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# ADI CABIN ELECTRONICS SYSTEM

## Application Description

ADI's cabin electronics system includes head-unit, audio amplifiers, and an audio bus.

The host system combines the functions of audio/video playback, navigation, driver assistance, and in-car communications into one device, offering the driver a comfortable and convenient driving experience. The typical features of the system include FM/AM/digital/satellite radio, CD/DVD player, multimedia peripheral connection, rear-seat entertainment, navigation, camera integration, gesture recognition, voice recognition, Bluetooth®, and wireless communication connections.

The stand-alone audio amplifier is connected to the multichannel speakers to transform vehicles into a diverse acoustic environment, providing high fidelity audio enjoyment. Typical features of the system include powerful sound processing, active noise reduction within the car, and engine sound simulation.

The audio bus is used for the transmission of audio and control signals among the head unit, amplifier, active noise-reduction module, and microphone/microphone array.

## System Requirements and Design Challenges

In addition to the basic audio/video playback function, a modern automotive infotainment system is expected to deliver better performance in terms of audio/video quality, connectivity, its human-machine interface, ease of operation, and power consumption. The system features various highly efficient digital signal processing technologies that are integrated with advanced audio algorithms so as to improve the acoustic experience and reinforce the acoustic response inside the car.

## Solutions from ADI

As a leading company with years of experience in high performance signal processing and automotive electronics, ADI offers a variety of infotainment systems that are qualified for automotive applications.

ADI offers a wide range of video decoding converters, transcoders and coprocessors with outstanding signal performance and functionality. We can also provide low power LVDS/HDMI®/MHL/APIX2 interface devices.

ADI's automotive audio bus ($A^2B$®) is mainly used to connect audio modules. Only a pair of twisted-pair cables need be used to transmit audio and control signals, as well as providing power supply.

The fixed-point audio DSP, SigmaDSP®, floating-point audio DSP, SHARC® DSP, and multicore floating-point audio SOC Griffin produced by ADI are widely adopted in host systems and stand-alone audio amplifiers as the audio processor dedicated to high quality, efficient postprocessing or routing/mixing. The award-winning graphical user interface, SigmaStudio™, makes DSP programming as simple as drawing a flowchart.

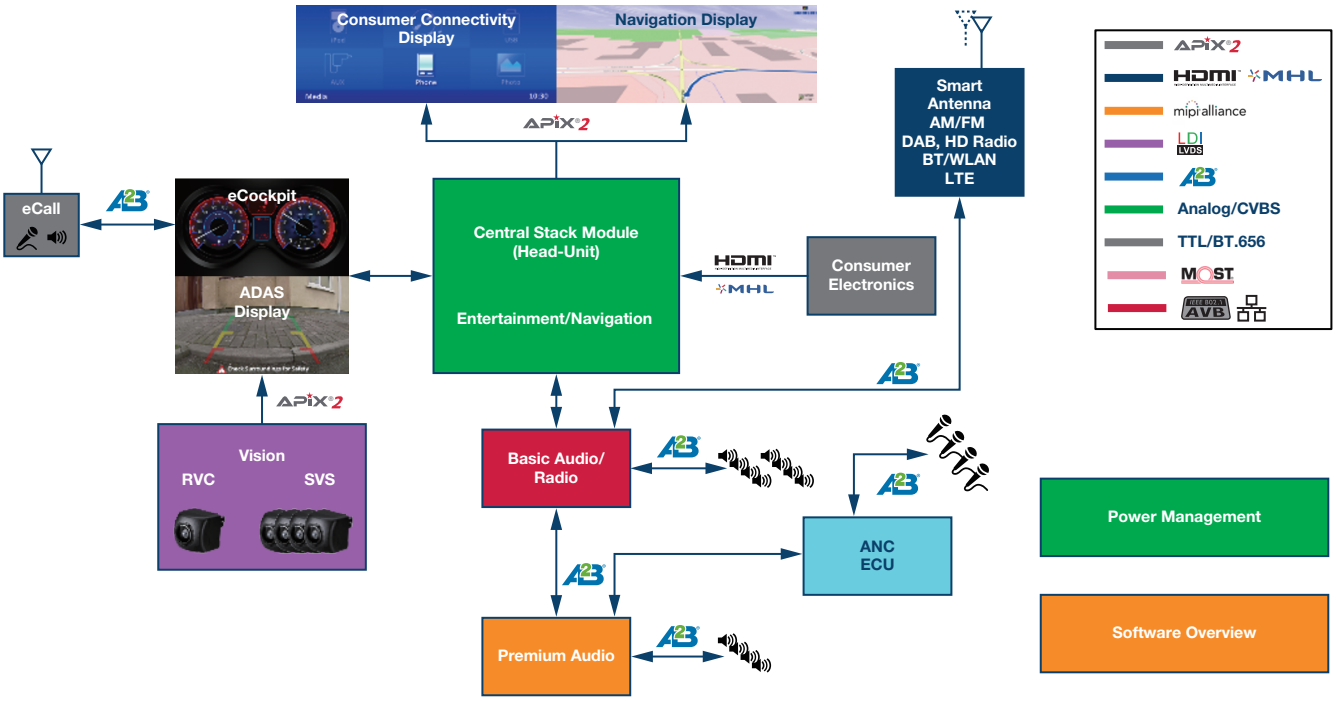
ADI's highly integrated Blackfin® DSP series is applicable for multimedia connections, network connections, and software audio processing applications.

