

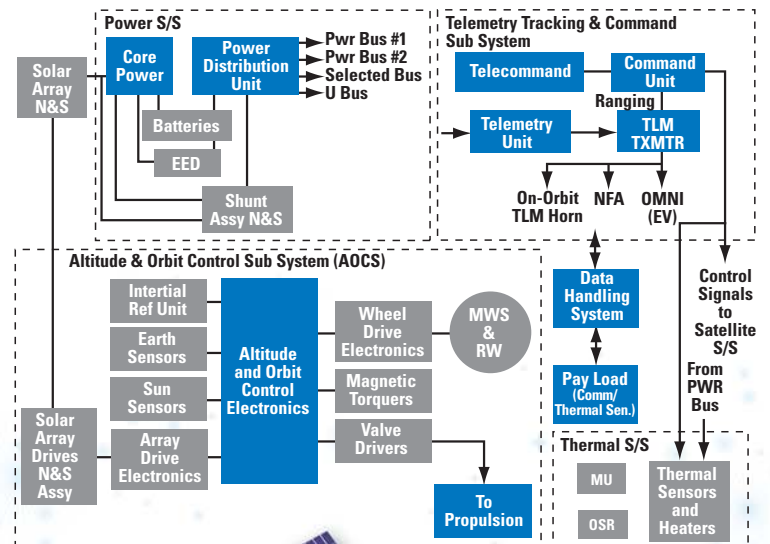
Space Solutions

Selection Guide

national.com/space

2010 Vol. 1

- Imaging Solutions
- Signal Path Solutions
- Amplifier Solutions
- Power Management
- Interface Solutions
- ELDRS-Free Products



National Semiconductor

Space Solutions

Commitment to Space Programs

As a leader in the supply of fully-qualified military and space grade IC's, National Semiconductor's analog and mixed signal product portfolio has been utilized in numerous military and aerospace applications for many years. Our ELDRS-free Bipolar analog products continue to strengthen our commitment to the space market and we are investing in new products to support evolving requirements for space applications. National's new product releases in the last several years have focused on enabling lower power and weight for the highest performance applications, such as communications systems and attitude and orbital controls.

- More than 40 years in the military/aerospace markets
- Rich space heritage
- World-class analog product portfolio
- QMLV DSCC certified products
- One of only 8 RHA (Radiation Hardness Assured) DSCC QML suppliers worldwide
- Expanding product capabilities with focus on space markets
- State-of-the-art radiation tolerant process technology
- Industry-leading hermetic packaging technology
- Space level die and wafer products
- World-class supply chain management with dedicated space program managers
- Proven quality, delivery, and performance

The National Semiconductor Advantage

National Semiconductor serves the needs of the global space community by manufacturing the highest quality analog and mixed signal products.

National's product specialists understand that space customers face new opportunities for creativity, innovation, and cost effectiveness. New platforms designed for longer lifecycles must be brought to market faster and more cost effectively.

National's space product portfolio is certified and qualified to government performance specifications MIL-PRF-38535 and MIL-STD-883, including support for legacy requirements such as the JM38510 flows.

Advanced Radiation Testing Parameters

Many of National's space-grade products are radiation-tested and guaranteed beyond RHA requirements through a qualification flow that performs TID and ELDRS tests on each wafer to ensure the highest reliability.

Radiation Testing Capabilities

- **TID** – ⁶⁰Co gamma cell in South Portland, Maine, and Santa Clara, California
- **ELDRS** – ELDRS Free products
- SEL, SEU, and SET reports on new products at national.com/space
- TID and ELDRS reports at national.com/space
- Ability to collaborate with customers for additional product enhancements and testing

Radiation Resistance Level	Applications
0-3 krad	Commercial industrial, robotic, nuclear, biomedical, space shuttle
3-30 krad	Tactical submarines, tanks, missiles, airborne, ground (field radar, communications), space station
20-50 krad	Space low earth orbit
50-200 krad	Space high orbit
100+ krad	Deep space Strategic military

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Featured Space-Qualified Products

Product ID	Description	Page
LM4050QML	Precision micropower shunt voltage reference	10
LM98640QML	Dual channel, 14-Bit, 40 MSPS Analog Front End with LVDS output	4
ADC10D1000QML	High-performance, low-power, dual channel, 10-bit 1 GSPS or single 10-bit 2 GSPS ADC	5
ADC14155QML	14-bit, 155 MSPS A/D converter	5
ADC128S102QML	8-channel, 50 kSPS to 1 MSPS, 12-bit A/D converter	6
DAC121S101QML	12-bit micropower rail-to-rail output D/A converter	6
LMP2012QML	Dual channel, high-precision, rail-to-rail output operational amplifier	7

