

TI Space Products Guide

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



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.
- Radiation-tolerant portfolio: www.ti.com/SEP.
- The "Radiation Handbook for Electronics" eBook: www.ti.com/RadBook.

Space-grade power management

Featured products

3- to 7-V_{IN}, 18-A, current-mode monolithic point-of-load DC/DC converter

TPS7H4001-SP / TPS7H4003-SEP

Key features

- 0.6 V ±1.5% V_{REF} accuracy over load, line, temp and TID
- Integrated high-side and low-side power MOSFETs
- Programmable frequency from 100–1000 kHz
- Parallel support for 2–4 devices with 180° or 90° Φ shifted SYNC1 and SYNC2 pins (50-kHz master/slave operation)
- Configurable softstart/tracking, external compensation, power good, enable
- Configurable slope compensation
- QML Class-V: 34-pin CDFP, 7.6 mm x 21.6 mm
- QML Class-P: 44-pin HTSSOP, 6.1mm x 14.0mm
- Space EP: 44-pin HTSSOP, 6.1mm x 14.0mm

Radiation performance

- Rad-hard (RHA) TPS7H4001-SP:
 - TID characterization to 100 krad(Si)
 - SEL immunity to 75 MeV-cm²/mg at 125°C
- Rad-tolerant TPS7H4003-SEP:
 - TID characterization to 50 krad(Si)
 - SEL immune to 43 MeV-cm²/mg at 125°C

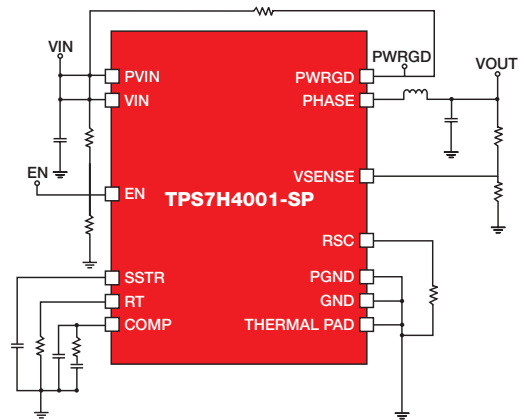
More information at www.ti.com/product/TPS7H4001-SP and at www.ti.com/product/TPS7H4003-SEP

Applications

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

Benefits

- Higher output current in smaller footprint for powering high-current FPGA and ASIC core voltage rails
- Ease of implementing sequencing schemes
- Easily paralleled for even higher currents with no external components and no external clock needed



1.6-V to 5.5-V, 1.25 A, load switch in small plastic package

TPS7H2221-SEP

Key features

- Space Enhanced Plastic (-SEP): Controlled baseline, product traceability, gold bond wire, Ni-Pd-Au lead finish, enhanced mold compound for low outgassing.
- On Resistance (R_{ON}) of 115 m Ω (typ.) at V_{IN}=5 V @ 25 °C
- Fixed controlled slew rate, short-circuit protection, thermal shutdown and quick output discharge (QOD)
- Low control input threshold enables use of 1.5 V to 5.5 V logic
- SOT 6-pin package: 2.0 x 2.1 mm

Applications

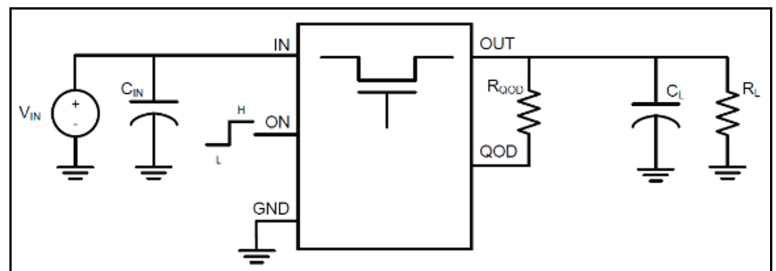
- Space Satellite Power Management and Distribution
- Radiation Hardened and Tolerant Power Tree Applications

Radiation performance

- TID = 30 krad(Si) RHA
- SEL/SEB/SEGR immune to LET = 43 MeV-cm²/mg
- SET/SEFI characterized to LET = 43 MeV-cm²/mg

Benefits

- Validated radiation performance with Radiation Lot Acceptance Testing (RLAT) up to 20krad(Si)
- Smallest form factor load switch for space
- Quick Output Discharge for known “zero” state at t₀
- Automatic Protection and Recovery from Short Circuits
- Thermal Shutdown to Protect Against Overheating
- Controlled inrush current during system power-up
- Able to parallel for current sharing and reduced R_{ON}



More information at www.ti.com/product/TPS7H2221-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

- $0.6\text{ V} \pm 1\%$ V_{REF} accuracy over load, line, temperature and TID
- Configurable switching frequency from 100 kHz to 2 MHz.
External synchronization using SYNC pin
- 5-V outputs, 150 mA 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 100 krad(Si)
 - SEL immunity to 75 MeV-cm²/mg at 125°C
- Rad-tolerant TPS7H5005-SEP:
 - TID characterization to 50 krad(Si)
 - SEL immunity to 43 MeV-cm²/mg at 125°C

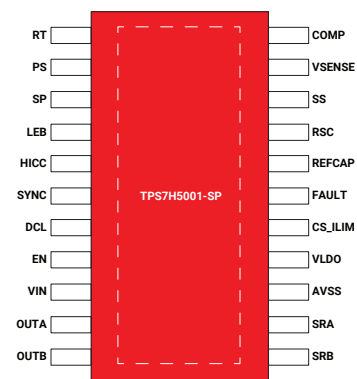
Applications

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

More information at www.ti.com/product/TPS7H5001-SP and at www.ti.com/product/TPS7H5005-SEP

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



3- to 7- V_{IN} , 6-A monolithic point-of-load DC/DC converter

TPS50601A-SP

Key features

- $PV_{IN} = V_{IN} = 3.0\text{ V to }7\text{ V}$
- 6-A maximum output current
- Min output voltage to 0.8 V
- Integrated 58-m Ω high-side and 50-m Ω low-side power FETs
- Adjustable frequency from 100 kHz to 1.0 MHz
- Parallel operation 180° out of phase with sync pin
- Integrated tracking function
- $R_{\theta JC} = 0.6^\circ\text{C/W}$
- Packaged in thermally enhanced 20-pin ceramic flatpack (HKH) and known good die (KGD)

Radiation performance

- TID = 100 krad(Si) RHA
- SEL, SEB and SEGR immune to LET = 75 MeV-cm²/mg
- SET/SEFI onset 65 MeV-cm²/mg

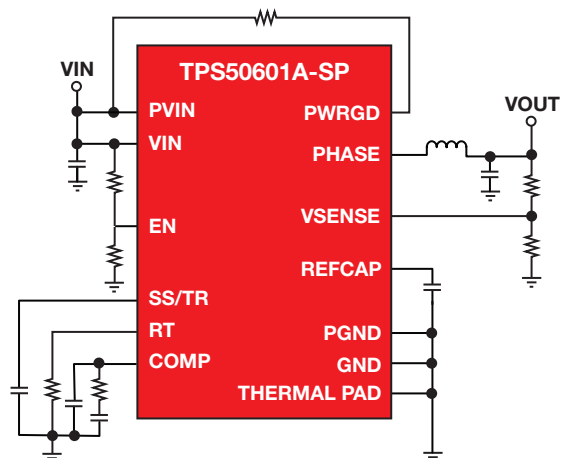
Applications

- Satellite point-of-load (POL) power supplies

More information at www.ti.com/product/TPS50601A-SP

Benefits

- RHA qualified and orderable as SMD: 5962R1022102VSC (RHA) 5962R1022102V9A (KGD)
- 96.6% peak efficiency ($V_{OUT} = 3.3\text{ V}$) and low V_{OUT} optimized
- Excellent for driving 12-A current through current share
- Ease of implementing power sequencing schemes
- Best-in-class thermal performance
- WEBENCH® and PSpice models available



Space-grade power management

Featured products

1.5- to 7-V_{IN} 3-A low-dropout regulator

TPS7H1101A-SP

Key features

- V_{IN} = 1.5 V to 7 V
- Ultra-low dropout, PMOS pass device
 - 62 mV (typ) @ 1 A, 335 mV (Max) at 3 A
- Very-high accuracy = ±2%
 - Internal V_{REF} = ±1.8%
- Ultra-low noise: 20.33 μV_{RMS}
- PSRR: >45 dB at 1 kHz
- Programmable softstart and OCP (with current reading)
- Enable across all input voltages and power good output (for sequencing)
- Temperature range: -55°C to 125°C
- Packaged in thermally enhanced 16-pin ceramic flatpack

Radiation performance

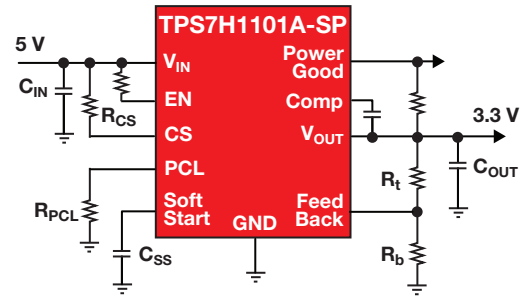
- TID = 100 krad(Si) RHA
- SEL immune to LET = 85 MeV-cm²/mg
- SET onset 52 MeV-cm²/mg

Applications

- Power management – LDO
- High PSRR and low noise for clean analog-supply requirement applications

Benefits

- RHA qualified: 5962R1320202VXC
- ELDRS free
- High power savings with lowest V_{IN} on the market for LDO



More information at www.ti.com/product/TPS7H1101A-SP

Wide V_{IN} (2.3 to 20 V) 1.5-A low-dropout regulator

TPS7A4501-SP

Key features

- V_{IN} = 2.3 V to 20 V
- Adjustable output from 1.21 V to 20 V
- Optimized for fast transient response
- Low noise: 35 μV_{RMS} (10 Hz to 100 kHz)
- High ripple rejection: 68 dB at 1 kHz
- No protection diodes needed
- Less than 1-μA quiescent current in shutdown
- Reverse battery and reverse current protection
- Thermally enhanced 10-pin CFP (HKU) package

Radiation Performance

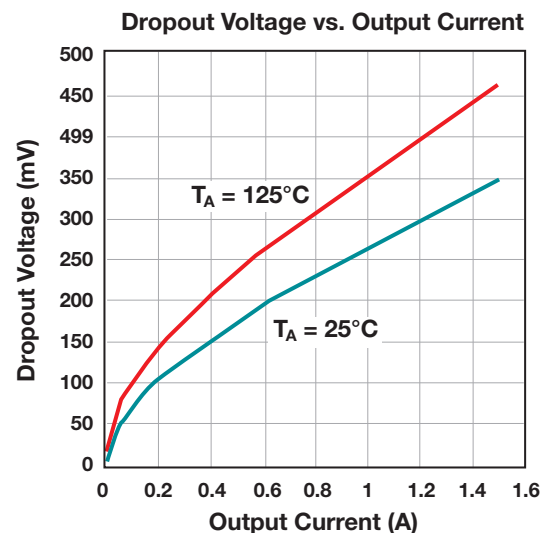
- Total dose (TID) = 100 krad(Si) RHA
- SEL immune to LET = 85 MeV-cm²/mg
- SET immune to LET = 75 MeV-cm²/mg for V_{OUT} < 5%

Applications

- Power management – LDO
- Satellite point-of-load (POL) power supplies
- Satellite bus and payload

Benefits

- RHA qualified and orderable as SMD: 5962R1222403VXC
- Outstanding low-noise performance
- Widest input voltage range for a RHA LDO



