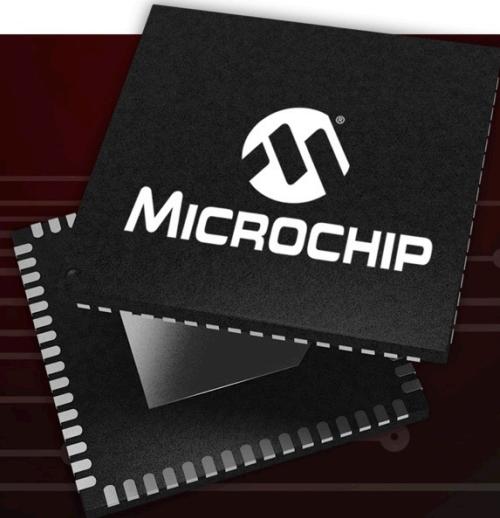




MICROCHIP



A Leading Provider of Microcontroller, Security,
Mixed-Signal, Analog & Flash-IP Solutions

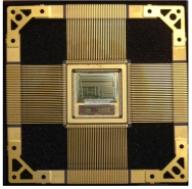


***Mixed Signal ICs for Space
Dorian L. Johnson
Space Forum 2019***



MICROCHIP

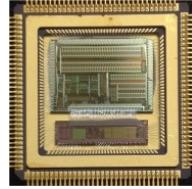
Mixed Signal Portfolio



New Standard Products

Roadmap Focus Space, Aviation, Defense

- Space
 - Telemetry System Manager
 - Motor Control System Manager
 - High-Side Driver
 - Diode Array
 - Programmable Current Limiting Power Driver
 - Radiation Tolerance TID, SEU, ELDRS, Neutron, Prompt Dose
 - QML Listed
- Actuation:
 - Data Acquisition System with Motor Control
 - Aviation, Defense, Robotics



Custom

20+ Years of ASIC Design Wide Range of Markets

- Broad voltage range supported
- Pure Analog Products and Mixed Signal: Drivers, Controllers, Amplifiers
- Serving various high reliability markets:
 - Space, Aviation, Defense, Industrial, Automotive, Commercial
- Expertise in custom development led the way to our standard product offering
- Long product life supported



MICROCHIP

Mixed Signal Products



- **Standard Products** - All Space products are Radiation-Hardened by Design

Market	Part Number	Description	Status
Production			
Space	AAHS298B	RHBD 8-channel high side driver	QML certified Q and V
Space	LX7710	RHBD 8-pair diode array	QML certified Q and V
Space	LX7720	RHBD Motor controller w position sensing SSM	Q in production / V coming soon
Space	LX7730	RHBD Telemetry controller SSM	QML certified Q and V
Pre-Production			
Space	LX7712	RHBD Programmable Current Limiting Power Driver	Sampling Now
In Design			
Space	LX7714	RHBD Quad resettable e-Fuse	Sampling soon
Actuation	LX4580	24-ch acquisition with synchronized motor control	Sampling soon

- **Custom Products** - 31 active production parts: 12 Space, 9 Aviation, 5 Defense, 5 Industrial



