AUDIO SOLUTIONS GUIDE

Analog and Digital Amplifiers, Audio Converters, Digital Signal Processors.
Power Management, USB

1Q 2002

INSIDE ▶

Includes

BB | **Burr-Brown Products**
from Texas Instruments

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Indonesia	001-801-10	-800-800-1450
Korea	080-551-2804	—
Malaysia	1-800-800-011	-800-800-1450
New Zealand	000-911	-800-800-1450
Philippines	105-11	-800-800-1450
Singapore	800-0111-111	-800-800-1450
Taiwan	0800-006800	—
Thailand	0019-991-1111	-800-800-1450
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AUDIO SOLUTIONS

By offering **open, flexible, cost-efficient, all digital end-to-end** audio solutions, TI provides **faster time-to-market** in addition to convenient **one-stop shopping.** TI's complete audio solutions include best-in-class silicon, systems expertise, software and support. By leveraging the programmability, performance headroom and design flexibility of TI's leading DSP and analog technologies, our customers have the ability to build audio products with more functionality that offers a true, lifelike sound experience at a competitive overall system cost.

Texas Instruments is serious about delivering **effective solutions for audio design.** We have audio-focused silicon, software, systems, and support under one roof to help you win market share. TI understands that consumers are enjoying new ways of listening to music while demanding more flexibility, better quality and multifunction products. There is an ever-increasing **demand for high-performance and feature-rich entertainment** for the everyday consumer. The market expects the best listening experience from any audio format and source, mobile or stationary all at a competitive price.

Please read on to find out **more about TI's solutions** for select audio applications.

DIGITAL
AUDIO PROCESSING
TEXAS INSTRUMENTS TECHNOLOGY

AUDIO SIGNAL CHAIN

Digital Input
• S/PDIF
• IEEE 1394
• USB

DIR

Analog Input
• Tape
• Tuner
• Mic
• 5.1 Analog in

ADC

DSP (Decode and Post Processing)

Storage
• CD/CD-ROM   • Hard-drive
• DVD   • Flash
• Mini-disc   Memory

Digital Amp

Power Stage

DAC

Filter, Volume, EQ

Analog Amp

Power Supply/Power Management
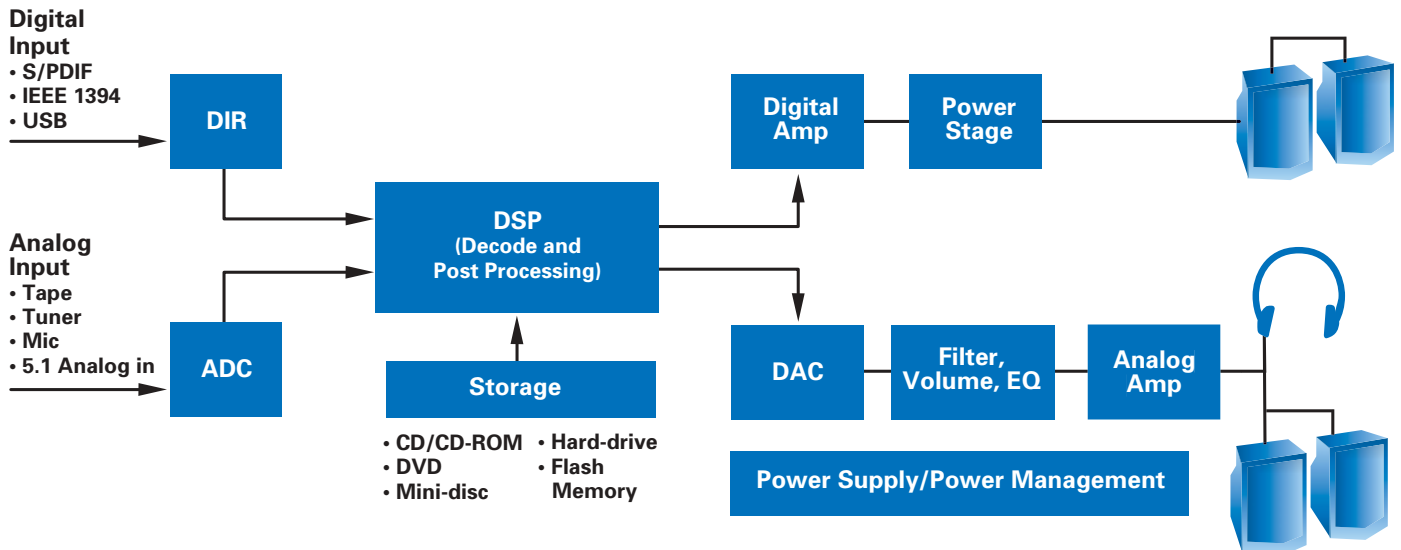
Under the surface, all modern audio systems are the same — even 21st century systems.

HOME THEATER

The emergence and rapid acceptance of digital media such as the DVD format have been a catalyst for the home theater market. One of the most important functions in home theater systems is the audio-visual (AV) receiver, **the engine behind the life-like high fidelity surround sound** demanded by today's consumer.

Receivers — available as a separate component **(AV receivers)** or integrated with the DVD players in a single chassis **(DVD receivers)** — control various components in a typical home theater system, decode compressed audio signals using standard algorithms such as Dolby and DTS, perform post-processing on these signals, and also amplify audio signals and drive loudspeakers.

Separate AV receiver component systems give the consumer the greatest choice in terms of input and output selection, decoder and software functions and audio quality. With an AV receiver, consumers make mix-and-match various system components to customize their system setup and sound quality for their listening environment and budget.

DVD receivers, on the other hand, give consumers a highly integrated, compact system that is easy to set up and often provides a wide variety of software features and listening options. The unique requirements of the DVD receiver (small and compact, high functionality, high power output) present several challenges to designers that TI audio solutions can help overcome.

The receiver and surround-sound decode markets are growing rapidly. This growth is driven by various trends including: the move to a digital signal chain fuelled by digital media and content (DVD), the demand for a **more lifelike listening experience in the home** requiring greater number of channels and higher arithmetic precision, and the proliferation of decoding standards and flavors leading to sticker races between equipment makers.

Meeting market windows and releasing feature-rich differentiated products on time is a challenge. More than ever, manufacturers need advances from their suppliers: Higher performance **scalable audio processing solutions,** shorter development cycles, and easier development processes. Whether you are designing high fidelity receivers that deliver the most realistic listening experience to discerning audiophiles, or cost-driven feature-rich systems for the mass market, TI's audio DSP, digital amplifiers and analog solutions for the home theater space allow you to **meet and exceed your design goals.**

BLOCK DIAGRAM OF TYPICAL AV RECEIVER
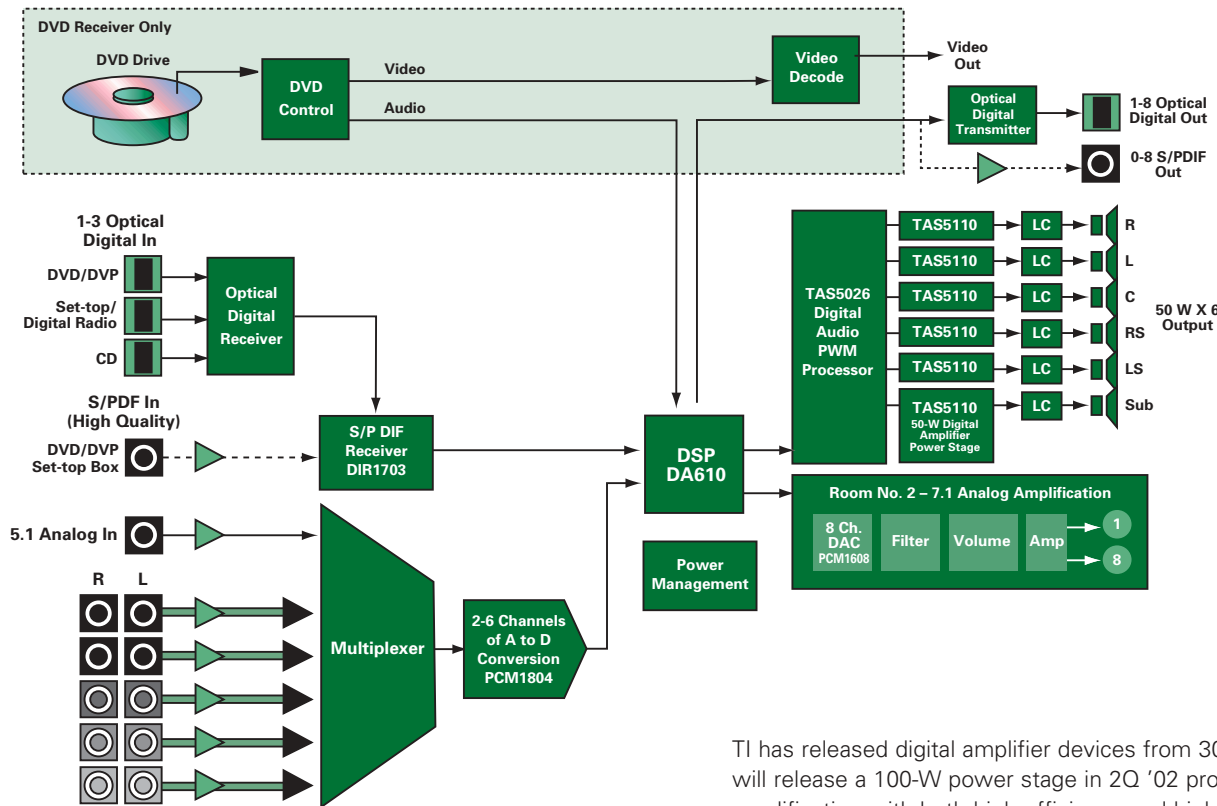
The new TMS320DA610 audio DSP from TI has 3X the processing power of competing DSPs. The digital amplifier enables high power and high quality amplification in compact spaces. The DACs, ADCs and digital interface products of Burr-Brown from TI complete the audio signal chain.

AV AND DVD RECEIVERS OVERVIEW

TI provides a complete and compelling solution that addresses the entire signal chain in AV receiver systems.

Audio DSP

TI's TMS320DA610 32-/64-bit floating point audio DSP delivers 3x the performance of existing solutions. At 225 MHz, it deliver 1800 MIPS or 1350 MFLOPS. The DA610 integrates 3Mb of RAM, 2Mb of ROM, two highly flexible multichannel audio ports with 16 stereo channels of IIS and four independent clock zones. With the performance, flexibility and integration of the DA610 audio DSP, its possible to offer single-chip solutions for advanced features such as automatic room correction and speaker virtualization in mass-market products, while enabling field upgradability.

This single-chip solution not only reduces the BOM but also minimizes design complexity and accelerates time-to-market.

Digital Amplifiers

The key to fitting all the AV and DVD receiver functionality (disk drive, tuner, decoding, amplifiers) into a low-profile chassis is a highly efficient, low-profile digital amplifier. In previous generations of AV receivers, linear amplifiers required bulky transformers and heatsinks. These can be greatly reduced in size or even eliminated with the advent of the highly efficient digital amplifier, enabling new possibilities for designers of consumer electronics.

TI has released digital amplifier devices from 30 W to 50 W and will release a 100-W power stage in 2Q '02 providing digital amplification with both high efficiency and high quality. Also a six-channel Digital Audio PWM Processor — with integrated volume control — specifically targeted at DVD receivers and AV receivers will release in 2Q '02.

Analog and Digital Inputs

The Burr-Brown products from TI make a strong contribution at the input, with high performance, low cost and easy-to-use ADCs. The digital interface side benefits from the revolutionary new SpAct™ clock recovery system, which dramatically reduces the sensitivity to input jitter on S/PDIF data. This lays to rest once and for all the arguments about variation in audio performance caused by digital audio interconnections because it eliminates the subtle data-dependent timing effects in the recovered clock. As a result, S/PDIF becomes a more robust and reliable interface.

Processing Audio Software

In addition to providing a complete silicon solution, TI also provides a comprehensive set of audio decoding software, including the Dolby and DTS suites. TI is also working to deliver the industry first open audio software framework that allows manufacturers to rapidly set up complete systems or change features in an artifact-free audio environment.

Generating the Outputs

For the AV receivers output signals for headphone and analog recording, the respected Burr-Brown product range covers the entire performance spectrum of DACs. Multichannel analog outputs are provided by a wide range of six- and eight-channel converters, saving space and cost.

HIGHEST PERFORMANCE DSP ENABLES LIFELIKE SOUND AT LOWER COSTS
### TMS320DA61x

For more information, visit:
www.ti.com/sc/haudio

Unparalleled performance and integrated peripherals of the TMS320DA61x DSP generation for audio provides higher quality, more features, faster time-to-market, and lower overall costs.

Key Features
- 1500 MFLOPS/2000 MIPS enable integration of more features (i.e., multiple digital zones of audio decode, speaker virtualization, etc.)
- Lifelike sound recreation with up to 64-bit words
- Open, scalable software solution enables fast integration of changing industry-standard algorithms with customer's own IP
- Easy-to-use development tools speed time-to-market
- Performance of the TMS320DA610 reduces the DSP and microcontroller count in audio systems, reducing costs
- Two multichannel audio serial ports (McASP)
- Two I^{2}C (inter IC control) interfaces

TMS320DA61x Floating-Point DSP Block Diagram
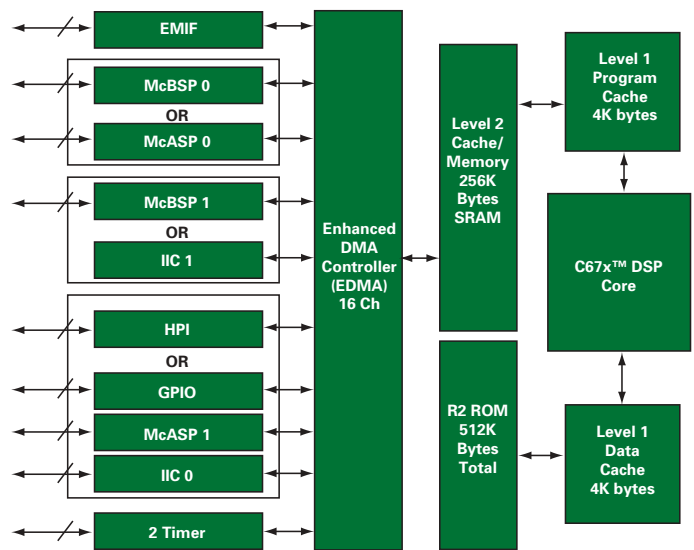
Applications
- Home entertainment: AV receivers, DVD receivers, home theater-in-a-box and mini/micro component systems
- Professional audio equipment: Digital mixing consoles, digital audio recorders, broadcast studio equipment, musical instruments, and surround-sound encoders/decoders
- Automotive DVD/CD receivers

PREVIEW SIX-CHANNEL DIGITAL AUDIO PWM PROCESSOR
TAS5026

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TAS5026

The TAS5026 is a six-channel, digital audio PWM processor designed for DVD and AV receivers. The TAS5026 provides independent volume control for each channel and will be released in 2Q '02.
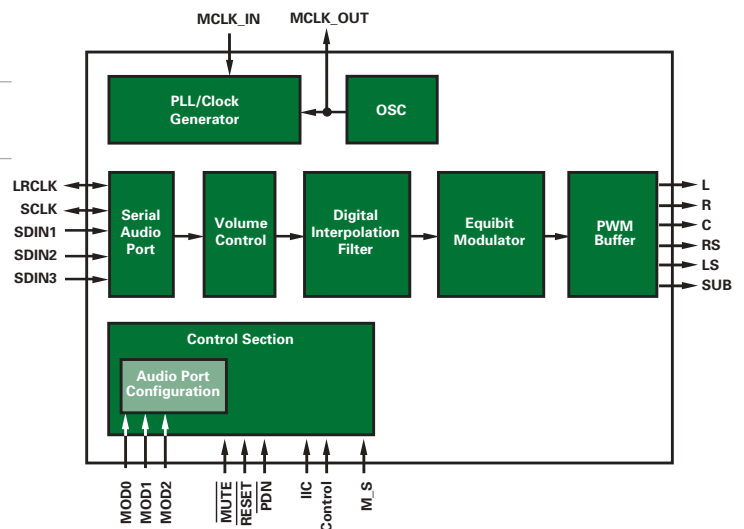
Key Features
- PWM processor
- Volume control
- High audio performance
- 96-dB SNR
- 0.06% THD+N (typ)
- 32-kHz to 192-kHz sampling rates supported
- 16-, 20-, or 24-bit operation
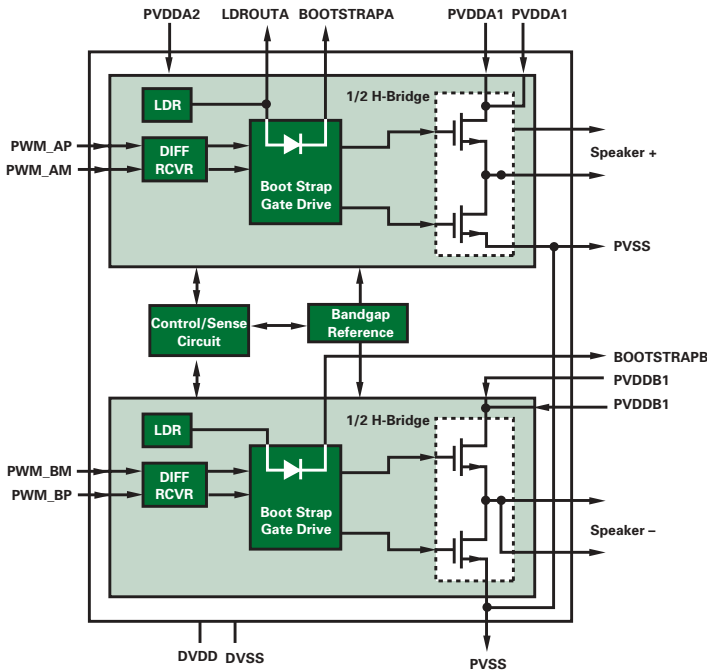- Low EMI design passes regulatory requirements
- Click and pop free

Applications
- DVD receivers
- AV receivers
- Mini-/micro-components
- Home networking
- Digital radio

TAS5026/36 Block Diagram

TAS5110 Block Diagram

DIGITAL AMPLIFIER POWER STAGE
TAS5110

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TAS5110

The TAS5110 is a 50-W digital amplifier power stage. The TAS5110 can supply 50-W continuous RMS power into 4 Ω at less than 0.08% distortion.

