

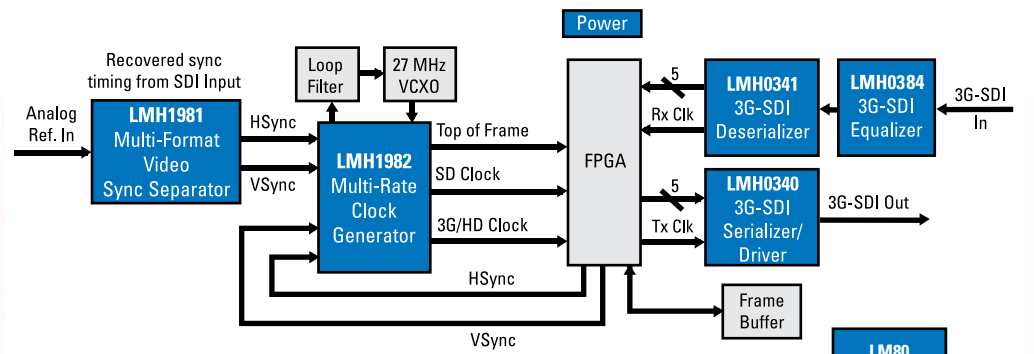
# Professional and Broadcast Video

Solutions Guide

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

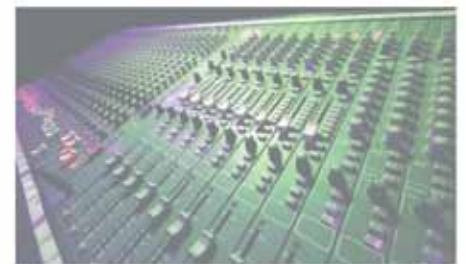
2009 Vol. 2

- SDI
- SerDes
- Clock and Timing
- HDMI
- Analog Video
- Audio
- Thermal Management
- Power Management



START

< broadcast > < PROJECTOR // DIGITAL PROJECTOR // PAL // NTSC // SECAM > --> HDTV << / broadcast >  
widescreen--letterbox < camera > 70mm II 35mm II 16mm II beta II digi-beta II mini-dv </ >  
< aspect ratio > 4:3 // 14:9 // 16:9 // beyond </ aspect ratio >



# Enabling Energy Efficiency Through PowerWise® Video Solutions

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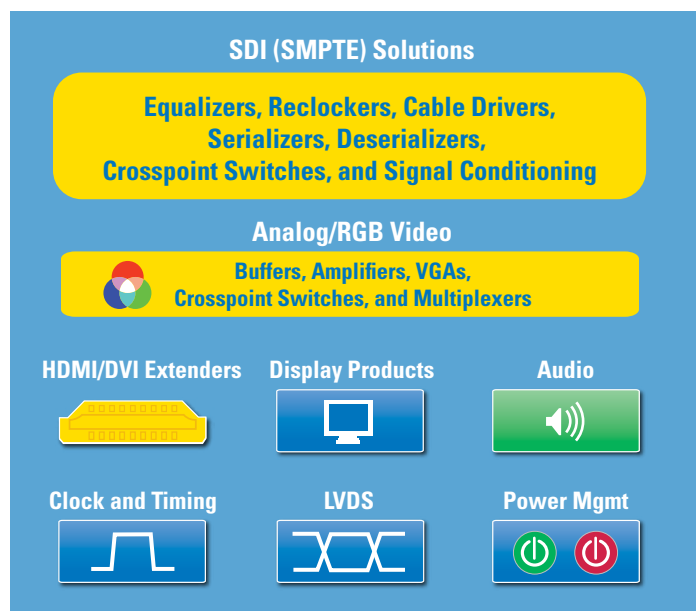
For decades, National Semiconductor has been a trusted advisor and solutions provider to the professional and broadcast video industry. National offers the industry's most comprehensive portfolio of analog and mixed-signal solutions including SDI, video clocking, FPGA-attach IP, analog video, performance audio, power management, LVDS, and signal conditioning products.

Today, energy conservation is driving innovation and forcing smarter design. National's PowerWise® family of ICs, subsystems, and architectures enable hardware designers to minimize power consumption, decrease heat, and improve performance. SDI system PowerWise features such as cable detect (LMH0303/07) and auto sleep (LMH0384) provide designers with intelligent diagnostic tools to evaluate operating conditions and potential faults. With these advanced features, system operators can make educated decisions to power down unused blocks to optimize efficiency, or flag system faults such as loss of signal or cable detachment. Clearly, smarter design results in smarter systems.

National is the only supplier to the broadcast video industry with in-house fabrication and manufacturing. By developing proprietary process technologies, National is able to optimize performance for specific parameters such as ultra-low-noise LC oscillators in BiCMOS that deliver the industry's lowest output jitter and highest input jitter tolerance reclockers. Similarly, National's in-house manufacturing facilities reduce part-to-part variation and guarantee maximum datasheet specifications, thereby delivering best-in-class performance products.

In-house manufacturing enables National to develop custom packages for a perfect-fit design. National's packaging experts work closely with process development technologists and IC designers to deliver the industry's smallest solutions. National's latest microArray and LLP-packaged equalizers, reclockers, and cable drivers can be seen on page 4.

With a proven track record in service, quality, performance, and financial stability, National Semiconductor is committed to investing in and leading the way in technology developments for professional and broadcast video.



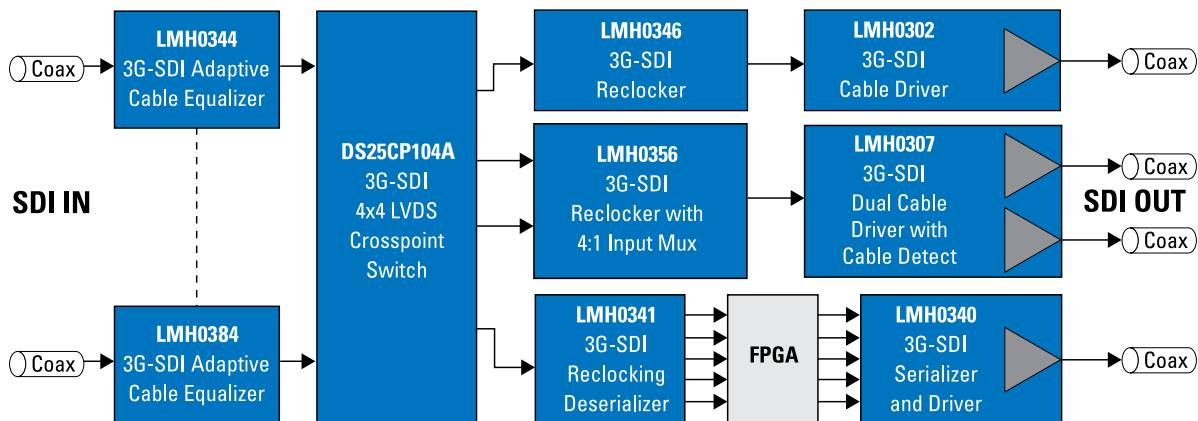
# Comprehensive 3 Gbps SDI Solutions

## 3G/HD/SD SDI Equalizer, Deserializer, Serializer, Reclocker, Cable Driver, and Signal-Conditioning Products

National is the only Tier 1 semiconductor supplier to offer a complete end-to-end solution for the 3 Gbps SDI market. National's broadcast video solutions deliver the right combination of best-in-class jitter performance, system-wide energy efficiency, and small package size for your design.

Each of National's 3G-SDI products has a footprint-compatible counterpart for HD/SD applications to maximize designer flexibility in building a system. For more information on National's SDI portfolio, visit National's SDI website: [national.com/sdi](http://national.com/sdi)

**3G/HD/SD SDI Switcher Simplified Block Diagram**



**Base Portfolio**

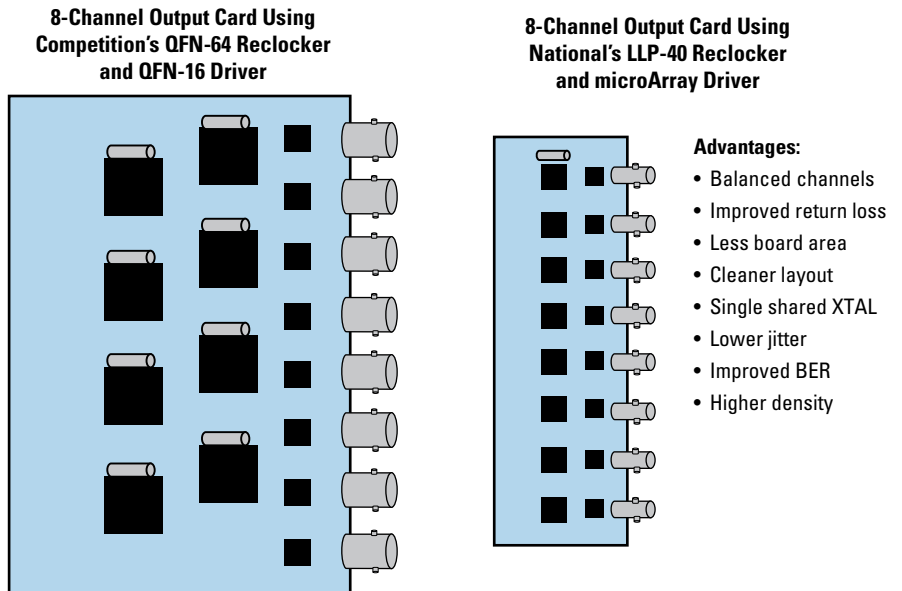
	Equalizers	Reclockers	Cable Drivers	Serializers	Deserializers	Video Clocking Products
<b>3G</b>	LMH0384 LMH0344	LMH0356 LMH0346	LMH0307 LMH0303 LMH0302	LMH0340	LMH0341	LMH1982 LMH1981
<b>HD</b>	LMH0044 LMH0034	LMH0056 LMH0046	LMH0002 LMH0202	LMH0050 LMH0040 LMH0030	LMH0051 LMH0041 LMH0031	
<b>SD</b>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