Imaging Solutions

Analog Front Ends

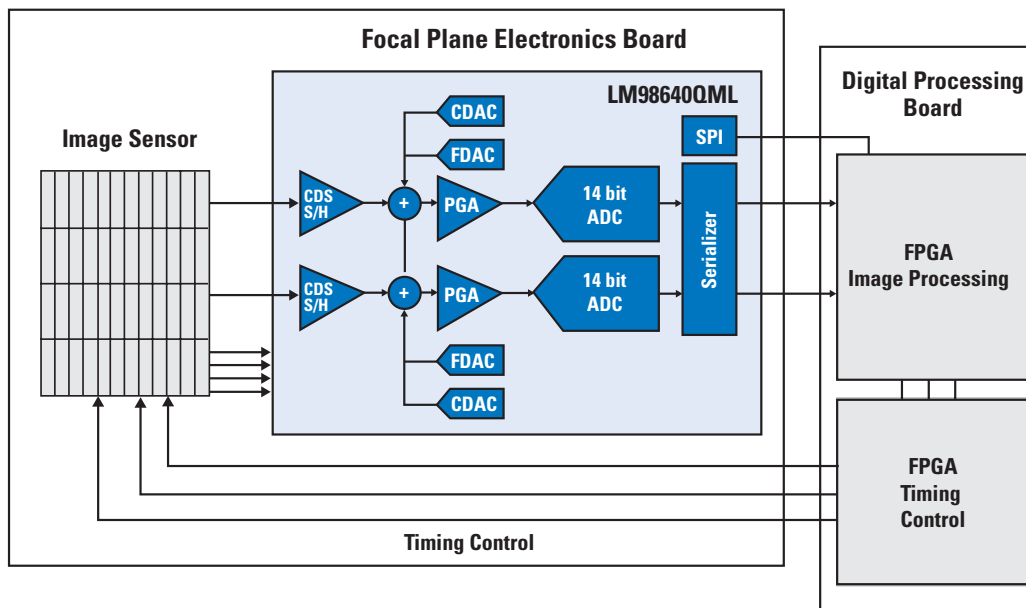
LM98640QML – Dual-Channel, 14-Bit, 40 MSPS Analog Front End with LVDS Outputs

Features

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

Applications

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



Analog Front End

Product ID	SMD Number	Resolution	Sample Rate	PGA Range	Offset DAC Range (Fine)	Power	Packaging	Radiation
NEW LM98640QML ^E	LM98640W-MLS	14	5 MHz to 40 MHz	-3 dB to 18 dB	+/- 5 mV	+/-122 mW/channel	CQFP-68	100 krad

PowerWise[®] product ^E Evaluation board

High-Speed and Precision Signal Path Solutions

Data Conversion

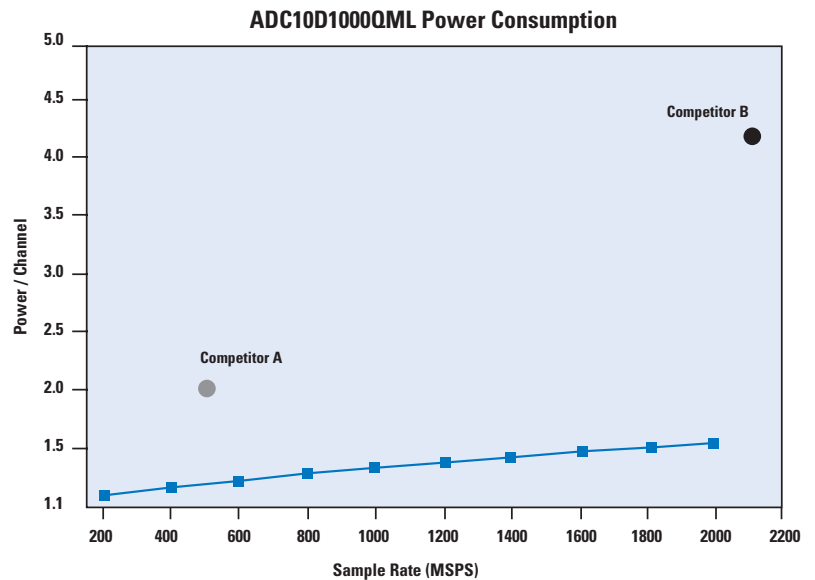
ADC10D1000QML – High-Performance, Low-Power, Dual Channel, 10-Bit 1 GSPS or Single 10-Bit 2 GSPS ADC

