## Microsemi
### Power Matters.

# SPACE BRIEF

**Newsletter Archive** | **Feedback** | **Microsemi**

Welcome to Microsemi's quarterly Space Brief newsletter, Edition 16.

This edition includes news about our next generation RTG4$^{TM}$ FPGA family, as well as our companion radiation-tolerant analog mixed signal ICs for telemetry and motor control. Also featured are the space events Microsemi has participated in this past quarter as well as the upcoming events.

We hope you find our newsletter useful and encourage you to pass this edition on to your colleagues, or click the archive link to explore past editions. Instructions for registering to receive this quarterly Space Brief are included at the end of this newsletter.

## Recent Product News

### RTG4 Military Temperature Engineering Silicon Available Now

RTG4 High-Speed Signal Processing FPGAs are now available in engineering silicon, tested to full military temperature from - 55 °C to 125 °C. The RTG4 MIL temperature silicon (MS) uses the current silicon revision and is intended for prototyping and early design evaluation of the new RTG4 FPGA family. For more information, see www.microsemi.com/document-portal/doc_download/135348-rtg4-ms-description for MS description document.

The next version of RTG4 silicon is RTG4 PROTO, and uses the same silicon revision as the flight units.

The first RTG4 PROTO devices are expected to be available in January 2016. Flight units qualified as per MIL-STD-883 Class B are expected to be available in June 2016.

**Minh U. Nguyen**
Marketing Manager, Space FPGAs, SoC Products

## Special Feature

### SpaceWire Successfully Demonstrated in RTG4 FPGAs

STAR-Dundee, a world leader in SpaceWire network technology for spacecraft on-board data-handling, recently took advantage of RTG4's embedded SpaceWire clock recovery circuits and high-speed SERDES capabilities to demonstrate our flight-proven SpaceWire Intellectual Property (IP) running at over 200 Mb/sec. The extensive logic, memory, DSP blocks, and I/O capabilities of the Microsemi RTG4 FPGA together with its inherent radiation tolerance and inbuilt configuration memory make this device perfect for spacecraft on-board applications, such as instrument control, data-handling, and data processing.

STAR-Dundee is currently working on SpaceFibre, a new technology that provides higher data-rates, integrated quality of service and fault detection, isolation and recovery. These advanced capabilities make SpaceFibre suitable for a wider range of spacecraft on-board applications including integrated payload data-handling, attitude and orbit control networks and launcher applications where deterministic data delivery is required.

Using the Microsemi RTG4 Development Kit, we were able to demonstrate our next-generation SpaceFibre IP at 2.5 Gb/sec. We believe that RTG4 FPGAs paired with our advanced IP's will make for a winning combination, creating great value for our space customers.

For more information about STAR-Dundee and RTG4 demonstrations, please contact enquiries@star-dundee.com

**Prof. Steve Parkes,**
Managing Director, STAR-Dundee

## Product Updates and Notifications

### New RTG4 Documents and Design Resources

The RTG4 preliminary datasheet is currently available on the Microsemi website. The datasheet includes AC and DC specifications, typical characterized silicon data and preliminary timing data for key features in RTG4 FPGAs. The datasheet is available at DS0131: RTG4 FPGA Datasheet

The Demo Guides & Lab section has also been updated. Five demos are currently available for RTG4 FPGA Fabric, SERDES EPCS interface, PCIe interface, DDR3 memory controllers and DSP FIR Filter. These demos have been validated in the latest Libero SoC software and the RTG4 development kit. The demo guides and design files can be downloaded from the following links:

- DG0624: RTG4 FPGA SERDES EPCS Protocol Design Demo Guide
- DG0622: RTG4 FPGA PCIe Data Plane Demo Using Two Channel Fabric DMA Demo Guide
- LG0623: RTG4 FPGA Fabric Lab Guide
- DG0625: Interfacing RTG4 FPGA with the External DDR3 Memory through FDDR Demo Guide
- DG0630: RTG4 FPGA DSP FIR Filter Demo Guide

### Industry's First Radiation-Tolerant FPGAs Development Kit Now Available

The RTG4 Development Kit provides space designers a comprehensive evaluation and design

platform for applications such as data transmission, serial connectivity, bus interfaces, and high-speed designs. The development board features an RT4G150 device offering up to 150,000 logic elements and 300 MHz system performance in a ceramic package with 1,657 pins.

