

December 2001

Features

- **3A, -200V, $r_{DS(ON)} = 1.50\Omega$**
- **Total Dose**
 - **Meets Pre-RAD Specifications to 100K RAD (Si)**
- **Single Event**
 - **Safe Operating Area Curve for Single Event Effects**
 - **SEE Immunity for LET of 36MeV/mg/cm² with V_{DS} up to 80% of Rated Breakdown and V_{GS} of 10V Off-Bias**
- **Dose Rate**
 - **Typically Survives 3E9 RAD (Si)/s at 80% BV_{DSS}**
 - **Typically Survives 2E12 if Current Limited to I_{DM}**
- **Photo Current**
 - **3.0nA Per-RAD(Si)/s Typically**
- **Neutron**
 - **Maintain Pre-RAD Specifications for 1E13 Neutrons/cm²**
 - **Usable to 1E14 Neutrons/cm²**

Ordering Information

RAD LEVEL	SCREENING LEVEL	PART NUMBER/BRAND
10K	Commercial	FSL9230D1
10K	TXV	FSL9230D3
100K	Commercial	FSL9230R1
100K	TXV	FSL9230R3
100K	Space	FSL9230R4

Formerly available as type TA17737.

Package

TO-205AF



Description

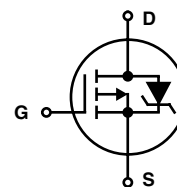
The Discrete Products Operation of Intersil Corporation has developed a series of Radiation Hardened MOSFETs specifically designed for commercial and military space applications. Enhanced Power MOSFET immunity to Single Event Effects (SEE), Single Event Gate Rupture (SEGR) in particular, is combined with 100K RADS of total dose hardness to provide devices which are ideally suited to harsh space environments. The dose rate and neutron tolerance necessary for military applications have not been sacrificed.

The Intersil portfolio of SEGR resistant radiation hardened MOSFETs includes N-Channel and P-Channel devices in a variety of voltage, current and on-resistance ratings. Numerous packaging options are also available.

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 be radiation tolerant. The MOSFET is well suited for applications exposed to radiation environments such as switching regulation, switching converters, motor drives, relay drivers and drivers for high-power bipolar switching transistors requiring high speed and low gate drive power. This type can be operated directly from integrated circuits.

Reliability screening is available as either commercial, TXV equivalent of MIL-S-19500, or Space equivalent of MIL-S-19500. Contact Intersil for any desired deviations from the data sheet.

Symbol



FSL9230D, FSL9230R

Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

	FSL9230D, FSL9230R	UNITS
Drain to Source Voltage	V_{DS} -200	V
Drain to Gate Voltage ($R_{GS} = 20k\Omega$)	V_{DGR} -200	V
Continuous Drain Current		
$T_C = 25^\circ\text{C}$	I_D 3	A
$T_C = 100^\circ\text{C}$	I_D 2	A
Pulsed Drain Current	I_{DM} 9	A
Gate to Source Voltage	V_{GS} ± 20	V
Maximum Power Dissipation		
$T_C = 25^\circ\text{C}$	P_T 25	W
$T_C = 100^\circ\text{C}$	P_T 10	W
Linear Derating Factor	0.20	W/ $^\circ\text{C}$
Single Pulsed Avalanche Current, $L = 100\mu\text{H}$, (See Test Figure)	I_{AS} 9	A
Continuous Source Current (Body Diode)	I_S 3	A
Pulsed Source Current (Body Diode)	I_{SM} 9	A
Operating and Storage Temperature	T_J, T_{STG} -55 to 150	$^\circ\text{C}$
Lead Temperature (During Soldering)	T_L 300	$^\circ\text{C}$
(Distance $>0.063\text{in}$ (1.6mm) from Case, 10s Max)		

