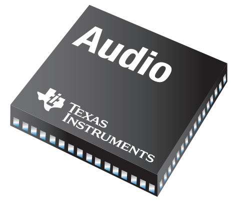
Audio Guide



Texas Instruments

Class-AB, Class-D and Class-G Amplifiers,
Audio Converters, Digital Signal Processing,
Interface, Switches, USB Audio and
PurePath™ Wireless Audio SoCs

www.ti.com/audio

1Q 2011

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Audio Overview

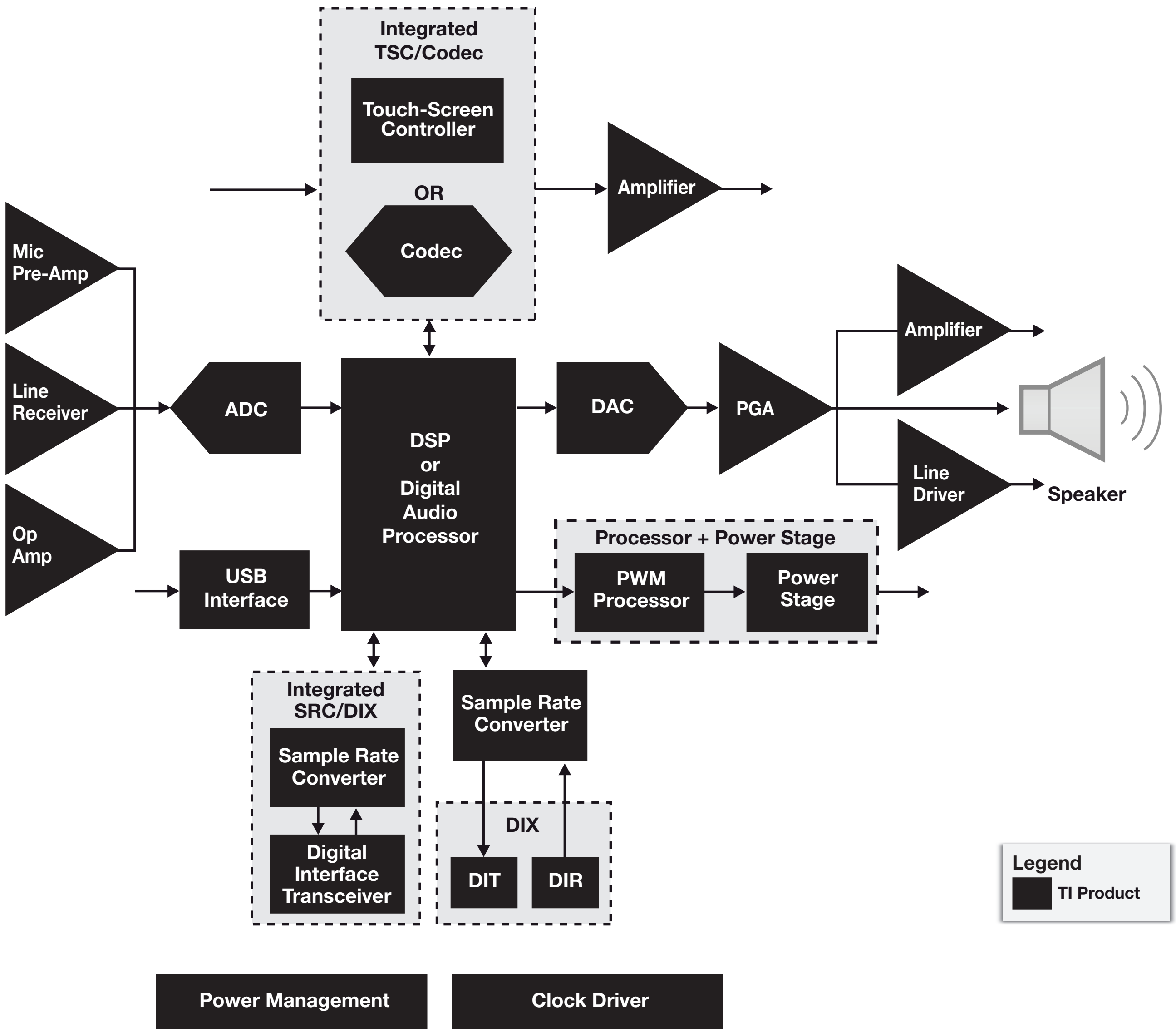
Today's consumers demand the best in audio. They want crystal-clear sound wherever they are – in whatever format they want to use.

Texas Instruments (TI) delivers the technology to enhance a listener's audio experience. Our portfolio features all-digital components as well as our digital and analog audio solutions. Offering high performance and unparalleled integration, TI's programmable components provide design flexibility to produce broad functionality and true life-like sound at a competitive cost.

This Audio Guide makes it easy to review TI portfolio options. In the guide, each audio signal-chain function is highlighted with corresponding device solutions for your needs. These solutions redefine a consumer's listening experience while offering increased application flexibility, higher performance and design longevity.

The block diagram below highlights these key signal-chain functions. TI provides complete solutions for your audio designs including: silicon, software, applications knowledge and local technical support to help you get to market faster. The Resources Section at the back of this guide highlights many online tools available featuring the latest technology and tools for audio design engineers.

With this guide and online resources at ***www.ti.com/audio***, new and experienced audio engineers can discover an audio advantage by working with TI on their next winning design.



Audio systems require a wide array of analog and digital support components.

Design Considerations for High-Power, Analog-Input Class-D Speaker Amplifiers

Output Power per Channel

- Maximum power is decided primarily by power supply (output voltage and current) and speaker impedance.
- Efficiency of Class-D amplifiers is typically between 80% and 90%, which reduces demands on the power supply design.
- The maximum input signal level dictates the required power amplifier gain to achieve the desired output power.
- For best noise performance, the gain should be as low as possible.

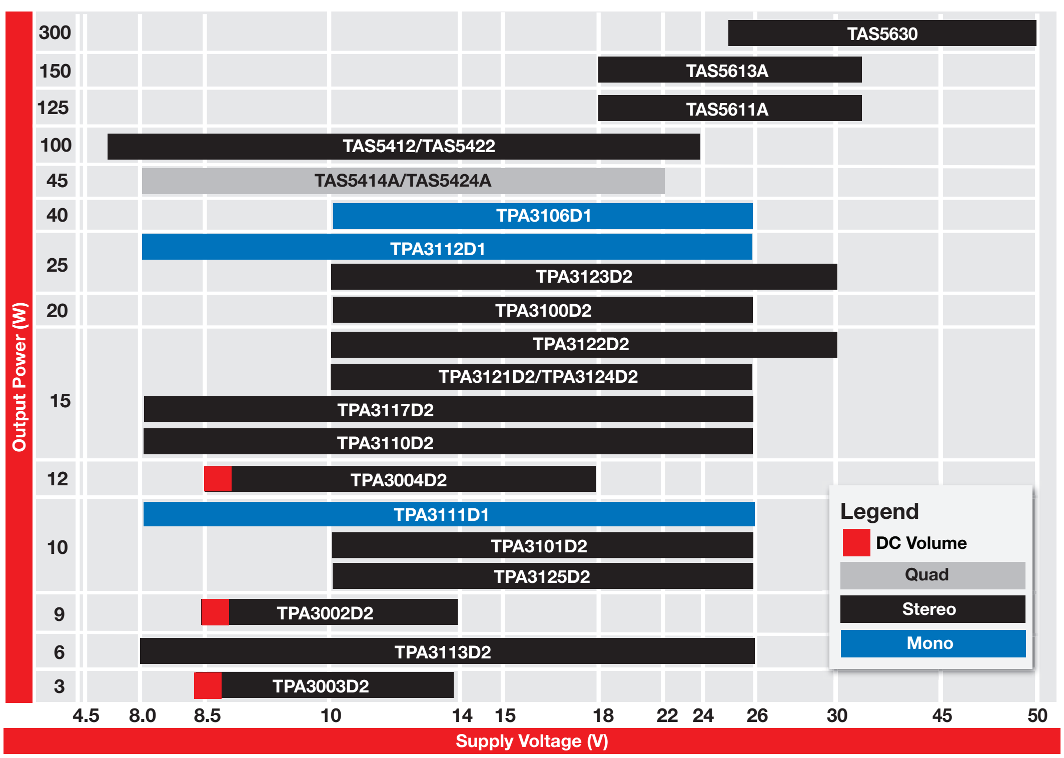
Output Filter Design

- Most of TI's Class-D amplifiers operate without a filter when speaker wires are less than 10 cm.
- When speaker wires are long, place a second-order low-pass (LC) filter as close as possible to the amplifier's output pins.
- The filter must be designed specifically for the speaker impedance because the load resistance affects the filter's quality factor, or Q.
- A ferrite bead may also eliminate very high-frequency interference.

PCB Layout

- Place decoupling capacitors and output filters as close as possible to the amplifier IC.
- When using a ferrite bead filter place the LC filter closest to the IC.
- Always connect the PowerPAD™ connection to the power ground.
- When the PowerPAD package serves as a central "star" ground for amplifier systems, use only a single point of connection for the analog ground to the power ground.

High-Power, Analog-Input Class-D Speaker Amplifiers



Product Highlights

- **TAS5613A**
  - PurePath™ HD integrated closed-loop feedback technology improves THD+N and efficiency
- **TAS5611A**
  - PurePath HD integrated closed-loop feedback technology improves THD+N and efficiency
- **TPA3111D1**
  - 10-W filter-free mono amplifier with SpeakerGuard™
- **TPA3113D2**
  - 6-W filter-free stereo amplifier with SpeakerGuard

For a complete list of **High-Power, Analog-Input Class-D Speaker Amplifiers**, see page 26.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Low-Power, Analog-Input Class-D Speaker Amplifiers

Output Power per Channel

- Maximum power is decided primarily by power supply and speaker impedance.
- Efficiency of Class-D amplifiers is typically between 80 and 90%, which reduces demands on the power supply design.
- The maximum input signal level dictates the required gain to achieve the desired output power.
- For best noise performance, the gain should be as low as possible.
- For louder volume from the speakers, use a TI Class-D amplifier with an integrated boost converter or SmartGain™ AGC/DRC function.
- An integrated boost converter provides louder volume at low battery levels.
- Dynamic Range Compression (DRC) increases the average volume, optimizes the audio to fit the dynamic range of the speaker and protects the speaker from high power damage.

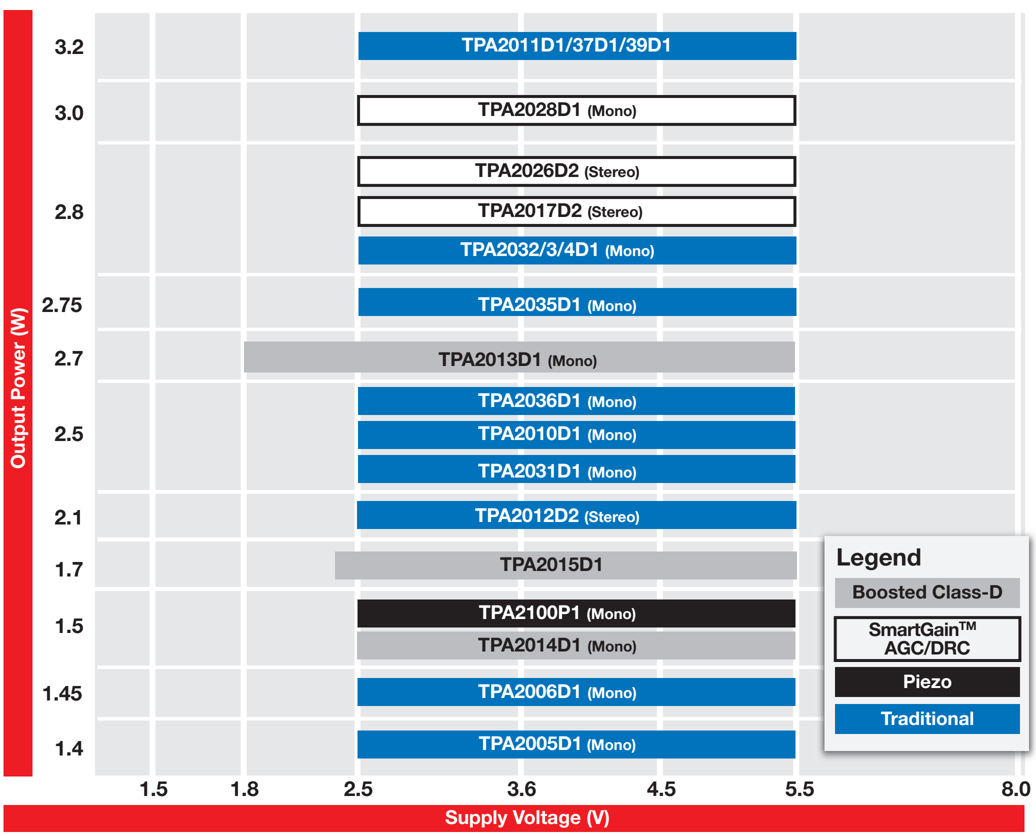
Output Filter Design

- Most of TI's Class-D amplifiers operate without a filter when speaker wires are less than 10 cm.
- A ferrite bead filter can also reduce very high-frequency interference.
- For very stringent EMC requirements, place a 2nd-order low-pass LC filter as close as possible to the amplifier's output pins.

PCB Layout

- Place decoupling capacitors and output filters as close as possible to the amplifier IC.
- When using a PowerPAD™, connect to the appropriate signal as per TI datasheet.

Low-Power, Analog-Input Class-D Speaker Amplifiers



Product Highlights

- **TPA2011D1/37D1/39D1**
  - Mono Class-D amplifiers
  - Auto short-circuit recovery
  - Variable gain ('2011D1)
  - 2-V/V fixed gain ('2037D1)
  - 4-V/V fixed gain ('2039D1)
  - WCSP package (0.4-mm pitch)
  - Integrated DAC noise filter
- **TPA2015D1**
  - Mono Class-D amplifier
  - Built-in boost converter
  - Battery-monitoring AGC
  - WCSP package (0.5-mm pitch)
  - Integrated DAC noise filter

For a complete list of **Low-Power, Analog-Input Class-D Speaker Amplifiers**, see page 27.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Digital-Input Class-D Speaker Amplifiers

Output Power per Channel

- After determining the number of speakers in a system, specify the output power for each channel.
- Maximum power is decided primarily by power supply (output voltage and current) and speaker impedance.
- Efficiency of Class-D amplifiers is typically between 80% and 90%, which reduces demands on power-supply designs when compared to Class-AB amplifier requirements.
- The maximum input signal level dictates the required power amplifier gain to achieve the desired output power.
- For best noise performance, the gain should be as low as possible.

Output Filter Design

- Most of TI's Class-D amplifiers operate without a filter when speaker wires are less than 10 cm.
- EMI from high-frequency switching is a major design challenge.
- When speaker wires are long, place a second-order low-pass (LC) filter as close as possible to the amplifier's output pins.
- The filter must be designed specifically for the speaker impedance because the load resistance affects the filter's quality factor, or Q.
- A ferrite bead may also eliminate very high-frequency interference.

PCB Layout

- Class-D amplifier outputs switch at relatively high frequencies, similar to switch-mode power supplies, and require additional attention to external component placement and trace routing.
- Place decoupling capacitors and output filters as close as possible to the amplifier IC.
- When using a ferrite bead filter, place the LC filter closest to the IC.
- Always connect the PowerPAD™ connection to the power ground.
- When the PowerPAD package serves as a central "star" ground for amplifier systems, use only a single point of connection for the digital and analog grounds to the power ground.
- See the application brief
- "PowerPAD Layout Guidelines" for IC package layout and other design considerations at: ***http://www.ti.com/lit/sloa120***

PurePath™ Digital-Input I²S Class-D 20-W Speaker Amplifiers

Closed-Loop I²S Amps

TAS5706A
- Speaker EQ
- 2.1 with external amp

TAS5708
- Speaker EQ

TAS5716
- Speaker EQ
- 3D, bass boost
- 2.1 support (SE)

TAS5706B
- Speaker EQ
- 2.1 support (SE)

TAS5710
- Speaker EQ
- 3D, bass boost
- 2-band DRC

H/W Control I²S Amps

TAS5701
- 2.1 with external amp

TAS5704
- Closed loop
- 2.1 support (SE)

Open-Loop I²S Amps

TAS5709
- Speaker EQ
- 3D, bass boost
- 2-band DRC

TAS5711
- Speaker EQ, 3D, bass boost
- 2-band DRC
- 2.1 support (SE)

TAS5715 NEW
- 25 W, fast attack 2-band DRC
- PWM HP output

TAS5719 NEW
- 15 W, fast attack 2-band DRC
- DirectPath™ HP amp

TAS5707/L
- 20 W, audio processing
- TAS5707L, no processing

TAS5713
- 25 W, stereo
- Speaker EQ

TAS5717 NEW
- 10 W, fast attack 2-band DRC
- DirectPath HP amp

TAS5727 PREVIEW
- 25 W, fast attack 2-band DRC
- Low $R_{SD(on)}$ for better thermal

For a complete list of **Digital-Input Class-D Speaker Amplifiers**, see page 27.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for PWM-Input Class-D Power Stages

Output Power per Channel

- After determining the number of speakers in a system, specify the output power for each channel.
- Maximum power is decided primarily by power supply (output voltage and current) and speaker impedance.
- Efficiency of Class-D amplifiers is typically between 80% and 90%, which reduces demands on power-supply designs when compared to Class-AB amplifier requirements.

Output Filter Design

- Most of TI's Class-D amplifiers operate without a filter when speaker wires are less than 10 cm.
- EMI from high-frequency switching is a major design challenge.
- When speaker wires are long, place a second-order low-pass (LC) filter as close as possible to the amplifier's output pins.
- The filter must be designed specifically for the speaker impedance because the load resistance affects the filter's quality factor, or Q.
- A ferrite bead may also eliminate very high-frequency interference.

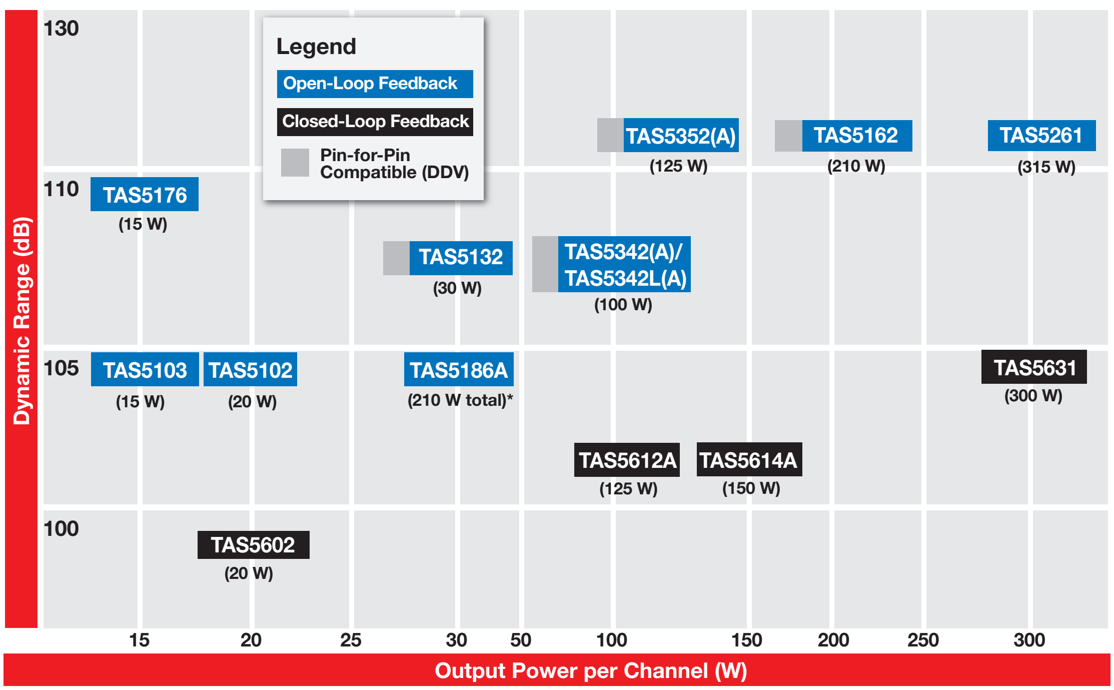
PCB Layout

- Class-D amplifier outputs switch at relatively high frequencies, similar to switch-mode power supplies, and require additional attention to external component placement and trace routing.
- Place decoupling capacitors and output filters as close as possible to the amplifier IC.
- When using a ferrite bead filter in conjunction with an LC filter, place the LC filter closest to the IC.
- See grounding layout guidelines in the application report "System Design Considerations for True Digital Audio Power Amplifiers" (TAS51xx) at: ***http://www.ti.com/lit/slaa117a***
- See the application brief "PowerPAD™ Layout Guidelines" for package layout and other design considerations at: ***http://www.ti.com/lit/sloa120***

Heat

- PWM-input Class-D amplifiers operate at high efficiencies.
- PWM-input Class-D amplifiers require significantly less heat-sinking than equivalent Class-AB amplifiers.

PurePath™ PWM-Input Class-D Power Stages



Product Highlights

- **TAS5614A**
  - 300-W/150-W stereo PWM-input power stage
  - PurePath™ HD integrated closed-loop feedback technology enables ultra-low THD+N across frequencies for natural sound
- **TAS5612A**
  - 250-W/125-W stereo PWM-input power stage
  - PurePath HD integrated closed-loop feedback technology enables ultra-low THD+N across frequencies for natural sound

*Multi-channel and mono devices feature total power.

For a complete list of **PWM-Input Class-D Speaker Amplifiers**, see page 28.

For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Class-AB Speaker Amplifiers

Output Power per Channel

- After determining the number of speakers in a system, specify the output power for each channel.
- Maximum power is decided primarily by:
  - Power supply (output voltage and current)
  - The amplifier's maximum output voltage
  - Speaker impedance
- Maximum efficiency is –40% with Class-AB amplifiers.
- The power supply must provide continuous current to support the desired maximum power.
- The maximum input signal level dictates the required power amplifier gain to achieve the desired output power.
- For best noise performance, the gain should be as low as possible.

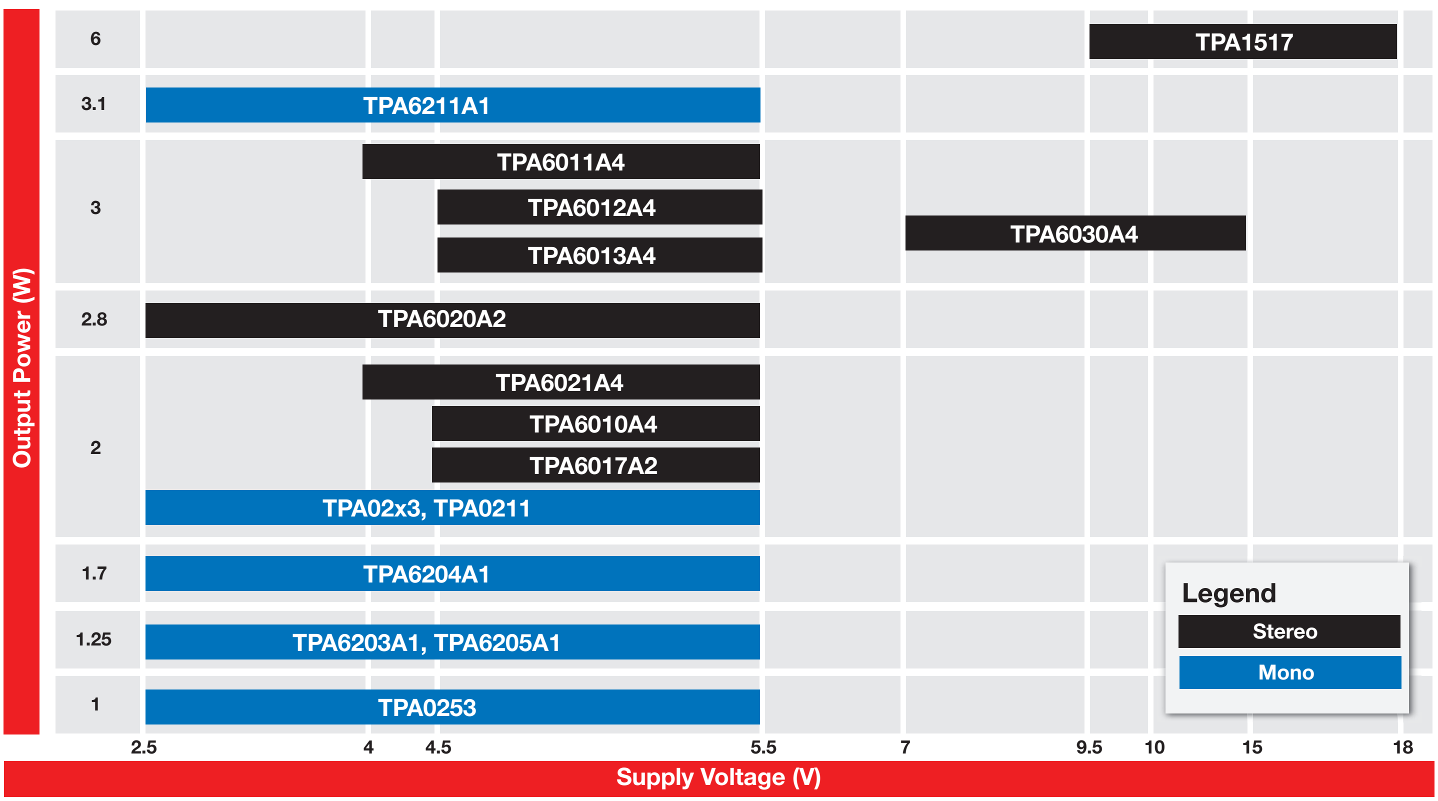
Heat

- Class-AB amplifiers run hotter than equivalent Class-D amplifiers.
- Driving 2 W per channel in stereo systems generates 6 W of heat with an efficiency of –40%.
- TI's Class-AB speaker amplifiers feature the PowerPAD™ package, using a PCB as a heatsink.
- See the application brief "PowerPAD™ Layout Guidelines" for package layout and other design considerations at: ***http://www.ti.com/lit/sloa120***

Features

- Class-AB amplifiers offer several different ways to control the gain or volume:
  - External resistors (similar to traditional op-amp circuits)
  - Integrated gain-setting resistors
  - DC volume control
  - I^2C volume control
- Most of TI's portfolio provides the three latter control options.
- When a headphone drive is part of the design, most Class-AB amplifiers can change outputs from bridge-tied load (BTL) to single-ended (SE) configurations, eliminating the need for an additional amplifier.

