

# Analog Product Guide

[www.national.com](http://www.national.com)

Q1 2008

Table of Contents .....	3
Why Efficiency Matters.....	4
PowerWise® Solutions .....	5
Design Tools .....	6
Data Conversion .....	7-21
Operational Amplifiers.....	22-43
Audio Amplifiers.....	44-63
Temperature Sensors.....	64-67
Interface .....	68-82
Power.....	83-141
Index .....	142-147



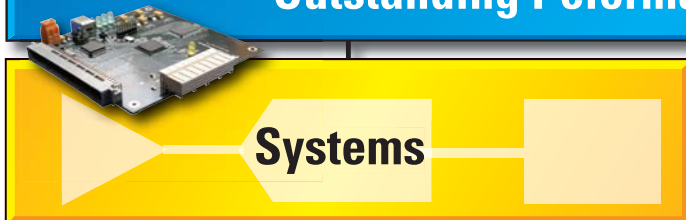
 **National  
Semiconductor**  
The Sight & Sound of Information

# PowerWise® Solutions for Energy-Efficient Designs

[national.com/powerwise](http://national.com/powerwise)



## PowerWise® Solutions Outstanding Performance-to-Power Ratios



## Solve Your Toughest Analog Problems at the Lowest Power

National's PowerWise solutions offer outstanding performance-to-power ratios in systems and products, including:

- Adaptive Energy Management Intellectual Property
- Reference Designs & Tools
- System-Optimized Integrated ICs
- Power, Amplifier, Interface and Data Conversion ICs

Get the highest performance at the lowest power at:

[national.com/powerwise](http://national.com/powerwise)

Or call: 1-800-272-9959

 **National  
Semiconductor**  
*The Sight & Sound of Information*

<b>Why Efficiency Matters</b> .....	4	<b>Power Management</b>	
<b>PowerWise® Solutions</b> .....	5	Power Management Product Portfolio .....	83
<b>Design Tools</b> .....	6	Power Switching Topologies .....	84-85
<b>Data Conversion</b>		Non-Synchronous Step-Down Switching Regulators .....	86-87
Data Converter Portfolio .....	7	Synchronous Step-Down (Buck) Switching Regulators .....	88-89
Ultra-High-Speed A/D Converters .....	8	SIMPLE SWITCHER® Non-Synchronous Regulators .....	90-91
High-Speed A/D Converters .....	9-14	SIMPLE SWITCHER® Synchronous Regulators .....	92
Low-Power A/D Converters .....	15-17	Switched-Capacitor Converters and Regulators .....	93
Low-Power D/A Converters .....	18-19	Step-Down (Buck) Switching Controllers .....	94
Analog Front Ends .....	20-21	Synchronous Step-Down (Buck) Switching Controllers .....	95-96
<b>Operational Amplifiers</b>		Step-Up (Boost) Switching Regulators .....	97
High-Speed Amplifiers .....	22-26	Step-Up (Boost) Switching Controllers .....	98
Buffers .....	26	Step-Up (Boost) and Step-Down (Buck) Regulators .....	99-100
Comparators .....	27	Industrial and Telecom Solutions .....	101
RF Detectors and Clock Buffers .....	28	Switching Regulators and Controllers for Isolated Applications .....	102
Analog Video Products .....	29-32	Isolated Controllers .....	103
Precision Amplifiers .....	33-36	MOSFET Drivers .....	104
Low-Voltage Amplifiers .....	37	Load-Share Controllers .....	105
Micropower Amplifiers .....	38	Low Dropout (LDO) Linear Regulators .....	106-108
Shutdown Amplifiers .....	39	Low-Noise LDOs to Power RF and Analog Circuits .....	109
Low-Power Amplifiers .....	40-41	Multi-Output LDOs .....	110
Low-Voltage, Low-Noise Amplifiers .....	42	Multi-Output Switching Regulators .....	111-115
CMOS-Input Amplifiers .....	43	PowerWise® Energy Management Units .....	116
<b>Audio</b>		Multi-Output Switching Controllers .....	117
Choosing an Audio Power Amplifier .....	44-45	Voltage References and Supervisors .....	118
High-Performance Audio .....	46-49	Power Sequencers .....	119
Mixed Signal Subsystems/Audio Codecs .....	50-51	LED Drivers .....	120-122
Analog Subsystems .....	52-53	Inductive-Boost Backlight LED Drivers .....	123-126
Headphone Amplifiers .....	54-55	Switched-Capacitor Boost Backlight LED Drivers .....	127
High-Efficiency Boomer® and Overture® Class D Amplifiers .....	56	Flash LED Drivers .....	128
Boosted Boomer Moving Coil .....	57	High-Brightness LED Drivers .....	129-132
Boosted Boomer Piezo Ceramic .....	58	Lighting Management Units .....	133-135
Mono Boomer Audio Amplifiers .....	59	Step-Down (Buck) Regulators for RF Power Amplifiers .....	136
Stereo Boomer Audio Amplifiers .....	60	Linear Regulators for DDR Termination .....	137
Specialty Audio .....	61	Power-over-Ethernet Controllers .....	138
Microphone Amplifiers .....	62	Hot-Swap Controllers .....	139
Audio Sound Solutions .....	63	Motor and Motion Controllers .....	140-141
<b>Temperature Sensors</b> .....	64-67	<b>Index by Product</b> .....	142-147
<b>Interface</b>			
Interface Product Overview .....	68		
Multi-Drop LVDS .....	69		
LVDS and CML PHYs .....	70-71		
Differential-to-Differential .....	72-73		
Serializer/Deserializer (SerDes) .....	74-75		
Comprehensive 3 Gbps SDI Solutions .....	76		
SDI Serializers and Deserializers with LVDS Interface .....	77		
High-Speed Industrial Ethernet .....	78-79		
LMK Clock Conditioner Family .....	80-81		
High-Performance Synthesizers .....	82		

# Why Efficiency Matters

## Rising Energy Demands and Costs

- 20% of base station operating expenses are electricity\*
- \$7 billion electricity costs at data centers worldwide\*\*
- \$7.2 billion worldwide electricity costs for operating servers and associated infrastructure in 2005\*\*\*
- 1 trillion minutes of mobile video by 2010 equates to \$100 million in energy costs\*
- 300 new Giga Watt power plants would be required by 2030 worldwide at current growth rate

Sources:

\* National Semiconductor calculation

\*\* Information Week

\*\*\* Lawrence Berkeley National Laboratory, February 2007 study

Learn more about the impact of energy-efficiency needs, National's corporate social responsibility, and PowerWise solutions at

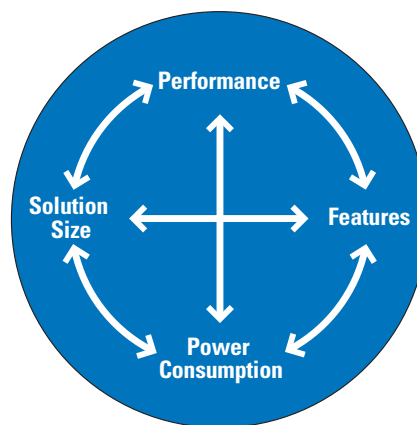
[www.national.com/powerwise](http://www.national.com/powerwise)



## System Benefits of Improved Performance-to-Power

- Lower power consumption
  - Reduced energy costs and carbon footprint
  - Extended equipment lifespan
  - Reduced landfill disposal
- Less heat
  - Greater performance in a smaller box
  - Added reliability from lower operating temperature
- Longer battery life
  - Better user experience on the same battery

Designers are constantly forced to make trade-offs between the design needs of added features and smaller form factors and the highest possible performance – and all of this with lower power consumption.



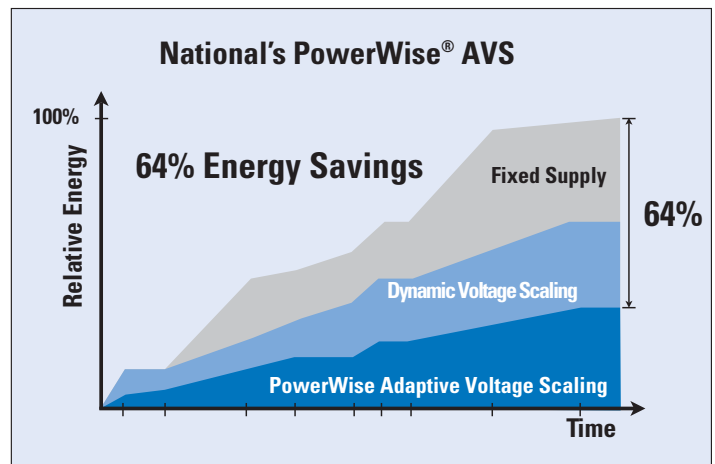


**National's PowerWise solutions offer outstanding performance-to-power ratios in systems and products, including:**

- Adaptive Energy Management Intellectual Property
- Reference Designs & Tools
- System-Optimized Integrated ICs
- Power, Amplifier, Interface and Data Conversion ICs

## PowerWise Adaptive Voltage Scaling Technology

PowerWise® technology is an advanced energy-management solution for the energy constrained digital devices of today and tomorrow: Mobile phones, PDAs, handheld gaming consoles, personal navigators and others. Developed by National Semiconductor in collaboration with ARM, PowerWise technology enables longer battery life, more features and improved user experience by reducing the energy consumption in digital processors by up to 64%.



# Design Tools

## Resources for Next-Generation Design

### Tools for Energy-Efficient Designs

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

[www.national.com/powerwise](http://www.national.com/powerwise)

### Parametric Catalog and Search

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

[www.national.com/cat](http://www.national.com/cat)

### WEBENCH® Online Design Tools

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

[www.national.com/webench](http://www.national.com/webench)



### Online Seminars

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

[www.national.com/onlineseminars](http://www.national.com/onlineseminars)



### Analog University®

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

[www.national.com/AU](http://www.national.com/AU)



### Power Designer

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

[www.national.com/powerdesigner](http://www.national.com/powerdesigner)



### Signal Path Designer®

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

[www.national.com/spdesigner](http://www.national.com/spdesigner)



### Analog Edge<sup>SM</sup> App Notes

National's monthly analog design technical journal.

[www.national.com/analogedge](http://www.national.com/analogedge)



### 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](http://www.national.com/appnotes)

### News@National Newsletter

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

[www.national.com/newsletter](http://www.national.com/newsletter)



### Application Solutions

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

[www.national.com/solutions](http://www.national.com/solutions)



### Analog by Design Talk Show

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

[www.national.com/analogbydesign](http://www.national.com/analogbydesign)



### FPGA Design Guides

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

[www.national.com](http://www.national.com)



### Knowledge Base

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

[www.national.com/kbase](http://www.national.com/kbase)



# Data Converter Portfolio

## GSPS Ultra-High Speed A/D Converters

### Features

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

### Applications:

Ideal for use in test & measurement and communication systems

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

## MSPS High-Speed A/D Converters

### Features

- 8- to 14-bit ADCs up to 200 MSPS sampling rate
- 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 & measurement, and portable instrumentation

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

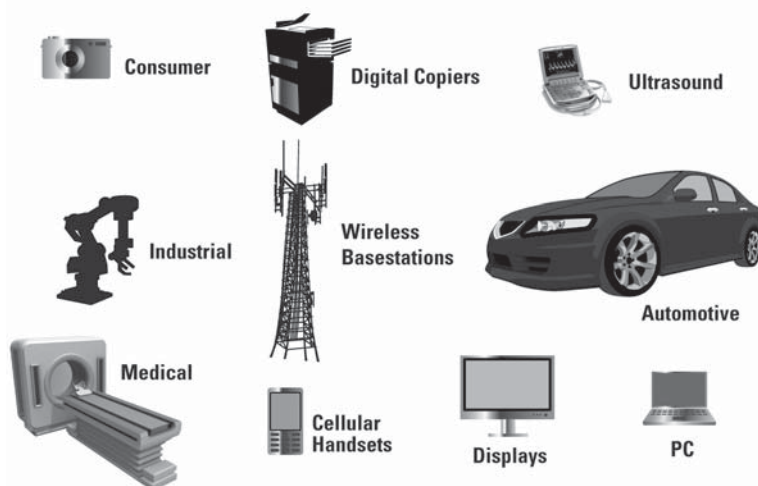
### Features

- 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

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

### GPS 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 GPS sampling speed
- DNL  $\pm 0.20$  LSB
- Operating power between 0.8W and 1.9W (*No heat sink required*)
- Power down mode: under 25 mW

### ADC083000 Features

- Interleaving capability enables up to 6 GPS 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
- 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

### 8-Bit GPS A/D Converters

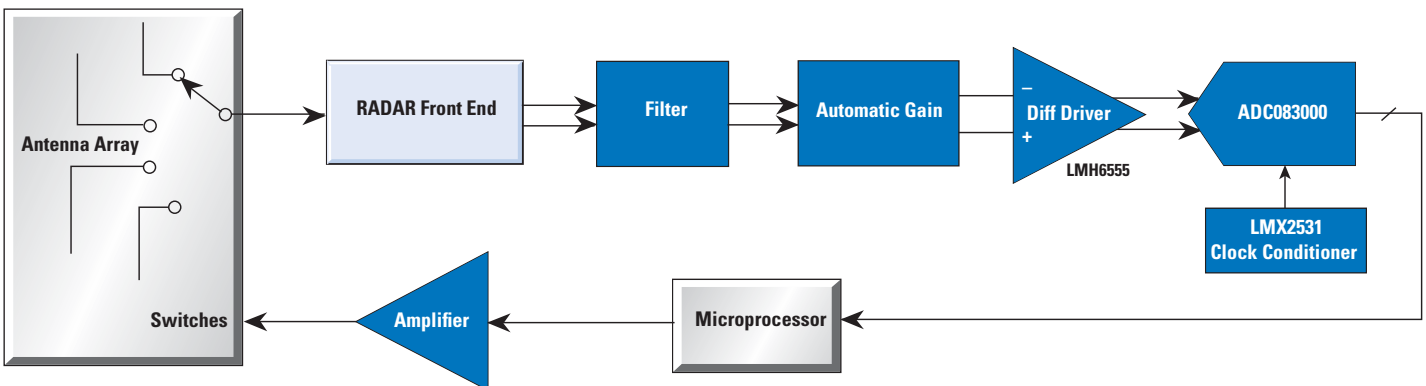
Product ID	Description
ADC081000	• 1 GPS
<b>NEW</b> ADC08D1000	• Dual, 1 GPS (2 GPS in interleave mode)
ADC08D1020	• Dual, 1 GPS (2 GPS in interleave mode), includes test pattern and clock phase adjustment
ADC081500	• 1.5 GPS
<b>NEW</b> ADC08D1500	• Dual, 1.5 GPS (3 GPS in interleave mode)
ADC08D1520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

• PowerWise product

### Applications:

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

### RADAR System



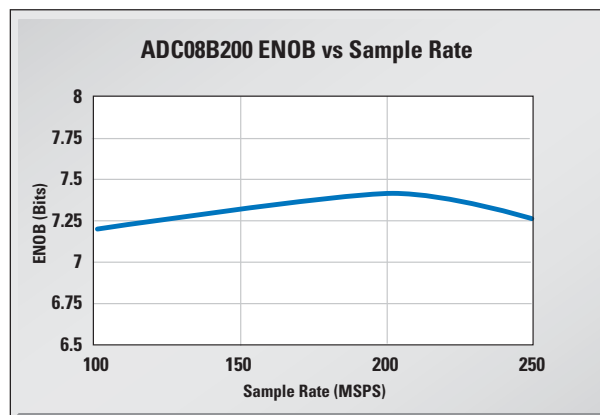


# MSPS High-Speed A/D Converters

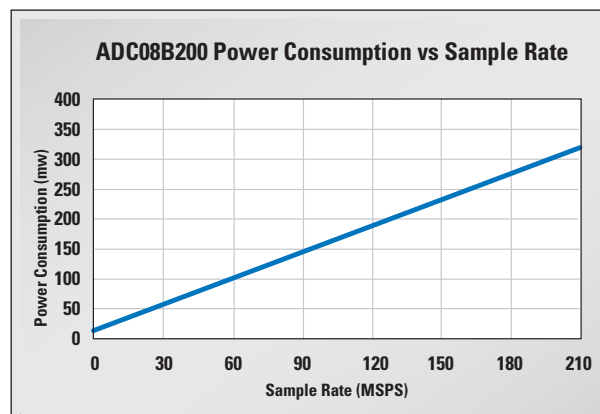
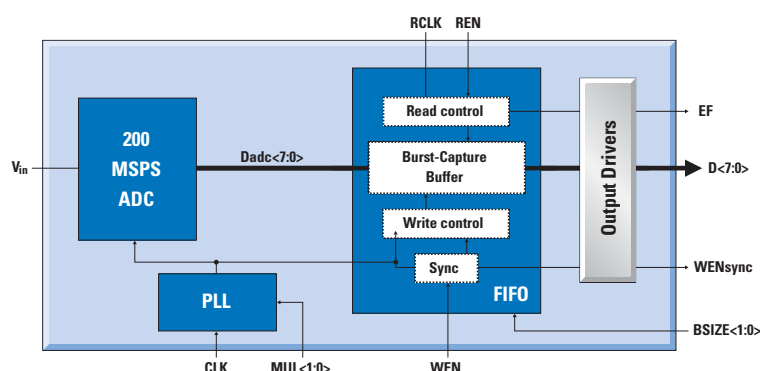
## ADC08B200 - 8-Bit, 200-MSPS ADC with 1K Capture Buffer

### 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	45.3	47.5	-47.5	LQFP-128
ADC08500	500	10.8W	7.5	45.3	47.5	-47.5	LQFP-128

\* Buffer

\*\* Dual

• PowerWise® product

# MSPS High-Speed A/D Converters

## MSPS High-Speed A/D Converters

Product ID	Channels	Speed (MSPS)	Power (mW)	SNR (dB)	SFDR (dB)	Outputs	Packaging
<b>10-Bit</b>							
ADC10040	• 1	40	55.5	59	80	CMOS	TSSOP-28
ADC10065	• 1	65	68.4	59	80	CMOS	TSSOP-28
ADC10080	• 1	80	78.6	59	79	CMOS	TSSOP-28
ADC10D020	2	20	150	59	75	CMOS	TQFP-48
ADC10D040	2	40	257	60	72	CMOS	TQFP-48
ADC10DL065	• 2	65	370	61	85	CMOS	TQFP-64
<b>11-Bit</b>							
ADC11L066	1	66	357	65	78	CMOS	LQFP-38
ADC11C125	1	125	608	65.5	88.2	CMOS	LLP-48
ADC11C170	1	170	715	65.1	85.4	CMOS	LLP-48
ADC11DL066	2	66	686	64	80	CMOS	TQFP-48
<b>12-Bit</b>							
ADC12081	1	5	105	68	79	CMOS	LQFP-32
ADC12010	1	10	160	70	83	CMOS	LQFP-32
ADC12020	1	20	185	70	86	CMOS	LQFP-32
ADC12040	1	40	340	70	84	CMOS	LQFP-32
ADC12L063	1	62	354	66	78	CMOS	LQFP-32
ADC12L066	1	66	357	66	80	CMOS	LQFP-32
ADC12L080/81	1	80	425	66	80	CMOS	LQFP-32
ADC12C170	• 1	170	715	67.2	85.4	CMOS	LLP-48
ADC12V170	• 1	170	781	67.2	85.8	Parallel LVDS	LLP-48
ADC12C080	• 1	80	300	71.2	90	CMOS	LLP-32
ADC12C105	• 1	105	400	70.1	90	CMOS	LLP-32
ADC12DS080	• 2	80	845	71.2	90	Serial LVDS	LLP-60
ADC12DS105	• 2	105	1060	70.1	88	Serial LVDS	LLP-60
ADC12D040	2	40	600	68	80	CMOS	TQFP-64
ADC12DL040	• 2	40	210	69	86	CMOS	TQFP-64
ADC12DL065	• 2	65	360	69	86	CMOS	TQFP-64
ADC12DL080	• 2	80	447	69.3	82	CMOS	TQFP-64
ADC12QS065	4	65	800	69	83	Serial LVDS	LLP-60
<b>14-Bit</b>							
ADC14L020	• 1	20	150	74	93	CMOS	LQFP-32
ADC14L040	• 1	40	235	73.3	90	CMOS	LQFP-32
ADC14155	• 1	155	967	71.3	87	CMOS	LLP-48
ADC14V155	• 1	155	951	71.7	86.9	Parallel LVDS	LLP-48
ADC14C080	• 1	80	300	74.2	90	CMOS	LLP-32
ADC14C105	• 1	105	400	73	88	CMOS	LLP-32
ADC14DS080	• 2	80	800	74.2	90	Serial LVDS	LLP-60
ADC14DS105	• 2	105	1000	70.5	83	Serial LVDS	LLP-60

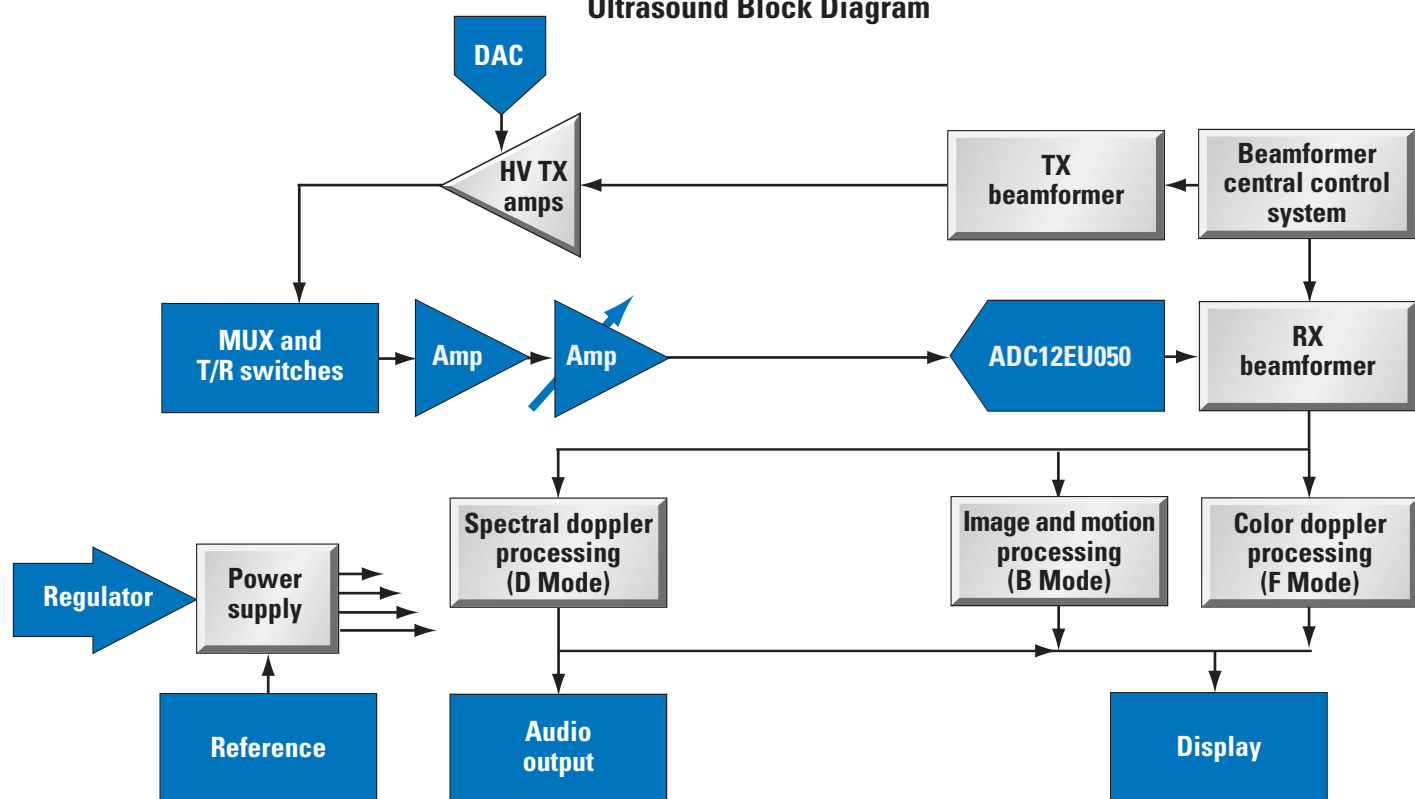
• PowerWise® product

## ADC12EU050 – PowerWise® Ultra-Low Power, High-Speed Continuous-Time Sigma-Delta ADC

### Features

- 8-channel, 12-bit, 50 MSPS ADC
- Energy-efficient PowerWise® ADC
- Ultra-low power consumption: 350 mW
- Consumes 44 mW/channel at 50 MSPS
- Alias-free sample bandwidth up to 25 MHz
- On-chip PLL+VCO
- 68 dB Signal-to-Noise and Distortion (SINAD)
- 70 dBFS Signal-to-Noise Ratio (SNR)
- Instant Overload Recovery (IOR)
- Available in LLP-68 packaging

Ultrasound Block Diagram



### Applications:

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

# MSPS High-Speed A/D Converters

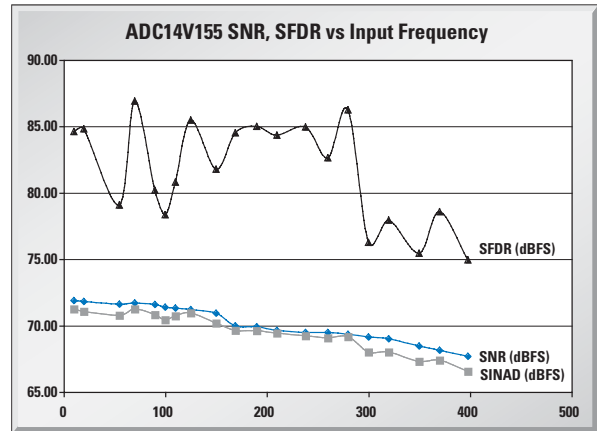
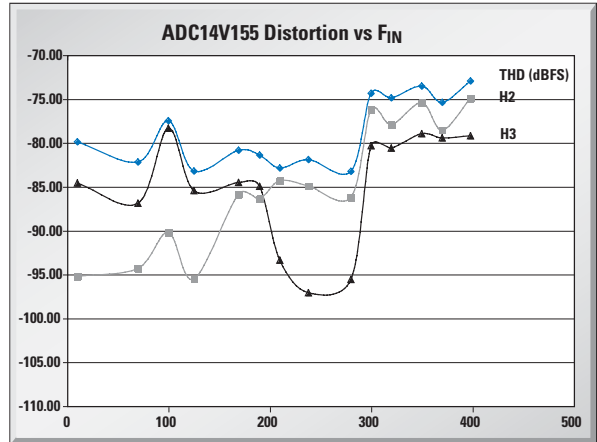
## ADC14V155 – PowerWise® 14-bit, 155 MSPS ADC for High IF Sampling

### Features

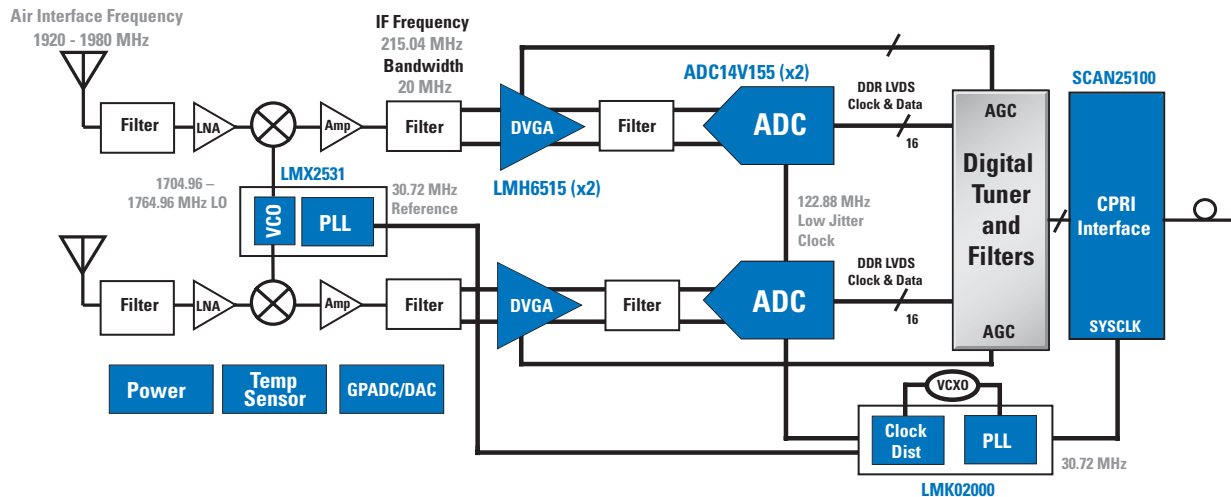
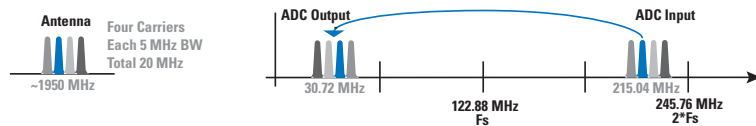
- 1.1 GHz full power bandwidth
- 69.5 dBFS SNR at 238 MHz input
- 85 dBFS SFDR at 238 MHz input
- -81.9 dBFS THD at 238 MHz input
- Dual 3.3V, 1.8V supply operation
- Power consumption: 951 mW
- Parallel LVDS outputs
- Available with CMOS outputs (ADC14155)
- Available in LLP-48 packaging (7 x 7 x 0.8 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



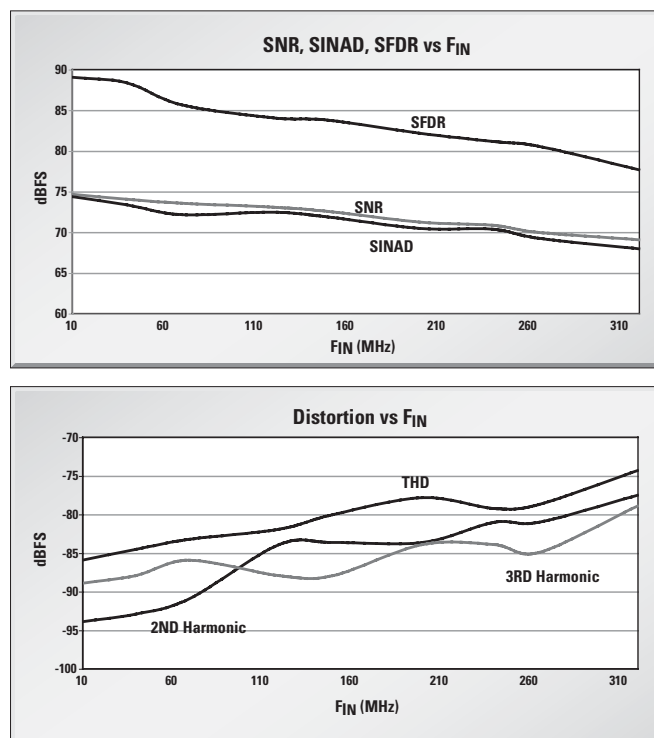
## ADC14C105 – PowerWise® 14-bit, 105/95 MSPS ADC for High IF Sampling

### 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 32-pin LLP® 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:

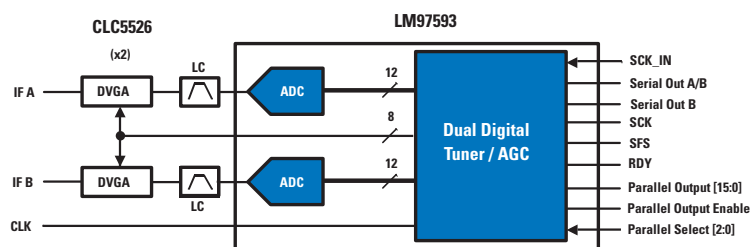
Ideal for use in 3G wireless basestation receivers, WiMAX, power amplifier linearization, high IF sampling receivers, multi-carrier, multi-mode receivers, test and measurement equipment, communications test equipment, and RADAR systems



## 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

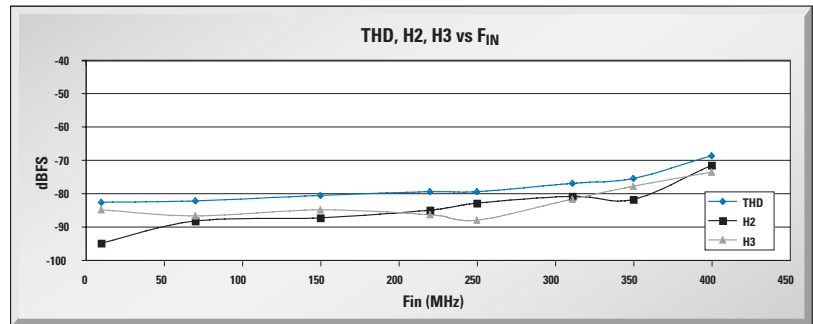
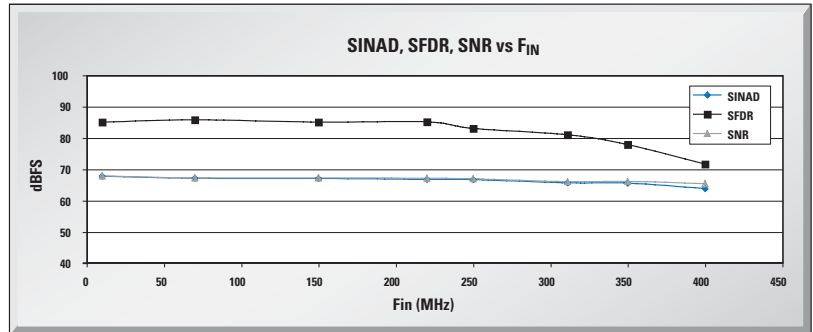
## ADC12V170 – PowerWise® 12-Bit, 170 MSPS ADC for High IF Sampling

### 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:

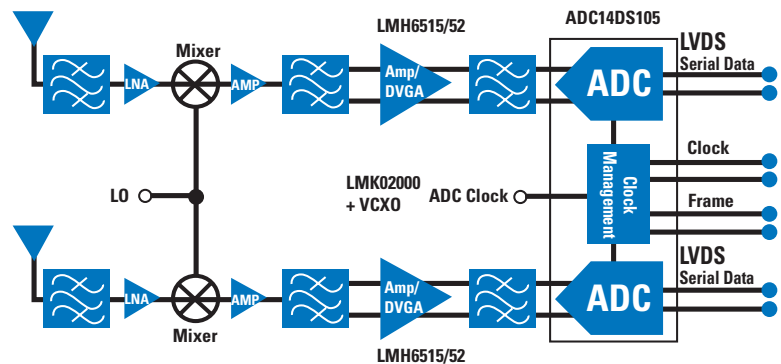
Ideal for use in 3G wireless basestation receivers, WiMAX, power amplifier linearization, high IF sampling receivers, multi-carrier, multi-mode receivers, test and measurement equipment, communications test equipment, and RADAR systems



## 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 (1-8 Channels) from the PowerWise® Family

#### 12-Bit ADC

- INL:  $\pm 0.64$  LSB
- ENOB: 11.7

#### 10-Bit ADC

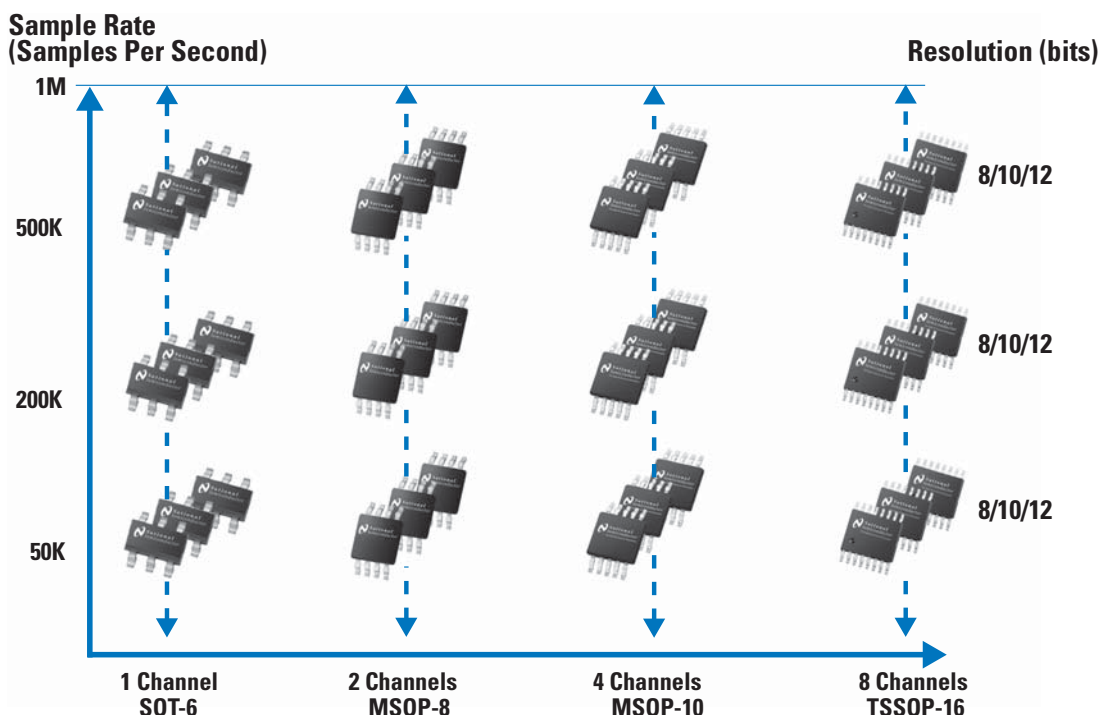
- INL:  $\pm 0.2$  LSB
- ENOB: 9.9

#### 8-Bit ADC

- INL:  $\pm 0.5$  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



## Featured Products

#### ADC141S626 14-bit ADC

- Conversion rate 50 to 250 kSPS
- INL  $\pm 0.95$  LSB (max)
- DNL  $\pm 0.95$  LSB (max)
- SINAD 82 dB (max)
- Offset error  $\pm 5$  LSB (max)
- Gain error  $\pm 5$  LSB (max)
- Power consumption at  $V_A = 3V$ 
  - Active, 250 kSPS, 2.0 mW (typ)
  - Active, 200 kSPS, 4.8 mW (typ)
  - Power down 4  $\mu$ W (typ)
- Temperature range:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

#### ADC122S706 Simultaneous Sampling ADC

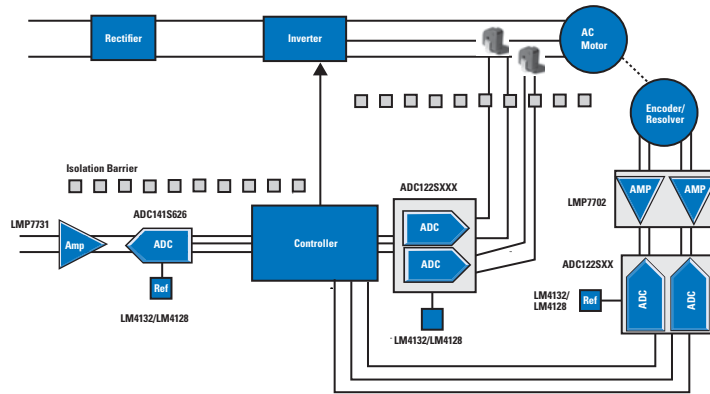
- Conversion rate 500 kSPS to 1MSPS
- INL  $\pm 1.0$  LSB (max)
- DNL  $\pm 0.95$  LSB (max)
- SINAD 69.5 dB (min)
- Offset error  $\pm 3.0$  LSB (max)
- Gain error  $\pm 8$  LSB (max)
- Power consumption at 1 MSPS
  - Converting  $V_A = 5V$ ,  $V_D = 3V$  20 mW (typ)
  - Power down 3  $\mu$ W (typ)
- Temperature range:  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$

#### ADC121C021/27 I<sup>2</sup>C ADC

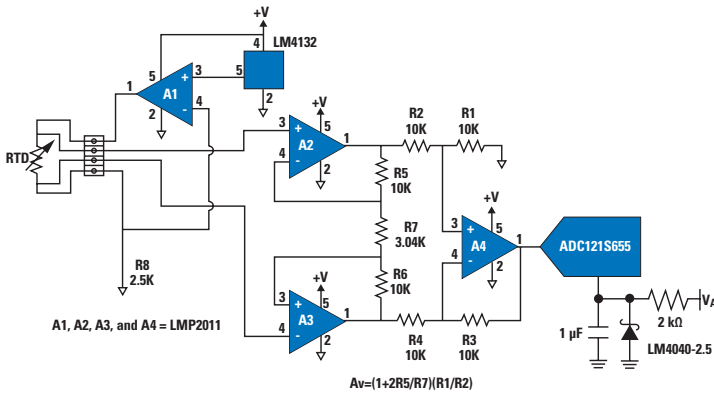
- Supports all 3 standard sample rate modes
- Alarm / address options
- Offset error  $\pm 4.0$  LSB (max)
- Gain error  $\pm 4.0$  LSB (max)
- INL  $\pm 1.0$  LSB up to 22 kSPS (max)
- DNL  $\pm 1.0$  LSB up to 22 kSPS (max)
- SINAD 68.5 dB (min)
- Power consumption at 22 kSPS
  - 0.26 mW (typ) at 3V
  - 0.78 mW (typ) at 5V
  - Power down 0.06  $\mu$ W (typ)
- Temperature range:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

# kSPS Low- Power A/D Converter Applications

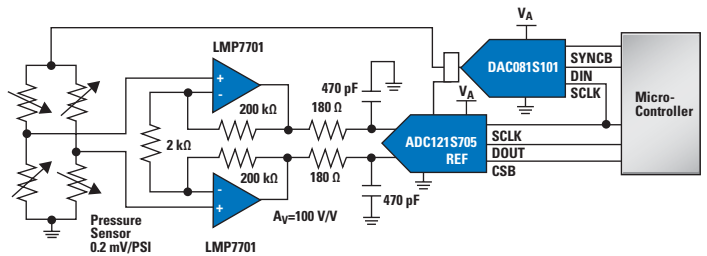
## Motor Control



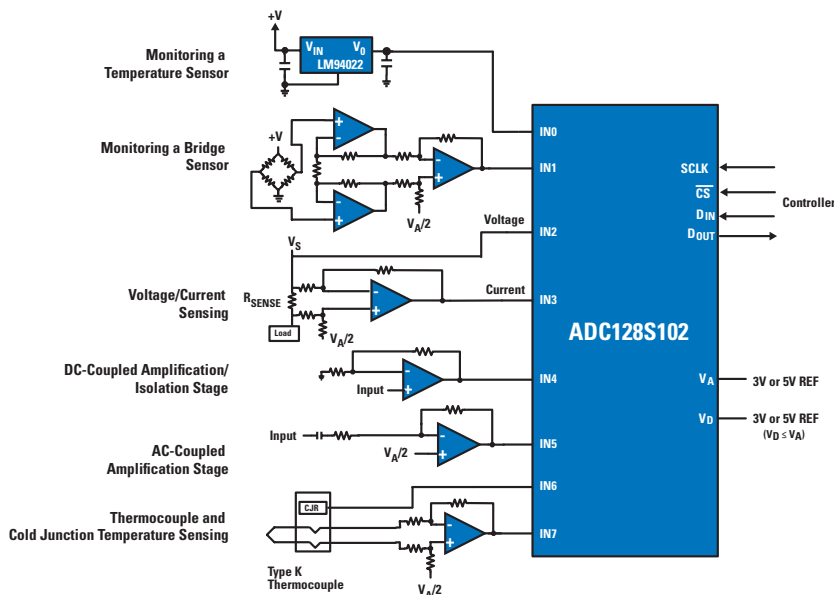
## Resistance Temperature Detector Application



## Pressure Sensor Application



## Multi-Channel Input: Multiple Applications





# kSPS Low-Power 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)			
<b>Single-Ended Input SPI A/D Converters</b>												
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
ADC081S051	8	1		200 to 500	2.7 to 5.25	1.6	8.5	+0.06, -0.04	+0.06, -0.05	7.9	-40 to 85	SOT-23, LLP-6
ADC081S101	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
ADC101S051	10	1		200 to 500	2.7 to 5.25	2.7	9.7	+0.15, -0.09	+0.15, -0.11	9.9	-40 to 85	SOT-23, LLP-6
ADC101S101	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
ADC121S051	12	1		200 to 500	2.7 to 5.25	1.7	8.7	+0.45, -0.4	+0.5, -0.25	11.6	-40 to 85	SOT-23, LLP-6
ADC121S101	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
ADC082S051	8	2	200 to 500		2.7 to 5.25	2.2	7.1	+0.12, -0.06	±0.09	7.9	-40 to 85	MSOP-8
ADC082S101	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
ADC102S051	10	2	200 to 500		2.7 to 5.25	2.7	8.6	+0.2, -0.1	±0.13	10.0	-40 to 85	MSOP-8
ADC102S101	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
ADC122S051	12	2	200 to 500		2.7 to 5.25	3	10	±0.5	+0.7, -0.4	11.7	-40 to 85	MSOP-8
ADC122S101	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
ADC084S051	8	4		200 to 500	2.7 to 5.25	2.2	7.1	+0.12, -0.06	±0.09	7.9	-40 to 85	MSOP-10
ADC084S101	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
ADC104S051	10	4		200 to 500	2.7 to 5.25	2.7	8.6	+0.2, -0.1	±0.13	10.0	-40 to 85	MSOP-10
ADC104S101	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
ADC124S051	12	4		200 to 500	2.7 to 5.25	3	10	±0.5	+0.7, -0.4	11.7	-40 to 85	MSOP-10
ADC124S101	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
ADC088S052	8	8	200 to 500		2.7 to 5.25	1.2	6.5	±0.05	±0.06	7.9	-40 to 105	TSSOP-16
ADC088S102	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	10.0	-40 to 105	TSSOP-16
ADC108S052	10	8	200 to 500		2.7 to 5.25	1.5	7.5	±0.10	±0.2	10.0	-40 to 105	TSSOP-16
ADC108S102	10	8	500 to 1000		2.7 to 5.25	2.1	9.4	±0.20	±0.2	10.0	-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
ADC121C021 <sup>2</sup>	12	1			5.56 to 189	2.7 to 5.5	0.26	0.78	±0.5	±0.5	11.7	-40 to 105
ADC121C027 <sup>1,2</sup>	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
<b>Differential-Input SPI A/D Converters</b>												
ADC121S625	12	1	↑	50 - 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 - 500	4.5 to 5.5	—	9	±0.6	±0.4	11.7	-40 to 105	MSOP-8
ADC121S705	12	1		500 - 1000	4.5 to 5.5	—	11.5	±0.6	±0.4	11.7	-40 to 105	MSOP-8
ADC141S626	14	1		50 - 250	2.7 to 5.5	2	4.8	±0.5	±0.5	13.7	-40 to 85	MSOP-10

<sup>1</sup> Alarm Option <sup>2</sup> I<sup>2</sup>C

• PowerWise® product

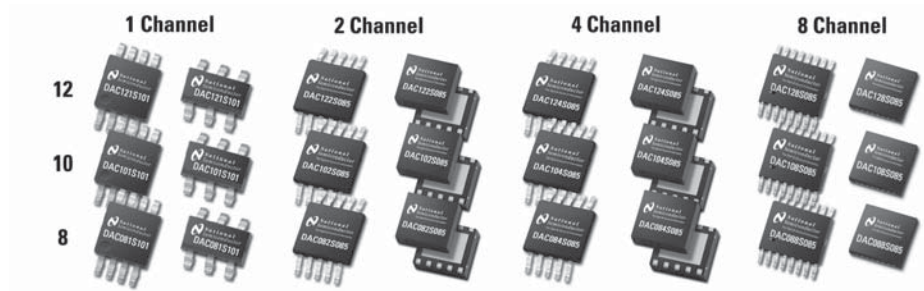
# kSPS Low-Power D/A Converters

## 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
- Power consumption at 3.6V
  - 1 channel, 226  $\mu\text{A}$  (max)
  - 2 channel, 270  $\mu\text{A}$  (max)
  - 4 channel, 485  $\mu\text{A}$  (max)
  - 8 channel, 585  $\mu\text{A}$  (max)
- External reference (2- and 4-channel), 8-channel has 2 references
- Up to 30 MHz over clock rates for 1-channel and 40 MHz for 2, 4, and 8-channel
- Operates over  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$

### Interchangeable DACs



### Applications:

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

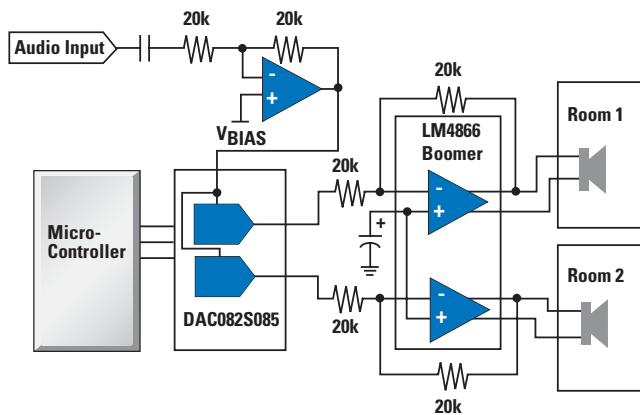
Product ID	Res (bits)	# Mux Inputs	Pin and Function Comp. Family	Typ Settling Time ( $\mu\text{sec}$ )	Supply Voltage (V)	Typ Current Consumption ( $\mu\text{A}$ )		Static Performance (Typ)		Reference	I/O Type <sup>1</sup>	Packaging
						3V	5V	INL (LSB)	DNL (LSB)			
<b>Digital-to-Analog Converters</b>												
DAC081S101	8	1	↕	3	2.7 to 5.5	175	260	+0.16, -0.12	+0.04, -0.02	From supply	Serial (SPI)	MSOP-8, TSOT-6
DAC101S101	10	1		5	2.7 to 5.5	175	260	$\pm 0.6$	+0.15, -0.05	From supply	Serial (SPI)	MSOP-8, TSOT-6
DAC121S101	12	1		8	2.7 to 5.5	175	260	$\pm 2.6$	+0.25, -0.15	From supply	Serial (SPI)	MSOP-8, TSOT-6
DAC082S085	8	2	↕	3	2.7 to 5.5	210	320	$\pm 0.14$	+0.04, -0.02	External	Serial (SPI)	MSOP-10, LLP-10
DAC102S085	10	2		4.5	2.7 to 5.5	210	320	$\pm 0.7$	+0.08, -0.03	External	Serial (SPI)	MSOP-10, LLP-10
DAC122S085	12	2		6	2.7 to 5.5	210	320	$\pm 2.4$	+0.2, -0.1	External	Serial (SPI)	MSOP-10, LLP-10
DAC084S085	8	4	↕	3	2.7 to 5.5	350	500	$\pm 0.14$	+0.04, -0.02	External	Serial (SPI)	MSOP-10, LLP-10
DAC104S085	10	4		4.5	2.7 to 5.5	350	500	$\pm 0.7$	+0.08, -0.03	External	Serial (SPI)	MSOP-10, LLP-10
DAC124S085	12	4		6	2.7 to 5.5	360	480	$\pm 2.4$	+0.2, -0.1	External	Serial (SPI)	MSOP-10, LLP-10
DAC088S085	8	8	↕	3	2.7 to 5.5	650	970	$\pm 0.125$	$\pm 0.03$	Dual External	Serial (SPI)	TSSOP-16, LLP-16
DAC108S085	10	8		4.5	2.7 to 5.5	650	970	$\pm 0.5$	+0.08, -0.04	Dual External	Serial (SPI)	TSSOP-16, LLP-16
DAC128S085	12	8		6	2.7 to 5.5	650	970	$\pm 2.0$	+0.15, -0.09	Dual External	Serial (SPI)	TSSOP-16, LLP-16
DAC121C081	12	1		6	2.7 to 5.5	0.38 mW	0.73 mW	+2.2/-1.5	+0.18/-0.12	Supply	I <sup>2</sup> C	TSOT-6, LLP-6
DAC121C085	12	1		6	2.7 to 5.5	0.38 mW	0.73 mW	+2.2/-1.5	+0.18/-0.12	External	I <sup>2</sup> C	MSOP-8

<sup>1</sup> SPI/QSPI/DSP compatible

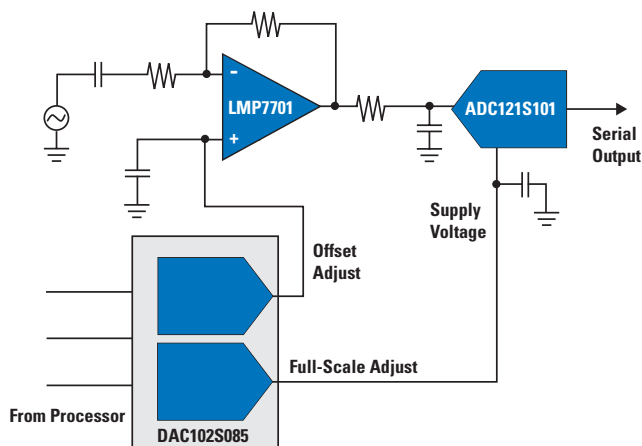
• PowerWise® product

# kSPS Low-Power D/A Converter Applications

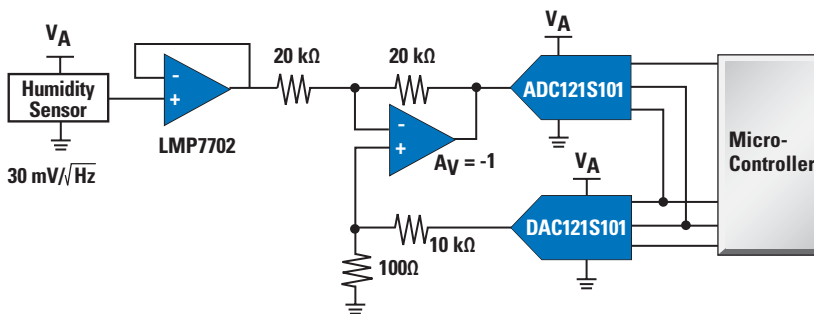
## Audio Performance Control



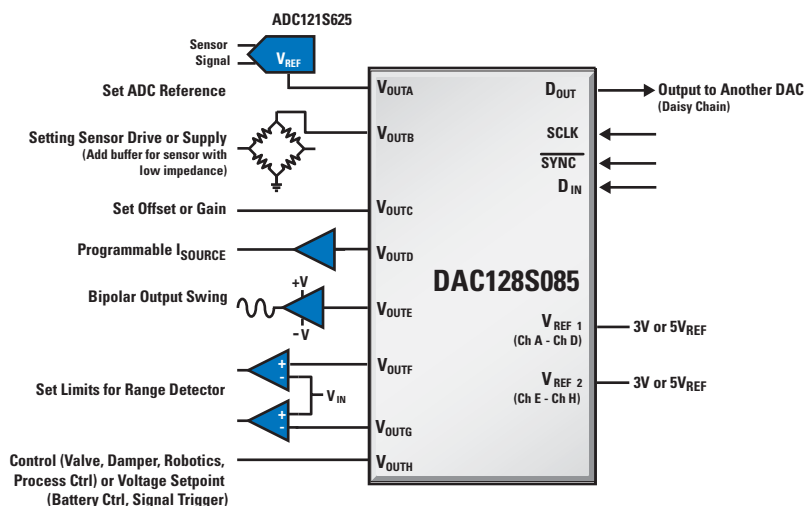
## Dynamic Range Optimization



## Sensor Set-Point Control



## Multi-Channel Output: Multiple Applications



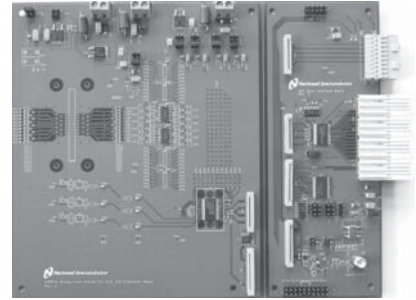
# Analog Front Ends (AFE)