MICROCHIP

Mixed Signal in Spacecraft

MICROCHIP
SPACE FORUM

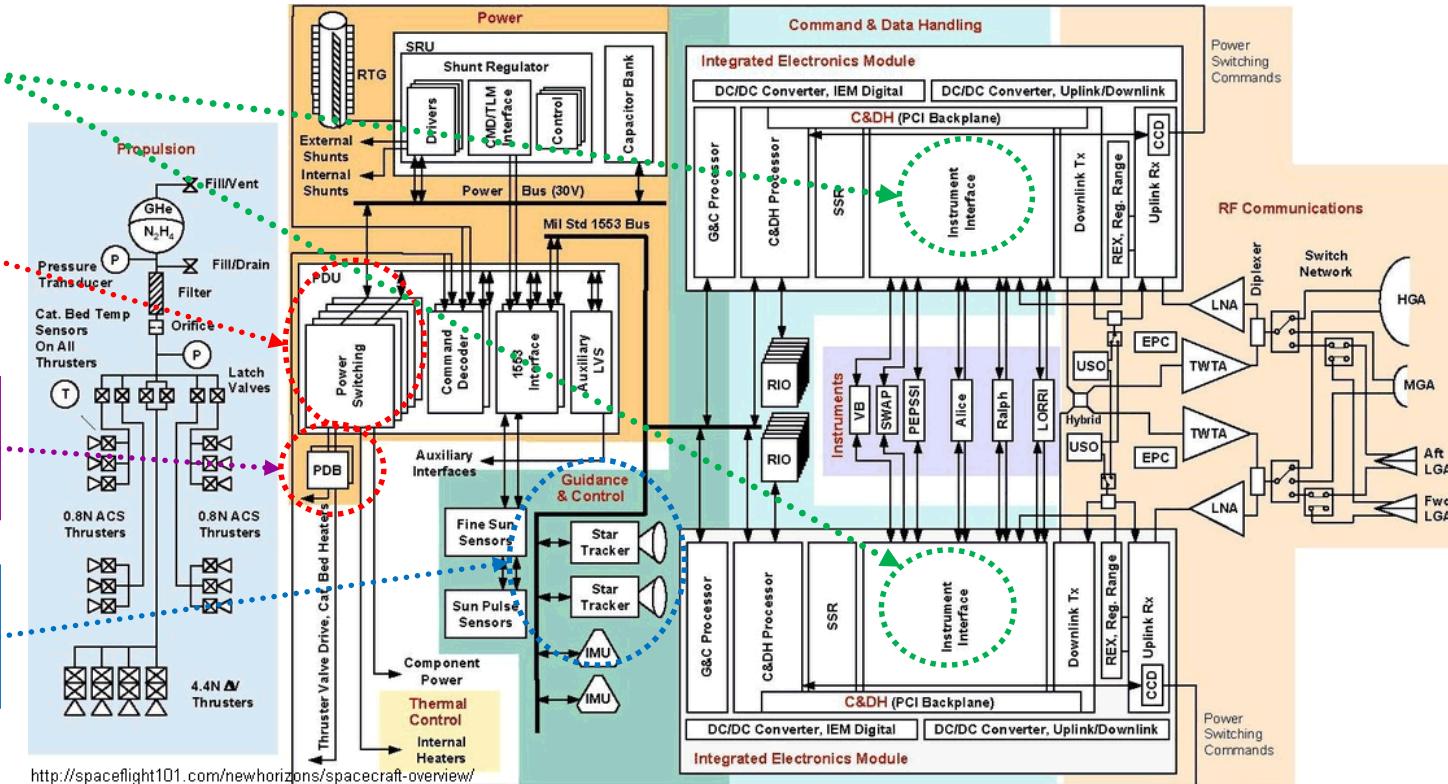


Telemetry (Data Acquisition)
LX7730

Power Protection
LX7712
LX7714

Protected Load Switching
LX7710
AAHS298B

Servo Systems/
Motor Drives
LX7720





Space System Managers

MICROCHIP

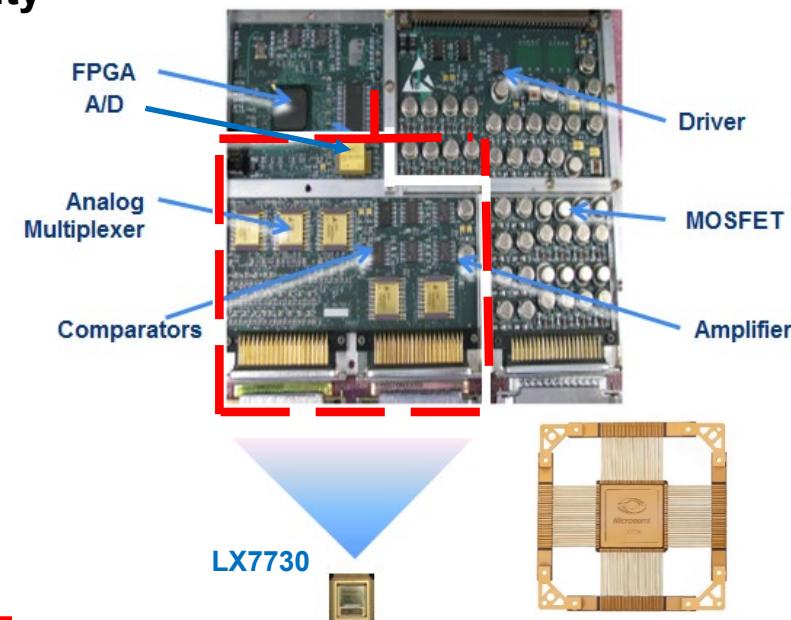
LX7730 and LX7720



- The Space System Manager (SSM) is a special purpose analog mixed signal IC that can be used with a microcontroller or an FPGA
- The SSM ICs add power and mixed signal capability to supplement the digital functionality and flexibility of the uC/FPGA

- We have two products:

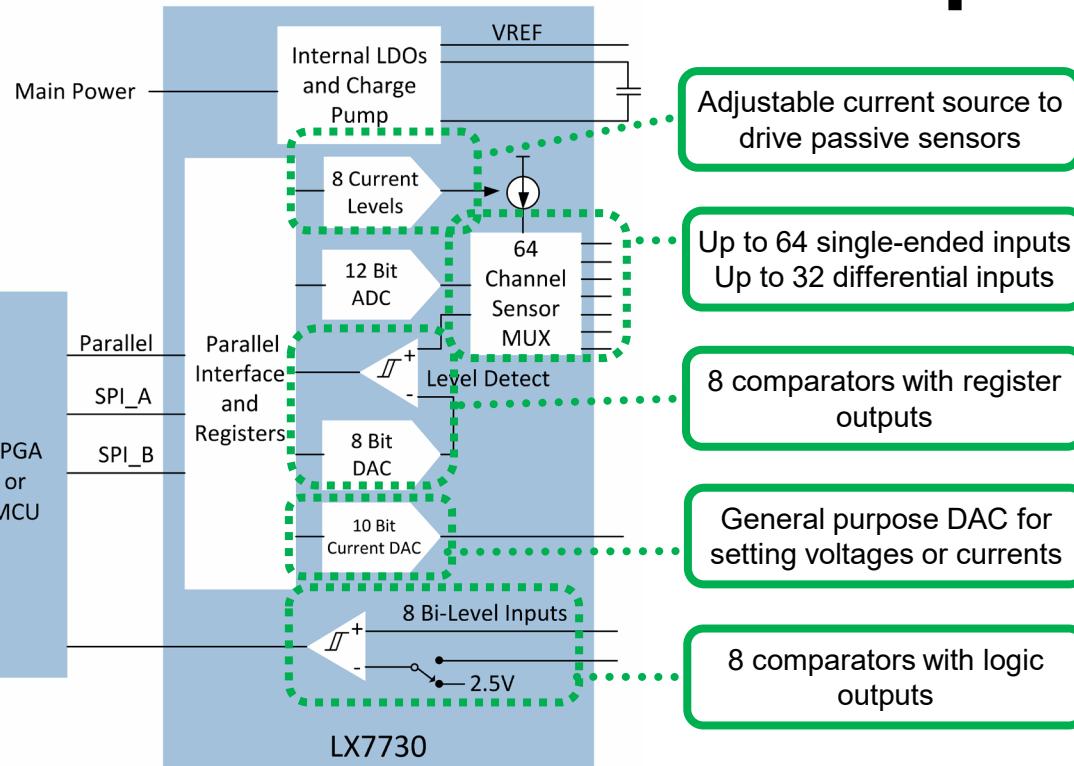
- LX7730 Telemetry controller
- LX7720 Motor controller with position sensing





MICROCHIP

LX7730 Telemetry & Data Acquisition



- QML SMD 5962-1721901 Q & V
- 132-pin CQFP, 24 mm x 24 mm
- 208 plastic QFP in sub-QML screening sampling this quarter
- Daughter board available to interface with RTG4 dev board





MICROCHIP

LX7730 Replacement BOM



LX7730 - 64 ch

LX7731 - 32 ch

QTY	QTY	Vendor	Description
4	2	Comp A	16 to 1 analog MUX
1	1	Comp B	12 bit ADC
3	3	Comp A	12 bit DAC
6	4	Comp A	Quad op amp
2	2	Comp A	Hex buffer
2	1	Comp A	Quad comparator
1	1	Comp A	Quad differential line receiver
1	1	Comp A	Quad differential line driver
3	3	Microchip	Linear voltage regulator
1	1	Comp A	Voltage reference (2.5V)
24	19	Parts	



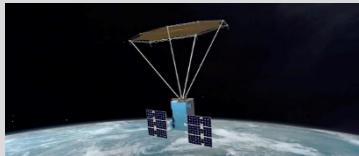
MICROCHIP

LX7730 Flight Heritage



Flight heritage

R3D2



Planned flight heritage

SARE



Orion
(NASA)



JUICE
(ESA)



Yenisey



Similar custom telemetry flight heritage

DirectTV



Eutelsat
ES'hail



JCSAT-16



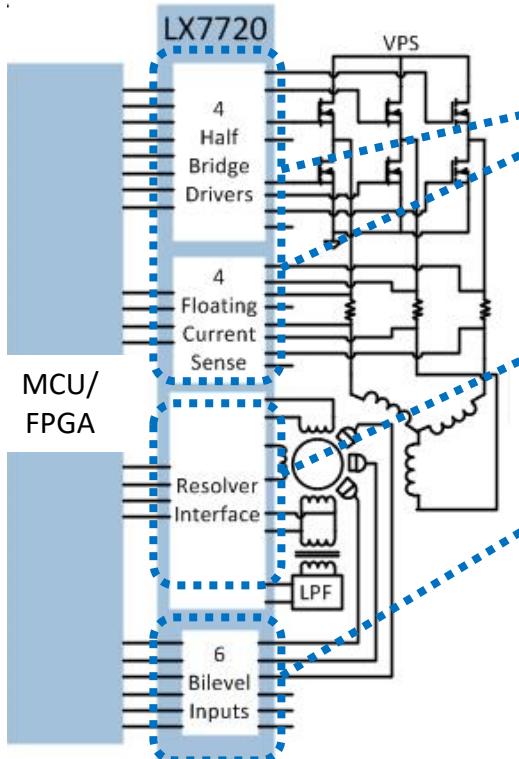
Azerbaijan





MICROCHIP

LX7720 Motor Control and Position Sensing



4 Half-bridge drivers with floating current sense for motor coil driving

Resolver to digital or LVDT interface with primary coil driver

6 bi-level inputs for sensing Hall effect sensors or rotary encoders



- Q flow production now
- Seeking QML SMD Q & V
- 132-pin CQFP, 24 mm x 24 mm
- Radiation tolerant:
 - 100 krad TID
 - 50 krad ELDRS
 - SEL free – 87 Mev-cm²/mg
- 208 plastic QFP in sub-QML
- Daughter board available to interface with SAMRH71 microcontroller or RTG4 dev board