Class-AB Speaker Amplifiers



For a complete list of **Class-AB Speaker Amplifiers**, see page 27.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Headphone Amplifiers

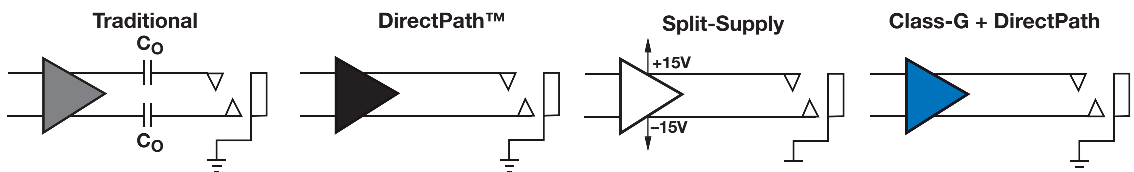
Issues to Consider When Using Single-Ended Power Supplies

- Most amplifiers work with single +3.3-V or +5-V supplies.
- These power supplies require a DC-biased amplifier output to ensure undistorted output.
- Placing DC-blocking capacitors between the speaker and the amplifier causes a high-pass filter and equates to poor bass response.
- TI counters this high-pass filter issue with capless and DirectPath™ technologies.
  - Capless creates a virtual ground (V_{DD}/2) for the headphone connector. Both amplifier outputs then have a V_{DD}/2 bias, ensuring that no DC passes through a speaker.
  - DirectPath-enabled devices include an internal charge pump which creates a negative power rail inside the device. With this design, an amplifier can be powered by a bipolar supply and have an output biased to ground.

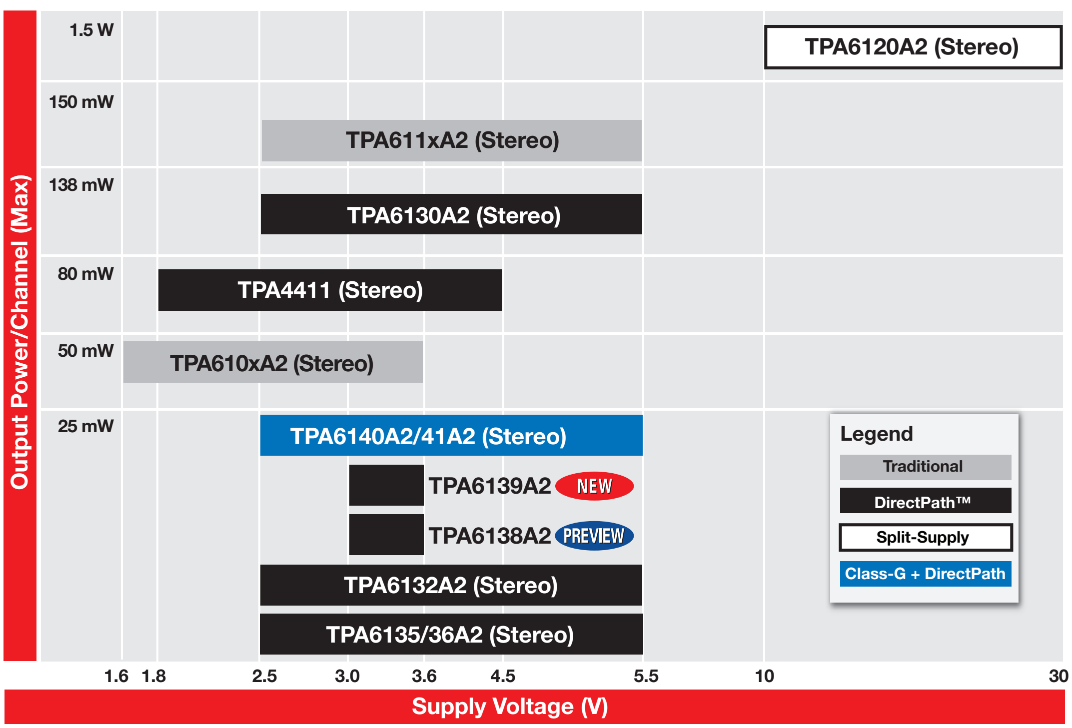
Headphone Impedance and Power

- Headphone impedances can vary greatly, from 16 W to 600 W.
- When choosing an amplifier, always ensure that it can handle the power at the specified voltage range and headphone impedance.

Headphone Architecture



Headphone Amplifiers



Product Highlights

- **TPA6140A2/41A2**
  - High-efficiency, Class-G
  - I^2C volume control ('6140)
  - Hi-Z mode
  - 0.4-mm WCSP
- **TPA6139A2**
  - Single-ended input
  - 10 programmable internal gain settings
  - 25 mW into 32 Ω
  - DirectPath™
  - TSSOP package

For a complete list of **Headphone Amplifiers**, see page 29.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Low-Power Audio Amplifier Sub-Systems

Radio Emission Interference in Notebook PCs

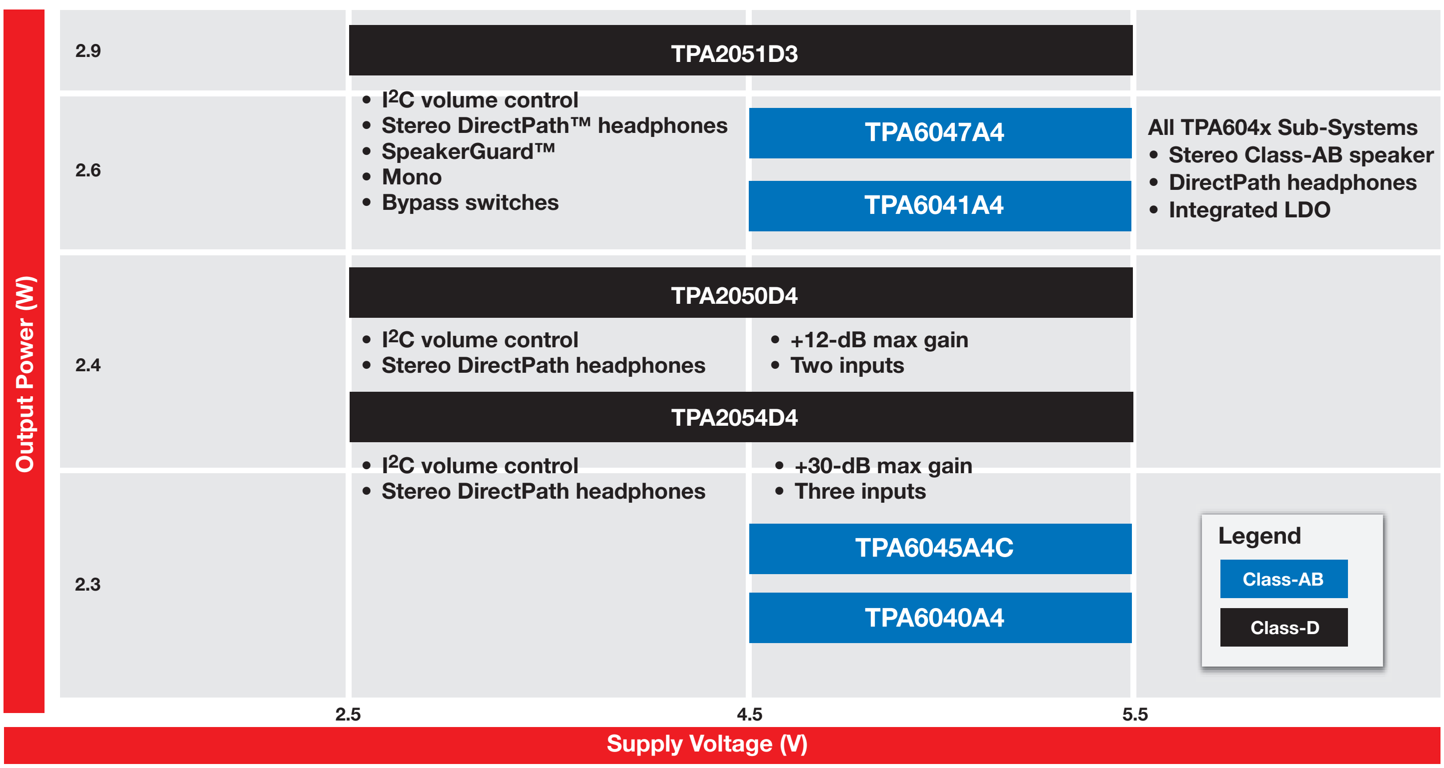
- RF emissions from mobile data add-in cards, 802.11 and Bluetooth® radios can create noise problems for amplifiers.
- It can be particularly problematic if the amplifiers, codecs or speakers are separated from each other by industrial or board design requirements.
- For additional design flexibility, use devices with differential inputs, which provide significantly better noise immunity.

Headphone Outputs Serving as Line Outs

- Traditional Class-AB design allowed headphone outputs to be used as line outs.
- The size and expense of DC-blocking capacitors has led to capless methods to implement output.
- VBias on ground sleeve removes the caps, but can inject a hum or damage the amplifier if ground loopback occurs with an external device.
- DirectPath™ solutions eliminate ground loopback and improve bass response.

Low-Power Audio Amplifier Sub-Systems

	TPA6040A4	TPA6041A4	TPA6045A4C	TPA6047A4
Speaker Enable	Mute: High Enable: Low	Mute: High Enable: Low	Mute: Low Enable: High	Mute: Low Enable: High
Gain (dB)	6, 10, 15.6, 21.6	10, 12, 15.6, 21.6	10, 12, 15.6, 21.6	10, 12, 15.6, 21.6
LDO Voltage	4.75 V	3.3 V	3.3 V	4.75 V



For a complete list of **Low-Power Audio Amplifier Sub-Systems**, see page 29.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Microphone Preamplifiers

Control Methods: Analog vs. Digital

- Analog control microphone preamplifiers typically use a variable resistor on a product's front panel that can be changed during performance.
- Digitally-controlled microphones are remotely controllable and have easily recallable settings, offering significant advantages when compared to their analog control counterparts.
- In the live sound and recording industry, digitally controlled microphones allow signals to be preamplified and converted closer to the source rather than sending tiny µV signals across meters of cable.

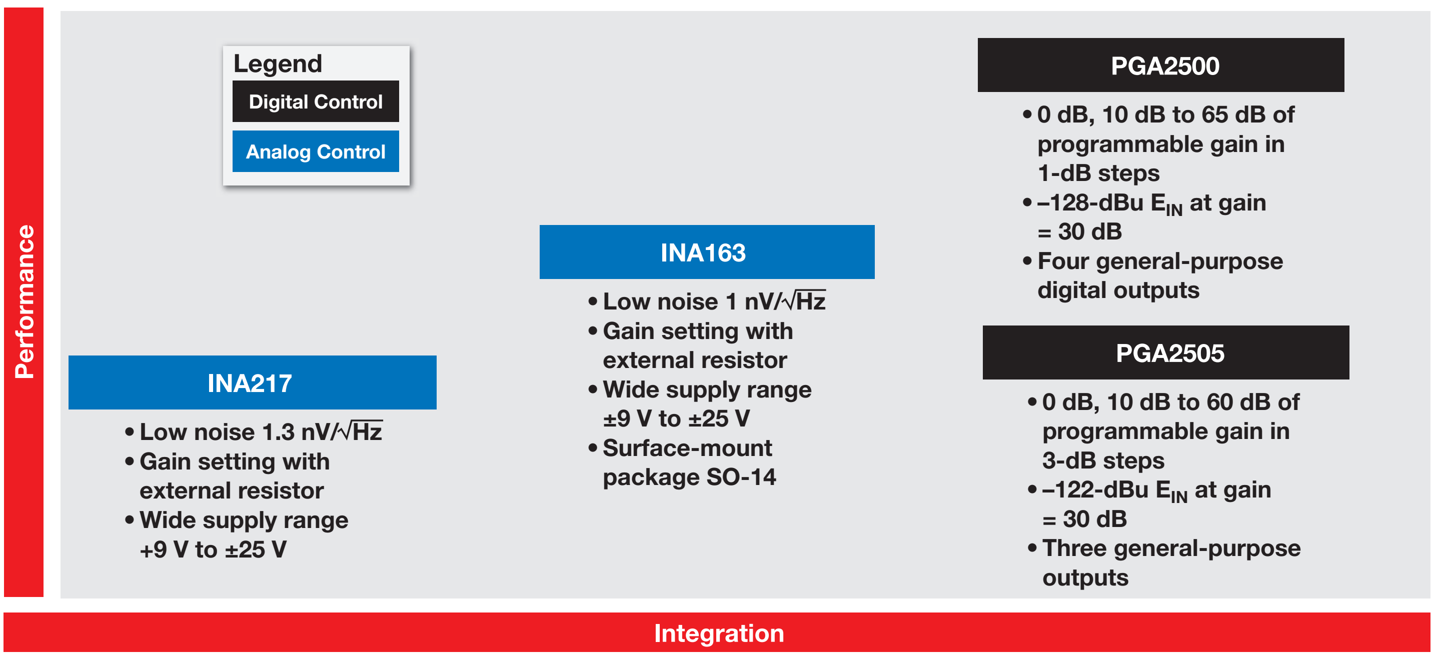
Equivalent Input Noise (EIN) Considerations

- EIN is a key specification in defining a microphone preamplifier.
- At a given gain, microphone preamplifiers exhibit a certain amount of input noise that is amplified together with the audio source.
- Ideally, microphone preamplifiers will have low EIN values to ensure that only the audio source is amplified instead of the noise.

Outputs: Differential vs. Single-Ended

- Inside a product, a single-ended output is sufficient to process signals needing further processing.
- Many high-performance ADCs require differential inputs. If the amplified differential microphone signal is taken directly to an ADC, a differential output will give an additional 6 dB of dynamic range.
- Differential outputs from a microphone preamplifier will help ensure that the differential input on the receiver will reject any common-mode interference induced on the cable by cancelling out the common noise on both connections.

Microphone Preamplifiers



For a complete list of **Microphone Preamplifiers**, see page 30.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Line Drivers/Receivers and Signal Conditioning Amplifiers

Driving 2 V_{RMS} for Audio/Visual Applications

- Almost all audio coming into a television has a ground-centered 2-V_{RMS} output.
- Most audio DACs have a sub-4 V_{PP} with a DC bias –2.5 V.
- The traditional solution for generating a ground-centered 2-V_{RMS} output is to run an output op amp stage from a higher voltage bipolar power supply (±12 V).
- This solution adds complexity, especially if the rest of the devices are using only 3.3 V or 5 V.
- TI's DRV60x family integrates the amplifier and charge pump to create positive and negative rails for clean, ground-centered 2-V_{RMS} output.

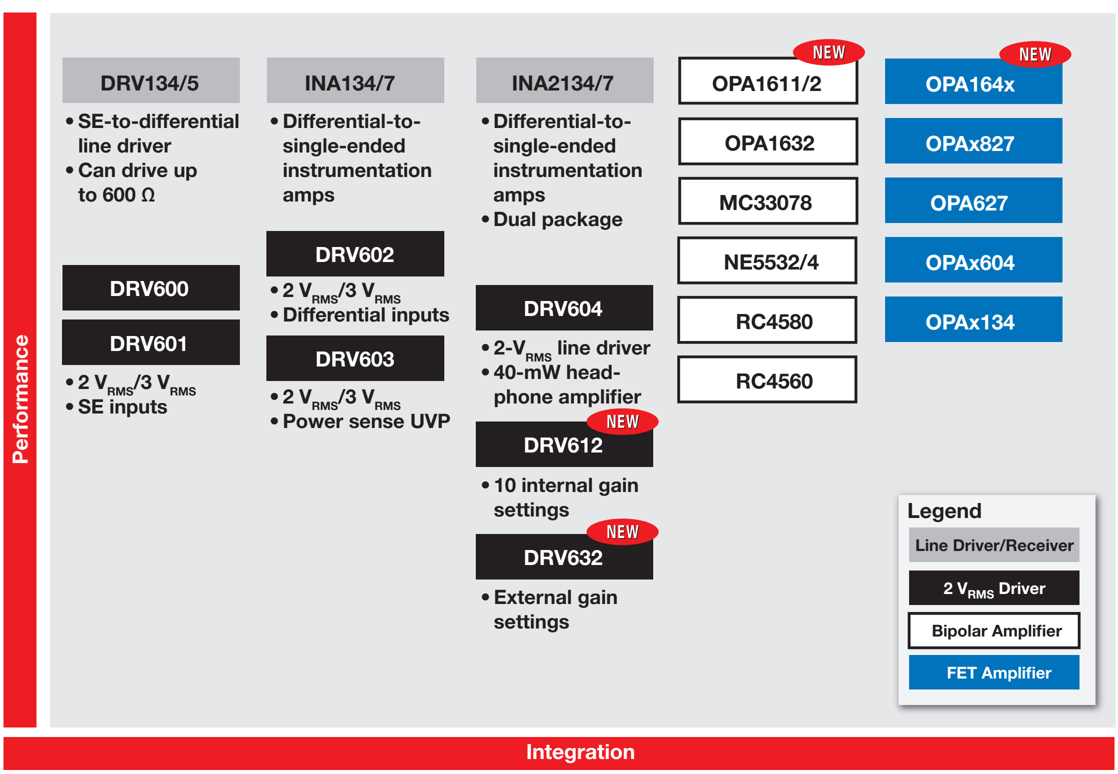
Balanced-Line I/O for Professional Audio Applications

- Balanced-line I/O is used in professional audio environments—live, recording and broadcast—to keep signals clean and interference free.
- By having equal impedance to ground on both conductors, balanced-line I/O offers two advantages:
  - The noise induced is near equal and should be cancelled by a balanced-line receiver as common-mode noise.
  - Having inverted signals on both conductors also adds another 6 dB to the dynamic range for the same supply voltage.

Overall Op Amps

- When selecting an op amp, investigate its input stage.
- FET-based op amps usually have a very high input impedance.
- FET-input devices are ideal when the output impedance of the source isn't easily known, such as with a musical instrument.
- BJT (bipolar)-based op amps exhibit lower input impedance and offer lower input noise.
- Bipolar op amps are ideal input devices for low-impedance output sources requiring low noise amplification.

Line Drivers/Receivers and Signal Conditioning Amplifiers



Product Highlights

- **OPA1611/12**
  - Ultra-low noise: 1.1 nV/$\sqrt{Hz}$
  - Ultra-low distortion: 0.000015% at 1 kHz
  - Supply range: ±2.25 V to ±18 V from 3.6 mA/channel
  - Rail-to-rail output swing to within 600 mV with 2-Ω load
- **DRV604**
  - Integrated 40-mW headphone amp and 2-V_{RMS} line driver
  - DirectPath™ eliminates the need for DC blocking caps
  - Ultra-low noise floor: 7 µV
  - Ultra-low DC offset: <1 mV

For a complete list of **Line Drivers/Receivers and Signal Conditioning Amplifiers**, see pages 30 and 31.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Volume Controls

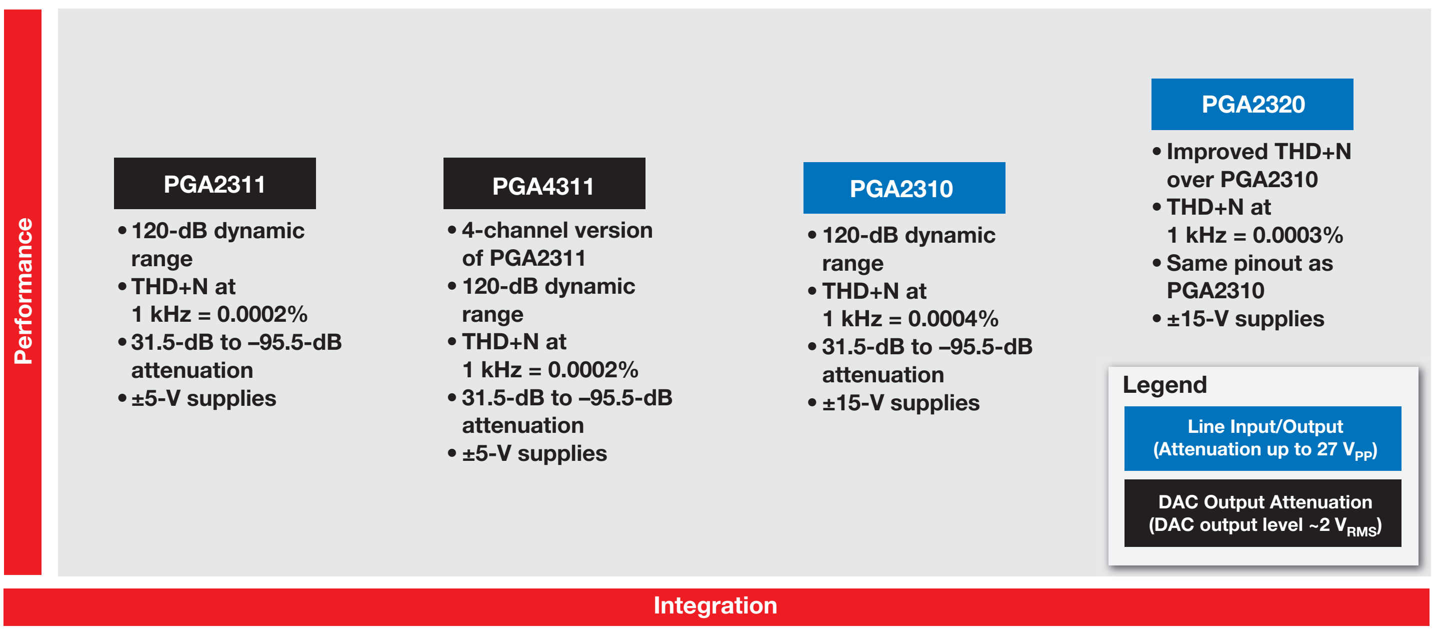
Supply Voltage: Signal Swing

- DAC outputs typically have a swing of around 3 V_{PP}.
- Broadcast signal swings can easily be 25 V_{PP} or higher.
- Knowledge of the signal amplitude that will be attenuated is critical when choosing digitally controlled analog volume controls.
- For controlling DAC output, ±5-V devices are more than adequate to provide 10-V_{PP} headroom for a signal that, at maximum, will be below 5 V_{PP}.

Maintenance of Dynamic Range

- Multiplying the DAC's digital value by < 1 is an acceptable way to control volume for many applications, using fewer bits to represent the signal while the noise level remains the same.
- Combining fewer bits to represent a signal with a fixed-noise level will increasingly reduce the dynamic range as the volume changes.
- By changing the volume in the analog domain while under digital control, the DAC's inherent noise will be attenuated along with the audio.

Volume Controls



For a complete list of **Volume Controls**, see page 32.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Portable Audio Codecs

The portable audio market is confronted with many challenges. Design complexity is leading towards thinner form factors and higher-performance devices, with continued pressure to achieve lower power, smaller footprints and reduced costs. In addition to the added complexity from design constraints, the market is requesting differentiated devices that have real end-user perceived value. With many devices having a life cycle of only 9 to 12 months between versions, meeting these challenges requires expert understanding of the system and hardware/software partitioning.

Reducing Noise on Microphone Inputs

- Microphone signals are susceptible to noise injection because of the low peak-to-peak range of 10 mV.
- Placing the codec or ADC close to the microphone often conflicts with user preference, industrial design or mechanical design requirements.
- Look for devices that can work with digital microphones or have differential inputs, both of which provide significantly better noise immunity.

Processing Allocation and Software Reusability

- Host processors in handheld consumer electronics are being given more tasks, pushing processor MIPS allocations and design schedules.
- One solution is to offload a number of audio functions to a converter or codec.
  - Audio functions include 3-D effects, equalization, notch filters or noise cancellation.
  - Look for devices with broad, easy software reusability and the ability to allocate the processing to either input or output functions.