More information at www.ti.com/product/TPS7A4501-SP

Space-grade power management

Featured products

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

TPS7H1111-SP / TPS7H1111-SEP

Key features

- Ultra-Low Noise: 1.68 μ V_{RMS} (10 Hz – 100 kHz)
- Ultra-low 1/f noise: 100 nV/Hz^{1/2} (typ at 10 Hz)
- High PSRR: 71 dB @ 100 kHz, 67 dB @ 1 MHz
- V_{OUT} : 0.4 V to 5.5 V
- Very high accuracy: \pm 1.5% across line, load, temperature, & radiation
- Low dropout: 200 mV (typ) @ 1 A, 450 mV (max) at 1.5 A
- Bias supply to minimize power dissipation (Set $V_{BIAS} \geq V_{OUT} + 1.6$ V)
- Ability to easily parallel multiple devices for higher output current
- Programmable soft start
- Enable and configurable power good threshold and indicator
- Exposed control loop with the external compensation STAB pin
- Configurable current limit behavior (brick-wall or turn-off)
- 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

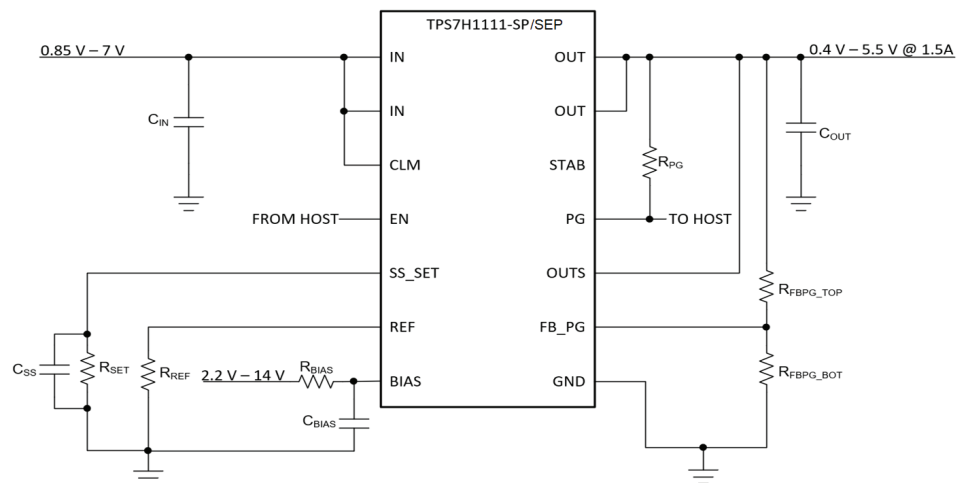
- Rad Hard (RHBD) TPS7H1111-SP:
 - TID (LDR & HDR) = 100 krad(Si)
 - SEL/SEB/SEGR immune to 75 MeV*cm²/mg
 - SET/SEFI characterized to LET = 75 MeV*cm²/mg
- Rad Tolerant TPS7H1111-SEP:
 - TID characterization to 50 krad(Si)
 - SEL/SEB/SEGR immune to 43 MeV-cm²/mg
 - SET/SEFI characterized to LET = 43 MeV*cm²/mg

Applications

- Power for high-speed and high-accuracy circuits
 - VCOs (voltage controlled oscillators)
 - Data Converters: ADCs and DACs (analog-to digital and digital-to-analog converters)
 - PLLs (phase-lock-loops), SerDes (serializer and deserializers), 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



More information at www.ti.com/product/TPS7H1111-SP and at www.ti.com/product/TPS7H1111-SEP

Space-grade interface

Featured products

3.3-V CAN transceiver

SN55HVD233-SP / SN55HVD233-SEP

Key features

- Compatible with ISO 11898-2
- Data rates up to 1 Mbps
- Extended -7-V to 12-V 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 6.48 × 6.48-mm ceramic flat pack (HKX)
- Bus pins ESD protection exceeds ±16 kV HBM

Radiation performance

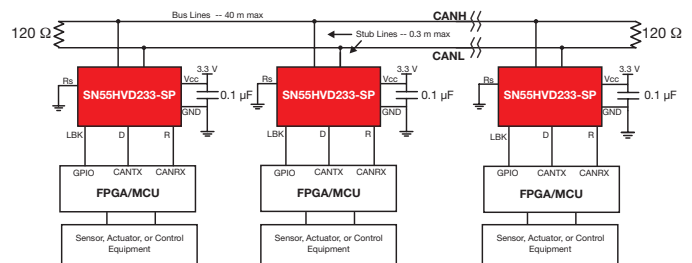
- Rad Hard (RHA) SN55HVD2331-SP:
 - TID = 50 krad(Si) RHA
 - SEL immune to 86 MeV*cm²/mg
- Rad Tolerant SN55HVD2331-SEP:
 - TID characterization to 30 krad(Si)
 - SEL immune to 43 MeV*cm²/mg

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

and at www.ti.com/product/SN55HVD233-SEP

RS-485 differential bus transceiver

DS16F95QML-SP

Key features

- Designed for multipoint transmission
- Wide positive and negative input/output bus voltage ranges
- Thermal shutdown protection
- Driver positive and negative current-limiting
- High-impedance receiver input
- Receiver input hysteresis of 50 mV typical
- Operates from single 5.0-V supply
- Available in 10-pin ceramic flatpack

Radiation performance

- TID = 300 krad(Si) RHA

Applications

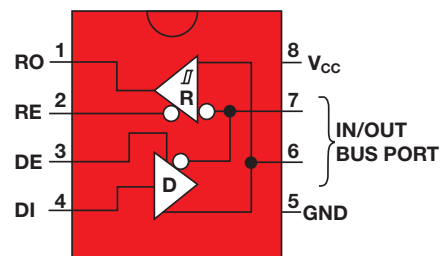
- Satellite communication
- Defense electronics
- Radar and guidance systems

Benefits

- Orderable as SMD RHA: 5962F8961501VHA
- Meets EIA-485 and EIA-422A specifications
- Meets SCSI-1 (5 MHz) specifications
- RHA and QMLV qualified

Other drivers/receivers in RS-485 family (Tx, Rx, 3.3 V, 5 V)

- DS96F174MQML-SP quad high-speed differential driver
- DS96F175MQML-SP quad high-speed differential receiver



More information at www.ti.com/product/DS16F95QML-SP

Space-grade interface

Featured products

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

DP83561-SP

Key features

- TID: 300 krad (Si), QMLV-RHA qualified
- SEL immune > 121 MeV-cm²/mg at max temp and voltage ratings
- SEU: No link drops and low packet loss up to 48 MeV-cm²/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-T
- 64-pin CFP (11 mm × 11 mm)

Radiation performance

- TID = 300 krad(Si) RHA
- SEL immune to LET = 121 MeV-cm²/mg

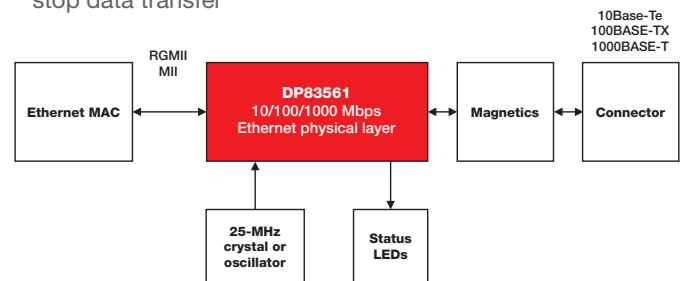
More information at www.ti.com/product/DP83561-SP

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



Space-grade data converters

Featured products

Octal, 128-kSPS, simultaneous-sampling 24-bit delta-sigma ADC

ADS1278-SP

Key features

- Simultaneous sampling of 8 inputs via independent 24-bit delta-sigma ADCs capable of converting up to 128 kSPS
- Bandwidth: 70 kHz
- Signal-to-noise ratio (SNR): 111dB
- Total harmonic distortion (THD): -96 dB (Max.)
- Operating temperature -55 to 125°C
- 84-lead ceramic HFQ 10 mm × 10 mm

Radiation performance

- TID = 75 krad, 50 krad(Si) RHA
- SEL immune to LET = 69 MeV-cm²/mg (125°C)

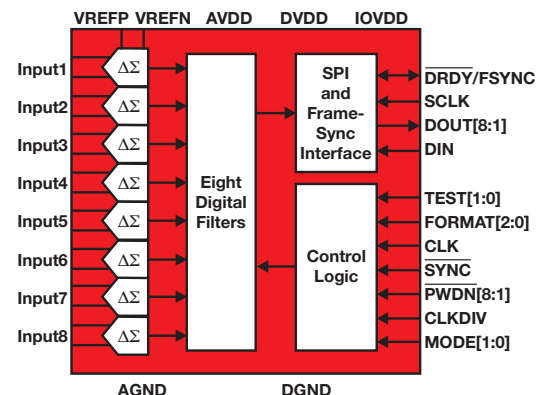
Applications

- Orbital observation systems
 - Satellite, shuttles, space stations, launchers
- Satellite sensing and closed-loop control
- Space scientific instrumentation

More information at www.ti.com/product/ADS1278-SP

Benefits

- Offers easy implementation of simultaneous analog-to-digital conversion for multiple inputs sourced from a wide range of transducers without the need of using an external multiplexer
- Allows accurate measurement of AC signals in the presence of noise; its highly linear transfer function provides high-fidelity and undistorted conversions
- Allows user to better resolve low-level signals found especially in the fields of satellite sensors



Space-grade data converters

Featured products

High-resolution delta-sigma analog-to-digital converter

ADS1282-SP

Key features

- Very high resolution:
 - 130-dB SNR (250 SPS, $G = 1$)
 - 125-dB SNR (250 SPS, $G = 16$)
 - Integrated low-noise ($5nV/\sqrt{Hz}$) high-gain (1–64V/V) PGA
- Ultra linear
 - THD = –122 dB, INL = 0.5 ppm
- Two-channel input MUX
- Low power consumption: 25 mW (high-res); 10 μ W (standby)
- Flexible digital filter (sync, FIR or IIR)
- Packaged in thermally enhanced CFP package

Radiation performance

- TID = 50 krad(Si) RHA
- SEL immune to 50 MeV-cm²/mg @ 125°C
- SEL immune to 60 MeV-cm²/mg @ 85°C

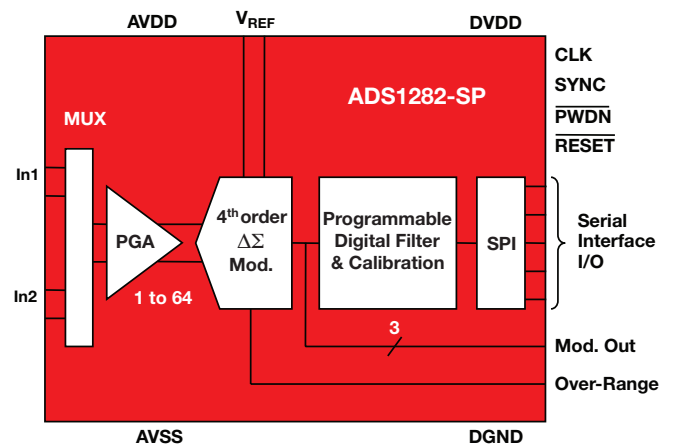
Applications

- Orbital observation systems (e.g., satellite, shuttles, space stations, launchers)
- Satellite temperature and bridge sensor measurements
- Space scientific instrumentation

Benefits

- RHA qualified and orderable as SMD: 5962L1423101VXC
- Allows user to acquire wide dynamic-range signals in satellite-telemetry sensors
- Minimal distortion to convert signals for frequency-domain analysis and post processing
- Selectable digital filter assures a flexible design that will meet the requirements of the most demanding applications

