



**VCO1S A<sup>2</sup>B**

**Automotive Audio Bus  
Tools**

**SIEMENS**

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AUTOMOTIVE BUSINESS UNIT

# SIEMENS VCOS

## Vehicle Compute Solutions

Highly integrated automotive solutions from SIEMENS

SIEMENS Automotive Business Unit provides automotive grade solutions under the name of VCOS™. Audio solutions are provided under VCO1S™, Infotainment and Driver Information solutions under VCO2S™ and Car Central Compute under VCO3S™.

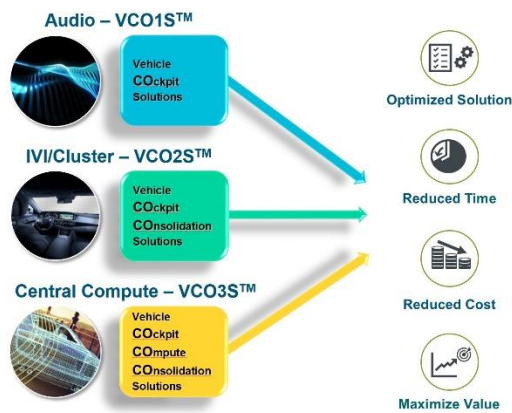


Figure 1 Vehicle Compute Solutions

Each of pillars of Vehicle Compute solutions are further tailored to address the needs of customers. The variants are shown in Figure 2.

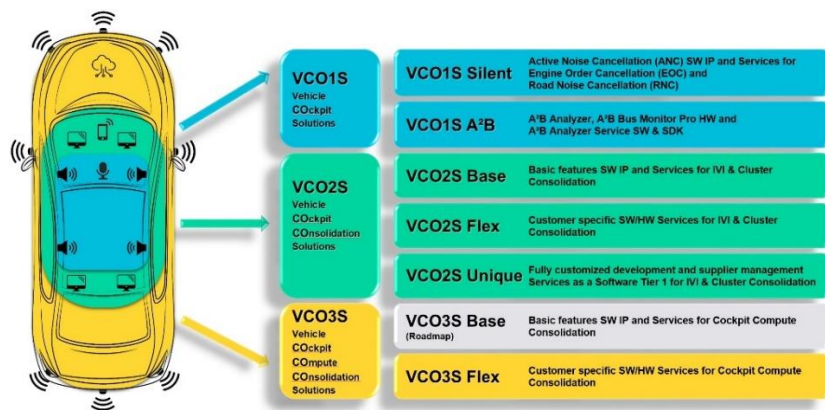


Figure 2 Vehicle Compute Solution variants

### Variants

The variants allow the product line engagements with customers at varying degree of flexibility and turn-key-solutions.



Figure 3 A²B tools

## VCO1S™ – A²B

### Executive Summary

The A²B® standard is fast becoming a critical technology for the advancement of vehicle infotainment systems. The A²B bus standard is an in-vehicle networking alternative to legacy multimedia focused bus systems such as Media Oriented System Transport (MOST).

Siemens offers tools for the test and development of A²B nodes and networks.

The A²B Analyzer system helps engineers configure, test, and deploy A²B networks and A²B devices. The A²B Analyzer accurately simulates nearly all aspects of A²B master and slave nodes. Essentially, the A²B Analyzer can be used to emulate any active node on the A²B network.

The A²B Bus Monitor PRO system helps engineers observe, capture, and analyze the data flowing on a live A²B network. The device can record and store the event traces, audio and other information that is available on the A²B network. Essentially, the A²B Bus Monitor PRO can be used as a passive spy node on the A²B network and non-intrusively capture the A²B network traffic.

The A²B Analyzer and the A²B Bus Monitor PRO devices can help engineers design, develop and test A²B networks along with rapid deployment of A²B compliant systems.

# Introduction to Automotive Audio Bus (A<sup>2</sup>B)

A<sup>2</sup>B is a simple, elegant two wire unshielded twisted pair (UTP) cable solution which is capable of transporting audio data and control information, along with clock and power over the same cable. It transports audio data as Inter IC Sound (I2S)/ Time Division Multiplexed (TDM)/ Pulse Density Modulated (PDM) data and control information over I2C.

