Analog for Altera® FPGAs

Introduction

Texas Instruments (TI) is the approved and tested vendor of analog solutions for the Altera® FPGAs and CPLDs. TI works closely with Xilinx to recommend the best power management, clocking, data converters and other analog solutions for a wide variety of applications.

For the latest from Texas Instruments for Altera FPGAs, see **www.ti.com/altera**

Table of Contents

Power Solutions for Altera® FPGAs
Integrated Inductor, Low-Noise LDOs, Sequencer

Integrated Inductor

Smallest 10-A Power Solution in Industry

**TPS84A20
10-A DC/DC
Module**

- 10 x 10 x 4.3-mm QFN package, 205-mm² total solution size
- Input voltage: 2.95 to 17 V
- Capable of current sharing up to 60 A
- Flexible features: Class-B EMI compliant, synchronous external clock, adjustable frequency/soft start/UVLO, PG, EN, 180° clockout signal, remote sense
- 2Q12 RTM pin-compatible 7-A and 4-A devices

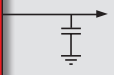### 6- to 36-V, 10-A Integrated Inductor Power Module

**LMZ23610
10-A DC/DC
Module**

- Current-sharing capability
- Low output-voltage ripple
- Flexible start-up sequencing using external soft start, tracking and enable
- Class-B EMI compliant

Integrated Inductor Power Module

**TPS84621/
TPS84320 6-A
DC/DC Module**

- Input voltage: 2.95 to 14.5 V
- 6-A/3-A modules in pin-compatible 9 x 15 x 2.8-mm packages
- Capable of current sharing up to 6 devices at 36 A
- Flexible features: Class-B EMI compliant, synchronous external clock, adjustable frequency/soft start/UVLO, PG, EN, 180° clockout signal, remote sense

Low-Noise LDOs

Lowest-Noise LDO in Industry

**TPS7A4901/4700
150-mA,
1-A LDO**

- Ultralow noise: 4 μV_{rms}
- High PSR: > 55 dB from 10 Hz to 10 MHz
- Adjustable output: 1.2 to 33 V
- Input voltage: 3 to 36 V

Low-Dropout Regulator (LDO)

**TPS747/8/901
0.5-A, 1.5-A,
3-A LDO**

- Adjustable output: 0.8 to 3.6 V
- Input voltage: 0.8 to 5.5 V with external bias
- Low noise: 25 μV_{rms} x V_{OUT}, 100 Hz to 100 kHz
- 2% accuracy over line, load and temperature
- Programmable soft start and Power Good output
- Low dropout: 60 mV at 1.5 A

Sequencer

Digital-Power PMBus Sequencer and System Health Monitor

**UCD90120A
12-Rail
Sequencer/
Monitor**

- Sequence up to 12 rails
- JTAG and PMBus communication interface (free Fusion Digital Power™ software)
- Overvoltage, undervoltage, current and temperature monitoring
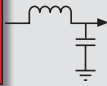- Margin up to 10 rails
- 9 x 9-mm QFN packaging

Power Solutions for Altera® FPGAs
High-Efficiency Integrated FETs, Multi-Rail Solution

High-Efficiency Integrated FETs

**High-Current DC/DC Converter
with Integrated FETs**

**LM21215A
15-A DC/DC
Converter**

- Low input voltage: 2.95 to 5.5 V
- Integrated FETs for small total solution
- Adjustable frequency up to 1.5 MHz
- Small 6.5 x 6.5-mm package

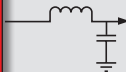**17-V_{IN}, High-Efficiency Single Buck Converter**

**TPS62130/40/50/60/70
17-V_{IN} Buck
0.5 A, 1 A, 2 A, 3 A**

- Up to 17 V_{IN}
- Adjustable and fixed V_{OUT} versions
- DCS-Control™ topology
- Tracking and programmable soft start, PG pin
- 100% duty cycle for lowest dropout
- Small inductor and low-ESR capacitors

**1-A DC/DC Nano Power Module
in Tiny 2.5 x 3-mm Package**

**LMZ10501
1-A DC/DC Nano
Power Module**

- Low input voltage: 2.7 to 5 V
- Integrated inductor
- Tiny packaging: 2.5 x 3 x 1.2 mm
- Integrated compensation with current-limit protection
- 0.6- to 3.6-V output

6-V_{IN}, High-Efficiency Single Buck Converter

**TPS62230/065/080/090
15-A
DC/DC Converter**
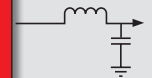
- V_{IN} from 2.5 to 6 V
- Adjustable and fixed V_{OUT} versions
- DCS-Control™ topology
- Smallest solution size: 2.8 MHz with 0.47 µH (highest efficiency at 1.4 MHz with 1 µH)
- 20-µA I_Q in power-save mode
- Small 5 x 6-mm QFN packaging

Multi-Rail Solution

Dual Buck Converter with I^{2}C and Current Sharing

- High-current dual buck with optional current sharing
- With and without I^{2}C/DVS
- V_{IN} range: 4.5 to 18 V
- V_{OUT} range: 0.68 to 1.95 V
- Feedback reference: 0.6 V ±1%
- All devices are pin-to-pin compatible
- ±1%, 600-mV reference

**TPS6527x
Dual Buck Family**
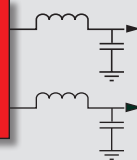
- TPS65273: 3.5 A/3.5 A, current sharing for 7 A
- TPS65276: 6 A/3.5 A
- TPS65279: 5 A/5 A, current sharing for 10 A
- TPS65273V: 3.5 A/3.5 A, current sharing for 7 A, I^{2}C/DVS
- TPS65276V: 6 A/3.5 A, I^{2}C/DVS
- TPS65279V: 5 A/5 A, current sharing for 10 A, I^{2}C/DVS

Get more information: **www.ti.com/alterafpga** and **www.ti.com/processorpower**

Power Solutions for Altera® FPGAs
Power-over-Ethernet (PoE)

The concept of providing power along with data is as old as basic telephone service, but the formal standard for providing power along Ethernet lines is much more recent. Though the original Power-over-Ethernet (PoE) specification was approved in 2005, the IEEE ratified a superseding standard in summer 2009—the IEEE 802.3at. Both standards specify behavior for devices receiving power across Ethernet lines, known as powered devices (PDs), and methods for injecting power onto the line, used in equipment known as power sourcing equipment (PSE).

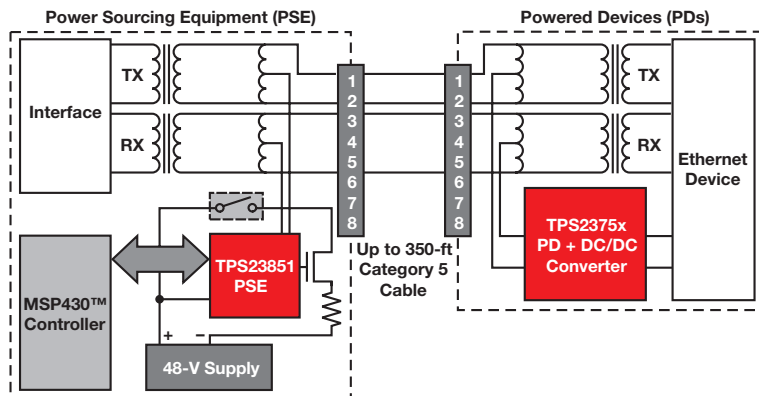*The new TPS23851 and TPS2375x are IEEE 802.3at-compliant power-management ICs designed for managing the connection between PSE and PDs over Ethernet cables. The TPS23851 is a quad-port PSE power manager with external FETs and individual ADCs per port for maximum monitoring and control.*

Original PoE . . . Only Better!
The vast majority of PoE applications need less than 12.95 W. For this growing market area, TI has a large portfolio of options to consider.
TPS23753A
- Simplest, most elegant, lowest-cost solution for a standard PoE PD
- Incorporates rugged tolerance for extended ESD exposure
- Auxiliary power supplies are fully supported—down to 12 V

