



Space Solutions



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A Legacy of Space Innovation for Sixty Years

Extensive Space Heritage

Microchip has been developing space solutions for almost six decades and has played an important role in a wide variety of space programs globally. The company has a proven track record for innovation, quality and reliability, and continues to build on that legacy with an impressive portfolio of industry-leading new products and technology innovations.

A Partner For The Long Run

Microchip's high-reliability products and solutions have been used in applications that require high levels of radiation-hardness for trips to the moon, Mars and beyond. We have always responded to the specific needs of space applications and have a longstanding commitment to the space market.

Broad Solutions Portfolio

With one of the industry's most comprehensive space products portfolios, we provide radiation-hardened and radiation-tolerant solutions including high-performance FPGAs, microcontrollers, microprocessors, communication interfaces, memories and digital and mixed-signal ASICs, precise frequency and timing solutions with space-grade oscillators, mixed-signal ICs, isolated DC-DC converter modules, custom power supplies, hybrid solutions, MOSFETs, diodes, transistors, RF components and custom solutions. We are committed to supporting our products throughout the lifetime of our customer's programs.

Continuous Innovation

We continue to innovate in areas such as semiconductor materials, advanced packaging technologies, and high-density integrated circuits. Our products are qualified to the highest government, DLA, NASA and ESA standards, and their reliability has been independently verified by multiple agencies. As your supply partner for electronic systems in space, we can solve problems at all stages of design and implementation, including power conversion and distribution, radio and radar signal processing, system telemetry and control, digital logic integration, and semiconductor packaging. We invite you to explore Microchip's solutions and engage with us to help solve your most difficult space system design challenges.



Satellites

- Attitude and orbit control systems
- Electrical power systems
- TT&C/C&DH systems
- Communications payloads
- Remote sensing payloads
- Solar array and power conditionings
- Active and passive image payloads
- Solid state recorders



Launchers

- Navigation and guidance systems
- Electrical power systems
- TT&C/C&DH systems
- Propulsion control systems

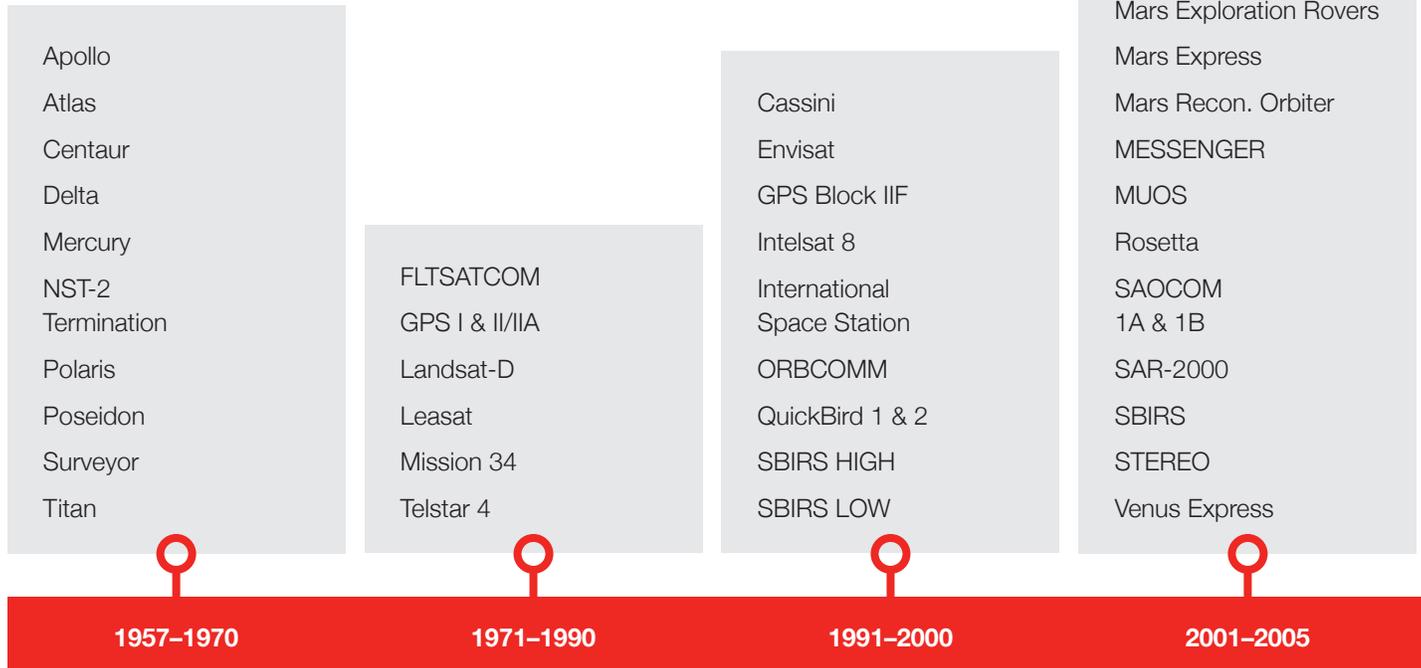


Landers

- Navigation and guidance systems
- Electrical power systems
- TT&C/C&DH systems
- Science experiment payloads
- RF communications subsystems
- Cameras and imagers
- Motor control systems

Leading Space Innovation Since 1957

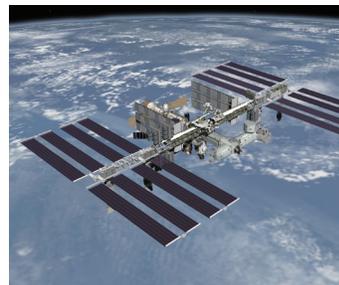
Microchip technology has been used in many major U.S. and international space initiatives since 1957. A selection of programs that have chosen our products is presented here.