ADS1282: MUX + PGA + Modulator + Digital Filter



More information at www.ti.com/product/ADS1282-SP

Dual-channel, 14-bit, 40-MSPS analog front end

LM98640QML-SP

Key features

- Fully integrated signal-processing solution for imaging systems
- Correlated double sampling (CDS) or sample/hold (S/H) processing for CCD or CIS sensors
- Serialized LVDS outputs
- Dual lane at 16 \times sample rate or quad lane at 8 \times sample rate
- Programmable sampling edge up to 1/64th pixel period
- Programmable analog gain for each channel
- Programmable analog offset correction
- Integrated low-noise ($5nV/\sqrt{Hz}$) high-gain (1–64V/V) PGA

Radiation performance

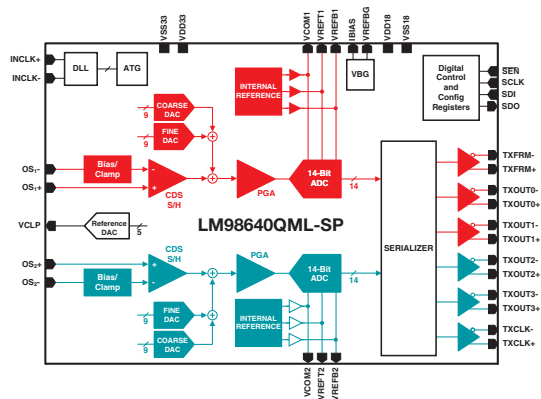
- TID = 100 krad(Si) RHA
- SEL and SEFI immune to LET > 120 MeV-cm²/mg

Applications

- CCD arrays
- CMOS image sensors
- Earth observation
- Star tracker
- Satellite temperature and bridge sensor measurements

Benefits

- RHA qualified and orderable as SMD: 5962R1820301VXC
- Enables digitization on the focal plane
 - No cabling
 - Reduced weight
- Low power consumption
- Meets space reliability requirements
- TID and SEU characterization data available for faster design in



More information at www.ti.com/product/LM98640QML-SP

Space-grade data converters

Featured products

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

ADC12DJ5200-SP / ADC12DJ5200-SEP

Key features

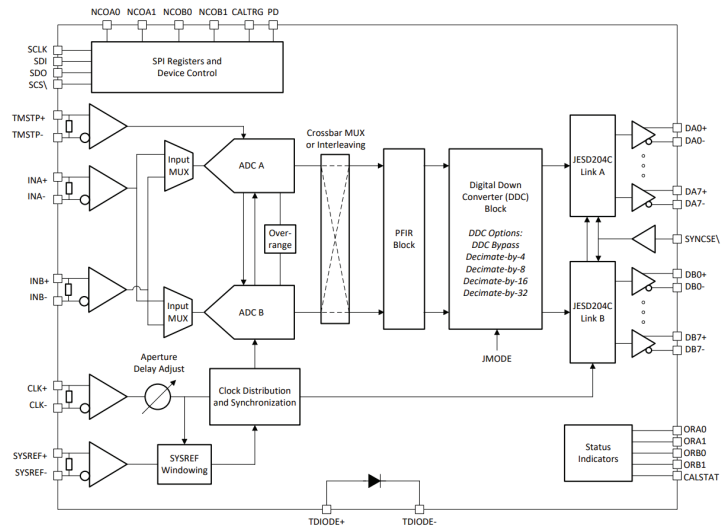
- 12-bit ADC with 8-GHz input bandwidth
- 10.4-GSPS as single, 5.2-GSPS as dual
- Noise Floor: -154.4 dBFS/Hz
- ENOB: 8.6 Bits
- Easy-to-use synchronization features
- 17.16Gbps JESD204B/C serial data interface
- Optional 4x-32x complex decimation
- Peak RF Input Power (Diff): +26.5 dBm
- Programmable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

Radiation performance

- Rad Hard ADC12DJ5200-SP:
 - TID = 300 krad(Si) RHA
 - SEL and SEFI immune to LET > 120 MeV-cm²/mg
- Rad Tolerant ADC12DJ5200-SEP:
 - TID characterization to 30 krad(Si)
 - SEL immune to 43 MeV-cm²/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 and at www.ti.com/product/ADC12DJ5200-SEP

Quad-channel, 12-bit, 1.6-GSPS ADC with JESD204C interface and integrated sample clock generator

ADC12QJ1600-SP / ADC12QJ1600-SEP

Key features

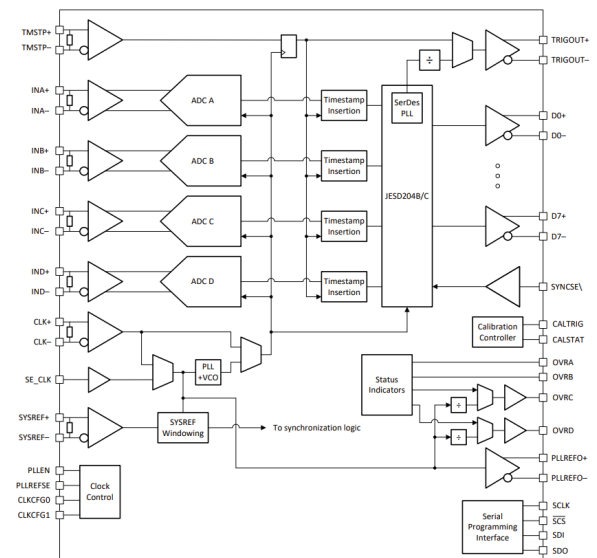
- Four channel 6-GHz 12 Bit 1.6-GSPS ADC
- Internal dither reduces high-order harmonics
- SNR (100 MHz): 57.4 dBFS
- ENOB (100 MHz): 9.1 Bits
- SFDR (100 MHz): 64 dBc
- Noise floor (-20 dBFS): -147 dBFS
- Easy-to-use synchronization features
- 17.16Gbps JESD204B/C serial data interface
- Power consumption: 1.9 W at 1 GSPS

Radiation performance

- Rad Hard ADC12QJ1600-SP:
 - TID = 300 krad(Si) RHA
 - SEL and SEFI immune to LET > 120MeV-cm²/mg
- Rad Tolerant ADC12QJ1600-SEP:
 - TID characterization to 30 krad(Si)
 - SEL immune to 43 MeV-cm²/mg at 125°C

Applications

- LIDAR / RADAR
- Spectrometry
- Electronic warfare (SIGINT, ELINT)
- Satellite communications (SATCOM)



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

ADC128S102QML-SP / ADC128S102-SEP

Key features

- Eight input channels
- V_A : 2.7 V to 5.25 V; V_D : 2.7 V to V_A
- 2.3 mW with 3-V supply and 0.06 μ W at shutdown
- DNL: -0.5 to $+0.9$ LSB (typ); INL: ± 0.9 LSB (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 (5.0 \times 4.4 mm)

Radiation performance

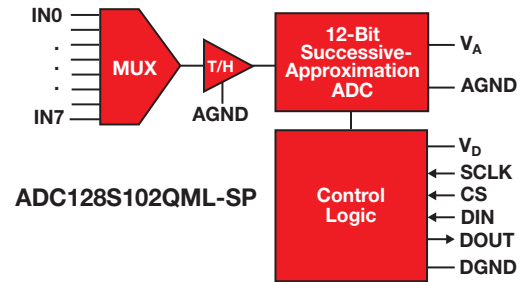
- Rad Hard (RHBD) ADC128S102QML-SP:
 - TID = 100 krad(Si) RHA
 - SEL and SEFI immune to LET > 120 MeV-cm²/mg
- Rad Tolerant ADC128S102-SEP:
 - TID characterization (ELDRS free) to 30 krad(Si)
 - SEL immune to 43 MeV-cm²/mg at 125°C

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 and at www.ti.com/product/ADC128S102-SEP

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
- I2C or SPI Interface
- 8 GPIO
- 64-Pin Plastic HTQFP Package (10 x 10 mm)

Applications

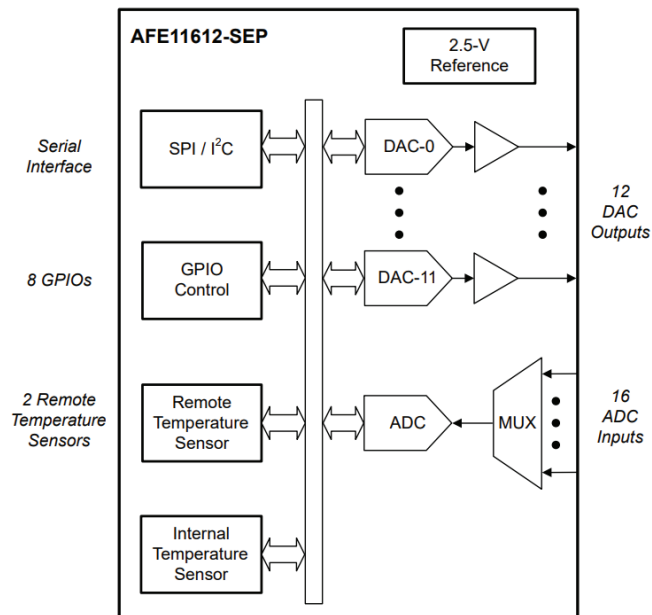
- Command and data handling (C&DH)
- Communications payload
- Radar imaging payload
- Optical imaging payload
- General analog monitoring and control

Radiation performance

- TID = 20 krad(Si) RLAT
- SEL/SEB/SEGR immune to LET = 43 MeV-cm²/mg
- SET/SEFI characterized to LET = 43 MeV-cm²/mg

Benefits

- High Integration
- Vendor Item Drawing (VID)



More information at www.ti.com/product/AFE11612-SEP

Space-grade amplifiers

Featured products

850-MHz 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: 2.7 to 5.4 V
- I_Q : 10.1 mA
- Power-down current: $\sim 2 \mu\text{A}$
- Bandwidth: $\sim 500 \text{ MHz}$ @ $G = 2 \text{ V/V}$ (GBW = 850 MHz)
- Input voltage noise: $2.2 \text{ nV}/\sqrt{\text{Hz}}$
- THD: -140 dBc @ 2 V_{pp} , 1 MHz
- Typical $V_{\text{OS}} / V_{\text{OS}}$ drift: $\pm 100 \mu\text{V} / \pm 0.5 \mu\text{V}/^\circ\text{C}$
- Operating temperature range: -55°C to 125°C

Radiation performance

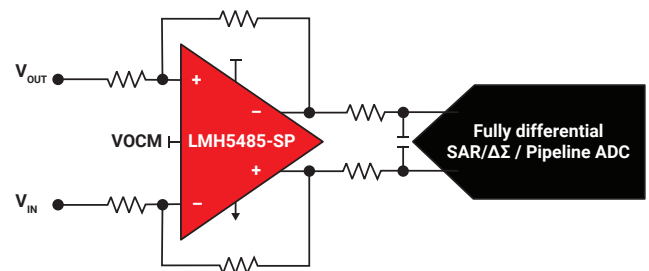
- Rad-hard (RHA) LMH5485-SP:
 - TID characterization to 100 krad(Si)
 - SEL immunity to $85 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ at 125°C
- Rad-tolerant LMH5485-SEP:
 - TID characterization to 30 krad(Si)
 - SEL immune to $43 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ at 125°C

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 100-krad qualified for GEO applications



More information at www.ti.com/product/LMH5485-SP and at www.ti.com/product/LMH5485-SEP

Four-channel, 11-MHz 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 11 MHz
- 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 pA (max)
- Supply current 1.8 mA (typ)
- Input stage voltage noise $5.1 \text{ nV}/\sqrt{\text{Hz}}$ at 1 kHz
- Current noise $0.8 \text{ fA}/\sqrt{\text{Hz}}$ at 1 kHz
- 0.1-Hz to 10-Hz noise $250 \text{ nV}_{\text{pp}}$
- 14-pin plastic package – TSSOP (PW) ($5.0 \text{ mm} \times 4.4 \text{ mm}$)