With a configurable 44.1 kHz or 48 kHz frame rate and up to a 50 Mbps bandwidth, A<sup>2</sup>B is ideal for transporting digital audio and delivers superior audio quality relative to analog connections.

The A<sup>2</sup>B transceiver's ability to provide power to remote nodes over the same UTP cable used to transport data removes the need for a local power supply on each bus-powered slave node, reducing the overall system BOM costs. The UTP cable provides system-level cost savings when compared to other digital bus architectures that may require two or three twisted-pair connections or a costly cabling scheme, such as the heavy cable harnesses required to connect audio systems in vehicles.

The network can be used over distances up to 15 m between nodes and 40 m over the entire daisy chain. A<sup>2</sup>B can be used as its own network with embedded sub-networks, or as an endpoint transport bus used in combination with other, longer distance protocols. The clock is synchronous on all nodes in a single A<sup>2</sup>B network. Microphone and serial audio data is received on each node in the system simultaneously.

A<sup>2</sup>B is a single master, multiple slave system where the transceiver chip at the host controller is the master. It generates clock, synchronization, and framing for all slave nodes on the network. A<sup>2</sup>B eliminates the need for an expensive microcontroller and external memory. An A<sup>2</sup>B Master can program and discover up to 10 slave nodes.

A<sup>2</sup>B technology ensures simultaneous sampling and delivery of data on all system nodes for each frame. The frame structure is fully managed at the master node to program each transceiver's use of the available data slots in both directions, whether to contribute, extract, or read and pass data on to the next node in the line topology. Delays due to bus collisions or the reassembly of packetized data are removed. A<sup>2</sup>B features deterministic and very low, sub 50 µs latency.

Once the A<sup>2</sup>B link is configured by the master node during bus initialization phase (or discovery process), the audio transport between nodes, I2C and GPIOs operate without any further host intervention.

A<sup>2</sup>B has wide host of applications like ANC, smart antenna, head unit/radio, amplifier, speakers, microphones, voice applications etc.

## Tools for A<sup>2</sup>B based networks

In commercial development and manufacturing, each node on the audio network is typically manufactured by different vendors with expertise in the area. Once a prototype of all the nodes becomes available then the A<sup>2</sup>B network is put together for the test. Most node manufacturers are able to perform a node level test but not a network level test as they don't have the other nodes in the network. Since no manufacturers have gone through the network testing process at this point, the chance that issues will come up at this point is high.

In order to increase confidence that the product would work as expected and also to identify issues early on, the prototype node can be tested with using A<sup>2</sup>B Analyzer which could be used as a node emulator. That is, an A<sup>2</sup>B Analyzer can emulate the non-proprietary part a node in the A<sup>2</sup>B network.

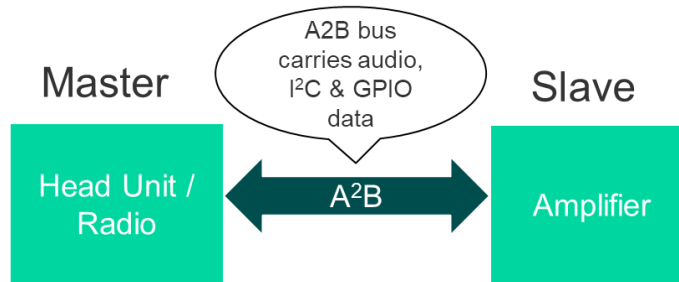


Figure 4. An example A²B network

Let's consider an example where manufacturer X is making head unit/radio and manufacturer Y is making amplifiers. Both these devices connect together in the final A²B network. With the help of A²B Analyzer manufacturer X doesn't need to depend on manufacturer Y for testing their head unit/radio product as they can use an A²B Analyzer to emulate the amplifier node in the test network. Similarly, manufacturer Y does not need to be dependent on manufacturer X for testing their product and can simply achieve the same by using an A²B Analyzer.

