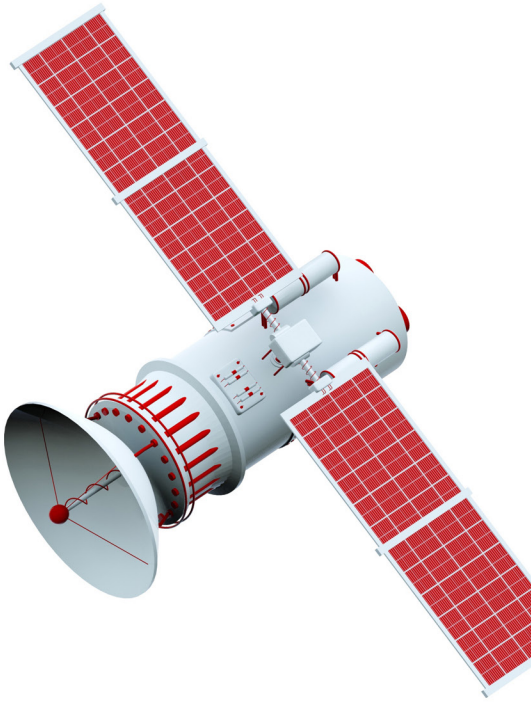
Peregrine Semiconductor

2015-2016 High Reliability Product Catalog



Welcome to

Peregrine Semiconductor

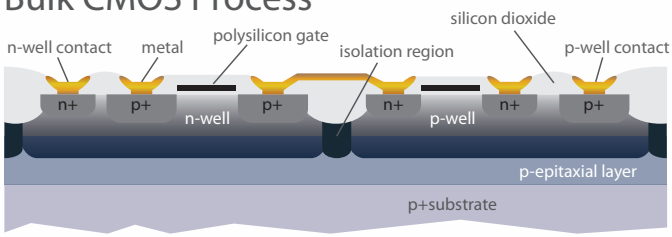
Peregrine Semiconductor is a fabless provider of high-performance radio-frequency (RF) integrated circuits (ICs). Our products deliver what we believe is an industry leading combination of performance and monolithic integration, and we leverage our extensive RF design expertise and systems knowledge to develop RFIC solutions that address the stringent performance, integration, and reliability requirements of high reliability (Hi-Rel) markets. Additionally, because UltraCMOS® devices are fabricated in standard high-volume CMOS facilities, products benefit from the fundamental reliability, cost effectiveness, high yields, scalability and integration of CMOS, while achieving the high performance levels historically expected from silicon-germanium (SiGe) and gallium arsenide (GaAs). It is this combination of attributes which enables ease-of-development essential to timely and cost-effective application design by our customers.

UltraCMOS® Technology

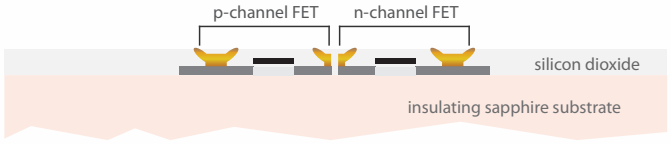
UltraCMOS RF process technology is an advanced form of silicon-on-insulator (SOI) semiconductor process. This technically superior process achieves significant RF performance and is well suited for demanding Hi-Rel designs. UltraCMOS technology circuitry is processed on an ultra-thin silicon (UTSi®) layer atop a dielectric sapphire wafer. As a result, variable capacitances in the junction region are virtually eliminated, which improves the transistor's voltage handling and linearity, and reduces the overall current drain. Additionally, high-quality passive and RF functions, as well as digital circuitry can be integrated on a single die.

An important advantage of Peregrine's UltraCMOS technology is that it is Inherently radiation tolerant. single event latch-up (SEL) is the radiation-induced latch-up of a CMOS logic gate. This can happen when a high-energy particle strikes the parasitic thyristor that is inherent to bulk silicon designs and causes a short circuit from power to ground within the device. This is often catastrophic and results in permanent damage, requiring, at a minimum, a power down to recover. However, UltraCMOS products do not contain the bulk parasitics found in standard CMOS devices, making latch-up virtually impossible.

Bulk CMOS Process



UltraCMOS® Process



Monolithic Integration

Another fundamental benefit of UltraCMOS products for Hi-Rel applications is its inherent ability to integrate RF, mixed-signal analog, digital and EEPROM on the same device. This high level of monolithic integration results in a smaller IC, which helps reduce overall design size and the number of external components required.

