A²B®: A Better Audio Design Experience

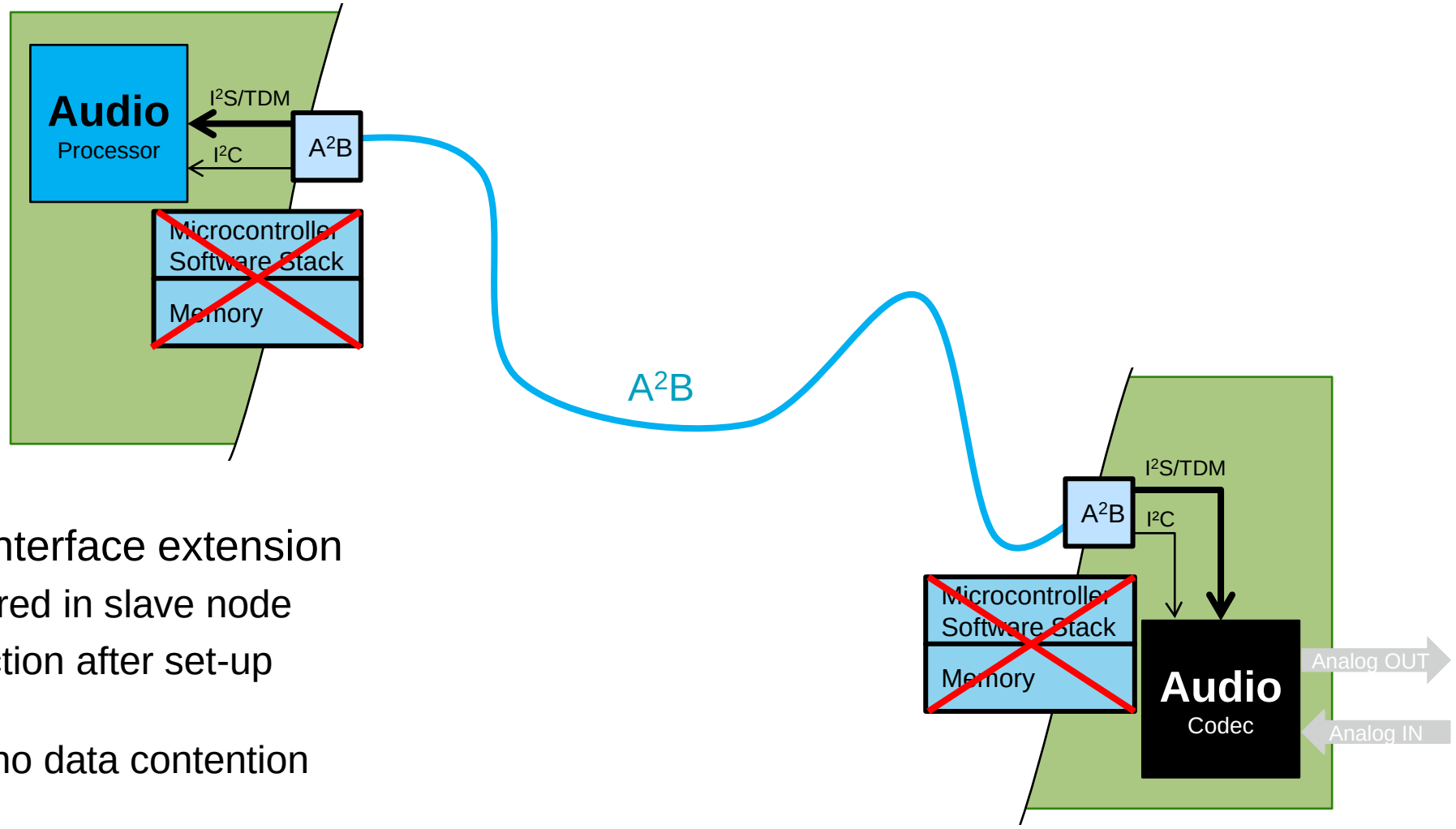
ANALOG DEVICES

AHEAD OF WHAT'S POSSIBLE™

Agenda

- Introduction to A^{2}B
- Overview of Ecosystem Products and Services
- Application Examples
- Creating A Better Audio Design Experience

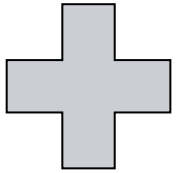
A²B Enables I²S/TDM Over Distance

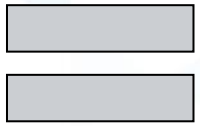


- Simple I²S- and I²C-interface extension
  - No intelligence required in slave node
  - No processor interaction after set-up
    - Zero-MIPS
  - No packet collision, no data contention

Where Did A²B Come From?

- Automotive Pressures (hence the name Automotive Audio Bus (A²B))
  - Explosion in number of microphones and speakers
  - Increase MPG by reducing weight
  - Better quality audio for cell phones
  - Reduce road noise
  - Manage costs
  - Reduced complexity – improved reliability





ADI A²B®

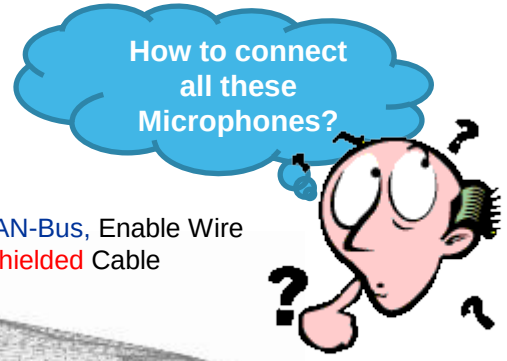
- ADI Culture
  - Solve tough problems
  - Best performance

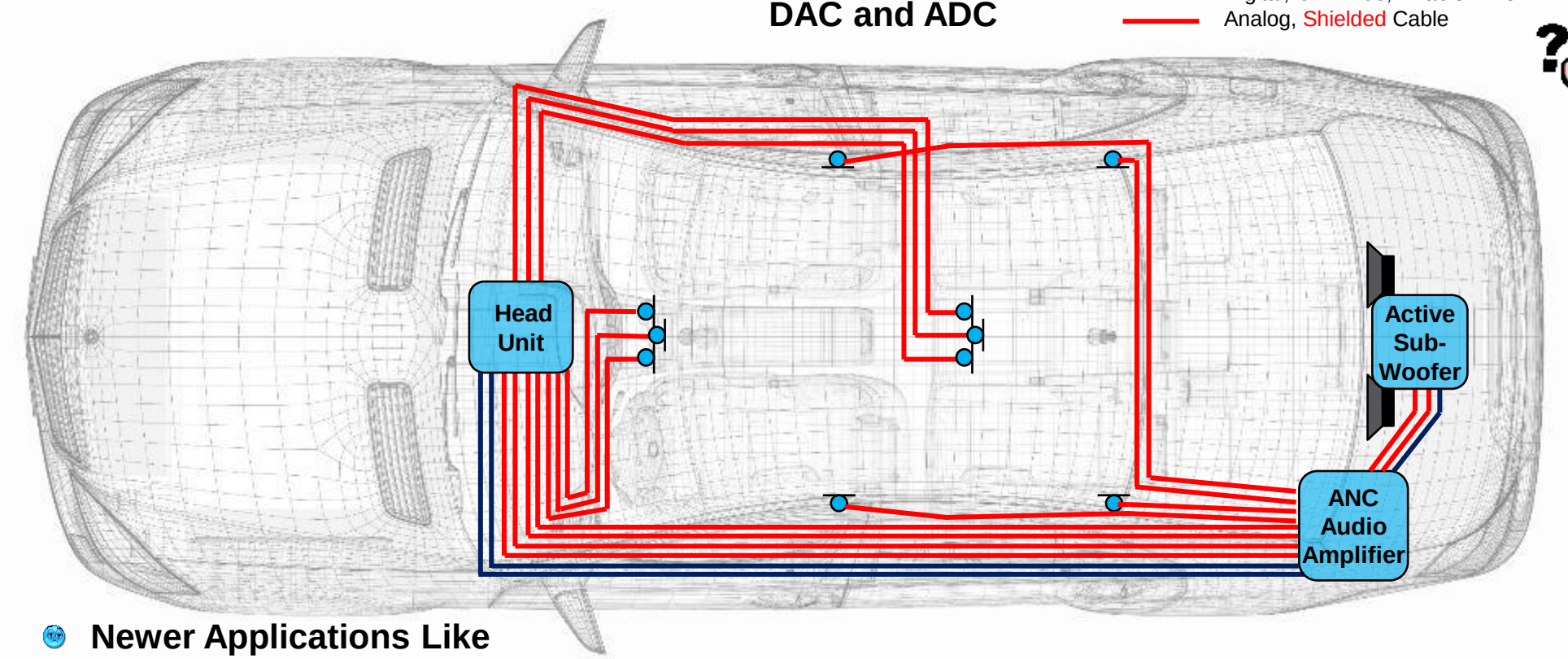
- Mature Technology
  - 3rd generation transceivers released to broad market
  - Over 30 automotive OEM commitments
  - 15+ M units shipped

Automotive Audio System

Traditional Approach

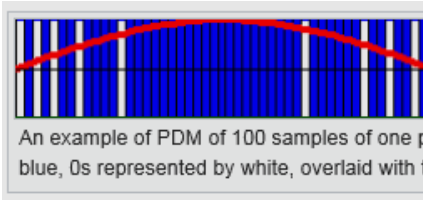
- **Vehicles Use Analog Connectivity for Microphones**
- **Analog Connection High Latency in DAC and ADC**

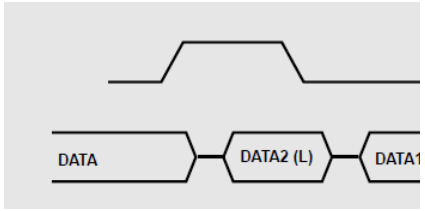


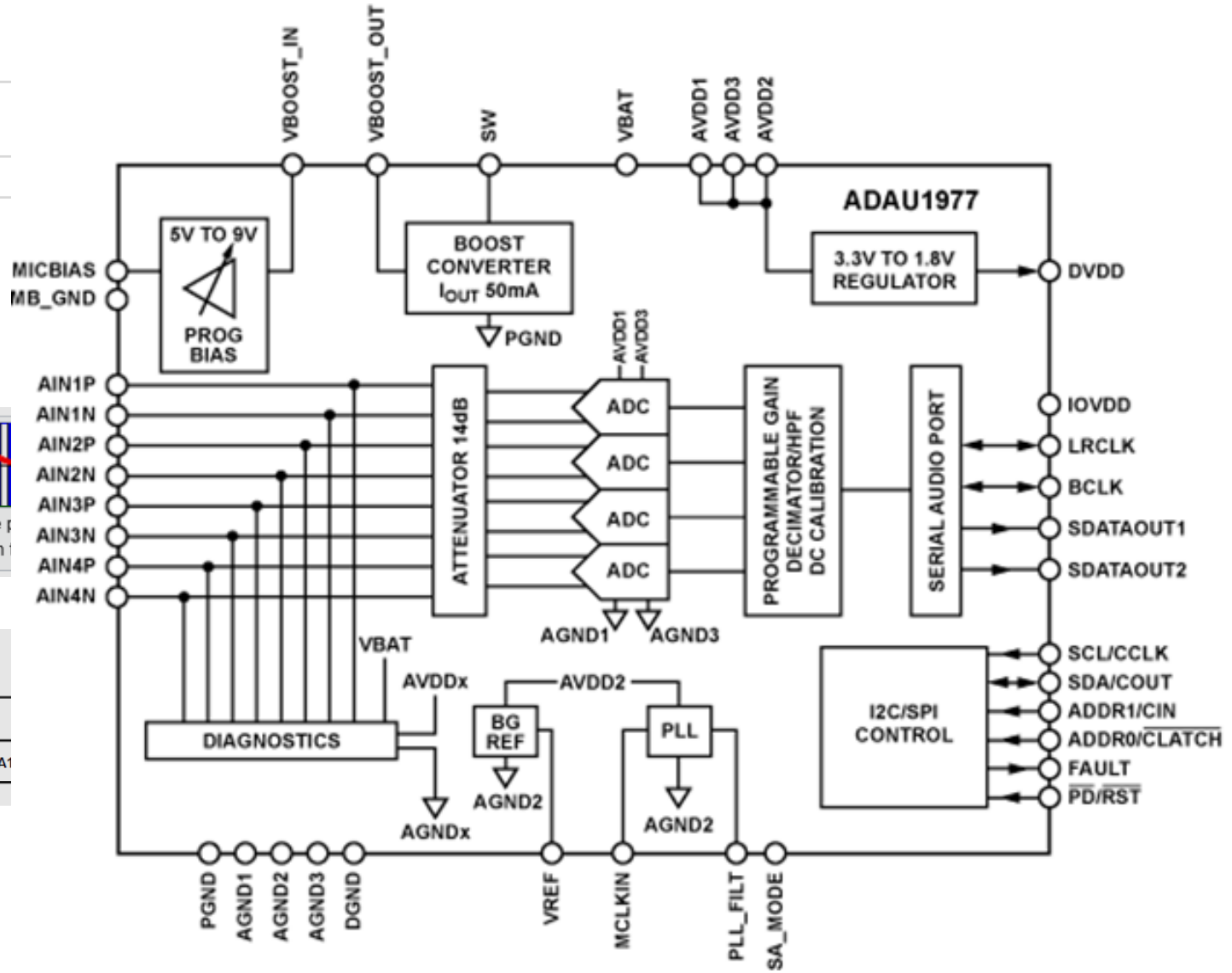


- **Newer Applications Like Acoustic Noise Cancellation Require More Microphones**
- **Too Many Connections!**