Features

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

Applications

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



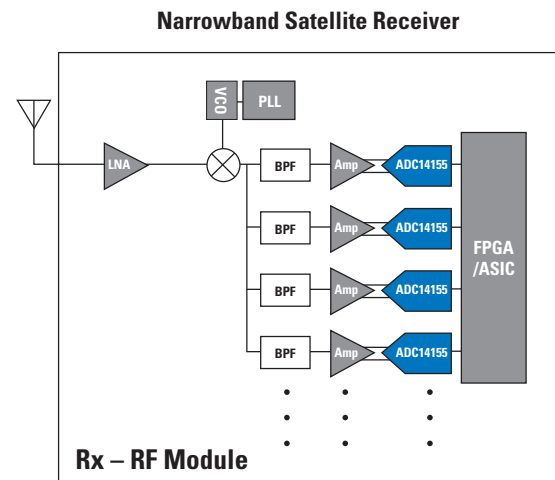
ADC14155QML – 14-Bit, 155 MSPS A/D Converter

Features

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

Applications

For use in satellite narrowband receivers



Data Conversion (High Speed)

Product ID	SMD Number	Sampling Rate	Power/ Channel (W)	Input Bandwidth (GHz)	ENOB (bits)	SNR (dB)	SFDR (dB)	Packaging	Radiation
ADC10D1000QML [Ⓔ]	ADC10D1000CCMLS	1.0 GSPS	1.45	2.8	9.0	55.6	66.7	CCGA-376	100 krad TID
ADC08D1520QML [Ⓔ]	5962F0721401VZC	1.5 GSPS	1.0	2.0	7.4	47	55.5	CQFP-128	300 krad TID
ADC14155QML [Ⓔ]	ADC14155W-MLS	155 MSPS	0.967	1.1	11.3	70.1	82.3	CQFP-48	100 krad TID

[Ⓔ] PowerWise® product [Ⓔ] Evaluation board

High-Speed and Precision Signal Path Solutions

Data Conversion

ADC128S102QML – 8-Channel, 50 kSPS to 1 MSPS, 12 Bit A/D Converter

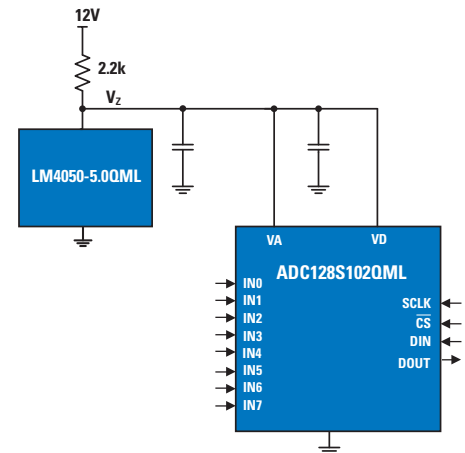
Features

- Only 2.3 mW of power
- SPI serialized outputs
- Radiation performance
 - TID of 100 krad(Si)
 - Single-event latchup-free up to 120 MeV-cm²/mg
- 8 input channels
- DNL -0.3 to 0.5 LSB typical
- INL \pm 0.6 LSB typical

Applications

Ideal for precision measurements in telemetry and control systems

Typical Application Diagram



Micropower A/D Converter

Product ID	SMD Number	Sampling Rate	Operating Power (mW)	Power Down (μ W)	Interface Type	Supply Voltage Range (V)	Packaging	Radiation
ADC128S102QML [Ⓔ]	5962R0722701VZA	50 kSPS to 1 MSPS	2.3	0.25	Serial	2.7 to 5.25	Ceramic SOIC-16	100 krad TID