In addition to DSP, ADI provides a wide range of software modules, such as decoders, surround sound, virtualization, echo elimination, noise-reduction during communication, and active noise-reduction.

ADI offers rich channel options for our audio encoding converters, with extremely high SNR/THD.

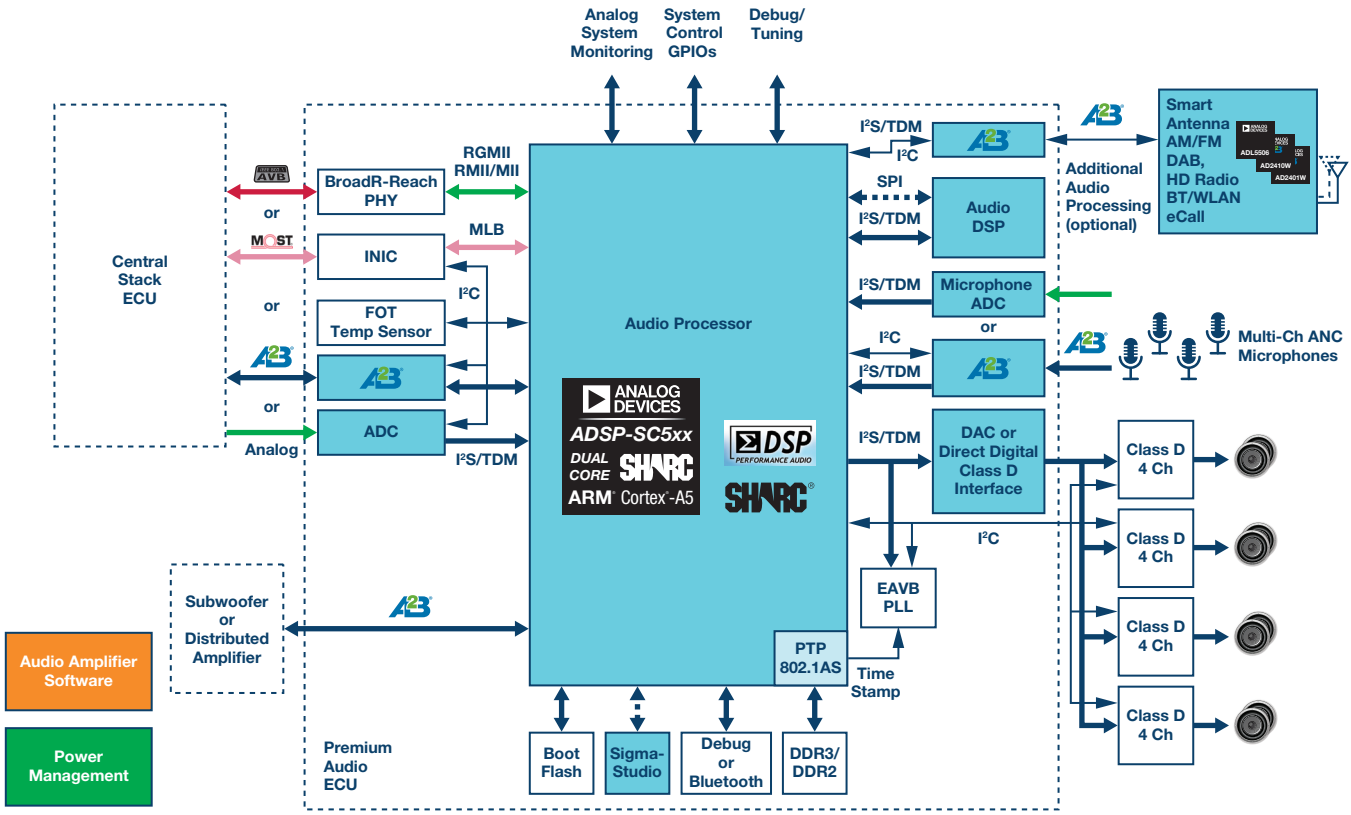
ADI's multifunction photometric sensor and signal conditioning technology are integrated with AFE, ADC, LED drives, and a timing core. As such they can be used in numerous optical measurement applications—for example, in-cabin near-distance detection and gesture recognition.