TPS23750
- TI's original PD front end plus DC/DC converter
- Supports simple, low-cost, non-isolated buck-converter topologies with no transformer required

New PoE Products for a New Standard

Selection Guide

Device	Description	Abs Max VIN (V)	Operating Temp (°C)	Full Inrush Current Limiting	Current Limit (mA)	Second Gate Driver for Maximum Efficiency	Package(s)	Price
Power-over-Ethernet (PoE) Powered Device (PD) Controllers with Integrated DC/DC Controllers								
TPS23750/70	Integrated PD with PWM controller	100	-40 to 85	Fixed	405	No	TSSOP-20	1.50
TPS23753A	PD+controller with AUX ORing	100	-40 to 85	Fixed	405	No	TSSOP-14	1.45
TPS23754/6	High-power PD + high-efficiency controller	100	-40 to 125	Fixed	850	Yes	TSSOP-20 PowerPAD™	1.90
TPS23757	PD + high-efficiency controller	100	-40 to 125	Fixed	405	Yes	TSSOP-20	1.65
TPS23751/2	PD with Green Mode PWM	100	-40 to 85	Fixed	800	No - VF	TSSOP-20	1.50
LM5070	Integrated PD with PWM controller	80	-40 to 125	Prog	500	No	TSSOP-16	1.45
LM5071	Integrated PD with PWM controller and AUX interface	80	-40 to 125	Fixed	390	No	TSSOP-16	1.45
LM5072	Integrated PD with PWM controller and AUX control	100	-40 to 125	Prog	800	No	TSSOP-16	1.85

Device	Description	Detection	Classification	Abs Max VIN (V)	Operating Temp (°C)	Full Inrush Current Limiting	Current Limit (mA)	Auto Retry or Latch Off in Fault	UVLO	DC/DC Interface	Package(s)	Price*
Power-over-Ethernet (PoE) Powered Device (PD) Interface Front-End Controllers												
TPS2375/-1	Powered device controller	4	Yes, Class 0-4	100	-40 to 85	Programmable	450	Latch Off/Retry	802.3af (30.6/39.4 V)	PG	SOIC-8, TSSOP-8/TSSOP-8	1.00
TPS2376	Powered device controller	4	Yes, Class 0-4	100	-40 to 85	Programmable	450	Latch Off	Adjustable	PG	SOIC-8, TSSOP-8	1.00
TPS2376-H	High-power PD controller	4	Yes, Class 0-4	100	-40 to 85	Programmable	600	Auto Retry	Adjustable	PG	SOIC-8	1.25
TPS2377	Power device controller	4	Yes, Class 0-4	100	-40 to 85	Programmable	450	Latch Off	Legacy (30.5/35.0 V)	PG	SOIC-8, TSSOP-8	1.00
TPS2377-1	Power device controller	4	Yes, Class 0-4	100	-40 to 85	Programmable	450	Auto Retry	Legacy (30.5/35.0 V)	PG	SOIC-8	1.00
TPS2378	PD with AUX control	4	Yes, Class 0-4	100	-40 to 85	Fixed	800	Auto Retry	30.5/35	PG	SOIC-8	1.00
TPS2379	PD with high power	4	Yes, Class 0-4	100	-40 to 85	Fixed	800	Auto Retry	30.5/35	PG	SOIC-8	1.00
LM5073	PD controller w/AUX control	4	Yes, Class 0-4	100	-40 to 85	Programmable	800	Auto Retry	Adjustable	PG	TSSOP-14	1.30

Device	Applications	Channels	Abs Max VIN (V)	Operating Temp (°C)	IEEE Compliant	Interface	Disconnect	Measurements	Power FET	Package	Price*
Power-over-Ethernet (PoE) Power Sourcing Equipment (PSE) Controllers											
TPS2384	Routers, switches, SOHO hubs, midspans	4	80	-40 to 125	802.3af	I²C	Both AC and DC	Current, voltage, capacitance and temperature	Internal	64-pin LQFP	4.75
TPS23841	Proprietary, higher-power 24-V/48-V PoE switches, hubs, midspans	4	80	-40 to 125	802.3af	I²C	Both AC and DC	Current, voltage, capacitance and temperature	Internal	64-pin LQFP	7.50
TPS23851	High power PoE for switches, hubs, midspans and industrial applications	4	70	-20 to 125	802.3af Type 1 & 2	I²C	Both AC and DC	Current, voltage and temperature	Internal	36-pin SSOP	4.50

*Suggested resale price in U.S. dollars in quantities of 1,000.

New devices are listed in bold red.

Power Solutions for Altera® FPGAs
Stratix®, Arria® and Cyclone® Families

Power Products

Output Current	Input Voltage Range (V)			
	1.5 to 3.0	3.0 to 5.5	4.5 to 17	> 17
< 200 mA	LP5900 TPS720xx TPS712xx	LP5900 TPS712xx TPS728	TPS715A TPS62170	TPS54062 TPS54040 LM5017 TPS7A16
≤ 500 mA	TPS720xx TPS7A7100	TPS7A7100 TPS62140 TPS6223x LMZ10500	TPS62170 TPS62160 LMZ12001 LMZ14201	LM22671 TPS54040/60 LM5017 LMZ14201
500 mA to 1.5 A	LP38500 TPS7A7200 TPS7A7100 TPS7A8001	LMZ10510 LMR10501 TPS62290 TPS62140 TPS54218 TPS84210	LMR12010 TPS54294/5 Dual TPS62140 TPS54120 TPS54225/6	LMR24210 TPS54231 TPS54160 LM557x LMZ23603
1.5 A to 3 A	TPS7A7200 TPS7A7300 TPS7A7001	TPS54318 PTH04070W TPS84410	TPS5432x LMZ22003 TPS84320	TPS54331 TPS54260 LM22676 LMZ23603
3 A to 6 A		TPS54418 TPS54618 TPS84610	TPS5462x TPS5442x LMZ22005/8 TPS84621	TPS5450 LM3150 LMZ13610 LMZ23605/8 LM25116
6 A to 10 A		LM21212 PTH04T240W TPS40040	TPS56121 TPS54821 LMZ22008/10	LM22679 LM3150 LMZ23608/10 TPS40170
≥ 10 A to 16 A		LM21215 TPS53353 PTH04T220W TPS40322	TPS56121 PTH08T220W TPS40400 TPS40322	LMZ23610 TPS40061 TPS40170 LM3150
≥ 20 A		TPS53355 PTH05T210W TPS40322	TPS56221 PTH08T255W TPS40322 PTH08T250W	LM(2)5119 LMZ23610 TPS40140

Texas Instruments provides the industry's cutting-edge PLL technology for FPGAs with a broad portfolio of clocking solutions that includes clock jitter cleaners, clock generators and clock buffers. The easy-to-use TI Clock Design Tool software simplifies clocking solutions for FPGA design by aiding in part selection, loop-filter design and simulation. The high-performance, low-power, flexible clocking solutions support existing and next-generation FPGA products from Altera,® moving to higher data rates and stringent clock requirements for various data-transmission standards. To see TI's latest clocks and timers, visit **www.ti.com/clocks**

Clock Jitter Cleaners
- Industry's lowest RMS jitter; < 150 fs (10 kHz to 20 MHz) at 156.25 MHz
- LOS alarm generation, reference switching, holdover, dynamic skew control
- Programmable differential or CMOS outputs

Clock Generators
- Superior performance with low power
- Flexible frequency planning
- Up to 14 outputs
- Low jitter
- Outstanding PSNR
- Industry's lowest noise floor
- Programmable via I^2C/SPI or pin-select holdover
- Dynamic skew control
- Programmable differential or CMOS outputs

