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| **Analog Devices A2B Data Link Implementation Specification** | | | | | | | | | | | | | | | | | | **000603.501.AA** | | | | | | | |
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| 3/25/14 | | |  | |  | V0.0 Used “Analog Devices A2B link Data Link and Physical Layer 000603 501 AB20140214.doc” as source template. | | | | | | | | | | | | |  | |  |  | | | |
| 4/1/14 | | |  | |  | V0.1 Incorporated input from Jim Lawlis, and Analog Devices Face to Face meetings. | | | | | | | | | | | | |  | |  | **MODIFIED BY** | | | |
| 5/22/14 | | |  | |  | Draft Release. Incorporated Audio Master Clock requirements. | | | | | | | | | | | | |  | |  |  | | | |
| 6/13/14 | | |  | |  | Draft Release. Added DV Matrix, Question List, input from Analog Devices Face to Face Meeting June 16-18, 14. | | | | | | | | | | | | |  | |  | **APPROVED BY** | | | |
| 9/30/14 | | |  | |  | First Functional Release. | | | | | | | | | | | | |  | |  |  | | | |
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# I. Scope

This document is a technical specification for a multiplexed A2B network between automotive audio ECU’s, an inter-systems network. In combination with a protocol standard for multiplex it is a full specification regarding communication, all requirements in the Technical Regulation for the specific ECU also have to be fulfilled.

This document shall be used to define and develop all production intent ECU’s using the Analog Devices A2B Automotive Audio Bus for the Ford Enterprise. The specification addresses only the upper layer of the ISO network reference model (see Ref[1]).

In the figure below a relation between the different documents is described based on the OSI-model below.

**This Document**

Protocol Standard

OSI-model









= Fully specified in this document (with reference to other documents)

= Partly specified in this document

= Not specified in this document

**Figure I: Document Relationship to OSI-model**

Attention: Failure to comply with these requirements of this specification by any production intent ECU may result in an inability to communicate on the vehicle network for which the ECU was intended.

## I.I Not in Scope

Requirements specifically related to the physical implementation of the A2B network (e.g. Connectors, Wires, Physical Layer and other specifically related components) are not within the scope of this specification. Please see III. References

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# III. References

* The requirements of the documents listed in the following table, form a part of this specification. The revision levels shown in the table were the latest at the time this Functional Specification was written. In the event of a conflict between the requirements of this specification and these documents, the requirements of the documents in the table shall have precedence.

| **Rev Level** | **Requirement Document Name (ie, SDS/ARL requirements, Deviations, Engineering Specifications)** |
| --- | --- |
|  | [1] - ISO 7498-1 Open Systems Interconnection - basic reference model |
| PrI | [2] - AD2410 Datasheet (PrI) |
|  | [3] - AD24xx Board design & layout considerations |
|  | [4] – AE\_09\_A2B\_PortingGuide.pdf (Analog Devices) |
| CS | [5] - EMC-CS-2009 Electronic component EMC Requirements, FMC |
| V1 | [6] Analog Devices A2B Link Implementation Specification |
| V1 | [7] Analog Devices A2B link Data Link and Physical Layer Specification 000603.501 |
| AA | [10] - Analog Devices A2B Hardware Review 000603.512 |
|  | [12]AD2410 A2B Transceiver Programming Reference, Rev 0.3 August 2014. |
|  |  |
| TBD | [13] A2B System Diagnostic Specification |
| TBD | [11] – SPSS DAT (**DAT-FRD-REQ-TBD-Digital A2B Audio Bus System Application Implementation**) |
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**Figure 1.0: Document References**