Quality and Reliability

We are committed to providing high-quality products and services that meet or exceed our customers' expectations. We have developed and implemented a quality management system to create an organizational environment designed to meet the highest level of quality and reliability standards. Our quality management system has been certified and maintained to ISO 9001 standards since 2001. We achieved AS9100 Quality Management System Standards certification in 2003 to address the strict quality system requirements of the aerospace industry. In early 2012, we further improved the robustness of our quality management system by receiving our ISO/TS 16949:2009 Quality Management System certification by the automotive industry.

Peregrine's Hi-Rel products use the test methods and procedures defined under MIL-STD 883 and MIL-PRF-38535 to fabricate, assemble, test, screen and qualify for space-level applications.

Radiation Tolerant Technology for Space Applications

Radiation Tolerance

The primary radiation concerns in the space environment are total ionizing dose (TID), enhanced low dose rate sensitivity (ELDRS) and single event effects (SEE). Peregrine's UltraCMOS process technology addresses these concerns with an inherent radiation tolerance.

Total Ionizing Dose

Peregrine performs total dose testing in accordance with MIL-STD 883, method 1019. TID degradation or gain drifts of component parameters cause changes to circuit supply and leakage currents, threshold voltages, and propagation times. Program missions will determine the level of TID tolerance required. For example, low-earth orbit, low-lifetime missions may require 30-50 kRad(Si), while deep-space, longer lifetime missions may require 100 kRad(Si) or more. Pre- and post-radiation measurements for key parameters are critical data points for device qualification.

Enhanced Low Dose Rate Sensitivity

Peregrine's Hi-Rel products are ELDRS-free. This is an inherent advantage because ELDRS can degrade certain types of bipolar devices more severely at very low dose rates than at higher dose rates. Semiconductors based on bipolar technology are subject to "enhanced" total ionizing dose degradation at very low-dose rates. CMOS technology does not use bipolar (minority carrier) elements and does not exhibit ELDRS.

Single Event Effects

SEEs occur when a high-energy particle passes through the active region of a semiconductor, triggering non-destructive effects such as upset, multiple-bit upset or analog transients; or destructive effects such as latch-up, gate rupture, and burnout. As a high-energy charged particle enters the silicon at a high velocity, it exerts a force on the bound electrons and separates them from the lattice, freeing substantial local charge to be collected across any junction within a diffusion length. The collection produces current spikes that can have various effects on the circuit.

Non-destructive or "soft-error effects" momentarily or permanently change the state of a device or cell/node, affecting its functionality. These types of errors are defined as single event upset (SEU), single event transient (SET) and single event functional interrupt (SEFI) errors.

Destructive or "hard-error effects" interrupt device function and can permanently damage the device without prompt external mitigation. These types of errors are defined as single event latch-up (SEL), single event gate rupture (SEGR), and single event burnout (SEB) events.

The ultra-thin epitaxial layer in UltraCMOS technology produces the lowest-possible SEU charge collection of any production silicon technology and simplifies the circuit design needed to achieve SEU, SET and SEFI immunity. The UltraCMOS device construction eliminates 4-layer devices and all forms of latch-up including SEL. The device design rules constrain operating voltages to less than one-third BVox and operating at these voltages prevents any SEGR. SEB is not observed in this technology, where high-current bipolar junction transistors (BJT) gain is absent by construction.

High Reliability
RF Products

Peregrine Semiconductor's S-level standard and semi-custom UltraCMOS® silicon-on-sapphire (SOS) RFICs are based on our high-volume commercial products, yet designed to meet the rad-hard, low-power needs of space applications. UltraCMOS technology delivers a cost-effective solution compared to the higher-voltage GaAs, SiGe or bulk silicon devices.

RF Switches

Our Hi-Rel RF switches feature high linearity, isolation and exceptionally rugged performance for space applications.

Hi-Rel RF Switches — 50Ω

Product Description*	Part Number	Operating Frequency (MHz)		Linearity IIP3 (dBm)	P0.1dB (dBm)	Insertion Loss (dB)	Isolation (dB)		Typical I_{DD} (µA)	V_{DD} (V)	V_{SS} (V)	ESD HBM (V)	Package
		Min	Max				Min	Max					
SPDT, R	PE9354	10	3000	55	31	0.55	28	32	28	2.7–3.3	—	200	8L CFP, Die
SPDT, A	PE95420	1	8500	60	33	0.77	38	75.6	100	3.0–3.6	–3.6 to –3.0	2000	7L CQFP, Die
NEW SPDT, A	PE95421	1	8500	60	33	0.77	38	75.6	100	3.0–3.6	–3.6 to –3.0	1000	7L CQFP, Die

Note: * Absorptive (A) or Reflective (R).

