Analog Products

Selection Guide

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2009 Vol. 2

- Data Conversion
- Amplifiers
- Temperature Sensors
- Clock and Timing
- Interface
- Audio
- Power Management
- Design Tools

PowerWise®

National Semiconductor

Energy-Efficient Analog Makes the Difference

national.com

With 50 years of analog innovation, National Semiconductor continues to create analog-intensive solutions that differentiate customers' products by providing greater energy efficiency, precision, portability, better audio, and sharper images in electronic systems. National's technologies address issues facing system designers in markets such as mobile handsets, communications, and industrial applications.

Proven Analog Technology Leadership

National's analog portfolio features leading-edge operational amplifiers, interface technologies, data converters, and power management solutions. These devices provide solutions for high-efficiency lighting, precision data acquisition, high-speed serial communication and highly efficient power conversion. As a recognized world leader in power management, National continues to pioneer new energy-efficient devices, subsystems, and architectures for next-generation system designs.

PowerWise® Products for Energy-Efficient Designs

For the growing number of designs where energy efficiency is a primary consideration, National has developed PowerWise® solutions. With National's PowerWise ICs, design engineers can create products and systems that consume less power, extend battery life, and generate less heat. PowerWise devices and subsystems, found in every National product family from interface products to high-speed data converters, from thermal management to power regulators, can help solve customers' design challenges.

The PowerWise portfolio includes more than 300 of National's top energy-efficient analog and mixed-signal semiconductor devices that meet or exceed a set of stringent performance-to-power metrics, making it easy for system designers to identify the most energy-efficient devices for their end products.

Personal Mobile Devices

National is focused on fully featured wireless handsets and personal mobile devices, products that enable people to search the Internet, send email, stream video, download music, and take photos. National's rich portfolio enables vibrant displays, clearer audio, better portability, and longer battery life.

Industrial Automation

Increased efficiency and lower operating costs are the driving trends in industrial automation, leading to increased modernization, as well as intelligent sensing and control. National continues to provide improved precision measurement and control, continuous-calibration capabilities, and diagnostic capabilities with reduced downtime and power usage.

LED Lighting

National's constant-current light-emitting diode (LED) drivers enable greater energy efficiency and flexibility in lighting designs. Driving numerous LEDs in one string, they provide greater than 90 percent efficiency and accurate current regulation with less power and heat dissipation. Demand is soaring as LEDs replace incandescent light bulbs in the home and HID lamps in street lights and projectors. With their energy-efficient nature, LEDs are also finding increased adoption in automotive, exterior lighting, and infotainment applications.

Communications Infrastructure

As more of the world's population shares files, photos, and video, networking and data centers are growing exponentially. Increasingly, new wireless technologies are driving higher data rates and requiring unprecedented power consumption. National's energy-efficient solutions enable routers, switches, wireless base stations, modems, and DSL equipment to consume less power and generate less heat. PowerWise solutions address rising energy costs and customer demand for "greener" operations.

Award-Winning Design Tools

National's unique WEBENCH® online design environment provides system engineers a competitive advantage and faster time to market. National's on-demand tools make it easy for system engineers to explore and learn, compare and select products, and then design and build their system online. National's WEBENCH tools enable novice and experienced WEBENCH dial designers alike to easily "dial in" their size and efficiency requirements using online controls.

50 Years of Industry Leadership

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PowerWise®

DESIGN MADE EASY

EXPLORE & LEARN

Discover a wealth of design resources

Explore "how to" videos, online courses, articles, and the latest design technologies.

COMPARE & SELECT

Find the perfect mix of products for your design

Use National's online product catalog, downloadable collateral, and featured online sites to compare and select products.

DESIGN & BUILD

Design, build and validate a solution

Speed time-to-market with the new WEBENCH® Sensor Designer and enhanced WEBENCH Power Designer.

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New Products

New Products	Description	Page
Data Conversion		
ADC10DV200	Dual 10-bit, 200 MSPS low-power ADC with parallel LVDS CMOS outputs	18
Interface		
DS64BR401	Bi-directional transceiver	71
DS50PCI400	Bi-directional PCIe transceiver	71
Amplifiers		
LMP8602/03	High common-mode voltage difference amplifier	45
Temperature Sensors		
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Audio		
LM49101	Mono class AB audio subsystem with true-ground headphone amplifier	91
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Power		
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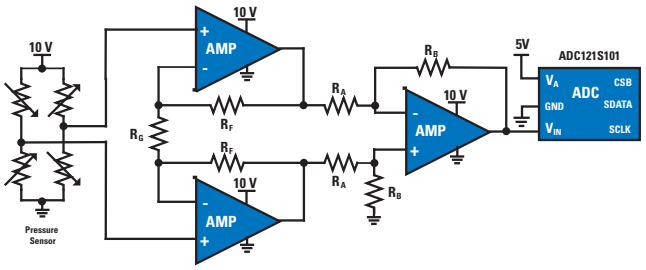
Precision Sensing Applications

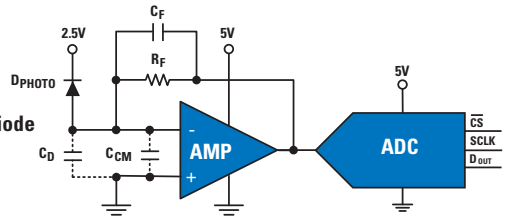
Bridge Sensors — Pressure, Load, Force



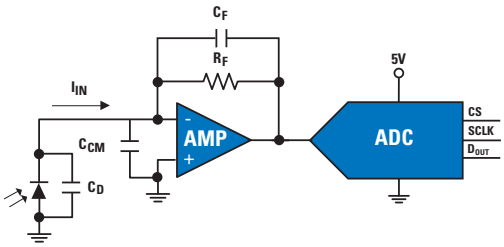
Solutions	Examples	Pages
Op amp	LMP7704/09	43
Single ended input SPI ADC	ADC101Sxx1, ADC101C02x	25, 24
Power	LM2267x, LM500x, LM284x	114, 118

Photoconductive/Photovoltaic

Photoconductive diode is biased, provides faster response

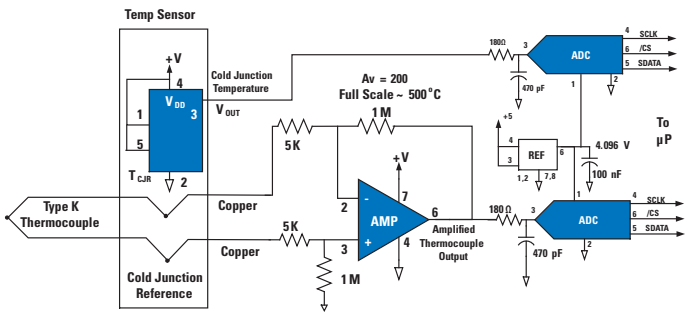


Photovoltaic more linear, no leakage current. Generates voltage proportional to light



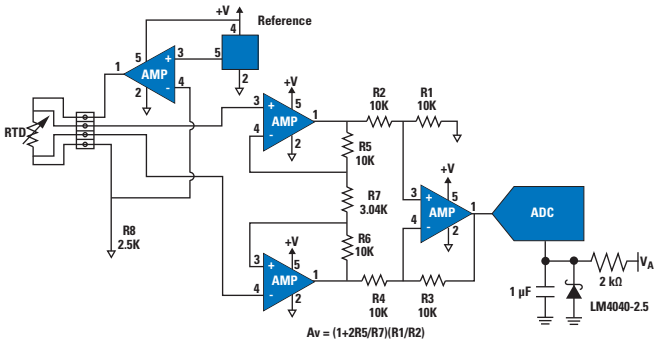
Solutions	Examples	Pages
Op amp	LMP7701, LMV851, LMP7715, LMV841	44, 46
Single-ended input SPI ADC	ADC121Sxx1, ADC121C02x	25, 24
Power	LM500x, LM284x	118
Reference	LM4132, LM4140	144

Temperature-Thermacouple Interface



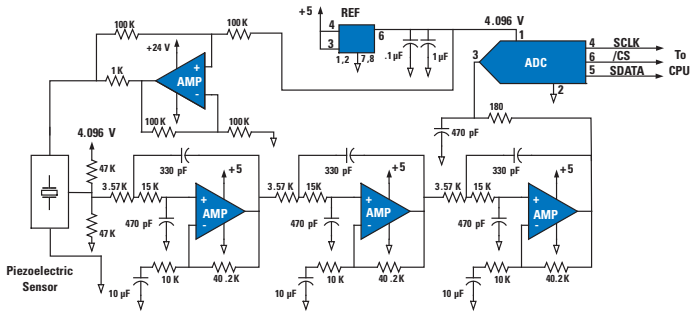
Solutions	Examples	Pages
Op amp	LMP7701, LMP7715	44
Single-ended input SPI ADC	ADC121x021	24, 25
Temp Sensor	LM94022	57
Reference	LM4140	144

Temperature-RTD



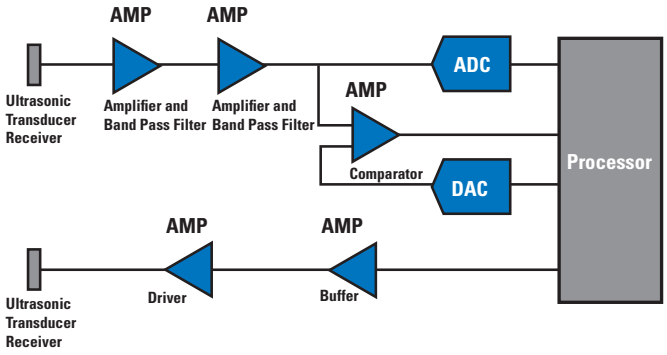
Solutions	Examples	Pages
Op amp	LMP7704, LMP7716, LMP7731	44, 51
Differential-Input SPI ADC	ADC121Sxx5, ADC141626	26
Reference	LM4132, LM4040	144
Power	LM284x, LM500x	118

Vibration



Solutions	Examples	Pages
Precision amps	LMV841	42
Differential-input SPI ADC	ADC141S626, ADC161S626	26
Voltage reference	LM4140	144
Power	LM284x, LM500x	118

Ultrasonic Speed Sensing

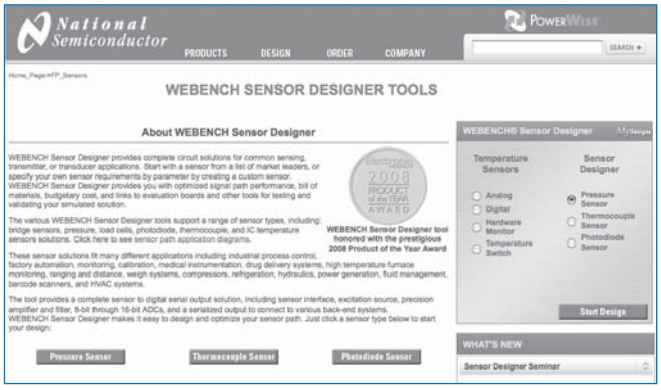


Solutions	Examples	Pages
Op amp	LMH6672, LMV791	33, 44
ADC	ADC121S101	25
DAC	DAC121S101	26
Comparator	LMV7219	53
Power	LM284x, LM500x	118
Reference	LM4140, LM4132	144

Solutions for pressure sensors, load cells, thermocouples, and optical sensors

Reduces design time — move rapidly from concept to design to prototyping

- Select a sensor
- Modify to key parameters to meet specification application needs
- WEBENCH tool creates a complete design (schematic, BOM, detailed error analysis)
- Customized solution to meet specific performance needs
- A 'Build It' option (PC board/components from design) expedites prototyping



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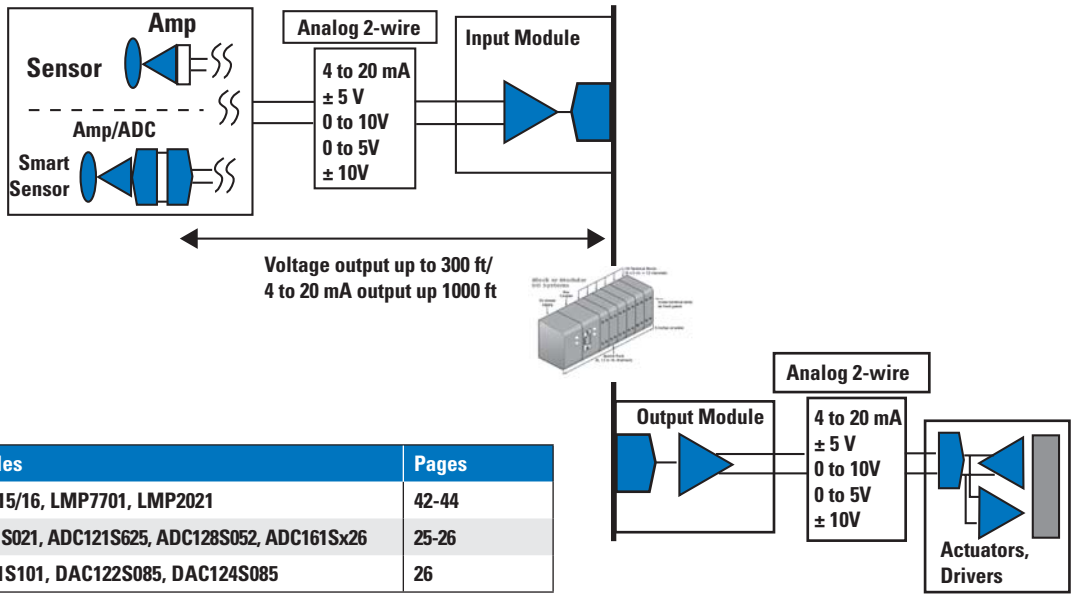
I/O Module

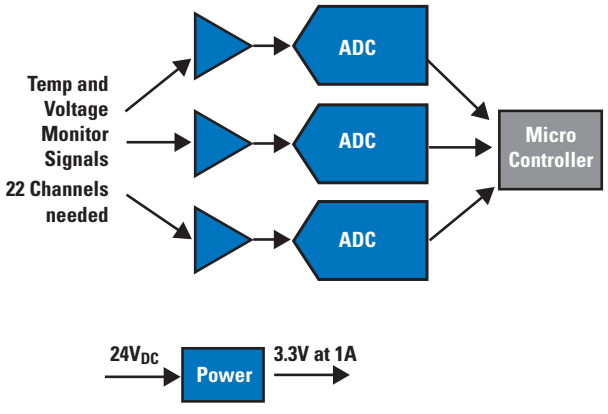
Input to I/Os Module

Output from I/O Module



Solutions	Examples	Pages
Op amp	LMP7715/16, LMP7701, LMP2021	42-44
ADC	ADC121S021, ADC121S625, ADC128S052, ADC161Sx26	25-26
DAC	DAC121S101, DAC122S085, DAC124S085	26

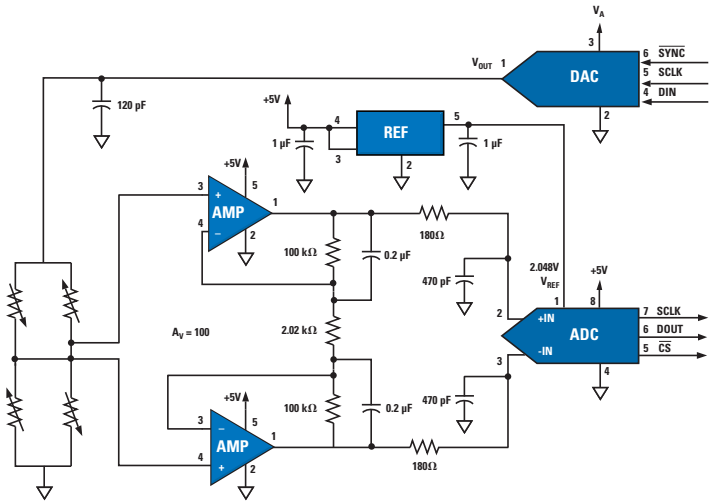
Data Acquisition



Solutions	Examples	Pages
Op Amp	LMP7712, LMP7704, LMP7715/16	44
ADC	ADC12XS022, ADC12XS052, ADC12XS102	25
Power	LP3869x	118
Reference	LM4140, LM4132	144

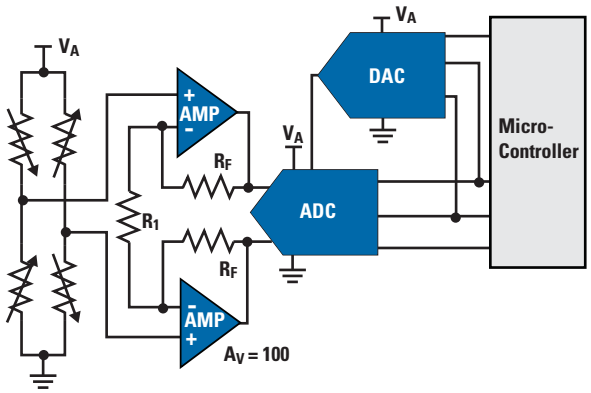
Setting Control Points/Sensor Drive

Variable Sensor Voltage Drive (adjusts sensor output)



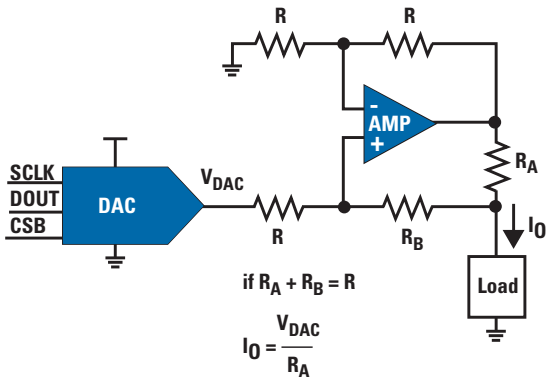
Solutions	Examples	Pages
Op amp	LMP7701	42-22
DAC	DAC081S101	26
ADC	ADC121S625	26
Reference	LM4132	144

Adjustable ADC Reference (adjusts ADC range)



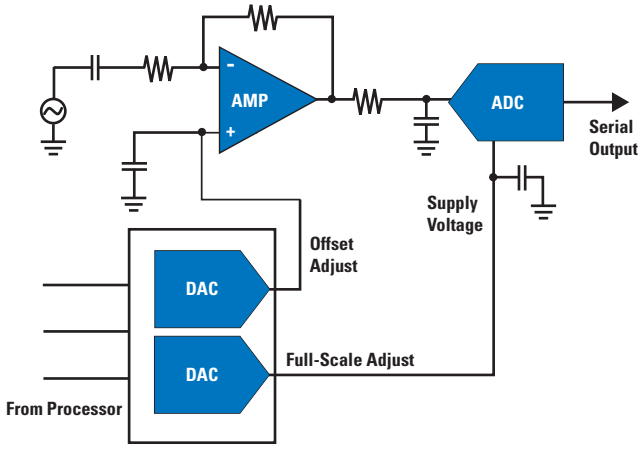
Solutions	Examples	Pages
Op amp	LMP7701	42
DAC	DAC081S101	26
ADC	ADC121S625	26

Variable Current Source



Solutions	Examples	Pages
Op Amp	LMP7711	42-44
DAC	DAC081S101	26

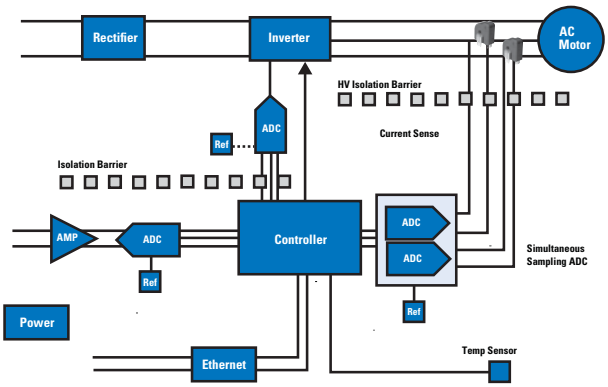
Offset and Gain Calibration



Solutions	Examples	Pages
Op Amp	LMP7701	42
ADC	ADC121S101	25

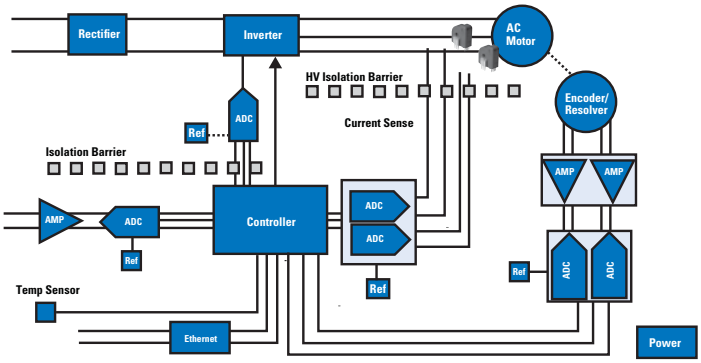
Motor Control

AC Motor



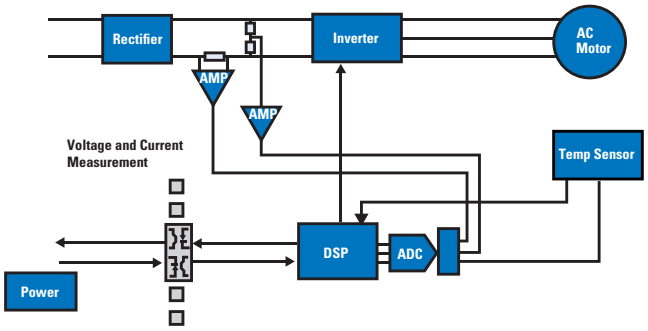
Solutions	Examples	Pages
Op amp	LMP7731/12, LMP2015/56	42-43
ADC	ADC121S021/625, ADC141S626, ADC122Sxxx	25-26
References	LM4132/4128	144
Ethernet	DP83640/8481/8491	85
Temp Sensor	LM73	57
Power	LM2557X, LM557X	115

Servo Motor Control



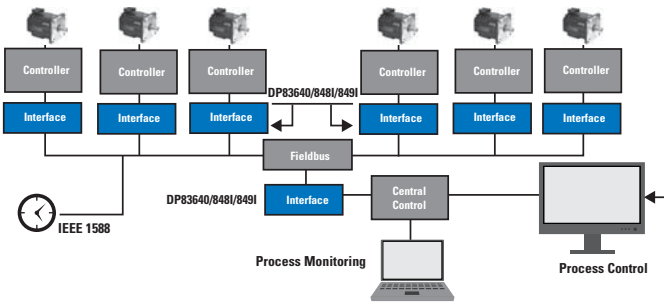
Solutions	Examples	Pages
Amp	LMP7702, LMP7731/32, LMP2015/16	42-44
ADC	ADC121S021, ADC121S625, ADC122Sxxx	25-26
References	LM4132, LM4128	144
Ethernet	DP83640, DP8481, DP8491	57
Power	LM284x, LM500x	118

Low-Side Motor Control



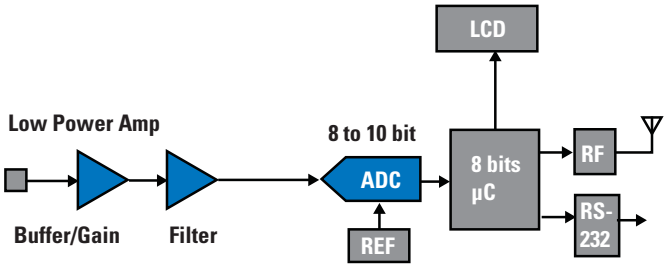
Solutions	Examples	Pages
Op amp	LMP7707, LMP8270/5, LMP7711, LMV797	42-46
ADC	ADC124Sxxx	25
Temp Sensors	LM94022	59

Multiple Motor Control Synchronization



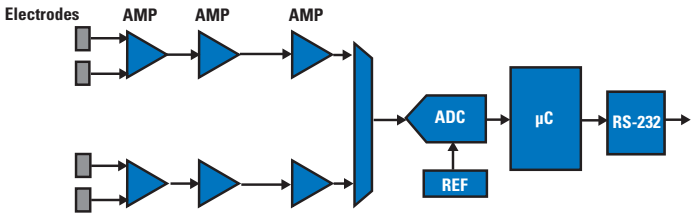
Solutions	Examples	Pages
Op amp	LMP7707, LMP8270/5, LMP7711, LMV797	42-46
ADC	ADC124Sxxx	25
Temp Sensors	LM94022	59

Blood Glucose



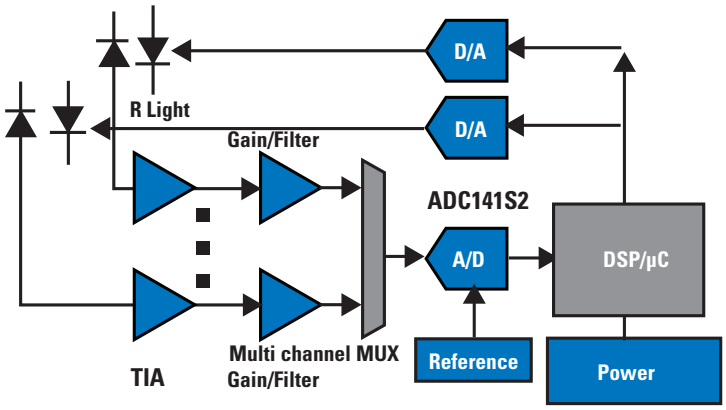
Solutions	Examples	Pages
Op amp	LMP7721, LMV551	42-47
ADC	ADC081S101, ADC101S101	25
Power	LM284x, LM500x	118

EEG System



Solutions	Examples	Pages
Op amp	LMP7711	42-44
ADC	ADC141S626, ADC161S626	26
HP Filter	LMV851	44, 46
Reference	LM4140	144

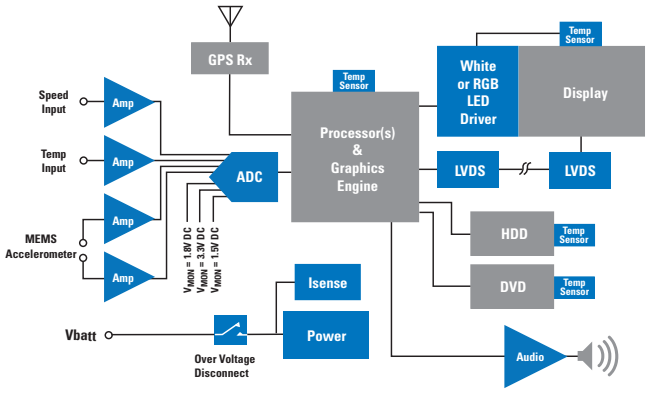
Pulse Oximeter



Solutions	Examples	Pages
Op amp	LMP7721, LMV551, LMV793, LMV861	42-47
ADC	ADC081S101, ADC101S101	25
DAC	DAC121S101, DAC122S085	26
Power	LP38691/13	141
Reference	LM4140	144

Automotive

GPS



Solutions	Examples	Pages
Temp Sensor	LM26/27/57, LM94021/22/23	57, 59
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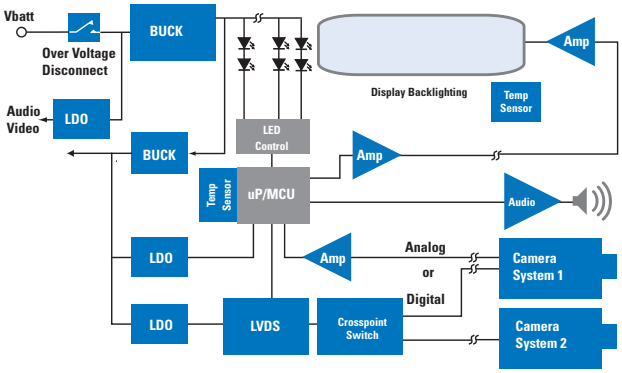
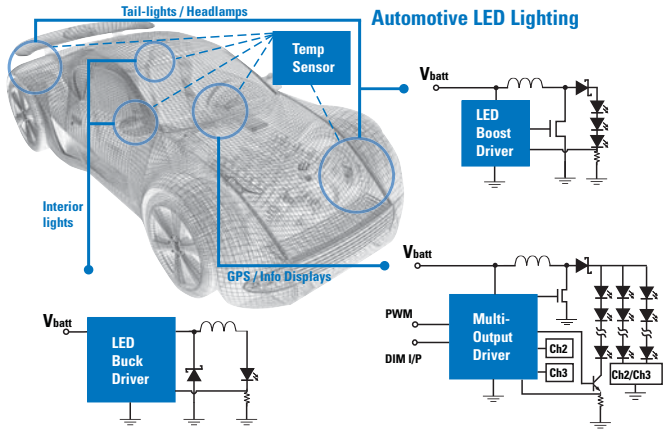
Audio	LM48100	98

Automotive Park Assist



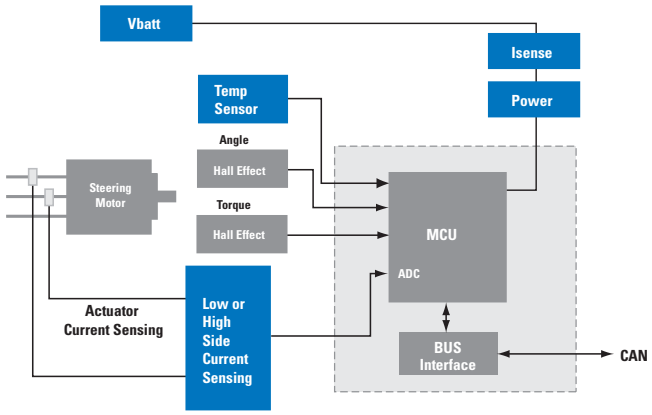
Solutions	Examples	Pages
Power	LM2600x, LM557x, LP3869x	118, 115, 57
Temp Sensors	LM94022/23	57, 59
LVDS	DS90UR241, DS90UR124	76
Crosspoint	DS25CP104A, DS10CP152	72

LED Lighting



Solutions	Examples	Pages
LED Driver	LM340x, LM3421/23	148, 150
Temp Sensor	LM94022Q	57, 59

Electric Power Steering



Solutions	Examples	Pages
Temp Sensors	LM95172, LM9402x, LM57	57
Power	LM2557x, LM557x, LM20xxx	115, 121
Amp	LMP7707/08/09	42-44

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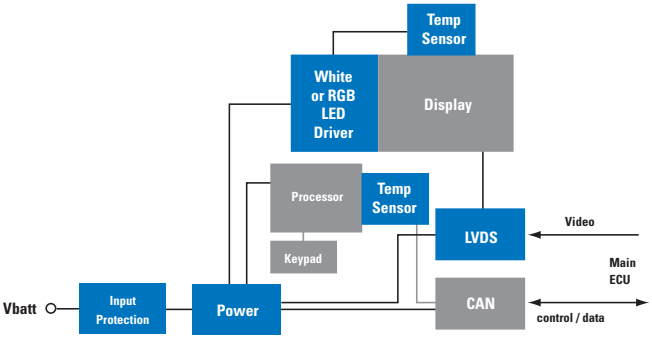
Central Information and Instrument Cluster Display



Solutions	Examples	Pages
Temp Sensors	LM57, LM9402x, LM95071	57
Power	LM3421/13	148-151
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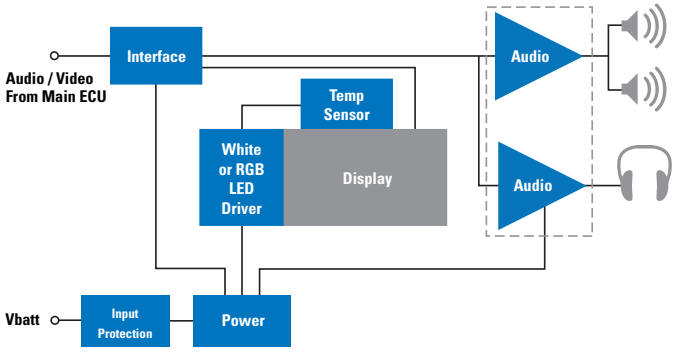
LVDS	DS90UR241, DS90UR124	76

Rear Seat Entertainment System



Solutions	Examples	Pages
LVDS	DS90UR124/241	76
LED	LM3431	148, 150
Temp Sensor	LM57, LM94021/22/23, LM95235Q	57
Audio	LM49450	88
Input Protection	LMV431/A/B	144

Data Converter Portfolio

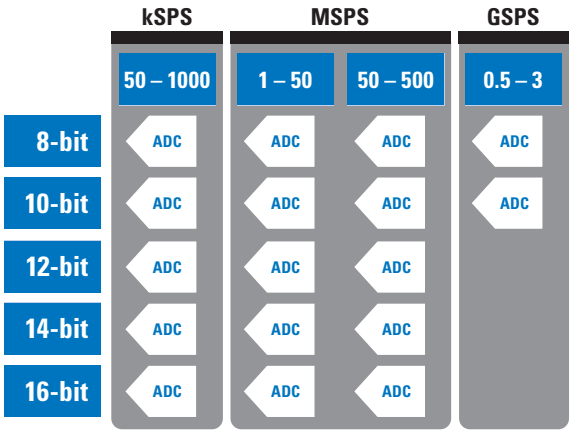
GSPS Ultra-High Speed A/D Converters

Features

- 10-bit ADCs up to 2 GSPS and 8-bit ADCs up to 3 GSPS sampling rate
- Key features:
  - Best-in-class performance vs. power
  - Energy-efficient PowerWise® products
- Full-power bandwidth beyond 3 GHz (ADC083000)

Applications

Ideal for use in test and measurement, military and communication systems



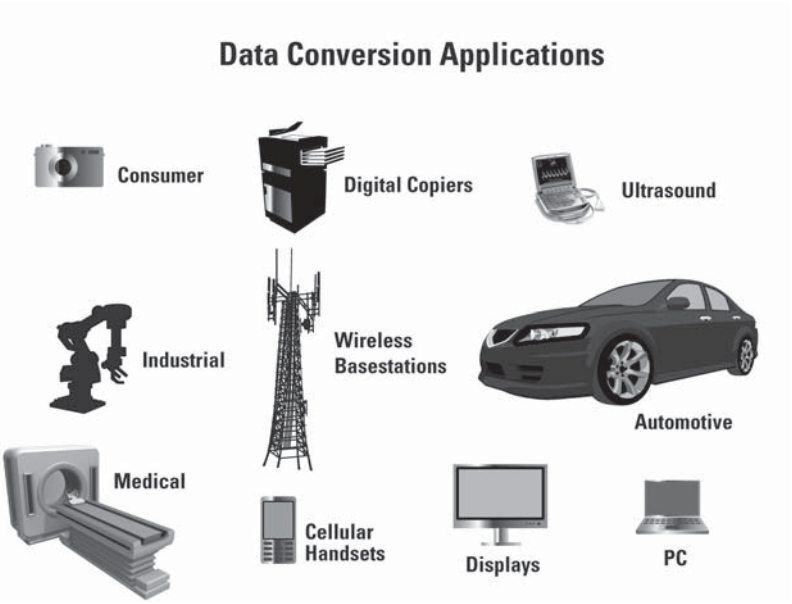
MSPS High-Speed A/D Converters

Features

- 8- to 16-bit ADCs
- Key features:
  - High-input bandwidth
  - Energy-efficient PowerWise products
  - Outputs available: CMOS, parallel LVDS, and serial LVDS

Applications

Ideal for use in medical and industrial imaging, wireless communications, infrastructure, test and measurement, and portable instrumentation



kSPS Low-Power A/D Converters and D/A Converters

Features

- 8- to 14-bit ADCs up to 1 MSPS sampling rate
- Key features:
  - Low-power, energy-efficient PowerWise products
  - Pin-and-function compatibility for easy selection and upgrade
  - ADCs guaranteed over sample rate
  - Small packaging

Applications

Ideal for use in industrial, medical, consumer, automotive, and portable systems

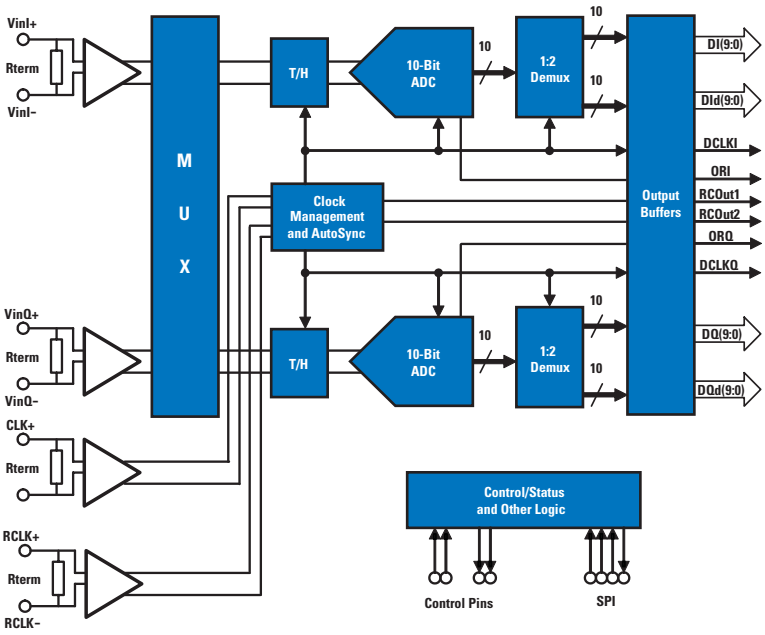
ADC10D1000 – Low-Power, 10-Bit, Dual 1.0 GSPS or Single 2.0 GSPS A/D Converter

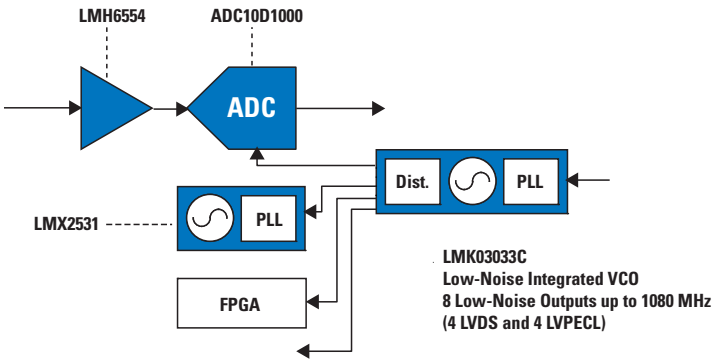
Features

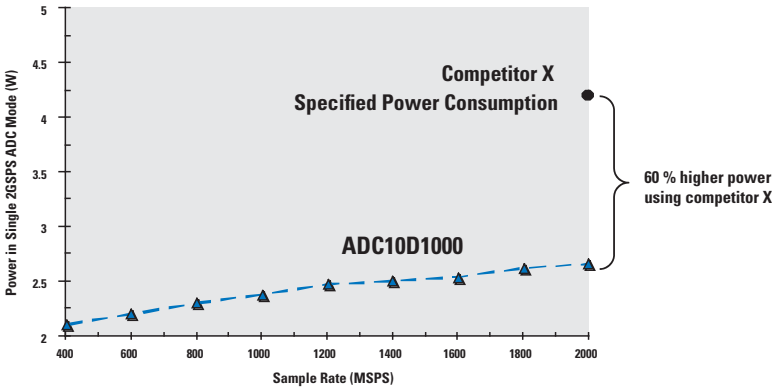
- World-class accuracy and dynamic performance
- Lowest available power consumption
- Internally terminated, buffered, differential analog inputs
- Selectable dual-edge sampling mode; the I- and Q-channels sample one input at twice the sampling clock rate
- Test patterns at output for system debug
- 1:1 non-demuxed or 1:2 demuxed LVDS outputs
- AutoSync feature for multi-chip systems
- Integrated tuneable L-C filter on the clock input to filter wideband clock jitter
- Single 1.9V power supply

Performance

- ENOB: 9.1 bits (typ)
- SNR: 57 dBc (typ)
- SFDR: 66 dBc (typ)
- Full power bandwidth: 2.8 GHz (typ)
- DNL: ±0.2 LSB (typ)
- INL: ±0.7 LSB (typ)
- Power consumption
  - Single-channel enabled: 1.6W (typ)
  - Dual-channel enabled: 2.8W (typ)
  - Power-down mode: 60 mW (typ)







GSPS Ultra-High Speed A/D Converters

ADC083000 – PowerWise® 8-Bit, 3 GSPS ADC Delivers Unsurpassed Performance without Heat Sinks

Features

- Interleaving capability enables up to 6 GSPS operation
- Adjustable sampling clock phase
- Multiple ADC synchronization capability
- Choice of single or dual data rate output clocking
- Serial interface for extended control (including gain and offset)
- Full-speed test patterns for system testing and debugging
- ADC08B3000 4k byte on-chip FIFO memory
- Reference board available with LMX2531 clock conditioner and LMH6555 high-speed amplifier, for inputs between DC and 750 MHz

GSPS Family Performance (typical)

- Energy-efficient PowerWise® products
- High 7.2 to 7.5 Effective Number of Bits (ENOB)
- Full power bandwidth beyond 3 GHz (ADC083000)
- Up to 3 GSPS sampling speed
- DNL ±0.20 LSB
- Operating power between 0.8W and 1.9W *(No heat sink required)*
- Power-down mode: under 25 mW

8-Bit GSPS A/D Converters

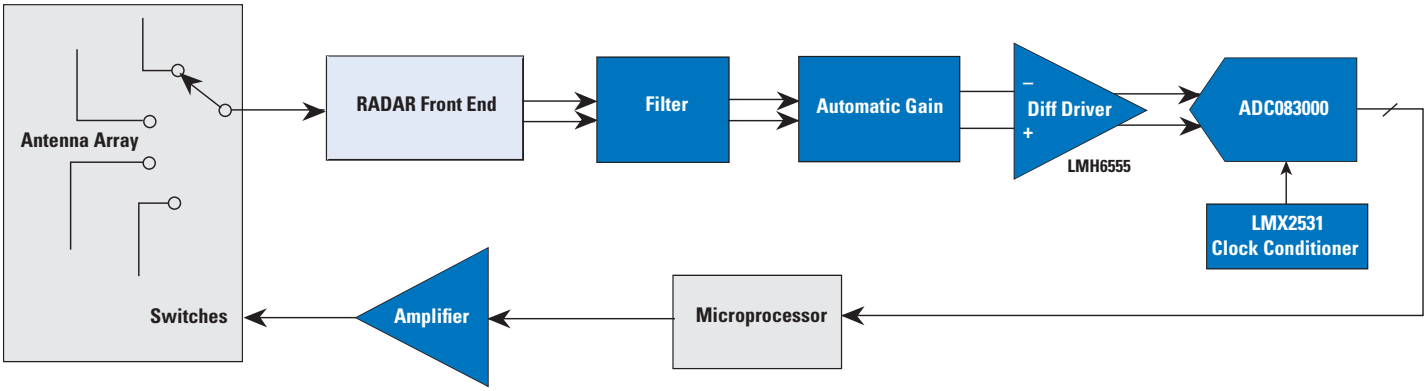
Product ID	Description
ADC081000	1 GSPS
ADC08D1000	Dual, 1 GSPS (2 GSPS in interleave mode)
ADC08D1020	Dual, 1 GSPS (2 GSPS in interleave mode), includes test pattern and clock phase adjustment
ADC081500	1.5 GSPS
ADC08D1500	Dual, 1.5 GSPS (3 GSPS in interleave mode)
ADC08D1520	Dual, 1.5 GSPS (3 GSPS in interleave mode), includes test pattern and clock phase adjustment
ADC083000	3 GSPS
ADC08B3000	3 GSPS, on-chip buffer

PowerWise® product

Applications

Ideal for use in direct RF down conversion, digital oscilloscopes, communications transceivers, test instrumentation, and ranging applications such as LIDAR and RADAR

RADAR System

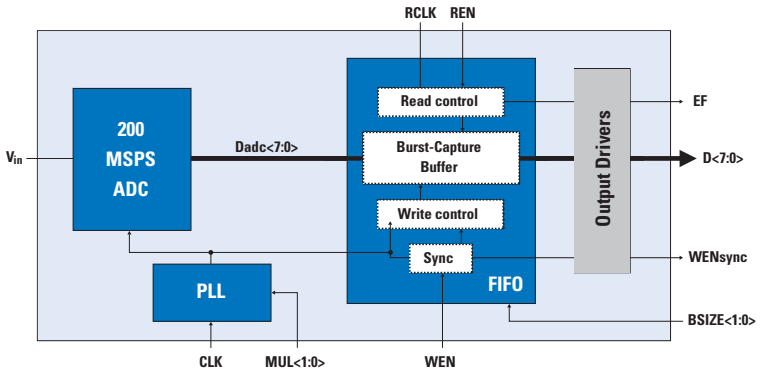


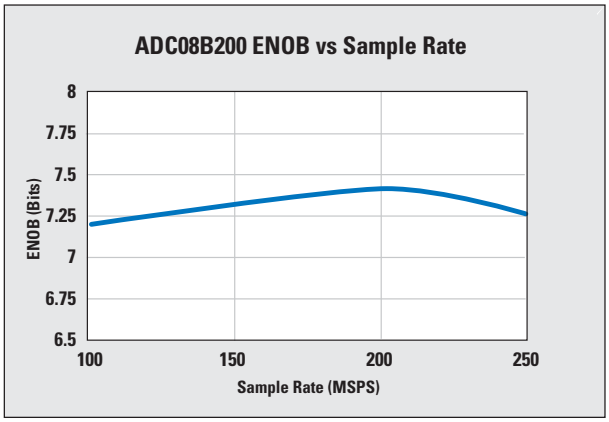
ADC08B200 – 8-Bit, 200 MSPS ADC with 1K Capture Buffer

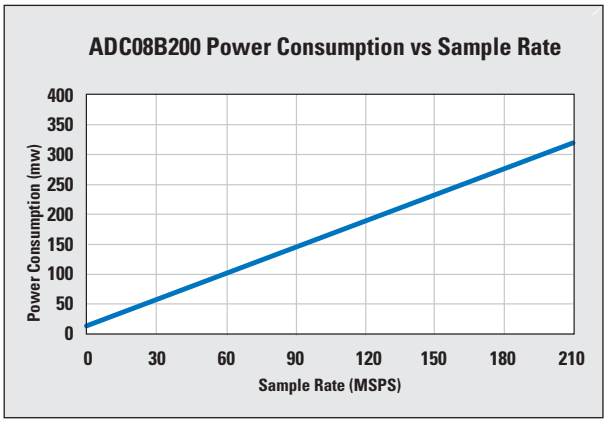
Features

- Variable-size FIFO eliminates the need for FPGA resources
- On-chip PLL provides option to multiply input clock signal frequency by 2, 4, or 8 times, allowing for slower on-board clock
- Direct access to internal reference ladder allows for flexibility in input voltage ranges
- Power consumption scales linearly with sampling rate
- FPGA training pattern simplifies high-speed data capture

ADC08B200 On-Chip FIFO and PLL Greatly Simplify Digital Interface and Sampling Clock Generation







Applications

Ideal for use in laser ranging, RADAR, pulse capturing, flat panel displays, projection systems, set-top boxes, battery-powered instruments, communications, medical scan converters, x-ray imaging, astronomy systems, high-speed Viterbi decoders, and astronomy applications

8-Bit MSPS A/D Converters

Product ID	Sampling Rate (MSPS)	Power	ENOB (Bits)	SNR (dB)	SFDR (dB)	THD (dBc)	Packaging
ADC08060	20 to 60	1.3 mW/MSPS	7.5	44.6	64	-57	TSSOP-24
ADC08L060	10 to 60	0.65 mW/MSPS	7.6	48	59.1	-57	TSSOP-24
ADC08100	100	1.3 mW/MSPS	7.5	47	60	-60	TSSOP-24
ADC08200	200	1.05 mW/MSPS	7.4	46	58	-58	TSSOP-24
ADC08B200*	200	2 mW/MSPS	7.4	47	56	-55	TQFP-48
ADC08D500**	500	1.4W	7.5	48	55	-55	LQFP-128
ADC08500	500	0.8W	7.5	47.5	56	-56	LQFP-128

* Buffer
** Dual
PowerWise® product

MSPS High-Speed A/D Converters

High-Speed MSPS A/D Converters

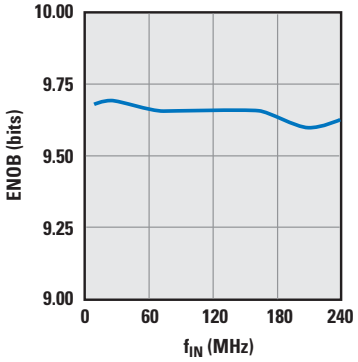
Product ID	Channels	Speed (MSPS)	Power (mW)	SNR (dB)	SFDR (dB)	Outputs	Packaging
16-bit							
ADC16V130	1	130	755	78.5	95.5	LVDS	LLP-64
14-Bit							
ADC14155	1	155	967	71.3	87	CMOS	LLP-48
ADC14V155	1	155	951	71.7	86.9	Parallel LVDS	LLP-48
ADC14DS080/105	2	80/105	800/1000	74.2/73	90	Serial LVDS	LLP-60
ADC14DC080/105	2	80/105	600/800	73/74	90	CMOS	LLP-60
ADC14C080/105	1	80/105	300/400	74.2/74	90	CMOS	LLP-32
ADC14L040	1	40	235	73	90	CMOS	LQFP-32
ADC14L020	1	20	150	74	93	CMOS	LQFP-32
12-Bit							
ADC12C170	1	170	715	67.2	85.4	CMOS	LLP-48
ADC12V170	1	170	781	67.2	85.8	Parallel LVDS	LLP-48
ADC12C105	1	105	400	71	90	CMOS	LLP-32
ADC12DS080/105	2	80/105	800/1000	71	88	Serial LVDS	LLP-60
ADC12DC080/105	2	80/105	600/800	71.5/71	90	CMOS	LLP-60
ADC12C080	1	80	300	71.2	90	CMOS	LLP-32
ADC12DL080	2	80	447	69	82	CMOS	TQFP-64
ADC12L080/81	1	80	425	66	80	CMOS	LQFP-32
ADC12L066	1	66	357	66	80	CMOS	LQFP-32
ADC12QS065	4	65	800	69	83	Serial LVDS	LLP-60
ADC12DL065	2	65	360	69	86	CMOS	TQFP-64
ADC12L063	1	62	354	66	78	CMOS	LQFP-32
ADC12EU050	8	50	384	69.3	77	Serial LVDS	LLP-68
ADC12DL040	2	40	210	69	85	CMOS	TQFP-64
ADC12D040	2	40	600	68	80	CMOS	TQFP-64
ADC12040	1	40	340	69.5	84	CMOS	LQFP-32
ADC12020	1	20	185	70	86	CMOS	LQFP-32
11-Bit							
ADC11C170	1	170	715	65.1	85.4	CMOS	LLP-48
ADC11C125	1	125	608	65.5	88.2	CMOS	LLP-48
ADC11DL066	2	66	686	64	80	CMOS	TQFP-64
ADC11L066	1	66	357	65	78	CMOS	LQFP-32
10-Bit							
ADC10080	1	80	78.6	59.5	79	CMOS	TSSOP-28
ADC10DL065	2	65	370	61	85	CMOS	TQFP-64
ADC10065	1	65	68.4	59.6	80	CMOS	TSSOP-28
ADC10D040	2	40	267	60	72	CMOS	TQFP-48
ADC10040	1	40	55.5	59.6	80	CMOS	TSSOP-28
ADC10D020	2	20	150	59	75	CMOS	TQFP-48
ADC11DV200	2	200	450	62.5	82	CMOS or LVDS	LLP-60
NEW! ADC10DV200	2	200	450	59.9	82	CMOS or LVDS	LLP-60

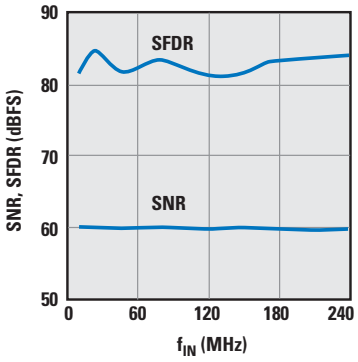
PowerWise® product

ADC10DV200 – PowerWise® 10-bit, 200-MSPS dual ADC for High-IF Sampling

Features

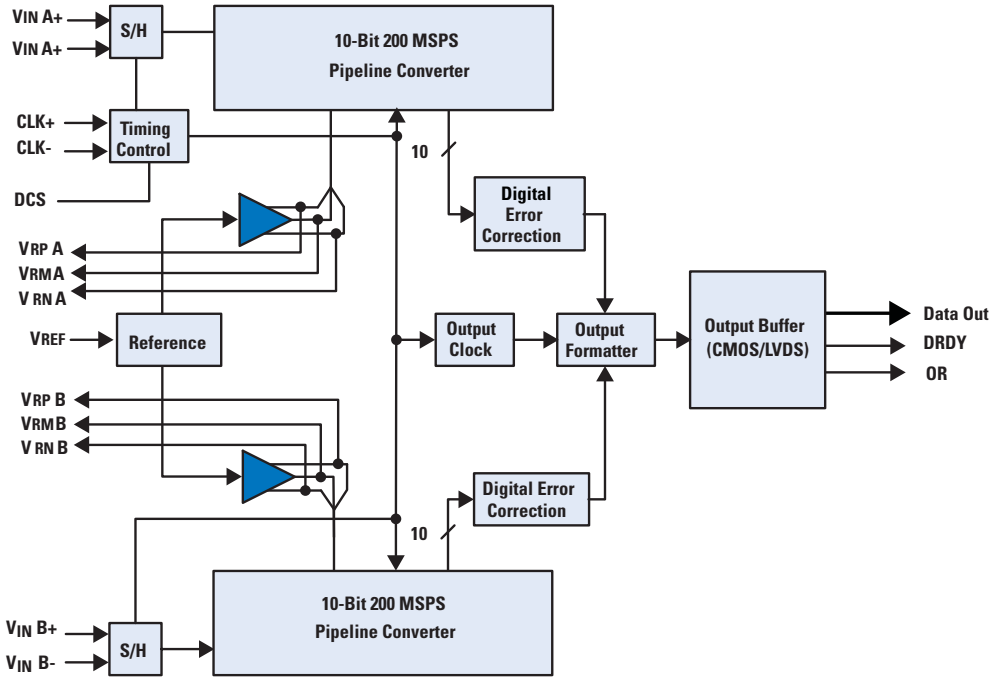
- 900 MHz full power bandwidth
- 59.9 dBFS SNR at 70 MHz input
- 82 dBFS SFDR at 70 MHz input
- LVDS or CMOS outputs
- 11-bit version available: ADC11DV200
- Low power consumption:
  - 225 mW/ch in LVDS mode at 200 MSPS
  - 140 mW/ch in CMOS mode at 170 MSPS
- Power scaling with sampling rate
- Single 1.8V power supply
- Over-range indicator
- Available in LLP-60 packaging





Applications

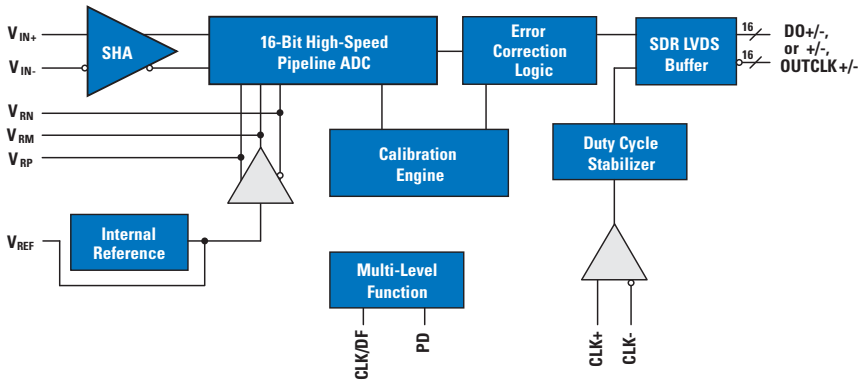
Ideal for use in Digital Predistortion (DPD), wireless communications infrastructure, medical imaging, portable instrumentation, and digital video



ADC16V130 – PowerWise® 16-bit, 130-MSPS ADC for High-IF, High-Dynamic Performance Applications

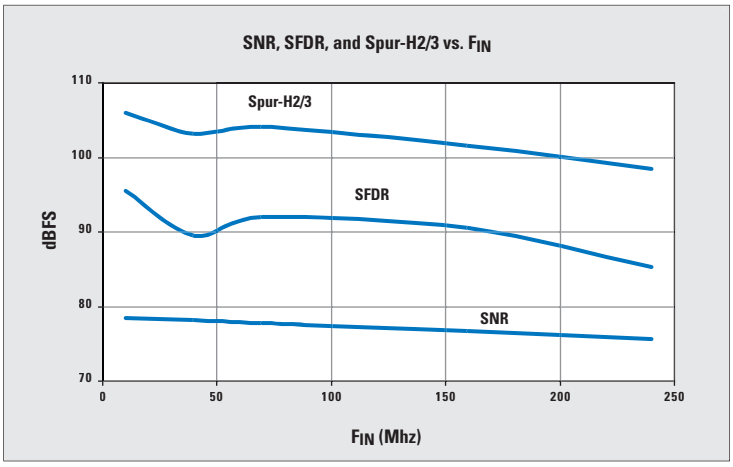
Features

- 1.4 GHz full power bandwidth
- Industry's best performance:
  - 90.6 dBFS SFDR at f_{IN} = 160 MHz
  - 76.7 dBFS SNR at f_{IN} = 160 MHz
  - 101.5 dBFS worst harmonic or spur (except H2 and H3) at f_{IN} = 160 MHz
- Industry's lowest power: 755 mW
- Dual 3V/1.8V supply operation
- Parallel LVDS outputs
- Available in LLP-64 packaging (9 mm x 9 mm)
- Reference board available with LMK04031B clock jitter cleaner



Applications

- Multi-carrier/multi-standard base station receivers
  - GSM/EDGE, CDMA2000, UMTS, LTE, and WiMAX
- Repeaters
- High-IF sampling systems
- Test and measurement equipment
- Communications instrumentation
- RADAR systems
- Medical imaging
- Data acquisition
- Portable instrumentation



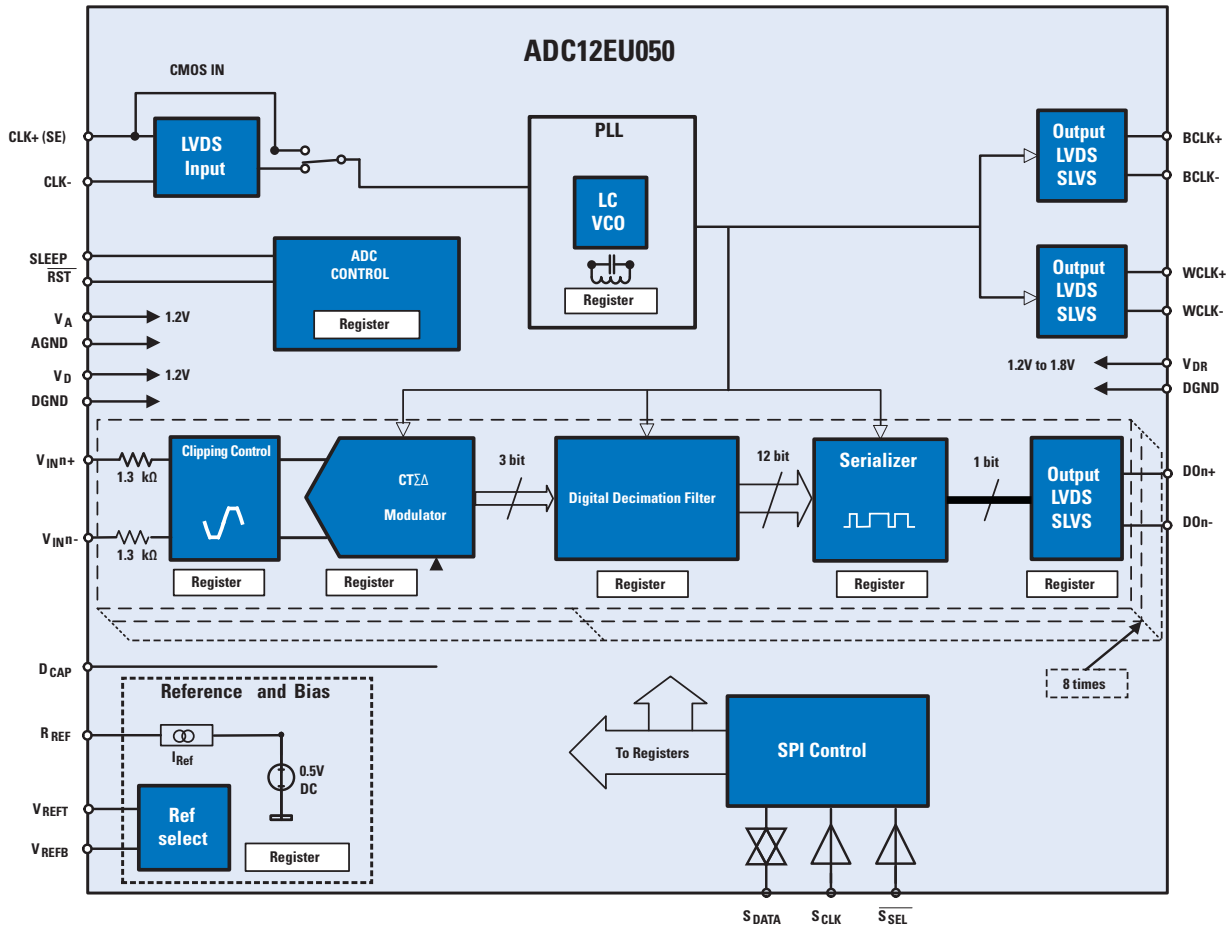
ADC12EU050 – PowerWise® High-Speed Continuous-Time Sigma-Delta ADC

Features

- 8-channel, 12-bit, 50 MSPS ADC
- Ultra-low power consumption: 384 mW
- Consumes 48 mW/channel at 50 MSPS
- Alias-free sample bandwidth up to 25 MHz
- On-chip PLL+VCO
- -76.6 dB Total Harmonic Distortion (THD)
- 69.3 dBFS Signal-to-Noise Ratio (SNR)
- Instant Overload Recovery (IOR)
- Available in LLP-68 packaging

Applications

Medical imaging, industrial imaging, communication, test and measurement, and portable systems



MSPS High-Speed A/D Converters

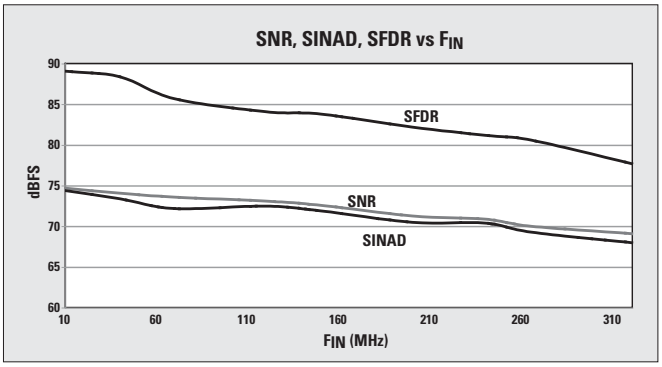
ADC14C105 – PowerWise® 14-bit, 105/95 MSPS ADC for High IF Sampling

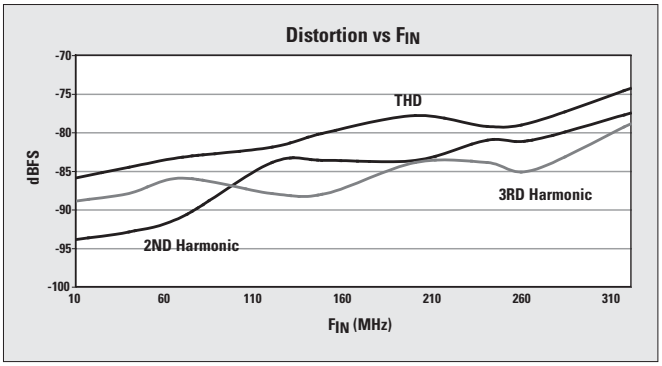
Features

- 1 GHz full power bandwidth
- 72 dBFS SNR at 240 MHz input
- 82 dBFS SFDR at 240 MHz input
- -79.3 dBFS THD at 240 MHz input
- Power consumption: 400 mW
- Single 3.3V supply operation
- Available in LLP-32 packaging (5 x 5 x 0.8 mm)
- 12-bit, 105/95 MSPS ADC (ADC12C105)
- 12-bit, 80/65 MSPS ADC (ADC12C080)
- 14-bit, 80/65 MSPS ADC (ADC14C080)

Applications

Ideal for use in 3G wireless basestation receivers, WiMAX, power amplifier linearization, high IF sampling receivers, multi-carrier, multi-mode receivers, test and measurement equipment, communications test equipment, and RADAR systems

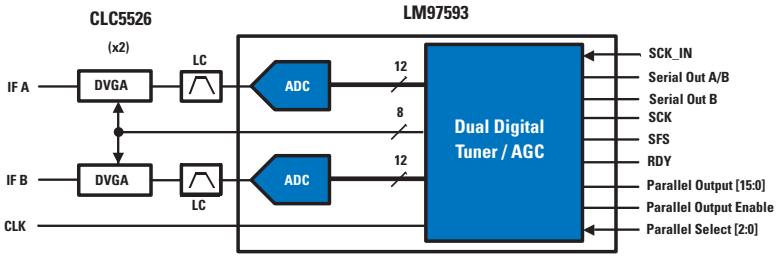




LM97593 – Integrated Dual ADC with Digital Downconverter and Automatic Gain Control for Communications Applications

Features

- 2-channel, 12-bit A/D converter
- 123 dB dynamic range with CLC5526 DVGA (200 kHz)
- 650 MHz input bandwidth allows direct IF sampling of inputs up to 300 MHz
- 83 dBFS SNR at f_{IN}=250 MHz, 200 kHz bandwidth
- 62 dBFS SNR at f_{IN}=250 MHz, Nyquist bandwidth
- 68 dBFS SFDR at f_{IN}=250 MHz, Nyquist bandwidth
- Digital downconverter composed of:
  - 4-stage CIC filter with programmable 8 to 2048 decimation ratio
  - 21-tap symmetric FIR filter providing decimation by 2
  - 63-tap symmetric FIR filter providing decimation by 2 or 4
- Integrated automatic gain control allows seamless integration with external DVGA
- Power consumption: 560 mW at 65 MSPS
- 3.3V analog supply, 1.8V digital
- Available in PQFP-128 packaging



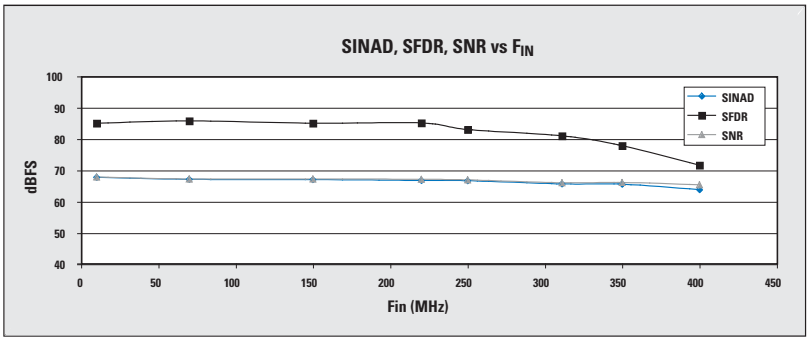
Applications

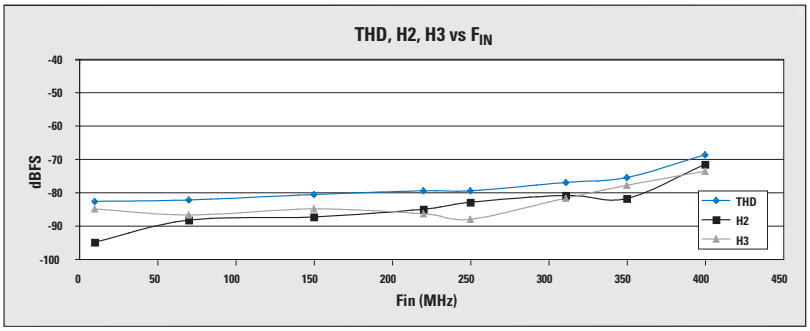
Ideal for use in cellular basestations including GSM/GPRS/EDGE/GSM Phase 2 receivers, satellite receivers, wireless local loop receivers, digital communications, and wireless microphone mainframes

ADC12V170 – PowerWise® 12-Bit, 170 MSPS ADC for High IF Sampling

Features

- 1.1 GHz full power bandwidth
- 66.3 dBFS SNR at 250 MHz input
- 82.1 dBFS SFDR at 250 MHz input
- -79.6 dBFS THD at 250 MHz input
- Dual 3.3V, 1.8V supply operation
- Power consumption: 781 mW
- Parallel LVDS outputs
- Available with CMOS outputs (ADC12C170)
- Available in LLP-48 packaging (7 x 7 x 0.8 mm)





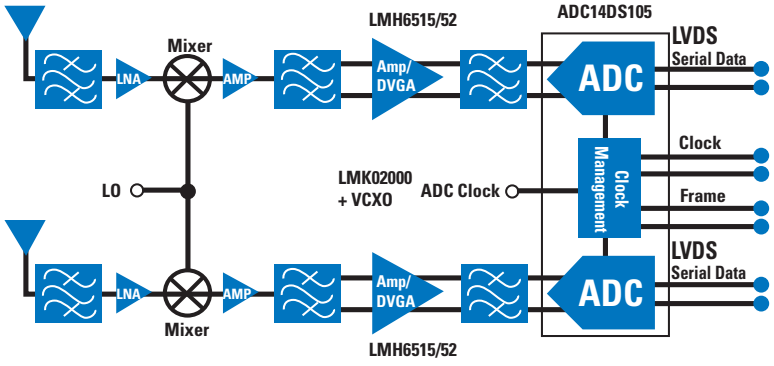
Applications

Ideal for use in 3G wireless basestation receivers, WiMAX, power amplifier linearization, high IF sampling receivers, multi-carrier, multi-mode receivers, test and measurement equipment, communications test equipment, and RADAR systems

ADC14DS105 – PowerWise® 14-Bit, Dual, 105/95 MSPS ADC with Serial LVDS Outputs

Features

- 1 GHz full power bandwidth
- 83 dBFS SFDR at 240 MHz input
- 70.5 dBFS SNR at 240 MHz input
- -80 dBFS THD at 240 MHz input
- Power consumption: 1000 mW
- Serial LVDS outputs
- Single +3.3V supply operation
- Available in LLP-60 packaging (9 x 9 x 0.8 mm, 0.5 mm pin-pitch)
- 12-bit, dual, 105/95 MSPS ADC (ADC12DS105)
- 12-bit, dual, 80/65 MSPS ADC (ADC12DS080)
- 14-bit, dual, 80/65 MSPS ADC (ADC14DS080)
- Reference board available with LMH6552 high-speed amplifier and LMK02000 clock conditioner



Applications

Ideal for use in high IF sampling receivers, wireless basestation receivers, test and measurement equipment, communications instrumentation, and portable instrumentation

kSPS Low-Power A/D Converters

ADCs Deliver Excellent INL and ENOB in Small Pin- and Function-Compatible Packages

Single-Ended Input ADCs (1 to 8 Channels) from the PowerWise® Family

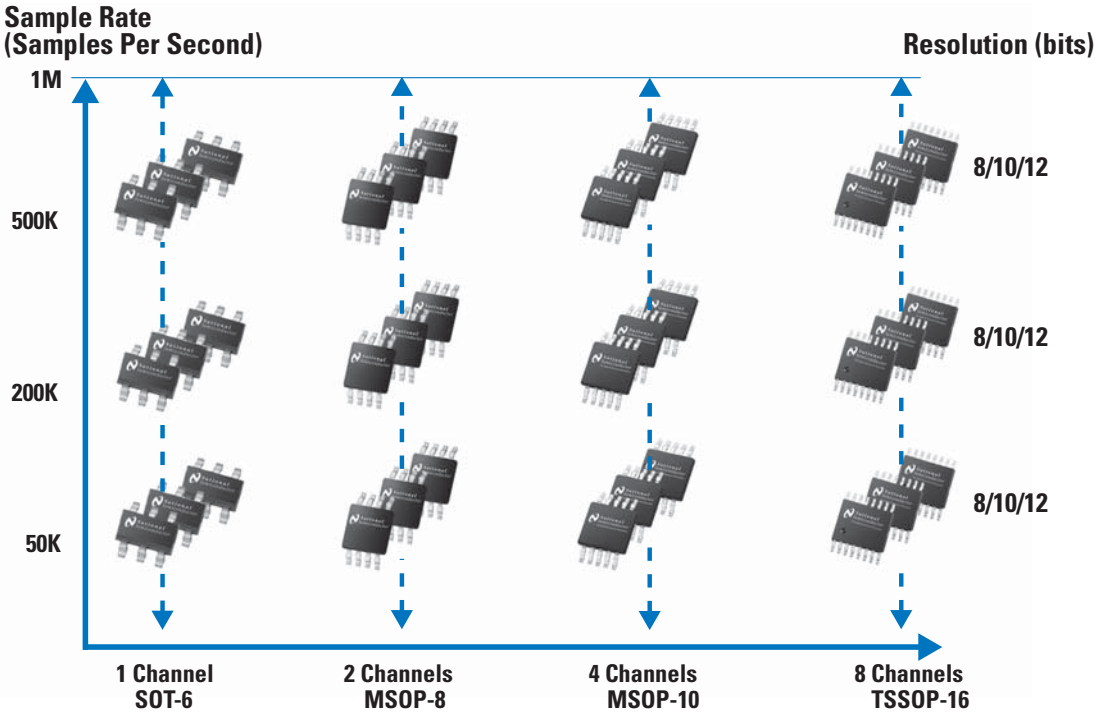
12-Bit ADC
- INL: ±0.64 LSB
- ENOB: 11.7