Evolution of Microphone Connectivity



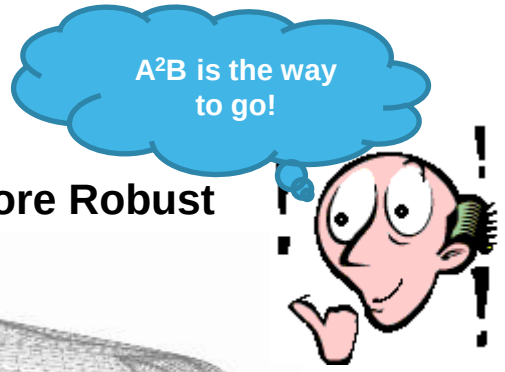




evices inside

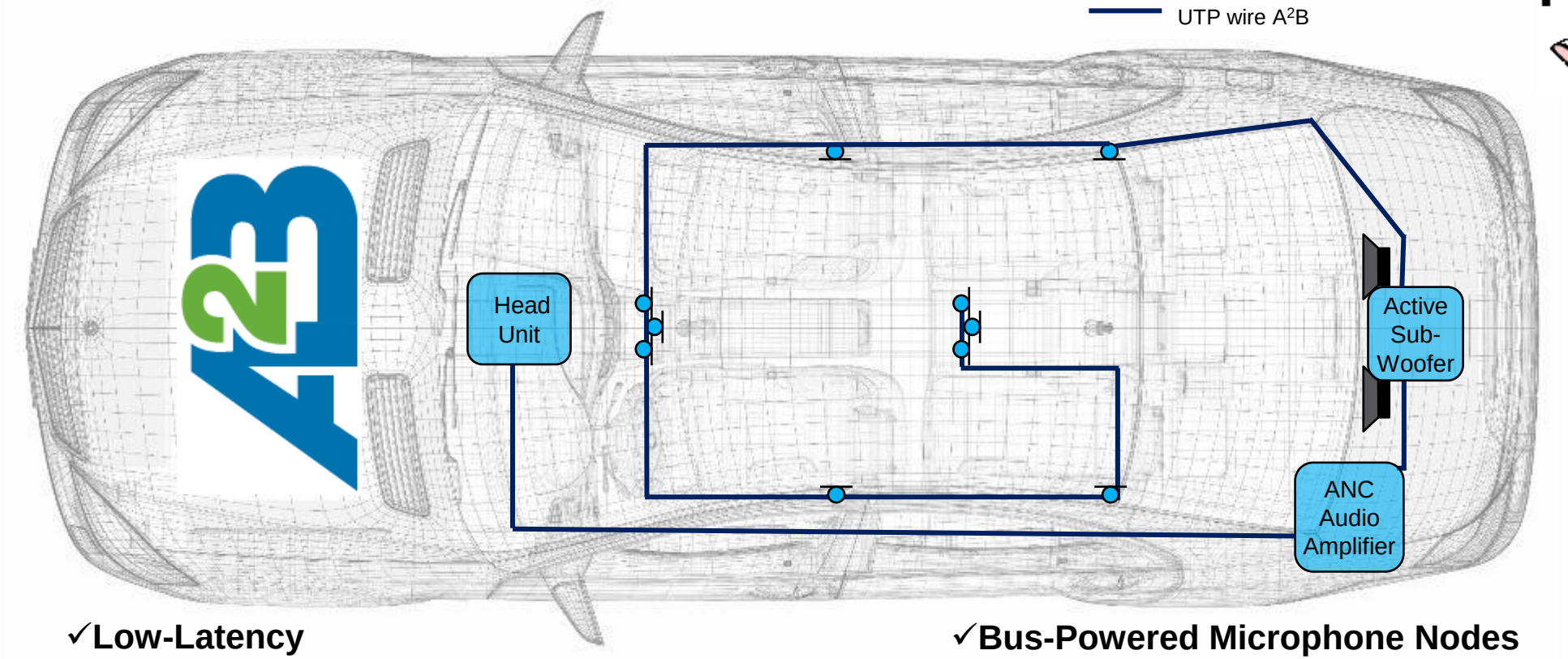
A²B = Automotive Audio Bus

The NEW Approach



✓**Cheaper Cables and Less Wires**
✓**Less Weight → Better Mileage & Less CO_2**

✓**All Digital Connections! ⟹ More Robust**



✓**Low-Latency**

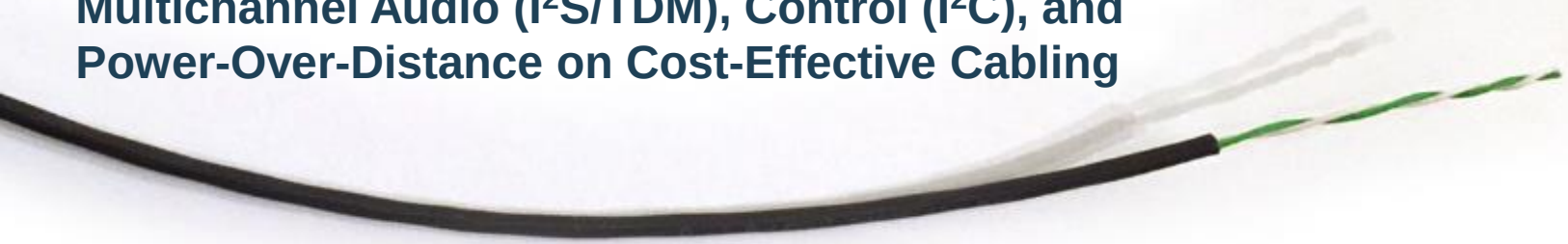
✓**Bus-Powered Microphone Nodes**

✓**Minimum # Connections**

Beyond Automotive…

A²B Technology Supports Cost-Effective Transport of Audio Data Over Distance

Multichannel Audio (I²S/TDM), Control (I²C), and Power-Over-Distance on Cost-Effective Cabling



Light Weight

Bus Power

Simple SW Stack

Easy to Configure Tools

Proven technology being made available to the broad market.

- Bidirectional data transfer at 50 Mbps bandwidth
- Low and deterministic latency (50 µs)
- System-level diagnostics
- Slave nodes can be locally-powered or bus-powered
- Programmable using ADI's SigmaStudio® GUI
- Uses cost-effective cables (unshielded twisted pair)

A²B vs Audio Cable/Connector Options

- The feature set was optimized for audio transport so it is compared with other audio transport options

Stage, ProAV cables

ADI A²B

- A²B can use a single unshielded twisted pair and any connector
- Offers lower cost, size, weight and other options