# Industry's Smallest Packages

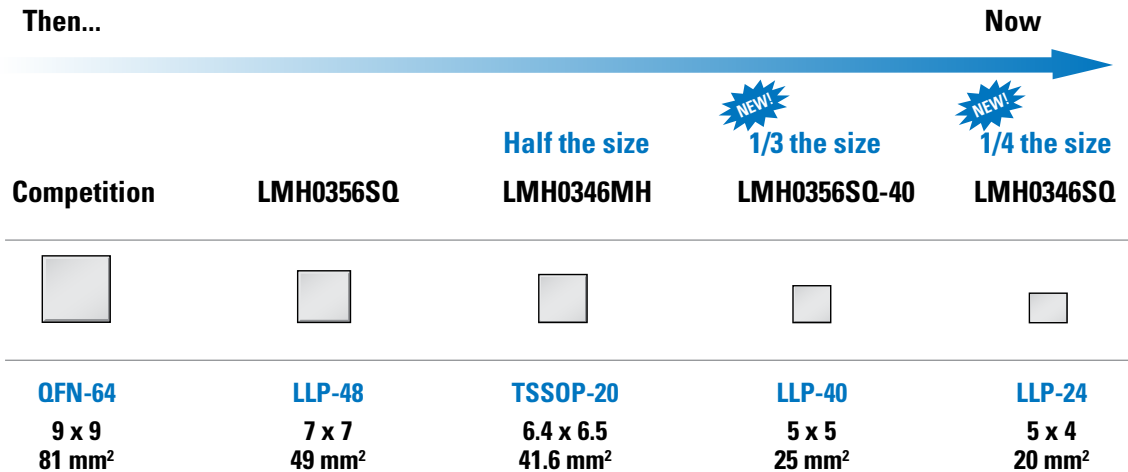
## Features

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

## Cleaner Layout, Reduced Board Area, and Simplified BOM



## Evolution of Reclockers: Size Comparison\*



\*Actual sizes shown

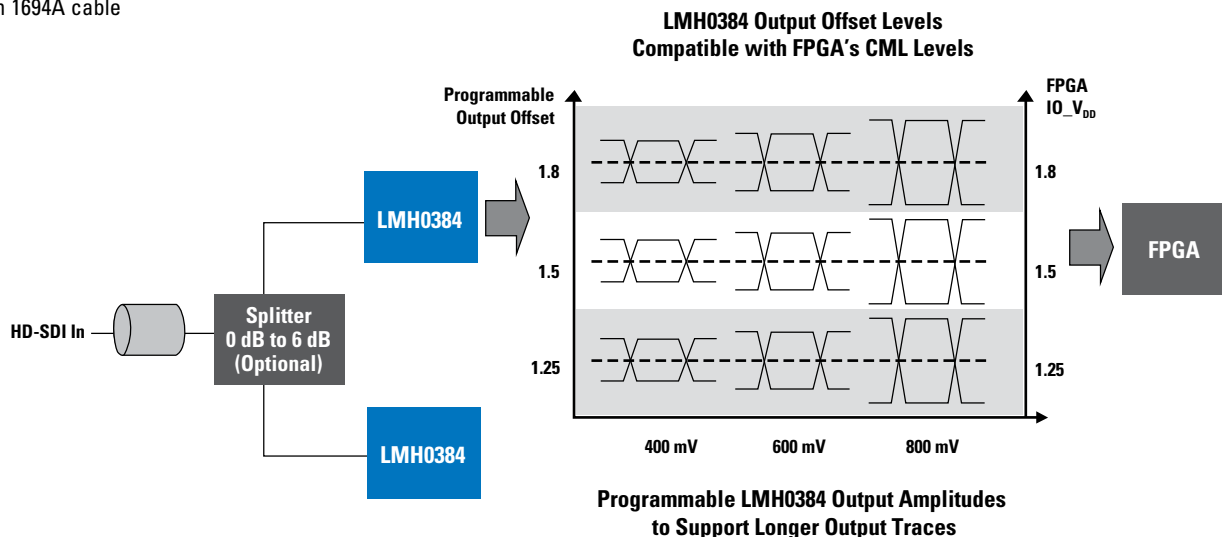
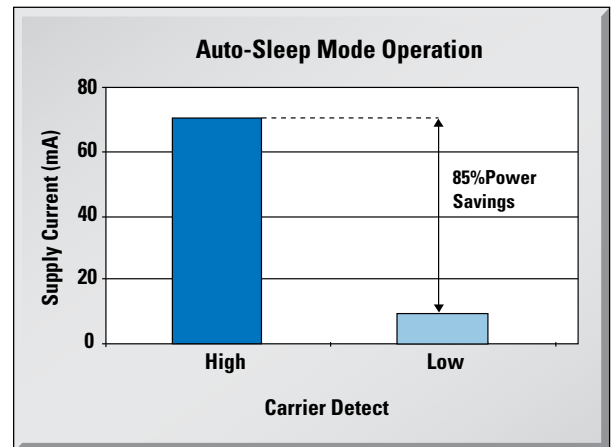
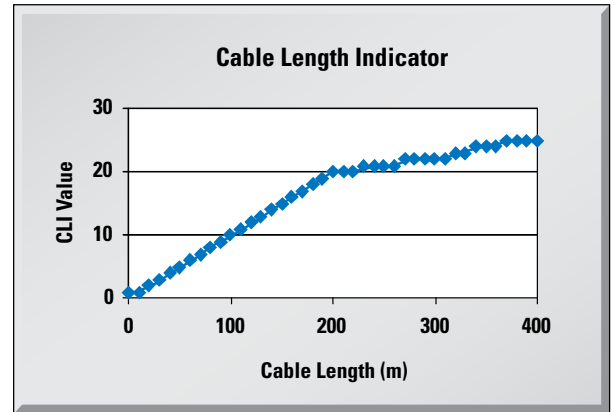
# Configurable 3G SDI PowerWise® Adaptive Cable Equalizer

## LMH0384 – Adaptive Cable Equalizer

### Features

- SMPTE-standard compliant
  - Supports SMPTE 424M (3G), 292M (HD), 259M/C (SD), and DVB-ASI
- Equalized cable lengths\*
  - 140m at 2.97 Gbps
  - 200m at 1.485 Gbps
  - 400m at 270 Mbps
- Power-save mode with auto-sleep control
  - Detects presence of valid input signal
  - 85% power savings in power-save mode
- Low-power LVDS output driver with internal termination
  - Allows DC coupling to most signal conditioning devices
- Two selectable modes of operation
  - Pin mode: compatible with other National equalizers (LMH0344, LMH0044/74)
  - Register mode: SPI interface to access enhanced feature set
- Enhanced feature set in Register mode
  - Cable length indicator
  - Bypass and output mute threshold
  - Input amplitude control: allows operation with external splitters
  - Programmable output common-mode voltage and swing to enable direct coupling to deep sub-micron geometry CMOS FPGAs

\* Belden 1694A cable

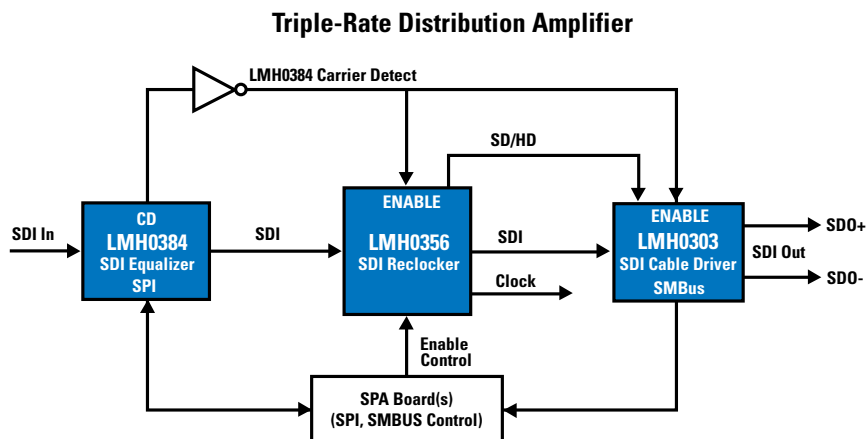


# SDI Equalizers, Reclockers, and Cable Drivers

## PowerWise® Triple-Rate Distribution Amplifier

### Features

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



## SDI Equalizers, Reclockers, and Cable Drivers

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

<sup>1</sup> Temperature ranges: Com: 0°C to 70°C Ext: 0°C to 85°C Ind: -40°C to 85°C

Older products not shown in the table, but still in production include: CLC001AJE, CLC005AJE, CLC006AJE, CLC007AJE

# Flexible IP and High-Performance SerDes for Future-Proof System Solutions

National's SDI SerDes devices and SMPTE protocol processing FPGA firmware provide a complete system solution. Unlike competing solutions that combine SerDes functionality with SMPTE processing in a single chip, National's solution:

- Provides system designers an easy-upgrade firmware path to keep up with evolving SMPTE specifications
- Eliminates expensive and time-consuming silicon re-spins
- Eliminates need for additional board qualifications
- Future-proof system design
- Reduces lifetime cost-of-system maintenance

High-end FPGAs with integrated transceivers use low-geometry CMOS processes and have a high noise floor, causing poor jitter performance. To compensate, designers need additional components such as premium regulators, reference clocks, isolated power and ground planes, and thermal protection that increase design complexity, time, and cost. In contrast, National's SerDes solutions work with cost-effective FPGAs that require few additional components.

National delivers the industry's lowest-output-jitter solution (30 ps p-p) in a package that is 60% smaller than competing solutions. The smaller size enables optimal placement of the SerDes close to BNC connectors, facilitating return loss network design.

## Comparison of System Design Options

	National SerDes	High-end FPGA with Integrated SerDes	SerDes with Integrated SMPTE Processing
System design flexibility to evolve with changing standards	✓	✓	—
Good jitter performance	✓	—	✓
Small board area (Device + additional components)	✓	—	—
Upgradable firmware	✓	✓	—
Low Bill of Materials (BOM) cost	✓	—	—
Fast time to market	✓	—	✓
Embedded audio support (up to 16 channels)	✓	—	—

## SDI Serializers and Deserializers

Product ID	Description	Supply Voltage (V)	Typ. Power (mW)	Data Rate (Mbps)	Temp Range <sup>1</sup>	Eval board Product ID	Packaging
<b>Serializers</b>							
<b>NEW!</b> LMH0340	3G/HD/SD serializer with LVDS interface and integrated cable driver	3.3, 2.5	440	270 to 2970	Ind	SDALTEVK (Altera)	LLP-48
<b>NEW!</b> LMH0040	HD/SD serializer with LVDS interface and integrated cable driver	3.3, 2.5	440	270 to 1485	Ind	SDXILEVK (Xilinx)	LLP-48
<b>NEW!</b> LMH0050	HD/SD serializer with LVDS interface	3.3, 2.5	460	270 to 1485	Ind	SDXILEVK (Xilinx)	LLP-48
<b>NEW!</b> LMH0070	SD serializer with LVDS interface and integrated cable driver	3.3, 2.5	400	270	Ind	SD130EVK	LLP-48
LMH0030	HD/SD serializer with FIFOs, integrated cable driver, 85 ps typical output jitter, no external VCOs required, BIST, and TPG	3.3, 2.5	430	270 to 1485	Com	SD130EVK	TQFP-64
<b>Deserializers</b>							
<b>NEW!</b> LMH0341	3G/HD/SD reclocking deserializer with LVDS interface and active loopthrough	3.3, 2.5	590	270 to 2970	Ind	SDALTEVK (Altera)	LLP-48
<b>NEW!</b> LMH0041	HD/SD reclocking deserializer with LVDS interface and active loopthrough	3.3, 2.5	550	270 to 1485	Ind	SDXILEVK (Xilinx)	LLP-48
<b>NEW!</b> LMH0051	HD/SD reclocking deserializer with LVDS interface	3.3, 2.5	555	270 to 1485	Ind	SDXILEVK (Xilinx)	LLP-48
<b>NEW!</b> LMH0071	SD reclocking deserializer with LVDS interface and active loopthrough	3.3, 2.5	525	270	Ind	SD131EVK	LLP-48
LMH0031	HD/SD deserializer / descrambler with FIFOs, 27 MHz reference, BIST, TPG, and automatic EDH/CRC	3.3, 2.5	850	270 to 1485	Com	SD131EVK	TQFP-64

<sup>1</sup>Temperature ranges: Com: 0°C to 70°C    Ext: 0°C to 85°C    Ind: -40°C to 85°C

# Triple-Rate SDI Development Platform for Altera FPGAs

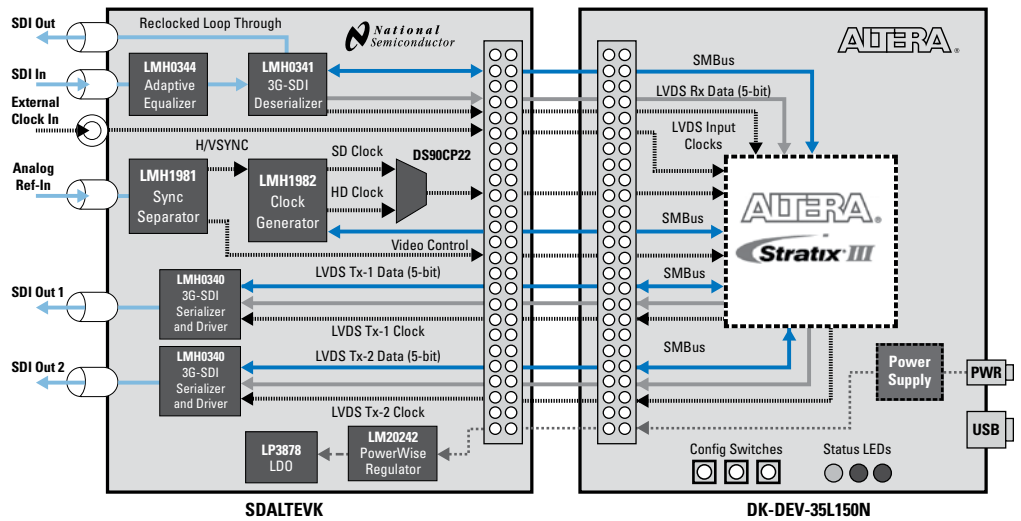
In collaboration with Altera, National Semiconductor has developed a triple-rate SDI and video clocking daughter card for Altera FPGA development kits. National's daughter card is compatible with both the Cyclone-III and the Stratix-III development kits. It plugs directly into the host FPGA development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

