

# TI Space Products Guide

Radiation-hardened and radiation-tolerant products  
to help innovate your space designs

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# Space Products Guide

## Overview/table of contents

### TI space products

Our heritage in space applications spans over 60 years, dating as far back as 1958 when the first satellite launched by the U.S., Explorer I, carried aloft radiation detection circuitry using the newly released TI 2N335 silicon-grown junction transistor. From that first satellite, to the first moon landing and first comet landing, to exploring the planets, TI semiconductor devices have been there.

We focus on radiation performance and best-in-class performance products to both our QMLV/QMLP (typically identified by the -SP suffix) and radiation tolerant (identified by the -SEP suffix) portfolios. The breadth of TI's space portfolio provides a full signal-chain solution. The portfolio includes the smallest RHA point-of-load power solutions, fast discrete SerDes and some of the world's highest performance data converters.

TI's Space products include MIL-PRF-38535 QMLV/QMLP, RHA, and radiation tolerant plastic components. These devices are typically supported with Total Ionizing Dose (TID) and Single Event Effects (SEE) test reports to address potential product degradation in a space environment. The test results for these devices are available in the product folder under the Technical documents tab.

### Satellite applications

- Communications payload
- Laser communications payload
- Radar imaging payload
- Optical imaging payload
- Navigation payload
- Scientific exploration payload
- Command & data handling (C&DH)
- Attitude & orbit control system (AOCS)
- Satellite electrical power system (EPS)
- Satellite mechanisms
- Launchers, landers and rovers

### TI space products portfolio

TI offers RHA and radiation-tolerant, hermetically packaged components highlighted in each of the red blocks to the right. TI also offers many of these space grade products in die form (known good die or tested die).

For acronyms specific to space terminology, see the end of this document.

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### Additional resources

- TI space products and applications: [www.ti.com/space](http://www.ti.com/space).
- Radiation-tolerant portfolio: [www.ti.com/SEP](http://www.ti.com/SEP).
- The "Radiation Handbook for Electronics" eBook: [www.ti.com/RadBook](http://www.ti.com/RadBook).

# Space-grade power management

## Featured products

### 4.5 to 14V<sub>IN</sub>, 12A, 6A, & 3A current mode POL DC-DC converter TPS7H4011/12/13-SP & TPS7H4011/12/13-SEP

#### Key features

- Integrated high side and low side power MOSFETs
- $0.6V \pm 0.67\% V_{REF}$  + offset error accuracy over load, line, temperature, and TID
- TPS7H4011-SP/SEP: Configurable high side current limit
- TPS7H4011-SP/SEP: Differential remote sensing capability
- TPS7H4011-SP/SEP: External input FAULT pin for flexible fault management
- Configurable slope compensation and external OTA compensation
- Programmable frequency from 100kHz – 1MHz at 15% accuracy
- Parallel 2 - 4 devices with 90° or 180° phase shifted outputs
- Adjustable soft-start, power good, and enable for sequencing
- QML Class-V: 30-pin CDFP, 7.84mm x 19.28mm
- TPS7H4011-SP: QML Class-P: 44-pin TSSOP, 6.1mm x 14.0mm
- Space EP: 44-pin TSSOP, 6.1mm x 14.0mm

#### Radiation performance

- Rad-hard (RHA) TPS7H4011/12/13-SP:
  - TID characterization to 100krad(Si)
  - SEL immunity to 75MeV-cm<sup>2</sup>/mg at 125°C
- Rad-tolerant TPS7H4011/12/13-SEP:
  - TID characterization to 50krad(Si)
  - SEL immunity to 43MeV-cm<sup>2</sup>/mg at 125°C

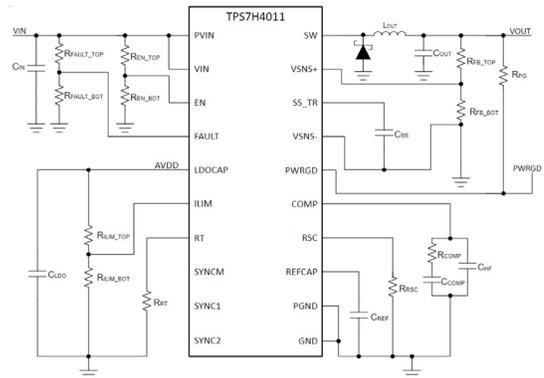
More information at [www.ti.com/product/TPS7H4011-SP](http://www.ti.com/product/TPS7H4011-SP) and at [www.ti.com/product/TPS7H4011-SEP](http://www.ti.com/product/TPS7H4011-SEP) and at [www.ti.com/product/TPS7H4012-SP](http://www.ti.com/product/TPS7H4012-SP) and at [www.ti.com/product/TPS7H4012-SEP](http://www.ti.com/product/TPS7H4012-SEP) and at [www.ti.com/product/TPS7H4013-SP](http://www.ti.com/product/TPS7H4013-SP) and at [www.ti.com/product/TPS7H4013-SEP](http://www.ti.com/product/TPS7H4013-SEP)

#### Applications

- Space satellite point of load supply
- Space satellite payloads

#### Benefits

- Wide input voltage range allows for operation directly from 12V distribution rail
- Programmable current limit
- Differential remote sense allows for voltage drop mitigation



### 2.25V to 14V input, 2A low-dropout (LDO) regulator TPS7H1121-SP/TPS7H1121-SEP

#### Key features

- VIN: 2.25V to 14V & VOUT: 0.6V to 13.5V
- Low dropout: 300mV (typ) @ 1A, 500mV (typ) at 2A
- High accuracy:  $\pm 1.5\%$  across line, load, temperature & TID
- Low Noise: 35 $\mu$ V<sub>RMS</sub>
- QML Class-V: 22-pin CDFP, 6.21mm x 7.69mm
- QML Class-P: 24-pin TSSOP, 4.40mm x 7.80mm
- Space EP: 24-pin TSSOP, 4.40mm x 7.80mm

#### Applications

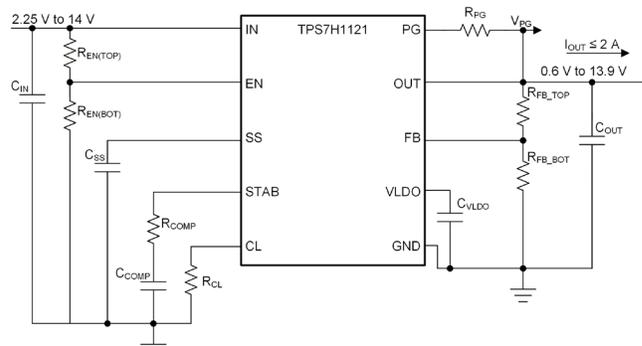
- Space satellite point of load supply
- Space satellite payloads

#### Radiation performance

- Rad-hard (RHA) TPS7H1121-SP:
  - TID: 100krad(Si)
  - SEL immune to 75MeV-cm<sup>2</sup>/mg
- Rad-tolerant TPS7H1121-SEP:
  - TID: 50krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg

#### Benefits

- Programmable current limit
- Configurable soft start, enable and open drain power good
- Access to internal control loop for configurable compensation
- Able to parallel for current sharing and reduced RON
- Low threshold enable compatible with multiple IO standards
- Over current system protection with programmable fault timer



More information at [www.ti.com/product/TPS7H1121-SP](http://www.ti.com/product/TPS7H1121-SP) and at [www.ti.com/product/TPS7H1121-SEP](http://www.ti.com/product/TPS7H1121-SEP)

# Space-grade power management

## Featured products

### Radiation-hardened high-speed dual-output current-mode pulse-width modulation controller TPS7H5001-SP/TPS7H5005-SEP

#### Key features

- 0.6V  $\pm$ 1%  $V_{REF}$  accuracy over load, line, temperature and TID
- Configurable switching frequency from 100kHz to 2MHz.  
External synchronization using SYNC pin
- 5V outputs, 150mA drive,  $R_{OUT} = 15\Omega$
- Synchronous rectification outputs, dead time (PS and SP) and duty cycle limit configurable (leading edge blanking)
- Configurable soft start, EN (UVLO), FAULT (OCP, OVP and OTP) slope compensation and current limit, Hiccup OCP mode
- QML Class-V: 22-pin CDFP, 6.2mm x 7.7mm
- QML Class-P: 24-pin TSSOP, 4.4mm x 7.7mm
- Space EP: 24-pin TSSOP, 4.4mm x 7.7mm

#### Radiation performance

- Rad-hard (RHA) TPS7H5001-SP:
  - TID characterization to 100krad(Si)
  - SEL immunity to 75MeV-cm<sup>2</sup>/mg at 125°C
- Rad-tolerant TPS7H5005-SEP:
  - TID characterization to 50krad(Si)
  - SEL immunity to 43MeV-cm<sup>2</sup>/mg at 125°C

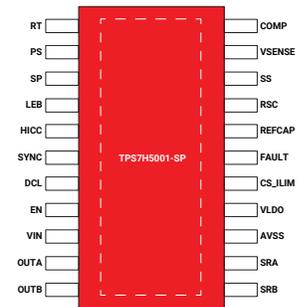
More information at [www.ti.com/product/TPS7H5001-SP](http://www.ti.com/product/TPS7H5001-SP) and at [www.ti.com/product/TPS7H5005-SEP](http://www.ti.com/product/TPS7H5005-SEP)

#### Applications

- Space satellite power management and distribution
- Radiation-hardened and tolerant power tree applications

#### Benefits

- Support for non-isolated (buck, boost) and isolated (flyback, forward, active clamp, push-pull, half/full-bridge) topologies
- External driver allows support of Si MOSFETs and GaN FETs
- High level of features integration minimizes radiation risks and overall solution size
- Synchronous rectification to enable higher efficiency
- During the cross conduction SET testing, zero events were recorded



### Half-bridge GaN FET gate drivers

#### TPS7H6003/13/23-SP, TPS7H6005/15/25-SP & TPS7H6005/15/25-SEP

#### Key features

- TPS7H6003-SP, TPS7H6005-SP/-SEP  $V_{IN} = 200V$
- TPS7H6013-SP, TPS7H6015-SP/-SEP  $V_{IN} = 60V$
- TPS7H6023-SP, TPS7H6025-SP/-SEP  $V_{IN} = 22V$
- $V_{IN} = 10$  to 14V (8.5V UVLO).
- Integrated 5V LDOs for both high-side and low-side GaN FETs
- $f_{SW} \geq 5MHz$ , 1.3A peak source current, 2.5A peak sink current
- 30ns typical propagation delay and 5.5ns typical delay matching
- Split outputs for adjustable turn-on and turn-off times
- Input modes: Independent input mode & PWM input mode
- QML Class-V: 48-pin CDFP, 8.48mm x 16.71mm
- QML Class-P: 56-pin TSSOP, 6.1mm x 14.0mm
- Space EP: 56-pin TSSOP, 6.1mm x 14.0mm

#### Radiation performance

- Rad-hard (RHA) TPS7H6003/13/23-SP and TPS7H6005/15/25-SP:
  - TID characterization to 100krad(Si)
  - SEL immunity to 75MeV-cm<sup>2</sup>/mg at 125°C
- Rad-tolerant TPS7H6005/15/25-SEP:
  - TID characterization to 50krad(Si)
  - SEL immunity to 43MeV-cm<sup>2</sup>/mg at 125°C

More information at [www.ti.com/product/TPS7H6003-SP](http://www.ti.com/product/TPS7H6003-SP)

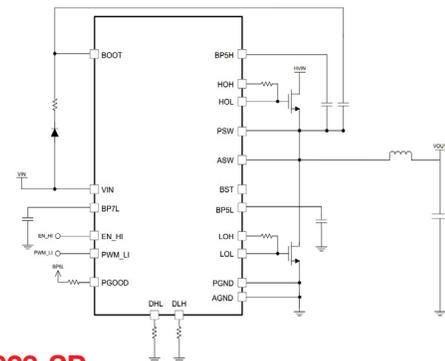
and at [www.ti.com/product/TPS7H6013-SP](http://www.ti.com/product/TPS7H6013-SP) and at [www.ti.com/product/TPS7H6023-SP](http://www.ti.com/product/TPS7H6023-SP) and at [www.ti.com/product/TPS7H6005-SP](http://www.ti.com/product/TPS7H6005-SP) and at [www.ti.com/product/TPS7H6015-SP](http://www.ti.com/product/TPS7H6015-SP) and at [www.ti.com/product/TPS7H6025-SP](http://www.ti.com/product/TPS7H6025-SP) and at [www.ti.com/product/TPS7H6005-SEP](http://www.ti.com/product/TPS7H6005-SEP) and at [www.ti.com/product/TPS7H6015-SEP](http://www.ti.com/product/TPS7H6015-SEP) and at [www.ti.com/product/TPS7H6025-SEP](http://www.ti.com/product/TPS7H6025-SEP)

#### Applications

- Space satellite power supplies
- Communications payload
- Command and data handling
- Optical imaging payload
- Satellite electrical power system

#### Benefits

- Internal regulator supports GaN applications by properly controlling gate drive voltage
- Dead time configuration in PWM mode allows system optimization in high frequency applications
- Input interlock protection can be enabled or disabled in independent input mode to accommodate multiple converter topologies



# Space-grade power management

## Featured products

### 3 to 14V<sub>IN</sub>, 4 channel sequencer TPS7H3014-SP/TPS7H3014-SEP

#### Key features

- Sequence up and down with ability to daisy chain
- Programmable delay from 0.25 to 25ms ( $\pm 10\%$  accuracy), or no delay
- Logical input compatible with 1.2V Logic Programmable hysteresis  $24\mu\text{A} \pm 3\%$
- Trip Point =  $0.6\text{V} \pm 1\%$  (across voltage, temp & radiation)
- Push-Pull EN outputs with external inputs for the pull-up voltage domain
- QML Class-V: 22-pin CDFP, 6.21mm x 7.69mm
- QML Class-P: 24-pin TSSOP, 4.5mm x 7.9mm
- Space EP: 24-pin TSSOP, 4.5mm x 7.9mm

#### Radiation performance

- Rad-hard (RHA) TPS7H3014-SP:
  - TID characterization to 100krad(Si)
  - SEL immunity to 75MeV-cm<sup>2</sup>/mg at 125°C
- Rad-tolerant TPS7H3014-SEP:
  - TID characterization to 50krad(Si)
  - SEL immunity to 43MeV-cm<sup>2</sup>/mg at 125°C

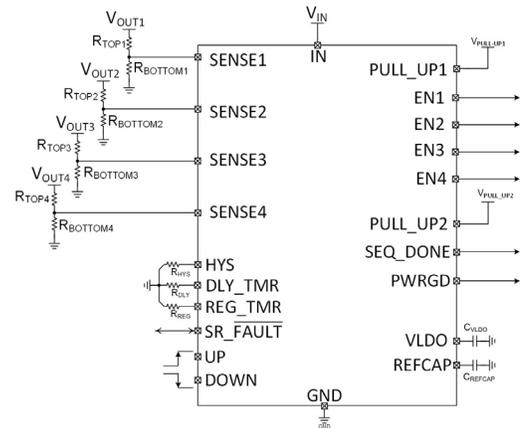
More information at [www.ti.com/product/TPS7H3014-SP](http://www.ti.com/product/TPS7H3014-SP) and at [www.ti.com/product/TPS7H3014-SEP](http://www.ti.com/product/TPS7H3014-SEP)

#### Applications

- Satellite electrical power system (EPS)
- Control sequence and monitoring for complex digital processors such as: FPGAs, SoCs, AFEs, and power systems for space applications

#### Benefits

- Compelling radiation performance support for complex FPGA and ASIC power-up and power-down sequences
- Multiple devices can be cascaded to sequence as many supplies as needed
- Highest accuracy radiation-validated device
- Smallest ceramic solution in the industry



### Inverting switched-capacitor

#### TPS7H1301-SP

#### Key features

- VIN: 3V to 6.3V & VOUT: -0.6V to -6V
- 400 mA of output current
- FSW = 500kHz
- $0.6\text{V} \pm 1\%$  VREF accuracy over line, load, temperature and TID
- Switched-capacitor 5V to -5V efficiency targets:
  - 50% at 10 mA
  - 87% at 100 mA
  - 86% at 250 mA
- QML Class-V: 14-pin CFP, 8.0mm x 9.1mm

#### Radiation performance

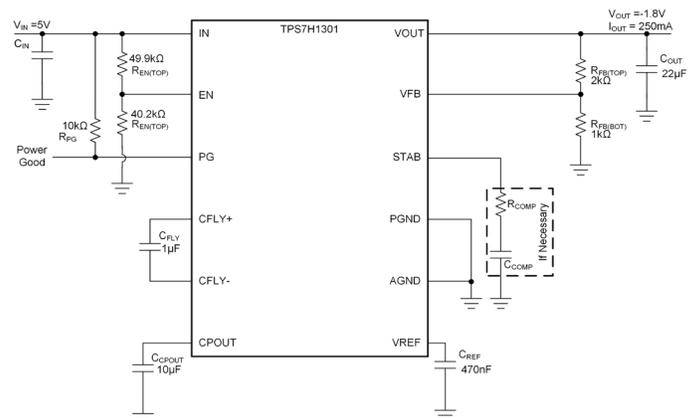
- Rad-hard (RHA) TPS7H1301-SP
  - TID characterization to 100krad(Si)
  - SEL immunity to 75MeV-cm<sup>2</sup>/mg at 125°C

#### Applications

- Space satellite power supplies for analog circuits
- Space satellite point of load supply
- Space satellite payloads

#### Benefits

- Creates negative rail using an integrated inverter with a flying capacitor
- Regulated by a built-in negative LDO



More information at [www.ti.com/product/TPS7H1301-SP](http://www.ti.com/product/TPS7H1301-SP)

# Space-grade power management

## Featured products

0.85V – 7V  $V_{IN}$ , 2.2V – 14V  $V_{BIAS}$ , 1.5A, low-noise, high PSRR performance LDO

### TPS7H1111-SP/TPS7H1111-SEP

#### Key features

- Ultra-Low Noise: 1.68 $\mu$  VRMS (10Hz – 100kHz)
- Ultra-low 1/f noise: 100nV/Hz $^{1/2}$  (typ at 10Hz)
- High PSRR: 71dB at 100kHz, 67dB at 1MHz
- $V_{OUT}$ : 0.4V to 5.5V
- Very high accuracy:  $\pm 1.5\%$  across line, load, temperature, & radiation
- Low dropout: 200mV (typ) at 1A, 450mV (max) at 1.5A
- Bias supply to minimize power dissipation (Set  $V_{BIAS} \geq V_{OUT} + 1.6V$ )
- QML Class-V: 14-pin CDFP, 8.0mm x 9.1mm
- QML Class-P & -SEP 28-pin HTSSOP, 4.4mm x 9.7mm

#### Radiation performance

- Rad Hard (RHBD) TPS7H1111-SP:
  - TID (LDR & HDR) = 100krad(Si)
  - SEL/SEB/SEGR immune to 75MeV-cm $^2$ /mg
- Rad Tolerant TPS7H1111-SEP:
  - TID characterization to 50krad(Si)
  - SEL/SEB/SEGR immune to 43MeV-cm $^2$ /mg

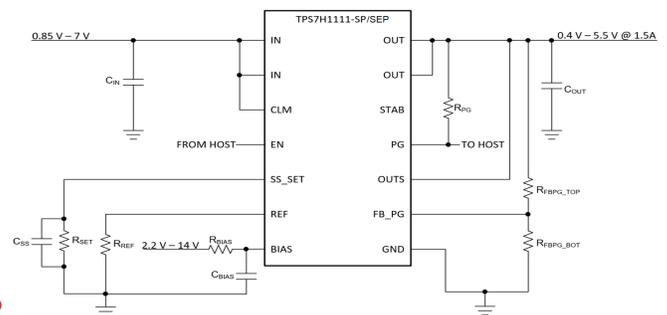
More information at [www.ti.com/product/TPS7H1111-SP](http://www.ti.com/product/TPS7H1111-SP) and at [www.ti.com/product/TPS7H1111-SEP](http://www.ti.com/product/TPS7H1111-SEP)

#### Applications

- Power for high-speed and high-accuracy circuits
  - VCOs, ADCs, DACs, PLLs, SerDes, and Imaging Sensors
- Accurate supply for precision ASIC and FPGA supply rails

#### Benefits

- Lowest noise, highest PSRR LDO in space industry
- Enable full performance of high speed and high precision circuits through clean power supply generation without bulky filters recorded



### Single ended PWM controller for driving MOSFET or GaN FETs

### TPS7H5020/21-SP/TPS7H5020/21-SEP, & TPS7H5030/31-SP/TPS7H5030/31-SEP

#### Key features

- TPS7H5020-SP/SEP  $V_{in}$  = 4.5 to 14V and 100% duty cycle
- TPS7H5021-SP/SEP  $V_{in}$  = 4.5 to 14V and 50% duty cycle
- TPS7H5030-SP/SEP  $V_{in}$  = 8V to 14V and 100% duty cycle
- TPS7H5031-SP/SEP  $V_{in}$  = 8V to 14V and 50% duty cycle
- 0.6 V  $\pm 1\%$  VREF accuracy over load, line, temperature and TID
- Configurable switching frequency up to 500kHz with external sync
- Integrated soft-start and configurable slope compensation
- $\pm 1.2$  A driver peak source/sink capability
- Split gate drive allows for adjustable turn-on and turn-off time
- QML Class-V: 22-pin HFT, 6.2mm x 7.7mm
- QML Class-P and Space EP: 24-pin TSSOP, 4.4 mm x 7.8 mm

#### Radiation performance

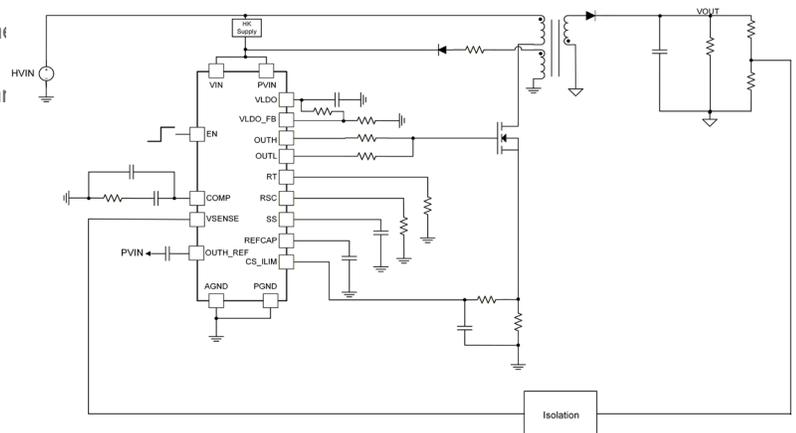
- Rad-hard (RHA) TPS7H5020/21/30/31-SP:
  - TID characterization to 100krad(Si)
  - SEL immunity to 75MeV-cm $^2$ /mg at 125°C
- Rad-tolerant TPS7H5020/21/30/31-SEP:
  - TID characterization to 50krad(Si)
  - SEL immunity to 43MeV-cm $^2$ /mg at 125°C

#### Applications

- Space satellite power supplies
- Communications payload
- Radar Imaging payload
- Satellite electrical power system

#### Benefits

- A highly integrated solution supporting both MOSFETs and GaN



More information at [www.ti.com/product/TPS7H5020-SP](http://www.ti.com/product/TPS7H5020-SP) and at [www.ti.com/product/TPS7H5020-SEP](http://www.ti.com/product/TPS7H5020-SEP) and at [www.ti.com/product/TPS7H5021-SP](http://www.ti.com/product/TPS7H5021-SP) and at [www.ti.com/product/TPS7H5021-SEP](http://www.ti.com/product/TPS7H5021-SEP) and at [www.ti.com/product/TPS7H5030-SP](http://www.ti.com/product/TPS7H5030-SP) and at [www.ti.com/product/TPS7H5030-SEP](http://www.ti.com/product/TPS7H5030-SEP) and at [www.ti.com/product/TPS7H5031-SP](http://www.ti.com/product/TPS7H5031-SP) and at [www.ti.com/product/TPS7H5031-SEP](http://www.ti.com/product/TPS7H5031-SEP)

# Space-grade interface

## Featured products

### 3.3V CAN transceiver

#### SN55HVD233-SP/SN55HVD233-SEP

##### Key features

- Compatible with ISO 11898-2
- Data rates up to 1Mbps
- Extended -7V to 12V common mode range
- High-input impedance allows for 120 nodes
- LVTTTL I/Os are 5-V tolerant
- Unpowered node does not disturb the bus
- Temperature range: -55°C to 125°C
- Available in 8-pin 6.48mm × 6.48mm ceramic flat pack (HKX)
- Bus pins ESD protection exceeds ±16kV HBM

##### Radiation performance

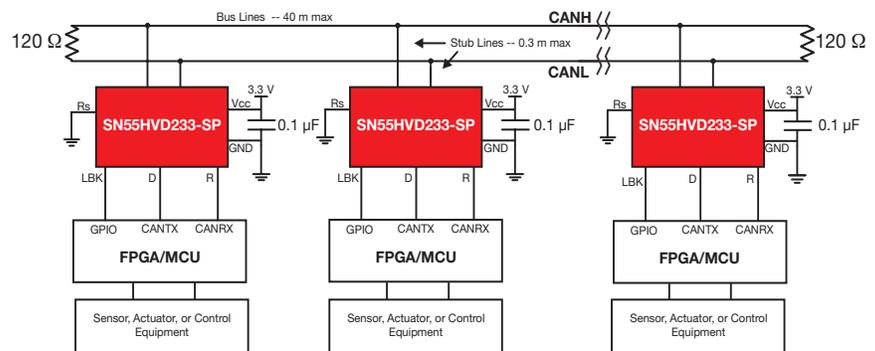
- Rad Hard (RHA) SN55HVD2331-SP:
  - TID = 50krad(Si) RHA
  - SEL immune to 86MeV-cm<sup>2</sup>/mg
- Rad Tolerant SN55HVD2331-SEP:
  - TID characterization to 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg

##### Applications

- Spacecraft backplane data bus communication and control
- Telemetry/Sensor data transmission
- CAN bus standards such as CANopen, DeviceNet, CAN Kingdom, ISO 11783, NMEA 2000, SAE J1939

##### Benefits

- RHA qualified and orderable as SMD: 5962L1420901VXC
- Thermal shutdown protection
- Adjustable driver transition times for improved signal quality



More information at [www.ti.com/product/SN55HVD233-SP](http://www.ti.com/product/SN55HVD233-SP) and [www.ti.com/product/SN55HVD233-SEP](http://www.ti.com/product/SN55HVD233-SEP)

### 3V to 5.5V RS-485 transceiver with flexible I/O supply and IEC ESD

#### THVD9491-SEP

##### Key features

- 3V – 5.5V supply voltage (1.65V-5.5V operation support for I/Os)
- Fully integrated system-level EMC protection on bus pins
- ±15kV HBM ESD protection
- Common-mode range: ±12V
- Bus fault protection for DC shorts: ±15V
- Large receiver hysteresis: 250mV
- Data rates up to 12Mbps
- Open, short, and idle bus failsafe receiver
- 1/8th unit load to support up to 256 nodes on a bus

##### Radiation performance

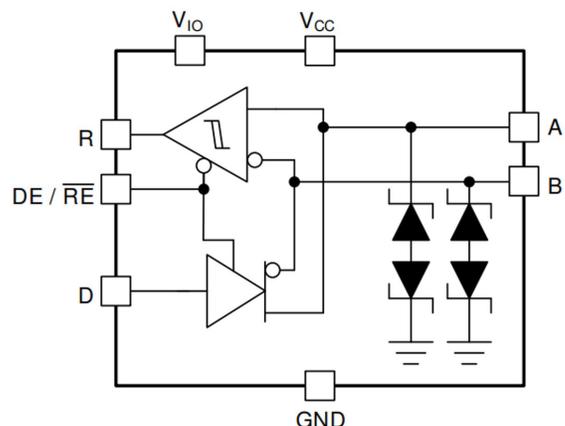
- TID = 30krad(Si) RHA
- SEL immune to 43MeV-cm<sup>2</sup>/mg

##### Applications

- Low/mid orbit satellite applications

##### Benefits

- 1.8V – 5V logic supply support eliminates the need for level translator when interfacing with processors with 1.8V I/Os
- Fully integrated IEC ESD, EFT and surge protection – Eliminate system level protection components and reduce system BOM



More information at [www.ti.com/product/THVD9491-SEP](http://www.ti.com/product/THVD9491-SEP)

# Space-grade interface

## Featured products

### Radiation-hardness-assured (RHA), 10/100/1000 Gigabit Ethernet PHY with SEFI monitor DP83561-SP

#### Key features

- TID: 300krad(Si), QMLV-RHA qualified
- SEL immune > 121MeV-cm<sup>2</sup>/mg at max temp and voltage ratings
- SEU: No link drops and low packet loss up to 48MeV-cm<sup>2</sup>/mg
- SEFI support suite:
  - Configuration registers protection: ECC corrects SEFI related bit changes
  - PHY state machine monitor: Looks for invalid changes
  - Supply current monitor: Indicates general PHY health to system
  - Interrupt indication for monitors
  - PLL lock monitor
- Operating temperature range: -55 to 125°C
- MAC I/Fs: RGMII, MII
- IEEE 1000Base-T, 100Base-TX, 10Base-Tc
- 64-pin CFP (11mm × 11mm)

#### Radiation performance

- TID = 300krad(Si) RHA
- SEL immune to LET = 121MeV-cm<sup>2</sup>/mg

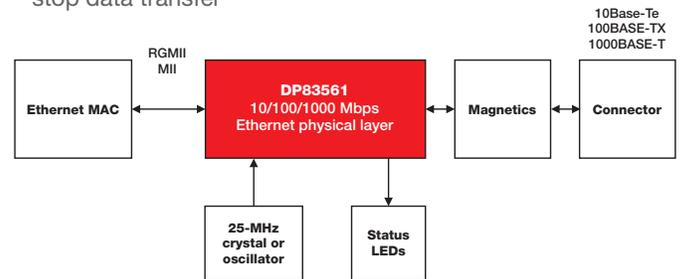
More information at [www.ti.com/product/DP83561-SP](http://www.ti.com/product/DP83561-SP)