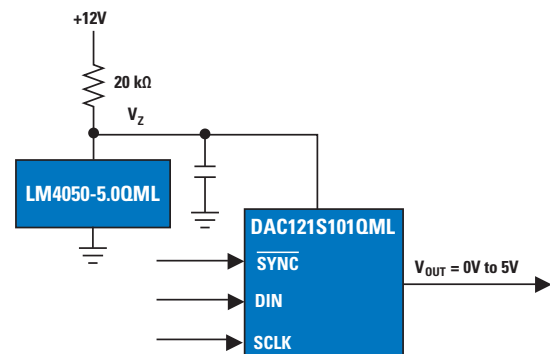
DAC121S101QML – 12-Bit Micropower Rail-to-Rail Output D/A Converter

Features

- Only 0.64 mW of power
- 3-wire, 20 MHz SPI digital interface
- TID of 100 krad(Si)
- Single-event latchup-free up to 120 MeV-cm²/mg
- Supply range 2.7V to 5.5V
- DNL -0.1 to 0.21 LSB
- Setting time 12 μ S

Applications

For use in programmable precision biasing in telemetry and control systems



Micropower Digital-to-Analog Converter

Product ID	SMD Number	Resolution (bits)	Operating Power (mW)	Power Down (μ W)	Interface Type	INL (LSB)	Packaging	Radiation
DAC121S101QML [Ⓔ]	5962R0722601VZA	12	0.64	0.14	Serial	\pm 0.25	Ceramic SOIC-10	100 krad TID

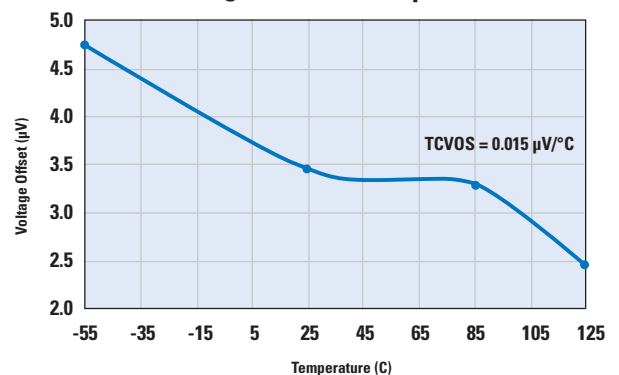
[Ⓔ] PowerWise[®] product [Ⓔ] Evaluation board

LMP2012QML – Dual Channel, High-Precision, Rail-to-Rail Output Operational Amplifier

Features

- Low supply current of 920 uA
- Very low TCVOs of 0.015 $\mu\text{V}/^\circ\text{C}$
- Low input offset voltage of 60 μV over time and temperature
- No 1/f noise
- 3 MHz wide gain bandwidth
- TID of 50 krad(Si)
- ELDRS qualified to 50 krad(Si)
- Single-event latchup-free up to 120 MeV-cm²/mg
- 10 Id hermetic gull wing ceramic cerpack packaging
- Low SET cross section

Voltage Offset vs Temperature



Applications

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

Precision Operational Amplifiers with Offset Voltage <0.5 mV

Product ID	SMD Number	TCVos ($\mu\text{V}/^\circ\text{C}$)	CMRR (dB)	PSRR (dB)	Voltage Noise (nV/Hz)	Channels	Supply Current per Channel (mA)	Packaging	Radiation
LMP2012QML	5962L0620601VZA	0.015	90	90	35	2	0.919	Ceramic SOIC-10	50 krad TID
LMP2012QML	5962L0620602VZA	0.015	90	90	35	2	0.919	Ceramic SOIC-10	50 krad, ELDRS-free

High-Performance Operational Amplifiers

Product ID	SMD Number	Description	-3 dB BW (MHz)	Supply Voltage Range (V)	Supply Current (mA)	Channels	Offset Voltage (mV)	Packaging	Radiation
LM6172QML	5962F9560401VxA	Dual, high-speed, low-power, low-distortion voltage feedback op amp	160	5.5 to 36	2.3	2	1.5, 3	CDIP-8, Ceramic SOIC-16	300 krad TID
LM7171QML	5962F9553601VxA	Very high-speed, high-output current voltage feedback op amp	220	5.5 to 36	6.5	1	1.0	CDIP-8, Cerpack-10, Ceramic SOIC-10	300 krad TID
LM7171QML	5962F9553602VxA	Very high-speed, high-output current voltage feedback op amp	220	5.5 to 36	6.5	1	1.0	CDIP-8, Cerpack-10, Ceramic SOIC-10	300 krad TID, ELDRS-free
LMH6628QML	5962F0254501VxA	Dual, wideband, low-noise voltage feedback op amp	300	5.0 to 12	9.0	2	2.0	CERDIP-8, Ceramic SOIC-10	300 krad TID
LMH6702QML	5962F0254501VxA	1.7 GHz, ultra-low-distortion, wideband op amp	1700	10 to 12	12.5	1	4.5	CERDIP-8, Ceramic SOIC-10	300 krad TID
LMH6715QML	5962F0254701VPA	Dual, wideband video op amp	480	10 to 12	5.8	2	6.0	CERDIP-8	300 krad TID
LMH6612QML	Coming soon	Single-supply, dual 345 MHz RRO op amp	365	2.7 to 11	3.45	2	0.6	Ceramic SOIC-10	300 krad TID