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

## Features

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

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

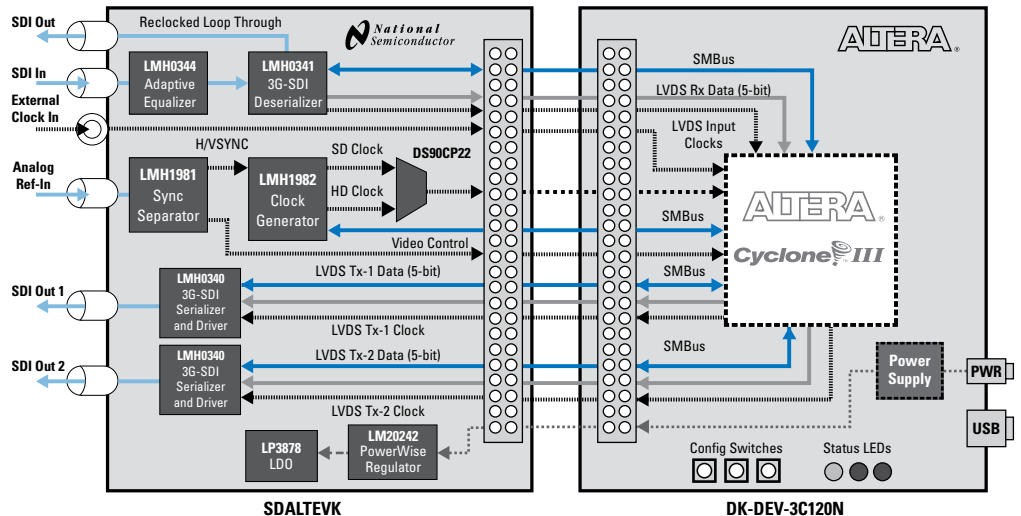


**SDALTEVK: 3G-SDI Development Platform with Altera Cyclone-III FPGA**

— Video  
 Clocks\*  
 Parallel  
— Data Control  
... Power

\*Four clocking options available

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





# Triple-Rate SDI Development Platform for Xilinx FPGAs

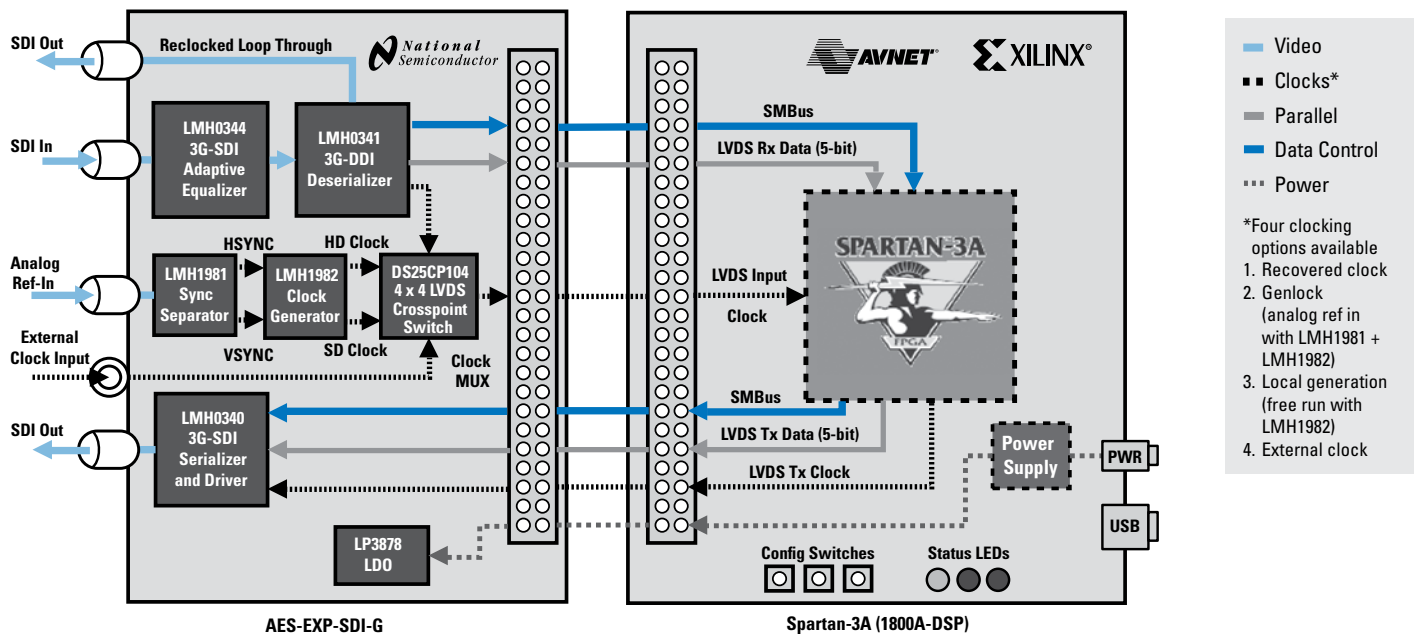
In collaboration with Avnet and Xilinx, National Semiconductor developed a triple-rate SDI and video clocking daughter card for the Xilinx Spartan-3A/3E development kits. The daughter card plugs directly into the Spartan development board through an

EXP connector. The combined solution of the daughter card and the development kit provides broadcast video system designers with a comprehensive platform for rapid evaluation and prototyping of new designs, thereby reducing time to market.

## Features

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

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



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

# Sync Separators and Video Clocking Solutions

## Sync Separators

Product ID	Type	Key Features	Supported Video Formats	Inputs	Outputs	Spec Supply Range (V)	Packaging
LMH1981	50% slicing	Auto-video format detection, 50% sync slicing, low H sync jitter,	NTSC, PAL, SECAM, 480i/p, 576i/p, 720p, 1080i/p	0.5 to 2.0 V <sub>p-p</sub>	H sync, V sync, C sync, odd/even, burst/clamp, video format	3.3 - 5	TSSOP-14
LMH1980	70 mV fixed	Auto-video format detection	NTSC, PAL, SECAM, 480i/p, 576i/p, 720p, 1080i/p, PC Sync on Green	0.5 to 2.0 V <sub>p-p</sub>	H sync, V sync, C sync, odd/even, burst/clamp, HD detect flag	3.3 - 5	MSOP-10

## Clock Generators

Product ID	Key Features	Number of Inputs	Inputs Reference	Number of Outputs	Output Clock Frequencies (MHz)	Supply (V)	Packaging
LMH1982	Simultaneous SD and 3G/HD clock outputs, exceeds SMPTE jitter spec, genlock and free-run modes, programmable output top-of-frame pulse generator	2	H/V Sync, and/or 27 MHz	2	SD: Clock 27 or 67.5 MHz 3G/HD Clock: 74.25, 74.25/1.001, 148.5 or 148.5/1.001 MHz	3.3 and 2.5	LLP-32

## LMH1981 Lowest Jitter Sync Separator for HD Video Formats Featuring 50% Sync Slicing

### Features

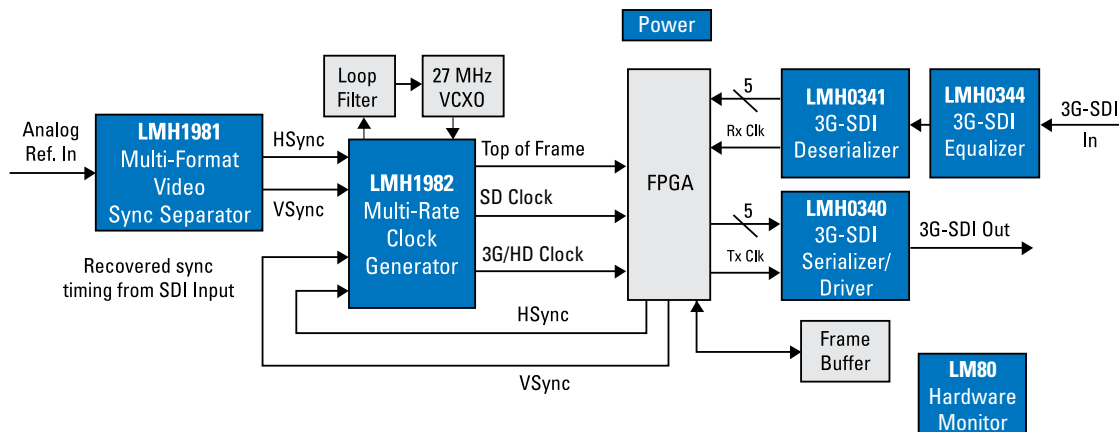
- 50% sync slicing
- Low-jitter horizontal sync outputs
- Supports NTSC, PAL, SECAM, 480i/p, 576i/p, 720p, 1080i/p
- Accepts video signals from 0.5 V<sub>p-p</sub> to 2.0 V<sub>p-p</sub>
- No external programming with  $\mu\text{C}$  required
- Horizontal sync output propagation delay < 50 ns
- 3.3V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

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

### Features

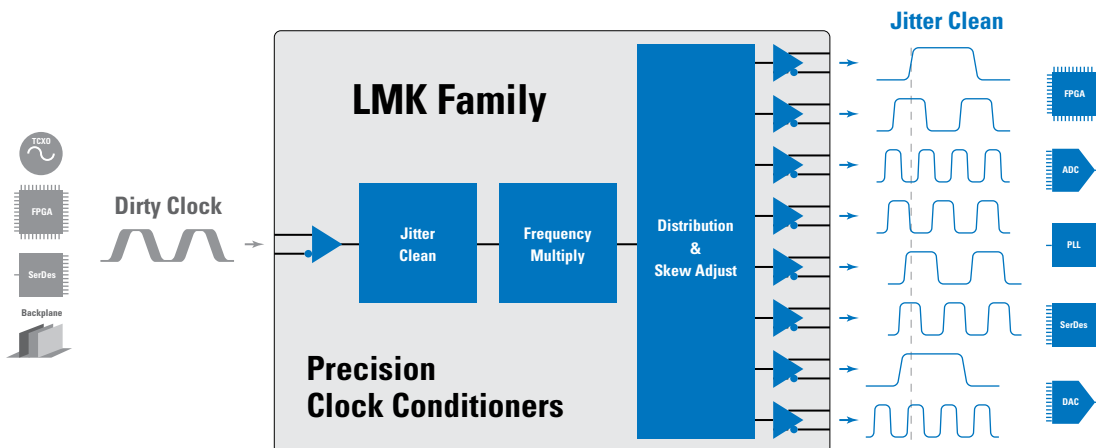
- Two reference ports for genlocking the outputs
  - H and V sync inputs for NTSC/525i, PAL/625i, 525p, 625p, 720p, 1080i, 1080p video timing
- Simultaneous SD and 3G/HD LVDS-compatible clock outputs
- Achieves low jitter output clocks capable of directly driving FPGA serializers with no additional clock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

### Genlock and Video Timing Interface



# LMK Clock Conditioner Family

## Jitter Cleaning + Multiplication + Distribution



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

\*Integrated from 10 kHz to 20 MHz <sup>E</sup> Evaluation board <sup>W</sup> WEBENCH enabled

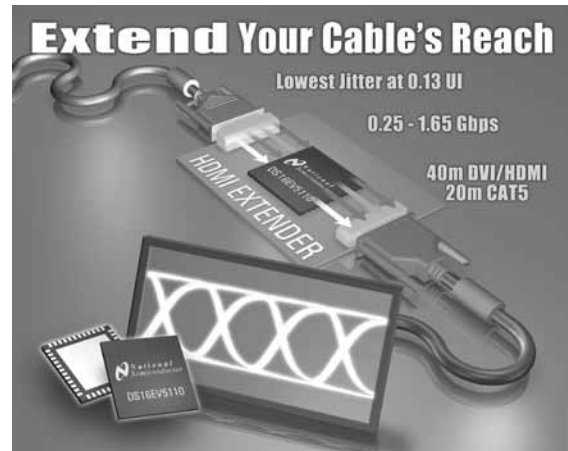
# Eye-Opening Cable Equalizers for HDMI/DVI Applications