The A²B Analyzer can be used during the pre-development and development phase where the product is prototyped and developed, as well as during the manufacturing phase where the product goes through end of line testing.

Some of the hardware features of the A²B Analyzer include:

- Ability to simulate both Master and Slave node using the same hardware
- Command, control and power using the same USB connection between the A²B Analyzer and the PC
- Generate internal test signals/tones (sine tone, white/pink noise, DC bit pattern etc.)
- Stereo analog IN and Stereo analog OUT connector  
Stereo S/PDIF IN and Stereo S/PDIF OUT connector  
Simultaneously sink and/or source two slots audio using the onboard analog and/or S/PDIF connectors
- External GPIO connector for GPIO communication and also I2C lines are available externally

Some of the software features of the A²B Analyzer include:

- A²B Analyzer Application is divided into 2 sections:
  - Network Builder – helps build the A²B network layout
  - Node Simulator – helps simulate the A²B network layout with the A²B Analyzer
- Dynamic re/routing of any sink/source without rediscovery of the A²B network
- Show debug and diagnostic information regarding errors or warnings on the A²B network
- Inspect discovery trace for errors
- Error messages and notifications for common A²B network errors like cable reverse connected, cable not connected, etc.

**Apart from these features A²B Analyzer also has another neat feature of ASIO compatibility. This feature allows a USB device to be exposed as a virtual ASIO device on the Windows subsystem which is supported by many audio analysis packages.**

From simulation and bench testing in early-stage development, to validation and production testing, having a closed-loop system to measure audio and dynamic signal performance over an A²B network is an integral part of incorporating the bus technology into next-generation automotive systems. By combining the capabilities of Audio Precision's APx500 audio analyzers and software, and A²B Analyzer System,

software and ASIO driver, developers can easily create a complete, closed-loop multichannel A<sup>2</sup>B audio test system.

Within this test system, the A<sup>2</sup>B Analyzer platform provides straightforward A<sup>2</sup>B network configuration and simulation, as well as flexible routing, and high-fidelity audio. The APx audio analyzer delivers comprehensive, multichannel audio measurement analysis and offers a wide range of interface options, including analog, Bluetooth®, digital serial (TDM) and PDM. Working as a complete system, these tools eliminate the effort required to develop, and support, in-house, custom test solutions.

