TI Components for Space, Avionics and Defense

TEXAS INSTRUMENTS

Introduction

The following guide outlines TI's latest components for space, avionics and defense, along with a high-level overview of TI's commitment to this segment.

TI's Broad COTS Portfolio

For more than 80 years, customers have counted on the industry's broadest portfolio of analog and embedded processing products to address challenging or extreme environments. TI's commercial off-the-shelf (COTS) components offer various benefits, including: extended industrial temperature performance, pin-to-pin compatibility among several product families and lower BOM costs for those applications that require it. With a vast selection of data converters, power components, digital signal processors, logic, op amps, memory, clocking and interface offerings, TI aims to be a one-stop shop for space, avionics and defense customers.

Look for **COTS** under a featured device to find the commercial-off-the-shelf solution for your application.

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Accelerating today's mission-critical designs, preparing for tomorrow's.

TI Enhanced Products (EP)
Ruggedized Plastic Devices

Enhanced Products

TI's Enhanced Products (EP) portfolio consists of more than 750 commercial off-the-shelf (COTS) products that span the board to create your solution for harsh environment applications. These products offer variety and design flexibility while still meeting avionic, defense and industrial standards for operating in environments where high quality and long service life are a requirement. Designers for any rugged operating environments and long service life application fields can benefit from this extensive portfolio. In addition, though these are products designed for harsh environments, more than 90% are EAR99 and can be sold with no restrictions anywhere in the world.

Key Benefits

- Extended temperature performance (typically -55°C to +125°C or customer specified)
- No pure tin used in device
- Au bond wire used exclusively
- Long product life cycles
- Fabrication, Assembly, Test, and Material Set controlled baseline
- DLA Vendor Items Drawings (VID or V62) part numbers eliminate need for source-controlled drawings
- Extended 180-day product change notification (PCN)
- Extended 250-hour HAST testing
- Product traceability through reliability reports

Enhanced Products (EP) Minimum Qualification Requirements

Description	Condition	Sample Size	Test Method
Electromigration	Maximum Recommended Operating Conditions	N/A	Per TI Design Rules
Wire Bond Life	Maximum Recommended Operating Conditions	N/A	Per TI Design Rules
Electrical Characterization	TI Data Sheet	50 units/lot	N/A
Electrostatic Discharge Sensitivity	HBM MM	3 units/voltage	EIA/JESD22-A114 EIA/JESD22-A115
Latch-up	Per Technology	5/0 units/lot	EIA/JESD78
Physical Dimensions	TI Data Sheet	5/0	EIA/JESD22- B100
Thermal Impedance	Theta-JA on board	Per Pin-Package	EIA/JESD51
Bias Life Test	125°C / 1000 hours or equivalent	116/0	JESD22-A108*
Biased Humidity	85°C / 85% / 1000 hours or	77/0	JESD22-A101*
HAST	130°C / 85% / 96 hours		JESD22-A110
Autoclave	121 °C @ 2 atmospheres absolute for 96 hours	77/0	JESD22-A102*
Temperature Cycle	-65 °C to +150 °C non-biased for 1,000 cycles	77/0	JESD22-A104*
Solder Heat	260 °C for 10 seconds	22/0	JESD22-B106
Resistance to Solvents	Ink symbol only	12/0	JESD22-B107
Solderability	Condition A (steam age for 8 hours)	22/0	ANSI/J-STD-002-92
Flammability	Method A / Method B	5/0	UL-1964
Bond Strength	—	76/0 wires	ASTM F-459
Die Shear	—	5/0	TM 2019
High Temp Storage	150 °C / 1,000 hours	45/0	JESD22-A103-A*
Moisture Sensitivity	Surface Mount Only	12/0	J-STD-020-A*

Precondition performed

Look for **Enhanced Product** under a featured device to find the ruggedized plastic for your application

Look for **QMLQ** rated products under a featured device to find the ceramic solution for your application

EP Versus Upscreening

TI's EP portfolio offers an alternative to third party upscreening for designers who need higher reliability components. *TI's EP line eliminates the following issues with upscreening:*

- Yield loss and damage caused by electrical overstress and handling
- Mechanical damage, which causes moisture issues
- Burn-in, which can cause lead finish degradation
- Lack of support by IC manufacturers
- Few upscreening test facilities have the ability to test complex parts
- No access to TI's wafer processing history by third parties

Qualification

- Qualification data reviewed and audited for accuracy and compliance
- Reliability and electromigration monitoring performed at maximum recommended operating conditions in the targeted package
- Certified test programs and test hardware
- Electrical characterization performed across specified temperature range
- Package performance confirmed over extended temperatures (some mold compounds are not suitable for extended temperatures)
- Qualification and reliability reports

Click on image to see the guide.

For a complete list of TI enhanced products, see **www.ti.com/ep**

Space Products
## Components for Extreme Environments

TI Space Products

Texas Instruments offers the largest selection of leading edge radiation hardened and assured products for space flight. With a proven legacy of 45+ years in the space market supporting countless space programs both domestically and internationally, TI is a trusted partner. We focus on radiation assurance and best in class SWaP (Size, Weight, and Power) to enable leading edge designs. The breath of TI's space portfolio provides a full signal chain solution. The portfolio includes the smallest rad hard point-of-load power solutions, fastest discrete SerDes, and some of the world's highest performance data converters.

TI's Space products include MIL-PRF-38535 QML Class V and Radiation Hardness Assured (RHA) 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 at **www.ti.com/radiation**.

TI Space Products Portfolio

TI offers radiation-tolerant, hermetically packaged components highlighted in each of the red blocks below.
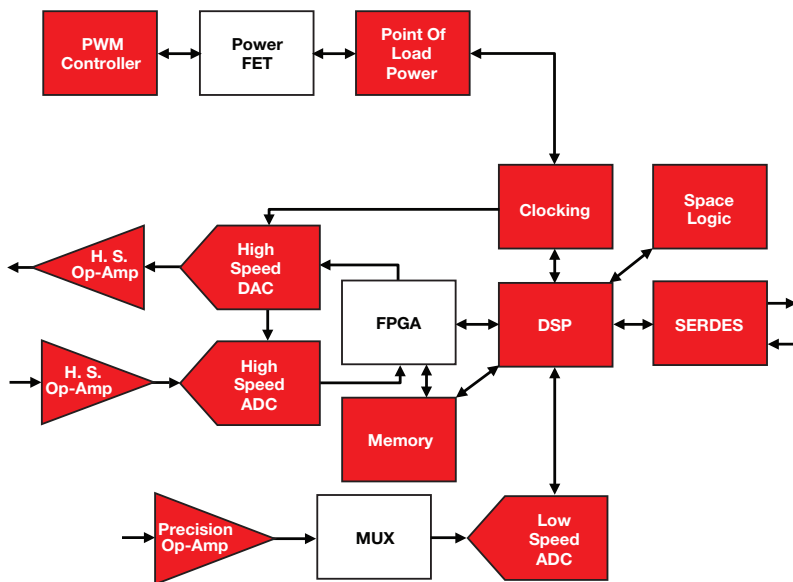
TI offers various educational resources to provide an understanding of the development process of our space products at the new **Space and High Reliability Learning Center**

- **Radiation Hardness Assurance (RHA) Process for TI Space Products**
- **Total Ionizing Dose Effects on MOSFETs**

> Look for **QMLV** under a featured device to find the solution for your application.

Satellite Applications

- Satellite Bus/Platform
- General Payload
- Communications Payload
- Imaging Payload
- Data Processing and Storage (Solid State Recorder)
- Telemetry Sensors
- Inertial Navigation (IMU/INS)
- Manned Vehicles
- Launch Vehicles
- Power Generation and Distribution
- Health Monitoring

This product brief is only a subset of the devices we offer.

For a complete list of TI space products, see **www.ti.com/space**.
For a printable list of space products, visit **www.ti.com/spaceparts**

Click on image to see the guide.

High-Speed Signal Chain
High-Speed Analog-to-Digital Converters (ADCs)

TI is the industry's leading innovator in gigasample per second (GSPS) ADCs, providing the highest performance to meet your toughest requirements. TI brings RF sampling with high sample rates, wide bandwidth, high dynamic range and integrated digital down-converters to defense and aerospace applications. By leading the charge in to the JESD204B interface standard and providing education material around RF sampling architectures, TI provides the necessary reference designs and training seminars to reduce the board size of the latest radars, electronic signal intelligence, software defined radios, and electronic warfare designs.

High Speed ADC

Part Number	Description	Rating	Resolution (Bits)	Sample Rate (max) (SPS)	# Input Channels	SNR (dB)	SFDR (dB)	Power Consumption (Typ) (mW)	Interface	Analog Input BW (MHz)
ADC12D1620QML-SP	12-Bit, Single or Dual, 3200/1600/800 MSPS RF Sampling ADC	QMLV	12	3200	2	58.5	70.3	3880	Parallel LVDS, Serial SPI Interface	2800
ADC12J2700	12-Bit, 2.7-GSPS, RF Sampling ADC	COTS	12	2700	1	55	71	1800	JESD204B	3300
ADC12J4000	12-Bit, 4.0-GSPS, RF Sampling ADC	COTS	12	4000	1	55	71	2000	JESD204B	3300
ADC16DX370	Dual-Channel, 16-Bit, 370-MSPS ADC	COTS	16	370	2	69.8	85	1607	JESD204B	800
ADC32RF45	Dual-Channel, 12-bit 3 GSPS or 14-bit 2.46 GSPS RF-sampling ADC	COTS	14	3000	2	62.7	69	6400	JESD204B	3200
ADS5400	12-bit, 1.0-GSPS ADC	COTS	12	1000	1	59.1	75	2200	Parallel LVDS, Serial SPI Interface	2150
ADS5400-SP	Rad-tolerant 12-bit, 1000 MSPS ADC	QMLV	12	1000	1	58.5	72	2200	Parallel LVDS, Serial SPI Interface	2150
ADS54J40	Dual-Channel, 14-Bit, 1.0-GSPS ADC	COTS	14	1000	2	69	86	2700	JESD204B	1200
ADS54J60	Dual-Channel, 16-Bit, 1.0-GSPS ADC	COTS	16	1000	2	70	86	2700	JESD204B	1200
ADS54J66	Quad-Channel, 14-Bit, 500-MSPS ADC	COTS	14	500	4	70.8	89	2700	JESD204B	900
ADS54J69	Dual-Channel, 16-Bit, 500-MSPS ADC	COTS	16	500	2	73	91	2700	JESD204B	1200