## Features

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

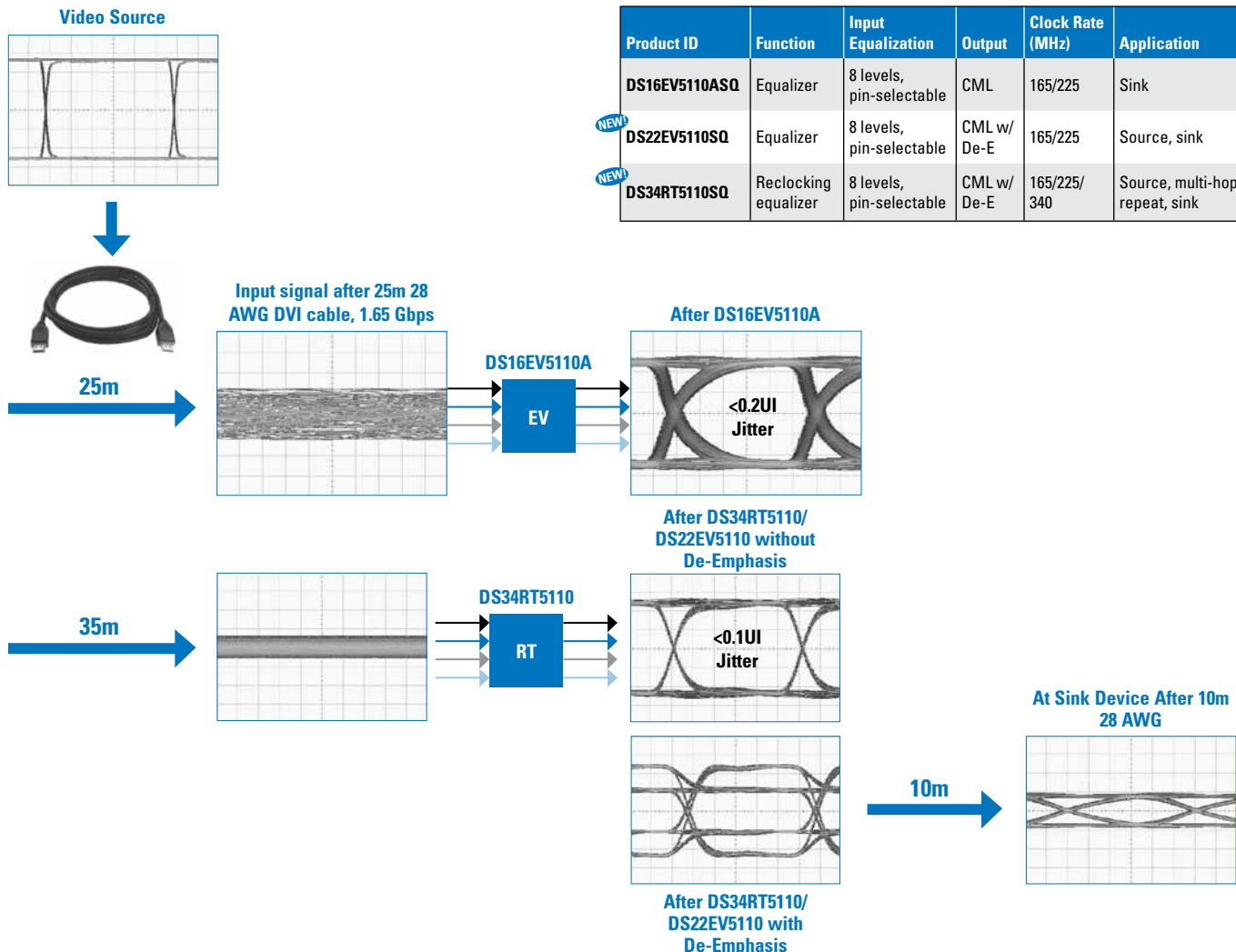
## Applications

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

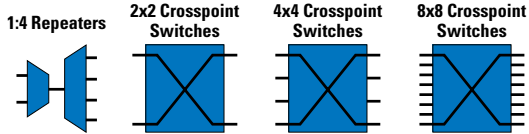


## Cable Extending Equalizers

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



# High-Speed Switching and Signal Conditioning



## Signal Conditioning

### Buffers and Repeaters



Product ID	Function	Inputs	Outputs	Input Compatibility	Output	Pre-emphasis (dB)	Receive Equalization (dB)	Max Speed/Ch (Mbps)	Package	Comments
DS15BR400TSQ/TVS	Quad LVDS buffer	4	4	LVDS/LVPECL/CML	LVDS	0/6	—	2000	LLP-32, TQFP-48	Int termination, 15 kV ESD
DS15BR401TSQ/TVS	Quad LVDS buffer	4	4	LVDS/LVPECL/CML	LVDS	0/6	—	2000	LLP-32, TQFP-48	15 kV ESD
DS25BR440SQ	Quad LVDS buffer	4	4	LVDS/LVPECL/CML	LVDS	0/6	0/6	3125	LLP-40	Loss of signal
DS25BR100TSD	LVDS repeater	1	1	LVDS/LVPECL/CML	LVDS	0/6	4/8	3125	LLP-8	
DS25BR110TSD	LVDS equalizer	1	1	LVDS/LVPECL/CML	LVDS	—	0/4/8/12	3125	LLP-8	
DS25BR120TSD	LVDS buffer	1	1	LVDS/LVPECL/CML	LVDS	0/3/6/9	—	3125	LLP-8	

### Crosspoint Switches/Splitters

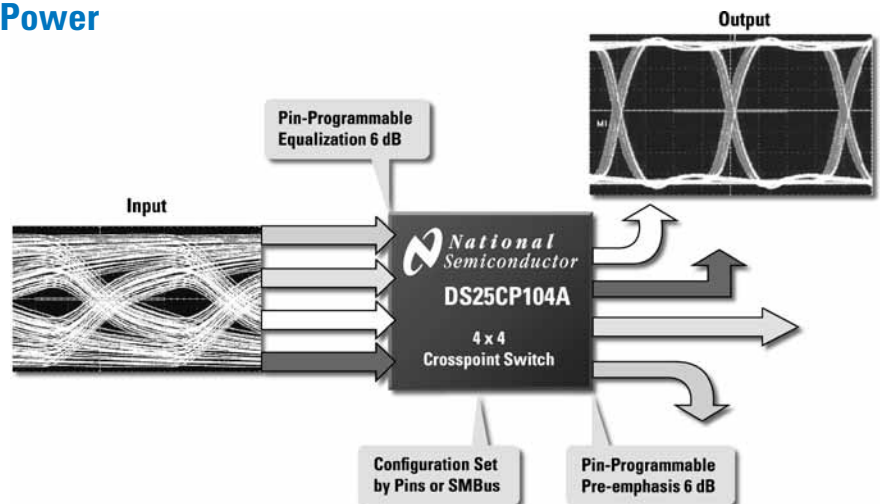
Product ID	Description	Supply Voltage (V)	Typ. Power (mW)	Max Speed/Ch (Mbps)	Total Jitter (psp-p)	ESD (kV)	Eval board Product ID	Package	Comments
DS25CP102TSQ	2 x 2 LVDS crosspoint switch	3.3	254	3125	12	8.0	DS25CP102EVK	LLP-16	Transmit pre-emphasis and receive equalization
DS25CP104TSQ	4 x 4 LVDS crosspoint switch	3.3	518	3125	10	8.0	DS25CP104EVK	LLP-40	Transmit pre-emphasis and receive equalization
DS25CP152TSQ	2 x 2 LVDS crosspoint switch	3.3	211	3125	3.0	8.0	DS25CP152EVK	LLP-16	
DS10CP152TMA	2 x 2 LVDS crosspoint switch	3.3	191	1500	9.0	7.0	DS10CP152EVK	SOIC-16	
DS10CP154TSQ	4 x 4 LVDS crosspoint switch	3.3	380	1500	12	8.0	DS10CP154EVK	LLP-40	SMBus interface
DS25BR204TSQ	1:4 LVDS repeater	3.3	495	3125	9.0	8.0	DS25BR204EVK	LLP-40	Transmit pre-emphasis and receive equalization
DS10BR254TSQ	1:4 LVDS repeater	3.3	373	1500	7.0	8.0	—	LLP-40	

PowerWise product

## DS25CP104A Lowest Jitter, Lowest Power 4 x 4 LVDS Crosspoint

### Features

- 3.125 Gbps max data rate
- 10 ps typ jitter
- I<sub>CC</sub> 37 mA per channel (typ)
- 6 dB pin-programmable equalization compensates for lossy cables, backplanes
- 6 dB pin-programmable pre-emphasis for improved cable driving
- Crosspoint configurable using external pins or SMBus
- Available in LLP-40 packaging



# Analog Video Amplifiers and Buffers

Product ID	Key Features	SSBW (MHz)	Av (V/V)	Slew Rate (V/ $\mu$ s)	I <sub>CC</sub> (mA/ch)	Spec. Supply Range (V)	2nd/3rd HD into R <sub>L</sub> = 100 $\Omega$	NTSC Diff. G/P %/Deg.
<b>Fully Differential Amplifiers</b>								
LMH6550	Fully differential amplifier with disable	400	1	3000	20	4.5 to 12	-78/-88 at 20 MHz, R <sub>L</sub> = 800 $\Omega$	—
LMH6551	Fully differential amplifier	370	1	2400	12.5	3.0 to 12	-94/-96 at 5 MHz, R <sub>L</sub> = 800 $\Omega$	—
NEW LMH6552	Fully differential amplifier with disable	1500	1	3800	22.5	4.5 to 12	-92/-93 at 20 MHz, R <sub>L</sub> = 800 $\Omega$	—
<b>Consumer Video Applications</b>								
LMH6601 <sup>E</sup>	250 MHz, 2.4V CMOS op amp with shutdown	125	2	260	9.2	2.4 to 6.0	-79/-69 at 10 MHz into R <sub>L</sub> = 1 K $\Omega$	0.06/0.23
NEW LMH6611/12 <sup>E</sup>	365 MHz rail-to-rail output amplifier	365	1	460	3.2	2.7 to 11	-69/-74 R <sub>L</sub> =1k $\Omega$	0.05/0.05
LMH6643/44	130 MHz, 75 mA rail-to-rail output amplifiers	130	1	135	2.7	3.0 to 12.8	-62 at 5 MHz	0.15/0.04
LMH6647	Rail-to-rail input/output, low power, shutdown VFB	55	1	22	0.73	2.5 to 12	N/A	N/A
LMH6657/58 <sup>E</sup>	270 MHz single supply, CMIR < 0V amplifiers	270	1	700	6.5	3.0 to 12	-70/-57 at 5 MHz	0.03/0.1
LMH6682/83	3V single supply, CMIR < 0V, low diff. gain/phase amp	190	2	940	6.5	3.0 to 12	-66/-54 at 5 MHz	0.01/0.08
<b>High-End Professional Video Applications</b>								
LMH6609	900 MHz, 1400 V/ $\mu$ s VFB amplifier	900	2	1400	7.0	$\pm$ 6.6	-63 /-57 at 20 MHz	0.01/0.026
LMH6702	Ultra-low distortion, wide bandwidth op amp	1700	2	3100	12.5	$\pm$ 5.0 to $\pm$ 6.0	-63/-70 at 60 MHz	0.01/0.02
LMH6703	Low distortion, op amp with shutdown	1.2 GHz	2	3300	11.5	$\pm$ 5.0 to $\pm$ 6.0	-80/-90 at 5 MHz	0.02/0.02
LMH6714	Wideband video op amp	400	2	1800	5.6	$\pm$ 5.0 to $\pm$ 6.0	-58/-70 at 20 MHz	0.01/0.01
LMH6715	Wideband video op amp	400	2	1300	5.8	$\pm$ 5.0 to $\pm$ 6.0	-60/-75 at 20 MHz	0.02/0.02
LMH6720	Wideband video, disable	400	2	1800	5.6	$\pm$ 5.0 to $\pm$ 6.0	-58/-70 at 20 MHz	0.02/0.01
LMH6722	Wideband video op amp	400	2	1800	5.6	$\pm$ 5.0 to $\pm$ 6.0	-58/-70 at 20 MHz	0.01/0.01
LMH6732	Adjustable supply current vs bandwidth	540 (1.5 GHz)	2	2700	9.0	$\pm$ 4.5 to $\pm$ 6.0	-60/-64 at 20 MHz	0.02/0.01
NEW LMH6733	Triple wideband amplifier with shutdown	1 GHz	1	3750	5.5	3.0 to 12	-72/-63 at 10 MHz	0.03/0.025
LMH6738	Triple wideband op amp individual disable	750	1	3300	11.6	8.0 to 12	-80/-90 at 5 MHz	0.02/0.01
<b>Video Buffers/Programmable Gain Buffers</b>								
LMH6559	Ultra-high slew rate, closed-loop buffer	1.75 GHz	1	4580	10	3.0 to $\pm$ 5.0	-58/-53 at 20 MHz	0.06/0.02
LMH6704	Buffer with shutdown	650	1	3000	11.5	8.0 to 12	-62/-78 at 10 MHz	0.02/0.02
LMH6739	RGB buffer with shutdown	750	1	3300	11.5	8.0 to 12	-80/-90 at 20 MHz	0.02/0.01

1 Blank evaluation board: A=CLC730227/CLC730027; B=CLC730036; C=CLC730031/CLC730231; D=CLC730245; E=CLC730145; F=CLC730033/CLC730146; G=CLC730066/CLC730166; M=LMH730275, N=LMH730154, P=LMH730276, Q=LMH730277 and S=LMH730277 Note: Evaluation boards accompany sample requests and cannot be ordered separately.