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Drain to Source Breakdown Voltage	BV_{DSS}	$I_D = 1\text{mA}, V_{GS} = 0\text{V}$	-200	-	-	V	
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 1\text{mA}$	$T_C = -55^\circ\text{C}$	-	-7.0	V	
			$T_C = 25^\circ\text{C}$	-2.0	-6.0	V	
			$T_C = 125^\circ\text{C}$	-1.0	-	V	
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = -160\text{V}, V_{GS} = 0\text{V}$	$T_C = 25^\circ\text{C}$	-	25	μA	
			$T_C = 125^\circ\text{C}$	-	250	μA	
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = \pm 20\text{V}$	$T_C = 25^\circ\text{C}$	-	100	nA	
			$T_C = 125^\circ\text{C}$	-	200	nA	
Drain to Source On-State Voltage	$V_{DS(ON)}$	$V_{GS} = -12\text{V}, I_D = 3\text{A}$	-	-	-4.73	V	
Drain to Source On Resistance	$r_{DS(ON)12}$	$I_D = 2\text{A}, V_{GS} = -12\text{V}$	$T_C = 25^\circ\text{C}$	-	1.00	1.50	Ω
			$T_C = 125^\circ\text{C}$	-	-	2.78	Ω
Turn-On Delay Time	$t_{d(ON)}$	$V_{DD} = -100\text{V}, I_D = 3\text{A}, R_L = 33.3\Omega, V_{GS} = -12\text{V}, R_{GS} = 7.5\Omega$	-	-	65	ns	
Rise Time	t_r		-	-	130	ns	
Turn-Off Delay Time	$t_{d(OFF)}$		-	-	140	ns	
Fall Time	t_f		-	-	120	ns	
Total Gate Charge	$Q_g(TOT)$	$V_{GS} = 0\text{V to } -20\text{V}$	$V_{DD} = -100\text{V}, I_D = 3\text{A}$	-	-	61	nC
Gate Charge at 12V	$Q_g(12)$	$V_{GS} = 0\text{V to } -12\text{V}$		-	31	41	nC
Threshold Gate Charge	$Q_g(TH)$	$V_{GS} = 0\text{V to } -2\text{V}$		-	-	2.5	nC
Gate Charge Source	Q_{gs}			-	5.5	8.7	nC
Gate Charge Drain	Q_{gd}			-	13	17	nC
Plateau Voltage	$V_{(PLATEAU)}$	$I_D = 3\text{A}, V_{DS} = -15\text{V}$	-	-6	-	V	
Input Capacitance	C_{ISS}	$V_{DS} = -25\text{V}, V_{GS} = 0\text{V}, f = 1\text{MHz}$	-	850	-	pF	
Output Capacitance	C_{OSS}		-	185	-	pF	
Reverse Transfer Capacitance	C_{RSS}		-	35	-	pF	
Thermal Resistance Junction to Case	$R_{\theta JC}$		-	-	5.0	$^\circ\text{C/W}$	
Thermal Resistance Junction to Ambient	$R_{\theta JA}$		-	-	175	$^\circ\text{C/W}$	

FSL9230D, FSL9230R

Source to Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Forward Voltage	V_{SD}	$I_{SD} = 3A$	-0.6	-	-1.8	V
Reverse Recovery Time	t_{rr}	$I_{SD} = 3A, dI_{SD}/dt = 100A/\mu s$	-	-	190	ns

Electrical Specifications up to 100K RAD $T_C = 25^\circ C$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	MAX	UNITS
Drain to Source Breakdown Volts (Note 3)	BV_{DSS}	$V_{GS} = 0, I_D = 1mA$	-200	-	V
Gate to Source Threshold Volts (Note 3)	$V_{GS(TH)}$	$V_{GS} = V_{DS}, I_D = 1mA$	-2.0	-6.0	V
Gate to Body Leakage (Notes 2, 3)	I_{GSS}	$V_{GS} = \pm 20V, V_{DS} = 0V$	-	100	nA
Zero Gate Leakage (Note 3)	I_{DSS}	$V_{GS} = 0, V_{DS} = -160V$	-	25	μA
Drain to Source On-State Volts (Notes 1, 3)	$V_{DS(ON)}$	$V_{GS} = -12V, I_D = 3A$	-	-4.73	V
Drain to Source On Resistance (Notes 1, 3)	$r_{DS(ON)12}$	$V_{GS} = -12V, I_D = 2A$	-	1.50	Ω

NOTES:

1. Pulse test, 300 μs Max.
2. Absolute value.
3. Insitu Gamma bias must be sampled for both $V_{GS} = -12V, V_{DS} = 0V$ and $V_{GS} = 0V, V_{DS} = 80\% BV_{DSS}$.