#### Applications

- Space/satellite communications

#### Benefits

- EMDIO register monitor: Changes in PHY configuration registers will be indicated to system for action/correction
- PHY PCS state machine monitor: Invalid state changes may be indicative of SEFI, system is notified to adjust accordingly
- Supply current monitor: SEFI events may cause PHY failure modes undetectable by other method
- PLL lock monitor: Loss of lock indication can be used to stop data transfer



### Current-driven, analog isolator with transistor output ISOS510-SP/ISOS510-SEP

#### Key features

- Isolation voltage: 3750 VRMS
- Working voltage: 707 VPK
- Creepage: ≥ 5 mm
- Propagation delay (TON/TOFF): 5 μs (typ)
- Bandwidth: 680 kHz (typ)
- Input current (IF): 0.7 mA to 10 mA recommended
- CTR: 100%-155% at IF = 5 mA
- VF range: 1.2 V (typ)
- Operating temperature range: -55°C to 125°C
- Small SO-4 package (4.8mm x 2.54mm)

#### Radiation performance

- Rad Hard ISOS510-SP
  - TID = 100krad(Si) RHA
  - SEL and SEFI immune to LET > 75MeV-cm<sup>2</sup>/mg
- Rad Tolerant ISOS510-SEP
  - TID characterization (ELDRS free) to 50krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg at 125°C

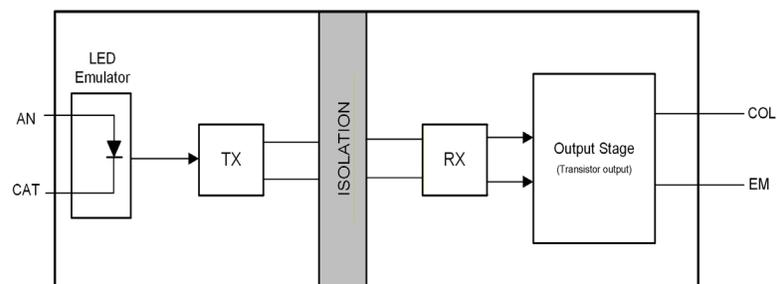
#### Applications

- Space isolated DC/DC module
- Satellite propulsion power processing unit
- Communications Payload and Radar Imaging Payload

More information at [www.ti.com/product/ISOS510-SP](http://www.ti.com/product/ISOS510-SP) and at [www.ti.com/product/ISOS510-SEP](http://www.ti.com/product/ISOS510-SEP)

#### Benefits

- Supports low input current (0.7 mA) with flat CTR for low power applications.
- Eliminate the need to overdesign your system to account for the LED aging effect of optocouplers
- Ease of design for feedback loop compensation with stable and tight current transfer ratio (CTR) over both temperature and lifetime
- Reduced part-to-part variation enables improved designs for optimized efficiency
- Wide bandwidth enables improved load transient response and improves system cost by reducing requirements of output capacitor



# Space-grade data converters

## Featured products

### 2-channel, ultra-low power, 1 to 65MSPS, 18-bit ADC & 1 to 125MSPS, 14-bit ADC

#### ADC3683-SP/-SEP & ADC3664-SP/SEP

##### Key features

- ADC3683-SP/SEP - Resolution: 18-bit, no missing codes
- ADC3664-SP/SEP - Resolution: 14-bit
- Ultra-low power: 50mW/ch (10MSPS), 94mW/ch (65MSPS)
- Noise spectral density: -160dBFS/Hz
- Spectral performance ( $f_{IN} = 5\text{MHz}$ )
  - SNR: 83.5dBFS
  - SFDR: 87dBc HD2, HD3, SFDR: 99dBFS worst spur
- Analog input bandwidth (-3dB): 400MHz
- Low latency: 1 to 2 clock cycles
- INL/DNL:  $\pm 9.0 / \pm 0.7\text{LSB}$  (typ)
- Reference: Integrated or external (buffer integrated)
- Interface: Serial LVDS (SLVDS) – options: 2-, 1-, and 1/2-wire

##### Radiation performance

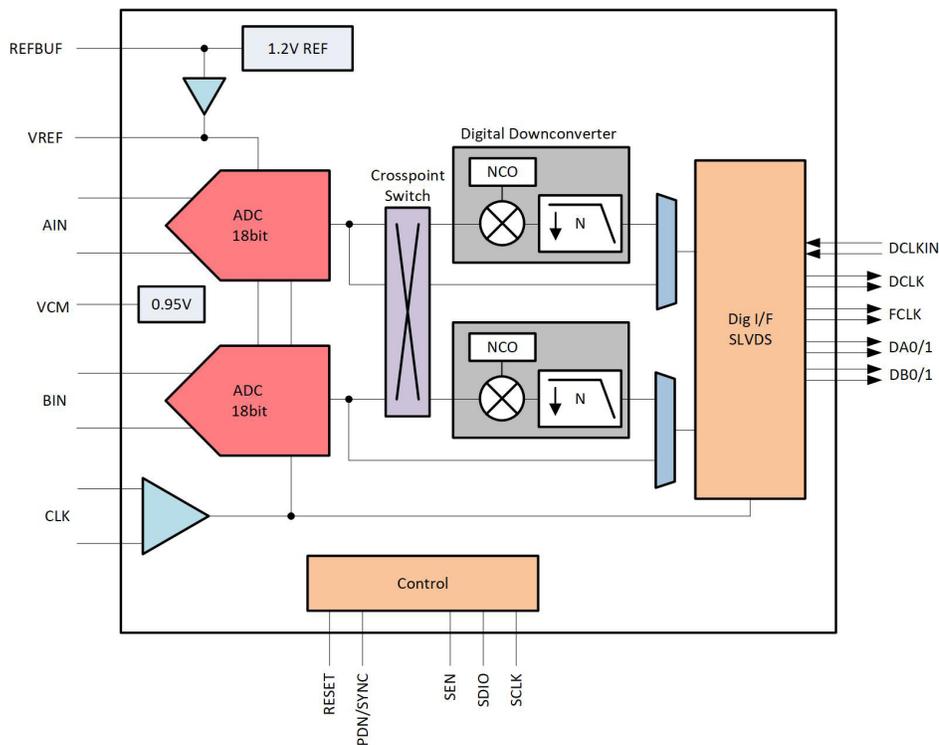
- Space Grade ADC3683-SP and ADC3664-SP:
  - TID = 300krad(Si) RHA
  - SEL immune to 75MeV-cm<sup>2</sup>/mg
- Rad Tolerant ADC3683-SEP and ADC3664-SEP:
  - TID = 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg

##### Applications

- Narrow band radio/radar
- Precision telemetry
- Satellite optical communications payload
- Satellite imaging payloads

##### Benefits

- Integrates digital filter options to reduce processing requirements
  - Decimation by 2, 4, 8, 16, or 32, and 32-Bit NCO
- Low latency (1 to 2 clock cycles) for high-speed control loops
- Low offset voltage and offset voltage drift parameters allow for accurate measurements across temperature
- Offers excellent DC precision together with IF sampling support which makes it ideally suited for a wide range of applications
- SLVDS interface minimizes the number of digital interconnects



More information at [www.ti.com/product/ADC3683-SP](http://www.ti.com/product/ADC3683-SP) and at [www.ti.com/product/ADC3683-SEP](http://www.ti.com/product/ADC3683-SEP) and at [www.ti.com/product/ADC3664-SP](http://www.ti.com/product/ADC3664-SP) and at [www.ti.com/product/ADC3664-SEP](http://www.ti.com/product/ADC3664-SEP)

# Space-grade data converters

## Featured products

### 12-bit, dual 5.2GSPS or single 10.4GSPS ADC

#### ADC12DJ5200-SP/ADC12DJ5200-SEP

##### Key features

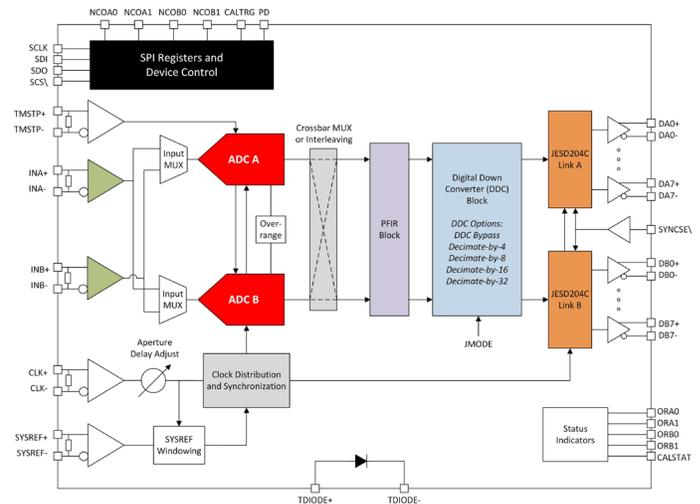
- 12-bit ADC with 8GHz input bandwidth
- 10.4GSPS as single, 5.2GSPS as dual
- Noise Floor: -154.4dBFS/Hz
- ENOB: 8.6 bits
- Easy-to-use synchronization features
- 17.16Gbps JESD204B/C serial data interface
- Optional 4x-32x complex decimation
- Peak RF Input Power (Diff): +26.5dBm
- Programmable FIR filter for equalization
- Power consumption: 4W

##### Radiation performance

- Rad Hard (RHBD) ADC12DJ5200-SP:
  - TID = 300krad(Si) RHA
  - SEL and SEFI immune to LET > 120MeV-cm<sup>2</sup>/mg
- Rad Tolerant ADC12DJ5200-SEP:
  - TID characterization to 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg at 125°C

##### Applications

- Wideband Satellite communications (SATCOM)
- RF-sampling software-defined radio (SDR)
- Spectrometry
- RADAR / LIDAR



More information at [www.ti.com/product/ADC12DJ5200-SP](http://www.ti.com/product/ADC12DJ5200-SP) and at [www.ti.com/product/ADC12DJ5200-SEP](http://www.ti.com/product/ADC12DJ5200-SEP)

### 16-bit, 2-channel, up to 20.8GSPS 12GHz RF digital-to-analog converter

#### DAC39RF10-SP/DAC39RF10-SEP

##### Key features

- Sample rate: 10.4GSPS (single edge) and 20.8GSPS (dual edge)
- 16-bits resolution
- Max input rates (real data, 1-ch)
  - 20.8GSPS at 8-bits, 15.52GSPS at 12-bits, 10.4GSPS at 16-bits
- Max input rates (real data, 2-ch)
  - 7.75GSPS at 12-bits, 6.2GSPS at 16-bits
- Output current: 5 - 42mA w/ 7-bit control
- Interface: 16x JESD204C at 12.8Gbps

##### Radiation performance

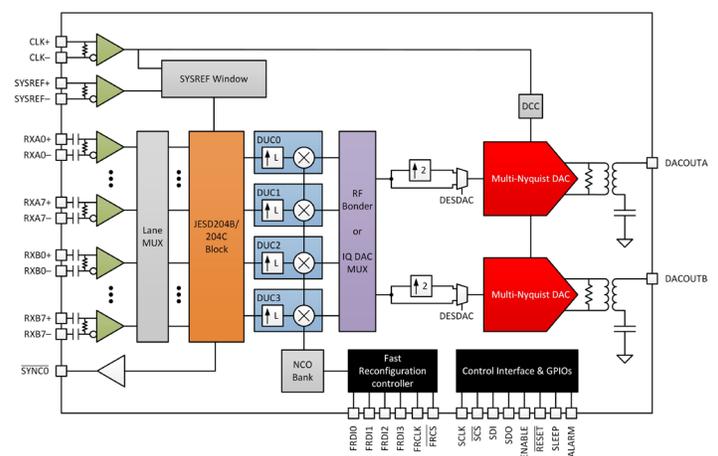
- Rad Hard (RHBD) DAC39RF10-SP:
  - TID = 300krad(Si) RHA
  - SEL immune to 120MeV-cm<sup>2</sup>/mg
- Rad Tolerant DAC39RF10-SEP:
  - TID = 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg

##### Applications

- Satellite Communications (SATCOM)
- Phased array antenna systems
- Synthetic Aperture Radar (SAR) exciter
- RADAR calibration source
- Arbitrary Waveform Generator (AWG)

##### Benefits

- Low Phase Noise: -148dBc/Hz at 1GHz/10kHz offset
- Direct RF synthesis with 12GHz+ output
- Digital Up-Converters: 1-256x interpolation, 64-bit NCO phase coherent frequency hopping covering 4x30MHz to 1x5GHz signals
- SERDES Lanes: Lower baud rate, in-package AC caps, & 1mm ball pitch for small PCB size & easier RF routing



More information at [www.ti.com/product/DAC39RF10-SP](http://www.ti.com/product/DAC39RF10-SP) and at [www.ti.com/product/DAC39RF10-SEP](http://www.ti.com/product/DAC39RF10-SEP)

## Eight-channel 12-bit 50kSPS to 1MSPS analog-to-digital converter

### ADC128S102QML-SP/ADC128S102-SEP

#### Key features

- Eight input channels
- $V_A$ : 2.7V to 5.25V;  $V_D$ : 2.7V to  $V_A$
- 2.3mW with 3V supply and 0.06 $\mu$ W at shutdown
- DNL: -0.5 to +0.9LSB (typ); INL:  $\pm$ 0.9LSB (typ)
- SPI digital output
- ADC addressing through CS decoder
- SPI/QSPI/MICROWIRE/DSP compatible
- ADC128S102QML-SP: 16-pin ceramic SOIC, CFP and die
- ADC128S102-SEP: 16-pin plastic TSSOP package (5mm x 4.4mm)

#### Radiation performance

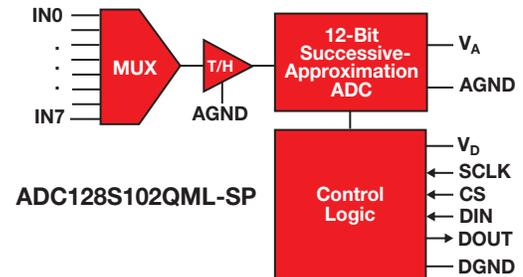
- Rad Hard (RHBD) ADC128S102QML-SP:
  - TID = 100krad(Si) RHA
  - SEL and SEFI immune to LET > 120MeV-cm<sup>2</sup>/mg
- Rad Tolerant ADC128S102-SEP:
  - TID characterization (ELDRS free) to 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg at 125°C

#### Applications

- Sensors, thermistors, motor control
- Satellite system health, power-supply voltage and current monitoring

#### Benefits

- Eight sensors can be monitored with one ADC
- All ADC serialized data shares the same input bus to onboard FPGA/ASIC
- Ultra-low power consumption



More information at [www.ti.com/product/ADC128S102QML-SP](http://www.ti.com/product/ADC128S102QML-SP) and at [www.ti.com/product/ADC128S102-SEP](http://www.ti.com/product/ADC128S102-SEP)

## 4-transmit, 6-receive RF-sampling transceiver up to 12GHz

### AFE7950-SP/AFE7950-SEP

#### Key features

- Four RF sampling 12GSPS TX DACs
- Six RF sampling 3GSPS RX ADCs
- Maximum RF signal bandwidth: 1200MHz (or 2400MHz for 2TX)
- RF frequency range:
  - TX: 600MHz - 12GHz, RX: 5MHz - 12GHz
- Digital step attenuators (DSA):
  - TX: 40dB range, 0.125dB steps, RX or FB: 25dB range, 0.5dB steps
- 8 SerDes transceivers up to 24.75Gbps
- Package: 17mm x 17mm FCBGA, 0.8mm pitch

#### Radiation performance

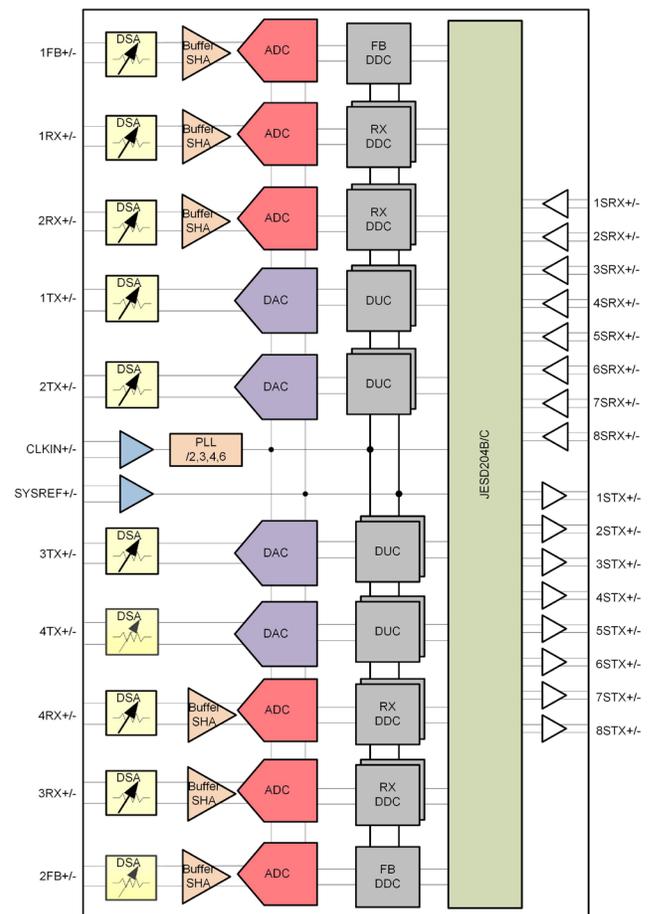
- Space Grade AFE7950-SP:
  - TID = 100krad(Si) RHA
  - SEL immune to 70MeV-cm<sup>2</sup>/mg
- Rad Tolerant AFE7950-SEP:
  - TID characterization to 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg at 125°C

#### Applications

- Satellite communications payload downlink
- Satellite telemetry payload downlink
- Radar
- Electronic Warfare

#### Benefits

- Wide bandwidth multi-channel transceiver
- Direct RF sampling in the L, S, C and X-band frequency ranges
- Density and flexibility enables high-channel count, multi-mission systems
- Pin to pin compatibility with other devices in AFE79xx family



More information at [www.ti.com/product/AFE7950-SP](http://www.ti.com/product/AFE7950-SP) and at [www.ti.com/product/AFE7950-SEP](http://www.ti.com/product/AFE7950-SEP)

# Space-grade data converters

## Featured products

### 12-bit telemetry & control – 16 ADC, 12 DAC, and temperature sensor with GPIO

#### AFE11612-SEP

##### Key features

- ADC, 12-bit, 16-ch, single-ended or differential options
- DAC, 12-bit, 12-ch, 0 to 5V or 0 to 12.5V
- Temperature sensors
  - Two (2) remote sensors
  - One (1) local/internal sensor
- Internal 2.5V reference
- I<sup>2</sup>C or SPI interface
- 8 GPIO
- 64-pin plastic HTQFP package (10mm x 10mm)

##### Applications

- Command and data handling (C&DH)
- Communications payload
- Radar imaging payload
- Optical imaging payload
- General analog monitoring and control

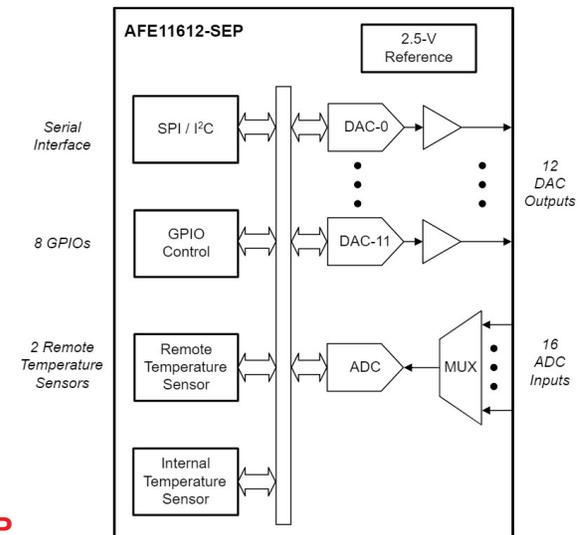
##### Benefits

- High integration
- Vendor Item Drawing (VID)

More information at [www.ti.com/product/AFE11612-SEP](http://www.ti.com/product/AFE11612-SEP)

##### Radiation performance

- TID = 20krad(Si) RLAT
- SEL/SEB/SEGR immune to LET = 43MeV-cm<sup>2</sup>/mg
- SET/SEFI characterized to LET = 43MeV-cm<sup>2</sup>/mg



### 16-bit, 1MSPS, 8-Ch SE / 4-Ch DIFF, Dual Simultaneous Sampling SAR ADC w/ Internal Reference

#### ADC168M102R-SP/ADC168M102R-SEP

##### Key features

- Dual SAR ADC Cores 1 MSPS per ADC
- 8 single ended and 4 differential channels
- Dual programmable internal reference
- Digital Interface: SPI
- AVDD: 2.5V to 5.5V, DVDD: 2.3V to 5.5V
- Power: 67mW
- 5mm x 5mm QFN

##### Radiation performance

- Rad Hard ADC168M102R-SP:
  - TID = 100krad(Si) RHA
  - SEL and SEFI immune to LET > 75MeV-cm<sup>2</sup>/mg
- Rad Tolerant ADC168M102R-SEP:
  - TID characterization (ELDRS free) to 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg at 125°C

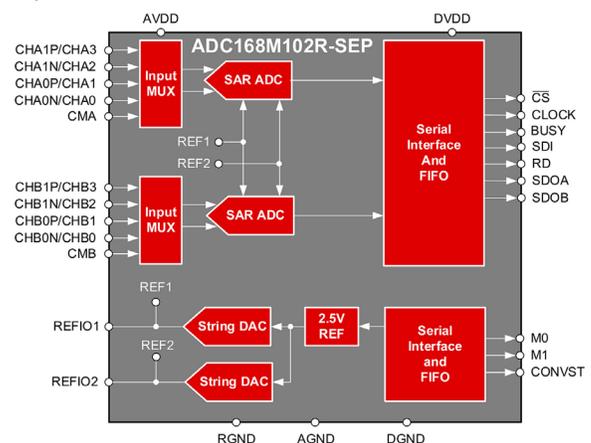
##### Applications

- Telemetry
  - Latch-Up Diagnostics, Module Temperature Sensing
  - Environmental Sensing
- Closed Loop-Controls
  - Inertial Measurement Unit and Gyroscope AFE

More information at [www.ti.com/product/ADC168M102R-SEP](http://www.ti.com/product/ADC168M102R-SEP) and at [www.ti.com/product/ADC168M102R-SP](http://www.ti.com/product/ADC168M102R-SP)

##### Benefits

- Radiation tolerant performance in a small plastic package for high-volume LEO deployments reducing size, cost, & weight
- Dual programmable internal reference enables input range scaling and monitoring for up to 8 signals
- 1MSPS sampling rate enables faster response for closed loop controls



# Space-grade amplifiers and comparators

## Featured products

### Radiation-tolerant near-DC to >11GHz, fully differential (D2D & S2D) RF amplifier

#### TRF0208-SP/TRF0208-SEP

##### Key features

- RF FDA that enables compact multi-channel designs
- 9GHz, -1dB bandwidth
- 10.5GHz, -3dB bandwidth
- 16dB fixed gain

##### Radiation performance

- Rad-hard (RHA) TRF0208-SP:
  - TID characterization to 100krad(Si)
  - SEL immunity to 75MeV-cm<sup>2</sup>/mg at 125°C
- Rad-tolerant TRF0208-SEP:
  - TID characterization to 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg at 125°C

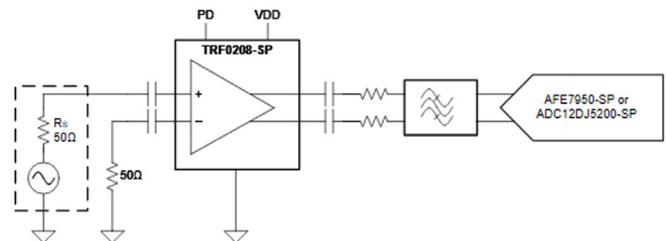
##### Applications

- Space Phased Array Radar
- UHF & C-Band Sat Uplink RX
- Space High Speed Digitizer
- RF Active Balun Benefits

More information at [www.ti.com/product/TRF0208-SP](http://www.ti.com/product/TRF0208-SP) and at [www.ti.com/product/TRF0208-SEP](http://www.ti.com/product/TRF0208-SEP)

##### Benefits

- Directly drive RF sampling or GSPS ADCs up to 8GHz
- Suitable for Aerospace & Defense Application with up to C-band support
- Low Noise Figure for better signal integrity
- Reduced system size with small foot print and elimination of passive RF balun
- Low power, with power-down mode for optimized system design



### 850MHz gain bandwidth, rail-to-rail output, negative rail input precision fully differential amplifier

#### LMH5485-SP/LMH5485-SEP

##### Key features

- Single channel, fully differential amplifier (FDA)
- Single supply range: 2.7V to 5.4V
- I<sub>Q</sub>: 10.1mA
- Power-down current: ~2μA
- Bandwidth: ~500MHz at G = 2V/V (GBW = 850MHz)
- Input voltage noise: 2.2nV/√Hz,
- THD: -140dBc at 2V<sub>PP</sub>, 1MHz
- Typical V<sub>OS</sub>/V<sub>OS</sub> drift: ±100μV/±0.5μV/°C
- Operating temperature range: -55°C to 125°C

##### Radiation performance

- Rad-hard (RHA) LMH5485-SP:
  - TID characterization to 100krad(Si)
  - SEL immunity to 85MeV-cm<sup>2</sup>/mg at 125°C
- Rad-tolerant LMH5485-SEP:
  - TID characterization to 30krad(Si)
  - SEL immune to 43MeV-cm<sup>2</sup>/mg at 125°C

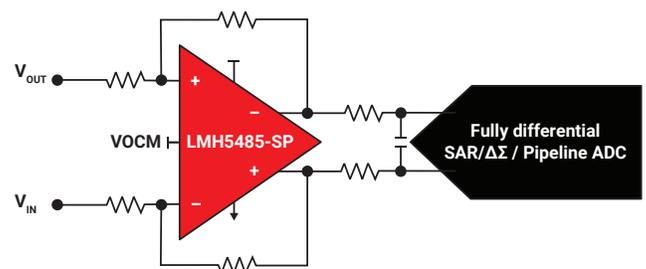
More information at [www.ti.com/product/LMH5485-SP](http://www.ti.com/product/LMH5485-SP) and at [www.ti.com/product/LMH5485-SEP](http://www.ti.com/product/LMH5485-SEP)

##### Applications

- SE to DE
- ADC driver
- Narrow-band radar

##### Benefits

- Low offset voltage and offset voltage drift parameters allow for accurate measurements across temperature
- Offers excellent DC precision together with IF sampling support which makes it ideally suited for a wide range of applications
- Supports single-ended to differential conversion
- RLAT to 100krad qualified for GEO applications



# Space-grade amplifiers and comparators

## Featured products

### 12V, quad femtoampere bias current, precision rail-to-rail input/output operational amplifier

#### LMP7704-SP

##### Key features

- Ultra-low input bias current:  $\pm 500\text{fA}$  (typ)
- Low offset voltage:  $\pm 260\mu\text{V}$  (max)
- +2.7V to +12V supply operation
- Rail-to-rail input and output
- Unity gain bandwidth: 2.5MHz
- Input voltage noise:  $9\text{nV}/\sqrt{\text{Hz}}$
- Supply current:  $725\mu\text{A}/\text{ch}$
- Package: 14-lead CFP, 9.9mm  $\times$  6.35mm

##### Radiation performance

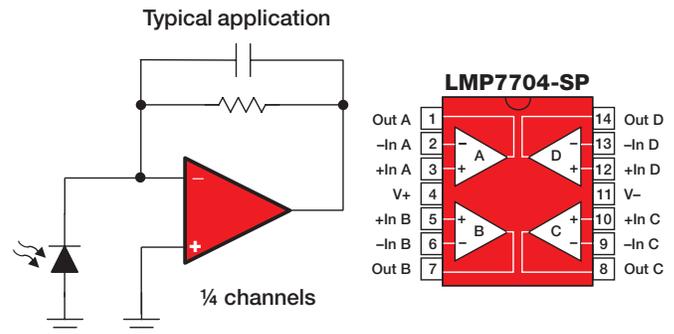
- TID = 100krad(Si) RHA
- SEL =  $85\text{MeV}\cdot\text{cm}^2/\text{mg}$  (125°C)

##### Applications

- Precision transimpedance amplifier for satellite telemetry
- High-impedance satellite sensor interface
- High-gain amplifiers

##### Benefits

- RHA qualified
- Exceptional DC performance with lowest bias current available for space applications
- Unity gain stable operation
- Rail-to-rail with precision allows single op amp for most board applications



More information at [www.ti.com/product/LMP7704-SP](http://www.ti.com/product/LMP7704-SP)

### Four-channel, 18V, 11MHz gain bandwidth, low-noise ( $5.1\text{nV}/\sqrt{\text{Hz}}$ ), rail-to-rail output precision ( $120\mu\text{V}$ ) junction FET operational amplifier

#### OPA4H014-SEP

##### Key features

- Gain bandwidth 11MHz
- Slew rate  $20\text{V}/\mu\text{s}$
- Input stage offset voltage  $20\mu\text{V}$  (max)
- Offset voltage drift  $1\mu\text{V}/^\circ\text{C}$  (max)
- Input bias current  $10\text{pA}$  (max)
- Supply current  $1.8\text{mA}$  (typ)
- Input stage voltage noise  $5.1\text{nV}/\sqrt{\text{Hz}}$  at 1kHz
- Current noise  $0.8\text{fA}/\sqrt{\text{Hz}}$  at 1kHz
- 0.1Hz to 10Hz noise  $250\text{nV}_{\text{pp}}$
- 14-pin plastic package – TSSOP (PW)  
(5.0mm  $\times$  4.4mm)

