



Supplier Update for SPWG

Peter Cash, Director of Space, Defense and Avionics

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Overview

- Space, Defense and Avionics Group
- Space Qualified Crystal Oscillators
- SGR Product Updates
- AAHS298B Channel Driver Details
- RTG4 Updates
- MVR MSR Series Product Introduction
- MRH I²Mos™ Radiation Hardened Mosfets

Space, Defense and Avionics (SDA)

- SDA group located in Beverly, MA and focuses on providing precision frequency references for military and space applications
 - Group formed in 2003 to serve unique requirements of space and military oscillators and atomic clocks
 - Based on > 44 years of heritage
 - More than 800 Space Qualified Crystal Oscillators and 72 Space Qualified Cesium Clocks
- Dedicated manufacturing capability focused on additional environmental controls and enhanced process tolerances
- Stand-alone program management, engineering, and manufacturing dedicated to meeting program goals
- Strong technical skills in quartz oscillators, ruggedized atomic clocks, frequency and time sub-systems
- Experience in radiation hardening and test for natural and manmade environments



Space Qualified Crystal Oscillators

Model	Characteristics
9500B	<ul style="list-style-type: none"> • 5-500MHz (OCXO) • World-class Phase Noise and Allan Deviation performance $< 1e-13$ • High resolution Frequency Control • 1 Pulse Per Second KAS-2 Kalman Steering • Integrated mechanical shock isolation
9600 9700	<ul style="list-style-type: none"> • 5-25 MHz (OCXO) • Compact form-factor with ruggedized construction • Exceptional low-noise/high stability
9600QT	<ul style="list-style-type: none"> • 5MHz and 10 MHz OCXO (STD) • Compact form-factor • Short lead times • < 4weeks (Engr. Model), < 12weeks (Flight Model)
9800	<ul style="list-style-type: none"> • 50-200 MHz OCXO
9960/ 9940	<ul style="list-style-type: none"> • 10-600 MHz (TCXO/VCXO) • Through hole or surface mount options • Hybrid space qualified oscillators

9500B



9600/9700



9800



9960



9551 MOG



Microsemi 9500 Ultra Stable Oscillator

■ Highest Performance available oscillator

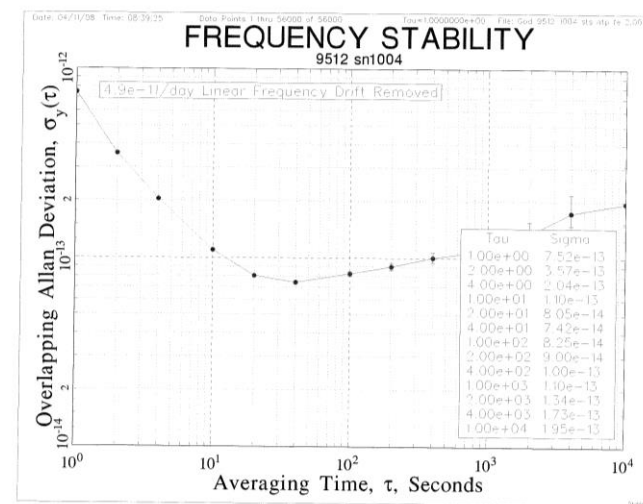
- Temperature Stability $< 3 \times 10^{-12}/^{\circ}\text{C}$ (with option for $1 \times 10^{-12}/^{\circ}\text{C}$)
- Frequency Stabilities $< 1 \times 10^{-13}$ for $\tau=1$ -100 seconds

■ Key Programs

- GPS III – Navigation Payload Master Reference Oscillator
- SBIRS High – Master Reference Oscillator
- Lunar Reconnaissance Orbiter
- EOS – AM
- Platform Timing Module for Government Programs



	Typical Performance
T=1 second	1.1×10^{-13}
T=10 seconds	1.3×10^{-13}
T=100 seconds	1.5×10^{-13}



9600,9700 and 9800 Ovenized Crystal Oscillators

- High Stability and Low Phase Noise
- Allan Deviation of $< 1 \times 10^{-12}$ 1-10 seconds (5 MHz)
- Phase Noise < -110 dBc/Hz @ 1 Hz (5 MHz)
- Frequency Range of 1 MHz to 200 MHz
- Level 1 or 2 EEE Parts
- Class K hybrid circuit for size reduction
- 1.3 W @ 25°C in thermal vacuum
- 300+ oscillators delivered for space missions
- Survivability to high levels of Random Vibration and Pyroshock
- Volume of 2.25 in²