Analog audio

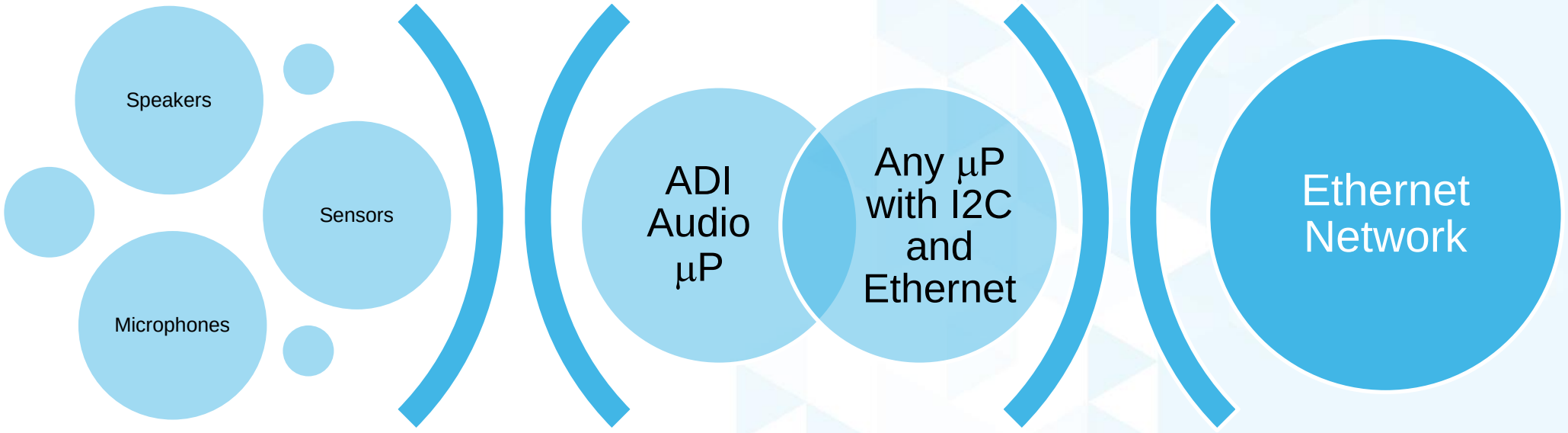
Digital audio

Dante over Ethernet

AES67 over Ethernet

ADI A²B

A²B + Ethernet



Audio or Non-Critical Edge Devices

Packet/Protocol Conversion

Any Distance and Bandwidth

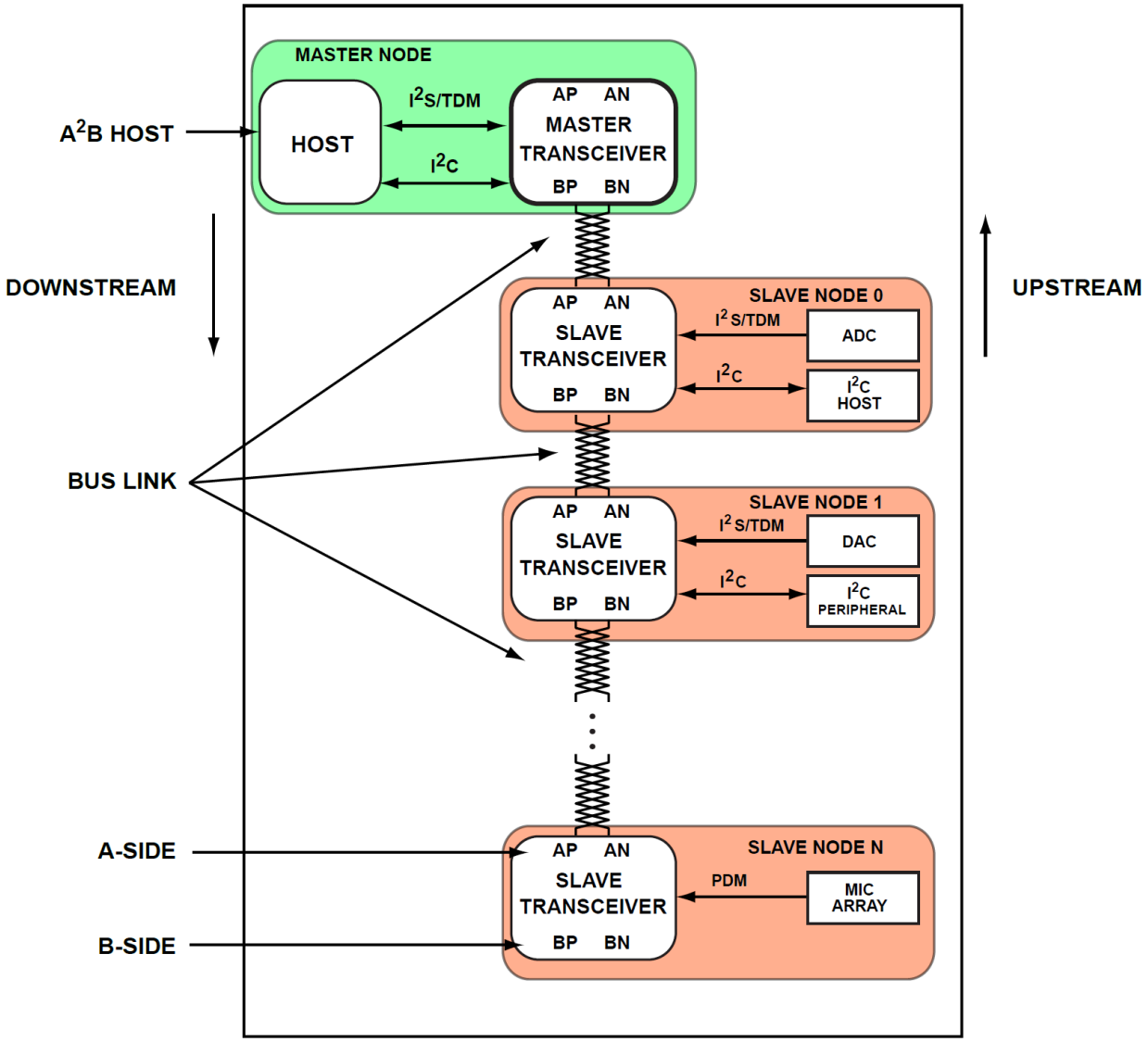
Best of Both

	Ethernet	A²B
Target Application	Backbone, Multimedia Bus	Microphone, Sensor and Audio Bus
Data Rate (Mbps)	**100/1000**	50
Cable Type	Fiber, Coax, 4 wire UTP (Cat5e), STP	**2 wire UTP (Cat5e)**
Cable Length (meters)	**20+**	**40 total (15 between nodes)**
Connection Topology	Ring, Star, Pt-to-Pt	**Daisy-Chained Line**
Latency	On order of ms	**2 samples for entire bus (50µs)**
MCU in Slave Node	Required	**Not Required**
Remote Power	Yes on PoE variants	**Yes**
Integrated Audio Compression	No	**Yes**
GPIO Support	No	**Yes**
System Complexity	Complex and High Load	**Simple and No Load**

- Ethernet
  - Distance
  - Higher data rate
  - Reuse of existing building wiring
  - Plug in compatibility to existing equipment

- A²B
  - Trx cost $2-$5, No Royalties
  - Cable cost – UTP with 100 Ω impedance
  - Bus power – remote microphones, speakers, sensors
  - Low deterministic latency (< 50 µs)
  - Bidirectional data transfer at 50Mbps
  - Advanced system-level diagnostics
  - No µP per node to run stack
  - Removes endpoint challenges for traditional Ethernet
    - Cable/connector cost, Bus power, Low latency
  - Audio + non-critical data channels

A²B Terminology / System Overview

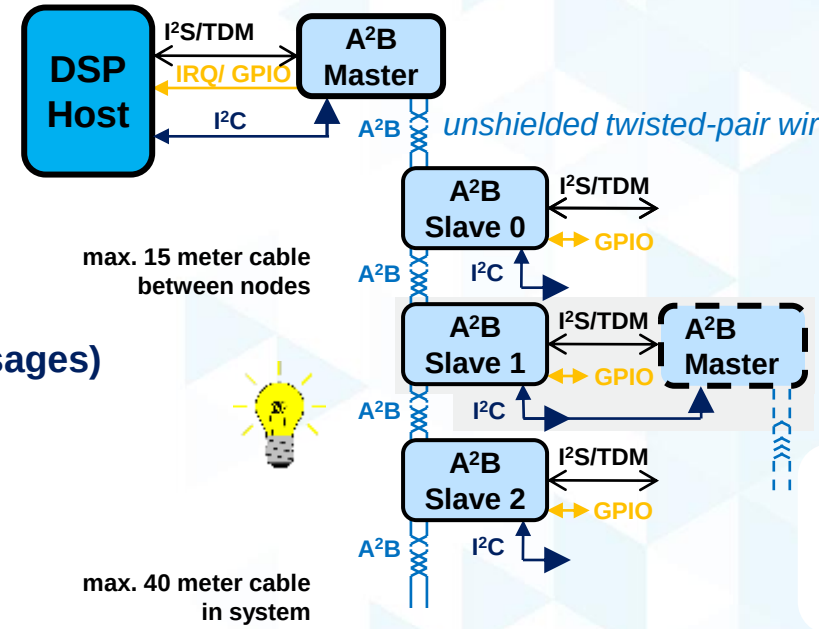


- A²B System Setup/Discovery Concepts
  - Host provides clocking to master
  - Host programs master registers via I2C
  - Master discovers slave(s)
  - Clock synchronized to master clock at slaves
  - Host programs slaves through master over A²B

Introduction to A²B Concept

- I²S to I²S over Distance
  - Multi-Channel I2S (TDM)
    - Up to 32 Audio Channels upstream and downstream between Each Node
      - Combinations of microphones and speakers
      - Audio Data Rates: 48kHz - 44.1kHz
        Sampling of: x 1, x 2 (96kHz), x4 (192kHz); ÷2 (24kHz), ÷4, ÷8, .. ÷32 (1.5kHz)
    - 49.152 Mbit/s. Digital Audio or Other Data
    - Less than 50 µs Latency
    - Node-to-Node and Broadcast
- Clock on Bus
  - Audio Clock Synchronous System
- I²C to I²C over Distance
  - incl. Mailbox transfers (e.g. CAN protocol messages)
- GPIO to GPIO over Distance
  - GPIOs logically combined
  - Interrupt Requests
- Power-Supply on Same Bus

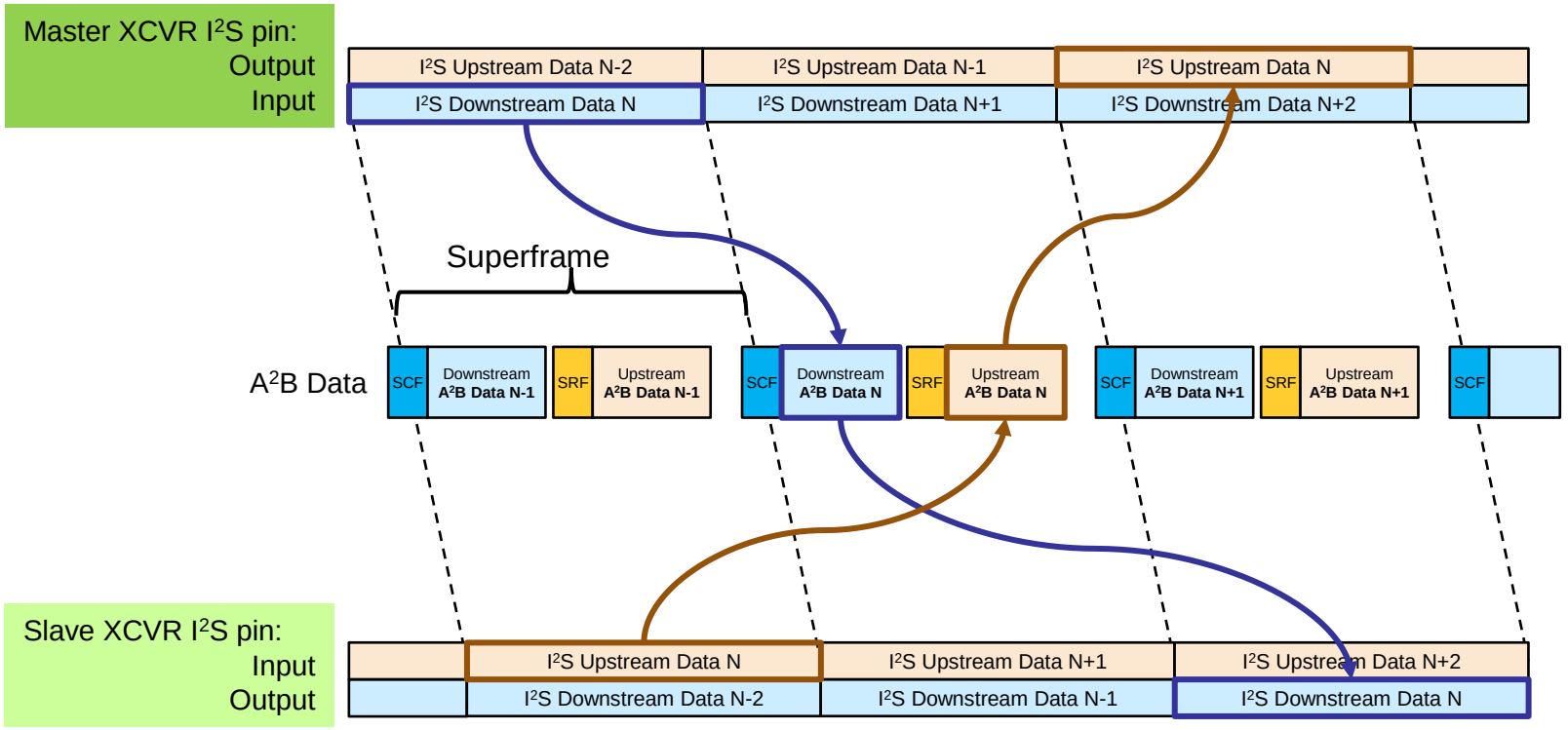
- A²B Bus Topology
  - Point-to-Point
  - Line
    - Daisy-Chained Nodes
    - Single Master – Multiple Slaves
      - Up to 11 Nodes (10 Slaves)
  - Tree
    - Optional Branches



Data size example	Max. Data Slots between each node	
	Each Direction	Overall
16 Bit	32	51
24 Bit	32	34

➢30V Robust, Line Diagnostics

A²B Bus Synchronous Data Exchange (Latency)

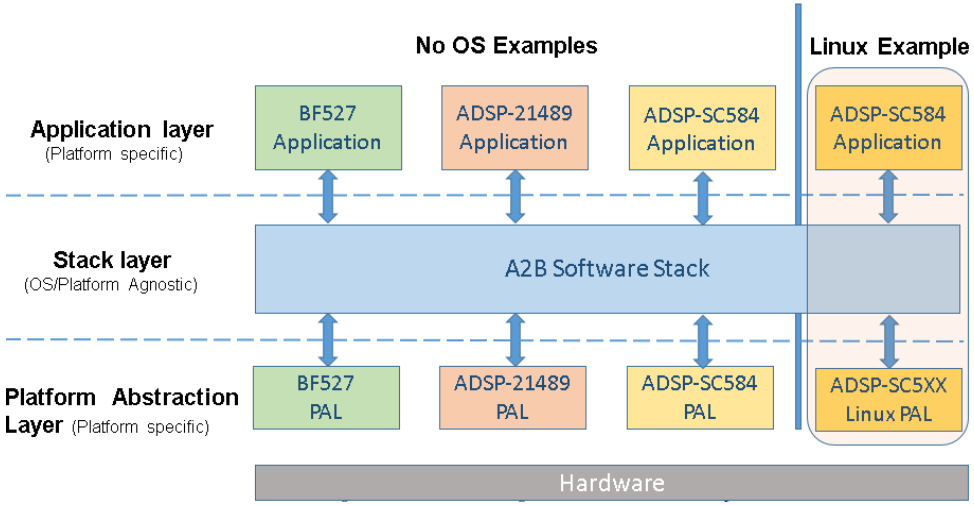


Latency: ~2 SYNC periods at 48 kHz
(2 × 1/48 kHz < **50 µs**)

A²B Software Offerings

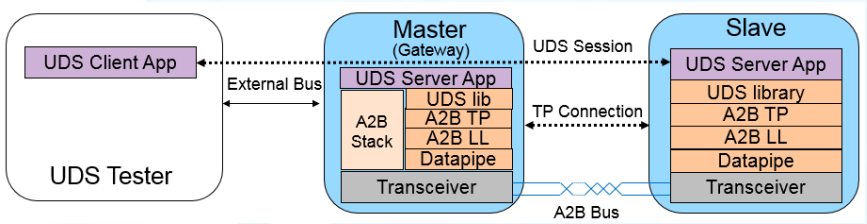
Automotive Audio Serial Bus (A²B)

- SigmaStudio - Network configuration tool
- A²B Software Stack
  - With Examples



- A²B DataPipe Library
  - Library for carrying asynchronous data packets over synchronous A²B slots.
  - Application
    - Ethernet/CAN/Async data over A²B