Key Features
- All-digital 50-W into 4 Ω
- 90% efficiency
- 32-kHz to 192-kHz sampling rates supported
- Surface-mount products eliminate manual heatsink assembly
- Heat is dissipated through PCB or through heat sink
- High efficiency reduces power supply wattage required
- Fault detection and protection
  - Over-current
  - Over-temperature
  - Under-voltage
- Low EMI design passes regulatory requirements

Applications
- DVD receivers
- AV receivers
- Mini-/micro-components
- Home networking
- Digital radio

DIR1703 Block Diagram
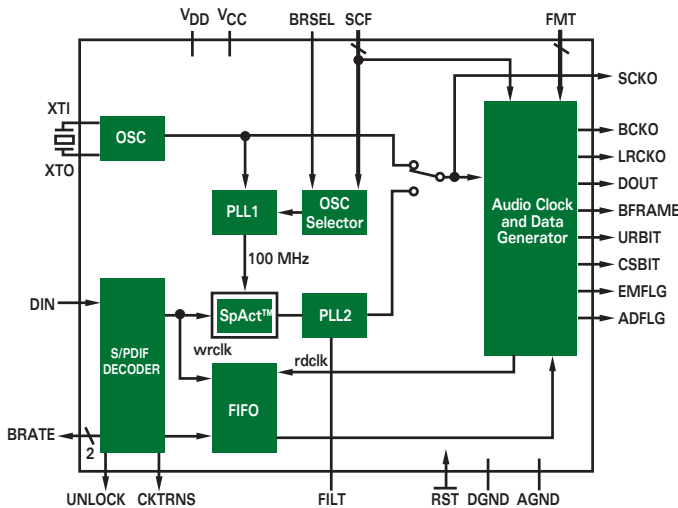
Applications
• AV receiver	• Mini-/micro-components
• MD player	• DVD receivers
• DAC unit	• Home networking

DIGITAL AUDIO INTERFACE RECEIVER
DIR1703

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/DIR1703

The DIR1703 is a digital audio interface receiver (DIR), which receives and decodes audio data up to 96 kHz in accordance with consumer and professional-format interface standard. It has a very low jitter system clock output and dual clock selectable modes.

Key Features
- Standard digital audio interface receiver (EIAJ1201)
- Sampling rate: 32/44.1/48/88.2/96 kHz
- Recover 128/256/384/512 f_S system clock
- Very low jitter system clock output (75 ps typ)
- On-chip master clock oscillator, only an external crystal required:
  - 24.576-/22.5792-/18.432-/16.9344-/16.384-/12.288-/11.2896-/8.192-/6.144-/5.6448-/4.096-MHz crystals are available
- Selectable output PCM audio data format
- Selectable crystal clock and PPL clock operation mode
- Output user bit data, flag signals, and channel status data with block start signal
- Single 3.3-V power supply
- Packaging: 28-pin SSOP

ADVANCED-SEGMENT DAC
PCM1738

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/PCM1738

The PCM1738 is a high-performance DAC utilizing a newly developed advanced-segment DAC architecture to achieve excellent dynamic performance and improved tolerance to clock jitter. The PCM1738 has two optional modes of operation: an external digital-filter mode, and a DSD decoder interface for SACD playback applications.

Key Features
- 24-bit resolution
- Sampling rate up to 192 kHz
- Excellent analog performance
- THD+N: 0.0004%
- DYR/SNR: 117 dB
- Analog out: Differential current output, ±2.5 mA
- 8X oversampling digital filter up to 192 kHz
- System clock: 128/192/256/384/512/768 f_S auto detect
- DF through mode available
- DSD mode available
- Dual power supply: 3.3 V for digital, 5 V for analog
- Packaging: 28-pin SSOP

PCM1738 Block Diagram
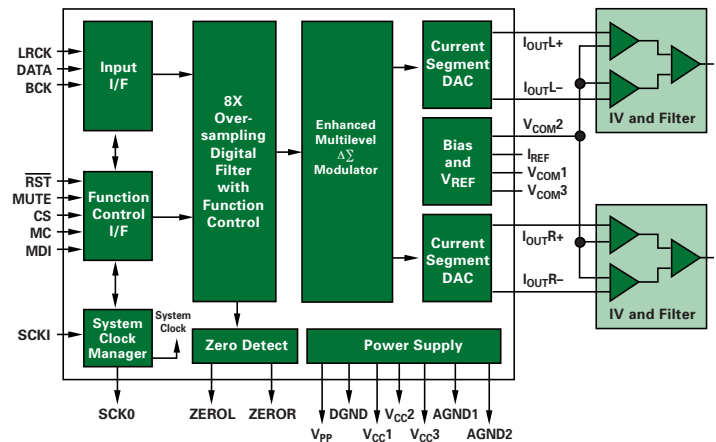
Applications
- AV receivers
- SACD players
- DVD players
- DVD receivers

HIGH PERFORMANCE STEREO ADC
PCM1804

Get samples, datasheets and app reports at:
www.ti.com/sc/device/PCM1804

The PCM1804 is a two-channel audio ADC that offers a high level of analog performance at a moderate price. It is the industrys first monolithic ADC with native single-bit DSD output capability.

Key Features
- Power dissipation 225 mW (single rate, f_S = 48 kHz)
- 24-bit PCM resolution
- Native 1-bit 64 f_S DSD mode
- All functions set by pins, no system controller required
- Analog performance:
  – DYR: 112 dB (typ); THD+N: 0.0008% (typ)
  – Fully differential analog input: 5 V_{PP} (typ)
- Linear phase decimation filter:
  – Stopband attenuation: -100 dB
  – Passband ripple: ±0.005 dB
- Sampling frequency: 32 kHz to 192 kHz
- PCM data format: Standard, I²S and left-justified, in master or slave mode
- Peak detection function
- High-pass filter (f_S/48000), can be bypassed
- System clock: 128 f_S, 192 fs, 256 f_S, 384 f_S, 512 fs or 768 f_S
- +5-V Analog power supply, +3.3-V digital supply
- Packaging: 28-lead SSOP

PCM1804 Block Diagram
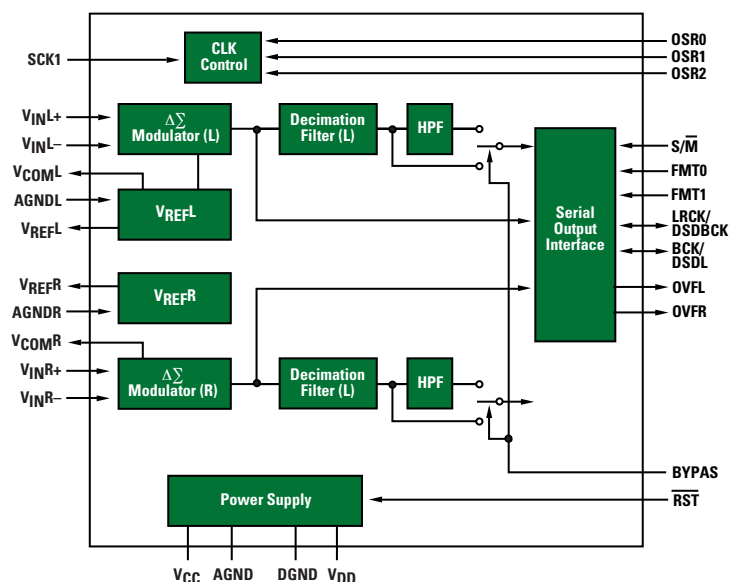
Applications:
- Integrated AV receivers
- High quality DVD, MD and CD-RW recorders
- Musical instruments
- Digital audio workstations

DSD1608 Block Diagram
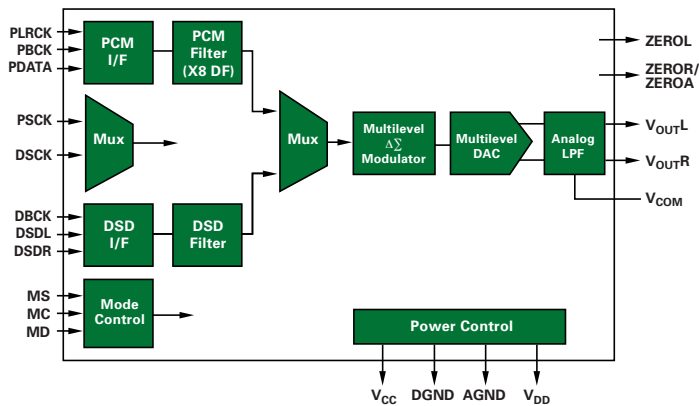
Applications
- Universal AV players
- Super audio CD players
- Car audio systems
- Other applications requiring 24-bit audio

LOW COST 8-CH PCM-/DSD-COMPATIBLE DAC
DSD1608

For datasheets, samples and app reports visit
www.ti.com/sc/device/DSD1608

The DSD1608 is a low-cost, 8-channel PCM-/DSD-compatible DAC that supports both PCM and DSD audio formats.

Key Features
- Data word length:16/18/20/24 bits for PCM, direct stream for DSD
- Sampling rate (f_S):
  – Up to 192 kHz for PCM format
  – 2.8224 MHz (= 64 X 44.1 kHz) for DSD format
- 8-channel, single-ended voltage output
- System clock:
  – 128/192/256/384/512/768 f_S for PCM,
  – 256/384/512/768 f_S for DSD
- Analog performance (at V_{CC} = 5 V, PCM/DSD mode)
  – DYR: 105 dB, SNR: 105 dB, THD+N: 0.002%
  – Full-scale output: 4.0 V_{PP}
- 8X oversampling digital filter included (PCM format only)
- Packaging: 52-lead TQFP

DSD1702 Block Diagram

Applications
- Universal AV players
- Super audio CD players
- Car audio systems
- Other applications requiring 24-bit audio

ENHANCED MULTIFORMAT, $\Delta\Sigma$, AUDIO DAC
DSD1702

For datasheets, samples or app reports visit
www.ti.com/sc/device/DSD1702

The DSD1702 is a CMOS, monolithic, stereo DAC that supports both PCM audio data format and direct stream digital (DSD) audio data format.

Key Features
- Accepts 16-, 18-, 20- and 24-bit audio data for PCM format
- Accepts direct stream digital (1 bit)
- Analog performance (V_{CC} = 5 V):
  – DYR: 106 dB (typ), SNR: 106 dB (typ), THD+N: 0.0015% (typ)
  – Fullscale output: 3.1 V_{PP} (typ)
- Includes 8X oversampling digital filter for PCM format:
  – Stopband attenuation: 60 dB
  – Passband ripple: ±0.02 dB
- Including digital DSD filter for DSD format:
  – Passband choices: 50 kHz, 70 kHz or 60 kHz at 3 dB
- Sampling frequency:
  – PCM mode: 10 kHz to 200 kHz
  – DSD mode: 64 X 44.1 kHz
- System clock: 128 f_S 192 f_S, 256 f_S, 384 f_S, 512fs f_S, 768 f_S
- Data formats: Standard, I²S, and left-justified for PCM direct stream digital
- Dual supply operation: 5-V analog, 3.3-V digital
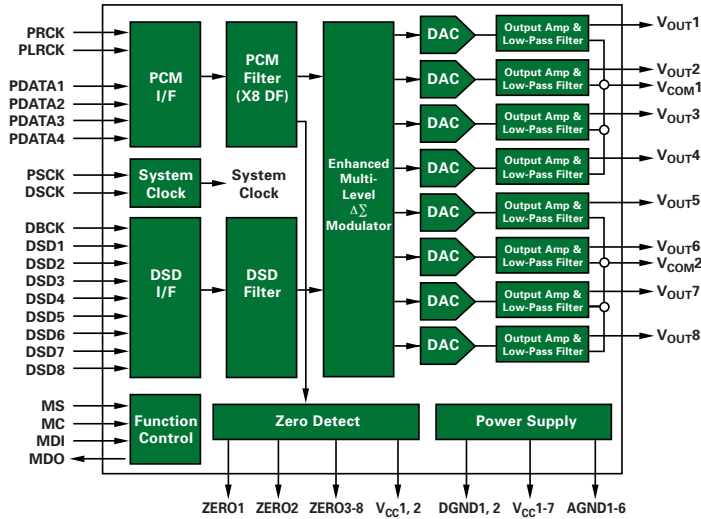- 5-V tolerant digital inputs
- Packaging: Small 20-lead QSOP

LOWEST COST SIX-CHANNEL DAC
PCM1606

Get samples, datasheets and app reports at:
www.ti.com/sc/device/PCM1606

The PCM1606 is the world's smallest-package and lowest-cost 24-bit, 192-kHz, six-channel, delta-sigma DAC.

Key Features
- 24-bit resolution
- Analog performance:
  – DNR: 103 dB (typ); SNR: 103 dB (typ); THD+N: 0.004% (typ)
  – Full-scale output: 3.1 V_{P-P} (typ)
- 8X Oversampling interpolation filter:
  – Stopband attenuation: -55 dB
  – Passband ripple: ±0.03 dB
- Sampling frequency: 5 kHz to 200 kHz (ch 1, 2); 5 kHz to 100 kHz (ch 3, 4, 5, 6)
- Accepts 16-bit and 24-bit audio data
- Data formats: Standard, I²S, and left-justified, TDM
- System clock: 128 f_S, 192 f_S, 256 f_S, 384 f_S, 512 f_S or 768 f_S
- Digital de-emphasis for 32 kHz, 44.1 kHz, 48 kHz
- Power supply: 5-V single supply
- Packaging: 20-lead SSOP

PCM1606 Block Diagram
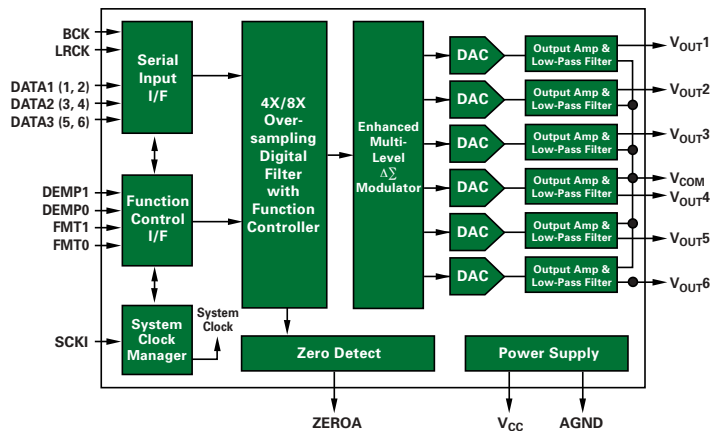
Applications
- Integrated AV receivers
- DVD movie and audio players
- HDTV receivers
- Car audio systems
- DVD add-on cards for high-end PCs
- Digital audio workstations
- Other multichannel audio systems

STEREO 96-kHz/192-kHz, 24-BIT DAC
PCM1742/48

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/PCM1742

The PCM1742 is a CMOS, monolithic, integrated circuit that includes stereo DACs and support circuitry in a small SSOP-16 package.