## 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
- SNR -74 dB (at 0 dB PGA gain)
- INL:  $\pm 23$  LSB (typ)
- Power dissipation: 505 mW
- Integrated PGA: gain range 0.7 to 7.84x in 256 steps
- Integrated analog DAC: offset range  $\pm 300$  mV or  $\pm 600$  mV with  $\pm 9$  bit resolution
- Integrated digital DAC: offset range -1024 LSB to +1008 LSB with  $\pm 6$  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\*

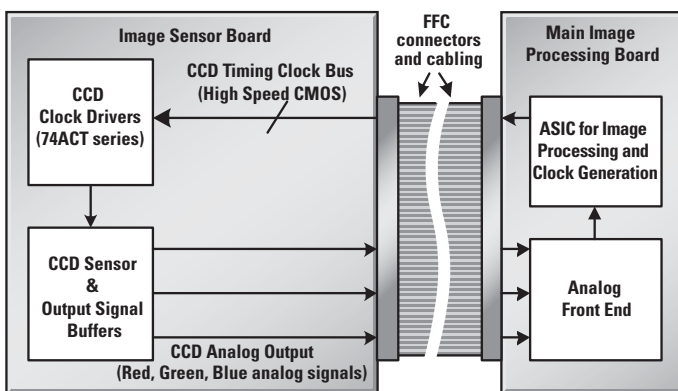


\*Available for order – contact sales rep

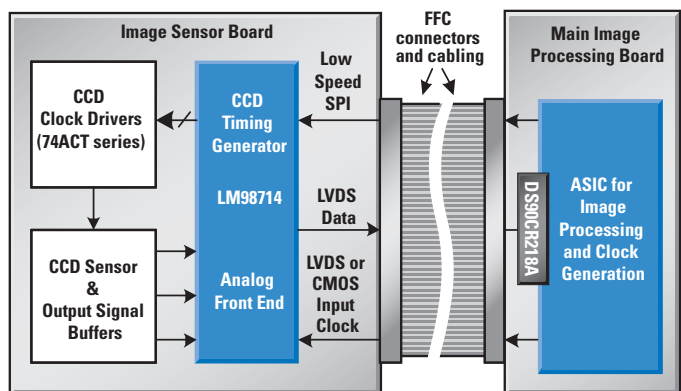
### Applications:

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

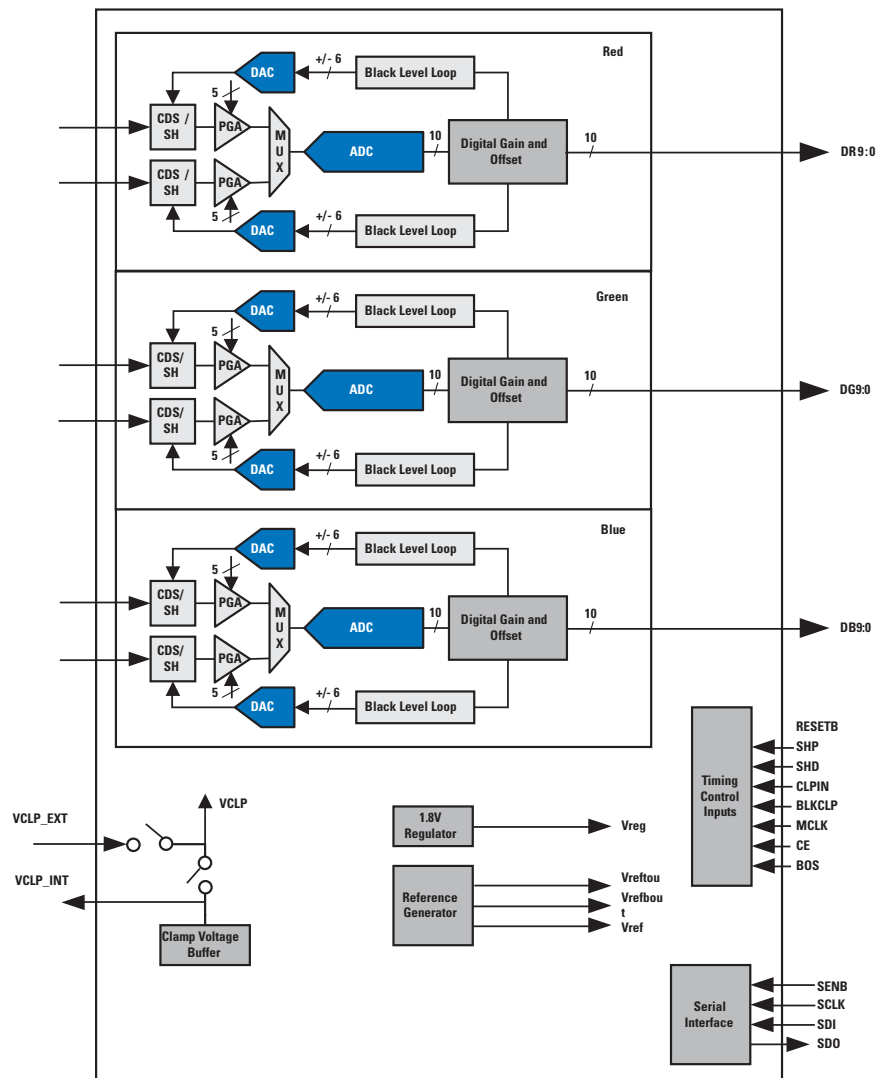
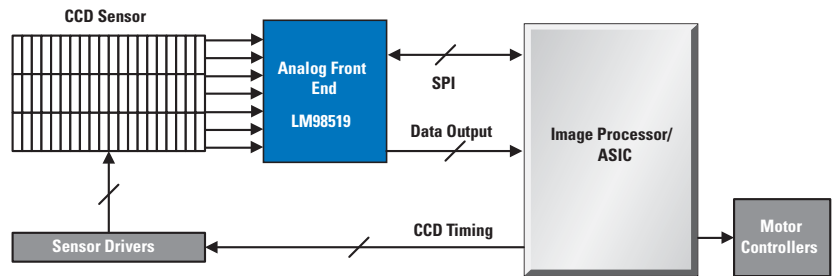


Read Analog Edge AN-1583. Topic:  
"Simplifying CCD/CIS Image Capturing with a 3-Channel 16-Bit AFE/Timing Generator"  
[www.national.com/analogedge](http://www.national.com/analogedge)

## 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
- SNR: 68 dB (at 0 dB PGA gain)
- INL:  $\pm 1$  LSB (typ)
- Power dissipation: 1.04W
- Integrated PGA: total gain range 1x to 20x in 256 steps
- Integrated analog coarse DAC: offset range  $\pm 277$  mV with  $\pm 4$  bit resolution
- Integrated analog fine DAC: offset range  $\pm 111$  mV or  $\pm 60$  mV with  $\pm 11$  bit resolution
- Operating temperature range:  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$
- Single 3.3V supply
- Available in TQFP-80 packaging



# PowerWise® High-Speed Amplifiers

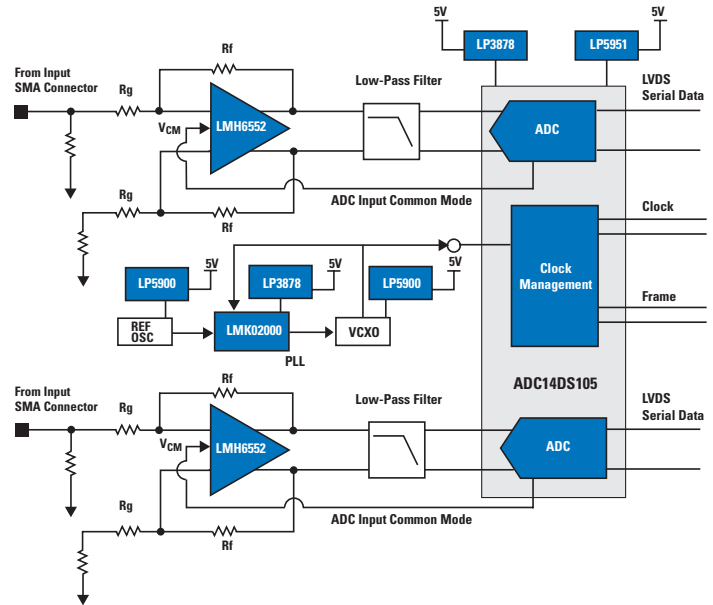
## LMH6552 – 1.5 GHz Fully Differential Amplifier

### 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/ $\mu$ s slew rate
- 10 ns settling time to 0.1%
- 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

### Applications:

Ideal for use in communications receivers, differential ADC drivers, video over twisted pair, differential line drivers, single ended to-differential converters, high speed differential signaling, intermediate frequency amplifiers, SAW filter buffers/drivers, and data acquisition front ends



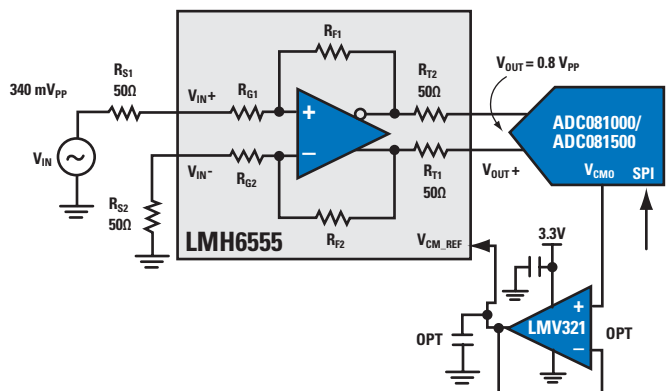
## LMH6555 – 1.2 GHz Low-Distortion Differential Driver

### 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/ $\mu$ s slew rate
- Ideal match for 8-bit ADCs up to 3 GSPS, such as the ADC08(D)1000/1500/3000 family
- Reference board available with LMX2531 clock conditioner and ADC083000/1000
- Available in LLP-16 packaging

### Applications:

Ideal for use in communications receivers, differential ADC drivers, video over twisted pair, differential line drivers, single ended to-differential converters, high speed differential signaling, intermediate frequency amplifiers, SAW filter buffers/drivers, and data acquisition front ends



## High-Speed Amplifiers

Product ID	Gain Bandwidth (MHz)	Slew Rate (V/ $\mu$ s)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Channels	Offset Voltage max, 25C (mV)	Voltage Noise (nV/ $\sqrt{\text{Hz}}$ )	2nd/3rd HD (dB)	Packaging
<b>Fully Differential Amplifiers</b>									
LMH6550	400	3000	5 to 12	20	1	5	6	-92/-103	SOIC-8
LMH6551	370	2400	3 to 12	12.5	1	5	6	-94/-96	SOIC-8
LMH6552	1000	3800	4.5 to 12	19	1	16.5	1.1	-82/-79	SOIC-8, LLP-8
LMH6555	1200	1300	3 to 3.6	120	1	50	19	-53/-54	LLP-16
<b>Low-Noise Amplifiers</b>									
LMH6622	160	80	5 to 12	4.3	2	1.2	1.6	-90/-100	SOIC-8
LMH6624	1500	400	5 to 12	12	1	0.5	0.92	-65/-80	SOIC-8, SOT23-5
LMH6626	1300	360	5 to 12	12	2	0.5	1	-65/-80	SOIC-8
LMH6628	300	550	5 to 12	9	2	2	2	-65/-75	SOIC-8
LMH6702	1700	3100	10 to 12	12.5	1	4.5	1.83	-100/-96	SOIC-8, SOT23-5
LMH6703	1200	4200	8 to 12	11	1	7	2.3	-87/-100	SOIC-8, SOT23-6
<b>Low-Power, Rail-to-Rail Input/Output Amplifiers</b>									
LMH6645	55	22	2.5 to 12	0.725	1	3	17	—	SOIC-8, SOT23-5
LMH6646	55	22	2.5 to 12	0.725	2	3	17	—	SOIC-8
LMH6647	55	22	2.5 to 12	0.725	1	3	17	—	SOIC-8, SOT23-6
<b>Low -Voltage Amplifiers</b>									
LMH6601	125	275	2.4 to 5.5	9.6	1	2.4	10	—	SC70-6
LMH6642	130	135	2.7 to 12.8	2.7	1	5	17	—	SOIC-8, SOT23-5
LMH6643	130	135	2.7 to 12.8	2.7	2	5	17	—	SOIC-8
LMH6644	130	135	2.7 to 12.8	2.7	4	5	17	—	SOIC-14, TSSOP-14
LMH6645	55	22	2.5 to 12	0.725	1	3	17	—	SOIC-8, SOT23-5
LMH6646	55	22	2.5 to 12	0.725	2	3	17	—	SOIC-8
LMH6658	270	700	3 to 12	6	2	5	11	—	SOIC-8
LMH6683	190	940	3 to 12	6.5	3	5	12	—	SOIC-14, TSS

## Rail-to-Rail Input / Output High-Speed Amplifiers

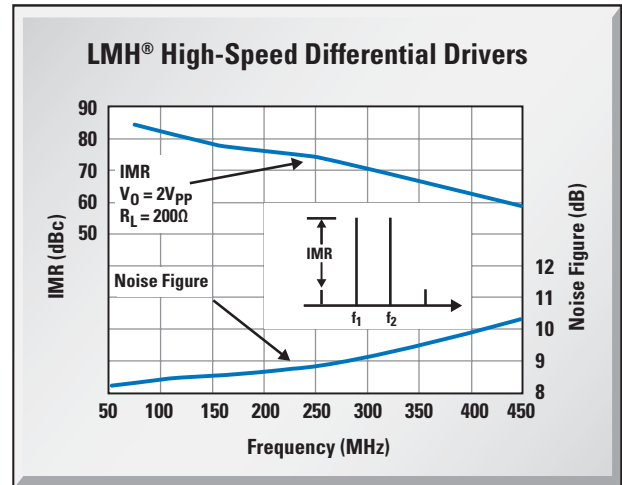
Product ID	Channels	V <sub>CM</sub> Min/Max from Neg Supply	V <sub>OUT</sub> Min/Max vs Neg Supply	Offset Voltage max, 25C (mV)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Gain Bandwidth (MHz)	Slew Rate (V/ $\mu$ s)	Voltage Noise (nV/ $\sqrt{\text{Hz}}$ )	Packaging
LMH6618	1	-0.2/0.2	0.43/-0.44	0.6	2.7 to 10	1.6	140	57	10	TSOT-6
LMH6619	2			0.6	2.7 to 11	1.25	130	55	10	SOIC-8
LMH6645	1	-0.5/0.5	0.02/-0.03	3	2.5 to 12	0.725	55	22	17	SOIC-8, SOT23-5
LMH6646	2	-0.5/0.5	0.02/-0.03	3	2.5 to 12	0.725	55	22	17	SOIC-8

# High-Speed 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,  $R_L = 200$
- 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



### Applications:

Ideal for use in communications infrastructure, basestations, high-bandwidth instrumentation, and automatic test equipment

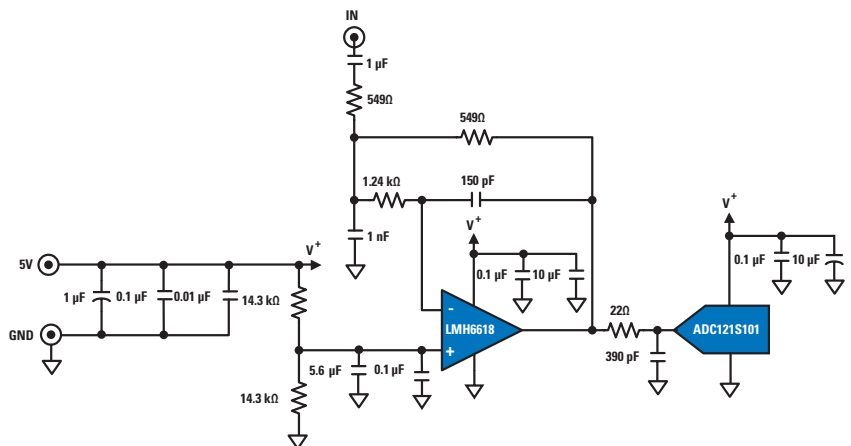
## LMH6618 – 130 MHz, 1.25 mA Rail-to-Rail Input and Output Op Amp with Shutdown

### Features

- Operating voltage range 2.7V to 11V
- Small signal bandwidth 130 MHz
- 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  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$
- Available in TSOT23-6 packaging

### Applications:

Ideal for use in factory automation, industrial, video, medical, and test and measurement applications



## Precision High-Speed Amplifiers

Product ID	Channels	Offset Voltage max, 25C (mV)	TcVos ( $\mu\text{V}/^\circ\text{C}$ )	CMRR (dB)	PSRR (dB)	Voltage Noise (V)	Gain Bandwidth (MHz)	Slew Rate ( $\text{V}/\mu\text{s}$ )	Supply Voltage Range (V)	Packaging
LMH6611	1	10	0.1	98	96	10	345	460	2.7 to 11	SOT23-6
LMH6618	1	0.6	0.9	98	104	10	140	57	2.7 to 10	TSOT-6
LMH6619	2	10	0.8	98	104	10	130	55	2.7 to 11	SOIC-8
LMH6624	1	0.5	0.2	95	88	0.92	1500	400	5 to 12	SOIC-8, SOT23-5
LMH6626	2	0.5	0.2	95	88	1	1300	360	5 to 12	SOIC-8



## Amplifiers &gt; 50 MHz

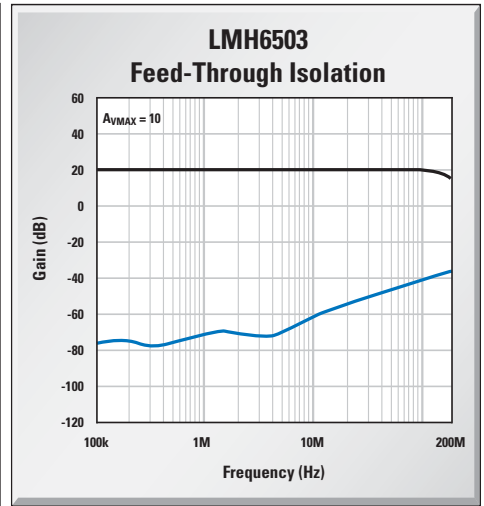
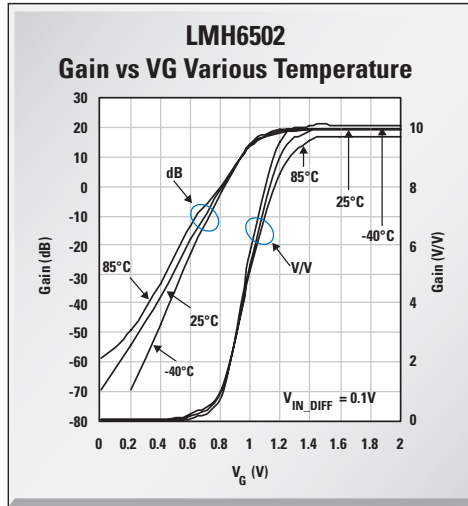
Product ID	Gain Bandwidth (MHz)	Slew Rate (V/ $\mu$ s)	Supply Voltage Range (V)	Supply Current/Channel (mA)	Channels	Offset Voltage max, 25C (mV)	Voltage Noise (V)	2nd/3rd HD (dB)	Packaging
LMH6550	400	3000	5 to 12	20	1	5	6	-92/-103	SOIC-8
LMH6551	370	2400	3 to 12	12.5	1	5	6	-94/-96	SOIC-8
LMH6552	1000	3800	4.5 to 12	19	1	16.5	1.1	-82/-79	SOIC-8, LLP-8
LMH6601	125	275	2.4 to 5.5	9.6	1	2.4	10	-56/-73	SC70-6
LMH6609	900	1400	6 to 12	7	1	2.5	3.1	-63/-57	SOIC-8, SOT23-5
LMH6618	140	57	2.7 to 10	1.6	1	0.6	10	-75/-75	TSOT-6
LMH6622	160	80	5 to 12	4.3	2	1.2	1.6	-90/-100	SOIC-8
LMH6624	1500	400	5 to 12	12	1	0.5	0.92	-65/-80	SOIC-8, SOT23-5
LMH6626	1300	360	5 to 12	12	2	0.5	1	-65/-80	SOIC-8
LMH6628	300	550	5 to 12	9	2	2	2	-65/-75	SOIC-8
LMH6640	62	170	4.5 to 16	4	1	1	10	-71/-72	SOT23-5
LMH6642	130	135	2.7 to 12.8	2.7	1	5	17	-80/-65	SOIC-8, SOT23-5
LMH6643	130	135	2.7 to 12.8	2.7	2	5	17	-80/-65	SOIC-8
LMH6644	130	135	2.7 to 12.8	2.7	4	5	17	—	SOIC-14, TSSOP-14
LMH6645	55	22	2.5 to 12	0.725	1	3	17	-62/-72	SOIC-8, SOT23-5
LMH6646	55	22	2.5 to 12	0.725	2	3	17	-62/-72	SOIC-8
LMH6647	55	22	2.5 to 12	0.725	1	3	17	-62/-72	SOIC-8, SOT23-6
LMH6654	260	200	4.5 to 12	4.5	1	3	4.5	-80/-85	SOIC-8, SOT23-5
LMH6655	260	200	4.5 to 12	4.5	2	3	4.5	-80/-85	SOIC-8
LMH6657	270	700	3 to 12	6	1	5	11	-70/-57	SC70-5, SOT23-5
LMH6658	270	700	3 to 12	6	2	5	11	-70/-57	SOIC-8
LMH6672	130	170	3 to 12	6.2	2	5.5	4.5	-92/-95	SOIC-8, PSOP-8
LMH6682	190	940	3 to 12	6.5	2	5	12	-66/-54	SOIC-8
LMH6683	190	940	3 to 12	6.5	3	5	12	-66/54	SOIC-14, TSSOP-14
LMH6702	1700	3100	10 to 12	12.5	1	4.5	1.83	-100/-96	SOIC-8, SOT23-5
LMH6703	1200	4200	8 to 12	11	1	7	2.3	-87/-100	SOIC-8, SOT23-6
LMH6715	480	1300	10 to 12	5	2	6	3.4	-60/-75	SOIC-8
LMH6720	400	1800	10 to 12	5.6	1	6	3.4	-58/-70	SOIC-8, SOT23-6
LMH6722	400	1800	10 to 12	5.6	4	6	3.4	-58/-70	SOIC-14, TSSOP-14
LMH6723	370	600	5 to 12	1	1	3	4.3	-65/-63	SOIC-8, SOT23-5
LMH6724	370	600	5 to 12	1	2	3	4.3	-65/-63	SOIC-8
LMH6725	370	600	5 to 12	1	4	3	4.3	-65/-63	SOIC-14, TSSOP-14
LMH6732	540	2700	9 to 12	9	1	8	2.5	-65/-64	SOIC-8, SOT23-6
LMH6733	1000	3750	3 to 12	6.5	3	2.2	2.1	-72/-63	SSOP-16
LMH6738	400	3300	10 to 12	10.5	3	2.5	2.2	-80/-90	SSOP-16
LMH6611	345	460	2.7 to 11	3.2	1	0.6	10	—	SOT23-6
LMH6619	130	55	2.7 to 11	1.3	2	0.6	10	—	SOIC-8

# High-Speed Amplifiers and Buffers

## LMH6502/03/05 – Variable Gain Amplifiers Feature >70 dB Gain Range

### Features

- Energy-efficient PowerWise® product (LMH6505)
- Linear-in-dB (LMH6502)
- Linear-in-V/V (LMH6503)
- 11 mA supply current (LMH6505)
- 100 MHz gain control bandwidth
- 1800 V/μs slew rate (LMH6502/03)
- 1500 V/μs slew rate (LMH6505)
- Available in SOIC-14 narrow and TSSOP-14 packaging (LMH6502/03)
- Available in SOIC-8 narrow and mini SOIC-8 packaging (LMH6505)



### Applications:

Ideal for use in test and measurement, communications, video, and medical imaging

## LMH6321 – ±15V High-Speed Buffer Delivers Up to 300 mA with ±5% Accurate Current Limit

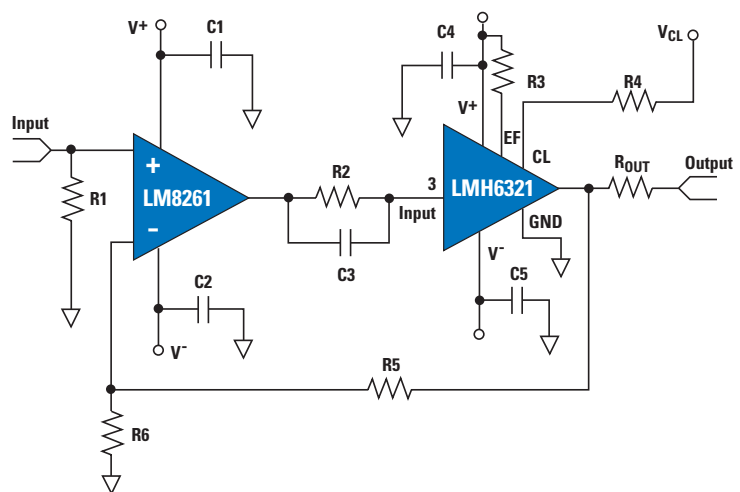
### Features

- Stable ±300 mA continuous current while driving large capacitive loads
- 10 mA to 300 mA at ±5 mA, ±5% accurate adjustable current limit
- Thermal shutdown protection prevents overheating
- ±15V supply voltages allow wide output voltage swings
- High-speed and high-output current for a high-performance system solution

### Applications:

Ideal for use in automatic test equipment, instrumentation, industrial controls, and factory automation

### Non-Inverting Buffer Application Diagram



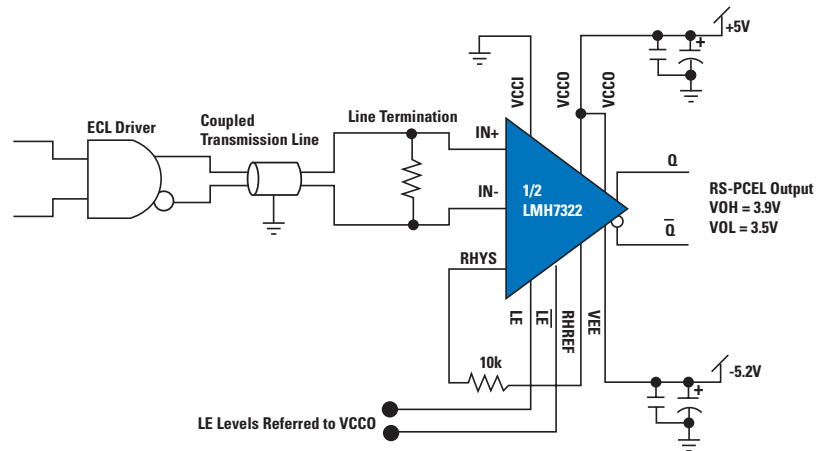
## Fixed Buffers

Product ID	Channels	Av+1 BW (MHz)	Slew Rate (V/μs)	Supply Range (V)	Offset Voltage max, 25C (mV)	Voltage Noise (V)	2nd/3rd HD (dB)	Temperature Range (°C)	Packaging
LMH6321	1	110	1800	5 to 30	15	2.8	-57/-59	-40 to 125	PSOP-8, T0263-7
LMH6559	1	1750	4580	3 to 10	3	2.8	-58/-53	-40 to 85	SOIC-8, SOT23-5
LMH6560	4	680	3100	3 to 10	20	3	-58/-52	-40 to 85	SIC-14, TSSOP-14

## LMH7322/24 – Dual / Quad 700 ps Comparators with 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 ( $\mu s$ )	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
LMV7239	1	0.045	6	55	2.7 to 5	0.065	600	-40 to 85	SC70-5, SOT23-5
LMH7220	1	0.0029	2.7	5	2.7 to 12	7.5	7000	-40 to 125	TSOT-6
LMH7322	2	0.0007	8	50	2.7 to 12	30	5000	-40 to 125	LLP-24
LMH7324	4	0.0007	9.5	25	5 to 12	4.3	5000	-40 to 85	LLP-32

## Low-Power Comparators

Product ID	Channels	Response Time ( $\mu s$ )	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

# RF Detectors and Clock Buffers

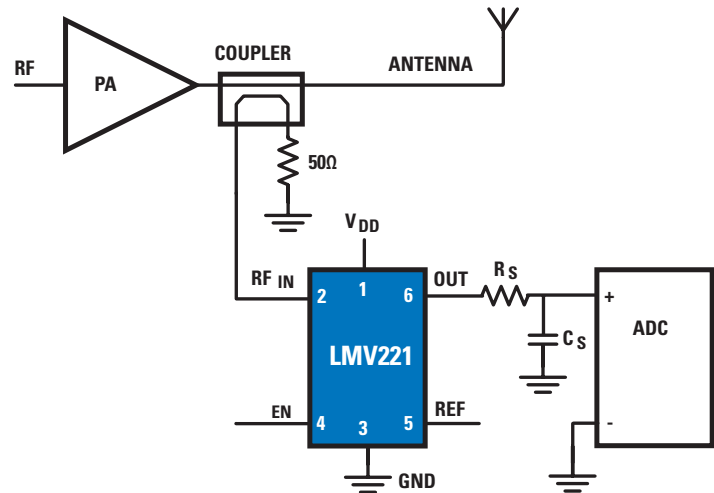
## LMV221 – 50 MHz to 3.5 GHz 40 dB Logarithmic Power Detector for CDMA and WCDMA

### 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)

### Applications:

Ideal for use in wireless handsets, GSM/GPRS RF power control loops, PA modules, 2G and 3G cellular transmit paths, and battery-powered wireless applications



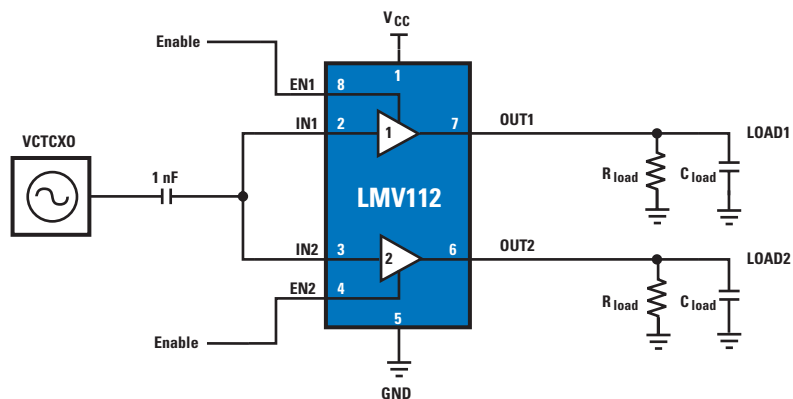
## RF Detectors

Product ID	Application	Channels	Supply Voltage Range (V)	Dynamic Range (dB)	Frequency Range (MHz)	Packaging
LMV221	CDMA, WCDMA, GSM, GPRS	1	2.75 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

## LMV112 – 40 MHz Dual Clock Buffer

### Features

- Small signal bandwidth 40 MHz
- Supply voltage range 2.4V to 5V
- Slew rate 110 V/ $\mu$ s
- Total supply current 1.6 mA
- Shutdown current 59  $\mu$ A
- Rail-to-rail input and output
- Individual buffer enable pins
- Rapid ton technology
- Crosstalk rejection circuitry
- Available in LLP-8 pin-access packaging
- Also available: LMV115 26 MHz clock buffer



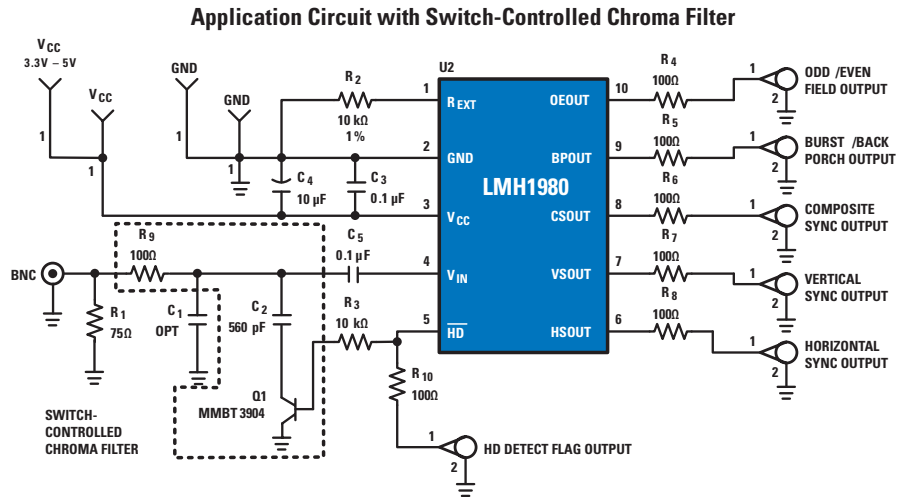
### Applications:

Ideal for use in 2G and 3G mobile applications, TD\_SCDMA handsets, GSM modules, portable media players, smart phones, PDAs, and battery-powered systems

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

### Features

- Sync separation for NTSC, PAL, SECAM, 480I/P, 576I/P, 720P, 1080I/P, and VESA-compatible timing
- Composite Video (CVBS), S-Video (Y/C), Component Video (YPBPR/GBR) and PC Graphics (RGsB) Compatibility
- Bi-level and tri-level sync compatible
- HD detect output flag
- Automatic video format detection
- Fixed-level sync slicing of 0.5 V<sub>P-P</sub> to 2 V<sub>P-P</sub> 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 – Ultra Low-Jitter Sync Separator for SD/HD Video

### Features

- 50% sync slicing
- Low-jitter horizontal sync outputs
- Supports NTSC, PAL, SECAM, 480i, 480p, 576i, 576p, 720p, 1080i, and 1080p
- Accepts video signals from 0.5 V<sub>P-P</sub> to 2 V<sub>P-P</sub>
- No external programming with μC required
- Horizontal sync output propagation delay <50 ns
- 3.3V or 5V single supply operation

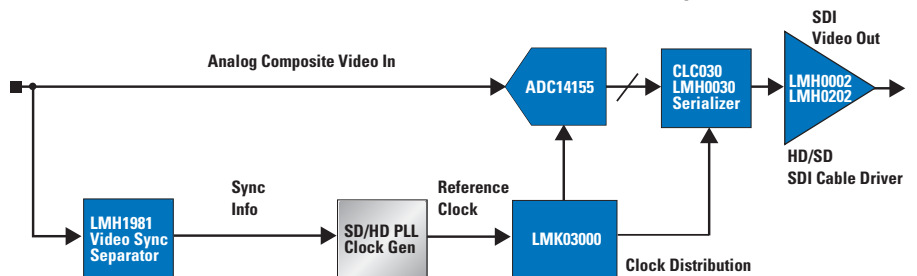
### Applications:

Ideal for use in sync separation, A/V clock generation, video genlock, back porch clamp generator, video format detection circuit, and analog-to-SDI converter applications

### Outputs

- Horizontal sync
- Vertical sync
- Odd/even field
- Burst/back porch clamp
- Composite sync
- Video format (horizontal lines/field)

### Analog Video to Serial Digital Interface (SDI) Converter Typical Diagram



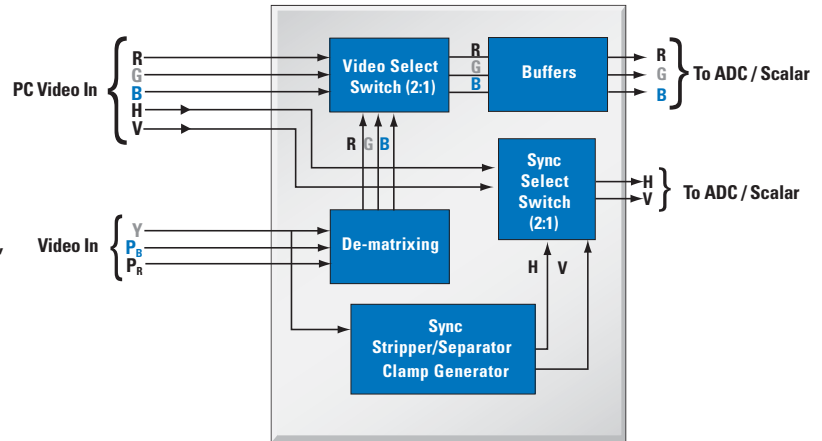
Read Analog Edge Volume 4, Issue 7. Topic:  
 "Improving Video Clock Generation in Modern Broadcast Video Systems"  
[www.national.com/analogedge](http://www.national.com/analogedge)

# 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



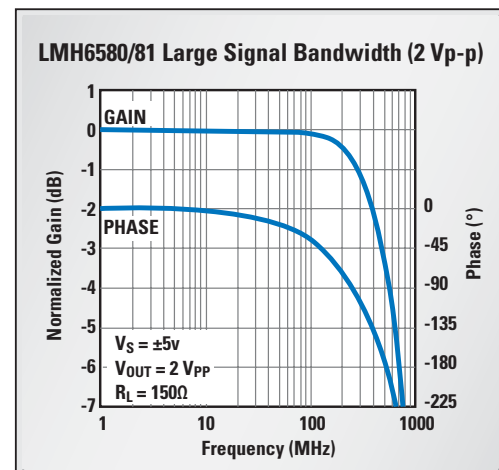
### Applications:

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 small signal bandwidth
- 2100 V/ $\mu$ 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

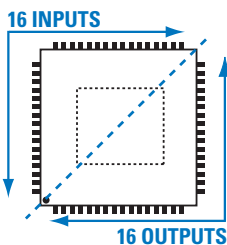
## LMH6582/83 – 550 MHz, 16 x 8 Ultra-Low Crosstalk Crosspoint Switches

### Features

- 16 inputs, 8 outputs
- 550 MHz, -3 dB bandwidth
- Fast slew rate: 3000 V/ $\mu$ 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

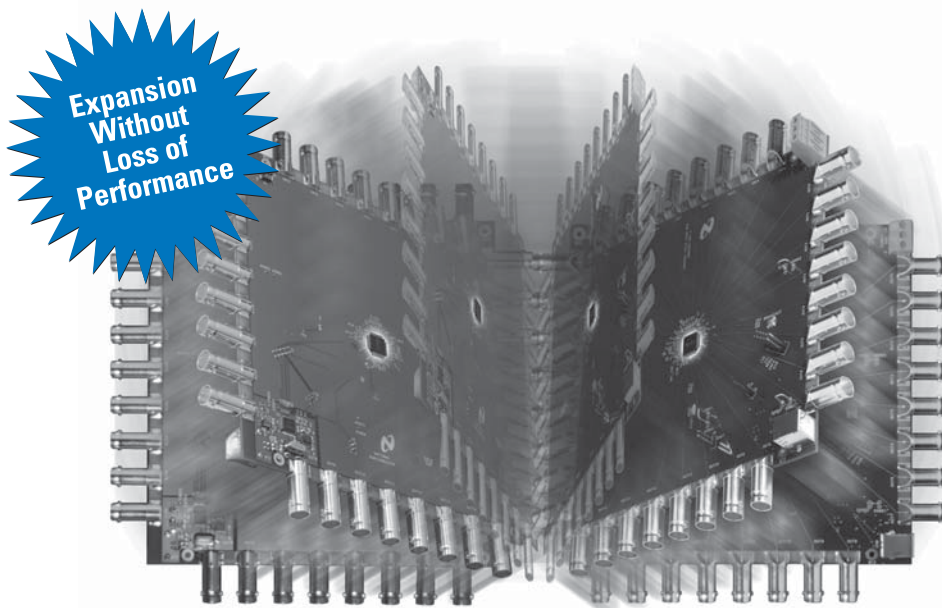
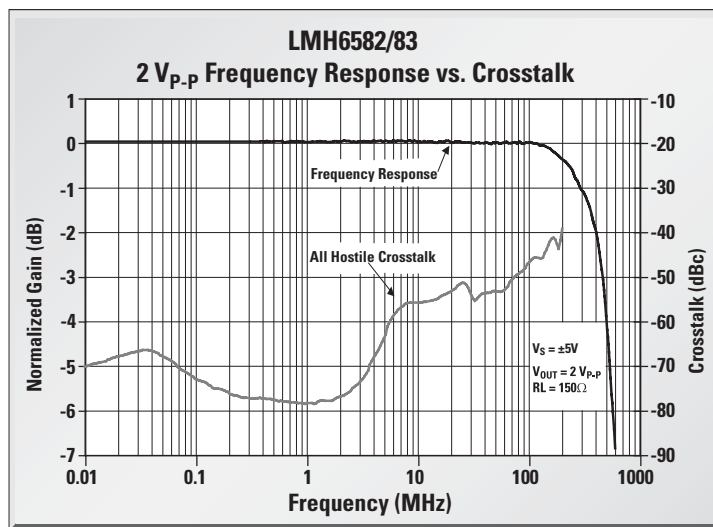
### Symmetrical Pin-Out Allows for Easy Expansion

- One-chip solution:
  - 16 inputs, 8 outputs
- Two-chip solution:
  - 16 inputs, 16 outputs or
  - 32 inputs, 8 outputs



### Applications:

Ideal for use in wideband routers and switchers, conference room systems, KVM (keyboard, video, and mouse) systems, security/surveillance systems, multimedia video systems, and professional A/V systems



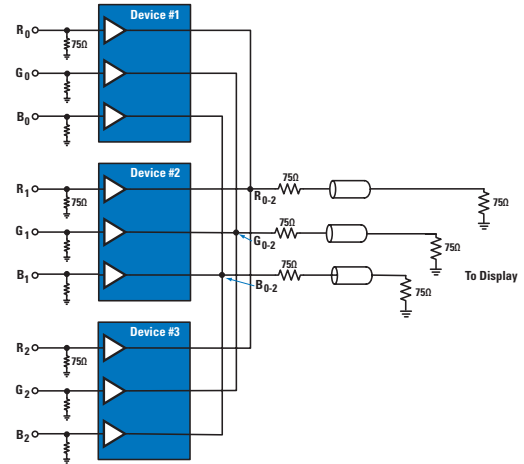
# Analog Video Products

## 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/ $\mu$ s slew rate
- Low supply current (5.5 mA per op amp,  $V_S = 5V$ )
- 70 mA linear output current
- 2.1 nV/ $\sqrt{\text{Hz}}$  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, wideband 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	12 to 15	-40 to 85	SOIC-8
LMH6572	300	3	10	90	15	to 0.05%	-80/-85	10 to 24	-40 to 85	SSOP-8
LMH6574	500	4	10	85	17	to 0.05%	-65/-85	12 to 13	-40 to 85	SOIC-14

## Video Amplifiers/Buffers

Product ID	Gain Bandwidth (MHz)	Slew Rate (V/ $\mu$ s)	Supply Voltage Range (V)	Supply Current Per Channel (mA)	Channels	Offset Voltage max, 25C (mV)	Voltage Noise (V)	2nd/3rd HD (dB)	Packaging
LMH6702	1700	3100	10 to 12	12.5	1	4.5	1.83	-100/-96	SOIC-8, SOT23-5
LMH6703	1200	4200	8 to 12	11	1	7	2.3	-87/-100	SOIC-8, SOT23-6
LMH6704	650	3000	8 to 12	11.5	1	7	2.3	-62/-78	SOIC-8, SOT23-6
LMH6733	1000	3750	3 to 12	6.5	3	2.2	2.1	-72/-63	SSOP-16
LMH6734	925	3750	3 to 12	5.5	3	2	2.1	-63/73	SSOP-16
LMH6738	400	3300	10 to 12	10.5	3	2.5	2.2	-80/-90	SSOP-16
LMH6739	750	3300	8 to 12	10.6	3	2.5	2.3	-80/-90	SSOP-16
LMH6601	125	275	2.4 to 5.5	9.6	1	2.4	10	-56/-73	SC70-6
LMH6683	190	940	3 to 12	6.5	3	5	12	-66/-54	SOIC-14, TSSOP-14



## LMP2015/16 – Single/Dual High-Precision, Rail-to-Rail Output Op Amps

### Features

- Low guaranteed Vos over temperature 10  $\mu$ V
- TCV<sub>OS</sub> guaranteed: 50 nV/°C (max)
- Low noise with no 1/f 35 nV/ $\sqrt{\text{Hz}}$
- High CMRR (130 dB) and PSRR (120 dB)
- High AVOL 130 dB
- Wide gain bandwidth product 3 MHz
- High slew rate 4 V/ $\mu$ s
- Low supply current 930  $\mu$ A
- Available in SOIC-8 (LMP2015/16) and SOT23-5 (LMP2016) 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 ( $\mu$ V/°C)	CMRR (dB)	PSRR (dB)	Avol (dB)	Voltage Noise (nV/ $\sqrt{\text{Hz}}$ )	Channels	Supply Current Per Channel (mA)	Supply Range (V)	Packaging
LMP2011	0.025	0.015	130	120	130	35	1	0.93	2.7 to 5	SOIC-8, SOT23-5
LMP2012	0.025	0.015	130	120	130	35	2	0.93	2.7 to 5	SOIC-8, MSOP-10
LMP2014MT	0.025	0.01	130	120	130	35	2	0.93	2.7 to 5	TSSOP-14
LMP7731/32	0.05	1	120	129	130	2.9	1	2.2	2.5 to 5	SOT23-5/SOIC-8
LMP2231/32	0.15	1	97	120	120	60	1/2	0.01	1.6 to 5	SOIC-8, SOT23-5
LMP2234	0.15	1	97	120	120	60	4	0.009	1.8 to 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	SOT23-5
LMP7716	0.15	1.8	100	98	110	5.8	2	1.3	1.8 to 5	MSOP-8
LMP7717	0.15	1	100	98	110	5.8	1	1.15	1.8 to 5	SOIC-8, SOT23-5
LMP7718	0.15	1	100	98	110	5.8	2	1.3	1.8 to 5	SOIC-8, MSOP-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	0.2	1	138	98	119	9	2	0.715	2.7 to 12	MSOP-8
LMP7709	0.2	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
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
LMV841	0.5	0.5	112	108	123	20	1	1	2.7 to 12	SC70-5

# Precision Amplifiers

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

### Features

- 3.3 nV/ $\sqrt{\text{Hz}}$  input voltage noise,  $f = 3 \text{ Hz}$
- Offset voltage  $\pm 40 \mu\text{V}$  (max)
- CMRR 130 dB
- Open loop gain 130 dB
- Slew rate 2.4 V/ $\mu\text{s}$
- 0.001% THD at  $f = 10 \text{ kHz}$ ,  $A_V = 1$ ,  $R_L = 2 \text{ k}\Omega$

### Applications:

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

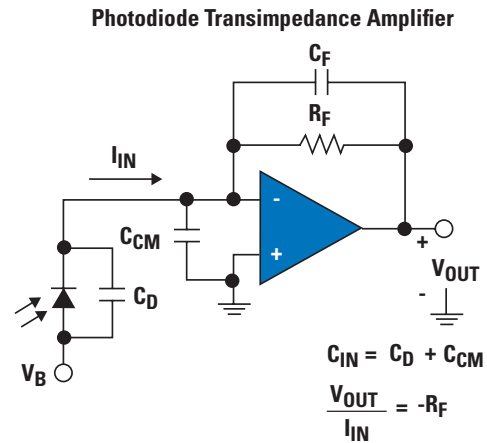
## Low-Noise Operational Amplifiers

Product ID	Channels	Voltage Noise (nV/ $\sqrt{\text{Hz}}$ )	Max Input Bias Current (nA)	Offset Voltage max, 25C (mV)	Supply Current Per Channel (mA)	Gain Bandwidth (MHz)	Supply Range (V)	Temperature Range ( $^{\circ}\text{C}$ )	Packaging
LMH6624	1	0.92	25000	0.5	12	1500	5 to 12	-40 to 125	SOIC-8, SOT23-5
LMH6626	2	1	25000	0.5	12	1300	5 to 12	-40 to 125	SOIC-8, MSOP-8
LMH6622	2	1.6	15000	1.2	4.3	160	5 to 12	-40 to 85	SOIC-8, MSOP-8
LMH6702	1	1.83	34000	4.5	12.5	1700	10 to 12	-40 to 85	SOIC-8, SOT23-5
LMH6628	2	2	20000	2	9	300	5 to 12	-55 to 125	SOIC-8
LMP7731	1	2.9	85	0.05	2.2	22	2.5 to 5	-40 to 125	SOT23-5
LMP7732	2	2.9	85	0.05	2.2	22	2.5 to 5	-40 to 125	SOIC-8
LMP7711	1	5.8	0.1	0.15	1.15	17	1.8 to 5.5	-40 to 125	TSOT-6
LMP7712	2	5.8	0.1	0.15	1.3	17	1.8 to 5.5	-40 to 125	MSOP-10
LMP7715	1	5.8	0.1	0.15	1.15	17	1.8 to 5	-40 to 125	SOT23-5
LMP7716	2	5.8	0.1	0.15	1.3	17	1.8 to 6	-40 to 125	SOIC-8, MSOP-8
LMP7717	1	5.8	0.1	0.15	1.15	88	1.8 to 7	-40 to 125	SOIC-8, SOT23-5
LMV791	1	5.8	0.025	1.35	1.15	17	1.8 to 8	-40 to 125	TSOT-6
LMV792	2	5.8	0.1	1.35	1.3	17	1.8 to 9	-40 to 125	MSOP-10
LMV793	1	5.8	0.1	1.35	1.15	88	1.8 to 10	-40 to 125	SOIC-8, SOT23-5
LMV794	2	5.8	0.1	1.35	1.3	88	1.8 to 11	-40 to 125	SOIC-8, MSOP-8
LMV796	1	5.8	0.1	1.35	1.15	17	1.8 to 12	-40 to 125	SOT23-5
LMV797	2	5.8	0.1	1.35	1.3	17	1.8 to 13	-40 to 125	MSOP-8
LM6211	1	6	0.01	2.5	0.96	17	5 to 24	-40 to 125	SOT23-5
LMV751	1	6.5	0.1	1	0.6	5	2.7 to 5.5	-40 to 85	SOT23-5
LMP7701	1	9	0.05	0.2	0.715	2.5	2.7 to 12	-40 to 125	SOIC-8, SOT23-5
LMP7702	2	9	0.4	0.22	0.75	2.5	2.7 to 12	-40 to 125	SOIC-8, MSOP-8
LMP7704	4	9	0.4	0.22	0.725	2.5	2.7 to 12	-40 to 125	TSSOP-14
LMV771	1	12	0.1	0.85	0.6	3.5	2.7 to 5.5	-40 to 125	SC70-5
LMV772	2	12	0.1	1	0.6	3.5	2.7 to 5.5	-40 to 125	SOIC-8, MSOP-8
LMV774	4	12	0.1	1	0.6	3.5	2.7 to 5.5	-40 to 125	TSSOP-14
LMV716	2	12.8	0.13	5	1.6	5	2.7 to 5.5	-40 to 85	MSOP-8

## LMP7717/18 – 88 MHz Precision, Low-Noise, Low-Power, 1.8V CMOS Input Op Amps

### Features

- Input offset voltage  $\pm 150 \mu\text{V}$  (max)
- Input referred voltage noise  $5.8 \text{ nV}/\sqrt{\text{Hz}}$
- Input bias current  $100 \text{ fA}$
- Gain bandwidth product  $88 \text{ MHz}$ ,  $A_V=10$
- Supply current per channel  $1.15 \text{ mA}$
- Supply voltage range  $1.8\text{V}$  to  $5.5\text{V}$
- Rail-to-rail output swing
  - $10 \text{ k}\Omega$  load  $25 \text{ mV}$  from rail
  - $2 \text{ k}\Omega$  load  $35 \text{ mV}$  from rail
- Available in SOT23-5 and SOIC-8 packaging (LMP7717)
- Available in MSOP-8 and SOIC-8 packaging (LMP7718)



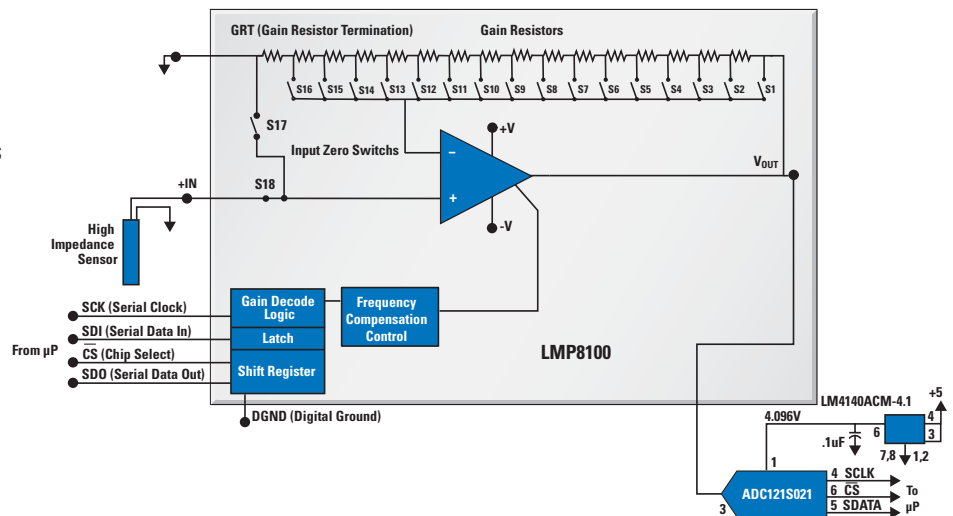
### Applications:

Ideal for use in A/D converter interface, photo diode amplifiers, active filters and buffers, low noise signal processing, medical instrumentation, and sensor interface applications

## 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  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$
- Gain range  $1$  to  $16 \text{ V/V}$  in  $1 \text{ V/V}$  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
- $12 \text{ nV}/\sqrt{\text{Hz}}$  input noise voltage accurately signal conditions in near DC-sensor applications
- Available in SOIC-14 packaging
- Ideal match for 12-bit, 1-channel ADCs up to  $1 \text{ MSPS}$