- Unified Diagnostic Services over A²B Library
  - UDS services as per ISO14229-1 over A²B
  - Application
    - Software Update over A²B
    - Vehicle Diagnostics over A²B



- A²B Mailbox Communication Library
  - Lightweight library for command, control over A²B Mailbox.
  - Application
    - Interprocessor communication between host and slave processors

High-Level Values

- Automotive
  - Cable cost and weight
  - Bus power - remote microphones, speakers, sensors
  - Low deterministic latency (< 50 µs) ideal for ANC
  - Bidirectional data transfer at 50Mbps
  - Simplified software stack
  - Advanced system-level diagnostics
  - Compliance to stringent EMC, EMI, and ESD standards within Automotive grade

Multichannel Audio (I^2S), Control (I^2C), and Power over Distance on Cost-Effective Lightweight Cabling

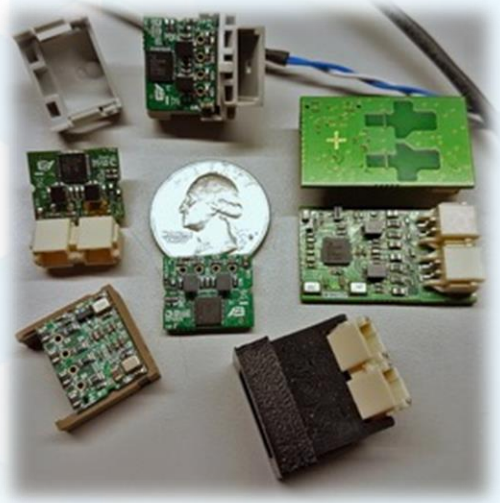
- ProAV, Transportation, Smart Buildings
  - Cable cost – UTP with 100 Ω impedance
    - Any twisted pair
  - Bus power – remote microphones and sensors
  - Low deterministic latency (50 µs) ideal for ANC
  - Bidirectional data transfer at 50Mpbs
  - Advanced system-level diagnostics
  - No µP per node to run stack
  - Removes endpoint challenges for traditional Ethernet
    - Cable/connector cost, bus power, low latency
    - Combination of A^2B+ Ethernet has more value than each on its own
  - Audio + non-critical data channels

A²B Ecosystem

Portfolio of Options

A²B Devices	Master*: AD2428	Slave: AD2427	Endpoint Slave: AD2426	Limited Master*: AD2429	Limited Endpoint Slave: AD2420
Master Capable	Yes	No	No	Yes	No
Functional TRX Blocks	A + B	A + B	A	B	A
I²S/TDM Support	Yes	No	No	Yes	No
PDM Microphone Inputs	4	4	4	4	2
# of Slaves Supported	Up to 10	N/A	N/A	Up to 2	N/A
Max Node-to-Node Cable Length	15 m	15 m	15 m	5 m	5 m

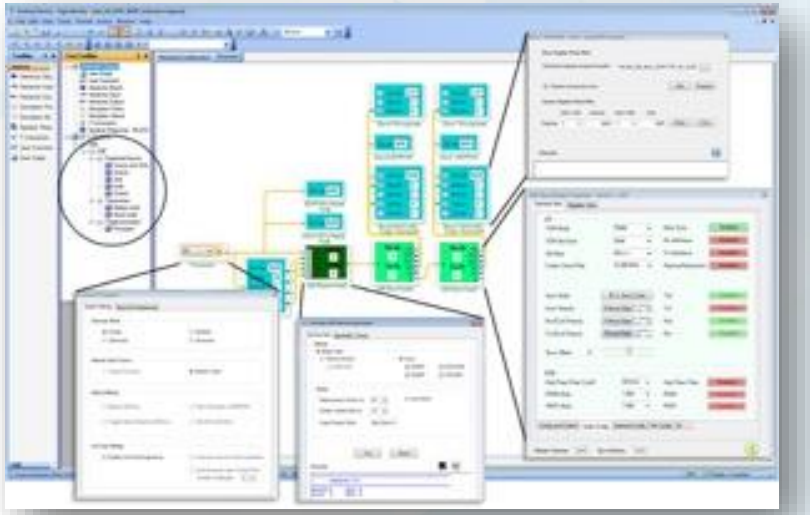
** Also used for slaves requiring an I2S/TDM interface*



Design Tools

- Evaluation boards (master, slave, local/bus powered)
- Reference designs (App Notes, schematics, PCB layouts)
- SigmaStudio Development Environment
- Algorithms (audio, voice, ANC, etc.)
- For more information please visit:

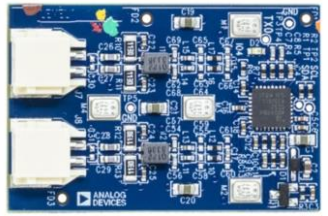
  www.analog.com/A2B



Evaluation and Development Boards

- Evaluation Boards
  - EVAL-AD2428WB1BZ : Bus powered slave board (I2S/TDM, 2 mics) $295
  - EVAL-AD2428WC1BZ : Bus powered slave board (no I2S/TDM, 4 mics) $250
  - EVAL-AD2428WD1BZ : Master & local powered slave board (I2S/TDM, 3 mics) $495
  - EVAL-AD2428WG1BZ : Local powered slave board (I2S/TDM, no mics) $295
  - ADZS-AUDIOA2BAMP: Includes class-D amplifiers to drive speakers $95


EVAL-AD2428WB1BZ

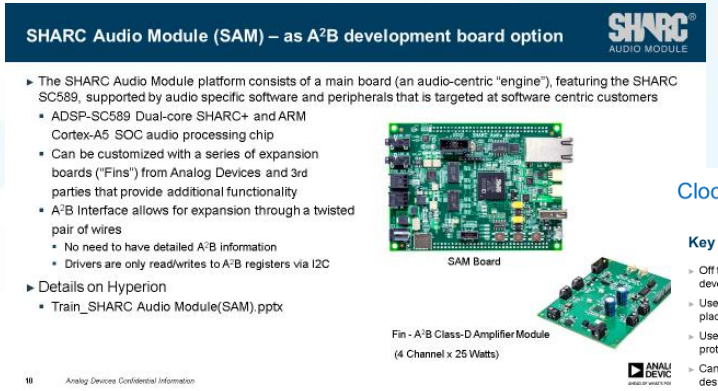

EVAL-AD2428WC1BZ

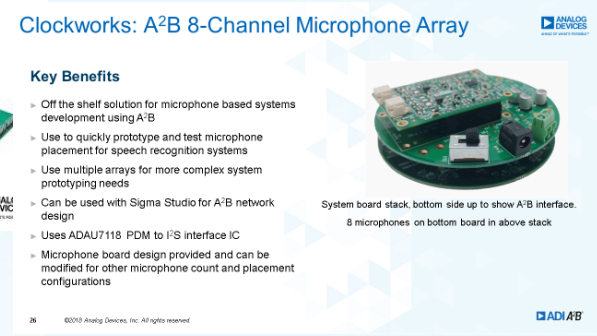

ADZS-AUDIOA2BAMP


EVAL-AD2428WD1BZ


EVAL-AD2428WG1BZ

- Development Boards
  - SHARC Audio Module (SAM) - Wiki Page
  - Clockworks - Module and development board
  - Clockworks 8 channel microphone array
  - NVIDIA Drive Xavier Pegasus platform
  - Arrow Thor96 Machine Human Interface
  - Plus other boards in development

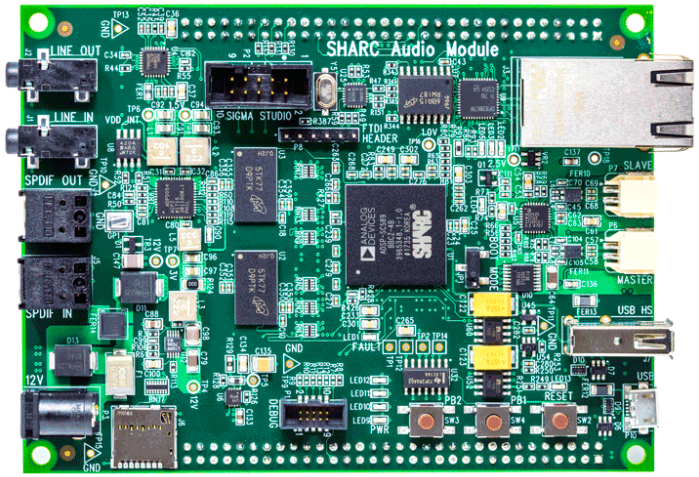




SHARC Audio Module (SAM)

The SHARC Audio Module platform consists of a main board (an audio-centric “engine”), featuring the SHARC SC589, supported by audio specific software and peripherals that is targeted at software centric customers

- ADSP-SC589 dual-core SHARC+ and ARM Cortex-A5 SOC audio processing chip
- Can be customized with a series of expansion boards (“Fins”) from Analog Devices and 3rd parties that provide additional functionality
- A^{2}B Interface allows for expansion through a twisted pair of wires
  - No need to have detailed A^{2}B information
  - Drivers are only read/writes to A^{2}B registers via I2C
- Cost: $195.00



SAM Board

A^{2}B Class-D Amplifier Module

(4 Channel x 25 Watts)

A²B - Development Tools Strategy

Evaluation, Prototyping, System Design

Rapid Prototyping & Evaluation Platforms

Available NOW from ADI

- Master/Slave Capable
- Bus or Local Powered
- SigmaStudio GUI

System Verification / Production Validation

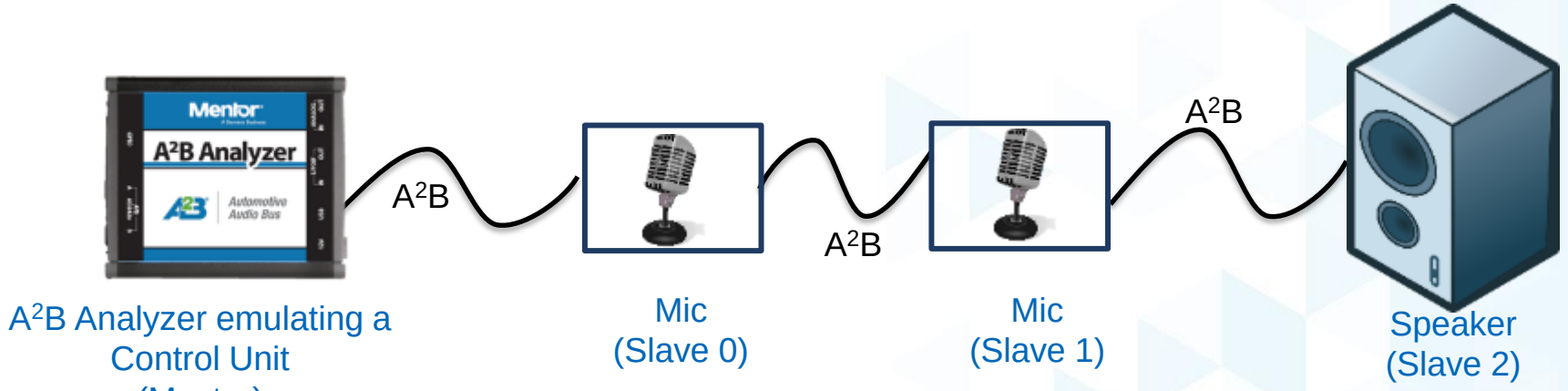
Network Analysis, System Verification, and Software Development

Available NOW from Mentor Graphics with flows available from Listen & Total Phase

- Network Discovery and Simulation
- Real-Time Bus Monitoring
- Seamless Software Integration