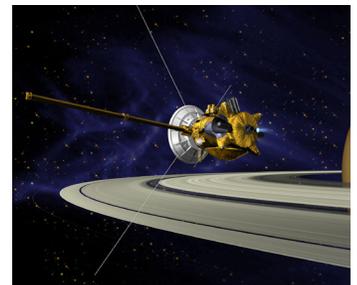
Atlas
NASA



Mars Science Lab
NASA



International Space Station
NASA



Cassini-Huygens
NASA

Space Heritage

AEHF	MetOp
ALOS	MUOS FS3-5
Astro-F (IRIS/Akari)	New Horizons
CHIRP	PAN
Columbus	SBIRS
Cosmo IV	HIGH 3 & 4
GOSAT/IBUKI	SDS-1
GPS III	SELENE
INTELSAT	WINDS/KIZUNA
KOMPSAT	WorldView II

ALOS 2 (DAICHI-2)	IRNSS Series
ASNARO	Juno
ATV	JPSS-1
Chandrayaan I	Mangalyaan
CLIO (PAN II)	Mars Science Lab
Cygnus	MetOp SG
DSAC	Orbcomm Gen 2
Gaia	PAN 2
Galileo	SBIRS 5 & 6
GCOM-W (SHIZUKU)	Sentinel 1, 2, 3, 4
GOES-R	Skyfox
Hayabusa 2	Terrasar & Tandem X
Himawari 8	WorldView III
Iridium Next	

2006–2010

2011–2020



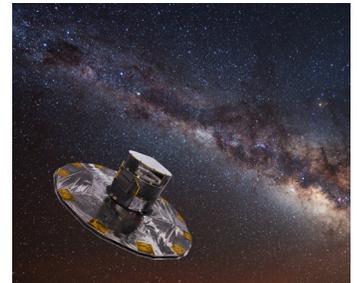
Juno
NASA



Cygnus
NASA



Mars Rovers
NASA



Gaia
ESA



ATV



Globalstar 2



Galileo



SVOM

Radiation-Tolerant FPGAs

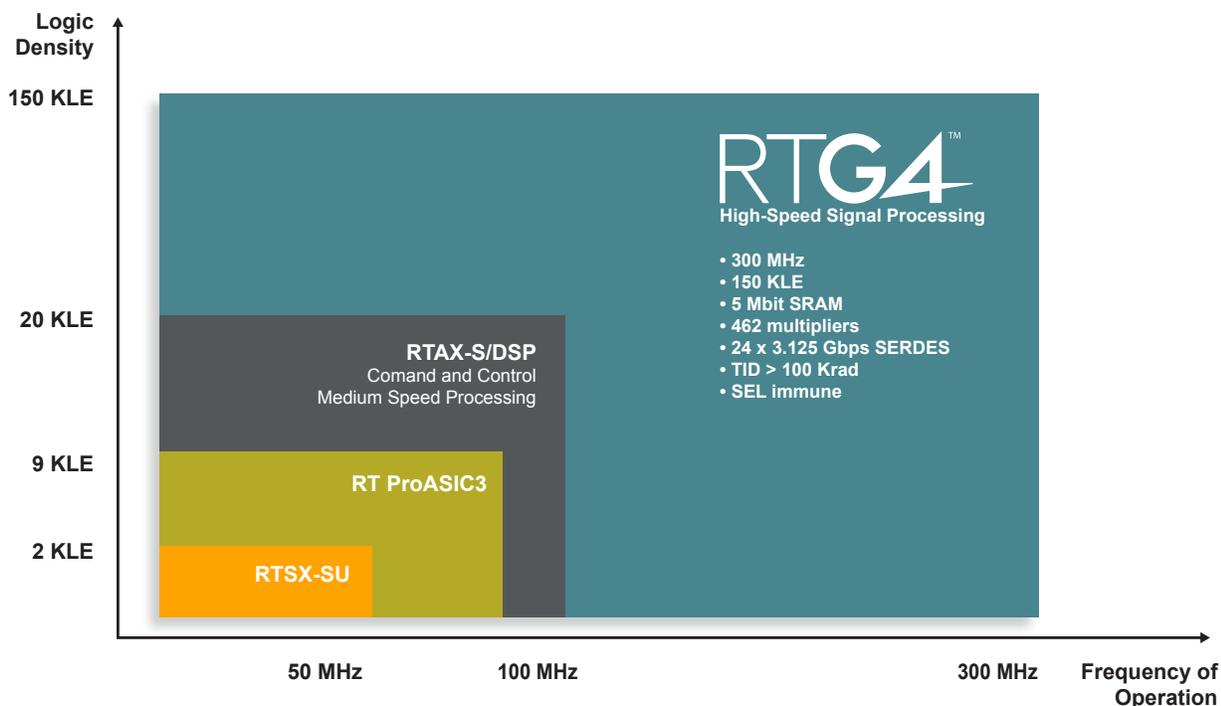
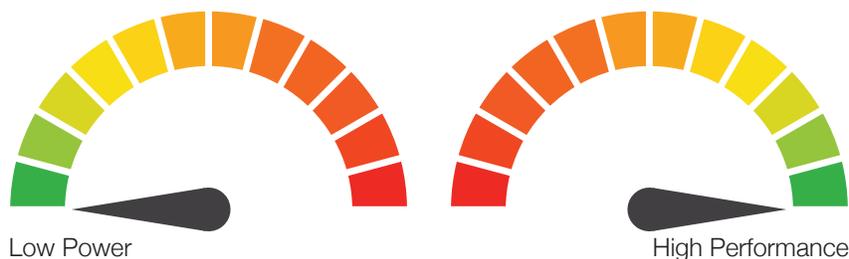
Microchip's space-proven, radiation-tolerant FPGAs provide a wide range of gate counts, hardwired multiply-accumulate blocks for fast, efficient digital signal processing and high-speed serial interfaces such as SERDES. They also feature QML qualification to classes Q and V, and are available in a variety of package types and sizes. Our FPGAs have survived more than 33 million device-hours of reliability data from flight and commercially equivalent units, and performed flight-critical functions in space systems orbiting around the Earth, the moon, Venus, and the sun. They also have been used on missions to the surface of Mars, and into the furthest reaches of the solar system. Microchip's innovations include radiation-hardening techniques that protect against Single Event Upset (SEU) radiation effects, novel packaging technologies to enable integration of FPGAs into hybrids and multi-chip modules, and high-density ceramic column grid array packaging. Product family specifications include:

- Up to 300 kRad (Si) functional TID
- Up to 150K LEs, 5 Mbits SRAM, 462 multipliers
- Up to 840 I/Os and 24 x 3.125 Gbps SERDES
- Reprogrammable Flash or permanently programmed anti-fuse interconnects

www.microsemi.com/products/fpga-soc/rad-tolerant-fpgas



RTG4™ Radiation-Tolerant FPGA

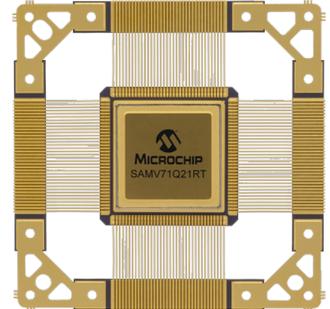
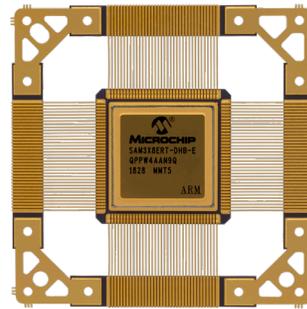
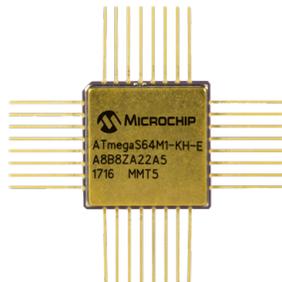
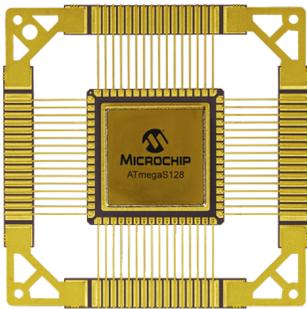


Leading Edge Products for Space

Rad-Tolerant Microcontroller: 8-bit AVR® and 32-bit Arm®

Microchip's rad-tolerant devices rely on AVR and Arm Cortex® MCUs that are currently widely used in industrial and automotive markets. Compared to the commercial versions, the same mask set functionality is used, but with an extended temperature range and increased radiation performance to ensure latch-up immunity. These devices benefit from Microchip's widely used development tool chain and libraries for AVR and Arm devices with commercial evaluation kits.

ATMEGAS128 8-bit AVR® MCU	ATMEGAS64M1 8-bit AVR MCU	SAM3X8ERT 32-bit Arm® Cortex®-M3	SAMV71Q21RT 32-bit Arm Cortex M7
10 MIPS 128 KB Flash 10-bit ADC 6 PWM channels Timers UART/TWI/SPI	10 MIPS 64 KB Flash CAN controller 10-bit ADC/DAC Power Stage Cont. Analog comparators	100 DMIPS Dual bank Flash Dual bank SRAM Ethernet 10/100 12-bit ADC/DAC Timers and PWM Dual CAN 2.0B	600 DMIPS 2 MB Flash FPU/DSP TCM/MPU/ECC Hmatrix architecture Dual CAN FD Ethernet 10/100 12-bit ADC/DAC Timers and PWM ICM



SAMRH71: Rad-Hard by Design 32-bit Arm Cortex-M7 MCU: The Scalable V71 Family

Beyond the powerful Rad-Tolerant SAMV71Q21RT, Microchip also proposes the Rad-Hard by Design version of the SAMV71 family. Based on Microchip's ATMX150RHA space qualified technology, SAMRH71 offers customers improved radiation performances for missions in harsh environment.

- ATMX150RHA space qualified 150 nm technology
- 32-bit Arm Cortex-M7 based MCU
- Multi-layer AMBA interconnect with flexible DMA and QoS
- Multi-port SRAM with 4 ports to optimize bandwidth and latency
- 384 KB Tightly Coupled Memory (TCM) to provide low-latency memory
- ECC on TCM interface, SRAM (768 KB), Flash (128 KB) and External memory controller
- Communication interfaces: SpaceWire, 1553 BC/RT, Dual CAN FD and Ethernet AVB



Rad-Tolerant Companion Chips

A large choice of companion chips for use with the MCU such as Ethernet PHYs and switches, CAN transceivers, analog-to-digital converters and non-volatile memory.

Rad-Hard SPARC® Processors

Microchip's space processors, based on the SPARC architecture utilizing the TSC695 and AT697F provide unrivalled flight heritage.

	TSC695F 32-bit SPARC® V7	AT7913E 32-bit SPARC V8 SpaceWire Remote Terminal Controller	AT697F 32-bit SPARC V8
Performance	20 MIPS @ SYSCLK = 25 MHz	40 MIPS @ SYSCLK = 50 MHz	90 MIPS @ SYSCLK = 100 MHz
Consumption	Typ. 1W 50 mW/MIPS	Typ. 1W 25 mW/MIPS	Typ. 0.7W 8 mW/MIPS
Operating Voltage	4.5V to 5.5V	1.65–1.95V/3–3.6V	1.65–1.95V/3–3.6V
TID	>300 Krad	>300 Krad	>300 Krad
Latch-up @ 125°C	70 MeV/mg/cm ²	80 MeV/mg/cm ²	95 MeV/mg/cm ²

AT7991 (Advanced GPS/GALILEO Device, AGGA-4)

AT7991 (Advanced GPS/GALILEO device, AGGA-4) is a Rad-Hard GNSS baseband SoC capable of processing the modernized GPS, Galileo and other signals such as Glonass.

- Applications: Precise Orbit Determination (POD) and Radio Occultation (RO)
- Features: GNSS core, LEON2FT processor, multiple interfaces (SPI, UART, Spacewire and 1553)

AT7910E SpaceWire Router

AT7910E SpaceWire router is comprised of eight SpaceWire link interfaces and a routing matrix which enables packets arriving at one link interface to be transferred to and sent out of another link interface on the routing switch.

Rad-Hard Memory Products

Microchip has a long track record with memory devices and currently supports the space industry's efforts regarding standardization of part variations with respect to size, format, package, power consumption and speed.

Part Number	Type	Format	Operating Voltage (V)	TID (krad)
AT65609EHV	SRAM	128K × 8	4.5–5.5	300
AT65609E	SRAM	128K × 8	3.0–3.6	300
AT60142H/HT	SRAM	512K × 8	3.0–3.6*	300
AT68166H/HT	MCP SRAM	512K × 32	3.0–3.6*	300
AT69170F	Serial EEPROM	4M × 1	3.0–3.6	60

Rad-Tolerant Memory Products

For different configurations (processor code, FPGA, parameters, calibration, etc.), Microchip offers use of the rad-tolerant EEPROM devices that are qualified for space use.

Part Number	Type	Format	Operating Voltage (V)	TID (krad)
AT28C010-12DK	Parallel EEPROM	128K × 8	4.5–5.5	30
AT17LV010-10DP	Serial EEPROM	1M × 1	3.0–3.6	60



Custom/ASIC Mixed Signal Solutions for Space

Microchip has a strong heritage in supplying high-performance custom application specific integrated circuits (ASIC) for space applications. Our experienced teams are located in both the US and Europe allowing us to offer solutions developed and manufactured solely in each region as required by our worldwide customers.