x – Indicates multiple package options available

Amplifiers Solutions

Amplifiers

Standard Operational Amplifiers

Product ID	SMD Number	Description	Gain Bandwidth (MHz)	Channels	Supply Voltage Range (V)	Offset Voltage (mV)	Supply Current (mA)	Packaging	Radiation
LM148QML	JM38510/11001SCA	Series quad 741 op amp	0.9	4	10 to 44	5.0	0.6	CERDIP-14	—
LF411QML	LF411MWG-MLS	Low-offset, low-drift JFET input op amp	4.0	1	10 to 36, 44	2.0	1.8	Ceramic SOIC-10	50 krad
LM101AQML	5962L9951501VxA	Op amp	1.0	1	10 to 44	2.0	1.8	CERDIP-8, Cerpack-10, TO99-8	50 krad
LM108AQML	5962R9863702VxA	Op amp	—	1	±2 to ±20	0.5	0.6	Cerpack-10, Ceramic SOIC-10, TO99-8	100 krad
LM124QML	5962R9950401VxA	Low-power op amp	1.0	4	3.0 to 32	2.0	0.18	Cerpack-14, Ceramic SOIC-14, CERDIP-14	100 krad
LM124QML	5962R9950402VxA	Low-power op amp	1.0	4	3.0 to 32	2.0	0.18	Cerpack-14, Ceramic SOIC-14, CERDIP-14	100 krad, ELDRS-free
LM158QML	5962R8771002VxA	Low-power, dual op amp	1.0	2	3.0 to 32	2.0	0.25	Cerpack-8, Ceramic SOIC-10, TO99-8	100 krad
LM158QML	5962R8771003VxA	Low-power, dual op amp	1.0	2	3.0 to 32	2.0	0.25	Cerpack-8, Ceramic SOIC-10, TO99-8	100 krad, ELDRS-free

x – Indicates multiple package options available

Monolithic Sample and Hold Circuits

Product ID	SMD Number	Positive Supply Current (mA)	Negative Supply Current (mV)	Input Offset Voltage (mV)	Input Bias Current (nA)	Acquisition Time (μs)	Leakage (pA)	Packaging	Radiation
LF198QML	JM38510/12501SGA	6.5	-6.5	5.0	75	10	<100	TO99-8	—
LF198QML	5962-8760801VZA	6.5	-6.5	5.0	75	10	<100	Ceramic SOIC-10	—

