



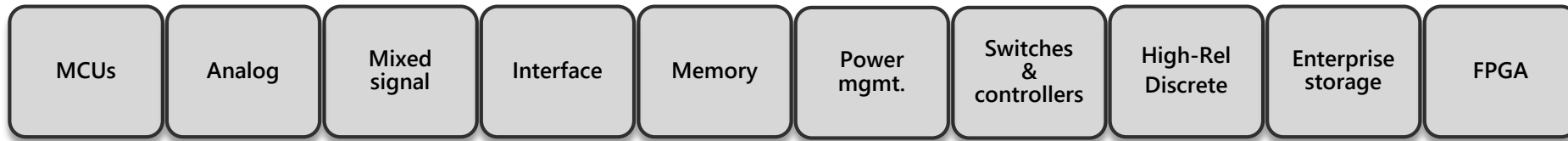
a  MICROCHIP company

RTG4 Radiation Tolerant FPGA Update

Ken O'Neill
Director of Marketing, Space and Aviation

Microsemi – a Microchip Company

Microchip Corporate Overview

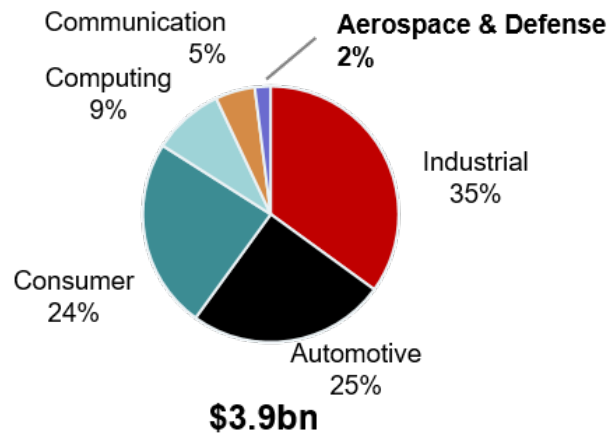


- Headquartered in Chandler, AZ
- ~ \$6 Billion revenue run rate

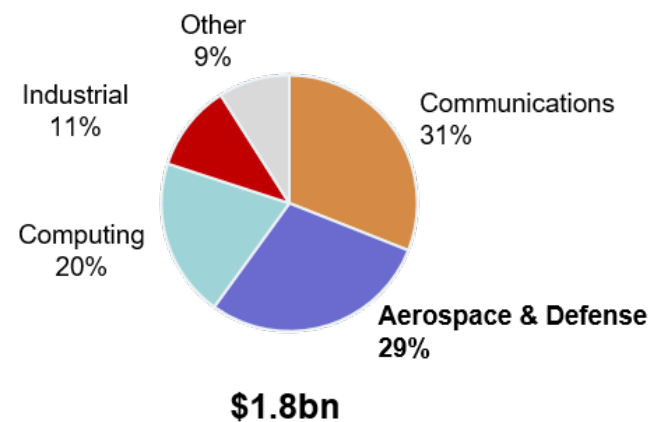
- ~19,000 employees
- Leading Total Systems Solutions provider

End-Market Diversification

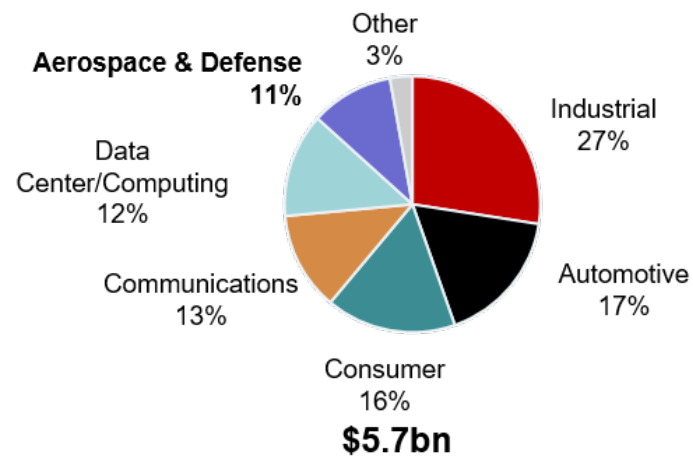
Microchip



Microsemi


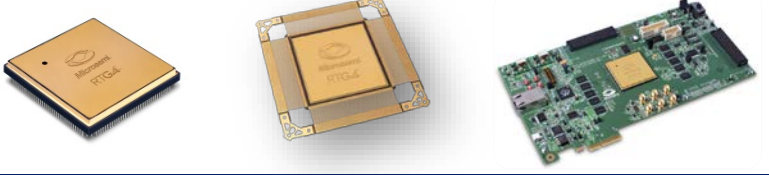






Combined



Note: Reflects non-GAAP financials and end market diversification is based on management estimates

