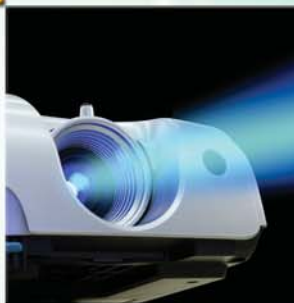


Analog Product Guide

www.national.com

2009 Vol. 1

Table of Contents	3
Data Conversion	5-21
Amplifiers.....	22-49
Audio.....	50-69
Temperature Sensors.....	70-73
Interface	74-96
Power Management	97-163
Design Tools	164-167
Index	168-174



 *National
Semiconductor*

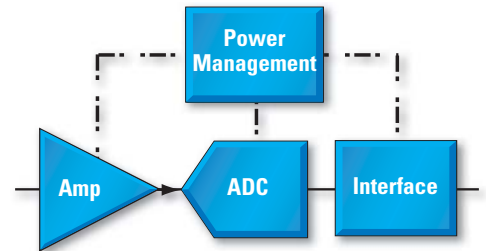


Optimize Performance at the Lowest Power

National's PowerWise® Solutions Help Engineers Design Energy Efficient Systems

PowerWise products are analog and mixed-signal semiconductors that balance higher performance with lower power consumption.

PowerWise subsystems are architectural innovations designed to enable energy-efficient systems.



PowerWise Metrics Help Designers Compare Analog Components

PowerWise metrics are formulas and thresholds that distinguish energy efficient components from those that are less efficient. National has developed PowerWise metrics for 25 product categories and selected the best-in-class energy efficient products in each of these categories. Each PowerWise product has a PowerWise label and rating which summarizes its key specifications.

PowerWise® Efficiency Ratings (4 out of 25 categories shown)

Product Family	Metric	Threshold	Units
Switching Regulators	Peak Efficiency	≥ 95	%
High-Speed ADCs	$\frac{P}{2^{ENOB} \cdot F_s \cdot ch}$	≤ 2.5	pJ/conversion
Equalizers	$\frac{P}{T_r \cdot ch}$	≤ 20	pJ/bit
Timing Solutions	$\frac{P \cdot t_j}{ch}$	≤ 55	mW•pS



PowerWise Resources Help Designers Improve System Performance to Power

Visit national.com/powerwise for white papers, app notes and design tools that help system engineers by highlighting the optimal balance between performance and power consumption at the component, subsystem and system level.

Find PowerWise products, metrics, white papers, app notes and tools at:
national.com/powerwise

Design Made Easy	4	Extended the Reach of SDI Transmissions	88
Data Conversion		PowerWise® SDI Cable Drivers	89
Data Converter Portfolio.....	5	Mobile Pixel Link	90
GSPS Ultra-High-Speed A/D Converters.....	6-7	High-Speed Industrial Ethernet	91-92
MSPS High-Speed A/D Converters.....	8-14	LMK Clock Conditioner Family	93-94
kSPS Low-Power A/D Converters.....	15-17	High-Performance Frequency Synthesizers	95-96
kSPS Low-Power D/A Converters.....	18-19		
Analog Front Ends.....	20-21	Power Management	
Amplifiers		Power Management Product Portfolio.....	97
Amplifier Portfolio Selection Table and Tree.....	22-25	Commonly Used Power Switching Topologies.....	98-100
High-Speed Amplifiers.....	26-30	Power Management Products.....	101-103
High-Speed Variable Gain Amplifiers.....	31	WEBENCH® Online Design Environment.....	104-105
Comparators.....	32	SIMPLE SWITCHER® Solutions.....	106
RF Detectors and Clock Buffers.....	33-34	SIMPLE SWITCHER Regulators.....	107
Analog Video Products.....	35-38	SIMPLE SWITCHER Synchronous Regulators.....	108-109
Precision Amplifiers.....	39-41	Non-Synchronous Step-Down (Buck)	
Current Sensing Amplifiers.....	42	Switching Regulators.....	110-111
Low-Voltage Amplifiers.....	43	Synchronous Step-Down (Buck)	
Micropower Amplifiers.....	44	Switching Regulators.....	112-113
Shutdown Amplifiers.....	45	Switched-Capacitor Converters and Regulators.....	114
Low-Power Amplifiers.....	46	Step-Down (Buck) Switching Controllers.....	115
Precision and EMI-Hardened Amplifiers.....	47	Synchronous Step-Down (Buck) Switching Controllers.....	116-117
Low-Voltage, Low-Noise Amplifiers.....	48	Step-Up (Boost) Switching Regulators.....	118
±15V Supply Amplifiers.....	49	Boost and Buck-Boost Regulators.....	119
		Boost and Buck-Boost Controllers.....	120
		Two-Switch Buck-Boost Controller and	
		Two-Switch Forward Regulator.....	121
Audio		LM5000 Series High-Voltage Power IC Family.....	122-123
Mixed Signal Subsystems/Audio Codecs.....	50-51	Switching Regulators and Controllers for	
Analog Subsystems.....	52-53	Isolated Applications.....	124
Noise Reduction.....	54	Isolated Controllers.....	125-126
Microphone Amplifiers.....	55	MOSFET Drivers.....	127
OCL/CC Headphone Boomer® Amplifiers.....	56	Power-over-Ethernet Controllers.....	128
Ground-Referenced Headphone Boomer Amplifiers.....	57	Hot Swap/In-Rush Current Controllers.....	129
High-Efficiency Boomer and Overture® Class D Amplifiers.....	58	Low Dropout (LDO) Linear Regulators.....	130-131
Boosted Boomer Moving Coil.....	59	Wide Input Voltage LDOs.....	132
Boosted Boomer Piezo Ceramic.....	60	Single- and Multi-Output LDOs.....	133
Mono Boomer Audio Amplifiers.....	61	Low-Noise LDOs to Power RF and Analog Circuits.....	134
Stereo Boomer Audio Amplifiers.....	62	Multi-Output Switching Regulators.....	135-139
Specialty Audio.....	63	PowerWise® AVS Energy Management Units.....	140
Choosing an Audio Power Amplifier.....	64-65	Multi-Output Switching Controllers.....	141
High-Performance Audio.....	66-69	Voltage References.....	142
		Power Sequencers and Supervisors.....	143
		WEBENCH® LED Designer.....	144
		Applications for High-Brightness LED Drivers.....	145
		LED Drivers.....	146-156
		Inductive-Boost Backlight LED Drivers.....	148-151
		Switched-Capacitor Boost Backlight LED Drivers.....	152
		Flash LED Drivers.....	153
		High-Brightness LED Drivers.....	154-156
		Lighting Management Units.....	157-159
		Linear Regulators for DDR Termination.....	160
		Motor and Motion Controllers.....	161
		Advanced Packaging Technologies.....	162
		Package Solutions.....	163
		Design Tools	164-167
		Index by Product	168-174
Interface			
Interface Product Overview.....	74		
Multi-Drop LVDS.....	75		
LVDS and CML PHYs.....	76		
Cable Extension and Switching/Redundancy.....	77		
Differential-to-Differential.....	78-79		
Serializer/Deserializer (SerDes).....	80-82		
FPGA Link.....	83		
Comprehensive 3 Gbps SDI Solutions.....	84		
Triple-Rate Development Platforms.....	85		
Triple-Rate SDI SerDes FPGA IP.....	86		
Dual Channel 3G-SDI SerDes Transceiver.....	87		

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.

Data Converter Portfolio

GPS Ultra-High Speed A/D Converters

Features

- 10-bit ADCs up to 2 GPS and 8-bit ADCs up to 3 GPS 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

	kSPS	MSPS		GPS
	50 – 1000	1 – 50	50 – 500	0.5 – 3
8-bit	ADC	ADC	ADC	ADC
10-bit	ADC	ADC	ADC	ADC
12-bit	ADC	ADC	ADC	
14-bit	ADC	ADC	ADC	
16-bit	ADC	ADC	ADC	

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

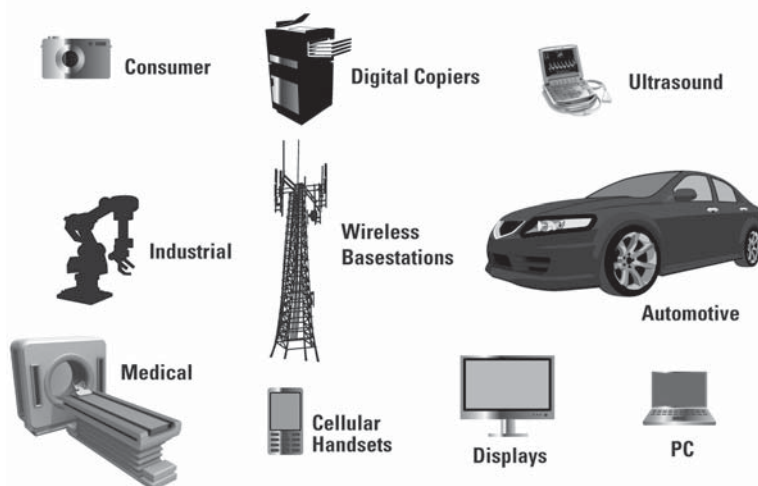
Features

- 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/upgrade
 - ADCs guaranteed over sample rate
 - Small packaging

Applications:

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

Data Conversion Applications



GPS Ultra-High Speed A/D Converters

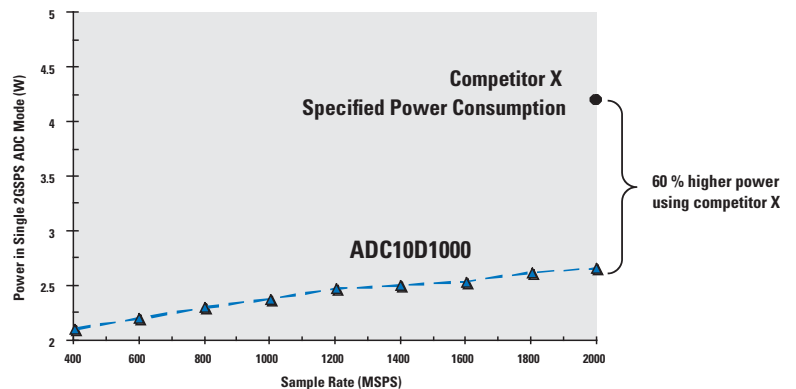
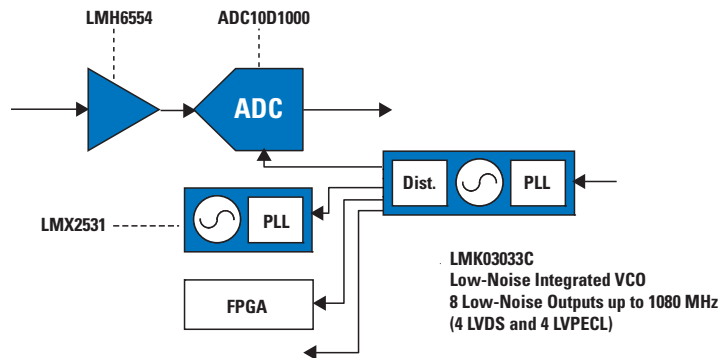
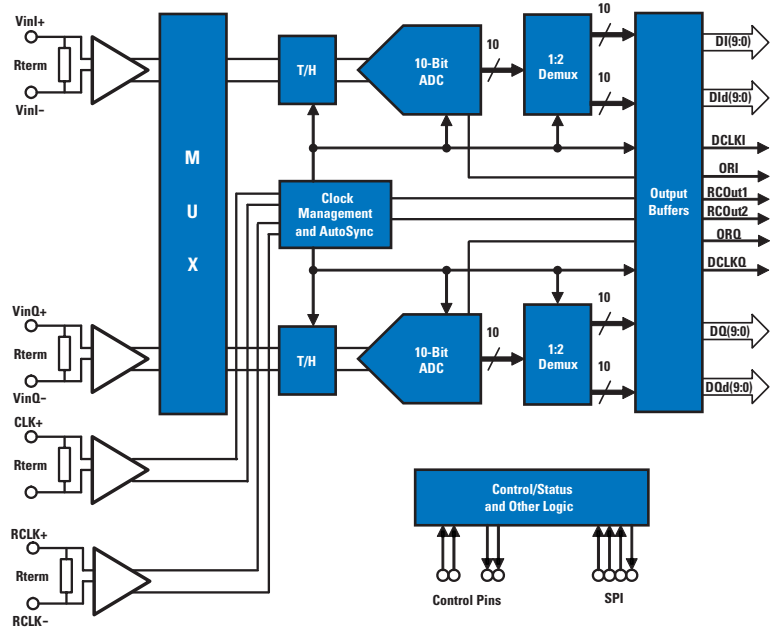
ADC10D1000 – Low-Power, 10-Bit, Dual 1.0 GPS or Single 2.0 GPS A/D Converter

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)



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

ADC083000 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

Applications:

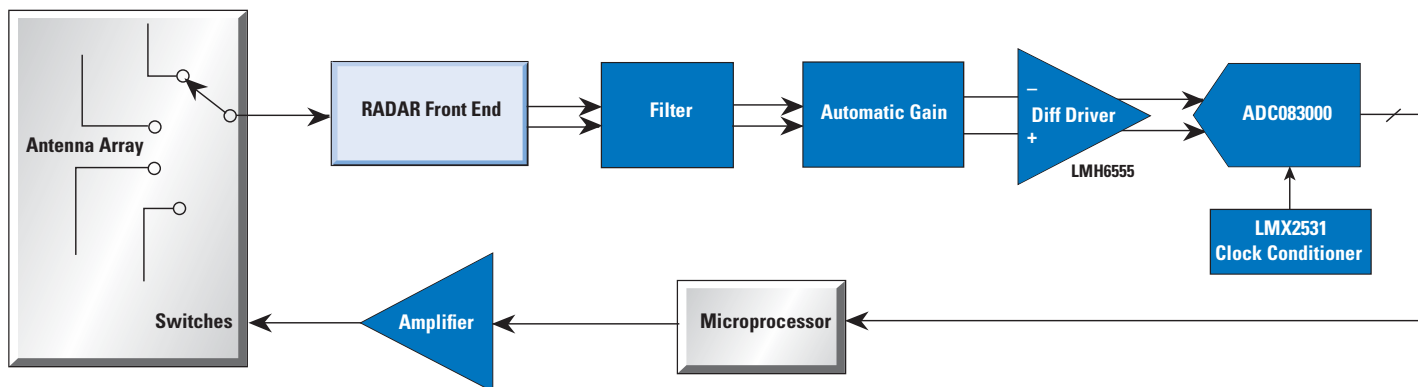
Ideal for use in direct RF down conversion, digital oscilloscopes, communications transceivers, test instrumentation, and ranging applications such as LIDAR and RADAR

8-Bit GSPS A/D Converters

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

 PowerWise product

RADAR System



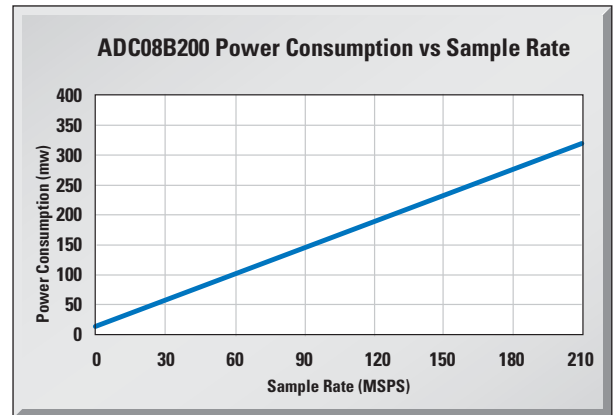
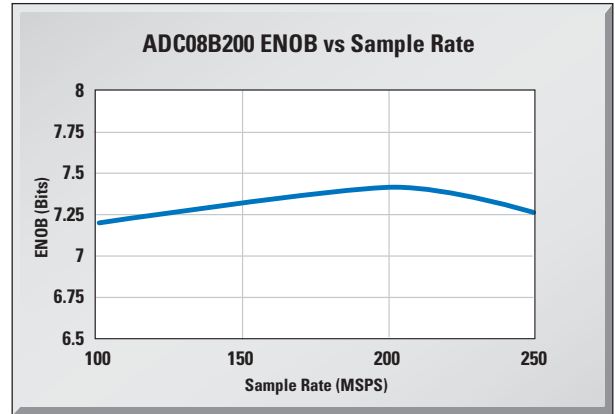
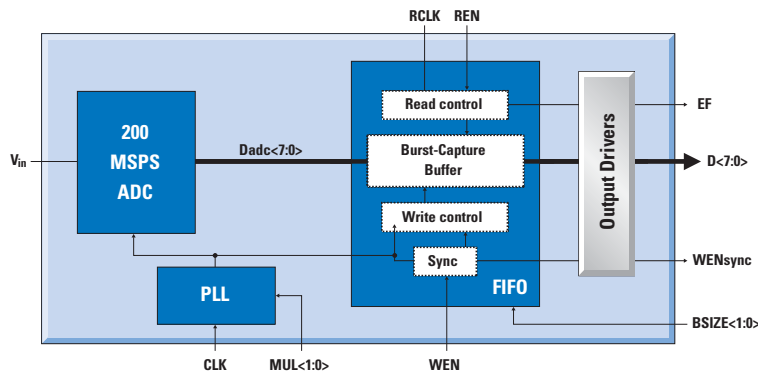
MSPS High-Speed A/D Converters

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

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
ADC12010	1	10	160	70	83	CMOS	LQFP-32
ADC12081	1	5	105	68	79	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

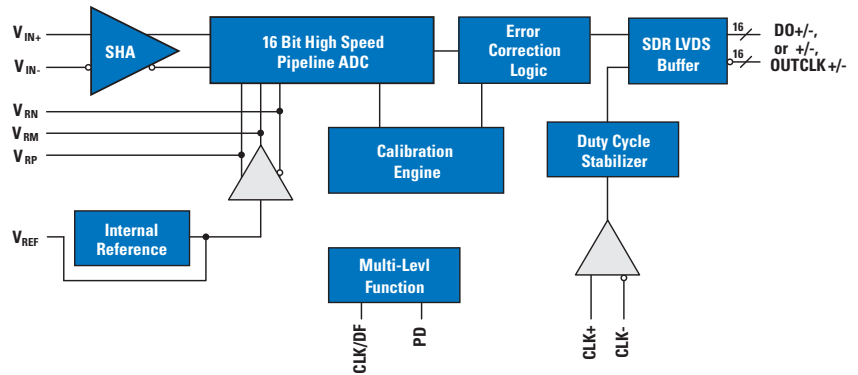
 PowerWise® product

MSPS High-Speed A/D Converters

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

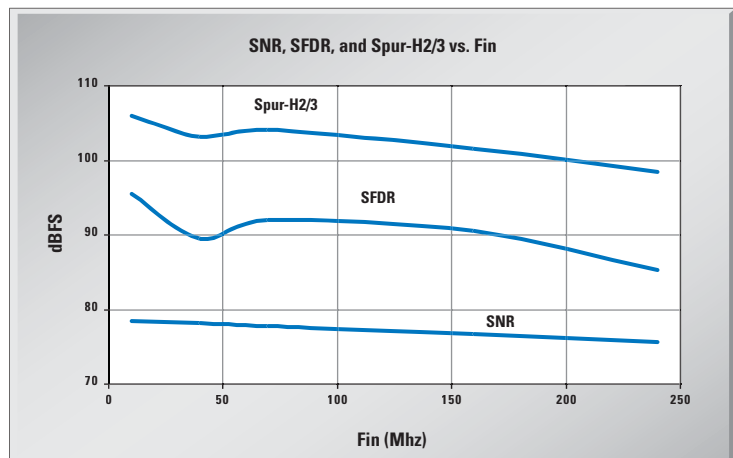
Features:

- 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



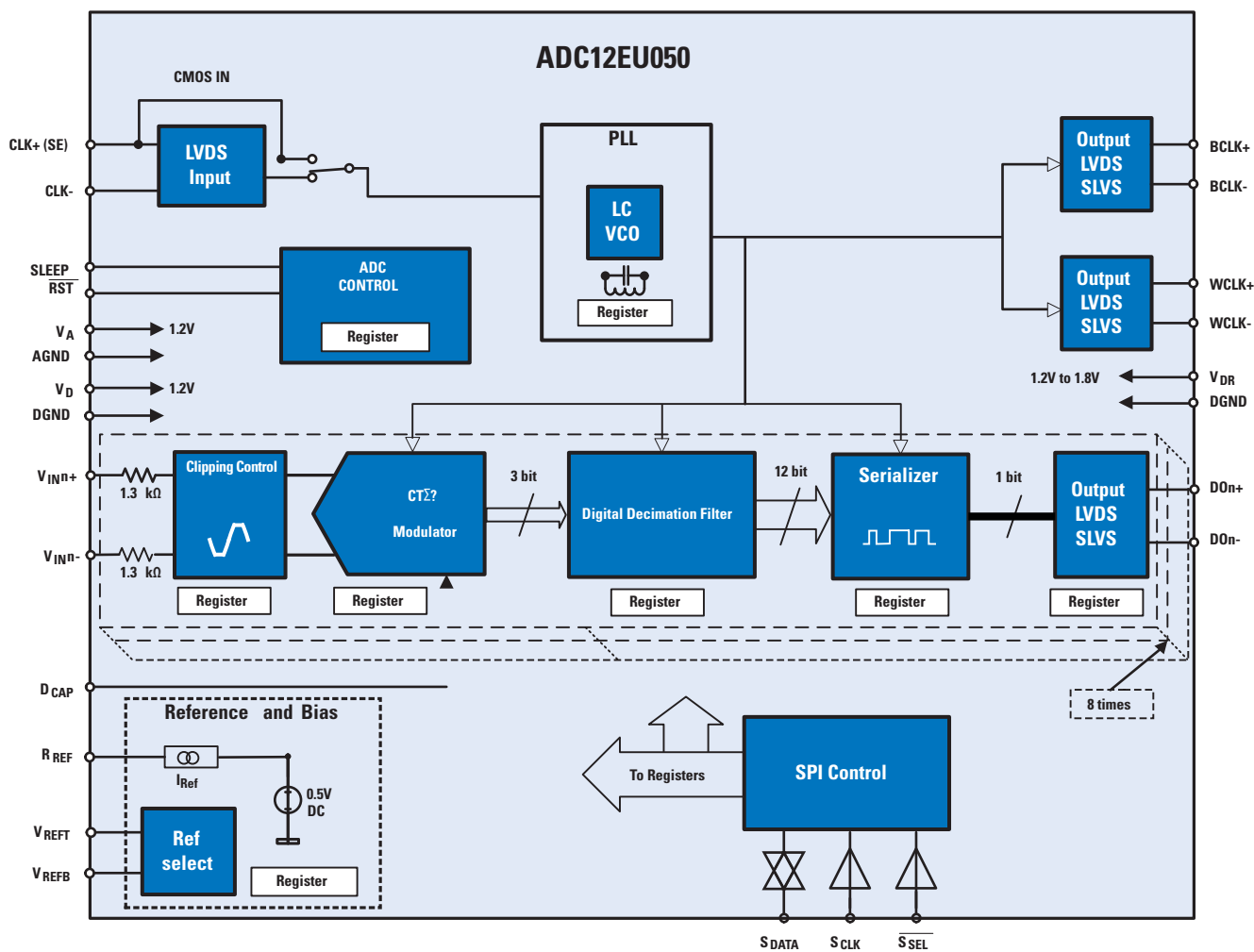
ADC12EU050 – PowerWise® High-Speed Continuous-Time Sigma-Delta ADC

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

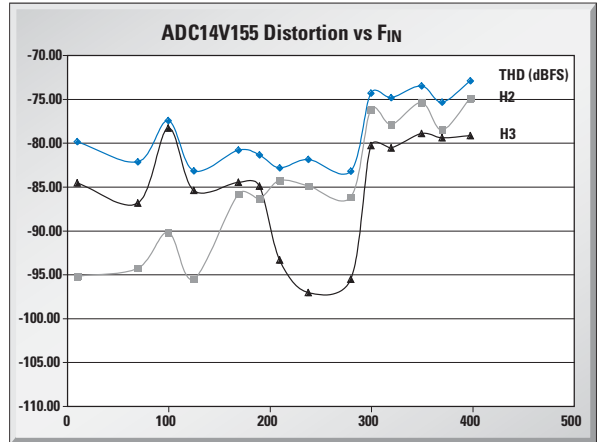


MSPS High-Speed A/D Converters

ADC14V155 – PowerWise® 14-bit, 155 MSPS ADC for High IF Sampling

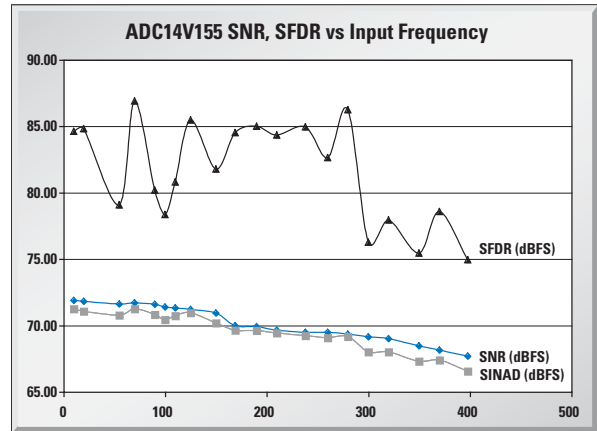
Features

- 1.1 GHz full power bandwidth
- 69.5 dBFS SNR at 238 MHz input
- 85 dBFS SFDR at 238 MHz input
- -81.9 dBFS THD at 238 MHz input
- Dual 3.3V, 1.8V supply operation
- Power consumption: 951 mW
- Parallel LVDS outputs
- Available with CMOS outputs (ADC14155)
- Available in LLP-48 packaging (7 x 7 x 0.8 mm)
- Reference board available with LMH6515 high-speed amplifier and LMK03001 clock conditioner

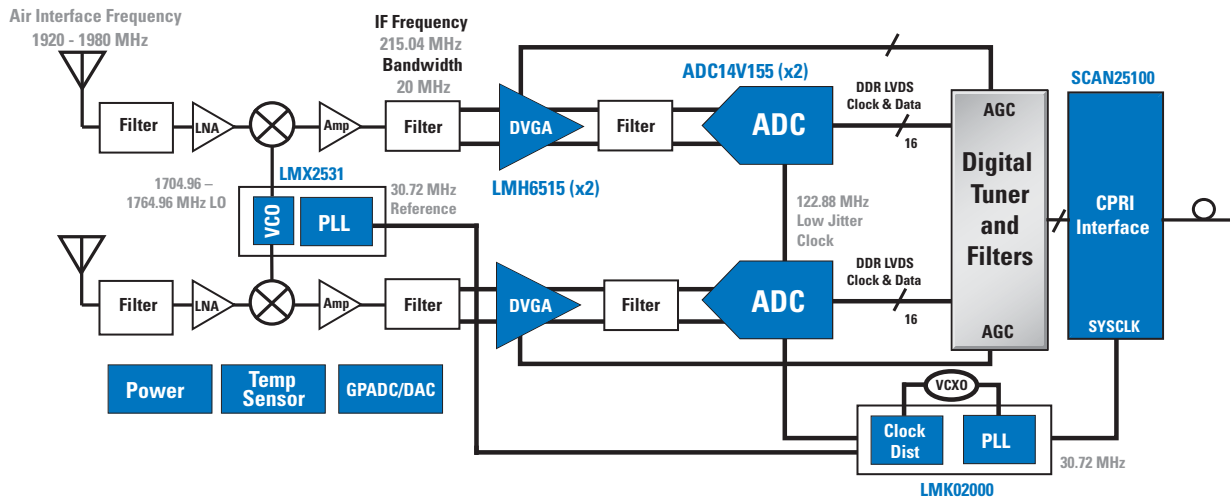
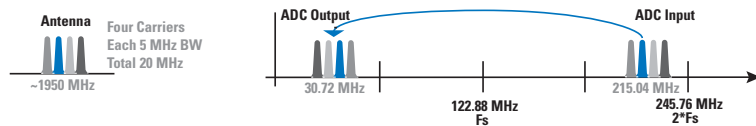


Applications:

Ideal for use in wireless basestation transceivers, WiMAX, power amplifier linearization, high IF sampling receivers, multi-carrier, multi-mode receivers, cable modem termination systems, communications instrumentation, spectrum analyzers, digitizers, and RADAR systems



UMTS Diversity Receiver IF-Sampled, Four Carrier Using ADC14V155



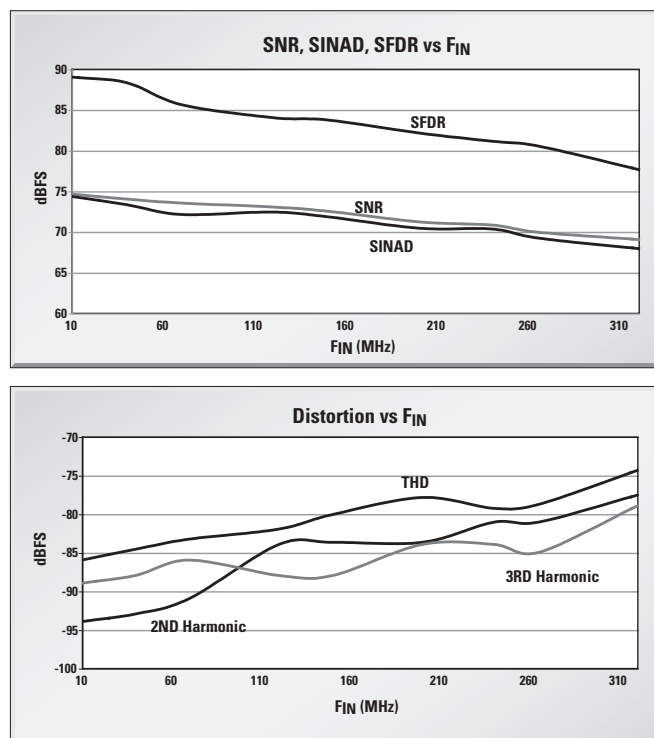
ADC14C105 – PowerWise® 14-bit, 105/95 MSPS ADC for High IF Sampling

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:

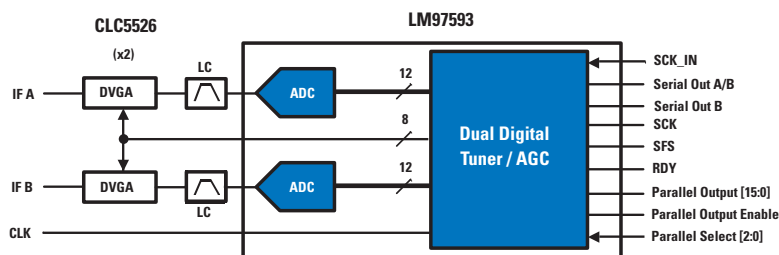
Ideal for use in 3G wireless basestation receivers, WiMAX, power amplifier linearization, high IF sampling receivers, multi-carrier, multi-mode receivers, test and measurement equipment, communications test equipment, and RADAR systems



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:

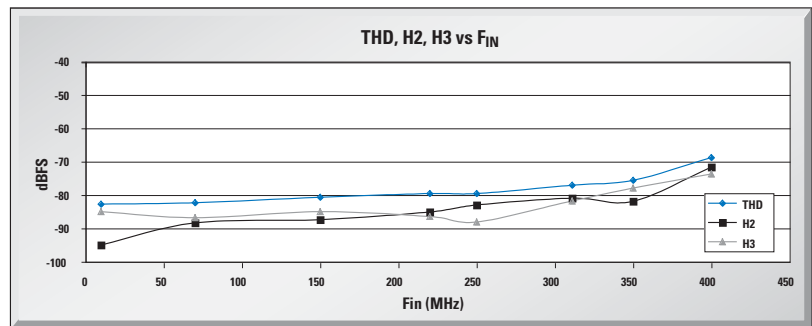
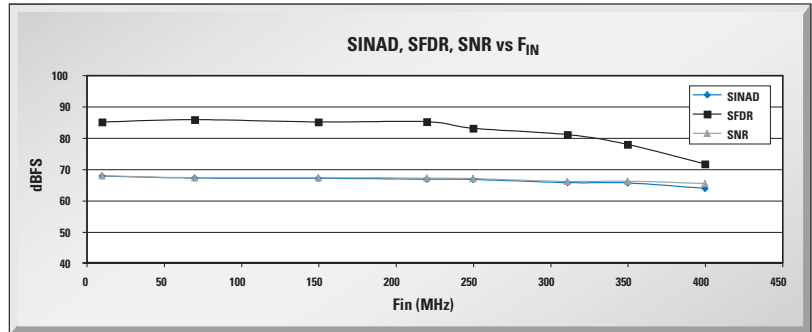
Ideal for use in cellular basestations including GSM / GPRS / EDGE / GSM Phase 2 receivers, satellite receivers, wireless local loop receivers, digital communications, and wireless microphone mainframes

MSPS High-Speed A/D Converters

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)



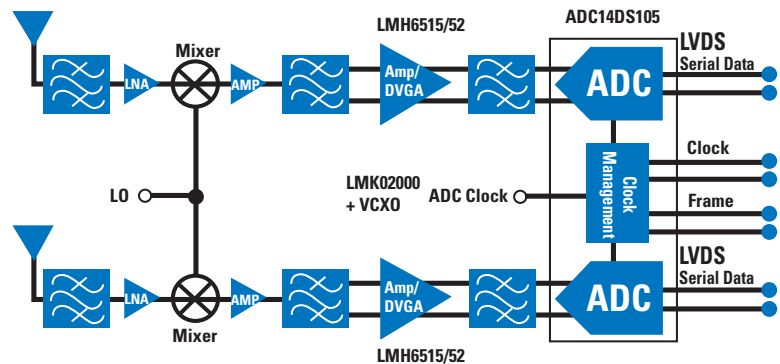
Applications:

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

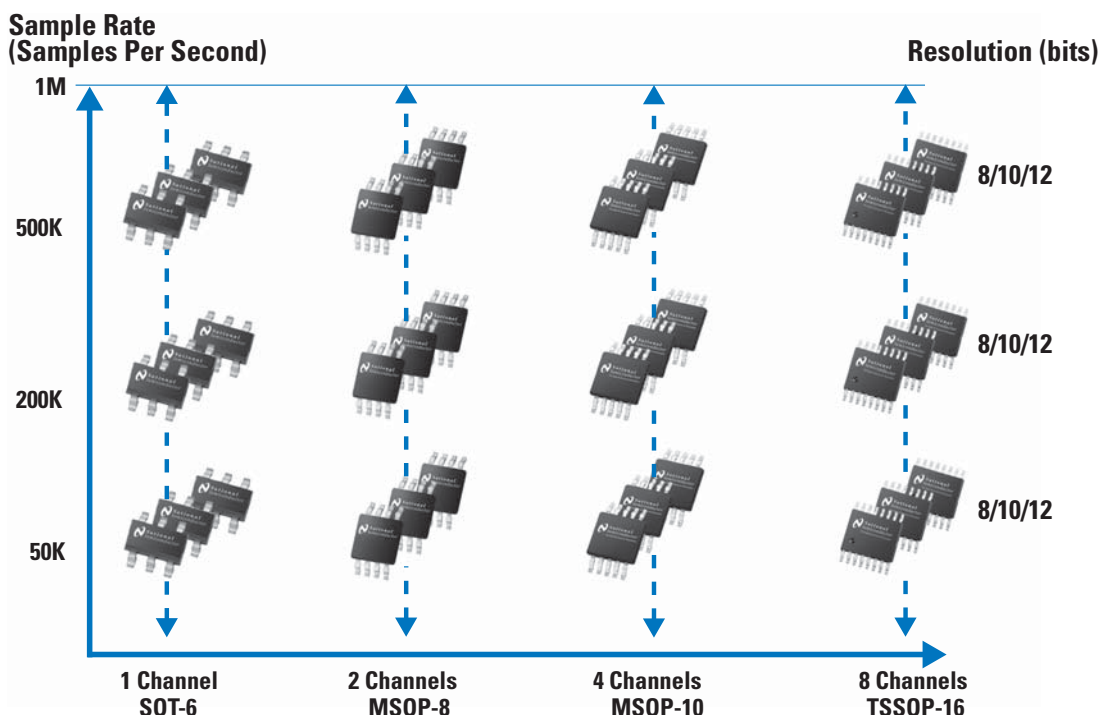
- INL: ± 0.2 LSB
- ENOB: 9.9

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

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)			
ADC081C021	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
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
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
ADC081C027 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
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

¹Alarm Option

PowerWise product

kSPS Low-Power A/D Converters

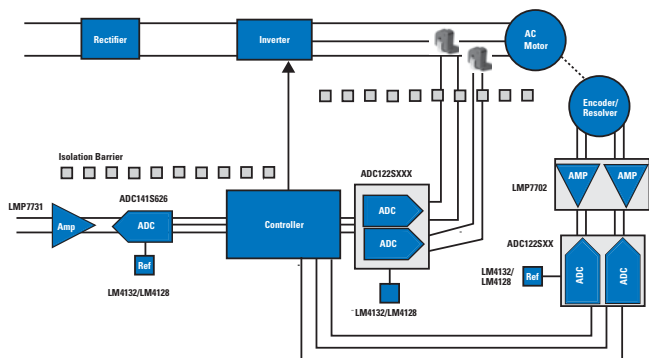
Single-Ended Input SPI A/D Converters

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	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
ADC081S031	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
ADC081S121	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	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
ADC101S031	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
ADC101S121	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	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
ADC121S031	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
ADC121S121	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	8	2		↑	50 to 200	2.7 to 5.25	1.6	5.8	±0.04	±0.04	7.9	-40 to 85
ADC082S031	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	
ADC082S121	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	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	
ADC102S031	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	
ADC102S121	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	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	
ADC122S031	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	
ADC122S121	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	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
ADC084S031	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	
ADC084S121	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	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	
ADC104S031	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	
ADC104S121	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	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	
ADC124S031	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	
ADC124S121	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	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
ADC088S032	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	
ADC088S122	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	10	8	50 to 200	2.7 to 5.25	1.1	6.4	±0.10	±0.1	10	-40 to 105	TSSOP-16	
ADC108S032	10	8	200 to 500	2.7 to 5.25	1.5	7.5	±0.10	±0.2	10	-40 to 105	TSSOP-16	
ADC108S122	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	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	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	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	

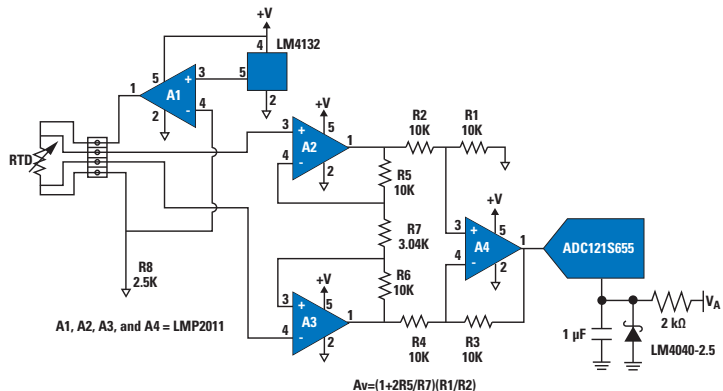
 PowerWise product

kSPS Low-Power A/D Converters and Applications

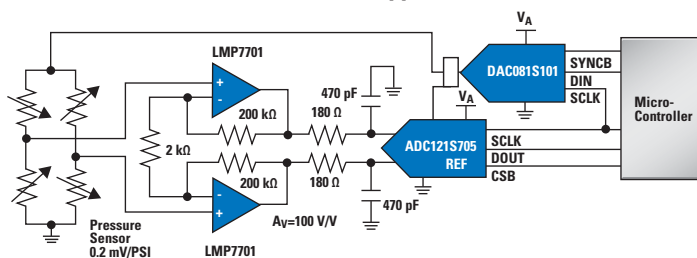
Motor Control



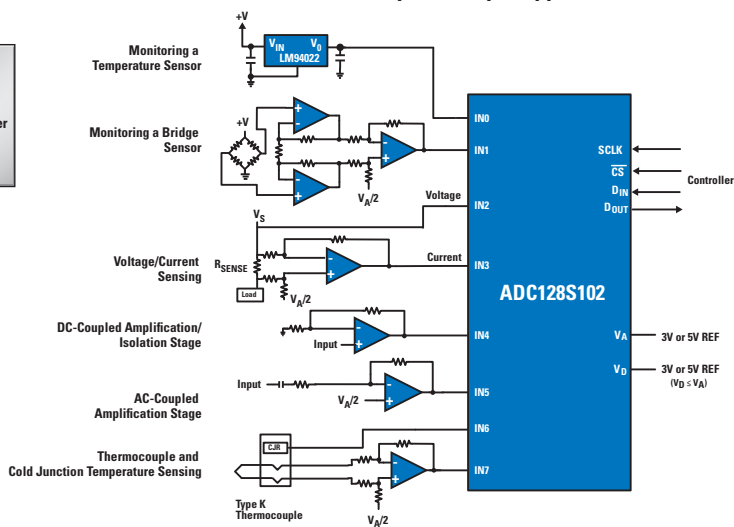
Resistance Temperature Detector Application



Pressure Sensor Application



Multi-Channel Input: Multiple Applications



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	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	12	1	↕	200 to 500	4.5 to 5.5	—	9	±0.6	±0.4	11.7	-40 to 105	MSOP-8
ADC121S705	12	1	↕	500 to 1000	4.5 to 5.5	—	11.5	±0.6	±0.4	11.7	-40 to 105	MSOP-8
ADC122S625	12	2	↕	50 - 200	4.5 to 5.5	—	—	±1.0	±0.95	11.25	-40 to 105	MSOP-10
ADC122S655	12	2	↕	200 to 500	4.5 to 5.5	—	25	±1.0	±0.95	11.25	-40 to 105	MSOP-10
ADC122S706	12	2	—	500 to 1000	4.5 to 5.5	20	25	±1	±0.95	11.25	-40 to 105	TSSOP-14
ADC141S626	14	1	—	50 to 250	2.7 to 5.5	2	4.8	±0.5	±0.5	13.7	-40 to 85	MSOP-10
NEW ADC161S626	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

kSPS Low-Power 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

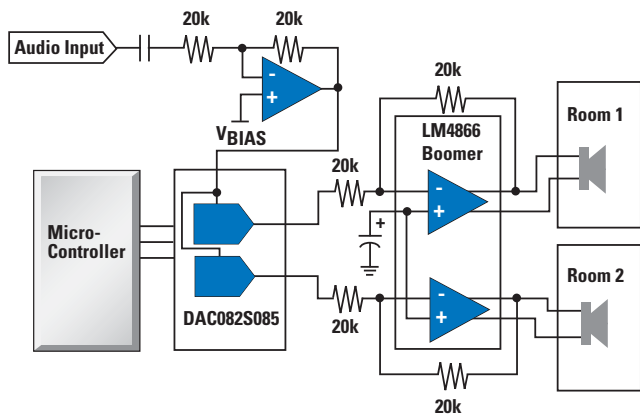
Product ID	Res (bits)	# Mux Inputs	Pin and Function Comp. Family	Typ Settling Time (µs)	Supply Voltage Range (V)	Typ Current Consumption (µA)		Static Performance (Typ)		Reference	Packaging
						3V	5V	INL (LSB)	DNL (LSB)		
Single-Ended Input SPI Digital-to-Analog Converters											
DAC081S101	8	1		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
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
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

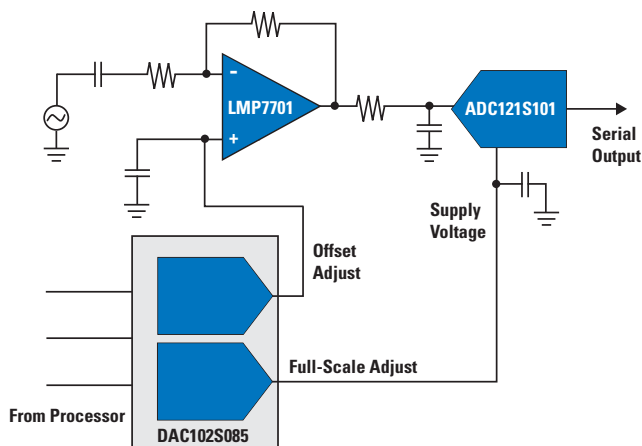
PowerWise® product

kSPS Low-Power D/A Converter Applications

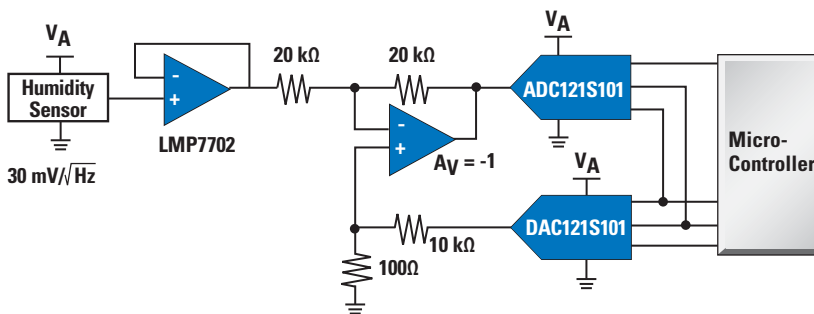
Audio Performance Control



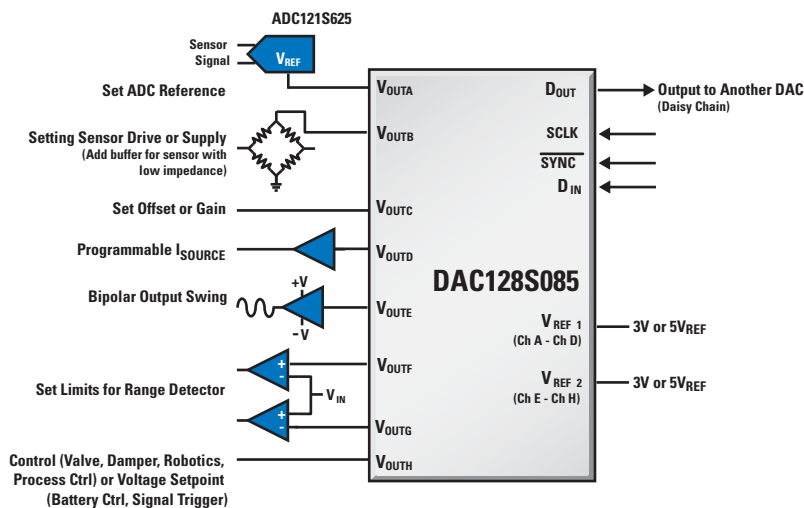
Dynamic Range Optimization



Sensor Set-Point Control



Multi-Channel Output: Multiple Applications



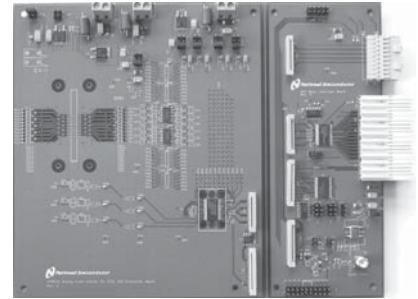
Analog Front Ends (AFE)

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*



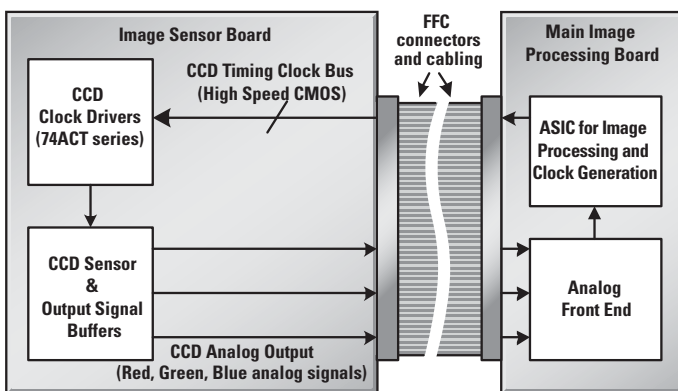
*Available for order – contact sales rep



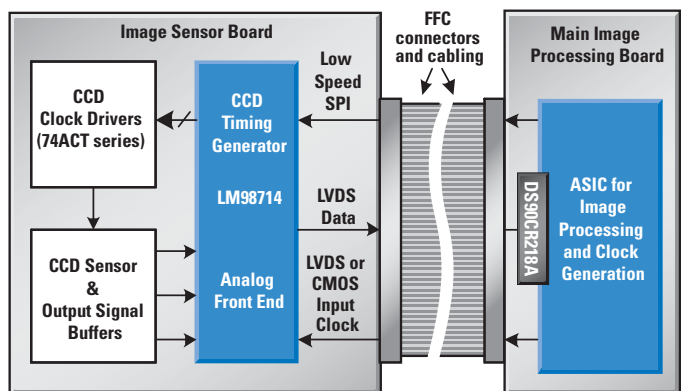
Applications:

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:

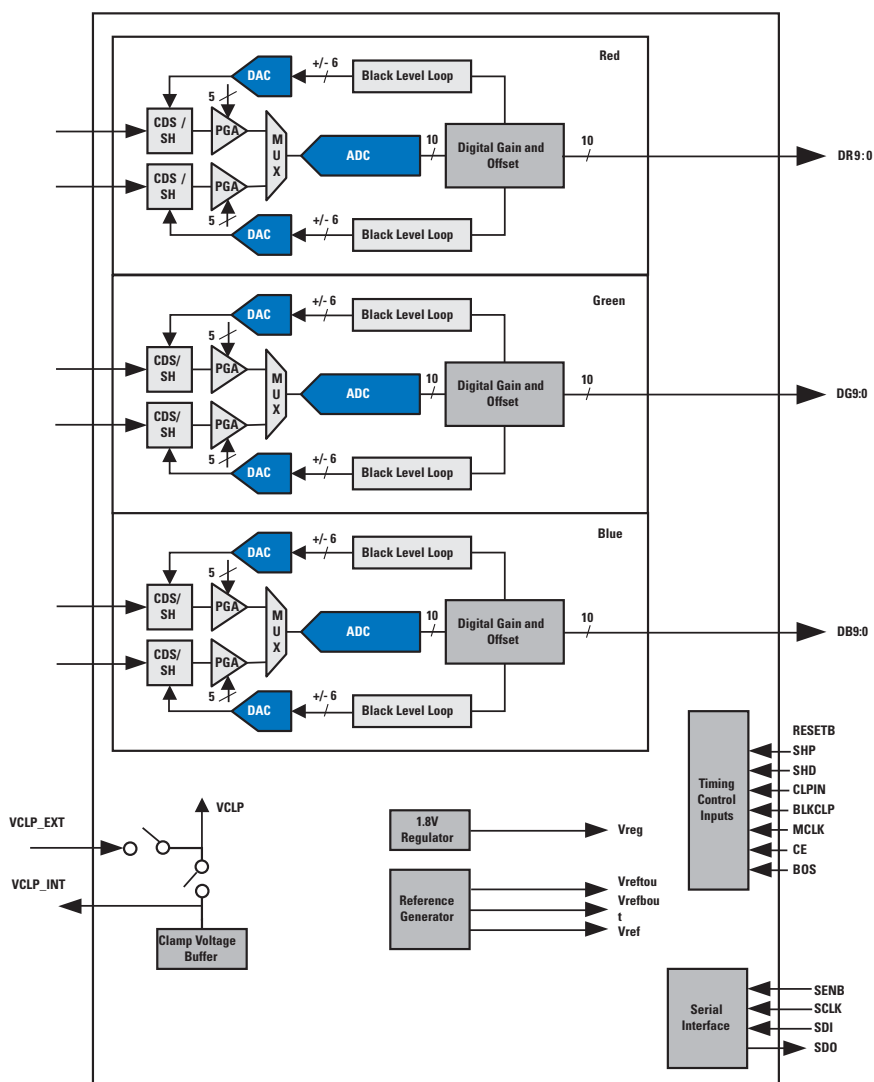
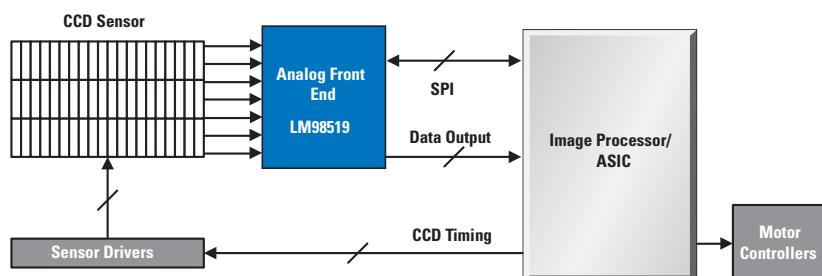
“Simplifying CCD/CIS Image Capturing with a 3-Channel 16-Bit AFE/Timing Generator”

www.national.com/analogedge

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 coarse 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 the competitive products
- Improved usability by reducing glitches due to parasitic capacitance
- Suitable for any type of application

 Voltage Feedback
 Current Feedback
 Rail-to-Rail Output

		100 MHz	200 MHz	300 MHz	500 MHz	1 GHz					
General Purpose High Speed	1 ch	LMH6642 135 V/ μ s	LMH6618 55 V/ μ s	LMH6640 170 V/ μ s	LMH6654 200 V/ μ s	LMH6611 460 V/ μ s	LMH6723 700 V/ μ s	LMH6704 3000 V/ μ s -1, +1, +2 PGA			
	2 ch	LMH6643 135 V/ μ s	LMH6619 55 V/ μ s	LMH6672 135 V/ μ s	LMH6655 200 V/ μ s	LMH6658 700 V/ μ s	LMH6612 460 V/ μ s	LMH6724 700 V/ μ s	LMH6715 1800 V/ μ s	LMH6609 1400 V/ μ s	
	4 ch	LMH6644 135 V/ μ s						LMH6725 700 V/ μ s	LMH6722 1800 V/ μ s		
Low Noise ≤ 2 nV/ \sqrt Hz	1 ch		LMH6624 400 V/ μ s, 0.92 nV/ \sqrt Hz					LMH6702 3100 V/ μ s 1.2 nV/ \sqrt Hz			
	2 ch		LMH6626 400 V/ μ s, 1.0 nV/ \sqrt Hz	LMH6622 85 V/ μ s, 1.6 nV/ \sqrt Hz	LMH6628 550 V/ μ s, 2 nV/ \sqrt Hz						
Ultra Low Distortion ≤ -90 dBc	1 ch						LMH6703 3100 V/ μ s -100 dBc	LMH6702 3100 V/ μ s -98 dBc			
	2 ch	LMH6718 600 V/ μ s -91 dBc -1, +1, +2, PGA									
Fully Differential	1 ch				LMH6551 2400 V/ μ s -94 dBc	LMH6550 3000 V/ μ s -92 dBc		LMH6553 2300 V/ μ s O/P Clamp	LMH6555 1300 V/ μ s -67 dBc	LMH6552 3800 V/ μ s -92 dBc	LMH6554 6200 V/ μ s -95 dBc
	3 ch		LMH6683 940 V/ μ s	LMH6574 2:1 MUX	LMH6574 4:1 MUX	LMH6570 2:1 MUX	LMH6738 Selectable Gain	LMH6739 6 dB Fixed Gain	LMH6733 Selectable Gain		
Supply Current Adjustable $I_{cc} = 1$ to 9 mA	1 ch	LMH6732 400 to 2700 V/ μ s 55 MHz ← → 540 MHz									
VGA	1 ch		LMH6502 70 dB linear-in-dB	LMH6503 70 dB linear in V/V	LMH6505 80 dB linear-in-dB			LMH6515 DVGA	LMH6518 DVGA 40 db		

		10 MHz	20 MHz	50 MHz	70 MHz	100 MHz	250 MHz
Rail-to-Rail I/O	1 ch	LM8261 15 V/ μ s, Unlimited Cap Load		LM6645/6 22 V/ μ s		LMH6618 55 V/ μ s	
	2 ch	LM8262 15 V/ μ s, Unlimited Cap Load	LM8272 15 V/ μ s, Unlimited Cap Load			LMH6619 55 V/ μ s	
	4 ch		LM6588 11 V/ μ s, Unlimited Cap Load		LM6154 25 V/ μ s		
CMOS Input	1 ch		LM6211 5.65 V/ μ s, 5 to 24 V				LMH6601 275 V/ μ s, 2.4 to 5.5V

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

LMV Family

- $2.7V (1.8V) \leq V_s \leq 5V (12V)$
- Rail-to-rail output
- Low power
- Variety of small size packages

LMC Family

- $3V \leq V_s \leq 15V$
- Fully CMOS process
- High input impedance
- Variety of products

		1 MHz	3 MHz	5 MHz	10 MHz	30 MHz	50 MHz	
General Purpose	1 ch		LMV551	LMV821	LMV651		LMV116/8	
	2 ch		LMV552	LMV822	LMV652			
	4 ch			LMV824	LMV654			
Low Noise, Low Offset	1 ch		LMV771	LMV751	LMV851	LMV721	LMV791/6	LMV793
	2 ch		LMV772		LMV852	LMV722	LMV792/7	LMV794
	4 ch		LMV774		LMV854			
Rail-to-Rail I/O	1 ch	LMV931	LMV981	LMV951	LMV841	LMV715		
	2 ch	LMV932			LMV842	LMV712		
	4 ch	LMV934			LMV844			
CMOS	1 ch	LMV341	LMV771	LMV841		LMV851		
	2 ch		LMV772	LMV842	LMV716	LMV852		
	4 ch	*LMC6484	LMV774	LMV844		LMV854		
Low Voltage Operation 1.8V to 5.0V	1 ch	LMV301	LMV931	LMV981				
	2 ch		LMV932					
	4 ch		LMV934					
Programmable Supply Current	1 ch							
Power Select Mode	2 ch							
Wide Supply Voltage Range 2.7V to 12V	1 ch	LPV511		LMV841			LMV116/8	
	2 ch			LMV842				
	4 ch			LMV844				

Amplifier Selection Tree

Feature	Supply Voltage	Bandwidth	Other Features	Family			
Low Power	< 50 μ A/ch	< 5 V	3 MHz	Ultra Low Power	LMV551/2		
		< 5 V	12 MHz	WideBand, Rail-to-Rail Output	LMV651/2/4		
	< 200 μ A/ch	< 5 V	1.5 MHz	Rail-to-Rail I/O	LMV981		
			1.5 MHz	Rail-to-Rail I/O	LMV931/2/4		
			1 MHz	MOS Input	LMV301		
			1 MHz	MOS Input	LMV341		
Low Input Offset Voltage	< 1 mV (max)	< 5 V	All LMP Family				
		3.5 MHz	Low Noise (7.5 nV/ $\sqrt{\text{Hz}}$)	LMV771/2/4			
	< 12 V	All LMP Family					
		4.5 MHz	MOS Input, Low Power	LMV841/2/4			
Low Input Bias Current	< 300 pA (max)	< 5 V	17 MHz	WideBand, Rail-to-Rail Output	LMP7711/2/5/6		
			5 MHz	Rail-to-Rail I/O, S/D	LMV710/1/2/5		
			5 MHz	Low Noise (6.5 nV/ $\sqrt{\text{Hz}}$)	LMV751		
			3.5 MHz	Low Noise (7.5 nV/ $\sqrt{\text{Hz}}$)	LMV771/2/4		
			1 MHz	MOS Input	LMV301		
			1 MHz	MOS Input	LMV341		
	< 12 V	14 MHz	Precision, Rail-to-Rail I/O	LMP7707/8/9			
		4.5 MHz	MOS Input, Low Power	LMV841/2/4			
	< 24 V	2.5 MHz	Precision, Rail-to-Rail I/O	LMP7701/2/4			
		20 MHz	MOS Input, Low Power, Medium Speed	LM6211			
Low Voltage Noise	< 2 nV/ $\sqrt{\text{Hz}}$	< 12 V	1.5 GHz	Low Noise (0.92 nV/ $\sqrt{\text{Hz}}$)	LMH6624/6		
			1 GHz	Low Noise (1.1 nV/ $\sqrt{\text{Hz}}$), Differential Amp	LMH6552		
			160 MHz	Low Noise (1.7 nV/ $\sqrt{\text{Hz}}$)	LMH6622		
			300 MHz	Low Noise (2.0 nV/ $\sqrt{\text{Hz}}$)	LMH6628		
			< 10 nV/ $\sqrt{\text{Hz}}$	< 5 V	22 MHz	Low Noise (2.9 nV/ $\sqrt{\text{Hz}}$)	LMP7731/32
					88 MHz	Low Noise (5.8 nV/ $\sqrt{\text{Hz}}$)	LMP7717/8
	88 MHz	Low Noise (5.8 nV/ $\sqrt{\text{Hz}}$)			LMV793/4		
	17 MHz	Low Noise (5.8 nV/ $\sqrt{\text{Hz}}$)			LMP7711/2/5/6		
	17 MHz	Low Noise (5.8 nV/ $\sqrt{\text{Hz}}$)			LMV791/2/6/7		
	5 MHz	Low Noise (6.5 nV/ $\sqrt{\text{Hz}}$)			LMV751		
	15 MHz	Low Noise (7.5 nV/ $\sqrt{\text{Hz}}$)			LMP7721		
	3.5 MHz	Low Noise (7.5 nV/ $\sqrt{\text{Hz}}$)			LMV771/2/4		
	10 MHz	Low Noise (9.0 nV/ $\sqrt{\text{Hz}}$)			LMV721/2		
	< 12 V	1.75 GHz			Low Noise (3.0 nV/ $\sqrt{\text{Hz}}$)	LMH6559/60	
		400 MHz			Low Noise (3.4 nV/ $\sqrt{\text{Hz}}$)	LMH6720/22	
		480 MHz			Low Noise (3.4 nV/ $\sqrt{\text{Hz}}$)	LMH6715	
		900 MHz			Low Noise (3.7 nV/ $\sqrt{\text{Hz}}$)	LMH6609	
		370 MHz			Low Noise (4.3 nV/ $\sqrt{\text{Hz}}$)	LMH6723	
		250 MHz	Low Noise (4.5 nV/ $\sqrt{\text{Hz}}$)	LMH6654/5			
		130 MHz	Low Noise (4.5 nV/ $\sqrt{\text{Hz}}$)	LMH6672			
	130 MHz	Low Noise (6.6 nV/ $\sqrt{\text{Hz}}$)	LMH6502/3/5				
	110 MHz	Low Noise (8.0 nV/ $\sqrt{\text{Hz}}$)	LMH6718				
< 24 V	2.5 MHz	Low Noise (9 nV/ $\sqrt{\text{Hz}}$)	LMP7701/02/04				
	20 MHz	Low Noise (5.5 nV/ $\sqrt{\text{Hz}}$)	LM6211				