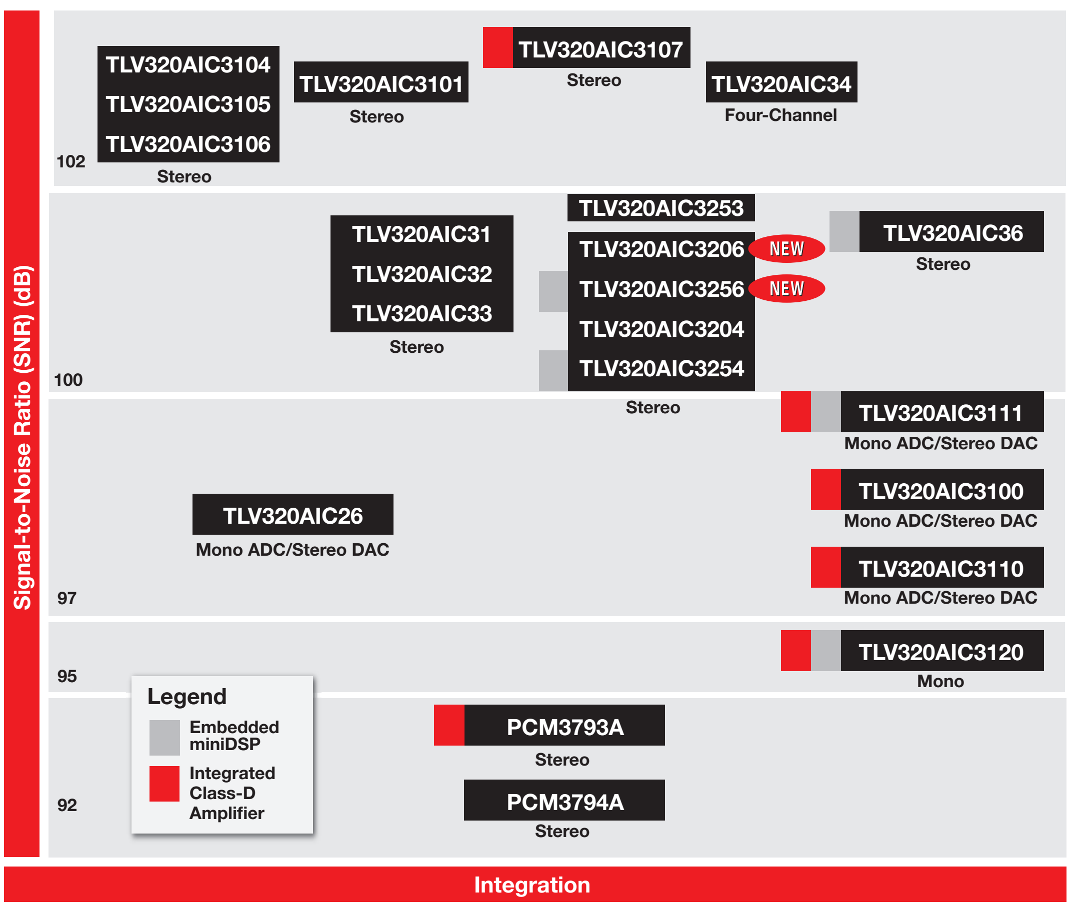
Simultaneously Handling Multiple Audio Sources

- Designers of handheld consumer electronics don't have the option of focusing on a single sample rate or audio signal source. With multiple functions come different radios and sampling rates. Look for codecs with:
  - Multiple independent analog and digital interfaces.
  - The ability to independently sample and process these two signals.

Embedded miniDSP

- The miniDSP allows customers to run advanced audio algorithms on the audio codec. Running algorithms on the codec:
  - Optimizes system partitioning.
  - Offloads the host processor.
  - Simplifies regression testing.

Portable Audio Codecs



Product Highlights

- **TLV320AIC3256**
  - Very low power stereo codec with DirectPath™ HP driver
  - miniDSP for advanced audio processing and custom algorithms
  - PowerTune™ technology to adjust power vs. SNR
- **TLV320AIC3206**
  - Very low power stereo codec with DirectPath HP driver
  - PowerTune technology to adjust power vs. SNR

For a complete list of **Portable Audio Converters**, see page 34.

For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Portable Audio Converters

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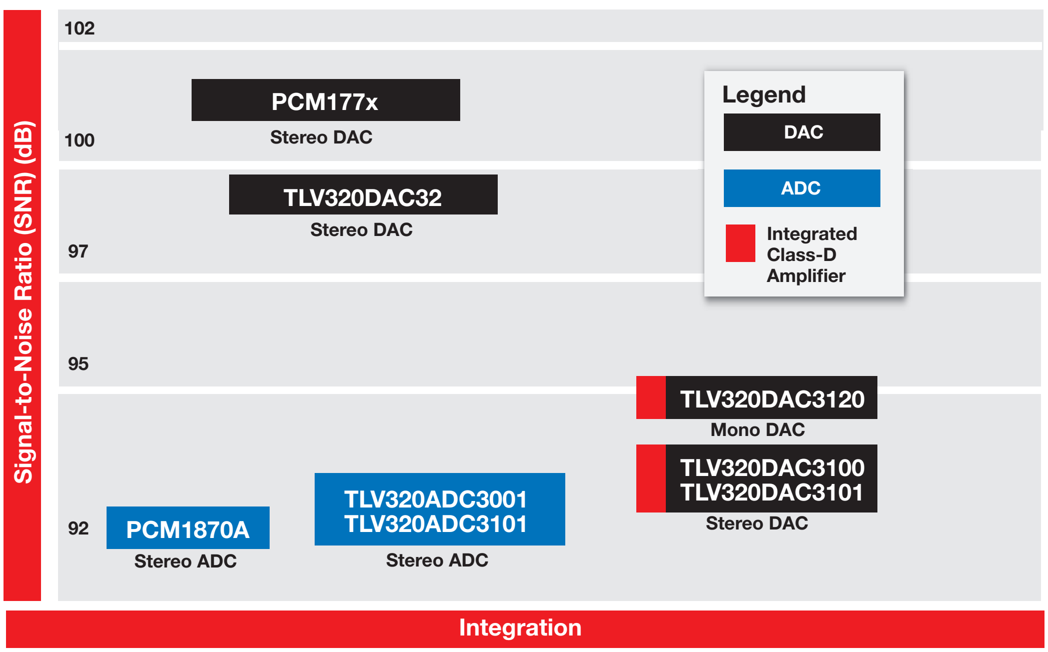
Portable Audio ADCs and DACs



Product Highlights

- **TLV320DAC3100**
  - Stereo DAC with mono 2.5-W Class-D speaker amplifier
  - 6 bi-quads, DRC, beep generator

For a complete list of **Portable Audio Converters**, see page 33.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Portable Audio Converters with Integrated Touch-Screen Controller

Using Touch-Screen Controllers (TSCs) to Offload Host Processing

- TSCs detect contact and then require the host to handle as many as 40 to 50 register read/write cycles.
- These requirements create additional interrupts and processing cycles, which reduces processing efficiency.
- To reduce this load on the host, look for "smart" TSCs with the ability to generate coordinates with minimal interaction from the host.

Other Methods for Using TSCs to Offload Host Processing

- Host processors in handheld
- consumer electronics are being given more tasks, pushing processor MIPS allocations and design schedules.
- One solution is to offload a number of audio functions to the DAC or codec functions of a TSC.
  - Audio functions include 3-D effects, equalization, notch filters or noise cancellation
  - Look for devices with integrated audio, software reusability and the ability to allocate the processing to either input or output functions

Supporting Varying Mechanical System Designs

- The preferred solution with a single integrated TSC + audio device or a discrete TSC and audio codec may depend on whether a handheld device is built on:
  - A single-board platform, such as a candy bar
  - A PDA form factor
  - An in-dual board platform like a flip phone
- TI offers a wide selection of stand-alone TSCs and audio codecs as well as integrated TSC + audio devices for all types of system designs.

Portable Audio Converters with Integrated Touch-Screen Controller

SNR (dB)

98

TSC2300
Mono ADC/Stereo DAC
- 98-dB dynamic range
- 4-wire touch-screen interface
- I²S interface

TSC2302
Stereo Codec
- 98-dB dynamic range
- 4-wire touch-screen interface
- I²S interface

TSC2301
Stereo Codec
- 98-dB dynamic range
- 4-wire touch-screen interface
- 4x4 keypad interface
- I²S interface

TSC2117
Mono ADC/Stereo DAC
- miniDSP
- 4-wire touch-screen interface
- I²S interface
- Stereo class-D speaker amplifiers

97

TSC2102
Stereo DAC
- 97-dB stereo playback
- Low-power, 11-mW playback
- Programmable audio effects

95

TSC2111
Mono ADC/Stereo DAC
- 95-dB dynamic range
- 4-wire touch-screen interface
- Programmable audio effects
- Stereo, capless headphone amp
- Battery-connected speaker amp

Legend
Touch-Screen Controllers with: DAC / Codec

Integration

For a complete list of **Audio Converters with Integrated Touch-Screen Controller**, see page 35.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Home and Professional Audio Converters

Dynamic Range

- Home and professional audio converter performance is measured in dynamic range, not bit depth.
- A 24-bit converter describes its output format, not its quality.
- Therefore, many of the least significant bits in a 24-bit audio word may be noise.
- At its peak, a standard CD has 98.08-dB (16-bit) dynamic range.
- In professional environments, a converter may have a dynamic range of up to 132 dB.

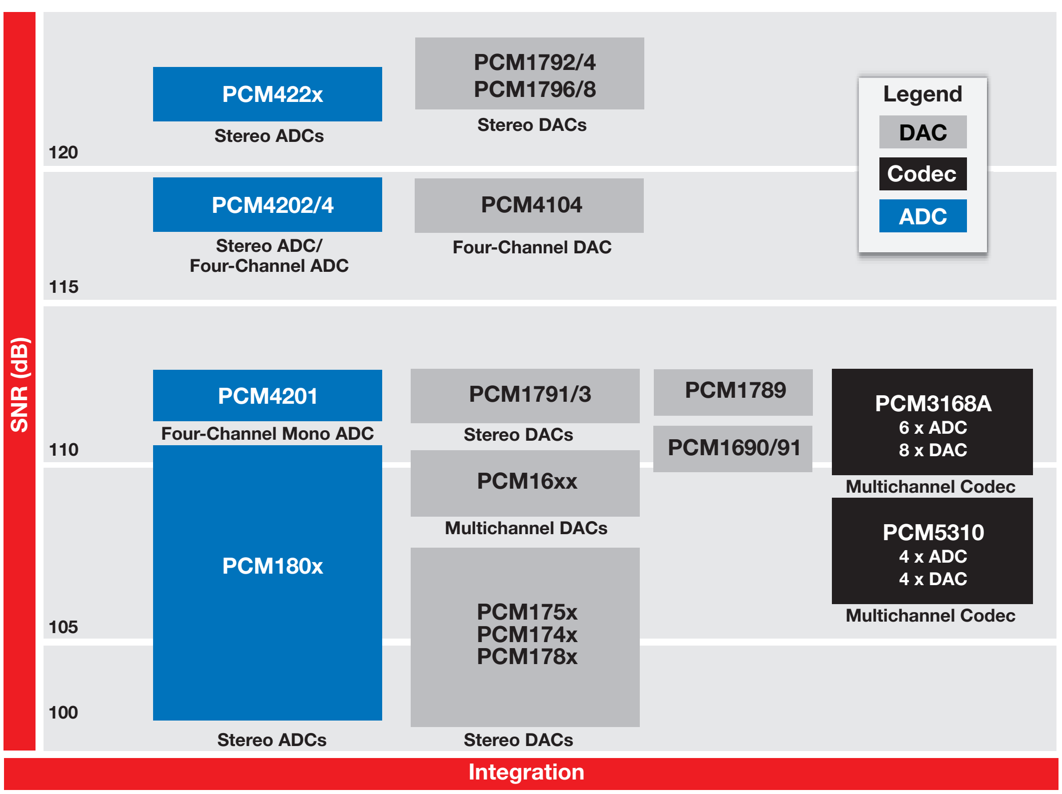
Analog Integration and Multichannel Support

- TI's highly integrated range of consumer converters support complex signal-chain designs.
- Integrating functionality such as multiplexers, programmable gain and S/PDIF transmitters into a single package reduces cost, design complexity and time to market.

Control Methods

- Converters can be controlled in many different ways; many simply by tying pins high and low.
- A small micro, SPI shift register or I^2C expander can allow control from a remote source.
- For products with increased integration, control is typically through either SPI or I^2C.
- When choosing converters or codecs, confirm both the control method and the existence of additional I/O (GPIO, SPI or I^2C) for the main processor to support the device.

Performance Audio Converters



Product Highlights

- **PCM3168A**
  - 113-dB DAC: 8-channel, differential
  - 107-dB ADC: 6-channel, single ended differential
- **PCM1789**
  - 113-dB DAC: stereo, differential
- **PCM5310**
  - 2-V_{RMS} inputs
  - 2-V_{RMS} outputs
  - Headphone amplifier

For a complete list of **Performance Audio Converters**, see pages 32 and 33.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for S/PDIF Interface and Sample-Rate Converters

Sample Rate Converters (SRCs)

- SRCs create sample rate and phase-independent interfaces between fixed-rate digital processors and the outside world.
- SRCs can serve as "jitter cleaners," lowering the amount of jitter on incoming data streams.
- SRCs allow similar phase-independent sample rates to be brought into systems without the need for time alignment/word clock distribution.

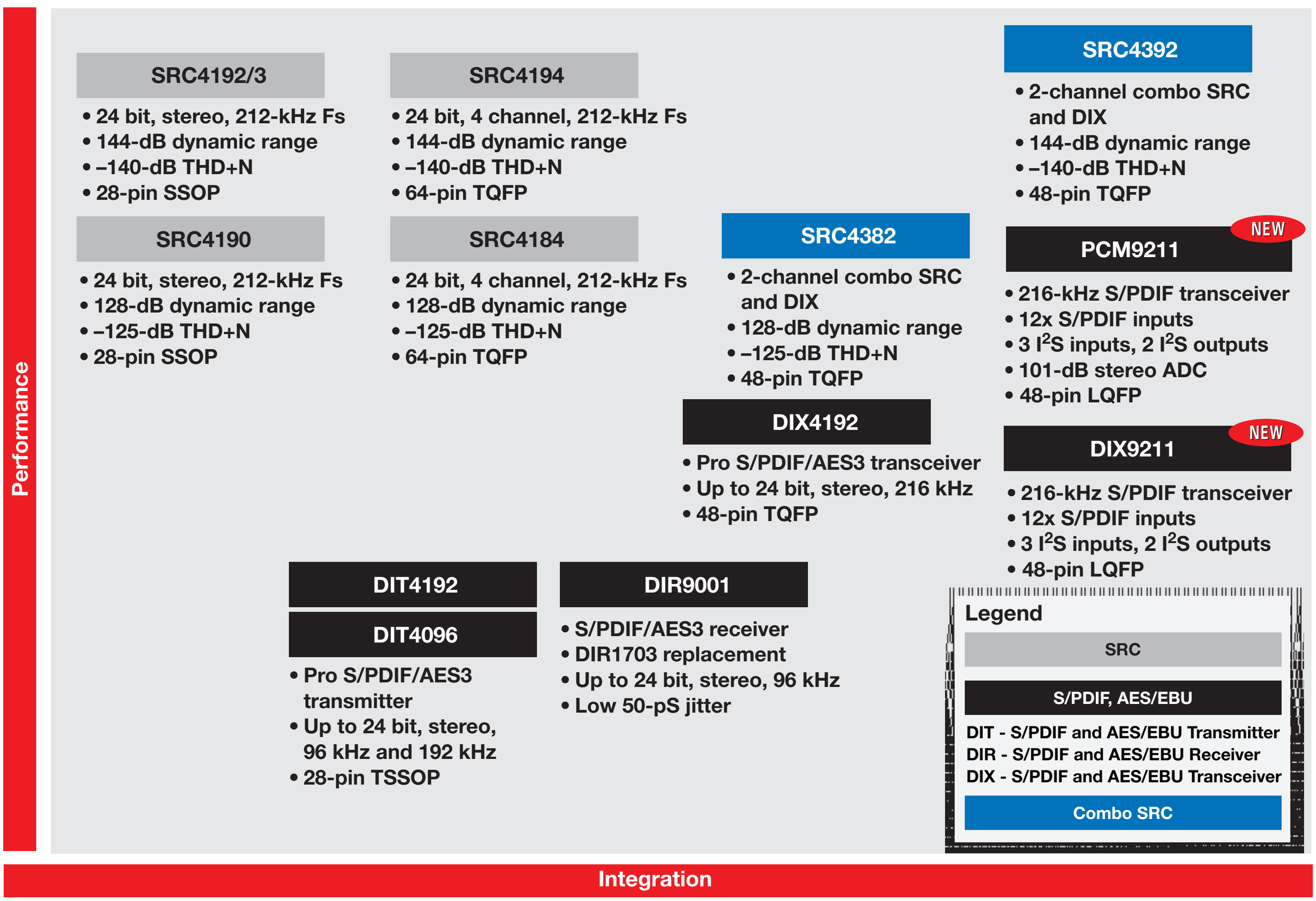
Jitter Sensitivity

- Jitter can be a major problem in a digital audio system.
- Jitter is introduced when digital audio clocks are generated or regenerated from a different clock source and by using interconnects that have significant parasitic impedance (capacitance, inductance, etc.).
- Jitter in digital audio systems moves the sampling instant back and forth in time, adding noticeable distortion in high frequencies.
- For the smallest adverse impact on the audio content, choose S/PDIF receivers with low jitter.

System Partitioning

- System partitioning options include discrete transmitters, receivers and stand-alone SRCs, as well as combinations of transceivers and SRCs.
- Flexible functionality allows end products to be either:
  - A clock master (and SRC from the outside to its internal process clock)
  - A slave to an external clock (and SRC the output to the new clock rate)

S/PDIF Interface Products and Sample-Rate Converters



For a complete list of **S/PDIF Interface and Sample-Rate Converters**, see page 36.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for PurePath Wireless Audio SoCs

Overview

By employing proprietary technology called PurePath™ Wireless, the CC85xx device family provides high-quality, short-range, 2.4-GHz wireless digital audio streaming in cost-effective single-chip solutions. Two or more devices form a PurePath Wireless audio network. Great care has been taken to ensure that this network provides gap-less and robust audio streaming in varied environments and that it can coexist amicably with existing wireless technologies in the crowded 2.4-GHz ISM band. Most applications can be implemented without any software development, requiring only that the CC85xx be connected to an external audio source or sink (such as an audio codec, S/PDIF interface or class-D amplifier) and that a few push buttons, switches or LEDs be provided for human interaction. Advanced applications can interface a host processor or DSP directly to the CC85xx to stream audio and control most aspects of device and audio-network operation.

The PurePath Wireless Configurator, a PC-based configuration tool, is used to set up the desired functionality and parameters of the target system. It then produces firmware images that subsequently must be programmed into the embedded flash memory of each CC85xx. All devices in the CC85xx family interface seamlessly with the CC2590 RF range-extender device to allow for even wider RF coverage and improved robustness in difficult environments.

Key Specifications

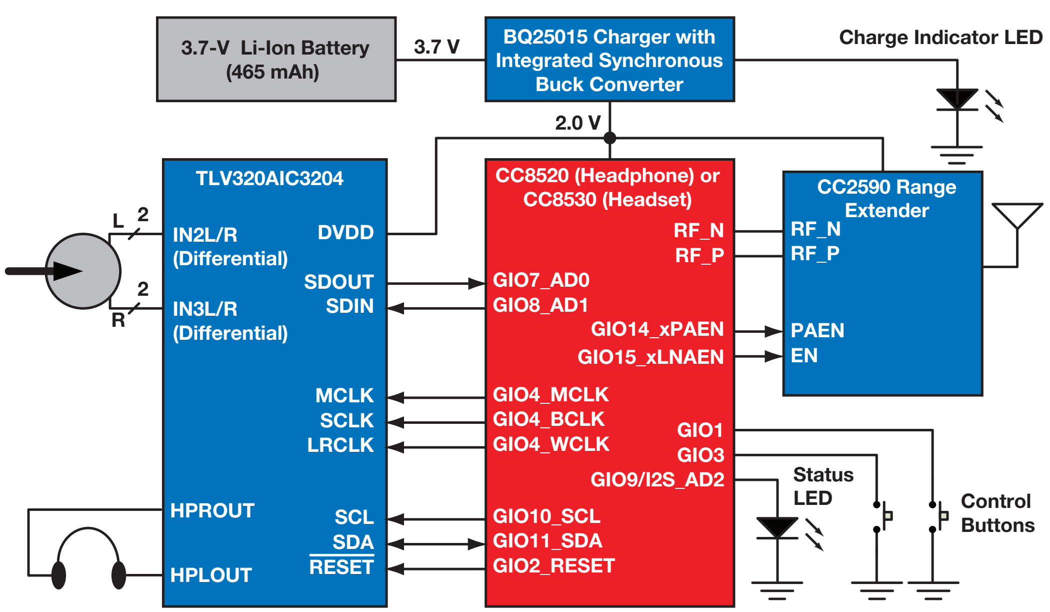
- The PurePath built-in wireless audio protocol provides excellent robustness and coexistence through multiple techniques:
  - Adaptive frequency hopping
  - Forward-error correction buffering and retransmission
  - Error concealment
  - Optional high-quality audio compression
- External System
  - Seamless connection and control of select TI audio codecs, DACs/ADCs and digital audio amplifiers using I^2S and I^2C
  - HID functions like power control, binding, volume control and audio-channel selection can be mapped to I/Os
  - RoHS-compliant 6 x 6-mm QFN-40 package
- RF Section
  - 5-Mbps over-the-air data rate
  - Bandwidth-efficient modulation format
  - Excellent link budget with programmable output power of up to +4 dBm and sensitivity of –83 dBm
  - Seamless support for CC2590 range extender
  - Suited for systems targeting compliance with worldwide radio-frequency regulations: ETSI EN 300 328 and EN 300 440 class 2 (Europe), FCC CFR47 Part 15 (U.S.) and ARIB STD-T66 (Japan)
- Digital Audio Support
  - CD-quality uncompressed audio (44.1 or 48 kHz and 16 bits)
  - Digital I^2S audio interface supports one or two audio channels (CC852x) or three or four audio channels (CC853x) at sample rates of 32, 40.275, 44.1 or 48 kHz with 16-bit word widths
  - Audio latency less than 20 ms
  - Data-side channel allows data to be sent alongside the audio between external host controllers

Applications

- Wireless headphones/headsets
- Wireless speaker systems
- Wireless signal cable replacement
- Wireless home theater systems

Wireless Headphone or Headset

- Cost-optimized design with 100% TI content
- 2x longer battery life than typical headphones (22 h on 465-mAh battery)
- Well-suited for high-quality headphones/headsets
- Design files available from TI



For a complete list of **PurePath™ Wireless Audio SoC** solutions, see page 36.
For the latest information on PurePath Wireless Audio SoCs, visit **www.ti.com/purepathwireless**

Design Considerations for Audio Controllers and Converters with USB Interface

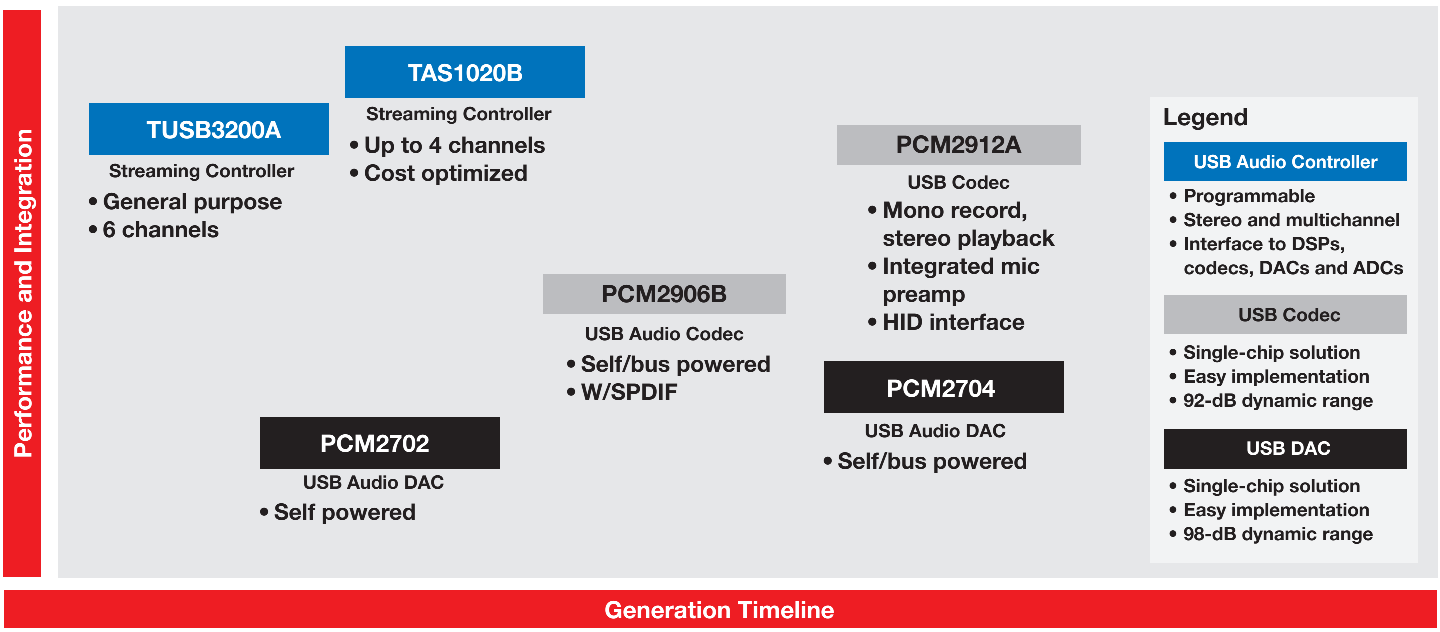
Programmable vs. USB Codecs

- For designers with little USB experience, one of the biggest challenges is deciding between a plug-and-play device and one that requires coding.
- TI codecs (PCM2xxx) deliver an extremely simple plug-and-play experience by being completely USB-class compliant.
- For the highest flexibility and performance defined by an external converter, the TAS1020B and TUSB3200A offer completely programmable solutions based on an 8052, 8-bit processor core.