Rad-Hard ASIC with Mixed Signal

Microchip has been a provider of radiation-hardened ASICs since 1985 providing competitive solutions to critical space applications. We utilize our proven design rules within our Physical Design Kit (PDK) to develop our radiation-hardened IP and ASIC designs as well as our fully qualified IP and radiation-hardened standard cell libraries.

ASIC Benefits

- A unique radiation-hardened, proven, space qualified source
- Continuously monitored and maintained to guarantee radiation performance
- Qualified supply chain from design to qualified parts
- Wide range of quality levels from HiRel Plastic to QMLV
- Large package portfolio with options up to CCGA896
- Quick turn prototyping available via quarterly multi-project wafer processing

www.microchip.com/ATMX150RHA

		ATMX150RHA
Process/Feature size		SOI CMOS/150 nm
Library		Mixed-Signal; -55°C/125°C
Usable gates		22M equivalent NAND2
Signal I/Os		>700
5V and HV (up to 25V)		Y
Specific I/Os		LVDS, PCI
Supply voltage	Core/I/Os	1.8V/2.5V, 3.3V, 5V
Consumption (nW/gate/MHz)		<10 at 20% duty cycle
Analog IPs (*)		ADC, DAC, PLL, BG, MUX, COMP, OSC
RAM compiler		Y
TID		Successfully tested up to 300 krad(Si)
SEL (at 125°C/ Vccmax)		LETth 78MeV.cm2/mg

ATMX150RHA is a mixed-signal ASIC offer providing high-performance and high-density solutions for space applications. This provides for ASIC solutions of up to 22 million routable gates. With a set of pre-qualified analog IPs, such as ADCs, DACs, PLL and regulators, the ATMX150RHA eases the design of mixed-signal ASICs.

Full-Custom IC Development

We offer full design, assembly, test and qualification services from specification finalization through production. Our custom solutions include ICs requiring both high and low voltage circuitry, multiple die per package, and customized qualification flows. Our solutions have achieved over a decade of flight heritage and are radiation-hardened-by-design to tolerate various levels of radiation exposure required by mission profiles. Microchip's access to numerous wafer fabrication facilities ensures maximum flexibility in process selection, allowing for optimized designs and cost-effective solutions.

Full-Custom Benefits

- Board space optimization
- Significant weight reduction
- Reliability improvement
- Power optimization
- Hermetic and plastic package options
- Wide range of screening levels from HiRel plastic to QMLV
- Obsolescence management
- Differentiation from standard products

Please see our brochure www.microsemi.com/product-directory/services/1043-mixed-signal-asic-design-services

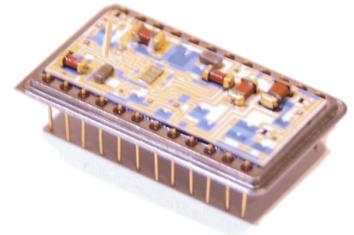
Available IP

Signal Conditioning and Converters	PGA, AFE, demodulators, peak detectors, ADCs SAR, Sigma-Delta, HV analog muxes, analog filters
Digital Integration and Signal Processing	Digital filters, Compiled memories, Processors: 32-bit RISC and peripherals, DSP functions
Interfaces and Protections	SPI, I2C, JTAG, SENT, PWM, PSI5, ESD protection cells up to 4kV , Reverse battery protections
Drivers and Actuation	High-voltage drivers, Line protectors and current limiters, Motor drivers and pre-drivers
Power Management	Switching regulators, linear regulators, E-Fuse protection devices, Charge pumps, thermal protection
Clock Management	RC, VCO oscillators, PLLs, LC tank exciter, sleep-mode timer

Point-of-Load Space Hybrids

Microchip designs and manufactures high-reliability micro-circuits qualified to MIL-PRF-38534, Class H or K. The portfolio includes standard and custom power conversion products linear regulators and switching converters that offer the following capabilities, including:

- Space-qualified products to Class H and K, MIL-PRF-38534
- Radiation qualifications up to 100 krad (Si) TID
- Single-event-rated products up to LET= 82 MeV
- Custom build-to-print capabilities
- DBC, thick and thin film technologies
- Assemblies with low thermal resistance



Radiation-Hardened Mixed-Signal ICs

Microchip has a long history of providing successful and reliable industry-standard, radiation-hardened-by-design Integrated Circuits (ICs), including our new, highly integrated Space System Manager (SSM) Family as well as satellite power management ICs. Our mixed-signal portfolio includes:

Part Number	Description
AAHS298B	8 channel high side driver
LX7710	8 pair diode array
LX7712	Programmable current limiting power switch
LX7714	Resettable quad E-Fuse
LX7720	Position sensing/Motor Control SSM (see page 16)
LX7730	Telemetry Controller SSM (see page 16)



Please visit the product pages on our website for more information www.microsemi.com/applications/space.

Radiation-Hardened Bipolar Transistors, Diodes, Zeners, TVS, Solar Diodes and Rectifiers

Microchip's discrete solutions are qualified to MIL-PRF-19500, and the company has more DLA slash sheet qualifications than any other manufacturer of space-level discrete products (over 60% of the QPL/QML). We were the first diode manufacturer selected by the U.S. military services as a source of supply to qualify products to the highest specified reliability level. We have expanded our offerings to include a growing range of space solutions and capabilities including:

- Radiation-hardened bipolar transistors, diodes, rectifiers, zeners, Transient Voltage Suppressors (TVS) and solar diodes
- JAN, JANTX, JANTV and JANS-qualified products
- Radiation-qualified products (TID, ELDRS, SEE)
- Solar cell blocking and bypass diodes
- Radiation testing services
- Customized devices



Radiation-Hardened Bipolar Transistors

www.microsemi.com/product-directory/transistors/3274-bjt-bipolar-junction-transistor

