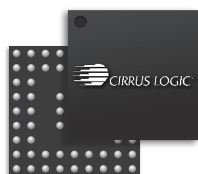




Smart Home



*Audio Experts in a Voice Connected World*

**Cirrus Logic Consumer and Mobile Audio Solutions**

# World-Class Audio Leadership

Cirrus Logic is the leading supplier of hardware and software solutions for audio signal processing from voice capture to audio playback in the newest technology found in mobile, consumer and automotive applications.





## Audio Innovation for a Voice Connected World™

### Best-in-Class Hardware and Software

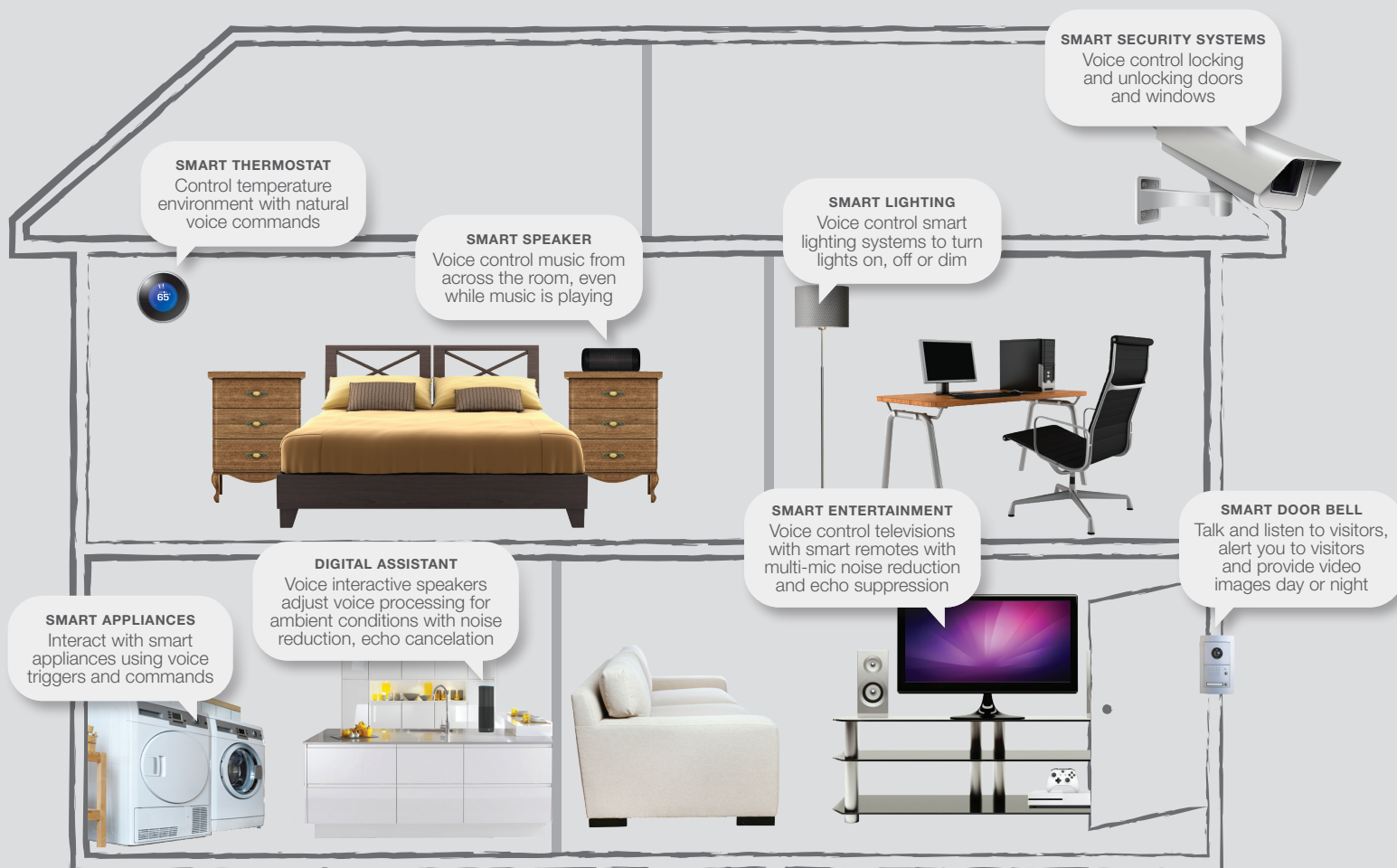
With a complete portfolio of products throughout the audio signal chain — from voice capture to playback — Cirrus Logic's best-in-class, ultra low power ICs and patented SoundClear® software technology elevate the clarity and quality of the audio signal by enhancing voice quality, voice capture, speech recognition and audio playback.