Feature	Supply Voltage	Bandwidth	Other Features	Family		
Rail-to-Rail I/O	< 5 V	5 MHz	MOS Input, S/D	LMV710/1/5/2		
		2.8 MHz	Ultra Low Voltage (0.9 V to 3.0V)	LMV951		
		1.5 MHz	Low Voltage (1.8 V-), S/D	LMV981/*2		
		1.5 MHz	Low Voltage (1.8 V-)	LMV931/2/4		
	< 12 V	130 MHz	High Speed, Low Noise	LMH6618/19		
		55 MHz	Low Power (650 μ A/ch)	LMH6645/6/7		
		14 MHz	Precision, WideBand	LMP7707/8/9		
		4.5 MHz	MOS Input, Low Power,	LMV841/2/4		
	$\leq 30V$	2.5 MHz	Precision	LMP7701/2/4		
		20 MHz	High Output Current	LM7321/2		
Low Supply Voltage	< 2.7 V	15 MHz	Very High Output Current	LM7332		
		250 MHz	2.4 V to 5.5 V, MOS Input, High Speed Amp	LMH6601		
		88 MHz	1.8 V to 5.5 V, Low Noise	LMP7717/8		
		88 MHz	1.8 V to 5.5 V, Low Noise	LMV793/4		
		17 MHz	1.8 V to 5.5 V, Low Noise	LMP7711/2/5/6		
		17 MHz	1.8 V to 5.5 V, Low Noise	LMV791/2/6/7		
		10 MHz	2.2 V to 5.0 V, Low Noise (9 V/\sqrt{Hz})	LMV721/2		
		2.8 MHz	0.9 V to 3.0 V	LMV951		
		1.5 MHz	1.8 V to 5.0 V, Rail-to-Rail I/O with S/D	LMV981		
		1.5 MHz	1.8 V to 5.0 V, Rail-to-Rail I/O	LMV931/2/4		
		1 MHz	1.8 V to 5.0 V, MOS Input, Single	LMV301		
		130 kHz	1.8 V to 5.5 V, MOS Input, Micropower	LMP2231/2/4		
		LLP®	< 5 V	10 MHz	2.2 V to 5.0 V, Low Noise (9 V/\sqrt{Hz}), Dual	LMV722
				5 MHz	Rail-to-Rail I/O, S/D, Dual	LMV712
		micro SMD	< 3.6 V	120 MHz	High Output Current (150 mA), Dual	LM7372
< 5 V	5 MHz		Rail-to-Rail I/O, S/D, Dual	LMV712		
	1.5 MHz		1.8 V to 5.0 V, Rail-to-Rail I/O with S/D, Single	LMV981		

High-Speed Amplifiers

High-Speed Fully Differential Amplifiers

Product ID	-3 dB SSBW (MHz)	AVCL for -3 dB SSBW (V/V)	Slew Rate (V/ μ s)	Supply Voltage Range (V)	Supply Current per Channel (mA)	Channels	Voltage Noise (nV/ \sqrt Hz)	Packaging
LMH6550	400	1	3000	5 to 12	20	1	6	SOIC-8,MSOP-8
LMH6551	370	1	2400	3 to 12	12.5	1	6	SOIC-8,MSOP-8
LMH6552	1500	1	3800	4.5 to 12	19	1	1.1	SOIC-8,LLP-8
LMH6553	900	1	2300	4.5 to 12	29.5	1	1.1	PSOP-8, LLP-8
NEW LMH6554	2500	1	6200	4.7 to 5.3	52	1	0.9	FCOL-14
LMH6555	1200	13.6 dB	1300	3 to 3.6	120	1	19	LLP-16

High-Speed Single-Supply Optimized Amplifiers

Product ID	-3 dB SSBW (MHz)	AVCL for -3 dB SSBW (V/V)	Slew Rate (V/ μ s)	Supply Voltage Range (V)	Supply Current per Channel (mA)	Channels	Voltage Noise (nV/ \sqrt Hz)	Packaging
Low-Power, Rail-to-Rail Input and Output Amplifiers								
LMH6645/46/47	55	1	22	2.5 to 12	0.725	1/2/4	17	SOIC-8, SOT23-5
LMH6618/19	140	1	57	2.7 to 11	1.35	1/2	10	TSOT-6, SOIC-8
Low-Power, Rail-to-Rail Output Amplifiers								
LMH6642/43	130	1	135	2.7 to 12.8	2.7	1/2	17	SOIC-8, SOT23-5/SOIC-8
LMH6644	130	1	135	2.7 to 12.8	2.7	4	17	SOIC-14, TSSOP-14
LMH6601	250	1	275	2.4 to 5.5	9.6	1	7	SC70-6
LMH6611/12	365	1	460	2.7 to 11	3.3/3.45	1/2	10	TSOT-6/SOIC-8

High-Speed, Low-Noise and Distortion Amplifiers

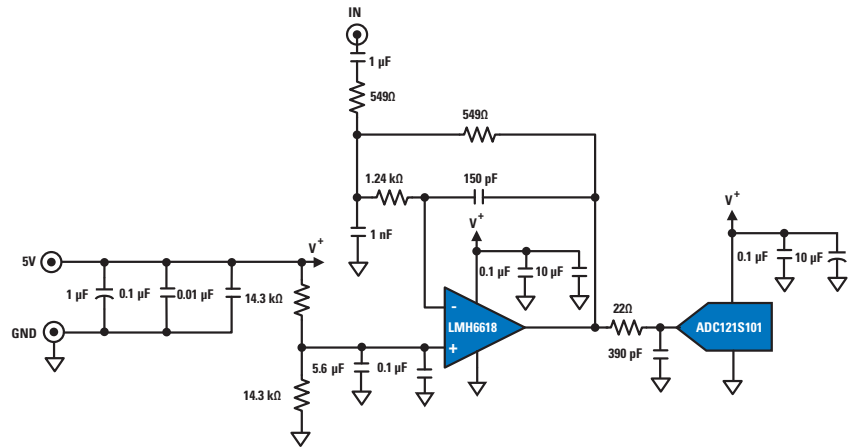
Product ID	-3 dB SSBW (MHz)	AVCL -3 dB SSBW (V/V)	Slew Rate (V/ μ s)	Supply Voltage Range (V)	Supply Current/Channel (mA)	Channels	Voltage Noise (nV/ \sqrt Hz)	2nd/3rd HD (dBc)	Packaging
LMH6672	90	2	170	3 to 12	6.2	2	4.5	-90/-97 at $V_o=8.4 V_{pp}$, $f=1$ MHz, $R_L=100\Omega$	SOIC-8, PSOP-8
LMH6618/19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

 PowerWise product

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



Precision High-Speed Amplifiers

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

PowerWise product

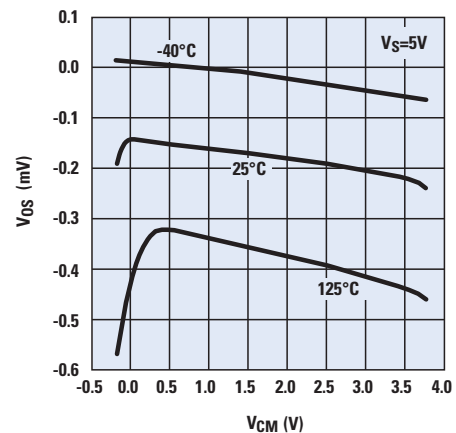
LMH6611/12 – 345 MHz Rail-to-Rail Output Single/Dual Amplifiers

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



High-Speed Amplifiers

Amplifiers > 50 MHz

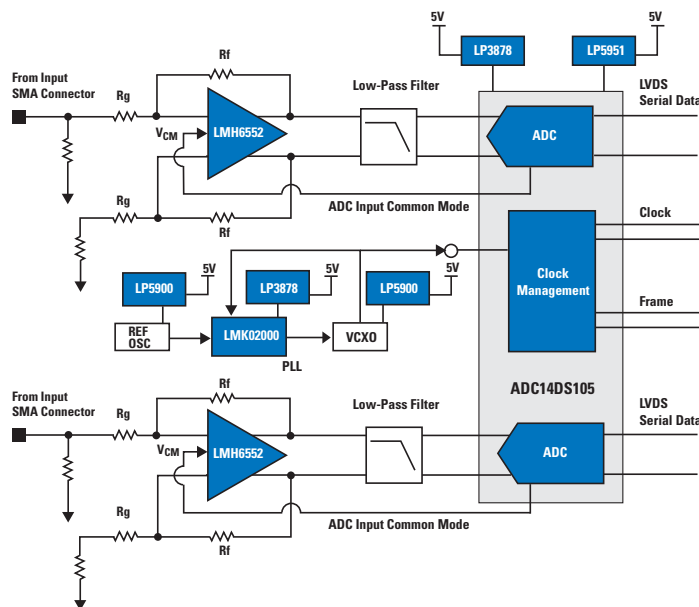
Product ID	-3 dB BW (MHz)	AVCL for -3 dB (V/V)	Slew Rate (V/ μ s)	Supply Voltage Range (V)	Supply Current/Channel (mA)	Channels	Offset Voltage max, 25C (mV)	Voltage Noise (nV/ \sqrt Hz)	Packaging
LMH6645	55	1	22	2.5 to 12	0.725	1	3	17	SOIC-8, SOT23-5
LMH6646	55	1	22	2.5 to 12	0.725	2	3	17	SOIC-8
LMH6647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

 PowerWise product

LMH6552 – 1.5 GHz Fully Differential Amplifier

Features

- 1.5 GHz bandwidth at $A_v = 1$; 750 MHz at $A_v = 8$
- 450 MHz, 0.1 dB flatness
- -90 dB THD at 20 MHz, -74 dB THD at 70 MHz
- 3800 V/ μ s slew rate
- 10.3 dB noise figure
- 5 to 12V operation
- Available in SOIC-8 narrow and LLP-8 packaging
- Ideal match for 8/10/12/14-bit high-speed ADCs, such as the ADC14DS105
- Reference board available with LMK02000 clock conditioner and ADC14DS105

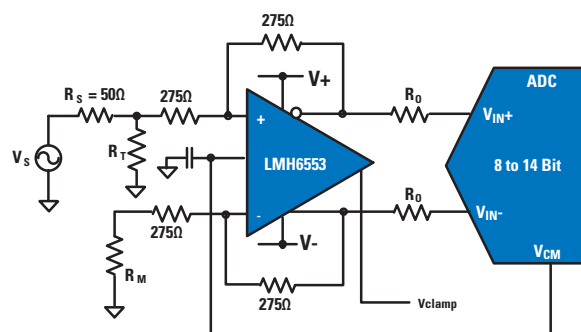


LMH6553 – 900 MHz Fully Differential Amplifier With Output Limiting Clamp

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

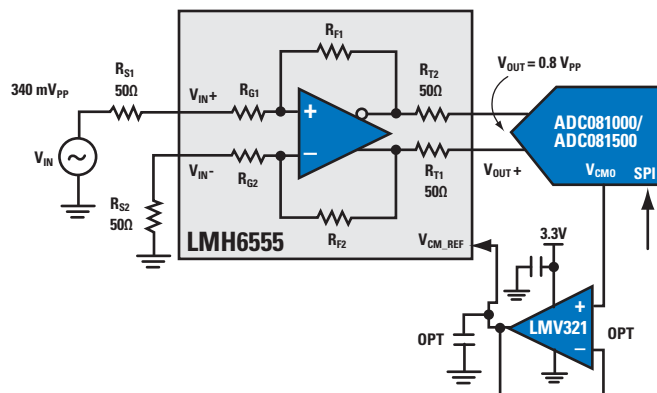
Single-Ended Input Differential Output ADC Driver



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/ μ s 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

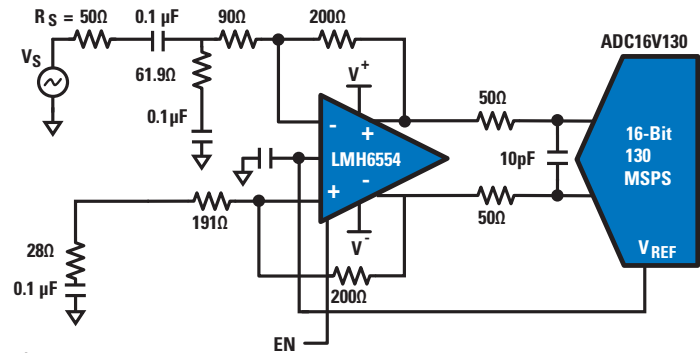


LMH6554 – 2.5 GHz Ultra Linear Fully-Differential Amplifier

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
- $0.9 \text{ nV}/\sqrt{\text{Hz}}$ input noise voltage
- $11 \text{ pA}/\sqrt{\text{Hz}}$ input noise current
- $6200 \text{ V}/\mu\text{s}$ slew rate
- 4.7 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



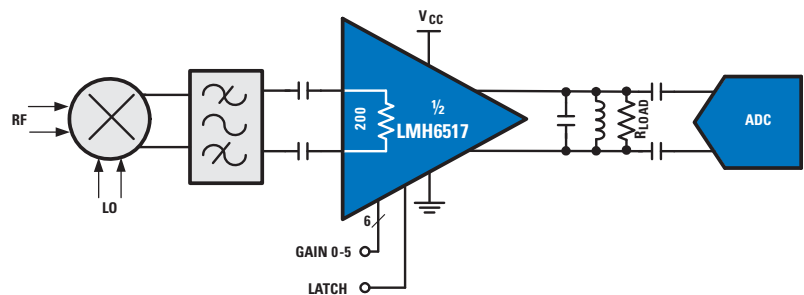
Applications:

Ideal for use in IF/RF gain blocks, DC-coupled wideband amplifiers, saw filter buffer/drivers, single-ended to differential and differential-to-differential amplifiers, and 8- to 16-bit high-speed differential-input ADC drivers

LMH6517 – Low-Power, High-Linearity IF and Baseband Dual 16-bit ADC Driver with Digitally-Controlled Gain

Features

- Differential 200Ω input
- 45 dBm OIP3 at 200 MHz
- 6 dB noise figure
- 1.2 GHz bandwidth
- Digital attenuator: 0 to 31.5 dB , 0.5 dB steps
- 22 dB maximum gain
- Differential output
- Serial and Parallel Interface (SPI)
- Dual channel
- $80 \text{ mA}/\text{ch}$ I_{CC} at 5 V supply
- 3.15 V to 5.25 V operation



Applications:

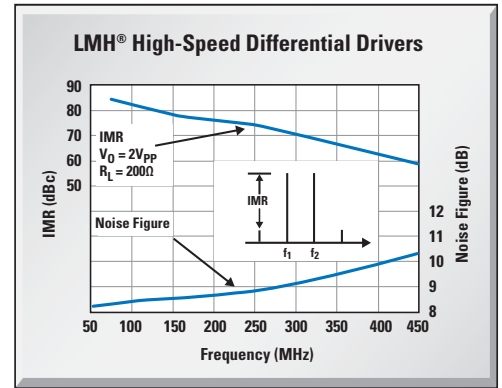
Ideal for use in multi-carrier cellular basestations, IF sampling receivers, instrumentation, and modems

High-Speed Variable Gain Amplifiers

LMH6515 – High-Speed Differential Driver Increases Dynamic Range Performance

Features

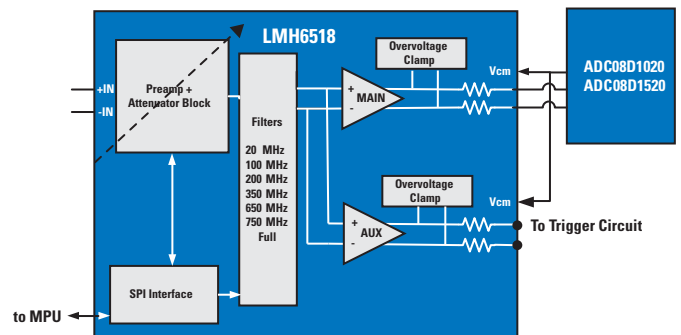
- 8.3 dB noise figure, 40 dBm OIP3
- 500 mW power dissipation
- 26 dB maximum gain, $R_L = 200\Omega$
- 31 dB gain range in precise 1 dB steps
- Gain step error < 0.05 dB at $F = 100$ MHz
- Differential-to-differential and single-to-differential
- Available in small LLP-16 packaging (4 mm x 4 mm)
- Ideal 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 ($V_{IN} \geq 25$ mVpp FS, 200 MHz BW) 52dBFS
- HD2/HD3 at 100 MHz -50 dBc/-53 dBc
- Input referred noise (max gain) $0.98 \text{ nV}/\sqrt{\text{Hz}}$
- 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/ $\sqrt{\text{Hz}}$)	Configuration (input/output)	2nd/3rd HD (dB)	Packaging
LMH6502	Analog	130	72	—	5 to 12	27	1	7.7	Diff/single	HD2/HD3= -55/ -57 (2 VP-P, 20 MHz)	SOIC-14, TSSOP-14
LMH6503	Analog	135	70	—	5 to 12	37	1	6.6	Diff/single	HD2/HD3= -60/ -61 (2 VP-P, 20 MHz)	SOIC-14, TSSOP-14
LMH6505	Analog	150	80	—	7 to 12	11	1	4.4	Single/single	HD2/HD3= -47/ -61 (2 VP-P, 20 MHz)	SOIC-8, MSOP-8
LMH6514	Digital	600	42	6	4 to 5.25	107	1	1.8	Diff/diff	OIP3= 40 dBm at 70 MHz	LLP-16
LMH6515	Digital	600	31	1	4 to 5.25	107	1	1.8	Diff/diff	OIP3= 40 dBm at 70 MHz	LLP-16
NEW LMH6517	Digital	1200	31.5	0.5	3.15 to 5.25	80	2	1.1	Diff/diff	OIP3= 47 dBm at 100 MHz	LLP-32
NEW LMH6518	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

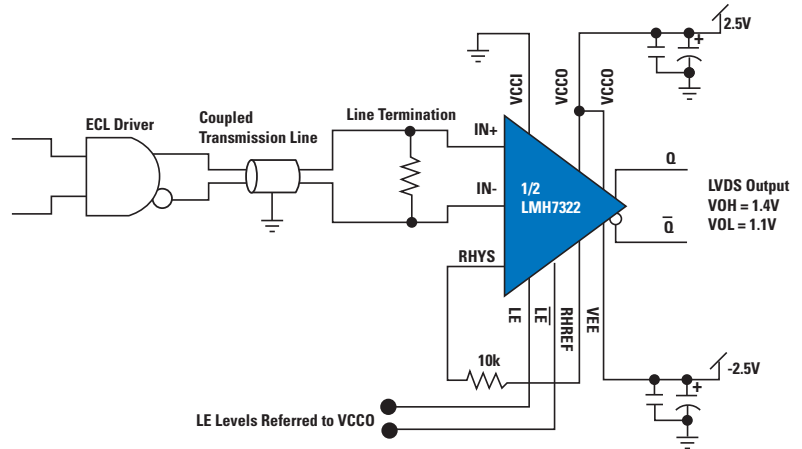
PowerWise product

Comparators

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)
 - 5 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 (μ s)	Offset Voltage max, 25C (mV)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Input Bias Current (μ A)	Output Compatibility	Temperature Range ($^{\circ}$ 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

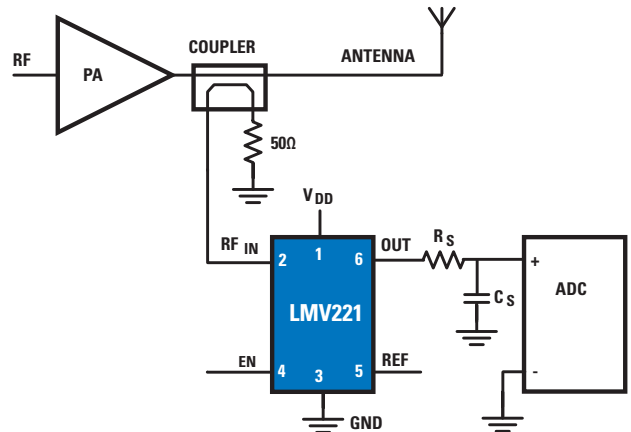
Low-Power Comparators

Product ID	Channels	Response Time (μ s)	Offset Voltage max, 25C (mV)	Output Current (mA)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Max Input Bias Current (nA)	Temperature Range ($^{\circ}$ C)	Packaging
LMP7300	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

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 0.3 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)



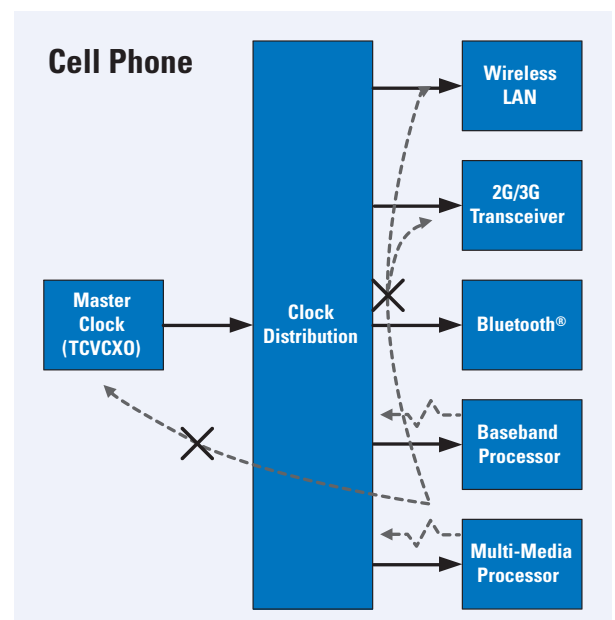
RF Detectors

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

Master Clock Distribution in Cell Phones; Optimized Clock Distribution Solution

Features

- Proper clock distribution circuitry prevents increased 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

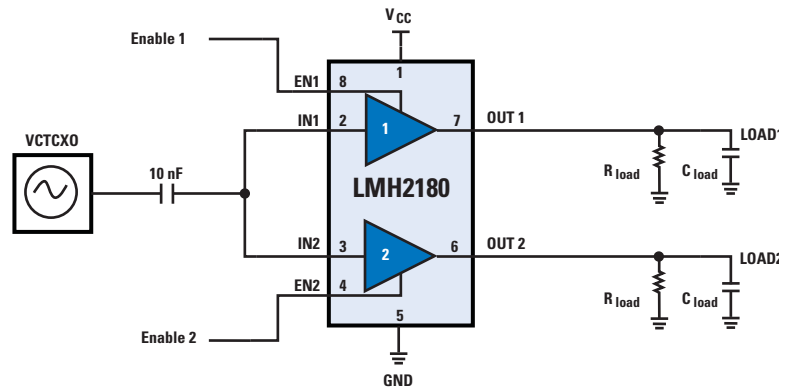


Clock Buffers

LMH2180 – 75 MHz Dual Analog Clock Buffer

Features

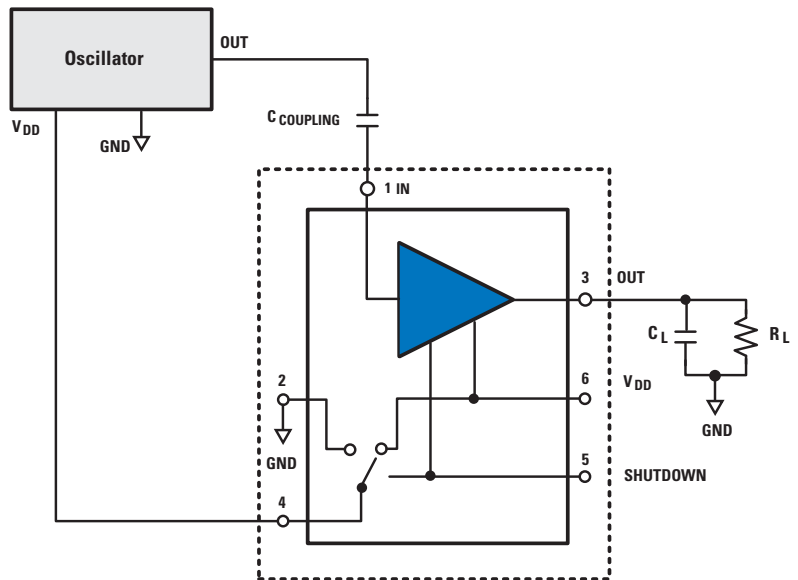
- Large signal -3dB BW at 1 V_{pp}: 60 MHz
- Slew rate: 106 V/μs
- Reverse isolation: 84 dB at 1 MHz, 50Ω source
- Channel isolation: >41 dB up to 100 MHz, 30 kΩ/10 pF load
- >20 mA output drive
- Phase noise (38.4 kHz, 1 V_{pp} input):
-132 dBc/Hz at 10 kHz offset
- 1.2 mA/15 μA at 2.7V per channel
- Individual selectable shutdown
- Available in LLP-8 (3 mm x3 mm) and 8-bump micro SMD (1.25 mm x 1.25 mm)



LMV115 – 30 MHz Analog Clock Buffer

Features

- 30 MHz (<0.5 V_{pp}) VCTCXO buffer
- Shutdown feature for VCTCXO
- Slew rate 18V/μs
- 2.5V to 3.3V V_{CC}
- 300 μA I_{CC} at 2.8V, no load
- -40°C to +85°C operating range
- Available in SC70-6 packaging (2 mm x 2mm)



Product ID	Bandwidth	Channels	I _{sup}	Phase Noise	Slew Rate	Shutdown	Package
LMH2180	75 MHz	2	2.3 mA	-132 dBc/Hz, 10 kHz offset	106 V/μs	✓	LLP-8 micro SMD-8 (1.25 mm x 1.25 mm)
LMV112	40 Mhz	2	1.6 mA	-116 dBc/Hz, 10 kHz offset	110 V/μs	✓	LLP-8
LMV115	30 MHz	1	0.3 mA	n/a	18 V/μs	✓	SC70-6
LMV116	45 MHz	1	0.6 mA	n/a	40 V/μs	—	SOT23-5
LMV118	45 MHz	1	0.6 mA	n/a	40 V/μs	✓	SOT23-6

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 (RGB) 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

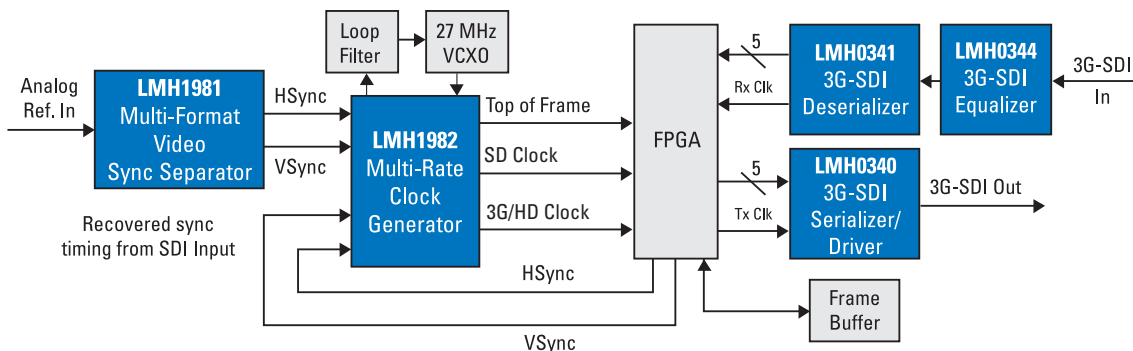
Features

- 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



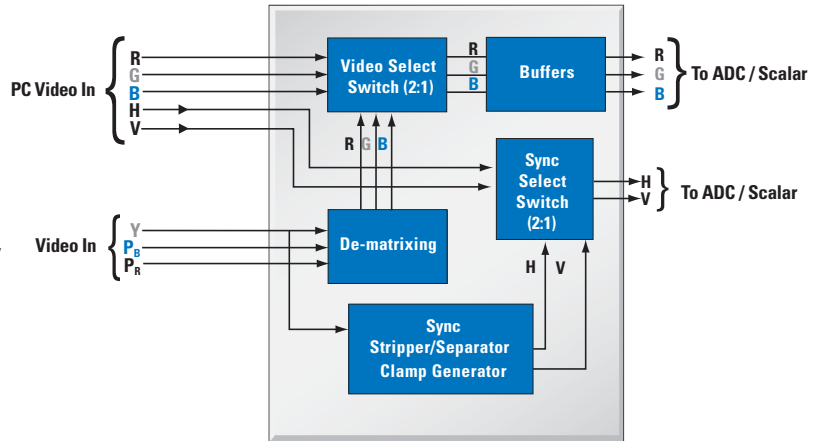
Read Analog Edge Volume 4, Issue 7. Topic:
 "Improving Video Clock Generation in Modern Broadcast Video Systems"
www.national.com/analogedge

Analog Video Products

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

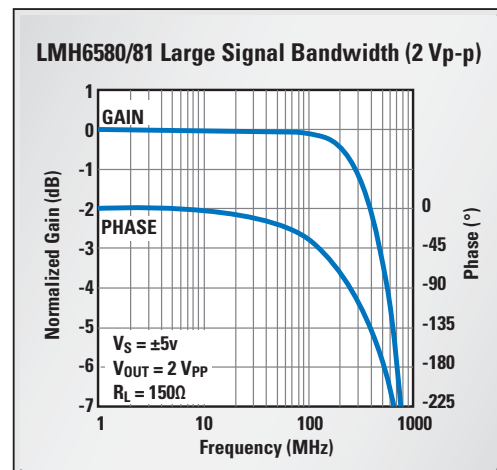
LMH6580/81 – 8 x 4, 500 MHz Analog Crosspoint Switch, Gain of 1, Gain of 2

Features

- 8 inputs and 4 outputs
- 500 MHz -3 dB bandwidth
- 1700 V/ μ s 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:

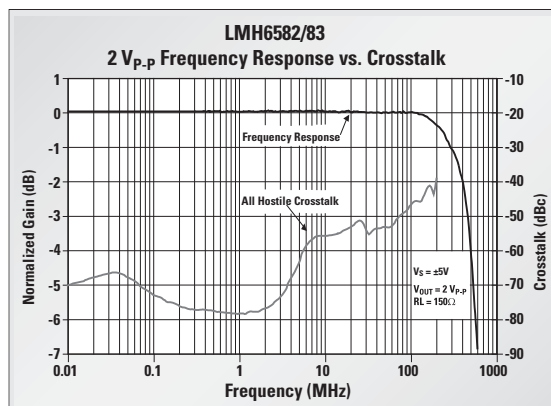
Ideal for use in studio monitoring/production video systems, conference room multimedia video systems, KVM (keyboard video mouse) systems, security/surveillance systems, multi antenna diversity radio, video test equipment, medical imaging, and wide-band routers and switches



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

Features

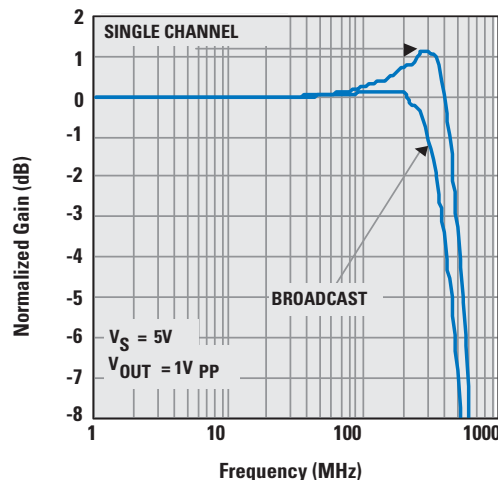
- 16 inputs, 8 outputs
- 550 MHz, -3 dB bandwidth
- Fast slew rate: 1900 V/ μ s
- 100 MHz, 0.1 dB gain flatness
- All hostile crosstalk
 - -64 dBc at 5 MHz
 - -46 dBc at 100 MHz
- $A_v = +1/+2$
- Ease of control: 4-pin serial interface
- Available in TQFP-64 exposed pad packaging



NEW! LMH6584/85 – 400 MHz, 32 x 16 Crosspoint Switches A_v1 and A_v2

Features

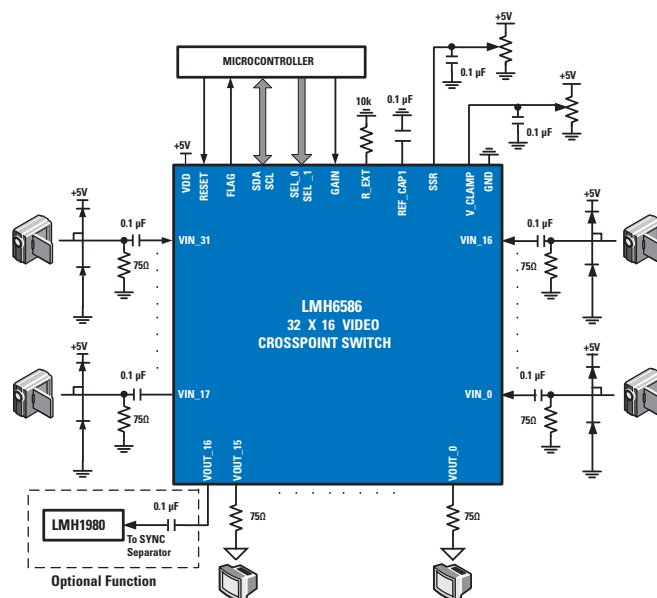
- 32 inputs, 16 outputs
- 400 MHz, -3 dB bandwidth
- Fast slew rate; 1200 V/ μ s
- All hostile crosstalk
 - -52 dBc at 10 MHz
 - -46 dBc at 100 MHz
- Available in LQFP-144 packaging



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 $R_L = 150\Omega$
- -70 dB off-isolation at 6 MHz
- Single +5V supply operation
- Input and output amp power shutdowns



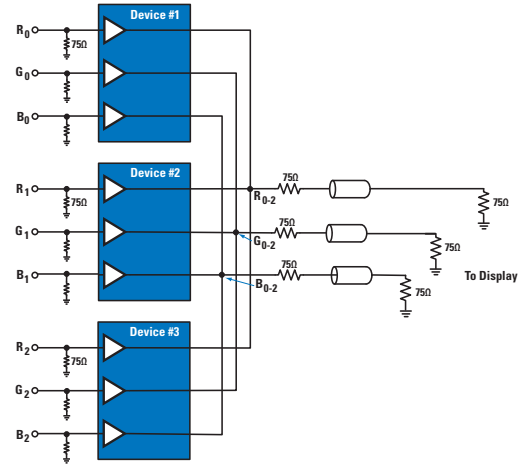
Analog Video Products

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

Features

- Energy-efficient PowerWise® product (LMH6733)
- 1 GHz –3 dB small signal bandwidth ($A_V = +1$, $V_S = \pm 5V$)
- 650 MHz –3 dB small signal bandwidth ($A_V = +2$, $V_S = 5V$)
- 3750 V/ μ s slew rate
- Low supply current (5.5 mA per op amp, $V_S = 5V$)
- 70 mA linear output current
- 2.1 nV/ \sqrt{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 3 to 12V single supply

3:1 UXGA Mux Using Three LMH6733 Devices



Applications:

Ideal for use in HDTV component video driver, high resolution projectors, flash A/D driver, D/A transimpedance buffer, wide dynamic range IF amp, RADAR/communication receivers, DDS post-amps, wide-band inverting summer, and line driver applications

Analog Multiplexers

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

Video Amplifiers/Buffers

Product ID	-3 dB Unity SSBW (MHz)	AVCL at -3 dB SSBW	-3 dB LSBW at A=2 (MHz)	Slew Rate (V/ μ s)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Channels	Voltage Noise (V)	Packaging
LMH6702	1700	2	720	3100	10 to 12	12.5	1	1.83	SOIC-8, SOT23-5
LMH6703	1800	1	750	4200	8 to 12	11	1	2.3	SOIC-8, SOT23-6
LMH6704	650	1	400	3000	8 to 12	11.5	1	2.3	SOIC-8, SOT23-6
LMH6733	1000	1	600	3750	3 to 12	6.5	3	2.1	SSOP-16
LMH6734	925	1	560	3750	3 to 12	5.5	3	2.1	SSOP-16
LMH6738	750	1	750	3300	10 to 12	10.5	3	2.2	SSOP-16
LMH6739	750	1	400	3300	8 to 12	10.6	3	2.3	SSOP-16
LMH6611	365	1	87	460	2.7 to 11	3.3	1	10	TSOT23-6
LMH6612	365	1	87	460	2.7 to 11	3.45	2	10	SOIC-8
LMH6601	250	1	81	275	2.4 to 5.5	9.6	1	10	SC70-6
LMH6683	190	2	110	940	3 to 12	6.5	3	12	SOIC-14, TSSOP-14

PowerWise product

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















Features

- Low guaranteed VOS over temperature 5 μV
- TCVOS guaranteed: 20 $\text{nV}/^\circ\text{C}$ (max)
- Low noise with no 1/f, 12 $\text{nV}/\sqrt{\text{Hz}}$ 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 $\text{V}/\mu\text{s}$
- 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	Offset Voltage max, 25C (mV)	TcVos ($\mu\text{V}/^\circ\text{C}$)	CMRR (dB)	PSRR (dB)	Avol (dB)	Voltage Noise ($\text{nV}/\sqrt{\text{Hz}}$) @kHz	Channels	Supply Current Per Channel (mA)	Supply Range (V)	Packaging
LMP2015	0.005	0.015	130	120	130	35	1	0.93	2.7 to 5.25	SOIC-8, SOT23-5
LMP2016	0.005	0.015	130	120	130	35	2	0.93	2.7 to 5.25	SOIC-8, MSOP-8
NEW LMP2021	0.005	0.020 (max)	139	130	160	11 ($A_v = 1000\text{V}/\text{V}$)	1	1.1	2.2 to 5.5	SOIC-8, SOT23-5
NEW LMP2022	0.005	0.020 (max)	139	130	160	11 ($A_v = 1000\text{V}/\text{V}$)	2	1.1	2.2 to 5.5	SOIC-8, MSOP-8
LMP2011	0.025	0.015	130	120	130	35	1	0.93	2.7 to 5.25	SOIC-8, SOT23-5
LMP2014MT	0.025	0.015	130	120	130	35	2	0.93	2.7 to 5.25	TSSOP-14
LMP2012	0.025	0.015	130	120	130	35	2	0.93	2.7 to 5	SOIC-8, MSOP-8
LMP7731/32 	0.04	0.5	120	129	130	2.9	1/2	2.2	2.5 to 5	SOT23-5/SOIC-8
LMP2231/32 	0.15	0.4/0.5 (max)	97	120	120	60	1/2	0.01	1.6 to 5.5	SOIC-8, SOT23-5/SOIC-8
LMP2234 	0.15	0.3	97	120	120	60	4	0.009	1.6 to 5.5	SOIC-14, TSSOP-14
LMP7711 	0.15	1	100	100	110	5.8	1	1.15	1.8 to 5.5	TSOT-6
LMP7712 	0.15	1.75	100	100	95	5.8	2	1.3	1.8 to 5.5	MSOP-10
LMP7715 	0.15	1	100	98	110	5.8	1	1.15	1.8 to 5.5	SOT23-5
LMP7716 	0.15	1.8	100	98	110	5.8	2	1.3	1.8 to 5.5	MSOP-8
LMP7717 	0.15	1	100	98	110	5.8	1	1.15	1.8 to 5.5	SOIC-8, SOT23-5
LMP7718 	0.15	1.8	100	95	110	5.8	2	1.3	1.8 to 5.5	SOIC-8, MSOP-8
LMP7721 	0.18	1.5	100	96	111	7.5	1	1.3	1.8 to 5.5	SOIC-8
LMP7701	0.2	1	130	100	119	9	1	0.715	2.7 to 12	SOIC-8, SOT23-5
LMP7707 	0.2	1	138	98	119	9	1	0.715	2.7 to 12	SOT23-5
LMP7708 	0.22	1	138	98	119	9	2	0.715	2.7 to 12	MSOP-8
LMP7709 	0.22	1	138	98	119	9	4	0.715	2.7 to 12	TSSOP-14
LMP7702	0.22	1	130	100	119	9	2	0.75	2.7 to 12	SOIC-8, MSOP-8
LMP7704	0.22	1	130	100	119	9	4	0.725	2.7 to 12	TSSOP-14
LMV841	0.5	0.35	112	108	133	20	1	1	2.7 to 12	SC70-5
NEW LMV842	0.5	0.35	112	108	133	20	2	1	2.7 to 12	MSOP-8, SOIC-8
NEW LMV844	0.5	0.35	112	108	133	20	2	1	2.7 to 12	TSSOP-14, SOIC-14
LMV771	0.85	0.35	90	90	100	12	1	0.6	2.7 to 5	SC70-5
LMV751 	1	1	103	107	120	6.5	1	0.6	2.7 to 5.5	SOT23-5
LMV772	1	0.35	90	90	100	12	2	0.6	2.7 to 5	SOIC-8, MSOP-8
LMV774	1	0.35	90	90	100	12	4	0.6	2.7 to 5	TSSOP-14

 PowerWise product

Precision Amplifiers

LMP7731/32 – Low-Noise, Precision, RRI/O Op Amps

Features

- 2.9 nV/√Hz input voltage noise
- Offset voltage ±40 μV (max)
- CMRR 130 dB
- Open loop gain 130 dB
- Slew rate 2.4 V/μs
- 0.001% THD at f = 10 kHz, AV = 1, RL = 2 kΩ
















Applications:

Ideal for use in thermopile amplifiers, gas analysis instruments, photometric instrumentation, and medical instrumentation

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)	Temperature Range (°C)	Packaging
LMH6624	1	0.92	0.5	25000	12	1500	5 to 12	-40 to 125	SOIC-8, SOT23-5
LMH6626	2	1	0.5	25000	12	1300	5 to 12	-40 to 125	SOIC-8, MSOP-8
LMH6622	2	1.6	1.2	15000	4.3	160	5 to 12	-40 to 85	SOIC-8, MSOP-8
LMH6702	1	1.83	4.5	34000	12.5	1700	10 to 12	-40 to 85	SOIC-8, SOT23-5
LMH6628	2	2	2	20000	9	300	5 to 12	-55 to 125	SOIC-8
LMP7731/32	1/2	2.9	0.04	30	2.2	22	1.8 to 5.5	-40 to 125	SOT23-5 / SOIC-8
LMP7717/18	1	5.8	0.15	0.05	1.15	88	1.8 to 5.5	-40 to 125	SOIC-8, SOT23-5
LMV793	1	5.8	1.35	0.025	1.15	88	1.8 to 5.5	-40 to 125	SOIC-8, SOT23-5
LMV794	2	5.8	1.35	0.025	1.3	88	1.8 to 5.5	-40 to 125	SOIC-8, MSOP-8
LMP7711/12	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	1	5.8	0.15	0.05	1.15	17	1.8 to 5.5	-40 to 125	SOT23-5
LMP7716	2	5.8	0.15	0.05	1.3	17	1.8 to 5.5	-40 to 125	SOIC-8, MSOP-8
LMV791/92	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	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	1	6	2.5	0.01	0.96	17	5 to 24	-40 to 125	SOT23-5
LMV751	1	6.5	1	0.1	0.6	5	2.7 to 5.5	-40 to 85	SOT23-5
LMP7721	1	7.5	0.18	0.00003	1.3	15	1.8 to 5.5	-40 to 125	SOIC-8
LMP7701	1	9	0.2	0.05	0.715	2.5	2.7 to 12	-40 to 125	SOIC-8, SOT23-5
LMP7702	2	9	0.22	0.05	0.75	2.5	2.7 to 12	-40 to 125	SOIC-8, MSOP-8
LMP7704	4	9	0.22	0.05	0.725	2.5	2.7 to 12	-40 to 125	TSSOP-14
LMP7707	1	9	0.2	0.05	0.715	14	2.7 to 12	-40 to 125	SOIC-8, SOT23-5
LMP7708	2	9	0.22	0.05	0.75	14	2.7 to 12	-40 to 125	SOIC-8, MSOP-8
LMP7709	4	9	0.22	0.05	0.725	14	2.7 to 12	-40 to 125	TSSOP-14
LMP2021/22	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	2	12	1	0.1	0.6	3.5	2.7 to 5.5	-40 to 125	SOIC-8, MSOP-8
LMV774	4	12	1	0.1	0.6	3.5	2.7 to 5.5	-40 to 125	TSSOP-14
LMV716	2	12.8	5	0.115	1.6	5	2.7 to 5.5	-40 to 85	MSOP-8
NEW! LMV861	1	8	1	0.01	2.6	30	2.7 to 5.5	-40 to 125	SC70-5
NEW! LMV862	2	8	1	0.01	2.6	30	2.7 to 5.5	-40 to 125	MSOP-8
NEW! LMV864	4	8	1	0.01	2.6	30	2.7 to 5.5	-40 to 125	TSSOP-14

CMOS-Input Operational Amplifiers

Product ID	Description	Vos (mV) (max)	TCVos typ ($\mu\text{V}/^\circ\text{C}$)	Is Typ (mA/Ch)	CMRR (dB)	PSRR (dB)	Temperature Range ($^\circ\text{C}$)	Packaging
LMP7711	 17 MHz, single precision, low-noise CMOS input op amp	0.15	1	1.15	100	100	-40 to 125	TSOT-6
LMP7715/16	 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	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	Ultra-low input bias current op amp	0.35	2.5	0.45	83	83	-40 to 85	Plastic DIP-8
LMC6061/62/64	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	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	 Low-offset, low-noise single CMOS input op amp	1	1	0.6	103	107	-40 to 85	SOT23-5
LMV791/92	 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	 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	5 MHz, low-noise, CMOS input RRO op amp	5	5	1.6	80	82	-40 to 85	MSOP-8
LMV861	 30 MHz low power	1000	2.6	2.59	93	93	-40 to 125	SOIC-8, SC-70
LM6211	 Low-noise, CMOS input RRO op amp with 24V operation	2.5	2	0.96	98	98	-40 to 125	SOT23-5
 LMP2021/22	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	 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	 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	 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	 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	 3 femtoampere input bias current precision amplifier	0.15	1.5	1.1	100	96	-40 to 125	SOIC-8
 LMP831/32/34	Low-power CMOS, EMI-hardened op amp	1	1.7	0.24	93	93	-40 to 125	SC70-5/MSOP-8/TSSOP-14
 LMP851/52/54	Low-power CMOS, EMI-hardened op amp	1	2	0.43	94	93	-40 to 125	SC70-5/MSOP-8/TSSOP-14

 PowerWise product

Current Sensing Amplifiers

Current Sense Amplifiers¹

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	-2V to 16V	1	15	20	4.7 to 5.5	1	80	SOIC-8
LMP8271	High common-mode, AV = 20, bidirectional	-2V to 16V	1	15	20	4.7 to 5.5	1	80	SOIC-8
LMP8272	High common-mode, AV = 14, unidirectional	-2V to 16V	1	15	14	4.7 to 5.5	1	80	SOIC-8
LMP8275	High common-mode, AV = 20, unidirectional	-2V to 16V	2	30	20	4.7 to 5.5	1	80	SOIC-8
LMP8276	High common-mode, AV = 20, bidirectional	-2V to 16V	2	30	20	4.7 to 5.5	1	80	SOIC-8
LMP8277	High common-mode, AV = 14, unidirectional	-2V to 16V	2	30	14	4.7 to 5.5	1	80	SOIC-8
NEW LMP8601/Q	High common-mode, 60V, current sensing precision difference amplifier	-20V to 60V	1	10	20	3.0 to 5.5	1.1	90	SOIC-8

¹National's Current Sense Amplifiers are 100% Production Tested at -40 to +125° C, TcVos is guaranteed by test

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

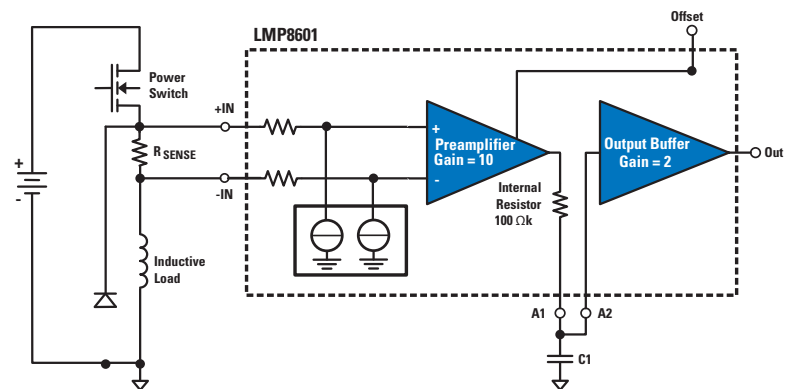
Features

- 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
- TcVos 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

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

High-Side Current Sensing Application



Low-Voltage Amplifiers

Low-Voltage Operational Amplifiers

Product ID	Channels	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Gain Bandwidth (MHz)	Slew Rate (V/ μ s)	Offset Voltage max, 25C (mV)	Max Input Bias Current (nA)	Voltage Noise (nV/ $\sqrt{\text{Hz}}$)	Packaging
LMV951	1	0.9 to 3	0.57	2.8	1.4	2.8	80	25	TSOT-6
LMP2231	1	1.6 to 5.5	0.01	0.13	0.058	0.015	0.001	60	SOIC-8, SOT23-5
LMP2232/34	2/4	1.6 to 5.5	0.009	0.13	0.058	0.015	0.001	60	SOIC-8, MSOP-8 / SOIC-14, TSSOP-14
LMV301	1	1.8 to 5	0.163	1	0.66	8	0.05	40	SC70-5
LMV791/92	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	1/2	1.8 to 5	1.15	88	28	1.35	0.01	5.8	SOIC-8, SOT23-5/MSOP-8
LMV796/97	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	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	1	1.8 to 5	0.116	1.5	0.42	4	35	50	micro SMD-6, SC70-6, SOT23-6
LMP7721	1	1.8 to 5.5	1.1	15	9.3	0.015	0.000000003	7	SOIC-8
LM8262/72	2	2.5 to 22/24	1.05 / 0.9	21 / 13	12	5	2000	15	MSOP-8
LM8261	1	2.5 to 30	0.97	21	12	5	2000	15	SOT23-5
LM7332/22	2	2.5 to 32	1.2/1	19/21	15 / 18	5	2500/2000	15	SOIC-8, MSOP-8
LM7321	1	2.5 to 32	1.1	21	18	5	2000	15	SOIC-8, SOT23-5
LM7341	1	2.5 to 32	0.6	4	1.25	4	250	36	SOT23-5
LMV821	1	2.5 to 5.5	0.3	5.6	2	3.5	100	24	SC70-5, SOT23-5
LMV822	2	2.5 to 5.5	0.25	5.6	2	3.5	100	24	SOIC-8, MSOP-8
LMV824	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	1	2.7 to 12	0.158	10	1.6	0.5	0.01	14	SOIC-8, SC70-5
LMV841/42/44	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	1	2.7 to 12	0.00097	0.027	0.0077	3	0.8	320	SC70-5
LM6154	4	2.7 to 24	1.4	75	30	5	0.12	9	SOIC-14
LMV341	1	2.7 to 5	0.107	1	1	4	0.115	39	SC70-6
LMV712	2	2.7 to 5	1.17	5	5	3	0.115	20	micro SMD-10, LLP-10, SOIC-10
LMV715/16	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	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	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	4	2.7 to 5	0.6	3.5	1.4	1	0.01	12	TSSOP-14
LMV851/52/54	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	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	1/2	2.7 to 5.5	0.116	12	0.83	1.5	120	17	SC70-5/MSOP-8
LMV654	4	2.7 to 5.5	0.116	12	0.83	1.5	120	17	TSSOP-14
LMV751	1	2.7 to 5.5	0.6	5	2.3	1	0.1	6.5	SOT23-5
LMV831/32/34	1/2/4	2.7 to 5.6	0.24	3.3	2	1	10	12	SC70-5/MSOP-8/TSSOP-14



PowerWise product

Micropower Amplifiers

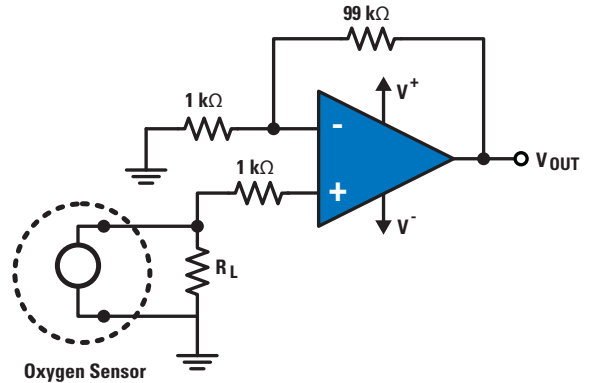
LMP2231/32/34 – Single/Dual/Quad Micropower Precision Op Amps with CMOS Inputs

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/ $\sqrt{\text{Hz}}$ input voltage noise, $f = 1 \text{ kHz}$

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 Bandwidth (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/ $\sqrt{\text{Hz}}$)	Temp Range ($^{\circ}\text{C}$)	Packaging
LPV511	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	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	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	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	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	4	118	12	1.5	120	100	95	2.7 to 5.5	3	15	17	-40 to 125	TSSOP-14
LMV641	1	158	10	0.5	90	120	100	2.7 to 12	2.6	26	14	-40 to 125	SOIC-8, SC70-5

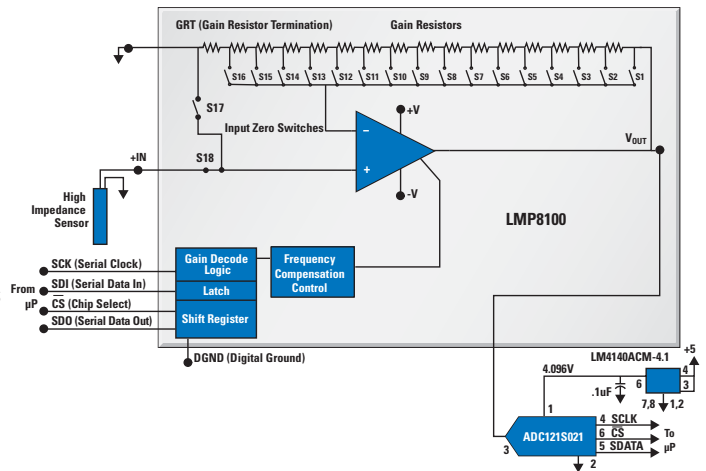
Low-Power Comparators

Product ID	Channels	Response Time (μs)	Offset Voltage max, 25C (mV)	Output Current (mA)	Supply Voltage Range (V)	Supply Current Per Channel (μA)	Max Input Bias Current (nA)	Temp Range ($^{\circ}\text{C}$)	Packaging
LMP7300	1	4	0.3	10	2.7 to 12	12	3	-40 to 125	SOIC-8
LMV7271	1	0.88	4	34	1.8 to 5	9	100	-40 to 85	SC70-5, SOT23-5
LMV7272	2	0.88	4	34	1.8 to 5	9	100	-40 to 85	micro SMD-8
LMV7275	1	0.88	4	34	1.8 to 5	9	100	-40 to 85	SC70-5, SOT23-5
LMV7291	1	0.88	4	34	1.8 to 5	9	100	-40 to 85	SC70-5
LPV7215	1	4.5	3	15	1.8 to 5	0.58	0.001	-40 to 85	SC70-5, SOT23-5

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	1	1	2.7 to 5	4	-40 to 125	Tri-State® output	SC70-6
LMV981	1	1.4	1.8 to 5	4	-40 to 125	Tri-State output, RRIO	micro SMD-6, SC70-6, SOT23-6
LMV982	2	1.4	1.8 to 5	4	-40 to 125	Tri-State output, RRIO	MSOP-10
LMV951	1	2.8	0.9 to 3	2.8	-40 to 125	RRIO	TSOT23-6
LMV711	1	5	2.7 to 5	3	-40 to 85	Output low for shutdown	SOT23-6
LMV712	2	5	2.7 to 5	3	-40 to 85	RRIO	LLP-10, SOIC-10
LMV715	1	5	2.7 to 5	3	-40 to 85	Tri-State output	SOT23-61
LMP7711	1	17	1.8 to 5.5	0.15	-40 to 125	CMOS input	TSOT-6
LMP7712	2	17	1.8 to 5.5	0.15	-40 to 125	CMOS input	MSOP-10
LMV791	1	17	1.8 to 5.5	1.35	-40 to 125	Tri-State output	TSOT23-6
LMV792	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	1	125	2.4 to 5.5	2.4	-40 to 85	CMOS input	SC70-6
LMH6618	1	65	2.7 to 11	0.6	-40 to 125	RRIO	TSOT23-6
LMH6611	1	135	2.7 to 11	0.6	-40 to 125	RRO	TSOT23-6
LMH6647	1	40	2.5 to 12	3	-40 to +85	RRIO	SOIC-8, SOT23-6
LMH6703	1	1800*	8 to 12	7	-40 to 85	Low distortion	SOIC-8, SOT23-6
LMH6720	1	420*	10 to 12	6	-40 to 85	CFB	SOIC-8, SOT23-6
LMH6733	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	3	750*	8 to 12	2.5	-40 to 85	CFB	SSOP-16
LMH6739	3	750*	8 to 12	2.5	-40 to 85	CFB	SSOP-16

PowerWise product *Unity Gain Bandwidth

Low-Power Amplifiers

Low-Power Operational Amplifiers

Product ID	Channels	Supply Current Per Channel (mA)	Supply Voltage Range (V)	Offset Voltage max, 25°C (mV)	Max Input Bias Current (nA)	Gain Bandwidth (MHz)	Slew Rate (V/μs)	Output Current (mA)	Voltage Noise (nV/√Hz)	Packaging
LPV511	1	0.00088	2.7 to 12	3	0.8	0.027	0.0077	0.225	320	SC70-5
LMV422	2	0.002	2.7 to 5.5	4	0.005	8	3.8	5	60	MSOP-10
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	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	1	0.01	1.6 to 5.5	0.15	0.001	0.13	0.058	30	60	SOIC-8, SOT23-5
LMV341	1	0.107	2.7 to 5	4	0.12	1	1	75	39	SC70-6
LMV931	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	1	0.116	1.8 to 5	4	35	1.5	0.42	65	50	micro SMD-6, SC70-6, SOT23-6
LMV651/52	1/2	0.116/0.118	2.7 to 5.5	1.5	120	12	2.8	15	17	SC70-5/MSOP-8
LMV654	4	0.122	2.7 to 5.5	1.8	120	12	2.8	15	17	TSSOP-14
LMV641	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	1/2/4	0.24	2.7 to 5.5	1	10	3.3	2	60	12	SC70-5/MSOP-8/TSSOP-14
NEW LMV822/24	2/4	0.25	2.7 to 5.5	3.5	100	5.6	2	40	24	SOIC-8, MSOP-8/TSSOP-14
LMV821	1	0.3	2.7 to 5.5	3.5	100	5.6	2	40	24	SC70-5, SOT23-5
NEW LMV851/52/54	1/2/4	0.43	2.7 to 5.5	1	10	8	4.5	60	11	SC70-5/MSOP-8/TSSOP-14
LMV951	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	1	0.6	2.7 to 5.5	1	0.1	5	2.3	24	6.5	SOT23-5
LM7341	1	0.6	2.5 to 32	4	400	4	1.25	6	36	SOT23-5
LMV771/72	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	1	1	2.5 to 32	5	2000	16	12.3	50	14	SOT23-5,SOIC-8
LMV774	4	1.03	2.7 to 5	1	260	3.5	1.4	24	12	TSSOP-14
LMV722	2	1.03	2.7 to 5	3	260	10	5.25	15	8.5	LLP-8, SOIC-8
LMV2011	1	1.17	2.7 to 5	0.025	0.115	3	4	35	35	SOIC-8, SOT23-5
LMV721	1	1.17	2.7 to 5	3	0.115	10	5.25	40	8.5	SC70-5, SOT23-5
LMV712	2	1.17	2.7 to 5	3	0.13	5	5	35	20	micro SMD-10, LLP-10, MSOP
LMV715	1	1.17	2.7 to 5	3	0.1	5	5	40	20	SOT23-6

Precision and EMI-Hardened Amplifiers

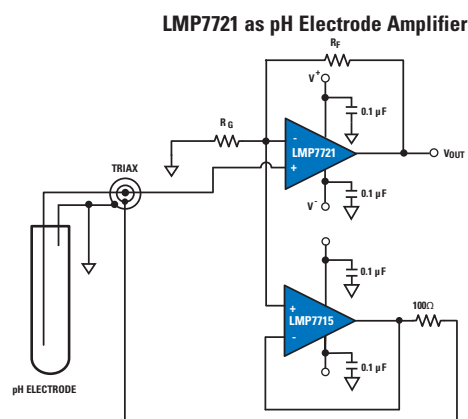
LMP7721 – 3 fA Input Bias Current Precision Amplifier

Features

- Input bias current ($V_{CM} = 1V$)
 - ± 20 fA at 25°C (max)
 - ± 900 fA at 85°C (max)
- 6.5 nV/ \sqrt{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

Applications:

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



Read the Application Note: “Designing with Electro-Chemical Sensors” go to www.national.com/analogedge

EMI-Hardened Amplifiers

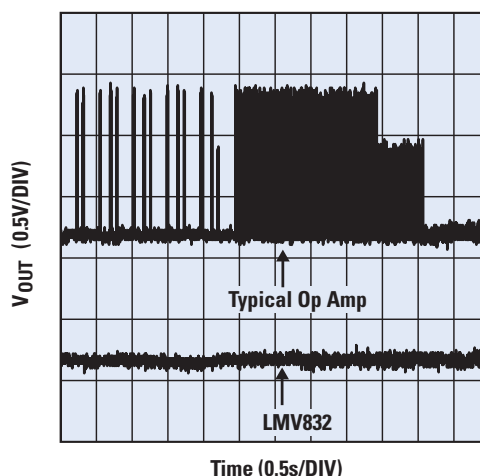
Product ID	EMIRR (dB)	Channels	Supply Voltage (V)	Supply Current (mA)	Offset Voltage	Input Bias Current (pA)	Packaging
LMV831/2/4	120	1/2/4	2.7 to 5.5	0.24	1 mV	1	SC-70/MSOP/TSSOP
LMV861/2	110	1/2	2.7 to 5.5	2.25	1 mV	0.1	SC-70/MSOP-8
LMV851/2/4	89	1/2/4	2.7 to 5.5	0.4	1 mV	0.1	SC-70/MSOP/TSSOP
LMP2021/22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

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

Features

Unless otherwise noted, typical values at $T_A = 25^\circ C$, $V_{+} = 3.3V$

- 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/ \sqrt{Hz}
- Slew rate 2 V/ μs
- Output voltage swing rail to rail
- Output current drive 30 mA
- Operating temperature range ambient $-40^\circ C$ to $125^\circ C$



Applications

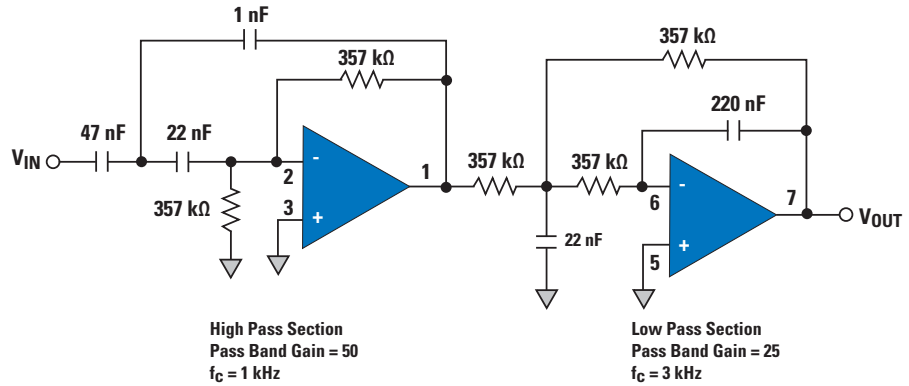
Ideal for use in photodiode preamps, piezoelectric sensors, portable/battery-powered electronic equipment filters/buffers and PDAs/phone accessories

Low-Voltage, Low-Noise Operational Amplifiers

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

Features

- Input noise voltage $12.8 \text{ nV}/\sqrt{\text{Hz}}$
- 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 $5.8 \text{ V}/\mu\text{s}$
- Supply current 1.6 mA
- Supply voltage range 2.7 V to 5 V
- Available in MSOP-8 packaging



Applications:

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

Low-Voltage, Low-Noise Operational Amplifiers

Product ID	Channels	Voltage Noise ($\text{nV}/\sqrt{\text{Hz}}$)	Max Input Bias Current (nA)	Offset Voltage max, 25C (mV)	Supply Current Per Channel (mA)	Gain Bandwidth (MHz)	Slew Rate ($\text{V}/\mu\text{s}$)	Supply Voltage Range (V)	Output Current (mA)	Temp Range ($^{\circ}\text{C}$)	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	2	2.9	30	0.04	2.2	22	2.4	1.8 to 5.5	47	-40 to 125	SOIC-8
LMV861	1	5	0.01	1	2.59	30	18	2.7 to 5.5	61	-40 to 125	SOIC-8, SC-70
LMV791	1	5.8	0.025	1.35	1.15	17	9.5	1.8 to 5	21	-40 to 125	TSOT-6
LMV792	2	5.8	0.1	1.35	1.3	17	9.5	1.8 to 5	21	-40 to 125	MSOP-10
LMV796	1	5.8	0.1	1.35	1.15	17	9.5	1.8 to 5	21	-40 to 125	SOT23-5
LMV797	2	5.8	0.1	1.35	1.3	17	9.5	1.8 to 5	21	-40 to 125	MSOP-8
LMV793	1	5.8	0.1	1.35	1.15	88	28	1.8 to 5	21	-40 to 125	SOIC-8, SOT23-5
LMV794	2	5.8	0.1	1.35	1.3	88	28	1.8 to 5	21	-40 to 125	SOIC-8, MSOP-8
LMP7715	1	5.8	0.05	0.15	1.15	17	9.5	1.8 to 5.5	23	-40 to 125	SOT23-5
LMP7716	2	5.8	0.05	0.15	1.3	17	9.5	1.8 to 5.5	23	-40 to 125	MSOP-8
LMV751	1	6.5	0.1	1	0.6	5	2.3	2.7 to 5.5	15	-40 to 85	SOT23-5
LMV721	1	8.5	400	3	1.03	10	5.25	2.7 to 5	24	-40 to 85	SC70-5, SOT23-5
LMV722	2	8.5	400	3	0.9	10	5.25	2.7 to 5	24	-40 to 85	LLP-8, SOIC-8
LMV771	1	12	0.1	0.85	0.6	3.5	1.4	2.7 to 5	66	-40 to 125	SC70-5
LMV772	2	12	0.1	1	0.6	3.5	1.4	2.7 to 5	66	-40 to 125	SOIC-8, MSOP-8
LMV774	4	12	0.1	1	0.6	3.5	1.4	2.7 to 5	66	-40 to 125	TSSOP-14
LMV716	2	12.8	0.13	5	1.6	5	5.8	2.7 to 5	31	-40 to 85	MSOP-8
NEW LMV861/62/64	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

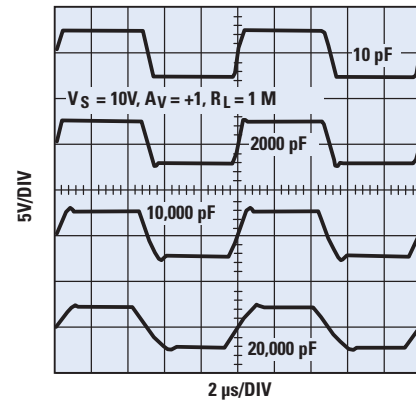
LM7332 – Dual RRIO, 30V Wide Voltage Range Operational Amplifier

Features

($V_+ = 10V$, $T_A = 25^\circ C$, 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 $-40^\circ C$ to $+125^\circ C$
- Voltage offset 100% tested at 5V, $\pm 5V$, 30V

Large Signal Step Response for Various Capacitive Loads



High-Performance ±15V Supply Amplifiers

Product ID	Channels	Voltage Noise (nV/ \sqrt{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	1	1.9	132	1900	90	1	8	Current feedback	SOIC-8
LM4562	2	2.7	55	20	23	0.7	6	High-AC accuracy, low noise	SOIC-8, PDIP-8, TO-99
LME49710	1	2.7	55	20	23	0.7	6	Can drive 600 Ω loads	SOIC-8, PDIP-8, TO-99
LME49720	2	2.7	55	20	23	0.7	5.5	Good for active filters, 120 dB CMRR	SOIC-8, PDIP-8, TO-99
LME49740	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 $\pm 22V$	SOIC-8
LME49860	2	2.7	55	20	30	0.7	5.5	Supply voltage to $\pm 22V$	SOIC-8, PDIP-8
LM7372	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	1	15	21	24	50	5	1.3	RRIO and unlimited cap load	SOIC-8, SOT23-5
LM7322	2	15	21	24	50	5	1.3	RRIO and unlimited cap load	SOIC-8, MSOP-8
LM7341	1	33	4	1.7	11	4	1	Rail-to-rail input and output	SOT23-5

Mixed-Signal Subsystems/Audio Codecs

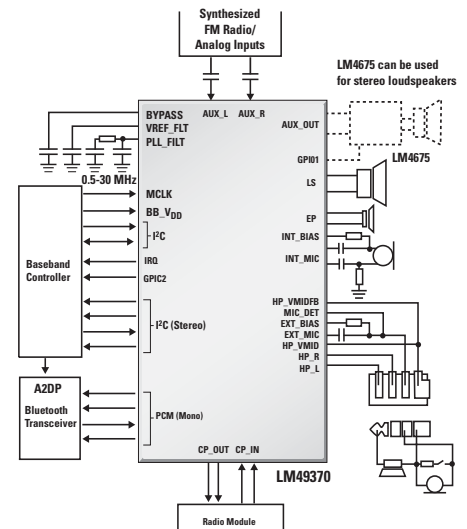
LM49370 – PowerWise® Audio Codec Subsystem with Ultra-Low EMI, Class D Amplifier, and a PCM Interface for Bluetooth® Transceivers

Features

- Spread spectrum Class D architecture reduces EMI
- Mono Class D 8Ω amplifier, 490 mW at 3.3V
- 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: 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 and portable gaming, portable DVD/CD/AAC/MP3 players, and digital cameras/camcorders



LM49450 – 2.2W Stereo Boomer® Class D Audio Subsystem

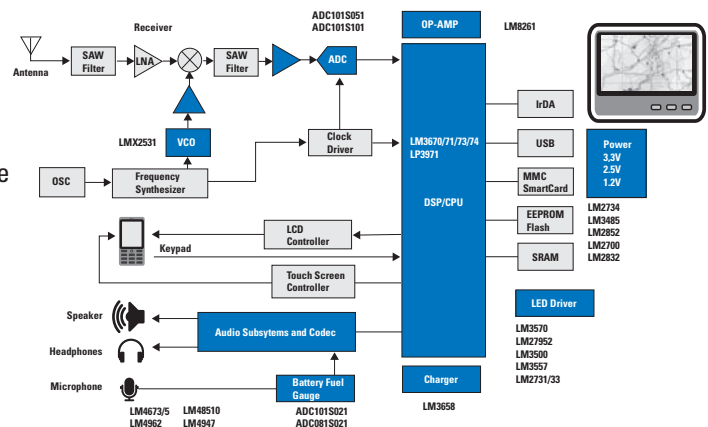
Features

- 24-bit stereo DAC
- Selectable spread spectrum mode reduces EMI
- Ground-referenced headphone amplifiers with 100 dB SNR
- I²S-compatible audio interface; I²C-compatible control interface
- Audio sample rates up to 192 kHz
- 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

Handheld GPS Navigation



Product ID	Description	Mono Input Ch.	Stereo Input Ch.	Class D Speaker Driver	Packaging
LM4931	1.1W mono speaker 26 mW headphone with microphone pre-amp, GPIO, headphone sense, I ² C/SPI control, PCM, and I ² S	2, PCM	I ² S		micro SMDxt-42
LM4934	1.2W stereo speaker 80 mW OCL headphone 175 mW earpiece with line out, I ² C/SPI control, I ² S and National 3D	1	2, I ² S	—	micro SMDxt-42
LM4935	1.3W mono speaker 33 mW headphone 115 mW earpiece with I ² S/PCM and auxiliary inputs, I ² C control, mic pre-amp, DC volume control and AGC	2	2, I ² S		micro SMDxt-49
LM4937	520 mW mono speaker, 36 mW headphone, 55 mW earpiece with I ² C/SPI mode	1	2, I ² S	—	micro SMDxt-36
NEW LM49321	520 mW mono speaker, 36 mW headphone, 55 mW earpiece with I ² C/SPI and lower power MP3 playback mode	1	2, I ² S	—	micro SMDxt-36
NEW LM49370	1.2W mono speaker, 31 mW headphone, 115 mW earpiece with I ² C/SPI mode and selectable OCL output	3, PCM	I ² S		micro SMDxt-49
NEW LM49450	Filterless 2.2W stereo Class D audio subsystem with ground-referenced headphone amplifier, 3D enhancement, and headphone sense	—	2, I ² S		LLP-32
NEW LM49350	1.1W Class D speaker, 69 mW ground-referenced headphone with stereo DAC and stereo ADC with I ² S/PCM and auxiliary inputs, I ² C control, 3D, five band EQ, and AGC	2, PCM	3, I ² S		micro SMDxt-36

PowerWise® product

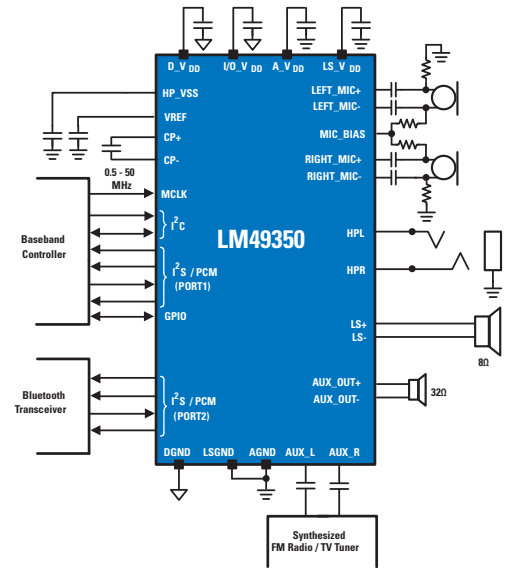
LM49350 – High-Performance Audio Codec Subsystem with a Ground-Referenced Stereo Headphone Amplifier and Ultra-Low EMI Class D Loudspeaker Amplifier with Dual I²S/PCM Digital Audio Interfaces

Features

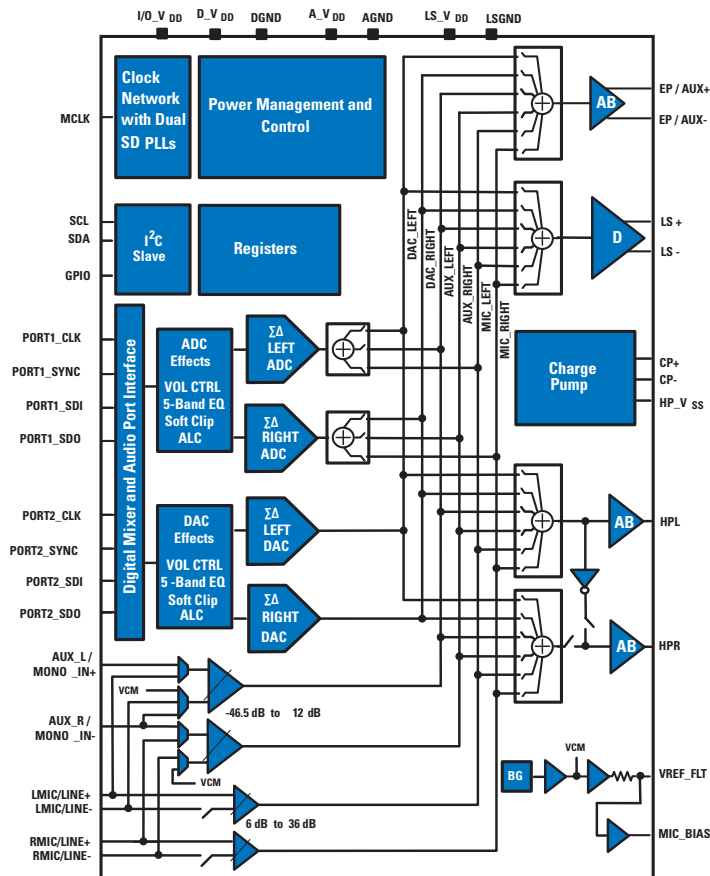
- High-performance 96 dB SNR stereo DAC and ADC
- Up to 192 kHz stereo audio playback
- Up to 48 kHz stereo recording
- Dual bidirectional I²S- or PCM-compatible audio interfaces
- Dual 5-band parametric equalizers
- ALC/compressor/limiter on both DAC and ADC paths
- Ultra-low EMI, Class D loudspeaker amplifier with spread spectrum control
- Ground-referenced output cap-less headphone amplifier operation

Applications

Ideal for use in smart phones, mobile phones, VOIP phones, portable GPS, portable gaming devices, and digital cameras/camcorders



AUDIO



Analog Subsystems

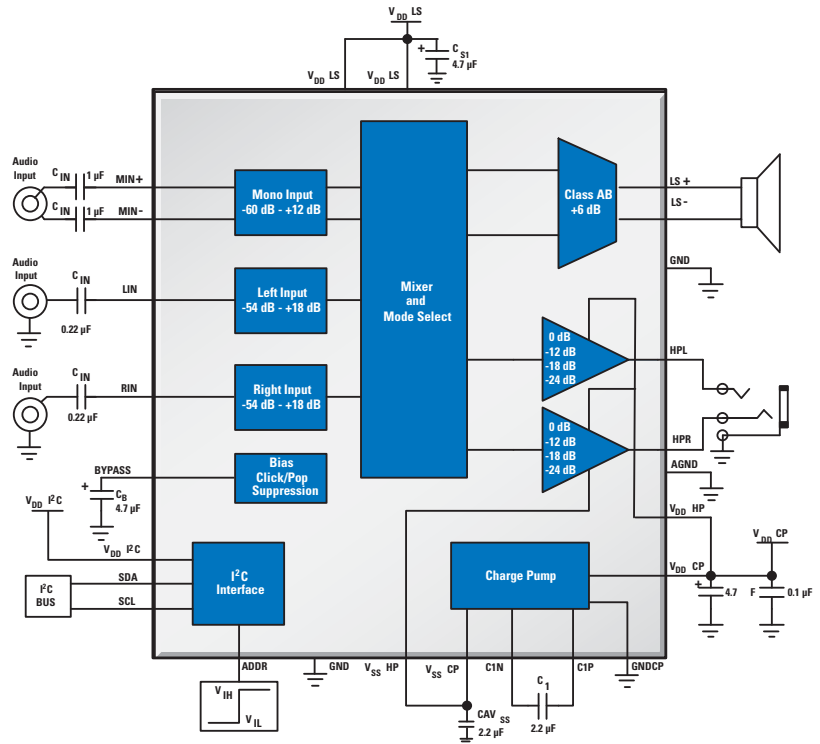
LM49100 – PowerWise® Mono Class AB Audio Subsystem with a True-Ground Headphone Amplifier

Features

- Very low power consumption
- 5 mA IDDQ with speaker and headphone enabled
- Mono and stereo inputs
- Thermal overload protection
- Total harmonic distortion: 0.035%
- I²C-compatible control interface
- Input mute attenuation
- 2nd stage headphone attenuator
- 32-step digital volume control
- Ten operating modes
- Minimum external components
- Click-and-pop suppression
- Micro-power shutdown
- RF suppression
- Available in space-saving GR-25 packaging (3 x 3 mm)

Applications:

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



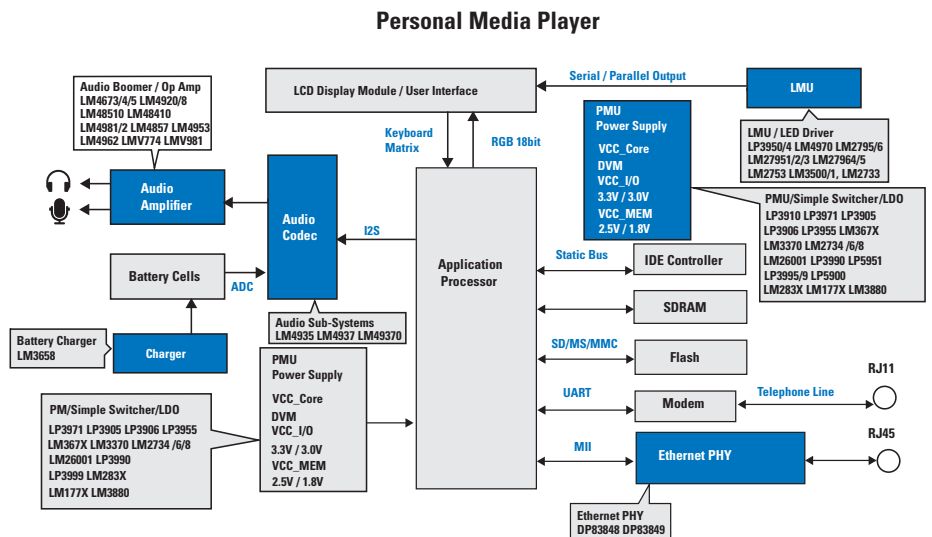
LM49250 – Stereo Boomer® Class D Audio Subsystem with Ground-Referenced Headphone Amplifier and Mono Earpiece

Features

- Output short circuit protection
- Thermal overload protection
- Spread spectrum modulation
- I²C-compatible control interface
- Total harmonic distortion: 0.01%
- RF suppression
- 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



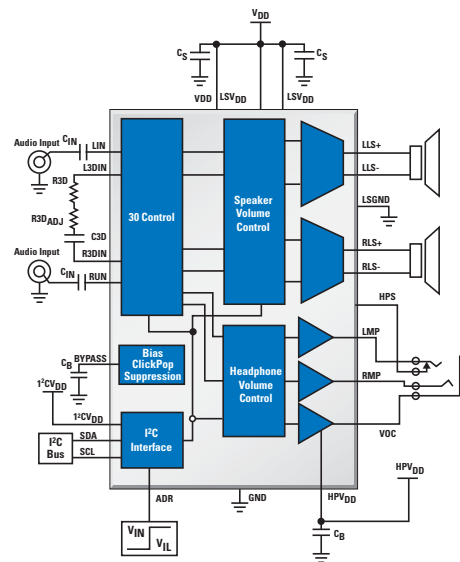
LM49270 – Boomer® Filterless 2.2W Stereo Class D Audio Subsystem with OCL Headphone Amplifier, 3D Enhancement, and Headphone Sense

Features

- Stereo filterless Class D amplifier
- Selectable OCL/CC headphone amplifier
- Headphone sense ability
- National's 3D enhancement
- RF suppression
- I²C-compatible control interface
- 32-step digital volume control
- Total harmonic distortion: 0.02%
- Available in space-saving LLP-28 packaging

Applications:

Ideal for use in portable media players, smart phones, PDAs, and laptops



Product ID	Description	Mono Input Ch.	Stereo Input Ch.	THD (%)	Class D Speaker Driver	Packaging
LM4844	Stereo 1.2W audio subsystem with 3D enhancement	—	—	—	—	micro SMD-30
LM4845	1.15W mono speaker 75 mW headphone with I ² C/SPI volume and mode control, programmable National 3D and selectable OCL HP output	1	1	0.5	—	micro SMD-25
LM4846	1.15W mono speaker 75 mW headphone with I ² C/SPI volume and mode control, programmable National 3D and selectable OCL HP output	1	1	0.5	—	micro SMD-25
LM4856	1.1W mono speaker 60 mW headphone with I ² C control	2	1	0.5	—	LLP-24, micro SMD-18
LM4857	1.2W stereo speaker, 75 mW headphone, 135 mW earpiece and line out with I ² C mode and volume control and National 3D	1	1	0.05	—	LLP-28, micro SMD-30
LM4888	1.3W stereo speaker, 90 mW headphone with National 3D	—	1	0.06	—	LLP-24
LM4938	Stereo 2W audio power amp with DC volume control, selectable gain, and docking station interface	—	1	0.05	—	TSSOP-28 exp pad
4 mm LM4946	1.3W mono speaker, 85 mW headphone with I ² C/SPI mode and volume control, National 3D and selectable OCL output	1	2	0.05	—	LLP-24, micro SMD-25
LM4947	1.19W mono speaker, 87 mW headphone with I ² C mode and volume control, National 3D and selectable OCL output	1	1 or 2	0.03	✓	micro SMD-25
LM4949	1.19W stereo speaker, 89 mW headphone with I ² C mode and volume control and selectable OCL output	1	1 or 2	0.02	✓	micro SMD-25
LM49270	2.2W stereo speaker, 155 mW headphone with volume control, National 3D and selectable OCL output	1	2	0.02	✓	LLP-28
NEW LM49100	1.275W mono speaker (BTL), 50 mW headphone with I ² C, mode and volume control, and ground-referenced headphone drivers	1	2	0.035	—	Micro Array-25
NEW LM49250	Stereo Class D audio subsystem with ground-referenced headphone amplifier and mono earpiece	1	2	0.14	✓	micro SMD-36
NEW LM49120	1.3W mono speaker, 85 mW headphone with I ² C/SPI mode and volume control, and selectable OCL output	1	2	0.05	—	micro SMD-16
NEW LM49150	1.25W mono Class D audio subsystem with earphone path and ground-referenced headphone amplifier	1	1	0.04	✓	micro SMD-20

PowerWise® product

Noise Reduction

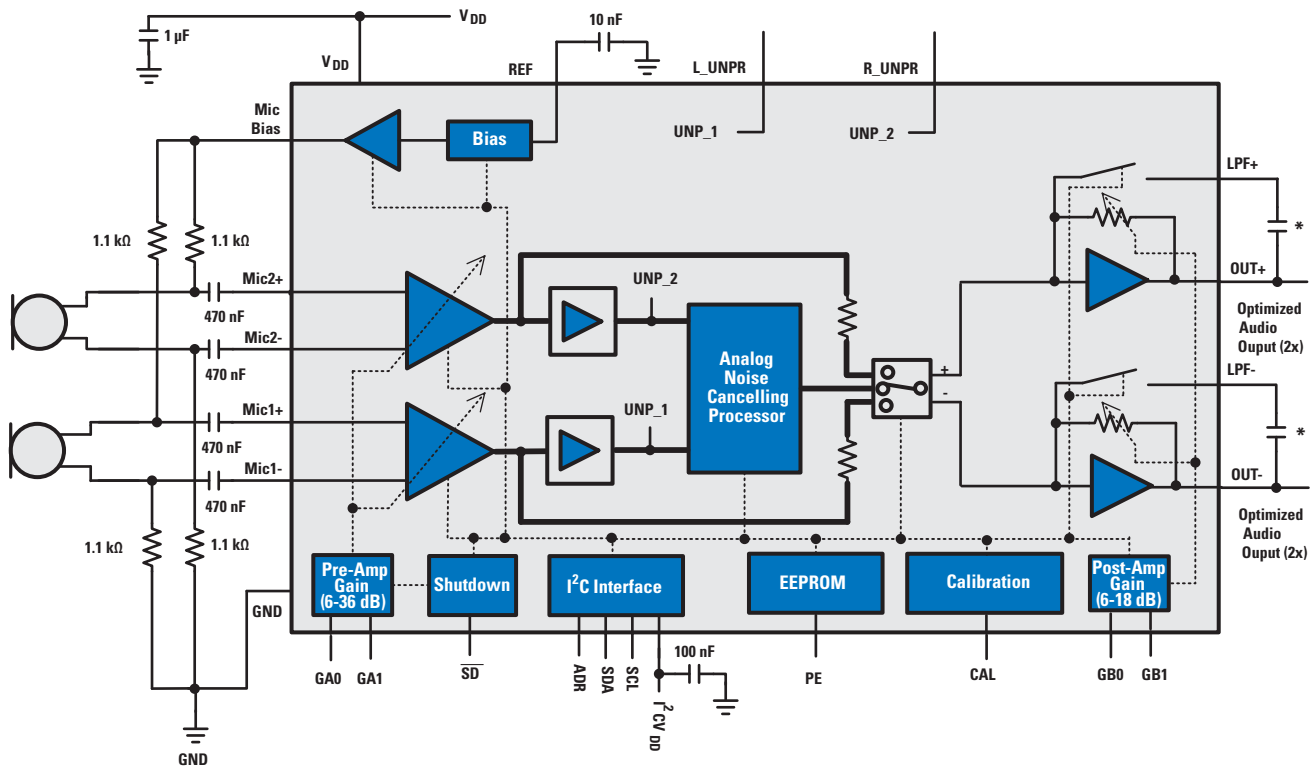
LMV1088/89 – Far Field Noise Suppression Microphone Amplifier

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 package (3.5 mm x 3.5 mm)

Applications

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



Noise Reduction Microphone Amplifiers

Product ID	Description	Output	SNR (dB)	PSRR (dB)	Shutdown	Supply Voltage Range (V)	Packaging
LMV1088	Noise reduction mic amp	Single-ended	60	85	—	2.7 to 5.5	micro SMD-36
LMV1089	Noise reduction mic amp	Differential	65	96	✓	2.7 to 5.5	micro SMD-36

Microphone Amplifiers

AUDIO

LMV1012/32 – Amplifiers for Electret Microphones

LMV1012 Amplifier Features

- Improved gain of 25 dB over common JFET
- Lower THD: 0.5%
- Better SNR: >55 dB
- 2-wire interface/connectivity
- Available in the world's thinnest micro SMD-4 packaging

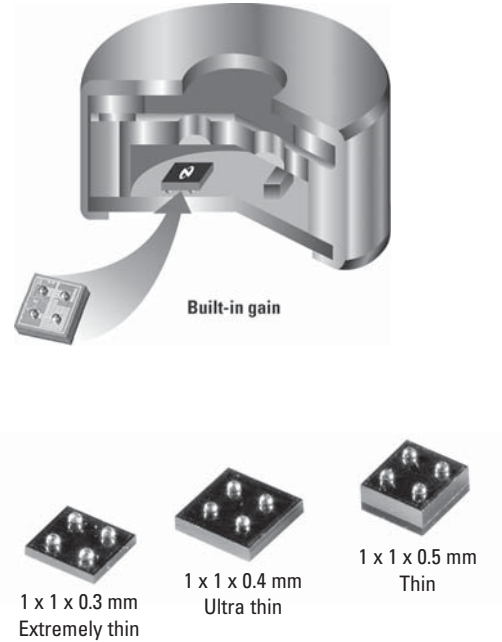
LMV1032 Amplifier Features

- Low-supply current: <60 μ A
- Low-output impedance: 200 Ω
- SNR: >55 dB
- Improved gain of 6 dB over common JFET
- 3-wire interface/connectivity

Applications:

Ideal for use in mobile communications, automotive communications, PDAs, and accessory microphone products

Next-Generation Electret Condenser Microphone (ECM)



Amps for Mics

Product ID	Application	Integrated Digital Floor Noise (dbFS A) ¹	SNR (dB at V _{DD} = 5V)	Gain (dB)	THD (% at V _{IN} = 18 mV _{p-p} , V _{DD} = 5V)	PSRR (dB)	Typ IS/Ch (μ A)	Supply Voltage Range (V)	Packaging
LMV1032-6	3-wire Electret	—	59	6	0.11	75	< 60	1.7 to 5	micro SMD-4
LMV1032-15	3-wire Electret	—	61	15	0.001	70	< 60	1.7 to 5	micro SMD-4
LMV1032-25	3-wire Electret	—	62	25	0.35	65	< 60	1.7 to 5	micro SMD-4
LMV1031-20	3-wire Electret 1V bias	—	62	20	0.18 ¹	56	< 72	2 to 5	micro SMD-4 (LDB*)
LMV1015-15	2-wire high-gain	—	60	15.6	0.13	—	< 180	2 to 5	micro SMD (LDB*) XP ⁴
LMV1015-25	2-wire high-gain	—	61	23.9	0.21	—	< 180	2 to 5	micro SMD (LDB*) XP ⁴
LMV1012-7	2-wire high-gain	—	59	7.8	0.1	—	< 180	2 to 5	micro SMD-4
LMV1012-15	2-wire high-gain	—	60	15.6	0.09	—	< 180	2 to 5	micro SMD-4
LMV1012-20	2-wire high-gain	—	61	20.9	0.12	—	< 180	2 to 5	micro SMD-4
LMV1012-25	2-wire high-gain	—	61	23.8	0.15	—	< 180	2 to 5	micro SMD-4 (UP/XP) ⁴
LMV1031	3-wire analog	—	62	20	0.18	56	—	2 to 5	micro SMD-4

¹Patent pending

²1.8V, 1.2 MHz, 18 mV_{p-p}

³PDM Output Right

⁴PDM Output Left

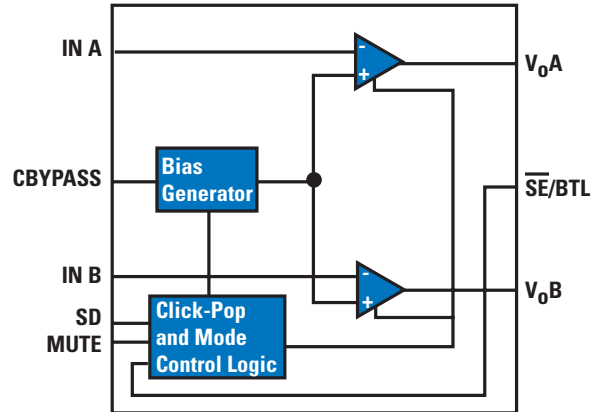
⁵Thinnest preamp at 0.3 mm is XP version

OCL/CC Headphone Boomer® Amplifiers

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



Applications

Ideal for use in portable one-cell audio products and electronic devices

OCL/CC Headphone Boomer Amplifiers

Product ID	Description	THD (%)	PSRR (dB)	Output Power THD ≤ 1%, V _{CC} = 3V	
				16Ω (mW)	32Ω (mW)
LM4809	105 mW headphone with shutdown low, can drive 8Ω	0.03	70	38	25
LM4811	105 mW headphone with up/down volume control, can drive 8Ω	0.03	60	38	25
LM4908 ¹	120 mW headphone, 0.1% THD+N	0.05	84	35	25
LM4910	35 mW headphone, bypass capacitor-less, OCL output	0.03	65	46	28
LM4911	40 mW headphone, low noise, selectable cap-coupled/OCL output	—	65	40	25
LM4912	40 mW headphone, low noise, with mute	—	65	40	25
LM4916	1.5V, mono 85 mW BTL output, 14 mW stereo headphone audio amplifier	0.2	66	—	—
LM4921	Low-voltage IS 16-bit stereo DAC with stereo headphone power amplifiers and volume control	0.03	62	—	—
LM4925	2-cell, single-ended output, 40 mW stereo headphone audio amplifier	0.05	70	—	—
LM4924	40 mW 2-cell headphone with OCL output	0.01	66	40	24
LM4929	40 mW headphone with low noise and OCL output	—	65	40	25
LM4980	42 mW stereo headphone with 2-cell battery operation and click/pop suppression	0.02	90	42	28
LM4985	135 mW headphone with OCL or cap-coupled output, 32-step I ² C volume control	0.08	77	45	23

¹10 kV ESD Rated

PowerWise® product

Ground-Referenced Headphone Boomer® Amplifiers

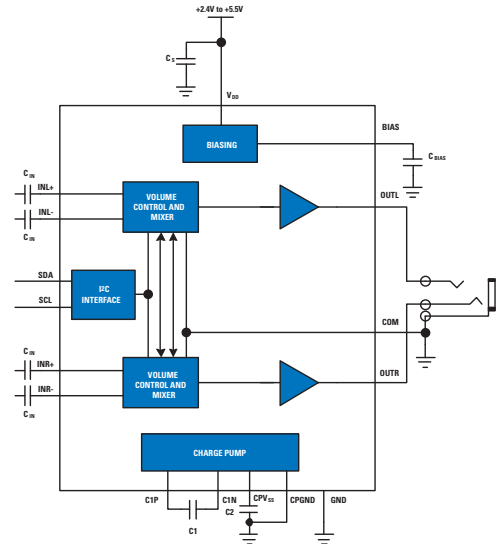
LM48822 – Ground-Referenced, Ultra-High PSRR, Ultra-Low Noise, 35 mW/Channel Stereo Headphone Amplifier with Common-Mode Sense, and I²C-compatible Volume Control

Features

- Ground-referenced outputs – eliminates output-coupling capacitors
- Common-mode sense
- Ultra-high PSRR
- I²C-compatible volume and mode control
- High-output impedance in shutdown
- Differential inputs
- Advanced click-and-pop suppression
- Low supply current
- Minimum external components
- Micro-power shutdown
- Available in space-saving 16-bump micro SMD packaging

Applications:

Ideal for use in mobile phones, PDAs, notebook PCs, portable electronic devices, and MP3 players



AUDIO

LM48860 – Ground-Referenced, Ultra-Low Noise, Fixed-Gain, Stereo Boomer® Headphone Amplifier

Features

- Fixed logic levels
- High PSRR
- Ultra-low current shutdown mode
- No output coupling capacitors, snubber networks, bootstrap capacitors, or gain-setting resistors required
- Shutdown either channel independently
- Click-and-pop circuitry eliminates noises
- Available in space-saving micro SMD-12 packaging

Applications:

Ideal for use in mobile phones, personal media/MP3 players, PDAs, laptops, and other portable electronic devices

Product ID	Description	THD (%)	PSSR (dB)	Supply Voltage Range (V)	Output Power THD ≤ 1%, V _{CC} = 3V		Packaging
					16Ω (mW)	32Ω (mW)	
LM4920	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	50 mW headphone, ultra-low noise, IntelliSense, 32-step I ² C volume control	0.05	66	1.6 to 4.0	47	51	micro SMD-16
LM48820	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, I ² C volume control	0.015	82	2 to 4	52	53	micro SMD-16
LM48860	30 mW headphone, ultra-low noise, fixed 1.5V/V gain	—	—	2.5 to 5.5	40	50	micro SMD-12
LM48822	35 mW headphone, ultra-low noise, common mode sense and I ² C volume control	0.04	110	2.4 to 5.5	35	40	micro SMD-16
LM48861	22 mW headphone Boomer, ultra-low noise, and common mode sense	0.04	83	1.2 to 2.8	22	24	micro SMD-12

PowerWise product

High-Efficiency Boomer® and Overture® Class D Amplifiers

LM48411 – Ultra-Low EMI, Filterless, 2.5W, Stereo, Class D Audio Power Amplifier with E²S








Features

- E²S system reduces EMI preserving audio quality and efficiency
- Output short circuit protection
- No output filter required for inductive loads
- Logic selectable gain
- Independent shutdown control
- Minimum external components
- Click-and-pop suppression circuitry
- Micro-power shutdown mode
- Available in space-saving micro SMD-16 packaging (0.5 mm pitch)

Applications:

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

High-Efficiency Boomer Class D Amplifier

Product ID	Description	THD (%)	Output Power THD ≤ 1%		Packaging
			4Ω (W)	8Ω (W)	
LM4666 ¹	Stereo	0.65	—	450 mW	LLP-14
LM4671	Mono filterless	0.04	2.21	1.19	micro SMD-9
 LM4673 	Mono filterless	0.02	2.15	1.24	micro SMD-9, LLP-8
LM4674 	Stereo filterless	0.05	1.9	1.25	micro SMD-16, LLP-16
LM4674A 	Filterless 2.5 stereo Class D audio power amplifier	—	—	—	micro SMD-16
LM4675 	Mono, ultra-low EMI	0.02	2.2	1.3	micro SMD-9, LLP-8
LM48310	Mono filterless, E ² S	0.03	2.1	1.3	LLP-10
 LM48410	Stereo, ultra-low EMI, filterless, 3D	0.025	1.9	1.2	LLP-24
LM48411	Stereo filterless, E ² S	0.03	2	1.25	micro SMD-16
 LM49413	Stereo, E ² S, 3D	0.03	—	1.2	micro SMD-18

¹ V_{DD} = 3V

 PowerWise product

High-Efficiency Overture Class D Amplifier

Product ID	Mono/ Stereo	Supply Voltage (V)	Output Power THD ≤ 1%		Output Power THD ≤ 10%		Typical THD Ratings (%)	THD Measurement Conditions (W at V _S = 3V, R _L = 8Ω unless otherwise specified)	Supply Voltage Range (V)	Shutdown	Packaging
			4Ω (W)	8Ω (W)	4Ω (W)	8Ω (W)					
LM4668	Mono	12	—	6	—	7.5	0.2	P ₀ = 1 at V _S = 12V	9 to 14	Low	LLP-14, TSSOP-20
LM4680	Mono	12	—	6	—	7.5	0.2	P ₀ = 1 at V _S = 12V	9 to 14	Low	LLP-14
LM4681	Stereo	12	—	6	—	7.5	0.2	P ₀ = 1 at V _S = 12V	9 to 16	Low	LLP-48
LM4682	Stereo	12	—	6	—	7.5	0.2	P ₀ = 1 at V _S = 12V	9 to 15	Low	LLP-48

Boosted Boomer[®] Moving Coil

AUDIO

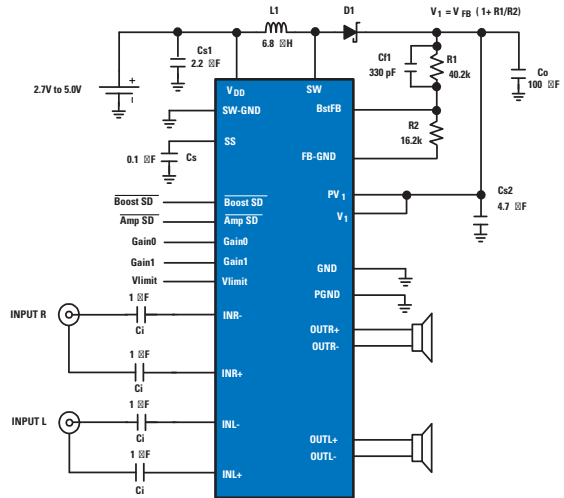
LM48520 – Boosted Stereo Class D Audio Power Amplifier with Output Speaker Protection and Spread Spectrum

Features

- 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 amps
- Independent boost and amplifier shutdown pins

Applications:

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



Boosted Boomer Moving Coil

Product ID	Description	THD (%)	Output Power at THD \leq 1%		Packaging
			4 Ω (W)	8 Ω (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
NEW LM48510	1.2W boosted Class D	0.07	1.7 at 3.3V	1.2 at 3.3V	LLP-16
NEW LM48511	3W boosted Class D with ultra low EMI and spread spectrum	—	5.4 at 5V	3 at 5V	LLP-24
NEW LM48520	1.1W boosted Class D with speaker protection and spread spectrum	0.04	—	1.1 at 3.3V	micro SMD-25

PowerWise[®] product

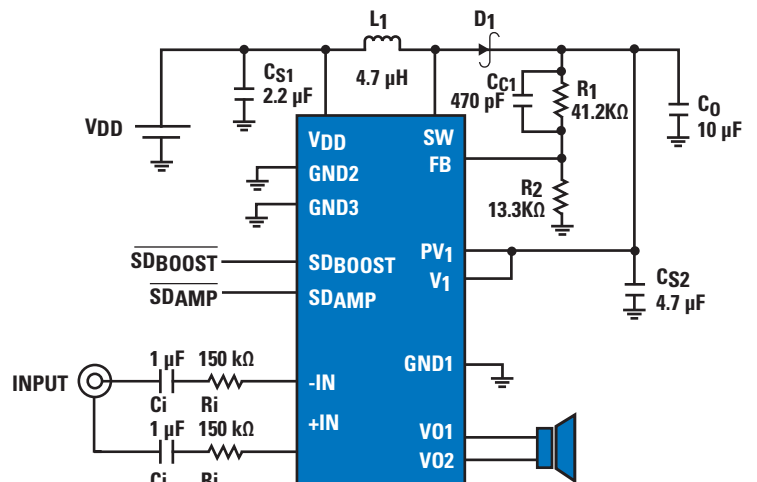
LM48510 – PowerWise[®] Boosted Boomer Class D Audio Power Amplifier

Features

- 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, cameras, and handheld games

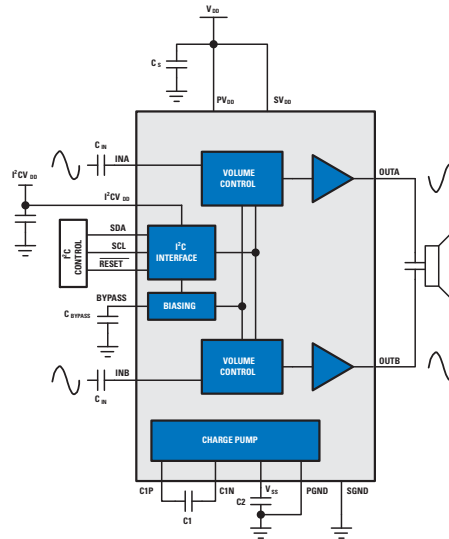


Boosted Boomer® Piezo Ceramic

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

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	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	15 V _{P-P} ceramic speaker driver	0.05	15	V _{DD} =5V, 2 μF + 30Ω, THD ≤ 1%	LLP-28
LM4962	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
NEW LM48555	15.5 V _{P-P} ceramic speaker driver	0.05	15	V _{DD} =5V, 2 μF + 9.4Ω, THD ≤ 1%	micro SMD-12
NEW LM48556	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	5.4V _{RMS} ceramic speaker driver with I ² C-compatible volume control and reset	0.015	5.4V _{RMS}	V _{DD} =4.2, RL=2.2 μF+15Ω, THD ≤ 1%	micro SMD-16



*ZL = 2 μF + 9.4Ω
Audio eBook resources available online

Mono Boomer® Audio Amplifiers

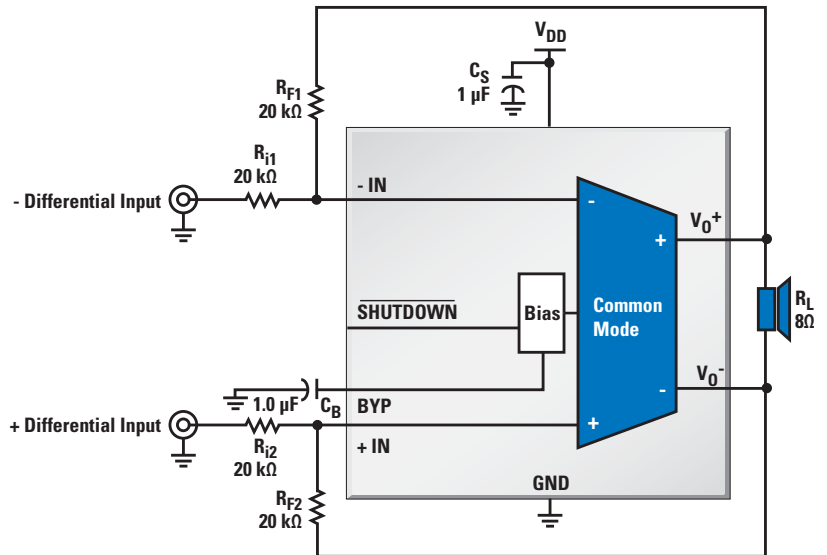
LM4941 – PowerWise® Boomer 1.25 Watt Fully Differential Audio Power Amplifier with RF Suppression and Shutdown

Features

- Improved RF suppression, by up to 20 dB over previous designs in selected applications
- Fully differential amplification
- Available in space-saving micro SMD package
- Ultra low current shutdown mode
- Can drive capacitive loads up to 100 pF
- Improved click-and-pop circuitry eliminates noises during turn-on and turn-off transitions
- 2.4 to 5.5V operation
- No output coupling capacitors, snubber networks or bootstrap capacitors required

Applications:

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



AUDIO

Fully Differential Mono Boomer Amplifier

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

PowerWise® product

Mono Boomer Audio Amplifiers

Product ID	Description	THD (%)	Output Power $V_{CC} = 5V$		Packaging
			4Ω (W)	8Ω (W)	
LM4819	350 mW audio power amplifier with shutdown mode	1	—	0.25	LLP-8, SOIC-8
LM4905	1W audio power amplifier	0.1	—	1.1	LLP-8, SOIC-8
LM4906	1W with no bypass cap, selectable gain	0.02	—	1	LLP-10, MSOP-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
LM4990	2W (into 4Ω) with selectable shutdown	0.02	2.03	1.25	LLP-10, micro SMD-9, MSOP-8, TSSOP-10
LM4991	3W (into 3Ω)	0.02	2.13	1.1	LLP-8, SOIC-8
NEW 4 mm LM4995	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

Stereo Boomer[®] Audio Amplifiers

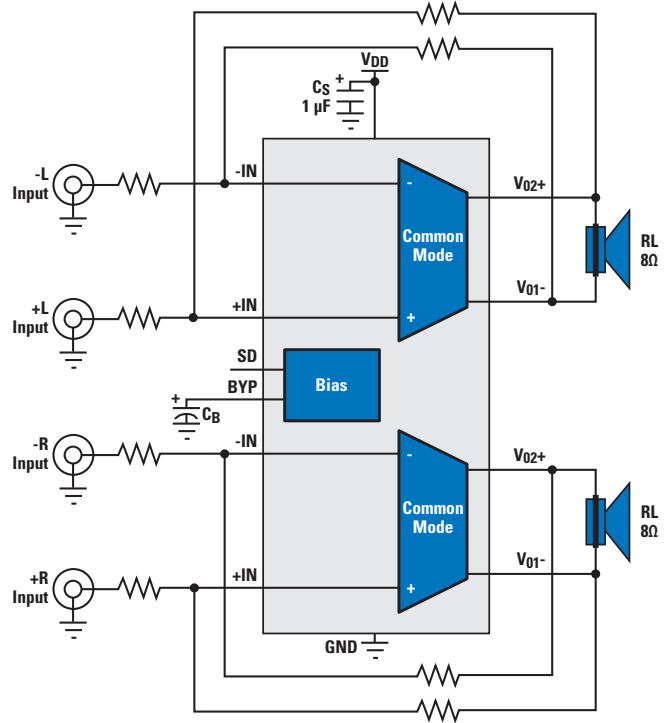
LM4928 – 1.2W, Stereo Fully Differential Audio Amplifier with RF Suppression

Features

- RF suppression circuitry
- Fully differential amplification
- Ultra-low current shutdown mode
- Can drive capacitive loads up to 100 pF
- Click-and-pop circuitry
- 2.4 to 5.5V operation
- No output coupling capacitors, snubber networks, or bootstrap capacitors required
- Available in space-saving micro SMD-16 and LLP-14 packaging

Applications:

Ideal for use in portable equipment, battery-powered systems, sensors, instrumentation, and automotive applications



Stereo Boomer Amplifiers

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

Specialty Audio Synch LED Drivers

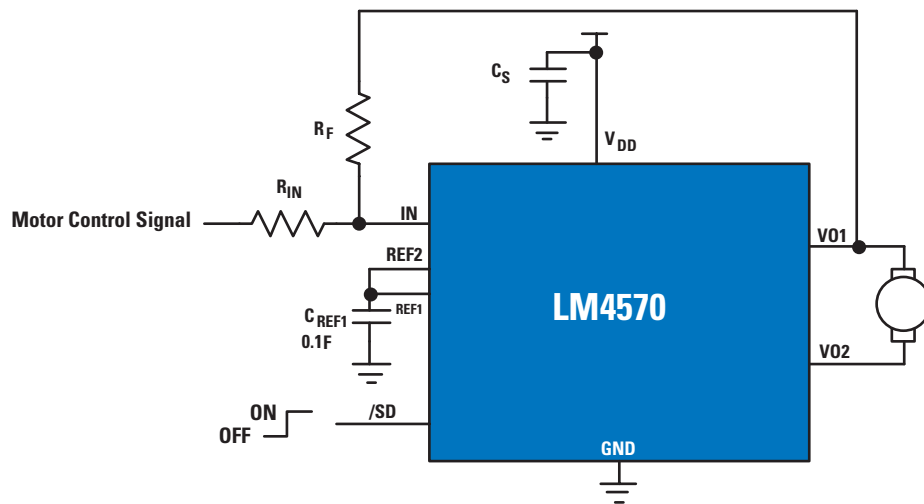
Product ID	Description	Audio Channels	Control	Number of Outputs	Supply Voltage (V)	LED Drive Current (1x)	Supply Voltage Range (V)	Packaging
LM4970	Audio synchronized color LED driver	3	I ² C	3	3	18 mA	2.7 to 5.5	LLP-14

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	T0220-9, T0263-9

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	Haptic motor driver	2.4 to 5.5	1.9	2.4	192	Low	LLP-8



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 sine wave whose rms voltage can be obtained through *Equation 4*.

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

Deriving the above equation for one period of a sine wave [$v(t) = V_{\text{pk}}\sin(\omega t)$] results in *Equation 5*.

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

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

$$(6) P_{\text{O}_{\text{rms}}} = V_{\text{rms}}^2/R_L$$

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*.

$$(7) P_{\text{O}_{\text{rms}}} = V_{\text{pk}}^2/2R_L$$

Equation 6 or *7* are the most general equations stating the output power of a power IC based on a sine wave 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 sine wave 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: $P_o = 80W$, THD+N = 0.00056%, $R_L = 8\Omega$

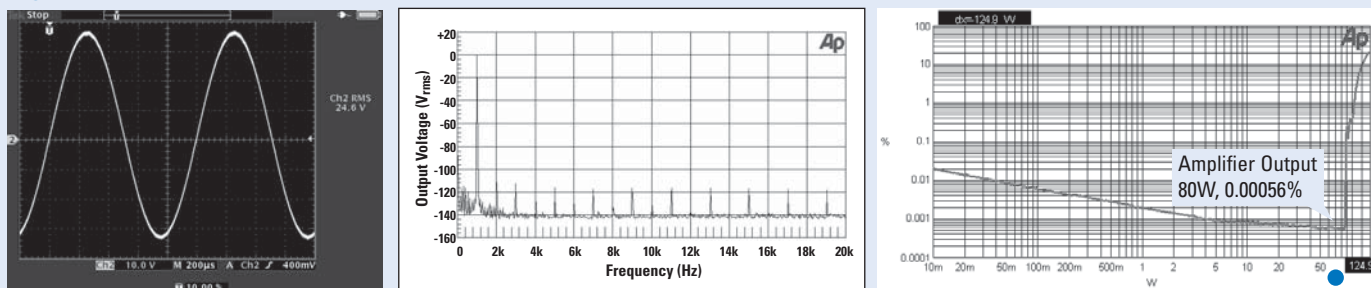


Figure 2: Amplifier output: $P_o = 106W$, THD+N = 1%, $R_L = 8\Omega$

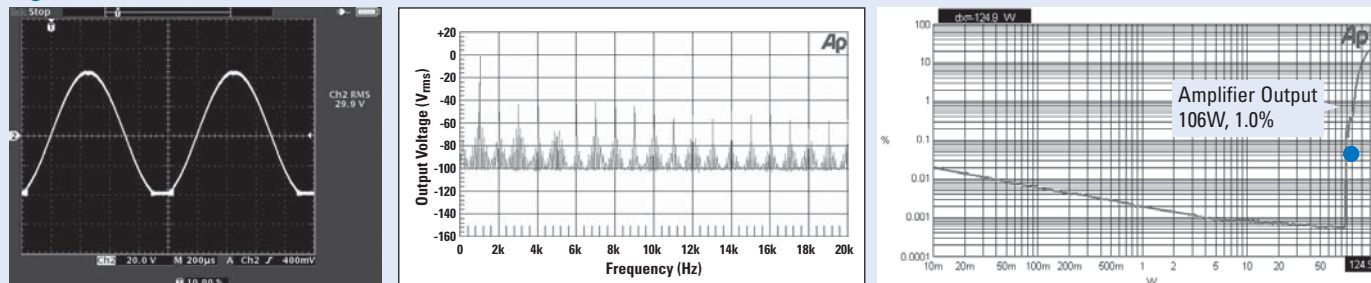


Figure 3: Amplifier output: $P_o = 125W$, THD+N = 10%, $R_L = 8\Omega$

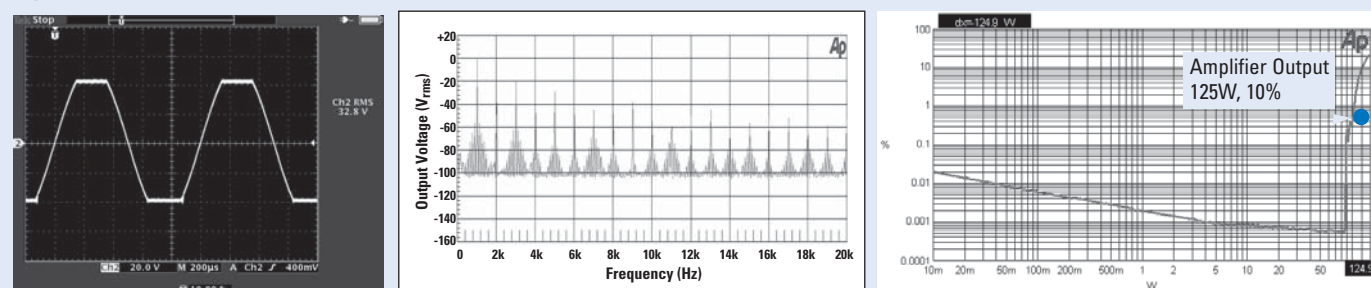


Figure 1 - 3 are collected using National's LM4702

High-Performance Audio

Typical High-Performance Audio Signal Path



Ideal for applications such as:

- High-end components (Pre-amps/DACs/DVD-SCAD etc.)
- Music (including guitar amps)
- Powered speakers and subwoofers
- Home theater
- Home automation and dist. audio
- Professional mixers and effects
- Commercial sound reinforcement
- After-market automotive
- Portable performance audio



High-Performance Audio Op Amps and Buffers

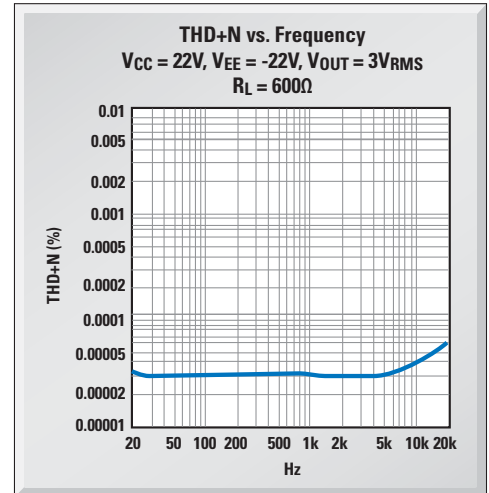
LME49860 – 44V Dual High-Performance, High-Fidelity Operational Amplifier

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



AUDIO

Product ID	Description	Input Voltage Noise Density (nV/ \sqrt{Hz})	THD (%)	Slew Rate (V/ μ S)	GBWP (MHz)	PSRR (dB)	Supply Voltage (V)	Packaging
LME49710	High-performance, high-fidelity audio op amp	2.7	0.00003	20	56	125	± 2.5 to ± 17	DIP-8, MSOP-8, T099-8
LME49870	High-performance, high-fidelity audio op amp	2.7	0.00003	20	55	125	± 2.5 to ± 22	SOIC-8
LM4562*	Dual high-performance, high-fidelity audio op amp	2.7	0.00003	20	56	110	± 2.5 to ± 17	DIP-8, MSOP-8, T099-8
LME49720	Dual high-performance, high-fidelity op amp	2.7	0.00003	20	56	110	± 2.5 to ± 17	DIP-8, MSOP-8, T099-8
LME49860	44V dual high-performance, high-fidelity audio op amp	2.7	0.00003	20	55	120	± 2.5 to ± 22	SOIC-8
LME49740	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	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	Dual, high-fidelity audio op amp	3.6	0.0002	8	17	100	± 2.5 to ± 17	MSOP-8
NEW LME49722	Dual high-performance, high-fidelity audio op amp	1.9	0.00002	22	55	120	± 2.5 to ± 18	MSOP-8
NEW LME49725	Dual high-performance, high-fidelity audio op amp	3.3	0.0004	15	40	120	± 4.5 to ± 18	MSOP-8
NEW LME49743	Quad high-performance, high-fidelity audio op amp	3.5	0.0001	12	30	98	± 4 to ± 17	TSSOP-14
NEW 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
NEW LME49724	High-performance, high-fidelity, fully-differential audio op amp	2.1	0.00003	18	50	125	± 2.5 to ± 18	PSOP-8
NEW LME49871	High-performance, high-fidelity, current-feedback audio op amp	1.9	0.00012	1900	213	102	± 5.0 to ± 22	SOIC-8

*EETimes China ACE Awards 2007 Product of the Year; Electronic Products 2006 Product of the Year; EDN's 100 of Product of 2006

Headphone Buffer

Product ID	Description	THD (%)	Output Current (mA)	Slew Rate (V/ μ S)	GBWP (MHz)	Supply Voltage (V)	Supply Voltage (V)	Packaging
LME49600	High-performance, high-fidelity, high-current audio buffer	0.00015	250	2000	110/180	$\pm 18V$	± 5 to ± 18	T0263-5
NEW LME49610	High-performance, high-fidelity, high-current audio buffer	0.00003	250	2000	120/200	$\pm 22V$	± 2.5 to ± 22	T0263-5

High-Performance Audio Amplifier Power Amplifier Driver

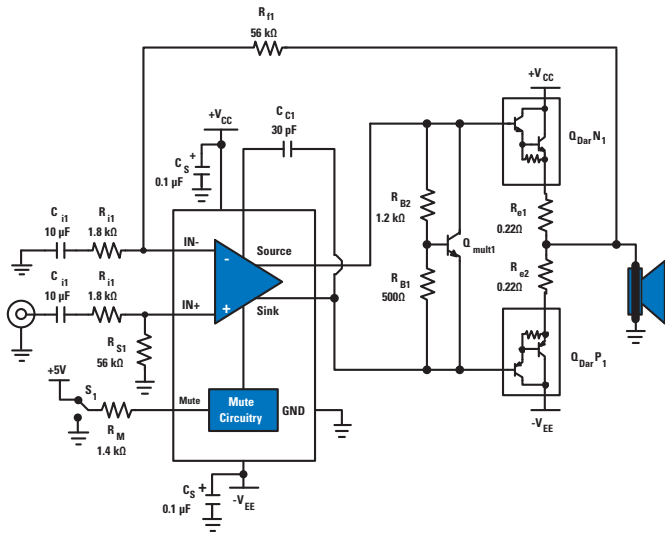
LME49811 – Audio Power Amplifier Series Mono High Fidelity 200 Volt Driver with Mute

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	T0220-15
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	T0220-15
NEW 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	T0247-15
NEW 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	T0220-15
NEW 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	T0247-15

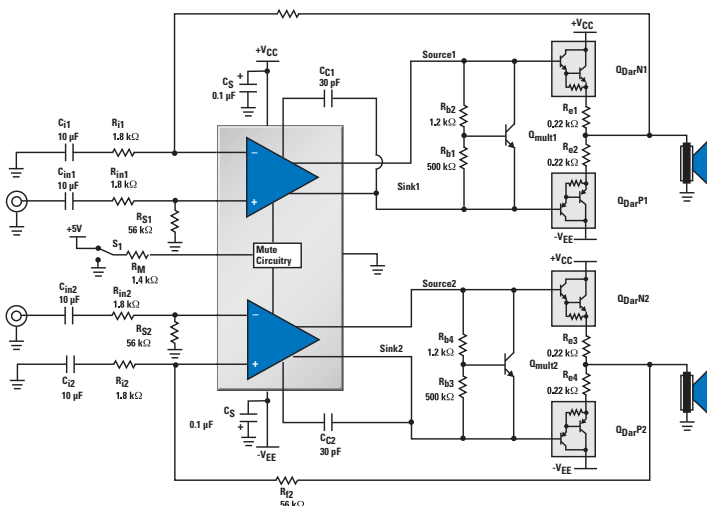
LM4702 – Audio Power Amplifier Series Stereo High-Fidelity 200 Volt Driver with Mute

Features

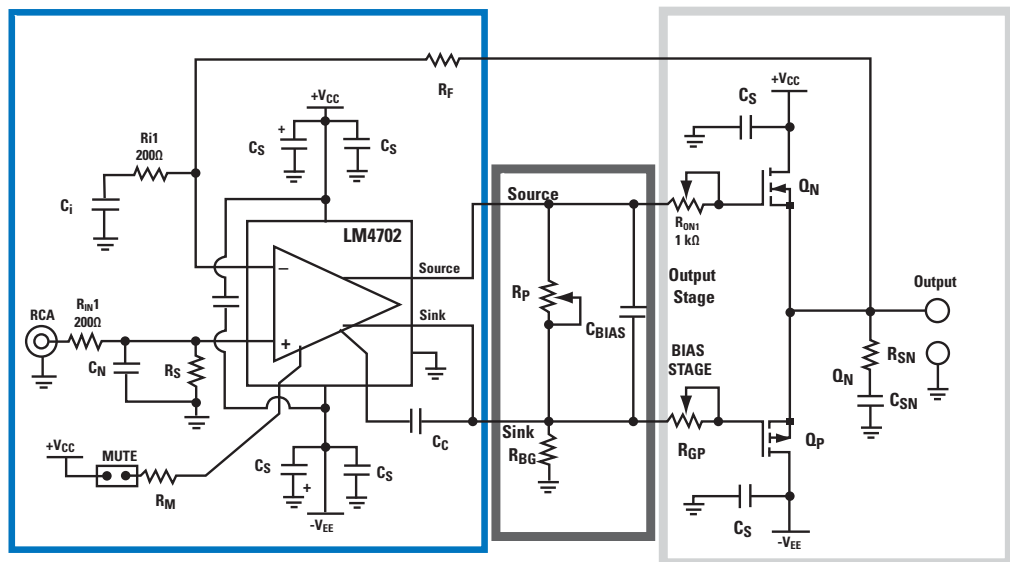
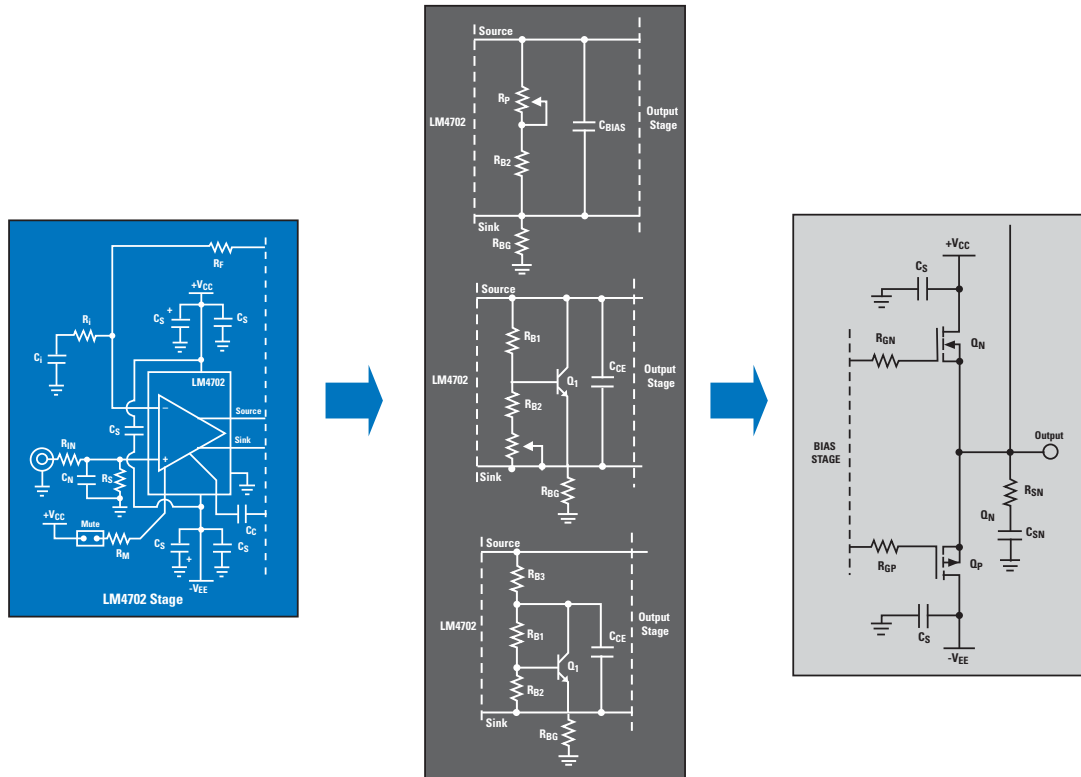
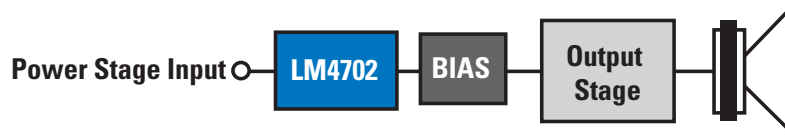
- Very high voltage operation
- Scalable output power
- Minimum external components
- External compensation
- Thermal shutdown and mute