2 Temperature ranges: COM = 0°C to 70°C Ext = 0°C to 85°C Ind = -40°C to 85°C

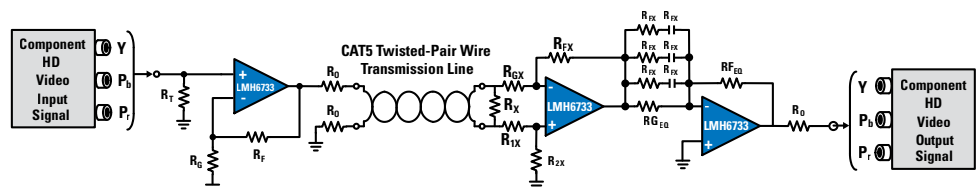
PowerWise® product <sup>E</sup> Evaluation board

## NEW LMH6733 – Triple Amplifier with Industry's Best Bandwidth-to-Power Ratio

### Features

- 1.0 GHz -3 dB small signal bandwidth (A<sub>v</sub> = +1, V<sub>S</sub> =  $\pm$ 5V)
- 600 MHz -3 dB large signal bandwidth (A<sub>v</sub> = +2, V<sub>S</sub> =  $\pm$ 5V)
- 350 MHz 0.1 dB gain flatness
- -80 dB crosstalk at 10 MHz
- 5.5 mA/channel supply current
- Single supply operation: 3V to 12V

### LMH6733 Typical Application



$I_{OUT}$ (mA) (typ.)	Settling Time (2V step) (ns to %)	VOS Typ./Temp. (mV)	Voltage Noise (nV/√Hz)	$i_{nn}$ (pA/√Hz)	$i_{ni}$ (pA/√Hz)	Temp. Range (°C)	SPICE Model	Blank Eval. Board <sup>1</sup>	Package Type	Packaging
<b>Fully Differential Amplifiers</b>										
±75	8.0 to 0.1	0.5	6.0	1.5	—	-40 to 85	✓	N	Single	SOIC-8, MSOP-8
±65	18 to 0.05	0.5	6.0	1.5	—	0 to 85	✓	N	Single	SOIC-8, MSOP-8
±80	10 to 0.1	1.5	1.1	19.5	—	-40 to 85	✓	N	Single	SOIC-8, LLP-8
<b>Consumer Video Applications</b>										
+50/-75	70 to 0.1 <sup>3</sup>	1/5	10	0.05	0	-40 to 85	—	T	Single	SC70-6
120	60 to 0.1	0.074/1.1	10	2.0	2.0	-40 to 85	✓	Y	Single/Dual	TSOT23-6/SOIC-8
75	68 to 0.1	1/7	17	0.9	0.9	-40 to 85	✓	B/C	Dual/Quad	SOIC-8, MSOP-8/SOIC-14, TSSOP-14
20	N/A	1/4	17	0.75	0.75	-40 to 85	✓	A	Single	SOIC-8, SOT23-6
110	35 to 0.1	1/7	11	2.1	2.1	-40 to 85	✓	B	Single/Dual	SC70-5, SOT23-5, SOIC-8, MSOP-8
85	42 to 0.1	1/7	12	3.0	3.0	-40 to 85	✓	B/C	Dual/Triple	SOIC-8, MSOP-8, SOIC-14, TSSOP-14
<b>High-End Professional Video Applications</b>										
90	15 to 0.05	—	4.0	1.0	1.0	-40 to 85	✓	A	Single	SOIC-8, SOT23-5
80	13.4 to 0.1	1/6	1.83	3.0	18.5	-40 to 85	✓	A	Single	SOIC-8, SOT23-5
90	10 to 0.1	0.5/6	2.3	3.0	12	-40 to 85	✓	A	Single	SOT23-6, SOIC-8
70	12 to 0.05	0.2/8	3.4	1.2	10	-40 to 85	✓	A	Single	SOIC-8, SOT23-5
70	12 to 0.05	2/8	3.4	1.4	10	-40 to 85	✓	B	Dual	SOIC-8
70	12 to 0.05	0.2/8	3.4	1.2	10	-40 to 85	✓	B	Single	SOIC-8
70	12 to 0.05	0.2/8	3.4	1.2	10	-40 to 85	✓	C	Quad	SOIC-14
115	18 to 0.04	3/9.9	2.5	1.8	9.7	-40 to 85	✓	A	Single	SOT23-6, SOIC-8
60	10 to 0.1	2.0/2.5	2.1	26.9	18.6	-40 to 85	✓	M	Triple	SSOP-16
90	13.4 to 0.1	0.5/2.5	2.0	4.0	12	-40 to 85	✓	M	Triple	SSOP-16
<b>Video Buffers/Programmable Gain Buffers</b>										
74	9.0 to 0.1	3/25	2.8	1.6	N/A	-40 to 85	✓	D	Single	SOIC-8, SOT23-5
90	10 to 0.1	2/9.3	2.3	3.0	12	-40 to 85	✓	A	Single	SOT23-6, SOIC-8
90	10 to 0.1	0.5/4.5	2.3	3.0	12	-40 to 85	✓	M	Triple	SSOP-16

<sup>1</sup> Blank evaluation board: A=CLC730227/CLC730027; B=CLC730036; C=CLC730031/CLC730231; D=CLC730245; E=CLC730145; F=CLC730033/CLC730146; G=CLC730066/CLC730166, M=LMH730275, N=LMH730154, P=LMH730276, Q=LMH730277 and S=LMH730277 Note: Evaluation boards accompany sample requests and cannot be ordered separately.

# Multiplexers, VGAs, and Crosspoint Switches for Analog Video

Product ID	Single/Dual/Triple/Quad	Key Features	Single Channel BW (MHz)	Control Channel BW (MHz)	Gain Adjust Range (dB)	Slew Rate SR (V/ $\mu$ s)	Supply Voltage Vs (V)	Supply Current Is (mA)	Common Mode Input Range CMIR (V)	Gain Response	Temp. Range ( $^{\circ}$ C)	SPICE Model	Blank Eval Board <sup>1</sup>	Packaging
<b>Video Equalizer</b>														
LMH6502	S	Differential input	130	100	70	1800	5.0 to 12	27	$\pm$ 2.2	Linear-in-dB	-40 to 85	Y	F	SOIC-14, TSSOP-14
LMH6503	S	Differential input	135	100	70	1800	5.0 to 12	37	$\pm$ 2.2	Linear-in-V/V	-40 to 85	Y	F	SOIC-14, TSSOP-14
LMH6505	S	Single-ended input	150	100	80	1500	7.0 to 12	11	$\pm$ 3.0	Linear-in-dB	-40 to 85	Y	G	SOIC-8, MSOP-8

Product ID	Channels	Key Features	SSBW (MHz)	Switching Speed (ns)	Crosstalk Rejection (dB)	Settling Time to 0.1% (ns)	2nd/3rd HD into $R_L=100\Omega$ (dBc)	$I_{OUT}$ [mA] (typ.)	Supply Current $I_{CC}$ (mA)	Spec. Supply Range (V)	Temp. Range ( $^{\circ}$ C)	SPICE Model	Blank Eval Board <sup>1</sup>	Packaging
<b>High-Performance Multiplexer Products</b>														
LMH6570	2:1	Buffered video mux, shutdown	500	8.0	85	17	-68/-84 at 5 MHz	80	13	$\pm$ 3.3 to $\pm$ 5	-40 to 85	Y	S	SOIC-8
LMH6572	Triple 2:1	Buffered video mux, 2x gain stage disable	350	10	90	17	-78/-75 at 10 MHz	80	23	$\pm$ 3.3 to $\pm$ 6	-40 to 85	Y	N	SSOP-16
LMH6574	4:1	Buffered video mux, shutdown	500	8.0	70	17	-68/-84 at 5 MHz	75	13	$\pm$ 3.3 to $\pm$ 5	-40 to 85	Y	P	SOIC-14, TSSOP-14

Product ID	Channels	Key Features	SSBW (MHz)	Slew Rate (V/ $\mu$ s)	Crosstalk Rejection (dB)	Settling Time	Diff. G/P %/deg. into $R_L=150\Omega$	2nd/3rd HD into $R_L=100\Omega$ (dBc)	$I_{OUT}$ (mA) (typ.)	Temp. Range ( $^{\circ}$ C)	Spec. Supply	Packaging
<b>High-Performance Crosspoint Switch</b>												
NEW LMH6585 <sup>E</sup>	32 x 16	Crosspoint switch, gain+1, +2, serial prog.	400	1200	-43 dB at 100 MHz	15 ns 2V step at 0.5%	0.04/0.03 at 3.58 MHz and 4.43 MHz	-70 at 10 MHz/ -75 at 10 MHz	+/- 45	-40 to 85	$\pm$ 3.0 to $\pm$ 5.0	TQFP-144
LMH6583 <sup>E</sup>	16 x 8	Crosspoint switch, gain +1, +2, serial prog.	550	1900	-70/-45 (10 MHz/100 MHz)	18 ns 2V step at 0.1%	0.04/0.04 at 3.58 MHz and 4.43 MHz	-74 at 20 MHz/ -77 at 5 MHz	$\pm$ 60	-40 to 85	$\pm$ 3.0 to $\pm$ 5.0	eTQFP-64

Product ID	Channels	Key Features	SSBW (MHz)	LSBW (MHz)	Crosstalk Rejection (dB)	Diff. G/P %/deg. into $R_L=150\Omega$	Temp. Range ( $^{\circ}$ C)	Spec. Supply	Packaging
<b>Composite Video Crosspoint Switch</b>									
NEW LMH6586 <sup>E</sup>	32 x 16	Video clamps, loss of video det., I <sup>2</sup> C prog.	66	29	-58 db at 6 MHz	0.05/0.05 at 3.58 MHz	-40 to 85	5V	TQFP-80

<sup>1</sup> A=CLC730227/027; B=CLC730036; C=CLC730031/231; D=CLC730245; E=CLC730145; F=CLC730033/146; G=CLC730066/166; M=LMH730275; N=LMH730151; P=LMH730276; Q=LMH730277 and S=LMH730277 Note: Evaluation boards accompany sample requests only.

PowerWise<sup>®</sup> product      <sup>E</sup> Evaluation board

## LMH6570/72/74 – Family of Multiplexers

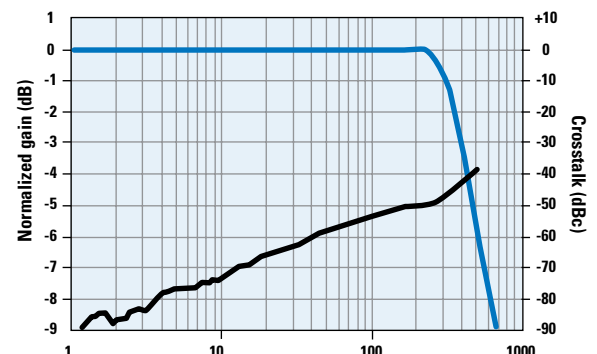
### LMH6570/74 Features

- Single 2:1 Mux (LMH6570)
- Single 4:1 Mux (LMH6574)
- 400 MHz, 2 V<sub>P-P</sub>, -3 dB bandwidth
- 0.1 dB gain flatness to 150 MHz
- 8 ns channel switching time

### LMH6572 Features

- Triple 2:1 Mux
- 290 MHz, 2 V<sub>P-P</sub>, -3 dB bandwidth
- 0.1 dB gain flatness to 140 MHz
- 10 ns channel switching time

### LMH6574 Performance Bandwidth vs Crosstalk





## LMH6583 – Industry’s Fastest Analog Crosspoint Switches for High-Resolution Video Applications

### Features

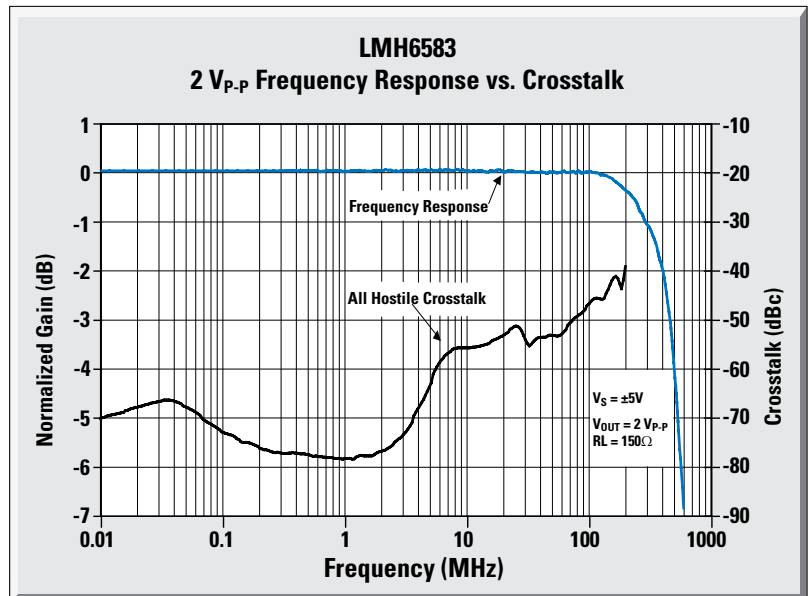
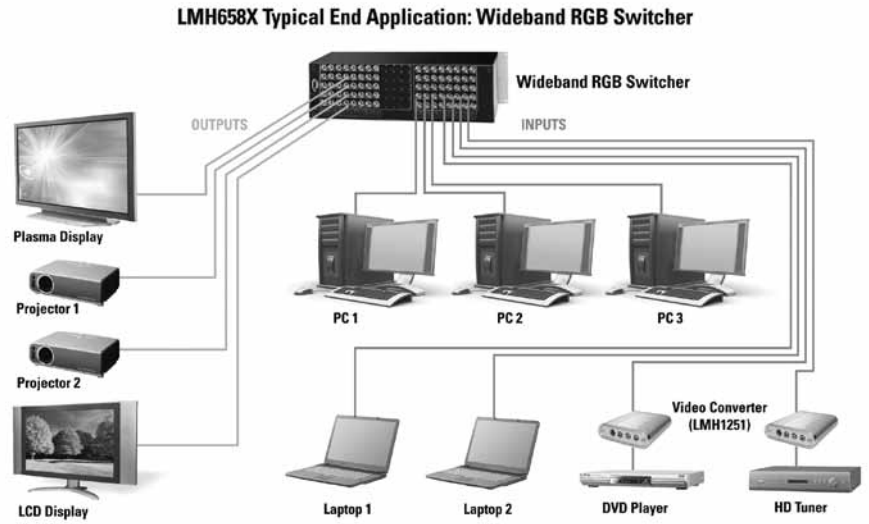
- 550 MHz, -3 dB bandwidth
- Fast slew rate: 1900 V/ $\mu$ s
- 100 MHz, 0.1 dB gain flatness
- Low crosstalk:
  - -70 dBc at 10 MHz (channel-to-channel)
  - -45 dBc at 100 MHz (all hostile)
- Gain of 2
- Diagonally symmetrical pin configuration
- Ease of control: 4-pin serial interface
- Available in eTQFP-64 packaging