Digital Step Attenuators

The PE94302 digital step attenuator (DSA) provides highly competitive IP3, accuracy, temperature stability and ESD protection, with lower distortion and power consumption. The combination of these features enables excellent performance and cost-effectiveness.

Hi-Rel Digital Step Attenuators (Monolithic) — 50Ω

Product Description, Part Number	Attenuation (dB) (range / steps)	Programming Mode	Operating Frequency (MHz)		Insertion Loss (dB)	Input IP3 (dBm)	Attenuation Accuracy (dB @ 1 GHz)	Switching Speed (µs)	ESD HBM (V)	Package
			Min	Max						
6-bit – PE94302	31.5 / 0.5	Parallel, Serial	0.25	4000	1.5	52	±(0.55 + 7% of setting)	1	500	28L CQFP, Die

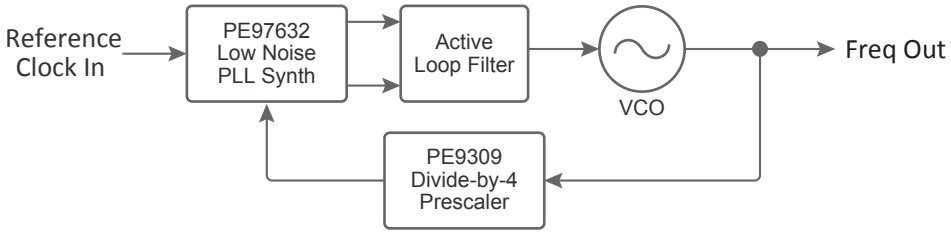
Prescalers

The high-performance UltraCMOS RF prescaler family offers a fixed divide ratio of 2, 4, or 8 and an operating frequency ranging from DC to 13.5 GHz on a nominal 3V supply while drawing between 6.5 and 16 mA. These devices have excellent sensitivity and are well suited for microwave phase-locked loop (PLL) synthesis solutions.

Hi-Rel Prescalers

Product Description, Part Number	Operating Frequency (MHz)		Divide Ratio	Typical I_{DD} (µA)	V_{DD} Range (V)	ESD HBM (V)	Package
	Min	Max					
PE9301 – Divide-by-2	1500	3500	2	13	2.85–3.15	250	8L CFP, Die
PE9303 – Divide-by-8	1500	3500	8	14	2.85–3.15	250	8L CFP, Die
PE9304 – Divide-by-2	1000	7000	2	14	2.85–3.15	500	8L CFP, Die
PE9309 – Divide-by-4	3000	13500	4	16 @ 2.6V	2.45–2.75	250	8L CFP, Die
PE9311 – Divide-by-2	DC	1500	2	6.5	2.85–3.15	1000	8L CFP, Die
PE9312 – Divide-by-4	DC	1500	4	6.5	2.85–3.15	1000	8L CFP, Die
PE9313 – Divide-by-8	DC	1500	8	6.5	2.85–3.15	1000	8L CFP, Die

The PE93xx prescalers extend the upper frequency range of a PLL synthesizer while offering low power, small size and radiation hardness.



Phase-locked Loop Frequency Synthesizers

Peregrine's integer-N and fractional-N PLL frequency synthesizers deliver superior phase noise performance where low phase noise is critical. The new PE97240 integer-N and PE97640 fractional-N PLLs feature improved normalized phase noise of –230 and –225 dBc/Hz, respectively, and offer an additional 5/6 prescaler divide ratio.