Key Features
- Low-cost stereo 96-kHz/192-kHz, 24-bit DAC
  – PCM1748E and PCM1748KE: 96 kHz
  – PCM1742E and PCM1742KE: 192 kHz
- Analog performances (at V_{CC} = 5 V):
  – DYR: 100 dB (E)/106 dB (KE)
  – THD+N: 0.003% (E)/ 0.002% (KE)
- 8X oversampling digital filter
- 8X up to 96 kHz
- Stopband attenuation: -55 dB
- Sharp roll-off /slow roll-off selectable
- System clock 256/384/512/768 f_S auto detect
- Multifunctions
- Packaging: 16-lead SSOP

PCM174x Block Diagram
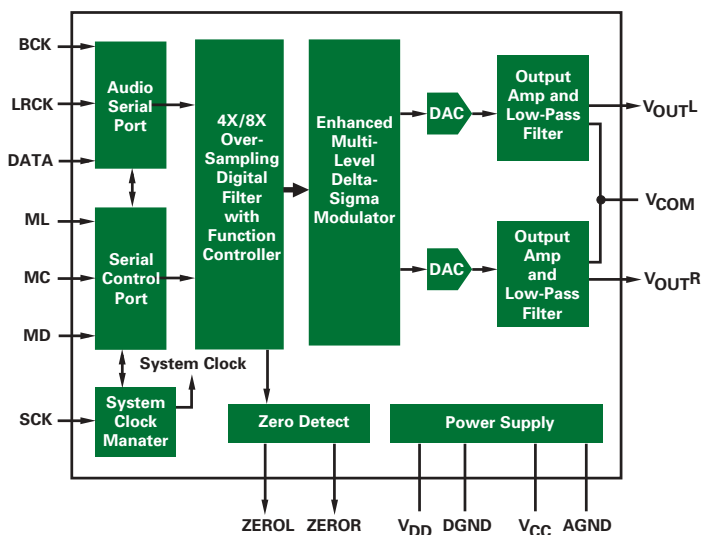
Applications
- AV receivers
- Home theater-in-a-box
- Automotive audio applications
- Personal audio applications

DACs, ADCs and Audio Interface Receivers

Device	Description	Resolution (Bits) Max	Dynamic Range (dB)	Sampling Rate (kHz) Max	Configuration	Audio Date Format
DACs						
PCM1742/K	Low-cost audio DAC w/volume control	24	100/105	192	Stereo	Normal, I^2S
PCM1748/K	Low-cost audio DAC w/volume control	24	100/105	96	Stereo	Normal, I^2S
PCM1716/28	CMOS, multilevel DS w/volume control	24	106	96	Stereo	Normal, I^2S
PCM1737/39	CMOS, multilevel DS w/volume control	24	106	192	Stereo	Normal, I^2S
PCM1741	Low-cost audio DAC w/volume control	24	98	96	Stereo	Normal, I^2S
DSD1702	2-ch DSD DAC	24	106	192	Stereo	Normal, I^2S, DSD
High-performance DACs						
PCM1791	Advanced segment	24	113	192	Stereo	L, R, I^2S, DSD
PCM1738/30	Advanced segment	24	117	192	Stereo	Normal, I^2S, DSD
Multichannel DACs						
PCM1608/K	Highly integrated 8-ch audio DAC	24	100/105	192	8ch	Normal, I^2S
PCM1602/K	Low-cost CMOS, multilevel DS	24	100/105	192	6ch	Normal, I^2S
PCM1606	Smallest, low-cost 6-ch DAC	24	103	192	6ch	Normal, I^2S
PCM1605	CMOS, multilevel DS	24	105	192	6ch	Normal, I^2S
PCM1604	CMOS, multilevel DS	24	105	192	6ch	Normal, I^2S
PCM1601	CMOS, multilevel DS	24	105	96	6ch	Normal, I^2S
PCM1600	CMOS, multilevel DS	24	105	96	6ch	Normal, I^2S
DSD1608	8-ch DSD DAC	24	105	192	8ch	Normal, I^2S, DSD
ADCs						
PCM1802	$\Delta\Sigma$ audio ADC	24	105	96	Stereo	Normal, I^2S
PCM1804	$\Delta\Sigma$ audio ADC	24	112	192	Stereo	Normal, I^2S, DSD

Device	Description	Jitter (ps)	Sampling Rate (kHz) max	Clock Mode	Power Supply (V)
Audio Interface Receivers (S/PDIF)					
DIR1701	Digital audio interface receiver	80	96	PLL only	+3.3
DIR1703	Digital audio interface receiver	75	96	PLL and crystal	+3.3

Digital Audio Amplifiers

Device	f_S	Dynamic Range	THD+N (System Performance) (%)	Channels
Digital Audio PWM Processors				
TAS5001	32 to 96	96	<0.08	2
TAS5010	32 to 192	96	<0.08	2
TAS5012	32 to 192	102	<0.08	2
TAS5026 PREVIEW	32 to 192	96	<0.08	6
TAS5036 PREVIEW	32 to 192	102	<0.08	6

* Coming in 2Q 2002

Device	f_S	Power (W_{RMS} at 4 Ω)	THD+N (%)	Channels
Digital Amplifier Power Stages				
TAS5100	32 to 192	30	<0.08	1
TAS5112	32 to 192	50	<0.08	1
TAS5182	32 to 192	100	<0.08	2

Refer to the TI Audio Selection Guide (SSYT014) for a complete listing of DACs, ADCs and other audio components.

DIGITAL MINI-/MICRO-COMPONENT SYSTEMS

The evolution of digital audio is driving major changes in the architecture of modern mini-component and micro-component systems. These changes are necessary to respond to consumer demand for new features, such as playing encoded audio CDs, smaller and lighter products, enhanced sound field processing, and the addition of digital sources such as minidisk and USB.

The mini/micro-component systems of today are turning to digital technology to keep up with the new innovations in audio. The first stage in the transition to an all-digital system was the source material with the invention of audio CDs. Even with the popularity of audio CDs, analog sources used to be more prevalent and thus the entire audio system including processing and amplification was also analog. In many cases the CD was actually provided as an analog input to the system to simplify the design.

As the world evolves to digital sources and interfaces like CD, DVD Audio, Minidisk, SACD, USB, S/PDIF, the system architecture of modern mini-/micro-component systems also needs to become digital. This will enable not only higher audio quality but also facilitate the new features that consumers demand.

DIGITAL MINI-/MICRO-COMPONENT SYSTEM BLOCK DIAGRAM
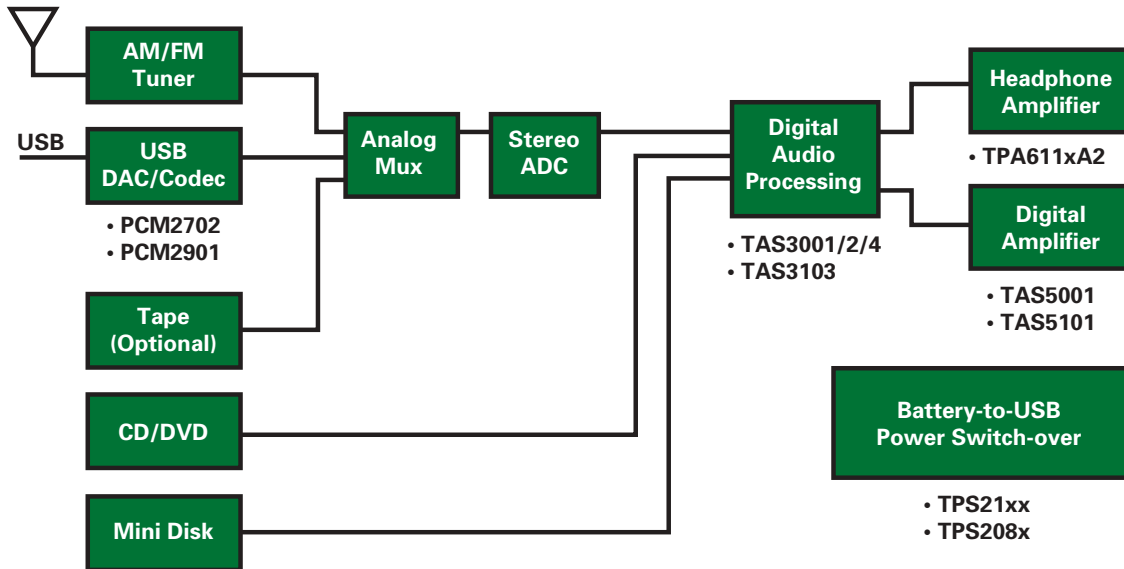
The basic block diagram of any digital mini-/micro-component system will have not only the traditional analog sources but also many digital sources. Using digital audio processing and digital amplification enables new product features and smaller, lighter solutions.

MINI-/MICRO-COMPONENT PRODUCTS

USB DAC and USB Codec

Want to add a USB interface to your mini or micro-component system? TI makes it easy with the PCM2702 and PCM2901 devices. These devices provide a simple high performance USB audio interface which fits into existing mini-/micro-component architectures with ease. And since no programming is required you can get your new differentiated mini- or micro-component system to market faster with fewer engineers. The PCM2702 is an integrated stereo USB DAC and the PCM2901 is an integrated stereo USB Codec, so no matter what kind of USB interface you want on your next mini-/micro-component system TI has a solution for you.

Stereo Analog-to-Digital Converters (ADCs)

Burr-Brown products from Texas Instruments have long been known for high-performance DACs, now you can add high performance ADCs to that list also. TI introduced a new line of stereo ADCs with the PCM18xx series of devices. With a wide range of performance from 93 dB dynamic range for cost sensitive systems to 110 dB for best-in-class performance, TI has a broad portfolio of ADCs to also fit any consumer audio application. The only question is which one to use.

Digital Audio Processors

Digital audio processing enables feature-rich cost-competitive products that require fewer components and are easier to update and differentiate than analog processing solutions. Now you can have all the features your customers demand with a single digital audio processing chip.

TI's newest digital audio processor is the TAS3103 (samples available 1Q '02). With a multitude of features this processor enables a new range of audio processing for mini-/micro-component systems. At the heart of this digital audio processor is a 48-bit DSP core designed for audio so there is no need to worry about digital artifacts. It requires absolutely no programming, because all of its functions are register controlled via I^{2}C commands.

So what can you do with a TAS3103 beyond volume and tone control? One answer is the ability to take a 5.1-channel source and use the algorithm of your choice to create stereo outputs that sound three dimensional, even without programming a DSP. Another answer is to use high quality dither to make a 16-bit CD sound more like a DVD while performing concert hall delays or stereo enhancement algorithms. These options are available in a cost competitive single-chip solution that can be easily re-configured to provide an entire line of differentiated mini-/micro-component systems without changing the hardware.

Digital Amplifiers

Digital amplification is changing the way consumers view home audio. Home audio products were considered large bulky products where heavier was even considered better, but that perception is being reversed by small lightweight products enabled by digital amplifiers. TI provides one of the most compact and cost-effective digital amplifier solutions available on the market. The TAS5001 PWM and TAS5101 H-Bridge combine for a powerful 15-W per channel stereo solution. Using extremely high efficiency digital amplification in conjunction with TI's PowerPAD™ packaging technology, this solution requires no heatsink or fan even at full output saving both space and money. Combined with TI's patented approach for EMI compliance without shielding, and a broad portfolio of digital amplifier products, the TAS5x01 creates a winning solution for your next amplifier design.

INTEGRATED USB INTERFACE WITH DAC
PCM2702

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/PCM2702

The PCM2702 is a single-chip DAC offering two D/A output channels and an integrated USB 1.0-compliant interface controller.

Key Features
- Provides the highest audio performance with 100-dB signal-to-noise ratio and 0.002% total harmonic distortion
- Supports 32-kHz, 44.1-kHz, and 48-kHz playback rates in a wide range of common playback frequencies
- Generates all necessary clocks from a single 12-MHz external crystal on the chip
- Patent-pending SpAct™ Technology synchronizes the internal audio clocks to the USB audio data received, which maintains low clock jitter
- Packaging: 28-pin SSOP does not require programming

Applications
- USB headphone sets
- USB speakers

PCM2702 Block Diagram
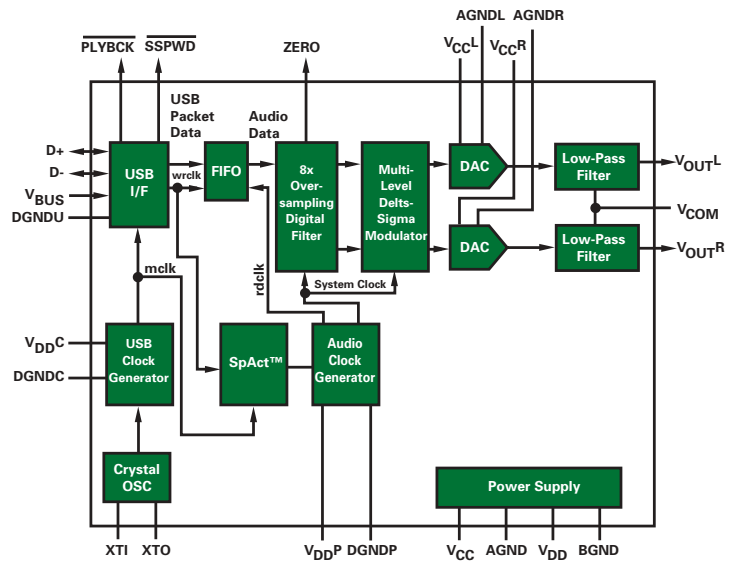
PREVIEW DIGITAL AUDIO PROCESSORS
TAS3103

Get datasheets and app reports at:
www.ti.com/sc/device/TAS3103

The TAS3103 is a cost-effective, three-channel, 48-bit digital audio processor with a 76-bit accumulator providing 135-MIPS of audio processing. It supports sample rates from 8 kHz to 96 kHz and two ICs can be used for a six-channel application gluelessly.

Key Features
- No programming required, register controlled via I^{2}C
- Six-channel input and output mixing
- Pool of memory for up to 42 ms of delay/reverberation
- Independent soft volume and tone control with loudness
- Effects block for audio algorithms (stereo spreading, 3D surround, six-channel to two-channel downmix)
- Up to 16 second-order IIR filters per channel for parametric EQ, graphic EQ, or crossovers
- Stereo five-band or mono 10-band spectrum analyzer
- Dynamic range compression/expansion with three slopes
- High-quality configurable dither eliminates undesired tones
- Extensive, six-channel bass management and crossover implementations

Applications
- Mini-/micro-component systems
- Home theater post-decode processing
- Automotive headunits/amps

TAS3103 Block Diagram
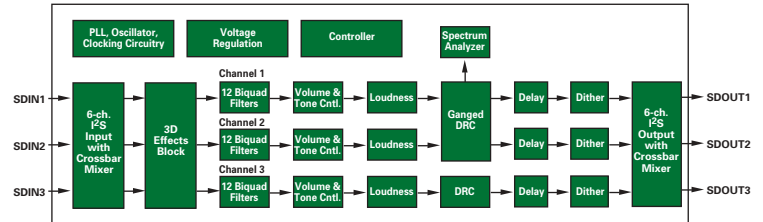
TAS50xx Block Diagram
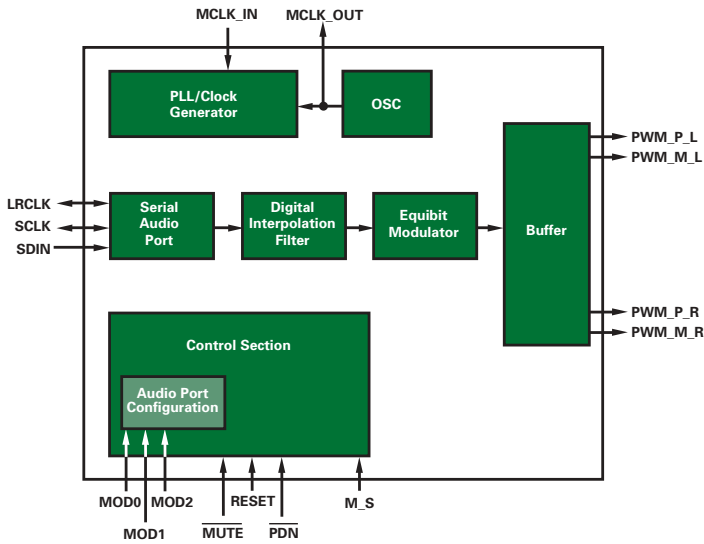
STEREO DIGITAL AUDIO PWM PROCESSOR
TAS5001

Get datasheets and app reports at:
www.ti.com/sc/device/TAS5001

The TAS5001 is a stereo Digital Audio PWM Processor featuring 24-bit/96-kHz performance. When combined with one of TI's Digital Amplifier Power Stages, it is an all-digital high power amplifier solution.

Key Features
• High audio performance
• 96 dB SNR
• 0.06% THD+N (typ)
• Sampling rates: 32 kHz to 96 kHz
• 16-, 20- or 24-bit operation
• Low EMI design passes regulatory requirements
• Click and pop reduction

Applications
• Mini-/micro-component systems
• AV receivers
• DVD receivers

TAS51xx Block Diagram
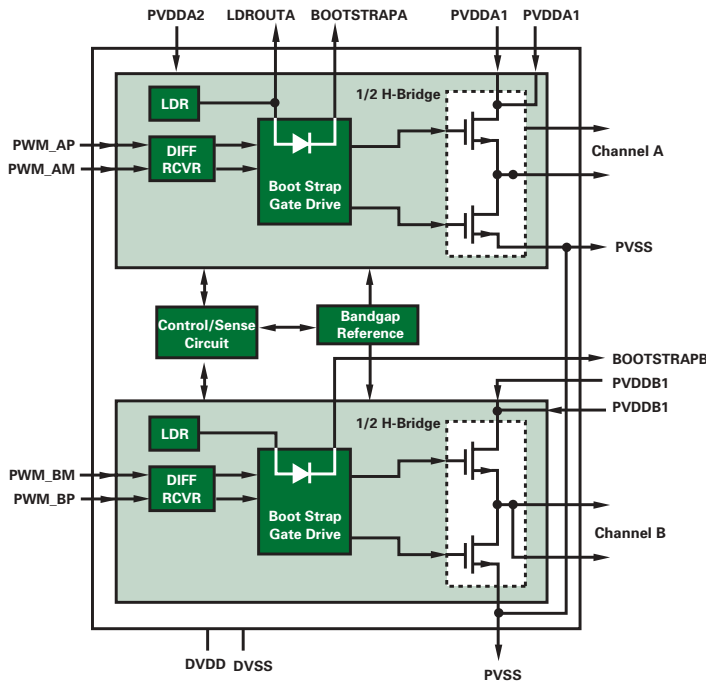
PREVIEW

STEREO DIGITAL AUDIO POWER AMPLIFIER
TAS5101

Get datasheets and app reports at:
www.ti.com/sc/device/TAS5101

The TAS5101 is a stereo Digital Amplifier Power Stage capable of delivering 15 watts per channel at 0.1% THD+N. This device is used in conjunction with one of TI's Digital Audio PWM Processors.