|                                         |     |
|-----------------------------------------|-----|
| Audio Innovation for the Connected Home | 2   |
| Audio Components                        | 3   |
| The SoundClear® Advantage               | 4-5 |
| Alexa-Enabled Smart Home Products       | 6   |
| Digital Assistants, Smart Speakers      | 8   |
| Lighting, Heating, Appliances           | 10  |
| Security Systems                        | 12  |
| Proven Technology                       | 14  |

# Audio Innovation for the Smart Home

The “Smart Home” is a *connected home* where multiple smart devices are integrated to create an environment that is automated and easily controlled. Cirrus Logic’s portfolio of advanced audio and voice solutions allows the natural interaction with these smart devices—using them for communication, controlling them easily with voice commands, using them to detect audio events, and of course, using them to enjoy high-fidelity audio playback. By combining Cirrus Logic’s extensive portfolio of audio ICs with our SoundClear software technology, every aspect of the smart home experience can be enhanced daily.



# Audio Components

## Audio DSPs

- Single chip solution for Dolby ATMOS and DTS UHD
- 3 to 4 32-bit DSP cores, 300 MHz, 2.88 MB on chip RAM
- Clock PLL, rich set of serial audio I/O
- Cirrus DSP tool support

## Codecs

- Superior input and playback performance
- Low power sleep mode, smart accessory detect
- Support for digital and analog microphone interfaces
- Choice of features, performance, digital interfaces and packages allows a wide-range of system architectures

## D/A Converters

- Advanced multibit delta-sigma architecture
- Up to 24-bit, 192 kHz with 128 dB dynamic range
- High-end HiFi digital filters for improved audio playback
- Professional audio quality for consumer products

## A/D Converters

- Advanced multibit delta-sigma architecture
- 2 to 8 channels with up to 24-bit, 192 kHz inputs
- Ultra low idle power consumption for “always on” applications
- Enhances voice clarity for mic-array and beam-forming algorithms

## Headphone and Speaker Amplifiers

- Class-D speaker amplifier with high efficiency and low idle power consumption
- Speaker driver up to 2.4 W into 4 ohm @ 1% THD+N
- Class-G headphone amplifier with 3.8 mW quiescent power consumption
- Headphone driver up to 32 mW into 15 ohm @ <1% THD

## MEMS Microphones

- The best sounding audio capture
- Leading dynamic range and linearity for true accuracy and clarity
- Devices acoustically matched to enhance algorithms
- Super robust MEMS minimize field issues

## S/PDIF Interfaces

- Single chip 192 kHz transmitter and receiver
- Advanced jitter attenuating PLL
- Single 2.7 to 3.6 V digital and PLL supply
- Small SSOP package size

# The SoundClear<sup>®</sup> Advantage

Cirrus Logic's SoundClear Control software is defining the next generation of easy to use connected home devices via touchless user interfaces, including natural voice control and ultrasonic gesture control. Conversations are clearer and noise free, whether 5 inches or 5 feet away from the device. Smoke alarms, security systems and baby monitors can now be smart devices running intelligent acoustic event "detection" software. For the music lover, whether your speakers are in the living room or the kitchen, on the floor or on the counter-top, you won't ever compromise on audio playback quality. Cirrus Logic delivers high-fidelity quality audio to multiple devices, wall outlet- or battery- powered. The Cirrus Logic technology advantage includes working with our software partners to broaden the use cases supported by our smart codec and DSP products, as well as working with customers to enable their proprietary software on a Cirrus Logic IC.

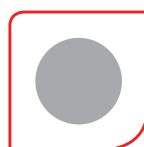
## SOUNDCLEAR<sup>®</sup> FROM CIRRUS LOGIC