### Expansion Options

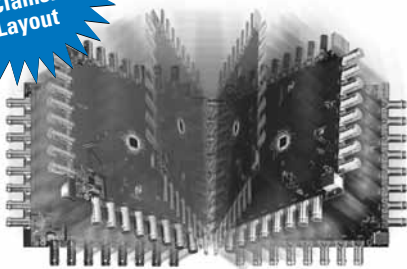
- One-chip solution: 16 inputs, 8 outputs
- Two-chip solution: 16 inputs, 16 outputs\* or 32 inputs, 8 outputs

### Applications

Ideal for use in conference room systems, KVM (Keyboard, Video, and Mouse) systems, security and surveillance systems, multimedia video systems, and professional A/V systems



Symmetrical Pin-out Allows for "Clamshell" Layout



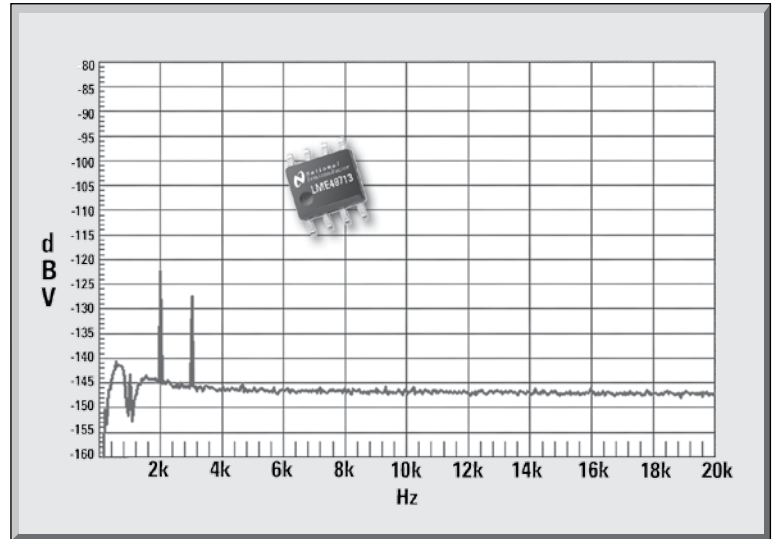
\* 16 x 16 configuration using two LMH6583 devices on opposite sides of the board is shown above

# High-Performance, High-Fidelity Audio Products

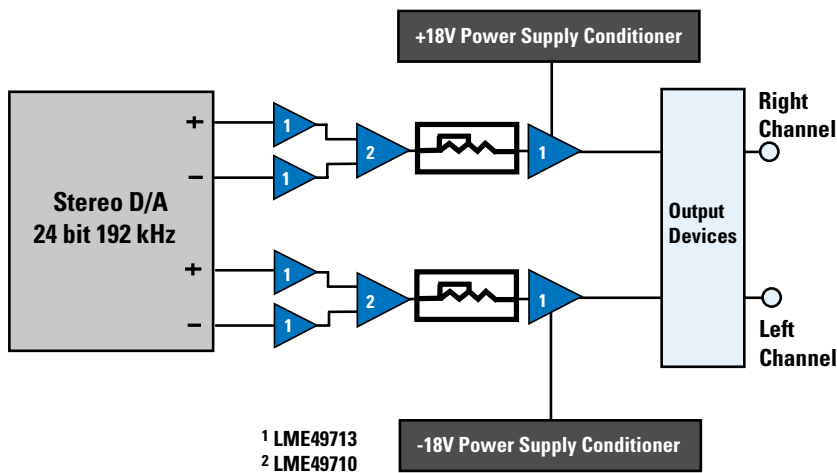
## LME49713 Current Feedback Op Amp FFT Plot

### LME49713 Features

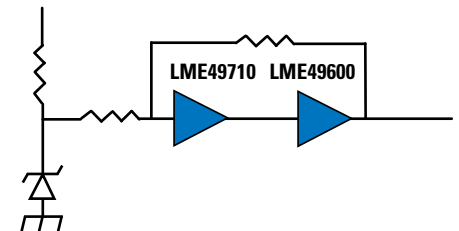
- Extended dynamic range: 139 dB
- Distortion and noise <0.00008%
- +22 dBu input/output handling capability
- Slew rate: 1900 V/μs ensures accurate bandwidth and high dynamic range
- Operates from ±5V to ±8V



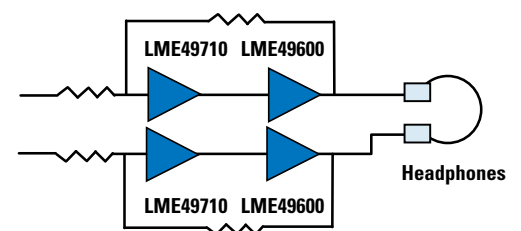
### Digital-to-Analog Converter



### Power Supply Voltage Conditioner



### Buffer Headphone



## Performance Audio Products

Product ID	Type	Channels	V <sub>CC</sub> (V)	I <sub>CC</sub> (per amp)	THD+N	Bandwidth (MHz)	Slew Rate (V/μs)	Noise (nV/√Hz)	V <sub>OS</sub> (mV)	I <sub>BIAS</sub> (μA)
LME49710	Variable Feedback	1	34	5 mA	0.00003%	55	20	2.5	0.1	10 nA
LME49713	Current Feedback	1	36	8 mA	0.00008%	132	1900	1.9	0.05	1.8
LME49600	Buffer	1	36	7.3 mA	0.00003%*	180	2000	2.6	17	1

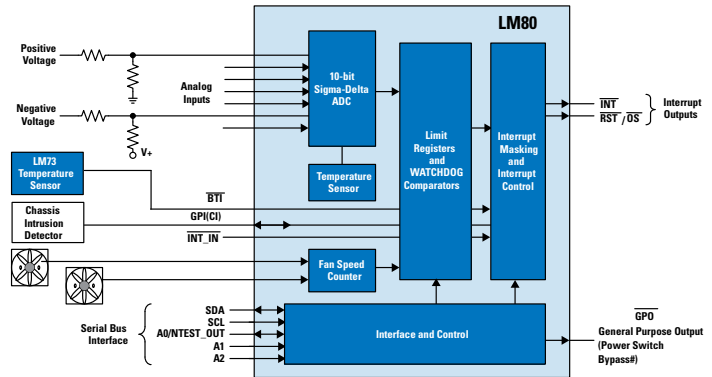
\* Enclosed loop with the LME49710

# Hardware Monitors and Thermal Management

## LM80 – PowerWise® Serial Interface ACPI-Compatible Microprocessor System Hardware Monitor

### Features

- Temperature sensing
- 7 positive voltage inputs
- 2 programmable fan speed monitoring inputs
- 10 mV LSV and 2.56V input range accepts outputs from linear temperature sensors such as the LM50
- WATCHDOG comparison of all monitored values
- Separate input to show status in Interrupt Status Register of additional external temperature sensors such as the LM57
- I<sup>2</sup>C serial bus interface compatibility
- Shutdown mode to minimize power consumption
- Available in TSSOP-24 packaging



### Applications

Ideal for use in routers, switchers, and encoder/decoders

## Selected Temperature Sensors

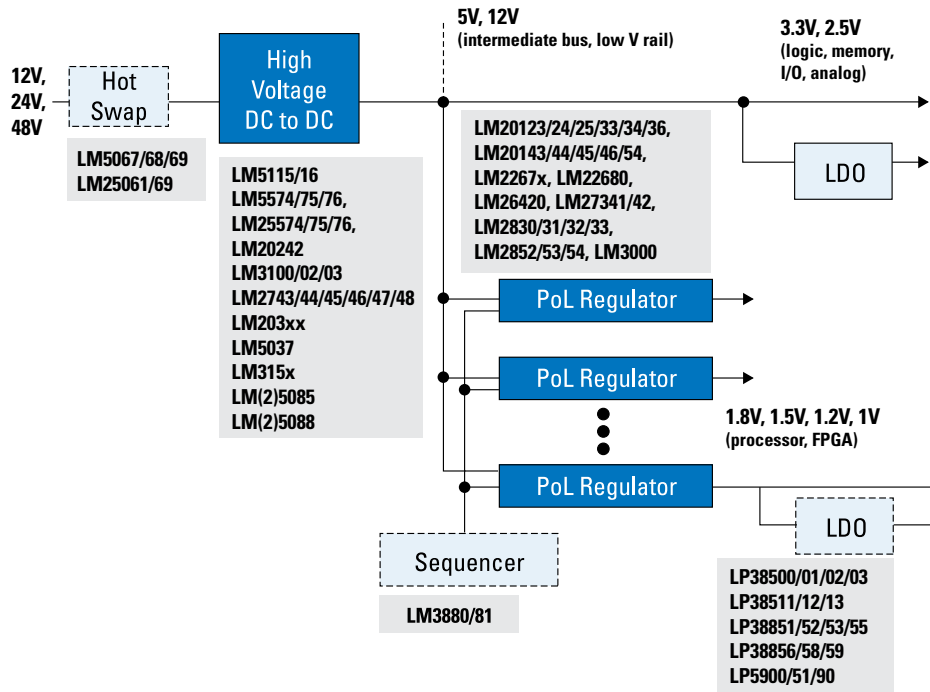
Product ID	Description	Temperature Range (°C)	Accuracy	Scale Factor / Resolution	Power supply voltage (V)	Supply Current	Packaging
<b>Analog</b>							
LM94022	1.5V analog temperature sensor with 4 selectable gains and class-AB output	-50°C to 150°C	± 1.5°C (20°C to 40°C)	-5.5 to -13.6 mV/°C	1.5V to 5.5V	5.4 µA	SC-70
<b>Digital</b>							
LM73	11- to 14-bit, 2-wire local digital temperature sensor	-40°C to 150°C	± 1.0°C (-10°C to 80°C)	0.03125°C/LSB	2.7V to 5.5V	320 µA	SOT23-6
LM75A	9-bit digital temperature sensor and thermal watchdog with two-wire interface	-55°C to 125°C	± 2.0°C (-25°C to 100°C)	0.5°C/LSB	3.0V to 5.5V	250 µA	MSOP-8, SOIC-8
<b>Remote Diode</b>							
LM95214	11-bit quad remote diode temperature sensor with SMBus interface, 3 Tcrit	-40°C to 140°C	± 1.1°C (TA=25°C to 85°C, TD=60°C to 100°C)	0.03125°C/LSB	3.0V to 3.6V	570 µA	LLP-14
<b>Temperature Switch</b>							
LM26LV	1.6 V factory preset temperature switch and temperature sensor	-50°C to 150°C	± 2.2°C (0°C to 150°C)	—	1.6V to 5.5V	8 µA	LLP-6
LM57	2.4V user programmable temperature switch and temperature sensor	-50°C to 150°C	± 1.5, ± 2.3 (-50°C to 150°C)	—	2.4V to 5.5V	24 µA	LLP-8
<b>Hardware Monitor</b>							
LM80	Hardware monitor with voltage monitoring, DAC output, TACH inputs	-40°C to 150°C	± 3.0°C (-25°C to 125°C)	0.0625°C/LSB	2.8V to 5.75V	0.2 mA	TSSOP-24
LM87	Hardware monitor with dual remote diodes, DAC output, TACH inputs	-40°C to 125°C	± 3.0°C (TA=60°C to 125°C)	1°C/LSB	2.8V to 3.8V	0.7 mA	TSSOP-24
LM96194	Hardware monitor, 4 TruTherm® RDTS, 4 fan monitor, 2 fan controls, 8 voltage monitors, closed loop fan control for 4-pin fans	-40°C to 85°C	± 3°C (TA=0°C to 85°C TD=0°C to 100°C)	0.5°C/LSB	3.0V to 3.6V	1.6 mA	LLP-48
LM96163	Hardware monitor with a TruTherm remote clocks and with integrated fan control	-40°C to 140°C	± 0.75°C (TA=±25°C to 85°C TD=50°C to 105°C)	0.125°C/LSB	3.0V to 3.6V	4.56 mA	LLP-10

# Power Products for Broadcast Video

National's analog leadership extends into power management, with a complete portfolio of products for any broadcast video application. National's PowerWise® family spotlights innovative products with industry-leading performance and minimal power

consumption. National's WEBENCH® environment provides end-to-end design and prototyping tools to easily create power supplies that meet your design requirements. Visit National's website today to design a power supply for your video application.