## The Main Signal Chain—In-Cabin Infotainment Hosts Processing Blocks




*Note: The signal chains above are representative of the host design. The technical requirements of the blocks vary, but the products listed in the table below are representative of ADI's solutions that meet some of those requirements.*

## The Main Signal Chain—In-Cabin Standalone Audio Amplifier




*Note: The signal chains above are representative of the design of stand-alone audio amplifier. The technical requirements of the blocks vary, but the products listed in the table below are representative of ADI's solutions that meet some of those requirements.*

## ADI Products

| Part Number | Description | Package | Key Advantages |
|---|---|---|---|
| *SigmaDSP* | | | |
| ADAU1401AW | 28-/56-bit, 50 MIPS, 4 kB parameter RAM, 2×ADC, 4×DAC, 8 inputs and 8 outputs digital audio, 12× GPIO, EEPROM self-boot supported | 48-lead LQFP | Sigma100, built-in ADC and DAC |
| ADAU1442/ ADAU1445/ ADAU1446W | 28-/56-bit, 175 MIPS, 16 kB parameter RAM, 24 inputs and 24 outputs digital audio, 12×GPIO, sample rate converter, self-boot supported | 100-lead TQFP 100-lead LQFP | Sigma200, high MIPS, multiple audio channels, sample rate converter |
| ADAU1450/ ADAU1451/ ADAU1452W | 32-bit, 294 MIPS, 40 kB parameters/data RAM, 48-channel digital audio input and output, 10 SAR AUX control ADC, 16-channel sample rate converter, EEPROM self-boot supported | 72-lead LFCSP | Sigma300, higher MIPS, more audio channels, sample rate converter |
| *SHARC DSP* | | | |
| ADSP-21477/ ADSP-21478/ ADSP-21479W | 32-/40-bit floating-point, 266 MHz, 3 Mb SRAM, FIR/IIR/FFT accelerometer, 16-bit SDRAM interface, S/PDIF/DTCP, 8× I²S/TDM, 2× SPI, 16× PWM | 88-lead LFCSP 100-lead LQFP | Low cost version of the fourth generation SHARC processor |
| ADSP-21486/ ADSP-21487/ ADSP-21488/ ADSP-21489W | 32-/40-bit floating-point, 400 MHz, 3 Mb SRAM, FIR/IIR/FFT accelerometer, 16-bit SDRAM interface, S/PDIF/DTCP, 8× I²S/TDM, 2× SPI, 16× PWM | 100-lead LQFP 176-lead LQFP | Low cost version of the fourth generation SHARC processor |
| ADSP-SC582/ ADSP-SC583/ ADSP-SC584/ ADSP-SC587W/ ADSP-21583/ ADSP-21584W | 32-/40-/64-bit floating point, 5.4 GFLOPs, 1.8 GMACS SHARC+ DSP performance (2 MHz × 450 MHz), industry-standard ARM® Cortex®-A5 with FPU and Neon® DSP extension (450 MHz/hr, 720 DMIPS), FIR/IIR/FFT/IFFT/ HAE/SINC, encrypted hardware accelerrator, quick installation guide, supports gigabit Ethernet (with AV), MLB, USB, CAN, and SDIO, each SHARC+ core is equipped with large capacity 384 kB L1 SRAM, 1MB shared L2 SRAM and advance DMA features, high performance external storage ports including DDR3L support (only BGA package provided), seamless DSP digital audio port, including four complete SPORT (with I²S), SPDIF and sampling rate converter, multiple serial interfaces including 4-channel SPI, I²C, and UART | 349-ball BGA 529-ball BGA | High performance SOC with at most dual-core SHARC+ floating point DSP and ARM Cortex-A5 integrated |
| *Blackfin DSP* | | | |
| BF592W | 400 MHz, 68 kB L1, 2× SPI, 2× SPORT, 2× UART, 1× PPI, 32× GPIO | 64-lead LFCSP | Low cost, universal |
| BF531/ BF532/ BF533W | 400 MHz/600 MHz, 52 kB/84 kB/148 kB SRAM, 1× SPI, 2× SPORT, 1× UART, 1× PPI, 16× GPIO | 160-ball BGA/ 169-ball BGA 176-lead LQFP | Low power, universal |
| BF534W | 500 MHz, 132 kB SRAM, 1× CAN, 1× SPI, 2× SPORT, 2× UART, 1× PPI, 48×GPIO | 182-ball BGA/ 208-ball BGA | CAN PHY |
| BF539W | 533 MHz, 148 kB SRAM, 1× CAN, 3× SPI, 4× SPORT, 3× UART, 1× PPI, 38×GPIO | 316-ball BGA | CAN PHY, navigation/entertainment/audio processing |
| BF700/ BF701/ BF702/ BF703/ BF704/ BF705/ BF706/ BF707W | 400 MHz, 128 kB L1 SRAM, 128 kB/256 kB/512 kB/ 1024 kB L2 SRAM, 512 kB ROM, 2× CAN, 3× SPI, 2× SPORT, 2× UART, 1× PPI, 43× GPIO/47× GPIO | 88-ball BGA/ 184-ball BGA | Low power, general-purpose |
| *A²B* | | | |
| AD2421/ AD2422/ AD2425W | 50 bps, maximum 32-channel, I²S/TDM, I²C, 4-loop microphone input | 32-lead LFCSP | A²B reception/transmission |
| *Video Coprocessor* | | | |
| ADV7186W | 6-channel SD/HD decoder, 3D comb filter, bitmap OSD and overlay capability, scaler & de-interlacing display controller, LVDS Rx and Tx | 196-ball BGA | Hardware coprocessor, multiple functions, high simulation performance |