##### Radiation performance

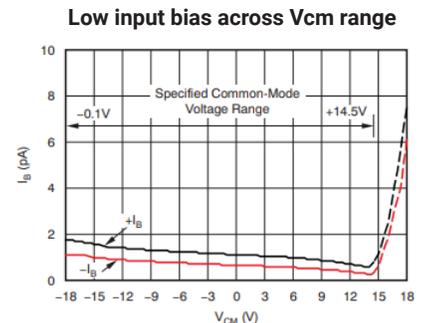
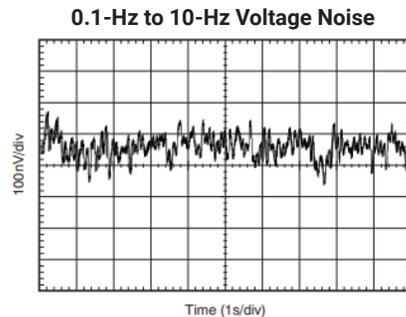
- TID characterization (ELDRS free) to 30krad(Si)
- SEL immune to  $43\text{MeV}\cdot\text{cm}^2/\text{mg}$  at 125°C

##### Applications

- Sensors
- Thermistors
- Instrumentation
- Telemetry/monitoring

##### Benefits

- High accuracy, stability over full military temperature range
- Precision JFET provides better matching to high-impedance sources such as sensor outputs and very-low-input bias current
- Low total noise (voltage and current) enables a wide range of input impedance sources for minimal error contributions
- Better matching to high-impedance sources such as sensor outputs
- RLAT to 40krad qualified for new space LEO applications



More information at [www.ti.com/product/OPA4H014-SEP](http://www.ti.com/product/OPA4H014-SEP)

# Space-grade amplifiers and comparators

## Featured products

### Quad, 40V 4.5MHz rail-to-rail input and output operational amplifier

#### OPA4H199-SEP

##### Key features

- Low offset voltage:  $\pm 125\mu\text{V}$
- Low noise:  $10.8\text{nV}/\sqrt{\text{Hz}}$  at 1kHz
- High common-mode rejection: 130dB
- Low bias current:  $\pm 10\text{pA}$
- Rail-to-rail input and output
- Wide bandwidth: 4.5MHz GBW
- High slew rate:  $21\text{V}/\mu\text{s}$
- High capacitive load drive: 1nF
- MUX-friendly/comparator inputs
- Low quiescent current:  $560\mu\text{A}$  per amplifier
- Wide supply:  $\pm 1.35\text{V}$  to  $\pm 20\text{V}$ , 2.7V to 40V
- Robust EMIRR performance: EMI/RFI filters on input and supply pins)

##### Radiation performance

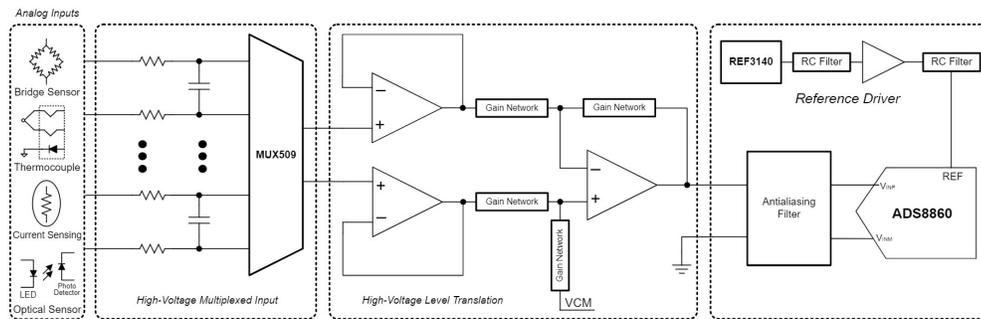
- TID characterization to 30krad(Si)
- SEL immune to  $43\text{MeV}\cdot\text{cm}^2/\text{mg}$  at  $125^\circ\text{C}$

##### Applications

- Support low earth orbit space applications
- Space sensor and control (telemetry)
- Satellite electrical power system (EPS)
- Flight control
- Satellite command & data handling
- Satellite payloads

##### Benefits

- Broadest supply voltage (2.7V - 40V) rail-to-rail input and output support offers exceptional flexibility in a range of applications
- Smallest Radiation Tolerant, 4-ch op amp in the industry
- Low offset voltage and offset voltage drift parameters allow for accurate measurements across temperature
- Low noise and THD+N enables audio/high-gain configurations
- Strong output current and cap load drive with low settling time ideal for ADC applications



More information at [www.ti.com/product/OPA4H199-SEP](http://www.ti.com/product/OPA4H199-SEP)

### High common-mode Voltage ( $\pm 120\text{V}$ ) difference amplifier

#### INA1H94-SP

##### Key features

- Common-mode volt. range:  $\pm 120\text{V}$
- CMRR (minimum): 90dB
- VOS/VOS drift:  $1.1\text{mV}/15\mu\text{V}/^\circ\text{C}$
- Max. gain error: 0.02%
- Max. gain error drift:  $10\text{ppm}/^\circ\text{C}$
- Max. gain non-linearity: 0.001% FSR
- Bandwidth: 500kHz
- Slew rate:  $5\text{V}/\mu\text{s}$  (typ)
- Supply current: 0.9mA (max)

##### Radiation performance

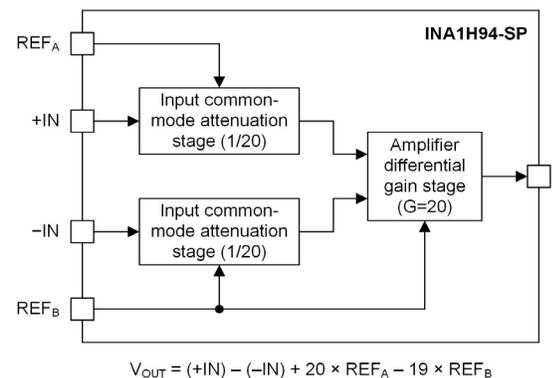
- TID = 100krad(Si) RHA
- SEL =  $75\text{MeV}\cdot\text{cm}^2/\text{mg}$  at  $125^\circ\text{C}$

##### Applications

- HV current sensing
- Battery cell voltage monitor
- Motor sensing

##### Benefits

- Accurately measure small differential voltages in the presence of common-mode signals up to  $\pm 275\text{V}$
- In many applications, where galvanic isolation is not required, the INA1H94-SP can replace isolation amplifiers



More information at [www.ti.com/product/INA1H94-SP](http://www.ti.com/product/INA1H94-SP)

# Space-grade amplifiers and comparators

## Featured products

### 100ns precision 25uA quad comparator

#### TLV4H290-SEP & TLV4H390-SEP

##### Key features

- Supply range: 1.65V to 5.5V
- Common Mode Range: (V-) to (V+)-1.5V
- Output structure: Open Drain (4H290) / Push-Pull (4H390)
- Prop Delay: 100ns (typ @100 mV OD)
- Vos (Max@25C): 3 mV
- IQ (Typ@25C): 25uA/Ch
- Package: 14-lead DYY, 4.2mm x 3.26mm

##### Radiation performance

- TID = 30krad(Si)
- SEL = 43MeV-cm<sup>2</sup>/mg (125°C)

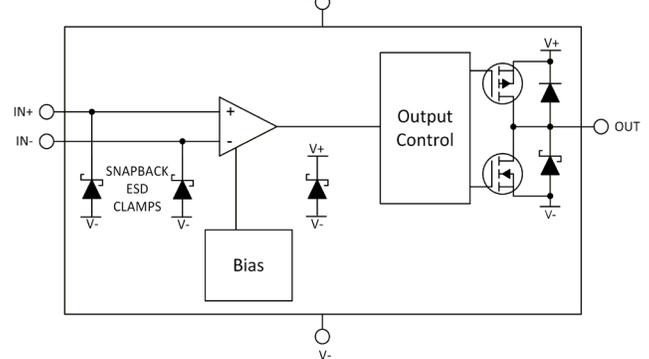
##### Applications

- Low-power, low-side current sensing
- Voltage Monitoring in Battery-Powered Devices
- Threshold Detectors and Discriminators
- Window Comparators
- Zero-Crossing Detectors

More information at [www.ti.com/product/TLV4H290-SEP](http://www.ti.com/product/TLV4H290-SEP) and at [www.ti.com/product/TLV4H390-SEP](http://www.ti.com/product/TLV4H390-SEP)

##### Benefits

- Excellent speed-to-power combination for power-constrained diagnostic functions (i.e. OCP)
- Fail Safe Inputs – Input voltage tolerant to abs max ratings independent of supply voltage
- Both OD and PP outputs provide options from driving uC alert pins to wired OR-ing logic



# Space-grade clocks and timing

## Featured products

### 5MHz to 30GHz Wideband Synthesizer With Phase Synchronization and JESD204B/C Support

#### LMX2624-SP/LMX2695-SEP

##### Key features

- Wide band frequency synthesizer : 5MHz to 30GHz output frequency
- -101dBc/Hz phase noise at 100kHz offset with 24GHz carrier
- 60fs RMS jitter at 24GHz (1kHz to 300MHz)
- Programmable output power
- PLL key specifications:
  - Figure of merit: -236dBc/Hz
  - Normalized 1/f noise: -129dBc/Hz
  - Up to 200MHz phase detector frequency
- Synchronization of output phase across multiple devices
- Independent mute pins for RFoutA and RFoutB with 200ns mute/unmute time
- Support for SYSREF with 9ps resolution programmable delay
- Pin-mode: Pin configurable N divider and output divider in Integer PLL mode
- 10 x 10mm<sup>2</sup> 64 lead QFP package

##### Radiation performance

- Rad-hard (RHA) LMX2624-SP
  - TID = 100krad (ELDRS-free)
  - SEL/ SEFI immune up to 75MeV-cm<sup>2</sup>/mg
- Rad-tolerant LMX2695-SEP:
  - TID = 50krad (ELDRS-free)
  - SEL immune up to 45MeV-cm<sup>2</sup>/mg

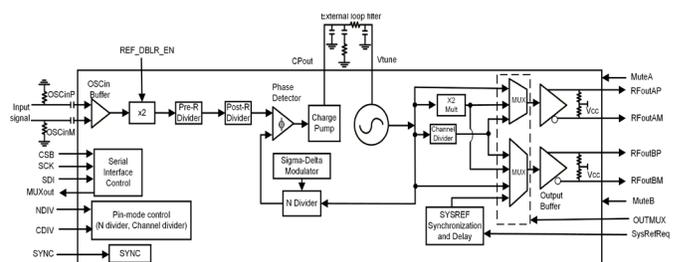
More information at [www.ti.com/product/LMX2624-SP](http://www.ti.com/product/LMX2624-SP) and at [www.ti.com/product/LMX2695-SEP](http://www.ti.com/product/LMX2695-SEP)

##### Applications

- Communications payload
- Optical imaging payload
- Radar imaging payload
- Command & data handling

##### Benefits

- Single device, space grade PLL + integrated VCO for generating up to 30GHz frequency
- Cover Data Converter clocking up to 30GHz and LO clocking for Ku/Ka band
- No MCU/CPLD/FPGA needed for programming the device. Output frequency is set using pin-mode.
- SYSREF support for JESD204B/C clocking
- Single 3.3V power supply



# Space-grade clocks and timing

## Featured products

### JESD204B clock generator and jitter cleaner

#### LMK04832-SP/LMK04832-SEP

#### Key features

- Supports 7 JESD204B targets (7 device clock and 7 SYSREF) or 14 differential output clocks
- Dual-loop platinum PLL architecture
- 54fs RMS jitter at 2.5GHz, 61fs RMS jitter at 3.2GHz (12kHz–20MHz)
- Noise floor  $-156.5\text{dBc/Hz}$  at 3200MHz
- CML swing:  $1.2V_{PP}$  differential at 3.2GHz
- 2 integrated VCO to support 2 independent frequency plans
  - VCO0 = 2440 to 2580MHz
  - VCO1 = 2945 to 3255MHz
- 320MHz PLL2 maximum phase detector frequency
- $-230\text{dBc/Hz}$  PLL2 FOM and  $-128\text{dBc/Hz}$  PLL2 1/f
- SYSREF analog delay 25-ps step resolution
- 0-delay mode for either dual loop or single loop
- JESD204B sourced from distribution or clock generation mode/Hz
- Holdover mode when input clock is lost
- LMK04832-SP:  $10.9\text{mm} \times 10.9\text{mm}^2$  64-lead CFP ceramic package
- LMK04832-SEP:  $10\text{mm} \times 10\text{mm}^2$  64-lead TQFP plastic package

More information at [www.ti.com/product/LMK04832-SP](http://www.ti.com/product/LMK04832-SP) and at [www.ti.com/product/LMK04832-SEP](http://www.ti.com/product/LMK04832-SEP)

### 15GHz buffer, multiplier and divider with SYSREF and FPGA clock

#### LMX1906-SP/LMX1860-SEP

#### Key features

- Up to 15GHz output frequency
  - SYSREF and SYNC features work with up to 12.8GHz input
- Noise Floor of  $-158\text{dBc/Hz}$  for a 6GHz output
- 4 high frequency clock outputs
  - Can be used as a buffer, divider (divide by 2, 3, 4, 5, 6, 7 or 8) or multiplier (x2, x3, x4)
- 1 LOGICLK Output for FPGA clocking
  - Includes divider values of 1, 2, 3, ... up to 1023
- SYSREF paired with each clock output
  - Individual delay adjustment
  - Supports both master and repeater mode
- SYSREF Windowing optimizes setup and hold times of SYSREFREQ

#### Radiation performance

- Rad-hard (RHA) LMX1906-SP:
  - TID = 100krad(Si) RHA
  - SEL/SEU immune to LET =  $87\text{MeV}\cdot\text{cm}^2/\text{mg}$  ( $125^\circ\text{C}$ )
- Rad-tolerant LMX1860-SEP:
  - TID characterization to 30krad(Si)
  - SEL/SEU immune to LET =  $43\text{MeV}\cdot\text{cm}^2/\text{mg}$  ( $125^\circ\text{C}$ )

#### Applications

- Radar imaging payload
- Communications payloads
- Command and data handling
- Data converter clocking
- Clock distribution/multiplication/division

More information at [www.ti.com/product/LMX1906-SP](http://www.ti.com/product/LMX1906-SP) and at [www.ti.com/product/LMX1860-SEP](http://www.ti.com/product/LMX1860-SEP)

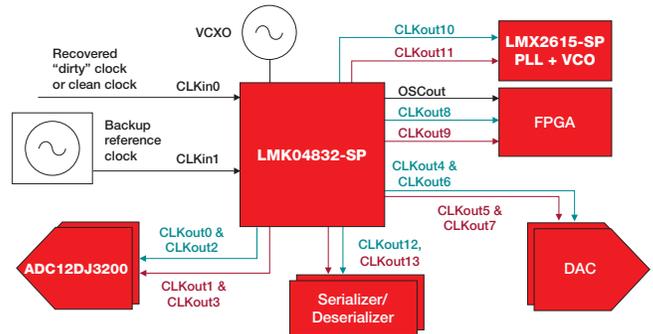
#### Radiation performance

- Rad-hard (RHA) LMK04832-SP:
  - TID characterization to 100krad(Si)
  - SEL immunity to  $120\text{MeV}\cdot\text{cm}^2/\text{mg}$  at  $125^\circ\text{C}$
- Rad-tolerant LMK04832-SEP:
  - TID characterization to 30krad(Si)
  - SEL immune to  $43\text{MeV}\cdot\text{cm}^2/\text{mg}$  at  $125^\circ\text{C}$

#### Applications

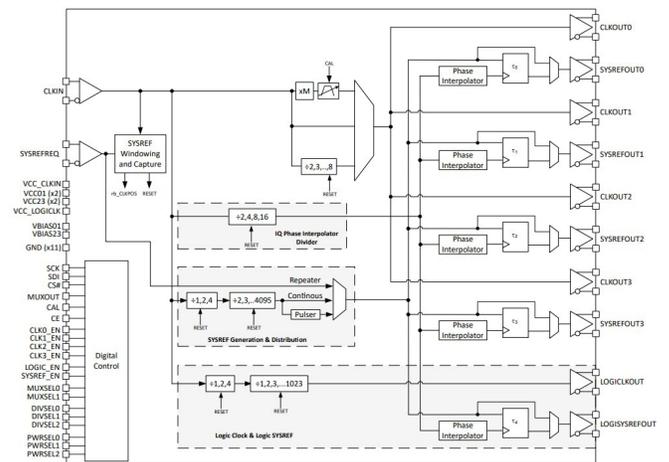
Low jitter noise with JEDEC JESD204B

- Space communications
- JESD204B clocking systems



#### Benefits

- High integration reduces components & improves skew variation
- Low noise floor minimizes clock degradation of data converter SNR
- Pin modes for easy device configuration without SPI – power, divider, mux selection and output EN



# Space-grade microcontrollers

## Featured product

### 16MHz ultra-low-power microcontroller with ferroelectric RAM and 40 inputs/outputs

#### MSP430FR5969-SP

##### Key features

- Extremely low power consumption 16-bit RISC architecture:
  - 100µA/MHz active
  - 0.02µA shutdown, 0.4µA standby
- 64KB of non-volatile, ferroelectric RAM (FRAM)
- Integrated peripherals for system housekeeping, telemetry
  - Real-time clock (RTC)
  - Five 16-bit timers
  - 16-channel analog comparator
  - 12-bit analog-to-digital converter (ADC) with 16 inputs, internal reference and sample-and-hold
  - Serial interfaces supporting UART, SPI, I<sup>2</sup>C
  - Multi-function I/O ports
- Support for 32kHz crystals or internal clock sources
- 48-pin VQFN and TQFP plastic packages for reduced size/weight

##### Radiation performance

- TID = 75krad(Si), 50krad(Si) RHA
- SEL immune to LET = 72MeV-cm<sup>2</sup>/mg

More information at [www.ti.com/product/MSP430FR5969-SP](http://www.ti.com/product/MSP430FR5969-SP)

##### Applications

- Spacecraft distributed telemetry and housekeeping
- Sensor management and data logging
- Satellite remote terminal units

##### Benefits

- Reduced SWaP needed for system housekeeping functions
- Housekeeping/telemetry can be offloaded from FPGA
- Reusable RTU architecture across subsystems

MSP430FR5969-SP

Ultra-low power 16-bit MCU	64-KB FRAM
16 MHz	Watch dog timer, Timer 0_A3, Timer 1_B3, Timer 2_A3, Timer 3_B3, Timer 4_B3
Real-time JTAG, Embedded emulation, BSL	2 UARTs or SPI 1 I <sup>2</sup> C or SPI
32x32 Multiplier DMA (3 ch), CRC16	Power-on reset Brown-out reset XT1, VLO DCO (±2%), Real-time clock
Up to 3 1x8 + 1 1x3 I/O ports w/ interrupts / wake up	
Comp_D / Vref ADC12 (up to 16 ch)	

### Radiation Tolerant, 32-bit MCU with 800MIPs and dual C28 and CLA cores

#### F28377D-SEP

##### Key features

- Real-time performance of dual C28x core with dual CLA co-processors to run parallel control loops
- 800 MIPS DSP Processing Power
- 4 differential 16-bit ADC, 1MSPS each
- 3x 12-bit DAC (external outputs)
- Trigonometric Math Unit (TMU) - 1 to 3 cycle SIN, COS, ARCTAN
- Direct memory access through dual EMIFs (16bit/32bit)
- 8x Windowed Comparators w/ 12b DAC
- 8 Sigma Delta Decimation Filters

##### Radiation performance

- TID characterization (ELDRS free) to 30krad(Si)
- SEL immune to 43MeV-cm<sup>2</sup>/mg at 125°C

##### Applications

- Spacecraft distributed processing
- Sensing & control
- Motor Control
- Digital Power

More information at [www.ti.com/product/F28377D-SEP](http://www.ti.com/product/F28377D-SEP)

##### Benefits

- CLA (Control Law Accelerator) - Co-processor to execute time-critical control loops concurrently with the main CPU
- 12 pairs high/low side ePWMs
- High Performance & Precision Analog

		Temperatures		-55	125C	SEP
<b>Connectivity</b>	<b>Processing</b>	<b>Processing</b>		<b>Actuation</b>		
4x UART	<b>C28x™ DSP core</b>	<b>C28x™ DSP core</b>		12x ePWM Modules (Type 4)		
2x I <sup>2</sup> C (w/ I <sup>2</sup> S PMBus)	200 MHz	200 MHz		24x Outputs (16x High-Res)		
3x SPI	FPU	FPU		Fault Trip Zones		
2x McBSP	TMU	TMU		3x 12-bit DAC		
2x CAN 2.0	VCU-II	VCU-II		<b>Sensing</b>		
USB 2.0 OTG FS MAC & PHY	<b>CLA core</b>	<b>CLA core</b>		ADC1: 16-bit, 1.1-MSPS		
uPP	200 MHz	200 MHz		12-bit, 3.5 MSPS		
<b>System Modules</b>	FPU	FPU		ADC2: 16-bit, 1.1-MSPS		
3x 32-bit CPU Timers	CRC	CRC		12-bit, 3.5 MSPS		
NMI Watchdog Timer	6ch DMA	6ch DMA		ADC3: 16-bit, 1.1-MSPS		
2x 192 Interrupt PIE	<b>Memory</b>	<b>Memory</b>		12-bit, 3.5 MSPS		
<b>Power &amp; Clocking</b>	Up to 512 kB Flash +ECC	Up to 512 kB Flash +ECC		ADC4: 16-bit, 1.1-MSPS		
2x 10 MHz OSC	36 kB SRAM +ECC/parity	36 kB SRAM +ECC/parity		12-bit, 3.5 MSPS		
4-20 MHz Ext OSC Input	128 kB SRAM Shared +parity			8x Windowed Comparators w/ Integrated 12-bit DAC		
<b>Debug</b>	ROM			8x Sigma Delta Channels (2 filters per ch)		
Real-time JTAG	2x 128-bit Security Zones			Temperature Sensor		
	2x EMIF			3x eDEP		
				6x eCAP		
				<b>Configurable Logic Block</b>		
				4 Tiles		

# Space-grade sensor products

## Featured products

### Very wide common voltage current-sense amplifier with split stage for filtering

#### INA901-SP

##### Key features

- -15V to 65V common-mode range independent of supply
- 2.7V to 16V supply
- Split stages for filtering
- Bandwidth up to 130kHz
- Gain: 20V/V
- Package: Ceramic 8-lead HKX 6.5mm × 6.5mm

##### Radiation performance

- TID = 50krad(Si) RHA
- SEL immune to LET = 75MeV-cm<sup>2</sup>/mg

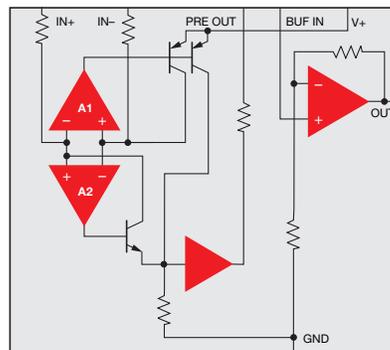
##### Applications

- Current monitor for current-mode control DC/DC converter
- Current measurement in an H-Bridge for motor control
- Latching current limiters on high common-mode bus
- Current sensing on GaN modules for increased efficiency

More information at [www.ti.com/product/INA901-SP](http://www.ti.com/product/INA901-SP)

##### Benefits

- Eliminates need for additional protective components in the event of CMR reversals
- Preserves buffered voltage output and saves using an additional op amp
- Simplifies design of current control loops
- Enables a flexible circuit design
- Orderable as SMD: 5962L1821001VXC



### Very wide common voltage, 1.1MHz bandwidth, ultra-precise unidirectional current-sense amplifier

#### INA950-SEP

##### Key features

- 2.7V to 80V common-mode range independent of supply
  - -20V to 80V survivability
- 2.7V to 5.5V supply
- High current monitoring accuracy
- Bandwidth up to 1.1MHz with 2V/μA Slew Rate
- Gain: 20V/V
- Package: 8-lead TSSOP 6.4mm x 3.0mm

##### Radiation performance

- TID = 30krad(Si) RHA
- SEL immune to LET = 43MeV-cm<sup>2</sup>/mg

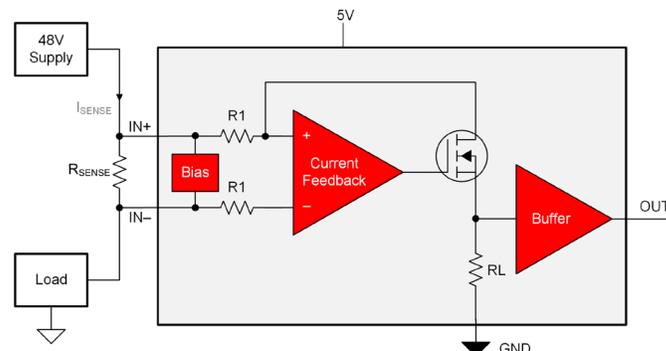
##### Applications

- Current monitor for power supplies
- High-Side overcurrent/fault Detection
- Latching current limiters on high common-mode bus
- High-Side solenoid control

More information at [www.ti.com/product/INA950-SEP](http://www.ti.com/product/INA950-SEP)

##### Benefits

- Simplifies design and reduces component count when compared to discrete implementations
- Allows accurate current measurement over a wide common-mode range
- High bandwidth and slew rate supports faster signal throughput
  - Ripple current measurement
  - Faster current throughput for protection



# Space-grade sensor products

## Featured products

### Remote and local digital temperature sensor with QMLV, QMLP, and radiation tolerant variants

#### TMP461-SP, TMP9R01-SP, TMP9R01-SEP

##### Key features

- Enables measurement of remote diode temperatures in the range of -64°C to 191°C
- Programmable calibration registers
- Remote diode temperature sensor accuracy:  $\pm 1.5^\circ\text{C}$
- Local temperature sensor accuracy:  $\pm 2^\circ\text{C}$
- Accuracy post calibration :  $\pm 0.1^\circ\text{C}$
- Supply and logic voltage range: 1.7V to 3.6V
- 35- $\mu\text{A}$  operating current (1 SPS), 3- $\mu\text{A}$  shutdown current

##### Radiation performance

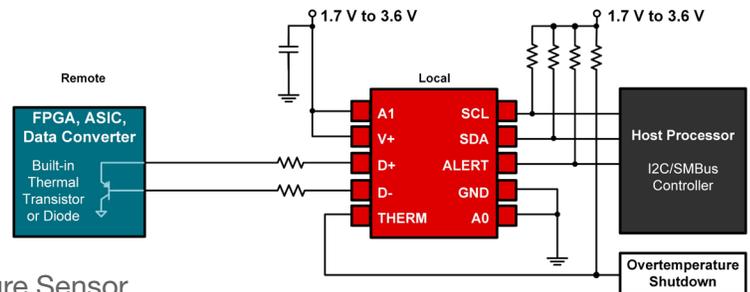
- TMP461-SP (QMLV) and TMP9R01-SP (QMLP)
  - TID = 100krad(Si) RHA
  - SEL Immune to LET = 75MeV-cm<sup>2</sup>/mg
- TMP9R01-SEP (Radiation Tolerant)
  - TID Characterization = 50krad(Si)
  - TID RLAT/RHA = 30krad(Si)
  - SEL Immune to LET = 43MeV-cm<sup>2</sup>/mg

##### Benefits

- RHA and radiation tolerant versions available
- Available in ceramic package with thermal pad, as well as a small VSSOP with 3mm x 3mm body size.
- Supports measurements of integrated thermal diode in FPGAs and ASICs, as well as discrete diodes for accurate temperature monitoring.

