

TI Space Products

Components for Extreme Environments



Amplifiers and Linear

Clocks

Data Converters

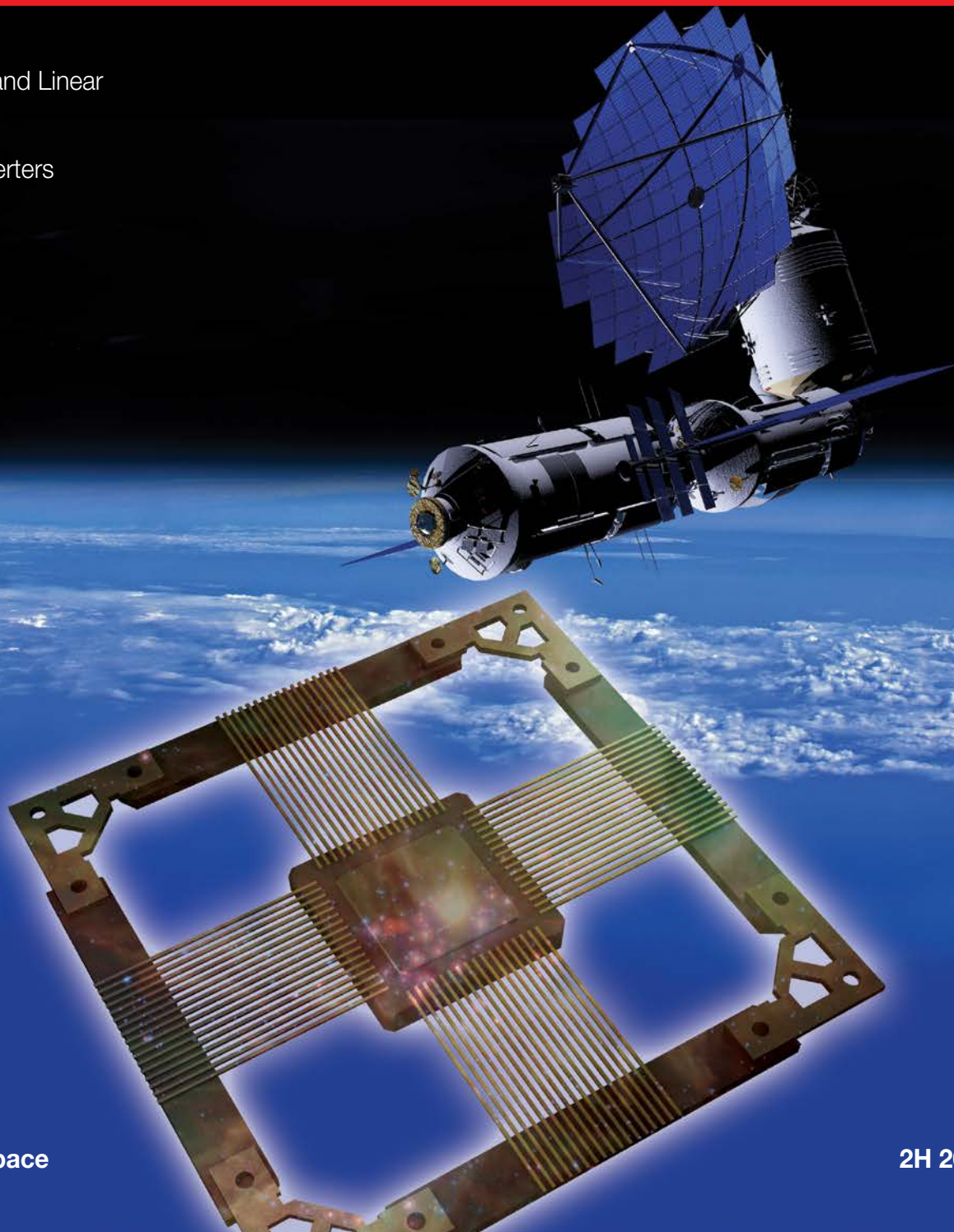
DSP

Interface

Logic

Memory

Power



Space Products Guide

Overview/Table of Contents

TI-HiRel Space Products

To support the demanding nature of space applications TI and National have combined product lines to create a strong and united offering for space applications. By combining our portfolios we provide a complete signal chain solution for space.

National customers can be assured:

- No Part Number Changes
- No Requalification
- Continued new product development

Potential applications:

- Commercial and defense space-based systems
- Data processing
- Flight critical control systems
- Gas chromatographs
- Particle detectors
- Photometers
- Space-based imaging and surveillance
- Spectrometers
- Wave analyzers

For more information on TI-HiRel space products, see www.ti.com/space.

Radiation Data is available at www.ti.com/radiation.

Radiation Effects

High-energy protons, electrons and charged particles in natural space environments can strongly affect the operation of electronic circuits used in space applications.

Radiation is energy in transit, taking the form of high-speed particles and electromagnetic waves. We encounter electromagnetic waves every day. They make up our visible light, radio and television waves, ultraviolet (UV) light and microwaves with a large spectrum of energies. These examples of electromagnetic waves do not cause ionizations of atoms because they do not carry enough energy to separate molecules or remove electrons from atoms.

Ionizing radiation is radiation with enough energy so that during an interaction with an atom, it can remove tightly bound electrons from their orbits, causing the atom to become charged or ionized. Examples are gamma rays, protons and neutrons.

The most common radiation requirement in the aerospace design community is total ionizing dose (TID), also known as total dose. Total dose irradiation is primarily caused by electrons and

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protons that penetrate into the silicon and can result in device degradation and/or device failure.

Charge buildup affects the current-voltage characteristics of transistors used in semiconductor circuits. Proper operation of a transistor relies on the ability to switch it from a low-conductance (off) state to a high-conductance (on) state as the gate voltage passes through a threshold. Extended exposure to radiation can shift the threshold voltages making the transistors easier or harder to switch. Radiation may also increase the leakage current, causing the on and off states of the transistors to become less distinguishable. Either effect can ultimately cause circuit failure.

HiRel performs total dose testing on space-qualified, QML Class-V new product releases in order to determine how much radiation our devices can absorb before device degradation occurs. The test results for select devices are available at www.ti.com/radiation.

Space Products Guide

Overview

Radiation Effects

Although TID is typically the first step in determining the radiation tolerance of a device to be used in the space industry, single event effects, or SEE, rank as the next concern for space system designers. The first “must have” is that the device must be free of single event latch-up (SEL). SEL can lead to severe disruption or even catastrophic device failure in the system. Once a device latches, it can sometimes be recovered by powering down the system and/or performing a system reset. If left unchecked, the increased supply current demand can lead to device burnout. One approach to making a device SEL free, is to use a semiconductor process that is inherently SEL free. TI’s complementary bipolar (BiCOM) processes are manufactured using “silicon over insulator,” deep-trench isolated wafer construction techniques that result in devices that are inherently immune to latch-up.

Once a device has been checked to be SEL free, the device will need to be rated as to its single event upset or “SEU” tolerance. As charged particles pass through the silicon, they deposit enough energy to cause logical errors to occur in digital devices. This so called bit flipping, i.e. a “1” to “0” state, or “0” to “1” state, can propagate into multiple bit errors, or “MBU’s” and the logic error propagates through the system. Often a system may hang-up from these unexpected logic state changes, and may require a device reset, or restart. Unlike the SEL, SEU’s can often be tolerated to some extent, and are classified as errors in time. The actual SEU rate, or so called Soft Error Rate (SER) is determined by device exposure to heavy ion’s at various energy levels (LET) over time, and determining the number of errors that occur. This data can be used to generate a Weibull distribution of the error rate.

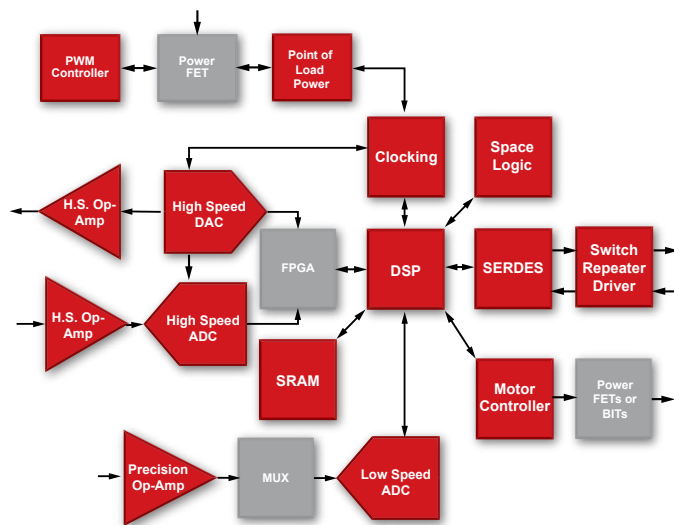
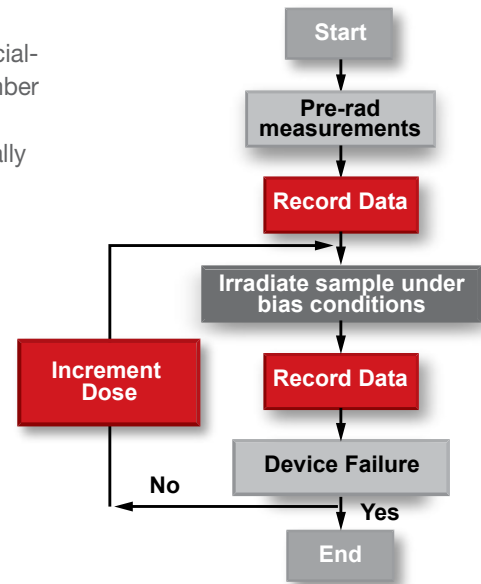
Radiation Test Method

To assure reliable performance under the aforementioned environmental conditions, the HiRel space product line is thoroughly tested for radiation performance as part of the qualification process per MIL-STD-883, method 1019. The flow diagram shown here illustrates the HiRel radiation test procedure.

The devices are electrically tested before irradiation, with parametrics recorded and datalogged for later comparison. Devices are electrically biased in specialized fixtures within the radiation chamber and exposed to a predetermined radiation level. They are then electrically

tested after irradiation to determine if degradation or device failure has occurred. If no measurable degradation has occurred, the devices are irradiated again at a higher dose level and tested once more. This process repeats until the devices fail or reach the maximum predetermined radiation level.

Radiation test method



TI Space Solutions

TI has radiation-tolerant, hermetically packaged devices released for each one of the red blocks shown in the block diagram.

Featured Products

Power Management

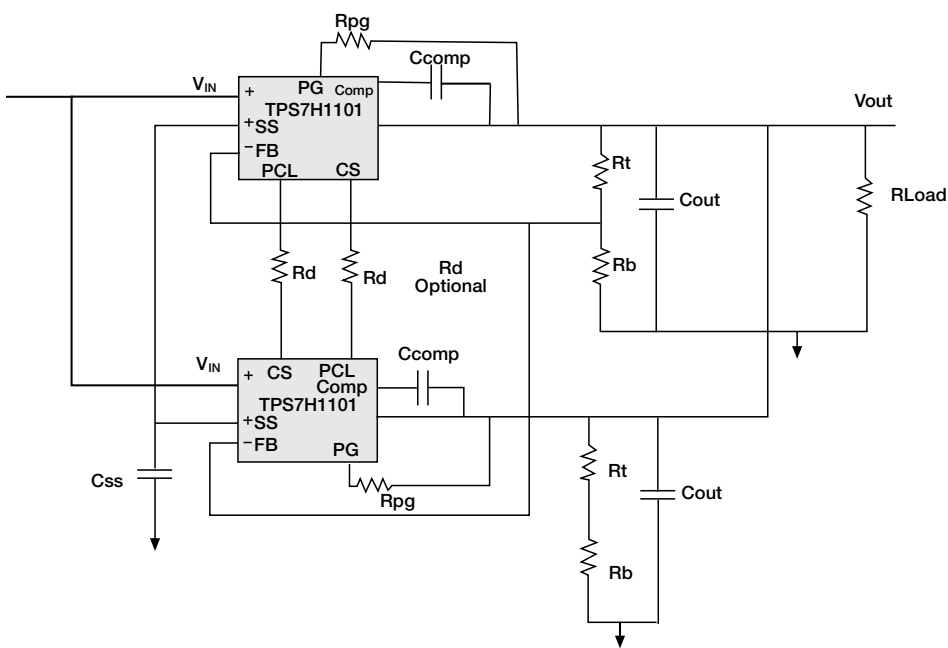
1.5-7 V_{IN}, 3A Ultra Low Dropout Regulator

TPS7H1101-SP

The TPS7H1101-SP is an ultra low dropout (LDO) linear regulator that uses a PMOS pass element configuration. The TPS7H1101-SP operates under wide range of input voltage, from 1.5 V to 7 V which enables $6-V_{IN}$ to $5-V_{OUT}$ or $1.5-V_{IN}$ to $1.2-V_{OUT}$ voltage conversion while offering excellent PSRR.