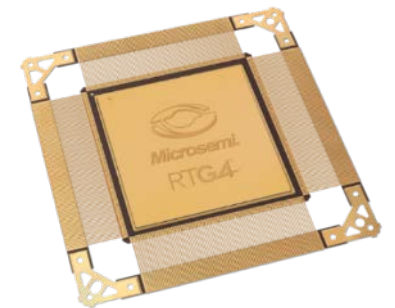
Delivering A Comprehensive Space Portfolio

<p>Rad-Tolerant & RHBD MCUs, Comm & Mem</p>	<p>Pin for pin, COTS equivalent – QML rad tolerant & RHBD 8-bit & 32-bit AVR & ARM core microcontrollers, ADC, SpaceWire Routers, Gbit PHY & switch, CAN, memory</p>	
<p>Radiation-Tolerant FPGAs</p>	<p>High Performance, High Density, Low Power TID up to 300 Krad, SEL Immune RTG4 FPGAs up to 300 MHz and 150K LE RTProASIC3, RTAX and RTSX-SU QML Qualified</p>	
<p>Rad-Hard Mixed Signal Integrated Circuits</p>	<p>Telemetry and Motor Control Space System Managers High Side Drivers Regulators and PWMs Extensive Custom IC Capability</p>	
<p>Space Qualified Oscillators</p>	<p>Ovenized Quartz Oscillators Hybrid Voltage Controlled and Temperature Compensated Crystal Oscillators Cesium Clocks</p>	
<p>Rad-Hard Power Solutions</p>	<p>Rad-hard JANS Diodes, Bi-Polar Small Signal Transistors Rad-hard Isolated DC-DC Converter Modules Custom Power Supplies 2 W to > 5 KW Point of Load Hybrid Solutions Electromechanical Relays</p>	
<p>Space Screening for RF Products</p>	<p>Surface Acoustic Wave (SAW) Filters Packaged and Chip Si Diodes Si Bipolar Transistors & GaAs pHEMT MMICs</p>	

RTG4 Reliability and Radiation Update

RTG4 Product Overview

Resources	RT4G150	
Logic Elements (TMR Register + 4-Input C Logic)	151,824	151,824
18x18 Multiply-Accumulate Blocks	462	462
RAM Mbits (1.5 Kbit and 24 Kbit Blocks, with ECC)	5.2	5.2
UPROM Kbits	381	381
DDR2/3 SDRAM Controller (with ECC)	2 x 32	0
PCI Express Endpoints	2	1
Globals	24	24
PLLs (Rad Tolerant)	8	8
SpaceWire Clock and Data Recovery Circuits	16	4
User IO (excluding SERDES)	720	166
SERDES lanes (3.125 Gbps)	24	4
Hermetic, Ceramic Packages		
CG1657 (Ceramic Column Grid Array, Six Sigma Columns) LG1657 (Ceramic Land Grid Array, No Solder Termination) CB1657 (Ceramic Ball Grid Array, For Prototyping Only)	Available Now	
CQ352 (Ceramic Quad Flat Pack)		Samples Now Flight Units Mid 2019
Package Body Size	42.5 mm x 42.5 mm	48 mm x 48 mm

