

**CS4329**

# **20-Bit, Stereo D/A Converter for Digital Audio**

The following information is based on the  
Crystal Semiconductor Product Datasheet:

*DS153PP1 FEB '95*

Please contact Crystal Semiconductor for  
further information.

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## **CRYSTAL SEMICONDUCTOR PRODUCTS DIVISION PRODUCT INFORMATION**

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PI153PP1 JAN '98

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## ***20-Bit, Stereo D/A Converter for Digital Audio***

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### **Features**

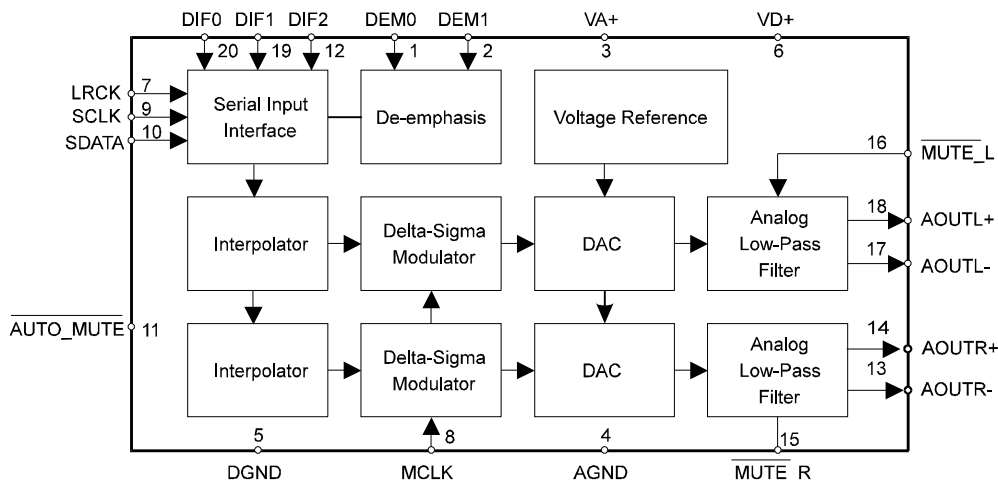
- 20-Bit Resolution
- 112 dB Signal-to-Noise-Ratio (EIAJ)
- Complete Stereo DAC System
  - 128X Interpolation Filter
  - Delta-Sigma DAC
  - Analog Post Filter
- 105 dB Dynamic Range
- Low Clock Jitter Sensitivity
- Filtered Line-Level Outputs
  - Linear Phase Filtering
  - Zero Phase Error Between Channels
- Adjustable System Sampling Rates including 32 kHz, 44.1 kHz & 48 kHz
- Digital De-emphasis for 32 kHz, 44.1 kHz & 48 kHz

### **Description**

The CS4329 is a complete stereo digital-to-analog output system. In addition to the traditional D/A function, the CS4329 includes a digital interpolation filter followed by an 128X oversampled delta-sigma modulator. The modulator output controls the reference voltage input to an ultra-linear analog low-pass filter. This architecture allows for infinite adjustment of sample rate between 1 and 50 kHz while maintaining linear phase response simply by changing the master clock frequency.

The CS4329 also includes an extremely flexible serial port utilizing mode select pins to support multiple interface formats.

The master clock can be either 256, 384, or 512 times the input sample rate, supporting various audio environments.



## Overview

### **CRYSTAL INTRODUCES TWO DELTA-SIGMA D/A CONVERTERS FOR DIGITAL AUDIO APPLICATIONS**

Today, Crystal Semiconductor the leader in audio conversion, announced two audio D/A converters - the CS4327 and CS4329. The CS4329 is the world's highest performance delta-sigma digital-to-analog converter, and the CS4327 provides an optimal price vs. performance trade-off for cost sensitive applications. The CS4329 device is the first to achieve 105 dB dynamic range using on-chip switched-capacitor analog low pass filtering. The device's performance target it directly at the emerging digital mixing desk market and other professional applications such as digital audio tape (DAT) players, multi-track recorders and high-end effects processors. At 101 dB dynamic range, the CS4327 targets lower cost musical keyboard and effects processor applications.

