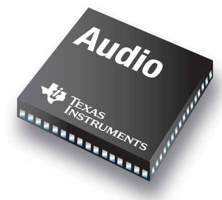
Audio Guide



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

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Audio Overview

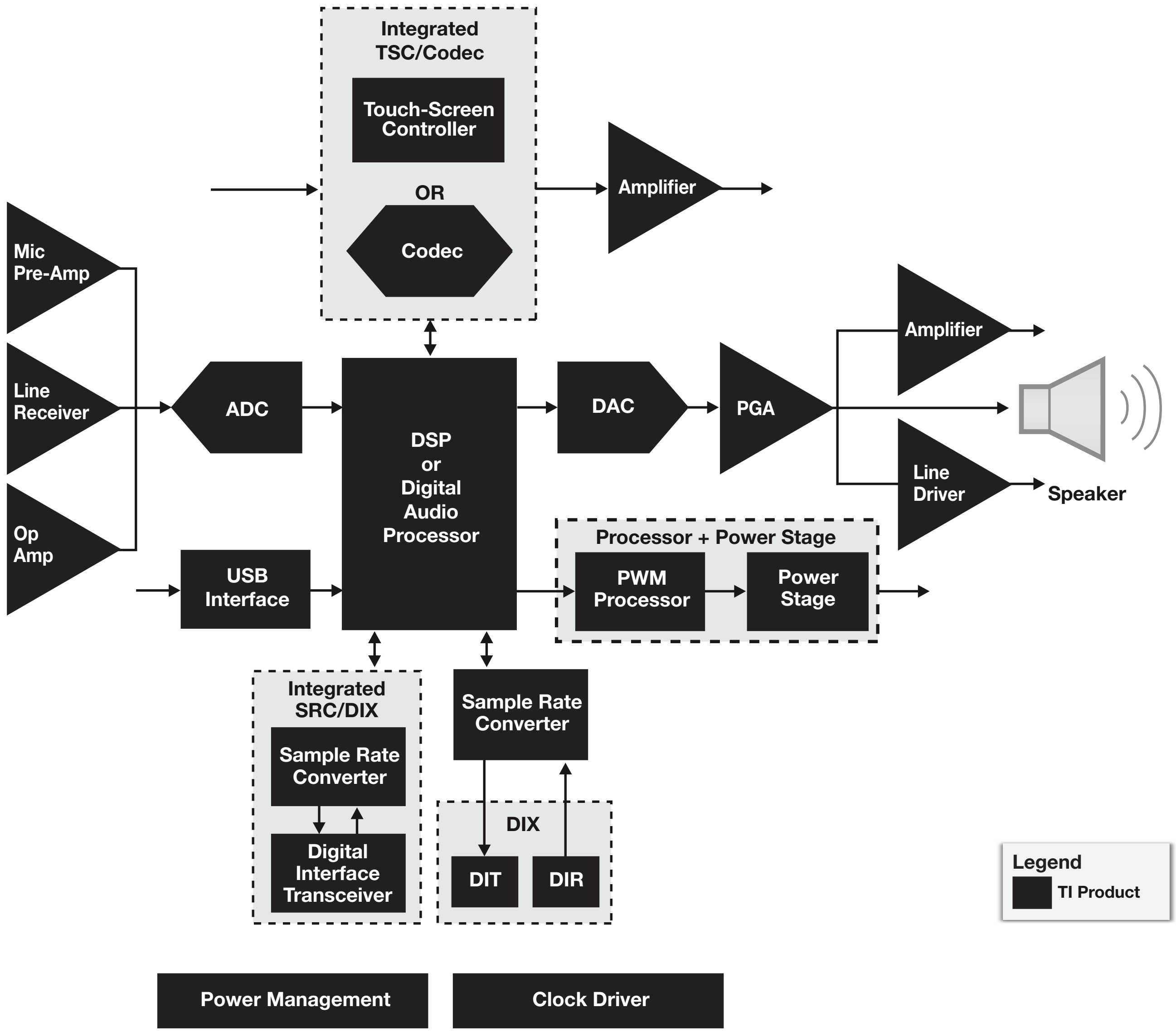
Today's consumers demand the best in audio. They want crystal-clear sound wherever they are – in whatever format they want to use.

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 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.

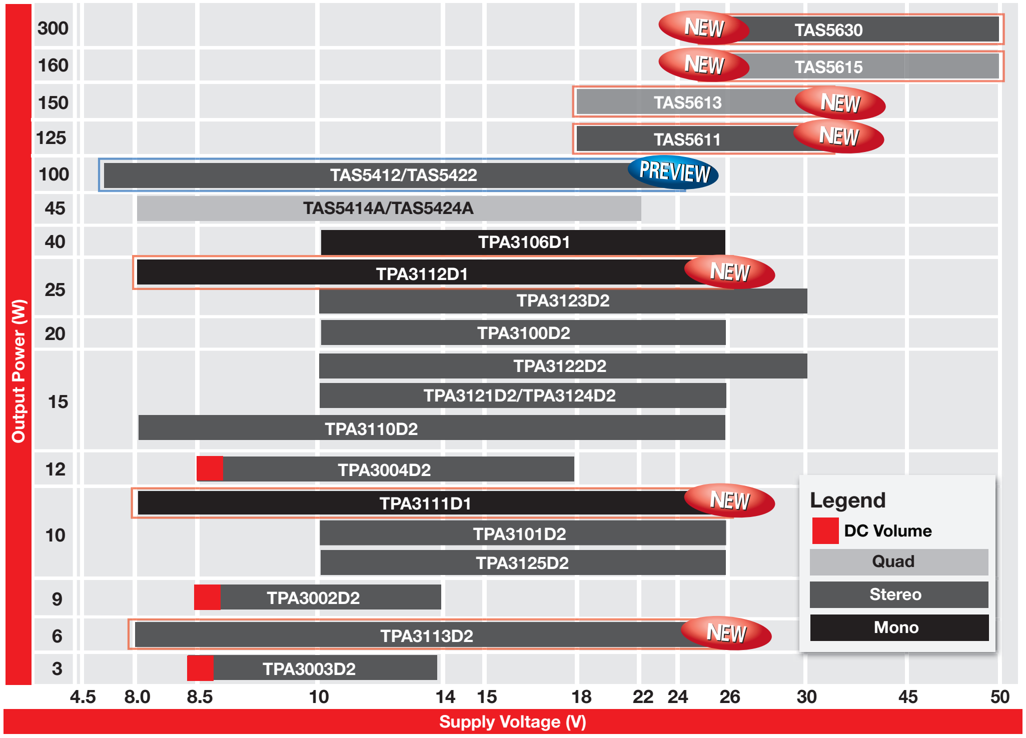
Output Filter Design

- 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

- **TAS5613**
  - PurePath™ HD integrated closed-loop feedback technology improves THD+N and efficiency
- **TAS5611**
  - 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 25.
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.

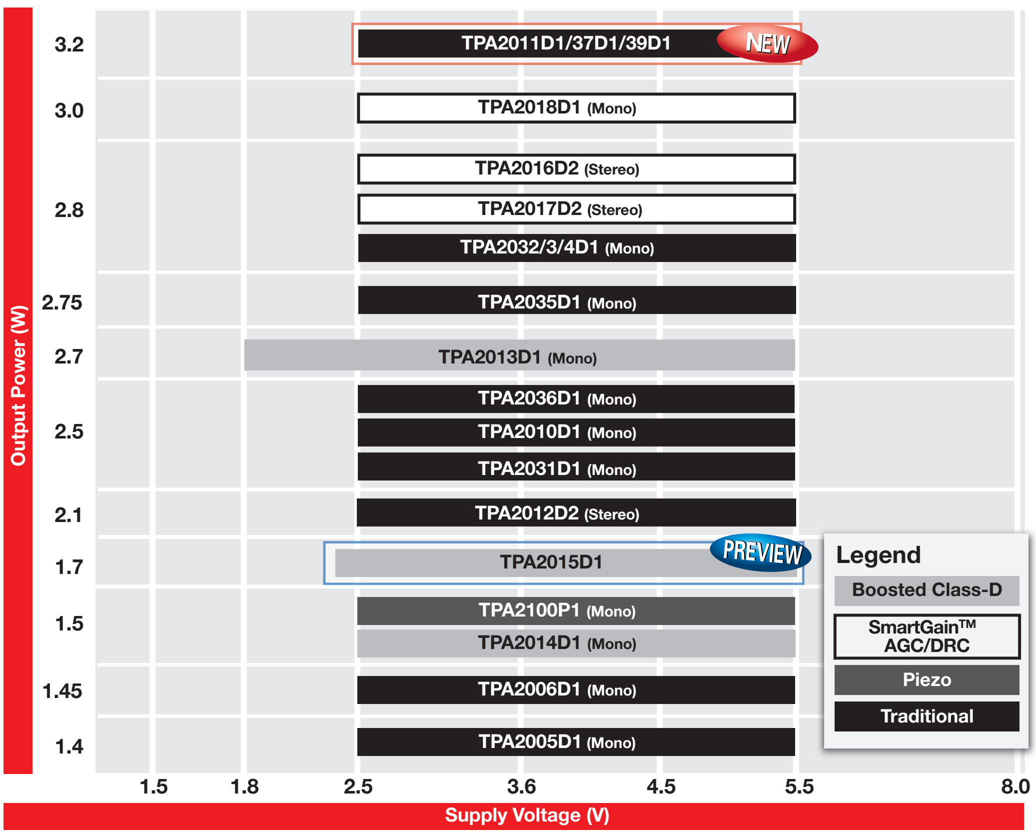
Output Filter Design

- 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 25.
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

TAS5705
- Speaker EQ
- 2.1 with external amp

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

TAS5713 NEW
- 25 W, stereo
- Speaker EQ

TAS5707
- Speaker EQ

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

For a complete list of **Digital-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 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.

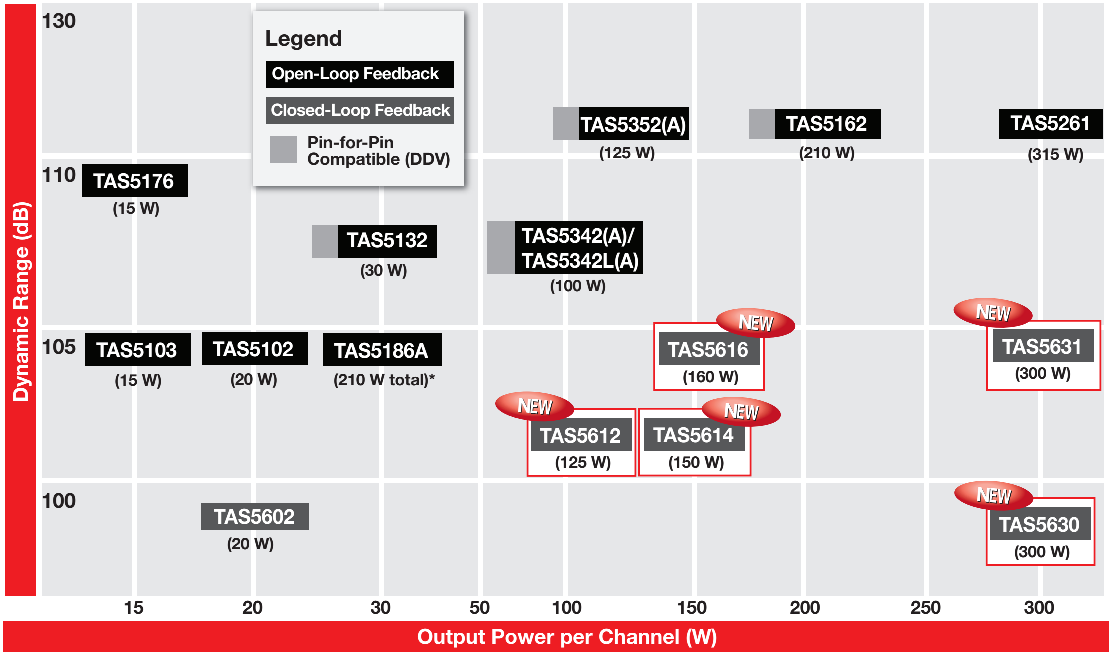
PCB Layout

- 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

- **TAS5614**
  - 150-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
- **TAS5612**
  - 150-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

For a complete list of **PWM-Input Class-D Speaker Amplifiers**, see page 26.

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

*Multi-channel and mono devices feature total power.

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.

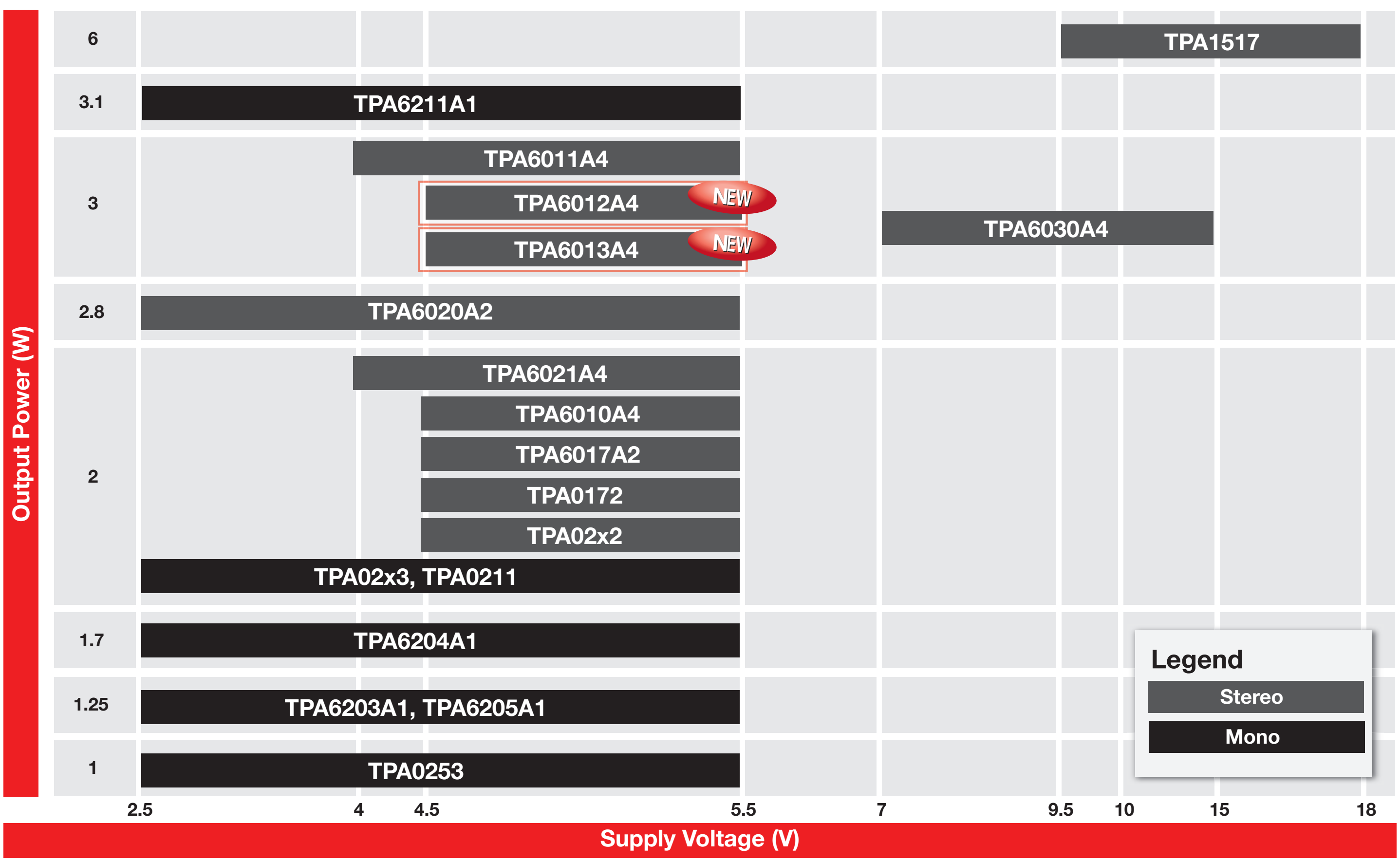
Heat

- 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
  - I²C 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

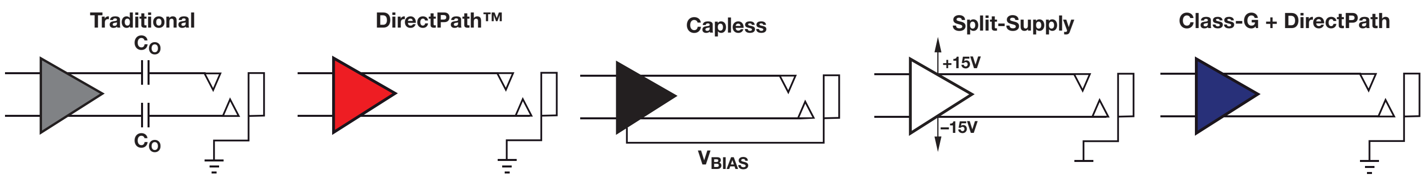
Issues to Consider When Using Single-Ended Power Supplies

- 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.