Diodes

www.microsemi.com/product-directory/discretes/607-diodes

Zeners

www.microsemi.com/product-directory/diodes/630-zener

Transient Voltage Suppressors (TVS)

www.microsemi.com/product-directory/discretes/682-transient-voltage-suppressors

Rectifiers

www.microsemi.com/product-directory/diodes/666-rectifier-diode



Rad Hard Discrete Products

Part Number	Slash Sheet	Package	Polarity	Rated Voltage	Device Speed	Rated Power	Max TJ	MSC RHA Level	Qual Level	DLA Qual Level
2N2222A	/255	TO-18	NPN	50V	300ns	0.5W	200°C	D, R, F, H	JXVSH, HKC	JXVS
2N2222AL	/255	TO-18	NPN	50V	300ns	0.5W	200°C	D, R, F, H	JXVSH, HKC	JXVS
2N2222AUA	/255	LCC4 UA	NPN	50V	300ns	1W	200°C	D, R, F, H	JXVSH, HKC	JXVS
2N2222AUB	/255	LCC3 UB	NPN	50V	300ns	1W	200°C	D, R, F, H	JXVSH, HKC	JXVS
2N2222AUBC	/255	LCC3 UBC	NPN	50V	300ns	1W	200°C	D, R, F, H	JXVSH, HKC	JXVS
2N2484	/376	TO-18	NPN	60V	60MHz	0.36W	200°C	D, R	JXVSR	JXVS
2N2484UA	/376	LCC4 UA	NPN	60V	60MHz	0.36W	200°C	D, R	JXVSR	JXVS
2N2484UB	/376	LCC3 UB	NPN	60V	60MHz	0.36W	200°C	D, R	JXVSR	JXVS
2N3019	/391	TO-39KM	NPN	80V	100MHz	0.8/5W	200°C	F	JXVSR	JXVS
2N3019S	/391	TO-39KM	NPN	80V	100MHz	0.8/5W	200°C	F	JXVSR	JXVS
2N3501U4	/366	SMD.22 (U4)	NPN	150V	1150ns	5W	200°C	M, R	JXV	JXV
2N3501UB	/366	LCC3 UB	NPN	150V	1150ns	0.5W	200°C	M, R	JXVS, R, KC	JXVS
2N2907A	/291	TO-18	PNP	60V	300ns	0.5W	200°C	R	JXVS, R	JXVS
2N2907AL	/291	TO-18	PNP	60V	300ns	0.5W	200°C	R	JXVS, R	JXVS
2N2907AUA	/291	LCC4 UA	PNP	60V	300ns	1W	200°C	R	JXVS, R	JXVS
2N2907AUB	/291	LCC3 UB	PNP	60V	300ns	1W	200°C	R	JXVS, R	JXVS
2N2907AUBC	/291	LCC3 UBC	PNP	60V	300ns	1W	200°C	R	JXVS, R	JXVS

Radiation-Hardened DC/DC Converters

Microchip designs and manufactures rad-hard isolated dc/dc converters with proven 30+ year flight heritage, full worst case analysis and reliability analysis, operating over a wide input bus voltage with single, dual, triple or multiple outputs.

Features	Benefits
120 V _{IN} (86 Vdc–156 Vdc), with internal EMI filter Triple, dual and single output versions (20+ catalog options) Isolated outputs 50 W total combined power output Inhibit, remote sense, and remote adjust Isolated sync input, 600 kHz Less than 1% accuracy over temp and radiation >86% efficient full load at 5 ±15V output (T version) 3.055" L × 2.055" W × 0.50" H envelope Total dose rating of 100 krad(Si) at LDR SEE (all effects) >80 MeV-cm ² /mg (H version) Thermal resistance = 0.041°C in ² /W (measured at 55°C) NASA outgassing compliant: (TML)= 1% max, (CVCM)= 0.1% max	Support for standard satellite bus voltages No external EMI filtering needed saving valuable real estate Semi-custom solution in half the lead time of a full custom solution Patented load sharing techniques to maximize performance Optimal output voltage accuracy through internal reference and remote current sense Peak efficiency at full load Up to 5 modules can be connect in parallel Best in class radiation performance and accuracy Best in Class Efficiency EAR99 Solution

Design Support Available

- Radiation analysis
- Worse case analysis
- Reliability analysis
- FMEA
- EMI test report
- Structural analysis
- Stress analysis
- Thermal analysis



<https://www.microsemi.com/product-directory/switching-regulators/1272-dc-dc-power-modules#overview>

SAW Filters

The Vectron Military and Space Family of SAW Filters offers high reliability under the most stringent environmental conditions. However, each solution is unique to a particular requirement. Therefore, Vectron's SAW design team offers custom filter designs over a wide frequency range from 30 MHz to 2.7 GHz.

- Low loss SAW = approx. 1...5 dB insertion attenuation ($f_c \leq 2.7$ GHz)
- Loss reduced SAW = approx. 5...15 dB insertion attenuation ($f_c \leq 1$ GHz)
- Precision high-loss SAW: ≥ 10 dB insertion attenuation; shape factor ≥ 1.03 ($f_c \leq 1$ GHz)

In addition, we have hundreds of filters already designed and production ready which can be built and screened to most military and Space requirements. The SAW Filters shown are only a sample of the many filters available for military applications. We invite you to visit our website at www.vectron.com to see a listing of most of the standard products available.

Monolithic/Discrete Crystal Filters

Vectron offers a wide array of standard Monolithic (MCF) type crystal filters for use in military and space applications in the 10.7 MHz, 21.4 MHz, 45 MHz, 70 MHz and 90 MHz center frequencies. In addition, Vectron also offers other standard designs in the center frequency range of 1.4 MHz to 173 MHz with designs from 2 poles to 12 poles.

LC Filters

For military and space applications requiring bandwidth in excess of 5% of center frequency, Vectron LC filters can provide the necessary selectivity and reliability to meet system performance objectives.

High-Reliability Temperature Compensated Crystal Oscillators (TCXO)

A TCXO is an XO or VCXO combined with temperature compensation providing output stabilities as tight as ± 0.5 ppm over the operating temperature range.

- No SCD to write
- No additional qualification required
- Quicker delivery
- Lower overall cost
- Multiple screening choices
- Multiple package choices

Vectron International has created a general specification for High Reliability Space TCXOs that can be used in place of a customer generated SCD. Vectron's DOC200103 specification has become the industry standard by many of the leading satellite OEMs. This specification defines the design, assembly and functional evaluation for a wide variety of CMOS and Sine wave temperature compensated crystal oscillators for various mechanical configurations.

High-Reliability Clock Oscillators (XO)

- No SCD to write
- No additional qualification required
- Quicker delivery
- Lower overall cost
- Multiple screening choices
- Multiple package choices
- Includes +3.3V supply option

Vectron International has created general specifications for High-Reliability Space Clock Oscillators that can be used in place of customer generated SCDs. Vectron's OS-68338, DOC203679, DOC203810 and DOC204900 have become the industry standard for many of the leading satellite OEMs. These specifications define the design, assembly and functional evaluation for a wide variety of TTL, AC MOS, LVDS and LVPECL clock oscillators for various mechanical configurations.