### Applications:

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

# Precision Amplifiers

## CMOS-Input Operational Amplifiers

Product ID	Description	Vos ( $\mu\text{V}$ ) (max)	TCVos typ ( $\text{nV}/^\circ\text{C}$ )	IsTyp Ch	CMRR (dB)	PSRR (dB)	Temperature Range ( $^\circ\text{C}$ )	Packaging
LMP7711	Precision, 17 MHz, single, low-noise CMOS input op amp	0.15	1	1.15	100	100	-40 to 125	TSOT-6
LMP7715	17 MHz, single precision low noise, CMOS input, 1.8V op amp	0.15	1	1.15	100	98	-40 to 125	SOT23-5
LMP7716	17 MHz, dual precision low noise, CMOS input, 1.8V op amp	0.15	1.8	1.3	100	98	-40 to 125	MSOP-8
LMP7701	Precision, single CMOS input R-R I/O, wide supply range op amp	0.2	1	0.715	130	100	-40 to 125	SOT23-5, SOIC-8
LMP7702	Precision, dual CMOS input R-R I/O, wide supply range op amp	0.22	1	0.75	130	100	-40 to 125	MSOP-8, SOIC-8
LMP7704	Precision, quad CMOS input R-R I/O, wide supply range op amp	0.22	1	0.725	130	100	-40 to 125	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	Precision CMOS single micropower R-R output op amp	0.35	1	0.02	85	85	-40 to 85	SOIC-8
LMC6062	Precision CMOS dual micropower R-R output op amp	0.35	1	0.016	85	85	-40 to 85	SOIC-8
LMC6064	Precision CMOS quad micropower R-R output op amp	0.35	1	0.016	85	85	-40 to 85	SOIC-14
LMV771	Low offset, low noise single R-R out op amp	0.85	0.35	0.6	90	90	-40 to 125	SC70-5
LMV751	Low noise, low offset, single CMOS input op amp	1	1	0.6	103	107	-40 to 85	SOT23-5
LMV772	Low offset, low noise dual R-R out op amp	1	0.35	0.6	90	90	-40 to 125	SOIC-8, MSOP-8
LMV791	17 MHz, single low noise, CMOS input, 1.8V op amp with shutdown	1.35	1	1.15	100	98	-40 to 125	TSOT-6
LMV792	17 MHz, dual low noise, CMOS input, 1.8V op amp with shutdowns	1.35	1.8	1.3	100	98	-40 to 125	MSOP-10
LMV796	17 MHz, single low noise, CMOS input, 1.8V op amp	1.35	1	1.15	100	98	-40 to 125	SOT23-5
LMV797	17 MHz, dual low noise, CMOS input, 1.8V Op Amp	1.35	1.8	1.3	100	98	-40 to 125	MSOP-8
LMV716	5 MHz, low-noise, RRO CMOS input op amp	5	5	1.6	80	82	-40 to 85	MSOP-8
LM6211	Low noise, RRO CMOS input op amp with 24V operation	2.5	2	0.96	98	98	-40 to 125	SOT23-5

## Current Sense Amplifiers

Product ID	Description	Vcm Range (V)	Vos (mV) (max)	Max TCvos ( $\mu\text{V}/^\circ\text{C}$ )	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	4.75 to 5.5	1	80	SOIC-8
LMP8272	High common-mode, AV = 14, unidirectional	-2V to 16V	1	15	14	4.75 to 5.6	1	80	SOIC-8
LMP8275	High common-mode, AV = 20, unidirectional	-2V to 16V	1	15	20	4.75 to 5.7	1	80	SOIC-8
LMP8276	High common-mode, AV = 20, bidirectional	-2V to 16V	1	30	20	4.75 to 5.8	1	80	SOIC-8
LMP8277	High common-mode, AV = 14, unidirectional	-2V to 16V	1	30	14	4.75 to 5.9	1	80	SOIC-8

# 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/ $\mu$ s)	Offset Voltage max, 25C (mV)	Max Input Bias Current (nA)	Voltage Noise (nV/ $\sqrt$ Hz)	Packaging
LMV951	1	0.9 to 3	0.57	2.8	1.4	2.8	85	25	TSOT-6
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	0.025/0.1	5.8	TSOT-6/MSOP-10
LMV793/94	1/2	1.8 to 5	1.15	88	28	1.35	0.1	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	0.1	5.8	SOT23-5/MSOP-8
LMV931	1	1.8 to 5	0.116	1.5	0.42	4	50	50	SC70-5, SOT23-5
LMV932/34	2/4	1.8 to 5	0.116	1.5	0.42	5.5	50	50	MSOP-8, SOIC-8/ TSSOP-14
LMV981	1	1.8 to 5	0.116	1.5	0.42	4	50	50	micro SMD-6, SC70-6, SOT23-6
LM8262	2	2.5 to 22	1.05	21	12	7	2700	15	MSOP-8
LM8272	2	2.5 to 24	0.9	13	12	5	2700	15	MSOP-8
LM8261	1	2.5 to 30	0.97	21	12	5	2700	15	SOT23-5
LMV821	1	2.5 to 5.5	0.3	5.6	2	3.5	150	24	SC70-5, SOT23-5
LMV822	2	2.5 to 5.5	0.25	5.6	2	3.5	150	24	SOIC-8, MSOP-8
LMV824	4	2.5 to 5.5	0.25	5.6   6.5	2	3.5	150	24	SOIC-14, TSSOP-14
LMV116/18	1	2.7 to 12	0.6	45	40	5	2200	40	SOT23-5/SOT23-6
LMV641	1	2.7 to 12	0.158	10	1.6	0.5	105	14	SOIC-8, SC70-5
LMV841/42	1/2	2.7 to 12	1.02	4.5	2.5	0.5	0.3	20	SC70-5/SOIC-8, MSOP-8
LMV844	4	2.7 to 12	1.02	4.5	2.5	0.5	0.3	20	TSSOP-14
LPV511	1	2.7 to 12	0.00097	0.027	0.0077	3	1.9	320	SC70-5
LM6154	4	2.7 to 24	1.4	75	30	5	1500	9	SOIC-14
LMV341	1	2.7 to 5	0.107	1	1	4	0.375	39	SC70-6
LMV712	2	2.7 to 5	1.17	5	5	3	0.13	20	micro SMD-10, LLP-10, SOIC-10
LMV715/16	1/2	2.7 to 5	1.17/1.6	5	5/5.8	3/5	0.1/0.13	20/12.8	SOT23-6/MSOP-8
LMV721	1	2.7 to 5	1.03	10	5.25	3	400	8.5	SC70-5, SOT23-5
LMV722	2	2.7 to 5	0.9	10	5.25	3	400	8.5	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	0.1	12	TSSOP-14
LMV851/52	1/2	2.7 to 5	0.41	8	4.5	1	0.5	11	SC70-5/MSOP-8
LMV854	4	2.7 to 5	0.41	8	4.5	1	0.5	11	TSSOP-14
LPV531	1	2.7 to 5	0.425	4.6	2.5	4.5	0.01	25	TSOT-6
LMV422	2	2.7 to 5.5	0.4	8	3.8	4	0.1	25	MSOP-10
LMV651/52	1/2	2.7 to 5.5	0.11	12	2.8	1.5	100	17	SC70-5/MSOP-8
LMV654	4	2.7 to 5.5	0.119	12	3.2	1.8	300	17	TSSOP-14
LMV751	1	2.7 to 5.5	0.6	5	2.3	1	0.1	6.5	SOT23-5

# Micropower Amplifiers

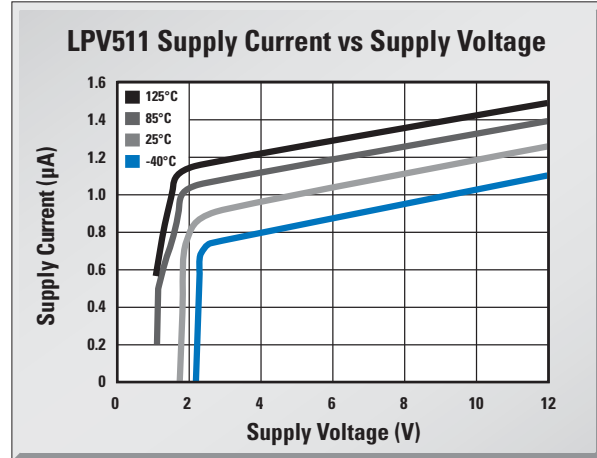
## LPV511 – Micropower Rail-to-Rail Input and Output Op Amp

### Features

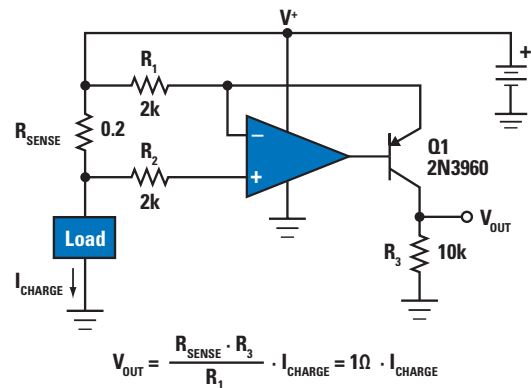
- Guaranteed 3V, 5V, and 12V performance
- Supply current: 880 nA
- Bandwidth: 27 kHz
- Supply voltage range: 2.7V to 12V
- Slew rate: 7.7 v/ms
- Rail-to-rail input
- Rail-to-rail output 100 mV from rails
- Unity gain stable
- Output short circuit current: 1.35 mA
- Operating temperature range –40 to 125 °C
- Available in SC70-5 packaging

### Applications:

Ideal for use in battery powered systems, security systems, micropower thermostats, solar powered systems, portable instrumentation, micropower filters, and remote sensor amplifiers



### Battery current sensing



## Micropower Operational Amplifiers

Product ID	Channels	Supply Current Per Channel (mA)	Gain Band width (MHz)	Offset Voltage max, 25C (mV)	Max Input Bias Current (nA)	CMRR (dB)	PSRR (dB)	Supply Voltage Range (V)	Slew Rate (V/µs)	Output Current (mA)	Voltage Noise (nv/√Hz)	Temp Range (°C)	Packaging
LMP2231	1	0.013	0.13	0.15	0.001	97	120	1.6 to 5	0.048	22	60	-40 to 125	SOT23-5, SOIC-8
LMP2232	2	0.01	0.13	0.15	0.001	97	120	1.6 to 5	0.048	22	60	-40 to 125	SOIC-8, MSOP-8
LMP2234	4	0.009	0.13	0.15	0.001	97	120	1.6 to 5	0.048	22	60	-40 to 125	SOIC-14, TSSOP-14
LMV551/52	1/2	0.037	3	3	38	93	90	2.7 to 5.5	1	10	70	-40 to 125	SC70-5/MSOP-8
LMV554	4	0.037	3	3	38	93	90	2.7 to 5	1	10	70	-40 to 85	TSSOP-14
LMV641	1	0.158	10	0.5	105	120	100	2.7 to 12	1.6	26	14	-40 to 125	SOIC-8, SC70-5
LMV651/52	1/2	0.11	12	1.5	100	100	95	2.7 to 5.5	2.8	15	17	-40 to 125	SC70-5/MSOP-8
LMV654	4	0.119	12	1.8	300	100	95	2.7 to 5.5	3.2	15	17	-40 to 125	TSSOP-14
LPV531	1	0.425	4.6	4.5	0.01	95	90	2.7 to 5	2.5	15	25	-40 to 85	TSOT-6

• PowerWise® product

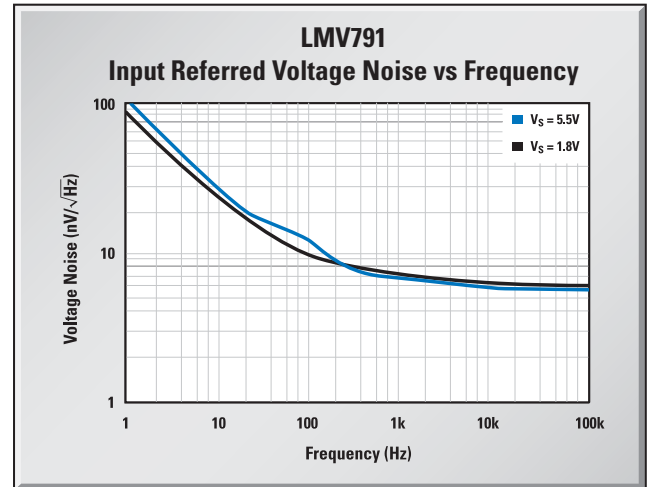
## LMV791/92 – 17 MHz, Low-Noise, Low-Power, CMOS Input Op Amps with Shutdown

### Features

- Supply current
  - 1.15 mA (LMV791)
  - 1.30 mA (LMV792)
- High unity gain bandwidth: 17 MHz
- Low input voltage noise:  $5.8 \text{ nV}/\sqrt{\text{Hz}}$
- Low input offset voltage: 1.3 mV (max)
- Rail-to-rail output with 2 kΩ loads
- High PSRR (100 dB) ensures higher accuracy with noisy supplies
- High CMRR (95 dB) ensures high accuracy over a wide input range

### Applications:

Ideal for use in battery-powered systems, sensor interfaces, embedded systems, and precision instruments



## Shutdown Amplifiers

Product ID	Channels	Gain Bandwidth (MHz)	Supply Voltage Range (V)	Offset Voltage max 25 C (mV)	Temperature Range (°C)	Comments	Packaging
LMP7711	1	17	1.5 to 5.5	0.15	-40 to 125	CMOS input	TSOT-6
LMP7712	2	17	1.5 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 <sup>®</sup> output	TSOT23-6
LMV792	2	17	1.8 to 5.5	1.35	-40 to 125	Tri-State output	MSOP-10
LMH6601	1	125	2.4 to 5.5	2.4	-40 to 85	CMOS input	SC70-6
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
LMH6647	1	47	2.5 to 12	3	-40 to 85	Tri-State output	SOIC-8, SOT23-6
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
LMC8101	1	1	2.7 to 10	5	-40 to 85	Tri-State output	micro SMD-8, MSOP-8
LMV118	1	45	2.7 to 12	5	-40 to 85	RRO	SOT23-6
LMH6703	1	1200	8 to 12	7	-40 to 85	Low distortion	SOIC-8, SOT23-6

# Low-Power Amplifiers

## Low-Power Operational Amplifiers

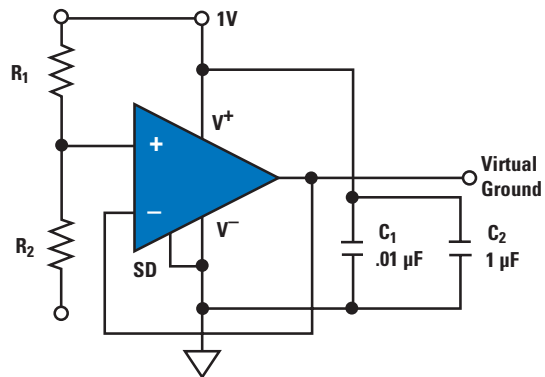
Product ID	Channels	Supply Current Per Channel (mA)	Supply Voltage Range (V)	Offset Voltage max, 25C (mV)	Max Input Bias Current (nA)	Gain Bandwidth (MHz)	Slew Rate (V/us)	Output Current (mA)	Voltage Noise (nV/ $\sqrt{\text{Hz}}$ )	Packaging
LMV341	1	0.107	2.7 to 5	4	0.375	1	1	75	39	SC70-6
LMV651	1	0.11	2.7 to 5.5	1.5	100	12	2.8	15	17	SC70-5
LMV652	2	0.11	2.7 to 5.5	1.5	100	12	2.8	15	17	MSOP-8
LMV931	1	0.116	1.8 to 5	4	50	1.5	0.42	100	50	SC70-5, SOT23-5
LMV932	2	0.116	1.8 to 5	5.5	50	1.5	0.42	65	50	SOIC-8, MSOP-8
LMV934	4	0.116	1.8 to 5	5.5	50	1.5	0.42	65	50	SOIC-14, TSSOP-14
LMV981	1	0.116	1.8 to 5	4	50	1.5	0.42	65	50	micro SMD-6, SC70-6, SOT23-6
LMV654	4	0.119	2.7 to 5.5	1.8	300	12	3.2	15	17	TSSOP-14
LMV641	1	0.158	2.7 to 12	0.5	105	10	1.6	26	14	SOIC-8, SC70-5
LMV301	1	0.163	1.8 to 5	8	0.05	1	0.66	60	40	SC70-5
LMV822	2	0.25	2.7 to 5.5	3.5	150	5.6	2	40	24	SOIC-8, MSOP-8
LMV824	4	0.25	2.7 to 5.5	3.5	150	5.6	2	40	24	TSSOP-14
LMV821	1	0.3	2.7 to 5.5	3.5	150	5.6	2	40	24	SC70-5, SOT23-5
LMV422	2	0.4	2.7 to 5.5	4	0.1	8	3.8	5	25	MSOP-10
LMV851	1	0.41	2.7 to 5	1	0.5	8	4.5	62	11	SC70-5
LMV852	2	0.41	2.7 to 5	1	0.5	8	4.5	62	11	MSOP-8
LMV854	4	0.41	2.7 to 5	1	0.5	8	4.5	62	11	TSSOP-14
LPV531	1	0.425	2.7 to 5	4.5	0.01	4.6	2.5	15	25	TSOT-6
LMV951	1	0.57	0.9 to 3	2.8	85	2.8	1.4	80	25	TSOT-6
LMV116	1	0.6	2.7 to 12	5	2200	45	40	54	40	SOT23-5
LMV118	1	0.6	2.7 to 12	5	2200	45	40	54	40	SOT23-6
LMV751	1	0.6	2.7 to 5.5	1	0.1	5	2.3	15	6.5	SOT23-5
LMV771	1	0.6	2.7 to 5	0.85	0.1	3.5	1.4	66	12	SC70-5
LMV772	2	0.6	2.7 to 5	1	0.1	3.5	1.4	66	12	SOIC-8, MSOP-8
LMV774	4	0.6	2.7 to 5	1	0.1	3.5	1.4	66	12	TSSOP-14
LM6588	4	0.8	5 to 16	4	7000	15.4	15	230	23	SOIC-14, TSSOP-14
LMV722	2	0.9	2.7 to 5	3	400	10	5.25	24	8.5	LLP-8, SOIC-8
LMV2011	1	0.93	2.7 to 5	0.025	0.005	3	4	15	35	SOIC-8, SOT23-5
LMV721	1	1.03	2.7 to 5	3	400	10	5.25	24	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, SOIC-10
LMV715	1	1.17	2.7 to 5	3	0.1	5	5	40	20	SOT23-6



## LMV951 – High Bandwidth, 1V, Rail-to-Rail Input and Output CMOS Op Amp

### Features

- Guaranteed 1V single supply operation
- Wide bandwidth: 2.8 MHz
- No  $V_{os}$  glitch over the input CMVR
- No input  $I_{BIAS}$  current reversal over VCM range
- Buffered output stage
- High output drive capability
  - Sink current 35 mA
  - Source current 45 mA
- Available in TSOT-6 packaging



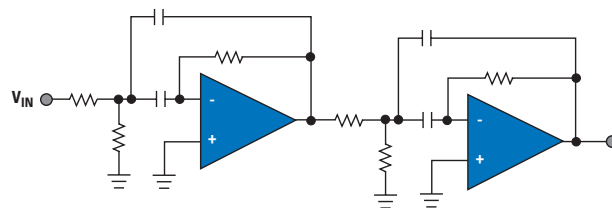
### Applications:

Ideal for use in battery-operated systems, battery monitoring, and supply current monitoring applications

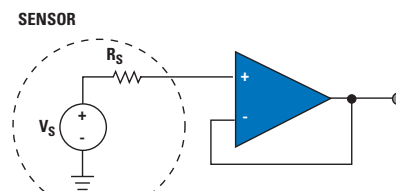
## LMV841/42/44 – Single/Dual/Quad CMOS Input, RRI/O, Wide Supply Range Op Amps

### Features

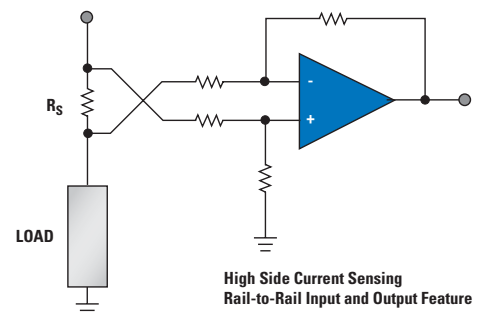
- Supply voltage range 2.7V to 12V
- Guaranteed at 3.3V, 5V and  $\pm 5V$
- Low supply current 1 mA per channel
- Unity gain bandwidth 4.5 MHz
- Open loop gain 100 dB
- Input offset voltage 500  $\mu V$  max
- Input bias current 0.3 pA
- CMRR 100 dB
- Input voltage noise 20  $nV/\sqrt{Hz}$
- Rail-to-rail input and output
- Available in SC70-5 packaging (LMV841)
- Available in SOIC-8 narrow and mini SOIC-8 packaging (LMV842)
- Available in TSSOP-14 packaging (LMV844)



Active Band-Pass Filter



High Impedance Sensor Interface  
CMOS Input Feature



High Side Current Sensing  
Rail-to-Rail Input and Output Feature

### Applications:

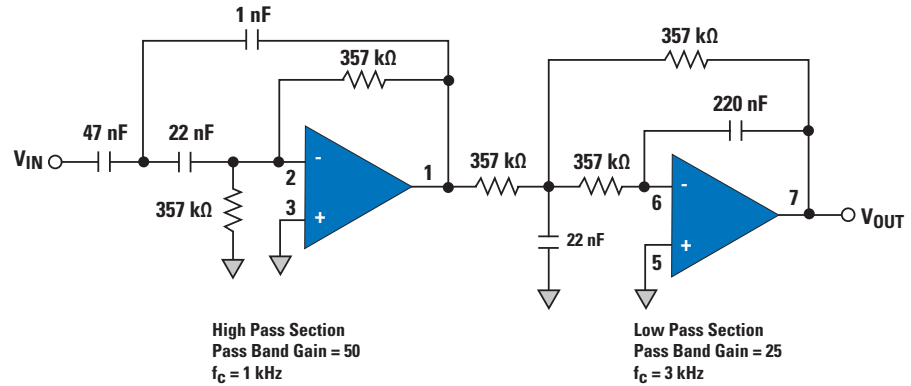
Ideal for use in high impedance sensor interface, battery-powered instrumentation, high-gain amplifiers, DAC buffers, instrumentation amplifiers, and active filters

# Low-Voltage, Low-Noise Operational Amplifiers

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

### Features

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



### Applications:

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

## Low-Voltage, Low-Noise Operational Amplifiers

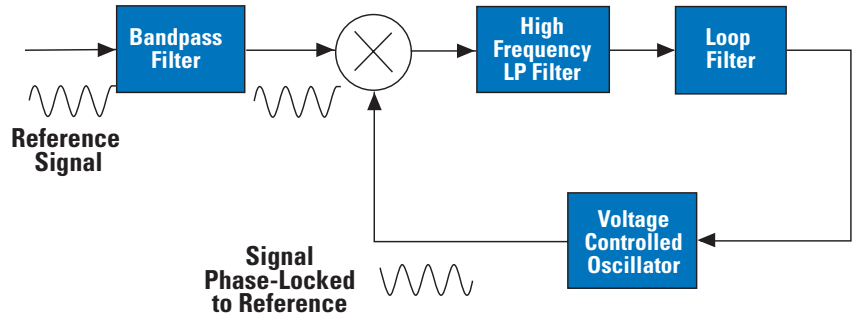
Product ID	Channels	Voltage Noise (nV/ $\sqrt{\text{Hz}}$ )	Max Input Bias Current (nA)	Offset Voltage max, 25C (mV)	Supply Current Per Channel (mA)	Gain Bandwidth (MHz)	Slew Rate (V/ $\mu\text{s}$ )	Supply Voltage Range (V)	Output Current (mA)	Temperature Range ( $^{\circ}\text{C}$ )	Packaging
LMV716	2	12.8	0.13	5	1.6	5	5.8	2.7 to 5	31	-40 to 85	MSOP-8
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
LMV751	1	6.5	0.1	1	0.6	5	2.3	2.7 to 5.5	15	-40 to 85	SOT23-5
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
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
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
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

# CMOS-Input Operational Amplifiers

## LM6211 – Low-Noise, Rail-to-Rail Output, CMOS Op Amp Operates Up to 24V

### Features (typ 24V)

- 5V to 24V supply voltage range
- 5.5 nV/√Hz input referred voltage noise
- 20 MHz unity gain bandwidth
- 400 Hz 1/f corner frequency
- 5.6 V/μs slew rate
- 1.05 mA supply current
- Low input capacitance of 5.5 pF
- Extended temperature range of -40°C to +125°C
- THD of 0.01% at 1 kHz, 600Ω
- Output short circuit current: 25 mA
- PLL loop filters
- Available in SOT23-5 packaging



### Applications:

Ideal for use in low-noise active filters, strain gauge amplifiers, and low-noise microphone amplifiers

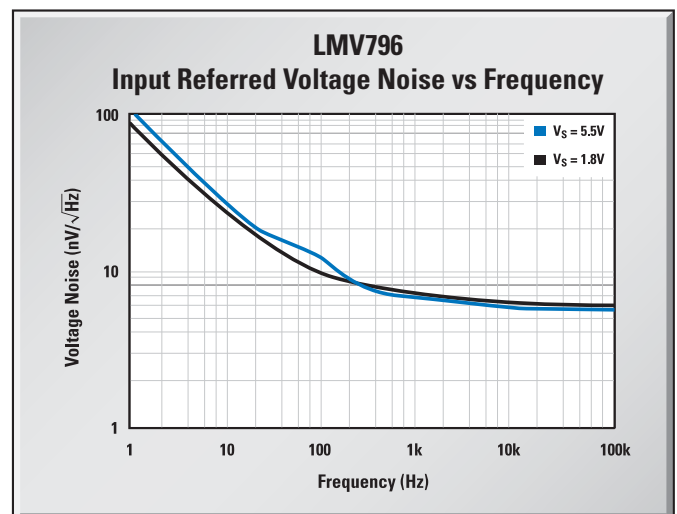
## LMV796/97 – 17 MHz, Low-Noise, Low-Power, CMOS Input 1.8V Op Amps

### Features

- Low supply current:
  - 1.15 mA (LMV796)
  - 1.30 mA (LMV797)
- High unity gain bandwidth: 17 MHz
- Low input voltage noise: 5.8 nV/√Hz
- Low input offset voltage: 1.3 mV (max)
- Rail-to-rail output with 2 kΩ loads
- High PSRR (100 dB) ensures higher accuracy with noisy supplies
- High CMRR (95 dB) ensures high accuracy over a wide input range

### Applications:

Ideal for use in battery-powered systems, sensor interfaces, embedded systems, and precise instrumentation



# 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*.

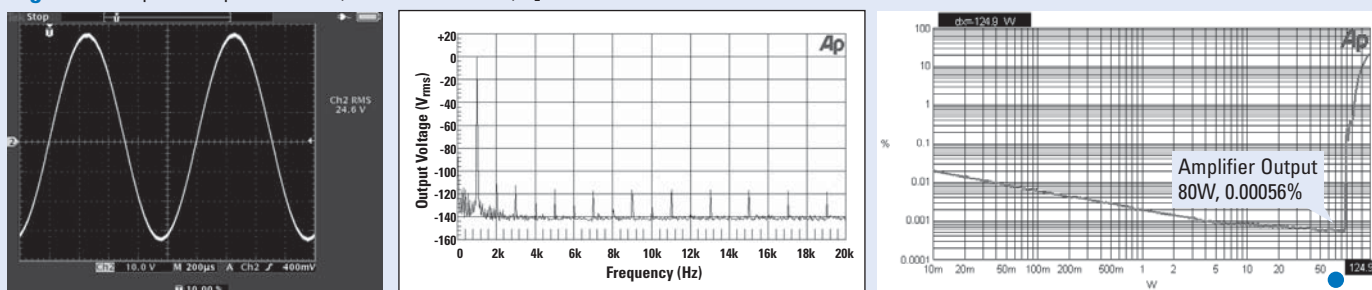
As shown in *Figures 1-3*, the amount of clipping increases the number and level of harmonics produced by the amplifier as its output limitations are reached and exceeded. Although output power is increased as the amplifier is driven farther into clipping, the quality of sound is adversely affected by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

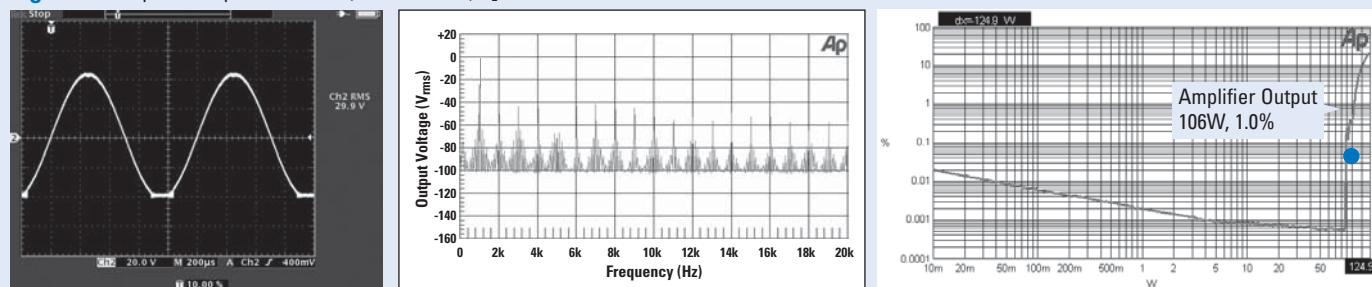
In summary, it should be remembered when selecting an audio IC that any power rating has a corresponding THD specification which is based on a given voltage supply and load. Most consumer applications require clean crisp music as opposed to the harsh sound of clipping, so beware of those 10% distortion 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%,  $R_L = 8\Omega$

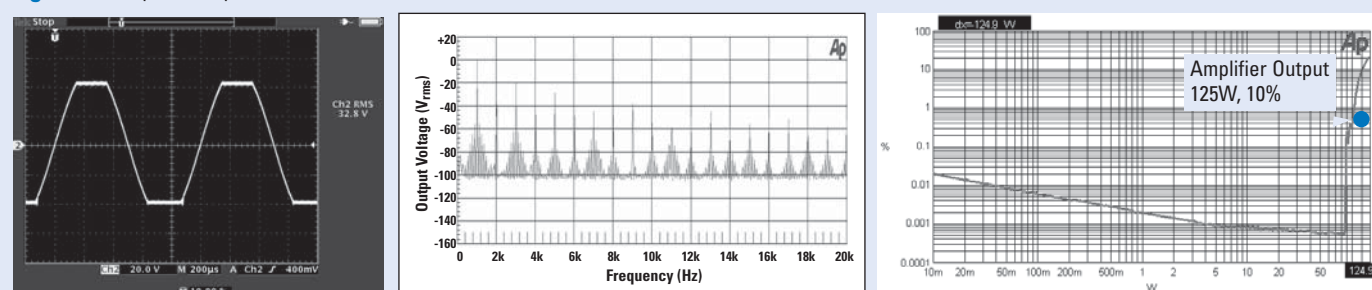
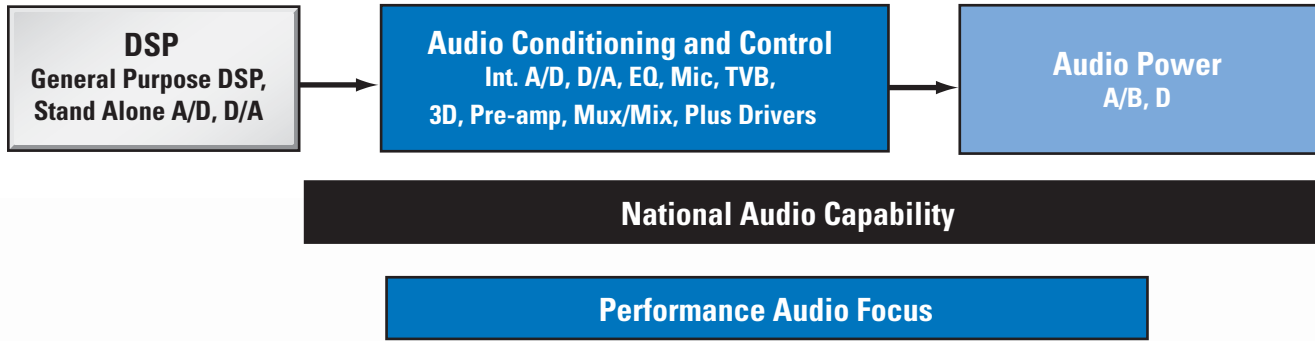


Figure 1 - 3 are collected using National's LM4702

# 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

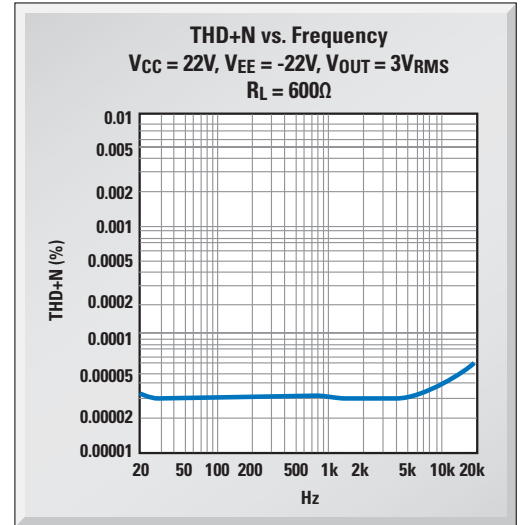
## LME49860 – 44V Dual High-Performance, High-Fidelity Operational Amplifier

### 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 and DIP 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



	LM833	LME48860
THD+N	0.002%	0.00003%
Input Noise Density	4.5 nV/ $\sqrt{Hz}$	2.7 nV/ $\sqrt{Hz}$
Supply Voltage Range	$\pm 5$ to $\pm 18V$	$\pm 5$ to $\pm 22V$



AUDIO

Product ID	Description	Input Voltage Noise Density (nV/ $\sqrt{Hz}$ )	THD (%)	Slew Rate (V/ $\mu s$ )	GBWP (MHz)	PSRR (dB)	Supply Voltage (V)	Packaging
<b>NEW</b> LME49710	High-performance, high-fidelity audio op amp	2.7	0.00003	20	56	125	$\pm 2.5$ to $\pm 17$	DIP-8, MSOP-8, TO99-8
<b>NEW</b> LME49870	High-performance, high-fidelity audio op amp	2.7	0.00003	20	55	125	$\pm 2.5$ to $\pm 22$	SOIC-8
<b>NEW</b> LM4562*	Dual high-performance, high-fidelity audio op amp	2.7	0.00003	20	56	110	$\pm 2.5$ to $\pm 17$	DIP-8, MSOP-8, TO99-8
<b>NEW</b> LME49720	Dual high-performance, high-fidelity op amp	2.7	0.00003	20	56	110	$\pm 2.5$ to $\pm 17$	DIP-8, MSOP-8, TO99-8
<b>NEW</b> LME49860	44V dual high-performance, high-fidelity audio op amp	2.7	0.00003	20	55	120	$\pm 2.5$ to $\pm 22$	SOIC-8
<b>NEW</b> LME49740	Quad high-performance, high-fidelity audio op amp	2.7	0.00003	20	56	125	$\pm 2.5$ to $\pm 17$	DIP-8, MSOP-8
<b>NEW</b> LME49713	High-performance, high-fidelity current feedback audio op amp	1.9	0.00008	1900	30	102	$\pm 5$ to $\pm 18$	SOIC-8
<b>NEW</b> 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
<b>NEW</b> LME49723	Dual, high-fidelity audio op amp	3.6	0.0002	8	17	100	$\pm 2.5$ to $\pm 17$	MSOP-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/ $\mu s$ )	GBWP (MHz)	Supply Voltage (V)	Supply Voltage (V)	Packaging
LME49600	High-performance, high-fidelity, high-current audio buffer	0.00015	250	2000	20/180	$\pm 18V$	$\pm 5$ to $\pm 18$	TO263-5

# High-Performance Audio Amplifier Power Amplifier Driver

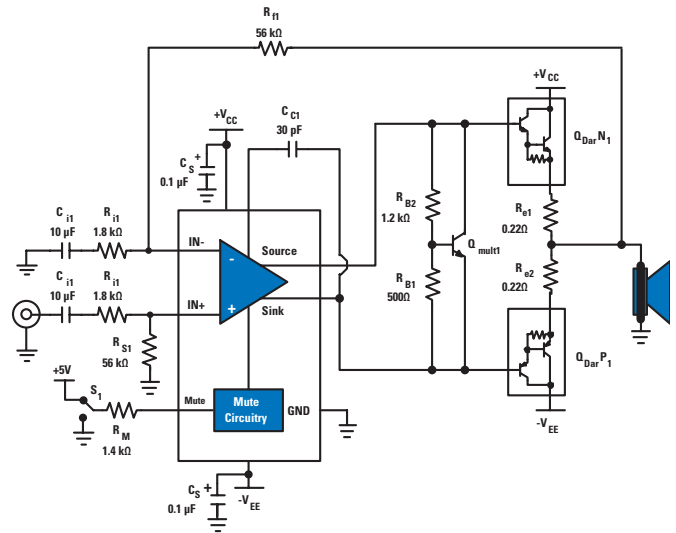
## LME49811 – Audio Power Amplifier Series Mono High Fidelity 200 Volt Driver with Mute

### 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	$A_v = 30 \text{ dB}$ , $V_{OUT} = 20 V_{RMS}$ at 1 kHz	110	±20 to ±100	Mute	T0220-15
LM4702C	Stereo high-fidelity audio power amplifier driver	±75	0.005	$A_v = 30 \text{ dB}$ , $V_{OUT} = 14 V_{RMS}$ 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, $A_v = 30 \text{ dB}$ $V_{OUT} = 10 V_{RMS}$ at 1 kHz	110	±20 to ± 100	Mute	T0220-15

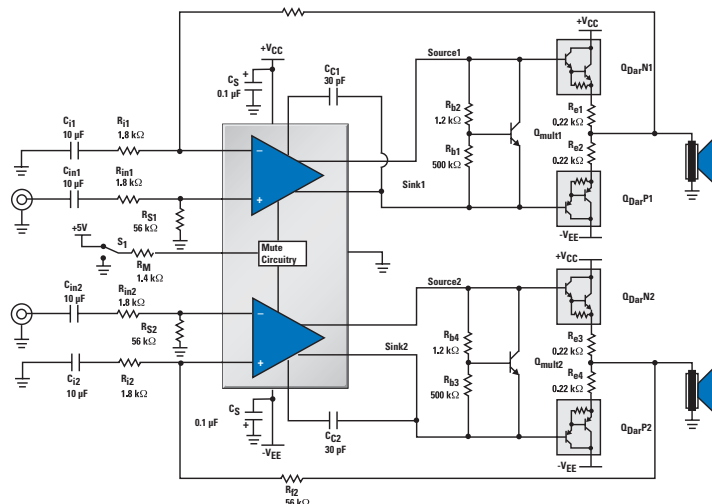
## LM4702 – Audio Power Amplifier Series Stereo High Fidelity 200 Volt Driver with Mute

### Features

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

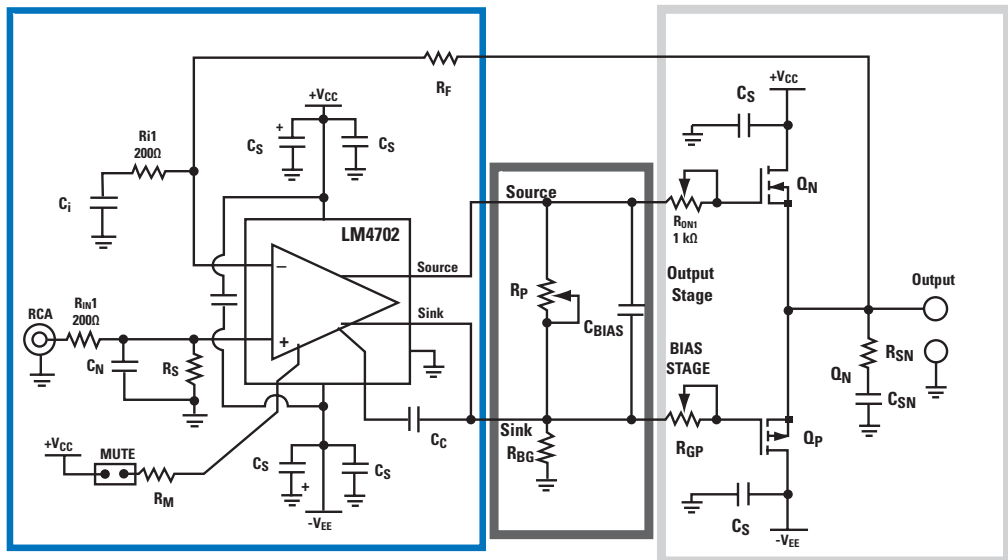
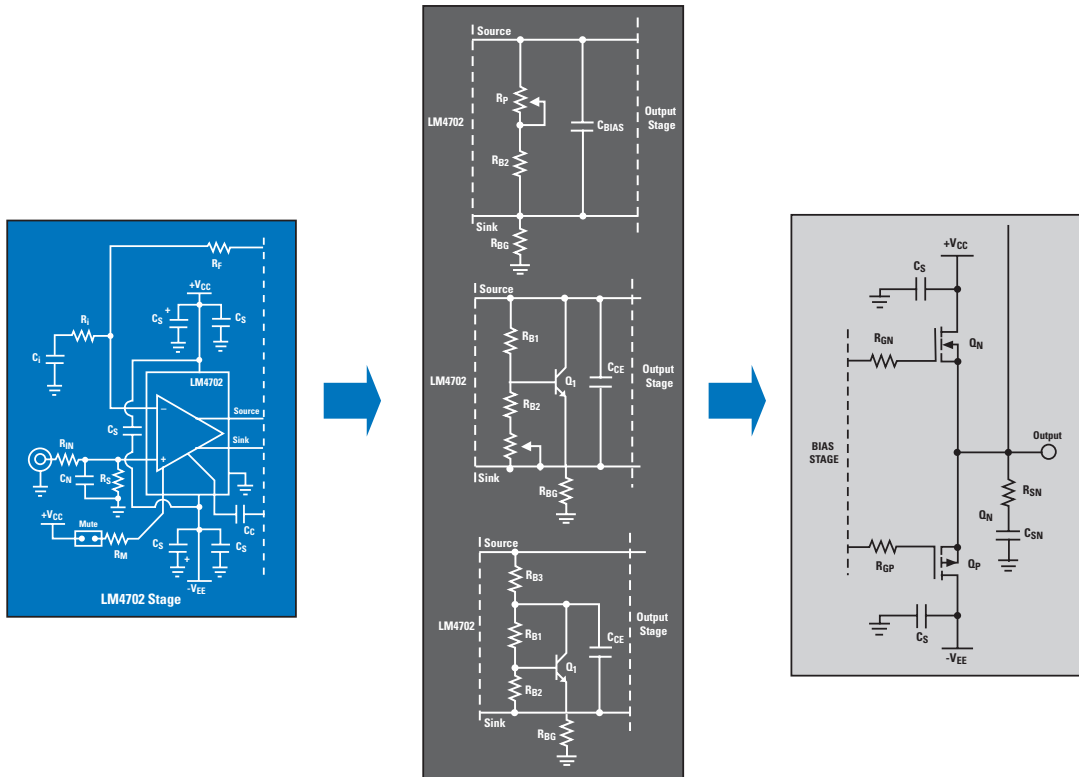
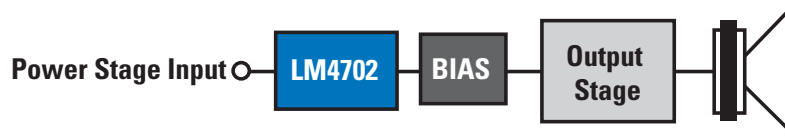
### Applications:

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

# Mixed Signal Subsystems/Audio Codecs

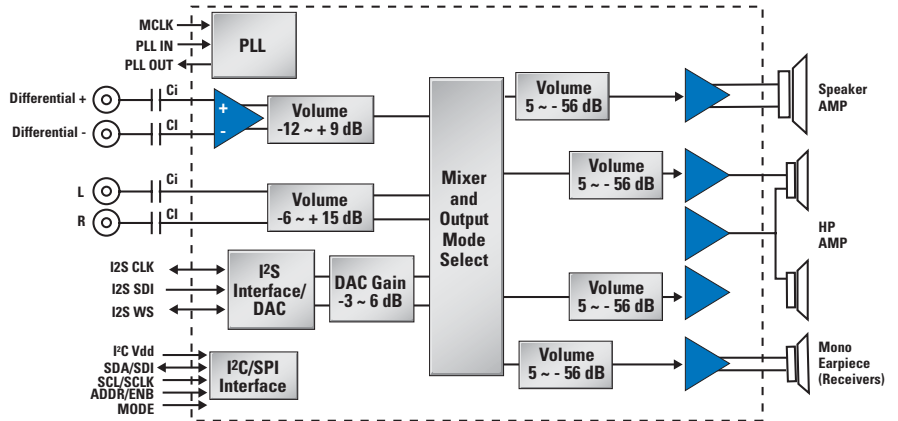
## LM4937 – Boomer® Audio Subsystem with OCL Stereo Headphone Output and RF Suppression

### Features

- 18-bit stereo DAC
- Multiple distinct output modes
- Stereo headphone amplifier
- Mono earpiece amplifier
- Differential mono analog input
- Independent loudspeaker, headphone, and mono earpiece volume controls
- Ultra-low shutdown current
- Click-and-pop suppression circuit

### Applications:

Ideal for use in cell phones and PDAs



## LM49450 – 2.2W Stereo Boomer Class D Audio Subsystem

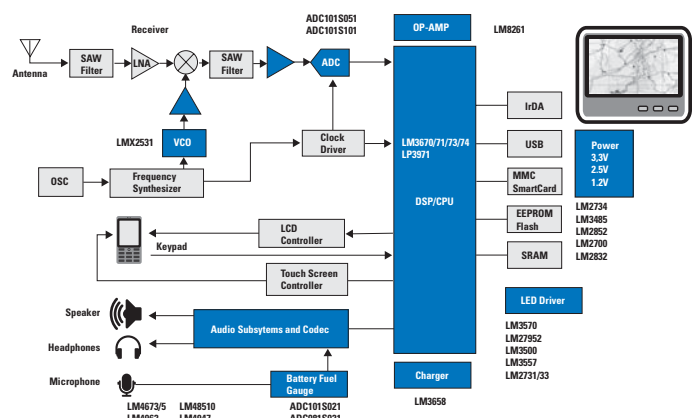
### Features

- 24-bit stereo DAC
- Selectable spread spectrum mode reduces EMI
- Ground-referenced headphone amplifiers with 100 dB SNR
- I<sup>2</sup>S compatible audio interface; I<sup>2</sup>C 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
LM4844	Stereo 1.2W audio subsystem with 3D enhancement	—	—	—	micro SMD-30
LM4888	Dual 2.1W audio amplifier plus stereo headphone and 3D enhancement	—	—	—	LLP-24
LM4930	1W mono speaker 27 mW headphone Boomer amplifier with microphone pre-amp, headphone sense, PCM and I <sup>2</sup> S	PCM	I <sup>2</sup> S	—	LLP-44, micro SMDxt-36
LM4931	1.1W mono speaker 26 mW headphone Boomer with microphone pre-amp, GPIO, headphone sense, I <sup>2</sup> C/SPI control, PCM, and I <sup>2</sup> S	PCM	I <sup>2</sup> S	✓	micro SMDxt-42
LM4934	1.2W stereo speaker 80 mW OCL headphone 175 mW earpiece Boomer with line out, I <sup>2</sup> C/SPI control, I <sup>2</sup> S and National 3D	1	2, I <sup>2</sup> S	—	micro SMDxt-42
LM4935	1.3W mono speaker 33 mW headphone 115 mW earpiece Boomer with I <sup>2</sup> S/PCM and auxiliary inputs, I <sup>2</sup> C control, mic pre-amp, DC volume control and AGC	1	2, I <sup>2</sup> S	✓	micro SMDxt-49
NEW LM4937	520 mW mono speaker, 36 mW headphone, 55 mW earpiece with I <sup>2</sup> C/SPI mode	1	I <sup>2</sup> S	—	micro SMDxt-36
NEW LM49370	1.2W mono speaker, 31 mW headphone, 115 mW earpiece with I <sup>2</sup> C/SPI mode and selectable OCL output	PCM	I <sup>2</sup> S	✓	micro SMDxt -49
NEW LM49450	Filterless 2.2W stereo Boomer Class D audio subsystem with OCL headphone amplifier, 3D enhancement, and headphone sense	1	I <sup>2</sup> S	✓	LLP-32

• PowerWise® product

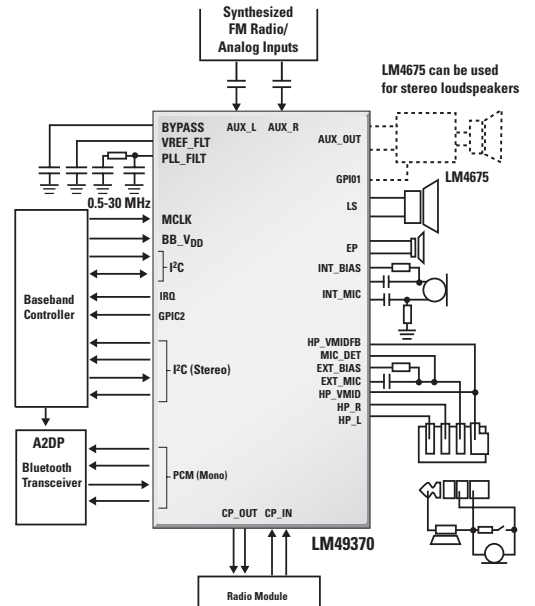
# LM49370 – PowerWise® Audio Codec Subsystem with Ultra-Low EMI, Class D Amplifier, and a PCM Interface for Bluetooth Transceivers

## Features

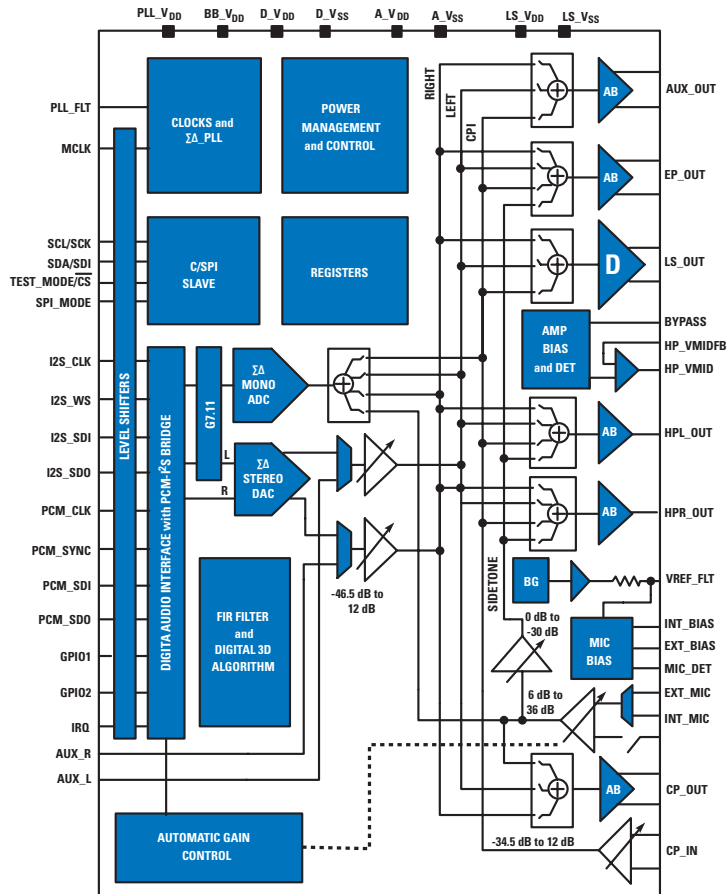
- Spread spectrum Class D architecture reduces EMI
- Mono Class D 8Ω amplifier, 490 mW at 3.3V
- OCL or AC-coupled headphone operation
- 33 mW stereo headphone amplifier at 3.3V
- 115 mW earpiece amplifier at 3.3V
- Digital 3D stereo enhancement
- Total harmonic distortion: 0.04%
- Available in micro 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



AUDIO



# Analog Subsystems

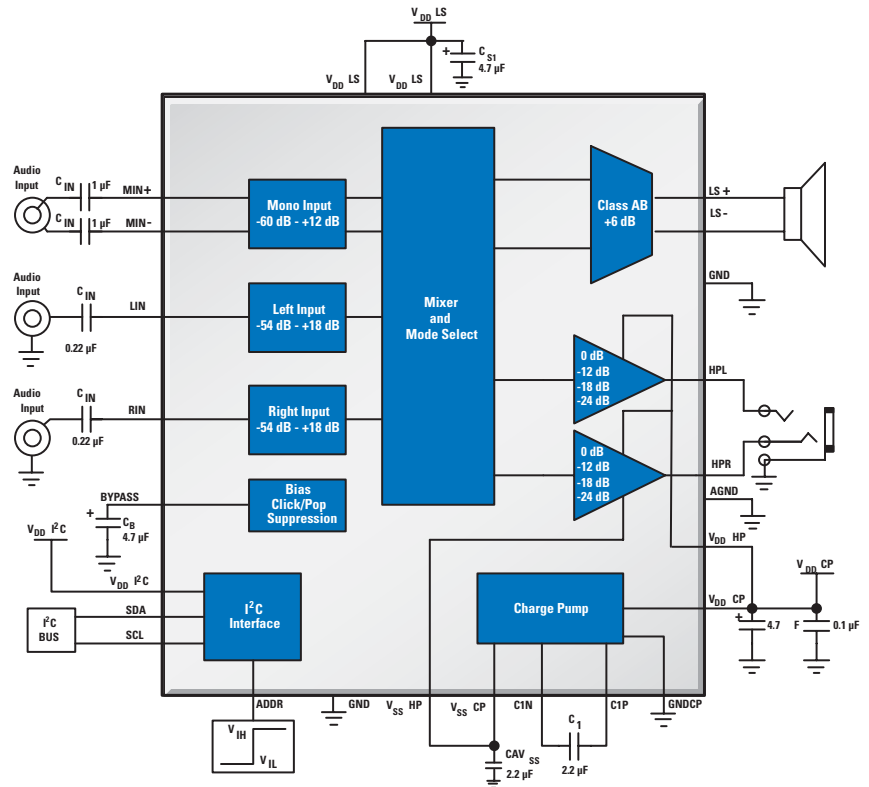
## LM49100 – PowerWise® Mono Class AB Audio Subsystem with a True-Ground Headphone Amplifier

### 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%
- I<sup>2</sup>C 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



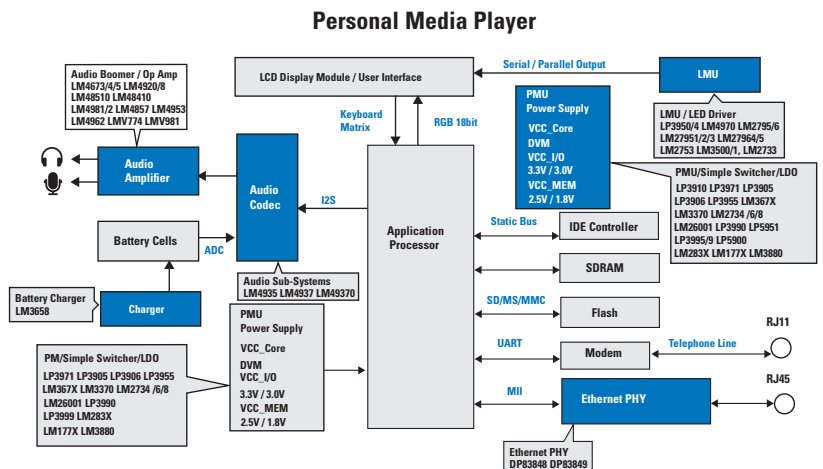
## LM49250 – Stereo Boomer® Class D Audio Subsystem with Ground-Referenced Headphone Amplifier and Mono Earpiece

### Features

- Output short circuit protection
- Thermal overload protection
- Spread spectrum modulation
- I<sup>2</sup>C 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