Microsemi 9900 Hybrid Oscillators

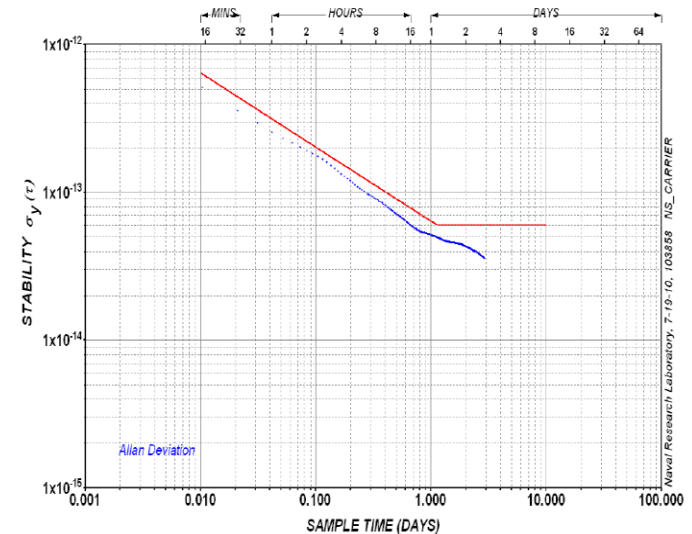
- 10 MHz to 1.2 GHz XO, VCXOs and TCXOs
- 3rd or 5th overtone AT Cut packaged and unpackaged crystals
- Experienced hybrid oscillator Design Engineers
- Thick Film Construction
- Assembled at Class K Certified Company
- Crystal options
 - TO-5 vacuum package
 - Low profile ceramic package

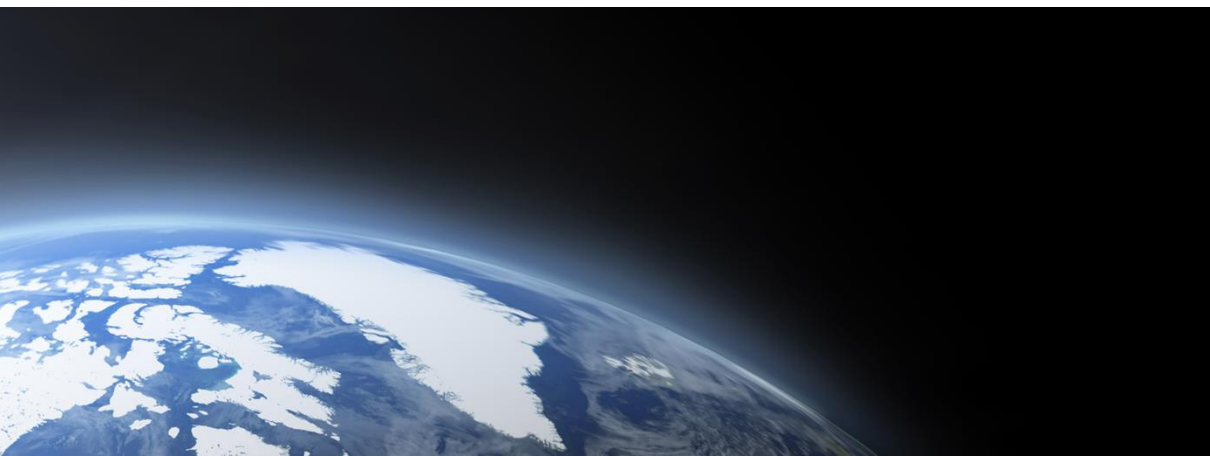
Model 4410 CAFS – Cesium Atomic Clock GPS Block IIF

Parameter

Output Frequency	10.23 MHz (nominal in-orbit)
Output Power	+18 dBm \pm 1.5 dB
Adjustment Range	$\pm 1 \times 10^{-9}$
Adjustment Resolution	1×10^{-15}
Accuracy	$\pm 1 \times 10^{-11}$
Reproducibility	$\pm 2 \times 10^{-12}$
Stability	$2 \times 10^{-11} \tau^{-1/2}$
Temperature Sensitivity	$< 5 \times 10^{-14} / ^\circ\text{C}$
Voltage Sensitivity	$< 1.3 \times 10^{-13} / \text{Volt}$
Magnetic Field Sensitivity	$< 1 \times 10^{-12} / \text{Gauss}$
Operating Temperature Range	0° to 50°C
Functional Temperature Range	-29° to 66°C
Size	6.25" x 7.70" x 16.50"
Weight	30 lbs
Power	29Watts