Hi-Rel Integer-N PLL Frequency Synthesizers*

Part Number	Φ Det Type	Programming Mode	Normalized Phase Noise (dBc/Hz)	Max Input Operating Freq (GHz) RF PLL	Max Input Operating Freq (MHz) Ref	Max Input Operating Freq (MHz) Compare	Prescaler	Reference Counters	Typical I_{DD} (mA)	V_{DD} Range (V)	ESD HBM (V)	Package
PE9601	CP	Par, Ser, Hardwire	–210	2.2	100	20	10/11	6-bit	24	2.85–3.15	1000	44L CQFJ, DIE
PE9701	CP	Par, Ser, Hardwire	–210	3.0	100	20	10/11	6-bit	24	2.85–3.15	1000	44L CQFJ, DIE
PE9702	PD	Par, Ser, Hardwire	–210	3.0	100	20	10/11	6-bit	24	2.85–3.15	1000	44L CQFJ, DIE
PE9704	PD	Serial, Hardwire	–210	3.0	100	20	10/11	6-bit	24	2.85–3.15	1000	44L CQFJ, DIE
PE97022	PD	Par, Ser, Hardwire	–216	3.5	100	50	10/11	6-bit	45	2.85–3.45	1000	44L CQFJ, DIE
PE97042	PD	Serial, Hardwire	–216	3.5	100	50	10/11	6-bit	45	2.85–3.45	1000	44L CQFJ, DIE
NEW PE97240	PD	Serial, Hardwire	–230	5	100	100	5/6 and 10/11	6-bit	75	2.6–2.8	1000	44L CQFP

Note: * Main Counters M, A = 9-bit, 4-bit.

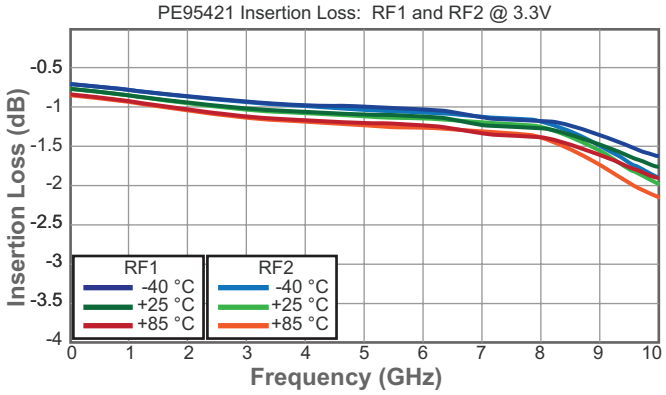
Hi-Rel Delta-Sigma Modulated Fractional-N PLL Frequency Synthesizers*

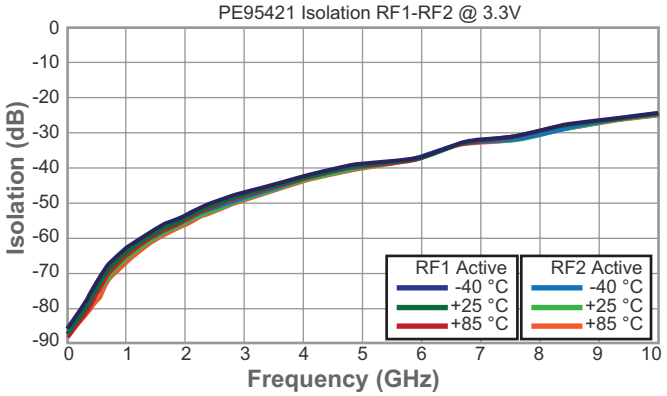
Part Number	Description	Programming Mode	Normalized Phase Noise (dBc/Hz)	Max Input Operating Freq (GHz) RF PLL	Max Input Operating Freq (MHz) Ref	Max Input Operating Freq (MHz) Compare	Prescaler	Reference Counters	Typical I_{DD} (mA)	V_{DD} Range (V)	ESD HBM (V)	Package
PE9763	Low Phase Noise 3rd Order DSM	Ser, Hardwire	–210	3.2	100	50	10/11	6-bit	30	2.85–3.15	1000	68L CQFJ, DIE
PE97632	Ultra-Low Phase Noise 3rd Order DSM	Ser, Hardwire	–216	3.5	100	50	10/11	6-bit	40	2.85–3.15	1000	68L CQFJ, DIE
NEW PE97640	Ultra-Low Phase Noise 3rd Order DSM	Ser, Hardwire	–225	5.0	100	50	5/6 and 10/11	6-bit	80	2.6–2.8	1000	64L CQFP

Note: * Main Counters M, A, K = 9-bit, 4-bit, 18-bit.