10-Bit ADC
- INL: ±0.2 LSB
- ENOB: 9.9

8-Bit ADC
- INL: ±0.5 LSB
- ENOB: 7.8

Applications

Ideal for use in portable systems, medical instrumentation, factory automation/ automatic test equipment, consumer products, mobile communications, instrumentation, and control systems



Single-Ended Input I²C-Compatible A/D Converters with Alarm and Multiple Addresses

Product ID	Res (bits)	Inputs	Pin and Function Compatible	Speed Range (kSPS)	Supply Voltage Range(V)	Typ Power (mW)		Static Performance (Typ)		ENOB (bits) typ	Temp Range (°C)	Packaging
						3V	5V	INL (LSB)	DNL (LSB)			
NEW! ADC081C021 [W]	8	1		5.5 to 189	2.7 to 5.5	0.26	0.78	±0.2	±0.5	7.98	-40 to 105	TSOT-6, MSOP-8
NEW! ADC101C021	10	1		5.5 to 189	2.7 to 5.5	0.26	0.78	±0.5	±0.5	9.94	-40 to 105	TSOT-6, MSOP-8
NEW! ADC121C021	12	1		5.56 to 189	2.7 to 5.5	0.26	0.78	±0.5	±0.5	11.7	-40 to 105	TSOT-6, MSOP-8
ADC081C027[1]	8	1		5.5 to 189	2.7 to 5.5	0.26	0.78	±0.5	±0.5	9.94	-40 to 105	TSOT-6
ADC101C027[1]	10	1		5.5 to 189	2.7 to 5.5	0.26	0.78	±0.5	±0.5	9.94	-40 to 105	TSOT-6
ADC121C027[1]	12	1		5.56 to 189	2.7 to 5.5	0.26	0.78	±0.5	±0.5	11.7	-40 to 105	TSOT-6

[1]Alarm Option

PowerWise® product [W] WEBENCH enabled

Single-Ended Input SPI A/D Converters

Product ID	Res (bits)	Inputs	Pin and Function Compatible	Speed Range (kSPS)	Supply Voltage Range(V)	Typ Power (mW)		Static Performance (Typ)		ENOB (bits) typ	Temp Range (°C)	Packaging
						3V	5V	INL (LSB)	DNL (LSB)			
ADC081S021[W]	8	1		50 to 200	2.7 to 5.25	1.3	7.7	+0.45, -0.3	+0.45, -0.3	7.9	-40 to 85	SOT-23, LLP-6
ADC081S051[W]	8	1		200 to 500	2.7 to 5.25	1.6	8.5	+0.06, -0.04	+0.06, -0.05	7.9	-40 to 85	SOT-23, LLP-6
ADC081S101[W]	8	1		500 to 1000	2.7 to 5.25	2	10	±0.05	±0.07	7.9	-40 to 85	SOT-23, LLP-6
ADC101S021[W]	10	1		50 to 200	2.7 to 5.25	2.4	8.9	+0.14, -0.13	+0.16, -0.09	9.9	-40 to 85	SOT-23, LLP-6
ADC101S051[W]	10	1		200 to 500	2.7 to 5.25	2.7	9.7	+0.15, -0.09	+0.15, -0.11	9.9	-40 to 85	SOT-23, LLP-6
ADC101S101[W]	10	1		500 to 1000	2.7 to 5.25	2	10	±0.2	+0.3, -0.2	9.9	-40 to 85	SOT-23, LLP-6
ADC121S021[W]	12	1		50 to 200	2.7 to 5.25	1.5	7.9	+0.45, -0.4	+0.45, -0.25	11.7	-40 to 85	SOT-23, LLP-6
ADC121S051[W]	12	1		200 to 500	2.7 to 5.25	1.7	8.7	+0.45, -0.4	+0.5, -0.25	11.6	-40 to 85	SOT-23, LLP-6
ADC121S101[W]	12	1		500 to 1000	2.7 to 5.25	2	10	±0.4	+0.5, -0.3	11.7	-40 to 125	SOT-23, LLP-6
ADC082S021[W]	8	2		50 to 200	2.7 to 5.25	1.6	5.8	±0.04	±0.04	7.9	-40 to 85	MSOP-8
ADC082S051[W]	8	2		200 to 500	2.7 to 5.25	2.2	7.1	+0.12, -0.06	±0.09	7.9	-40 to 85	MSOP-8
ADC082S101[W]	8	2		500 to 1000	2.7 to 5.25	3.2	9.6	±0.13	±0.10	7.9	-40 to 85	MSOP-8
ADC102S021[W]	10	2		50 to 200	2.7 to 5.25	1.94	6.9	±0.13	±0.13	9.9	-40 to 85	MSOP-8
ADC102S051[W]	10	2		200 to 500	2.7 to 5.25	2.7	8.6	+0.2, -0.1	±0.13	10	-40 to 85	MSOP-8
ADC102S101[W]	10	2		500 to 1000	2.7 to 5.25	3.9	11.4	+0.4, -0.1	+0.26, -0.16	9.9	-40 to 85	MSOP-8
ADC122S021[W]	12	2		50 to 200	2.7 to 5.25	2.2	7.9	±0.35	+0.4, -0.2	11.7	-40 to 85	MSOP-8
ADC122S051[W]	12	2		200 to 500	2.7 to 5.25	3	10	±0.5	+0.7, -0.4	11.7	-40 to 85	MSOP-8
ADC122S101[W]	12	2		500 to 1000	2.7 to 5.25	4.3	13.1	±0.64	+0.9, -0.6	11.7	-40 to 85	MSOP-8
ADC084S021[W]	8	4		50 to 200	2.7 to 5.25	1.6	5.8	±0.04	±0.04	7.9	-40 to 85	MSOP-10
ADC084S051[W]	8	4		200 to 500	2.7 to 5.25	2.2	7.1	+0.12, -0.06	±0.09	7.9	-40 to 85	MSOP-10
ADC084S101[W]	8	4		500 to 1000	2.7 to 5.25	3.2	9.6	±0.13	±0.10	7.9	-40 to 85	MSOP-10
ADC104S021[W]	10	4		50 to 200	2.7 to 5.25	1.94	6.9	±0.13	±0.13	9.9	-40 to 85	MSOP-10
ADC104S051[W]	10	4		200 to 500	2.7 to 5.25	2.7	8.6	+0.2, -0.1	±0.13	10	-40 to 85	MSOP-10
ADC104S101[W]	10	4		500 to 1000	2.7 to 5.25	3.9	11.4	+0.4, -0.1	+0.26, -0.16	9.9	-40 to 85	MSOP-10
ADC124S021[W]	12	4		50 to 200	2.7 to 5.25	2.2	7.9	±0.35	+0.4, -0.2	11.7	-40 to 85	MSOP-10
ADC124S051[W]	12	4		200 to 500	2.7 to 5.25	3	10	±0.5	+0.7, -0.4	11.7	-40 to 85	MSOP-10
ADC124S101[W]	12	4		500 to 1000	2.7 to 5.25	4.3	13.1	±0.64	+0.9, -0.6	11.7	-40 to 85	MSOP-10
ADC088S022[W]	8	8		50 to 200	2.7 to 5.25	0.9	5.5	±0.04	±0.04	7.9	-40 to 105	TSSOP-16
ADC088S052[W]	8	8		200 to 500	2.7 to 5.25	1.2	6.5	±0.05	±0.06	7.9	-40 to 105	TSSOP-16
ADC088S102[W]	8	8		500 to 1000	2.7 to 5.25	1.8	8	±0.05	±0.06	7.9	-40 to 105	TSSOP-16
ADC108S022[W]	10	8		50 to 200	2.7 to 5.25	1.1	6.4	±0.10	±0.1	10	-40 to 105	TSSOP-16
ADC108S052[W]	10	8		200 to 500	2.7 to 5.25	1.5	7.5	±0.10	±0.2	10	-40 to 105	TSSOP-16
ADC108S102[W]	10	8		500 to 1000	2.7 to 5.25	2.1	9.4	±0.20	±0.2	10	-40 to 105	TSSOP-16
ADC128S022[W]	12	8		50 to 200	2.7 to 5.25	1.2	7.5	±0.4	-0.3, +0.5	11.8	-40 to 105	TSSOP-16
ADC128S052[W]	12	8		200 to 500	2.7 to 5.25	1.6	8.7	±0.4	-0.4, +0.6	11.8	-40 to 105	TSSOP-16
ADC128S102[W]	12	8		500 to 1000	2.7 to 5.25	2.3	10.7	±0.5	-0.4, +0.7	11.8	-40 to 105	TSSOP-16

PowerWise product [W]WEBENCH enabled

kSPS Low-Power A/D and D/A Converters

8-/10-/12-Bit D/A Converters Provide Seamless Upgradeability

Features

- Pin- and function-compatible across resolutions
- 2- and 4-channel family with smallest package outline in class (3 mm x 3 mm)
- Rail-to-rail output swing

Applications

Ideal for use in portable, battery-powered applications in industrial, medical, and consumer designs

Product ID	Res (bits)	# Mux Inputs	Pin and Function Comp. Family	Typ Settling Time (µs)	Supply Voltage Range (V)	Typ Current Consumption (µA)		Static Performance (Typ)		Reference	Packaging
						3V	5V	INL (LSB)	DNL (LSB)		
Single-Ended Input SPI Digital-to-Analog Converters											
DAC081S101	8	1		3	2.7 to 5.5	175	260	+0.16, -0.12	+0.04, -0.02	From supply	MSOP-8, TSOT-6
DAC101S101	10	1		5	2.7 to 5.5	175	260	±0.6	+0.15, -0.05	From supply	MSOP-8, TSOT-6
DAC121S101	12	1		8	2.7 to 5.5	175	260	±2.6	+0.25, -0.15	From supply	MSOP-8, TSOT-6
DAC082S085	8	2		3	2.7 to 5.5	210	320	±0.14	+0.04, -0.02	External	MSOP-10, LLP-10
DAC102S085	10	2		4.5	2.7 to 5.5	210	320	±0.7	+0.08. -0.03	External	MSOP-10, LLP-10
DAC122S085	12	2		6	2.7 to 5.5	210	320	±2.4	+0.2, -0.1	External	MSOP-10, LLP-10
DAC084S085	8	4		3	2.7 to 5.5	350	500	±0.14	+0.04, -0.02	External	MSOP-10, LLP-10
DAC104S085	10	4		4.5	2.7 to 5.5	350	500	±0.7	+0.08, -0.03	External	MSOP-10, LLP-10
DAC124S085	12	4		6	2.7 to 5.5	360	480	±2.4	+0.2, -0.1	External	MSOP-10, LLP-10
DAC088S085	8	8		3	2.7 to 5.5	650	970	±0.125	±0.03	Dual external	TSSOP-16, LLP-16
DAC108S085	10	8		4.5	2.7 to 5.5	650	970	±0.5	+0.08, -0.04	Dual external	TSSOP-16, LLP-16
DAC128S085	12	8		6	2.7 to 5.5	650	970	±2.0	+0.15, -0.09	Dual external	TSSOP-16, LLP-16
Single-Ended Input I²C Digital-to-Analog Converters											
DAC081C081	8	1		6	2.7 to 5.5	0.38	0.73	±0.1	±0.08	Supply	TSOT-6, LLP-6
DAC101C081	10	1		6	2.7 to 5.5	0.38	0.73	+0.21, -0.16	+0.25, -0.16	Supply	TSOT-6, LLP-6
NEW! DAC121C081	12	1		6	2.7 to 5.5	0.38	0.73	+2.2, -1.5	+0.18, -0.12	Supply	TSOT-6, LLP-6
NEW! DAC081C085	8	1		6	2.7 to 5.5	0.38	0.73	±0.1	±0.08	External	MSOP-8
DAC101C085	10	1		6	2.7 to 5.5	0.38	0.73	+0.21, -0.16	+0.25, -0.16	External	MSOP-8
DAC121C085	12	1		6	2.7 to 5.5	0.38	0.73	+2.2, -1.5	+0.18, -0.12	External	MSOP-8

[1] SPI/QSPI/DSP compatible

Differential-Input SPI A/D Converters

Product ID	Res (bits)	Inputs	Pin and Function Compatible	Speed Range (kSPS)	Supply Voltage Range(V)	Typ Power (mW)		Static Performance (Typ)		ENOB (bits) typ	Temp Range (°C)	Packaging
						3V	5V	INL (LSB)	DNL (LSB)			
ADC121S625[W]	12	1		50 to 200	4.5 to 5.5	—	2.25	- 0.5 / -0.3	±0.4	11.8	-40 to 85	MSOP-8
ADC121S655[W]	12	1		200 to 500	4.5 to 5.5	—	9	±0.6	±0.4	11.7	-40 to 105	MSOP-8
ADC121S705[W]	12	1		500 to 1000	4.5 to 5.5	—	11.5	±0.6	±0.4	11.7	-40 to 105	MSOP-8
ADC122S625[W]	12	2		50 - 200	4.5 to 5.5	—	—	±1.0	±0.95	11.25	-40 to 105	MSOP-10
ADC122S655[W]	12	2		200 to 500	4.5 to 5.5	—	25	±1.0	±0.95	11.25	-40 to 105	MSOP-10
ADC122S706[W]	12	2	—	500 to 1000	4.5 to 5.5	20	25	±1	±0.95	11.25	-40 to 105	TSSOP-14
ADC141S626[W]	14	1	—	50 to 250	2.7 to 5.5	2	4.8	±0.5	±0.5	13.7	-40 to 85	MSOP-10
ADC161S626[W]	16	1	—	50 to 250	4.5 to 5.5	—	5.8	±0.8	±0.5/ ±0.8	14.3	-40 to 85	MSOP-10

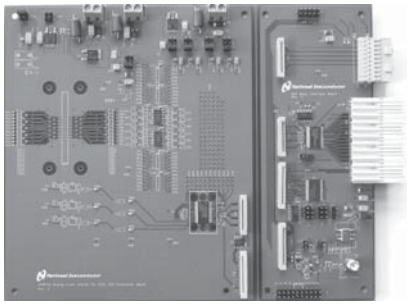
PowerWise® product [W]WEBENCH enabled

LM98714 – 3-Channel, 16-Bit, 45 MSPS Analog Front End with Integrated CCD/CIS Sensor Timing Generator and LVDS Output

Features

- Maximum input level selectable between 1.2V and 2.4V
- Input signal polarity selectable as + or - for use with CIS or CCD sensors
- Channel sampling rate: 15/22.5/30 MSPS in 3/2/1 channel mode
- Noise floor: -74 dB (at 0 dB PGA gain)
- INL: ± 23 LSB (typ)
- Power dissipation: 505 mW
- Integrated PGA: gain range 0.7 to 7.84x in 256 steps
- Integrated analog DAC: offset range ±300 mV or ±600 mV with ±9 bit resolution
- Integrated digital DAC: offset range -1024 LSB to +1008 LSB with ±6 bit resolution
- Operating temp: 0°C to 70°C
- Single 3.3V supply
- Available in TSSOP-48 packaging

LM98714 Eval Board and Graphical User Interface*

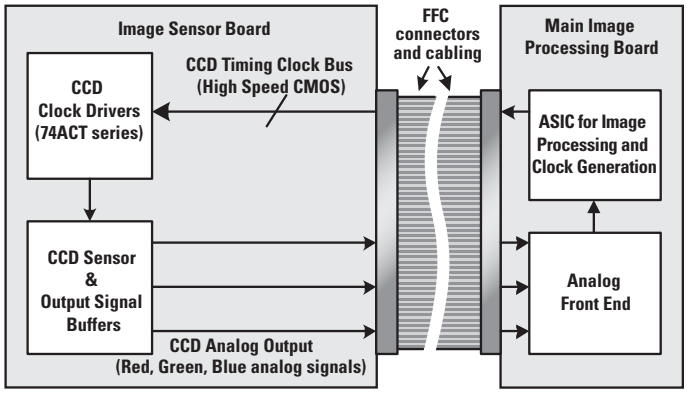


*Available for order – contact sales rep

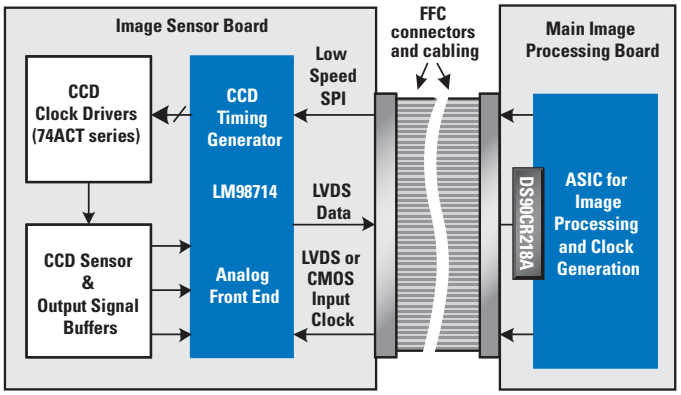
Applications

Ideal for use in multi-function peripherals, facsimile equipment, flatbed or handheld color scanners, and high-speed document scanners

Legacy MFP Image Sensor Block Diagram



New MFP Image Sensor Block Diagram Partitioning



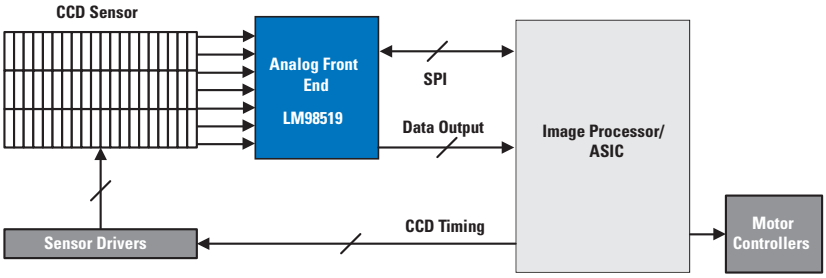
Read Analog Edge AN-1583. Topic:
"Simplifying CCD/CIS Image Capturing with a 3-Channel 16-Bit AFE/Timing Generator"
www.national.com/edge

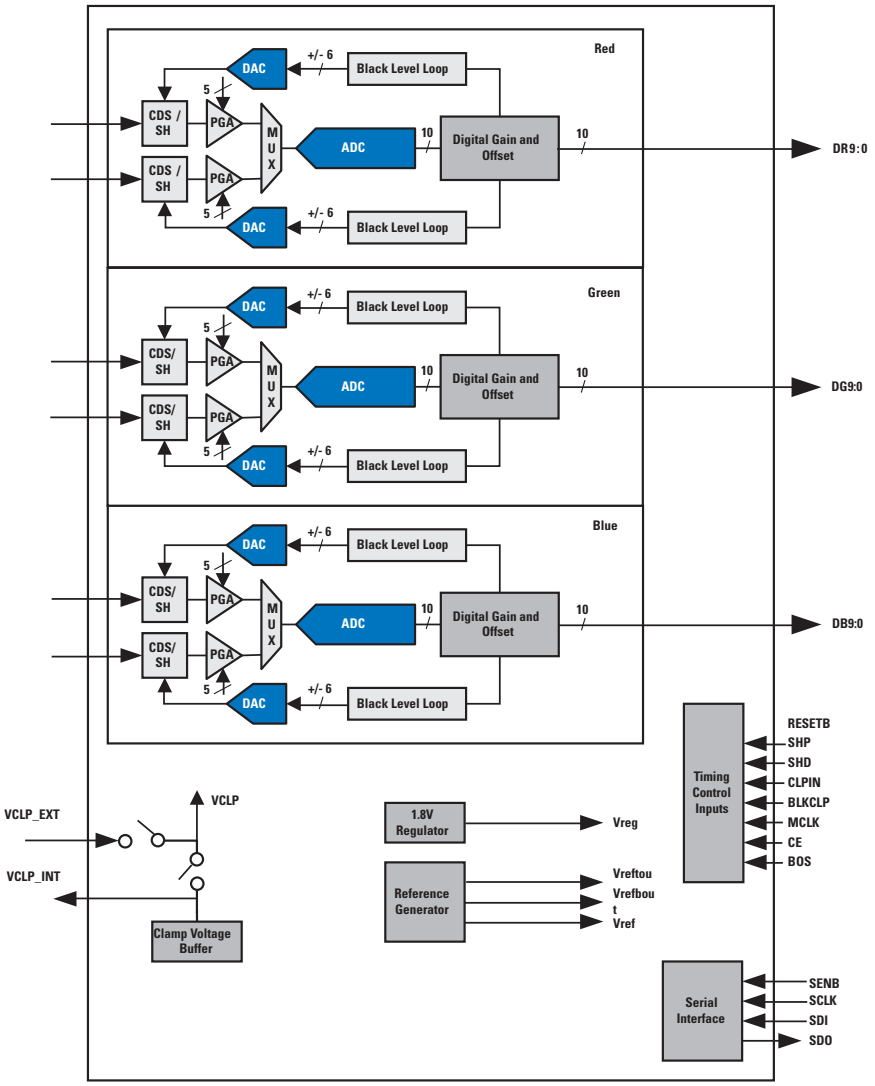
Analog Front Ends (AFE)

LM98519 – 6-Channel, 10-Bit, 32.5 MSPS per Channel, Analog Front End for High-Speed Linear CCD and CIS Sensors

Features

- CDS or S/H processing with negative input signal polarity
- Enhanced ESD protection on timing and control pins
- 6-channel AFE optimized for operation with 3-color, 6-output linear CCDs
- Digital black level calibration for each channel
- Digital white level calibration for each channel
- Programmable input clamp
- Maximum input level 1.2V
- Channel sampling rate: 32.5 MSPS
- Noise floor: -68 dB (at 0 dB PGA gain)
- INL: ± 1 LSB (typ)
- Power dissipation: 1.04W
- Integrated PGA: total gain range 1x to 20x in 256 steps
- Integrated analog course DAC: offset range ± 277 mV with ±4 bit resolution
- Integrated analog fine DAC: offset range ± 111 mV or ± 60 mV with ±11 bit resolution
- Operating temperature range: 0°C to 70°C
- Single 3.3V supply
- Available in TQFP-80 packaging





Amplifier Portfolio Selection Table

High-Speed Amplifier Selection Table

LMH Family

- Lower power and lower distortion than competitive products
- Improved usability by reducing glitches due to parasitic capacitance
- Suitable for any type of application

General-Purpose High-Speed Amplifiers
Low Noise (Noise ≤ 2n V/√Hz, ≤ 2 pA/√Hz)
Low distortion (HD2 and HD3 <-50 dBC)
Rail-to-rail I/O
Single supply
Precision (offset voltage ≤ 1 mV)

Special Features
Fully differential
Variables gain amplifiers

Application-Specific Amplifiers
Mobile devices: RF detectors, clock buffers
Analog video: multiplexers, amplifiers/buffers

Low-Voltage, Low-Power/CMOS Amplifier Selection Table

LMV Family

- 2.7V (1.8V) ≤ Vs ≤ 5V (12V)
- Rail-to-rail output
- Low power
- Variety of small size packages

LMC Family

- 3V ≤ Vs ≤ 15V
- Fully CMOS process
- High input impedance
- Variety of products

Precision Amplifiers
Low noise (≤ 2nV/√Hz, ≤2 pA/√Hz)
Low voltage (min supply voltage ≤ 2.7V)
Low power
High voltage (supply voltage ± 15V)

Special Features
CMOS input
Current sense amplifiers
Shutdown
EMI-hardened

High-Speed Amplifiers

High-Speed Fully Differential Amplifiers

Product ID	Unity Gain BW (MHz) at AVCL (V/V)	Slew Rate (V/µs)	Supply Voltage Range (V)	Supply Current per Channel (mA)	Channels	Voltage Noise (nV/√Hz)	2nd/3rd HD (dBc)	Packaging
LMH6550 E	400 at 1	3000	5 to 12	20	1	6	-92/-103 at V_O = 2 V_{PP}, f = 5 MHz, RL = 800Ω	SOIC-8,MSOP-8
LMH6551 E	370 at 1	2400	3 to 12	12.5	1	6	-94/-96 at V_O = 2 V_{PP}, f = 5 MHz, RL=800Ω	SOIC-8,MSOP-8
LMH6552 E	1500 at 1	3800	4.5 to 12	19	1	1.1	-92/-93 at V_{OUT} = 2 V_{PP}, f = 20 MHz, RL = 800Ω	SOIC-8, LLP-8
LMH6553 E	900 at 1	2300	4.5 to 12	29.5	1	1.1	-79/-90 at V_{OUT} = 2 V_{PP}, f = 20 MHz, RL = 800Ω	PSOP-8, LLP-8
LMH6554 E	2500 at 1	6200	4.7 to 5.3	52	1	0.9	-68/-70 at V_{OUT} = 2 V_{PP}, f = 250 MHz, RL = 200Ω	FCOL-14
LMH6555 E	1200 at 13.6 dB	1300	3 to 3.6	120	1	19	-60/-67 at V_{OUT} = 0.8 V_{PP}, f = 250 MHz, RL = 100Ω	LLP-16

PowerWise® product E Evaluation board

High-Speed Single-Supply Optimized Amplifiers

Product ID	Unity Gain BW (MHz) at AVCL (V/V)	Slew Rate (V/µs)	Supply Voltage Range (V)	Supply Current per Channel (mA)	Channels	Voltage Noise (nV/√Hz)	Packaging
Low-Power, Rail-to-Rail Input and Output Amplifiers							
LMH6645/46/47 E,W	55 at 1	22	2.5 to 12	0.725	1/2/4	17	SOIC-8, SOT23-5
LMH6618/19 E,W	140 at 1	57	2.7 to 11	1.35	1/2	10	TSOT-6, SOIC-8
Low-Power, Rail-to-Rail Output Amplifiers							
LMH6642/43 E,W	130 at 1	135	2.7 to 12.8	2.7	1/2	17	SOIC-8, SOT23-5/SOIC-8
LMH6644 E,W	130 at 1	135	2.7 to 12.8	2.7	4	17	SOIC-14, TSSOP-14
LMH6601 E,W	250 at 1	275	2.4 to 5.5	9.6	1	7	SC70-6
LMH6611/12 E,W	365 at 1	460	2.7 to 11	3.3/3.45	1/2	10	TSOT-6/SOIC-8

PowerWise® product E Evaluation board W WEBENCH enabled

High-Speed, Low-Noise and Distortion Amplifiers

Product ID	Unity Gain BW (MHz) at AVCL (V/V)	Slew Rate (V/µs)	Supply Voltage Range (V)	Supply Current/ Channel (mA)	Channels	Voltage Noise (nV/√Hz)	Current Noise (pA/√Hz)	2nd/3rd HD (dBc)	Packaging
LMH6672 E, W	90 at 2	170	3 to 12	6.2	2	4.5	1.8	-90/-97 at Vo=8.4 V_{PP}, f=1 MHz, RL=100Ω	SOIC-8, PSOP-8
LMH6618/19 E, W	140 at 1	57	2.7 to 10/11	1.6/1.3	1/2	10	1	-102/-102 at Vo=2 V_{PP}, f=100 kHz, RL=1KΩ	TSOT-6/SOIC-8
LMH6622 E, W	160 at 2	80	5 to 12	4.3	2	1.6	1.5	-90/-94 at Vo =2 V_{PP}, f=1 MHz, RL=100Ω	SOIC-8
LMH6626 E, W	160 at 10	360	5 to 12	12	2	1	1.8	-63/-80 at Vo=1 V_{PP}, f=5 MHz, RL=100Ω	SOIC-8
LMH6624 E, W	180 at 10	400	5 to 12	12	1	0.92	2.3	-63/-80 at Vo=1 V_{PP}, f=5 MHz, RL=100Ω	SOIC-8, SOT23-5
LMH6628 E, W	300 at 1	550	5 to 12	9	2	2	2	-65/-74 at Vo=1 V_{pp}, f=10 MHz, Rl=100Ω	SOIC-8
LMH6654 E, W	250 at 1	200	4.5 to 12	4.5	1	4.5	1.7	-80/-85 at Vo=2 V_{PP}, f=5 MHz, RL=100Ω	SOIC-8, SOT23-5
LMH6655 E, W	250 at 1	200	4.5 to 12	4.5	2	4.5	1.7	-80/-85 at Vo=2 V_{PP}, f=5 MHz, RL=100Ω	SOIC-8
LMH6611/12 E, W	365 at 1	460	2.7 to 11	3.3/3.45	1/2	10	2	-83/-100 at Vo=2 V_{PP}, f=1 MHz, RL=150Ω	TSOT23-6/ SOIC-8
LMH6550 E	400 at 1	3000	5 to 12	20	1	6	1.5	-92/-103 at Vo=2 V_{PP}, f=5 MHz, RL=800Ω	SOIC-8
LMH6738 E	750 at 1	3300	10 to 12	10.5	3	2.2	3 (non-inverting)	-80/-90 at Vo=2 V_{PP}, f=5 MHz, RL=100Ω	SSOP-16
LMH6552 E	1500 at 1	3800	4.5 to 12	19	1	1.1	19.5	-92/-93 at Vo=2 V_{PP}, f=20 MHz, RL=800Ω	SOIC-8, LLP-8
LMH6702 E, W	1700 at 2	3100	10 to 12	12.5	1	1.83	3 (non-inverting)	-100/-96 at Vo=2 V_{PP}, f=5 MHz, RL=100Ω	SOIC-8, SOT23-5
LMH6703 E	1200 at 2	4200	8 to 12	11	1	2.3	3 (non-inverting)	-87/-100 at Vo=2 V_{PP}, f=5 MHz, RL=100Ω	SOIC-8, SOT23-6
LMH6554	2500 at 1	6200	4.7 to 5.3	52	1	0.9	11	-68/-70 at Vo=2 V_{PP}, f=250 MHz, RL=200Ω	FCOL-14

PowerWise® product E Evaluation board W WEBENCH enabled

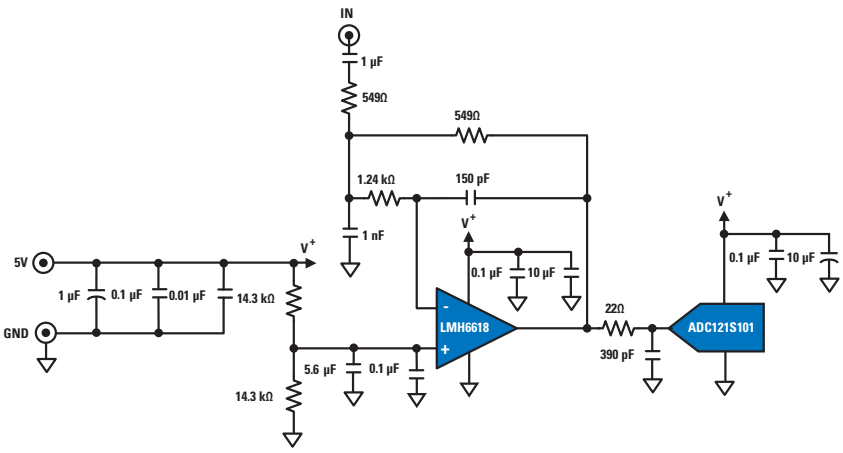
High-Speed Amplifiers

LMH6618/19 – 130 MHz, 1.25 mA Rail-to-Rail Input and Output Op Amp with Shutdown

Features

- Operating voltage range 2.7V to 11V
- Small signal bandwidth 130 MHz
- 1 mV max voltage offset over full temperature range
- 90 ns settling time to 0.1%, 120 ns to 0.01%
- SFDR (f = 1 MHz, AV = +1, V_{OUT} = 2 V_{PP}) 80 dBc
- 0.1 dB bandwidth (AV = +2) 15 MHz
- Industrial temperature grade -40°C to +125°C
- Low-power shutdown (LMH6618)
- Available in TSOT23-6 (LMH6618) and SOIC-8 (LMH6619) packaging

Single-to-Single ADC Driver



Precision High-Speed Amplifiers

Product ID	Channels	Offset Voltage max, 25C (mV)	TcVos (µV/°C)	CMRR (dB)	PSRR (dB)	Voltage Noise nV/√Hz	-3 dB SSBW (MHz)	AVCL for -3 dB SSBW (V/V)	Slew Rate (V/µs)	Supply Voltage Range (V)	Packaging
LMH6611 E,W	1	0.6	0.1	98	96	10	365	1	460	2.7 to 11	TSOT-6
LMH6612 E,W	2	0.75	0.1	98	96	10	365	1	460	2.7 to 11	TSOT-6
LMH6618 E,W	1	0.6	0.8	98	104	10	140	1	57	2.7 to 11	TSOT-6
LMH6619 E,W	2	0.6	0.8	98	104	10	140	1	57	2.7 to 11	SOIC-8
LMH6624 E,W	1	0.5	0.2	95	88	0.92	180	10	400	5 to 12	SOIC-8, SOT23-5
LMH6626 E,W	2	0.5	0.2	95	88	1	160	10	360	5 to 12	SOIC-8

PowerWise® product [E]Evaluation board [W]WEBENCH enabled

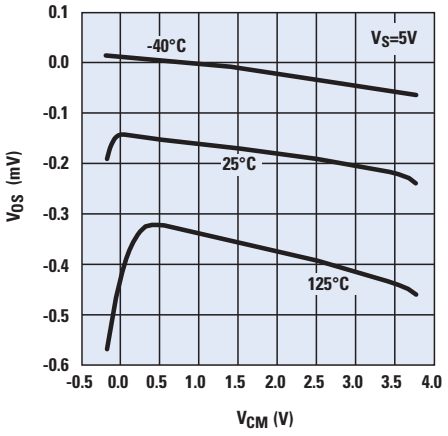
LMH6611/12 – 345 MHz Rail-to-Rail Output Single/Dual Amplifiers

Features

- 345 MHz small signal gain of 1 bandwidth
- 85 MHz large signal gain in 2 bandwidth
- 1 mV max input voltage offset over full temp on LMH6611 (1.3 mV for LMH6612)
- 102 dBc SFDR at 100 kHz
- 3.2 mA/ch supply current at V_{CC} = 5V
- -40°C to +125°C operating temperature range

Applications

Ideal for use in ADC and DAC buffering, high-speed filter design, and 1080i and 720p video amps



Amplifiers > 50 MHz

Product ID	Unity Gain BW (MHz) at AVCL (V/V)	Slew Rate (V/µs)	Supply Voltage Range (V)	Supply Current/ Channel (mA)	Channels	Offset Voltage max, 25C (mV)	Voltage Noise (nV/√Hz)	Packaging
LMH6645 E, W	55 at 1	22	2.5 to 12	0.725	1	3	17	SOIC-8, SOT23-5
LMH6646 E, W	55 at 1	22	2.5 to 12	0.725	2	3	17	SOIC-8
LMH6647 E, W	55 at 1	22	2.5 to 12	0.725	1	3	17	SOIC-8, SOT23-6
LMH6672 E, W	90 at 2	170	3 to 12	6.2	2	5.5	4.5	SOIC-8, PSOP-8
LMH6642 E, W	130 at 1	135	2.7 to 12.8	2.7	1	5	17	SOIC-8, SOT23-5
LMH6643 E, W	130 at 1	135	2.7 to 12.8	2.7	2	5	17	SOIC-8
LMH6644 E, W	130 at 1	135	2.7 to 12.8	2.7	4	5	17	SOIC-14, TSSOP-14
LMH6619 E, W	140 at 1	57	2.7 to 11	1.3	2	0.6	10	SOIC-8
LMH6618 E, W	140 at 1	57	2.7 to 10	1.6	1	0.6	10	TSOT-6
LMH6622 E, W	160 at 2	80	5 to 12	4.3	2	1.2	1.6	SOIC-8
LMH6624 E, W	1500 at 10	400	5 to 12	12	1	0.5	0.92	SOIC-8, SOT23-5
LMH6626 E, W	160 at 10	360	5 to 12	12	2	0.5	1	SOIC-8
LMH6639	228 at 1	172	3 to 12	3.6	1	5	12	SOIC-8, SOT23-6
LMH6640	190 at 1	170	4.5 to 16	4	1	1	15	SOT23-5
LMH6682 E	190 at 2	940	3 to 12	6.5	2	5	12	SOIC-8
LMH6683 E, W	190 at 2	940	3 to 12	6.5	3	5	12	SOIC-14, TSSOP-14
LMH6601 E, W	250 at 1	275	2.4 to 5.5	9.6	1	2.4	10	SC70-6
LMH6654 E	250 at 1	200	4.5 to 12	4.5	1	3	4.5	SOIC-8, SOT23-5
LMH6655 E	250 at 1	200	4.5 to 12	4.5	2	3	4.5	SOIC-8
LMH6657 E	270 at 1	700	3 to 12	6	1	5	11	SC70-5, SOT23-5
LMH6658 E	270 at 1	700	3 to 12	6	2	5	11	SOIC-8
LMH6628 E, W	300 at 1	550	5 to 12	9	2	2	2	SOIC-8
LMH6611 E, W	365 at 1	460	2.7 to 11	3.3	1	0.6	10	TSOT23-6
LMH6612 E, W	365 at 1	460	2.7 to 11	3.45	2	0.75	10	SOIC-8
LMH6551 E	370 at 1	2400	3 to 12	12.5	1	5	6	SOIC-8
LMH6723 E	370 at 1	600	5 to 12	1	1	3	4.3	SOIC-8, SOT23-5
LMH6724 E	370 at 1	600	5 to 12	1	2	3	4.3	SOIC-8
LMH6725 E	370 at 1	600	5 to 12	1	4	3	4.3	SOIC-14, TSSOP-14
LMH6550 E	400 at 1	3000	5 to 12	20	1	5	6	SOIC-8
LMH6722 E	400 at 2	1800	10 to 12	5.6	4	6	3.4	SOIC-14, TSSOP-14
LMH6714/20 E	400 at 2	1800	10 to 12	5.6	1	6	3.4	SOIC-8,SOT23-5
LMH6715 E, W	480 at 2	1300	10 to 12	5	2	6	3.4	SOIC-8
LMH6732 E	540 at 2	2700	9 to 12	9	1	8	2.5	SOIC-8, SOT23-6
LMH6738 E	750 at 1	3300	10 to 12	10.5	3	2.5	2.2	SSOP-16
LMH6553 E	900 at 1	2300	4.5 to 12	29.5	1	n/a	1.1	PSOP-8,LLP-8
LMH6609 E	900 at 1	1400	6 to 12	7	1	2.5	3.1	SOIC-8, SOT23-5
LMH6733 E, W	1000 at 1	3750	3 to 12	6.5	3	2.2	2.1	SSOP-16
LMH6552 E	1500 at 1	3800	4.5 to 12	19	1	n/a	1.1	SOIC-8, LLP-8
LMH6702 E, W	1700 at 2	3100	10 to 12	12.5	1	4.5	1.83	SOIC-8, SOT23-5
LMH6703 E	1200 at 2	4200	8 to 12	11	1	7	2.3	SOIC-8, SOT23-6
NEW! LMH6554	2500 at 1	6200	4.7 to 5.3	52	1	n/a	0.9	FCOL-14

PowerWise® product E Evaluation board W WEBENCH enabled

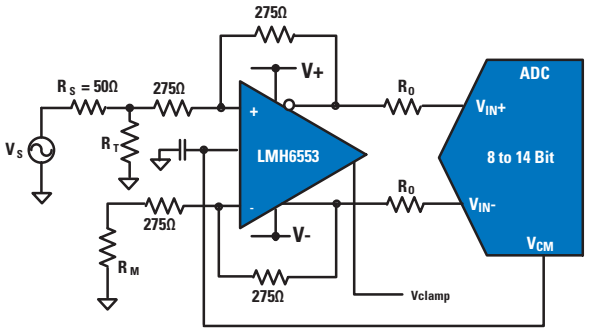
High-Speed Amplifiers

LMH6553 – 900 MHz Fully Differential Amplifier With Output Limiting Clamp

Features

- 900 MHz small signal gain of 1 bandwidth
- 670 MHz large signal gain of 1 bandwidth
- Integrated adjustable output limiting clamp protects low voltage ADC inputs from overload
- 600 ps clamp overdrive recovery time
- 10 ns settling time to 0.1%
- -79 dB THD at 20 MHz
- 4.5 to 12V operation
- Ideal match to National's 8/10/12/14-bit high-speed ADCs

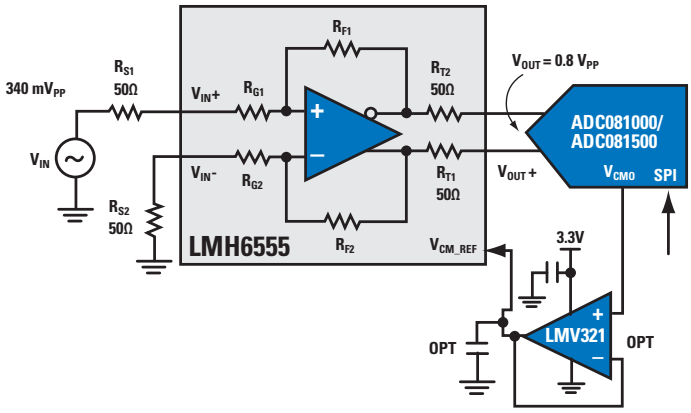
Single-Ended Input Differential Output ADC Driver



LMH6555 – 1.2 GHz Low-Distortion Differential Driver

Features

- 1.2 GHz bandwidth
- -50.5 dBc THD at 750 MHz
- 15 dB noise figure
- 13.7 dB fixed gain
- 3.3V operation
- 1300 V/µs slew rate
- Ideal match for 8-bit ADCs up to 3 GSPS, such as the ADC08(D)1000/1500/3000 family
- Available in LLP-16 packaging

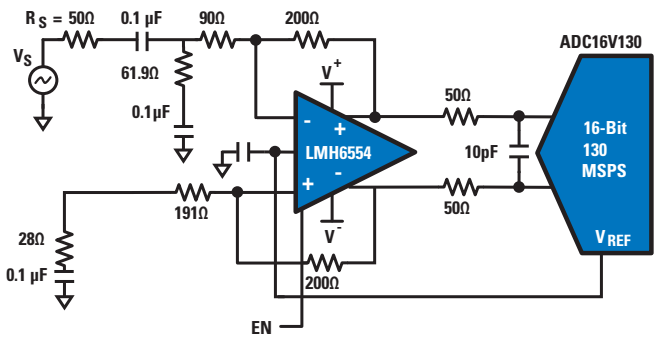


LMH6554 – 2.5 GHz Ultra Linear Fully-Differential Amplifier

Features

- 2.5 GHz small signal gain of 1 bandwidth
- 1.8 GHz large signal gain of 1 bandwidth
- 800 MHz 0.1 dB gain flatness
- -99 dBc IMD3 at f = 150 MHz
- 72 dBc SFDR at f = 250 MHz
- 0.9 nV/√Hz input noise voltage
- 11 pA/√Hz input noise current
- 4.7V to 5.3V operation
- Available in quad FCOL-14 packaging
- Ideal match to National's new ADC10D1000 1 GSPS dual ADC and ADC16V130 130 MSPS 16-bit ADC

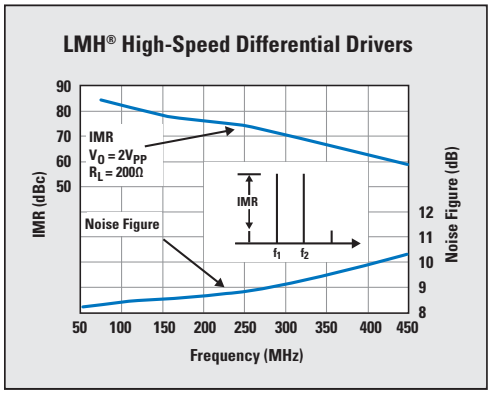
AC Coupled, Single to Differential ADC Driver



LMH6515 – High-Speed Differential Driver Increases Dynamic Range Performance

Features

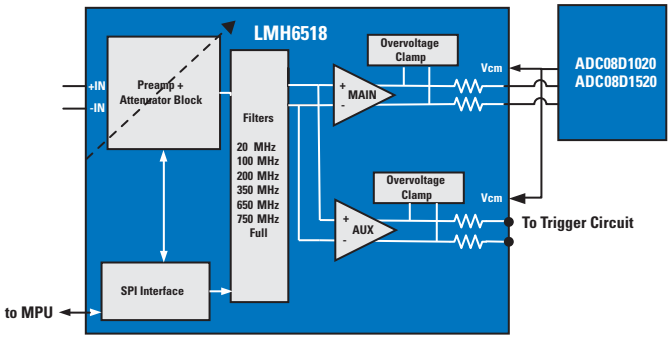
- 8.3 dB noise figure, 40 dBm OIP3
- 500 mW power dissipation
- 26 dB maximum gain, R_L = 200
- 31 dB gain range in precise 1 dB steps
- Gain step error < 0.05 dB at F = 100 MHz
- Differential-to-differential and single-to-differential
- Available in small LLP-16 packaging (4 mm x 4 mm)
- Ideal match for 12/14-bit high-speed ADCs up to 300 MHz, such as the ADC14V155 and ADC14DS105
- Reference board available with LMK03001 clock conditioner and ADC14V155



LMH6518 – 900 MHz DVGA with 40 dB Adjustment Gain and 8.5 mdB Effective Gain-Step Resolution

Features

- Integrated bandwidth filters
- Auxiliary output for trigger path
- Gain range 40 dB
- Gain step size 2 dB
- Gain step size with ADC 8.5 mdB
- SNR (V_{IN}≥25 mVpp FS, 200 MHz BW) 52dBFS
- HD2/HD3 at 100 MHz -50 dBc/-53 dBc
- Input referred noise (max gain) 0.98 nV/√Hz
- Power consumption 1.1W/0.75W



High-Speed Variable Gain Amplifiers

Product ID	Gain Control	-3 dB Bandwidth (MHz)	Gain Adj Range (dB)	Gain Step Size (dB)	Supply Voltage Range (V)	Supply Current/ Channel (mA)	Channels	Voltage Noise (nV/√Hz)	Configuration (input/ output)	2nd/3rd HD (dB)	Packaging
LMH6502 [E]	Analog	130	72	—	5 to 12	27	1	7.7	Diff/single	HD2/HD3= -55/ -57 (2 V_{P-P}, 20 MHz)	SOIC-14, TSSOP-14
LMH6503 [E]	Analog	135	70	—	5 to 12	37	1	6.6	Diff/single	HD2/HD3= -60/ -61 (2 V_{P-P}, 20 MHz)	SOIC-14, TSSOP-14
LMH6505 [E] PowerWise®	Analog	150	80	—	7 to 12	11	1	4.4	Single/single	HD2/HD3= -47/ -61 (2 V_{P-P}, 20 MHz)	SOIC-8, MSOP-8
LMH6514 [E] PowerWise®	Digital	600	42	6	4 to 5.25	107	1	1.8	Diff/diff	OIP3= 40 dBm at 70 MHz	LLP-16
LMH6515 [E] PowerWise®	Digital	600	31	1	4 to 5.25	107	1	1.8	Diff/diff	OIP3= 40 dBm at 70 MHz	LLP-16
LMH6518 [E]	Digital	900	40	2/8.5m	4.75 to 5.25	210/150	1	0.98	Diff/diff	HD2/HD3=-50/-53 all gains, 100 MHz	LLP-16

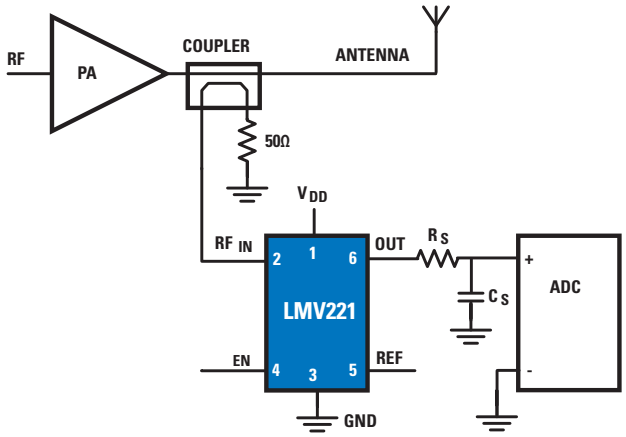
PowerWise® product [E] Evaluation board

RF Detectors

LMV221/LMH2100 – 50 MHz to 4 GHz 40 dB Logarithmic Power Detector for CDMA and WCDMA

Features

- 40 dB linear in dB power detection range
- Output voltage range 0.3V to 2V
- Shutdown pin
- Multi-band operation from 50 MHz to 3.5 GHz
- 0.5 dB accurate temperature compensation
- External configurable output filter bandwidth
- Available in LLP-6 packaging, 2.2 x 2.5 x 0.8 mm (LMV221)
- Available in micro SMD packaging, 0.85 x 1.25 x 0.6 mm (LMH2100)

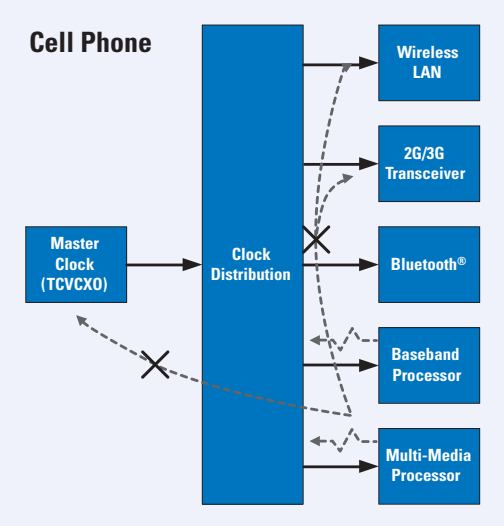


RF Detectors

Product ID	Application	Channels	Supply Voltage Range (V)	Dynamic Range (dB)	Frequency Range (MHz)	Packaging
LMV221 [E]	CDMA, WCDMA, GSM, GPRS	1	2.7 to 3.3	40	50 to 3500	LLP-6
LMV225 [E]	CDMA, WCDMA, GSM, EDGE, GPRS, TDMA	1	2.7 to 5	>30	450 to 2000	micro SMD-4, LLP-6
LMV226 [E]	CDMA, WCDMA, GSM, EDGE, GPRS, TDMA	1	2.7 to 5	>30	450 to 2000	micro SMD-4
LMV228 [E]	CDMA, WCDMA, GSM, EDGE, GPRS, TDMA	1	2.7 to 5	>30	450 to 2000	micro SMD-4
LMV232 [E]	3G, UMTS, WCDMA, CDMA2000, LAN, GPS	2	2.5 to 3.3	20	50 to 2000	micro SMD-8
LMH2100 [E]	CDMA, WCDMA, GSM, GPRS	1	2.7 to 3.3	40	50 to 4000	micro SMD-6
LMV242 [E]	GSM, GPRS, TDMA, LAN	2	2.6 to 5.5	50	450 to 2000	LLP-10
LMV243 [E]	GSM, GPRS, TDMA, LAN	1	2.7 to 3.3	50	450 to 2000	micro SMD-8

[E] Evaluation board

Master Clock Distribution in Cell Phones; Optimized Clock Distribution Solution



Features

- Proper clock distribution circuitry decreases bit error rate
- Isolates master clock from switching noise in digital modules
- Isolates sensitive modules from noise in other modules
- Preserves clock amplitude; high drive capability, minimal clock loading
- Prevents frequency pulling; constant clock load impedance under all conditions
- Preserves clock accuracy: low additive phase noise
- Low power consumption
- Tiny footprint

LMH2190 – Clock Tree Driver and Conditioner

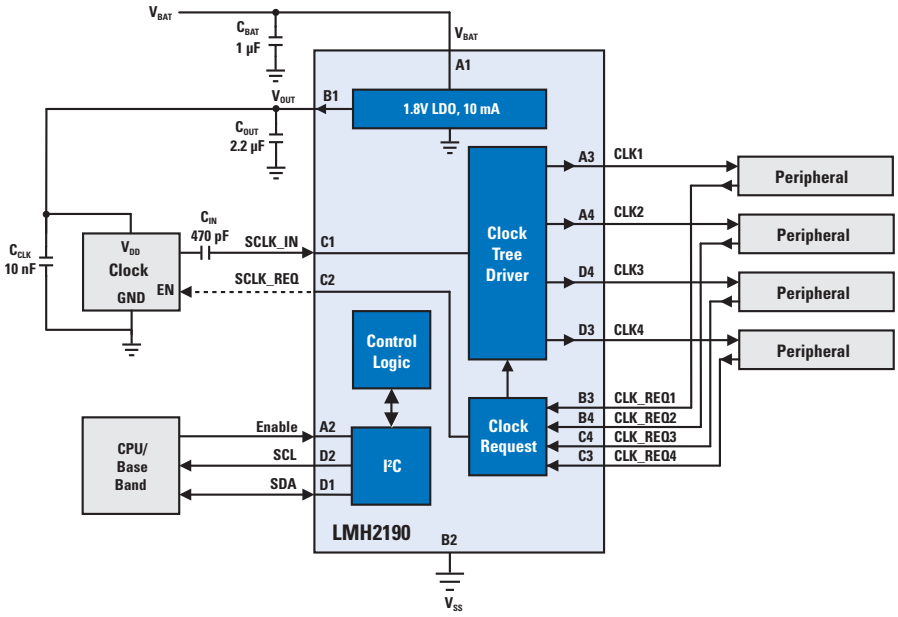
Features

- 1 input clock, 4 output clocks
- Excellent phase noise specifications
- Independent clock request pins
- Supports both square or sine wave input
- Clock outputs can be skewed
- High isolation of supply noise to clock input
- Selectable output drive capability from 10 pF to 50 pF
- EMI-controlled output edges and EMI filtering
- Integrated LDO
  - 10 mA output current
  - Low-output voltage noise
- Ultra-low standby current

Applications:

Ideal for use in mobile handsets and portable equipment

LMH2190 Typical Application Circuit



Product ID	Bandwidth	Channels	Isup (mA)	Phase Noise	Slew Rate	Shutdown	Output	Packaging
NEW! **LMH2190**	26 MHz	4	3.0	-152 dBc/Hz, 10 kHz offset	N/A	✔	Digital	micro SMD-16 (1.65 x 1.65 mm)
NEW! **LMH2180** [E]	75 MHz	2	2.3	-132 dBc/Hz, 10 kHz offset	106 V/µs	✔	Analog	LLP-8, micro SMD-8
LMV112 [E]	40 MHz	2	1.6	-116 dBc/Hz, 10 kHz offset	110 V/µs	✔	Analog	LLP-8
LMV115 [E]	30 MHz	1	0.3	n/a	18 V/µs	✔	Analog	SC70-6
LMV116	45 MHz	1	0.6	n/a	40 V/µs	—	Analog	SOT23-5
LMV118	45 MHz	1	0.6	n/a	40 V/µs	✔	Analog	SOT23-6

[E] Evaluation board

Analog Video Products

LMH1980 – Auto-Detecting SD/HD/PC Video Sync Separator

Features

- Sync separation for NTSC, PAL, SECAM, 480I/P, 576I/P, 720P, 1080I/P, and VESA-compatible timing
- Composite Video (CVBS), S-Video (Y/C), Component Video (YPBPR/GBR) and PC Graphics (RGsB) compatibility
- Bi-level and tri-level sync compatible
- HD detect output flag
- Automatic video format detection
- Fixed-level sync slicing of 0.5 V_{P-P} to 2 V_{P-P} video inputs
- 3.3V to 5V supply operation
- Available in tiny MSOP-10 packaging

Applications

Ideal for use in consumer, professional, automotive and industrial video, video capture, editing and processing, genlock circuits, surveillance and security video systems, Set-Top Boxes (STB) and Digital Video Recorders (DVR), LCD/plasma displays and video projectors, machine vision and inspection systems, and video trigger oscilloscopes and waveform monitors

LMH1981 Lowest Jitter Sync Separator for High-Definition Video Formats Featuring 50% Sync Slicing

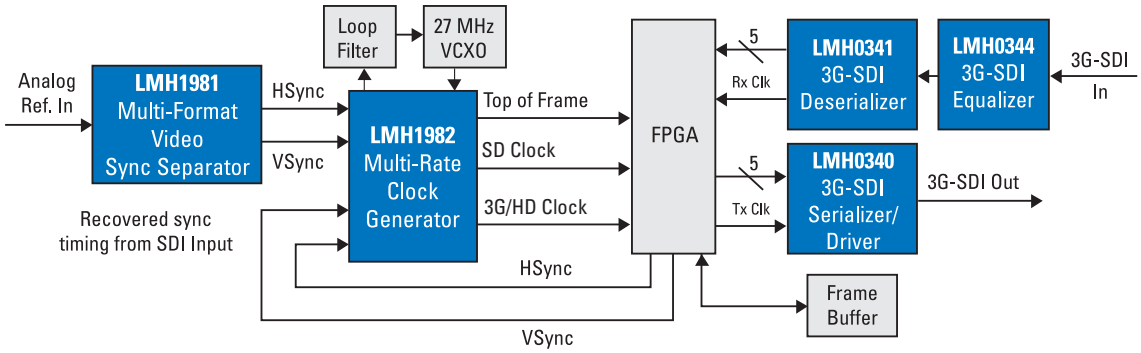
Features

- 50% sync slicing
- Low-jitter horizontal sync outputs
- Supports NTSC, PAL, SECAM, 480i/p, 576i/p, 720p, 1080i/p
- Accepts video signals from 0.5 V_{P-P} to 2.0 V_{P-P}
- No external programming with µC required
- Horizontal sync output propagation delay < 50 ns
- 3.3V or 5V single supply operation
- 31 mW typical power dissipation

LMH1982 – 3G/HD/SD Video Clock Generator with Genlock

Features

- Two reference ports for genlocking the outputs
  - H and V sync inputs for NTSC/525i, PAL/625i, 525p, 625p, 720p, 1080i, 1080p video timing
- Simultaneous SD and 3G/HD LVDS-compatible clock outputs
- Achieves low jitter output clocks capable of directly driving FPGA serializers with no additional clock cleansing required
- Genlock or free run mode operation
- Programmable output top-of-frame pulse
- Supports cross locking



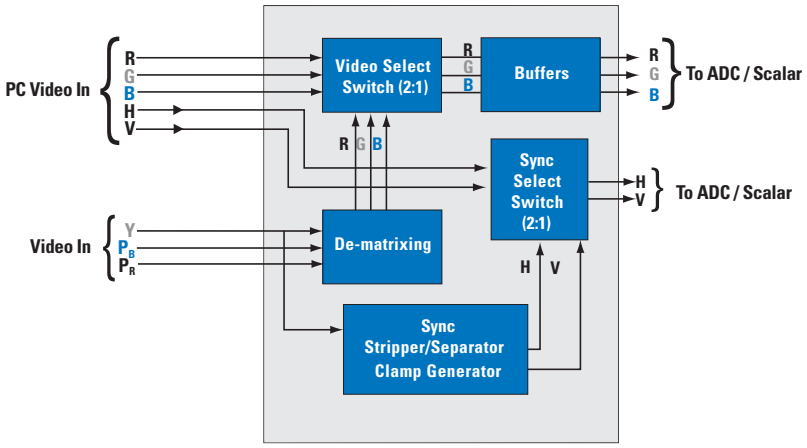
ANALOG Edge

Read Analog Edge Volume 4, Issue 7, Application Note 1489. Topic: "Improving Video Clock Generation in Modern Broadcast Video Systems"
www.national.com/edge

LMH1251 – Analog Video Converter for Converting HD Video to RGB Composite Video

Features

- YPBPR to RGBHV conversion within 1% accuracy
- YPBPR path: 70 MHz, -3 dB bandwidth
- RGB path: 400 MHz, -3 dB bandwidth
- Sync separator and processor
- Supports PC video display resolutions up to UXGA (1600 x 1200 at 75 Hz)
- Smart video format detection for 480i, 480p, 576i, 576p, 720p, 1080i, and 1080p
- Power-save mode
- Integrated 2:1 mux
- Available in TSSOP-24 packaging



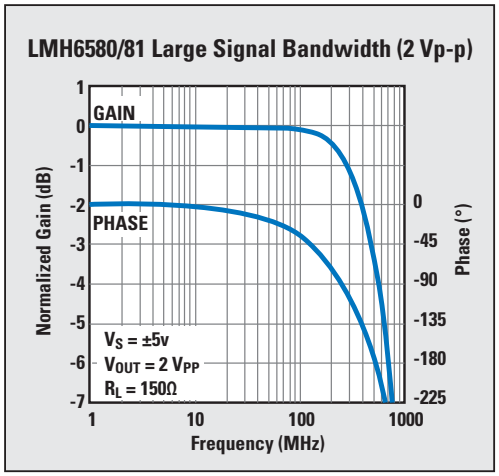
Applications

Ideal for use in TFT LCD monitors, set-top boxes, projectors, video format conversion systems, video editing and broadcast equipment, and CRT displays

LMH6580/81 – 8 x 4, 500 MHz Analog Crosspoint Switch, Gain of 1, Gain of 2

Features

- 8 inputs and 4 outputs
- 500 MHz -3 dB bandwidth
- 1700 V/µs slew rate
- -70/-52 dBc channel-to-channel crosstalk (10/100 MHz)
- -55/-45 dBc all hostile crosstalk (10/100 MHz)
- Easy to use 4-wire serial programming
- Flexible programming modes: serial and addressed mode
- Symmetrical pinout facilitates expansion
- Two gain options: $A_V = 1$ or $A_V = 2$
- Available in TQFP-48 packaging



Applications

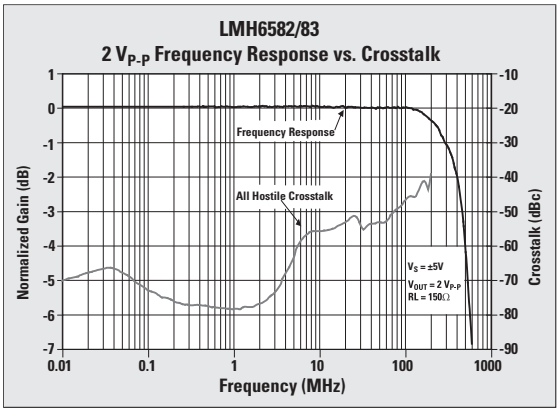
Ideal for use in studio monitoring/production video systems, conference room multimedia video systems, KVM (keyboard video mouse) systems, security/surveillance systems, multi-antenna diversity radio, video test equipment, medical imaging, and wide-band routers and switches

Analog Video Products

LMH6582/83 – 550 MHz, 16 x 8 Crosspoint Switches

Features

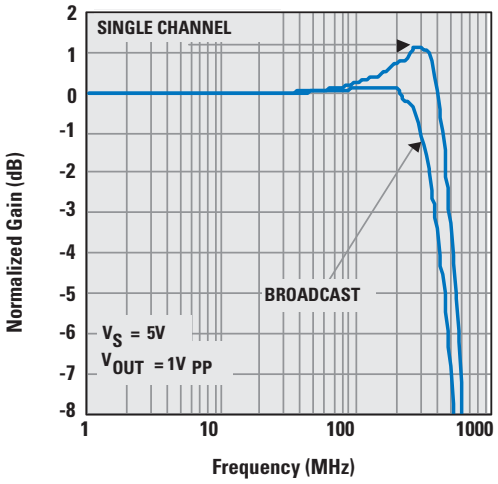
- 16 inputs, 8 outputs
- 550 MHz, -3 dB bandwidth
- Fast slew rate: 1900 V/µs
- 100 MHz, 0.1 dB gain flatness
- All hostile crosstalk
  - -64 dBc at 5 MHz
  - -46 dBc at 100 MHz
- Av = +1/+2
- Ease of control: 4-pin serial interface
- Available in TQFP-64 exposed pad packaging



LMH6584/85 – 400 MHz, 32 x 16 Crosspoint Switches A_V1 and A_V2

Features

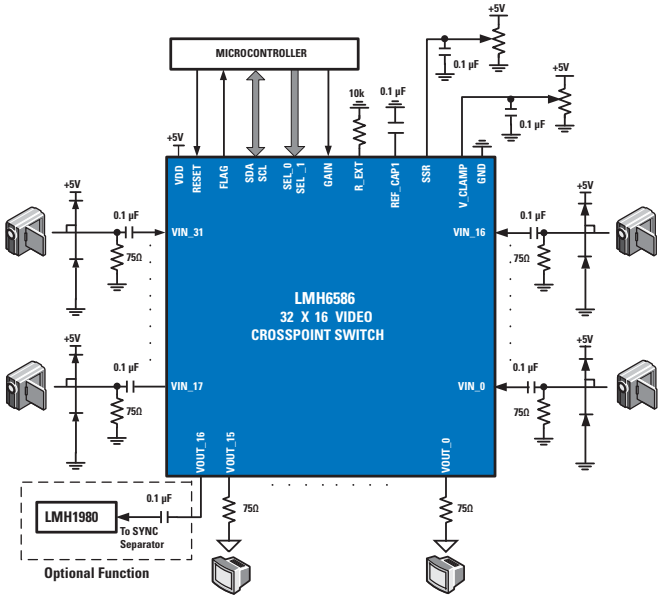
- 32 inputs, 16 outputs
- 400 MHz, -3 dB bandwidth
- Fast slew rate; 1200 V/µs
- All hostile crosstalk
  - -52 dBc at 10 MHz
  - -46 dBc at 100 MHz
- Available in LQFP-144 packaging



LMH6586 32 x 16 Video Crosspoint Switch

Features

- 32 x 16 non-blocking switch with buffered inputs and outputs
- Video detect with 8 adjustable programmable threshold levels
- Input video clamp
- Sync detect with adjustable programmable threshold level
- Extra video output for external sync separator (OUT16)
- Selectable output buffer gain (+1V/V or +2V/V)
- Individually addressable outputs
- I²C-compatible interface with 2-bit programmable slave address
- -3 dB bandwidth = 66 MHz
- DG = 0.05%, DP = 0.05° at R_L = 150Ω
- -70 dB off-isolation at 6 MHz
- Single +5V supply operation
- Input and output amp power shutdowns

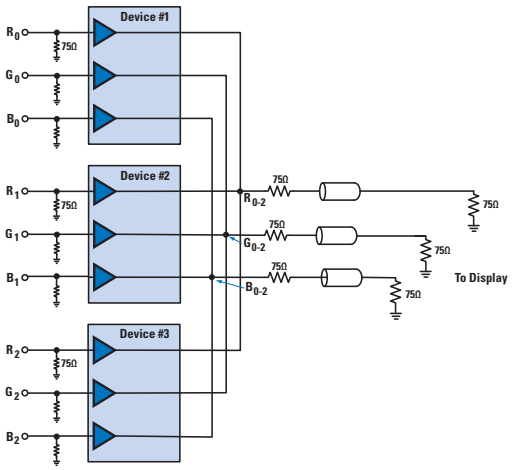


LMH6733/34 – Single-Supply, Ultra High-Speed Triple Op Amps

Features

- Energy-efficient PowerWise® product (LMH6733)
- 1 GHz –3 dB small signal bandwidth (A_V = +1, V_S = ±5V)
- 650 MHz –3 dB small signal bandwidth (A_V = +2, V_S = 5V)
- 3750 V/µs slew rate
- Low supply current (5.5 mA per op amp, V_S = 5V)
- 70 mA linear output current
- 2.1 nV/√Hz input noise voltage
- CMIR and output swing to 1V from each supply rail
- Selectable gain buffer integrates gain setting resistors, A_V = -1, +1, +2 V/V (LMH6734)
- Supply range 3V to 12V single supply

3:1 UXGA Mux Using Three LMH6733 Devices



Analog Multiplexers

Product ID	SSBW (dB)	Mux Ratio	Channels	Switching Speed (ns)	Crosstalk Rejection (dB)	Settling Time (ns)	Tsettling Conditions	2nd/3rd HD (dB)	Supply Voltage Range (V)	Temperature Range (°C)	Packaging
LMH6570	500	3:1	1	8	70	17	to 0.05%	-68/-84	±3.3 to ±6.0	-40 to 85	SOIC-8
LMH6572	350	3:1	3	10	90	17	to 0.05%	-78/-75	±3.3 to ±6.0	-40 to 85	SSOP-16
LMH6574	500	4:1	1	8	85	17	to 0.05%	-68/-84	±3.3 to ±6.0	-40 to 85	SOIC-14

Video Amplifiers/Buffers

Product ID	Unity Gain BW (MHz) at AVCL (V/V)	Differential Gain (dB)	Differential Phase (%)	-3 dB LSBW at A=2 (MHz)	Slew Rate (V/µs)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Channels	Voltage Noise nV/√Hz	Packaging
LMH6702 E, W	1700 at 2	.024	.004	720	3100	10 to 12	12.5	1	1.83	SOIC-8, SOT23-5
LMH6703 E	1800 at 1	.01	.02	750	4200	8 to 12	11	1	2.3	SOIC-8, SOT23-6
LMH6704 E	650 at 1	.01	.02	400	3000	8 to 12	11.5	1	2.3	SOIC-8, SOT23-6
LMH6733 E,W	1000 at 1	.03	.03	600	3750	3 to 12	6.5	3	2.1	SSOP-16
LMH6734	925 at 1	.03	.025	560	3750	3 to 12	5.5	3	2.1	SSOP-16
LMH6738 E	750 at 1	.02	.01	750	3300	10 to 12	10.5	3	2.2	SSOP-16
LMH6739 E	750 at 1	.02	.01	400	3300	8 to 12	10.6	3	2.3	SSOP-16
LMH6611 E, W	365 at 1	.05	.05	87	460	2.7 to 11	3.3	1	10	TSOT23-6
LMH6612 E, W	365 at 1	.05	.05	87	460	2.7 to 11	3.45	2	10	SOIC-8
LMH6601 E, W	250 at 1	0.25	0.25	81	275	2.4 to 5.5	9.6	1	10	SC70-6
LMH6657 E, W	270 at 1	.03	.1	100	700	3 to 12	6	1	11	SC70-5, SOT23-5
LMH6658 E, W	270 at 1	.03	.1	100	700	3 to 12	6	2	11	SOIC-8, MINI SOIC-8
LMH6682 E	180 at 2	.01	.08	110	940	3 to 12	6.5	2	12	SOIC-8, MINI SOIC-8
LMH6683 E, W	190 at 2	.01	.08	110	940	3 to 12	6.5	3	12	SOIC-14, TSSOP-14

PowerWise® product E Evaluation board W WEBENCH enabled

Precision Amplifiers

LMP2021/22 – Single/Dual, Zero-Drift, Low-Noise, EMI-Hardened Op Amp

Features

- Low guaranteed V_{OS} over temperature 5 µV
- TCVOS guaranteed: 20 nV/°C (max)
- Low noise with no 1/f, 12 nV/√Hz at 1000V/V
- High CMRR (139 dB) and PSRR (130 dB)
- High AVOL 160 dB
- Wide gain bandwidth product 5 MHz
- High slew rate 2.6 V/µs
- Low supply current 1.10 mA
- Available in SOIC-8, SOT23-5, and MSOP-8 packaging

Applications

Ideal for use in medical, industrial, test and measurement, scales and weigh stations, PC, automotive, and telecommunications