Key Features
• Stereo 15 W RMS into 4 Ω (20 W, 10% THD+N)
• Up to 90% efficiency
• Sampling rates: 32 kHz to 192 kHz
• Surface-mount products eliminate manual heatsink assembly
• Heat is dissipated through PCB
• High efficiency reduces power supply wattage required
• Fault detection and protection
• Over-current
• Over-temperature
• Low EMI design passes regulatory requirements

Applications
• Mini-/micro-component systems
• AV receivers
• DVD receivers

INTERNET AUDIO

The portable Internet audio player market has exploded with new technologies, devices and design challenges for the consumer electronics and wireless terminal industries. Today's portable audio systems have as much processing horsepower as the fabled first Cray supercomputer developed in the 1960s. In a modern-day comparison, it would require a 10'x10' temperature-controlled room and multimillion dollar machine just to listen to the latest hits. No industry is more open to progress than the dynamic audio industry.

The combination of several factors has made **portable audio a hit with consumers:**
• Audio-friendly compression technologies
• Inexpensive mass storage
• Battery-friendly processors
• Integrated performance analog output technology.

The classic audio compression format MP3 has been joined by WMA, AAC, and ATRAC-3 with MP3s first sequel on the way. There are also Digital Rights Management (DRM) techniques raised through the spirit and intent of SDMI developed out of the need to protect the rights of those who write, perform, develop, market and distribute musical content. Through all of this, one thing is clear; today's audio systems are complex — both in processing and design.

TI understands that during product development, designers need to spend time on **unique product aspects** instead of checkbox, got-to-have items. This is the key to getting a time-to-market advantage and a winning product.

Covering rapid-fire serial and parallel product developments with this era's limited staffing is a challenge. It demands benchmark vendor tools and support, scalable processing engines, high levels of reuse, integrated systems-on-chips and overall shorter development cycles. TI's **complete audio solutions** for the portable audio space can help achieve these goals.

INTERNET AUDIO/PORTABLE PLAYER SYSTEM DIAGRAM
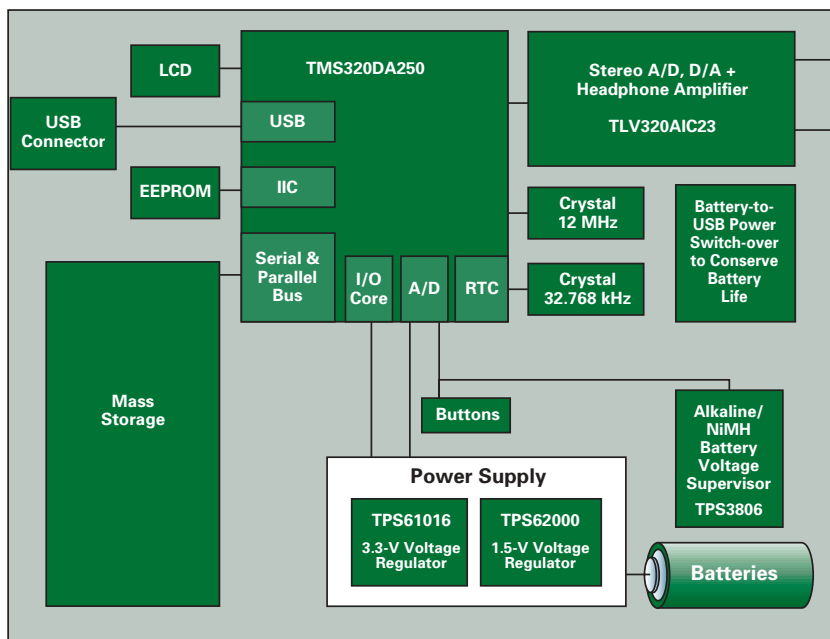
Portable audio player systems vary greatly, depending on the type of mass storage used to store recorded audio and music files. Once a user selects a song title or track number to be played, the file system initializes and the DSP begins loading DRM software that may be required. The digital rights (if any) of the music file are determined, the type of file format is determined and the DSP dynamically loads the appropriate MP3, WMA, AAC or additional format decoder into program memory and begins processing the file. Once the audio stream has been decoded, extra audio processing can be applied to enhance and shape the reproduction. This post processing can include equalization and reverberation to adjust the sound to the user's taste and to stimulate the effect of reproducing the performance in different acoustic spaces.

INTERNET AUDIO PRODUCTS

TI provides a complete solution that addresses the various components of functionality in an Internet audio portable player system.

Processing the Audio DSP

Stemming from the success of TI's TMS320C54x™-based TMS320DA150 DSP, the TMS320C55x™-based TMS320DA250 has been introduced to continue the fixed-point DSP audio solutions. TI's TMS320DA150 DSP is a 16-bit fixed-point audio DSP delivering 160 MIPs of processing power in a small MicroStar BGA™ package. The DA150 also integrates 128 kW RAM and 16 kW ROM of internal memory, three multichannel buffered serial ports, 8-/16-bit HPI, and six-channel DMA.

The TMS320DA250 DSP is the fourth-generation chip to be used in the Internet audio market and is ideal for portable audio players, car stereos, home audio jukeboxes and many other audio applications. It is a dual-MAC, 16-bit fixed-point audio DSP delivering close to 200 MIPs of processing power in its own MicroStar BGA package.

Aside from the 128 kW of RAM and 32 kW of ROM, the TMS320DA250 packs in a low and full speed rated USB 2.0 client controller, a real-time clock, a watchdog timer and a 10-bit ADC for general-purpose processing controls.

TI's TMS320DA250 provides the optimal combination of high performance, peripheral options, small packaging and power-efficient performance. It gives designers an edge in the portable digital audio markets and is proof that the TMS320DAx family of DSPs is the solution for personal and portable digital audio products.

Low-Power Codec with Integrated Headphone Amplifier

The TLV320AIC23 Codec with integrated headphone amplifier provides extraordinarily low power dissipation with programmable flexibility and space savings of having three devices (a Codec, a headphone amplifier and a microphone amp) in one small package at a cost-effective price.

The TLV320AIC23's 23-mW power dissipation in playback mode makes it among the world's lowest power dissipation Codecs in the world, while providing 100-dB signal-to-noise ratio (SNR). It features programmable gain amplifiers on the analog inputs and headphone output, an integrated crystal oscillator with programmable frequency divider, and programmable power down modes that allows optimized power dissipation by powering down sections of the device not being used. A microphone amplifier and microphone bias are also included in the device. One feature is the multiplexers in the device, which allows the analog line and microphone inputs to be mixed with the DAC output and fed to the headphone amp.

For applications not requiring an ADC, the TLV320DAC23 provides a great solution. This is a low-power DAC with an integrated 30-mW headphone amplifier with programmable gain, an analog line input, crystal oscillator, and a mixer. For applications requiring even lower power dissipation, TI is introducing the PCM177x family of DACs with power dissipation as low as 8 mW. The PCM177x family incorporates pop-noise-free circuits, eliminating noise caused by turning the device on/off or powering the device up/down. A total of four products are offered within the PCM177x family, providing a choice of two types of amplifiers, a headphone amplifier or a line amplifier, as well as a choice of hardware or software control.

Continued from the previous page

Processing Audio Software

TI's Internet audio solution provides the flexibility to listen to music in any format at any time. Whether is is in AAC, ACELP®, ADPCM, ATRAC3, MP3, QDX, Windows® Media Audio or another format. Chances are, it's supported by the TI Internet audio DSP platform.

Additionally, TI incorporates security compliance by supporting the leading digital rights management security software from InterTrust, Liquid Audio, Lockstream and Microsoft.

Portable digital audio players engineered with TI DSPs can be programmed to accommodate music in any format. The audio standards will either be encoded in the program material, reside in the player, or be downloaded from the Internet. Regardless of the delivery methods, any player engineered with TI's TMS320DAx DSP platform will be able to handle any audio standard.

TI's internet audio solution also supports multiple media formats including Compact Flash™, Smart Media™, Secure Digital™, Memory Stick™, and Secure Multimedia Card, hard disk drive, CD and dataplay drives.

CELLPHONE AUDIO PLAYER BLOCK DIAGRAM

This figure shows the block diagram of a cell phone audio player. A USB link is used to download music files from a PC to the cell phone. A file can be transferred via the USB quickly in a compressed AAC or MP3 format. One of the key careabouts in cell phones is battery life. Power dissipation is one of the most important design considerations. Designers must concentrate new product development on decreasing power dissipation while enhancing features.
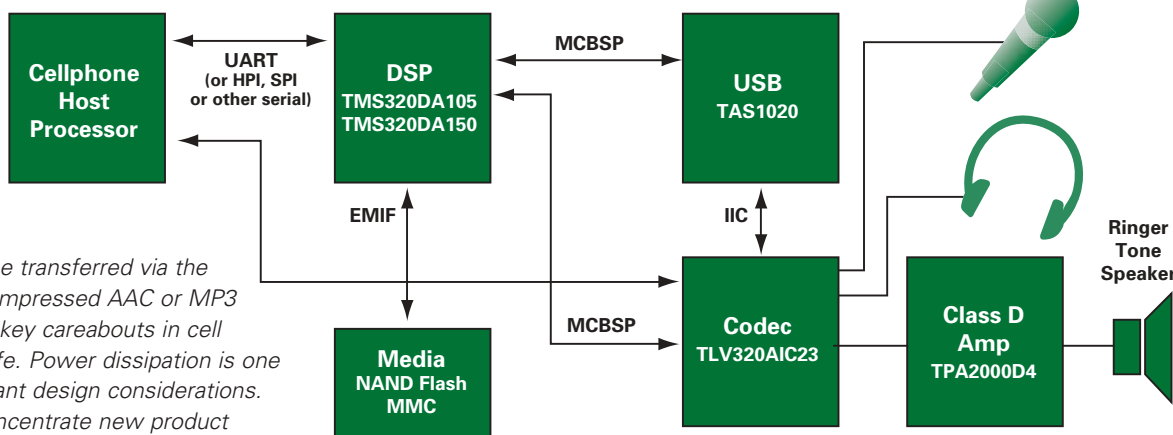
PROGRAMMABLE DSP WITH ON-BOARD USB
TMS320DA250

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TMS320DA250

TI provides complete Internet audio solutions including audio-centric DSPs, evaluation modules (EVMs) and development tools in addition to a vast security and audio software algorithm library.

Key Features
• Enable 50% longer battery life and product differentiation with programmable DSP (200- to 400-MIPS)
• Smaller on board space with an integrated processor design featuring on board USB, real-time clock and 10-bit ADC
• Flexibility to chose desired storage medium via support for Memory Stick, SD, MMC, Compact Flash (CF), and more
• Seamless listening with a fully integrated software library including AAC, ADPCM, MP3, WMA, WAV and more

Applications
• Multifunction Internet audio players (portable audio players, cell phones, PDAs, digital cameras, etc.)
• Portable CD players
• Portable jukeboxes
• Portable radios/boom boxes

TMS320DA250 Block Diagram

PCM177x Block Diagram
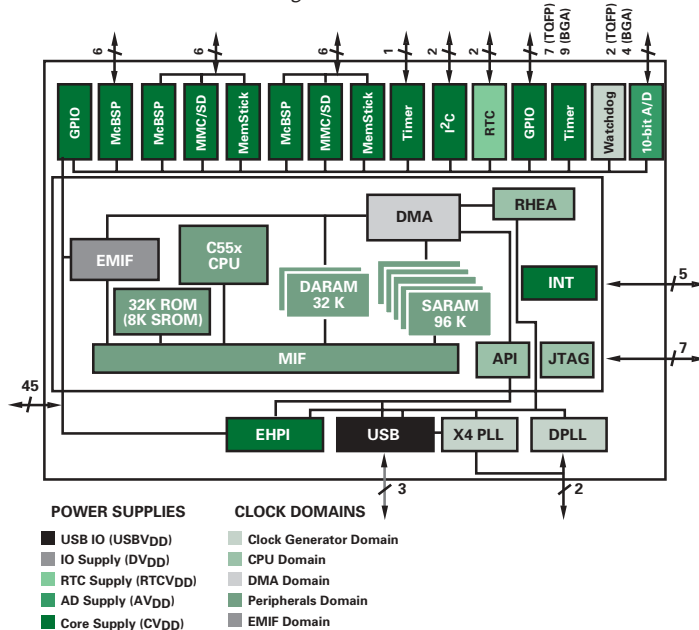
PCM177x Block Diagram

Applications

- Multifunction Internet audio players (portable audio players, cell phones, PDAs, digital cameras, etc.)
- Portable CD players
- Portable jukeboxes
- Portable radios/boom boxes

PREVIEW

LOW-VOLTAGE, LOW-POWER STEREO DACS
PCM177x

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/partnumber
Replace partnumber in URL with PCM1770, PCM1771, PCM1772 or PCM1773

The PCM177x is a family of high-performance DACs that offers the lowest power consumption and the lowest supply voltages in the industry. A total of four products are offered within the PCM177x family, providing a headphone amp and a line amp and a variety of control methods and features.

Key Features
- Analog performance (VCC1, VHP= 2.4 V):
- Dynamic range: 96 dB (typ)
- THD+N: 0.032% (typ)
- Output power at R L = 16 : 10 mW (stereo), 20 mW (monaural)
- Low power dissipation:
  - 9.6 mW at V_{CC1}, VHP= 2.4 V
    - System clock: 128 f_S, 256 f_S, 384 f_S
    - Sampling frequency: 5 kHz to 50 kHz
- Digital attenuation:
  - 44.1-kHz digital de-emphasis
  - Digital soft mute
  - Pop-noise free circuit
  - 1.6-V to 3.6-V single power supply
- 3.3-V tolerance
- Packaging: TSSOP16 and VQFN20 (4.2 mm x 4.2 mm)

TLV320AIC23 Block Diagram

TLV320AIC23 Block Diagram
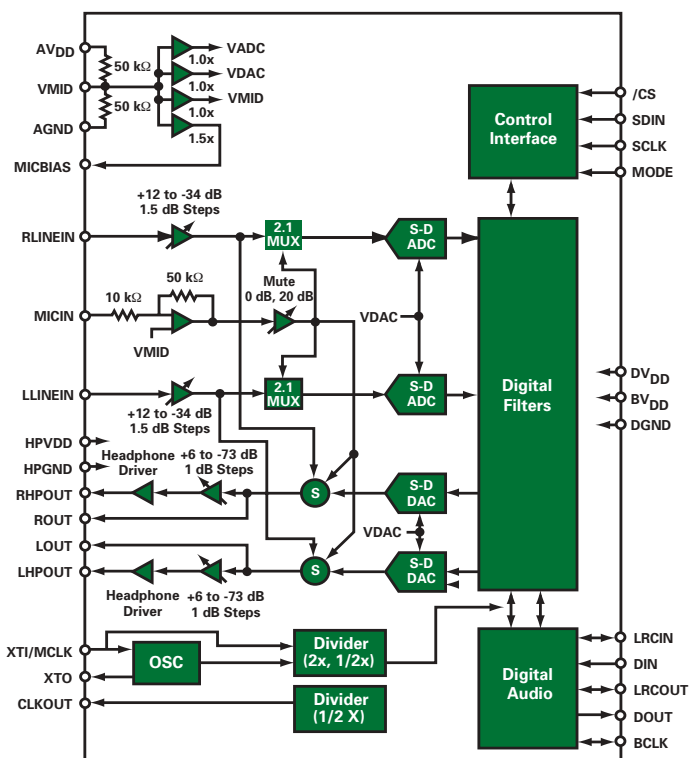
LOW-POWER STEREO AUDIO CODEC
TLV320AIC23

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TLV320AIC23

The TLV320AIC23 high-performance, low-power stereo audio Codec — with highly integrated functionality — allows many features to fit into a small area with minimal power consumption.

Key Features
- Very low-power dissipation: 23 mW in playback mode
- 90-dB SNR ADC, 100-dB SNR DAC
- Integrated 30-mW headphone amplifier
- Microphone input with side-tone mixer
- Maximum sample rate of 96 kHz
- Bypass mode enables an all-analog path
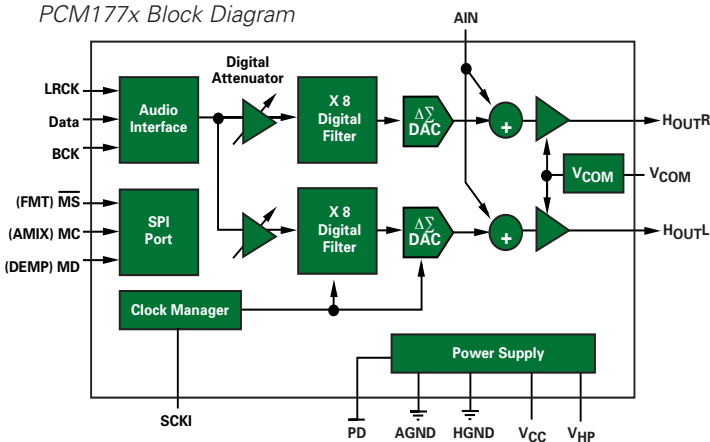- Packaging: Small, 25 mm^2 MicroStar Jr.™ BGA or TSSOP

Applications
- Multifunction Internet audio players (portable audio players, cell phones, PDAs, digital cameras, etc.)
- Portable CD players
- Portable jukeboxes
- Portable radios/boom boxes

FILTER-FREE CLASS-D FOR CELLULAR HANDSETS
TPA2000D1

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TPA2000D1

The TPA2000D1 drives 2 W into 4-Ω speakers with no output filter. The 85-percent maximum efficiency ensures long battery life and minimal heat generation while the amplifier plays music.