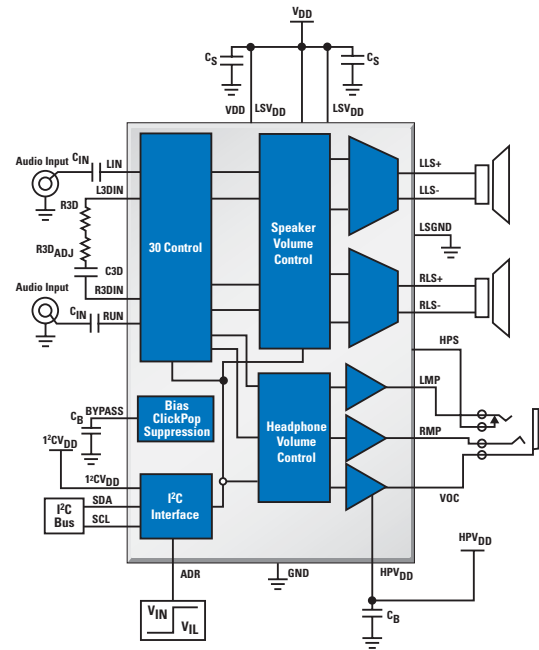
# LM49270 – Boomer® Filterless 2.2W Stereo Class D Audio Subsystem with OCL Headphone Amplifier, 3D Enhancement, and Headphone Sense

## Features

- Stereo filterless Class D amplifier
- Selectable OCL/CC headphone amplifier
- Headphone sense ability
- National's 3D enhancement
- RF suppression
- I<sup>2</sup>C 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



AUDIO

Product ID	Description	Mono Input Ch.	Stereo Input Ch.	THD (%)	Class D Speaker Driver	Packaging
LM4845	1.15W mono speaker 75 mW headphone Boomer with I <sup>2</sup> 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 Boomer with I <sup>2</sup> C/SPI volume and mode control, programmable National 3D and selectable OCL HP output	1	1	0.5	—	micro SMD-25
LM4851	1.1W mono speaker 115 mW differential headphone Boomer with SPI control	1	1	0.3	—	LLP-24, micro SMD-18
LM4852	1.1W mono speaker 60 mW headphone Boomer with I <sup>2</sup> C control	1	1	1	—	LLP-24, micro SMD-18
LM4855	1.1W mono speaker 115 mW differential headphone Boomer with SPI control	2	1	0.5	—	LLP-24, micro SMD-18
LM4856	1.1W mono speaker 60 mW headphone Boomer with I <sup>2</sup> C control	2	1	0.5	—	LLP-24, micro SMD-18
LM4857	1.2W stereo speaker, 75 mW headphone, 135 mW earpiece Boomer and line out with I <sup>2</sup> 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 Boomer 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 Boomer with I <sup>2</sup> 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 Boomer with I <sup>2</sup> 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 Boomer with I <sup>2</sup> 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 Boomer with I <sup>2</sup> C, mode and volume control, and true-ground headphone drivers	1	2	0.035	—	Micro Array
NEW LM4950	Stereo Boomer Class D audio subsystem with ground-referenced headphone amplifier and mono earpiece	1	2	0.14	✓	micro SMD-36

• PowerWise® product

# OCL/CC Headphone Boomer® Amplifiers

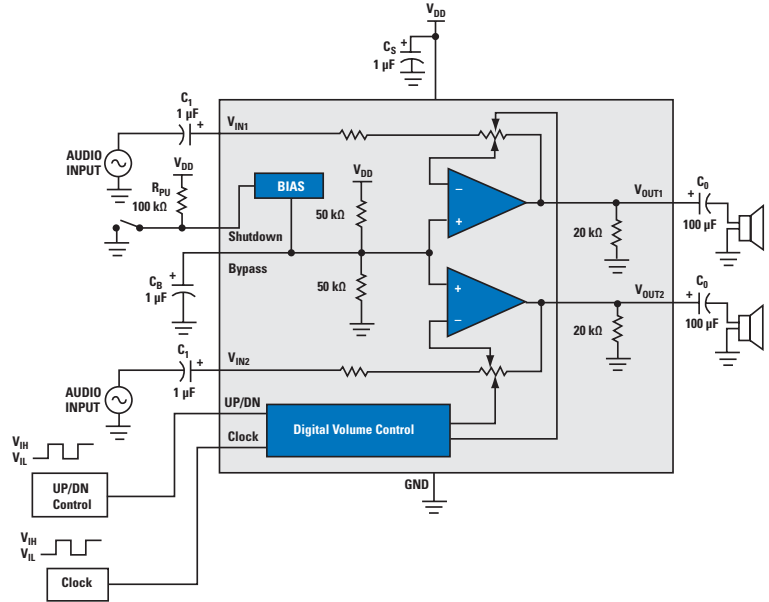
## LM4811 – Dual 105 mW Headphone Amplifier with Digital Volume Control and Shutdown Mode

### Features

- Digital volume control range from +12 dB to -33 dB
- LD and MSOP surface mount packaging
- Click-and-pop suppression circuitry
- No bootstrap capacitors required
- Low shutdown current
- Available in LLP-10 and mini SOIC-10 packaging

### Applications:

Ideal for use in cellular phones, MP3, CD, DVD players, PDAs, and portable electronics



## OCL/CC Headphone Boomer Amplifiers

Product ID	Description	THD (%)	PSRR (dB)	Output Power THD ≤ 1%, V <sub>CC</sub> = 3V	
				16Ω (mW)	32Ω (mW)
LM4809	105 mW headphone Boomer with shutdown low, can drive 8Ω	0.03	70	38	25
LM4811	105 mW headphone Boomer with up/down volume control, can drive 8Ω	0.03	60	38	25
LM4908 <sup>1</sup>	120 mW headphone Boomer amp, 0.1% THD+N	0.05	84	35	25
LM4910	35 mW headphone Boomer amp, bypass capacitor-less, OCL output	0.03	65	46	28
LM4911	40 mW headphone Boomer, low noise, selectable cap-coupled/OCL output	—	65	40	25
LM4912	40 mW headphone Boomer amp, 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 Boomer amp with OCL output	0.01	66	40	24
LM4929	40 mW headphone Boomer with low noise and OCL output	—	65	40	25
LM4980	42 mW stereo headphone Boomer with 2-cell battery operation and click/pop suppression	0.02	90	42	28
NEW LM4985	135 mW headphone Boomer with OCL or cap-coupled output, 32-step I <sup>2</sup> C volume control	0.08	77	45	23

<sup>1</sup>10 kV ESD Rated

• PowerWise® product

# Ground-Referenced Headphone Boomer® Amplifiers

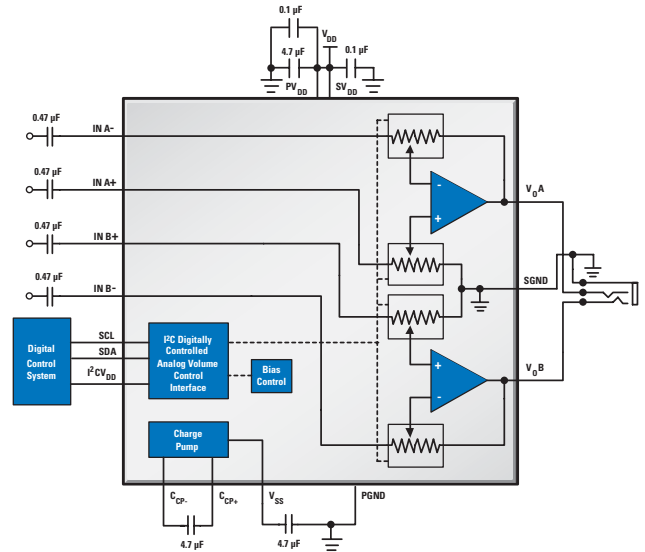
## LM48821 – Boomer Direct Coupled, Ultra-Low Noise, 52 mW Differential Input Stereo Headphone Amplifier with I<sup>2</sup>C Volume Control

### Features

- Ground-referenced outputs
- Differential inputs
- I<sup>2</sup>C volume and mode controls
- Ultra low current shutdown mode
- Advanced output transient suppression circuitry eliminates noise during turn-on and turn-off transitions
- 1.8V to 4V operation (I<sup>2</sup>CV<sub>DD</sub>)
- No output coupling capacitors, snubber networks, bootstrap capacitors, or gain setting resistors required
- Available in micro SMD-16 packaging

### Applications:

Ideal for use in notebook PCs, desktop PCs mobile phones PDAs, 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 <sub>CC</sub> = 3V		Packaging
					16Ω (mW)	32Ω (mW)	
LM4920	50 mW headphone Boomer, 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 Boomer amp, ultra-low noise, IntelliSense, 32-step I <sup>2</sup> C volume control	0.05	66	1.6 to 4.0	47	51	micro SMD-16
<span style="color: blue;">4 mm</span> LM48820	95 mW headphone Boomer, ultra-low noise, fixed 1.5 V/Vgain	0.01	80	1.6 to 4.5	95	80	micro SMD-14
<span style="color: blue;">NEW</span> LM48821	52 mW headphone Boomer, ultra-low noise, direct coupled, I <sup>2</sup> C volume control	0.015	82	2 to 4	52	53	micro SMD-16
LM48860	30 mW headphone Boomer amp, ultra-low noise, fixed 1.5V/V gain	—	—	2.5 to 5.5	40	50	micro SMD-12

# High-Efficiency Boomer<sup>®</sup> and Overture<sup>®</sup> Class D Amplifiers

## LM48411 – Ultra-Low EMI, Filterless, 2.5W, Stereo, Class D Audio Power Amplifier with E<sup>2</sup>S



### Features

- E<sup>2</sup>S 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

Product ID	Description	THD (%)	Output Power THD ≤ 1%		Packaging
			4Ω (W)	8Ω (W)	
LM4666 <sup>1</sup>	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 <sup>2</sup> 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 <sup>2</sup> S	0.03	2	1.25	micro SMD-16

<sup>1</sup> V<sub>DD</sub> = 3V

- PowerWise<sup>®</sup> product

### High-Efficiency Overture Class D

Product ID	Mono/Stereo	Supply Voltage (V)	Output Power THD ≤ 1%		Output Power THD ≤ 10%		Typical THD Ratings (%)	THD Measurement Conditions (W at V <sub>S</sub> = 3V, R <sub>L</sub> = 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 <sub>0</sub> = 1 at V <sub>S</sub> = 12V	9 to 14	Low	LLP-14, TSSOP-20
LM4680	Mono	12	—	6	—	7.5	0.2	P <sub>0</sub> = 1 at V <sub>S</sub> = 12V	9 to 14	Low	LLP-14
LM4681	Stereo	12	—	6	—	7.5	0.2	P <sub>0</sub> = 1 at V <sub>S</sub> = 12V	9 to 16	Low	LLP-48
LM4682	Stereo	12	—	6	—	7.5	0.2	P <sub>0</sub> = 1 at V <sub>S</sub> = 12V	9 to 15	Low	LLP-48



# Boosted Boomer<sup>®</sup> Moving Coil

AUDIO

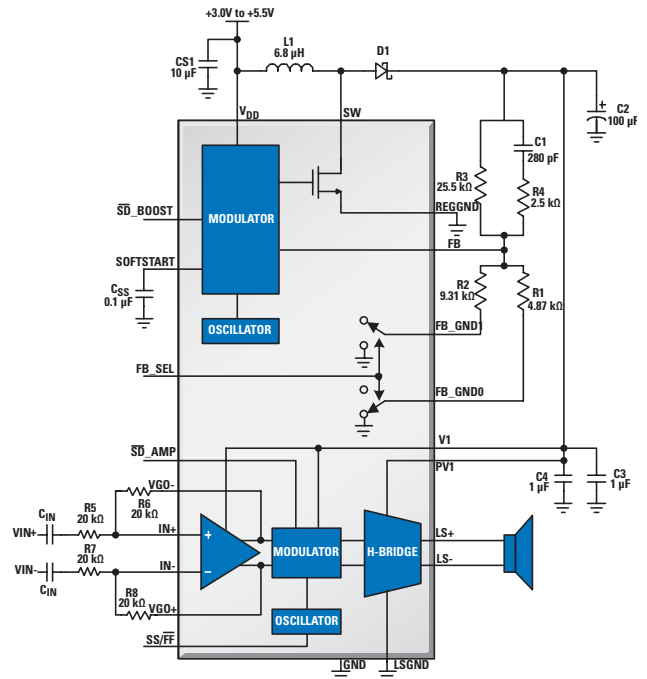
## LM48511 – Boosted Boomer Class D Audio Power Amplifier with Ultra-Low EMI and Spread Spectrum

### Features

- 3W output into 8Ω at 5V with THD+N = 1%
- Selectable spread spectrum mode reduces EMI
- 80% efficiency
- Independent regulator and amplifier shutdown controls
- Dynamically selectable regulator output voltages
- Filterless Class D
- 3.0V to 5.5V operation
- Low shutdown current
- Click-and-pop suppression

### Applications:

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



## Boosted Boomer Moving Coil

Product ID	Description	THD (%)	Output Power at THD ≤ 1%		Packaging
			4Ω (W)	8Ω (W)	
LM4804	1.8W low voltage, high power Boomer	0.15	—	1.9 at 4.2V, 2%	LLP-28
LM4805	1W low voltage, high power Boomer (Supplies 1W down to 3V)	0.25	—	1.2 at 4.2V	LLP-28
NEW LM48510	1.2W Boosted Class D Boomer	0.07	1.7 at 3.3V	1.2 at 3.3V	LLP-16
NEW LM48511	3W Boosted Class D Boomer with ultra low EMI and spread spectrum	—	5.4 at 5V	3 at 5V	LLP-24

• PowerWise<sup>®</sup> product

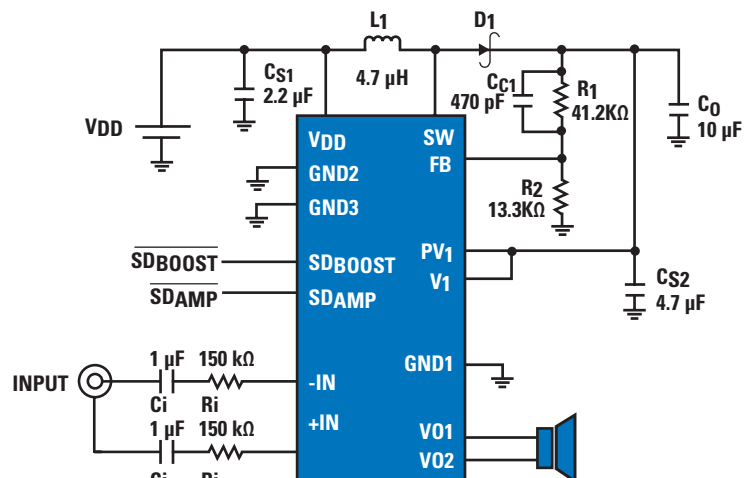
## LM48510 – PowerWise<sup>®</sup> Boosted Boomer Class D Audio Power Amplifier

### Features

- Click-and-pop suppression
- Low 0.01 µA shutdown current
- 76% efficiency
- Filterless Class D
- 2.7V to 5.0V operation (V<sub>DD</sub>)
- 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<sup>®</sup> Piezo Ceramic

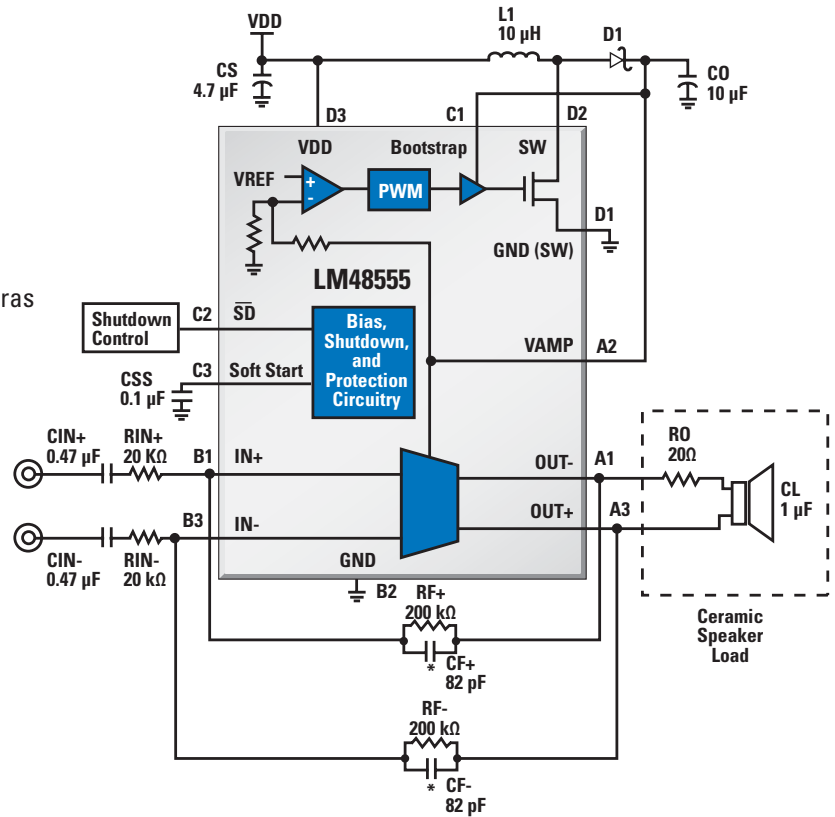
## LM48555 – Boomer Ceramic Speaker Driver

### Features

- Fully differential amplifier
- Externally configurable gain
- Soft-start function
- Low power shutdown mode
- Under voltage lockout

### Applications:

Ideal for use in mobile phones, PDAs, and digital cameras



## Boosted Boomer Piezo Ceramic

Product ID	Description	THD (%)	Output Voltage at THD ≤ 1% (V <sub>p-p</sub> ) V <sub>CC</sub> = 5V		Packaging
			800 nF + 20Ω	2 μF + 30Ω	
LM4802B	12 V <sub>p-p</sub> boosted ceramic speaker driver	0.05	—	12 at 4.2V	LLP-28
LM4953	12.6 V <sub>p-p</sub> ceramic speaker driver with ground reference, ultra low noise, fixed gain	0.02	—	—	LLP-14
LM4960	24 V <sub>p-p</sub> Piezoelectric speaker driver	0.04	24	—	LLP-28
LM4961	15 V <sub>p-p</sub> ceramic speaker driver	0.05	—	15	LLP-28
LM4962	15 V <sub>p-p</sub> ceramic speaker driver with band switch function, can drive LM4951 for stereo solution	0.04	—	15*	micro SMD-20
<b>NEW</b> LM48555	15.5 V <sub>p-p</sub> ceramic speaker driver	0.05	—	15*	micro SMD-12



\*ZL = 2 μF + 9.4Ω

Audio eBook resources available online

# Mono Boomer® Audio Amplifiers

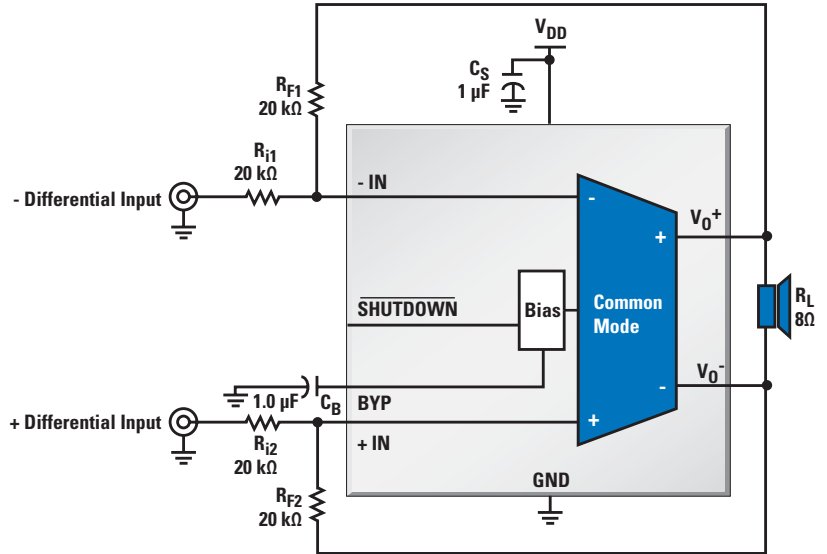
## LM4941 – PowerWise® Boomer 1.25 Watt Fully Differential Audio Power Amplifier with RF Suppression and Shutdown

### 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

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 Boomer, high PSRR	—	2.1	1.3	LLP-8
<b>NEW</b> 4 mm LM4941 •	1.25W Boomer, 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 Boomer with no bypass cap, selectable gain	0.02	—	1	LLP-10, MSOP-8
LM4951	1.8W (at 7.5V) wide voltage range Boomer	0.07	—	0.9	micro SMD-9, LLP-10
LM4954	3W (into 3Ω) wide voltage range Boomer	0.01	1.6	1.2	micro SMD-9
LM4990	2W (into 4Ω) Boomer with selectable shutdown	0.02	2.03	1.25	LLP-10, micro SMD-9, MSOP-8, TSSOP-10
LM4991	3W (into 3Ω) Boomer amplifier	0.02	2.13	1.1	LLP-8, SOIC-8
<b>NEW</b> 4 mm LM4995 •	1.3W Boomer amplifier	0.01	—	1.3	micro SMD-9, LLP-8

• PowerWise® product

# Stereo Boomer<sup>®</sup> Audio Amplifiers

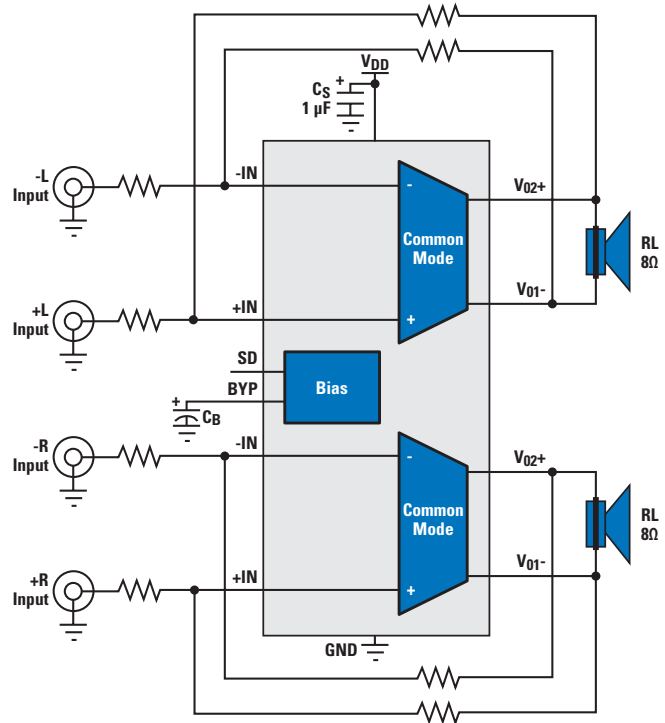
## LM4928 – 1.2W, Stereo Fully Differential Audio Amplifier with RF Suppression

### 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 <sub>VCC</sub> = 5V		Packaging
			4Ω (W)	8Ω (W)	
LM4928	1.2W stereo fully differential Boomer with RF suppression	0.04	1.8	1.2	micro SMD-16, LLP-14
LM4992	1.07 stereo Boomer with independent channel shutdown	0.15	—	1.07	LLP-14

## 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

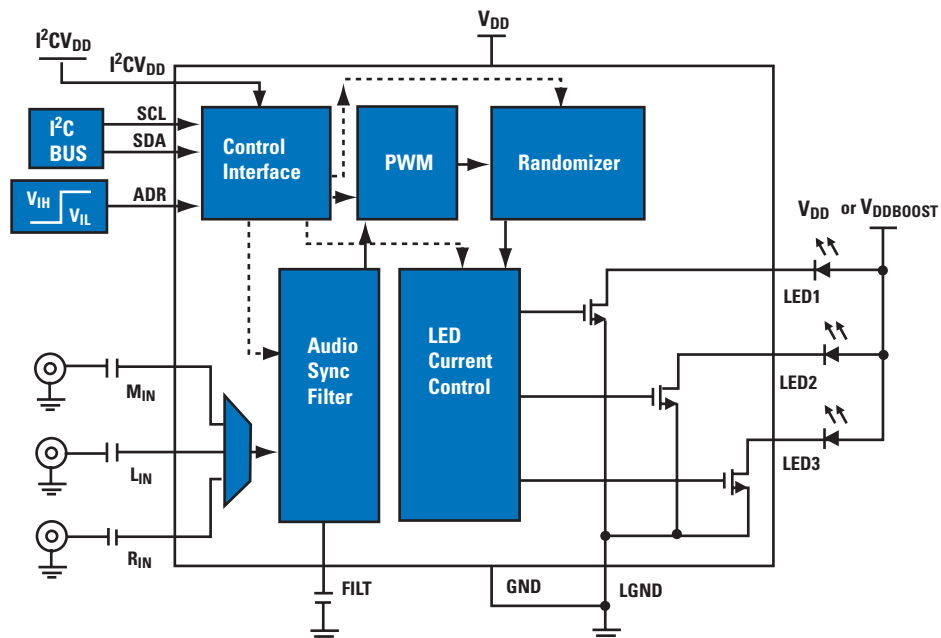
## 12V Boomer® Audio Amps

Product ID	Description	Supply Voltage Range (V)	THD (%)	Output Power at THD $\leq$ 1% $V_{CC} = 12V$		Packaging
				4 $\Omega$ (W)	8 $\Omega$ (W)	
LM4950	7.5W mono or 3.1W stereo Boomer	9.6 to 16	0.14	3.1	6.2	T0220-9, T0263-9

## 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 <sup>2</sup> C	3	3	18 mA	2.7 to 5.5	LLP-14

## Audio Synch LED Driver Typical Application



# Microphone Amplifiers

## 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

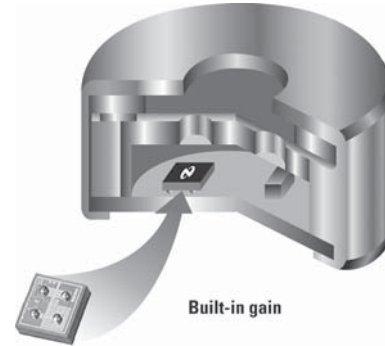
### LMV1032 Amplifier Features

- Low-supply current: <60  $\mu$ A
- Low-output impedance: 200 $\Omega$
- 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) <sup>1</sup>	SNR (dB at $V_{DD} = 5V$ )	Gain (dB)	THD (% at $V_{IN} = 18$ mV <sub>P-P</sub> , $V_{DD} = 5V$ )	PSRR (dB)	Typ IS/Ch ( $\mu$ A)	Supply Voltage Range (V)	Packaging
LMV1024 <sup>2</sup>	4-wire PDM preamp	-89	59	15	0.03	100	< 518	1.6 to 3	micro SMD-6 (LDB*)
LMV1026 <sup>3</sup>	4-wire PDM preamp	-89	59	15	0.03	100	< 518	1.6 to 3	micro SMD-6 (LDB*)
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 <sup>1</sup>	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 <sup>4</sup>
LMV1015-25	2-wire high-gain	—	61	23.9	0.21	—	< 180	2 to 5	micro SMD (LDB*) XP <sup>4</sup>
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) <sup>4</sup>
LMV1031	3-wire analog	—	62	20	0.18	56	—	2 to 5	micro SMD-4
LMV1088	—	—	60	36	0.1	85	—	2.7 to 5.5	micro SMD-36

<sup>1</sup>Patent pending

<sup>1</sup>1.8V, 1.2 MHz, 18 mV<sub>P-P</sub>

<sup>2</sup>PDM Output Right

<sup>3</sup>PDM Output Left

<sup>4</sup>Thinnest preamp at 0.3 mm is XP version

# National Semiconductor Audio: Your Sound Solutions



## LM48410

**Stereo Class D efficiency for portable audio applications.**  
For more information, see Class D on p. 56

## LM49370

**Integrated PS/analog subsystem simplifies mixed-signal audio implementation in handheld and portable devices.**  
For more information, see subsystems on p. 51



AUDIO

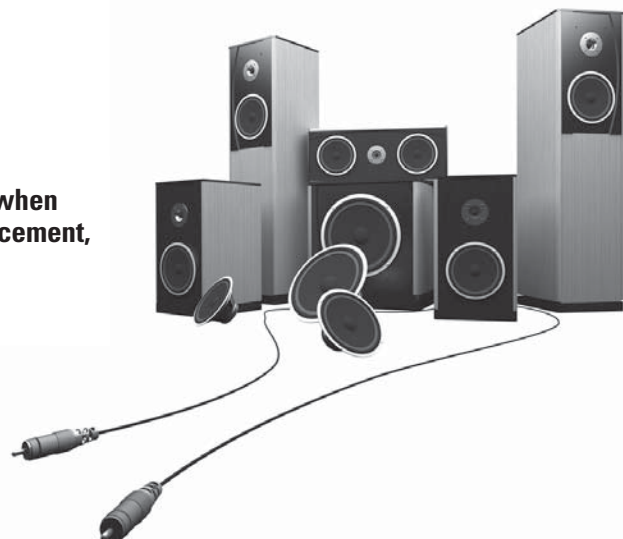


## LME49860

**0.00003% THD+N across bandwidth and loads operating up to  $\pm 22V$ .**  
**Apart from professional and consumer audio applications, this device also provides value in high-voltage industrial applications.**  
For more information, see audio op amps on p. 47

## LME49810

**100W to 3 kW Drive capability. Emulates a guitar amp when overdriven. Made for powered speakers, sound reinforcement, amplifiers, and professional audio systems.**  
For more information, see audio drivers on p. 48



# Remote Diode Temperature Sensors and Hardware Monitors

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

### TruTherm Beta Compensation Technology

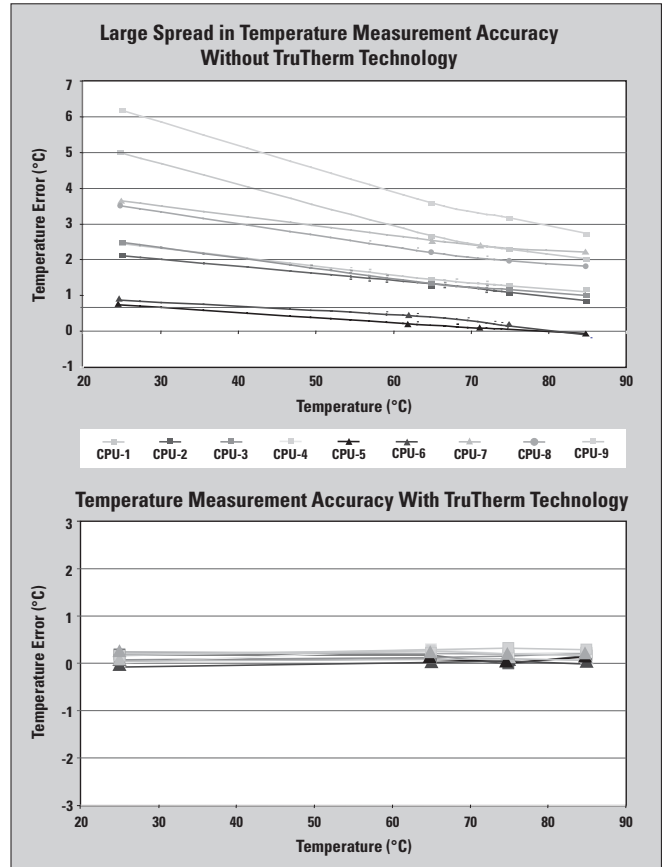
- Precisely senses the temperature of remote diodes in deep-submicron processes
- Compensates effects of beta variation
- Eliminates processor dependent offset calibration
- Precise temperature measurement combined with National's advanced fan control solution enables optimal acoustic solutions

### 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)



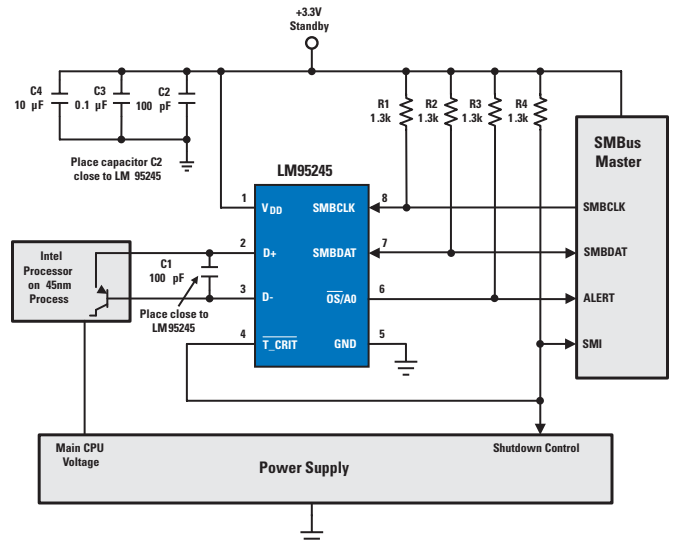
## LM95245 – PowerWise® Single Remote Diode and Local Temperature Sensor

### 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  $\mu\text{A}$  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	• $\pm 0.75^{\circ}\text{C}$ , MSOP-8	↕	P4 & AMD	Traditional	1	1	Factory set
LM95235	• $\pm 0.75^{\circ}\text{C}$ , MSOP-8		65 nm	TruTherm	1	1	✓
LM95245	• $\pm 0.75^{\circ}\text{C}$ , MSOP-8		45 nm	TruTherm	1	1	✓
LM95231	• $\pm 1.25^{\circ}\text{C}$ , MSOP-8	↕	90 nm	TruTherm	2	—	Factory set
LM95241	$\pm 1.25^{\circ}\text{C}$ , MSOP-8		65 nm	TruTherm	2	—	Factory set
LM95213	• $\pm 1.1^{\circ}\text{C}$ , LLP-14	↕	—	Traditional	0-2	3	✓
LM95233	• $\pm 0.875^{\circ}\text{C}$ , LLP-14		65 nm	TruTherm	0-2	3	✓
LM95214	• $\pm 1.1^{\circ}\text{C}$ , LLP-14		—	Traditional	0-4	3	✓
LM95234	• $\pm 0.875^{\circ}\text{C}$ , LLP-14		65 nm	TruTherm	0-4	3	✓
LM96194	• $\pm 2.5^{\circ}\text{C}$ , LLP-48	↕	65 nm	TruTherm	2-4	—	Full PI hardware monitor
LM87	$\pm 4^{\circ}\text{C}$ , TSSOP-24		—	Traditional	2	1	DAC hardware monitor
LM93	$\pm 3^{\circ}\text{C}$ , TSSOP-56	↕	—	Traditional	2	—	Full LVT hardware monitor
LM94	• $\pm 2.5^{\circ}\text{C}$ , TSSOP-56		65 nm	TruTherm	2-4	—	Full PI and LVT hardware monitor

• PowerWise® product

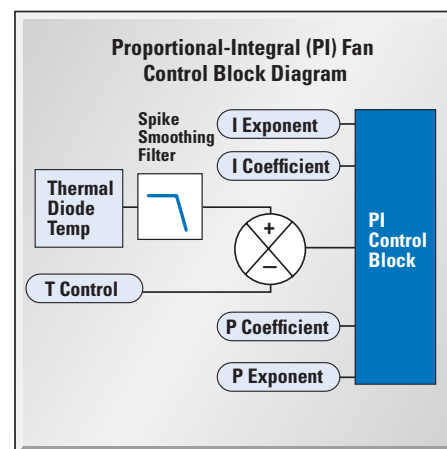
## LM94/96194 – PowerWise® TruTherm™ Hardware Monitor with PI Loop Fan Control

### Features

- TruTherm beta compensation technology
- Monitors up to 4 remote diodes, local temperature, 4 cooling fans, and 16 power supplies (LM94) or 9 power supplies (LM96194)
- Controls cooling fans with advanced fan speed control techniques
- Voltage measurement accuracy:  $\pm 2\%$  FS (max)
- Dual dynamic VID monitoring supports VRD10.2/11
- Temperature resolution: 9-bits,  $0.5^{\circ}\text{C}$
- Temperature sensor accuracy:  $\pm 2.5^{\circ}\text{C}$  (max)
- Power supply voltage: 3.0V to 3.6V
- Available in TSSOP-56 packaging (LM94)
- Available in LLP-48 packaging (LM96194)

### Applications:

Ideal for use in servers, workstations, and other single/multi-processor based equipment



Product ID	Key Features
LM63C/D	11-bit remote diode and LVT fan control
LM80/81B	Voltage monitoring, DAC output, Tach inputs
LM96000	Desktop hardware monitor, dual RDTS, linear fan control for 4-pin fans

# Analog Temperature Sensors

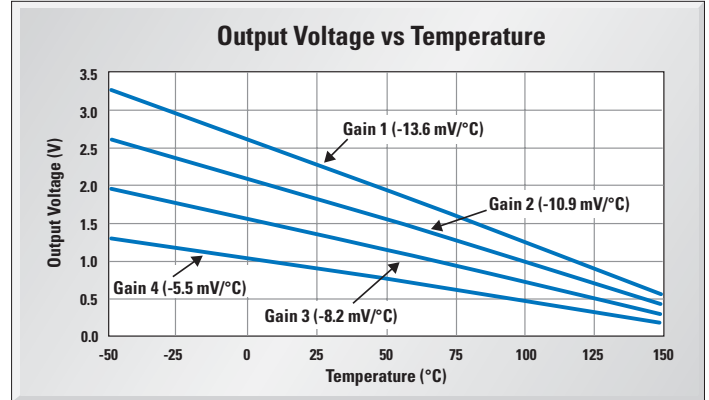
## LM94021/22 – Low-Voltage, Low-Power, 1.5 to 5.5V, Analog Temperature Sensor

### 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  $\mu\text{A}$  quiescent current
- Wide temperature range of  $-50^\circ\text{C}$  to  $+150^\circ\text{C}$
- Short-circuit protected output
- Available in SC-70 packaging and die form
- 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 ( $\mu\text{A}$ )	Output Drive		Output
		Source ( $\mu\text{A}$ )	Sink ( $\mu\text{A}$ )	
LM94021	9	2	100	Class A
LM94022	5.4	50	50	Class AB

## LM26LV – 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  $\mu\text{A}$  (typ)
- Highest accuracy with temperature trip point accuracy of  $\pm 2.3^\circ\text{C}$  (0 to  $69^\circ\text{C}$ )
- $0^\circ\text{C}$  to  $150^\circ\text{C}$  temperature trip point range,  $-50^\circ\text{C}$  to  $150^\circ\text{C}$  analog output temperature range
- Trip-test pin allows in-situ 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  $V_{\text{TEMP}}$  output drives external circuits, such as A/D converters
- $5^\circ\text{C}$  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
LM26	2.7V to 5.5V, $\pm 3^\circ\text{C}$ , $-40^\circ\text{C}$ to $125^\circ\text{C}$ factory preset set point, SOT-23	Small, low power, analog temperature switch plus analog temperature sensor
LM27	2.7V to 5.5V, $\pm 3^\circ\text{C}$ , $120^\circ\text{C}$ to $150^\circ\text{C}$ 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

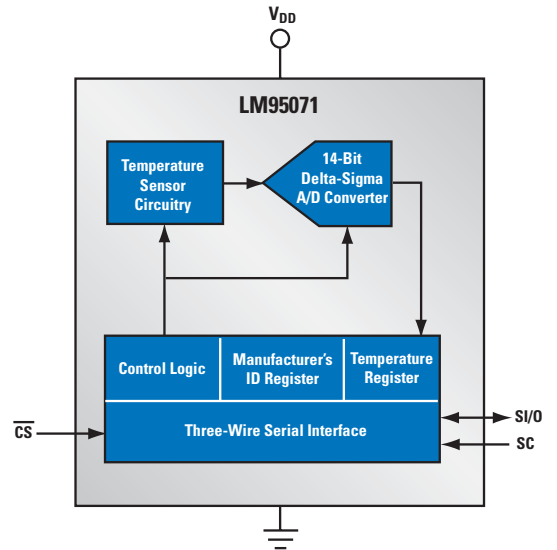
## LM95071 – High-Accuracy SPI General Purpose Digital Temperature Sensor

### Features

- $\pm 1^\circ\text{C}$  accuracy ( $0^\circ\text{C}$  to  $70^\circ\text{C}$ )
- 14-bit resolution ( $0.03125^\circ\text{C}/\text{LSB}$ )
- 2.4V to 5.5V supply
- Low power: 280  $\mu\text{A}$  typical
- $-40^\circ\text{C}$  to  $150^\circ\text{C}$  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
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, $\pm 0.5^\circ\text{C}$ & $\pm 1.0^\circ\text{C}$	Higher accuracy
LM77	2-wire, 10 bits, $\pm 1.5^\circ\text{C}$	ACPI compliance
LM92	2-wire, 13 bits, $\pm 0.33^\circ\text{C}$ & $\pm 0.5^\circ\text{C}$	World's most accurate

TEMPERATURE SENSORS

## Automotive AEC-Q100 Portfolio

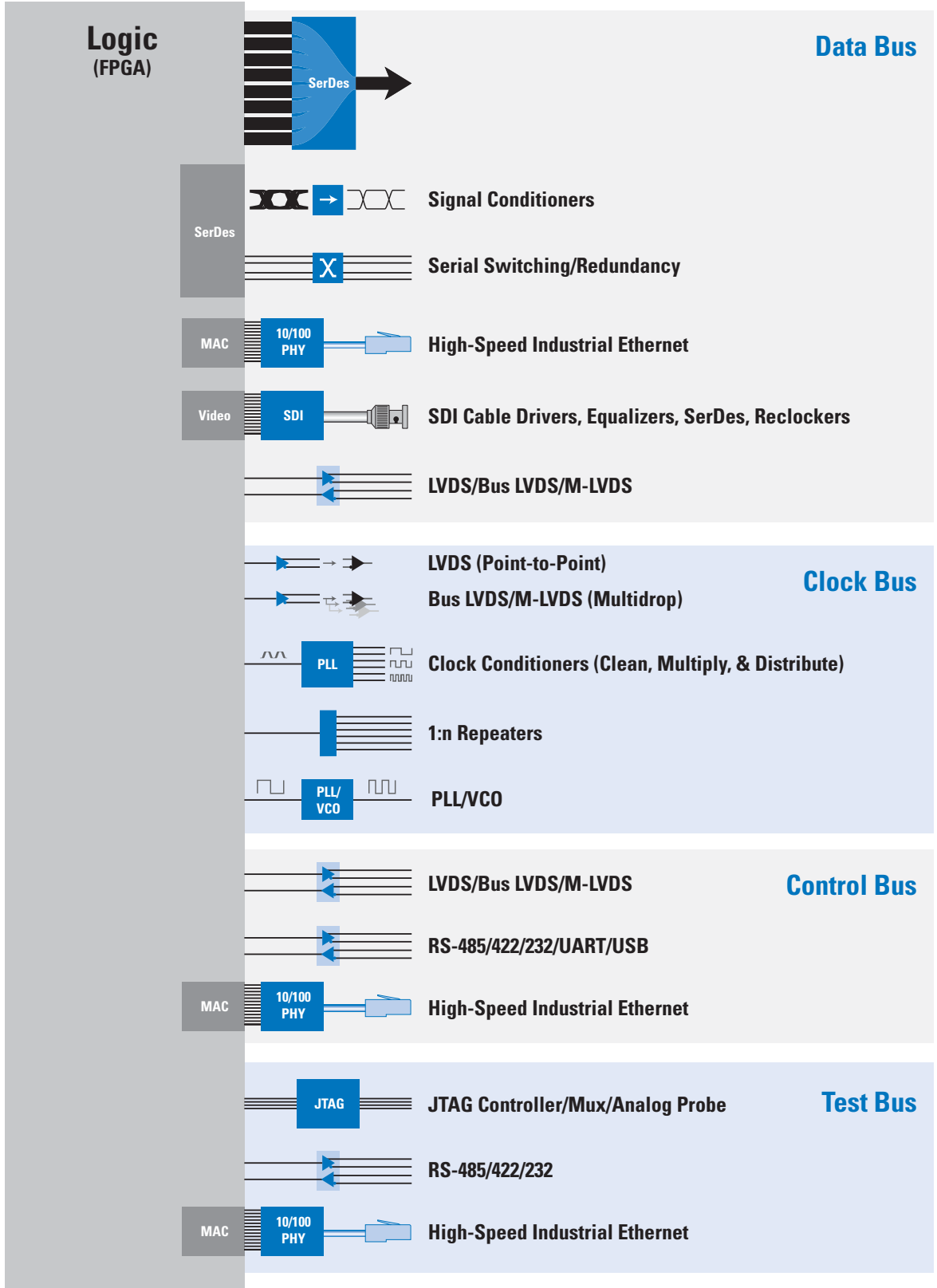
This family of temperature sensors is optimized for the automotive market. Increased electronic content in critical automotive and industrial applications is driving the need for specialized high temperature thermal management solutions. These temperature sensors provide high accuracy at the critical 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 AEC-Q100 Portfolio

Product ID	Description
LM95235Q •	Remote diode temperature sensor with TruTherm™ technology
LM94022Q	Low-voltage analog temperature sensor
LM27A	High temperature ( $120 - 150^\circ\text{C}$ ) thermostat
LM71A	General purpose digital temperature sensor
LM95071	General purpose digital temperature sensor

• PowerWise® product

# Interface Product Overview



## Multi-drop: Drive as many as 32 loads using Bus LVDS or M-LVDS

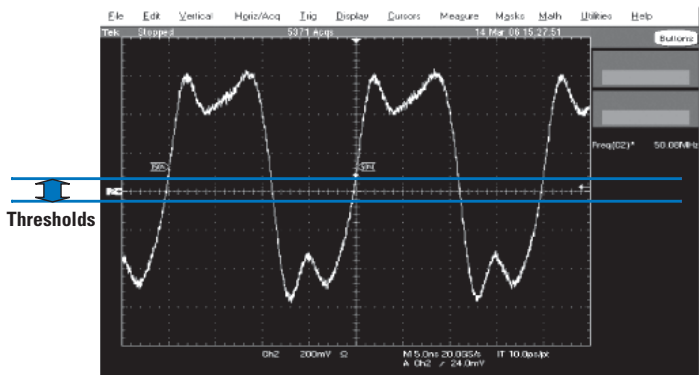
**Bus LVDS** is a multi-drop version of LVDS with beefed-up drive to support as many as 32 loads. Controlled edge rates help reduce reflections and allow B-LVDS to support data rates as high as 400 Mbps.

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

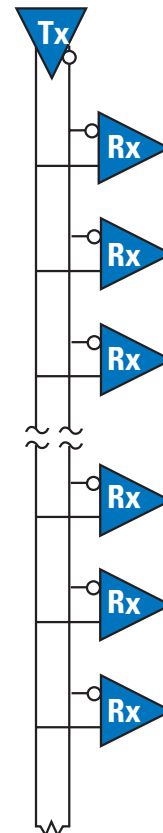
**M-LVDS** is described in the TIA/EIA-899 standard and is a multi-drop solution capable of data rates as high as 125 MHz. M-LVDS has guaranteed edge rates greater than 1 ns, increased drive and a wider input common mode range.

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

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



### Multidrop Topology



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

Product ID	Drivers	Receivers	LVDS Type	Max Speed/Ch (Mbps)	Supply Voltage	Temperature	Packaging	Comments
<b>Transceivers</b>								
DS91C176TMA	1	1	M-LVDS	100 MHz	3.3	-40 to +85°C	SOIC-8	M-LVDS, half duplex, type 2
DS91D176TMA	1	1	M-LVDS	100 MHz	3.3	-40 to +85°C	SOIC-8	M-LVDS, half duplex, type 1
DS91C180TMA	1	1	M-LVDS	100 MHz	3.3	-40 to +85°C	SOIC-14	M-LVDS, full duplex, type 2
DS91D180TMA	1	1	M-LVDS	100 MHz	3.3	-40 to +85°C	SOIC-14	M-LVDS, full duplex, type 1
DS92001TMA	1	1	B-LVDS	400	3.3	-40 to +85°C	SOIC/LLP-8	
DS92LV010ATM	1	1	B-LVDS	155	3.3	-40 to +85°C	SOIC-8	
DS92LV040TLQA	4	4	B-LVDS	200	3.3	-40 to +85°C	LLP-44	
DS92LV090ATVEH	9	9	B-LVDS	200	3.3	-40 to +85°C	PQFP-64	
DS92CK16TMTCT	6	1	B-LVDS	250	3.3	-40 to +85°C	TSSOP-24	Master/Slave

# LVDS and CML PHYs

## Signal Conditioning—Extend Your Reach

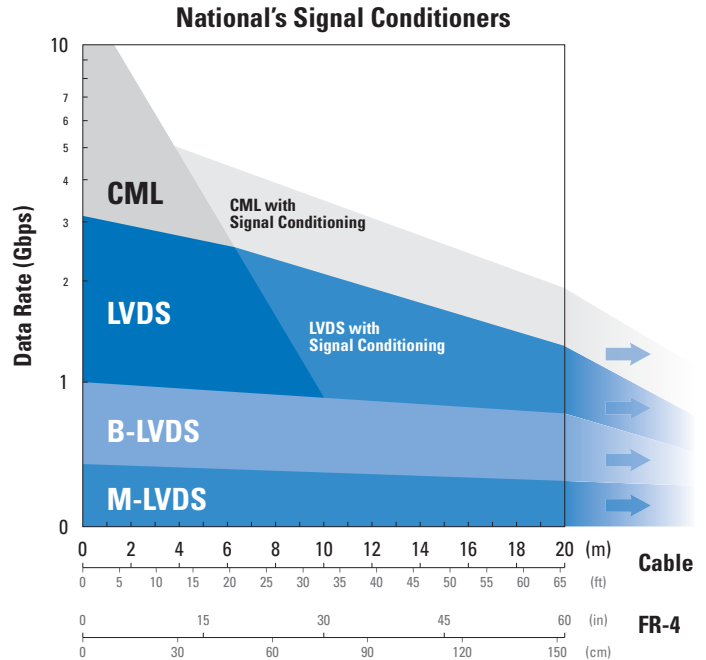
National offers an array of signal conditioning solutions, covering data rates from DC to 10 Gbps and topologies ranging from point-to-point to 32 multidrop loads.

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 multidrop or multipoint configurations.



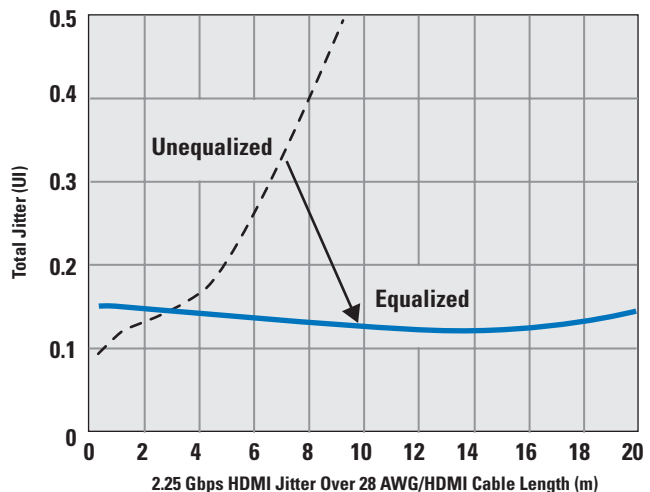
## DS16EV5110 – HDMI/DVI Cable Equalizer

### 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](http://www.national.com/nationaltv)

# Cable Extension and Switching/Redundancy

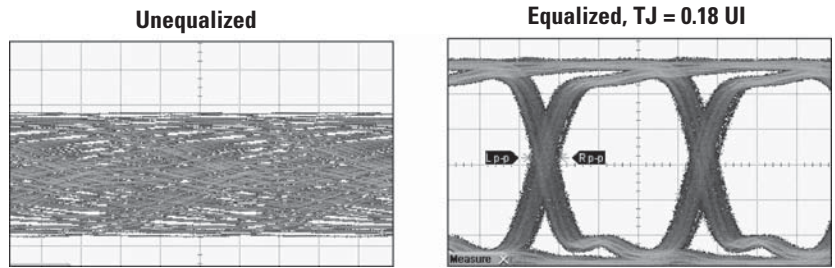
## PowerWise® Cable and Backplane Equalizer Family Operates from 2.5 to 10 Gbps

### 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 medial applications, and in reducing jitter in high-speed backplanes



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

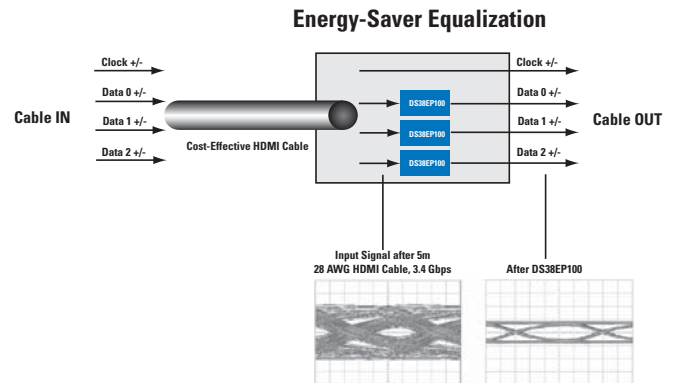
Product ID	Description	Supply Voltage	Channels	Package
DS32EV400	Quad 1-5 Gbps general purpose equalizer	3.3	4	LLP-48
DS64EV400 •	Quad 5-10 Gbps general purpose equalizer	3.3	4	LLP-48
DS32EV100 •	Single Channel 1-5 Gbps general purpose equalizer	3.3	1	LLP-14
DS64EV100 •	Single Channel 5-10 Gbps general 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.