## Power Architecture For Broadcast Video



## SIMPLE SWITCHER® Buck Family

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

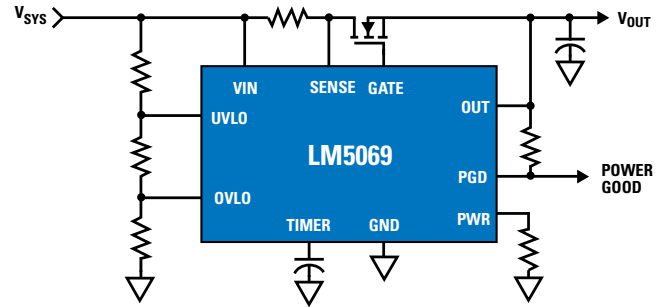
Asynchronous Rectification, Synchronous Rectification, CM = Current Mode Control Loop, VM = Voltage Mode Control Loop, COT = Constant On Time Control

# Hot Swap and PWM Controllers

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

### Features

- In-rush current limit for safe module insertion and removal from live power sources
- Adjustable power limit sets maximum power dissipation in the external pass device and ensures MOSFET stays in Safe Operating Area (SOA)
- Programmable input Under Voltage Lockout (UVLO) and hysteresis
- Programmable input Over Voltage Lockout (OVLO) and hysteresis
- Programmable multifunction timer to prevent nuisance trips
- Programmable Power GOOD flag output using FB pin (LM25061)
- Internal high-side charge pump and gate driver for external N-channel MOSFET
- Available in latched fault and automatic restart versions



### Hot Swap/In-Rush Current Controllers

Product ID	V <sub>IN</sub> Range	POWER GOOD	Adjustable UVLO	Adjustable OVLO	Active In-Rush Current Limit	Active Current Limiting	Active Power Limiting	Fault Latch-Off / Auto Retry	Packaging
LM5067 <sup>E</sup>	-9V to -80V	V <sub>DS</sub>	✓	✓	✓	✓	✓	✓	MSOP-10, LLP-10
LM5069 <sup>E</sup>	+9 to +100V	V <sub>DS</sub>	✓	✓	✓	✓	✓	✓	MSOP-10
<b>NEW</b> LM25061 <sup>E</sup>	+2.9V to +16V	V <sub>OUT</sub> (adj.)	✓	—	✓	✓	✓	✓	MSOP-10
<b>NEW</b> LM25069 <sup>E</sup>	+2.9V to +16V	V <sub>DS</sub>	✓	✓	✓	✓	✓	✓	MSOP-10

### PWM Switching Controllers

Product ID	Description
LM5020 <sup>E</sup>	Single-ended 100V current-mode PWM controller
LM3000	Dual-output emulated current-mode 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 <sup>E</sup>	Active-clamp current-mode 100V PWM controller with 3A gate driver
LM5030 <sup>E</sup>	100V push-pull current-mode PWM controller with synchronization
LM5032	High-voltage dual interleaved current-mode PWM controller
LM5033 <sup>E</sup>	100V push-pull voltage-mode IBC PWM controller with synchronization
LM5034 <sup>E</sup>	High-voltage dual interleaved current-mode controller with active clamp
<b>NEW</b> LM(2)5037 <sup>E</sup>	Dual-mode PWM controller with alternating outputs
LM5041/A <sup>E</sup>	100V input cascaded PWM controller
<b>NEW</b> LM5085/LM25085 <sup>E</sup>	4.5 to 75V/42V constant on-time PFET buck switching controller
<b>NEW</b> LM5088/LM25088 <sup>E</sup>	4.5 to 75/42V non-synchronous buck controller
LM5115/A <sup>E</sup>	Secondary side post regulator controller or synchronous buck controller
LM5116 <sup>E</sup>	6V to 100V current-mode synchronous buck controller
<b>NEW</b> LM5118 <sup>E</sup>	Wide 3V to 75V input, buck-boost controller
LM5035/A/B <sup>E</sup>	High-performance, half-bridge PWM controller-driver for compact, efficient converters

PowerWise® product <sup>E</sup> Evaluation board

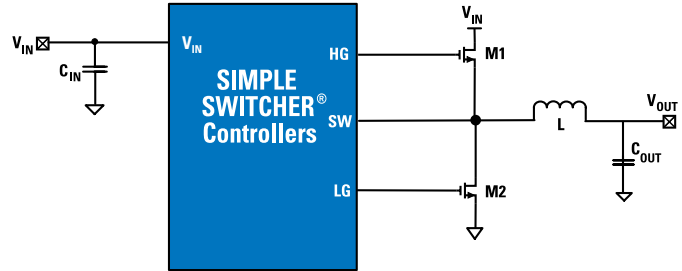
# Synchronous Switching Controllers and Regulators

## **NEW!** LM315x – SIMPLE SWITCHER® Synchronous Controllers

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

### Features

- Input voltage ranging from 6V to 42V
- Output current up to 12A
- Constant On-Time control eliminates the need for complex compensation circuitry
- Patent-pending emulated ripple mode allows for the use of low-ESR output capacitors for reduced solution size and reduced output voltage ripple
- Fully WEBENCH® enabled, including MOSFET selector tool



### LM315x Family of SIMPLE SWITCHER Controllers

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







### High-Current Synchronous Step-Down 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 (computed field)	On/Off Pin	PWM Mode	Packaging
LM20242 <sup>E</sup>	36	4.5	0.8	32	2000	1000	✓	Current-mode control	TSSOP-20
LM20123 <sup>E, W</sup>	5.5	2.95	0.8	5.0	3000	1500	✓	Current-mode control	eTSSOP-16
LM20133 <sup>E, W</sup>	5.5	2.95	0.8	5.0	3000	460 to 1.5 MHz, sync	✓	Current-mode control	eTSSOP-16
LM20143 <sup>E, W</sup>	5.5	2.95	0.8	5.0	3000	500 to 1500	✓	Current-mode control	eTSSOP-16
LM20323 <sup>E, W</sup>	36	4.5	0.8	32	3000	500 KHz	✓	Current-mode control	eTSSOP-20
LM20333 <sup>E, W</sup>	36	4.5	0.8	32	3000	200 to 1500	✓	Current-mode control	eTSSOP-16
LM20343 <sup>E, W</sup>	36	4.5	0.8	32	3000	500, sync	✓	Current-mode control	eTSSOP-20
LM20124 <sup>E, W</sup>	5.5	2.95	0.8	5.0	4000	1000	✓	Current-mode control	eTSSOP-16
LM20134 <sup>E, W</sup>	5.5	2.95	0.8	5.0	4000	460 to 1.5 MHz, sync	✓	Current-mode control	eTSSOP-16
LM20144 <sup>E, W</sup>	5.5	2.95	0.8	5.0	4000	500 to 1000	✓	Current-mode control	eTSSOP-16
LM20154 <sup>E, W</sup>	5.5	2.95	0.8	5.0	4000	1000	✓	Current-mode control	eTSSOP-16
LM20125 <sup>E, W</sup>	5.5	2.95	0.8	5.0	5000	500	✓	Current-mode control	eTSSOP-16
LM20145 <sup>E, W</sup>	5.5	2.95	0.8	5.0	5000	250 to 750	✓	Current-mode control	eTSSOP-16
<b>NEW!</b> LM20136 <sup>E, W</sup>	5.5	2.95	0.8	5.0	6000	460 to 750, sync	✓	Current-mode control	eTSSOP-16
<b>NEW!</b> LM20146 <sup>E, W</sup>	5.5	2.95	0.8	5.0	6000	250 to 750 adj.	✓	Current-mode control	eTSSOP-16











PowerWise® product <sup>E</sup> Evaluation board <sup>W</sup> WEBENCH enabled

# Synchronous Step-Down (Buck) Switching Regulators

## 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)	PWM Mode	Packaging
LM3103 <sup>E, W</sup> 	42	4.5	0.6	38	750	1000	COT	eTSSOP-16
LM3100 <sup>E, W</sup> 	36	4.5	0.8	32	1500	1000	COT	eTSSOP-20
LM2852 <sup>E, W</sup> 	5.5	2.85	0.8	3.3	2000	500, 1500	Voltage	TSSOP-14
LM3102 <sup>E, W</sup> 	42	4.5	0.8	38	2500	1000	COT	eTSSOP-20
LM2853 <sup>E, W</sup> 	5.5	3	0.8	3.3	3000	550	Voltage	TSSOP-14
LM2854 <sup>E, W</sup> 	5.5	2.95	0.8	V <sub>IN</sub>	4000	500, 1000	Voltage	eTSSOP-16

## Synchronous Buck 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
LM3670 <sup>E, W</sup> 	5.5	2.5	0.7	3.3	350	1000	✓	Voltage with input feedforward	SOT23-5
LM3673 <sup>E, W</sup> 	5.5	2.7	1.1	3.3	350	2000	✓	Voltage with input feedforward	micro SMD-5
LM3679 <sup>E</sup> 	5.5	2.5	1.2	1.8	350	3000	✓	Auto	micro SMD-5
LM3671 <sup>E, W</sup> 	5.5	2.7	1.1	3.3	600	2000	✓	Voltage with input feedforward	SOT23-5, LLP-6, micro SMD-5
LM3674 <sup>E, W</sup> 	5.5	2.7	1.0	3.3	600	2000	✓	Voltage with input feedforward	SOT23-5
LM3676 <sup>E</sup>	5.5	2.9	1.1	3.3	600	2000	✓	Voltage with input feed forward	LLP-8
LM3677 <sup>E</sup> 	5.5	2.7	1.2	3.3	600	3000	✓	Voltage with input feedforward	micro SMD-5
LM3218** 	5.5	2.7	0.8	3.6	650	2000	✓	Current	LTCC-8
LM3691 <sup>E</sup> 	5.5	2.3	0.75	1.8	1000	4000	✓	Voltage with input feedforward	micro SMD-6
LP3907* (dual) <sup>E</sup>	5.5	2.8	0.8	3.5	1000, 600	2100	✓	Voltage	LLP-24, micro SMD-25
LM2651 <sup>E</sup>	14	4	1.24	13	1500	3000	✓	Current	TSSOP-16
LM3678 <sup>E</sup> 	5.5	2.5	0.8	3.3	1500	3300	✓	PWM only	LLP-10
LM26480* (dual) <sup>E</sup>	5.5	2.8	0.8	3.3	1500 per channel	2000	✓	Voltage	LLP-24
<sup>NEW</sup> LM26420 (dual) <sup>E</sup> 	6.6	3	0.8	4.5	2000 per output	660, 2200	✓	Current	eTSSOP-20, LLP-16