##### Variants

- **TMP461-SP** – QMLV-RHA, 100krad(Si), 76MeV
- **TMP9R01-SP** – QMLP-RHA, 100krad(Si), 76MeV
- **TMP9R01-SEP** – Rad Tolerant, 50krad(Si), 43MeV



For more information see TI Space-Grade Temperature Sensor Selection Guide at [www.ti.com/lit/SBOA607](http://www.ti.com/lit/SBOA607)

# Space-grade logic products

## Featured products

### Space CMOS Logic Family

#### SN54SCxT-SEP

##### Key features and benefits

- Wide supply voltage range of 1.2V to 5.5V, enabling compatibility with modern FPGAs
- SCxT enhanced input voltage enables single-supply voltage translation
- Supports  $\pm 24\text{mA}$  continuous output drive at 5V
- Fast operation with typical propagation delays (tpd) near 10ns
- SEU/SET Immune Latches (43MeV LETEFF)
- Built-in triple redundancy feature for Latches, Flip-Flops, and Shift Registers
- Configurable multi-function gates enable design flexibility (SC3T97 & SC3T98)

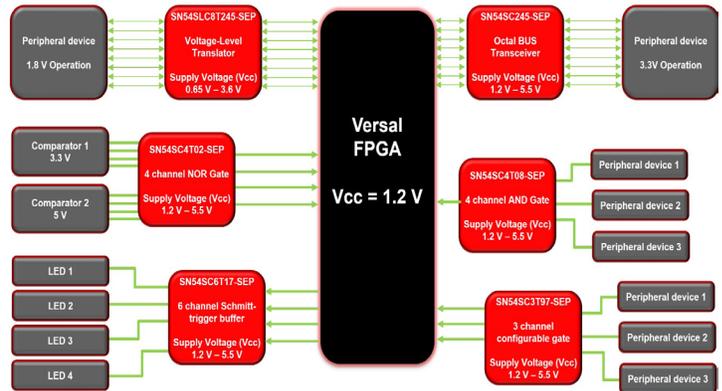
##### Applications

- Power sequencing
- Fault control and detection
- Driving signals across long board traces and transmission lines
- Single or dual supply level translation
- System reset and redundancy
- GPIO Expansion

##### Radiation performance

- TID = 30-50krad(Si)
- SEL immune to LET = 43MeV-cm<sup>2</sup>/mg

More information at [www.ti.com/product/SN54SCxT-SEP](http://www.ti.com/product/SN54SCxT-SEP)



### 29 Logic Functions across 7 product categories

- Logic Gates
- Configurable Gates
- Buffers and Inverters
- Transceivers
- Flip-Flops, Latches, and shift Registers
- Voltage Translators
- Digital Multiplexers and Demultiplexers

# Space-grade motor drive products

## Featured products

### 40V, 3-Phase BLDC Gate Driver with Integrated Bootstrap Diode

#### DRV8351-SEP

##### Key features

- Triple 1/2 H-Bridge Driver with Bootstrap gate drive architecture
- PVDD Voltage Range: 40V Three Phase Half-Bridge Gate driver (BSTx Abs Max: 57.5V)
- GVDD Voltage Range: 5V to 15V
- Sources/ Sink Current: 0.75A / 1.5A
- Extended Temperature: -55 to 150 °C
- Low leakage current on SHx pins (<55  $\mu\text{A}$ )
- Integrated Protections:
  - BST Undervoltage Lockout
  - GVDD undervoltage

##### Radiation performance

- TID = 30krad(Si) RHA
- SEL immune to LET = 43MeV-cm<sup>2</sup>/mg

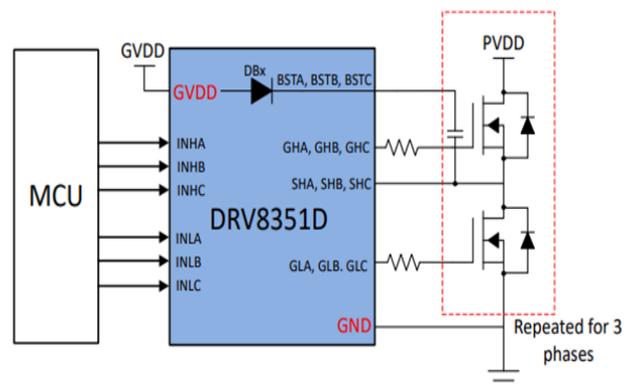
##### Applications

- Thruster Gimbal mechanism
- Antenna Pointing mechanism
- Reaction Wheel
- Propellant Control Valve

More information at [www.ti.com/product/DRV8351-SEP](http://www.ti.com/product/DRV8351-SEP)

##### Benefits

- Wide motor voltage to support up to 40V to accommodate platform designs and various battery and regulated power supply rails
- Reduced system cost and size through integration of 3 half-bridges and bootstrap diodes
- Three half bridge can be independently controlled to support different motor and actuators



# Space-grade parts list

## Space-grade amplifiers and comparators

### Comparators

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Ch #	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	Propagation Delay Time (μs)	VICR (Max) (V)	VICR (Min) (V)	V <sub>os</sub> Max at 25°C (Max) (mV)	Input Bias Current (±) (Max) (nA)	Rail-to-Rail	I <sub>q</sub> per Ch (Typ) (mA)	Package Group	ECCN <sup>2</sup>
LM139AQL-SP	5962-96738	QMLV-RHA	100	100	Bipolar	4	2.0	36	0.7	34	0	2	100	Out	0.2	CDIP, CFP, Die	EAR99
LM193QML-SP	5962-94526	QMLV-RHA	100	100	Bipolar	2	2.0	36	0.7	34.5	0	5	100	Out	0.2	CDIP, TO-99, Die	EAR99
LM111QML-SP	5962-00524	QMLV-RHA	100	50, 100	Bipolar	1	5.0	36	0.2	34	0.5	3	100	No	5.1	CDIP, CFP, TO-99, Die	EAR99
LM119QML-SP	5962-96798	QMLV-RHA	100	100	Bipolar	2	5.0	36	0.025	33	3	4	500	Out	4	CDIP, CFP, TO-100, Die	EAR99
LM139-SP	5962-96738	QMLV	40	–	Bipolar	4	2.0	36	1.3	34.5	0	2	25	Out	0.2	CDIP, Die	EAR99
LM139A-SP	5962-77008	QMLV QMLP	100	100	Bipolar	4	2.0	36	1.3	34.5	0	2	25	Out	0.2	CDIP, SOT23	EAR99

### General-Purpose Op Amps

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Ch #	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	GBW (MHz)	Slew Rate (typ) (V/μs)	V <sub>os</sub> Max at 25°C (mV)	Drift Typ (μV/C)	Rail-to-Rail	V <sub>n</sub> (nV/√Hz)	I <sub>sc</sub> Typ (mA)	I <sub>Bias</sub> (Typ) (nA)	Available Packages	ECCN <sup>2</sup>
LM124AQL-SP	5962-99504	QMLV-RHA	100	100	Bipolar	4	3	3	1.0	1	2	7	In to V–	40	60	45	CDIP, CFP, Die	EAR99
LM158QML-SP	5962-87710	QMLV-RHA	100	100	Bipolar	2	3	32	0.7	0.5	2	7	In to V–	40	30	45	CDIP, CFP, TO-99, Die	EAR99
LF411QML-SP	5962-11222	QMLV-RHA	100	100	Bipolar	1	10	44	3.0	15	2	10	No	18	25	0.05	CFP	EAR99
LM101AQL-SP	5962-99515	QMLV-RHA	50	50	Bipolar	1	10	44	1.0	0.3	2	3	In to V+	15	25	30	CDIP, TO-99, Die	EAR99
LM124-SP	5962-99504	QMLV	50	–	Bipolar	4	3	32	1.2	0.5	3	7	In to V–	35	40	30	CDIP, Die	EAR99
LM124-SP	5962-77043	QMLV	–	–	Bipolar	4	3	32	1.2	0.5	5	7	In to V–	35	40	20	CDIP	EAR99
LM148JAN-SP	M38510/110	JANS	–	–	Bipolar	4	10	44	1.0	0.5	5	15	No	60	25	30	CDIP	EAR99
OPA4H199-SP	5962-23214	QMLP	100	100	75	4	2.7	40	4.5	21	0.895	0.3	In, Out	10.8	75	0.01	SOT23	EAR99

### Precision Op Amps (V<sub>OS</sub> < 1mV)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Ch #	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	GBW (Typ) (MHz)	Slew Rate (Typ) (V/μs)	V <sub>os</sub> Max at 25°C (mV)	Drift Typ (μV/C)	Rail-to-Rail	I <sub>q</sub> Typ (mA)	V <sub>n</sub> (nV/√Hz) 1kHz	I <sub>Bias</sub> (Typ) (pA)	Available Packages	ECCN <sup>2</sup>
LMP7704-SP	5962-19206	QMLV-RHA	100	100	85	4	2.7	12	2.5	1.5	0.200	1	In, Out	0.73	9	0.2	CFP	EAR99
LMP2012QML-SP	5962-06206	QMLV-RHA	50	50	77.5	2	2.7	5	3	4.0	0.036	0.015	In to V–, Out	0.93	35	3	CDIP, CFP, Die	EAR99
OPA4277-SP	5962-16209	QMLV-RHA	50	50	85	4	4	36	1	0.8	0.065	0.1	No	0.79	8	500	CFP, CDIP-SB, Die	EAR99
TLC2201-SP	5962-90882	QMLV	–	–	–	1	4.6	16	1.8	2.5	0.200	0.50	In to V–, Out	1.1	8	1	LCCC	EAR99

### Difference Amplifiers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	Max I <sub>q</sub> (μA)	BW (kHz)	Slew Rate (V/μs)	Gain Error (max)	V <sub>cm</sub> (V)	Available Packages	ECCN <sup>2</sup>
INA1H94-SP	5962-21212	QMLV-RHA	100	–	75	4	18V	900	500	5	±0.067 %FSR	±150	CFP	EAR99

<sup>1</sup>All device operating temperatures are –55 to +125°C.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space-grade amplifiers and comparators (cont'd)

## High-Speed Op Amps ( $\geq 50\text{MHz}$ )

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV $\cdot$ cm <sup>2</sup> /mg)	Ch #	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	GBW (MHz)	Slew Rate (Typ) (V/ $\mu$ s)	V <sub>n</sub> (nV/ $\sqrt$ Hz)	V <sub>os</sub> Max at 25°C (mV)	Drift Typ ( $\mu$ V/C)	Rail-to-Rail	I <sub>q</sub> typ per Ch (mA)	I <sub>sc</sub> Typ (mA)	I <sub>Bias</sub> (Typ) (nA)	I <sub>Bias</sub> (max) (nA)	Available Packages	ECCN <sup>2</sup>
LM6172QML-SP	5962-95604	QMLV-RHA	300	100, 300	Bipolar	2	5.5	36	100	3000	12	1.5	6	No	2.3	85	1200	2500	CDIP, CFP, Die	EAR99
LM7171QML-SP	5962-95536	QMLV-RHA	300	300	Bipolar	1	5.5	36	200	4100	14	1	35	No	6.5	100	2700	10000	CDIP, CFP	EAR99
LMH6628QML-SP	5962-02545	QMLV-RHA	300	300	Bipolar	2	5	12	300	550	2	2		No	9.0	85	7000	10000	CDIP, CFP	EAR99
LMH6702QML-SP	5962-02546	QMLV-RHA	300	300	Bipolar	1	10	12	1700	3100	4.5	4.5	7	No	12.5	80	6000	15000	CDIP, CFP	EAR99
LMH6715QML-SP	5962-02547	QMLV-RHA	300	300	Bipolar	2	8	12	480	1300	3.4	6	30	No	5.8	70	5000	12000	CDIP	EAR99
THS4304-SP	5962-07219	QMLV	150	–	Bipolar	1	2.7	5	3000	790	8.5	4	5	No	18	100	–	12000	CFP	EAR99

## Fully Differential Amplifiers (FDAs)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV $\cdot$ cm <sup>2</sup> /mg)	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	GBW (MHz)	BW at A <sub>CL</sub> (MHz)	Min. A <sub>CL</sub> (MHz)	Slew Rate (Typ) (V/ $\mu$ s)	V <sub>n</sub> at Flatband (nV/ $\sqrt$ Hz)	CMRR (Typ) (dB)	Rail-to-Rail	V <sub>os</sub> Max at 25°C (mV)	I <sub>Bias</sub> (Max) ( $\mu$ A)	I <sub>q</sub> Typ per Ch (mA)	Available Packages	ECCN <sup>2</sup>
LMH5401-SP	5962-17214	QMLV-RHA	100	100	85	3.15	5.25	6500	4100	5	17500	1.25	72	No	5	60	60	LCCC	EAR99
LMH5485-SP	5962-19204	QMLV-RHA	100	100	75	2.7	5.2	850	620	1	1500	2.2	100	In to V–, Out	0.45	14.5	10.1	CFP	EAR99
THS4511-SP	5962-07222	QMLV	150	–	62	3.75	5.25	3000	1100	2	5100	2	80	In to V–	4	15.5	39.2	CFP	EAR99
THS4513-SP	5962-07223	QMLV	150	–	–	3	5.5	3000	1100	2	5100	2.2	90	No	4	15.5	37.7	CFP	EAR99

## RF Fully Differential Amplifiers (FDAs)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV $\cdot$ cm <sup>2</sup> /mg)	Min Freq (GHz)	Max Freq (GHz)	Supply Voltage (V)	P1 dB (dBm)	Gain (dB)	OIP3 (dBm)	NF (dB)	Input/Output	Available Packages	ECCN <sup>2</sup>
TRF0108-SP	TBD	QMLP-RHA	100	100	75	0.01	11	5	12	15.5	28	11	DE-SE	WQFN	EAR99
TRF0206-SP	5962-21220	QMLV-RHA	100	100	75	0.01	6.5	3.3	12	12.5	38	8	SE-DE	LCCC	EAR99
TRF0208-SP	5962-24202	QMLP-RHA	100	100	75	0.01	11	3.3	14.5	16	36	6.8	SE-DE	WQFN	EAR99
LMH5401-SP	5962-17214	QMLV-RHA	100	100	85	0	2	5	12	12	37.5	12.5	SE-DE	LCCC	EAR99

## Sample-and-Hold Amplifiers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV $\cdot$ cm <sup>2</sup> /mg)	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	Acquisition Time ( $\mu$ s)	PSRR (dB)	V <sub>os</sub> Max at 25°C (mV)	Droop Rate (V/ms)	I <sub>q</sub> Typ (mA)	Available Packages	ECCN <sup>2</sup>
LF198QML-SP	5962-87608	QMLV	–	–	Bipolar	10	36	6	80	3.5	0.001	5.5	CFP	EAR99
LF198JAN-SP	M38510/125	JANS	–	–	Bipolar	10	36	6	80	3	0.001	5.5	TO-99	EAR99

# Space-grade data converters

## RF-Sampling Transceivers

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV $\cdot$ cm <sup>2</sup> /mg)	Resolution	Number of DAC Channels	Number of ADC Channels	# of DUCs per TX	# of DDCs per RX	Package Group	ECCN <sup>2</sup>
AFE7950-SP	–	SHP-RHA	100	100	70	14 bits	4	6	2	2	FCBGA	–

<sup>1</sup>All device operating temperatures are  $-55$  to  $+125^\circ\text{C}$ .

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space-grade data converters (cont'd)

## Precision ADCs (< = 10MSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Res. (Bits)	Sample Rate (Max) (kSPS)	# of Ch	Multi-Ch wConfig.	SNR (dB)	INL (Max) (±LSB)	Input Type	Ref. Voltage (V)	Power (Typ) (mW)	Type	Package Group	ECCN <sup>2</sup>
<b>ADC168M102R-SP</b>	5962-25216	QMLP-RHA	100	100	73	16	1000	8 SE/ 4 DIFF	Multiplexed, Simultaneous	93	+/- 3	SE/DIFF	INT/EXT	67	Dual SAR	QFN	–
<b>ADC128S102QML-SP</b>	5962-07227	QMLV-RHA	100	100	120	12	1000	8	Multiplexed	72	1.1	SE	Supply	2.3	SAR	CFP, Die	EAR99 <sup>†</sup>
<b>ADS1278-SP</b>	5962-25210	QMLV-RHA	75	50	68	24	128	8	Simultaneous	111	201.4	DIFF	External	530	ΔΣ	CQFP	EAR99 <sup>‡</sup>
<b>ADS1282-SP</b>	5962-14231	QMLV-RHA	50	50	60	31	4	2	Multiplexed	130	–	DIFF	External	25	ΔΣ	CFP	EAR99 <sup>‡</sup>

<sup>†</sup>EAR99 only pertains to the Engineering Model device, ADC128S102WGMPPR. For up-to-date ECCN information contact: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com)

<sup>‡</sup>EAR99 only pertains to certain device variants, including Engineering Models (ADS1278HFQ/EM and ADS1282HKV/EM), and some Flight Models (ADS1278WHFQ-MLS and 5962L1423102VXC).

## Precision DACs (≤10MSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Res. (Bits)	Sample/Update Rate (MSPS)	Settling Time (Typ) (μs)	DNL (Typ) (±LSB)	INL (Typ) (±LSB)	Zero Code Error (mV)	Supply Voltage (V)	Power (Typ) (mW)	Architecture	Package Group	ECCN <sup>2</sup>
<b>DAC121S101QML-SP</b>	5962-07226	QMLV-RHA	100	100	120	12	1.8	12.5	-0.15/+0.25	2.75	2.12	2.7 to 5.5	0.57	String	CFP, Die	EAR99 <sup>†</sup>

## High-Speed ADCs (>1GSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Sample Rate (Max) (MSPS)	Res. (Bits)	# of Ch	Analog Input BW (-3 dB) (GHz)	SNR (dB)	ENOB (Bits)	SFDR (dB)	Input Range (V <sub>p-p</sub> )	Input Buffer	Power (Typ) (mW)	Architecture	Package Group
<b>ADC12DJ5200-SP</b>	–	SHP-RHA	300	300	120	10400, 5200	12	1, 2	8	55.6	8.8	65	0.80	Yes	4000	Folding-Interpolating	FCBGA
<b>ADC12QJ1600-SP</b>	–	SHP-RHA	300	300	120	1600	12	4	6	57	9.1	64	0.80	Yes	1900	Folding-Interpolating	FCBGA
<b>ADC12DJ3200QML-SP</b>	5962-18209	QMLV-RHA	300	300	120	3200, 6400	12	1, 2	7.3	57.2	8.9	76.0	0.80	Yes	3000	Folding Interpolating	CCGA, CLGA
<b>ADC12D1620QML-SP</b>	5962-12205	QMLV-RHA	300	300	120	1600, 3200	12	1, 2	2.4	59.8	9.5	67.4	0.80	Yes	3880	Folding Interpolating	CCGA, CLGA
<b>ADC12D1600QML-SP</b>	–	TI Space Grade RHA	300	300	120	1600, 3200	12	1, 2	2.4	58.2	9.3	67.3	0.80	Yes	3880	Folding Interpolating	CCGA
<b>ADC08D1520QML-SP</b>	5962-07214	QMLV-RHA	300	300	120	1500, 3000	8	1, 2	2.0	47.0	7.4	55.5	0.87	Yes	2000	Folding Interpolating	CQFP
<b>ADC10D1000QML-SP</b>	–	TI Space Grade RHA	100	100	120	1000, 2000	10	1, 2	2.8	56.8	9.0	67.6	0.80	Yes	2770	Folding Interpolating	CCGA

## High-Speed ADCs (>10MSPS and <1GSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Sample Rate (Max) (MSPS)	Res. (Bits)	# of Ch	Analog Input BW (MHz)	SNR (dB)	ENOB (Bits)	SFDR (dB)	Input Range (V <sub>p-p</sub> )	Input Buffer	Power (Typ) (mW)	Type	Pkg. Group	ECCN <sup>2</sup>
<b>ADS5400-SP</b>	5962-09240	QMLV	50	–	–	1000	12	1	2150	58.5	9.55	77.9	2.0	Yes	2200	Pipeline	CQFP	–
<b>ADS5463-SP</b>	5962-07208	QMLV-RHA	100	100	86	500	12	1	2000	65.4	10.1	65.0	2.2	Yes	2250	Pipeline	CQFP	–
<b>ADS5474-SP</b>	5962-13208	QMLV-RHA	200	100	87	400	14	1	1440	70.5	10.9	78.0	2.2	Yes	2500	Pipeline	CQFP	–
<b>ADS5444-SP</b>	5962-07207	QMLV	–	–	86	250	13	1	500	69.1	11.3	84.0	2.2	Yes	2250	Pipeline	CQFP	–
<b>ADC14155QML-SP</b>	5962-06262	QMLV-RHA	100	100	121	155	14	1	1100	70.1	11.3	82.3	2.0	No	967	Pipeline	CQFP	EAR99 <sup>†</sup>
<b>ADS5424-SP</b>	5962-07206	QMLV	150	–	–	105	14	1	570	72.4	11.7	82.6	2.2	No	1900	Pipeline	CQFP	–
<b>ADC3683-SP</b>	5962-23204	QMLV-RHA	300	300	75	65	18	2	400	83.8	13.7	89	3.2	No	186	Serial LVDS	CQFP	–
<b>ADC3664-SP</b>	5962-23205	QMLV-RHA	300	300	75	125	14	2	700	77.5	12.6	84	3.2	No	200	Serial LVDS	CQFP	–

<sup>†</sup>EAR99 only pertains to the engineering model device, ADC14155W-MPPR.

<sup>1</sup>All device operating temperatures are -55 to +125°C.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space-grade data converters (cont'd)

## High-Speed DACs (>10MSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Res. (Bits)	# of Ch	Update Rate (Max) (MSPS)	Settling Time (Typ) (ns)	SNR (dB)	SFDR (dBc)	THD (dBc)	Interpolation	Power (Typ) (mW)	Architecture	Interface	Pkg. Group	ECCN <sup>2</sup>
<b>DAC5670-SP</b>	5962-07247	QMLV	100	–	–	14	1	2400	3.5	52	55	52	1x, 2x	2000	Current Sink	Parallel LVDS	CBGA	–
<b>DAC5675A-SP</b>	5962-07204	QMLV	100	–	109	14	1	400	12	67	82	70	None	660	Current Sink	Parallel LVDS	CQFP	EAR99 <sup>†</sup>
<b>DAC39RF10-SP</b>	–	SHP-RHA	300	300	120	16	2	20800	36	–	85	–	128x, 12x, 16x, 192x, 1x, 24x, 256x, 2x, 32x, 3x, 48x, 4x, 64x, 6x, 8x, 96x	3800	Current Source	JESD204B, JESD204C	FCBGA	–
<b>DAC39RFS10-SP</b>	–	SHP-RHA	300	300	120	16	1	20800	36	–	85	–	128x, 12x, 16x, 192x, 1x, 24x, 256x, 2x, 32x, 3x, 48x, 4x, 64x, 6x, 8x, 96x	2800	Current Source	JESD204B, JESD204C	FCBGA	–

<sup>†</sup>EAR99 only pertains to certain device variants, including the Engineering Model (DAC5675AHFG/EM) and one Flight Model variant (5962-0720402VXC).

For up-to-date ECCN information please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com)

## Analog Front Ends: CCD/CIS Imaging

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	# of Ch	Resolution (Bit)	Sampling Rate (MSPS)	PGA Range (dB)	Fine Offset DAC Range (mV)	Power per Channel (mW/Ch)	Package	ECCN <sup>2</sup>
<b>LM98640QML-SP</b>	5962-18203	QMLV-RHA	100	100	120	2	14	5 to 40	-3 to 18	±5	122	CQFP	EAR99

# Space-grade clocks and timing

## RF PLLs and Synthesizer

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Normalized PLL Phase Noise (dBc/Hz)	1/f Noise (10-kHz Offset at 1-GHz Carrier) (dBc/Hz)	Output Frequency (Min) (MHz)	Output Frequency (Max) (MHz)	Supply Voltage (V)	Features	Package Body Size – W × L (mm <sup>2</sup> )	Package Group	ECCN <sup>2</sup>
<b>LMX2615-SP</b>	5962-17236	QMLV	100	100	120	-236	-129	40	15200	3.2 to 3.45	JESD204B	10.90 × 10.90	CQFP	EAR99
<b>LMX2624-SP</b>	5962-23210	QMLP-RHA	100	100	75	-236	-129	5	30000	3.2to3.45	JESD204B/C	10.00 × 10.00	QFP	EAR99

## Clock Jitter Cleaners

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	# of In	# of Out	RMS Jitter (fs)	Output Freq. (Min) (MHz)	Output Freq. (Max) (MHz)	Supply Voltage (V)	Input Type	Output Type	Package Group	ECCN <sup>2</sup>
<b>CDCM7005-SP</b>	5962-07230	QMLV	100	–	60	2	5	–	0	1500	3.0 to 3.6	LVCMOS (REF_CLK), LVPECL (VCXO_CLK)	LVCMOS, LVPECL	CQFP	EAR99
<b>LMK04832-SP</b>	5962-17237	QMLV-RHA	100	100	120	3	15	54	0.305	3255	3.135 to 3.465	LVCMOS, LVDS, LVPECL	CML, LVPECL, LCPECL, HSDS, LVDS, LVCMOS	CQFP	EAR99

## Clock Buffers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Additive RMS Jitter (Typ) (fs)	Output Freq. (Max) (MHz)	Number of Outputs	Output Skew (ps) (MHz)	Supply Voltage (V)	Input Type	Output Type	Package Body Size – W × L (mm <sup>2</sup> )	Package Group	ECCN <sup>2</sup>
<b>CDCLVP111-SP</b>	5962-16207	QMLV	75	–	69	40	3500	10	50	2.375 to 3.8	CML, LVDS, LVPECL, SSTL	LVPECL	9.078 × 9.078	CQFP	EAR99
<b>LMX1906-SP</b>	5962-23202	QMLV-RHA QMLP-RHA	100	100	87	5	15000	4	10	2.4 to 2.6	CML, LVDS	JESD204B/C	10.00 × 10.00	HTQFP	EAR99

## Timers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>CC</sub> Range (V)	Output Level	Package	ECCN <sup>2</sup>
<b>SE555-SP</b>	5962-98555	QMLV	25	–	Bipolar	4.5 to 16.5	TTL	CDIP	EAR99

<sup>1</sup>All device operating temperatures are -55 to +125°C.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com)

# Space-grade interface

ΑϚΔΣ

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Device Function	# of TX	# of RX	Supply Voltage (V)	Speed (Mbps)	Common-Mode Range (V)	Offset Voltage (V)	ESD (HBM) [kV]	Protocols	Package Group	ECCN <sup>2</sup>
<b>DS90C031QML-SP</b>	5962-95833	QMLV-RHA	100	100	120	Driver	4	–	5.0	155.5	–	1.2	3.5	LVDS	CFP, Die	–
<b>DS90LV031AQML-SP</b>	–	TI Space Grade	–	–	–	Driver	4	–	3.3	400	–	1.2	6	LVDS	CFP	EAR99
<b>SN55LVDS31-SP</b>	5962-97621	QMLV	150	–	110	Driver	4	–	3.3	400	–	1.2	8	LVDS	CFP	EAR99
<b>SN55LVDS32-SP</b>	5962-97622	QMLV	100	–	110	Receiver	–	4	3.3	100	0.2 to 2.2	–	8	LVDS	CFP	EAR99
<b>SN55LVDS33-SP</b>	5962-07248	QMLV	100	–	90	Receiver	–	4	3.3	400	–4.0 to 5.0	–	15	LVDS	CFP	EAR99
<b>DS90C032QML-SP</b>	5962-95834	QMLV-RHA	50	50	120	Receiver	–	4	5.0	155.5	0.2 to 2.2	–	2	LVDS	CFP, Die	EAR99
<b>DS90LV032AQML-SP</b>	–	TI Space Grade	–	–	–	Receiver	–	4	3.3	400	0.2 to 2.2	–	4.5	LVDS	CFP	EAR99
<b>SN55LVCP22-SP</b>	5962-11242	QMLV	100	–	–	Crosspoint	2	2	3.3	1000	0.05 to 3.95	1.2	5	LVDS, LVPECL, CML	CFP	–
<b>SN55LVCP22A-SP</b>	5962-11242	QMLV-RHA	100	100	75	Crosspoint	2	2	3.3	1000	0.05 to 3.95	1.2	5	LVDS, LVPECL, CML	CFP	EAR99

## RS-485 and RS-422

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Device Type	No. of TX	No. of RX	Duplex	Supply Voltage (Nom) (V)	Signaling Rate (Max) (Mbps)	Fault Protection (V)	# of nodes	Common mode range	I <sub>CC</sub> (Max) (mA)	Package Group	ECCN <sup>2</sup>
<b>DS16F95QML-SP</b>	5962-89615	QMLV-RHA	300	300	Bipolar	Transceiver	1	1	Half	5.0	10	–12 to 12	32	–7 to 12	0.5	CFP, Die	EAR99
<b>DS26F31MQML-SP</b>	5962-78023	QMLV-RHA	300	300	Bipolar	Driver	4	–	Half	5.0	10	–	10	–6 to 6	40	CFP	EAR99
<b>DS96F174MQML-SP</b>	5962-90765	QMLV	–	–	Bipolar	Driver	4	–	Half	5.0	10	–	32	–7 to 12	50	CDIP	EAR99
<b>DS26F32MQML-SP</b>	5962-78020	QMLV-RHA	100	100	Bipolar	Receiver	–	4	Half	5.0	10	–	10	–6 to 6	50	CFP, CDIP	EAR99
<b>DS96F175MQML-SP</b>	5962-90766	QMLV	–	–	Bipolar	Receiver	–	4	Half	5.0	10	–	32	–7 to 12	75	CDIP	EAR99
<b>AM26LS33A-SP</b>	5962-78020	QMLV	25	–	Bipolar	Receiver	–	4	Half	5.0	10	–25 to 25	32	–15 to 15	70	CDIP	EAR99

## Voltage Translators

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/RHA	SEL (MeV•cm <sup>2</sup> /mg)	Signaling Rate (Max) (Mbps)	Supply Voltage (Nom) (V)	Bit Count	Description	Features	Package Group	ECCN <sup>1</sup>
<b>SN54SMCS8T-SP</b>	5962-TBD	QMLP	100	100	75	200	1.1 to 5.5	8	Dir-Ctrl/Push-Pull	Ioff Circuitry, Cold-Sparing	TSSOP	EAR99

## Analog Isolators

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/RHA	SEL (MeV•cm <sup>2</sup> /mg)	Isolation Voltage	Propagation Delay	Bandwidth (max)	Input Current (mA)	Package Group	Package Body Size - W × L (mm)	ECCN <sup>1</sup>
<b>IS0S510-SP</b>	5962-TBD	QMLP	100	100	75	3750 Vrms	5 μV	680 kHz	0.7 to 10	SOIC	4.8 x 2.54	EAR99

## CAN

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Signaling Rate (Max) (Mbps)	Supply Voltage (Nom) (V)	Common Mode Range	Fault Protection (V)	Features	Package Group	ECCN <sup>2</sup>
<b>SN55HVD233-SP</b>	5962-14209	QMLV-RHA	50	50	86	1	3.0 to 3.6	–7 to 12	–16 to 16	Diagnostic loopback	CFP	EAR99

## Ethernet PHY

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Data Rate (Mbps)	Interface Type	Supply Voltage (V)	IO Supply Options (Typ) (V)	Features	Package Body Size - W × L (mm <sup>2</sup> )	Package Group	ECCN <sup>2</sup>
<b>DP83561-SP</b>	5962-20216	QMLV-RHA	300	300	121	10/100/1000	RGMII, MII	1.1 and 2.5	1.8, 2.5, 3.3	SEFI Monitoring Suite	10.90 × 10.90	CQFP	EAR99

<sup>1</sup>All device operating temperatures are –55 to +125°C.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space-grade interface (cont'd)

## Serializers, Deserializers (SerDes)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Signaling Rate (Gbps)	V <sub>CC</sub> (V)	Power (mW)	Package Group	ECCN <sup>2</sup>
<b>TLK2711-SP</b>	<a href="#">5962-05221</a>	QMLV	25	–	67.9	1.6 to 2.5	2.5	< 500	CQFP	EAR99

## Line Drivers, Line Receivers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Device Type	No. of TX	No. of RX	Supply Voltage (Nom) (V)	Common Mode Range	I <sub>CC</sub> (Max) (mA)	Input Signal	Output Signal	Package Group	ECCN <sup>2</sup>
<b>SN55183-SP</b>	<a href="#">5962-79009</a>	QMLV	40	–	Bipolar	Driver	2	–	5.0	–	10	TTL	Differential	CDIP	EAR99
<b>SN55182-SP</b>	<a href="#">5962-79008</a>	QMLV	40	–	Bipolar	Receiver	–	2	5.0	–15 to 15	9.4	Differential	TTL	DFP, CDIP	EAR99

# Space-grade sensing

## Current-Sense Amplifier

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	Common-Mode Voltage (V)	Bandwidth (MHz)	Gain (V/V)	V <sub>OS</sub> Max at 25°C (mV)	Gain Error (%)	I <sub>q</sub> Typ (mA)	Available Packages	ECCN <sup>2</sup>
<b>INA901-SP</b>	<a href="#">5962-18210</a>	QMLV-RHA	50	50	75	2.7	16	–15 to 65	0.13	20	2.5	1	0.9	CFP	EAR99
<b>INA951-SP</b>	<a href="#">5962-TBD</a>	QMLP-RHA	50	50	75	2.7	5.5	–4 to 80	1.3	20	150µV	0.15%	1.5	SOT23	EAR99

## Digital Output Temperature Sensors

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	# of Remote Temp. Sensor	# of Local Temp. Sensor	Remote Sensor Accuracy (±°C)	Local Sensor Accuracy (±°C)	Remote Temp. Range (°C)	Local Temp. Range (°C)	Temp. Resolution (°C)	Interface	Available Package	ECCN <sup>2</sup>
<b>TMP461-SP</b>	<a href="#">5962-17218</a>	QMLV-RHA	100	100	76	1	1	1.5	2.0	–64 to 191	–55 to 125	0.0625	I <sup>2</sup> C, SMBus, 2-Wire	CFP	EAR99
<b>TMP9R01-SP</b>	<a href="#">5962-17218</a>	QMLP-RHA	100	100	75	1	1	1.5	2	–64 to 191	–55 to 125	0.0625	I <sup>2</sup> C, SMBus, 2-Wire	VSSOP	EAR99
<b>TMP9R00-SP</b>	<a href="#">5962-20214</a>	QMLV-RHA	100	100	75	8	1	2	1.50	–55 to 150	–55 to 125	0.0625	I <sup>2</sup> C, SMBus, 2-Wire	CFP	EAR99

# Space-grade motor control

## Brushless-DC (BLDC) Drivers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Architecture	VS (Min) (V)	VS (Max) (V)	VS (ABS Max) (V)	Peak Output Current (A)	Gate Drive (A)	Control Interface	Package Body Size (W×L, mm)	Package Group	ECCN <sup>2</sup>
<b>UC1625-SP</b>	<a href="#">5962-91689</a>	QMLV	40	–	Bipolar	Gate driver	10	18	20	0.5	0.2	1 × PWM	35.56 × 7.49	CDIP-SB	EAR99

## Brushed-DC (BDC) and Stepper Drivers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	VS (Min) (V)	VS (Max) (V)	Peak Output Current (A)	Control Mode	Control Interface	Package Body Size (W×L, mm)	Package Group	ECCN <sup>2</sup>
<b>UC1637-SP</b>	<a href="#">5962-89957</a>	QMLV	50	–	Bipolar	±2.5	±20	0.5	PWM	Hardware	6.92 × 13.09	CFP	EAR99

<sup>1</sup>All device operating temperatures are –55 to +125°C.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftteam@list.ti.com](mailto:gtc_eccn-hts-naftteam@list.ti.com).