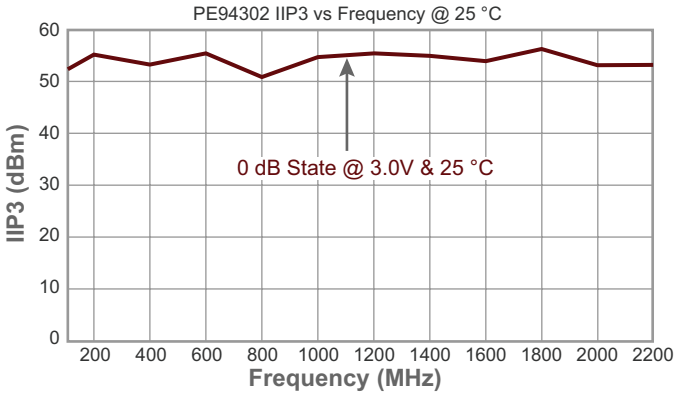
UltraCMOS Technology Delivers High Linearity and Low Phase Noise

HaRP™ technology enhancements allow for excellent linearity, and minimize gate lag, insertion loss and phase drift.

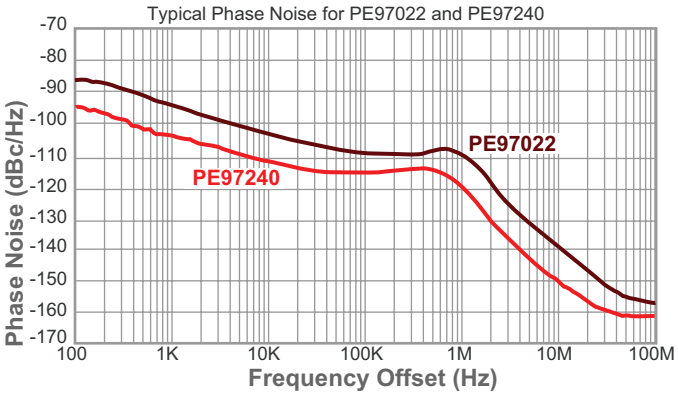




The PE94302 DSA features unprecedented levels of broadband linearity down to 100 kHz.



PE97022 and PE97240 phase noise: V_{DD} = 2.8V, temp = 25 °C, Fvco = 4 GHz, Fcomp = 50 MHz, loop bandwidth = 500 kHz



High Reliability

Power Management Products

Peregrine's power management products follow a steep tradition of high performance and efficiency. The flagship power management family supports DC to DC conversion with radiation hardened point-of-load (POL) synchronous buck regulators with integrated switches. These devices offer SEE immunity to a linear energy transfer (LET) greater than 90 MeV.cm^2 /mg and radiation hardness of 100 kRad(Si), and replace multichip modules by offering superior performance, smaller size and reduced weight in sensitive space applications.

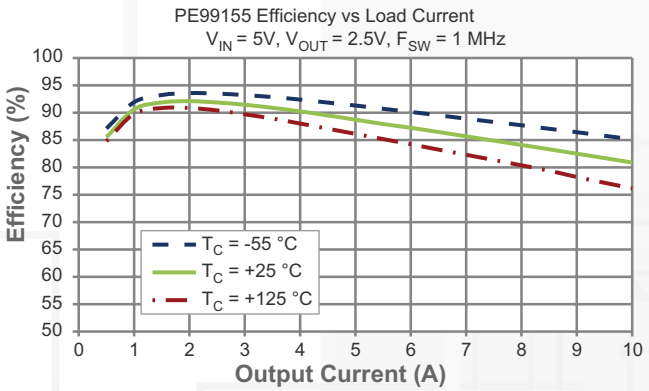
Hi-Rel Point-of-Load DC-DC Buck Regulators

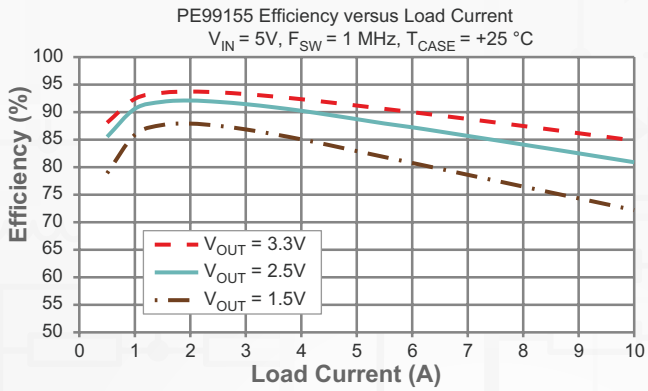
Part Number	Product Description	I_{OUT} (Max) (A)	V_{IN} (Min) (V)	V_{IN} (Max) (A)	V_{OUT} (Min) (V)	V_{OUT} (Max) (V)	Async Switching Frequency (kHz)	Sync Switching Frequency (kHz)		ESD HBM (V)	Package
								Min	Max		
PE99151	2A DC-DC Buck Regulator	2	4.6	6	1	3.6	500/1000	100	5000	1000	32L CQFP, Die
PE99153	6A DC-DC Buck Regulator	6	4.6	6	1	3.6	500/1000	100	5000	1000	32L CQFP, Die
PE99155	10A DC-DC Buck Regulator	10	4.6	6	1	3.6	500/1000	100	5000	1000	32L CQFP, Die