I/O Considerations (S/PDIF, I^2S, HID)

- Beyond analog audio in and out, many USB audio products now offer:
  - S/PDIF I/O
  - Raw PCM data (in I^2S form)
  - Human interface device (HID) functionality
- HID functionality allows control of PC/Mac applications:
  - Mute, volume up/down, play, stop, rewind, fast-forward, etc.

Audio Controllers and Converters with USB Interface



For a complete list of **Audio Controllers and Converters with USB Interface**, see page 37.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Digital Audio Processors and SoCs

Input Considerations

Audio SoC inputs can be digital or analog.

- Digital inputs in the I^{2}S form are suitable if the audio source is digital in nature, such as an MP3 decoder or DSP.
- Analog inputs can be either single ended or differential.
- Single-ended circuits are simpler and require fewer components.
- Differential circuits offer better noise performance.
- Differential inputs are robust against TDMA noise generated by mobile phones.

Audio Processing Considerations

The digital core of an audio SoC can be based on two types of architectures, ROM or RAM.

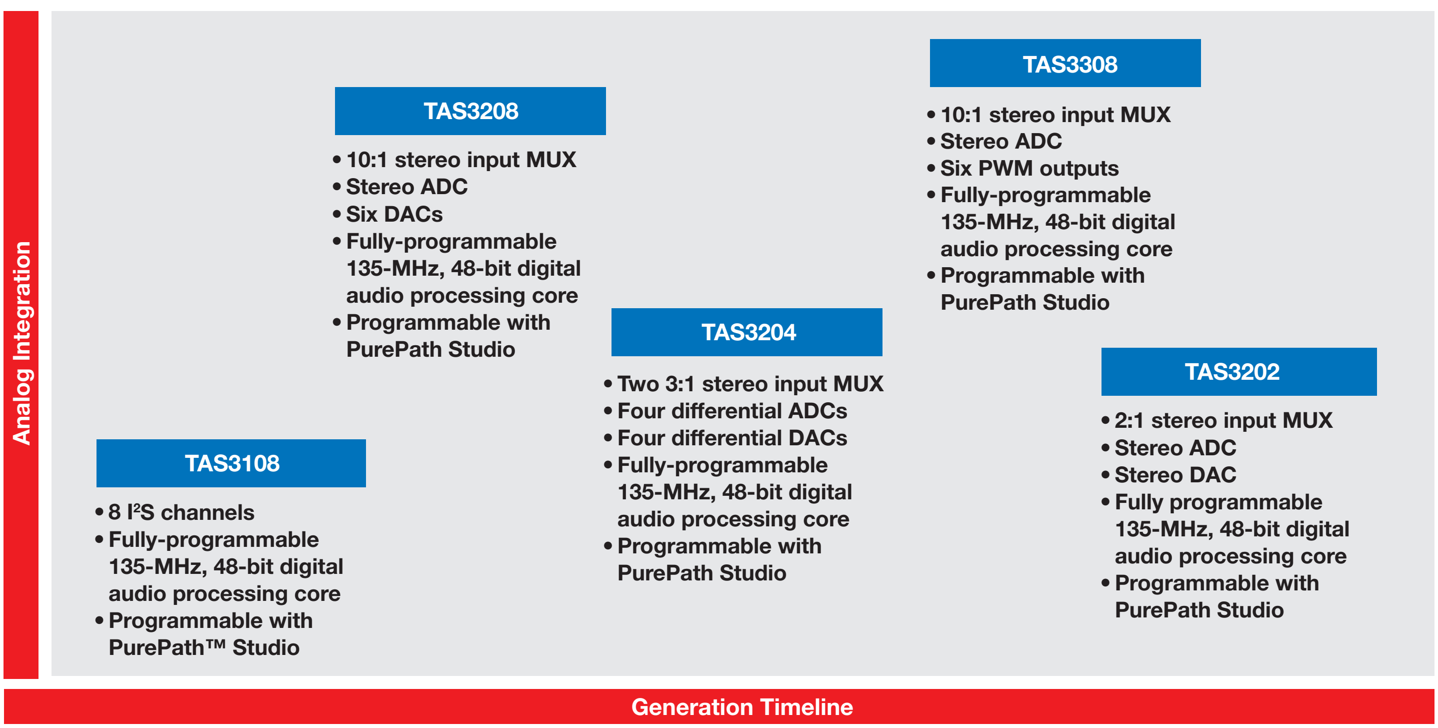
- ROM-based cores:
  - Are not fully programmable
  - Feature a fixed-process flow that can be configured
    - Example: Each audio channel might have a bank of seven fixed-frequency bi-quad filters in which only the gains can be altered by a user
- RAM-based cores are fully programmable:
  - Example: A user can implement any desired number of bi-quad filters on a channel and specify gain, band-width, and center frequency

Output Considerations

Audio SoC outputs can be digital, analog or PWM.

- Digital outputs are in an I^{2}S or S/PDIF form
  - I^{2}S is useful if the output signal is being sent to another IC
  - S/PDIF is generally used for an output that is expected to be routed to an external audio system
- Analog outputs:
  - Can be either single ended or differential
  - Reference input consideration section for benefits of each type of output
- PWM outputs:
  - Can be routed directly to an H-bridge PWM power stage, such as TI's TAS53xx family
  - Are beneficial because the audio stream is maintained as digital for as long as possible

Digital Audio SoCs



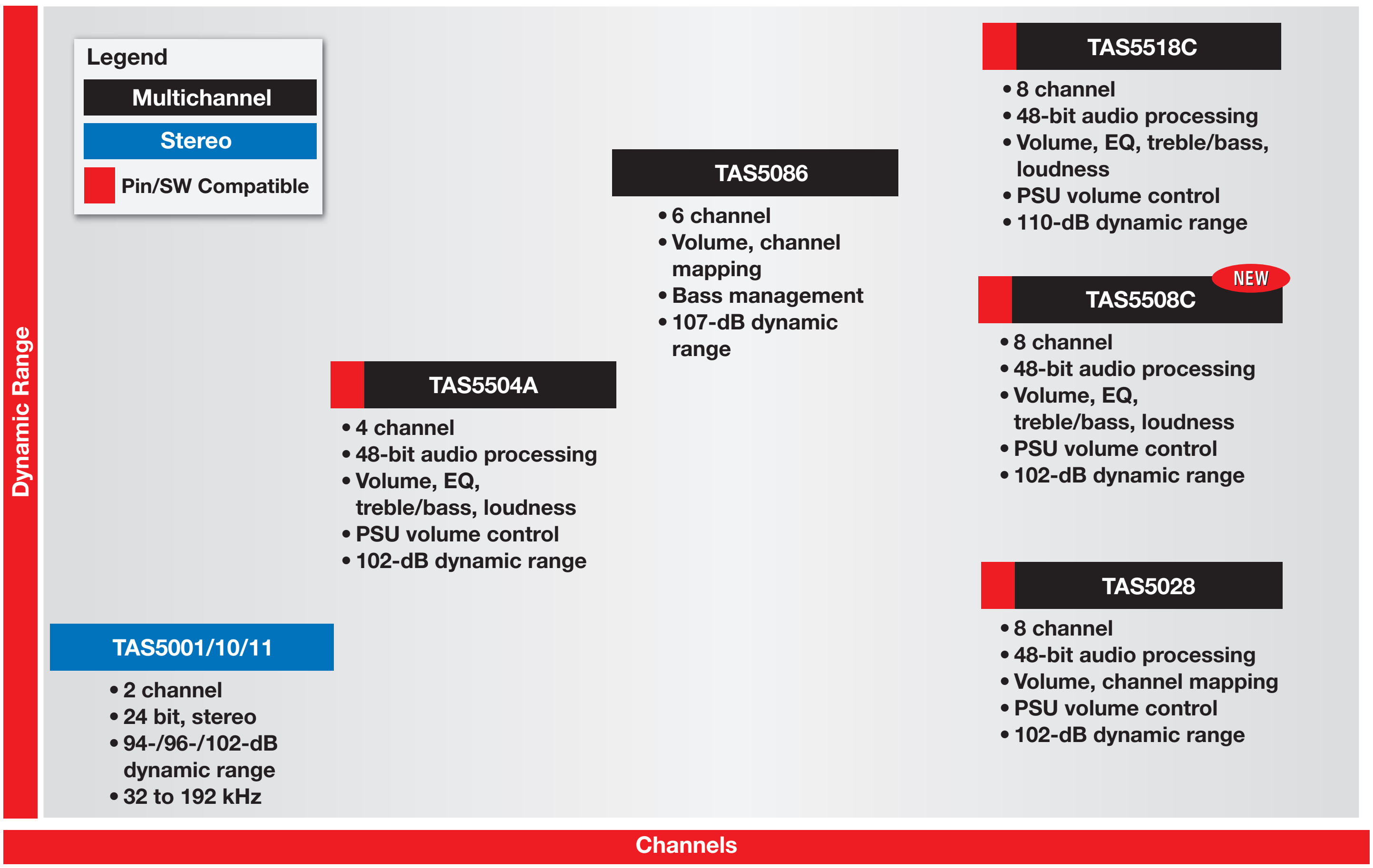
For a complete list of **Digital Audio Processors and SoCs**, see page 37.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for PWM Processors

Digital Amplifier Chipset

- The digital audio PWM processor is the first chip in a two-chip digital amplifier chipset.
- It accepts PCM data from a DSP, ADC or interface (S/PDIF) and converts the data into PWM format.
- The PWM data is passed to the power stage that drives the speaker.
- Some PWM processors include a digital audio processor to handle post-processing functions such as:
  - Volume control
  - Treble/bass control
  - EQ
  - Bass management
  - Compression/limiting
  - Loudness
- Channel counts vary from stereo versions to multichannel, ideal for the 5.1, 6.1 and 7.1 markets.
- Software configurability and pin-for-pin compatibility allow a single board to be used for many design platforms.

PurePath™ PWM Processors



For a complete list of **PWM Processors**, see page 29.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Floating-Point DSPs and Applications Processors

TMS320C67x™ processors, the industry's highest performance floating-point DSPs, offer precision, speed, power savings and dynamic range with performance ranging from 600 to 3648 MFLOPS. These devices are ideal for professional audio products, biometrics, medical, industrial, digital imaging, speech recognition and voice-over packet.

With the new TMS320C674x low-power floating-point processors, designers now have the ability to bring connectivity and more portability to audio applications.

The new OMAP-L13x applications processors combine an ARM9 processor with a floating-point DSP to provide the ability to implement user interfaces or networking stacks.

Key Features

- 100% code-compatible DSPs
- Advanced VLIW architecture
- Up to eight 32-bit instructions executed each cycle
- Eight independent, multi-purpose functional units and up to sixty-four 32-bit registers
- Industry's most advanced DSP C compiler and assembly optimizer maximize efficiency and performance

OMAP-L13x Applications Processors

- Integrate GUIs and/or networking capabilities into portable designs with ARM9 + C674x floating-point DSP
- Operating system flexibility with Linux, DSP/BIOS™ real-time kernel, or WinCE
- Pin-for-pin compatible with TMS320C674x DSP

C674x DSP

- Industry's lowest-power floating-point DSPs
- High precision and wide dynamic range enabled through the 32-/64-bit accuracy of the floating-point DSP core
- Pin-for-pin compatible with OMAP-L13x applications processor

C672x DSP

- Sixty-four 32-bit registers
- Large (32-KB) program cache dMAX DMA engine tuned for audio performance

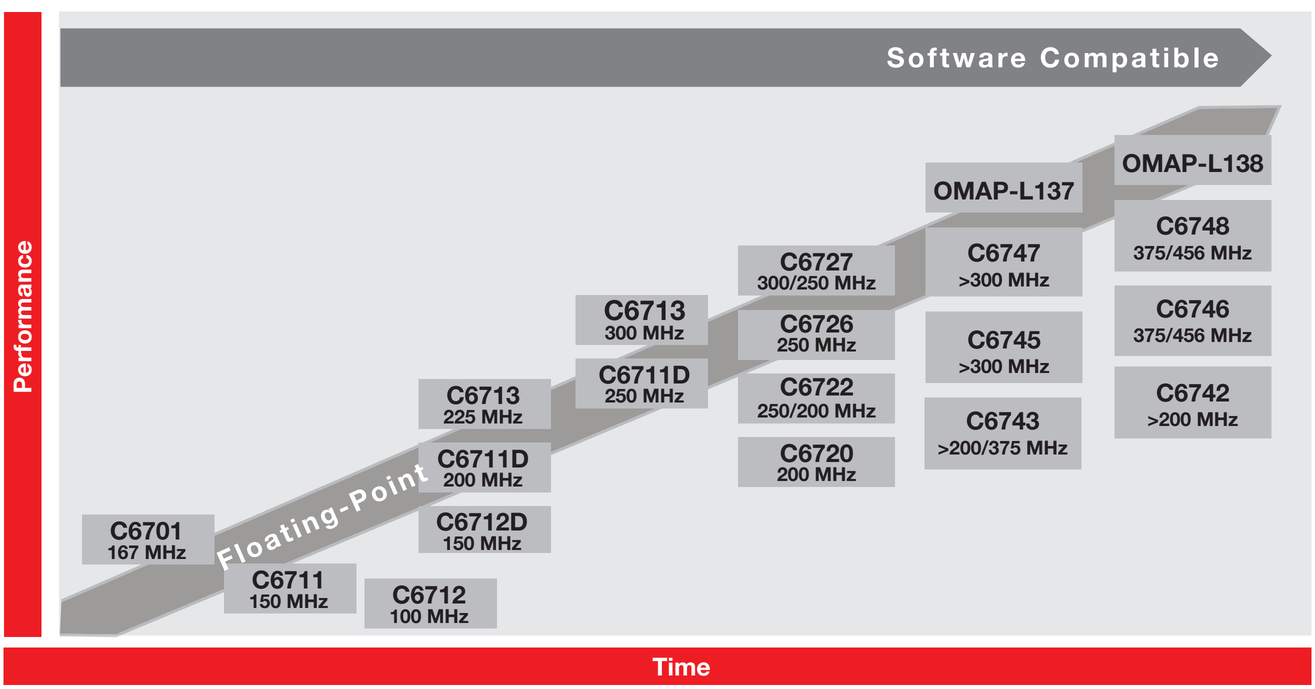
C671x DSP

- L1/L2 cache architecture
- Thirty-two 32-bit registers
- EDMA DMA engine

Applications

- Professional audio products, mixers, audio synthesis
- Instrument/amplifier modeling
- Audio conferencing
- Audio broadcast
- Emerging audio applications in biometrics, medical, industrial, digital imaging, speech recognition and voice-over packet, musical foot pedals, electronic keyboards

Floating-Point Processors



For a complete list of **Floating-Point Processors**, see page 39.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for TMS320C2000™ Microcontrollers

The 32-bit C2000™ MCU family offers up to 300-MHz performance with floating-point capabilities and highly integrated analog peripherals.

Combined with integrated Flash and RAM memory blocks, the C2000 MCU provides a powerful single-chip solution ideal for many audio applications such as Class-D amplifier control and low-latency audio processing.

Specifications

- Single-cycle 32x32-bit MAC
- Only processors with full software compatibility between fixed-point and floating-point
- Full software compatibility across all C2000 platform controllers
- All C28x™ microcontrollers are AEC Q-100 qualified for automotive applications

Key Features

- Robust software library drastically reduces development time
- Best-in-class compiler efficiency
- Low-cost development tools starting at $39

Peripherals

- SCI, SPI, I^{2}C, McBSP and CAN 2.0b ports
- High-resolution PWM modules with a maximum resolution of 150 ps
- On-chip 12-bit ADC with up to 16 channels and up to 12.5 MSPS

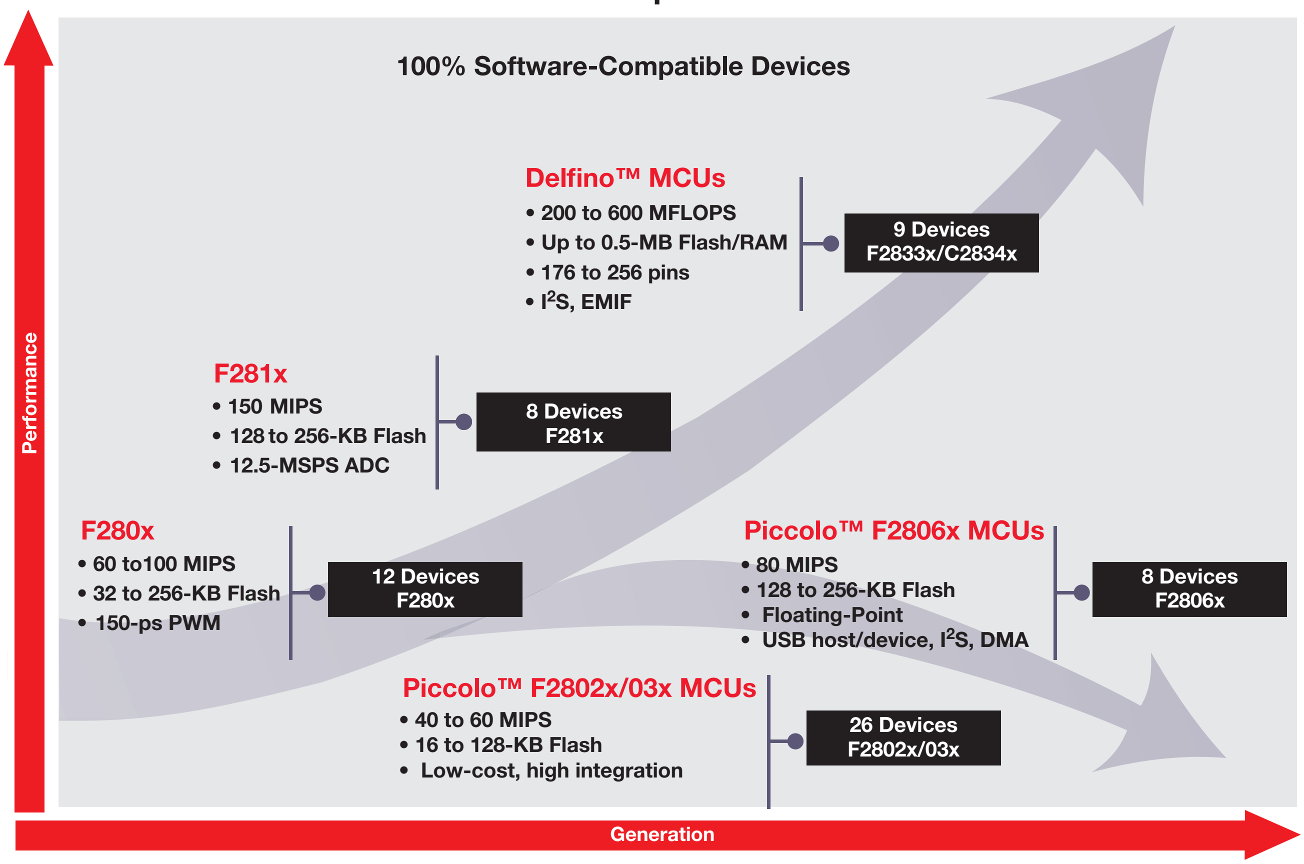
Delfino™ MCUs F2833x/C2834x (with floating point)

- Up to 300 MIPS and 600 MFLOPS for real-time analysis
- Up to 512-KB Flash and 516-KB RAM
- 6-channel DMA support for ADC, I^{2}S, EMIF

Target Audio Applications

- Class-D amplifier control
- Musical effects
- Low-latency audio processing

TMS320C2000™ Microcontrollers Roadmap



For a complete list of **C2000 Microcontrollers**, see page 40.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Analog Multiplexers and Switches

V+ and the Max Analog Signal Amplitude

- V+ determines the analog signal amplitude that can be passed without clipping for noncharge-pump switches.
- The gate(s) of the pass transistors must be biased relative to the minimum and maximum values of the expected input voltage range.
- Some switches feature negative signal capability and allow signals below ground to pass through the switch without distortion, making it easy to pass both positive and negative signals.
- Switches with integrated charge pumps can elevate the gate voltage above V+ (at the expense of larger I+) and thus pass signals of a magnitude greater than V+.

VIH/VIL Compatibility

- The signal switch is controlled by the output of a digital source in most applications.
- The control signal levels, VIH and VIL, must be compatible with the digital source to ensure proper operation of the switch.

On-State Resistance (r_{on}) Tradeoffs

- r_{on} contributes to signal loss and degradation.
- Non-charge-pump switches achieve low r_{on} with large pass transistors.
  - Leads to larger die sizes and increased channel capacitance (CI/O)
  - Limits the frequency response of the switch
- Switches using charge-pump technology can achieve low r_{on} and CI/O but require significantly higher I+.

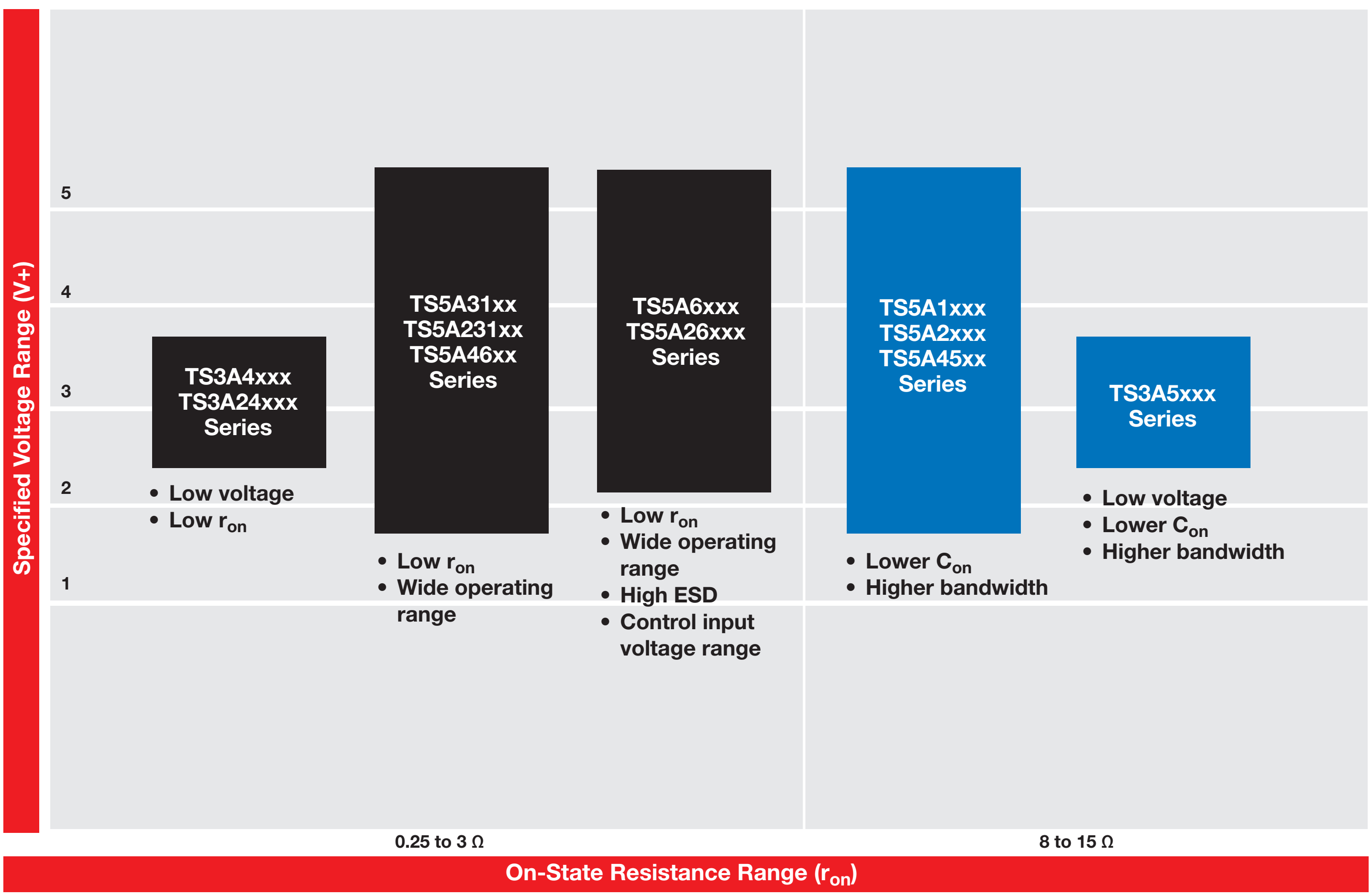
On-State Resistance Flatness [r_{on}(flat)]

- On-state resistance flatness specifies the minimum and maximum value of r_{on} over the specified range of conditions.
- Conditions may include changes in temperature or supply voltage.

Negative Signal I/O Capability

- Switches that interface with "cap-free" headphone amps such as the TPA6130A2 from TI need to be able to support audio signals that swing below ground.
- When used with audio amps that use a DC-blocking capacitor, switches that are placed between the audio jack and the blocking capacitor need to support audio signals that swing below ground.