VOICE



PLAYBACK



RECORD



CONTROL

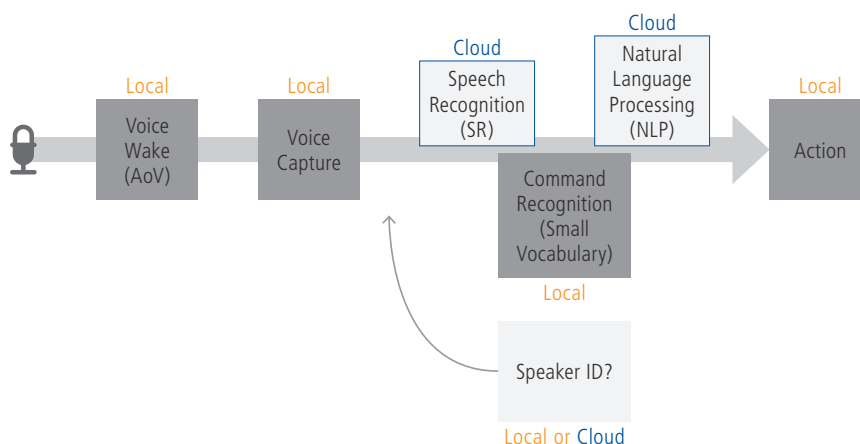
|                                    |                          |                                 |                                      |
|------------------------------------|--------------------------|---------------------------------|--------------------------------------|
| HD Voice Multi-mic Noise Reduction | Decoding Post Processing | Multi-mic Record                | ASR Enhance                          |
| AEC + Residual Echo Suppression    |                          | Intelligent Gain Control        | Voice Detector                       |
| Spectrally Matched Comfort Noise   |                          | Ambient and Mic Noise Reduction | Simultaneous Voice Trigger           |
| Voice Enhancement                  |                          | Wind and Motor Noise Reduction  | Far-Field Operation Barge-In Control |

### THIRD PARTY SOFTWARE PARTNERS



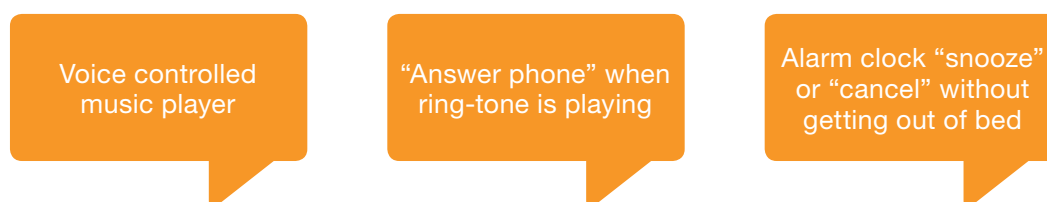
# Voice Call and Control in the Smart Home

SoundClear® Voice is designed to be flexible and robust, improving voice quality by eliminating noise through advanced processing features such as multi-mic noise reduction, echo cancelation and speech enhancement. SoundClear® Control enables “always on, always listening” voice activation and control of a device without keeping the application processor awake. This ultra low power solution eliminates the need for keypress activation to awaken devices such as smartphones, tablets, computers, home electronics, wireless speakers, appliances and other audio enabled devices. SoundClear Control allows a wide variety of trigger phrases which may be system — or user — defined and can be targeted to specific localities.