The TPS7H1101-SP is ideally suited for high reliability applications. It features a very precise and programmable fold back current limit implementation with a very wide adjustment range. This product is pending qualification to both QML class V and high temperature standards to address the specific requirements of both environments.

To support complex requirements of FPGAs or DSPs, TPS7H1101-SP provides programmable SoftStart and PowerGood output for easy power sequencing. TPS7H1101-SP is available in a thermally enhanced 16-pin ceramic flatpack package.



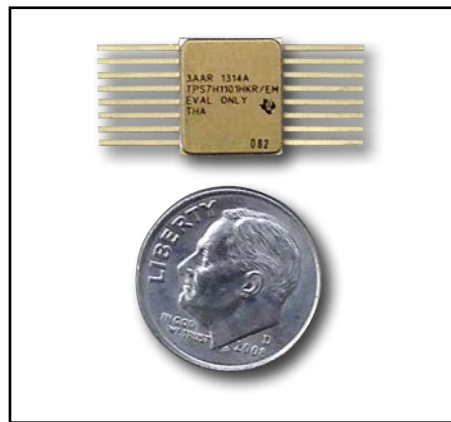
TPS7H1101-SP Functional diagram

Key Features

- Wide V_{IN} Range: 1.5 V-7 V
- Stable with ceramic output capacitor
- $\pm 2\%$ accuracy
- Programmable SoftStart
- PowerGood output
- Low dropout voltage:
 - 196 mV at 3 A (25°C)
 - 62 mV at 1 A (25°C)
- Current sharing capable to support up to 6 A
- Excellent thermal performance
- Orderable as 5962R1320201VXC

Radiation Performance

- TID = 100 kRAD (Si)
- ELDRS free to 100 kRAD(Si) at 10 mRAD/sec. exposure rate
- Single event latchup (SEL) immune at LET ≤ 85 MeV-cm²/mg
- SEB and SEGR immune at LET ≤ 85 MeV-cm²/mg



Get more information: www.ti.com/product/TPS7H1101-SP

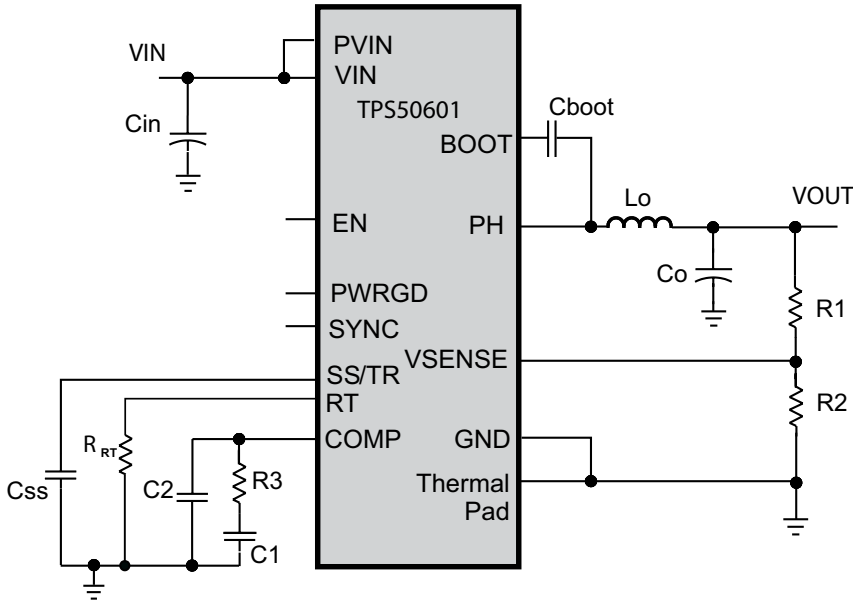
Featured Products

Power Management

3- 6.3 V_{IN}, 6A Point-of-Load Regulator

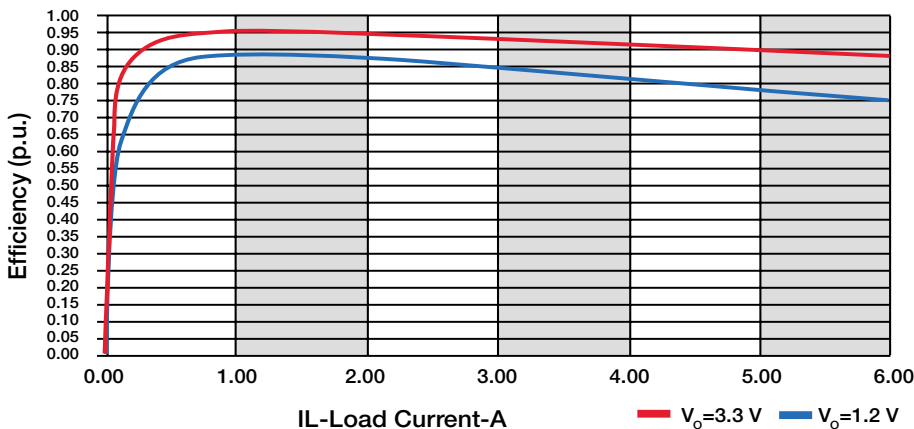
TPS50601-SP

The TPS50601-SP is an integrated FET Point-of-Load regulator. 3 V–6.3 V Input, 6 A synchronous POL stepdown SWIFT™ DC-DC Converter that has been designed and qualified for harsh environments such as down hole drilling, geological exploration and space. This product is qualified to both QML Class V and High Temp standards to address the specific requirements of both environments.



Simplified schematic

Efficiency vs. Load Current V_{IN}=5 V



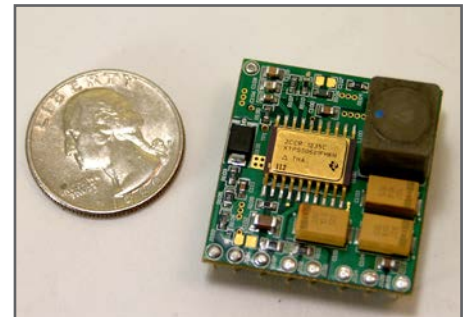
Very efficient DC-DC conversion at 95% at 1 amp.

Key Features

- 6 A output current
- Peak efficiency: 95% ($V_{out} = 3.3 V$)
- Single-supply operation above 3 V_{IN}
- Split power-rail 1.6 V to 6.3 V PV_{IN}
- Min output voltage to 0.8 V
- Integrated high-side and low-side power MOSFETs
- External sync capability from 100 kHz to 1 MHz
- Supported by TI's SwitcherPro™ design software tool
- Parallel operation 180° out of Φ with sync pin (Ideal for driving power rails with up to 12 A requirements)
- Adjustable switching frequency
 - 100-kHz to 1-MHz adjustable internal oscillator
 - Allows designers to select desired external capacitor and inductor component sizes
 - Eliminates "Spurious Noise" in the operating bandwidth of interest
- Dynamic bias feature – Improves load transient response with smaller output capacitances
- Thermally enhanced 20-pin HKH ceramic dual flat-pack package – saves valuable PCB space
- Orderable as 5962R1022101VSC, 100 kRad RHA certified

Radiation Performance:

- TID = 100 kRAD (Si)
- Single Event Latchup (SEL) immune at LET $\leq 85\text{MeV}\cdot\text{cm}^2/\text{mg}$
- ELDRS Free
- Visit www.ti.com/radiation for detailed rad reports



Small form factor reference design available.

Get more information: www.ti.com/product/TPS50601-SP

Featured Products

Power Management

QML-V RHA 100kRad
IN PROGRESS

Wide V_{IN} (2.3 - 20 V), 750 mA Low Drop-Out Regulator

TPS7A4501-SP

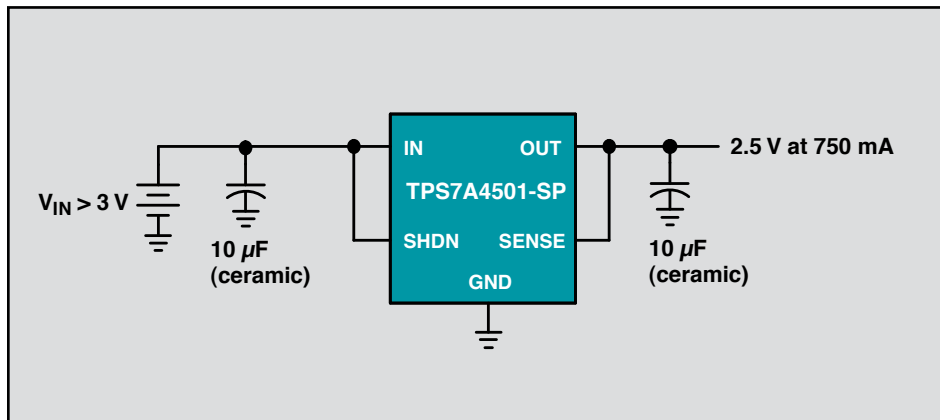
The TPS7A4501-SP is a low-dropout (LDO) regulator optimized for fast transient response. The device can supply 750 mA (1.5A RHA) of output current with a dropout voltage of 300 mV. Operating quiescent current is 1 mA, dropping to less than 1 μ A in shutdown. Quiescent current is well controlled; it does not rise in dropout, as with many other regulators. In addition to fast transient response, the TPS7A4501-SP regulator has very low output noise, which makes it ideal for sensitive RF supply applications.