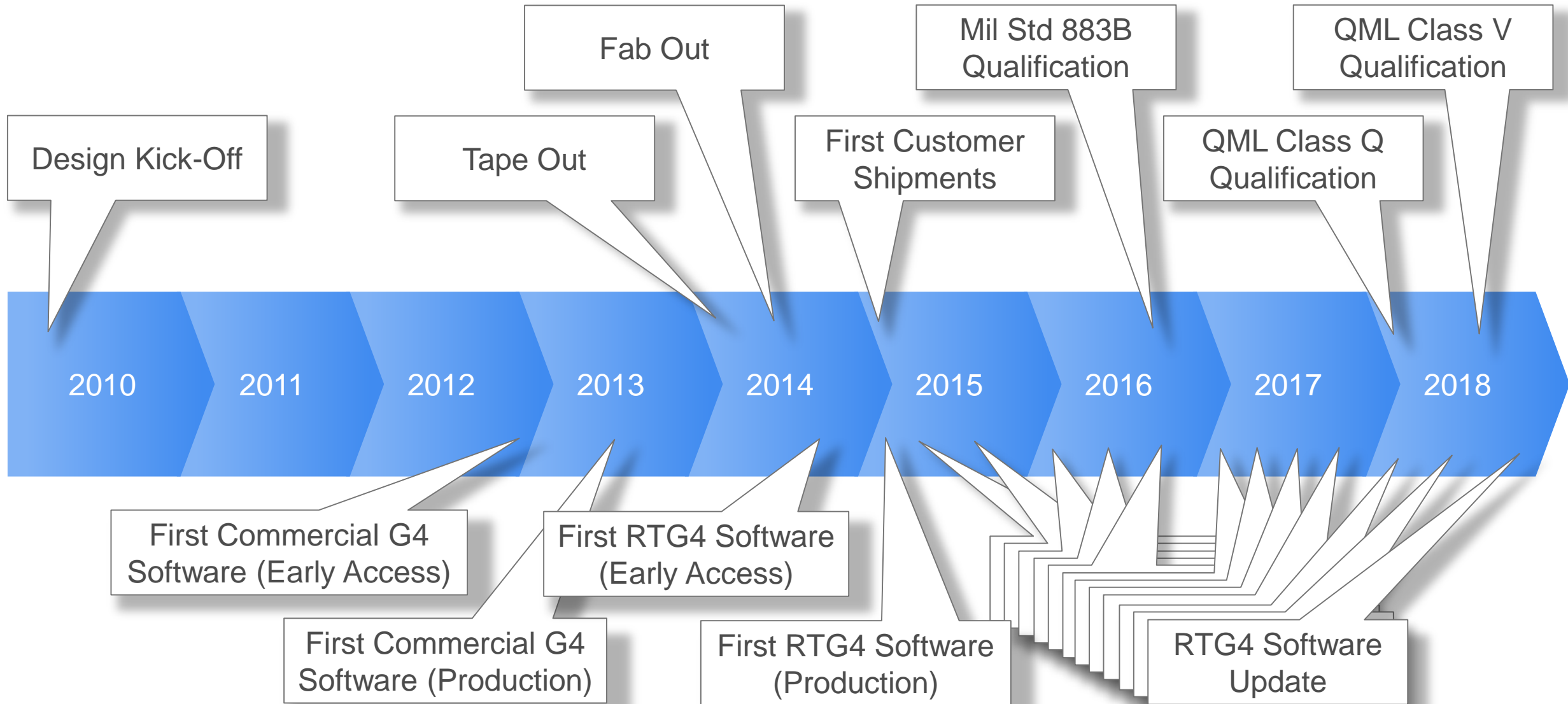


RTG4 QML Class Q and V Qualification Completed!

- QML Class Q and Class V qualification completed
- SMD 5962-16208
- SMD has been approved and is posted on DLA web site
- RTG4 FPGAs can be ordered using SMD number or Microsemi part number
- RTG4 FPGAs are now dual marked with SMD number and Microsemi part number
- SMD numbers on Microsemi web site in DLA Cross Reference Guide
- Plan to pursue QML Class Q and Class V for CQ352
 - RT4G150 in CQ352 B and E flows will be added to SMD after MIL-STD-883B qualification completes in mid 2019
 - RT4G150 in CQ352 QML Class Q and Class V qualification in 2020