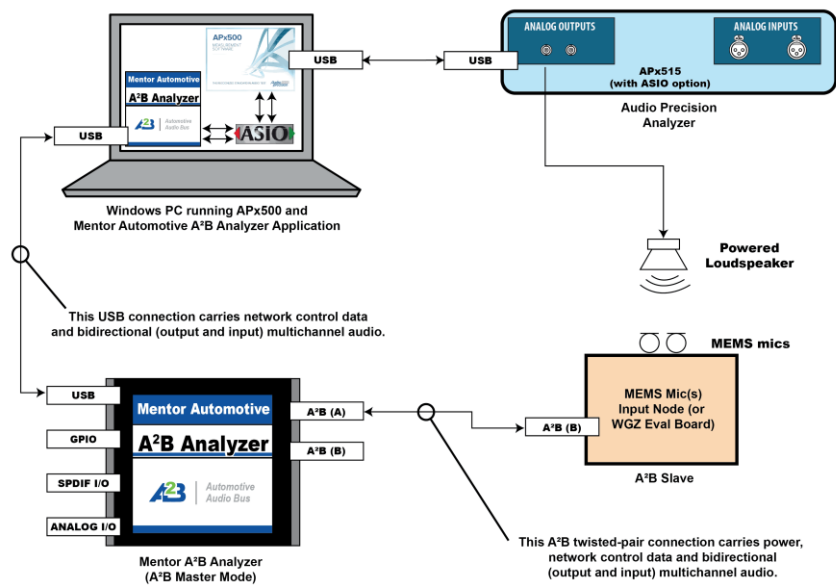


Figure 5 A<sup>2</sup>B Analyzer test setup with Audio Precision Analyzer

In some situations where end-of-line testing is required it is desirable for programmatic control of the A<sup>2</sup>B Analyzer and control the network's operation and record pass fail results programmatically. The A<sup>2</sup>B Analyzer Service software is specifically designed for this purpose. This software allows programmatic control of the A<sup>2</sup>B Analyzer device using RESTful APIs which can be used when it comes to endurance testing and end-of-the line tests. Figure 6 shows sample discovery code for automated testing with the A<sup>2</sup>B Analyzer and A<sup>2</sup>B Analyzer Service software.

```
import sys
import json
import requests
import httpplib

url = "http://127.0.0.1:3030/jsonrpc" # URL of headless server
sessionUri = "file:///c:/sessions/sample1.ses" # Location of session
file

def processRequest(payload):
    response = requests.post(url, data=json.dumps(payload),
headers={'content-type': 'application/json'}).json()
    if "error" in response :
        print ("Error processing " + payload["method"] + "\n")
```

```

        sys.exit(1)
    return response

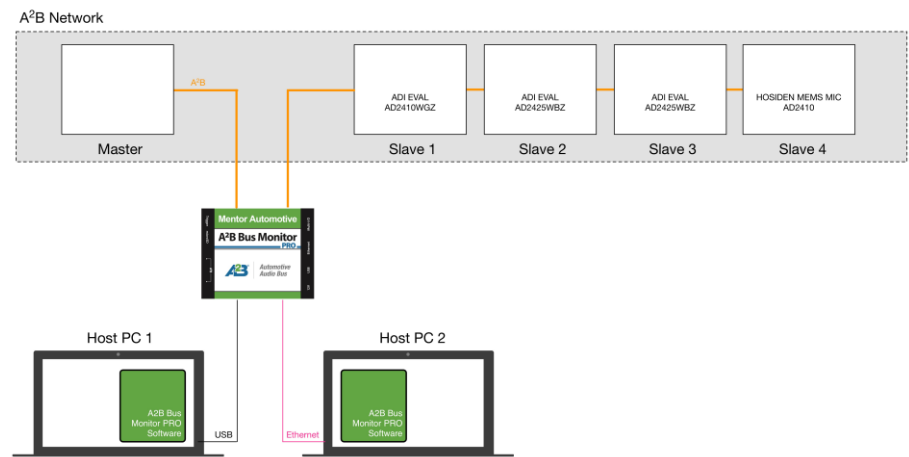
# Connect to first device found
payload = { "jsonrpc": "2.0", "id": 1, "method":
"platform.connectDevice", "params": { "apiVer": "1" } }
response = processRequest(payload)

# Load and set active session file. Selects first node in first
network
payload = { "jsonrpc": "2.0", "id": 1, "method":
"platform.setActiveSession", "params": { "apiVer": "1", "uri":
sessionUri } }
response = processRequest(payload)

# Start discovery of A2B network
payload = { "jsonrpc": "2.0", "id": 1, "method":
"device.discoverNetwork", "params": { "apiVer": "1", "seqChart": False
} }
response = processRequest(payload)

if "result" in response :
    print ("\n Discovery complete with " +
str(response["result"]["numNodes"]) + " node(s) discovered \n")

```

Figure 6: Python code for discovery using the A<sup>2</sup>B Analyzer Service SWFigure 7: A<sup>2</sup>B Bus Monitor PRO

Since the A<sup>2</sup>B Analyzer is an active device on the A<sup>2</sup>B network, it occupies an active node position on the network. Sometimes, it is beneficial to understand what is happening on the bus without having to emulate a node on the network. For such purposes the A<sup>2</sup>B Bus Monitor device could be used. The A<sup>2</sup>B Bus Monitor acts as a passive spy node on the A<sup>2</sup>B network and is capable of capturing all the live A<sup>2</sup>B network activity between the nodes which the device is inserted. The software does not just capture the data but also analyzes the data and can visually represent both audio and I2C data on the same view and can correlate the audio flow and the I2C



data. It offers a variety of connectivity options to easily attach to, and monitor, an A<sup>2</sup>B based network. With a small form-factor, the dongle affords portability and enables usage in multiple environments — from development on an engineer's bench to extended in-vehicle testing.