## Far Field ASR Enhanced and Barge-In Control

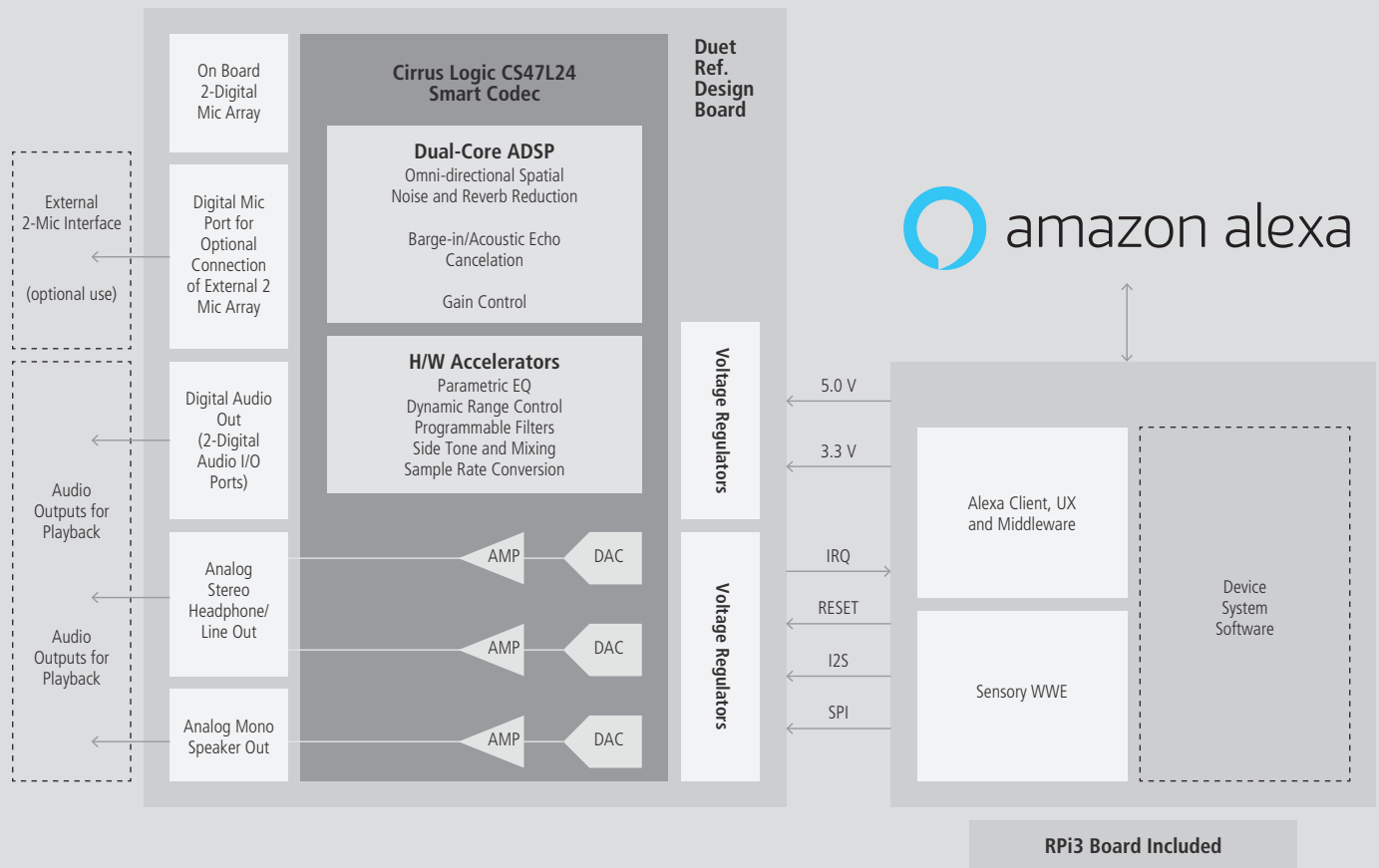
Cirrus Logic’s SoundClear Control also provides industry-leading Far Field ASR Enhance™ to maintain communication that is relaxed and effortless even in a noisy environment. The range of communication between the user and the smart device can extend to 15 feet or beyond and still the impact of distracting background noise is reduced. Additionally, “barge-in” technology extends voice commands for touchless operation even during loud music playback.



## High-Fidelity Audio Playback

Audio playback using smart devices should be a near perfect reproduction of the original recording. Cirrus Logic audio ICs supported by SoundClear Playback, or a partner software offering, deliver a music playback experience that maximizes volume while maintaining audio quality. Software partner solutions include Waves and Dirac to provide the ultimate listening experience.

# Development Platforms for Alexa-Enabled Smart Home Products



Cirrus Logic's Amazon certified voice capture development kit requires minimum customization to reduce time-to-market for the evaluation, prototyping and development of smart home products enabled with Alexa Voice Service (AVS). The CRD1569-1 kit is a fully functioning solution featuring the SoundClear® Voice Control two-mic reference board designed to enhance the end-user experience of AVS by increasing accuracy of voice interaction and by supporting high-fidelity audio playback. A web-based control console simplifies tuning and provide audio diagnostics.