TI offers various resources to accelerate high-speed designs. Together with **TI's Data Converter Learning Center,** the following materials are aimed at helping engineers who are focused on mission-critical projects:
- Training materials: High-speed signal chain university, **www.ti.com/hsscu**
- How unmatched impedance at the clock input of an RF ADC affects SNR and jitter **www.ti.com/lit/pdf/slyt679**
- Vibration and Shock Sensitivity: A Comparative Study of Oscillators, **www.ti.com/lit/pdf/snaa296**

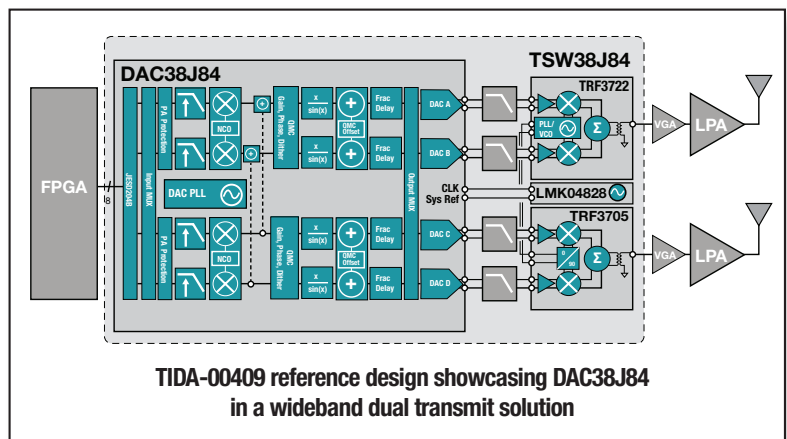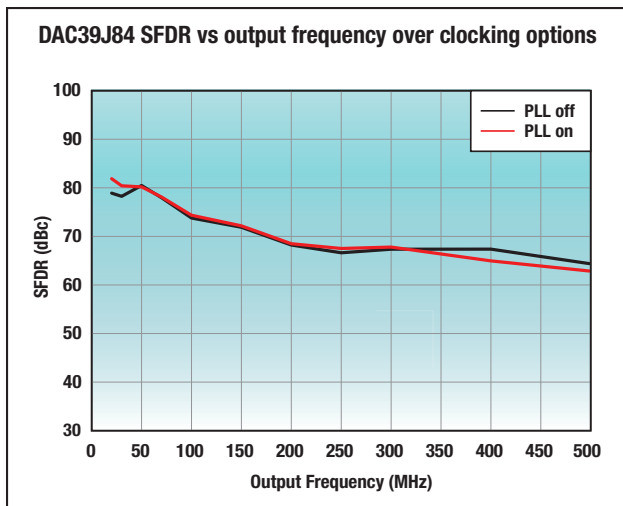Learn more about high-speed ADC solutions at: **www.ti.com/highspeedadc**

High-Speed Signal Chain
High-Speed Digital-to-Analog Converters (DACs)

TI's broad portfolio ranges from industry-standard communication DACs to ultra-high-speed and wide bandwidth DACs with advanced digital features and lowest power consumption bringing the highest performance to applications such as radar, software-defined radios (SDR) and electronic warfare.

High Speed DAC

Part Number	Description	Rating	Resolution (Bits)	Sample / Update Rate (MSPS)	DAC: Channels	Interface	SFDR (dB)	IMD3 (dBc)	Power Consumption (Typ) (mW)
DAC3484	Quad-Channel, 16-Bit, 1.25-GSPS, 1x-16x Interpolating DAC	COTS	16	1250	4	Parallel LVDS	82	81	1200
DAC34SH84	Quad-Channel, 16-Bit, 1.5-GSPS, 1x-16x Interpolating DAC	COTS	16	1500	4	Parallel LVDS	80	86	1448
DAC37J82	Dual-Channel, 16-Bit, 1.6-GSPS, 1x-16x Interpolating DAC	COTS	16	1600	2	JESD204B	81	83	789
DAC37J84	Quad-Channel, 16-Bit, 1.6-GSPS, 1x-16x Interpolating DAC	COTS	16	1600	4	JESD204B	81	83	1277
DAC38J82	Dual-Channel, 16-Bit, 2.5-GSPS, 1x-16x Interpolating DAC	COTS	16	2500	2	JESD204B	79	83	1144
DAC38J84	Quad-Channel, 16-Bit, 2.5-GSPS, 1x-16x Interpolating DAC	COTS	16	2500	4	JESD204B	79	83	1859
DAC38RF83	Dual-Channel, 14-bit, 9-GSPS, 6x-24x Interpolating DAC	COTS	14	9000	2	JESD204B	70	70	3500
DAC39J82	Dual-Channel, 16-Bit, 2.8-GSPS, 1x-16x Interpolating DAC	COTS	16	2800	2	JESD204B	68	76	1135
DAC39J84	Quad-Channel, 16-Bit, 2.8-GSPS, 1x-16x Interpolating DAC	COTS	16	2800	4	JESD204B	68	76	1619
DAC5670-SP	Rad-tolerant 14-Bit, 2.4 GSPS DAC	QMLV	14	2400	1	Parallel LVDS	55	70	2000
DAC5687-EP	Enhanced Product 16-Bit 500 Msps 2X-8X Interpolating Dual-Channel Dac	Enhanced Product	16	500	2	Parallel CMOS	80	79	1410

DAC39J84 SFDR vs output frequency over clocking options

TIDA-00409 reference design showcasing DAC38J84 in a wideband dual transmit solution

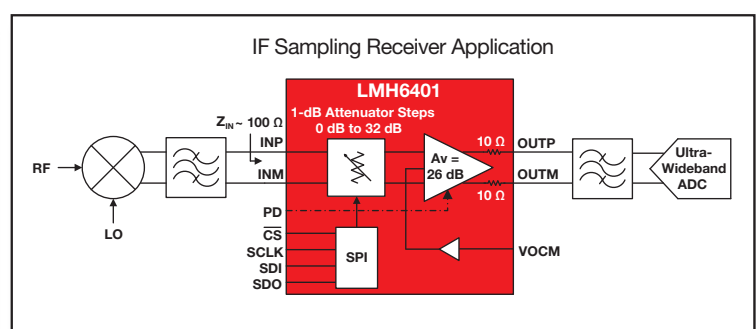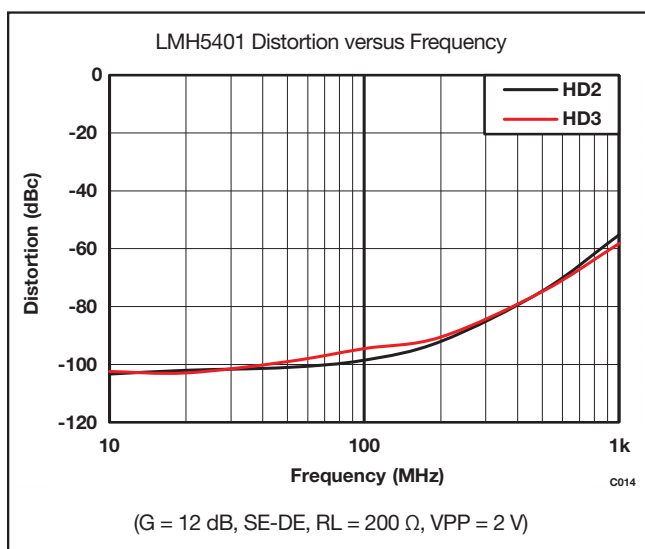Learn more about high-speed DAC solutions at: **www.ti.com/highspeeddac**

High-Speed Signal Chain
High-Speed Amplifiers

TI offers the industry's most comprehensive high speed amplifier portfolio with the widest bandwidth and best in class distortion, precision and power consumption across a broad range of supply voltages. Our industry leading FDA's, DVGA's, TIA's and general purpose amplifiers coupled with the reliability and longevity of our parts makes TI the ideal supplier of high speed amplifiers.

High Speed Amplifiers

Part Number	Description	Rating	Architecture	Number of Channels (#)	Total Supply Voltage (Min) (+5V=5, +/-5V=10)	Total Supply Voltage (Max) (+5V=5, +/-5V=10)	BW @ Acl (MHz)
LMH3401	7-GHz, Ultra-Wideband, Fully Differential Amplifier	COTS	Fully Differential, Voltage FB	1	3.15	5	7000
LMH6401	4.5 GHz Ultra Wideband Digital Variable Gain Amplifier	COTS	DVGA	1	4	5.25	4500
LMH5401	8GHz Ultra Wideband Fully Differential Amplifier	COTS	Bipolar, Fully Differential, Voltage FB	1	3.15	5.25	6200
LMH3404	Dual, 7-GHz, Low-Noise, Low-Power, Fully-Differential Amplifier	COTS	Fully Differential, Voltage FB	2	3.15	5.25	7000
LMH6521	High Performance Dual DVGA	COTS	Variable Gain (Dig), Fully Differential	2	4.75	5.25	1400
LMH6522	High Performance Quad DVGA	COTS	Variable Gain (Dig), Fully Differential	4	4.75	5.25	1400
OPA365-EP	Enhanced Product 2.2V, 50MHz, Low-Noise, Single-Supply Rail-to-Rail Op Amp	Enhanced Product	Voltage FB, CMOS	1	2.2	5.5	50
THS4524-EP	Enhanced Product very low power quad channel rail-to-rail output fully differential amplifier	Enhanced Product	Fully Differential, Voltage FB	4	2.5	5.5	145
THS4304-SP	Rad-Tolerant Class V, Wideband Operational Amplifier	QMLV	Voltage FB, Bipolar	1	2.7	5	3000
THS4551	Low Noise, Precision, 150MHz, Fully Differential Amplifier	COTS	Bipolar, Fully Differential, Voltage FB	1	2.7	5.4	150
THS4552	Dual Channel, Low-Noise, Precision, 150-MHz, Fully Differential Amplifier	COTS	Bipolar, Fully Differential, Voltage FB	2	2.7	5.4	150

LMH5401 Distortion versus Frequency

(G = 12 dB, SE-DE, RL = 200 Ω, VPP = 2 V)

IF Sampling Receiver Application

Find out whether your RF/IR signal chain should consider using a **fully differential amplifier (FDA) or balun to drive high speed ADCs** in this new blog post.