Total harmonic distortion plus noise (THD+N) is 0.15 percent with a 1-kHz test tone driving 2 W into a 4-Ω speaker, and the integrated noise floor is -85 dB.

Key Features
- Filter-free Class-D operation minimizes solution cost and space
- Efficient Class-D operation maximizes battery life and minimizes heat
- Low THD+N (0.15%) and integrated noise floor (-85 dB) deliver high-quality fidelity
- Programmable gain settings eliminate feedback components
- Characterized from -40° C to 85° C

Filter-Free Class-D Device Comparison

Device	Output Power (W)	Stereo/Mono Speaker	Stereo Headphones
TPA2000D4	2	Stereo	Yes
TPA2000D2	2	Stereo	No
TPA2000D1	2	Mono	No
TPA2001D2	1	Stereo	No
TPA2001D1	1	Mono	No

Applications
- Cellular handsets
- Portable DVD players
- Notebook computers
- USB-powered multimedia speakers

LOW-POWER, STEREO AUDIO CODECS
PCM3008

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/PCM3008

The PCM3008 is a low-cost, single-chip stereo audio Codec with single-ended, analog voltage input and output.

Key Features
- 2.4-V stereo audio Codec
- 16-bit, 48-kHz sampling, stereo audio Codec (hardware control only)
- Power supply: 2.4 V to 3.3 V
- Low power dissipation: 28 mW at 2.4 V
- Dynamic range: PCM3008, 90 dB (DAC), 88 dB (ADC)
- THS+N: 0.006%
- System clock: 256/384/512 f_S
- Power-down mode: 10 µA (ADC, DAC individual)
- Packaging: 16-lead TSSOP; AK4550 pin-compatible

Applications
- Portable audio players
- Home theater-in-a-box

PCM3008 Block Diagram

Internet Audio Selection Table

Device	RAM	Power	Core Voltage (V)	I/O Voltage (V)	Package	Audio S/W Algorithms	Storage Medium Support	Other
DSPs								
TMS320DA250	128 k	17 mW	1.5	3.3	144 TQFP, 176 MicroStar BGA™	AAC, ADPCM, MP3, WMA, WAV, InterTrust, Liquid Audio, Microsoft WMA	Memory Stick, SD, MMC CF, Smart Media, SDRAM, CD, Hard Disk, DataPlay™ PocketZip™	
TMS320DA105	128 k	17 mW	1.5	3.3	144 TQFP, 176 MicroStar BGA™	MP3, WMA, AAC, MP3Pro, Musicmatch, Real Networks Adaptec	SDRAM, DRAM	CD burners supported: Philips, Sony, Yamaha
TMS320DA106	128 k	17 mW	1.5	3.3	144 TQFP, 176 MicroStar BGA™	MP3, WMA, AAC, MP3Pro, Musicmatch, Real Networks Adaptec	SDRAM, DRAM	CD burners supported: Philips, Sony, Yamaha

INTERNET AUDIO CD SOLUTION

With the invention of CDs in the early 1980s, the technology to store **digital audio signals on audio CDs** became necessary as well. The Compact Disc Digital Audio (CD-DA) standard — also known as Red Book format — has enabled the encoding and organization of digital audio files onto audio CDs. Red Book was designed to hold approximately 60 minutes of audio data in as many as 99 tracks.

Yellow Book was later introduced to describe the extension of CD storage capabilities to store other data (i.e., CD-ROM). Burning CDs in Red Book format only allows for one hour of music in .wav file format. However Yellow Book supports CD audio, MP3, AAC, and WMA files allowing up to 10 hours of music. Naturally, consumers want the 10 hours of storage associated with Yellow Book format and the ability to use CD-R/RW media to burn their own CDs. Giving users the **ability to burn CDs inexpensively** will only increase the growth in this market segment.

In addition to cost considerations, the music enthusiast/gadget lover is becoming more sophisticated and is demanding more from his listening experience. Manufacturers of portable CD players are seeking to deliver products that will not merely play music, but that will **support ever-changing standards and issues of digital security,** and will offer enriched functions such as anti-shock and multisession. The days of single-format and limited-function products are over.

As the market quickly becomes inundated with products that look and do the same things, manufacturers will need to differentiate their products with solutions that can support the ever-growing demands of the user.

TI offers a DSP-enabled CD audio solution to address these challenges. TI's suite of audio solutions enables OEMs to quickly deliver innovative and differentiated products to market. These **complete audio solutions** include audio-centric DSPs, evaluation modules and development tools and a vast security and audio software algorithm library.

TI's DSP-based solution provides low-power, high-performance, enriched-features, and multiformat solutions that **allow customers the flexibility** and the ability to upgrade to meet multiple compression formats and get to market quicker.

The complete combination — silicon offering, software library, industry algorithms, and complete development tools — is the reason why many customers select the TI solution as their premier choice in an audio system.

INTERNET AUDIO CD SYSTEM DIAGRAM

The hardware architecture of an audio CD player is fairly simple and consistent for all CD systems. The CD technology has experienced few changes in the past 20 years. The front-end CD mechanism consists of the spindle motor, motor driver, servo controller, and pick-up. This mechanism controls the CD once placed into the system. On the back-end, the hardware consists of a decoder to play back compressed audio data, a controller to handle the user interface (LCD and keypad), and an audio playback path including a stereo DACs, an amplifier, and power management unit of voltage regulators and supervisors. At the heart of the system is the TMS320C5000™ DSP that acts as decoder and handles controller tasks to be executed from a single chip.
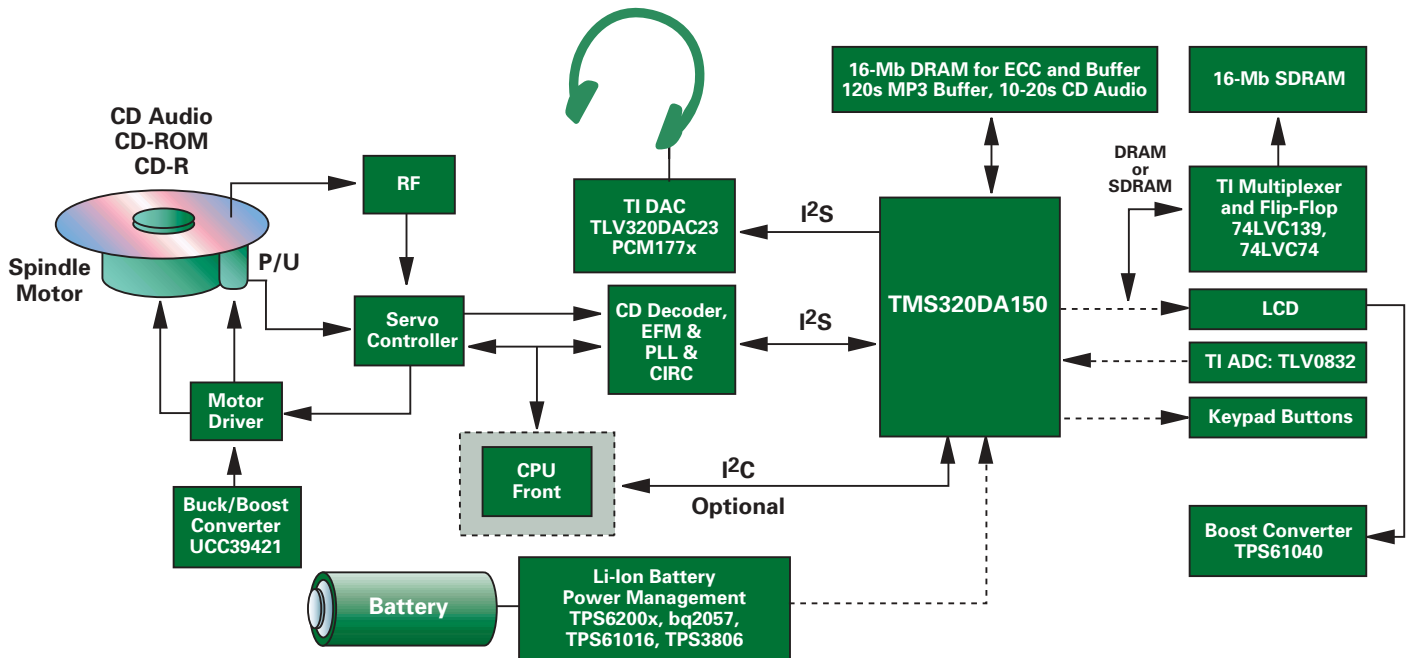
INTERNET AUDIO CD PRODUCTS

TI provides a complete and compelling solution that addresses the various components of functionality in the internet audio CD system.

Analog and Digital Inputs

TI acquired industry-leading Burr-Brown, whose products include high performance, low cost and easy-to-use ADCs. Digital interface benefits from the revolutionary new SpAct™ clock recovery system, which dramatically reduces the sensitivity to input jitter on S/PDIF data. This lays to rest once and for all the arguments about variation in audio performance caused by digital audio interconnections because it eliminates the subtle data-dependent timing effects in the recovered clock. As a result, S/PDIF becomes a more robust and reliable interface.

Processing the Audio DSP

TI's TMS320DA150 DSP is a 16-bit, fixed point audio DSP delivering 160 MIPs of processing power in a small MicroStar BGA™ package. The TMS320DA150 also integrates 128K RAM and 16K ROM of internal memory, three multichannel buffered serial ports, 8- or 16-bit HPI, and 6-channel DMA.

With the performance, flexibility and integration of the DA150 audio DSP, its possible to offer single-chip solutions for advanced features such as UDF file system, 480-second anti-shock buffering in MP3, WMA, AAC, 120 second anti-shock in CD audio playback, audible support (ACELP and LBR WMA), multi-session, mixed-mode, and upgradeability of software by CD.

This single-chip solution not only reduces the BOM but also minimizes design complexity and accelerates time-to-market.

The DA product family roadmap includes plans for higher performance. The TMS320DA250 delivers 3X the available MIPs, and lower cost alternative like the TMS320DA105.

No matter which TI DSP device is selected, there is a path to code compatibility and system upgradeabilty to maintain the development investment.

Processing Audio Software

In addition to providing a complete silicon solution, TI also provides a comprehensive set of audio encoding/decoding software, content protection and DRM systems, speech coders, and audio post processing algorithms. TI also offers CD-ROM decoding functions and CD control software.

PROGRAMMABLE, 160-MHz DSP
TMS320DA150

Get more information at: www.ti.com/sc/device/TMS320DA150

TI provides complete Internet audio and Internet audio-enabled CD solutions including audio-centric DSPs, a vast audio algorithm software library, security compliance, evaluation modules and development tools.

Key Features
- 50% longer battery life than other solutions with lowest power DSPs in industry
- Smaller board space with an integrated uniprocessor design featuring on board — TI MicroStar BGA™ packaging
- Seamless listening with a fully integrated software library. TI provides complete system solution including Internet Audio software supporting AAC, ADPCM, MP3, WMA, and WAV among others, in addition to security software supporting Intertrust®, Liquid Audio™ and Microsoft DRM

Applications
- Portable digital audio players
- Portable CD players
- Portable jukeboxes
- Portable radios/boom boxes
- Mini-/micro-component stereo systems
- Car radios

TMS320DA150 Block Diagram

HIGH-EFFICIENCY DC/DC CONVERTERS
TPS6200x

Get samples, datasheets, app reports and EVMs at: www.ti.com/sc/device/TPS6200

The TPS6200x devices are low-noise synchronous step-down DC/DC converters in MSOP-10 ideally suited for systems powered from a 1-cell Li-Ion battery or from a 2- to 3-cell NiMH/ Alkaline battery. The TPS6200x ideally pairs with the TPS6101x step-up converters.

Key Features
- Synchronous step-down converter with >95% efficiency
- Operating input-voltage range: 2 V to 5.5 V
- Adjustable output-voltage range: 0.9 V to V_{IN}
- Synchronizable to external clock signal up to 1 MHz
- Up to 600-mA output current
- Pin-programmable current limit

Applications
- Internet audio players
- PDAs
- Wireless handsets/cellular telephones
- Any single-cell Li-Ion powered portable application
- Low-power CPUs and DSPs

TPS6200x Block Diagram

TPA611xA2 Block Diagram

150-mW STEREO HEADPHONE AMPLIFIER
TPA611xA2

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/partnumber
Replace partnumber with TPA6110A2, TPA6111A2 or TPA6112A2

The newest family in TI's broad line of linear audio power amplifiers (APAs) virtually eliminates all "pops" and "clicks" present in other headphone amplifiers during on/off/shutdown transitions.

Key Features
- 150-mW stereo output drive
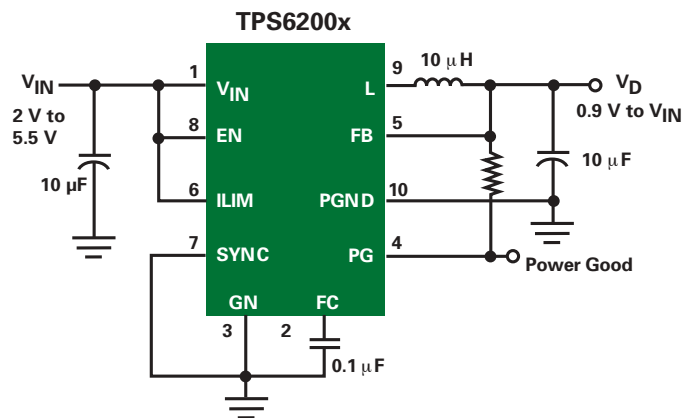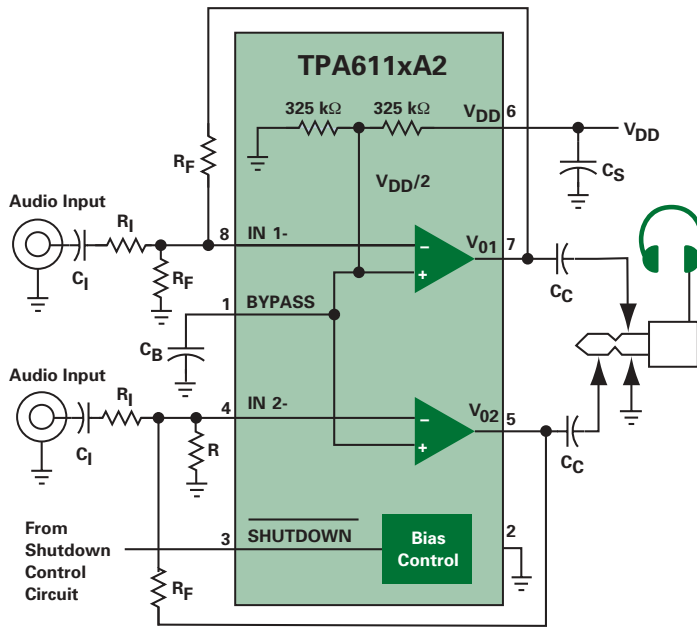- Depop circuitry eliminates "pops" and "clicks"
- Internal mid-rail generator minimizes external components
- Ultra-small, MSOP packaging reduces solution size
- Pin compatible to the TPA1x2 family
- Characterized for operation from –40° C to 85° C

Applications
- MP3 or Internet audio players
- Wireless handsets/headsets
- Internet appliances
- Voice recorders
- CD players

bq2057 Block Diagram
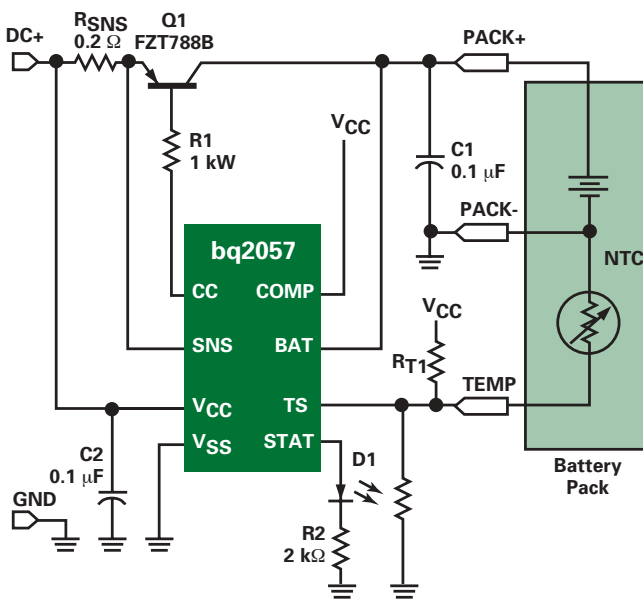
LI-ION CHARGE MANAGEMENT IC IN MSOP-8
bq2057

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/partnumber
Replace partnumber in URL with bq2057, bq2057T, bq2057W or bq2057C

The bq2057 series of advanced Li-Ion and Li-Pol linear charge-management ICs are designed for cost-sensitive and compact portable electronics.

Key Features
- Ideal for low-dropout (0.3 V) linear charger design for one-(bq2057/2057C) and two-cell (bq2057T/2057W) applications
- Proprietary AutoComp™ feature for dynamic compensation of battery pack's internal impedance to reduce charge time
- ±1% voltage regulation accuracy over operating temperature and supply voltage
- Battery conditioning, temperature monitoring and charge termination
- Sleep mode for low power consumption (3 µA)
- Charge status display shows charge in progress, charge complete and fault conditions
- Packaging: 8-pin MSOP, TSSOP, and SOIC

Applications
- Internet audio players
- PDAs and wireless handsets
- Cellular telephones
- Consumer electronics
- Any single- or dual-cell Li-Ion-powered portable application
- Pagers

EUREKA DAB DIGITAL RADIO

Eureka Digital Audio Broadcasting (DAB) digital radio offers listeners more stations and higher fidelity sound. It offers **more than just audio:** a robust data stream transforms radio into personal communication and information delivery with content on demand from song lyrics, album names, stock quotes, traffic and weather reports to news, sports and more.