Key Features:

- V_{IN} = 2.3V to 20 V
- I_{OUT} = 750 mA, 1.5A (RHA)
- Dropout Voltage: 300 mV at 750 mA
- Adjustable Output from 1.21 to 20 V
- Optimized for fast transient response.
- Low Noise: 35 μ V_{RMS} (10 Hz to 100 kHz)
- High Ripple rejection: 68dB at 1 kHz
- No Protection Diodes needed
- Less than 1 μ A Quiescent Current in Shutdown
- High Output Voltage Accuracy 1% at 25°C
- Reverse Battery and Reverse Current Protection
- Temperature Range: -55 °C to 125 °C
- Available in a 10 pin ceramic flat-pack (CFP) package
- SMD Orderable: 5962-1222402VHA
- 100kRad(Si) RHA certification in progress

Radiation Performance:

- TID = 100kRad(Si)
- Visit www.ti.com/radiation for detailed RAD reports
- Single Event latchup (SEL) immune @ LET \leq 85 MeV-cm²/mg
- SEU immune @ LET \leq 85 MeV-cm²/mg



Typical Application

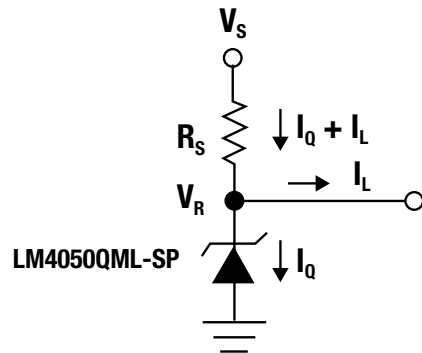
Get more information: www.ti.com/product/TPS7A4501-SP

Featured Products

Power Management

Precision Micropower Shunt Voltage Reference

LM4050QML-SP



Typical application circuit

Key Features

- Radiation performance
 - Low dose rate qualified to 100 kRAD (Si)
 - Single-event latchup-free up to 120 MeV-cm²/mg
- Fixed reverse breakdown voltages of 2.5 V and 5.0 V
- Voltage tolerance ± 0.1%
- Tempco 17 ppm/°C
- 60 µA to 15 mA operating current range
- SET free with 60 µF capacitor

1.2 V and 3.3 V_{IN} In Qualification

- QML-V RHA qualified, SMD 5962R09235
- **Applications**
 - For use in space-critical applications, such as satellite control systems and instrumentation
 - Power supply for micropower data converters

Get more information: www.ti.com/product/LM4050QML-SP

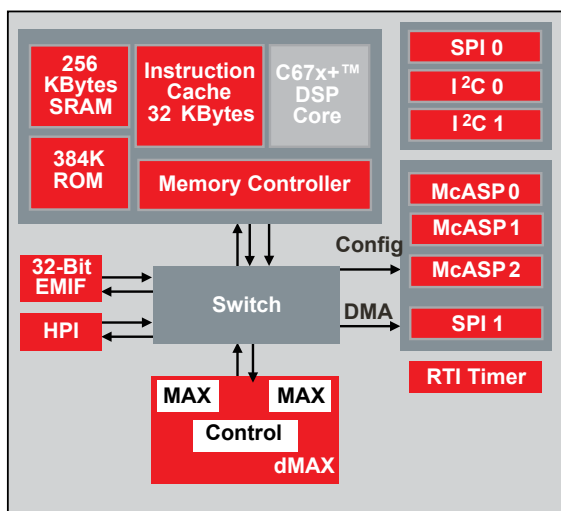
DSP

32/64-Bit, 250Mhz Floating-Point DSP

SMV320C6727B-SP

The SM320C6727B is the next generation of Texas Instruments' C67x generation of high-performance 32-/64-bit floating-point digital signal processor.

The C67x+ CPU is an enhanced version of the C67x CPU used on the C671x DSPs. It is compatible with the C67x CPU but offers significant improvements in speed, code density, and floating-point performance per clock cycle. At 300 MHz, the CPU is capable of a maximum performance of 2400 MIPS/1800 MFLOPS by executing up to eight instructions (six of which are floating-point instructions) in parallel each cycle. The CPU natively supports 32-bit fixed-point, 32-bit single-precision floating-point, and 64-bit double-precision floating-point arithmetic.



SMV320C6727B block diagram

RHA Certification Pending

Key Features

- New C67x+™ DSP Core
 - 250 MHz; 1500 MFLOPS
- Memory
 - 256 KB of SRAM and 32 KB of I-Cache
 - DSP/BIOS™/DSPLIB/FastRTS Library included in the device
- Peripherals
 - 32-bit HPI for Connecting to Hosts
 - dMAX Support for 1D, 2D, 3D Transfers as well as Multi-Tap Memory Delay
 - Three McASPs
 - Two I²C, two SPIs, 133 MHz/32-bit EMIF
- Temperature Range: -55°C to +115°C, -55°C to +125°C
- Available in 256-pin Ceramic QFP Package
- VelociTI Advanced Very Long Instruction Word (VLIW) C67x CPU Core
- 5962R1023101QXC, RHA certification pending
- Orderable as SMV320C6727BHFHW

Radiation Performance:

- TID = 100kRad(Si)
- SEL Immune to LET ≤ 117 MeV-cm²/mg
- Visit www.ti.com/radiation for detailed rad reports

Applications:

- Satellite
- Radar and Guidance Systems
- Geological Exploration

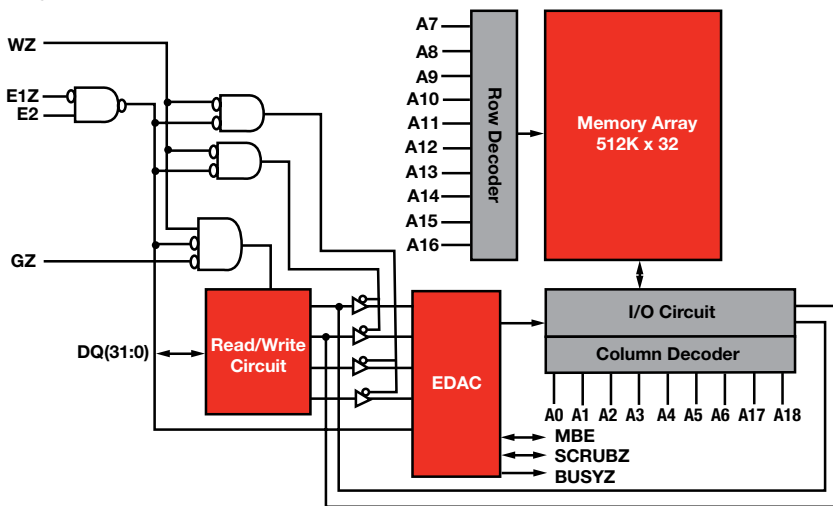
Get more information: www.ti.com/product/SMV320C6727B-SP

Featured Products

Memory

Monolithic Asynchronous Rad Hard 16M SRAM with Embedded EDAC and Scrub SMV512K32-SP

The SMV512K32 is a high performance asynchronous CMOS SRAM organized as 524,288 words by 32-bits. It is pin selectable between two modes: master or slave. The master device selection provides user defined autonomous EDAC scrubbing options. The slave device selection employs a scrub on demand feature that can be initiated by a master device.



SMV512K32-SP block diagram

Key Features

- Radiation performance
 - TID ≥ 300 kRAD (Si)
 - SER $< 5e-17$ upsets/bit-day
 - Proton upset saturation cross section $< 3e-16$ cm²/bit
 - Latch up immune to LET < 110 MeV-cm²/mg (T=398°K)
- Functionally compatible with commercial 512K x 32 asynchronous 16 Mb SRAMs
- 20ns read, 13.8ns write-through maximum access time
- Built-in error detection and correction (EDAC)
- Built-in scrub engine for autonomous correction (scrub frequency and delay is user defined)
- Three state bidirectional data bus
- Orderable as 5962-1123701VXC

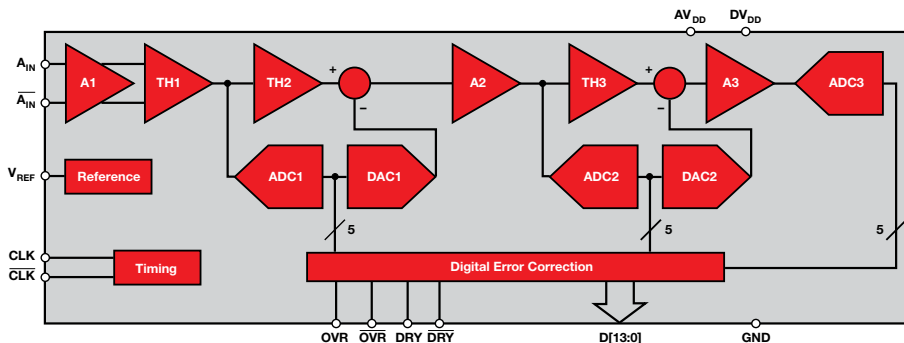
Get more information: www.ti.com/product/SMV512K32-SP

Data Converters

14-Bit 400-MSPS Analog-to-Digital Converter

ADS5474-SP

The ADS5474 is a 14-bit, 400-MSPS analog-to-digital converter (ADC) that operates from both a 5-V supply and 3.3-V supply while providing LVDS-compatible digital outputs. This ADC is one of a family of 12-, 13-, 14-bit ADCs that operate from 210 MSPS to 500 MSPS. The ADS5474 input buffer isolates the internal switching of the onboard track and hold (T&H) from disturbing the signal source while providing a high-impedance input.



ADS5474-SP functional block diagram

Key Features

- 400 MSPS Sample Rate
- 14 Bit Resolution, 10.9 Bits Effective Number of bits (ENOB)
- 5962R13208:
- Radiation Hardness Assurance (RHA) up to TID 100 krad (Si)
 - ELDRS free 100 krad (Si)
 - SEL/SEU characterized
- 1.28 GHz Input Bandwidth
- SFDR = 78 dBc at 230 MHz and 400 MSPS
- SNR = 69.8 dBFS at 230 MHz and 400 MSPS
- 2.2 VPP Differential Input Voltage
- LVDS-Compatible Outputs
- Total Power Dissipation: 2.5 W
- Output Data Transitions on the Rising and Falling Edges of a Half-Rate Output Clock
- On-Chip Analog Buffer, Track-and-Hold, and Reference Circuit
- Available in a 84-Pin Ceramic Nonconductive Tie-Bar Package (HFG)
- Orderable as 5062R1320801VXA

Applications

- Orbital communication
- Orbital control systems
- Spacecraft communications

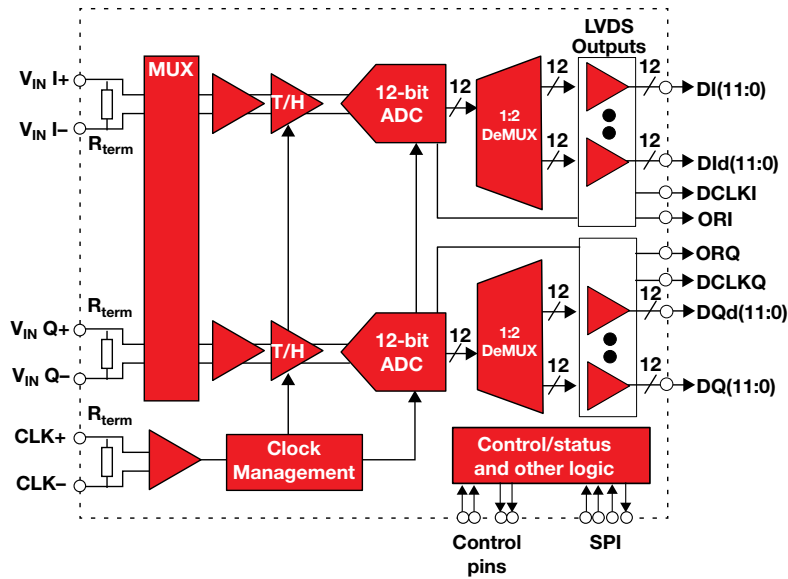
Get more information: www.ti.com/product/ADS5474-SP

Featured Products

Data Converters

12-bit 3.2 GSPS ADC /12-bit Dual 1.6 GSPS ADC

ADC12D1600QML-SP



ADC12D1600QML-SP block diagram

Key Features

- Radiation performance
 - SEL and SEFI immune > 120MeV-cm²/mg
 - TID 100 kRAD (Si)
- Full power bandwidth of 2.7 GHz
- 9.2/8.9 ENOB
- SNR: 58.3/56.6 dB
- SFDR: 67/62 dBc
- 1.71 W per channel at 1 GSPS from single 1.9-V supply
- Low-noise deMUX'd LVDS outputs
- Guaranteed no missing codes
- Space qualified
- Temperature range: -55°C to +125°C
- Orderable as 5962F1220501VXF (pending)
- Column Grid Array (CGA) package

Applications

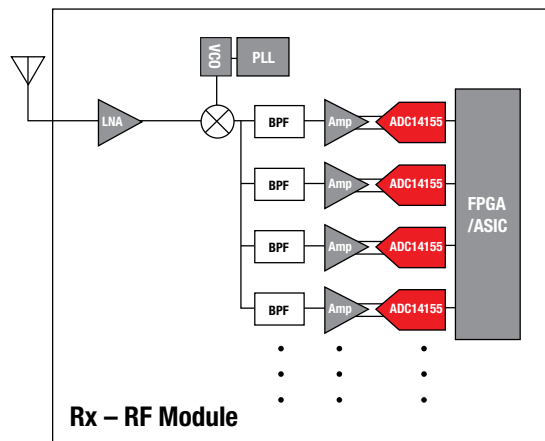
- Satellite communication system
- Wideband communications
- Data acquisition systems
- RADAR/LIDAR
- Software defined radio