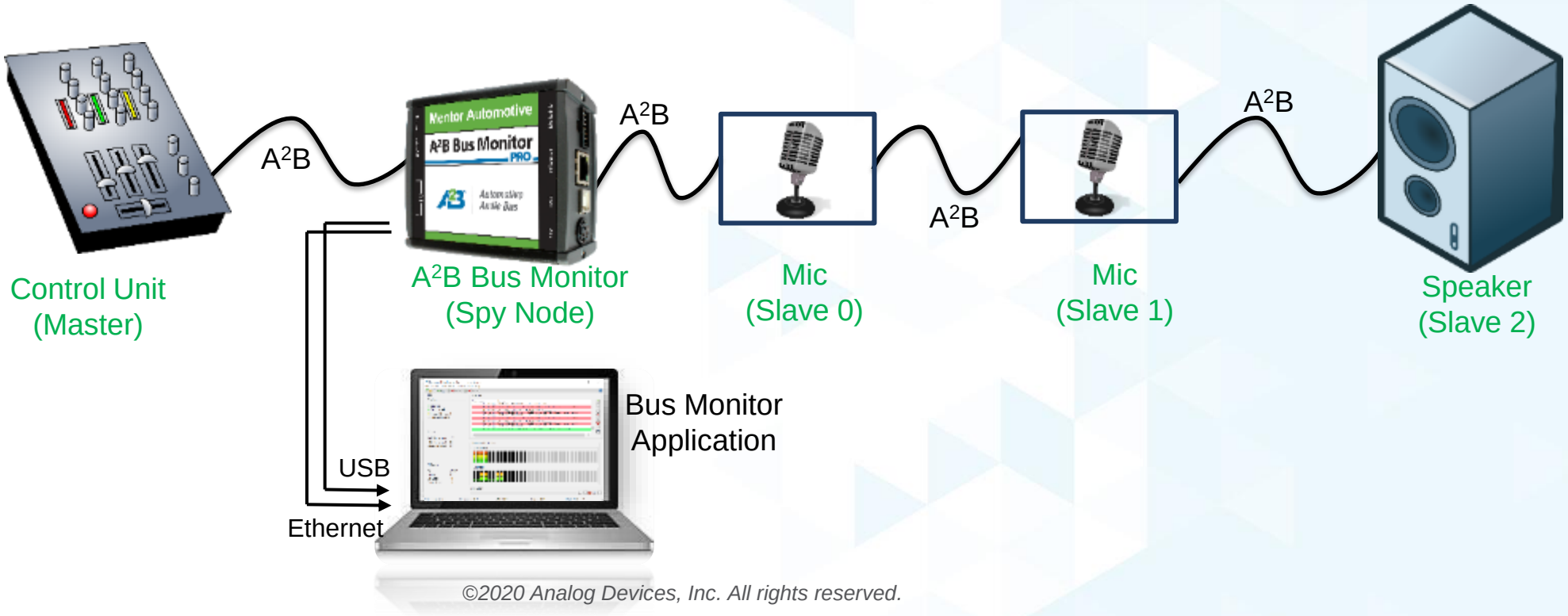
Mentor A²B Tools

- **A²B Analyzer** – Node Simulator
  - Emulates either a master or slave node in an A²B network
  - Includes powerful host application software
    - Easily build & deploy error free networks
    - Out of box support for popular ADI evaluation boards
  - Sink and source audio from onboard 3.5 mm analog or S/PDIF connectors for quick testing and verification
  - Real-time on-line audio analysis available with ASIO
  - Test automation capability with available SDK & Service API



Mentor A²B Tools

- **A²B Bus Monitor PRO** – Monitor all A²B traffic
  - Functions as a passive spy node in an A²B network and sniffs all A²B data and audio in its path
  - Capable of logging and capturing multiple days of data on the PC for debugging and analysis
  - Interfaces available: USB, Ethernet, microSD, etc.



Mentor Active Noise Cancelation (ANC) Demo

- Demo shows example of ANC for automotive where they have developed options for road noise and engine noise
- Road noise highlights the real time nature of their IP and the A^{2}B bus performance
- Underlining IP and expertize is not application or market specific and can be used in a variety of situations

- https://www.mentor.com/embedded-software/resources/overview/anc-in-car-engine-noise-cancellation-demo-0fce1ad3-ddf7-4b58-8692-72fad0954259?sfm=free_form

Arrow Thor 96 Development Board

Thor96 Board

The Thor96 Board is a single-board computer powered by the NXP i.MX 8M SoC, incorporating a quad-core 64-bit Arm-A53, dedicated GPU and VPU, 4K support, Wi-Fi, Bluetooth and a wide range of I/O. 96Boards is a 32-bit and 64-bit ARM® Open Platform hosted by Linaro™ with the intention to serve the software/ maker and embedded OEM communities.

Do More with i.MX 8M SoC

The iMX 8M SoC is a feature-rich system containing a quad-core, 64-bit Arm A53 processor, Vulkan GPU with four shader cores and VPU capable of decoding 4Kvideo at 60 fps. These features alone make the Thor96 board highly capable in a wide range of applications involving video and high processor requirements, including robotics, local AI systems, monitoring and drones.

Low-Power Processing

The iMX 8M SoC integrates a secondary generic Arm Cortex-M4 that can run firmware when in low-power mode as well as for real-time processing of I/O. Unlike other competitor single-board computers, the Thor96 can process I/O at a superior speed without affecting normal operation or performance.

Superior Graphics and Video Performance

Integrated into the Thor96 is a high-performance GPU with four shader processors that are capable of processing 267 million triangles/second, 1.6 Gpixels/second and 32 GFLOPs for 32-bit calculations, all while supporting OpenGL 1.1, 2.0, 3.0, 3.1 and Open CL 1.2. The on-board VPU can decode 4K video at 60 fps, making it highly ideal for billboards and other large displays including control centers and even home cinema centers. 4K video capabilities also significantly future-proofs the Thor96, keeping it relevant for the coming years.

Low-latency multi-node Digital Audio

The Thor96 supports low latency digital audio to multiple microphone arrays and speakers using A²B® technology by Analog Devices. Running both power and multi-channel digital audio over a single unshielded twisted pair of cables reduces weight, cost and complexity while enabling advanced voice recognition and active noise cancelation applications.

Connect to the World with the Thor96

While Wi-Fi and Ethernet are now commonplace in single-board computers, the Thor96 takes the lead with the Cypress' WICED Wi-Fi + Bluetooth combo solution which integrates IEEE 802.11 a/ b/ g/ n/ ac WLAN and Bluetooth in a single-chip solution to enable small-form-factor IoT designs, 1,000-Mbps Ethernet support, CAN bus, Zigbee, Thread, and a debug UART port. Along with the wide range of communication ports, the Thor96 also has two expansion ports: a 40-pin low-speed port and a 60-pin high-speed port.

Partner Information

AVX is the premier passive supplier on these platforms and provides solutions for transient protection, decoupling and signal integrity optimization. TE Connectivity is our comprehensive connector solution provider for these platforms as well.

FEATURES

- Arm A53 Quad-Core 64-bit @ 1.5 GHz
- Cortex-M4F Core @ 266MHz
- 3-GB LPDDR4 @ 1,600 MHz Industrial Temp by Micron
- H.265 — 4K @ 60 fps Decode
- H.264 — 1,080 @ 60 fps Encode
- HDMI Output and DSI to HDMI
- Cypress' industry-leading 802.11ac Wi-Fi and Dual-Mode Bluetooth wireless connectivity
- Silicon Labs MGM111 Thread / Zigbee Module
- Dual MIPI Display support
- Multi-channel digital audio enabled by A²B® from Analog Devices
- 2 USB (2x 3.0 and 1x Micro-USB B)
- 40-Pin Low-Speed Connector
- 60-Pin High-Speed Connector
- Dimensions: 85 mm by 54 mm meeting 96Boards™ Consumer Edition Extended specifications

APPLICATIONS

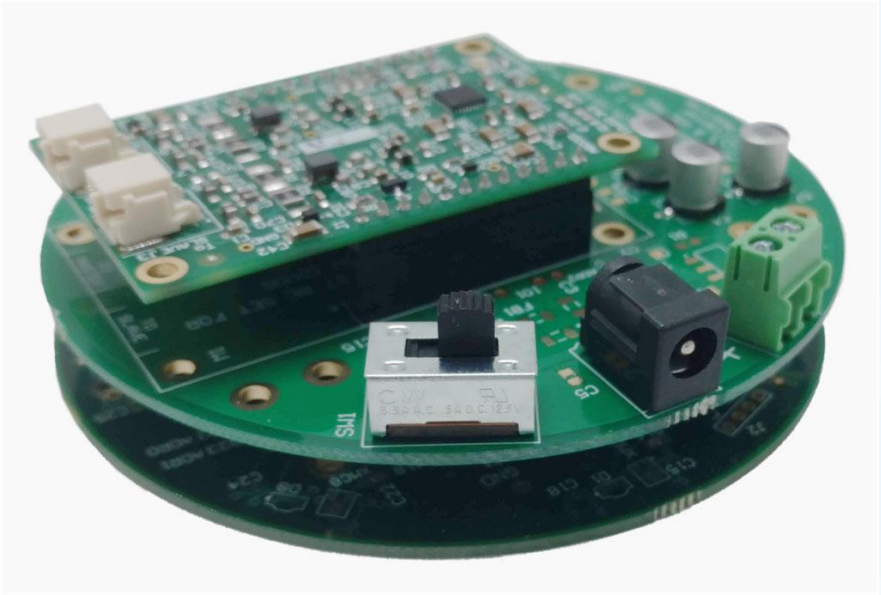
- Robotics
- Building Automation
- Drones
- Wireless Monitoring
- AI Execution and Subsystems
- Automotive Cabin Electronics
- Visual Machine Learning
- Home Cinema
- Advertisement Billboards

- Development board featuring A²B
- Low latency digital audio to multiple microphone arrays and speakers enabling advanced voice recognition and active noise cancelation applications
- Part of 96boards ecosystem which includes other Analog Devices technologies

Clockworks: A²B 8-Channel Microphone Array

Key Benefits

- Off the shelf solution for microphone based systems development using A²B
- Use to quickly prototype and test microphone placement for speech recognition systems
- Use multiple arrays for more complex system prototyping needs
- Can be used with Sigma Studio for A²B network design
- Uses ADAU7118 PDM to I²S interface IC
- Microphone board design provided and can be modified for other microphone count and placement configurations



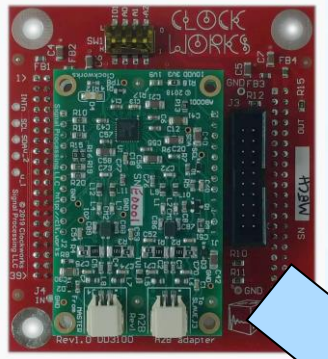
System board stack, bottom side up to show A²B interface.

8 microphones on bottom board in above stack

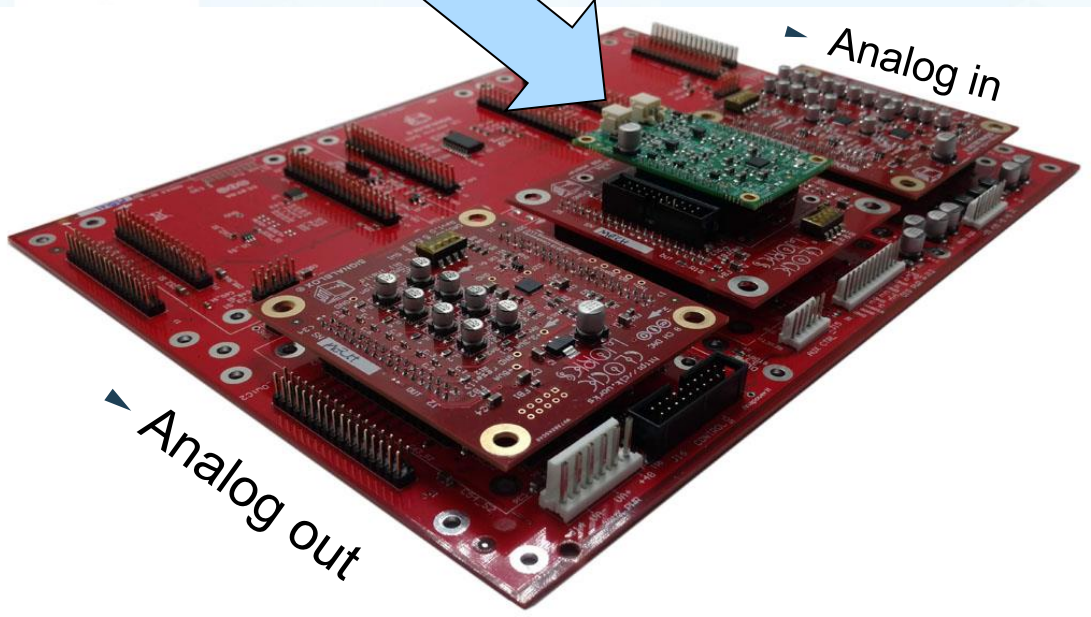
Clockworks: A²B to SignalBlox® Adapter

Key Benefits

- When combined with SignalBlox ADC and DAC modules and carrier board provides an off the shelf solution for multichannel audio systems development using A²B
- Use to quickly prototype and test complex audio systems
- Can be used with SigmaStudio for A²B network design
- See SignalBlox datasheets for the carrier board and module descriptions
- Add more sections for greater than 8 channels
- Optional SignalBlox modules for power and analog signal processing