# Space-grade power management

## Buck Converters

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	I <sub>OUT</sub> (Max) (A)	V <sub>IN</sub> (Min) (V)	V <sub>IN</sub> (Max) (V)	V <sub>OUT</sub> (Min) (V)	# of ch	Control Mode	f <sub>s</sub> (Min) (kHz)	f <sub>s</sub> (Max) (kHz)	Duty Cycle (Max) (%)	Minimum On-Time (Max) (ns)	I <sub>q</sub> (Typ) (mA)	Package Group	ECCN <sup>2</sup>
<b>TPS50601-SP</b>	5962-10221	QMLV-RHA	100	100	85	6	3	6.3	0.8	1	Current mode	100	1000	95%	175	5	CFP, Die	EAR99
<b>TPS50601A-SP</b>	5962-10221	QMLV-RHA	100	100	75	6	3	7	0.8	1	Current mode	100	1000	100%	235	5	CFP, Die	EAR99
<b>TPS7H4001-SP</b>	5962-18205	QMLV-RHA QMLP-RHA	100	100	75	18	3	7	0.6	1	Current mode	100	1000	100%	235	4	CFP, Die, HTSSOP	EAR99
<b>TPS7H4002-SP</b>	5962-20210	QMLV-RHA	100	100	75	3	3	5.5	0.8	1	Current mode	100	1000	100%	235	2.5	CFP, Die	EAR99
<b>TPS7H4011-SP</b>	5962-21221	QMLV-RHA QMLP-RHA	100	100	75	12	4.5	14	0.6	1	Current mode	100	1000	100%	250	8	CFP, HTSSOP	EAR99
<b>TPS7H4012-SP</b>	5962-21221	QMLP-RHA	100	100	75	6	4.5	14	0.6	1	Current mode	100	1000	100%	250	6	HTSSOP	EAR99
<b>TPS7H4013-SP</b>	5962-21221	QMLP-RHA	100	100	75	3	4.5	14	0.6	1	Current mode	100	1000	100%	250	4	HTSSOP	EAR99
<b>TPS7H4102-SP</b>	5962-23208	QMLP-RHA	100	100	75	6	3	7	0.5	2	Current mode	100	1000	100%	250	10	HTQFP	EAR99
<b>TPS7H4104-SP</b>	5962-23208	QMLP-RHA	100	100	75	12	3	7	0.5	4	Current mode	100	1000	100%	250	15	HTQFP	EAR99

## Low-Dropout (LDO) Linear Regulators (Typical VDO ≤400mV)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	I <sub>OUT</sub> (Max) (A)	V <sub>IN</sub> (Min) (V)	V <sub>IN</sub> (Max) (V)	V <sub>OUT</sub> (Min) (V)	V <sub>OUT</sub> (Max) (V)	V <sub>DO</sub> (Typ) (mV)	Acc. (%)	Noise (μVrms)	PSRR at 100 KHz (dB)	PSRR at 1MHz (dB)	PSRR at 10MHz (dB)	Output Options	Package Group	ECCN <sup>2</sup>
<b>TPS7A4501-SP</b>	5962-12224	QMLV-RHA	100	100	86	1.5	2.3	20	1.21	19.2	270	3	50	44	35	32	Adj.	CFP, Die	EAR99
<b>TPS7H1101A-SP</b>	5962-13202	QMLV-RHA	100	100	85	3	1.5	7	0.8	6.65	210	2	20	25	15	12	Adj.	CFP, Die	EAR99
<b>TPS7H1111-SP</b>	5962-21203	QMLV-RHA QMLP-RHA	100	100	75	1.5	0.85	7	0.4	5.5	200	1.5	1.68	71	67	30	Adj.	CFP, HTSSOP	EAR99
<b>TPS7H1121-SP</b>	5962-23203	QMLV-RHA QMLP-RHA	100	100	75	2	2.25	14	0.6	13.9	250 at 1A, 500 at 2A	1.5	50	40	34	33	Adj.	CFP, HTSSOP	EAR99
<b>TPS7H1301-SP</b>	5962-24215	QMLV-RHA	100	100	75	0.4	3	6.3	-0.6	-6	200	1	20	25	48	-	Adj.	CFP	EAR99

## Standard Linear Regulators (Typical VDO >400mV)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	I <sub>OUT</sub> (Max) (A)	V <sub>IN</sub> (Min) (V)	V <sub>IN</sub> (Max) (V)	V <sub>OUT</sub> (Min) (V)	V <sub>OUT</sub> (Max) (V)	V <sub>DO</sub> (Typ) (mV)	Acc. (%)	Noise (μVrms)	PSRR at 100 KHz (dB)	Output Options	Package Group	ECCN <sup>2</sup>
<b>LM117QML-SP</b>	5962-99517	QMLV-RHA	100	100	Bipolar	1.5	4.2	40	1.25	37	1200	4	120	40	Adj.	CFP, TO-3, TO-2, Die	EAR99
<b>LM117HVQML-SP</b>	5962-07229	QMLV-RHA	100	100	Bipolar	0.5	4.2	60	1.25	57	1500	2	1710	40	Adj.	CFP, TO-3, Die	EAR99
<b>LM137QML-SP</b>	5962-99517	QMLV-RHA	30	30	Bipolar	1.5	-40	-4.2	-37.0	-1.2	3000	4	1110	30	Adj.	TO-3	EAR99
<b>LM137JAN-SP</b>	M38510/118	JANS	-	-	Bipolar	1.5	-40	-4.2	-37.0	-1.2	3000	4	1110	30	Adj.	TO-2	EAR99
<b>LM2940QML-SP</b>	5962-89587	QMLV-RHA	100	100	Bipolar	1	6	26	5	5	500	5	350	50	5.0	CFP, Die	EAR99
<b>LM2941QML-SP</b>	5962-91667	QMLV-RHA	100	100	Bipolar	1	6	26	5	20	500	5	600	67	Adj.	CFP, Die	EAR99
<b>LM723JAN-SP</b>	M38510/102	JANS	-	-	Bipolar	0.15	9.5	40	2	37	3000	3	86	-	Adj.	CDIP, TO-100	EAR99
<b>LP2953QML-SP</b>	5962-92336	QMLV	-	-	Bipolar	0.25	2.3	30	1.2	29	470	3	80	32	Adj., 5.0	CFP, Die	EAR99

## Linear Regulator (LDO) Controllers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	I <sub>drive</sub> (Max) (mA)	V <sub>OUT</sub> (min) (V)	V <sub>OUT</sub> (max) (V)	Package	ECCN <sup>2</sup>
<b>UC1832-SP</b>	5962-93265	QMLV	40	-	Bipolar	100	2	40	CDIP, LCCC	EAR99
<b>UC1834-SP</b>	5962-87742	QMLV	40	-	Bipolar	200	1.5	40	CDIP, LCCC	EAR99

<sup>1</sup>All device operating temperatures are -55 to +125°C.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space-grade power management (cont'd)

## DDR Memory Power

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (Max) (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	Regulator Type	I <sub>OUT</sub> VTT (Max) (A)	V <sub>IN</sub> (Min) (V)	V <sub>IN</sub> (Max) (V)	V <sub>OUT</sub> VTT (Min) (V)	DDR Memory Type(s)	V <sub>IN</sub> Bias (Min) (V)	V <sub>IN</sub> Bias (Max) (V)	Package Group	ECCN <sup>2</sup>
<b>TPS7H3301-SP</b>	5962-14228	QMLV-RHA	100	100	70	Linear	3.0	0.9	3.5	0.6	DDR2, DDR3, DDR4	2.375	3.5	CFP	EAR99
<b>TPS7H3302-SP</b>	5962-14228	QMLP-RHA	100	100	70	Linear	3.0	0.9	3.5	0.6	DDR2, DDR3, DDR4	2.375	3.5	HTSSOP	EAR99

## eFuses and Load Switches

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	V <sub>IN</sub> Range (V)	Type	R <sub>ON</sub> (Typ) (mΩ)	Continuous Current Load (Max) (A)	Programmable Current Limit Range (A)	Package	ECCN <sup>2</sup>
<b>TPS7H2201-SP</b>	5962-17220	QMLV-RHA QMLP-RHA	100	100	75	1.5 to 7.0	eFuse	35	6	0.5–7.0	CFP, HTSSOP	EAR99
<b>TPS7H2211-SP</b>	5962-18220	QMLV-RHA QMLP-RHA	100	100	75	4.5 to 14	eFuse	60	3.5	–	CFP, HTSSOP	EAR99

## Shunt Voltage References

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>O</sub> (V)	Initial Accuracy (Max) (%)	Accuracy Over Temp. (%)	I <sub>Z</sub> for Reg. (Min) (μA)	I <sub>OUT</sub> /I <sub>Z</sub> (Max) (mA)	Output Noise (μVrms)*	V <sub>n</sub> (nV/√Hz) at 1kHz	Temp. Coeff. (Typ) at 25°C (ppm/°C)	Operating Temp. Range (°C)	Package Group	ECCN <sup>2</sup>
<b>LM136A-2.5QML-SP</b>	5962-00501	QMLV-RHA	100	100	Bipolar	2.5	1.0	–2.4/+1.6	400	10	–	120	26	–55 to 125	TO, Die	EAR99
<b>LM185-1.2QML-SP</b>	5962-87594	QMLV-RHA	100	100	Bipolar	1.2	1.0	+0.42/+5	10	20	28	400	–	–55 to 125	TO	EAR99
<b>LM185-2.5QML-SP</b>	5962-87594	QMLV	100	–	Bipolar	2.5	0.8	±3	20	20	42	800	–	–55 to 125	TO	EAR99
<b>LM4050QML-SP (2.5V)</b>	5962-09235	QMLV-RHA	100	100	Bipolar	2.5	0.1	±0.7	65	15	50	–	3	–55 to 125	CFP	EAR99
<b>LM4050QML-SP (5.0V)</b>	5962-09235	QMLV-RHA	100	100	Bipolar	5	0.1	±0.74	74	15	100	–	9	–55 to 125	CFP	EAR99
<b>TL1431-SP</b>	5962-99620	QMLV-RHA	150	100	Bipolar	2.5–36	0.4	±2	450	100	–	122	38	–55 to 125	CDIP, CFP	EAR99
<b>TL1431-DIE</b>	–	Tested die	100	–	Bipolar	2.5–36	0.4	–	450	100	–	122	–	25	Die	EAR99

\*For frequencies 10Hz ≤ f ≤ 10kHz.

## Low-Side Gate Drivers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	# of Ch	Output Channel Types	Power Switch	Input V <sub>CC</sub> (Min) (V)	Input V <sub>CC</sub> (Max) (V)	Peak Output Current (A)	Rise Time (ns)	Fall Time (ns)	Prop Delay (ns)	Package Group	ECCN <sup>2</sup>
<b>UC1705-SP</b>	5962-95798	QMLV	–	–	Bipolar	1	Single low-side	MOSFET, IGBT	5	40	1.5	40	40	100	CDIP	EAR99
<b>UC1707-SP</b>	5962-87619	QMLV	50	–	Bipolar	2	Single low-side	MOSFET, IGBT	5	40	1.5	40	40	100	CFP, LCCC, CDIP	EAR99
<b>UC1708-SP</b>	5962-00514	QMLV	40	–	Bipolar	2	Dual low-side	MOSFET, IGBT	5	35	3	25	25	25	LCCC, CDIP	EAR99
<b>UC1709-SP</b>	5962-01512	QMLV	–	–	Bipolar	2	Dual low-side	MOSFET, IGBT	5	40	1.5	40	40	25	CDIP	EAR99
<b>UC1710-SP</b>	5962-01520	QMLV	–	–	Bipolar	1	Single low-side	MOSFET, IGBT	5	18	6	25	20	35	CDIP	EAR99
<b>UC1715-SP</b>	5962-00521	QMLV	50	–	Bipolar	2	Low-side, Aux low-side	MOSFET	7	20	2	30	25	50	CFP	EAR99

## Half-bridge Gate Drivers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Channel Input Logic	Power Switch	Input V <sub>CC</sub> (Min) (V)	Input V <sub>CC</sub> (Max) (V)	Peak Output Current (A)	Bus Voltage (max) (V)	Package Group	ECCN <sup>2</sup>
<b>TPS7H6003-SP</b>	5962-22201	QMLV-RHA	100	100	75	TTL/PWM	GaN FET	10	16	1.3	200	CFP	EAR99
<b>TPS7H6013-SP</b>	5962-22201	QMLV-RHA	100	100	75	TTL/PWM	GaN FET	10	16	1.3	60	CFP	EAR99
<b>TPS7H6023-SP</b>	5962-22201	QMLV-RHA	100	100	75	TTL/PWM	GaN FET	10	16	1.3	22	CFP	EAR99
<b>TPS7H6005-SP</b>	5862-22201	QMLP-RHA	100	100	75	TTL/PWM	GaN FET	10	16	1.3	200	HTSSOP	EAR99
<b>TPS7H6015-SP</b>	5962-22201	QMLP-RHA	100	100	75	TTL/PWM	GaN FET	10	16	1.3	60	HTSSOP	EAR99
<b>TPS7H6025-SP</b>	5962-22201	QMLP-RHA	100	100	75	TTL/PWM	GaN FET	10	16	1.3	22	HTSSOP	EAR99

# Space-grade power management (cont'd)

## PWM Controllers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. Max (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	V <sub>CC</sub> (Min) (V)	V <sub>CC</sub> (Max) (V)	Duty Cycle (Max) (%)	UVLO Thresholds On/Off(V)	Frequency (Max) (kHz)	Gate Drive (Typ) (A)	PWM Outputs (#)	Operating Temp. Range (°C)	Package	ECCN <sup>2</sup>
TPS7H5001-SP	5962-18222	QMLV-RHA QMLP-RHA	100	100	75	4	14	50, 75, 100	Adjustable	2000	0.15	2	-55 to 125	CFP, Die HTSSOP	EAR99
TPS7H5002-SP	5962-18222	QMLV-RHA QMLP-RHA	100	100	75	4	14	75, 100	Adjustable	2000	0.15	1	-55 to 125	CFP, HTSSOP	EAR99
TPS7H5003-SP	5962-18222	QMLV-RHA QMLP-RHA	100	100	75	4	14	75, 100	Adjustable	2000	0.15	1	-55 to 125	CFP, HTSSOP	EAR99
TPS7H5004-SP	5962-18222	QMLV-RHA QMLP-RHA	100	100	75	4	14	50	Adjustable	2000	0.15	2	-55 to 125	CFP, HTSSOP	EAR99
TPS7H5020-SP	5962-24201	QMLP-RHA	100	100	75	4	14	100	Adjustable	1000	1.2	1	-55 to 125	HTSSOP	EAR99
TPS7H5021-SP	5962-24201	QMLP-RHA	100	100	75	4	14	50	Adjustable	1000	1.2	1	-55 to 125	HTSSOP	EAR99
TPS7H5030-SP	5962-24201	QMLP-RHA	100	100	75	8	14	100	Adjustable	500	1.2	1	-55 to 125	HTSSOP	EAR99
TPS7H5031-SP	5962-24201	QMLP-RHA	100	100	75	8	14	50	Adjustable	500	1.2	1	-55 to 125	HTSSOP	EAR99
UC1525B-SP	5962-89511	QMLV	40	-	Bipolar	8	35	50	7/6.8	400	0.5	2	-55 to 125	CDIP, LCCC	EAR99
UC1823A-SP	5962-89905	QMLV	-	-	Bipolar	12	20	100	9.2/8.4	1000	2	1	-55 to 125	CDIP	EAR99
UC1825-DIE	-	Tested die	30	-	Bipolar	12	20	50	9.2/8.4	1000	2	2	25	Die	EAR99
UC1825-SP	5962-87681	QMLV	40	-	Bipolar	12	20	50	9.2/8.4	1000	2	2	-55 to 125	CDIP, LCCC	EAR99
UC1825A-DIE	-	Tested die	30	-	Bipolar	10	30	50	9.2/8.4	1000	2	2	25	Die	EAR99
UC1825A-SP	5962-87681	QMLV-RHA	40	30	Bipolar	10	30	50	9.2/8.4	1000	2	2	-55 to 125	CFP, CDIP, LCCC	EAR99
UC1825B-SP	5962-87681	QMLV-RHA	100	100	Bipolar	10	30	50	10.0/9.2	1000	2	2	-55 to 125	CFP, Die	EAR99
UC1842-SP	5962-86704	QMLV	-	-	Bipolar	12	28	100	16/10	500	1	1	-55 to 125	CDIP	EAR99
UC1842A-SP	5962-86704	QMLV	30	-	Bipolar	12	25	100	16/10	500	1	1	-55 to 125	CDIP	EAR99
UC1843-SP	5962-86704	QMLV	50	-	Bipolar	8.5	30	100	8.4/7.6	500	1	1	-55 to 125	CDIP, LCCC, Die	EAR99
UC1843A-DIE	-	Tested die	30	-	Bipolar	12	25	100	8.4/7.6	500	1	1	25	Die	EAR99
UC1843A-SP	5962-86704	QMLV-RHA	40	30	Bipolar	12	25	100	8.4/7.6	500	1	1	-55 to 125	CFP, CDIP, LCCC	EAR99
UC1843B-SP	5962-86704	QMLV-RHA	100	100	Bipolar	12	25	100	8.4/7.6	500	1	1	-55 to 125	CFP, Die	EAR99
UC1844-SP	5962-86704	QMLV	-	-	Bipolar	12	30	50	16/10	500	1	1	-55 to 125	LCCC	EAR99
UC1844A-SP	5962-86704	QMLV	30	-	Bipolar	12	30	50	16/10	500	1	1	-55 to 125	CDIP	EAR99
UC1845-SP	5962-86704	QMLV	-	-	Bipolar	12	30	50	8.4/7.6	500	1	1	-55 to 125	CDIP, LCCC	EAR99
UC1845A-SP	5962-86704	QMLV-RHA	45	30	Bipolar	12	25	50	8.4/7.6	500	1	1	-55 to 125	CFP, CDIP, LCCC	EAR99
UC1846-DIE	-	Tested die	-	-	Bipolar	12	40	50	7.70/6.95	500	1	1	25	Die	EAR99
UC1846-SP	5962-86806	QMLV-RHA	40	30	Bipolar	12	40	50	7.70/6.95	500	0.5	2	-55 to 125	CFP, CDIP, LCCC, Die	EAR99
UC1856-SP	5962-94530	QMLV	-	-	Bipolar	12	40	50	7.7/7.0	1000	1.5	2	-55 to 125	CFP, CDIP	EAR99
UC1863-SP	5962-92031	QMLV	-	-	Bipolar	12	22	50	8.0/7.0	500	1	2	-55 to 125	LCCC	EAR99
UC1875-SP	5962-94555	QMLV	50	-	Bipolar	10.8	18	100	10.75/11.75	1000	2	4	-55 to 125	CFP, CDIP	EAR99
UCC1806-SP	5962-94575	QMLV	-	-	Bipolar	8	14.5	50	7.5/6.75	1000	0.5	2	-55 to 125	CDIP, LCCC	EAR99

## Supervisors and Reset ICs

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (Max) (MeV•cm <sup>2</sup> /mg)	V <sub>CC</sub> Range (V)	Threshold Voltage	Function	Output Type	Package	ECCN <sup>2</sup>
TPS7H3024-SP	5962-24206	QMLV-RHA	100	100	75	14	Adjustable	2 Window	Push-Pull	CFP	EAR99
TPS7H3124-SP	5962-24206	QMLV-RHA	100	100	75	14	Adjustable	2 Window	Open-Drain	CFP	EAR99
TPS7H3134-SP	5962-24206	QMLV-RHA	100	100	75	14	Adjustable	4 OV or 4 UV	Push-Pull	CFP	EAR99
TPS7H3134-SP	5962-24206	QMLV-RHA	100	100	75	14	Adjustable	4 OV or 4 UV	Open-Drain	CFP	EAR99

## Sequencers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	V <sub>IN</sub> (min)	V <sub>OUT</sub> (max)	# of Ch.	Package	ECCN <sup>2</sup>
TPS7H3014-SP	5962-23201	QMLV	100	100	75	3	14	4	CFP	EAR99

<sup>1</sup>Device operating temperatures are -55 to +125°C, as noted.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space-grade power management (cont'd)

## Isolated Feedback Generators

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	V <sub>IN</sub> Range (V)	Ref. Voltage	Ref. Tolerance (%)	Package	ECCN <sup>2</sup>
<b>UC1901-SP</b>	5962-89441	QMLV	–	–	Bipolar	4.5 to 40	1.5	1	CDIP	EAR99

## Precision Analog Controllers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	I <sub>drive</sub> (Max) (mA)	V <sub>OUT</sub> (min) (V)	V <sub>OUT</sub> (max) (V)	Package	ECCN <sup>2</sup>
<b>UC19432-SP</b>	5962-09233	QMLV	30	–	Bipolar	100	2	40	CDIP, LCCC	EAR99

# Space-grade embedded processing and memory

## MSP430™ Mixed-Signal Microcontrollers (MCUs)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	ADC	FRAM (KB)	RAM (KB)	ADC #	GPIO #	I <sup>2</sup> C (#)	SPI (#)	UART (#)	Compa-rators (# of Ch)	16-bit Timers #	Operating Temp. Range (°C)	Package	ECCN <sup>2</sup>
<b>MSP430FR5969-SP</b>	–	RH Plastic	75	50	72	12-bit SAR	64	2	16	40	1	3	2	16	5	–55 to 105	QFP, QFN	EAR99

## Digital Signal Processors (DSPs)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	DSP	CPU	DSP Max Freq. (MHz)	GFLOPS	I/O Supply (V)	Package
<b>SMJ320C6701-SP</b>	5962-98661	QMLV	100	–	117	C67x	32/64-bit	140	1	3.3	CBGA, CLGA
<b>SMV320C6727B-SP</b>	–	RH Ceramic	150	100	100	C67x+	32/64-bit	250	1.5	3.3	CQFP

## SRAM Memory

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	Memory Density (Mb)	Memory Configuration	Read Time (ns)	Write Time (ns)	Error Mitigation	Package
<b>SMV512K32-SP</b>	5962-11237	QMLV	300	–	110	16	512k x 32	20	13.8	Built-In EDAC	CFP

<sup>1</sup>All device operating temperatures are –55 to +125°C.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space-grade logic

## Logic

Generic Part Number	Military Spec	Qualification	TID Char. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	Sub-Family (Part Type)	Family	# of Ch	V <sub>CC</sub> Range (V)	Package	Operating Temp. (°C)	ECCN <sup>1</sup>
SN54AC00-SP	5962-87549	QMLV-RHA	100	100	86	NAND gate	AC	4	2 to 6	CDIP, CFP, Die	-55 to 125	EAR99 <sup>†</sup>
SN54HC00-DIE	–	Tested die	–	–	–	NAND gate	HC	4	2 to 6	Die	25	EAR99
SN54HC00-SP	5962-84037	QMLV	–	–	–	NAND gate	HC	4	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HC10-SP	5962-84038	QMLV	–	–	–	NAND gate	HC	3	2 to 6	CDIP	-55 to 125	EAR99
SN54HC132-SP	5962-89845	QMLV	–	–	–	NAND gate	HC	4	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HC20-SP	5962-84039	QMLV	–	–	–	NAND gate	HC	2	2 to 6	CDIP	-55 to 125	EAR99
SN54LS00-SP	M38510/300	JANS	–	–	Bipolar	NAND gate	LS	4	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54LS10-SP	M38510/300	JANS	–	–	Bipolar	NAND gate	LS	3	4.5 to 5.5	CFP	-55 to 125	EAR99
SN54LS26-SP	5962-76020	QMLV	–	–	Bipolar	NAND gate	LS	4	4.5 to 5.5	CFP	-55 to 125	EAR99
SN54LVC00A-SP	5962-97533	QMLV	–	–	–	NAND gate	LVC	4	2 to 6	CFP	-55 to 125	EAR99
SN54AC02-DIE	–	Tested die	50	–	–	NOR gate	AC	4	2 to 6	Die	25	EAR99
SN54AC02-SP	5962-87612	QMLV	50	–	–	NOR gate	AC	4	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HC02-SP	5962-84041	QMLV	–	–	–	NOR gate	HC	4	2 to 6	CDIP	-55 to 125	EAR99
SN54LS02-SP	M38510/303	JANS	–	–	Bipolar	NOR gate	LS	4	4.5 to 5.5	CFP	-55 to 125	EAR99
SN54AHCT08-SP	5962-96821	QMLV	–	–	–	AND gate	AHCT	4	4.5 to 5.5	CFP	-55 to 125	EAR99
SN54HC08-DIE	–	Tested die	–	–	–	AND gate	HC	4	2 to 6	Die	25	EAR99
SN54HC08-SP	5962-84047	QMLV	–	–	–	AND gate	HC	4	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HC11-SP	5962-84048	QMLV	–	–	–	AND gate	HC	3	2 to 6	CDIP	-55 to 125	EAR99
SN54LS08-SP	M38510/310	JANS	–	–	Bipolar	AND gate	LS	4	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54HC32-SP	5962-84045	QMLV	–	–	–	OR gate	HC	4	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54LS32-SP	M38510/305	JANS	–	–	Bipolar	OR gate	LS	4	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54AC14-SP	5962-87624	QMLV	50	–	–	Inverting buffer	AC	6	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54ACT04-SP	5962-89734	QMLV	–	–	–	Inverting buffer	ACT	6	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54AHCT14-SP	5962-96801	QMLV	–	–	–	Inverting buffer	AHCT	6	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54HC04-SP	5962-84098	QMLV	–	–	–	Inverting buffer	HC	6	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HC14-SP	5962-84091	QMLV	–	–	–	Inverting buffer	HC	6	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HCT04-SP	5962-89747	QMLV	–	–	–	Inverting buffer	HCT	6	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54LS04-SP	M38510/300	JANS	–	–	Bipolar	Inverting buffer	LS	6	4.5 to 5.5	CDIP	-55 to 125	EAR99
SN54LS14-SP	5962-96658	QMLV	–	–	Bipolar	Inverting buffer	LS	6	4.5 to 5.5	CFP	-55 to 125	EAR99
SN54LS240-SP	5962-78012	QMLV	–	–	Bipolar	Inverting buffer	LS	8	4.5 to 5.5	CFP	-55 to 125	EAR99
SN54LVC14A-SP	5962-97615	QMLV	–	–	–	Inverting buffer	LVC	6	2 to 3.6	CDIP, CFP, LCCC	-55 to 125	EAR99
SN54AC244-SP	5962-87552	QMLV	–	–	–	Non-inverting buffer	AC	8	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54ACT244-SP	5962-87760	QMLV	–	–	–	Non-inverting buffer	ACT	8	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54AHC244-SP	5962-96782	QMLV	–	–	–	Non-inverting buffer	AHC	8	2 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54ALS244C-SP	5962-86839	QMLV	–	–	Bipolar	Non-inverting buffer	ALS	8	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54HC244-SP	5962-84096	QMLV	–	–	–	Non-inverting buffer	HC	8	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HCT244-SP	5962-85130	QMLV	–	–	–	Non-inverting buffer	HCT	8	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54LS244-SP	M38510/324	JANS	–	–	Bipolar	Non-inverting buffer	LS	8	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99
SN54LVCH244A-SP	5962-97542	QMLV	–	–	–	Non-inverting buffer	LVC	8	2 to 3.6	CFP, LCCC	-55 to 125	EAR99
SN54LVTH162244-SP	5962-96809	QMLV	–	–	–	Non-inverting buffer	LVT	16	2.7 to 3.6	CFP	-55 to 125	EAR99
SN54LVTH16244A-SP	5962-96685	QMLV	–	–	–	Non-inverting buffer	LVT	16	2.7 to 3.6	CFP	-55 to 125	EAR99
SN54LVTH244A-SP	5962-95844	QMLV	–	–	–	Non-inverting buffer	LVT	8	2.7 to 3.6	CDIP, CFP, LCCC	-55 to 125	EAR99
SN54AC74-SP	5962-88520	QMLV	–	–	–	D-type flip-flop	AC	2	2 to 6	CFP	-55 to 125	EAR99
SN54ACT374-SP	5962-87631	QMLV	–	–	–	D-type flip-flop	ACT	8	4.5 to 5.5	CFP	-55 to 125	EAR99
SN54HC273-DIE	–	Tested die	–	–	–	D-type flip-flop	HC	8	2 to 6	Die	25	EAR99
SN54HC273-SP	5962-84099	QMLV	–	–	–	D-type flip-flop	HC	8	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HC374-SP	5962-84071	QMLV	–	–	–	D-type flip-flop	HC	8	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54HC74-SP	5962-84056	QMLV	–	–	–	D-type flip-flop	HC	2	2 to 6	CDIP, CFP	-55 to 125	EAR99
SN54LS273-SP	5962-78010	QMLV	–	–	Bipolar	D-type flip-flop	LS	8	4.5 to 5.5	CDIP	-55 to 125	EAR99
SN54LS74A-SP	M38510/301	JANS	–	–	Bipolar	D-type flip-flop	LS	2	4.5 to 5.5	CDIP, CFP	-55 to 125	EAR99