Read more at: **www.ti.com/highspeedamp**

High-Speed Signal Chain
Clocks and PLLs/Synthesizers

JESD204B interface

The JESD204B serial interface standard for data converters provides board area, FPGA/ASIC pin-count and latency improvements over traditional LVDS and CMOS interfaces. TI's JESD204B ADCs, DACs, clock ICs and development tools enable quick evaluation, design and implementation of designs utilizing the JESD204B interface.
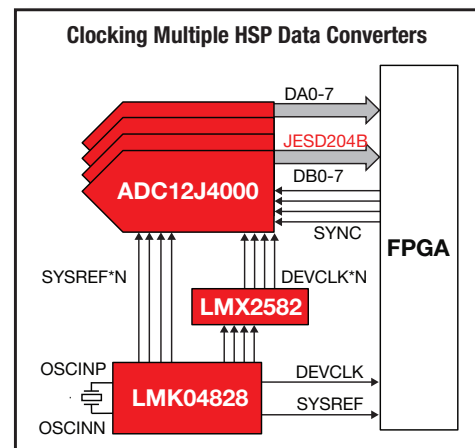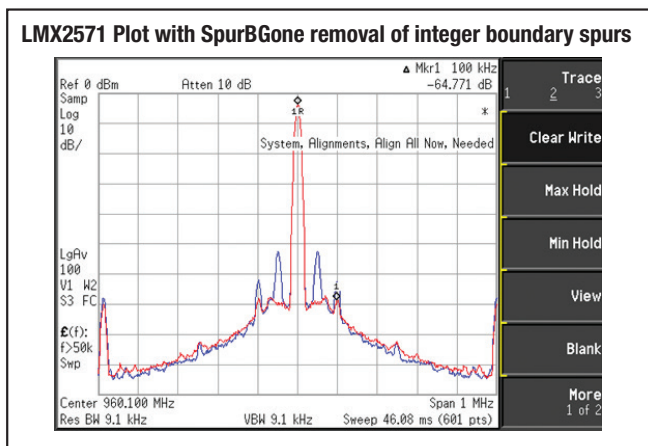
For more information on TI's JESD204B supported products, please visit the TI JESD204B landing page at:
www.ti.com/jesd204b

Clocks

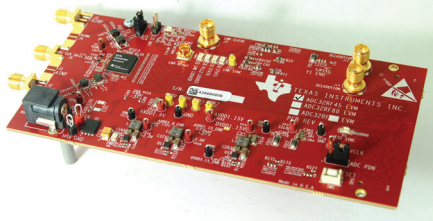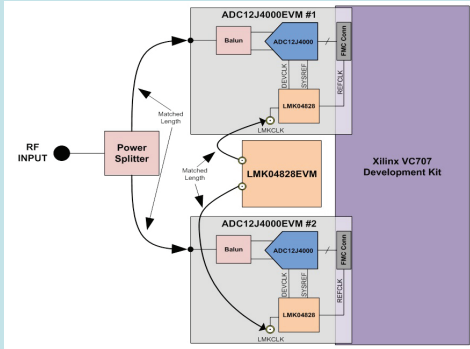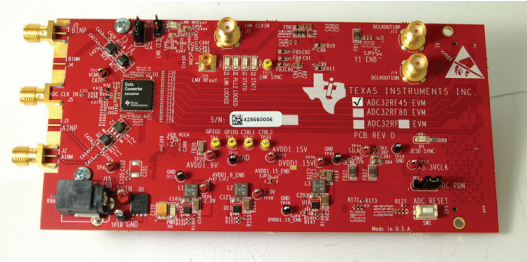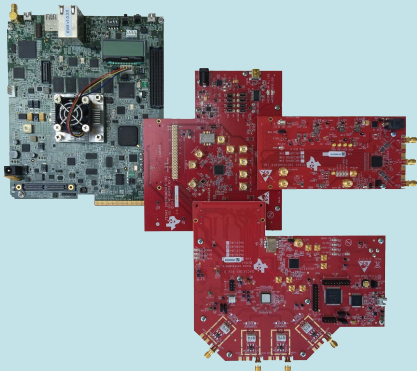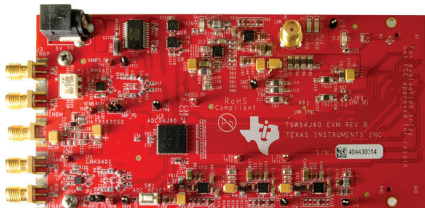| Part Number	Description	Rating	SubFamily	No. of Outputs	Output Level	Output Frequency (Min) (MHz)	Output Frequency (Max) (MHz)
CDCM7005-SP	3.3-V High Performance Rad-Tolerant Class V, Clock Synchronizer And Jitter Cleaner	QMLV	Single-Loop PLL	5	LVCMOS, LVPECL	0	1500
LMK03328	Ultra-Low Jitter Clock Generator Family With Two Independent PLLs	COTS	Single-Loop PLL	8	CML, HCSL, LVCMOS, LVDS, LVPECL	—	1000
LMK04208	Ultra Low Noise Clock Jitter Cleaner With 6 Programmable Outputs	COTS	Dual / Cascaded PLL	7	LVCMOS, LVDS, LVPECL	0.329	3072
LMK04828	Ultra Low Jitter Synthesizer and Jitter Cleaner with JESD204B Support	COTS	Dual / Cascaded PLL	15	HSDS, LCPECL, LVCMOS, LVDS, LVPECL	0.289	3080
LMK04828-EP	Ultra Low Jitter Synthesizer and Jitter Cleaner with JESD204B Support	Enhanced Product	Dual / Cascaded PLL	15	HSDS, LCPECL, LVCMOS, LVDS, LVPECL	0.289	3080
LMK04610	Low Power, 65 fs Jitter Cleaner, Clock Generator and Synchronizer	COTS	Dual / Cascaded PLL	10	HSDS, HCSL, LVPECL	—	2000
LMK01801	High performance Clock Buffer with dividers and programmable delay	COTS	Clock Buffer	12	LVCMOS, LVDS, LVPECL	0	3100
LMK61E2	Ultra-Low Jitter Programmable Oscillator, Integrated EEPROM, +/-50ppm and +/-25ppm	COTS	Oscillator	1	HCSL, LVDS, LVPECL	10	1000

PLL Synth

Part Number	Description	Rating	Output Frequency (Min) (MHz)	Output Frequency (Max) (MHz)	Normalized PLL Phase Noise (dBc/Hz)	VCO Phase Noise (Nom) (dBc/Hz)	1/f Noise (10 kHz offset at 1 GHz carrier) (dBc/Hz)
LMX2582	High Performance, Wideband PLLatinum RF Synthesizer	COTS	20	5500	-231	-129	-126
LMX2592	Wideband Frequency Synthesizer with Integrated VCO	COTS	20	9800	-231	-129	-126
LMX2571	LMX2571 Low Power Synthesizer with FSK Modulation	COTS	10	1344	-231	-115	-124
LMX2492	500MHz to 14GHz Wideband, Low Noise Fractional N PLL with Ramp/Chirp Generation	COTS	500	14000	-227	—	-120

LMX2571 Plot with SpurBGone removal of integer boundary spurs

Clocking Multiple HSP Data Converters

Learn more about clocking solutions at: **www.ti.com/clocks**

High-Speed Signal Chain
High-Speed TI Designs

TI's catalog of broadband RF products feature high-linearity, low-noise solutions with EVMs and reference designs available.

Design Number	Description	
TIDA-01163 Multi-band RF Sampling Receiver Reference Design	The reference design showcases the **ADC32RF80** dual channel, 14-bit, 3-GSPS RF sampling receiver. • Digital down converter with decimation solution • Low noise, high dynamic range RF sampling receiver solution • Low-phase noise clocking solution for RF sampling ADC	
TIDA-01017 High Speed Multi-Channel ADC Clock Reference Design for Oscilloscopes, Wireless Testers and Radars	The TIDA-01017 reference design demonstrates the performance of a clocking solution for a high speed multi-channel system, analyzed by measuring the channel to channel skew for the entire input frequency range of the RF sampling ADC	
TIDA-00814 RF Sampling S-Band Radar Receiver Reference Design	A direct RF sampling receiver approach to a radar system operating in S-band is demonstrated using the **ADC32RF45**, 3-Gsps, 14-bit analog to digital converter (ADC). • Supports greater than 1-GHz instantaneous signal bandwidth • Receiver based on the ASR-11 air traffic control radar specifications	
TIDEP0081 Wideband Receiver Design Using 66AK2L06 JESD204B Attach to ADC32RF80 Reference Design	This reference design incoudes the first widely available processor integratin a JESD204B interface and Digital Front End Processing (DFE). Connecting ADC32RF80 to DAC34J84 provides an efficient solution for avionics and defense, test and measurements and industrial applications.	
TIDA-00823 16-Bit 1-GSPS Digitizer Reference Design with AC and DC Coupled Fixed Gain Amplifier	This reference design discusses the use and performance of the Ultra-Wideband, Fixed-gain high-speed amplifier, the **LMH3401** to drive the high-speed analog-to-digital converter (ADC), the **ADS54J60** device. Different options for common-mode voltages, power supplies, and interfaces are discussed and measured, including AC-coupling and DC-coupling, to meet the requirements of a variety of applications.	

Precision Signal Conditioning and Monitoring
Precision Amplifiers

TI offers catalog precision amplifiers, featuring low-noise, zero-drift and low input bias current for sensor signal conditioning and accurate system monitoring.

Op-Amps

Part Number	Description	Rating	# of Channels	Total Supply Voltage (Min)	Total Supply Voltage (Max)	GBW (Typ) (MHz)	Vos @ 25C (Max) (mV)	CMRR (Typ) (dB)
OPA140	11MHz, Single Supply, Low Noise, Precision, Rail-to-Rail Output, JFET Amplifier	COTS	1	4.5	36	11	0.12	140
OPA191	Low-Power, Precision, 36-V, e-trim CMOS Amplifier	COTS	1	4.5	36	2.5	0.025	140
OPA192	High Voltage, Rail-to-Rail Input/Output,Precision Op Amps, E-Trim(TM) Series	COTS	1	4.5	36	10	0.025	120
OPA197	36-V, Precision, Rail-to-Rail Input Output, Low Offset Voltage Op Amp	COTS	1	4.5	36	10	0.25	140
OPA2192	36-V, Precision, RRIO, Low Offset Voltage, Low Input Bias Current Op Amp with e-trim	COTS	2	4.5	36	10	0.025	120
OPA2211-EP	1.1nV/rtHz Noise, Low Power, Precision Operational Amplifier	Enhanced Product	2	4.5	36	45	0.175	120
OPA4192	Low-Noise, Low Quiescent Current, 36V RRI/O Precision Op Amps, E-Trim(TM) Series	COTS	4	4.5	36	10	0.025	120
OPA4277	High Precision Operational Amplifiers	COTS	4	4	36	1	0.05	140
OPA4277-EP	Enhanced Products High Precision Operational Amplifiers	Enhanced Product	4	4	36	1	0.065	140
OPA625	High Bandwidth, High Precision, Low Noise & Distortion Amplifier SAR ADC Driver with Power Scaling	COTS	1	2.7	5.5	80	0.1	117

TI Precision Labs is the electronics industry's first comprehensive online classroom for analog engineers. The on-demand curriculum pairs theory and applied lab exercises to deepen the technical expertise of experienced engineers and accelerate the development of those early in their career. Watch any of the 40, free hands-on trainings and lab videos, covering analog amplifier design considerations with online course work at **training.ti.com/ti-precision-labs-op-amps**

Learn more about our precision amplifier portfolio at: **www.ti.com/precisionamp**

Precision Signal Conditioning and Monitoring
Voltage References

With more than 40 years of supply history, TI offers a broad portfolio of precision voltage references featuring low temperature coefficient, high initial accuracy and excellent long-term stability performance. Rely on TI's voltage reference solutions to support mission-critical applications requiring extended operating temperature ranges, robust materials and standard qualifications.