Precision Operational Amplifiers

Product ID	Avol (dB)	Offset Voltage Max. 25C (mV)	TcVos (µV/°C)	CMRR (dB)	PSRR (dB)	Voltage Noise (nV/√Hz) @kHz	Channels	Supply Current Per Channel (mA)	Supply Range (V)	Packaging
LMP2015 W	130	0.005	0.015	130	120	35	1	0.93	2.7 to 5.25	SOIC-8, SOT23-5
LMP2016 W	130	0.005	0.015	130	120	35	2	0.93	2.7 to 5.25	SOIC-8, MSOP-8
LMP2021 E, W	160	0.005	0.020 (max)	139	130	11 (Av = 1000V/V)	1	1.1	2.2 to 5.5	SOIC-8, SOT23-5
LMP2022 W	160	0.005	0.020 (max)	139	130	11 (Av = 1000V/V)	2	1.1	2.2 to 5.5	SOIC-8, MSOP-8
LMP2011 W	130	0.025	0.015	130	120	35	1	0.93	2.7 to 5.25	SOIC-8, SOT23-5
LMP2014 W	130	0.025	0.015	130	120	35	4	0.93	2.7 to 5.25	TSSOP-14
LMP2012 W	130	0.025	0.015	130	120	35	2	0.93	2.7 to 5	SOIC-8, MSOP-8
LMP7731/32 W	130	0.04	0.5	120	129	2.9	1/2	2.2	2.5 to 5	SOT23-5, SOIC-8
LMP2231/32 E, W	120	0.15	0.4/0.5 (max)	97	120	60	1/2	0.01	1.6 to 5.5	SOIC-8, SOT23-5, SOIC-8
LMP2234 E, W	120	0.15	0.3	97	120	60	4	0.009	1.6 to 5.5	SOIC-14, TSSOP-14
LMP7711 W	110	0.15	1	100	100	5.8	1	1.15	1.8 to 5.5	TSOT-6
LMP7712 W	95	0.15	1.75	100	100	5.8	2	1.3	1.8 to 5.5	MSOP-10
LMP7715 W	110	0.15	1	100	98	5.8	1	1.15	1.8 to 5.5	SOT23-5
LMP7716 W	110	0.15	1.8	100	98	5.8	2	1.3	1.8 to 5.5	MSOP-8
LMP7717 W	110	0.15	1	100	98	5.8	1	1.15	1.8 to 5.5	SOIC-8, SOT23-5
LMP7718 E, W	110	0.15	1.8	100	95	5.8	2	1.3	1.8 to 5.5	SOIC-8, MSOP-8
LMP7721 E, W	111	0.18	1.5	100	96	7.5	1	1.3	1.8 to 5.5	SOIC-8
LMP7701 W	119	0.2	1	130	100	9	1	0.715	2.7 to 12	SOIC-8, SOT23-5
LMP7707 W	119	0.2	1	138	98	9	1	0.715	2.7 to 12	SOT23-5
LMP7708 E, W	119	0.22	1	138	98	9	2	0.715	2.7 to 12	MSOP-8
LMP7709 W	119	0.22	1	138	98	9	4	0.715	2.7 to 12	TSSOP-14
LMP7702 W	119	0.22	1	130	100	9	2	0.75	2.7 to 12	SOIC-8, MSOP-8
LMP7704 W	119	0.22	1	130	100	9	4	0.725	2.7 to 12	TSSOP-14
LMV841 E	133	0.5	0.35	112	108	20	1	1	2.7 to 12	SC70-5
LMV842	133	0.5	0.35	112	108	20	2	1	2.7 to 12	MSOP-8, SOIC-8
LMV844	133	0.5	0.35	112	108	20	2	1	2.7 to 12	TSSOP-14, SOIC-14

PowerWise® product E Evaluation board W WEBENCH enabled

LMP7715/7716/Q – 17 MHz, Low-Noise, CMOS Input Amplifier

Features

- 5.8V/√Hz input voltage noise
- ±150 µV (max) input offset voltage
- Input bias current 100 fA
- Gain bandwidth product = 17 MHz
- Supply current per channel 1.15 mA (LMP7715), 1.30 mA (LMP7716)
- CMRR 100 dB, PSRR 98 db

Applications

Ideal for use in active filters and buffers, sensor interface, transimpedance, and automotive

Low-Noise Operational Amplifiers

Product ID	Channels	Voltage Noise (nV/√Hz)	Offset Voltage Max, 25C (mV)	Max Input Bias Current (nA)	Supply Current Per Channel (mA)	Gain Bandwidth (MHz)	Supply Range (V)	Temp. Range (°C)	Packaging
LMH6624 E, W	1	0.92	0.5	25000	12	1500	5 to 12	-40 to 125	SOIC-8, SOT23-5
LMH6626 E, W	2	1	0.5	25000	12	1300	5 to 12	-40 to 125	SOIC-8, MSOP-8
LMH6622 E,W	2	1.6	1.2	15000	4.3	160	5 to 12	-40 to 85	SOIC-8, MSOP-8
LMH6702 E, W	1	1.83	4.5	34000	12.5	1700	10 to 12	-40 to 85	SOIC-8, SOT23-5
LMH6628 E, W	2	2	2	20000	9	300	5 to 12	-55 to 125	SOIC-8
LMP7731/32 W	1/2	2.9	0.04	30	2.2	22	1.8 to 5.5	-40 to 125	SOT23-5, SOIC-8
LMP7717/18 E, W	1	5.8	0.15	0.05	1.15	88	1.8 to 5.5	-40 to 125	SOIC-8, SOT23-5
LMV793 W	1	5.8	1.35	0.025	1.15	88	1.8 to 5.5	-40 to 125	SOIC-8, SOT23-5
LMV794 E, W	2	5.8	1.35	0.025	1.3	88	1.8 to 5.5	-40 to 125	SOIC-8, MSOP-8
LMP7711/12 W	1/2	5.8	0.15	0.05	1.15 / 1.3	17	1.8 to 5.5	-40 to 125	TSOT-6, MSOP-10
LMP7715 W	1	5.8	0.15	0.05	1.15	17	1.8 to 5.5	-40 to 125	SOT23-5
LMP7716 W	2	5.8	0.15	0.05	1.3	17	1.8 to 5.5	-40 to 125	SOIC-8, MSOP-8
LMV791/92 W	1/2	5.8	1.35	0.025	1.15 / 1.3	17	1.8 to 5.5	-40 to 125	TSOT-6, MSOP-10
LMV796/97 W	1/2	5.8	1.35	0.025	1.15 / 1.3	17	1.8 to 5.5	-40 to 125	SOT23-5, MSOP-8
LM6211 W	1	6	2.5	0.01	0.96	17	5 to 24	-40 to 125	SOT23-5
LMV751 W	1	6.5	1	0.1	0.6	5	2.7 to 5.5	-40 to 85	SOT23-5
LMP7721 E, W	1	7.5	0.015	0.00003	1.3	15	1.8 to 5.5	-40 to 125	SOIC-8
LMP7701 W	1	9	0.2	0.05	0.715	2.5	2.7 to 12	-40 to 125	SOIC-8, SOT23-5
LMP7702 W	2	9	0.22	0.05	0.75	2.5	2.7 to 12	-40 to 125	SOIC-8, MSOP-8
LMP7704 W	4	9	0.22	0.05	0.725	2.5	2.7 to 12	-40 to 125	TSSOP-14
LMP7707 W	1	9	0.2	0.05	0.715	14	2.7 to 12	-40 to 125	SOIC-8, SOT23-5
LMP7708 E, W	2	9	0.22	0.05	0.75	14	2.7 to 12	-40 to 125	SOIC-8, MSOP-8
LMP7709 W	4	9	0.22	0.05	0.725	14	2.7 to 12	-40 to 125	TSSOP-14
LMP2021/22 E	1/2	11 (Av=1000V/V)	0.005	25	1.1	5	2.2 to 5.5	-40 to 125	SOIC-8, SOT23-5, MSOP-8
LMV772 W	2	12	1	0.1	0.6	3.5	2.7 to 5.5	-40 to 125	SOIC-8, MSOP-8
LMV774 W	4	12	1	0.1	0.6	3.5	2.7 to 5.5	-40 to 125	TSSOP-14
LMV716 W	2	12.8	5	0.115	1.6	5	2.7 to 5.5	-40 to 85	MSOP-8
LMV861 E, W	1	8	1	0.01	2.6	30	2.7 to 5.5	-40 to 125	SC70-5
LMV862 E, W	2	8	1	0.01	2.6	30	2.7 to 5.5	-40 to 125	MSOP-8
LMV864	4	8	1	0.01	2.6	30	2.7 to 5.5	-40 to 125	TSSOP-14

PowerWise® product E Evaluation board W WEBENCH enabled

Precision Amplifiers

CMOS-Input Operational Amplifiers

Product ID	Description	Vos (mV) (Max)	TCVos Typ (µV/°C)	Is Typ (mA/Ch)	CMRR (dB)	PSRR (dB)	Temperature Range (°C)	Packaging
LMP7711/12 W	17 MHz, single/dual precision, low-noise CMOS input op amp	0.15	1/1.75	1.15	100	100	-40 to 125	TSOT-6
LMP7715/16 W	17 MHz, single/dual precision, low-noise CMOS input, 1.8V op amp	0.15	1/1.75	1.15 / 1.3	100	98	-40 to 125	SOT23-5, MSOP-8
LMP7701/02/04 W	Precision, single/dual/quad CMOS input RRIO, wide supply range op amp	0.2/0.22/ 0.22	1	0.715/0.75/ 0.725	130	100	-40 to 125	SOT23-5, SOIC-8, MSOP-8, SOIC-8, TSSOP-14
LMC6001 W	Ultra-low input bias current op amp	0.35	2.5	0.45	83	83	-40 to 85	Plastic DIP-8
LMC6061/62/64 W	Micropower single precision CMOS RRO op amp	0.35	1	0.02/0.016/ 0.016	85	85	-40 to 85	SOIC-8, SOIC-8, SOIC-14
LMV771/72 E, W	Low-offset, low-noise single/dual RRO op amp	0.85/1	0.35	0.6	90	90	-40 to 125	SC70-5, SOIC-8, MSOP-8
LMV751 W	Low-offset, low-noise single CMOS input op amp	1	1	0.6	103	107	-40 to 85	SOT23-5
LMV791/92 W	17 MHz, single/dual low-noise, CMOS input, 1.8V op amp with shutdown	1.35	1/1.8	1.15/1.3	100	98	-40 to 125	TSOT-6, MSOP-10
LMV796/97 W	17 MHz, single/dual low-noise, CMOS input, 1.8V op amp	1.35	1/1.8	1.15/1.3	100	98	-40 to 125	SOT23-5, MSOP-8
LMV716 W	5 MHz, low-noise, CMOS input RRO op amp	5	5	1.6	80	82	-40 to 85	MSOP-8
LMV861/62 E, W	30 MHz low power	1000	2.6	2.59	93	93	-40 to 125	SOIC-8, SC-70
LM6211 W	Low-noise, CMOS input RRO op amp with 24V operation	2.5	2	0.96	98	98	-40 to 125	SOT23-5
LMP2021/22 E, W	Zero-drift, EMI-hardened RR op amp	0.005	0.020 max	1.10	139	130	-40 to 125	SOT23-5, SOIC-8, MSOP-8
LMP7707/08/09 E, W	14 MHz, single/dual/quad 12V CMOS input RRIO op amp	0.2/0.22/ 0.22	1	0.715/0.75/ 0.725	130	100	-40 to 125	SOT23-5, SOIC-8, MSOP-8, SOIC-8, TSSOP-14
LMP7712 W	17 MHz, single precision, low-noise CMOS input op amp	0.15	1.75	1.15	100	100	-40 to 125	TSOT-6
LMP7717/18 E, W	88 MHz, single/dual precision, low-noise, CMOS input 1.8V op amp	0.15	1/1.8	1.15/1.3	100	98	-40 to 125	SOT23-5, SOIC-8, MSOP-8, SOIC-8
LMP2231/32/34 E, W	Micropower, single/dual/quad precision, 1.6V CMOS input op amp	0.15	0.4/0.5/0.75 (max)	0.01/0.009/ 0.009	92	97	-40 to 125	SOIC-8, SOT23-5, SOIC-8, MSOP-8, SOIC-14, TSSOP-14
LMP7721 E, W	3 femtoampere input bias current precision amplifier	0.15	1.5	1.1	100	96	-40 to 125	SOIC-8
LMV831/32/34 E	Low-power CMOS, EMI-hardened op amp	1	1.7	0.24	93	93	-40 to 125	SC70-5, MSOP-8, TSSOP-14
LMV851/52/54 E, W	Low-power CMOS, EMI-hardened op amp	1	2	0.43	94	93	-40 to 125	SC70-5, MSOP-8, TSSOP-14

PowerWise® product E Evaluation board W WEBENCH Enabled

Current-Sense Amplifiers[1]

Product ID	Description	V_{CM} Range (V)	V_{OS} (mV) (max)	Max TcVos (µV/°C)	Gain Output (V/V)	Supply Voltage Range (V)	Supply Current (mA)	PSRR (dB)	Packaging
LMP8270	High common-mode, AV = 20, unidirectional	-2 to 16	1	15	20	4.7 to 5.5	1	80	SOIC-8
LMP8271	High common-mode, AV = 20, bidirectional	-2 to 16	1	15	20	4.7 to 5.5	1	80	SOIC-8
LMP8272	High common-mode, AV = 14, unidirectional	-2 to 16	1	15	14	4.7 to 5.5	1	80	SOIC-8
LMP8275	High common-mode, AV = 20, unidirectional	-2 to 16	2	30	20	4.7 to 5.5	1	80	SOIC-8
LMP8276	High common-mode, AV = 20, bidirectional	-2 to 16	2	30	20	4.7 to 5.5	1	80	SOIC-8
LMP8277 [E]	High common-mode, AV = 14, unidirectional	-2 to 16	2	30	14	4.7 to 5.5	1	80	SOIC-8
LMP8601/Q [E]	High common-mode, AV = 20, bidirectional	–22 to 60	1	10	20	3.0 to 5.5	1.1	90	SOIC-8
NEW! **LMP8602**	High common-mode, AV = 50, bidirectional	–22 to 60	1	10	50	3.0 to 5.5	1.1	90	SOIC-8, MSOP-8
NEW! **LMP8603**	High common-mode, AV = 100, bidirectional	–22 to 60	1	10	100	3.0 to 5.5	1.1	90	SOIC-8, MSOP-8

[E] Evaluation board

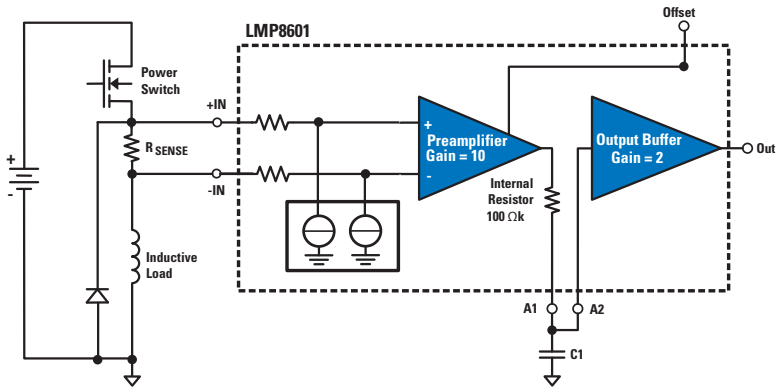
[1] National's current sense amplifiers are 100% production tested at -40 to +125° C, TcV_{OS} is guaranteed by test

LMP8601/1Q/02/03 – High Common-Mode, 60V, Current Sensing Precision Difference Amplifier

Features

- LMP8601Q is an automotive-grade product that is AECQ100 grade 1 qualified
- CMVR at
  - V_S = 3.3V to 4V to 27V
  - V_S = 5.0V to 20V to 60V
- Bidirectional current sense capability
- Supply voltage 3.0V to 5.5V
- Supply current 1 mA
- Input offset voltage 1 mV max
- TcV_{OS} 10 µV/°C max, by test
- CMRR 80 dB min
- Output voltage swing rail to rail
- Bandwidth 60 kHz
- Operating temperature range ambient -40°C to 125°C
  - LMP8601/Q - gain of 20 V/V
  - LMP8602 - gain of 50 V/V
  - LMP8603 - gain of 100 V/V

High-Side Current Sensing Application



Applications

Ideal for use in automotive fuel injection control, transmission control, accelerometers, high-side and low-side drivers, configuration current sensing, power management systems, and current loop to voltage conversion applications

Low-Voltage Amplifiers

Low-Voltage Operational Amplifiers

Product ID	Chan.	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Gain Bandwidth (MHz)	Slew Rate (V/µs)	Offset Voltage Max, 25C (mV)	Max Input Bias Current (nA)	Voltage Noise (nV/√Hz)	Packaging
LMV951 W	1	0.9 to 3	0.57	2.8	1.4	2.8	80	25	TSOT-6
LMP2231 E, W	1	1.6 to 5.5	0.016	0.13	0.058	0.015	0.001	60	SOIC-8, SOT23-5
LMP2232/34 E, W	2/4	1.6 to 5.5	0.0135/0.012	0.13	0.058	0.015	0.001	60	SOIC-8, MSOP-8 / SOIC-14, TSSOP-14
LMV301 E	1	1.8 to 5	0.163	1	0.66	8	0.05	40	SC70-5
LMV791/92 W	1/2	1.8 to 5	1.15/1.3	17	9.5	1.35	0.01	5.8	TSOT-6, MSOP-10
LMV793/94 E, W	1/2	1.8 to 5	1.15	88	28	1.35	0.01	5.8	SOIC-8, SOT23-5, MSOP-8
LMV796/97 W	1/2	1.8 to 5	1.15/1.3	17	9.5	1.35	0.01	5.8	SOT23-5, MSOP-8
LMV931/32/34 E	1/2/4	1.8 to 5	0.116	1.5	0.42	4/5.5/5.5	35	50	SC70-5, SOT23-5, MSOP-8, SOIC-8/ TSSOP-14
LMV981 E, W	1	1.8 to 5	0.116	1.5	0.42	4	35	50	micro SMD-6, SC70-6, SOT23-6
LMP7721 E, W	1	1.8 to 5.5	1.1	15	9.3	0.015	0.00002	7	SOIC-8
LM8262/72 E, W	2	2.5 to 22/24	1.05 / 0.9	21 / 13	12	5	2000	15	MSOP-8
LM8261 W	1	2.5 to 30	0.97	21	12	5	2000	15	SOT23-5
LM7332/22 W	2	2.5 to 32	1.2/1	19/21	15 / 18	5	2500/2000	15	SOIC-8, MSOP-8
LM7321 W	1	2.5 to 32	1.1	21	18	5	2000	15	SOIC-8, SOT23-5
LM7341 W	1	2.5 to 32	0.6	4	1.25	4	250	36	SOT23-5
LMV821 E, W	1	2.5 to 5.5	0.3	5.6	2	3.5	100	24	SC70-5, SOT23-5
LMV822 W	2	2.5 to 5.5	0.25	5.6	2	3.5	100	24	SOIC-8, MSOP-8
LMV824 W	4	2.5 to 5.5	0.25	5.6/6.5	2	3.5	100	24	SOIC-14, TSSOP-14
LMV116/18	1	2.7 to 12	0.6	45	40	5	90	40	SOT23-5, SOT23-6
LMV641 E	1	2.7 to 12	0.158	10	1.6	0.5	0.01	14	SOIC-8, SC70-5
LMV841/42/44 E	1/2/4	2.7 to 12	1.02	4.5	2.5	0.5	0.01/0.01/1.9	20	SC70-5, SOIC-8, MSOP-8, TSSOP-14
LPV511 E, W	1	2.7 to 12	0.00097	0.027	0.0077	3	0.8	320	SC70-5
LM6154 W	4	2.7 to 24	1.4	75	30	5	0.12	9	SOIC-14
LMV341 E, W	1	2.7 to 5	0.107	1	1	4	0.115	39	SC70-6
LMV712 W	2	2.7 to 5	1.17	5	5	3	0.115	20	micro SMD-10, LLP-10, SOIC-10
LMV715/16 W	1/2	2.7 to 5	1.17/1.6	5	5/5.8	3	260	20/12.8	SOT23-6, MSOP-8
LMV721/22 E, W	1/2	2.7 to 5	1.03/0.9	10	5.25	3	260/0.1	8.5	SC70-5, SOT23-5, LLP-8, SOIC-8
LMV771/72 E, W	1/2	2.7 to 5	0.6	3.5	1.4	0.85/1	0.1	12	SC70-5, SOIC-8, MSOP-8
LMV774 W	4	2.7 to 5	0.6	3.5	1.4	1	0.01	12	TSSOP-14
LMV851/52/54 E, W	1/2/4	2.7 to 5	0.41	8	4.5	1	0.01	11	SC70-5, MSOP-8, TSSOP-14
LPV531	1	2.7 to 5	0.425	4.6	2.5	4.5	0.05	25	TSOT-6
LMV861/62 E, W	1	2.7 to 5.5	2.59	30	18	1	0.01	5	SC-70, MSOP-8
LMV422	2	2.7 to 5.5	0.4	8	3.8	4	120	25	MSOP-10
LMV651/52 E, W	1/2	2.7 to 5.5	0.116	12	0.83	1.5	120	17	SC70-5, MSOP-8
LMV654 W	4	2.7 to 5.5	0.116	12	0.83	1.5	120	17	TSSOP-14
LMV751 W	1	2.7 to 5.5	0.6	5	2.3	1	0.1	6.5	SOT23-5
LMV831/32/34 E	1/2/4	2.7 to 5.6	0.24	3.3	2	1	10	12	SC70-5, MSOP-8, TSSOP-14

PowerWise® product E Evaluation board W WEBENCH enabled

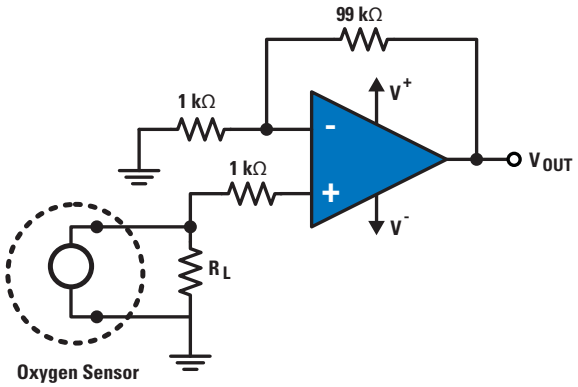
LMP2231/32/34 – Single/Dual/Quad Micropower Precision Op Amps with CMOS Inputs

Features

- Operating voltage range: 1.6V to 5.5V
- PSRR: 120 dB
- CMRR: 97 dB
- Open loop gain: 120 dB
- Gain bandwidth product: 130 kHz
- Slew rate: 58 V/ms
- 60 nV/√Hz input voltage noise, f = 1 kHz

Applications

Ideal for use in precision instrumentation amplifiers, battery-powered medical instrumentation, high-impedance sensors, strain gauge bridge amplifiers, and thermocouple amplifiers



Micropower Operational Amplifiers

Product ID	Channels	Supply Current Per Channel (µA)	Gain Band-width (MHz)	Offset Voltage Max, 25C (mV)	Max Input Bias Current (nA)	CMRR (dB)	PSRR (dB)	Supply Voltage Range (V)	Slew Rate (V/µs)	Output Current (mA)	Voltage Noise (nv/√Hz)	Temp Range (°C)	Packaging
LPV511 E, W	1	0.88	0.027	3	0.8	115	115	2.7 to 12	0.007	0.225	320	-40 to 85	SC70-5
LPV531	1	5 to 425	4.6	4.5	0.01	95	90	2.7 to 5	2.5	15	25	-40 to 85	TSOT-6
LMP2232 W	2	10	0.13	0.15	0.001	97	120	1.6 to 5	0.048	22	60	-40 to 125	SOIC-8, MSOP-8
LMP2231 W	1	13	0.13	0.15	0.001	97	120	1.6 to 5	0.048	22	60	-40 to 125	SOT23-5, SOIC-8
LMV551/52 E, W	1/2	37	3	3	38	93	90	2.7 to 5.5	1	10	70	-40 to 125	SC70-5, MSOP-8
LMV554	4	37	3	3	38	93	90	2.7 to 5	1	10	70	-40 to 85	TSSOP-14
LMV651/52 E, W	1/2	116	12	1.5	120	100	95	2.7 to 5.5	3	15	17	-40 to 125	SC70-5, MSOP-8
LMV654 W	4	118	12	1.5	120	100	95	2.7 to 5.5	3	15	17	-40 to 125	TSSOP-14
LMV641 E	1	158	10	0.5	90	120	100	2.7 to 12	2.6	26	14	-40 to 125	SOIC-8, SC70-5
LMV831 E	1	25	3.3	1	.01	77	76	27.55	2	30	12	-40 to 125	SC70-5

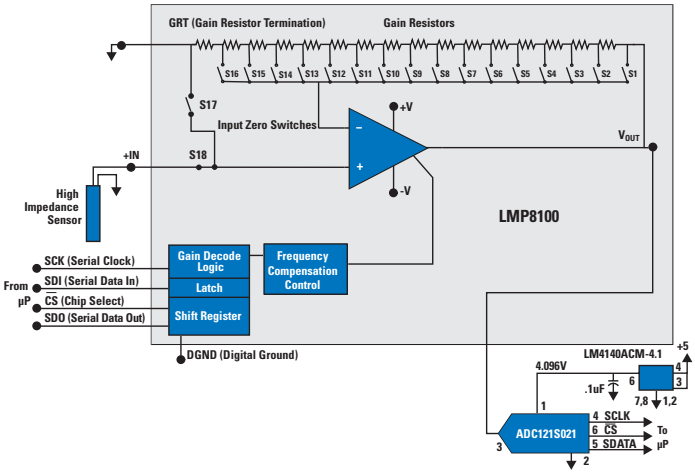
PowerWise® product E Evaluation board W WEBENCH enabled

Shutdown Amplifiers

LMP8100 – Programmable Gain Amplifier Delivers 0.03% Accuracy Over Temperature and Gain Settings

Features

- Unmatched gain accuracy for every gain setting enables accurate signal conditioning from -40°C to +125°C
- Gain range 1 to 16 V/V in 1 V/V steps enables flexible and fine gain adjustments
- Programmable frequency compensation increases usable bandwidth for all gain settings
- Input zero calibration switch allows output offset voltage measurement and calibration
- Glitch-free transition between programmed settings eliminates errors
- 12 nV/√Hz input noise voltage accurately signal conditions in near DC-sensor applications
- Ideal match for 12-bit, 1-channel ADCs up to 1 MSPS
- Available in SOIC-14 packaging



Applications

Ideal for use in industrial instrumentation, sensor interface, data acquisition, test equipment, and gain control applications

Shutdown Amplifiers

Product ID	Channels	Gain Bandwidth (MHz)	Supply Voltage Range (V)	Offset Voltage Max 25 C (mV)	Temperature Range (°C)	Comments	Packaging
LMV341 E, W	1	1	2.7 to 5	4	-40 to 125	Tri-State® output	SC70-6
LMV981 E, W	1	1.4	1.8 to 5	4	-40 to 125	Tri-State output, RRIO	micro SMD-6, SC70-6, SOT23-6
LMV982 W	2	1.4	1.8 to 5	4	-40 to 125	Tri-State output, RRIO	MSOP-10
LMV951 W	1	2.8	0.9 to 3	2.8	-40 to 125	RRIO	TSOT23-6
LMV711 E, W	1	5	2.7 to 5	3	-40 to 85	Output low for shutdown	SOT23-6
LMV712 W	2	5	2.7 to 5	3	-40 to 85	RRIO	LLP-10, SOIC-10
LMP7711 W	1	17	1.8 to 5.5	0.15	-40 to 125	CMOS input	TSOT-6
LMP7712 W	2	17	1.8 to 5.5	0.15	-40 to 125	CMOS input	MSOP-10
LMV791 W	1	17	1.8 to 5.5	1.35	-40 to 125	Tri-State output	TSOT23-6
LMV792 W	2	17	1.8 to 5.5	1.35	-40 to 125	Tri-State output	MSOP-10
LMV118	1	45	2.7 to 12	5	-40 to 85	RRO	SOT23-6
LMH6601 E, W	1	125	2.4 to 5.5	2.4	-40 to 85	CMOS input	SC70-6
LMH6618 E, W	1	65	2.7 to 11	0.6	-40 to 125	RRIO	TSOT23-6
LMH6611 E, W	1	135	2.7 to 11	0.6	-40 to 125	RRO	TSOT23-6
LMH6647 E, W	1	40	2.5 to 12	3	-40 to +85	RRIO	SOIC-8, SOT23-6
LMH6703 E	1	1800*	8 to 12	7	-40 to 85	Low distortion	SOIC-8, SOT23-6
LMH6720 E	1	420*	10 to 12	6	-40 to 85	CFB	SOIC-8,SOT23-6
LMH6733 E, W	3	1000*	3 to 12	2.2	-40 to 85	CFB	SSOP-16
LMH6734	3	925*	3 to 12	2.4	-40 to 85	CFB	SSOP-16
LMH6738 E	3	750*	8 to 12	2.5	-40 to 85	CFB	SSOP-16
LMH6739 E	3	750*	8 to 12	2.5	-40 to 85	CFB	SSOP-16

PowerWise® product *Unity Gain Bandwidth E Evaluation board W WEBENCH enabled

Low-Power Operational Amplifiers

Product ID	Channels	Supply Current Per Channel (mA)	Supply Voltage Range (V)	Offset Voltage Max, 25C (mV)	Max Input Bias Current (nA)	Gain Bandwidth (MHz)	Slew Rate (V/µs)	Output Current (mA)	Voltage Noise (nV/√Hz)	Packaging
LPV511 [E, W]	1	0.00088	2.7 to 12	3	0.8	0.027	0.0077	0.225	320	SC70-5
LPV531	1	0.005 to 0.425	2.7 to 5	4.5	0.01	4.6	2.5	15	25	TSOT-6
LMP2232/34 [E, W]	2/4	0.009	1.6 to 5.5	0.15	0.001	0.13	0.058	30	60	SOIC-8, MSOP-8, SOIC-14, TSSOP-14
LMP2231 [E, W]	1	0.01	1.6 to 5.5	0.15	0.001	0.13	0.058	30	60	SOIC-8, SOT23-5
LMV341 [E, W]	1	0.107	2.7 to 5	4	0.12	1	1	75	39	SC70-6
LMV931 [E, W]	1	0.116	1.8 to 5	4	35	1.5	0.42	100	50	SC70-5, SOT23-5
LMV932/34	2/4	0.116	1.8 to 5	5.5	35	1.5	0.42	65	50	SOIC-8, MSOP-8, SOIC-14, TSSOP-14
LMV981 [E, W]	1	0.116	1.8 to 5	4	35	1.5	0.42	65	50	micro SMD-6, SC70-6, SOT23-6
LMV651/52 [E, W]	1/2	0.116/0.118	2.7 to 5.5	1.5	120	12	2.8	15	17	SC70-5, MSOP-8
LMV654 [E, W]	4	0.122	2.7 to 5.5	1.8	120	12	2.8	15	17	TSSOP-14
LMV641 [E]	1	0.158	2.7 to 12	0.5	90	10	2.6	26	14	SOIC-8, SC70-5
LMV301	1	0.163	1.8 to 5	8	0.035	1	0.66	60	40	SC70-5
LMV831/32/34 [E]	1/2/4	0.24	2.7 to 5.5	1	10	3.3	2	60	12	SC70-5, MSOP-8, TSSOP-14
LMV822/24 [W]	2/4	0.25	2.7 to 5.5	3.5	100	5.6	2	40	24	SOIC-8, MSOP-8, TSSOP-14
LMV821 [E, W]	1	0.3	2.7 to 5.5	3.5	100	5.6	2	40	24	SC70-5, SOT23-5
LMV851/52/54 [E, W]	1/2/4	0.43	2.7 to 5.5	1	10	8	4.5	60	11	SC70-5, MSOP-8, TSSOP-14
LMV951 [E, W]	1	0.57	0.9 to 3	2.8	80	2.8	1.4	85	25	TSOT-6
LMV116/18	1	0.6	2.7 to 12	5	0.1	45	40	15/24	40	SOT23-5, SOT23-6
LMV751 [W]	1	0.6	2.7 to 5.5	1	0.1	5	2.3	24	6.5	SOT23-5
LM7341 [W]	1	0.6	2.5 to 32	4	400	4	1.25	6	36	SOT23-5
LMV771/72 [E, W]	1/2	0.6/0.8	2.7 to 5	0.85/1	0.1/1000	3.5	1.4	66	12	SC70-5, SOIC-8,MSOP-8
LM6588	4	0.93	5 to 16	4	0.005	15.4	15	15	23	SOIC-14, TSSOP-14
LM7321 [W]	1	1	2.5 to 32	5	2000	16	12.3	50	14	SOT23-5, SOIC-8
LMV774 [W]	4	1.03	2.7 to 5	1	260	3.5	1.4	24	12	TSSOP-14
LMV722 [W]	2	1.03	2.7 to 5	3	260	10	5.25	15	8.5	LLP-8, SOIC-8
LMV2011 [W]	1	1.17	2.7 to 5	0.025	0.115	3	4	35	35	SOIC-8, SOT23-5
LMV721 [E, W]	1	1.17	2.7 to 5	3	0.115	10	5.25	40	8.5	SC70-5, SOT23-5
LMV712 [W]	2	1.17	2.7 to 5	3	0.13	5	5	35	20	micro SMD-10, LLP-10, MSOP

[E] Evaluation board [W] WEBENCH enabled

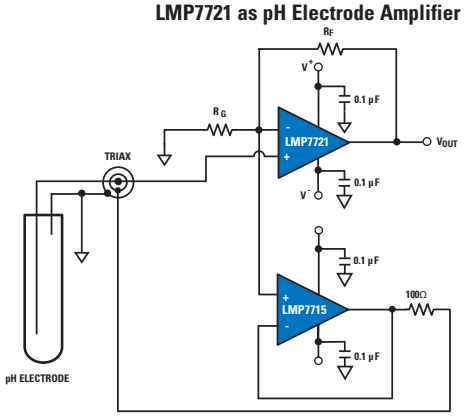
Precision Amplifiers and EMI-Hardened Amplifiers

LMP7721 – 3 fA Input Bias Current Precision Amplifier

Features

- Input bias current (V_{CM} = 1V)
  - ±20 fA at 25°C (max)
  - ±900 fA at 85°C (max)
- 6.5 nV/√Hz input voltage noise, f = 1 kHz
- Supply current 1.3 mA
- Gain bandwidth: 17 MHz
- Slew rate (falling edge) 12.76 V/µs
- Supply voltage 1.8V to 5.5V
- Available in SOIC-8 packaging

LMP7721 as pH Electrode Amplifier



Applications

Ideal for use in photodiode amplifiers, high-impedance sensor amplifiers, ion chamber amplifiers, electrometer amplifiers, pH electrode amplifiers, and transimpedance amplifiers

ANALOG Edge

Read the Application Note 1798 : "Designing with Electro-Chemical Sensors"
www.national.com/edge

EMI-Hardened Amplifiers

Product ID	EMIRR (dB)	Channels	Supply Voltage (V)	Supply Current (mA)	Offset Voltage	Input Bias Current (pA)	Packaging
LMV831/32/34 [E]	120	1/2/4	2.7 to 5.5	0.24	1 mV	1	SC-70/MSOP/TSSOP
LMV861/62 [E, W]	110	1/2	2.7 to 5.5	2.25	1 mV	0.1	SC-70/MSOP-8
LMV851/52/54 [E, W]	89	1/2/4	2.7 to 5.5	0.4	1 mV	0.1	SC-70/MSOP/TSSOP
LMP2021/22 [E, W]	82	1/2	2.2 to 5.5	1.1	5 µV	25	SOT23-5, SOIC-8, MSOP-8

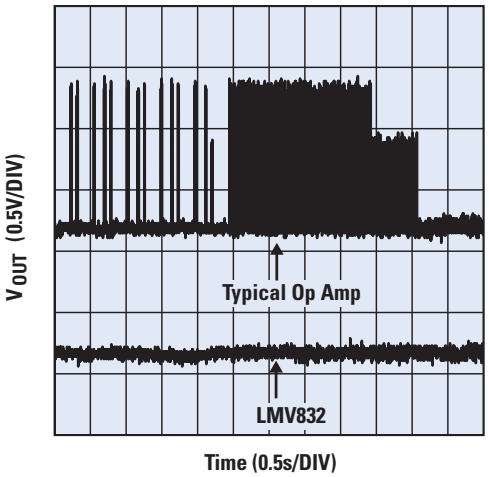
[E] Evaluation board [W] WEBENCH enabled

LMV831/32/34 – 3 MHz Low-Power CMOS, EMI-Hardened Operational Amplifiers

Features

Unless otherwise noted, typical values at T_A= 25°C, V+= 3.3V

- Supply voltage 2.7V to 5.5V
- Supply current (per channel) 240 µA
- Input offset voltage 1 mV max
- Input bias current 1 pA
- GBW 3.3 MHz
- EMIRR at 1.8 GHz 120 dB
- Input noise voltage at 1 kHz 12 nV/√Hz
- Slew rate 2 V/µs
- Output voltage swing rail to rail
- Output current drive 30 mA
- Operating temperature range ambient -40°C to 125°C



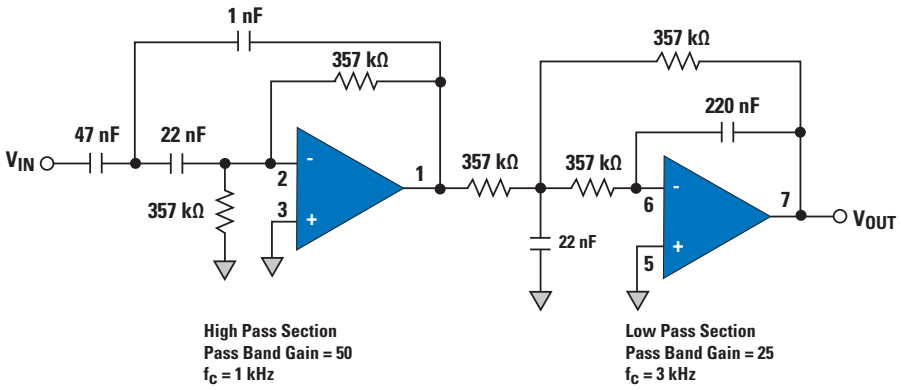
Applications

Ideal for use in photodiode preamps, piezoelectric sensors, portable/battery-powered electronic equipment filters/buffers and PDAs/phone accessories

LMV716 – 5 MHz, Low-Noise, Dual Op Amp with CMOS Input

Features

- Input noise voltage 12.8 nV/√Hz
- Input bias current 0.6 pA
- Offset voltage 1.6 mV
- CMRR 80 dB
- Open loop gain 122 dB
- Rail-to-rail output
- Gain bandwidth 5 MHz
- Slew rate 5.8 V/µs
- Supply current 1.6 mA
- Supply voltage range 2.7V to 5V
- Available in MSOP-8 packaging



Applications

Ideal for use in active filters, transimpedance amplifiers, audio preamps, and HDD vibration cancellation circuitry

AMPLIFIERS

Low-Voltage, Low-Noise Operational Amplifiers

Product ID	Channels	Voltage Noise (nV/√Hz)	Max Input Bias Current (nA)	Offset Voltage Max, 25C (mV)	Supply Current Per Channel (mA)	Gain Bandwidth (MHz)	Slew Rate (V/µs)	Supply Voltage Range (V)	Output Current (mA)	Temp Range (°C)	Packaging
LMP7731	1	2.9	30	0.04	2.2	22	2.4	1.8 to 5.5	47	-40 to 125	SOT23-5
LMP7732 [W]	2	2.9	30	0.04	2.2	22	2.4	1.8 to 5.5	47	-40 to 125	SOIC-8
LMV791 [W]	1	5.8	0.025	1.35	1.15	17	9.5	1.8 to 5	21	-40 to 125	TSOT-6
LMV792 [W]	2	5.8	0.1	1.35	1.3	17	9.5	1.8 to 5	21	-40 to 125	MSOP-10
LMV796 [W]	1	5.8	0.1	1.35	1.15	17	9.5	1.8 to 5	21	-40 to 125	SOT23-5
LMV797 [W]	2	5.8	0.1	1.35	1.3	17	9.5	1.8 to 5	21	-40 to 125	MSOP-8
LMV793 [W]	1	5.8	0.1	1.35	1.15	88	28	1.8 to 5	21	-40 to 125	SOIC-8, SOT23-5
LMV794 [E, W]	2	5.8	0.1	1.35	1.3	88	28	1.8 to 5	21	-40 to 125	SOIC-8, MSOP-8
LMP7715 [W]	1	5.8	0.05	0.15	1.15	17	9.5	1.8 to 5.5	23	-40 to 125	SOT23-5
LMP7716 [W]	2	5.8	0.05	0.15	1.3	17	9.5	1.8 to 5.5	23	-40 to 125	MSOP-8
LMV751 [W]	1	6.5	0.1	1	0.6	5	2.3	2.7 to 5.5	15	-40 to 85	SOT23-5
LMV721 [E, W]	1	8.5	400	3	1.03	10	5.25	2.7 to 5	24	-40 to 85	SC70-5, SOT23-5
LMV722 [W]	2	8.5	400	3	0.9	10	5.25	2.7 to 5	24	-40 to 85	LLP-8, SOIC-8
LMV771 [E, W]	1	12	0.1	0.85	0.6	3.5	1.4	2.7 to 5	66	-40 to 125	SC70-5
LMV772 [W]	2	12	0.1	1	0.6	3.5	1.4	2.7 to 5	66	-40 to 125	SOIC-8, MSOP-8
LMV774 [W]	4	12	0.1	1	0.6	3.5	1.4	2.7 to 5	66	-40 to 125	TSSOP-14
LMV716 [W]	2	12.8	0.13	5	1.6	5	5.8	2.7 to 5	31	-40 to 85	MSOP-8
LMV861/62/64 [E, W]	1/2/4	8	10	1	0.43	8	4.5	2.7 to 5.5	60	-40 to 85	SC70-5, MSOP-8, TSSOP-14

[E] Evaluation board [W] WEBENCH enabled

High-Voltage Supply Amplifiers

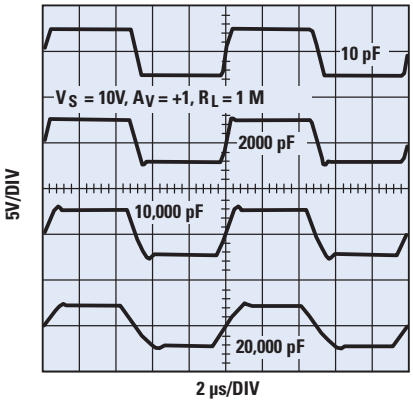
LM7332 – Dual RRIO, 30V Wide Voltage Range Operational Amplifier

Features

(V+ = 10V, T_A = 25°C, typical values unless specified)

- Wide supply voltage range 2.5V to 32V
- Wide input common mode voltage 0.3V beyond rails
- Output short circuit current ±120 mA
- Output current (1V from rails) ±65 mA
- GBWP 19 MHz
- Slew rate 15 V/µs
- Capacitive load tolerance unlimited
- Supply current/channel 0.75 mA
- Temperature range -40°C to +125°C
- Voltage offset 100% tested at 5V, ±5V, 30V

Large Signal Step Response for Various Capacitive Loads



High-Voltage Supply Amplifiers

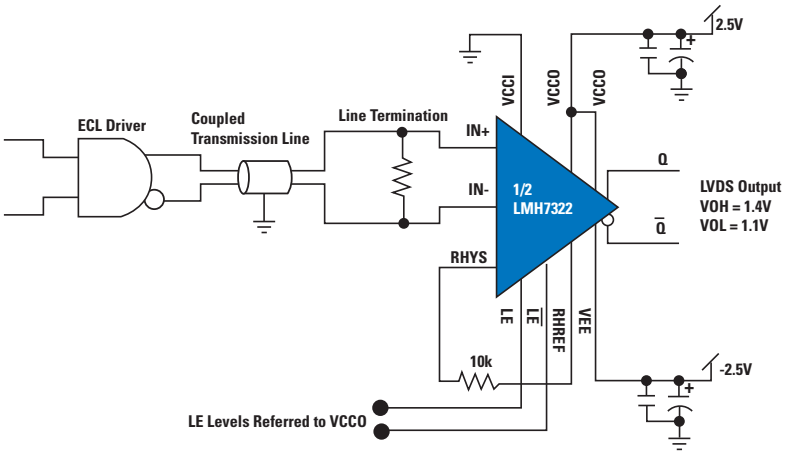
Product ID	Channels	Voltage Noise (nV/√Hz)	Gain Bandwidth (MHz)	Slew Rate (V/µs)	Output Current (mA)	Offset Voltage Max, 25°C (mV)	Supply Current Per Channel (mA)	Comments	Packaging
LME49713 [E]	1	1.9	132	1900	90	1	8	Current feedback	SOIC-8
LM4562 [E]	2	2.7	55	20	23	0.7	6	High-AC accuracy, low noise	SOIC-8, PDIP-8, TO-99
LME49710 [E]	1	2.7	55	20	23	0.7	6	Can drive 600Ω loads	SOIC-8, PDIP-8, TO-99
LME49720 [E]	2	2.7	55	20	23	0.7	5.5	Good for active filters, 120 dB CMRR	SOIC-8, PDIP-8, TO-99
LME49740 [E]	4	2.7	55	20	23	0.7	6	Quad, low noise	SOIC-14, PDIP-14
LME49870	1	2.7	55	20	30	0.7	6.5	Supply voltage to ±22V	SOIC-8
LME49860	2	2.7	55	20	30	0.7	5.5	Supply voltage to ±22V	SOIC-8, PDIP-8
LM7372 [W]	2	14	120	2000	150	8	9	High output driver, xDSL	SOIC-16, PSOP-8, LLP-8
LM7332	2	15	19	15	100	6	1.2	Unlimited capacitive load	SOIC-8, MSOP-8
LM7321 [W]	1	15	21	24	50	5	1.3	RRIO and unlimited cap load	SOIC-8, SOT23-5
LM7322 [W]	2	15	21	24	50	5	1.3	RRIO and unlimited cap load	SOIC-8, MSOP-8
LM7341 [W]	1	33	4	1.7	11	4	1	Rail-to-rail input and output	SOT23-5

[E] Evaluation board [W] WEBENCH enabled

LMH7322/24 – Dual/Quad 700 ps Comparators with LVDS/RSPECL Outputs

Features

- 700 ps propagation delay
- Overdrive dispersion:
  - 20 ps (LMH7324)
  - 75 ps (LMH7322)
- 4 Gbps toggle rate with 150 ps rise/ fall times
- Wide input range includes negative rail V_{CCI}-1.5V to V_{EE}-0.2V
- Supply range
  - 2.7V to 12V (LMH7322)
  - 5V to 12V (LMH7324)
- Dual supplies and wide supply range for level translation applications
- Low supply current
- Available in small LLP-24 (LMH7322) and LLP-32 (LMH7324) packaging



Applications

Ideal for use in oscilloscopes, digitizers, mass spectrometers, logic analyzers, network/spectrum analyzers, automated test equipment, RADAR, and PET scanners

High-Speed Comparators

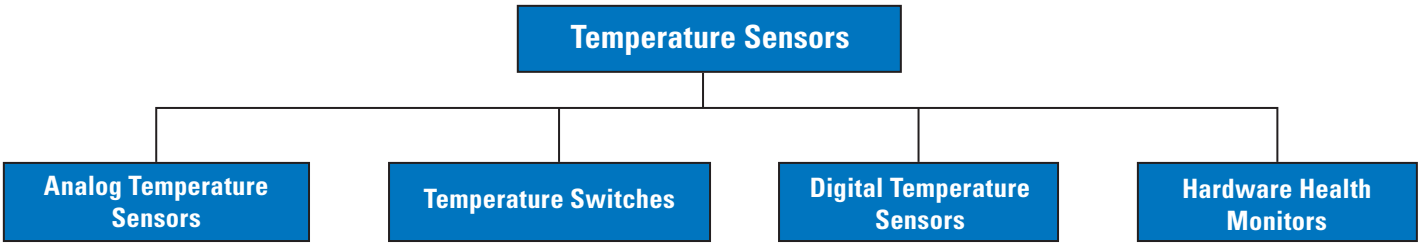
Product ID	Channels	Response Time (µs)	Offset Voltage max, 25C (mV)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Input Bias Current (µA)	Output Compatibility	Temperature Range (°C)	Packaging
LMV7219	1	0.007	6	2.7 to 5	1.1	0.45	Push-pull	-40 to 85	SC70-5, SOT23-5
LMV7235/39	1	0.045	6	2.7 to 5	0.065	0.03	Open drain/ Push-pull	-40 to 85	SC70-5, SOT23-5
LMH7220	1	0.0029	2.7	2.7 to 12	7.5	1.5	LVDS	-40 to 125	TSOT-6
LMH7322	2	0.0007	8	2.7 to 12	22.8	2.6	RS(P)ECL, LVDS	-40 to 125	LLP-24
LMH7324	4	0.0007	9.5	5 to 12	17.2	2.6	RS(P)ECL, LVDS	-40 to 125	LLP-32

Low-Power Comparators

Product ID	Channels	Response Time (µs)	Offset Voltage max, 25C (mV)	Output Current (mA)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Max Input Bias Current (nA)	Temperature Range (°C)	Packaging
LMP7300 [E]	1	4	0.3	10	2.7 to 12	0.012	3	-40 to 125	SOIC-8
LMV7271	1	0.88	4	34	1.8 to 5	0.009	100	-40 to 85	SC70-5, SOT23-5
LMV7272	2	0.88	4	34	1.8 to 5	0.009	100	-40 to 85	micro SMD-8
LMV7275	1	0.88	4	34	1.8 to 5	0.009	100	-40 to 85	SC70-5, SOT23-5
LMV7291	1	0.88	4	34	1.8 to 5	0.009	100	-40 to 85	SC70-5
LMV761	1	0.12	0.3	40	2.7 to 5	0.275	0.05	-40 to 125	SOIC-8, SOT23-6
LMV762	2	0.12	0.2	40	2.7 to 5	0.275	0.05	-40 to 125	SOIC-8
LPV7215	1	4.5	3	15	1.8 to 5	0.00058	0.001	-40 to 85	SC70-5, SOT23-5

[E] Evaluation board

Temperature Sensors



Analog Temperature Sensor

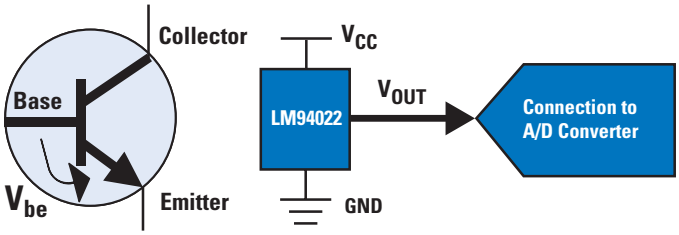
Analog temperature sensors utilize the temperature-dependent V_{be} characteristic of a transistor to convert the temperature being measured into a voltage. The resulting output voltage is directly proportional to the temperature.

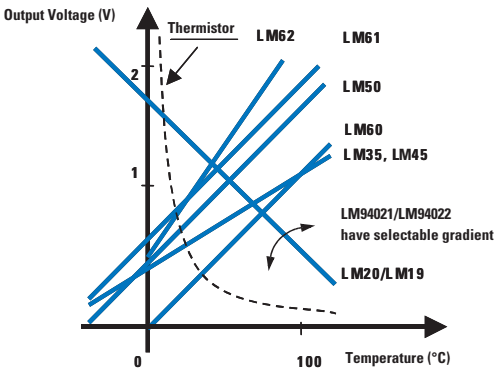
National has a wide range of models available for selection based on the first-order gradient, offset, and operating supply voltage characteristics.

Features

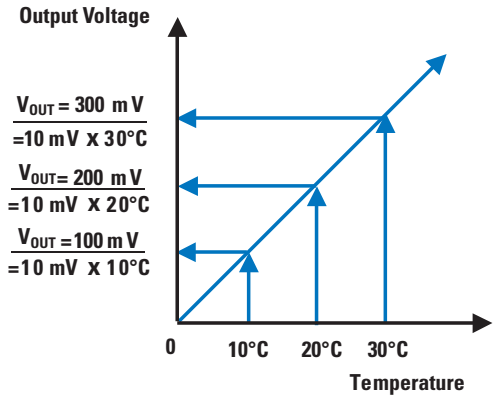
- The excellent linearity compared to thermistors means compensation is not required.
- Very simplified and easy-to-use configuration with only three terminals. These are the power supply, ground, and analog output terminals, respectively.
- A wide range of packages are available to suit many different applications (SO-8, TO-92, SOT23-3, SC-70).
- Power consumption is less than a thermistor making these sensors ideal for battery-driven applications: for example, LM19/LM20 LM94021/LM94022 : 4µA, LM45/50/60/61/62 : 120µA

Simple Configuration





Seven Types are Available with Different Gradients and Offsets

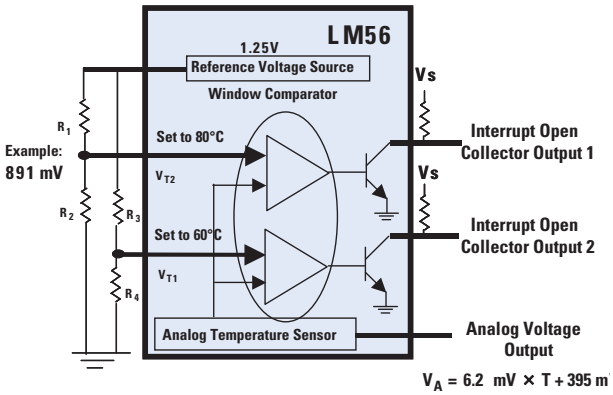


For the LM45, V (Output Voltage) = +10 mV/°C x Temperature (°C)

Analog Temperature Switch

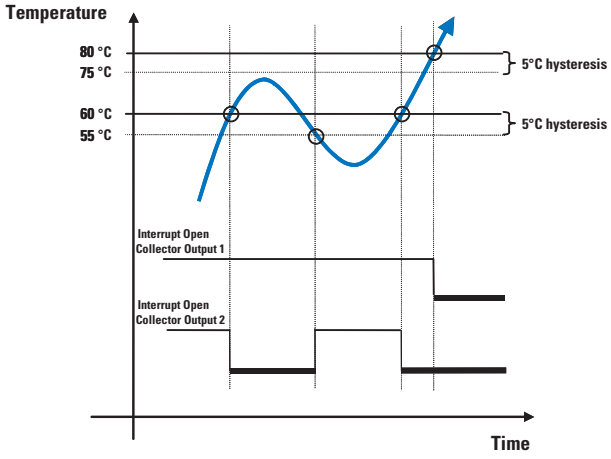
An analog temperature switch integrates an analog temperature sensor with a comparator and reference voltage source that can output an alarm (interrupt signal) at a specific temperature threshold. The setting method is particularly simple and in the case of the LM56 and LM57 temperature sensors, consists of using voltage divider resistors to divide the reference voltage source and obtain the voltage corresponding to the threshold temperature.

This voltage is applied to one input of the comparator while the other input is driven by the analog temperature sensor. In the case of the LM26 and LM27 sensors in which the threshold temperature is preset in the factory, the devices can be used to implement a temperature monitor function on their own and do not require any software or external resistors to set the threshold.



Example: Procedure for setting 80°C. When the interrupt temperature is set to 80°C, VA = 6.20 mV x 80 °C +395 mV = 891 mV. The reference voltage source needs to be divided by the divider resistors to obtain 891 mV and connected to V_{T1} or V_{T2} on the LM56.

LM56 Interrupt Output vs Measured Temperature



*** Open collector output 1 is set to 80 °C.**
*** Open collector output 2 is set to 60 °C.**
*** The 5 °C hysteresis is fixed in the LM56**

Temperature Sensors

Digital Temperature Sensor

A digital temperature sensor integrates an analog temperature sensor, A/D converter, and digital interface to provide a convenient temperature sensor capable of directly being read by a CPU or microprocessor. National has a wide range of digital temperature sensors that can be selected based on criteria such as (1) accuracy, (2) digital interface, (3) interrupt function, and (4) whether a remote thermal diode sensing function is used.

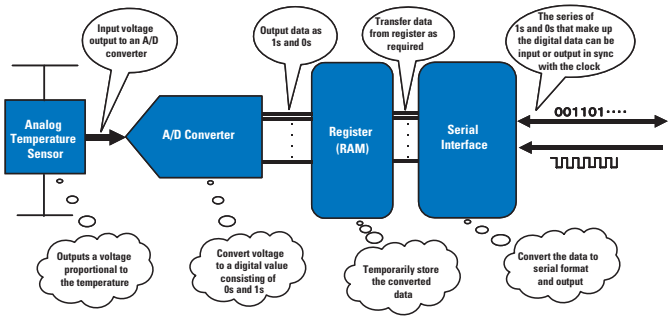
(1) The range includes a part (the LM92) with an accuracy of ±0.33°C, which is superior to any other digital temperature sensor on the market. A sensor can be selected based on the temperature margin in a design.

(2) Two digital interfaces are available: 2-wire interfaces (I^2C Bus and SMBus) and 3-wire interfaces (SPI and Microwire). The interface can be selected that suits the given microprocessor.

(3) A function is available to output an interrupt signal at a specified set temperature. Applicable uses include fan control and shutting down the system at an application-specified temperature.

4) A diode-sensing function utilizes the temperature characteristics of a bipolar transistor's base-emitter junction to measure temperature. A bias current from the temperature sensor is applied to a transistor and the differential voltage (representing the change in temperature) is converted to digital temperature data. This method can be used to make direct measurements of the internal temperature of a CPU or GPU that has an integrated thermal diode. Also, because this technique can be used with a general purpose transistor (2N3904), it simplifies circuit board design since only the transistor needs to be located next to the heat source and the sensor can be mounted elsewhere.

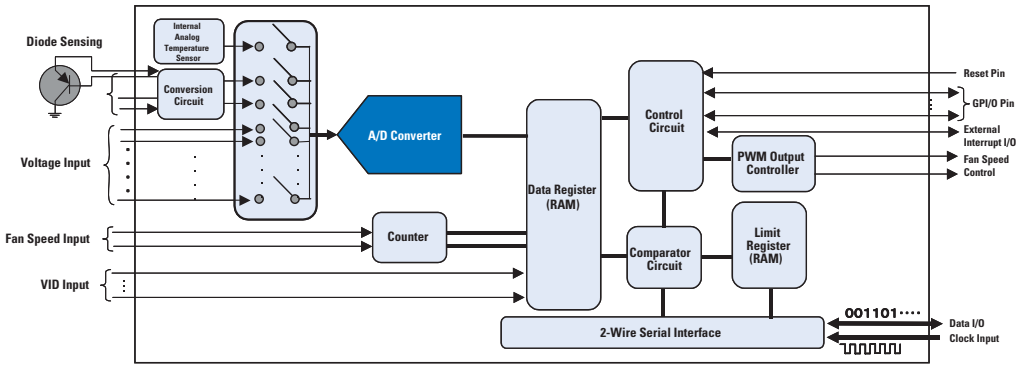
(5) The range includes the parts that use TruTherm® technology to provide high-precision temperature detection for processors produced using 90 mm or finer geometry.



Structure of a Digital Sensor

Hardware Monitors

Hardware monitors are integrated monitoring ICs that, in addition to their temperature measurement function, extend the digital temperature sensor by integrating additional functions including voltage monitoring, fan speed, monitoring, power supply control signal monitor parameters, fan speed control, a GPIO port, and an external alert output. The measurement data is automatically saved in an internal RAM and can be read at any time via an interface. Also, the measurement data is automatically compared to user-specified limit values and an alert signal output is provided to signal if an abnormal measurement is detected. In addition to monitoring functions, the ICs can also incorporate a PWM (Pulse Width Modulator) output function that can be used to control fan speed based on temperature. The LM94/96194 are available with TruTherm® technology.



Analog Temperature Sensors

Product ID	Key Features	Operating Temp (°C)	Temp Accuracy (°C)	Operating Supply Voltage Range (V)	Temp Coefficient (mV/C)	Supply Current (µA)	Packaging
LM19/20 [E]	Low power consumption	-55 to 130	±1.5, ±2.5	2.4 to 5.5	-11.7	4	SC-70, TO-92
LM45	Calibrated in °C	-40 to 125	±3, ±4.0	4 to 10	10	120	SOT23/3
LM50	Negative temperature support	-40 to 150	±3, ±4.0	4.5 to 10	10	130	SOT23-3
LM60	Low voltage support	-40 to 125	±3, ±4.0	2.7 to 10	6.25	82	SOT23-3, TO-92-3
LM61	Low voltage support	-30 to 100	±3, ±4.0	2.7 to 10	10	82	SOT23-3, TO-92-3
LM62 [E]	Low voltage support	0 to 90	±3, ±4.0	2.7 to 10	15.6	155	SOT23-3
LM94022	Low 1.5V operation	-50 to 150	±2.4	1.5 to 5.5	-5.5/-8.2/10.9/-13.6	5.4	SC70-5

Temperature Switches

Product ID	Trip Point Range (°C)	Accuracy (°C)	Supply Range (V)	Interrupt Outputs	Interrupt Temp Setting	Analog Temp Sensor	Packaging
LM26 [E]	-55 to 125	±3	2.7 to 5.5	1	Factory set	✔	SOT 23-5
LM27	+120 to 150	±3	2.7 to 5.5	1	Factory set	✔	SOT 23-5
LM56	-40 to 125	±2, 3, 4	2.7 to 10	2	User specified	✔	SOP-8, MSOP-8
LM26LV	0 to 150	±22.2	1.6 to 5.5	2	Factory set	✔	LLP-6
NEW! **LM57**	-50 to 150	±1.5, 2.3	2.4 to 5.5	2	User specified	✔	LLP-8

Digital Temperature Sensors

Product ID	Key Features	Temp Accuracy @ Range (°C)	Temp Accuracy Accuracy (°C)	Interface	Operating Supply Voltage (V)	Temp Resolutions (°C/LSB)	No. of Interrupts	No. of Available Addresses	Packaging
LM70 [E]	Low precision version of LM74	-10 to 85	±1.5/2	Microwire/SPI	2.85 to 5.5	0.125	—	—	MSOP-8, LLP-8
LM74	Small package	-10 to 85/100	±1.25, 2.1	Microwire/SPI	3.0 to 5.5	0.0625	—	—	SOP-8, micro SMD
LM71/ LM95071	High accuracy and resolution	0 to 70	±1.0	Microwire/SPI	2.4 to 5.5	0.03125	—	—	SOT23-5
LM73	Precision, programmable resolution	-10 to 110	±1.0, 1.5	I²C/SMBus2.0	2.7 to 5.5	0.03125	1	6	SOT23-6
LM75	Industry standard	25 to 100	±2.0	I²C BUS	3.0 to 5.5	0.5	1	8	SOP-8, MSOP-8
LM76	Precision	-10 to 100	±.5, 1.0, 2.5	I²C BUS	3.0 to 5.5	0.0625	2	4	SOP-8
LM77	Separate open-drain outputs	-10 to 100	±1.5, 2	I²C BUS	3.0 to 5.5	0.25	2	4	SOP-8, MSOP-8
LM92	Highly accurate sensor	-25 to 150	±.33 to 1.5	I²C BUS	2.7 to 5.5	0.0625	2	4	SOP-8
LM95172Q	175°C operation, high accuracy	-40 to 160	±1.2 to 3.5	SPI	3.0 to 5.5	0.0625	—	—	Die

[E] Evaluation board

Temperature Sensors

Remote Diode Temperature Sensors

Product ID	Description	Pin-Compatible	Processor Supported	Measurement Method	No. of Remote Channels	T_{CRIT}	Selectable Addresses
LM86/89/99 [E]	±0.75°C, MSOP-8		P4 and AMD	Traditional	1	1	Factory set
LM95235 [E]	±0.75°C, MSOP-8		65 nm	TruTherm®	1	1	✔
LM95245	±0.75°C, MSOP-8		45 nm	TruTherm	1	1	✔
LM95231	±1.25°C, MSOP-8		90 nm	TruTherm	2	—	Factory set
LM95241	±1.25°C, MSOP-8		65 nm	TruTherm	2	—	Factory set
LM95213 [E]	±1.1°C, LLP-14		—	Traditional	0 to 2	3	✔
LM95233 [E]	± 0.875°C, LLP-14		65 nm	TruTherm	0 to 2	3	✔
LM95214 [E]	±1.1°C, LLP-14		—	Traditional	0 to 4	3	✔
LM95234 [E]	±0.875°C, LLP-14		65 nm	TruTherm	0 to 4	3	✔
LM96194	±2.5°C, LLP-48		65 nm	TruTherm	2 to 4	—	Full PI hardware monitor
LM87	±4°C, TSSOP-24		—	Traditional	2	1	DAC hardware monitor
LM93	±3°C, TSSOP-56		—	Traditional	2	—	Full LUT hardware monitor
LM94	±2.5°C, TSSOP-56		65 nm	TruTherm	2 to 4	—	Full PI and LUT hardware monitor
LM96163 [E]	±0.75°C, LLP-10		45 nm	TruTherm	1	1	LUT fan control

PowerWise® product [E] Evaluation board

Hardware Monitors

Product ID	Temp Range (°C)	Temp Accuracy	Interface	Supply Voltage Range (V)	Temp Resolution	Remote Diode Thermal Sensor Count	Fan Speed Inputs	Packaging
LM80	-25 to 125	±3	I^2C BUS	2.8 to 5.75	0.0625	—	2	TSSOP-24
LM81	-25 to 125	±3	SMBus/I^2C Bus	2.8 to 3.8	0.0625	—	2	TSSOP-24
LM87 [E]	-40 to 125	±3, 2	SMBus/I^2C Bus	2.8 to 3.8	0.0625	2	2	TSSOP-24
LM96000	0 to 125	±3, 2, 4	SMBus	3.0 to 3.6	0.0625	2	4	TSSOP-24
LM93	0 to 100	±3, 2	SMBus	3.0 to 3.6	1	2	4 (max)	TSSOP-56
LM94	0 to 100	±3, 2	SMBus	3.0 to 3.6	0.5	2	4 (max)	TSSOP-56
LM96194	0 to 100	±3, 4	SMBus	3.0 to 3.6	0.5	4	4 (max)	LLP-48

[E] Evaluation board

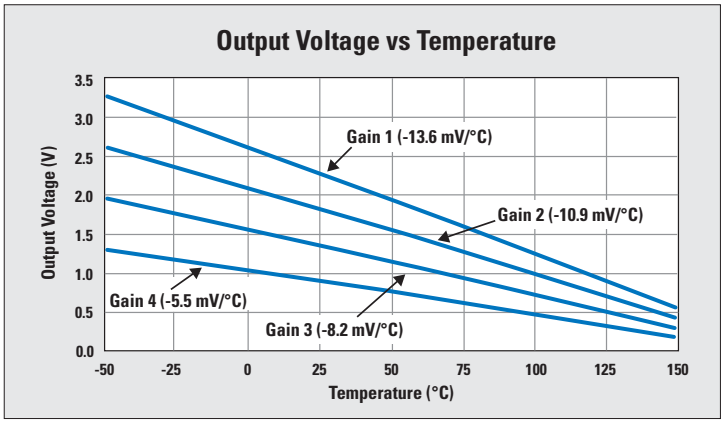
LM94021/22/23 – PowerWise® Low-Voltage, Low-Power, 1.5V to 5.5V Analog Temperature Sensor

Features

- Next generation LM20
- Supply voltage 1.5V to 5.5V
- ±1.5°C temperature accuracy
- Four configurable gains for optimum sensitivity vs. supply and temperature
- Low 5.4 µA quiescent current
- Wide temperature range of -50°C to +150°C
- Short-circuit protected output
- Available in SC-70 packaging
- New: LM94023 — micro SMD, dual gain
- Evaluation board available

Applications

Ideal for use in low-voltage, battery-powered systems such as cellular phones, PDAs, MP3 players, and digital cameras, as well as automotive and storage devices

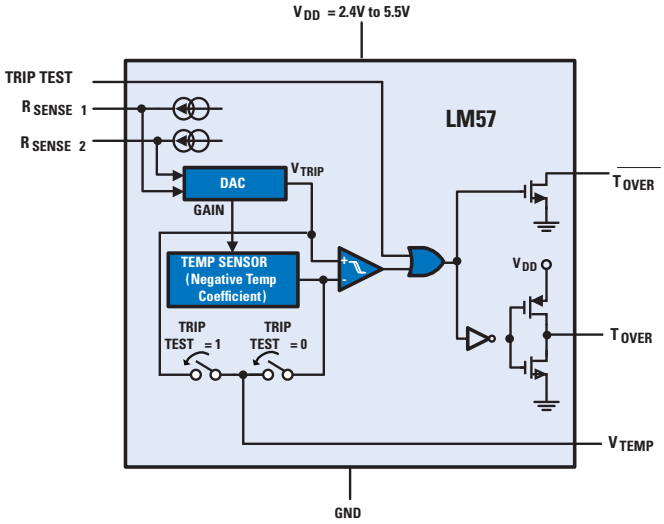


Product ID	Supply Current (µA)	Output Drive		Output	Packaging
		Source (µA)	Sink (µA)		
LM94022	5.4	50	50	Class AB	SC-70
LM94023	5.4	50	50	Class AB	micro SMD

LM26/27 and LM56/57 – Low-Power Temperature Switch with Single or Dual Output

Features

- Combines window comparator output and analog voltage output
- Alarm output temperature is set at the factory (LM26 and LM27)
- Low supply current: 20 µA to 230 µA (typ)
- Operating supply voltage range: +2.7V to +5.5V
- Detection temperature accuracy:
  - LM26 ±3°C (max) (-55°C to 110°C), ±4°C (max) (+120°C)
  - LM27 ±3°C (max) (-120°C to 150°C)
  - LM56BIM ±2°C (max) (-25°C to 85°C)
  - LM57B ±1.5°C (max) (-50°C to 150°C)
  - LM77 ±2.3°C (max) (-55°C to 150°C)



Temperature Sensors

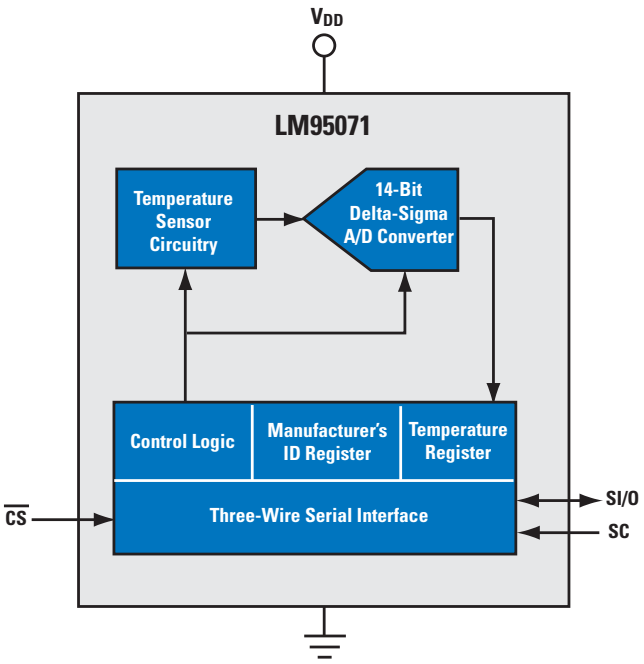
LM95071 – PowerWise® High-Accuracy SPI General-Purpose Digital Temperature Sensor

Features

- ±1°C accuracy (0°C to 70°C)
- 14-bit resolution (0.03125°C/LSB)
- 2.4V to 5.5V supply
- Low power: 280 µA typical
- -40°C to 150°C temperature range
- Next generation to the LM70 and LM74 sensors
- Available in SOT23-5 packaging

Applications

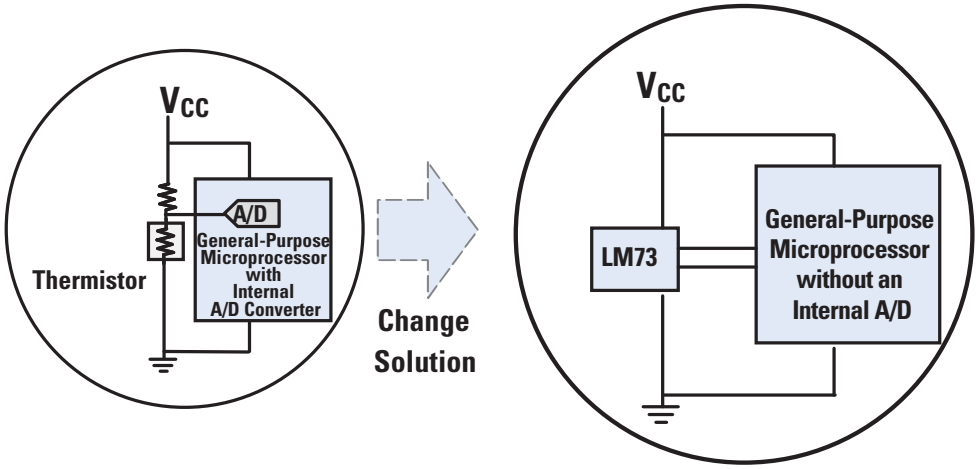
Ideal for use in system thermal management, portable devices, personal computers, disk drives, and test equipment



LM73 – 13-bit + Sign Digital Temperature Sensor with a 2-Wire Interface

Features

- 2-wire interface (I^2C/SMbus2.0)
- Temperature detection accuracy:
  - ±1.0°C (max) (-10°C to +80°C)
  - ±15°C (max) (-25°C to +115°C)
  - ±2.0°C (max) (-40°C to +150°C)
- Internal ADC resolution : 14-bit (13-bit + sign)
- Supply voltage: ±2.7V to +5.5V
- Low supply current: 320 µA (typ) (when interface used)
  : 1.9 µA (typ) (when shut down)



