(Note 4, 6)	IGSSF	FRM440D, R	VGS = 20V, VDS = 0	-	100	nA
	(Note 5, 6)	IGSSF	FRM440H	VGS = 20V, VDS = 0	-	200	nA
Gate-Body Leakage Reverse	(Note 2, 4, 6)	IGSSR	FRM440D, R	VGS = -20V, VDS = 0	-	100	nA
	(Note 2, 5, 6)	IGSSR	FRM440H	VGS = -20V, VDS = 0	-	200	nA
Zero-Gate Voltage Drain Current	(Note 4, 6)	IDSS	FRM440D, R	VGS = 0, VDS = 400V	-	25	μA
	(Note 5, 6)	IDSS	FRM440H	VGS = 0, VDS = 400V	-	100	μA
Drain-Source On-State Volts	(Note 1, 4, 6)	VDS(on)	FRM440D, R	VGS = 10V, ID = 6A	-	8.82	V
	(Note 1, 5, 6)	VDS(on)	FRM440H	VGS = 16V, ID = 6A	-	13.20	V
Drain-Source On Resistance	(Note 1, 4, 6)	RDS(on)	FRM440D, R	VGS = 10V, ID = 4A	-	1.40	Ω
	(Note 1, 5, 6)	RDS(on)	FRM440H	VGS = 14V, ID = 4A	-	2.10	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 = 3E12
5. Gamma = 1000KRAD(Si). Neutron = 3E12
6. Insitu Gamma bias must be sampled for both VGS = +10V, VDS = 0V and VGS = 0V, VDS = 80% BVDSS
7. Gamma data taken 3/15/90 on TA 17645 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, Intersil Application note AN-8831, Oct. 1988

Typical Performance Characteristics



**Rad Hard Data Packages - Intersil Power Transistors**

**TXV Equivalent**

**1. Rad Hard TXV Equivalent - Standard Data Package**

- A. Certificate of Compliance
- B. Assembly Flow Chart
- C. Preconditioning - Attributes Data Sheet
- D. Group A - Attributes Data Sheet
- E. Group B - Attributes Data Sheet
- F. Group C - Attributes Data Sheet
- G. Group D - Attributes Data Sheet

**2. Rad Hard TXV Equivalent - Optional Data Package**

- A. Certificate of Compliance
- B. Assembly Flow Chart
- C. Preconditioning - Attributes Data Sheet
  - Precondition Lot Traveler
  - Pre and Post Burn-In Read and Record Data
- D. Group A - Attributes Data Sheet
  - Group A Lot Traveler
- E. Group B - Attributes Data Sheet
  - Group B Lot Traveler
  - Pre and Post Read and Record Data for Intermittent Operating Life (Subgroup B3)
  - Bond Strength Data (Subgroup B3)
  - Pre and Post High Temperature Operating Life Read and Record Data (Subgroup B6)
- F. Group C - Attributes Data Sheet
  - Group C Lot Traveler
  - Pre and Post Read and Record Data for Intermittent Operating Life (Subgroup C6)
  - Bond Strength Data (Subgroup C6)
- G. Group D - Attributes Data Sheet
  - Group D Lot Traveler
  - Pre and Post RAD Read and Record Data

**Class S - Equivalents**

**1. Rad Hard "S" Equivalent - Standard Data Package**

- A. Certificate of Compliance
- B. Serialization Records
- C. Assembly Flow Chart
- D. SEM Photos and Report

- E. Preconditioning Attributes Data Sheet
  - Hi-Rel Lot Traveler
  - HTRB - Hi Temp Gate Stress Post Reverse Bias Data and Delta Data
  - HTRB - Hi Temp Drain Stress Post Reverse Bias Delta Data

- F. Group A - Attributes Data Sheet
- G. Group B - Attributes Data Sheet
- H. Group C - Attributes Data Sheet
- I. Group D - Attributes Data Sheet