Clock Buffers
- Low additive phase jitter: < 40 fs
- Low output skew
- LVPECL, LVDS, HCSL, HSTL and LVCMOS output support
- Programmable digital delay
- Low power consumption

Clocking Portfolio by Application

Application	Protocol	Line Rate (Gbps)	Jitter Cleaners					Clock Generators					Clock Buffers		
			LMK04906	LMK0480x	LMK04828	CDCE72010	CDCM7005	LMK03806	CDCM6208	CDCE62005/2	CDCM6100x	CDCM9102	LMK0030x	CDCLVD12xx/21xx	CDCLVP12xx/21xx
Communication Links	PCIe Gen1/Gen2	2.5/5	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔
	PCIe Gen3	8	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔
	1 GbE	1.25	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔
	40 GbE	10.3125	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔
	10 GbE/XAUI	3.125	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔
	10 GbE XFI	10.3125	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔
	Serial Rapid I/O	1.25/2.5/3.125/5/6.25	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔
	SAS/SATA	1.5/3/6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Fiber Channel	1.0625/2.125/4.25/8.5/10.52/14.025	✔	✔	✔	✔	✔	✔	✔	✔			✔	✔	✔
	JESD204B	12.5/6.375		✔											
Optical	OC-3/OC-12	0.155/0.622		✔				✔	✔	✔	✔		✔	✔	✔
	OC-48	2.488	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔
	OC-192	9.953	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔
Wireless	CPRI	0.644/1.2288/2.4576/3.072/4.9152/6.144/9.8304	✔	✔	✔	✔	✔						✔	✔	✔
	OBSAI	0.768/1.536/3.072/6.144	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔
Video	SDI 3G/HD/SD	2.97/1.485/0.27	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔
	HDMI/DVI	0.25 to 3.4	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔
	DisplayPort	1.62/2.7/5.4	✔	✔	✔	✔	✔	✔	✔				✔	✔	✔

Clocking Solutions for FPGAs
Clock Recommendations for Altera®
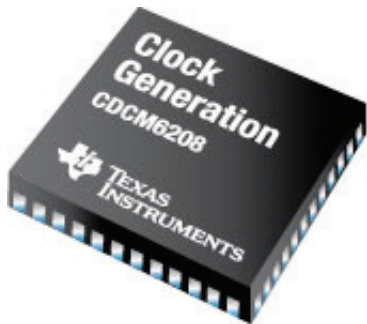
CDCM6208

The Texas Instruments CDCM6208 is a highly versatile, low-jitter (< 300-fs RMS typical, 12 kHz to 20 MHz), low-power frequency synthesizer. It can generate up to eight clock outputs with flexible supply voltages of 1.8, 2.5 or 3.3 V. It features ultraflexible frequency planning with four fractional and two integer output dividers. A system clock, SGMII GTX clock, PS clock and user clock can be generated by a single CDCM6208, which can support any frequency rate up to 400 MHz.

The CDCM6208 can be used as a single multi-frequency generator to replace fixed/programmable clock generators and fanout buffers, thereby minimizing board space and overall BOM cost. The device can be easily configured via an I^2C/SPI programming interface. Pin-programming modes are additionally supported.

For more information about TI's CDCM6208, visit **www.ti.com/product/cdcm6208**

LMK04906

A jitter-attenuated clock can be generated by the Texas Instruments LMK04906, which is a clock jitter cleaner/multiplier featuring a dual-loop PLLatinum™ PLL architecture for ultralow jitter cleaning over the widest range of output frequencies (from 2.26 MHz to 2.6 GHz). It accepts three redundant input clocks with frequencies ranging from 1 kHz to 750 MHz and generates up to six outputs programmable as LVDS, LVPECL or LVCMOS. The input clock frequency and clock multiplication ratio are

programmable through an SPI interface. The LMK04906 can also buffer a crystal or VCXO to generate a seventh unique clock frequency. With an output jitter performance of less than 100-fs RMS (10 kHz to 20 MHz), the LMK04906 is ideal for clock multiplication and jitter attenuation in high-performance clocking applications.

For more information about TI's LMK04906, visit **www.ti.com/product/lmk04906**

Altera EVM Platforms	Proposed TI Solution	Output Frequencies (MHz)	Output Formats	TI Solution – Value Proposition
Arria - V	CDCM6208	125	LVDS	Lower RMS jitter, flexible frequency generation, more outputs, reduces BOM
		25		
		50	LVCMOS	
	CDCM6208	125	LVDS	Lower RMS jitter, flexible frequency generation, more outputs
		409.6		
		156.25		
		100		
	CDCLVD1204	100	LVDS	
	LMK00304	125	LVDS	Lower jitter, flexible outputs, lower power consumption
Cyclone - V	CDCM6208	50	CMOS	Lower RMS jitter, flexible frequency generation, more outputs
		50	CMOS	
		25	CMOS	
		100	CMOS	
		125	LVDS	
Stratix - V	LMK00306	625	LVDS	Lowest additive jitter, flexible outputs (LVDS / LVPECL / HCSL), low power, high operating frequency
		875		
		644.53		
		706.25		
	CDCM6208	50	LVCMOS	Lower RMS jitter, flexible frequency generation, more outputs
		25/100/125/200	LVDS / LVPECL	
	CDCLVC1104	50		Lowest additive jitter, high operating frequency
	CDCM9102	25/100/125/200	HCSL	Very low jitter, flexible outputs (LVPECL, LVDS, LVCMOS, HCSL), PCIe Gen 1/2/3

## JESD204B ADC—Highest Dynamic Performance to Maximize Receiver Sensitivity

The ADS42JB69 is the industry's first dual-channel, 16-bit analog-to-digital converter (ADC) featuring the JESD204B interface and is also the fastest at 250 MSPS.
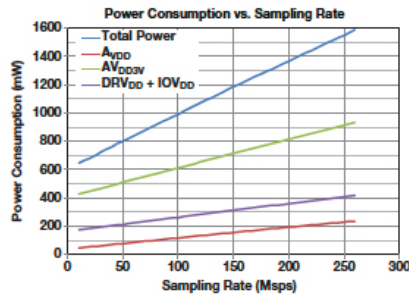
Get more information: www.ti.com/product/ADS42JB69

High-Speed DAC34SH84 Family

High-speed, wide bandwidth, single- and dual-channel DACs designed for applications requiring exact frequency placement and superior linearity, crosstalk and PLL phase-noise performance.
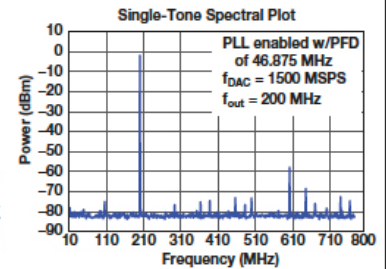
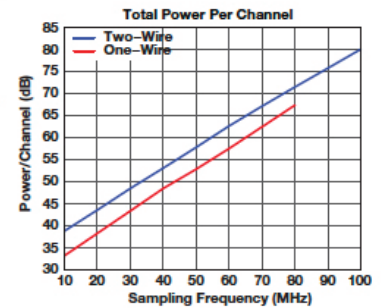Get more information: www.ti.com/product/DAC34SH84

ADC12D1x00 Family

The ADS12D1x00 family offers excellent dynamic performance over large input bandwidths and sampling rates—up to 3.6 gigasamples per second (GSPS). The product plugs directly into a Xilinx evaluation board with no adapter cards required.
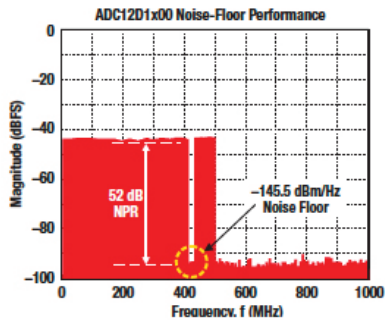
Get more information: www.ti.com/product/ADC12D1600

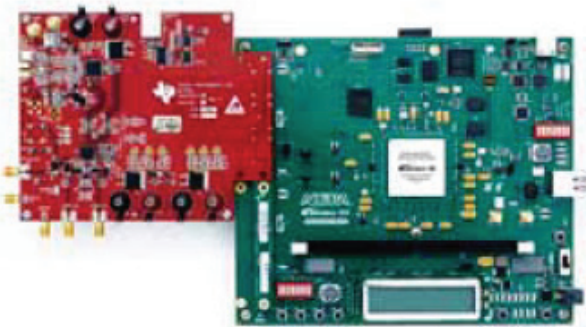## ADS5295 Family

Lowest power, 8-channel, 10- to 12-bit ADCs capable of speeds to 80 MSPS in a 80-pin PQFP package.