# Space-grade logic (cont'd)

## Logic (cont'd)

Generic Part Number	Military Spec	Qualification	TID Char. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	Sub-Family (Part Type)	Family	# of Ch	V <sub>CC</sub> Range (V)	Package	Operating Temp. (°C)	ECCN <sup>1</sup>
<b>SN54LVC74A-SP</b>	<a href="#">5962-97616</a>	QMLV	–	–	–	D-type flip-flop	LVC	2	2 to 3.6	CFP	–55 to 125	EAR99
<b>SN54LVTH162374-SP</b>	<a href="#">5962-98542</a>	QMLV	–	–	–	D-type flip-flop	LVT	16	2.7 to 3.6	CFP	–55 to 125	EAR99
<b>SN54LVTH574-SP</b>	<a href="#">5962-95832</a>	QMLV	–	–	–	D-type flip-flop	LVT	8	2.7 to 3.6	CFP	–55 to 125	EAR99
<b>SN54HC109-SP</b>	<a href="#">5962-84150</a>	QMLV	–	–	–	J-K flip-flop	HC	2	2 to 6	CFP	–55 to 125	EAR99
<b>SN54AC373-SP</b>	<a href="#">5962-87555</a>	QMLV	–	–	–	D-type latch	AC	8	2 to 6	CFP	–55 to 125	EAR99
<b>SN54ACT373-SP</b>	<a href="#">5962-87556</a>	QMLV	–	–	–	D-type latch	ACT	8	4.5 to 5.5	CDIP	–55 to 125	EAR99
<b>SN54HC373-DIE</b>	–	Tested die	–	–	–	D-type latch	HC	8	2 to 6	Die	25	EAR99
<b>SN54HC373-SP</b>	<a href="#">5962-84072</a>	QMLV	–	–	–	D-type latch	HC	8	2 to 6	CDIP, CFP	–55 to 125	EAR99
<b>SN54HC573A-SP</b>	<a href="#">5962-85128</a>	QMLV	–	–	–	D-type latch	HC	8	2 to 6	CDIP	–55 to 125	EAR99
<b>SN54HCT373-SP</b>	<a href="#">5962-86867</a>	QMLV	–	–	–	D-type latch	HCT	8	4.5 to 5.5	CFP	–55 to 125	EAR99
<b>SN54LS373-SP</b>	<a href="#">M38510/325</a>	JANS	–	–	Bipolar	D-type latch	LS	8	4.75 to 5.25	CDIP, CFP	–55 to 125	EAR99
<b>SN54LVTH162373-SP</b>	<a href="#">5962-97638</a>	QMLV	–	–	–	D-type latch	LVT	16	2.7 to 3.6	CFP	–55 to 125	EAR99
<b>SN54HC161-SP</b>	<a href="#">5962-84075</a>	QMLV	–	–	–	Counter	HC	–	2 to 6	CDIP	–55 to 125	EAR99
<b>SN54LS161A-SP</b>	<a href="#">5962-76008</a>	QMLV	–	–	Bipolar	Counter	LS	–	4.75 to 5.25	CDIP	–55 to 125	EAR99
<b>SN54LS193-SP</b>	<a href="#">M38510/315</a>	JANS	–	–	Bipolar	Counter	LS	–	4.75 to 5.25	CFP	–55 to 125	EAR99
<b>SN54LS393-SP</b>	<a href="#">M38510/327</a>	JANS	–	–	Bipolar	Counter	LS	–	4.75 to 5.25	CFP	–55 to 125	EAR99
<b>SN54LS283-SP</b>	<a href="#">5962-76043</a>	QMLV	–	–	Bipolar	Adder	LS	–	4.75 to 5.25	CDIP	–55 to 125	EAR99
<b>SN54HC138-SP</b>	<a href="#">5962-84062</a>	QMLV	–	–	–	Encoders & decoders	HC	1	2 to 6	CDIP, CFP	–55 to 125	EAR99
<b>SN54HC139-SP</b>	<a href="#">5962-84092</a>	QMLV	–	–	–	Encoders & decoders	HC	2	2 to 6	CFP	–55 to 125	EAR99
<b>SN54HC153-SP</b>	<a href="#">5962-84093</a>	QMLV	–	–	–	Encoders & decoders	HC	2	2 to 6	CDIP, CFP	–55 to 125	EAR99
<b>SN54HC157-SP</b>	<a href="#">5962-86061</a>	QMLV	–	–	–	Encoders & decoders	HC	4	2 to 6	CDIP	–55 to 125	EAR99
<b>SN54LS138-SP</b>	<a href="#">M38510/307</a>	JANS	–	–	Bipolar	Encoders & decoders	LS	1	4.5 to 5.5	CDIP, CFP	–55 to 125	EAR99
<b>SN54LS139A-SP</b>	<a href="#">M38510/307</a>	JANS	–	–	Bipolar	Encoders & decoders	LS	2	4.5 to 5.5	CDIP, CFP	–55 to 125	EAR99
<b>SN54LS145-SP</b>	<a href="#">5962-85084</a>	QMLV	–	–	Bipolar	Encoders & decoders	LS	1	4.5 to 5.5	CDIP	–55 to 125	EAR99
<b>SN54LVC138A-SP</b>	<a href="#">5962-97526</a>	QMLV	–	–	–	Encoders & decoders	LVC	1	2 to 3.6	CFP	–55 to 125	EAR99
<b>SN54LS123-SP</b>	<a href="#">5962-76039</a>	QMLV	–	–	Bipolar	Monostable multivibrator	LS	2	4.75 to 5.25	CDIP, CFP	–55 to 125	EAR99
<b>SN54LVC646A-SP</b>	<a href="#">5962-97626</a>	QMLV	50	–	–	Registered transceiver	LVC	–	2 to 3.6	CFP	–55 to 125	EAR99
<b>SN54HC164-SP</b>	<a href="#">5962-84162</a>	QMLV	–	–	–	Shift register	HC	8	2 to 6	CDIP, CFP	–55 to 125	EAR99
<b>SN54HC166-SP</b>	<a href="#">5962-90501</a>	QMLV	–	–	–	Shift register	HC	8	2 to 6	CDIP	–55 to 125	EAR99
<b>SN54HC595-SP</b>	<a href="#">5962-86816</a>	QMLV	–	–	–	Shift register	HC	8	2 to 6	CDIP, CFP	–55 to 125	EAR99
<b>SN54LS164-SP</b>	<a href="#">M38510/306</a>	JANS	–	–	Bipolar	Shift register	LS	8	4.75 to 5.25	CDIP, CFP	–55 to 125	EAR99
<b>SN54LS165A-SP</b>	<a href="#">5962-77006</a>	QMLV	–	–	Bipolar	Shift register	LS	8	4.75 to 5.25	CDIP, CFP	–55 to 125	EAR99
<b>SN54AC245-SP</b>	<a href="#">5962-87758</a>	QMLV	–	–	–	Standard transceiver	AC	–	2 to 6	CFP	–55 to 125	EAR99
<b>SN54ACT245-SP</b>	<a href="#">5962-87663</a>	QMLV	–	–	–	Standard transceiver	ACT	–	4.5 to 5.5	CDIP, CFP	–55 to 125	EAR99
<b>SN54AHC245-SP</b>	<a href="#">5962-96818</a>	QMLV	–	–	–	Standard transceiver	AHC	–	2 to 5.5	CFP	–55 to 125	EAR99
<b>SN54HC245-SP</b>	<a href="#">5962-84085</a>	QMLV	–	–	–	Standard transceiver	HC	–	2 to 6	CDIP, CFP	–55 to 125	EAR99
<b>SN54HCT245-SP</b>	<a href="#">5962-85506</a>	QMLV	–	–	–	Standard transceiver	HCT	–	4.5 to 5.5	CDIP, CFP	–55 to 125	EAR99
<b>SN54LS245-SP</b>	<a href="#">5962-80021</a>	QMLV	–	–	Bipolar	Standard transceiver	LS	–	4.5 to 5.5	CFP	–55 to 125	EAR99
<b>SN54LVCH245A-SP</b>	<a href="#">5962-97543</a>	QMLV	–	–	–	Standard transceiver	LVC	–	2 to 3.6	CDIP, CFP, LCCC	–55 to 125	EAR99
<b>SN54LVTH162245-SP</b>	<a href="#">5962-96780</a>	QMLV	–	–	–	Standard transceiver	LVT	–	2.7 to 3.6	CFP	–55 to 125	EAR99
<b>SN54LVTH16245A-SP</b>	<a href="#">5962-96686</a>	QMLV	–	–	–	Standard transceiver	LVT	–	2.7 to 3.6	CFP	–55 to 125	EAR99
<b>SN54LVTH245A-SP</b>	<a href="#">5962-95642</a>	QMLV	–	–	–	Standard transceiver	LVT	–	2.7 to 3.6	CDIP, CFP, LCCC	–55 to 125	EAR99

# Radiation-tolerant portfolio overview

## Space EP

The space-enhanced plastic (Space EP) is a portfolio of radiation-tolerant devices designed for emerging NewSpace and LEO commercial applications. Space EP offers a cost-effective radiation-tolerant solution for shorter-duration and higher-volume space missions while providing the features highlighted below. TI identifies radiation-tolerant devices with the -SEP suffix.

### Radiation performance

- TID characterization (ELDRS-free) to 30–50krad(Si).
- TID RLAT to 20, 30 or 50krad(Si).
- SEL immunity to 43MeV•cm<sup>2</sup>/mg.

### Reliability

- Military temperature range: –55°C to +125°C.
- Improved material set (gold-bond wires, no pure tin).
- Enhanced qualification (highly accelerated stress tests, extended temperatures, meets MIL-PRF 38535 Class N).
- Meets NASA's American Society for Testing and Materials 3595 outgassing specification.

## Space EP

### Comparators

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Ch #	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	Propagation Delay Time (µs)	VICR (Max) (V)	VICR (Min) (V)	V <sub>os</sub> Max at 25°C (Max) (mV)	Input Bias Current (±) (Max) (nA)	Rail-to-Rail	I <sub>q</sub> per Ch (Typ) (mA)	Output type	Package Group	ECCN <sup>1</sup>
<b>TLV1704-SEP</b>	V62/18613	TI Space EP	30	30	43	4	2.2	24	0.56	24	2	2.5	15	In	0.055	Open-Collector	TSSOP	EAR99
<b>TLV4H290-SEP</b>	V62/24636	TI Space EP	30	30	43	4	1.65	5.5	0.1	5.7	0	3	0.005	In	0.025	Open-Drain	SOT23	EAR99
<b>TLV4H390-SEP</b>	V62/24636	TI Space EP	30	30	43	4	1.65	5.5	0.1	5.7	0	3	0.005	In	0.025	Push-Pull	SOT23	EAR99
<b>TLV1H103-SEP</b>	V62/23605	TI Space EP	30	30	43	1	2.4	5.5	0.0035	VCC + 0.2	VEE - 0.2	10	5000	In	6	Push-Pull	SOT23	EAR99
<b>LM139A-SEP</b>	V62/TBD	TI Space EP	30	30	43	4	2.0	36	1.3	34.5	0	2	25	Out	0.2	Open-Collector	SOT23	EAR99

### General-Purpose Op Amps

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Ch #	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	GBW (MHz)	Slew Rate (typ) (V/µs)	V <sub>os</sub> Max	Drift Typ (µV/C)	Rail-to-Rail	V <sub>n</sub> (nV/√Hz)	I <sub>sc</sub> Typ (mA)	I <sub>Bias</sub> (Typ) (nA)	Available Packages	ECCN <sup>1</sup>
<b>OPA4H199-SEP</b>	V62/21615	TI Space EP	30	30	43	4	2.7	40	4.5	21	0.895	0.3	In, Out	10.8	75	0.01	SOT23	EAR99

### Precision Op Amps (V<sub>os</sub> < 1mV)

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Ch #	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	GBW (MHz)	Slew Rate (typ) (V/µs)	V <sub>os</sub> Max at 25°C (Max) (mV)	Rail-to-Rail	I <sub>q</sub> Typ (mA)	V <sub>n</sub> Max (nV/√Hz)	I <sub>Bias</sub> (Typ) (pA)	Available Packages	ECCN <sup>1</sup>
<b>OPA4H014-SEP</b>	V62/21607	TI Space EP	30	30	43	4	4.5	18	11	20	0.12	In to V-, Out	1.8	5.1	0.5	TSSOP	EAR99
<b>OPA4H838-SEP</b>	V62/TBD	TI Space EP	30	30	43	4	2.5	5.5	10	5	0.008	In, Out	1.7	7	30	TSSOP	EAR99

### Difference Amplifiers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	Max I <sub>q</sub> (µA)	BW (kHz)	Slew Rate (V/µs)	Gain Error (max)	V <sub>cm</sub> (V)	Package	ECCN <sup>1</sup>
<b>INA1H94-SEP</b>	VID/TBD	TI Space EP	30	30	43	4	18	900	500	5	+/-0.067%FSR	+/-150	SOIC	EAR99

### Instrumentation Amplifiers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	Max I <sub>q</sub> (µA)	BW (MHz)	Slew Rate (V/µs)	Gain Error (max)	V <sub>cm</sub> (V)	Package	ECCN <sup>1</sup>
<b>INA1H182-SEP</b>	VID/TBD	TI Space EP	30	30	43	4.5	18	650	4.7 @ G=1	2	G = 100: 0.15%	(V+) - 2, (V-) +2	DGK	EAR99

<sup>1</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

### Traceability

- Single-controlled baseline and lot traceability.
- Vendor item drawing.

For more information about TI's Space EP device roadmap and offerings, see [ti.com/SEP](https://ti.com/SEP), contact your TI representative, or reach out to TI through the TI E2E™ design support forums.

**Minimum orderable quantity (MOQ) is one (1) for any of TI's radiation-tolerant products when ordering through TI.com. Check TI.com product folder for availability and ordering.**



Reduce the risk in NewSpace with Space Enhanced Plastic products

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# Space EP (cont'd)

## Fully Differential Amplifiers (FDAs)

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	GBW (MHz)	BW at Acl (MHz)	Min. ACL (MHz)	Slew Rate (V/μs)	V <sub>n</sub> at Flatband (nV/√Hz)	CMRR (Typ) (dB)	Rail-to-Rail	V <sub>os</sub> Max at 25°C (Max) (mV)	IBias (Typ) (nA)	I <sub>q</sub> per Ch (Typ) (mA)	Available Packages	ECCN <sup>1</sup>
LMH5485-SEP	V62/TBD	TI Space EP	30	30	43	2.7	5.2	850	620	1	1500	2.2	100	In to V-, Out	0.45	14.5	10.1	MSOP	EAR99

## RF Fully Differential Amplifiers (FDAs)

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Min Freq (GHz)	Max Freq (GHz)	Supply Voltage (V)	P1dB (dBm)	Gain (dB)	OIP3 (dBm)	NF (dB)	Input/Output	Available Packages	ECCN <sup>1</sup>
TRF0108-SEP	TBD	TI Space EP	30	30	43	0.01	11	5	12 (2GHz)	15.5 (2GHz)	28 (2GHz)	11 (2GHz)	DE-SE	WQFN	EAR99
TRF0208-SEP	V62/23605	TI Space EP	30	30	43	0.01	11	3.3	14.5 (2GHz)	16 (2GHz)	36 (2GHz)	6.8 (2GHz)	SE-DE	WQFN	EAR99
TRF0213-SEP	TBD	TI Space EP	30	30	43	0.01	14	5	14.4 (4GHz)	14	34 (4 GHz)	8.6 (4GHz)	SE-DE	WQFN	EAR99

## Low-Noise Amplifiers (LNAs)

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Min Freq (MHz)	Max Freq (MHz)	Supply Voltage (V)	P1dB at L1 (dBm)	Gain at L1 (dB)	IP3 at L1 (dBm)	NF at L1 (dB)	Available Packages	ECCN <sup>1</sup>
TRF0302-SEP	TBD	TI Space EP	30	30	43	1165	1630	1.8 - 3.3	-10.2	16.9	-5.4	<0.85	USON	EAR99

## Integrated Precision ADC and DAC

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Res. (Bits)	Number of DAC Channels	DAC Architecture	Number ADC Channels	Input Type	Number of GPIOs	Ref Voltage	INL MAX	Package Group	Package Body Size - W x L (mm)	ECCN <sup>1</sup>
AFE11612-SEP	V62/22614	TI Space EP	30	20	43	12	12	String	16	Single-Ended or Fully-differential	8	Internal 2.5V or External	+/- 1LSB	HTQFP	10 x 10	EAR99

## RF-Sampling Transceivers

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Res. (Bits)	Number of DAC Channels	Number of ADC Channels	Number of DUCs per TXe	Number of DDCs per RX	RF Range	Package Group	ECCN <sup>1</sup>
AFE7950-SEP	-	TI Space EP	50	30	43	14	4	6	2	2	0.6-10.2	FCBGA	-

## Precision ADCs (≤10MSPS)

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Res. (Bits)	Sample rate (Max) (kSPS)	Number of input Ch	Multi-Ch Configuration	SNR (dB)	INL (Max) (± LSB)	Input Type	Reference Voltage (V)	Power (Typ) (mW)	Architecture	Packages	ECCN <sup>1</sup>
ADC128S102-SEP	V62/22608	TI Space EP	30	30	43	12	1000	8	Multiplexed	72	1.1	SE	Analog supply	2.3	SAR	TSSOP	-
ADC168M102R-SEP	V62/24631	TI Space EP	30	30	43	16	1000	8 SE/ 4 DIFF	Multiplexed, simultaneous sampling	93	+/- 3	SE/DIFF	INT/EXT	67	Dual SAR ADC Cores	QFN	-

## High-Speed ADCs (>1GSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Sample Rate (Max) (MSPS)	Res. (Bits)	# of Ch	Analog Input BW (GHz)	SNR (dB)	ENOB (Bits)	SFDR (dB)	Input Range (V <sub>p-p</sub> )	Input Buffer	Power (Typ) (mW)	Type	Pkg. Group
ADC12DJ5200-SEP	V62/22611	TI Space EP	30	30	43	10400, 5200	12	1, 2	8	55.6	8.8	65	0.8	Yes	4000	Folding-Interpolating	FCBGA
ADC12QJ1600-SEP	V62/22610	TI Space EP	30	30	43	1600	12	4	6	57	9.1	64	0.8	Yes	1900	Folding-Interpolating	FCBGA

<sup>1</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space EP (cont'd)

## High-Speed ADCs (>10MSPS and <1GSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Sample Rate (Max) (MSPS)	Res. (Bits)	# of Ch	Analog Input BW (MHz)	SNR (dB)	ENOB (Bits)	SFDR (dB)	Input Range (V <sub>p-p</sub> )	Input Buffer	Power (Typ) (mW)	Type	Pkg. Group	ECCN <sup>1</sup>
<b>ADC3683-SEP</b>	V62/24602	TI Space EP	50	30	43	65	18	2	400	83.8	13.7	89	3.2	No	186	Serial LVDS	QFN	–
<b>ADC3664-SEP</b>	V62/24601	TI Space EP	50	30	43	125	14	2	700	77.5	12.6	84	3.2	No	200	Serial LVDS	QFN	–

## High-Speed DACs (>10MSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Res. (Bits)	Update Rate (Max) (MSPS)	Settling Time (Typ) (ns)	SNR (dB)	SFDR (dBc)	THD (dBc)	Interpolation	Power (Typ) (mW)	Architecture	Interface	Pkg. Group	ECCN <sup>1</sup>
<b>DAC39RF10-SEP</b>	–	TI Space EP	50	30	43	16	20800	36	–	85	–	128x, 12x, 16x, 192x, 1x, 24x, 256x, 2x, 32x, 3x, 48x, 4x, 64x, 6x, 8x, 96x	3800	Current Source	JESD204B, JESD204C	FCBGA	–
<b>DAC39RFS10-SEP</b>	–	TI Space EP	50	30	43	16	20800	36	–	85	–	128x, 12x, 16x, 192x, 1x, 24x, 256x, 2x, 32x, 3x, 48x, 4x, 64x, 6x, 8x, 96x	2800	Current Source	JESD204B, JESD204C	FCBGA	–

## Precision DACs (≤10MSPS)

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Res. (Bits)	Sample/Update Rate (MSPS)	DNL (Typ) (±LSB)	INL (Typ) (±LSB)	Zero Code Error (mV)	Supply Voltage (V)	Power (Typ) (mW)	Architecture	Package Group	ECCN <sup>1</sup>
<b>DAC121S101-SEP</b>	V62/TBD	TI Space EP	30	–	43	12	1.8	–0.10/+0.21	2.75	2.23	2.7 to 5.5	0.52	String	VSSOP	EAR99 <sup>†</sup>

## Mux

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Configuration	Input Voltage Range	On-resistance (Ω)	Switch Input Off Leakage (nA)	Transition Time (ns)	Overvoltage Protection (V)	Power-off protection	Package Group	Package Body Size - W x L (mm)	ECCN <sup>1</sup>
<b>TMUX582F-SEP</b>	V62/23607	TI Space EP	30	30	43	8:1	5 to 22V	180	15	250	60V	Yes	TSSOP	6.5 x 4.4	EAR99
<b>TMUX182-SEP</b>	V62/TBD	TI Space EP	30	30	43	8:1	5 to 15V	75	0.3	100	–	Yes	SOT23	4.2 x 3.26	EAR99

## Clock Jitter Cleaners

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	# of In	# of Out	RMS Jitter (fs)	Output Freq. (MHz)	Supply Voltage (V)	Input Type	Output Type	Package Group	ECCN <sup>1</sup>
<b>LMK04832-SEP</b>	V62/22612	TI Space EP	30	30	43	3	15	54	0.305 to 3255	3.135 to 3.465	LVC MOS, LVDS, LVPECL	CML, LVPECL, LCPECL, HSDS, LVDS, LVC MOS	QFP	EAR99

## RF PLLs and Synthesizers

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Normalized PLL Phase Noise (dBc/Hz)	1/f Noise (10-kHz Offset at 1-GHz Carrier) (dBc/Hz)	Output Frequency (Min) (MHz)	Output Frequency (Max) (MHz)	Supply Voltage (V)	Features	Package Body Size - W x L (mm)	Package Group	ECCN <sup>1</sup>
<b>LMX2694-SEP</b>	V62/19616	TI Space EP	30	30	43	–236	–129	39.3	15100	3.2 to 3.45	JESD204B	7.0 x 7.0	VQFN	EAR99
<b>LMX2695-SEP</b>	V62/25658	TI Space EP	50	50	43	–236	–129	5	30000	3.2 to 3.45	JESD204B/C	10.0 x 10.0	QFP	EAR99

## Clock Buffers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	RMS Jitter (fs)	Output Freq. (Max) (MHz)	# of Outputs	Output Skew (ps)	Supply Voltage (V)	Input Type	Output Type	Package Body Size - W x L (mm)	Package Group	ECCN <sup>1</sup>
<b>GDCLVP111-SEP</b>	V62/12624	TI Space EP	30	–	43	40	3500	10	50	2.375 to 3.8	CML, LVDS, LVPECL, SSTL	LVPECL	9.078 x 9.078	LQFP	EAR99
<b>LMX1860-SEP</b>	V62/24630	TI Space EP	30	–	43	5	15000	4	10	2.4 to 2.6	CML, LVDS	JESD204B/C	12.0 x 12.0	QFP	EAR99

## CAN

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Signaling Rate (Max) (Mbps)	Supply Voltage (Nom) (V)	Common Mode Range	Fault Protection (V)	Features	Package Group	ECCN <sup>1</sup>
<b>SN55HVD233-SEP</b>	V62/18617	TI Space EP	30	20	43	1	3.0 to 3.6	–7 to 12	–16 to 16	Diagnostic loopback	SOIC	EAR99

<sup>†</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space EP (cont'd)

## LVDS

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Device Type	# of TX	# of RX	Supply Voltage (V)	Common-Mode Range (V)	I <sub>CC</sub> (Max) (mA)	Input Signal	Output Signal	Package Group	ECCN <sup>2</sup>
<b>SN55LVTA4-SEP</b>	<a href="#">V62/25605</a>	TI Space EP	30	30	43	Driver	4	–	3.3	1.125V - 1.375V	35mA	LVTTTL	LVDS Differential	SOIC	EAR99
<b>SN55LVRA4-SEP</b>	<a href="#">V62/25606</a>	TI Space EP	30	30	43	Receiver	–	4	3.3	-4.0V - 5.0V	25mA	LVDS Differential	LVTTTL	SOIC	EAR99

## RS-485 and RS-422

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Device Type	No. of TX	No. of RX	Duplex	Supply Voltage (Nom) (V)	Signaling Rate (Max) (Mbps)	Fault Protection (V)	# of nodes	Common mode range	I <sub>CC</sub> (Max) (mA)	Package Group	ECCN <sup>1</sup>
<b>SN65C1168E-SEP</b>	<a href="#">V62/19606</a>	TI Space EP	30	20	43	Transceiver	2	2	Full	5.0	10	-10 to 15	32	-7 to 7	17	TSSOP	EAR99
<b>THVD9491-SEP</b>	<a href="#">V62/24626</a>	TI Space EP	30	30	43	Transceiver	1	1	Full	3.3, 5	50	-70 to 70	256	-12 to 12	72	SOIC	–

## Voltage Translators

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Signaling Rate (Max) (Mbps)	Supply Voltage (Nom) (V)	Bit Count	Description	Features	Package Group	Package Body Size - W x L (mm)	ECCN <sup>1</sup>
<b>SN54SC4T125-SEP</b>	<a href="#">V62/23631</a>	TI Space EP	50	30	43	150	1.2 to 5.5	4	Fixed Direction w/ 3 State Output	Over-voltage tolerant inputs, balanced outputs	TSSOP	5.0 x 4.4	EAR99
<b>SN54SC6T06-SEP</b>	<a href="#">V62/24618</a>	TI Space EP	50	30	43	-	1.2 to 5.5	6	Inverting Fixed Direction w/ 3 State Output	Over-voltage tolerant inputs, balanced outputs	TSSOP	5.0 x 4.4	EAR99
<b>SN54SC6T07-SEP</b>	<a href="#">V62/24617</a>	TI Space EP	50	30	43	-	1.2 to 5.5	6	Fixed Direction w/ Open-Drain outputs	Over-voltage tolerant inputs, balanced outputs	TSSOP	5.0 x 4.4	EAR99
<b>SN54SC6T14-SEP</b>	<a href="#">V62/24618</a>	TI Space EP	50	30	43	-	1.2 to 5.5	6	Inverting Fixed Direction w/ Schmitt-Tigger inputs	Over-voltage tolerant inputs, balanced outputs	TSSOP	6.5 x 4.4	EAR99
<b>SN54SLC8T245-SEP</b>	<a href="#">V62/22604</a>	TI Space EP	20	20	43	380	0.65 to 3.6	8	Direction Controlled w/ 3 State Output	VCC Isolation, Partial Power Down (loff), Overvoltage tolerant inputs	TSSOP	4.40 x 7.80	EAR99
<b>SN54SC8T541-SEP</b>	<a href="#">V62/25632</a>	TI Space EP	50	30	50	150	1.2 to 5.5	8	Fixed Direction w/ 3 State Output	Over-voltage tolerant inputs, balanced outputs	TSSOP	4.40 x 7.80	EAR99
<b>SN54SC8T244-SEP</b>	<a href="#">V62/25631</a>	TI Space EP	50	30	50	150	1.2 to 5.5	8	Fixed Direction w/ 3 State Output	Over-voltage tolerant inputs, balanced outputs	TSSOP	6.5 x 4.4	EAR99
<b>SN54SC8T240-SEP</b>	<a href="#">V62/25630</a>	TI Space EP	50	30	50	150	1.2 to 5.5	8	Inverting Fixed Direction w/ 3-State Output	Over-voltage tolerant inputs, balanced outputs	TSSOP	6.5 x 4.4	EAR99
<b>SN54SC8T9541-SEP</b>	<a href="#">V62/25633</a>	TI Space EP	50	30	50	150	1.2 to 5.5	8	Fixed Direction w/ Schmitt-Trigger inputs	Over-voltage tolerant inputs, balanced outputs	TSSOP	6.5 x 4.4	EAR99
<b>SN54SLC8T245-SEP</b>	<a href="#">V62/22604</a>	TI Space EP	20	20	50	150	0.65 to 3.6	8	Fixed Direction/ Push-Pull	Output enable, Overvoltage tolerant inputs	TSSOP	7.8 x 6.4	EAR99
<b>TXGS441-SEP</b>	V62/TBD	TI Space EP	20	20	50	-	1.7 to 5.5	4	Fixed Direction ground-level translator	Partial power down (loff)	SOT23	4.2 x 3.26	EAR99