Single Event Effects (SEB, SEGR) (Note 4)

TEST	SYMBOL	ENVIRONMENT (NOTE 5)			APPLIED V_{GS} BIAS (V)	(NOTE 6) MAXIMUM V_{DS} BIAS (V)
		ION SPECIES	TYPICAL LET (MeV/mg/cm ²)	TYPICAL RANGE (μ)		
Single Event Effects Safe Operating Area	SEESOA	Ni	26	43	20	-200
		Br	37	36	5	-200
		Br	37	36	10	-160
		Br	37	36	15	-100
		Br	37	36	20	-40

NOTES:

4. Testing conducted at Brookhaven National Labs; sponsored by Naval Surface Warfare Center (NSWC), Crane, IN.
5. Fluence = 1E5 ions/cm² (typical), T = 25 $^\circ C$.
6. Does not exhibit Single Event Burnout (SEB) or Single Event Gate Rupture (SEGR).

Typical Performance Curves Unless Otherwise Specified

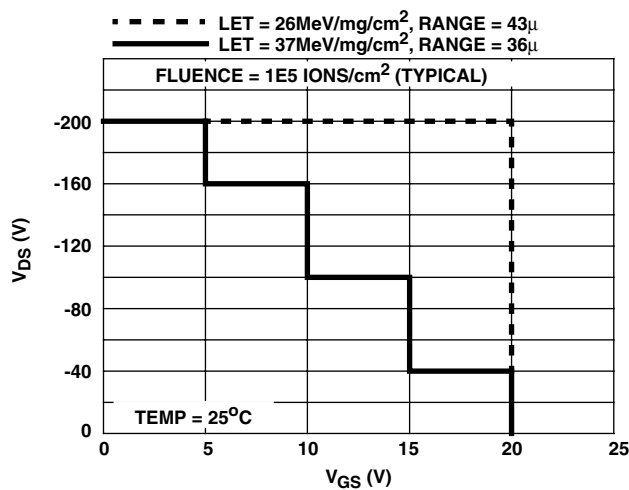


FIGURE 1. SINGLE EVENT EFFECTS SAFE OPERATING AREA

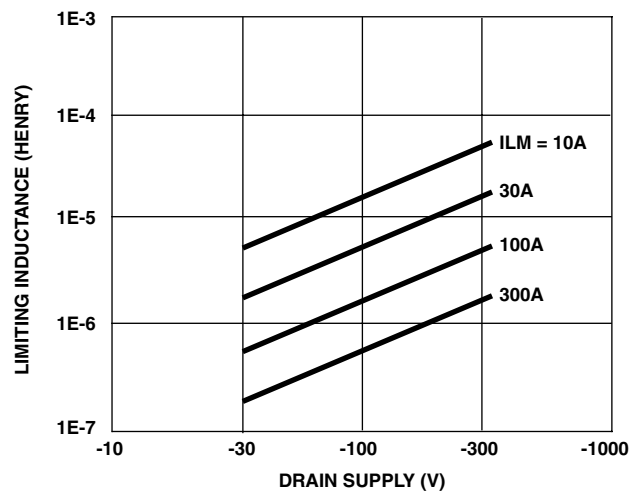


FIGURE 2. DRAIN INDUCTANCE REQUIRED TO LIMIT GAMMA DOT CURRENT TO I_{AS}

Typical Performance Curves Unless Otherwise Specified (Continued)