\* Includes 2 integrated LDO regulators

\*\* Integrated 2.6  $\mu$ H inductor







 PowerWise® product <sup>E</sup> Evaluation board <sup>W</sup> WEBENCH enabled


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

## Non-Synchronous SIMPLE SWITCHER® Step-Down Regulators

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Frequency Range (kHz) and Sync	PWM Mode	Packaging
<b>NEW</b> LM22671/74 <sup>E, W</sup>	42	4.5	1.285	35	500	500 to 1000 Adj	Voltage	PSOP-8
<b>NEW</b> LM22672/75 <sup>E, W</sup>	42	4.5	1.285	35	1000	500 to 1000 Adj	Voltage	PSOP-8
<b>NEW</b> LM22680 <sup>E, W</sup>	42	4.5	1.285	35	2000	500 to 1000 Adj	Voltage	PSOP-8
<b>NEW</b> LM22670/73/76 <sup>E, W</sup>	42	4.5	1.285	35	3000	500 to 1000 Adj	Voltage	TO263-7 Thin, PSOP-8
<b>NEW</b> LM22677/78/79 <sup>E, W</sup>	42	4.5	1.285	35	5000	500 to 1000 Adj	Voltage	TO263-7 Thin
LM2671/72/74/75 <sup>E, W</sup>	40	6.5	1.23	37	500 (LM2671/74) 1000 (LM2672/75)	260 sync (LM2671/2)	Voltage with V <sub>IN</sub> Feedforward	MDIP-8, LLP-16, SO-8
LM2670/73/76/77/78/79 <sup>E, W</sup>	40	8.0	1.23	37	3000 (LM2670/73/76) 5000 (LM2677/78/79)	260 sync (LM2670/7)	Voltage with V <sub>IN</sub> Feedforward	TO263-7, LLP-14, TO220-9
LM25574/75/76 <sup>E, W</sup> 	42	6.0	1.23	40	500 / 1500 / 3000	50 to 1000, sync	Current	TSSOP-16 / eTSSOP-16 / eTSSOP-20
LM5574/75/76 <sup>E, W</sup> 	75	6.0	1.23	70	500 / 1500 / 3000	500, sync	Current	TSSOP-16 / eTSSOP-16 / eTSSOP-20

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

Product ID	Input Max Voltage (V)	Input Min Voltage (V)	Output Min (V)	Output Max (V)	Output Current (mA)	Frequency Range (kHz) and Sync	On/Off Pin	PWM Mode	Packaging
LM2841/42 <sup>E</sup>	42	4.5	0.765	34	300/600	550 to 1250	—	Current	TSOT-6
LM5008/09 <sup>E, W</sup> 	95	9.5	2.5	75/85	350/150	50 to 600	—	Constant on-time	LLP-8, MSOP-8
LM25007 <sup>E, W</sup>	42	9.0	2.5	37	500	50 to 800	—	Constant on-time	MSOP-8
LM2694 <sup>E</sup>	30	8.0	2.5	24	600	50 to 1000	—	Hysteretic	LLP-10, TSSOP-14
LM34919 <sup>E</sup>	40	8.0	2.5	35	600	1600	—	Constant on-time	micro SMD-10
LM2736 <sup>E, W</sup>	18	3.0	1.25	16	750	550, 1600	—	Current	SOT23-6
LM2830 <sup>W</sup>	5.5	3.0	0.6	4.5	1000	1600, 3000	—	Current	SOT23-5
LM2734/Z <sup>E, W</sup>	20	3.0	0.8	18	1000	550, 1600/3000	—	Current	SOT23-6, LLP-6
<b>NEW</b> LM34930 <sup>E</sup> 	30	8.0	2.5	30	1000	up to 2000	—	Constant on-time	micro SMD-12
LM5010A/25010 <sup>E, W</sup>	75/42	6.0	2.5	70/37	1000	50 to 1000	—	Constant on-time	LLP-10, eTSSOP-14
LM2695 <sup>E</sup>	30	8.0	2.5	24	1250	50 to 800	—	Hysteretic	LLP-10, eTSSOP-14
LM34917A <sup>E</sup> 	33	8.0	2.5	30	1250	2000	—	Constant on-time	micro SMD-12
LM34910/C <sup>E, W</sup>	36/50	8.0	2.5	33/45	1250	1000	—	Constant on-time	LLP-10
LM34914 <sup>E</sup>	40	8.0	2.5	37	1250	1300	—	Constant on-time	LLP-10
LM2831 <sup>E, W</sup>	5.5	3.0	0.6	4.5	1500	550, 1600, 3000	—	Current	SOT23-5
LM2738 <sup>E</sup>	20	3.0	0.8	18	1500	500, 1600	—	Current	LLP-8, eMSOP-8
LM26001 <sup>E</sup> 	38	3.0	1.25	35	1500	150 to 1000, sync	✓	Current	TSSOP-16
<b>NEW</b> LM27341/12 <sup>E</sup>	20	3.0	1.0	18	1500/2000	1000 to 2350, sync	✓	Current	LLP-10, eMSOP-10
LM2832 <sup>E, W</sup>	5.5	3.0	0.6	4.5	2000	550, 1600, 3000	—	Current	LLP-6, eMSOP-8
LM25011 <sup>E</sup>	42	6.0	2.51	40	2000	2000	—	Constant on-time	mini SOIC-10
LM5005/25005 <sup>E, W</sup>	75/42	7.0	1.23	70/40	2500	50 to 500, sync/ 50 to 1000, sync	—	Current	TSSOP-20
<b>NEW</b> LM2833 <sup>E</sup> 	5.5	3.0	0.6	4.5	3000	3000	✓	Current	LLP-10, eMSOP-10
LM2696 <sup>E, W</sup>	24	4.5	1.29	20	3000	100 to 500	—	Constant on-time	TSSOP-16
<b>NEW</b> LM26003 <sup>E</sup> 	38	3.0	1.25	35	3000	150 to 500, sync	—	Current	TSSOP-20

 PowerWise® product <sup>E</sup> Evaluation board <sup>W</sup> WEBENCH enabled

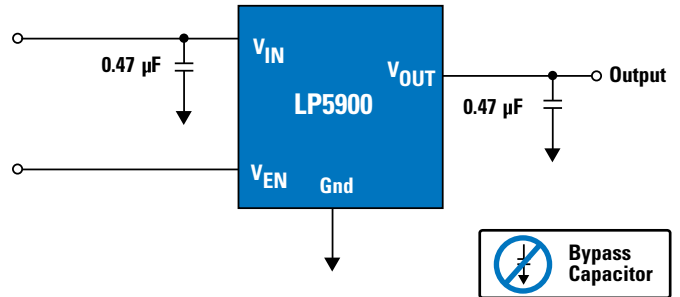


# Low Dropout (LDO) Linear Regulators

## LP5900 – Low-Noise 150 mA CMOS LDO

### Features

- Industry's lowest noise (6.5  $\mu\text{VRMS}$ ) combined with 85 dB of power supply ripple rejection (PSRR) guarantees signal integrity
- 25  $\mu\text{A}$   $I_q$  minimizes current drain when system operates in low-power mode
- Elimination of bypass capacitor reduces BOM to only two ceramic 0.47  $\mu\text{F}$  capacitors
- Available in a micro SMD-4 and LLP-6 packaging



## Low Dropout (LDO) Linear Regulators

Product ID	Load Current (mA)	$V_{IN}$ Min (V)	$V_{IN}$ Max (V)	$V_{OUT}$ (V)	Packaging
LP38511	800	2.25	5.5	1.8, adj down to 0.8V	T0263-5
LP38851	800	1.2	5.5	0.8 to 1.8V, adj	PSOP-8
LP38690	1000	3.95	10	1.25V to 9V, adj	TO-252
LP38692	1000	3.75	10	1.25V to 9V, adj	LLP-6
LP38512	1500	2.25	5.5	1.8, adj down to 0.8V	T0263, LLP-8
LP38500	1500	2.7	5.5	0.6V to 5V, adj	TO-263
LP38502	1500	2.7	5.5	0.6V to 5V, adj	TO-263
LP38852	1500	1.2	5.5	0.8 to 1.8V, adj	T0220-7
LP38855	1500	1.38	5.5	1.2 to 1.8V, adj	T0220-7
LP38858	1500	1.38	5.5	1.2 to 1.8V, adj	T0220-7
LP38513	3000	2.25	5.5	1.8, adj down to 0.8V	T0263-5
LP38501	3000	2.7	5.5	0.6V to 5V, adj	TO-263 THIN
LP38503	3000	2.7	5.5	0.6V to 5V, adj	TO-263 THIN
LP38853 <sup>E</sup>	3000	1.2	5.5	0.8 to 1.8V, adj	PSOP-8
LP38856 <sup>E</sup>	3000	1.15	5.5	0.8 to 1.8V, adj	T0263-7
LP38859 <sup>E</sup>	3000	1.55	5.5	1.2 to 1.8V, adj	T0220-7

## Low-Noise, Low-Power Linear Regulators

Product ID	Output Current (mA)	Input Max Voltage (V)	Input Min Voltage (V)	Dropout Voltage (V)	Output Voltage (V)	On/Off Pin	Quiescent Current (mA)	PSRR (dB)	Voltage Noise ( $\mu\text{VRMS}$ )	Packaging
LP3995	150	6	2.5	0.06	3, 2.8, 1.9	—	0.085	60	25	micro SMD-5, LLP-6
LP3999	150	6	2.5	0.06	1.5, 2.4, 1.8, 2.5, 2.8, 3.3	—	0.085	60	30	micro SMD-5
LP5900	150	5.5	2.5	0.08	1.5, 2.8, 3.3	—	0.025	75	6.5	micro SMD-4
LP5990 <sup>E</sup>	200	5.5	2.2	0.15	0.8 to 3.6	—	0.03	55	60	micro SMD-4
LP8900*	200 per channel	5.5	1.8	0.055	1.2 to 3.6	✓	0.085	75	6.0	micro SMD-6
LP3871/74	800	7	2.5	0.24	5, 1.8, 2.5, 3.3	✓	6	73	150	TO-263-5, SOT-223-5, TO-220-5
LP3878	800	16	2.5	0.475	Adj	✓	0.18	60	18	LLP-8, PSOP-8
LP3879	800	6	2.5	—	1.2, 1	✓	0.1	60	18	LLP-8, PSOP-8
LP3875	1500	7	2.5	0.38	1.8, 2.5, 3.3	✓	6	73	150	TO-263-5, SOT-223-5
LP3876	3000	7	2.5	0.8	2.5, adj.	✓	6	73	150	TO-263-5

\*Dual output <sup>E</sup>Evaluation board

# WEBENCH® Online Design Environment

## Save Development Time and Costs

WEBENCH online design and prototyping tools deliver results faster than ever. Now you have the world's most powerful and award-winning online design environment right at your

fingertips. Design, optimize, generate your prototype, and download your test vectors—all online. And do it all for free, anywhere, anytime.

### Select It

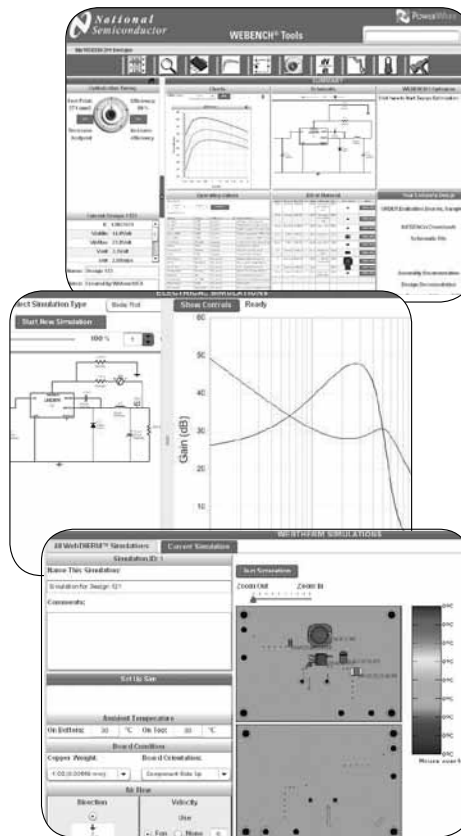
- Input your design requirements
- Choose a recommended part from a customized list

Choose from only those parts that meet your specifications

### Design It

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

Create your custom BOM using readily available parts



### Analyze It

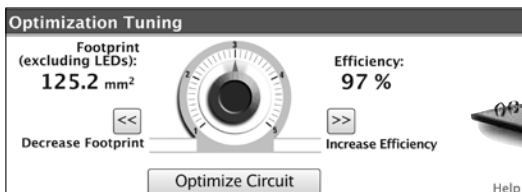
- Simulate your circuit and evaluate performance using electrical and thermal simulations
- Simulate electrical characteristics, choose probe points, and examine waveforms to determine performance
- Simulate thermal behavior and your circuit on a PCB in your defined environment and view color heat maps
- Overlay alternate circuits and compare results to get optimal performance

Solve your design problems before you prototype

### Build It

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

Save weeks getting your final design into production



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# Worldwide Design Centers and Manufacturing Facilities



- Design Centers
- Manufacturing Facilities

## Design Centers

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Chandler, Arizona  
Federal Way, Washington  
Fort Collins, Colorado  
Grass Valley, California  
Indianapolis, Indiana  
Longmont, Colorado  
Norcross, Georgia  
Phoenix, Arizona  
Salem, New Hampshire  
Santa Clara, California  
South Portland, Maine  
Tucson, Arizona

### EUROPE:

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

### ASIA:

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

## Manufacturing Facilities

### Wafer (Die) Fabrication:

Arlington, Texas  
South Portland, Maine  
Greenock, Scotland

### Chip Test and Assembly:

Melaka, Malaysia

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