Analog Switches Optimized for Audio Applications



For a more detailed list of **Analog Multiplexers and Switches** optimized for audio applications, see page 42.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Audio Amplifiers

Device	Description	Amplifier Class	Amplifier Input Type	Amplifier Output Type	Open/ Closed Loop	Speaker Output Power (W)	Load Impedance (Ω)	Supply (V)	Half Power THD+N at 1 kHz (%)	Speaker PSRR (dB)	Package(s)	Price*
Speaker Amplifiers – Mid/High Power – Analog Input												
TAS5630	Analog Input 300-W Stereo (300 W Total) Class-D Amplifier with Integrated Feedback	Class-D	Analog	Up to 4 ch	Closed	600	4	10.8 to 13.2	0.03	80	HSSOP-44, HTQFP-64	6.35
TAS5613A	150-W Stereo PurePath HD Analog-Input Power Stage	Class-D	Analog	Up to 2 ch	Closed	150	4	10.8 to 13.2	0.03	80	HTQFP-64	4.45
TAS5611A	125-W Stereo/250W Mono PurePath™ HD Analog-Input Power Stage	Class-D	Analog	Up to 2 ch	Closed	125	4	10.8 to 13.2	0.03	80	HTQFP-64	4.30
TPA3106D1	40-W Mono Class-D Audio Power Amplifier (TPA3106)	Class-D	Analog	Mono	Closed	40	4	10 to 26	0.2	70	HLQFP-32	2.25
TPA3112D1	25-W Filter-Free Mono Class-D Audio Amplifier with SpeakerGuard™ (TPA3112)	Class-D	Analog	Mono	Closed	25	4	8 to 26	0.07	70	HTSSOP-28	0.85
TPA3123D2	25-W Stereo Class-D Audio Power Amplifier with SE Outputs (TPA3123)	Class-D	Analog	Stereo	Closed	25	4	10 to 30	0.08	60	HTSSOP-24	1.75
TPA3100D2	20-W Stereo Class-D Audio Power Amplifier (TPA3100)	Class-D	Analog	Stereo	Closed	20	4	10 to 26	0.11	70	HTQFP-48 VQFN-48	3.50
TPA3100D2-Q1	Automotive Catalog 20-W Stereo Class-D Audio Power Amplifier	Class-D	Analog	Stereo	Closed	20	4	10 to 26	0.11	70	VQFN-48	4.45
TPA3110D2	15-W Filter-Free Class D Stereo Amplifier with SpeakerGuard (TPA3110)	Class-D	Analog	Stereo	Closed	15	4	8 to 26	0.07	70	HTSSOP-28	1.45
TPA3121D2	15-W Stereo Class-D Audio Power Amplifier with SE Outputs (TPA3121)	Class-D	Analog	Stereo	Closed	15	4	10 to 26	0.08	60	HTSSOP-24	1.45
TPA3124D2	15-W Stereo Class-D Audio Power Amplifier with SE Outputs and Fast Mute Time (TPA3124)	Class-D	Analog	Stereo	Closed	15	4	10 to 26	0.08	60	HTSSOP-24	1.60
TPA3004D2	12-W Stereo Class-D Audio Power Amplifier with Volume Control (TPA3004)	Class-D	Analog	Stereo	Closed	12	4	8.5 to 18	0.1	80	HTQFP-48	3.60
TPA3101D2	10-W Stereo Class-D Audio Power Amplifier (TPA3101)	Class-D	Analog	Stereo	Closed	10	4	10 to 26	0.09	70	HTQFP-48, VQFN-48	3.45
TPA3111D1	10-W Mono Class-D Audio Power Amplifier with SpeakerGuard (TPA3111)	Class-D	Analog	Mono	Closed	10	4	8 to 26	0.07	70	HTSSOP-28	0.90
TPA3002D2	9-W Stereo Class-D Audio Power Amplifier with Volume Control (TPA3002)	Class-D	Analog	Stereo	Closed	9	8	8.5 to 14	0.06	80	HTQFP-48	3.65
TPA1517	Stereo, Medium Power, Class-AB Audio Amplifier	Class-AB	Analog	Stereo	Closed	6	4	9.5 to 18	0.15	65	PDIP-20, SO-20 PowerPAD™	1.15
TPA3113D2	6-W Stereo Class-D Audio Power Amplifier with SpeakerGuard (TPA3113)	Class-D	Analog	Stereo	Closed	6	4	8 to 26	0.07	70	HTSSOP-28	0.85
TPA3003D2	3-W Stereo Class-D Audio Power Amplifier with Volume Control (TPA3003)	Class-D	Analog	Stereo	Closed	3	8	8.5 to 14	0.2	80	TQFP-48	3.00
TPA3117D2	15-W Stereo Differential Amplifier with SpeakerGuard	Class-D	Analog	Stereo	Closed	15	4	8 to 26	0.1	70	QFN-32	1.85

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**.*

Audio Amplifiers (Continued)

Device	Description	Amp Class	Amplifier Input Type	Amplifier Output Type	Open/ Closed Loop	Speaker Output Power (W)	Headphone Output Power (W)	Load Impedance (Ω)	Supply (V)	Half Power THD+N at 1 kHz (%)	Head-phone PSRR (dB)	Speaker PSRR (dB)	Package(s)	Price*
Speaker Amplifiers – Portable														
TPA2011D1	3.2-W Mono Class-D with Auto-Recovering Short-Circuit Protection	Class-D	Analog	Mono	Closed	3.2	—	4	2.5 to 5.5	0.18	—	86	DSBGA-9	0.65
TPA2026D2	3.2-W/Ch Stereo SmartGain™ Class-D Audio Amplifier with Dynamic Range	Class-D	Analog	Stereo	Closed	3.2	—	4	2.5 to 5.5	0.1	—	80	DSBGA-16	1.30
TPA2037D1	Fixed-Gain 3.2-W Mono Class-D with Integrated DAC Noise Filter	Class-D	Analog	Mono	Closed	3.2	—	4	2.5 to 5.5	0.18	—	86	DSBGA-9	0.65
TPA2039D1	Fixed-Gain 3.2-W Mono Class-D with Integrated DAC Noise Filter	Class-D	Analog	Mono	Closed	3.2	—	4	2.5 to 5.5	0.18	—	86	DSBGA-9	0.65
TPA6211A1	3.1-W Mono, Fully Differential, Class-AB Audio Amplifier	Class-AB	Analog	Mono	Closed	3.1	—	3	2.5 to 5.5	0.02	—	85	MSOP-8 PowerPAD™, SON-8	0.65
TPA2028D1	3.0-W Mono Class-D Audio Amplifier with Fast Gain Ramp SmartGain AGC and DRC	Class-D	Analog	Mono	Closed	3	—	4	2.5 to 5.5	0.1	—	80	DSBGA-9	0.99
TPA6012A4	3-W Stereo Audio Power Amp w/Advanced DC Volume Control	Class-AB	Analog	Stereo	Closed	3	—	3	4.5 to 5.5	0.06	—	70	HTSSOP-24	1.35
TPA6013A4	3-W Stereo Audio Power Amplifier with Advanced DC Volume Control and 2.1 Input Stereo Input Mux	Class-AB	Analog	Stereo	Closed	3	—	3	4.5 to 5.5	0.06	—	70	HTSSOP-24	1.45
TPA6205A1	Fully Differential, 1.8-V Compatible Shutdown Voltage	Class-AB	Analog	Mono	Closed	1.25	—	8	2.5 to 5.5	0.06	—	90	MSOP, QFN, BGA	0.32
TPA2010D1	2.5-W Mono Class-D Audio Amplifier with Variable Gain (TPA2010)	Class-D	Analog	Mono	Closed	2.5	—	4	2.5 to 5.5	0.2	—	75	DSBGA-9	1.20
TPA2015D1	2-W Class-D Audio Amplifier with Adaptive Boost and Battery Tracking SpeakerGuard AGC	Class-D	Analog	Mono	Closed	2	—	8	2.3 to 5.2	0.1	—	85	DSBGA-16	1.15
TPA6017A2	Stereo, Cost-Effective, Class-AB Audio Amplifier	Class-AB	Analog	Stereo	Closed	2	—	3	4.5 to 5.5	0.1	—	77	HTSSOP-20	0.65
TPA2100P1	19-V_{PP} Mono Class-D Audio Amplifier for Piezo/Ceramic Speakers (TPA2100)	Class-D	Analog	Mono	Closed	—	—	1.5-μF Piezo	2.5 to 5.5	0.07	—	100	DSBGA-16	1.15
Speaker Amplifiers – Portable – Digital Input														
TLV320DAC3120	Digital-Input Class-D Speaker Amp with miniDSP	Class-D	I^2S	Mono	Closed	2.5	60	4	2.7 to 3.6	1.65 to 1.95	Y/Y	Y	5 x 5-mm QFN-32	1.75

Device	Description	Amplifier Class	Amplifier Input Type	Amplifier Output Config.	Open/ Closed Loop	Speaker Output Power (W)	Head-phone Output Power (W)	Load Impedance (Ω)	Supply (V)	Half Power THD+N at 1 kHz (%)	3-D/ Bass Boost	Dynamic Range Control	Package(s)	Price*
Speaker Amplifiers – Mid/High Power – Digital Input														
TAS5704	20-W Stereo Closed-Loop I^2S Audio Power Amplifier with Speaker EQ and DRC (H/W Controlled)	Class-D	I^2S	Stereo/ 2.1/4.0	Closed	20	—	4	10 to 26	<0.1	N/N	No	HTQFP-64	3.00
TAS5705	20-W Stereo I^2S Audio Power Amplifier with Speaker EQ and DRC	Class-D	I^2S	Stereo/2.1	Closed	20	—	6	8 to 23	<0.1	N/N	2	HTQFP-64	2.70
TAS5706A	20-W Stereo Closed-Loop I^2S Audio Power Amp w/Speaker EQ and DRC	Class-D	I^2S	Stereo/2.1	Closed	20	—	4	10 to 26	<0.1	N/N	2	HTQFP-64	3.00

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Audio Amplifiers (Continued)

Device	Description	Amplifier Class	Amplifier Input Type	Amplifier Output Config.	Open/ Closed Loop	Speaker Output Power (W)	Head-phone Output Power (W)	Load Impedance (Ω)	Supply (V)	Half Power THD+N at 1 kHz (%)	3-D/ Bass Boost	Dynamic Range Control	Package(s)	Price*
Speaker Amplifiers – Mid/High Power – Digital Input (Continued)														
TAS5706B	20-W Closed-Loop I^{2}S Audio Power Amp w/ Speaker EQ, DRC and SE Output Support	Class-D	I^{2}S	Stereo/ 2.1/4.0	Closed	20	—	4	10 to 26	<0.1	N/N	2	HTQFP-64	3.00
TAS5707	20-W Stereo I^{2}S Audio Power Amp with Speaker EQ and DRC	Class-D	I^{2}S	Stereo	Closed	20	—	6	8 to 26	<0.1	N/N	1	HTQFP-48	2.55
TAS5707A	20-W Stereo Digital Audio Power Amplifier with EQ and DRC	Class-D	I^{2}S	Stereo	Closed	20	—	6	8 to 26	<0.1	N/N	1	HTQFP-48	2.30
TAS5708	20-W Stereo Closed-Loop I^{2}S Audio Power Amp w/Speaker EQ and DRC	Class-D	I^{2}S	Stereo	Closed	20	—	6	10 to 26	<0.1	N/N	1	HTQFP-48	2.85
TAS5709	20-W Stereo I^{2}S Audio Amplifier with Speaker EQ and 2-Band DRC	Class-D	I^{2}S	Stereo	Closed	20	—	6	8 to 26	<0.1	Y/Y	2	HTQFP-48	2.40
TAS5709A	20-W Stereo I^{2}S Audio Amplifier with Speaker EQ and 2-Band DRC	Class-D	I^{2}S	Stereo	Closed	20	—	6	8 to 26	<0.1	Y/Y	2	HTQFP-48	2.65
TAS5710	20-W Stereo Closed-Loop I^{2}S Audio Amp w/Speaker EQ and 2-Band DRC	Class-D	I^{2}S	Stereo	Closed	20	—	6	10 to 26	<0.1	Y/Y	2	HTQFP-48	2.65
TAS5711	20-W Stereo I^{2}S Audio Amplifier with Speaker EQ, DRC and 2.1 Support	Class-D	I^{2}S	Stereo/2.1	Closed	20	—	4	8 to 26	<0.1	Y/N	2	HTQFP-48	2.75
TAS5713	25-W Stereo I^{2}S Audio Amplifier with Speaker EQ and 2-Band DRC	Class-D	I^{2}S	Stereo	Closed	25	—	4	8 to 26	<0.1	N/Y	2	HTQFP-48	2.85
TAS5715	25-W Stereo (BTL) I^{2}S Amplifier with Speaker EQ, 2-Band DRC and DC Protection	Class-D	I^{2}S	Stereo	Closed	25	—	4	8 to 26	<0.1	N/Y	2	QFN-32	2.25
TAS5716	20-W Stereo with Feedback, Speaker EQ, DRC, 3D and 2.1 Support	Class-D	I^{2}S	Stereo/ 2.1/4.0	Closed	20	—	4	10 to 26	<0.1	Y/Y	1	HTQFP-64	3.15
TAS5717	10-W Digital Audio Power Amplifier with Integrated DirectPath™ Headphone Amplifier	Class-D	I^{2}S	Stereo	Closed	10	0.040/ 2 V_{RMS}	4	8 to 26	<0.1	N/N	2	QFN-32	2.25
TAS5719	15-W Digital Audio Power Amplifier with Integrated DirectPath Headphone Amplifier	Class-D	I^{2}S	Stereo	Closed	15	0.040/ 2 V_{RMS}	4	8 to 26	<0.1	N/N	2	QFN-32	2.35
TAS5727	25-W Stereo Digital-Input Audio Amplifier with Speaker EQ and 2-Band DRC	Class-D	I^{2}S	Stereo	Closed	25	—	4	8 to 26	<0.1	N/N	2	QFN-32	2.75

Device	Description	Amplifier Class	Amplifier Input Type	Amplifier Output Type	Open/ Closed Loop	Speaker Output Power (W)	Load Impedance (Ω)	Supply (V)	Half Power THD+N at 1 kHz (%)	Dynamic Range	Package(s)	Price*
Speaker Amplifiers – Mid/High Power – PWM Input/Power Stage												
TAS5631	PWM Input 300-W Stereo (600 W Total) Class-D Amplifier with Integrated Feedback	Class-D	PWM	Up to 4 ch	Closed	600	4	10.8 to 13.2	0.04	110	HSSOP-44, HTQFP-64	6.35
TAS5261	315-W Mono Digital Amplifier Power Stage	Class-D	PWM	Mono	Closed	315	3	10.8 to 13.2	<0.05	110	HSSOP-36	5.25
TAS5162	210-W Stereo Digital Amplifier Power Stage	Class-D	PWM	Stereo	Closed	200	3	10.8 to 13.2	<0.05	110	HSSOP-36, HTSSOP-44	4.95
TAS5614A	150-W Stereo/300-W Mono PurePath™ HD Digital-Input Power Stage	Class-D	PWM	Up to 2 ch	Closed	150	4	10.8 to 13.2	0.03	103	HTQFP-64	4.45
TAS5352A	125-W Stereo Digital Amplifier Power Stage	Class-D	PWM	Up to 4 ch	Closed	125	2	10.8 to 13.2	0.06	110	HTSSOP-44	3.10
TAS5612A	125-W Stereo/250-W Mono PurePath HD Digital-Input Power Stage	Class-D	PWM	Up to 2 ch	Closed	125	4	10.8 to 13.2	0.03	103	HTQFP-64	4.30
TAS5121	100-W Mono Digital Amplifier Power Stage	Class-D	PWM	Mono	Closed	100	4	10.8 to 13.2	0.05	95	HTSSOP-32	3.25
TAS5176	100-W (5.1-Channel) Digital Amplifier Power Stage	Class-D	PWM	6 ch	Closed	100	3	10.8 to 13.2	<0.05	109	HTSSOP-44	4.30
TAS5342LA	100-W Stereo Digital Amplifier Power Stage	Class-D	PWM	Up to 4 ch	Closed	100	2	10.8 to 13.2	0.1	110	HTSSOP-44	2.75
TAS5111A	70-W Mono Digital Amplifier Power Stage	Class-D	PWM	Mono	Closed	70	4	16 to 30.5	0.025	95	HTSSOP-32	2.40
TAS5112A	50-W Stereo Digital Amplifier Power Stage	Class-D	PWM	Stereo	Closed	50	6	16 to 30.5	0.025	95	HTSSOP-56	4.05
TAS5122	50-W Stereo Digital Amplifier Power Stage	Class-D	PWM	Stereo	Closed	30	6	16 to 25.5	0.05	95	HTSSOP-56	3.25

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*New products are listed in **bold red**. Preview products are listed in **bold blue**.*

Audio Amplifiers (Continued)

Device	Description	Amplifier Class	Amplifier Input Type	Amplifier Output Type	Open/ Closed Loop	Speaker Output Power (W)	Load Impedance (Ω)	Supply (V)	Half Power THD+N at 1 kHz (%)	Dynamic Range	Package(s)	Price*
Speaker Amplifiers – Mid/High Power – PWM Input/Power Stage (Continued)												
TAS5186A	210-W (5.1-Channel) Digital Amplifier Power Stage	Class-D	PWM	6 ch	Closed	30	3	10.8 to 13.2	0.07	105	HTSSOP-44	5.50
TAS5102	20-W Stereo Digital Amplifier Power Stage	Class-D	PWM	Up to 4 ch	Closed	20	4	8 to 26	<0.1	105	HTSSOP-32	1.80
TAS5602	20-W Stereo Digital Amplifier Power Stage with Feedback	Class-D	PWM	Up to 4 ch	Closed	20	4	10 to 26	<0.1	96	HTSSOP-44	2.00
TAS5103	15-W Stereo Digital Amplifier Power Stage	Class-D	PWM	Up to 4 ch	Closed	15	4	8 to 26	<0.1	105	HTSSOP-32	1.80

Device	Description	Output Chs	Dynamic Range (dB)	Data Resolution	Dynamic Range	PWM Headphone Output	Volume Control	Serial Interface	Loudness Compensation	Mute	EQ	Bass/ Treble Tone Control	Package(s)	Price*
Audio PWM Processors														
TAS5001	Digital Audio PWM Processor	2	96	16, 20, 24	96	No	No	I^2S, R, L, DSP	No	Yes	No	No	TQFP-48	3.00
TAS5010	Digital Audio PWM Processor	2	96	16, 20, 24	96	No	No	I^2S, R, L, DSP	No	Yes	No	No	TQFP-48	3.75
TAS5012	Digital Audio PWM Processor	2	102	16, 20, 24	102	No	No	I^2S, R, L, DSP	No	Yes	No	No	TQFP-48	5.95
TAS5086	PurePath™ Digital Audio 6-Channel PWM Processor	6	105	16, 20, 24	105	No	Yes	I^2S, R, L	No	Yes	Yes	No	TSSOP-38	1.75
TAS5508C	8-Channel Digital Audio PWM Processor	8	102	16, 20, 24	102	Yes	Yes	I^2S, R, L	Yes	Yes	Yes	Yes	TQFP-64	6.25

Device	Description	Amplifier Class	Amplifier Input Type	Amplifier Output Type	Open/ Closed Loop	Speaker Output Power (W)	Headphone Output Power (W)	Load Impedance (Ω)	Supply (V)	Half Power THD+N at 1 kHz (%)	Head-phone PSRR (dB)	Speaker PSRR (dB)	Package(s)	Price*
Headphone Amplifiers														
TPA6139A2	DirectPath™ with 10 Selectable Gain Settings	Class-AB	Analog	Stereo	Closed	—	0.40	32	3.0 to 3.6	0.003	80	—	TSSOP-14	0.60
TPA6132A2	25-mW DirectPath Stereo Headphone Amplifier with Pop Suppression (TPA6132)	Class-AB	Analog	Stereo	Closed	—	0.025	16	2.3 to 5.5	0.025	100	—	WQFN-16	0.55
TPA6136A2	25-mW DirectPath Stereo Headphone Amplifier with Pop Suppression and Hi-Z Mode	Class-AB	Analog	Stereo	Closed	—	0.025	16	2.3 to 5.5	0.025	100	—	DSBGA-16	0.70
TPA6138A2	25-mW DirectPath Headphone Amplifier with UVP	Class-AB	Analog	Stereo	Closed	—	0.025	32	3.0 to 3.6	0.007	80	—	TSSOP-14	0.60
TPA6140A2	25-mW Class-G DirectPath Stereo Headphone Amp with I^2C Volume Control (TPA6140)	Class-G	Analog	Stereo	Closed	—	0.025	16	2.5 to 5.5	0.0025	105	—	DSBGA-16	0.95
TPA6141A2	25-mW Class-G DirectPath Stereo Headphone Amp (TPA6141)	Class-G	Analog	Stereo	Closed	—	0.025	16	2.5 to 5.5	0.0025	105	—	DSBGA-16	0.85
Amplifier Subsystems														
TPA2051D3	2.9-W 3-Input Audio Subsystem with SmartGain™ Mono Class-D and DirectPath Headphone Amplifier	Class-AB	Analog	Stereo HP, Mono Speaker	Closed	2.9	0.025	4	2.5 to 5.5	0.05	80	75	DSBGA-25	0.75
TPA2054D4A	2.4-W/Ch 3-Input Audio Subsystem with Stereo Class-D and DirectPath Headphone Amplifier	Class-AB	Analog	Stereo HP, Stereo Speaker	Closed	1.4	0.145	4	2.5 to 5.5	0.27	78.5	77.7	DSBGA-25	1.30

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Audio Preamplifiers and Line Drivers

Device	Description	Gain Range (dB)	Noise (Ein) with G = 30 dB	THD+N with Gain = 30 dB (%)	Power Supply	Package(s)	Price*
Microphone Preamplifiers							
PGA2500	Digitally Controlled Microphone Preamplifier	0 dB, and 10 dB to 65 dB in 1-dB steps	–128 dBu	0.0004000	±5	SSOP-28	7.95
PGA2505	Digitally Controlled Microphone Preamplifier	0 dB and 9 dB to 60 dB in 3-dB steps	–123 dBu	0.000600	±5	SSOP-28	4.95

Device	Description	Fixed/Variable Gain	Supply Min ([V+] + [V-])	Supply Max ([V+] + [V-])	GBW (typ) (MHz)	Slew Rate (typ) (V/µs)	Distortion at 1 kHz (typ) (%)	Package(s)	Price*
Audio Line Drivers									
DRV134/DRV135	Audio-Balanced Line Driver	Fixed–2 V	9	36	1.5	15	0.00050	SOIC-16, PDIP-8, SOIC-8	1.95/2.95
DRV602/DRV603	3-V_{RMS} DirectPath™ Pop-Free Variable Input Gain Line Driver with Diff Inputs	Variable	3	5.5	8	4.5	0.01000/ 0.00100	TSSOP-14	0.70/0.85
DRV604	2-V_{RMS} Line Driver and Headphone Amp with Adjustable Gain	Variable	3	3.7	8	4.5	0.00100	HTSSOP-28	1.00
DRV612	2-V_{RMS} DirectPath Audio Line Driver with Programmable Fixed Gain	Fixed	3	3.6	8	4.5	0.01	TSSOP-14	0.80
DRV632	2-V_{RMS} DirectPath Audio Line Driver with Adjustable Gain	Fixed	3	3.6	8	4.5	0.01	TSSOP-14	0.75
Audio Line Receivers									
INA134	Audio Differential Line Receiver	Fixed – 0 dB (G = 1)	8	36	3.1	14	0.00050	PDIP-8, SOIC-8	1.05
INA137	Audio Differential Line Receiver	Fixed – ±6 dB (G = 1/2 or 2)	8	36	4	14	0.00050	PDIP-8, SOIC-8	1.05
INA2134	Audio Differential Line Receiver	Fixed – 0 dB (G = 1)	8	36	3.1	14	0.00050	PDIP-14, SOIC-14	1.70
INA2137	Audio Differential Line Receiver	Fixed – ± 6 dB (G = 1/2 or 2)	8	36	4	14	0.00050	PDIP-14, SOIC-14	1.70

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*New products are listed in **bold red**.*