Get more information: www.ti.com/product/ADC12D1600QML-SP

14-Bit, 155 MSPS A/D Converter

ADC14155QML-SP

Narrowband Satellite Receiver



ADC14155QML-SP functional block diagram

Key Features

- Radiation performance
 - TID of 100 kRAD (Si)
 - Single-event latchup-free up to 120 MeV-cm²/mg
- Input bandwidth of 1.1-GHz for high IF sampling
- SFDR of 80.3 dBFS
- Power consumption of 967 mW at 155 MSPS
- Guaranteed no missing codes
- Dual 1.8-V and 3.3-V operation

Applications

- For use in satellite narrowband receivers

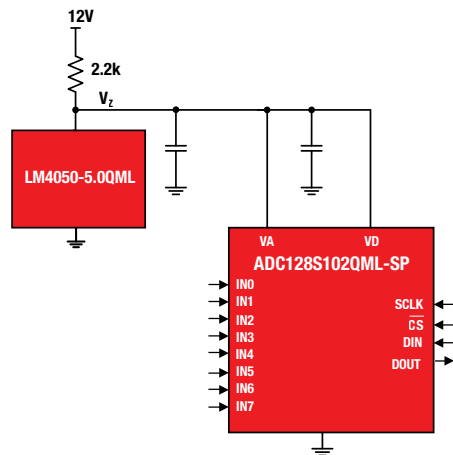
Get more information: www.ti.com/product/ADC14155QML-SP

Featured Products

Data Converters

8-Channel, 50 kSPS to 1 MSPS, 12-Bit A/D Converter

ADC128S102QML-SP



Typical application diagram

Key Features

- Radiation performance
 - TID of 100 kRAD (Si)
 - Single-event latchup-free up to 120 MeV-cm²/mg
- Only 2.3 mW of power consumption
- SPI serialized outputs
- 8 input channels
- DNL -0.3 to 0.5 LSB typical
- INL ± 0.6 LSB typical
- QML-V RHA qualified, SMD
- 962R0722701VZA

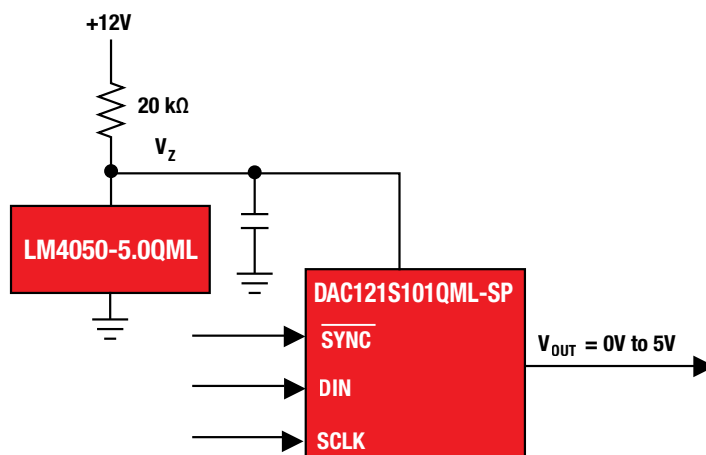
Applications

- Ideal for precision measurements in telemetry and control systems

Get more information: www.ti.com/product/ADC128S102QML-SP

12-Bit Micropower Rail-to-Rail Output D/A Converter

DAC121S101QML-SP



Functional block diagram

Key Features

- Radiation performance
 - TID of 100 kRAD (Si)
 - Single-event latchup-free up to 120 MeV-cm²/mg
- Only 0.64-mW of power
- 3-wire, 20-MHz SPI digital interface
- Supply range 2.7 V to 5.5 V
- DNL -0.1 to 0.21 LSB
- Setting time 12 μS
- QML-V RHA qualified, SMD
- 5962R0722601VZA

Applications

- For use in programmable precision biasing in telemetry and control system

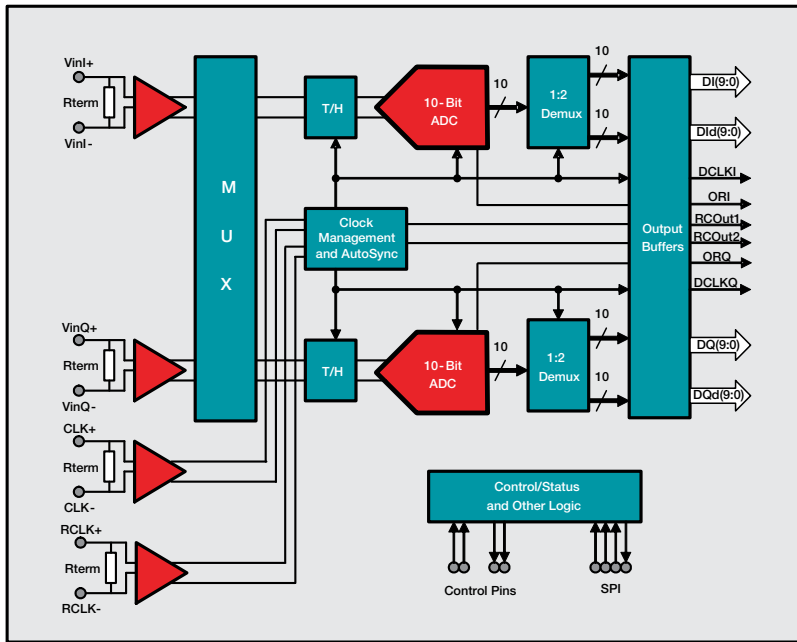
Get more information: www.ti.com/product/DAC121S101QML-SP

Featured Products

Data Converter

High-Performance, Low-Power, Dual Channel, 10-Bit 1 GSPS or Single 10-Bit 2 GSPS ADC

ADC10D1000QML-SP



ADC10D1000QML-SP Block Diagram

Key Features

- Radiation performance
 - TID of 100 kRAD (Si)
 - Single-event latchup-free up to 120 MeV-cm²/mg
- Full power bandwidth of 2.8 GHz
- 9 ENOB with FIN 248 MHz Fs and 1 GHz sample rate
- Single 1.9 V power supply
- Lowest power in the industry at 1.45 W per channel at 1 GSPS
- Low noise 1:2 demuxed LVDS outputs
- Guaranteed no missing codes

Applications

- For use in satellite wideband software-defined radios for communications, radar, and LIDAR

Get more information: www.ti.com/product/ADC10D1000QML-SP

Logic

Quadruple 2-Input Positive-NAND Gates

SN54AC00-SP

The SN54AC00 device contains four independent 2-input NAND gates. Each gate performs the Boolean function of $Y = A \cdot B$ or $Y = A + B$ in positive logic.

INPUTS		OUTPUTS
A	B	Y
H	H	Y
L	X	H
X	L	H

LOGIC DIAGRAM (POSTITIVE LOGIC)



SN54AC00-SP-SP Block Diagram

Key Features

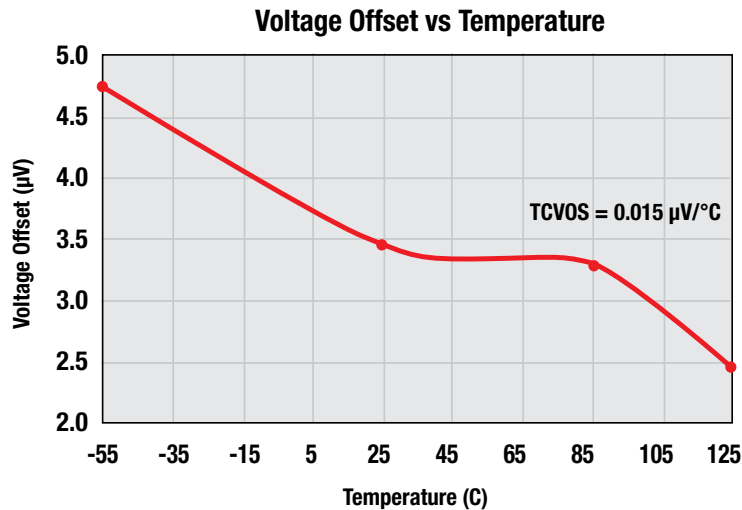
- 5962R87549:
 - Radiation Hardness Assurance (RHA) up to TID 100 krad (Si)
- 5962-87549:
 - Total Ionizing Dose 50 krad (Si)
- 2-V to 6-V VCC Operation
- Inputs Accept Voltages to 6 V
- Max t_{pd} of 7 ns at 5 V

Get more information: www.ti.com/product/SN54AC00-SP

Featured Products

Precision Amplifier

Dual Channel, High-Precision, Rail-to-Rail Output Operational LMP2012QML-SP



Typical application diagram

Key Features

- TID of 50 kRAD (Si)
- ELDRS qualified to 50 kRAD (Si)
- Low SET cross section
- Low supply current of 920 µA
- Very low TCVos of 0.015 µV/°C
- Low input offset voltage of 60 µV over time and temperature
- Low 1/f noise of 35µV/√Hz
- 3-MHz wide gain bandwidth
- 10 pin hermetic gull wing ceramic cerpack package
- QML-V RHA qualified, SMD 5962L0620601VZA

Applications

- Ideal for use in precision measurements in telemetry and control systems, as well as sensing solutions

Get more information: www.ti.com/product/LMP2012QML-SP

Analog Front End

Dual-Channel, 14-Bit, 40 MSPS Analog Front End with LVDS Outputs LM98640QML-SP

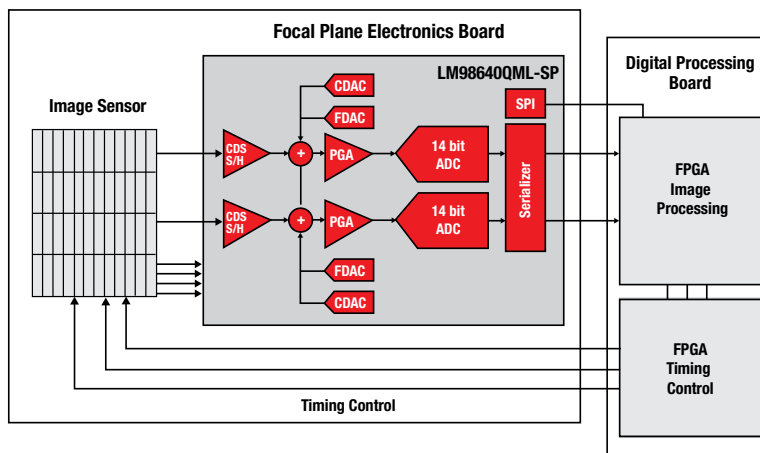


Image sensor functional block diagram

Key Features

- Radiation tolerant up to a total ionizing dose of 100 kRAD (Si)
- Single-event latchup and SEFI-free up to 120 MeV-cm²/mg
- Space-qualified, fully-integrated, high-performance, 14-bit, 5 to 40 MSPS image-processing solution
- Low power 125 mW/channel
- Serialized LVDS outputs and LVDS input clock
- CDS or S/H processing with selectable 0 dB or 6 dB Gain for CCD or CMOS sensors
- Independent programmable gain and offset correction for each channel
- Programmable input clamp voltage
- Programmable sampling edge up to 1/64th period

Applications

- Ideal for use in image processing applications for earth observation, space imaging, and star trackers