Applications:

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



High-Performance Audio Driving a MOSFET Stage



AUDIO

For more information, read AN-1645 for help with the design of MOSFET drivers

Remote Diode Temperature Sensors and Hardware Monitors

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

TruTherm® Beta Compensation Technology

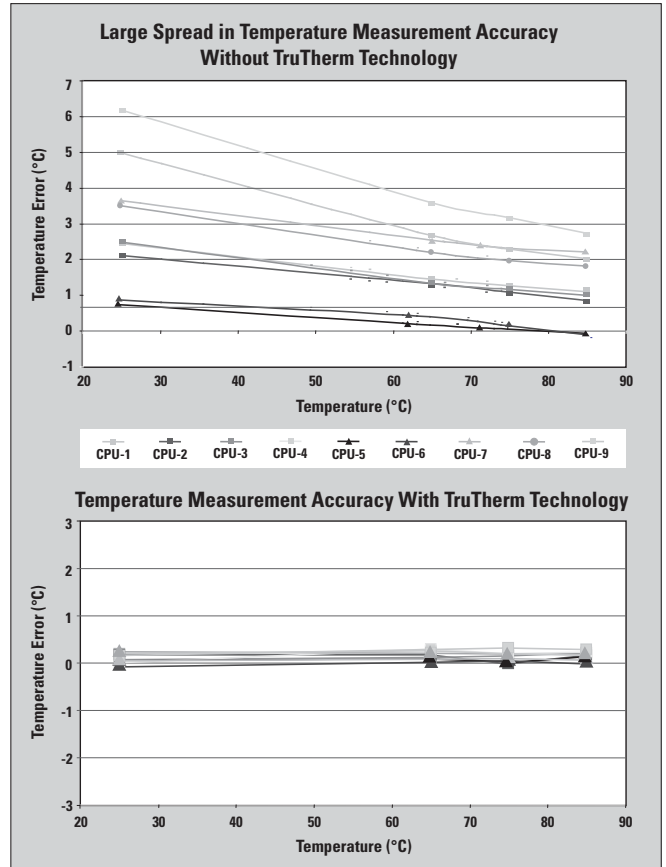
- Precisely senses the temperature of remote diodes in deep-submicron processes
- Compensates effects of beta variation
- Eliminates processor dependent offset calibration
- Precise temperature measurement combined with National's advanced fan control solution enables optimal acoustic solutions

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. laptop, desktop, workstations, server), electronic test equipment, and office electronics)



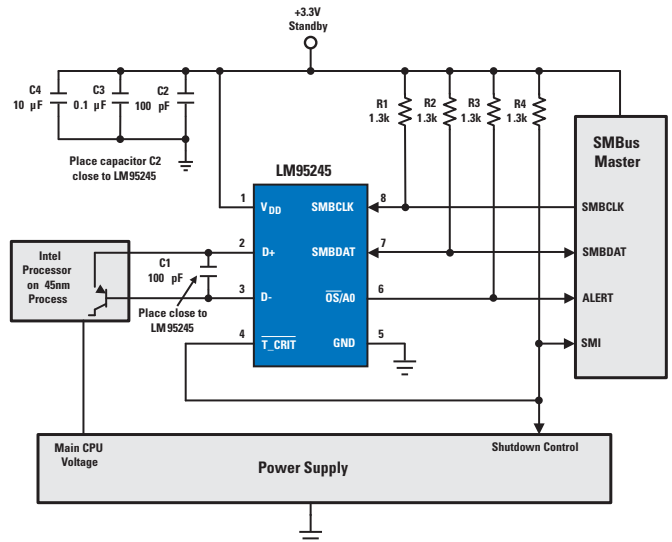
LM95245 – PowerWise® Single Remote Diode and Local Temperature Sensor

Features

- 45 nm supported TruTherm beta compensation technology
- Monitors one remote diode and local temperature
- Remote temperature accuracy: $\pm 0.75^{\circ}\text{C}$ (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



Remote Diode Temperature Sensors

Product ID	Description	Pin-Compatible	Processor Supported	Measurement Method	No. of Remote Channels	Tcrit	Selectable Addresses
LM86/89/99	±0.75°C, MSOP-8	↑	P4 & AMD	Traditional	1	1	Factory set
LM95235	±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	±1.1°C, LLP-14	↑	—	Traditional	0-2	3	✓
LM95233	± 0.875°C, LLP-14		65 nm	TruTherm	0-2	3	✓
LM95214	±1.1°C, LLP-14	↓	—	Traditional	0-4	3	✓
LM95234	±0.875°C, LLP-14		65 nm	TruTherm	0-4	3	✓
LM96194	±2.5°C, LLP-48		65 nm	TruTherm	2-4	—	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	2-4	—	Full PI and LUT hardware monitor
LM96163	±0.75°C, LLP-10		45 nm	TruTherm	1	1	LUT Fan Control

PowerWise® product

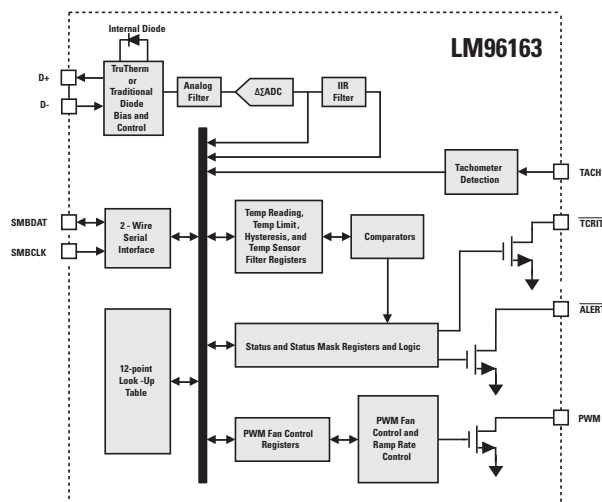
LM96163 – PowerWise® TruTherm® Remote Diode Integrated Look-Up Table Fan Control

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
- TCRIT 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



Product ID	Key Features
LM63C/D	11-bit remote diode and LUT fan control
LM80/81B	Voltage monitoring, TACH inputs, local temp
LM96000	Desktop hardware monitor, dual RDTs, linear fan control for 4-pin fans

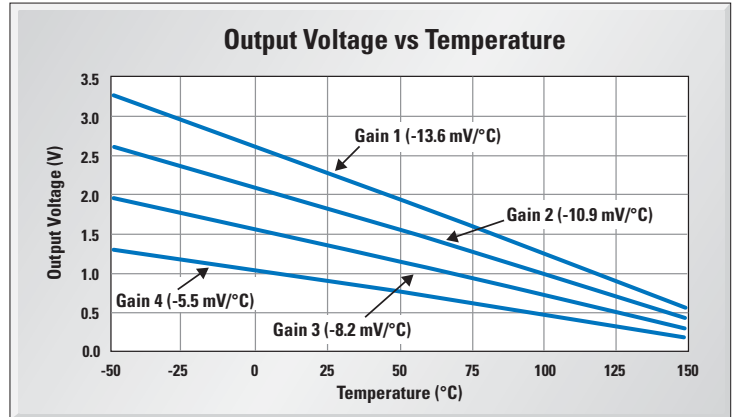
PowerWise® product

Analog Temperature Sensors

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

Features

- Next generation LM20
- Supply voltage 1.5V to 5.5V
- $\pm 1.5^\circ\text{C}$ 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 $+150^\circ\text{C}$
- 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
NEW LM94023	5.4	50	50	Class AB	micro SMD

LM26LV – PowerWise® 1.6V Lowest Power, Factory Preset Temperature Switch and Temperature Sensor

Features

- Ultra-low supply voltage: 1.6V to 5.5V for all trip points
- Ultra-low supply current: 8 μA (typ)
- Highest accuracy with temperature trip point accuracy of $\pm 2.3^\circ\text{C}$ (0 to 69°C)
- 0°C to 150°C temperature trip point range, -50°C to 150°C analog output temperature range
- Trip-test pin allows in-situation testing to verify connectivity and comparator function
- Analog output can be overdriven for trip point testing
- Push-pull and open-drain digital outputs in same package
- Buffered V_{TEMP} output drives external circuits, such as A/D converters
- 5°C hysteresis
- Factory programmable temperature set point
- Available in 2.2 mm x 2.5 mm LLP-6 packaging (SC-70 footprint)

Applications:

Ideal for use in industrial and automotive markets, and in consumer applications including notebooks and cell phones

Product ID	Key Features	Description
LM26LV	1.6V to 5.5V, $\pm 2.3^\circ\text{C}$, -50°C to 150°C factory preset set point, LLP-6	Lowest power, ultra-low voltage, analog temperature switch plus analog temperature sensor
LM26	2.7V to 5.5V, $\pm 3^\circ\text{C}$, -40°C to 125°C factory preset set point, SOT-23	Small, low power, analog temperature switch plus analog temperature sensor
LM27	2.7V to 5.5V, $\pm 3^\circ\text{C}$, 120°C to 150°C factory preset set point, SOT-23	Small, low power, analog temperature switch plus analog temperature sensor
LM45	4V to 10V supply voltage, $\pm 3^\circ\text{C}$, SOT-23	Low-power, precision temperature sensor
LM56	2.7V to 10V supply voltage, $\pm 3^\circ\text{C}$ accuracy, user programmable set point	User programmable temperature switch plus analog temperature sensor

PowerWise® product

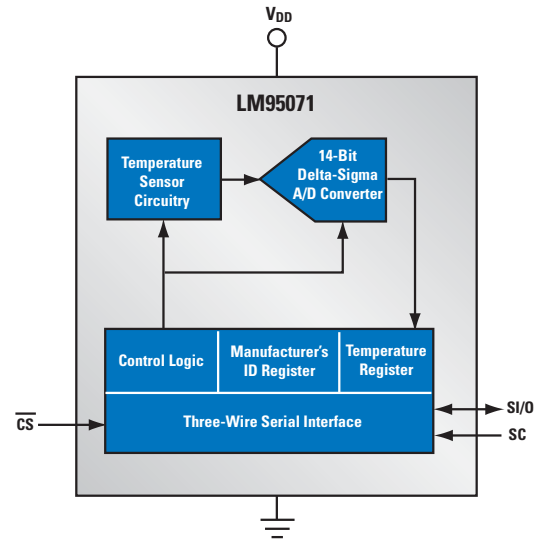
LM95071 – PowerWise® High-Accuracy SPI General-Purpose Digital Temperature Sensor

Features

- $\pm 1^\circ\text{C}$ accuracy (0°C to 70°C)
- 14-bit resolution ($0.03125^\circ\text{C}/\text{LSB}$)
- 2.4V to 5.5V supply
- Low power: 280 μA typical
- -40°C to 150°C temp range
- Next generation to the LM70 and LM74
- Available in SOT23-5 packaging

Applications:

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



Product ID	Key Features	Comments
LM70	3-wire, 11 bits, $\pm 2.0^\circ\text{C}$	Bare bones sensor, LLP® packaging
LM71/LM95071	3-wire, 14 bits, $\pm 1.0^\circ\text{C}$	High accuracy and resolution
NEW LM95172Q	3-wire, 13 to 16 bits, $\pm 1.0^\circ\text{C}$	175°C , high accuracy and resolution
LM73	2-wire, 11 to 14 bits, $\pm 1^\circ\text{C}$	High accuracy, programmable resolution, fast conversion time
LM74	3-wire, 13 bits, $\pm 1.25^\circ\text{C}$	World's smallest, low power, micro SMD packaging
LM75	2-wire, 9 bits, $\pm 2.0^\circ\text{C}$	Industry standard
LM76	2-wire, 13 bits, $\pm 0.5^\circ\text{C}$ and $\pm 1.0^\circ\text{C}$	Higher accuracy
LM77	2-wire, 10 bits, $\pm 1.5^\circ\text{C}$	ACPI compliance
LM92	2-wire, 13 bits, $\pm 0.33^\circ\text{C}$ and $\pm 0.5^\circ\text{C}$	World's most accurate

PowerWise® product

Automotive Portfolio

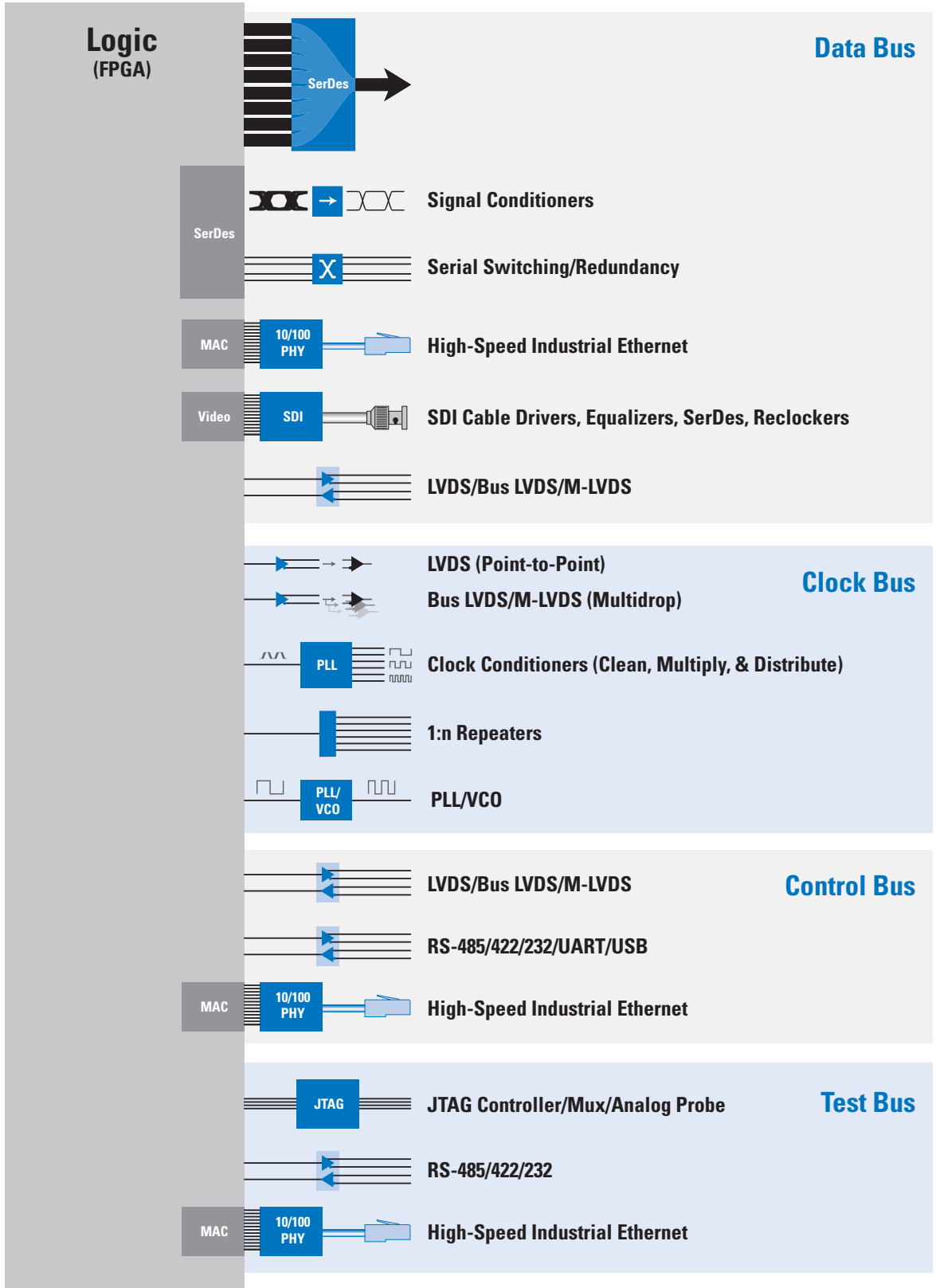
This family of temperature sensors is optimized for the automotive market. Increased electronic content in critical automotive and industrial applications is driving the need for specialized high-temperature thermal management solutions. These temperature sensors provide high accuracy at the critical high-temperature area and operate in extended temperature range, making them ideal for use in automotive head units, transmission control, diesel systems, electric motor control, and suspension systems.

Automotive Portfolio

Product ID	Grade	Description
LM95172Q	0	SPI/MICROWIRE® high-temperature digital temperature sensor, available in die form
LM95235Q	3	Remote diode temperature sensor with TruTherm® technology AEC-Q100 Grade 3
LM94022Q	0	Low-voltage analog temperature sensor AEC-Q100 Grade 0
LM27A		High-temperature ($120 - 150^\circ\text{C}$) thermostat, available in die form
LM71A		SPI/MICROWIRE high-temperature digital temperature sensor, available in die form
LM95071		SPI/MICROWIRE high-accuracy and resolution digital temperature sensor

PowerWise® product

Interface Product Overview



Multi-Drop: Drive as Many as 32 Loads Using Bus LVDS or M-LVDS

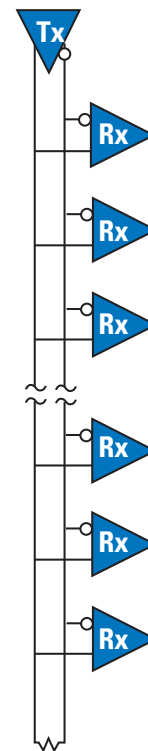
Bus LVDS is a multi-drop version of LVDS with beefed-up drive to support as many as 32 loads. Controlled edge rates help reduce reflections and allow B-LVDS to support data rates as high as 400 Mbps.

- High drive with controlled edge rates
- Up to 400 Mbps

M-LVDS is described in the TIA/EIA-899 standard and is a multi-drop solution capable of data rates as high as 125 MHz. M-LVDS has guaranteed edge rates greater than 1 ns, increased drive and a wider input common mode range.

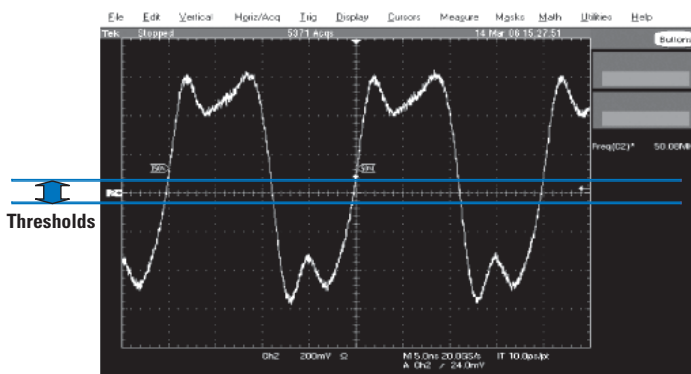
- High drive with >1 ns edge rates
- Up to 125 MHz

Multi-Drop Topology



$$R_T = Z_0 \text{ (diff.)}$$

DS91D176 driving 50 MHz clock on ATCA backplane
- 13 loads - 1/2 inch stubs - Rx slot 7, Tx slot 14



Product ID	Drivers	Receivers	LVDS Type	Max Speed/Ch (Mbps)	Supply Voltage	Temp Range °C	Packaging	Comments
Transceivers								
DS91C176TMA	1	1	M-LVDS	100 MHz	3.3	-40 to +85	SOIC-8	M-LVDS, half duplex, type 2
DS91D176TMA	1	1	M-LVDS	100 MHz	3.3	-40 to +85	SOIC-8	M-LVDS, half duplex, type 1
DS91C180TMA	1	1	M-LVDS	100 MHz	3.3	-40 to +85	SOIC-14	M-LVDS, full duplex, type 2
DS91D180TMA	1	1	M-LVDS	100 MHz	3.3	-40 to +85	SOIC-14	M-LVDS, full duplex, type 1
NEW DS91M040TSQ	4	4	M-LVDS	125 MHz	3.3	-40 to +85	LLP-32	Selectable Rx type
NEW DS91M124TMA	4	1	M-LVDS	125 MHz	3.3	-40 to +85	SOIC-16	
NEW DS91M125TSQ	4	1	M-LVDS	125 MHz	3.3	-40 to +85	SOIC-16	Differential input
NEW DS91M047TSQ	4	4	M-LVDS	125 MHz	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	
DS92CK16TMTCT	6	1	B-LVDS	250	3.3	-40 to +85	TSSOP-24	Master/slave

LVDS and CML PHYs

Signal Conditioning—Extend Your Reach

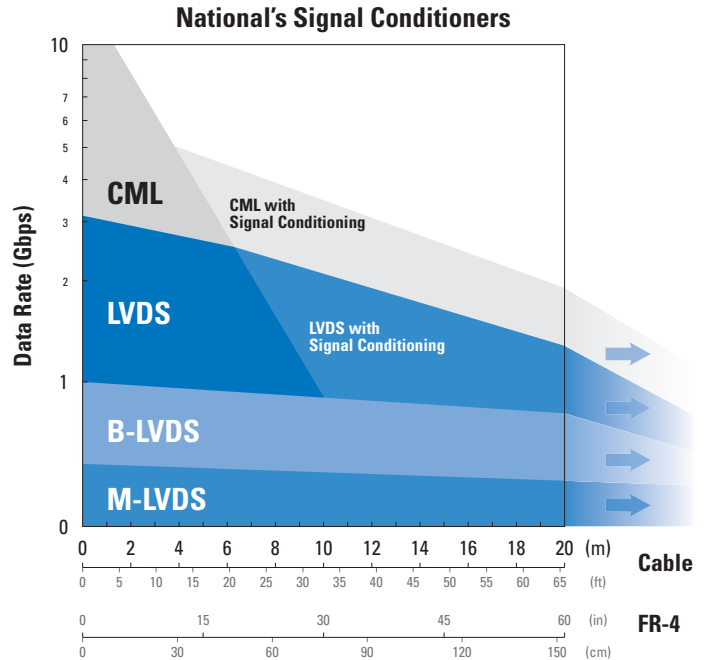
National offers an array of signal conditioning solutions, covering data rates from DC to 10 Gbps and topologies ranging from point-to-point to 32 multidrop loads.

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.



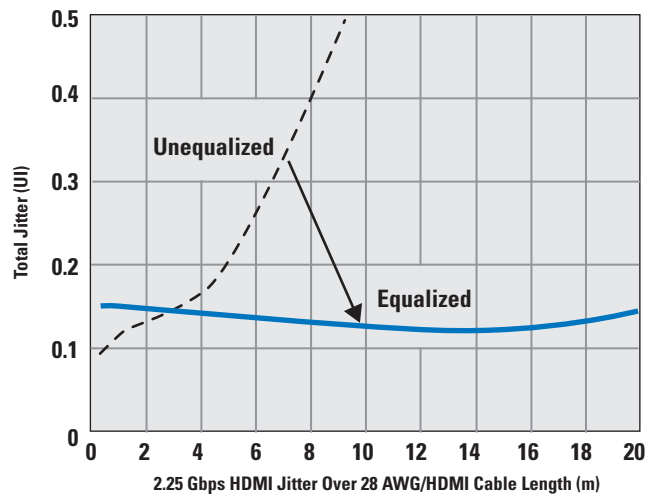
DS16EV5110 – HDMI/DVI Cable Equalizer

Features

- 1.65 Gbps (DVI 1.0 and HDMI 1.2a)
 - > 40m 24 AWG HDMI/DVI cable
 - > 25m 28 AWG HDMI/DVI cable
 - > 20m CAT5/5e/6
- 2.25 Gbps (HDMI 1.3)
 - > 30m 24 AWG HDMI/DVI cable
- Supports digital TV resolutions: 480i/p, 720i/p, and 1080i/p (including 1080p with 12-bit color depth)
- Supports computer resolutions from VGA to WQXGA
- Flexible Serial Management Bus (SMBus) interface
- Settable boost for optimum equalization
- Optimized for 250 Mbps to 1.65 Gbps
- Clock channel loss of signal (LOS) detect
- 0.13 UI total at 1.65 Gbps including cable
- Low-power consumption: 430 mW (typ)

Applications:

Ideal for use in DVI/HDMI cable extenders/switchers, digital routers, projectors, and high definition displays



See the new show:

“Designing Long-Reach Applications with DVI HDMI and PCI Express Cable Standards”

www.national.com/nationaltv

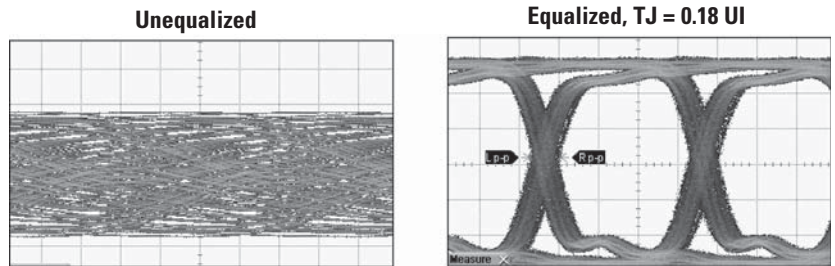
PowerWise® Cable and Backplane Equalizer Family Operates from 2.5 to 10 Gbps

Features

- Equalizes 40 inch FR4 or 10m 24 AWG Twin-AX at 6.4 Gbps
- 94 mW typical power consumption per channel

Applications:

Ideal for use in extending cable reach in storage, automated test equipment, networking, and medical applications, and in reducing jitter in high-speed backplanes



40" TYCO XAUI Backplane, PRBS-7 at 6.25 Gbps

Product ID	Description	Supply Voltage	Channels	Package
DS32EV400	Quad 1-5 Gbps general purpose equalizer	3.3	4	LLP-48
DS64EV400	Quad 5-10 Gbps general purpose equalizer	3.3	4	LLP-48
DS32EV100	Single Channel 1-5 Gbps general purpose equalizer	3.3	1	LLP-14
DS64EV100	Single Channel 5-10 Gbps general purpose equalizer	3.3	1	LLP-14
DS50EV401	Quad 2.5-8Gbps PCI Express equalizer	2.5-3.3	4	LLP-48

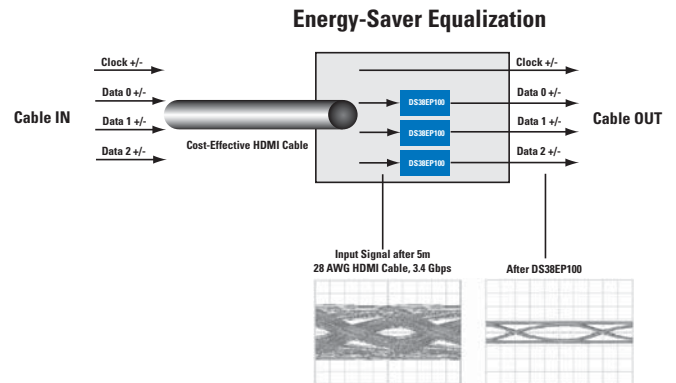
PowerWise product

PowerWise Energy-Saver Equalizers

Energy-saver equalizers employ passive components to provide as much as 7 dB relative boost. Energy-savers require no power or ground, add no Rj and are bi-directional. Energy-savers are ideal for placement in connectors, backplanes, and cables, and can act independently or in conjunction with an active equalizer.

Device	Datarate	Boost	Packaging
DS38EP100	1 to 5 Gbps	7 dB	LLP-6
DS80EP100	5 to 12.5 Gbps	7 dB	LLP-6

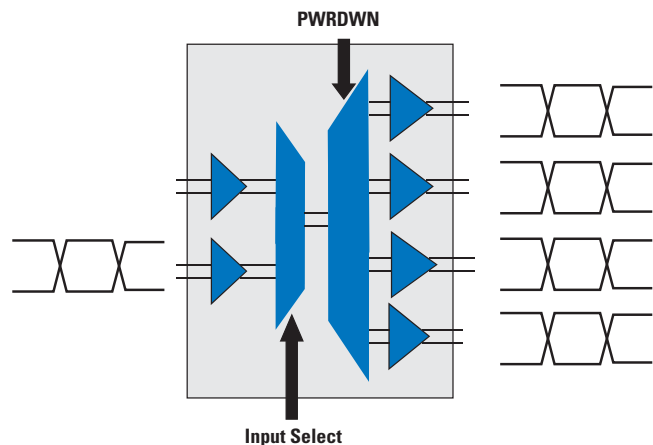
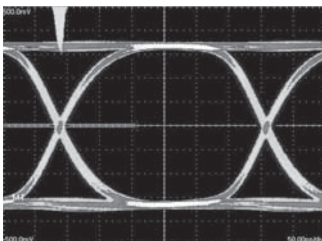
PowerWise product



DS25BR204 1 to 4 LVDS Splitter with Selectable Input

Features

- DC to 3.125 Gbps
- Select 1 of 2 inputs
- .5 ps Rj typical
- Input Equalization and Output Pre-emphasis



INTERFACE

Differential-to-Differential

Switching/Redundancy

Signal Conditioning



Product ID	Function	In-puts	Out-puts	Muxing Options	Input Compatibility	Output	Pre-emphasis (dB) ¹	Receive Equalization (dB)	Max Speed/Ch (Mbps)	Packaging	Comments
Buffers											
DS15BA101SD	Adjustable output buffer	1	1	—	CML	LVPECL	—	—	1500	LLP-8	Adjustable output swing
DS10BR150TSD	Single LVDS Buffer	1	1	—	LVDS/LVPECL/CML	LVDS	—	—	1000	LLP-8	Int termination, 8 kV ESD
DS25BR100TSD	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	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	Quad LVDS Buffer	4	4	—	LVDS/LVPECL/CML	LVDS	0/6	—	1500	LLP-32	15 kV ESD, JTAG
DS15BR400TSQ/TVS	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	Quad CML transceiver	8	8	Loopback	CML	CML	0/-3/-6/-9	0/5	2500	LLP-60	Int termination, 6 kV ESD
DS42BR400TSQ	Quad CML transceiver	8	8	Loopback	CML	CML	0/-3/-6/-9	0/5	4250	LLP-60	Int termination, 6 kV ESD
Equalizers											
DS15EA101SQ	Adaptive cable equalizer	1	1	—	LVPECL	CML	—	Adaptive	1500	LLP-16	Use with DS15BA101
DS16EV5110SQ	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
DS38EP100DSD	Power-saver equalizer	1	1	—	LVDS/LVPECL/CML	—	—	7	5000	LLP-6	No PWR or GND required,
DS80ESP100SD	Power-saver equalizer	1	1	—	LVDS/LVPECL/CML	—	—	7	12500	LLP-6	No PWR or GND required
DS32EV400SQ	Quad Settable equalizer	4	4	—	CML	CML	—	Up to 14	3125	LLP-48	8 EQ settings
DS32EV100SD	Single Settable equalizer	1	1	—	CML	CML	—	Up to 14	4250	LLP-14	8 EQ settings
DS64EV400SQ	Quad Settable equalizer	4	4	—	CML	CML	—	Up to 20	10000	LLP-48	8 EQ settings
DS64EV100SD	Single Settable equalizer	1	1	—	CML	CML	—	Up to 20	10000	LLP-14	8 EQ settings

LB = Loopback ¹CML devices in this column that feature de-emphasis show negative dB PowerWise product

DS25BR100/10/20 – PowerWise® 3.125 Gbps LVDS Buffers with Pre-Emphasis and Equalization

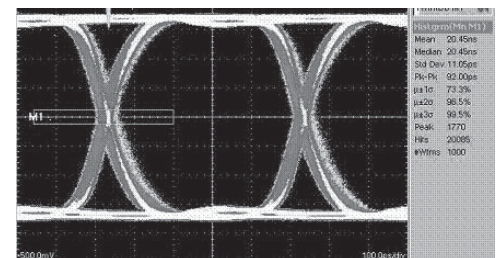
Features

- 17 ps typ jitter (2.5 Gbps, 2²³-1 pattern)
- Programmable pre-emphasis and equalization
- Wide common mode input accepts LVDS, CML, and LVPECL
- Integrated 100Ω input and output termination
- 7 kV ESD protection on LVDS pins
- Available in LLP-8 packaging

Applications:

Ideal for use in routers, switches, storage, medical imaging, video security, image capture, and processing

DS25BR110 Equalization



74 in FR4, 2 Gbps, PRBS-23

Switching/Redundancy

Signal Conditioning



Product ID	Function	In-puts	Out-puts	Muxing Options	Input Compatibility	Output	Pre-emphasis (dB) ¹	Receive Equalization (dB)	Max Speed/ Ch (Mbps)	Packaging	Comments
Multiplexers and Mux-Buffers											
DS25MB100TSQ	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	Dual 2:1/1:2 mux/buffer	6	6	2:1/1:2	LVDS/LVPECL/CML	LVDS	0/6	—	2000	LLP-48	JTAG
DS25MB200TSQ	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	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	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
NEW DS10CP152TMA	2 x 2 crosspoint	2	2	2 x 2	LVDS/LVPECL/CML	LVDS	—	—	1500	SOIC-16	9 ps Jitter typical
NEW DS25CP102SQ	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
NEW DS25CP152SQ	2 x 2 crosspoint	2	2	2 x 2	LVDS/LVPECL/CML	LVDS			3125	LLP-16	10 ps jitter typical
NEW DS10CP154ASQ	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
NEW DS25CP104ASQ	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
NEW DS10BR254SQ	1:4 LVDS repeater	2	4	1:4	LVDS/LVPECL/CML	LVDS	—	—	1500	LLP-40	Select 1 of 2 inputs
NEW DS25BR204SQ	1:4 LVDS repeater	2	4	1:4	LVDS/LVPECL/CML	LVDS	0/6	0/6	3125	LLP-40	Select 1 of 2 inputs

LB = Loopback ¹CML devices in this column that feature de-emphasis show negative dB

PowerWise product

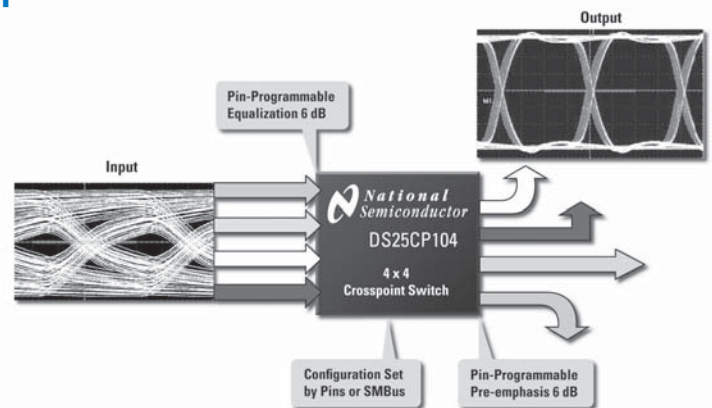
DS25CP104A – PowerWise® LVDS 4 x 4 Crosspoint Switch

Features

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

Applications:

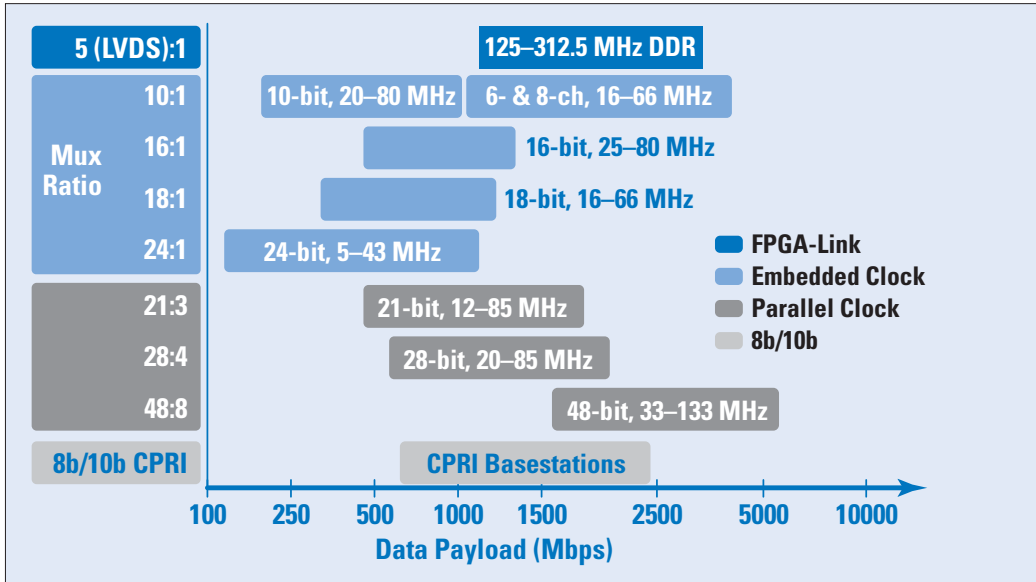
Ideal for use in routing and switching of video, data, or clock signals, and redundancy



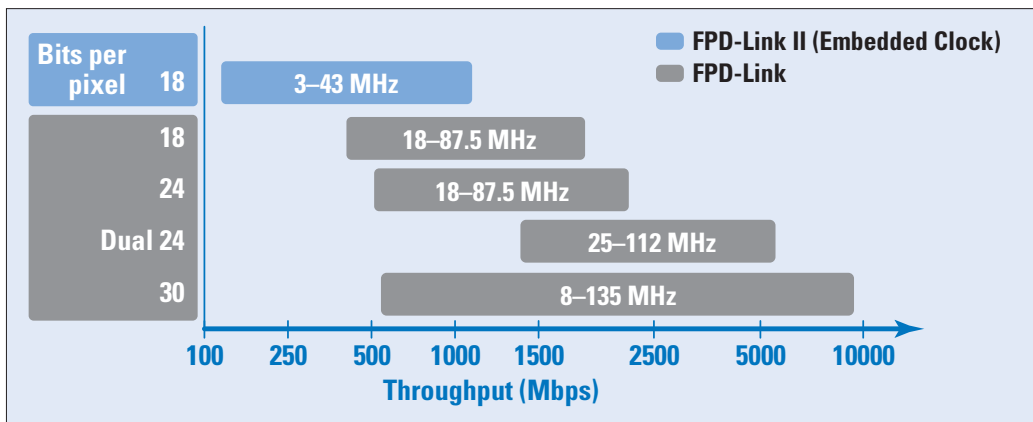
INTERFACE

Serializer/Deserializer (SerDes)

Data Interface



Display and Imaging



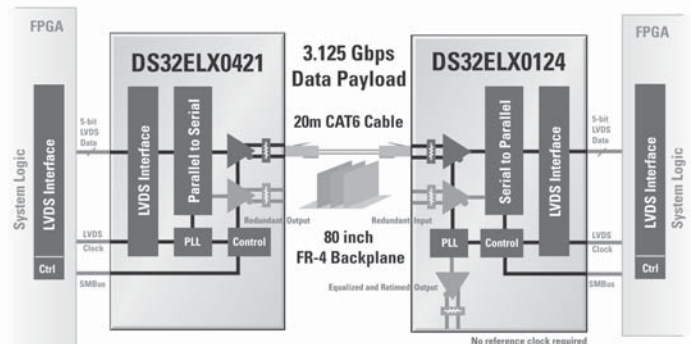
Select SerDes Products

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	5:1 DDR LVDS	Serializer	1		125	312.5	3.125 Gbps	-40 to +85	LLP-48	ELXLEVK01
DS32ELX0124SQ		Reclocking Deserializer		1	125	312.5	3.125 Gbps	-40 to +85	LLP-48	ELXLEVK01
DS32EL0421SQ	5:1 DDR LVDS	Serializer	1		125	312.5	3.125 Gbps	-40 to +85	LLP-48	ELXLEVK01
DS32EL0124SQ		Deserializer		1	125	312.5	3.125 Gbps	-40 to +85	LLP-48	ELXLEVK01
Embedded Clock : 8b/10b										
SCAN25100TYA	10:1	SerDes	1	1	30.72	122.16	2456	-40 to +85	TQFP-100	SCAN25100EVK
SCAN12100TYA	10:1	SerDes	1	1	30.72	61.44	1228.8	-40 to +85	TQFP-100	SCAN25100EVK
Embedded Clock : Start/Stop Bit										
DS92LV1023EMQ	10:1	Serializer	1		30	66	660	-40 to +85	SSOP-EIAJ 28L	BLVDS03
DS92LV1224TMSA	1:10	Deserializer		1	30	66	660	-40 to +85	SSOP-EIAJ 28L	BLVDS03
SCAN921025HSM	10:1	Serializer	1		20	80	800	-40 to +125	BGA-49	BLVDS03
SCAN921226HSM	1:10	Deserializer		1	20	80	800	-40 to +125	BGA-49	BLVDS03
DS92LV16TVHG	16:1	SerDes	1	1	25	80	1280	-40 to +85	PQFP-80	BLVDS16EVK
DS92LV18TVV	18:1	SerDes	1	1	15	66	1188	-40 to +85	PQFP-80	LVDS-18B-EVK
NEW DS92LV2411VS	24:1	Serializer	1		5	43	1032	-40 to +85	TQFP-48	DS92LV2411EVK
NEW DS92LV2412VS	1:24	Deserializer		1	5	43	1032	-40 to +85	TQFP-64	DS92LV2411EVK
Parallel Clock : Channel Link										
DS90CR217MTD	21:3	Serializer	1		20	85	595/1785	-10 to +70	TSSOP-48	CLINK3V28BT-85
DS90CR218AMTD	3:21	Deserializer		1	12	85	595/1785	-10 to +70	TSSOP-48	CLINK3V28BT-85
DS90CR287MTD	28:4	Serializer	1		20	85	595/2380	-10 to +70	TSSOP-56	CLINK3V28BT-85
DS90CR288AMTD	4:28	Deserializer		1	20	85	595/2380	-10 to +70	TSSOP-56	CLINK3V28BT-85
DS90CR483AVJD	48:8	Serializer	1		33	112	672/5376	-10 to +70	TQFP-100	CLINK48BT-112
DS90CR484AVJD	8:48	Deserializer		1	33	112	672/5376	-10 to +70	TQFP-100	CLINK48BT-112

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



INTERFACE

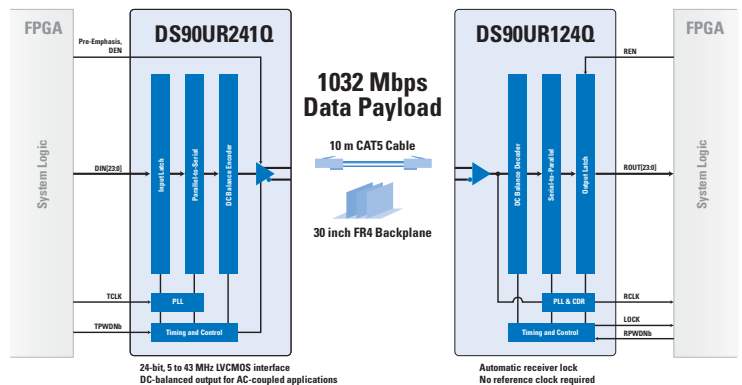
SerDes – Display and Imaging Interface

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*	18-Bit	Serializer	1		5	43	120	1032	-40 to +105	TQFP-48	SERDESUR-43USB
DS90UR124QVS*		Deserializer		1	5	43	120	1032	-40 to +105	TQFP-64	
DS90C241QVS*		Serializer	1		5	35	120	840	-40 to +105	TQFP-48	SERDES24-35USB
DS90C124QVS*		Deserializer		1	5	35	120	840	-40 to +105	TQFP-48	
DS99R421QSQ**		Serializer	1		5	43	120	1032	-40 to +105	LLP-36	FPDXSDUR-43USB
DS99R103TSQ		Serializer	1		3	40	72	960	-40 to +85	LLP-48, TQFP-48	SERDES03-40USB
DS99R104TSQ		Deserializer		1	3	40	72	960	-40 to +85	LLP-48, TQFP-48	
DS99R105SQ		Serializer	1		3	40	72	960	0 to +70	LLP-48, TQFP-48	SERDES05-40USB
DS99R106SQ		Deserializer		1	3	40	72	960	0 to +70	LLP-48, TQFP-48	
DS99R115VS		Serializer	1		5	43	120	1204	-40 to +85	TQFP-48	DS99R115EVK
DS99R116VS	Deserializer		1	5	43	120	1204	-40 to +85	TQFP-64	DS99R115EVK	
Parallel Clock : FPD-LINK/ Open LDI											
DS90C365AMT	18-Bit	Serializer	1		18	87.5	378	612.5/1785	-10 to +70	TSSOP-48	FLINK3V8BT-85
DS90CF366MTD		Deserializer		1	20	85	420	595/1785	-10 to +70	TSSOP-48	FLINK3V8BT-85
DS90C385AMT	24-Bit	Serializer	1		18	87.5	504	612.5/2380	-10 to +70	TSSOP-56	FLINK3V8BT-85
DS90CF386MTD		Deserializer		1	20	85	560	595/2380	-10 to +70	TSSOP-56, FBGA-64	FLINK3V8BT-85
DS90C387AVJD	24-Bit Open LDI	Serializer	1		32.5	112	227.5/1820	784/6722	-10 to +70	TQFP-100	LDI3V8BT-112
DS90C387RVJD		Serializer	1		25	85	175/1400	595/4760	-10 to +70	TQFP-100	
DS90CF388AVJD		Deserializer		1	32.5	112	227.5/1820	784/6722	-10 to +70	TQFP-100	LDI3V8BT-112
DS90C3201VS	30-Bit	Serializer	1		8	135	56/560	945/9450	0 to +70	TQFP-128	FLINK3V10BT-TX
DS90C3202VS		Deserializer		1	8	135	56/560	945/9450	0 to +70	TQFP-128	FLINK3V10BT-RX

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 to +105°C temperature range
- Meets National automotive-grade compliance (includes AEC-Q100)

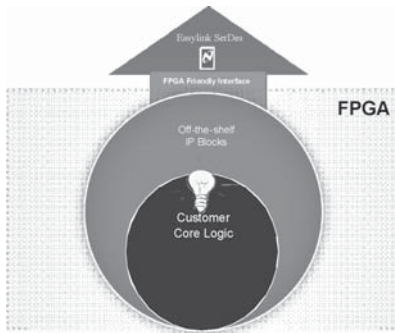


Applications:

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

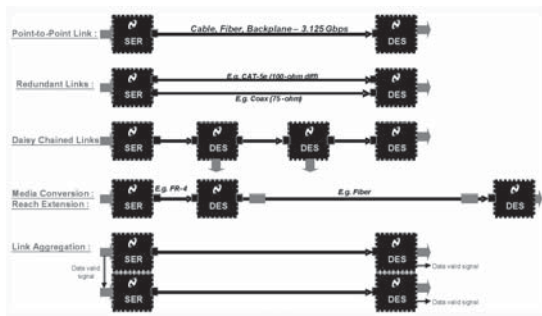
FPGA Link

Use Analog or Digital, Whichever Works Best



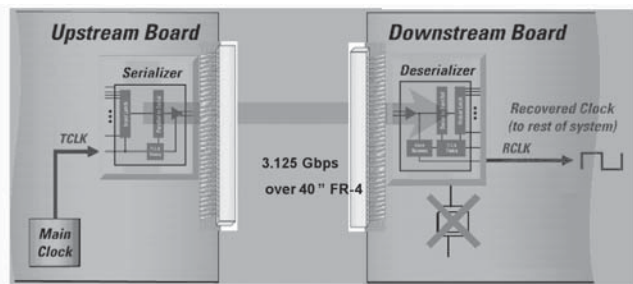
FPGA Link analog circuit collaboration combining signal integrity and FPGA digital logic to maximize flexibility for the user

Topologies (connection schemes)



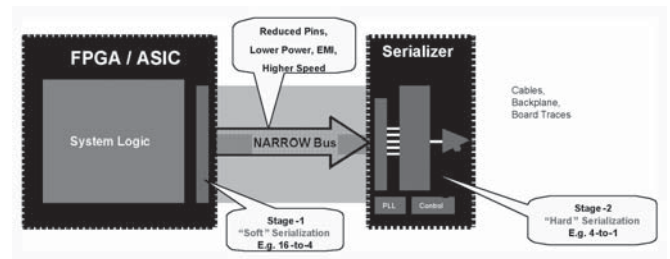
Supports a wide range of topologies including point-to-point, daisy chain, media converter, and aggregation mode (synchronized transmission from multiple chips).

Simple Design



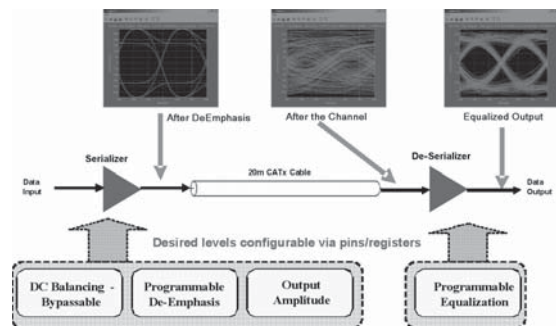
1. No reference clock required
2. Automatic negotiation (minimal user control)
3. Internal termination resistor

Simple Design



With increasing signal bandwidth, simultaneous switching noise generated on the parallel bus and the number of signal lines become more and more of a problem. FPGA Link solves these issues by replacing the parallel bus with LVDS (low noise and low power consumption).

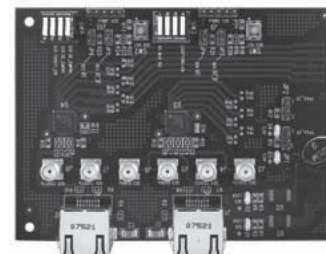
Topologies (connection schemes)



Signal conditioning including powerful equalizer (EQ) and de-emphasis circuits are integrated into the chipset. Cables and backplanes can be driven directly without requiring any additional chips.

Evaluation Board

EXP High-Performance SerDes Module



AES-EXP-HPSER-G

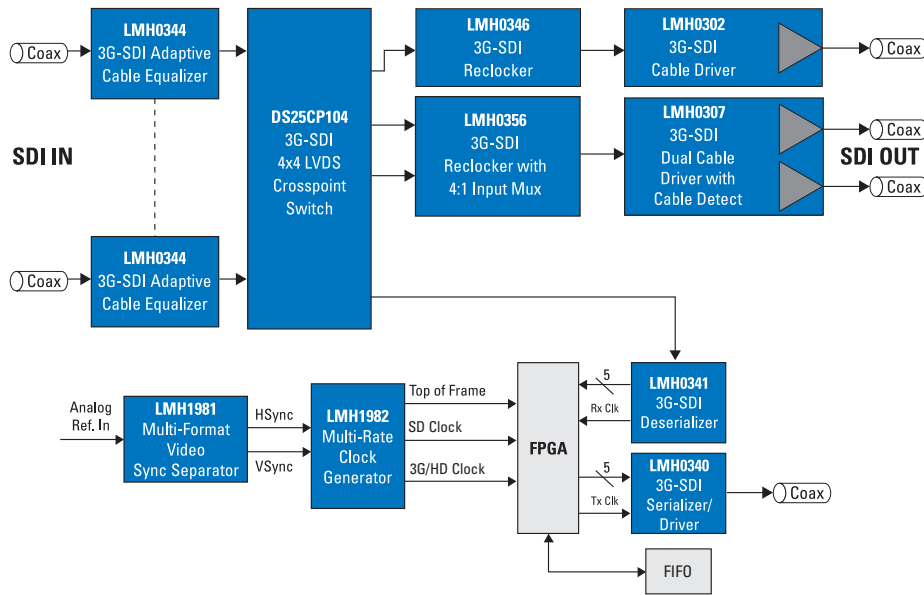
Comprehensive 3 Gbps SDI Solution

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. Do you require HD/SD operation today with an upgrade path to 3 Gbps SDI tomorrow? National's technology offers solutions for all your SDI needs.

3G/HD/SD SDI Switcher Simplified Block Diagram

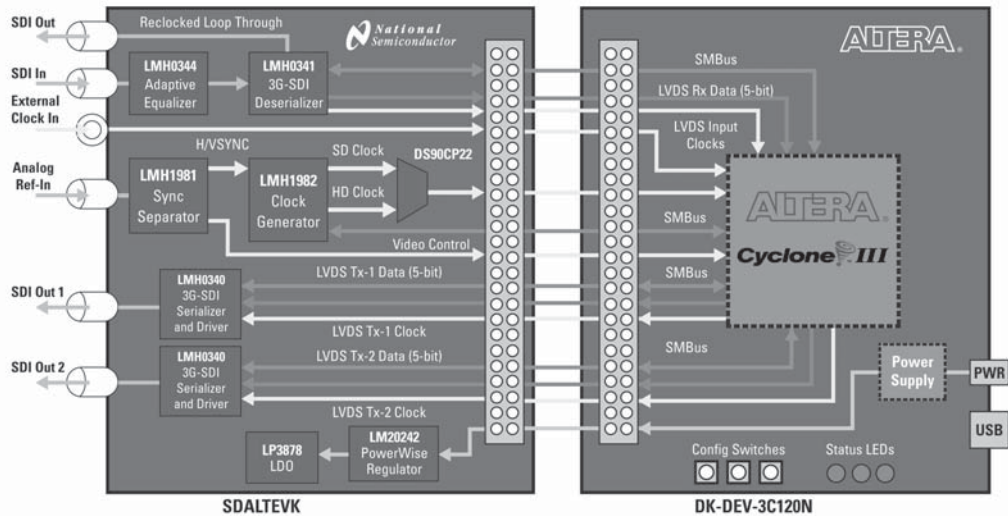


Complete Footprint-Compatible SDI Solutions

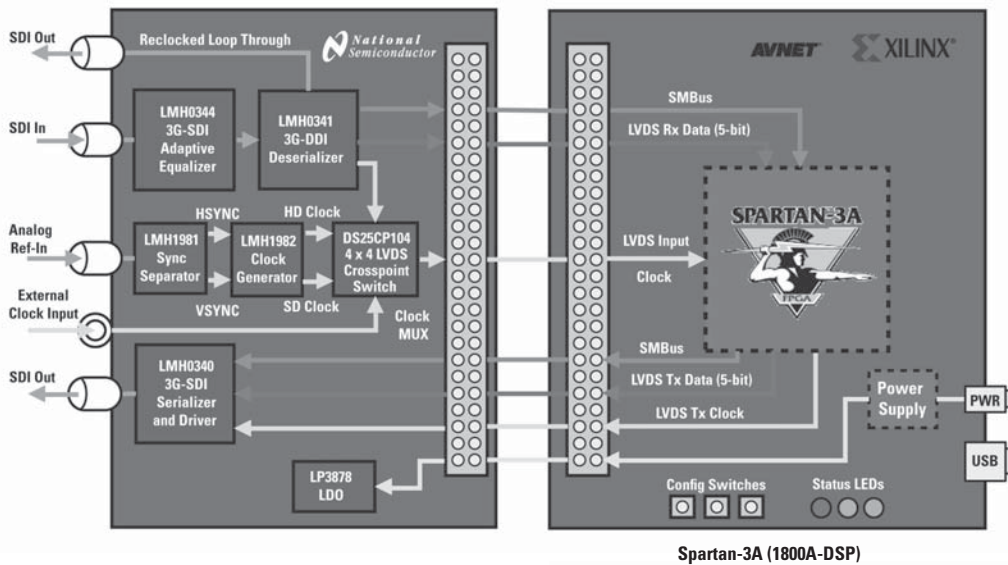
	Equalizers	Reclockers	Reclockers with 4:1 Mux	Cable Drivers	Serializers /Drivers	Reclocking Deserializers
3G	LMH0344 3G/HD/SD	LMH0346 3G/HD/SD	LMH0356 3G/HD/SD	LMH0302 3G/HD/SD	LMH0340 3G/HD/SD	LMH0341 3G/HD/SD
HD	LMH0044 HD/SD	LMH0046 HD/SD	LMH0056 HD/SD	LMH0002 HD/SD	LMH0040 HD/SD	LMH0041 HD/SD
SD	LMH0074 SD	LMH0026 SD	LMH0036 SD	LMH0001 SD	LMH0070 SD	LMH0071 SD
	LLP-16	TSSOP-20	LLP-48	LLP-16	LLP-48	LLP-48

Comprehensive Triple-Rate Development Platforms with Xilinx and Altera FPGAs

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



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



Spartan-3A (1800A-DSP)

Video Clocks* Parallel Data Control Power

Features

- Supports triple-rate 3G/HD/SD SDI standards including SMPTE 424M, 292M, and 259M (C)
- Supports 2.967 Gbps, 2.97 Gbps, 1.485 Gbps, 1.483 Gbps and 270 Mbps serial data rate operation
- Comprehensive reference for hardware design and FPGA IP development
- Included HDL (Verilog, VHDL source) supports SDI framing, audio embedding/de-embedding and test pattern generation
- Four clocking options available
 - Recovered clock
 - Genlock (analog ref in with LMH1981 + LMH1982)
 - Local generation (free run with LMH1982)
 - External clock
- Reference design includes popular low-cost FPGAs

www.national.com/sdaltevk
www.national.com/sdxilevk

www.national.com/interface

Triple-Rate SDI SerDes FPGA IP

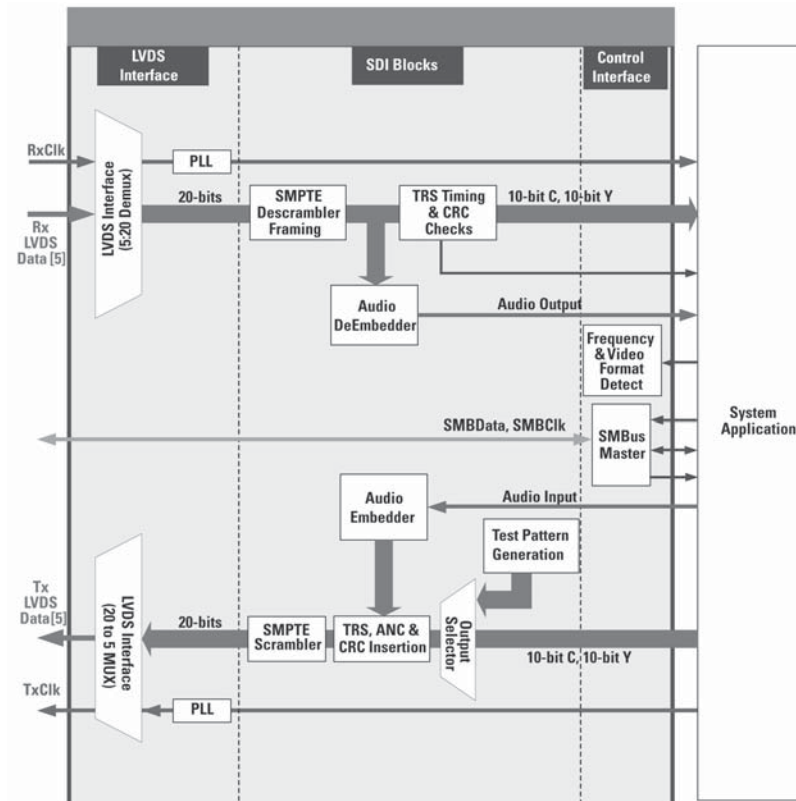
Today's designers of high-speed video applications face a significant challenge in addressing both the digital IP and analog physical interface requirements of their professional and broadcast video systems. Attempts to support both in one application-specific chip have compromised the flexibility, quality, or cost-effectiveness of the solution. National's 3G SDI SerDes family of products overcomes these difficulties by intelligently partitioning the analog and digital tasks between the 3G SDI SerDes PHYs and FPGA, thereby increasing the performance and flexibility of the entire solution.