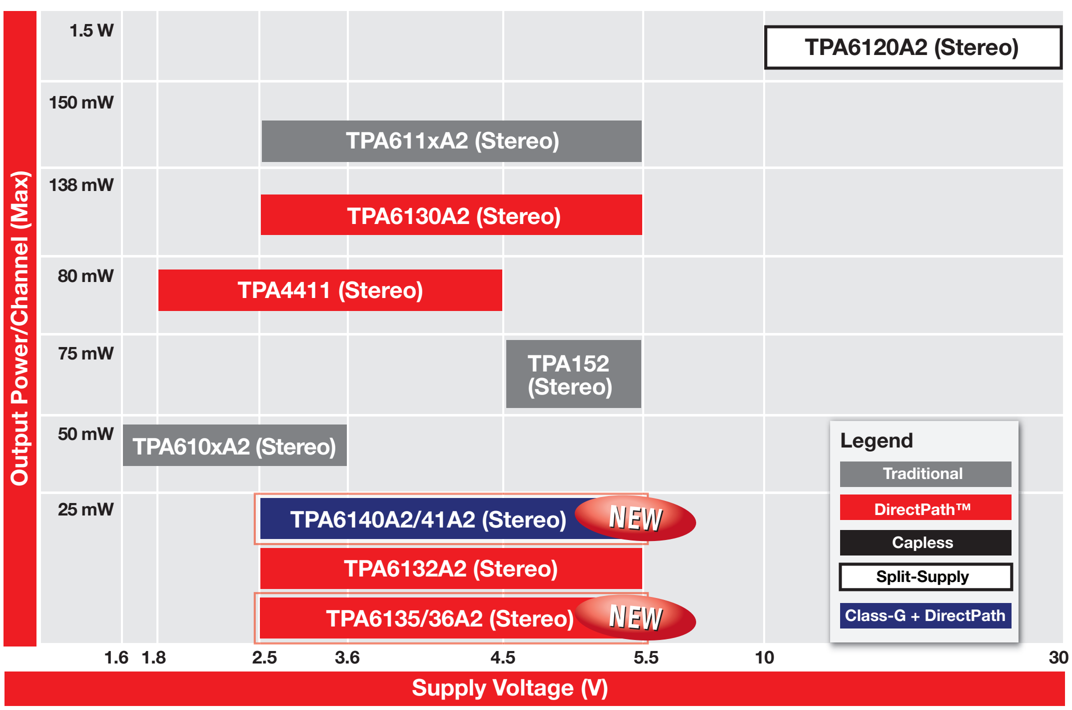
Headphone Impedance and Power

- Headphone impedances can vary greatly, from 16 Ω to 600 Ω.
- 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
- **TPA6135A2/36A2**
  - Fixed-gain
  - DirectPath™
  - Hi-Z mode
  - QFN ('6135)

For a complete list of **Headphone Amplifiers**, see page 27.
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

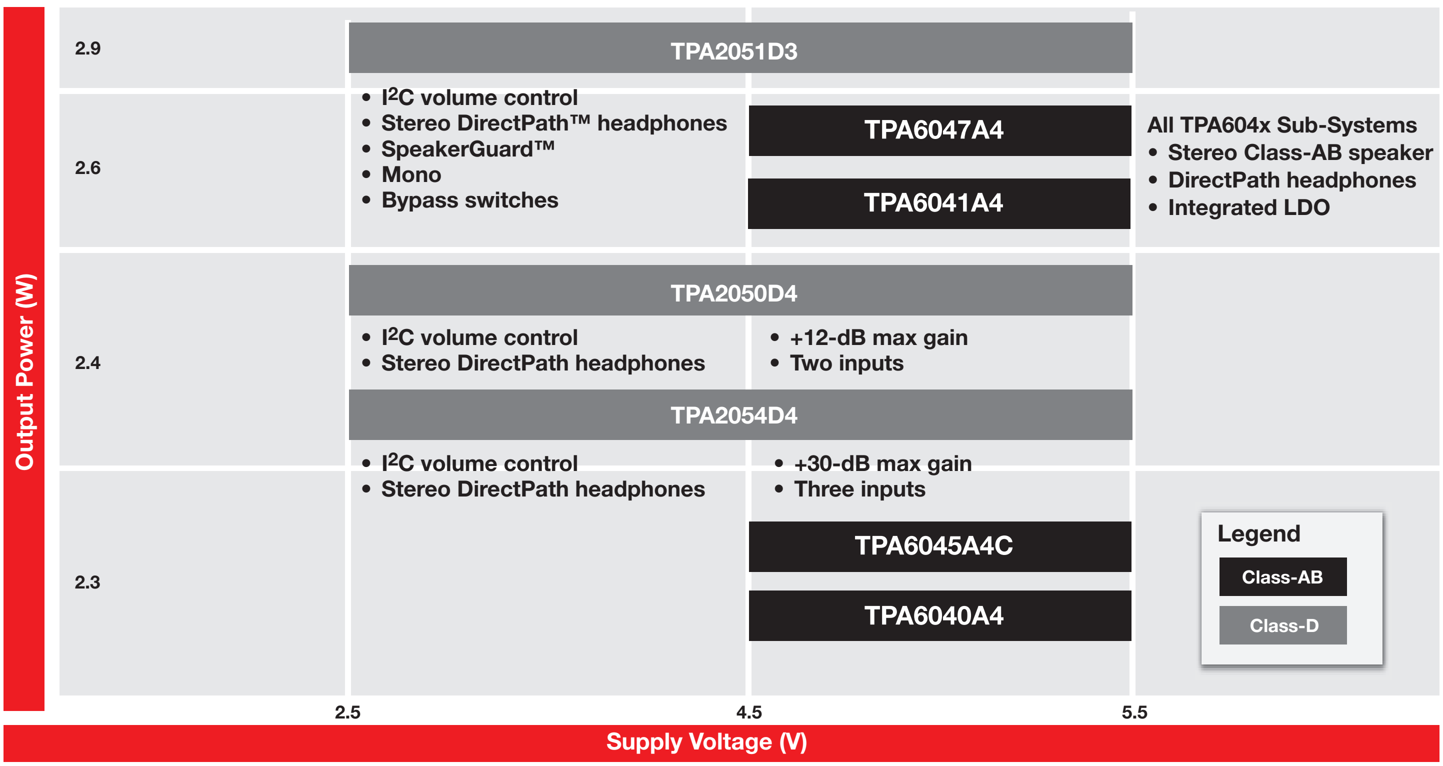
- RF emissions from mobile data add-in cards, 802.11 and *Bluetooth*® radios can create noise problems for amplifiers.
- It can be particularly problematic if the amplifiers, codecs or speakers are separated from each other by industrial or board design requirements.
- For additional design flexibility, 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.
- V_{Bias} 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 28.
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.

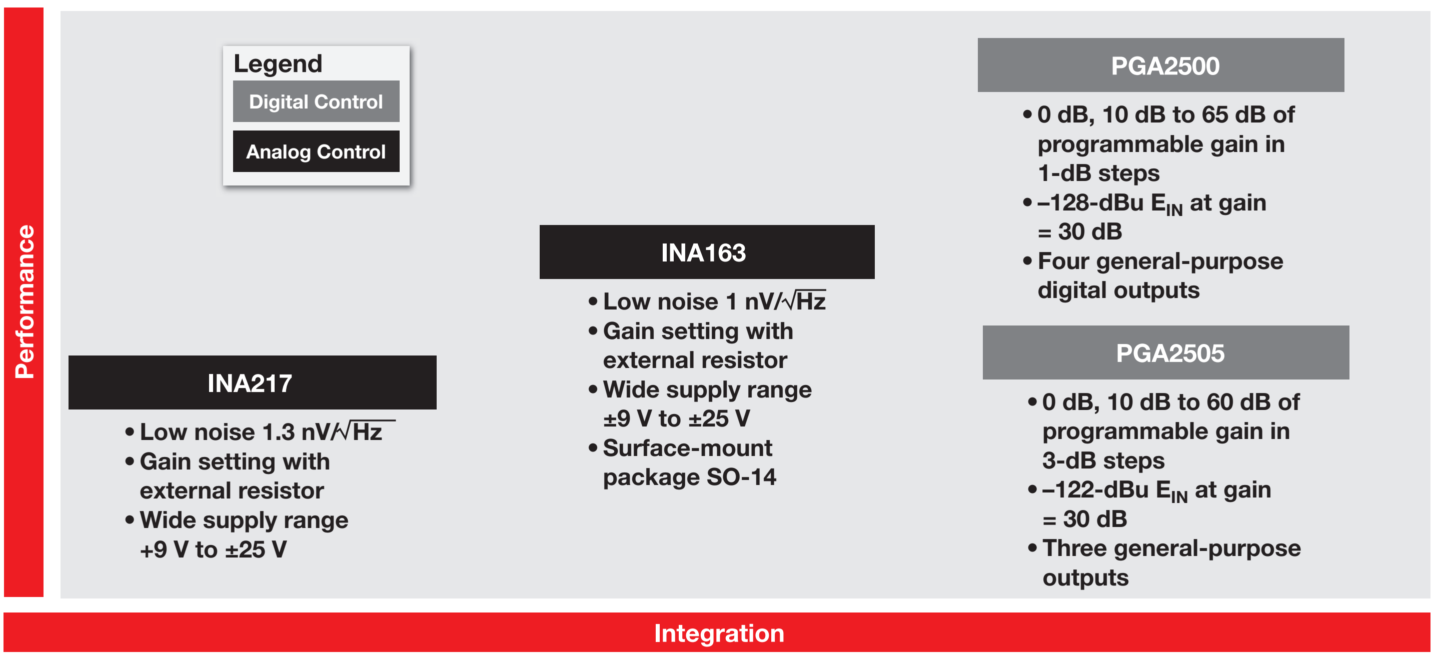
Equivalent Input Noise (EIN) Considerations

- 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 28.
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.

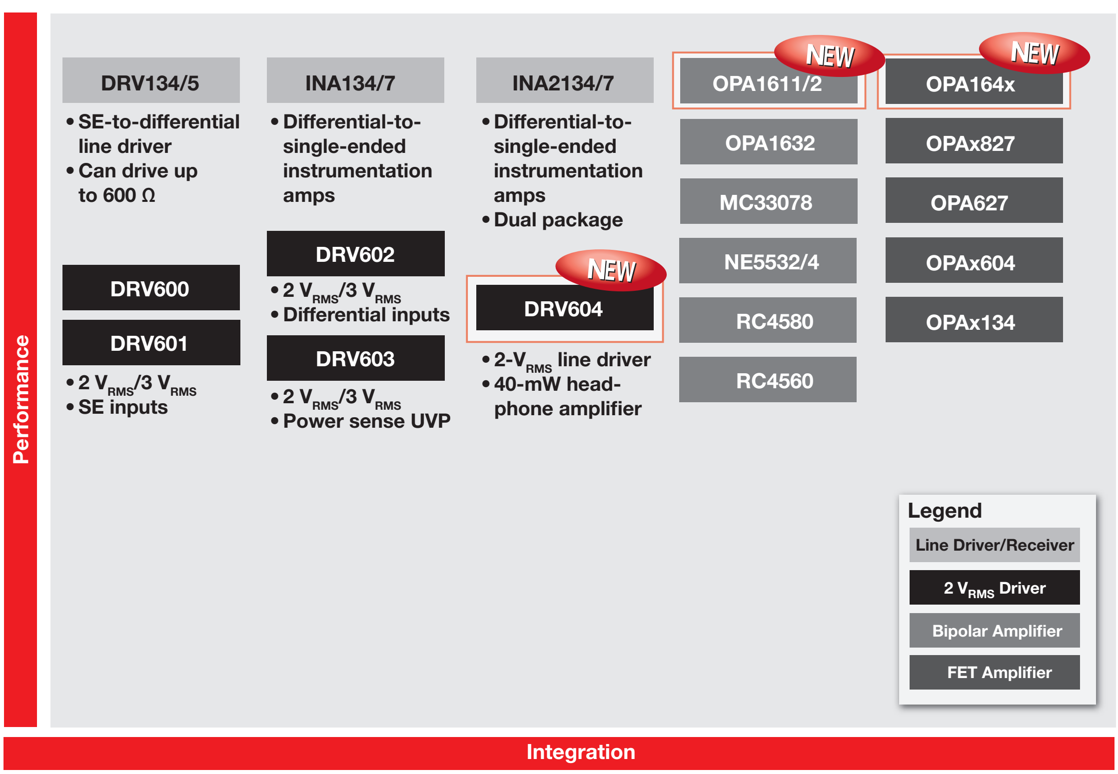
Balanced-Line I/O for Professional Audio Applications

- 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/√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 28 and 29.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Volume Controls

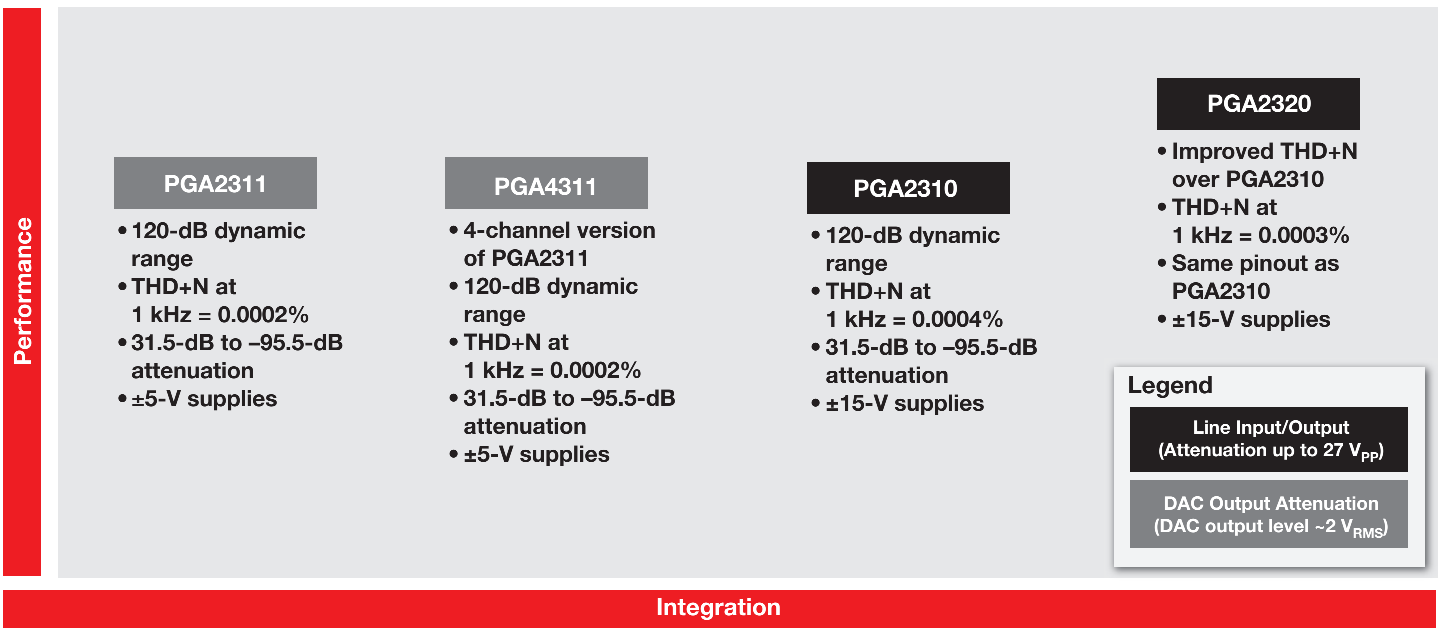
Supply Voltage: Signal Swing

- 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 29.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Portable Audio Codecs

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 DAC 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.

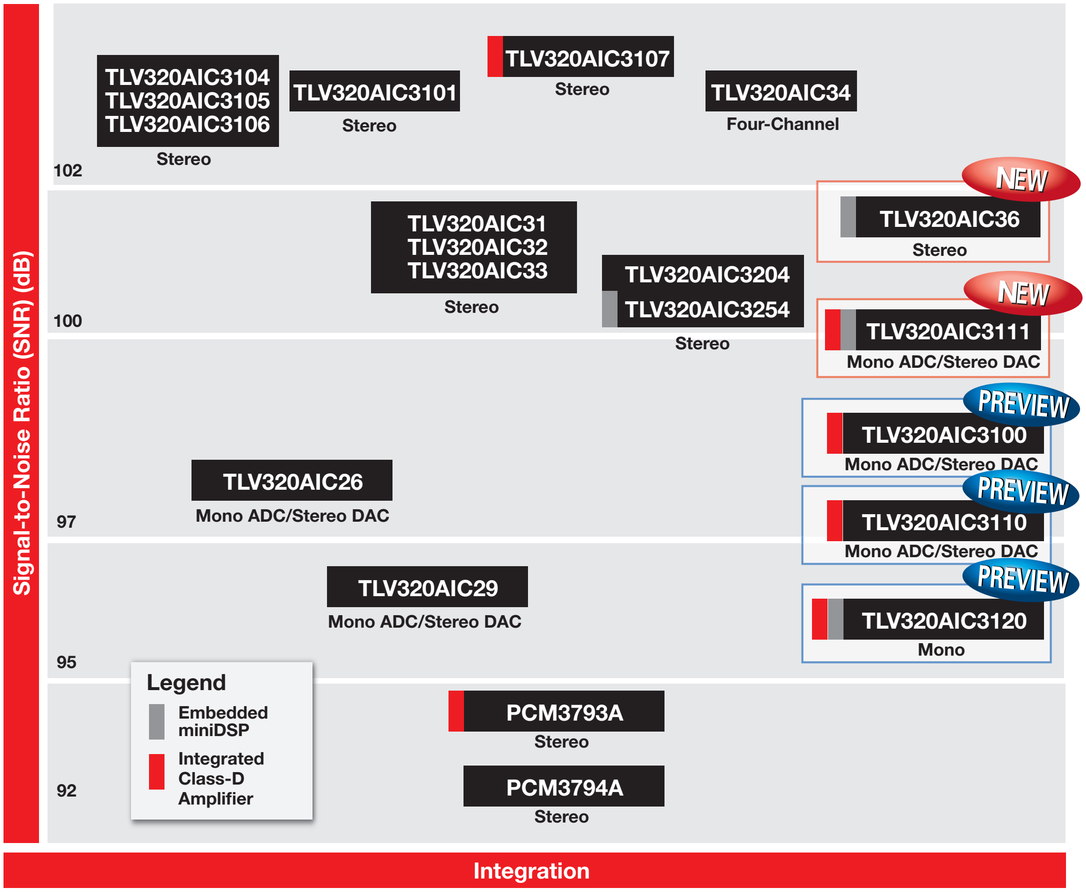
Simultaneously Handling Multiple Audio Sources

- 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

- **TLV320AIC36**
  - Stereo codec with DirectPath™ headphone driver
  - miniDSP for advanced audio processing and custom algorithms
- **TLV320AIC3111**
  - Codec with stereo Class-D speaker amplifier
  - miniDSP for advanced audio processing and custom algorithms
- **TLV320AIC3120**
  - Mono codec with mono Class-D speaker amplifier
  - Advanced filtering capabilities

For a complete list of **Portable Audio Converters**, see pages 29 and 30.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Portable Audio Converters