Audio Operational Amplifiers

Device	Description	Amplifier Type	No. of Chs	Supply Min ([V+] + [IV-I])	Supply Max ([V+] + [IV-I])	I_q per channel (max) (mA)	GBW (typ) (MHz)	Slew Rate (typ) (V/µs)	V_n at 1 kHz (typ) (nV/√Hz)	Distortion at 1 kHz (typ) (%)	Package(s)	Price*
FET Operational Amplifiers												
OPA134	Sound-Plus High-Performance, JFET-Input Audio Operational Amplifier	FET Operational Amplifier	1	5	36	5	8	20	8	0.000080	PDIP-8, SOIC-8	1.10
OPA343	Single-Supply, Rail-to-Rail Operational Amplifiers	FET Operational Amplifier	1	2.5	5.5	1.25	5.5	6	25	0.000700	5SOT-23, SOIC-8	0.65
OPA353	High-Speed, Single-Supply, Rail-to-Rail Operational Amplifiers	FET Operational Amplifier	1	2.7	5.5	8	44	22	18	0.000600	5SOT-23, SOIC-8	1.00
OPA604	FET-Input, Audio Operational Amplifier	FET Operational Amplifier	1	9	48	7	20	25	11	0.000300	PDIP-8, SOIC-8	1.05
OPA627	Precision High-Speed Difet® Operational Amplifiers	FET Operational Amplifier	1	9	36	7.5	16	55	5.6	0.000030	PDIP-8, SOIC-8	12.25
OPA827	Low-Noise, High-Precision, JFET-Input Operational Amplifier	FET Operational Amplifier	1	8	36	5.2	22	28	4	0.000040	MSOP-8, SOIC-8	3.75
OPA1641	Sound-Plus™ High-Performance, JFET-Input Audio Operational Amplifier	FET Operational Amplifier	1	5	36	2.3	11	20	5.1	0.000050	MSOP-8, SOIC-8	0.95
OPA1642	Sound-Plus High-Performance, JFET-Input Audio Operational Amplifier	FET Operational Amplifier	2	5	36	2.3	11	20	5.1	0.000050	MSOP-8, SOIC-8	1.45
OPA1644	Sound-Plus High-Performance, JFET-Input Audio Operational Amplifier	FET Operational Amplifier	4	5	36	2.3	11	20	5.1	0.000050	SOIC-14, TSSOP-14	1.95
OPA2134	Sound-Plus High-Performance, JFET-Input Audio Operational Amplifier	FET Operational Amplifier	2	5	36	5	8	20	8	0.000080	PDIP-8, SOIC-8	1.25
OPA2343	Single-Supply, Rail-to-Rail Operational Amplifiers	FET Operational Amplifier	2	2.5	5.5	1.25	5.5	6	25	0.000700	MSOP-8, SOIC-8	1.00
OPA2353	High-Speed, Single-Supply, Rail-to-Rail Operational Amplifiers	FET Operational Amplifier	2	2.7	5.5	8	44	22	18	0.000600	MSOP-8, SOIC-8	1.70
OPA2604	Dual FET-Input, Low Distortion Operational Amplifier	FET Operational Amplifier	2	9	48	6	20	25	11	0.000300	PDIP-8, SOIC-8	1.90
OPA4134	Sound-Plus High-Performance, JFET-Input Audio Operational Amplifier	FET Operational Amplifier	4	5	36	5	8	20	8	0.000080	SOIC-14	2.00
OPA4343	Single-Supply, Rail-to-Rail Operational Amplifiers	FET Operational Amplifier	4	2.5	5.5	1.25	5.5	6	25	0.000700	SOIC-14, TSSOP-14, SSOP-16/QSOP	1.85
OPA4353	High-Speed, Single-Supply, Rail-to-Rail Operational Amplifiers	FET Operational Amplifier	4	2.7	5.5	8	44	22	18	0.000600	SOIC-14, SSOP-16/ QSOP	2.50
TL072	Low-Noise JFET-Input General-Purpose Operational Amplifier	FET Operational Amplifier	1	7	36	2.5	3	8	18	0.003000	PDIP-8, SO-8, SOIC-8, TSSOP-8	0.29
TL074	Low-Noise JFET-Input General-Purpose Operational Amplifier	FET Operational Amplifier	4	7	36	2.5	3	8	18	0.003000	PDIP-14, SO-14, SOIC-14, TSSOP-14	0.22
Bipolar Differential Amplifiers												
MC33078	High-Speed Low-Noise Operational Amplifier	Bipolar Operational Amplifier	2	10	36	2.5	16	7	4.5	0.002000	MSOP-8, PDIP-8, SOIC-8	0.30
NE5532A	3.5-nV/√Hz Noise, Precision Operational Amplifier	Bipolar Operational Amplifier	2	10	30	4	10	9	5	0.002000	PDIP-8, SO-8, SOIC-8	0.45
NE5534A	3.5-nV/√Hz Noise, Precision Operational Amplifier	Bipolar Operational Amplifier	1	10	30	8	10	13	4	0.002000	PDIP-8, SO-8, SOIC-8	0.45
OPA1602	2.5 nV/√Hz Noise, Low Power, Precision Operational Amplifier	Bipolar Operational Amplifier	1	5	36	2.6	35	20	2.5	0.000030	SO, MSOP	1.45
OPA1604	2.5 nV/√Hz Noise, Low Power, Precision Operational Amplifier	Bipolar Operational Amplifier	4	5	36	2.6	35	20	2.5	0.000030	SO, MSOP	1.95
OPA1611	1.1 nV/√Hz Noise, Low Power, Precision Operational Amplifier	Bipolar Operational Amplifier	1	5	36	3.6	40	27	1.1	0.000015	SOIC-8	1.75

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Audio Operational Amplifiers (Continued)

Device	Description	Amplifier Type	No. of Chs	Supply Min ([V+] + [IV-I])	Supply Max ([V+] + [IV-I])	I_q per channel (max) (mA)	GBW (typ) (MHz)	Slew Rate (typ) (V/µs)	V_n at 1 kHz (typ) ($nV/\sqrt{Hz}$)	Distortion at 1 kHz (typ) (%)	Package(s)	Price*
Bipolar Differential Amplifiers (Continued)												
OPA1612	1.1 $nV/\sqrt{Hz}$ Noise, Low Power, Precision Operational Amplifier	Bipolar Operational Amplifier	2	5	36	3.6	40	27	1.1	0.000015	SOIC-8	2.75
OPA1632	Fully Differential I/O Audio Amplifier	Bipolar Differential Amplifier	1	5	32	14	180	50	1.3	0.000022	SOIC-8, MSOP-8, PowerPAD™	1.75
OPA2228	3-$nV/\sqrt{Hz}$ Noise, Low Power, Precision Operational Amplifier	Bipolar Operational Amplifier	1	5	36	3.8	33	11	3	0.000050	PDIP-8, SOIC-8	1.85
OPA4228	3-$nV/\sqrt{Hz}$ Noise, Low Power, Precision Operational Amplifier	Bipolar Operational Amplifier	4	5	36	3.8	33	11	3	0.000050	PDIP-14, SOIC-14	4.05

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Volume Controls

Device	Description	Dynamic Range (dB)	Half Power THD+N at 1 kHz (%)	Crosstalk at 1 kHz (dBFS)	Power Supply (V)	Voltage Swing (V_{PP})	Package(s)	Price*
PGA2310	±15 V, DIP Package, Pin Compatible with PGA2311, Voltage Swing of 27 V_{PP}	120	0.0004	–126	±15	27	SOL-16, DIP-16	9.95
PGA2320	±15 V, Improved THD, Pin Compatible with PGA2310, Voltage Swing of 28 V_{PP}	120	0.0003	–126	±15	27	SOL-16	7.95
PGA2311U[1]	2-Channel, ±5 V, Low Inter-Channel Crosstalk, Voltage Swing of 7.5 V_{PP}	120	0.0002	–130	±5	7.5	SOL-16, DIP-16	3.95
PGA4311U[1]	4-Channel, ±5 V, Low Inter-Channel Crosstalk, Voltage Swing of 7.5 V_{PP}	120	0.0002	–130	±5	7.5	SOP-28	7.45

[1]U indicates U-Grade devices.
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Audio Analog-to-Digital Converters

Device	Description	ADC SNR (typ) (dB)	Inputs/ Outputs	Max Sample Rate (kHz)	Resolution (Bits)	Digital Audio Interface	Power Consumption (mW)	Package(s)	Price*
Battery-Powered									
TLV320ADC3001	92-dB SNR Low-Power Stereo ADC	92	3/0	96	24	L, R, I^2S, DSP, TDM, PCM	17	DSBGA-16	1.45
TLV320ADC3101	92-dB SNR Low-Power Stereo ADC with Digital Mic Support	92	6/0	96	24	L, R, I^2S, DSP, TDM, PCM	17	VQFN-24	1.55
PCM1870A	90-dB SNR Low-Power Stereo Audio ADC with Microphone Bias, ALC, Sound Effect, Notch Filter	90	2/0	50	16	L, R, I^2S, DSP	13	DSBGA-24	1.70
Line-Powered									
PCM4222	124-dB SNR Stereo Audio ADC with PCM/DSD and Modulator Outputs	124	2/0	216	24	L, I^2S, TDM, DSD	305	TQFP-48	14.95
PCM4220	123-dB SNR Stereo Audio ADC with PCM Output	123	2/0	216	24	L, I^2S, TDM	305	TQFP-48	9.95
PCM4202	118-dB SNR Stereo Audio ADC	118	2/0	216	24	PCM, DSD	300	SSOP-28	4.95
PCM4204	118-dB SNR 4-Channel Audio ADC	118	4/0	216	24	PCM, DSD	600	HTQFP-64	7.95
PCM1804	112-dB SNR Stereo ADC with Differential Inputs	112	2/0	192	24	L, R, I^2S, DSP	225	SSOP-28	3.95
PCM4201	112-dB SNR Low-Power Mono Audio ADC	112	1/0	108	24	PCM, DSP	40	TSSOP-16	2.50
PCM1802	105-dB SNR Stereo ADC with Single-Ended Inputs	105	2/0	96	24	L, R, I^2S	225	SSOP-20	3.35
PCM1803A	103-dB SNR Stereo ADC with Single-Ended Inputs	103	2/0	96	24	L, R, I^2S	55	SSOP-20	1.10
PCM1850A	101-dB SNR Stereo ADC with 6x2 Ch MUX and PGA	101	6 x 2/2	96	24	L, R, I^2S	160	TQFP-32	5.15
PCM1851A	101-dB SNR Stereo ADC with 6x2 Ch MUX and PGA	101	6 x 2/2	96	24	L, R, I^2S	160	TQFP-32	5.15
PCM1808	99-dB SNR Stereo ADC with Single-Ended Inputs	99	2/0	96	24	L, I^2S	62	TSSOP-14	1.00

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Audio Digital-to-Analog Converters

Device	Description	DAC SNR (typ) (dB)	Inputs/ Outputs	Max Sample Rate (kHz)	Resolution (Bits)	Digital Audio Interface	Power Consumption (mW)	IC Integration	Package(s)	Price*
Battery-Powered										
TLV320AIC3253	Ultra-Low Power Stereo Audio Codec with Embedded miniDSP	100	4/2	192	32	L, R, I^2S, TDM, DSP	4.5	miniDSP	VQFN-24, DSBGA-25	2.95
PCM1773	98-dB SNR Low-Power Stereo DAC with Line-Out (H/W Control)	98	0/2	48	24	L, I^2S	6.5	—	TSSOP-16, VQFN-20	1.35
TSC2102	"SMART" 4-Wire Touch-Screen Controller with Stereo DAC with HP Amplifier	96	0/2	53	24	I^2S, R, L, DSP	11	Touch-Screen Controller, Class-AB Speaker Amp	TSSOP-32	3.75
TLV320DAC32	Low-Power Stereo DAC with 4 Outputs, HP/Speaker Amplifier and 3-D Effects	95	2/4	96	24	L, R, I^2S, DSP, TDM	18	Class-AB Speaker Amp	QFN-32	1.35
TLV320DAC3100	Low-Power Stereo Audio DAC with Mono Class-D Speaker Amplifier	95	2/4	192	32	L, R, I^2S, TDM, DSP	13	Class-D Speaker Amp	QFN-32	1.45
TLV320DAC3101	Low-Power Stereo Audio DAC with Stereo Class-D Speaker Amplifier	95	2/4	192	32	L, R, I^2S, TDM, DSP	13	Class-D Speaker Amp	QFN-32	1.75
TLV320DAC3120	Low-Power Audio DAC with miniDSP and 2.5-W Mono Class-D Speaker Amplifier	95	2/2	192	32	L, R, I^2S, TDM, DSP	10	Class-D Speaker Amp, miniDSP	QFN-32	1.75
PCM1774	93-dB SNR Low-Power Stereo DAC with HP Amplifier (S/W Control)	93	0/2	50	16	L, R, I^2S, DSP	7	—	QFN-20	1.50
Line-Powered										
DSD1792A	132-dB SNR Highest Performance Stereo Audio DAC (S/W Control)	127	0/2	192	24	L, R, I^2S, TDMCA, DSD	205	—	SSOP-28	10.65
PCM1792A	132-dB SNR Highest Performance Stereo DAC (S/W Control)	127	0/2	192	24	L, R, I^2S, TDMCA, DSD	205	—	SSOP-28	10.65
PCM1794A	132-dB SNR Highest Performance Stereo DAC (H/W Control)	127	0/2	192	24	L, R, I^2S	205	—	SSOP-28	10.65
DSD1796	123-dB SNR Stereo DAC (S/W Control)	123	0/2	192	24	L, R, I^2S, TDMCA, DSD	115	—	SSOP-28	2.95
PCM1795	32-Bit, 192-kHz Sampling, Advanced Segment, Audio Stereo DAC	123	0/2	200	32	L, R, I^2S, TDMCA, DSD	110	—	SSOP-28	3.95
PCM1796	123-dB SNR Stereo DAC (S/W Control)	123	0/2	192	24	L, R, I^2S, TDMCA, DSD	115	—	SSOP-28	2.95
PCM1798	123-dB SNR Stereo DAC (H/W Control)	123	0/2	192	24	L, R, I^2S	115	—	SSOP-28	2.95
PCM4104	118-dB SNR 4-Channel Audio DAC	118	0/2x2	192	24	I^2S, TDM	200	—	TQFP-48	4.95
PCM1690	113-dB SNR 8-Channel Audio DAC with Differential Outputs	113	0/8	192	24	L, R, I^2S, TDM, DSP	558	—	HTSSOP-48	2.60
PCM1789	113-dB SNR Stereo DAC	113	0/2	192	24	L, R, I^2S, DSP	154	—	TSSOP-24	1.90
PCM1691	111-dB SNR 8-Channel Audio DAC with Single-Ended Output	111	0/8	192	24	L, R, I^2S, TDM, DSP	558	—	HTSSOP-48	2.50
PCM1780	106-dB SNR Stereo DAC (S/W Control)	106	0/2	192	24	L, R, I^2S	80	—	SSOP-16, QSOP	1.00
PCM1781	106-dB SNR Stereo DAC (H/W Control)	106	0/2	192	24	R, I^2S	80	—	SSOP-16, QSOP	1.10
PCM1782	106-dB SNR Stereo DAC (S/W Control)	106	0/2	192	24	L, R, I^2S	80	—	SSOP-16, QSOP	1.00
PCM1602A	105-dB SNR 6-Channel Audio DAC	105	0/6	192	24	L, R, I^2S	171	—	LQFP-48	2.80
PCM1609A	105d-B SNR 8-Channel Audio DAC	105	0/8	192	24	L, R, I^2S	224	—	LQFP-48	3.20
PCM1681	105-dB SNR 8-Channel Audio DAC with TDM Mode	105	0/8	200	24	L, R, I^2S, TDM, DSP	386	—	HTSSOP-28	1.65
PCM1606	103-dB SNR 6-Channel Audio DAC	103	0/6	192	24	L, R, I^2S, TDM	250	—	SSOP-20	2.00

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Audio Codecs

Device	Description	ADC SNR (typ) (dB)	DAC SNR (typ) (dB)	Inputs/ Outputs	Max Sample Rate (kHz)	Resolution (Bits)	Digital Audio Interface	Power Consumption (mW)	IC Integration	Package(s)	Price*
Battery-Powered											
TLV320AIC3253	Ultra-Low Power Stereo Audio Codec with Embedded miniDSP	—	100	4/2	192	32	L, R, I²S, TDM, DSP	4.5	miniDSP	VQFN-24, DSBGA-25	2.95
TLV320AIC3204	Very Low-Power Stereo Audio Codec with PowerTune™ Technology	93	100	6/4	192	32	L, R, I²S, TDM, DSP	4.1	—	QFN-32	2.25
TLV320AIC3206	Very Low-Power Stereo Audio Codec with PowerTune Technology and DirectPath™ HP Amp	93	100	6/4	192	32	L, R, I²S, TDM, DSP	5	DirectPath HP Amp	QFN-40	2.75
TLV320AIC3254	Very Low-Power Stereo Audio Codec with miniDSP and PowerTune Technology	93	100	6/4	192	32	L, R, I²S, TDM, DSP	4.1	miniDSP	QFN-32	3.95
TLV320AIC3256	Very Low-Power Stereo Audio Codec with PowerTune Technology, DirectPath HP Amp and miniDSP	93	100	6/4	192	32	L, R, I²S, TDM, DSP	5	DirectPath HP Amp, miniDSP	QFN-40, WCSP-42	4.45
TLV320AIC3101	Low-Power Stereo Codec with 6 Inputs, 6 Outputs, Speaker/HP Amp and Enhanced Digital Effects	92	102	6/6	96	24	L, R, I²S, DSP, TDM	14	Class-AB Speaker Amp	QFN-32	2.10
TLV320AIC3104	Low-Power Stereo Codec with 6 Inputs, 6 Outputs, HP Amp and Enhanced Digital Effects	92	102	6/6	96	24	L, R, I²S, DSP, TDM	14	—	QFN-32	1.95
TLV320AIC3105	Low-Power Stereo Codec with 6 Inputs, 6 Outputs, HP Amp and Enhanced Digital Effects	92	102	6/6	96	24	L, R, I²S, DSP, TDM	14	—	QFN-32	1.95
TLV320AIC3106	Low-Power Stereo Codec with 10 Inputs, 7 Outputs, HP Amplifier and Enhanced Digital Effects	92	102	10/7	96	24	L, R, I²S, DSP, TDM	14	—	VQFN-48, BGA-80 MicroStar Junior™	2.25
TLV320AIC3107	Low-Power Stereo Codec with Integrated Mono Class-D Amplifier	92	97	7/6	96	24	L, R, I²S, DSP, TDM	14	Class-D Speaker Amp	WQFN-40, DSBGA-42	2.55
TLV320AIC36	Low-Power Stereo Audio Codec for Portable Audio/Telephony	92	100	8/8	192	32	L, R, I²S, TDM, DSP	10	miniDSP	BGA-80 MicroStar Junior™	4.25
TLV320AIC3100	Low-Power Audio Codec with 2.5-W Mono Class-D Speaker Amplifier	91	95	3/3	192	32	L, R,I²S, TDM, DSP	13	Class-D Speaker Amp	QFN-32	1.95
TLV320AIC3110	Low-Power Audio Codec with 1.3-W Stereo Class-D Speaker Amplifier	90	95	3/4	192	32	L, R, I²S, TDM, DSP	13	Class-D Speaker Amp	QFN-32	2.25
TLV320AIC3111	Low-Power Audio Codec with Embedded miniDSP and Stereo Class-D Speaker Amplifier	90	95	3/4	192	32	L, R, I²S, TDM, DSP	13	Class-D Speaker Amp miniDSP	QFN-32	2.95
TLV320AIC3120	Low-Power Audio Codec with miniDSP and 2.5-W Mono Class-D Speaker Amp	90	95	3/2	192	32	L, R, I²S, TDM, DSP	10	Class-D Speaker Amp	QFN-32	2.25
TSC2117	4-Wire Touch-Screen Controller with Low-Power Mono ADC/Stereo DAC	90	95	3/4	192	24	I²S, R, L, TDM, DSP	13	Touch-Screen Controller, Class-D Speaker Amp, miniDSP	VQFN-48	5.15
TSC2100	"SMART" 4-Wire Touch-Screen Controller with Stereo DAC/Mono ADC with HP/Speaker Amplifier	88	96	2/2	53	24	I²S, R, L, DSP	11	Touch-Screen Controller, Class-AB Speaker Amp	QFN-32, TSSOP-32	3.70
TSC2101	"SMART" 4-Wire Touch-Screen Controller, St. DAC/Mono ADC with HP/Speaker Amplifier	88	95	6/5	53	24	I²S, R, L, DSP	11	Touch-Screen Controller, Class-AB Speaker Amp	VQFN-48	4.50
TSC2111	"SMART" 4-Wire Touch-Screen Controller, St. DAC/Mono ADC, 6 Audio Inputs and HP/Speaker Amplifier	88	95	6/5	53	24	I²S, R, L, DSP	19	Touch-Screen Controller, Class-AB Speaker Amp	VQFN-48	4.35
TLV320AIC3007	Low-Power Stereo Codec with Integrated Class-D Amplifier	87	93	7/6	96	24	L, R, I²S, TDM, DSP	15	Class-D Speaker Amp	WQFN-40	2.35
TLV320AIC12K	Low-Power Mono Voice Band Codec with 8-Ω Speaker Amplifier	84	92	3/3	26	16	DSP, SMART TDM	11.2	Class-AB Speaker Amp	TSSOP-30, QFN-32	1.60

Suggested resale price in U.S. dollars in quantities of 1,000.

*New products are listed in **bold red**.*

Audio Codecs (Continued)

Device	Description	ADC SNR (typ) (dB)	DAC SNR (typ) (dB)	Inputs/ Outputs	Max Sample Rate (kHz)	Resolution (Bits)	Digital Audio Interface	Power Consumption (mW)	IC Integration	Package(s)	Price*
Battery-Powered (Continued)											
TLV320AIC24K	Low-Power Stereo Voice Band Codec	84	92	5/3	26	16	DSP, SMART TDM	20	—	TQFP-48	2.45
TLV320AIC1106	PCM Codec With Microphone Amps and Speaker Driver	62	68	1/1	8	13	PCM	13.5	—	TSSOP-20	2.70
Line-Powered											
PCM3168A	24-Bit Multichannel Audio Codec 6 Ch-In/ 8 Ch-Out with 96/192-kHz Sampling Rate	107	112	6/8	192	24	R, L, I^2S, TDM, DSP	1160	—	HTQFP-64	5.00
PCM3052A	24-Bit Stereo Audo Codec with Mic Amp, Bias, MUX and PGA	101	105	2/2	96	24	I^2S	228	—	VQFN-32	3.00
PCM3060	24-Bit Asynchronous Stereo Audio Codec with 96/192kHz Sampling Rate	99	105	2/2	192	24	R, L, I^2S	160	—	TSSOP-28	2.10
PCM5310	4 Ch/4 Ch Audio Codec with 2-V_{RMS} Driver	95	100	12/6	192	24	I^2S, LJ, RJ	360	—	HTQFP-64	3.40

Device	Description	Sample Rate (kHz)	Number of Input Channel(s)	SNR DAC (dB)	SNR ADC (dB)	Interface	Analog Supply (V)	Logic Supply (V)	Power Supply (typ) (mW)	Package(s)	Price*
Voiceband Codecs											
AIC111	Lowest Power, 20-Bit	40	1	87	87	SPI , DSP	1.1 to 1.5	+1.1 to +3.3	0.46	QFN-32, FlipChip	5.20
TLV320AIC12K	Low Power, Mono Codec, 16-Bit, 26-kSPS Voiceband Codec with 8W Driver	26	1	90	92/84	I^2C, S^2C, DSP	1.65 to 1.95/2.7 to 3.6	+1.1 to +3.6	10	TSSOP-30	1.60
TLV320AIC14K	Low Power, Mono Codec, 16-Bit, 26-kSPS Voiceband Codec	26	1	90	92/84	I^2C, S^2C, DSP	1.65 to 1.95/2.7 to 3.6	+1.1 to +3.6	10	TSSOP-30	1.35
TLV320AIC20K	Low Power, Stereo Codec, 16-Bit, 26-kSPS Voiceband Codec with 8W Driver	26	2	90	92/84	I^2C, S^2C, DSP	1.65 to 1.95/2.7 to 3.6	+1.1 to +3.6	20	TQFP-48	2.70
TLV320AIC24K	Low Power, Stereo Codec, 16-Bit, 26-kSPS Voiceband Codec	26	2	90	92/84	I^2C, S^2C, DSP	1.65 to 1.95/2.7 to 3.6	+1.1 to +3.6	20	TQFP-48	2.45

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Audio Converters with Integrated Touch-Screen Controller

Device	Description	Resolution (max) (Bits)	Dynamic Range DAC (dB)	Dynamic Range ADC (dB)	Sampling Rate (max) (kHz)	Configuration	Audio Data Format	Power Supply (V)	Package(s)	Price*
TSC2117	4-Wire Touch-Screen Interface, Low Power, Integrated PLL, HP Amp, Stereo Class-D Speaker Amplifier, MiniDSP	32	95	91	192	Mono/Stereo	I^2S, L, R, DSP, TDM	+2.7 to +3.6	QFN-48	4.45
TSC2100	4-Wire Touch-Screen Interface, Low Power, Lower Cost, Stereo DAC, Mono ADC, Integrated PLL, Speaker/HP Amp	24	97	88	53	Mono/Stereo	Normal, I^2S, DSP	+2.7 to +3.6	QFN-32, TSSOP-32	3.05
TSC2102	4-Wire Touch-Screen Interface, Low Power, Stereo DAC, Integrated PLL, Speaker/HP Amp, Low Cost	24	97	—	53	Stereo	Normal, I^2S, DSP	+2.7 to +3.6	TSSOP-32	2.50
TSC2111	4-Wire Touch-Screen Interface, Low Power, Stereo DAC, Mono ADC, Integrated PLL, Speaker/HP Amp, Additional Inputs and Outputs (TSC2111 – Differential)	24	95	88	53	Mono/Stereo	Normal, I^2S, DSP	+2.7 to +3.6	QFN-48	3.75
TSC2300	4-Wire Touch-Screen Interface, Low Power, Stereo DAC, Mono ADC, Integrated PLL	20	98	88	48	Mono/Stereo	Normal, I^2S	+2.7 to +3.6	TQFP-64	4.45
TSC2301	4-Wire Touch-Screen Interface, Low Power, Stereo DAC, Stereo ADC, Integrated PLL, HP Amp, 4 x 4 Keypad Interface	20	98	88	48	Stereo/Stereo	Normal, I^2S	+2.7 to +3.6	TQFP-64, BGA-120	4.65
TSC2302	4-Wire Touch-Screen Interface, Low Power, Stereo DAC, Stereo ADC, Integrated PLL, HP Amp	20	98	88	48	Stereo/Stereo	Normal, I^2S	+2.7 to +3.6	QFN-48	4.55