MICROCHIP

AAHS298B 8-Channel Source Driver

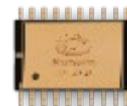


Features

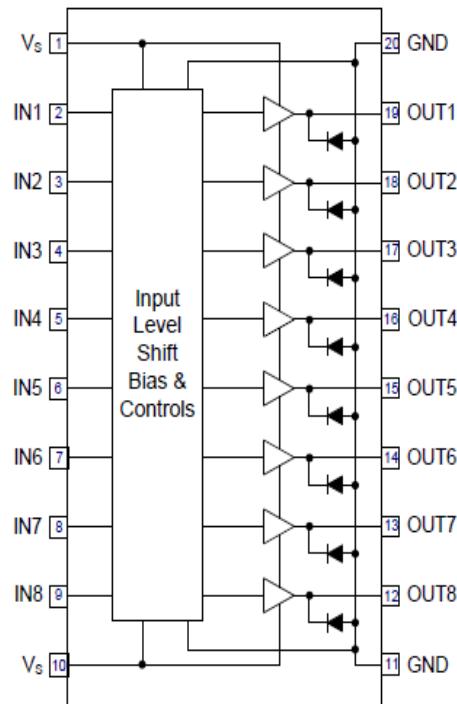
- 700 mA per output source current
- Fully isolated channels with DI process
- 80 V minimum output breakdown
- Low quiescent current consumption
- Internal ground clamp diodes
- Internal thermal shutdown
- TTL, 5V, and 12V logic compatible
- QML certified with 4 SMDs
 - SMD 5962-1523101VXC, SMD 5962-1523101VYC(V)
 - SMD 5962-1523101QXC, SMD 5962-1523101QYC(Q)
- Radiation tolerant: 100 krad TID, 50 krad ELDRS, SEL free—87 Mev-cm²/mg
- Two package options: 20-lead ceramic SOIC with formed or flat leads

Applications

- Relay/solenoid drivers
- Lamp/LED drivers
- Stepper and/or servo motor drivers



20-lead ceramic SOIC package: 13 mm x 7.5 mm





MICROCHIP

LX7710 8-Pair Diode Array

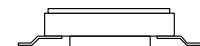
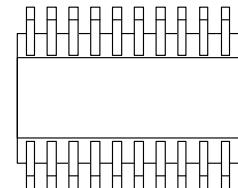
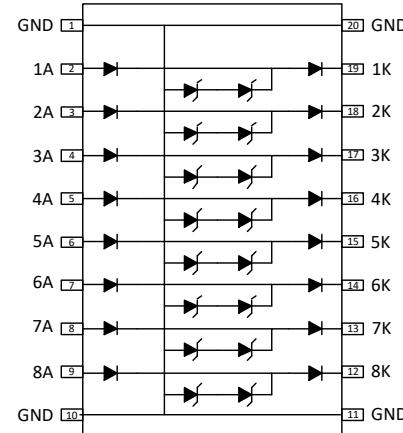


Features

- 125 V min breakdown voltage
- 1 A current rating/diode
- 2800 mA combined rating
- Redundancy if one diode fails
- Discharge path for inductive kick-back
- -55°C to 125°C ambient
- 20-lead ceramic SOIC. QML certified
 - 5962-1621001QXC
 - 5962-1621001VXC
- Radiation tolerant: 100 krad TID, 50 krad ELDRS, SEL free—87 Mev-cm²/mg
- Applications
 - Relay driver, uninterruptable power
 - Redundant power sourcing
 - Prevents channel backflow



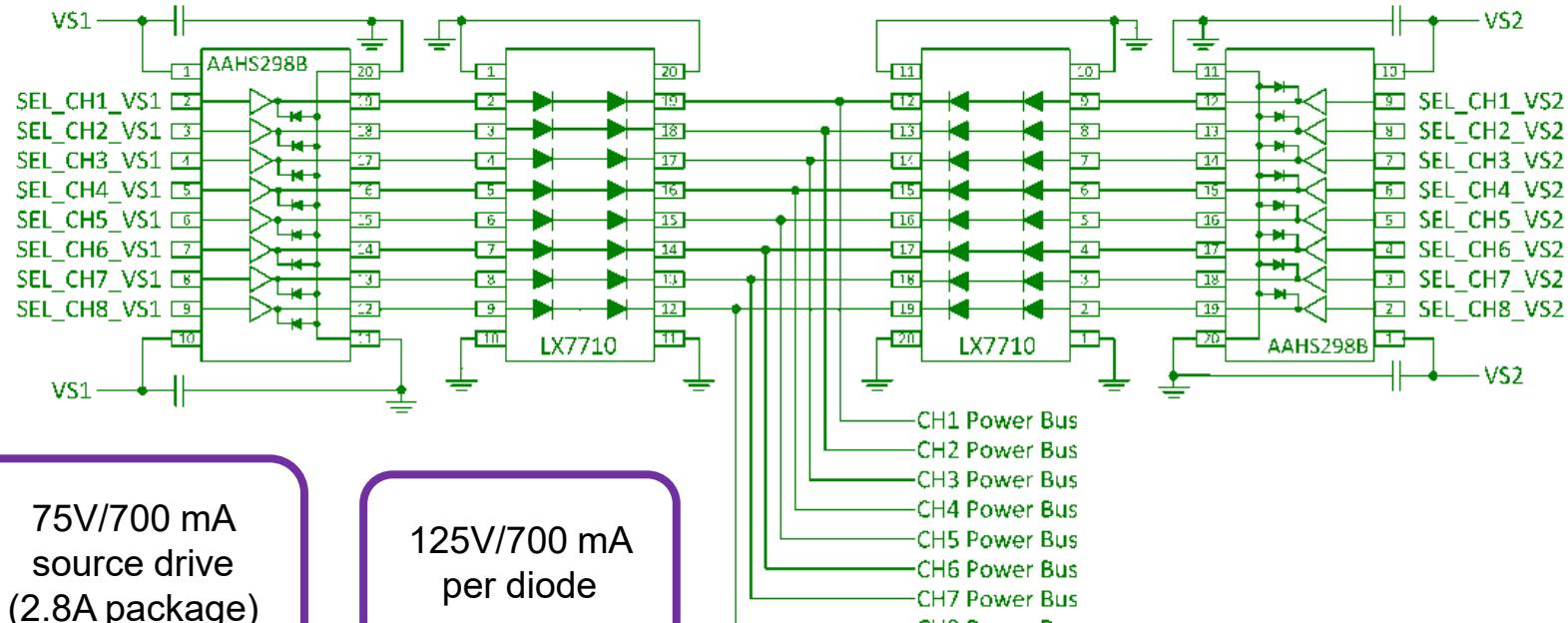
20-lead ceramic SOIC package:
13 mm x 7.5 mm