| Part Number | Description | Package | Key Advantages |
|---|---|---|---|
| *Video ADC* | | | |
| ADV7180W | CVBS decoder, SDTV, 3-channel/6-channel inputs, NTSC/PAL/SECAM input, 8-/16-bit BT656 output | 32-lead LFCSP/ 40-lead LFCSP 48-lead LQFP/ 64-lead LQFP | Best-in-class simulation performance |
| ADV7181DW | RGB decoder, SD/HDTV, 6-channel inputs, NTSC/PAL/SECAM input, 8-/16-bit BT656 output | 64-lead LQFP | Best-in-class simulation performance |
| ADV7182W | CVBS decoder, SDTV, SE/differential input, NTSC/PAL/SECAM input, 8-bit BT656 output, cable diagnostics | 32-lead LFCSP | Single-ended/differential input, cable diagnostics |
| ADV7280/ ADV7280-MW | CVBS decoder, SDTV, 4-channel/8-channel inputs, NTSC/PAL/SECAM input, 8-bit BT656 output/MIPI output, interlaced-to-progressive conversion | 32-lead LFCSP | MIPI output, interlaced-to-progressive conversion |
| ADV7281/ ADV7281-M/ ADV7281-MAW | CVBS decoder, SDTV, 4-channel/6-channel/8-channel input, differential input supported, NTSC/PAL/SECAM input, 8-bit BT656 output/MIPI output, two-way diagnostic input | 32-lead LFCSP | Single-ended/differential input, MIPI input/ output with diagnostics |
| ADV7282/ ADV7282-MW | CVBS decoder, SDTV, 4-channel/6-channel input, differential input supported, NTSC/PAL/SECAM input, 8-bit BT656 output/MIPI output, interlaced-to-progressive conversion, two-way diagnostic input | 32-lead LFCSP | Single-ended/differential input, MIPI output, interlaced-to-progressive conversion, with diagnostics |
| *Video DAC* | | | |
| ADV7390/ ADV7391/ ADV7392/ ADV7393W | SD/HD encoder, YCrCb/RGB input, CVBS/S-video/YPrPb/RGB output | 32-lead LFCSP 40-lead LFCSP | CVBS encoders, high simulation performance |
| ADV7125W | CMOS, 330 MHz, triple 8-bit video DAC, complementary outputs | 48-lead LFCSP 48-lead LQFP | RGB encoders, high simulation performance |
| AD723W | Low cost RGB to PAL/NTSC encoder with load detect, 2.7 V to 5 V | 28-lead TSSOP | Low cost RGB to PAL/NTSC encoder |
| *Video Amplifier* | | | |
| ADA4851-1/ ADA4851-2/ ADA4851-4W | Single/dual/quad video amplifier, 130 MHz, rail-to-rail output, 3 V to 10 V supply | 6-lead SOT-23/ 8-lead MSOP/ 14-lead TSSOP | Video receiver, high speed, flat gain, low cost |
| ADA4891-1/ ADA4891-2/ ADA4891-4W | Single/dual/quad video amplifier, 220 MHz, rail-to-rail output, 2.7 V to 5.5 V supply | 6-lead SOT-23/ 8-lead MSOP/ 14-lead TSSOP | Video receiver, high speed, flat gain, low cost |
| ADA4430-1W | Single video amplifier, fixed low-pass SD video filter, ultralow power, rail-to-rail output, 2.65 V to 6 V supply | 6-lead SOT-23 | Video driver, SD low-pass filter, gain flatness, low power consumption |
| ADA4830-1/ ADA4830-2W | Difference video amplifier, gain = 0.5, 85 MHz @ 3 dB, short-to-battery protection, 3 V to 5 V supply | 8-lead LFCSP | Video receiver, short-circuit protection, low system cost |
| ADA4432-1/ ADA4433-1W | Single-channel SD video amplifier, battery short circuit protection, fifth-order low-pass video filter, ultralow power consumption | 8-lead LFCSP 6-lead SOT-23 | Video receiver, short-circuit protection, low power consumption |
| *Video Multiplexer* | | | |
| ADG1411W | Quad SPST, 1.8 Ω $R_{ON}$, 170 MHz, 4.5 V to 16.5 V supply | 16-lead LFCSP | Low $R_{ON}$, high channel matching |
| ADG786W | Triple SPDT, 2.5 Ω $R_{ON}$, 160 MHz, 1.8 V to 5.5 V supply | 20-lead LFCSP | Low voltage, low $R_{ON}$ |
| ADG5412W | High voltage, quad SPST, latch-up | 16-lead TSSOP 16-lead LFCSP | High voltage, latch-up |
| *HDMI/MHL Rx* | | | |
| ADV7611/ ADV7612W | Single-/dual-channels, HDMI v1.4a, 165 MHz, all mandatory/additional 3D video formats, 24 output pixel bus, SPDIF or 8-channel $I^2S$ audio | 62-lead LQFP 100-lead LQFP | Low power consumption |
| ADV7480/ ADV7481/ ADV7482W | MHL v2.1, 75 MHz; HDMI v1.4a, 165 MHz; 8-channel analog input with diagnostics, dual MIPI-CSI 2.0 outputs, 8 TTL digital input/output | 100-ball BGA | Low power consumption, HDMI/MHL dual mode, MIPI-CSI 2.0 output |
| *HDMI Tx* | | | |
| ADV7511W | HDMI transmitter, 225 MHz, HDMI V1.4, DVI v1.0, 3D video formats supported, RGB, YCbCr, DDR and ITU656 input supported, 8-channel $I^2S$, S/PDIF audio input, maximum sampling speed of 192 KHz | 100-lead LQFP | HDMI transmitters |