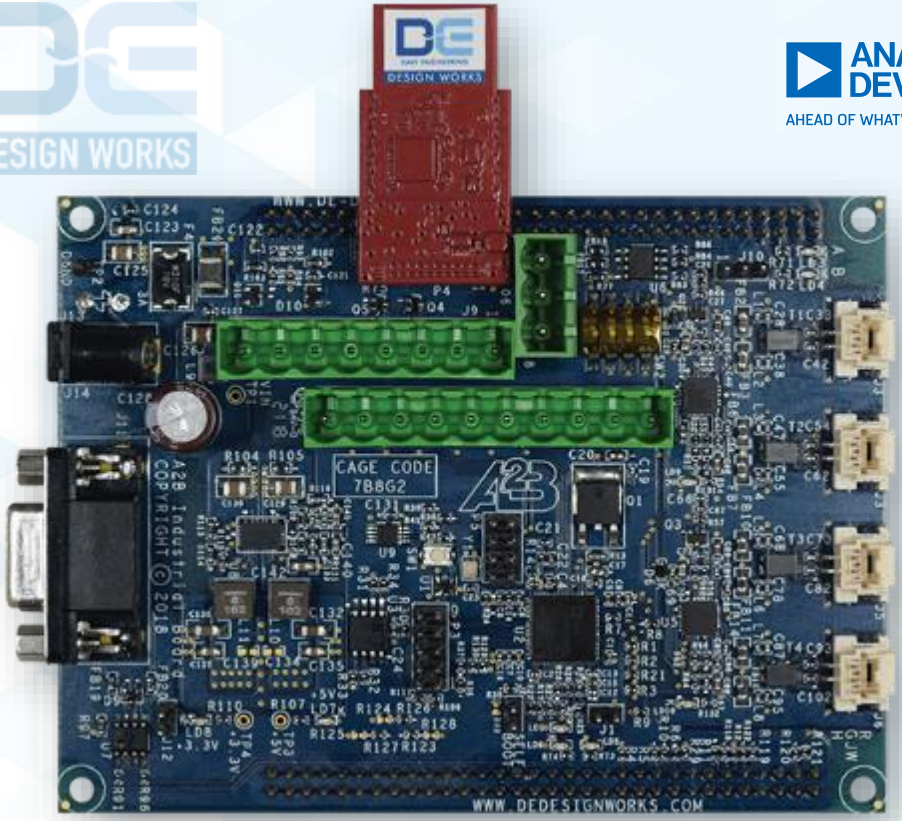
Adapter board with A²B module



System configuration for A²B with ADC and DAC.

DE Design Works

- Industrial A²B – SHARC ADSP-SC589 Plug-in or Stand-Alone Operation
  - (2) AD2425
  - ADAU1462 Sigma DSP
  - LT8650 Power
  - CAN, RS232, RS485, Analog and Digital IO, Expansion Header

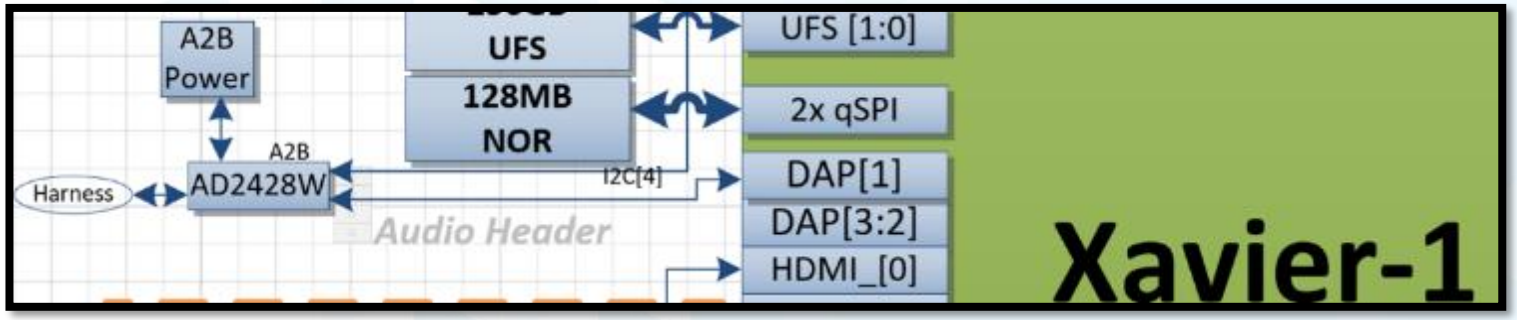


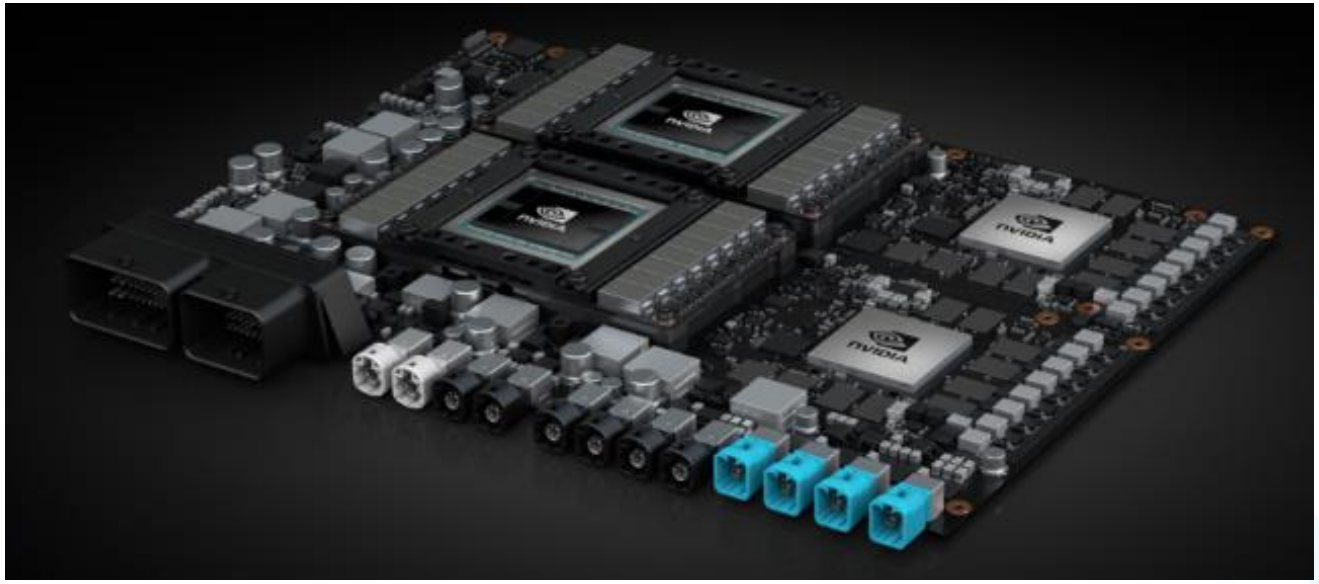
DE offers custom design and prototypes for Industrial, Medical, and Military Customers

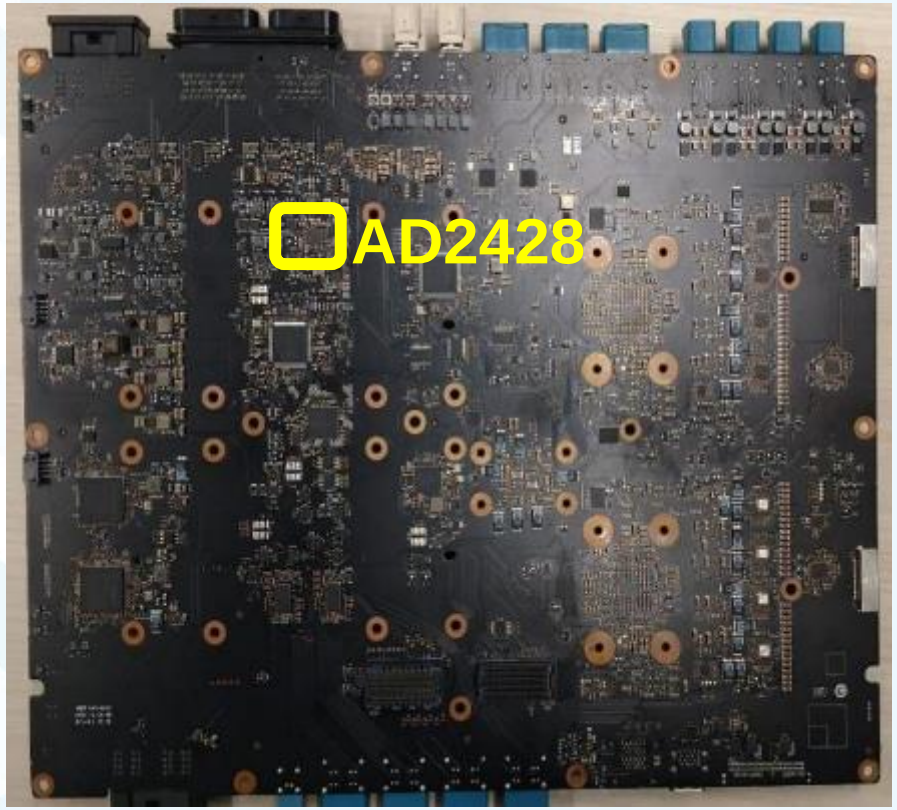
- "Mini Board"
  - AD2425

NVIDIA : A²B Automotive SoC Platforms

- AD2428 master NVIDIA Drive Xavier Pegasus platform
  - SoC: NVIDIA Tegra Xavier (12nm)
  - Mass production: Now
  - https://www.nvidia.com/en-us/self-driving-cars/drive-platform/
- Application:
  - ADAS and Autonomous vehicles

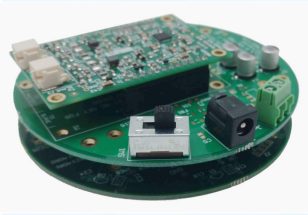






Design Service Options

- Alliances Members
  - DE Design
  - Clockworks Signal Processing
  - Mentor
  - Phoenix Engineering Corp
  - bdSound
  - Cardinal Peak
- Many offer customization on existing boards
- Other audio partners



Complementary ADI Audio Products

ADI Premium Audio Processor Portfolio & Roadmap

Scalable Flexibility and Performance

Broad Portfolio of SHARC Floating-Point Audio Processors

Optimized for Scalable Low Latency Audio, Large On-Chip SRAM, C Compiler

40nm Performance
EAVB/CAN, FFT, DDR, BGA

- **ADSP-SC58x** Dual-SHARC + ARM
- **ADSP-2158x** Dual-SHARC

2x 500MHz / 1.5MB

System Cost Optimized
EAVB/CAN, DDR, BGA/LQFP

- **ADSP-SC57x** Dual-SHARC + ARM
- **ADSP-2157x** Dual-SHARC

2x 500MHz / 1.8MB

28nm Lowest-cost
Large SRAM, DDR, BGA/LQFP, Advanced Filter Accelerator
(equivalent ~2.5GHz SHARC)

- **ADSP-2156x** Single-SHARC

Up to 1GHz / 1.6MB

Programmable SHARC MHz / DSP SRAM (Bytes)

SigmaDSP: 32-bit Fixed-point

Entry-level audio & sample based processing

Sigma300

- **ADAU-145x**

▸ 300MHz, 1.2GMACs

Sigma350

- **ADAU-146x**

▸ 2x SRAM & connectivity

Key Features of ADSP-SC5xx/ADSP-215xx Portfolio

	Feature	ADSP-SC58x ADSP-2158x	ADSP-SC57x ADSP-2157x	ADSP-2156x
Cores	SHARC+ Total (MHz, peak)	2x 500 MHz	2x 500 MHz	1 GHz
	ARM Cortex-A5 (MHz, peak)	500MHz (SC58x)	500MHz (SC57x)	-
Memory	L1 SHARC+ SRAM (w/parity)	2x 640 KByte	2x 384 KByte	640 KByte
	L2 Shared System SRAM (w/ECC)	256 KByte	1 MByte	256K →1 MByte
	DDR Interface (including DDR3L)	Single or Dual 16-bit	16-bit (BGA only)	16-bit (BGA only)
	ARM cache with parity	No	Yes	-
Accelerators	Filter (FIR/IIR) Engines	1 (CCLK/4)	1 (CCLK/4)	1 (CCLK)
	FFT/iFFT HW accelerator	Yes (CCLK/4)	No	No
	Security Engines	Yes (CCLK/4)	Yes (CCLK/4)	Yes (CCLK/2)
	SINC filter / HAE	Yes	No	No
Audio	Serial ports (Full-duplex I²S/TDM)	8	4	8
	S/PDIF interface	2	1	2
	MLB Interface	3/6 pin	3/6 pin	3 pin
	Asynchronous SRCs	8× Stereo	4× Stereo	8× Stereo
Connectivity (SC5xx only)	Ethernet MACs (EAVB)	2	1	No
	CAN2.0	2	2	No
	USB interfaces	2	1	No
	PCIe	Yes	No	No
	Packages	349-ball BGA (0.8p) 529-ball BGA (0.8p)	400-ball BGA (0.8p) 176-lead LQFP	400-ball BGA (0.8p) 120-lead LQFP