## Digital Isolators

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Signaling Rate (Max) (Mbps)	Supply Voltage (V)	Working Voltage (V)	Features	Package Group	Package Body Size - W x L (mm)	ECCN <sup>1</sup>
<b>ISOS141-SEP</b>	<a href="#">V62/21610</a>	TI Space EP	30	30	43	100	2.25 to 5.5	600	Signal Isolation	SSOP	3.9 x 4.9	EAR99

<sup>1</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space EP (cont'd)

## Analog Isolators

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	Isolation Voltage	Propagation Delay	Bandwidth (max)	Input Current (mA)	Package Group	Package Body Size - W x L (mm)	ECCN <sup>1</sup>
<b>ISO510-SEP</b>	V62/TBD	TI Space EP	50	30	43	3750 Vrms	5 μV	680 kHz	0.7 to 10	SOIC	4.8 x 2.54	EAR99

## Digital Output Temperature Sensors

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	# of Remote Temp. Sensor	# of Local Temp. Sensor	Remote Sensor Accuracy (±°C)	Local Sensor Accuracy (±°C)	Remote Temp. Range (°C)	Local Temp. Range (°C)	Temp. Resolution (°C)	Interface	Available Package	ECCN <sup>2</sup>
<b>TMP9R01-SEP</b>	V62/TBD	TI Space EP	50	30	43	1	1	1.5	2.0	-64 to 191	-55 to 125	0.0625	I <sup>2</sup> C, SMBus, 2-Wire	VSSOP	EAR99

## Current-Sense Amplifier

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>s</sub> Min (V)	V <sub>s</sub> Max (V)	Common-Mode Voltage (V)	Bandwidth (MHz)	Gain (V/V)	V <sub>os</sub> Max at 25°C	Gain Error (%)	I <sub>q</sub> Typ (mA)	Available Packages	ECCN <sup>2</sup>
<b>INA950-SEP</b>	V62/25635	TI Space EP	30	30	43	2.7	5.5	2.7 to 80	1.1	20	±25uV	0.1	370	TSSOP	EAR99
<b>INA951-SEP</b>	V62/TBD	TI Space EP	30	30	43	2.7	10	-4 to 80	1.3	20	150uV	0.15%	1.5	SOT23	EAR99

## Brushless-DC (BLDC) Drivers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Architecture	V <sub>s</sub> (Min) (V)	V <sub>s</sub> (Max) (V)	V <sub>s</sub> (ABS Max) (V)	Peak Output Current (A)	Gate Drive (A)	Control Interface	Package Body Size (WxL, mm)	Package Group	ECCN <sup>2</sup>
<b>DRV8351-SEP</b>	V62/24612	TI Space EP	30	30	43	Gate Driver	5	15	15	1.5	0.75	-	4 x 4, 6.4 x 4.4	TSSOP	EAR99

## Buck Converters

Part Number	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT/ RHA	SEL (Max) (MeV•cm <sup>2</sup> /mg)	I <sub>OUT</sub> (Max) (A)	V <sub>IN</sub> (Min) (V)	V <sub>IN</sub> (Max) (V)	V <sub>OUT</sub> (Min) (V)	# of Ch	Control Mode	Switching Frequency (min) (kHz)	Switching Frequency (max) (kHz)	Duty Cycle (max) (%)	Min. On-Time (max) (ns)	I <sub>q</sub> (Typ) (mA)	ECCN <sup>1</sup>
<b>TPS7H4010-SEP</b>	V62/19623	TI Space EP	30	30	43	6	3.5	32	1.0	1	Current Mode	350	2200	95%	82	0.015	EAR99
<b>TPS7H4003-SEP</b>	V62/21609	TI Space EP	50	50	43	18	3	7	0.6	1	Current Mode	100	1000	100%	235	4	EAR99
<b>TPS7H4011-SEP</b>	V62/25640	TI Space EP	50	30	43	12	4.5	14	0.6	1	Current Mode	100	1000	100%	250	8	EAR99
<b>TPS7H4012-SEP</b>	V62/25640	TI Space EP	50	50	43	6	4.5	14	0.6	1	Current Mode	100	1000	100%	250	6	EAR99
<b>TPS7H4013-SEP</b>	V62/25640	TI Space EP	50	50	43	3	4.5	14	0.6	1	Current Mode	100	1000	100%	250	4	EAR99
<b>TPS7H4102-SEP</b>	V62/25661	TI Space EP	50	50	43	6	3	7	0.5	2	Current Mode	100	1000	100%	250	10	EAR99
<b>TPS7H4104-SEP</b>	V62/25661	TI Space EP	50	50	43	12	3	7	0.5	4	Current Mode	100	1000	100%	250	15	EAR99

## eFuses and Load Switches

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>IN</sub> Range (V)	Type	R <sub>ON</sub> (Typ) (mΩ)	Continuous Current Load (Max) (A)	Programmable Current Limit Range (A)	Package	ECCN <sup>1</sup>
<b>TPS7H2221-SEP</b>	V62/22609	TI Space EP	30	20	43	1.6 to 5.5	Load Switch	90 at V <sub>IN</sub> =5V	1.25	-	SC70	EAR99
<b>TPS7H2201-SEP</b>	V62/23608	TI Space EP	50	50	43	1.5 to 7.0	eFuse	35	6	0.5-7.0	HTSSOP	EAR99
<b>TPS7H2211-SEP</b>	V62/23609	TI Space EP	50	50	43	4.5 to 14	eFuse	60	3.5	-	HTSSOP	EAR99
<b>TPS7H2140-SEP</b>	V62/23610	TI Space EP	30	20	43	4.5 to 32	eFuse	160	4Ch at 1.35 A/Ch	0-11	HTSSOP	EAR99

## Low-Dropout (LDO) Linear Regulators (Typical VDO ≤400mV)

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (Max) (MeV•cm <sup>2</sup> /mg)	I <sub>OUT</sub> (Max) (A)	V <sub>IN</sub> (Min) (V)	V <sub>IN</sub> (Max) (V)	V <sub>OUT</sub> (Min) (V)	V <sub>OUT</sub> (Max) (V)	Dropout (Vdo) (Typ) (mV)	Accuracy (%)	Noise (μVrms)	PSRR at 100 KHz (dB)	PSRR at 1MHz (dB)	Output options	ECCN <sup>1</sup>
<b>TPS73801-SEP</b>	V62/18616	TI Space EP	50	50	43	1	2.2	20	1.2	20.0	240	3	45	45	23	Adjustable	EAR99
<b>TPS7H1210-SEP</b>	V62/21616	TI Space EP	30	20	43	1	-16.5	-3	-15	-1.2	363	2	13.7	52	55	Adjustable	EAR99
<b>TPS7H1111-SEP</b>	V62/23602	TI Space EP	50	50	43	1.5	0.85	7	0.4	5.5	200	1.5	1.68	71	67	Adjustable	EAR99
<b>TPS7H1121-SEP</b>	V62/23604	TI Space EP	50	50	43	2	2.25	14	0.6	13.5	300	1.5	40	60	60	Adjustable	EAR99

<sup>1</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space EP (cont'd)

## DDR Memory Power

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (Max) (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	Regulator Type	I <sub>OUT</sub> VTT (Max) (A)	V <sub>IN</sub> (Min) (V)	V <sub>IN</sub> (Max) (V)	V <sub>OUT</sub> VTT (Min) (V)	DDR Memory Type(s)	V <sub>IN</sub> Bias (Min) (V)	V <sub>IN</sub> Bias (Max) (V)	Package Group	ECCN <sup>1</sup>
TPS7H3302-SEP	V62/22615	TI Space EP	50	50	43	Linear	3.0	0.9	3.5	0.6	DDR2, DDR3, DDR4	2.375	3.5	HTSSOP	EAR99

## Supervisors and Reset ICs

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	V <sub>CC</sub> Range (V)	Threshold Voltage	Accuracy (%)	Operating Temp. Range (°C)	Packages	ECCN <sup>1</sup>
TL7700-SEP	V62/19602	TI Space EP	30	20	43	1.8 to 40	Adjustable	2	-55 to 125	TSSOP	EAR99

## PWM Controllers

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (Max) (MeV•cm <sup>2</sup> /mg)	V <sub>CC</sub> Range (Min) (V)	V <sub>CC</sub> (Max) (V)	Duty Cycle (Max) (%)	UVLO Thresholds On/Off(V)	Frequency (Max) (kHz)	Gate Drive (Typ) (A)	PWM Outputs (#)	SR Outputs (#)	Operating Temp Range (°C)	Package	ECCN <sup>1</sup>
TPS7H5005-SEP	V62/22607	TI Space EP	50	50	43	4	14	50,75,100	Adjustable	2000	0.15	2	2	-55 to 125	TSSOP	EAR99
TPS7H5006-SEP	V62/22607	TI Space EP	50	50	43	4	14	75,100	Adjustable	2000	0.15	1	1	-55 to 125	TSSOP	EAR99
TPS7H5007-SEP	V62/22607	TI Space EP	50	50	43	4	14	75,100	Adjustable	2000	0.15	1	1	-55 to 125	TSSOP	EAR99
TPS7H5008-SEP	V62/22607	TI Space EP	50	50	43	4	14	50	Adjustable	2000	0.15	2	0	-55 to 125	TSSOP	EAR99
TPS7H5020-SEP	V62/25651	TI Space EP	50	50	43	4	14	100	Adjustable	2000	1.2	1	0	-55 to 125	HTSSOP	EAR99
TPS7H5021-SEP	V62/25651	TI Space EP	50	50	43	4	14	50	Adjustable	2000	1.2	1	0	-55 to 125	HTSSOP	EAR99
TPS7H5030-SEP	V62/25651	TI Space EP	50	50	43	8	14	100	Adjustable	500	1.2	1	0	-55 to 125	HTSSOP	EAR99
TPS7H5031-SEP	V62/25651	TI Space EP	50	50	43	8	14	50	Adjustable	500	1.2	1	0	-55 to 125	HTSSOP	EAR99

## Half-bridge Gate Drivers

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Channel Input Logic	Power Switch	Input V <sub>CC</sub> (Min) (V)	Input V <sub>CC</sub> (Max) (V)	Peak Output Current (A)	Bus Voltage (max) (V)	Package Group	ECCN <sup>1</sup>
TPS7H6005-SEP	V62/24632	TI Space EP	50	50	43	TLL/PWM	GaN FET	10	16	1.3	200	HTSSOP	EAR99
TPS7H6015-SEP	V62/24632	TI Space EP	50	50	43	TLL/PWM	GaN FET	10	16	1.3	60	HTSSOP	EAR99
TPS7H6025-SEP	V62/24632	TI Space EP	50	50	43	TLL/PWM	GaN FET	10	16	1.3	22	HTSSOP	EAR99

## Power Stages

Part Number <sup>1</sup>	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm <sup>2</sup> /mg)	Channel Input Logic	Power Switch	Input V <sub>CC</sub> (Min) (V)	Input V <sub>CC</sub> (Max) (V)	RDS(on) (typ) (mΩ)	Bus Voltage (max) (V)	Package Group	ECCN <sup>1</sup>
TPS7H6101-SEP	-	TI Space EP	50	50	43	TLL/PWM	GaN FET	10	14	15	200	QFN	EAR99

## Arm®-Based Microcontrollers (MCUs)

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	CPU	Frequency (MHz)	Flash Memory (kB)	RAM (kB)	ADC	ADC #	GPIO #	I <sup>2</sup> C (#)	SPI (#)	UART (#)	CAN	Ethernet	Package	ECCN <sup>1</sup>
TMS570LC4357-SEP	V62/18621	TI Space EP	30	30	43	Arm Cortex-R5F	300	4096	2	12-bit ×2	41	168	2	5	4	4	10/100 Mbps EMAC	NFBGA	-

## C2000 Real-Time Microcontrollers (MCUs)

Part Number	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm <sup>2</sup> /mg)	CPU	Frequency (MHz)	Flash Memory (kB)	RAM (kB)	ADC	ADC #	GPIO #	I <sup>2</sup> C (#)	SPI (#)	UART (#)	CAN	Package	ECCN <sup>1</sup>
F28377D-SEP	V62/25638	TI Space EP	30	30	43	C2000	200	1024	204	2 16-bit SAR, 4 16-bit	24	169	2	3	4	2	HLQFP	-

<sup>1</sup> ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

<sup>†</sup> EAR99 only pertains to certain device variants, including the following flight model devices: 5962-8754903VCA and 5962-8754903VDA.

**Note:** TI HiRel started releasing QMLV devices in 2001; at that time several logic devices were released as QMLV. However, TI did not perform any radiation testing on these early releases – as such, although third-party data might be available, most of these TI QMLV logic devices do not have radiation data available. In the tables above, radiation performance data is only included for devices where TI has performed radiation testing.

# Space EP (cont'd)

## Logic

Generic Part Number	Military Spec	Qualification	TID Char. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm <sup>2</sup> /mg)	Sub-Family (Part Type)	Family	# of Ch	V <sub>CC</sub> Range (V)	Package	Operating Temp. (°C)	ECCN <sup>1</sup>
<b>SN54SC245-SEP</b>	V62/23616	TI Space EP	50	30	43	Standard Transceiver	SC	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC4T08-SEP</b>	V62/23620	TI Space EP	50	30	43	AND Gate	SCxT	4	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC2T74-SEP</b>	V62/23632	TI Space EP	50	30	43	D-Type Flip-Flop	SCxT	2	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC4T00-SEP</b>	V62/23627	TI Space EP	50	30	43	NAND Gate	SCxT	4	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC4T02-SEP</b>	V62/23628	TI Space EP	50	30	43	NOR Gate	SCxT	4	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC4T32-SEP</b>	V62/23629	TI Space EP	50	30	43	OR Gate	SCxT	4	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC4T86-SEP</b>	V62/23630	TI Space EP	50	30	43	XOR Gate	SCxT	4	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC3T97-SEP</b>	V62/23633	TI Space EP	50	30	43	Configurable Gate	SCxT	3	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC3T98-SEP</b>	V62/23626	TI Space EP	50	30	43	Configurable Gate	SCxT	3	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC6T17-SEP</b>	V62/24619	TI Space EP	50	30	43	Schmitt Trigger Buffer	SCxT	6	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T595-SEP</b>	V62/25621	TI Space EP	50	30	50	Shift Register	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T138-SEP</b>	V62/25622	TI Space EP	50	30	50	3-line to 8-line Demultiplexer	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T139-SEP</b>	V62/25623	TI Space EP	50	30	50	2-line to 4-Line Demultiplexer	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T151-SEP</b>	V62/25634	TI Space EP	50	30	50	8-to-1 Multiplexer	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T157-SEP</b>	V62/25624	TI Space EP	50	30	50	2-to-1 multiplexer	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T164-SEP</b>	V62/25620	TI Space EP	50	30	50	8-bit Shift Register	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T165-SEP</b>	V62/25625	TI Space EP	50	30	50	8-bit Shift Register	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T373-SEP</b>	V62/25626	TI Space EP	50	30	50	D-type Latch	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T374-SEP</b>	V62/25627	TI Space EP	50	30	50	D-type Flip-Flop	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T573-SEP</b>	V62/25628	TI Space EP	50	30	50	D-type Latch	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC8T574-SEP</b>	V62/25629	TI Space EP	50	30	50	D-type Flip-Flop	SCxT	8	1.2 to 5.5	TSSOP	-55 to 125	EAR99
<b>SN54SC1G08-SEP</b>	V62/TBD	TI Space EP	50	30	50	AND Gate	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC1G125-SEP</b>	V62/TBD	TI Space EP	50	30	50	Buffer Gate	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC1G97-SEP</b>	V62/TBD	TI Space EP	50	30	50	AND Gate	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC1G125-SEP</b>	V62/TBD	TI Space EP	50	30	50	Buffer Gate	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC1G00-SEP</b>	V62/TBD	TI Space EP	50	30	50	2-input NAND	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC1G14-SEP</b>	V62/TBD	TI Space EP	50	30	50	Inverter; Schmitt-trigger	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC1G175-SEP</b>	V62/TBD	TI Space EP	50	30	50	D-type Flip-Flop	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC1G17-SEP</b>	V62/TBD	TI Space EP	50	30	50	Buffer; Schmitt-trigger	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC1G32-SEP</b>	V62/TBD	TI Space EP	50	30	50	2-input OR	SCxG	1	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC2G14-SEP</b>	V62/TBD	TI Space EP	50	30	50	Inverter; Schmitt-trigger	SCxG	2	1.2 to 5.5	DBV	-55 to 125	EAR99
<b>SN54SC2G17-SEP</b>	V62/TBD	TI Space EP	50	30	50	Buffer; Schmitt-trigger	SCxG	2	1.2 to 5.5	DBV	-55 to 125	EAR99

# TI space products – engineering models

TI engineering evaluation (/EM and -MPR) models are units intended for engineering evaluation only. EM devices are processed to a noncompliant flow (for example, no burn-in) and tested to a temperature rating of +25°C only. These units are not suitable for qualification, production, radiation testing or flight use. Engineering models are not specified for performance over the full military specified temperature range of –55°C to +125°C or for operating life. For more information about engineering models, see the “[Texas Instruments Engineering Evaluation Units Versus MIL-PRF-38535 QML Class V Processing](#)” application report.

## Engineering models

Generic Part Number	TI Orderable Part Number	Device Type	Package   Pins	ECCN <sup>1</sup>
<b>ADC08D1520QML-SP</b>	ADC08D1520WGMPR	/EM	CFP (NBC)   128	–
<b>ADC10D1000QML-SP</b>	ADC10D1000CCMPR	/EM	CCGA (NAA)   376	–
<b>ADC128S102QML-SP</b>	ADC128S102WGMPR	/EM	CFP (NAC)   16	–
<b>ADC12D1600QML-SP</b>	ADC12D1600CCMPR	/EM	CCGA (NAA)   376	–
<b>ADC12D1620QML-SP</b>	ADC12D1620CCMPR	/EM	CCGA (NAA)   376	–
<b>ADC12QJ1600-SP</b>	ADC12QJ1600-EP	/EM	FCCSP (ALR)   144	–
<b>ADC12DJ5200-SP</b>	ADC12DJ5200-EP	/EM	FCCSP (ALR)   144	–
<b>ADC12DJ3200QML-SP</b>	ADC12DJ3200NWE/EM	/EM	CCGA (NWE)   196	–
<b>ADC14155QML-SP</b>	ADC14155W-MPR	/EM	CFP (NBA)   48	–
<b>ADS1278-SP</b>	ADS1278HFQ/EM	/EM	CFP (HFQ)   84	EAR99
<b>ADS1282-SP</b>	ADS1282HKV/EM	/EM	CFP (HKV)   28	EAR99
<b>ADS5400-SP</b>	ADS5400HFS/EM	/EM	CFP (HFS)   100	–
<b>ADS5424-SP</b>	ADS5424HFG/EM	/EM	CFP (HFG)   52	–
<b>ADS5444-SP</b>	ADS5444HFG/EM	/EM	CFP (HFG)   84	–
<b>ADS5463-SP</b>	ADS5463HFG/EM	/EM	CFP (HFG)   84	–
<b>ADS5474-SP</b>	ADS5474HFG/EM	/EM	CFP (HFG)   84	–
<b>CDCLVP111-SP</b>	CDCLVP111HFG/EM	/EM	CFP (HFG)   36	EAR99
<b>CDCM7005-SP</b>	CDCM7005HFG/EM	/EM	CFP (HFG)   52	EAR99
<b>DAC121S101QML-SP</b>	DAC121S101WGMPR	/EM	CFP (NAC)   10	EAR99
<b>DAC5670-SP</b>	DAC5670MGEM/EM	/EM	CBGA (GEM)   192	–
<b>DAC5675A-SP</b>	DAC5675AHFG/EM	/EM	CFP (HFG)   52	EAR99
<b>DP83561-SP</b>	DP83561HBE/EM	/EM	CFP (HBE)   64	EAR99
<b>INA901-SP</b>	INA901HKX/EM	/EM	CFP (HKX)   8	EAR99
<b>INA1H94-SP</b>	INA1H94HKX/EM	/EM	CFP (HKX)   8	EAR99
<b>LM117HVQML-SP</b>	LM117HVNAC/EM	/EM	CFP (NAC)   10	EAR99
<b>LM117QML-SP</b>	LM117K/EM	/EM	TO (K)   2	EAR99
<b>LM117QML-SP</b>	LM117NDT/EM	/EM	TO (NDT)   3	EAR99
<b>LM4050QML-SP</b>	LM4050WG2.5-MPR	/EM	CFP (NAC)   10	EAR99
<b>LM4050QML-SP</b>	LM4050WG5.0-MPR	/EM	CFP (NAC)   10	EAR99
<b>LM7171QML-SP</b>	LM7171NAB/EM	/EM	CDIP (NAB)   8	EAR99
<b>LM7171QML-SP</b>	LM7171NAC/EM	/EM	CFP (NAC)   10	EAR99
<b>LM7171QML-SP</b>	LM7171NAD/EM	/EM	CFP (NAD)   10	EAR99
<b>LM98640QML-SP</b>	LM98640W-MPR	/EM	CFP (NBB)   68	–
<b>LMH5401-SP</b>	LMH5401FFK/EM	/EM	LCCC (FFK)   14	EAR99
<b>LMH5485-SP</b>	PLMH5485HKX/EM	/EM	CFP (HKX)   8	EAR99
<b>LMK04832-SEP</b>	LMK04832PAP/EM	/EM	HTQFP (PAP)   64	EAR99
<b>LMK04832-SP</b>	LMK04832W/EM	/EM	CFP (HBE)   64	EAR99
<b>LMP7704-SP</b>	LMP7704HBH/EM	/EM	CFP (HBH)   14	EAR99
<b>LMX1906-SP</b>	LMX1906PAP/EM	/EM	HTQFP (PAP)   64	EAR99
<b>LMX2615-SP</b>	LMX2615W-MPR	/EM	CFP (HBD)   64	EAR99
<b>OPA4277-SP</b>	OPA4277HFR/EM	/EM	CFP (HFR)   14	EAR99
<b>SMJ320C6701-SP</b>	SMV320C6701GLP/EM	/EM	CFCBGA (GLP)   429	EAR99
<b>SMV320C6727B-SP</b>	SMV320C6727BHFH/EM	/EM	CFP (HFH)   256	–
<b>SMV512K32-SP</b>	SMV512K32HFG/EM	/EM	CFP (HFG)   76	–
<b>SN55HVD233-SP</b>	HVD233HKX/EM	/EM	CFP (HKX)   8	EAR99
<b>SN55LVCP22-SP</b>	SN55LVCP22W/EM	/EM	CFP (W)   16	EAR99

Generic Part Number	TI Orderable Part Number	Device Type	Package   Pins	ECCN <sup>1</sup>
<b>THS4511-SP</b>	THS4511HKT/EM	/EM	CFP (HKT)   16	EAR99
<b>THS4513-SP</b>	THS4513HKT/EM	/EM	CFP (HKT)   16	EAR99
<b>TL1431-SP</b>	TL1431U/EM	/EM	CFP (U)   10	EAR99
<b>TLK2711-SP</b>	TLK2711HFG/EM	/EM	CFP (HFG)   68	EAR99
<b>TMP461-SP</b>	TMP461HKU/EM	/EM	CFP (HKU)   10	EAR99
<b>TMP9R00-SP</b>	TMP9R00HKT/EM	/EM	CFP (HKT)   16	EAR99
<b>TPS50601-SP</b>	TPS50601HKH/EM	/EM	CFP (HKH)   20	EAR99
<b>TPS50601A-SP</b>	TPS50601AY/EM	/EM Die	(Y)   0	EAR99
<b>TPS50601A-SP</b>	TPS50601AHKH/EM	/EM	CFP (HKH)   20	EAR99
<b>TPS7A4501-SP</b>	TPS7A4501HKU/EM	/EM	CFP (HKU)   10	EAR99
<b>TPS7A4501-SP</b>	TPS7A4501U/EM	/EM	CFP (U)   10	EAR99
<b>TPS7H1101A-SP</b>	TPS7H1101HKR/EM	/EM	CFP (HKR)   16	EAR99
<b>TPS7H1101A-SP</b>	TPS7H1101AY/EM	/EM Die	(Y)   0	EAR99
<b>TPS7H1111-SP</b>	TPS7H1111HBL/EM	/EM	CFP (HBL)   14	EAR99
<b>TPS7H1121-SP</b>	TPS7H1121HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H2201-SP</b>	TPS7H2201Y/EM	/EM Die	(Y)   0	EAR99
<b>TPS7H2201-SP</b>	TPS7H2201HKR/EM	/EM	CFP (HKR)   16	EAR99
<b>TPS7H2211-SP</b>	TPS7H2211HKR/EM	/EM	CFP (HKR)   16	EAR99
<b>TPS7H2211-SP</b>	TPS7H2211Y/EM	/EM Die	(Y)   0	EAR99
<b>TPS7H3014-SP</b>	TPS7H3014HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H3301-SP</b>	TPS7H3301HKR/EM	/EM	CFP (HKR)   16	EAR99
<b>TPS7H4001-SP</b>	TPS7H4001Y/EM	/EM Die	(Y)   0	EAR99
<b>TPS7H4001-SP</b>	TPS7H4001HKY/EM	/EM	(HKY)   34	EAR99
<b>TPS7H4011-SP</b>	TPS7H4011HLB/EM	/EM	CFP (HLB)   30	EAR99
<b>TPS7H4002-SP</b>	TPS7H4002HKH/EM	/EM	CFP (HKH)   20	EAR99
<b>TPS7H4002-SP</b>	TPS7H4002Y/EM	/EM Die	(Y)   0	EAR99
<b>TPS7H5001-SP</b>	TPS7H5001Y/EM	/EM Die	(Y)   0	EAR99
<b>TPS7H5001-SP</b>	TPS7H5001HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H5002-SP</b>	TPS7H5002HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H5003-SP</b>	TPS7H5003HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H5004-SP</b>	TPS7H5004HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H6005-SP</b>	TPS7H6005HBX/EM	/EM	CFP (HBX)   48	EAR99
<b>TPS7H6015-SP</b>	TPS7H6015HBX/EM	/EM	CFP (HBX)   48	EAR99
<b>TPS7H6025-SP</b>	TPS7H6025HBX/EM	/EM	CFP (HBX)   48	EAR99
<b>TPS7H3024-SP</b>	TPS7H3024HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H3124-SP</b>	TPS7H3124HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H3034-SP</b>	TPS7H3034HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H3134-SP</b>	TPS7H3034HFT/EM	/EM	CFP (HFT)   22	EAR99
<b>TPS7H1301-SP</b>	TPS7H1301HBL/EM	/EM	CFP (HBL)   14	EAR99
<b>TRF0206-SP</b>	TRF0206FFM/EM	/EM	LCCC (FFM)   12	EAR99
<b>TRF0208-SEP</b>	TRF0208RPVT/EM	/EM	WQFN-FCRLF (RPV)   12	EAR99
<b>TRF0208-SP</b>	TRF0208RPVTS/EM	/EM	WQFN-FCRLF (RPV)   12	EAR99
<b>UC1825B-SP</b>	UC1825BHKT/EM	/EM	CFP (HKT)   16	EAR99
<b>UC1843B-SP</b>	UC1843BKU/EM	/EM	CFP (HKU)   10	EAR99

# TI space products – die products

In addition to packaged QMLV products and radiation-tolerant products, TI also offers a variety of space-grade die options, including:

**QMLV known good die (KGD):** TI fabricates, tests, and qualifies this die product in compliance with MIL-PRF-38535 QMLV with specification in an SMD. RHA versions are available.

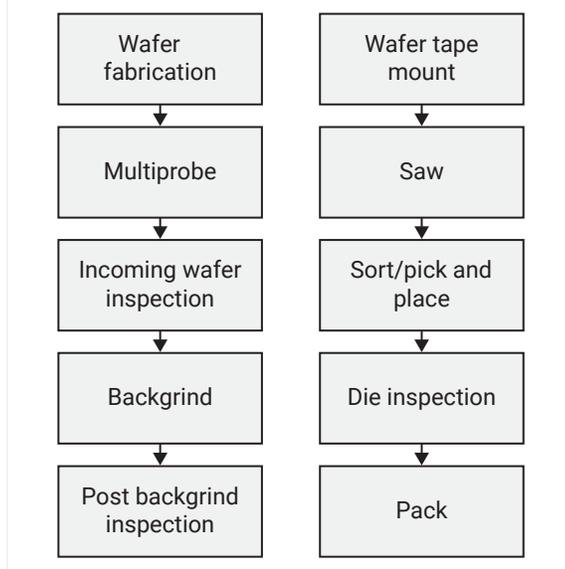
**TI space-grade KGD:** TI qualifies this die product by wafer lots manufactured and tested in accordance with MIL-PRF-38535; it is not included in an SMD, however.