Remote Diode Temperature Sensors and Hardware Monitors

PowerWise® Precision Remote Diode Temp Sensors (RDTS) with TruTherm® Technology

TruTherm® Beta Compensation Technology

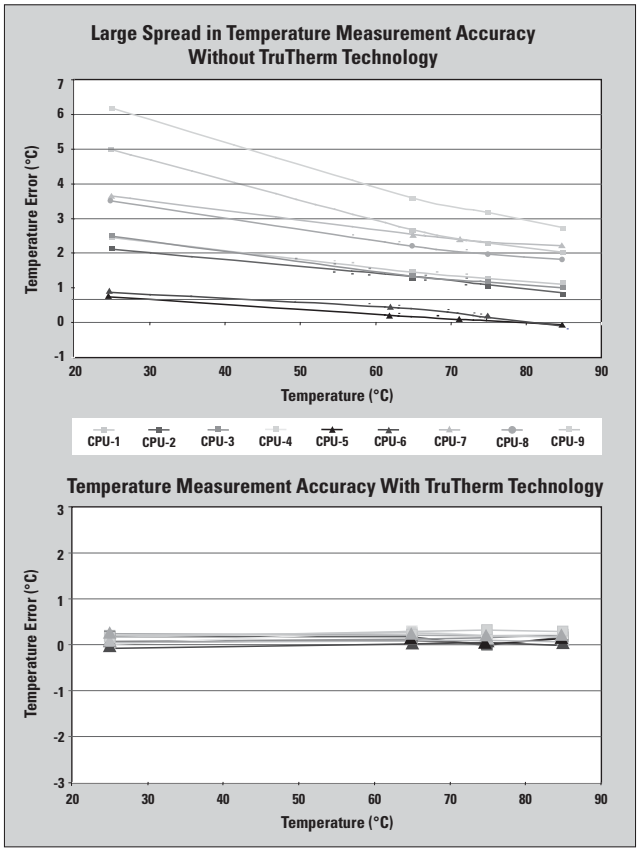
- Precisely senses the temperature of remote diodes in deep-submicron processes
- Compensates effects of beta variation
- Eliminates processor-dependent offset calibration
- Precise temperature measurement combined with National's advanced fan control solution enables optimal acoustic solutions

Features (LM95233/34/35/41/45)

- Remote and local sensors
- Analog and digital filters to reduce noise
- Calibrated for 2N3904 or processors on 45, 65, or 90 nm processes
- Resolves temperatures above 127°C
- Remote diode fault detection
- SMBus 2.0-compatible interface, supports TIMEOUT

Applications

Ideal for use in processor/computer system thermal management (e.g. laptops, desktops, workstations, servers), electronic test equipment, and office electronics



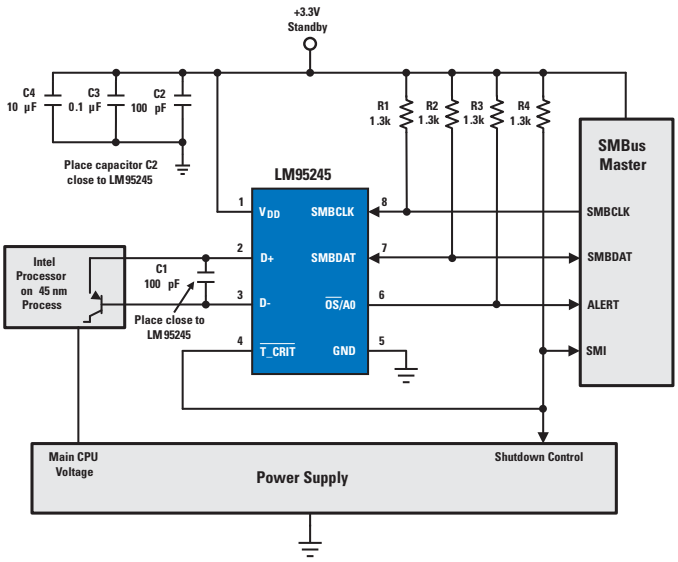
LM95245 – PowerWise® Single Remote Diode and Local Temperature Sensor

Features

- 45 nm supported TruTherm beta compensation technology
- Monitors one remote diode and local temperature
- Remote temperature accuracy: ±0.75°C (max)
- One programmable critical temperature alarm
- Supply voltage: 3.0V to 3.6V
- 350 µA supply current
- 3-level address pin
- Available in MSOP-8 and SOIC-8 packaging

Applications

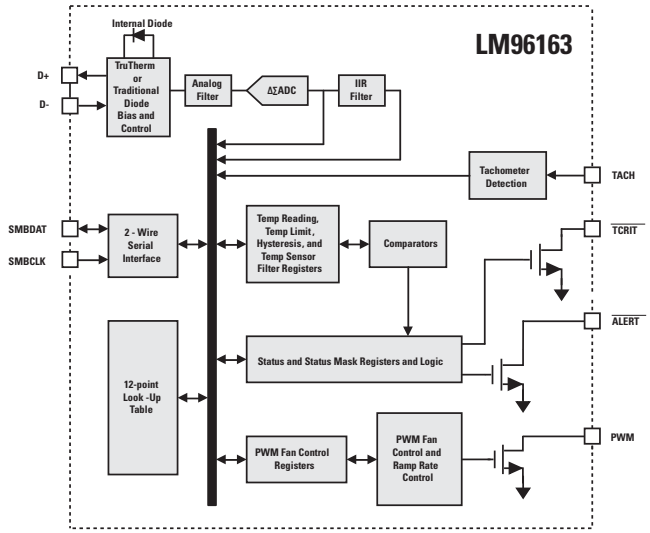
Ideal for use in processor/computer system thermal management, electronic test equipment, and office electronics



LM96163 – PowerWise® TruTherm® Remote Diode Integrated Look-Up Table Fan Control

Features

- TruTherm 45 nm and 65 nm BJT beta compensation technology
- Monitors remote diode, local temperature, and 1 cooling fan
- Remote temperature accuracy ± 0.75°C
- Controls cooling fans with advanced fan speed control techniques
- Features that minimize acoustical noise:
  - Programmable PWM duty-cycle transition smoothing
  - 12-point LUT
  - 0.39% PWM duty-cycle resolution at 22.5 kHz PWM frequency
- T_{CRIT} output for critical temperature system shutdown
- ALERT output for processor event notification
- Available in LLP-10 (QFN10) packaging



Applications

Ideal for use in single processor-based equipment, industrial controls, and electronic test and office equipment

LM93/94 and LM96194 – 2-Wire Serial Interface Hardware Monitor IC with Internal TruTherm® Digital Temperature Sensor

Features

LM93 (TruTherm® not used)/LM94 (TruTherm)

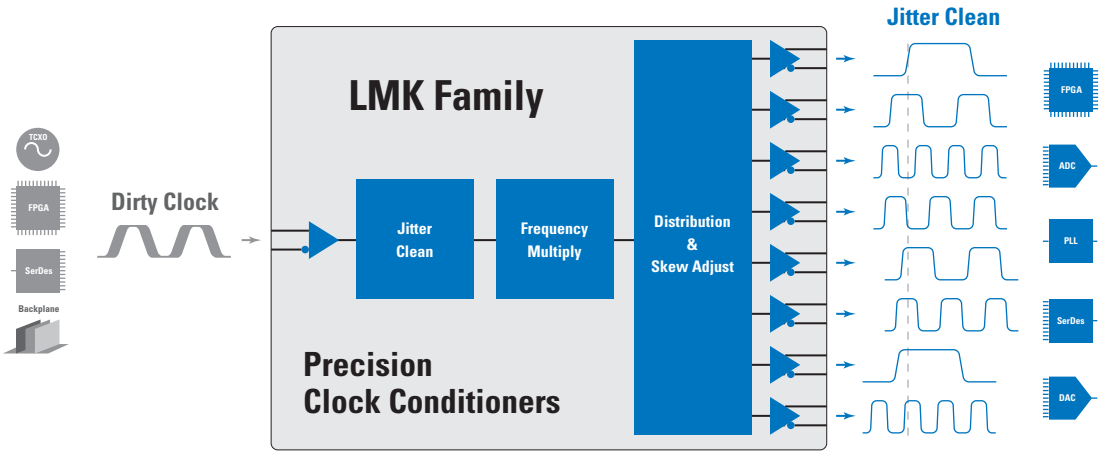
- Supply voltage range: 3.0V to 3.6V
- 2-wire serial bus interface (SMBus)
- Temperature monitoring accuracy
  - Local temperature detection accuracy
    :±3°C (max) (25°C<T_D<100°C)
  - Remote temperature detection accuracy
    LM93: ±3°C (max) (25°C<T_D<100°C)
    LM94: ±3°C (max) (0°C<T_D<100°C)
- Number of input voltages able to be monitored: 16
- Number of fan speeds able to be monitored: 4
  - LM94: 4

LM96194 (TruTherm)

- Supply voltage range: 3.0V to 3.6V
- 2-wire serial bus interface (SMBus)
- Temperature monitoring accuracy
  - Local temperature detection accuracy
    :±3°C (max) (0°C to 85°C)
  - Remote temperature detection accuracy
    :±3°C (max) (0°C<T_A<85°C, 0°C<T_D<100°C)
    :±2.5°C (max) (0°C<T_A<85°C, T_D=70°C)
- Number of input voltages to be monitored: 9
- Number of fan speeds able to be monitored: 4

LMK Clock Conditioner Family

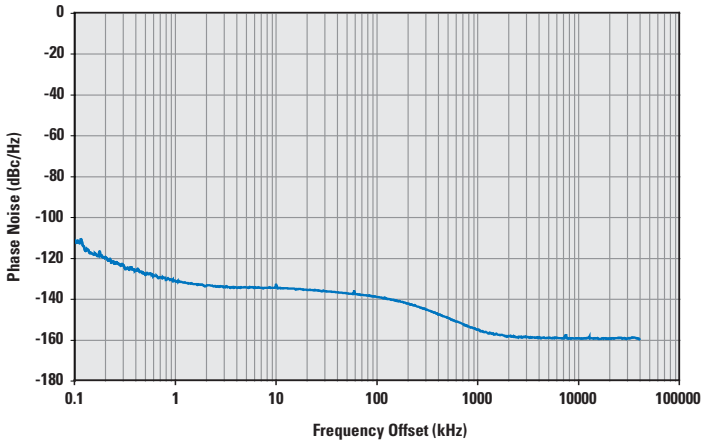
Jitter Cleaning + Multiplication + Distribution



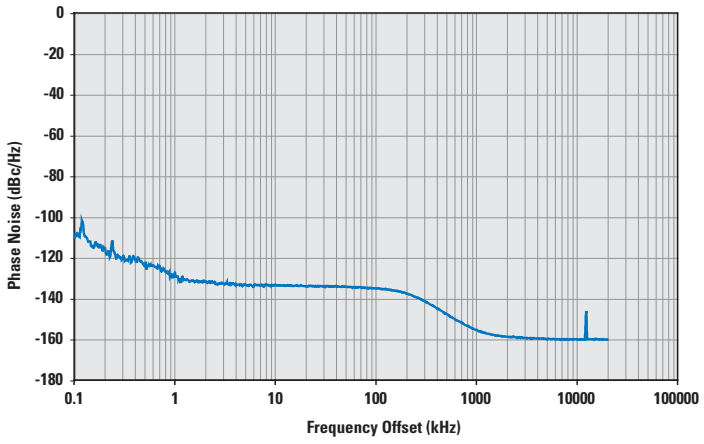
Product ID	Outputs			Architecture	Output Clock Range (MHz)	VCO Frequency Range (MHz)	RMS Jitter (ps) *
	LVPECL	LVDS	LVCMOS				
LMK01000ISQ [E]	5	3	0	2:10 Clock Distribution	1 to 1600	NA	0.03 (additive)
LMK01010ISQ [E]	0	8	0		1 to 1600	NA	0.03 (additive)
LMK01020ISQ [E]	8	0	0		1 to 1600	NA	0.03 (additive)
LMK02000ISQ [E]	5	3	0	PLL + Clock Distribution (needs external VCXO)	1 to 860	NA	0.2 (+VCXO)
LMK02002ISQ [E]	4	0	0		1 to 860	NA	0.2 (+VCXO)
LMK03000CSQ [E]	5	3	0	PLL + VCO + Clock Distribution	1 to 648	1185 to 1296	0.4
LMK03000ISQ [W]	5	3	0		1 to 648	1185 to 1296	0.8
LMK03000DISQ	5	3	0		1 to 648	1185 to 1296	1.2
LMK03001CISQ [E]	5	3	0		1 to 785	1470 to 1570	0.4
LMK03001ISQ [W]	5	3	0		1 to 785	1470 to 1570	0.8
LMK03001DISQ	5	3	0		1 to 785	1470 to 1570	1.2
LMK03002CISQ [E]	4	0	0		1 to 860	1566 to 1724	0.4
LMK03002ISQ	4	0	0		1 to 860	1566 to 1724	0.8
LMK03033CISQ [E]	4	4	0		1 to 1080	1840 to 2160	0.4
LMK03033ISQ	4	4	0		1 to 1080	1840 to 2160	0.8
LMK04000BISQ [E]	3	0	4	Cascaded PLLs + VCO + Clock Distribution (needs external Crystal or VCXO in PLL1)	1 to 648	1185 to 1296	0.15/0.2 (+VCXO/Crystal)
LMK04001BISQ [E]	3	0	4		1 to 785	1430 to 1570	0.15/0.2 (+VCXO/Crystal)
LMK04011BISQ [E]	5	0	0		1 to 785	1430 to 1570	0.15/0.2 (+VCXO/Crystal)
LMK04031BISQ [E]	2	2	2		1 to 785	1430 to 1570	0.15/0.2 (+VCXO/Crystal)
LMK04033BISQ [E]	2	2	2		1 to 1080	1840 to 2160	0.15/0.2 (+VCXO/Crystal)

*Integrated from 10 kHz to 20 MHz [E] Evaluation board [W] WEBENCH enabled

Superior Phase Noise Performance



LMK04031B LVCMOS Output Phase Noise at 122.88 MHz using a Crystek VCXO



LMK04031B LVCMOS Output Phase Noise at 122.88 MHz using a Low-Cost Vectron Crystal

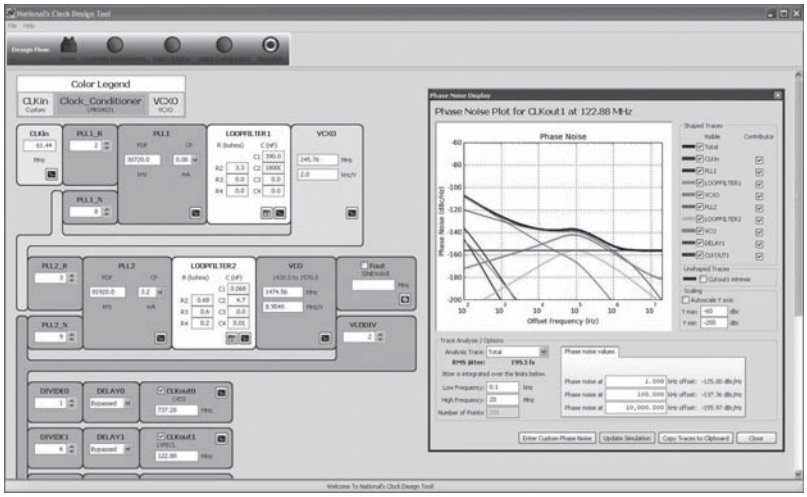
National's Clock Design Tool

Easy-to-use and feature-rich design tool for simple and quick clock subsystem design and analysis

Features

- Easy design parameter entry
- LMK part selection and configuration
- PLL and loop filter customization
- Input clock and VCXO phase noise entry
- Phase noise and jitter simulations and plotting

Visit: www.**national.com/timing**

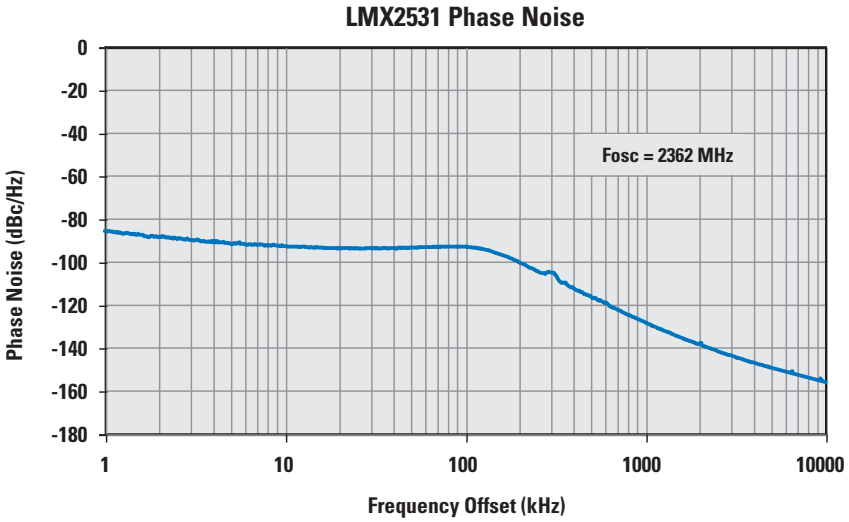


High-Performance Frequency Synthesizers

LMX2531 – PLLatinum® Frequency Synthesizer with Integrated VCO

Features

- 553 MHz to 3132 MHz frequency range
- Very low phase noise and spurs
- Sigma-Delta fractional-N PLL
- Fully-integrated low-noise VCO
- Low 34 mA (typ) current consumption
- High +4 dBm (typ) output power
- Fast-lock and cycle-slip reduction
- Very low power-down current
- Partially integrated and adjustable loop filter
- 2.8V to 3.2V operation
- 1.8V MICROWIRE® support
- Available in LLP-36 packaging (6 mm x 6 mm)



Product ID	Low Band (MHz)	High Band (MHz)
LMX2531LQ1146E [E]	553 to 592	1106 to 1184
LMX2531LQ1226E [E]	592 to 634	1184 to 1268
LMX2531LQ1314E	634 to 680	1268 to 1360
LMX2531LQ1415E [E]	680 to 735	1360 to 1470
LMX2531LQ1500E [E]	749.5 to 755	1499 to 1510
LMX2531LQ1515E [E]	725 to 790	1450 to 1580
LMX2531LQ1570E [E, W]	765 to 818	1530 to 1636
LMX2531LQ1650E [E, W]	795 to 850	1590 to 1700
LMX2531LQ1700E [E, W]	831 to 885	1662 to 1770
LMX2531LQ1742 [E, W]	880 to 933	1760 to 1866
LMX2531LQ1778E [E, W]	863 to 920	1726 to 1840
LMX2531LQ1910E [E, W]	917 to 1014	1834 to 2028
LMX2531LQ2080E [E, W]	952 to 1137	1904 to 2274
LMX2531LQ2265E [E, W]	1089 to 1200	2178 to 2400
LMX2531LQ2570E [E, W]	1168 to 1395	2336 to 2790
SAMPLING! **LMX2531LQ2820E**	1355 to 1462	2710 to 2925
SAMPLING! **LMX2531LQ3010E**	1455 to 1566	2910 to 3132

Other frequency bands in development and by request
[E] Evaluation board [W] WEBENCH enabled

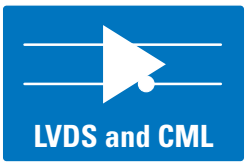
Design Tools and Resources	
WEBENCH® Tool	EasyPLL WEBENCH Design Tool
Handbook	PLL Performance, Simulation and Design Handbook 4th Edition
AN-884	Integrated LNA and Mixer Basics
AN-1001	An Analysis and Performance Evaluation of a Passive Filter Design Technique for Charge Pump PLLs
AN-1006	Phase-Locked Loop Based Clock Generators
Web Seminar	Advantages and Pitfalls of Using Fractional N PLLS
Web Seminar	PLL Loop Filter Optimization
Web Seminar	Non-PLL Radio Frequency (RF) Basics
Web Seminar	PLL Building Blocks
Web Seminar	PLL Performance
Web Seminar	Fractional PLLs
Web Seminar	National's PLL Tools
Web Seminar	Advanced PLL Concepts
Article	The Impact of Various PLL Parameters on System Performance
Application Brief	Delta Sigma PLLs Raise The Standard For Performance
Evaluation Boards	Visit: national.com/wireless
Software	PLL Codeloader Evaluation Software
Reading Lists	List of literature for further reading about PLLs
Discussion Forum	Visit: www.national.com/national/wirelessMB.nsf

High-Performance PLLatinum® Family of PLL Products

Product ID	Main Operating Frequency Range (GHz)	Aux. Operating Frequency Range (MHz)	Main Normalized Phase Noise (dBc/Hz)	Supply Current (mA)	Supply Voltage (V)	Package Size (mm)
Single-Integer PLLs						
LMX2326 E, W	0.1 to 2.8	—	-210	4.7	2.3 to 5.5	3.5 x 3.5 x 1.0
LMX2310U E, W	0.5 to 2.5	—	-212	2.3	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2346 W	0.2 to 2.0	—	-217	3.0	2.7 to 5.5	3.5 x 3.5 x 1.0
LMX2312U E, W	0.2 to 1.2	—	-212	1.4	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2316 E, W	0.1 to 1.2	—	-210	2.5	2.3 to 5.5	3.5 x 3.5 x 1.0
LMX2313U E, W	45 to 600 MHz	—	-212	1.0	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2306 E, W	25 to 550 MHz	—	-210	1.7	2.3 to 5.5	3.5 x 3.5 x 1.0
Dual-Integer PLLs						
LMX2434 E, W	1.0 to 5.0	500 to 2500	-219	7.0	2.35 to 2.75	3.5 x 3.5 x 0.6
LMX2433 E, W	0.5 to 3.6	250 to 1700	-219	5.2	2.25 to 2.75	3.5 x 3.5 x 0.6
LMX2330L W	0.5 to 2.5	45 to 510	-211	5	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2336L W	0.2 to 2.0	50 to 1100	-211	5.5	2.7 to 5.5	4.5 x 3.5 x 1.0
LMX2331L E, W	0.2 to 2.0	45 to 510	-211	4	2.7 or 5.5	3.5 x 3.5 x 0.8
LMX2332L E, W	0.1 to 1.2	45 to 510	-211	3	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX1601 E, W	0.1 to 1.1	40 to 500	-197	4	2.7 to 3.6	3.5 x 3.5 x 1.0
LMX1602 E, W	0.1 to 1.1	100 to 1100	-197	5	2.7 to 3.6	3.5 x 3.5 x 1.0
LMX2335L W	0.1 to 1.1	50 to 1100	-211	4	2.7 to 5.5	3.5 x 3.5 x 1.0
Fractional-N PLLs						
LMX2487 E, W	3.0 to 6.0	250 to 3000	-209	8.2	2.5 to 3.6	4.0 x 4.0 x 0.75
LMX2487E W	3.0 to 7.5	250 to 3000	-209	8.2	2.5 to 3.6	4.0 x 4.0 x 0.75
LMX2486 E, W	1.0 to 4.5	250 to 3000	-210	8.3	2.5 to 3.6	4.0 x 4.0 x 0.75
LMX2485 E, W	0.5 to 3.0	75 to 800	-209	5	2.5 to 3.6	4.0 x 4.0 x 0.75
LMX2485E E, W	0.05 to 3.0	75 to 800	-209	5	2.5 to 3.6	4.0 x 4.0 x 0.75
LMX2364 E, W	0.5 to 2.6	50 to 850	-210	7	2.7 to 5.5	4.5 x 3.5 x 0.6
LMX2470 E, W	0.5 to 2.6	75 to 800	-210	4.1	2.25 to 2.75	4.5 x 3.5 x 0.6
LMX2353 W	0.5 to 2.5	—	-201	5.5	2.7 to 5.5	3.5 x 3.5 x 1.0
LMX2350 W	0.5 to 2.5	10 to 550	-201	6.5	2.7 to 5.5	4.5 x 3.5 x 1.0
LMX2354 E, W	0.5 to 2.5	10 to 550	-204	6	2.7 to 5.5	4.5 x 3.5 x 1.0
LMX2352 W	0.25 to 1.2	10 to 550	-201	4.75	2.7 to 5.5	4.5 x 3.5 x 1.0

E Evaluation board W WEBENCH enabled

Interface Products Overview



LVDS and CML Interface Solutions

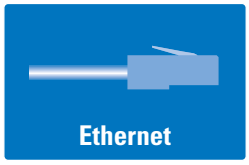
- Signal conditioners
- Crosspoint switches, multiplexers, and clock distribution
- Drivers, receivers, transceivers, buffers, level translators
- LVDS Owner's Manual and other design tools

SerDes

- FPGA-Link SerDes up to 3.125 Gbps
- Broad range of easy-to-use SerDes drive long distances
- 8, 10, 16, 18, 21, 24, 28, 48-bit interfaces

SDI/Broadcast Video

- Triple-rate cable drivers, equalizers, reclockers
- FPGA-friendly serializers/deserializers with reference designs
- Sync separators, video reclockers, clock jitter cleaners and distribution
- Crosspoints, muxes, and 1:n repeaters



Ethernet

- 10/100 PHY with IEEE1588 PTP support for sub-10 ns timing
- PHYTER 10/100 singles, dual, and minis (industrial and extreme temp)
- PHY and MAC+PHY, Gigabit Ethernet, reference designs, and more

Display Products

- Embedded clock, low-EMI display links
- FPD-Link, timing controllers, row/column drivers, and CRT solutions
- MPL for mobile applications

LVDS and CML PHYs

Signal Conditioning—Extend Your Reach

National offers an array of signal conditioning solutions, covering data rates from DC to 10 Gbps and topologies ranging from point-to-point to 32 multidrop loads.

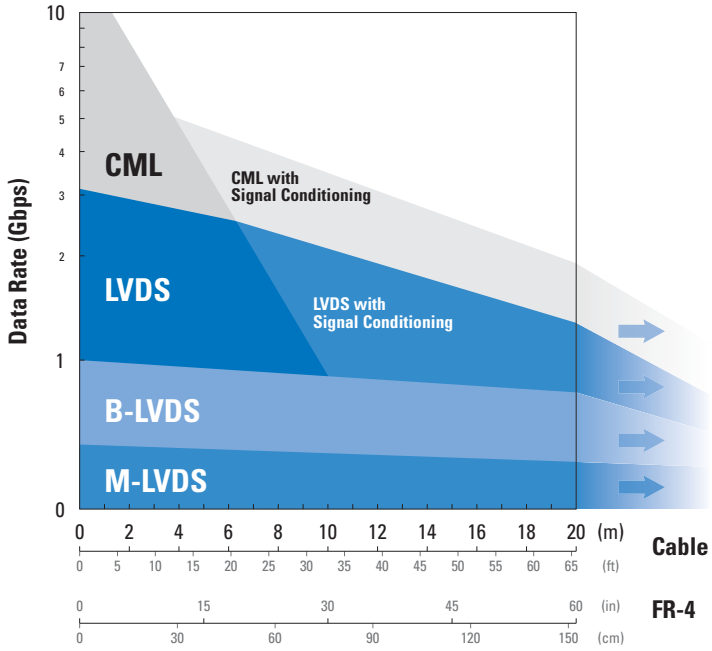
LVDS is the most widespread high-speed signaling technology and generally requires the least amount of power while supporting data rates from DC to 3.125 Gbps.

CML supports data rates as high as 10 Gbps while generally maintaining the lowest jitter.

Signal conditioning using equalization and pre-emphasis (for CML, de-emphasis) enables both technologies to significantly extend cable and backplane reach by compensating for media loss.

B-LVDS and M-LVDS are lower-speed technologies that use controlled edge rates to improve signal integrity when driving multiple loads in multi-drop or multi-point configurations.

National's Signal Conditioners



Transceivers

Product ID	Drivers	Receivers	LVDS Type	Max Data Rate (Mbps)	Supply Voltage (V)	Temp Range (°C)	Packaging
DS91C176TMA [E]	1	1	M-LVDS	200	3.3	-40 to +85	SOIC-8
DS91D176TMA [E]	1	1	M-LVDS	200	3.3	-40 to +85	SOIC-8
DS91C180TMA	1	1	M-LVDS	200	3.3	-40 to +85	SOIC-14
DS91D180TMA	1	1	M-LVDS	200	3.3	-40 to +85	SOIC-14
DS91M040TSQ [E]	4	4	M-LVDS	250	3.3	-40 to +85	LLP-32
DS91M124TMA [E]	4	1	M-LVDS	250	3.3	-40 to +85	SOIC-16
DS91M125TSQ [E]	4	1	M-LVDS	250	3.3	-40 to +85	SOIC-16
DS91M047TSQ [E]	4	4	M-LVDS	250	3.3	-40 to +85	SOIC-16
DS92001TMA	1	1	B-LVDS	400	3.3	-40 to +85	SOIC/LLP-8
DS92LV010ATM	1	1	B-LVDS	155	3.3	-40 to +85	SOIC-8
DS92LV040TLQA	4	4	B-LVDS	200	3.3	-40 to +85	LLP-44
DS92LV090ATVEH	9	9	B-LVDS	200	3.3	-40 to +85	PQFP-64
DS92CK16TMTC	6	1	B-LVDS	250	3.3	-40 to +85	TSSOP-24

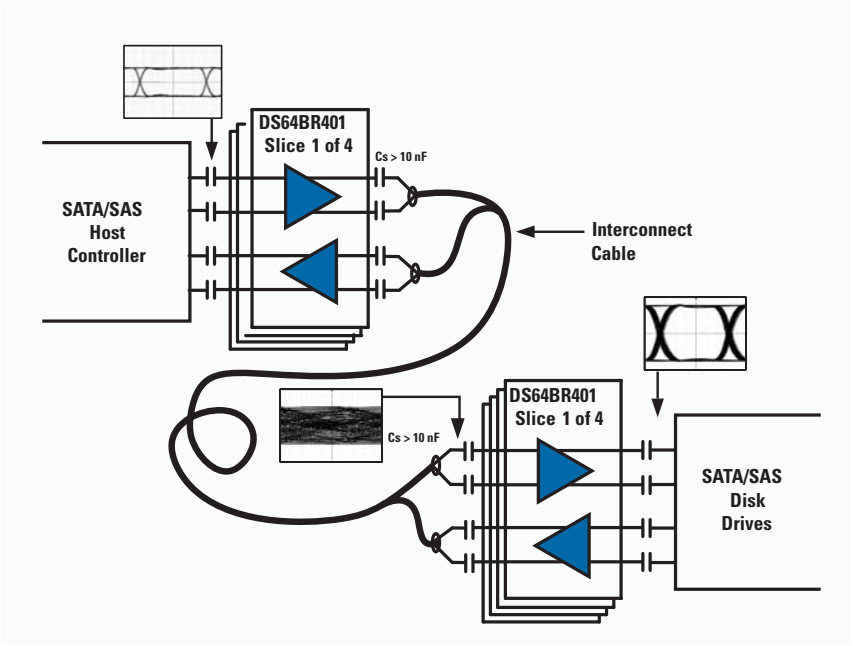
[E] Evaluation board

Signal Conditioning

DS64BR401 – Quad Bi-Directional Transceivers with Equalizations and De-Emphasis Extend Reach

Features

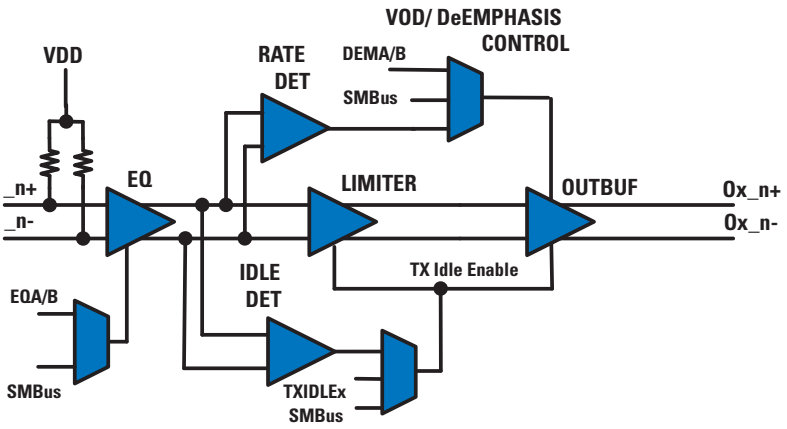
- 1.5 Gbps up to 6.4 Gbps
- Supports SAS, SATA, XAVI, RXAVI, and FC data rates
- <0.25 UI Jitter with 40" 4-mil FR4 or 12-meter 30 AWG cable
- Supports Quad Bi-directional
- Low-power 2.5V design
- VOD, EQ, DE control pins or optional SMBus interface
- Sleep mode (<0.1 mW)
- Available in space-saving LLP-0 (5.5 x 10 x 0.8 mm)



PCIe Applications – DS50PCI400 Quad Bi-Directional Transceiver

Features

- 2.5 Gbps or 5.0 Gbps
- Extends reach for cables or backplanes
- <0.18 UI Jitter with 40" FR4 at 5.0 Gbps
- <0.16 UI Jitter with 40" FR4 at 2.5 Gbps
- Optional SMBus control
- Flow-through pinout
- Available in space-saving LLP-0 packaging (5.5 x 10 x 0.8 mm)



Differential-to-Differential

				Switching/Redundancy			Signal Conditioning				
Product ID	Function	In-puts	Out-puts	Muxing Options	Input Compatibility	Output	Pre-em-phasis (dB)[1]	Receive Equal-ization (dB)	Max Speed/ Ch (Mbps)	Packaging	Comments
Buffers											
DS15BA101SD [E]	Adjustable output buffer	1	1	—	CML	LVPECL	—	—	1500	LLP-8	Adjustable output swing
DS10BR150TSD [E]	Single LVDS buffer	1	1	—	LVDS/LVPECL/CML	LVDS	—	—	1000	LLP-8	Int termination, 8 kV ESD
DS25BR100TSD [E]	Single LVDS buffer	1	1	—	LVDS/LVPECL/CML	LVDS	0/6	3/6	3125	LLP-8	Int termination, 8 kV ESD
DS25BR110TSD	Single LVDS buffer	1	1	—	LVDS/LVPECL/CML	LVDS	—	0/3/6/9	3125	LLP-8	Int termination, 8 kV ESD
DS25BR120TSD	Single LVDS buffer	1	1	—	LVDS/LVPECL/CML	LVDS	0/3/6/9	—	3125	LLP-8	Int termination, 8 kV ESD
DS25BR150TSD [E]	Single LVDS buffer	1	1	—	LVDS/LVPECL/CML	LVDS	—	—	3125	LLP-8	Int termination, 8 kV ESD
DS90LV804TSQ	Quad LVDS buffer	4	4	—	LVDS/LVPECL/CML	LVDS	—	—	800	LLP-32	15 kV ESD
DS90LV004TVS	Quad LVDS buffer	4	4	—	LVDS/LVPECL/CML	LVDS	0/6	—	1500	TQFP-48	15 kV ESD
SCAN90004TVS [E]	Quad LVDS buffer	4	4	—	LVDS/LVPECL/CML	LVDS	0/6	—	1500	LLP-32	15 kV ESD, JTAG
DS15BR400TSQ/TVS [E]	Quad LVDS buffer	4	4	—	LVDS/LVPECL/CML	LVDS	0/6	—	2000	LLP-32, TQFP-48	Int termination, 15 kV ESD
DS15BR401TSQ/TVS	Quad LVDS buffer	4	4	—	LVDS/LVPECL/CML	LVDS	0/6	—	2000	LLP-32, TQFP-48	15 kV ESD
DS25BR440SQ	Quad LVDS buffer	4	4	—	LVDS/LVPECL/CML	LVDS	0/3/6/9	0/3/6/9	3125	LLP-40	8 kV ESD
DS25BR400TSQ [E]	Quad CML transceiver	8	8	Loopback	CML	CML	0/-3/-6/-9	0/5	2500	LLP-60	Int termination, 6 kV ESD
DS42BR400TSQ [E]	Quad CML transceiver	8	8	Loopback	CML	CML	0/-3/-6/-9	0/5	4250	LLP-60	Int termination, 6 kV ESD
NEW! DS64BR401	Bi-directional transceiver	8	8	—	CML	CML	—	—	6400	LLP-54	Buffer
Equalizers											
DS15EA101SQ [E]	Adaptive cable equalizer	1	1	—	LVPECL	CML	—	Adaptive	1500	LLP-16	Use with DS15BA101
DS16EV5110SQ [E]	Settable HDMI/DVI EQ	1	1	—	LVDS/LVPECL/CML	CML	—	30	1650	LLP-48	Settable EQ in 8 steps
DS25BR110TSD	Single LVDS equalizer	1	1	—	LVDS/LVPECL/CML	LVDS	—	0/3/6/9	3125	LLP-8	Int termination, 8 kV ESD
DS38EP100SD [E]	Power-saver equalizer	1	1	—	LVDS/LVPECL/CML	—	—	7	5000	LLP-6	No PWR or GND required
DS80EP100SD [E]	Power-saver equalizer	1	1	—	LVDS/LVPECL/CML	—	—	7	12500	LLP-6	No PWR or GND required
DS32EV400SQ [E]	Quad settable equalizer	4	4	—	CML	CML	—	Up to 14	3125	LLP-48	8 EQ settings
DS32EV100SD [E]	Single settable equalizer	1	1	—	CML	CML	—	Up to 14	4250	LLP-14	8 EQ settings
DS64EV400SQ [E]	Quad settable equalizer	4	4	—	CML	CML	—	Up to 20	10000	LLP-48	8 EQ settings
DS64EV100SD [E]	Single settable equalizer	1	1	—	CML	CML	—	Up to 20	10000	LLP-14	8 EQ settings
DS50EV401 [E]	Quad PCIe equalizer	4	4	—	CML	CML	—	20	8000	LLP-48	2 EQ settings
NEW! DS50PCI400	Bi-directional PCIe transceiver	8	8	—	CML	CML	—	—	5000	LLP-54	Data rate optimized EQ
DS38EP100DSD	Bi-directional passive EQ	1	1	—	LVDS/LVPECL/CML	LVDS/LVPECL/CML	—	7	5000	LLP-6	Fixed EQ
DS80EP100 [E]	Bi-directional passive EQ	1	1	—	LVDS/LVPECL/CML	LVDS/LVPECL/CML	—	7	12500	LLP-6	Fixed EQ

[1]CML devices in this column that feature de-emphasis show negative dB

PowerWise® product [E] Evaluation board

Differential-to-Differential

				Switching/Redundancy			Signal Conditioning				
Product ID	Function	In-puts	Out-puts	Muxing Options	Input Compatibility	Output	Pre-emphasis (dB)[1]	Receive Equal-ization (dB)	Max Speed/ Ch (Mbps)	Packaging	Comments
Multiplexers and Mux/Buffers											
DS25MB100TSQ [E]	2:1/1:2 mux/buffer	3	3	2:1/1:2, LB	CML	CML	0/-3/-6/-9	0/5	2500	LLP-36	Int termination, 6 kV ESD
DS42MB100TSQ	2:1/1:2 mux/buffer	3	3	2:1/1:2, LB	CML	CML	0/-3/-6/-9	0/5	4250	LLP-36	Int termination, 6 kV ESD
DS08MB200TSQ	Dual 2:1/1:2 mux/buffer	6	6	2:1/1:2	LVDS/LVPECL/CML	LVDS	—	—	800	LLP-48	15 kV ESD
DS15MB200TSQ	Dual 2:1/1:2 mux/buffer	6	6	2:1/1:2	LVDS/LVPECL/CML	LVDS	0/6	—	2000	LLP-48	15 kV ESD
SCAN15MB200TSQ [E]	Dual 2:1/1:2 mux/buffer	6	6	2:1/1:2	LVDS/LVPECL/CML	LVDS	0/6	—	2000	LLP-48	JTAG
DS25MB200TSQ [E]	Dual 2:1/1:2 mux/buffer	6	6	2:1/1:2, LB	CML	CML	0/-3/-6/-9	0/5	2500	LLP-48	Int termination, 6 kV ESD
DS40MB200SQ [E]	Dual 2:1/1:2 mux/buffer	6	6	2:1/1:2, LB	CML	CML	0/-3/-6/-9	0/5	4000	LLP-48	Int termination, 6 kV ESD
DS42MB200TSQ	Dual 2:1/1:2 mux/buffer	6	6	2:1/1:2, LB	CML	CML	0/-3/-6/-9	0/5	4250	LLP-48	Int termination, 6 kV ESD
Crosspoint Switches											
DS90CP22M-8/MT [E]	2 x 2 crosspoint	2	2	2 x 2	LVDS/LVPECL/CML	LVDS	—	—	800	TSSOP-16, SOIC-16	
SCAN90CP02SP/VY	2 x 2 crosspoint	2	2	2 x 2	LVDS/LVPECL/CML	LVDS	0/2/3.5/5	—	1500	LLP-28, LQFP-32	JTAG, 1149.6
DS10CP152TMA [E]	2 x 2 crosspoint	2	2	2 x 2	LVDS/LVPECL/CML	LVDS	—	—	1500	SOIC-16	9 ps jitter typical
DS25CP102SQ [E]	2 x 2 crosspoint	2	2	2 x 2	LVDS/LVPECL/CML	LVDS	0/3/6/9	0/3/6/9	3125	LLP-16	10 ps jitter typical
DS25CP152SQ [E]	2 x 2 crosspoint	2	2	2 x 2	LVDS/LVPECL/CML	LVDS	—	—	3125	LLP-16	10 ps jitter typical
DS10CP154ASQ [E]	4 X 4 crosspoint	4	4	4 x 4	LVDS/LVPECL/CML	LVDS	0/3/6/9	0/3/6/9	1500	LLP-40	Low power - 22 mA channel
DS25CP104ASQ [E]	4 X 4 crosspoint	4	4	4 x 4	LVDS/LVPECL/CML	LVDS	0/3/6/9	0/3/6/9	3125	LLP-40	10 ps jitter typical
1:n Repeaters											
DS90LV110ATMT	1:10 LVDS repeater	1	10	1:10	LVDS/LVPECL/CML	LVDS	—	—	400	TSSOP-28	Input failsafe
DS10BR254SQ	1:4 LVDS repeater	2	4	1:4	LVDS/LVPECL/CML	LVDS	—	—	1500	LLP-40	Select 1 of 2 inputs
DS25BR204SQ [E]	1:4 LVDS repeater	2	4	1:4	LVDS/LVPECL/CML	LVDS	0/6	0/6	3125	LLP-40	Select 1 of 2 inputs

[1]CML devices in this column that feature de-emphasis show negative dB

PowerWise product [E] Evaluation board

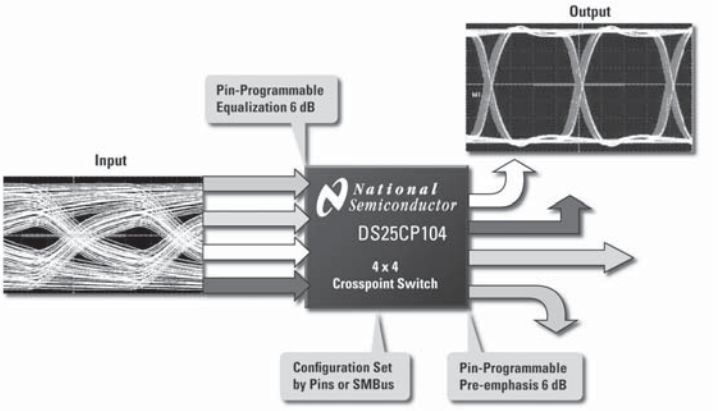
DS25CP104A – PowerWise® LVDS 4 x 4 Crosspoint Switch

Features

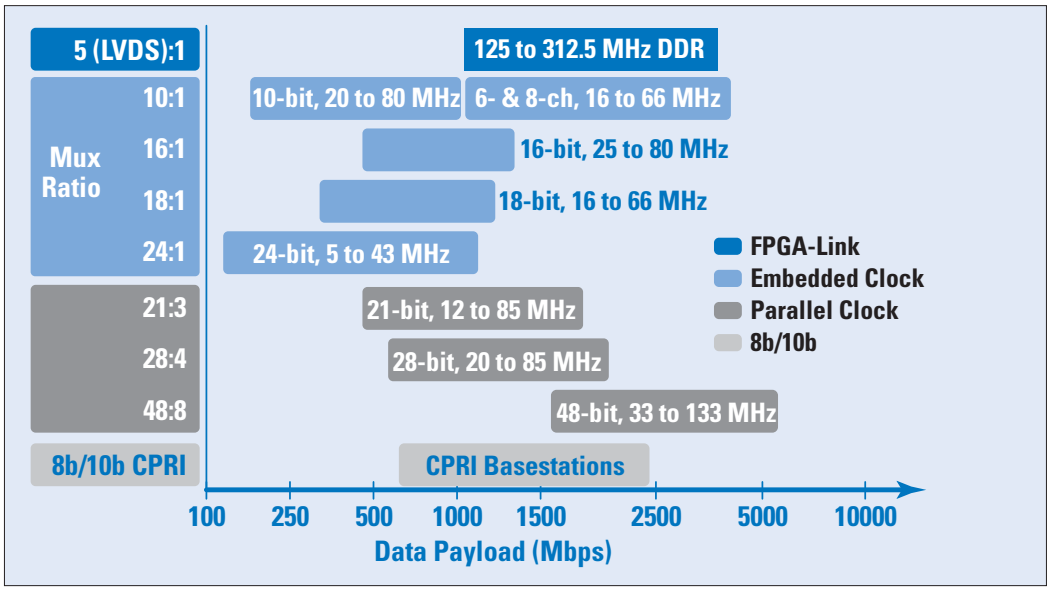
- DC to 3.125 Gbps
- 10 ps typical jitter
- Programmable equalization and pre-emphasis
- Configurable using pins or SMBus

Applications

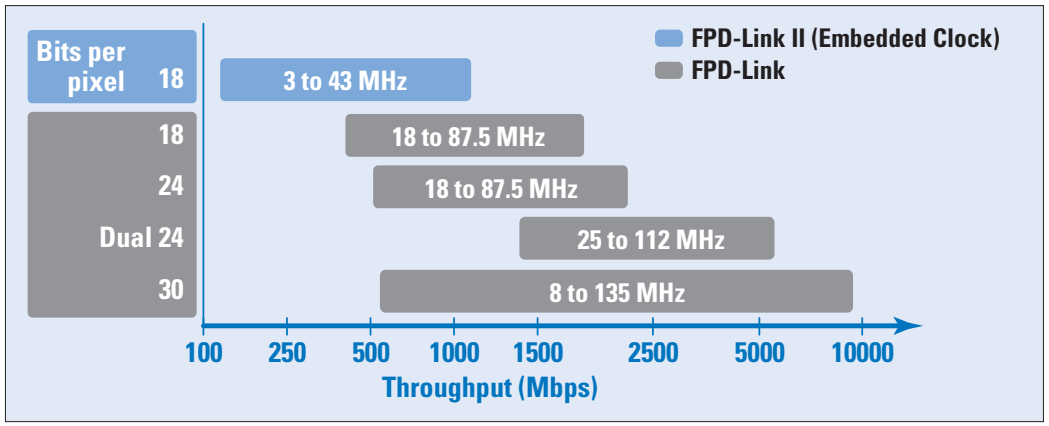
Ideal for use in routing and switching of video, data, or clock signals, and redundancy



Data Interface



Display and Imaging Interface



SerDes – Data Interface

Select SerDes Products

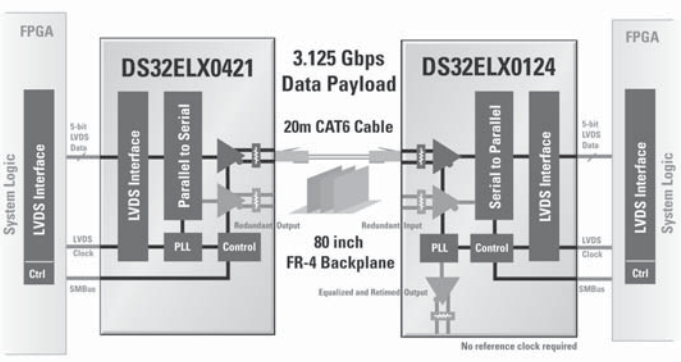
Product ID	MUX Ratio	Function	Ser	Des	Clock Min (MHz)	Clock Max (MHz)	Payload Channel/ Device (Mbps)	Temp Range (°C)	Packaging	Eval Kit
Embedded Clock : FPGA-Link										
DS32ELX0421SQ [E]	5:1 DDR LVDS	Serializer	1		125	312.5	3.125 Gbps	-40 to +85	LLP-48	AES-EXP-HPSER-G (Avnet)
DS32ELX0124SQ [E]		Reclocking Deserializer		1	125	312.5	3.125 Gbps	-40 to +85	LLP-48	AES-EXP-HPSER-G (Avnet)
DS32EL0421SQ [E]	5:1 DDR LVDS	Serializer	1		125	312.5	3.125 Gbps	-40 to +85	LLP-48	AES-EXP-HPSER-G (Avnet)
DS32EL0124SQ [E]		Deserializer		1	125	312.5	3.125 Gbps	-40 to +85	LLP-48	AES-EXP-HPSER-G (Avnet)
Embedded Clock : 8b/10b										
SCAN25100TYA [E]	10:1	SerDes	1	1	30.72	22.16	2456	-40 to +85	TQFP-100	SCAN25100EVK
SCAN12100TYA [E]	10:1	SerDes	1	1	30.72	61.44	1228.8	-40 to +85	TQFP-100	SCAN25100EVK
Embedded Clock : Start/Stop Bit										
DS92LV1023EMQ [E]	10:1	Serializer	1		30	66	660	-40 to +85	SSOP-EIAJ 28L	BLVDS03
DS92LV1224TMSA [E]	1:10	Deserializer		1	30	66	660	-40 to +85	SSOP-EIAJ 28L	BLVDS03
SCAN921025HSM [E]	10:1	Serializer	1		20	80	800	-40 to +125	BGA-49	BLVDS03
SCAN921226HSM [E]	1:10	Deserializer		1	20	80	800	-40 to +125	BGA-49	BLVDS03
DS92LV16TVHG [E]	16:1	SerDes	1	1	25	80	1280	-40 to +85	PQFP-80	BLVDS16EVK
DS92LV18TVV [E]	18:1	SerDes	1	1	15	66	1188	-40 to +85	PQFP-80	LVDS-18B-EVK
Parallel Clock : Channel Link										
DS90CR217MTD [E]	21:3	Serializer	1		20	85	595/1785	-10 to +70	TSSOP-48	CLINK3V28BT-85
DS90CR218AMTD [E]	3:21	Deserializer		1	12	85	595/1785	-10 to +70	TSSOP-48	CLINK3V28BT-85
DS90CR287MTD [E]	28:4	Serializer	1		20	85	595/2380	-10 to +70	TSSOP-56	CLINK3V28BT-85
DS90CR288AMTD [E]	4:28	Deserializer		1	20	85	595/2380	-10 to +70	TSSOP-56	CLINK3V28BT-85
DS90CR483AVJD [E]	48:8	Serializer	1		33	112	672/5376	-10 to +70	TQFP-100	CLINK48BT-112
DS90CR484AVJD [E]	8:48	Deserializer		1	33	112	672/5376	-10 to +70	TQFP-100	CLINK48BT-112

[E] Evaluation board

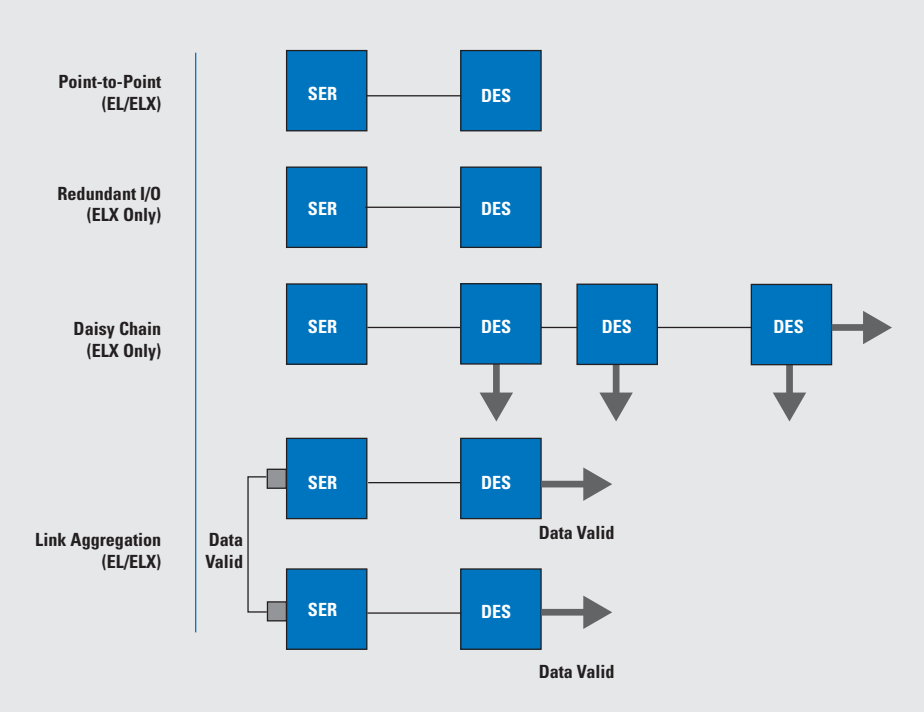
DS32EL(X)0421/DS32EL(X)0124 – 3.125 Gbps FPGA-Link Serializers and Deserializers

Features

- Wide serial data rate – 1.25 Gbps to 3.125 Gbps
- Tx de-emphasis, RX equalizer, DC balancing, scrambler
- Supports – CAT5e/6/7, FR-4, coax (50Ω, 75Ω)
- FPGA-friendly interface – 5-bit DDR LVDS data
- "Remote sense" back-channel enables self-healing link
- 35 ps_{pp} (typ) Tx jitter, 0.9 UI (typ) Rx jitter tolerance
- Low power – auto standby and configurable sleep modes
- ELX version features – retimed output and redundant I/O
- Sample FPGA IP for Ser/Des interfacing included



3.125 Gbps Serializers and Deserializers Enable Multiple Application Scenarios



Features

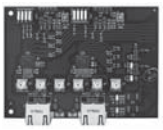
- 1.25 to 3.125 Gbps serial data rate
- 125 to 312.5 MHz DDR parallel clock
- Typical power consumption (at 3.125 Gbps)
- DS32EL0421: 470 mW (typ)
- DS32EL0124: 525 mW (typ)
- Deserializer jitter tolerance 0.9 UI (typ)
- Serializer output jitter 35 ps_{pp} (typ)
- FPGA-friendly LVDS parallel interface

Applications

Ideal for use in industrial imaging, medical imaging, communications infrastructure, commercial displays, test and measurement, printers, and security infrastructure

FPGA IP package includes:

- Sample FPGA firmware to kick-start a design
- BERT engine for test pattern generation and validation
- 5-bit LVDS serialization/deserialization
- Link aggregation
- Failover/redundancy



AES-EXP-HPSER-G

To order the evaluation package, visit:
http://www.em.avnet.com/exp-nsc-serdes

SerDes – Display and Imaging Interface

Product ID	LCD Display Color Depth	Function	Ser	Des	Pixel Clock Min (MHz)	Pixel Clock Max (MHz)	Min Throughput/ Device (Mbps)	Max Throughput Channel/ Device (Mbps)	Temp Range (°C)	Packaging	EVK Status
Embedded Clock : FPD-Link II											
DS90UR241QVS [E]	18-Bit	Serializer	1		5	43	120	1032	-40 to +105	TQFP-48	SERDESUR-43USB
DS90UR124QVS [E]		Deserializer		1	5	43	120	1032	-40 to +105	TQFP-64	
DS90C241QVS [E]		Serializer	1		5	35	120	840	-40 to +105	TQFP-48	SERDES24-35USB
DS90C124QVS [E]		Deserializer		1	5	35	120	840	-40 to +105	TQFP-48	
DS99R421QSQ [E]		Serializer	1		5	43	120	1032	-40 to +105	LLP-36	FPDXSDUR-43USB
DS99R103TSQ [E]		Serializer	1		3	40	72	960	- 40 to +85	LLP-48, TQFP-48	SERDES03-40USB
DS99R104TSQ [E]		Deserializer		1	3	40	72	960	- 40 to +85	LLP-48, TQFP-48	
DS99R105SQ [E]		Serializer	1		3	40	72	960	0 to +70	LLP-48, TQFP-48	SERDES05-40USB
DS99R106SQ [E]		Deserializer		1	3	40	72	960	0 to +70	LLP-48, TQFP-48	
Parallel Clock : FPD-LINK/ Open LDI											
DS90C365AMT [E]	18-Bit	Serializer	1		18	87.5	378	612.5/1785	- 10 to +70	TSSOP-48	FLINK3V8BT-85
DS90CF366MTD [E]		Deserializer		1	20	85	420	595/1785	- 10 to +70	TSSOP-48	FLINK3V8BT-85
DS90C385AMT [E]	24-Bit	Serializer	1		18	87.5	504	612.5/2380	- 10 to +70	TSSOP-56	FLINK3V8BT-85
DS90CF386MTD [E]		Deserializer		1	20	85	560	595/2380	- 10 to +70	TSSOP-56, FBGA-64	FLINK3V8BT-85
DS90C387AVJD [E]	24-Bit Open LDI	Serializer	1		32.5	112	227.5/1820	784/6722	- 10 to +70	TQFP-100	LDI3V8BT-112
DS90CF388AVJD [E]		Deserializer		1	32.5	112	227.5/1820	784/6722	- 10 to +70	TQFP-100	LDI3V8BT-112
DS90C3201VS [E]	30-Bit	Serializer		1	8	135	56/560	945/9450	0 to +70	TQFP-128	FLINK3V10BT-TX
DS90C3202VS [E]		Deserializer		1	8	135	56/560	945/9450	0 to +70	TQFP-128	FLINK3V10BT-RX

[E] Evaluation board

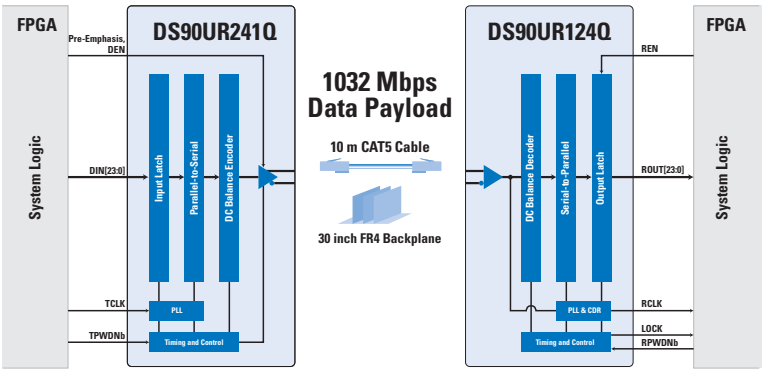
DS90UR241/124 – 5 to 43 MHz 24-bit Serializer/Deserializer with DC-Balance and Pre-Emphasis

Features

- Serializes 24 bits at 5 to 43 MHz (125 to 1032 Mbps)
- Receiver automatically locks to any data pattern without external clock
- DC-balance encoding for AC-coupled and optical interconnects
- Drives 10m twisted pair cable
- At-speed BIST pattern generation/verification
- 10 kV ESD (ISO-10605) and hot plug protection
- Extreme -40˚C to +105˚C temperature range
- Meets National automotive-grade compliance (includes AEC-Q100)

Applications

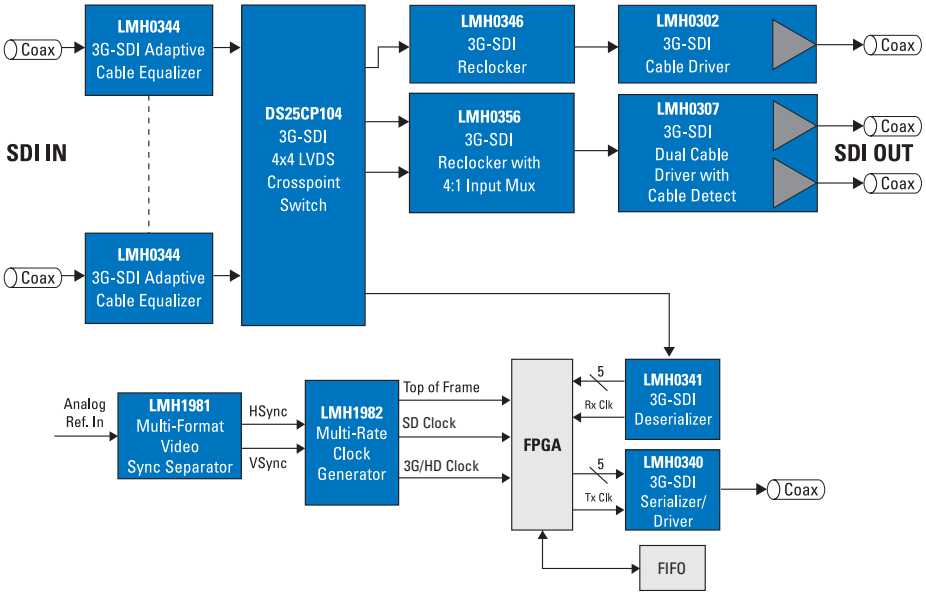
Ideal for use in remote displays, remote cameras, signal acquisition, automotive, and bus extension



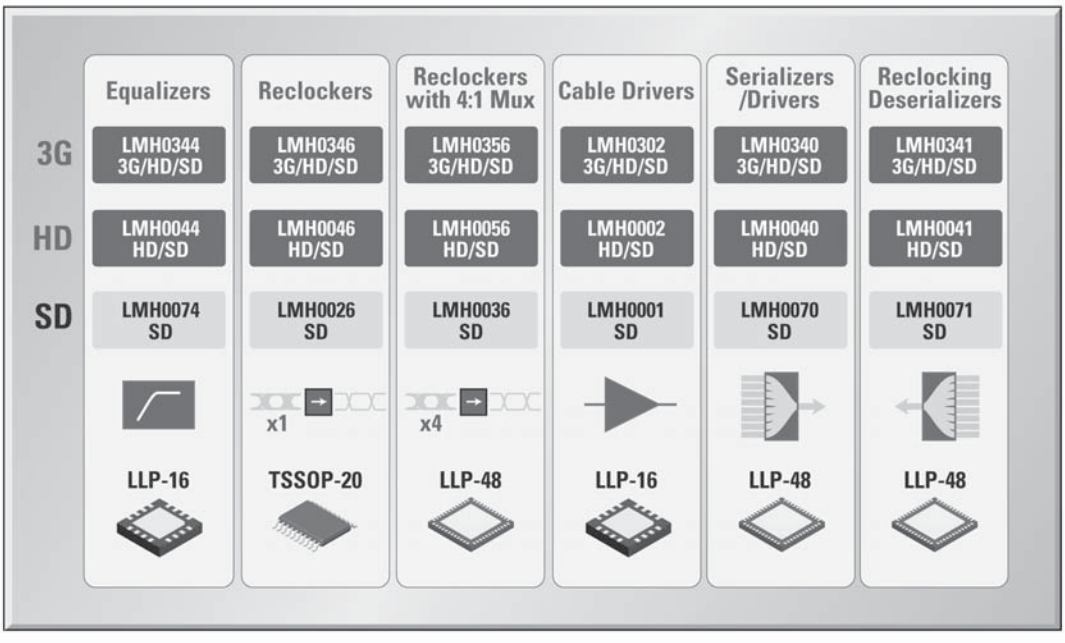
3G/HD/SD SDI Equalizer, Deserializer, Serializer, Reclocker, and Cable Driver

National is the first semiconductor supplier to offer a complete end-to-end solution for the rapidly emerging 3 Gbps SDI market. Each of National's 3G-SDI products has a footprint-compatible counterpart for HD/SD and SD-only applications to maximize designer flexibility in building a system. From HD/SD operation today with an upgrade path to 3 Gbps SDI tomorrow, National's technology offers solutions for any and all SDI needs.

3G/HD/SD SDI Switcher Simplified Block Diagram



Complete Footprint-Compatible SDI Solutions



Triple-Rate SDI Development Platform for Xilinx FPGAs

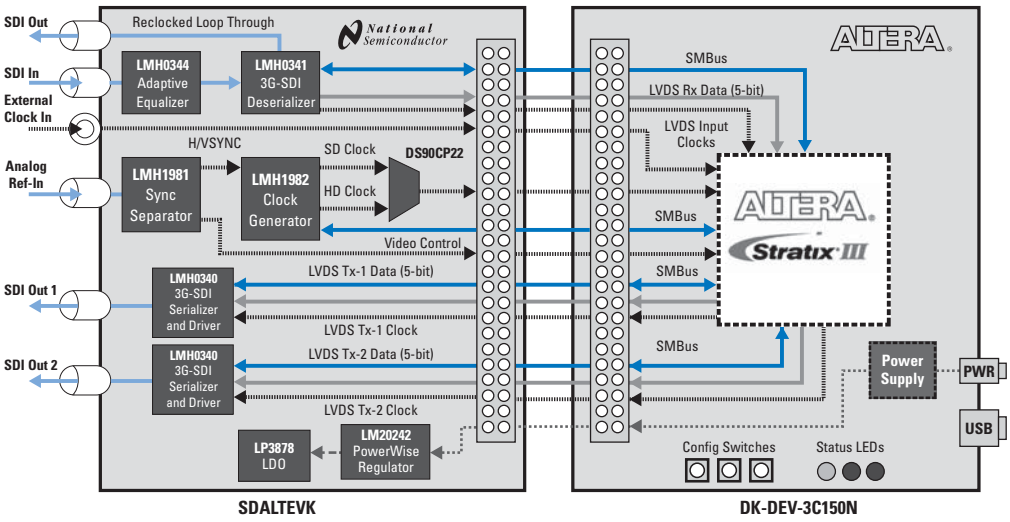
In collaboration with Altera, National Semiconductor has developed a triple-rate SDI and video clocking daughter card for Altera FPGA development kits. National's daughter card is compatible with both the Cyclone-III and the Stratix-III development kits. It plugs directly into the host FPGA development board via Altera's high-speed mezzanine connector (HSMC).

National provides FPGA source code for SMPTE protocol processing (included with the purchase of an evaluation kit or ICs). The FPGA IP along with the daughter card and the FPGA development kit provide broadcast video system designers a comprehensive platform for rapid evaluation and prototyping of new designs, thereby reducing time to market.

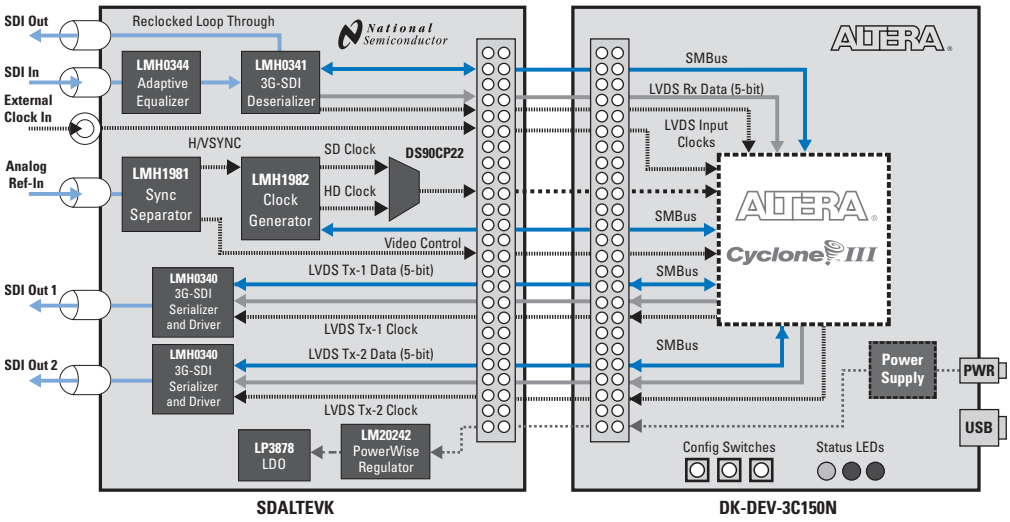
Features

- 3G, HD, and SD compatible
- Comprehensive reference for hardware design and FGPA IP development
- Included HDL (Verilog, VHDL source) supports SDI framing, audio embedding/de-embedding and test pattern generation
  - IP available for both Cyclone-III and Stratix-III FPGAs
- Support for Genlock

SDALTEVK: 3G-SDI Development Platform with Altera Stratix-III FPGA



SDALTEVK: 3G-SDI Development Platform with Altera Cyclone-III FPGA



- Video
- Clocks*
- Parallel
- Data Control
- Power

*Four clocking options available
1. Recovered clock
2. Genlock (analog ref in with LMH1981 + LMH1982)
3. Local generation (free run with LMH1982)
4. External clock

www.national.com/analog/interface/sdaltevk

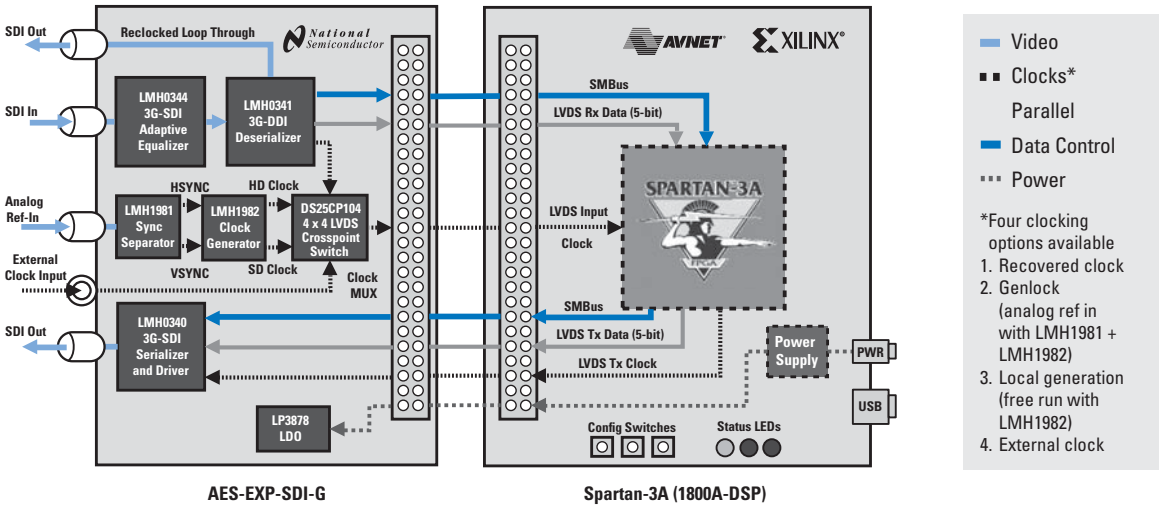
Triple-Rate SDI Development Platform for Xilinx FPGAs

In collaboration with Avnet and Xilinx, National Semiconductor developed a triple-rate SDI and video clocking daughter card for the Xilinx Spartan-3A/3E development kits. The daughter card plugs directly into the Spartan development board through an EXP connector. The combined solution of the daughter card and the development kit provides broadcast video system designers with a comprehensive platform for rapid evaluation and prototyping of new designs, thereby reducing time to market.