Comparators

Product ID	SMD Number	Description	Response Time (μs)	Channels	Supply Voltage Range (V)	Offset Voltage (mV)	Output Current (mA)	Packaging	Radiation
LM111QML	5962L0052401VxA	Voltage comparator	0.2, 0.1	1	5.0 to 36	3.0	50	CERDIP-8, Cerpack-10, Ceramic SOIC-10, T099-8	50 krad
LM111QML	5962R0052402VxA	Voltage comparator	0.2, 0.1	1	5.0 to 36	3.0	50	CERDIP-8, Cerpack-10, Ceramic SOIC-10, T099-8	100 krad, ELDRS-free
LM119QML	5962R9679801VxA	High-speed, dual comparator	0.05, 0.08	2	5.0 to 36	4.0	25	CERDIP-14, Cerpack-10, Ceramic SOIC-10, TO100-10	100 krad
LM119QML	5962R9679802VxA	High-speed, dual comparator	0.05, 0.08	2	5.0 to 36	4.0	25	CERDIP-14, Cerpack-10, Ceramic SOIC-10, TO100-10	100 krad, ELDRS-free
LM119QML	5962-9679801VxA	High-speed, dual comparator	0.05, 0.08	2	5.0 to 36	4.0	25	CERDIP-14, Cerpack-10, TO100-10	100 krad
LM139QML	5962R9673801VxA	Low-power, low-offset voltage quad comparator	0.5	4	2.0 to 36	2.0	16	CERDIP-14, Cerpack-14, Ceramic SOIC-14	100 krad
LM139QML	5962R9673802VxA	Low-power, low-offset voltage quad comparator	0.5	4	2.0 to 36	2.0	16	CERDIP-14, Cerpack-14, Ceramic SOIC-14	100 krad, ELDRS-free
LM139QML	5962-9673801VxA	Low-power, low-offset voltage quad comparator	0.5	4	2.0 to 36	2.0	16	Cerpack-14, Ceramic SOIC-14	—
LM193QML	5962R9452602VxA	Low-power, low-offset voltage quad comparator	0.4	2	2.0 to 36	2.0	16	CERDIP-8, TO-99-8	100 krad
LM193QML	5962R9452603VxA	Low-power, low-offset voltage quad comparator	0.4	2	3.0 to 36	2.0	16	CERDIP-8, TO-99-8	100 krad ELDRS-free
LM193QML	5962-9452602VPA	Low-power, low-offset voltage quad comparator	0.4	2	3.0 to 36	2.0	16	CERDIP-8	—

x – Indicates multiple package options available

Power Management

Voltage References

LM4050QML – Precision Micropower Shunt Voltage Reference

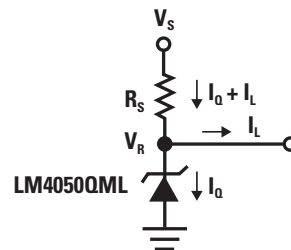
Features

- Fixed reverse breakdown voltages of 2.5V, 3.3V, and 5.0V
- Voltage tolerance $\pm 0.1\%$
- Tempco 17 ppm/ $^{\circ}\text{C}$
- 60 μA to 15 mA operating current range
- SET free with 60 μF capacitor
- ELDRS qualified to 100 krad
- Single-event latchup-free up to 120 MeV-cm²/mg

Applications

For use in space-critical applications, such as satellite control systems and instrumentation

Typical Application Circuit



Voltage References

Product ID	SMD Number	Description	Initial Accuracy (%)	Reference Voltage (V)	Output Current (mA)	Operating Current	Tempco Max (ppm)	Packaging	Radiation
NEW LM4050QML	5962R0923501VZA	Precision micropower shunt voltage reference	0.1	2.5	15	60 μA	17	Ceramic SOIC-10	100 krad, low-dose rate qualified
NEW LM4050QML	Coming Soon	Precision micropower shunt voltage reference	0.1	5.0	15	60 μA	50	Ceramic SOIC-10	100 krad, low-dose rate qualified
NEW LM4050QML	Coming Soon	Precision micropower shunt voltage reference	0.1	3.3	15	60 μA	20	Ceramic SOIC-10	100 krad, low-dose rate qualified
LM113-1QML	5962-9684302VxA	Precision reference	2.0	1.22	20	0.5 mA	100	TO-46, Ceramic SOIC-10	—
LM136-2.5QML	5962R0050101VXA	2.5V reference diode	2.5	2.5	10	1 mA	20	TO46-3	100 krad
LM136-2.5QML	5962R0050102VXA	2.5V reference diode	2.5	2.5	10	1 mA	20	TO46-3	100 krad, ELDRS-free
LM185-1.2QML	5962-8759401VxA	Micropower voltage reference diode	1.0	1.235	20	0.01 mA	150	TO46-2, Ceramic SOIC-10	—
LM185-2.5QML	5962-8759406VXA	Micropower voltage reference diode	1.5	2.5	20	0.02 mA	150	TO46-2	—