MICROCHIP

Protected Load Switching AAHS298B & LX7710





MICROCHIP

MSA Space Products Flight Heritage



LX7720 planned flight heritage



AAHS298B flight heritage





MICROCHIP

LX7712 Overview



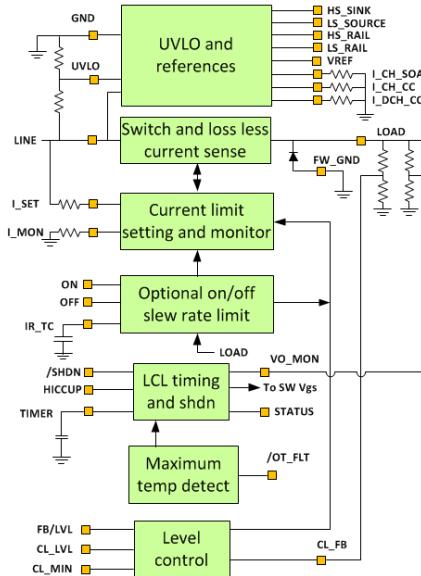
Programmable Current Limiting Power Switch

Features

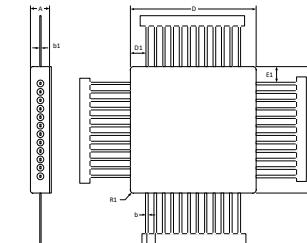
- Internal 5A PMOS switch and diode
- 120V rated
- LCL or FCL configurable
- ON, OFF, and STATUS pins
- Programmable UVLO and STATUS
- Parallel-able for higher currents
- Current limit and monitor
- Current slew rate limit
- Chip temp monitor
- 48-lead hermetic HTF flatpack package – 19 mm x19 mm
- Radiation tolerant: 100krad TID, 50 krad ELDRS, SEL free–87Mev-cm²/mg
- ESA Standards
 - ECSS-E-HB-20-20A
 - ECSS-E-ST-20-20C

Sampling Now:

Check with Sales for production availability



Single 120V, 5A, 40W switch with flexible LCL, FCL, RLCL limiting and retry features



Applications

- Power control and distribution
- Latch-able current limiter to 5A
- Fold back current limiter to 5A
- Can be paralleled for higher load currents

Product Webpage

<https://www.microsemi.com/existing-parts/part/150818>

Documentation Available

- [LX7712 Datasheet](#)
- AMICSA 2018 – A Fault Tolerant PMAD System using Radiation Hardened Highly Integrated AFE Circuits
- RADECS 2019 LX7712 Total Ionizing Dose Characterization

LX7714 Overview



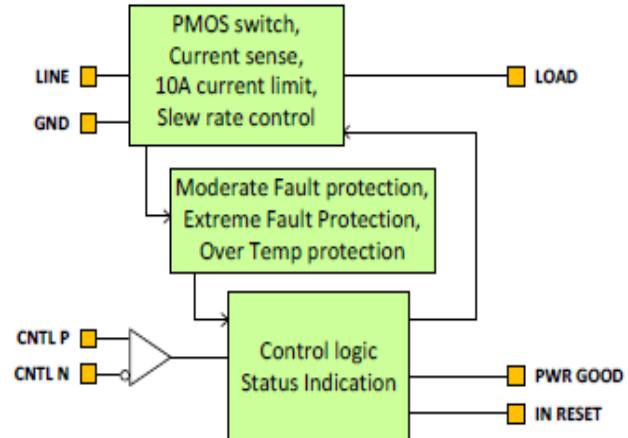
Quad Resettable e-Fuse

Features

- Internal 2.5A or 1.2A maximum rated power switch
- Switches voltage up to 45 VDC
- Low switch voltage drop
- Self-resettable for protection from faults
- Hiccup mode to enable healing from shorts
- Efficient current sharing when paralleled
- Internal output voltage rise time control
- Differential TTL input On/Off control
- Power On, Off, and Hiccup Mode status
- Thermal shutdown for secondary protection
- Low resistance DIP power package
- Single event immunity
- Radiation Tolerant: 100 krad TID, ELDRS tested up to 50 krads