# Definitions/Abbreviations

## General Definitions

|  |  |
| --- | --- |
| A2B Pin – BP | One of the two pins connecting a network node with ANALOG DEVICES A2B interface towards the last slave. |
| A2B Pin – BN | One of the two pins connecting a network node with ANALOG DEVICES A2B interface towards the last slave. |
| A2B Pin – AP | One of the two pins connecting a network node with ANALOG DEVICES A2B interface towards the master. |
| A2B Pin – AN | One of the two pins connecting a network node with ANALOG DEVICES A2B interface towards the master. |
| Bus | A bus is a collection of one or more wires connecting two or more nodes. Each electronic device (in this case: Host ECU, Master Node or Slave Node) is equipped with a specific, standardised electronic interface in order to guarantee compatibility between exchanged binary items of information |
| Host/ECU | An electronic control unit connected to a Master A2B node via I2S or I2C. A host can also be connected to one or more A2B peripherals. |
| Master node | An A2B Node that is connected to a Host/ECU and is the ‘master’ of one or more A2B slave units in an Automotive Audio network. |
| Multiplex | To interleave or simultaneously transmit two or more messages/signals or sets of data on a single channel. |
| Network | A set of electronic and cabling devices facilitating the multidirectional exchange of information between two or more nodes on one or more busses. |
| Slave node | An A2B node that is connected to an A2B master node or to a slave node that is closer in line to the master, and optionally to a next in line slave. A slave node can be connected to one or more A2B peripheral units (e.g. EEPROM, Microphone(s), Codec/DSP) |
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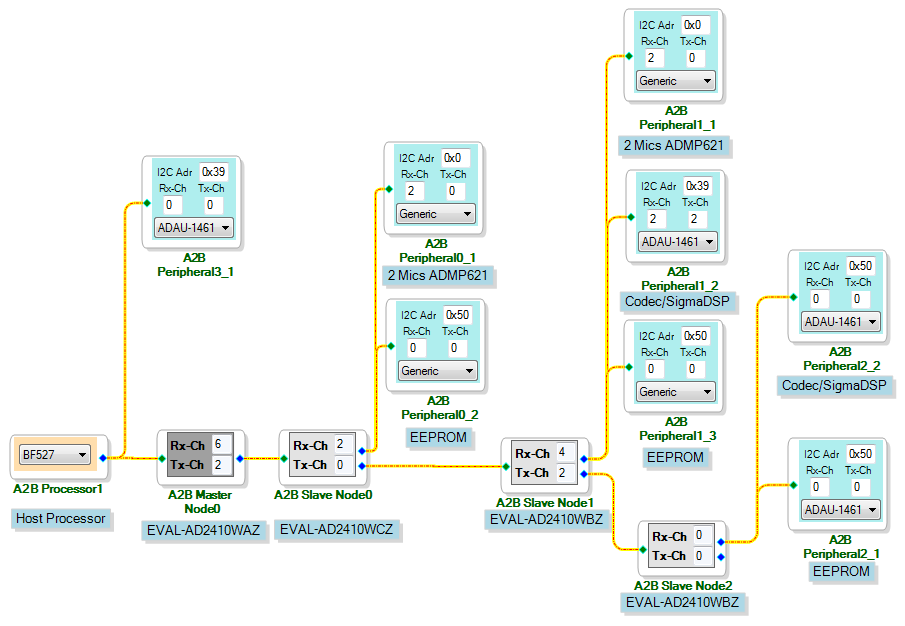
## Abbreviations used in this document

|  |  |
| --- | --- |
| A2B | **A**utomotive **A**udio **B**us (Analog Devices Trademark) |
| DPR | Design Prerequisites |
| ECU | Electronic Control Unit |
| EMC | Electromagnetic Compatibility |
| ESR | Equivalent Series Resistance |
| FMC | Ford Motor Company |
| ISO | International Standards Organisation |
| OSI | Open Systems Interconnect |
| PCB | Printed Circuit Board |
| PLL | Phase Locked Loop |
| SAE | Society of Automotive Engineers |

# PRODUCT OVERVIEW

The specification addresses the implementation of the ANALOG DEVICES Automotive Audio network. In general it addresses only the upper layers of the ISO network reference model (see Ref[1]).