Get more information: www.ti.com/product/LM98640QML-SP

Featured Products

Interface

SerDes Interface Transceiver

TLK2711-SP

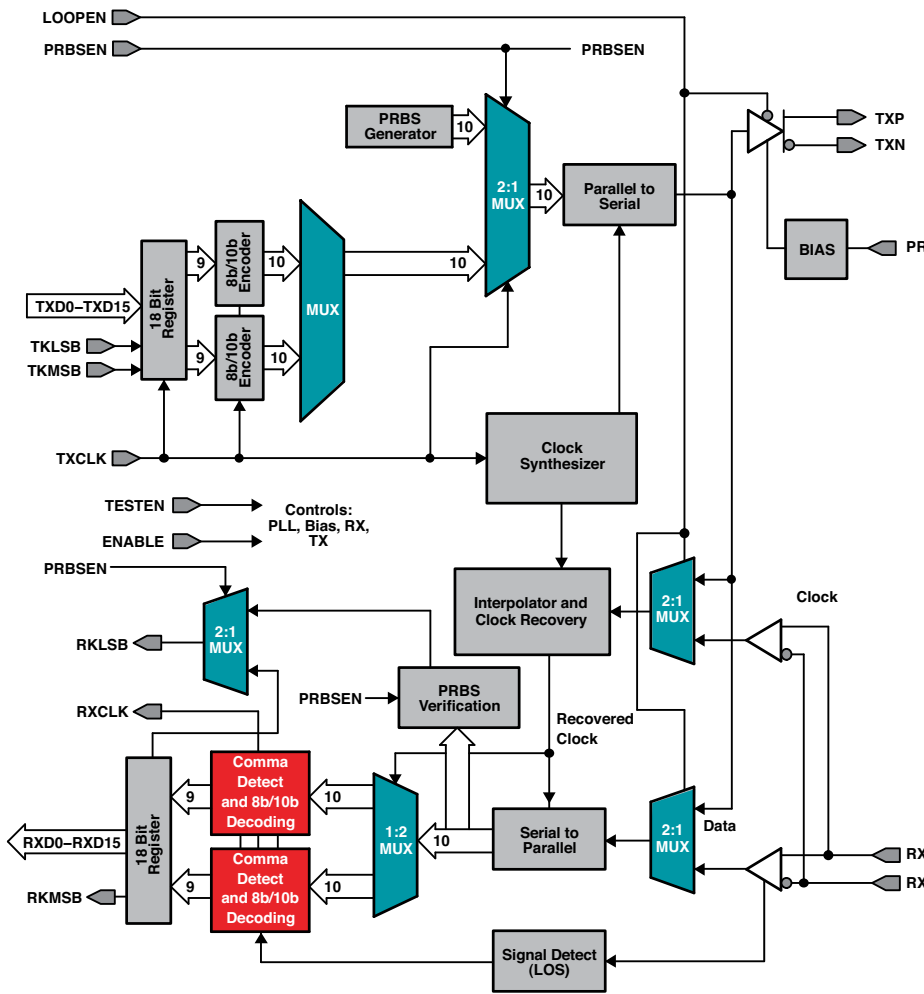
The TLK2711-SP is a member of the WizardLink transceiver family of multi-gigabit transceivers, intended for use in ultra-high-speed, bidirectional, point-to-point data transmission systems. The TLK2711-SP supports an effective serial interface speed of 1.6 Gbps to 2.5 Gbps, providing up to 2 Gbps of data bandwidth. The primary application of this transceiver is to provide very high-speed I/O data channels for point-to-point baseband data transmission over controlled impedance media of approximately 50Ω.

Key Features

- Radiation performance
 - TID = 25 kRAD (Si)
 - SEL immune to 67.9 MeV-cm²/mg
- Hot-plug protection
- High-performance 68-pin ceramic quad flat pack package (HFG)
- Interfaces to PCBs, copper cables or fiber-optic cable
- On-chip PLL provides clock synthesis from low-speed reference
- Receiver differential input thresholds 200-mV minimum
- Low power: < 500 mW
- Ideal for high-speed backplane interconnect and point-to-point data link
- QML-V qualified, SMD
- 5962-0522101VXC

Applications

- Flight critical control systems
- Launch vehicles
- Satellite communications
- Space-based imaging and surveillance



TLK2711-SP functional block diagram

Get more information: www.ti.com/product/TLK2711-SP

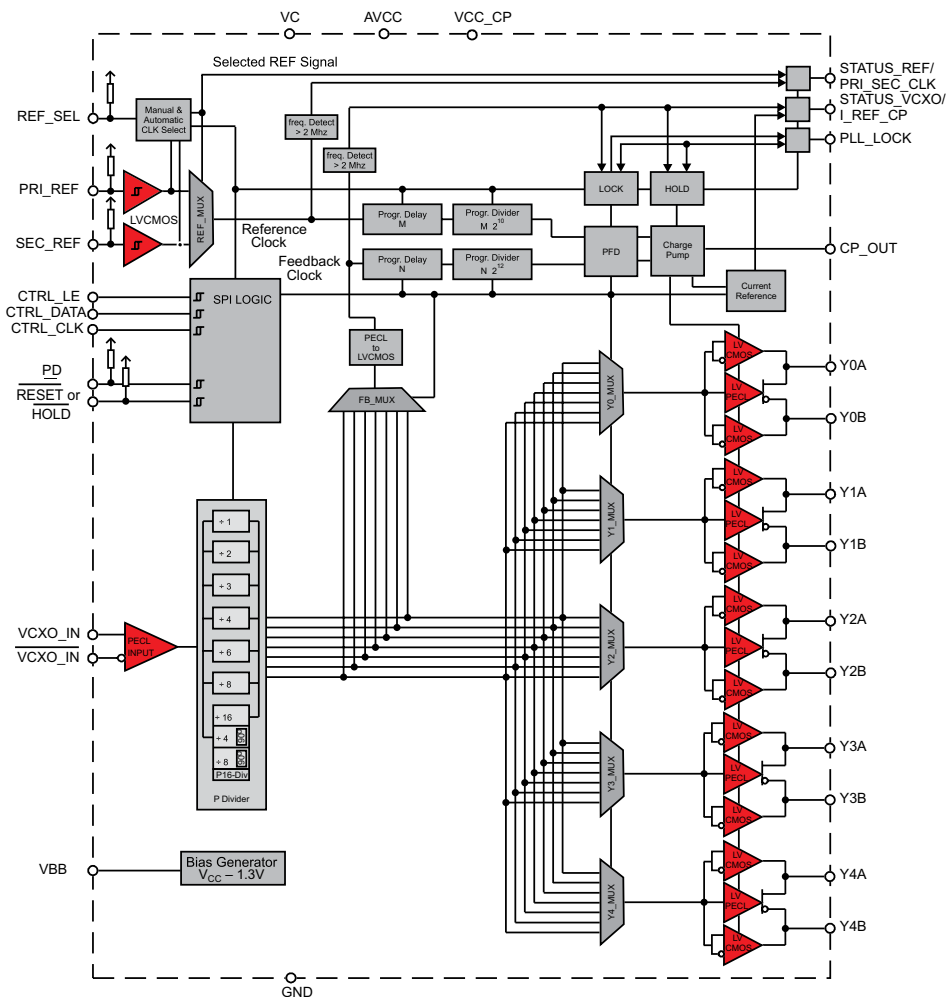
Featured Products

Clocks

Clock Synchronizer/Jitter Cleaner

CDCM7005-SP

The CDCM7005-SP high-performance, low-phase noise and low-skew clock synchronizer synchronizes a voltage-controlled crystal oscillator (VCXO) or voltage-controlled oscillator (VCO) frequency to one of two reference clocks. The CDCM7005-SP can lock to one of two reference clock inputs and supports frequency hold-over mode and fast frequency locking for fail-safe and increased system redundancy.



CDCM7005-SP functional block diagram

Key Features

- Radiation performance
 - TID = 50 kRAD (Si)
- Two reference clock inputs (primary and secondary clock) for redundancy support with manual or automatic selection
- Accepts LVCMOS input frequencies up to 200 MHz
- VCXO IN operating frequencies up to 2.2 GHz (LVPECL)
- Up to five differential LVPECL outputs or up to 10 LVCMOS outputs
- Frequency is individually selectable on each output
- SPI-controllable device setting
- 3.3-V power supply
- High-performance 52-pin ceramic quad flat pack (HFG)
- QML-V qualified, SMD 5962-0723001VXC

Applications

- High-speed data acquisition and generation
- MRI: magnetic resonance imaging
- Orbital data acquisition
- Satellite communications
- Software defined radio (SDR)
- Space-based imaging & surveillance
- Spacecraft wireless infrastructure
- Ultrasound system
- X-ray: baggage scanner
- X-ray: medical

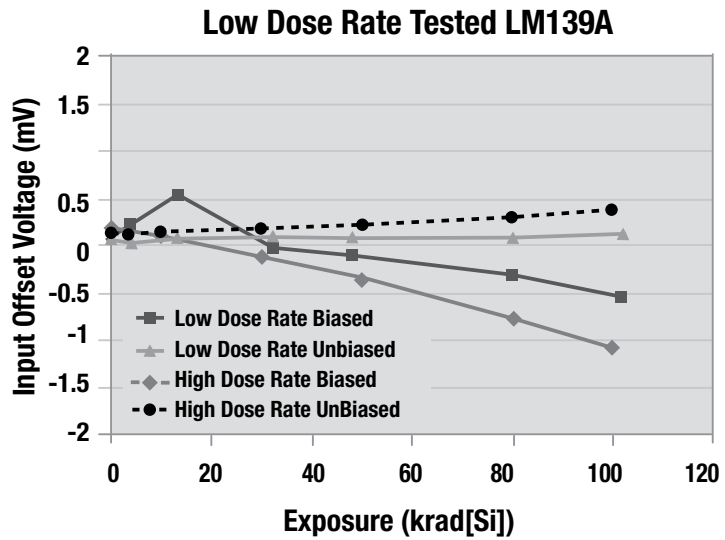
Get more information: www.ti.com/product/CDCM7005-SP

Low Dose Rate Tested Bipolar Analog Products

It has been shown that for many types of integrated circuits, the response to total ionizing dose (TID) radiation is dependent on the dose rate. Many bipolar products have been shown to exhibit enhanced low dose rate sensitivity (ELDRS), where they may pass TID testing at high dose rates, but fail at lower dose rates. TI's bipolar process technology delivers superior radiation performance and no ELDRS.

For low dose rate tested products, every wafer is tested and qualified at high and low dose rates

- Per Mil-Std-883 method 1019 condition D
- Low dose rate of 10 mrad/s (36 rad/hr)
- Biased and unbiased



SMD Ordering for Low Dose Rate Tested Products

Example LM124A SMD Ordering Number

Ordering info: 5 9 6 2 **R** 9 9 5 0 4 0 **2** V X A

Level of radiation exposure

Low dose rate qualified

Selection Tables

Low Dose Rate Tested Products

DLA Unique Low Dose Rate Certified Products

Device	Description	Part Number
Low Dose Rate Tested Product		
LM124AQML-SP ^W	Low-power, quad operational amplifier	5962R9950402VxA
LM139AQML-SP	Low-power, low-offset voltage quad comparator	5962R9673802VxA
LM117QML-SP	3-terminal adjustable regulator	5962R9951705VxA
LM136-2.5QML-SP	2.5 V reference diode	5962R0050102VxA
LM185-1.2QML-SP	Micropower voltage reference diode	5962R8759461VxA
LM193QML-SP	Low-power, low-offset voltage, dual comparator	5962R9452603VxA
LM111QML-SP	Voltage comparator	5962R0052402VxA
LM158QML-SP	Low-power, dual operational amplifier	5962R8771003VxA
LM119QML-SP	High-speed, dual comparator	5962R9679802VxA
LM2941QML-SP	1A, low-dropout adjustable regulator	5962R9166702VxA
LM185QML-SP	Adjustable micropower voltage reference	5962R8759461VYA
LM2940QML-SP	1A, low dropout regulator	5962R8958704VxA
LMP2012QML-SP	Dual, high precision, rail-to-rail output op amp	5962L0620602VxA
LM7171QML-SP ^{E, W}	High-speed, high-output voltage feedback amp	5962F9553602VxA
LMH6702QML-SP	1.7 GHz, ultra-low-distortion, wideband op amp	5962F0254502VxA
LF411QML-SP	Low-offset, low-drift JFET input op amp	5962R1122201VZA
Low-Dose Rate Qualified Products		
LM117HVQML-SP	3-terminal adjustable regulator	5962R0722961VxA
LM4050QML-SP	Precision micropower shunt voltage reference	5962R0923561VZA

x – Indicates multiple package options available ^E Evaluation board ^W WEBENCH® enabled