Applications

- Fault tolerant power bus control and distribution
- Centralized, distributed, and redundant topologies
- Configuration control
- Heaters power control switch
- Motor power drive control switch
- Valve coil driver
- Pyro Power Switch



Quad 45V, 2.5A or 1.2A switch with LCL or RLCL limiting and retry features

Sampling Soon:
Check with Sales for availability



MICROCHIP

Reduced Screening Sub-QML



Addresses new reduced screening flows desired for New Space / LEO Constellation programs

Flow	Purpose	Package	Burn-In	Temp	Qual	Life Test	DPA
V/EV	NSS, NASA Class 1	Hermetic Ceramic	Static Dynamic	-55 °C to 125 °C	QML-V	Wafer-Lot	Assy Lot
Q/EQ	Entry Level Trad.	Hermetic Ceramic	Dynamic	-55 °C to 125 °C	QML-Q	Generic Group C	None
ES	Engineering Samples	Ceramic (non-Hermetic)	None	Room temp only	None	None	None
Sub QML Flows*							
R	New Space	Hermetic Ceramic	Dynamic	-55 °C to 125 °C	MIL-STD-883/ B	None	None
M ceramic	New Space	Hermetic Ceramic	None	-55 °C to 125 °C	MIL-STD-883 /B	None	None
M plastic	New Space	Plastic Non-Hermetic	None	-55 °C to 125 °C	JEDEC	None	None
I	New Space	Plastic Non-Hermetic	None	-40 °C to 100 °C	JEDEC	None	None

Screening (Example SSMs)	Package	Part Numbers	Price
1. QML-V	132 CQFP	LX77x0MFQ-V	Volume dependent
2. QML-Q	132 CQFP	LX77x0MFQ-Q	
4. R-Flow	132 CQFP	LX77x0MFQ-R	
5. Mil Temp Ceramic	132 CQFP	LX77x0MFQ-M	
7. Mil Temp Plastic	208 MQFP	LX77x0xxx-M	
8. Ind Temp Plastic	208 MQFP	LX77x0xxx-I	< 1/20 V flow



MICROCHIP

LX4580 Overview



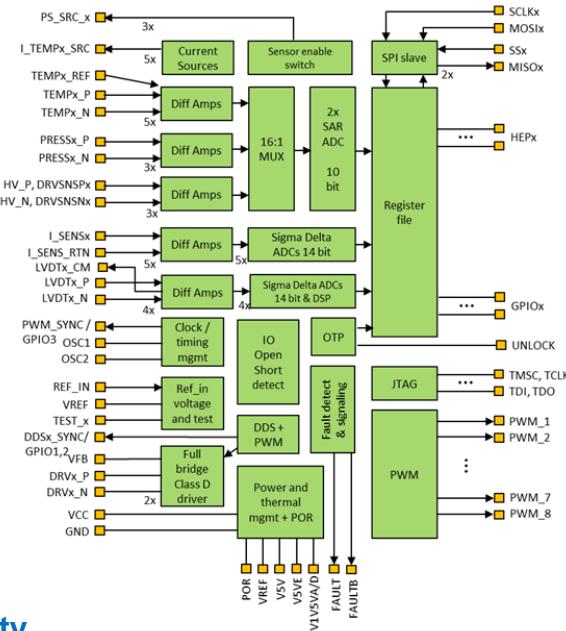
24-channel acquisition system with synchronized motor control

LX4580

Features

- Redundant SPI or UART interface to external processing
- 5 Temperature sensor interfaces
- 3 Pressure sensor interfaces
- 2 LVDT drivers and driver monitors
- 4 LVDT monitor differential pairs with instantaneous and RMS outputs
- 5 current sense interfaces
- 1 differential voltage measurement interface
- 3 Hall effect proximity sensor inputs
- 8 PWM outputs
- On chip power regulators
- Register programmable GPIOs
- Advanced fault detection and signaling
- JTAG scan and test IF
- Small 144 pin LQFP pin package