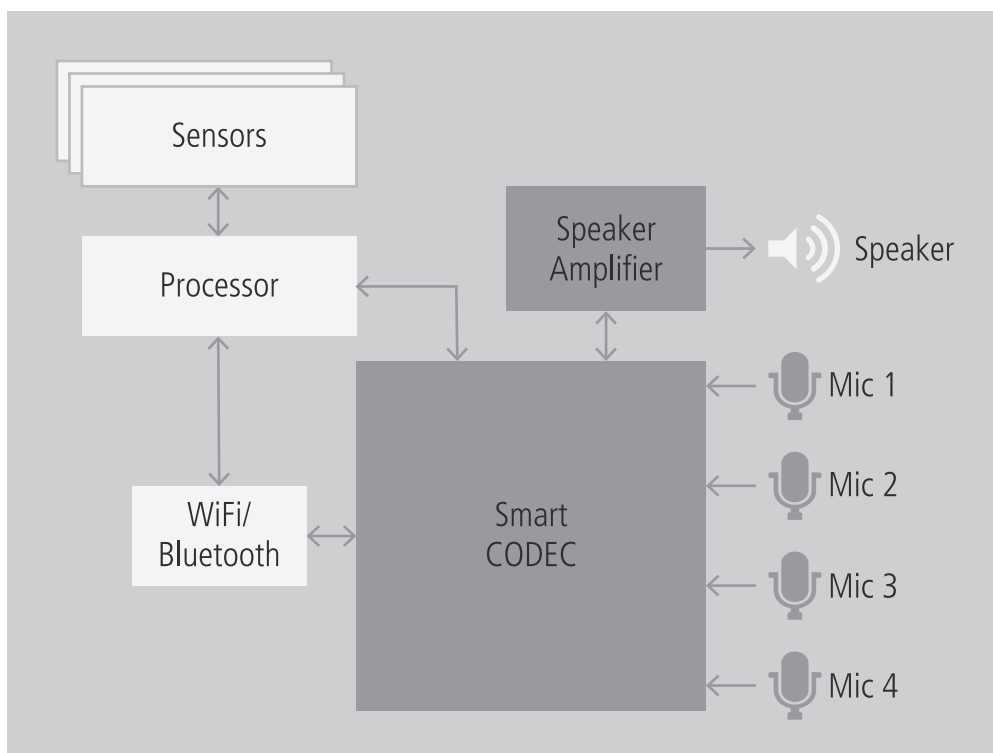
## Features

- Enhanced “Alexa” wake-word triggering and command interpretation at distance and in noisy environments
- Increases accuracy and reliability of Alexa voice responses to voice requests
- Acoustic Echo Cancelation (AEC) enables users to “barge-in” during Alexa response and music playback and be understood
- Consumes only 2mW for low power always on triggering
- Reference board features the Cirrus Logic CS47L24 dual core, low power smart codec with SoundClear® two-mic voice control DSP firmware
- Built-in 2 W Class D speaker driver
- Dual high performance digital MEMS microphone array for omni-directional spatial capture and noise reduction
- Port for connecting optional external digital MEMS microphone array
- Web-based firmware control console for simplified interactive operation, acoustic tuning and diagnostics
- Operates headless and wireless without anything connected to the RPi3 board other than the 5 V power source

# eCommerce, Information and Entertainment: Digital Assistants, Smart Speakers

## Soundclear Software Featuring “Always On” Voice Control

- Soundclear ASRe
- Soundclear Barge-in
- Soundclear Control
- Software Partner Far Field Voice solutions
- Software Partner Voice triggers and commands



Digital Assistant Application Diagram

## Smart Codecs

| Product | DACs | ADCs | DAC Dynamic Range (dB) | ADC Dynamic Range (dB) | DAC THD+N (dB) | ADC THD+N (dB) | Sample Rate (kHz) | Analog Inputs/Outputs      | ADSP Cores | DSP Capability (MIPS) | Analog Power Supply (V) | Supply Current (µA) | Package   |
|---------|------|------|------------------------|------------------------|----------------|----------------|-------------------|----------------------------|------------|-----------------------|-------------------------|---------------------|-----------|
| CS47L15 | 3    | 2    | 115                    | 98                     | -92            | -88            | 192               | Pseudo-differential        | 1          | 150                   | 1.8                     | 1.2                 | 173 WCSP  |
| CS47L24 | 3    | 4    | 121                    | 121                    | -85            | -88            | 192               | Pseudo-differential        | 2          | 300                   | 1.8                     | 1.2-1.8             | 63 WCSP   |
| CS47L35 | 3    | 4    | 120                    | 122                    | -85            | -88            | 8-192             | Pseudo-differential        | 3          | 450                   | 1.8                     | 1.2-1.8             | 102 WCSP  |
| WM8281  | 8    | 6    | 121                    | 100                    | -92            | -89            | 192               | Single-ended; differential | 4          | 600                   | 1.7-5.5                 | 1.14-1.9            | 138 WLCSP |
| CS47L90 | 10   | 7    | 115                    | 98                     | -93            | -88            | 192               | Single-ended; differential | 4          | 600                   | 1.8                     |                     | 70 WLCSP  |