Currently, two versions of the RTG4 Development Kits are available:

- RTG4-DEV-KIT-ES includes one RT4G150 FPGA in a Ceramic Ball Grid Array (CB1657) package.
- RTG4-DEV-KIT-ES-CG includes one RT4G150 FPGA in a Ceramic Column Grid Array (CG1657) package.

For more information about these Development Kits, visit www.microsemi.com/products/fpga-soc/design-resources/dev-kits/rtg4-development-kit or see our press release, Microsemi strengthens its Space Leadership with Availability of RTG4 FPGA Development Kit for High-bandwidth Space Applications
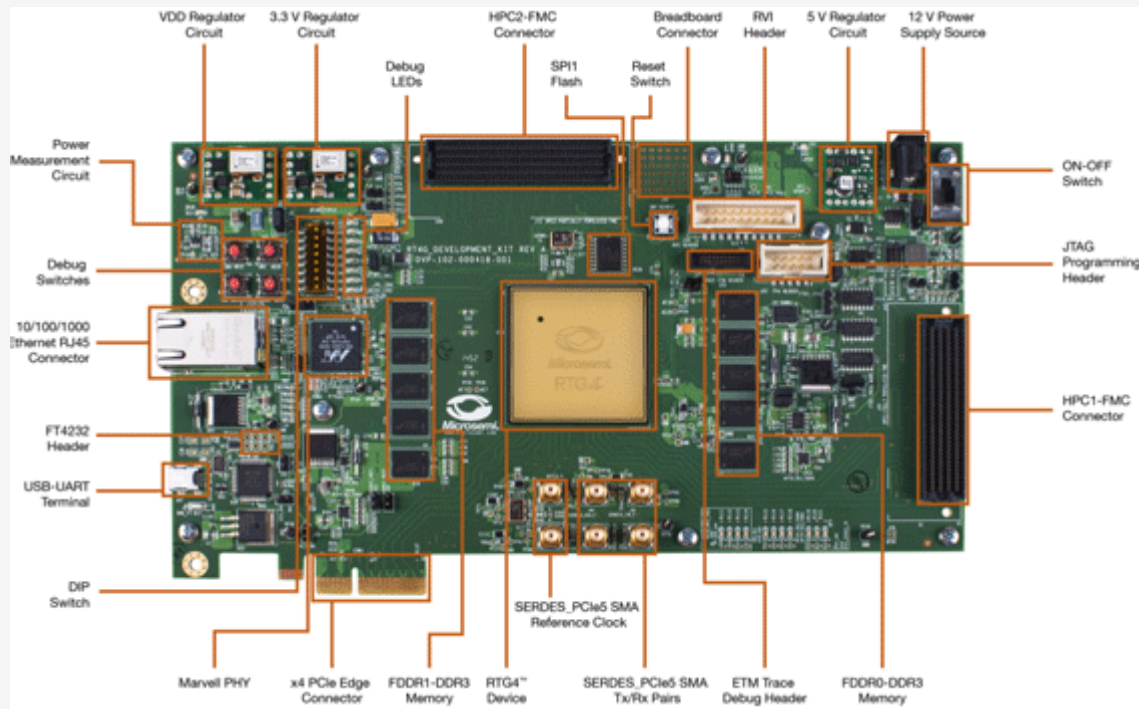


*RTG4 Development Kit*



**Ken O'Neill**
Director of Marketing, Space and Aviation, SoC Products Group

## LX7730 Telemetry Controller Radiation Test Results

Microsemi recently announced the LX7730 Radiation Tolerant Telemetry Controller, the first member of its Space System Manager product line. The LX7730 integrates the required functions of satellite telemetry systems and interfaces with radiation-tolerant FPGAs such as those offered in Microsemi's portfolio of FPGA solutions.

We have now completed Single Event Latch-up (SEL) radiation testing on the LX7730 Telemetry Controller with excellent results. This testing was performed at the Berkeley LBNL Cyclotron last June and led to the following conclusions:



- The LX7730 Telemetry Controller is SEL immune.
- The device showed strong performance during beam exposure and exhibited immunity to latch-up up to 1e8 particles/cm2 at 87.85MeV/mg.cm2 and 125 °C.