ADI SigmaDSP Comparison Table

Sigma 100 | Sigma 200 | Sigma 300 | Sigma 350

ANALOG DEVICES

	AD1940 AD1941	ADAU1701 ADAU1401A	ADAU1702	ADAU1761	ADAU1781	ADAU1442 ADAU1445 ADAU1446	ADAU1450/51/52	ADAU1462 ADAU1466	ADAU1463 ADAU1467
Core Frequency (MHz)	75	50	25	50	50	172	294 ADAU1450: 147	294	294
Program RAM (kWord)	1.5	1	0.5	1	0.5	3.5	8	24	24
Instructions per sample @ 48 kHz	1536	1024	512	1024	1024	3584	6144 (SIMD)	6144 (SIMD)	6144 (SIMD)
Parameter RAM (kWord)	1	1	1	1	0.5	4	ADAU1450: 8 ADAU1451: 16 ADAU1452: 40	ADAU1462: 48 ADAU1466: 80	ADAU1463: 48 ADAU1467: 80
Data RAM (kWord)	6	2	0.5	4	0.5	8	Shared with Parameter RAM	Shared with Parameter RAM	Shared with Parameter RAM
ADC / DAC Channels	0 / 0	2 / 4	2 / 4	2 / 2	2 / 2	0 / 0	0 / 0	0 / 0	0 / 0
Digital I/O Channels	16 / 16	8 / 8	8 / 8	8 / 8 2 x Digital Mics	8 / 8 2 x PDM Mics	24 / 24	48 / 48	48 / 48	48 / 48
Aux ADC		4 ch, 8-bit	4 ch, 8-bit			4 ch, 10-bit	6 ch, 10-bit	6 ch, 10-bit	8 ch, 10-bit
GPIOs		12	12	4	5	12	14	14	26
Selfboot		I2C	I2C			I2C	I2C / SPI	I2C / SPI	I2C / SPI
Master Port							I2C / SPI	I2C / SPI	I2C / SPI
ASRCs (Channels / Sample Rates)	No	No	No	No	No	*ADAU1442:* 16 / 8 *ADAU1445:* 16 / 2	ADAU1450: No ADAU1451: 16 / 8 ADAU1452: 16 / 8	16 / 8	16 / 8
S/PDIF							1450: No 1451/52 :I/O 96 kHz	In/Out (192 kHz)	In/Out (192 kHz)
Pacakge	48-Lead LQFP 7 x 7 mm	48-Lead LQFP 7 x 7 mm	48-Lead LQFP 7 x 7 mm	32-Lead LFCSP 5 x 5 mm	32-Lead LFCSP 5 x 5 mm	100-lead TQFP & LQFP 14 x 14mm	72-Lead LFCSP 10 x 10 mm	72-Lead LFCSP 10 x 10 mm	88-Lead LFCSP 12 x 12 mm

ADI A²B

Featured on the ADZS-AD2428WD1BZ Master A²B Evaluation Board

ADI Low-Power Codec Portfolio

	ADAU1361	ADAU1761	ADAU1372	ADAU1772	ADAU1777	ADAU1787	ADAU1788
Analog Input	Stereo mic Stereo input	Stereo mic Stereo input	Quad mic or line input	Quad mic or line input	Quad mic or line input	Quad mic or line input	Stereo mic or line input
Digital Mic Input	2	2	4	4	4	8	4
ADC/DAC	2/2	2/2	4/2	4/2	4/2	4/2	2/1
Sampling Rate	8kHz - 96kHz	8kHz - 96kHz	8kHz - 192kHz	8kHz - 192kHz	8kHz - 768kHz	8kHz - 768kHz	8kHz - 768kHz
Integrated Headphone Driver	Yes	Yes	Yes Class AB	Yes Class AB	Yes Class AB	Yes Class AB	Yes Class AB
PLL	Yes 8MHz-27MHz	Yes 8MHz-27MHz	Yes 8kHz-27MHz	Yes 8kHz-27MHz	Yes 8kHz-27MHz	Yes 30kHz-27MHz	Yes 30kHz-27MHz
Audio Processing	None	SigmaDSP	None	Programmable biquad filter DSP, 2 coeff banks	Programmable biquad filter DSP, 3 coeff banks, low latency ANC	SigmaDSP FastDSP (64 Low-Latency Biquads, 3 Banks)	SigmaDSP FastDSP (64 Low-Latency Biquads, 3 Banks)
Package Type	32-LFCSP	32-LFCSP	40-LFCSP	40-LFCSP	36-WLCSP	42-WLCSP	42-WLCSP

Featured on the ADZS-AD2428WD1BZ and ADZS-AD2428WG1BZ A²B Evaluation Boards

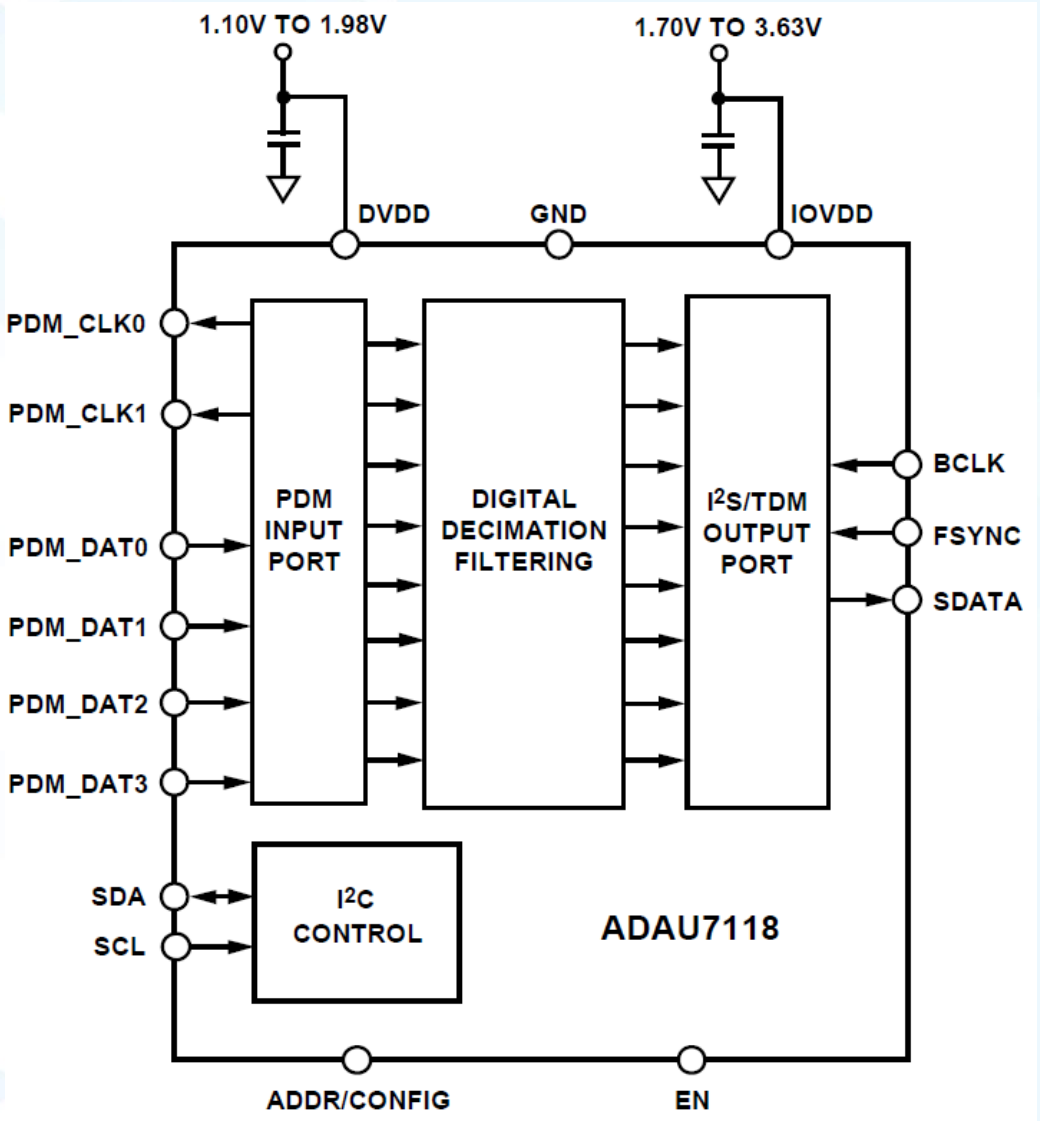
ADI Class-D Amplifier Portfolio

- Low Power (1W - 3W)
  - SSM2375/2377 : Analog Input, Mono
  - SSM2519/2537 : Digital Input, Mono
  - SSM2518 : Digital Input, Stereo
  - SSM4567 : Digital Input, Mono, Boosted 5V, Current and Voltage Sensing
  - SSM4329 : Digital or Analog Input, Mono, Boosted 5V, Current and Voltage Sensing, SigmaDSP
- Medium Power (5W – 50W)
  - SSM3302 : Analog Input, Stereo
  - SSM3515 : Digital Input, Mono
  - SSM3525 : Digital Input, Mono, Current and Voltage Sensing
  - SSM3582 : Digital Input, Stereo

Featured on ADZS-AUDIOA2BAMP

ADI PDM→PCM Converter: ADAU7118 Overview

- 8 channels decimated PDM bitstreams to PCM audio data
- Slave I2S or TDM Output Interface
- Configurable TDM slot routing and sizes
- 24-bit resolution
- 123dB AW Signal to Noise
- 4 kHz to 192 kHz output sample rate
- Selectable I2C control or Stand-Alone operation
- **Featured on Clockworks' 8-Mic Array Board**



Application Examples

Target Markets and Applications

A²B Solves Automotive and Other Audio Market Challenges

Automotive and Transportation

- Audio ECU
- Active noise cancellation
- Road noise cancellation
- Personal audio zones/active speakers
- eCall and telematics systems
- Autonomous driving systems
- Smart radio connectivity

Building Technology (Smart Buildings)

- Microphone arrays for hands-free/speech recognition
- A/V conference rooms
- Residential intercom systems