## Automotive Audio Network Example



I2S/TDM

A2B Bus

Slave Node 2

Slave Node 1

Host Module

**Figure 2.1: A2B Network Example**

# Implementation Requirements

This document specifies the High Level Hardware and Software Link (HLSL) requirements related to the implementation of an Analog Devices Automotive Audio (A2B) bus network.

The A2B network consists of a host microprocessor connected to a Master A2B chip, which is then connected to one or more A2B slaves for the purpose of sending and receiving multiple synchronous digitally encoded analog streams.

## Type of Network (Automotive Audio Bus)

HLSL\_A2B\_LINK\_REQ\_\_

ANALOG DEVICES A2B in accordance with ref [2].

### Sampling Rate

HLSL\_A2B\_LINK\_REQ\_\_

The network sampling rate shall be set to 48kHz, support for 96kHz and 192Khz will be supported by using multiple A2B slots.

Rationale: The default sample rate of 48kHz, usage of 44.1kHz will necessitate of upsampling to 48Khz.

### Audio Streams and Mapping to A2B slots

HLSL\_A2B\_LINK\_REQ\_\_

The A2B network will support a limited number of slots depending on the channel (audio stream) size and the sampling rate. Each pre-defined audio stream which shall be selected from the Digital Audio Bus SPSS 1.1 SR-REQ-086676/B-A2B Audio Stream ID assignments will be mapped to one or more A2B slots. All audio streams shall be documented and approved by the AVT/EESE Audio Section before usage.

Rationale: The number of slots an audio stream is encoded on, and the slot location is dependent on the specific configuration the slaves receiving/sending those streams in the A2B network, however the audio stream (e.g. CHIME) should always have a specific sample rate (e.g. 48 kHz) and Channel Size (e.g. 24 bits).

Rationale: At the sample rate of 48 kHz and 24 bits/sample the A2B network will support a total of 32 combined slots.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Audio Channel Identifier** | **Audio Stream Name** | **Sample Rate** | **Data Size** | **Slots Used** |
| Channel ID 1 | Stereo Right Audio | 48 KHz | 24 bit | 1 |
| Channel ID 2 | Stereo Left Audio | 48 KHz | 24 bit | 1 |
| Channel ID 3 | Mixable Prompts | 48 KHz | 24 bit | 1 |

**Table 3.1.2: EXAMPLE Audio Stream Definitions/Channel Mapping**

**Master is defined in the SPSS DAT Specification [Ref: 11]** SR-REQ-086676/B-A2B Audio Stream ID assignments

### Channel Size

HLSL\_A2B\_LINK\_REQ\_\_

Each audio stream shall be encoded in single channel size which shall be set at 24 bits for all channels.

Rationale: The A2B system supports different upstream and downstream channel sizes, but Ford will be utilizing 24 bits for both.

## Network Bandwidth Allocation

HLSL\_A2B\_LINK\_REQ\_\_

The total maximum A2B bus bandwidth shall not exceed 90% of the total available bandwidth of **1024 x 48kHz** = 49.158 Mbps.

Rationale: Total bandwidth allocation that can be supported by the A2B network is a function the number of Audio Streams, channel size, the number of Nodes, and the total network length. The total bandwidth allocation can also be determined within the Analog Devices SigmaStudioTM.

## System Level

### Audio Bus/Network Topology

HLSL\_A2B\_LINK\_REQ\_\_

The Automotive Audio bus link consists of one twisted pair wire cables (bus) running from one Master ECU to one Slave Node or from one Slave Node to the next Slave Node. The entire network will consist of one or more bus links. See 2.1 Automotive Audio Network Example.

### Number of Nodes and Links

An ANALOG DEVICES A2B bus utilizes point to point bus links which can be daisy chained to form a network. The maximum number of ECU's on an A2B bus link is 2 (one Master to one Slave, or one slave to one slave.)

HLSL\_A2B\_LINK\_REQ\_\_

The maximum number of Master and Slave Nodes for the entire network shall be 7 (1 Master, and a maximum of 6 slaves).