Selection Tables

Power Management

DC/DC Converter

Device	Orderable	Description	Radiation Tolerance	I _{out} (A)	V _{IN} (V)	Min V _{out} (V)	Max Duty Cycle (%)	Switching Frequency (kHz)	Packages
TPS50601-SP ^{WPE}	5962R1022101VSC	3-6.3 V, Monolithic 6 A buck converter	100 kRAD (TID) 85MeV (SEL)	6	3 to 6.3	0.8	85	100 to 1000	CFP-20

^E Evaluation board ^P MPR prototype ^W Web Bench

PWM Controllers

Device	Orderable	Description	Radiation Tolerance	V _{IN} (min) (V)	V _{IN} (max) (V)	Duty Cycle (Max)(%)	PWM Outputs (#)	Packages
UC1825-SP	5962-8768104VEA/V2A	High-speed PWM controller	40 kRAD	8.4	22	50	2	CDIP-16-, LCCC-20
UC1525B-SP	5962-8951105V2A	Regulating pulse-width modulator	40 kRAD	8	35	50	2	LCCC-20
UC1825A-SP	5962-8768105VEA	High-speed PWM controller	40 kRAD	8.4	30	50	2	CDIP-16
UC1843-SP	5962-8670410VPA/V9A	Current-mode PWM controller	40 kRAD	7.6	30	100	1	CDIP-8, KGD
UC1843A-SP	5962-8670409VPA	Current-mode PWM controller	40 kRAD	7.6	30	100	1	CDIP-8
UC1846-SP	5962-8680603VEA/ V2A/VFA	Current-mode PWM controller	40 kRAD	7	40	50	2	CDIP-16, LCCC-20 CFP-16
UC1875-SP	5962-9455502VKA/VFA	Phase-shift resonant controller	50 kRAD	9.25	20	100	4	CFP-20, CDIP-20
UCC1805-SP	5962-9451305VPA	Low-power BiCMOS current-mode PWM	—	3.6	12	50	1	CDIP-8
UCC1806-SP	5962-9457501VEA/V2A	Low-power, dual-output, current-mode PWM controller	—	6.75	15	50	2	CDIP-16, LCCC-20
UC1823A-SP	5962-8990502VEA/V2A	High-speed PWM controller	—	8.4	22	100	1	CDIP-16, LCCC-20
UC1842-SP	5962-8670401VPA/VXA	Current-mode PWM controller	—	10	30	100	1	CDIP-8, LCCC-20
UC1842A-SP	5962-8670405VPA/VXA	Current-mode PWM controller	—	10	30	100	1	CDIP-8, LCCC-20
UC1844-SP	5962-8670403VPA/VXA	Current-mode PWM controller	—	10	30	50	1	CDIP-8, LCCC-20
UC1844A-SP	5962-8670407VPA/VXA	Current-mode PWM controller	—	10	30	50	1	CDIP-8, LCCC-20
UC1845-SP	5962-8670404VPA/VXA	Current-mode PWM controller	—	7.6	30	50	1	CDIP-8, LCCC-20
UC1845A-SP	5962-8670408VPA/VXA	Current-mode PWM controller	—	7.6	30	50	1	CDIP-8, LCCC-20
UC1856-SP	5962-9453001VXC/VEA	Current-Mode PWM Controller	—	—	40	50	2	CDIP (16) CFP(16)
UC1863-SP	5962-9203103VEA/V2A	Resonant-mode power-supply controller	—	7	22	50	2	CDIP-16, LCCC-20

Power Drivers

Device	Orderable	Description	Radiation Tolerance	V _{IN} (min) (V)	V _{IN} (max) (V)	Duty Cycle (Max)(%)	PWM Outputs (#)	Packages
UC1707-SP	5962-8761903VEA	Complementary high-speed power driver	50 kRAD	1.5	5	40	2	CDIP-16
UC1705-SP	5962-9579801VPA	Complementary high-speed power driver w/ internal regulator	—	1.5	5	40	1	CDIP-8
UC1708-SP	5962-0051401VEA/V2A	Non-inverting high-speed power driver	—	3	5	35	2	CDIP-16, LCCC-20
UC1709-SP	5962-0151201VPA	Inverting high-speed MOSFET driver	—	1.5	5	40	2	CDIP-8
UC1710-SP	5962-0152001VPA	Complementary high-current MOSFET driver	—	6	4.7	18	1	CDIP-8
UC1715-SP	5962-0052102VFA	Complementary switch FET drivers	50 kRAD	7	20	40	2	CFP-16

Feedback Signal Generator

Device	Orderable	Description	Radiation Tolerance	Operating Supply Current (mA)	V _{IN} (min) (V)	V _{IN} (max) (V)	Reference Voltage (V)	Tolerance (%)	Package
UC1901-SP	5962-8944101VCA	Isolated feedback generator	—	5	4.5	40	1.5	1	CDIP-14

LDO Controllers

Device	Orderable	Description	Radiation Tolerance	I _{drive} (Max) (mA)	V _O (min) (V)	V _{IN} (max) (V)	Packages
UC1832-SP	5962-9326501VCA/V2A	Precision low-dropout linear controller	—	100	2	40	CDIP-14, LCCC-20
UC1834-SP	5962-8774201VEA/V2A	High-efficiency linear regulator	—	200	1.5	40	CDIP-16, LCCC-20

Selection Tables

Power Management

Analog Controller

Device	Orderable	Description	Radiation Tolerance	Supply Voltage (Max)	Transconductance Amp BW (MHz)	V _{REF} min (V)	V _{ref} Max (V)	Package
UC19432-SP	5962-0923301VPA	Precision analog controller	40 kRAD	24 V	1.5	1.295	1.305	CDIP-8

Motor Driver

Device	Orderable	Description	Radiation Tolerance	Voltage Supply Min (V)	Voltage Supply Max (V)	Operating Supply Current (mA)	Peak Output Current (A)	Package
UC1637-SP	5962-8995701VSA	Switched-mode controller for DC motor drive	40 kRAD	5	35	8.5	0.4	CFP-20
UC1625-SP	5962-9168902VYA	Space-rated brushless DC motor controller	40 kRAD	10	18	14.5	—	CDIP-28

Voltage References

Device	Orderable	Description	Radiation Tolerance	Initial Accuracy (%)	Reference Voltage (V)	Output Current (mA)	Operating Current	Tempco Max (ppm)	Packaging
LM4050QML-SP	5962R0923561VZA	Precision micropower shunt voltage reference	100 kRAD, low-dose rate qualified	0.1	2.5	15	60 µA	17	CSOIC-10
LM4050QML-SP	5962R0923562VZA	Precision micropower shunt voltage reference	100 kRAD, low-dose rate qualified	0.1	5.0	15	60 µA	50	CSOIC-10
LM4050QML-SP	—	Precision micropower shunt voltage reference	100 kRAD, low-dose rate qualified	0.1	1.2	15	60 µA	20	CSOIC-10
LM113-1QML-SP	5962-9684302VxA	Precision reference	—	2.0	1.22	20	0.5 mA	100	T0-46, CSOIC-10
LM136-2.5QML-SP	5962R0050101VxA	2.5 V reference diode	100 kRAD	2.5	1.2	10	1 mA	20	T046-3
LM136-2.5QML-SP	5962R0050102VxA	2.5 V reference diode	100 kRAD, Low dose rate tested	2.5	2.5	10	1 mA	20	T046-3
LM185-1.2QML-SP	5962R8759461VxA	Micropower voltage reference diode	—	1.0	1.235	20	0.01 mA	150	T046-2, CSOIC-10
TL1431-SP	5962R9962001VxA	Precision-adjustable (programmable) shunt reference	100 kRAD	0.4	2.5	20	1 mA	—	CDIP-8 CFP-10

x – Indicates multiple package options available

In Qualification.

Voltage Regulators

Device	Orderable	Description	Radiation Tolerance	Output Current (mA)	Output Min (V)	Input Min (V)	Input Max (V)	Quiescent Current (mA)	Packaging
LM723QML-SP	JM38510/10201SxA	Voltage regulator	N/A	150	2.0	9.5	40	—	CDIP, -14 TO-100-10
LM117QML-SP	5962R9951703VxA	3-terminal adjustable regulator	100 kRAD	500	1.2	4.2	40	5.0	T039-3
LM117QML-SP	5962R9951705VxA	3-terminal adjustable regulator	100 kRAD, Low dose rate tested	500	1.2	4.2	40	5.0	T039-3
LM117QML-SP	5962R9951706VZA	3-terminal adjustable regulator	100 kRAD	500	1.2	4.2	40	5.0	CSOIC-16
LM117QML-SP	5962R9951707VZA	3-terminal adjustable regulator	100 kRAD, Low dose rate tested	500	1.2	4.2	40	5.0	CSOIC-16
LM117HVHQL-SP	5962R0722901VXA	3-terminal adjustable regulator	100 kRAD	1500	1.2	4.2	40	5.0	T039-3
LM117HVHQL-SP	5962R0722961VXA	3-terminal adjustable regulator	100 kRAD, low-dose rate qualified	1500	1.2	4.2	40	5.0	T039-3
LM117HVHQL-SP	5962R0722902VZA	3-terminal adjustable regulator	100 kRAD	1500	1.2	4.2	40	5.0	CSOIC-16

Note: All parts have adjustable output x – Indicates multiple package options available

Selection Tables

Power Management

Voltage Regulators (continued)

Device	Orderable	Description	Radiation Tolerance	Output Current (mA)	Output Min (V)	Input Min (V)	Input Max (V)	Quiescent Current (mA)	Packaging
LM117HVHQL-SP	5962R0722962VZA	3-terminal adjustable regulator	100 kRAD, low-dose rate qualified	500	1.2	4.2	60	5.0	CSOIC-16
LM117KQML-SP	5962R9951704VYA	3-terminal adjustable regulator	100 kRAD	1500	1.2	4.2	40	5.0	T0-3
LM137QML-SP	5962P9951701VXA	3-terminal adjustable regulator	30 kRAD	1500	-37	-40	-4.2	—	T039-3
LM137JAN-SP	JM38510/11803SXA/11803SYA	3-terminal adjustable regulator	30 kRAD	1500	1.2	-40	-4.2	—	T0-2
LM140JAN-SP	JM38510/10706SYA	Serial 3-terminal positive regulator	N/A	1000	5.0	7.2	35	7.0	T03-2

Low Dropout Voltage Regulators (LDO)

Device	Orderable	Description	Radiation Tolerance	Output Current (mA)	Output Min (V)	Input Min (V)	Input Max (V)	Quiescent Current (mA)	Packaging
LM2940QML-SP	5962R8958704VXA	1 A low dropout regulator	100 kRAD, low-dose rate tested	1000	5.0	—	26	10	CSOIC-16
LP2953QML-SP	5962-9233602VXA	Adjustable micropower low dropout regulator	N/A	250	1.23	-20	30	0.13	CSOIC-16
TPS7H1101-SP ^{WPE}	5962R1320201VCX	Wide V _{IN} , very low dropout regulator	100 kRAD	3000	0.8	1.5	7.0	7.0	CFP-16
TPS7A4501-SP ^{EP}	5962-12224	Low Noise, fast transient response adjustable Low-Dropout Voltage Regulator	100 kRAD	750	1.2	2.3	20	1	OXCEPT CFP-10
LM2941QML-SP	5962-9166703ZYA	1 A adjustable regulator	100 kRAD	1000	—	-15	26	1	ZFP-16

Note: All parts have adjustable output x – Indicates multiple package options available