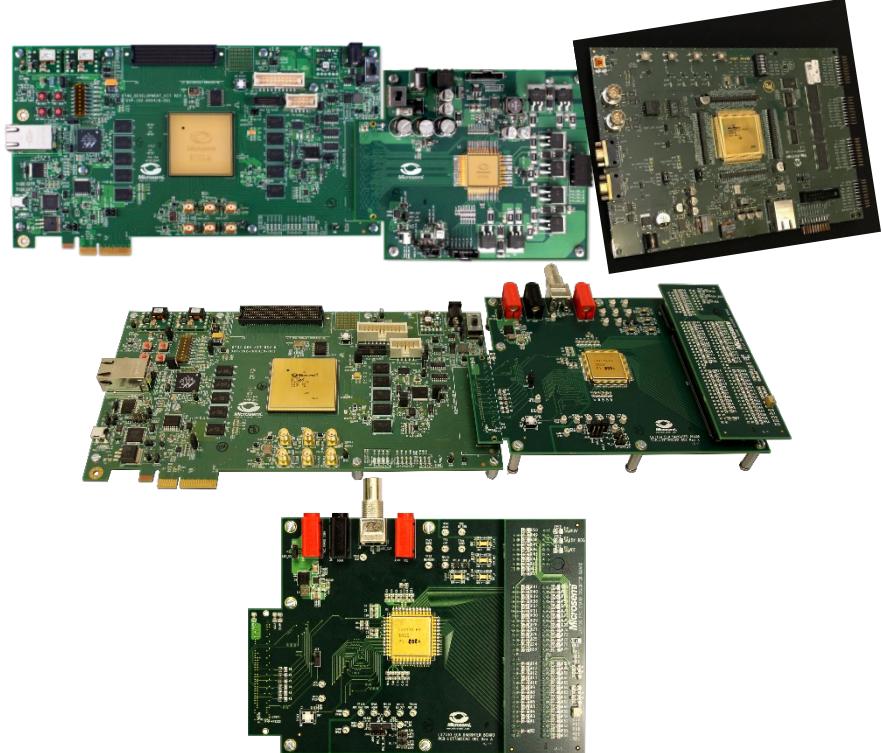
Sampling Soon
Check with Sales on availability



Development Tools



- LX7720-DB daughter board that can be connected to the RTG4 dev kit or the SAMRH71 dev board
- LX7730-DB daughter board that can be connected to the RTG4 dev kit
- LX7730-EVB evaluation board that runs basic functions via user's computer and provided GUI





MICROCHIP

Mixed Signal Custom



Space

- High-Side Driver
- High-Side Driver with Current Fold Back
- System Serial Interface ASIC
- Digital Interface ASIC
- I/O Bus Interface Chip
- Semi-Custom
- Generic Arrays
- Motor Control with Switches
- Single Chip Servo



Aviation

- AC and DC Circuit Breakers
- AC Dimmer
- Universal Lamp Driver
- Squibb Driver
- Wheel Speed XDCR
- Valve Driver Interface
- ARINC Protocol
- LVDT Excitation and Modulation
- RF Processor
- Switch Driver



Defense

- ARINC Receiver
- Low-Voltage Log/Linear Amplifier
- 8-Ch Input Discrete
- Dual Channel ARINC Transmitter
- CRT Corrector
- Inverter Control for RF Attenuator Coupler
- Constant Current/Solid-State Relay
- High Current Switch Driver



Hi-Temp / Industrial

- Hi-Temp Buffer Amplifier
- Hi-Temp Pressure Sensor
- Photoelectric ASIC
- Proximity Detect ASIC



MICROCHIP

Mixed Signal Custom Development



Reliable and proven ASIC development

- 20+ years of custom development
- 31 active parts in production
- Low volume products: Aerospace, Defense
- High volume products: Commercial, Automotive

Capabilities targeting differentiated markets

- Wide range of on-chip voltages: Up to 600V
- Radiation tolerance: TID, SEU, ELDRS, Neutron, Prompt-Dose
- Stringent temperature environment: -55 °C to 225 °C
- Safety critical applications: ISO26262, DO-254

Broad foundry technology expertise

- Extensive experience with analog mixed-signal and high-voltage on CMOS, Bi-CMOS, SOI, DI

- **Customer funds NRE – typically \$500k to \$1.5M**
- **Development + Production contract (3-year min)**
- **Shipment of \$3-5M over first 3 years of production**

Mixed-Signal ASICs

Leading-Edge Analog Mixed-Signal ASICs

ASIC Solutions

Summary

Microchip offers custom integrated circuit designs of analog mixed-signal solutions for leading aerospace, avionics, defense, industrial and automotive companies, and is a leading Application-Specific Integrated Circuit (ASIC) manufacturer of analog embedded systems. Our custom solutions include IC chips requiring high voltages, radiation tolerance, a focus on safety standards and tolerance to harsh environments. Our fabless model ensures maximum flexibility in process selections, allowing for optimized designs and cost-effective solutions. Our experienced teams are dedicated to your success by working in collaboration with you throughout all stages of design and production.



Reliable, Proven Application-Specific Integrated Circuit Development and Manufacturing

- Full custom ASIC design flow
- Full supply services, from specification to production
- Custom Specific Standard Product (CSSP)
- System integration and packaging optimization

Benefits to Customers

- IP investment protection
- Board space optimization
- Power optimization
- Overall application cost reduction
- Reliability improvement
- Obsolescence management
- Product differentiation from standard products

Experienced Team

- System architects
- Analog, digital, firmware, layout, packaging, test and product engineers
- Program managers

Safety, Quality and Reliability

- Safety-critical applications: Automotive ISO 26262, Avionics DO-254
- Radiation tolerance: TID, SEL, SEU, ELDRS, prompt dose, neutron
- High-reliability, stringent temperature: -55°C to 225°C
- Standards/certifications/classification: AS9100, ISO 9001, MIL-PRF-38558, CML-V, QML-Q, ITAR, EAR