SV63 On-orbit Performance





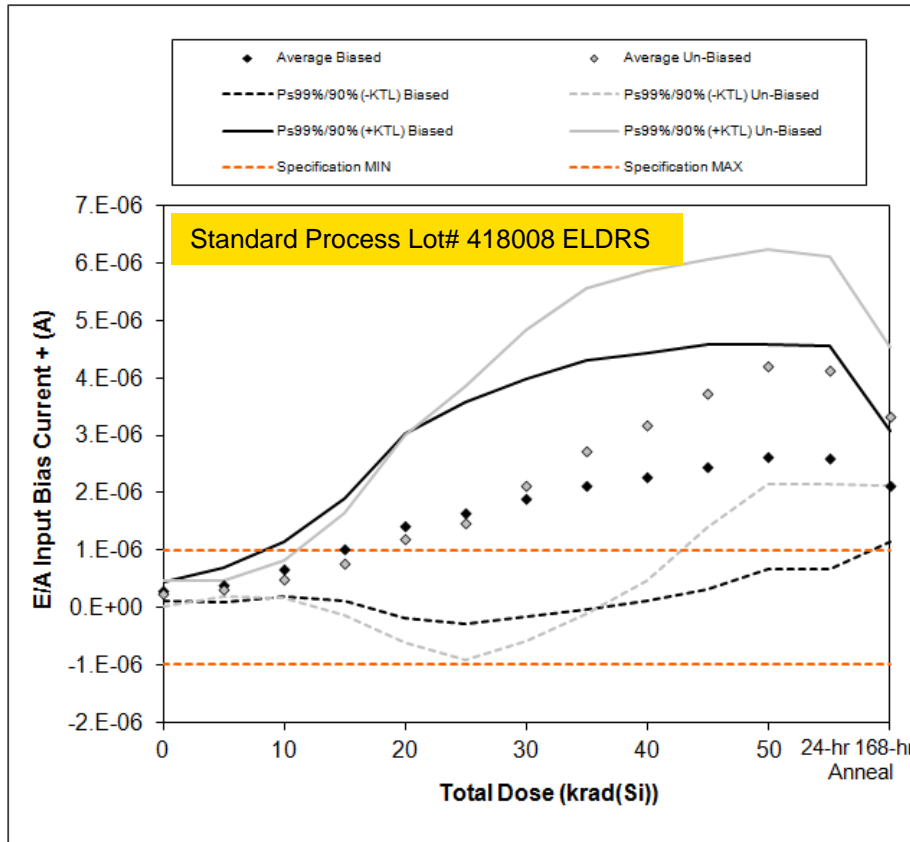
Jim Larrauri

Director of Business Development, Rad Hard/Hybrid Projects

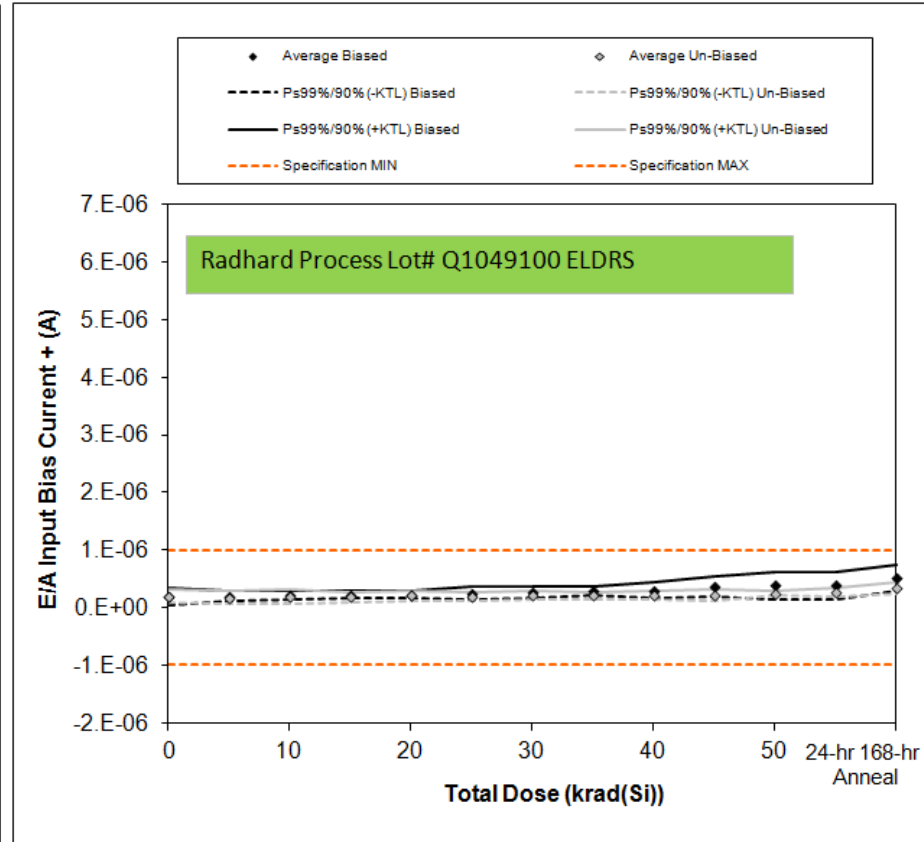
The SGR Product Line

- Our Industry Standard ICs have been a trusted solution for 30+ years (originally Silicon General)
- Still active and fully supported. Functions include:
 - PWM Controllers, Linear Voltage Regulators, Arrays, Op Amps
- To address requirement for both Extended Low Dose Radiation (ELDR) and Total Ionization Dose (TID) guaranteed performance, we have launched the SGR Product Family- In production and sampling now
 - Minimum Total Ionization Dose (TID) tolerance of 100kRad
 - Minimum Extended Low Dose Radiation (ELDR) tolerance of 50kRad
 - Single Event Latch-up (SEL) immunity
- Fit-form-function enhancement of SG part. Process change ONLY
- Manufactured per QML-V flow. Certification in process