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
- Supports both level-A and level-B 3G SDI formats
- Source code provided in synthesizable HDL (Verilog, VHDL) format
- Detailed design documentation

Tripe Rate SDI IP Architecture



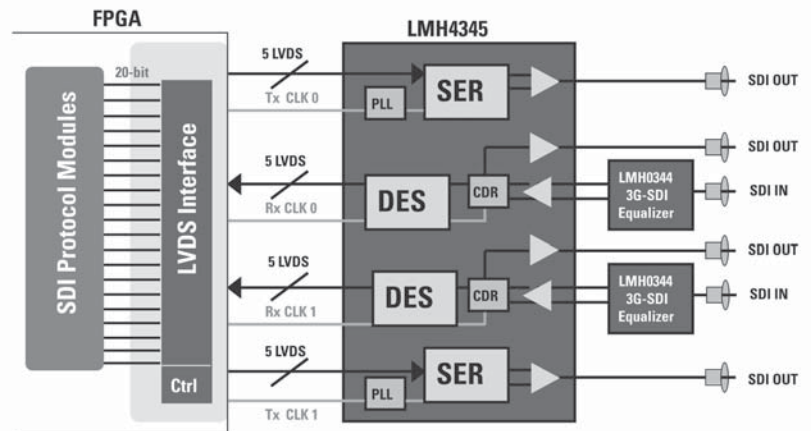
Reference IP Features

FPGA	Source	Triple-Rate (3G/HD/SD) Video	Audio Embed/DeEmbed	Gen Lock Clocking	Verilog Source	VHDL Source	Ref Board	More Info and Download
Xilinx Spartan-3A/3E	National/Avnet	✓	✓	✓	✓	✓	SDXILEVK	www.national.com/sdxilevk
Altera Cyclone-III	Altera	✓	✓	✓	✓	✓	SDALTEVK	www.national.com/sdaltevk
	National	✓	✓	✓	✓	✓	SDALTEVK	www.national.com/sdaltevk

Industry's First Dual Channel 3G-SDI SerDes Transceiver

LMH4345 Features
Dual SerDes Transceiver
Supports 3G/HD/SD SDI and DVB-ASI
Independent data rates on each channel
30 ps typical output alignment jitter at 3G and HD data rates
0.6 UI minimum jitter tolerance
Reclocked loopthrough on each Rx channel
Narrow 5-bit LVDS parallel data interface simplifies layout
Differential signaling reduces EMI
No external VCOs required
Integrated LC-based PLL cleans FPGA PCLK jitter
Integrated SMPTE cable drivers
1600 mW typical power consumption at 3G rates (all channels active)
Sleep modes for reduced power consumption (unused channels)
Small 100-pin package reduces board area

Dual SerDes Block Diagram



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	3G/HD/SD Serializer with LVDS interface and integrated cable driver	3.3, 2.5	440	270-2970	Ind	SDALTEVK	LLP-48
NEW LMH0040SQ	HD/SD Serializer with LVDS interface and integrated cable driver	3.3, 2.5	440	270-1485	Ind	(Altera)	LLP-48
NEW LMH0050SQ	HD/SD Serializer with LVDS interface	3.3, 2.5	460	270-1485	Ind	SDXILEVK (Xilinx)	LLP-48
NEW LMH0070SQ	SD Serializer with LVDS interface and integrated cable driver	3.3, 2.5	400	270	Ind		LLP-48
LMH0030VS	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	270-1485	Com	SD130EVK	TQFP-64
CLC020BCQ	SD Serializer with integrated cable driver	5	235	100-400	Com	SD020EVK	PLCC-28
CLC021AVGZ-5.0	SD Serializer with EDH generation and insertion	5	235	100-400	Com	SD021-5EVK	PQFP-44
CLC021AVGZ-3.3	SD Serializer with EDH generation and insertion	3.3	235	100-400	Com	SD021-3EVK	PQFP-44
Deserializers							
NEW LMH0341SQ	3G/HD/SD reclocking Deserializer with LVDS interface and active loopthrough	3.3, 2.5	590	270-2970	Ind	SDALTEVK	LLP-48
NEW LMH0041SQ	HD/SD reclocking Deserializer with LVDS interface and active loopthrough	3.3, 2.5	550	270-1485	Ind	(Altera)	LLP-48
NEW LMH0051SQ	HD/SD reclocking Deserializer with LVDS interface	3.3, 2.5	555	270-1485	Ind	SDXILEVK (Xilinx)	LLP-48
NEW LMH0071SQ	SD reclocking Deserializer with LVDS interface and active loopthrough	3.3, 2.5	525	270	Ind		LLP-48
LMH0031VS	HD/SD Deserializer / descrambler with FIFOs, 27 MHz reference, BIST, TPG, and automatic EDH/CRC	3.3, 2.5	850	270-1485	Com	SD131EVK	TQFP-64
CLC011BCQ	SD Deserializer	5	525	Up to 360	Com	SD901EVK	PLCC-28

¹Temperature ranges: Com: 0°C to 70°C Ext: 0°C to 85°C Ind: -40°C to 85°C

INTERFACE

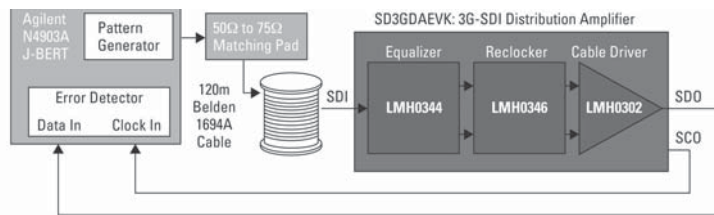
SDI SerDes Transceivers

Product ID	Description	Supply Voltage (V)	Typ. Power (mW)	Data Rates (Mbps)	Temp Range	Eval board Product ID	Packaging
NEW LMH4345	3G/HD/SD Dual Transceiver with integrated cable drivers	3.3	1600	270, 1485, 2970	Ind	—	TQFP-100
NEW LMH4045	HD/SD Dual Transceiver with integrated cable drivers	3.3	—	270, 1485	Ind	—	TQFP-100
NEW LMH4075	SD Dual Transceiver with integrated cable drivers	3.3	—	270	Ind	—	TQFP-100

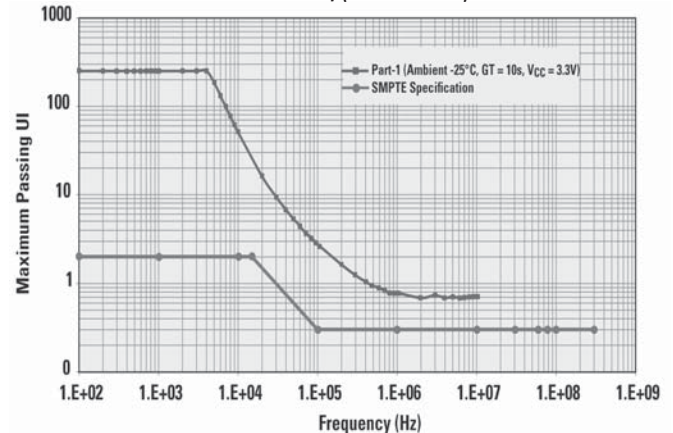
Extending the Reach of SDI Transmissions

3G-SDI Distribution Amplifier

- Highest jitter tolerance
- Lowest output jitter
- Exceeds SMPTE 424M specifications for jitter injection with significant margin, even using matrix pathological test signals
- Less than 0.1 UI output jitter difference between PRBS and Pseudo-Matrix Pathological signals at 3 Gbps data rates



Distribution Amplifier Jitter Tolerance, 2.97 Gbps, PRBS 2¹⁰-1, (BER = 1e-10)



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 LMH0344SQ	3G/HD/SD adaptive cable equalizer	3.3	280	143-2970	Ind	SD344EVK	LLP-16
LMH0044SQ	HD/SD adaptive cable equalizer in LLP	3.3	208	143-1485	Ext	SD044EVK	LLP-16
LMH0034MA	HD/SD adaptive cable equalizer	3.3	208	143-1485	Ext	SD034EVK	SOIC-16
LMH0074SQ	SD adaptive cable equalizer with carrier detect	3.3	208	143-540	Ind	SD074EVK	LLP-16
LMH0024MA	3.3V SD adaptive cable equalizer	3.3	198	143-540	Ind	SD024EVK	SOIC-16
CLC014AJE	Adaptive cable equalizer	5	290	50-650	Ind	SD014EVK	SOIC-14
CLC012AJE	Adaptive cable equalizer	5	290	50-650	Ind	SD012EVK	SOIC-14
Reclockers							
NEW LMH0346MH/SQ	3G/HD/SD reclocker with dual differential outputs	3.3	370	270-2970	Ind	SD3GDAEVK/SD346EVK	eTSSOP-20/LLP-24
NEW LMH0356SQ	3G HD/SD reclocker with 4:1 input mux and FR4 equalization	3.3	430	270-2970	Ind	SD356EVK	LLP-48
LMH0046MH	HD/SD reclocker with dual differential outputs	3.3	330	143-1485	Ind	SD046EVK	eTSSOP-20
LMH0056SQ	HD/SD reclocker with 4:1 input mux and dual outputs	3.3	360	143-1485	Ind	SD046EVK	LLP-48
NEW LMH0026MH	SD SDI reclocker with dual differential outputs	3.3	330	270	Ind	SD046EVK	eTSSOP-20
NEW LMH0036SQ	SD SDI reclocker with 4:1 input mux and dual outputs	3.3	350	270	Ind	SD046EVK	LLP-48
CLC016AJQ/MTC/ACQ	Data retiming PLL and clock recovery	5	525	40-400	Ind/Com	SD901EVK	PLCC-28/TSSOP-28
Cable Drivers							
LMH0302SQ	3G/HD/SD cable driver with enable feature	3.3	165	Up to 2970	Ind	SD302EVK	LLP-16
NEW LMH0303SQ	3G/HD/SD SDI cable driver with cable detect, input LOS, selectable slew rate and 4 mW power down mode	3.3	155	Up to 2970	Ind	SD303EVK	LLP-16
NEW LMH0307SQ	3G/HD/SD SDI dual cable driver with cable detect, input LOS, selectable slew rate and 3 mW power down mode	3.3	275	Up to 2970	Ind	SD307EVK	LLP-16
LMH0002MA/TMA	HD/SD Serial digital cable driver with selectable slew rate	3.3	149	Up to 1485	Com/Ind	SD002EVK	SOIC-8
LMH0002SQ	HD/SD serial digital cable driver with selectable slew rate	3.3	149	Up to 1485	Ind	SD002SQ-EVK	LLP-16
LMH0202MT	Dual HD/SD serial cable driver with dual differential input and output	3.3	298	Up to 1485	Com	SD202EVK/DVB202-EVK	TSSOP-16
LMH0001SQ	SD serial digital cable driver with adjustable output amplitude	3.3	125	Up to 540	Ind	SD001SQ-EVK	LLP-16
CLC001AJE	LVDS/LVPECL to adjustable output amplitude buffer/cable driver	3.3	231	Up to 622	Ind	SD001EVK	SOIC-8
CLC005AJE	ITU-T G.703 serial digital cable driver with adjustable output amplitude	5	185	Up to 622	Ind	SD005EVK	SOIC-8
CLC006AJE	Serial digital cable driver with adjustable output amplitude	5	185	Up to 400	Ind	SD006EVK	SOIC-8
CLC007AJE	Serial digital cable driver with dual complementary outputs	5	195	Up to 400	Ind	SD007EVK	SOIC-8

PowerWise® Product ¹ Temperature ranges: Com: 0°C to 70°C Ext: 0°C to 85°C Ind: -40°C to 85°C

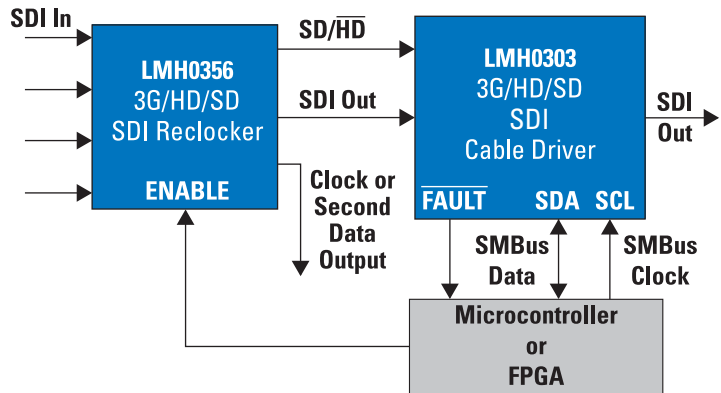
PowerWise® SDI Cable Drivers with Cable Detect Reduce System Power

LMH0303 and LMH0307 SDI Cable Drivers

Features

- Output cable detect alerts if cable is disconnected from BNC or improperly terminated
- Input loss of signal detect notifies when no input video signal is present
- Less than 4 mW power consumption in power saver mode
- Compliant with SMPTE 424M, 292M, 344M and 259M
- Dual differential output available (LMH0307)
- 7-bit SMBus accessible registers allows control of up to 127 cable drivers with one bus
- Easily communicates with LMH0356 3G-SDI reclocker, placing the reclocker in a 10 mW consuming power saver mode when possible
- Small LLP-16 packaging (4 x 4 mm)

LMH0303 Control Interface

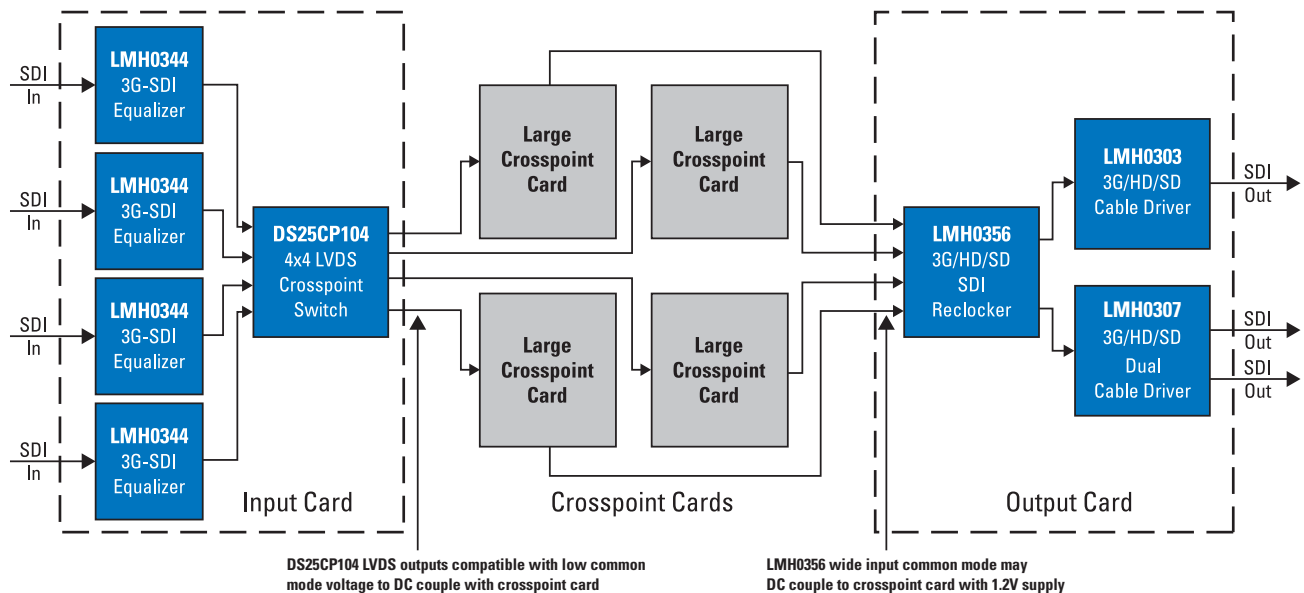


Video Router Solution

National's 3G-SDI products deliver the highest performance to power consumption ratio. The LMH0303 and LMH0307 cable drivers can automatically initiate a deep, 4 mW, power saver mode upon system faults such as output cable disconnection and input loss of signal. The cable drivers can also activate the deep power saver mode of National's LMH0356 3G/H/D/SD SDI reclocker reducing the reclocker power consumption to 10 mW.

The LMH0356 features equalization on each of the inputs capable of equalizing up to 30 inches of FR4 trace. Additionally, the DS25CP104 4x4 LVDS crosspoint switch from National's PowerWise® family supports receive equalization and transmit pre-emphasis while consuming only 120 mW per channel, extending performance with minimal power.

Large Video Router Simplified Block Diagram



INTERFACE

Mobile Pixel Link

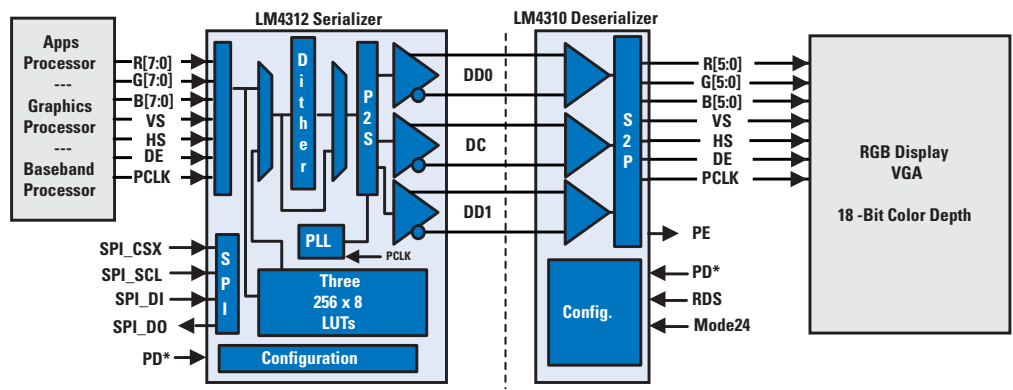
Mobile Pixel Link

Mobile Pixel Link Two (MPL-2) is a robust serial interface between video ports on sources and displays. MPL-2 features a robust differential transmission interface with a small magnitude signal to offer system-level low-power and low-EMI benefits.

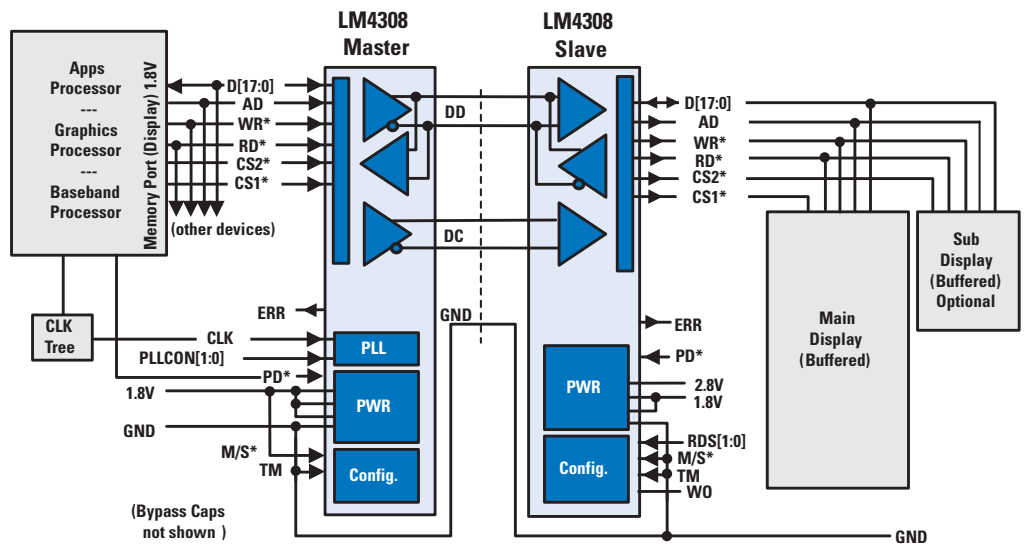
Features

- Less wires
- Low power
- Low EMI
- Robust differential interface
- SLVS physical layer

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.



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



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/micro-array
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

High-Speed Industrial Ethernet Advanced 10/100 Ethernet PHYs

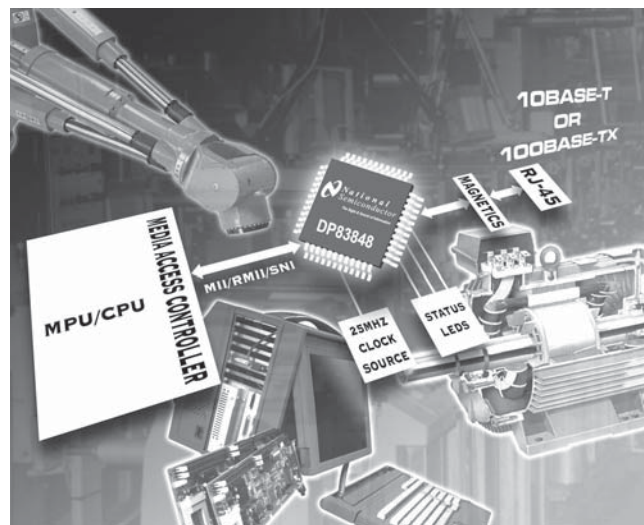
DP83848 – PHYTER® 10/100 Ethernet PHY Transceivers

Features

- 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



NEW! Precision PHYTER 10/100 IEEE 1588 PHY Transceiver

Product ID	DP83640T
Parameter	Industrial
Temp Range (°C)	-40 to 85
Number of Ports	Single
Interface	MII/RMII
IEEE 1588 Precision Time Protocol v1 & 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 Transceiver

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/SPI			
Low, Deterministic Delay	•	•	•	•
IEEE 1149.1 (JTAG)		•	•	•
Packaging	LQFP-48			
Package Size (mm)	9 x 9 x 1.4			

Mini PHYTER Transceiver

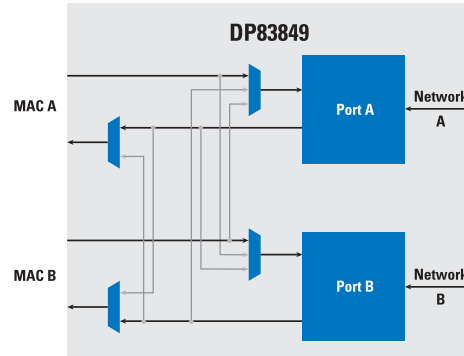
Product ID	DP83848M	DP83848J	DP83848K	DP83848T	DP83848H
Parameter	Commercial	Commercial	Industrial	Industrial	Extreme
Temp Range (°C)	0 to 70	0 to 70	-40 to 85	-40 to 85	-40 to 125
Number of Ports	Single				
Interface	MII/RMII				
Low, Deterministic Delay	•	•	•	•	•
Interrupt Pin	•			•	•
LEDs	1	2	2	1	1
Packaging	LLP-40				
Package Size (mm)	6 x 6 x 0.8				

High-Speed Industrial Ethernet

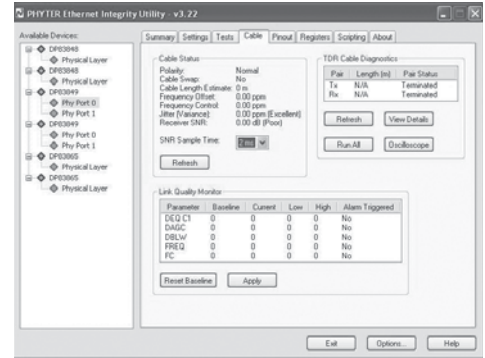
DP83849 – Dual PHYTER® 10/100 Ethernet PHY Transceiver for Commercial, Industrial, and Fiber Applications

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:

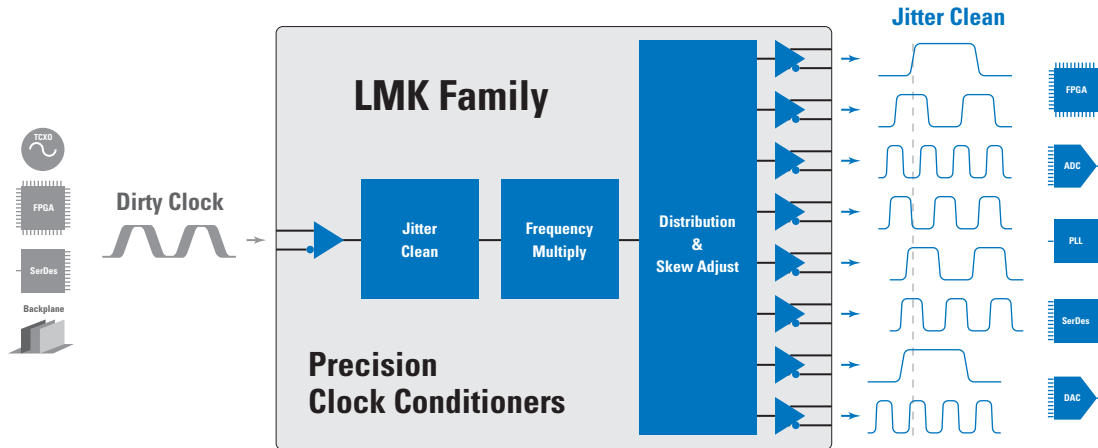
Ideal for use in industrial automation, test and measurement, telecom, military, and aerospace applications

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			

LMK Clock Conditioner Family

Jitter Cleaning + Multiplication + Distribution



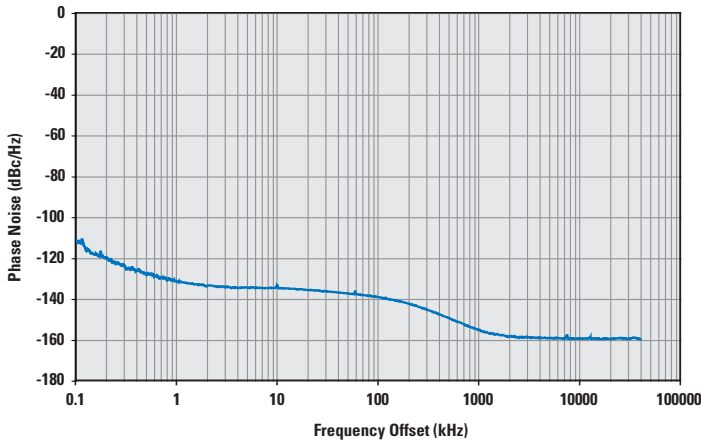
Product ID	Outputs			Architecture	Output Clock Range (MHz)	VCO Frequency Range (MHz)	RMS Jitter (ps) *
	LVPECL	LVDS	LVC MOS				
LMK01000ISQ	5	3	0	2:10 Clock Distribution	1 to 1600	NA	0.03 (additive)
LMK01010ISQ	0	8	0		1 to 1600	NA	0.03 (additive)
LMK01020ISQ	8	0	0		1 to 1600	NA	0.03 (additive)
LMK02000ISQ	5	3	0	PLL + Clock Distribution (needs external VCXO)	1 to 860	NA	0.2 (+VCXO)
LMK02002ISQ	4	0	0		1 to 860	NA	0.2 (+VCXO)
LMK03000CSQ	5	3	0	PLL + VCO + Clock Distribution	1 to 648	1185 to 1296	0.4
LMK03000ISQ	5	3	0		1 to 648	1185 to 1296	0.8
LMK03000DISQ	5	3	0		1 to 648	1185 to 1296	1.2
LMK03001CISQ	5	3	0		1 to 785	1470 to 1570	0.4
LMK03001ISQ	5	3	0		1 to 785	1470 to 1570	0.8
LMK03001DISQ	5	3	0		1 to 785	1470 to 1570	1.2
LMK03002CISQ	4	0	0		1 to 860	1566 to 1724	0.4
LMK03002ISQ	4	0	0		1 to 860	1566 to 1724	0.8
LMK03033CISQ	4	4	0		1 to 1080	1840 to 2160	0.4
LMK03033ISQ	4	4	0		1 to 1080	1840 to 2160	0.8
LMK04000BISQ	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	3	0	4		1 to 785	1430 to 1570	0.15/0.2 (+VCXO/Crystal)
LMK04011BISQ	5	0	0		1 to 785	1430 to 1570	0.15/0.2 (+VCXO/Crystal)
LMK04031BISQ	2	2	2		1 to 785	1430 to 1570	0.15/0.2 (+VCXO/Crystal)
LMK04002BISQ	3	0	4		1 to 875	1566 to 1750	0.15/0.2 (+VCXO/Crystal)
LMK04033BISQ	2	2	2		1 to 1080	1840 to 2160	0.15/0.2 (+VCXO/Crystal)

*Integrated from 10 kHz to 20 MHz

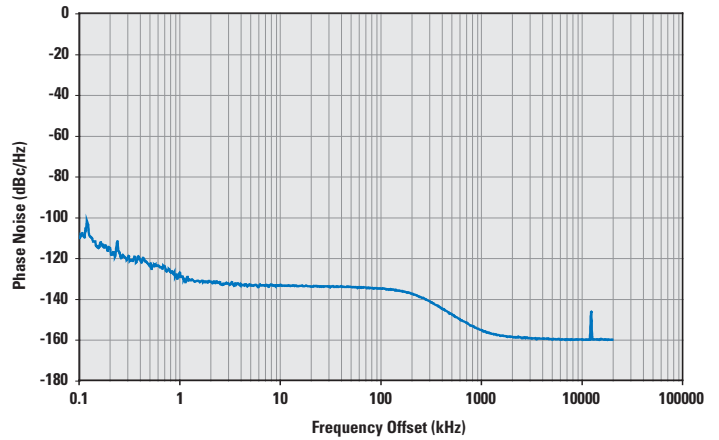
INTERFACE

LMK Clock Conditioner Family Performance

Superior Phase Noise Performance



LMK04031B LVC MOS Output Phase Noise at 122.88 MHz using a Crystek VCXO



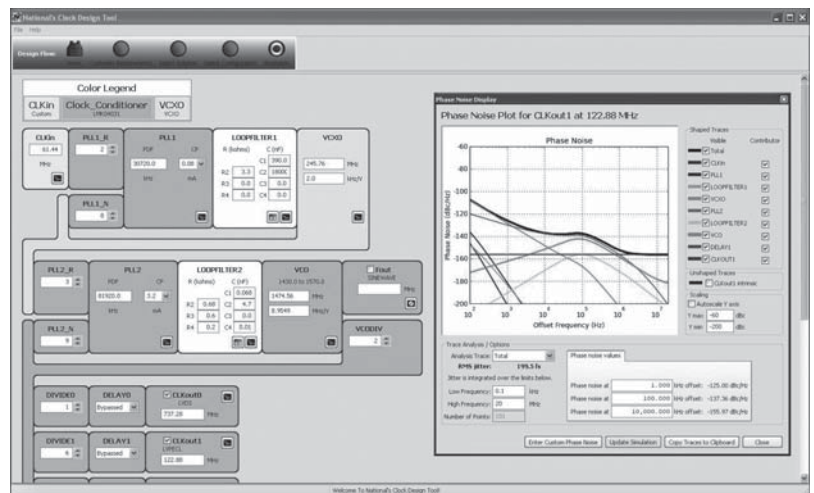
LMK04031B LVC MOS Output Phase Noise at 122.88 MHz using a Low-Cost Vectron Crystal

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

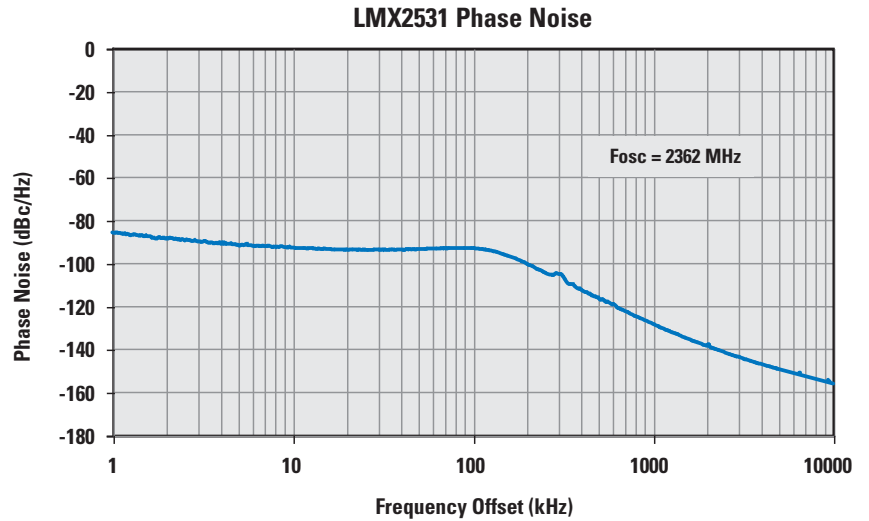


High-Performance Frequency Synthesizers

LMX2531 – PLLatinum® Frequency Synthesizer with Integrated VCO

Features

- 553 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
- 2.8 to 3.2V operation
- 1.8V MICROWIRE® support
- Available in 6 mm x 6 mm LLP-36 packaging



Product ID	Low Band (MHz)	High Band (MHz)
NEW LMX2531LQ1146E	553 to 592	1106 to 1184
NEW LMX2531LQ1226E	592 to 634	1184 to 1268
NEW LMX2531LQ1314E	634 to 680	1268 to 1360
NEW LMX2531LQ1415E	680 to 735	1360 to 1470
LMX2531LQ1500E	749.5 to 755	1499 to 1510
NEW LMX2531LQ1515E	725 to 790	1450 to 1580
LMX2531LQ1500E	749.5 to 755	1499 to 1510
LMX2531LQ1570E	765 to 818	1530 to 1636
LMX2531LQ1650E	795 to 850	1590 to 1700
LMX2531LQ1700E	831 to 885	1662 to 1770
LMX2531LQ1742	880 to 933	1760 to 1866
LMX2531LQ1778E	863 to 920	1726 to 1840
LMX2531LQ1910E	917 to 1014	1834 to 2028
LMX2531LQ2080E	952 to 1137	1904 to 2274
LMX2531LQ2265E	1089 to 1200	2178 to 2400
LMX2531LQ2570E	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

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

INTERFACE

High-Performance Frequency Synthesizers

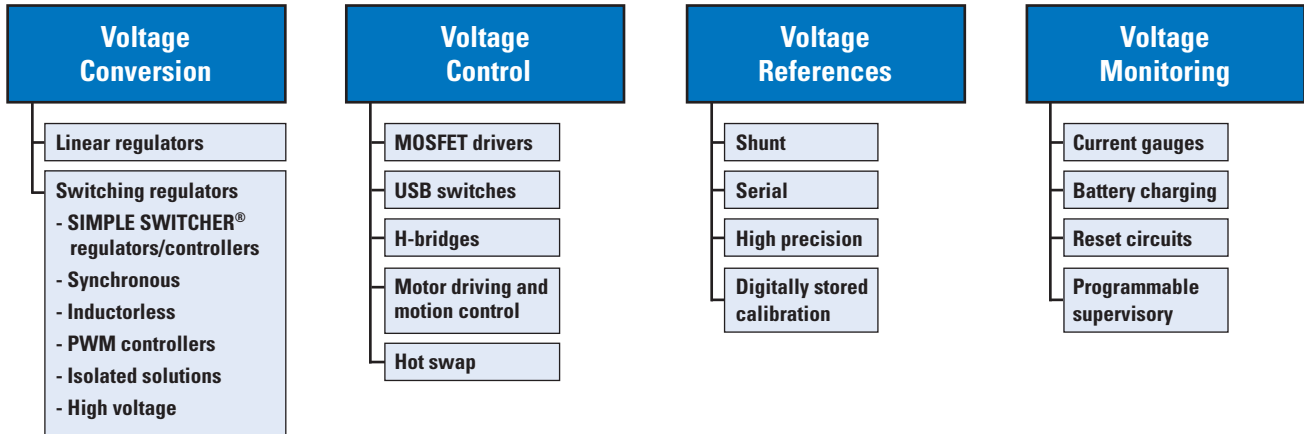
High-Performance PLLatinum® Family of PLL Products

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	0.1 to 2.8	—	-210	4.7	2.3 to 5.5	3.5 x 3.5 x 1.0
LMX2310U	0.5 to 2.5	—	-212	2.3	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2347	0.2 to 2.5	—	-217	3.6	2.7 to 5.5	3.5 x 3.5 x 0.6
LMX2311U	0.5 to 2.0	—	-212	2.0	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2346	0.2 to 2.0	—	-217	3.0	2.7 to 5.5	3.5 x 3.5 x 1.0
LMX2312U	0.2 to 1.2	—	-212	1.4	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2316	0.1 to 1.2	—	-210	2.5	2.3 to 5.5	3.5 x 3.5 x 1.0
LMX2313U	45 to 600 MHz	—	-212	1.0	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2306	25 to 550 MHz	—	-210	1.7	2.3 to 5.5	3.5 x 3.5 x 1.0
Dual-Integer PLLs						
LMX2434	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	0.5 to 3.6	250 to 1700	-219	5.2	2.25 to 2.75	3.5 x 3.5 x 0.6
LMX2430	0.25 to 3.0	100 to 800	-219	4.2	2.25 to 2.75	3.5 x 3.5 x 0.6
LMX2330L	0.5 to 2.5	45 to 510	-211	5	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX2336L	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	0.2 to 2.0	45 to 510	-211	4	2.7 or 5.5	3.5 x 3.5 x 0.8
LMX1600	0.2 to 2.0	40 to 500	-197	5	2.7 to 3.6	3.5 x 3.5 x 1.0
LMX2332L	0.1 to 1.2	45 to 510	-211	3	2.7 to 5.5	3.5 x 3.5 x 0.8
LMX1601	0.1 to 1.1	40 to 500	-197	4	2.7 to 3.6	3.5 x 3.5 x 1.0
LMX1602	0.1 to 1.1	100 to 1100	-197	5	2.7 to 3.6	3.5 x 3.5 x 1.0
LMX2335L	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	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	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	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	0.5 to 3.0	75 to 800	-209	5	2.5 to 3.6	4.0 x 4.0 x 0.75
LMX2485E	0.05 to 3.0	75 to 800	-209	5	2.5 to 3.6	4.0 x 4.0 x 0.75
LMX2364	0.5 to 2.6	50 to 850	-210	7	2.7 to 5.5	4.5 x 3.5 x 0.6
LMX2470	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	0.5 to 2.5	—	-201	5.5	2.7 to 5.5	3.5 x 3.5 x 1.0
LMX2350	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	0.5 to 2.5	10 to 550	-204	6	2.7 to 5.5	4.5 x 3.5 x 1.0
LMX2352	0.25 to 1.2	10 to 550	-201	4.75	2.7 to 5.5	4.5 x 3.5 x 1.0

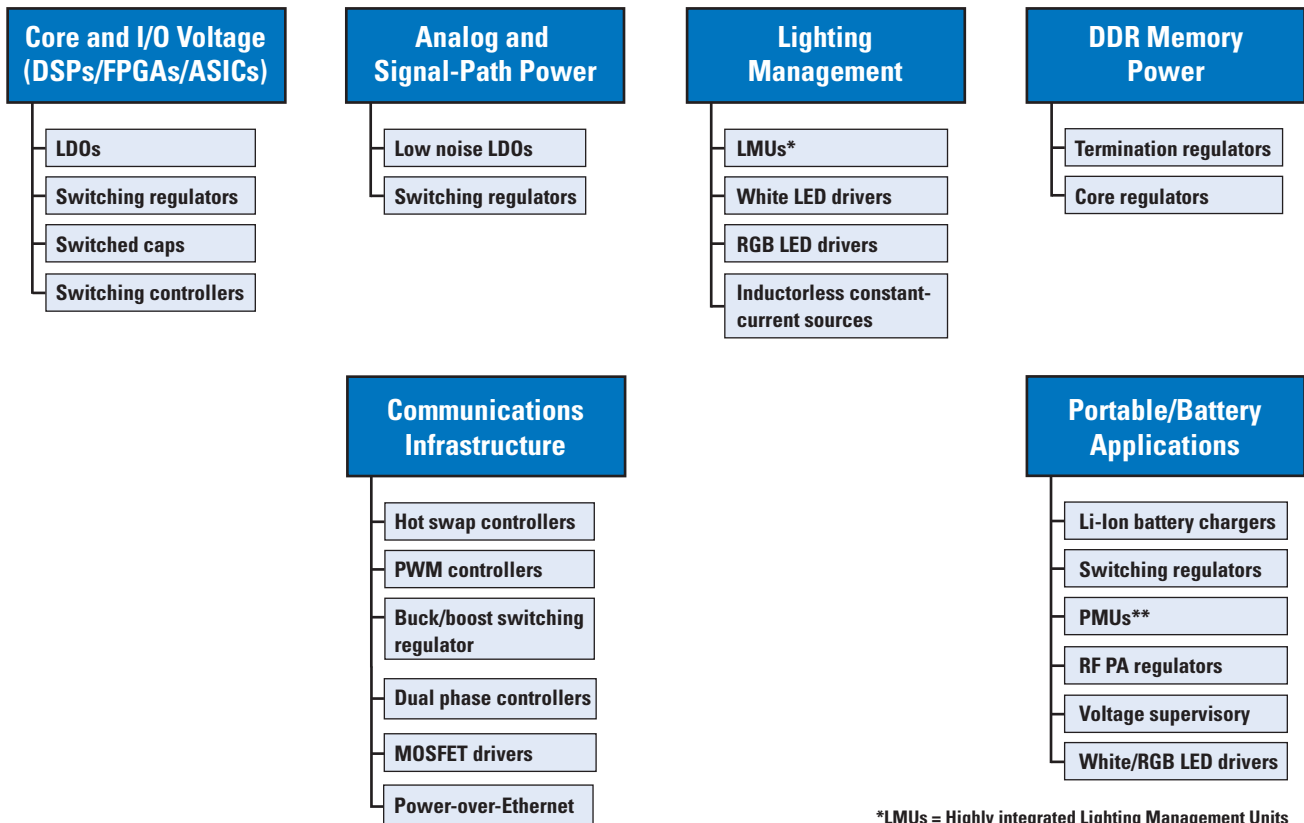
For additional information refer to PLLatinum Family of PLL and PLL + VCO Products, 2006 Selection Guide, Literature Number 550240-014

National's Power Management Product Portfolio

Power Solutions by Category



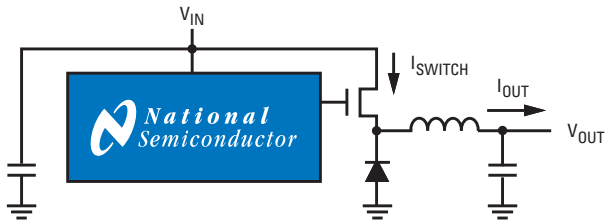
Power Solutions by Application



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

Commonly Used Power Switching Topologies

Buck

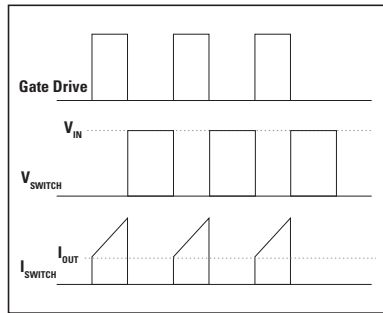


Function: Step-down ($V_{OUT} < V_{IN}$)
When to use: Typically when V_{IN} is 3x to 5x V_{OUT} and I_{OUT} is $> 0.5A$ and $< 5A$

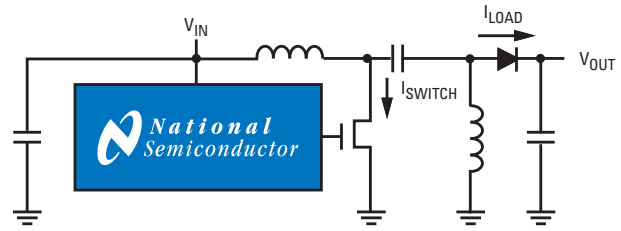
Characteristics: Easy to design and good efficiency for the above mentioned typical $V_{IN}/V_{OUT}/I_{OUT}$ conditions

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

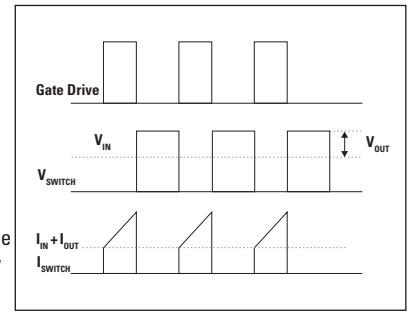
Function: Buck-boost (V_{IN} max. $> V_{OUT} > V_{IN}$ min.)

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

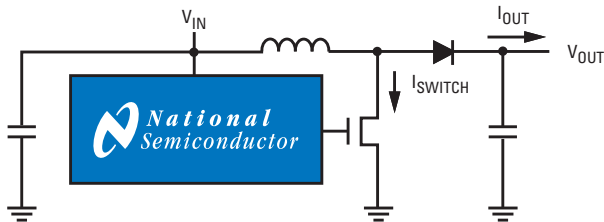
Characteristics: Lower input ripple than flyback, no snubber circuitry required

Devices to use: Any boost/flyback regulator or controller

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



Boost



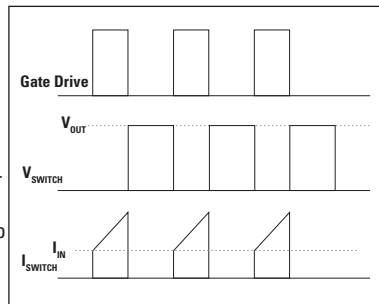
Function: Step-up ($V_{OUT} > V_{IN}$)

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

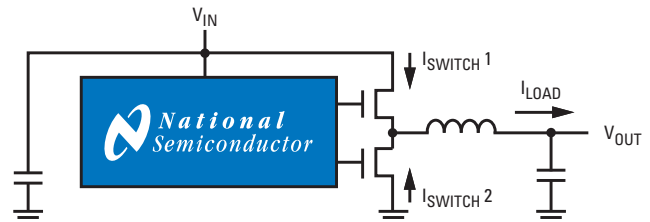
Characteristics: Best for low-power conversion (up to 10W or 20W) and output voltages less than or equal to 7x the input voltage

Devices to use: All boost/flyback regulators and controllers

Comments: Output current $V_{IN}/V_{OUT} \times 0.7 \times$ switch current



Synchronous Buck

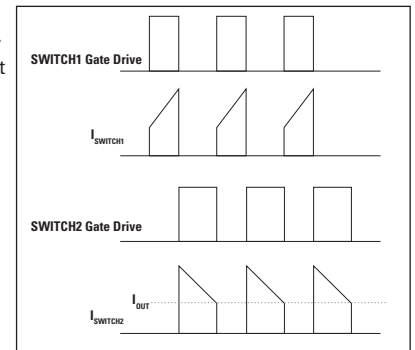


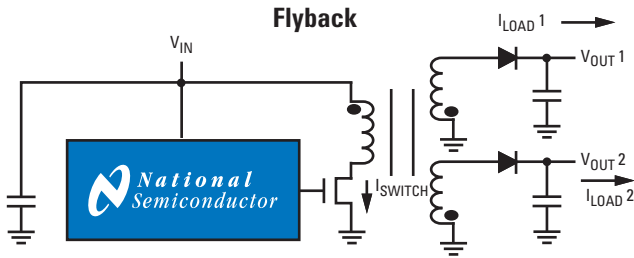
Function: Step-down ($V_{OUT} < V_{IN}$)

When to use: When high efficiency is required with high-output current ($> 5A$) or low duty cycles ($V_{IN} > 5 \times V_{OUT}$ 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



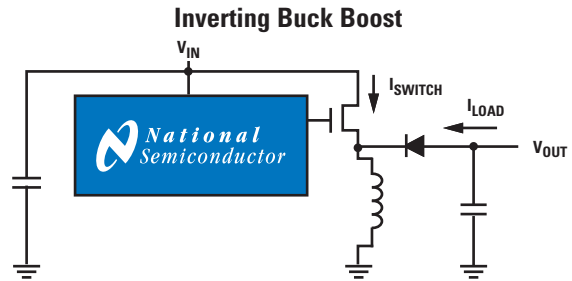
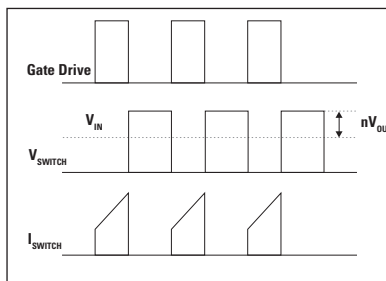


Function: Step-up, step-down, invert or buck-boost

When to use: Typically when multi-output or isolation is required, when step-up beyond $8 \times V_{IN}$ 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



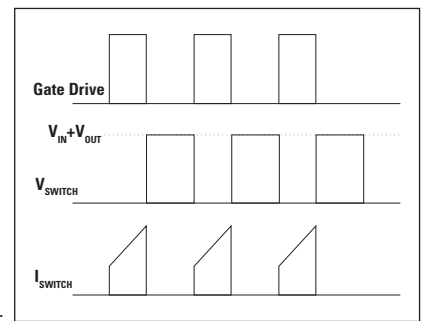
Function: Inverting (negative output from positive input, $-V_{OUT}$ can be greater than or less than V_{IN})

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

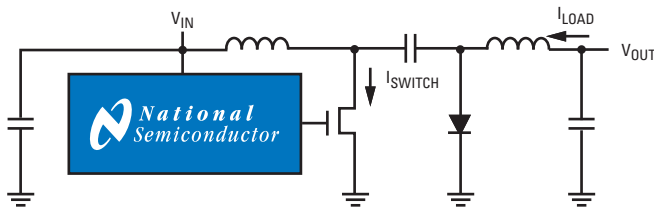
Characteristics: Easy to implement, single output

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)

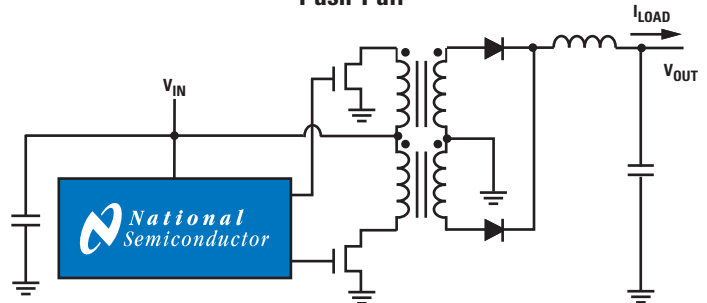
When to use: When a regulated, negative, low-ripple voltage is needed from a positive supply

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

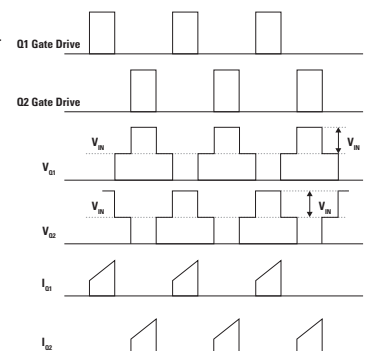


Function: Isolated step-down, step-up or buck-boost and multiple outputs

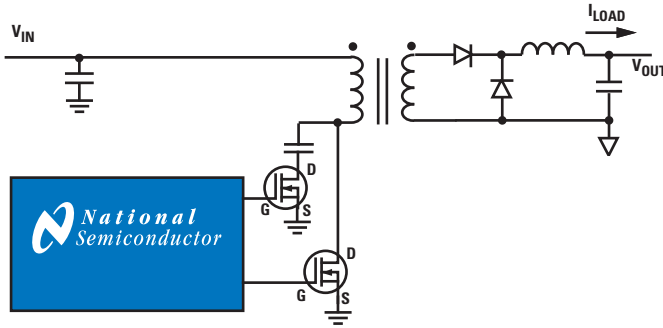
When to use: When isolated, medium-to-high power conversion is needed (25 W to 1000 W). This topology can also be used when the input voltage range is very wide or when the V_{IN}/V_{OUT} ratio in step-down applications requires a very small duty cycle (and thus might yield poor regulation) if a standard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

Devices to use: LM5030 current-mode push-pull controller

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

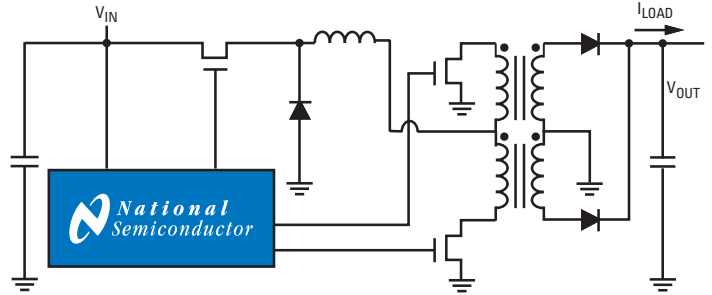


Active Clamp Forward

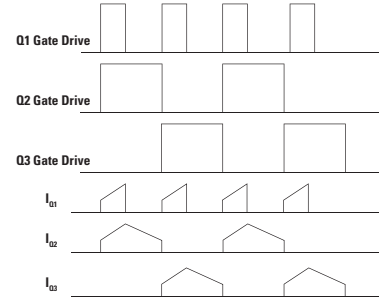


Function: Isolated, step-down or step-up
When to use: High step down ratios and/or isolated output and 100-300W power
Devices to use: LM5025, LM5026, LM5032, LM5034
Comments: Forward topology requires lower peak current than flyback. At the start of a switch conduction, the net magnetization of the transformer core must be zero. Active Clamp recycles the reset energy, improving efficiency.

Current-Fed Push-Pull (Cascaded)



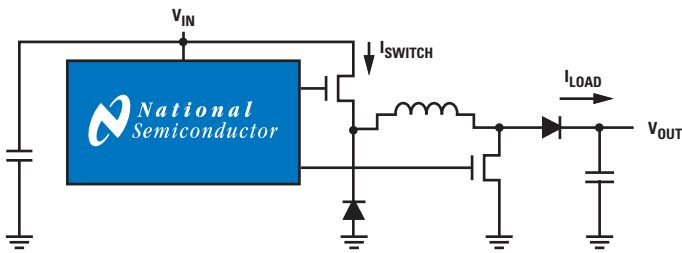
Function: Isolated step-down, step-up, or buck-boost topologies. Can do tightly regulated multiple outputs.
When to use: When isolated medium- to high-power conversion is needed, but reduced losses, high efficiency, and no output inductor are also desired.



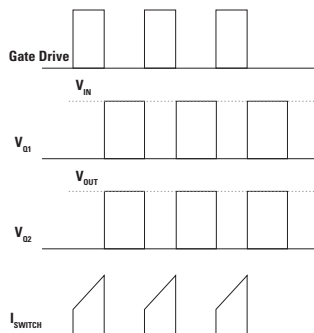
Characteristics: The current-fed cascaded topology consists of a buck regulation stage followed by a push-pull isolation stage. Because the buck stage feeds continuous current to the push-pull stage, no output inductor is required.

Devices to use: LM5041 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)

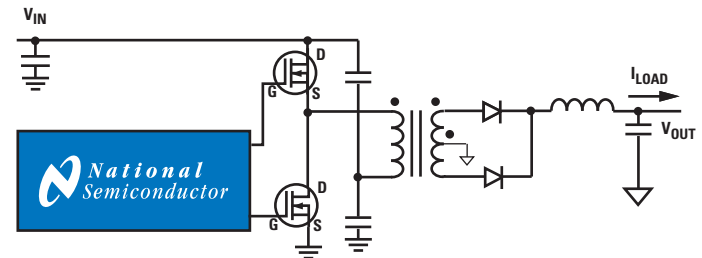
Single Inductor Buck & Boost



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 increase 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.

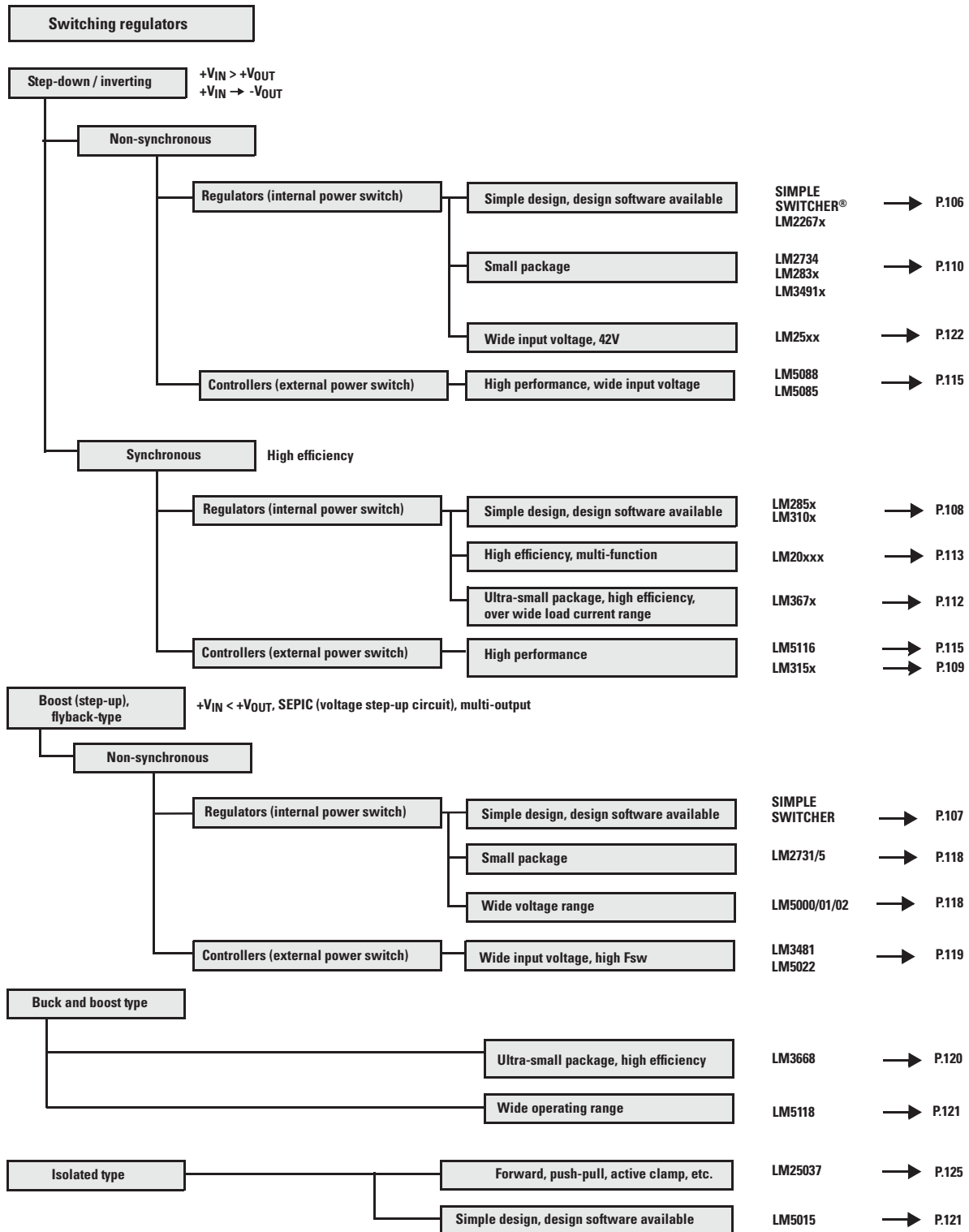


Half Bridge

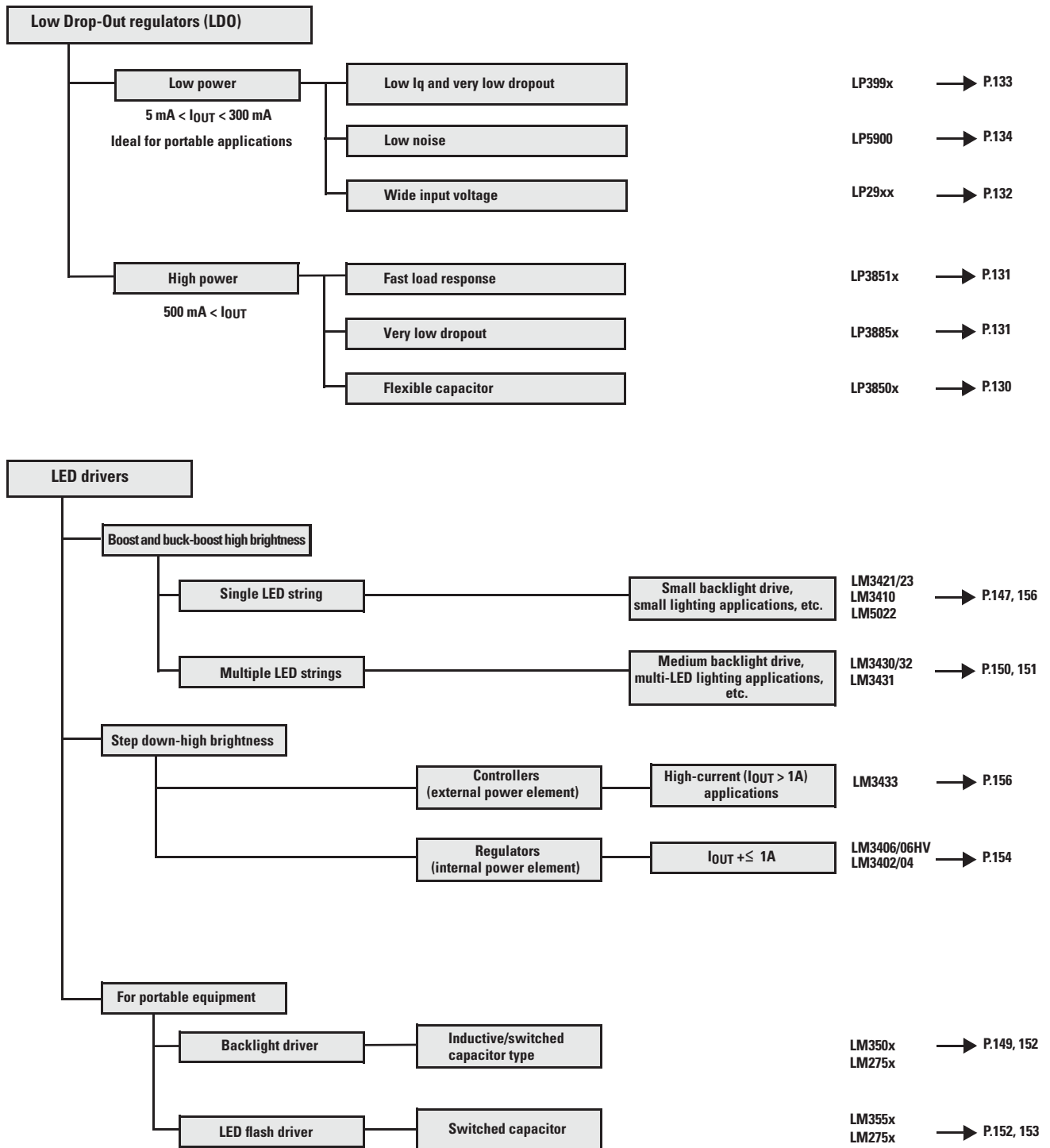


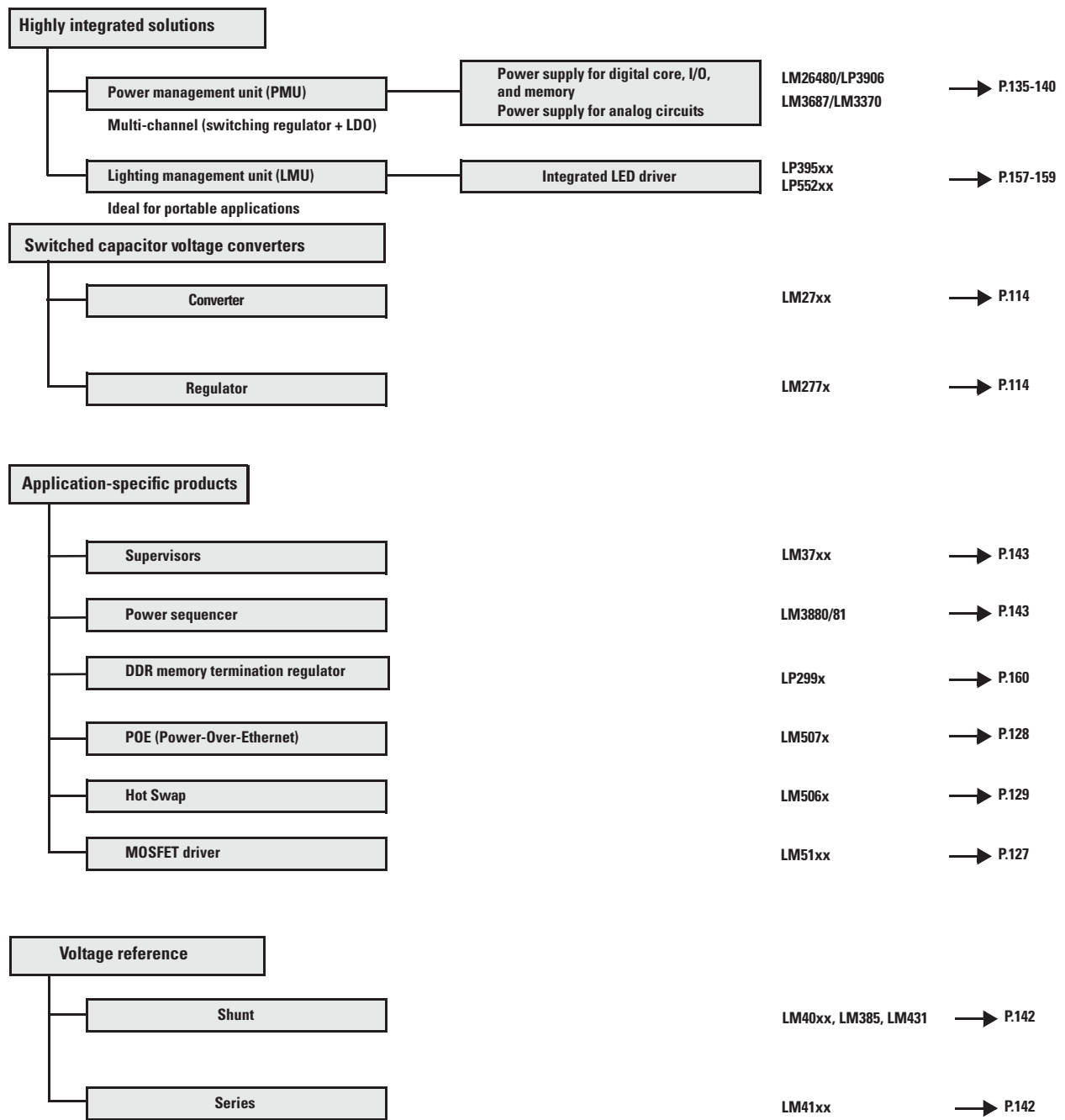
Function: Isolated, step-down or step-up
When to use: High step down ratios and/or isolated output and 200-1000W power
Devices to use: LM5033, LM5035
Comments: The half bridge converter is similar to the push pull converter, but FETs are subject to lower voltages stresses and a center tapped primary 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.