Rationale: The maximum number of nodes will be related to the Total bandwidth allocation that can be supported by the A2B network, the number of Nodes, and the total network length.

### Allowed Devices

HLSL\_A2B\_LINK\_REQ\_\_

An A2B network shall be constructed from the one or more of the following approved devices.

1. Host Processor/ECU (e.g. BF527). See Appendix.1 Approved A2B Host Processors
2. Master Node A2B Transceiver(s). See Appendix.2 Approved A2B Masters/Slaves
3. Slave Node A2B Transceiver(s) See Appendix.2 Approved A2B Masters/Slaves
4. Audio Peripheral Devices. See Appendix.3 Approved A2B Peripherals
5. Non-Audio Peripheral Devices See Appendix.3 Approved A2B Peripherals

Rationale: Devices must be pre-approved by the appropriate EESE Automotive Audio section **before** usage.

### Common A2B Network Wakeup Source

HLSL\_A2B\_LINK\_REQ\_\_

All A2B hosts, masters and slaves shall be connected to a single common wakeup source. This may be a dedicated hardware wakeup source, or a single CAN Network wakeup source.

Rationale: All devices must use a single wakeup source to make sure that all A2B nodes will startup and shutdown in the same time periods.

## Host ECU Level Requirements

An A2B network will consist of a single host connected to one Master A2B device, which is then connected to a slave device via an A2B link. The slave may be connected to additional downstream slave units.

### Host to A2B Master Network Interface

HLSL\_A2B\_LINK\_REQ\_\_

The host interface to the master A2B device interface shall be specified according to ANALOG DEVICES A2B standard, ref [2, 3]. Currently it can be an I2C or I2S connection.

### Host to A2B Master Software

HLSL\_A2B\_LINK\_REQ\_\_

The Host ECU shall utilize an approved A2B Software driver to communicate to/from the A2B master.

This software shall be derived from the Analog Devices Recommended Porting Guide [Ref: AE\_09\_A2B\_PortingGuide.pdf], and shall be reviewed/approved by the AVT/EESE Audio Section.

### Host A2B Network Startup/Shutdown Time

HLSL\_A2B\_LINK\_REQ\_\_

The host shall be capable of completing initialization of the A2B network (1 Master, and up to 6 Slaves) within 350 ms of a wakeup event.

The A2B system may be configured at vehicle runtime IF it can be completed within 350, otherwise the A2B system shall be configured at EOL/Service Bay and stored in non-volatile memory.

Consider Adding Startup Timing Diagram from CAN/Powerup to master to slaves.

T0: Wakeup (Source via Hardware Input, or CAN Wakeup)

T1: Host Provides A2B Master Clock to A2B Master (not to exceed 50 ms)

T2: Host Discovers and Initializes Each Slave (not to exceed 50 ms per slave)

T3: Host Finishes ‘Discovery and Initialization) (not to exceed 300 ms from T0)

Rationale: Wakeup may come from dedicated input pins (e.g. power or wakup) or an attached CAN network. This time will include potential runtime discovery of the A2B devices, or the discovery may be performed at end of line or in the service bay.

HLSL\_A2B\_LINK\_REQ\_\_

The host shall be capable of shutting down the A2B network within 250 ms of the wakeup source going away.

Rationale: Sleep may come from dedicated input pins or an attached CAN network.

### A2B Master/Slave/Peripheral Network Configuration Information

The A2B network consists of one master, one or more slaves, and one or more peripheral devices attached to a slave. Each device requires specific initialization information which is performed by the master reading and writing specific “registers”. The Host or the Master node shall contain this information.

HLSL\_A2B\_LINK\_REQ\_\_

Each Master, Slave or Peripheral device shall identify its specific needs for “register initialization” in the form of one or more specifically defined .XML files **TBD** **reference [?]**. This information shall be passed from the Host to the Master, then from the Master to one or more slaves at startup/EOL.