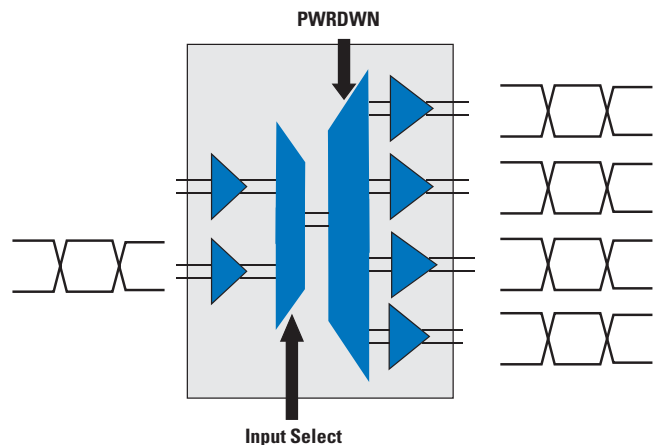
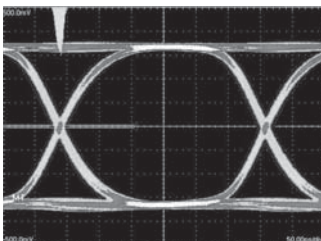
Device	Datarate	Boost	Packaging
DS38EP100	1 to 5 Gbps	7 dB	LLP-6
DS80EP100	5 to 12.5 Gbps	7 dB	LLP-6



## 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) <sup>1</sup>	Receive Equalization (dB)	Max Speed/Ch (Mbps)	Packaging	Comments
<b>Buffers</b>											
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, PowerWise® product
DS25BR110TSD	• Single LVDS buffer	1	1	—	LVDS/LVPECL/CML	LVDS	—	0/3/6/9	3125	LLP-8	Int termination, 8 kV ESD, PowerWise product
DS25BR120TSD	• Single LVDS buffer	1	1	—	LVDS/LVPECL/CML	LVDS	0/3/6/9	—	3125	LLP-8	Int termination, 8 kV ESD, PowerWise product
DS25BR150TSD	• Single LVDS buffer	1	1	—	LVDS/LVPECL/CML	LVDS	—	—	3125	LLP-8	Int termination, 8 kV ESD, PowerWise product
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
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
<b>Equalizers</b>											
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, PowerWise product
DS38EP100DS	• Power-saver equalizer	1	1	—	LVDS/LVPECL/CML	—	—	7	5000	LLP-6	No PWR or GND required, PowerWise product
DS80SP100SD	Power-saver equalizer	1	1	—	LVDS/LVPECL/CML	—	—	7	12500	LLP-6	No PWR or GND required
NEW DS32EV400SQ	Quad Settable equalizer	4	4	—	CML	CML	—	Up to 14	3125	LLP-48	8 EQ settings, PowerWise product
NEW DS32EV100SD	Single Settable equalizer	1	1	—	CML	CML	—	Up to 14	4250	LLP-14	8 EQ settings
NEW DS64EV400SQ	• Quad Settable equalizer	4	4	—	CML	CML	—	Up to 20	10000	LLP-48	8 EQ settings, PowerWise product
NEW DS64EV100SD	• Single Settable equalizer	1	1	—	CML	CML	—	Up to 20	10000	LLP-14	8 EQ settings

LB = Loopback <sup>1</sup>CML 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

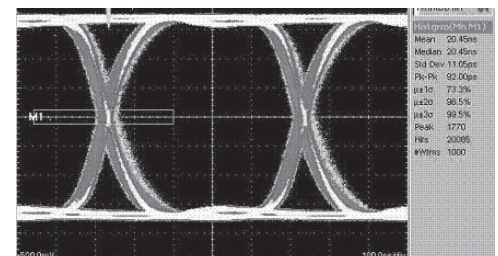
### Features

- 17 ps typ jitter (2.5 Gbps, 2<sup>23</sup>-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) <sup>1</sup>	Receive Equalization (dB)	Max Speed/Ch (Mbps)	Packaging	Comments
<b>Multiplexers and Mux-Buffers</b>											
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	—	1500	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	—	1500	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
<b>Crosspoint Switches</b>											
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
<b>NEW</b> DS10CP152TMA	2 x 2 crosspoint	2	2	2 x 2	LVDS/LVPECL/CML	LVDS	—	—	1500	SOIC-16	9 ps Jitter typical
<b>NEW</b> 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
<b>NEW</b> DS10CP154SQ	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, PowerWise product
<b>NEW</b> DS25CP104SQ •	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, PowerWise product
<b>1:n Repeaters</b>											
DS90LV110ATMT	1:10 LVDS repeater	1	10	1:10	LVDS/LVPECL/CML	LVDS	—	—	400	TSSOP-28	Input failsafe
<b>NEW</b> DS10BR254SQ	1:4 LVDS repeater	2	4	1:4	LVDS/LVPECL/CML	LVDS	—	—	1500	LLP-40	Select 1 of 2 inputs
<b>NEW</b> 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 <sup>1</sup>CML devices in this column that feature de-emphasis show negative dB  
 • PowerWise® product

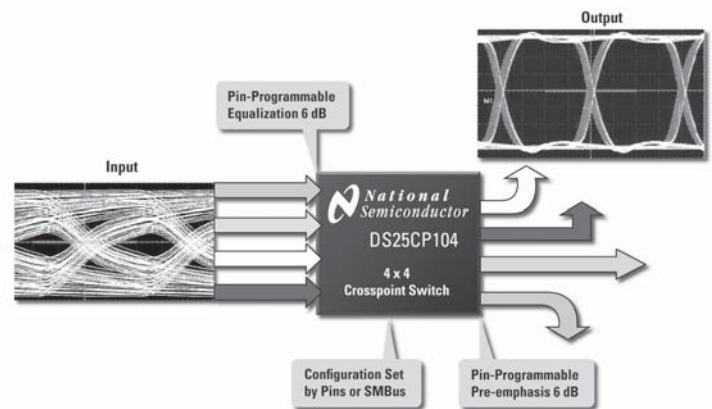
## DS25CP104 – PowerWise® LVDS 4 x 4 Crosspoint Switch

### Features

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

### Applications:

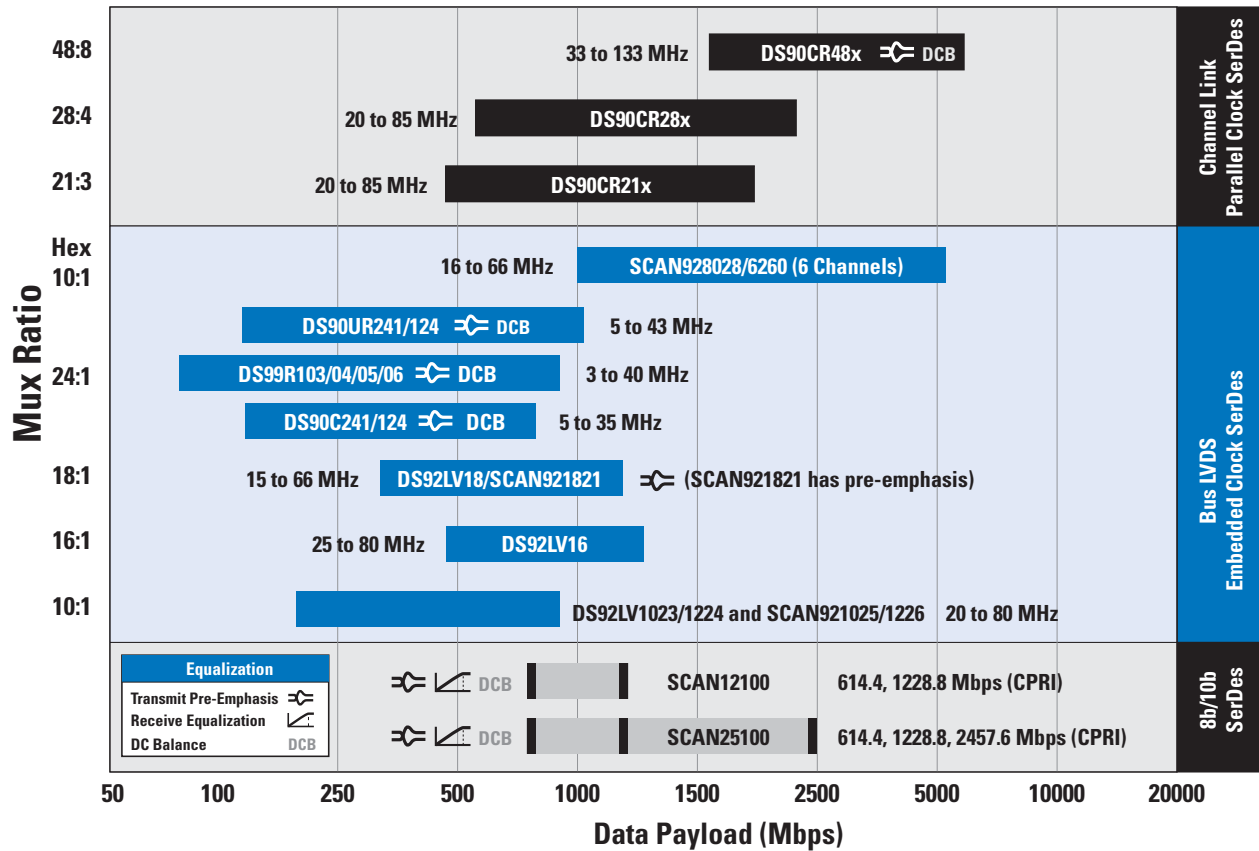
Ideal for use in routing and switching of video, data, or clock signals, and redundancy



INTERFACE

# Serializer/Deserializer (SerDes)

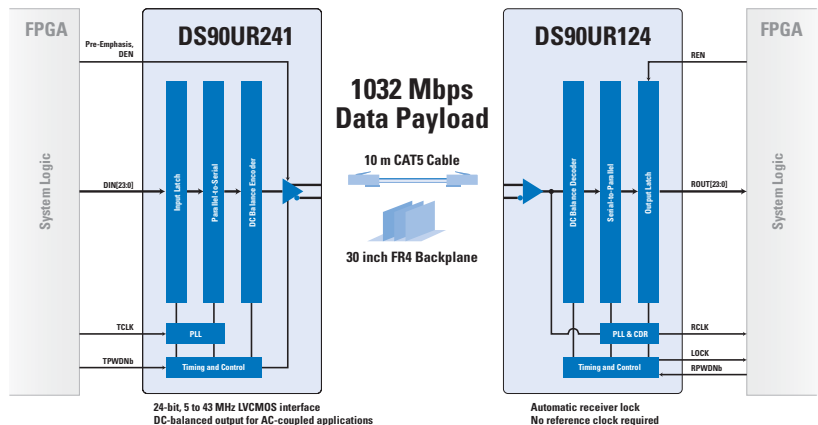
## Selecting the Right SerDes



## 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

## Selected SerDes Products

Product ID	Mux Ratio	Function	#Ser	#Des	Clock Speed (MHz)	Max Rate/Ch (Mbps)	Max Throughput (Mbps)	Temperature	Packaging	Eval Kit
<b>Single-Channel 10-bit SerDes</b>										
DS92LV1021ATMSA	10:1	Serializer	1	—	16 to 40	400	400	-40 to +85°C	SSOP-28	BLVDS03
DS92LV1212AMSA	10:1	Deserializer	—	1	16 to 40	400	400	-40 to +85°C	SSOP-28	BLVDS03
DS92LV1023ETMSA	10:1	Serializer	1	—	30 to 66	660	660	-40 to +85°C	SSOP-28	BLVDS03
DS92LV1224TMSA	10:1	Deserializer	—	1	30 to 66	660	660	-40 to +85°C	SSOP-28	BLVDS03
SCAN921025SLC	10:1	Serializer	1	—	30 to 80	800	800	-40 to +85°C	BGA-49	BLVDS03
SCAN921226SLC	10:1	Deserializer	—	1	30 to 80	800	800	-40 to +85°C	BGA-49	BLVDS03
SCAN921025HSM	10:1	Serializer	1	—	20 to 80	800	800	-40 to +125°C	BGA-49	BLVDS03
SCAN921226HSM	10:1	Deserializer	—	1	20 to 80	800	800	-40 to +125°C	BGA-49	BLVDS03
<b>Multi-Channel 10-bit SerDes</b>										
SCAN921260UJB	10:1	Deserializers	—	6	20 to 66	660	3960	-40 to +85°C	LBGA-196	BLVDS03
SCAN926260TUF	10:1	Deserializers	—	6	16 to 66	660	3960	-40 to +85°C	LBGA-196	BLVDS03
SCAN928028TUF	10:1	Serializers	8	—	25 to 66	660	5280	-40 to +85°C	LBGA-196	BLVDS03
<b>16-bit</b>										
DS92LV16TVHG	16:1	SerDes	1	1	25 to 80	1280	1280 per direction	-40 to +85°C	PQFP-80	BLVDS16EVK
<b>18-bit</b>										
DS92LV18TVV	18:1	SerDes	1	1	15 to 66	1188	1188 per direction	-40 to +85°C	PQFP-80	LVDS-18B-EVK
<b>21-bit</b>										
DS90CR217MTD	21:3	Transmitter	1	—	20 to 85	595	1780	-10 to +70°C	TSSOP-48	CLINK3V28BT-85
DS90CR218AMTD	21:3	Receiver	—	1	12 to 85	595	1780	-10 to +70°C	TSSOP-48	CLINK3V28BT-85
<b>24-bit with DC-Balance and Pre-Emphasis</b>										
DS90C241QVS*†	24:1	Serializer	1	—	5 to 35	840	840	-40 to +105°C	TQFP-48	SERDES24-35USB
DS90C124QVS*	1:24	Deserializer	—	1	5 to 35	840	840	-40 to +105°C	TQFP-48	SERDES24-35USB
DS99R103TVS	24:1	Serializer	1	—	3 to 40	960	960	-40 to +85°C	TQFP-48	SERDES03-40USB
DS99R103TSQ	24:1	Serializer	1	—	3 to 40	960	960	-40 to +85°C	LLP-48	SERDES03-40USB
DS99R104TVS	1:24	Deserializer	—	1	3 to 40	960	960	-40 to +85°C	TQFP-48	SERDES03-40USB
DS99R104TSQ	1:24	Deserializer	—	1	3 to 40	960	960	-40 to +85°C	LLP-48	SERDES03-40USB
DS99R105VS	24:1	Serializer	1	—	3 to 40	960	960	0 to +70°C	TQFP-48	SERDES05-40USB
DS99R105SQ	24:1	Serializer	1	—	3 to 40	960	960	0 to +70°C	LLP-48	SERDES05-40USB
DS99R106VS	1:24	Deserializer	—	1	3 to 40	960	960	0 to +70°C	TQFP-48	SERDES05-40USB
DS99R106SQ	1:24	Deserializer	—	1	3 to 40	960	960	0 to +70°C	LLP-48	SERDES05-40USB
DS90UR241QVS*†	24:1	Serializer	1	—	5 to 43	1030	1030	-40 to +105 C	TQFP-48	SERDESUR-43USB
DS90UR124QVS*†	1:24	Deserializer	—	1	5 to 43	1030	1030	-40 to +105 C	TQFP-64	SERDESUR-43USB
<b>28-bit</b>										
DS90CR287MTD	28:4	Transmitter	1	—	20 to 85	595	2380	-10 to +70°C	TSSOP-56	CLINK3V28BT-85
DS90CR288AMTD	28:4	Receiver	—	1	20 to 85	595	2380	-10 to +70°C	TSSOP-56	CLINK3V28BT-85
<b>48-bit (with DC Balance and Pre-Emphasis)</b>										
DS90CR483VJD	48:8	Transmitter	1	—	33 to 112	672	5376	-10 to +70°C	TQFP-100	CLINK3V48BT-112
DS90CR484VJD	48:8	Receiver	—	1	33 to 112	672	5376	-10 to +70°C	TQFP-100	CLINK3V48BT-112
DS90CR485VS <sup>1</sup>	48:8	Transmitter	1	—	66 to 133	798	6384	-10 to +70°C	TQFP-100	CLINK3V48BT-133
DS90CR486VS <sup>1</sup>	48:8	Receiver	—	1	66 to 133	798	6384	-10 to +70°C	TQFP-100	CLINK3V48BT-133
<b>8b/10b CPRI Basestation SerDes</b>										
SCAN12100TYA	8:1	SerDes	1	1	30.72	614.4, 1228.8		-40 to +85°C	TQFP-100	SCAN25100EVK
SCAN25100TYA	8:1	SerDes	1	1	30.72	614.4, 1228.8, 2457.6		-40 to +85°C	TQFP-100	SCAN25100EVK

\*This Product is National Automotive Grade Compliant (Includes AEC-Q100 Compliance)

†These products are ISO 10605 ESD compliant

<sup>1</sup> Package codes: National has recently moved to 2-letter package code suffixes for new products. The new VV code refers to the same PQFP-80 package as the old VHG code.

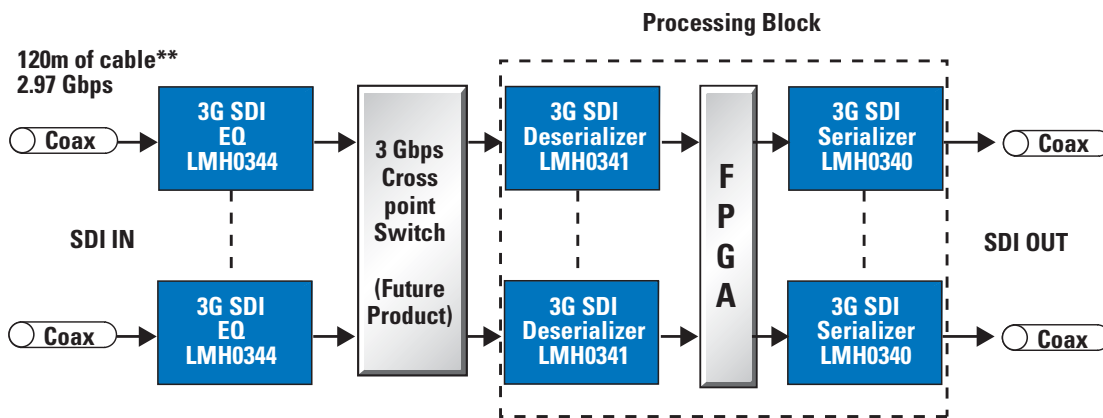
# National's Comprehensive 3 Gbps SDI Solution

## 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 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

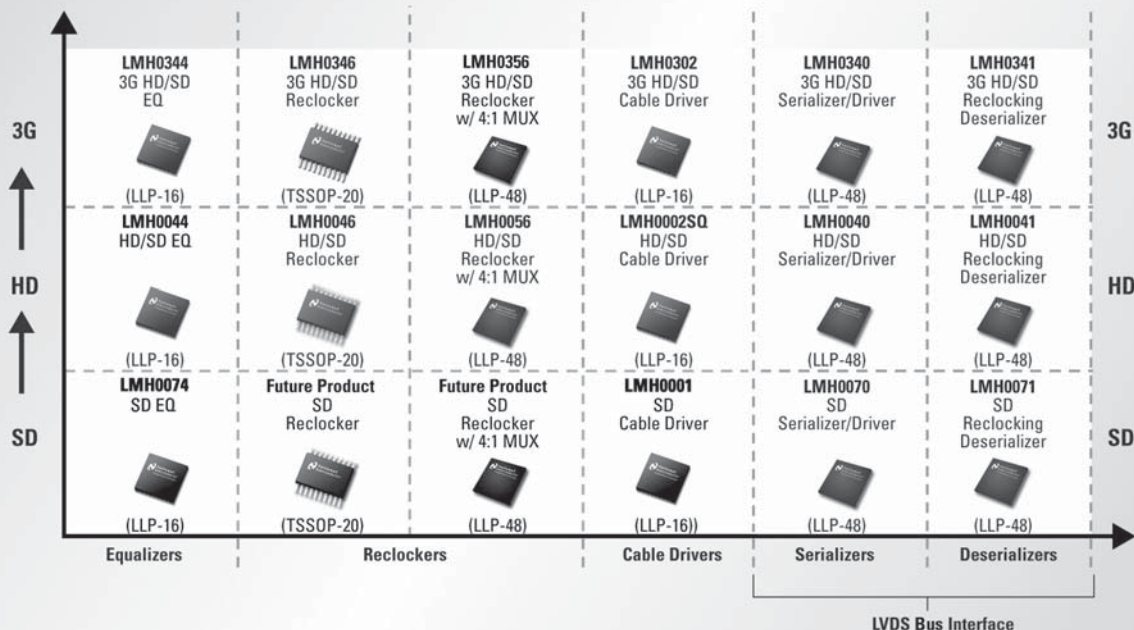
designer flexibility for building a system. Do you require HD/SD operation today with an upgrade path to 3 Gbps SDI tomorrow? National's SDI technology offers solutions for all your SDI needs.

3G HD/SD SDI Production Switcher Simplified Block Diagram

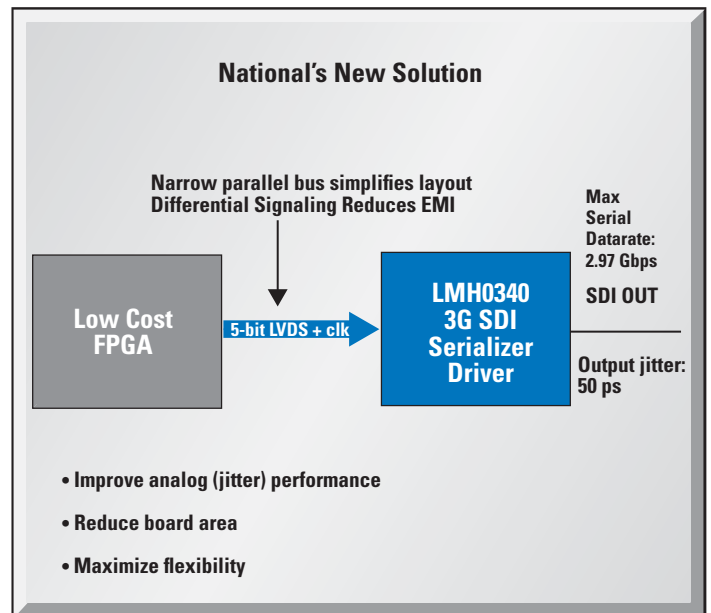
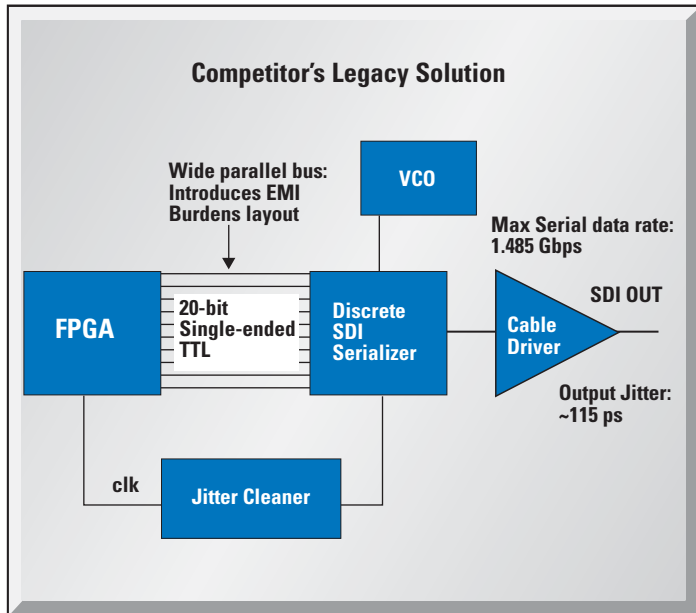


\*\*Belden 1694A coaxial cable

Backward Compatible Solutions for SD, HD, and 3G SDI



# SDI Serializers and Deserializers with LVDS Interface



	Feature	Benefit
<b>Tx and Rx</b>	Supports 3G, HD, SD, SDI, and DVB-ASI	Supports SMPTE 424M, 292M, 259M, and DVB-ASI
	5-bit LVDS interface	Narrow parallel bus simplifies layout and conserves board area
	Differential signalling	Reduces EMI
	No external VCO required	Simplify design, conserve board area, and reduce system cost
	Available in LLP-48 packaging	7 x 7 mm <sup>2</sup> package is 60% smaller than BGA-100
<b>Serializer</b>	50 ps <sub>p-p</sub> output alignment jitter at 3G and HD rates	Lowest output jitter (0.15 UI) provides ample margin for designing to SMPTE specifications
	Integrated cable driver	Reduce power consumption and board area
	420 mW typical power consumption	Lowest power serializer / driver
<b>Deserializer</b>	0.6 UI minimum jitter tolerance	Recover noisy signals with greater than 60% of eye closed
	Reclocked active loop through with serial cable driver	Facilitates input monitoring
	510 mW typical power consumption	Lowest power SDI deserializer

**Serializers:**  
 LMH0340 3G HD/SD  
 LMH0040 HD/SD  
 LMH0070 SD

### Key Features

- Integrated cable driver
- 50 ps<sub>p-p</sub> output alignment jitter at 3G and HD rates
- No external VCO required

**Deserializers:**  
 LMH0341 3G HD/SD  
 LMH0041 HD/SD  
 LMH0071 SD

### Key Features

- Reclocked loop through
- 0.6 UI minimum input jitter tolerance
- No external VCO required
- No reference clock required

# High-Speed Industrial Ethernet

## Advanced 10/100 Ethernet PHYs

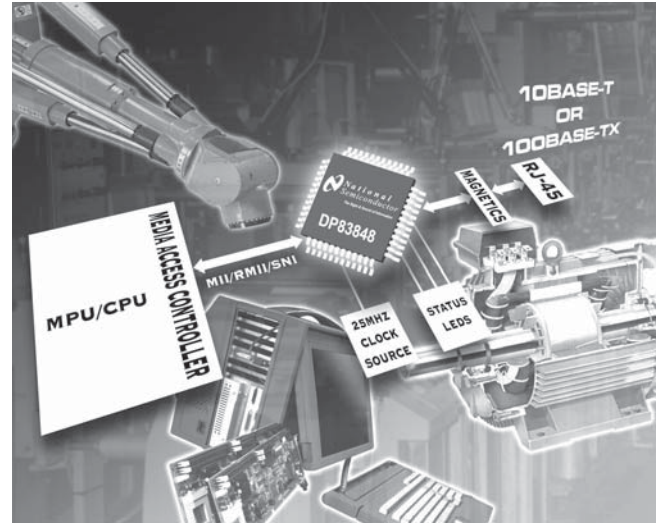
### DP83848 – PHYTER® 10/100 Ethernet PHYs for Commercial, Industrial, and Extreme Applications

#### 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

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

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

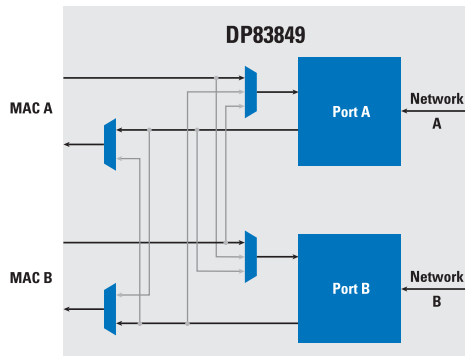
#### Mini PHYTER

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

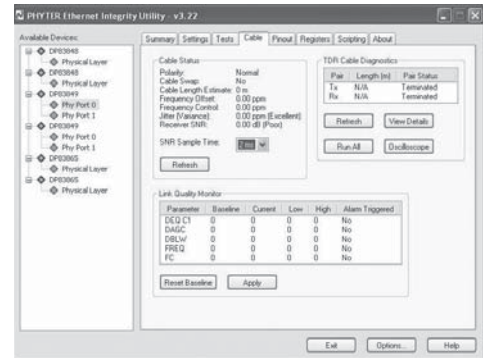
## DP83849 – Dual PHYTER 10/100 Ethernet PHY for Commercial, Industrial, and Fiber Applications

### Features

- Flexible port switching and chaining
  - MII port assignment
  - MDI chaining
- Industry’s lowest deterministic latency
- Enhanced cable diagnostics
  - 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:

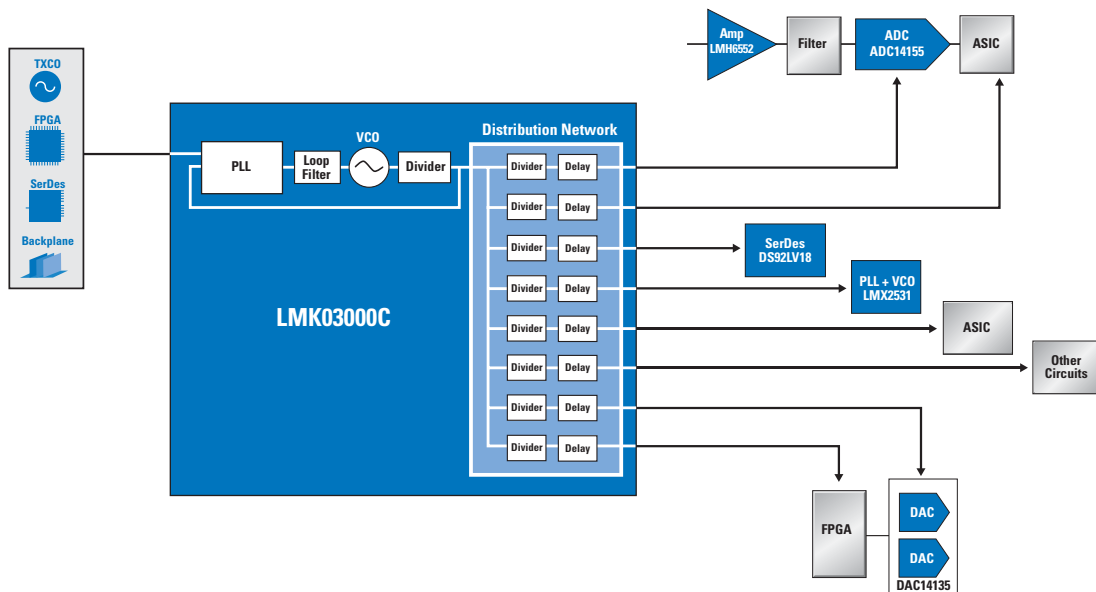
Ideal for use in industrial automation, test and measurement, telecom, military, and aerospace applications

### Dual PHYTER

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



### LMK03000/01/02 and LMK02000/02 Features

- Fully integrated VCO option delivers unprecedented jitter performance, reducing board space and risk
- Can be configured as jitter cleaner or clock generator
- Available in three performance grades for clocking various high performance applications with diverse jitter requirements
- Footprint compatibility between performance grades
- Three LVDS and five LVPECL clock outputs with dedicated divider and delay blocks simplifies distribution architecture
- Wide clock output frequency range of 1 to 862 MHz
- Small form factor minimizes PCB space by 70%

### Applications:

Ideal for use in 2G/3G basestations, data converter clocking, networking, medical equipment, instrumentation, military, and aerospace applications

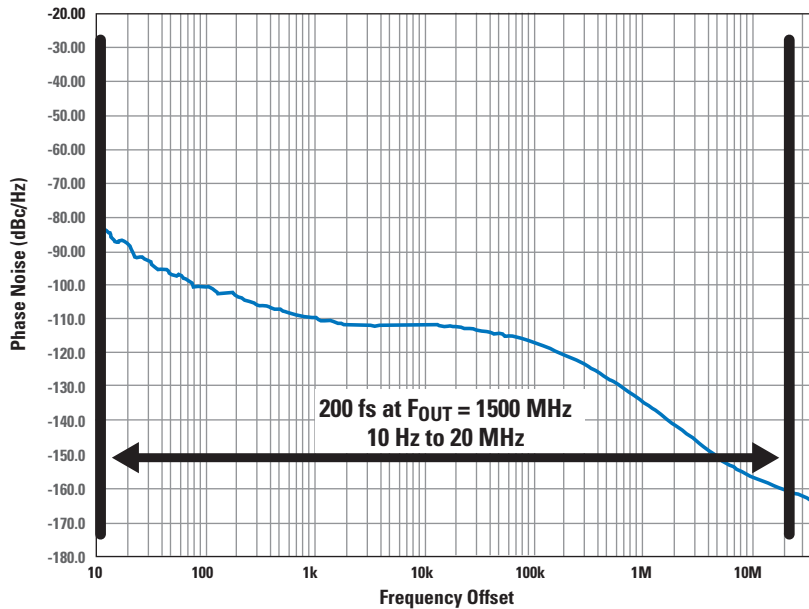
Product ID	PowerWise	LVDS Outputs	LVPECL Outputs	VCO	PLL	VCO Frequency	Jitter (RMS typ)
LMK02000	✓	3	5	External VCXO	Integrated	—	0.2 ps <sup>†</sup>
LMK03000C	✓	3	5	Integrated	Integrated	1185 to 1296 MHz	0.4 ps
LMK03001C	✓	3	5	Integrated	Integrated	1470 to 1570 MHz	0.4 ps
LMK03000	✓	3	5	Integrated	Integrated	1185 to 1296 MHz	0.8 ps
LMK03001	✓	3	5	Integrated	Integrated	1470 to 1570 MHz	0.8 ps
NEW LMK03002C	—	0	4	Integrated	Integrated	1566 to 1724 MHz	0.4 ps
NEW LMK03002	—	0	4	Integrated	Integrated	1566 to 1724 MHz	0.8 ps
NEW LMK02002	—	0	4	External	Integrated	1566 to 1724 MHz	0.2 ps

<sup>†</sup> 0.2 ps including external VCXO



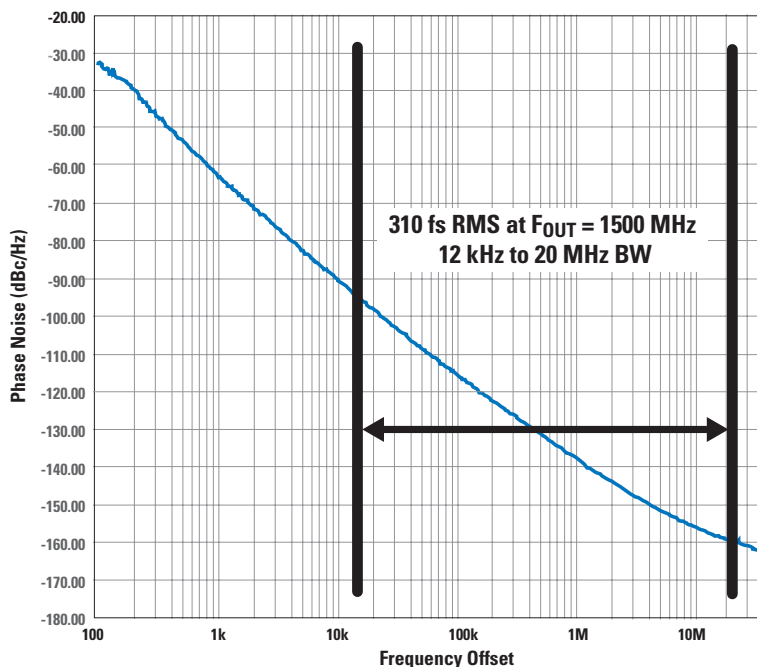
# LMK Clock Conditioner Family Performance

## LMK03001C as a Clock Generator



The performance graph shows the LMK03001C is the optimal solution for your clock generator application. When configured as a clock generator with a wide loop bandwidth, a high phase detector frequency, and a low noise clock source, the LMK03001C features unprecedented jitter performance of 200 fs RMS (10 Hz to 20 MHz). The low jitter measured at offsets close to the carrier frequency is a result of the best-in-class integrated integer-N PLL, which has a phase noise contribution of -224 dBc/Hz.

## LMK03001C as a Jitter Cleaner



The performance graph shows the LMK03001C also is the optimal solution for your jitter cleaner application. The LMK03001C features jitter performance as low as 310 fs RMS (12 kHz to 20 MHz) from a dirty clock. When configured as a clock jitter cleaner with a narrow loop bandwidth, the VCO phase noise becomes critical. The low jitter measured at higher offsets from the carrier frequency is a result of the integrated VCO, which has an outstanding noise floor of -157 dBc/Hz.



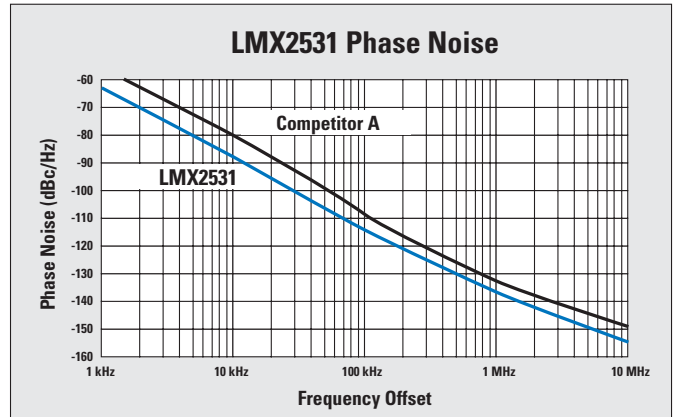
Read Signal Path Designer 109. Topic:  
"Generating Precision Clocks for Time-Interleaved ADCs"  
[www.national.com/spdesigner](http://www.national.com/spdesigner)

# High-Performance Synthesizers

## LMX2531 – PLLatinum® Frequency Synthesizer System with Integrated VCO from the PowerWise® Family

### Features

- 750 to 2790 MHz range in multiple frequency options
- Up to 10 dB improvement over next best monolithic competitor
- Significant cost savings over discrete and module solutions
- Fractional-N PLL programmable up to 4th order
- Low 34 mA typ power consumption
- High +4 dB typ output power simplifies external matching circuitry and buffering
- Fast lock, cycle slip reduction with timeout counter
- Partially integrated adjustable loop filter
- Very low phase noise and spurs
- Low phase noise VCO with integrated tank inductor and programmable output power level
- 2.8 to 3.2V operation
- Very low power down current
- 1.8V MICROWIRE™ support



### Applications:

Ideal for use in 3G basestations, data converter clocking, wireless LAN, broadband wireless access, CATV equipment, RFID readers, bar code scanners, and automotive applications

Product ID	Eval Board ID	F <sub>OUT</sub> Low Band (MHz)	F <sub>OUT</sub> High Band (MHz)	Phase Noise (10 kHz offset)*	Phase Noise (1 MHz offset)*
LMX2531LQ1500E	LMX25311500EVAL	750 to 755	1499 to 1510	- 99 dBc/Hz	-144 dBc/Hz
LMX2531LQ1570E	LMX25311570EVAL	765 to 818	1530 to 1636	- 99 dBc/Hz	-144 dBc/Hz
LMX2531LQ1650E	LMX25311650EVAL	795 to 850	1590 to 1700	- 99 dBc/Hz	-144 dBc/Hz
LMX2531LQ1700E	LMX25311700EVAL	831 to 885	1662 to 1770	- 98 dBc/Hz	-139 dBc/Hz
LMX2531LQ1742	LMX25311742EVAL	880 to 933	1760 to 1866	- 99 dBc/Hz	-143 dBc/Hz
LMX2531LQ1778E	LMX25311778EVAL	863 to 920	1726 to 1840	- 97 dBc/Hz	-144 dBc/Hz
LMX2531LQ1910E	LMX25311910EVAL	917 to 1014	1834 to 2028	- 95 dBc/Hz	-143 dBc/Hz
LMX2531LQ2080E	LMX25312080EVAL	952 to 1137	1904 to 2274	- 93 dBc/Hz	-142 dBc/Hz
LMX2531LQ2265E	LMX25312265EVAL	1089 to 1200	2178 to 2400	- 94 dBc/Hz	-141 dBc/Hz
LMX2531LQ2570E	LMX25312570EVAL	1168 to 1395	2336 to 2790	- 91 dBc/Hz	-139 dBc/Hz

\*Measured at F<sub>OUT</sub> low band

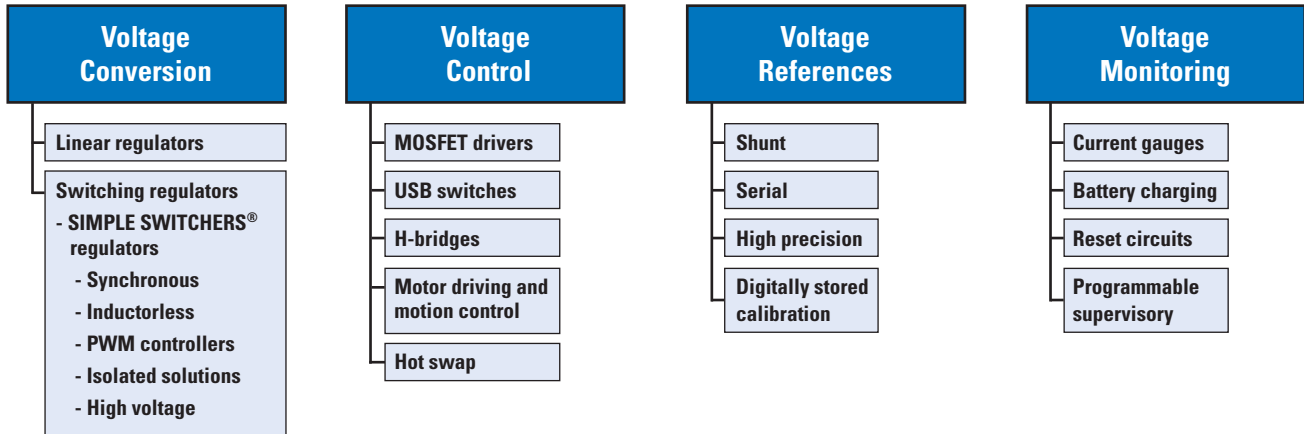
## High-Performance PLLatinum Family of PLL Products

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)
<b>Fractional-N PLLs</b>						
<b>NEW</b> 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
<b>NEW</b> 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
<b>NEW</b> 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
<b>NEW</b> LMX2485	0.5 to 3.0	75 to 800	-209	5	2.5 to 3.6	4.0 x 4.0 x 0.75
<b>NEW</b> LMX2485E	0.05 to 3.0	75 to 800	-209	5	2.5 to 3.6	4.0 x 4.0 x 0.75

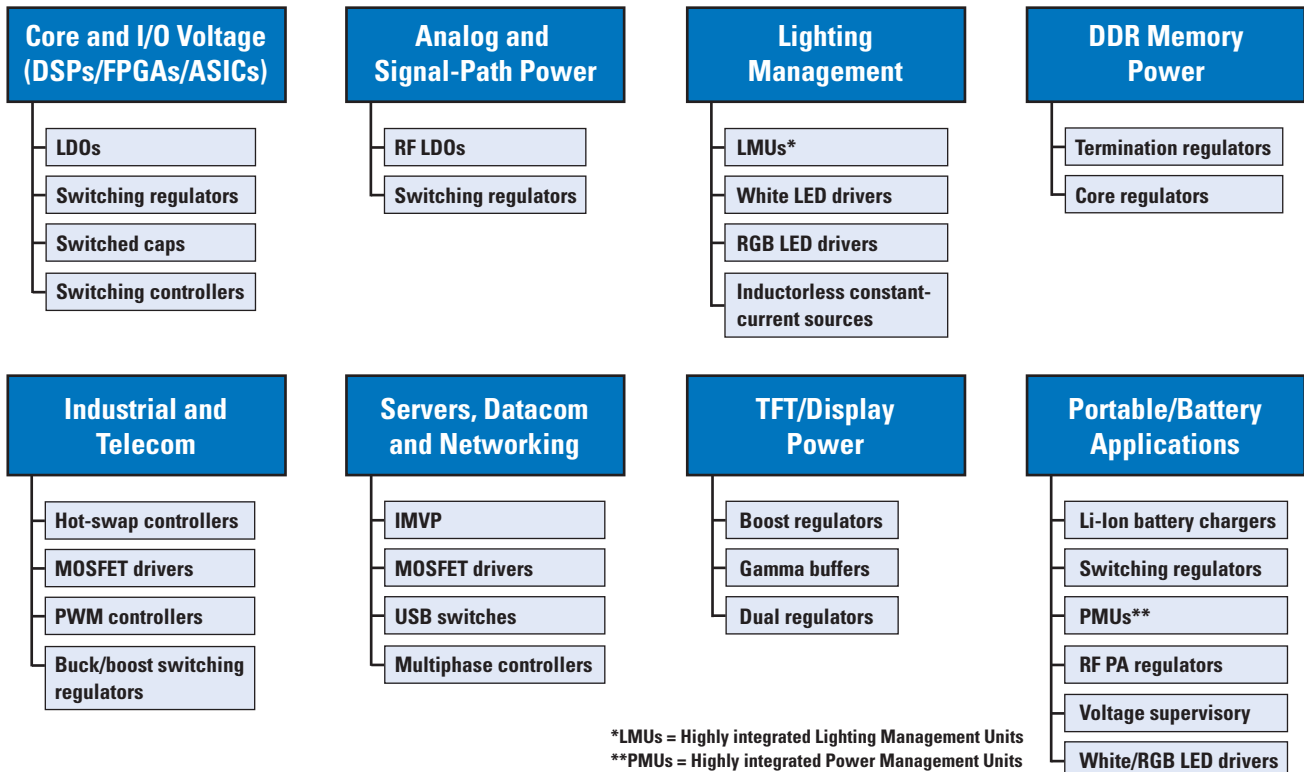
For additional information refer to PLLatinum Family of PLL and PLL + VCO Products, 2006 Selection Guide, Literature Number 550240-014

# National's Power Management Product Portfolio

## Power Solutions by Category



## Power Solutions by Application

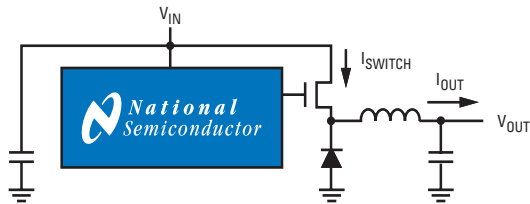


\*LMUs = Highly integrated Lighting Management Units

\*\*PMUs = Highly integrated Power Management Units

# Commonly Used Power Switching Topologies

## Buck



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

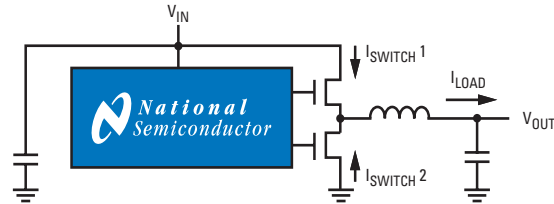
**When to use:** Typically when  $V_{IN}$  is 3x to 5x  $V_{OUT}$  and  $I_{OUT}$  is  $> 0.5A$  and  $< 5A$

**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

## Synchronous Buck



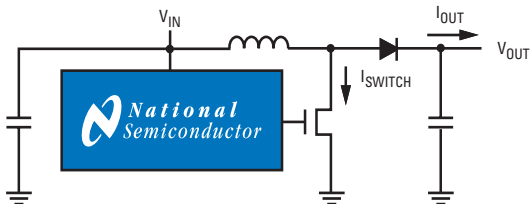
**Function:** Step-down ( $V_{OUT} < V_{IN}$ )

**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

## Boost



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

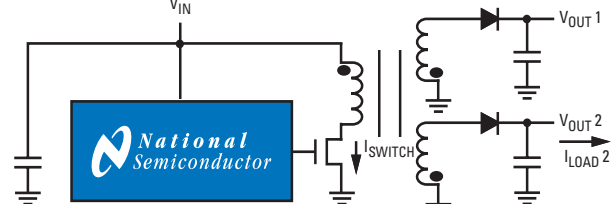
**When to use:** Typically used when transformerless, regulated output voltages larger than input voltages at output currents beyond 100 mA - 200 mA are required

**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

## Flyback



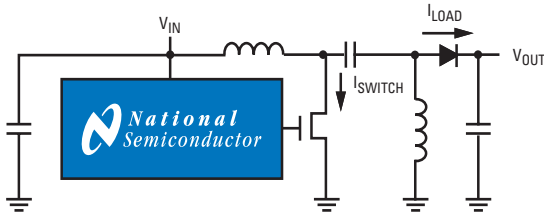
**Function:** Step-up, step-down, invert or buck-boost

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

## SEPIC



**SEPIC** = Single Ended Primary Inductor Converter

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

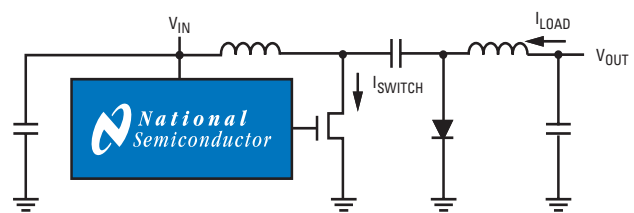
**When to use:** Excellent option when buck-boost operation is needed and no transformer is desired

**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

## Cuk



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

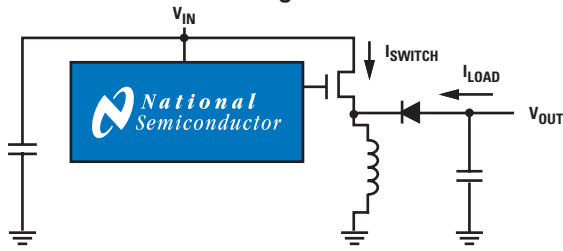
**When to use:** When a regulated, negative, low-ripple voltage is needed from a positive supply

**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

### Inverting Buck Boost



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

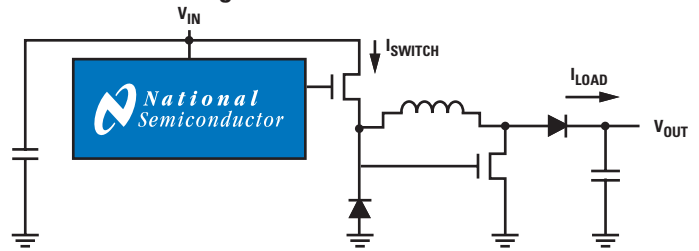
**When to use:** When an inverted, regulated output is needed. This topology is commonly used for output currents from approximately 300 mA to 5 A.

**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)

### Single Inductor Buck & Boost



**Function:** Step-up and step-down

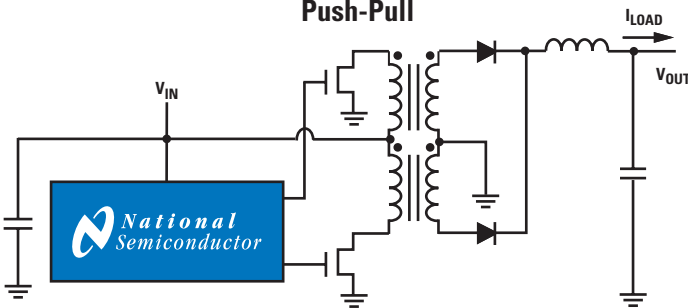
**When to use:** This topology is an alternative to sepic and flyback topologies when automatic step-up/step-down functionality is needed, but no transformer or second inductor is required

**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:** Any integrated buck regulator or controller, including SIMPLE SWITCHER buck regulators

**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.

### Push-Pull



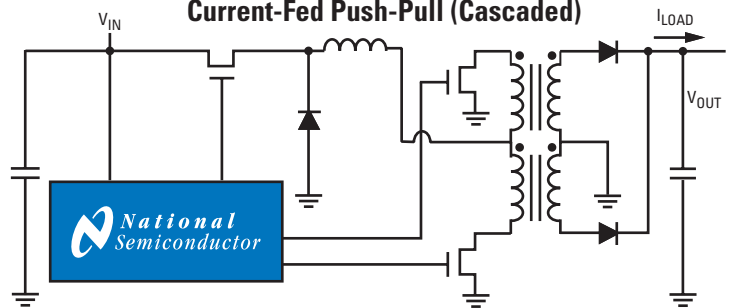
**Function:** Isolated step-down, step-up or buck-boost and multiple outputs

**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:  $V_{PK} = 2.6 V_{IN} \text{ max.}$ ,  $I_{PK} = 1.56 \times P_{OUT}/V_{IN} \text{ min.}$

### Current-Fed Push-Pull (Cascaded)



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

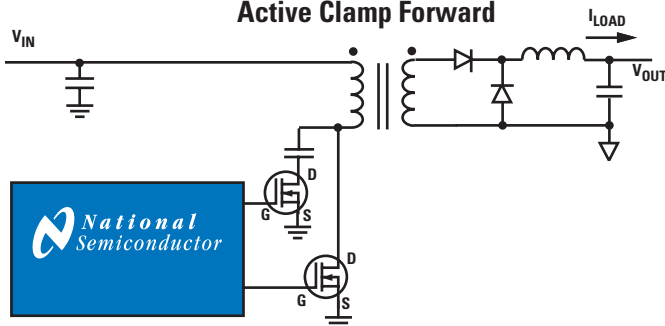
**When to use:** When isolated medium- to high-power conversion is needed, but reduced losses, high efficiency, and no output inductor are also desired.