The LX7730 is currently sampling, and Evaluation Boards are available.

Visit our website for more information:
Product Webpage

Product Datasheet
Press Release

## CASESTUDY : Mitigation of SEE effects in PWM Controllers

Microsemi has used the UC1846 PWM in many designs for decades, with not a single failure in space, proven by extensive simulation and a stellar heritage history. Recently, we had a customer who understood and appreciated what we did, but required evidence of our success.

Before we disclose the results, let us state the known issue with the UC1846 PWM is that the SEE activates the SCR latch. The SCR latch is specified to remain latched as long as greater than 3 mA anode current is provided through pin 1, the Current Limit Adjust / Soft Start pin of the IC.

Solutions to this issue rely on eliminating the anode current to the SCR latch. It has been demonstrated by circuit simulation and electrical testing that eliminating the anode current to the SCR latch allows the SCR to reset in the order of micro seconds.

In the event of an ion strike causing the SCR to latch, the "Current Limit Adjust" pin is pulled low. This turns on Q2 in the external latch and causes Q1 to turn on also, completing the external latch trigger. Q1 has a lower saturation voltage than the internal SCR. so, the latching current in the SCR is diverted out into Q1. This causes the internal latch to reset. C1 and R4 are a slow charging timing circuit. The charge on C1 is enough to maintain the external latch on for a couple of PWM cycles only, which is enough time to "de-latch" the internal SCR and significantly discharge C2 through R3. As a result, the "slow start" voltage level on C2 is maintained throughout the event, and the PWM action completely resumes after a 2 cycle delay.



BLOCK DIAGRAM
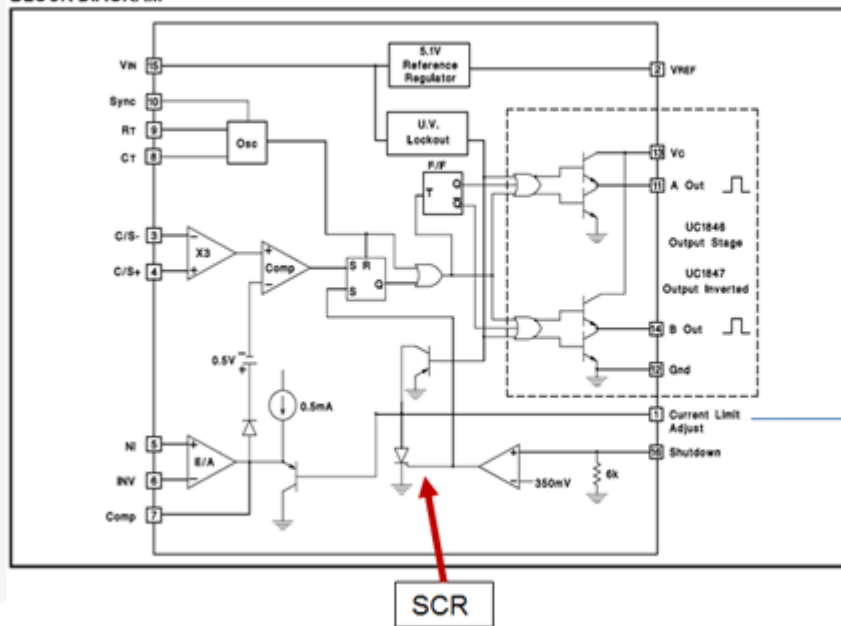
External Latch diverts current from internal SCR latch for sufficient time to ensure SCR Latch reset

SCR
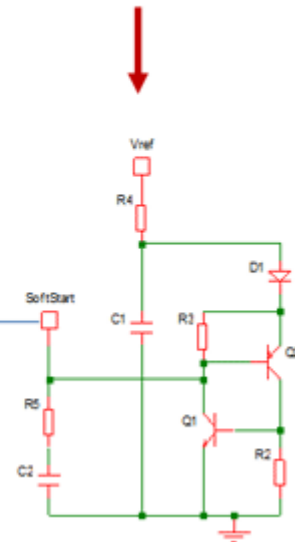
Proof: We took a representative circuit board, with the PWM in a socket to the Lawrence Berkeley National Laboratory. Multiple Ion Streams at a Linear Energy Transfer (LET0) from ˜10 MeV/(mg/cm2) to ˜60 MeV/(mg/cm2) were used on multiple PWMs.