Voltage References

Part Number	Description	Rating	Sub Family	Vin (Min) (V)	Vin (Max) (V)	VO (V)	Initial Accuracy (Max) (%)	Temp Coeff (Max) (ppm/ degree C)
REF5020 / 30 / 40 / 50	Low Noise, Very Low Drift, Precision Voltage Reference	COTS	Series Voltage Reference	2.7 / 3.2 / 4.3 / 5.2	18	2.048 / 3 / 4.096 / 5	0.05, 0.1	3
REF5020 / 25 / 40 / 50-EP	Enhanced Product Low-Noise, Very Low Drift, Precision Voltage Reference	Enhanced Product	Series Voltage Reference	2.7 / 2.7 / 4.3 / 5.2	18	2.048 / 2.5 / 4.096 / 5	0.05, 0.1	3
LM136-2.5-N	Voltage Reference Diode	COTS	Shunt Voltage Reference	–	–	2.5	1	90
LM136-5.0	5.0V Reference Diode	COTS	Shunt Voltage Reference	–	–	5	1	90
LM136-5.0QML	5.0V Reference Diode	QMLQ	Shunt Voltage Reference	–	–	5	1	Adjustable
LM136-5.0QML-SP	5.0V Reference Diode	QMLV	Shunt Voltage Reference	–	–	5	1	Adjustable
LM136A-2.5QML	2.5V Reference Diode	QMLQ	Shunt Voltage Reference	–	–	2.5	1	Adjustable
LM136A-2.5QML-SP	2.5V Reference Diode	QMLV	Shunt Voltage Reference	–	–	2.5	1	Adjustable
LM136A-5.0QML	5.0V Reference Diode	QMLQ	Shunt Voltage Reference	–	–	5	1	Adjustable
LM185-1.2-N	Micropower Voltage Reference Diode	COTS	Shunt Voltage Reference	–	–	1.2	1	30
LM185-1.2QML	Micropower Voltage Reference Diode	QMLQ	Shunt Voltage Reference	–	–	1.2	1	30
LM185-1.2QML-SP	Micropower Voltage Reference Diode	QMLV	Shunt Voltage Reference	–	–	1.2	1	30
LM185-2.5QML	Micropower Voltage Reference Diode	QMLQ	Shunt Voltage Reference	–	–	2.5	0.8	30
LM185-2.5QML-SP	Micropower Voltage Reference Diode	QMLV	Shunt Voltage Reference	–	–	2.5	0.8	30
LM185-ADJ	Adjustable Micropower Voltage Reference	COTS	Shunt Voltage Reference	–	–	1.24	1, 2	30
LM185QML	Adjustable Micropower Voltage Reference	QMLQ	Shunt Voltage Reference	–	–	1.24	1	50
LM4050-N	Precision Micropower Shunt Voltage Reference	COTS	Shunt Voltage Reference	–	–	2.048, 2.5, 4.096, 5, 8.192, 10	0.1, 0.2, 0.5	50
LM4050QML-SP	Precision Micropower Shunt Voltage Reference	QMLV	Shunt Voltage Reference	–	–	2.5, 5	0.1	15
TL1431	Precision Adjustable (Programmable) Shunt Reference	COTS	Shunt Voltage Reference	–	–	2.5 to 36	0.4	114
TL1431-EP	Enhanced Product Precision Adjustable (Programmable) Shunt Reference	Enhanced Product	Shunt Voltage Reference	–	–	2.5 to 36	0.4	114
TL1431-SP	Precision Adjustable (Programmable) Shunt Reference	QMLV	Shunt Voltage Reference	–	–	2.5 to 36	0.4	114
TL1431M	Precision Adjustable (Programmable) Shunt Reference	QMLQ	Shunt Voltage Reference	–	–	2.5 to 36	0.4	114

Learn more at: **www.ti.com/vref**

Precision Signal Conditioning and Monitoring
Precision Analog-to-Digital Converters (ADCs)

TI's broad precision successive approximation register (SAR) and delta-sigma analog-to-digital converters (ADCs) operate at sampling rates less than 10 MSPS and with 12-bit to 32-bit resolution. Our industry-leading portfolio provides pinpoint precision for the most demanding designs; high integration to slash design time, board space and system cost; and the lowest power to reduce power consumption and extend battery life.

Precision ADCs

Part Number	Description	Rating	Resolution (Bits)	Sample Rate (max) (SPS)	# Input Channels	Multi-Channel Configuration	Input Range (Min) (V)	Input Range (Max) (V)	Integrated Features	Architecture
ADS1282-SP	High Resolution Analog-to-Digital Converter	QMLV	31	4kSPS	2	Multiplexed	0.5Vref/ PGA		PGA	Delta-Sigma
ADS1278-EP	Enhanced Product Octal, 144kHz, Simultaneous Sampling 24-Bit Delta Sigma ADC	Enhanced Product	24	144kSPS	8	Simultaneous Sampling	0	5.25	Daisy-Chainable	Delta-Sigma
ADS1278	Octal, 144kHz, Simultaneous Sampling 24-Bit Delta Sigma ADC	COTS	24	144kSPS	8	Simultaneous Sampling	0	5.25	Daisy-Chainable	Delta-Sigma
ADS8698	18-bit SAR ADC, 8 channels, 500 kSPS, and bipolar inputs off +5V supply	COTS	18	500kSPS	8	Multiplexed	-10.24	10.24	Daisy-Chainable, Oscillator, Over-Voltage Protection, PGA	SAR
ADS8344	16-Bit, 8-Channel Serial Output Sampling Analog-to-Digital Converter	COTS	16	100kSPS	8	Multiplexed	0	5.25	–	SAR
ADS8688	SAR ADC with 16 bits, 8 channels, 500 kSPS, and bipolar inputs off +5V supply	COTS	16	500kSPS	8	Multiplexed	-10.24	10.24	Daisy-Chainable, Oscillator, Over-Voltage Protection, PGA	
ADS8568	16-Bit, 8-Channel, Simultaneous Sampling, Bipolar Input ADC	COTS	16	500kSPS	8	Simultaneous Sampling	-12	12	Daisy-Chainable, Oscillator	SAR
ADS8548	14-Bit, 8-Channel, Simultaneous Sampling, Bipolar Input ADC	COTS	14	600kSPS	8	Simultaneous Sampling	-12	12	Daisy-Chainable, Oscillator	SAR

For more information on PGA411-Q1, see **www.ti.com/product/PGA411-Q1**

Resolver Sensing Solution Based on TI's PGA411-Q1

- +/- 10.56 arc min or +/- 2.64 arc min maximum angular accuracy
- Integrated exciter amplifier (10-20 kHz) with short protection and integrated exciter boost power supply
- Built-in-Self-Test for functional safety enables better latent fault coverage
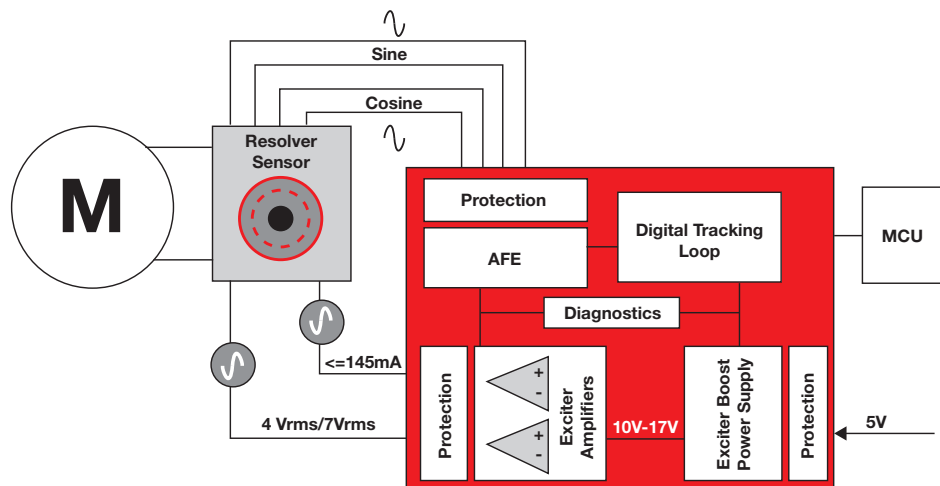
Learn more about TI's precision ADC portfolio at: **www.ti.com/precisionadc**

Precision Signal Conditioning and Monitoring
Precision Digital-to-Analog Converters (DACs)

TI's precision DAC portfolio includes several, highly integrated solutions to bias a LDMOS, GaN or GaAs power amplifier (PA) in an RF application. Monitoring the performance of your PA will allow you to improve the overall efficiency of the transmission system, maximize output power and achieve highest linearity.
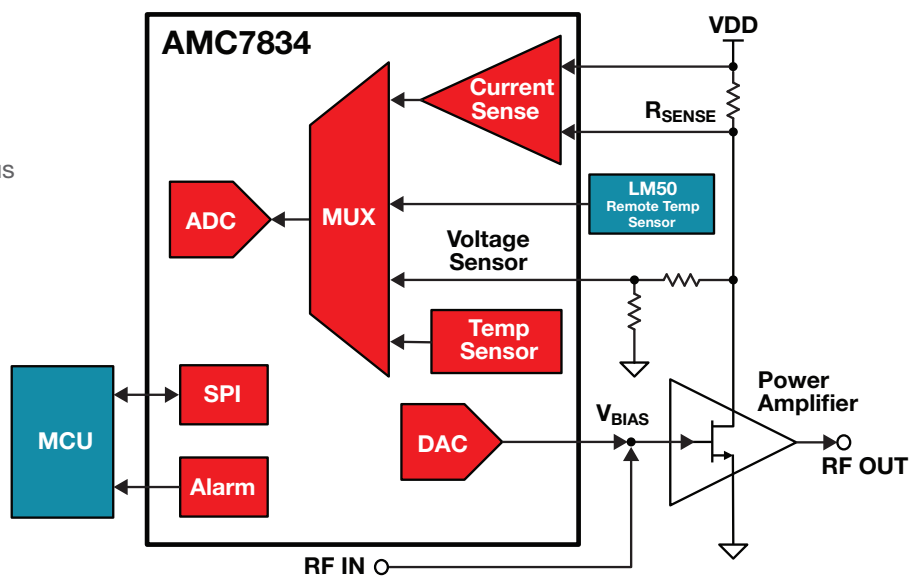
Precision DACs