Power Management Products



Power Management Products





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

Analyze It

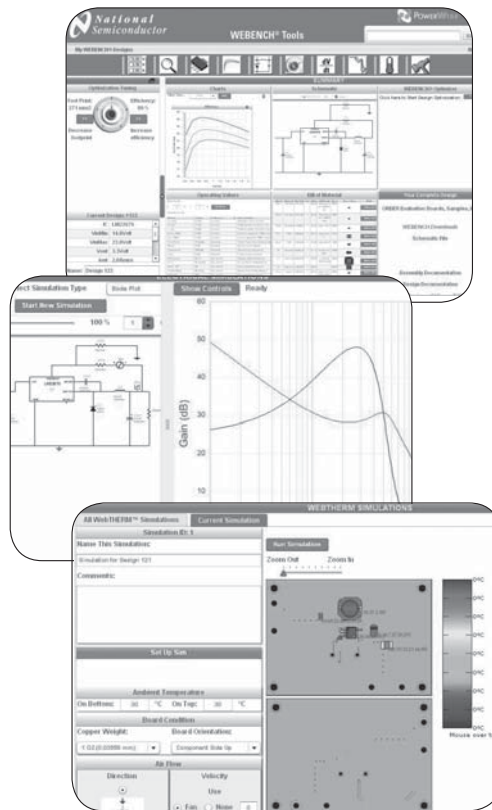
- Stimulate your circuit and evaluate performance using electrical and thermal simulations
- Overlay alternate circuits and compare results to get optimal performance

Solve your design problems before you prototype

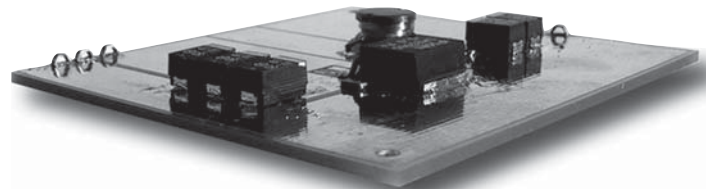
Build It

- 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!



Power Supply Design Tool

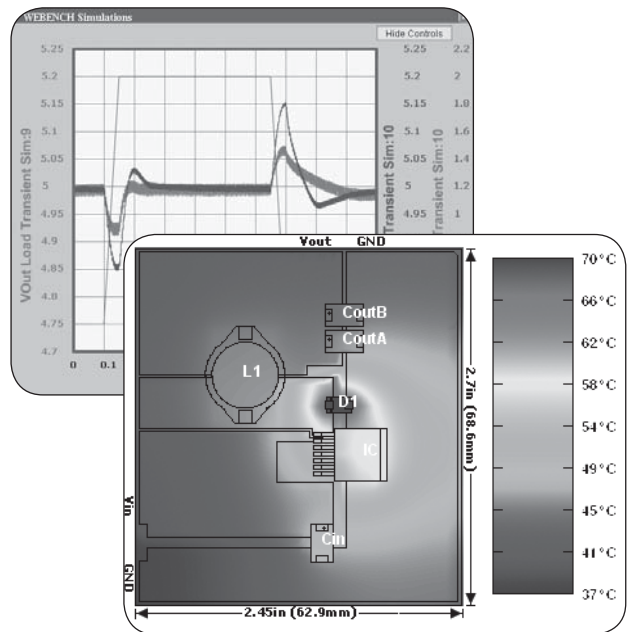
The WEBENCH environment provides the end-to-end design and prototyping tools you need to create power supplies that meet your design's requirements. WEBENCH tools let designers solve design problems before prototyping—alleviating the time and trouble associated with traditional design methods.

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.

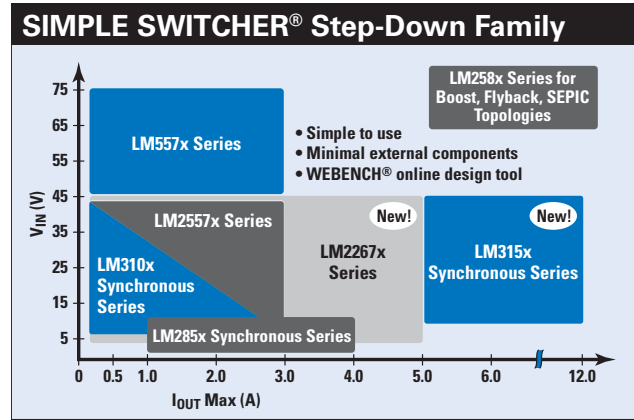
The figure shows the 'Optimization Tuning' interface. On the left, the 'Footprint (excluding LEDs)' is displayed as 125.2 mm². A rotary knob is used to adjust this value, with a scale from 1 to 5. Below the knob are buttons for '<<' (Decrease Footprint) and '>>' (Increase Efficiency). The current 'Efficiency' is shown as 97%. A large 'Optimize Circuit' button is centered below the knob. On the right, there are several configuration options: 'User Preferred Freq (Hz)' is set to 348300 (with a range of < 611111); 'No Output Cap' is unchecked; and 'User Preferred LED Ipp %' is set to 'System Defined'. Below these options is a 'Edge Temperatures' section showing a schematic of the PCB with four edges labeled 'Edge 1 Insulated', 'Edge 2 Insulated', 'Edge 3 Insulated', and 'Edge 4 Insulated'. A temperature scale on the right of this section ranges from 60°C to 100°C.

SIMPLE SWITCHER® Solutions

WEBENCH® Power Designer Tool Offers Flexibility and Time-Saving Design Capabilities

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



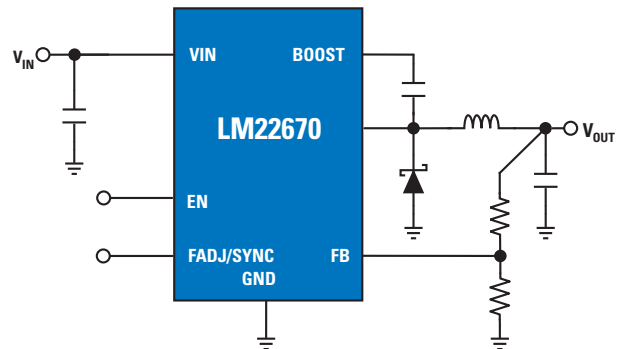
SIMPLE SWITCHER Products and WEBENCH Power Designer

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
- PSOP-8 and T0263-7 THIN packages – exposed DAPs provide enhanced thermal dissipation, halogen-free and lead-free
- Fully enabled for WEBENCH® online design tool



Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Current (mA)	Frequency Range (kHz)	Sync	PWM Mode	Packaging
NEW! LM22671/74	42	4.5	1.285	500	500 to 1000 Adj	✓/–	Voltage	PSOP-8
NEW! LM22672/75	42	4.5	1.285	1000	500 to 1000 Adj	✓/–	Voltage	PSOP-8
NEW! LM22680	42	4.5	1.285	2000	500 to 1000 Adj	✓	Voltage	PSOP-8
NEW! LM22670/73/76	42	4.5	1.285	3000	500 to 1000 Adj	✓/–/–	Voltage	T0263-7 Thin, PSOP-8
NEW! LM22677/78/79	42	4.5	1.285	5000	500 to 1000 Adj	✓/–/–	Voltage	T0263-7 Thin

SIMPLE SWITCHER® Regulators

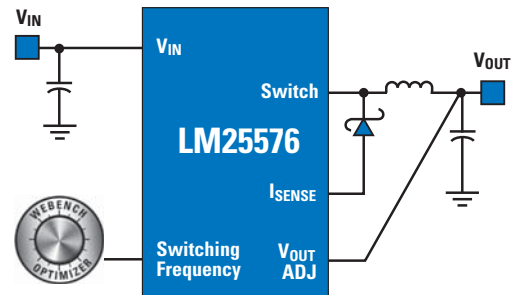
LM2557x/LM557x – PowerWise® SIMPLE SWITCHER Regulators Deliver Customized Performance and Flexibility to Fit Your Design

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

Applications:

Ideal for use in designing a power supply optimized for your design that's guaranteed to work



SIMPLE SWITCHER Non-Synchronous Regulators

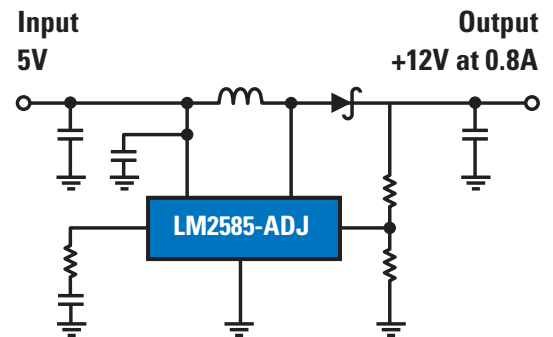
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Frequency Range (kHz), Sync	On/Off Pin	PWM Mode	Packaging
LM25574	42	6	1.23	40	500	50 to 1000, Sync	✓	Current	TSSOP-16
LM5574	75	6	1.23	70	500	500, Sync	✓	Current	TSSOP-16
LM25575	42	6	1.23	40	1500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

PowerWise product

LM258x – Boost/Flyback/SEPIC SIMPLE SWITCHER Series

Features

- NPN output switches support up to 5.0A and can stand off 65V
- Wide input voltage range: 4V to 40V
- Current-mode operation for improved transient response, line regulation, and current limit
- 100 to 200 kHz switching frequencies supported
- Internal soft-start function reduces in-rush current during startup
- Output transistor protected by current limit, under voltage lockout, and thermal shutdown
- System output voltage tolerance of $\pm 4\%$ max over line and load conditions
- Available in both TO-220 and TO-263 packaging



SIMPLE SWITCHER Boost/Flyback/SEPIC

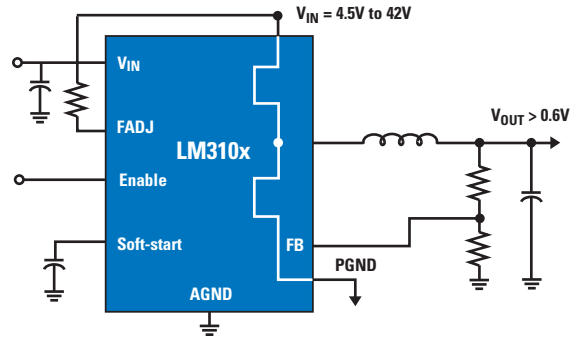
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min Voltage (V)	I _{OUT}	Frequency Range (kHz), Sync	Packaging
LM2585	40	4	1.23	3	100	TO-220, 20-263
LM2586	40	4	1.23	3	100 to 200	TO-220, 20-263
LM2587	40	4	1.23	5	100	TO-220, 20-263
LM2588	40	4	1.23	5	100 to 200	TO-220, 20-263

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



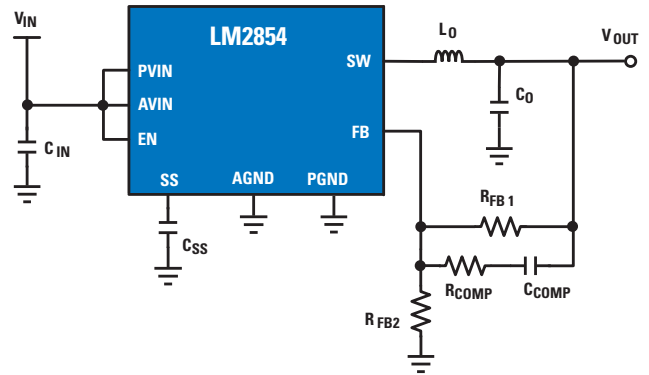
Applications:

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, communications infrastructure

Simple Switcher Synchronous Regulators

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

NEW! **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

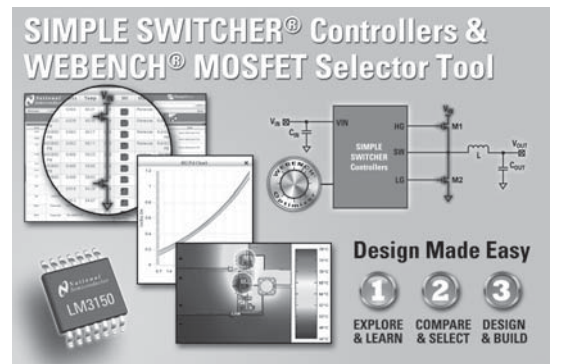
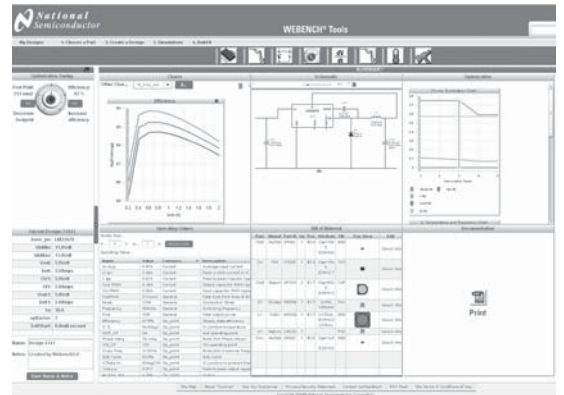
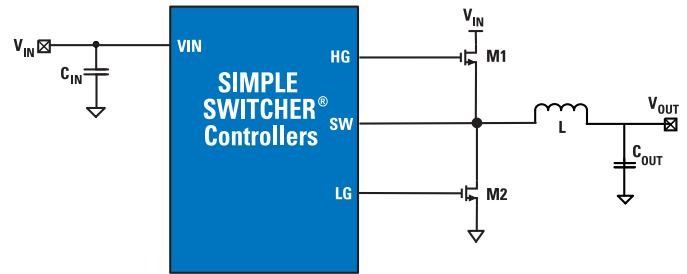
LM3150 controller

- 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



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

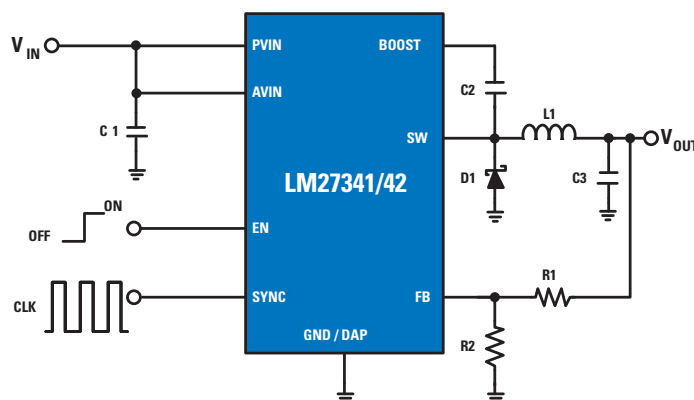
PowerWise product

Non-Synchronous Step-Down (Buck) Switching Regulators

LM27341/42 – 1.5A/2A Wide Input Range Buck Regulator with Frequency Synchronization

Features

- 3.0V to 20V input voltage range
- 1V to 18V output voltage range
- 2 MHz fixed switching frequency
- 1% internal voltage reference accuracy
- 1 MHz to 2.35 MHz frequency synchronization
- 30 nA shutdown current
- 150 mΩ NMOS switch with internal bootstrap supply
- Available in space -saving 3 mm x 3 mm LLP-10 and eMSOP-10 packaging



Applications:

Ideal for 12V to point-of-load conversions in communications, industrial, medical ultrasound, and automotive infotainment applications

Non-Synchronous Step-Down (Buck) Switching Regulators

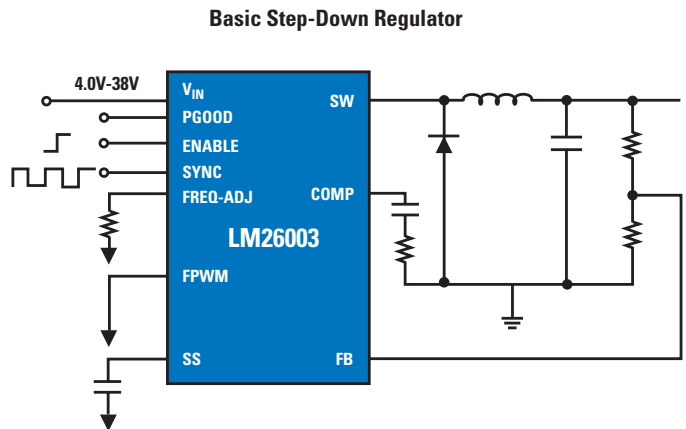
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Frequency Range (KHz) & Sync	On/Off Pin	PWM Mode	Packaging
LM5008/9	95	9.5	2.5	75/85	350/150	50 to 600		Constant on-time	LLP-8, MSOP-8
LM25007	42	9	2.5	37	500	50 to 800		Constant on-time	MSOP-8
LM2694	30	8	2.5	24	600	50 to 1000		Hysteretic	LLP-10, TSSOP-14
LM34919	40	8	2.5	35	600	1600		Constant on-time	micro SMD-10
LM2736	18	3	1.25	16	750	550, 1600		Current	SOT23-6
LM2830	5.5	3	0.6	4.5	1000	1600, 3000		Current	SOT23-5
LM2734/Z	20	3	0.8	18	1000	550, 1600/3000		Current	SOT23-6
NEW LM34930	30	8	2.5	30	1000	up to 2000		Constant on-time	micro SMD-12
LM25010	42	6	2.5	37	1000	50 to 1000		Constant on-time	LLP-10, TSSOP-14EP
LM5010A	75	6	2.5	70	1000	50 to 1000		Constant on-time	LLP-10, TSSOP-14EP
LM2695	30	8	2.5	24	1250	50 to 800		Hysteretic	LLP-10, TSSOP-14EP
LM34917A	33	8	2.5	30	1250	2000		Constant on-time	micro SMD-12
LM34910/C	36/50	8	2.5	33/45	1250	1000		Constant on-time	LLP-10
LM34914	40	8	2.5	37	1250	1300		Constant on-time	LLP-10
LM2831	5.5	3	0.6	4.5	1500	550, 1600, 3000		Current	SOT23-5
LM2738	20	3	0.8	18	1500	500, 1600		Current	LLP-8, eMSOP-8
LM26001	38	3	1.25	35	1500	150 to 1000, Sync		Current	TSSOP-16
NEW LM27341/2	20	3	1	18	1500/2000	1000 to 2350, Sync	✓	Current	LLP-10, eMSOP-10
LM2832	5.5	3	0.6	4.5	2000	550, 1600, 3000		Current	LLP-6, eMSOP-8
LM25005	42	7	1.23	40	2500	50 to 1000, Sync		Current	TSSOP-20
LM5005	75	7	1.23	70	2500	50 to 500, Sync		Current	TSSOP-20
NEW LM2833	5.5	3	0.6	4.5	3000	3000	✓	Current	LLP-10, eMSOP-10
LM2696	24	4.5	1.29	20	3000	100 to 500		Constant on-time	TSSOP-16
NEW LM26003	38	3	1.25	35	3000	150 to 500, Sync		Current	TSSOP-20

PowerWise® product

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

Features

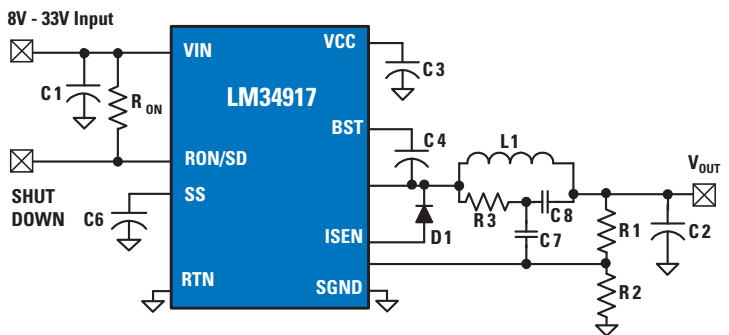
- High-efficiency sleep mode (40 μ A I_q typ.)
- 10 μ A in shutdown mode
- 3V cold-crank compatibility
- 4V to 38V continuous input range
- 1.5% reference accuracy
- Frequency synchronization
- Low input version LM26001B (4.8V to 18V)
- Available in eTSSOP-16/20 exposed-pad packaging



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:

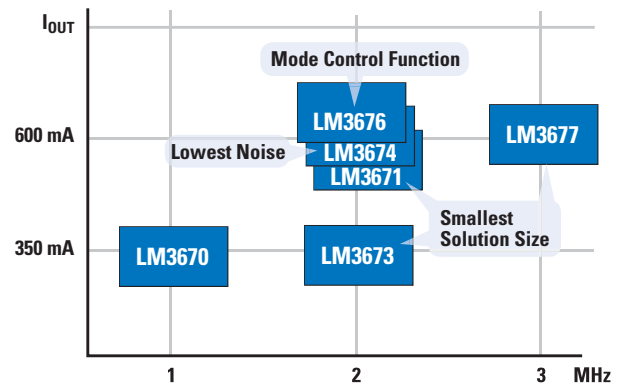
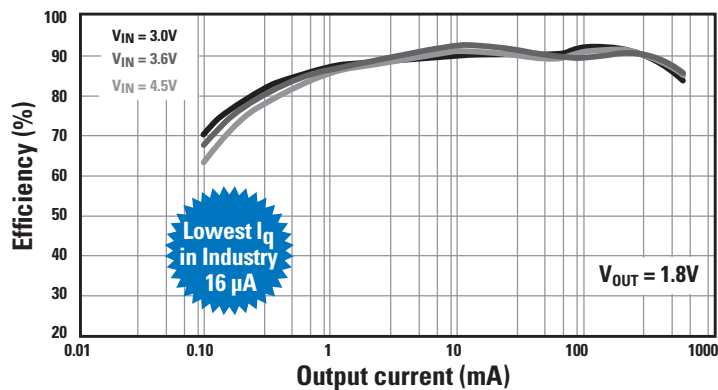
Ideal for use in high-efficiency Point-Of-Load (POL) regulators, non-isolated buck regulator, and portable applications

Synchronous Step-Down (Buck) Switching Regulators

LM3677 – PowerWise® Highest-Efficiency DC-DC Converters in Smallest Solution Size

Features

- >90% efficiency in PWM mode and lowest standby I_q (16 µA) in the industry
- Smallest switcher in the industry, 3 MHz switching frequency (1 µH chip inductor) and tiny ceramic capacitors
- Tight V_{OUT} accuracy, tiny V_{OUT} ripple (5 mV peak-peak) and excellent transient response
- Available in micro SMD-5 packaging for optimal solution size



Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Frequency Range (kHz) & Sync (computed field)	On/Off Pin	PWM Mode	Packaging
LM3670	5.5	2.5	0.7	3.3	350	1000	✓	Voltage with input feedforward	SOT23-5
LM3673	5.5	2.7	1.1	3.3	350	2000	✓	Voltage with input feedforward	micro SMD-5
LM3679	5.5	2.5	1.2	1.8	350	3000	✓	Auto	micro SMD-5
LM2614	5.5	2.8	1	3.6	400	500 to 1000, Sync	✓	Current	micro SMD-10
LM2612	5.5	2.8	1.05	1.8	400, 300	500 to 1000, Sync	✓	Current	micro SMD-10
LM2612BL	5.5	2.8	1.05	1.8	400, 300	500 to 1000, Sync	✓	Current	micro SMD-10
LM2618	5.5	2.8	1.8	1.92	400, 300	500 to 1000, Sync	✓	Current	micro SMD-10
LM2619	5.5	2.8	1.5	3.6	500	500 to 1000, Sync	✓	Current	micro SMD-10
LM3671	5.5	2.7	1.1	3.3	600	2000	✓	Voltage with input feedforward	SOT23-5, LLP-6, micro SMD
LM3674	5.5	2.7	1.0	3.3	600	2000	✓	Voltage with input feedforward	SOT23-5
LM3676	5.5	2.9	1.1	3.3	600	2000	✓	Voltage with input feed forward	LLP-8
LM3677	5.5	2.7	1.2	3.3	600	3000	✓	Voltage with input feedforward	micro SMD-5
LM3691	5.5	2.3	0.75	1.8	1000	4000	✓	Voltage with input feedforward	micro SMD-6
LM2651	14	4	1.24	13	1500	3000	✓	Current	TSSOP-16
LM2653	4	14	1.5	5	1500	300	✓	Current	TSSOP-16
LM3678	5.5	2.5	0.8	3.3	1500	3300	✓	PWM only	LLP-10
LM2655	4	14	1.24 3.3	13 3.3	2500	300	✓	Current	TSSOP-16
LM2650	4.5	18	1.5	16	3000	90 to 300	✓	Current	SOIC-14 WIDE

PowerWise product

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

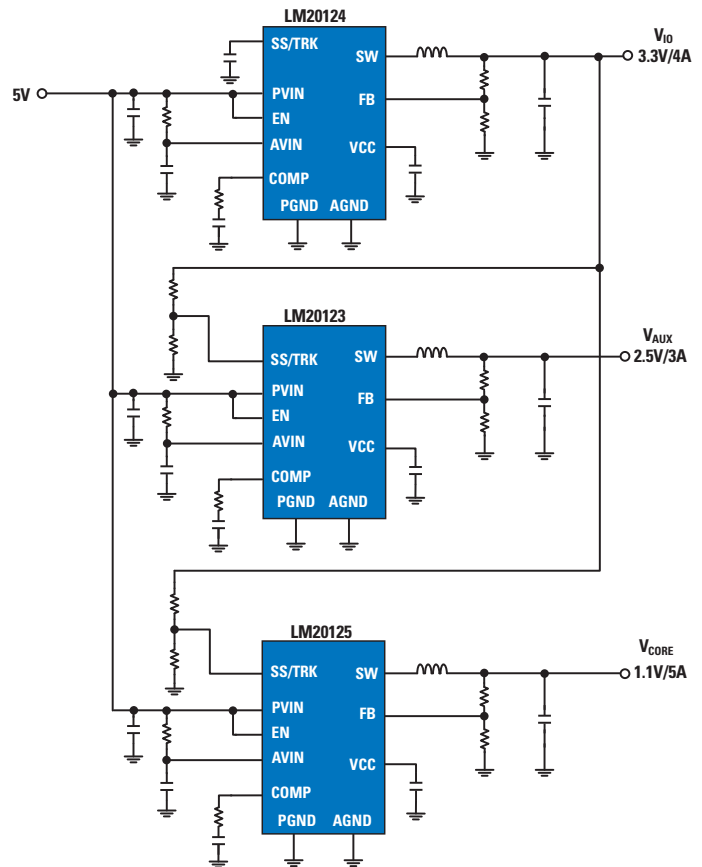
Features

- 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	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Frequency Range (kHz) & Sync (computed field)	On/Off Pin	PWM Mode	Packaging
LM20242	36	4.5	0.8	32	2000	1000	✓	Current-Mode Control	eTSSOP-16
LM20123	5.5	2.95	0.8	5	3000	1500	✓	Current-Mode Control	eTSSOP-16
LM20133	5.5	2.95	0.8	5	3000	460 to 1.5 MHz, Sync-in	✓	Current-Mode Control	eTSSOP-16
LM20143	5.5	2.95	0.8	5	3000	500 to 1500	✓	Current-Mode Control	eTSSOP-16
LM20323	36	4.5	0.8	32	3000	500	✓	Current-Mode Control	eTSSOP-20
LM20333	36	4.5	0.8	32	3000	250 to 1.5 MHz, Sync-in	✓	Current-Mode Control	eTSSOP-20
LM20343	36	4.5	0.8	32	3000	250 to 1 MHz	✓	Current-Mode Control	eTSSOP-20
LM20124	5.5	2.95	0.8	5	4000	1000	✓	Current-Mode Control	eTSSOP-16
LM20134	5.5	2.95	0.8	5	4000	460 to 1.5 MHz, Sync-in	✓	Current-Mode Control	eTSSOP-16
LM20144	5.5	2.95	0.8	5	4000	500 to 1000	✓	Current-Mode Control	eTSSOP-16
LM20154	5.5	2.95	0.8	5	4000	1000, Sync-out	✓	Current-Mode Control	eTSSOP-16
LM20125	5.5	2.95	0.8	5	5000	500	✓	Current-Mode Control	eTSSOP-16
LM20145	5.5	2.95	0.8	5	5000	250 to 750	✓	Current-Mode Control	eTSSOP-16

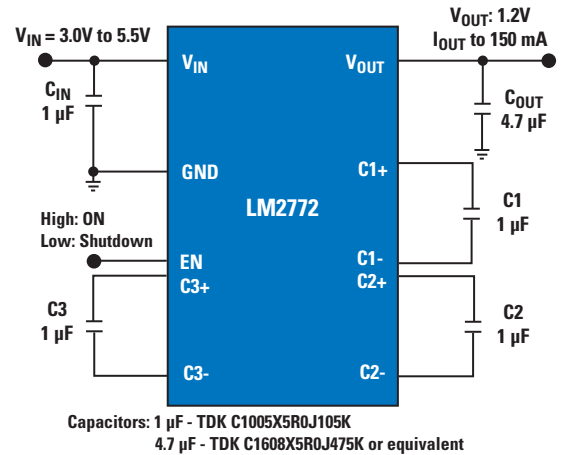
PowerWise product

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	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Frequency range (kHz)	On/Off Pin	Quiescent Current	Packaging
LM2787	5.5	2.7	-5.2	-1.5	10	260	✓	0.4	micro SMD-8
LM2772	5.5	2.7	1.2	1.2	150	1100	✓	0.05	LLP-10
LM2771	5.5	2.7	1.5	1.5	250	1100	✓	0.045	LLP-10
LM2773	5.5	2.5	1.6	1.8	300	1150	✓	0.048	micro SMD-9
Boost Converters									
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Switch Current (mA)	Frequency range (kHz)	On/Off Pin	Quiescent Current	Packaging
LM2750	5.6	2.7	5	5.2	0.12	1700	✓	5	LLP-10
LM2751	5.5	2.8	4.5	5	0.15	9.5 to 725	✓	0.425	LLP-10
LM2757	5.5	2.7	4.1	5	0.18	1242	✓	1.3	micro SMD-12
LM2753	5.5	3	5	5	0.4	725	✓	0.06	LLP-10
Buck-Boost Converters									
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Frequency range (kHz)	On/Off Pin	Quiescent Current	Packaging
LM2760	4.4	2	3.3	3.3	20	750	—	0.006	SOT23-5
LM3354	5.5	2.5	1.8	5	90	1000	✓	0.375	MSOP-10
Inverter/Doubler									
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Switching Frequency (kHz)	On/Off Pin	Quiescent Current	Packaging
LM2781	5.5	1.8	-5.5	-1.8	50	2100	—	0.7	micro SMD-8

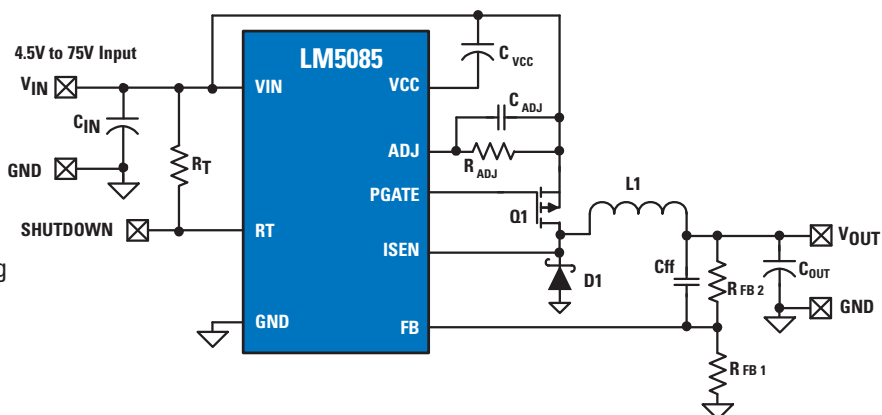
PowerWise product

Step-Down (Buck) Switching Controllers

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	10	2.7	0.8	1	1.5	0 to 1400	✓	Hysteretic	SOT23-5
LM3477	35	2.95	1.265	30.8	1.5	500 to 500	✓	Current	MSOP-8
LM3485	35	4.5	1.242	V _{IN}	2	0 to 1400	—	Hysteretic	MSOP-8
LM3489	35	4.5	1.239	V _{IN}	2	0 to 1400	✓	Hysteretic	MSOP-8
LM(2)5085	(42), 75	4.5	1.25	V _{IN}	2	1000	—	Constant On-Time	MSOP-8, LLP-8
LM(2)5088	(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 Max (V)	Output Min (V)	Feedback Tolerance %	Frequency Range and Sync (kHz)	On/Off Pin	Topology, PWM Mode	Error Flag	Packaging
LM1770	5.5	2.8	4.5	0.8	2	300 to 1000	—	Constant on-time	—	SOT23-5
LM1771	5.5	2.8	4.5	0.8	2	300 to 1000	✓	Constant on-time	—	LLP-6, MSOP-8
LM3743	5.5	3	4.6	0.8	1.75	300 to 1000	✓	Voltage	—	MSOP-10
LM2727/37	16	2.2	5/0.6	0.6/5	1.5	50 to 2000	✓	Voltage	✓	TSSOP-14
LM3495	18	2.9	0.6	5.5	1	200 to 1500, Sync	✓	Emulated Peak Current Mode	—	TSSOP-16
LM25115/A	42	4.5	13.5	0.75	1.7	100 to 1000, Sync	✓	SSPR, Voltage/current-injection	—	TSSOP-16
LM25116	42	6	36	1.215	1.5	50 to 1000, Sync	✓	Emulated Peak Current Mode	—	TSSOP-20EP
LM5115/A	75	4.5	13.5	0.75	1.7	50 to 1000, Sync	✓	Voltage/current-injection Valley current mode	—	TSSOP-16
LM5116	100	6	80	1.215	1.5	50 to 1000, Sync	✓	Emulated Peak Current Mode	—	TSSOP-20EP

PowerWise® product

Synchronous Step-Down (Buck) Switching Controllers

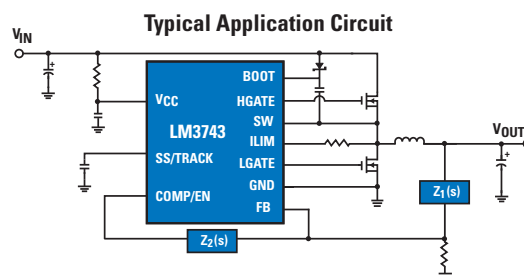
LM3743 – PowerWise® Synchronous 1 MHz Buck Controller with Programmable Tracking

Features

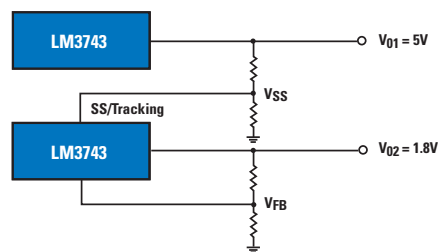
- IC and power supply input voltage from 3V to 5.5V
- Output voltage adjustable down to 0.8V
- $\pm 1.75\%$ reference accuracy over full temperature and input voltage range
- Externally programmable soft-start with tracking capability
- Low-side sensing programmable current limit without sense resistor
- 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



Tracking Multiple Rail Application



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

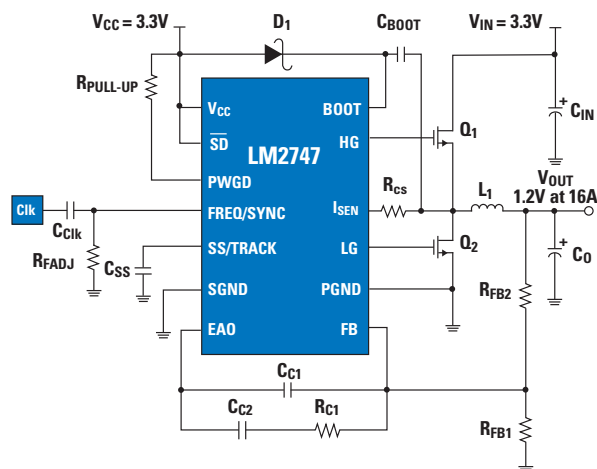
Synchronous Buck Controllers

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

PowerWise product

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



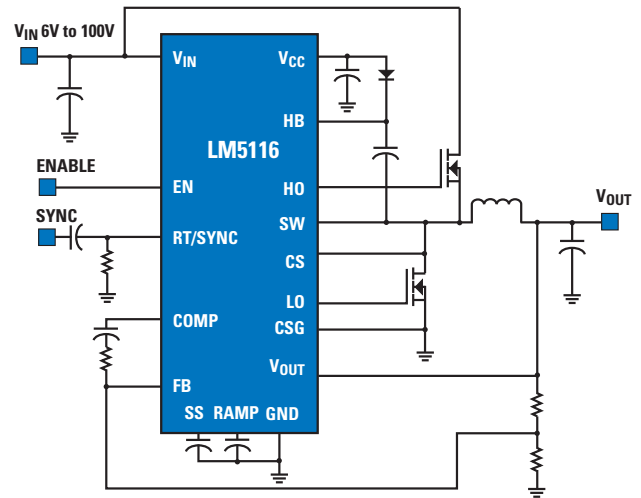
LM5116 – PowerWise® 6V to 100V Emulated Current-Mode Buck Controller

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 TSSOP-20EP packaging

Applications:

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



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

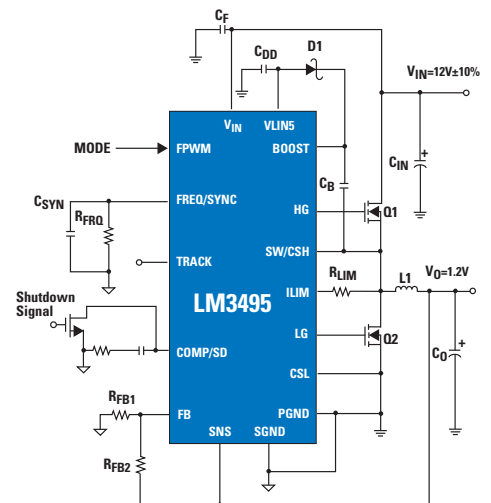
LM3495 – $\pm 1\%$ Accurate, Ultra-High Precision PWM Buck Controller

Features

- Input voltage from 2.9V to 18V
- Adjustable output from 0.6V to 5.5V
- Feedback accuracy: $\pm 1\%$ 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



Step-Up (Boost) Switching Regulators

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

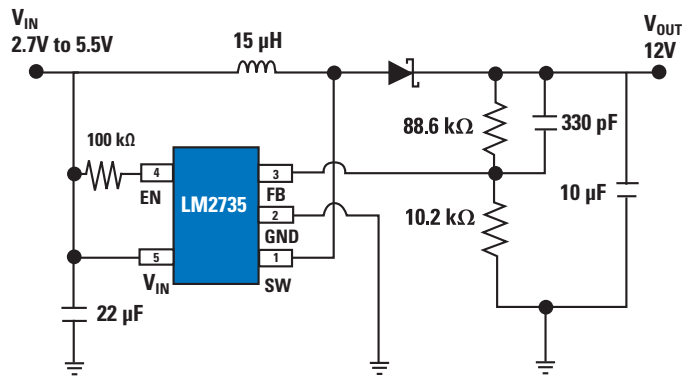
Features

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	1150 to 1900	4	28	✓	SOT23-5
LM2733	1	2.7	14	600, 1600	3	40	✓	SOT23-5
LM3668	1	2.5	5.5	1600 to 2700, Sync	2.8	5.0	✓	LLP-12
LM5001	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 100	—	18	✓	LLP-10
LM2698	1.35	2.2	12	600 to 1250	2.2	17	✓	MSOP-8
LM2731	1.5	2.7	14	600, 1600	1.23	22	✓	SOT23-5
LM2622	1.65	2	12	600 to 1300	1.26	12	✓	MSOP-8
LM3310	2	2.5	7	660 to 1280	V_{IN}	20	✓	LLP-24
LM3311	2	2.5	7	660 to 1280	V_{IN}	20	✓	LLP-24
LM5000	2	3.1	40	300, 600	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	2.25	2.7	5.5	475, 1500	3	24	✓	SOT23-5, MSOP-8, LLP-6
LM3224	2.6	2.7	7	615 to 1250	V_{IN}	20	—	MSOP-8
LM2585	3	4	40	100	1.23	12	—	TO263-5, TO220-5
LM2586	3	4	40	100 to 200, Sync	1.23	12	—	TO263-7, TO220-7
LM2700	3.6	2.2	12	600 to 1250	1.26	17.5	✓	LLP-14, TSSOP-14
LM2587	5	4	40	100	1.23	12	—	TO263-5, TO220-5
LM2588	5	4	40	100 to 200, Sync	1.23	12	✓	TO263-7, TO220-7

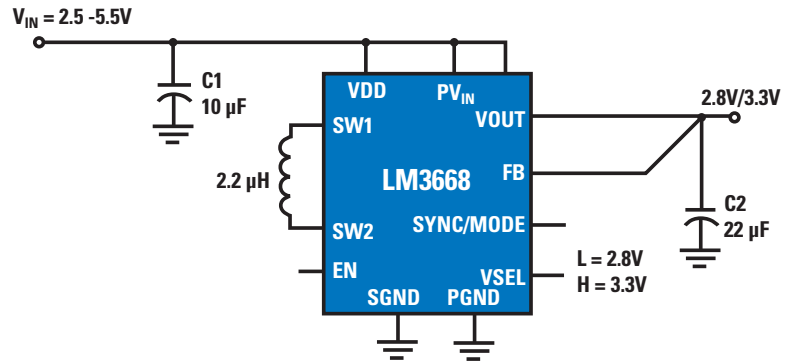
PowerWise product

Boost and Buck-Boost Regulators

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 I_q (45 μ A) 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

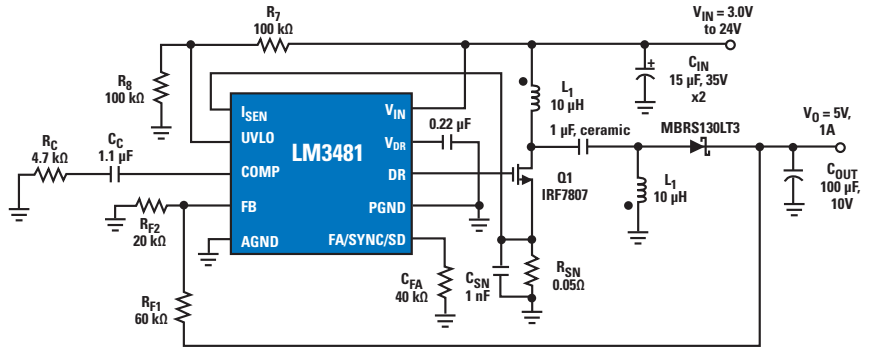
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Switch Current (A)	Frequency Range (kHz) and Sync	PWM Mode	Topology	Packaging
LM5002	75	3.1	Undefined	Undefined	0.5	50 to 1500, Sync	Current Mode	Boost	SO-8, LLP-8
LM3668	5.5	2.5	2.8	3.3	1	1600 to 2700, Sync	Auto PWM/PFM	Buck-Boost	LLP-12
LM5001	75	3.1	Undefined	Undefined	1	50 to 1500, Sync	Current Mode	Boost	SO-8, LLP-8
LM5015	75	4.25	Undefined	Undefined	1.2	25 to 750, Sync	Current Mode	Two-Switch Forward	TSSOP-14
LM2611	14	2.7	-1.23	Undefined	0.9, 1.2	1400	CUK	Inverting	SOT23-5

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 μ A 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



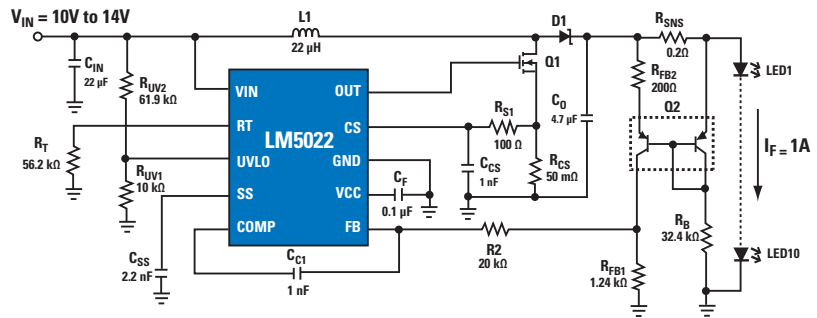
Applications:

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

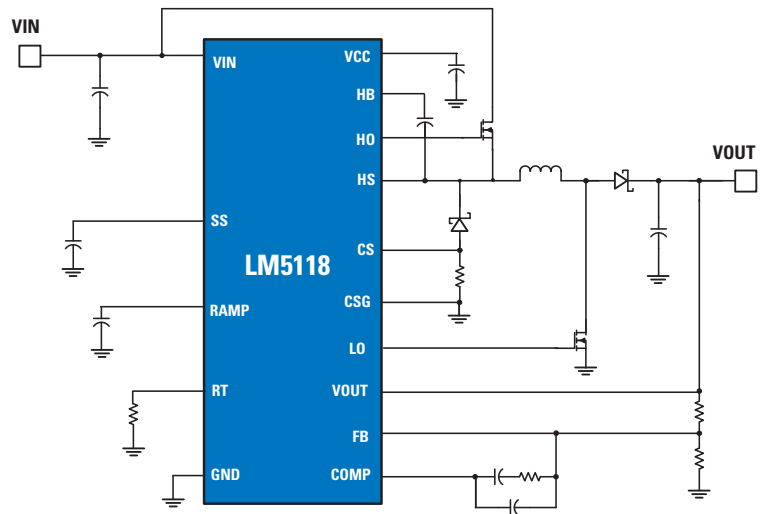
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min Voltage (V)	Frequency Range (kHz) and Sync	On/Off Pin	Topology	Packaging
LM5021	30	8	Set by external feedback network	50 to 1000, Sync	✓	Flyback, Forward	MSOP-8
LM3430	40	6	1.25	50 to 2000, Sync	—	Boost	LLP-12
LM3478	40	2.95	1.26	100 to 1000, Sync	✓	Boost, Sepic, Flyback	MSOP-8
LM3488	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	60	6	1.25	50 to 2000, Sync	✓	Boost, Sepic	MSOP-10
LM5020	100	13	Set by external feedback network	50 to 1000, Sync	✓	Flyback, Inverting, Buck, Boost, Forward	MSOP-10, LLP-10

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

LM5118 – Wide Voltage Range 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



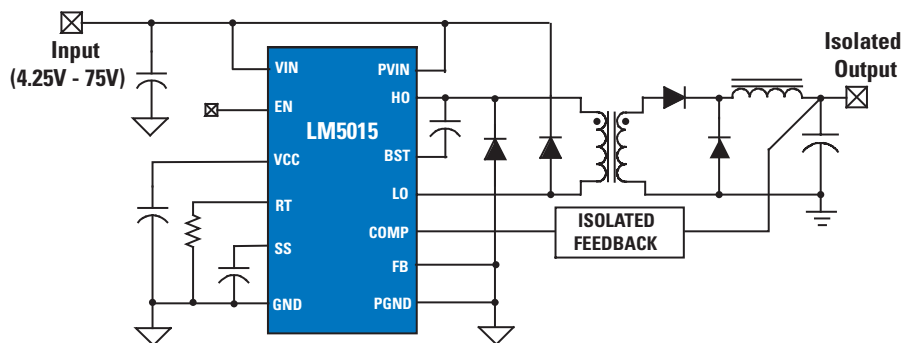
Applications:

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

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

Features

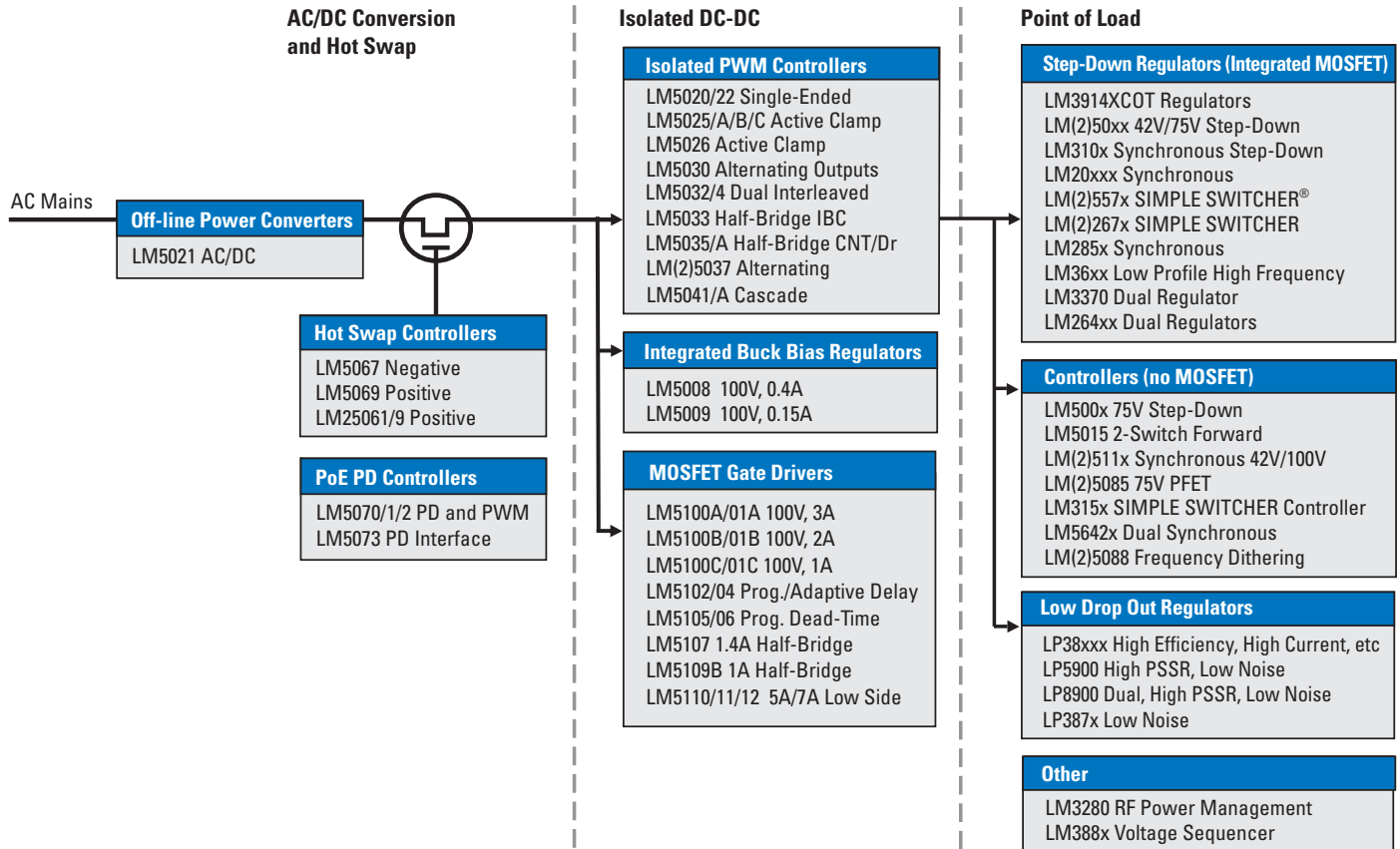
- Dual Integrated 75V N-Channel MOSFETs
- Ultra-wide input voltage range: 4.25V to 75V
- Integrated high voltage bias regulator
- Adjustable output voltage
- 1.5% feedback reference accuracy
- Current mode control with selectable compensation
- Wide bandwidth error amplifier
- Integrated current sensing 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 Ethernet-powered devices

LM5000 Series High-Voltage Power IC Family



Product ID	Description
Integrated Switching Regulators	
LM5000	Wide 3.1V to 40V input, 2A switch PWM boost or flyback
LM5001	Wide 3.1V to 75V input, 1A switch PWM for Boost, Flyback, SEPIC
LM5002	Wide 3.1V to 75V input, 0.5A switch PWM for Boost, Flyback, SEPIC
LM5005/LM25005	9V to 75V/42V input 2.5A buck regulator
LM5007/LM25007	9V to 75V/42V input, 500 mA step-down with fast transient response
LM5008	9V to 100V input, 350 mA step-down with fast transient response
LM5009	9V to 100V input, 150 mA step-down with fast transient response
LM5010A/LM25010	6V to 75V/42V input, 1A step-down with fast transient response
LM5015	Wide 4.25V to 75V input, two 1A switches and PWM 1A switch PWM for Two-Switch Forward and Flyback
PWM Switching Controllers	
LM5020 	Single-ended 100V current-mode PWM controller
LM5021	AC-DC current mode PWM controller
LM5025/A/B 	Active-clamp voltage-mode 100V PWM controller with feed-forward and 3A gate driver
LM5026 	Active-clamp current-mode 100V PWM controller with 3A gate driver
LM5030 	100V push-pull current-mode PWM controller with synchronization
LM5032 	High-voltage dual interleaved current mode PWM controller
LM5033 	100V push-pull voltage-mode IBC PWM controller with synchronization
LM5034 	High-voltage dual interleaved current mode controller with active clamp
 LM5037 	100V alternating output PWM controller
 LM25037 	Dual-mode PWM controller with alternating outputs
LM5041/A 	100V input cascaded PWM controller
LM(2)5115/A 	Secondary side post regulator controller or synchronous buck controller
LM(2)5116 	6V to 42V/100V current-mode synchronous buck controller
LM5118 	Wide 3V to 75V input, buck-boost controller
LM5035A 	High-performance, half-bridge PWM controller-driver for compact, efficient converters
 LM5085/LM25085 	4.5 to 75V/42V constant on-time PFET buck switching controller
 LM5088/LM25088 	4.5 to 75/42V non-synchronous buck controller
MOSFET Drivers	
LM5100A/B/C/1/2/4	Dual FET drivers for 100V synchronous buck and bridge topologies
LM5105/07/09	100V half-bridge power MOSFET drivers
LM5110/11/12	Single and dual high-current MOSFET drivers
Load Share Controller	
LM5080	Modular current-sharing controller
Hot Swap Controllers	
LM5067	Negative high-voltage hot swap/inrush current controller with power limiting
LM5069	Positive high-voltage hot swap/inrush current controller with power limiting
Power-over-Ethernet Powered Device Controllers	
LM5070 	Integrated Power-over-Ethernet PD interface and PWM controller
LM5071 	Integrated Power-over-Ethernet PD interface and PWM controller with auxiliary power support
LM5072 	100V Integrated Power-over-Ethernet PD interface and PWM controller with auxiliary power support
LM5073 	100V Power-over-Ethernet PD interface with auxiliary support and flexible DC-DC regulator selection

 PowerWise® product

Switching Regulators and Controllers for Isolated Applications

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

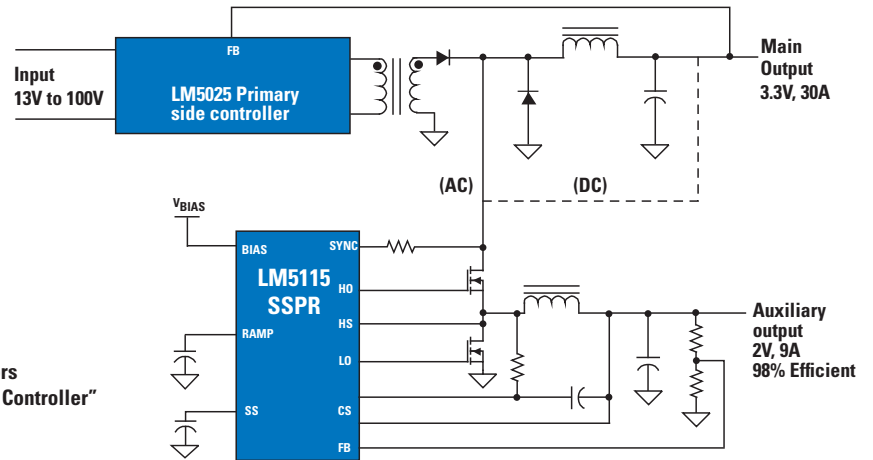
Features

- 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 LMH5115 'Dual Personality Controller'" www.national.com/online seminars



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	✓	Null/2.5	Cycle-cycle	Voltage/current-injection	Synchronous secondary-side post-regulator	LLP-16, TSSOP-16
LM5015 	75	4.25	750	✓	—	Cycle-cycle	Current	Two-switch forward	TSSOP-14EP
LM(2)5037 	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 	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 	100	8	1000	✓	3	Cycle-cycle, hiccup	Current	Forward active clamp	LLP-16, TSSOP-16
LM5030 	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 	100	15	1000	✓	1.5	Hiccup	Voltage	Push-pull, half-bridge, full-bridge, IBC	MSOP-10, LLP-10
LM5034 	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

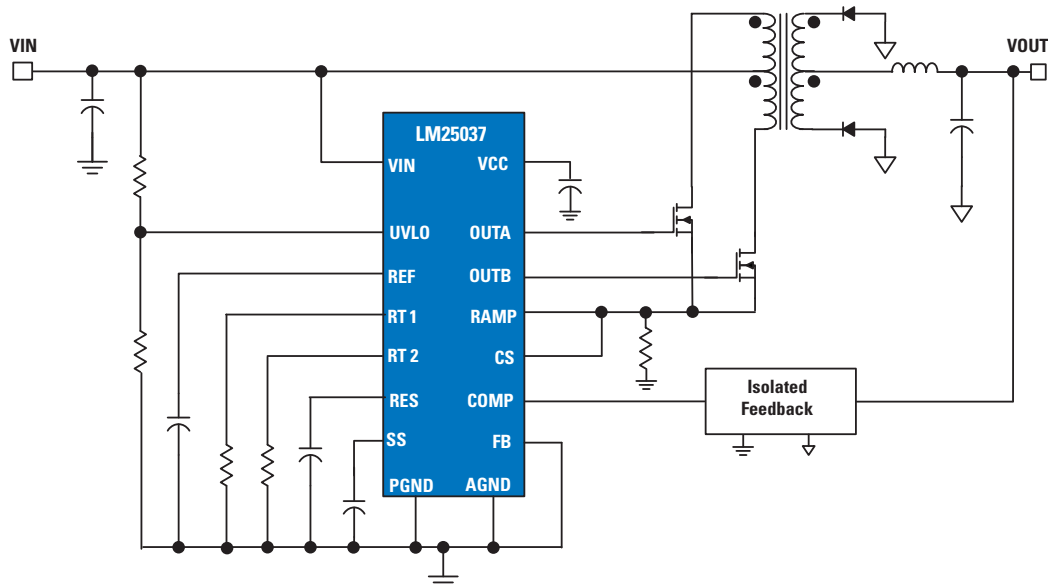
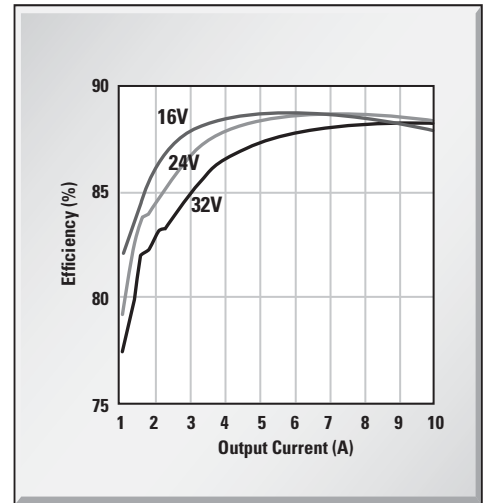
LM25037 – Dual-Mode PWM Controller with Alternating Outputs

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 1 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

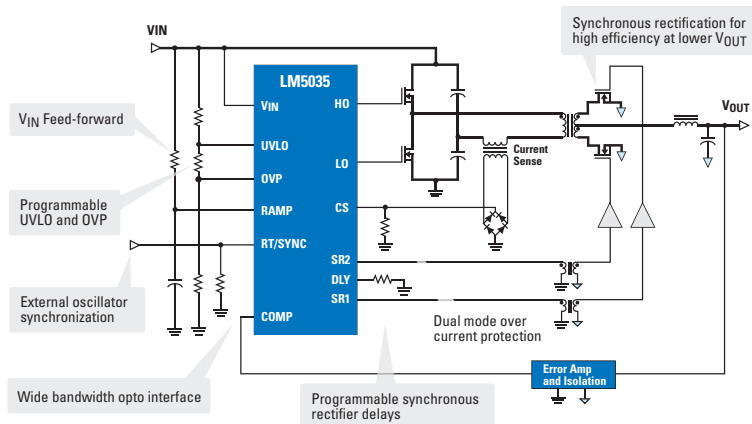


Isolated Controllers

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



Watch our Online Seminar on
“Half-Bridge Power Converter Design Using the LM5035A”

www.national.com/onlineseminars

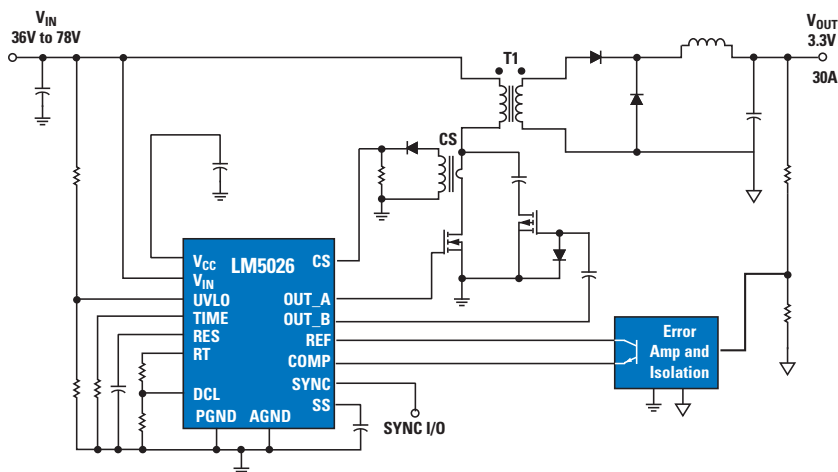
LM5026 – PowerWise® Simplified Forward Power Converter with Active Clamp Reset

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:

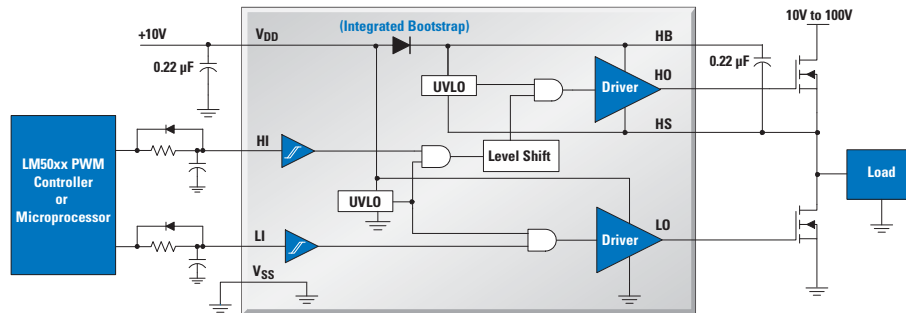
Ideal for use in telecommunications, automotive, networking equipment, and industrial applications



Watch our Online Seminar on
“Introduction to Forward Power Converters Utilizing Active Clamp Reset”

www.national.com/onlineseminars

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	100	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	N/A	3.5	14	5	2	25	25	25	Dual, independent	LLP-10, SO-8
LM5111	Forward, Push-Pull, etc	N/A	3.5	14	5	3	25	25	25	Dual, independent	SO-8
LM5112	Forward, Push-Pull, etc	N/A	3.5	14	7	3	25	N/A	25	Dual, independent	LLP-6

Note: This table sorted by peak sink current

Applications:

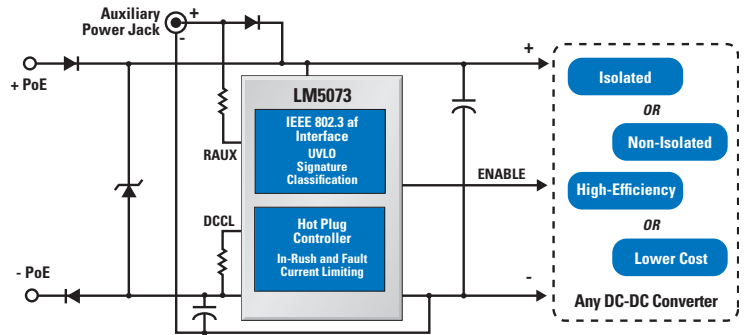
Ideal for use in telecommunications, networking equipment, automotive, motor driver systems, and industrial applications

Power-over-Ethernet Controllers

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



Watch our Online Seminar on
“Power Supply Design for POE-Powered Devices”
www.national.com/online seminars

Applications:

VoIP telephony, security cameras, wireless access points, IEEE 802.3af-compliant PoE powered devices, non-compliant, application specific devices, 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	60	1.8	1	✓	13	48V Front only	2	0.7	LLP-16, TSSOP-16
LM5071	75	1.8	1	✓	13	48V Front only	2	0.7	TSSOP-16
LM5072	100	9	0.7	✓	25	Fully configurable front/rear	2	0.7	TSSOP-16EP

PowerWise product

Power-over-Ethernet Powered Device Interface

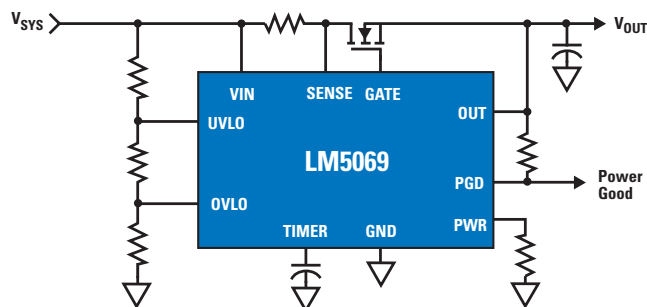
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Hot Swap FET RDS (ON) Typ (Ω)	Integrated DC-DC controller	Output Power (W)	Auxiliary Support	Packaging
LM5073	100	9	0.7	—	25	Fully configurable front/rear	TSSOP-14EP

Hot Swap/In-Rush Current Controllers

LM506x – 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 for fast response to fault current conditions
- Internal high-side charge pump and gate driver for external N-channel MOSFET (LM5067)
- Available in latched fault and automatic restart versions



Applications:

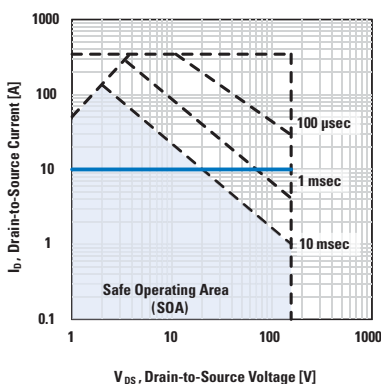
Ideal for use in server backplane systems, basestation power distribution systems, 24/48V industrial systems, in-rush current limiting, solid-state circuit breakers, solid-state relays, transient voltage protection, and POWER GOOD detectors

Power Limiting Protects External Pass Device for Improved System Reliability

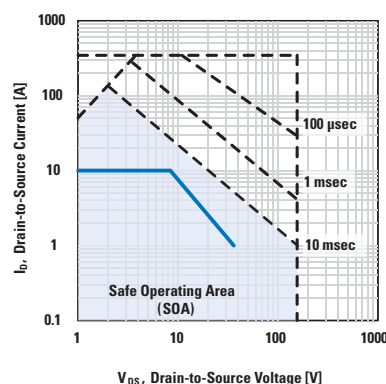
To ensure system reliability, any MOSFET must operate within its Safe Operating Area (SOA) in order to avoid FET failure. National's LM506x hot swap controllers provide both current and

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}



LM506x: 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	-9V to -80	V_{DS}	✓	✓	✓	✓	✓	Both	MSOP-10, LLP-10
LM5069	+9 to +100	V_{DS}	✓	✓	✓	✓	✓	Both	MSOP-10

Low Dropout (LDO) Linear Regulators

LP38xxx Family of High-Performance CMOS LDOs Power Digital ICs

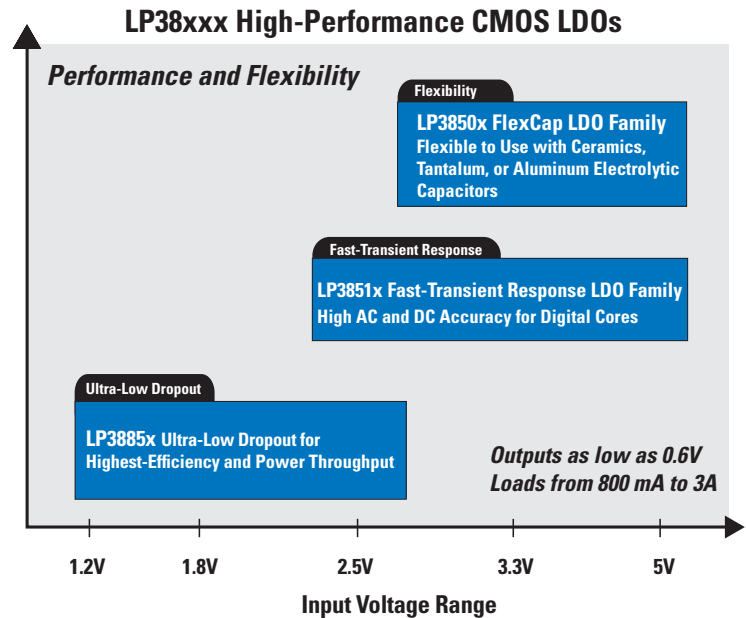
Performance and Flexibility

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:

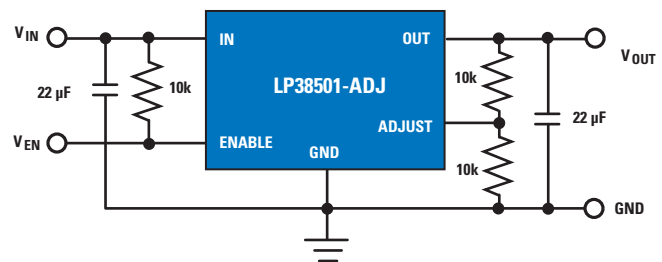
- Flexible to use with ceramics, tantalum, aluminum electrolytic capacitors
- Supports input voltages from 1.2V, 1.5V, 1.8V, 2.5V, 3.3V, and 5V rails
- Load currents from 800 mA to 3A with the same pin-out



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	1.5	2.7	5.5	Adj down to 0.6	220	✓	TO263-, LLP-8
LP38501	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

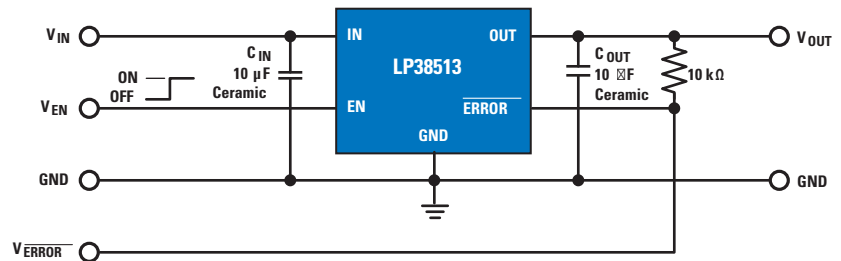
To see a more complete list and to learn more about LDOs, visit:

www.national.com/LDO

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 μ F ceramic capacitors
- Error flag feature
- Available in TO220-5 or TO263-5 packaging



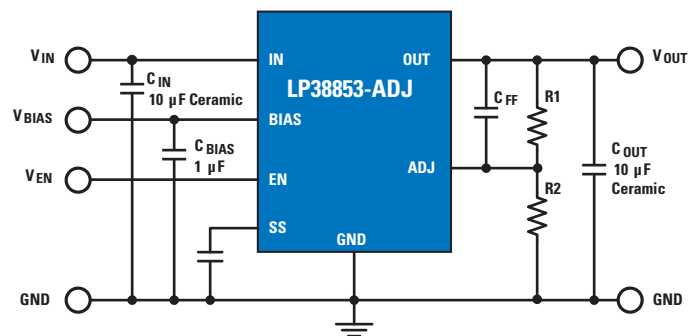
Product ID	Load Current (A)	V _{IN} Min (V)	V _{IN} Max (V)	V _{OUT} (V)	Error Flag	Enable	Packaging
LP38511	0.8	2.25	5.5	1.8, Adj down to 0.8V	✓	✓	TO263-5
LP38512	1.5	2.25	5.5	1.8, Adj down to 0.8V	✓	✓	TO263-, LLP-8
LP38513	3.0	2.25	5.5	1.8, Adj down to 0.8V	✓	✓	TO263-5

See more at www.national.com/lldo

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	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	3	Adj 0.8 to 1.8	✓	✓	✓	450	PSOP-8, TO263-7
LP38856	3	0.8V, 1.2	—	✓	—	450	TO263-5, TO220-5
LP38859	3	0.8V, 1.2	—	—	✓	450	TO263-5, TO220-5

Wide Input Voltage LDOs

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	150	5.5	1.8	0.2	1.3, 1.5, 1.8, 2.0, 2.5, 2.8, 3, 3.3	✓	SOT23-5, SC70-5
LP3991	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	350	4.5	0.9	0.088, 0.128	.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, Undefined	0.05	✓	.8, 1.2, 1.3, 1.5, 1.8, 2.5, 2.8, 3	micro SMD-4
LP3981	300	6	2.7	0.132	0.07	✓	2.5, 2.7, 2.8, 2.83, 3.03, 3.3	LLP-6, MSOP-8
LP3982	300	6	2.5	0.12	0.09	✓	1.8, 2.5, 2.82, 3.3, Adj	LLP-8, MSOP-8

Multi-Output LDOs

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output1 V_{OUTMin}	Output2 V_{OUTMin}	Output1 I_{OUTMax}	Output2 I_{OUTMax}	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	0.34	—	—	micro SMD-8, MSOP-8
LP3986	6	2.5	2.5	2.8	300	150	0.06	0.075	—	—	micro SMD-8
LP3996	6	2	0.8	0.8	150	300	0.21	0.07	✓	✓	LLP-10
LP5996	6	2	0.8	0.8	150	300	0.21	0.07	—	—	LLP-10
LP8900	5.5	1.8	2.7	1.8	280	280	0.11	90	—	—	micro SMD-6

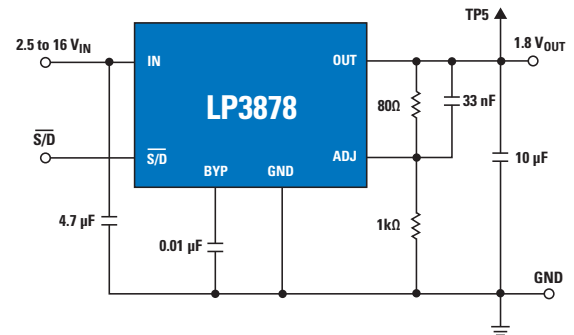
Low-Noise LDOs to Power RF and Analog Circuits

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

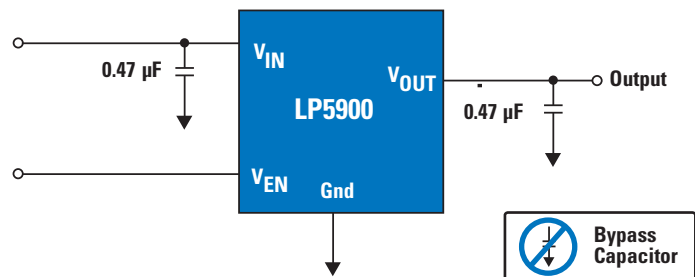
Typical Application Circuit



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 I_q 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
LP3995	150	6	2.5	0.06	1.9, 2.8, 3	—	—	0.085	60	25	micro SMD-5, LLP-6
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	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	3.3	✓	✓	6	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	—	✓	0.1	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

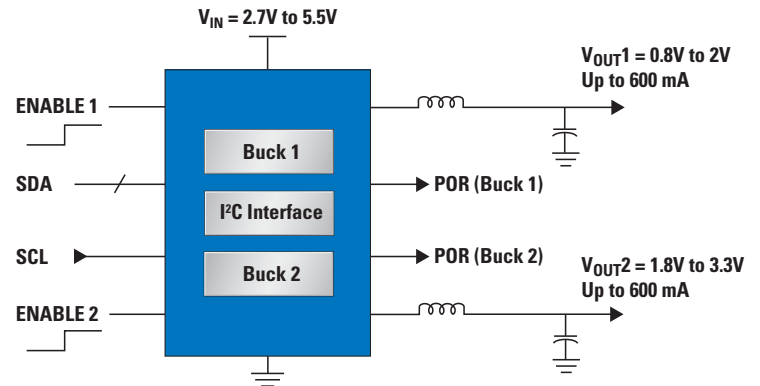
PowerWise product

Multi-Output Switching Regulators

LM3370 – PowerWise® Dual Buck Regulator Provides Highest Efficiency for FPGAs and Multimedia Processors

Features

- Automatic PFM-PWM mode switching provides high efficiency at all loads
- I²C DVS interface scales power to match processor clock frequency
- Lowest I_q (<20 μA) extends battery life
- 2 MHz operation enables smaller external components and minimizes footprint
- Power-on-reset prevents fault condition in processors
- Spread spectrum reduces noise (ideal for RF systems)
- Available in LLP-16 micro SMD packaging



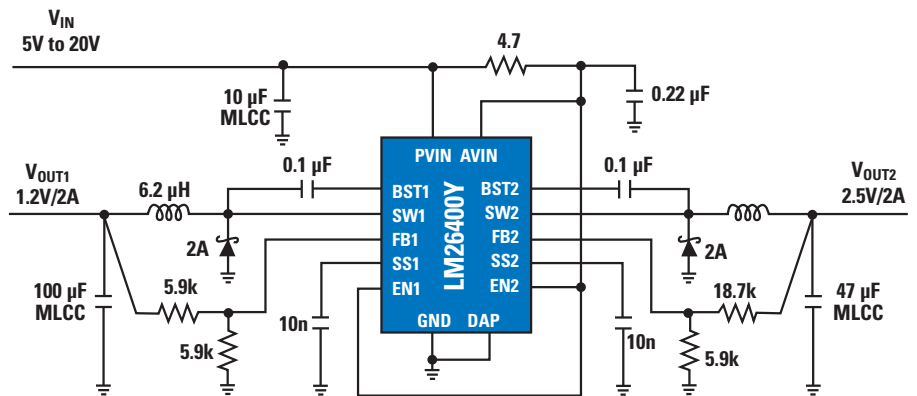
Applications:

Ideal for use in low-power FPGAs, CPLDs, and application processors

LM26400Y – Dual 2A Wide Input Range Buck Regulator

Features

- Input voltage range of 3V to 20V
- Dual 2A output
- Output voltage down to 0.6V
- Internal compensation
- 500 kHz PWM frequency
- Separate enable and soft-start pins
- Frequency foldback protection
- Available in eTSSOP-16 and LLP-16 packaging



Applications:

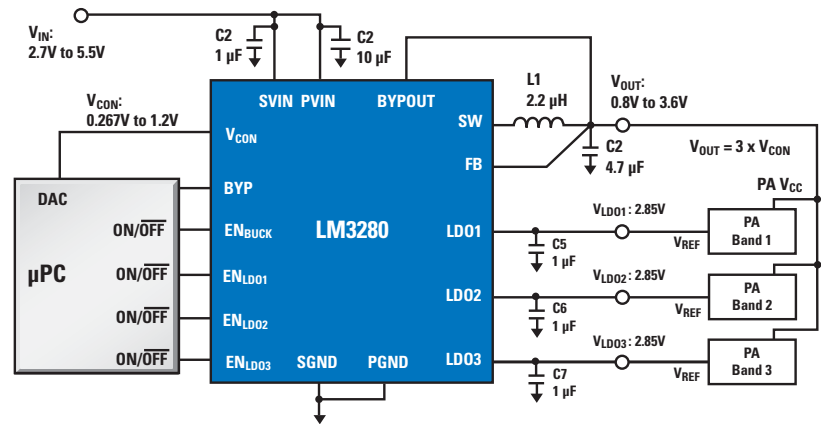
Ideal for use in powering point-of-loads in broadband modems/routers, POS terminals/scanners, security/surveillance systems, set-top boxes, DTV-LCD displays, computing peripherals, and industrial controls

Multi-Output Switching Regulators

LM3280 – Adjustable Buck DC-DC Converter and 3 LDOs for RF Power Management

Features

- 2 MHz PWM switching frequency
- Operates from a single Li-Ion cell (2.7V to 5.5V)
- Adjustable output voltage (0.8V to 3.6V) DC-DC
- High-efficiency synchronous buck converter
- 300 mA maximum load capability (PWM mode)
- 500 mA maximum load capability (bypass mode)
- PWM, forced and automatic bypass mode
- 3 low-dropout and fast transient response LDOs
- Current overload protection
- Thermal overload protection
- Available in micro SMD-16 packaging



Applications:

Ideal for use in handset multi-band PA chipset power, handheld radio, and other battery operated RF devices

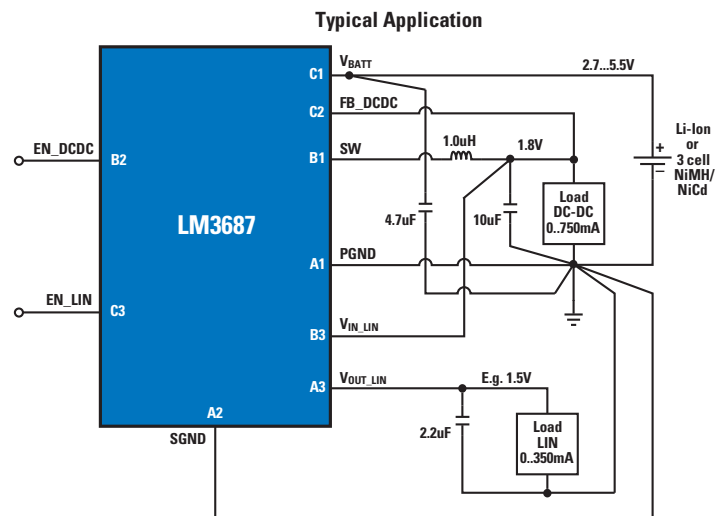
LM3687 – PowerWise® DC-DC Converter with Integrated Linear Regulator in Tiny Package

Features

- Combined load current of 750 mA
- Dual output voltage rails (DC-DC converter: 1.8V, linear regulator: 1.5V)
- Automatic PFM/PWM mode switching maximizes battery life
- Design flexibility for independent or combined operation
- Fast 1.8 MHz switching frequency decreases solution size
- Low quiescent current prevents excessive current loss in standby mode
- Startup mode option when input voltage for linear regulator is not sufficiently high
- Available in tiny micro SMD-9 packaging for optimizing solution size

Applications:

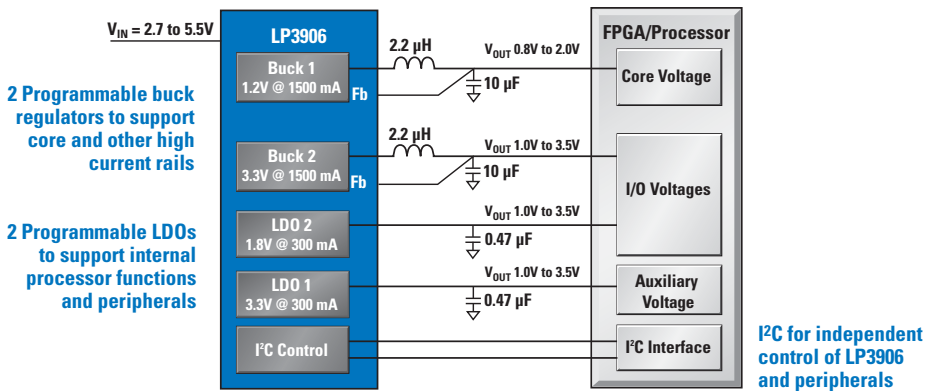
Ideal for use in mobile phones, handheld radios, PDAs, Palm-top PCs, portable instruments, and battery-powered devices



LP3906 – PowerWise® Dual High-Current Buck Regulator and Dual Linear Regulator with I²C-Compatible Interface

Features

- Compatible with advanced applications processors and FPGAs
- Low input, low output voltage LDOs
- Additional external enables for each regulator output and a separate enable for the built-in sequence
- I²C-compatible interface for independent control of device functions and settings
- Thermal overload protection
- Current overload protection
- Spread spectrum reduces noise
- Available in LLP-24 packaging



Applications:

Ideal for use in powering application processors, DSPs and FPGAs: Altera Cyclone Series, and Xilinx Spartan series

LP3907 – PowerWise® Dual High-Current Buck Regulator and Dual Linear Regulator with I²C-Compatible Interface

Features

Buck DC-DC Converter

- 1A/600 mA output current
- Programmable V_{OUT} from:
 - Buck1 : 0.8V to 2.0V at 1A
 - Buck2 : 1.0V to 3.5V at 600 mA

Linear Regulators (LDO)

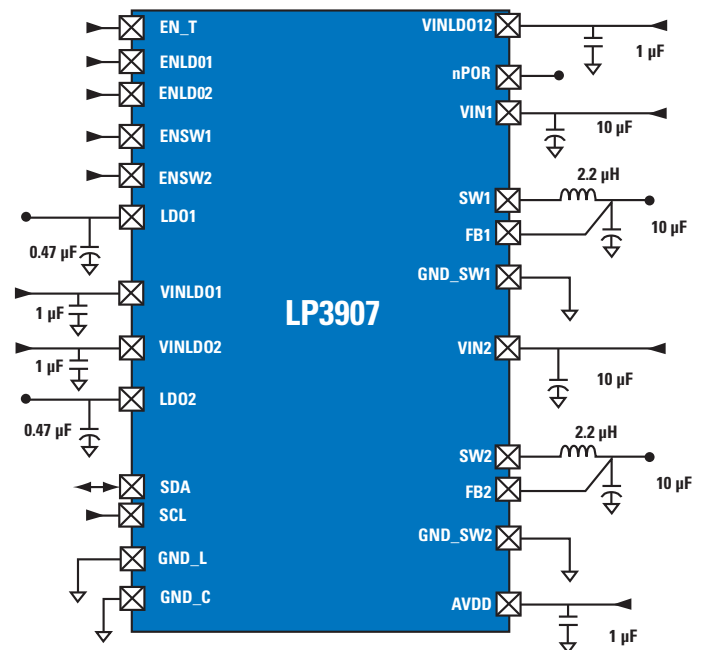
- Programmable V_{OUT} of 1.0V to 3.5V
- 300 mA output current
- Low input, low output

Features

- External power-on-reset function for Buck1 and Buck2
- Compatible with advanced applications processors and FPGAs
- I²C-compatible interface for independent control of device functions and settings
- Available in LLP-24 and μ SMD packaging

Applications:

Ideal for use in WiFi chipset power, mobile-TV chipset power, WiMax chipset power, handset sub-system power, and FPGA power



Multi-Output Switching Regulators

LM26480 – Dual High-Current Buck Regulator and Dual Linear Regulator with Externally Controlled Voltage Outputs

Features

- 1.5A output current
- V_{OUT} from:
 - Buck1 : 0.8V to 2.0V at 1.5A
 - Buck2 : 1.0V to 3.3V at 1.5A
- Up to 96% efficiency
- $\pm 3\%$ FB voltage accuracy
- 2 MHz PWM switching frequency
- PWM - PFM automatic mode change under low loads
- Automatic soft-start

Linear Regulators (LDO)

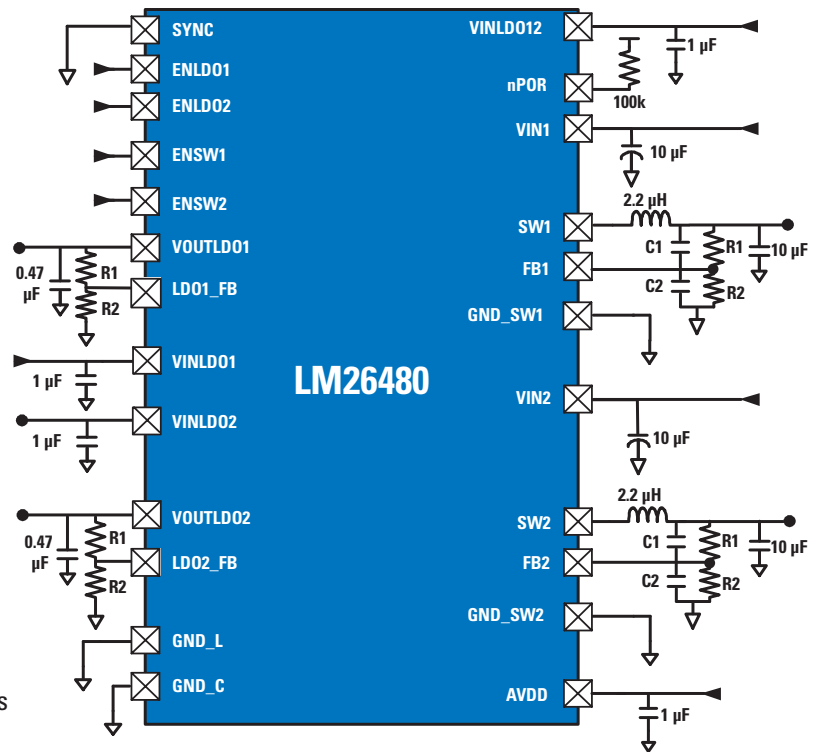
- V_{OUT} of 1.0V to 3.5V
- $\pm 3\%$ FB voltage accuracy
- 300 mA output current
- 25 mV (typ) dropout

Features

- Compatible with advanced applications processors and FPGAs
- 2 LDOs for powering internal processor functions and I/Os
- Precision internal reference
- Thermal overload protection
- Current overload protection
- External Power-On-Reset function for Buck1 and Buck 2
- Undervoltage lock-out detector to monitor input supply voltage
- Available in LLP-24 packaging (4 x 4 x 0.8 mm)

Applications

Ideal for use in core digital power, applications processors, and peripheral I/O power



LP3910/13 – PowerWise® Power Management ICs for Portable Media Players

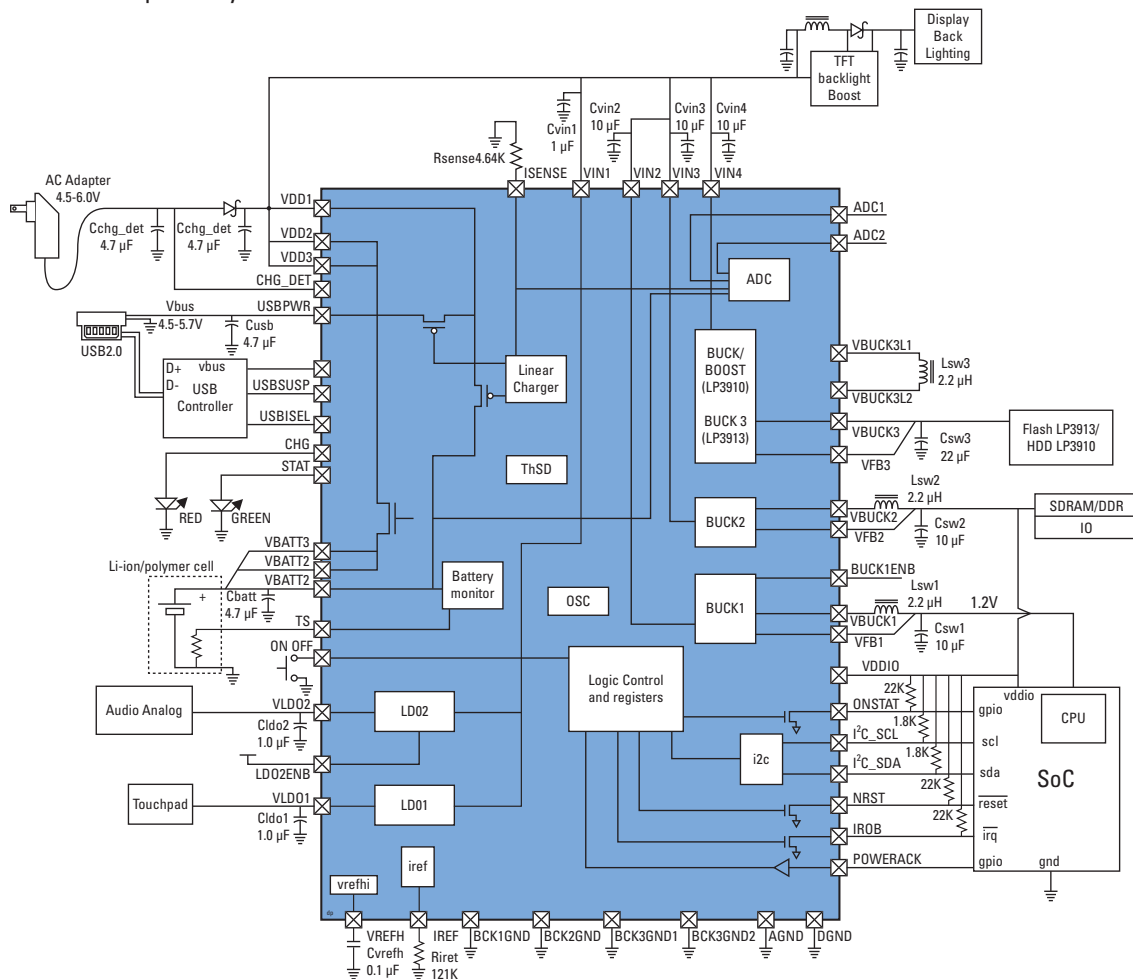
Features

- Wide load range buck-boost DC-DC converter (LP3910) targeting hard disk drive power management to maintain a constant 3.3V output with a varying battery input voltage
- Linear constant-current/constant-voltage charger for single cell Li-Ion batteries
- Green and red LED charger status Indicators
- 4-channel 8-bit dual slope A/D converter
- High-efficiency DVS buck converters: 2 (LP3910) and 3 (LP3913)
- 400 kHz I²C-compatible interface
- USB and adapter charging
- System power supply management including power routing
- Voltage and thermal supervisory circuits

- Continuous battery voltage monitoring
- Interrupt request output with 8 sources
- LP3913 is pin-for-pin compatible with the LP3910 hard drive based PMIC
- Available in 6 x 6 x 0.8 mm LLP-48 packaging

Applications

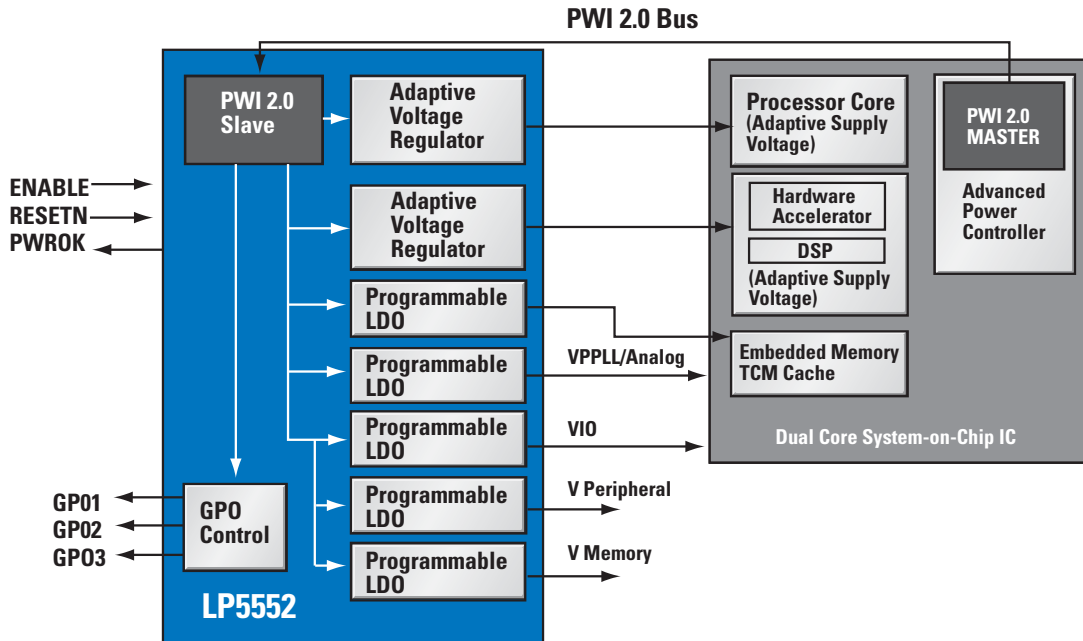
Ideal for use in powering portable gaming devices, portable media players, hard drive-based MP3 players (LP3910), flash-based portable media players (LP3913), portable navigation systems (LP3913)



Read the Application Note: "Powering Portable Media Players (PMP) with Innovative Solutions" go to www.national.com/analogedge

PowerWise® AVS Energy Management Units

LP5552 – 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	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	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

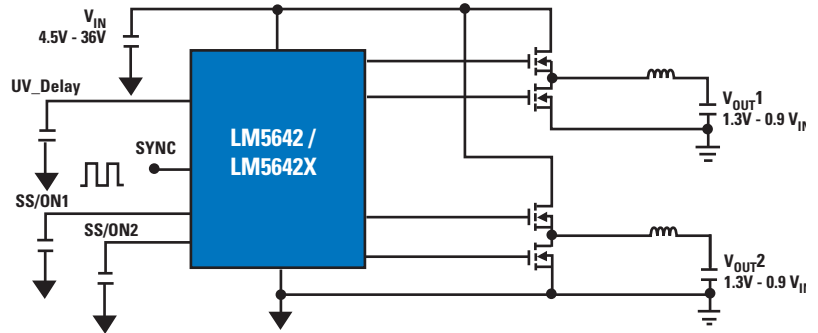
PowerWise product

Multi-Output Switching Controllers

LM5642x – PowerWise® High-Voltage, Dual Synchronous Buck Converter with Oscillator Synchronization

Features



- Two synchronous buck regulators
- 180° out-of-phase operation
- 200 kHz fixed nominal frequency: LM5642
- 375 kHz fixed nominal frequency: LM5642x
- Synchronizable switching frequency from 150 kHz to 250 kHz for the LM5642, and 200 kHz to 500 kHz for the LM5642x
- Available in TSSOP-28 packaging




Applications:

Ideal for use in embedded computer, navigation systems, telecommunications, set-top boxes, and Point-of-Load (POL) architecture

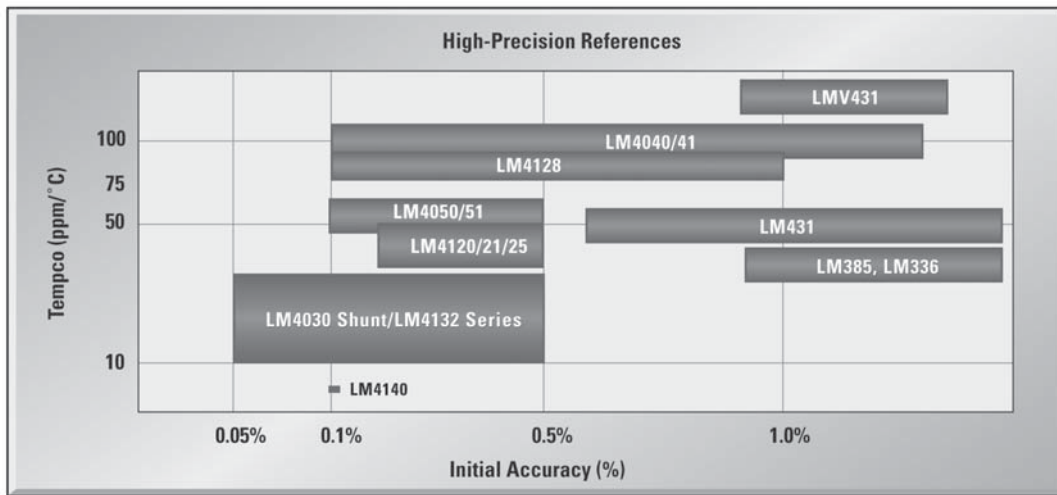
Multi-Output Switching Controllers

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Feedback Tolerance %	Frequency Range & Sync (Hz)	On/Off Pin	Error Flag	Channels	Topology, PWM mode	Packaging
LM2647	28	5.5	0.6	5	1.5	200 to 500	—	—	2	Voltage with V_{IN} Feedforward	LLP-28, TSSOP-28
LM2642	30	4.5	1.3	13.5	2	300	✓	✓	2	Buck	TSSOP-28
LM5642 	36	4.5	1.3	34.5	1.5	150 to 250, Sync	—	—	2	Current	TSSOP-28
LM5642X 	36	4.5	1.3	34.5	1.5	200 to 500, Sync	—	—	2	Current	TSSOP28-EP, TSSOP-28

 PowerWise product

Voltage References

LM4030 – High-Precision Shunt Reference Features 0.05% Initial Accuracy and Low 10 ppm 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	1.2	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

Power Sequencers and Supervisors

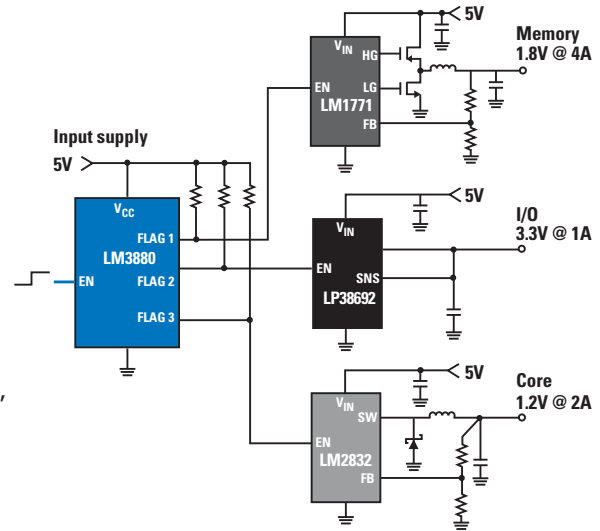
LM3880 – Industry’s Easiest and Smallest Solution for Multiple-Rail Power Sequencing

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:

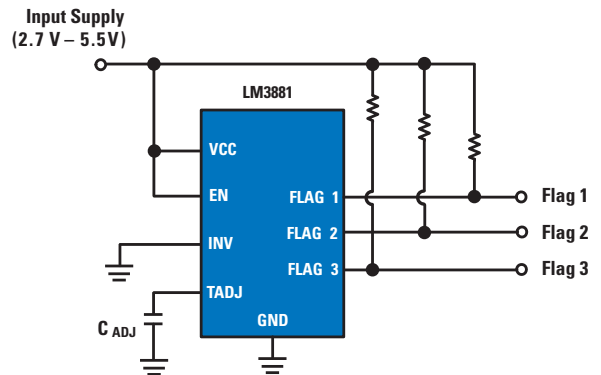
Ideal for use in sequencing power rails of digital logic devices (ASICs, FPGAs, DSPs, microcontrollers) to avoid latch-up conditions, and systems with multiple rails



LM3881 – Adjustable Power Sequencer

Features

- Input voltage: 2.7V to 5.5V
- 20 μ A 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



Supervisors

Product ID	Active Reset	Voltage Rails Supervised ¹	Reset Timeout Period (ms)	I _q (μ A)	Manual Reset	Low Line Output	PFI Comparator	Watchdog	Temp Range ($^{\circ}$ 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

¹Most 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.

WEBENCH® LED Designer

WEBENCH® LED Tool for the Optimal LED and a Complete Power Supply Design in Minutes

1. Choose an LED at national.com/led

Enter your requirements and receive a list of LEDs from the leading manufacturers

2. Design Your Power Supply

Select a PowerWise® LED driver from the optimized short list provided

3. Complete Your Design

Optimize between efficiency and size

4. Verify Your Design

Use the electrical simulator to verify circuit stability and operation

5. Order a Customized Prototype Kit

Guaranteed to ship in just one business day

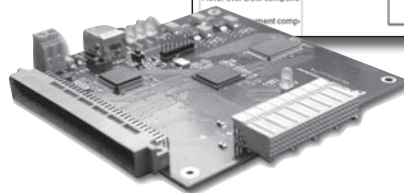
The image displays several screenshots of the WEBENCH LED Designer software interface. The top screenshot shows the 'LED Reference Guide Selector' window with a navigation bar and a list of LED options. The middle screenshot shows the 'LED Reference Guide Selector' window with a list of LED options and a table of components. The bottom screenshot shows the 'WEBENCH® - Electrical Simulator' window with a circuit diagram and simulation controls.

Vendor	Family	Color	Vf	Ia	Lt	Phy	View
Cree	XLamp®-4550	blue	3	0.125	8.4		
Cree	XLamp®-4550	cyan	4	0.125	4.5		
Cree	XLamp®-4550	green	4	0.125	18		
Cree	XLamp®-4550	red	3	0.125	12		
Cree	XLamp®-4550	royal blue	4	0.125	8.4		
OSRAM	Advanced Power TOPLED®	LA-GASP	amber	2.1	0.14	16.8	
OSRAM	Advanced Power TOPLED®	LR-GASP	red	2.1	0.14	13.4	

Part	Manufacturer	Part#	Attributes	Top View
Cb	Vishay-Metromon	VJ1206Y103KQBAT4X	0.01 uF	Select Alternate Part
Chyp	TDK	C3216X7R2A104K	0.1 uF	Select Alternate Part
Clm	Murata	GRM31MR71E103K	NumCaps=3 1 uF	Select Alternate Part

Watch Analog by Design
"Driving High-Power LEDs
Without Getting Burned"

Try the WEBENCH LED Designer tool today at:
www.national.com/LED



Applications for High-Brightness LED Drivers

National Offers a Diverse Portfolio of Constant-Current Regulators for Driving LEDs

Features

- PowerWise® energy-efficient solutions
 - Providing the best power-to-performance ratios
 - Enabling reliable and robust solutions
- Cutting-edge features including dimming, thermal management, fault protection, and more
- 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	✓				✓					✓	

Bold = Featured

LED Drivers

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	2.7 to 5.5	18	20	4	2 to 8	PWM	Variable switching frequency	SOT23-6
LM3500	2.7 to 7	16, 21	30	5	1	PWM	Low feedback voltage; no external Schottky diode	micro SMD-8
LM3501	2.7 to 7	16, 21	30	5	1	Analog	No external Schottky diode	micro SMD-8
LM3502	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	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	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	2.7 to 5.5	21.2	30 per string	10	1.27	I ² C	Dual-current sinks; 32 exponential dimming steps; 800:1 dimming ratio	LLP-10
LM3528	2.7 to 5.5	20	30 per string	10	1.27	I ² C	Dual-current sinks, 128 logarithmic dimming steps; 800:1 dimming ratio	micro SMD-12
LM3430/32	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
NEW LP8541	6 to 22	40	60	—	1.25	PWM	PWM phase shift control, two-wire, SMBus/I ² C-compatible control interface	LLP-24
LM3431	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
LM4510	2.7 to 5.5	18	280	—	1	—	Power Supply for OLED display; no external Schottky diode	LLP-10
LM2731/33	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	3 to 5.5	5	90	3	1.25	I ² C	Independently controlled RGB outputs; programmable trapezoidal waveforms	micro SMD-18
LM2750	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	2.7 to 5.5	4.6	180	8	1.3	I ² C	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	I ² C	3 independent LED banks (Group A = 4 LEDs, Group B = 2 LEDs, Group C up to 80mA); Dedicated Keypad LED Driver	LLP-24
LM27965	2.7 to 5.6	5	180	9 (3 banks)	1.27	I ² C	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	I ² C	2 independent LED banks (Group A = 5 LEDs, Group B = 1 LEDs)	LLP-24
LM2757	2.7 to 5.5	4.1, 4.5, 5	180	10	1.25	No Dimming	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	2.8 to 5.5	5	800	4	1	Switched capacitor	TX input ensures synchronization with RF power amplifier pulse	LLP-24
LM2758/59	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	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
LM3553	2.7 to 5.5	19	1200	2	1.3	Inductive boost	Indicator, torch, flash modes, and voltage mode; 128 current levels	LLP-12

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
LM3407	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	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	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	3 to 15 / 3 to 22	14/20	1000	4	1.6	Buck	205 mV feedback voltage, PWM dimming	TSOT-6
LM3410	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
LM5022	6 to 60	80+	1000+	20+	Adjustable up to 2 MHz	Boost, Flyback	PWM dimming, current-mode control, precision enable	MSOP-10, LLP-10
LM3406/06HV	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
LM3421/23	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
LM3401	4.5 to 35	35	3000	9	1.5	Buck	Adjustable hysteresis, 100% duty cycle, PWM dimming	MSOP-8
LM3433	-9 to -14	-6	6000+	1	Adjustable up to 1 MHz	Buck	Drives common anode LEDs, analog and fast PWM dimming	LLP-24

Lighting Management Units

Product ID	Description	V _{IN} Range	Drive Current for All	Current for Flash Mode	Current Matching	Temp Range (°C)	Packaging
LP5522	Autonomous single LED controller with one wire interface	2.7 to 5.5	20 mA	—	—	-30 to +85	micro SMD-6
LP3943	LED controller for RGB/white/blue LEDs	2.3 to 5.5	25 mA/LED	—	—	-40 to +125	LLP-24
LP3944	LED controller for RGB/white/blue LEDs	2.3 to 5.5	25 mA/LED	—	—	-40 to +125	LLP-24
LP8501	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	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	Parallel LED Driver with PWM brightness control	2.7 to 5.5	100 mA	—	1%	-40 to +85	micro SMD-9
LP5526	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	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 12C 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

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

www.national.com/power

Inductive-Boost Backlight LED Drivers

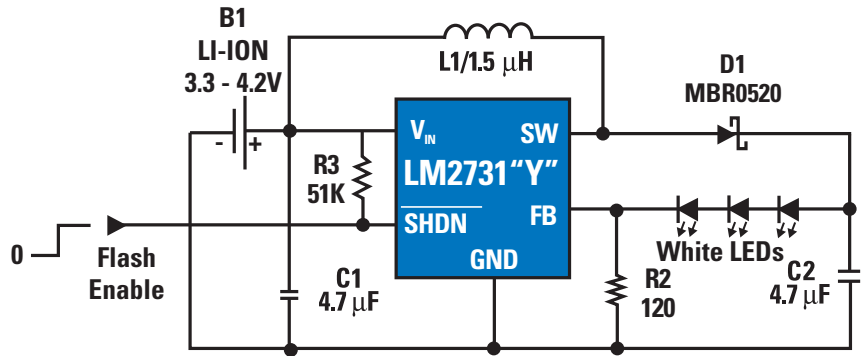
LM2731 – 0.6/1.6 MHz Boost Converter with 22V Internal FET Switch

Features

- 22V DMOS FET switch
- 1.6 MHz (“X”), 0.6 MHz (“Y”) switching frequency
- Low RDS(ON) DMOS FET
- Switch current up to 1.8A
- Wide input voltage range (2.7V to 14V)
- Low shutdown current (<1 μ A)
- Uses tiny capacitors and inductors
- Cycle-by-cycle current limiting
- Internally compensated
- Available in SOT23-5 packaging

Applications

Ideal for use in white LED current source, PDAs and palm-top computers, digital cameras, portable phones and games, local boost regulator



White LED Flash Application

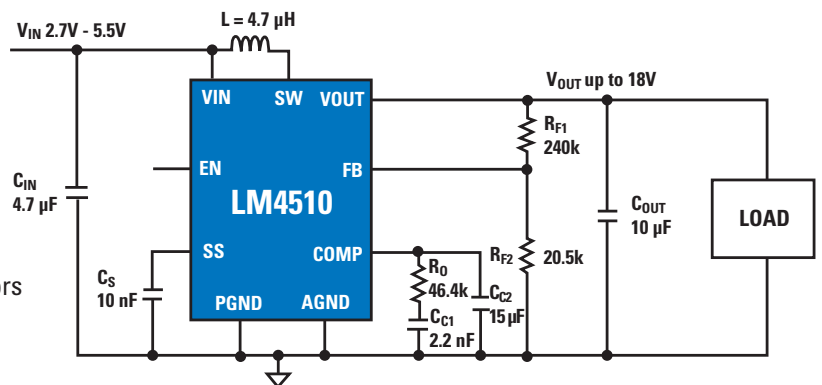
LM4510 – PowerWise® Synchronous Step-Up DC-DC Converter for White LEDs and/or OLED Displays

Features

- 18V at 80 mA from 3.2V input
- 5V at 280 mA from 3.2V input
- No external Schottky diode required
- 85% peak efficiency
- Soft-start
- True shutdown isolation
- Stable with small ceramic or tantalum output capacitors
- Output short-circuit protection
- Feedback fault protection
- Input under-voltage lock out
- Thermal shutdown
- 0.002 μ A shutdown current
- Wide input voltage range: 2.7V to 5.5V
- 1.0 MHz fixed frequency operation
- Available in low-profile LLP-10 packaging (3 x 3 x 0.8mm)

Applications

Ideal for use in organic LED panel power supply, charging holster, white LED backlight, USB power supply, class D audio amplifier, camera flash LED driver



LM4510 Typical Application Circuit

LM3509 – PowerWise® High-Efficiency Boost for White LEDs and/or OLED Displays

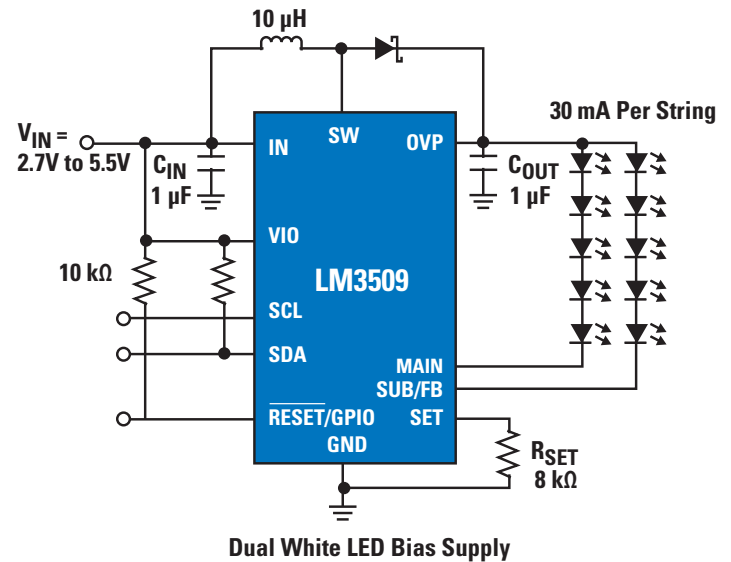
Features

- Integrated OLED display power supply and LED driver
- Drives up to 10 LEDs at 30 mA
- Drives up to 5 LEDs at 20 mA and delivers up to 21V at 40 mA
- Over 90% efficient
- 32 exponential dimming steps
- 0.15% accurate current matching between strings
- Internal soft-start limits inrush current
- True shutdown isolation for LED's
- Wide 2.7V to 5.5V input voltage range
- 21V over-voltage protection
- 1.27 MHz fixed frequency operation
- General-purpose I/O
- Active low hardware reset
- Available in low-profile LLP-10 packaging (3 x 3 x 0.8 mm)

Applications

Ideal for use in dual-display LCD backlighting for portable applications, large format LCD backlighting, OLED panel power supply

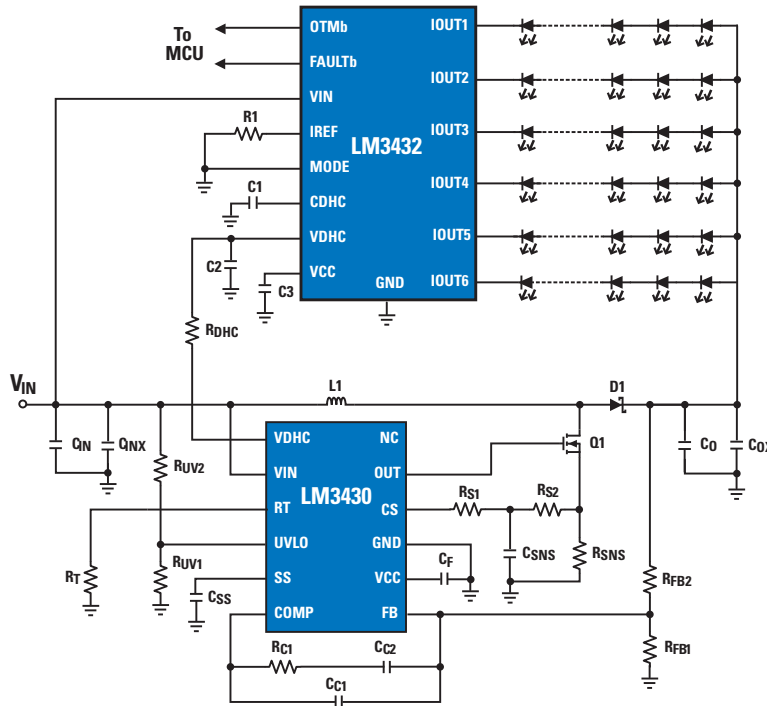
LM3509 Typical Application Circuit



Inductive-Boost Backlight LED Drivers

LM3430 and LM3432 – PowerWise® Boost Controller and 6-Channel Current Regulator for LED Backlighting

LM3430/LM3432 Typical Application Circuit



LM3430 Features:

- Internal 40V startup regulator
- 1A peak MOSFET gate driver
- V_{IN} Range 6V to 40V
- Duty cycle limit in excess of 90%
- Programmable UVLO with hysteresis
- Cycle-by-cycle current limit
- External synchronizable (AC-coupled)
- Single resistor oscillator frequency set
- Slope compensation
- Adjustable soft-start
- LLP-12 (3mm x 3mm)

LM3432 Features:

- Dynamic Headroom Control (DHC) output to maximize efficiency when used with an LM3430
- Current sinking adjustable up to 40 mA in each string
- Fast current switching slew rate, $t_r = 60$ ns typical
- Wide dimming ratio, up to 4000:1 with $f_{DIM} = 500$ Hz
- High LED driving voltage up to 80V
- $\pm 2.0\%$ current matching between strings
- Accepts both digital and analog dimming control
- LED open/short fault indication
- Over-temperature indication
- Internal thermal shutdown with hysteresis
- Available in low profile and thermally enhanced LLP-24 (5 x 4 x 0.8 mm) and eTSSOP-28 (9.7 x 6.4 x 1.1 mm) packaging

LM3431 – 3-Channel Constant-Current LED Driver with Integrated Boost Controller

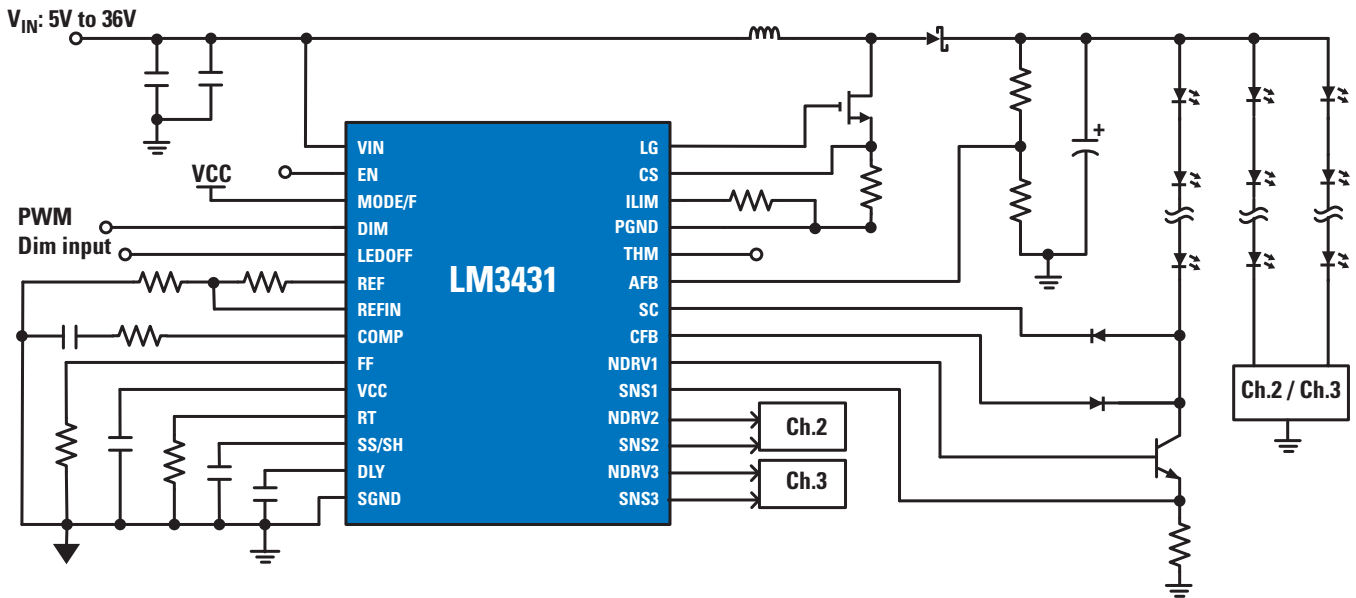
Features

- 3-channel programmable LED current
- High accuracy linear current regulation
- Analog and digital PWM dimming control
- Up to 25 kHz dimming frequency
- >100:1 contrast ratio
- Integrated boost controller
- 5V to 36V input voltage range
- Adjustable switching frequency up to 1 MHz
- LED short and open protection
- Selectable fault shutdown or automatic restart
- Programmable fault delay
- Programmable cycle-by-cycle current limit
- Output over voltage protection
- No audible noise
- Enable pin
- LED over-temperature shutdown input
- Thermal shutdown
- Available in TSSOP-28 exposed pad packaging

Applications

Ideal for use in automotive infotainment displays, small-to-medium format displays

LM3431 Typical Application Circuit



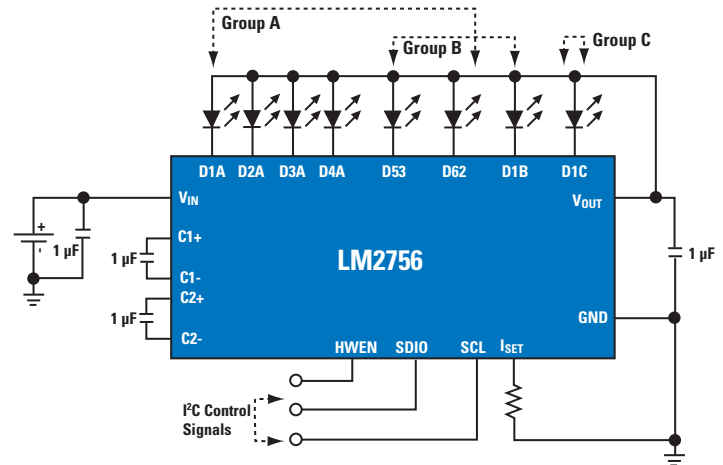
Switched-Capacitor Boost Backlight LED Drivers

LM2756 – Multiple-Display LED Driver with I²C-Compatible Brightness Control

Features

- Drives up to 8 LEDs with up to 30 mA of diode current each
- 32 exponential dimming steps with 800:1 dimming ratio for group A (up to 6 LEDs)
- 8 linear dimming states for groups B (up to 3 LEDs) and D1C (1 LED)
- Programmable auto-dimming function
- 3 independently-controlled LED groups via I²C-compatible interface
- Up to 90% efficiency
- Total solution size < 21 mm
- 0.4% accurate current matching
- Internal soft-start limits inrush current
- True shutdown isolation for LEDs
- Wide input voltage range (2.7V to 5.5V)
- Active high hardware enable
- Available in low-profile, micro SMD-20 packaging (1.615 x 2.015 x 0.6 mm)

LM2756 Typical Application Circuit



Applications

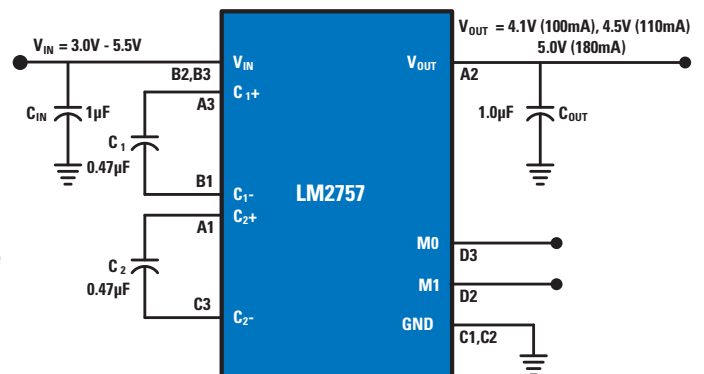
Ideal for use in dual display LCD backlighting for portable applications, large format LCD backlighting, and display backlighting with indicator light

LM2757 – Switched-Capacitor Boost Regulator with High Impedance Output in Shutdown

Features

- Dual gain converter (2x, 3/2x) with up to 93% efficiency
- Inductor-less solution uses only 4 small ceramic capacitors
- Total solution area < 12 mm
- True input-output and output-input disconnect
- Up to 180 mA output current capability (5V)
- Selectable 4.1V, 4.5V, or 5.0V output
- Pre-regulation minimizes input current ripple
- 1.24 MHz switching frequency for a low-noise, low-ripple output voltage
- Integrated over current and thermal shutdown protection
- Available in tiny micro SMD-12 packaging (1.2 x 1.6 x 1.6 mm)

LM2757 Typical Application Circuit



Applications

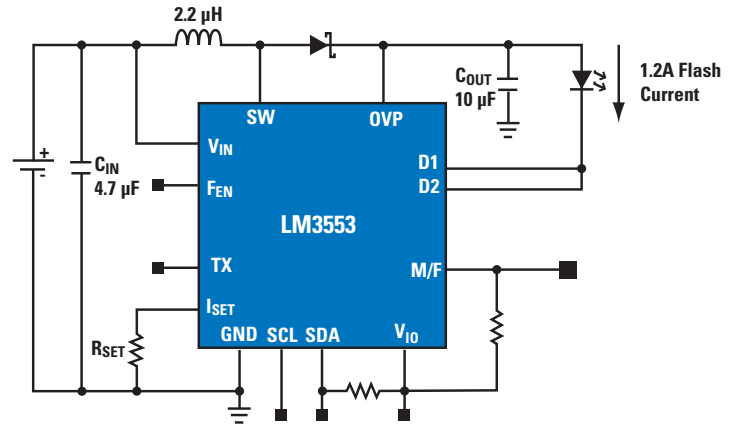
USB/USB-OTG power, super capacitor charger, keypad LED driver, and audio amplifier power supply

LM3553 – PowerWise® High-Current Inductive DC-DC Converter for Flash LED Applications

Features

- Accurate and programmable LED current up to 1.2A in 128 steps delivers optimal input current control
- 90% peak efficiency
- Drives 2 LEDs in series with up to 1.2A from 5V input
- Drives 2 LEDs in series with 600 mA from 2.7V input
- Adjustable over-voltage protection allows for a wide range of applications requiring one or more high current LEDs
- Adjustable switch current limit allows for the use of small inductors with lower saturation currents
- Voltage mode offers a 5V rail for backlight LEDs and/or audio amplifiers
- TX pin forces Torch mode allowing for synchronization between RF power amplifier and Flash/Torch modes
- Total solution size < 29 mm² optimizes PCB area occupation
- Available in low-profile LLP-12 packaging