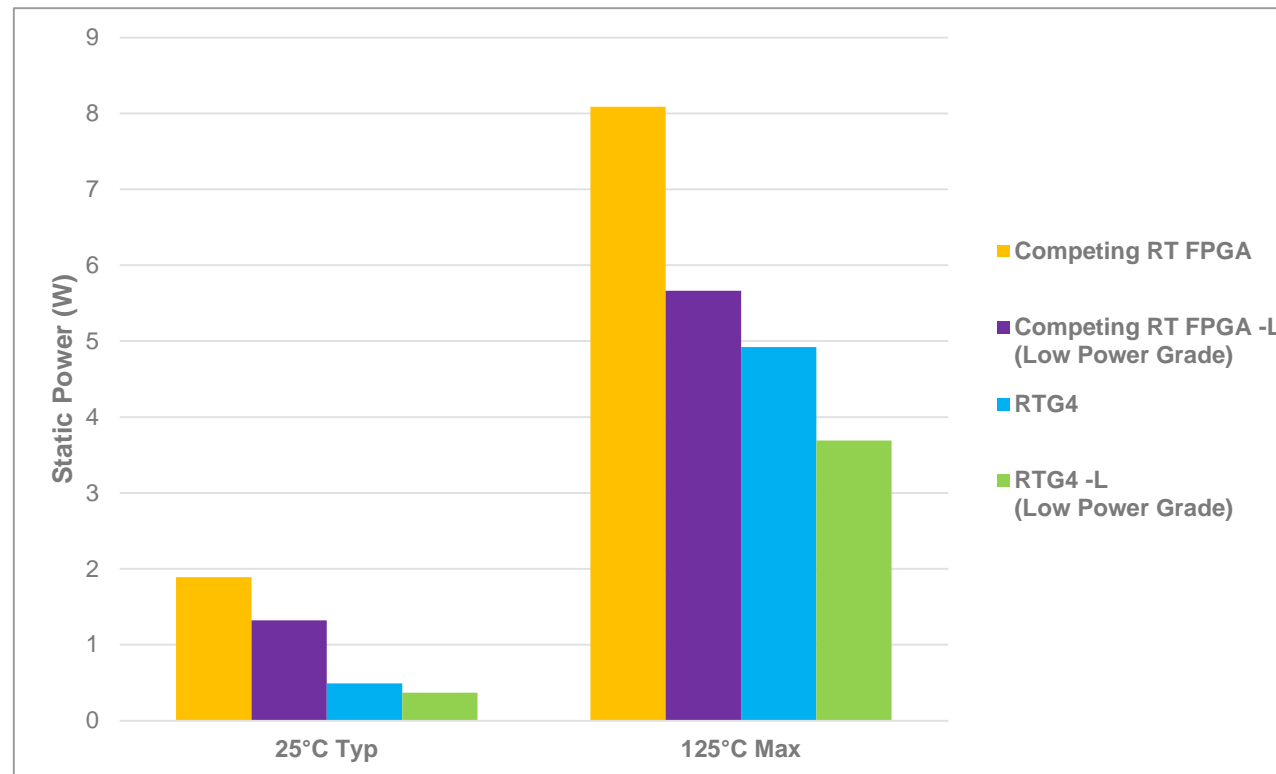
RT4G150	1657-CCGA	RT4G150-CG1657B	5962-1620801QXF
		RT4G150-1CG1657B	5962-1620802QXF
		RT4G150-CG1657E	5962-1620805QXF
		RT4G150-1CG1657E	5962-1620806QXF
		RT4G150-CG1657V	5962-1620809VXF
		RT4G150-1CG1657V	5962-1620810VXF
	1657-LGA	RT4G150-LG1657B	5962-1620803QZC
		RT4G150-1LG1657B	5962-1620804QZC
		RT4G150-LG1657E	5962-1620807QZC
		RT4G150-1LG1657E	5962-1620808QZC
		RT4G150-LG1657V	5962-1620811VZC
		RT4G150-1LG1657V	5962-1620812VZC