Get more information: www.ti.com/product/ADS5295

Get more information: www.ti.com/dataconverters

TI DAC with Direct Connection to Altera Development Kit

*TI ADC Evaluation Module with Interposer Card Connection to Altera Development Kit*

Get more information: www.ti.com/altera

Arria V FPGA RF Development Kit

The TI and Altera Arria V FPGA RF Development Kit includes all of the hardware and software needed for RF transmit, receive and digital pre-distortion feedback helping you to reduce RF system design and validation time from months to weeks.
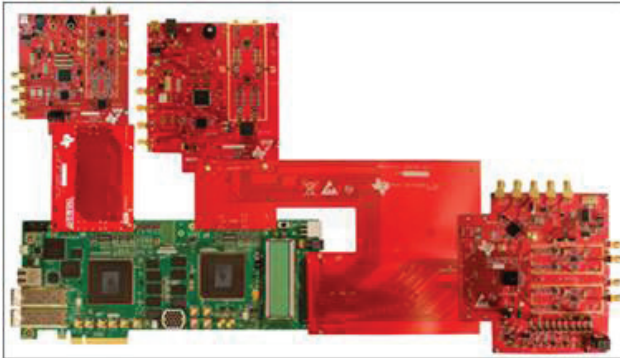
High Speed ADC to HSMC (Altera) Header Adaptor Card

The HSMC-ADC-Bridge passive
interconnect board enables the output of TI's LVDS output high speed ADCs to directly connected to a standard HSMC interconnect header, a typical input on the latest Altera FPGA EVMs. This enables users of TI's high speed data converter EVMs to directly interface to Altera FPGA's for prototyping purposes, saving the time and cost of producing a Custom prototyping board.
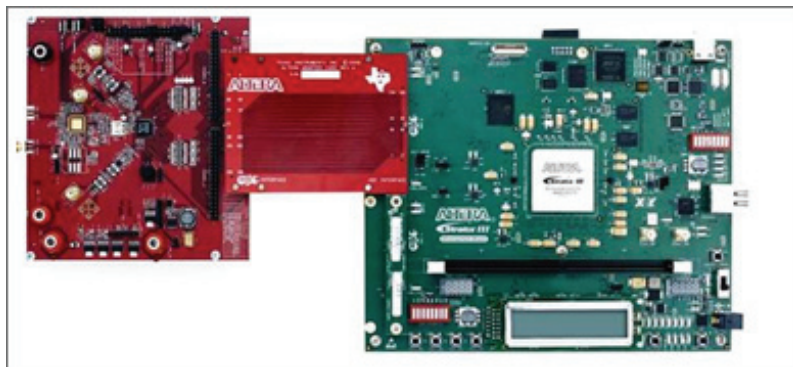
ArriaV-TI-Adaptor
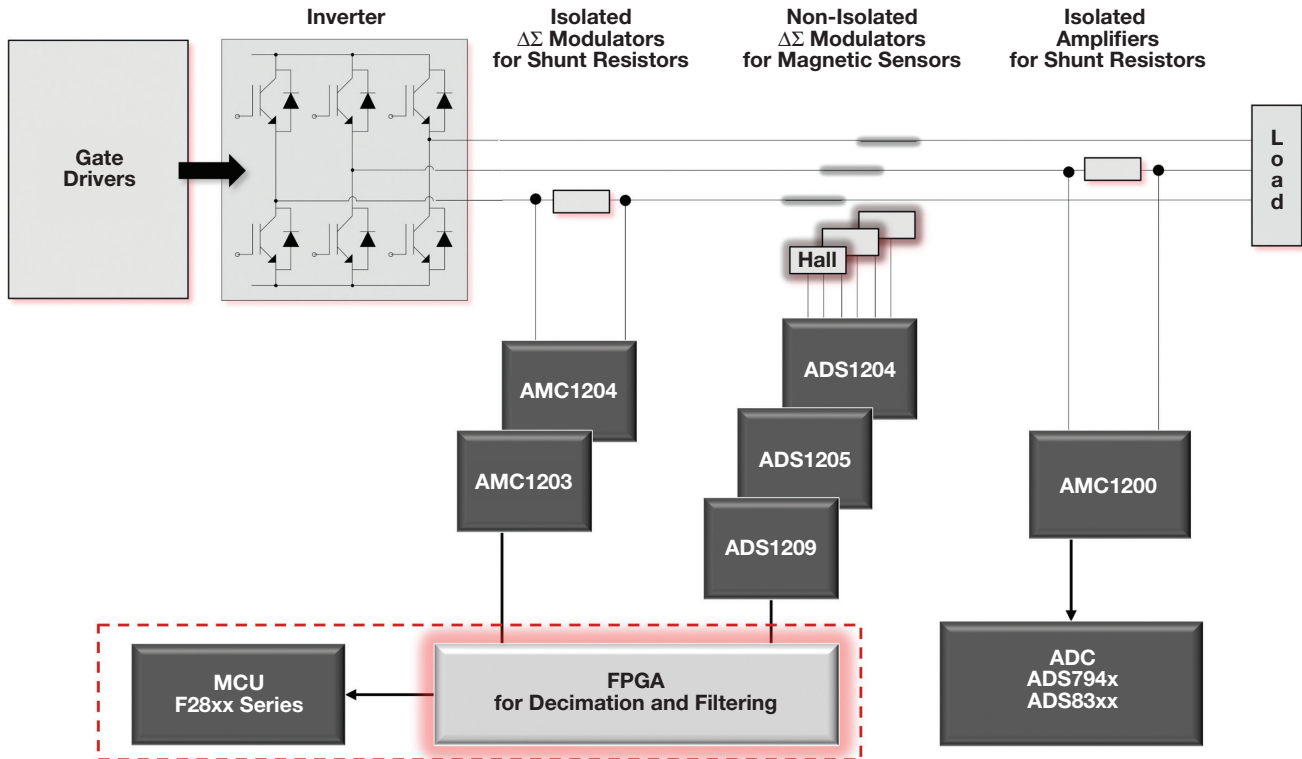
The ArriaV-TI-Adaptor is an adapter that enables TI's TSW1266 quadrated receive/DPD-observation path EVM and TSW30H84 transmit EVM to simultaneously connect to Arria V development kit from Altera. When used together the TSW1266, TSW30H84 and Arria V development kit enables the testing and development of advanced DPD hardware and software platforms for up to 500MHz of observation bandwidth.