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 DAC or codec.
  - Audio functions include 3-D effects, equalization, notch filters or noise cancellation.
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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.
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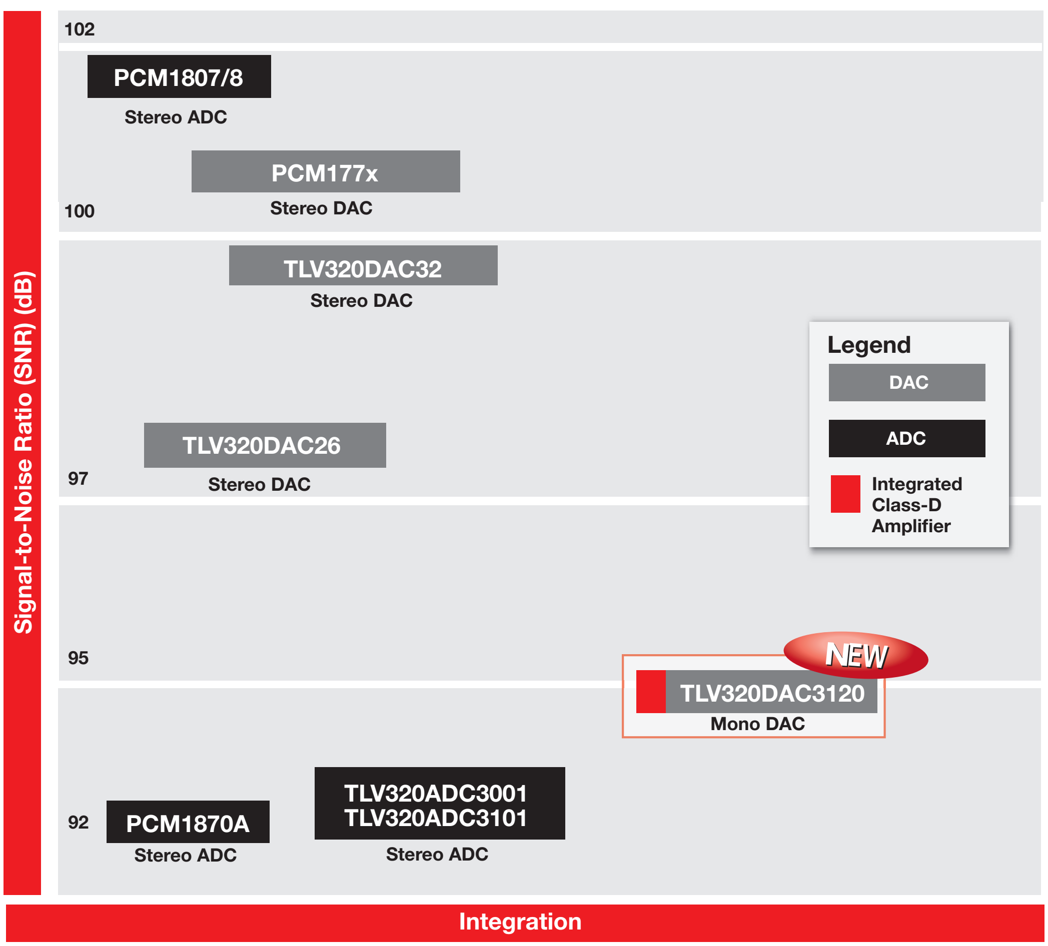
Portable Audio Converters



Product Highlights

- **TLV320DAC3120**
  - Mono DAC with mono Class-D amplifier
  - Advanced filtering capabilities

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

Design Considerations for Audio Converters with Integrated Touch-Screen Controllers

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.

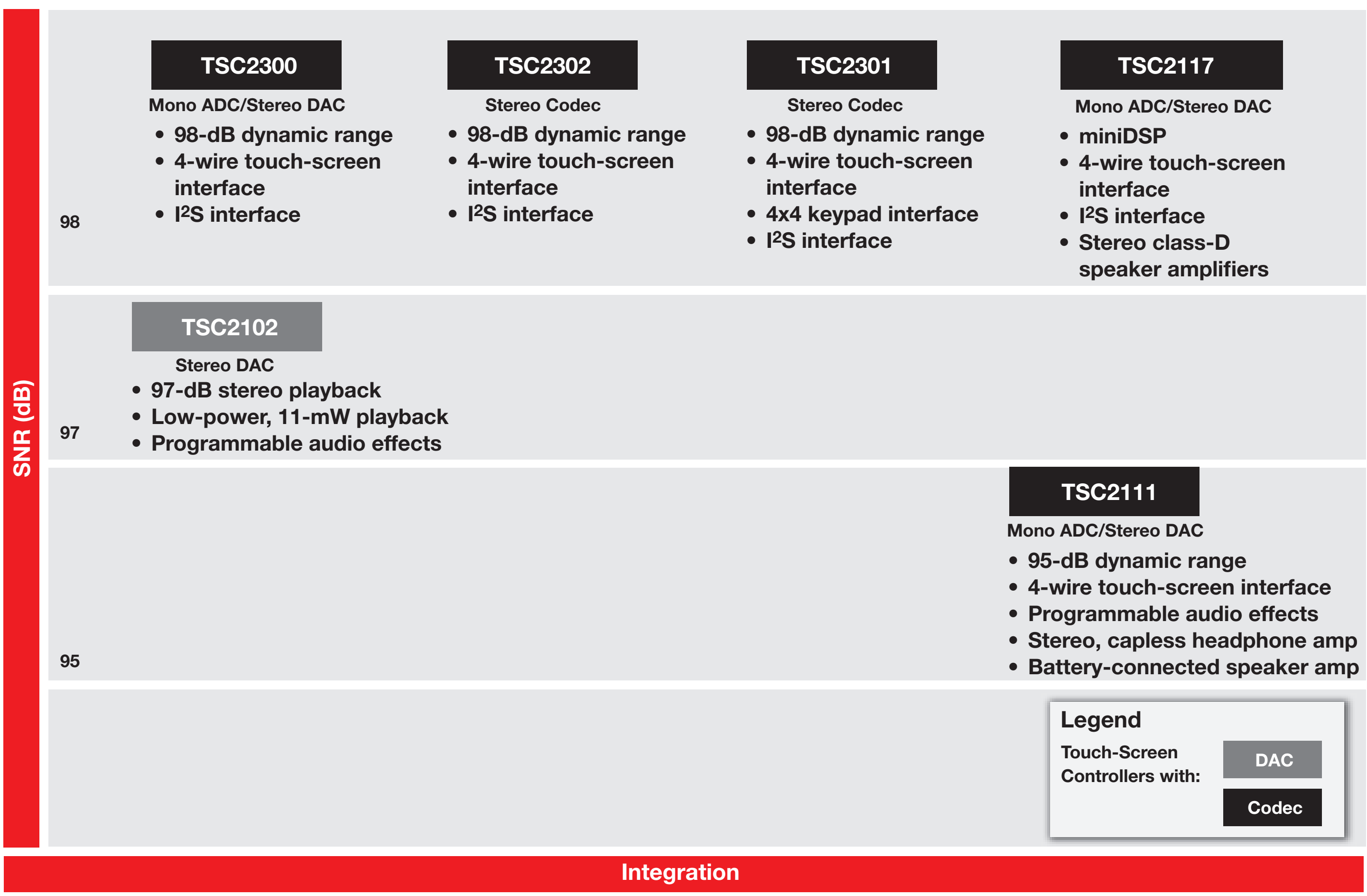
Other Methods for Using TSCs to Offload Host Processing

- 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 Touch-Screen Controller



For a complete list of **Audio Converters with Integrated Touch-Screen Controller**, see page 32.
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.

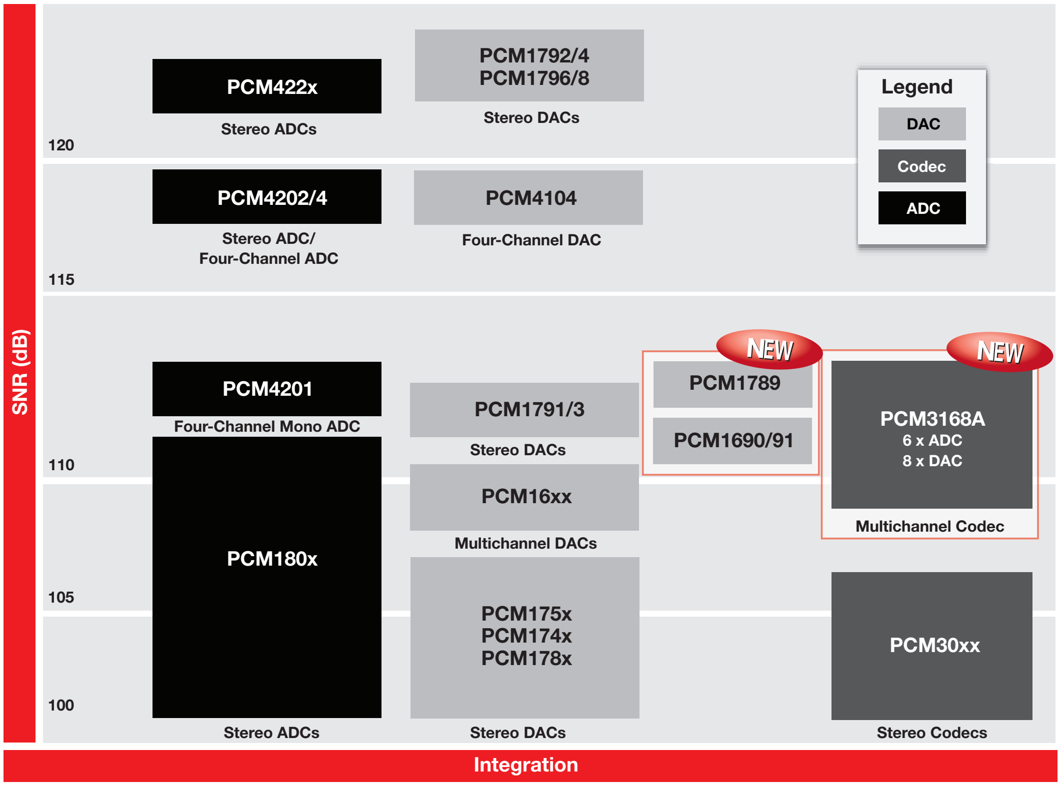
Analog Integration and Multichannel Support

- 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
- **PCM1690**
  - 113-dB DAC – 8 channel, differential
- **PCM1691**
  - 111-dB DAC – 8 channel, single ended
- **PCM1789**
  - 113-dB DAC – stereo, differential

For a complete list of **Performance Audio Converters**, see page 29.
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.

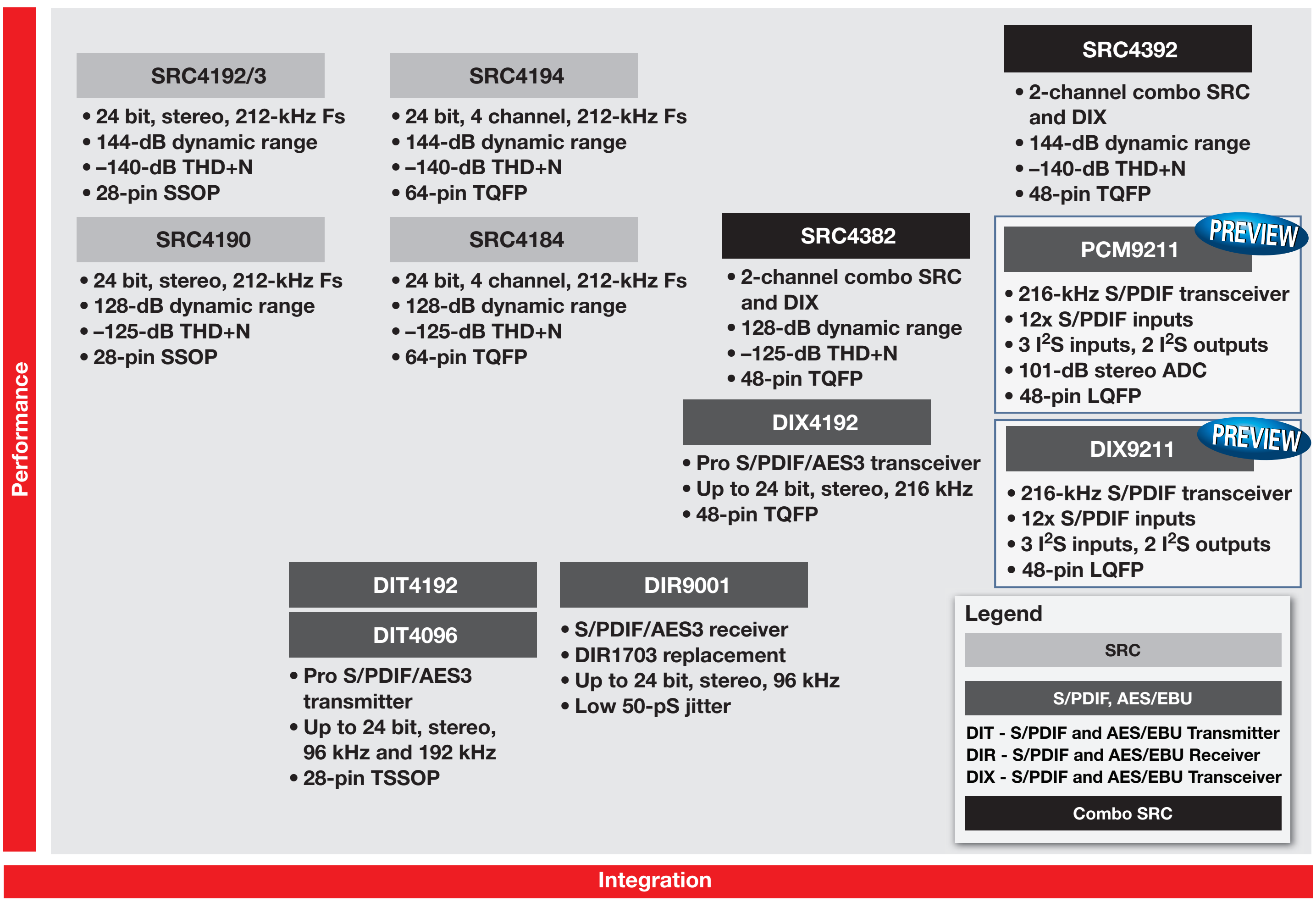
Jitter Sensitivity

- 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 32.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Design Considerations for Audio Controllers and Converters with USB Interface

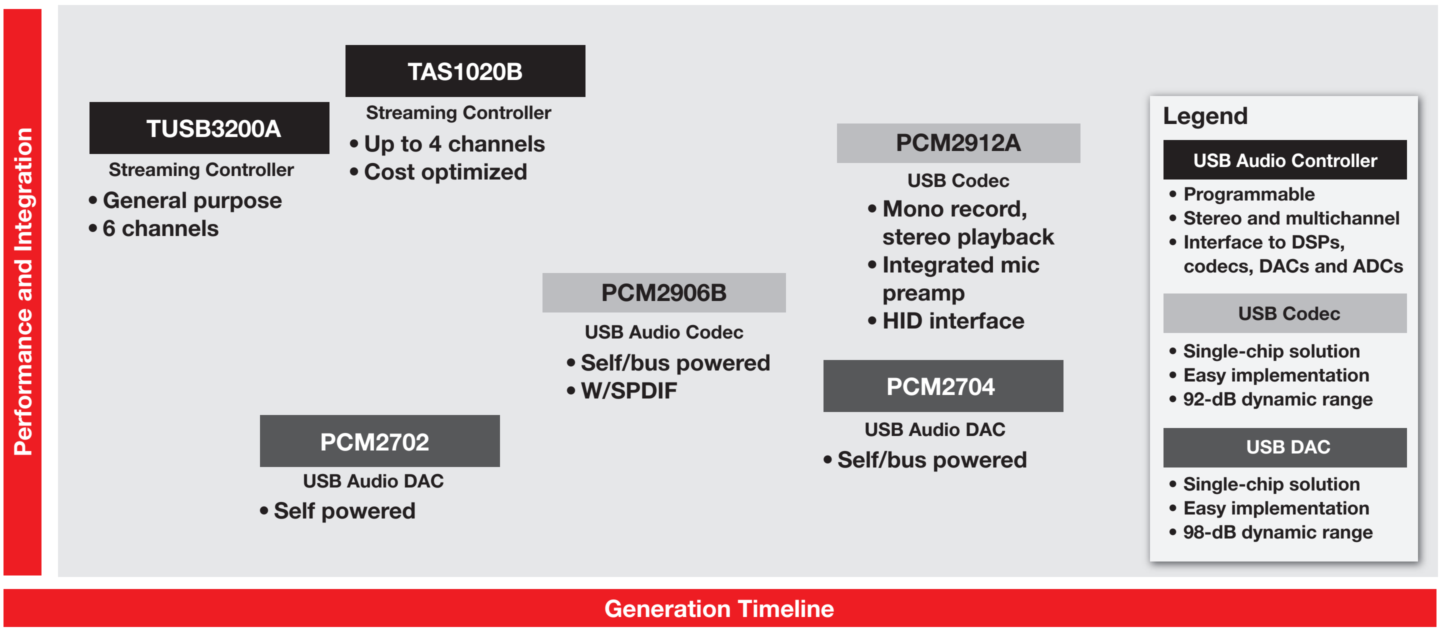
Programmable vs. USB Codecs

- 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, I²S, HID)

- Beyond analog audio in and out, many USB audio products now offer:
  - S/PDIF I/O
  - Raw PCM data (in I²S 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 33.
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 I²S 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, bandwidth, and center frequency

Output Considerations

Audio SoC outputs can be digital, analog or PWM.