The Long Road to Qualification



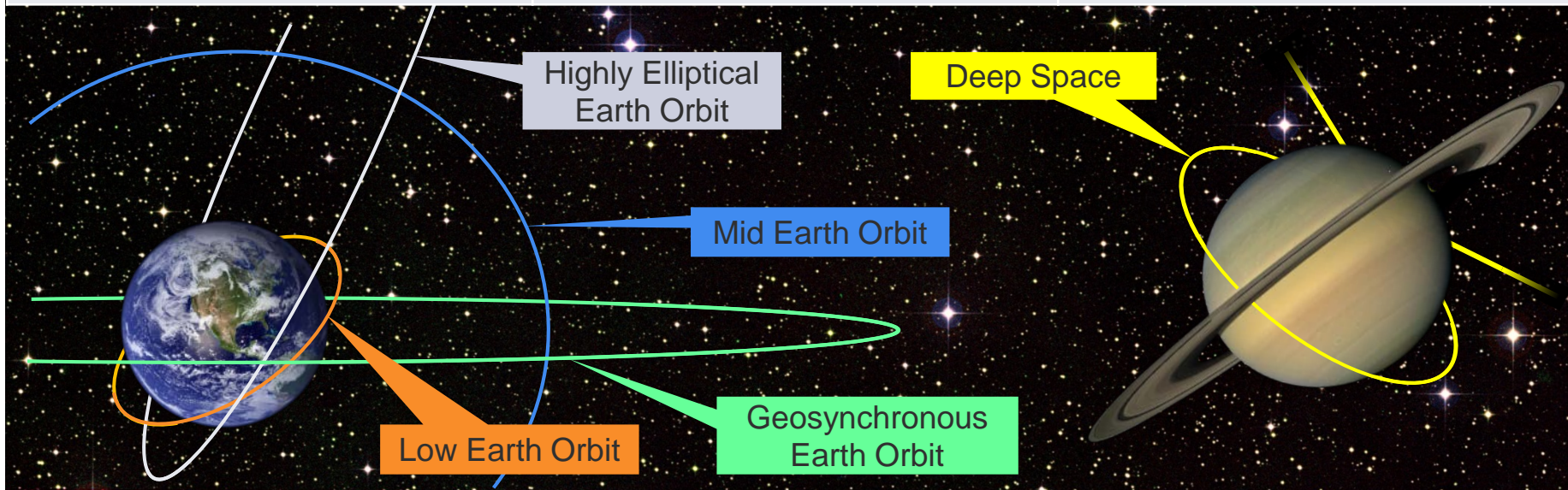
RTG4 Low Power Grade

- Low power grade (-L) for RTG4 standard speed (-STD) available NOW
 - 25% quiescent supply current reduction: from 4.1 A to 3.1 A at 125 °C
 - RT4G150L device setting available in Libero SoC v12.0 and power calculator
 - RTG4 continues to be **best in class**



RTG4 Radiation Summary

Total Ionizing Dose	Stays within parametric limits > 125 Krad (Si)	
Single Event Latch-Up	No failure at facility limit of 103 MeV-cm ² /mg, 100 °C	
Configuration Upset	No failure at facility limit of 103 MeV-cm ² /mg, 100 °C	
Flip-Flop Single Event Upset	2.6E-12 errors/bit-day, GEO solar minimum, 1 MHz	
LSRAM Single Event Upset	2.0E-7 errors/bit-day, GEO solar min (no EDAC)	1.1E-11 errors/bit-day, GEO solar min (with EDAC)
uSRAM Single Event Upset	3.1E-8 errors/bit-day, GEO solar min (no EDAC)	2.7E-13 errors/bit-day, GEO solar min (with EDAC)



RTG4 Radiation Effects Update

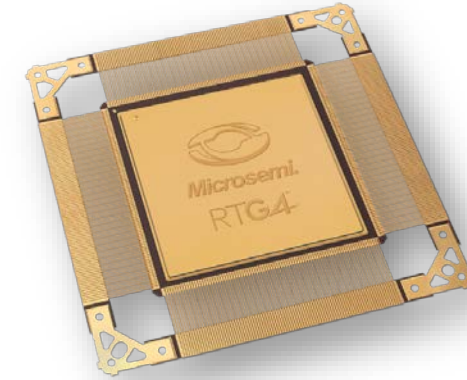
Test	Environment	Test Schedule	Status
Fabric, SRAM and PLL SEE	Proton	Complete	Report available on Microsemi Web
SERDES SEE	Proton	UCD in 10/2018	Less link loss than previous HI testing Report in progress
SERDES SEE	Heavy Ion	LBNL in 10/2018	Report in progress
In-Beam Programming	Proton	UCD in 10/2018	Data available – contact Microsemi
In-Beam Programming	Heavy Ion, Low dose rate Heavy Ion	LBNL in 2016 TAMU in 9/2018	Data available – contact Microsemi Additional report in progress
PLL SEE including TMR	Heavy Ion	TAMU in 2016 TAMU in 11/2018	Report available on Microsemi Web Additional report in progress
Fabric DDR Controller SEE	Heavy Ion	Completed, LBNL 2018	Report available on Microsemi Web
MSIO SEE	Heavy Ion	Complete	Report available on Microsemi Web
POR	Heavy Ion	Complete	Data available – contact Microsemi Report in progress
CCC blocks (Div, Mux, etc)	Heavy Ion	To be scheduled	Pending facility schedule
TID (leakage current and propagation effects)	Gamma, X-ray	Complete (X-ray) Ongoing / per wafer lot (Gamma)	Reports available on Microsemi Web
TID (retention effects)	Gamma, HTOL	Complete	Reports available