The results were exactly as simulated!
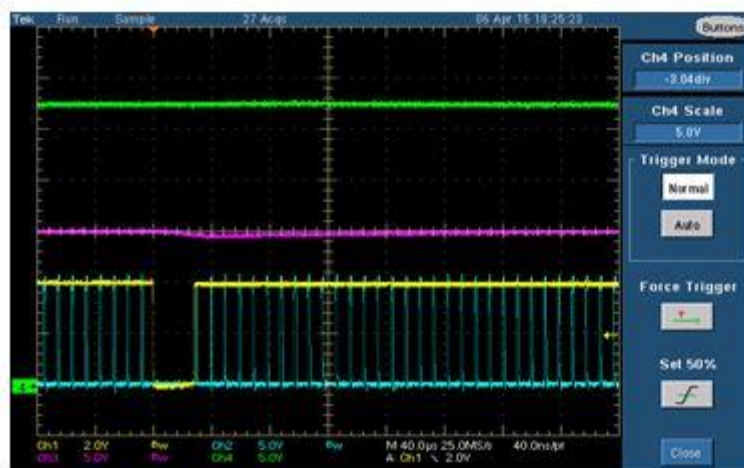


Output Voltage at max load

Ch1: PWM- pin 1.
Ch2: PWM output pulses
Ch3: Output Voltage at max load
Ch4: Input line voltage

This presentation is available at http://www.microsemi.com/document-portal/doc_download/135245-space-power-development-expanding-heritage-with-new-technology-space-forum-2015

**Kent Brooten**
National Sales Manager, Power Module Group

## Microsemi Precise Satellite Timing Module for Next Generation Satellite Bus

Precision frequency sources are required for time keeping and metrology in communication and navigation satellites. The frequency sources for the satellites are typically quartz oscillators and in rare instances atomic clocks, when absolute accuracy is required. Frequency sources can be used to establish a time base for each satellite or groups of satellites, typically with ground station support. All frequency sources are subject to change over time, usually referred to as drift or aging. As a result, the frequency and time must be adjusted remotely, a process that consumes effort and often impacts the accuracy of the local time. Autonomous and accurate local frequency and time for individual or constellations of satellites provide a significant improvement to current system capabilities.

The availability of time by means of Global Navigation Satellite Systems (GNSS), allows for adjustment of the local time of a system by means of one pulse per second (1 PPS) and delivered time of day information provided in the constellations. The use of Kalman filtering to steer high-performance crystal oscillators provides high accuracy and stability while maintaining the long term performance of the GNSS on-board atomic clocks. With the Satellite Timing Module, Microsemi has developed a space-borne product that leverages heritage space-ovenized oscillators and advanced Kalman filter algorithms with demonstrated exceptional performance for 1 PPS steered and un-steered conditions.

For more information about Microsemi's Satellite Timing Module please contact Peter Cash, peter.cash@microsemi.com or download this presentation: http://www.microsemi.com/document-portal/doc_download/135244-precise-satellite-timing-module-for-next-generation-satellite-bus-timing-space-forum-2015

**Peter Cash**
Director of Space, Defense and Advanced Technology, Frequency and Time Division

## Bipolar Junction Transistor - Radiation Testing Lessons Learned

Microsemi has extensively studied the requirements of testing and achieving both Total Ionizing Dose TID and Enhanced Low Dose Rate Sensitivity (ELDRS) ratings of bipolar transistors. The potential metrics required for comparison have been defined. An examination of a common ground for comparison of PNP with NPN transistors was established showing, the difficulty in testing PNP types and the effects of hydrogen on ELDRS performance of PNP types. TID vs. ELDRS was performed on NPN and PNP transistors and compared to determine if relationships exist, which can be used to correlate between the two, or, determine if unique testing requirements are needed for each. Tests were then performed on both types of transistors to understand TID with and without Vce.

The following conclusions and recommendations are proposed to ensure that the product fully meets both TID and ELDRS requirements.