SG1846 ELDRS vs. SGR1846



- STD process failed 10 Krad



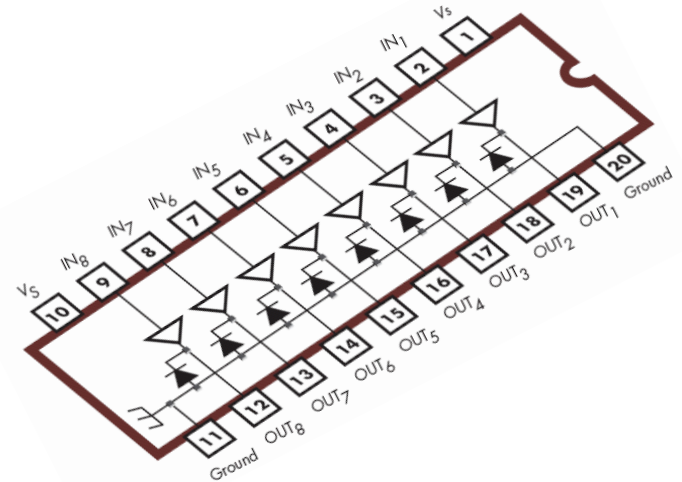
- New process passed 50 Krad

AAHS298B – 8 Channel Source Driver LX7710 – 125V Octal Series Diode Pairs Array



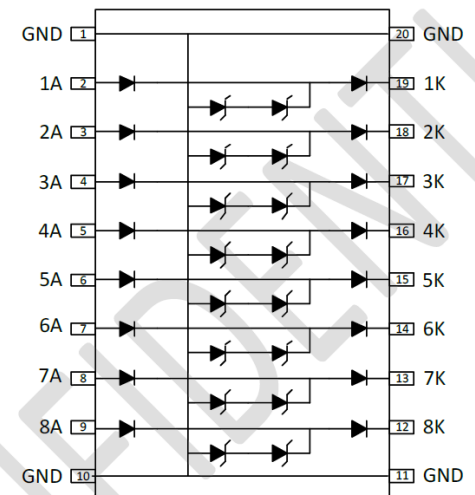
AAHS298B

- 700mA per output source current
- Fully isolated channels with DI process
- 100krad TID, 50krad ELDRS, and SEL immune
- 80V minimum output breakdown
- Low quiescent current consumption
- Internal ground clamp diodes
- Internal thermal shutdown
- TTL, 5V, and 12V logic compatible



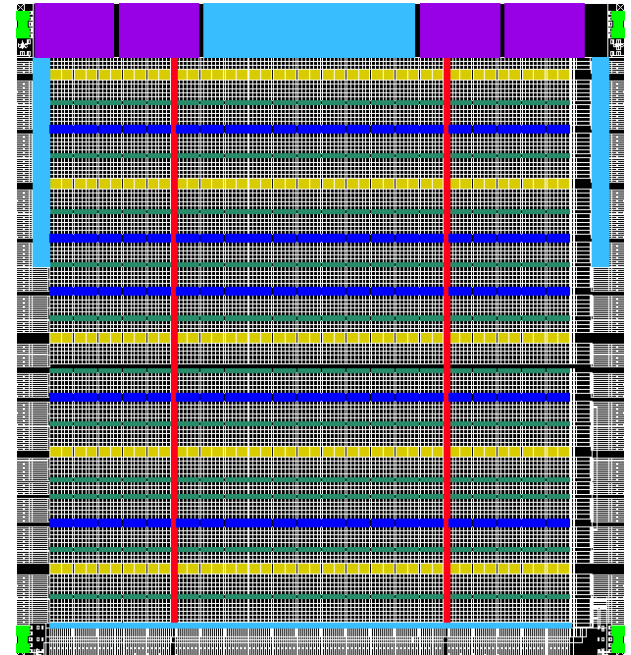
LX7710

- Redundant diode pair
- 125V working voltage per diode
- Forward current
- Low leakage current
- Internal ESD protection
- Zener supports inductive kickback



RTG4 – Next-Gen Radiation Tolerant FPGAs

- Flexible, non-volatile, and reprogrammable
 - Low power 65nm Flash process
 - Family of three parts
- High density, high speed signal processing
 - Up to 200,000 logic cells, with 4-input LUT and TMR flip flop
 - Up to 5.0Mbits of embedded SRAM
 - Up to 492 Mathblocks with 18x18 multiply and accumulate
 - Up to 32 lanes of SERDES, up to 3.125 Gbit/sec
 - Up to 300 MHz in-system performance
- Radiation tolerant
 - 100 Krad TID
 - Immune to single-event latch-up
 - Immune to configuration upsets



RTG4 Product Availability

- RT devices for space flight applications
 - Initial device: RT4G150
 - Early SW access: **NOW**
 - Sample RT4G150 silicon: 2015
 - 883B flight units: 2016
 - QML qualification: 2016

- Non-RT *SmartFusion2* and *Igloo2* for emulation and development
 - Software general availability: **NOW**
 - Commercial device availability: **NOW**

MVR MSR Series Product Introduction

MRH I²Mos™ Radiation Hardened Mosfets

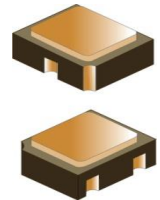
Radiation Hardness Assured (SR) Level



MSR™ SERIES

JANS (R) LEVEL RADIATION HARDNESS ASSURED BI-POLAR JUNCTION TRANSISTORS (BJT)