#### ***Delta-Sigma versus Resistor Ladder D/A converters***

The C4327 and CS4329 are designed using a 1-bit delta-sigma conversion. The advantage of single-bit converters over multi-bit topologies is that they are inherently linear. Single-bit conversion yields perfect linearity independent of signal amplitude, while the performance of multi-bit (or resistor ladder) devices degrade with small input signals. The poor linearity of multi-bit devices has been accepted as these devices have offered the lowest noise solutions of any other D/A conversion architectures. The CS4329 breaks the 100 dB noise barrier as it is the first delta-sigma device to provide 105 dB dynamic range, performance better than multi-bit DACs, and the ideal linearity of delta-sigma conversion.

Delta-sigma D/A conversion offers a high level of integration over multi-bit DAC solutions. The CS4327 and CS4329 are complete D/A conversion system providing interpolation, D/A conversion, and switched-capacitor analog filtering. Competing resistor ladder solutions require two single channel DACs, a separate digital filter, and external analog low pass filtering for the DAC outputs. David Bresemann, Digital Audio Product Manager, states, "The CS4327 and CS4329 are offered in a space saving 16-pin and 20-pin SSOP packages providing a 400% board space reduction over existing R2R solutions with no sacrifice in performance."

### ***Design and Performance***

The CS4327 and CS4329 devices achieve low noise designs through 4th order delta-sigma modulation and 128X oversampling. The 128X oversampling spreads the noise energy over twice the bandwidth of previous 64X oversampled systems enabling a 3 dB improvement in dynamic range. In addition, the 128X oversampling enables lower out-of-band noise than previous 64X oversampled designs minimizing the negative effects of non-linear components downstream from the D/A converter in digital audio systems.

The CS4329 features 20-bit resolution, 112 dB signal-to-noise ratio, and 105 dB dynamic range. Total harmonic distortion + noise is specified at -97 dB for a full scale output signal. The CS4327 features 20-bit resolution, 110 dB signal-to-noise ratio, 101 dB dynamic range, and -90 dB total harmonic distortion + noise. The low noise and distortion of these devices target them directly at high performance professional and high-end consumer audio systems. Both devices support sample rates from 1kHz to 50 kHz and include selectable de-emphasis filters for 32kHz, 44.1 kHz, and 48 kHz applications, such as Digital Audio Tape (DAT). Both devices support muting on zero input data which provides the lowest noise floor during an idle channel condition, such as between music tracks on a compact disc player. The CS4329 also provides independent muting for the left and right channel outputs.

### ***Tolerant to Clock Jitter***

The CS4327 and CS4329 contain on-chip analog low pass filtering implemented using a switched-capacitor design. This analog low pass filter architecture is ideal for digital audio applications because of the requirement for a low jitter D/A clock can be essentially eliminated by the use of the switched capacitor structure. The switched capacitor filter processes packets of charge by charging a voltage reference. As long as the voltage reference value settles on the capacitor, the magnitude of the charge packet will be independent of the clock jitter. Often the clocks available in a digital audio system contain jitter, such as recovered clocks from an AES/EBU data stream, the CS4327 and CS4329 will reject this jitter with no degradation in sound quality.

***Packaging, Pricing, and Availability***

The CS4327 is available in a 16-pin SSOP package. The device operates from a single +5 volt power supply and typical power consumption is a low 205 mW. The CS4327 is available in volume production. When purchased in a quantity of 1,000 or more, the CS4327 is priced at \$4.95 each.

The CS4329 is available in both 20-pin DIP and SSOP packages, and it operates from a single +5 volt power supply. Typical power consumption is a low 205 mW. The CS4329 is available in production quantities. When purchased in a quantity of 1,000 or more, the CS4329 is priced at \$9.95 each.

## FAQs

- 1) Is the CS4329 Crystal's highest performance DAC?  
A: Yes. The CS4329 is the highest performance delta-sigma DAC available at 105 dB dynamic range and 112 dB signal-to-noise ratio.
- 2) What is the purpose of AUTO\_MUTE on the device?  
A: The AUTO\_MUTE function enables a lower system noise floor when all zero data is presented to the CS4329. When AUTO\_MUTE is enabled, the DAC output will automatically mute on zero input data, hereby improving the signal-to-noise ratio from 105 dB to 112 dB.

## Ordering Info


CS4329-KP	-10 to 70 ×C	20-pin Plastic DIP
CS4329-KS	-10 to 70 ×C	20-pin Plastic SSOP
CDB4329 CS4329 Evaluation Board		

For further information on Crystal products, please visit our website "www.crystal.com" or call our literature department (800) 888-5016 ext. 3594 or (512) 912-3594 for data sheets and application notes.

### Schematic & Layout Review Service

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