Radiation Hardened POL Synchronous Buck Regulators

- Integrated synchronous FET switches with 93% peak efficiency.
- Peak current mode control and voltage mode control for wide loop bandwidth and excellent load step response.
- Better than 1% initial accuracy at 25 °C.
- Powers up into pre-biased loads allowing safe start-up with load applied.
- Adjustable switching frequency (100 kHz to 5 MHz) allows operation at the optimum frequency to minimize RF spur impact and minimize inductor size and weight.
- Inverted sync buffer pin for easy poly-phase operation, enabling ripple reduction and faster loop response.
- Adjustable soft-start with external capacitor to adjust load voltage/current rise-time.
- Integrated power good pin for sequencing and telemetry.
- Shutdown function pin for remote on/off control.
- Accurate and simple current sharing for higher power loads.
- Adjustable current threshold and over current protection.
- N+K redundant control through simple enable pin.
- Hermetic ceramic package with exposed thermal pad.
- The UltraCMOS process does not exhibit ELDRS since bipolar minority carrier elements are not used.

Power Conversion Efficiency Curves





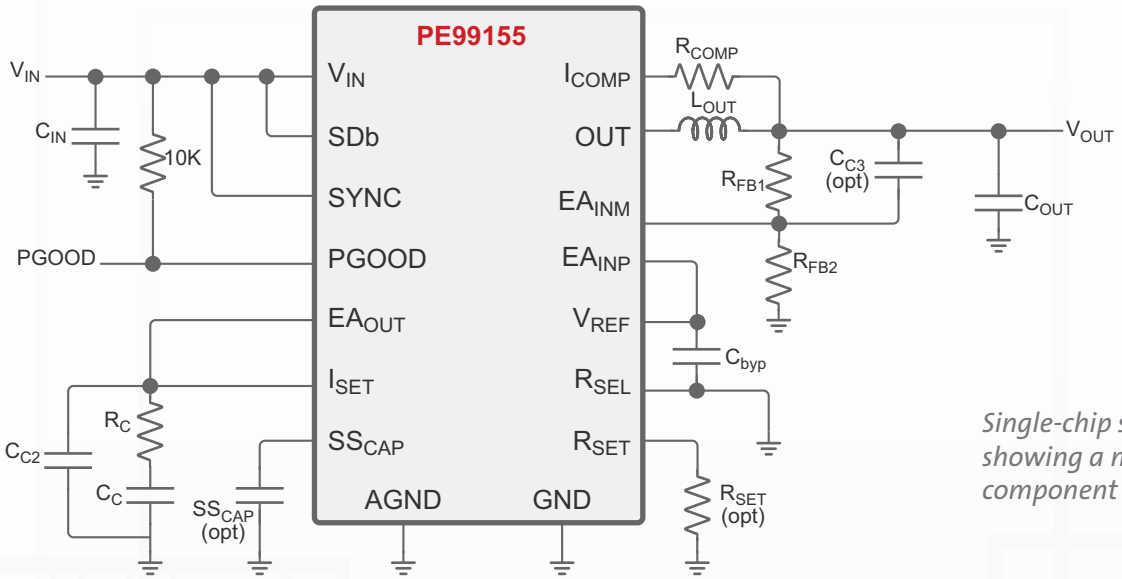
The PE9915x POL buck regulators are capable of supplying high load currents at low output voltages while maintaining high efficiency.