Amplifiers and Linear

Comparators

Device	Orderable	Description	Radiation Tolerance	Response Time (µs)	Chs	Supply Voltage Range (V)	Offset Voltage (mV)	Output Current (mA)	Packaging
LM111QML-SP	5962L0052401VXA	Voltage comparator	50 kRAD	0.2, 0.1	1	5.0 to 36	3.0	50	CERDIP-8, CFP-10, CSOIC-10, TO99-8
LM111QML-SP	5962R0052402VXA	Voltage comparator	100 kRAD, low-dose rate tested	0.2, 0.1	1	5.0 to 36	3.0	50	CERDIP-8, CFP-10, CSOIC-10, TO99-8
LM119QML-SP	5962R9679801VXA	High-speed, dual comparator	100 kRAD	0.05, 0.08	2	5.0 to 36	4.0	25	CERDIP-14, CFP-10, CSOIC-10, TO100-10
LM119QML-SP	5962R9679802VXA	High-speed, dual comparator	100 kRAD, low-dose rate tested	0.05, 0.08	2	5.0 to 36	4.0	25	CERDIP-14, CFP-10, CSOIC-10, TO100-10
LM119QML-SP	5962-9679801VXA	High-speed, dual comparator	100 kRAD	0.05, 0.08	2	5.0 to 36	4.0	25	CERDIP-14, CFP-10, TO100-10
LM139QML-SP	5962R9673801VXA	Low-power, low-offset voltage quad comparator	100 kRAD	0.5	4	2.0 to 36	2.0	16	CERDIP-14, CFP-14, CSOIC-14
LM139QML-SP	5962R9673802VXA	Low-power, low-offset voltage quad comparator	100 kRAD, low-dose rate tested	0.5	4	2.0 to 36	2.0	16	CERDIP-14, CFP-14, CSOIC-14
LM139QML-SP	5962-9673801VXA	Low-power, low-offset voltage quad comparator	—	0.5	4	2.0 to 36	2.0	16	CFP-14, CSOIC-14
LM193QML-SP	5962R9452602VXA	Low-power, low-offset voltage quad comparator	100 kRAD	0.4	2	2.0 to 36	2.0	16	CERDIP-8, TO-99-8
LM193QML-SP	5962R9452603VXA	Low-power, low-offset voltage quad comparator	100 kRAD low-dose rate tested	0.4	2	3.0 to 36	2.0	16	CERDIP-8, TO-99-8
LM193QML-SP	5962-9452602VPA	Low-power, low-offset voltage quad comparator	—	0.4	2	3.0 to 36	2.0	16	CERDIP-8
LM139-SP	5962-9673802VXA	Quad differential comparator	50 kRAD	0.5	4	2.0 to 36	4.0	20	CDIP-14, KGD

x – Indicates multiple package options available. SP is TI, QML is National.

Selection Tables

Amplifiers and Linear

Standard Operational Amplifiers

Device	Orderable	Description	Radiation Tolerance	Gain Bandwidth (MHz)	Channels	Supply Voltage Range (V)	Offset Voltage (mV)	Supply Current (mA)	Packaging
LM148QML-SP	JM38510/11001SCA	Series quad 741 op amp	—	0.9	4	10 to 44	5.0	0.6	CERDIP-14
LF411QML-SP	5962R1122201VZA	Low-offset, low-drift JFET input op amp	100 kRAD, Low dose rate tested	4.0	1	10 to 36, 44	2.0	1.8	Ceramic SOIC-10, KGD
LM101AQML-SP	5962L9951501VXA	Op amp	50 kRAD,	1.0	1	10 to 44	2.0	1.8	CERDIP-8, CFP-10, T099-8
LM124QML-SP	5962R9950401VXA	Low-power op amp	100 kRAD	1.0	4	3.0 to 32	2.0	0.18	CFP-14, CSOIC-14, CERDIP-14
LM124QML-SP	5962R9950402VXA	Low-power op amp	100 kRAD, Low dose rate tested	1.0	4	3.0 to 32	2.0	1.8	CFP-14, CSOIC-14, CERDIP-14
LM124-SP	5962-9950403VXA	Quad op-amp	40 kRAD	1.2	4	3.0 to 32	1.0	0.8	CSOIC-14, KGD
LM158QML-SP	5962R8771002VXA	Low-power, dual op amp	100 kRAD	1.0	2	3.0 to 32	2.0	0.25	CFP-8, CSOIC-10, T099-8
LM158QML-SP	5962R8771003VXA	Low-power, dual op amp	100 kRAD, Low dose rate tested	1.0	2	3.0 to 32	2.0	0.25	CFP-8, CSOIC-10, T099-8

x – Indicates multiple package options available

Precision Operational Amplifiers

Device	Orderable	Radiation Tolerance	TCVos ($\mu\text{V}/^\circ\text{C}$)	CMRR (dB)	PSRR (dB)	Voltage Noise ($\text{nV}/\sqrt{\text{Hz}}$)	Channels	Supply Current per Channel (mA)	Packaging
LMP2012QML-SP	5962L0620601VZA	50 kRAD	0.015	90	90	35	2	0.919	CSOIC-10
LMP2012QML-SP	5962L0620602VZA	50 kRAD, Low dose rate tested	0.015	90	90	35	2	0.919	CSOIC-10

High Speed Operational Amplifiers

Device	Orderable	Description	Radiation Tolerance	-3 dB BW (MHz)	Supply Voltage Range (V)	Supply Current (mA)	Channels	Offset Voltage (mV)	Packaging
LM6172QML-SP	5962F9560402VXA	Dual, high-speed, low-power, low-distortion voltage feedback op amp	300 kRAD	160	5.5 to 36	2.3	2	1.5, 3	CDIP-8, CSOIC-16
LM6172QML-SP	5962R9560403VXA	Dual, high-speed, low-power, low-distortion voltage feedback op amp	100 kRAD, Low dose rate tested	160	5.5 to 36	2.3	2	1.5, 3	CDIP-8, CSOIC-16
LM7171QML-SP	5962F9553601VXA	Very high-speed, high-output current voltage feedback op amp	300 kRAD	220	5.5 to 36	6.5	1	1.0	CDIP-8, CFP-10, CSOIC-10
LM7171QML-SP	5962F9553602VXA	Very high-speed, high-output current voltage feedback op amp	300 kRAD, Low dose rate tested	220	5.5 to 36	6.5	1	1.0	CDIP-8, CFP-10, CSOIC-10
LMH6628QML-SP	5962F0254501VXA	Dual, wideband, low-noise voltage feedback op amp	300 kRAD	300	5.0 to 12	9.0	2	2.0	CERDIP-8, CSOIC-10
LMH6702QML-SP	5962F0254601VXA	1.7 GHz, ultra-low-distortion, wideband op amp	300 kRAD	1700	10 to 12	12.5	1	4.5	CERDIP-8, CSOIC-10
LMH6702QML-SP	5962F0254602VXA	1.7 GHz, ultra-low-distortion, wideband op amp	300 kRAD, Low dose rate tested	1700	10 to 12	12.5	1	4.5	CERDIP-8, CSOIC-10
LMH6715QML-SP	5962F0254701VPA	Dual, wideband video op amp	300 kRAD	480	10 to 12	5.8	2	6.0	CERDIP-8
THS4511-SP	5962-0722201VFA	Wideband, fully differential amplifier, 100 MHz, 1 ch	150 kRAD	110	5	39.2	1	4, 5.5	CFP-16
THS4513-SP	5962-0722301VFA	Wideband, fully differential amplifier, 100 MHz, 1 ch	150 kRAD	110	5	39.2	1	4, 5.5	CFP-16
THS4304-SP	5962-0721901VHA	1GHz wideband low noise, 1 channel	150 kRAD	110	6	18.0	1	1.0	CFP-10

x – Indicates multiple package options available

Selection Tables

Data Converters

Analog to Digital Converter (High Speed)

Device	Orderable	Radiation Tolerance	Sampling Rate	Power/Channel (W)	Input Bandwidth (GHz)	ENOB (bits)	SNR (dB)	SFDR (dB)	Packaging
ADC10D1000QML-SP ^E	ADC10D1000CCMLS	100 kRAD	1.0 GSPS	1.45	2.8	9.0	55.6	66.7	CCGA-376
ADC08D1520QML-SP ^E	5962F0721401VZC	300 kRAD	1.5 GSPS	1.0	2.0	7.4	47	55.5	CQFP-128
ADC14155QML-SP ^E	ADC14155W-MLS	100 kRAD	155 MSPS	0.967	1.1	11.3	70.1	82.3	CQFP-48
ADS5400-SP ^E	ADS5400MHFSV, 5962-0924001VXC	50 kRAD	1.0 GSPS	1.0	2.1	9.2	58	70	CQFP-100
ADS5424-SP	5962-0720601VXC	100 kRAD	105 MSPS	2.0	0.570	11.5	64	65.4	CFP-52
ADS5444-SP ^E	5962-0720701VXC	100 kRAD	250 MSPS	2.0	0.8	11.3	6.5	60.5	CFP-84
ADS5463-SP ^E	5962R0720802VXC, 5962-0720801VXC	100 kRAD	500 MSPS	1.0	2.0	9.0	62.2	51.6	CFP-84
ADS5474-SP	5962R1320801VXC	100 kRAD	400 MSPS	2.5	1.4	10.2	69.8	80	CFP-84
ADC12D1600QML-SP ^E	ADC12D1600CCMLS	300 kRAD	3.2 GSPS	1.9	2.8	8.9	56.6	61.5	CPGA-376

^E Evaluation board ^P MPR prototype

Analog to Digital Converter (Precision Micropower)

Device	Orderable	Radiation Tolerance	Sampling Rate	Operating Power (mW)	Power Down (μ W)	Interface Type	Supply Voltage Range (V)	Packaging
ADC128S102QML-SP ^E	5962R0722701VZA	100 kRAD	50 kSPS to 1 MSPS	2.3	0.25	Serial	2.7 to 5.25	CSOIC-16

^E Evaluation board

Digital to Analog Converter (Precision Micropower)

Device	Orderable	Radiation Tolerance	Resolution (Bits)	Operating Power (mW)	Power Down (μ W)	Interface Type	INL (LSB)	Packaging
DAC121S101QML-SP ^E	5962R0722601VZA	100 kRAD	12	0.64	0.14	Serial	± 2.75	CSOIC-10

^E Evaluation board

Digital-to-Analog Converters (High Speed)

Device	Orderable	Description	Radiation Tolerance	Sample/Update Rate (MSPS)	Settling Time (μ s)	SNR (dB)	SFDR (dB)	DNL LSB	INL LSB	Supply Voltage (V)	Power (mW)	Packages
DAC5670-SP	5962-0724701VXA	14-bit, 2.4-GSPS DAC with two DAC channels	100 kRAD	2400	0.0035	60	55	1.75	7.5	3.0, 3.6	2000	CBGA-192
DAC5675A-SP ^P	5962-0720401VXC	14-bit, 400-MSPS DAC with one DAC channels	150 kRAD	400	0.012	67	82	2.5	4.6	3.15, 3.6	660	CFP-52

^P MPR prototype

Analog Front End (Imaging Systems)

Device	Orderable	Radiation Tolerance	Resolution	Sample Rate	PGA Range	Offset DAC Range (Fine)	Power	Packaging
LM98640QML-SP ^E	LM98640W-MLS	100 kRAD	14	5 MHz to 40 MHz	-3 dB to 18 dB	± 5 mV	± 122 mW/ch	CQFP-68

Monolithic Sample and Hold Circuits

Device	Orderable	Radiation Tolerance	Positive Supply Current (mA)	Negative Supply Current (mV)	Input Offset Voltage (mV)	Input Bias Current (nA)	Acquisition Time (μ s)	Leakage (pA)	Packaging
LF198QML-SP	JM38510/12501SGA	—	6.5	-6.5	5.0	75	10	<100	T099-8
LF198QML-SP	5962-8760801VZA	—	6.5	-6.5	5.0	75	10	<100	Ceramic SOIC-10