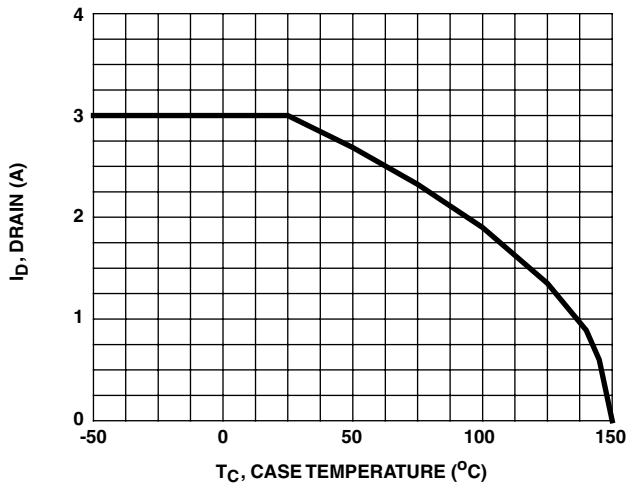


FIGURE 3. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

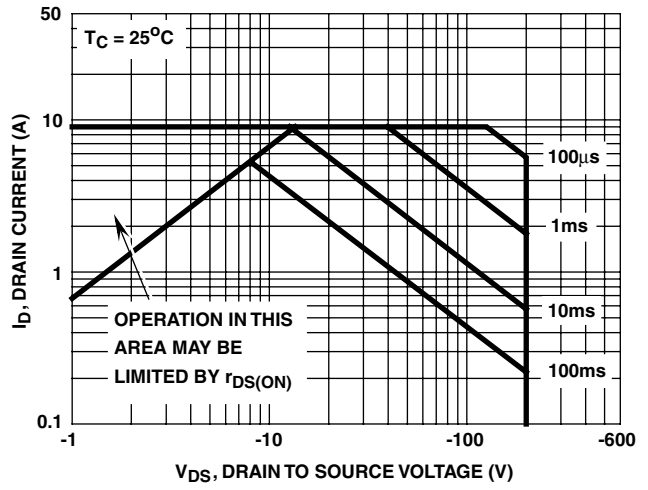


FIGURE 4. FORWARD BIAS SAFE OPERATING AREA

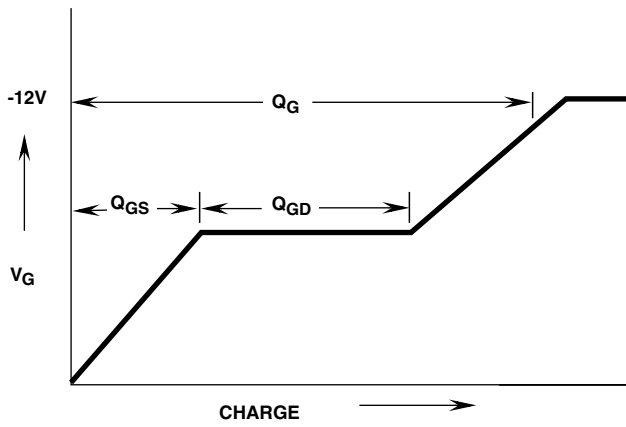


FIGURE 5. BASIC GATE CHARGE WAVEFORM

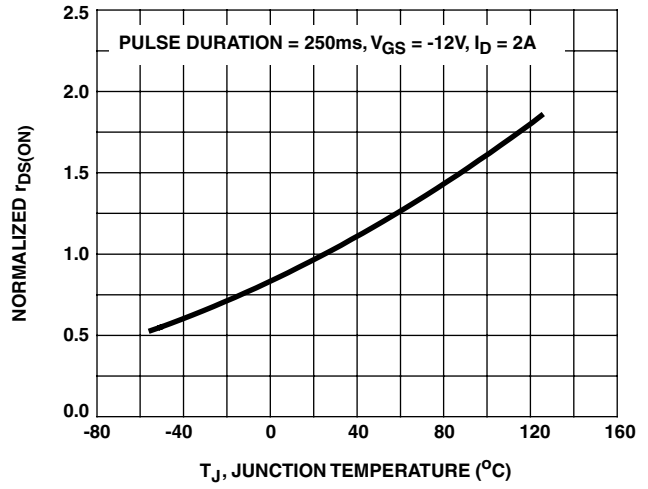


FIGURE 6. NORMALIZED r_{DS(ON)} vs JUNCTION TEMPERATURE

Typical Performance Curves Unless Otherwise Specified (Continued)