Test Results

Radiation Hardness	
TID	100 kRad(Si)
SEL	> 90 MeV•cm²/mg
SEB	> 90 MeV•cm²/mg
SET	> 90 MeV•cm²/mg
SEFI	> 90 MeV•cm²/mg
SEGR	> 90 MeV•cm²/mg

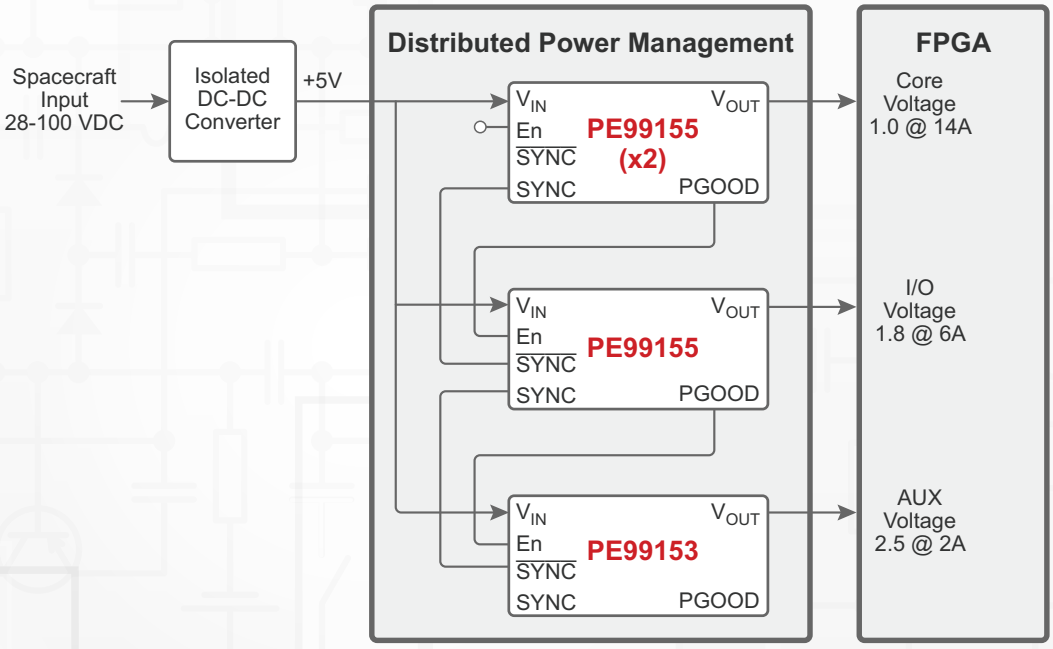
- SEL, SEB, SEGR, SEU, SEFI: None observed, Au/60 degrees.
- SET: No events exceeding 30 mV transient observed @ Au, LET = 90, 60 degrees normal incidence.
- The UltraCMOS process does not exhibit ELDRS since bipolar minority carrier elements are not used.

Simplified Application Schematic



Single-chip solution showing a minimal external component count.

Distributed Power Architecture



A distributed power architecture example using the intermediate bus to supply several POL synchronous buck regulators reduces distribution losses through smaller cables and connectors, which reduces size, weight and cost.

Design and Application Support

Designing for tomorrow's challenging RF applications requires high-performance products and outstanding technical support. From engineering excellence to streamlined manufacturing and technical sales and applications support, Peregrine Semiconductor is committed to providing a complete product solution. Choose among our comprehensive library of datasheets, application notes, tutorials, reference designs and other engineering resources, all developed to help get your design to market on time.

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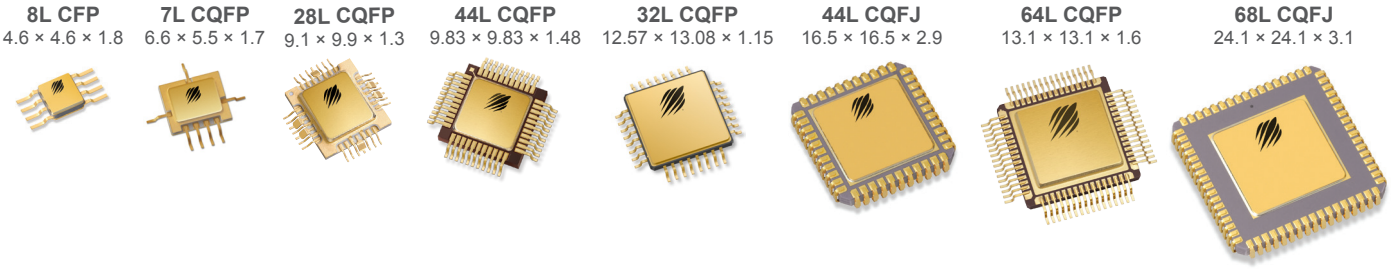

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