Consumer

- ProAV
- Vital signs monitoring (wearables)
- Home theater

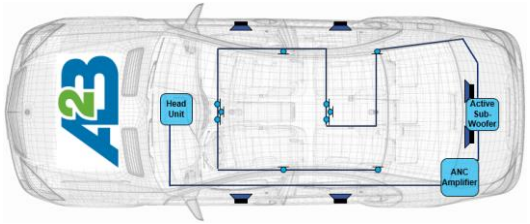
Examples of Applications Enabled by A²B

Transportation

Buses, Airplanes, Ships/Yachts

Automotive

Original + Aftermarket



Audio + Non-Critical Data

Smart Buildings, Hospital Beds, Live Voting

Conference Systems, Machine Health

Public Spaces

Masking Noise for Call Centers,
Office Buildings, Libraries

Music Industry

Studios, Small Stage, Disc Jockey,
Guitar Pickup, Microphone Arrays

Distributed Audio

Conference Rooms, Halls, Auditoriums,
Churches, Department Stores, Homes

A²B Technology Provides Power, Low-Latency, Distance, Wiring Flexibility

A Closer Look at an A²B Application

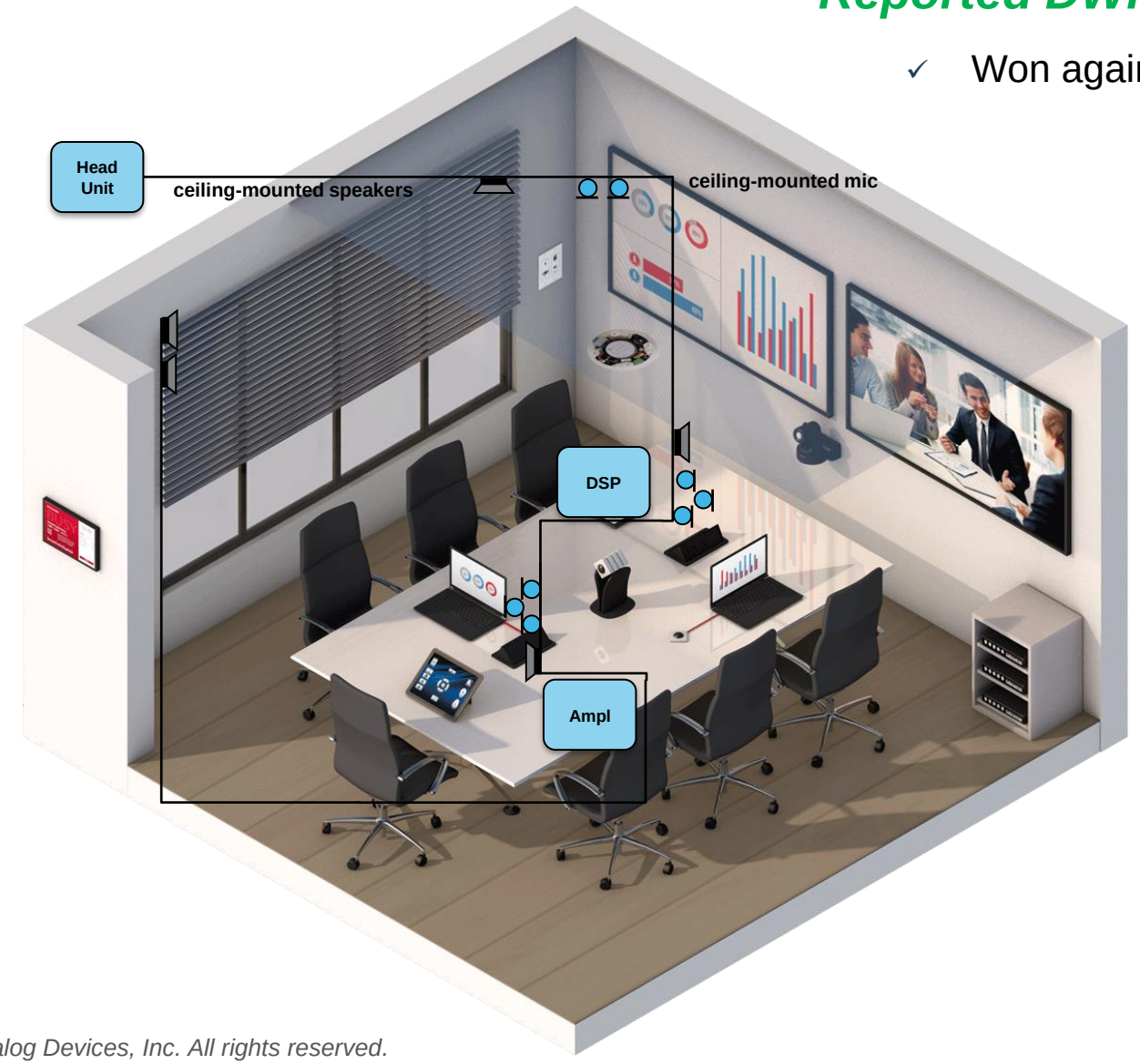
A²B Communication Network for:

- ✓ Microphones and Speakers
- ✓ Sensor and Actuators
- ✓ I²C peripherals

Example: Conference Room and Lecture Hall

The entire listening area must have equal coverage

- ✓ Acoustic echo cancellation
- ✓ Ambient noise cancellation
- ✓ Sound reinforcement system
- ✓ Intelligent equalizer
- ✓ Volume Leveler and Modeler



Reported DWIN

- ✓ Won against Dante

Microphone Arrays, Speakers, Sensors

- Building blocks that can be used in multiple applications
- Can be used to create adaptive noise cancelation (ANC) solutions
- Example solutions
  - Molex road noise cancelation sensors

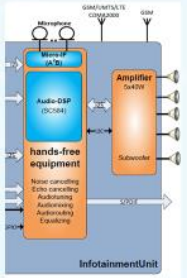
Additional Applications

Agricultural - Construction Equipment

- Audio diffusion and noise cancellation
- Commuincation without requireing operatator to take hands off controls

Reported DIN

- ✓ Active noise cancelation in construction machine



Hospital

- Hospital bed application
  - Pressure (is the person on the bed?)
  - Temperature,
  - Position (is the bed level or at an angle)
  - Low precision motor control for the bed
  - Audio interface to nursing station (intercom)

Machine health (CbM)

- Machine monitoring applications
  - Listening for changes in noise as an indication of wear or failure
  - Other sensor inputs like temperature, vibration, humidity, etc. (non- critical data)

Reported Opp

- ✓ Machine Health Monitoring, with mics and sensors connected with A2B

Pro Audio - Application Examples

Here are a number of Pro Audio applications/use cases that can be enable by A2B.

Linking of multiple guitar amplifiers

- Allows multiple extension amps/cabinets to be synchronized for time-based effects and precise phasing control.

Mixer expansion bus

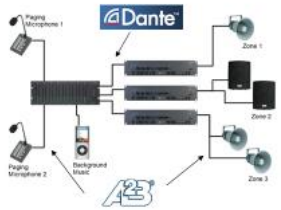
- An expandable mixer platform where A2B is the interconnect to additional units. (this is already being pursued by some of our customers.)

Acoustic Instrument embedded processor connection

- An acoustic guitar pre-amp to allow a sigmaDSP to be installed *inside* a guitar with no additional holes or power required at the guitar. This can support MEMs mics + ADC + processing with a simple cable to provide power and link to the external amplifier.

Professional Audio Distribution

- Using A2B in combination with Ethernet (Dante)
  - A2B for the local distribution where wiring/ power can be challenging
  - Use Ethernet to cover the larger distances in building



SAM Board – can do both A2B and run Dante

Creating A Better Audio Design Experience

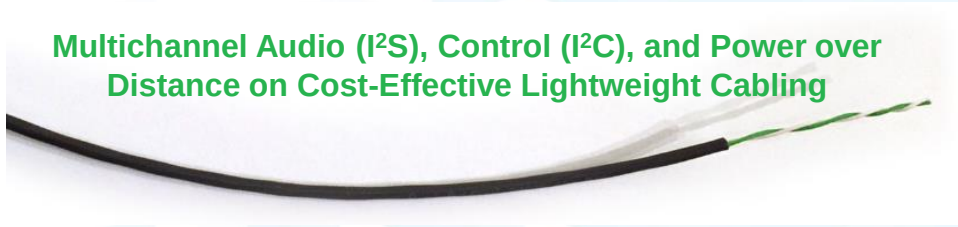
Audio Landscape

- Traditional automotive customers view A²B as the best solution
  - Starting to see adoption in electric cars and autonomous systems for non audio applications as well

- In all other applications, A²B is new disruptive technology
  - A²B offers better value than all other audio transport options in small encloses
  - Value at edge in combination with long distance options (Ethernet)

- Leadership in deterministic low latency provides
  - High fidelity audio
  - Best Adaptive Noise Cancelation (ANC) solution
  - Microphone arrays for directional information
- Reduced system complexity
  - Single UTP
  - Bus power
  - Connector flexibility

Advantages of A²B



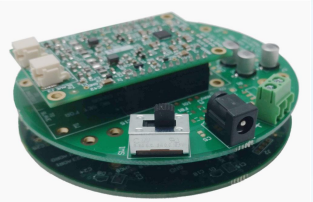
- Low deterministic latency provides multiple channels of high fidelity audio and ability to do adaptive noise cancelation with lowest system cost/complexity

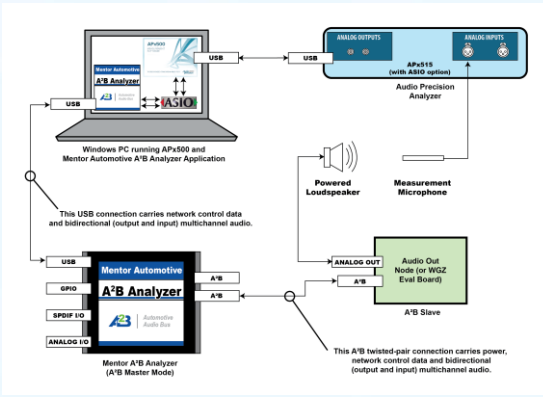
- System advantages to reduce cost/complexity
  - Single Trx device for $2-$5 without royalties, free Linux driver for host
  - No µP needed on slave nodes
  - Bus power removes need for power delivery infrastructure – devices
  - Lower cost cable vs other protocols – Single CAT5e UTP
  - Connector flexibility for cost and space
  - Any µP with I2C can act as host and mange conversion to other protocols

- Proven technology with existing ecosystem of partner analyzers, monitors, testers, development platforms, and design services

A²B Partner Ecosystem

- A²B Protocol Analyzers
  - Mentor
  - Total Phase
- A²B Testing Solutions
  - Audio Precision + Mentor
  - NOFFZ Technologies
  - Alldaq
  - HEAD Acoustics
- Design Services
  - DE Design
  - Clockworks Signal Processing
  - Mentor – several options
  - Phoenix Engineering Corp
  - bdSound
  - Cardinal Peak
- ANC, Audio Algorithms
  - Mentor
  - bdSound
- Development Boards
  - Arrow – Thor96 Human Machine Interface
  - Clockworks
    - Module and EVM kit
    - 8 Microphone array module
  - DE Design
  - Nvidia Drive Xavier: AD2428 on board



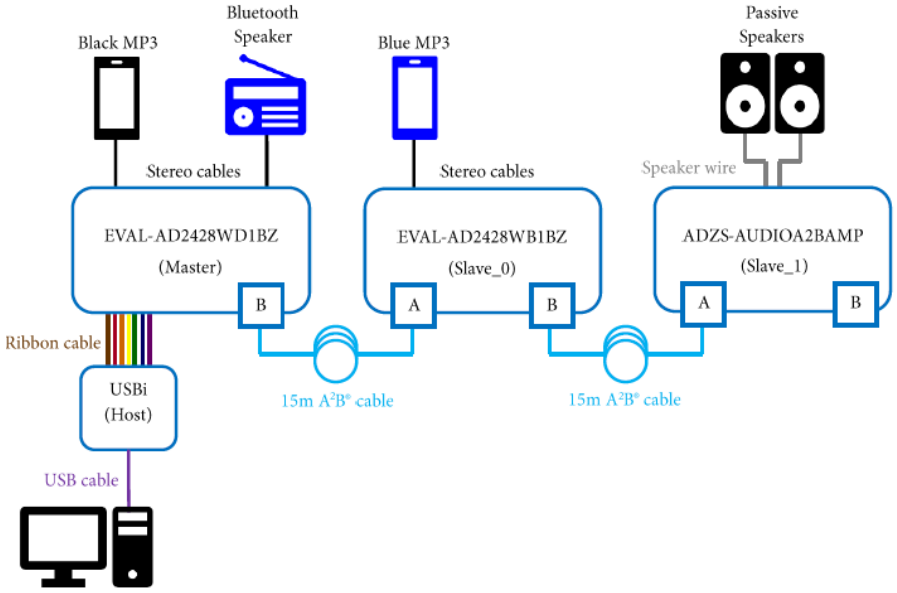


A²B Technology Demonstration

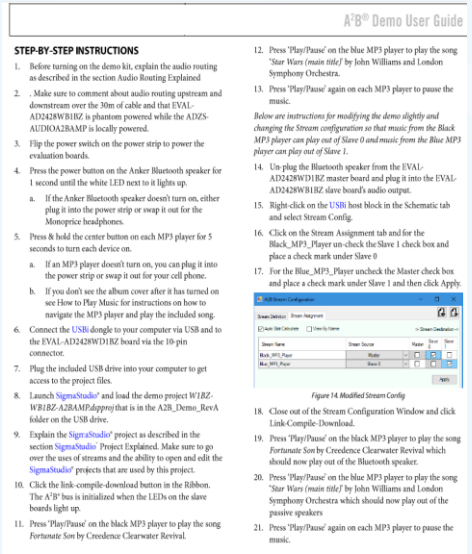
NA Suitcase

EMEA Suitcase

Japan Suitcase



- To help customers explore the A²B technology using a combination of ADI evaluation boards
- Contact ADI to obtain



Summary

- A^2B is a disruptive technology for audio design
- Proven technology being opened up to the board market
- Analog Devices audio expertise + a portfolio of options and partners = a design environment that enables a new audio system design experience

THANK YOU!!