BENEFITS & TARGET MARKET

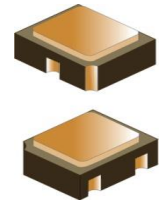


- ❑ **ELDR (enhanced low dose rate) guarantee- 1000Gy(Si)/100Krad(Si)**
 - ✓ Targeted at all commercial communication satellites, military and critical space
 - ✓ Compliant to NASA GSFC EEE-INST-002 requirements for space flight
 - ✓ Meets all level 1 requirements for missions of (5+) year missions per EEE
 - ✓ 100% wafer lot radiation hardness assurance with radiation validation test reporting
 - ✓ MSR series product are guaranteed to full compliance of MIL-PRF-19500 specification JANS(R) Radiation level and are also guaranteed to meet or exceed ESCC 22900 specifications (General specifications) for radiation performance requirements
 - ✓ Eliminates customers costly man-power/documentation/test verification hours in attempt validate RHA performance of non rated product

Radiation Hardness Assured (TXVR) level



MVR™ SERIES JANTXV (R) LEVEL RADIATION HARDNESS ASSURED BI-POLAR JUNCTION TRANSISTORS (BJT)



BENEFITS & TARGET MARKET

- ❑ **ELDR (enhanced low dose rate) guarantee- 1000Gy(Si)/100Krad(Si)**
 - ✓ Targeted at earth science, observation and commercial space applications
 - ✓ Compliant to NASA GSFC EEE-INST-002 requirements for space flight
 - ✓ Meets all level 2 requirements for missions of one (1) to (5) year missions per EEE
 - ✓ 100% wafer lot radiation hardness assurance with radiation validation test reporting
 - ✓ MVR series product are guaranteed to full compliance of MIL-PRF-19500 specification JANTXV(R) radiation level and are also guaranteed to meet or exceed ESCC 22900 specifications (General specifications) for radiation performance requirements
 - ✓ Eliminates customers costly man-power/documentation/test verification hours in attempt validate RHA performance of non rated product

MVR™-MSR™ Radiation Validation Testing

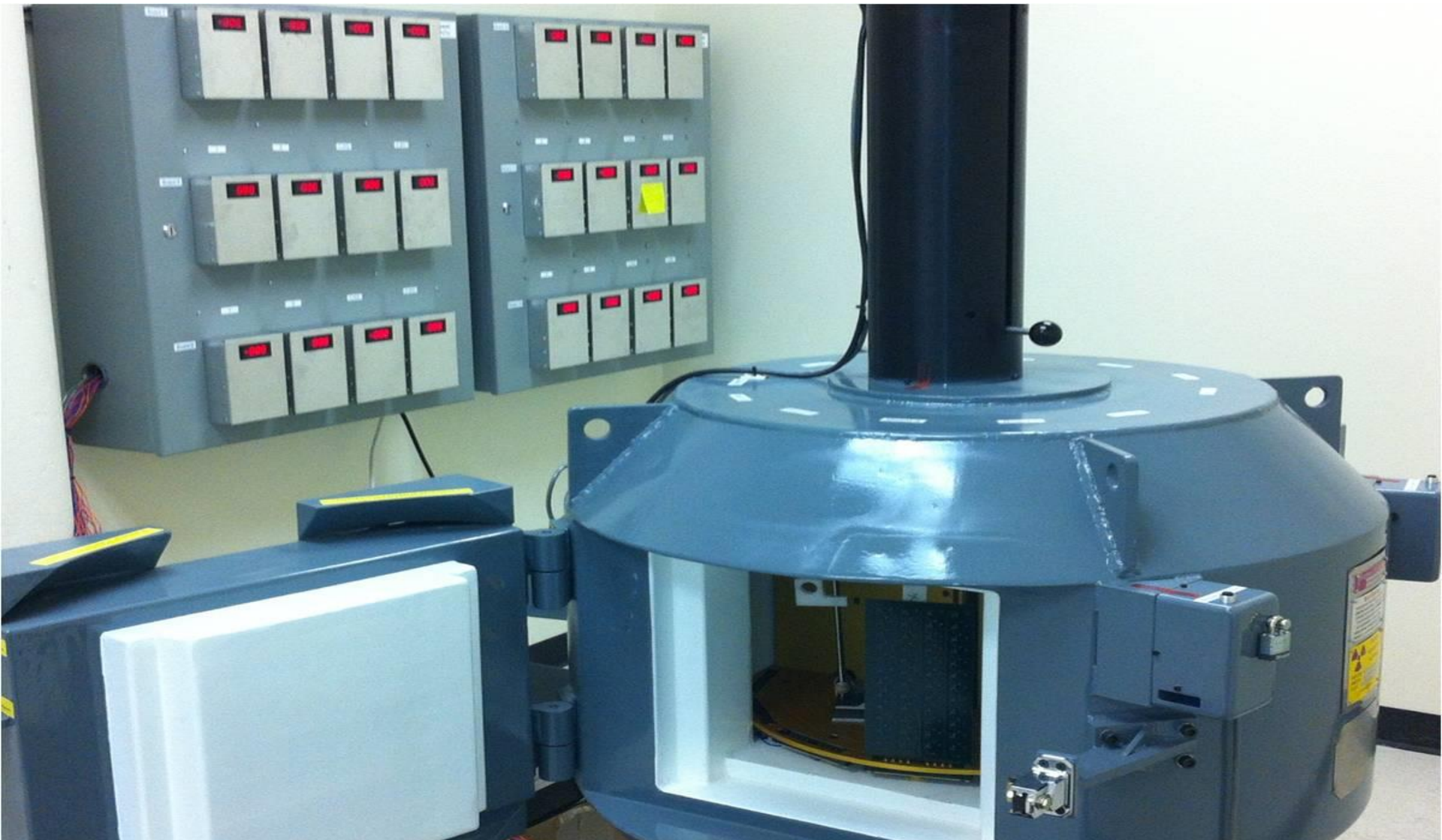
- ALL product lots are tested according to
 - ESCC basic specification 22900, with minimum of 21 samples per diffusion lot and 10 samples per wafer. One sample being kept as unirradiated sample, all of them being fully compliant with the applicable ESCC generic and/or detailed specification.
 - Microsemi performs testing of 10 pieces by wafer, 10 biased at least 80% of V(BR)CEO, 10 unbiased* and 1 kept for reference, Irradiation at 0.1 rad (Si)/s, Acceptance criteria of each individual wafer if as 100 krad guaranteed if all 20 samples comply with the post radiation electrical characteristics provided. **This testing exceeds standard protocol.**
 - ELDRS testing is conducted onsite at Microsemi HRG Lawrence Massachusetts facilities utilizing our JL Shepherd Co-60 source, dual hemisphere capable of
 - ❖ Dose rates of: 0.10 Rad(s)/sec. Standard,*
 - ❖ 0.01 Rad(s)/ sec. option available