| Part Number | Description | Package | Key Advantages |
|---|---|---|---|
| *APIX2 Rx* | | | |
| ADV7782W | APIX2 receiver, dual HDCP v1.4 decoding supported, daisy-chaining; openLDI input, 85 MHz; dual MIPI-CSI 2.0 output; color gamut conversion, 4:2:2 to 4:4:4; support I²C host, MII, HDCP repeater | 100-ball BGA | APIX2 receiver, MIPI-CSI 2.0 output, OpenLDI input supported, with video processing |
| *APIX2 Tx* | | | |
| ADV7680/ ADV7682W | APIX2 transmitter, 3 Gbps; dual HDMI receiver, HDCP v1.4 content protection supported; dual display supported, 3D linear de-interlacing; BT.656 input; 7.1 channel 24-bit, stereo audio sample rate conversion; two-way communication (100 Mbps Ethernet, SPI, I²C, GPIO) | 64-lead LFCSP 100-lead LQFP | APIX2 transmitter, dual HDMI receiver, BT656 input, two-way communication, dual display supported |
| *Audio Codecs* | | | |
| ADAU1961W | 24-bit, 96 kHz, 1× MIC, 2× differential ADC, 2× differential + 1× single-channel DAC, 99 dB SNR | 32-lead LFCSP | Integrated MIC interface, high signal-to-noise ratio |
| AD1937/ AD1938W | 24-bit, 192 kHz, 4× differential ADC, 8× differential/single-ended DAC, 102 dB SNR | 64-lead LQFP/ 48-lead LQFP | High number of channels, high signal-to-noise ratio |
| ADAU1962/ ADAU1966W | 24-bit, 96 kHz, 12×/16× differential DAC, 118 dB SNR | 80-lead LQFP | High number of channels, high signal-to-noise ratio |
| ADAU1977/ ADAU1978W | 24-bit, 96 kHz, 4× differential ADC, 106 dB SNR, with a microphone interface | 40-lead LFCSP | High number of channels, high signal-to-noise ratio |
| ADAU1979W | 24-bit, 192 kHz, 4× differential ADC, 4.5 V rms ac-coupled input | 40-lead LFCSP | High number of channels, high signal-to-noise ratio |
| *MEMS Gyroscope/Vibration Accelerometer* | | | |
| ADXRS810W | MEMS angular rate sensor, 300°/s range, 16-bit, 3.3 V/5 V power supply, SPI | 16-lead SOIC | Excellent null offset, high vibration rejection ratio, continuous self-testing |
| ADXL312/ ADXL313W | MEMS accelerometer, three-axis, ±1.5 *g*/3 *g*/6 *g*/12 *g* range, 2.9 m*g*/LSB, 2.0 V to 3.6 V power supply, SPI/I²C | 32-lead LFCSP | Ultralow power, embedded FIFO, high impact resistance |
| ADXL316 | MEMS accelerometer, 3-axis, ±16 *g* range (minimum), 1.8 V to 3.6 V power | 12-lead LFCSP | Compact dimensions, low power consumption |
| *Power Monitoring* | | | |
| ADM8318/ ADM8319/ ADM8320/ ADM8321/ ADM8322W | Watchdog, manual reset, push-pull output, 26-level reset threshold, 4-level timeout reset setting, 4-level watchdog timeout reset setting | 5-lead SOT-23 | Low power consumption, with the watchdog, manual reset |
| ADM8323/ ADM8324W | Watchdog, manual reset, push-pull/open collector output, 26-level reset threshold, 4-level timeout reset setting | 5-lead SOT-23 | Low power consumption, with the watchdog, manual reset |