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Interface and Sample-Rate Converters

Device	Description	No. of SRC Channels	THD+N (dB)	Sample Rate (max)	Inputs	Digital Audio Interface	Control Interface	Dynamic Range (dB)	AES Receive/ Transmit	Power Supply (V)	Package(s)	Price*
S/PDIF/AES3 Transmitter												
DIT4192	192-kHz Digital Audio Transmitter	—	—	192	—	AES/EBU, S/PDIF, I^2S, R, L	H/W, SPI	—	—/Yes	3.3, 5.0	TSSOP-28	1.95
DIT4096	96-kHz Digital Audio Transmitter	—	—	96	—	AES/EBU, S/PDIF, I^2S, R, L	H/W, SPI	—	—/Yes	3.3, 5.0	TSSOP-28	1.65
S/PDIF/AES3 Receiver												
DIR9001	96-kHz Digital Audio Receiver	—	—	96	—	AES/EBU, S/PDIF, I^2S, R, L	H/W	—	Yes/No	3.3	TSSOP-28	2.10
S/PDIF/AES3 Transceiver												
DIX4192	Digital Audio Interface Transceiver	—	—	216	4 differential inputs	AES/EBU, S/PDIF, I^2S, R, L	I^2S, SPI	—	Yes/Yes	2.9, 3.7	TQFP-48	3.95
DIX9211	Digital Audio Interface Transceiver	—	—	216	Up to 12 single-ended inputs	AES/EBU, S/PDIF, I^2S, R, L	I^2S, SPI	—	Yes/Yes	2.9, 3.6	LQFP-48	2.95
Sample-Rate Converter												
SRC4382	Combo Sample-Rate Converter	2	–125	216	—	AES/EBU, S/PDIF, I^2S, R, L	I^2S, SPI	128	Yes/Yes	1.8, 3.3	TQFP-48	6.50
SRC4392	High-End Combo Sample-Rate Converter	2	–140	216	—	AES/EBU, S/PDIF, I^2S, R, L	I^2S, SPI	144	Yes/Yes	1.8, 3.3	TQFP-48	8.50
SRC4184	4-Channel, Asynchronous Sample-Rate Converter	4	–125	212	—	I^2S, R, L, TDM	SPI	128	—	1.8, 3.3	TQFP-64	5.95
SRC4190	192-kHz Stereo, Asynchronous Sample-Rate Converter	2	–125	212	—	I^2S, R, L, TDM	H/W	128	—	3.3	SSOP-28	3.50
SRC4192	High-End Sample-Rate Converter	2	–140	212	—	I^2S, R, L, TDM	H/W	144	—	3.3	SSOP-28	5.95
SRC4193	High-End Sample-Rate Converter	2	–140	212	—	I^2S, R, L, TDM	SPI	144	—	3.3	SSOP-28	5.95
SRC4194	4-Channel, Asynchronous Sample-Rate Converter	4	–140	212	—	I^2S, R, L, TDM	SPI	144	—	1.8, 3.3	TQFP-64	9.95

**Suggested resale price in U.S. dollars in quantities of 1,000.*

2.4-GHz PurePath™ Wireless Audio SoCs

Device	Number of Wireless Audio Channels	Number of Audio Slaves per Master	Standby Current (µA)	Power Consumption (RX) (mA)[1]	Power Consumption (TX) (mA)[1]	Data Rate (max) (Mbps)	Frequency Range (GHz)	TX Power with/ without CC2590 (dBm)	Price*
CC8520	1 to 2	4	1	25	29	5	2.4	+10/+4	3.75
CC8530	3 to 4	4	1	25	29	5	2.4	+10/+4	3.95

[1]Streaming PCM16 uncompressed stereo audio, operating voltage 2.0 V without CC2590.
**Suggested resale price in U.S. dollars in quantities of 1,000.*

USB Audio

Device	Description	Max USB Speed	Application Processor Interface	ESD HBM (kV)	Package(s)	Price*
USB Transceivers (PHYs)						
TUSB1105	Advanced USB Full-Speed Transceiver	Full	Single or Differential	±15	16-QFN	0.55
TUSB1106	Advanced USB Full-Speed Transceiver	Full	Differential	±15	16-QFN, 16-TSSOP	0.55
TUSB1210	USB 2.0 ULPI Transceiver	High	ULPI	±2	32-QFN	Call
TUSB1211	USB 2.0 ULPI Transceiver with USB Charger Detection	High	ULPI	±2	36-BGA	Call
TUSB1310	SuperSpeed USB Transceiver	SuperSpeed	ULPI and PIPE3	±2	167-BGA	6.00
TUSB2551A	Advanced USB Full-Speed Transceiver	Full	Single	±15	16-QFN	0.55

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**. Preview products are listed in **bold blue**.*

USB Audio (Continued)

Device	Description	Resolution (Bits)	Power Supply (V)	SNR (typ) (dB)	Pd (typ) (mW)	Sampling Rate (max) (kHz)	Package(s)	Price*
Stereo USB DACs								
PCM2702	Low-Power, High-Performance USB DAC	16	3.3, 5	105	175	48	SSOP-28	5.80
PCM2704	Low Power, External EEPROM Interface	16	3.3, 5	98	175	48	SSOP-28	2.75
PCM2705	Low Power, SPI Interface	16	3.3, 5	98	175	48	SSOP-28	2.75
PCM2706	Low Power, Selectable I^2C Interface/HD Mode	16	3.3, 5	98	175	48	TQFP-32	3.60
PCM2707	Low Power, SPI Interface, Selectable I^2C Interface	16	3.3, 5	98	175	48	TQFP-32	3.60

Device	Description	SNR (typ) (dB)	Power Supply (V)	Pd (typ) (mW)	Sampling Rate (max) (kHz)	Package(s)	Price*
USB Codecs							
PCM2900B	5-V Stereo Codec	89	2.7 to 5.5	280	48	SSOP-28	4.45
PCM2901	5-V Stereo Codec, S/PDIF Interface	89	3.3	178	48	SSOP-28	4.45
PCM2902B	3.3-V Stereo Codec	89	2.7 to 5.5	280	48	SSOP-28	4.80
PCM2903B	3.3-V Stereo Codec, S/PDIF Interface	89	3.3	178	48	SSOP-28	4.80
PCM2904	5-V Stereo Codec, Full 500-mA USB Bus Power	89	4.35 to 5.25	280	48	SSOP-28	4.45
PCM2906B	5-V Stereo Codec, S/PDIF Interface, Full 500-mA USB Bus Power	89	4.35 to 5.25	280	48	SSOP-28	4.80
PCM2912A	USB-Headset Codec, Mono ADC, Stereo DAC, Integrated Mic Pre and Headphone Amp	89	4.35 to 5.25	425	48	TQFP-32	4.50

Suggested resale price in U.S. dollars in quantities of 1,000.

Processors

Device	Description	Digital I/O	Input FS (kHz)	Processing Bits/ Accumulator	I/O Max Resolution (Bits)	Package(s)	Price*
Digital Audio Processors							
TAS3103A	Configurable Volume, Bass, Treble, Loudness, DRC, Mixing, Delay, 3-D Effects, Biquad Filters	4/3	8 to 96	48/76	32	PSOP-32	4.15
TAS3108	Fully-Programmable, 135-MHz, 48-Bit, 8-Channel Processor	8/8	16 to 192	48/76	24	TSSOP-38	5.10
TAS3108IA	Fully-Programmable, 135-MHz, 48-Bit, 8-Channel Processor (Automotive Qualified)	8/8	16 to 192	48/76	24	TSSOP-38	5.75

Device	Description	Stereo Input MUX	Number of ADCs/DNR (dB)	Number of DACs/DNR (dB)	Number of PWMs/DNR	Package(s)	Price*
Digital Audio SoCs							
TAS3202	Fully Programmable, 135-MHz, 48-Bit, 8-Channel Processor with Integrated Analog I/O	2:1	2/102	2/105	—	TQFP-64	5.65
TAS3204	Fully Programmable, 135-MHz, 48-Bit, 8-Channel Processor with Integrated Analog I/O	3:1 (x2)	4/102	4/105	—	TQFP-64	6.15
TAS3208	Fully Programmable, 135-MHz, 48-Bit, 8-Channel Processor with Integrated Analog I/O	10:1	2/93	6/96	—	TQFP-100	6.50
TAS3308	Fully Programmable, 135-MHz, 48-Bit, 8-Channel Processor with Integrated Analog I/O	10:1	2/96	—	6/100 dB	TQFP-100	6.60

Suggested resale price in U.S. dollars in quantities of 1,000.

Processors (Continued)

Device	CPU	Frequency (MHz)	L1P (Bytes)	L1D (Bytes)	L2 (Bytes)	RAM (Bytes)	External Memory I/F	DMA	Timers	Serial Ports	Misc.	Voltage (V) Core	I/O	Package(s)	Price*
OMAP-L13x Applications Processors															
OMAP-L137BZKB3[1]	ARM926EJS, C674x	456 456	16K 32K	16K 32K	256K	128K Shared	SDRAM, NAND, NOR	32 Ch	1 GP, 1 GP/WD	USB 2.0 HS OTG, USB 1.1, 3 McASP, 2 SPI, 2 I²C, 3 UART	10/100 Ethernet MAC, MMC/SD, 3 PWMs, LCD controller, 3 eCAP, 2 eQEP, UHPI	1.2	1.8/ 3.3	17 mm, BGA-256	16.35
OMAP-L138BZCE3[1]	ARM926EJS, C674x	456 456	16K 32K	16K 32K	256K	128K Shared	DDR2, mDDR, NAND, NOR, SDRAM	64 Ch	3 GP, 1 GP/WD	USB 2.0 HS OTG, USB 1.1, 1 McASP, 2 McBSP, 2 I²C, 3 UART 2 SPI,	10/100 Ethernet MAC, 2 MMC/SD, 2 PWMs, LCD controller, video interface, UPI, SATA, 3 eCAP	1.0 – 1.2	1.8/ 3.3	13 mm, 0.65-mm pitch, BGA-361	18.60
OMAP-L138BZWT3[1]	ARM926EJS, C674x	456 456	16K 32K	16K 32K	256K	128K Shared	DDR2, mDDR, NAND, NOR, SDRAM	64 Ch	3 GP, 1 GP/WD	USB 2.0 HS OTG, USB 1.1, 1 McASP, 2 McBSP, 2 I²C, 3 UART 2 SPI,	10/100 Ethernet MAC, 2 MMC/SD, 2 PWMs, LCD controller, video interface, UPI, SATA, 3 eCAP	1.0 – 1.2	1.8/ 3.3	16 mm, 0.8-mm pitch, BGA-361	18.60

[1]Devices with an extended temperature range are available.
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Device	RAM (Bytes) Data/Prog	McBSP	McASP	DMA	COM	SPI/ I²C	MHz	MFLOPS	Typical Activity Total Internal Power (W) (Full Device Speed)	Voltage (V) Core	I/O	Package(s)	Price*
TMS320C67x™ DSP Generation — Floating-Point DSPs													
TMS320**C6720B**RFP200[4]	32K/64K/384K[6]	—	2	dMAX[2]	—	2/2	200	1200	See Datasheet	1.2	3.3	22mm PQFP-144	7.53†
TMS320**C6712D**GDP150	4K/4K/64K[1]	2	—	16[2]	—	—	150	900	See Datasheet	1.2	3.3	27mm BGA-272	15.16†
TMS320**C6722B**RFP200[3,4]	32K/128K/384K[6]	—	2	dMAX	—	2/2	200	1200	See Datasheet	1.2	3.3	22mm PQFP-144	11.14†
TMS320**C6722B**RFPA225[3,4,5]	32K/128K/384K[6]	—	2	dMAX	—	2/2	225	1350	See Datasheet	1.2	3.3	22mm PQFP-144	12.94†
TMS320**C6722B**RFP250[3,4]	32K/128K/384K[6]	—	2	dMAX	—	2/2	250	1500	See Datasheet	1.2	3.3	22mm PQFP-144	12.94†
TMS320**C6726B**RFPA225[3,4,5]	32K/256K/384K[6]	—	37[8]	dMAX	—	2/2	225	1350	See Datasheet	1.2	3.3	22mm PQFP-144	16.68†
TMS320**C6726B**RFP266[4]	32K/256K/384K[7]	—	3[7]	dMAX	—	2/2	266	1600	See Datasheet	1.2	3.3	22mm PQFP-144	16.68†
TMS320**C6713B**PYP200	4K/4K/256K[2]	2[9]	2[8]	16[2]	HPI/16	—	200	1200	See Datasheet	1.2	3.3	28mm TQFP-208	20.95†
TMS320**C6727B**ZDH250	32K/256K/384K	—	3	dMAX	UHPI	2/2	250	1500	See Datasheet	1.2	3.3	17mm BGA-256	19.74†
TMS320**C6727B**ZDHA250[3,4,5]	32K/256K/384K[6]	—	3	dMAX	UHPI	2/2	250	1500	See Datasheet	1.2	3.3	17mm BGA-256	23.58†
TMS320**C6727B**ZDH275[3,4]	32K/256K/384K[6]	—	3	dMAX	UHPI	2/2	275	1650	See Datasheet	1.2	3.3	17mm BGA-256	20.84†
TMS320**C6727B**ZDH300[3,4,9]	32K/256K/384K[6]	—	3	dMAX	UHPI	2/2	300	1800	See Datasheet	1.2	3.3	17mm BGA-256	23.58†
TMS320**C6727B**ZDH350	32K/256K/384K	—	3	dMAX	UHPI	2/2	350	2100	See Datasheet	1.4	3.3	17mm BGA-256	32.29†
TMS320**C6701G**JC150	64K/64K	2	—	4	HPI/16	—	120	900	See Datasheet	1.8	3.3	35mm BGA-352	95.34†
TMS320**C6701G**JC16719V	64K/64K	2	—	4	HPI/16	—	167	1000	See Datasheet	1.9	3.3	35mm BGA-352	144.52†
TMS320**C6748B**ZCE3	32K/256K/128K	2	1	64 Ch	UHPI	2/2	375	3000	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	15.20
TMS320**C6748B**ZWT3[11]	32K/256K/128K	2	1	64 Ch	UHPI	2/2	375	3000	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	15.20
TMS320**C6748B**ZCEA3[11]	32K/256K/128K	2	1	32/16 Bit	UHPI	2/2	375	3000	See Datasheet	1.2	3.3	16mm BGA-361	18.25
TMS320**C6748B**ZWTA3[11]	32K/256K/128K	2	1	64 Bit	UHPI	2/2	375	3000	See Datasheet	1.2	3.3	16mm BGA-361	18.25
TMS320**C6748B**ZCE4	32K/256K/128K	2	1	64 Bit	UHPI	2/2	456	3648	See Datasheet	1.2	3.3	16mm BGA-361	18.25
TMS320**C6748B**ZCED4	32K/256K/128K	1	1	64 Bit	UHPI	2/2	456	3648	See Datasheet	1.2	3.3	16mm BGA-361	20.55
TMS320**C6748B**ZWT4	32K/256K/128K	2	1	64 Bit	UHPI	2/2	456	3648	See Datasheet	1.2	3.3	16mm BGA-361	18.25
TMS320**C6748B**ZWTD4[10]	32K/256K/128K	2	1	64 Bit	UHPI	2/2	456	3648	See Datasheet	1.2	3.3	16mm BGA-361	20.55
TMS320**C6747B**ZKB3	32K/256K/128K	2	3	32/16 Bit	UHPI	2/2	375	3000	See Datasheet	1.2	3.3	16mm BGA-361	13.00

[1]Format represents cache memory architecture: [data cache] /[program cache] / [unified cache].
[2]Enhanced DMA.
[3]Extended temperature versions available for C6722, C6726, C6727, C6713, C6711D DSPs.
[4]RFP and ZDH packages are Pb-Free.
[5]The "A" designation is for extended temperature range of –40°C to 105°C.
[6]Format represents program cache/program or data memory/ROM.
[7]McASP2 DIT only.
[8]The C6713 DSP can be configured to have up to three serial ports in various McASP/McBSP combinations by not utilizing the HPI. Other configurable serial options include I²C and additional GPIO.
[9]Also available in 256-pin BGA, 17-mm (GDH) package.
[10]The designation "D4" is for industrial temperature range of –40°C to 90°C.
[11]The designations "A3, T2 and T3" are for automotive temperature range of –40°C to 125°C.
Note: All devices include two timers.
Note: Enhanced plastic and military DSP versions are available for selected DSPs.
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Processors (Continued)

Device	RAM (Bytes) Data/Prog	McBSP	McASP	DMA	COM	SPI/ I²C	MHz	MFLOPS	Typical Activity Total Internal Power (W) (Full Device Speed)	Voltage (V) Core	I/O	Package(s)	Price*
TMS320C67x™ DSP Generation — Floating-Point DSPs (Continued)													
TMS320**C6747B**ZKB4	32K/256K/128K	—	3	32/16 Bit	UHPI	2/2	456	3648	See Datasheet	1.2	3.3	17mm BGA-256	15.60
TMS320**C6747B**ZKBA3[11]	32K/256K/128K	—	3	32/16 Bit	UHPI	2/2	375	3000	See Datasheet	1.2	3.3	17mm BGA-256	15.60
TMS320**C6747B**ZKBD4[10]	32K/256K/128K	—	3	32/16 Bit	UHPI	2/2	456	3648	See Datasheet	1.2	3.3	17mm BGA-256	17.55
TMS320**C6747B**ZKBT3[11]	32K/256K/128K	—	2	32/16 Bit	UHPI	2/2	375	3648	See Datasheet	1.2	3.3	17mm BGA-256	15.60
TMS320**C6746B**ZCE3	32K/32K/256K	2	1	64 Ch	UHPI	2/2	375	1800	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	13.50
TMS320**C6746B**ZWT3[11]	32K/32K/256K	2	1	64 Ch	UHPI	2/2	375	1800	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	13.50
TMS320**C6746B**ZCE4	32K/32K/256K	2	1	64 Ch	UHPI	2/2	456	3648	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	15.00
TMS320**C6746B**ZCEA3[11]	32K/32K/256K	2	1	64 Ch	UHPI	2/2	375	3000	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	15.00
TMS320**C6746B**ZCED4[10]	32K/32K/256K	2	1	64 Ch	UHPI	2/2	456	3648	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	16.90
TMS320**C6746B**ZWTA3[11]	32K/32K/256K	2	1	64 Ch	UHPI	2/2	375	3000	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	15.00
TMS320**C6746B**ZWTD4[10]	32K/32K/256K	2	1	64 Ch	UHPI	2/2	456	3648	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	16.90
TMS320**C6745B**PTP3	32K/32K/256K	—	2	32 Bit	—	2/2	375	1800	See Datasheet	1.2	3.3	24mm QFP-176	11.25
TMS320**C6745B**PTP4	32K/32K/256K	—	2	32 Bit	—	2/2	456	3648	See Datasheet	1.2	3.3	24mm QFP-176	13.50
TMS320**C6745B**PTPA3[11]	32K/32K/256K	—	2	32 Bit	—	2/2	375	3000	See Datasheet	1.2	3.3	24mm QFP-176	13.50
TMS320**C6745B**PTPD4[10]	32K/32K/256K	—	2	32 Bit	—	2/2	456	3648	See Datasheet	1.2	3.3	24mm QFP-176	15.20
TMS320**C6745B**PTPT3[11]	32K/32K/256K	—	2	32 Bit	—	2/2	375	3000	See Datasheet	1.2	3.3	24mm QFP-176	15.20
TMS320**C6743B**PTPT3[11]	32K/32K/128K	—	2	32 Ch	—	1/2	375	3000	See Datasheet	1.2	3.3	24mm QFP-176	10.55
TMS320**C6743B**PTPT2[11]	32K/32K/128K	—	2	32 Ch	—	1/2	200	1600	See Datasheet	1.2	3.3	24mm QFP-176	9.40
TMS320**C6743B**PTP3	32K/32K/128K	—	2	32 Ch	—	1/2	375	3000	See Datasheet	1.2	3.3	24mm QFP-176	8.95
TMS320**C6743B**PTP2	32K/32K/128K	—	2	32 Ch	—	1/2	200	1600	See Datasheet	1.2	3.3	24mm QFP-176	7.80
TMS320**C6743B**ZKB3	32K/32K/128K	—	2	32 Ch[2]	—	1/2	375	1800	See Datasheet	1.2	3.3	17mm BGA-256	8.95
TMS320**C6743B**ZKBT3[11]	32K/32K/128K	—	2	32 Ch[2]	—	1/2	200	1600	See Datasheet	1.2	3.3	17mm BGA-256	7.80
TMS320**C6742B**ZCE2	32K/32K/64K	1	1	64 Ch	—	1/1	200	1600	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	6.70
TMS320**C6742B**ZCEA2	32K/32K/64K	1	1	64 Ch	—	1/1	200	1600	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	8.05
TMS320**C6742B**ZWT2	32K/32K/64K	1	1	64 Ch	—	1/1	200	1600	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	6.70
TMS320**C6742B**ZWTA2	32K/32K/64K	1	1	64 Ch	—	1/1	200	1600	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	8.05

[1]Format represents cache memory architecture: [data cache] /[program cache] / [unified cache].
[2]Enhanced DMA.
[3]Extended temperature versions available for C6722, C6726, C6727, C6713, C6711D DSPs.
[4]RFP and ZDH packages are Pb-Free.
[5]The "A" designation is for extended temperature range of –40°C to 105°C.
[6]Format represents program cache/program or data memory/ROM.
[7]McASP2 DIT only.
[8]The C6713 DSP can be configured to have up to three serial ports in various McASP/McBSP combinations by not utilizing the HPI. Other configurable serial options include I²C and additional GPIO.
[9]Also available in 256-pin BGA, 17-mm (GDH) package.
[10]The designation "D4" is for industrial temperature range of –40°C to 90°C.
[11]The designations "A3, T2 and T3" are for automotive temperature range of –40°C to 125°C.
Note: All devices include two timers.
Note: Enhanced plastic and military DSP versions are available for selected DSPs.
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TMS320C2000™ Microcontrollers