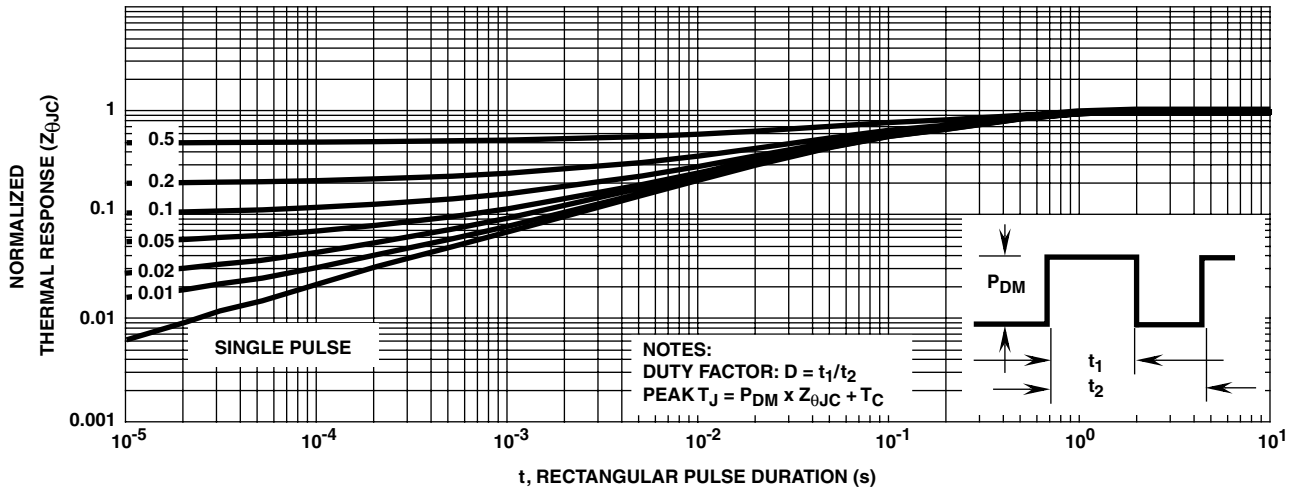


FIGURE 7. NORMALIZED MAXIMUM TRANSIENT THERMAL RESPONSE

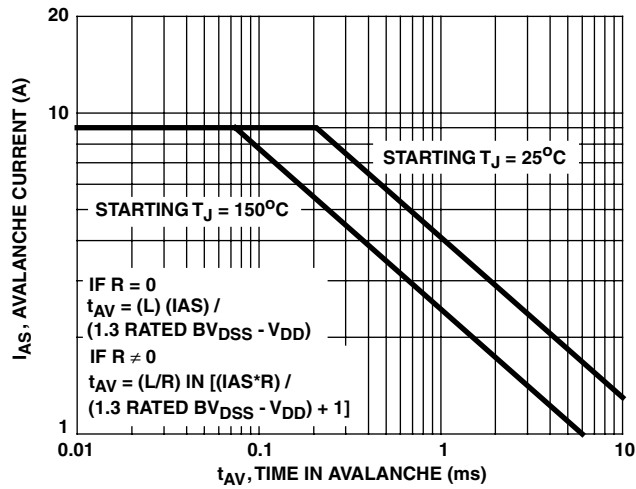


FIGURE 8. UNCLAMPED INDUCTIVE SWITCHING

Test Circuits and Waveforms

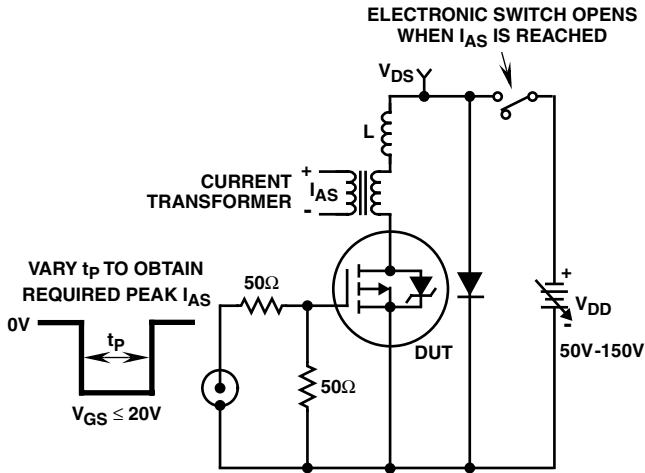


FIGURE 9. UNCLAMPED ENERGY TEST CIRCUIT

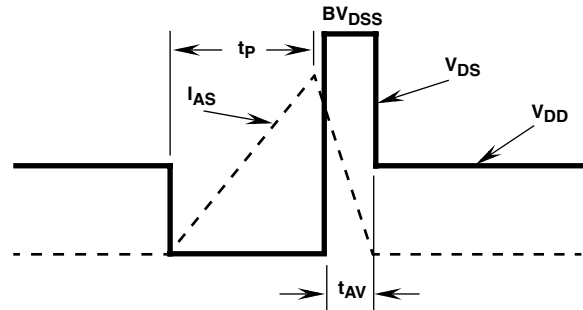