*Suffix "W" represents automotive grade

## Design Resources

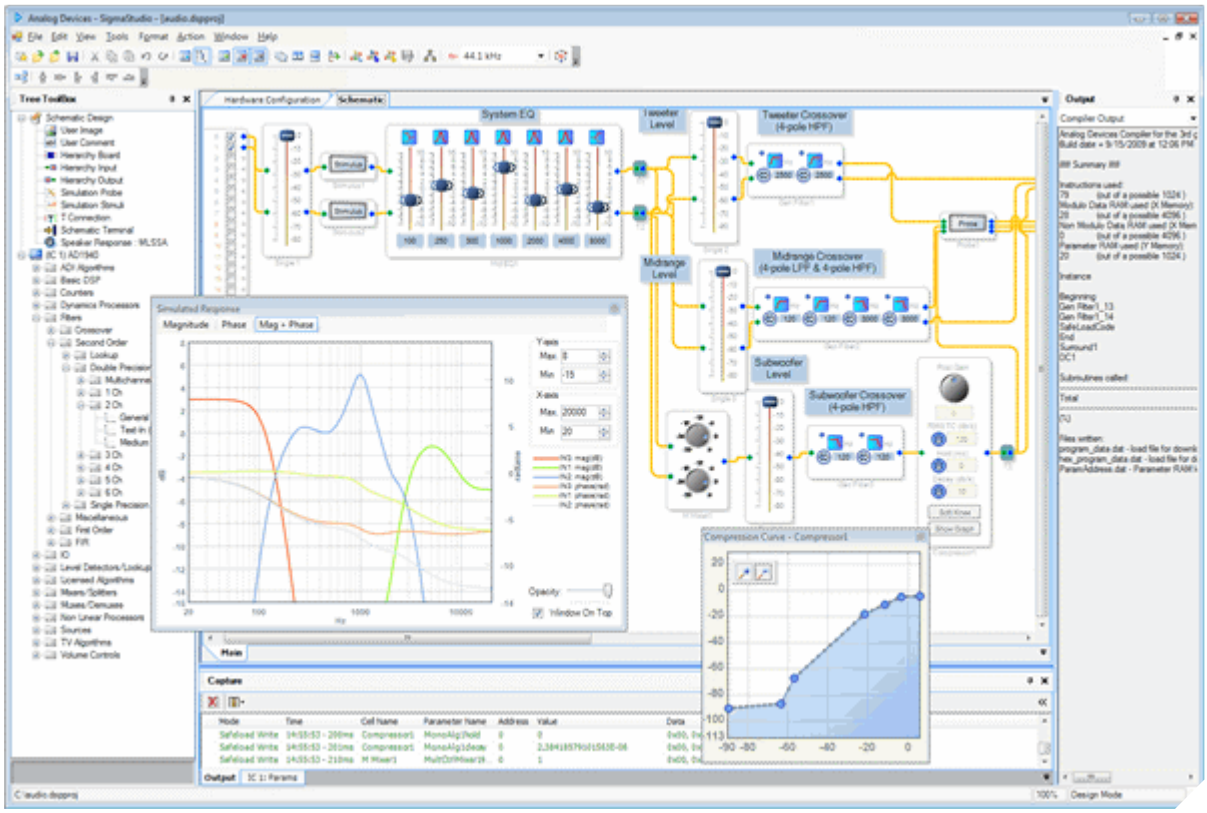
The SigmaStudio graphical development tool it is a software designed for programming, development, and tuning of SigmaDSP and SHARC DSPs. Common audio processing blocks can be wired together, and the compiler generates DSP-ready code and a control surface for setting and tuning parameters.

SigmaStudio standard algorithms include, but are not limited to, the following:

- FIR/IIR filters, crossovers, blocking
- Peak detector, rms detector, level detector, slicer
- Dynamic bass, loudness, stereo capture
- Lookup table, volume control, mute
- Mixers, splitters, hard/soft clipping

SigmaStudio plug-in algorithms include but not limited to the following:

- AM3D (Power Bass)
- Dolby (DAEP, headphones, Virtual Speaker, Pro Logic)
- BBE (MP, ViVA)
- SRS (Circle Surround, Trubass, TruSurround XT, WOW, WOW HD)
- DTS (surround sensation)
- Embracing sound (TH4)
- ADI (surround sound, virtual, EAS, ultralow sound)



## SHARC and Blackfin DSP Evaluation Platforms

### Software Module and Algorithm:

- SigmaStudio plug-in for SHARC processors and ADSP-SC5xx