Radiation performance

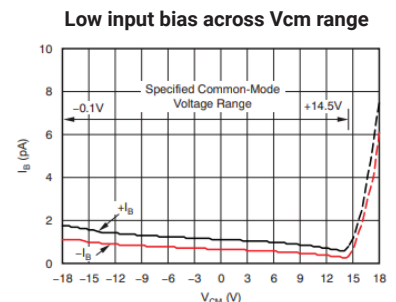
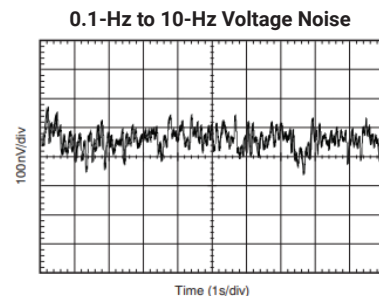
- TID characterization (ELDRS free) to 30 krad(Si)
- SEL immune to $43 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ at 125°C

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 30-krad qualified for new space LEO applications



More information at www.ti.com/product/OPA4H014-SEP

Space-grade amplifiers

Featured products

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

LMP7704-SP

Key features

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

Radiation performance

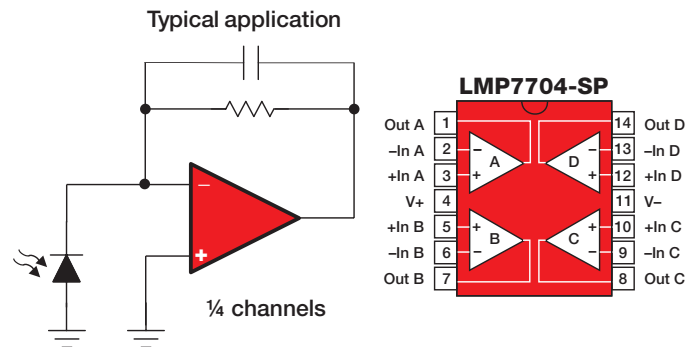
- TID = 100 krad(Si) RHA
- SEL = 85 MeV-cm²/mg (125°C)

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

Space-grade clocks and timing

Featured products

15-GHz low-noise wideband phase-locked loop with integrated voltage-controlled oscillation

LMX2615-SP

Key features

- Space grade 40-MHz to 15-GHz wideband synthesizer with phase synchronization and JESD204B support
- -110 dBc/Hz closed-loop phase noise at 100 KHz offset at 15-GHz carrier frequency
- 45-fs RMS jitter at 8 GHz (100 Hz to 100 MHz)
- Ability to synchronize output phase with OSCin
- > 50 fixed-pin programmable options
- Single 3.3-V supply
- 11 \times 11 mm² 64-lead CQFP ceramic package

Radiation performance

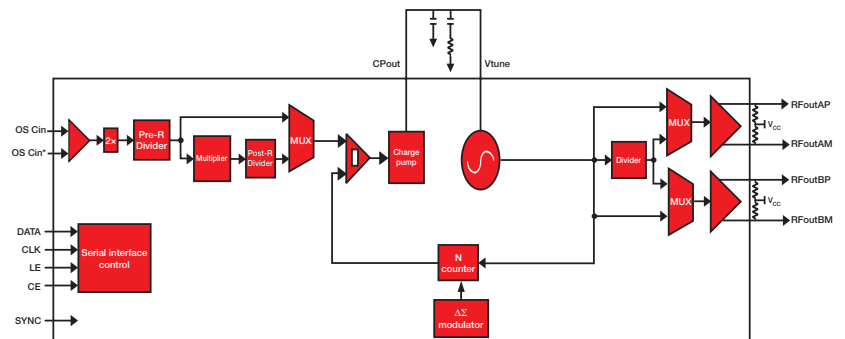
- TID = 100 krad(Si) RHA
- SEL/SEU immune to LET = 120 MeV-cm²/mg (125°C)

Applications

- Space communications
- Space radar systems
- Phased-array antennas and beam forming

Benefits

- Wideband clock source to generate any clock frequency for high-speed data converters
- Support for generating or repeating SYSREF compliant to JESD204B standard
- Save board space and complexity by replacing discrete components with LMX2615
- High-performance PLL can attain very low in-band noise and integrated jitter



More information at www.ti.com/product/LMX2615-SP

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
- 54-fs RMS jitter at 2.5 GHz, 61-fs RMS jitter at 3.2 GHz (12 kHz–20 MHz)
- Noise floor -156.5 dBc/Hz @ 3200 MHz
- CML swing: $1.2 V_{PP}$ differential @ 3.2 GHz
- 2 integrated VCO to support 2 independent frequency plans
 - VCO0 = 2440 to 2580 MHz
 - VCO1 = 2945 to 3255 MHz
- 320-MHz PLL2 maximum phase detector frequency
- -230 dBc/Hz PLL2 FOM and -128 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
- Rad Hard: 64-pin ceramic with nonconductive tie bar
- Rad tolerant: 64-pin PAP0064E, 10mm x 10mm

More information at www.ti.com/product/LMK04832-SP and at www.ti.com/product/LMK04832-SEP

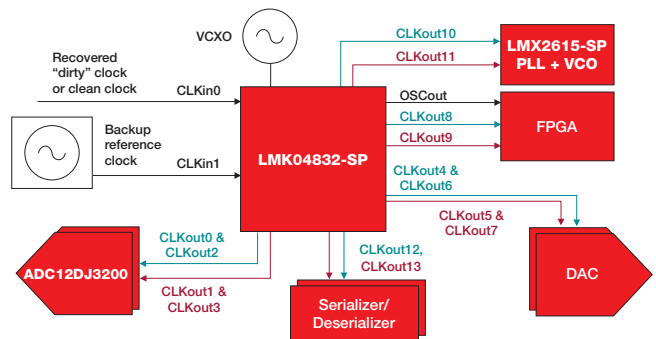
Radiation performance

- Rad-hard (RHA) LMK04832-SP:
 - TID characterization to 100 krad(Si)
 - SEL immunity to 120 MeV-cm²/mg at 125°C
- Rad-tolerant LMK04832-SEP:
 - TID characterization to 30 krad(Si)
 - SEL immune to 43 MeV-cm²/mg at 125°C

Applications

Low jitter noise with JEDEC JESD204B

- Space communications
- JESD204B clocking systems



Space-grade microcontrollers

Featured product

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

MSP430FR5969-SP

Key features

- Extremely low power consumption 16-bit RISC architecture:
 - 100 μ A/MHz active
 - 0.02 μ A shutdown, 0.4 μ A standby
- 64 KB 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, I²C
 - Multi-function I/O ports
- Support for 32-kHz crystals or internal clock sources
- 48-pin VQFN and TQFP plastic packages for reduced size and weight

Radiation performance

- TID = 75 krad(Si), 50 krad(Si) RHA
- SEL immune to LET = 72 MeV-cm²/mg

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 ² C or SPI
32x32 Multiplier DMA (3 ch), CRC16	Power-on reset Brown-out reset XT1, VLO DCO ($\pm 2\%$), Real-time clock
Up to 3 1x8 + 1 1x3 I/O ports w/ interrupts / wake up	
Comp_D / Vref ADC12 (up to 16 ch)	

More information at www.ti.com/product/MSP430FR5969-SP

Space-grade sensor products

Featured products

Radiation-hardness-assured nine-channel (eight remote and one local) high-accuracy temperature sensor **TMP9R00-SP**

Key features

- 8-channel remote: $\pm 2.0^{\circ}\text{C}$ (max), local: $\pm 1.5^{\circ}\text{C}$ (max)
- Temperature resolution 0.0625°C
- Supply and logic voltage range: 1.7 V to 2 V
- 67- μA operating current, 0.3- μA shutdown current
- Remote diode features:
 - Series resistance cancellation
 - η -factor correction
 - Offset correction
 - Diode fault detection
- Register lock function secures key registers
- I²C or SMBus compatible two-wire interface with pin-programmable address

Radiation performance

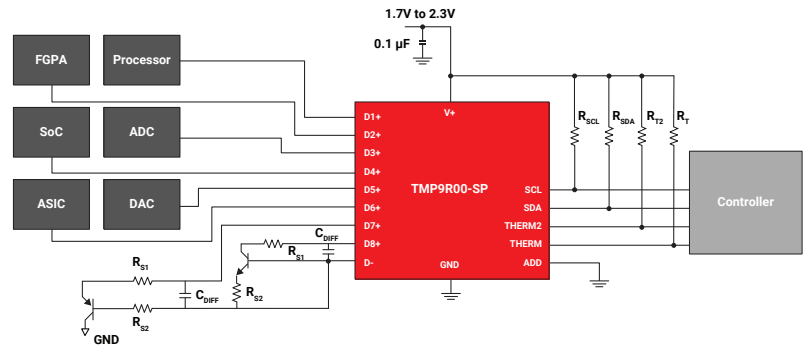
- TID = 100 krad(Si) RHA at LDR (10 mrad/s)
- SEL immune to LET = 76 MeV-cm²/mg

Applications

- Spacecraft FPGA, ADCs, DACs and ASIC temperature monitoring
- Spacecraft housekeeping and telemetry

Benefits

- Multi-zone temperature monitoring
- Increased temperature accuracy
- Flexible programming in each channel



More information at www.ti.com/product/TMP9R00-SP

also see www.ti.com/product/TMP461-SP

Space-grade parts list

Space-grade amplifiers and comparators

Comparators

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV-cm ² /mg)	Ch #	V _S Min (V)	V _S Max (V)	Propagation Delay Time (μs)	VICR (Max) (V)	VICR (Min) (V)	V _{OS} Max @ 25°C (Max) (mV)	Input Bias Current (±) (Max) (nA)	Rail-to-Rail	I _q per Ch (Typ) (mA)	Package Group	ECCN ²
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
LM139-SP	5962-77008	QMLV	-	-	Bipolar	4	2.0	36	1.3	34.5	0	2	25	Out	0.2	CDIP	EAR99

¹All device operating temperatures are -55 to +125°C.

²ECCN 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.

Space-grade amplifiers and comparators (cont'd)

General-Purpose Op Amps

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Ch #	V _s Min (V)	V _s Max (V)	GBW (MHz)	Slew Rate (typ) (V/μs)	V _{os} Max @ 25°C (mV)	Drift Typ (μV/C)	Rail-to-Rail	V _n (nV/√Hz)	I _{sc} Typ (mA)	I _{Bias} (Typ) (nA)	Available Packages	ECCN ²
LM124AQML-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
LM101AQML-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

Precision Op Amps (V_{OS} < 1 mV)

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Ch #	V _s Min (V)	V _s Max (V)	GBW (Typ) (MHz)	Slew Rate (Typ) (V/μs)	V _{os} Max @ 25°C (mV)	Drift Typ (μV/C)	Rail-to-Rail	I _q Typ (mA)	V _n (nV/√Hz) 1 kHz	I _{Bias} (Typ) (pA)	Available Packages	ECCN ²
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

High-Speed Op Amps (≥ 50 MHz)

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Ch #	V _s Min (V)	V _s Max (V)	GBW (MHz)	Slew Rate (Typ) (V/μs)	V _n (nV/√Hz)	V _{os} Max @ 25°C (mV)	Drift Typ (μV/C)	Rail-to-Rail	I _q typ per Ch (mA)	I _{sc} Typ (mA)	I _{Bias} (Typ) (nA)	I _{Bias} (max) (nA)	Available Packages	ECCN ²
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 ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	V _s Min (V)	V _s Max (V)	GBW (MHz)	BW @ A _{CL} (MHz)	Min. A _{CL} (MHz)	Slew Rate (Typ) (V/μs)	V _n at Flatband (nV/√Hz)	CMRR (Typ) (dB)	Rail-to-Rail	V _{os} Max @ 25°C (mV)	I _{Bias} (Max) (μA)	I _q Typ per Ch (mA)	Available Packages	ECCN ²
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 Differential Amplifiers

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Min Freq (GHz)	Max Freq (GHz)	Diff Input Swing (Vpp)	Supply Voltage (V)	P1dB @ 2GHz (dBm)	Gain @ 2GHz (dB)	OIP3 @ 2GHz (dBm)	ONF @ 2GHz (dB)	Available Packages	ECCN ²
TRF0206-SP	5962-21220	QMLV-RHA	100	100	75	0.01	6.5	1.7	3.3	12	12.5	38	8	LCCC	EAR99
TRF0208-SP	5962-TBD	QMLP-RHA	TBD	100	75	0.01	11	2	3.3	15	16	37	6.8	WQFN	EAR99

¹All device operating temperatures are -55 to +125°C.