In the past year, **usage of the Eureka DAB standard has grown** significantly. Countries in Europe, Asia and North America have adopted it as their next-generation radio. Hundreds of stations are on the air with access to millions of listeners. Germany announced analog shutoff within 10 years. Texas Instruments estimates that with these types of developments, digital radio receiver sales will explode from tens of thousands of units sold per year to over 50 million sold by 2010.

The digital radio receiver industry must also change to help the market grow to its full potential. More consumers will want **affordable, portable (battery-operated), and full-featured digital products** that can accommodate the advantages of Eureka DAB digital radio.

The digital radio designer must have solutions that are **inexpensive, power efficient, easy-to-use, and flexible** to create products that will take advantage of the great growth potential and changes that the Eureka DAB market provides. An example includes the potential combination of a one-way data broadcast and a back-channel (e.g., GSM).

With Eureka DAB digital radio, there is no one single chip or piece of software that solves the challenges of digital radio design. Meshing a radio frequency (RF) with a digital subsystem is complex, and should not be solved by simply dealing with one portion of the design.

First, **a complete RF design is needed** for selecting the frequency bands and multiplex of interest. Its channel selection will be frequency control handled by the digital baseband. Then, an ADC is used to sample the IF output from the RF. The digital output from the ADC is then passed to the digital baseband, where the demodulation and decoding of the Eureka DAB digital radio signal occurs. Next, the MPEG1 layer 2 decoded output is sent to the DAC, and ultimately the appropriate amplifiers for speaker or headphone output. In addition, the baseband must have a flexible interface to provide for data decoding. Finally, this entire system must be powered and regulated from either a battery or AC input.

EUREKA SYSTEM BLOCK DIAGRAM

This figure illustrates TI's complete solution for a digital radio. This standard-compliant, single-chip, digital baseband is based on a TI DSP. In the future, applciations cana be built on top of the single-chip baseband using software archi-tecture to enable data features and integrated combo products.
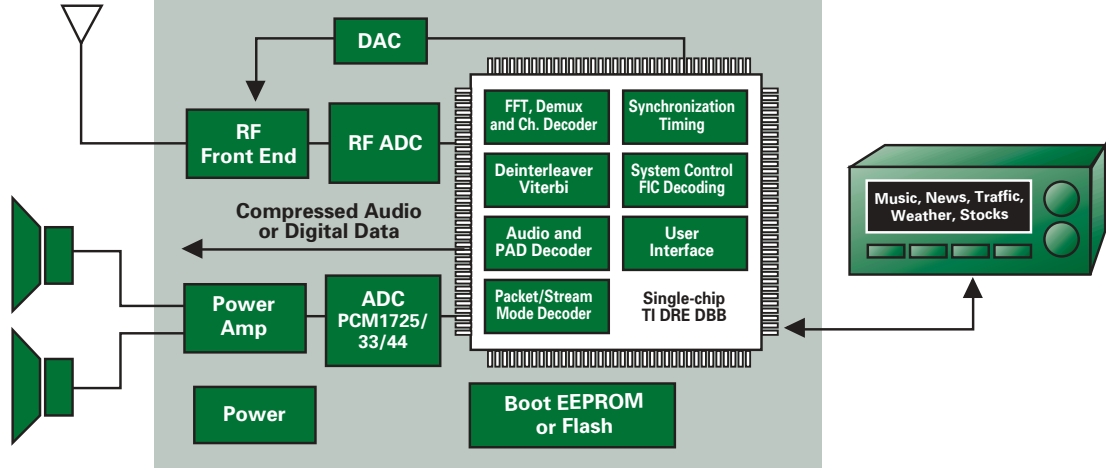
DIGITAL RADIO PRODUCTS

TI, partnering with Radioscape, offers a complete digital radio solution through the TMS320DRE200. TI's complete solution overcomes the challenges previously mentioned:
- TMS320DRE200 is the lowest bill of materials in the industry today (<$40 for VHF)
- TMS320DRE200 has a low system power consumption
- TMS320DRE200 is flexible, enabling more than just digital radio with easy-to-implement functions

TMS320DRE200 Digital Baseband
The ETSI 300 401-compliant TMS320DRE200 baseband performs channel and source decoding on a single chip. In addition, the digital baseband can decode all Eureka modes and perform user-interface functions. Features and specifications of the TMS320DRE200 baseband are:
- Does not require the use of external memory for DAB operation.
- Can interface to an external microcontroller (not required for operation)
- Disturbance-free operation during multiplex sub-channel reconfiguration or ensemble switch
- Can feed data to external TPEG or MOT decoder and external memory
- Baseband <175 mW, standby <1 mA
- 3.3 V and 1.6 V operation
- 144-pin TQFP or 144-pin MicroStar BGA™
- -40° to +85° C

TMS320DRE200 Software
TI delivers the first open, software-driven Eureka DAB digital radio receiver solution. This architecture offers the designer several advantages:
- Quickly and easily update and upgrade products via software, e.g., adding MP3 to DAB chip
- Flexibility to replace/add feature software modules with TI's award-winning DSP toolset
- The ability to add and integrate multiple functions on a single chip, minimizing hardware design time in addition to decreasing cost and power

TMS320DRE200 Analog
TI also builds the ADC, DAC, power amplifier, and other power-management devices for this application. TI has taken advantage of its product breadth and bundled these chips together for the lowest system cost for digital radio on the market today. TI also provides designers the proverbial one-stop shopping by offering an entire digital radio solution.

The performance of these parts, along with the digital baseband and software, are demonstrated in the TMS320DRE200 EVM and Turn-key Reference Design.

TMS320DRE200 Evaluation Module (EVM)
Designers interested in creating commercial digital radios can evaluate this total solution using the TMS320DRE200 EVM. The EVM includes the evaluation board, schematics, users guides, human-machine interface (HMI) source code, and the digital radio object code. Available now, the EVM (DRE200EVAL) costs $5,000.

TMS320DRE200 Turn-Key Reference Design
Some customers desire a quick time-to-market solution with little design effort or risk required. TI's partner, Radioscape, offers a turn-key reference design that will accomplish this. Please contact TI's digital radio team for more details on this solution at digitalradio@ti.com

INDUSTRY'S LOWEST SYSTEM COST
TMS320DRE200

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TMS320DRE200

The Eureka DAB digital radio receiver solution is the first open, software-driven, power-efficient, complete receiver design available in the industry.

Key Features
- Lowers baseband cost
- Lowers system cost by bundling eight analog components required for reference design
- Eliminates need for DRAM, SRAM and microcontrollers
- Cost to add additional functions is minimal (e.g., music recording, internet audio, data decoding, etc.)
- 60% reduction in power on the baseband (170 mW); using the lowest power RF on the market today
- Add differentiated features such as an equalizer by plugging in new software modules
- Replace/add software modules via easy-to-use software tools

Applications
- Digital radios
- AV receivers
- Mini/micro component stereo systems
- Integrated internet audio/stereos
- IA player/digital radios
- Cellphone/IA player/digital radios
- PDA/IA player/digital radio

TMS320DRE200 Digital Baseband

ADVANCED STEREO AUDIO POWER AMP
TPA6010A4

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/tpa6010a4

The TPA6010A4 is a stereo audio power amplifier in a 28-pin TSSOP thermally enhanced PowerPAD™ package capable of delivering 2 W of continuous RMS output power into 3-Ω loads. The device offers features optimized for digital radios including bass boost, line outputs, DC volume control, and DC gain control.

Key Features
- Maximum output power 2-W stereo into 3-Ω speakers
- Integrated stereo headphone drive
- DC volume control and gain setting adjust from 34 dB to -86 dB
- Bass boost
- Fully differential inputs
- Buffered docking station outputs
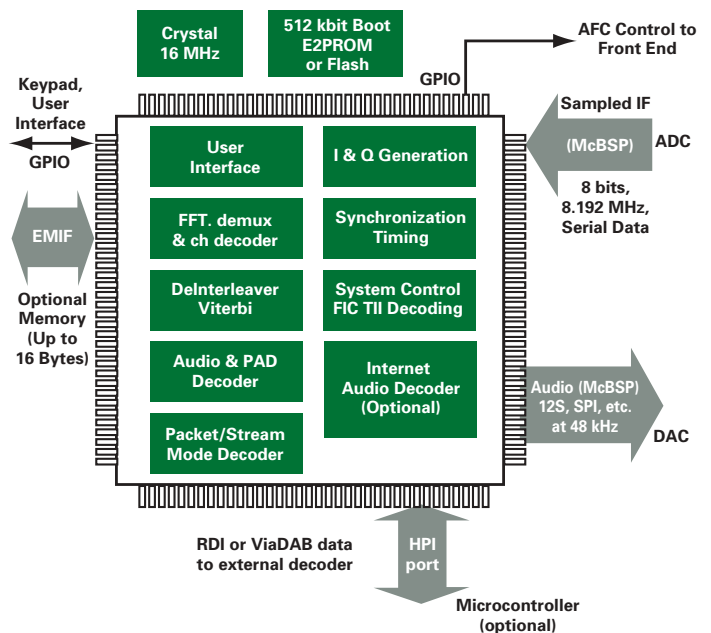
Stereo Audio Power Amplifier for Digital Radios

Device	Output Power (W)	DC Volume Control	Dig. Volume Control	Internal Gain Settings	Bass Boost	Differential Inputs	Stereo Input MUX	Docking Station Outputs	Stereo Head-phones
TPA6010A4	2.0	■		■	■	■	■	■	■
TPA0112	2.0			■		■			■
TPA0212	2.0			■		■	■		■
TPA0132	2.0	■				■			■
TPA0232	2.0	■				■	■		■
TPA0152	2.0		■			■			■
TPA0252	2.0		■			■	■		■

Applications
- Digital radios
- Notebook computers with:
  – Docking stations
  – Desktop computers
  – Internet appliances

TLV320DAC23 Block Diagram
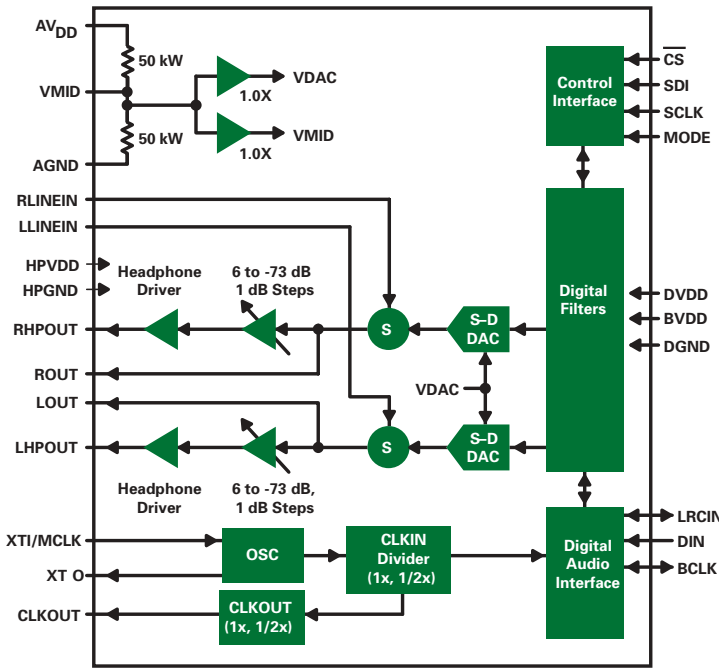
LOW-POWER DAC WITH ANALOG LINE INPUTS
TLV320DAC23

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TLV320DAC23

A high-performance, low-power stereo audio DAC with highly integrated analog functionality includes analog line inputs with an analog bypass path and a stereo headphone driver.

Key Features
• 100-dB SNR DAC
• Very low power dissipation: 9 mW in playback mode
• Integrated 30-mW headphone amplifier
• 8-kHz to 96-kHz sampling frequency support
• Power down power consumption <15 μW
• Packaging: Small, 25 mm^2 MicroStar Jr.™ BGA or TSSOP

Applications
• MP3 audio players and recorders
• Internet jukeboxes
• Cell phones with audio
• Digital cameras with audio
• Personal digital assistants with audio
• Any digital audio application

PCM1725 Block Diagram
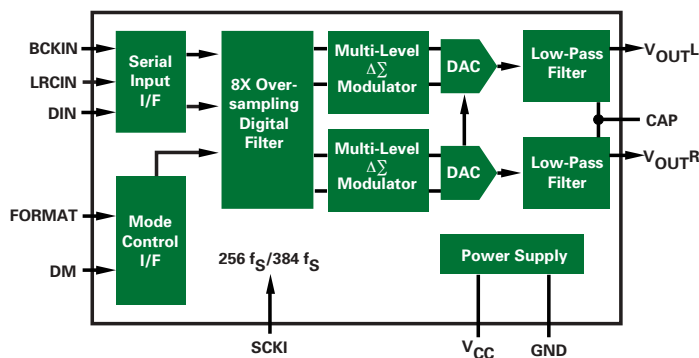
DAC FOR CONSUMER AUDIO APPLICATIONS
PCM1725/33/44

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/partnumber
Replace partnumber in URL with PCM1725, PCM1733 or PCM1744

The PCM1725/33/44 low-cost stereo audio DACs operate off of a 256 f_S or 384 f_S system clock. The DAC contains a third-order Delta-Sigma modulator.

Key Features
• Complete stereo DAC includes digital interpolation filter and analog output amplifier
• Dynamic range: 95 dB
• Multiple sampling frequencies: 16 kHz to 96 kHz
• 8X oversampling digital filter
• System clock: 256 f_S/384 f_S
• Normal or I^{2}S data input formats
• Packaging: Small 14-pin SOIC

Applications
• Network security camera

PROFESSIONAL AUDIO

The choices in consumer audio electronics are growing exponentially. The market segment that has been dubbed "professional" (pro) audio is a fascinating field with a broad requirement for both high performance and ease of use. Pro audio includes anything from compact home recording equipment and electric instruments for the part-time musician, to high quality audio distribution infrastructure and large recording studio projects. TI's complete product portfolio addresses the **wide variety of applications** in the pro audio market.

TI's new 32-/64-bit floating-point audio DSPs offer a dramatic performance increase in a highly integrated device. Designers can access and harness the full performance and flexibility of this programmable DSP through TI's **industry-leading** development tools including the **industry's leading** DSP integrated development environment (IDE), DSP real-time operating system (RTOS), and most efficient C compiler.

In addition, TI's advanced processing technology and analog design capability harmonizes with Burr-Brown's heritage of high quality audio conversion and processing, to provide a **comprehensive tool kit** for the hard-pressed system designer.