Part Number	Description	Rating	Resolution (Bits)	DAC Outputs	DAC Output Range (V)	ADC Inputs	Temp Sensing	Current Sensing	Interface
AMC7812	Integrated, Multichannel ADC and DAC for Analog Monitoring & Control	COTS	12	12	0 to 5	16	Local + 2 Remote	No	SPI, I2C
AMC7823	Integrated, Multichannel ADC and DAC for Analog Monitoring & Control	COTS	12	8	0 to 5 -5 to 0 -4 to 1	8	Local	No	SPI
AMC7832	12-Bit High Density Analog Monitor and Control (AMC) Solution	COTS	12	12	0 to 5 0 to 12.5	17	Local	No	SPI
AMC7836	High-Density, 12-Bit Analog Monitor and Control Solution, Bipolar DAC	COTS	12	16	0 to 5 0 to 10 -10 to 0	21	Local	No	SPI
AMC7834	Integrated Power-Amplifier Monitor and Control System	COTS	12	8	0 to 5 0 to 10 -5 to 0 -10 to 0	4	Local + 2 Remote	4 current sensors 4 to 60	SPI

RF Power Amp Biasing Using
AMC7834
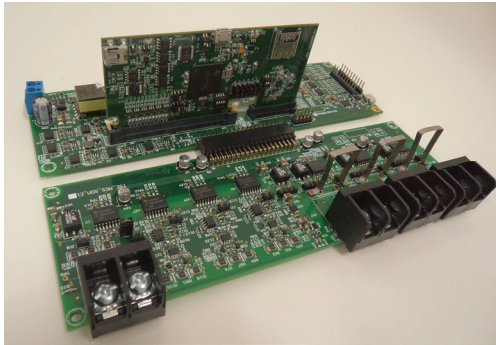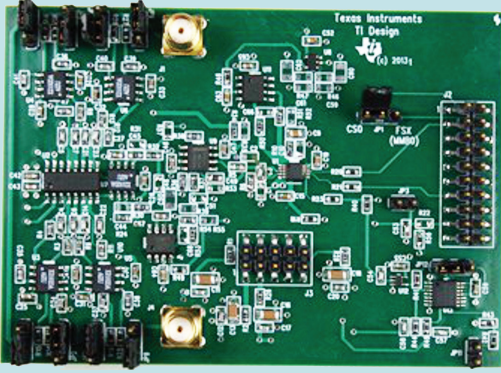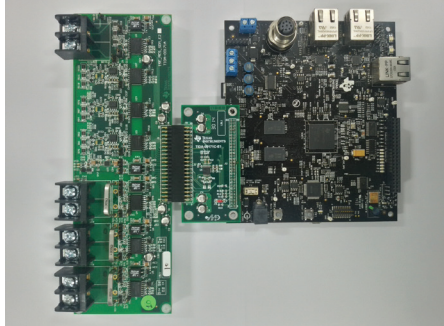
- Eight monotonic 12-bit DACs with programmable ranges
- Integrated current sensors enable calibration on-the-fly and autonomous drain current control
- Flexible DAC output ranges enables biasing for LDMOS, GaAs and GaN transistor technologies

Learn more about TI's precision DAC portfolio at: **www.ti.com/precisiondac**

Precision Signal Conditioning and Monitoring
Precision TI Designs

The Precision TI Designs library is a collection of board and sub-system level circuits designed to help engineers quickly evaluate and customize their systems while expanding their analog knowledge base. Three levels of designs are offered — Reference, Verified and CerTIfied — providing a combination of theory, methodology, simulation, tested results and design files from the desks of our analog experts.

Design Number	Description	
TIDA-00171 Isolated Current Shunt and Voltage Measurement Reference Design for Motor Drives	The design provides an ability to evaluate the performance of these measurements: three motor currents, three inverter voltages and the DC Link voltage. Provided in the kit is firmware to configure the Sinc filters, set the PLL frequency and receive data from Sinc filters.	
TIPD151 16-bit 400KSPS 4-Ch. Multiplexed Data Acquisition Ref Design for High Voltage Inputs, Low Distortion	This TI Design implements a 16-bit, differential 4-channel multiplexed data acquisition system at 400KSPS throughput for high voltage differential input of ±20 V (40 Vpk-pk) harsh environment applications	
TIDA-00209 Isolated Current Shunt and Voltage Measurement Reference Design for Motor Drives Using AM437x	This reference design uses the AMC130x reinforced isolated delta-sigma modulators along with AM437x Sitara™ ARM® Cortex® -A9 Processor, which implements Sinc filters on PRU-ICSS. The design provides an ability to evaluate the performance of these measurements: three motor currents, three inverter voltages, and the DC Link voltage.	

See the complete list of TI Designs — Precision at **www.ti.com/precisiondesigns**

Power Management
LDOs

TI's low noise LDO portfolio will help reduce the flicker noise and reject ripple generated from switching power supplies. Using TI low noise LDOs can help improve SNR performance for your sensitive signal intelligence (SIGINT) systems. The use of new space FPGAs, ASICs and ADCs with multiple voltage rails in satellites has led to the need for an increase in point-of-load (POL) solutions in every design, causing a functionality vs. size trade-off. TI has developed several of the industry's smallest solutions, many at 50% of the size of competition, to enable our space customers to fit these POL components into designs without sacrificing product functionality.

Low Noise LDO

Part Number	Description	Rating	Iout (Max) (A)	Vin (V)	Vout (V)	PSRR @ 100 kHz (dB)	Output noise voltage (µVRMS)
TPS7A85	High-Current (4 A), High-Accuracy (1%), Low-Noise (4.4 µVRMS), LDO Voltage Regulator	COTS	4	1.1 to 6.5	0.8 to 5	25	4.4
TPS7A84	High-Current (3 A), High-Accuracy (1%), Low-Noise (4.4 µVRMS), LDO Voltage Regulator	COTS	3	1.1 to 6.5	0.8 to 5	25	4.4
TPS7A47	36-V, 1-A, 4.17-µVRMS, RF LDO Voltage Regulator	COTS	1	3 to 36	1.4 to 34	60	4.17
TPS7H1101-SP	1.5 -7V Input, 3 Amp, Ultra Low Dropout Regulator	QMLV	3	1.5 to 7	0.8 to 6.8	25	20.33
TPS7A88	Dual, 1-A, Low Noise (3.8-µVRMS), LDO Voltage Regulator	COTS	1	1.4 to 6.5	0.8 to 5.2	64	16
TPS7A33	Vin -3V to -36V, -1A, Ultra-Low Noise, High PSRR, Low-Dropout Linear Regulator	COTS	1	-36 to -3	-33 to -1.2	64	16

Wide V~IN~ LDO

Part Number	Description	Rating	Iout (Max) (A)	Vin (V)	Vout (V)	Additional Features
TPS7A4001-EP	100V Input Voltage, 50mA Single Output Low Dropout Linear Regulator	Enhanced Product	0.05	7 to 100	1.2 to 90	Enable, Overcurrent Protection, Thermal Shutdown
TPS7A4501-SP	Wide Vin Low-Dropout Voltage Regulator	QMLV	1.5	2.3 to 20	1.21 to 20	Enable, Overcurrent Protection, Reverse Current Protection, Thermal Shutdown
TPS7A3001-EP	Enhanced Product Vin -3V to -36V, -200mA, Ultra-Low Noise, High PSRR, Low-Dropout Linear Regulator	Enhanced Product	0.2	-36 to -3	-33 to -1.2	Enable, Overcurrent Protection, Soft Start, Thermal Shutdown, Fast Transient Response
TPS7A49	Vin 3V to 36V, 150mA, Ultra-Low Noise, High PSRR, Low-Dropout Linear Regulator	COTS	0.15	3 to 36	1.2 to 33	Enable, Fast Transient Response, Overcurrent Protection, Soft Start, Thermal Shutdown
TPS54120	Low-Noise 1A Power Supply with Integrated DC-DC Converter and Low-Dropout Regulator	COTS	0.8 to 6	1	4.5 to 17	Enable, Power Good, Synchronous Rectification
TPS54122	Dual Output, High Efficiency 3A Switcher + 3A Low Noise LDO	COTS	0.8 to 4.5	3	2.95 to 6	Enable, Power Good
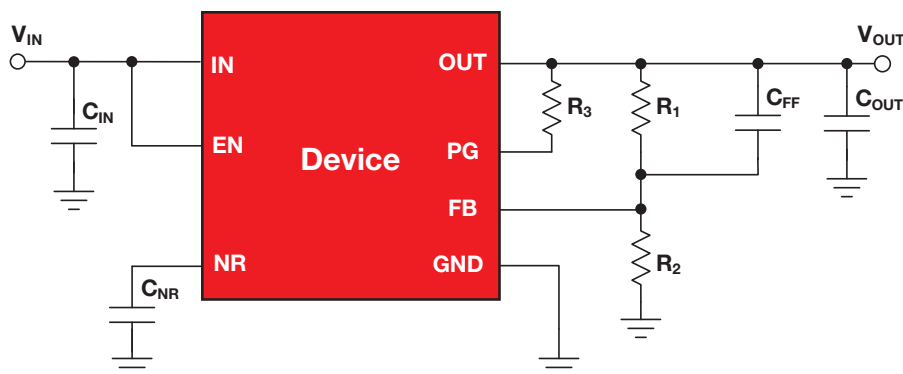
New app note available: External Soft-Start Circuit for TPS7H3301-SP Power-Up Sequencing Applications **www.ti.com/lit/pdf/slva781**

Learn more about TI's complete LDO portfolio at: **www.ti.com/ldo**
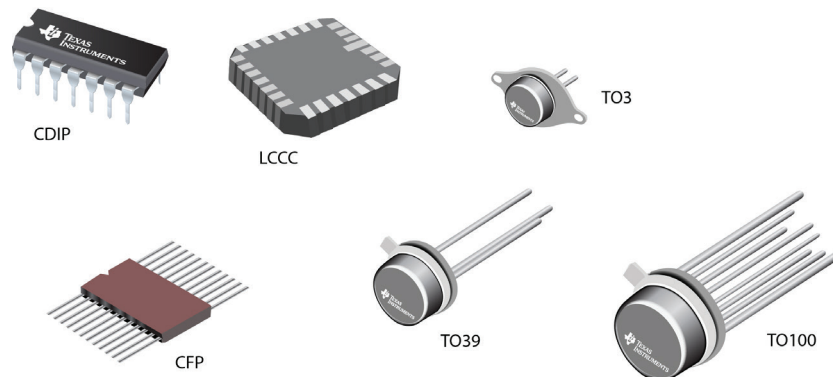
Power Management
Linear Regulators

TI's broad portfolio of wide V$_{IN}$ voltage regulators going up to ±60 V and 7 A of peak current have a number of package and die options to help your mission critical designs.