RTG4 Availability and Qualification Schedule

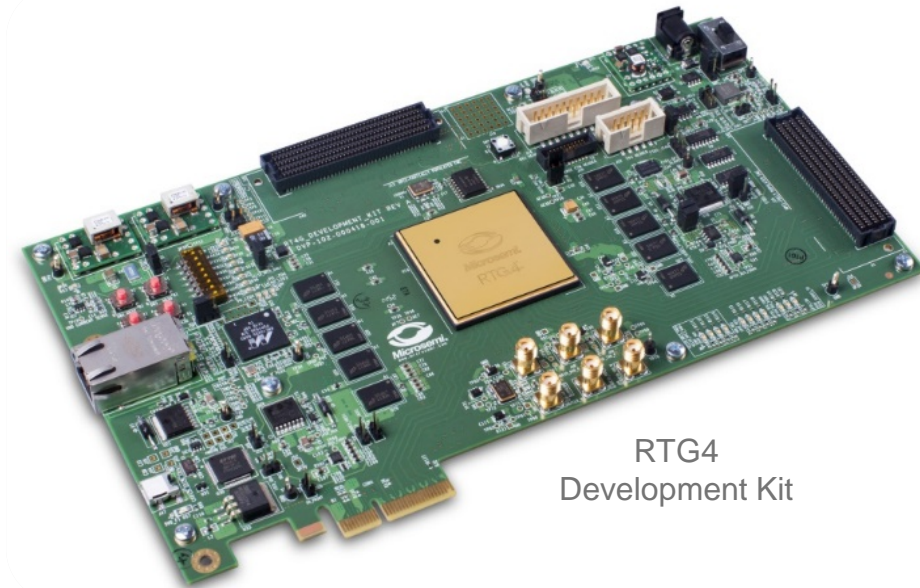
- QML class Q and V qualification: **Completed!**
 - RTG4 can be ordered to DLA SMD part number
 - DLA SMD part numbers on [Microsemi web site](#)
- RT4G150 PROTO FPGAs: Now
- RT4G150 development kit: Now
- CG1657 B, E, and V-flow flight units: Available to lead time now
- CG1657 daisy chain packages: Now
- CQ352 B-flow flight units: mid 2019
- CQ352 engineering models: Available to lead time now



RT4G150-
CG1657



RT4G150-
CQ352



RTG4
Development Kit

Sub-QML FPGAs

RT FPGAs for New Space Programs

- Objective

- Create versions of RT FPGAs that can meet aggressive price targets to win business in New Space programs that would not use traditional B / E / V flow FPGAs

- Requirements

- Reduction in cost and price
- Faster lead-time / cycle-time

- Sub-QML RT FPGAs

- Ceramic – R Flow (Reduced Flow) and Mil Temp Hermetic
- Plastic Package – Industrial temperature, Military temperature