## Amplifiers

| Product | Input Type        | Channels                | Output Power (V) | SNR (dB) | THD+N @ 1 W (dB) | Power Supply (V) | Package  |
|---------|-------------------|-------------------------|------------------|----------|------------------|------------------|----------|
| CS35L32 | Analog            | Class D Speaker Driver; | 1.7 W into 8 ohm | 102      | 0.02             | 3-5.25           | 30 WLCSP |
|         |                   | 1 x Mono Hybrid         |                  |          |                  |                  |          |
| CS35L33 | I <sup>2</sup> S; | Class D Speaker Driver; | 4.4 W into 8 ohm | 95       | 0.02             | 3-5.5            | 42 WLCSP |
|         | TDM               | 1 x Mono Hybrid         |                  |          |                  |                  |          |

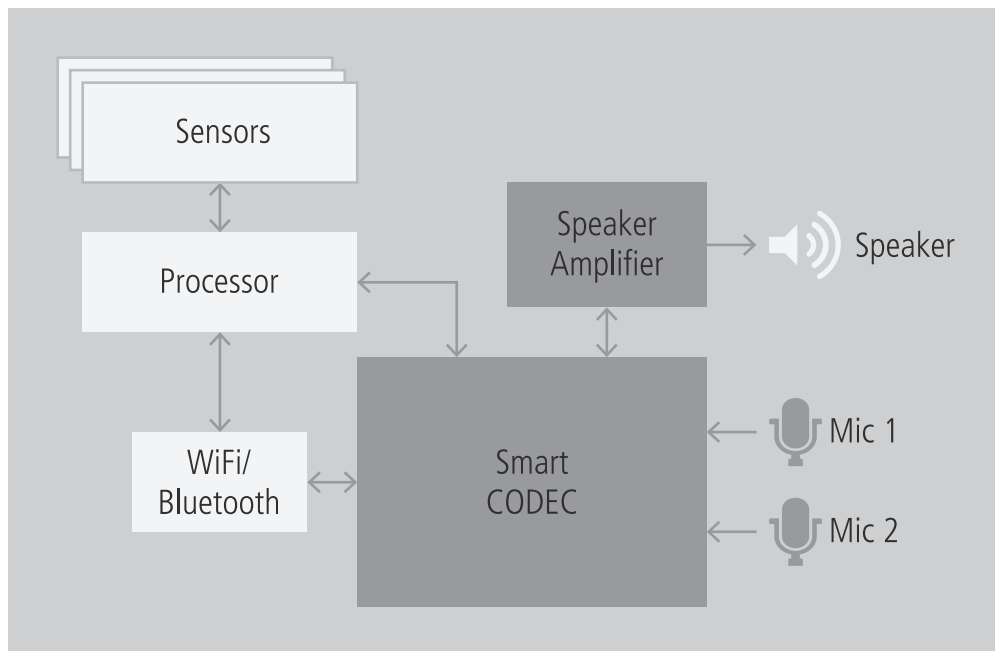
## Portable Codecs

| Product | DACs | ADCs | DAC THD+N (db) | ADC THD+N (dB) | Sample Rate (kHz) | Analog Power Supply | Supply Current (uA) | Package |
|---------|------|------|----------------|----------------|-------------------|---------------------|---------------------|---------|
| CS42L51 | 2    | 2    | -86            | -88            | 96                | 1.8-2.5             |                     | 32QFN   |

# Energy and Appliance Control: Lighting, Heating, Appliances

## Soundclear Software Featuring “Always On” Voice Control

- Soundclear ASRe
- Soundclear Barge-in
- Soundclear Control
- Software Partner Voice triggers and commands



Smart Thermostats Application Diagram

## Smart Codecs

| Product | DACs | ADCs | DAC Dynamic Range (dB) | ADC Dynamic Range (dB) | DAC THD+N (dB) | ADC THD+N (dB) | Sample Rate (kHz) | Analog Inputs/Outputs      | ADSP Cores | DSP Capability (MIPS) | Analog Power Supply (V) | Supply Current (μA) | Package   |
|---------|------|------|------------------------|------------------------|----------------|----------------|-------------------|----------------------------|------------|-----------------------|-------------------------|---------------------|-----------|
| CS47L15 | 3    | 2    | 115                    | 98                     | -92            | -88            | 192               | Pseudo-differential        | 1          | 150                   | 1.8                     | 1.2                 | 173 WCSP  |
| CS47L24 | 3    | 4    | 121                    | 121                    | -85            | -88            | 192               | Pseudo-differential        | 2          | 300                   | 1.8                     | 1.2-1.8             | 63 WCSP   |
| CS47L35 | 3    | 4    | 120                    | 122                    | -85            | -88            | 8-192             | Pseudo-differential        | 3          | 450                   | 1.8                     | 1.2-1.8             | 102 WCSP  |
| WM8281  | 8    | 6    | 121                    | 100                    | -92            | -89            | 192               | Single-ended; differential | 4          | 600                   | 1.7-5.5                 | 1.14-1.9            | 138 WLCSP |