Wide VIN Linear Regulators

Part Number	Description	Rating	Iout (Max) (A)	Vin (V)	Vout (V)	Operating Temperature Range (C)
LM1085	3A Low Dropout Positive Regulators	COTS	3	2.6 to 29	1.25 to 27.5	-40 to 125
LM1086	1.5A Low Dropout Positive Regulators	COTS	1.5	2.6 to 29	1.25 to 27.5	-40 to 125
LM117	3-Terminal Adjustable Regulator	COTS	5	4.2 to 40	1.25 to 37	-55 to 150
LM117HV	3-Terminal Adjustable Regulator	COTS	1.5	4.2 to 60	1.25 to 57	-55 to 125
LM117HVQML	3-Terminal Adjustable Regulator	QMLQ	1.5	4.2 to 60	1.25 to 57	-55 to 125
LM117HVQML-SP	3-Terminal Adjustable Regulator	QMLV	1.5	4.2 to 60	1.25 to 57	-55 to 125
LM117JAN	3-Terminal Adjustable Regulator	QMLQ	1.5	4.2 to 40	1.25 to 37	-55 to 125
LM117JAN-SP	3-Terminal Adjustable Regulator	QMLV	1.5	4.2 to 40	1.25 to 37	–
LM117QML	3-Terminal Adjustable Regulator	QMLQ	1.5	4.2 to 40	1.25 to 37	-55 to 125
LM117QML-SP	3-Terminal Adjustable Regulator	QMLV	1.5	4.2 to 40	1.25 to 37	-55 to 125
LM137	3-Terminal Adjustable Negative Regulator	COTS	1.5	-40 to -4.2	-37 to -1.2	-55 to 150
LM137HVQML	3-Terminal Adjustable Negative Regulator (High Voltage)	QMLQ	1.5	-50 to -4.2	-47 to -1.2	-55 to 150
LM137JAN	3-Terminal Adjustable Negative Regulator	QMLQ	1.5	-40 to -4.2	-37 to -1.2	-55 to 150
LM137JAN-SP	3-Terminal Adjustable Negative Regulator	QMLV	1.5	-40 to -4.2	-37 to -1.2	-55 to 150
LM137QML	3-Terminal Adjustable Negative Regulator	QMLQ	1.5	-40 to -4.2	-37 to -1.2	-55 to 125
LM137QML-SP	3-Terminal Adjustable Negative Regulator	QMLV	1.5	-40 to -4.2	-37 to -1.2	-55 to 125
LM138	5 Amp Adjustable Regulator	COTS	5	4.2 to 40	1.24 to 32	-55 to 125
LM2940QML	1A Low Dropout Regulator	QMLQ	1	0 to 26	5 to 15	-55 to 125
LM2940QML-SP	1A Low Dropout Regulator	QMLV	1	0 to 26	5 to 15	-55 to 125
LM723	Voltage Regulator	COTS	0.15	9.5 to 40	2 to 37	-55 to 150
LM723JAN-SP	Voltage Regulator	QMLV	0.15	9.5 to 40	2 to 37	-55 to 125
LM723QML	Voltage Regulator	QMLQ	0.15	9.5 to 40	2 to 37	-55 to 125

Package Designators

CDIP

LCCC

TO3

CFP

TO39

TO100

Learn more about linear regulator solutions at: **www.ti.com/ldo**

Power Management
Power Modules

Leverage the industry's most comprehensive catalog power module portfolio to find the solution that best fits your defense or aerospace design.

Ruggedized Power Modules

Extended temperature (EXT) family of power modules

The SIMPLE SWITCHER® EXT power modules provide excellent performance in the most extreme conditions
- Supports max input voltage ranges from 5.5 to 42 V and output currents up to 5 A
- Compliant to vibration standard MIL-STD-883 method 2007.2 condition A
- Compliant to drop standard MIL-STD-883 method 2002.3 condition B
- Passes 10 V/m radiated immunity EMI test standard EN61000 4-3
- IC junction temperature range: -55 to +125°C

Part Number	Description	Vin (Max) (V)	Vin (Min) (V)	Iout (Max) (A)	Vout (Min) (V)	Vout (Max) (V)	Package Type	Special Features
Wide VIN Power Modules								
LMZ34202	SIMPLE SWITCHER, 4.5V to 42V, 2A Step-Down Voltage Regulator	42	4.5	2	2.5	7.5	QFN	EMI Tested, Enable, Frequency Synchronization, Light Load Efficiency, Power Good, Remote Sense
LMZ36002	SIMPLE SWITCHER® 4.5V to 60V, 2A Step-Down Power Module in QFN Package	60	4.5	2	2.5	7.5	QFN	EMI Tested, Enable, Frequency Synchronization, Light Load Efficiency, Power Good, Remote Sense
LMZ14203EXT	3A SIMPLE SWITCHER Power Module with 42V Maximum Input Voltage	42	6	3	0.8	6	Leaded	EMI Tested, Enable, Tracking, -55 to 125°C Temp Range, MIL-STD-883 drop and vibration
LMZ23610	10A SIMPLE SWITCHER® Power Module with 36V Maximum Input Voltage	36	6	10	0.8	6	Leaded	Current Sharing, EMI Tested, Enable, Frequency Synchronization, Tracking
LMZ14203	SIMPLE SWITCHER® 6V to 42V, 3A Power Module	42	6	3	0.8	6	Leaded	EMI Tested, Enable, Tracking
LMZ34002	SIMPLE SWITCHER® 4.5V to 40V, 2A Negative Output Power Module	40	4.5	2	-3	-17	QFN	EMI Tested, Negative Output, Remote Sense
Point of Load (POL) Power Modules								
TPS82130	3-A 17V Step-down Converter Module with Integrated Inductor	17	3	3	0.9	5	MicroSiP (LGA)	Enable, Light Load Efficiency, Power Good, Tracking
TPS82084	2-A, High-Efficiency Step-Down Converter Module with Integrated Inductor	6	2.5	2	0.8	6	MicroSiP (LGA)	Enable, Light Load Efficiency, Output Discharge, Power Good
TPS82085	3A, High-Efficiency Step-Down Converter Module with Integrated Inductor	6	2.5	3	0.8	6	MicroSiP (LGA)	Enable, Light Load Efficiency, Output Discharge, Power Good
LMZ20501	SIMPLE SWITCHER® 2.7V to 5.5V, 1A High Density Nano Module	5.5	2.7	1	0.8	3.6	MicroSiP (LGA)	EMI Tested, Enable, Light Load Efficiency, Power Good
LMZ21701	SIMPLE SWITCHER® 3V to 17V, 1A High Density Nano Module	17	3	1	0.9	6	MicroSiP (LGA)	EMI Tested, Enable, Light Load Efficiency, Power Good
LMZ31530	SIMPLE SWITCHER® 3V to 14.5V, 30A Power Module in Small QFN Package	14.5	3	30	0.6	3.6	QFN	EMI Tested, Enable, Light Load Efficiency, Power Good, Remote Sense
LMZ31710	SIMPLE SWITCHER® 2.95V to 17V, 10A Power Module with Current Sharing	17	2.95	10	0.6	5.5	QFN	Current Sharing, EMI Tested, Frequency Synchronization, Power Good, Remote Sense, Tracking, Light Load Efficiency
LMZ30606	SIMPLE SWITCHER® 2.95V to 6V, 6A Power Module in Small QFN Package	6	2.95	6	0.8	3.6	QFN	EMI Tested, Enable, Frequency Synchronization, Power Good, Remote Sense, Tracking
LMZ22010	10A SIMPLE SWITCHER® Power Module with 20V Maximum Input Voltage	20	6	10	0.8	6	Leaded	Current Sharing, EMI Tested, Enable, Frequency Synchronization, Tracking
LMZ12003EXT	3A SIMPLE SWITCHER Power Module with 20V Maximum Input Voltage	20	4.5	3	0.8	6	Leaded	EMI Tested, Enable, Tracking, MIL-STD-883 drop and vibration
LMZ12002EXT	2A SIMPLE SWITCHER Power Module with 20V Maximum Input Voltage	20	4.5	2	0.8	6	Leaded	EMI Tested, Enable, Tracking, MIL-STD-883 drop and vibration
LMZ12001EXT	1A SIMPLE SWITCHER Power Module with 20V Maximum Input Voltage	20	4.5	1	0.8	6	Leaded	EMI Tested, Enable, Tracking, MIL-STD-883 drop and vibration
LMZ10505EXT	5A SIMPLE SWITCHER Power Module with 5.5V Maximum Input Voltage	5.5	2.95	5	0.8	5	Leaded	Enable, MIL-STD-883 drop and vibration
LMZ10504EXT	4A, SIMPLE SWITCHER Power Module with 5.5V Maximum Input Voltage	5.5	2.95	4	0.8	5	Leaded	Enable, MIL-STD-883 drop and vibration
LMZ10503EXT	3A SIMPLE SWITCHER Power Module with 5.5V Maximum Input Voltage	5.5	2.95	3	0.8	5	Leaded	Enable, MIL-STD-883 drop and vibration

Learn more about TI's power module solutions at: **www.ti.com/modules**

Power Management
Power TI Designs

TI provides a board portfolio of power management reference designs created to improve the size, weight and power (SWaP) of your next system. From low noise, high PSRR designs to noise sensitive RF components to complete solutions for the latest FPGA, our TI Designs will help move your designs to production faster. You can even use the power reference design parametric search to look for the design that matches your power needs.