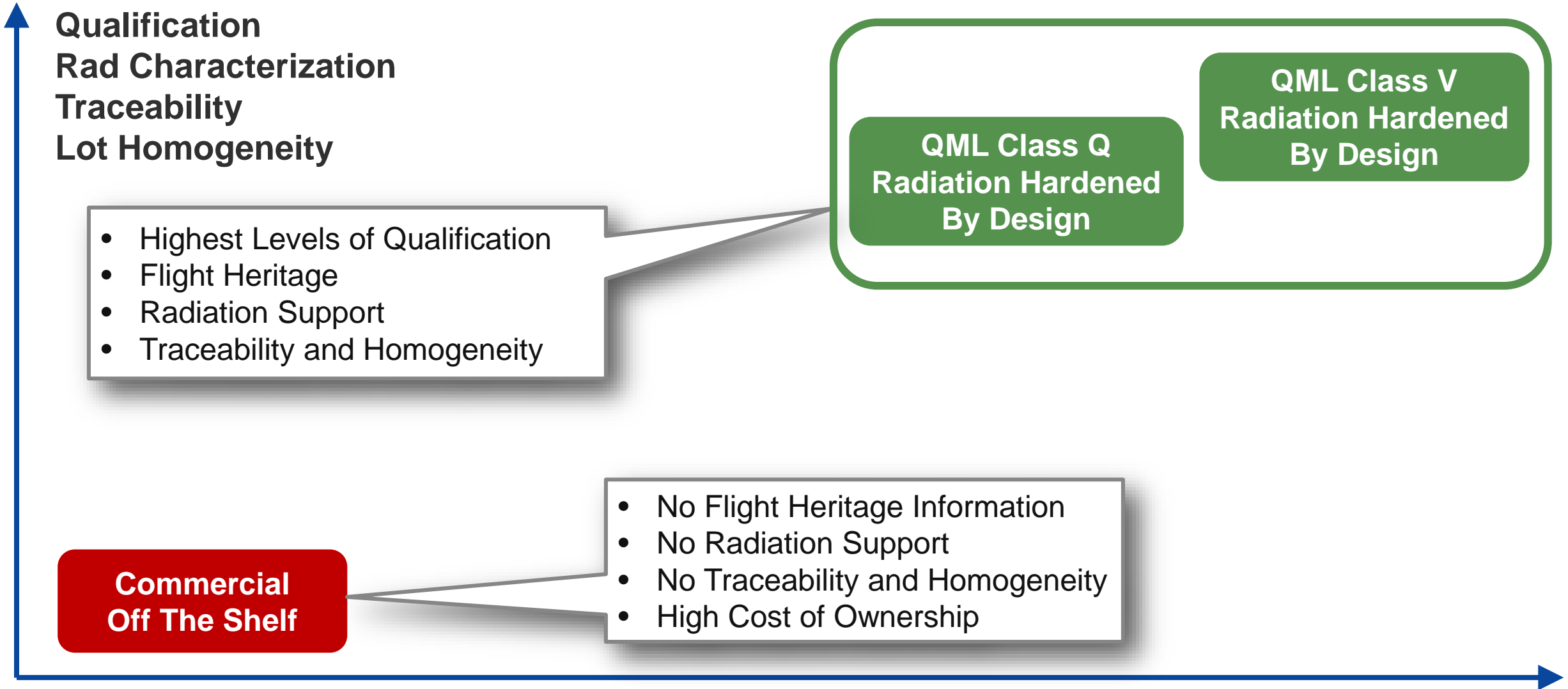
Cost and COTS

- Satellite operators are seeking lower acquisition cost and faster service entry
- Commercial Off The Shelf (COTS) components to reduce cost and lead-time
- The cost of COTS – lower component cost, higher cost of ownership

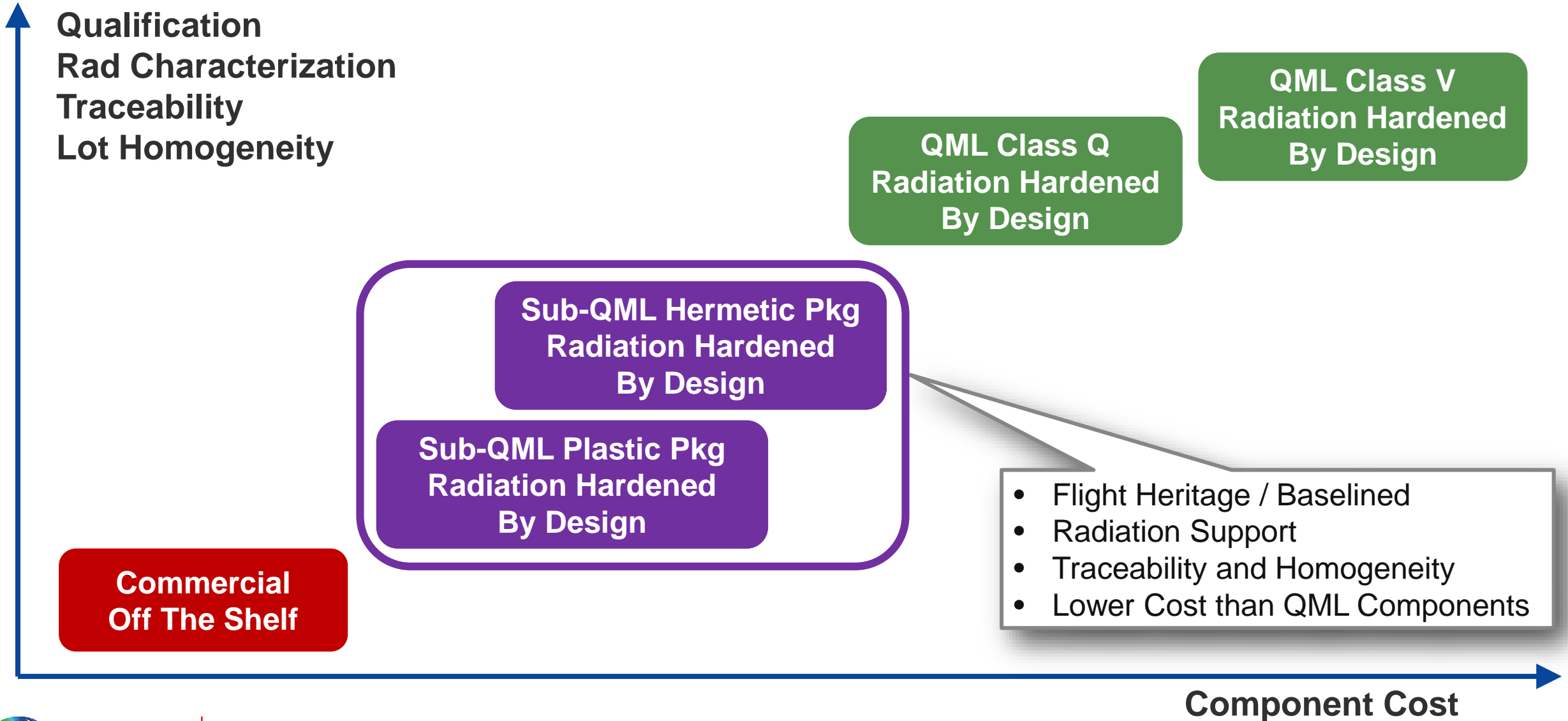
	General Industry COTS	QML Rad Tolerant
Unit Cost	✓ Low	✗ High
Leadtime	✓ Short	✗ Long
Space-flight Heritage	✗ No	✓ Yes
Supplier Tech Support	✗ No	✓ Yes
Radiation Data and Support	✗ No	✓ Yes
Reliability Data and Support	✗ No	✓ Yes
Lot Traceability, Homogeneity	✗ No	✓ Yes