**BJT gamma radiation results are sensitive to:**

- Package: Constructions with hydrogen (like ceramic) affect PNP ELDR results
- Bias: PNP do worse at lower bias while NPN do worse at higher bias
- Surrogate Packages: These Save money but masks problems with ceramic packages
- TID: TID can Occasionally do more damage than ELDR
- Sample Size: Small samples sizes per Mil-Prf-19500 can miss one-off failures

**Recommendations:**

- Do ELDR 100mRAD/s at 80% rated BVceo
  - Small Die Sample = 11 pieces, all ELDRS testing
  - ELDR at 100mRAD/s correlates very well with 10mRAD/s
- Do ELDR 100mRAD/s at Vce = 0V
- Do ELDR in Final Package (not Surrogate)

- Do TID at 80% Rated BVceo (Original TM1019)
  - Small Die Sample = 10 pieces, all TID testing Required for Group D.
- Do TID at Vce=0V only if response unknown
  - Not required by Group D but better do for PNP
- Do consider ELDR 100mRAD/s in Lieu of TID
  - 100kRAD only takes about 2-Weeks

**The Microsemi MSR and MVR Cure for Radiation Testing Headaches**

- Get ELDR 100mRAD/s at 80% Rated BVceo
- Get ELDR 100mRAD/s at Vce = 0V
- Get ELDR in Final Package (not Surrogate)
- Get TID at 80% Rated BVceo
- Get TID at Vce=0V
- Get ELDRS 11 samples and TID 10 samples for total of 42 for all bias values
  - Very big or expensive packages may reduce samples to half

The presentation is available at http://www.microsemi.com/document-portal/doc_download/135247-tid-versus-eldrs-on-transistors-the-whole-picture-space-forum-2015

For more information, please contact Ray DiBugnara at rdibugnara@microsemi.com

**Ray DiBugnara**
Director of Technology, DPG Group

## Space News

### RTG4 Receives Best Aerospace Product Award

Microsemi is honored that our RTG4 FPGAs were recognized as the single best product in the defense/aerospace category by ElectroniqueS Magazine on June 24, 2015 in Paris, France. RTG4 was selected from among other innovative products and technologies as making the largest impact on the industry in 2014-2015 by an independent jury of renowned electronics experts. This award validates Microsemi's commitment to our customers and the space industry, and our position as the leading supplier of space qualified FPGAs to the defense and aerospace market.

**For more information, see the press release:** http://investor.microsemi.com/2015-07-01-Microsemis-RTG4-Radiation-tolerant-FPGAs-Win-Electron-dOr-Award-from-ElectroniqueS-Magazine

### RTG4 in the Media

Microsemi's latest radiation-tolerant FPGAs have been featured in separate articles in the past few months. "Q&A: A Closer Look at Microsemi's Rad-Tolerant FPGAs" in Electronic Design magazine and "Radiation-tolerant FPGAs solve the satellite signal processing bottleneck" in Embedded Systems magazine. Most recently, the COTS Journal published "RTG4 FPGAs combine signal processing with radiation mitigation.

### NASA's New Horizons space exploration mission benefits from Microsemi FPGAs, power supplies, electromechanical relays

Microsemi is honored that NASA has once again selected our high-reliability products for the Pluto New Horizons spacecraft exploration mission. Our RTSX-SU FPGAs were used in the imaging camera that provided the remarkable images of Pluto recently. We also have power supplies, relays, diodes, and transistor discrete devices on-board New Horizons. The success of this historic NASA mission once again proves our commitment to the agency, and is a significant contribution to the long list of flight heritage for Microsemi space solutions.

**For more information, see the following press release:** http://investor.microsemi.com/2015-09-02-Microsemis-Industry-leading-Space-Products-Support-Pluto-New-Horizons-Space-Exploration-Mission

**Leading Space Innovation: Space Solutions Brochure**

Microsemi has been developing space solutions for almost six decades and has played an important role in a wide variety of space programs globally. With a proven track record for innovation, quality and reliability we continue to build on that legacy with an impressive portfolio of industry- leading new product and technology introductions. We invite you to explore Microsemi's solutions and engage with us to help solve your most difficult space system design challenges.