Leading Edge Products for Space

Chip Scale Clock Background

- CSAC development started in 2001 under a contract from DARPA with Draper and Sandia Laboratories
- Army funding on ManTech Contract to improve manufacturability 2009 to 2013
- Coherent population trapping architecture allows for simplification and power reduction of physics package
- Key features are low power and small size, with atomic clock accuracy and precision



SA45 CSAC – Chip Scale Atomic Clock

- DARPA funded development released to production in 2011
- 120 mW Atomic Clock with 16 cm³ volume
- $\pm 5 \times 10^{-10}$ temperature stability
- 3.0×10^{-10} Allan Deviation at 1 second
- 1 pps steering option
- Extremely-low sensitivity to acceleration
- Rugged physics package by design specification compliant to 10 grms >1000g shock resistant
- Tensioned polyimide suspension
- Micro-fabricated silicon vapor cell
- Low-power Vertical-Cavity Surface Emitting Laser (VCSEL)
- Vacuum-packaged to eliminate convection/conduction – overall thermal resistance of 7000°C/W
- Entire physics package can operate on 15 mW

Space CSAC

- Identical performance to CSAC
- TCXO replaced and electronics radiation lot screened
- Radiation Tolerance: 20 Krad and no SEL to 64 MeV-cm²/mg
- The Space CSAC design has been qualified:
 - Total Ionizing Dose and SEE to simulate Low Earth Orbit (LEO)
 - Shock and vibration
 - Steady state life
 - Thermal vacuum
- Radiation lot acceptance testing for commercial device susceptibility
- EAR-99 component (commercial – no restrictions)
- Initial units flying on NASA missions
- First customer contract received for government program
- “New Space” type of product that leverage commercial state of the Art technology for missions



Space CSAC Approach

Space CSAC – COTS+

- 20 krad radiation tolerant COTS
- Shorter mission duration (3–5 years)
- Lot control/rad testing
- Parts in stock
- Short lead times
- Lower cost/cutting edge technology
- Medium risk/redundancy may be required
- Optional Additional Screening: COTS++
 - Temperature cycling
 - Vibration
 - Burn in
 - Steady-state life test at elevated temperature

Traditional Space Oscillator

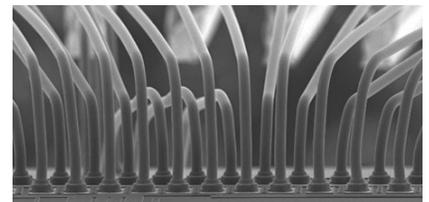
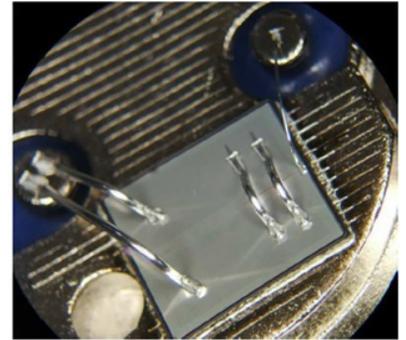
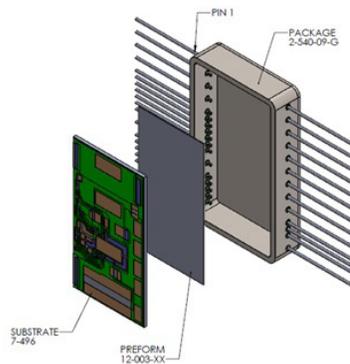
- 100 krad + radiation hardened
- Long mission duration (10+ years)
- Hermetic packaging
- Mature technology
- No supplier stock
- Long lead times
- High component cost
- Low risk

Space Oscillators and Atomic Clocks

- Eliminate the need for SCD Creation
- Use Microchip’s Hi-Rel Standard documentation for space applications

Microchip/MMT Hermetic Packaging Capability

- MMT Founded in 1989, a Microchip company in 2011
- 22,000 sq feet dedicated to hermetic assembly operations
- 8,500 sq. feet of Class 1K
- 14,000 sq. feet of test/scan space
- QML-Q and QML-V Certified
- MIL-PRF-38535, -38534, -19500
- DLA certified Reliability Lab to MIL-STD-883, MIL-STD -750 and QCI Group Test
- Turn-key capabilities including:
 - Back grinding, probe test
 - Die attach & wire bonding
 - Hermeticity testing
 - Thermal cycling
 - PIND
 - Burn-in
- Full hermetic product line including:
 - CDIP, CQFP, CERQUAD, Flip-chip BGA
 - TO-3, TO-5, TI-39 up to TO-258
 - Hybrid FlatPack
- Hi-Rel plastic
 - PDIP, SOIC, TSSOP, PLCC
 - MQFO, TQFP, SiP
 - SSOP, SOT23



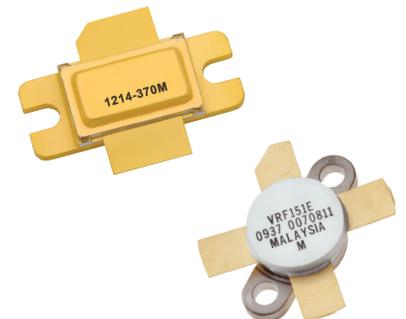
RF Integrated Solutions

Microchip has a long history of supplying custom RF and microwave diodes, transistors and control devices for domestic and international space applications. We offer dedicated service and provide the necessary performance, packaging and testing that is required for these demanding applications. Our components have been deployed in GPS, Galileo and TerraSAR satellites, performing a wide variety of clock, navigation, telemetry, power amplification and signal control functions.