x – Indicates multiple package options available

Power Management

Voltage Regulators

Voltage Regulators

Product ID	SMD Number	Description	Output Current (mA)	Output Min (V)	Input Min (V)	Input Max (V)	Quiescent Current (mA)	Packaging	Radiation
LM723	JM38510/10201SxA	Voltage regulator	150	2.0	9.5	40	—	CERDIP-14, TO-100-10	N/A
LM117HQML	5962R9951703VxA	3-terminal adjustable regulator	500	1.2	4.2	40	5.0	TO39-3, Ceramic SOIC-16	100 krad
LM117HQML	5962R9951705VxA	3-terminal adjustable regulator	500	1.2	4.2	40	5.0	TO39-3, Ceramic SOIC-16	100 krad, ELDRS-free
LM117HVQML	5962R0722901VxA	3-terminal adjustable regulator	1500	1.2	4.2	40	5.0	TO39-3, Ceramic SOIC-16	100 krad
LM117HVQML	5962R0722961VxA	3-terminal adjustable regulator	1500	1.2	4.2	40	5.0	TO39-3, Ceramic SOIC-16	100 krad, low-dose rate qualified
LM117KQML	5962R9951704VYA	3-terminal adjustable regulator	1500	1.2	4.2	40	5.0	TO-3	100 krad
LM137	5962P9951701VXA	3-terminal adjustable negative regulator	1500	-37	-40	-4.2	—	TO39-3	30 krad
LM2941QML	5962-9166701VYA	1A low dropout adjustable regulator	1000	5.0	-15	26	45	Ceramic SOIC-16	N/A
LM2941QML	5962R9166702VYA	1A low dropout adjustable regulator	1000	5.0	-15	26	45	Ceramic SOIC-16	100 krad, ELDRS-free
LM2940QML	5962R8958701VxA	1A low dropout regulator	1000	5.0	—	26	10	Ceramic SOIC-16	100 krad
LM2940QML	5962R8958702VxA	1A low dropout regulator	1000	5.0	—	26	10	Ceramic SOIC-16	100 krad, ELDRS-free
LP2953QML	5962-9233601VxA	Adjustable micropower low dropout regulator	250	1.23	-20	30	0.13	CERDIP-16, Ceramic SOIC-16	N/A
LM140	JM38510/10706SYA	Series 3-terminal positive regulator	1000	5.0	7.2	35	7.0	TO3-2	N/A

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

Interface Solutions

Signal Conditioning

RS232 and Low-Voltage Differential Signaling (LVDS)

Product ID	SMD Number	Description	Channels	Max Data (Mbps)	I/O Compatibility	Power (mW)	Supply Voltage (V)	Packaging	Radiation
DS90C031QML	5962R9583301VxA	Quad CMOS differential line driver	4	155	TTL/LVDS	20	5	Ceramic SOIC-16, Cerpack-16	100 krad
DS90C031QML	5962-9583301VFA	Quad CMOS differential line driver	4	155	TTL/LVDS	20	5	Cerpack-16	—
DS90C032QML	5962R9583401VxA	Quad CMOS differential line receiver	4	155	LVDS/TTL	18	5	Ceramic SOIC-16, Cerpack-16	50 krad
DS90C032QML	5962-9583401VFA	Quad CMOS differential line receiver	4	155	LVDS/TTL	18	5	Cerpack-16	—
DS90LV031QML	DS90LV031AW-MLS	3V quad CMOS differential line driver	4	400	LVTTTL/LVDS	17	3.3	Cerpack-16	—
DS90LV032QML	DS90LV032AW-MLS	3V quad CMOS differential line receiver	4	400	LVDS/LVTTTL	34	3.3	Cerpack-16	—