**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)

### Active Clamp Forward



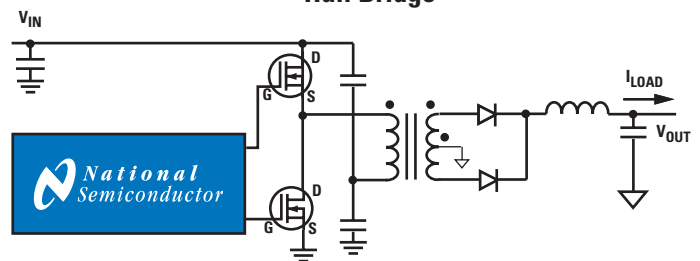
**Function:** Isolated, step-down or step-up

**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.

### 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 voltage 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.

# Non-Synchronous Step-Down (Buck) Switching Regulators

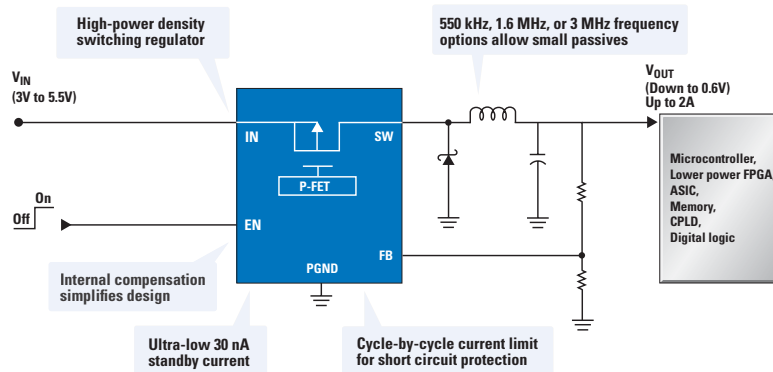
## LM2830/31/32 – High-Power Density Switching Regulator Delivers Up to 2A Output Current

### Features

- 550 kHz, 1.6 MHz, or 3 MHz frequency options allow small passives
- High-power density switching regulator
- Internal compensation simplifies design
- Ultra-low 30 nA standby current
- Cycle-by-cycle current limit for short circuit protection

### Applications:

Ideal for use in multimedia set-top boxes, USB-powered devices, DSL modems, and hard disk drives



## High Power Density 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
LM25005	42	7	1.23	40	2500	500, Sync	✓	Current	TSSOP-20
LM25007	42	9	2.5	37	500	50 to 800	✓	Constant on-time	MSOP-8
LM25010	42	6	2.5	37	1000	50 to 1000	✓	Constant on-time	LLP-10, TSSOP-14EP
LM26001 •	38	3	1.25	35	1500	150 to 1000, Sync	✓	Current	TSSOP-16
LM2694	30	8	2.5	24	600	50 to 1000	✓	Hysteretic	LLP-10, TSSOP-14
LM2695	30	8	2.5	24	1250	50 to 800	✓	Hysteretic	LLP-10, TSSOP-14EP
LM2696	24	4.5	1.29	20	3000	100 to 500	✓	Constant on-time	TSSOP-16
LM2734	20	3	0.8	18	1000	550, 1600	✓	Current	SOT23-6
LM2734Z	20	3	0.8	18	1000	3000	✓	Current	SOT23-6
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
LM2831	5.5	3	0.6	4.5	1500	550, 1600, 3000	✓	Current	SOT23-5
LM2832	5.5	3	0.6	4.5	2000	550, 1600, 3000	✓	Current	LLP-6, eMSOP-8
LM34910C	50	8	2.5	45	1250	1000	✓	COT Hysteretic	LLP-10
LM34910	36	8	2.5	33	1250	1000	✓	Hysteretic	LLP-10
LM34914	40	8	2.5	37	1250	1300	✓	Hysteretic	LLP-10
LM5005	75	7	1.23	70	2500	500, Sync	✓	Current	TSSOP-20
LM5007	75	9	2.5	73	500	50 to 800	✓	Hysteretic	LLP-8, MSOP-8
LM5008	95	9.5	2.5	75	350	50 to 600	✓	Hysteretic	LLP-8, MSOP-8
LM5009 •	95	9.5	2.5	85	150	50 to 600	✓	Hysteretic	LLP-8, MSOP-8
LM5010A	75	6	2.5	70	1000	50 to 1000	✓	Hysteretic	LLP-10, TSSOP-14EP
LM5010	75	8	2.5	70	1000	50 to 1000	✓	Hysteretic	LLP-10, TSSOP-14EP

• PowerWise® product

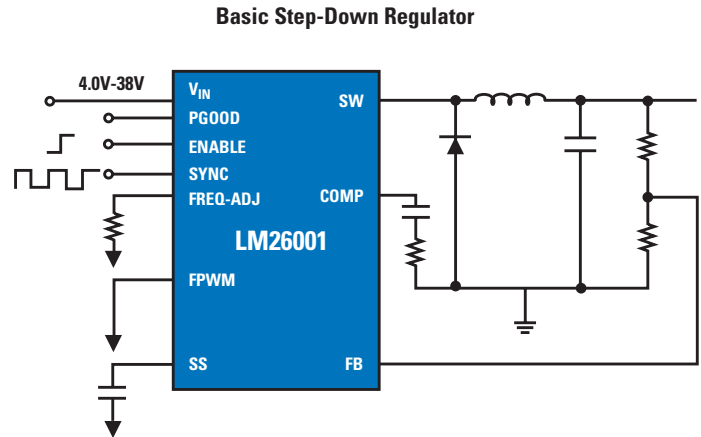
## LM26001 – PowerWise® 1.5A Buck Regulator Delivers Industry-Leading Low $I_q$ and Feedback Voltage Accuracy

### Features

- High-efficiency sleep mode (40  $\mu$ A  $I_q$  typ.)
- 10  $\mu$ 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 TSSOP-16 exposed-pad packaging

### Applications:

Ideal for use in automotive telematics, navigation systems, in-dash instrumentation, standby power for home gateways/ set-top boxes, and battery-powered applications



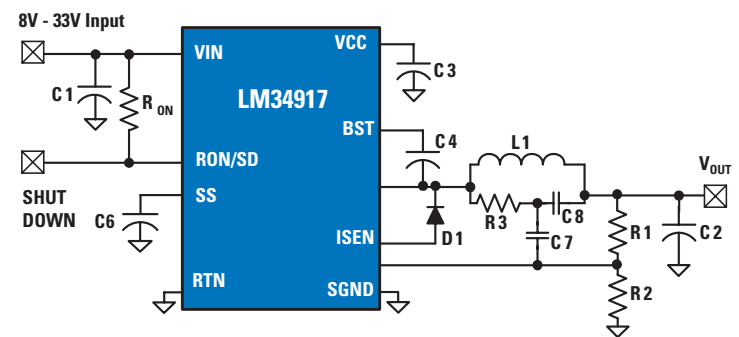
## LM34917 – Ultra-Small 1.25A Buck Switching Regulator with Intelligent Current Limit and OVP

### 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 packaging

### Applications:

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

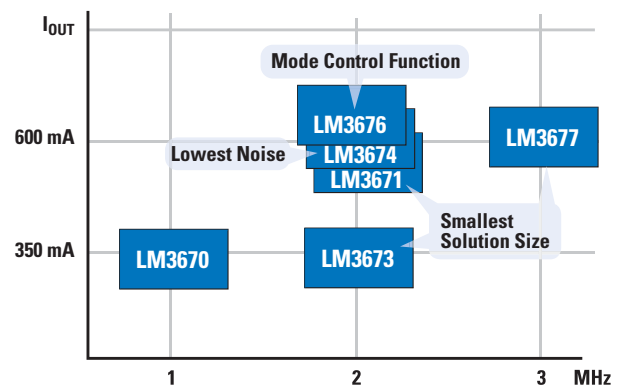
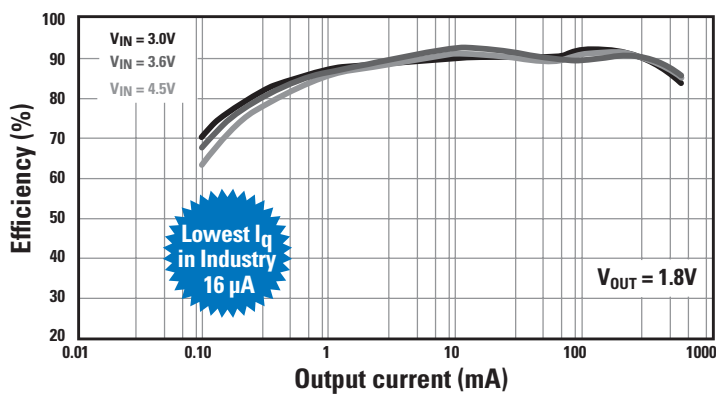


# Synchronous Step-Down (Buck) Switching Regulators

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

### Features

- >90% efficiency in PWM mode and lowest standby  $I_q$  (16  $\mu$ A) in the industry
- Smallest switcher in the industry, 3 MHz switching frequency (1  $\mu$ H 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 and integrated solution optimizes solution size



### Applications:

Ideal for use in powering digital subsystems in portable devices where size and efficiency are important

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
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
LM2614	5.5	2.8	1	3.6	400	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
LM2651	14	4	1.24	13	1500	3000	✓	Current	TSSOP-16
LM3670 •	5.5	2.5	0.7	3.3	350	1000	✓	Voltage with input feedforward	SOT23-5
LM3671 •	5.5	2.7	1.1	3.3	600	2000	✓	Voltage with input feedforward	SOT23-5, LLP-6
LM3673 •	5.5	2.7	1.1	3.3	350	2000	✓	Voltage with input feedforward	micro SMD-5
LM3674 •	5.5	2.7	1.1	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	✓	Auto	micro SMD-5
LM3679	5.5	2.5	1.8	1.8	350	3000	✓	Auto	micro SMD-5

• PowerWise® product



# Synchronous Step-Down (Buck) Regulators

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

### Features

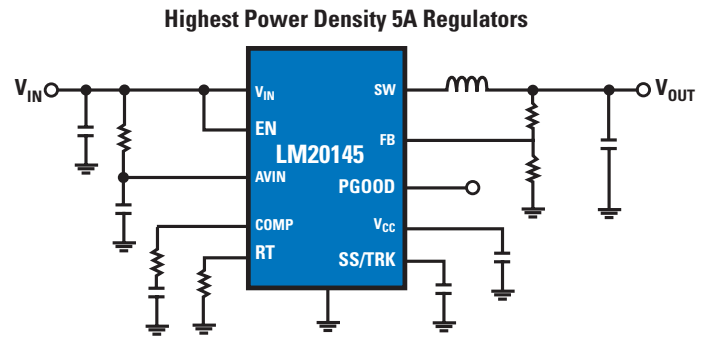
- External soft-start
- Tracking
- Precision enable
- Power good
- Pre-biased start-up
- Enhanced system reliability
  - High-accuracy current limit
  - Over-voltage protection, under voltage lockout, and over-current protection
- Available in eTSSOP-16 packaging

### Feature Options

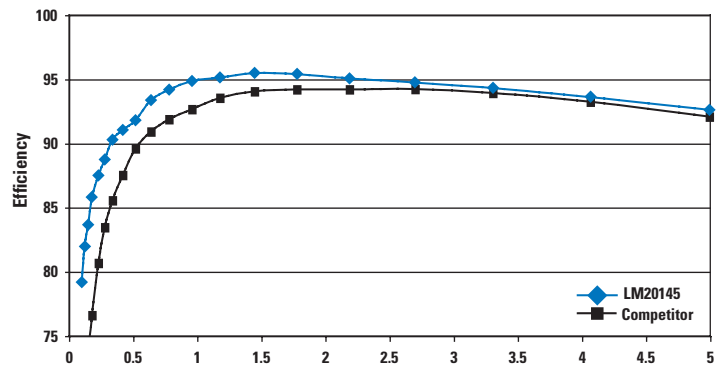
- Fixed and adjustable switching frequency
- Clock synchronization in
- Clock synchronization out

### Applications:

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



Efficiency vs Output Current ( $V_{IN} = 5.0V$ ,  $V_{OUT} = 3.3V$ ,  $f_{SW} = 500\text{ kHz}$ )



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
LM20123 •	5.5	2.95	0.8	5	3000	1500	✓	Current Mode Control	eTSSOP-16
LM20124 •	5.5	2.95	0.8	5	4000	1000	✓	Current Mode Control	eTSSOP-16
LM20125 •	5.5	2.95	0.8	5	5000	500	✓	Current Mode Control	eTSSOP-16
LM20133 •	5.5	2.95	0.8	5	3000	460 to 1.5 MHz, Sync	✓	Current Mode Control	eTSSOP-16
LM20134 •	5.5	2.95	0.8	5	4000	460 to 1.5 MHz, Sync	✓	Current Mode Control	eTSSOP-16
LM20143 •	5.5	2.95	0.8	5	3000	500 to 1500	✓	Current Mode Control	eTSSOP-16
LM20144 •	5.5	2.95	0.8	5	4000	500 to 1000	✓	Current Mode Control	eTSSOP-16
LM20145 •	5.5	2.95	0.8	5	5000	250 to 750	✓	Current Mode Control	eTSSOP-16
LM20154 •	5.5	2.95	0.8	5	4000	1000	✓	Current Mode Control	eTSSOP-16
LM20242 •	36	4.5	0.8	32	2000	1000	✓	Current Mode Control	eTSSOP-16

• PowerWise® product

# SIMPLE SWITCHER® Non-Synchronous Regulators

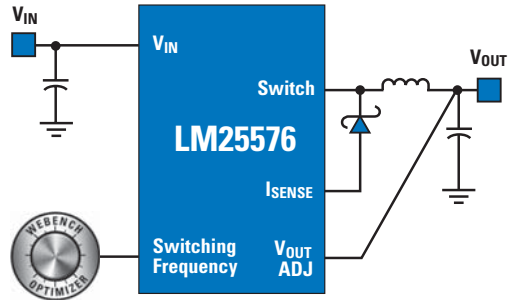
## LM25576 – PowerWise® SIMPLE SWITCHER Regulators Deliver Customized Performance and Flexibility to Fit Your Design

### 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

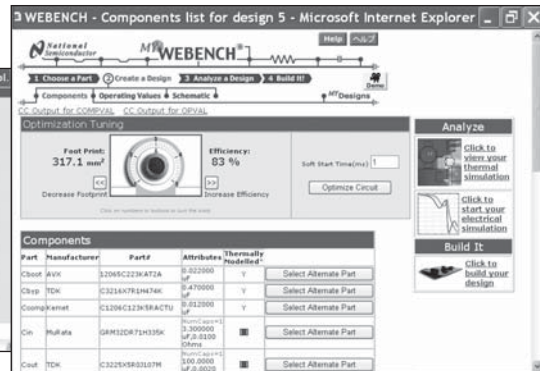
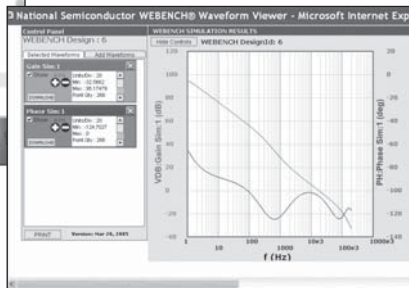
### Applications:

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



## Optimize Your Design with WEBENCH® and SIMPLE SWITCHER Regulators

Try the WEBENCH online design tool:  
[www.national.com/WEBENCH](http://www.national.com/WEBENCH)



### 1. Select it

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

### 2. Design it

Adjust components and exercise operating values such as power dissipation, current flow, offset voltage, drift, and frequency response

### 3. Analyze it

Stimulate your circuit and evaluate performance using electrical and thermal simulations

### 4. Build it

Request samples and purchase parts or demo boards **24 HOUR SHIPPING!**

### 5. Test it

Download your custom test vectors to verify your real board versus virtual results



Watch our Online Seminar on  
 "Introduction to Emulated Current Mode (ECM) Control"

[www.national.com/onlineseminars](http://www.national.com/onlineseminars)

# 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
LM25575 •	42	6	1.23	40	1500	50 to 1000, Sync	✓	Current	TSSOP-16EP
LM25576 •	42	6	1.23	40	3000	50 to 1000, Sync	✓	Current	TSSOP-20EP
LM2590HV	60	4.5	1.23	57	1000	150	✓	Voltage	TO263-7, TO220-7
LM2591HV	60	4.5	1.23	57	1000	150	✓	Voltage	TO263-5, TO220-5
LM2592HV	60	4.5	1.23	57	2000	150	✓	Voltage	TO263-5, TO220-5
LM2593HV	60	4.5	5	5	2000	150	✓	Voltage	T 263-7, TO220-7
LM2594HV	60	4.5	1.23	57	500	150	✓	Voltage	MDIP-8, SO-8
LM2594	40	4.5	1.23	57	500	150	✓	Voltage	MDIP-8, SO-8
LM2595	40	4.5	1.23	57	1000	150	✓	Voltage	TO263-5, TO220-5
LM2596	40	4.5	1.23	57	3000	150	✓	Voltage	TO263-5, TO220-5
LM2597HV	60	4.5	1.23	57	500	150	✓	Voltage	MDIP-8, SO-8
LM2597	40	4.5	1.23	57	500	150	✓	Voltage	MDIP-8, SO-8
LM2598	40	4.5	1.23	57	1000	150	✓	Voltage	TO263-7, TO220-7
LM2599	40	4.5	1.23	57	3000	150	✓	Voltage	TO263-7, TO220-7
LM2670	40	8	12	12	3000	260, Sync	✓	Voltage with V <sub>IN</sub> Feedforward	TO263-7, LLP-14, TO220-7
LM2671	40	6.5	1.23	37	500	260, Sync	✓	Voltage with V <sub>IN</sub> Feedforward	MDIP-8, LLP-16, SO-8
LM2672	40	6.5	1.23	37	1000	260, Sync	✓	Voltage with V <sub>IN</sub> Feedforward	MDIP-8, LLP-16, SO-8
LM2673	40	8	1.23	37	3000	260	—	Voltage with V <sub>IN</sub> Feedforward	TO263-7, LLP-14, TO220-7
LM2674	40	6.5	1.23	37	500	260	✓	Voltage with V <sub>IN</sub> Feedforward	MDIP-8, LLP-16, SO-8
LM2675	40	6.5	1.23	37	1000	260	✓	Voltage with V <sub>IN</sub> Feedforward	MDIP-8, LLP-16, SO-8
LM2676	40	8	1.23	37	3000	260	✓	Voltage with V <sub>IN</sub> Feedforward	TO263-7, LLP-14, TO220-7
LM2677	40	8	1.23	37	5000	260, Sync	✓	Voltage with V <sub>IN</sub> Feedforward	TO263-7, LLP-14, TO220-7
LM2678	40	8	1.23	37	5000	260	✓	Voltage with V <sub>IN</sub> Feedforward	TO263-7, LLP-14, TO220-7
LM2679	40	8	1.23	37	5000	260	—	Voltage with V <sub>IN</sub> Feedforward	TO263-7, LLP-14, TO220-7
LM5574 •	75	6	1.23	70	500	500, Sync	✓	Current	TSSOP-16
LM5575 •	75	6	1.23	70	1500	500, Sync	✓	Current	TSSOP-16EP
LM5576 •	75	6	1.23	70	3000	500, Sync	✓	Current	TSSOP-20EP

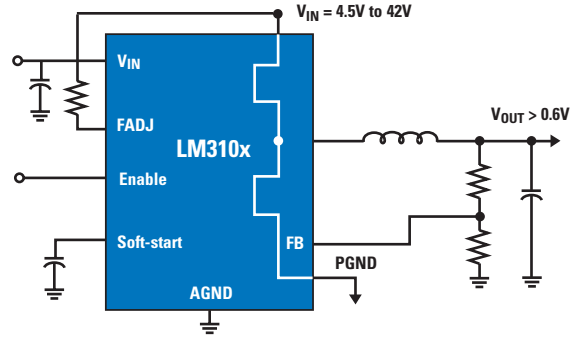
• PowerWise® product

# SIMPLE SWITCHER® Synchronous Regulators

## LM3102 – PowerWise® 2.5A, 42V SIMPLE SWITCHER Synchronous 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



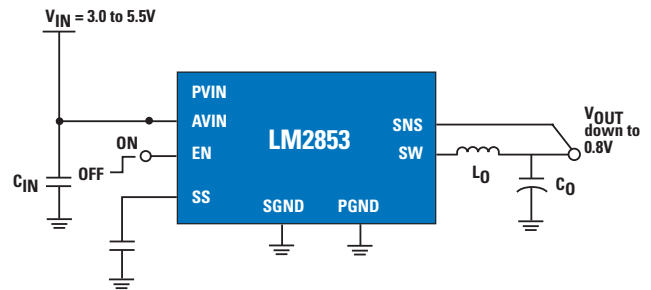
### Applications:

Ideal for use in embedded systems, industrial controls, automotive telematics and body electronics, point-of-load

## LM2853 – PowerWise Synchronous SIMPLE SWITCHER Regulators Provides High Efficiency Up to 3A

### Features

- Input voltage range: 3.0V to 5.5V
- Maximum load current: 3A
- Constant switching frequency at 550 kHz
- Internal compensation reduces external component count
- Synchronous conversion for efficient operation below 3.3V output
- Fixed voltage outputs (0.8V, 1.0V, 1.2V, 1.5V, 1.8V, 2.5V, 3.0V, 3.3V) eliminates feedback resistors



### Applications:

Ideal for use in low voltage point of load regulation, broadband networking and communications infrastructure, and FPGA/DSP/ASIC core power applications

## 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)	On/Off Pin	PWM Mode	Packaging
LM2852 •	5.5	2.85	0.8	3.3	2000	500, 1500	✓	Voltage	TSSOP-14
LM2853 •	5.5	3	0.8	3.3	3000	550000	✓	Voltage	TSSOP-14
LM2854 •	5.5	2.95	0.8	V <sub>IN</sub>	4000	500, 1000	✓	Voltage	TSSOP-14
LM3100 •	36	4.5	0.8	32	1500	1000	✓	COT	eTSSOP-20
LM3102 •	42	4.5	0.8	38	2500	1000	✓	COT	eTSSOP-20
LM3103 •	42	4.5	0.6	38	750	1000	✓	COT	eTSSOP-16

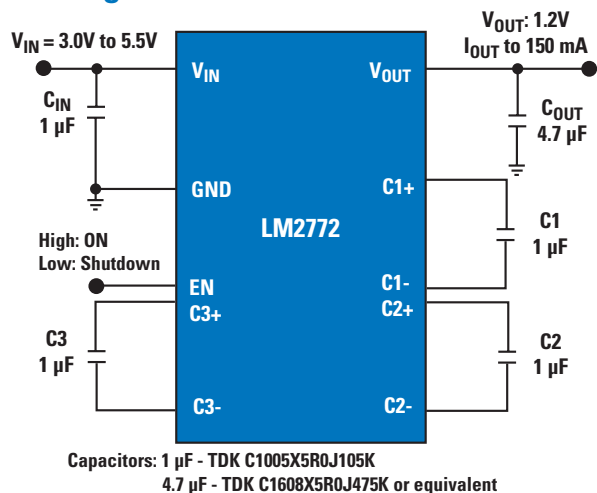
• PowerWise® product

# 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
LM2760	4.4	2	3.3	3.3	20	750	—	0.006	SOT23-5
LM2770	5.5	2.7	1.2	1.575	250	700	✓	0.055	LLP-10
LM2771	5.5	2.7	1.5	1.5	250	1100	✓	0.045	LLP-10
LM2772	5.5	2.7	1.2	1.2	150	1100	✓	0.05	LLP-10
LM2787	5.5	2.7	-5.2	-1.5	10	260	✓	0.4	micro SMD-8
LM2797 •	5.5	2.6	1.8	1.8	120	500	✓	0.035	MSOP-10
LM2798 •	5.5	2.6	1.5	2	120	500	✓	0.035	MSOP-10
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
LM2753	5.5	3	5	5	0.4	725	✓	0.06	LLP-10
LM2757	5.5	2.7	4.1	5	0.18	1242	✓	1.3	micro SMD-12
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

## LM1771 – PowerWise® High-Efficiency Synchronous Controller for Low-Voltage DC-DC Conversion

### Features

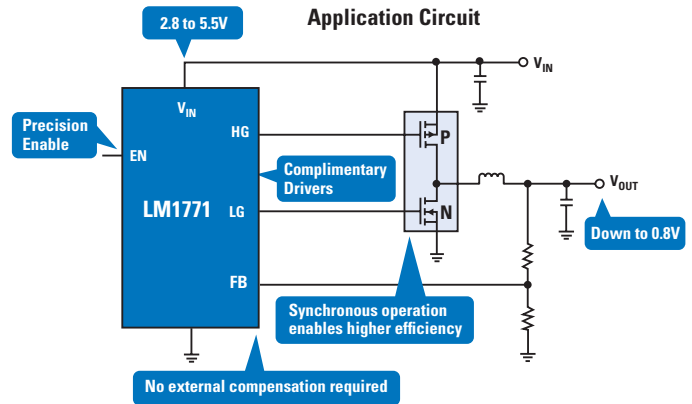
- Input voltage range of 2.8V to 5.5V
- 0.8V reference voltage
- Precision enable allows power supply sequencing
- No compensation required
- Constant frequency across input range
- Internal soft-start
- Short circuit protection
- Available in SOT23 packaging

### Applications:

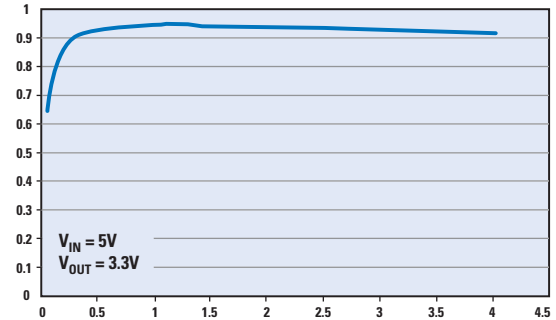
Ideal for use in point-of-load regulation in consumer applications, set-top boxes, cable modems, digital video recorders, printers, servers, and point-of-sale terminals

### Simple Controllers

Product ID	V <sub>IN</sub>		Enable Pin	Synchronous	Packaging
	Min	Max			
LM1770	2.8	5.5	—	✓	SOT23-5
LM1771	2.8	5.5	✓	✓	LLP-6 and MSOP-8
LM3475	2.7	10	✓	—	SOT23-5



>90% Efficiency Over Load Current



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

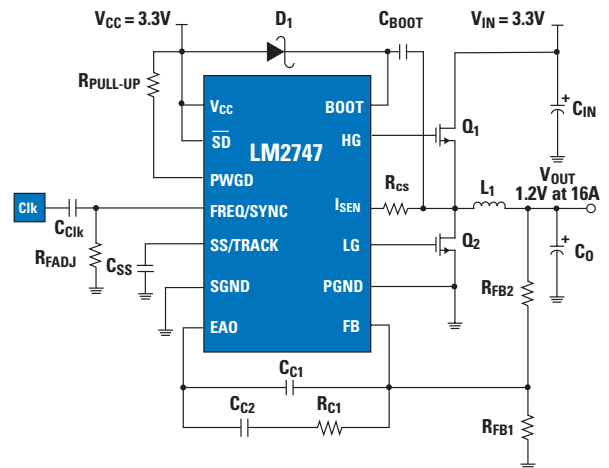
### Synchronous Buck Controllers

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



# Synchronous Step-Down (Buck) Switching Controllers

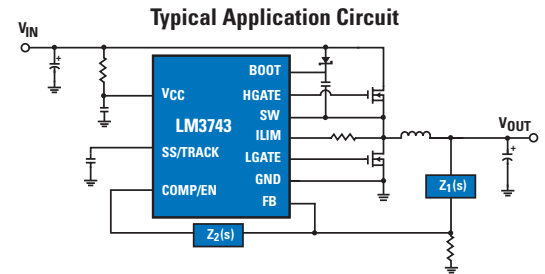
## LM3743 – PowerWise® Synchronous 1 MHz Buck Controller with Programmable Tracking

### Features

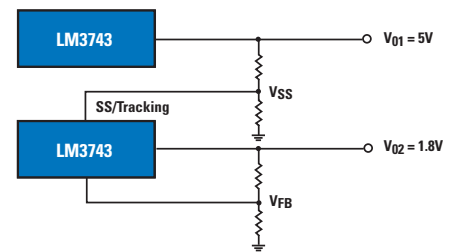
- IC and power supply input voltage from 3V to 5.5V
- Output voltage adjustable down to 0.8V
- $\pm 1.75\%$  reference accuracy over full temperature and input voltage range
- Externally programmable soft-start with tracking capability
- Low-side sensing programmable current limit without sense resistor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



## 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

## 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 & 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
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	✓	Current		TSSOP-20EP
LM27241	28	5.5	7.84	0.6	1.5	200 to 500	✓	Voltage	X	TSSOP-20
LM2727	16	2.2	5	0.6	1.5	50 to 2000	✓	Voltage	X	TSSOP-14
LM2737	16	2.2	0.6	5	1.5	50 to 2000	✓	Voltage	X	TSSOP-14
LM3495	• 18	2.9	0.6	5.5	1	200 to 1500, Sync	✓	Emulated Peak Current Mode		TSSOP-16
LM3743	• 5.5	3	4.6	0.8	1.75	300 to 1000	✓	Voltage		MSOP-10
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	✓	Current		TSSOP-20EP

• PowerWise® product

# Synchronous Step-Down (Buck) Switching Controllers

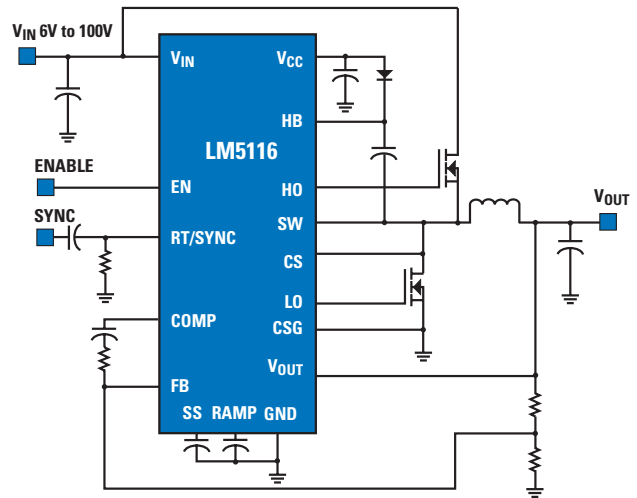
## LM5116 – PowerWise® 6V to 100V Emulated Current Mode Buck Controller

### Features

- Ultra-wide input range: 6V to 100V
- Programmable output from 1.215V to 80V
- Less than 10  $\mu$ A Iq in sleep 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](http://www.national.com/analogedge)

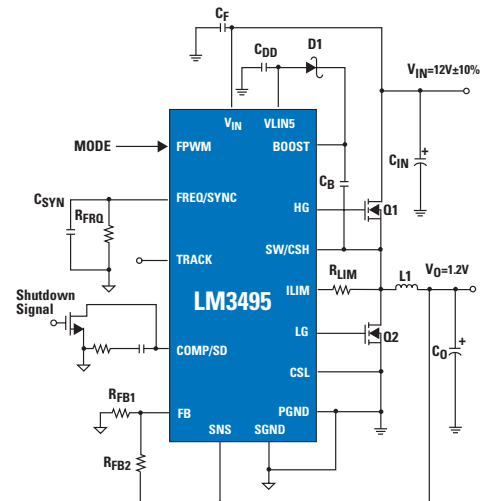
## LM3495 – PowerWise® $\pm 1\%$ Accurate, Ultra-High Precision PWM Buck Controller

### 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 – Integrates 2.1A Switch, Internal Compensation in Tiny Packages

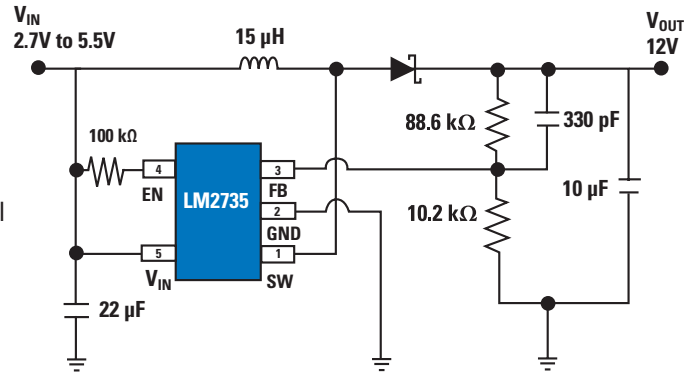
### Features

#### 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



### Applications:

Ideal for use in TFT-LCD Bias, USB bus power, white LED flash/torch applications

## Step-Up (Boost) Switching Regulators

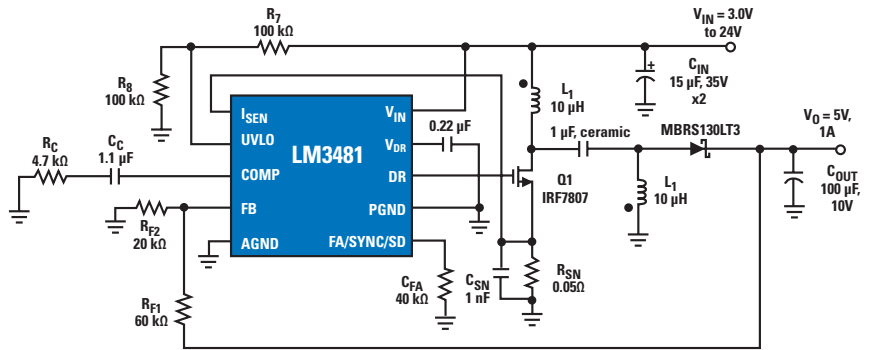
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Switch Current (A)	Frequency Range (KHz) & Sync	On/Off Pin	Packaging
LM2585	40	4	1.23	12	3	100	—	T0263-5, T0220-5
LM2586	40	4	1.23	12	3	100 to 200, Sync	✓	T0263-7, T0220-7
LM2587	40	4	1.23	12	5	100	—	T0263-5, T0220-5
LM2588	40	4	1.23	12	5	100 to 200, Sync	✓	T0263-7, T0220-7
LM2622	12	2	1.26	12	1.65	600 to 1300	✓	MSOP-8
LM2698	12	2.2	2.2	17	1.35	600 to 1250	✓	MSOP-8
LM2700	12	2.2	1.26	17.5	3.6	600 to 1250	✓	LLP-14, TSSOP-14
LM27313	14	2.7	4	28	1	1150 to 1900	✓	SOT23-5
LM2731	14	2.7	1.23	22	1.5	600, 1600	✓	SOT23-5
LM2733	14	2.7	3	40	1	600, 1600	✓	SOT23-5
LM2735	5.5	2.7	3	24	2.25	475, 1500	✓	SOT23-5, MSOP-8, LLP-6
LM3224	7	2.7	V <sub>IN</sub>	20	2.6	615 to 1250	✓	MSOP-8
LM3310	7	2.5	V <sub>IN</sub>	20	2	660 to 1280	✓	LLP-24
LM3311	7	2.5	V <sub>IN</sub>	20	2	660 to 1280	✓	LLP-24
LM3668	5.5	2.5	2.8	3.3	1	1600 to 2700, Sync	✓	LLP-12
LM4510	5.5	2.7		18	1.2	85 to 100	✓	LLP-10
LM5000	40	3.1	1.259	Set by external feedback network	2	300, 600	✓	LLP-16, TSSOP-16
LM5001	75	3.1	1.26	Set by external feedback network	1	50 to 1500, Sync	✓	SO-8, LLP-8
LM5002	75	3.1	1.26	Set by external feedback network	0.5	50 to 1500, Sync	✓	SO-8, LLP-8
LM5015	75	4.25	Set by external feedback network	Set by external feedback network	1.2	25 to 750, Sync	✓	TSSOP-14EP

# Step-Up (Boost) Switching 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  $\mu$ 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



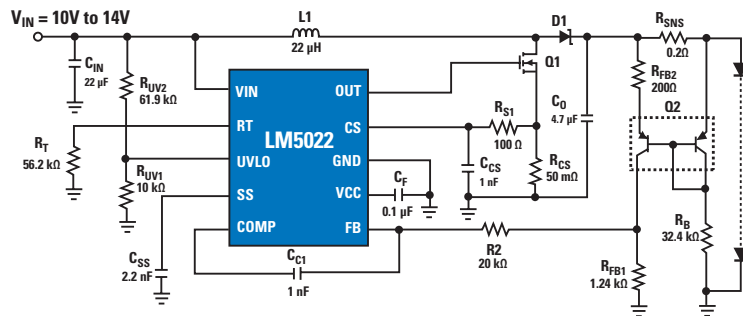
### Applications:

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

## Step-Up (Boost) Switching Controllers

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min Voltage (V)	Frequency Range (KHz) & Sync	On/Off Pin	Topology	Packaging
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
LM3481	48	2.97	1.275	100 to 1000, Sync	✓	Boost, SEPIC, Flyback	MSOP-10
LM3488	40	2.95	1.26	100 to 1000, Sync	✓	Boost, Sepic, Flyback	MSOP-8
LM5020 •	100	13	Set by external feedback network	50 to 1000, Sync	✓	Flyback, Inverting, Buck, Boost, Forward	MSOP-10, LLP-10
LM5021	30	8	Set by external feedback network	50 to 1000, Sync	✓	Flyback, Forward	MSOP-8, MDIP-8
LM5022	60	6	1.25	50 to 2000, Sync	✓	Boost, Sepic	MSOP-10

• PowerWise® product

# Step-Up (Boost) and Step-Down (Buck) Regulators

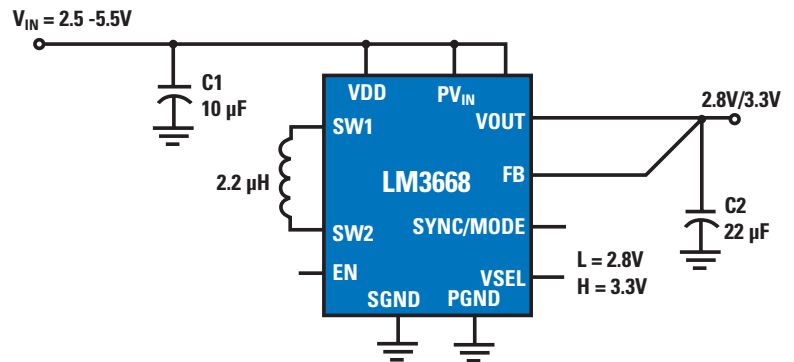
## LM3668 – Inductive Buck-Boost DC-DC Converter

### 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  $\mu$ 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

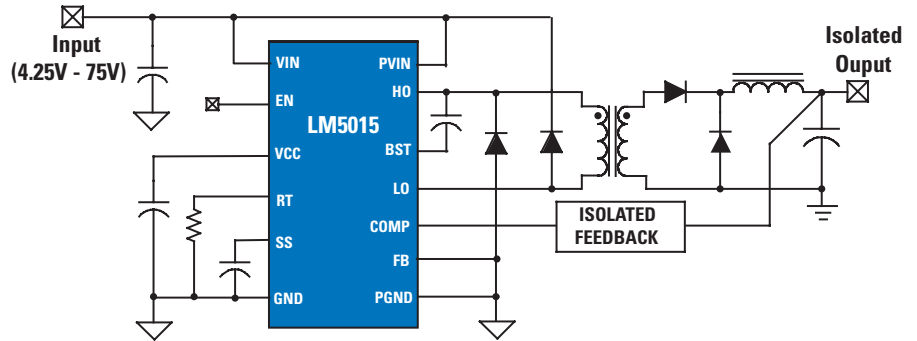


# Step-Up (Boost) and Step-Down (Buck) Regulators

## 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



### Applications:

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

## Buck Boost Inductive Regulators

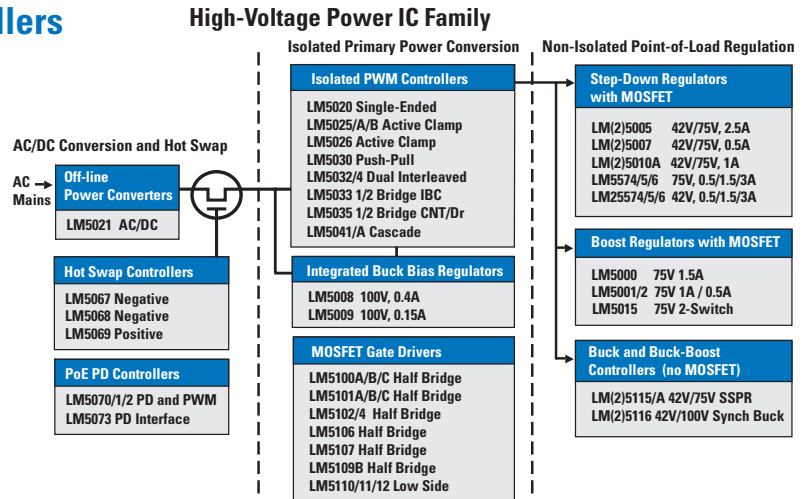
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Switch Current (A)	Frequency Range (KHz) & Sync	PWM Mode	Topology	Packaging
LM2611	14	2.7	-1.23	Undefined	0.9, 1.2	1400	CUK	Inverting	SOT23-5
LM3668	5.5	2.5	2.8	3.3	1	1600 to 2700, Sync	Auto PWM/PFM	Buck-Boost	LLP-12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

## Buck Boost Switching Controllers

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min Voltage (V)	Frequency Max (KHz)	On/Off Pin	Topology	Sync Pin	Packaging
LM3478	40	2.95	1.26	1000	✓	Boost, Sepic, Flyback	Yes	MSOP-8
LM3481	48	2.97	1.275	1000	✓	Boost, SEPIC, Flyback	Yes	MSOP-10
LM3488	40	2.95	1.26	1000	✓	Boost, Sepic, Flyback	Yes	MSOP-8
LM5020 •	100	13	Set by external feedback network	1000	✓	Flyback, Inverting, Buck, Boost, Forward	Yes	MSOP-10, LLP-10
LM5021	30	8	Set by external feedback network	1000	✓	Flyback, Forward	Yes	MSOP-8, MDIP-8
LM5022	60	6	1.25	2000	✓	Boost, Sepic	Yes	MSOP-10

• PowerWise® product

## LM5000 Series – Regulators and Controllers



## Regulators and Controllers

Product ID	Description
<b>Integrated Switching Regulators</b>	
LM5000	Wide 3.1V to 40V input, 2A switch PWM boost or flyback
LM5001	Wide 3.1 to 75V input, 1A switch PWM for Boost, Flyback, SEPIC
LM5002	Wide 3.1 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
LM5010A/LM25010	6V to 75V/42V input, 1A step-down with fast transient response
LM5015	Wide 4.25 to 75V input, two 1A switches and PWM 1A switch PWM for Two-Switch Forward and Flyback
<b>PWM Switching Controllers</b>	
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
LM5041/A	• 100V input cascaded PWM controller
LM5115/A	• Secondary side post regulator controller or synchronous buck controller
LM5116	6V to 100V current-mode synchronous buck controller
LM5035A	• High-performance, half-bridge PWM controller-driver for compact, efficient converters
<b>MOSFET Drivers</b>	
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
<b>Load Share Controller</b>	
LM5080	Modular current-sharing controller
<b>Hot Swap Controllers</b>	
LM5067	Negative high-voltage hot swap inrush current controller with power limiting
LM5068	Negative voltage hot swap controller
LM5069	Positive high-voltage hot swap inrush current controller with power limiting
<b>Power-over-Ethernet Controllers</b>	
LM5070/1/72	• Combo PoE interface and PWM controller
<b>Power-over-Ethernet Powered Device Controller</b>	
LM5073	• Combo PoE interface and PWM controller

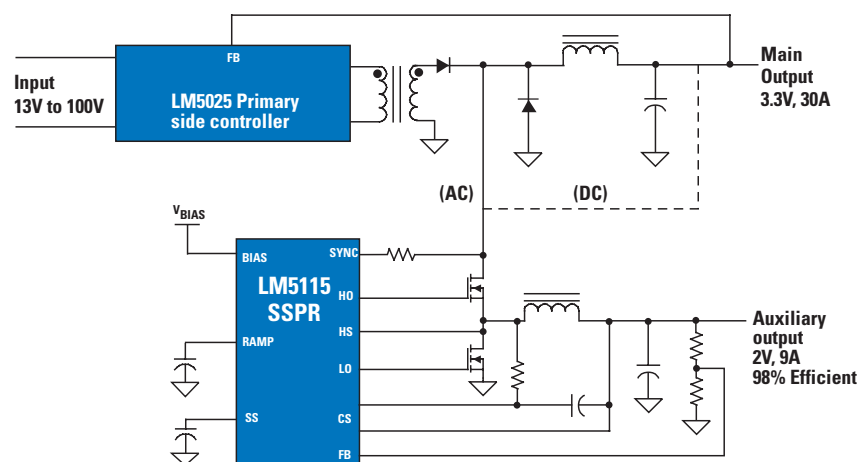
• PowerWise® product

# 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



## Switching Regulators and Controllers for Isolated Applications

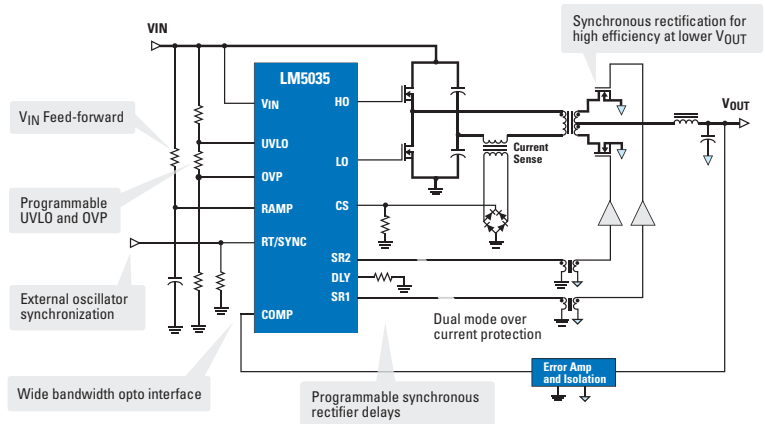
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Frequency Max (KHz)	Sync Pin	Gate Drive	Current Limit Type	PWM Mode	Topology	Packaging
LM25115	42	4.5	1000	✓	2.5	Cycle-cycle	Voltage/current-injection	Synchronous secondary-side post-regulator	LLP-16, TSSOP-16
LM5020	100	13	1000	✓	1	Cycle-cycle	Current	Flyback, Inverting, Buck, Boost, Forward	MSOP-10, LLP-10
LM5021	30	8	1000	✓	0.7	Cycle-cycle, Hiccup	Current	Flyback, Forward	MSOP-8, MDIP-8
LM5025A	90	8	1000	✓	3	Cycle-cycle, Hiccup	Voltage/Feed-forward	Forward Active Clamp	LLP-16, TSSOP-16
LM5025B	100	8	1000	✓	3	Cycle-cycle, Hiccup	Voltage/Feed-forward	Forward Active Clamp	LLP-16, TSSOP-16
LM5025	90	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	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	Forward Active Clamp	TSSOP-20
LM5035/A	105	8	2000	✓	2	Cycle-cycle, Hiccup	Voltage	Half-bridge	LLP-24, TSSOP-20EP
LM5041	100	10	1000	✓	1.5	Cycle-cycle, Hiccup	Current	Voltage-fed or Current-fed push-pull	LLP-16, TSSOP-16
LM5115	75	4.5	1000	✓	Null/ 2.5	Null/ cycle-cycle	Voltage/current-injection/ Valley current mode	Secondary-side post regulator	TSSOP-16

• PowerWise® product

## LM5035 – 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](http://www.national.com/onlineseminars)

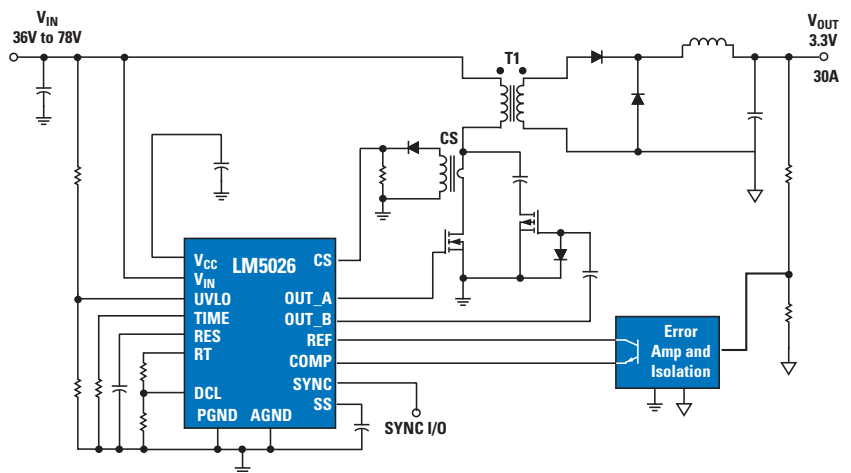
## LM5026 – PowerWise® Simplified Forward Power Converter with Active Clamp Reset

### Features

- Current mode control
- Internal 100V start-up 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:

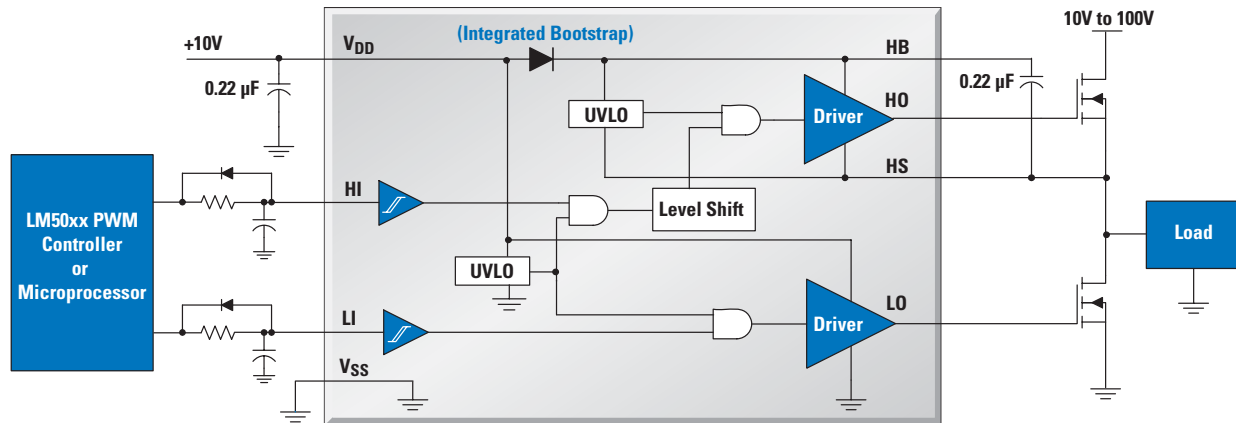
Ideal for use in telecommunications, automotive, networking equipment, and industrial applications



Watch our Online Seminar on  
**“Introduction to Forward Power Converters Utilizing Active Clamp Reset”**  
[www.national.com/onlineseminars](http://www.national.com/onlineseminars)

# MOSFET Drivers

## LM510x – Family of High-Speed FET Drivers



## MOSFET Drivers

Product ID	Topology	Input Max Voltage (V)	Supply Min (V)	Supply Max (V)	Peak Sink Current (A)	Peak Source Current (A)	Bottom Driver Prop Delay (nS)	Top Driver Prop Delay (nS)	Pulse Width Min	Input Control Type	Packaging
LM5100A	Synchronous Buck, Bridge	100	7.5	14	3	3	25	25	50	Dual, independent	LLP-8, SO-8
LM5100B	Synchronous Buck, Bridge	100	7.5	14	2	2	25	25	50	Dual, independent	LLP-10, SO-8
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
LM5101A	Synchronous Buck, Bridge	100	7.5	14	3	3	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
LM5107	Buck, Bridge	100	7.5	14	1.4	1.3	25	25	50	Dual, independent	LLP-8, SO-8
LM5109	Buck, Bridge	100	7.5	14	1	1	25	25	50	Dual, independent	LLP-8, 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

### Applications:

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



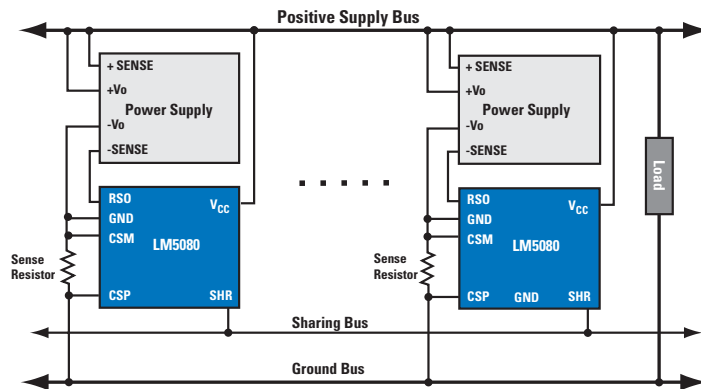
## LM5080 – Modular Current Sharing Controller

### Features

- Average program current share method
- Single-wire star link current share bus
- No precision external resistors necessary
- 3V to 15V bias voltage range
- Adaptable for high or low side current sensing
- Available in MSOP-8 packaging

### Applications:

Ideal for use in consumer electronics, industrial test equipment, telecom, data communications systems, automotive, distributed power systems, and battery-powered applications



# Low Dropout (LDO) Linear Regulators

## LP38xxx Family of High-Performance CMOS LDOs Power Digital ICs

### Performance and Flexibility

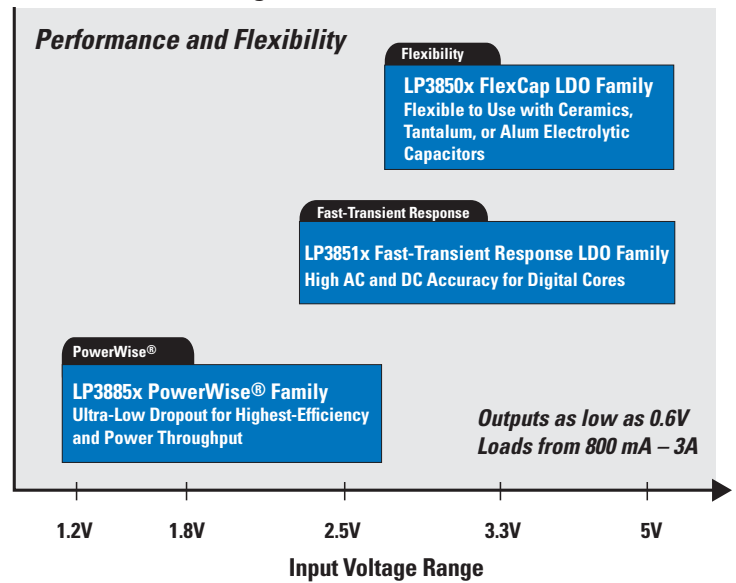
#### The LP38xxx Family Offers Performance:

- 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-3A with the same pin-out

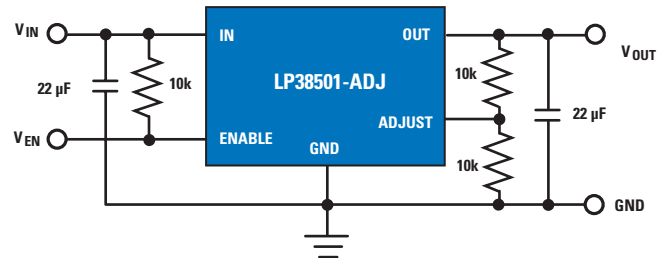
### LP38xxx High Performance CMOS LDOs



## LP3850x – FlexCap LDOs 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 T0263-5 or LLP-8 packages



Product ID	Load Current (A)	V <sub>IN</sub> Min (V)	V <sub>IN</sub> Max (V)	V <sub>OUT</sub> (V)	Typical Dropout (mV)	Enable	Packaging
LP38503	3.0	2.7	5.5	ADJ down to 0.6	450m	—	T0263-5
LP38502	1.5	2.7	5.5	ADJ down to 0.6	220m	✓	T0263-, LLP-8
LP38501	3.0	2.7	5.5	ADJ down to 0.6	450m	✓	T0263-5
LP38500	1.5	2.7	5.5	ADJ down to 0.6	220m	—	T0263-5, LLP-8

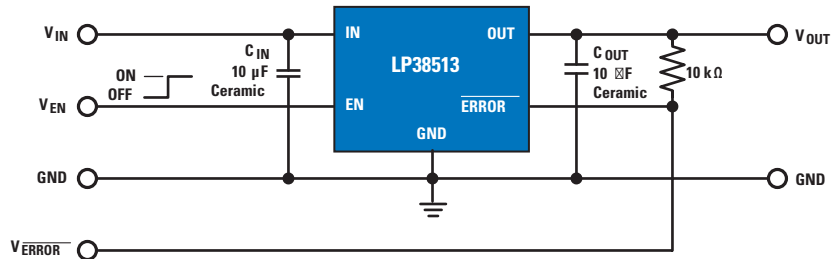
See more at [www.national.com/lldo](http://www.national.com/lldo)

To see a more complete list and to learn more about LDOs, visit:  
[www.national.com/LDO](http://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 800mA, 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 10µF Ceramic Capacitors
- Error flag feature
- Available in 5-pin TO220 or TO263 packages



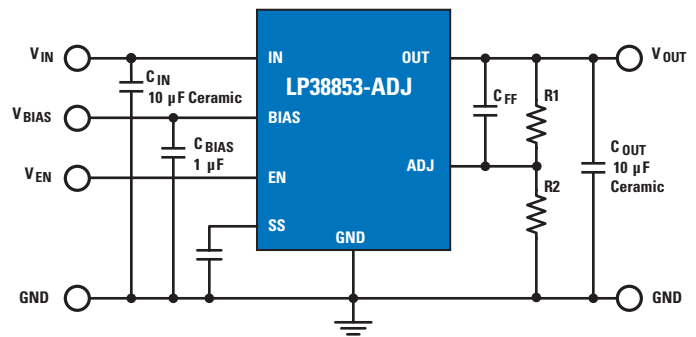
Product ID	Load Current (A)	V <sub>IN</sub> Min (V)	V <sub>IN</sub> Max (V)	V <sub>OUT</sub> (V)	Error Flag	Enable	Packaging
LP38513	3.0	2.25	5.5	1.8, ADJ down to 0.8V	✓	✓	TO263-5
LP38512	1.5	2.25	5.5	1.8, ADJ down to 0.8V	✓	✓	TO263-, LLP-8
LP38511	800 mA	2.25	5.5	1.8, ADJ down to 0.8V	✓	✓	TO263-5

See more at [www.national.com/lldo](http://www.national.com/lldo)

## LP3885x – PowerWise® Low Input Voltage and Efficiency LDOs

The LP3885x PowerWise® family of LDOs provides ultra low-dropout for highest 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 7-Pin TO220, 7-Pin TO263, or 8-Pin PSOP packages



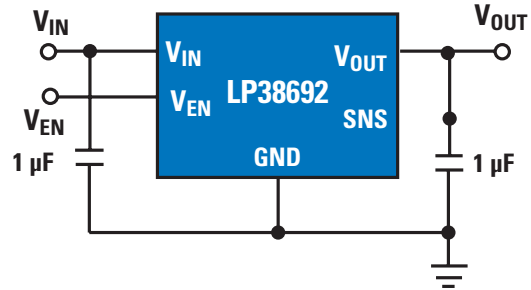
Product ID	Load Current (V)	V <sub>OUT</sub> Options (V)	Adj. Output	Enable Pin	Soft-Start Pin	Typical Dropout (mV)	Packaging
LP38859	3	0.8V, 1.2	—	—	✓	450	TO263-5, TO220-5
LP38858	1.5	0.8V, 1.2	—	—	✓	180	TO263-5, TO220-5
LP38856	3	0.8V, 1.2	—	✓	—	450	TO263-5, TO220-5
LP38855	1.5	0.8V, 1.2	—	✓	—	180	TO263-5, TO220-5
LP38853	3	ADJ 0.8 to 1.8	✓	✓	✓	450	PSOP-8, TO263-7
LP38852	1.5	ADJ 0.8 to 1.8	✓	✓	✓	180	PSOP-8, TO263-7
LP38851	0.8	ADJ 0.8 to 1.8	✓	✓	✓	115	PSOP-8, TO263-7

# Low Dropout (LDO) Linear Regulators

## LP38692 – PowerWise® 1A Low Dropout, CMOS Low $I_q$ Linear Regulator

### Features

- 2.5% output accuracy at 25°C
- Designed for use with low ESR ceramic capacitors
- 450 mV dropout at 1A and 5V out
- 2.7V to 10V input voltage
- 1  $\mu\text{A}$  off-state quiescent current
- Available in SOT223-5 and LLP-6 packaging