²ECCN 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.

Space-grade amplifiers and comparators (cont'd)

Sample-and-Hold Amplifiers

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	V _s Min (V)	V _s Max (V)	Acquisition Time (μs)	PSRR (dB)	V _{os} Max @ 25°C (mV)	Droop Rate (V/ms)	I _q Typ (mA)	Available Packages	ECCN ²
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

Precision ADCs (≥ 10 MSPS)

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Res. (Bits)	Sample Rate (Max) (kSPS)	# of Ch	Multi-Ch Config.	SNR (dB)	INL (Max) (±LSB)	Input Type	Ref. Voltage (V)	Power (Typ) (mW)	Type	Package Group	ECCN ²
ADC128S102QML-SP	5962-07227	QMLV-RHA	100	100	120	12	1000	8	Multiplexed	72	1.1	Single ended	Supply	2.3	SAR	CFP, Die	EAR99 [†]
ADS1278-SP	–	TI Space Grade	75	50	68	24	128	8	Simultaneous	111	201.4	Differential	External	530	ΔΣ	CQFP	EAR99 [‡]
ADS1282-SP	5962-14231	QMLV-RHA	50	50	60	32	4	2	Multiplexed	130	–	Differential	External	25	ΔΣ	CFP	EAR99 [‡]

[†]EAR99 only pertains to the Engineering Model device, ADC128S102WGMPPR. For up-to-date ECCN information contact: gtc_eccn-hts-naftateam@list.ti.com

[‡]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 (≤ 10 MSPS)

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Res. (Bits)	Sample/Update Rate (MSPS)	Setting Time (Typ) (μs)	DNL (Typ) (±LSB)	INL (Typ) (±LSB)	Zero Code Error (mV)	Supply Voltage (V)	Power (Typ) (mW)	Architecture	Package Group	ECCN ²
DAC121S101QML-SP	5962-07226	QMLV-RHA	100	100	120	12	1.8	12.5	–0.10/+0.21	2.75	2.12	2.7 to 5.5	0.52	String	CFP, Die	EAR99 [†]

[†]EAR99 only pertains to the Engineering Model device, DAC121S101WGMPPR. For up-to-date ECCN information contact: gtc_eccn-hts-naftateam@list.ti.com

High-Speed ADCs (> 1 GSPS)

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Sample Rate (Max) (MSPS)	Res. (Bits)	# of Ch	Analog Input BW (–3 dB) (GHz)	SNR (dB)	ENOB (Bits)	SFDR (dB)	Input Range (V _{p-p})	Input Buffer	Power (Typ) (mW)	Architecture	Package Group
ADC12DJ5200-SP	–	SHP-RHA	300	300	120	10400, 5200	12	2	7.9 GHz	55.6	8.8	65	0.8	Yes	4000	Folding-Interpolating	BGA
ADC12QJ1600-SP	–	SHP-RHA	300	300	120	1600	12	4	6 GHz	57	9.1	64	0.8	Yes	1900	Folding-Interpolating	BGA
ADC12DJ3200QML-SP	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
ADC12D1620QML-SP	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
ADC12D1600QML-SP	–	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
ADC08D1520QML-SP	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
ADC10D1000QML-SP	–	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
ADS5400-SP	5962-09240	QMLV	50	–	–	1000	12	1	2.15	58.5	9.55	77.9	2.00	Yes	2200	Pipeline	CQFP

¹All device operating temperatures are –55 to +125°C.

²ECCN 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.

Space-grade data converters (cont'd)

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

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Sample Rate (Max) (MSPS)	Res. (Bits)	# of Ch	Analog Input BW (MHz)	SNR (dB)	ENOB (Bits)	SFDR (dB)	Input Range (V _{p-p})	Input Buffer	Power (Typ) (mW)	Type	Pkg. Group	ECCN ²
ADS5400-SP	5962-09240	QMLV	50	–	–	1000	12	1	2150	58.5	9.55	77.9	2.0	Yes	2200	Pipeline	CQFP	–
ADS5463-SP	5962-07208	QMLV-RHA	100	100	86	500	12	1	2000	65.4	10.1	65.0	2.2	Yes	2250	Pipeline	CQFP	–
ADS5474-SP	5962-13208	QMLV-RHA	200	100	87	400	14	1	1440	70.5	10.9	78.0	2.2	Yes	2500	Pipeline	CQFP	–
ADS5444-SP	5962-07207	QMLV	–	–	86	250	13	1	500	69.1	11.3	84.0	2.2	Yes	2250	Pipeline	CQFP	–
ADC14155QML-SP	5962-06262	QMLV-RHA	100	100	121	155	14	1	1100	70.1	11.3	82.3	2.0	No	967	Pipeline	CQFP	EAR99 [†]
ADS5424-SP	5962-07206	QMLV	150	–	–	105	14	1	570	72.4	11.7	82.6	2.2	No	1900	Pipeline	CQFP	–

[†]EAR99 only pertains to the engineering model device, ADC14155W-MPR.

High-Speed DACs (> 10 MSPS)

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /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 ²
DAC5670-SP	5962-07247	QMLV	100	–	–	14	2400	3.5	52	55	52	1×, 2×	2000	Current sink	Parallel LVDS	CBGA	–
DAC5675A-SP	5962-07204	QMLV	100	–	109	14	400	12	67	82	70	None	660	Current sink	Parallel LVDS	CQFP	EAR99 [†]

[†]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

Analog Front Ends: CCD/CIS Imaging

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	# of Ch	Resolution (Bit)	Sampling Rate (MSPS)	PGA Range (dB)	Fine Offset DAC Range (mV)	Power per Channel (mW/Ch)	Package	ECCN ²
LM98640QML-SP	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 ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /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 ²)	Package Group	ECCN ²
LMX2615-SP	5962-17236	QMLV	100	100	120	-236	-129	40	15200	3.2 to 3.45	JESD204B	10.90 × 10.90	CQFP	EAR99

Clock Jitter Cleaners

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /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 ²
CDCM7005-SP	5962-07230	QMLV	100	–	60	2	5	–	0	1500	3.0 to 3.6	LVCOS (REF_CLK), LVPECL (VCXO_CLK)	LVCOS, LVPECL	CQFP	EAR99
LMK04832-SP	5962-17237	QMLV-RHA	100	100	120	3	15	54	0.305	3255	3.135 to 3.465	LVCOS, LVDS, LVPECL	CML, LVPECL, LCPECL, HSDS, LVDS, LVCOS	CQFP	EAR99

Clock Buffers

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /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 ²)	Package Group	ECCN ²
CDCLV111-SP	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

Timers

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

¹All device operating temperatures are –55 to +125°C.

²ECCN 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.

Space-grade interface

LVDS

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /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 ²
DS90C031QML-SP	5962-95833	QMLV-RHA	100	100	120	Driver	4	–	5.0	155.5	–	1.2	3.5	LVDS	CFP, Die	–
DS90LV031AQML-SP	–	TI Space Grade	–	–	–	Driver	4	–	3.3	400	–	1.2	6	LVDS	CFP	EAR99
SN55LVDS31-SP	5962-97621	QMLV	150	–	110	Driver	4	–	3.3	400	–	1.2	8	LVDS	CFP	EAR99
SN55LVDS32-SP	5962-97622	QMLV	100	–	110	Receiver	–	4	3.3	100	0.2 to 2.2	–	8	LVDS	CFP	EAR99
SN55LVDS33-SP	5962-07248	QMLV	100	–	90	Receiver	–	4	3.3	400	–4.0 to 5.0	–	15	LVDS	CFP	EAR99
DS90C032QML-SP	5962-95834	QMLV-RHA	50	50	120	Receiver	–	4	5.0	155.5	0.2 to 2.2	–	2	LVDS	CFP, Die	EAR99
DS90LV032AQML-SP	–	TI Space Grade	–	–	–	Receiver	–	4	3.3	400	0.2 to 2.2	–	4.5	LVDS	CFP	EAR99
SN55LVCP22-SP	5962-11242	QMLV	100	–	–	Crosspoint	2	2	3.3	1000	0.05 to 3.95	1.2	5	LVDS, LVPECL, CML	CFP	–
SN55LVCP22A-SP	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 ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /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 _{CC} (Max) (mA)	Package Group	ECCN ²
DS16F95QML-SP	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
DS26F31MQML-SP	5962-78023	QMLV-RHA	300	300	Bipolar	Driver	4	–	Half	5.0	10	–	10	–6 to 6	40	CFP	EAR99
DS96F174MQML-SP	5962-90765	QMLV	–	–	Bipolar	Driver	4	–	Half	5.0	10	–	32	–7 to 12	50	CDIP	EAR99
DS26F32MQML-SP	5962-78020	QMLV-RHA	100	100	Bipolar	Receiver	–	4	Half	5.0	10	–	10	–6 to 6	50	CFP, CDIP	EAR99
DS96F175MQML-SP	5962-90766	QMLV	–	–	Bipolar	Receiver	–	4	Half	5.0	10	–	32	–7 to 12	75	CDIP	EAR99
AM26LS33A-SP	5962-78020	QMLV	25	–	Bipolar	Receiver	–	4	Half	5.0	10	–25 to 25	32	–15 to 15	70	CDIP	EAR99

CAN

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Signaling Rate (Max) (Mbps)	Supply Voltage (Nom) (V)	Common Mode Range	Fault Protection (V)	Features	Package Group	ECCN ²
SN55HVD233-SP	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 ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Data Rate (Mbps)	Interface Type	Supply Voltage (V)	IO Supply Options (Typ) (V)	Features	Package Body Size– W × L (mm ²)	Package Group	ECCN ²
DP83561-SP	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

Serializers, Deserializers (SerDes)

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Signaling Rate (Gbps)	V _{CC} (V)	Power (mW)	Package Group	ECCN ²
TLK2711-SP	5962-05221	QMLV	25	–	67.9	1.6 to 2.5	2.5	< 500	CQFP	EAR99

Line Drivers, Line Receivers

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

¹All device operating temperatures are –55 to +125°C.

²ECCN 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.

Space-grade sensing

Current-Sense Amplifiers

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	V _s Min (V)	V _s Max (V)	Common-Mode Voltage (V)	Bandwidth (kHz)	Gain (V/V)	V _{os} Max @ 25°C (mV)	Gain Error (%)	I _q Typ (mA)	Available Packages	ECCN ²
INA901-SP	5962-18210	QMLV-RHA	50	50	75	2.7	16	-15 to 65	130	20	2.5	1	0.9	CFP	EAR99

Digital Output Temperature Sensors

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /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 ²
TMP461-SP	5962-17218	QMLV-RHA	100	100	76	1	1	1.5	2.0	-64 to 191	-55 to 125	0.0625	I ² C, SMBus, 2-Wire	CFP	EAR99
TMP9R00-SP	5962-20214	QMLV-RHA	100	100	75	8	1	2	1.50	-55 to 150	-55 to 125	0.0625	I ² C, SMBus, 2-Wire	CFP	EAR99

Space-grade motor control

Brushless-DC (BLDC) Drivers

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /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 ²
UC1625-SP	5962-91689	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 ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	VS (Min) (V)	VS (Max) (V)	Peak Output Current (A)	Control Mode	Control Interface	Package Body Size (W×L, mm)	Package Group	ECCN ²
UC1637-SP	5962-89957	QMLV	50	–	Bipolar	±2.5	±20	0.5	PWM	Hardware	6.92 × 13.09	CFP	EAR99

¹All device operating temperatures are -55 to +125°C.