High-Speed ADCs and DACs
Precision ADCs and DACs

Delta-Sigma Modulators—Current-Measurement Applications

Inverter

**Isolated
ΔΣ Modulators
for Shunt Resistors**

**Non-Isolated
ΔΣ Modulators
for Magnetic Sensors**

**Isolated
Amplifiers
for Shunt Resistors**

Gate Drivers

Load

Hall

AMC1204

AMC1203

ADS1204

ADS1205

ADS1209

AMC1200

MCU
F28xx Series

FPGA
for Decimation and Filtering

ADC
ADS794x
ADS83xx

Delta-Sigma Modulators—Motor-Control Applications

Inverter

Shunt Resistors

Resolver

Motor

Gate Drivers

**Isolated
ΔΣ Modulators**

**Isolated
Amplifiers**

**Non-Isolated
ΔΣ Modulators**

AMC1204

AMC1203

ADS1200

sin

cos

ADS1209

ADS1205

MCU
F28xx Series

FPGA
for Decimation
and Filtering

MCU
F28xx Series

PWM
Excitation

FPGA
for Decimation and
Filtering

MCU
F28xx Series
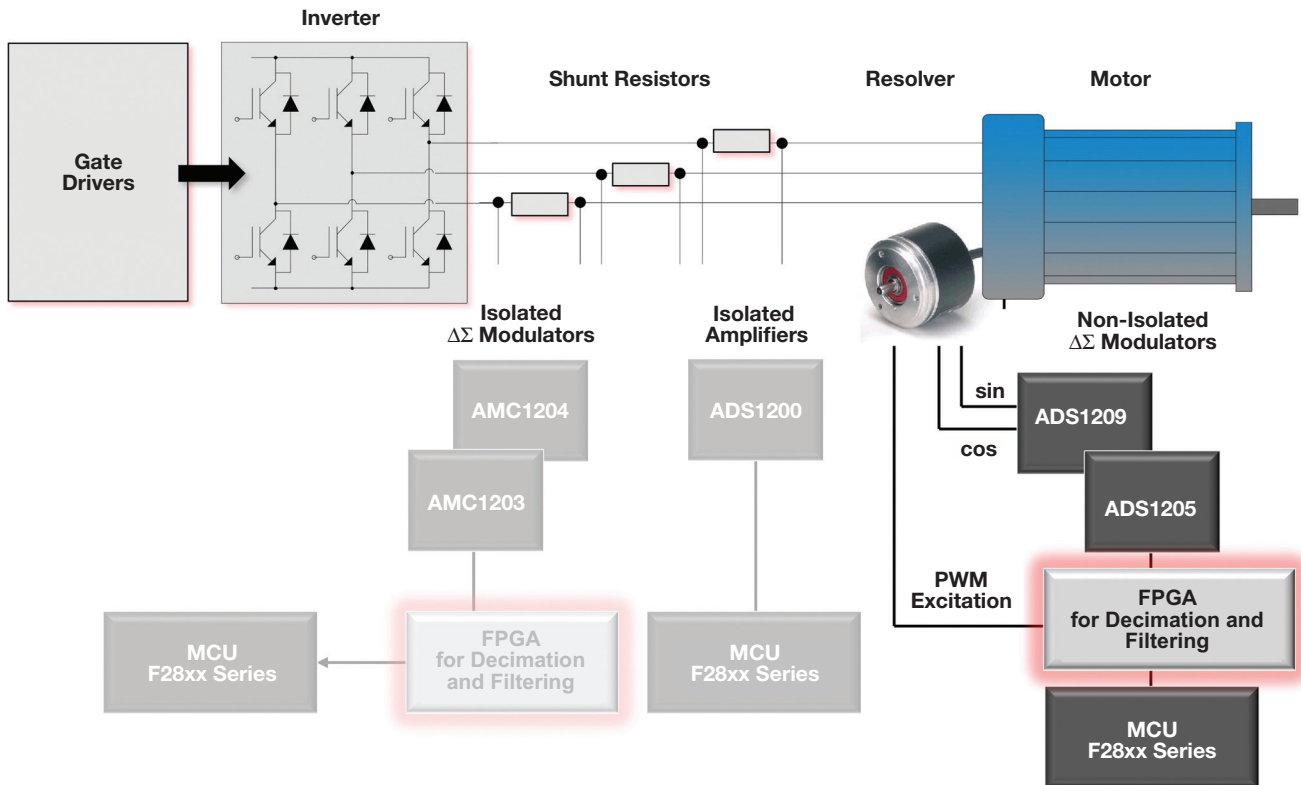
Retimers and Redrivers
Extending Reach and Solving Jitter Issues

Telecom Switch/Router Solutions

Clean Signal

Noisy Signal
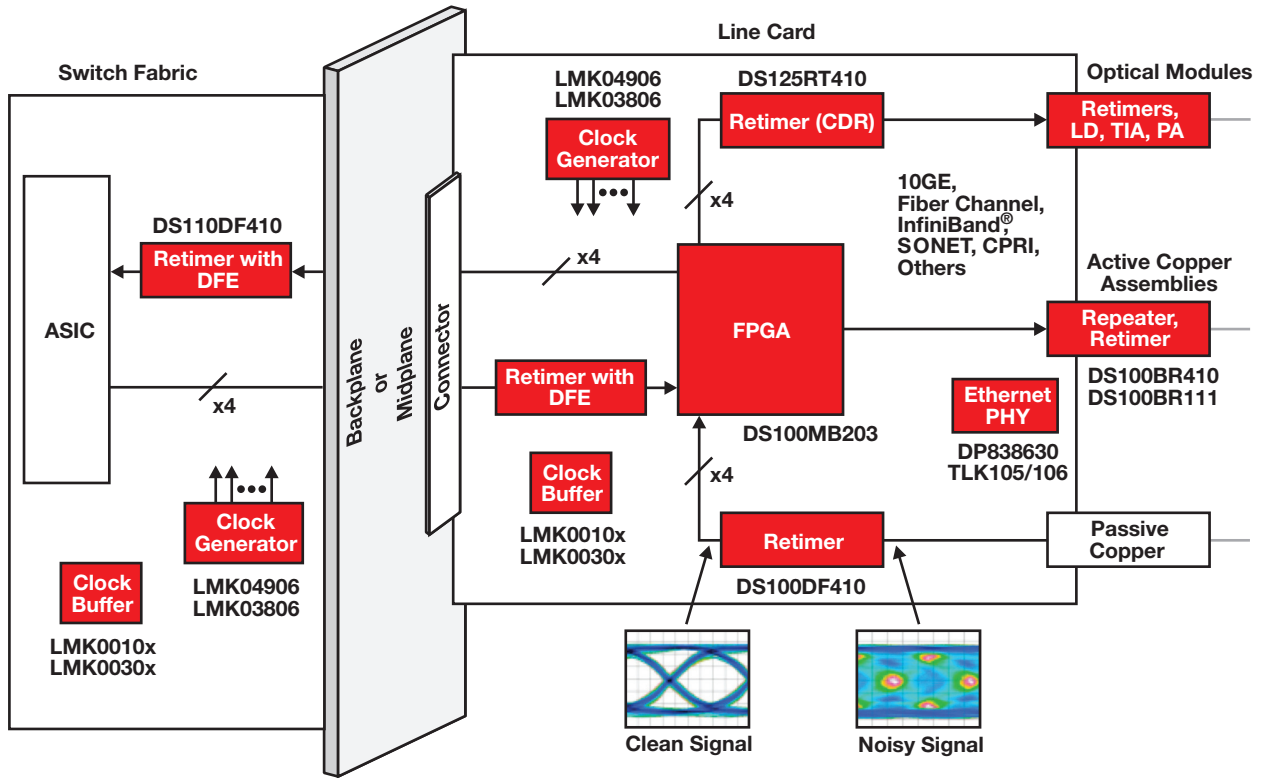
Repeaters/Redrivers and Retimers