Selection Tables

Interface

General Purpose

Device	Orderable	Description	Radiation Tolerance	V _{cc} (V)	I _{cc} (mA)	ESD HBM (kV)	Packages
SN55182-SP	5962-7900801VXA	Dual differential line receiver	40 kRAD	5	10	2	CDIP-14, CFP
SN55183-SP	5962-7900901VCA	Dual differential line driver	40 kRAD	5	18	2	CDIP-14

LVDS

Device	Orderable	Description	Radiation Tolerance	V _{cc} (V)	I _{cc} (mA)	ESD HBM (kV)	Packages
DS90C031QML-SP	5962R9583301VXA	Quad CMOS differential line driver	100 kRAD	5	25	3.5	CSOIC-16, CFP-16
DS90C031QML-SP	5962-9583301VFA	Quad CMOS differential line driver	—	5	25	3.5	CFP-16
DS90C032QML-SP	5962L9583401VXA	Quad CMOS differential line receiver	50 kRAD	5	11	2	CSOIC-16, CFP-16
DS90C032QML-SP	5962-9583401VFA	Quad CMOS differential line receiver	—	5	11	2	CFP-16
DS90LV031QML-SP	DS90LV031AW-MLS	3V quad CMOS differential line driver	—	3.3	30	6	CFP-16
DS90LV032QML-SP	DS90LV032AW-MLS	3V quad CMOS differential line receiver	—	3.3	15	4.5	CFP-16
SN55LVDS31-SP	5962-9762101VFA	Quad LVDS transmitter	100 kRAD	-0.5 to 4	35	8	CFP-16
SN55LVDS32-SP	5962-9762201VFA	Quad LVDS receiver	100 kRAD	-0.5 to 4	18	8	CFP-16
SN55LVDS33-SP	5962-0724801VFA	High-speed differential receiver	50 kRAD	-0.5 to 4	25	15	CFP-16

SERDES

Device	Orderable	Description	Radiation Tolerance	V _{cc} (V)	I _{cc} (mA)	ESD HBM (kV)	Packages
TLK2711-SP ^{PE}	5962-0522101VXC	1.6- to 2.5-Gbps, low power serializer/deserializer	25 kRAD	2.5	160	2	CQFP-68

^E Evaluation board ^P MPR prototype

RS-422 and RS-485

Device	Orderable	Description	Radiation Tolerance	Packaging
AM26LS33A-SP	5962-7802007VEA	RS422 quad differential line driver	25 kRAD	CDIP-16
DS16F95QML-SP	5962F8961501VHA	EIA/485/EIA-422A differential bus transceiver	300 kRAD	Cerpack-10
DS26F31MQML-SP	5962F7802302VFA	Quad high speed differential line driver	300 kRAD	Cerpack-16
DS26F32MQML-SP	5962R7802005VEA	Quad high speed differential line receiver	100 kRAD	Cerdip-16
DS26LS31MQML-SP	5962-7802301VEA	Quad high speed differential line driver	—	Cerdip-16
DS96F174M	5962-9076502VEA	RS-485/RS-422 quad differential driver	—	Cerdip-16
DS96F175M	5962-9076601VEA	RS-485/RS-422 quad differential receiver	—	Cerdip-16

CAN

Device	Orderable	Description	Radiation Tolerance	I/O & Supply voltage	Supply Current	Packages
SN65HVD233-SP	—	3.3 V CAN Transceiver	50kRAD	3.3V	TBD	CFP-10

In Qualification.

Clocks/Buffers

Device	Orderable	Description	Radiation Tolerance	Input level	Output Frequency (Max) (Mhz)	Output Level	V _{cc} (V)	No. of Outputs	Package
CDCM7005-SP ^{PE}	5962-0723001VXC	3.3-V, clock synchronizer and jitter cleaner	50 kRAD	LVC MOS, LVPECL	2000	LVPECL, LVC MOS	3.3	5	QCQP-52
SE555-SP	5962-98555 VPA	Precision timer monostable oscillator	25 kRAD	—	—	TTL	4.5 V - 16.5	1	CDIP-8

^E Evaluation board ^P MPR prototype

Selection Tables

Memory

Device	Orderable	Description	Radiation Tolerance	Technology	V _{dd} (V) Core/I/O	I _{dd1} SB (mA)	Packages
SMV512K32-SP	5962-1123701VXC	16 MB (512k x 32) Radiation-hardened SRAM	>300 kRAD	CMOS	3.3/1.8	0.375	76p CFP

Logic

Device	Orderable	Description	Radiation Tolerance	V _{cc} /V _{dd} (V)	I _{cc} (mA)	Packages
SN54AC14-SP	5962-8762402VDA/VCA	Hex inverter Schmitt Trigger	50 kRAD	2 to 6	0.05	CDIP-14 CFP
SN54AC02-SP	5962-8761203VDA	Quadruple 2-input positive-NOR gates	50 kRAD	2 to 6	0.05	CDIP-14 CFP
SN54AC00-SP	5962-8754903VDA/VCA	Quadruple 2-input positive-NAND gates	50 kRAD	2 to 6	0.05	CDIP-14 CFP
SN54AC00-SP	5962R8754903VDA/VCA	RHA Quadruple 2-input positive-NAND gates	100 kRAD	2 to 6	0.05	CDIP-14 CFP
SN54AC373-SP	5962R875550xVXA	Octal D-type transparent latches with 3-state outputs	100 kRAD	2 to 6	0.05	CDIP-14 CFP
54HC244-SP	5962-8409601VRA/VSA	Octal buffer and line driver with 3-state outputs	—	2 to 6	0.08	CDIP-20 CFP
54HC273-SP	5962-8409901VRA/VSA	Octal D-type flip-flop	—	2 to 6	0.08	CDIP-20 CFP
54HCT244-SP	5962-8513001VRA/VSA	Octal buffer and line driver with 3-state outputs	—	5	0.08	CDIP-20 CFP
54LVTH244A-SP	5962-9584401V2A/VRA/VSA	3.3-V ABT 16-bit octal buffer/driver with 3-state outputs	—	2.7 to 3.6	0.19	LCCC-20 CDIP CFP
54LVTH162245-SP	5962-9678001VXA	3.3-V ABT 16-bit bus transceiver with 3-state outputs	—	2.7 to 3.6	0.19	CFP-48
54LVTH162373-SP	5962-9763801VXA	3.3-V ABT 16-bit transparent D-type latch with 3-state outputs	—	2.7 to 3.6	0.19	CFP-48
54LVTH162244-SP	5962-9680901VXA	3.3-V ABT 16-bit buffer/driver with 3-state outputs	—	2.7 to 3.6	0.19	CFP-48
54LVTH16244A-SP	5962-9668501VXA	3.3-V ABT 16-bit buffer/driver with 3-state outputs	—	2.7 to 3.6	0.19	CFP-48
54ALS244-SP	5962-8683901VRA/VSA	Octal buffer and line driver with 3-state outputs	—	5	27	CDIP-20 CFP

Digital Signal Processor

Device	Orderable	Description	Radiation Tolerance	MFLOPS	Core Supply (V)	I/O Supply (V)	Timers	Packages
SMJ320C6701-SP	5962-9866102V VXA/VYC	140 MHz Floating-point digital signal processor	100 kRAD	1000	1.9	3.3	(2) 32-bit	CFCBGA-429, FCLGA-429
SMV320C6727B-SP ^{PE}	5962R1023101QXC	250 MHz Floating-point digital signal processor	100 kRAD	1500	1.2	3.3	32/64 bit	CQFP-256

In Qualification

Selection Tables

Die Products

Space-Qualified Die Products

A wide range of die products are available to support our customers needs for radiation tolerant applications.

TI offers three categories of bare die screening:

- Tested die (TD): TD is defined as 25C DC probed die that have not undergone any special testing. Also called bare die.
- Known Good Die (KGD): KGD is defined as die that have the same quality and reliability as the equivalent packaged part.

- Commercial wafers
If a product is available as a Space, Radiation Tolerant, or ELDRS level

package part, in most cases an equivalent die is also available. Visit ti.com/die for a current list of available die and wafer products.

Die Products Value Advantage

The implementation rate of die products is rapidly increasing due to form factor needs and system performance improvement requirements. Factors influencing the migration from packaged semiconductor die to wire bond die include:

- Improved integration
- Smaller size and weight
- Reliability
- Improved electrical performance

Radiation-Tolerant Die Products – Cross Referencing DLA-Certified Part Numbers

Low Dose Rate		High Dose Rate		Description
Device	Orderable	Device	Orderable	
LM117H MDE	5962R9951705V9A	LM117H MDR	5962R9951703V9A	3-terminal adjustable regulator
LM117HVH MDE	5962R0722961V9A	LM117HVH MDR	5962R0722901V9A	3-terminal adjustable regulator
LM119 MDE	5962R9679802V9A	LM119 MDR	5962R9679801V9A	High-speed dual comparator
LM124 MDE	5962R9950402V9A	LM124 MDR	5962R9950401V9A	Low-power quad operational amplifier
LM136-2.5 MDE	5962R0050102V9A	LM136-2.5 MDR	5962R0050101V9A	2.5V reference diode
LM139 MDE	5962R9673802V9A	LM139 MDR	5962R9673801V9A	Low-power, low-offset-voltage quad comparator
LM158A MDE	5962R8771003V9A	LM158A MDR	5962R8771002V9A	Low-power, dual operational amplifier
LM193 MDE	5962R9452603V9A	LM193 MDR	5962R9452602V9A	Low-power, low-offset-voltage dual comparator
LMP2012 MDE	5962L0620602V9A	—	—	Precision dual operational amplifier
LM2940-5.0 MDE	5962R8958702V9A	LM2940-5.0 MDR	—	1A fixed LDO
LM2941 MDE	5962R9166702V9A	LM2941 MDR	—	1A adjustable LDO
LM6172-MDE	5962R9560403V9A	LM6172 MDR	5962F9560401V9A	Dual high-speed amp
LMH6715-MDE	—	LMH6715-MDR	5962F0254701V9A	Dual wide-band video
LMP2012 MDE	5962L0620602V9A	LMP2012 MDR	—	Dual precision rail-to-rail
UC1843-SP	5962-8670410V9A	—	—	QML class-V current-mode PWM controller
LM124-SP	5962-9950403V9A	—	—	Quadruple operational amplifier
LM139-SP	5962-9673802V9A	—	—	Quadruple differential amplifier
LM111-MDE	SMD 5962R0052402V9A	—	—	Voltage Comparator

More radiation-tolerant and ELDRS-free products are in development.

Radiation-Tolerant Tested Die for Space

Part Number	Orderable	Description
SN54AC00-DIE	SN54AC00VTD1, SN54AC00VTD2	RadTolerant Class V, Quadruple 2-Input Positive-NAND Gate
SN54AC02-DIE	SN54AC02VTD1, SN54AC02VTD2	Quadruple 2-Input Positive-NOR Gates
SN54HC08-DIE	SN54HC08VTD1, SN54HC08VTD2	Quadruple 2-Input Positive-AND Gates
SN54HC273-DIE	SN54HC273VTDG1, SN54HC273VTDG2	Octal D-type Flip-Flops With Clear
SN54HC373-DIE	SN54HC373VTDG1, SN54HC373VTDG2	Octal Transparent D-Type Latch With 3-State Outputs
TL1431-DIE	TL1431VTD1, TL1431VTD2	Precision Adjustable (Programmable) Shunt Reference
TPS50601-DIE	TPS50601TDC1, TPS50601TDC2	1.6-V to 6.3-V input, 6-A Synchronous Step Down Converter
UC1825A-DIE	UC1825AVTD1, UC1825AVTD2	High Speed PWM Controller
UC1825-DIE	UC1825VTD1, UC1825VTD2	High Speed PWM Controller
UC1843A-DIE	UC1843AVTD1, UC1843AVTD2	Current Mode PWM Controller
UC1846-DIE	UC1846VTD1, UC1846VTD2	Current-Mode PWM Controller

In Qualification

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