FIGURE 10. UNCLAMPED ENERGY WAVEFORMS

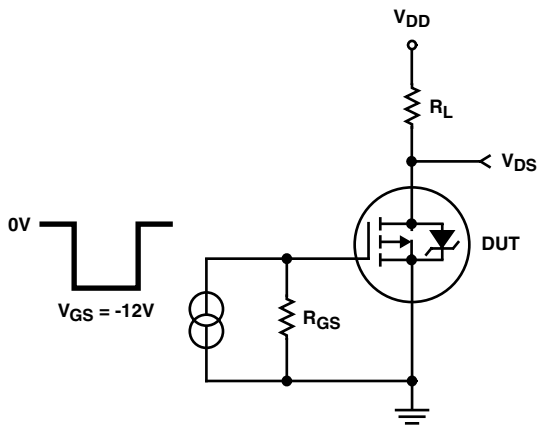


FIGURE 11. RESISTIVE SWITCHING TEST CIRCUIT

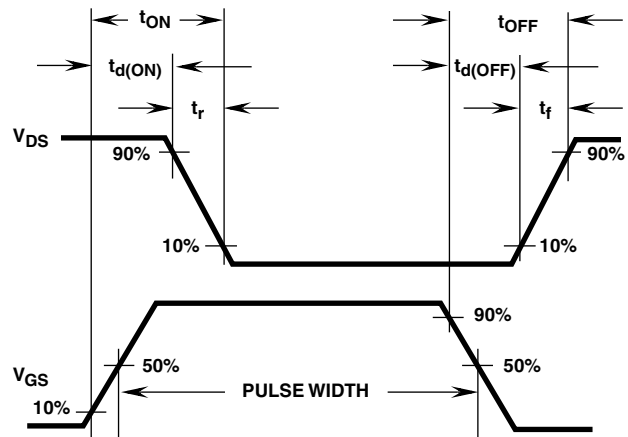


FIGURE 12. RESISTIVE SWITCHING WAVEFORMS

FSL9230D, FSL9230R

Screening Information

Screening is performed in accordance with the latest revision in effect of MIL-S-19500, (Screening Information Table).