- Digital outputs are in an I²S or S/PDIF form
  - I²S 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 Processors

TAS3103A
- 812-S channels
- Fully-programmable 135-MHz, 48-bit digital audio processing core
- Programmable with PurePath™ Studio

TAS3308
- 10:1 stereo input MUX
- Stereo ADC
- Six PWM outputs
- Fully-programmable 135-MHz, 48-bit digital audio processing core
- Programmable with PurePath Studio

TAS3208
- 10:1 stereo input MUX
- Stereo ADC
- Six DACs
- Fully-programmable 135-MHz, 48-bit digital audio processing core
- Programmable with PurePath Studio

TAS3204
- Two 3:1 stereo input MUX
- Four differential ADCs
- Four differential DACs
- Fully-programmable 135-MHz, 48-bit digital audio processing core
- Programmable with PurePath Studio

NEW

TAS3202
- 2:1 stereo input MUX
- Stereo ADC
- Stereo DAC
- Fully programmable 135-MHz, 48-bit digital audio processing core
- Programmable with PurePath Studio

Legend
- Digital Audio SoC
- Stand-Alone DSP

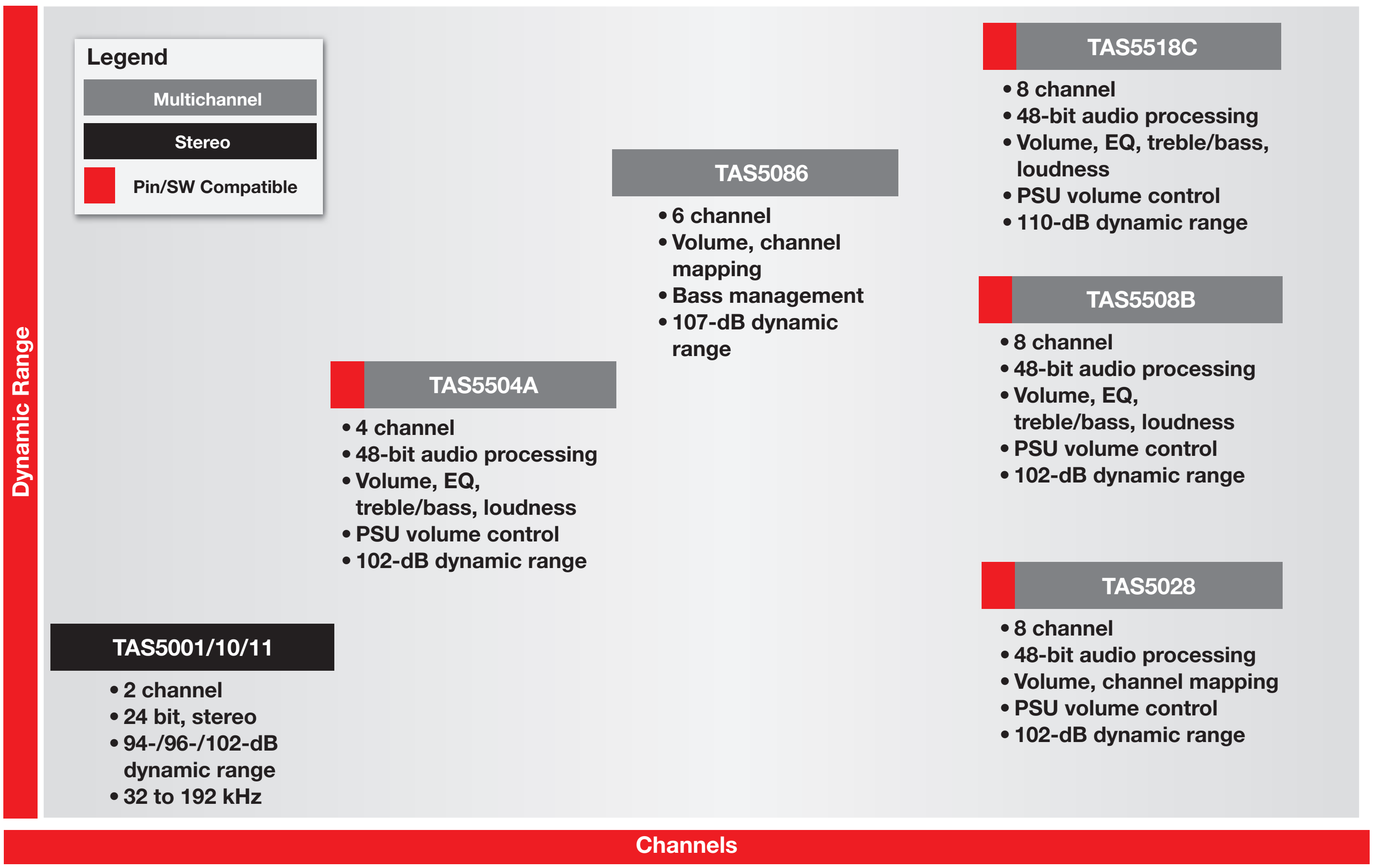
For a complete list of **Digital Audio Processors and SoCs**, see page 34.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

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



Some of TI's digital audio processors and SoCs also include PWM outputs, see page 20.
For a complete list of **PWM Processors**, see page 34.
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 2100 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 or DSP/BIOS™ real-time kernel
- 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

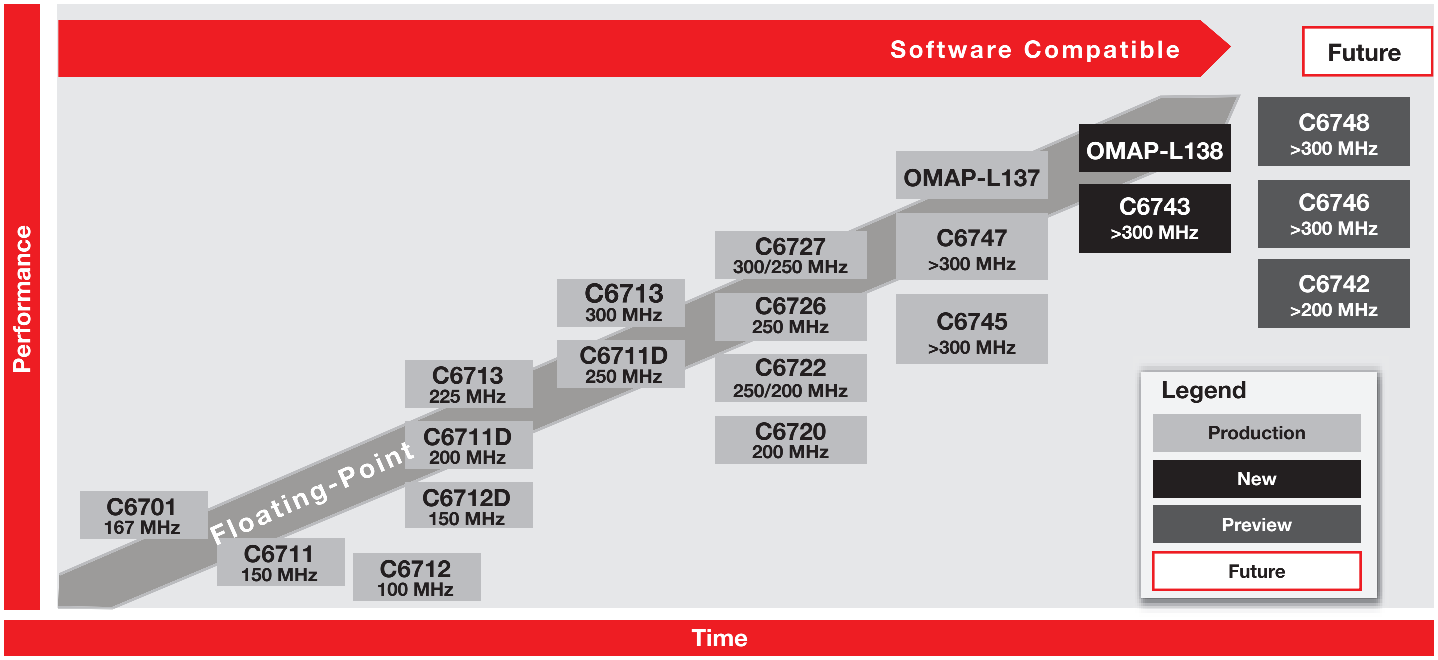
C671x DSP

- 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 Roadmap



For a complete list of **Floating-Point Processors**, see page 35.
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 150-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

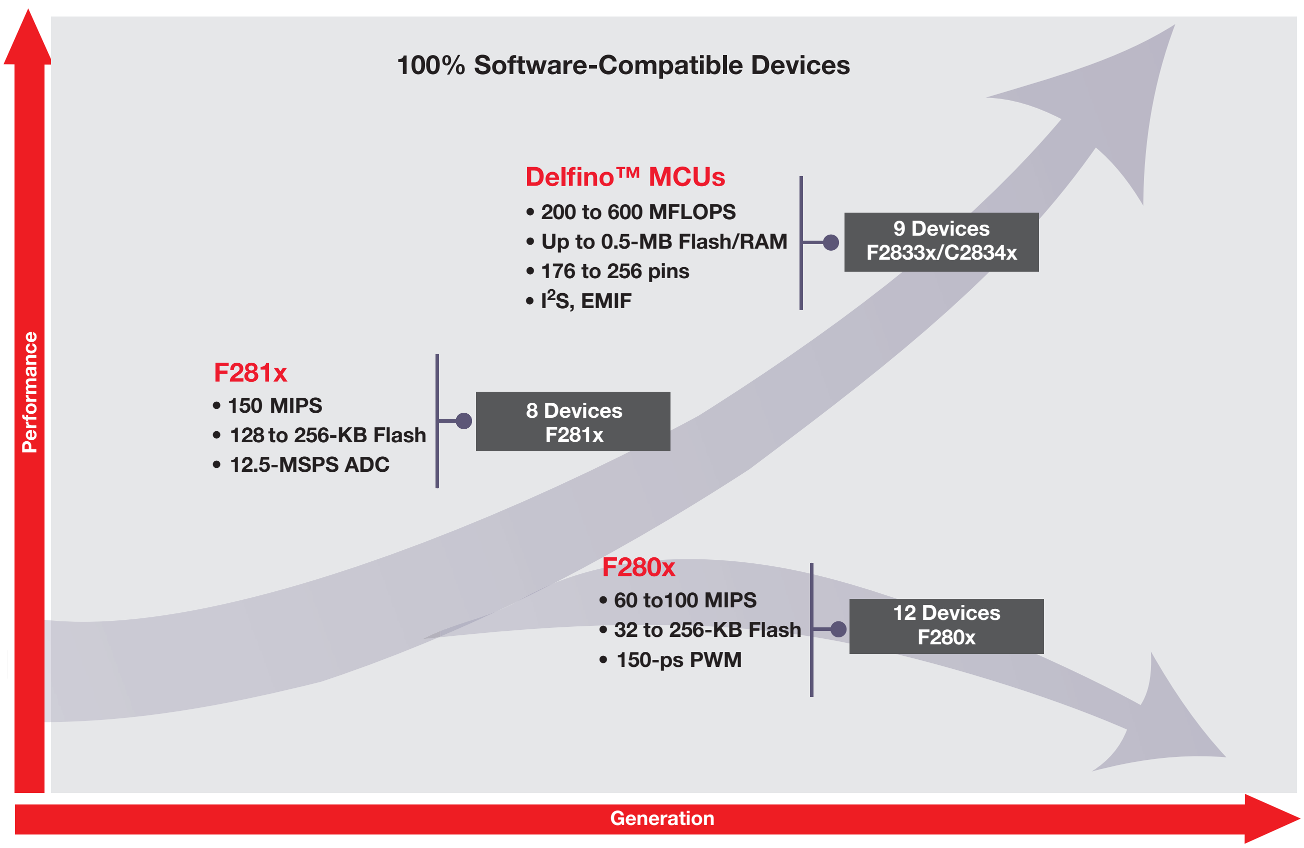
Delfino™ MCUs F2833x/C2834x (with floating point)

- 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 38.
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+.

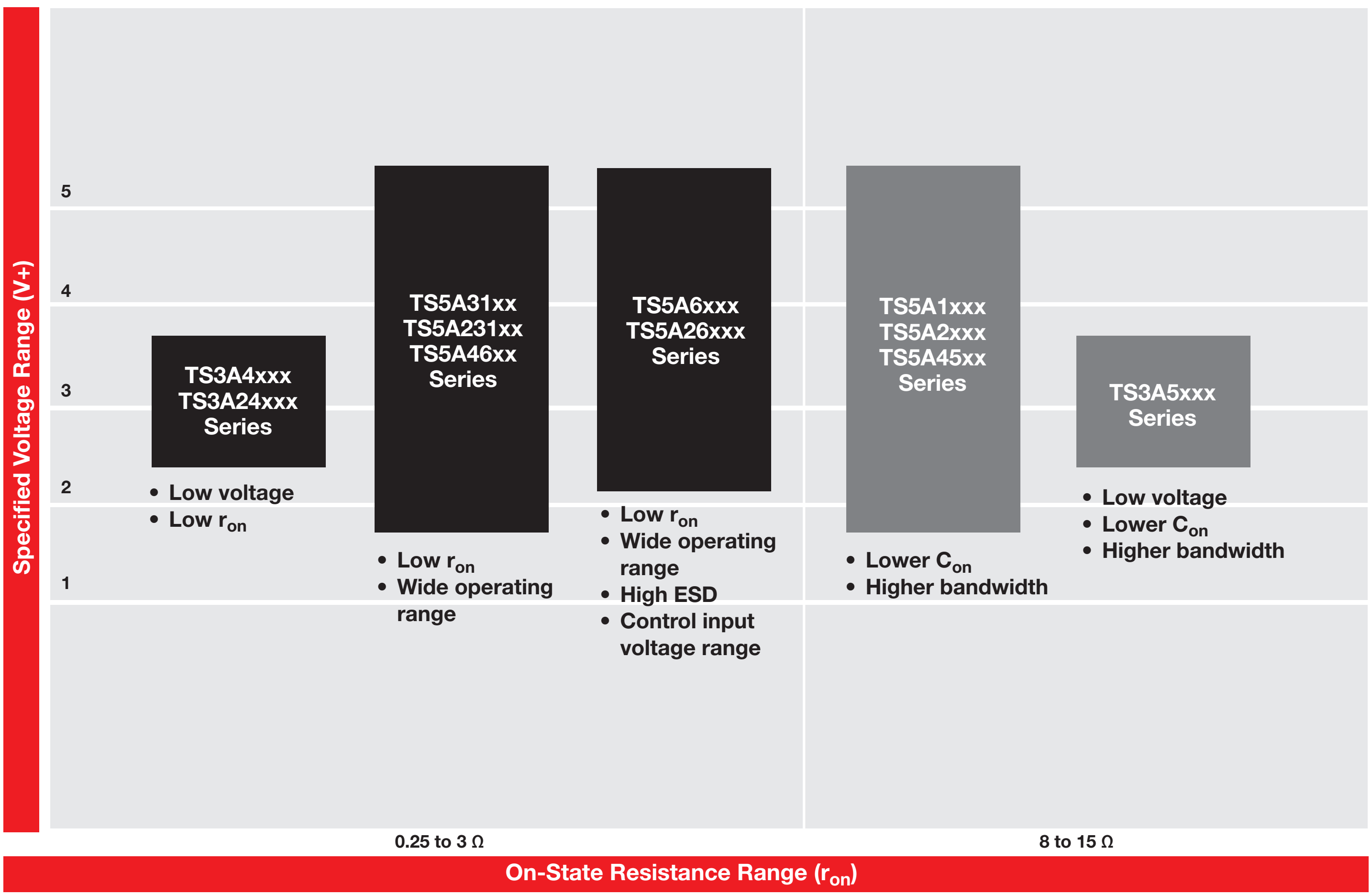
On-State Resistance Flatness [r_{on}(flat)]

- 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 40.
For the latest information on audio end-equipment system block diagrams, visit **www.ti.com/audio**

Audio Amplifiers (Class-D)

High-Power Analog-Input Class-D Speaker Amplifiers

Device	Description	Output Power (W)	Min Load Impedance (Ω)	Power Supply (V) (min)	Power Supply (V) (max)	Half Power THD+N at 1 kHz (%)	PSRR (dB)	Package(s)	Price*
TAS5630	300-W Stereo Analog-Input Closed-Loop Amplifier	300	4	25	50	0.03	80	QFP-64, PSSOP-44	5.45
TAS5615	150-W Stereo Analog-Input Closed-Loop Amplifier	150	8	25	50	0.03	80	QFP-64, PSSOP-44	4.45
TAS5613	150-W Stereo Analog-Input Closed-Loop Amplifier	150	4	18	36	0.025	80	QFP-64, PSSOP-44	4.45
TAS5611	125-W Stereo Analog-Input Closed-Loop Amplifier	125	4	18	36	0.025	80	QFP-64, PSSOP-44	4.30
TAS5412	Stereo, Automotive, Single-Ended Analog Inputs	100	2	6	24	0.04	75	HTQFP-64	5.30
TAS5422	Stereo, Automotive, Differential Analog Inputs	100	2	6	24	0.04	75	HTQFP-64	5.80
TAS5414A	Quad, Automotive, Single-Ended Analog Inputs	45	2	8	22	0.04	75	SSOP-36, HTQFP-64	8.80
TAS5424A	Quad, Automotive, Differential Analog Inputs	45	2	8	22	0.04	75	SSOP-44	10.75
TPA3106D1	40-W Mono Amp with Sync Pin	40	4	10	26	0.2	70	HLQFP-32	2.25
TPA3112D1	25-W Filter-Free Mono Amp with SpeakerGuard™ Technology	25	4	8	26	0.07	70	TSSOP-28	0.85
TPA3123D2	25-W Stereo Single-Ended Amp	25	4	10	30	0.08	60	HTSSOP-24	1.75
TPA3100D2	20-W Stereo Amp with Sync Pin	20	4	10	26	0.1	80	HTQFP-48, QFN-48	3.50
TPA3110D2	15-W Filter-Free Stereo Amp with SpeakerGuard Technology	15	4	8	26	0.07	70	TSSOP-28	1.45
TPA3122D2	15-W Stereo Single-Ended Amp in DIP Package	15	4	10	30	< 0.15	60	PDIP-20	0.99
TPA3124D2	15-W Stereo Single-Ended Amp with Fast Mute	15	4	10	26	0.04	60	TSSOP-24	1.45
TPA3121D2	15-W Stereo Single-Ended Amp	15	4	10	26	0.04	60	TSSOP-24	1.45
TPA3004D2	12-W Stereo Amp with DC Volume Control	12	4	8.5	18	0.1	80	HTQFP-48	3.25
TPA3125D2	10-W Stereo Single-Ended Amp in DIP Package	10	4	10	26	0.15	60	PDIP-20	0.85
TPA3101D2	10-W Stereo Amp with Sync Pin	10	4	10	26	0.1	80	HTQFP-48, QFN-48	3.10
TPA3111D1	10-W Filter-Free Mono Amp with SpeakerGuard Technology	10	4	8	26	0.07	70	TSSOP-28	0.90
TPA3002D2	9-W Stereo Amp with DC Volume Control	9	8	8.5	14	0.06	80	HTQFP-48	3.30
TPA3113D2	6-W Filter-Free Stereo Amp with SpeakerGuard Technology	6	4	8	26	0.07	70	TSSOP-28	0.85
TPA3003D2	3-W Stereo Amp with DC Volume Control	3	8	8.5	14	0.2	80	TQFP-48	3.00
TPA2008D2	Stereo, Med. Power, Volume Control, Ideal for Docking Stations	3	3	4.5	5.5	0.05	70	TSSOP	1.80