### Applications:

Ideal for use in consumer applications for conversions from 3.3V or 5V rails

## Low Dropout CMOS Linear Regulator Family

Product ID	$V_{IN}$		$V_{OUT}$	Maximum Dropout (mV)	Load (mA)	Enable Pin	Packaging
	Min	Max					
LP38690	2.7	10	ADJ (1.25 - 9) or 1.8, 2.5, 3.3, 5	1600	1000	—	T0252-3, SOT223-5 or LLP-6
LP38691	2.7	10	ADJ (1.25 - 9) or 1.8, 2.5, 3.3, 5	725	500	—	T0252-3 or LLP-6
LP38692	2.7	10	ADJ (1.25 - 9) or 1.8, 2.5, 3.3, 5	1600	1000	✓	SOT223-5 or LLP-6
LP38693	2.7	10	ADJ (1.25 - 9) or 1.8, 2.5, 3.3, 5	725	500	✓	SOT223-5 or LLP-6

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

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Current (mA)	Dropout Voltage (V)	Output Voltage (V)	Adjustable Output	On/Off Pin	Quiescent Current (mA)	PSRR (dB)	Voltage Noise (rms)	Package
LP3990 •	6	2	150	0.06	1.5, 3.8, 1.8, 2.5, 0.8, 1.35, 2.8, 1.2, 3.3	—	✓	0.043	55	125	SOT23-5, micro SMD-4, LLP-6
LP3991 •	3.6	1.65	300	0.075	1.5, 1.3, 2.8, 1.2	—	✓	0.05	65	280	micro SMD-4
LP5951 •	5.5	1.8	150	0.2	2.0, 1.5, 3.0, 1.8, 1.3, 2.5, 2.8, 3.3	—	✓	0.029	60	125	SOT23-5, SC70-5
LP5952 •	4.5	0.9	350	0.088, 0.128	2.0, 1.6, 1.5, 0.7, 1.8, 1.3, 1.0, 1.2, 1.2, 1.4	—	✓	0.011	95	100	micro SMD-5

• PowerWise® product

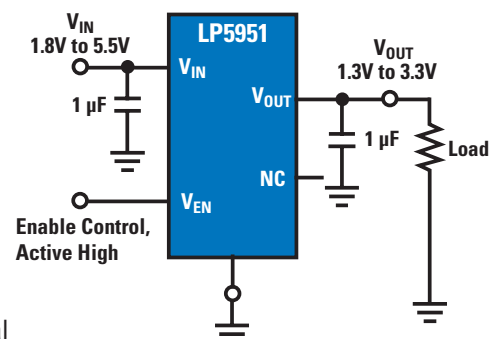
## LP5951 – Tiny LDO Features Low $I_q$ and Wide $V_{IN}$ Range

### Features

- Low quiescent current: 29  $\mu\text{A}$  at 0 mA maximizes portability and size
- Wide  $V_{IN}$  range: 1.8V to 5.5V supports next generation Li-Ion batteries, also can be used in post regulation applications
- Wide  $V_{OUT}$  range: 1.3V to 3.3V for use in analog and digital point-of-load
- PSRR: -60 dB at 1 kHz (typical) with 150 mA full load without bypass capacitor
- Available in SC70 and SOT23 packaging

### Applications:

Ideal for use in powering digital and analog point-of-load systems where size is critical



# Low-Noise LDOs to Power RF and Analog Circuits

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

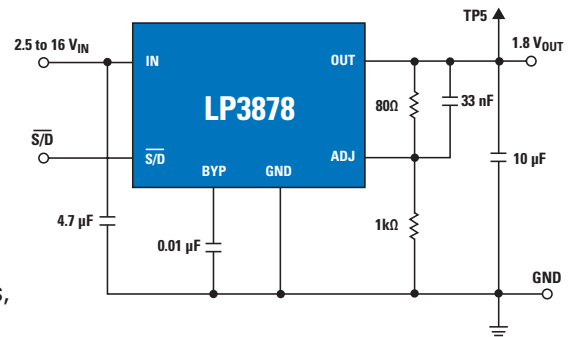
### Features

- 1.0V to 5.5V output
- Designed for use with low ESR ceramic capacitors
- <10  $\mu$ A 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

### Applications:

Ideal for use in low-noise amplifiers, voltage-controlled oscillators, RF receivers, medical instrumentation, automated test equipment, and measurement devices

### Typical Application Circuit



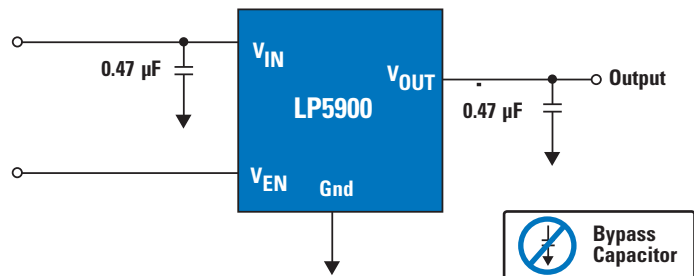
## LP5900 – PowerWise® Low-Noise 150 mA CMOS LDO

### Features

- Industry's lowest noise (6.5  $\mu$ V<sub>RMS</sub>) combined with 85 dB of Power Supply Ripple Rejection guarantees signal integrity
- 25  $\mu$ A Iq minimizes current drain when system operates in low-power mode
- Elimination of bypass capacitor reduces BOM to only two ceramic 0.47  $\mu$ F capacitors
- Available in a micro SMD-4 and LLP packaging

### Applications:

Ideal for use in powering analog and RF signal path ICs, including low-noise amplifiers, voltage-controlled oscillators, and RF receivers



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

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Current (mA)	Dropout Voltage (V)	Output Voltage (V)	Adjustable Output	On/Off Pin	Quiescent Current (mA)	PSRR (dB)	Voltage Noise (rms)	Packaging
LP3995 •	6	2.5	150	0.06	3, 2.8, 1.9	—	✓	0.085	60	25	micro SMD-5, LLP-6
LP3997 •	6	2	250	0.14	3.3	—	✓	0.055	61	100	MSOP-8
LP3999 •	6	2.5	150	0.06	1.5, 2.4, 1.8, 2.5, 2.8, 3.3	—	✓	0.085	60	30	micro SMD-5
LP5900 •	5.5	2.5	150	0.08	1.5, 2.8, 3.3	—	✓	0.025	75	6.5	micro SMD-4
LP5990	5.5	2.2	200	0.15	0.8 to 3.6	—	✓	0.03	55	60	micro SMD-4

• PowerWise® product

# Multi-Output LDOs

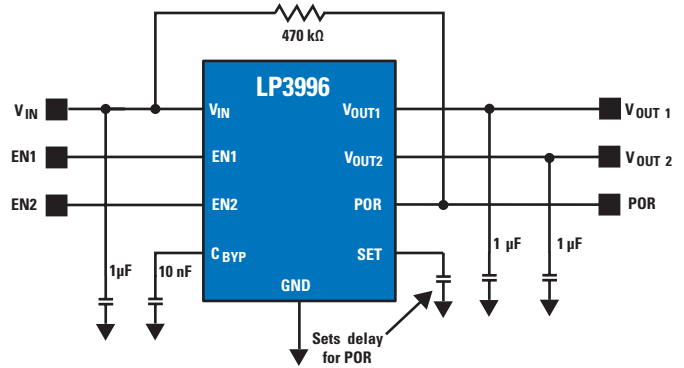
## LP3996 – Dual Linear Regulator with 300 mA and 150 mA Outputs and Power-On-Reset

### Features

- 2 LDO outputs with independent enable
- 1.5% accuracy at room temperature, 3% over temperature
- Power-On-Reset function with adjustable delay
- Thermal shutdown protection
- Stable with ceramic capacitors

### Applications:

Ideal for use in cellular handsets, PDAs, and wireless network adaptors



## Multi-Output LDOs

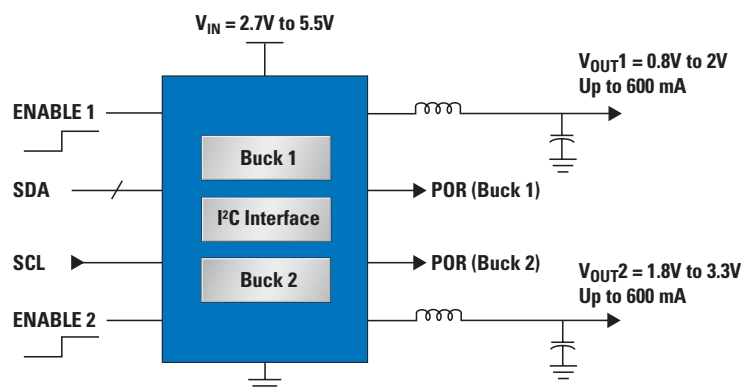
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output1 V <sub>OUTMin</sub>	Output2 V <sub>OUTMin</sub>	Output1 I <sub>OUTMax</sub>	Output2 I <sub>OUTMax</sub>	Dropout Voltage	Quiescent Current	Error Flag	Power on Reset	Packaging
LP2966	7	2.7	1.8	1.8	150	150	0.135	0.34	✓	—	LLP-16, PSOP-8, SO-8
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	210	70	✓	✓	LLP-10
LP5996	6	2	0.8	0.8	150	300	210	70	—	—	LLP-10

# 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
- I<sup>2</sup>C DVS interface scales power to match processor clock frequency
- Lowest I<sub>q</sub> (<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 packaging



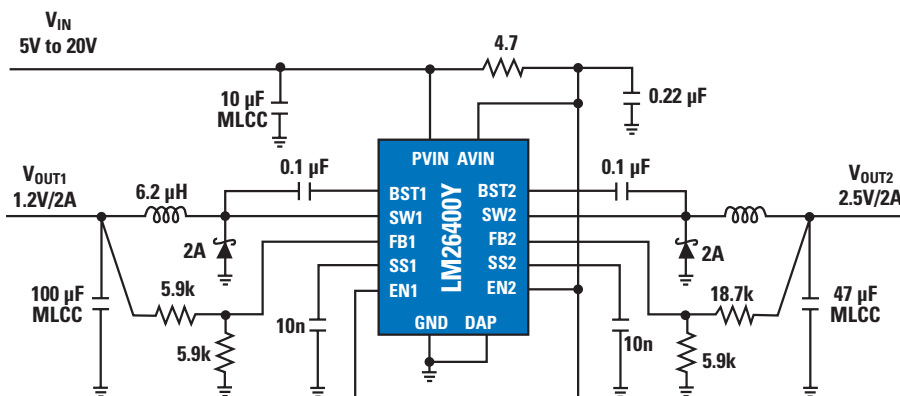
### Applications:

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:

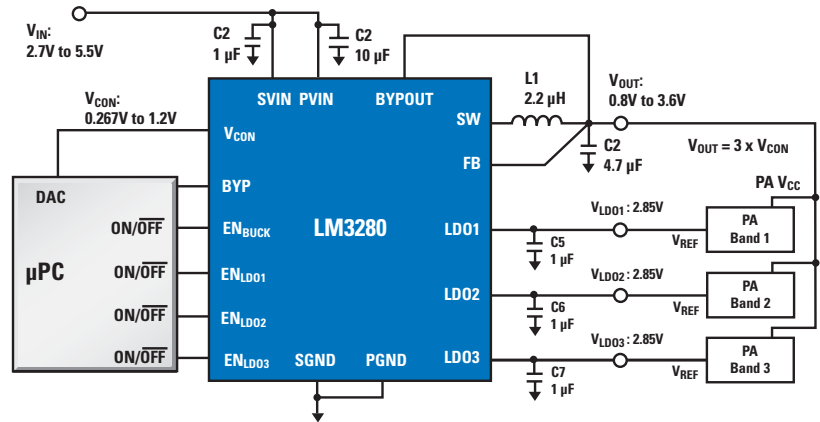
Ideal for use in powering point-of-loads in broadband modems/routers, POS terminals/scanners, security/surveillance systems, set-top boxes, DTV-LCD displays, computing peripherals, and industrial controls

# Multi-Output Switching Regulators

## LM3280 – PowerWise® 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

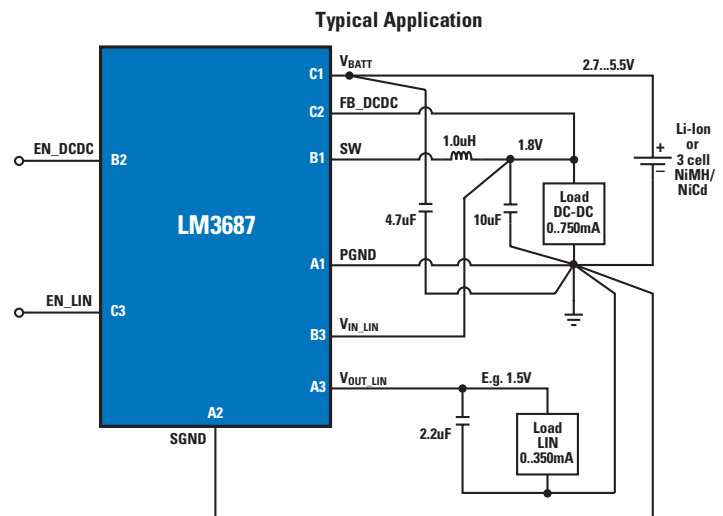
## LM3687 – DC-DC Converter with Integrated Linear Regulator in Tiny Package

### 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 2 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



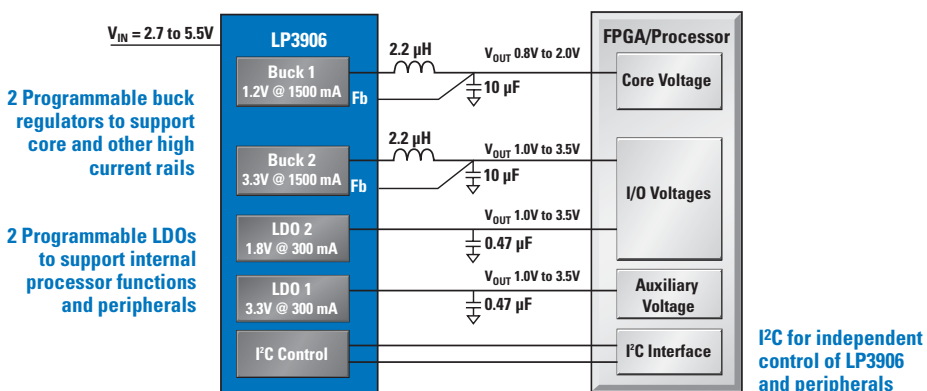


# Multi-Output Switching Regulators

## LP3906 – PowerWise® Dual High-Current Buck Regulator and Dual Linear Regulator with I<sup>2</sup>C-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
- I<sup>2</sup>C-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 I<sup>2</sup>C-Compatible Interface

### Features

#### Buck DC-DC Converter

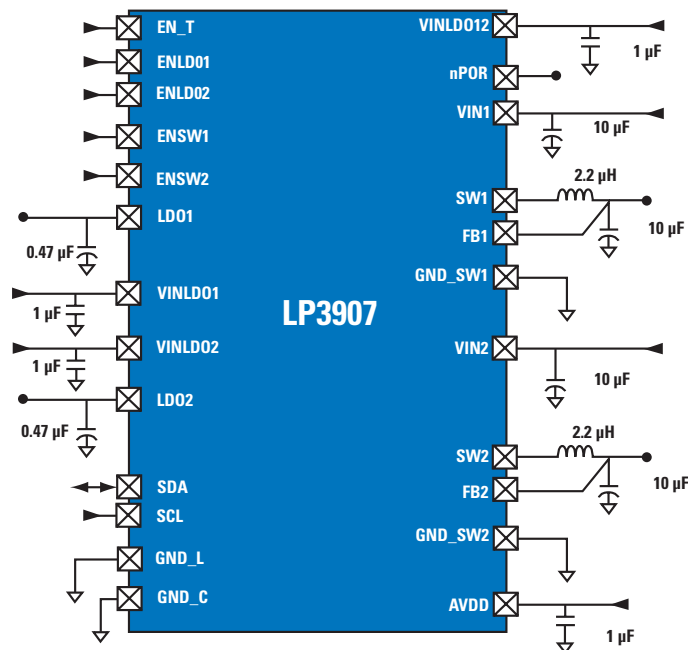
- 1A/600 mA output current
- Programmable  $V_{OUT}$  from:
  - Buck1 : 0.8V–2.0V at 1A
  - Buck2 : 1.0V–3.5V at 600 mA

#### Linear Regulators (LDO)

- Programmable  $V_{OUT}$  of 1.0V–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
- I<sup>2</sup>C-compatible interface for independent control of device functions and settings
- Available in LLP-24 packaging (4 × 4 × 0.8 mm)



### 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–2.0V @ 1.5A
  - Buck2 : 1.0V–3.3V @ 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)

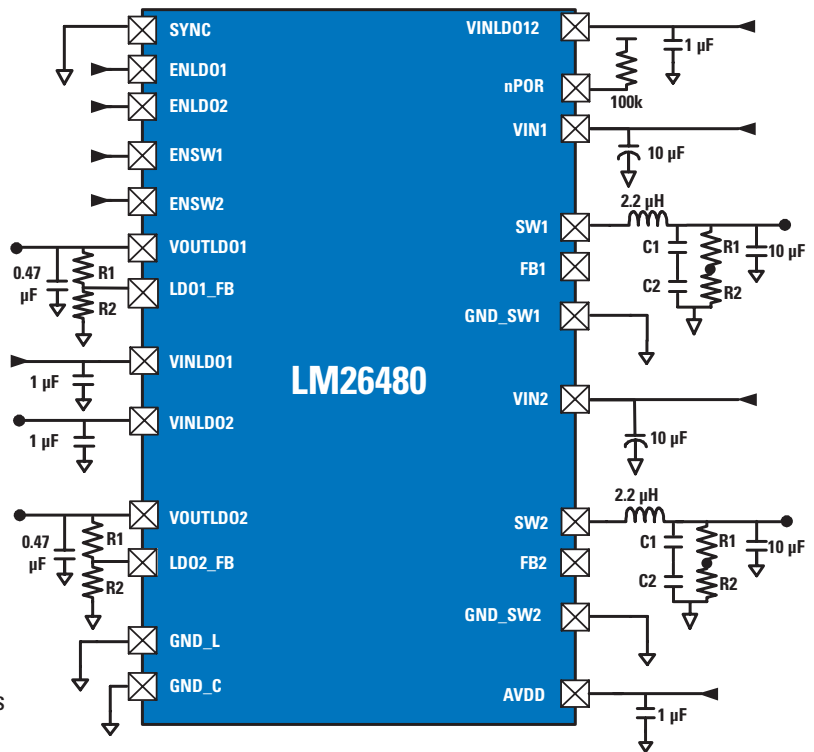
- $V_{OUT}$  of 1.0V–3.5V
- $\pm 3\%$  FB voltage accuracy
- 300 mA output current
- 25 mV (typ) dropout

### 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 Buck2
- Undervoltage lock-out detector to monitor input supply voltage
- 24-lead 4 x 4 x 0.8 mm LLP package

### Applications

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



# Multi-Output Switching Regulators

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

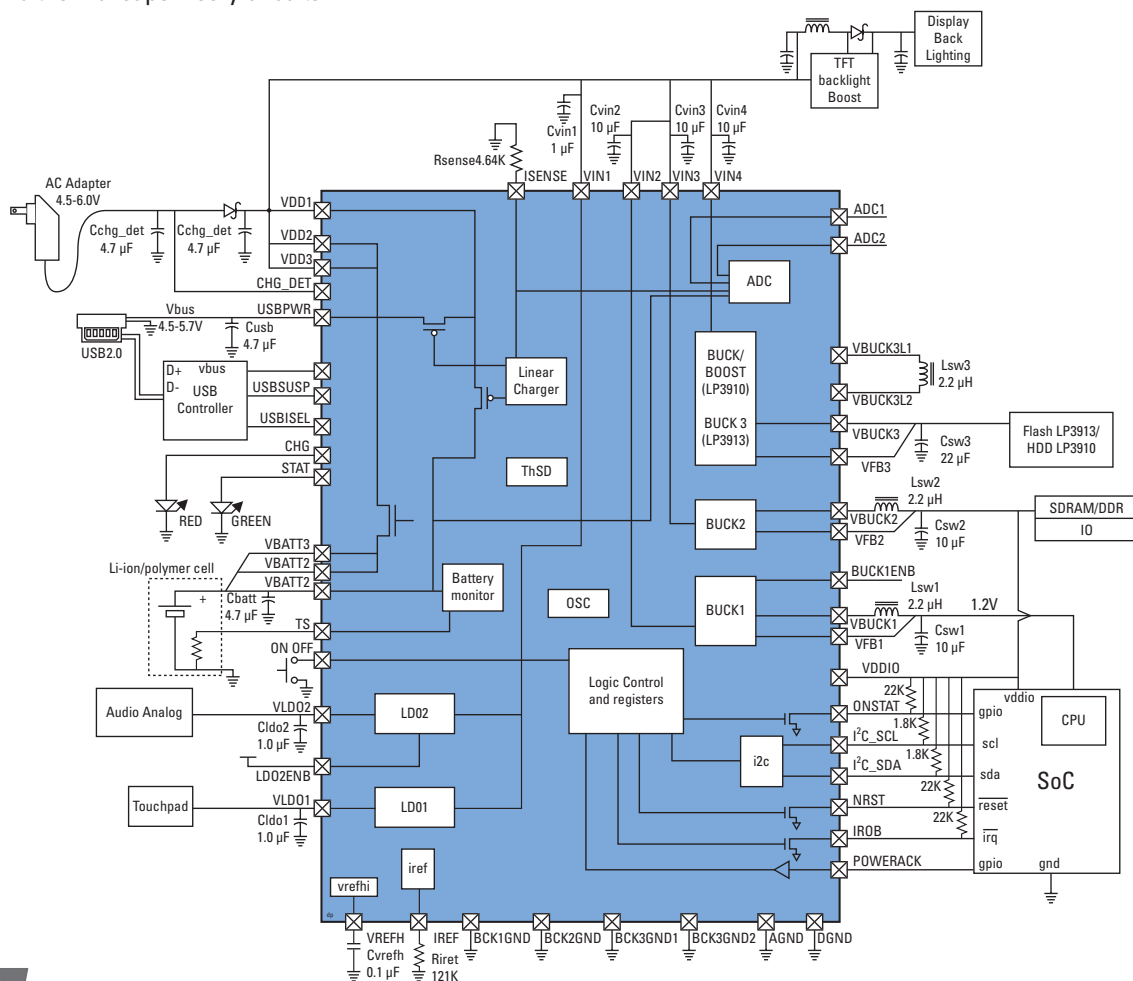
### Features

- 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-efficient DVS buck converters: 2 (LP3910) and 3 (LP3913)
- 400 kHz I<sup>2</sup>C-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

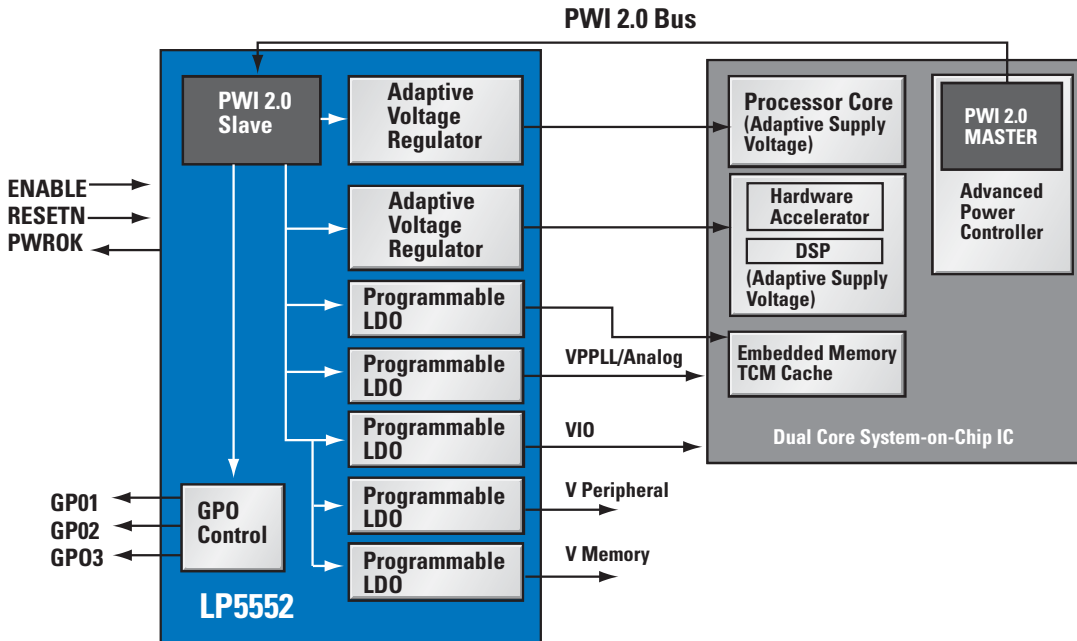
Ideal for use in powering portable gaming devices, portable media players, hard drive-based MP3 players (LP3910), flash-based portable media players (LP3913), portable navigation systems (LP3913)



To read the Application Note: "Powering Portable Media Players (PMP) with Innovative Solutions" go to [www.national.com/analogedge](http://www.national.com/analogedge)

# PowerWise® 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 <sub>IN</sub> Range	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

To learn about PowerWise technology, visit:

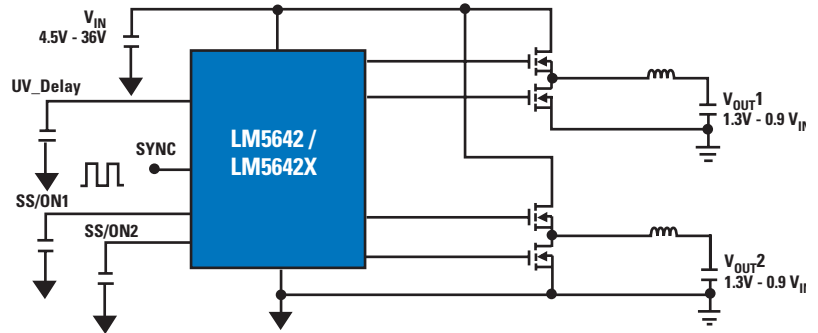
[www.national.com/powerwise](http://www.national.com/powerwise)

# 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, telecom, set-top boxes, and point-of-load architecture

## Multi-Output Switching Controllers

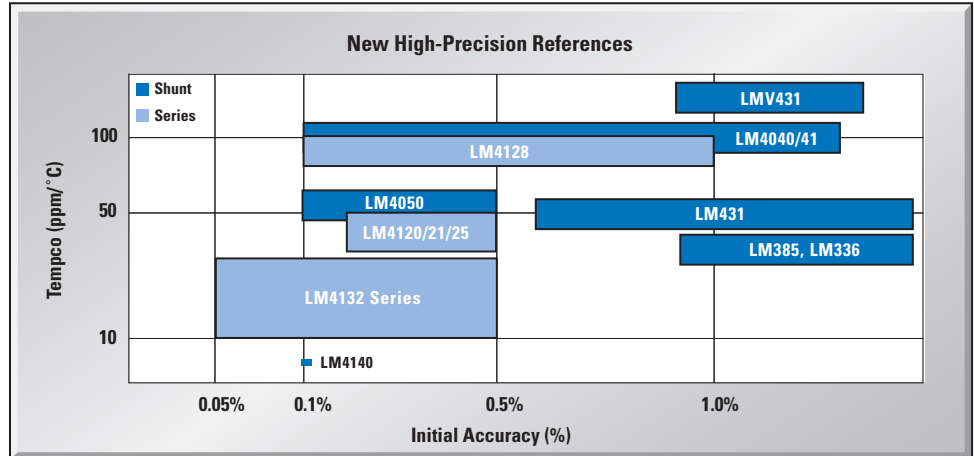
Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Feedback Tolerance %	Frequency Range & Sync (Hz)	On/Off Pin	Error Flag	Channels	Topology, PWM mode	Packaging
LM2647	28	5.5	0.6	5	1.5	200 to 500	✓	✓	2	Voltage with $V_{IN}$ Feedforward	LLP-28, TSSOP-28
LM2657	28	4.5	0.6	8.4	1.5	200 to 500	✓	✓	2	Voltage	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

# Voltage References and Supervisors

## LM4132 – PowerWise® Voltage References Featuring the Highest Precision Over Broad Temperature Range

### Applications:

Ideal for use in instrumentation and process control, test equipment, data acquisition systems, basestations, servo systems, battery chargers, precision regulators, and portable battery-powered equipment



## Voltage References

Product ID	Type	Input Max Voltage (V)	Input Min Voltage (V)	Reference Voltage (V)	Initial Accuracy (+/-) Max	Tempco, max (ppm/°C)	Output Current (mA)	Quiescent Current (mA)	Long Term Stability (ppm/1000hr)	Voltage Noise (uVpp)	Packaging
LM4120 •	Series	14	3.3	3, 3.3, 4.096, 2.048, 5, 1.8, 2.5	0.2, 0.5	50	5	0.16	100	20	SOT23-5
LM4125 •	Series	6	3.3	4.096, 2.048, 2.5	0.2, 0.5	50	5	0.16	100	20	SOT23-5
LM4128 •	Series	5.5	2.2	3, 3.3, 4.096, 2.048, 1.8, 2.5	0.1, 0.2, 0.5, 1	75, 100	20	0.06	50	170	SOT23-5
LM4132 •	Series	5.5	2.2	4.096, 2.048, 2.5	0.05, 0.1, 0.2, 0.4, 0.5	10-30	20	0.06	50	170	SOT23-5
LM4140 •	Series	5.5	1.8	1.25, 4.096, 2.048, 1.024, 2.5	0.1	3	8	0.23	60	2.2	SO-8
LM4030	Shunt	NA	NA	2.5, 4.096, 5.0	0.05, 0.10, 0.15	10,20,30	30	0.12	50	100	SOT23-5

• PowerWise® product

## Supervisors

Product ID	Active Reset	Voltage Rails Supervised <sup>1</sup>	Reset Timeout Period (ms)	Iq (µA)	Manual Reset	Low Line Output	PFI Comparator	Watchdog	Temp Range (°C)	Packaging
LM3722	Low	2.5, 3.3, 5.0	190	6	✓	—	—	—	-40 to 125	SOT23-5
LM3723	High	2.5, 3.3, 5.0	190	6	✓	—	—	—	-40 to 125	SOT23-5, D, W
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

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

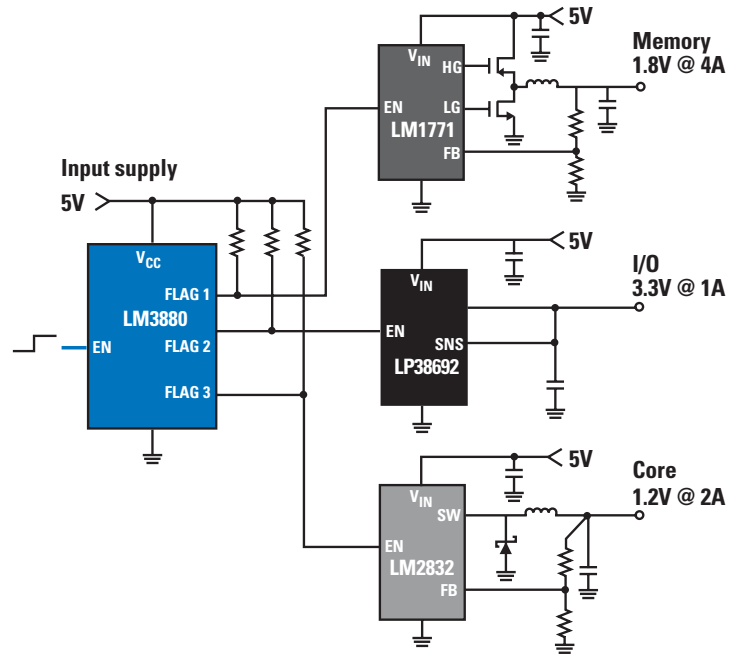
## LM3880 – Industry’s Easiest and Smallest Solution for Multiple-Rail Power Sequencing

### 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 power up 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



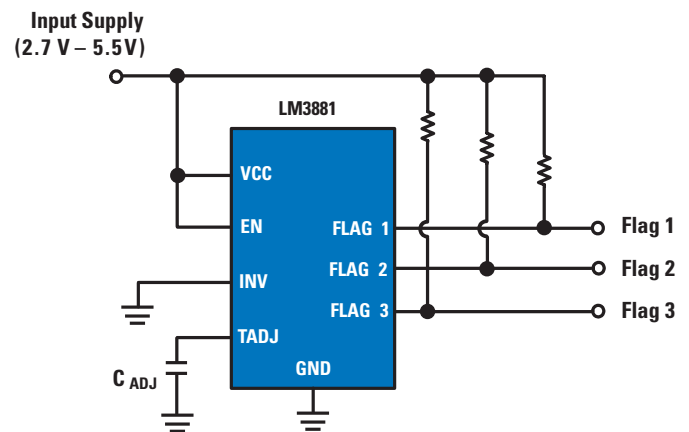
## LM3881 – Adjustable Power Sequencer

### Features

- Input voltage: 2.7V to 5.5V
- 20  $\mu$ A quiescent current
- 3 output flags
- Master sequence enable pin
- Power up and power down control
- Digital logic invert pin
- Adjustable timing pin
- 8-Pin MSOP Package

### 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



# LED WEBENCH® Design Tool

## New LED WEBENCH® Tool Recommends the Optimal LED for Your Specifications and Delivers 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

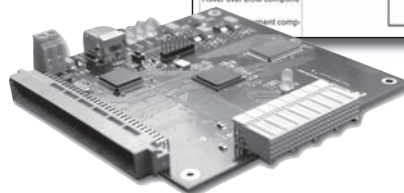
Guaranteed to ship in just one business day

The image displays three overlapping screenshots of the LED WEBENCH design tool interface:

- Top Screenshot: LED Reference Guide Selector** - Shows the 'Step 1: Choose your LED(s)' section with a list of manufacturers (Avago, Cree, Nichia, OSRAM, Philips Lumileds) and a table of LED options. The table includes columns for Manufacturer, Family, Color, Vf, If, Lp, and View. A 'Show Recommended Power LED ICs' button is visible.
- Middle Screenshot: Optimization Tuning** - Shows a circular gauge for 'Foot Print (excluding LEDs): 169.9 mm²' and 'Efficiency: 93%'. It includes controls for 'Decrease Footprint' and 'Increase Efficiency', along with a 'Show Switching Regulators' button.
- Bottom Screenshot: WEBENCH® - Electrical Simulator** - Shows a circuit diagram with components like the LNK402 LED driver, capacitors, and LEDs. It includes simulation controls like 'Start New Simulation' and 'View Past Sims'.



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



Try the LED WEBENCH tool today at:  
[www.national.com/LED](http://www.national.com/LED)



## 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
LM2731/33	2.7 to 14	Adjustable up to 20/40	1A/1.5A (switch)	9	600 kHz	PWM	Internal compensation, cycle-by-cycle current limit	SOT23-5
<b>NEW</b> 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
<b>NEW</b> 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
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 100kHz; No external Schottky diode	micro SMD-9
<b>NEW</b> LM3509	2.7 to 5.5	21.2	30 per string	10	1.27	I <sup>2</sup> C	Dual-current sinks; 32 exponential dimming steps; 800:1 dimming ratio	LLP-10
LM3519	2.7 to 5.5	18	20	4	2 to 8	PWM	Variable switching frequency	SOT23-6
LM3520	2.7 to 5.5	23	30	5	1.1	PWM	Power supply for OLED subdisplay	LLP-14
LM3557	2.7 to 7.5	26	30	5	1.25	PWM	Input under-voltage protection; Cycle-by-cycle current limit	LLP-8
<b>NEW</b> LM4510	2.7 to 5.5	18	up to 280	—	1	—	Power Supply for OLED display; No external Schottky diode	LLP-10

• PowerWise® product

## 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
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
LM2751	2.8 to 5.5	4.5, 5	80 to 150	10	0.01 to 0.725	PWM	Programmable switching frequencies	LLP-10
<b>NEW</b> LM2755	3 to 5.5	5	90	3	1.25	I <sup>2</sup> C	Independently controlled RGB outputs; Programmable trapezoidal waveforms	micro SMD-18
<b>NEW</b> LM2756	2.7 to 5.5	4.6	180	8	1.3	I <sup>2</sup> C	3 independent LED banks with 2 variable drivers; 32 exponential dimming steps; 800:1 dimming ratio	micro SMD-20
<b>NEW</b> LM2757	2.7 to 5.5	4.1, 4.5, 5	100 to 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
LM27951/52	3 to 5.5	5	120	4	0.75	PWM	Regulated current sources with 0.2% matching	LLP-14
LM27964	2.7 to 5.5	5	180	7 (3 banks)	0.7	I <sup>2</sup> 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 <sup>2</sup> 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 <sup>2</sup> C	2 independent LED banks (Group A = 5 LEDs, Group B = 1 LEDs)	LLP-24

• PowerWise® product

## 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
<b>NEW</b> LM2758	2.7 to 5.5	5	700	1	1.2	Switched Capacitor	Indicator, torch, and flash modes; Flash timeout protection	micro SMD-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
<b>NEW</b> 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

• PowerWise® product

For a complete list of LED Drivers, visit [www.national.com/LED](http://www.national.com/LED)

# LED Drivers

## High-Brightness LED Drivers

Product ID	Input Voltage Range (V)	Maximum Output Voltage (V)	Max LED Current (mA)	Maximum Number of LEDs in Series	Switching Frequency (MHz)	Topology	Key Features	Packaging
<b>NEW</b> 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	37 / 67	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	37 / 67	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
<b>NEW</b> 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
<b>NEW</b> LM3401	4.5 to 35	35	3000	9	1.5	Buck	Adjustable hysteresis, 100% duty cycle, PWM dimming	MSOP-8
<b>NEW</b> LM3433	-9 to -14	-6	6000+	1	Adjustable up to 1 MHz	Buck	Drives common anode LEDs, analog and fast PWM dimming	LLP-24

• PowerWise® product

## Lighting Management Units

Product ID	Description	V <sub>IN</sub> Range	Drive Current for All	Current for Flash Mode	Current Matching	Temp Range (°C)	Packaging
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
LP3950	• Color-LED driver with audio sync	3 to 7.2	300 mA	—	3%	-40 to 125	Laminate TCSP-32
<b>NEW</b> 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
<b>NEW</b> 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
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
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
<b>NEW</b> LP55271	• LED driver for camera flash and 4 LEDs with I <sup>2</sup> C programmability, connectivity test, and audio synchronization	3 to 5.5	1A total	400 mA	1%	-30 to 85	micro SMD-30
LM4970	• LED controller with LED lighting effects synchronized to audio	2.7 to 5.5	42 mA	—	—	-40 to 85	LLP-14
<b>NEW</b> LP5520	• RGB backlight driver with white balance compensation	2.9 to 5.5	180 mA	—	0.2%	-30 to 85	micro SMD-25
<b>NEW</b> 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
<b>NEW</b> LP5522	• Autonomous single LED controller with one wire interface	2.7 to 5.5	20 mA	—	—	-30 to 85	micro SMD-6
<b>NEW</b> LP5524	• Parallel LED Driver with PWM brightness control	2.7 to 5.5	100 mA	—	1%	-40 to 85	micro SMD-9
<b>NEW</b> 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

• PowerWise® product

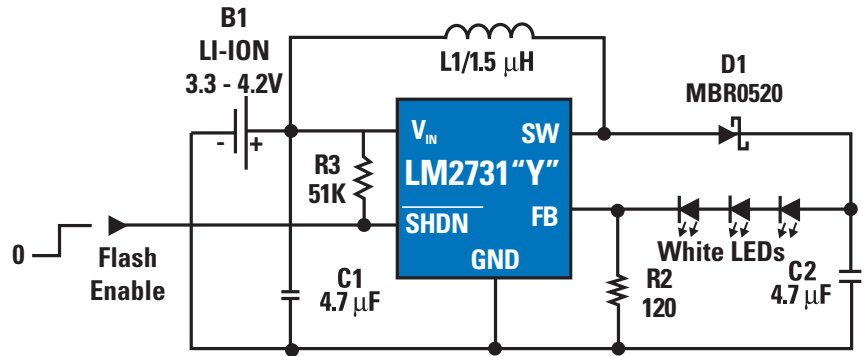
For a complete list of LED Drivers, visit [www.national.com/LED](http://www.national.com/LED)

# 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–14V)
- Low shutdown current (<1  $\mu$ A)
- Uses tiny capacitors and inductors
- Cycle-by-cycle current limiting
- Internally compensated
- 5-Lead SOT-23 package



White LED Flash Application

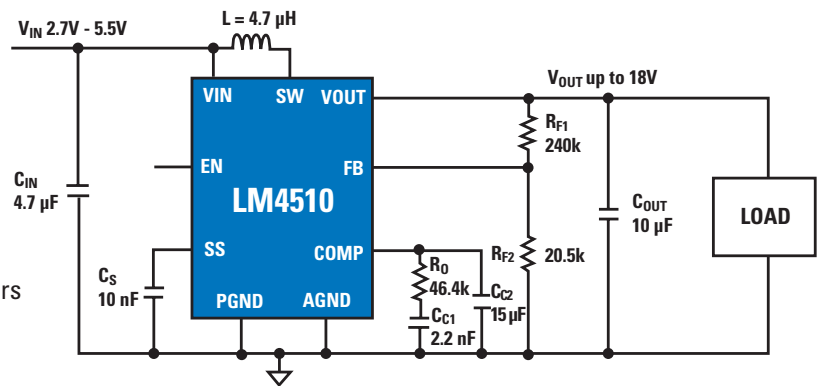
### Applications

White LED current source, PDAs and palm-top computers, digital cameras, portable phones and games, local boost regulator

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

### Features

- 18V@80 mA from 3.2V input
- 5V@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  $\mu$ A shutdown current
- Wide input voltage range: 2.7V to 5.5V
- 1.0 MHz fixed frequency operation
- Low-profile 10-pin LLP package (3 x 3 x 0.8mm)



LM4510 Typical Application Circuit

### Applications

Organic LED panel power supply, charging holster, white LED backlight, USB power supply, class D audio amplifier, camera flash LED driver

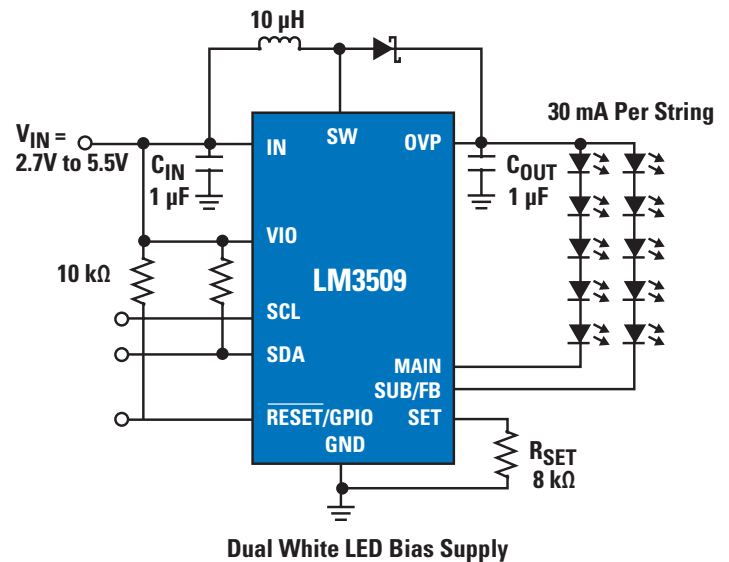
# Inductive-Boost Backlight LED Drivers

## 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
- 1.27MHz fixed frequency operation
- General purpose I/O
- Active low hardware reset
- Low-profile 10-pin LLP Package (3 mm x 3 mm x 0.8 mm)

LM3509 Typical Application Circuit

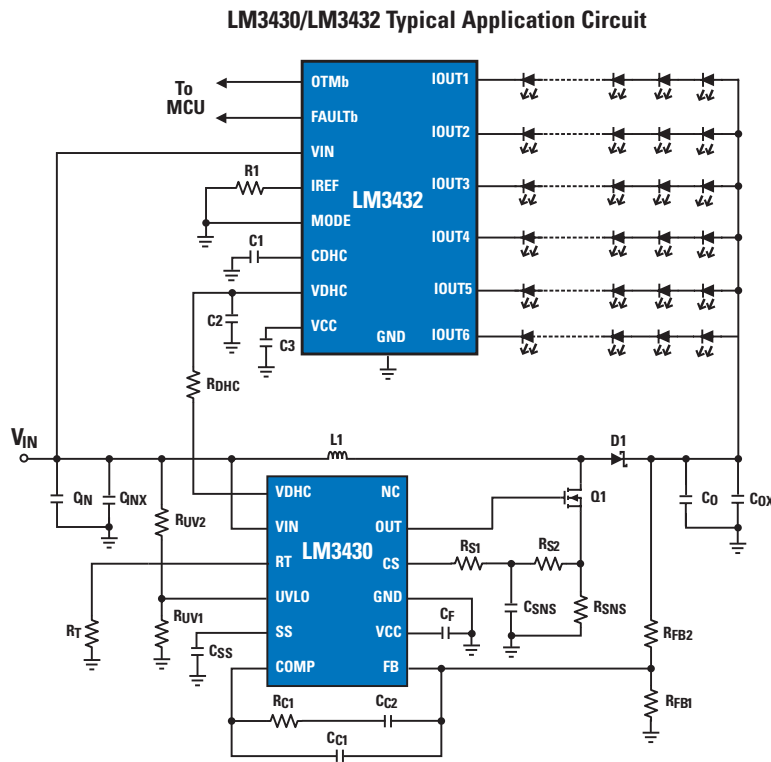


### Applications

Dual display LCD backlighting for portable applications, large format LCD backlighting, OLED panel power supply

# Inductive-Boost Backlight LED Drivers

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



### 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 40mA 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
- Low profile, thermally enhanced LLP-24 (5 x 4 x 0.8 mm) and eTSSOP-28 (9.7x6.4x1.1 mm) packages

# Inductive-Boost Backlight LED Drivers

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

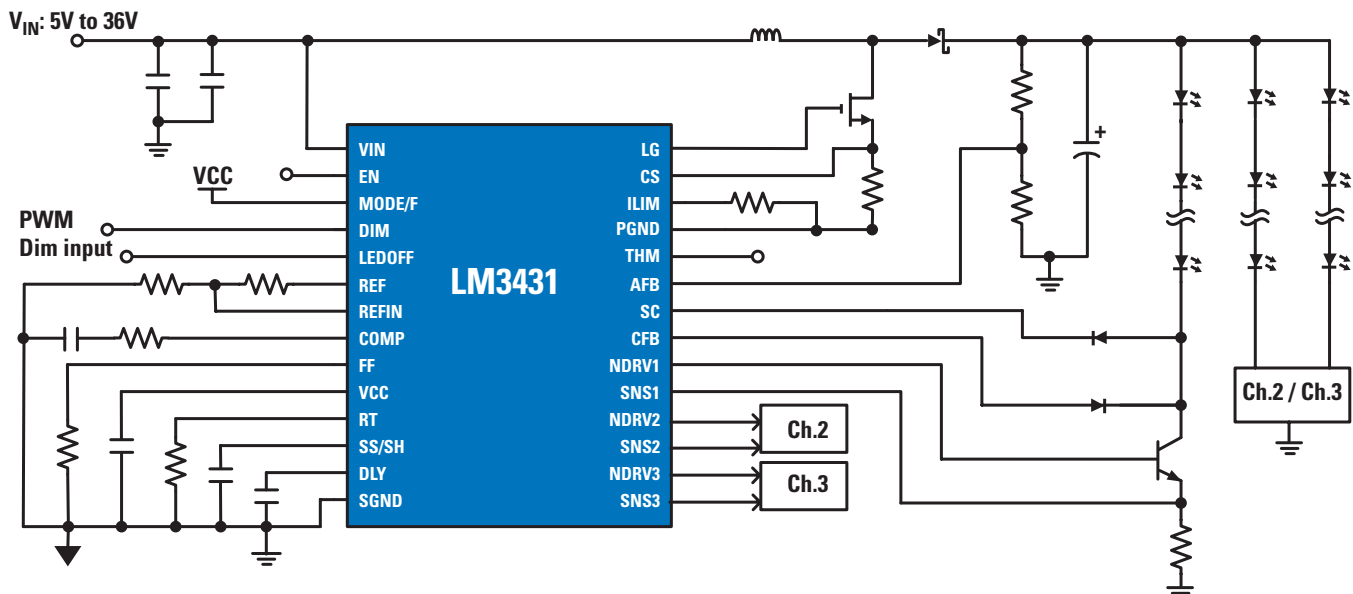
### Features

- 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-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
- TSSOP-28 exposed pad package

### Applications

Automotive infotainment displays, small-to-medium format displays

LM3431 Typical Application Circuit

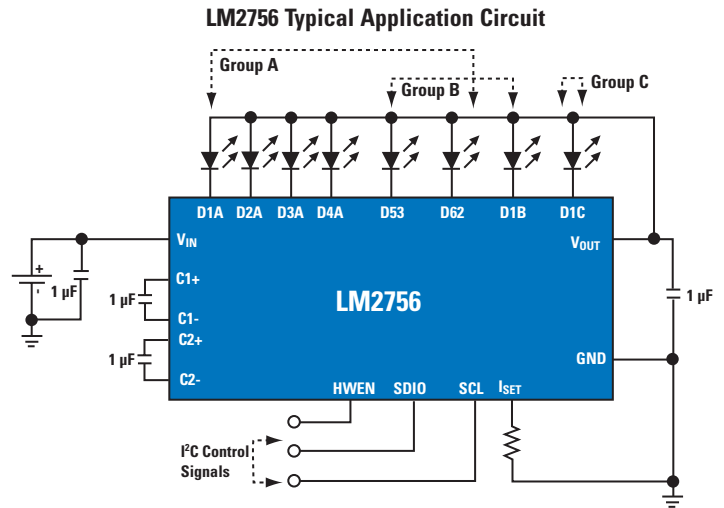


# Switched-Capacitor Boost Backlight LED Drivers

## LM2756 – Multiple-Display LED Driver with I<sup>2</sup>C-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 I<sup>2</sup>C-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
- Low-profile 20 bump micro SMD package (1.615 x 2.015 x 0.6 mm)



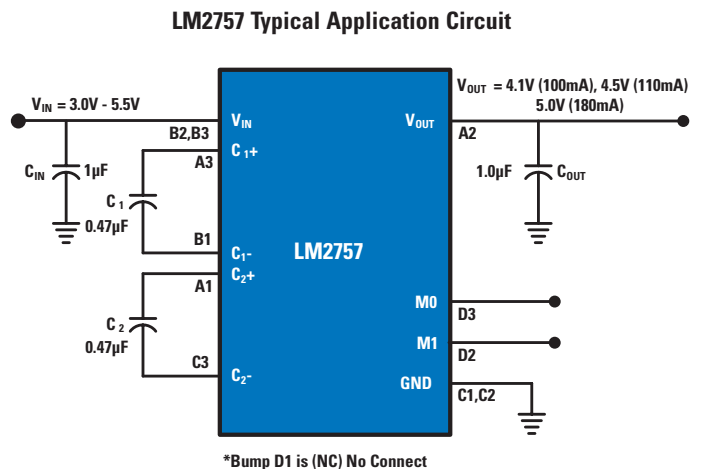
### Applications

Dual display LCD backlighting for portable applications, large format LCD backlighting, 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
- Tiny 12-bump micro SMD package (1.2 x 1.6 x 0.4 mm)



### Applications

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

# Flash LED Drivers

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

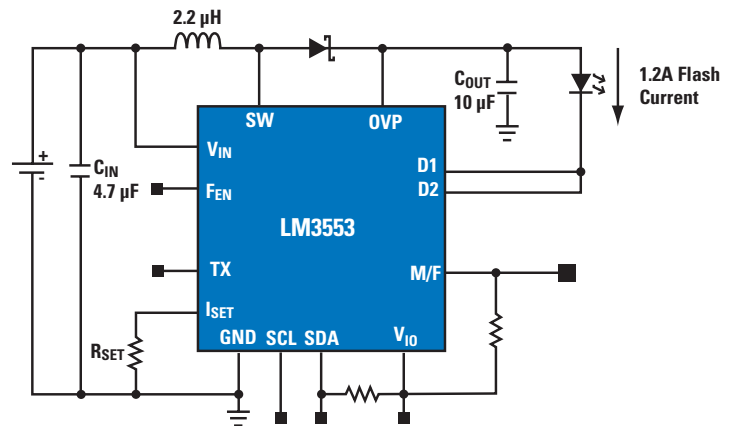
### Features

- 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 mm<sup>2</sup> optimizes PCB area occupation
- Low profile 12-pin LLP package: 3 mm x 3 mm x 0.8 mm

### Applications

Mobile phones, smart phones, PDAs, portable scanners, medical strobe lights, handheld devices

LM3553 Typical Application Circuit





## LM3401 – PowerWise® Hysteretic PFET Controller for High-Power LED Drivers

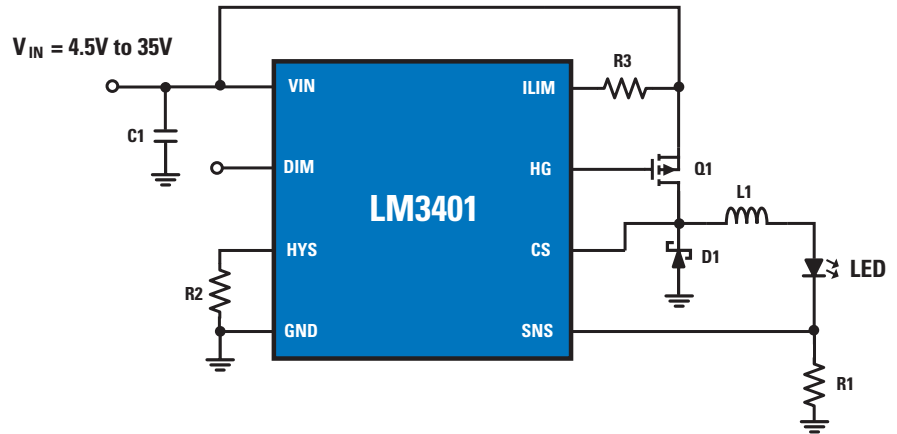
### Features

- Hysteretic control for speed and simplicity
- Input operating range of 4.5V-35V
- 1.5 MHz maximum switching frequency
- Low 200 mV reference voltage
- Programmable current limit
- High speed CMOS compatible enable/dimming
- Adjustable hysteresis
- Input UVLO
- No output capacitor required
- MSOP-8 package