Key Features Include

- Proven silicon and gallium arsenide diodes covering a broad frequency range (up to Ka band)
- Silicon bipolar junction transistors covering UHF, VHF, L-Band and S-Band frequency bands
- Product screening to JAN Class S requirements per MIL-PRF-19500, MIL-PRF-38534, ESA ESCC 5010
- Tailored screening flows to individual customer specifications are available

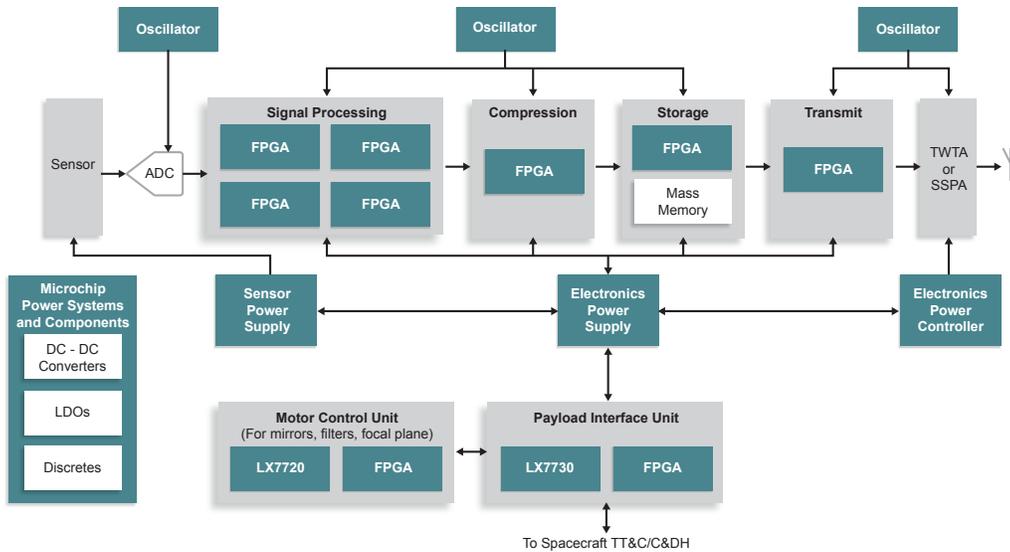
Our latest generation of RF microwave transistors is based on Gallium Nitride (GaN) wide band gap material. These innovative devices allow manufacturers to reduce component count and achieve smaller transmitter footprints with less weight and improved power density and efficiency. Microchip pulsed and CW GaN transistors are available in frequency bands between 50 MHz to X-band, making them ideal for satellite applications.



Remote Sensing Payload

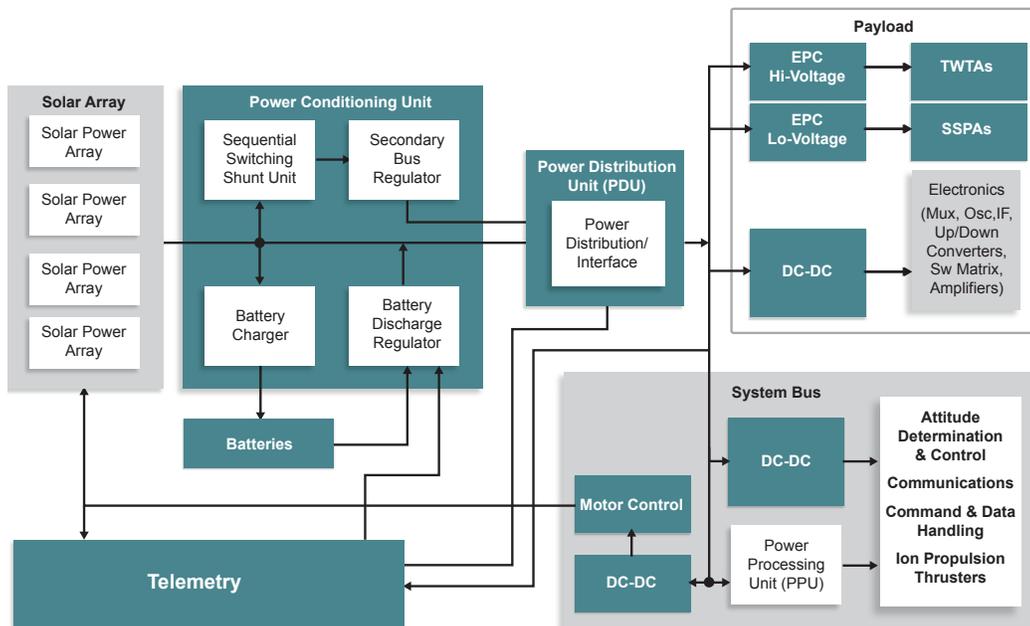
Microchip FPGAs have achieved flight heritage on many programs in command and control applications that require limited amounts of logic and modest performance levels. RTG4 has much greater logic density and much higher performance, which combined give a >10 times improvement in signal processing throughput. Now, you can use high-speed

data paths in space payloads RTG4 to take advantage of the flexibility and ease-of-use of programmable logic. This is particularly important for remote sensing payload instruments, which are required to perform rapidly increasing amounts of on-board processing, as sensor resolution is increasing faster than downlink bandwidth.



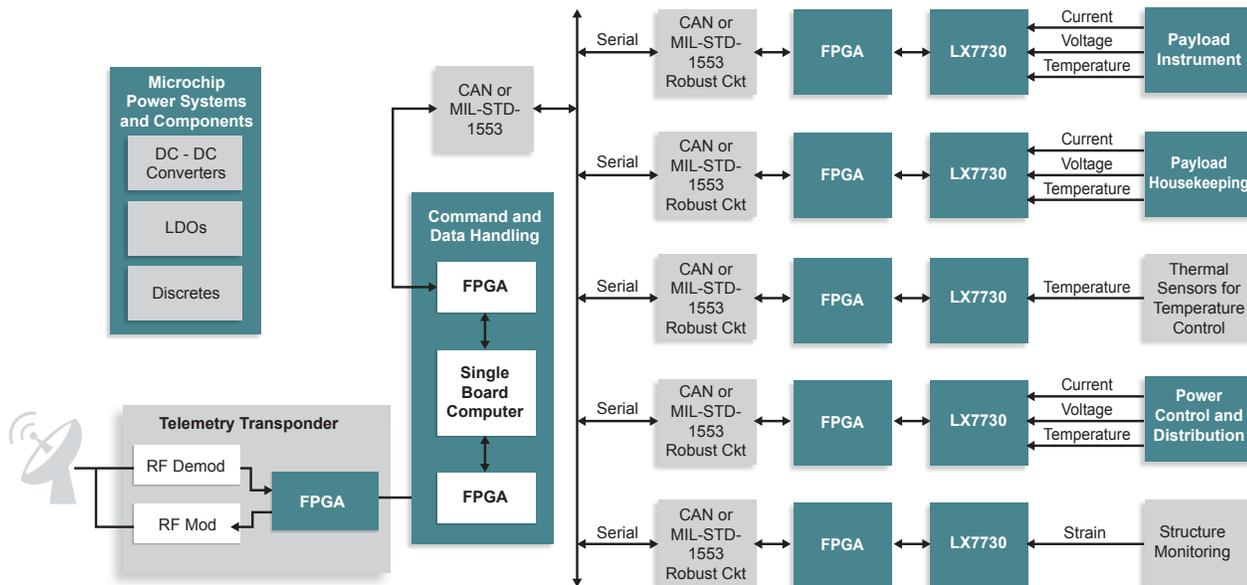
www.microsemi.com/applications/landers/instrument-payload