AUDIO RECORDING APPLICATION
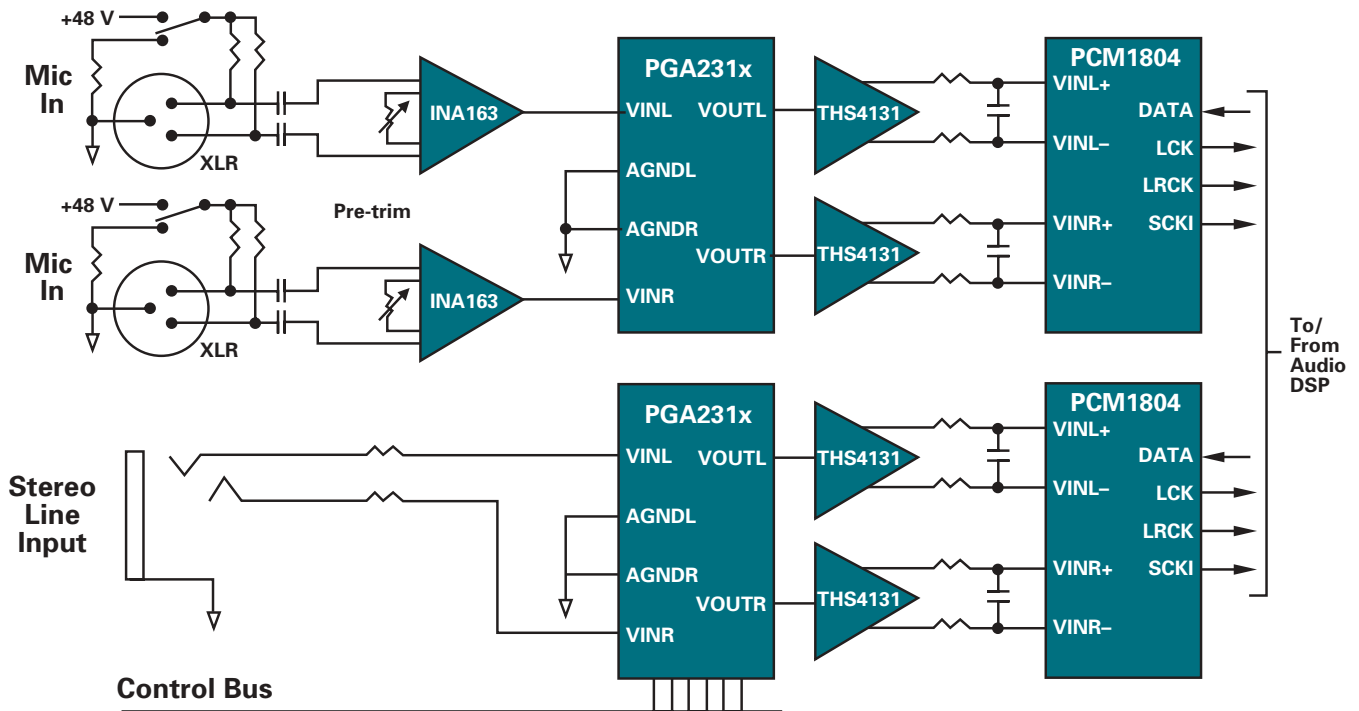
AUDIO PLAYBACK APPLICATION
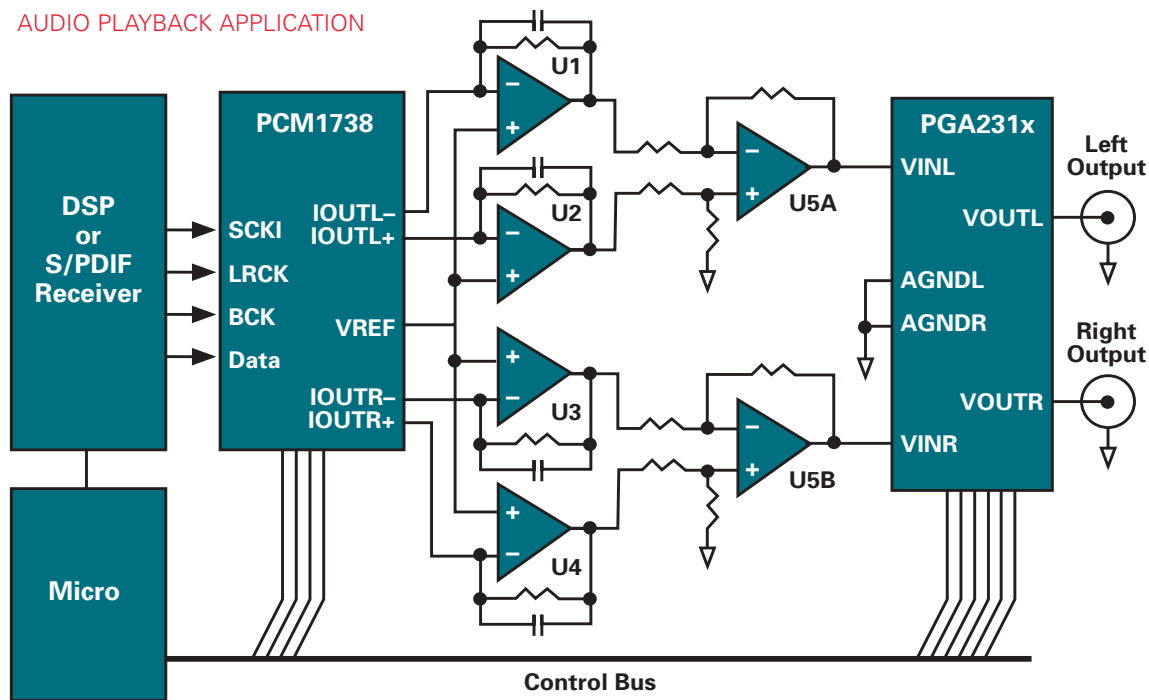
PROFESSIONAL AUDIO PRODUCTS

TI has a broad range of analog audio signal chain components and audio converters. Combined with overwhelming digital signal processing advantages from the latest 64-bit DSPs, TI provides a platform for pro audio design that is unmatched in its breadth and practical applicability.

Analog and Digital Inputs

Large signals are the norm in pro audio applications, and TI has a complete chain of analog processing parts for industry standard ±15-V supplies, allowing signal levels and dynamic range to be preserved right up to the conversion to digital. The INA163 microphone preamp, PGA2310 ±15-V programmable volume control and the THS4131 low noise differential op amp are just three highlights of this range.

Processing the Audio DSP

TI's TMS320C6713 is a 32-/64-bit floating-point audio DSP. At 225 MHz, it delivers 1800 MIPS or 1350 MFLOPS. The C6713 also integrates 3Mb of RAM, two highly flexible multichannel audio ports with 16 stereo channels of I^{2}S and four independent clock zones. This provides extreme precision and massive computing power in an audio-optimized solution.

Development Tools

TI offers a world-class development environment. The Code Composer Studio™ integrated development environment (IDE) is a fully integrated suite of easy-to-use DSP software development tools, incorporating TI's efficient TMS320C6000™ DSP

C compiler with the Code Composer IDE, DSP/BIOS™ kernel foundation and Real-Time Data Exchange (RTDX™) technologies. Code Composer Studio IDE provides standard open APIs, allowing third parties to build higher-level products that add functionality to the environment.

Generating the Outputs

TI carries on the Burr-Brown tradition of high quality DACs. The multibit, mono PCM1704 converters provide unparalleled freedom from unwanted high frequency signal components in professional broadcast equipment. Also, the new two-channel PCM1730 offers 117 dB dynamic range, low out-of-band noise and great jitter resistance in a convenient, pin-programmable device that does not require a separate control interface.

The PGA2310 ±15 V programmable volume control, and the PGA2311 ±5 V programmable volume control, are very useful for adjusting analog line output levels, while preserving the overall performance (Dynamic Range, THD+N) of the signal path.

The THS6032 ADSL (asymmetric digital subscriber line) can be used as a high current audio output stage. This device has been used effectively in multiple output distribution amplifiers where its high speed and low heat dissipation enables versatile products in very compact form factors.

TI also has the industry's only fully balanced audio line driver in an SO-8 package, the DRV135. By emulating a transformer-coupled output, such drivers ensure compatibility with both differential input and single-ended equipment without short-circuit worries.

STEREO AUDIO VOLUME CONTROL
PGA2310 and PGA2311

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/partnumber
Replace partnumber in URL with PGA2310 or PGA2311

The PGA2310 is a complete stereo digitally selectable analog volume control providing high-end audio performance. It includes a 16-bit serial interface and a precision matched resistor attenuator. The PGA2311 is a CMOS version with ±5-V analog power supply and is pin-software-compatible with the PGA2310.

Key Features
- Wide adjustable gain and attenuation range:
  - -95.5 dB of attenuation to +31.5 dB of Gain, with 0.5-dB steps
- Noise-free level transition
- Dynamic Range: 120 dB
- THD+N:
  - PGA2310: 0.0004% at 1 kHz
  - PGA2311U (standard grade): 0.0004% at 1 kHz
  - PGA2311UA (high grade): 0.0002% at 1 kHz
- Crosstalk at 1 kHz: -126 dBFS (PGA2310); -130 dBFS (PGA2311)
- Voltage swing: 27 V_{PP} (PGA2310); 7.5 V_{PP} (PGA2311)
- Power supplies:
  - PGA2310: ±15 V Analog, +5 V Digital
  - PGA2311: ±5 V Analog, +5 V Digital
- Packaging: SOL-16, and DIP-16

PGA2310 and PGA2311 Block Diagram
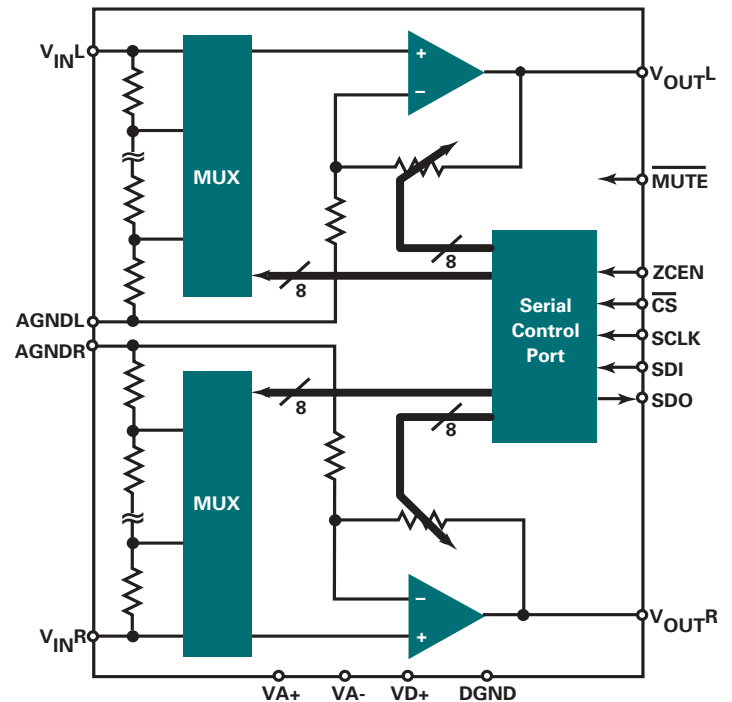
Applications
- Stereo volume amplifier/attenuator
- Mixers and control boards
- Broadcast equipment

LOW-DISTORTION MICROPHONE PREAMP
INA163

Get samples and datasheets at:
www.ti.com/sc/device/INA163

The INA163 is a very low-noise, low-distortion, current-feedback amplifier with balanced "instrumentation amp" inputs. It achieves very wide bandwidth and excellent dynamic response.

Key Features
- Low noise: 1 nV/√Hz at 1 kHz
- Low THD+N: 0.002% at 1 kHz, G = 100
- Wide bandwidth: 800 kHz at G = 100
- Wide supply range: ±4.5 V to ±18 V
- High CMR: >100 dB
- Gain set with external resistor
- Packaging: SO-14 surface mount

INA163 Block Diagram

$$G = 1 + \frac{6000}{R_G}$$

Applications
- Professional microphone pre-amplifier
- Mixer boards and consoles
- Broadcast studios
- Music performance equipment
- Instrumentation, industrial and medical applications

DIT4096 and DIT4192 Block Diagram
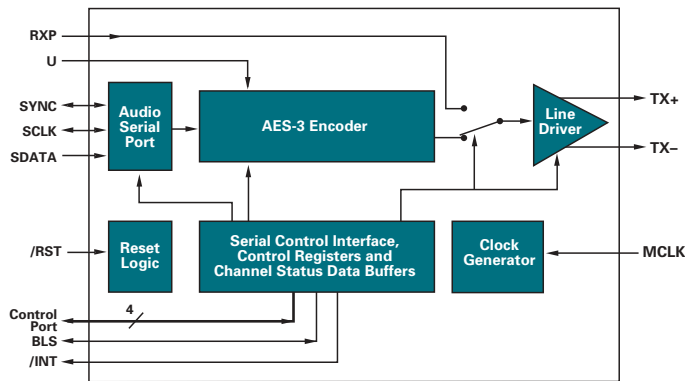
Applications
- Digital mixing consoles
- Digital microphones
- Digital audio workstations
- Broadcast studio equipment
- Effects processors
- Surround sound encoders/decoders
- AV receivers
- DVD/CD/DAT/MD players
- Audio test equipment

96-kHz AND 192-kHz DIGITAL AUDIO TRANSMITTERS
DIT4096 and DIT4192

Get samples and datasheets at:
www.ti.com/sc/device/partnumber
Replace partnumber in URL with DIT4096 or DIT4192

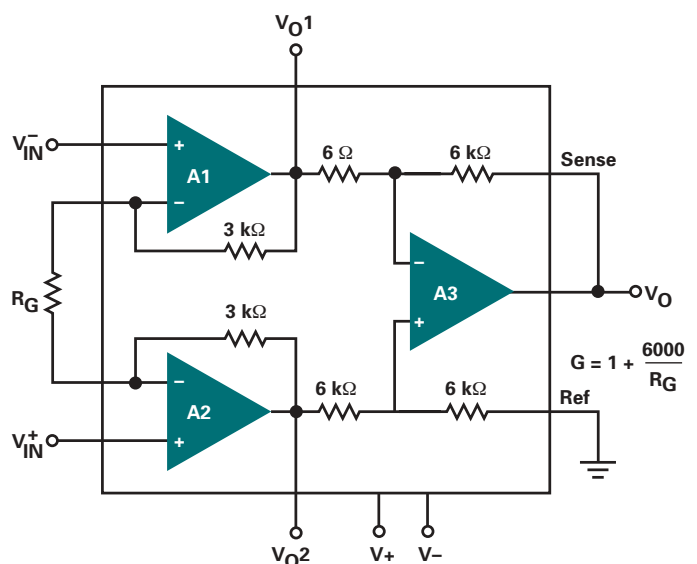The DIT4096 and DIT4192 are digital audio transmitters designed for use in both professional and consumer audio applications. Both support software or hardware operation, allowing for either host-controlled or stand-alone operation. A flexible serial port is provided, which supports standard audio data formats and provides direct interface to many audio processing and conversion products.

Key Features
- Sampling rates: 96 kHz (DIT4096), 192 kHz (DIT4192)
- On-chip differential line driver
- CRC code generation for professional mode
- Compliant with AES-3, IEC-60958, EIAJ CP1201 interface standards
- Master clock rate: 128x f_S (DIT4192), 256x f_S, 384x f_S or 512x f_S
- Single +5-V power supply
- Packaging: 28-lead TSSOP

USB HEADSETS

New gaming consoles with USB audio support and emerging PC applications such as Internet telephony and voice recognition are driving the need for higher quality audio headsets. Relying on the internal soundcard to provide the necessary quality level and user experience is no longer acceptable to consumers. These catalysts have launched USB headsets into a high growth market.

USB headsets provide **a simple, clean user interface** with both voice and control data over a single wire. Compared to a traditional soundcard solution, the user's experience is significantly increased and exciting new applications become possible.

There are many challenges for designers of USB headsets. USB headsets need to be bus-powered devices that meet the USB IF power requirements, while providing **necessary features and user feedback** such as power and mute indicators. Power drawn from the USB cable before enumeration also needs to be limited, which is a considerable challenge for USB audio devices. From a software compatibility standpoint, many existing operating systems have quirks that are unique and need special USB device descriptors to provide the **maximum reliability** across many PC platforms.

In addition to all the technical challenges, people have become accustomed to using analog phones and expect their new USB headsets to provide a similar environment with **better performance and new features.** One such environmental concern is to provide a small amount of feedback from the microphone to the earpiece. Without this feedback, people think the USB headset is not working because it sounds similar to a disconnected phone line.

Meeting these needs and **adapting to future PC environments** is crucial for having a successful USB headset or other USB audio product. TI has developed a USB headset reference design to speed our customers to market. This solution enables our customers to get to market faster with a more reliable solution and have the flexibility to keep pace with tomorrow's changing PC environment.

USB HEADSETS
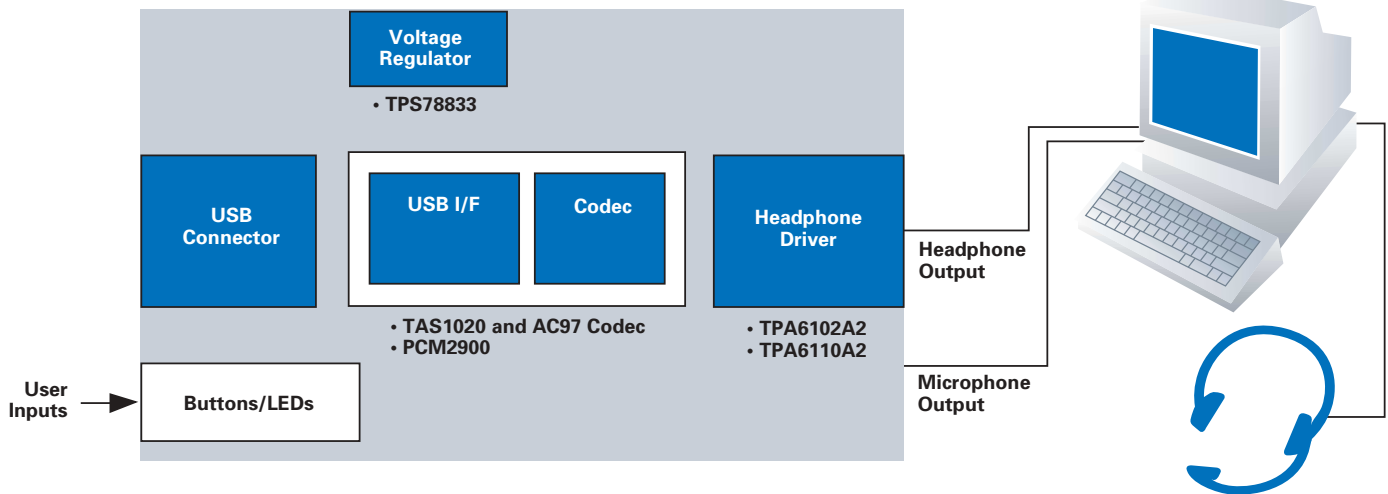
USB headset architectures can vary depending on the target application; however, in general, most will have the same basic design blocks. The audio signals to and from the PC need to be transmitted by a device with a USB interface. This device performs many tasks beyond just buffering the data and reformatting the data. It is also the system controller and interfaces to LEDs and buttons as well as controlling the power sequencing for the entire board. The playback audio data also needs to be synchronized.

USB HEADSET PRODUCTS

TI provides a complete and compelling solution that addresses the entire signal chain in a USB headset solution.

TI provides several options for USB headset designers from a highly integrated option with a great price to the most flexible solution available on the market. The PCM2900 offers a high degree of integration and requires no programming that enables quick designs, while the TAS1020 offers the world's best versatility for USB headsets. The TAS1020 is specially designed for audio applications and has many features that are unique in the industry. One such feature is a configurable Codec port that allows almost any audio Codec to be used in the system. This enables the USB headset to have the perfect price to performance ratio. The TAS1020 also is completely programmable, which allows for a completely tailored solution that can be upgraded in the field. Whether you are looking to do a design with the lowest cost or the highest performance, TI has the right USB headset solution for you.