²ECCN 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.

Space-grade power management

Buck Converters

Part Number ¹	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm ² /mg)	I _{OUT} (Max) (A)	V _{IN} (Min) (V)	V _{IN} (Max) (V)	V _{OUT} (Min) (V)	V _{OUT} (Max) (V)	Control Mode	f _s (Min) (kHz)	f _s (Max) (kHz)	Duty Cycle (Max) (%)	Minimum On-Time (Max) (ns)	I _q (Typ) (mA)	Package Group	ECCN ²
TPS50601-SP	5962-10221	QMLV-RHA	100	100	85	6	3	6.3	0.795	6.35	Current mode	100	1000	95%	175	5	CFP, Die	EAR99
TPS50601A-SP	5962-10221	QMLV-RHA	100	100	75	6	3	7	0.804	6.70	Current mode	100	1000	100%	235	5	CFP, Die	EAR99
TPS7H4001-SP	5962-18205	QMLV-RHA QMLP-RHA	100	100	75	18	3	7	0.604	6.65	Current mode	100	1000	100%	235	4	CFP, Die, HTSSOP	EAR99
TPS7H4002-SP	5962-20210	QMLV-RHA	100	100	75	3	3	5.5	0.804	5.30	Current mode	100	1000	100%	235	2.5	CFP, Die	EAR99

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

Part Number ¹	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max.) (MeV•cm ² /mg)	I _{OUT} (Max) (A)	V _{IN} (Min) (V)	V _{IN} (Max) (V)	V _{OUT} (Min) (V)	V _{OUT} (Max) (V)	V _{DO} (Typ) (mV)	Acc. (%)	Noise (μVrms)	PSRR @ 100 KHz (dB)	PSRR @ 1MHz (dB)	PSRR @ 10MHz (dB)	Output Options	Package Group	ECCN ²
TPS7A4501-SP	5962-12224	QMLV-RHA	100	100	86	1.5	2.3	20	1.21	20	270	3	50	44	35	32	Adj.	CFP, Die	EAR99
TPS7H1101A-SP	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
TPS7H1111-SP	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.	HBL, HTSSOP	EAR99

Standard Linear Regulators (Typical VDO > 400 mV)

Part Number ¹	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max.) (MeV•cm ² /mg)	I _{OUT} (Max) (A)	V _{IN} (Min) (V)	V _{IN} (Max) (V)	V _{OUT} (Min) (V)	V _{OUT} (Max) (V)	V _{DO} (Typ) (mV)	Acc. (%)	Noise (μVrms)	PSRR @ 100 KHz (dB)	Output Options	Package Group	ECCN ²
LM117QML-SP	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
LM117HVQML-SP	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
LM137QML-SP	5962-99517	QMLV-RHA	30	30	Bipolar	1.5	-40	-4.2	-37.0	-1.2	3000	4	1110	30	Adj.	TO-3	EAR99
LM137JAN-SP	M38510/118	JANS	-	-	Bipolar	1.5	-40	-4.2	-37.0	-1.2	3000	4	1110	30	Adj.	TO-2	EAR99
LM2940QML-SP	5962-89587	QMLV-RHA	100	100	Bipolar	1	6	26	5	5	500	5	350	50	5.0	CFP, Die	EAR99
LM2941QML-SP	5962-91667	QMLV-RHA	100	100	Bipolar	1	6	26	5	20	500	5	600	67	Adj.	CFP, Die	EAR99
LM723JAN-SP	M38510/102	JANS	-	-	Bipolar	0.15	9.5	40	2	37	3000	3	86	-	Adj.	CDIP, TO-100	EAR99
LP2953QML-SP	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 ¹	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm ² /mg)	I _{drive} (Max) (mA)	V _{OUT} (min) (V)	V _{OUT} (max) (V)	Package	ECCN ²
UC1832-SP	5962-93265	QMLV	40	-	Bipolar	100	2	40	CDIP, LCCC	EAR99
UC1834-SP	5962-87742	QMLV	40	-	Bipolar	200	1.5	40	CDIP, LCCC	EAR99

DDR Memory Power

Part Number ¹	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (Max) (krad)	SEL (Max) (MeV•cm ² /mg)	Regulator Type	I _{OUT} VTT (Max) (A)	V _{IN} (Min) (V)	V _{IN} (Max) (V)	V _{OUT} VTT (Min) (V)	DDR Memory Type(s)	V _{IN} Bias (Min) (V)	V _{IN} Bias (Max) (V)	Package Group	ECCN ²
TPS7H3301-SP	5962-14228	QMLV-RHA	100	100	70	Linear	3.0	0.9	3.5	0.6	DDR, DDR2, DDR3, DDR3L, DDR4, LPDDR2, LPDDR3	2.375	3.5	CFP	EAR99

eFuses and Load Switches

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

¹All device operating temperatures are -55 to +125°C.

²ECCN 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.

Space-grade power management (cont'd)

Shunt Voltage References

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	V _O (V)	Initial Accuracy (Max) (%)	Accuracy Over Temp. (%)	I _Z for Reg. (Min) (μA)	I _{out} /I _Z (Max) (mA)	Output Noise (μVrms)*	V _n (nV/√Hz) @ 1 kHz	Temp. Coeff. (Typ) at 25°C (ppm/°C)	Operating Temp. Range (°C)	Package Group	ECCN ²
LM136A-2.5QML-SP	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
LM185-1.2QML-SP	5962-87594	QMLV-RHA	100	100	Bipolar	1.2	1.0	+0.42/+5	10	20	28	400	–	-55 to 125	TO	EAR99
LM185-2.5QML-SP	5962-87594	QMLV	100	–	Bipolar	2.5	0.8	±3	20	20	42	800	–	-55 to 125	TO	EAR99
LM4050QML-SP (2.5 V)	5962-09235	QMLV-RHA	100	100	Bipolar	2.5	0.1	±0.7	65	15	50	–	3	-55 to 125	CFP	EAR99
LM4050QML-SP (5.0 V)	5962-09235	QMLV-RHA	100	100	Bipolar	5	0.1	±0.74	74	15	100	–	9	-55 to 125	CFP	EAR99
TL1431-SP	5962-99620	QMLV-RHA	150	100	86	2.5–36	0.4	±2	450	100	–	122	38	-55 to 125	CDIP, CFP	EAR99
TL1431-DIE	–	Tested die	100	–	Bipolar	2.5–36	0.4	–	450	100	–	122	–	25	Die	EAR99

*For frequencies 10 Hz ≤ f ≤ 10 KHz.

PWM Controllers

Part Number ¹	Military Spec	Qualification Level	TID Char. Max (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm ² /mg)	V _{CC} (Min) (V)	V _{CC} (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 ²
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 TSSOP	EAR99
TPS7H5002-SP	5962-18222	QMLV-RHA	100	100	75	4	14	75, 100	Adjustable	2000	0.15	1	-55 to 125	CFP,Die	EAR99
TPS7H5003-SP	5962-18222	QMLV-RHA	100	100	75	4	14	75, 100	Adjustable	2000	0.15	1	-55 to 125	CFP,Die	EAR99
TPS7H5004-SP	5962-18222	QMLV-RHA	100	100	75	4	14	50	Adjustable	2000	0.15	2	-55 to 125	CFP,Die	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

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

²ECCN 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.

Space-grade power management (cont'd)

Low-Side Gate Drivers

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

Isolated Feedback Generators

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

Precision Analog Controllers

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

Schottky Diode Arrays

Part Number ¹	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm ² /mg)	# of Ch	V _F (typ) (mV)	Leakage Current (typ) (mA)	Package	ECCN ²
UC1611-SP	5962-90538	QMLV	–	–	Bipolar	4	400	0.01	CDIP, LCCC	EAR99

Space-grade embedded processing and memory

MSP430™ Mixed-Signal Microcontrollers (MCUs)

Part Number ²	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm ² /mg)	ADC	FRAM (KB)	RAM (KB)	ADC #	GPIO #	I ² C (#)	SPI (#)	UART (#)	Comparators (# of Ch)	16-bit Timers #	Operating Temp. Range (°C)	Package	ECCN ²
MSP430FR5969-SP	–	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 ¹	Military Spec	Qualification Level	TID Char. Max. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm ² /mg)	DSP	CPU	DSP Max Freq. (Mhz)	GFLOPS	I/O Supply (V)	Package
SMJ320C6701-SP	5962-98661	QMLV	100	–	117	C67x	32/64-bit	140	1	3.3	CBGA, CLGA
SMV320C6727B-SP	–	RH Ceramic	150	100	100	C67x+	32/64-bit	250	1.5	3.3	CQFP

SRAM Memory

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

¹All device operating temperatures are –55 to +125°C.

²ECCN 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.

Space-grade logic

Logic

Generic Part Number	Military Spec	Qualification	TID Char. (krad)	TID RLAT (krad)	SEL (Max) (MeV•cm ² /mg)	Sub-Family (Part Type)	Family	# of Ch	V _{CC} Range (V)	Package	Operating Temp. (°C)	ECCN ¹
SN54AC00-SP	5962-87549	QMLV-RHA	100	100	86	NAND gate	AC	4	2 to 6	CDIP, CFP, Die	-55 to 125	EAR99 [†]
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

¹ 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.

[†] 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-grade logic (cont'd)

Logic (cont'd)

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

¹ 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.

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.

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 30–50 krad(Si).
- TID RLAT to 20, 30 or 50 krad(Si).
- SEL immunity to 43 MeV·cm²/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 ² /mg)	Ch #	V _s Min (V)	V _s Max (V)	Propagation Delay Time (μs)	VICR (Max) (V)	VICR (Min) (V)	V _{os} Max @ 25°C (Max) (mV)	Input Bias Current (±) (Max) (nA)	Rail-to-Rail	I _q per Ch (Typ) (mA)	Output type	Package Group	ECCN ¹
TLV1704-SEP	V62/18613	TI Space EP	30	20	43	4	2.2	36	0.56	36	2	2.5	15	In	0.055	Open-Collector	TSSOP	EAR99
TLV4H290-SEP	V62/TBD	TI Space EP	30	30	43	4	1.65	5.5	0.1	5.5	0	2.5	0.005	In	0.025	Open-Drain	TSSOP	EAR99
TLV2H290-SEP	V62/TBD	TI Space EP	30	30	43	2	1.65	5.5	0.1	5.5	0	2.5	0.005	In	0.025	Open-Drain	SOIC, SOT-23	EAR99
TLV4H390-SEP	V62/TBD	TI Space EP	30	30	43	4	1.65	5.5	0.1	5.5	0	2.5	0.005	In	0.025	Push-Pull	TSSOP	EAR99
TLV2H390-SEP	V62/TBD	TI Space EP	30	30	43	2	1.65	5.5	0.1	5.5	0	2.5	0.005	In	0.025	Push-Pull	SOIC, SOT-23	EAR99
TLV1H103-SEP	V62/TBD	TI Space EP	30	30	43	1	2.4	5.5	0.0035	5	0	10	5000	In	6	Push-Pull	SC-70-5	EAR99



Reduce the risk in NewSpace with Space Enhanced Plastic products

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Precision Op Amps (VOS < 1 mV)

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV·cm ² /mg)	Ch #	V _s Min (V)	V _s Max (V)	GBW (MHz)	Slew Rate (typ) (V/μs)	V _{os} Max @ 25°C (Max) (μV)	Rail-to-Rail	I _q Typ (mA)	V _n Max (nV/√Hz)	IBias (Typ) (nA)	Available Packages	ECCN ¹
OPA4H199-SEP	V62/TBD	TI Space EP	50	30	43	4	2.7	40	4.5	21	895	In, Out	0.56	10.8	0.01	SOT-23-THIN	EAR99
OPA4H014-SEP	V62/TBD	TI Space EP	30	30	43	4	4.5	18	11	20	120	In to V-, Out	1.8	5.1	0.0005	TSSOP	EAR99

Full Differential Amplifiers (FDAs)

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV·cm ² /mg)	V _s Min (V)	V _s Max (V)	GBW (MHz)	BW @ Acl (MHz)	Min. ACL (MHz)	Slew Rate (V/μs)	V _n at Flatband (nV/√Hz)	CMRR (Typ) (dB)	Rail-to-Rail	V _{os} Max @ 25°C (Max) (mV)	IBias (Typ) (nA)	I _q per Ch (Typ) (mA)	Available Packages	ECCN ¹
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

¹ECCN 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.