The A<sup>2</sup>B Bus Monitor is useful for understanding A<sup>2</sup>B network behavior or learn about the A<sup>2</sup>B network. It can also record audio to the PC allowing the user to analyze the recorded file.

Some of the hardware features of the A<sup>2</sup>B Bus Monitor include:

- Passive bus monitoring and data capture
- Access to all A<sup>2</sup>B network traffic: audio, I2C and GPIO
- Supports automotive power ignition line
- Data can be accessed either via USB or via Ethernet connection
- Compact single device solution for use in engineering workbench and in-car scenarios

Some of the software features of the A<sup>2</sup>B Bus Monitor include:

- A<sup>2</sup>B Bus Monitor PRO Application is the only application which can provide a centralized view of all activity on the A<sup>2</sup>B bus
- Allows users to gain deeper insights into network behavior
- Improve debugging via visibility into, and correlation to, system events
- Quick analysis by visual indication of per channel audio traffic
- Software is available for both Windows and Linux systems

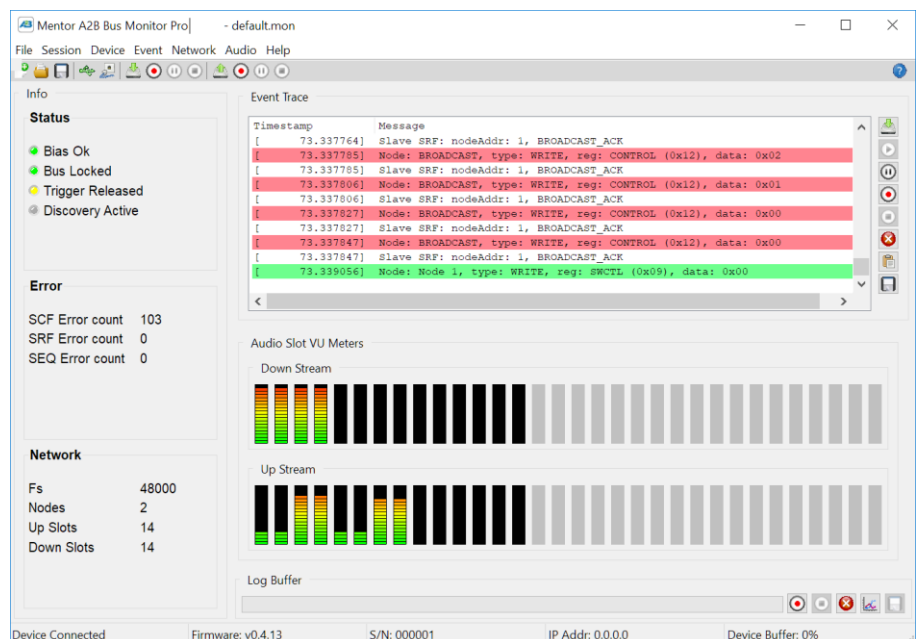


Figure 8: A<sup>2</sup>B Bus Monitor PRO Software

## Conclusion

A<sup>2</sup>B Analyzer and A<sup>2</sup>B Bus Monitor have become indispensable tools for the design, debug and test of A<sup>2</sup>B based networks. These tools provide unparalleled access to the A<sup>2</sup>B bus and can help with the rapid deployment of A<sup>2</sup>B based nodes and networks.

# Abbreviations

Abbreviation	Description
ANC	Active Noise Cancellation
API	Application Programming Interface
ASIO	Audio Stream Input/Output
A <sup>2</sup> B	Automotive Audio Bus
BOM	Bill of Materials
GPIO	General Purpose Input Output
I2S	Inter IC Sound
I2C	Inter Integrated Circuit
MOST	Media Oriented Systems Transport
PDM	Pulse Density Modulation
REST	Representational State Transfer
SW	Software
S/PDIF	Sony/Philips Digital Interface
TDM	Time Division Multiplexing
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair
VC03S	Vehicle Cockpit Compute Consolidation Solutions
VC02S	Vehicle Cockpit Consolidation Solutions
VC01S	Vehicle Cockpit Solutions
VCOS	Vehicle Compute Solutions

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