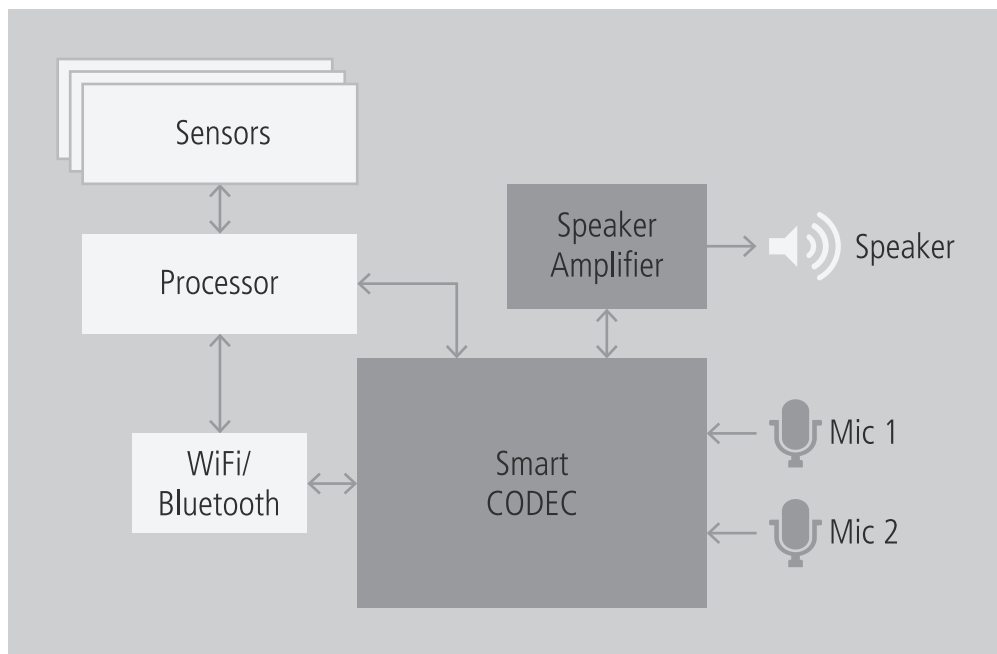
## Amplifiers

| Product | Input Type        | Channels                | Output Power (W) | SNR (dB) | THD+N @ 1 W (dB) | Power Supply (V) | Package  |
|---------|-------------------|-------------------------|------------------|----------|------------------|------------------|----------|
| CS35L32 | Analog            | Class D Speaker Driver; | 1.7 W into 8 ohm | 102      | 0.02             | 3-5.25           | 30 WLCSP |
|         |                   | 1 x Mono Hybrid         |                  |          |                  |                  |          |
| CS35L33 | I <sup>2</sup> S; | Class D Speaker Driver; | 4.4 W into 8 ohm | 95       | 0.02             | 3-5.5            | 42 WLCSP |
|         | TDM               | 1 x Mono Hybrid         |                  |          |                  |                  |          |

# Security Systems and Audio Monitoring: Wireless Security Cameras, Smoke Detectors, Audio Monitoring Systems

## Soundclear Software Featuring “Always On” Voice Control

- Soundclear Record
- Soundclear Control
- Software Partner Audio Sensors



Wireless Security Camera Block Diagram

## Smart Codecs

| Product | DACs | ADCs | DAC Dynamic Range (dB) | ADC Dynamic Range (dB) | DAC THD+N (dB) | ADC THD+N (dB) | Sample Rate (kHz) | Analog Inputs/Outputs      | ADSP Cores | DSP Capability (MIPS) | Analog Power Supply (V) | Supply Current (μA) | Package   |
|---------|------|------|------------------------|------------------------|----------------|----------------|-------------------|----------------------------|------------|-----------------------|-------------------------|---------------------|-----------|
| CS47L15 | 3    | 2    | 115                    | 98                     | -92            | -88            | 192               | Pseudo-differential        | 1          | 150                   | 1.8                     | 1.2                 | 173 WCSP  |
| CS47L24 | 3    | 4    | 121                    | 121                    | -85            | -88            | 192               | Pseudo-differential        | 2          | 300                   | 1.8                     | 1.2-1.8             | 63 WCSP   |
| CS47L35 | 3    | 4    | 120                    | 122                    | -85            | -88            | 8-192             | Pseudo-differential        | 3          | 450                   | 1.8                     | 1.2-1.8             | 102 WCSP  |
| WM8281  | 8    | 6    | 121                    | 100                    | -92            | -89            | 192               | Single-ended; differential | 4          | 600                   | 1.7-5.5                 | 1.14-1.9            | 138 WLCSP |