Device	Channels	Protocol	Max Data Rate (Gbps)	Input SigCon (dB)	Output SigCon (dB)	Power/Ch (mW)	Package(s)
DS100KR401/800	Up to 8[1]	Multi-protocol[2]	10.3	36	−12	65	QFN-54
DS100BR410	4	Multi-protocol[3]	10.3	36	−9	55	QFN-48
DS100DF410	4	10GbE/1GbE retimer	10.3	36	−12	175	QFN-48
DS110DF410	4	Multi-protocol retimer	11.3	36	−12	175	QFN-48
DS125DF410	4	Multi-protocol retimer	12.5	36	−12	175	QFN-48
DS100BR111/210	2[1]	Multi-protocol[2, 3]	10.3	36	−12	65	QFN-24
DS80PCI402/800	8[1]	PCIe Gen-1/2/3	8	36	−12	65	QFN-54
DS80PCI102	2[1]	PCIe Gen-1/2/3	8	36	−12	65	QFN-24
DS50PCI402	8[1]	PCIe Gen-1/2	5	26	−12	95	QFN-54
DS64BR401	8[1]	Multi-protocol[1, 3]	6.4	33	−12	95	QFN-54
SN75LVCP600S	1	Multi-protocol[3]	6	15	−1.5	106	QFN-10
SN75LVCP601	2[1]	Multi-protocol[3]	6	14	−7	110	QFN-20
SN65LVPE502CP	2[1]	USB 3.0	5	15	−7	165	QFN-24
DS42BR400	8[1]	Multi-protocol	4.2	5	−9	163	QFN-60
DS25BR440	4	Multi-protocol	3.125	5	6	134	QFN-40
DS25BR100	1	Multi-protocol	3.125	8	6	115	QFN-8

[1]Bidirectional channel.
[2]Includes support for 10G-KR link training.
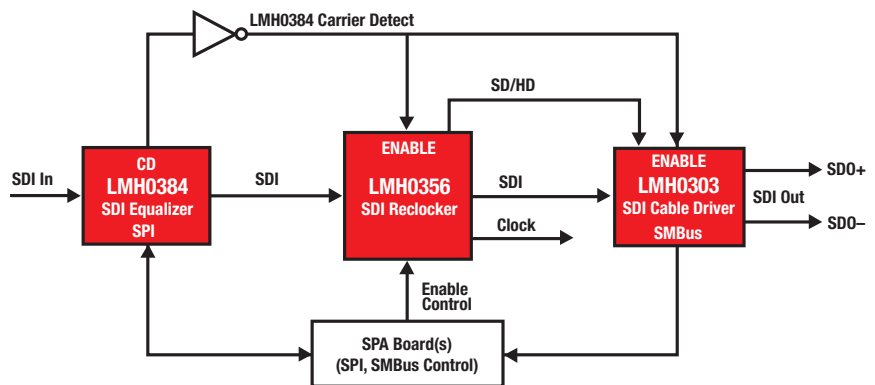[3]Includes SAS/SATA OOB support.

Triple-Rate Distribution Amplifier

Key Features
- Auto signal detection at equalizer input
- Cable detection at driver output
- Significant power savings
- 95% power savings in power-save mode
- Triple-rate SMPTE support
- Supports SMPTE 424M (3G), 292M (HD), 259M/C (SD) and DVB-ASI

Equalizers, Reclockers and Cable Drivers[1]

Device	Description	Supply Voltage (V)	Typ Power (mW)	Data Rate (Mbps)	Temp Range[2]	Evaluation Board	Package(s)
Cable Equalizers							
LMH0384SQ	3G/HD/SD extended-reach adaptive cable equalizer	3.3	230	143 to 2970	Ind	SD384EVK	LLP-16
LMH0344GR/SQ	3G/HD/SD adaptive cable equalizer	3.3	280	143 to 2970	Ind	SD344EVK	microArray-25, LLP-16
LMH0044SQ	HD/SD adaptive cable equalizer	3.3	208	143 to 1485	Ext	SD044EVK	LLP-16
LMH0034MA	HD/SD adaptive cable equalizer	3.3	208	143 to 1485	Ext	SD034EVK	SOIC-16
LMH0074SQ	SD adaptive cable equalizer with cable detect	3.3	208	143 to 540	Ind	SD074EVK	LLP-16
LMH0024MA	3.3-V SD adaptive cable equalizer	3.3	198	143 to 540	Ind	SD024EVK	SOIC-16
Reclockers							
LMH0346MH/SQ	3G/HD/SD reclocker with dual differential outputs	3.3	370	270 to 2970	Ind	SD3GDAEVK/ SD346EVK	eTSSOP-20, LLP-24
LMH0356SQ/SQ-40	3G/HD/SD reclocker with 4:1 input MUX and FR4 equalization	3.3	430	270 to 2970	Ind	SD356EVK	LLP-48, LLP-40
LMH0046MH	HD/SD reclocker with dual differential outputs	3.3	330	143 to 1485	Ind	SD046EVK	eTSSOP-20
LMH0056SQ	HD/SD reclocker with 4:1 input MUX and FR4 equalization	3.3	360	143 to 1485	Ind	SD046EVK	LLP-48
LMH0026MH	SD reclocker with dual differential outputs	3.3	330	270	Ind	SD046EVK	eTSSOP-20
LMH0036SQ	SD reclocker with 4:1 input MUX and FR4 equalization	3.3	350	270	Ind	SD046EVK	LLP-48
Cable Drivers							
LMH0307GR/SQ	3G/HD/SD SDI dual cable driver with cable detect, input LOS, selectable slew rate and 4-mW power-down mode	3.3	275	Up to 2970	Ind	SD307EVK	microArray-25, LLP-16
LMH0302SQ	3G/HD/SD cable driver with enable feature	3.3	165	Up to 2970	Ind	SD302EVK	LLP-16
LMH0303SQ	3G/HD/SD SDI cable driver with cable detect, input LOS, selectable slew rate and 4-mW power-down mode	3.3	155	Up to 2970	Ind	SD303EVK	LLP-16
LMH0002MA/TMA	HD/SD serial digital cable driver with selectable slew rate	3.3	149	Up to 1485	Com/Ind	SD002EVK	SOIC-8
LMH0002SQ	HD/SD serial digital cable driver with selectable slew rate	3.3	149	Up to 1485	Ind	SD002SQ-EVK	LLP-16
LMH0202MT	Dual SD/DS serial cable driver with dual differential input and output	3.3	298	Up to 1485	Com	SD202EVK/ DVB202-EVK	TSSOP-16
LMH0001SQ	SD serial digital cable driver with adjustable output amplitude	3.3	125	Up to 540	Ind	SD001SQ-EVK	LLP-16

[1] Older products not shown in the table but still in production include CLC001AJE, CLC005AJE, CLC006AJE and CLC007AJE.
[2] Temperature ranges: Com = 0°C to 70°C, Ext = 0°C to 85°C, Ind = −40°C to 85°C.

Serial Digital Interface (SDI) Solutions
SerDes Solutions

TI's Easy-to-Use Video Solutions

For decades, Texas Instruments has been a trusted advisor and solutions provider to the professional and broadcast video industry. TI continues to offer the industry's most comprehensive portfolio of serial digital interface (SDI) solutions. Energy-efficient, easy-to-use products save design time and reduce development costs to get your products to market more quickly. The following diagram and base portfolio table provide an overview of SDI solutions for 3-Gbps (3G), high-definition (HD) and standard-definition (SD) applications.