For more information about how Microsemi is serving the space market, access or download our new brochure at:

http://www.microsemi.com/index.php?option=com_docman&task=doc_download&gid=125140

## Microsemi's Commitment to Space

**Space Forum 2015**



As part of our on-going commitment to the space industry, Microsemi recently concluded our Space Forum 2015, scheduled across five different locations spanning North America, Europe and India. These Space Forums are hosted in each global region every two years and have attracted senior management, program managers, system level architects, hardware and software engineers as well as component and quality engineering. The program was very comprehensive showcasing focus products from our space product portfolio as well as sharing our technology roadmaps.



We featured our newly introduced RTG4 radiation-tolerant field programmable gate arrays (FPGAs), the LX7730 telemetry controller, as well as a variety of our complementary radiation-hardened DC-to-DC converters, precision time and frequency solutions, linear and point of load (POL) hybrids, the latest generation radiation-hardened MOSFET technology and our radiation enhanced bi-polar transistor discrete devices.

Thank you again to our partners ([STAR-Dundee](), [Synopsys](), [e2v]() and [Cobham Gaisler AB]()) for presenting at this year's Space Forum and adding to the value for all those in attendance.



For more information and to download the Space Forum presentations please visit [www.microsemi.com/spaceforum#presentations]() or email [Sylvia.Keane@microsemi.com]().



## Appearances and Events

### SEE Symposium & MAPLD / NSREC



Microsemi radiation effects scientists presented papers covering total ionizing dose (TID) and single event effects (SEE) testing on Microsemi's latest RTG4 radiation tolerant FPGAs at the Single Event Effects Symposium in La Jolla, CA in May 2015 and the IEEE Nuclear and Space Radiation Effects Conference in Boston, MA, in July 2015.

Copies of the conference papers may be obtained from the Microsemi Space Marketing team [ken.oneill@microsemi.com]() and [minh.u.nguyen@microsemi.com]()

### RADECS

Microsemi participated in the Radiation Effects on Components and Systems (RADECS) conference and exhibition in Moscow, Russia on September 14-18, 2015. The conference featured a technical program consisting of technical sessions of contributed papers describing the latest observations in radiation effects, short courses on radiation effects, a radiation effects data workshop, and an industrial exhibit.



Microsemi presented a paper titled "*Flash-Based FPGA TID and Long-Term Retention Reliability through VT Shift Investigation*" and exhibited in the common booth area where we

ken.oneill@microsemi.com. For more information visit: http://www.radecs2015.org/

## JAXA (Japan Aerospace Exploration Agency) - The 28th Microelectronics Workshop



Microsemi attended the 28th JAXA Microelectronics Workshop from October 21-22, 2015 at the Tsukuba International Congress Center in Japan. This was a highly technical workshop discussing the current status of future trends in the space industry. Microsemi presented during the workshop on "*RTG4™ High-Speed Radiation-Tolerant FPGAs Changes Space Electronics by Solving Satellite Signal Processing Congestion*".

For more information, please contact Minh U. Nguyen, at Minh.U.Nguyen@microsemi.com or visit https://eeepitnl.tksc.jaxa.jp/mews/en/index.htm

## Radiation Hardened Electronics Technology (RHET) Meeting

Microsemi will attend the Radiation Hardened Electronics Technology RHET meeting November 17-18, 2015 at the Embassy Suites Hotel in Albuquerque, New Mexico. Hosting the event this year will be Triad Semiconductor. RHET is a meeting for the entire space avionics community, with presentations oriented towards requirements, plans, and programs for the space and missile electronic systems technology base. Director of Marketing Space and Aviation, Ken O' Neill will be presenting material on our radiation-tolerant flash FPGA technology and our LX7730 Telemetry Controller.

## Register to Receive the Microsemi Space Brief

If you enjoyed reading this Space Brief you can register to receive your own personal copy, delivered directly to your inbox at: http://www.microsemi.com/soc/interact/default.aspx?p=E402. To read past issues, visit our archive at http://www.microsemi.com/spaceforum/space-brief-newsletter

For more information about how Microsemi is serving the space market, access our brochure at Microsemi Space Solutions Brochure and our space webpage at http://www.microsemi.com/applications/space.

If you have any feedback or content suggestions for the Space Brief Newsletter, send an email to SpaceBrief@microsemi.com or click the "Feedback" link. Thank you for your assistance in ensuring the Space Brief continues to serve the space market and all employees.

**Sylvia Keane**
Marketing Executive,
Aerospace and (Space Brief Editor-in-Chief)