## Amplifiers

| Product | Input Type        | Channels                | Output Power (W) | SNR (dB) | THD+N @ 1 W (dB) | Power Supply (V) | Package  |
|---------|-------------------|-------------------------|------------------|----------|------------------|------------------|----------|
| CS35L32 | Analog            | Class D Speaker Driver; | 1.7 W into 8 ohm | 102      | 0.02             | 3-5.25           | 30 WLCSP |
|         |                   | 1 x Mono Hybrid         |                  |          |                  |                  |          |
| CS35L33 | I <sup>2</sup> S; | Class D Speaker Driver; | 4.4 W into 8 ohm | 95       | 0.02             | 3-5.5            | 42 WLCSP |
|         | TDM               | 1 x Mono Hybrid         |                  |          |                  |                  |          |

# Proven Technology

Cirrus Logic's network of acoustic lab facilities provides feasibility and viability testing for our smart home hardware and software technologies. The centerpiece of these activities is our Phoenix, Arizona location featuring a far-field lab, AVS test chamber, three listening rooms, an Anechoic chamber and an ACQUA test lab.



## Far-Field Lab Features:

- Moveable walls enable ability to test in varying room volumes
- Ability to recreate varying noise environments
- Vanechoic cabinets provide tunable reverberation times







Copyright © 2018 Cirrus Logic, Inc.

All rights reserved

Printed in the USA

Cirrus Logic, Inc. and its subsidiaries ("Cirrus") believe that the information contained in this document is accurate and reliable. However, the information is subject to change without notice and is provided 'as is' without warranty of any kind (express or implied). Customers are advised to obtain the latest version of relevant information to verify, before placing orders, that information being relied upon is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, indemnification, and limitation of liability. No responsibility is assumed by Cirrus for the use of this information, or for infringement of patents or other rights of third parties. This document is the property of Cirrus and, by furnishing this information, Cirrus grants no license, express or implied, under any patents, mask work rights, copyrights, trademarks, trade secrets, or other intellectual property rights. No part of this publication may be copied, reproduced, stored in a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photographic, or otherwise) unless distributed in its entirety with all copyright notices attached. No part of this publication may be used as a basis for manufacture or sale of any items without the prior written consent of Cirrus.

Certain applications using semiconductor products may involve potential risks of death, personal injury, or severe property or environmental damage ("critical applications"). Cirrus products are not designed, authorized, or warranted to be suitable for use in products surgically implanted into the body, automotive safety or security devices, life-support products or other critical applications. Inclusion of Cirrus products in such applications is understood to be fully at the customer's risk and Cirrus disclaims and makes no warranty of merchantability and fitness for particular purpose, with regard to any Cirrus product that is used in such a manner. If the customer uses or permits the use of Cirrus products in critical applications, customer agrees, by such use, to fully indemnify Cirrus, its officers, directors, employees, distributors and other agents from any and all liability, including attorneys' fees and costs, that may result from or arise in connection with these uses.

Cirrus Logic, Cirrus, Band Xpander, CLIDE (Cirrus Logic Integrated Development Environment), Cirrus Bass Enhancement (CBE), Cirrus Dynamic Volume Leveler (DVL), Cirrus Virtualizer Technology (CVT), CobraCAD, CobraCom, CobraNet, Crystal LAN, DSP Composer, DSP Condenser, DSP Conductor, Entertainment Processors, EXL Core, Extreme-S, Intelligent Room Calibration, MaverickCrunch, MaverickKey, Micro Condenser, Multipath, Optimal Integration, PacketPage, Popguard, Single-S, SoundClear, Total-S, Cirrus Logic framework, Cirrus Extended Surround, and the Cirrus Logic logo designs are among the trademarks of Cirrus Logic, Inc. and/or its subsidiaries. All other brand and product names in this document may be trademarks or service marks of their respective owners.



CORPORATE HEADQUARTERS  
800 West Sixth Street  
Austin, Texas 78701  
United States

T +1 512-851-4000  
Toll Free +1 800-888-5016

[cirrus.com](http://cirrus.com)

SEPT2018