- ADSP-SC5xx audio processing framework
- Advanced noise-elimination algorithm (ADI tool box, reference framework, third-party solution)
- Ethernet AVB protocol stack

## Evaluation Boards:

- ADV7180/ADV7180-M/ADV7181/ADV7182 evaluation board
- ADV7186 Evaluation Board
- ADAU1450/ADAU1451/ADAU1452 evaluation board
- ADSP-21479/ADSP-21489 evaluation board EZLITE
- ADZS-SC584-EZLITE evaluation board
- ADSP-BF592/ADSP-533/ADSP-707 evaluation board
- Evaluation boards of video amplifiers, video multiplexers, audio codecs

### Circuits from the Lab®

- CN-0101: Reconstruction Video Filter Using the ADA4430-1 Amplifier After the ADV7393 Video Encoder—*www.analog.com/en/cn-0101*
- CN-0060: Low Cost Differential Video Receiver Using the ADA4851 Amplifier and the ADV7180 Video Decoder—*www.analog.com/en/cn-0060*
- CN-0282: USB Powered DVI/HDMI-to-VGA Converter (HDMI2VGA) with Audio Extraction—*www.analog.com/en/cn-0282*
- CN-0224: Quad HDMI Input, Fast Switching Multiplexer Using the ADV7612 Receiver with Extended Temperature Range—*www.analog.com/en/cn-0224*

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