Design Number	Description	
TIDA-01215 Power Supply Reference Design for Optimizing Spur and Phase Noise in RF-sampling DACs	This reference design uses both DC/DC switchers and an LDO to power-up the DAC38RF8x while achieving high analog performance (spurious and phase noise) and minimizing power efficiency trade-offs. The design method outlined here can be extended to the power supply design of other RF-sampling data converters.	
PMP10601 Xilinx® Zynq® 7000 Series (XC7Z015) Reference Design	As part of the extensive TI Design Library, **PMP10601** offers all the power supply rails necessary to power Xilinx Zynq 7000 series (XC7Z015) FPGA. • Design optimized to support a 12-V input • On board power-up and power-down sequencing • Supports DDR3 memory device	
TIDA-00270 Current-Sharing Dual-LDO Reference Design	TIDA-00270 offers a power-supply topology capable of sourcing 6 A via two LDOs operating in parallel for high-current, low-noise applications. • Includes soft-start procedure for monotonic startup • Allows better thermal dissipation for air flow restricted environment • Achieves ≥40 dB PSRR at 6 A (0.8 V_{out})	 TIDA-00270 V_{IN} PSRR vs frequency (V_{OUT}: 3.3 V, I_{OUT}: 6 A)
TIDA-00783 Space Optimized Wide Vin Triple-Output Power Module Reference Design	The TIDA-00783 reference design is a triple output wide Vin power module design. It provides 3.3V, 1.8V and 1.2V output, at 6W total power.	

Architecture Highlights

KeyStone Architecture

- Great fit for radar systems, electronic warfare, software-defined radio and avionics applications with devices ranging from single core DSPs, up to devices such as a quad-core ARM® Cortex®-A15 or an ARM + DSP device with 12 cores
- TI devices using the KeyStone architecture deliver full processing entitlement, meaning every processing element is able to process at nearly its full capacity all of the time. The KeyStone architecture is the basis for DSP-only, ARM-only, and ARM + DSP device families, providing a common platform for multiple processing solutions

- Scalable platforms allow for software design reuse
- Integrated high-throughput I/O — such as on-chip 1 Gb/10 Gb Ethernet switches, PCIe gen 2, and SRIO — support data-intensive applications
- TI's HyperLink interface offers up to 50 Gbps connection to another TI KeyStone architecture or an FPGA
- High performance in a constrained power budget, up to 16 GFLOPS/W, and available extended temperature ranges meet SWaP requirements
- On-chip memories have error-correction code (ECC); the DDR3 interfaces support ECC-capable memory

- Secure boot and other security features available on some devices
- Linux and TI-RTOS kernal are available from TI, commercial RTOS offerings from Wind River and Green Hills are available for ARM-only and ARM + DSP devices

C66x DSP Core

- Software compatible with previous-generation C67x and C64x DSP cores
- Includes SIMD support for floating point operations
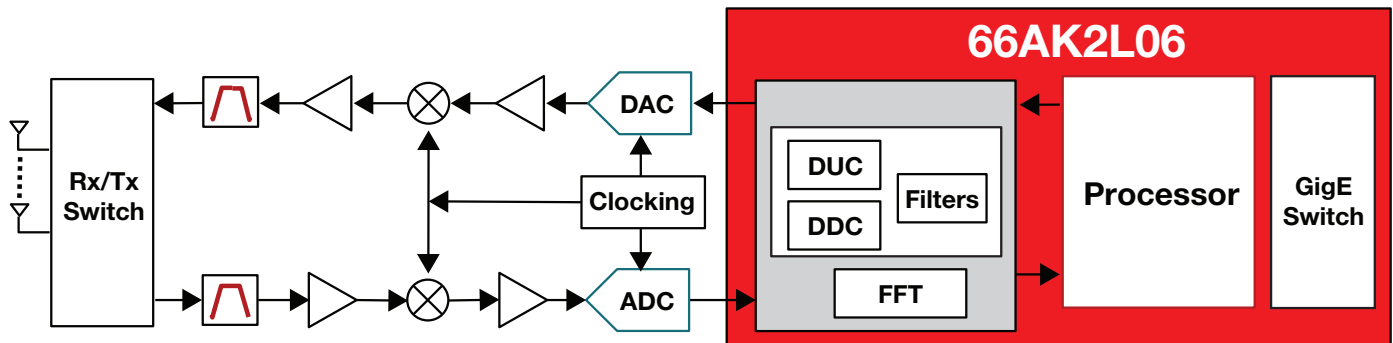
66AK2L06 DFE

DDC / DUC
- 368Msps TX and 368Msps RX
- Up to 48 channels and 4 streams
- 18-24 bit data path

Filter
- Programmable FIR Filter: 18-bit data path and coefficients, up to 399 Taps
- CIC & Farrow Filter

FFT
- Programmable FFT Coprocessors
- Up to 8192pts, > 84db SNR, 35GFLOPS @ 8Kpts
- 2x 1024pt in 2.1us

Additional Features
Real to complex converter, front end AGC, NCO/mixer, signal generator, power measurements, IQ Imbalance Comp

Learn more about TIDEP0060: Optimized Radar System Reference Design Using a DSP+ARM SoC at **www.ti.com/tool/TIDEP0060**

Processors
COTS Multicore Processors Featured Devices

DSP

Part Number	Description	ARM CPU	ARM MHz (Max.)	DSP Cores	DSP MHz (Max.)	EMAC	PCI/PCIe	Hardware Accelerators
66AK2E02	Multicore DSP+ARM KeyStone II System-on-Chip (SoC)	1 ARM Cortex-A15	1250, 1400	1 C66x	1250, 1400	8-Port 1Gb Switch, 2-Port 10Gb Switch	4 PCIe Gen2	–
66AK2E05	Multicore DSP+ARM KeyStone II System-on-Chip (SoC)	4 ARM Cortex-A15	1250, 1400	1 C66x	1250, 1400	8-Port 1Gb Switch, 2-Port 10Gb Switch	4 PCIe Gen2	–
66AK2G02	Multicore DSP+ARM KeyStone II System-on-Chip (SoC)	1 ARM Cortex-A15	600	1 C66x	600	1-port 1Gb	PCIe Gen2	Security Acceleration, PRU-ICSS
66AK2H06	Multicore DSP+ARM KeyStone II System-on-Chip (SoC)	2 ARM Cortex-A15	1200, 1400	4 C66x	1200	4-port 1Gb Switch	2 PCIe Gen2	Packet Accelerator, Security Accelerator
66AK2H12	Multicore DSP+ARM KeyStone II System-on-Chip (SoC)	4 ARM Cortex-A15	1200, 1400	8 C66x	1200	4-port 1Gb Switch	2 PCIe Gen2	Packet Accelerator, Security Accelerator
66AK2H14	Multicore DSP+ARM KeyStone II System-on-Chip (SoC)	4 ARM Cortex-A15	1200, 1400	8 C66x	1200	4-port 1Gb Switch	2 PCIe Gen2	Packet Accelerator, Security Accelerator
66AK2L06	Multicore DSP+ARM KeyStone II System-on-Chip (SoC)	2 ARM Cortex-A15	1200	4 C66x	1200	4-Port 1Gb Switch	2 PCIe Gen2	FFT Coprocessor, Digital Front End
TMS320C6671	Fixed and Floating-Point Digital Signal Processor	–	–	1 C66x	1000, 1250	2-Port 1Gb Switch	2 PCIe Gen2	–
TMS320C6672	Multicore Fixed and Floating-Point Digital Signal Processor	–	–	2 C66x	1000, 1250, 1500	2-Port 1Gb Switch	2 PCIe Gen2	–
TMS320C6674	Multicore Fixed and Floating-Point Digital Signal Processor	–	–	4 C66x	1000, 1250	2-Port 1Gb Switch	2 PCIe Gen2	–
TMS320C6678	Multicore Fixed and Floating-Point Digital Signal Processor	–	–	8 C66x	1000, 1250	2-Port 1Gb Switch	2 PCIe Gen2	–

Sitara™ Processors

Part Number	Description	ARM CPU	ARM MHz (Max.)	EMAC	PCI/PCIe	Serial I/O	Co-Processor(s)
AM5K2E04	Multicore ARM KeyStone II System-on-Chip (SoC)	4 ARM Cortex-A15	1250, 1400	8-Port 1Gb Switch	4 PCIe Gen2	Hyperlink, I2C, SPI, TSIP, UART, USB	–
AM5K2E02	Multicore ARM KeyStone II System-on-Chip (SoC)	2 ARM Cortex-A15	1250, 1400	8-Port 1Gb Switch	4 PCIe Gen2	Hyperlink, I2C, SPI, TSIP, UART, USB	–
AM5728	Sitara Processor	2 ARM Cortex-A15	1500	10/100/1000, 2-Port 1Gb Switch	2 PCIe Gen 2	CAN, I2C, SPI, UART, USB	2 ARM Cortex-M4, 4 PRU-ICSS
AM5726	Sitara Processor	2 ARM Cortex-A15	1500	10/100/1000, 2-Port 1Gb Switch	2 PCIe Gen 2	CAN, I2C, SPI, UART, USB	2 ARM Cortex-M4, 4 PRU-ICSS
AM5718	Sitara Processor	1 ARM Cortex-A15	1500	10/100/1000, 2-Port 1Gb Switch	2 PCIe	CAN, I2C, SPI, UART, USB	2 ARM Cortex-M4, 4 PRU-ICSS
AM5716	Sitara Processor	1 ARM Cortex-A15	500, 1500	10/100/1000, 2-Port 1Gb Switch	2 PCIe	CAN, I2C, SPI, UART, USB	2 ARM Cortex-M4, 4 PRU-ICSS
AM3359	Sitara Processor	1 ARM Cortex-A8	800	2-Port 1Gb Switch	–	CAN, I2C, SPI, UART, USB	2 PRU-ICSS
AM3358-EP	AM3358 Sitara™ Processors	1 ARM Cortex-A8	800	2-Port 1Gb Switch	–	CAN, I2C, SPI, UART, USB	2 PRU-ICSS
AM3357	Sitara Processor	1 ARM Cortex-A8	300, 600, 800	2-Port 1Gb Switch	–	CAN, I2C, SPI, UART, USB	2 PRU-ICSS
AM3356	Sitara Processor	1 ARM Cortex-A8	300, 600, 800	2-Port 1Gb Switch	–	CAN, I2C, SPI, UART, USB	2 PRU-ICSS
AM3354	Sitara Processor	1 ARM Cortex-A8	600, 800, 1000	2-Port 1Gb Switch	–	CAN, I2C, SPI, UART, USB	–
AM3352	Sitara Processor	1 ARM Cortex-A8	300, 600, 800, 1000	2-Port 1Gb Switch	–	CAN, I2C, SPI, UART, USB	–
AM3351	Sitara Processor	1 ARM Cortex-A8	300, 600	10/100/1000	–	I2C, SPI, UART, USB	–

Processors
Hardware Solutions for Multicore Processors

Hardware Ecosystem

TI has also worked together with several 3rd party board manufacturers to develop off-the-shelf solutions. Click on any of the links below to gather more information on the design.