The following information will be required from both the Master and the Slaves:

1. Transmit Channels defined in order (dependant on the TDM interfaces used)
2. Receive Channels defined in order (dependant on the TDM interfaces used)
3. Any specific ‘register’ addresses and values

### Host A2B Network Configuration

HLSL\_A2B\_LINK\_REQ\_\_

The A2B network master and slave modules need to be initialized with specific information to set the Sample Rate, Number of Slots, Channel size and other A2B information. This activity may be performed in one of the following ways:

1. Master, Slave, and peripherals will pre-configured with all information with no Host interaction needed.
2. Host will configure Master, Slaves, and peripherals from a Diagnostic EOL Command which will select a single specific configuration from a pre-defined configuration table at end of line. This table may encode master, slave, and peripheral configuration information.
3. Host will perform network “discovery” to discover the master and any attached slaves and peripherals, and properly configure them. Due to the additional workload discovery may not support the 200 ms network startup time. The configuration information for ‘discovery’ will also be larger than pre-configuration, or ‘table’ configuration.

### Host A2B Network Error DTC support

HLSL\_A2B\_LINK\_REQ\_\_

The A2B network host shall be capable of determining A2B network errors on the master, or any of its slaves or peripherals. The Host shall set an A2B Network Specific Diagnostic DTC, and an additional code identifying the specific node and/or type of error.

### Host A2B Network Error Detection and Reporting

HLSL\_A2B\_LINK\_REQ\_\_

The A2B network host shall support detection and reporting of the following A2B network errors:

1. Errors during Host A2B Network Configuration (w/ Diagnostic Command Response Code) [A2BCONFIG\_ERROR]
2. Hard Network Errors counts during operation of the A2B network (w/ Non-volatile DID support) [A2BHARD\_NETWORK\_ERROR\_CTR]
3. Transient Errors counts during operation of the A2B network (w/ Non-volatile DID support) [A2BTRANSIENT\_NETWORK\_ERROR\_CTR]

Rationale: See AD2410 Programming Reference Manual for flowcharts and additional A2B register information.

A2B\_INTSRC Slave # that generated the interrupt

A2B\_INTTYPE Specific Error enumerated by value

A2B\_SWCTL Switch Control Register

### Host A2B Network Error Handling

HLSL\_A2B\_LINK\_REQ\_\_

The A2B network host shall support the following error handling procedures:

1. For errors which occur during the Host A2B Network configuration, the host shall try the configuration a single time, and then report the success or failure of that configuration via the Diagnostic Command Response code. The host will not retry configuration, until commanded via an additional Diagnostic Command.
2. For hard network errors (errors which require one or more master or slave nodes to be re-initialized) which occur at a normal A2B wakeup event and require re-initialization of the A2B network, the host shall increment a nonvolatile A2B\_HARD\_ERROR\_COUNTER, and allow up to 300 ms [CAL\_MAX\_STARTMS] for startup and initialization (@50 ms per node[CAL\_NODE\_STARTMS]), and will perform constant retries until the A2B network starts, or the wakeup source is turned off. The host shall identify the specific hard error via a Diagnostic DTC and related DID.
3. For transient errors (detected by the master, or detected by the slaves) which occur after a successful key on or other startup event, the host shall count the number of transient errors per second. If more than 50 [CAL\_MAX\_ERRORCNT] errors occur within a 5 second interval [CAL\_MAX\_ERRORSEC], the Host shall increment an non-volatile A2B\_TRANSIENT\_ERROR\_COUNTER (perform automatic retries every until the A2B network re-starts, or the wakeup source is turned off. The host shall identify the specific error via a Diagnostic DTC.