3G/HD/SD SDI Switcher Simplified Block Diagram
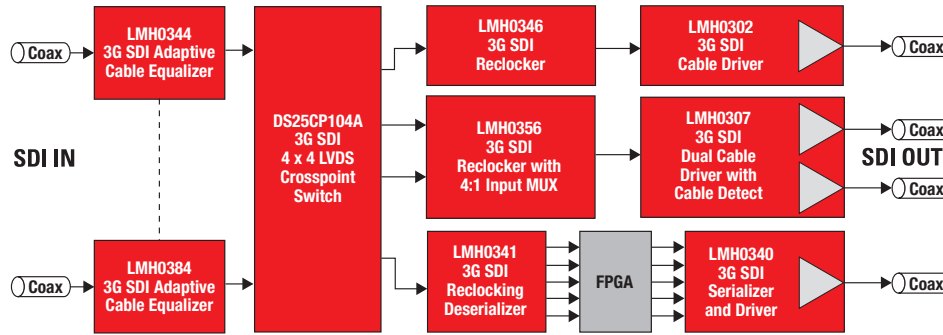
Base Portfolio

SDI Family	Equalizers	Reclockers	Cable Drivers	Serializers	Deserializers	Video Clocking Products
3G	LMH0384	LMH0356	LMH0307	LMH0340	LMH0341	LMH1982
	LMH0344	LMH0346	LMH0303			LMH1981
			LMH0302			
HD	LMH0044	LMH0056	LMH0002	LMH0050 LMH0040 LMH0030	LMH0051 LMH0041 LMH0031	
	LMH0034	LMH0046	LMH0202			
SD	LMH0024	LMH0036	LMH0001	LMH0070	LMH0071	
	LMH0074	LMH0026				

Get more information: **www.ti.com/sdi**

Signal Conditioning Extends Signal Integrity of FPGA Solutions

Key Features
- Wide operating frequency
- Integrated signal conditioning
- Sends raw data easily
- No reference clock required
- Low EMI, high ESD protection
- Supports FR4, cable, fiber

SerDes Families

Family	Serializer	Deserializer	Parallel Interface	SigCon	CLK Min (MHz)	CLK Max (MHz)	Typ Reach (m)	Special Features
FPGA-Link	DS32EL0421	DS32EL0124	5-bit LVDS	TX De-E, RX EQ	125	312.5	20	
FPGA-Link	DS32ELX0421	DS32ELX0124	5-bit LVDS	TX De-E, RX EQ	125	312.5	20	Redundant output, loop-through
Channel Link 2	DS92LV2411	DS92LV2412	24-bit LVCMOS	RX EQ	5	50	10	Supports embedded video control
Channel Link 2	DS92LV2421	DS92LV2422	24-bit LVCMOS	RX EQ	10	75	10	Supports embedded video control

Get more information: **www.ti.com/lvds**

Ethernet Solutions
Ethernet PHYs for Xilinx®-6 and -7 Series FPGAs

Key Features
- Supports IEEE1588 v1 and v2 precision time protocol (DP83640)
- Enables IEEE 1588 with any MAC-based FPGA, ASIC or microcontroller
- Node-synchronization accuracy to < 10 ns
- Replaces E1/T1 lines and expensive GPS clocks
- Synchronized clock output
- Synchronous Ethernet support
- Industry's lowest deterministic latency

Ethernet PHYs for Altera®

Device	Interface	Cable Length (m)	No. of LEDs	JTAG	Cable Diagnostics	FX Support	IEEE1588 HW Support	25-MHz Clock Out	Temp Range (ºC)	Package
DP83848I	MII, RMII, SNI	150	3	4				4	−40 to 85	QFP-48
DP83848Q*	MII, RMII	150	1					4	−40 to 105	QFN-40
TLK110	MII, RMII	150	3	4	4			4	−40 to 85	QFP-48
DP83630	MII, RMII	150	3	4	4	4	4	4	−40 to 85	QFN-48
TLK105	MII, RMII	150	1						−40 to 85	QFN-32
TLK105L	MII, RMII	150	2			4			−40 to 85	QFN-32
TLK106	MII, RMII	150	1		4				−40 to 105	QFN-32
TLK106L	MII, RMII	150	2		4	4			−40 to 105	QFN-32
DP83848J	MII, RMII	137	2						0 to 70	QFN-40
DP83848K	MII, RMII	137	2						−40 to 85	QFN-40
DP83848M	MII, RMII	137	1					4	0 to 70	QFN-40
DP83848T	MII, RMII	137	1					4	−40 to 85	QFN-40
DP83848H	MII, RMII	137	1					4	−40 to 125	QFN-40
DP83848C	MII, RMII, SNI	137	3					4	0 to 70	QFP-48
TLK100	MII	200	3	4	4				−40 to 85	QFP-48
DP83620	MII, RMII	150	3	4	4	4		4	−40 to 85	QFN-48
DP83640	MII, RMII	150	3	4	4	4	4	4	−40 to 85	QFP-48
DP83848VYB	MII, RMII, SNI	150	3	4				4	−40 to 105	QFP-48
DP83848YB	MII, RMII, SNI	150	3	4				4	−40 to 125	QFP-48

AEC–Q100 Grade 2

*New products are listed in **bold red**. Preview products are listed in **bold teal**.*
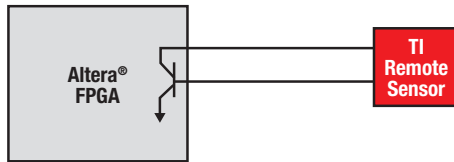
Temperature Sensors
Thermal-Management Products for Altera®

TI offers a portfolio of thermal-management products that work well with Altera® FPGAs.

Remote Sensors

TI's remote sensors connect directly to the DXP_0 and DXN_0 pins to accurately measure the true temperature of your Altera FPGA. TI's portfolio offers a wide array of multi-channel and enhanced-accuracy options such as Beta and N-Factor correction to meet your needs. Be sure to also check out the TMP512/TMP513, which combine precision current/power monitoring with a state-of-the-art remote sensor.

Device Features	TMP411	TMP432	TMP513
Channels	1	2	3
N-Factor Correction	Yes	Yes	Yes
Beta Correction	No	Yes	Yes
Int. Power Monitor	No	No	Yes

Local Sensors

Simplify your design with a digital local temperature sensor. Unlike thermistors, these low-power devices offer noise-free measurements and require no additional components or calibration. Available in SPI or I^{2}C interfaces, TI's industry-leading portfolio offers best-in-class accuracy, power and footprint size.
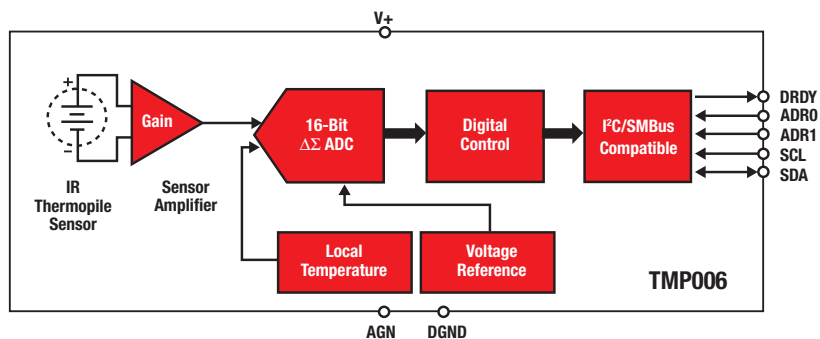
Device Features	TMP112	TMP103	TMP122
Accuracy	±0.5°C	±0.3°C	±1.5°C
Quiescent Current	10 µA	3 µA	75 µA
Size	1.6 x 1.6 mm	0.76 x 0.76 mm	2.9 x 2.8 mm
Interface	I^{2}C	I^{2}C	SPI

Contactless Sensors

Measure the temperature of an object from the PCB without wires. Developed through TI's expertise in MEMS technology, the TMP006 is the first of a new class of ultrasmall, low-power and low-cost passive-infrared temperature sensors. It has 90% lower power consumption and is more than 95% smaller than existing solutions. These features make contactless temperature measurement possible in completely new markets and applications.

TMP006 Features	
Description	• IR MEMS temperature sensor • IR spectrum sensitivity: 4 to 8 µm • 16-bit ADC with I^{2}C SMBus interface • Integrated local temperature and voltage references
Measurement Range	• Local temperature sensor: –40° to 125°C (±0.5°C) • Passive IR sensor: –40° to 125°C (±1°C)
Power	• Quiescent power: 240 µA • Shutdown power: 1 µA • Supply: 2.4 to 5.5 V
Package	• 1.6 x 1.6-mm WCSP (0.625-mm profile)

TMP006 Functional Block Diagram

WEBENCH® Power Architect

Rapidly create, optimize, and implement multiple-output, high-performance DC-DC power supplies for an entire system. Defi ne an input voltage source, list desired output voltage and current loads and the WEBENCH® Power Architect tool will collect the common loads and create a range of intermediate rail topologies and optimize each of the individual power supplies. Results are displayed at a system level to compare alternatives and select based on price, effi ciency, and footprint.