Radiation Validation Testing Facilities

- **Location – Microsemi Lawrence Massachusetts**
- Dual-Hemisphere Cobalt-60 Low-Dose-Rate gamma irradiator with simultaneous 10mRAD/s and 100mRAD/s capability. Capacity is 288 components (MOSFET, BJT, Diodes, etc. in any package combination) in the 100mRAD/s Hemisphere plus... 288 components in the 10mRAD/s Hemisphere (576 total) with up to 24 simultaneous and independent bias settings per Hemisphere (48 total) with each individual bias voltage being continuously variable from 0V to +/-800V or card configurable to +/-1200V
- All Low Dose Rate on all discrete RAD-Hard lots and to meet the rated RHA level with ELDR testing done in-house

"FATBOY" Our ELDR's System

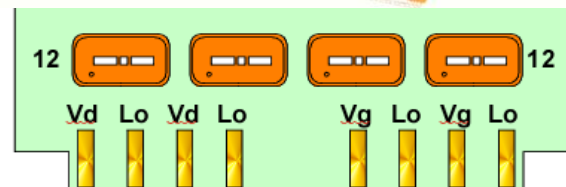
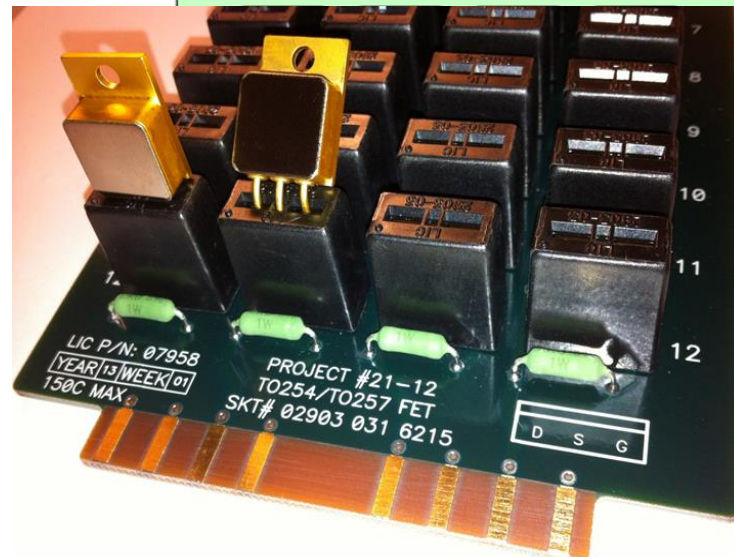
Bias Levels = 48
Positions = 576 Total
Both 100mRAD/s and
10mRAD/s





Microsemi.

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100mRAD/s Report on One Run

Status of This Information in Main Table (1=Active, 0=Inactive)	=	1
Package Number or Description	=	11
Part Number	=	JANSR2N2907AUB
Date Code	=	1243
Wafer Lot Number	=	F2080-2
Assembly Lot Number or Work Order Number	=	WO#45635
SampleSize	=	5
Record Run Number	=	100038
Board Number (1 to 6)	=	2
Channel BJT A,B,C or D or FET A or B and AG or BG	=	A
Board Socket Numbers Example: 1 to 10 6 to 10 (0 = n/a)	=	1 to 5
Required Bias Voltage (+/- V)	=	-48
FET Gate Bias Voltage (+/- V)	=	
Note, Comment or Request	=	7.1kRAD (21.3kRAD Total) JMM
Desired Gamma Target Dosage For This Run (RAD)	=	7,100
Run is On? (1=Yes, 0=Closed, Blank=Not Started)	=	0
Start Date (Blank = Not Yet) Date and Time (m/d/yy h:mm AM)	=	Wed 10/23/13 11:41 AM
Projected Finish Date (Blank = Not Yet) Date and Time (Day, m/d/yy h:mm AM)	=	RAD Run Ended
Actual Finish Date (Blank = Not Yet) Date and Time (m/d/yy h:mm AM)	=	Thu 10/24/13 7:52 AM
Total Drop Out Interrupt Time if Any (0=None) in Hours	=	0
Actual Received Gamma Dosage (RAD)	=	7,103
Average Dose Rate Today at Selected Part and Board (mRAD/s)	=	97.8
Test Board Number	=	LIC 07963
Package Type	=	UB (LCC3)
Device Type	=	BJT
Number of Biases Required (1=BJT, Diode and 2=FET)	=	1
Maximum Positions per Channel	=	12
Socket Mounting Plane Height (in)	=	0.245
Chip Height Above Socket (in)	=	-0.04