Packaging Solutions

- Flip chip multi-layer stack up
- Bump die and WLCSP
- Plastic encapsulated
- Multi Chip Module (MCM)
- Hermetic high reliability

www.microchip.com

MICROCHIP



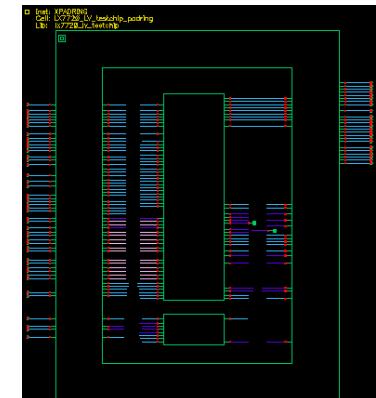
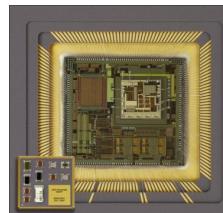
MICROCHIP

Mixed Signal Custom Development



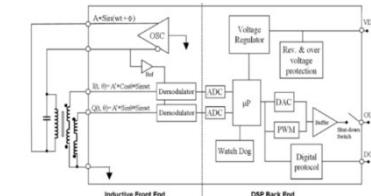
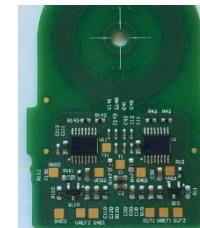
Reliable and proven ASIC development

- Mixed-signal solutions integrating complex analog functions, digital up to 2M gates
- Precision analog blocks including AFEs, analog filter, D/A, SAR and sigma-delta A/D, linear and switching regulators, references
- Integration of SRAM, ROM, NVM , FLASH, EEPROM
- OTP for IC programming or post-packaging customer programming
- Embedded firmware



Test Development Capabilities

- DFT and fault coverage analysis
- Low and high-volume product testing: aerospace, military, commercial, automotive
- 3 temp testing: -55°C to 125°C for hi-rel products
- Low- and high-voltage capabilities up to 600V, high-power
- Testers: Credence ASL-1000, Credence D10, Eagle ETS88





MICROCHIP

Mixed Signal Process Technologies



Process	1µm DI CMOS 0.6µm BiCMOS Rad-Tolerant	0.35µm HVCMOS AECQ-100 Grade 0	180nm BCD Lite, HV AECQ-100 Grade 0	150nm SOI Rad-Hard	130nm BCD AECQ-100 Grade 0	65/55nm BCD Lite
Max Voltage	200V	45V	40V	45V	85V	12V
Temperature	-55°C – 125°C	-40°C – 175°C	-40°C – 175°C	-55°C – 125°C	-40°C – 150°C	-40°C – 125°C
Gate count	2.5k gates/mm ²	28k gates/mm ²	125k gates/mm ²	150k gates/mm ²	220k gates/mm ²	1M gates/mm ²
Metal layers	3	4	6	6	8	TBD
Mem type	ROM, RAM, DPRAM, OTP	ROM, RAM, DPRAM, OTP, EEPROM	ROM, RAM, DPRAM, OTP, NVRAM	ROM, RAM, DPRAM, OTP various IPs other than memory	ROM, RAM, SRAM OTP, MTP, FLASH	ROM, RAM, SRAM OTP, FLASH



MICROCHIP

Mixed Signal IP Portfolio



Signal Conditioning & Converters

- ▶ PGA, AFE sensors
- ▶ Demodulators, peak detectors
- ▶ ADCs SAR, sigma-delta
- ▶ HV analog muxes
- ▶ Analog filters

Interfaces / Protection

- ▶ SPI, I2C, JTAG, SENT, PWM, PSI5
- ▶ ESD protection cells up to 4kV
- ▶ Reverse battery protections

Power Management

- ▶ Switching regulators
- ▶ Linear regulators
- ▶ E-fuse protection devices
- ▶ Charge pumps
- ▶ Thermal protection

Digital Integration and Signal Processing

- ▶ Digital filters
- ▶ Compiled memories RAM, SRAM, ROM
- ▶ NVM, EEPROM, OTP, FLASH
- ▶ Processor – 32-bit RISC and peripherals
- ▶ DSP function

Drivers & Actuation

- ▶ High-voltage drivers
- ▶ Line protectors and current limiters
- ▶ Motor drivers and pre-drivers

Clock Management

- ▶ RC, VCO oscillators
- ▶ PLLs
- ▶ LC tank exciter
- ▶ Sleep-mode timer

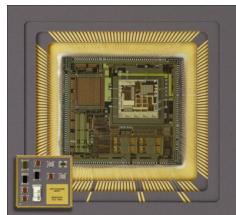


MICROCHIP

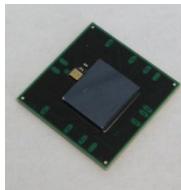
Packaging

MICROCHIP

SPACE FORUM



Hermetic High Reliability



Multi Chip Module (MCM)



Multi-die on substrate

Plastic Encapsulated

Die in Waffle Pack



MICROCHIP



Thank You!