Addressing these shortcomings results in hidden cost for organizations using COTS in space systems

Significant Gap between QML and COTS



Sub-QML: Bridging the Gap Between QML and COTS




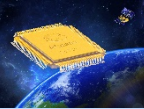


Sub-QML Components

- Reducing or eliminating QML testing and documents removes a lot of cost
- Elimination of solder columns removes cost and reduces lead times
- Plastic packaging reduces cost still further

	General Industry COTS	QML Rad Tolerant	Sub-QML RT Hermetic	Sub-QML RT Plastic
Unit Cost	✓ Lowest	✗ High	✓ Lower	✓ Lower
Leadtime	✓ Shortest	✗ Long	✓ Shorter	✓ Shorter
Space-flight Heritage	✗ No	✓ Yes	✓ Yes	✓ Yes
Supplier Tech Support	✗ No	✓ Yes	✓ Yes	✓ Yes
Radiation Data and Support	✗ No	✓ Yes	✓ Yes	✓ Yes
Reliability Data and Support	✗ No	✓ Yes	✓ Yes	✓ Yes
Lot Traceability, Homogeneity	✗ No	✓ Yes	✓ Yes	✓ Yes

Update: RHBD Mixed Signal IC Chip Scale Atomic Clock

Microsemi Mixed Signal Space Portfolio Radiation Testing

Part Number	Description	Total Dose	Single Event	ELDRS	Prompt
LX7730 	RT telemetry controller SSM QML certified Q and V <ul style="list-style-type: none"> RADECS 2016 RADECS 2017 	✓ 300krad(Si)	✓ 87 MeV.cm2/mg and 125°C	✓ 50krad(Si)	✓ (contact factory)
LX7720 	RT motor/position controller SSM Q and V quals in process <ul style="list-style-type: none"> RADECS 2018 NSREC 2018 	✓ 100krad(Si) (300krad planned)	✓ 87 MeV.cm2/mg and 125°C	planned	planned
LX7710 	RT 8 pair 125V diode array QML certified Q and V	✓ 100krad(Si)			
AAHS298B 	RT 8 ch high side driver QML certified Q and V	✓ 100krad(Si)	✓ 117 MeV.cm2/mg and 125°C	✓ 100krad(Si)	

↑
Links to product pages

↙ ↑ ↘
Links to radiation test reports

Space CSAC – Radiation Tolerant

- Only Chip Scale Atomic Clock available for Space
- Offered as a COTS part
- Rad tolerant for wide range of LEO applications
- Tested to 20kRad TID
- Proton tested at 64 MeV-cm²/mg
 - Regains lock after proton bombardment
 - Retains frequency accuracy and aging rate
- Shock, Steady state Life, TVAC tested
- LDC Qualification Process: TID test to 20 kRad of components
- Each Space CSAC build use only LDC qualified parts for TCXO and PBCA combination
- New PTTI Paper and presentation available soon
 - Contact Microsemi to request paper and presentation



Space Brief Newsletter

- Sign up to receive quarterly updates on:
 - Parts, packages, screening levels
 - Radiation data
 - Product qualification
 - PCN, CN, PDN
 - IP and Software tools
 - And much more

- RT FPGAs
- RHBD Mixed Signal ICs
- Power discretes and modules
- Clocks and Oscillators
- RT and RHBD Microprocessors and Microcontrollers



[Sign up here!](#)

Thank you!

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