**TI Space EP KGD:** TI qualifies this die product with TI’s radiation-tolerant Space EP flow. See [ti.com/SEP](https://www.ti.com/SEP).

**TI space-grade tested die:** TI fabricates this die product on a MIL-PRF-38535-certified manufacturing line; it does not follow the QML manufacturing flow, however, and is tested for DC and functional performance only at ambient temperatures.

**Engineering model (EM) die:** This die product is intended only for engineering evaluation of its QMLV equivalent. EM die are processed to a noncompliant flow (no burn-in) and tested to a temperature rating of +25°C only. These units are not suitable for qualification, production, radiation testing or flight use. For more information about engineering models, see the “[Texas Instruments Engineering Evaluation Units Versus MIL-PRF-38535 QML Class V Processing](#)” application report.

## Example flow (QMLV Class V KGD)



## Die products

Generic Part Number	Sub-Family (Part Type)	DLA		MIL Orderable Part Number	Device Type Description	Radiation <sup>1</sup>			Temp	ECCN <sup>2</sup>
		Mil Spec (SMD, VID, SS)	TI Orderable Part Number			Max. TID (krad) Characterization	RHA: TID RLAT (krad)	RHA: HDR or LDR		
<a href="#">LM111QML-SP</a>	Comparator	5962-00524	LM111-MDE	5962R0052402V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<a href="#">LM119QML-SP</a>	Comparator	5962-96798	LM119 MDR	5962R9679801V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<a href="#">LM119QML-SP</a>	Comparator	5962-96798	LM119 MDE	5962R9679802V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<a href="#">LM139-SP</a>	Comparator	5962-96738	–	5962-9673802V9B	QMLV Die	40	–	–	-55 to 125°C	EAR99
<a href="#">LM139AQML-SP</a>	Comparator	5962-96738	LM139 MDR	5962R9673801V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<a href="#">LM139AQML-SP</a>	Comparator	5962-96738	LM139 MDE	5962R9673802V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<a href="#">LM193QML-SP</a>	Comparator	5962-94526	LM193 MDR	5962R9452602V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<a href="#">LM193QML-SP</a>	Comparator	5962-94526	LM193 MDE	5962R9452603V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<a href="#">LM101AQML-SP</a>	General-Purpose Op Amps	5962-99515	LM101 MDR	–	TI Space-Grade RHA Die	100	50	HDR	-55 to 125°C	EAR99
<a href="#">LM124-SP</a>	General-Purpose Op Amps	5962-99504	–	5962-9950403V9B	QMLV Die	50	–	–	-55 to 125°C	EAR99
<a href="#">LM124AQML-SP</a>	General-Purpose Op Amps	5962-99504	LM124 MDR	5962R9950401V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<a href="#">LM124AQML-SP</a>	General-Purpose Op Amps	5962-99504	LM124 MDE	5962R9950402V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<a href="#">LM158QML-SP</a>	General-Purpose Op Amps	5962-87710	LM158A MDR	5962R8771002V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<a href="#">LM158QML-SP</a>	General-Purpose Op Amps	5962-87710	LM158A MDE	5962R8771003V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<a href="#">LM6172QML-SP</a>	High-Speed Op Amps (>=50MHz)	5962-95604	LM6172 MDR	5962F9560401V9A	QMLV RHA Die	300	300	HDR	-55 to 125°C	EAR99
<a href="#">LM6172QML-SP</a>	High-Speed Op Amps (>=50MHz)	5962-95604	LM6172-MDE	5962R9560403V9A	QMLV RHA Die	300	100	LDR	-55 to 125°C	EAR99
<a href="#">LMP2012QML-SP</a>	Precision Op Amps (Vos<1mV)	5962-06206	LMP2012 MDE	5962L0620602V9A	QMLV RHA Die	50	50	LDR	-55 to 125°C	EAR99
<a href="#">LMP2012QML-SP</a>	Precision Op Amps (Vos<1mV)	5962-06206	LMP2012 MDR	–	TI Space-Grade RHA Die	50	50	HDR	-55 to 125°C	EAR99

<sup>1</sup>Devices with “–” in the radiation data columns might not have updated detailed radiation data or reports.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# Space products – die products (cont'd)

## Die products (cont'd)

Generic Part Number	Sub-Family (Part Type)	DLA	TI Orderable Part Number	MIL Orderable Part Number	Device Type Description	Radiation <sup>1</sup>			Temp	ECCN <sup>2</sup>
		Mil Spec (SMD, VID, SS)				Max. TID (krad) Characterization	RHA: TID RLAT (krad)	RHA: HDR or LDR		
<b>OPA4277-SP</b>	Precision Op Amps (Vos<1mV)	5962-16209	–	5962L1620901V9A	QMLV RHA Die	50	50	LDR	-55 to 125°C	EAR99
<b>ADC128S102QML-SP</b>	Precision ADCs (<= 10MSPS)	5962-07227	ADC128S102 MDR	5962R0722701V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	–
<b>DAC121S101QML-SP</b>	Precision DACs (<= 10MSPS)	5962-07226	DAC121S101 MDR	5962R0722601V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	–
<b>DS90C031QML-SP</b>	LVDS	5962-95833	DS90C031 MDR	–	TI Space-Grade RHA Die	100	100	HDR	-55 to 125°C	–
<b>DS90C032QML-SP</b>	LVDS	–	DS90C032 MDR	–	TI Space-Grade RHA Die	50	50	HDR	-55 to 125°C	EAR99
<b>DS16F95QML-SP</b>	RS-485 & RS-422	5962-89615	DS16F95 MDR	5962F8961501V9A	QMLV RHA Die	300	300	HDR	-55 to 125°C	EAR99
<b>TPS50601-SP</b>	Buck Converter	5962-10221	–	5962R1022101V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>TPS50601A-SP</b>	Buck Converter	5962-10221	–	5962R1022102V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>TPS50601A-SP</b>	Buck Converter	5962-10221	TPS50601AY/EM	–	/EM Die	–	–	–	25°C	EAR99
<b>TPS7H4001-SP</b>	Buck Converter	5962-18205	TPS7H4001Y/EM	5962R1820501V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>TPS7H4001-SP</b>	Buck Converter	5962-18205	–	–	/EM Die	–	–	–	25°C	EAR99
<b>TPS7H4002-SP</b>	Buck Converter	5962-20210	–	5962R2021001V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>TPS7H4002-SP</b>	Buck Converter	5962-20210	TPS7H4002Y/EM	–	/EM Die	–	–	–	25°C	EAR99
<b>TPS7H4010-SEP</b>	Buck Converter	–	TPS7H4010KGDSEP	–	TI Space-Grade Die	30	30	HDR	-55 to 125°C	EAR99
<b>TPS7H2201-SP</b>	eFuses & Hot Swap Controllers	5962-17220	–	5962R1722001V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>TPS7H2201-SP</b>	eFuses & Hot Swap Controllers	5962-17220	TPS7H2201Y/EM	–	/EM Die	–	–	–	25°C	EAR99
<b>TPS7H2211-SP</b>	eFuses & Hot Swap Controllers	5962-18220	–	5962R1822001V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>TPS7H2211-SP</b>	eFuses & Hot Swap Controllers	5962-18220	TPS7H2211Y/EM	–	/EM Die	–	–	–	25°C	EAR99
<b>LM117HVQML-SP</b>	Linear Regulators (LDOs)	5962-07229	LM117HVH MDR	5962R0722901V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>LM117HVQML-SP</b>	Linear Regulators (LDOs)	5962-07229	LM117HVH MDE	5962R0722961V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<b>LM117QML-SP</b>	Linear Regulators (LDOs)	5962-99517	LM117H MDR	5962R9951703V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>LM117QML-SP</b>	Linear Regulators (LDOs)	5962-99517	LM117H MDE	5962R9951705V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<b>LM2940QML-SP</b>	Linear Regulators (LDOs)	5962-89587	LM2940-5.0 MDE	–	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<b>LM2941QML-SP</b>	Linear Regulators (LDOs)	5962-91667	LM2941 MDE	5962R9166702V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<b>LP2953QML-SP</b>	Linear Regulators (LDOs)	5962-92336	LP2953 MDS	–	TI Space-Grade Die	–	–	–	-55 to 125°C	EAR99
<b>TPS7A4501-SP</b>	Linear Regulators (LDOs)	5962-12224	–	5962-1222402V9A	QMLV Die	100	–	–	-55 to 125°C	EAR99
<b>TPS7A4501-SP</b>	Linear Regulators (LDOs)	5962-12224	–	5962R1222403V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>TPS7H1101A-SP</b>	Linear Regulators (LDOs)	5962-13202	–	5962R1320202V9A	QMLV RHA Die	100	100	?	-55 to 125°C	EAR99
<b>TPS7H1101A-SP</b>	Linear Regulators (LDOs)	–	TPS7H1101AY/EM	–	/EM Die	–	–	–	25°C	EAR99
<b>TPS7H1111-SP</b>	Linear Regulators (LDOs)	–	–	5962R2120301V9A	QMLV-RHA KGD	100	100	LDR	-55 to 125°C	EAR99
<b>UC1834-DIE</b>	Linear Regulators (LDOs)	–	UC1834VTD1	–	Tested Die	–	–	–	25°C	EAR99
<b>UC1834-DIE</b>	Linear Regulators (LDOs)	–	UC1834VTD2	–	Tested Die	–	–	–	25°C	EAR99
<b>UC1825-DIE</b>	PWM Controllers	–	UC1825VTD1	–	Tested Die	30	–	–	25°C	EAR99
<b>UC1825-DIE</b>	PWM Controllers	–	UC1825VTD2	–	Tested Die	30	–	–	25°C	EAR99
<b>UC1825A-DIE</b>	PWM Controllers	–	UC1825AVTD1	–	Tested Die	30	–	–	25°C	EAR99
<b>UC1825A-DIE</b>	PWM Controllers	–	UC1825AVTD2	–	Tested Die	30	–	–	25°C	EAR99
<b>UC1825B-SP</b>	PWM Controllers	5962-87681	–	5962R8768106V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<b>UC1843-SP</b>	PWM Controllers	5962-86704	–	5962-8670410V9A	QMLV Die	50	–	–	-55 to 125°C	EAR99
<b>UC1843A-DIE</b>	PWM Controllers	–	UC1843AVTD1	–	Tested Die	30	–	–	25°C	EAR99
<b>UC1843A-DIE</b>	PWM Controllers	–	UC1843AVTD2	–	Tested Die	30	–	–	25°C	EAR99
<b>UC1843B-SP</b>	PWM Controllers	5962-86704	–	5962R8670412V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<b>UC1846-DIE</b>	PWM Controllers	–	UC1846VTD1	–	Tested Die	45	–	–	25°C	EAR99
<b>UC1846-DIE</b>	PWM Controllers	–	UC1846VTD2	–	Tested Die	45	–	–	25°C	EAR99
<b>UC1846-SP</b>	PWM Controllers	5962-86806	–	5962-8680603V9A	QMLV Die	40	–	–	-55 to 125°C	EAR99
<b>TPS7H5001-SP</b>	PWM Controllers	5962-18222	–	5962R1822201V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>TPS7H5001-SP</b>	PWM Controllers	5962-18222	TPS7H5001Y/EM	–	/EM Die	–	–	–	25°C	EAR99
<b>LM136A-2.5QML-SP</b>	Shunt Voltage Reference	5962-00501	LM136-2.5 MDR	5962R0050101V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	EAR99
<b>LM136A-2.5QML-SP</b>	Shunt Voltage Reference	5962-00501	LM136-2.5 MDE	5962R0050102V9A	QMLV RHA Die	100	100	LDR	-55 to 125°C	EAR99
<b>TL1431-DIE</b>	Shunt Voltage Reference	–	TL1431VTDB1	–	Tested Die	100	–	–	25°C	EAR99
<b>TL1431-DIE</b>	Shunt Voltage Reference	–	TL1431VTDB2	–	Tested Die	100	–	–	25°C	EAR99
<b>SN54HC08-DIE</b>	AND gate	–	SN54HC08VTF1	–	Tested Die	–	–	–	25°C	EAR99

<sup>1</sup>Devices with “-” in the radiation data columns might not have updated detailed radiation data or reports.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftteam@list.ti.com](mailto:gtc_eccn-hts-naftteam@list.ti.com).

# Space products – die products (cont'd)

## Die products (cont'd)

Generic Part Number	Sub-Family (Part Type)	DLA		MIL Orderable Part Number	Device Type Description	Radiation <sup>1</sup>			Temp	ECCN <sup>2</sup>
		Mil Spec (SMD, VID, SS)	TI Orderable Part Number			Max. TID (krad) Characterization	RHA: TID RLAT (krad)	RHA: HDR or LDR		
<b>SN54HC08-DIE</b>	AND gate	–	SN54HC08VTDF2	–	Tested Die	–	–	–	25°C	EAR99
<b>SN54HC273-DIE</b>	D-type flip-flop	–	SN54HC273VTDG1	–	Tested Die	–	–	–	25°C	EAR99
<b>SN54HC273-DIE</b>	D-type flip-flop	–	SN54HC273VTDG2	–	Tested Die	–	–	–	25°C	EAR99
<b>SN54HC373-DIE</b>	D-type latch	–	SN54HC373VTDG1	–	Tested Die	–	–	–	25°C	EAR99
<b>SN54HC373-DIE</b>	D-type latch	–	SN54HC373VTDG2	–	Tested Die	–	–	–	25°C	EAR99
<b>SN54AC00-DIE</b>	NAND gate	–	SN54AC00VTD1	–	Tested Die	100	–	–	25°C	EAR99
<b>SN54AC00-DIE</b>	NAND gate	–	SN54AC00VTD2	–	Tested Die	100	–	–	25°C	EAR99
<b>SN54AC00-SP</b>	NAND gate	5962-87549	–	5962R8754903V9A	QMLV RHA Die	100	100	HDR	-55 to 125°C	–
<b>SN54AC02-DIE</b>	NOR gate	–	SN54AC02VTD1	–	Tested Die	50	–	–	25°C	EAR99
<b>SN54AC02-DIE</b>	NOR gate	–	SN54AC02VTD2	–	Tested Die	50	–	–	25°C	EAR99

<sup>1</sup>Devices with "-" in the radiation data columns might not have updated detailed radiation data or reports.

<sup>2</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# TI space products – mechanical samples

Mechanical samples (dummy packages) are nonelectrically functional packages (typically without the die) used for mechanical evaluations or process setups. TI offers a number of space product mechanical samples.

Refer to the orderable part number listed in the tables below when ordering mechanical samples.

## Mechanical samples

Generic Part Number	Orderable Part Number	Package   Pins	ECCN <sup>1</sup>
LM111QML-SP	MKT-W10A-MS	CFP (NAD)   10	EAR99
LM111QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
LM119QML-SP	MKT-W10A-MS	CFP (NAD)   10	EAR99
LM119QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
LM139AQML-SP	MKT-W14B-MS	CFP (NAD)   14	EAR99
LF411QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
LM124AQML-SP	MKT-W14B-MS	CFP (NAD)   14	EAR99
LM158QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
LM6172QML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
LM7171QML-SP	MKT-W10A-MS	CFP (NAD)   10	EAR99
LM7171QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
LMH6628QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
LMH6702QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
LMP2012QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
CDCM7005-SP	SN00052HFG-DC	CFP (HFG)   52	EAR99
LMK04832-SP	SN0064HBE	CFP (HBE)   64	EAR99
LMX2615-SP	LMX2615-MKT-MS	CFP (HBD)   64	EAR99
LM98640QML-SP	MKT-EL68D-MS	CFP (NBB)   68	EAR99
ADC10D1000QML-SP	ADC10D1000DAISY	CCGA (NAA)   376	-
ADC12D1600QML-SP	ADC10D1000DAISY	CCGA (NAA)   376	-
ADC12D1620QML-SP	ADC10D1000DAISY	CCGA (NAA)   376	-
ADC14155QML-SP	MKT-EL48A-MS	CFP (NBA)   48	EAR99
ADS5424-SP	SN00052HFG-DC	CFP (HFG)   52	EAR99
DAC5675A-SP	SN00052HFG-DC	CFP (HFG)   52	EAR99
ADC128S102QML-SP	MKT-W16A-MS	CFP (NAD)   16	EAR99
ADC128S102QML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
DAC121S101QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
DP83561-SP	SN0064HBE	CFP (HBE)   64	EAR99
DS90C031QML-SP	MKT-W16A-MS	CFP (NAD)   16	EAR99
DS90C031QML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
DS90C032QML-SP	MKT-W16A-MS	CFP (NAD)   16	EAR99
DS90C032QML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
DS90LV031AQML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
DS90LV032AQML-SP	MKT-W16A-MS	CFP (NAD)   16	EAR99
DS16F95QML-SP	MKT-W10A-MS	CFP (NAD)   10	EAR99
DS26F31MQML-SP	MKT-W16A-MS	CFP (NAD)   16	EAR99
DS26F32MQML-SP	MKT-W16A-MS	CFP (NAD)   16	EAR99
TLK2711-SP	SN0068HFG	CFP (HFG)   68	EAR99
TLK2711-SP	SN00068HFG-DC	CFP (HFG)   68	EAR99
ADC12DJ3200QML-SP	ADC12DJ3200NWE/DC	CCGA (NWE)   196	EAR99
ADC12DJ5200-SP	SN0144ALR-DC	FCCSP (ALR)   144	EAR99
ADC12QJ1600-SP	SN0144ALR-DC	FCCSP (ALR)   144	EAR99
DAC39RF10-SP	SN0256ACL-DC	FCBGA (ACK)   256	EAR99
AFE7950-SP	SN0400ALK-DC	FCBGA (ALK)   400	EAR99
TPS50601-SP	SN0020HKH	CFP (HKH)   20	EAR99

Generic Part Number	Orderable Part Number	Package   Pins	ECCN <sup>1</sup>
TPS50601A-SP	SN0020HKH	CFP (HKH)   20	EAR99
TPS7H4001-SP	SN0034HKY	CFP (HKY)   34	EAR99
TPS7H4002-SP	SN0020HKH	CFP (HKH)   20	EAR99
TPS7H3301-SP	SN0016HKR	CFP (HKR)   16	EAR99
UC1611-SP	SN00020FK	LCCC (FK)   20	EAR99
TPS7H2201-SP	SN0016HKR	CFP (HKR)   16	EAR99
TPS7H2211-SP	SN0016HKR	CFP (HKR)   16	EAR99
LM117HVQML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
LM117QML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
LM2940QML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
LM2941QML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
LP2953QML-SP	MKT-WG16A-MS	CFP (NAC)   16	EAR99
TPS7A4501-SP	SN0010HKU	CFP (HKU)   10	EAR99
TPS7H1101A-SP	SN0016HKR	CFP (HKR)   16	EAR99
UC1832-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1834-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1707-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1708-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1525B-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1825-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1825A-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1843-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1843A-SP	SN0010HKU	CFP (HKU)   10	EAR99
UC1843B-SP	SN0010HKU	CFP (HKU)   10	EAR99
UC1844-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1845-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1845A-SP	SN0010HKU	CFP (HKU)   10	EAR99
UC1845A-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1846-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1863-SP	SN00020FK	LCCC (FK)   20	EAR99
UC1806-SP	SN00020FK	LCCC (FK)   20	EAR99
TPS7H5001-SP	SN0022HFT	CFP (HFT)   22	EAR99
TPS7H5002-SP	SN0022HFT	CFP (HFT)   22	EAR99
TPS7H5003-SP	SN0022HFT	CFP (HFT)   22	EAR99
TPS7H5004-SP	SN0022HFT	CFP (HFT)   22	EAR99
LM4050QML-SP	MKT-WG10A-MS	CFP (NAC)   10	EAR99
SMV512K32-SP	SN0076HFG	CFP (HFG)   76	EAR99
TMP461-SP	SN0010HKU	CFP (HKU)   10	EAR99
TPS7H1111-SP	SN0014HBL	CFP (HBL)   14	EAR99
TPS7H1121-SP	SN0022HFT	CFP (HFT)   22	EAR99
TPS7H3014-SP	SN0022HFT	CFP (HFT)   22	EAR99
TPS7H4001-SP	SN0034HKY	CFP (HKY)   34	EAR99
TPS7H4011-SP	SN0030HLB	CFP (HLB)   30	EAR99
TPS7H6003-SP	SN0048HBX	CFP (HBX)   48	EAR99
TPS7H6013-SP	SN0048HBX	CFP (HBX)   48	EAR99
TPS7H6023-SP	SN0048HBX	CFP (HBX)   48	EAR99

<sup>1</sup>ECCN information for products that are EAR99 are shown. For up-to-date ECCN information on any product, please email: [gtc\\_eccn-hts-naftateam@list.ti.com](mailto:gtc_eccn-hts-naftateam@list.ti.com).

# TI space products – Reference Designs

Reference designs are resources with the necessary information to design, build, and implement various systems. These designs include detailed schematics, bill of materials (BOM) and design files that explain the circuit's function and performance. Reference designs are intended to be used as reference material and are not sold by TI.

## Reference Designs

Part Number	Description	Isolated/Non-Isolated	Topology
<a href="#">TIDA-010984</a>	<a href="#">Motor Control Reference Design</a>	-	-
<a href="#">PMP23598</a>	<a href="#">75W synchronous forward for space applications</a>	Isolated	Forward-synchronous
<a href="#">TIDA-011004</a>	<a href="#">Space VPX 3U Power Card</a>	Isolated	Full Bridge-Resonant
<a href="#">TIDA-010931</a>	<a href="#">Radiation hardened space battery management system (BMS) reference design</a>	-	-
<a href="#">TIDA-050088</a>	<a href="#">Radiation-tolerant power reference design for the Versal AI Edge</a>	Non-Isolated	Buck-synchronous
<a href="#">PMP23391</a>	<a href="#">300W, 12V output ZVS full-bridge converter reference design for 100kRad applications</a>	Isolated	Full Bridge-Resonant
<a href="#">PMP23546</a>	<a href="#">2.4W multi-output PSR flyback reference design for bias supplies</a>	Isolated	Flyback
<a href="#">TIDA-010958</a>	<a href="#">Radiation-hardened dual-phase Versal® FPGA power reference design</a>	Non-Isolated	Buck-synchronous
<a href="#">PMP23389</a>	<a href="#">Space-grade 12V to 5V 15A synchronous buck converter reference design</a>	Non-Isolated	Buck-synchronous
<a href="#">TIDA-010274</a>	<a href="#">Space-grade discrete RF sampling transceiver reference design</a>	-	-
<a href="#">TIDA-010259</a>	<a href="#">Cascaded LMX1204 reference design</a>	-	-
<a href="#">PMP23193</a>	<a href="#">50- to 150-VIN, 28-V 5-A synchronous buck converter reference design for 100-kRad space applications</a>	Non-Isolated	Buck-synchronous
<a href="#">TIDA-010191</a>	<a href="#">Space-grade multichannel JESD204B 15-GHz clocking reference design</a>	-	-
<a href="#">PMP23033</a>	<a href="#">40-W 5-V single-switch forward converter with magnetic feedback reference design</a>	Isolated	Forward-integrated switch
<a href="#">PMP22680</a>	<a href="#">40-W, ±15-V flyback with magnetic feedback reference design</a>	Isolated	Flyback-DCM
<a href="#">TIDA-010197</a>	<a href="#">Versatile satellite health monitoring and control platform reference design with &lt; 1% accuracy</a>	-	-
<a href="#">TIDA-070004</a>	<a href="#">Space-grade reference design using integrated digital-output temperature sensor</a>	-	-
<a href="#">TIDA-070001</a>	<a href="#">3- to 7-VIN, Space-grade point-of-load (POL) reference design with redundant eFuse inputs for OCP</a>	Non-Isolated	Buck-synchronous
<a href="#">TIDA-01215</a>	<a href="#">Power Supply Reference Design for Optimizing Spur and Phase Noise in RF-sampling DACs</a>	-	-

# Acronyms

ADC	analog-to-digital converter	FET	field-effect transistor	RFID	radio-frequency identification
AMU	atomic mass unit	FIT	failures in time	RHA	radiation hardness assurance
ASET	analog single-event transient	FPGA	field-programmable gate array	RHBD	radiation hardening by design
ASTM	American Society for Testing and Materials	GCR	galactic cosmic ray	RHBP	radiation hardening by process
ATE	automated test equipment	GEO	geostationary orbit	RLAT	radiation lot acceptance testing
BiCMOS	bipolar complementary metal-oxide semiconductor	GSO	geosynchronous orbit	SAA	South Atlantic Anomaly
BJT	bipolar junction transistor	Gy	gray	SBU	single-bit upset
BL	bitline	HDR	high dose rate	SEB	single-event burnout
BOX	buried oxide	HEO	high Earth orbit	SEC-DED	single-error correct-double-error detect
BPSG	boron-doped phosphosilicate glass	hFE	bipolar transistor gain	SEDR	single-event dielectric rupture
CAT	computerized axial tomography	IC	integrated circuit	SEE	single-event effect
CCD	charge-coupled device	IGBT	insulated gate bipolar transistor	SEFI	single-event functional interrupt
CMEs	coronal mass ejections	LBNL	Lawrence Berkeley National Labs	SEGR	single-event gate rupture
CMOS	complementary metal-oxide semiconductor	LDO	low-dropout regulator	SEL	single-event latch-up
COTS	commercial off-the-shelf	LDR	low dose rate	SEM	scanning electron microscope
CT	computer tomography	LEO	low Earth orbit	SEP	solar energetic particles
DAC	digital-to-analog converter	LET	linear energy transfer	SER	soft-error rate
DBU	double-bit upset	LOCOS	local oxidation of silicon	SET	single-event transient
DD	displacement damage	MAAT	metal-oxide semiconductor accelerated anneal test	SEU	single-event upset
DDD	displacement damage dose	MBU	multiple-bit upset	Si	silicon
DEC-TED	double-error correct-triple-error detect	MCU	microcontroller	SiGe	silicon germanium
DICE	dual interlocked storage cell	MEO	medium Earth orbit	SMD	standard microcircuit drawing
DMOSFET	double-diffused metal-oxide semiconductor field-effect transistor	MIL-STD	military standard	SOA	safe operating area
DMR	dual-modular redundant	MOS	metal-oxide semiconductor	SoC	system-on-chip
DRAM	dynamic random-access memory	MOSFET	metal-oxide semiconductor field-effect transistor	SOI	silicon-on-insulator
DSET	digital single-event transient	MUX	multiplexer	SOS	silicon-on-sapphire
DTI	deep trench isolation	ND/PD	neutron dose/proton dose	SRAM	static random-access memory
DUT	device under test	NIEL	nonionizing energy loss	SRIM	Stopping and Range of Ions in Matter
e-h	electron hole	NMOS	N-channel metal-oxide semiconductor	STI	shallow trench isolation
ECC	error correction circuit	NPN	NPN transistor	TAMU	Texas A&M University
ELDRS	enhanced low-dose-rate sensitivity	NYC	New York City	TDE	time-dependent effect
EMP	electromagnetic pulse	OM	optical microscope	TEM	transmission electron microscope
ESA	European Space Agency	PMOS	P-channel metal-oxide semiconductor	TID	total ionizing dose
ESCC	European Space Components Coordination	PNP	PNP transistor	TM	test method
		PNPN	PNPN silicon controlled rectifier	TMR	triple-modular redundant
		QML	Qualified Manufacturers List	TPA	two-photon absorption
		R	read	ULA	ultra-low alpha
				W	write
				WL	wordline

## TI Product Classifications and Qualifications

Rating		Space				
Classification		Space EP	SHP	QMLP	QMLY	QMLV
<b>Production Testing and Documentation Provided</b>	Vendor Item Drawing (VID)	✓	✓	x	x	x
	Standard Microcircuit Drawing (SMD)	x	x	✓	✓	✓
	Process Conformance Report	✓	✓	✓	✓	✓
	Process Conformance Report Content	See Product Page		MIL-PRF-38535 Group A, B, C, D, E		
<b>Manufacturing</b>	Single Controlled Baseline	✓	✓	✓	✓	✓
	Multiple Wafer Lots Per Reel Possible	x	x	x	x	x
	Life Test Per Wafer Lot	x	✓	✓	✓	✓
<b>Packaging</b>	Package Construction	Plastic	Plastic	Plastic - Wirebond or Flip Chip with Overmold	Plastic - Flip Chip w/o Overmold	Hermetic
	Bond Wires	Au	Au	Au	N/A	Al
	Pure Tin (Sn) Lead Finish Possible?	x	x	x	x	x
	>97% Tin (Sn) Inside Package Possible	✓ For Flip Chip				x
	Production Burn-In Required	x	✓	✓	✓	✓
	Outgassing Tested Per ASTM E595	✓	✓	✓	✓	N/A
<b>Radiation</b>	TID Characterization Range (krad/Si)	30 to 50	50 to 300			
	TID Radiation Lot Acceptance Testing (RLAT) Range – RHA (krad/Si)	20, 30 or 50	50, 100 or 300			
	SEL Immunity (MeV*cm <sup>2</sup> /mg)	≥43	≥60			
<b>Typical Temperature Range</b>		-55–125°C				

Table illustrates typical values for each classification rating. For precise data or detailed information, please refer to the product-specific page.

\*BI unless optimization aligned with DLA

TID = Total Ionizing Dose

VID = Vendor Item Drawing

SEL = Single-Event Latch-up

RHA = Radiation Hardness Assured

QML = Qualified Manufacturers List

SMD = Standard Microcircuit Drawing

# TI Worldwide Technical Support

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