Features

- 3G, HD, and SD compatible
- Comprehensive reference for hardware design and FGPA IP development
  - HDL (Verilog, VHDL) available from AVNET
  - Supports SDI framing, audio embedding/ de-embedding and test pattern generation
- Support for Genlock

AES-EXP-SDI-G: 3G-SDI Development Platform with Xilinx Spartan-3A FPGA



www.national.com/analog/interface/sdxilevk

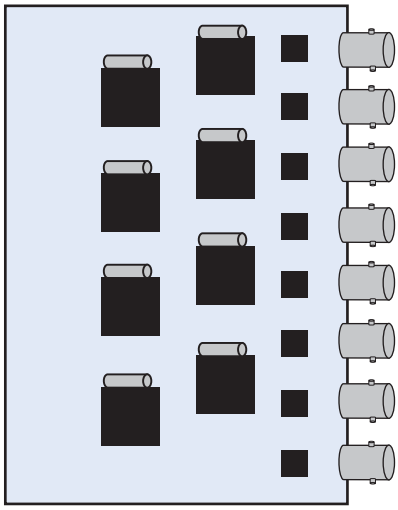
Broadcast Video Industry's Smallest Packages

Features

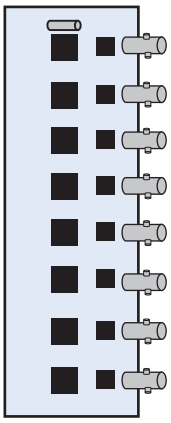
- Enables high-port-density applications
- 3G-SDI cable equalizer: LMH0344GR
  - µArray-25 package (3 mm x 3 mm)
  - 44% board area savings compared to QFN-16 package
- 3G-SDI cable driver: LMH0307GR
  - µArray-25 package (3 mm x 3 mm)
  - 44% board area savings compared to QFN-16 package
- 3G-SDI reclocker with 4:1 input mux: LMH0356SQ-40
  - LLP-40 package (5 mm x 5 mm)
  - 70% board area savings compared to QFN-64 package
- 3G-SDI reclocker: LMH0346SQ
  - LLP-24 package (5 mm x 4 mm)
  - 75% board area savings compared to QFN-64 package

Cleaner Layout, Reduced Board Area, and Simplified BOM

8-Channel Output Card Using Competition's QFN-64 Reclocker and QFN-16 Driver



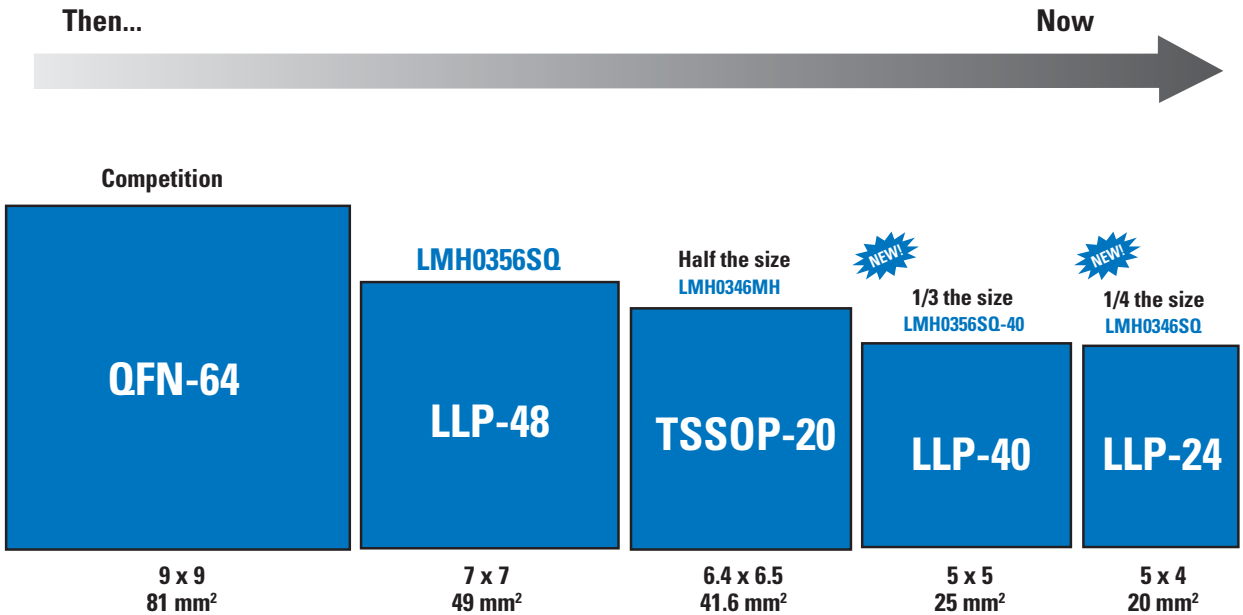
8-Channel Output Card Using National's LLP-40 Reclocker and µ Array Driver



Advantages:

- Balanced channels
- Improved return loss
- Less board area
- Cleaner layout
- Single shared XTAL
- Lower jitter
- Improved BER
- Higher density

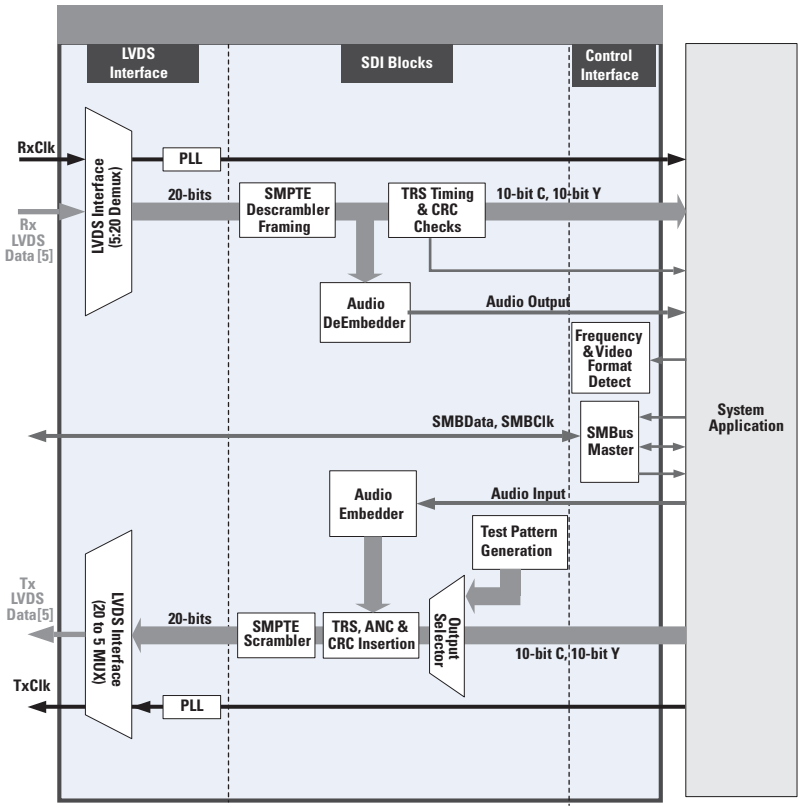
Evolution of Reclockers: Size Comparison



Flexible IP and High-Performance SerDes

Triple-Rate FPGA IP
National's SerDes solution includes a comprehensive IP package to support common SDI applications and popular FPGA models.

IP Package includes:
- Triple-rate SDI support with automatic rate detect
- SMPTE scrambling, descrambling, and framing
- Support for embedded audio
- Test pattern generation for development and validation
- 20:5 output muxing and 5:20 input demuxing to support the 5-bit LVDS interface bus
- SMBus management interface
- Support for both level-A and level-B 3G-SDI formats
- Source code in synthesizable HDL (Verilog, VHDL format)



SDI Serializers and Deserializers

Product ID	Description	Supply Voltage (V)	Typ. Power (mW)	Data Rate (Mbps)	Temp Range[1]	Eval Board Product ID	Packaging
Serializers							
NEW! **LMH0340SQ** [E]	3G/HD/SD serializer with LVDS interface and integrated cable driver	3.3, 2.5	440	270 to 2970	Ind	SDALTEVK (Altera) SDXILEVK (Xilinx)	LLP-48
NEW! **LMH0040SQ**	HD/SD serializer with LVDS interface and integrated cable driver	3.3, 2.5	440	270 to 1485	Ind		LLP-48
NEW! **LMH0050SQ**	HD/SD serializer with LVDS interface	3.3, 2.5	460	270 to 1485	Ind		LLP-48
NEW! **LMH0070SQ**	SD serializer with LVDS interface and integrated cable driver	3.3, 2.5	400	270	Ind		LLP-48
LMH0030VS [E]	HD/SD serializer with FIFOs, integrated cable driver, 85 ps typical output jitter, no external VCOs required, BIST, and TPG	3.3, 2.5	430	270 to 1485	Com	SD130EVK	TQFP-64
Deserializers							
NEW! **LMH0341SQ** [E]	3G/HD/SD reclocking deserializer with LVDS interface and active loopthrough	3.3, 2.5	590	270 to 2970	Ind	SDALTEVK (Altera) SDXILEVK (Xilinx)	LLP-48
NEW! **LMH0041SQ**	HD/SD reclocking deserializer with LVDS interface and active loopthrough	3.3, 2.5	550	270 to 1485	Ind		LLP-48
NEW! **LMH0051SQ**	HD/SD reclocking deserializer with LVDS interface	3.3, 2.5	555	270 to 1485	Ind		LLP-48
NEW! **LMH0071SQ**	SD reclocking deserializer with LVDS interface and active loopthrough	3.3, 2.5	525	270	Ind		LLP-48
LMH0031VS [E]	HD/SD deserializer / descrambler with FIFOs, 27 MHz reference, BIST, TPG, and automatic EDH/CRC	3.3, 2.5	850	270 to 1485	Com	SD131EVK	TQFP-64

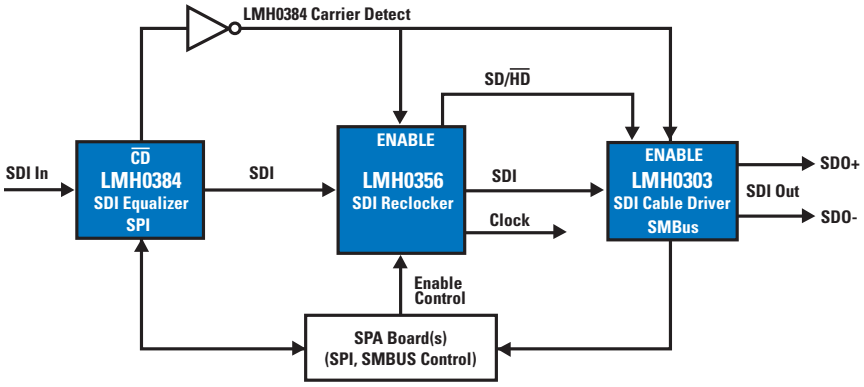
[1]Temperature ranges: Com: 0°C to 70°C Ext: 0°C to 85°C Ind: -40°C to 85°C [E] Evaluation board
Older products not shown in the table, but still in production include: CLC020BCQ, CLC021AVGZ-5.0, CLC021AVGZ-3.3, CLC011BCQ

Intelligent Sensing to Reduce System Power Consumption

PowerWise® Triple-Rate Distribution Amplifier

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



SDI Equalizers, Reclockers, and Cable Drivers

Product ID	Description	Supply Voltage (V)	Typ Power (mW)	Data Rate (Mbps)	Temp Range[1]	Eval Board Product ID	Packaging
Cable Equalizers							
NEW! **LMH0384SQ** [E] PowerWise®	3G/HD/SD extended reach adaptive cable equalizer	3.3	230	143 to 2970	Ind	SD384EVK	LLP-16
NEW! **LMH0344GR/SQ** [E]	3G/HD/SD adaptive cable equalizer	3.3	280	143 to 2970	Ind	SD344EVK	µArray-25/LLP-16
LMH0044SQ [E]	HD/SD adaptive cable equalizer	3.3	208	143 to 1485	Ext	SD044EVK	LLP-16
LMH0034MA [E]	HD/SD adaptive cable equalizer	3.3	208	143 to 1485	Ext	SD034EVK	SOIC-16
LMH0074SQ [E]	SD adaptive cable equalizer with cable detect	3.3	208	143 to 540	Ind	SD074EVK	LLP-16
LMH0024MA [E]	3.3V SD adaptive cable equalizer	3.3	198	143 to 540	Ind	SD024EVK	SOIC-16
Reclockers							
NEW! **LMH0346MH/SQ** [E]	3G/HD/SD reclocker with dual differential outputs	3.3	370	270 to 2970	Ind	SD3GDAEVK/ SD346EVK	eTSSOP-20/ LLP-24
NEW! **LMH0356SQ/SQ-40** [E]	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 [E]	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							
NEW! **LMH0307GR/SQ** [E] PowerWise®	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	µArray-25/LLP-16
LMH0302SQ [E]	3G/HD/SD cable driver with enable feature	3.3	165	Up to 2970	Ind	SD302EVK	LLP-16
LMH0303SQ [E] PowerWise®	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 [E]	HD/SD serial digital cable driver with selectable slew rate	3.3	149	Up to 1485	Com/ Ind	SD002EVK	SOIC-8
LMH0002SQ [E]	HD/SD serial digital cable driver with selectable slew rate	3.3	149	Up to 1485	Ind	SD002SQ-EVK	LLP-16
LMH0202MT [E]	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 [E]	SD serial digital cable driver with adjustable output amplitude	3.3	125	Up to 540	Ind	SD001SQ-EVK	LLP-16

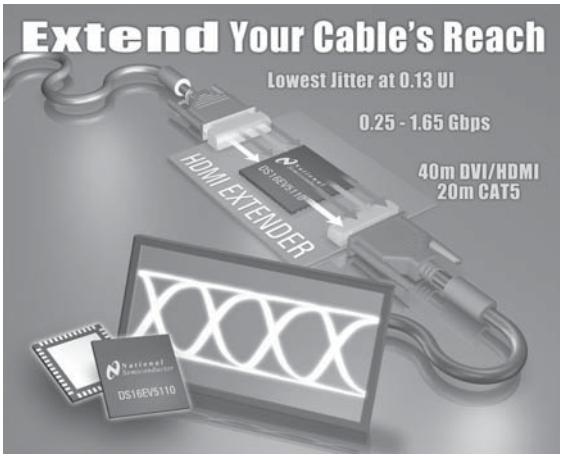
PowerWise® Product [1] Temperature ranges: Com: 0°C to 70°C Ext: 0°C to 85°C Ind: -40°C to 85°C [E] Evaluation board

Older products not shown in the table, but still in production include: CLC012AJE, CLC014AJE, CLC016AJQ/MTC/ACQ, CLC001AJE, CLC005AJE, CLC006AJE, CLC007AJE, CLC007BM, CLC006BM

Eye-Opening Cable Equalizers for HDMI/DVI Applications

Features

- Significantly extends the reach of DVI, HDMI, and CAT5 cables
- Pin-selectable boost for equalization optimization
- Pin-selectable de-emphasis for signal conditioning optimization (DS34RT5110)
- Low output jitter
- DS16EV5110A EQ supports 1080p applications – 225 MHz/6.75 Gbps
- DS22EV5110 Super-EQ supports 1080p applications, enables longer reach with lower output jitter
- DS34RT5110 reclocking EQ supports 1080p/1440p and/or deeper-color/higher-resolutions/higher-frame rate applications – 340 MHz/10.2 Gbps
  - Enables multi-hop applications

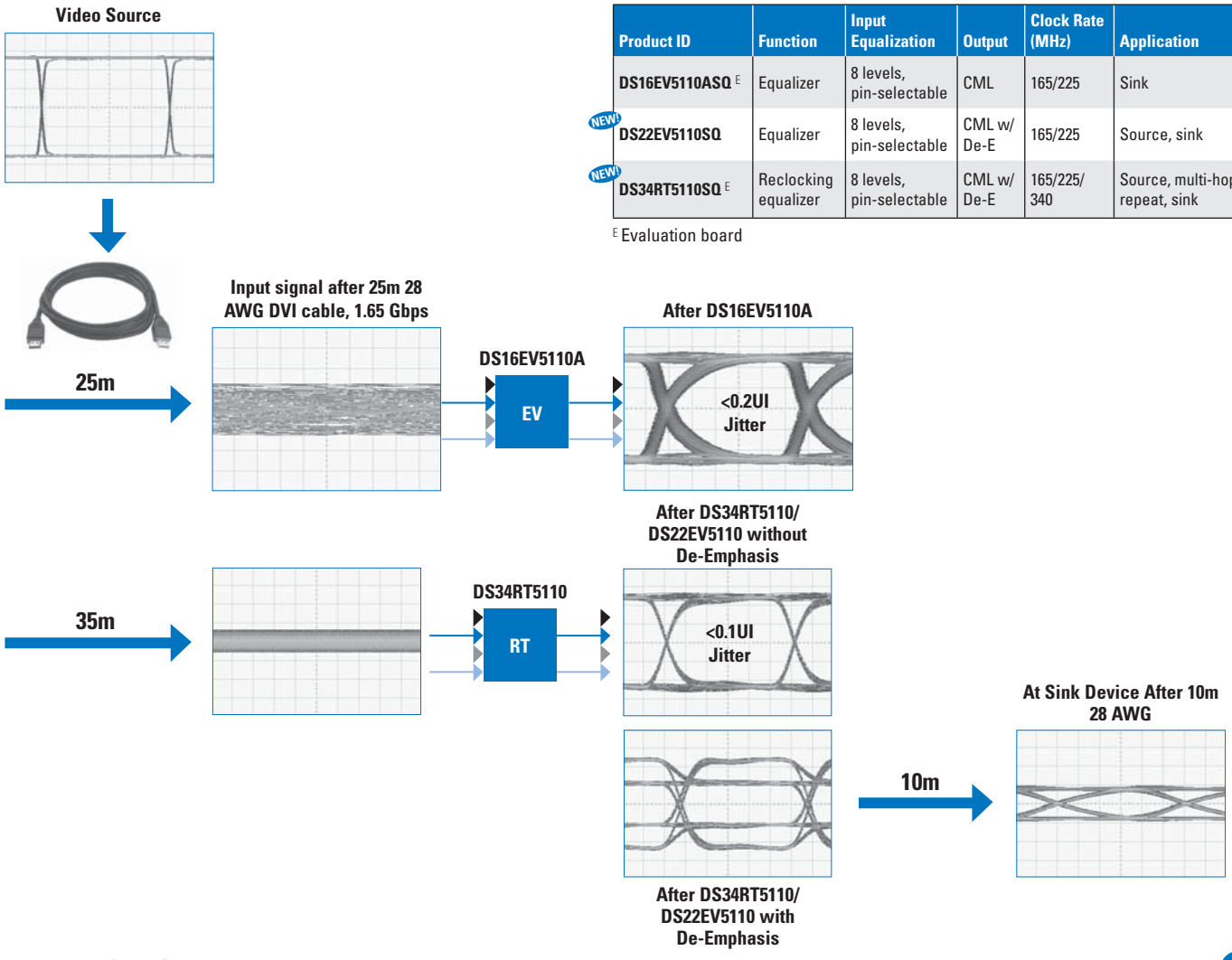


Applications

Ideal for use in HDTVs, projectors, extenders, and dongles

Product ID	Function	Input Equalization	Output	Clock Rate (MHz)	Application
DS16EV5110ASQ [E]	Equalizer	8 levels, pin-selectable	CML	165/225	Sink
NEW! DS22EV5110SQ	Equalizer	8 levels, pin-selectable	CML w/ De-E	165/225	Source, sink
NEW! DS34RT5110SQ [E]	Reclocking equalizer	8 levels, pin-selectable	CML w/ De-E	165/225/ 340	Source, multi-hop, repeat, sink

[E] Evaluation board



Mobile Pixel Link

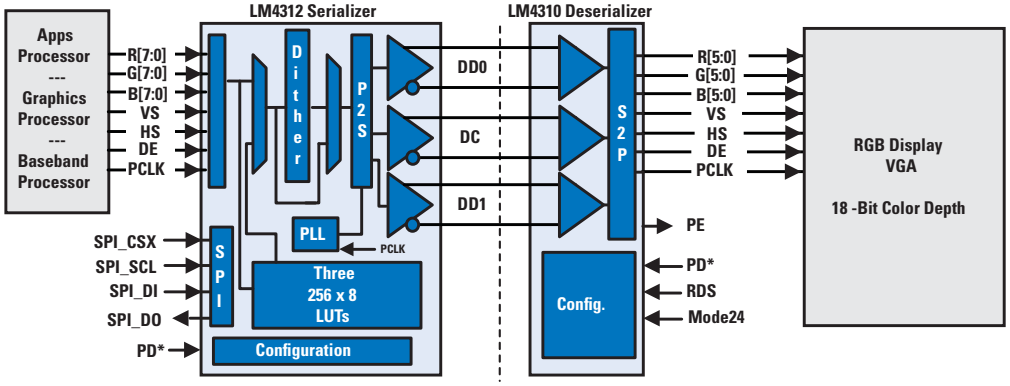
Mobile Pixel Link

Mobile Pixel Link (MPL) is a robust serial interface between video ports on sources and displays that reduces the number of interface wires. MPL features a robust differential transmission interface with a small magnitude signal to offer system-level low-power and low-EMI benefits. Serialized data is sent in mini-parallel fashion to simplify the data recovery on the receiver and to eliminate the need for a PLL, thus saving power in the receiver. The number of lanes is also scalable, depending upon the bandwidth required by the end application.

MPL-2 Solution

- Most flexible
- Robust differential interface
- Wide clocking range that supports many resolutions
- SLVS physical layer

MPL-2

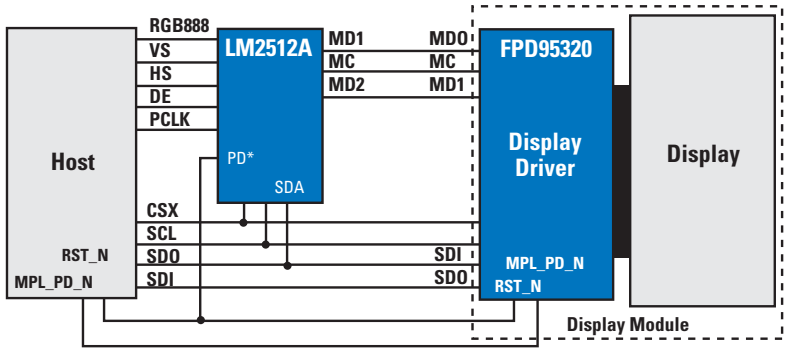


[Supply, all configuration pins, bypass caps and grounding not shown]

MPL-1 Solution

- Ideal for H-VGA displays (320 x 480)
- 18-bit - 24-bit color depth
- FPD95320 display driver integrates MPL-1 deserializer

MPL-1



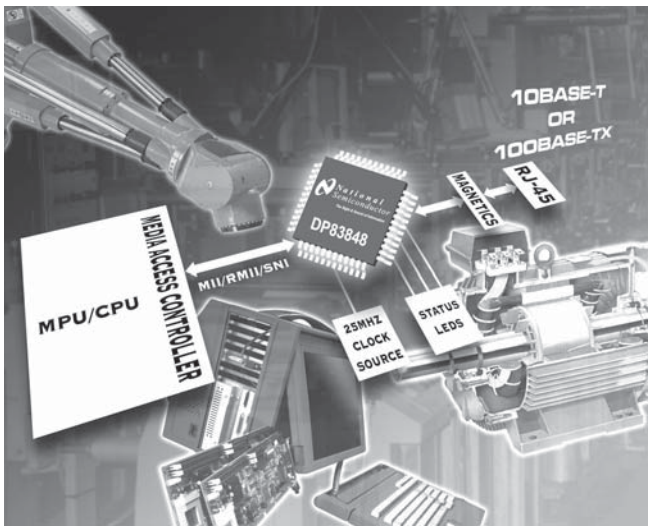
Product ID	Function	Bits	Max PCLK Freq (Hz)	Interface	I/O Levels	Special Features	Packaging
LM4308	Master/Slave	18	30	CPU	MPL-2	Write and read supported	LLP/microArray
LM4310	Receiver	18 or 24	30	RGB	MPL-2	Sleep mode	LLP
LM4312	Transmitter	18 or 24	30	RGB	MPL-2	Sleep mode, optional dithering	LLP
LM2512A	Transmitter	24	20	RGB	MPL-1	24 - 18-bit dither	LLP/microArray
FPD95320 *	Receiver	18	—	RGB	MPL-1	Support for partial display modes	Bumped die

*Chip on Glass (COG) display driver

PHYTER 10/100 Family of Ethernet PHYs for Commercial, Industrial, and Extreme Applications

Features

- Industry's first PHY with support for IEEE1588 v1 and v2
- 8 ns timestamp resolution
- Internal IEEE1588 clock
- Industry's lowest deterministic latency
- Software utility support
- Selectable MII/RMII interface
- Flexible interrupt capability
- Reference clock output (to MAC)
- Controlled I/O during power up
- Very low power consumption
  < 23 mW (energy detect mode)
  < 250 mW (normal operation)
- Built-in Self-Test (Packet BIST)



Applications

Ideal for use in industrial automation, test and measurement, telecom, military, and aerospace applications

Precision PHYTER 10/100 IEEE 1588 PHY

Product ID	DP83640T
Parameter	Industrial
Temp Range (°C)	-40 to 85
Number of Ports	Single
Interface	MII/RMII
IEEE 1588 Precision Time Protocol v1 and v2	<10 nS
Cable Health Diagnostics	•
Fiber Support	•
Synchronized GPIOs	12
Synchronized Clock Output	•
IEEE 1149.1 (JTAG)	•
LEDs	3
Packaging	LQFP-48
Package Size (mm)	9 x 9 x 1.4

Single PHYTER

Product ID	DP83848C	DP83848I	DP83848VYB	DP83848YB
Parameter	Commercial	Industrial	Extended	Extreme
Temp Range (°C)	0 to 70	-40 to 85	-40 to 105	-40 to 125
Number of Ports	Single			
Interface	MII/RMII/SNI			
Low, Deterministic Delay	•	•	•	•
IEEE 1149.1 (JTAG)		•	•	•
Packaging	LQFP-48			
Package Size (mm)	9 x 9 x 1.4			

Mini PHYTER

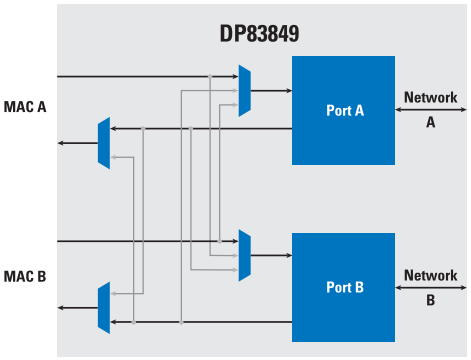
Product ID	DP83848MSQ	DP83848J	DP83848K	DP83848TSQ	DP83848HSQ
Parameter	Commercial	Commercial	Commercial	Industrial	Extreme
Temp Range (°C)	0 to 70	0 to 70	-40 to 85	-40 to 85	-40 to 125
Number of Ports	Single				
Interface	MII/RMII				
Low, Deterministic Delay	•	•	•	•	•
Smart Power Up/Down	•	•	•	•	•
LEDs	1	2	2	1	1
Packaging	LLP-40				
Package Size (mm)	6 x 6 x 0.8				

High-Speed Industrial Ethernet

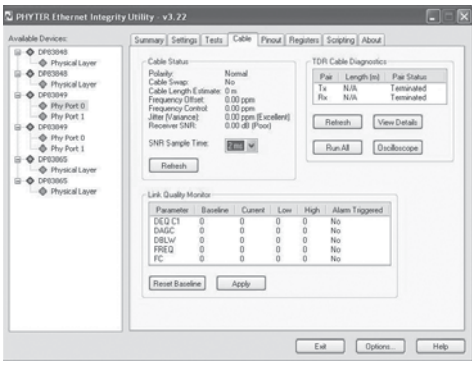
DP83849 – Dual PHYTER® 10/100 Ethernet PHY Transceiver for Commercial, Industrial, and Fiber Applications

Features

- Flexible port switching and chaining
  - MII port assignment
  - MDI chaining
- Industry's lowest deterministic latency
- Enhanced cable diagnostics
- Two fully independent 10/100 ports
  - Selectable 100Base-Tx/100Base-Fx
  - MII/RMII/SNI
- Controlled I/O during power up
- Built-in Self-Test (Packet BIST)
- Industrial temperature range
- Fully IEEE 802.3u compliant
- Available in TQFP-80 packaging (12 x 12 mm)
- Low power consumption: < 300 mW per port



Unique Flexible Switching Capability



Enhanced Cable Diagnostics

Applications

Ideal for use in industrial automation, test and measurement, telecom, military, and aerospace applications

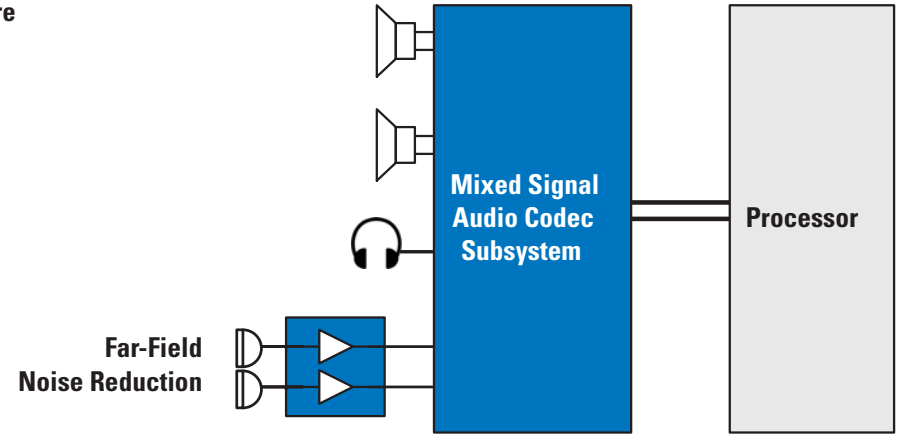
Dual PHYTER Transceiver

Product ID	DP83849C	DP83849I	DP83849ID	DP83849IF
Parameter	Commercial	Industrial	Industrial	Industrial
Temp Range (°C)	0 to 70	-40 to 85	-40 to 85	-40 to 85
Number of Ports	Dual			
Interface	MII/RMII			
Low, Deterministic Delay	•	•	•	•
Fiber Support			•	•
Flexible Port Switching		•		•
Cable Health Diagnostics	•	•	•	•
IEEE 1149.1 (JTAG)		•	•	•
Packaging	TQFP-80			
Package Size (mm)	12 x 12 x 1.0			

Audio System Architectures

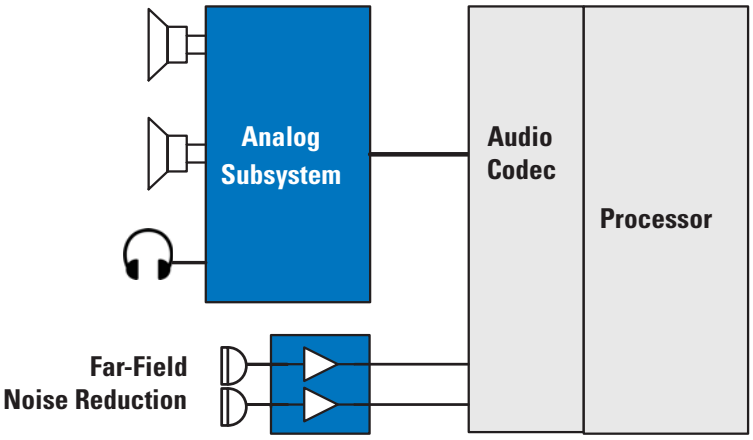
Use this integrated subsystem architecture for processors with digital audio outputs

- Mixed-signal audio codec sub systems
- Far-field noise reduction



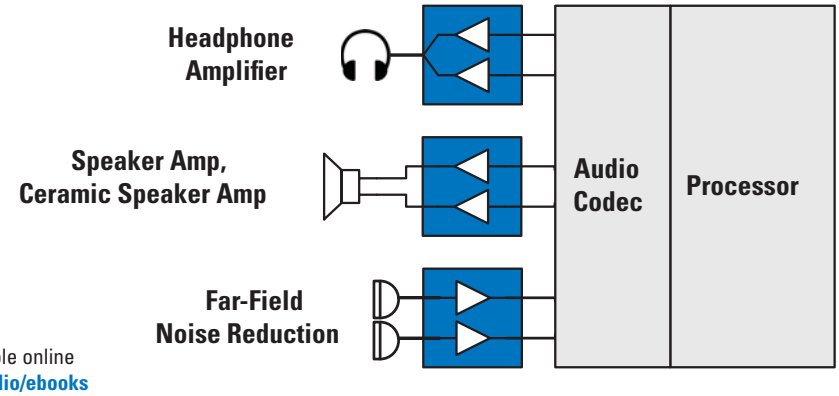
Use this integrated subsystem architecture for processors with analog audio output

- Analog sub systems



Use this discrete audio architecture for processors with analog audio output

- Headphone amplifiers
- Speaker amplifiers
- Ceramic speaker amplifiers



eBOOK Tutorials

Audio eBook resources available online
www.national.com/analog/audio/ebooks

Mixed-Signal Subsystems/Audio Codecs

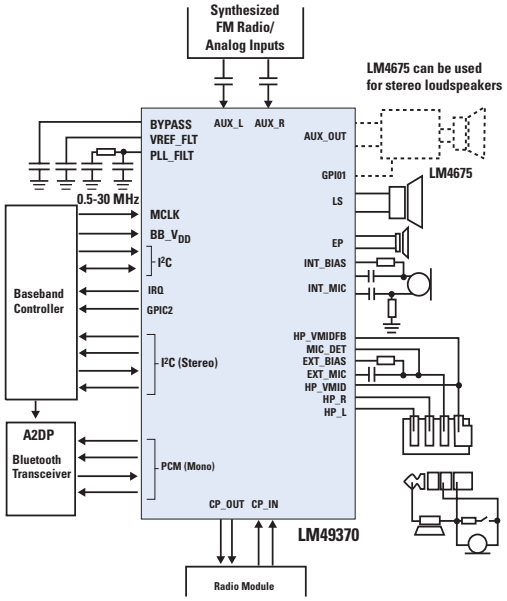
LM49370 – PowerWise® Audio Codec Subsystem with Ultra-Low EMI, Class D Amplifier, and a PCM Interface for Bluetooth® Transceivers

Features

- Spread spectrum Class D architecture reduces electromagnetic interference (EMI)
- Mono Class D 8Ω amplifier, 490 mW at 3.3V
- Output capacitorless (OCL) or AC-coupled headphone operation
- 33 mW stereo headphone amplifier at 3.3V
- 115 mW earpiece amplifier at 3.3V
- Digital 3D stereo enhancement
- Total harmonic distortion (THD): 0.04%
- Available in micro SMDxt-49 packaging (4 x 4 mm)

Applications

Ideal for use in smart phones, mobile phones, and multimedia terminals, PDAs, Internet appliances, portable gaming, portable DVD/CD/AAC/MP3 players, and digital cameras/camcorders



LM49450 – 2.2W Stereo Boomer® Class D Audio Subsystem

Features

- 24-bit stereo DAC
- Selectable spread spectrum mode reduces EMI
- Ground-referenced headphone amplifiers with 100 dB SNR
- I²C compatible audio interface; I²C compatible control interface
- Audio sample rates up to 192 kHz
- Advanced click-and-pop suppression
- Micro power shutdown

Applications

Ideal for use in personal media/MP3 players, portable navigation, digital still/video cameras, mobile phones, and VoIP devices

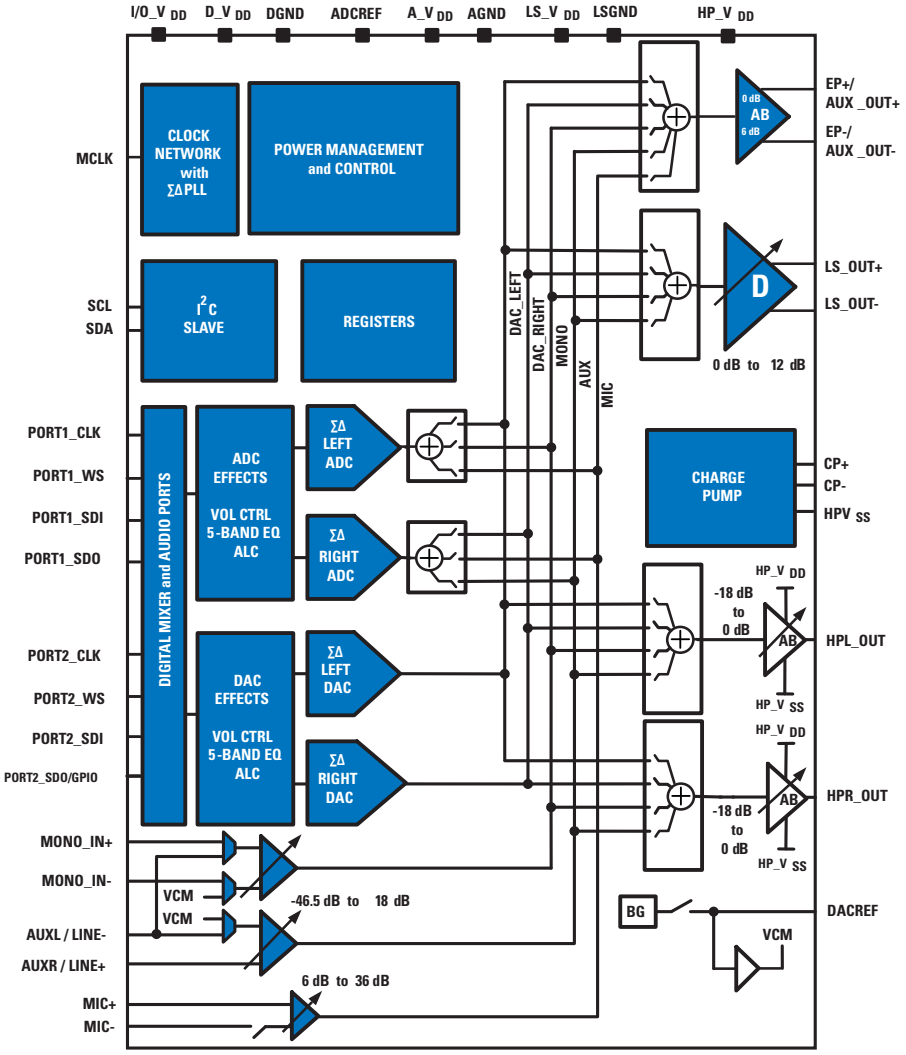
Product ID	Description	Mono Input Ch.	Stereo Input Ch.	Class D Speaker Driver	Packaging
NEW! **LM49352** E	1.4W mono Class D speaker, 65 mW ground-referenced headphone with stereo DAC and stereo ADC with I²S/PCM and auxiliary inputs, I²C compatible control, 3D, five band EQ, and AGC	2, PCM	I²S, I²C compatible	✔	micro SMDxt-36
LM49350 E	1.1W Class D speaker, 69 mW ground-referenced headphone with stereo DAC and stereo ADC with I²S/PCM and auxiliary inputs, I²C compatible control, 3D, five-band EQ, and AGC	2, PCM	I²C compatible	✔	micro SMDxt-36
LM49450	Filterless 2.2W stereo Class D audio subsystem with ground-referenced headphone amplifier, 3D enhancement, and headphone sense	—	2, I²S	✔	LLP-32
LM49370 E	1.2W mono speaker, 31 mW headphone, 115 mW earpiece with I²C/SPI mode and selectable OCL output	3, PCM	I²S	✔	micro SMDxt-49
LM49321	520 mW mono speaker, 36 mW headphone, 55 mW earpiece with I²C/SPI and lower power MP3 playback mode	1	2, I²S	—	micro SMDxt-36

PowerWise® product E Evaluation board

LM49352 – Mono Class D Audio Codec Subsystem with Ground-Referenced Headphone Amplifiers

Features

- Low-voltage, true-ground headphone amplifier operation
- High-performance 103 dB SNR stereo DAC
- High-performance 97 dB SNR stereo ADC
- Up to 96 kHz stereo audio playback
- Up to 48 kHz stereo recording
- Dual bidirectional I²S- or PCM compatible audio interface
- Read/write I²C compatible control interface
- Flexible digital mixer with sample rate conversion



Analog Subsystems

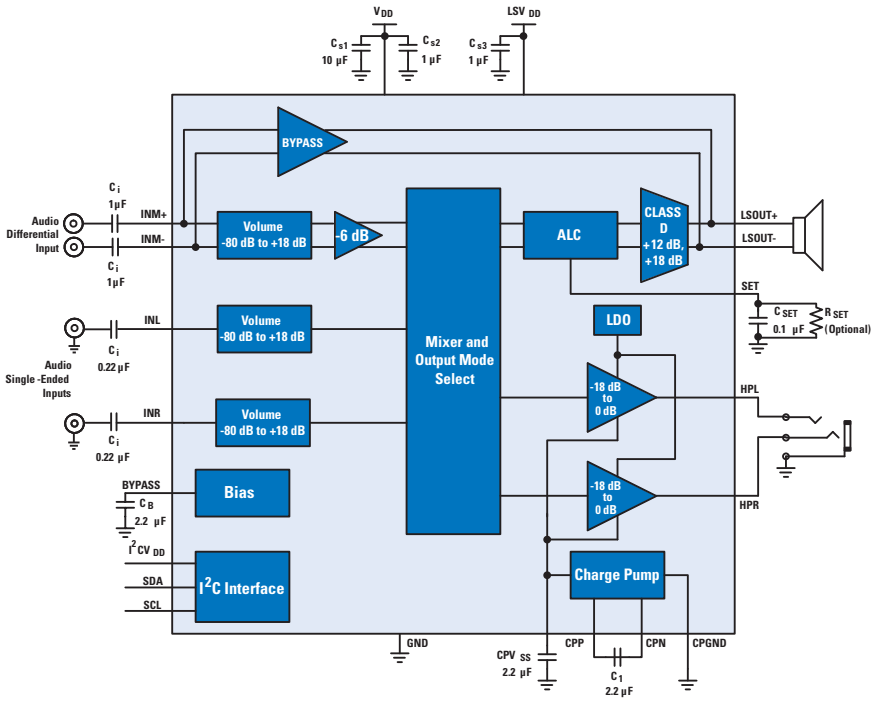
LM49151 – PowerWise® Mono Class D Audio Subsystem with Earpiece Driver and Ground-Referenced Headphone Amplifiers

Features

- Class D amplifier with E²S enhanced emission suppression technology for reduced EMI
- Ground-referenced outputs — eliminates output-coupling capacitors
- I²C programmable no clip function with clip control
- Voltage limiter speaker protection
- I²C compatible volume and mode control
- Earpiece amplifier
- Advanced click-and-pop suppression
- Low supply current

Applications

Ideal for use in mobile phones, personal media devices, MP3 players, portable navigation, laptops, and VoIP devices



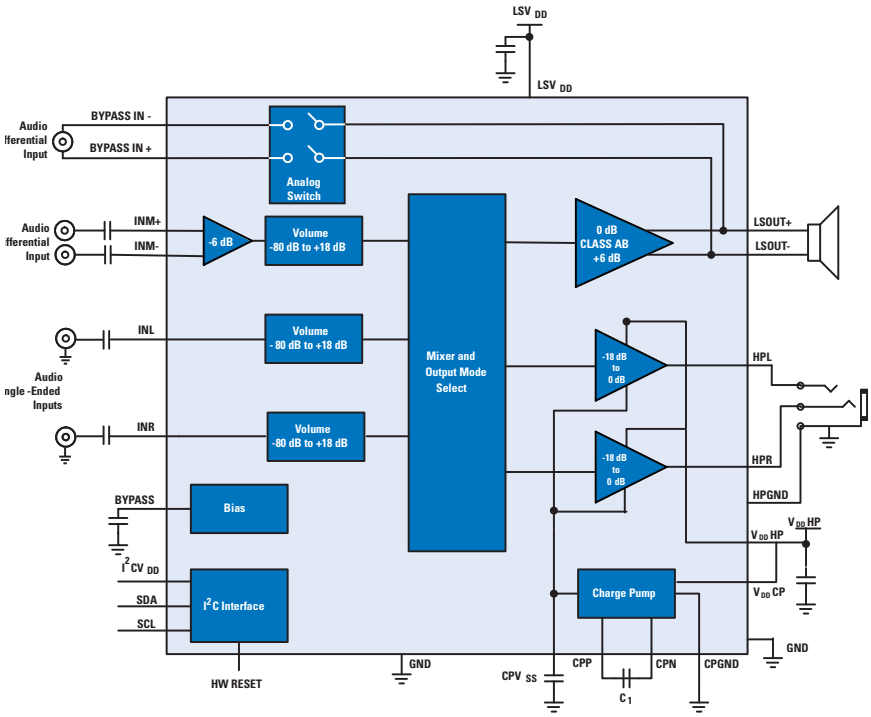
LM49101 – Mono Class AB Audio Subsystem with a True-Ground Headphone Amplifier and Earpiece Switch

Features

- Differential mono input and stereo single-ended input
- Separate earpiece (receiver) differential input
- Analog switch for a separate earpiece path
- 32-step digital volume control (-80 dB to +18 dB)
- Three independent volume channels (left, right, mono)
- Separate headphone volume control
- Flexible output for speaker and headphone output

Applications

Ideal for use in portable electronic devices, mobile phones, and PDAs



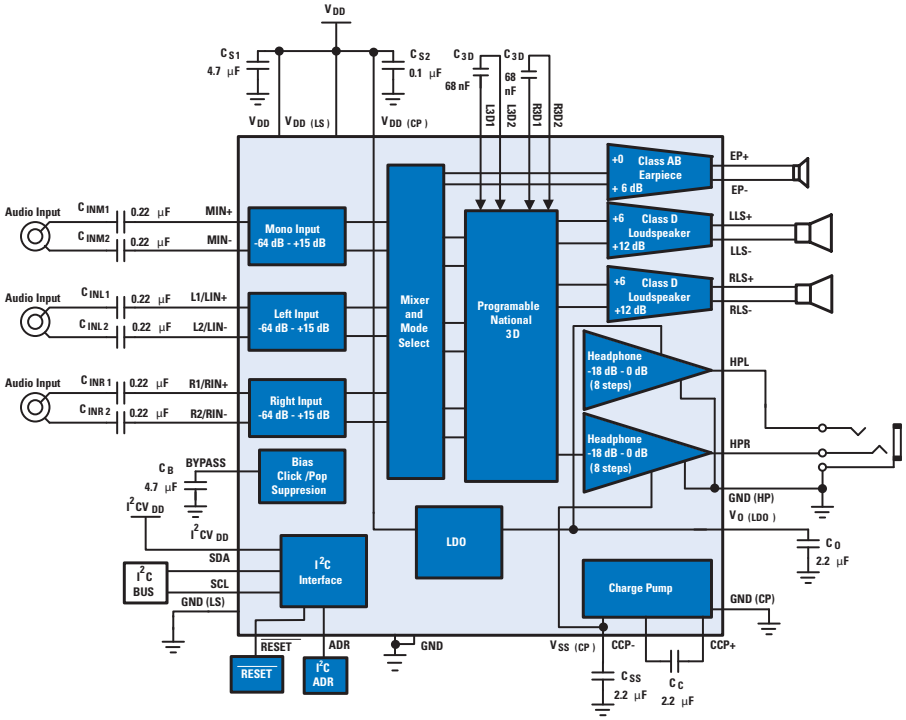
LM49250 – Stereo Boomer® Class D Audio Subsystem with Ground-Referenced Headphone Amplifier and Mono Earpiece

Features

- Output short-circuit protection
- Thermal overload protection
- Spread spectrum modulation
- I²C compatible control interface
- Total harmonic distortion (THD): 0.01%
- RF suppression
- Advanced click-and-pop suppression
- Micro-power shutdown
- Available in space-saving micro SMD-36 packaging

Applications

Ideal for use in mobile phones, personal media/MP3 players, portable navigation, and VoIP devices



Analog and Codec Subsystems

Product ID	Description	Mono Input Ch.	Stereo Input Ch.	THD (%)	Class D Speaker Driver	Packaging
NEW! **LM49151** E	1.25W mono Class D audio subsystem with automatic level control, earphone path and ground-referenced headphone amplifier	1	1	0.02	✔	micro SMD-20
LM49150 E	1.25W mono Class D audio subsystem with earphone path and ground-referenced headphone amplifier	1	1	0.04	✔	micro SMD-20
LM49250 E	Stereo Class D audio subsystem with ground-referenced headphone amplifier and mono earpiece	1	2	0.14	✔	micro SMD-36
NEW! **LM49101** E	1.3W mono Class AB audio subsystem with ground-referenced headphone amplifier and mono earpiece	2	1	0.065	—	micro SMD-25
LM49100 E	1.275W mono speaker (BTL), 50 mW headphone with I²C compatible, mode and volume control, and ground-referenced headphone drivers	1	2	0.035	—	microArray-25
LM49120 E	1.3W mono speaker, 85 mW headphone with I²C/SPI mode and volume control, and selectable OCL output	1	2	0.05	—	micro SMD-16
LM4946 E	1.3W mono speaker, 85 mW headphone with I²C/SPI mode and volume control, National 3D and selectable OCL output	1	2	0.05	—	LLP-24, micro SMD-25
LM49270 E	2.2W stereo speaker, 155 mW headphone with volume control, National 3D and selectable OCL output	1	2	0.02	✔	LLP-28
LM4949 E	1.19W stereo speaker, 89 mW headphone with I²C compatible mode and volume control and selectable OCL output	1	1 or 2	0.02	✔	micro SMD-25
LM4947 E	1.19W mono speaker, 87 mW headphone with I²C compatible mode and volume control, National 3D and selectable OCL output	1	1 or 2	0.03	✔	micro SMD-25
LM4938	Stereo 2W audio power amplifier with DC volume control, selectable gain, and docking station interface	—	1	0.05	—	eTSSOP-28

PowerWise® product E Evaluation board

Noise Reduction

LMV1088/89 – Far-Field Noise Suppression Microphone Amplifier

Features

- First analog noise suppression solution
- Up to 20 dB of far-field acoustic noise suppression
- Low 1 mA current consumption (1/10th of DSP solution)
- Automatic microphone calibration feature
- Calibration data stored in EEPROM
- Available in micro SMD-36 packaging (3.5 mm x 3.5 mm)
- Available in LQFP-32 packaging (LMV1089)

Applications

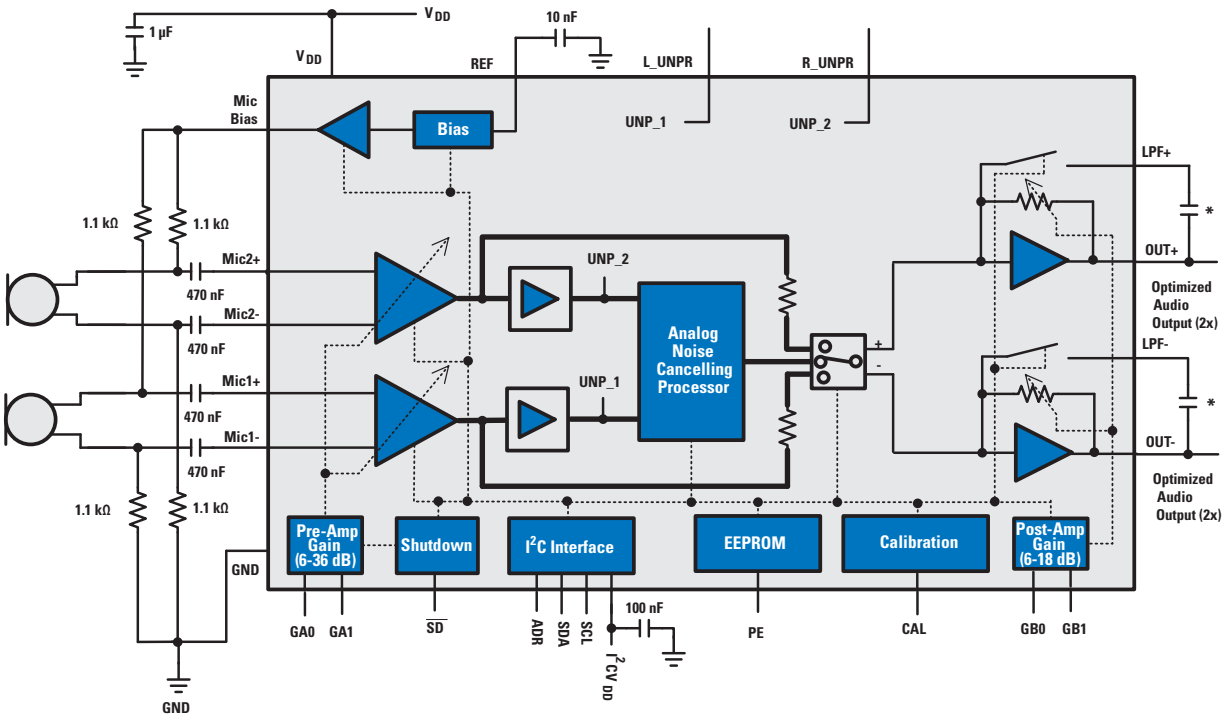
Ideal for use in mobile handsets, long-boom headsets, and two-way radios

Far-Field Noise Suppression ($FFNS_E$)

$FFNS_E$ addresses the ability of the amplifier to reject far-field signals (considered noise) over the desired near-field signal. It describes the ratio of far-field noise (as it rides on the whole signal) between the input and output of the amplifier in decibels.

Signal-to-Noise Ratio Improvement Electrical ($SNRI_E$)

$SNRI_E$ describes the ratio of the Far-Field Noise Suppression (FFNS) to near-field (desired) signal amplitude attenuation through the noise suppression process, as measured in decibels.



Noise Reduction Microphone Amplifiers

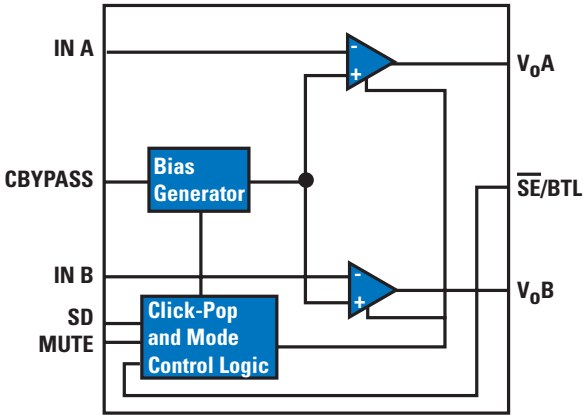
Product ID	Output	Fair-field Noise Suppression (dB) at 300 Hz	SNRI (dB) at 300 Hz	PSRR (dB)	Shutdown	Supply Current (mA)	Supply Voltage Range (V)	Packaging
LMV1088 E	Single-ended	37	28	85	—	1.0	2.7 to 5.5	micro SMD-36
LMV1089 E	Differential	37	28	96	✔	1.0	2.7 to 5.5	micro SMD-36, LQFP-32
NEW **LMV1090** E	Differential	43	33	99	✔	0.6	2.7 to 5.5	micro SMD-16

PowerWise® product E Evaluation board

LM4916 – 1.5V, Mono 85 mW BTL Output, 14 mW Stereo Headphone Audio Amplifier

Features

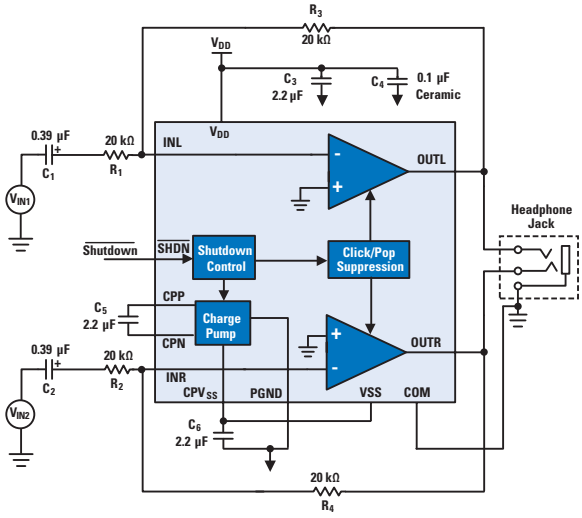
- Single-cell 0.9V to 2.5V battery operation
- BTL mode for mono speaker
- Single-ended headphone operation with coupling capacitors
- Unity-gain stable
- Click-and-pop suppression circuitry
- Active-low micropower shutdown
- Low current, active-low mute mode
- Thermal shutdown protection circuitry



LM48861 – PowerWise® Ground-Referenced, Ultra-Low Noise, Stereo Headphone Amplifier

Features

- Ground-referenced outputs – eliminates output-coupling capacitors
- Common-mode sensing
- Click-and-pop suppression circuitry
- Low supply current
- Low power shutdown mode
- Minimum external components
- Micro-power shutdown
- ESD protection of 8 kV HBM contact



Product ID	Description	THD (%)	PSSR (dB)	Supply Voltage Range (V)	Output Power THD ≤ 1%, V_{CC} = 3V		Packaging
					16Ω (mW)	32Ω (mW)	
LM4920 E	50 mW headphone, fixed logic levels, fixed 1.5 V/Vgain	0.03	70	1.6 to 4.2	43	50	micro SMD-14
LM4982 E	50 mW headphone, ultra-low noise, IntelliSense, 32-step I²C volume control	0.05	66	1.6 to 4.0	47	51	micro SMD-16
4 mm **LM48820** E	95 mW headphone, ultra-low noise, fixed 1.5 V/Vgain	0.01	80	1.6 to 4.5	95	80	micro SMD-14
LM48821	52 mW headphone, ultra-low noise, direct coupled, I²C volume control	0.015	82	2 to 4	52	53	micro SMD-16
LM48860 E	30 mW headphone, ultra-low noise, fixed 1.5V/V gain	—	—	2.5 to 5.5	40	50	micro SMD-12
LM48822 E	35 mW headphone, ultra-low noise, common mode sense and I²C volume control	0.04	110	2.4 to 5.5	35	40	micro SMD-16
4 mm **LM48861**	22 mW headphone Boomer amplifier, ultra-low noise, and common mode sense	0.04	83	1.2 to 2.8	22	24	micro SMD-12
NEW! **LM48824** E	37 mW Class G headphone, ultra-low noise, I²C volume control	0.02	100	2.4V to 5.5	37	29	micro SMD-16

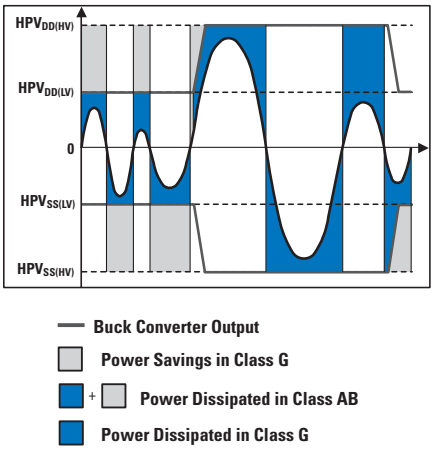
PowerWise® product E Evaluation board

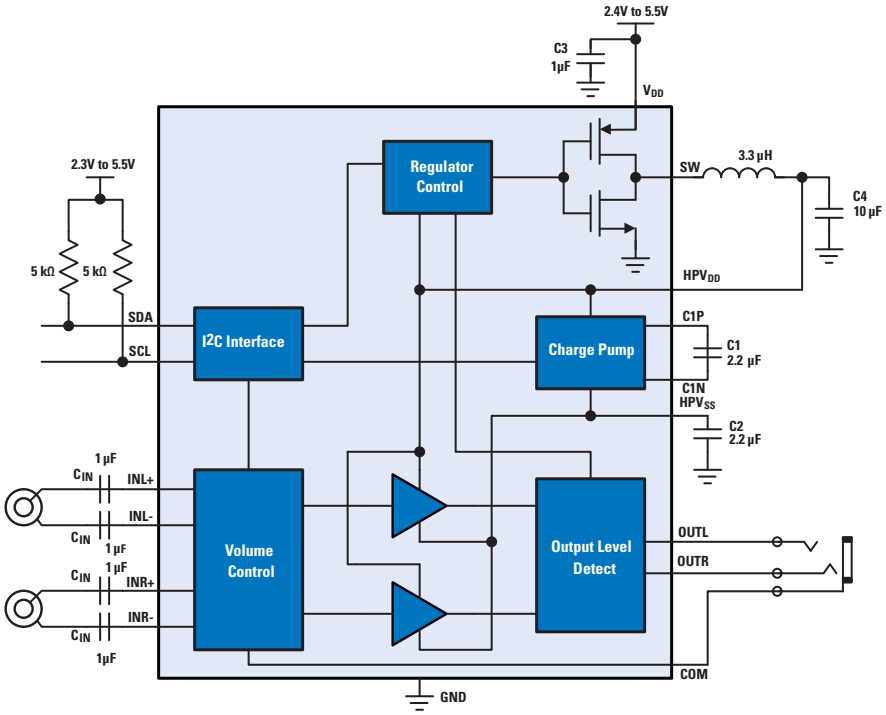
Ground-Referenced Headphone Boomer® Amplifiers

LM48824 – Class G Headphone Amplifier with I²C Compatible Volume Control

Features

- Class G power savings
- Ground-referenced headphone outputs – eliminates output-coupling capacitors
- Common-mode sense
- I²C compatible volume and mode control
- High-output impedance in shutdown
- Differential inputs
- Advanced click-and-pop suppression
- Low supply current
- Low total harmonic distortion (THD) mode option

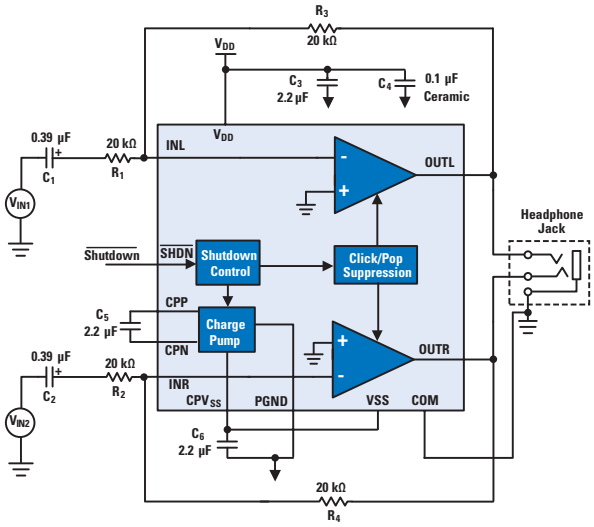




LM48861 – PowerWise® Ground-Referenced, Ultra-Low Noise, Stereo Headphone Amplifier

Features

- Ground-referenced outputs – eliminates output-coupling capacitors
- Common-mode sensing
- Advanced click-and-pop suppression
- Low supply current
- Low-power shutdown mode
- Minimum external components
- Micro-power shutdown
- ESD protection of 8 kV HBM contact



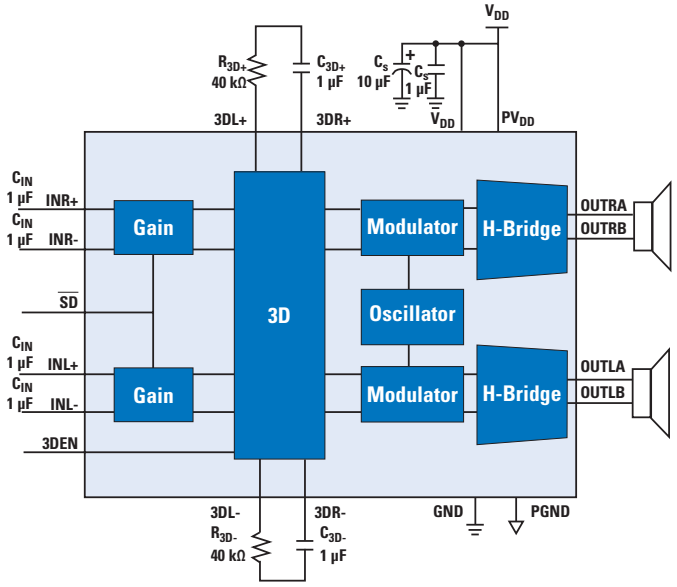
LM48413 – Ultra-Low EMI, Filterless, 2.5W, Stereo, Class D Audio Power Amplifier with E²S

Features

- E²S system reduces electromagnetic interference (EMI), preserving audio quality and efficiency
- Output short-circuit protection
- Stereo Class D operation
- No output filter required
- National 3D enhancement
- Minimum external components
- Advanced click-and-pop suppression
- Micro-power shutdown

Applications

Ideal for use in mobile phones, PDAs, and other portable electronic devices



High-Efficiency Boomer Class D Amplifiers

Product ID	Description	THD (%)	Output Power THD ≤ 1%		Packaging
			4Ω (W)	8Ω (W)	
LM4673 [E]	Mono filterless	0.02	2.15	1.24	micro SMD-9, LLP-8
LM4674 [E]	Stereo filterless	0.05	1.9	1.25	micro SMD-16, LLP-16
LM4674A [E]	Filterless 2.5W stereo Class D audio power amplifier	0.05	1.9	1.25	micro SMD-16
LM4675 [E]	Mono, ultra-low EMI	0.02	2.2	1.3	micro SMD-9, LLP-8
LM48310 [E]	Mono filterless, E²S	0.03	2.1	1.3	LLP-10
LM48410 [E]	Stereo, ultra-low EMI, filterless, 3D	0.025	1.9	1.2	LLP-24
LM48411 [E]	Stereo filterless, E²S	0.03	2.0	1.25	micro SMD-16
LM48413 [E]	Stereo, E²S, 3D	0.03	—	1.2	micro SMD-18

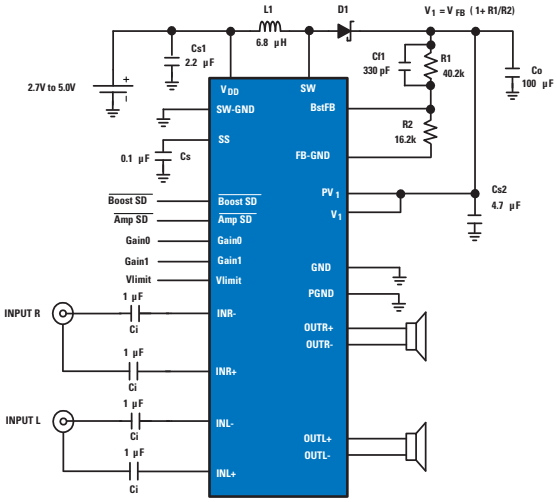
PowerWise® product [E] Evaluation board

Boosted Boomer® Moving Coil

LM48520 – Boosted Stereo Class D Audio Power Amplifier with Output Speaker Protection and Spread Spectrum

Features

- Advanced click-and-pop suppression
- Low 0.04 µA shutdown current
- 78% efficiency
- Filterless Class D
- 2.7V to 5.0V operation
- 4 adjustable gain settings
- Adjustable output swing limiter with soft clipping
- Speaker protection
- Short-circuit protection on audio amplifiers
- Independent boost and amplifier shutdown pins



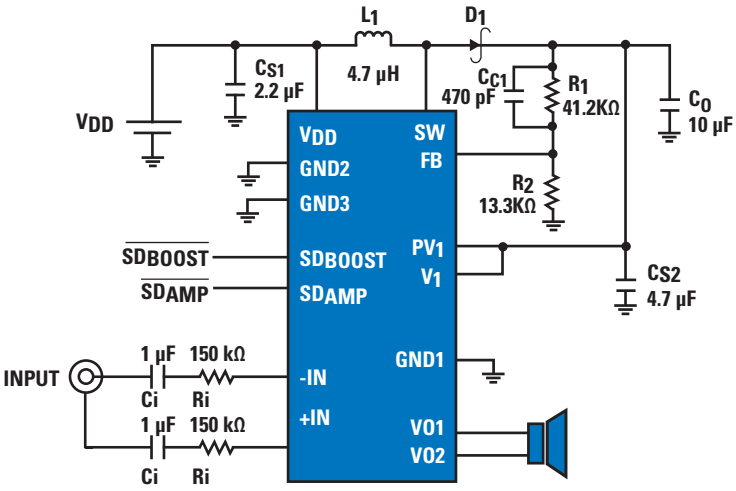
Applications

Ideal for use in mobile phones, PDAs, portable media devices, cameras, and handheld games

LM48510 – PowerWise® Boosted Boomer Class D Audio Power Amplifier

Features

- Advanced click-and-pop suppression
- Low 0.01 µA shutdown current
- 76% efficiency
- Filterless Class D
- 2.7V to 5.0V operation (V_{DD})
- Externally configurable gain on Class D
- Very fast turn-on time: 17 µs
- Independent boost and amplifier shutdown pins



Applications

Ideal for use in mobile phones, PDAs, portable media devices, cameras, and handheld games

Boosted Boomer Moving Coils

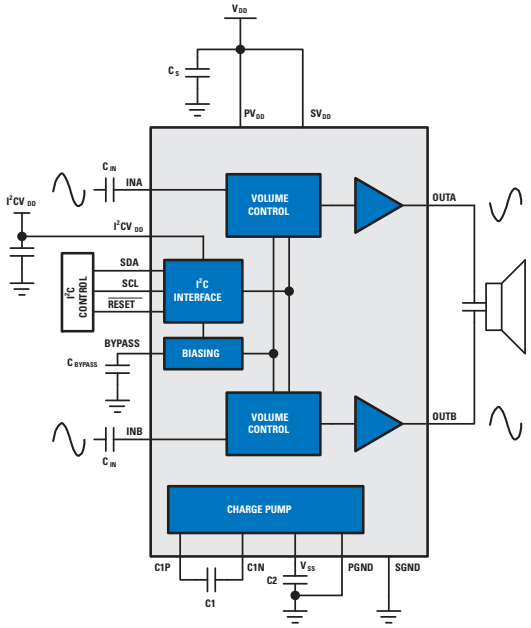
Product ID	Description	THD (%)	Output Power at THD ≤ 1%		Packaging
			4Ω (W)	8Ω (W)	
LM4804	1.8W low voltage, high power	0.15	—	1.9 at 4.2V, 2%	LLP-28
LM4805	1W low voltage, high power (supplies 1W down to 3V)	0.25	—	1.2 at 4.2V	LLP-28
LM48510 [E]	1.2W boosted Class D	0.07	1.7 at 3.3V	1.2 at 3.3V	LLP-16
LM48511 [E]	3W boosted Class D with ultra-low EMI and spread spectrum	0.03	5.4 at 5V	3.0 at 5V	LLP-24
LM48520 [E]	1.1W boosted Class D with speaker protection and spread spectrum	0.04	—	1.1 at 3.3V	micro SMD-25

PowerWise® product [E] Evaluation board

LM48823 – Mono, Bridge-Tied Load, Ceramic Speaker Driver with I²C Compatible Volume Control and Reset

Features

- Integrated charge pump
- Bridge-tied load output
- High PSRR
- I²C compatible volume and mode control
- Reset input
- Advanced click-and-pop suppression
- Low supply current
- Minimum external components
- Micro-power shutdown
- Available in space-saving micro SMD-16 packaging



Applications

Ideal for use in cell phones, smart phones, portable media devices, and notebook PCs

Boosted Boomer Piezo Ceramic Speaker Drivers

Product ID	Description	THD (%)	Output Voltage (V_{P-P})	Condition	Packaging
LM4802B	12 V_{P-P} boosted ceramic speaker driver	0.05	12	V_{DD}=4.2V, 2 µF + 30Ω, THD ≤ 1%	LLP-28
LM4953 [E]	12.6 V_{P-P} ceramic speaker driver with ground reference, ultra-low noise, fixed gain	0.02	12.6	V_{DD}=3.6V, 2 µF + 30Ω, THD ≤ 1%	LLP-14
LM4960	24 V_{P-P} Piezoelectric speaker driver	0.04	24	V_{DD}= 3.0V, 800 nF + 20Ω, THD ≤ 1%	LLP-28
LM4961 [E]	15 V_{P-P} ceramic speaker driver	0.05	15	V_{DD}= 5V, 2 µF + 30Ω, THD ≤ 1%	LLP-28
LM4962 [E]	15 V_{P-P} ceramic speaker driver with band switch function, can drive LM4951 for stereo solution	0.04	15	V_{DD}=5V, 2 µF + 9.4Ω, THD ≤ 1%	micro SMD-20
LM48555 [E]	15.5 V_{P-P} ceramic speaker driver	0.05	15	V_{DD}=5V, 2 µF + 9.4Ω, THD ≤ 1%	micro SMD-12
LM48556 [E]	17.5 V_{P-P} fully differential ceramic speaker driver	0.03	17.5	V_{DD}=4.5V, THD ≤ 1%	micro SMD-12
NEW! **LM48823** [E]	5.4V_{RMS} ceramic speaker driver with I²C compatible volume control and reset	0.015	5.4V_{RMS}	V_{DD}= 4.2, RL=2.2 µF+15Ω, THD ≤ 1%	micro SMD-16

[E] Evaluation board

eBOOK Tutorials

Audio eBook resources available online
www.national.com/analog/audio/ebooks

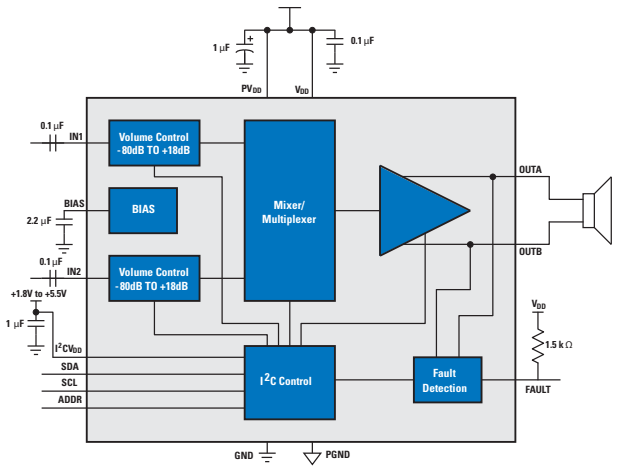
AUDIO

Mono and Stereo Boomer® Audio Amplifiers

LM48100Q - Mono, 1.3W Audio Power Amplifier with Output Fault Detection and Volume Control from the PowerWise® Family

Features

- Output fault detection
- I²C volume and mode control
- Input mixer/multiplexer
- High PSRR
- Individual 32-step volume control
- Short circuit and thermal protection
- Advanced click-and-pop suppression
- Low-power shutdown mode



Fully Differential Mono Boomer Amplifiers

Product ID	Description	THD (%)	Output Power at 1% THD+N V_{CC} = 5V		Packaging
			4Ω (W)	8Ω (W)	
LM4923 [E]	LM4898 with improved output power	0.02	—	1.1	LLP-8
LM4927	1.3W high PSRR	0.03	2.1	1.3	LLP-8
LM4941 [E]	1.25W RF suppression, high PSRR and CMRR	0.04	—	1.25	micro SMD-9, LLP-8

PowerWise® product [E] Evaluation board

Mono Boomer Audio Amplifiers

Product ID	Description	THD (%)	Output Power V_{CC} = 5V		Packaging
			4Ω (W)	8Ω (W)	
LM4819 [E]	350 mW audio power amplifier with shutdown mode	1.0	—	0.25	LLP-8, SOIC-8
LM4951	1.8W (at 7.5V) wide voltage range	0.07	—	0.9	micro SMD-9, LLP-10
LM4954	3W (into 3Ω) wide voltage range	0.01	1.6	1.2	micro SMD-9
LM4991 [E]	3W (into 3Ω)	0.02	2.13	1.1	LLP-8, SOIC-8
LM4995 [E]	1.3W	0.01	—	1.3	micro SMD-9, LLP-8
NEW **LM4951A**	1.8W (at 7.5V) wide voltage range with short circuit protection	0.07	—	1.8	LLP-10
NEW **LM48100**	Mono, 1.25W audio power amplifier with output fault detection and volume control	0.02	—	1.25	Exposed-pad TSSOP-14

PowerWise® product [E] Evaluation board

Stereo Boomer Amplifiers

Product ID	Description	THD (%)	Output Power THD ≤ 1%, V_{CC} = 5V		Packaging
			4Ω (W)	8Ω (W)	
LM4928 [E]	1.2W stereo fully differential with RF suppression	0.04	1.8	1.2	micro SMD-16, LLP-14
LM4992 [E]	1.07W stereo with independent channel shutdown	0.15	—	1.07	LLP-14

[E] Evaluation board

Specialty Audio Synch LED Drivers

Product ID	Description	Audio Channels	Control	Number of Outputs	Supply Voltage (V)	LED Drive Current (1x)	Supply Voltage Range (V)	Packaging
LM4970	Audio synchronized color LED driver	3	I^2C	3	3	18 mA	2.7 to 5.5	LLP-14

12V Boomer® Audio Amps

Product ID	Description	Supply Voltage Range (V)	THD (%)	Output Power at THD ≤ 1% V_{CC} = 12V		Packaging
				4Ω (W)	8Ω (W)	
LM4950	7.5W mono or 3.1W stereo	9.6 to 16	0.14	3.1	6.2	TO220-9, TO263-9

Specialty Audio Motor Drivers

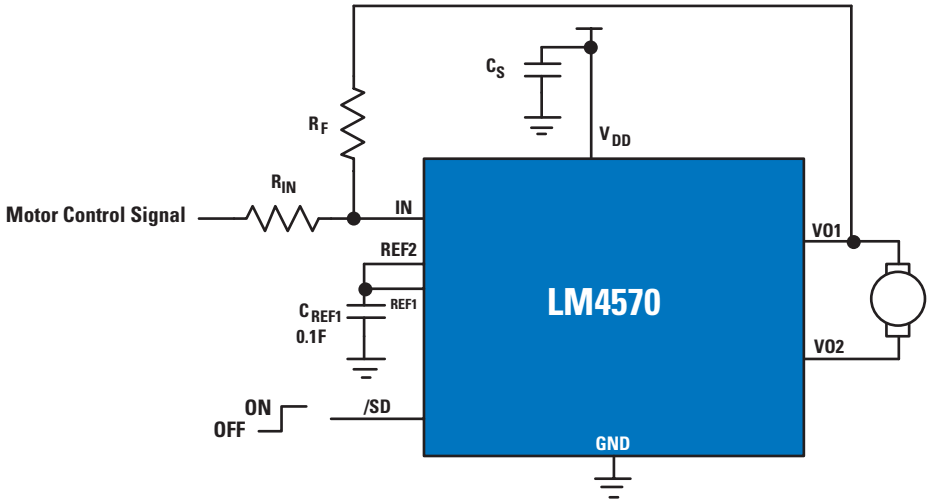
Product ID	Description	Supply Voltage Range (V)	Quiescent Current V_{DD} = 3V (mA)	Wake up Time (ms)	Output Current V_{DD} = 3V (mA)	Shutdown	Packaging
LM4570 [E]	Haptic motor driver	2.4 to 5.5	1.9	2.4	192	Low	LLP-8

[E] Evaluation board

Features

- Output short-circuit protection
- High output current capability
- Wide output voltage range
- Fast turn-on time
- Output short-circuit protection
- Low-power shutdown mode
- Minimum external components

Haptic Motor Driver



Choosing an Audio Power Amplifier

Selecting an appropriate audio power IC for a particular application is dependent upon the desired output power, its corresponding THD specification, a specified load impedance, and available voltage supply rails. With the varying output power specifications stated by IC manufacturers, and the variables mentioned above, choosing the correct IC is sometimes difficult. The following paragraphs are intended to simplify the decision making process by explaining the general issues with specifying output power with respect to THD and some of the other variables mentioned above.