- Quickly design and simulate an entire power supply system
- Easily confi gure the power supply load requirements for voltage and current
- Optimize the overall footprint, effi ciency, and BOM cost for the entire system
- Perform electrical and thermal simulations

WEBENCH® Clock Tree Builder

The WEBENCH Clock Tree Builder recommends a list of solutions of interconnected clocks and PLLs based on a set of input frequencies, output frequencies, and feature requirements for the system. The purpose is to provide the user with a general idea of the broad class of potential solutions that are available. In future releases, the simulation and design capabilities of WEBENCH EasyPLL and the Clock Design Tool will be incorporated into the WEBENCH Clock Tree Builder. In addition, the ability to interact with the Codeloader EVM Software will also be added. Until these features become available, the WEBENCH EasyPLL and National Clock Design Tools can be used to support the simulation capabilities.
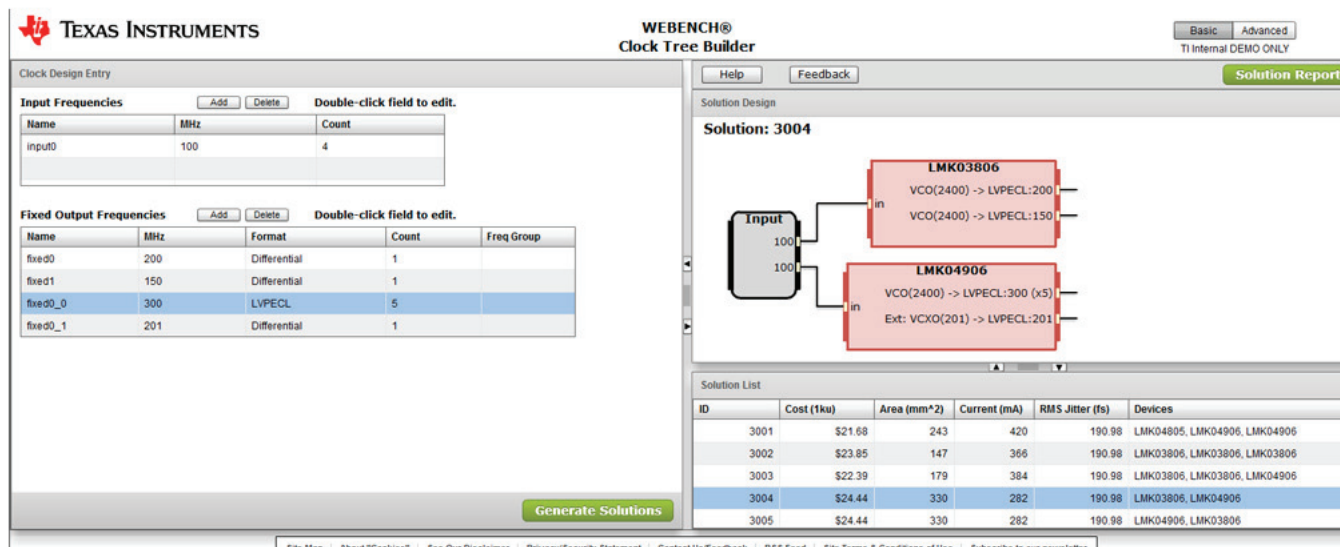
WEBENCH® Resources
## Advanced Design Tools

WEBENCH® Sensor Designer

WEBENCH Sensor Designer provides complete circuit solutions for common sensing, transmitter, or transducer applications. Start with a sensor from a list of market leaders, or specify your own sensor requirements by parameter by creating a custom sensor. Sensor Designer provides optimized signal path performance, BOM, budgetary cost, and links to evaluation boards and other tools for testing and validating your simulated solution.
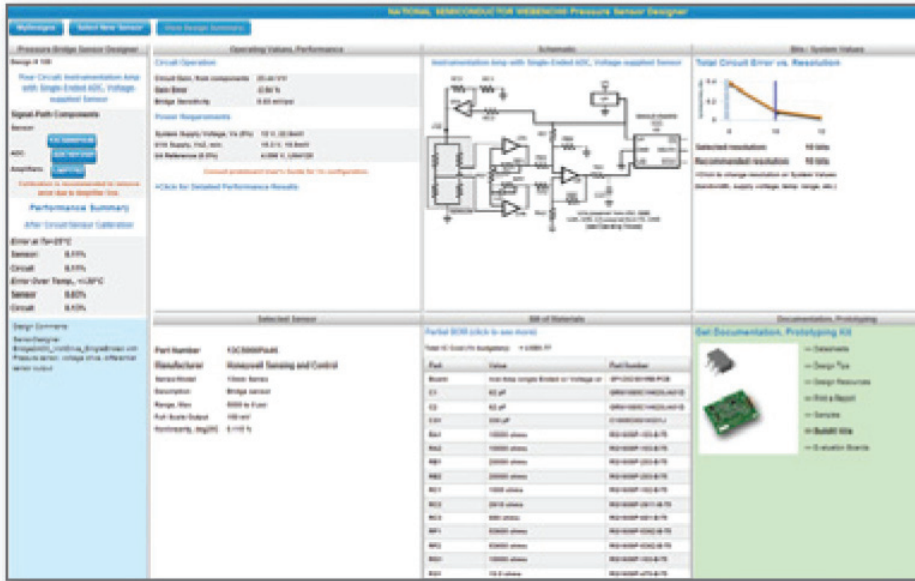
WEBENCH® Sensor AFE Designer

WEBENCH Sensor AFE Designer for the confi gurable Sensor AFE ICs provides the ability to select a sensor, design and confi gure the solution, and download configuration data to the Sensor AFE. A typical sensing application that traditionally requires several boards and up to 25 components, is reduced to just one of TI's ICs. Weeks or months to create a sensor system design is reduced to just minutes using TI's products and tools.
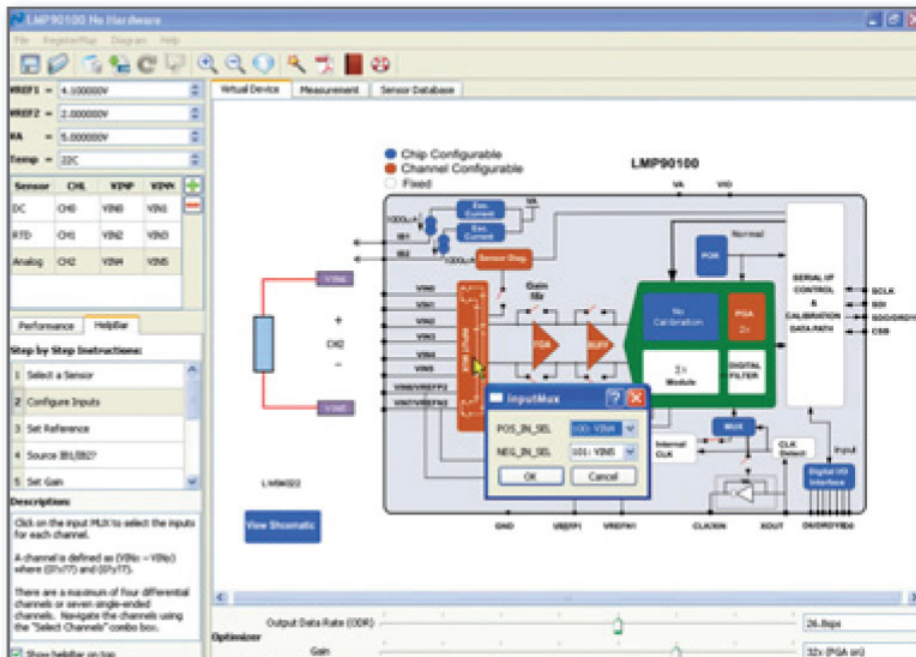
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