Delta Tests and Limits (JANTXV Equivalent, JANS Equivalent) $T_C = 25^\circ\text{C}$, Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MAX	UNITS
Gate to Source Leakage Current	I_{GSS}	$V_{GS} = \pm 20\text{V}$	± 20 (Note 7)	nA
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 80\%$ Rated Value	± 25 (Note 7)	μA
Drain to Source On Resistance	$r_{DS(ON)}$	$T_C = 25^\circ\text{C}$ at Rated I_D	$\pm 20\%$ (Note 8)	Ω
Gate Threshold Voltage	$V_{GS(TH)}$	$I_D = 1.0\text{mA}$	$\pm 20\%$ (Note 8)	V

NOTES:

7. Or 100% of Initial Reading (whichever is greater).

8. Of Initial Reading.

Screening Information

TEST	JANTXV EQUIVALENT	JANS EQUIVALENT
Gate Stress	$V_{GS} = -30\text{V}$, $t = 250\mu\text{s}$	$V_{GS} = -30\text{V}$, $t = 250\mu\text{s}$
Pind	Optional	Required
Pre Burn-In Tests (Note 9)	MIL-S-19500 Group A, Subgroup 2 (All Static Tests at 25°C)	MIL-S-19500 Group A, Subgroup 2 (All Static Tests at 25°C)
Steady State Gate Bias (Gate Stress)	MIL-STD-750, Method 1042, Condition B $V_{GS} = 80\%$ of Rated Value, $T_A = 150^\circ\text{C}$, Time = 48 hours	MIL-STD-750, Method 1042, Condition B $V_{GS} = 80\%$ of Rated Value, $T_A = 150^\circ\text{C}$, Time = 48 hours
Interim Electrical Tests (Note 9)	All Delta Parameters Listed in the Delta Tests and Limits Table	All Delta Parameters Listed in the Delta Tests and Limits Table
Steady State Reverse Bias (Drain Stress)	MIL-STD-750, Method 1042, Condition A $V_{DS} = 80\%$ of Rated Value, $T_A = 150^\circ\text{C}$, Time = 160 hours	MIL-STD-750, Method 1042, Condition A $V_{DS} = 80\%$ of Rated Value, $T_A = 150^\circ\text{C}$, Time = 240 hours
PDA	10%	5%
Final Electrical Tests (Note 9)	MIL-S-19500, Group A, Subgroup 2	MIL-S-19500, Group A, Subgroups 2 and 3

NOTE:

9. Test limits are identical pre and post burn-in.

Additional Screening Tests

PARAMETER	SYMBOL	TEST CONDITIONS	MAX	UNITS
Safe Operating Area	SOA	$V_{DS} = -160\text{V}$, $t = 10\text{ms}$	0.71	A
Unclamped Inductive Switching	I_{AS}	$V_{GS(PEAK)} = -15\text{V}$, $L = 0.1\text{mH}$	9	A
Thermal Response	ΔV_{SD}	$t_H = 100\text{ms}$; $V_H = -25\text{V}$; $I_H = 1\text{A}$	125	mV
Thermal Impedance	ΔV_{SD}	$t_H = 500\text{ms}$; $V_H = -25\text{V}$; $I_H = 1\text{A}$	250	mV

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

TRADEMARKS

The following are registered and unregistered trademarks Fairchild Semiconductor owns or is authorized to use and is not intended to be an exhaustive list of all such trademarks.

ACE _x TM	FAST [®]	OPTOLOGIC TM	SMART START TM	VCX TM
Bottomless TM	FAST _r TM	OPTOPLANAR TM	STAR*POWER TM	
CoolFET TM	FRFET TM	PACMAN TM	Stealth TM	
CROSSVOLT TM	GlobalOptoisolator TM	POPT TM	SuperSOT TM -3	
DenseTrench TM	GTO TM	Power247 TM	SuperSOT TM -6	
DOMET TM	HiSeC TM	PowerTrench [®]	SuperSOT TM -8	
EcoSPARK TM	ISOPLANAR TM	QFET TM	SyncFET TM	
E ² CMOS TM	LittleFET TM	QST TM	TinyLogic TM	
EnSigna TM	MicroFET TM	QT Optoelectronics TM	TruTranslation TM	
FACT TM	MicroPak TM	Quiet Series TM	UHC TM	
FACT Quiet Series TM	MICROWIRE TM	SILENT SWITCHER [®]	UltraFET [®]	

STAR*POWER is used under license

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.