**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**.*

Low-Power Analog-Input Class-D Speaker Amplifiers

Device	Description	Stereo/ Mono	Output Power (W)	Min Load Impedance (Ω)	Power Supply (V) (min)	Power Supply (V) (max)	Half Power THD+N at 1 kHz (%)	PSRR (dB)	Package(s)	Price*
TPA2017D2	Stereo, Dynamic Range Compression, SmartGain™ AGC/DRC, GPIO Interface	Stereo	2.8	4	2.5	5.5	0.2	80	QFN	1.40
TPA2016D2	Dynamic Range Compression, SmartGain AGC/DRC, I^2C Interface	Stereo	2.8	4	2.5	5.5	0.2	80	WCSP	1.30
TPA2000D2	Medium Power, Ideal for Docking Stations	Stereo	2.5	3	4.5	5.5	0.05	77	TSSOP	1.55
TPA2000D4	Headphone Amp, Medium Power, Ideal for Docking Stations	Stereo	2.5	4	3.7	5.5	0.1	70	TSSOP	2.10
TPA2012D2	Smallest Stereo Amp in 2mm x 2mm WCSP Package	Stereo	2.1	4	2.5	5.5	0.2	75	WCSP, QFN	0.70
TPA2001D2	Lower Power, Ideal for Docking Stations	Stereo	1.25	8	4.5	5.5	0.08	77	TSSOP	1.65
TPA2100P1	Piezo Electric Speaker Driver	Mono	19 Vpp	1.5 µF Piezo	2.5	5.5	0.2	90	WCSP	1.30
TPA2011D1	External Gain with Integrated DAC Noise Filter	Mono	3.2	4	2.5	5.5	0.03	86	WCSP (0.4-mm pitch)	0.65
TPA2037/39D1	Fixed Gain with Integrated DAC Noise Filter 2V/V, 4 V/V	Mono	3.2	4	2.5	5.5	0.03	86	WCSP (0.4-mm pitch)	0.65
TPA2018D1	Dynamic Range Compression, SmartGain AGC/DRC, I^2C Interface	Mono	3.0	4	2.5	5.55	0.2	80	WCSP	0.90
TPA2035D1	Fully Differential, High Power, Fixed Gain, with Auto Recovery	Mono	2.75	4	2.5	5.5	0.2	75	WCSP	0.65
TPA2032/3/4D1	Smallest Solution Size, Fully Differential, Internal Gain 2 V/V, 3 V/V, 4 V/V	Mono	2.75	4	2.5	5.5	0.2	75	WCSP	0.45
TPA2013D1	Integrated Boost Converter, High and Constant Output Power	Mono	2.7	4	1.8	5.5	0.2	95	QFN, WCSP	1.05
TPA2036D1	Similar to TPA2010D1 with Short-Circuit Auto Recovery	Mono	2.5	4	2.5	5.5	0.2	75	WCSP	0.35
TPA2031D1	Similar to TPA2010D1 with Slower Start-Up	Mono	2.5	4	2.5	5.5	0.2	75	WCSP	0.60
TPA2010D1	Fully Differential, 1.45mm x 1.45mm WCSP Package, High Power	Mono	2.5	4	2.5	5.5	0.2	75	WCSP	0.55
TPA2015D1	Integrated Boost Converter with Battery Monitor for Constant Output Power	Mono	1.7	8	2.3	5.5	0.06	82	WCSP	TBD
TPA2014D1	Integrated Boost Converter, Medium and Constant Power	Mono	1.5	8	2.5	5.5	0.1	91	QFN, WCSP	0.90
TPA2006D1	Fully Differential, 1.8-V Compatible Shutdown Voltage	Mono	1.45	8	2.5	5.5	0.2	75	QFN	0.49
TPA2005D1	Fully Differential, Most Package Options	Mono	1.4	8	2.5	5.5	0.2	75	BGA, QFN, MSOP	0.49

See page 34 for complementary PWM processors for PurePath™ power stages.
**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**.*

Audio Amplifiers (Class-D)

Digital-Input Class-D Speaker Amplifiers (PurePath™)

Device	Description	Output Power (W)	2.1 Support	Closed Loop	Power Supply (PVDD) (min)	Power Supply (PVDD) (max)	Half Power THD+N at 1 kHz (%)	SNR (dB)	On Chip DRC/EQ	I^2C	Price*
TAS5701	20 W, Stereo, H/W Control	20	Yes (w/ext amp)	No	0	21	< 0.1	101	No	No	2.45
TAS5704	20 W, Stereo with Feedback, H/W Control	20	Yes	Yes	10	26	< 0.1	99	No	No	3.00
TAS5705	20 W, Stereo with Speaker EQ and DRC	20	Yes (w/ext amp)	No	8	23	< 0.1	105	Yes	Yes	2.45
TAS5706A	20 W, Stereo with Feedback, Speaker EQ and DRC	20	Yes (w/ext amp)	Yes	10	26	< 0.1	99	Yes	Yes	3.00
TAS5706B	20 W, Stereo with Feedback, Speaker EQ, DRC and 2.1 Support	20	Yes	Yes	10	26	< 0.1	99	Yes	Yes	3.00
TAS5707	20 W, Stereo with Speaker EQ and DRC	20	No	No	8	26	< 0.1	106	Yes	Yes	2.55
TAS5708	20 W, Stereo with Feedback, Speaker EQ and DRC	20	No	Yes	10	26	< 0.1	100	Yes	Yes	2.55
TAS5709	20 W, Stereo with Speaker EQ, 2-Band DRC and 3D	20	No	No	8	26	< 0.1	106	Yes	Yes	2.40
TAS5710	20 W, Stereo with Feedback, Speaker EQ, 2-Band DRC and 3D	20	No	Yes	10	26	< 0.1	100	Yes	Yes	2.65
TAS5711	20 W, Stereo with Speaker EQ, 2-Band DRC, 3D and 2.1 Support	20	Yes	No	8	26	< 0.1	106	Yes	Yes	2.75
TAS5713	25 W, Stereo with Speaker EQ and 2-Band DRC	25	No	No	8	26	< 0.1	106	Yes	Yes	TBD
TAS5716	20 W, Stereo with Feedback, Speaker EQ, DRC, 3D and 2.1 Support	20	Yes	Yes	10	26	< 0.1	99	Yes	Yes	3.15

See page 34 for complementary PWM processors for PurePath™ power stages.

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

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

PWM-Input Class-D Power Stages (PurePath™)

Device	Description	PBTL Power[1]	BTL Power[1]	SE Power[1]	Package(s)	Price*
TAS5182	Controller Only, For Use with External FETs	—	—	—	HTSSOP-56	6.60
TAS5186A	Highest Integration Power	—	—	5x30 W + 1x60 W	HTSSOP-44	5.50
TAS5103	15 W, Stereo, Supports 2 to 4 Channels, Pad Down Package	—	15	7.5	HTSSOP-32	1.80
TAS5602	20 W, Stereo with Feedback, Supports 2 to 4 Channels, Hi-Z Pin	—	20	10	HTSSOP-56	2.00
TAS5102	20 W, Stereo, Supports 2 to 4 Channels, Pad Up Package	—	20	10	HTSSOP-32	1.80
TAS5132	Stereo, Low Power	—	25	12	HTSSOP-44	2.10
TAS5122	Stereo, Low Power	—	30	—	HTSSOP-56	3.25
TAS5112A	Stereo, Medium Power	—	50	—	HTSSOP-56	4.05
TAS5111A	Mono, Medium Power	—	70	—	HTSSOP-32	2.40
TAS5121	Mono, High Power	—	100	—	SSOP-36	3.25
TAS5142	High Power, Pin Compatible with TAS5152	200	100	40	SSOP-36, HTSSOP-44	3.35
TAS5342LA	100 W, Stereo, Digital Power	214	113	42	HTSSOP-44	2.75
TAS5342A	100 W, Stereo, Digital Power	220	117	41	HTSSOP-44	2.95
TAS5152	High Power, Pin Compatible with TAS5142	240	125	45	SSOP-36	4.60
TAS5612	125-W Stereo PWM-Input Closed-Loop Amplifier	250	125	45	QFP-64, PSSOP-44	4.30
TAS5352A	125 W, Stereo, Digital Power	268	138	48	HTSSOP-44	3.10
TAS5614	150-W Stereo PWM-Input Closed-Loop Amplifier	300	150	50	QFP-64, PSSOP-44	4.45
TAS5616	150-W Stereo PWM-Input Closed-Loop Amplifier	300	150	75	QFP-64, PSSOP-44	4.45
TAS5261	Mono, High Power	—	210	—	SSOP-36	5.25
TAS5162	Stereo, High Power	331	210	99	SSOP-36, HTSSOP-44	4.95
TAS5631	300-W Stereo PWM-Input Closed-Loop Amplifier	600	300	150	QFP-64, PSSOP-44	5.45
TAS5176	6-Channel, Medium Power	—	2x30 W +1x40 W	5x15 W + 1x25 W	HTSSOP-44	4.30

[1] These power indications should be considered a guide, as final power output capability will rely heavily on external factors such as heat dissipation techniques, power supply ripple and speaker load impedance.

See page 34 for complementary PWM processors for PurePath™ power stages.

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

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

Audio Amplifiers (Class-AB, Class-G)

Class-AB Speaker Amplifiers

Device	Description	Stereo/ Mono	Output Power (W)	Min Load Impedance (Ω)	Power Supply (V) (min)	Power Supply (V) (max)	Half Power THD+N at 1 kHz (%)	PSRR (dB)	Package(s)	Price*
TPA1517	Mute, Medium Power, Low Cost, DIP Package, Single Ended	Stereo	6	4	9.5	18	0.15	65	PDIP-20, SO-20	1.05
TPA6030A4	Stereo with Stereo HP, Wide Supply Voltage, Low Power, Volume Control, Fully Differential	Stereo	3	16	7	15	0.06	60	HTSSOP-28	1.40
TPA6013A4	Stereo Audio Power Amplifier with Advanced DC-Volume Control and Input Mux	Stereo	3	3	4.5	5.5	< 0.8	82	PowerPAD™	0.50
TPA6012A4	Stereo Audio Power Amplifier with Advanced DC-Volume Control	Stereo	3	3	4.5	5.5	< 0.8	82	PowerPAD	1.20
TPA6011A4	Stereo with Stereo HP, Volume Control, Fully Differential	Stereo	3	3	4	5.5	0.06	70	HTSSOP-24	1.20
TPA6020A2	Fully Differential, Low Voltage, Smallest Package	Stereo	2.8	3	2.5	5.5	0.05	85	QFN-20	0.60
TPA6017A2	Cost Effective, Internal Gain, Fully Differential	Stereo	2.6	3	4.5	5.5	0.1	77	HTSSOP-20	0.99
TPA6010A4	Stereo with Stereo HP, Volume Control and Bass Boost, Fully Differential	Stereo	2.6	3	4.5	5.5	0.06	67	HTSSOP-28	2.25
TPA0212	Stereo with Stereo Headphone, Internal Gain, Low-Cost Computing Solution	Stereo	2.6	3	4.5	5.5	0.15	77	TSSOP	1.10
TPA6021A4	Stereo with Stereo HP, Volume Control, Fully Differential	Stereo	2	4	4	5.5	0.19	70	PDIP-20	1.00
TPA0172	Stereo with Stereo Headphone, Mute Function, I^2C Volume Control	Stereo	2	4	4.5	5.5	0.08	75	TSSOP	2.60
TPA6211A1	Fully Differential, Highest Power	Mono	3.1	3	2.5	5.5	0.05	85	MSOP, QFN	0.55
TPA0233	Mono with Stereo Headphone, Summed Inputs	Mono	2.7	4	2.5	5.5	0.06	75	MSOP	1.05
TPA6204A1	Fully Differential, High Power	Mono	1.7	8	2.5	5.5	0.05	85	QFN	0.35
TPA6205A1	Fully Differential, 1.8-V Compatible Shutdown Voltage	Mono	1.25	8	2.5	5.5	0.06	90	MSOP, QFN, BGA	0.32
TPA6203A1	Fully Differential, Lower Cost Solution	Mono	1.25	8	2.5	5.5	0.06	90	BGA	0.45
TPA751	Differential Inputs, Active Low	Mono	0.9	8	2.5	5.5	0.15	78	SOIC, MSOP	0.35
TPA731	Differential Inputs, Active High	Mono	0.9	8	2.5	5.5	0.15	78	SOIC, MSOP	0.35
TPA721	Single Ended Inputs, Active High	Mono	0.9	8	2.5	5.5	0.15	85	SOIC, MSOP	0.35
TPA711	Single Ended Inputs, Active High, Mono Headphone	Mono	0.9	8	2.5	5.5	0.15	85	SOIC, MSOP	0.35

See page 34 for complementary PWM processors for PurePath™ power stages.
**Suggested resale price in U.S. dollars in quantities of 1,000.*
*New products are listed in **bold red**.*

Class-G Amplifiers, Class-AB Headphone Amplifiers

Device	Description	Output Power (W)	Min Load Impedance (Ω)	Power Supply (V) (min)	Power Supply (V) (max)	Half Power THD+N at 1 kHz (%)	PSRR (dB)	Package(s)	Price*
Class-G Amplifiers									
TPA6140A2	DirectPath™, High-Efficiency Class-G, I^2C Volume Control, Hi-Z Mode	0.025	16	2.5	5.5	0.0025	109	WCSP	0.95
TPA6141A2	DirectPath, High-Efficiency Class-G, Hi-Z Mode	0.025	16	2.5	5.5	0.0025	109	WCSP	0.85
Class-AB Headphone Amplifiers									
TPA6136A2	DirectPath, Fixed Gain, Hi-Z Mode	0.025	16	2.5	5.5	0.0025	109	WCSP	0.70
TPA6135A2	DirectPath, Fixed Gain, Hi-Z Mode	0.025	16	2.5	5.5	0.0025	109	QFN	0.55
TPA6132A2	DirectPath, Fixed Gain	0.025	16	2.5	5.5	0.0025	109	QFN	0.55
TPA6130A2	DirectPath with I^2C Volume Control	0.138	16	2.5	5.5	0.0025	109	QFN, WCSP	0.90
TPA6120A2	Hi-Fi, Current Feedback, 80 mW into 600 Ω from a ±12-V Supply at 0.00014% THD+N	1.5	32	10	30	0.0005	75	SO-20	2.05
TPA6112A2	Differential Inputs, 10-µA ISD	0.15	8	2.5	5.5	0.25	83	MSOP-10	0.39
TPA6111A2	Low Cost, Headphone, SOIC Package, 1-µA ISD	0.15	8	2.5	5.5	0.25	83	SOIC-8, MSOP-8	0.33
TPA6110A2	Headphone, 10-µA ISD	0.15	8	2.5	5.5	0.25	83	MSOP-8	0.39
TPA6102A2	Ultra-Low Voltage, Fixed Gain (14 dB)	0.05	16	1.6	3.6	0.1	72	SOIC-8, MSOP-8	0.50
TPA6101A2	Ultra-Low Voltage, Fixed Gain (2 dB)	0.05	16	1.6	3.6	0.1	72	SOIC-8, MSOP-8	0.35
TPA6100A2	Ultra-Low Voltage, External Resistors	0.05	16	1.6	3.6	0.1	72	SOIC-8, MSOP-8	0.45
TPA4411	DirectPath, Internal Gain	0.08	16	1.8	4.5	0.08	80	DSBGA-16, QFN-20	0.85
TPA152	Hi-Fi, Mute	0.075	32	4.5	5.5	0.007	81	SOIC-8	0.70

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

Audio Amplifiers (Class-AB)

Low-Power Audio Amplifier Sub-Systems

Device	Description	Speaker Output Power (W)	Headphone Output Power (W)	Half Power THD+N at 1 kHz (%)	PSRR (dB)	Power Supply (V) (min)	Power Supply (V) (max)	Package(s)	Price*
TPA6040A4	Stereo Class-AB and DirectPath™ Headphones and 4.75-V LDO	2.3	0.2	0.1	80	4.5	5.5	5x5 QFN-32	0.99
TPA6041A4	Stereo Class-AB and DirectPath Headphones and 3.3-V LDO	2.6	0.2	0.1	80	4.5	5.5	5x5 QFN-32	1.15
TPA6045A4C	Stereo Class-AB and DirectPath headphones and 3.3-V LDO	2.3	0.2	0.1	80	4.5	5.5	5x5 QFN-32	1.15
TPA6047A4	Stereo Class-AB and DirectPath headphones and 3.3-V LDO	2.6	0.06	0.1	65	4.5	5.5	5x5 QFN-32	1.15
TPA2050D4	Stereo Class-D and DirectPath Headphones (2 Inputs)	2.4	4	2.5	5.5	0.1	75	WCSP	1.25
TPA2051D3	Mono Class-D Sub-system with DirectPath Headphone Amplifier and SpeakerGuard™ (3 Inputs)	2.9	4	2.5	5.5	0.1	75	WCSP	0.75
TPA2054D4	Stereo Class-D and DirectPath Headphones (3 Inputs)	2.4	4	2.5	5.5	0.1	75	WCSP	1.30

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

Audio Preamplifiers and Line Drivers

Microphone Preamplifiers

Device	Description	Gain Range (dB)	Noise (E_{IN}), G = 30 dB	Half Power THD+N at 1 kHz (%)	Power Supply (V)	Package(s)	Price*
PGA2500	Digitally Controlled, Fully Differential, High Performance, Low Noise, Wide Dynamic Range, On-Chip DC Servo Loop	0 dB, and 10 dB to 65 dB in 1-dB Steps	–128 dBu	0.0004	±5	SSOP-28	7.95
PGA2505	Digitally Controlled, Fully Differential, High Performance, Low Noise, Wide Dynamic Range, On-Chip DC Servo Loop	0 dB, and 10 dB to 60 dB in 3-dB Steps	50	0.03	80	QFP-64, PSSOP-44	4.95
Device	**Description**	**Slew Rate (V/µs)**	**GBW (MHz)**	**Half Power THD+N at 1 kHz (%)**	**Power Supply (V)**	**Package(s)**	**Price***
INA163	Mono, Low Noise, Low Distortion, Current Feedback, Wide Bandwidth, Wide Range of Gain	15	8	0.0003	±4.5 to ±18	SO-14	2.90
INA217	Mono, Low Noise, Low Distortion, Current Feedback, Wide Bandwidth, Wide Range of Gain	15	8	0.004	±4.5 to ±18	PDIP-8, SOIC-16	2.50

Suggested resale price in U.S. dollars in quantities of 1,000. *New products are listed in **bold red**.*

Line Drivers

Device	Description	Power Supply (V)	Half Power THD+N at 1 kHz (%)	Slew Rate (V/µs)	GBW (MHz)	Package(s)	Price*
DRV134	Balanced Output, DIP Pkg., Companion to INA134 and INA137	±4.5 to ±18	0.0005	12	1.5	SOIC-16, PDIP-8	1.95
DRV135	Balanced Output, Small Pkg., Companion to INA134 and INA137	±4.5 to ±18	0.0005	12	1.5	SOIC-8	1.95
Line Receivers							
INAy134[1]	Differential, Fixed Gain, 0 dB (G=1) 1 V/V	±4 to ±18	0.0005	14	3.1	PDIP-8/14, SOIC-8/14	1.05
INAy137[1]	Differential, ±6 dB (G=1/2 or 2)	±4 to ±18	0.0005	14	4	PDIP-8/14, SOIC-8/14	TBD

[1] y denotes dual and/or quad versions are available.
Suggested resale price in U.S. dollars in quantities of 1,000.