Power may be represented in many forms, but for general purposes, power is based on the current through a resistance multiplied by the voltage drop across that resistance, as shown in ***Equation 1***.

(1) $P = VI$

Two other equivalent forms of the same equation based on either the voltage or current are shown in ***Equations 2*** and ***3***, respectively.

(2) $P = V^2/R$

(3) $P = I^2R$

The output power of an audio IC can be represented by any of the preceding equations, and depending upon the measurement device, the output voltage or current can be represented as peak or root-mean-square (rms) amplitude. It is an industry standard to evaluate linear systems with a sinewave whose rms voltage can be obtained through ***Equation 4***.

(4) $V_{rms} = \sqrt{[(1/T)\int v(t)dt]}$ from t=0 —> t=T

Deriving the above equation for one period of a sinewave [$v(t) = Vpk\sin(wt)$] results in ***Equation 5***.

(5) $V_{rms} = Vpk/\sqrt{2}$

The industry standard continuous average output is found by using the output rms voltage, as shown in ***Equation 6***.

(6) $Po_{rms} = V^2_{rms}/R_L$

If the same output power is to be obtained using the peak output voltage as seen on an oscilloscope, then ***Equation 5*** should be substituted into ***Equation 6***, resulting in ***Equation 7***.

(7) $Po_{rms} = Vpk^2/2R_L$

Equation 6 or ***7*** are the most general equations stating the output power of a power IC based on a sinewave output into pure resistance. All of the above equations would change if the signal form changed or the load included some form of reactance. It should also be noted that if the peak output voltage were used directly into ***Equation 2***, then a peak output power rating would result. This nonstandard technique misleads customers into thinking that a part is capable of much more than what is really true.

System design engineers therefore may have a difficult time distinguishing between the different power ratings stated by semiconductor manufacturers. Every output power rating of an audio IC has a corresponding Total Harmonic Distortion (THD) specification that states the quality of music reproduction by the device. The more linear an amplifier is, the lower the THD rating will be, therefore providing clearer music amplification.

In some instances, IC manufacturers state output power levels with THD values equal to 10%; a condition well into clipping. When observed on an oscilloscope, a sinewave appears to have its peaks cut off. This condition of clipping can occur from two factors; the maximum output voltage swing is reached or the maximum output current drive capability is reached. Both of these limiting factors can control the maximum output power capability, as indicated through ***Equations 1-3***.

As shown in ***Figures 1-3***, the amount of clipping increases the number and level of harmonics produced by the amplifier as its output limitations are reached and exceeded. Although output power is increased as the amplifier is driven farther into clipping, the quality of sound is adversely affected by the increasingly distorted waveform.

The output power obtained from one IC with a 10% THD specification will not be competitive with another amplifier whose power is the same, but whose THD is lower. For a given supply voltage load, two audio amplifiers can only be compared on equal footings if their THD specifications are equivalent. The amplifier whose power is the same, but has a lower THD, will generally be more expensive. This is partly because the output stage needs to be larger to support more current drive capability. This makes the device more expensive to produce and thus translates into a higher end cost for the customer.

In summary, it should be remembered when selecting an audio IC that any power rating has a corresponding THD specification which is based on a given voltage supply and load. Most consumer applications require clean crisp music as opposed to the harsh sound of clipping, so beware of those 10% distortion ratings and make sure that your comparisons are apples to apples.

In support of the above information, this audio selection guide is set up to allow easy selection of parts based on supply voltage range, load impedance, and most importantly, power with respect to THD level.

Figure 1: Amplifier output: Po = 80W, THD+N = 0.00056%, R_L = 8Ω

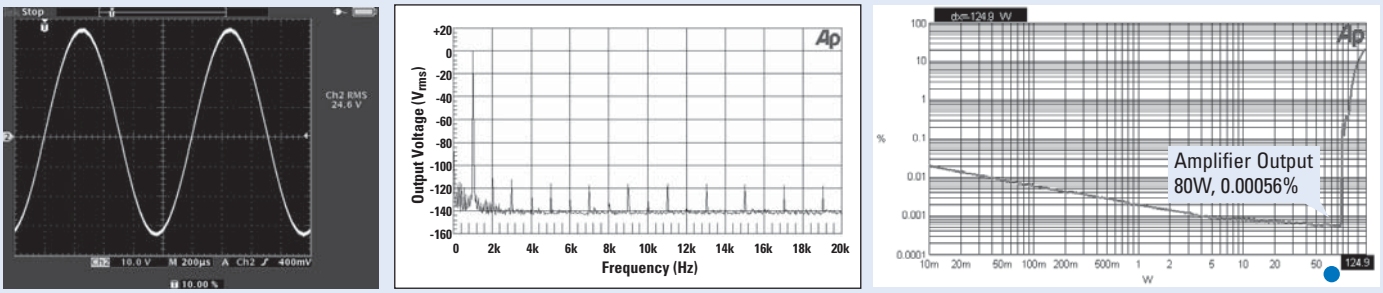


Figure 2: Amplifier output: Po = 106W, THD+N = 1%, R_L = 8Ω

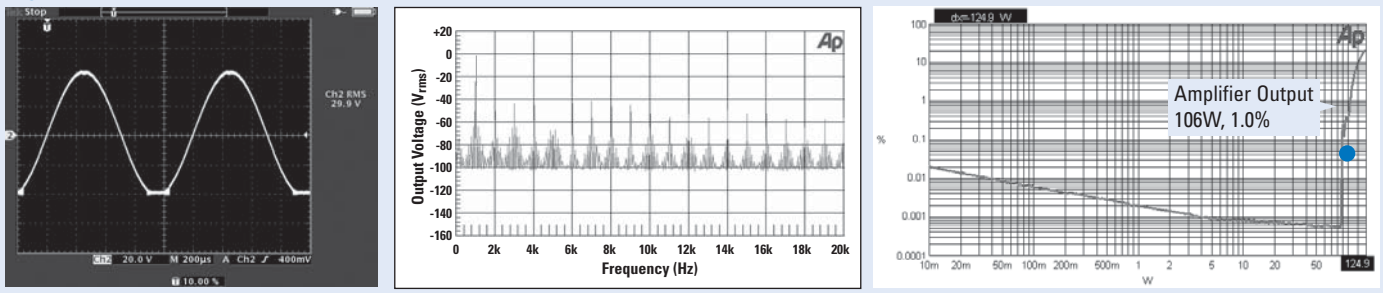


Figure 3: Amplifier output: Po = 125W, THD+N = 10%, R_L = 8Ω

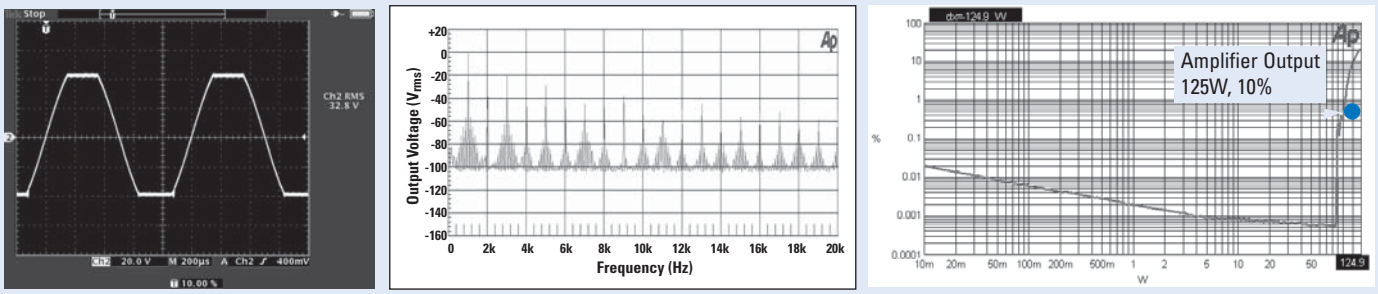


Figure 1 - 3 are collected using National's LM4702

High-Performance Audio Op Amps and Buffers

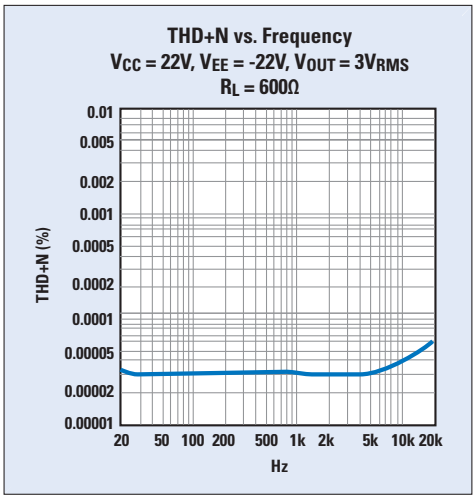
LME49860 – 44V Dual High-Performance, High-Fidelity Operational Amplifier

Features

- Easily drives 600Ω loads
- Optimized for superior audio signal fidelity
- Output short circuit protection
- PSRR and CMRR exceed 120 dB (typ)
- Available in SOIC-8 and DIP-8 packaging

Applications

Ideal for use in high-quality audio amplification, phono pre-amps, high-performance professional audio, high fidelity active filters, equalization and crossover networks, high-performance line drivers and receivers, and high-voltage industrial applications including test, measurement, and ultrasound



Product ID	Description	Input Voltage Noise Density (nV/√Hz)	THD (%)	Slew Rate (V/µS)	GBWP (MHz)	PSRR (dB)	Supply Voltage (V)	Packaging
LME49710 [E]	High-performance, high-fidelity audio op amp	2.7	0.00003	20	56	125	±2.5 to ±17	DIP-8, MSOP-8, TO99-8
LME49870 [E]	High-performance, high-fidelity audio op amp	2.7	0.00003	20	55	125	±2.5 to ±22	SOIC-8
LM4562 [E]	Dual high-performance, high-fidelity audio op amp	2.7	0.00003	20	56	110	±2.5 to ±17	DIP-8, MSOP-8, TO99-8
LME49720 [E]	Dual high-performance, high-fidelity op amp	2.7	0.00003	20	56	110	±2.5 to ±17	DIP-8, MSOP-8, TO99-8
LME49860	44V dual high-performance, high-fidelity audio op amp	2.7	0.00003	20	55	120	±2.5 to ±22	SOIC-8
LME49740 [E]	Quad high-performance, high-fidelity audio op amp	2.7	0.00003	20	56	125	±2.5 to ±17	DIP-14, SOIC-14
LME49713	High-performance, high-fidelity current feedback audio op amp	1.9	0.00008	1900	30	102	±5 to ±18	SOIC-8
LME49721 [E]	High-performance, high-fidelity, rail-to-rail input/output audio op amp	4	0.0002	8.5	20	103	2.2 to 5.5	MSOP-8
LME49723 [E]	Dual, high-fidelity audio op amp	3.6	0.0002	8	17	100	±2.5 to ±17	MSOP-8
LME49722 [E]	Dual high-performance, high-fidelity audio op amp	1.9	0.00002	22	55	120	±2.5 to ±18	MSOP-8
LME49725	Dual high-performance, high-fidelity audio op amp	3.3	0.0004	15	40	120	±4.5 to ±18	MSOP-8
LME49743	Quad high-performance, high-fidelity audio op amp	3.5	0.0001	12	30	98	±4 to ±17	TSSOP-14
LME49726	High-current, low-distortion, rail-to-rail output audio op amp	6.9	0.00002	3.7	6.25	104	2.5 to 5.5	MSOP-8
LME49724	High-performance, high-fidelity, fully-differential audio op amp	2.1	0.00003	18	50	125	±2.5 to ±18	PSOP-8
LME49871	High-performance, high-fidelity, current-feedback audio op amp	1.9	0.00012	1900	213	102	±5.0 to ±22	SOIC-8

[E] Evaluation board

Headphone Buffers

Product ID	Description	THD (%)	Output Current (mA)	Slew Rate (V/µS)	GBWP (MHz)	Supply Voltage (V)	Supply Voltage (V)	Packaging
LME49600	High-performance, high-fidelity, high-current audio buffer	0.00015	250	2000	110/180	±18V	±5 to ±18	TO263-5
LME49610	High-performance, high-fidelity, high-current audio buffer	0.00003	250	2000	120/200	±22V	±2.5 to ±22	TO263-5

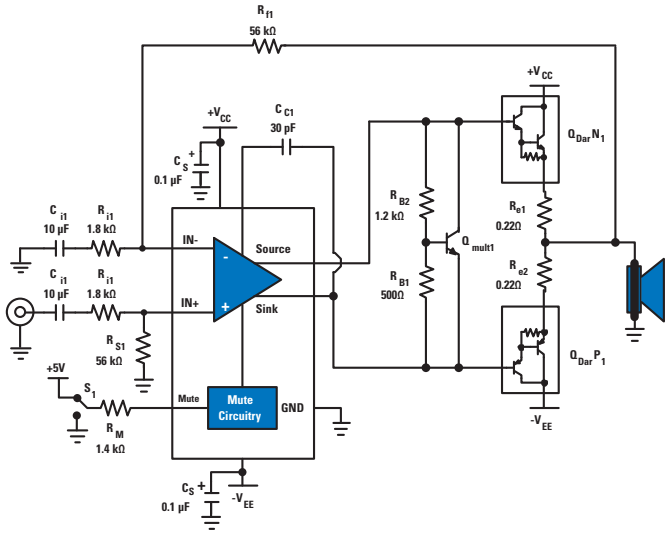
LME49811 – Audio Power Amplifier Series Mono High-Fidelity 200V Driver with Mute

Features

- Very high voltage operation
- Scalable output power
- Minimum external components
- External compensation
- Thermal shutdown and mute

Applications

Ideal for use in AV receivers, audiophile power amps, pro audio, and high-voltage industrial applications



Product ID	Description	Supply Voltage (V)	Typical THD Ratings (%)	THD Measurement Conditions	PSRR (dB)	Supply Voltage Range (V)	Mute/ Shutdown	Packaging
LM4702B	Stereo high-fidelity audio power amplifier driver	±100	0.003	A_V = 30 dB, V_{OUT} = 20 V_{RMS} at 1 kHz	110	±20 to ±100	Mute	TO220-15
LM4702C	Stereo high-fidelity audio power amplifier driver	±75	0.005	A_V = 30 dB, V_{OUT} = 14 V_{RMS} at 1 kHz	110	±20 to ±75	Mute	TO220-15
LME49810	Mono high-fidelity audio power amplifier driver with Baker clamp	±100	0.0007	No Load, BW = 30 kHz, V_{OUT} = 20 V_{RMS} at 1 kHz	110	±20 to ±100	Mute	TO247-15
LME49811	Mono high-fidelity audio power amplifier driver with mute	100	0.005	No load, A_V = 30 dB V_{OUT} = 10 V_{RMS} at 1 kHz	110	±20 to ± 100	Mute	TO220-15
LME49830	Mono high-fidelity audio power amplifier input state with mute	±100	0.0006	No load, A_V = 30 dB, V_{OUT} = 30 V_{RMS} at 30 kHz	105	±20 to ± 100	Mute	TO247-15

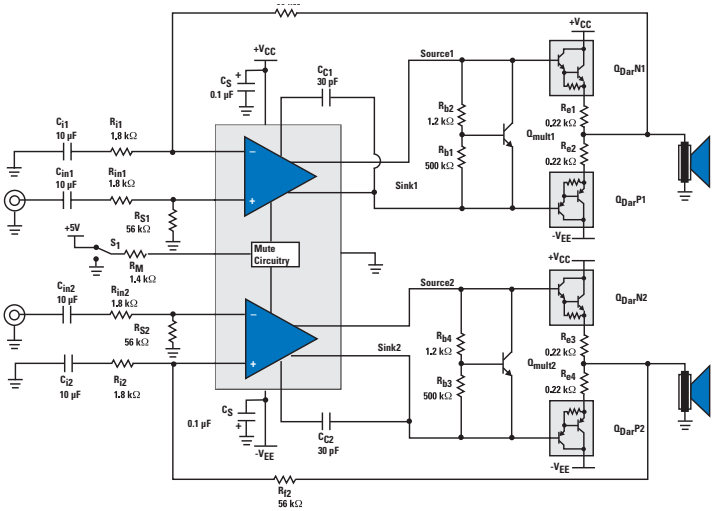
LM4702 – Audio Power Amplifier Series Stereo High-Fidelity 200V Driver with Mute

Features

- Very high voltage operation
- Scalable output power
- Minimum external components
- External compensation
- Thermal shutdown and mute

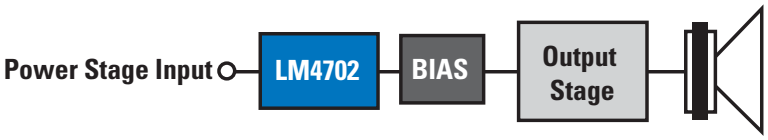
Applications

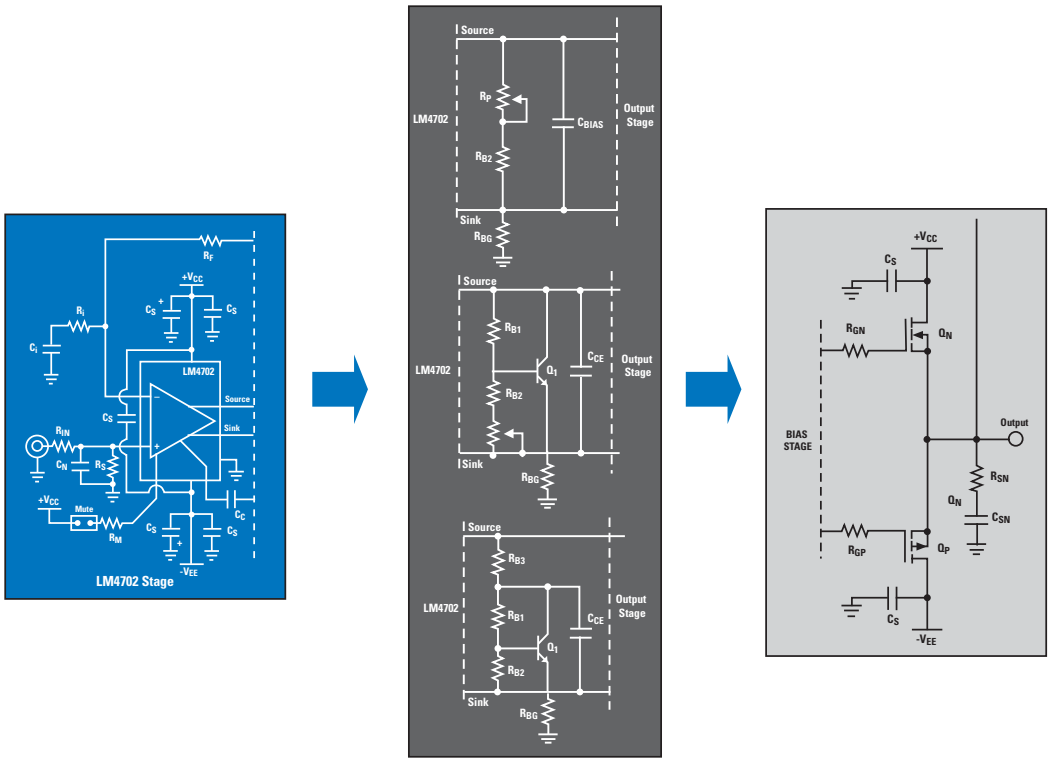
Ideal for use in AV receivers, audiophile power amps, pro audio, and high-voltage industrial applications

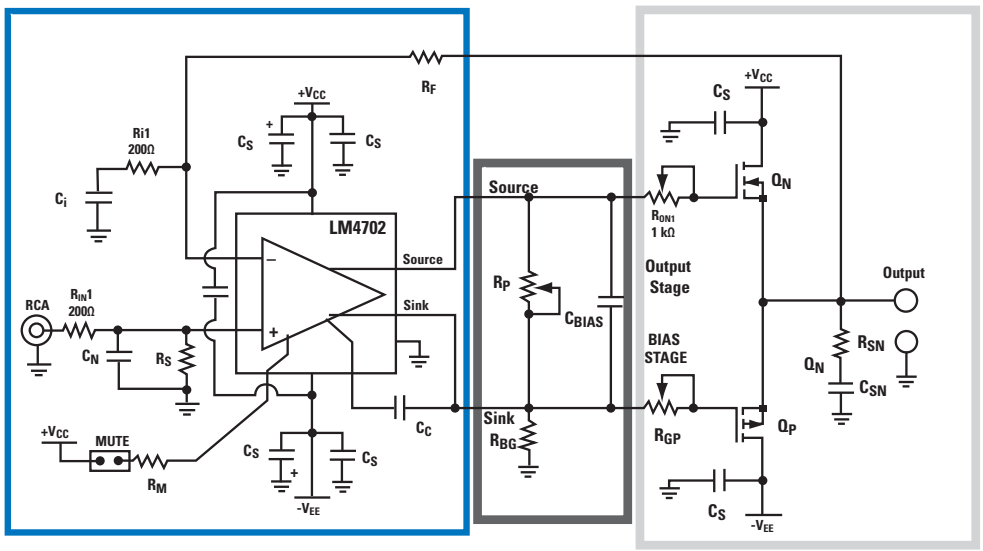


AUDIO

High-Performance Audio Driving a MOSFET Stage







TECHNOLOGY Edge

For more information, read AN-1645 for help with the design of MOSFET drivers www.national.com/edge

National's Power Management Product Portfolio

Power Solutions by Category

Voltage Conversion
- Linear regulators
- Switching regulators
  - SIMPLE SWITCHER® regulators/controllers
  - Synchronous
  - Inductorless
  - PWM controllers
  - Isolated solutions
  - High voltage

Voltage Control
- MOSFET drivers
- USB switches
- H-bridges
- Motor driving and motion control
- Hot swap

Voltage References
- Shunt
- Serial
- High precision
- Digitally stored calibration

Voltage Monitoring
- Current gauges
- Battery charging
- Reset circuits
- Programmable supervisory

Power Solutions by Application

Core and I/O Voltage (DSPs/FPGAs/ASICs)
- LDOs
- Switching regulators
- Switched caps
- Switching controllers

Analog and Signal-Path Power
- Low-noise LDOs
- Switching regulators

Lighting Management
- LMUs*
- White LED drivers
- RGB LED drivers
- Inductorless constant-current sources

DDR Memory Power
- Termination regulators
- Core regulators

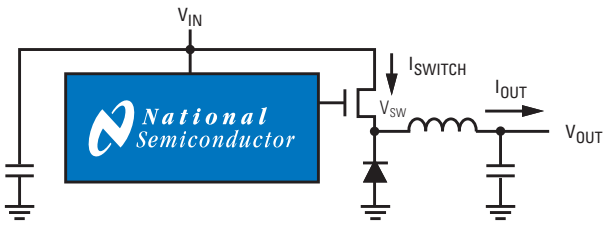
Communications Infrastructure
- Hot swap controllers
- PWM controllers
- Buck/boost switching regulators
- Dual phase controllers
- MOSFET drivers
- Power-over-Ethernet

Portable/Battery Applications
- Li-Ion battery chargers
- Switching regulators
- PMUs**
- RF PA regulators
- Voltage supervisory
- White/RGB LED drivers

*LMUs = Highly-integrated Lighting Management Units
**PMUs = Highly-integrated Power Management Units

Switching Power Supply Topologies

Buck



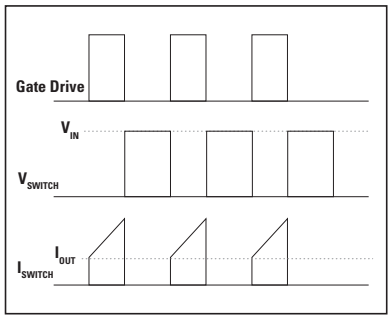
Function: Step-down ($V_{OUT} < V_{IN}$)

When to use: Typically when V_{IN} is 3x to 5x V_{OUT} and I_{OUT} is > 0.5A and < 5A

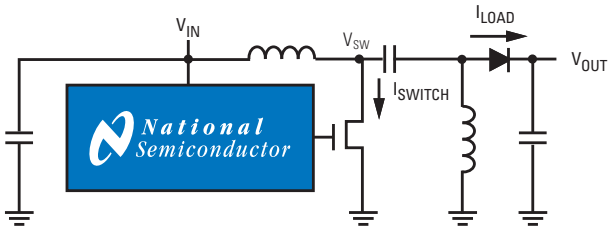
Characteristics: Easy to design and good efficiency for the above mentioned typical V_{IN}/V_{OUT}/I_{OUT} conditions

Devices to use: All buck integrated regulators and controllers

Comments: Can do multi-output or isolation through coupling a second inductor to the one shown in the basic circuit



SEPIC



SEPIC = Single Ended Primary Inductor Converter

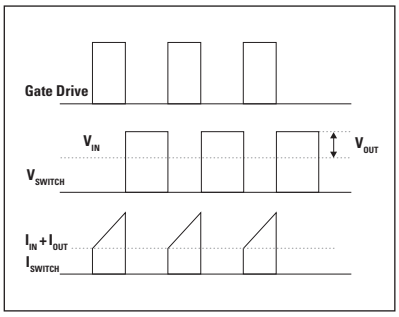
Function: Buck-boost (V_{IN} max. > V_{OUT} > V_{IN} min.)

When to use: Excellent option when buck-boost operation is needed and no transformer is desired

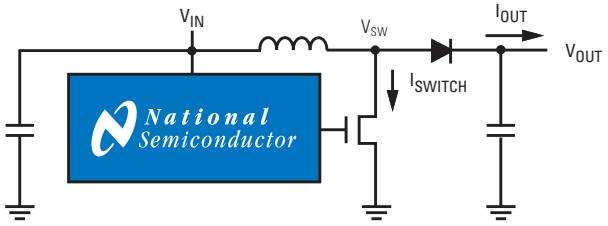
Characteristics: Lower input ripple than flyback, no snubber circuitry required

Devices to use: Any boost/flyback regulator or controller

Comments: Also useful for replacing boost circuits when true shutdown is required



Boost



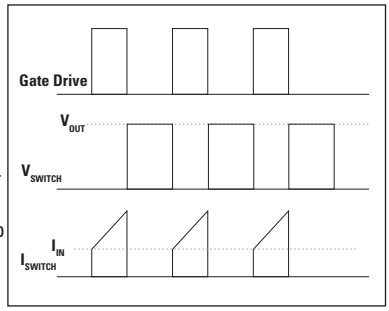
Function: Step-up ($V_{OUT} > V_{IN}$)

When to use: Typically used when transformerless, regulated output voltages larger than input voltages at output currents beyond 100 mA - 200 mA are required

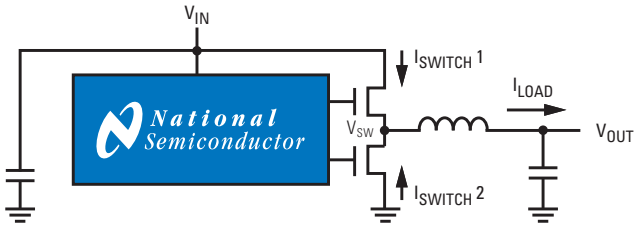
Characteristics: Best for low-power conversion (up to 10W or 20W) and output voltages less than or equal to 7x the input voltage

Devices to use: All boost/flyback regulators and controllers

Comments: Output current V_{IN}/V_{OUT} x 0.7 x switch current



Synchronous Buck

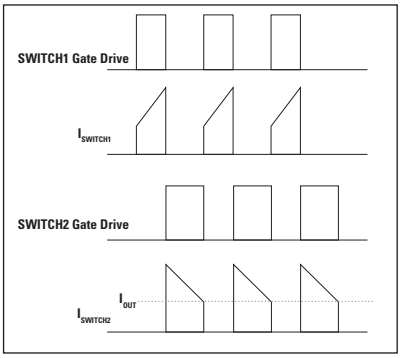


Function: Step-down ($V_{OUT} < V_{IN}$)

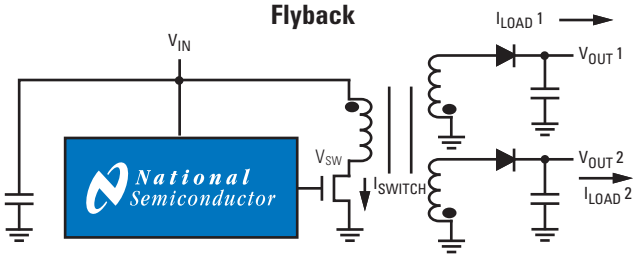
When to use: When high efficiency is required with high-output current (> 5A) or low duty cycles (V_{IN} > 5 x V_{OUT} and/or I_{OUT} < 0.5A)

Characteristics: A second switch replaces the diode in the basic buck topology, reducing losses in the conditions mentioned above

Devices to use: Any "synchronous rectification" buck integrated regulator or controller



Flyback

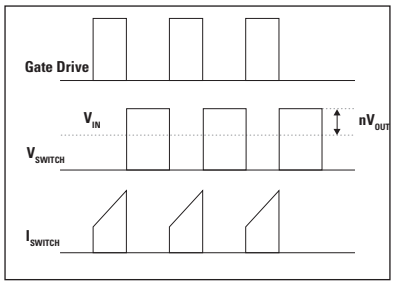


Function: Step-up, step-down, invert or buck-boost

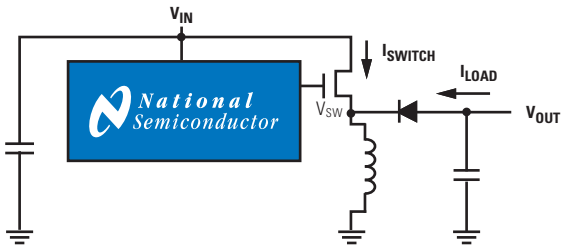
When to use: Typically when multi-output or isolation is required, when step-up beyond 8 x V_{IN} is required or when the max. voltage or current of the switch needs to be extended in order to take advantage of the turns-ratio conversion from the transformer

Characteristics: Ideal for medium-power conversion (5W to 100W)

Devices to use: All boost/flyback regulators and controllers



Inverting Buck Boost

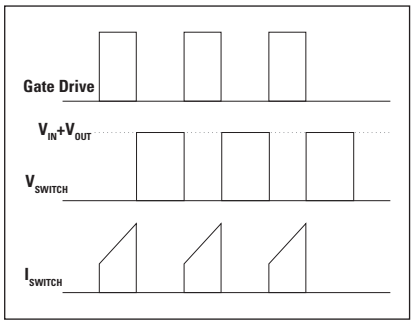


Function: Inverting (negative output from positive input, $-V_{OUT}$ can be greater than or less than V_{IN})

When to use: When an inverted, regulated output is needed. This topology is commonly used for output currents from approximately 300 mA to 5A

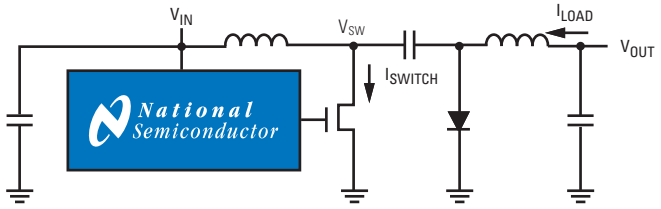
Characteristics: Easy to implement, single output

Devices to use: Any buck integrated regulator or controller (see National's App Note AN-1157 for implementing with a SIMPLE SWITCHER® buck regulator)



Comments: Alternatives for voltage inversion include cuk topologies (low noise) or switched capacitor converters where I_{OUT} is less than 200 mA (no inductor needed)

Cuk



Function: Inverting (V_{OUT} is negative; V_{IN} is positive)

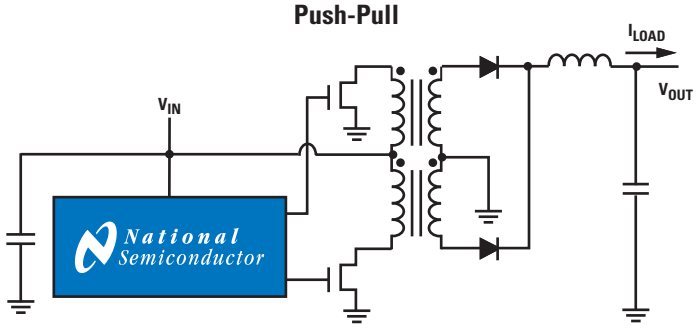
When to use: When a regulated, negative, low-ripple voltage is needed from a positive supply

Characteristics: Continuous current at input and output translates into a very low-ripple/very low-noise design

Devices to use: Any boost/flyback regulator – this is easiest with parts that have a negative FB input pin

Comments: OK for isolation when a 1:1 transformer is added

Push-Pull

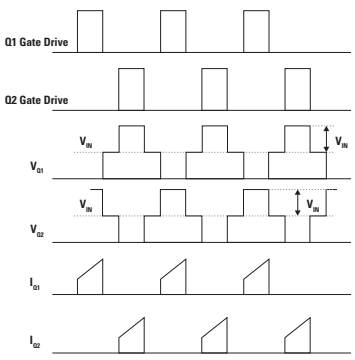


Function: Isolated step-down, step-up or buck-boost and multiple outputs

When to use: When isolated, medium-to-high power conversion is needed (25 W to 1000 W). This topology can also be used when the input voltage range is very wide or when the V_{IN}/V_{OUT} ratio instep-down applications requires a very small duty cycle (and thus might yield poor regulation) if a standard buck topology is used.

Devices to use: LM5030, LM5037, and LM25037 current-mode push-pull controller

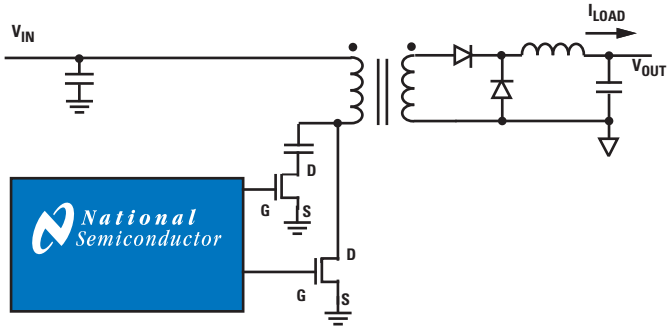
Comments: The peak current and voltage stress in the switches are given by: V_{PK} = 2.6 V_{IN} max., I_{PK} = 1.56 x P_{OUT}/V_{IN} min.



POWER

Switching Power Supply Topologies

Active Clamp Forward



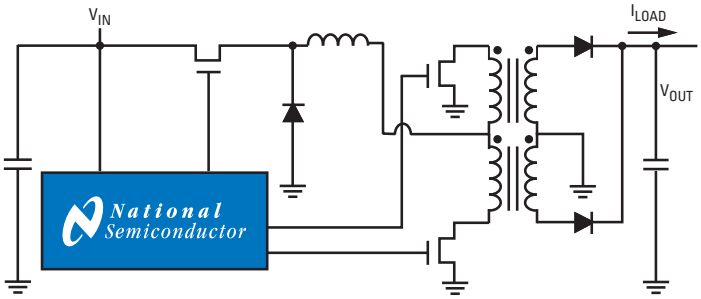
Function: Isolated, step-down or step-up

When to use: High step down ratios and/or isolated output and 100-300W power

Devices to use: LM5025, LM5026, LM5032, LM5034

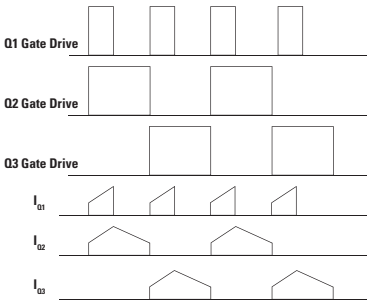
Comments: Forward topology requires lower peak current than flyback. At the start of a switch conduction, the net magnetization of the transformer core must be zero. Active Clamp recycles the reset energy, improving efficiency.

Current-Fed Push-Pull (Cascaded)



Function: Isolated step-down, step-up, or buck-boost topologies. Can do tightly regulated multiple outputs.

When to use: When isolated medium- to high-power conversion is needed, but reduced losses, high efficiency, and no output inductor are also desired.

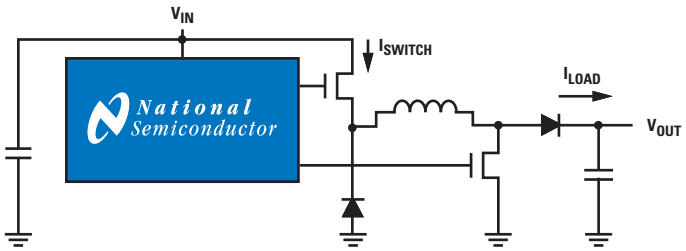


Characteristics: The current-fed cascaded topology consists of a buck regulation stage followed by a push-pull isolation stage. Because the buck stage feeds continuous current to the push-pull stage, no output inductor is required.

Devices to use: LM5041, LM5041A/41B current-mode cascaded controller

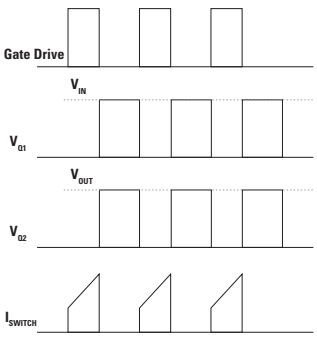
Comments: To increase conversion efficiency, the use of synchronous rectification is recommended, both for the current-fed buck stage and the push-pull output stage (self-driven synchronous rectification)

Single Inductor Buck and Boost



Function: Step-up and step-down

When to use: This topology is an alternative to sepic and flyback topologies when automatic step-up/step-down functionality is needed, but no transformer or second inductor is required

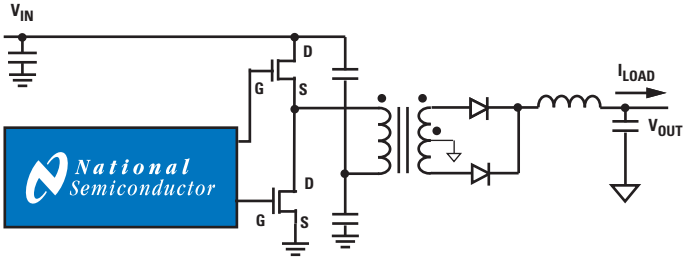


Characteristics: A second switch and output diode are added, resulting in an effective overlapped boost topology on top of a basic buck topology. If desired, synchronous rectification can be implemented to increased efficiency (both diodes may be replaced by FETs).

Devices to use: LM5118

Comments: Be sure to watch the voltage applied to the gate in the second FET which will be V_{IN}. If V_{IN} is too high for the selected FET specifications, use voltage limiting circuitry.

Half Bridge

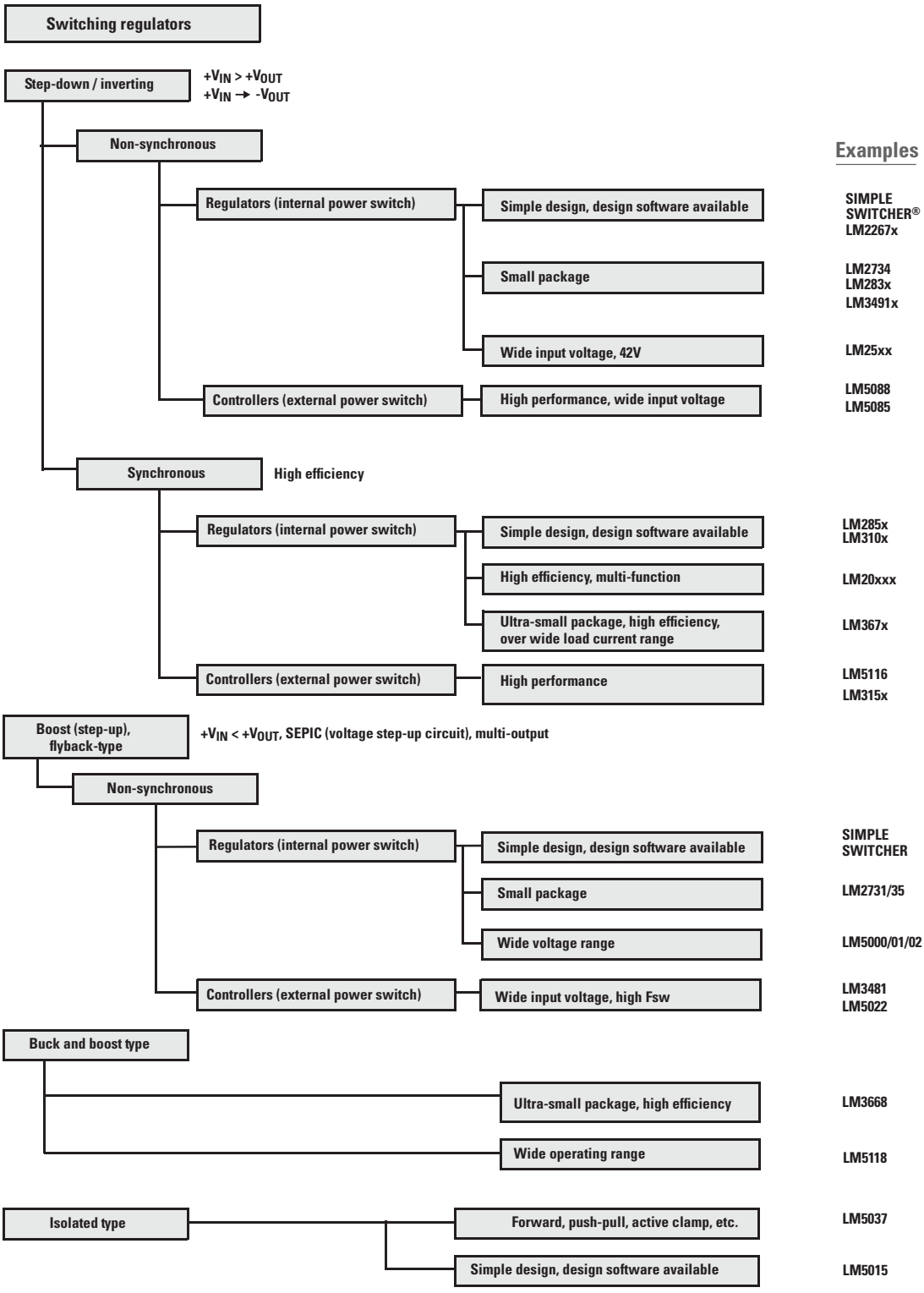


Function: Isolated, step-down or step-up

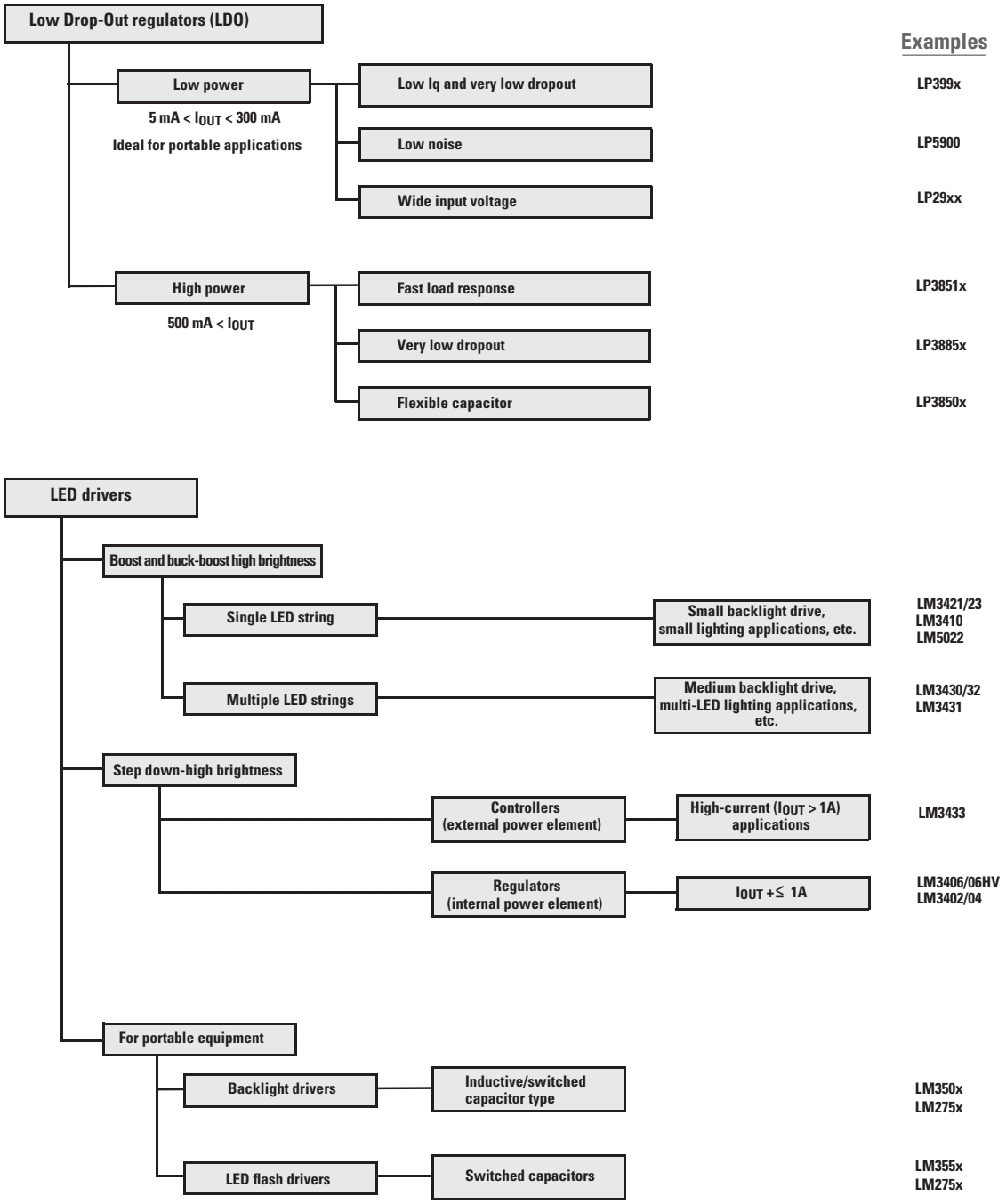
When to use: High step down ratios and/or isolated output and 200-1000W power

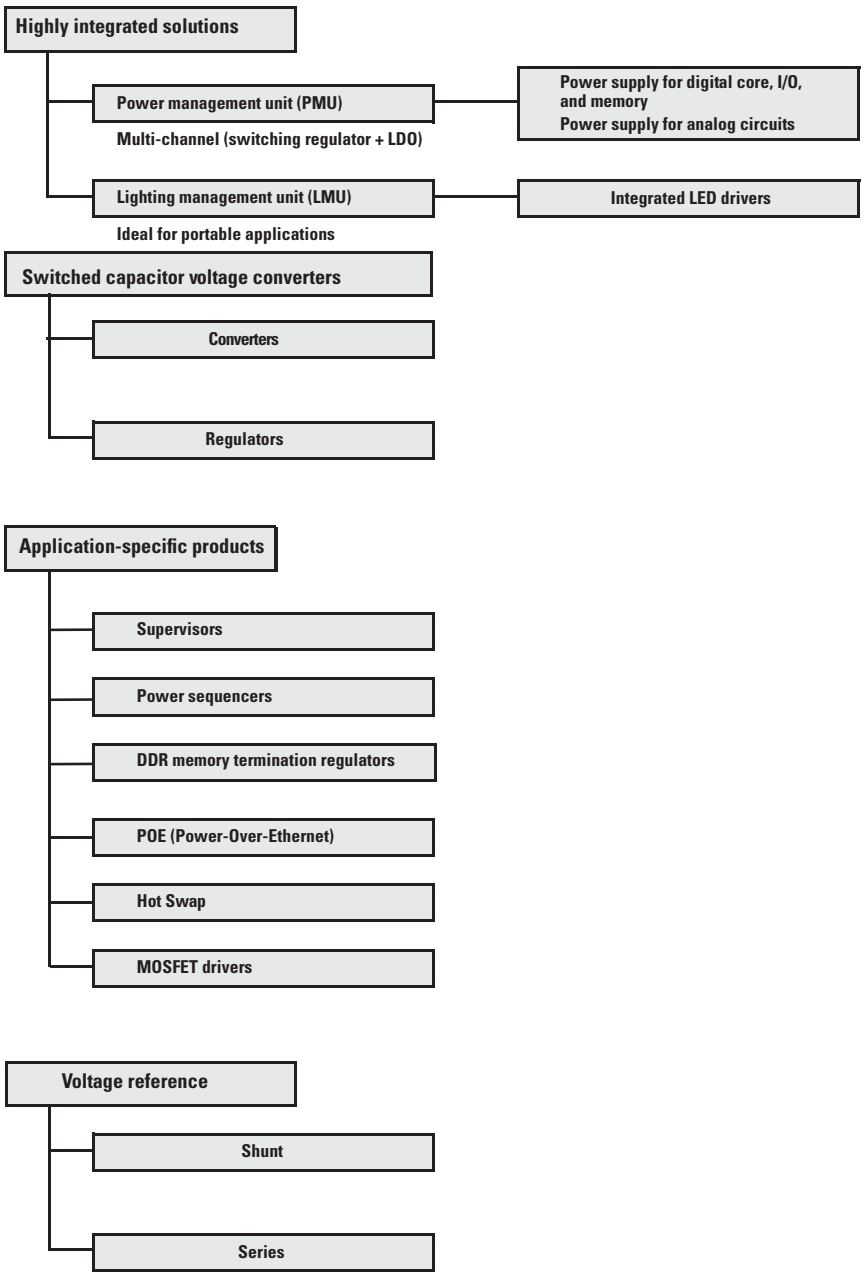
Devices to use: LM5033, LM5035, LM5037, and LM25037

Comments: The half bridge converter is similar to the push pull converter, but FETs are subject to lower voltages stresses and a center tapped primary is not required. The reversal of the magnetic field is achieved by reversing the direction of the primary winding current flow. For higher output power capability a full bridge may be used instead.


Switching regulators
Step-down / inverting
+VIN > +VOUT
+VIN → -VOUT
Non-synchronous
Regulators (internal power switch)
Simple design, design software available
Small package
Wide input voltage, 42V
Controllers (external power switch)
High performance, wide input voltage
Synchronous
High efficiency
Regulators (internal power switch)
Simple design, design software available
High efficiency, multi-function
Ultra-small package, high efficiency, over wide load current range
Controllers (external power switch)
High performance
Boost (step-up), flyback-type
+VIN < +VOUT, SEPIC (voltage step-up circuit), multi-output
Non-synchronous
Regulators (internal power switch)
Simple design, design software available
Small package
Wide voltage range
Controllers (external power switch)
Wide input voltage, high Fsw
Buck and boost type
Ultra-small package, high efficiency
Wide operating range
Isolated type
Forward, push-pull, active clamp, etc.
Simple design, design software available
Examples
SIMPLE SWITCHER®
LM2267x
LM2734
LM283x
LM3491x
LM25xx
LM5088
LM5085
LM285x
LM310x
LM20xxx
LM367x
LM5116
LM315x
SIMPLE SWITCHER
LM2731/35
LM5000/01/02
LM3481
LM5022
LM3668
LM5118
LM5037
LM5015

Power Management Products




Highly integrated solutions
Power management unit (PMU)
Multi-channel (switching regulator + LDO)
Power supply for digital core, I/O, and memory
Power supply for analog circuits
Lighting management unit (LMU)
Ideal for portable applications
Integrated LED drivers
Switched capacitor voltage converters
Converters
Regulators
Application-specific products
Supervisors
Power sequencers
DDR memory termination regulators
POE (Power-Over-Ethernet)
Hot Swap
MOSFET drivers
Voltage reference
Shunt
Series
Examples
LM26480/LP3906
LM3687/LM3370
LP395xx
LP552xx
LM27xx
LM277x
LM37xx
LM3880/81
LP299x
LM507x
LM506x
LM51xx
LM40xx, LM385, LM431
LM41xx

WEBENCH® Online Design Environment

Save Development Time and Costs

WEBENCH online design and prototyping tools deliver results faster than ever. Now you have the world's most powerful and award-winning online design environment right at your fingertips. Design, optimize, generate your prototype, and download your test vectors—all online.
And do it all for free, anywhere, anytime.

Select It

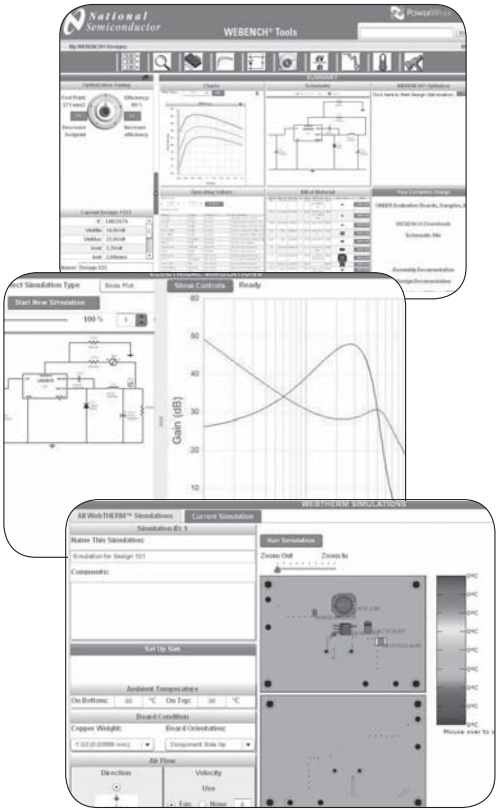
- Input your design requirements
- Choose a recommended part from a customized list

Choose from only those parts that meet your specifications

Design It

- Adjust components and use charts to make design decisions based on power dissipation, current flow, offset voltage, drift, frequency response, output-voltage ripple, efficiency, inductor-current ripple, and other electrical characteristics over the full operating range
- Exchange parts and use bill of materials graph for easy external component selection based on efficiency, footprint, cost, or vendors

Create your custom BOM using readily available parts

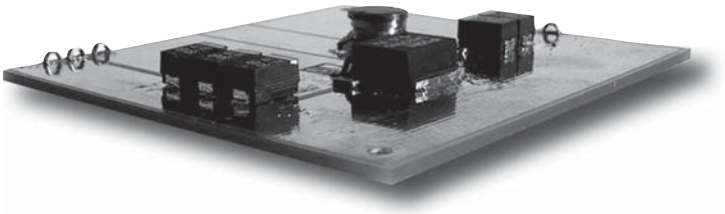


Build It

- Request samples and purchase parts or demo boards
- Receive your custom prototyping kit the next business day
- Download your automatically generated CAD files, assembly details, test instructions, and complete performance

Save weeks getting your final design into production

24 HOUR SHIPPING!



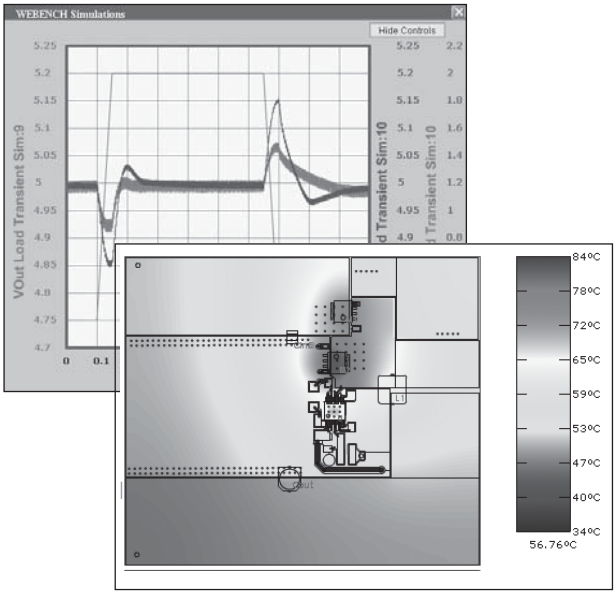
Analyze It

- Stimulate your circuit and evaluate performance using electrical and thermal simulations
- Overlay alternate circuits and compare results to get optimal performance

Solve your design problems before you prototype

Power Supply Design Tool

The WEBENCH environment provides the end-to-end design and prototyping tools you need to create power supplies that meet your design's requirements. WEBENCH tools let designers solve design problems before prototyping—alleviating the time and trouble associated with traditional design methods.



WEBENCH Electrical Simulator

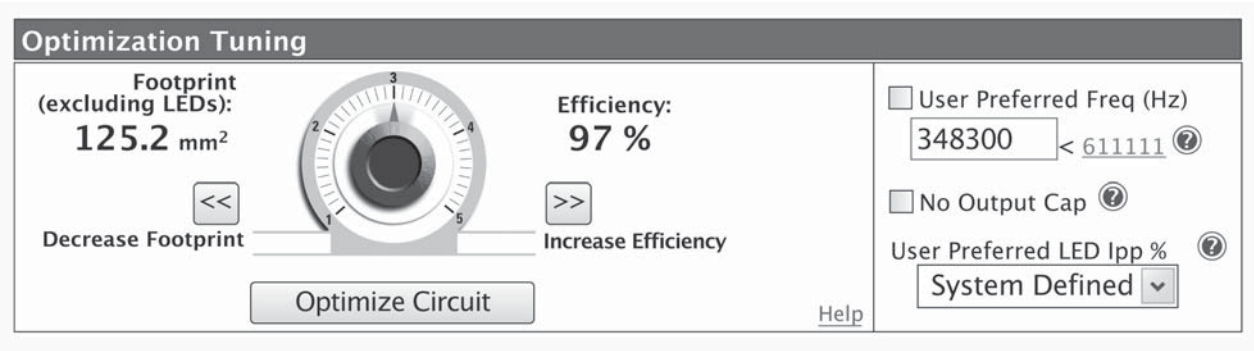
Use this tool to simulate your power supply circuit. Use probe points on a schematic display to examine waveforms, change component values, and view a history of simulation results to fine-tune your design.

WebTHERM™ Thermal Simulator

Use this tool to simulate thermal behavior of an electronic PCB. Define the environment, solve thermal problems and output a color plot of the PCB under user-specified load and environmental conditions.

Optimization Tool

Use the new WEBENCH optimization tool to quickly tune your design and balance your design objectives. By simply rotating a knob, you can achieve minimum component footprint, maximum efficiency, or a combination of both. Other key features include the ability to directly specify the switching frequency, and, for LED designs, specify output ripple current and eliminate the output capacitor. Use an alternate passive components list to make tradeoffs for key parameters such as voltage, current, price, size, and other electrical parameters.

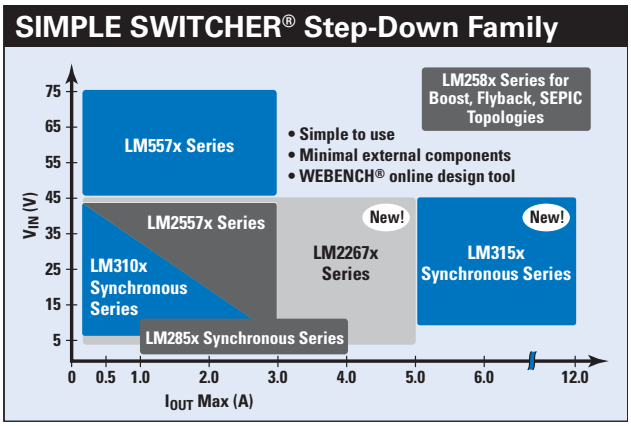


SIMPLE SWITCHER® Solutions

SIMPLE SWITCHER Products

National's award-winning SIMPLE SWITCHER® products allow you to design and optimize robust power supplies with a minimum set of external components. Supporting input voltage ranges of 3V to 75V, each SIMPLE SWITCHER series provides you with multiple products with pin-to-pin compatibility for added design flexibility. Plus, all SIMPLE SWITCHER products utilize National's WEBENCH Power Designer end-to-end design and prototyping tools.

Visit: national.com/switcher



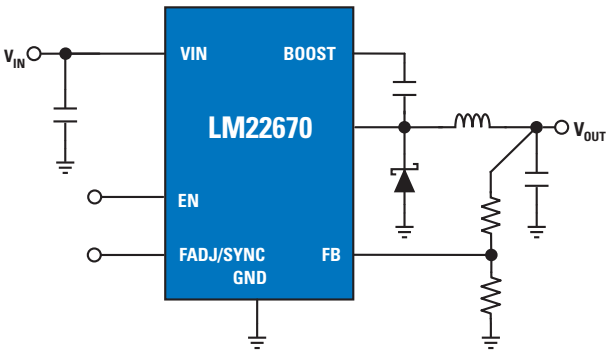
NEW!

LM2267x AND LM22680 SIMPLE SWITCHER Regulators

The LM2267x and LM22680 SIMPLE SWITCHER regulators provide intuitive, easy-to-use design capabilities while delivering high performance and flexibility.

Features

- Wide input voltage range from 4.5V to 42V
- Load currents from 0.5A to 5A
- Adjustable and fixed output voltages down to 1.285V
- Adjustable and fixed switching frequencies allows for optimization between size and efficiency (up to 1 MHz)
- Frequency sync up to 1 MHz allows for easy management of EMI and/or input capacitance optimization
- Precision enable – precise turn-on and turn-off for power sequencing needs assists with proper system startup
- External soft-start – flexibility to control output voltage rampup, ensuring proper end-system startup to avoid latch up conditions
- Available in PSOP-8 and TO263-7 THIN packaging – exposed DAPs provide enhanced thermal dissipation, halogen-free and lead-free
- Fully enabled for WEBENCH® online design tool



LM2267x and LM22680 SIMPLE SWITCHER Non-Synchronous Regulators

Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Frequency Range (kHz)	Sync	PWM Mode	Packaging
LM22671/74 [E, W]	500	42	4.5	1.285	200 to 1000 Adj	✔/–	Voltage	PSOP-8
LM22672/75 [E, W]	1000	42	4.5	1.285	200 to 1000 Adj	✔/–	Voltage	PSOP-8
LM22680 [E, W]	2000	42	4.5	1.285	200 to 1000 Adj	✔	Voltage	PSOP-8
LM22670/73/76 [E, W]	3000	42	4.5	1.285	200 to 1000 Adj	✔/–/–	Voltage	TO263-7 Thin, PSOP-8
LM22677/78/79 [E, W]	5000	42	4.5	1.285	200 to 1000 Adj	✔/–/–	Voltage	TO263-7 Thin

[E] Evaluation board [W] WEBENCH enabled

SIMPLE SWITCHER® Buck Family

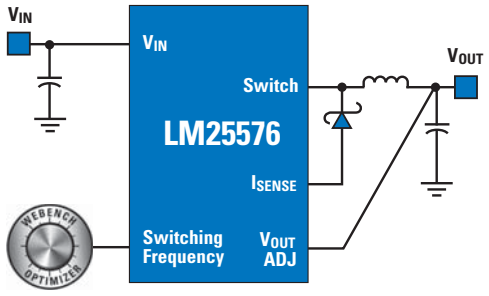
				Maximum Load Current								
		Frequency	Input Voltage (V)	0.5A	0.75A	1A	1.5A	2A	2.5A	3A	4A	5A
Asynchronous	VM	Adj. up to 1 MHz	4.5 to 42	LM22671		LM22672		LM22680		LM22670		LM22677
		Fixed 500 kHz	4.5 to 42	LM22674		LM22675				LM22673 LM22676		LM22678 LM22679
	CM	Adj. up to 1 MHz	6 to 42	LM25574			LM25575			LM25576		
		Adj. up to 500 kHz	6 to 75	LM5574			LM5575			LM5576		
Synchronous	COT	Adj. up to 1 MHz	4.5 to 42		LM3103		LM3100		LM3102			
	VM	500/1500 kHz	2.85 to 5.5					LM2852				
		550 kHz								LM2853		
		500/1000 kHz									LM2854	
	COT	Adj. up to 1 MHz	6 to 42	LM3150 SIMPLE SWITCHER controller up to **12A** with adjustable V_{OUT}								
		250/500/750 kHz		LM315x SIMPLE SWITCHER controller up to **12A** with fixed V_{OUT}								

Asynchronous Rectification, **Synchronous** Rectification, **CM** = Current Mode Control Loop, **VM** = Voltage Mode Control Loop, **COT** = Constant On Time Control

LM2557x/LM557x – PowerWise® SIMPLE SWITCHER Regulators Deliver Customized Performance and Flexibility to Fit Your Design

New Emulated Current Mode (ECM) SIMPLE SWITCHER® Family Features

- High V_{IN} to low V_{OUT} step-down ratios
- Superior transient response
- Fast design, guaranteed performance and flexibility
- Fully WEBENCH® enabled



LM2557x and LM557x SIMPLE SWITCHER Non-Synchronous Regulators

Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Frequency Range (kHz), Sync	On/Off Pin	PWM Mode	Packaging
LM25574 E,W	500	42	6	1.23	40	50 to 1000, Sync	✔	Current	TSSOP-16
LM5574 E,W	500	75	6	1.23	70	50, Sync	✔	Current	TSSOP-16
LM25575 E,W	1500	42	6	1.23	40	50 to 1000, Sync	✔	Current	TSSOP-16EP
LM5575 E,W	1500	75	6	1.23	70	50, Sync	✔	Current	TSSOP-16EP
LM25576 E,W	3000	42	6	1.23	40	50 to 1000,Sync	✔	Current	TSSOP-20EP
LM5576 E,W	3000	75	6	1.23	70	50, Sync	✔	Current	TSSOP-20EP

SIMPLE SWITCHER Boost/Flyback/SEPIC

Product ID	I_{OUT}	Input Max Voltage (V)	Input Min Voltage (V)	Output Min Voltage (V)	Frequency Range (kHz), Sync	Packaging
LM2585 W	3	40	4	1.23	100	TO-220, TO-263
LM2586 W	3	40	4	1.23	100 to 200	TO-220, TO-263
LM2587 E,W	5	40	4	1.23	100	TO-220, TO-263
LM2588 W	5	40	4	1.23	100 to 200	TO-220, TO-263

PowerWise product E Evaluation board W WEBENCH enabled

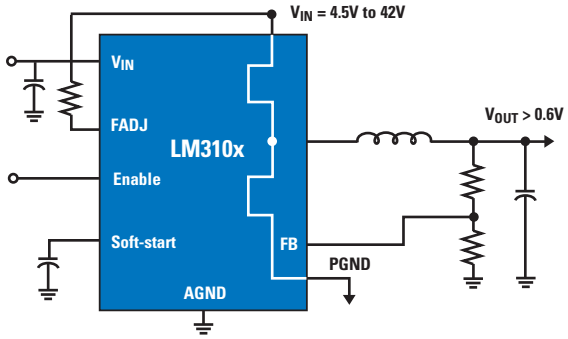
Visit: www.national.com/switcher

SIMPLE SWITCHER® Synchronous Regulators

LM310x – PowerWise® Synchronous SIMPLE SWITCHER® Step-Down Regulators

Features

- COT control provides lightning-fast transient response
- Stable with ceramic capacitors
- Near-constant frequency operation from unregulated supplies
- No loop compensation reduces external component count
- Pre-bias startup
- DCM operation for a light load
- Over voltage protection
- Available in thermally-enhanced eTSSOP-20 packaging



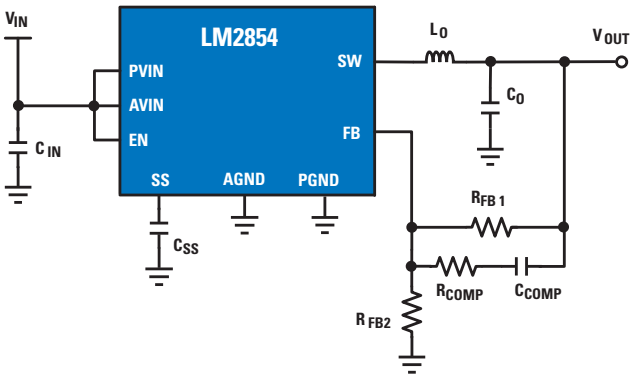
Applications

Ideal for use in embedded systems, industrial controls, automotive telematics and body electronics, Point-of-Load (POL)

LM285x – PowerWise 500 kHz/1 MHz Synchronous SIMPLE SWITCHER Step-Down Regulator

Features

- Input voltage range of 2.95V to 5.5V
- Maximum load current of 4A
- Fixed switching frequency of 500 kHz or 1 MHz
- Adjustable output down to 0.8V
- Wide bandwidth voltage mode control loop, partial internal compensation
- Pre-biased load startup capability
- 100% duty cycle capability
- Available in eTSSOP-16 packaging



Applications

Ideal for use in low-voltage point-of-load regulation, local solution for PGA/DSP/ASCI/µP core or I/O power, broadband, and communications infrastructure

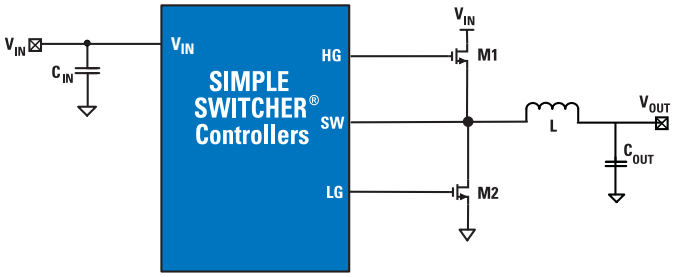
SIMPLE SWITCHER Synchronous Regulators

Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Frequency Range (kHz) and Sync (computed field)	PWM Mode	Packaging
LM3103 E,W	750	42	4.5	0.6	38	1000	COT	eTSSOP-16
LM3100 E,W	1500	36	4.5	0.8	32	1000	COT	eTSSOP-20
LM2852 E,W	2000	5.5	2.85	0.8	3.3	500, 1500	Voltage	eTSSOP-14
LM3102 E,W	2500	42	4.5	0.8	38	1000	COT	eTSSOP-20
LM2853 E,W	3000	5.5	3	0.8	3.3	550	Voltage	eTSSOP-14
LM2854 E,W	4000	5.5	2.95	0.8	5	500, 1000	Voltage	eTSSOP-16

PowerWise® product E Evaluation board W WEBENCH Enabled

LM315x – SIMPLE SWITCHER® Synchronous Controllers

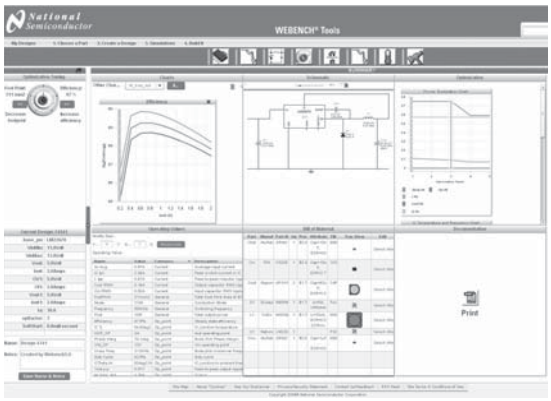
Designed to support higher current applications, the LM315x SIMPLE SWITCHER® controllers are National's newest addition to its popular brand of switching solutions.