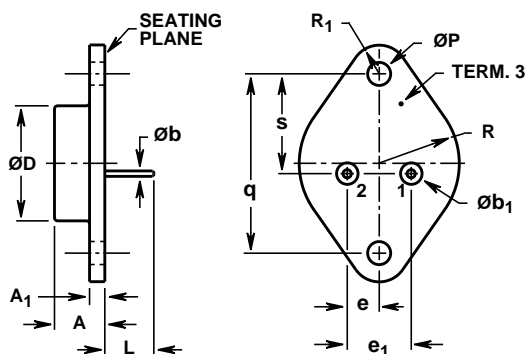
**2. Rad Hard Max. "S" Equivalent - Optional Data Package**

- A. Certificate of Compliance
- B. Serialization Records
- C. Assembly Flow Chart
- D. SEM Photos and Report
- E. Preconditioning - Attributes Data Sheet
  - Hi-Rel Lot Traveler
  - HTRB - Hi Temp Gate Stress Post Reverse Bias Data and Delta Data
  - HTRB - Hi Temp Drain Stress Post Reverse Bias Delta Data
  - X-Ray and X-Ray Report
- F. Group A - Attributes Data Sheet
  - Hi-Rel Lot Traveler
  - Subgroups A2, A3, A4, A5 and A7 Data
- G. Group B - Attributes Data Sheet
  - Hi-Rel Lot Traveler
  - Subgroups B1, B3, B4, B5 and B6 Data
- H. Group C - Attributes Data Sheet
  - Hi-Rel Lot Traveler
  - Subgroups C1, C2, C3 and C6 Data
- I. Group D - Attributes Data Sheet
  - Hi-Rel Lot Traveler
  - Pre and Post Radiation Data

# FRM440D, FRM440R, FRM440H

## TO-204AA

JEDEC TO-204AA HERMETIC STEEL PACKAGE



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.310	0.330	7.88	8.38	-
A <sub>1</sub>	0.060	0.065	1.53	1.65	-
Øb	0.038	0.042	0.97	1.06	2, 3
Øb <sub>1</sub>	0.138	0.145	3.51	3.68	-
ØD	-	0.800	-	20.32	-
e	0.215 TYP		5.46 TYP		4
e <sub>1</sub>	0.430 BSC		10.92 BSC		4
L	0.430	-	10.93	-	-
ØP	0.155	0.160	3.94	4.06	-
q	1.187 BSC		30.15 BSC		-
R	0.495	0.525	12.58	13.33	-
R <sub>1</sub>	0.131	0.185	3.33	4.69	-
s	0.655	0.675	16.64	17.14	-

### NOTES:

1. These dimensions are within allowable dimensions of Rev. C of JEDEC TO-204AA outline dated 11-82.
2. Lead dimension (without solder).
3. Add typically 0.002 inches (0.05mm) for solder coating.
4. Position of lead to be measured 0.250 inches (6.35mm) from bottom of seating plane.
5. Controlling dimension: Inch.
6. Revision 2 dated 6-93.

All Intersil semiconductor products are manufactured, assembled and tested under **ISO9000** quality systems certification.

*Intersil products are sold by description only. Intersil Corporation reserves the right to make changes in circuit design and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that data sheets are current before placing orders. Information furnished by Intersil is believed to be accurate and reliable. However, no responsibility is assumed by Intersil or its subsidiaries for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Intersil or its subsidiaries.*

For information regarding Intersil Corporation and its products, see web site <http://www.intersil.com>

### Sales Office Headquarters

#### NORTH AMERICA

Intersil Corporation  
P. O. Box 883, Mail Stop 53-204  
Melbourne, FL 32902  
TEL: (407) 724-7000  
FAX: (407) 724-7240

#### EUROPE

Intersil SA  
Mercure Center  
100, Rue de la Fusee  
1130 Brussels, Belgium  
TEL: (32) 2.724.2111  
FAX: (32) 2.724.22.05

#### ASIA

Intersil (Taiwan) Ltd.  
Taiwan Limited  
7F-6, No. 101 Fu Hsing North Road  
Taipei, Taiwan  
Republic of China  
TEL: (886) 2 2716 9310  
FAX: (886) 2 2715 3029