

## More Power News From NSREC 2017

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Last month we previewed some of the power components that vendors planned to display at the IEEE Nuclear and Space Radiation Effects Conference ([NSREC 2017](#)), which was held July 17-21 in New Orleans. In this post-conference follow-up, we present details on additional components that were demo'd and displayed in the industrial exhibition. Read on for more news about rad hard buck converter ICs and modules addressing a range of power levels and varying requirements for radiation immunity. There's also news about power MOSFETs & SSRs, optocouplers, and for possibly the first time, rad hard power sequencing ICs.

### Higher Performance For POL Converters

In their booth in the exhibits, [Texas Instruments](#) previewed two rad-hard buck converter devices that are currently in development, but expected to be released early next year. These devices are based on the TPS50601-SP, which was released four years ago. First, the company is working on an improved "A" version of the '50601, which will offer a tighter internal reference that will translate to tighter output voltage regulation, and better SEE radiation performance.

Secondly, the company is combining two of these die to create a dual-output buck labelled the TPS50602-SP. According to TI, this device is the first space-rated dual-output buck converter that is radiation hardened and is approximately 50% smaller than other monolithic solutions. Due to their tighter internal reference, these two devices will be able to achieve  $\pm 5\%$  voltage regulation across load line, temperature, aging and rad effects.

Unlike the single-die, single-output '50601, which offers a user-configurable switching frequency, the new TPS50602-SP has a switching frequency that is fixed at 500 kHz on each converter, operating 180° out of phase. Both the TPS50601A-SP and the TPS50602-SP are expected to be released in Q1 of 2018.

In addition to showing its new 3714 series 18-W triple-output sequenced hybrid dc-dc converter, which was described last month in our NSREC 2017 preview, [Modular Devices](#) presented information on several other series of hybrid dc-dc converters introduced in recent years. For example, the company's 3699, 3693 and 3694, which were introduced about two years ago, are rad hard converters with TID exceeding 100 kRad(Si) targeting cubesats and miniaturized satellites. These converters are rated at power levels up to 20 W. The 3699 series is fully isolated, while the 3693 and 3694 are nonisolated. All three operate from a 12-V nominal input corresponding to a 6-V to 16-V power bus (or 4.6 V to 16 V dc in the case of the nonisolated models.)

At its booth, [VPT](#) discussed the coming additions of 6-W and 1.5-W dc-dc converters to its SVR series of space-qualified products, which feature a TID of 100 krad(Si) and an SEE of 84 MeV.cm<sup>2</sup>/mg. Additionally, it discussed the full SV series of isolated converters for lower LEO and high-volume constellation programs, which feature the less stringent 30-krad(Si) TID and 44-MeV.cm<sup>2</sup>/mg specs. The company also displayed its existing 100-krad(Si)/85-MeV.cm<sup>2</sup>/mg, non-isolated point-of-load converters from its SVGA family of products. The company is preparing to add versions of these POLs in surface-mountable gull-wing packages.

[3D Plus](#) showed its 3DPM0289-1 rad hard point-of-load converter, which was introduced about a year ago. Designed to operate over a 4.5-V to 12-V input voltage range, this converter produces up to 2 A of output at 1.0 to 5.0 V. This module is compact, measuring 12.5 x 11 x 9.4 mm and weighing just 4 g. With its use of synchronous rectification, the converter achieves >90% efficiency at 3.3-V output from 0.3 A to 1.5 A. Rad hard specs include a TID of >40krad(Si), an SEL LET of >60 MeV.cm<sup>2</sup>/mg and an SET immunity of up to 35 MeV.cm<sup>2</sup>/mg.

The company also provided information on its 3DPM0237-2, a rad hard DDRII termination regulator. This bus termination regulator can sink or source 1 A and has been specifically designed for low input voltage (1.6 V to 2.8 V) low-noise and high-reliability systems. This regulator is offered in a 20-mm x 20-mm x 13.2-mm, 24-pin SOP that weighs 15 g. TID is >50 krad (Si), SEL LET is >80 MeV.cm<sup>2</sup>/mg and SET immunity is also >80 MeV.cm<sup>2</sup>/mg. For more information, see the 3D Plus [website](#).

**Peregrine Semiconductor**, whose space products group is now part of [Teledyne Hirel Electronics](#), continues to offer rad hard synchronous buck regulator ICs with integrated switches. Information on these products, which have been on the market for several years, was available at the Teledyne e2V booth. These products included

the 2-A PE99151, the 6-A PE99153 and the 10-A PE99155 dc-dc buck regulators. These devices offer SEE immunity to a LET >90 MeV.cm<sup>2</sup>/mg and a TID of 100 krad (Si).

In addition to these products, the company is also in the process of qualifying GaN FETs from GaN Systems for space. These include 650-V 200-A devices, which can be used with a GaN driver from Peregrine. For more information, see the Teledyne e2V [website](#).