Electrical Power System



www.microsemi.com/applications/satellite-bus-platform/power-distribution-control

Telemetry Tracking and Control



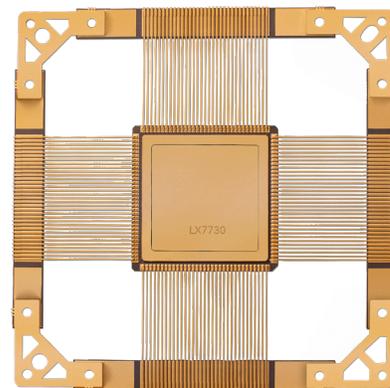
www.microsemi.com/applications/launchers/telemetry-tracking-control

Space System Manager Integrated Circuits

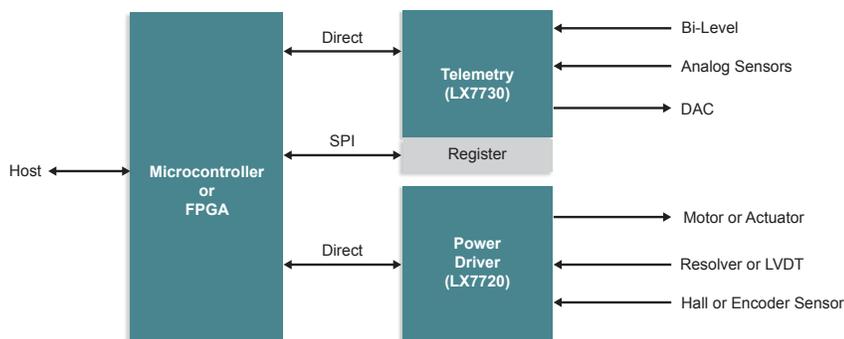
Microchip continues to build on its history with groundbreaking additions to our radiation-tolerant IC portfolio. Our new Space System Manager (SSM) family integrates commonly used mixed-signal satellite functions into a single space-saving IC. The SSM interfaces with a microcontroller or an FPGA to offer a complete application-specific solution that allows our customers to achieve aggressive weight and space requirements. Key features of the SSM family are:

- Radiation-tolerance: 100 krad TID, 50 krad ELDRS, SEU
- 132-pin, ceramic quad flat pack
- MIL-PRF-38535 Class V and Class Q processing
- LX7730: 64-channel telemetry controller
- LX7720: power driver/motor controller

<https://www.microsemi.com/product-directory/radiation-tolerant-devices/3574-space-system-managers>



LX7730 Radiation-Tolerant Telemetry Controller



Space System Manager Development Tools

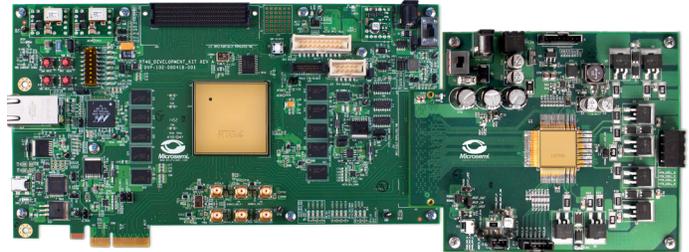
Various evaluation boards and daughterboards are available to support development using the space system manager products. Please refer to the product pages on our website for associated user guides and support material.

Space System Manager Daughterboards for use with RTG4 Development Kit

Allows you to connect the LX7720 or LX7730 to the RTG4 FPGA development kit and evaluate key functions.



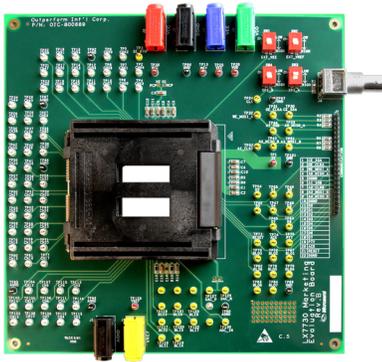
LX7730 Daughterboard With RTG4 Development Kit



LX7720 Daughterboard With RTG4 Development Kit

LX7730 Evaluation Board

Allows you to exercise LX7730 features when coupled with a USB-to-serial interface. Application software is provided and includes cable assembly.



RTG4 Development Kit

The RTG4 development kit features a RT4G150 Proto device which uses the same silicon as the flight-model FPGA. RT4G150 offers more than 150,000 logic elements in a Ceramic Ball Grid Array (CBGA) package with 1,657 pins.



<https://www.microsemi.com/product-directory/dev-kits-solutions/3865-rtg4-kits>

Software Environment

Atmel Studio is the Integrated Development Platform (IDP) for developing and debugging AVR and Arm processor-based MCU applications. It gives a seamless and easy-to-use environment to write, build and debug your applications written in C/C++ or assembly. It also connects to debuggers and development kits.

Software Framework are MCU software library providing over thousands of embedded software project examples for Flash-based MCUs, including AVR and Arm-based devices. The library contains basic C code examples for all Radiation-Tolerant MCUs peripherals.

Some operating system and other development environments are supported by third parties:



Starter Kits and Debugging Tools

To ease your design process and reduce time-to-market, Microchip offers a complete starter kit and development system for AVR and Arm microcontrollers. With its advanced features for prototyping and testing new designs, these kits give you a head start for developing code on AVR/Arm devices. For SAM3X8ERT, an evaluation kit is available through Arduino Due development board at: <https://store.arduino.cc/arduino-due>. Hardware development boards for AT697F are also available with debug capabilities.



*ATmegaS128 & ATmegaS64M1
Evaluation Board*



*ATATMEL-ICE
Programming & Debugging tool*



*SAMV71
Evaluation Board*

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If additional training interests you, Microchip offers several resources including in-depth technical training and reference material, self-paced tutorials and significant online resources.

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