A Portion of the
MVR™/MSR™
automatically generated
irradiator report

Start times and stop
times automatically track
the age of the source
plus the height of the
package and socket
plus bias conditions

A copy of the report is
recorded electronically
plus another copy is
printed out to be
attached to the traveler

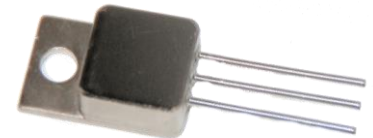
I²MOS™ MOS FET Development

I²MOS™ is equivalent+ to IR R6, N- Channel with improved radiation performance.

- 100V
 - Engineering Design Units: Available June 2014
 - JANSR2N7587U3 /746, Qual: End Q3 2014
- 150V size 3 die.
 - Engineering Design Units: Available June 2014
 - JANSR2N7589U3 /746, Qual: Q3-Q4 2014
- 200V size 3 die
 - Engineering Design Units: **Available Now**
 - JANSR2N7591U3 /746, Qual: Q3-Q4 2014
- 250V size 3 die
 - Engineering Design Units: Available August 2014
 - JANSR2N7593U3 /746, Qual: Q3-Q4 2014



SMD 0.5



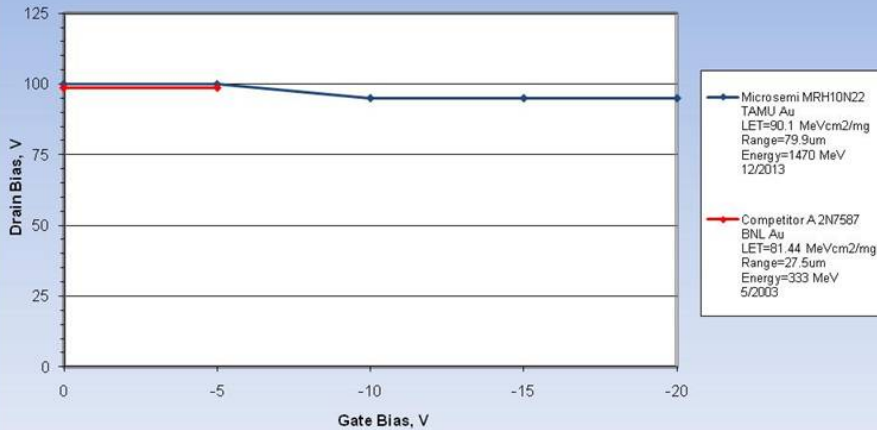
TO-257



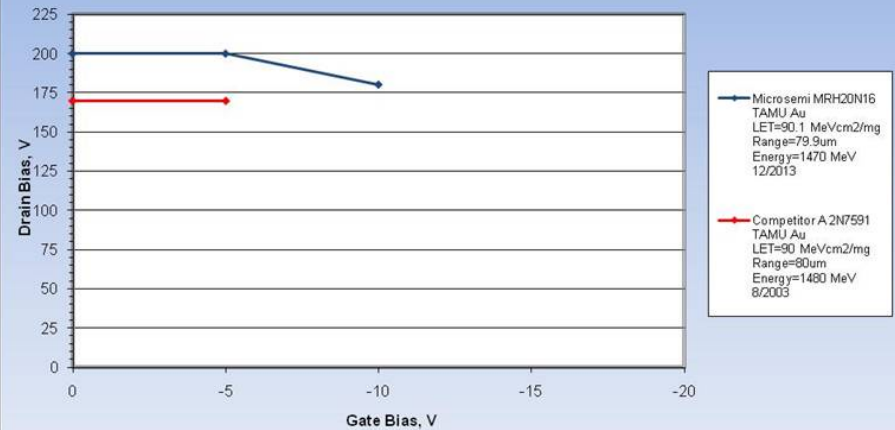
TO-39

SEE Performance

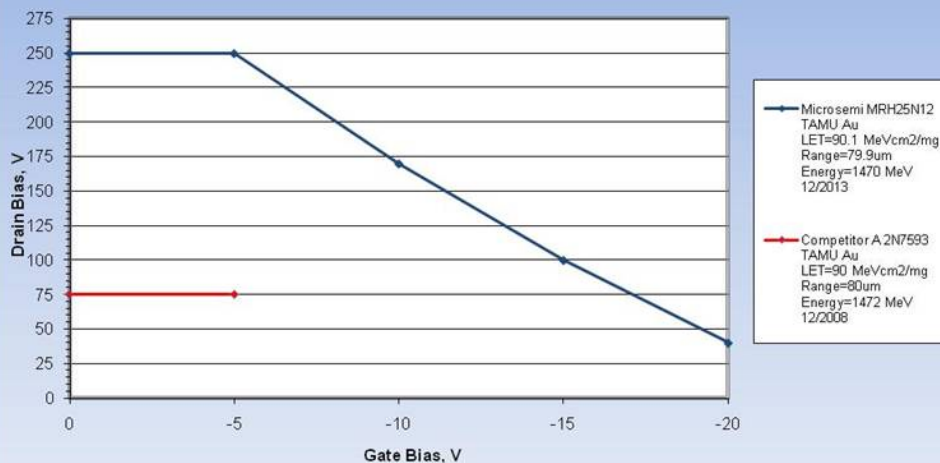
SEE SOA Curve MRH10N22
100V 22A N-Channel