DirectPath™ 2-V_{RMS} Line Drivers

Device	Description	Gain (V/V)	Power Supply (V)	Slew Rate (V/µs)	Drive Capability	Price*
DRV600	Fixed-Gain, Single-Supply, Ground-Biased Output 2-V_{RMS} Line Driver	1.5	±1.8 to ±4.5	2.2	2 V_{RMS} 600-Ω Load	0.95
DRV601	Variable-Gain, Single-Supply, Ground-Biased Output 2-V_{RMS} Line Driver	Variable	±1.8 to ±4.5	2.2	2 V_{RMS} 600-Ω Load	0.75
DRV602	Differential Input, Variable Gain 2-V_{RMS} Line Driver	Variable	±1.8 to ±4.5	2.2	2 V_{RMS} into 2500 Ω	0.70
DRV603	Differential Input, Variable Gain 2-V_{RMS} with Powersense Technology	Variable	±1.8 to ±5.5	2.2	2 V_{RMS} into 2500 Ω	0.85

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

Line Driver and Headphone Amplifier

Device	Description	Line Driver: Drive Capability	Line Driver: THD+N at 5 kΩ	Line Driver: Gain	Headphone: Output Power (W)	Headphone: Min Load Impedance (Ω)	Headphone: THD+N at 32 Ω	Power Supply (V) (min)	Power Supply (V) (max)	Package	Price*
DRV604	DirectPath™ 2-V_{RMS} Line Driver and Headphone Amp	2 V_{RMS} into 5 kΩ	0.001%	Variable	0.04	16	0.02%	2.9	3.7	HTSSOP-28	1.05

Suggested resale price in U.S. dollars in quantities of 1,000. *New products are listed in **bold red**.*

Signal Conditioning Amplifiers and Volume Controls

Signal Conditioning Amplifiers

Device	Description	Channel(s)	Power Supply (V)	Half Power THD+N at 1 kHz (%)	Slew Rate (V/µs)	GBW (MHz)	Package(s)	Price*
FET Amplifiers								
OPA164x	High Performance, Ultra-Low Distortion, JFET-Input	1, 2, 4	±2.25 to ±18	0.00005	22	11	SOIC-8, MSOP-8 SO-14, TSSOP-14	0.95
OPAx827	Ultra-Low THD+N, High Precision	1, 2	±4 to ±18	0.00004	22	18	MSOP, SOIC	5.75
OPAx627	Difet™, Low Noise, High Slew Rate	1	±4.5 to ±18	0.00003	55	16	PDIP-8, SOIC-8	12.25
OPAx604	FET Input, Low Distortion, Single Channel, Wide Supply Range, Unity Gain Stable	1, 2	±4.5 to ±24	0.0003	25	20	PDIP-8, SOIC-8	1.05
OPAx134	High Performance, Ultra-Low Distortion, True FET-Input	1, 2, 4	±2.5 to ±18	0.00008	20	8	PDIP-8, SOIC-8/14	1.00
Bipolar Amplifiers								
OPA1611/12	High Performance, Ultra-Low Distortion, Low Noise: 1.1 nV/√Hz, Low Power: 3.6 mA/Channel, High Precision	1, 2	±2.5 to ±18	0.000015	27	45	SOIC	1.75
OPA1632	High Performance, Fully Differential, High Speed, Wide Supply Range, High Gain Bandwidth	1	5 to 32	0.00003	50	180	MSOP-8, SOIC-8	1.75
OPAx228	High Precision, Low Noise: 3nV/√Hz, Improved Settling Time: 5 µs	1, 2, 4	±2.5 to ±18	0.00005	10	33	PDIP-8/14, SOIC-8/14	1.10
OPAx353	Single Supply, Rail-to-Rail, Unity Gain Stable	1, 2, 4	2.7 to 5.5	0.0006	22	44	MSOP-8, SOIC-8/16	1.00
MC33078	Dual, Bipolar, Dual Supply Operation, Skew Rate of 7 V/µs (typ), Input Noise Voltage of 4.5nV/√Hz	2	±10 to ±36	—	7	16	MSOP-8, PDIP-8, SOIC-8	0.30
NE5532A/4A	Low Noise, Input Noise Voltage of 3.5nV/√Hz (5532A) and 5nV/√Hz (5534A)	2/1	±3 to ±20	—	9/13	10	PDIP-8, SO-8, SOIC-8	0.50
RC4580	Dual, Lower Noise, High Gain, Wide Bandwidth, Capable of Driving 20-V Peak-to-Peak into 400-Ω Loads	2	±2 to ±18	0.0005	5	12	PDIP-8, SOIC-8, TSSOP-8	0.41
RC4560	Dual, High Gain, Wide Bandwidth, Capable of Driving 20-V Peak-to-Peak into 400-Ω Loads	2	±2 to ±18	0.05	5.5	15	PDIP-8, SOIC-8, TSSOP-8	0.41

Suggested resale price in U.S. dollars in quantities of 1,000.* *New products are listed in **bold red.*

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

Audio Converters

Audio ADCs

Device	Description	Portable Focus	Dynamic Range (dB)	No. of Inputs/No. of Outputs	Sampling Rate (max) (kHz)	Audio Data Format	Power Supply (V)	Package(s)	Price*
PCM4222	2-Channel, High-Performance ΔΣ ADC	—	124	2/0	216	6-Bit Modulator, DSD, Normal, I^2S, TDM	+3.3, +4	TQFP-48	14.95
PCM4220	2-Channel, High-Performance ΔΣ ADC	—	123	2/0	216	Normal, I^2S, TDM	+3.3, +4	TQFP-48	9.95
PCM4204	4-Channel, High-Performance ΔΣ ADC, PCM or DSD, High Pass Filter	—	118	4/0	216	Normal, I^2S, DSD, TDM	+3.3, +5	TQFP-64	7.95
PCM4202	Stereo, High-Performance ΔΣ ADC, PCM or DSD, High Pass Filter	—	118	2/0	216	Normal, I^2S, DSD	+3.3, +5	SSOP-28	4.95
PCM4201	Mono, High-Performance ΔΣ ADC, PCM or DSD, High Pass Filter, Wide Digital Supply Range, Low Power Dissipation	—	112	1/0	108	Normal, DSP	+3.3, +5	TSSOP-16	2.50

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

Audio Converters

Audio ADCs and DACs

Device	Description	Portable Focus	Dynamic Range (dB)	No. of Inputs/No. of Outputs	Sampling Rate (max) (kHz)	Audio Data Format	Power Supply (V)	Package(s)	Price*
Audio ADCs (Continued)									
PCM1804	Stereo ADC, Fully Differential, High Pass Filter	—	112	2/0	192	Normal, I²S, DSD	+3.3, +5	SSOP-28	3.95
PCM1802	Stereo ADC, SE Input	—	105	2/0	96	Normal, I²S	+3.3, +5	SSOP-20	3.35
PCM1803A	Stereo ADC, SE Input, High Pass Filter	—	103	2/0	96	Normal, I²S	+3.5, +5	SSOP-20	1.10
PCM1850A/1A	Stereo ADC w/2 x 6 Input MUX and PGA, SPI (1850) and I²C (1851) Control	—	101	2/0	96	Normal, I²S	+3.3, +5	TQFP-32	4.80
PCM1807A/8A	Stereo ADC, SE Input, Mute w/Fade, SPI Control, S/W (1807) H/W (1808) Controlled	—	101	2/0	96	I²S, L	+3.5, +5	TSSOP-14	1.00
TLV320ADC3101	Low-Power Stereo Audio ADC with Internal PLL and Highly Flexible Digital Filtering; 6 Inputs	✔	92	6/0	96	I²S, L, R, DSP and TDM	+2.7, +3.6	QFN-24	1.55
TLV320ADC3001	Low-Power Stereo Audio ADC with Internal PLL and Highly Flexible Digital Filtering; 3 Inputs	✔	92	3/0	96	I²S, L, R, DSP and TDM	+2.7, +3.6	WCSP-16	1.45
PCM1870A	Stereo ADC, SE Input, Digital Filter, Very Low Power Consumption	✔	90	2/0	50	Normal, I²S, DSP	+2.4, +3.6	QFN-24	1.70
Audio DACS									
PCM1792A	Stereo, Optional DSD Format, External Filter and DSP Interface, SPI/I²C, Differential Output Current: 7.8 mA_{P-P}	—	132	0/2	192	Standard, I²S, L	+3.3, +5	SSOP-28	10.65
PCM1796/8	Stereo Advanced Segment, 123-dB Dynamic Range, TDMCA Serial Interface (1798)	—	123	0/2	192	Standard, I²S, L	+3.5, +5	SSOP-28	2.95
PCM4104	4 Channel, High Performance, Sampling Rate up to 216kHz, H/W or S/W Controlled	—	118	0/4	216	Normal, I²S, TDM	+3.3, +5	TQFP-48	4.95
PCM1791A	Stereo Advanced Segment DAC, Optional DSD Format, External Filter and DSP Interface, SPI/I²C Differential Output Current: 3.2 mV_{P-P}	—	113	0/2	192	Normal, I²S, TDMCA	+3.3, +5	SSOP-28	2.25
PCM1793	Stereo Advanced Segment DAC, Balanced Voltage Outputs, Improved Clock Jitter	—	113	0/2	192	Normal, I²S, Left Justified	+3.3, +5	SSOP-28	2.25
PCM1789	Stereo, Differential Output DAC, SPI/I²C or H/W Control	—	113	0/2	192	I²S, Left, Right Justified	+3.3, +5	TSSOP-24	1.90
PCM1780/81/82	Stereo with Volume Control, Software (1780/82) and Hardware (1781), Open-Drain Output Zero Flag (1782), Improved Jitter Performance	—	106	0/2	192	Normal, I²S	+5	SSOP-16	1.10
TLV320DAC23	I²C and SPI Control with Headphone Amp, P_{diss} = 23 mW	✔	100	0/2	96	Normal, I²S, DSP	+1.5 to +3.3	VFBGA-80	2.00
PCM1770/1	Stereo with Integrated Headphone Driver, Software (1770) and Hardware (1771) Controlled	✔	98	0/2	48	Normal, I²S	+1.6 to +3.6	TSSOP-28, QFN-28, TSSOP-16, QFN-20	1.35
PCM1772/3	Stereo with Integrated Line Out, Software (1772) and Hardware (1773) Controlled	✔	98	0/2	48	Normal, I²S	+1.6 to +3.6	TSSOP-16, QFN-20	1.35
TLV320DAC26	Integrated PLL, SPI Control, Speaker/Headphone Amp, P_{diss} = 11 mW	✔	97	2/2	53	Normal, I²S, DSP	+2.7 to +3.6	QFN-32	2.45
TLV320DAC3120	Mono DAC with 2.5 W into 4-Ω Mono Class-D Speaker Amplifier	✔	95	2/2	192	I²S, L, R, DSP, TDM	+2.7 to +3.6	QFN-32	1.75
TLV320DAC32	Low-Power Stereo DAC with PLL and Stereo HP/Speaker Amplifiers	✔	95	2/4	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN-32	1.35
PCM1774	Low-Power Stereo DAC with HP Amplifier, Sound Effect	✔	93	0/2	50	LJ, RJ, I²S, DSP	+3.3	QFN-20	1.50
PCM4104	4 Channel, High Performance, Sampling Rate up to 216 kHz, H/W or S/W Controlled	—	118	0/4	216	Normal, I²S, TDM	+3.3, +5	TQFP-48	4.95
PCM1690	Octal DAC, Single-Ended Outputs, SPI/I²C or H/W Control Differential Outputs	—	113	0/8	192	I²S TDM, Left, Right Justified	+3.3, +5	HTSSOP-48	2.60
PCM1691	Octal DAC, Single-Ended Outputs, SPI/I²C or H/W Control	—	111	0/8	192	I²S TDM, Left, Right Justified	+3.3, +5	HTSSOP-48	2.50
DSD1608	8-Channel, Enhanced Multiformat ΔΣ DAC, Supports DSD with TDMCA	—	108	0/8	192	Normal, I²S, DSD	+3.3, +5	TQFP-52	6.40
PCM1680	8-Channel, Low-Cost DAC, Improved Jitter Performance, Pin Compatible with PCM1780	—	103	0/8	192	Normal, I²S	+5	SSOP-24	1.50
PCM1606	6-Channel, Low-Cost CMOS, Multilevel	—	103	0/6	192	Normal, I²S	+5	SSOP-20	2.00

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

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

Audio Codecs and Controllers

Audio Codecs

Device	Description	Portable Focus	SNR ADC (dB)	Dynamic Range (dB)	Sampling Rate (max) (kHz)	Audio Data Format	Power Supply (V)	Package(s)	Price*
PCM3168A	High-Performance, 6 Inputs, 8 Outputs Audio Codec	—	107	112	96	Normal, I²S, DSP, TDM	3.3 to 5	HTQFP-64	4.60
PCM3052A	Stereo Codec with Integrated Mic Preamp and S/PDIF Output	—	101	105	96	I²S	+3.3, +5	VQFN-32	3.00
PCM3060	Asynchronous Stereo Codec	—	99	104	192	I²S, L, R	+3.3, +5	TSSOP-28	2.10
TLV320AIC3107	Low-Power Stereo Codec, Integrated PLL, 10 Inputs (Mic/Line), 7 Outputs (Line, Headphone, Mono Integrated Class-D Amp)	✔	92	102	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN	2.55
TLV320AIC3106	Low-Power Stereo Codec, Integrated PLL, 10 Inputs (Mic/Line), 7 Outputs (Line, Headphone), Notch Filtering, Low-Power Analog Bypass	✔	92	102	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN-32, BGA-80	2.25
TLV320AIC3254	Low-Power Stereo Codec, Integrated PLL, Integrated LDO, PowerTune™ Technology, 6 SE/3 Differential Inputs, 4 Outputs (Stereo Line Out and Stereo HP), Integrated miniDSP for Enhanced Custom Audio Processing	✔	93	100	192	I²S, L, R, DSP, TDM	+1.5 to +3.6	QFN-32	3.95
TLV320AIC3204	Low-Power Stereo Codec, Integrated PLL, Integrated LDO, PowerTune Technology, 6 SE/3 Differential Inputs, 4 Outputs (Stereo Line Out and Stereo HP), Effects Processing	✔	93	100	192	I²S, L, R, DSP, TDM	+1.5 to +3.6	QFN-32	2.25
PCM3000	Stereo Audio Codec 18-Bits, Serial Interface, Software Controlled	✔	—	98	48	Normal, I²S, DSP	+4.5 to +5.5	SSOP-28	3.45
PCM3001	Stereo Audio Codec 18-Bits, Serial Interface, Hardware Controlled	✔	—	98	48	Normal, I²S, DSP	+4.5 to +5.5	SSOP-28	3.45
PCM3006	Low Power, 3-V Supply, Stereo Codec, Hardware Controlled	✔	—	93	48	Normal	+2.7 to +3.6	SSOP-24	3.45
PCM3794A	Ultra-Low-Power Stereo Codec, 6 Inputs (Mic/Line), 5 Outputs (Line/HP)	✔	—	93	48	Normal, I²S, DSP	+2.4 to +3.6	QFN-32	4.55
PCM3793A	Ultra-Low-Power Stereo Codec, 6 Inputs (Mic/Line), 3 Outputs (Line/HP/Class-D Speaker)	✔	—	93	48	Normal, I²S, DSP	+2.4 to +3.6	QFN-32	4.85
PCM3008	Low Power, 2.4-V Single Supply, Stereo Codec, Low Cost, Hardware Controlled	✔	—	88	48	Normal, I²S	+2.1 to +3.6	TSSOP-16	3.10
TLV320AIC3105	Low-Power Stereo Codec, Integrated PLL, 6 SE Inputs (Mic/Line), 6 Outputs (Line, Headphone), Notch Filtering, Low-Power Analog Bypass	✔	92	102	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN-32	1.95
TLV320AIC3104	Low-Power Stereo Codec, Integrated PLL, 6 Inputs (MicLine), 6 Outputs (Line, Headphone), Notch Filtering, Low-Power Analog Bypass	✔	92	102	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN-32	1.95
TLV320AIC3101	Low-Power Stereo Codec, Integrated PLL, 6 Inputs (Mic/Line), 6 Outputs (Line, Headphone/Speaker), Notch Filtering, Low-Power Analog Bypass	✔	92	102	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN-32	2.10
TLV320AIC34	Low-Power Quad Stereo (4-Channel) Codec, 12 Inputs (Mic/Line), 14 Outputs (Line, Headphone/Speaker), 2 PLLs and Audio Serial Buses Allow Fully Asynchronous Simultaneous Codec Operation	✔	92	102	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	BGA-87	3.95
TLV320AIC33	Low-Power Stereo Codec, Integrated PLL, 6 Inputs, 3 Line Out and Speaker/HP Outputs	✔	90	102	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN-48, BGA-80	3.45
TLV320AIC31/32	Low-Power Stereo Codec, Integrated PLL, 6 Inputs (AIC32 – 6 Single-Ended, AIC31 – 2 Differential and 2 Single Ended) 2 Line Out and Speaker/HP Outputs	✔	90	100	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN-32	3.25
TLV320AIC36	Low-Power Stereo Audio Codec, Integrated PLL, 5 Inputs (3 MICs + 2 Line), 6 Outputs (Stereo HP, Stereo Line, Stereo Receiver), Digital Mic Support, Advanced Programmable Filter Engines, Low-Power Bypass	✔	—	100	96	I²S, L, R, DSP, TDM	+2.5 to +3.3	BGA-80	4.25
TLV320AIC23B	Low Power, Lower Cost, Stereo Codec with Headphone Amps	✔	92	100	96	I²S, L, R	+2.7 to +3.3	VFBGA-80, TSSOP-28, QFN-28	3.35
TLV320AIC3111	Low-Power Stereo Audio Codec, Integrated PLL, 6 Inputs, 6 Outputs, Digital Mic Support, Integrated Stereo Headphone Amplifier and Stereo Class-D Speaker Amplifier and Integrated miniDSP	✔	90	95	96	I²S, L, R, DSP, TDM	+2.7 to +3.3	QFN-32	2.95
TLV320AIC3007	Low-Power Stereo Codec, Integrated Class-D Amp, 7 Inputs, 6 Outputs	✔	87	93	96	Normal, I²S, DSP, TDM	+2.7 to +3.6	QFN-40	2.35
TLV320AIC3120	Mono Codec with 2.5 W into 4-Ω Mono Class-D Speaker Amplifier and Integrated miniDSP, 2 Inputs, 2 Outputs	✔	90	95	192	I²S, L, R, DSP, TDM	+2.7 to +3.6	QFN-32	2.25
TLV320AIC3110	Mono ADC, Stereo DAC with Stereo Class-D Speaker Amplifier, 2 Inputs, 2 Outputs	✔	90	95	192	I²S, L, R, DSP, TDM	+2.7 to +3.6	QFN-32	2.25
TLV320AIC3100	Mono ADC, Stereo DAC with 2.5 W into 4-Ω Mono Class-D Speaker Amplifier, 3 Inputs, 2 Outputs	✔	90	95	192	I²S, L, R, DSP, TDM	+2.7 to +3.6	QFN-32	1.95