Device[1]	Processor			Memory			Control Interfaces							Communications Ports							Core Supply (V)	GPIO Pins	On-Chip Oscillator/ Regulator	Package(s)	Price*
	Speed (MHz)	FPU	CLA	RAM (kB)	Flash (kB)	ROM (kB)	PWM Channels	HiRes PWM	Quadrature Encoder	Event Captures	Timers[2]	12-Bit ADC Channels/ Conversion Time (ns)	Comparators	McBSP	I^2C	UART/SCI	SPI	LIN	CAN	External Memory Bus					
2803x Piccolo™ MCUs																									
TMS320F28035	60	—	Yes	20	128	Boot	9-15	4-7	1	1	11-12	14-16/217	3	—	1	1	1-2	1	1	—	3.3	33-45	Yes/Yes	TQFP-64, LQFP-80	4.41
TMS320F28034	60	—	—	20	128	Boot	9-15	4-7	1	1	11-12	14-16/217	3	—	1	1	1-2	1	1	—	3.3	33-45	Yes/Yes	TQFP-64, LQFP-80	3.75
TMS320F28033	60	—	Yes	20	64	Boot	9-15	4-7	1	1	11-12	14-16/217	3	—	1	1	1-2	1	1	—	3.3	33-45	Yes/Yes	TQFP-64, LQFP-80	4.11
TMS320F28032	60	—	—	20	64	Boot	9-15	4-7	1	1	11-12	14-16/217	3	—	1	1	1-2	1	1	—	3.3	33-45	Yes/Yes	TQFP-64, LQFP-80	3.49
TMS320F28031	60	—	—	16	64	Boot	13-15	—	1	1	11-12	14-16/500	3	—	1	1	1-2	1	1	—	3.3	33-45	Yes/Yes	TQFP-64, LQFP-80	2.97
TMS320F28030	60	—	—	12	32	Boot	13-15	—	1	1	11-12	14-16/500	3	—	1	1	1-2	1	1	—	3.3	33-45	Yes/Yes	TQFP-64, LQFP-80	2.79
2802x Piccolo MCUs																									
TMS320F28027	60	—	—	12	64	Boot	9	4	0	1	9	7-13/217	1-2	—	1	1	1	—	—	—	3.3	20-22	Yes/Yes	TSSOP-38, LQFP-48	2.85
TMS320F28026	60	—	—	12	32	Boot	9	4	0	1	9	7-13/217	1-2	—	1	1	1	—	—	—	3.3	20-22	Yes/Yes	TSSOP-38, LQFP-48	2.65
TMS320F28023	50	—	—	12	64	Boot	9	4	0	1	9	7-13/260	1-2	—	1	1	1	—	—	—	3.3	20-22	Yes/Yes	TSSOP-38, LQFP-48	2.45
TMS320F28022	50	—	—	12	32	Boot	9	4	0	1	9	7-13/260	1-2	—	1	1	1	—	—	—	3.3	20-22	Yes/Yes	TSSOP-38, LQFP-48	2.25
TMS320F28021	40	—	—	10	64	Boot	9	—	0	1	9	7-13/500	1-2	—	1	1	1	—	—	—	3.3	20-22	Yes/Yes	TSSOP-38, LQFP-48	2.20
TMS320F28020	40	—	—	6	32	Boot	9	—	0	1	9	7-13/500	1-2	—	1	1	1	—	—	—	3.3	20-22	Yes/Yes	TSSOP-38, LQFP-48	1.99
TMS320F280200	40	—	—	4	16	Boot	8	—	—	—	8	7-13/500	1-2	—	1	1	1	—	—	—	3.3	20-22	Yes/Yes	TSSOP-38, LQFP-48	1.85
2806x Piccolo (Floating Point) MCUs																									
TMS320F2806x	80	Yes	—	52-100	128-256	Boot	15-19	6-8	1-2	3-7	13-15	12-16/325	3	1	1	1-2	2	0	1	—	3.3	40-54	Yes/Yes	LQFP-80, LQFP-100	4.95-9.50
283x Delfino™ (Floating Point) MCUs																									
TMS320C28346	300	Yes	—	516	—	Boot	24	9	3	6	19	—	—	2	1	3	2	—	2	16 or 32-bit	1.2	88	—	BGA-256	16.39
TMS320C28345	200	Yes	—	516	—	Boot	24	9	3	6	19	—	—	2	1	3	2	—	2	16 or 32-bit	1.1	88	—	BGA-256, BGA-179	14.42
TMS320C28344	300	Yes	—	260	—	Boot	24	9	3	6	19	—	—	2	1	3	2	—	2	16 or 32-bit	1.2	88	—	BGA-256	12.78
TMS320C28343	200	Yes	—	260	—	Boot	24	9	3	6	19	—	—	2	1	3	2	—	2	16 or 32-bit	1.1	88	—	BGA-256, BGA-179	11.25
TMS320C28342	300	Yes	—	196	—	Boot	16	6	2	4	14	—	—	1	1	3	2	—	2	16 or 32-bit	1.2	88	—	BGA-256	10.17
TMS320C28341	200	Yes	—	196	—	Boot	16	6	2	4	14	—	—	1	1	3	2	—	2	16 or 32-bit	1.1	88	—	BGA-256, BBGA-179	8.95
TMS320F28335	150	Yes	—	68	512	Boot	18	6	2	6	16	16/80	—	2	1	3	1	—	2	16 or 32-bit	1.9	88	—	BGA-179, LQFP-176	15.65
TMS320F28334	150	Yes	—	68	256	Boot	16	6	2	4	14	16/80	—	2	1	3	1	—	2	16 or 32-bit	1.9	88	—	BGA-179, LQFP-176	14.75
TMS320F28332	100	Yes	—	52	128	Boot	16	4	2	4	14	16/80	—	1	1	2	1	—	2	16 or 32-bit	1.9	88	—	BGA-179, LQFP-176	13.85
28x Fixed Point MCUs																									
TMS320F28235	150	Yes	—	68	512	Boot	18	6	2	6	16	16/80	—	2	1	3	1	—	2	16 or 32-bit	1.9	88	—	BGA-179, LQFP-176	14.55
TMS320F28234	150	Yes	—	68	256	Boot	16	6	2	4	14	16/80	—	2	1	3	1	—	2	16 or 32-bit	1.9	88	—	BGA-179, LQFP-176	13.72
TMS320F28232	100	Yes	—	52	128	Boot	16	4	2	4	14	16/80	—	1	1	2	1	—	2	16 or 32-bit	1.9	88	—	BGA-179, LQFP-176	12.88
TMS320F2812	150	—	—	36	256	Boot	16	—	2	6	8	16/80	—	1	—	2	1	—	1	16-bit	1.9	56	—	BGA-179, LQFP-176	15.75
TMS320F2811	150	—	—	36	256	Boot	16	—	2	6	8	16/80	—	1	—	2	1	—	1	—	1.9	56	—	LQFP-128	14.75
TMS320F2810	150	—	—	36	128	Boot	16	—	2	6	8	16/80	—	1	—	2	1	—	1	—	1.9	56	—	LQFP-128	13.85
TMS320F2809	100	—	—	36	256	Boot	16	6	2	4	14	16/80	—	—	1	2	4	—	2	—	1.8	35	—	BGA-100, LQFP-100	12.95
TMS320F2808	100	—	—	36	128	Boot	16	4	2	4	14	16/160	—	—	1	2	4	—	2	—	1.8	35	—	BGA-100, LQFP-100	11.60
TMS320F2806	100	—	—	20	64	Boot	16	4	2	4	14	16/160	—	—	1	2	4	—	1	—	1.8	35	—	BGA-100, LQFP-100	8.70
TMS320F28044	100	—	—	20	128	Boot	16	16	—	—	24	16/80	—	—	1	1	1	—	—	—	1.8	35	—	LQFP-100	9.95
TMS320F2802	100	—	—	12	64	Boot	8	3	1	2	9	16/160	—	—	1	1	2	—	1	—	1.8	35	—	BGA-100, LQFP-100	7.10
TMS320F2801	100	—	—	12	32	Boot	8	3	1	2	9	16/160	—	—	1	1	2	—	1	—	1.8	35	—	BGA-100, LQFP-100	5.80
TMS320F2802-60	60	—	—	12	64	Boot	8	3	1	2	9	16/267	—	—	1	1	2	—	1	—	1.8	35	—	LQFP-100	4.75
TMS320F2801-60	60	—	—	12	32	Boot	8	3	1	2	9	16/267	—	—	1	1	2	—	1	—	1.8	35	—	LQFP-100	3.95
TMS320F28069PFP	80	Yes	Yes	100	256	Boot	15-19	6-8	1-2	3-7	12-16	12-16/325	3	1	1	1-2	2	—	1	—	3.3	44-58	Yes/Yes	LQFP-80, LQFP-100	7.90
TMS320F28068PFP	80	Yes	—	100	256	Boot	15-19	6-8	1-2	3-7	12-16	12-16/325	3	1	1	1-2	2	—	1	—	3.3	44-58	Yes/Yes	LQFP-80, LQFP-100	7.00
TMS320F28067PFP	80	Yes	—	100	256	Boot	15-19	6-8	1-2	3-7	12-16	12-16/325	3	1	1	1-2	2	—	1	—	3.3	44-58	Yes/Yes	LQFP-80, LQFP-100	6.60
TMS320F28066PFP	80	Yes	—	68	256	Boot	15-19	6-8	1-2	3-7	12-16	12-16/325	3	1	1	1-2	2	—	1	—	3.3	44-58	Yes/Yes	LQFP-80, LQFP-100	6.20
TMS320F28065PFP	80	Yes	Yes	100	128	Boot	15-19	6-8	1-2	3-7	12-16	12-16/325	3	1	1	1-2	2	—	1	—	3.3	44-58	Yes/Yes	LQFP-80, LQFP-100	7.00
TMS320F28064PFP	80	Yes	—	100	128	Boot	15-19	6-8	1-2	3-7	12-16	12-16/325	3	1	1	1-2	2	—	1	—	3.3	44-58	Yes/Yes	LQFP-80, LQFP-100	6.10
TMS320F28063PFP	80	Yes	—	68	128	Boot	15-19	6-8	1-2	3-7	12-16	12-16/325	3	1	1	1-2	2	—	1	—	3.3	44-58	Yes/Yes	LQFP-80, LQFP-100	5.40
TMS320F28062PFP	80	Yes	—	36	128	Boot	15-19	6-8	1-2	3-7	12-16	12-16/325	3	1	1	1-2	2	—	1	—	3.3	44-58	Yes/Yes	LQFP-80, LQFP-100	4.95

[1] *All devices available in Pb-Free/Green packaging. All TMS320C28 devices in LQFP package are available as AEC Q100 qualified.*

New products are listed in ***bold red****.*

[2] *Timers include CPU timers, PWM timers, eCAP timers, and Watchdog timers.*

**Prices are quoted in U.S. dollars and represent 2010 suggested resale pricing for baseline packages. All prices are subject to change.*
Minimum quantity order for all ROM devices is 10K units, NRE charge is $11,000 for C28x™.

Audio Clocks

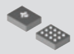
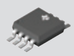
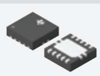
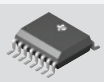
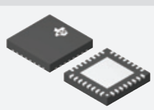
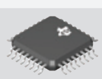
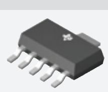
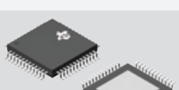
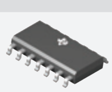
Device	Core Supply Voltage (V)	I/O Voltage (V)	Number of PLL	Number of Outputs (LVCMOS)	Max. Output Frequency (MHz)	Input Frequency (MHz)	Fully Integrated VCXO Circuitry Except Crystal	0ppm Frequency Generation	Spread-Spectrum Clocking on All Outputs	Support Frequency Switching	Programmability	Package(s)	Temp. Range (°C)	Period Jitter (pa) (typ)
Programmable Multiple PLL Clock Synthesizer Family with Fully-Integrated Fanouts														
CDCE706	3.3	2.5 to 3.3	3	6	300	Crystal: 8 to 54 LVCMOS & Differential: Up to 200	No	Yes	Yes (only 1 PLL)	Yes	SMBus and EEPROM	TSSOP-20	–40 to +85	60
CDCE906	3.3	2.5 to 3.3	3	6	167	Crystal: 8 to 54 LVCMOS & Differential: Up to 167	No	Yes	Yes (only 1 PLL)	Yes	SMBus and EEPROM	TSSOP-20	0 to 70	60
CDCE913	1.8	2.5 to 3.3	1	3	230	Crystal: 8 to 32 LVCMOS: Up to 150	Yes	Yes	Yes	Yes	I^2C and EEPROM	TSSOP-14	–40 to +85	60
CDCE925	1.8	2.5 to 3.3	2	5	230	Crystal: 8 to 32 LVCMOS: Up to 150	Yes	Yes	Yes	Yes	I^2C and EEPROM	TSSOP-16	–40 to +85	60
CDCE937	1.8	2.5 to 3.3	3	7	230	Crystal: 8 to 32 LVCMOS: Up to 150	Yes	Yes	Yes	Yes	I^2C and EEPROM	TSSOP-20	–40 to +85	60
CDCE949	1.8	2.5 to 3.3	4	9	230	Crystal: 8 to 32 LVCMOS: Up to 150	Yes	Yes	Yes	Yes	I^2C and EEPROM	TSSOP-24	–40 to +85	60
CDCEL913	1.8	1.8	1	3	230	Crystal: 8 to 32 LVCMOS: Up to 150	Yes	Yes	Yes	Yes	I^2C and EEPROM	TSSOP-14	–40 to +85	60
CDCEL925	1.8	1.8	2	5	230	Crystal: 8 to 32 LVCMOS: Up to 150	Yes	Yes	Yes	Yes	I^2C and EEPROM	TSSOP-16	–40 to +85	60
CDCEL937	1.8	1.8	3	7	230	Crystal: 8 to 32 LVCMOS: Up to 150	Yes	Yes	Yes	Yes	I^2C and EEPROM	TSSOP-20	–40 to +85	60
CDCEL949	1.8	1.8	4	9	230	Crystal: 8 to 32 LVCMOS: Up to 150	Yes	Yes	Yes	Yes	I^2C and EEPROM	TSSOP-24	–40 to +85	60

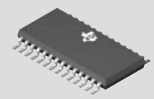
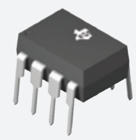
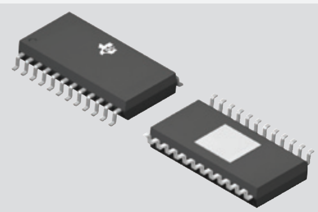
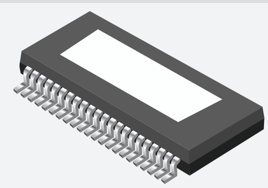
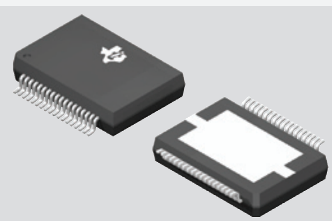
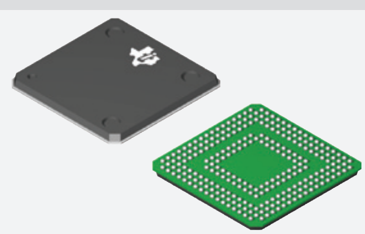
Analog Multiplexers and Switches

Device	r_{on} (max)	r_{on} Flatness (max)	r_{on} Mismatch (max)	V+ (min) (V)	V+ (max) (V)	ESD	Total Harmonic Distortion (THD) (%)	ON Time, OFF Time (max) (ns)	Package(s)	Features
SPST										
TS5A3166	0.9	0.15	—	1.65	5.5	2-kV HBM	0.005	7, 11.5	SC70-5, SOT-23, WCSP	
TS5A3167	0.9	0.15	—	1.65	5.5	2-kV HBM	0.005	7, 11.5	SC70-5, SOT-23, WCSP	
SPST x 2										
TS3A4741	0.9	0.4	0.05	1.65	3.6	2-kV HBM	0.003	14, 9	SSOP-8, MSOP-8	
TS3A4742	0.9	0.4	0.05	1.65	3.6	2-kV HBM	0.003	14, 9	SSOP-8, MSOP-8	
TS5A21366	1	0.25	0.1	1.65	5.5	2-kV HBM	0.002	72, 318	USB-8, µQFN	1.8-V Logic Compatible Inputs
TS5A23166	0.9	0.25	0.1	1.65	5.5	2-kV HBM	0.005	7.5, 11	US8-8,WCSP	
TS5A23167	0.9	0.25	0.1	1.65	5.5	2-kV HBM	0.005	7.5, 11	US8-8,WCSP	
SPST x 4										
TS3A4751	0.9	0.4	0.05	1.65	3.6	4-kV HBM	0.013	14, 9	14/TSSOP, SON, µQFN	
SPDT										
TS5A3153	0.9	0.15	0.1	1.65	5.5	2-kV HBM	0.004	16, 15	US8-8, WCSP-8	
TS5A3154	0.9	0.15	0.1	1.65	5.5	2-kV HBM	0.004	8, 12.5	US8-8, WCSP-8	
TS5A3159	1.1	0.15	0.1	1.65	5.5	2-kV HBM	0.01	35, 20	SC70-6, SOT-23	
TS5A3159A	0.9	0.25	0.1	1.65	5.5	2-kV HBM	0.004	30, 20	SC70-6, SOT-23, WCSP	
TS5A3160	0.9	0.25	0.1	1.65	5.5	2-kV HBM	0.004	6, 13	SC70-6, SOT-23	
TS5A4624	0.9	0.25	0.1	1.65	5.5	2-kV HBM	0.004	22, 8	SC70-6	
TS5A6542	0.75	0.25	0.25	2.25	5.5	15-kV Contact (IEC L-4)	0.004	25, 20	WCSP-8	
TS5A12301E	0.75	0.1	0.1	2.25	5.5	8-kV Contact (IEC L-4)	0.003	225, 215	WCSP-6 (0.4-mm pitch)	
SPDT x 2										
TS5A22362	0.74	0.46	0.23	2.3	5.5	2.5-kV HBM	0.01	80, 70	WCSP-10, SON-10, VSSOP	Negative Signal I/O Capability
TS5A22364	0.74	0.46	0.23	2.3	5.5	2.5-kV HBM	0.01	80, 70	WCSP-10, SON-10, VSSOP	Negative Signal I/O Capability
TS5A22366	1	0.51	0.2	2.25	5.5	2-kV HBM	0.02	375, 325	WCSP-12 (0.4-mm pitch), µQFN-10	Negative Signal I/O Capability
TS5A23159	0.9	0.25	0.1	1.65	5.5	2-kV HBM	0.004	13, 8	MSOP-10, QFN-10	
TS5A23160	0.9	0.25	0.1	1.65	5.5	2-kV HBM	0.004	5.5, 10	MSOP-10	
TS3A24157	0.6	0.04	0.07	1.65	3.6	2-kV HBM	0.005	35, 25	µQFN-10, VSSOP	
TS3A24159	0.3	0.04	0.05	1.65	3.6	2-kV HBM	0.003	35, 25	WCSP-10, SON, VSSOP	
TS5A26542	0.75	0.25	0.25	2.25	5.5	15-kV Contact (IEC L-4)	0.004	25, 20	WCSP-12	
TS5USBA224	3	1.5	0.3	2.7	5.5	2-kV HBM	5.00	<4 µs	QFN-10	USB and Audio Switch with Negative Signal Capability
DPDT x 2										
TS3A44159	0.45	0.1	0.07	1.65	4.3	2-kV HBM	0.003	23, 32	TSSOP-16, SON, µQFN	
SP3T										
TS5A3359	0.9	0.25	0.1	1.65	5.5	2-kV HBM	0.005	21, 10.5	US8-8, WCSP-8	

Packaging

High-Performance Analog Packages

	Package Type	Package Designator
	Wafer Chip Scale Package (WCSP)	YEA, YED, YEG, YEJ, YEK, YFF, YNA, YZA YZF,YZH, YZK
	Small Outline Transistor Package (SOT23)	DBY, DCN, Thin SOT, DDC
	Mini Small Outline Package (MSOP)	DGK, DGS
	Small Outline No Leads (SON)	DRD, DRB, DRC
	Shrink Small Outline Package (SSOP)	DBQ, DB, DL
	Quad Flatpack No Leads (QFN)	RGS, RGY, RGT, RGV, RGY, RHC, RGA, RGP, RGW, RGY, RGE, RGU, RHD, RGL, RGD, RHB, RGF, RHA, RTA, RGN, RGZ, RGQ, RGC, RHE, RHF, RSB, RTE
	Thin Quad Flatpack (TQFP)	PBS, PJT, PFB, PAG
	Small Outline Transistor (SOT223)	DCY, DCQ
	Heat Sink Thin Quad Flatpack (HTQFP)	PHD, PHP, PAP
	Small Outline Integrated Circuit (SOIC)	D, DTH, DTC, DW, DWU

	Package Type	Package Designator
	Thin Shrink Small Outline Package (TSSOP)	PW
	Plastic Dual-In-Line Package (PDIP)	P, N, NT, NTD
	Heat Sink Small Outline Package (HSOP)	DWP, DWD
	Heat Sink Thin Shrink Small Outline Package (HTSSOP)	DDV
	Power Small Outline Package (SSOP)	DKP (slug down), DKD (slug up)
	Ball Grid Array (BGA)	ZAS, ZQE

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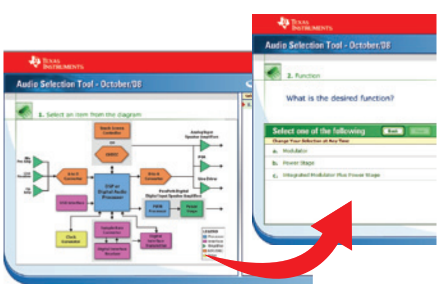

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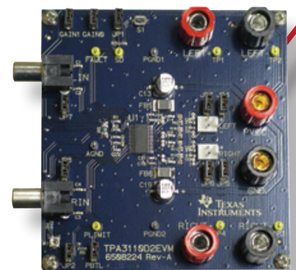

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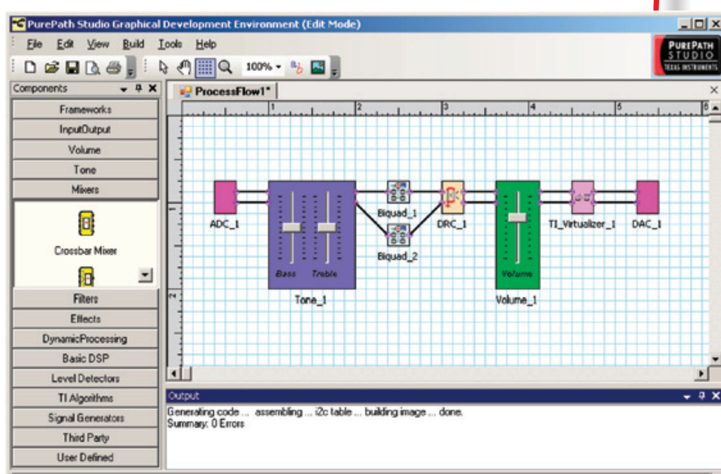
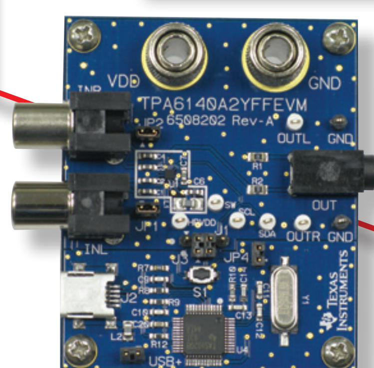
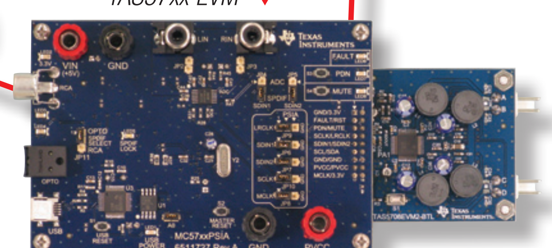




TPA6140A2 EVM ▲

TAS57xx EVM ▼



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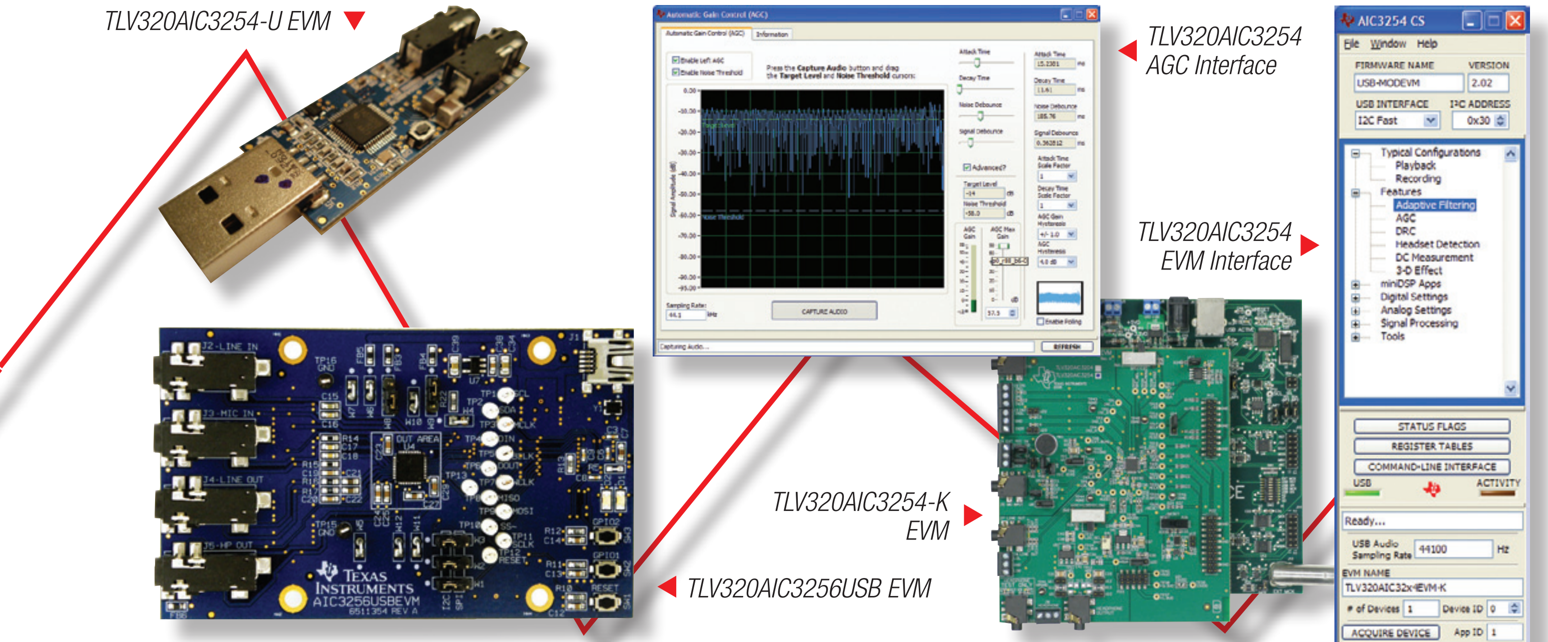

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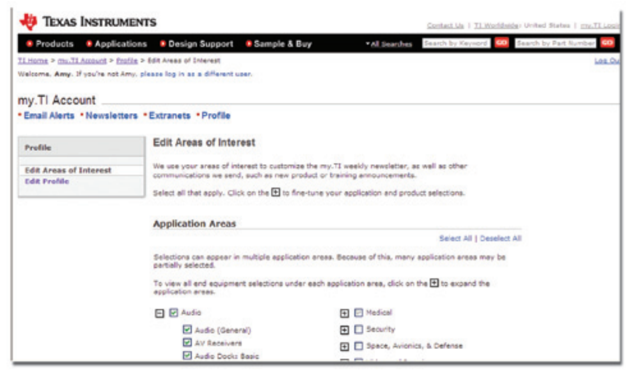

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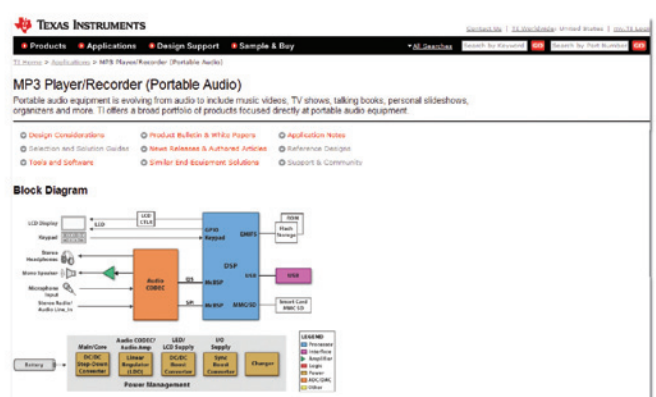

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Notes

Notes

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IMPORTANT NOTICE

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