Power Supply Voltage Regulator
TI has developed a special voltage regulator targeted for USB bus-powered applications, the TPS78833. This voltage regulator not only provides up to 150 mA of regulated 3.3-V power, but also controls USB inrush current. This feature eliminates the need for external circuitry to control inrush and reduces cost, board space, and design complexity.

USB Firmware & Host Software Drivers
In addition to providing a complete silicon solution, TI also provides a comprehensive solution for software needs. TI solutions are completely programmable to meet almost any application requirements. Example application firmware is provided under a no-cost software license agreement, which provides a jumpstart on product development. The USB headset reference design does not require any special host drivers to operate and demonstrates a wide range of features without custom drivers.

Driving the Headphones
TI has an extensive headphone driver portfolio, which is sure to meet any needs. For a USB headset, designers should choose one that supports a low power shutdown state to allow for USB bus powered applications. The TPA6102A2 is a perfect fit with up to 50 mW of driving power and excellent audio performance.

USB headset architectures can vary depending on the target application; however, in general, most will have the same basic design blocks. The audio signals to and from the PC need to be transmitted by a device with a USB interface. This device performs many tasks beyond just buffering the data and reformatting the data. It is also the system controller and interfaces to LEDs and buttons as well as controlling the power sequencing for the entire board. The playback audio data also needs to be synchronized.

LOW VOLTAGE HEADPHONE AMP
TPA610xA2

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/partnumber
Replace partnumber in URL with TPA6100A2, TPA6101A2 or TPA6102A2

The TPA610xA2 family of stereo audio power amplifiers operates from a 1.6-V to 3.6-V supply and delivers 50 mW of continuous RMS power per channel into 16-W loads.

The new TPA6101A2 and TPA6102A2 devices save board space by internally setting the amplifier gain, which eliminates six external resistors.The TPA6100A2 is set externally for designs that require maximum flexibility.

Key Features
• 50-mW stereo output drive
• 1.6-V to 3.6-V operating supply voltage
• 0.75-mA low supply current
• 50-nA low shutdown current
• Internal gain setting
• Internal mid-rail generation

TPA610xA2 Block Diagram

Applications
• USB headsets
• Internet-ready:
  – Wireless phones
  – PDAs
  – Internet appliances

PROGRAMMABLE USB AUDIO INTERFACE
TAS1020

Get samples, datasheets, app reports and EVMs at:
www.ti.com/sc/device/TAS1020A

The TAS1020 IC is a USB peripheral interface device designed specifically for applications that require isochronous data streaming.

Key Features
• Complements the TUSB3200 and provides a low-cost alternative for full duplex stereo solutions
• On-chip clock generation and adaptive clock generator (ACG)
• Customizable audio performance level; supports most standard AC97 or I^{2}S Codecs
• General-purpose mode allows interfacing with devices like TI's TMS320C54x™ DSPs
• Integrated DMA controller moves isochronous audio data from the PC to the Codec without intervention, eliminating the need to code tight assembly routines with critical timing
• Field upgrades enabled via USB DFU Class
• USB headset reference design available

Applications
• USB headsets
• USB headphones
• USB speakers

TAS1020 Block Diagram

PCM2900 Block Diagram

SINGLE-CHIP, STEREO AUDIO CODEC
PCM2900

Get samples, datasheets and app reports at:
www.ti.com/sc/device/PCM2900

The PCM2900 is a single-chip stereo audio codec with an integrated USB 1.1-compliant interface controller. The PCM2900 employs the same SpAct™ technology used in the popular PCM2702 device for outstanding audio quality.

Key Features
- Supports a wide range of sampling frequencies from 8 kHz up to 48 kHz for both playback and record. This allows the host to select any frequency without requiring sample rate conversion.
- Integrated clock generator requires only a single external 12-MHz crystal to generate all necessary clocks.
- Requires no programming, which shortens new product development cycles.
- Supports HID volume and mute controls through dedicated input pins.
- Packaging: 28-pin SSOP

Applications
- USB headsets
- USB speakers
- USB audio interface box

EVALUATION MODULES (EVMS)

To order any of the following evaluation modules (EVMs), please call the order desk, 1-800-477-8924, ext. 5800, in North America. To order from other regions, please contact the TI Product Information Center *(see listings on page 2)* or local TI distributor.

TUSB3200EVM
The TUSB3200EVM allows customers to evaluate the TUSB3200 for USB audio applications. The EVM includes an AC97 Codec and demonstrates full duplex audio capabilities. **Price: $499**

TUSB3200EVM2
The TUSB3200EVM2 is designed to allow development and evaluation of the TUSB3200 for multichannel applications. The TUSB3200 accepts USB data streams and generates output at the Codec port, I2C port, and/or GPIO port. A six-channel Codec is included on the EVM to provide six analog line level outputs that can be connected to amplified speakers. **Price: $499**

TAS1020AEVM
TAS1020A Customer Evaluation Module (EVM) is based on TIs TAS1020A integrated circuit (IC). The TAS1020A is a Universal Serial Bus (USB) peripheral interface device designed specifically for applications that require isochronous data streaming, e.g. streaming of digital audio data between the host PC and the speaker system via the USB connection. The TAS1020A fully complies with the USB Specification version 1.1 and the USB Audio Class Specification. **Price: $399**
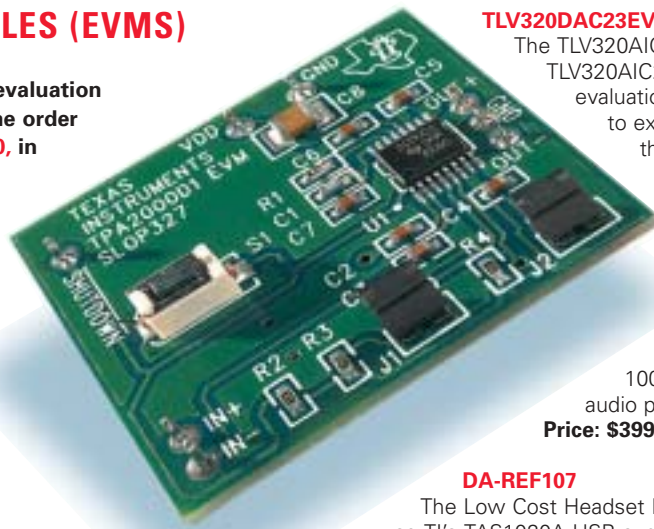
TAS3001EVM
The TAS3001EVM allows designers to evaluate and develop products using the TAS3001 Digital Audio Processor. The TAS3001 is a 32 bit audio processor that can perform EQ, VBT, DRC and other audio processing functions. It contains six bi-quads per channel; each can be changed dynamically. The EVM allows the full functionality of the TAS3001 to be evaluated. **Price: $499**

TAS5100EVM
TI's 30WX2, 24-bit digital amplifier solution can be fully evaluated using the TAS5100EVM. The EVM ships with the TAS5010 PWM processor but is footprint-compatible with the TAS5001 and TAS5012. The EVM has S/PDIF, I2S or analog input and can operate from 32 kHz to 192 kHz, 96 dB SNR, and 0.08% THD+N. It contains a bypass-able TAS3004 digital audio processor that can be used for digital volume, tone filtering, loudness and DRC. **Price: $499**

TLV32AIC23EVM
The TLV320AIC23EVM platform is useful for the TLV320AIC23 and the TLV320DAC23 device evaluations. The provided software allows users to exercise the various modes and features of the AIC23 Codec and DAC23 audio DAC. **Price: $299**

TLV320DAC23EVM
The TLV320AIC23EVM platform is useful for the TLV320AIC23 and the TLV320DAC23 device evaluations. The provided software allows users to exercise the various modes and features of the AIC23 Codec and DAC23 audio DAC. **Price: $299**

DA-REF105
The DA-REF105 is the TAS3004/3002 Reference Design Board and allows designers to evaluate and develop products using the TAS3004 Digital Audio Processor. The TAS3004 is a 32-bit, 100 MIP digital audio processor that performs audio processing on an audio stream. **Price: $399**

DA-REF107
The Low Cost Headset Reference Design demonstrates how to use TI's TAS1020A USB audio streaming controller in a USB headset application. The headset provides the capability of listening to and recording high quality audio with a PC. The DA-REF107 includes the TAS1020A, an AC97 Codec, TPA6110A2 audio amplifier and TPS78833 voltage regulator. **Price: $299**

USERS GUIDES

To access any of the following users guides or application reports, type the URL www-s.ti.com/sc/techlit/litnumber and replace litnumber with the number in parentheses.

6-Channel TUSB3200EVM2 for the TUSB3200 USB Streaming Data Controller (SLAU062)
This users guide describes the setup and operation of the TUSB3200EVM2 platform. This PCB contains two main active parts: TUSB3200 STC (TI USB streaming controller) and crystal CS4228 Codec. This PCB is referred to as the TUSB3200EVM2 from this point on. Familiarity with emulator hardware and software is required and assumed throughout this users guide.

DA-REF105: TAS3002/TAS3004 Reference Design Board (SLEU004)
The TAS3004 reference board demonstrates the operation of the digital equalization and the dramatic improvements that 32-bit digital audio signal processing can make on the quality of sound.

DEM-DAI1704/06 Demo Board (SLAU068)
The DEM-DAI1704/06 is an evaluation module for the PCM1704 and DF1704/DF1706 digital-to-analog converters (DACs). This module can achieve 24-bit/96-kHz sampling format. This DEM-DAI1704/06 uses two PCM1704 DACs (stereo), two OPA627 for current/voltage amplification, an OPA2134 in a second-order low-pass filter (LPF) in the analog section, and a digital audio receiver and a DF1704/DF1706 DAC in the digital section.

DEM-DIR1701 Demo Board Instruction Manual (SLAU070)
The DEM-DIR1701 is an evaluation board for digital audio interface receiver IC DIR1701. This board generates very low jitter system clock and PCM audio data for audio DAC interface from an S/PDIF digital audio interface input. The DEM-DIR1701 has switch-selectable coax and optical inputs. It accepts sampling rates up to 96 kHz. This board requires a 5-V power supply; a 3.3-V power supply is also required when jumper JP1 is removed. An internal 3.3-V regulator IC is used for operation of the DIR1701. The 5-V power supply operates the optical receiver and the input logic section. The PCM audio interface format and generated system clock frequency (either 128 f_S, 256 f_S, 384 f_S, or 512 f_S) can be selected by control switch SW2.

DSREF100R0 Low-Cost USB Headset Board Reference Design (SLAU064)

This users guide describes the operation of the TUSB3200 headset reference design board. This document contains descriptions and schematics for a low-cost universal serial bus (USB) headset. The board described is provided as an example that can be easily customized to fit specific needs. This board has been designed to pass USB IF compliance testing. It has also been tested to comply with international regulations.

Evaluation Module for the TLV320AIC23 Codec and the TLV320DAC23 Audio DAC (SLEU003)

This document covers the user software provided with the TLV320AIC23EVM board based on the TI TLV320AIC23 (AIC23) or the TLV320DAC23 (DAC23). Except where noted the AIC23 applies to both the TLV320AIC23 and the TLV320DAC23. The function, operation, and implementation of the software are described. A description of the TLV320AIC23 EVM boards connectors and jumpers is also provided, along with instructions on how to configure the board for use with the TLV320AIC23 EVM user software or as a stand-alone USB audio device. The TLV320AIC23 EVM platform is useful for the TLV320AIC23 and the TLV320DAC23 device evaluations. The provided software allows users to exercise the various modes and features of the AIC23 Codec and DAC23 audio DAC.

TAS1020A Evaluation Module for the TAS1020A (SLEU002)

The TAS1020A EVM is based on the TI TAS1020A integrated circuit (IC). The TAS1020A IC is a universal serial bus (USB) peripheral interface device designed specifically for applications that require isochronous data streaming, e.g., streaming of digital audio data between the host PC and the speaker system via the USB connection. The TAS1020A fully complies with the USB specification version 1.1 and the USB audio class specification. The TAS1020A uses a standard 8052 microcontroller unit (MCU) core with on-chip memory to handle all data transfer. The TAS1020A EVM is designed to allow development and evaluation of the TAS1020A for controlling streams of data.

TPA0252 Audio Power Amplifier Evaluation Module (SLOU102)

This provides an overview of the Texas Instruments TPA0252 audio amplifier EVM. It includes a list of EVM features, a brief description of the module illustrated with a pictorial diagram and a list of EVM specifications.

TUSB3200 EVM Development Platform for the TUSB3200 Universal Serial Bus Streaming Data Controller (SLAU059)

The TUSB3200 EVM was designed for use with additional hardware and software. The emulator hardware should consist of a PC card, an interface cable, and an emulator pod. The pod may or may not have an extension module in-cluded. These components may or may not be sold independently depending on the vendor. The emulator software should include everything required to run the hardware. If programming in C++ instead of assembly code is desired, then a C++ to assembly code compiler is also a nice tool to add to the shopping list. It is recommended to check the compiler and the emulator for compatibility before making a selection. A USB cable is required to interface the TUSB3200 EVM to the PC.

TUSB3200 USB with EQ 2-Channel Reference Design (SLAU063)

The USB interface is based on the Texas Instruments TUSB3200 universal serial bus device. The device includes a transceiver that supports 12 Mbps (full speed) data transfers. The TUSB3200 conforms to USB Specification Version 1.1 and USB Audio Class Specification 1.0. The USB receives isochronous audio and control data from the USB I/O connector. The USB separates the received digital audio data into separate left and right channels. The TUSB3200 sends the digital audio data to the TAS3001 digital equalizer function via the I 2 S port at one of the following sampling frequencies: 32 kHz, 44.1 kHz, or 48 kHz. The sampling frequency is defined only during initialization and can not change while the device is in normal operation. The TUSB3200 generates the control for the digital equalizer and the Codec. The TUSB3200 controls the circuit in the four functional modes: reset, initialization, mute, and operation.

TAS3001 EVM (SLAU060)

The TAS3001 EVM board demonstrates the operation of the digital equalization and the dramatic improvements that 32-bit digital audio signal processing can make on sound quality.

APPLICATION REPORTS

Digital Audio Measurements (SLAA114)

To perform correct measurements on a true digital audio amplifier (TDAA), it is important to understand the characteristics of the device, especially in comparison with conventional linear amplifiers such as class-A and class-AB. This report provides an overview of TI's proprietary digital amplification technology and information about how measurements on TDAAs must be performed in order to obtain correct results.

System Design Considerations for True Digital Audio Power Amplifiers (SLAA117A)

This report describes the conversion of pulse-code-modulated (PCM) to pulse-width-modulated (PWM) signals using Texas Instruments TDAA modulation devices (TAS50xx) and signal amplification using Texas Instruments family of H-bridge output stages (TAS51xx). It includes a detailed discussion of power supply voltage requirements, output circuit filters, and thermal dissipation. An example stereo application shows how to select various components and demonstrates TDAA measurements and what to look for in the results.

I^2C and the TAS3001C (SLEA001)

The TAS3001C stereo audio digital equalizer provides a serial control interface using the I^2C protocol. Since the TAS3001C is more complex than the typical serial EEPROM often found on an I^2C bus, designers must consider additional aspects of the I^2C specification. Methods of interfacing to the TAS3001C, applicable to a wide variety of I^2C masters, are discussed.
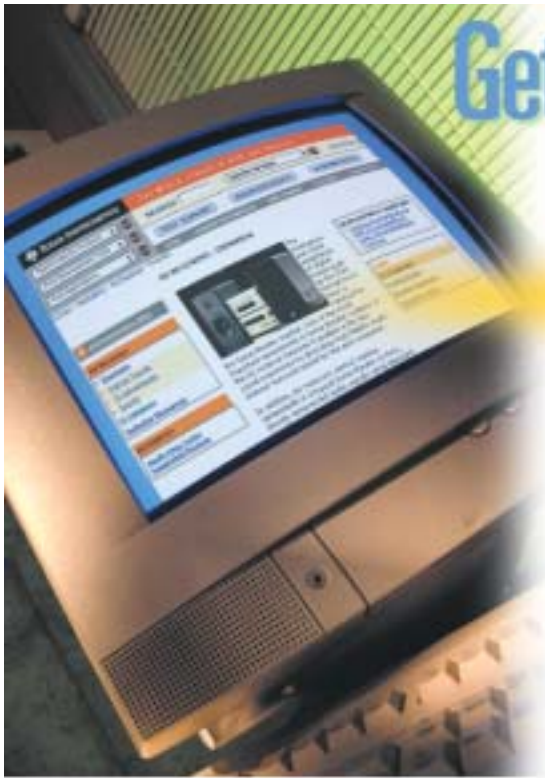
Solid State Voice Recorder Using Flash MSP430 (SLAA123)

The promise of cost-effective re-programmable MSP430 MCU systems has recently come to fruition with the integration of In-System Programmable (ISP) Flash memory. Firmware delivered just in time during manufacturing, updateable code in field-deployed systems, and the elimination of discrete EEPROMs are now design realities. This application report demonstrates the flexibility of in-system programmable Flash by implementing a solid state voice recorder.

TLC320AD77C Clock and Timing Issues (SLEA002)

The Texas Instruments TLC320AD77C stereo audio Codec requires a 3-ns separation in edges between MCLK and SCLK and an LRCLK phase stability of ±10 MCLKs over the duration that power is applied. This paper examines the source of these requirements and the impact they have on a design when using the Codec with the Texas Instruments TMS320C54xTM DSP and the Texas Instruments TUSB3200 USB controller.