**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**.*

Audio Codecs and Controllers

Voiceband Codecs

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 (mW) (typ)	Package(s)	Price*
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 (Bits) (max)	Dynamic Range DAC (dB)	Dynamic Range ADC (dB)	Sampling Rate (max) (kHz)	Configuration	Audio Data Format	Power Supply (V)	Package(s)	Price*
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
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
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
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
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 USB Audio

Integrated Sample Rate Converters and S/PDIF – AES/EBU Transceivers

Device	Description	# SRC Channel(s)	THD+N (dB)	Sample Rate (max) (kHz)	Digital Audio Interface	Control Interface	Dynamic Range (dB)	AES Receive	AES Transmit	Power Supply (V)	Package	Price*
SRC4392	High-End Combo Sample Rate Converter	2	–140	216	AES/EBU, S/PDIF, I^2S, R, L	I^2C, SPI	144	Yes	Yes	1.8, 3.3	TQFP-48	8.50
SRC4382	Combo Sample Rate Converter	2	–125	216	AES/EBU, S/PDIF, I^2S, R, L	I^2C, SPI	128	Yes	Yes	1.8, 3.3	TQFP-48	6.50
Stand-Alone Sample Rate Converters												
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

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

Integrated Sample Rate Converters and S/PDIF – AES/EBU Transceivers (Continued)

Device	Description	# SRC Channel(s)	THD+N (dB)	Sample Rate (max) (kHz)	Digital Audio Interface	Control Interface	Dynamic Range (dB)	AES Receive	AES Transmit	Power Supply (V)	Package	Price*
SRC4192	High-End Sample Rate Converter	2	–140	212	I²S, R, L, TDM	H/W	144	—	—	3.3	SSOP-28	5.95
SRC4193	High-End Sample Rate Converter	2	–140	212	I²S, R, L, TDM	SPI	144	—	—	3.3	SSOP-28	5.95
SRC4194	4-Channel, Asynchronous Sample Rate Converter	4	–140	212	I²S, R, L, TDM	SPI	144	—	—	1.8, 3.3	TQFP-64	9.95
Stand-Alone S/PDIF and AES/EBU Interfaces												
DIX4192	Digital Audio Interface Transceiver	0	—	216	AES/EBU, S/PDIF, I²S, R, L, TDM	I²C, SPI	—	Yes	Yes	1.8, 3.3	TQFP-48	4.95
DIX9211	216-kHz Digital Audio Transceiver	0	—	216	AES/EBU, S/PDIF, I²S, R, L	I²S, SPI, H/W	—	Yes	Yes	3.3, 5	LQFP-48	TBD
PCM9211	216-kHz Digital Audio Transceiver with 101-dB Stereo ADC	0	–93 (ADC)	216	AES/EBU, S/PDIF, I²S, R, L	I²S, SPI, H/W	101 (ADC)	Yes	Yes	3.3, 5	LQFP-48	TBD
DIT4192	192-kHz Digital Audio Transmitter	0	—	192	AES/EBU, S/PDIF, I²S, R, L	H/W, SPI	—	No	Yes	3.3, 5	TSSOP-28	1.95
DIT4096	96-kHz Digital Audio Transmitter	0	—	96	AES/EBU, S/PDIF, I²S, R, L	H/W, SPI	—	No	Yes	3.3, 5	TSSOP-28	1.65
DIR9001	96-kHz Digital Audio Receiver	0	—	96	AES/EBU, S/PDIF, I²S, R, L	H/W	—	Yes	No	3.3	TSSOP-28	2.10

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

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

USB Peripherals

Device	Speed(s)	Voltage (V)	Remote Wakeup	Package	Description	Price*
TUSB3210	Full	3.3	Yes	LQFP-64	USB Full-Speed General-Purpose Device Controller	2.50
TUSB3410	Full	3.3	Yes	LQFP-32	USB-to-Serial Converter (RS-232, RS-485)	2.25
TUSB6250	Full, High	3.3	Yes	TQFP-80	USB 2.0 High-Speed, Low-Power ATA/ATAPI Bridge Solution	2.80

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

USB On-The-Go (OTG) Devices

Device	Speed	Voltage (V)	Local Bus Interface	Package	Description	Price*
TUSB6020	High	1.5, 1.8, 3.3	VLYNQ™	80 MicroStar BGA™	USB 2.0 High-Speed On-The-Go to VLYNQ Controller	6.50

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

USB Transceivers

Device	Speed(s)	Voltage (V)	Package(s)	Singled Ended Input	Description	Price*
TUSB1105	Full, Low	1.6, 3.6	RTZ-16, RGT-16	Yes	USB Transceivers	1.10
TUSB1106	Full, Low	1.6, 3.6	RTZ-16, PW-16	No	USB Transceivers	1.10
TUSB2551	Full, Low	1.6, 3.6	PW-14, RGT-16	No	USB Transceivers	1.10

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

Stereo USB DACs

Device	Description	Resolution (Bits)	Power Supply (V)	SNR (dB) (typ)	Pd (mW) (typ)	Sampling Rate (max) (kHz)	Package	Price*
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 I²C Interface/HD Mode	16	3.3, 5	98	175	48	TQFP-32	3.60
PCM2707	Low Power, SPI Interface, Selectable I²C Interface	16	3.3, 5	98	175	48	TQFP-32	3.60

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

Interface and USB Audio

USB Codecs

Device	Description	SNR (dB) (typ)	Power Supply (V)	Pd (mW) (typ)	Sampling Rate (max) (kHz)	Package	Price*
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

Digital Audio Processors

Device	Description	Digital I/O	Input FS (kHz)	Processing Bits/ Accumulator	I/O Max Resolution (Bits)	Package	Price*
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

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

Digital Audio SoCs

Device	Description	Stereo Input MUX	Number of ADCs/DNR (dB)	Number of DACs/DNR (dB)	Number of PWMs/DNR	Package	Price*
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	TBD
TAS3202	Fully Programmable, 135-MHz, 48-Bit, 8-Channel Processor with Integrated Analog I/O	2:1	2/102	2/105	—	TQFP-64	TBD

Suggested resale price in U.S. dollars in quantities of 1,000. *New products are listed in **bold red**.*

PWM Processors (PurePath™)

Device	Description	Frequency (kHz)	Dynamic Range (dB)	Half Power THD+N at 1 kHz (%)	Resolution (Bits)	Package	Price*
TAS5010	Stereo Modulator Only	32 to 192	>93	< 0.08	16, 20, 24	TQFP-48	3.75
TAS5012	Stereo Modulator Only with Higher Dynamic Range	32 to 192	>102	< 0.06	16, 20, 24	TQFP-48	5.95
TAS5001	Stereo Modulator Only	32 to 192	>96	< 0.08	16, 20, 24	TQFP-48	3.00
TAS5028A	8-Channel, Volume Control and Channel Mapping	32 to 192	>102	< 0.1	16, 20, 24	TQFP-64	6.15
TAS5504A	4-Channel, EQ, Bass Management, Dynamic Range and Volume Control, HP Output	32 to 192	>102	< 0.1	16, 20, 24	TQFP-64	3.50
TAS5508B	8-Channel, EQ, Bass Management, Dynamic Range and Volume Control, HP Output	32 to 192	>102	< 0.1	16, 20, 24	TQFP-64	5.00
TAS5086	6-Channel, Bass Management, Tone and Volume Control	32 to 192	>105	< 0.1	16, 20, 24	TSSOP-38	1.75
TAS5518C	8-Channel, Highest Dynamic Range, Record Line and HP Outputs, DSVC Adds 24-dB Dynamic Range, EQ, Bass Management, Dynamic Range and Volume Control	32 to 192	>110	< 0.1	16, 20, 24	TQFP-64	7.95

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

TMS320C67x™ DSP Generation — Floating-Point DSPs

Device	RAM (Bytes) Data/Prog	McBSP	McASP	DMA	COM	SPI/ I^2C	MHz	Cycle (ns)	MFLOPS	Typical Activity Total Internal Power (W) (Full Device Speed)	Voltage (V)		Package	Price*
											Core	I/O		
TMS320**C6720B**RFP200[4]	32K/64K/384K[6]	—	2	dMAX[2]	—	2/2	200	5	1200	See Datasheet	1.2	3.3	22mm PQFP-144	7.53†
TMS320**C6712D**GDP150	4K/4K/64K[1]	2	—	16[2]	—	—	150	6.7	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	5	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	4.4	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	4	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	4.4	1350	See Datasheet	1.2	3.3	22mm PQFP-144	16.68†
TMS320**C6726B**RFP266[4,5]	32K/256K/384K[7]	—	3[7]	dMAX	—	2/2	266	3.75	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	5	1200	See Datasheet	1.2	3.3	28mm TQFP-208	20.95†
TMS320**C6727B**ZDH250	32K/256K/384K	—	3	dMAX	UHPI	2/2	250	4	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	4	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	3.6	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	3.3	1800	See Datasheet	1.2	3.3	17mm BGA-256	23.58†
TMS320**C6727B**ZDH350	32K/256K/384K	—	3	dMAX	UHPI	2/2	350	2.9	2100	See Datasheet	1.4	3.3	17mm BGA-256	32.29†
TMS320**C6701G**JC150	64K/64K	2	—	4	HPI/16	—	120	6.7	900	See Datasheet	1.8	3.3	35mm BGA-352	95.34†
TMS**C6701G**JC16719V	64K/64K	2	—	4	HPI/16	—	167	6	1000	See Datasheet	1.9	3.3	35mm BGA-352	144.52†
TMX320**C6748A**ZCE3	32K/32K/256K/128K	2	1	64 Ch	UHPI	2/2	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	18.25
TMX320**C6748B**ZCE3	32K/32K/256K/128K	2	1	64 Ch	UHPI	2/2	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	18.25
TMX320**C6748A**ZWT3	32K/32K/256K/128K	2	1	64 Ch	UHPI	2/2	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	18.25
TMX320**C6748B**ZWT3	32K/32K/256K/128K	2	1	64 Ch	UHPI	2/2	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	18.25
TMX320**C6747B**ZKB3	32K/32K/256K/128K	—	3	32/16 bit	UHPI	2/2	300	3.3	1800	See Datasheet	1.2	3.3	17mm BGA-256	13.00
TMX320**C6747B**ZKB2	32K/32K/256K/128K	—	3	32/16 bit	UHPI	2/2	200	5	1200	See Datasheet	1.2	3.3	17mm BGA-256	10.15
TMX320**C6747Z**KB3	32K/32K/256K/128K	—	3	32/16 bit	UHPI	2/2	300	3.3	1800	See Datasheet	1.2	3.3	17mm BGA-256	15.00†
TMX320**C6747Z**KB2	32K/32K/256K/128K	—	3	32/16 bit	UHPI	2/2	200	5	1200	See Datasheet	1.2	3.3	17mm BGA-256	11.72†
TMS320**C6746A**ZCE3	32K/32K/256K	2	1	64 Ch	UHPI	2/2	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	13.50
TMS320**C6746B**ZCE3	32K/32K/256K	2	1	64 Ch	UHPI	2/2	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	13.50
TMS320**C6746A**ZWT3	32K/32K/256K	2	1	64 Ch	UHPI	2/2	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	13.50
TMS320**C6746B**ZWT3	32K/32K/256K	2	1	64 Ch	UHPI	2/2	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	13.50
TMX320**C6745B**PTP3	32K/32K/256K	—	2	16 bit	—	2/2	300	3.3	1800	See Datasheet	1.2	3.3	24mm QFP-176	11.25
TMX320**C6745B**PTP2	32K/32K/256K	—	2	16 bit	—	2/2	200	5	1200	See Datasheet	1.2	3.3	24mm QFP-176	9.00
TMX320**C6745P**TP3	32K/32K/256K	—	2	16 bit	—	2/2	300	3.3	1800	See Datasheet	1.2	3.3	24mm TQFP-176	13.03†
TMX320**C6745P**TP2	32K/32K/256K	—	2	16 bit	—	2/2	200	5	1200	See Datasheet	1.2	3.3	24mm TQFP-176	10.41†
TMX320C6743BPTP3	32K/32K/128K	—	2	32 Ch[2]	—	1/2	300	3.3	1800	See Datasheet	1.2	3.3	24mm QFP-176	8.95
TMX320**C6743B**PTP2	32K/32K/128K	—	2	32 Ch[2]	—	1/2	200	5	1200	See Datasheet	1.2	3.3	24mm QFP-176	7.80
TMX320**C6743B**ZKB3	32K/32K/128K	—	2	32 Ch[2]	—	1/2	300	3.3	1800	See Datasheet	1.2	3.3	17mm BGA-256	8.95
TMX320**C6743B**ZKB2	32K/32K/128K	—	2	32 Ch[2]	—	1/2	200	5	1200	See Datasheet	1.2	3.3	17mm BGA-256	7.80
TMS320**C6742A**ZCE3	32K/32K/64K	2	1	64 Ch	UHPI	1/1	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	6.70
TMS320**C6742B**ZCE3	32K/32K/64K	2	1	64 Ch	UHPI	1/1	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	13mm BGA-361	6.70
TMS320**C6742A**ZWT3	32K/32K/64K	2	1	64 Ch	UHPI	1/1	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	6.70
TMS320**C6742B**ZWT3	32K/32K/64K	2	1	64 Ch	UHPI	1/1	300	3.3	1800	See Datasheet	1.0-1.2	1.8/3.3	16mm BGA-361	6.70

[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 industrial temperature range.
[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 I^2C and additional GPIO.
[9]Also available in 256-pin BGA, 17-mm (GDH) package.
Note: All devices include two timers.
Note: Enhanced plastic and military DSP versions are available for selected DSPs.
Prices are quoted in U.S. dollars in quantities of 1,000 (except where marked with †) and represent year 2009 suggested resale pricing. All prices are subject to change. Customers are advised to obtain the most current and complete pricing information from TI prior to placing orders. TI may verify final pricing prior to accepting any order.
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Processors

OMAP-L13x Applications Processors

Device	CPU	Frequency (MHz)	L1P (Bytes)	L1D (Bytes)	L2 (Bytes)	RAM (Bytes)	External Memory I/F	DMA	Timers	Serial Ports	Misc.	Voltage (V) Core	Voltage (V) I/O	Package(s)	Price*
OMAP-L137BZKB3	ARM926EJS, C674x	300 300	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 I^2C, 3 UART	10/100 Ethernet MAC, MMC/SD, 3 PWMs, LCD controller, 3 eCAP, 2 eQEP, UHPI	1.2	1.8/ 3.3	17mm BGA-256	16.35
OMAP-L138AZCE3	ARM926EJS, C674x	300 300	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 I^2C, 3 UART 2 SPI,	10/100 Ethernet MAC, 2 MMC/SD, 2 PWMs, LCD controller, video interface, UPI, SATA, 3 eCAP	1.2	1.8/ 3.3	13mm, 0.65mm pitch, BGA-361	18.60
OMAP-L138BZCE3[1]	ARM926EJS, C674x	300 300	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 I^2C, 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	13mm, 0.65mm pitch, BGA-361	18.60
OMAP-L138AZWT3	ARM926EJS, C674x	300 300	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 I^2C, 3 UART 2 SPI,	10/100 Ethernet MAC, 2 MMC/SD, 2 PWMs, LCD controller, video interface, UPI, SATA, 3 eCAP	1.2	1.8/ 3.3	16mm, 0.8mm pitch, BGA-361	18.60
OMAP-L138BZWT3[1]	ARM926EJS, C674x	300 300	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 I^2C, 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	16mm, 0.8mm pitch, BGA-361	18.60

[1]Devices with an extended temperature range are available.
**Prices are quoted in U.S. dollars in quantities of 100 and represent year 2009 suggested resale pricing. All prices are subject to change. Customers are advised to obtain the most current and complete pricing information from TI prior to placing orders. TI may verify final pricing prior to accepting any order.*