x – Indicates multiple package options available

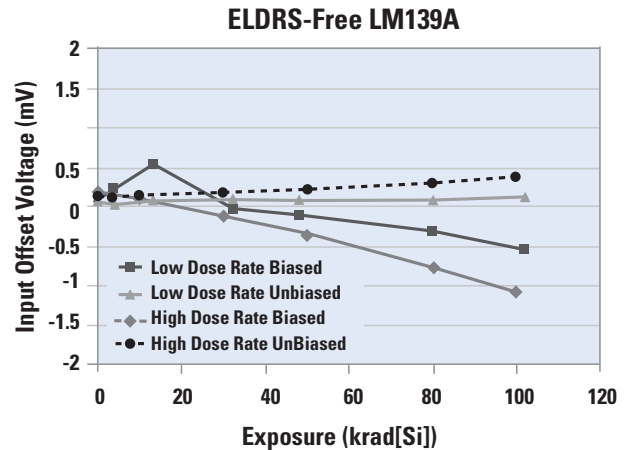
ELDRS-Free Bipolar Analog Products

Enhanced Low Dose Rate Sensitivity

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

Every is wafer tested and qualified at high and low dose rates

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



SMD Ordering for ELDRS-Free Products

Example LM124A SMD Ordering Number

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

Level of radiation exposure

Low dose rate qualified

DSCC Unique Low Dose Rate Certified Products

Product ID	Description	TID Part Number	ELDRS Part Number
ELDRS-Free Products			
LM124AQML ^W	Low-power, quad operational amplifier	5962R9950401VxA	5962R9950402VxA
LM139AQML	Low-power, low-offset voltage quad comparator	5962R9673801VxA	5962R9673802VxA
LM117QML	3-terminal adjustable regulator	5962R9951703VxA	5962R9951705VxA
LM136-2.5QML	2.5V reference diode	5962R0050101VxA	5962R0050102VxA
LM193QML	Low-power, low-offset voltage, dual comparator	5962R9452602VxA	5962R9452603VxA
LM111QML	Voltage comparator	5962L0052401VxA	5962R0052402VxA
LM158QML	Low-power, dual operational amplifier	5962R8771002VxA	5962R8771003VxA
LM119QML	High-speed, dual comparator	5962R9679801VxA	5962R9679802VxA
LM2941QML	1A, low-dropout adjustable regulator	5962R9166701VxA	5962R9166702VxA
LMP2012QML	Dual, high precision, rail-to-rail output op amp	5962L0620601VxA	5962L0620602VxA
LM7171QML ^{E,W}	High-speed, high-output voltage feedback amp	5962F9553601VxA	5962F9553602VxA
Low-Dose Rate Qualified Products			
LM117HVQML	3-terminal adjustable regulator	5962R0722901VxA	5962R0722961VxA
LM4050QML	Precision micropower shunt voltage reference	5962R09335501VZA	5962R09335601VZA
Products in Qualification			
LM101AQML	Operational amplifier	5962L9951501VxA	5962L9951502VxA
LM113	1.2V reference diode	5962R9684302VxA	5962R9684303VxA
LM137	3-terminal adjustable negative regulator	5962P9951701VxA	5962L9951706VxA

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

Space-Qualified Die Products

Die Products

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

If a product is available as a Space, Radiation Tolerant, or ELDRS level package part, in most cases an equivalent die is also available. Visit national.com/die for a current list of available die and wafer products.

Die Products Value Advantage

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

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

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

High Dose Rate		Low Dose Rate		Description
Part Number	SMD	Part Number	SMD	
LM111 MDR	5962L0052401V9A	LM111 MDE	5962R0052402V9A	Voltage comparator
LM117H MDR	5962R9951703V9A	LM117H MDE	5962R9951705V9A	3-terminal adjustable regulator
LM117HVH MDR	5962R0722901V9A	LM117HVH MDE	5962R0722961V9A	3-terminal adjustable regulator
LM119 MDR	5962R9679801V9A	LM119 MDE	5962R9679802V9A	High-speed dual comparator
LM124 MDR	5962R9950401V9A	LM124 MDE	5962R9950402V9A	Low-power quad operational amplifier
LM136-2.5 MDR	5962R0050101V9A	LM136-2.5 MDE	5962R0050102V9A	2.5V reference diode
LM139 MDR	5962R9673801V9A	LM139 MDE	5962R9673802V9A	Low-power, low-offset-voltage quad comparator
LM158A MDR	5962R8771002V9A	LM158A MDE	5962R8771003V9A	Low-power, dual operational amplifier
LM193 MDR	5962R9452602V9A	LM193 MDE	5962R9452603V9A	Low-power, low-offset-voltage dual comparator

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

Please contact us at national.com/die if you require a product not currently offered in die or wafer form, National will consider die or wafer form offerings of any package product from the broad product portfolio.



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Chip Test and Assembly:

Melaka, Malaysia

World Headquarters
2900 Semiconductor Drive
Santa Clara, CA 95051
USA
+1 408 721 5000
www.national.com

Mailing Address:
PO Box 58090
Santa Clara, CA 95052
support@nsc.com

European Headquarters
Livry-Gargan-Str. 10
82256 Fürstentfeldbruck
Germany
+49 8141 35 0
europe.support@nsc.com

Asia Pacific Headquarters
2501 Miramar Tower
1 Kimberley Road
Tsimshatsui, Kowloon
Hong Kong
+852 2737 1800
ap.support@nsc.com

Japan Headquarters
Beside KIBA
2-17-16
Kiba, Koto-ku
Tokyo, 135-0042, Japan
+81 3 5639 7300
jpn.feedback@nsc.com