SEE SOA Curve MRH20N16
200V 16A N-Channel



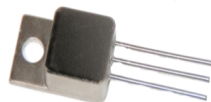
SEE SOA Curve MRH25N12
250V 12A N-Channel



**All data
performed at
TAMU under
Worst Case
condition for Au**

I²MOS™ portfolio- N- Channel, Size 3

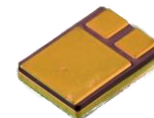
Bvdss V	RDS(on) Ω	Channel	JEDEC Number	Industry Equivalent	RH2 Base MSC p/n	Package	Slash Sheet
100	0.042	N	2N7587U3	IRH NJ67130	MRH10N22U3	SMD-0.5	746
150	0.088	N	2N7589U3	IRH NJ67134	MRH15N19U3	SMD-0.5	746
200	0.13	N	2N7591U3	IRH NJ67230	MRH20N16U3	SMD-0.5	746
200	0.13	N		IRHF67230	MRH20N12T2	TO- 39	
200	0.13	N		IRHYB67230CM	MRH20N12T3	TO-257	
250	0.21	N	2N7593U3	IRH NJ67234	MRH25N16U3	SMD-0.5	746
250	0.22	N	2N7494T3	IRHYS67234CM	MRH25N12T3	TO-257AA	755



TO-257



TO-39



SMD0.5

I²MOS™ MOS P/N Structure

<u>MRH</u>	<u>BVDSS/10</u>	<u>Channel</u>	<u>ID @</u> <u>25C</u>	<u>Package</u>	<u>Screening</u>	<u>RAD LEVEL</u>	<u>special features</u>
	(V)		(A)				
<u>MRH</u>	<u>20</u>	<u>N</u>	<u>22</u>	<u>U3</u>	<u>S</u>	<u>R</u>	<u>C</u>
Microsemi	20= 200V	N		U3= SMD0.5	S= JANS	R= 100K	<i>TBD</i>
Rad- Hard	10= 100V	P		T2= TO- 39	V= JANTXV	F= 300K	
MOSFET	13= 130V			T3= TO- 257			
	06= 60V			U5= LCC-18			
	03= 30V			C= die			

Key Contacts

- **SGR LINE (ICs)**

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- **FPGA (RTAX ProAsic)®**

Minh Nguyen, Marketing Manager, Space FPGAs

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- **Low Drop Out/ Point of Loads / Hybrids**

Jim Larrauri, Director Bus & Dev RH Projects

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Al Ortega, Product Line Manager

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- **Isolated POL DC/DC Converters (SB30)**

Patrick Franks, Director of Engineering

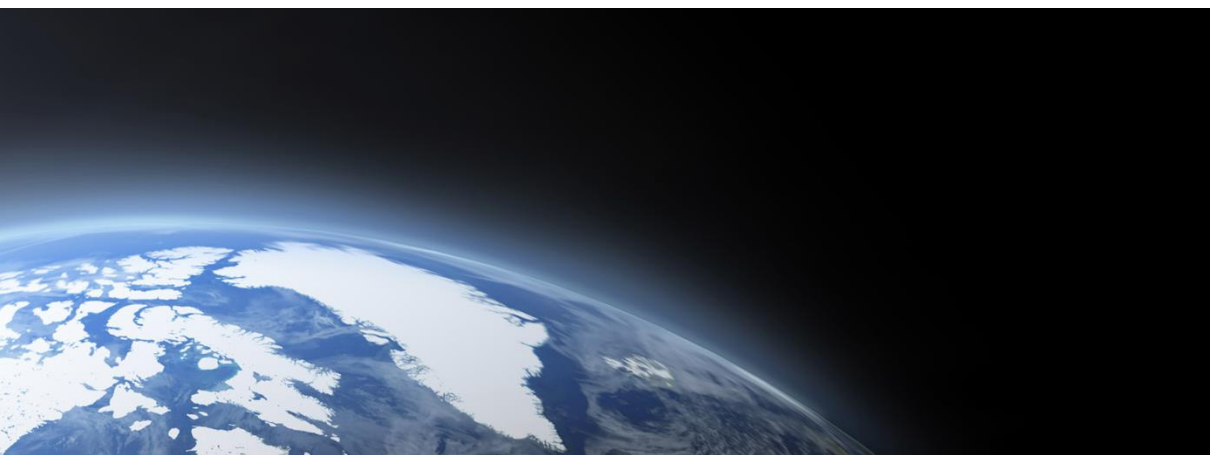
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Thank You!