### **Emergence Of Power Supply Sequencing ICs**

As reported in the NSREC expo preview, [Intersil](#) showed its rad hard GaN FET and driver, its switching regulators and various other devices. However, not mentioned previously, but demo'd at NSREC was Intersil's rad hard quad power supply sequencer. While there are many power supply sequencing ICs for commercial applications, up until now there have been no rad hard versions and companies have been forced to implement the same functionality using discrete components.

In October, Intersil will release its rad hard power supply sequencer IC, which according to Intersil's Josh Broline will offer a much smaller solution size than discretely as well as better reliability and easier programming. The usefulness of the part extends beyond four supply rails as multiple sequencers can be paralleled to sequence more rails.

Explaining the difficulty of designing a rad hard power sequencer versus a commercial equivalent, Broline commented that "there's a lot of logic in there with potential for single event upset." Developing a rad hard-by-design sequencer required a combination of process technology and chip design.

In addition to the sequencer and other previously mentioned parts, Intersil also showed its ISL71001M, a 6-A switching regulator in a plastic package. Unlike its rad hard components, this is a rad tolerant device designed to withstand lower TID and SEE levels.

This regulator is intended for use in small satellite mega constellations, launch vehicles, medical equipment and nuclear power plants. According to Broline, producing a rad tolerant plastic-package part is a bit of a departure from the company's usual rad hard approach to serving the space market for many decades. However, there is demand in the industry for lower-cost plastic parts for lower orbiting small satellites. The ISL71001M will formally launch at the end of September.

### **Power MOSFETs Now Include SJ MOSFETs**

[International Rectifier HiRel Products](#), an Infineon Technologies company, showed a wide range of power products including hybrid and non-hybrid dc-dc converters and point-of-load regulators. At its booth the company also highlighted its R9 family of rad hard power MOSFETs. According to the company, this is the first family of superjunction (SJ) MOSFETs for rad hard applications and unlike SJ MOSFETs for non-space applications, which typically carry higher voltage ratings (several hundred volts), the first members of the R9 family are low-voltage devices. 60-V and 100-V models are available now with 250-V versions coming in Q4 of this year. These are standard gate-drive parts rather than logic-level drive.

As Richard Southwell, senior director of sales & marketing for PMM HiRel explained, building these MOSFETs using SJ technology provided an improvement in performance versus planar. When used in the company's power converter designs "we obtained a 3% efficiency improvement just by changing from R5/R6 MOSFETs to R9." There was a corresponding improvement in FOM of 40%.

When compared with trench, the SJ MOSFETs were also much easier to bring up in voltage while achieving radiation hardening. Southwell added that the company expects to produce rad hard SJ MOSFETs at voltage ratings up to 600 V and possibly higher. Meanwhile, the company plans to make rad hard p-channel devices too.

The NSREC exhibit also included rad hard power MOSFETs and MOSFET switches from [ISOCOM](#). This company offers a wide range of power MOSFETs including n-channel devices with breakdown voltage ratings from 30 to 1200 V and p-channel devices with ratings of -60 and -100 V. These parts are offered in a variety of packages.

Similarly, the company offers a range of solid-state relays (SSRs) also referred to by the vendor as MOSFET switches. Intended as more reliable alternatives to electromechanical relays, which are vulnerable to shock and vibration, these SSRs are available in single-, dual- and quad-channel configurations with ratings of 100 V/1 A or 3 A and 400 V/1 A or 5 A. These rad hard devices are specified to a TID of 100 krad (Si).

These power MOSFETs and SSRs were introduced in 2015. Prior to that, there was only one vendor in the marketplace offering rad hard power MOSFETs (International Rectifier.) Note that, in addition to these MOSFETs and SSRs, ISOCOM offers custom-designed voltage regulators and POLs.

ISOCOM also offered data on its rad hard optocouplers including the IS49, CSM141A and CSM1800 devices, which were recently tested by JPL. The lab conducted proton displacement damage measurements which led to some conclusions about LED reliability as a function of forward current. For more information, see the [ISOCOM website](#).

### ***General-Purpose Components With Power Applications***

While power components are featured throughout the NSREC exhibition, the exhibits are much broader in scope than just power. So in addition to showcasing the latest rad hard power semiconductors, ICs, and modules, the NSREC exhibition is an excellent venue to learn about analog, mixed-signal and digital ICs with rad hard or rad tolerant specs. Naturally, some of these components find use in power-related applications.

For example, [Vorago Technologies](#) showed the VA10820 32-Bit ARM Cortex-M0 microcontroller, which boasts >300K rad (Si) for TID and latch-up immunity for extreme environments. According to Ross Bannatyne, marketing director for VORAGO Technologies, one customer uses the VA10820 as the computational kernel of an SMPS power converter. "It uses an external ADC to sample signals, performs MAC operations and (on the VA10820) adjusts PWM duty cycle and phase. The MCU also does some safety monitoring and instrumentation in the system," said Bannatyne.

#### **Reference:**

"[NSREC Highlights Latest Rad Hard Power Components For Space](#)" by David G. Morrison, How2Power Today, July 2017 issue.

For more information in rad-hard power components, see How2Power's [Space Power](#) section.