LM3553 Typical Application Circuit



Applications

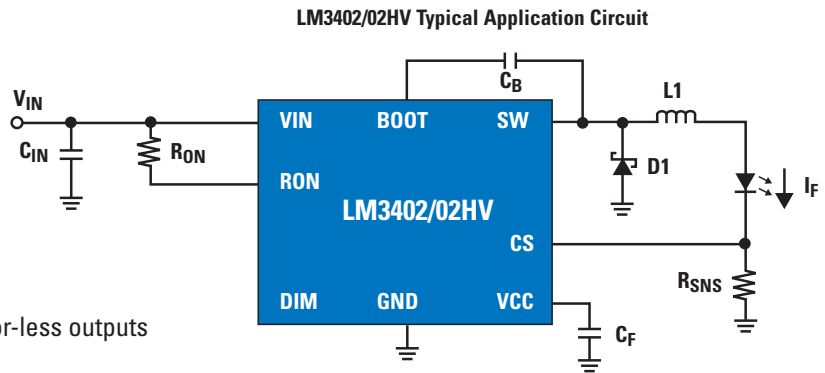
Ideal for use in mobile phones, smart phones, PDAs, portable scanners, medical strobe lights, and handheld devices

High-Brightness LED Drivers

LM3402/02HV – PowerWise® 0.5A Constant-Current Buck Regulator for Driving High-Power LEDs

Features

- Integrated 0.5A N-channel MOSFET
- V_{IN} Range from 6V to 42V (LM3402)
- V_{IN} Range from 6V to 75V (LM3402HV)
- 500 mA output current over temperature
- Cycle-by-cycle current limit
- No control loop compensation required
- Separate PWM dimming and low power shutdown
- Supports all-ceramic output capacitors and capacitor-less outputs
- Thermal shutdown protection
- Available in MSOP-8, PSOP-8 packaging



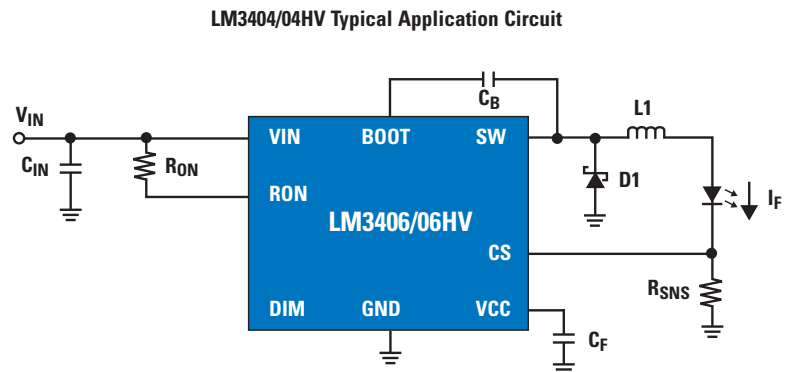
Applications

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

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



Applications

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

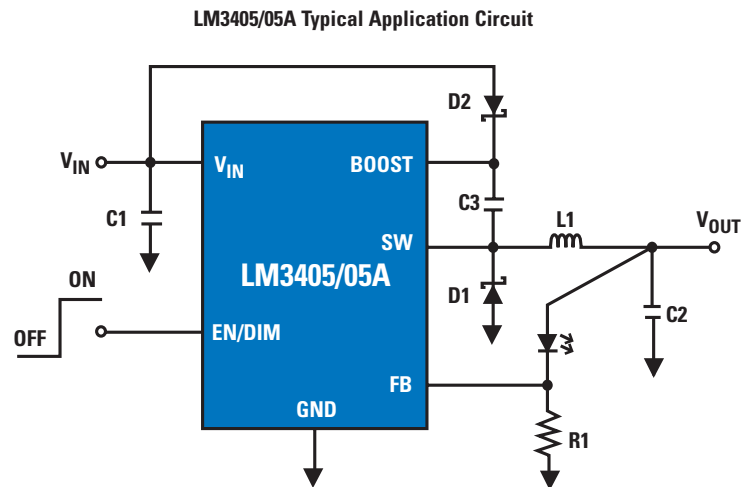
LM3405/05A – PowerWise® LED Driver 1A Constant-Current Buck Regulator

Features

- V_{IN} operating range of 3V to 15V
- 1.6 MHz switching frequency
- 300 mΩ NMOS switch
- 40 nA shutdown current at $V_{IN} = 5V$
- EN/DIM input for enabling and PWM dimming of LEDs
- Internally-compensated current-mode control
- Cycle-by-cycle current limit
- Input voltage UVLO
- Over-current protection
- Thermal shutdown
- Available in thin SOT23-6 packaging

Applications

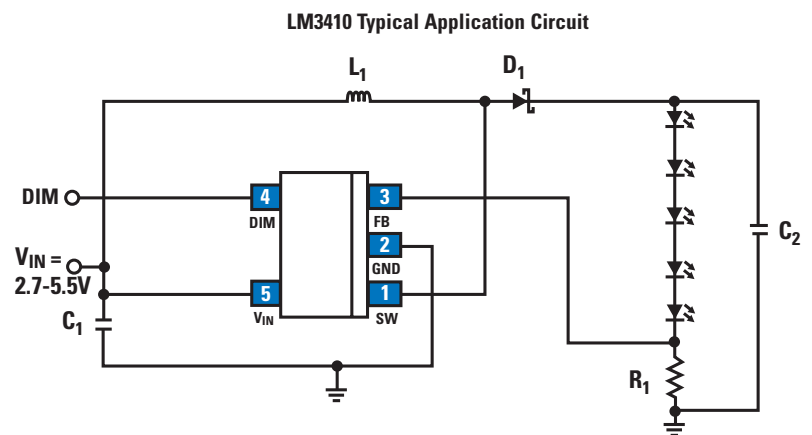
Ideal for use in LED drivers, constant-current sources, industrial lighting, and LED flashlights



LM3410 – PowerWise 525 kHz/1.6 MHz Constant-Current Boost and SEPIC LED Driver

Features

- Input voltage range of 2.7V to 5.5V
- Output voltage range of 3V to 24V
- 2.8A typical switch current
- High switching frequency
- 525 kHz (LM3410-Y)
- 1.6 MHz (LM3410-X)
- 170 mΩ NMOS switch
- 190 mV internal voltage reference
- Internal soft-start
- Current-mode, PWM operation
- Thermal shutdown
- Available in space-saving SOT23-5 and LLP-6 packaging



Applications

Ideal for use in LED backlight current sources, Li-Ion backlight OLED and HB LED drivers, handheld devices, and LED flash drivers

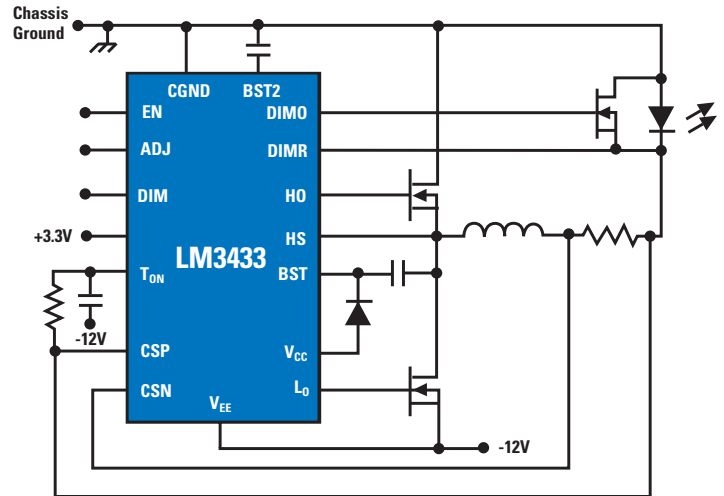
High-Brightness LED Drivers

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



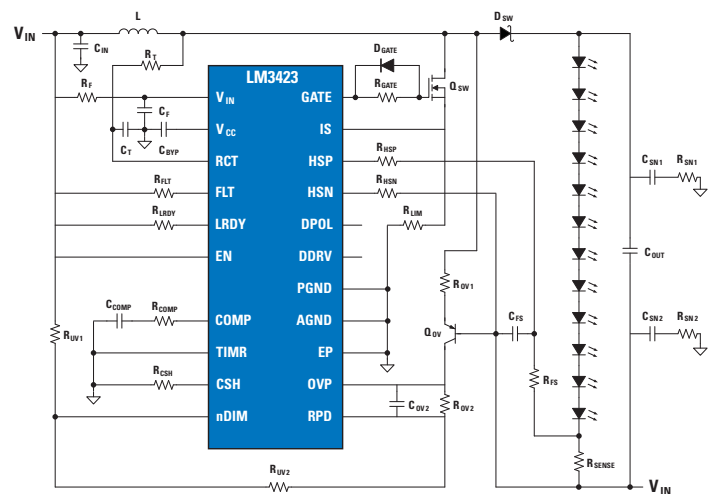
Applications

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

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

Features:

- Buck, buck/boost, SEPIC topologies
- V_{IN} range 4.5 to 75V
- High-side current sensing
- Fast (50 kHz) PWM dimming input
- Programmable running frequency
- Zero current shutdown
- Input UVLO
- LED-ready flag
- Fault timer pin
- Available in TSSOP-16/20 packaging



LP39542 – PowerWise® Advanced Lighting Management Unit

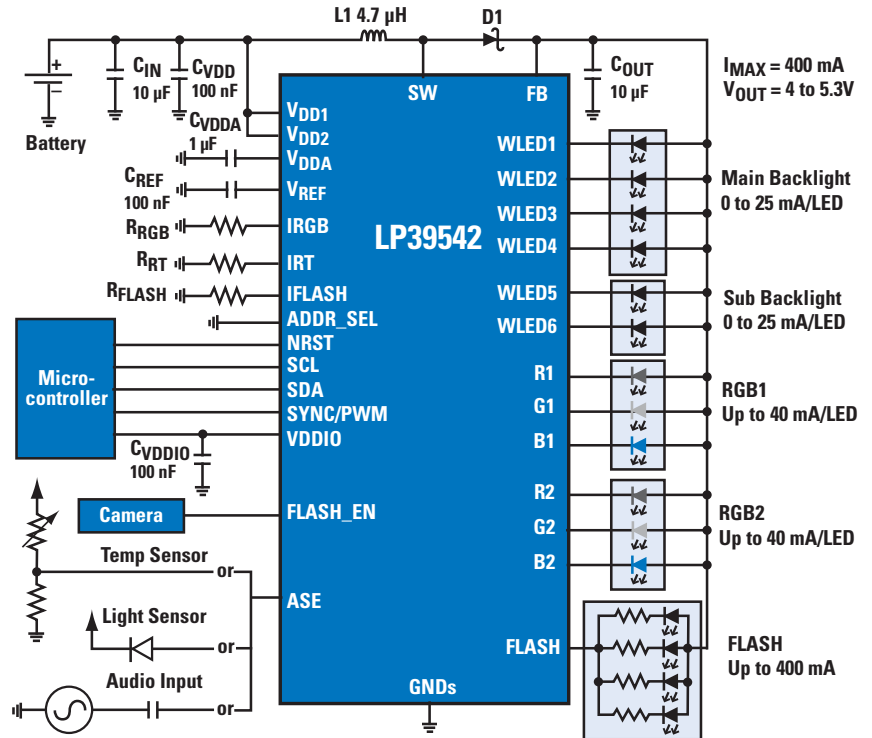
Features

- Audio synchronization for color/RGB LEDs
- Command-based PWM controlled RGB LED drivers
- Programmable ON/OFF blinking sequences for RGB LED
- High current driver for flash LED with built-in timing and safety feature
- 4+2 or 6 low voltage constant current white LED drivers with programmable 8-bit adjustment (0.25 mA/LED)
- High-efficiency boost DC-DC converter
- I²C-compatible interface
- Possibility for external PWM dimming control
- Possibility for clock synchronization for RGB timing
- Ambient light and temperature sensing possibility
- Available in micro SMD-36 packaging (3.0 x 3.0 x 0.6 mm)

Applications

Ideal for use in cellular phones, PDAs, and MP3 players

LP39542 Typical Application Circuit



Lighting Management Units

LP55281 – PowerWise® Quad RGB Driver

Features

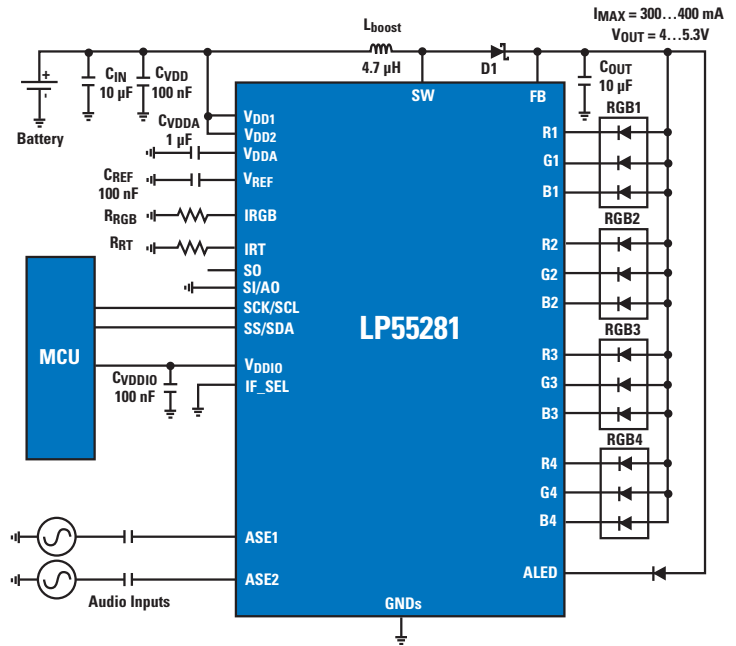
- Audio synchronization for a single fun light LED
- 4 PWM-controlled RGB LED drivers
- High-efficiency boost DC-DC converter
- SPI/I²C-compatible interface
- 2 addresses in I²C-compatible interface
- LED connectivity test through the serial interface
- Available in micro SMD-36 (3 mm x 3 mm x 0.6 mm) or micro SMDxt-36 packaging (3 mm x 3 mm x 0.65 mm)

Applications

Ideal for use in cellular phones, PDAs, and MP3 players



LP55281 Typical Application Circuit

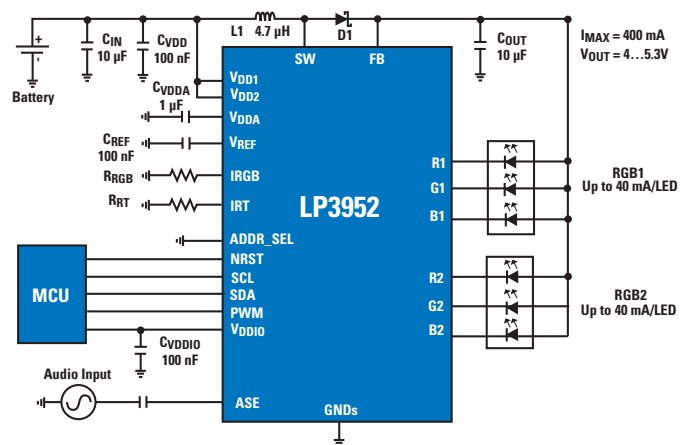


LP3952 – PowerWise 6-Channel Color LED Driver with Audio Synchronization

Features

- Constant-current and PWM-controlled color LED drivers
- Maximum current 40 mA / output in constant-current mode, supports also switch mode control with 50 mA maximum current/output
- Complete audio synchronization for color/RGB LEDs with amplitude, frequency, and speed optimization
- Command-based lighting pattern generator for RGB LEDs
- Programmable ON/OFF blinking sequences for RGB1 outputs
- High-efficiency boost DC-DC converter with programmable V_{OUT} and f_{SW}
- I²C-compatible interface
- Possibility for external PWM dimming control
- Available in micro SMDxt -36 packaging (3.0 mm x 3.0 mm x 0.65 mm)

LP3952 Typical Application Circuit



Applications

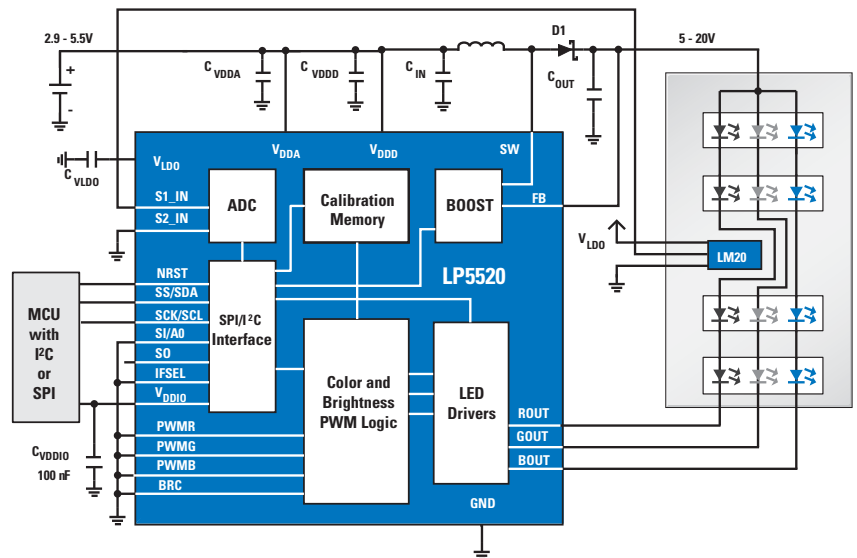
Ideal for use in cellular phones, PDAs, and MP3 players

LP5520 – RGB Backlight LED Driver

Features

- Temperature-compensated LED intensity and color
- Individual calibration coefficients for each color
- Color accuracy ΔX and $\Delta Y \leq 0.003$
- 12-bit ADC for measurement of 2 sensors
- Adjustable current outputs for RGB LED
- 0.2% typical LED output current matching
- PWM control inputs for each color
- SPI and I²C-compatible interface
- Stand-alone mode with 1-wire control
- Sequential mode for one color at a time
- Magnetic high-efficiency boost converter
- Available in micro SMD-25 packaging (2.77 x 2.59 x 0.6 mm)

LP5520 Typical Application Circuit



Applications

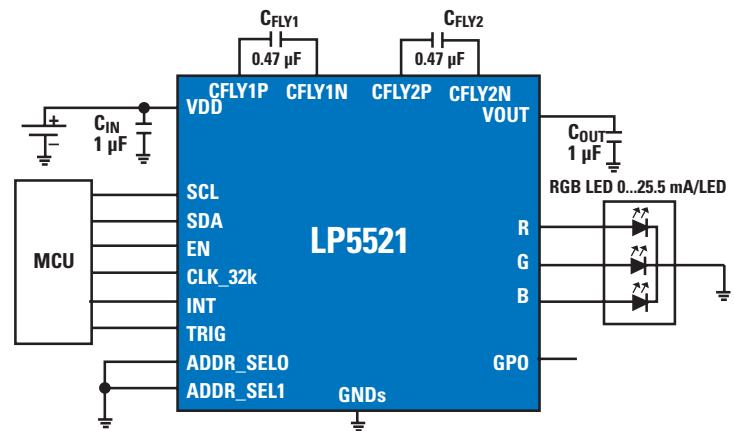
Ideal for use in color LCD display backlighting, LED lighting applications, non-linear temperature compensation, and ambient light compensation

LP5521 – PowerWise® Programmable 3-Channel LED Driver

Features

- Adaptive charge pump with 1x and 1.5x gain provides up to 95% LED drive efficiency
- Charge pump with soft-start and overcurrent/short circuit protection
- Low input ripple and EMI
- Very small solution size, no inductor or resistors required
- 200 nA typical shutdown current
- Automatic power save mode
- I²C-compatible interface
- Independently-programmable constant-current outputs with 8-bit current setting and 8-bit PWM control
- Typical LED output saturation voltage 50 mV and current matching 1%

LP5521 Typical Application Circuit



Applications

Fun/indicator lights, LCD sub-display backlighting, keypad RGB backlighting and phone cosmetics, vibra, speakers, and waveform generators

Linear Regulators for DDR Termination

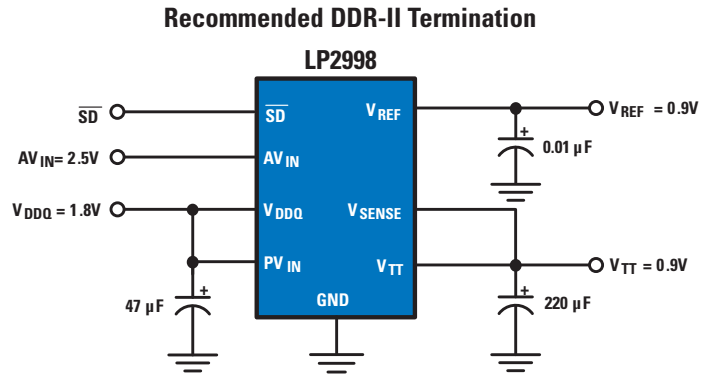
LP2998 – Double Data Rate (DDR) Termination Regulator

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



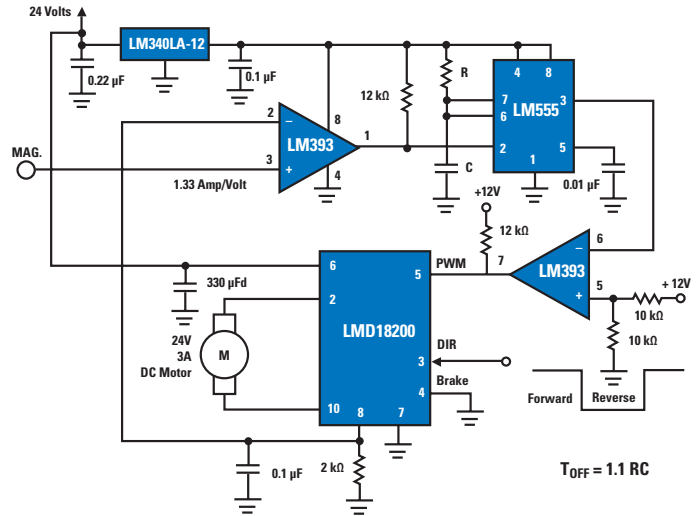
Linear Regulators for DDR Termination

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

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



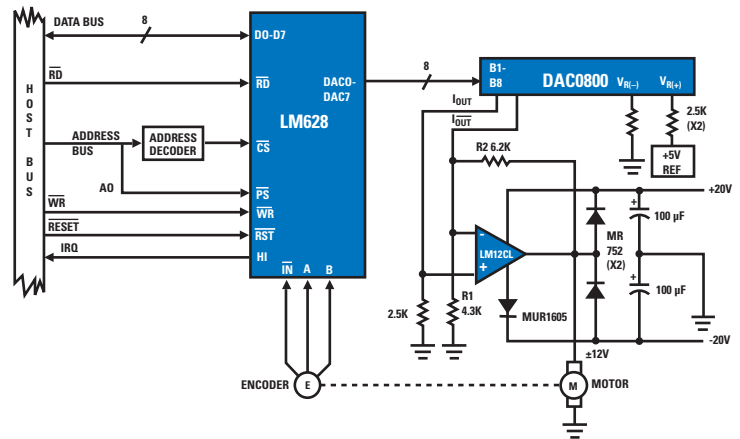
Half-Bridge Drivers for Motor Control

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	T0220-11
LMD18201	55	12	3	170°C	Thermal warning flag at 145°C	T0220-11
LMD18245	55	12	3	155°C	Low-loss internal current sense circuitry, 4-bit digital motor current control	T0220-15

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



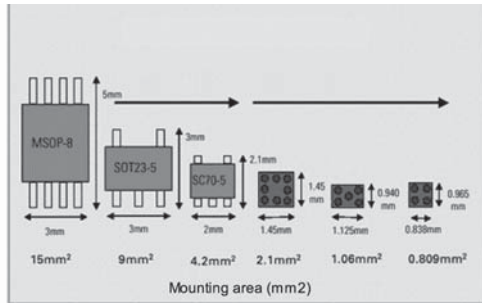
Digital Controllers for Motion Control

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

Advanced Packaging Technologies

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.

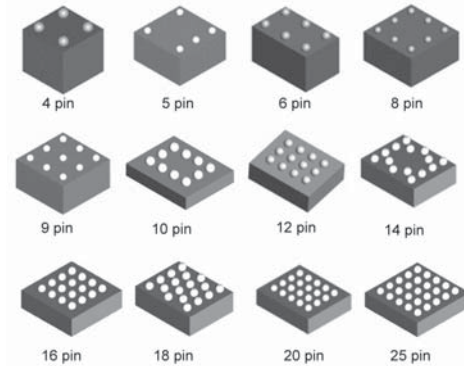
micro-SMD packaging also features the following benefits:

- 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:

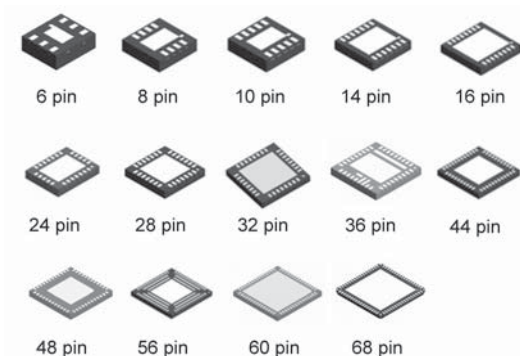


A key feature of the LLP package is that the large heat dissipation area provided by the "die attach pad" reduces thermal resistance and delivers excellent heat dissipation characteristics. At the same time, the package reduces board mounting area and enables high density mounting. The main features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



Package Solutions



SOT-23



TO-92



SOT-223

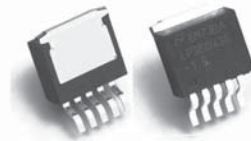


TO-252

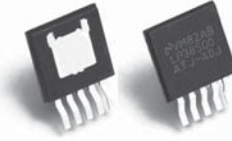


TSSOP

TSSOP
EXP PAD



TO-263



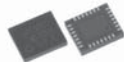
TO-263 THIN



Leadless Leadframe Package (LLP)



PQFP



Laminate CSP



SC70



TQFP/LQFP



MINI SOIC



MINI SOIC
EXP PAD

Design Tools

Resources for Next-Generation Design



Design, build, and test analog circuits in this online design and prototyping environment.

www.national.com/webench



Register to receive updates on the products and technical topics that interest you—spam-free!

www.national.com/newsletter



Online seminars by industry experts. Log onto National's analog online seminars today.

www.national.com/onlineseminars



Expand your knowledge and understanding of analog with our free online educational training tool.

www.national.com/AU



Published bi-monthly, the Power Designer technical articles cover key power design tips and techniques for today's design engineers.

www.national.com/powerdesigner



Published bi-monthly, the Signal Path Designer technical articles cover analog signal path tips and techniques for today's design engineers.

www.national.com/spdesigner



National's monthly analog design technical journal.

www.national.com/analgedge



Easy, natural-language online search engine provides quick access to products and technical information.

www.national.com/kbase



Tune in to this all-analog talk show, hosted by Bob Pease, and streamed 24/7 on the web.

www.national.com/analogbydesign

Tools for Energy-Efficient Designs

Access white papers, reference designs, and application notes on PowerWise® products and systems.

www.national.com/powerwise

Parametric Catalog and Search

Search for desired product folder, product database by attributes of interest.

www.national.com/cat

Application Solutions

Access over 100 dynamic diagrams for medical systems, consumer electronics, communications, and many more applications.

www.national.com/solutions

Application Notes

Access hundreds of application notes on a variety of design topics from product to end application specific app notes.

www.national.com/appnotes

FPGA Design Guides

These design guides feature National device solutions by part number for different FPGA manufacturers, including Xilinx and Altera.

www.national.com/selguide

Document Library

Find end market solutions and products using National's Solutions Guides.

www.national.com/selguide



National makes design easy no matter where you are in the design process. Explore the latest learning resources and selection tools to help you select the right products. Once you're ready to begin designing, use National's industry award-winning online design tools to guide you through the entire process - from concept, to simulation, to prototyping.



Explore & Learn

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

- Watch "Design Made Easy with New WEBENCH® Power Designer" to learn quick and easy tips and tricks for designing with the enhanced WEBENCH Power Designer tool, LM2267x SIMPLE SWITCHER® regulators and LM315x SIMPLE SWITCHER controllers
- Watch "Design Made Easy with New WEBENCH® Sensor Designer" to learn quick and easy tips and tricks for designing with the new WEBENCH Sensor Designer tool



Compare & Selection

Find the perfect mix of products for your design. Search, select and compare relevant products.

- Find up-to-date information about new products
- Search thousands of products, then sort information (by topology, output voltage range, input voltage and more) using National's online product catalog
- Download the latest materials featuring end-market solutions using National's newest products



Design & Build

Design, build and validate a solution using the WEBENCH® Designer online tools:

- Select it:
 - Input your design and choose a part
- Design It:
 - Adjust components and exercise operating values such as power dissipation, current flow, offset voltage, drift, and frequency response
 - Compare performance, size, and cost
 - Use recommended components or create a BOM
- Analyze It
 - Stimulate your circuit and evaluate performance using electrical and thermal simulations
 - Overlay alternate circuits and compare results
- Build It
 - Request samples and purchase parts or boards
 - Receive your custom prototyping kit
 - Download CAD files, assembly details, test instructions, and complete performance characteristics
- Test It
 - Download your custom test vectors to verify your real board versus virtual results
 - Perform board-level tests

Find out how National makes design easy at:
national.com/easy



EXPLORE
& LEARN



COMPARE
& SELECT



DESIGN
& BUILD

Design Tools

Technical Articles

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



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

Back Issues	
#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 $\geq 40V$ Input Voltage
#116:	Driving LEDs: To Cap or Not to Cap
#115:	Implementing Single-Chip FPGA Power Solutions
#114:	Best Layout Practices for Switching Power Supplies
#113:	Optimizing Efficiency in White LED Backlight Applications
#112:	Synchronous Rectification in High-Performance Power Converter Design
#111:	Buck Regulator Topologies for Wide Input/Output Voltage Differentials
#110:	Optimizing RF Power Amplifier System Efficiency Using DC-DC Converters
#109:	Advanced Topics in Powering FPGAs
#108:	Operation and Benefits of Active-Clamp Forward Power Converters
#107:	Analyzing Power Modules
#106:	Inside Current-Mode Control
#105:	Power Management Design for Applications Processors
#104:	Power Supply Design for Power-over-Ethernet Applications
#103:	Understanding Portable Applications Requirements
#102:	Power Management Considerations for FPGAs and ASICs
#101:	Feedback Techniques for Crossing the Isolation Boundary

You can view all past editions of Power Designer at the following website:

national.com/powerdesigner



Back Issues	
#115:	Liquid-Level Monitoring Using a Pressure Sensor
#114:	Continuous-Time Sigma-Delta A/D Converters
#113:	A 3 Gbps SDI Connectivity Solution Supporting Uncompressed 1080p60 Video
#112:	Adaptive Speed Control for Automotive Systems
#111:	Selecting Amplifiers, ADCs, and Clocks for High-Performance Signal Paths
#110:	Extending the Signal Path Over Data Transmission Lines
#109:	Generating Precision Clocks for Time-Interleaved ADCs
#108:	Low-Voltage Current Loop Transmitter
#107:	Delay Calibration of Signal Path Interconnect — In Basestations and Other Applications
#106:	Timing is Everything - The Broadcast Video Signal Path
#105:	LIDAR System Design for Automotive/Industrial/Military Applications
#104:	Improving Machinery Vibration Analysis
#103:	Understanding High-Speed Signals,Clocks, and Data Capture
#102:	Maximizing Signal-Path Performance
#101:	A Walk Along the Signal Path

View all issues at national.com/spdesigner

Back Issues*	
AN-1887	Expanding the Payload with FPGA-Link DS32ELX0421/124 Serializer and Deserializer
AN-1874	EMI-Hardened Operational Amplifiers for Robust Circuit Design
AN-1853	COT Drivers Control LED Ripple Current
AN-1852	Designing with pH Electrodes
AN-1824	FlexCap Technology Simplifies LDO Design
AN-1815	LDOs Ease the Stress of Start-up
AN-1803	Design Considerations for a Transimpedance Amplifier
AN-1798	Designing with Electro-Chemical Sensors
AN-1773	Designing Energy-Efficient Handheld Illumination Solutions
AN-1745	Powering FPGAs Using LM201xx PowerWise® Synchronous Buck Regulators
AN-1737	Managing EMI in Class D Audio Applications
AN-1727	Using Self-Calibration to Improve Performance of Ultra-High Speed Data Converters
AN-1719	Noise Figure Analysis - Fully Differential Amplifier
AN-1704	LMH6555 Application as High Speed ADC Input Driver
AN-1703	Powering Multi-Rate Systems Using the LM26400Y Regulator

*2007 - 2008 issues listed; additional archives available online at national.com/edge

Index by Product

A		
ADC08B200.....	8	
ADC08B3000.....	7	
ADC08D500.....	8	
ADC08D1000.....	7	
ADC08D1020.....	7	
ADC08D1500.....	7	
ADC08D1520.....	7	
ADC08L060.....	8	
ADC10D020.....	9	
ADC10D040.....	9	
ADC10DL065.....	9	
ADC11C125.....	9	
ADC11C170.....	9	
ADC11DL066.....	9	
ADC11L066.....	9	
ADC12C080.....	9, 13	
ADC12C105.....	9, 13	
ADC12C170.....	9	
ADC12D040.....	9	
ADC12DC080.....	9	
ADC12DC105.....	9	
ADC12DL040.....	9	
ADC12DL065.....	9	
ADC12DL080.....	9	
ADC12DS080.....	9, 14	
ADC12DS105.....	9, 14	
ADC12EU050.....	9, 11	
ADC12L063.....	9	
ADC12L066.....	9	
ADC12L080.....	9	
ADC12L081.....	9	
ADC12QS065.....	9	
ADC12V170.....	9, 14	
ADC14C080.....	9	
ADC14C080).....	13	
ADC14C105.....	9, 13	
ADC14DC080.....	9	
ADC14DC105.....	9	
ADC14DS080.....	9, 14	
ADC14DS105.....	9, 14	
ADC14L020.....	9	
ADC14L040.....	9	
ADC14V155.....	9, 12	
ADC16V130.....	9	
ADC081C021.....	15	
ADC081C027.....	15	
ADC081S021.....	16	
ADC081S051.....	16	
ADC081S101.....	16	
ADC082S021.....	16	
ADC082S051.....	16	
ADC082S101.....	16	
ADC084S021.....	16	
ADC084S051.....	16	
ADC084S101.....	16	
ADC088S022.....	16	
ADC088S052.....	16	
ADC101C021.....	15	
ADC101C027.....	15	
ADC101S021.....	16	
ADC101S051.....	16	
ADC101S101.....	16	
ADC102S021.....	16	
ADC102S051.....	16	
ADC102S101.....	16	
ADC104S021.....	16	
ADC104S051.....	16	
ADC104S101.....	16	
ADC108S022.....	16	
ADC108S052.....	16	
ADC108S102.....	16	
ADC121C021.....	15	
ADC121C027.....	15	
ADC121S021.....	16	
ADC121S051.....	16	
ADC121S101.....	16	
ADC121S625.....	17	
ADC121S655.....	17	
ADC121S705.....	17	
ADC122S021.....	16	
ADC122S051.....	16	
ADC122S101.....	16	
ADC122S625.....	17	
ADC122S655.....	17	
ADC122S706.....	17	
ADC124S021.....	16	
ADC124S051.....	16	
ADC124S101.....	16	
ADC128S022.....	16	
ADC128S052.....	16	
ADC128S102.....	16	
ADC141S626.....	17	
ADC161S626.....	17	
ADC0820.....	8	
ADC08060.....	8	
ADC08100.....	8	
ADC08500.....	8	
ADC10040.....	9	
ADC10065.....	9	
ADC10080.....	9	
ADC12010.....	9	
ADC12020.....	9	
ADC12040.....	9	
ADC12081.....	9	
ADC14155.....	9	
ADC081000.....	7	
ADC081500.....	7	
ADC083000.....	7	
C		
CLC001AJE.....	88	
CLC005AJE.....	88	
CLC006AJE.....	88	
CLC007AJE.....	88	
CLC011BCQ.....	87	
CLC012AJE.....	88	
CLC014AJE.....	88	
CLC016ACQ.....	88	
CLC016AJQ.....	88	
CLC016MTC.....	88	
CLC020BCQ.....	87	
CLC021AVGZ-3.3.....	87	
CLC021AVGZ-5.0.....	87	
CLC5526.....	13	
D		
DAC081C081.....	18	
DAC081C085.....	18	
DAC081S101.....	18	
DAC082S085.....	18	
DAC084S085.....	18	
DAC088S085.....	18	
DAC101C081.....	18	
DAC101C085.....	18	
DAC101S101.....	18	
DAC102S085.....	18	
DAC104S085.....	18	
DAC108S085.....	18	
DAC121C081.....	18	
DAC121C085.....	18	
DAC121S101.....	18	
DAC122S085.....	18	
DAC124S085.....	18	
DAC128S085.....	18	
DP83640T.....	91	
DP83848.....	91	
DP83848C.....	91	
DP83848H.....	91	
DP83848I.....	91	
DP83848J.....	91	
DP83848K.....	91	
DP83848M.....	91	
DP83848T.....	91	
DP83848VYB.....	91	
DP83848YB.....	91	
DP83849.....	92	
DP83849C.....	92	
DP83849I.....	92	
DP83849ID.....	92	
DP83849IF.....	92	
DS08MB200TSQ.....	79	
DS10BR150TSD.....	78	
DS10BR254SQ.....	79	
DS10CP152TMA.....	79	
DS10CP154SQ.....	79	
DS15BA101SD.....	78	
DS15BR400TSQ.....	78	
DS15BR400TVS.....	78	
DS15BR401TSQ.....	78	
DS15BR401TVS.....	78	
DS15EA101SQ.....	78	

DS15MB200TSQ	79	DS90LV804TSQ	78	LM80	71
DS16EV5110	76	DS90UR124	82	LM81B	71
DS16EV5110SQ	78	DS90UR124QVS	82	LM86	71
DS25BR100TSQ	78	DS90UR241	82	LM87	71
DS25BR110TSQ	78	DS90UR241QVS	82	LM89	71
DS25BR120TSQ	78	DS91C176TMA	75	LM92	73
DS25BR150TSQ	78	DS91C180TMA	75	LM93	71
DS25BR204	77	DS91D176TMA	75	LM94	71
DS25BR204SQ	79	DS91D180TMA	75	LM99	71
DS25BR400TSQ	78	DS91M040TSQ	75	LM264xx	122
DS25BR440SQ	78	DS91M047TSQ	75	LM285x	122
DS25CP102SQ	79	DS91M124TMA	75	LM310x	122
DS25CP104	89	DS91M125TSQ	75	LM315x	122
DS25CP104SQ	79	DS92CK16TMTC	75	LM385	142
DS25CP152SQ	79	DS92LV010ATM	75	LM385-1.2	142
DS25MB100TSQ	79	DS92LV16TVHG	81	LM385-2.5	142
DS25MB200TSQ	79	DS92LV18TVV	81	LM388s	122
DS32EL0124SQ	81	DS92LV040TLQA	75	LM431	142
DS32EL0421SQ	81	DS92LV090ATVEH	75	LM500x	122
DS32ELX0124SQ	81	DS92LV1023EMQ	81	LM557x	107
DS32ELX0421SQ	81	DS92LV1224TMSA	81	LM628	161
DS32EV100	77	DS92LV2411VS	81	LM629	161
DS32EV100SD	78	DS92LV2412VS	81	LM1770	115
DS32EV400	77	DS99R103TSQ	82	LM1771	115
DS32EV400SQ	78	DS99R104TSQ	82	LM2557x	107
DS38EP100	77	DS99R105SQ	82	LM2585	107, 118
DS38EP100DS	78	DS99R106SQ	82	LM2586	107, 118
DS40MB200SQ	79	DS99R115VS	82	LM2587	107, 118
DS42BR400TSQ	78	DS99R116VS	82	LM2588	107, 118
DS42MB100TSQ	79	DS99R421QSQ	82	LM2611	119
DS42MB200TSQ	79	DS92001TMA	75	LM2612	112
DS50EV401	77			LM2612BL	112
DS64EV100	77	L		LM2614	112
DS64EV100SD	78	LM(2)50xx	122	LM2618	112
DS64EV400	77	LM(2)5115	123	LM2619	112
DS64EV400SQ	78	LM(2)5116	123	LM2622	118
DS80EP100	77	LM(2)267x	122	LM2623	118
DS80SP100SD	78	LM(2)557x	122	LM2623A	118
DS90C124QVS	82	LM(2)5037	122, 124	LM2642	141
DS90C241QVS	82	LM(2)5085	122	LM2647	141
DS90C365AMT	82	LM(2)5088	122	LM2650	112
DS90C385AMT	82	LM26	72	LM2651	112
DS90C387AVJD	82	LM26LV	72	LM2653	112
DS90C387RVJD	82	LM27	72	LM2655	112
DS90C3201VS	82	LM27A	73	LM2694	110
DS90C3202VS	82	LM36xx	122	LM2695	110
DS90CF366MTD	82	LM45	72	LM2696	110
DS90CF386MTD	82	LM56	72	LM2698	118
DS90CF388AVJD	82	LM63C	71	LM2700	118
DS90CP22M-8	79	LM63D	71	LM2727	115
DS90CR217MTD	81	LM70	73	LM2731	118, 146, 148
DS90CR218AMTD	81	LM71	73	LM2732	110, 146
DS90CR287MTD	81	LM71A	73	LM2733	118
DS90CR288AMTD	81	LM73	73	LM27341	110
DS90CR483AVJD	81	LM74	73	LM27342	110
DS90CR484AVJD	81	LM75	73	LM2735	118
DS90LV004TVS	78	LM76	73	LM2736	110
DS90LV110ATMT	79	LM77	73	LM2737	115

LM2738	110	LM3432	145, 146, 150	LM4140	142
LM2742	116	LM3433	145, 147, 156	LM4308	90
LM2743	116	LM3475	115	LM4310	90
LM2744	116	LM3477	115	LM4312	90
LM2745	116	LM3478	120	LM4431	142
LM2746	116	LM3481	120	LM4510	118, 146, 148
LM2747	116	LM3485	115	LM4562	49, 67
LM2748	116	LM3488	120	LM4570	63
LM2750	146	LM3489	115	LM4666	58
LM2751	146	LM3495	115, 117	LM4668	58
LM2754	146	LM3500	146	LM4671	58
LM2755	146	LM3501	146	LM4673	58
LM2756	146, 152	LM3502	146	LM4674	58
LM2757	146, 152	LM3503	146	LM4674A	58
LM2758	146	LM3508	146	LM4675	58
LM2760	114	LM3509	146, 149	LM4680	58
LM2771	114	LM3519	146	LM4681	58
LM2772	114	LM3528	146	LM4682	58
LM2773	114	LM3551	146	LM4702	68
LM2781	114	LM3552	146	LM4702B	68
LM2787	114	LM3553	146, 153	LM4702C	68
LM2830	110	LM3557	146	LM4802B	60
LM2831	110	LM3668	118, 119	LM4804	59
LM2832	110	LM3670	112	LM4805	59
LM2833	110	LM3671	112	LM4809	56
LM2852	108	LM3673	112	LM4811	56
LM2853	108	LM3674	112	LM4819	61
LM2854	108	LM3676	112	LM4844	53
LM2990	132	LM3677	112	LM4845	53
LM2991	132	LM3678	112	LM4846	53
LM3100	108	LM3679	112	LM4856	53
LM3102	108	LM3687	136	LM4857	53
LM3103	108	LM3691	112	LM4888	53
LM3150	109	LM3700	143	LM4905	61
LM3151	109	LM3702	143	LM4906	61
LM3152	109	LM3706	143	LM4908	56
LM3153	109	LM3708	143	LM4910	56
LM3224	118	LM3709	143	LM4911	56
LM3280	122, 136	LM3710	143	LM4912	56
LM3310	118	LM3711	143	LM4916	56
LM3311	118	LM3712	143	LM4920	57
LM3354	114	LM3713	143	LM4921	56
LM3370	122, 135	LM3722	143	LM4923	61
LM3401	145, 147	LM3724	143	LM4924	56
LM3402	145, 147, 154	LM3743	115	LM4925	56
LM3402HV	145, 147, 154	LM3880	143	LM4927	61
LM3404	145, 147, 154	LM3881	143	LM4928	62
LM3404HV	145, 147	LM3914	122	LM4929	56
LM3405	145, 147, 155	LM4030	142	LM4931	50
LM3405A	145, 147, 155	LM4040	142	LM4934	50
LM3406	145, 147	LM4041	142	LM4935	50
LM3406HV	145, 147, 154	LM4050	142	LM4937	50
LM3407	145, 147	LM4051	142	LM4938	53
LM3410	145, 147, 155	LM4120	142	LM4941	61
LM3421	145, 147	LM4121	142	LM4946	53
LM3423	145, 147, 156	LM4125	142	LM4947	53
LM3430	120, 145, 146, 150, 156	LM4128	142	LM4949	53
LM3431	145, 146, 151	LM4132	142	LM4950	53, 63

LM4951	61	LM5105	123, 127	LM25085	123
LM4951A	61	LM5106	127	LM25088	123
LM4953	60	LM5107	122, 123, 127	LM25115	115, 124
LM4954	61	LM5109B	122, 127	LM25115A	115
LM4960	60	LM5110	122, 123, 127	LM25116	115
LM4961	60	LM5111	123, 127	LM25574	107
LM4962	60	LM5112	123, 127	LM25575	107
LM4970	63, 147	LM5115	115, 123, 124	LM25576	107
LM4980	56	LM5115A	115, 123	LM26001	110, 111
LM4982	57	LM5116	115, 117, 123	LM26003	110
LM4985	56	LM5118	100, 121, 123	LM26400Y	135
LM4990	61	LM5574	107	LM26480	138
LM4991	61	LM5575	107	LM27313	118
LM4992	62	LM5576	107	LM27951	146
LM4995	61	LM5642	141	LM27952	146
LM5000	118, 123	LM5642x	122, 141	LM27964	146
LM5001	118, 119, 123	LM6154	22, 43	LM27965	146
LM5002	118, 119, 123	LM6211	22, 24, 40, 41	LM27966	146
LM5005	110, 123	LM6588	22, 46	LM34910	110
LM5007	123	LM6645	22	LM34910C	110
LM5008	110, 122, 123	LM6646	22	LM34914	110
LM5009	110, 122	LM7321	25, 43, 46, 49	LM34917	111
LM5010A	110, 123	LM7322	25, 43, 49	LM34917A	110, 111
LM5015	119, 121, 122, 123, 124	LM7332	25, 43, 49	LM34919	110
LM5020	120, 122, 123, 124	LM7332	25, 43, 49	LM34930	110
LM5021	120, 122, 124	LM7341	43, 46, 49	LM48310	58
LM5022	120, 147	LM7372	25, 49	LM48410	58
LM5025	122, 123	LM8261	22, 25, 43	LM48411	58
LM5025A	122, 123, 124	LM8262	22, 25, 43	LM48510	59
LM5025B	122, 123, 124	LM8272	22, 25, 43	LM48511	59
LM5025C	122	LM20123	113	LM48520	59
LM5026	122, 123, 124, 126	LM20124	113	LM48555	60
LM5030	122, 123, 124	LM20125	113	LM48556	60
LM5032	122, 123, 124	LM20133	113	LM48820	57
LM5033	122, 123, 124	LM20134	113	LM48821	57
LM5034	122, 123, 124	LM20143	113	LM48822	57
LM5035	124, 126	LM20144	113	LM48823	60
LM5035A	123, 124, 126	LM20145	113	LM48860	57
LM5037	123	LM20154	113	LM48861	57
LM5041	122, 123, 124	LM20242	113	LM49100	52, 53
LM5041A	122, 123, 124	LM20323	113	LM49250	52
LM5067	122, 123, 129	LM20333	113	LM49270	53
LM5069	122, 123, 129	LM20343	113	LM49321	50
LM5070	122, 123, 128	LM22670	106	LM49350	50, 51
LM5071	122, 123, 128	LM22671	106	LM49370	50
LM5072	122, 123, 128	LM22672	106	LM49413	58
LM5073	122, 123, 128	LM22673	106	LM49450	50
LM5080	123	LM22674	106	LM51111	122
LM5085	123	LM22675	106	LM51112	122
LM5088	123	LM22676	106	LM94021	72
LM5100A	122, 123, 127	LM22677	106	LM94022	72
LM5100B	122, 123, 127	LM22678	106	LM94022Q	73
LM5100C	122, 123, 127	LM22679	106	LM95071	73
LM5101A	127	LM22680	106	LM95172Q	73
LM5101B	127	LM25005	110, 123	LM95213	71
LM5101C	127	LM25007	110, 123	LM95214	71
LM5102	122, 127	LM25010	110, 123	LM95231	71
LM5104	122, 127	LM25037	123, 125	LM95233	70, 71
		LM25061	122		

LM95234.....	70, 71	LMH0307.....	89	LMH6655.....	22, 24, 26, 28
LM95235.....	70, 71	LMH0307SQ.....	88	LMH6657.....	28
LM95235Q.....	73	LMH0340SQ.....	87	LMH6658.....	22, 28
LM95241.....	70, 71	LMH0341SQ.....	87	LMH6672.....	22, 24, 26, 28
LM95245.....	70, 71	LMH0344SQ.....	88	LMH6682.....	28
LM96000.....	71	LMH0346MH.....	88	LMH6683.....	22, 28, 38
LM96163.....	71	LMH0346SQ.....	88	LMH6702.....	22, 26, 28, 38, 40
LM96194.....	71	LMH0356.....	89	LMH6703.....	22, 26, 28, 38, 45
LM97593.....	13	LMH0356SQ.....	88	LMH6704.....	22, 38
LM98519.....	21	LMH1251.....	36	LMH6714.....	28
LM98714.....	20	LMH1980.....	35	LMH6715.....	22, 24, 28
LMC6001.....	41	LMH1981.....	35	LMH6718.....	22, 24
LMC6061.....	41	LMH1982.....	35	LMH6720.....	45
LMC6062.....	41	LMH2100.....	33	LMH6722.....	22, 24, 28
LMC6064.....	41	LMH2180.....	34	LMH6723.....	22, 24, 28
LMC6484.....	23	LMH4045.....	87	LMH6724.....	22, 28
LMD18200.....	161	LMH4075.....	87	LMH6725.....	22, 28
LMD18201.....	161	LMH4345.....	87	LMH6732.....	22, 28
LMD18245.....	161	LMH6502.....	22, 31	LMH6733.....	28, 38, 45
LME49600.....	67	LMH6503.....	22, 31	LMH6734.....	38, 45
LME49610.....	67	LMH6505.....	22, 24, 31	LMH6738.....	22, 26, 28, 38, 45
LME49710.....	49, 67	LMH6514.....	31	LMH6739.....	38, 45
LME49713.....	49, 67	LMH6515.....	22, 31	LMH7220.....	32
LME49720.....	49, 67	LMH6517.....	30, 31	LMH7322.....	32
LME49721.....	67	LMH6518.....	31	LMH7324.....	32
LME49722.....	67	LMH6550.....	22, 26, 28	LMK01000ISQ.....	93
LME49723.....	67	LMH6551.....	22, 26, 28	LMK01010ISQ.....	93
LME49725.....	67	LMH6552.....	14, 22, 24, 26, 28, 29	LMK01020ISQ.....	93
LME49740.....	49, 67	LMH6553.....	22, 26, 29	LMK02000.....	14
LME49810.....	68	LMH6554.....	22, 26, 28, 30	LMK02000ISQ.....	93
LME49811.....	68	LMH6555.....	7, 22, 26, 29	LMK02002ISQ.....	93
LME49830.....	68	LMH6560.....	24	LMK03000CSQ.....	93
LME49860.....	49, 67	LMH6570.....	22, 38	LMK03000DISQ.....	93
LME49870.....	49, 67	LMH6572.....	38	LMK03000ISQ.....	93
LMH0001SQ.....	88	LMH6574.....	22, 38	LMK03001CISQ.....	93
LMH0002MA.....	88	LMH6580.....	36	LMK03001DISQ.....	93
LMH0002SQ.....	88	LMH6582.....	37	LMK03001ISQ.....	93
LMH0002TMA.....	88	LMH6584.....	37	LMK03002CISQ.....	93
LMH0024MA.....	88	LMH6585.....	37	LMK03002ISQ.....	93
LMH0026MH.....	88	LMH6586.....	37	LMK03033CISQ.....	93
LMH0030VS.....	87	LMH6601.....	22, 25, 26, 28, 38, 45	LMK03033ISQ.....	93
LMH0031VS.....	87	LMH6609.....	22, 24, 28	LMK04000BISQ.....	93
LMH0034MA.....	88	LMH6611.....	22, 26, 28, 38, 45	LMK04001BISQ.....	93
LMH0036SQ.....	88	LMH6612.....	26, 27, 28, 38	LMK04002BISQ.....	93
LMH0040SQ.....	87	LMH6618.....	22, 26, 27, 28, 45	LMK04011BISQ.....	93
LMH0041SQ.....	87	LMH6619.....	22, 26, 27, 28	LMK04031BISQ.....	93
LMH0044SQ.....	88	LMH6622.....	22, 24, 26, 28, 40	LMK04033BISQ.....	93
LMH0046MH.....	88	LMH6624.....	22, 26, 27, 28, 40	LMP2011.....	39
LMH0050SQ.....	87	LMH6626.....	22, 24, 26, 27, 28, 40	LMP2012.....	39
LMH0051SQ.....	87	LMH6628.....	22, 24, 26, 28, 40	LMP2014MT.....	39
LMH0056SQ.....	88	LMH6640.....	22, 28	LMP2015.....	39
LMH0070SQ.....	87	LMH6642.....	22, 26, 28	LMP2016.....	39
LMH0071SQ.....	87	LMH6643.....	22, 26, 28	LMP2021.....	39, 40, 41, 47
LMH0074SQ.....	88	LMH6644.....	22, 26, 28	LMP2022.....	39, 40, 41, 47
LMH0202MT.....	88	LMH6645.....	25, 26, 28	LMP2231.....	25, 39, 41, 43, 44, 46
LMH0302SQ.....	88	LMH6646.....	25, 26, 28	LMP2232.....	25, 41, 43, 44
LMH0303.....	89	LMH6647.....	25, 26, 28, 45	LMP2234.....	25, 39, 41, 43, 44, 46
LMH0303SQ.....	88	LMH6654.....	22, 26, 28	LMP7300.....	32, 44

LMP7701	25, 39, 40, 41	LMV771	23, 24, 39, 41, 43, 48	LMX1601	96
LMP7702	25, 39, 40, 41	LMV772	23, 24, 39, 40, 41, 43, 46, 48	LMX1602	96
LMP7704	24, 25, 39, 40, 41	LMV774	23, 24, 39, 40, 43, 46, 48	LMX2306	96
LMP7707	25, 39, 40, 41	LMV791	23, 25, 40, 41, 43, 45, 48	LMX2310U	96
LMP7708	25, 39, 40, 41	LMV792	23, 25, 40, 41, 43, 45, 48	LMX2311U	96
LMP7709	24, 25, 39, 40, 41	LMV793	23, 25, 40, 43, 48	LMX2312U	96
LMP7711	24, 25, 39, 40, 41, 45	LMV794	23, 24, 25, 40, 43, 48	LMX2313U	96
LMP7712	25, 39, 40, 41, 45	LMV796	23, 24, 25, 40, 41, 43, 48	LMX2316	96
LMP7715	25, 39, 40, 41, 48	LMV797	23, 25, 41, 43, 48	LMX2326	96
LMP7716	24, 25, 39, 40, 41, 48	LMV821	23, 43, 46	LMX2330L	96
LMP7717	25, 39, 40, 41	LMV822	23, 43	LMX2331L	96
LMP7718	24, 25, 39, 40, 41	LMV824	23, 43, 46	LMX2332L	96
LMP7721	24, 39, 40, 41, 43, 47	LMV831	41, 43, 47	LMX2335L	96
LMP7731	39, 40, 48	LMV832	41, 43, 47	LMX2336L	96
LMP7732	24, 40, 48	LMV834	41, 43, 46, 47	LMX2346	96
LMP8100	45	LMV841	23, 24, 25, 39, 43	LMX2347	96
LMP8270	42	LMV842	23, 24, 25, 39, 43	LMX2350	96
LMP8271	42	LMV844	23, 24, 25, 39, 43	LMX2352	96
LMP8272	42	LMV851	23, 41, 43, 47	LMX2353	96
LMP8275	42	LMV852	23, 41, 43, 47	LMX2354	96
LMP8276	42	LMV854	23, 41, 43, 46, 47	LMX2364	96
LMP8277	42	LMV861	40, 43, 47, 48	LMX2430	96
LMP8601	42	LMV862	40, 43, 47, 48	LMX2433	96
LMP8601Q	42	LMV864	40, 48	LMX2434	96
LMV112	34	LMV931	23, 24, 25, 43, 46	LMX2470	96
LMV115	34	LMV932	23, 24, 25, 43	LMX2485	96
LMV116	23, 34, 43	LMV934	23, 24, 25, 43, 46	LMX2485E	96
LMV118	23, 34, 43, 45, 46	LMV951	23, 25, 43, 45, 46	LMX2486	96
LMV221	33	LMV981	23, 24, 25, 43, 45, 46	LMX2487	96
LMV225	33	LMV982	25, 45	LMX2487E	96
LMV226	33	LMV1012	55	LMX2531	7
LMV228	33	LMV1012-7	55	LMX2531LQ1146E	95
LMV232	33	LMV1012-15	55	LMX2531LQ1226E	95
LMV242	33	LMV1012-20	55	LMX2531LQ1314E	95
LMV243	33	LMV1012-25	55	LMX2531LQ1415E	95
LMV301	23, 24, 25, 43, 46	LMV1015-15	55	LMX2531LQ1500E	95
LMV341	23, 24, 43, 45, 46	LMV1015-25	55	LMX2531LQ1515E	95
LMV422	23, 43, 46	LMV1031	55	LMX2531LQ1570E	95
LMV431	142	LMV1031-20	55	LMX2531LQ1650E	95
LMV431A	142	LMV1032	55	LMX2531LQ1700E	95
LMV431B	142	LMV1032-6	55	LMX2531LQ1742	95
LMV551	23, 24, 44	LMV1032-15	55	LMX2531LQ1778E	95
LMV552	23, 24, 44	LMV1032-25	55	LMX2531LQ1910E	95
LMV554	44	LMV1088	54	LMX2531LQ2080E	95
LMV641	43, 44, 46	LMV1089	54	LMX2531LQ2265E	95
LMV651	23, 24, 43, 44	LMV2011	46	LMX2531LQ2570E	95
LMV652	23, 24, 43, 44, 46	LMV6618	25	LMX2531LQ2820E	95
LMV654	23, 24, 43, 44, 46	LMV6619	25	LMX2531LQ3010E	95
LMV710	25	LMV7219	32	LP38xxx	122
LMV711	25, 45	LMV7235	32	LP387x	122
LMV712	23, 25, 43, 45, 46	LMV7239	32	LP2966	133
LMV715	23, 25, 43, 45, 46	LMV7271	32, 44	LP2967	133
LMV716	23, 40, 41, 43, 48	LMV7272	32, 44	LP2975	132
LMV721	23, 25, 43, 46, 48	LMV7275	32, 44	LP2980	132
LMV722	23, 24, 25, 43, 46, 48	LMV7291	32, 44	LP2981	132
LMV751	23, 24, 39, 40, 41, 43, 46, 48	LMV7997	40	LP2982	132
LMV761	32	LMV8312	47	LP2983	132
LMV762	32	LMX1600	96	LP2985	132

LP2985LV.....	132	LP5990	134
LP2986	132	LP5996	133
LP2987	132	LP8501	147
LP2988	132	LP8541	146
LP2989	132	LP8900	122, 133
LP2989LV.....	132	LP38500.....	130
LP2992	132	LP38501.....	130
LP2995	160	LP38502.....	130
LP2996	160	LP38503.....	130
LP2997	160	LP38511.....	131
LP2998	160	LP38512.....	131
LP3852	133	LP38513.....	131
LP3853	133	LP38690.....	132
LP3855	133	LP38691.....	132
LP3856	133	LP38692.....	132
LP3871	134	LP38693.....	132
LP3874	134	LP38841.....	133
LP3875	134	LP38842.....	133
LP3876	134	LP38851.....	131
LP3878	132, 134	LP38852.....	131
LP3879	134	LP38853.....	131
LP3882	133	LP38855.....	131
LP3883	133	LP38856.....	131
LP3891	133	LP38858.....	131
LP3892	133	LP38859.....	131
LP3906	137	LP39542.....	147, 157
LP3907	137	LP55281.....	147, 158
LP3910	139	LPV511	23, 43, 44, 46
LP3913	139	LPV531	23, 43, 44, 46
LP3943	147	LPV7215.....	32, 44
LP3944	147		
LP3950	147	S	
LP3952	147, 158	SCAN15MB200TSQ.....	79
LP3958	147	SCAN90CP02SP	79
LP3981	133	SCAN12100TYA.....	81
LP3982	133	SCAN25100TYA.....	81
LP3983	133	SCAN90004TVS.....	78
LP3984	133	SCAN921025HSM.....	81
LP3985	133	SCAN921226HSM.....	81
LP3986	133	SDALTEVK	86
LP3987	133	SDXILEVK	86
LP3988	133		
LP3990	133		
LP3991	133		
LP3995	134		
LP3996	133		
LP5520	147, 159		
LP5521	147, 159		
LP5522	147		
LP5524	147		
LP5526	147		
LP5527	147		
LP5550	140		
LP5551	140		
LP5552	140		
LP5900	122, 134		
LP5951	133		
LP5952	133		

Worldwide Design Centers and Manufacturing Facilities



- Design Centers
- Manufacturing Facilities

Design Centers

USA:

Arlington, Texas
 Calabasas, California
 Chandler, Arizona
 Federal Way, Washington
 Fort Collins, Colorado
 Grass Valley, California
 Indianapolis, Indiana
 Longmont, Colorado
 Norcross, Georgia
 Phoenix, Arizona
 Rochester, New York
 Salem, New Hampshire
 San Diego, California
 Santa Clara, California
 South Portland, Maine
 Tucson, Arizona

EUROPE:

Delft, Netherlands
 Fürstfeldbruck, Germany
 Unterhaching, Germany
 Greenock, Scotland
 Kemi, Finland
 Milan, Italy
 Oulu, Finland
 Tallinn, Estonia

ASIA:

Bangalore, India
 Hangzhou, China
 (joint with Zhejiang University)
 Hong Kong, China
 Tokyo, Japan

Manufacturing Facilities

Wafer (Die) Fabrication:

Arlington, Texas USA
 South Portland, Maine USA
 Greenock, Scotland

Chip Test and Assembly:

Melaka, Malaysia
 Suzhou, China

World Headquarters

2900 Semiconductor Drive
 Santa Clara, CA 95051
 USA
 +1 408 721 5000
www.national.com

Mailing Address:

PO Box 58090
 Santa Clara, CA 95052
support@nsc.com

European Headquarters

Livry-Gargan-Str. 10
 82256 Fürstfeldbruck
 Germany
 +49 8141 35 0
national.com/support
europe.support@nsc.com

Asia Pacific Headquarters

2501 Miramar Tower
 1 Kimberley Road
 Tsimshatsui, Kowloon
 Hong Kong
 +852 2737 1800
ap.support@nsc.com

Japan Headquarters

Beside KIBA
 2-17-16
 Kiba, Koto-ku
 Tokyo, 135-0042, Japan
 +81 3 5639 7300
jpn.feedback@nsc.com