Space EP (cont'd)

RF Differential Amplifiers

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /mg)	Min Freq (GHz)	Max Freq (GHz)	Diff Voltage Swing (Vpp)	Supply Voltage (V)	P1dB @ 2GHz (dBm)	Gain @ 2GHz (dB)	OIP3 @ 2GHz (dBm)	NF @ 2GHz (dB)	Available Packages	ECCN ¹
TRF0208-SEP	V62-TBD	TI Space EP	30	30	43	0.01	11	2	3.3	15	16	37	6.8	QFN	EAR99

¹ECCN 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.

Integrated Precision ADC and DAC

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /mg)	Resolution	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 ¹
AFE11612-SEP	V62/22614	TI Space EP	30	20	43	12bits	12	String	16	Single-Ended or Fully-differential	8	Internal 2.5V or External	+/- 1LSB	HTQFP	10 x 10	EAR99

¹ECCN 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.

Precision ADCs (≤ 10 MSPS)

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /mg)	Resolution (Bits)	Sample rate (Max) (kSPS)	Number of input channels	Multi-Ch Configuration	SNR (dB)	INL (Max) (+/- LSB)	Input Type	Reference Voltage (V)	Power (Typ) (mW)	Architecture	Packages	ECCN ¹
ADC128S102-SEP	V62/TBD	TI Space EP	30	30	43	12	1000	8	Multiplexed	72	1.1	Single-Ended	Analog supply	2.3	SAR	TSSOP-16	-

High-Speed ADCs (> 1 GSPS)

Part Number ¹	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV•cm ² /mg)	Sample Rate (Max) (MSPS)	Res. (Bits)	# of Ch	Analog Input BW (MHz)	SNR (dB)	ENOB (Bits)	SFDR (dB)	Input Range (V _{p-p})	Input Buffer	Power (Typ) (mW)	Type	Pkg. Group
ADC12DJ5200-SEP	V62/TBD	TI Space EP	30	30	43	10400, 5200	12	2	7.9GHz	55.6	8.8	65	0.8	Yes	4000	Folding-Interpolating	BGA
ADC12QJ1600-SEP	V62/TBD	TI Space EP	30	30	43	1600	12	4	6 GHz	57	9.1	64	0.8	Yes	1900	Folding-Interpolating	BGA

Mux

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /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 ¹
TMUX582F-SEP	V62/TBD	TI Space EP	30	30	43	Single 8:1	±5 V to ±16.5 V	180	15	250	±60V	Yes	TSSOP	6.5 x 4.4	EAR99

Clock Jitter Cleaners

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /mg)	# of In	# of Out	RMS Jitter (fs)	Output Freq. (MHz)	Supply Voltage (V)	Input Type	Output Type	Package Group:	ECCN ¹
LMK04832-SEP	V62/TBD	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, HS DS, LVDS, LVC MOS	QFP	EAR99

Space EP (cont'd)

RF PLLs and Synthesizers

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /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 ¹
LMX2694-SEP	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

RS-422

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /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 _{cc} (Max) (mA)	Package Group	ECCN ¹
SN65C1168E-SEP	V62/19606	TI Space EP	30	20	43	Transceiver	2	2	Full	5.0	10	-10 to 15	32	-7 to 7	17	TSSOP	EAR99

CAN

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

Voltage Translator

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /mg)	Signaling Rate (Max) (Mbps)	Supply Voltage (Nom) (V)	Bit Count	Features	Package Group	Package Group	Package Body Size - W x L (mm)	ECCN ¹
SN54SLC8T245-SEP	V62/22604	TI Space EP	20	20	43	380	0.65 to 3.6	8	Voltage Translation	Diagnostic loopback	TSSOP	4.40 x 7.80	EAR99

Digital Isolators

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

Current-Sense Amplifiers

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /mg)	V _s Min (V)	V _s Max (V)	Common-Mode Voltage (V)	Bandwidth (kHz)	Gain (V/V)	V _{os} Max @ 25°C (mV)	Gain Error (%)	I _q Typ (mA)	Available Packages	ECCN ¹
INA240-SEP	V62/18615	TI Space EP	30	20	43	2.7	5.5	-4 to 80	400	20	0.05	0.2	2.6	TSSOP	EAR99

Buck Converters

Device	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT/ RHA	SEL (Max) (MeV•cm ² /mg)	I _{OUT} (Max) (A)	V _{IN} (Min) (V)	V _{IN} (Max) (V)	V _{OUT} (Min) (V)	V _{OUT} (Max) (V)	Control Mode	Switching Frequency (min) (kHz)	Switching Frequency (max) (kHz)	Duty Cycle (max) (%)	Min. On-Time (max) (ns)	I _q (Typ) (mA)	ECCN ¹
TPS7H4010-SEP	V62/19623	TI Space EP	30	20	43	6	3.5	32	1.0	30.4	Current Mode	350	2200	95%	82	0.015	EAR99
TPS7H4003-SEP	V62/21609	TI Space EP	50	50	43	18	3	7	0.604	6.65	Current Mode	100	1000	100%	235	4	EAR99

Space EP (cont'd)

eFuses and Load Switches

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /mg)	V _{IN} Range (V)	Type	R _{ON} (Typ) (mΩ)	Continuous Current Load (Max) (A)	Programmable Current Limit Range (A)	Package	ECCN ¹
TPS7H2221-SEP	V62/22609	TI Space EP	30	20	43	1.6 to 5.5	Load Switch	90 @ V _{IN} = 5V	1.25	-	SC70 (DCK)	EAR99
TPS7H2201-SEP	V62/TBD	TI Space EP	50	50	43	1.5 to 7.0	eFuse	35	6	0.5-7.0	HTSSOP	EAR99
TPS7H2211-SEP	v62/TBD	TI Space EP	50	50	43	4.5 to 14	eFuse	60	3.5	-	HTSSOP	EAR99

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

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (Max) (MeV•cm ² /mg)	I _{OUT} (Max) (A)	V _{IN} (Min) (V)	V _{IN} (Max) (V)	V _{OUT} (Min) (V)	V _{OUT} (Max) (V)	Dropout (V _{do}) (Typ) (mV)	Accuracy (%)	Noise (μVrms)	PSRR @ 100 KHz (dB)	PSRR @ 1MHz (dB)	Output options	ECCN ¹
TPS73801-SEP	V62/18616	TI Space EP	50	20	43	1	2.2	20	1.2	20.0	240	3	45	45	23	Adjustable	EAR99
TPS7H1210-SEP	V62/21616	TI Space EP	30	20	43	1	-16.5	-3	-15	-1.2	363	2	13.7	52	55	Adjustable	EAR99
TPS7H1111-SEP	V62/TBD	TI Space EP	50	50	43	1.5	0.85	7	0.4	5.5	200	1.5	1.68	71	67	Adjustable	EAR99

DDR Memory Power

Part Number ¹	Military Spec	Qualification Level	TID Char. (Max) (krad)	TID RLAT (Max) (krad)	SEL (Max) (MeV•cm ² /mg)	Regulator Type	I _{OUT} VTT (Max) (A)	V _{IN} (Min) (V)	V _{IN} (Max) (V)	V _{OUT} VTT (Min) (V)	DDR Memory Type(s)	V _{IN} Bias (Min) (V)	V _{IN} Bias (Max) (V)	Package Group	ECCN ²
TPS7H3302-SEP	V62/TBD	TI Space EP	50	50	43	Linear	3.0	0.9	3.5	0.6	DDR, DDR2, DR3, DDR3L, DDR4, LPDDR2, LPDDR3	2.375	3.5	HTSSOP	EAR99

Supervisors and Reset ICs

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

PWM Controllers

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (Max) (MeV•cm ² /mg)	VCC Range (Min) (V)	VCC (Max) (V)	Duty Cycle (Max) (%)	UVLO Thresholds On/Off(V)	Frequency (Max) (kHz)	Gate Drive (Typ) (A)	PWM Outputs (#)	Synchronous Rectification Outputs (#)	Operating Temp Range (°C)	Package	ECCN ¹
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

Arm[®]-Based Microcontrollers (MCUs)

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT/ RHA	SEL (MeV•cm ² /mg)	CPU	Frequency (MHz)	Flash Memory (kB)	RAM (kB)	ADC	ADC #	GPIO #	I2C (#)	SPI (#)	UART (#)	CAN	Ethernet	Package	ECCN ¹
TMS570LC4357-SEP	V63/TBD	TI Space EP	30	30	43	Arm Cortex-R5F	300	4096	2	12-Bit x2	41	168	2	5	4	4	10/100 Mbps EMAC	NFBGA	-

¹ECCN 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.