DaVinci™ Technology Digital Media Processors

Device	CPU	Frequency (MHz)	L1/ SRAM (Bytes)	L2/ SRAM (Bytes)	ROM (Bytes)	External Memory I/F	EDMA	Video Ports (Configurable)	Serial I/F	Connectivity I/F	Program/ Data Storage	Voltage (V) Core	Voltage (V) I/O	Package(s)	Price*
TMS320DM6446BZWT	C64x+™, ARM9, DaVinci Video	594 (DSP) 297 (ARM)	112K (DSP) 40K (ARM)	64K (DSP)	16K (ARM)	1 16-/8-Bit EMIFA 1 32-/16-Bit DDR2	64 Ch	1 Input, 1 Output	ASP, I^2C, SPI, 3 UARTs	USB 2.0, VLYNQ™, 10/100 EMAC	Async SRAM, DDR2 SDRAM, NAND Flash, SmartMedia/ xD	1.2	1.8/ 3.3	16 x 16mm BGA-361	35.65
TMS320DM6443BZWT	C64x+, ARM9, DaVinci Video	594 (DSP) 297 (ARM)	112K (DSP) 40K (ARM)	64K (DSP)	16K (ARM)	1 16-/8-Bit EMIFA 1 32-/16-Bit DDR2	64 Ch	1 Output	ASP, I^2C, SPI, 3 UARTs	USB 2.0, VLYNQ, 10/100 EMAC	Async SRAM, DDR2 SDRAM, NAND Flash, SmartMedia/ xD	1.2	1.8/ 3.3	16 x 16mm BGA-361	30.55
TMS320DM6441ZWT	C64x+, ARM9, DaVinci Video	513/405 (DSP) 256/202 (ARM)	112K (DSP) 40K (ARM)	64K (DSP)	16K (ARM)	1 16-/8-Bit EMIFA 1 32-/16-Bit DDR2	64 Ch	1 Input, 1 Output	ASP, I^2C, SPI, 3 UARTs	USB 2.0, VLYNQ, 10/100 EMAC	Async SRAM, DDR2 SDRAM, NAND Flash, SmartMedia/ xD	1.2/ 1.05	1.8/ 3.3	16 x 16mm BGA-361	30.35
TMS320DM6431	C64x+, DaVinci Video	300	64K	64K	64K	1 8-Bit EMIFA, 1 16-Bit DDR2	64 Ch	1 Input	McASP, I^2C, 1 UART, 1 McBSP, 1 HECC	10/100 EMAC	Async SRAM, DDR2 SDRAM, NAND Flash	1.05	1.8/ 3.3	16 x 16mm BGA-361, 23 x 23mm BGA-376	11.25
TMS320DM6433	C64x+, DaVinci Video	400 500 600 700	112K	128K	64K	1 8-Bit EMIFA, 1 16-/32-Bit DDR2	64 Ch	1 Output	McASP, 1 McBSP, I^2C, 1 UART	32-Bit PCI, VLYNQ, 10/100 EMAC, 16-Bit HPI	Async SRAM, DDR2 SDRAM, NAND Flash	1.05/ 1.2	1.8/ 3.3	16 x 16mm BGA-361, 23 x 23mm BGA-376	15.30 16.20 18.05 21.70

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DaVinci™ Technology Digital Media Processors (Continued)

Device	CPU	Frequency (MHz)	L1/ SRAM (Bytes)	L2/ SRAM (Bytes)	ROM (Bytes)	External Memory I/F	EDMA	Video Ports (Configurable)	Serial I/F	Connectivity I/F	Program/ Data Storage	Voltage (V) Core	Voltage (V) I/O	Package(s)	Price*
TMS320DM6435	C64x+, DaVinci Video	400 500 600 700	112K	128K	64K	1 8-Bit EMIFA, 1 16-/32-Bit DDR2	64 Ch	1 Input	McASP, I^2C, 1 McBSP, 2 UARTs, 1 HECC	VLYNQ, 10/100 EMAC, 16-Bit HPI	Async SRAM, DDR2 SDRAM, NAND Flash	1.05/ 1.2	1.8/ 3.3	16 x 16mm BGA-361 23 x 23mm BGA-376	15.85 16.80 18.70 22.45
TMS320DM6437	C64x+, DaVinci Video	400 500 600 700	112K	128K	64K	1 8-Bit EMIFA, 1 16-/32-Bit DDR2	64 Ch	1 Input, 1 Output	McASP, I^2C, 1 HECC, 2 McBSPs, 2 UARTs	32-Bit PCI, VLYNQ, 10/100 EMAC, 16-Bit HPI	Async SRAM, DDR2 SDRAM, NAND Flash	1.05/ 1.2	1.8/ 3.3	16 x 16mm BGA-361, 23 x 23mm BGA-376	20.35 21.55 24.00 28.85
TMS320DM355	ARM9, DaVinci Video	135 216 270	32K	—	8K	1 16-/8-Bit EMIFA, 1 16-Bit MDDR/ DDR2	64 Ch	1 Input, 1 Output	3 SPI, 2 ASP, 3 UARTs, 1 I^2C	USB 2.0 HS	Async SRAM, MDDR/DDR2 SDRAM, NAND Flash, SmartMedia/ xD	1.3	1.8/ 3.3	13 x 13mm BGA-329	11.50† 13.00† 18.55†
TMS320DM365	ARM9, DaVinci Video	216 270 300	32K	—	16K	1 16-/8-Bit EMIFA, 1 16-Bit MDDR/ DDR2	64 Ch	1 Input, 1 Output	5 SPI, 2 UARTs, 1 I^2C, 1 McBSP	USB 2.0 HS, 10/100 EMAC, 16-Bit HPI	Async SRAM, MDDR/DDR2 SDRAM, One NAND, NAND Flash, NOR Flash, SmartMedia/ xD	1.2/ 1.35	1.8/ 3.3	13 x 13mm BGA-338	14.70† 18.95† 20.90†
TMS320DM647	C64x+, DaVinci Video	720 900 1.1 GHz	32K/32K	256K	64K	1 16-/8-Bit EMIFA[1] 1 32-/16-Bit DDR2	64 Ch	5 Video Ports (Each Config-urable as Dual Capture, Single Capture, Display, TSI Capture)	1 I^2C, 1 SPI, 1 UART, 1 McASP	PCI/HPI, VLYNQ, 10/100/1000 3-pt Ethernet Switch Subsys w/ 1 SGMII Pt	Async SRAM, DDR2 SDRAM, NAND Flash, NOR Flash	1.2/ 1.2	1.8/ 3.3	19 x 19mm nFBGA-529	37.05 46.35 57.80
TMS320DM648	C64x+, DaVinci Video	720 900 1.1 GHz	32K/32K	512K	64K	1 16-/8-Bit EMIFA[1] 1 32-/16-Bit DDR2	64 Ch	5 Video Ports (Each Config-urable as Dual Capture, Single Capture, Display, TSI Capture)	2 I^2C, 1 SPI, 1 UART, 1 McASP 2 TSIP	PCI/HPI, VLYNQ, 10/100/1000 3-pt Ethernet Switch Subsys w/ 2 SGMII Pts	Async SRAM, DDR2 SDRAM, NAND Flash, NOR Flash	1.2/ 1.2	1.8/ 3.3	19 x 19mm nFBGA-529	46.35 57.95 72.35

[1]EMIFA does not support SDRAM.
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Processors

TMS320C2000™ Microcontrollers

Device[1]	Processor			Memory			Control Interfaces							Communications Ports											
	Speed (MHz)	FPU	DMA	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	Core Supply (V)	GPIO Pins	On-Chip Oscillator/ Regulator	Package(s)	Price*
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
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
TMS320F28016	60	—	—	12	32	Boot	10	4	0	2	10	16/267	—	—	1	1	1	—	1	—	1.8	35	—	LQFP-100	3.50
TMS320F28015	60	—	—	12	32	Boot	10	4	0	2	10	16/267	—	—	1	1	1	—	—	—	1.8	35	—	BGA-100, LQFP-100	3.25
28x ROM MCUs																									
TMS320C2812	150	—	—	36	—	256	16	—	2	6	8	16/80	—	1	—	2	1	—	1	16-bit	1.9	56	—	BGA-179, LQFP-176	—
TMS320C2811	150	—	—	36	—	256	16	—	2	6	8	16/80	—	1	—	2	1	—	1	—	1.9	56	—	LQFP-128	—
TMS320C2810	150	—	—	36	—	128	16	—	2	6	8	16/80	—	1	—	2	1	—	1	—	1.9	56	—	LQFP-128	—
TMS320C2802	100	—	—	12	—	64	8	3	1	2	9	16/160	—	—	1	1	2	—	1	—	1.8	35	—	BGA-100, LQFP-100	—
TMS320C2801	100	—	—	12	—	32	8	3	1	2	9	16/160	—	—	1	1	2	—	1	—	1.8	35	—	BGA-100, LQFP-100	—

[1]All devices available in Pb-Free/Green packaging. All TMS320C28 devices in LQFP package are available as AEC Q100 qualified.
[2]Timers include CPU timers, PWM timers, eCAP timers, and Watchdog timers.
**Prices are quoted in U.S. dollars and represent 2009 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™.

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

Audio Clocks

Programmable Multiple PLL Clock Synthesizer Family with Fully-Integrated Fan Outs

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	Oppm Frequency Generation	Spread-Spectrum Clocking on all Outputs	Support Frequency Switching	Programmability	Package	Temp. Range (°C)	Period Jitter (pa) (typ)
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
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
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
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
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
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
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
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
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
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

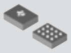
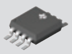
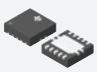
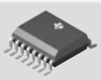
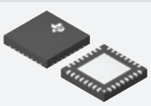
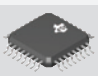
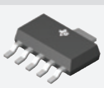
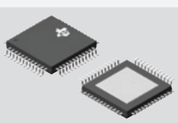
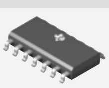
Analog Multiplexers and Switches

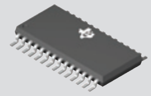
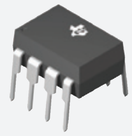
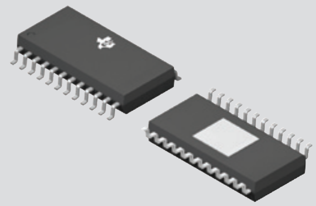
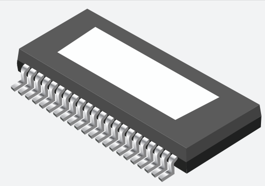
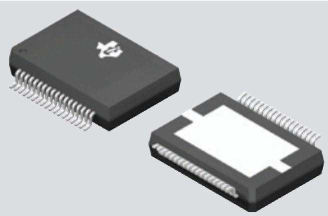
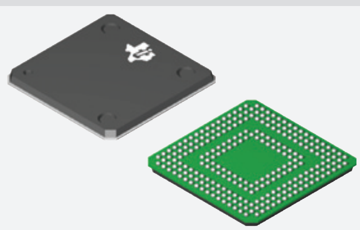
Analog Multiplexers and Switches

Device	r_{on} (max)	r_{on} Flatness (max)	r_{on} Mismatch (max)	V+ (V) (min)	V+ (V) (max)	ESD	Total Harmonic Distortion (THD) (%)	ON Time, OFF Time (ns) (max)	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										
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	
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
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	
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										
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	
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
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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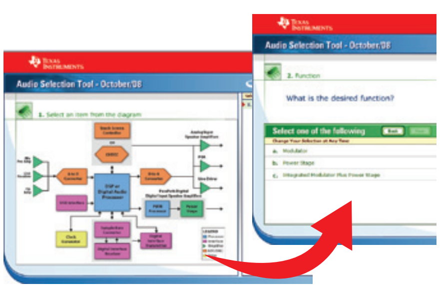

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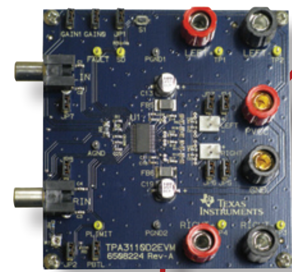

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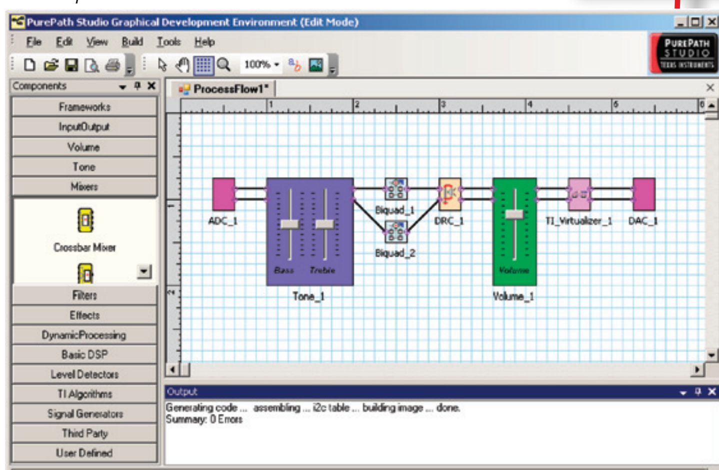
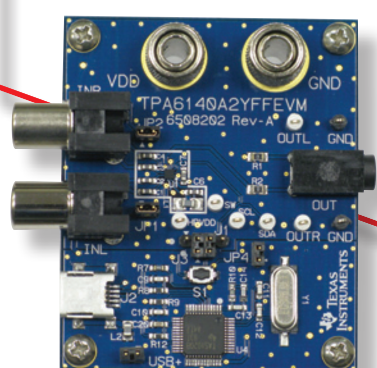
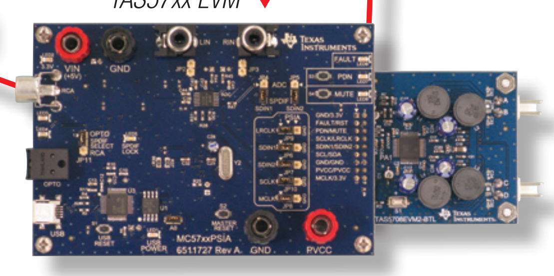




TPA6140A2 EVM ▲

TAS57xx EVM ▼



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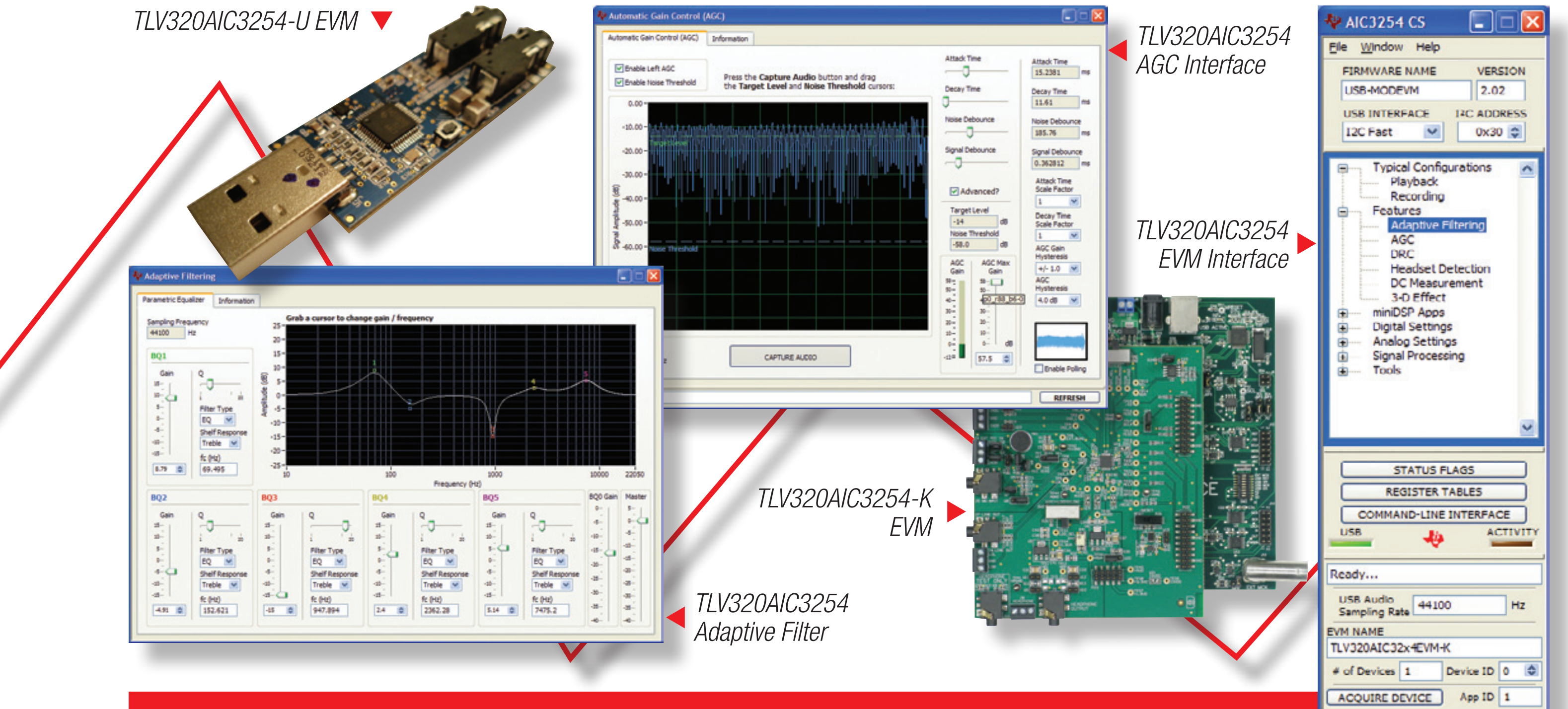

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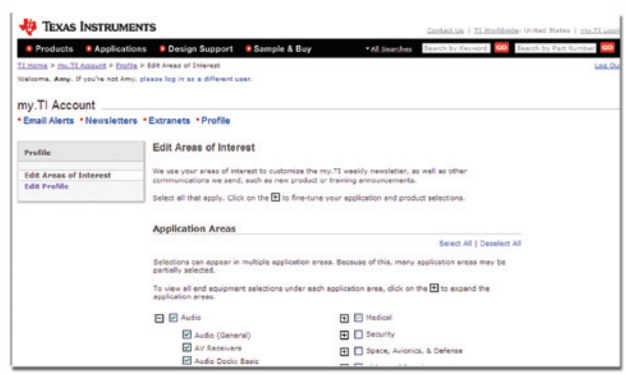

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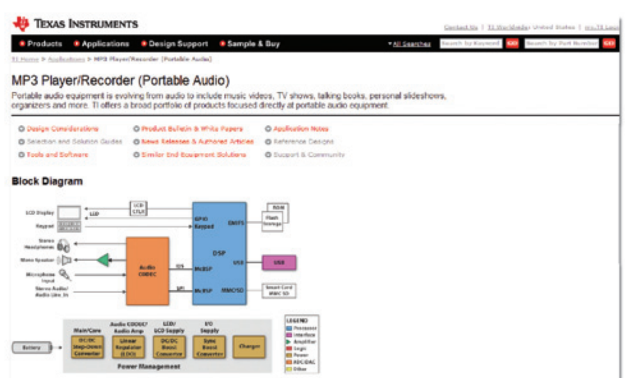

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