Features

LM315x Controller

- Input voltage ranging from 6V to 42V
- Output current up to 12A
- Constant On-Time control eliminates the need for complex compensation circuitry
- Patent-pending Emulated Ripple Mode allows for the use of low-ESR output capacitors for reduced solution size and reduced output voltage ripple
- Synchronous architecture for added efficiency
- Exposed pad TSSOP-14 packaging for enhanced thermal performance
- Fully WEBENCH® enabled



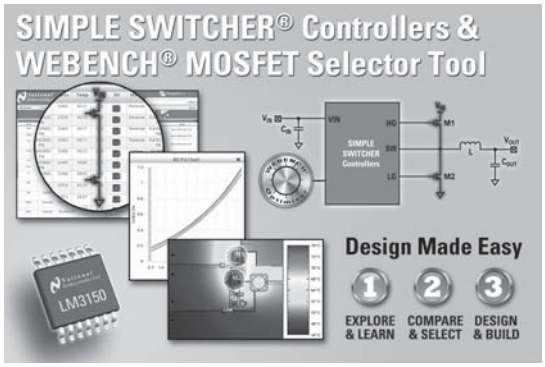
LM3150 Controller

- Adjustable output voltage down to 0.6V
- Adjustable frequency up to 1 MHz

LM3151/52/53 Controller

- Fixed output voltages: 3.3V
- Fixed frequencies: 250 kHz, 500 kHz, 750 kHz

Features robust design tools including the enhanced WEBENCH® Power Designer online tool, external component selection, new WEBENCH MOSFET selection tool, electrical and thermal simulation, and board evaluation



SIMPLE SWITCHER Synchronous Regulators

Product ID	Input Max (V)	Input Min (V)	Output Min (V)	Output Max (V)	Feedback Tolerance %	Frequency Range (kHz) and Sync	Packaging
LM3150 [E,W]	42	6	0.6	Adj	1.50	Adj to 1 MHz	eTSSOP-14
LM3151 [W]	42	6	3.3	42	1.50	250 kHz	eTSSOP-14
LM3152 [W]	33	6	3.3	3.3	1.50	500 kHz	eTSSOP-14
LM3153 [W]	18	6	3.3	3.3	1.50	750 kHz	eTSSOP-14

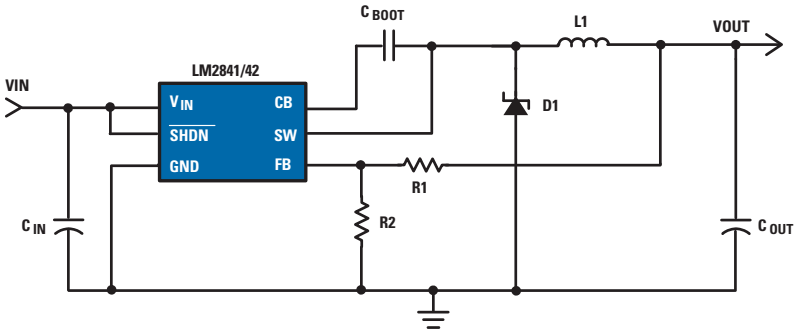
PowerWise® product [E] Evaluation board [W] WEBENCH enabled

Non-Synchronous Step-Down (Buck) Switching Regulators

LM284x – 300 mA/600 mA, 42V Step-Down DC-DC Regulator in Thin SOT-23

Features

- Input voltage range of 4.5V to 42V
- Feedback pin voltage of 0.765V
- 550 kHz (X) or 1.25 Mhz (Y) switching frequency
- Low shutdown I_q, 16 µA typical
- Short-circuit protected
- Internally compensated
- Soft-start circuitry



Non-Synchronous Step-Down (Buck) Switching Regulators

Product ID	Current Ouput (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Frequency Range (kHZ) and Sync	PWM Mode	Packaging
NEW! **LM5009/9A** E, W	150	95	9.5/6	2.5	85	50 to 600	Constant on-time	LLP-8, MSOP-8
NEW! **LM2841** E	300	42	4.5	0.765	34	550 to 1250	Voltage	TSOT-6
NEW! **LM5008/8A** E, W	350	95	9.5/6	2.5	75	50 to 600	Constant on-time	LLP-8, MSOP-8
LM25007 E, W	500	42	9	2.5	37	50 to 800	Constant on-time	MSOP-8, LLP-8
NEW! **LM2842** E	600	42	4.5	0.765	34	550 to 1250	Voltage	TSOT-6
LM2694 E	600	30	8	2.5	24	50 to 1000	Hysteretic	LLP-10, TSSOP-14
LM34919 E	600	40	8	2.5	35	Up to 2000	Constant on-time	micro SMD-10
LM2736 E, W	750	18	3	1.25	16	550, 1600	Current	SOT23-6
LM2830 W	1000	5.5	3	0.6	4.5	1600, 3000	Current	SOT23-5
LM2734/Z E, W	1000	20	3	0.8	18	550, 1600	Current	SOT23-6
LM34930 E	1000	33	8	2.5	30	Up to 2000	Constant on-time	micro SMD-12
LM25010 E, W	1000	42	6	2.5	37	50 to 1000	Constant on-time	LLP-10, TSSOP-14EP
LM5010A E, W	1000	75	8/6	2.5	70	50 to 1000	Constant on-time	LLP-10, TSSOP-14EP
LM2695 E	1250	30	8	2.5	24	50 to 800	Hysteretic	LLP-10, TSSOP-14EP
LM34917A E	1250	33	8	2.5	30	2000	Constant on-time	micro SMD-12
LM34910/C E, W	1250	36/50	8	2.5	33/45	1000	Constant on-time	LLP-10
LM34914 E	1250	40	8	2.5	37	1300	Constant on-time	LLP-10
LM2831 E, W	1500	5.5	3	0.6	4.5	550, 1600, 3000	Current	SOT23-5
LM2738 E	1500	20	3	0.8	18	500, 1600	Current	LLP-8, eMSOP-8
LM26001 E	1500	38	3	1.25	35	150 to 500, Sync	Current	TSSOP-16EP
LM2832 E, W	2000	5.5	3	0.6	4.5	550, 1600, 3000	Current	LLP-6, eMSOP-8
NEW! **LM25011**	2000	42	6	2.5	37	2000	Constant on-time	eMSOP-10
LM25005 E, W	2500	42	7	1.23	37	50 to 500, Sync	Current	TSSOP-20EP
LM5005 E, W	2500	75	7	1.23	70	50 to 500, Sync	Current	TSSOP-20EP
LM2833 E	3000	5.5	3	0.6	4.5	3000	Current	LLP-10, eMSOP-10
LM2696 E, W	3000	24	4.5	1.25	20	100 to 500	Constant on-time	TSSOP-16EP
LM26003 E	3000	38	3	1.25	35	150 to 500, Sync	Current	TSSOP-20EP
LM27341/2	1500/2000	20	3	1	18	1000 to 2350 , Sync	Current	LLP-10, eMSOP-10

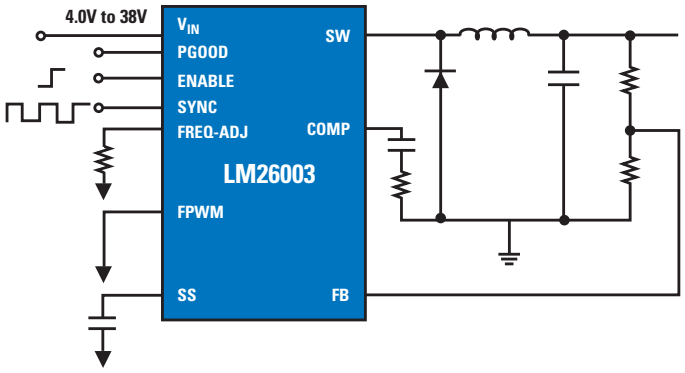
PowerWise® product E Evaluation board W WEBENCH enabled

LM26001/03 – PowerWise® 1.5/3.0A Buck Regulator Delivers Industry-Leading Low I_q and Feedback Voltage Accuracy

Features

- High-efficiency sleep mode (40 µA Iq typ.)
- 10 µA in shutdown mode
- 3V cold-crank compatibility
- 4V to 38V continuous input range
- 1.5% reference accuracy
- Frequency synchronization
- Low input version LM26001B (4.8V to 18V)
- Available in eTSSOP-16/20 exposed-pad packaging

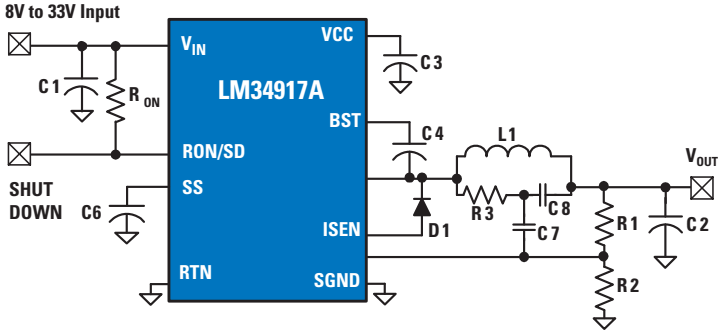
Basic Step-Down Regulator



LM34917A – PowerWise® Ultra-Small 1.25A Buck Switching Regulator with Intelligent Current Limit and OVP

Features

- Wide operating range: 8V to 33V (transient capability to 50V)
- Input Over-Voltage Shutdown at 35V
- Integrated N-Channel buck switch
- Constant On-Time (COT) control for ultra-fast transient response
- Operating frequency remains nearly constant with load current and input voltage variations
- Valley current limit varies with V_{IN} and V_{OUT} to reduce excessive inductor current
- No loop compensation is required
- Maximum switching frequency: 2 MHz
- Available in micro SMD-12 packaging



Applications

Ideal for use in high-efficiency Point-Of-Load (POL) regulators, non-isolated buck regulators, and portable applications

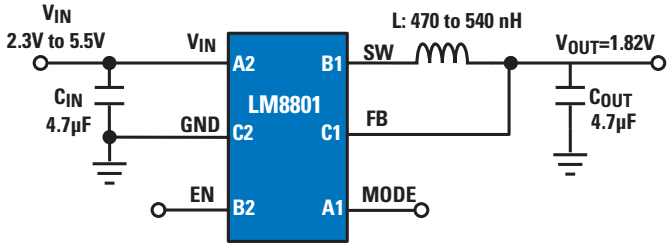
POWER

Synchronous Step-Down (Buck) Switching Regulators

LM8801 – High-Precision 6 MHz Step-Down DC-DC Converter for Mobile Applications

Features

- 6 MHz switching frequency
- High efficiency and low quiescent current
- ±1.5% output voltage accuracy and tight load transients
- Forced PWM and auto PFM/PWM modes
- Under voltage protection
- Current overload protection
- Thermal shutdown protection
- Soft-start
- Output current up to 600 mA
- Fixed output voltages from 0.7V to 2V
- Input voltage range from 2.3V to 5.5V



Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Frequency Range (kHz) and Sync (computed field)	On/Off Pin	PWM Mode	Packaging
LM3670 E, W	350	5.5	2.5	0.7	3.3	1000	✔	Voltage with input feedforward	SOT23-5
LM3673 E, W	350	5.5	2.7	1.1	3.3	2000	✔	Voltage with input feedforward	micro SMD-5
LM3679 E	350	5.5	2.5	1.2	1.8	3000	✔	Auto	micro SMD-5
LM2614	400	5.5	2.8	1	3.6	500 to 1000, Sync	✔	Current	micro SMD-10
LM2612	400	5.5	2.8	1.05	1.8	500 to 1000, Sync	✔	Current	micro SMD-10
LM2612BL	300	5.5	2.8	1.05	1.8	500 to 1000, Sync	✔	Current	micro SMD-10
LM2618	400, 300	5.5	2.8	1.8	1.92	500 to 1000, Sync	✔	Current	micro SMD-10
LM2619	500	5.5	2.8	1.5	3.6	500 to 1000, Sync	✔	Current	micro SMD-10
LM3671 E, W	600	5.5	2.7	1.1	3.3	2000	✔	Voltage with input feedforward micro SMD	SOT23-5, LLP-6,
LM3674 E, W	600	5.5	2.7	1	3.3	2000	✔	Voltage with input feedforward	SOT23-5
LM3676	600	5.5	2.9	1.1	3.3	2000	✔	Voltage with input feed forward	LLP-8
LM3677 E	600	5.5	2.7	1.2	3.3	3000	✔	Voltage with input feedforward	micro SMD-5, LLP-6
LM3691 E	1000	5.5	2.3	0.75	1.8	4000	✔	Voltage with input feedforward	micro SMD-6
NEW! **LM8801**	600	5.5	2.3	1.7	2.0	6000	✔	Voltage with input feedforward	micro SMD-6
LM2651 E	1500	14	14	1.24	13	3000	✔	Current	TSSOP-16
LM2653 E	1500	14	4	1.5	5	300	✔	Current	TSSOP-16
LM3678 E	1500	5.5	2.5	0.8	3.3	3300	✔	PWM only	LLP-10
LM2655 E	2500	14	4	1.24| 3.3	13| 3.3	300	✔	Current	TSSOP-16
LM2650 E	3000	18	4.5	1.5	16	90 to 300	✔	Current	SOIC-24 WIDE

PowerWise® product E Evaluation board W WEBENCH enabled

LM20xxx – PowerWise® Family of High-Efficiency, Full-Featured Synchronous Buck Regulators

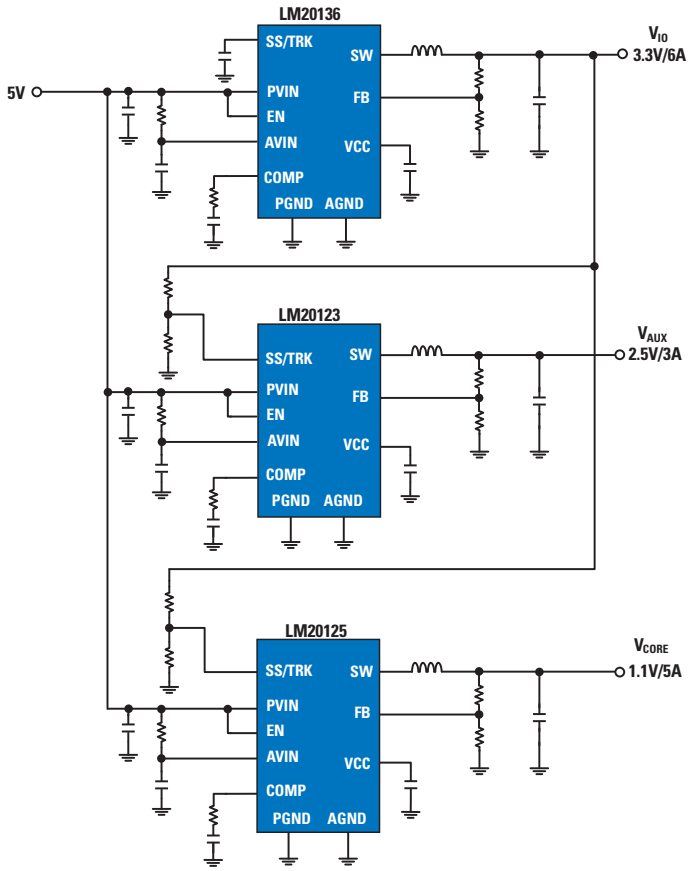
Features

- Fixed and adjustable switching frequency
- Clock synchronization in and out
- External soft-start
- Tracking
- Precision enable
- POWER GOOD
- Pre-biased startup
- Enhanced system reliability
  - High-accuracy current limit
  - Over-voltage protection, under voltage lockout, and over-current protection
- Available in eTSSOP-16 packaging

Applications

Ideal for use in powering FPGAs, DSPs, and microprocessors in servers, networking equipment, optical networks, and industrial power supplies

Sequencing and Tracking for Multiple Rails Typical Application



Product ID	Output Current (A)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Frequency Range (kHz) & Sync (computed field)	On/Off Pin	PWM Mode	Packaging
LM20242 E	2	36	4.5	0.8	32	1000	✔	Current-mode control	eTSSOP-20
LM20123 E, W	3	5.5	2.95	0.8	5	1500	✔	Current-mode control	eTSSOP-16
LM20133 E, W	3	5.5	2.95	0.8	5	460 to 1.5 MHz, Sync-in	✔	Current-mode control	eTSSOP-16
LM20143 E, W	3	5.5	2.95	0.8	5	500 to 1500	✔	Current-mode control	eTSSOP-16
LM20323 E, W	3	36	4.5	0.8	32	500	✔	Current-mode control	eTSSOP-20
LM20333 E, W	3	36	4.5	0.8	32	250 to 1.5 MHz, Sync-in	✔	Current-mode control	eTSSOP-20
LM20343 E, W	3	36	4.5	0.8	32	250 to 1 MHz	✔	Current-mode control	eTSSOP-20
LM20124 E, W	4	5.5	2.95	0.8	5	1000	✔	Current-mode control	eTSSOP-16
LM20134 E, W	4	5.5	2.95	0.8	5	460 to 1.5 MHz, Sync-in	✔	Current-mode control	eTSSOP-16
LM20144 E, W	4	5.5	2.95	0.8	5	500 to 1000	✔	Current-mode control	eTSSOP-16
LM20154 E, W	4	5.5	2.95	0.8	5	1000, Sync-out	✔	Current-mode control	eTSSOP-16
LM20125 E, W	5	5.5	2.95	0.8	5	500	✔	Current-mode control	eTSSOP-16
LM20145 E, W	5	5.5	2.95	0.8	5	250 to 750	✔	Current-mode control	eTSSOP-16
NEW! **LM20136** E, W	6	5.5	2.95	0.8	5	460 to 1500, Sync-in	✔	Current-mode control	eTSSOP-16
NEW! **LM20146** E, W	6	5.5	2.95	0.8	5	250 to 750, Adj	✔	Current-mode control	eTSSOP-16

PowerWise® product E Evaluation board W WEBENCH enabled

Switched-Capacitor Converters and Regulators

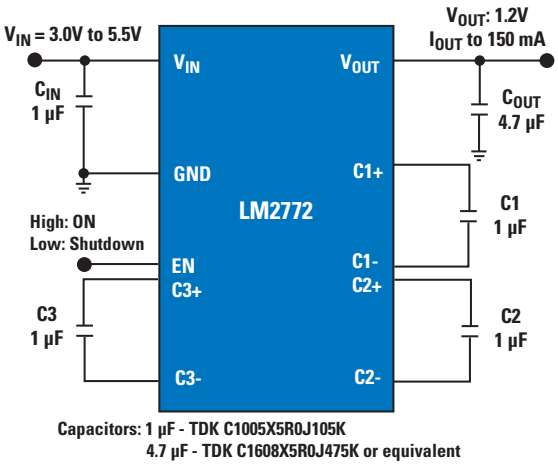
LM2772 – Switched-Capacitor Buck Regulator in Tiny Package

Features

- Output current up to 150 mA
- 1.2V output voltage
- Inductor-less charge pump solution minimizes PCB board space
- PFM mode during light load operation maximizes standby times in battery-powered applications
- 1.1 MHz fixed-frequency switching minimizes output voltage ripple and optimizes output voltage precision
- Multiple gain architecture provides high efficiency over entire input voltage range
- Built-in thermal protection to protect from damage due to overheating
- Available in LLP-10 packaging for optimizing solution size

Applications

Ideal for use in DSP, memory, and microprocessor power for cellular handsets, and battery-powered devices



Switched-Capacitor Converters and Regulators

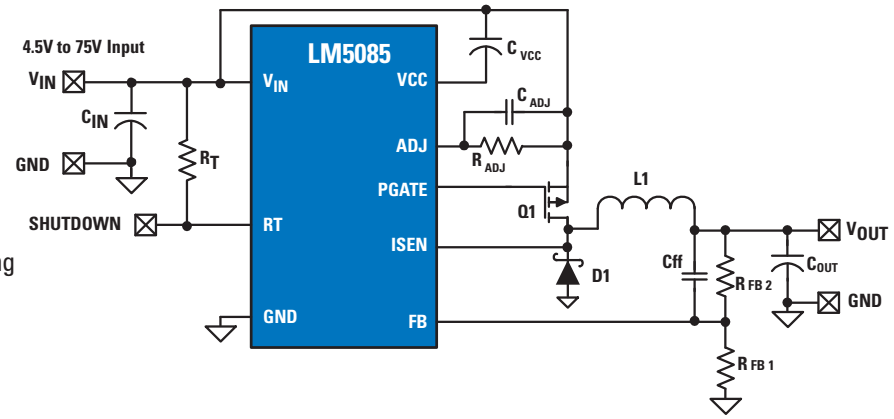
Buck Regulators									
Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Frequency Range (kHz)	On/Off Pin	Quiescent Current (mA)	Packaging
LM2787 E	10	5.5	2.7	-5.2	-1.5	260	✔	0.4	micro SMD-8
LM2772 E	150	5.5	2.7	1.2	1.2	1100	✔	0.05	LLP-10
LM2771 E	250	5.5	2.7	1.5	1.5	1100	✔	0.045	LLP-10
LM2773 E	300	5.5	2.5	1.6	1.8	1150	✔	0.048	micro SMD-9
Boost Converters									
Product ID	Switch Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Frequency Range (kHz)	On/Off Pin	Quiescent Current	Packaging
LM2750 E	0.12	5.6	2.7	5	5.2	1700	✔	5	LLP-10
LM2751	0.15	5.5	2.8	4.5	5	9.5 to 725	✔	0.425	LLP-10
LM2757 E	0.18	5.5	2.7	4.1	5	1242	✔	1.3	micro SMD-12
LM2753	0.4	5.5	3	5	5	725	✔	0.06	LLP-10
Buck-Boost Converters									
Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Frequency Range (kHz)	On/Off Pin	Quiescent Current	Packaging
LM2760	20	4.4	2	3.3	3.3	750	—	0.006	SOT23-5
LM3354 E	90	5.5	2.5	1.8	5	1000	✔	0.375	MSOP-10
Inverter/Doubler									
Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Switching Frequency (kHz)	On/Off Pin	Quiescent Current	Packaging
LM2781	50	5.5	1.8	-5.5	-1.8	210	—	0.7	micro SMD-8

PowerWise product E Evaluation board W WEBENCH enabled

LM(2)5085 – 42V/75V Constant On-Time PFET Buck Switching Controller

Features

- Adjustable current limit using RDS_{ON} or a current sense resistor
- Programmable switching frequency up to 1 MHz
- No loop compensation required
- Ultra-fast transient response
- Nearly constant operating frequency reduces EMI and provides more stable switching
- Adjustable output voltage from 1.25V
- Capable of 100% duty cycle operation
- Internal soft-start timer
- Integrated high-voltage bias regulator
- Thermal shutdown



Non-Synchronous Step-Down (Buck) Switching Controllers

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Feedback Tolerance %	Frequency Range (kHz) & Sync	On/Off Pin	PWM Mode	Packaging
LM3475 [E]	10	2.7	0.8	1	1.5	0 to 1400	✔	Hysteretic	SOT23-5
LM3477 [E]	35	2.95	1.265	30.8	1.5	500 to 500	✔	Current	MSOP-8
LM3485 [E, W]	35	4.5	1.242	V_{IN}	2	0 to 1400	—	Hysteretic	MSOP-8
LM3489 [E]	35	4.5	1.239	V_{IN}	2	0 to 1400	✔	Hysteretic	MSOP-8
LM(2)5085 [E]	(42), 75	4.5	1.25	V_{IN}	2	1000	—	Constant On-Time	MSOP-8, LLP-8
LM(2)5088 [E]	(42), 75	4.5	1.2	V_{IN}	1.5	50 to 1000	✔	Emulated Current Mode	TSSOP-16EP

Synchronous Step-Down (Buck) Switching Controllers

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Feedback Tolerance %	Frequency Range and Sync (kHz)	On/Off Pin	Topology, PWM Mode	Error Flag	Packaging
LM1770 [E, W]	5.5	2.8	0.8	4.5	2	300 to 1000	—	Constant on-time	—	SOT23-5
LM1771 [E]	5.5	2.8	0.8	4.5	2	300 to 1000	✔	Constant on-time	—	LLP-6, MSOP-8
LM3743 [E]	5.5	3	0.8	4.6	1.75	300 to 1000	✔	Voltage	—	MSOP-10
LM2727/37 [E]	16	2.2	0.6/5	5/0.6	1.5	50 to 2000	✔	Voltage	✔	TSSOP-14
LM3495 [E]	18	2.9	5.5	0.6	1	200 to 1500, Sync	✔	Emulated Peak Current Mode	—	TSSOP-16
LM25115/A	42	4.5	0.75	13.5	1.7	100 to 1000, Sync	✔	SSPR, Voltage/current-injection	—	TSSOP-16
LM25116 [E]	42	6	1.215	36	1.5	50 to 1000, Sync	✔	Emulated Peak Current Mode	—	TSSOP-20EP
LM5115/A [E]	75	4.5	0.75	13.5	1.7	50 to 1000, Sync	✔	Voltage/current-injection Valley current mode	—	TSSOP-16
LM5116 [E]	100	6	1.215	80	1.5	50 to 1000, Sync	✔	Emulated Peak Current Mode	—	TSSOP-20EP
NEW! **LM3000**	20	3.3	.6	15.5	1	200 to 1000	✔	ECM	✔	LLP-32
NEW! **LM3753/54**	18	4.5	.7	3.6	1	200 to 1000	✔	Voltage mode	✔	LLP-32

PowerWise® product [E] Evaluation board [W] WEBENCH enabled

Synchronous Step-Down (Buck) Switching Controllers

LM3743 – PowerWise® Synchronous 1 MHz Buck Controller with Programmable Tracking

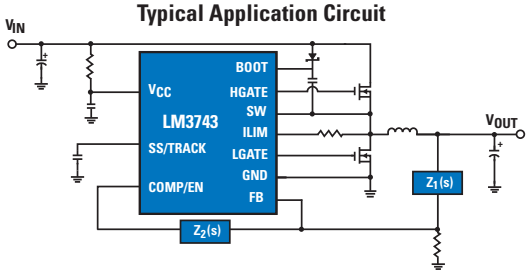
Features

- IC and power supply input voltage from 3V to 5.5V
- Output voltage adjustable down to 0.8V
- ±1.75% reference accuracy over full temperature and input voltage range
- Externally programmable soft-start with tracking capability
- Low-side sensing programmable current limit without sense resistor
- Fixed high-side sensing for supplemental short-circuit protection
- Available in tiny plastic MSOP-10 packaging

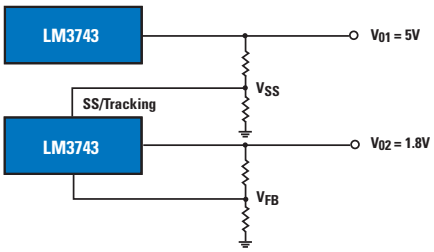
Applications

Ideal for use in communications, high-end consumer, computing, and industrial applications

Typical Application Circuit



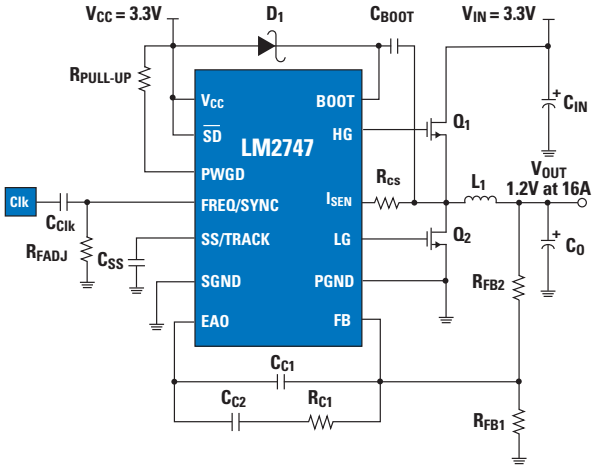
Tracking Multiple Rail Application



LM2747 – PowerWise Synchronous Buck Controller with 1% Voltage Feedback Accuracy Across -40°C to +125°C

Applications

Ideal for use in cable modems, DSL and ADSL, laser and ink jet printers, low-voltage power modules, DSP, ASIC, core, and portable computing



Synchronous Buck Controllers

Product ID	Operating Frequency	Product Features	Packaging
LM2742 [E]	50 kHz to 2 MHz	1.5% accuracy 0°C to 125°C, start-up delay	TSSOP-14
LM2743 [E, W]	50 kHz to 1 MHz	2% accuracy -40°C to 125°C, start-up delay	TSSOP-14
LM2744 [E]	50 kHz to 1 MHz	External reference, start-up delay, tracking	TSSOP-14
LM2745 [E]	50 kHz to 1 MHz	Pre-bias operation, external clock 250 kHz to 1 MHz, tracking	TSSOP-14
LM2746 [E]	50 kHz to 1 MHz	1% accuracy 0°C to 85°C, start-up delay, tracking	eTSSOP-14
LM2747 [E]	50 kHz to 1 MHz	1% accuracy -40°C to 125°C, pre-bias operation, external clock, programmable soft-start, tracking	TSSOP-14
LM2748	50 kHz to 1 MHz	1.5% accuracy -40°C to 125°C, tracking	TSSOP-14

PowerWise product [E] Evaluation board [W] WEBENCH enabled

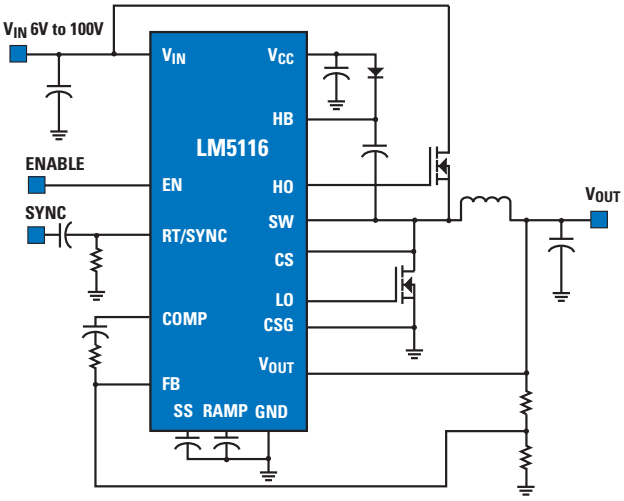
LM5116 – PowerWise® 6V to 100V Emulated Current-Mode Buck Controller

Features

- Ultra-wide input range: 6V to 100V
- Programmable output from 1.215V to 80V
- Less than 10 µA I_q in shutdown mode
- Frequency adjustable to 1 MHz with sync capability
- Programmable soft-start
- Drives standard or logic-level MOSFETs
- RDS_{ON} or resistor current sensing
- Available in thermally-enhanced eTSSOP-20 packaging

Applications

Ideal for use in telecommunications, automotive, and industrial control applications



ANALOG Edge

Read Analog Edge AN-1628
"Minimizing FET Losses For a High-Input Rail Buck Converter"
www.national.com/edge

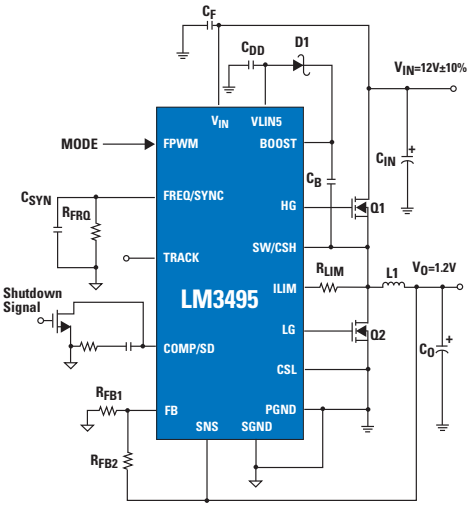
LM3495 – ±1% Accurate, Ultra-High Precision PWM Buck Controller

Features

- Input voltage from 2.9V to 18V
- Adjustable output from 0.6V to 5.5V
- Feedback accuracy: ±1% over temperature
- Switch node fault protection
- Hiccup mode current limit protection for reduced thermal design
- Available in TSSOP-16 packaging

Applications

Ideal for use in ASICs, FPGAs, DSPs, embedded controller power supplies, industrial applications, and high output current power modules



POWER

Step-Up (Boost) Switching Regulators

LM2735 – Integrated 2.1A Switch, Internal Compensation in Tiny Packages

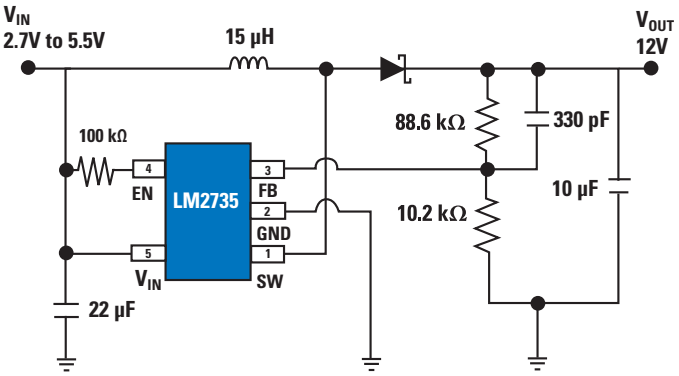
Features

High Current Density

- 2.1A switch current over full temperature range
- Boost from 5V to 12V at 700 mA

Easy-to-Use, Small Solution Size

- Internal compensation allows for ease-of-use and minimal external components
- 1.6 MHz operating frequency uses tiny passive components
- Available in SOT23-5, LLP-6, and eMSOP-8 packaging, making this product ideal for space-constrained applications



Step-Up (Boost) Switching Regulators

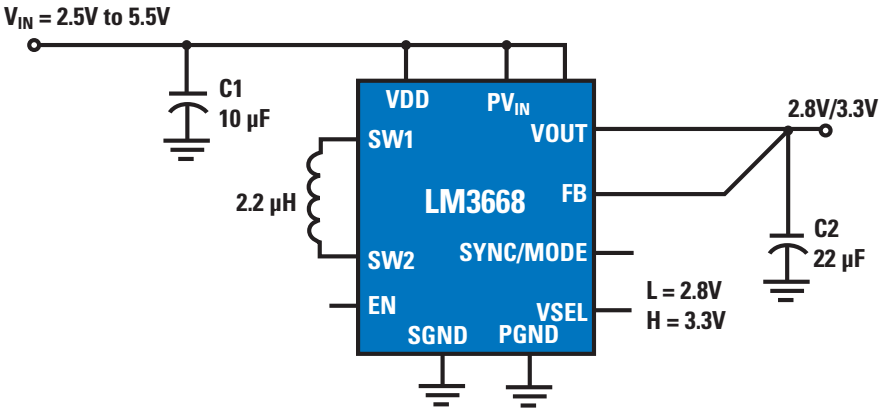
Product ID	Switch Current (A)	Input Min Voltage (V)	Input Max Voltage (V)	Frequency Range (kHz) and Sync	Output Min (V)	Output Max (V)	On/Off Pin	Packaging
LM5002	0.5	3.1	75	50 to 1500, Sync	1.26	Set by external feedback network	✔	SO-8, LLP-8
LM27313	1	2.7	14	1600	4	28	✔	SOT23-5
LM2733 E	1	2.7	14	600, 1600	3	40	✔	SOT23-5
LM3668 E, W	1	2.5	5.5	1600 to 2700, Sync	2.8	5.0	✔	LLP-12
LM5001 E	1	3.1	75	50 to 1500, Sync	1.26	Set by external feedback network	✔	SO-8, LLP-8
LM4510	1.2	2.7	5.5	85 to 1000	2.7	18	✔	LLP-10
LM2698 E	1.35	2.2	12	600 to 1250	2.2	17	✔	MSOP-8
LM2731 W	1.5	2.7	14	600, 1600	1.23	22	✔	SOT23-5
LM2622 E	1.6	2	12	600, 1300	1.26	12	✔	MSOP-8
LM3310	2	2.5	7	660, 1280	V_{IN}	20	✔	LLP-24
LM3311	2	2.5	7	660, 1280	V_{IN}	20	✔	LLP-24
LM5000 W	2	3.1	40	300 to 1300	1.259	Set by external feedback network	✔	LLP-16, TSSOP-16
LM2623/A	2.2/1.2	0.8	14	300 to 2000	1.24	14	✔	LLP-14, MSOP-8
LM2735 E, W	2.25	2.7	5.5	520, 1600	3	24	✔	SOT23-5, eMSOP-8, LLP-6
LM3224	2.6	2.7	7	615, 1250	V_{IN}	20	✔	MSOP-8
LM2585 W	3	4	40	100	1.23	12	—	TO263-5, TO220-5
LM2586 W	3	4	40	100 to 200, Sync	1.23	12	✔	TO263-7, TO220-7
LM2700	3.6	2.2	12	600, 1250	1.26	17.5	✔	LLP-14, TSSOP-14
LM2587 W	5	4	40	100	1.23	12	—	TO263-5, TO220-5
LM2588 W	5	4	40	100 to 200, Sync	1.23	12	✔	TO263-7, TO220-7

PowerWise® product E Evaluation board W WEBENCH enabled

LM3668 – Inductive Buck-Boost DC-DC Converter

Features

- 1A current capability
- Voltage select pin allows output voltage flexibility (2.8V/3.3V)
- Mode pin toggles between automatic PFM/PWM operation or forced PWM operation
- Frequency sync from 1.6 MHz to 2.7 MHz allows customization for lowest noise in system
- V_{IN} range from 2.5V to 5.5V supports Li-Ion batteries
- >90% efficiency maximizes battery life
- Low Iq (45 µA) in standby mode decreases current leakage in design
- Excellent transient response allows V_{OUT} to stay within regulation under all conditions
- Available in tiny LLP-12 packaging



Applications

Ideal for use in handset peripherals, MP3 players, pre-regulation for linear regulators, PDAs, portable hard disk drives, and WiMax modems

Buck-Boost Inductive Regulators

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Switch Current (A)	Frequency Range (kHz) and Sync	PWM Mode	Topology	Packaging
LM3668 [W]	5.5	2.5	2.8	3.3	1	1600 to 2700, Sync	Auto PWM/PFM	Buck-Boost	LLP-12
LM5015 [W]	75	4.25	—	—	1.2	25 to 750, Sync	Current mode	Two-switch forward	eTSSOP-14
LM2611 [E]	14	2.7	-1.23	—	0.9, 1.2	1400	Current mode	Inverting, CUK	SOT23-5

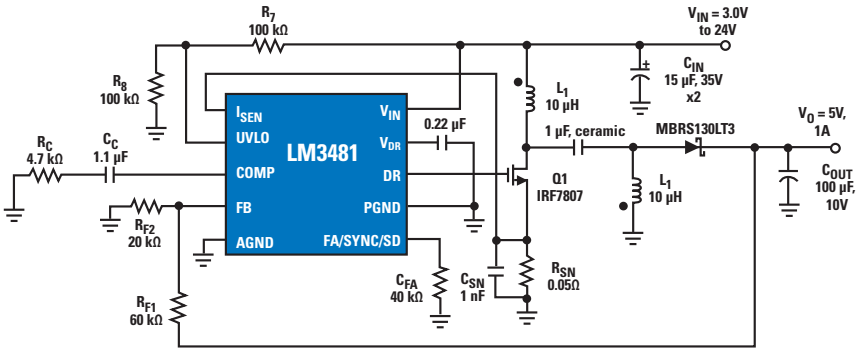
[E] Evaluation board [W] WEBENCH enabled

Boost and Buck-Boost Controllers

LM3481 – High-Efficiency Low-Side N-Channel Controller for Switching Regulators

Features

- Wide operating range: 2.97V to 48V
- Internal push-pull driver with 1A peak current capability
- 100 kHz to 1 MHz adjustable and synchronizable clock frequency
- 5 µA shutdown current (over temperature)
- Adjustable undervoltage lockout with hysteresis
- Frequency compensation optimized with a capacitor and a resistor
- 1.5% (over temperature) internal reference
- Available in MSOP-10 packaging



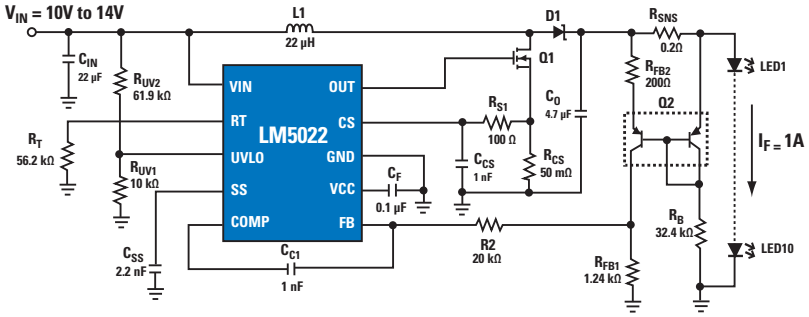
Applications

Ideal for use in distributed power systems, offline power supplies, set-top boxes, and portable applications

LM5022 – 60V Low-Side Controller for Boost and SEPIC Regulators

Features

- Internal 60V startup regulator
- 1A peak MOSFET gate driver
- V_{IN} range 6V to 60V
- Duty cycle limit of 90%
- Programmable UVLO with hysteresis
- Cycle-by-cycle current limit
- External synchronizable (AC-coupled)
- Single resistor oscillator frequency set
- Available in MSOP-10 packaging



Applications

Ideal for use in telecommunications, networking equipment, automotive, and industrial applications

Boost and Buck-Boost Controllers

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min Voltage (V)	Frequency Range (kHz) and Sync	On/Off Pin	Topology	Packaging
LM5021	30	8	Set by external feedback network	50 to 1000, Sync	✔	Flyback, forward	MSOP-8
LM3430	40	6	1.25	50 to 2000, Sync	—	Boost	LLP-12
LM3478 [W]	40	2.95	1.26	100 to 1000, Sync	✔	Boost, sepic, flyback	MSOP-8
LM3488 [W]	40	2.95	1.26	100 to 1000, Sync	✔	Boost, sepic, flyback	MSOP-8
LM3481	48	2.97	1.275	100 to 1000, Sync	✔	Boost, sepic, flyback	MSOP-10
LM5022/C [E]	60	6	1.25	50 to 2000, Sync	✔	Boost, sepic	MSOP-10
LM5020 [E]	100	13	Set by external feedback network	50 to 1000, Sync	✔	Flyback, inverting, buck, boost, forward	MSOP-10, LLP-10
NEW! **LM5118** [E]	75	3	1.23	50 to 500, Sync	✔	Buck-boost	eTSSOP-20

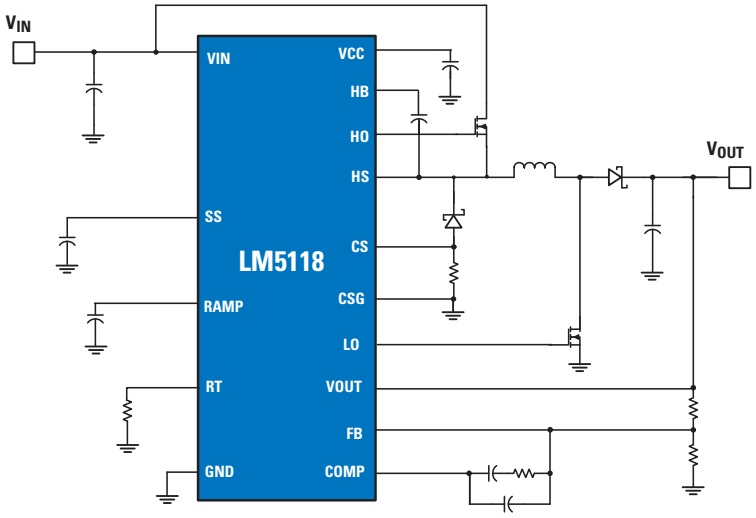
PowerWise® product [E] Evaluation board [W] WEBENCH enabled

Two-Switch Buck-Boost Controller and Two-Switch Forward Regulator

LM5118 – 3V to 75V Two-Switch Buck-Boost Controller

Features

- Ultra-wide input voltage range from 3V to 75V
- Emulated peak current mode control
- Smooth transition between step-down and step-up modes
- 10 µA I_q in shutdown mode
- Switching frequency programmable to 500 kHz
- Oscillator synchronization capability
- Internal high-voltage bias regulator
- Integrated high- and low-side gate drivers
- Programmable soft-start time
- Ultra low shutdown current
- Enable input wide bandwidth error amplifier
- 1.5% feedback reference accuracy
- Thermal shutdown
- Available in TSSOP-20 packaging



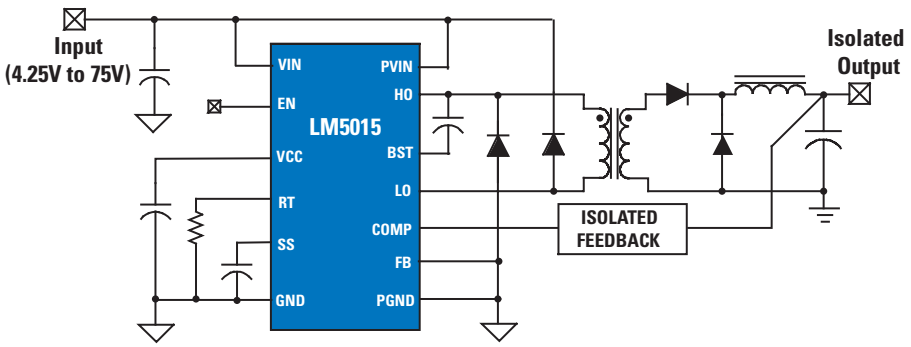
Applications

Ideal for use in automotive, telecommunications, and battery-powered systems

LM5015 – High-Voltage Monolithic Two-Switch Forward DC-DC Regulator

Features

- Dual integrated 75V N-Channel MOSFETs
- Ultra-wide input voltage range: 4.25V to 75V
- Integrated high-voltage bias regulator
- Adjustable output voltage
- 1.5% feedback reference accuracy
- Current mode control with selectable compensation
- Wide bandwidth error amplifier
- Integrated current sensing and limiting
- 50% maximum duty cycle limit
- Single resistor oscillator programming
- Oscillator synchronization capability
- Programmable soft-start
- Enable/Under-voltage Lockout (UVLO) pin
- Thermal shutdown
- Available in eTSSOP-14 packaging



Applications

Ideal for use in basestation power distribution systems, 48V telecom/data storage systems, and 24V/48V industrial systems, and Ethernet-powered devices

POWER

Multi-Output Switching Regulators

Multi-Output Switching Regulators

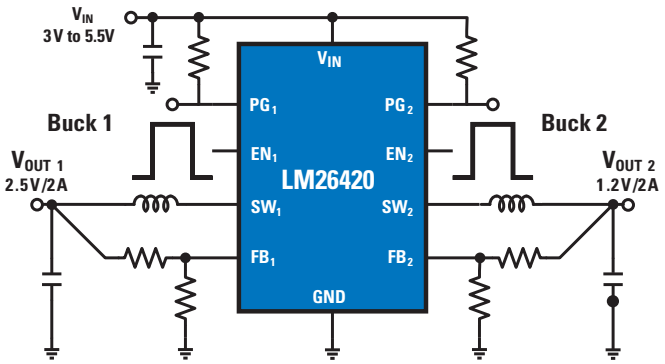
Product ID	Charger (mA)	DC/DC1 (mA)	DC/DC2 (mA)	DC/DC3 (mA)	LDO1 (mA)	LDO2 (mA)	LDO3 (mA)
LP3913	1000	600	600	500	150	—	—
LP3910	1000	600	600	1000	150	—	—
LP3906 [E]	—	1500	1500	—	300	300	—
LP3907 [E]	—	1000	600	—	300	300	—
LM26480 [E]	—	1500	1500	—	300	300	—
LM3370 [E]	—	600	600	—	—	—	—
LM26400Y [E]	—	2000	2000	—	—	—	—
LM3280 [E]	—	—	—	800	20	20	20
LM3687 [E]	—	750	—	—	350	—	—
LM3686 [E]	—	600	—	—	300	350	—
NEW! **LM26420** [E]	—	2000	2000	—	—	—	—

[E] Evaluation board

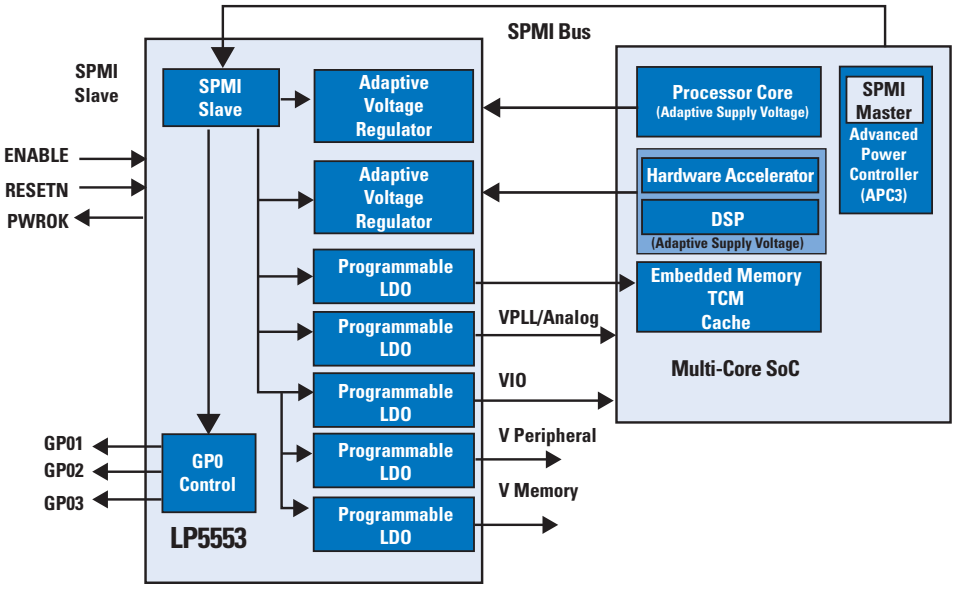
LM26420 – High-Frequency 2.0A Step-Down DC-DC Regulator

Features

- Input voltage range of 3.0V to 5.5V
- Output voltage range of 0.8V to 4.5V
- High switching frequencies
  - 2.2 MHz (LM26420X)
  - 0.55 MHz (LM26420Y)
- 0.8V, 1.5% internal voltage reference
- Independent precision enable for each output



LP5553 – Energy Management Unit Extends Battery Life and Enables New Features



Applications

Ideal for use in dual core processors, cellular handsets, handheld radios, PDAs, battery-powered devices, and portable instruments

Product ID	Number of Outputs	Output Voltages and Current	V_{IN} Range (V)	Interface	Packaging
LP5550	4	1 Buck: 0.6V to 1.2V, 300 mA 3 LDOs: 0.6V to 3.3V, up to 250 mA	3 to 5.5	PWI 1.0	LLP-16
LP5551 [E]	8	2 Bucks: 0.6V to 1.2V, 300 mA 4 LDOs: 0.6V to 3.3V, up to 250 mA N-well bias: -0.3 to +1V (to supply) P-well bias: -1V to +0.3V (to GND)	2.7 to 5.5	PWI 1.0	LLP-36
LP5552 [E]	7	2 Bucks: 0.6V to 1.235V, 800 mA 5 LDOs: 0.6V to 3.3V, up to 250 mA	2.7 to 4.8	PWI 2.0	micro SMD-36
NEW! LP5553	7	2 Bucks: 0.6V to 1.235V, 800 mA 5 LDOs: 0.6V to 3.3V, up to 250 mA	2.7 to 4.8	SPMI	micro SMD-36

PowerWise product [E] Evaluation board

PowerWise® Adaptive Voltage Scaling (AVS) technology is an advanced closed-loop technology for reducing active and standby energy consumption of digital processing engines and ASICs. Hardware Power Monitor (HPM) is designed into the digital engine together with an Advanced Power Controller (APC) to monitor the performance of the silicon based on process and temperature variation. Information is fed back to an Energy Management Unit (EMU) which then sets the voltage precisely according to the processor's needs. The AVS technology enables optimum energy management delivery to the processors, ASICs, and systems on a chip (SoCs), which maximizes overall system energy savings. AVS is suited to power-constrained applications such as portable devices, USB-powered peripherals, consumer electronics, and high-volume systems including data centers and cellular basestations. Anywhere an ASIC, processor, or SoC is used, designers can implement AVS.

Multi-Output Switching Controllers

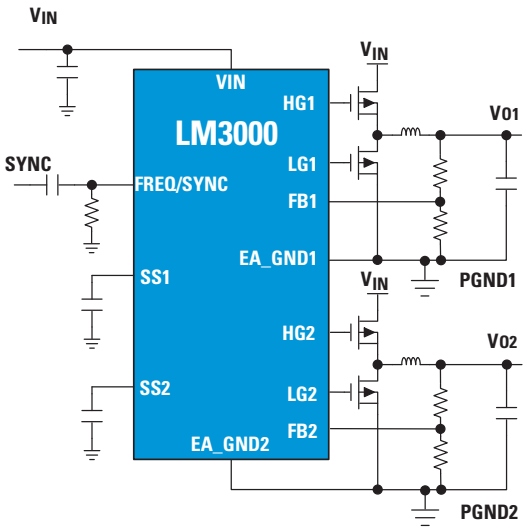
LM3000 Dual Synchronous Controller

Features

- V_{IN} Range 3-18.5V
- 0.6V, 1% accurate Vref ("A" version)
- Outputs 180° out of phase
- CLOCK_OUT (90 deg out of phase from system clock)
- Separate error amp ground inputs for remote voltage sensing
- Frequency Sync from 200Khz to 1.5Mhz
- Separate EN, SS and TRACK inputs

Applications

Ideal for use in networking equipment (routers, hubs), DC power distribution systems, 1.8V and 2.5V I/O supplies, ASIC, FPGA and CPLD power supplies



Multi-Output Switching Controllers

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Feedback Tolerance %	Frequency Range and Sync (Hz)	On/Off Pin	Error Flag	Channels	Topology, PWM Mode	Packaging
LM2647 [E]	28	5.5	0.6	5	1.5	200 to 500	✔	✔	2	Voltage with V_{IN} Feedforward	LLP-28, TSSOP-28
LM2642 [E]	30	4.5	1.238	27	2	300	✔	✔	2	Buck	TSSOP-28
LM5642	36	4.5	1.3	34.5	1.5	150 to 250, Sync	✔	—	2	Current	TSSOP-28, TSSOP-28EP
LM5642X	36	4.5	1.3	34.5	1.5	200 to 500, Sync	✔	—	2	Current	TSSOP-28EP, TSSOP-28
NEW! LM3000	20	3.3	0.6	15.5	1.0	200 to 1000	✔	✔	2	Emulated current mode	LLP-32

PowerWise® product [E] Evaluation board

LM5115 – Secondary-Side Post Regulator/Synchronous Step-Down (Buck) Controller

Features

- Self-synchronization to main channel output
- Stand alone DC-DC synchronous buck mode
- Voltage-mode control with current injection and input line feed-forward
- Operates from AC or DC input up to 75V
- Available in TSSOP-16 packaging

ONLINE Seminars

Watch our Online Seminar on "Multiple-Output Switching Regulators Featuring LM5115 'Dual Personality Controller"
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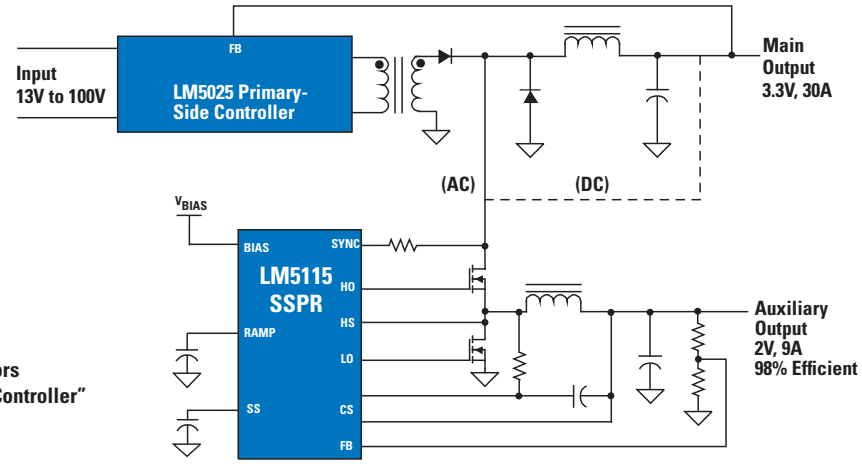


Switching Regulators and Controllers for Isolated Applications

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Frequency Max (kHz)	Sync Pin	Gate Drive	Current Limit Type	PWM Mode	Topology	Packaging
LM5021	30	8	1000	✔	0.7	Cycle-cycle, hiccup	Current	Flyback, forward	MSOP-8, MDIP-8
LM25115/5115	42/75	4.5	1000	✔	2.5	Cycle-cycle	Voltage/current-injection	Synchronous secondary-side post-regulator	LLP-16, TSSOP-16
LM5015 E, W	75	4.25	750	✔	—	Cycle-cycle	Current	Two-switch forward	TSSOP-14EP
LM(2)5037 E	75/105	6/13	2000	✔	1.2	Cycle-cycle, hiccup	Feedforward/current	Push-pull, half-bridge, full-bridge	TSSOP-16
LM5025/A	90	8	1000	✔	3	Cycle-cycle, hiccup	Voltage/feed-forward	Forward active clamp	LLP-16, TSSOP-16
LM5020 E	100	13	1000	✔	1	Cycle-cycle	Current	Flyback, inverting, buck, boost, forward	MSOP-10, LLP-10
LM5025B	100	8	1000	✔	3	Cycle-cycle, hiccup	Voltage/feed-forward	Forward active clamp	LLP-16, TSSOP-16
LM5026 E	100	8	1000	✔	3	Cycle-cycle, hiccup	Current	Forward active clamp	LLP-16, TSSOP-16
LM5030 E	100	8	1000	✔	1.5	Cycle-cycle, hiccup	Current	Push-pull, full-bridge, half-bridge	MSOP-10, LLP-10
LM5032	100	13	1000	✔	2.5	Cycle-cycle, hiccup	Current	Dual forward, flyback	TSSOP-16
LM5033 E	100	15	1000	✔	1.5	Hiccup	Voltage	Push-pull, half-bridge, full-bridge, IBC	MSOP-10, LLP-10
LM5034 E	100	13	1000	✔	2.5	Cycle-cycle, hiccup	Current	Dual forward, flyback	TSSOP-20
LM5041/A	100	10	1000	✔	1.5	Cycle-cycle, hiccup	Current	Voltage-fed or current-fed push-pull	LLP-16, TSSOP-16
LM5035/A	105	8	2000	✔	2	Cycle-cycle, hiccup	Voltage	Half-bridge	LLP-24, TSSOP-20EP

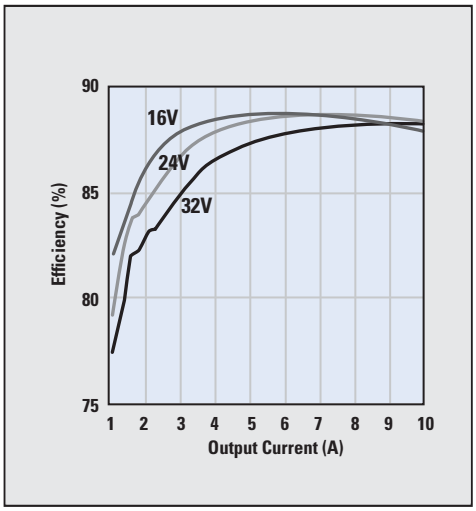
PowerWise® product E Evaluation board W WEBENCH enabled

Isolated Controllers

LM25037 – Dual-Mode PWM Controller with Alternating Outputs

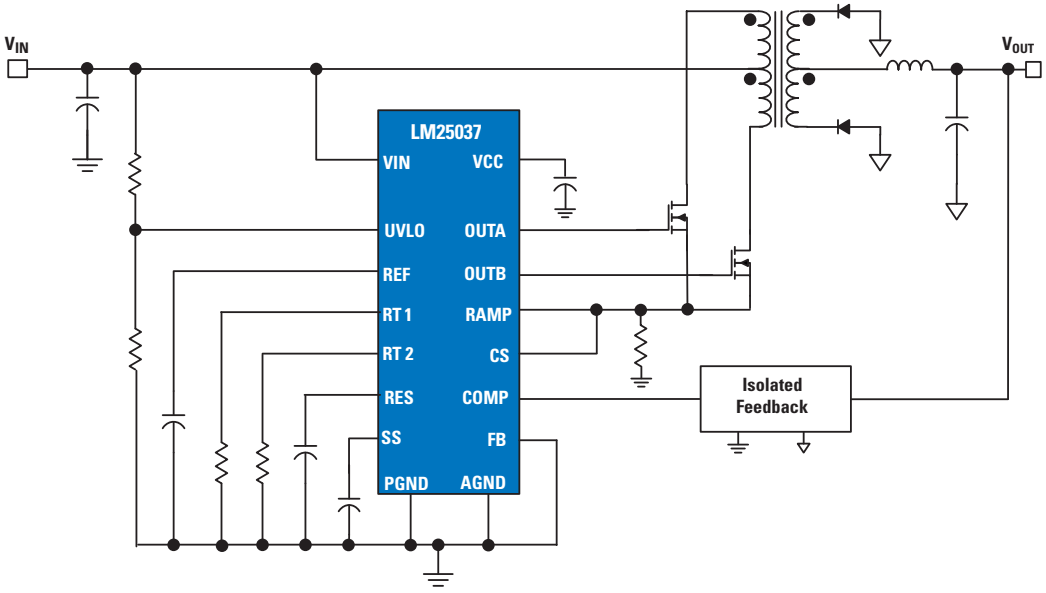
Features

- Ultra-wide input operating range from 5.5V to 75V
- Alternating outputs for double-ended topologies
- Current-mode or feed-forward voltage-mode control
- Programmable maximum duty cycle limit
- Versatile dual mode over-current protection with hiccup delay timer
- Programmable soft-start
- Precision 5V reference output
- Current sense leading edge blanking
- Resistor programmed 2 MHz capable oscillator
- Oscillator synchronization capability with low frequency
- Available in TSSOP-16 packaging



Applications

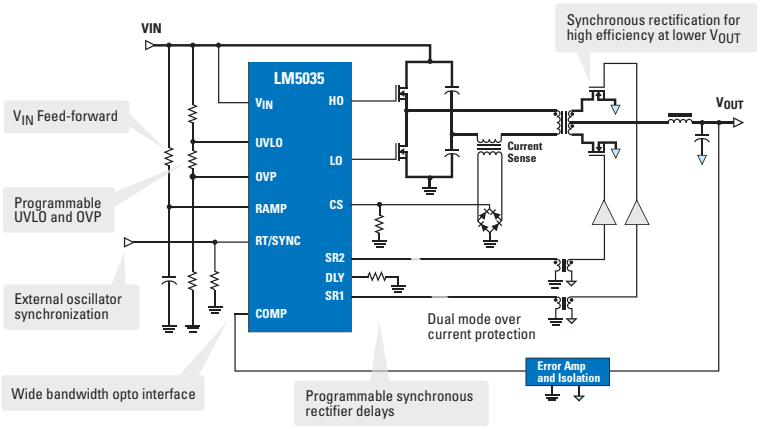
Ideal for use in telecommunications power converters, industrial power converters, and automotive systems



LM5035A – PowerWise® High-Performance, Half-Bridge Controller-Driver for Compact, Efficient Converters

Features

- 105V/2A half-bridge gate drivers
- Synchronous rectifier control outputs with programmable delays
- Oscillator synchronization (patent pending)
- Programmable line under-voltage lockout
- Line over-voltage protection
- Versatile dual mode over-current protection with hiccup delay timer
- Direct opto-coupler interface
- Available in TSSOP-20 and LLP-24 packaging



Applications

Ideal for use in telecommunications and data communications systems, industrial power supplies, distributed power systems, and consumer electronics

ONLINE Seminars

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"Half-Bridge Power Converter Design Using the LM5035A"

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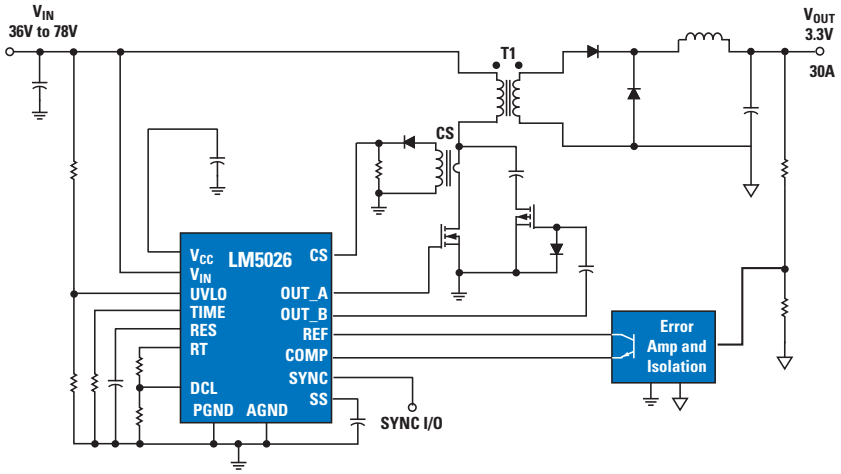
LM5026 – PowerWise® Simplified Forward Power Converter with Active Clamp Reset

Features

- Current mode control
- Internal 100V startup bias regulator
- 3A compound main gate driver
- High bandwidth opto-coupler interface
- Programmable line Under-Voltage Lockout (UVLO) with adjustable hysteresis
- Available in TSSOP-16 and LLP-16 packaging



Applications

Ideal for use in telecommunications, automotive, networking equipment, and industrial applications

ONLINE Seminars

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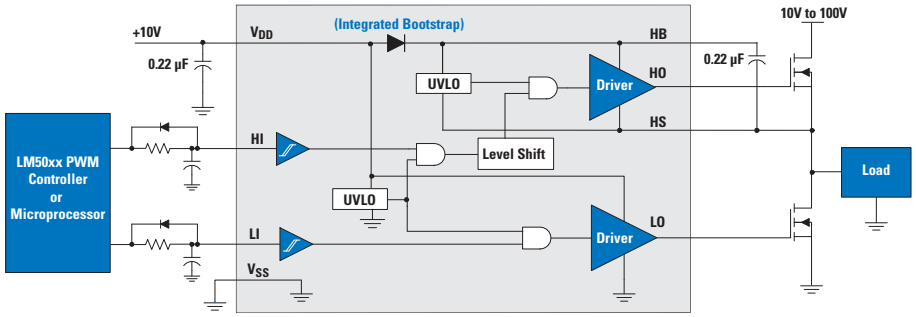
POWER

MOSFET Drivers

LM510x – Family of High-Speed FET Drivers



MOSFET Drivers

Product ID	Topology	Input Max Voltage (V)	Supply Min (V)	Supply Max (V)	Peak Sink Current (A)	Peak Source Current (A)	Bottom Driver Prop Delay (nS)	Top Driver Prop Delay (nS)	Pulse Width Min	Input Control Type	Packaging
LM5100C	Synchronous buck, bridge	100	7.5	14	1	1	25	25	50	Dual, independent	SO-8
LM5101C	Synchronous buck, bridge	100	7.5	14	1	1	25	25	50	Dual, independent	LLP-10, SO-8
LM5109B	Buck, bridge	90	7.5	14	1	1	25	25	50	Dual, independent	LLP-8, SO-8
LM5107	Buck, bridge	100	7.5	14	1.4	1.3	25	25	50	Dual, independent	LLP-8, SO-8
LM5106	Synchronous buck, bridge	100	7.5	14	1.8	1.2A	32	32	50	Single PWM	MSOP-10, LLP-10
LM5100B	Synchronous buck, bridge	100	7.5	14	2	2	25	25	50	Dual, independent	LLP-10, SO-8
LM5101B	Synchronous buck, bridge	100	7.5	14	2	2	25	25	50	Dual, independent	SO-8
LM5102	Synchronous buck, bridge	100	7.5	14	2	2	35	35	50	Dual, independent	MSOP-8
LM5104	Synchronous buck, bridge	100	7.5	14	2	2	35	35	50	Single PWM	LLP-10, SO-8
LM5105	Synchronous buck	100	7.5	14	2	2	35	35	50	Single PWM	LLP-10
LM5100A	Synchronous buck, bridge	100	7.5	14	3	3	25	25	50	Dual, independent	LLP-8, SO-8
LM5101A	Synchronous buck, bridge	100	7.5	14	3	3	25	25	50	Dual, independent	LLP-10, SO-8
LM5110	Forward, push-pull, etc	—	3.5	14	5	2	25	25	25	Dual, independent	LLP-10, SO-8
LM5111	Forward, push-pull, etc	—	3.5	14	5	3	25	25	25	Dual, independent	SO-8
LM5112	Forward, push-pull, etc	—	3.5	14	7	3	25	N/A	25	Dual, independent	LLP-6

Note: This table sorted by peak sink current

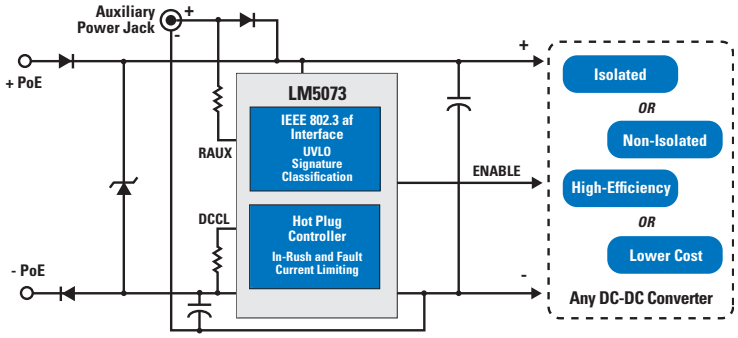
Applications

Ideal for use in telecommunications, networking equipment, automotive, motor driver systems, and industrial applications

LM5073 – 100V Power-over-Ethernet PD Interface with Auxiliary Support

Features

- Fully compliant IEEE 802.3af PD interface
- Versatile auxiliary power options, including flexible interface to AC adaptor
  - 13V minimum front auxiliary power range
  - 9V minimum rear auxiliary power range
- Programmable DC current limit up to 800 mA
- Complementary open drain outputs allow flexible DC-DC regulator selection



Optimizing for:	Pair LM5073 with:
High efficiency	LM5025/26 active clamp PWM controller (PowerWise®)
Low cost	LM5020 flyback controller (PowerWise)
Non-isolated and/or ease of design – regulator with integrated MOSFET	LM557x SIMPLE SWITCHER® regulator (PowerWise)
Isolated	LM5015 2-switch forward flyback regulator

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Applications

VoIP telephony, security cameras, wireless access points, IEEE 802.3af-compliant PoE-powered devices, non-compliant, application specific devices, and higher-power Ethernet-powered devices

Power-over-Ethernet Powered Device Interface with Integrated DC-DC Regulator

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Hot Swap FET Rds(ON) Typ (Ω)	Integrated DC-DC Controller	Output Power (W)	Auxiliary Support	Reference Accuracy (+/-)	Current Draw with AUX Winding (typ)	Packaging
LM5070 [E]	75	1.8	1	✔	13	48V front only	2	0.7	LLP-16, TSSOP-16
LM5071 [E]	75	1.8	1	✔	13	48V front only	2	0.7	TSSOP-16
LM5072 [E]	100	9	0.7	✔	25	Fully-configurable front/rear	2	0.7	TSSOP-16EP

PowerWise® product [E] Evaluation board

Power-over-Ethernet Powered Device Interface

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Hot Swap FET RDS (ON) Typ (Ω)	Integrated DC-DC Controller	Output Power (W)	Auxiliary Support	Packaging
LM5073 [E]	100	9	0.7	—	25	Fully-configurable front/rear	TSSOP-14EP

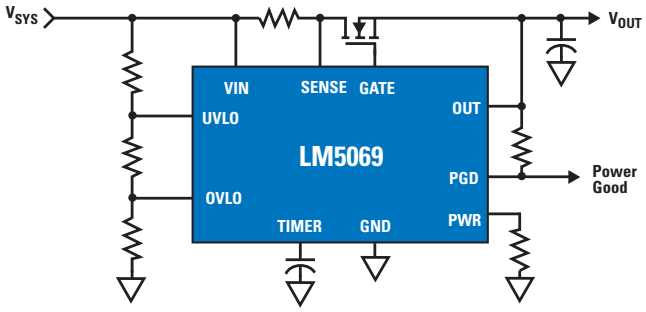
[E] Evaluation board

Hot Swap/In-Rush Current Controllers

LM(2)506x – Hot Swap/In-Rush Current Limit Controllers with Current and Power Limiting

Features

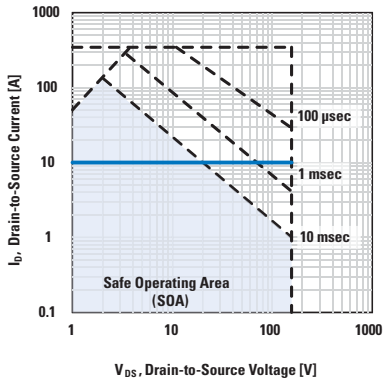
- In-rush current limit for safe module insertion and removal from live power sources
- Adjustable power limit sets maximum power dissipation in the external pass device and ensures MOSFET stays in safe operating area (SOA)
- Programmable input under voltage lockout (UVLO) and hysteresis
- Programmable input over voltage lockout (OVLO) and hysteresis
- Programmable multifunction timer to prevent nuisances trips
- Programmable POWER GOOD flag output using FB pin (LM25061)
- Internal high-side charge pump and gate driver for external N-channel MOSFET
- Available in latched fault and automatic restart versions



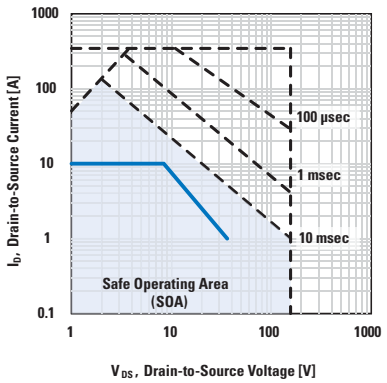
Power Limiting Protects External Pass Device for Improved System Reliability

To ensure system reliability, any MOSFET must operate within its Safe Operating Area (SOA) in order to avoid FET failure. National's LM(2)506x hot swap controllers provide both current and power limiting to dynamically adjust the current limit at large V_{DS} and ensure the MOSFET stays in the SOA at all conditions – maximizing long-term system reliability and robustness.