TI space products – engineering models

TI engineering evaluation (/EM and -MPR) models are units intended for engineering evaluation only. While using the same die as fully qualified and processed space-grade products (QMLV or products appended with the suffix -MLS), they 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 Description	Package Pins	ECCN ¹
ADC08D1520QML-SP	ADC08D1520WGMPPR	/EM	CFP (NBC) 128	–
ADC10D1000QML-SP	ADC10D1000CCMPR	/EM	CCGA (NAA) 376	–
ADC128S102QML-SP	ADC128S102WGMPPR	/EM	CFP (NAC) 16	–
ADC12D1600QML-SP	ADC12D1600CCMPR	/EM	CCGA (NAA) 376	–
ADC12D1620QML-SP	ADC12D1620CCMPR	/EM	CCGA (NAA) 376	–
ADC12D1620QML-SP	ADC12D1620LGMPPR	/EM	CLGA (FVA) 256	–
ADC12DJ3200QML-SP	ADC12DJ3200ZMX/EM	/EM	CLGA (ZMX) 196	–
ADC12DJ3200QML-SP	ADC12DJ3200NWE/EM	/EM	CCGA (NWE) 196	–
ADC14155QML-SP	ADC14155W-MPR	/EM	CFP (NBA) 48	–
ADS1278-SP	ADS1278HFQ/EM	/EM	CFP (HFQ) 84	EAR99
ADS1282-SP	ADS1282HKV/EM	/EM	CFP (HKV) 28	EAR99
ADS5400-SP	ADS5400HFS/EM	/EM	CFP (HFS) 100	–
ADS5424-SP	ADS5424HFG/EM	/EM	CFP (HFG) 52	–
ADS5444-SP	ADS5444HFG/EM	/EM	CFP (HFG) 84	–
ADS5463-SP	ADS5463HFG/EM	/EM	CFP (HFG) 84	–
ADS5474-SP	ADS5474HFG/EM	/EM	CFP (HFG) 84	–
CDCLVP111-SP	CDCLVP111HFG/EM	/EM	CFP (HFG) 36	EAR99
CDCM7005-SP	CDCM7005HFG/EM	/EM	CFP (HFG) 52	EAR99
DAC121S101QML-SP	DAC121S101WGMPPR	/EM	CFP (NAC) 10	EAR99
DAC5670-SP	DAC5670MGEM/EM	/EM	CBGA (GEM) 192	–
DAC5675A-SP	DAC5675AHFG/EM	/EM	CFP (HFG) 52	EAR99
DP83561-SP	DP83561HBE/EM	/EM	CFP (HBE) 64	EAR99
INA901-SP	INA901HKX/EM	/EM	CFP (HKX) 8	EAR99
LM117HVQML-SP	LM117HVNAC/EM	/EM	CFP (NAC) 10	EAR99
LM117QML-SP	LM117K/EM	/EM	TO (K) 2	EAR99
LM117QML-SP	LM117NDT/EM	/EM	TO (NDT) 3	EAR99
LM4050QML-SP	LM4050WG5.2-MPR	/EM	CFP (NAC) 10	EAR99
LM4050QML-SP	LM4050WG5.0-MPR	/EM	CFP (NAC) 10	EAR99
LM7171QML-SP	LM7171NAB/EM	/EM	CDIP (NAB) 8	EAR99
LM98640QML-SP	LM98640W-MPR	/EM	CFP (NBB) 68	–
LMH5401-SP	LMH5401FFK/EM	/EM	LCCC (FFK) 14	EAR99
LMH5485-SP	PLMH5485HKX/EM	/EM	CFP (HKX) 8	EAR99
LMK04832-SP	LMK04832W/EM	/EM	CFP (HBE) 64	EAR99
LMP7704-SP	LMP7704HBB/EM	/EM	CFP (HBB) 14	EAR99
LMK04832-SEP	LMK04832PAP/EM	/EM	HTQFP (PAP) 64	EAR99
LMX2615-SP	LMX2615W-MPR	/EM	CFP (HBD) 64	EAR99
OPA4277-SP	OPA4277HFR/EM	/EM	CFP (HFR) 14	EAR99
SMJ320C6701-SP	SMV320C6701GLP/EM	/EM	CFCBGA (GLP) 429	EAR99
SMV320C6727B-SP	SMV320C6727BHFH/EM	/EM	CFP (HFH) 256	–
SMV512K32-SP	SMV512K32HFG/EM	/EM	CFP (HFG) 76	–

Generic Part Number	TI Orderable Part Number	Device Type Description	Package Pins	ECCN ¹
SN55HVD233-SP	HVD233HKX/EM	/EM	CFP (HKX) 8	EAR99
SN55LVCP22-SP	SN55LVCP22W/EM	/EM	CFP (W) 16	EAR99
SN55LVCP22A-SP	SN55LVCP22W/EM	/EM	CFP (W) 16	EAR99
THS4511-SP	THS4511HKT/EM	/EM	CFP (HKT) 16	EAR99
THS4513-SP	THS4513HKT/EM	/EM	CFP (HKT) 16	EAR99
TL1431-SP	TL1431U/EM	/EM	CFP (U) 10	EAR99
TLK2711-SP	TLK2711HFG/EM	/EM	CFP (HFG) 68	EAR99
TMP461-SP	TMP461HKU/EM	/EM	CFP (HKU) 10	EAR99
TMP9R00-SP	TMP9R00HKT/EM	/EM	CFP (HKT) 16	EAR99
TPS50601A-SP	TPS50601AY/EM	/EM Die	(Y) 0	EAR99
TPS50601A-SP	TPS50601AHKH/EM	/EM	CFP (HKH) 20	EAR99
TPS50601-SP	TPS50601HKH/EM	/EM	CFP (HKH) 20	EAR99
TPS7A4501-SP	TPS7A4501HKU/EM	/EM	CFP (HKU) 10	EAR99
TPS7A4501-SP	TPS7A4501U/EM	/EM	CFP (U) 10	EAR99
TPS7H1101A-SP	TPS7H1101HKT/EM	/EM	CFP (HKT) 16	EAR99
TPS7H1101A-SP	TPS7H1101AY/EM	/EM Die	(Y) 0	EAR99
TPS7H1111-SP	TPS7H1111HBL/EM	/EM	CFP (HBL) 14	EAR99
TPS7H2201-SP	TPS7H2201Y/EM	/EM Die	(Y) 0	EAR99
TPS7H2201-SP	TPS7H2201HKT/EM	/EM	CFP (HKT) 16	EAR99
TPS7H2211-SP	TPS7H2211HKT/EM	/EM	CFP (HKT) 16	EAR99
TPS7H2211-SP	TPS7H2211Y/EM	/EM Die	(Y) 0	EAR99
TPS7H3301-SP	TPS7H3301HKT/EM	/EM	CFP (HKT) 16	EAR99
TPS7H4001-SP	TPS7H4001Y/EM	/EM Die	(Y) 0	EAR99
TPS7H4001-SP	TPS7H4001HKY/EM	/EM	(HKY) 34	EAR99
TPS7H4002-SP	TPS7H4002HKT/EM	/EM	CFP (HKT) 20	EAR99
TPS7H4002-SP	TPS7H4002Y/EM	/EM Die	(Y) 0	EAR99
TPS7H5001-SP	TPS7H5001Y/EM	/EM Die	(Y) 0	EAR99
TPS7H5001-SP	TPS7H5001HFT/EM	/EM	CFP (HFT) 22	EAR99
TPS7H5002-SP	TPS7H5002HFT/EM	/EM	CFP (HFT) 22	EAR99
TPS7H5003-SP	TPS7H5003HFT/EM	/EM	CFP (HFT) 22	EAR99
TPS7H5004-SP	TPS7H5004HFT/EM	/EM	CFP (HFT) 22	EAR99
TRF0206-SP	TRF0206FFM/EM	/EM	LCCC (FFM) 12	EAR99
UC1825B-SP	UC1825BKT/EM	/EM	CFP (HKT) 16	EAR99
UC1843B-SP	UC1843BHKU/EM	/EM	CFP (HKU) 10	EAR99

¹ECCN 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.

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.

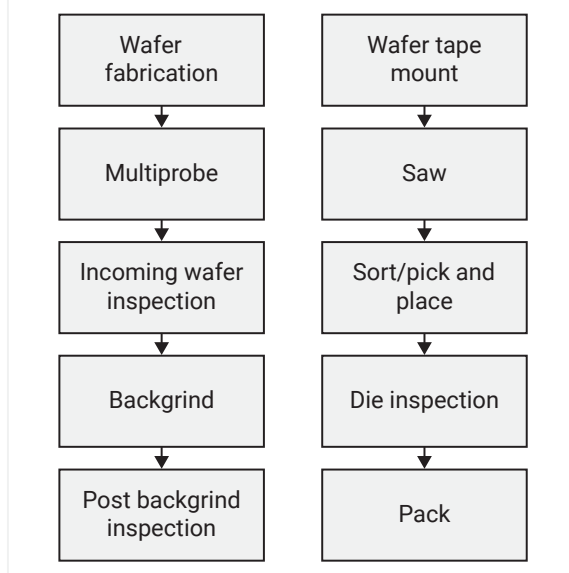
TI space-grade KGD: TI qualifies this die product by wafer lots manufactured and tested in accordance with MIL-PRF-38535; it is not included in an SMD, however.

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

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

²ECCN 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.

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

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

²ECCN 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.

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

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²ECCN 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.

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 ¹
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
LMH5401-SP	SN00014FFK	LCCC (FFK) 14	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
TPS50601-SP	SN0020HKH	CFP (HKH) 20	EAR99
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

Generic Part Number	Orderable Part Number	Package Pins	ECCN ¹
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
UCC1806-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

¹ECCN 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.

Acronyms

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

TI Product Classifications and Qualifications

	Commercial	Automotive AEC-Q100	Enhanced Product (EP)	QMLQ	Space EP	QMLP/SHP	QMLY/SHP	Space QMLV	Space QMLV-RHA
Packaging	Plastic	Plastic	Plastic	Ceramic	Plastic	Plastic	Plastic	Ceramic	Ceramic
Military spec	No	No	Yes – VID	Yes – SMD	Yes – VID	Yes - SMD ¹	Yes - SMD ¹	Yes – SMD	Yes – SMD
Single controlled baseline	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Multiple wafer lots per reel possible	Yes	Yes	Yes	No	No	No	No	No	No
Bond wires	Au/Cu	Au/Cu	Au	Al	Au	Au	Au	Al	Al
Can pure tin (Sn) be used?	Yes	Yes	No	No	No	No	No	No	No
Production burn-in	No	No	No	Yes	No	Yes	Yes	Yes	Yes
Radiation: TID characterization	No	No	No	No	Yes 30 to 50 krad(Si)	Yes 50 to 300 krad(Si)	Yes 50 to 300 krad(Si)	Yes 50 to 300 krad(Si)	Yes 50 to 300 krad(Si)
Radiation: TID Radiation Lot Acceptance Testing (RLAT) – RHA	No	No	No	No	Yes 20, 30 or 50 krad(Si)	Yes 50, 100 or 300 krad(Si)	Yes 50, 100 or 300 krad(Si)	No	Yes 50, 100 or 300 krad(Si)
Radiation: SEL immunity	No	No	No	No	Yes ($\geq 43 \text{ MeV}\cdot\text{cm}^2/\text{mg}$)	"Yes ≥ 60 ($\text{MeV}\cdot\text{cm}^2/\text{mg}$)"	"Yes ≥ 60 ($\text{MeV}\cdot\text{cm}^2/\text{mg}$)"	Yes ($\geq 60 \text{ MeV}\cdot\text{cm}^2/\text{mg}$)	Yes ($\geq 60 \text{ MeV}\cdot\text{cm}^2/\text{mg}$)
Typical temperature range	-40–85°C	-40–125°C	-55–125°C	-55–125°C	-55–125°C	-55-125oC	-55-125oC	-55–125°C	-55–125°C
Outgassing tested per ASTM E595	No	No	No	N/A	Yes	Yes	Yes	N/A	N/A
Extra qualification and process monitors	None	X-ray and reflow, outlier control	Extended HAST, X-ray and reflow, outlier	MIL-PRF-38535 Group A, B, C, D	MIL-PRF-38535 "like" A, D, E	MIL-PRF-38535 Group A, B, C, D, E	MIL-PRF-38535 Group A, B, C, D, E	MIL-PRF-38535 Group A, B, C, D	MIL-PRF-38535 Group A, B, C, D, E
Life test per wafer lot	No	No	No	No	No	Yes	Yes	No	Yes
Description	Tailored for high-volume commercial applications and flexible supply.	High reliability for automotive applications with flexible supply. Packages can use matte Sn and Cu bond wires.	Controlled baseline ensures more homogenous performance across lots. No Sn or Cu bond wire permitted. Uses increased reliability material set/homogeneous performance across lots. No Sn or Cu bond wire permitted. Uses increased reliability material set.	Ceramic military-grade parts released to a MIL spec. Intended for extreme environments and long-term dormant storage.	Space-grade parts meant for low-orbit missions. Screening for TID (Radiation Assured) high-reliability material set, similar to EP.	Space-grade parts in plastic package released to a MIL spec. Meant for long lifetime, high-reliability missions.	Space-grade, flip-chip parts with organic substrate released to a MIL spec. Meant for long lifetime, high-reliability missions.	Space-grade parts release to a MIL spec. Meant for long lifetime, high-reliability missions.	Same as QMLV but additional lot testing and screening for TID (Radiation Assured).

¹ SHP is a TI quality level that does not have a SMD part number

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