### Applications

LED driver, battery charger

LM3401 Typical Application Circuit



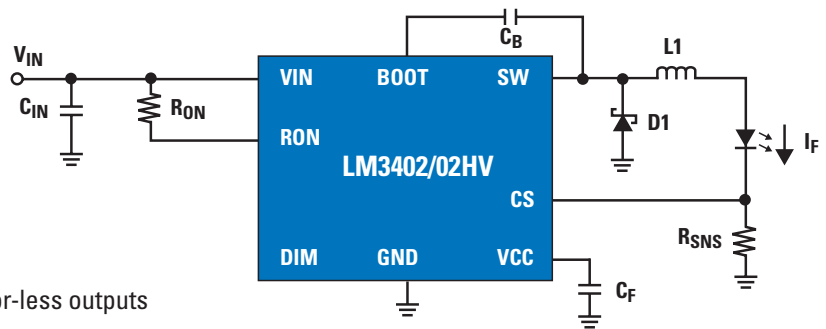
# High-Brightness LED Drivers

## LM3402/LM3402HV – 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
- MSOP-8, PSOP-8 packages

LM3402/02HV Typical Application Circuit



### Applications

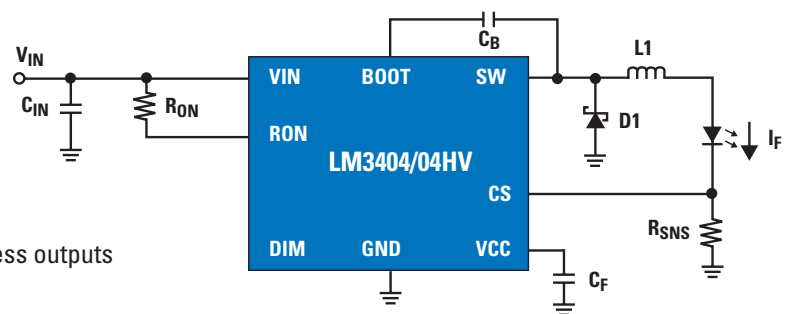
LED driver, constant-current source, automotive lighting, general illumination, industrial lighting

## LM3404/LM3404HV – PowerWise® 1.0A Constant-Current Buck Regulator for Driving High-Power LEDs

### Features

- Integrated 1.0A MOSFET
- $V_{IN}$  Range 6V to 42V (LM3404)
- $V_{IN}$  Range 6V to 75V (LM3404HV)
- 1.2A 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
- SO-8 package, PSOP-8 package

LM3404/04HV Typical Application Circuit



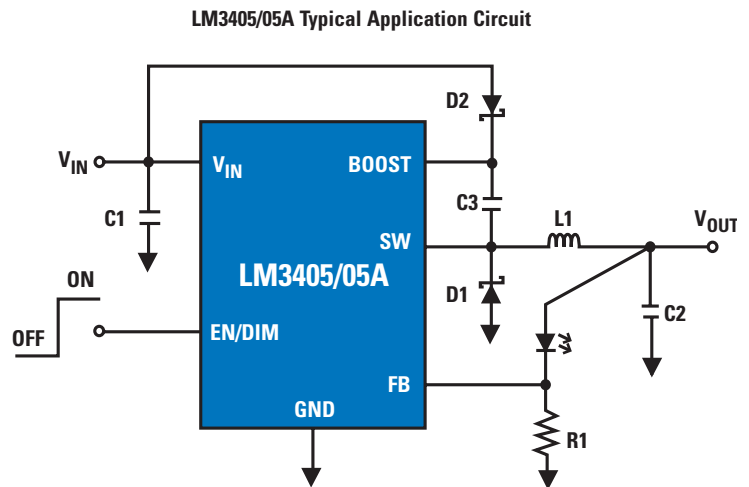
### Applications

LED driver, constant-current source, automotive lighting, general illumination, 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 m $\Omega$  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
- Thin SOT23-6 package



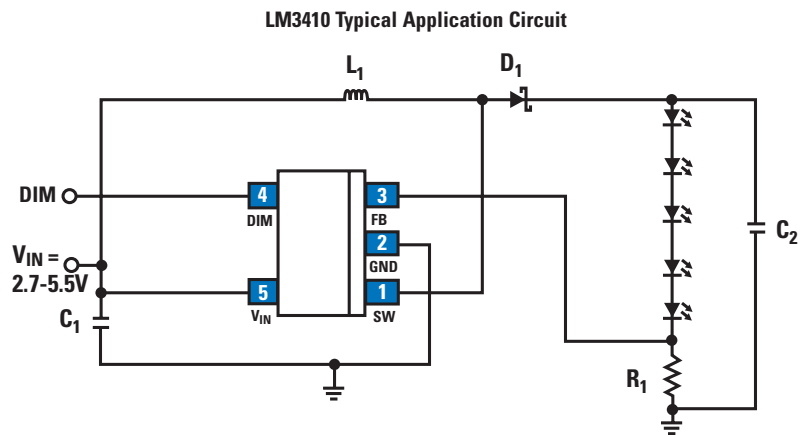
### Applications

LED driver, constant-current source, industrial lighting, 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 m $\Omega$  NMOS switch
- 190 mV internal voltage reference
- Internal soft-start
- Current-mode, PWM operation
- Thermal shutdown
- Space-saving SOT23-5 and LLP-6 Package



### Applications

LED backlight current source, Li-Ion backlight OLED & HB LED driver, handheld devices, LED flash driver

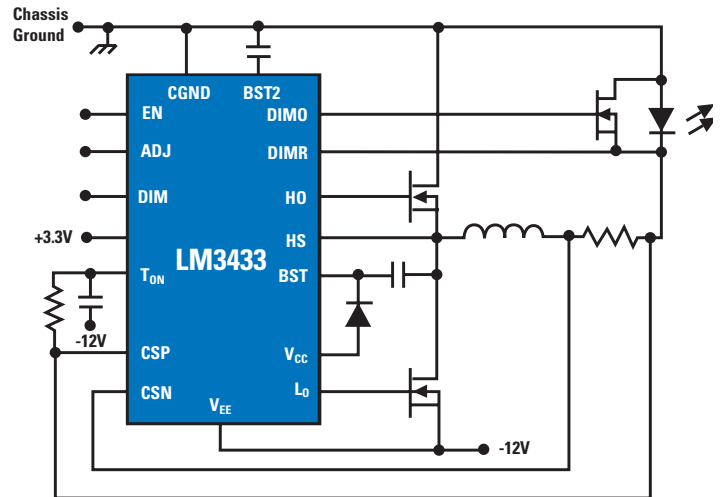
# High-Brightness LED Drivers

## 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
- LLP-24 package

LM3433 Typical Application Circuit



### Applications

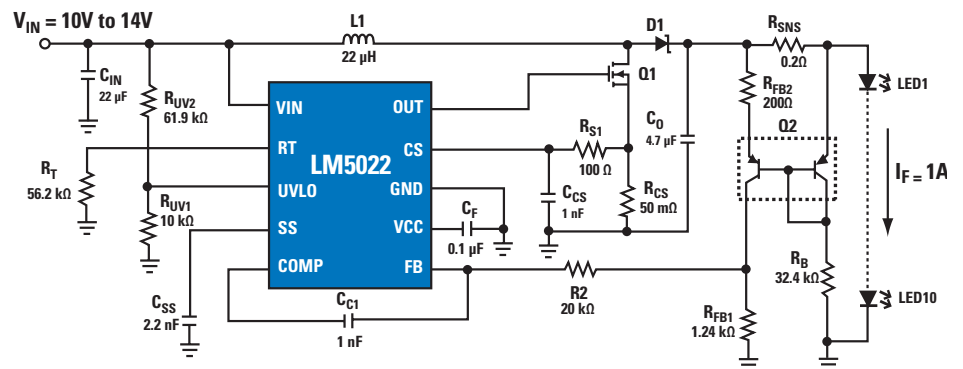
LCD backlighting, projection systems, solid state lighting, automotive lighting

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

### 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
- Slope compensation
- Adjustable soft-start
- MSOP-10 package

LM5022 Typical Application Circuit



### Applications

Boost converter, SEPIC converter

## LP39542 – PowerWise® Advanced Lighting Management Unit

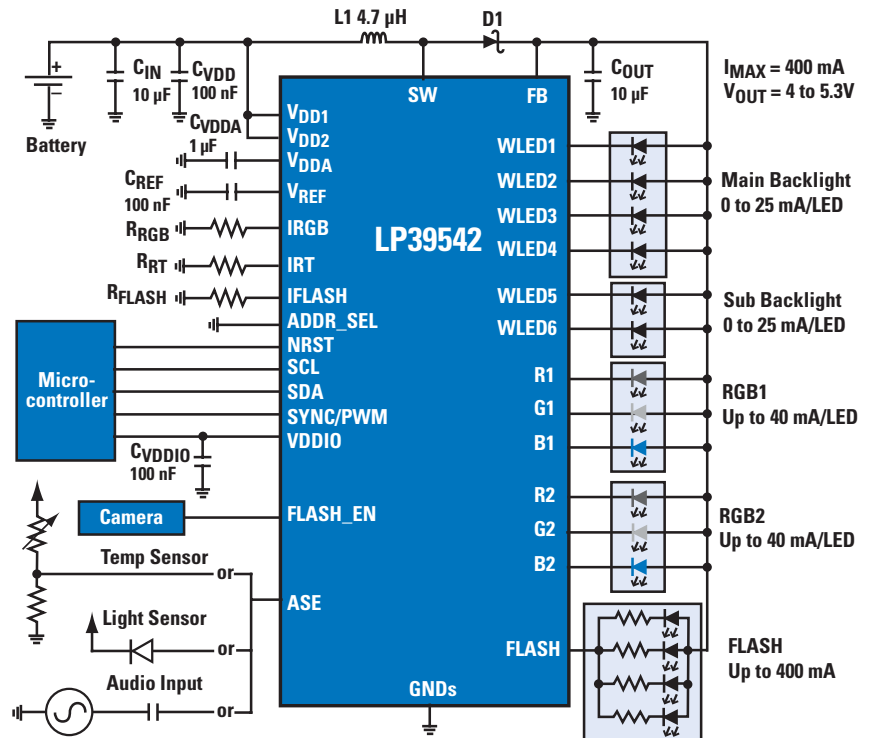
### Features

- 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
- I<sup>2</sup>C-compatible interface
- Possibility for external PWM dimming control
- Possibility for clock synchronization for RGB timing
- Ambient light and temperature sensing possibility
- Small package – micro SMD-36 (3.0 x 3.0 x 0.6 mm)

### Applications

Cellular phones, PDAs, MP3 players

LP39542 Typical Application Circuit



# Lighting Management Units

## LP55281 – PowerWise® Quad RGB Driver

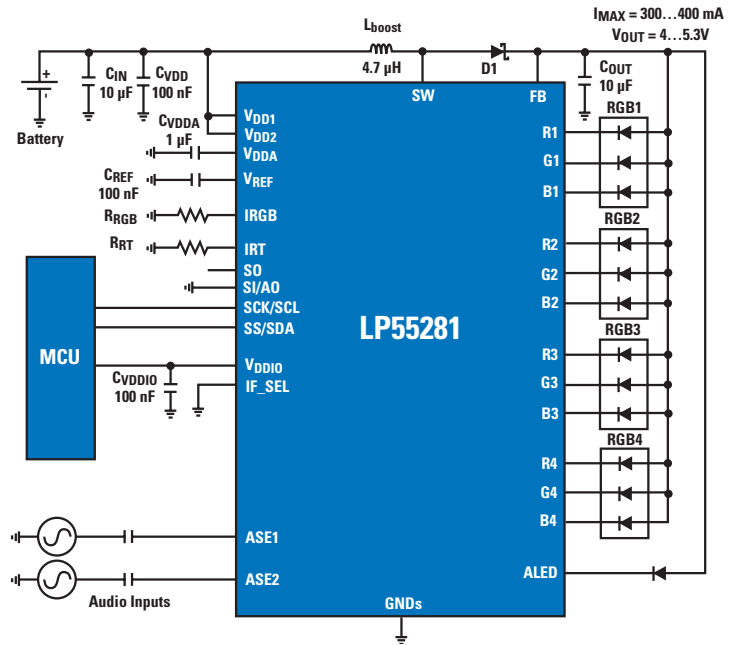
### Features

- Audio synchronization for a single fun light LED
- 4 PWM controlled RGB LED drivers
- High efficiency boost DC-DC converter
- SPI/I<sup>2</sup>C-compatible interface
- 2 addresses in I<sup>2</sup>C-compatible interface
- LED connectivity test through the serial interface
- Small 36-bump micro SMD (3 mm x 3 mm x 0.6 mm) or 36-bump micro SMDxt package (3 mm x 3 mm x 0.65 mm)

### Applications

Cellular phones, PDAs, MP3 players

LP55281 Typical Application Circuit

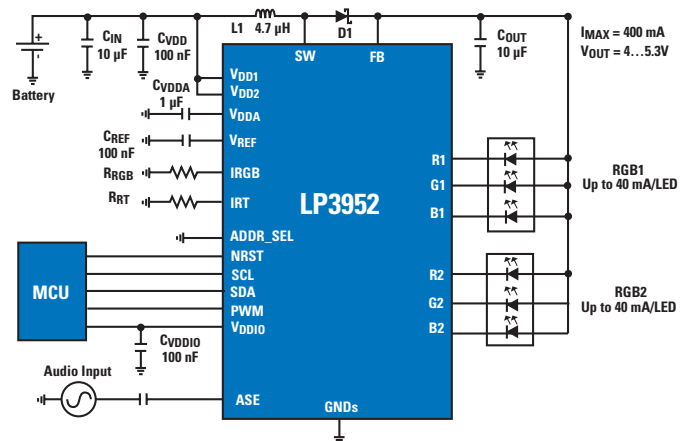


## LP3952 – PowerWise® 6-Channel Color LED Driver with Audio Synchronization

### 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<sub>OUT</sub> and f<sub>SW</sub>
- I<sup>2</sup>C-compatible interface
- Possibility for external PWM dimming control
- Small package – 36-bump micro SMDxt (3.0 mm x 3.0 mm x 0.65 mm)

LP3952 Typical Application Circuit



### Applications

Cellular phones, PDAs, MP3 players

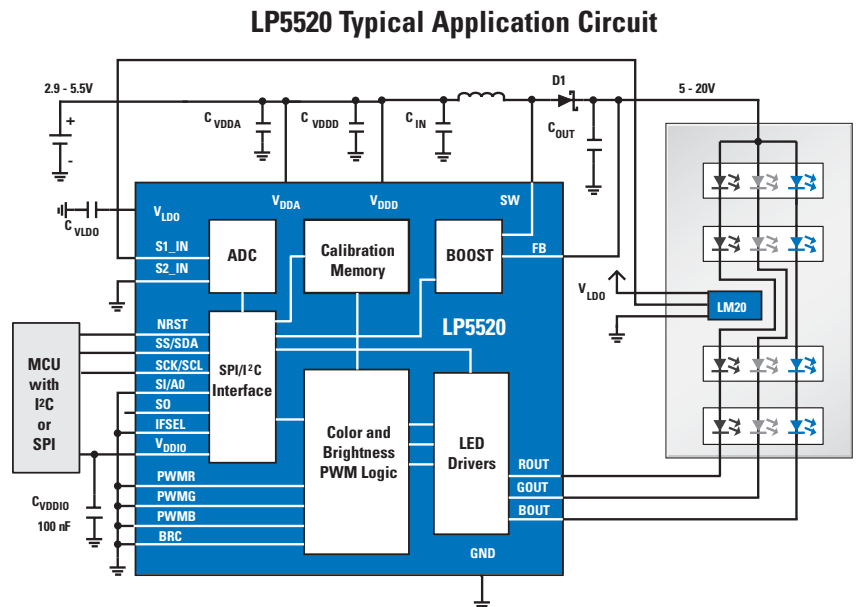
## LP5520 – RGB Backlight LED Driver

### Features

- Temperature compensated LED intensity and color
- Individual calibration coefficients for each color
- Color accuracy  $\Delta X$  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 I<sup>2</sup>C-compatible interface
- Stand-alone mode with 1 wire control
- Sequential mode for one color at a time
- Magnetic high efficiency boost converter
- micro SMD-25 package (2.77 x 2.59 x 0.6 mm)

### Applications

Color LCD display backlighting, LED lighting applications, non-linear temperature compensation, ambient light compensation



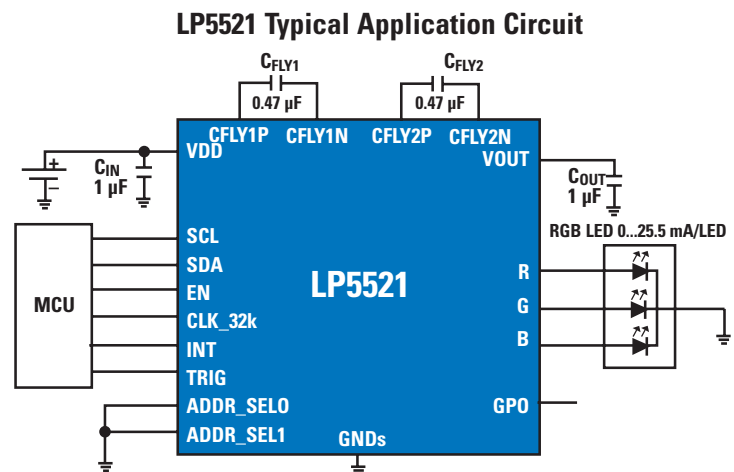
## LP5521 – PowerWise® Programmable 3-Channel LED Driver

### 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
- I<sup>2</sup>C-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%

### Applications

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



# Step-Down (Buck) Regulators for RF Power Amplifiers

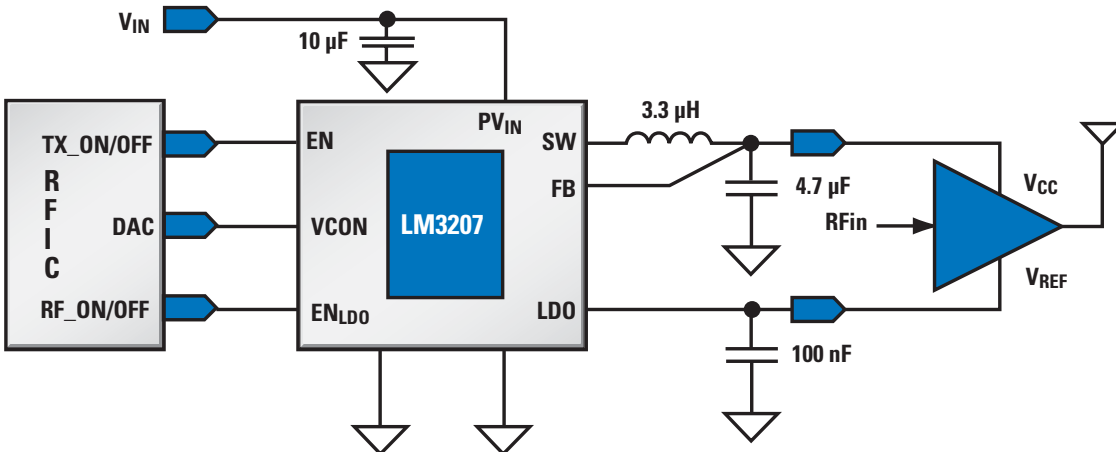
## LM3207 – PowerWise® Adjustable DC-DC Converter with Integrated LDO for Powering RF Power Amplifiers

### Features

- Dynamic output voltage control (0.8V to 3.6V) regulates power and maximizes talk time in RF-based systems
- Analog  $V_{CON}$  pin allows voltage control without need for external feedback resistors
- 650 mA maximum load capacity
- Integrated buck regulator plus LDO provide tiny integrated solution for RF PAs
- Fast 3  $\mu$ s  $V_{REF}$  LDO on/off time
- 3GPP standard compliant
- >90% efficiency maximizes battery life and improves reliability of RF sub-system
- Built-in thermal and current protection protects from damage related to overheating and overload
- Available in micro SMD-9 packaging and integrated solution optimizes solution size

### Applications:

Ideal for use in cellular phones, handheld radios, RF PC cards, battery-powered RF devices



## Step-Down (Buck) Regulators for RF Power Amplifiers

Product ID	Input Max Voltage	Input Min Voltage	Output Min	Output Max	Output Current (mA)	Switching Frequency (KHz)	Soft-Start	Turn on Time ( $\mu$ S)	Bypass Modes	Package
LM3200 •	5.5	2.7	0.8	3.6	500	2000	—	N/A	Forced and Automatic	micro SMD-10
LM3202 •	5.5	2.7	1.3	3.16	650	2000	—	N/A	None	micro SMD-8
LM3203 •	5.5	2.7	0.8	3.6	500	2000	✓	50	Forced	micro SMD-10
LM3204 •	5.5	2.7	0.8	3.6	500	2000	✓	50	Forced and Automatic	micro SMD-10
LM3205 •	5.5	2.7	0.8	3.6	650	2000	✓	50	None	LLP-10, micro SMD-8
LM3208 •	5.5	2.7	0.8	3.6	650	2000	✓	40	None	micro SMD-8

• PowerWise® product



# Linear Regulators for DDR Termination

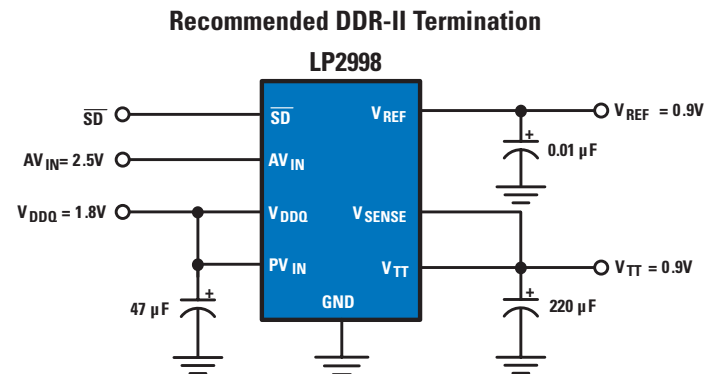
## LP2998 – Double Data Rate (DDR) Termination Regulator

### 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 to +125C 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 <sub>IN</sub> ) Min Voltage (V)	Output Current (mA)	Standards	External Components	Quiescent Current	Error Flag	On/Off Pin	Suspend to RAM shutdown	Packaging
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
LP2997	5.5	1.8	500	DDR-II	3	0.32	—	✓	✓	PSOP-8, SO-8
LP2998	5.5	1.8	1500	DDR, DDR-II	3	0.32	—	✓	✓	PSOP-8, SO-8

# Power-over-Ethernet Controllers

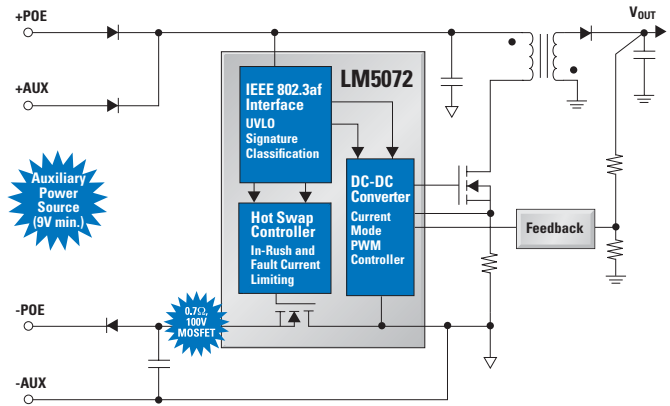
## LM5072 – PowerWise® Integrated PoE Powered Device

### Features

- Fully compliant IEEE 802.3af PD interface
- Versatile auxiliary power options
- 9V minimum auxiliary power operating range
- 100V maximum input voltage rating
- Programmable DC current limit up to 800 mA

### Applications:

Ideal for use in IEEE 802.3af compliant PoE powered devices, non-compliant application specific devices, higher power ethernet-powered devices



## Power-Over-Ethernet Power Devices 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)	Package
LM5070 •	75	1.8	1	✓	13	48V Front only	2	0.7	LLP-16, TSSOP-16
LM5071 •	60	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 Devices Front-End Controller

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

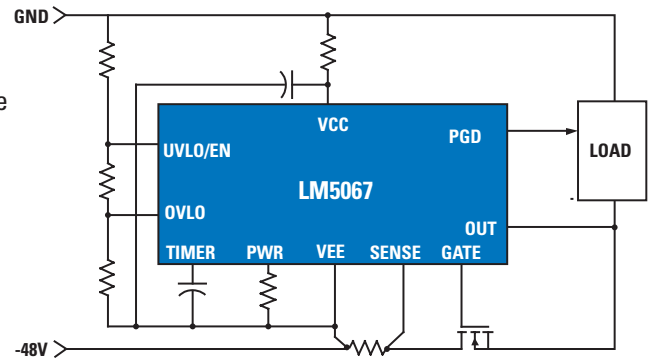
• PowerWise® product

# Hot-Swap Controllers

## LM5067 – Negative Hot Swap Controller with Current AND Power Limiting

### Features

- Wide operating range: -9V to -80V
- In-rush current limit for safe board insertion into live power sources
- Programmable maximum power dissipation in the external pass device
- Adjustable current limit
- Gate driver and current control loop for external N-channel MOSFET
- Adjustable under-voltage lockout (UVLO) and hysteresis
- Adjustable over-voltage lockout (OVLO) and hysteresis
- Programmable fault timer avoids nuisance trips
- Available in latched fault and automatic restart versions



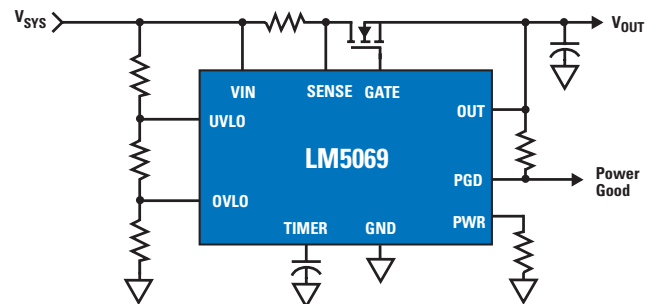
### Applications:

Ideal for use in server backplane systems, base station power distribution systems, solid state circuit breakers, 48V telecom/data storage systems, and 24V/48V industrial systems

## LM5069 – Positive Hot Swap Controller with Current AND Power Limiting

### Features

- Wide operating range: +9V to +80V
- In-rush current limit for safe board insertion into live power sources
- Programmable maximum power dissipation in the external pass device
- Adjustable current limit
- Internal high side charge pump and gate driver for external N-channel MOSFET
- Adjustable under-voltage lockout (UVLO) and hysteresis
- Adjustable over-voltage lockout (OVLO) and hysteresis
- Available in latched fault and automatic restart versions



### Applications:

Ideal for use in server backplane systems, basestation power distribution systems, solid state circuit breakers, 48V telecom/data storage systems, and 24V/48V industrial systems

## Hot-Swap Controller

Product ID	Description	Input Max Voltage (V)	Input Min Voltage (V)	Active Current Limit	Power Limiting	Fault Latch/Retry	PWRGD Output	In-Rush Current Limit	Comparator Current Limit	Overvoltage Protection	Packaging
LM5067	Negative hot swap controller	-9	-80	✓	✓	Latch-off/ auto retry	Active high	Active	✓	✓	MSOP-10
LM5068	Negative hot swap controller	-10	-90	✓	—	Latch-off/ auto retry	Active high/ active low	Active	✓	✓	MSOP-8
LM5069	Positive hot swap controller	100	9	✓	✓	Latch-off/ auto retry	Active high	Active	✓	✓	MSOP-10

# Motor and Motion Controllers

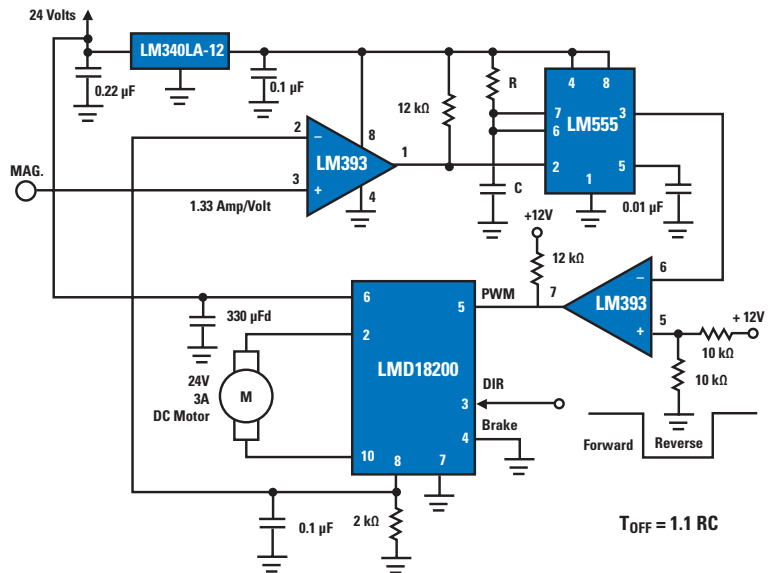
## LMD18200 – 3A, 55V H-Bridge

### 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

### Applications:

Ideal for use in DC and stepper motor drives, position and velocity servo mechanisms, factory automation robots, numerically controlled machinery, and computer printers and plotters



## 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

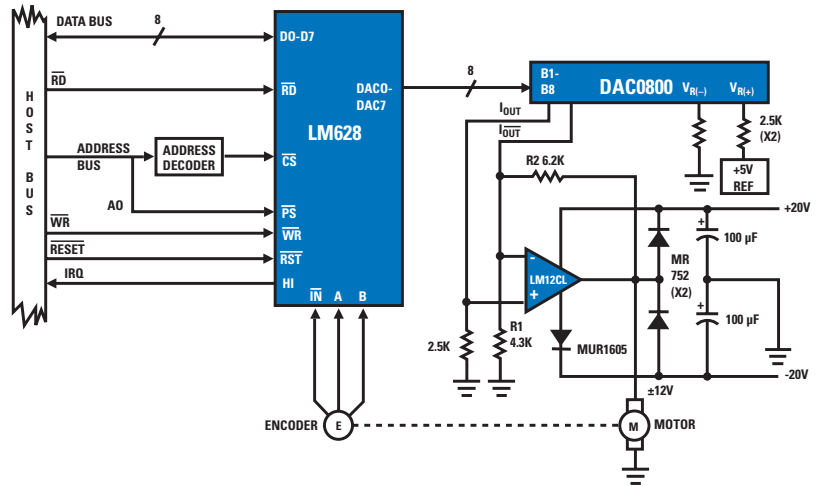
## LM628 – Precision Motion Controller

### 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

### Applications:

Ideal for use in DC and stepper motor drives, position and velocity servomechanisms, factory automation robots, numerically controlled machinery, and computer printers and plotters



## 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

# Index by Product

<b>A</b>		
ADC08B200.....	9	
ADC08B3000.....	8	
ADC08D500.....	9	
ADC08D1000.....	8	
ADC08D1020.....	8	
ADC08D1500.....	8	
ADC08D1520.....	8	
ADC08L060.....	9	
ADC10D020.....	10	
ADC10D040.....	10	
ADC10DL065.....	10	
ADC11C125.....	10	
ADC11C170.....	10	
ADC11DL066.....	10	
ADC11L066.....	10	
ADC12C080.....	10	
ADC12C105.....	10	
ADC12C170.....	10	
ADC12D040.....	10	
ADC12DL040.....	10	
ADC12DL065.....	10	
ADC12DS080.....	10	
ADC12DS105.....	10	
ADC12EU050.....	11	
ADC12L063.....	10	
ADC12L066.....	10	
ADC12L080/81.....	10	
ADC12QS065.....	10	
ADC12V170.....	10, 14	
ADC14C080.....	10	
ADC14C105.....	10, 13	
ADC14DS080.....	10	
ADC14DS105.....	10, 14, 22	
ADC14L020.....	10	
ADC14L040.....	10	
ADC14V155.....	10, 12	
ADC081S021.....	17, 50	
ADC081S051.....	17	
ADC081S101.....	17	
ADC082S021.....	17	
ADC082S051.....	17	
ADC082S101.....	17	
ADC084S021.....	17	
ADC084S051.....	17	
ADC084S101.....	17	
ADC088S022.....	17	
ADC088S052.....	17	
ADC088S102.....	17	
ADC101S021.....	50	
ADC101S051.....	17, 50	
ADC101S101.....	17, 50	
ADC102S021.....	17	
ADC102S051.....	17	
ADC102S101.....	17	
ADC104S021.....	17	
ADC104S051.....	17	
ADC104S101.....	17	
ADC108S022.....	17	
ADC108S052.....	17	
ADC108S102.....	17	
ADC121C021.....	15, 17	
ADC121C027.....	15, 17	
ADC121S021.....	17	
ADC121S051.....	17	
ADC121S101.....	17, 19, 24	
ADC121S625.....	17, 19	
ADC121S655.....	16, 17	
ADC121S705.....	16, 17	
ADC122S021.....	17	
ADC122S051.....	17	
ADC122S101.....	17	
ADC122S706.....	15	
ADC122Sxxx.....	16	
ADC124S021.....	17	
ADC124S051.....	17	
ADC124S101.....	17	
ADC128S022.....	17	
ADC128S052.....	17	
ADC128S102.....	16, 17	
ADC141S626.....	5, 16, 17	
ADC08060.....	9	
ADC08100.....	9	
ADC08200.....	9	
ADC08500.....	9	
ADC10040.....	10	
ADC10065.....	10	
ADC10080.....	10	
ADC12010.....	10	
ADC12020.....	10	
ADC12040.....	10	
ADC12081.....	10	
ADC14155.....	10, 29	
ADC081000.....	8	
ADC081500.....	8	
ADC083000.....	8	
<b>C</b>		
CLC030.....	29	
<b>D</b>		
DAC081S101.....	16, 18	
DAC082S085.....	18, 19	
DAC084S085.....	18	
DAC088S085.....	18	
DAC101S101.....	18	
DAC102S085.....	18, 19	
DAC104S085.....	18	
DAC108S085.....	18	
DAC121C081.....	18	
DAC121C085.....	18	
DAC121S101.....	18, 19	
DAC122S085.....	18	
DAC124S085.....	18	
DAC128S085.....	18, 19	
DP83640T.....	78	
DP83848.....	52, 78	
DP83848C.....	78	
DP83848HSQ.....	78	
DP83848I.....	78	
DP83848J.....	78	
DP83848K.....	78	
DP83848MSQ.....	78	
DP83848TSQ.....	78	
DP83848VYB.....	78	
DP83848YB.....	78	
DP83849.....	52, 79	
DP83849C.....	79	
DP83849I.....	79	
DP83849ID.....	79	
DP83849IF.....	79	
DS08MB200TSQ.....	73	
DS10BR150TSD.....	72	
DS10BR254SQ.....	73	
DS10CP152TMA.....	73	
DS10CP154SQ.....	73	
DS15BA101SD.....	72	
DS15BR400TSQ/TVS.....	72	
DS15BR401TSQ/TVS.....	72	
DS15EA101SQ.....	72	
DS15MB200TSQ.....	73	
DS16EV5110.....	70	
DS16EV5110SQ.....	72	
DS25BR100.....	72	
DS25BR100TSD.....	72	
DS25BR110.....	72	
DS25BR110TSD.....	72	
DS25BR120TSD.....	72	
DS25BR150TSD.....	72	
DS25BR204.....	71	
DS25BR204SQ.....	73	
DS25BR400TSQ.....	72	
DS25BR1020.....	72	
DS25CP102SQ.....	73	
DS25CP104.....	73	
DS25CP104SQ.....	73	

DS25MB100TSQ.....	73
DS25MB200TSQ.....	73
DS32EV100.....	71
DS32EV100SD.....	72
DS32EV400.....	71
DS32EV400SQ.....	72
DS38EP100.....	71
DS38EP100DS.....	72
DS40MB200SQ.....	73
DS42BR400TSQ.....	72
DS42MB100TSQ.....	73
DS42MB200TSQ.....	73
DS50EV401.....	71
DS64EV100.....	71
DS64EV100SD.....	72
DS64EV400.....	71
DS64EV400SQ.....	72
DS80EP100.....	71
DS80SP100SD.....	72
DS90C124QVS.....	75
DS90C241QVS.....	75
DS90CP22M-8/MT.....	73
DS90CR217MTD.....	75
DS90CR218AMTD.....	75
DS90CR287MTD.....	75
DS90CR288AMTD.....	75
DS90CR483VJD.....	75
DS90CR484VJD.....	75
DS90CR485VS.....	75
DS90CR486VS.....	75
DS90LV004TVS.....	72
DS90LV110ATMT.....	73
DS90LV804TSQ.....	72
DS90UR124.....	74
DS90UR124QVS.....	75
DS90UR241.....	74
DS90UR241QVS.....	75
DS91C176TMA.....	69
DS91C180TMA.....	69
DS91D176TMA.....	69
DS91D180TMA.....	69
DS92CK16TMTC.....	69
DS92LV010ATM.....	69
DS92LV16TVHG.....	75
DS92LV18TVV.....	75
DS92LV040TLQA.....	69
DS92LV090ATVEH.....	69
DS92LV1021ATMSA.....	75
DS92LV1023ETMSA.....	75
DS92LV1212AMSA.....	75
DS92LV1224TMSA.....	75
DS99R103TSQ.....	75

DS99R103TVS.....	75
DS99R104TSQ.....	75
DS99R104TVS.....	75
DS99R105SQ.....	75
DS99R105VS.....	75
DS99R106SQ.....	75
DS99R106VS.....	75
DS92001TMA.....	69

## L

LM26.....	66
LM26LV.....	66
LM27.....	66
LM27A.....	67
LM45.....	66
LM56.....	66
LM63C.....	65
LM63D.....	65
LM70.....	67
LM71.....	67
LM71A.....	67
LM73.....	67
LM74.....	67
LM75.....	67
LM76.....	67
LM77.....	67
LM80.....	65
LM81B.....	65
LM86.....	65
LM87.....	65
LM89.....	65
LM92.....	67
LM93.....	65
LM94.....	65
LM99.....	65
LM177x.....	52
LM283x.....	52
LM310x.....	92
LM367x.....	52
LM510x.....	105
LM628.....	142
LM629.....	142
LM1770.....	94, 95
LM1771.....	94, 95
LM2585.....	98
LM2586.....	98
LM2587.....	98
LM2588.....	98
LM2590HV.....	91
LM2591HV.....	91
LM2592HV.....	91
LM2593HV.....	91

LM2594.....	91
LM2594HV.....	91
LM2595.....	91
LM2596.....	91
LM2597.....	91
LM2597HV.....	91
LM2598.....	91
LM2599.....	91
LM2611.....	101
LM2612.....	88
LM2612BL.....	88
LM2614.....	88
LM2618.....	88
LM2619.....	88
LM2622.....	98
LM2651.....	88
LM2670.....	91
LM2671.....	91
LM2672.....	91
LM2673.....	91
LM2674.....	91
LM2675.....	91
LM2676.....	91
LM2677.....	91
LM2678.....	91
LM2679.....	91
LM2694.....	86
LM2695.....	86
LM2696.....	86
LM2698.....	98
LM2700.....	50,98
LM2727.....	95
LM2731.....	50, 98, 122, 124
LM2732.....	50
LM2733.....	98, 122
LM2734.....	50, 52, 86
LM2734Z.....	86
LM2735.....	98
LM2736.....	52,86
LM2737.....	95
LM2738.....	52
LM2742.....	94
LM2743.....	94
LM2744.....	94
LM2745.....	94
LM2746.....	94
LM2747.....	94
LM2748.....	94
LM2750.....	93, 122
LM2751.....	93,122
LM2753.....	93
LM2754.....	122

LM2755.....	122	LM3508.....	122	LM4702.....	48, 49
LM2756.....	122, 128	LM3509.....	122, 125	LM4702B.....	48
LM2757.....	93, 122, 128	LM3519.....	122	LM4702C.....	48
LM2758.....	122	LM3520.....	122	LM4802B.....	58
LM2760.....	93	LM3551.....	122	LM4804.....	57
LM2770.....	93	LM3552.....	122	LM4805.....	57
LM2771.....	93	LM3553.....	122, 129	LM4809.....	54
LM2772.....	93	LM3557.....	50, 122	LM4811.....	54
LM2781.....	93	LM3570.....	50	LM4819.....	59
LM2787.....	93	LM3658.....	50, 52	LM4844.....	50
LM2797.....	93	LM3668.....	98, 100, 101	LM4845.....	53
LM2798.....	93	LM3670.....	50, 88	LM4846.....	53
LM2830.....	86	LM3671.....	50, 88	LM4851.....	53
LM2831.....	86	LM3673.....	50, 88	LM4852.....	53
LM2832.....	50, 86	LM3674.....	50, 88	LM4855.....	53
LM2852.....	50, 92	LM3676.....	88	LM4856.....	53
LM2853.....	92	LM3677.....	88	LM4857.....	52, 53
LM2854.....	92	LM3679.....	88	LM4866.....	19
LM3100.....	92	LM3687.....	113	LM4888.....	50, 53
LM3102.....	92	LM3700.....	119	LM4905.....	59
LM3103.....	92	LM3702.....	119	LM4906.....	59
LM3224.....	98	LM3706.....	119	LM4908.....	54
LM3280.....	113	LM3708.....	119	LM4910.....	54
LM3310.....	98	LM3709.....	119	LM4911.....	54
LM3311.....	98	LM3710.....	119	LM4912.....	54
LM3354.....	93	LM3711.....	119	LM4916.....	54
LM3370.....	52, 112	LM3712.....	119	LM4920.....	52, 55
LM3401.....	123, 130	LM3713.....	119	LM4921.....	54
LM3402.....	123, 131	LM3722.....	119	LM4923.....	59
LM3402HV.....	123, 131	LM3723.....	119	LM4924.....	54
LM3404.....	123, 131	LM3724.....	119	LM4925.....	54
LM3404HV.....	123	LM3743.....	95	LM4927.....	59
LM3405.....	123, 132	LM3880.....	52, 120	LM4928.....	52, 60
LM3405A.....	123, 132	LM3881.....	120	LM4929.....	54
LM3407.....	123	LM4120.....	119	LM4930.....	50
LM3410.....	123, 132	LM4125.....	119	LM4931.....	50
LM3430.....	99, 122, 126	LM4128.....	16, 119	LM4934.....	50
LM3431.....	122, 127	LM4132.....	16, 119	LM4935.....	50
LM3432.....	122, 126	LM4140.....	119	LM4937.....	50
LM3433.....	123, 133	LM4510.....	98, 122, 124	LM4938.....	53
LM3475.....	94, 95	LM4562.....	47	LM4941.....	59
LM3477.....	95	LM4570.....	61	LM4946.....	53
LM3478.....	99, 101	LM4666.....	56	LM4947.....	50, 53
LM3481.....	99, 101	LM4668.....	56	LM4949.....	53
LM3485.....	50, 95	LM4671.....	56	LM4950.....	53, 61
LM3488.....	99, 101	LM4673.....	50, 52, 56	LM4951.....	59
LM3489.....	95	LM4674.....	52, 56	LM4953.....	52, 58
LM3495.....	95, 97	LM4674A.....	56	LM4954.....	59
LM3500.....	50, 122	LM4675.....	50, 52, 56	LM4960.....	58
LM3501.....	122	LM4680.....	56	LM4961.....	58
LM3502.....	122	LM4681.....	56	LM4962.....	52, 58
LM3503.....	122	LM4682.....	56	LM4970.....	61, 123



LM4980.....	54	LM5109.....	102, 105	LM49100.....	52, 53
LM4981.....	52	LM5110.....	105	LM49250.....	52
LM4982.....	52, 55	LM5111.....	105	LM49270.....	53
LM4985.....	54	LM5112.....	105	LM49370.....	50, 51, 63
LM4990.....	59	LM5115.....	102, 103	LM49450.....	50
LM4991.....	59	LM5115A.....	101	LM51001.....	102
LM4992.....	60	LM5115.....	95	LM51002.....	102
LM4995.....	59	LM5115A.....	95	LM51004.....	102
LM5000.....	98, 102	LM5116.....	95, 97, 102	LM94021.....	66
LM5001.....	98, 101, 102	LM5574.....	91	LM94022.....	16, 66
LM5002.....	98, 101, 102	LM5575.....	91	LM94022Q.....	67
LM5005.....	86, 102	LM5576.....	91	LM95071.....	67
LM5007.....	86, 102	LM6154.....	37	LM95213.....	65
LM5008.....	86, 102	LM6211.....	34, 36, 43	LM95214.....	65
LM5009.....	86	LM6588.....	40	LM95231.....	65
LM5010.....	86	LM8261.....	26, 37, 50	LM95233.....	64, 65
LM5010A.....	86, 102	LM8262.....	37	LM95234.....	64, 65
LM5015.....	98, 101, 102	LM8272.....	37	LM95235.....	64, 65
LM5020.....	99, 101, 102, 103	LM25005.....	86, 102	LM95235Q.....	67
LM5021.....	99, 101, 102, 103	LM25007.....	86, 102	LM95241.....	65
LM5022.....	99, 101, 123, 133	LM25010.....	86, 102	LM95245.....	64, 65
LM5025.....	102, 103	LM25115.....	103	LM96000.....	65
LM5025A.....	102, 103	LM25115/A.....	95	LM96194.....	65
LM5025B.....	102, 103	LM25116.....	95	LM97593.....	13
LM5026.....	102, 103, 104	LM25574.....	91	LM98519.....	21
LM5030.....	102, 103	LM25575.....	91	LM98714.....	20
LM5032.....	102, 103	LM25576.....	91	LMC6001.....	36
LM5033.....	102, 103	LM26001.....	52, 86, 87	LMC6061.....	36
LM5034.....	102, 103	LM26400Y.....	112	LMC6062.....	36
LM5035.....	103	LM26480.....	115	LMC6064.....	36
LM5035A.....	102	LM27241.....	95	LMC8101.....	39
LM5035A.....	102, 104	LM27313.....	98	LMD18200.....	141
LM5041.....	102, 103	LM27346.....	52	LMD18201.....	141
LM5041A.....	102	LM27348.....	52	LMD18245.....	141
LM5067.....	102, 140	LM27951.....	122	LME49600.....	47
LM5068.....	102, 140	LM27952.....	50, 122	LME49710.....	47
LM5069.....	102, 140	LM27964.....	122	LME49713.....	47
LM5070.....	102, 139	LM27965.....	122	LME49720.....	47
LM5071.....	102, 139	LM27966.....	122	LME49721.....	47
LM5072.....	102, 139	LM34910.....	86	LME49723.....	47
LM5073.....	102	LM34910C.....	86	LME49740.....	47
LM5080.....	102, 106	LM34914.....	86	LME49810.....	48, 63
LM5100A.....	105	LM34917.....	87	LME49811.....	48
LM5100B.....	102, 105	LM48310.....	56	LME49860.....	47, 63
LM5100C.....	105	LM48410.....	52, 56, 63	LME49870.....	47
LM5101A.....	105	LM48411.....	56	LMH0001.....	76
LM5101B.....	105	LM48510.....	50, 52, 57	LMH0002.....	29
LM5101C.....	105	LM48511.....	57	LMH0002SQ.....	76
LM5102.....	105	LM48555.....	58	LMH0030.....	29
LM5104.....	105	LM48820.....	55	LMH0040.....	76
LM5105.....	105	LM48821.....	55	LMH0041.....	76
LM5107.....	102, 105	LM48860.....	55	LMH0044.....	76

LMH0046.....	76	LMH6655.....	25	LMP7717.....	33, 34, 35
LMH0056.....	76	LMH6657.....	25	LMP7718.....	33, 35
LMH0070.....	76	LMH6658.....	23, 25	LMP7731.....	16, 33, 34
LMH0071.....	76	LMH6672.....	25	LMP7732.....	33, 34
LMH0074.....	76	LMH6682.....	25	LMP8100.....	35
LMH0302.....	76	LMH6683.....	23, 25, 32	LMP8270.....	36
LMH0340.....	76	LMH6702.....	23, 25, 32, 34	LMP8271.....	36
LMH0341.....	76	LMH6703.....	23, 25, 32, 39	LMP8272.....	36
LMH0344.....	76	LMH6704.....	32	LMP8275.....	36
LMH0346.....	76	LMH6715.....	25	LMP8276.....	36
LMH0356.....	76	LMH6720.....	25	LMP8277.....	36
LMH1251.....	30	LMH6722.....	25	LMV112.....	28
LMH1980.....	29	LMH6723.....	25	LMV116.....	40
LMH1981.....	29	LMH6724.....	25	LMV116.....	37
LMH2100.....	28	LMH6725.....	25	LMV118.....	37
LMH4132.....	16	LMH6732.....	25	LMV118.....	39, 40
LMH6321.....	26	LMH6733.....	25, 32	LMV221.....	28
LMH6502.....	26	LMH6734.....	32	LMV225.....	28
LMH6503.....	26	LMH6738.....	25, 32	LMV226.....	28
LMH6505.....	26	LMH6739.....	32	LMV228.....	28
LMH6515.....	14, 24	LMH7220.....	27	LMV232.....	28
LMH6515 (x2).....	12	LMH7322.....	27	LMV301.....	37, 40
LMH6550.....	23, 25	LMH7324.....	27	LMV341.....	37, 39, 40
LMH6551.....	23, 25	LMK0200.....	12, 22	LMV422.....	37, 40
LMH6552.....	14, 22, 23, 25	LMK0200+VCXO.....	14	LMV551.....	38
LMH6555.....	22, 23	LMK02000.....	80	LMV552.....	38
LMH6559.....	26	LMK02002.....	80	LMV554.....	38
LMH6560.....	26	LMK03000.....	29, 80	LMV641.....	37, 38, 40
LMH6570.....	32	LMK03000C.....	80	LMV651.....	40
LMH6572.....	32	LMK03001.....	80	LMV651.....	37, 38
LMH6574.....	32	LMK03001C.....	80	LMV652.....	37, 38, 40
LMH6580.....	30	LMK03002.....	80	LMV654.....	37, 38, 40
LMH6581.....	30	LMK03002C.....	80	LMV711.....	39
LMH6582.....	31	LMP2011.....	16, 33	LMV712.....	37, 39, 40
LMH6583.....	31	LMP2012.....	33	LMV715.....	39, 40
LMH6601.....	23, 25, 32, 39	LMP2014MT.....	33	LMV715.....	37
LMH6609.....	25	LMP2231.....	38	LMV716.....	34, 36, 37, 42
LMH6611.....	24, 25	LMP2231.....	33	LMV721.....	37, 40, 42
LMH6618.....	23, 24, 25	LMP2231.....	33	LMV722.....	37, 40, 42
LMH6619.....	23, 24, 25	LMP2232.....	33, 38	LMV751.....	33, 34, 36, 37, 40, 42
LMH6622.....	23, 25, 34	LMP2234.....	33, 38	LMV761.....	27
LMH6624.....	23, 24, 25, 34	LMP7300.....	27	LMV762.....	27
LMH6626.....	23, 24, 25, 34	LMP7701.....	16, 19, 33, 34, 36	LMV771.....	33, 34, 36, 40, 42
LMH6628.....	23, 25, 34	LMP7702.....	16, 19, 33, 34, 36	LMV771.....	37
LMH6640.....	25	LMP7704.....	34, 36	LMV772.....	33, 34, 36, 37, 40, 42
LMH6642.....	23, 25	LMP7707.....	33	LMV774.....	33, 34, 37, 40, 42, 52
LMH6643.....	23, 25	LMP7708.....	33	LMV791.....	34, 36, 39, 42
LMH6644.....	23, 25	LMP7709.....	33	LMV791.....	37
LMH6645.....	23, 25	LMP7711.....	33, 34, 36, 39	LMV792.....	34, 36, 37, 39, 42
LMH6646.....	23, 25	LMP7712.....	33, 34, 39	LMV793.....	34, 42
LMH6647.....	23, 25, 39	LMP7715.....	33, 34, 36	LMV793.....	37
LMH6654.....	25	LMP7716.....	33, 34, 36	LMV794.....	34, 37, 42

LMV796 .....	34, 36, 42, 43	LP3906 .....	52, 114	LPV511.....	37,38
LMV796 .....	37	LP3907 .....	114	LPV531.....	37, 38, 40
LMV797 .....	34, 36, 37, 42, 43	LP3910 .....	52, 116	LPV7215.....	27
LMV821 .....	37, 40	LP3913 .....	116		
LMV822 .....	37, 40	LP3943 .....	123	<b>S</b>	
LMV824 .....	37, 40	LP3944 .....	123	SCAN15MB200TSQ.....	73
LMV841 .....	33, 41	LP3950 .....	123	SCAN90CP02SP/VY.....	73
LMV841/42 .....	37	LP3952 .....	123, 135	SCAN12100TYA.....	75
LMV842 .....	41	LP3955 .....	52	SCAN25100.....	12
LMV844 .....	37, 41	LP3958 .....	123	SCAN25100TYA.....	75
LMV851 .....	40	LP3971 .....	50, 52	SCAN90004TVS.....	72
LMV851 .....	37	LP3986 .....	111	SCAN921025HSM.....	75
LMV852 .....	37, 40	LP3990 .....	52, 109	SCAN921025SLC.....	75
LMV854 .....	37, 40	LP3991 .....	109	SCAN921226HSM.....	75
LMV931 .....	37,40	LP3995 .....	52, 110	SCAN921226SLC.....	75
LMV932 .....	40	LP3996 .....	111	SCAN921260UJB .....	75
LMV932/34 .....	37	LP3997 .....	110	SCAN926260TUF.....	75
LMV934 .....	40	LP3999 .....	52, 110	SCAN928028TUF.....	75
LMV951 .....	37,39,40,41	LP5520 .....	123, 136		
LMV981 .....	37,39,40,52	LP5521 .....	123, 136		
LMV982 .....	39	LP5522 .....	123		
LMV1012 .....	62	LP5524 .....	123		
LMV1012-7 .....	62	LP5526 .....	123		
LMV1012-15 .....	62	LP5550 .....	117		
LMV1012-20 .....	62	LP5551 .....	117		
LMV1012-25 .....	62	LP5552 .....	117		
LMV1015-15 .....	62	LP5900 .....	22, 52, 110		
LMV1015-25 .....	62	LP5951 .....	22, 52, 109		
LMV1024 .....	62	LP5952 .....	109		
LMV1026 .....	62	LP5990 .....	110		
LMV1031 .....	62	LP5996 .....	111		
LMV1031-20.....	62	LP38500.....	107		
LMV1032-6.....	62	LP38501.....	107		
LMV1032-15.....	62	LP38502.....	107		
LMV1032-25.....	62	LP38503.....	107		
LMV1088 .....	62	LP38511.....	108		
LMV2011 .....	40	LP38512.....	108		
LMV7239 .....	27	LP38513.....	108		
LMV7271 .....	27	LP38690.....	109		
LMV7272 .....	27	LP38691.....	109		
LMV7275 .....	27	LP38692.....	109		
LMV7291 .....	27	LP38693.....	109		
LMV10132 .....	62	LP38851.....	108		
LMX2531 .....	12, 50	LP38852.....	108		
LP2966.....	111	LP38853.....	108		
LP2967 .....	111	LP38855.....	108		
LP2995.....	138	LP38856.....	108		
LP2996.....	138	LP38858.....	108		
LP2997 .....	138	LP38859 .....	108		
LP2998 .....	138	LP39542.....	123, 134		
LP3878 .....	22, 110	LP55271.....	123		
LP3905 .....	52	LP55281.....	123, 135		

# 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  
 Taipei, Taiwan  
 Tokyo, Japan

## Manufacturing Facilities

### Wafer (Die) Fabrication:

Arlington, Texas  
 South Portland, Maine  
 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](http://www.national.com)

### Mailing Address:

PO Box 58090  
 Santa Clara, CA 95052  
[new.feedback@nsc.com](mailto:new.feedback@nsc.com)

### European Headquarters

Livry-Gargan-Str. 10  
 82256 Fürstfeldbruck  
 Germany  
 +49 8141 35 0  
[europe.support@nsc.com](mailto:europe.support@nsc.com)

### Asia Pacific Headquarters

2501 Miramar Tower  
 1 Kimberley Road  
 Tsimshatsui, Kowloon  
 Hong Kong  
 +852 2737 1800  
[ap.support@nsc.com](mailto: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](mailto:jpn.feedback@nsc.com)