Conventional Hot Swap: Current Limit Only
MOSFET Out of SOA at Large V_{DS}



LM(2)506x: Current Limit AND Power Limit
Optimal Circuit and MOSFET Protection for All V_{DS}



Hot Swap/In-Rush Current Controllers

Product ID	V_{IN} Range (V)	POWER GOOD	Adjustable UVLO	Adjustable OVLO	Active In-Rush Current Limit	Active Current Limiting	Active Power Limiting	Fault Latch-Off/Auto Retry	Packaging
LM5067 [E]	-9V to -80	V_{DS}	✔	✔	✔	✔	✔	Both	MSOP-10
LM5069 [E]	+9 to +80	V_{DS}	✔	✔	✔	✔	✔	Both	MSOP-10
NEW **LM25061** [E]	+2.9 to +17	V_{OUT} (adj)	✔		✔	✔	✔	Both	MSOP-10
NEW **LM25069** [E]	+2.9 to +17	V_{DS}	✔	✔	✔	✔	✔	Both	MSOP-10

[E] Evaluation board

LP38xxx Family of High-Performance CMOS LDOs Power Digital ICs

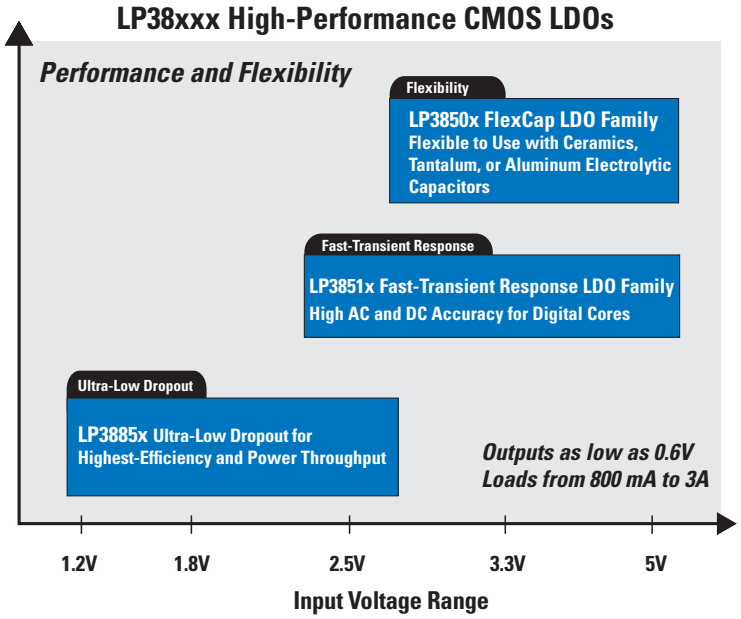
Performance and Flexibility

The LP38xxx family offers performance:

- Ultra-low dropout as low as 115 mV
- Fast-transient response with high AC and DC accuracy for powering digital cores
- High efficiency of 80% for 1.5V to 1.2V conversions

The LP38xxx family offers flexibility:

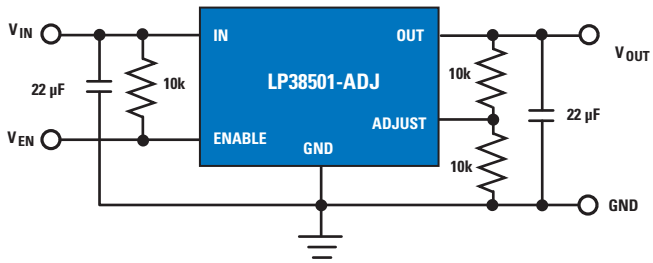
- Flexible to use with ceramics, tantalum, and aluminum electrolytic capacitors
- Supports input voltages from 1.2V, 1.5V, 1.8V, 2.5V, 3.3V, and 5V rails
- Load currents from 800 mA to 3A with the same pin-out



LP3850x – FlexCap LDOs Provide Flexibility and Simplicity

The LP3850x FlexCap family of LDOs features unique compensation that allows the use of any type of capacitor with no limits on minimum or maximum ESR.

- Optimized for conversions from 3.3V or 5V rails
- Outputs as low as 0.6V
- Load currents of 1.5A or 3A
- Typical dropout voltage, 450 mV at 3A
- Ultra-low, 25 nA, shutdown current
- Stable with ceramic, tantalum, or aluminum electrolytic capacitors
- Available in TO263-5 or LLP-8 packaging



Product ID	Load Current (A)	V_{IN} Min (V)	V_{IN} Max (V)	V_{OUT} (V)	Typical Dropout (mV)	Enable	Packaging
LP38500	1.5	2.7	5.5	Adj down to 0.6	220	—	TO263-5, LLP-8
LP38502 [E]	1.5	2.7	5.5	Adj down to 0.6	220	✔	TO263-5, LLP-8
LP38501 [E]	3.0	2.7	5.5	Adj down to 0.6	450	✔	TO263-5
LP38503	3.0	2.7	5.5	Adj down to 0.6	450	—	TO263-5

[E] Evaluation board

To see a more complete list and to learn more about LDOs, visit:

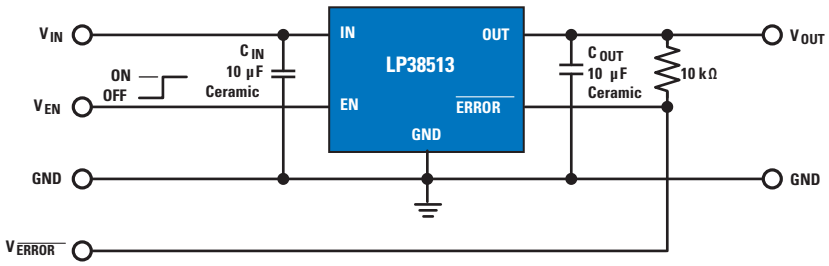
www.national.com/LDO

Low Dropout (LDO) Linear Regulators

LP3851x – Fast Transient-Response LDOs and Ultra-Low Dropout

The LP3851x fast transient-response family of LDOs offers the highest performance in meeting AC and DC accuracy requirements for digital cores.

- Ideal for conversions from 2.5V, 3.3V, or 5V rails
- Fixed 1.8V output
- Output currents of 800 mA, 1.5A, or 3A
- Typical dropout voltage: 275 mV at 3A
- Proprietary control loop enables extremely fast transient response
- High accuracy of 2.5% over line, load, and temperature (-40°C to 125°C)
- Stable with 10 µF ceramic capacitors
- Error flag feature
- Available in TO220-5 or TO263-5 packaging



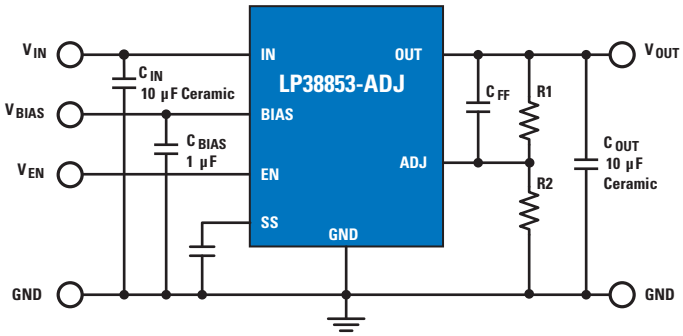
Product ID	Load Current (A)	V_{IN} Min (V)	V_{IN} Max (V)	V_{OUT} (V)	Error Flag	Enable	Packaging
LP38511	0.8	2.25	5.5	1.8, Adj down to 0.8V	✔	✔	TO263-5
LP38512	1.5	2.25	5.5	1.8, Adj down to 0.8V	✔	✔	TO263-5, LLP-8
LP38513	3.0	2.25	5.5	1.8, Adj down to 0.8V	✔	✔	TO263-5

See more at www.national.com/ldo

LP3885x – Low Input Voltage and High Efficiency LDOs

The LP3885x LDOs provide ultra low-dropout for high efficiency and power throughput.

- Designed for conversions from 1.8V rails and below
- Adjustable output voltage down to 0.8V
- Load currents of 800 mA, 1.5A, or 3A
- Typical dropout, 115 mV at 800 mA
- Efficiency of up to 80% for 1.5V to 1.2V conversion
- 2% accuracy over line, load, and temperature (0°C to 125°C)
- Enable pin option
- Soft-start pin option
- Available in TO220-7, TO263-7, or PSOP-8 packaging



Product ID	Load Current (A)	V_{OUT} Options (V)	Adj. Output	Enable Pin	Soft-Start Pin	Typical Dropout (mV)	Packaging
LP38851	0.8	Adj 0.8 to 1.8	✔	✔	✔	115	PSOP-8, TO263-7
LP38852 [E]	1.5	Adj 0.8 to 1.8	✔	✔	✔	180	PSOP-8, TO263-7
LP38855	1.5	0.8V, 1.2	—	✔	—	180	TO263-5, TO220-5
LP38858	1.5	0.8V, 1.2	—	—	✔	180	TO263-5, TO220-5
LP38853 [E]	3	Adj 0.8 to 1.8	✔	✔	✔	450	PSOP-8, TO263-7
LP38856 [E]	3	0.8V, 1.2	—	✔	—	450	TO263-5, TO220-5
LP38859 [E]	3	0.8V, 1.2	—	—	✔	450	TO263-5, TO220-5

[E] Evaluation board

Wide Input Voltage LDOs

Product ID	Load (mA)	V_{IN} Max (V)	V_{IN} Min (V)	Dropout Voltage (V)	Enable Pin	V_{OUT}	Packaging
LP2980	50	16	2.1	0.12	✔	2.5, 3.3, 4.7, 5, Adj	SOT-23-5
LP2982	50	16	2.1	0.12	✔	3, 3.3, 5, Adj	SOT-23-5
LP2981	100	16	2.1	0.2	✔	3, 3.3, 3.6, 5	SOT-23-5
LP2983	150	16	2.2	1.3, 1, 1.2	✔	1, 1.2, 3.3	SOT-23-5
LP2985LV	150	16	2.2	0.28	✔	1.5, 1.8, 2.0, 2.85, 3.0, 3.3	SOT-23-5, micro SMD-5
LP2985	150	16	2.5	0.28	✔	2.5, 2.6, 2.7, 2.8, 2.9, 3, 3.1, 3.2, 3.3, 3.6, 3.8, 4, 4.5, 5, 6.1	SOT-23-5, micro SMD-5
LP2986	200	16	2.1	0.18	✔	3, 3.3, 5, Adj	MSOP-8, LLP-8, SOIC NARROW-8
LP2987	200	16	2.1	0.18	✔	5	MSOP-8, LLP-8, SOIC NARROW-8
LP2988	200	16	2.1	0.18	✔	3, 3.3, 3.8, 5	MSOP-8, LLP-8, SOIC NARROW-8
LP2992	250	16	2.5	0.45	✔	1.5, 5, 1.8, 2.5, 3.3	SOT-23-5, LLP-6
LP2989	500	16	2.1	0.31	✔	2.8, 3, 3.3, 5	MSOP-8, LLP-8, SOIC NARROW-8
LP2989LV	500	16	2.1	0.31	✔	1.8	MSOP-8, LLP-8, SOIC NARROW-8
LP38691	500	10	2.7	0.25	—	1.8, 2.5, 3.3, 5 Adj	SOT223-5, LLP-6
LP38693	500	10	2.7	0.25	✔	3.3 Adj	SOT223-5, LLP-6
LP3878	800	16	2.5	0.475	✔	Adj	LLP-8, PSOP-8
LM2991	1000	0.3	-26	0.6	✔	Adj	TO-263-3, TO-220-3
LP38690	1000	10	2.7	0.45	—	1.8, 3.3, Adj	SOT223-5, LLP-6
LP38692	1000	10	2.7	0.45	✔	3.3, 5, Adj	SOT223-5, LLP-6
LM2990	1500	0.3	-26	0.6	—	-5, -12, -15	TO-263-3, TO-220-3
LP2975	Note1	24	1.8	—	✔	5	MSOP-8

Note 1: LDO Controller

Single- and Multi-Output LDOs

Low-Input/Low-Output LDOs for Powering Digital ICs

Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Dropout Voltage (V)	Output Voltage (V)	On/Off Pin	Packaging
LP3990	150	6	2	0.06	.8, 1.2, 1.8, 2.5, 2.8	✔	SOT23-5, micro SMD-4
LP5951 [E]	150	5.5	1.8	0.029	1.3, 1.5, 1.8, 2.0, 2.5, 2.8, 3, 3.3	✔	SOT23-5, SC70-5
LP3991 [E]	300	3.6	1.65	0.075	.8, 1.2, 1.3, 1.5, 1.55, 1.7, 2.5, 2.8, 3.0	✔	micro SMD-4
LP5952 [E]	350	4.5	0.9	0.061	.7, 1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 2.0	✔	micro SMD-5
LP38841	800	5.5	V_{OUT} + V_{DO}	0.075	Adj	—	TO-263-5, TO-220-5
LP3891	800	5.5	V_{OUT} + V_{DO}	0.1	1.2	✔	TO-263-5, TO-220-5, PSOP-8
LP3882	1500	6	V_{OUT} + V_{DO}	0.11	1.2	✔	TO-263-5
LP38842	1500	5.5	V_{OUT} + V_{DO}	0.115	1.2, Adj	—	TO-263-5, PSOP-8
LP3892	1500	5.5	V_{OUT} + V_{DO}	0.14	1.2, 1.5	✔	TO-263-5, TO-220-5, PSOP-8
LP3852/55	1500	7	2.5	0.24	5, 1.8, 2.5, 3.3, Adj	✔	TO-263-5, SOT-223-5, TO-220-5
LP3883	3000	5.5	V_{OUT} + V_{DO}	0.21	1.2	✔	TO-263-5
LP3853/56	3000	7	2.5	0.39	2.5, 5	✔	TO-263-5

Low-Iq LDOs

Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Dropout Voltage (V)	Quiescent Current (mA)	On/Off Pin	Output Voltage (V)	Packaging
LP3983	5	6	2.5	—	0.014	✔	1.6, 2.5	micro SMD-5
LP3990	150	6	2.0	0.06	0.043	✔	0.8, 1.2, 1.35, 1.5, 1.8, 2.5, 2.8	micro SMD-4, SOT23-5, LLP-6
LP3984	150	6	2.5	0.06	0.08	✔	1.5, 1.8, 3.1	micro SMD-4, SOT23-5
LP3985	150	6	2.5	0.06	0.085	✔	2.5, 2.8, 3, 3.3, 4.7, 5	micro SMD-5, SOT23-5
LP3987	150	6.5, 6	V_{OUT} + .200	0.06	0.085	✔	2.5, 2.6, 2.8, 2.85, 3.0	micro SMD-5
LP3988	150	6	2.5	0.08	0.085	✔	1.85, 2.5, 2.6, 2.85, 3	micro SMD-5, SOT23-5
LP3991	300	3.6	1.65	0.075	0.05	✔	.8, 1.2, 1.3, 1.5, 1.8, 2.5, 2.8, 3	micro SMD-4
LP38690/92	1000	10	2.7	0.45	0.055	✔	1.8, 2.5, 2.8, 3.3, 5, Adj	LLP-6, MSOP-8
LP38691/93	500	10	2.7	0.12, .25	0.055	✔	1.8, 2.5, 3.3, 5, Adj	LLP-8, MSOP-8

Multi-Output LDOs

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output1 V_{OUT}Min (V)	Output2 V_{OUT}Min (V)	Output1 I_{OUT}Max (mA)	Output2 I_{OUT}Max (mA)	Dropout Voltage (V)	Quiescent Current (mA)	Error Flag	Power on Reset	Packaging
LP2966	7	2.7	1.8	1.8	150	150	0.135	0.34	✔	—	LLP-16, PSOP-8, SO-8
LP2967	16	2.1	1.8	2.5	150	150	0.275	0.2	—	—	micro SMD-8, MSOP-8
LP3986	6	2.5	2.5	2.8	300	150	0.06	0.115	—	—	micro SMD-8
LP3996 [E]	6	2	0.8	0.8	150	300	0.21	0.035	✔	✔	LLP-10
LP5996 [E]	6	2	0.8	0.8	150	300	0.21	0.035	—	—	LLP-10
LP8900	5.5	1.8	2.7	1.8	280	280	0.11	0.085	—	—	micro SMD-6

[E] Evaluation board

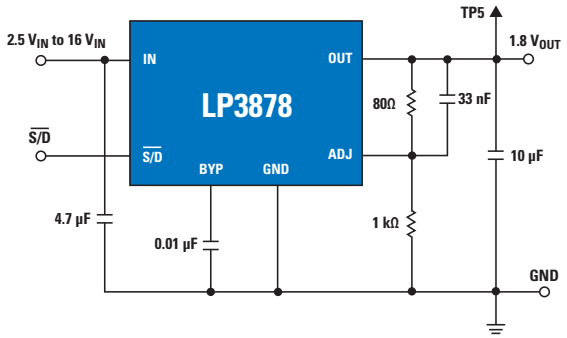
Low-Noise LDOs to Power RF and Analog Circuits

LP3878 – Low-Noise LDOs Power Noise-Sensitive Analog Loads

Features

- 1.0V to 5.5V output
- Designed for use with low-ESR ceramic capacitors
- <10 µA quiescent current in shutdown
- Low ground-pin current at all loads
- Over-temperature/over-current protection
- -40°C to +125°C operating junction temperature range

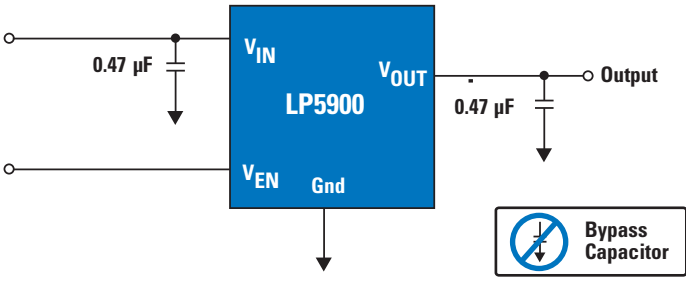
Typical Application Circuit



LP5900 – Low-Noise 150 mA CMOS LDO

Features

- Industry's lowest noise (6.5 μV_{RMS}) combined with 85 dB of Power Supply Ripple Rejection (PSRR) guarantees signal integrity
- 25 µA Iq minimizes current drain when system operates in low-power mode
- Elimination of bypass capacitor reduces BOM to only two ceramic 0.47 µF capacitors
- Available in a micro SMD-4 and LLP packaging



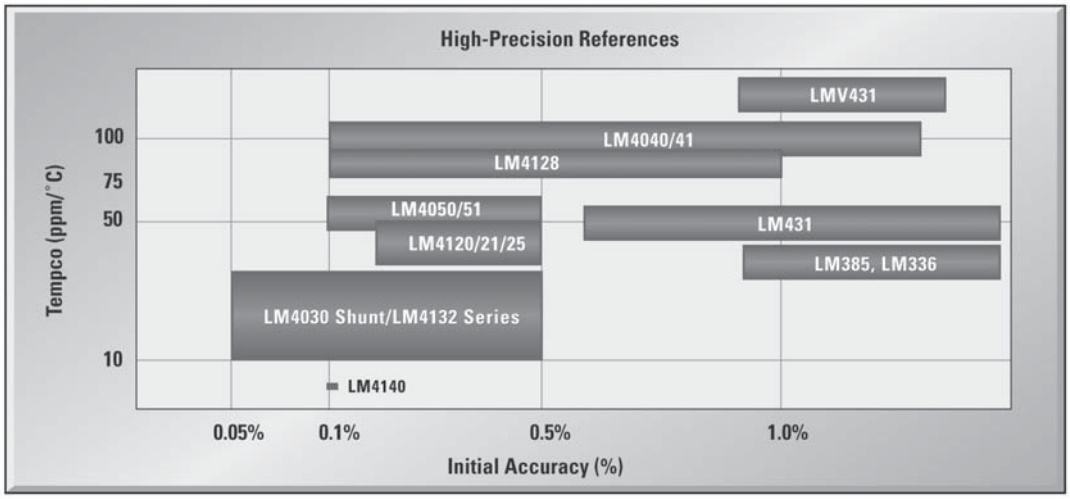
Low-Noise LDOs for Low-Power, Space-Constrained Applications

Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Dropout Voltage (V)	Output Voltage (V)	Adjustable Output	On/Off Pin	Quiescent Current (mA)	PSRR (dB)	Voltage Noise (rms)	Packaging
LP3999	150	6	2.5	0.06	1.5, 1.8, 2.4, 2.5, 2.8, 3.3	—	—	0.085	60	30	micro SMD-5
LP5900	150	5.5	2.5	0.08	1.5, 2.8, 3.3	—	—	0.025	75	6.5	micro SMD-4
LP5990 [E]	200	5.5	2.2	0.15	0.8 to 3.6	—	—	0.03	55	60	micro SMD-4
LP3871/74	800	7	2.5	0.24	1.8 to 5	✔	✔	5	73	150	TO-263-5, SOT-223-5, TO-220-5
LP3878	800	16	2.5	0.475	Adj	✔	✔	0.18	60	18	LLP-8, PSOP-8
LP3879	800	6	2.5	—	1.2, 1	—	✔	0.2	60	18	LLP-8, PSOP-8
LP3875	1500	7	2.5	0.38	1.8, 2.5, 3.3	✔	✔	6	73	150	TO-263-5, SOT-223-5
LP3876	3000	7	2.5	0.8	2.5, Adj	✔	✔	6	73	150	TO-263-5

PowerWise® product [E] Evaluation board

Voltage References

LM4030 – High-Precision Shunt Reference Features 0.05% Initial Accuracy and Low 10 ppm Tempco Over Temperature



Voltage References

Product ID	Type	V_{OUT} Options (V)	Initial Accuracy (%)	Tempco (ppm/°C)	Quiescent Current (µA)	Noise (μV_{PP})	Packaging
LM385-2.5	Shunt	2.5	3	150	0.02	120	die wafer
LMV431A	Shunt	1.2	1	138, 129	0.055	8	TO-92, SOT-23
LMV431B	Shunt	Adj	0.5	129	0.055	8	SOT-23
LMV431	Shunt	Adj	1.5	138, 129	0.055	8	TO-92, SOT-23
LM4041	Shunt	1.225, Adj	0.2, 2, 0.5, 1, 0.1	150, 100	0.06	20	SOT-23, SC-70
LM4051	Shunt	1.225, Adj	0.1	50	0.06	20	SOT-23
LM4040	Shunt	4.096, 10, 5, 2.5	0.2, 2, 0.5, 1, 0.1	150, 100	0.06, 0.068, 0.91, 0.074, 0.091, 0.1	35	TO-92,SOT-23, SC-70
LM4431	Shunt	2.5	2	—	0.1	35	SOT-23
LM4125	Series (LDO)	4.096, 2.048, 2.5	0.2, 0.5	50	0.16	20	SOT-23
LM4121	Series (LDO)	1.25, Adj	0.2	50	0.16	20	SOT-23
LM431	Shunt	Adj	1	54	1	8	TO-92 ,SOT-23, MICRO SMD, SOIC NARROW
LM4050	Shunt	2.0, 2.5, 4.096, 5.0, 8.2, 10	0.1, 0.2, 0.5	50	41	48	SOT23-3
LM4132	Series (LDO)	1.8, 2.0, 2.5, 3.0, 3.3, 4.096	0.05, 0.1, 0.2, 0.4, 0.5	10, 20, 30	60	170	SOT23-5
LM4128	Series (LDO)	1.8, 2.0, 2.5, 3.0, 3.3, 4.096	0.1, 0.2, 0.5, 1	75, 100	60	170	SOT23-5
LM4030	Shunt	2.5, 4.096, 5.0	0.05, 0.1, 0.15	10, 20, 30	65	105	SOT23-5
LM4120	Series (LDO)	1.8, 2.048, 2.5, 3.0, 3.3, 4.09, 5	0.2, 0.5	50	160	20	SOT23-5
LM4140	Series (LDO)	1.024, 1.25, 2.048, 2.5, 4.096	0.1	3, 6, 10	230	2.2	SO-8
LM385	Shunt	Adj	2	150	.01 mA	120	TO-92, SOIC N
LM385-1.2	Shunt	1.235	2	150	.01 mA	120	TO-92, SOT-23

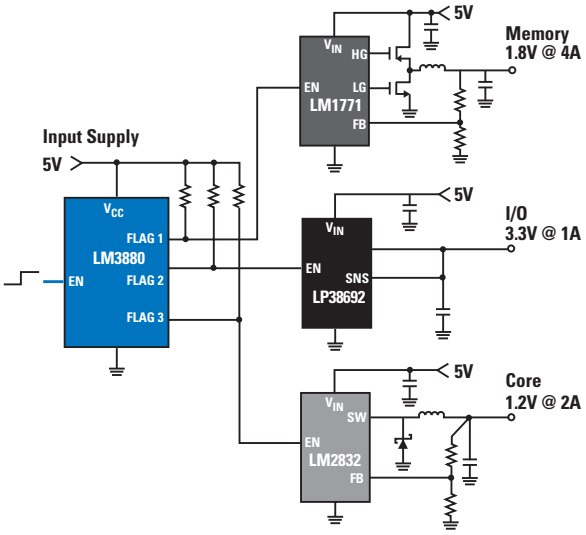
LM3880 – Industry's Easiest and Smallest Solution for Multiple-Rail Power Sequencing

Features

- Easiest method to sequence rails
- Input voltage range of 2.7V to 5.5V
- Standard timing options: 10 ms, 30 ms, 60 ms, 120 ms
- 1-2-3 powerup and reverse-power down 3-2-1 control
- Customization of timing and sequence available through factory programming
- Available in tiny SOT23-6 packaging

Applications

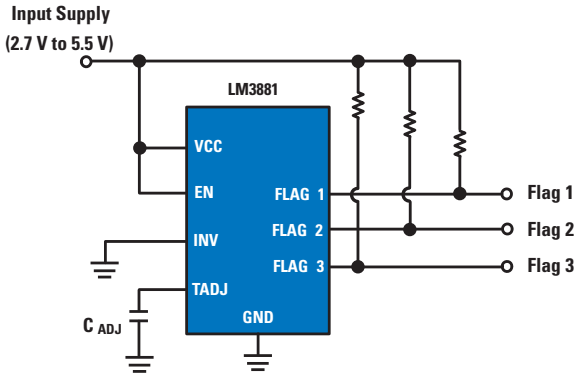
Ideal for use in sequencing power rails of digital logic devices (ASICs, FPGAs, DSPs, microcontrollers) to avoid latch-up conditions, and systems with multiple rails



LM3881 – Adjustable Power Sequencer

Features

- Input voltage: 2.7V to 5.5V
- 20 µA quiescent current
- 3 output flags
- Master sequence enable pin
- Powerup and powerdown control
- Digital logic invert pin
- Adjustable timing pin
- Available in MSOP-8 packaging



POWER

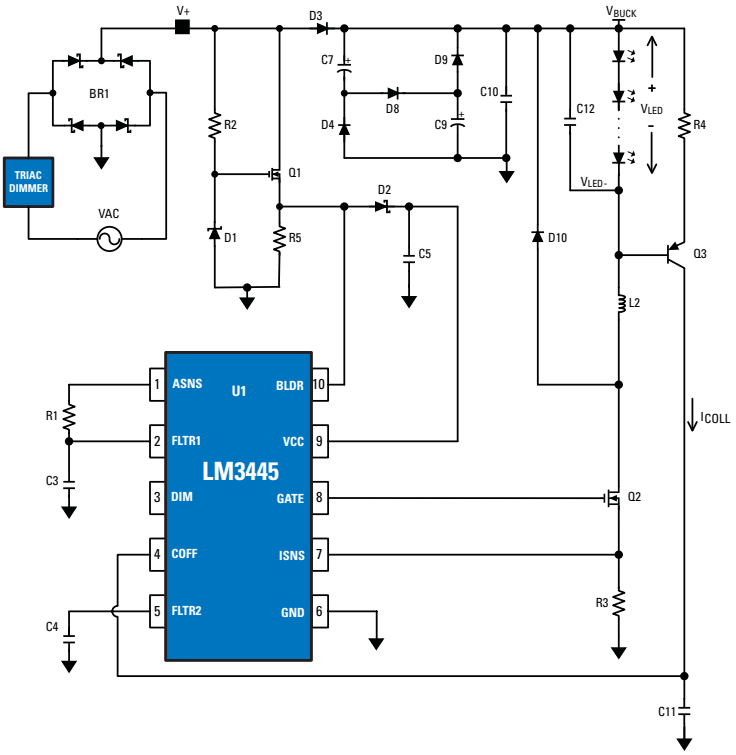
Supervisors

Product ID	Active Reset	Voltage Rails Supervised[1] (V)	Reset Timeout Period (ms)	Iq (µA)	Manual Reset	Low Line Output	PFI Comparator	Watchdog	Temp Range (°C)	Packaging
LM3722	Low	2.5, 3.3, 5.0	190	6	✔	—	—	—	-40 to 125	SOT23-5
LM3724	Low (open drain)	2.5, 3.3, 5.0	190	6	✔	—	—	—	-40 to 125	SOT23-5, D, W
LM3700	Low	2.9, 3.1, 3.3	1.4, 28, 200, 1600	28	—	✔	—	—	-40 to 85	micro SMD-9
LM3702	Low	2.35, 3.1, 3.3	1.4, 28, 200, 1600	28	✔	✔	—	—	-40 to 85	micro SMD-9
LM3706	Low	3.3	1.4, 28, 200, 1600	28	—	✔	—	✔	-40 to 85	micro SMD-9
LM3708	Low	3.3	1.4, 28, 200, 1600	28	✔	✔	—	✔	-40 to 85	micro SMD-9
LM3709	High	3.3	1.4, 28, 200, 1600	28	✔	✔	—	✔	-40 to 85	micro SMD-9
LM3710	Low	2.5, 3.3, 4.8, 5.0	1.4, 28, 200, 1600	28	✔	✔	✔	✔	-40 to 85	micro SMD-9, MSOP-10
LM3711	High	2.5, 3.3, 5.0	1.4, 28, 200, 1600	28	✔	✔	✔	✔	-40 to 85	micro SMD-9, MSOP-10
LM3712	Low	3.3	1.4, 28, 200, 1600	28	✔	—	✔	✔	-40 to 85	micro SMD-9
LM3713	High	3.3	1.4, 28, 200, 1600	28	✔	—	✔	✔	-40 to 85	micro SMD-9

[1]Most parts can monitor additional voltage rails in the 0.5V to 2.0V or the 2.2V to 5.0V range. For these custom threshold voltages, contact your National sales representative.

High-Performance TRIAC-Dimmable LED Driver

National's industry-leading TRIAC-dimmable offline LED driver solution is perfect for any application where an LED driver must interface to a standard TRIAC wall dimmer. The LM3445 LED driver delivers a wide, uniform dimming range free of flicker, with best-in-class dimming performance, and high efficiency—all while maintaining ENERGY STAR power-factor requirements in typical applications.



Features

- 100:1 full-range dimming capability
  - From full to nearly imperceptible light without being extinguished
  - Maintains constant current to large strings of LEDs driven in series off of standard line voltage
- Easy to use
  - Enables a direct replacement of incandescent or halogen lamps without changing infrastructure or sacrificing performance
  - WEBENCH® LED Designer is available for easy and quick design
- Uniform dimming without flicker
  - Allows master-slave operation control in multi-chip solutions
  - Single TRIAC dimmer controls multiple strings of LEDs
  - Enables smooth consistent dimming, free of flicker

Product ID	V_{IN} Range(V)	V_{OUT} max (V)	I_O (A)	Number of LEDs	Multi-Output	Internal Switch	Topology	Key Features
NEW! **LM3445** [E, W]	80 VAC to 270 VAC	Adj	1+	1 to 14+	No	No	Floating buck	Integrated TRIAC dim decoder circuit for LED dimming. Adaptive programmable offline allows for constant ripple current. No 120/100 Hz flicker

[E] Evaluation board [W] WEBENCH enabled

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3. Complete Your Design

Optimize between efficiency and size

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Use the electrical simulator to verify circuit stability and operation

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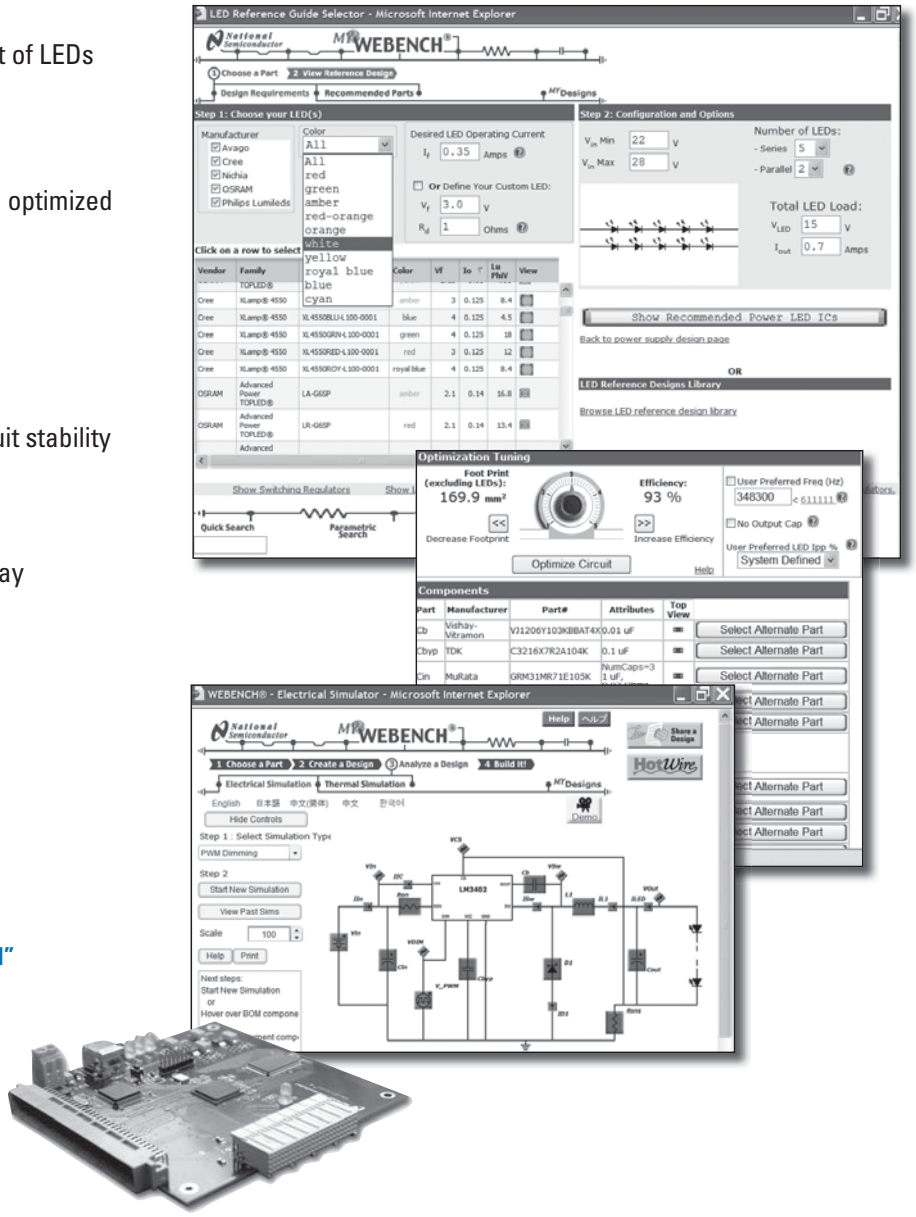

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Features

- PowerWise® energy-efficient solutions
  - Providing the best power-to-performance ratios
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- Low external component count and small solution sizes
- Easy-to-use tools and resources:
  - WEBENCH® LED Designer online design tool
  - Reference designs
  - Application notes

Applications

LED Driver	Architectural	Automotive	Display Backlighting	Outdoor Area Lighting	Medical	Industrial	Residential	Signage & Channel Lettering	Retail and Display	Entertainment	Portable Consumer
LM3401	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔
LM3402/HV	✔	✔		✔	✔	✔	✔	✔	✔	✔	
LM3404/HV	✔	✔		✔	✔	✔	✔	✔	✔	✔	
LM3405/A	✔	✔			✔	✔	✔	✔	✔		✔
LM3406/HV	✔	✔		✔	✔	✔	✔	✔	✔	✔	
LM3407	✔	✔		✔	✔	✔	✔	✔	✔		✔
LM3410	✔	✔	✔		✔	✔	✔	✔	✔		✔
LM3421/23	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	
LM3431		✔	✔		✔			✔			
LM3430/32		✔	✔		✔			✔			
LM3433	✔				✔		✔			✔	

Inductive-Boost Backlight LED Drivers

Product ID	Input Voltage Range (V)	Maximum Output Voltage (V)	Max LED Current (mA)	Number of LEDs	Switching Frequency (MHz)	Dimming Control Type	Key Features	Packaging
LM3519 [E]	2.7 to 5.5	18	20	4	2 to 8	PWM	Variable switching frequency	SOT23-6
LM3500 [E]	2.7 to 7	16, 21	30	5	1	PWM	Low feedback voltage; no external Schottky diode	micro SMD-8
LM3501 [E]	2.7 to 7	16, 21	30	5	1	Analog	No external Schottky diode	micro SMD-8
LM3502 [E]	2.5 to 5.5	16, 25, 35, 44	30	10	1	PWM	2 LED banks for dual-display backlighting	micro SMD-10, LLP-16
LM3503 [E]	2.5 to 5.5	16, 25, 35, 44	30	10	1	Analog	2 LED banks for dual-display backlighting	micro SMD-10, LLP-16
LM3508 [E]	2.7 to 5.5	17.5	30	4	0.85	PWM	Adjustable PWM signal up to 100 kHz; no external Schottky diode	micro SMD-9
LM3557	2.7 to 7.5	26	30	5	1.25	PWM	Input under-voltage protection; cycle-by-cycle current limit	LLP-8
LM3509 [E]	2.7 to 5.5	21.2	30 per string	10	1.27	I²C	Dual-current sinks; 32 exponential dimming steps; 800:1 dimming ratio	LLP-10
LM3528 [E]	2.7 to 5.5	20	30 per string	10	1.27	I²C	Dual-current sinks,128 logarithmic dimming steps; 800:1 dimming ratio	micro SMD-12
LM3430/32 [E]	6 to 40	80+	40 per string	100+	Adjustable up to 2 MHz	Analog, PWM	Dynamic headroom control for balanced current through up to 6 strings of LEDs	LLP-12, eTSSOP-28, LLP-24
LP8541	6 to 22	40	60	—	1.25	PWM	PWM phase shift control, two-wire, |SMBus/I²C-compatible control interface	LLP-24
LM4510 [E]	2.7 to 5.5	18	280	—	1	—	Power Supply for OLED display; no external Schottky diode	LLP-10
LM2731/33 [E]	2.7 to 14	Adj up to 20/40	1A/1.5A	9	600 kHz	PWM	Internal compensation, cycle-by-cycle current limit	SOT23-5

Switched-Capacitor Boost Backlight LED Drivers

Product ID	Input Voltage Range (V)	Output Voltage (V)	Max LED Current (mA)	Number of LEDs	Switching Frequency (MHz)	Dimming Type	Key Features	Packaging
LM2755 [E]	3 to 5.5	5	90	3	1.25	I²C	Independently-controlled RGB outputs; programmable trapezoidal waveforms	micro SMD-18
LM2750 [E]	2.9 to 5.6	5, Adj (3.8 to 5.2)	120	10	1.7	PWM	Pre-regulation minimizes input ripple	LLP-10
LM27951/52	3 to 5.5	5	120	4	0.75	PWM	Regulated current sources with 0.2% matching	LLP-14
LM2751	2.8 to 5.5	4.5, 5	150	10	0.01 to 0.725	PWM	Programmable switching frequencies	LLP-10
LM2756 [E]	2.7 to 5.5	4.6	180	8	1.3	I²C	3 independent LED banks with 2 variable drivers; 32 exponential dimming steps; 800:1 dimming ratio	micro SMD-20
LM27964	2.7 to 5.5	5	180	7 (3 banks)	0.7	I²C	3 independent LED banks (Group A = 4 LEDs, Group B = 2 LEDs, Group C up to 80 mA) ; Dedicated keypad LED driver	LLP-24
LM27965 [E]	2.7 to 5.6	5	180	9 (3 banks)	1.27	I²C	3 independent LED banks (Group A = 5 LEDs, Group B = 3 LEDs, Group C = 1 LED)	LLP-24
LM27966	2.7 to 5.7	5	180	6 (2 banks)	1.27	I²C	2 independent LED banks (Group A = 5 LEDs, Group B = 1 LEDs)	LLP-24
LM2757 [E]	2.7 to 5.5	4.1, 4.5, 5	180	10	1.25	No dim-ming	Pre-regulation minimizes input ripple; true input-output and output-input disconnect; high impedance output in shutdown	micro SMD-12

Flash LED Drivers

Product ID	Input Voltage Range (V)	Output Voltage (V)	Max LED Current (mA)	Number of LEDs	Switching Frequency (MHz)	Topology	Key Features	Packaging
LM2754 [E]	2.8 to 5.5	5	800	4	1	Switched capacitor	TX input ensures synchronization with RF power amplifier pulse	LLP-24
NEW! LM2758/59 [E]	2.7 to 5.5	5	700/1000	1	1.2/1.0	Switched capacitor	Indicator, torch, and flash modes; flash timeout protection	micro SMD-12/ LLP-12
LM3551/52 [E]	2.7 to 5.5	11	1000	4	1.25	Inductive boost	Flash timeout protection; shutdown mode via SD pin (LM3551) or EN pin (LM3552)	LLP-14
NEW! LM3553 [E]	2.7 to 5.5	19	1200	2	1.3	Inductive boost	Indicator, torch, flash modes, and voltage mode; 128 current levels	LLP-12

PowerWise® product [E] Evaluation board

POWER

LED Drivers

High-Brightness LED Drivers

Product ID	Input Voltage Range (V)	Maximum Output Voltage (V)	Max LED Current (mA)	Maximum Number of LEDs in Series	Switching Frequency (MHz)	Topology	Key Features	Packaging
LM3431 E, W	5 to 36	40+	150 per string	30	Adjustable up to 1 MHz	Analog, PWM	Balances current through 3 strings of LEDs	TSSOP-28, LLP-28
LM3407 E, W	4.5 to 30	27	350	7	Adjustable up to 1 MHz	Buck	Fast PWM dimming, low external component count, constant frequency	eMSOP-8
LM3402/02HV E, W	6 to 42 / 6 to 75	40/70	500	9/15	Adjustable up to 1 MHz	Buck	Fast PWM dimming, no control loop compensation, supports ceramic capacitor and capacitor-less outputs	MSOP-8, PSOP-8
LM3404/04HV E, W	6 to 42 / 6 to 75	40/70	1000	9/15	Adjustable up to 1 MHz	Buck	Fast PWM dimming, no control loop compensation, supports ceramic capacitor and capacitor-less outputs	SOIC-8, PSOP-8
LM3405/05A E, W	3 to 15 / 3 to 22	14/20	1000	4	1.6	Buck	205 mV feedback voltage, PWM dimming	TSOT-6
LM3410 E, W	2.7 to 5.5	24	1000	6	525 kHz / 1.6 MHz	Boost, SEPIC	PWM dimming, small footprint, low external component count	SOT23-5, LLP-6
LM3406/06HV E, W	6 to 42/ 6 to 75	40/70	1500	1-10/20	Adjustable to 1 MHz	Buck	Fast PWM dimming. no control loop compensation, supports ceramic capacitor and capacitor-less outputs	eTSSOP-14
NEW! **LM3421/23/29** E, W	4.5 to 75	75	>2000	20	Adjustable to 2 MHz	Boost, SEPIC	Fast PWM dimming, LED ready, broken open check overvoltage protection, FLT, cycle-by-cycle current limit	eTSSOP-16/20/14
LM3401 E, W	4.5 to 35	35	3000	9	1.5	Buck	Adjustable hysteresis, 100% duty cycle, PWM dimming	MSOP-8
LM3433 E, W	-9 to -14	-6	6000+	1	Adjustable up to 1 MHz	Buck	Drives common anode LEDs, analog and fast PWM dimming	LLP-24
NEW! **LM3409** E, W	6 to 42 / 6 to 75	42/75	5000	9/15	1 MHz	Buck	PWM and analog dimming,HS current sense 100% duty cycle achievable	eMSOP10

E Evaluation board W WEBENCH enabled

Lighting Management Units

Product ID	Description	V_{IN} Range (V)	Drive Current for All	Current for Flash Mode	Current Matching	Temp Range (°C)	Packaging
LP5522 E	Autonomous single LED controller with one wire interface	2.7 to 5.5	20 mA	—	—	-30 to +85	micro SMD-6
LP3943 E	LED controller for RGB/white/blue LEDs	2.3 to 5.5	25 mA/LED	—	—	-40 to +125	LLP-24
LP3944 E	LED controller for RGB/white/blue LEDs	2.3 to 5.5	25 mA/LED	—	—	-40 to +125	LLP-24
LP8501 E	9-channel LED driver with integrated SRAM memory and 3 light engines.	2.7 to 5.5	25.5 mA	—	1%	-30 to +85	micro SMD-25
LM4970	LED controller with LED lighting effects synchronized to audio	2.7 to 5.5	42 mA	—	—	-40 to +85	LLP-14
LP3958	Lighting management unit for controlling 4+2 white LEDs for main and sub-display and 3 sets of white LEDs for keypad	3 to 5.5	70 mA total	—	3% (Key)	-30 to +85	micro SMD-25
LP5521 E	Fully programmable 3-channel color LED driver with advanced power-save features	2.7 to 5.5	75 mA	—	1%	-30 to +85	micro SMD-20
LP5524 E	Parallel LED Driver with PWM brightness control	2.7 to 5.5	100 mA	—	1%	-40 to +85	micro SMD-9
LP5526 E	Lighting management unit with high-voltage boost converter with up to 150 mA serial flash LED driver	3 to 5.5	150 mA total	150 mA	2% (RGB)	-30 to +85	micro SMD-25
LP5520	RGB backlight driver with white balance compensation	2.9 to 5.5	180 mA	—	0.20%	-30 to +85	micro SMD-25
LP3952	6-channel color LED driver with audio synchronization	3 to 5.5	240 mA	—	5%	-30 to +85	micro SMD-36 or micro SMDxt-36
LP3950	Color-LED driver with audio sync	3 to 7.2	300 mA	—	3%	-40 to +125	Laminate TCSP-32
LP39542	Lighting management unit for 4+2 white LEDs, 2 sets RGB LEDs with audio sync and pattern control, and a flash LED driver	3 to 5.5	400 mA	400 mA	0.2% (White LED), 5% (RGB)	-30 to +85	micro SMD-36 or micro SMDxt-36
LP55281 E	Quad RGB LED driver with boost converter and LED connectivity test	3 to 5.55	400 mA	—	5%	-30 to +85	micro SMD-36 or micro SMDxt-36S
LP5527	Tiny LED driver for camera flash and 4 LEDs with I^2C programmability, connectivity test and audio synchronization from PowerWise family	3 to 5.5	1 A total	—	1%	-30 to +85	micro SMD-30

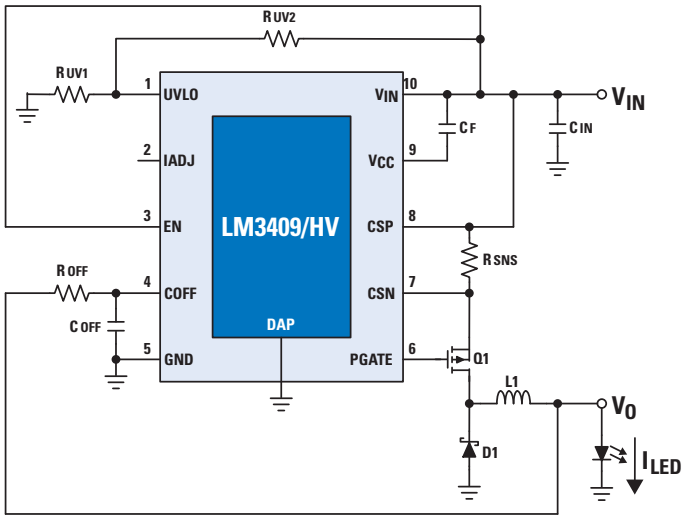
PowerWise® product E Evaluation board

For a complete list of LED Drivers, visit www.national.com/LED

LM3409

Features

- 2.0 Ω MOSFET gate drive
- VIN Range 6V to 42V (LM3409)
- VIN Range 6V to 75V (LM3409HV)
- Differential, high side current sensing
- No control loop compensation required
- Cycle-by-Cycle current limit
- 10,000:1 PWM dimming range
- 250:1 analog dimming range
- Low power shutdown
- Supports all-ceramic output capacitors and capacitorless outputs
- Thermal shutdown protection
- Available in thermally enhanced eMSOP-10 packaging



Applications

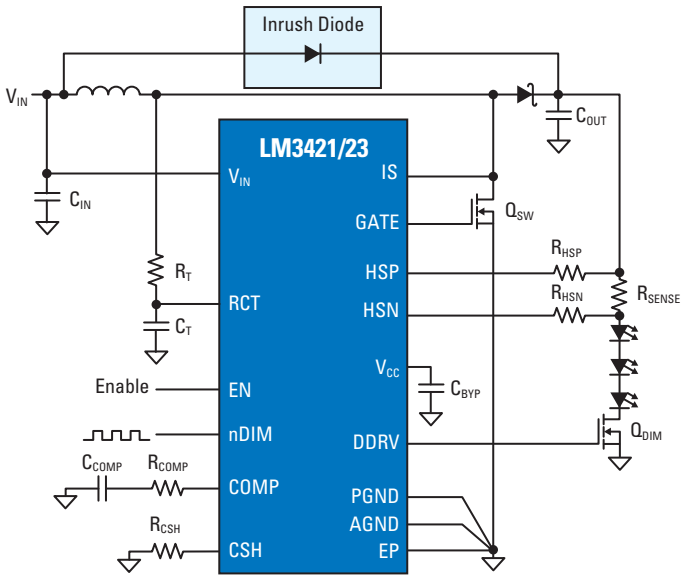
Ideal for use in LED Driver, Constant Current Source, Automotive Lighting, General Illumination, and Industrial Lighting

LM3421/23/29 – PowerWise N-Channel Controllers for Constant-Current LED Drivers

Shared Features

- V_{IN} range from 4.5V to 75V
- 2% 1.235V Internal reference voltage
- Current sense voltage adjustable from 20 mV
- High side current sensing
- 2Ω MOSFET gate driver
- Input under-voltage protection
- Over-voltage protection
- Low shutdown current, Iq < 1 mA
- Cycle-by-cycle current limit
- Programmable running frequency

LM3421/23 Typical Application Circuit



LM3421/23

Addition Features

- LED output status flag
- Fault flag
- Programmable fault timer
- Logic input to select the polarity of dimming output driver

POWER

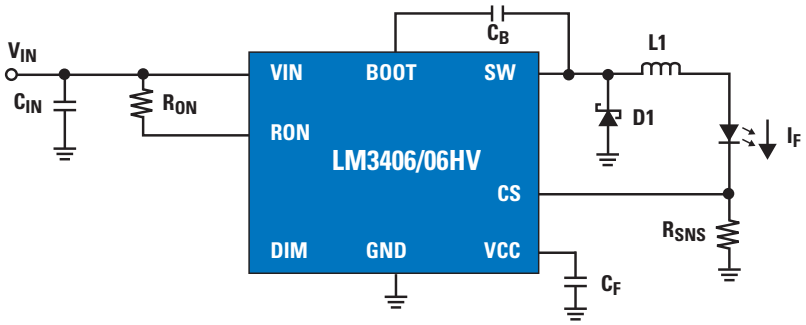
High-Brightness LED Drivers

LM3406/06HV – PowerWise® 1.5A Constant-Current Buck Regulator for Driving High-Power LEDs

Features

- Integrated 2.0A MOSFET
- V_{IN} range 6V to 42V (LM3406)
- V_{IN} range 6V to 75V (LM3406HV)
- 1.7A minimum output current limit over temperature
- Cycle-by-cycle current limit
- PWM dimming with dedicated logic input
- PWM dimming with power input voltage
- Simple control loop compensation
- Low power shutdown
- Supports all-ceramic output capacitors and capacitor-less outputs
- Thermal shutdown protection
- Available in eTSSOP-14 packaging

LM3406/06HV Typical Application Circuit



Applications

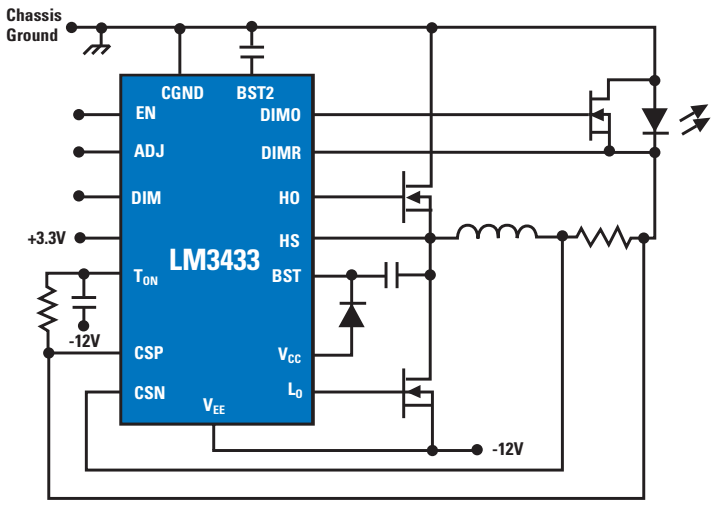
Ideal for use in LED drivers, constant-current sources, automotive lighting, general illumination, and industrial lighting

LM3433 – Common-Anode-Capable, High-Brightness LED Driver with High-Frequency Dimming

Features

- Operating input voltage range of -9V to -14V w.r.t. LED anode
- Control inputs are referenced to the LED anode
- Output current greater than 6A
- Greater than 30 kHz PWM frequency capable
- Negative output voltage capability allows LED anode to be tied directly to chassis for maximum heat sink efficacy
- No output capacitor required
- Up to 1 MHz switching frequency
- Low IQ, 1 mA typical
- Soft-start
- Adaptive programmable ON time allows for constant ripple current
- Available in LLP-24 packaging

LM3433 Typical Application Circuit



Applications

Ideal for use in LCD backlighting, projection systems, solid state lighting, and automotive lighting

LP2998 – Double Data Rate (DDR) Termination Regulator

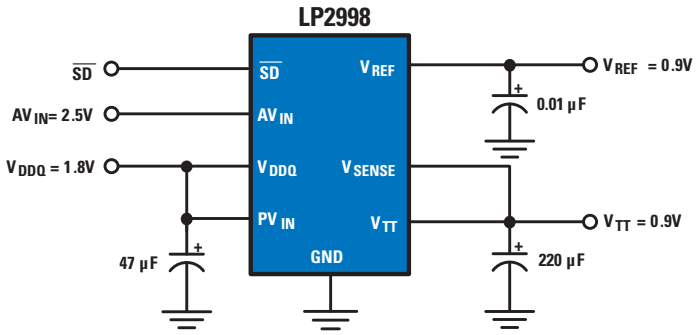
Features

- Linear topology
- Load current up to 0.5A (DDR-II)/1.5A (DDR-I)
- Source and sink current
- Thermal shutdown
- Suspend to RAM (STR) functionality
- Active low shutdown
- -40°C to +125°C operation

Applications

Ideal for use in DDR-I and DDR-II termination voltage, SSTL-2 and SSTL-3 termination, and HSTL termination

Recommended DDR-II Termination



Linear Regulators for DDR Termination

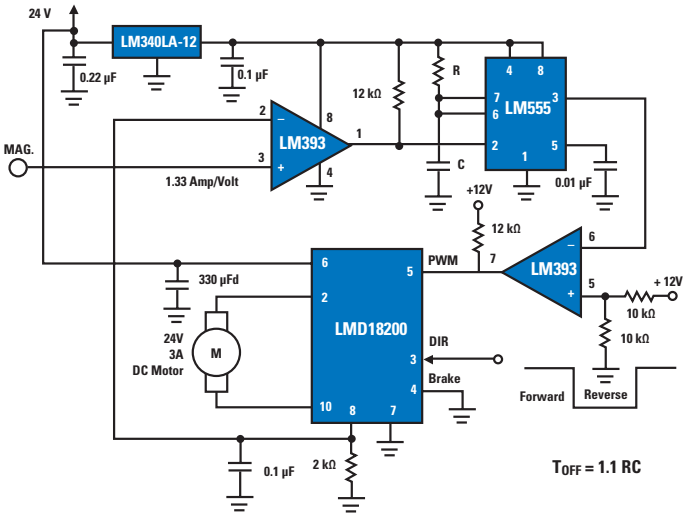
Product ID	Input Max Voltage (V)	Input (PV_{IN}) Min Voltage (V)	Output Current (mA)	Standards	External Components	Quiescent Current	Error Flag	On/Off Pin	Suspend to RAM shutdown	Packaging
LP2997	5.5	1.8	500	DDR-II	3	0.32	—	✔	✔	PSOP-8, SO-8
LP2995	5	2.2	1500	DDR	3	0.25	—	—	—	LLP-16, PSOP-8, SO-8
LP2996	5.5	1.8	1500	DDR, DDR-II	3	0.32	—	✔	✔	LLP-16, PSOP-8, SO-8
LP2998	5.5	1.8	1500	DDR, DDR-II	3	0.32	—	✔	✔	PSOP-8, SO-8

Motor and Motion Controllers

LMD18200 – 3A, 55V H-Bridge Controller

Features

- Delivers up to 3A continuous output
- Operates at supply voltages up to 55V
- Low RDS(ON) typically 0.3Ω per switch
- TTL- and CMOS-compatible inputs
- No "shoot-through" current
- Thermal warning flag output at 145°C
- Thermal shutdown (outputs off) at 170°C
- Internal clamp diodes
- Shorted load protection
- Internal charge pump with external bootstrap capability



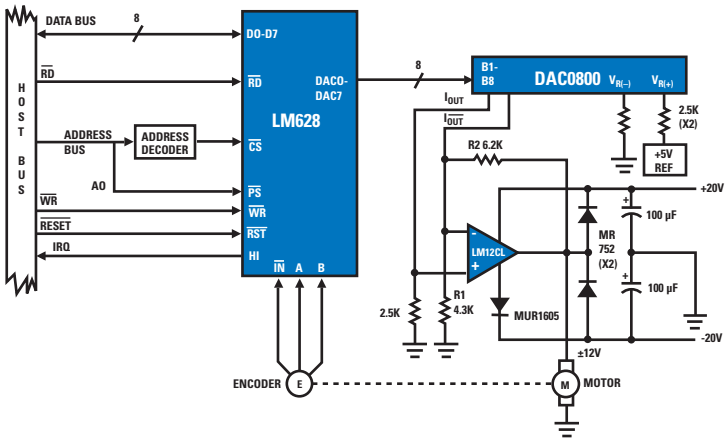
Half-Bridge Drivers for Motor Control

Product ID	Max V_{IN} (V)	Min V_{IN} (V)	I_{OUT} (A)	Thermal Shutdown	Features	Packaging
LMD18200	55	12	3	170°C	Thermal warning flag at 145°C, low-loss internal current sense circuitry, shorted load protection	TO220-11
LMD18201	55	12	3	170°C	Thermal warning flag at 145°C	TO220-11
LMD18245	55	12	3	155°C	Low-loss internal current sense circuitry, 4-bit digital motor current control	TO220-15

LM628 – Precision Motion Controller

Features

- 32-bit position, velocity, and acceleration registers
- Programmable digital PID filter with 16-bit coefficients
- Programmable derivative sampling interval
- 8- or 12-bit DAC output data (LM628)
- 8-bit sign-magnitude PWM output data (LM629)
- Internal trapezoidal velocity profile generator
- Velocity, target position, and filter parameters may be changed during motion
- Available in 28-pin dual in-line packaging or 24-pin surface mount packaging (LM629 only) capability

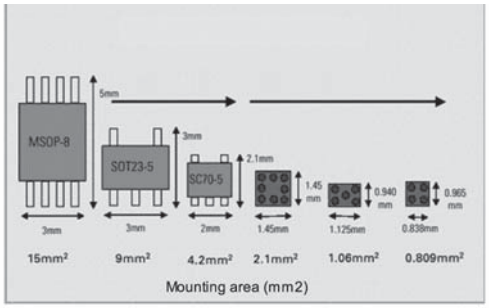


Digital Controllers for Motion Control

Product ID	Max Frequency	Features	Output Data	Packaging
LM628	6 MHz or 8 MHz	Digital PID filter, 32-bit velocity, position, acceleration registers	8-bit or 12-bit DAC	MDIP-28
LM629	6 MHz or 8 MHz	Digital PID filter, 32-bit velocity, position, acceleration registers	8-bit sign-magnitude PWM to drive H-bridge	DIP-28 or SOIC-24

National Semiconductor meets the requirements for pin count and size across all standard package types. In addition to providing advanced packages, National has taken steps to reduce or completely eliminate environmentally unfriendly and hazardous substances from its products. National is compliant with the European Union's RoHS Directive (an EU directive restricting the use of specific hazardous substances contained in electronic products). In addition, National has taken the environmental initiative to move to halogen-free products.

Comparison of Packages Sizes



National has led the industry in developing ground-breaking new packages that meet the needs of the mobile era. Typical examples include micro SMD and LLP®.

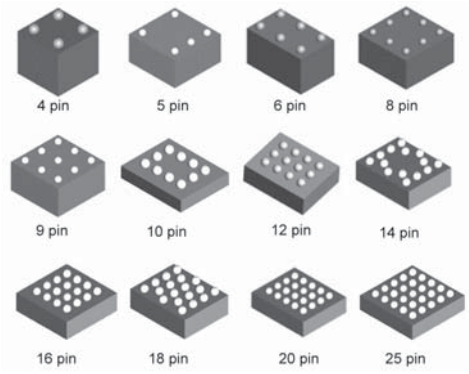
Features of National's CSP (chip scale package)
micro SMD: "The die is the package"

The micro SMD package is ideal for high-performance mobile devices and applications with space-constraint issues.

micro-SMD packaging also features the following benefits:
- Minimum mounting area relative to the number of I/O pins
- Excellent electrical characteristics and heat dissipation performance, level 1 moisture resistance, and low noise
- Two different types of solder bump are available (large bump: 300 µm, small bump: 170 µm)
- 0.5 mm pitch pad layout
- Standard (0.85 mm to 1.05 mm) or thin (0.5 mm to 0.6 mm) package thickness
- Supplied as standard embossed taping

National has adopted micro SMD technology for a wide range of products including power management, audio, amplifier, and temperature management ICs.

micro-SMD Package Range
LLP Packages Feature Excellent Heat Dissipation Characteristics:

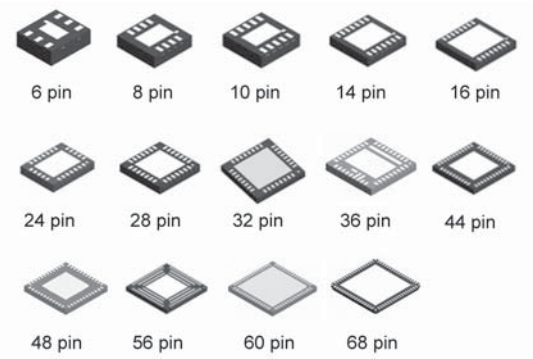


A key feature of the LLP package is that the large heat dissipation area provided by the "die attach pad" reduces thermal resistance and delivers excellent heat dissipation characteristics. At the same time, the package reduces board mounting area and enables high density mounting. The main features of LLP packaging are listed below.

- Provides better heat dissipation characteristics and improves self-alignment of packages during reflow due to the low thermal resistance
- Makes effective use of circuit board area with low package height and weight
- Affords low parasitic capacitance
- Maintains coplanarity
- Delivers faster signal transmission speed with minimal cross-talk and ground balance

The small dimensions and thin profile of the LLP package make it ideal for application in small devices such as mobile phones and PDAs that are heat-sensitive.

LLP Package Range



POWER

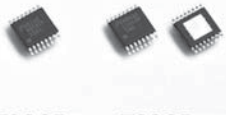
Package Solutions

SOT-23

TO-92

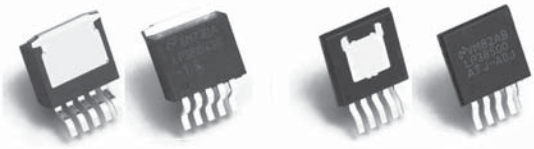
SOT-223

TO-252



TSSOP

TSSOP
EXP PAD



TO-263

TO-263 THIN

Leadless Leadframe Package (LLP)

PQFP

Laminate CSP

SC70

TQFP/LQFP

MINI SOIC

MINI SOIC
EXP PAD

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Reference Design Library

Power Management

National's broad range of power management solutions is supported by reference designs, covering an broad array of applications and topologies. This includes output voltage range of -52V to +100V, for load currents of up to 30A.

www.webench.mational.comwebench/refdesigns.do

Altera

National offers designers the Power-Expert software tool, power design guide, reference designs, and application notes to help them easily select and implement the best power management solutions for Altera FPGA or CPLD designs.

www.national.com/analog/pwer/altera_referencedesigns

Xilinx

Power solutions also include a downloadable power design guide for Xilinx FPGAs and application notes to help guide the engineer toward a typical solution for their Xilinx design.

www.webench.national.comwebench/refdesigns.do

LVDS

LVDS evaluation boards are available

www.national.com/analog/interface/eval_boards

LED Lighting

Inductive LED driver reference designs are available for powering a wide variety of white LED types of multiple colors and configurations with high power efficiency. Many designs offer high output current for multiple LEDs in series, LED flash, or high-power LEDs.

www.webench.national.com/webench/ledreferencedesigns.do

Analog Signl Path (ADC + Amp + Clock)

National's signal path reference design includes:

- Low IF receiver subsystem with large/small signal SNR of 75.8/78 dBFS and SFDR greater than 84/94 dBFS - ADC16V130
- Lowest power 8-bit 3 GSPS data acquisition system
- Low intermediate frequency receiver system

Serial Digital Interface

- Triple-rate SDI and video clocking daughter card for Altera Cyclone III FPGAs
- Triple-rate SDI and video clocking daughter card for Xilinx Spartan-3A/3E FPGAs
- High-performance video clock module for Xilinx Virtex-5 LXT FPGAs
- LMH0303 triple-rate single/dual SDI cable driver with cable detect

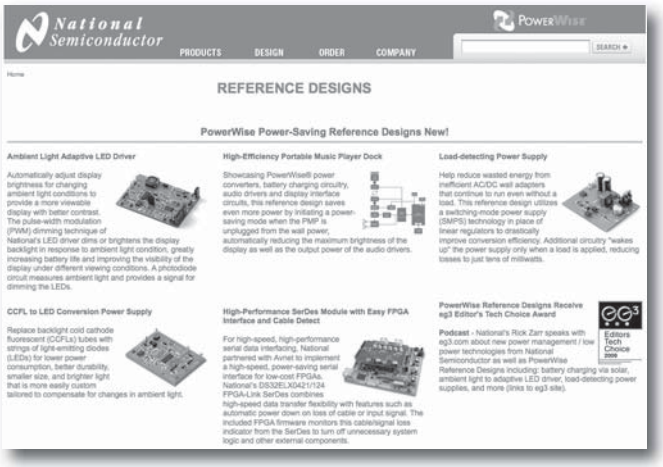
Ethernet

- 10/100 reference designs - including microcontroller-and FPGA- based systems and IEEE1588 solutions

www.national.com/analog/interface/refdesign_demoboards

- MotionFire motion control reference design National, in collaboration with Arrow Electronics and Altera, developed a complete FPGA-based motor control platform with industrial communications interface

www.national.com/analog/altera/motionfire



Technical and design information is available to users who have registered on National's website

POWER Designer

A technical publication that provides useful techniques and application data for power supply circuit design along with profiles of new products

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#124	Isolated Supply Overview and Design Trade-Offs
#123:	Voltage Reference Selection Basics
#122:	Optimizing Power Controller Designs through Effective Utilization of Performance Features
#121:	Power Supply Design Considerations for Modern FPGAs
#120:	Calculating Losses and Junction Temperature for High-Power-Density Switching Converters
#119:	Color-Management LED Drivers Have a Bright Future
#118:	Saving Energy via Smart Power Management
#117:	Overcoming Challenges in Designing Step-Down Regulator Applications with ≥ 40V Input Voltage
#116:	Driving LEDs: To Cap or Not to Cap
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#116	Energy Efficiency and Reliability in Automatic Transmission Systems
#115:	Liquid-Level Monitoring Using a Pressure Sensor
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