AMC-2C6678
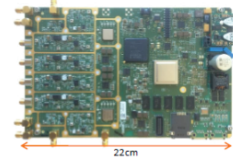**2x6678+FPGA AMC card**
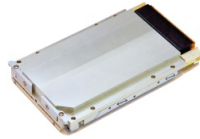
VPX-D16A4
66AK2H12 + C6678 3U Open VPX
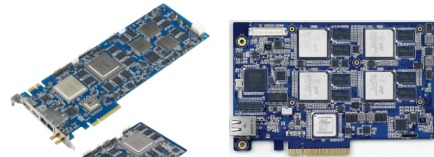
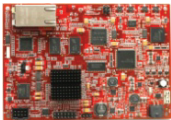**Full line of AMC and PCIe cards in various sizes with various processor counts.**
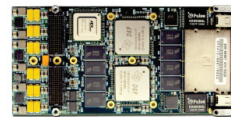
VF360 3U Open VPX Module

D.Module2.C6657 C6657 Module

Small Cell / SDR Products for Military/Aviation/Public Safety

14cm

22cm

Defense and Industrial-specialized Video networking

PDAK2H 66AK2H12 + 2x C6788 AMC

XMC-8320 2x C6670 XMC Card

FMC667 C6678 FMC Card

Processors
Software Solutions for Multicore Processors

TI's software offerings enable multicore performance with single core simplicity.

MCSDK Highlights

The Multicore Software Development Kit (MCSDK) provides foundational software and highly-optimized bundles of platform-specific drivers to enable development on TI's KeyStone multicore devices. Used along with TI's Code Composer Studio™ IDE, it encapsulates a collection of software elements and tools which enable straightforward customer application development and accelerate customer time to market by focusing on ease of use and performance. Available for free on the TI website, all software in the MCSDK is in source form along with pre-built libraries.

Included in the MCSDK:
- TI-RTOS kernal real-time embedded operating system for DSP cores
- Linux high-level operating system for ARM® cores, including SMP mode for multicore ARM devices

- DSP chip support libraries, ARM + DSP device drivers, and basic platform utilities
- Interprocessor communication models
- System-on-Chip (SoC) resource management
- Optimized application-specific and application non-specific algorithm libraries
- OpenMP™, the de facto industry standard for shared memory parallel programming, which allows users to implement multithreading algorithms on high-performance multicore devices
- OpenCL™, an open industry-standard framework for writing programs that run on a combination of ARM + DSP processors
- OpenEM, a centralized runtime system for event scheduling, which enables load balancing across all system resources

- MPI for cluster based calculations across multiple KeyStone architecture devices
- Trace, debug and instrumentation
- Bootloaders and boot utilities, power-on self-test
- Latest toolchain (ARM Linaro, DSP TI CodeGen)
- Demos and examples

OS Offerings
- TI-RTOS kernal provided for DSP development
- TI open-source Linux kernel provided with drivers on YoctoProject.org
- Third party operating systems available soon for KeyStone II devices:
  - Green Hills® INTEGRITY® RTOS
  - Wind River® VxWorks® RTOS
  - Wind River Linux
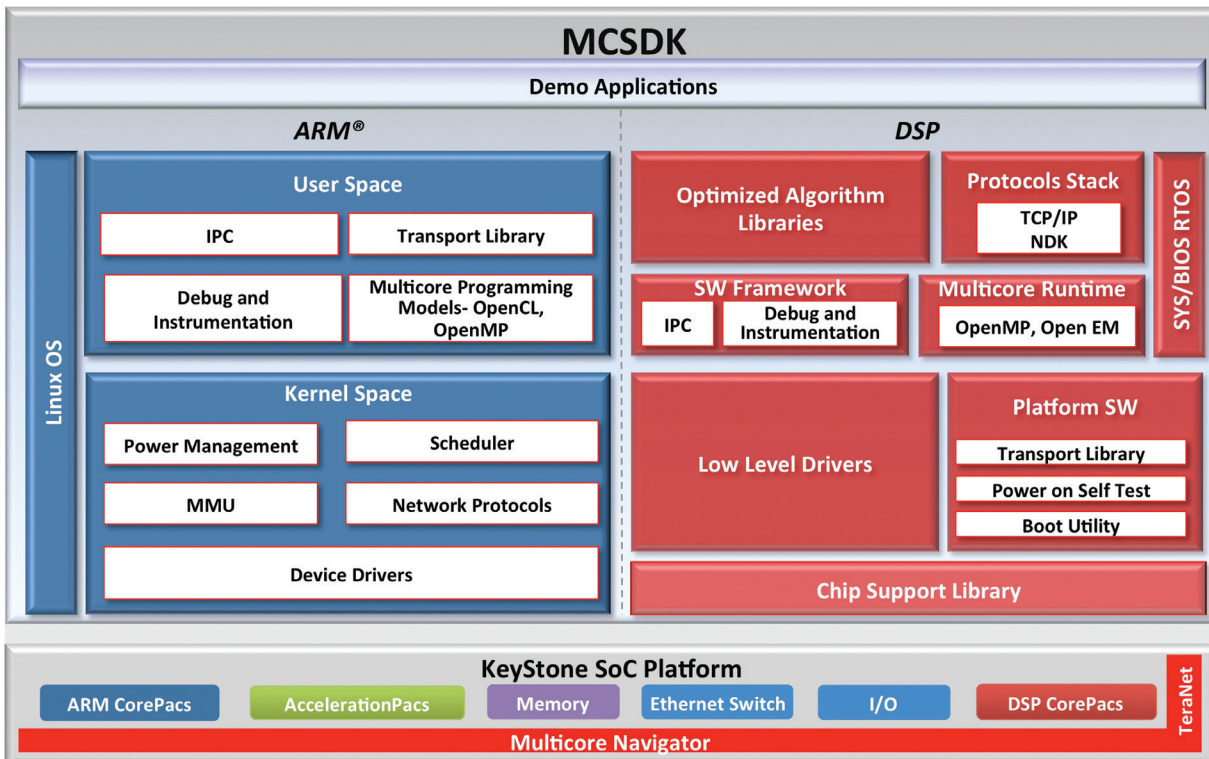
TI MCSDK for KeyStone II devices.

Processors
Software Solutions for Multicore Processors (Continued)

Development Tools

Code Composer Studio™, the best in class Eclipse™-based IDE, is provided at no cost with any of the KeyStone device evaluation kits (EVMs). Code Composer Studio is a common development tool for all TI processors and can be used for development on both the ARM® and DSP cores of KeyStone multicore processors. Code Composer Studio offers advanced debug features which include:

- Visibility into CPU Trace and System Trace: Allows identification of application hotspots and performance bottlenecks, bandwidth and latency analysis, interconnect and traffic monitoring
- Visibility into application and RTOS: Allows identification of thread and CPU load, OS object status, and correlation of information from various cores
- Trace: Provides a detailed, historical account of code execution, timing and accesses
- Debug Server Scripting: Allows automation of debugger functionality and is useful for performing regression testing

Third Party Ecosystem

A strong third party software ecosystem complements the tools and libraries provided by TI's MCSDK and Code Composer Studio™

- Third party plug-ins for Code Composer Studio
  - 3L's Diamond tool-suite and model provides an automated development flow and enables development to scale smoothly as cores per SoC and multicore SoCs per system increase.
  - CriticalBlue's Prism provides multicore analysis and exploration tools to evaluate parallelization strategies of existing software applications.
  - ENEA's Optima includes overview and management tools for multicore systems, profiling tools showing resource usage and debug tools that track execution of application and operating system events.
  - Polycore's Poly-Platform™ consists of productivity tools and run-time communications software that provide a programming model for applications to scale from one to many cores.

- Integretek's HyperLink IP core enables HyperLink connectivity between TI's KeyStone multicore processors and FPGAs from Xilinx® and Altera® using an industry standard AXI interface.
- nCore's Lithium Suite for KeyStone II processors is a set of tools, libraries and drivers that combine an optimized Linux kernel with HPC-oriented packages such as OpenMP, OpenMPI, BLAS, PAPI Performance Layer and more.
- RunTime Computing's VSI/Pro®, a VSIPL-compliant optimized library, provides highly efficient and portable computational middleware for signal and image processing applications.

For More Information

To learn more about the COTS DSP, ARM® and ARM + DSP products, please visit: **ti.com/multicore**

TI E2E Community
e2e.ti.com

TI Processors Wiki
processors.wiki.ti.com

TI Training Videos
training.ti.com

Third Party Partners: Software

Green Hills SOFTWARE
INTEGRITY RTOS
Hypervisor, Certified OS if needed

WIND RIVER
VxWorks RTOS, Wind River Linux
Hypervisor, Certified OS if needed

Signalogic We make computing faster. ®
CIM virtualization software
& SigRAD

Gedae
Gedae development environment

integretek
HyperLink FPGA IP block for Altera and Xylinx FPGAs

nCore
nCore Lithium Suite

Ittiam
Defense and Industrial-specialized Video networking

Comm Agility
mi!SmallCellPHY – 4G PHY Layer Software for SDR

Azcom Technology
3G/4G PHY Layer Software for SDR

Aricent
3G/4G Stack for SDR

TI Worldwide Technical Support

TI Support

Thank you for your business. Find the answer to your support need or get in touch with our support center at

www.ti.com/support

China: http://www.ti.com.cn/guidedsupport/cn/docs/supporthome.tsp

Japan: http://www.tij.co.jp/guidedsupport/jp/docs/supporthome.tsp

Technical support forums

Search through millions of technical questions and answers at TI's E2E™ Community (engineer-to-engineer) at

e2e.ti.com

China: http://www.deyisupport.com/

Japan: http://e2e.ti.com/group/jp/

TI Training

From technology fundamentals to advanced implementation, we offer on-demand and live training to help bring your next-generation designs to life. Get started now at

training.ti.com

China: http://www.ti.com.cn/general/cn/docs/gencontent.tsp?contentId=71968

Japan: https://training.ti.com/jp

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