HLSL\_A2B\_LINK\_REQ\_\_  
A2B Error Handling Table

**INTTYPE**

**Register**

**Value Description Error Type R Handling**

0x00 Header Count Error(HDCNTERR) Transient Error Increment Soft Error Counter

0x01 Data Decode Error (DDERR) Transient Error Increment Soft Error Counter

0x02 (CRCERR) Transient Error Increment Soft Error Counter

0x03 Parity Errors (DPERR) Transient Error Increment Soft Error Counter

0x04 Bit Errors (BECOVF) Transient Error Increment Soft Error Counter

0x05 (SRFERR) Transient Error Increment Soft Error Counter

0x09 Pos Short to Ground Hard Error Identify Error at location, Retry after correction

0x0A Neg Short to VBat Hard Error Identify Error at location, Retry after correction

0x0B Wires Shorted Together Hard Error Identify Error at location, Retry after correction

0x0C Wires Disconnected Hard Error Identify Error at location, Retry after correction

0x0D Wires Reversed Hard Error Identify Error at location, Retry after correction

0x0F Indeterminate Fault Hard Error Identify Error at location, Retry after correction

0x18 Discovery Done No Error Init Next Slave, or Discovery Finished

0x29 Neg Short to Ground Hard Error Non Localized Error, Retry after correction

0x2A Pos Short to VBat Hard Error Non Localized Error, Retry after correction

0xFF Master Running No Error

### Audio Master Clock

HLSL\_A2B\_LINK\_REQ\_\_

The network host shall support supplying the Audio Master Clock to the Master A2B chip within 50 ms [CAL\_MAX\_CLOCKMS] of power up (see 3.4.3 Host A2B Network Startup/Shutdown Time). This clock steam is required even if the Audio system is not on or functional.

### Loss of Audio Master Clock Error Detection on Master and Slave Hosts

HLSL\_A2B\_LINK\_REQ\_\_

Loss of Master Clock (from the Host to the Master, Master to Slave, or Slave to Slave), will result in the AD2410 transceiver going into RESET within 100us to 600us. This will result in the following actions:

1. Slave A2B transceivers will detect the loss of clock from the Master or another slave, and any GPIO’s used will tri-state (in our proposed configuration the GPIO outputs e.g. GPIO2 would indicate Clock not Available). Hosts attached to A2B Slaves shall use this as an indication that Digital Audio will not restart until the Host has re-initialized the Slave(s), and utilize a timer or counter to determine effect on the local audio (e.g. May want to mute or redirect the audio after a specified period of time, or number of errors). The Host response will be to detect the loss of the Slave (due to loss of Slave Response in the Master), Increment a Diagnostic DID Counter, and will re-initialize the Slave(s). The Host may want to mute or redirect audio after a specified period of time, or number of errors).
2. Master A2B transceivers will detect the loss of clock from the host, and will also reset. The Host response shall be to increment the A2B\_HARD\_ERROR\_COUNTER, and re-initialize the Master and ALL of the slaves (Note: Slaves will also enter RESET, due to loss of the master clock from the master or upstream slaves). The Host may want to mute or redirect audio after a specified period of time, or number of errors).
3. If GPIO’s are used, then it is the host responsibility to reset the I/O’s (the slaves will already have set them to a Tri-State condition).

## Specific Diagnostic Support via CAN

### A2B Network Discovery at EOL/Service Bay

HLSL\_A2B\_LINK\_REQ\_\_

The A2B Host processor shall support a Diagnostic Routine that supports A2B network initialization and slave discovery, and writing the correct configuration information to the master and slave nodes. The routine shall support a command to set the correct configuration, and shall return an appropriate success/failure code.

### A2B Network Errors

HLSL\_A2B\_LINK\_REQ\_\_

If the A2B network fails to initialize after a wakeup event, the Host ECU shall support one or more Diagnostic Trouble Codes, and two DID counters indicating the number of specific errors via the CAN network.

### 3.9.1 A2B Error Counters

HLSL\_A2B\_LINK\_REQ\_\_

The host shall support the following non-volatile diagnostic counters:

1. A2B\_HARD\_ERROR\_COUNTER (16 bits, will not wrap if it hits 0xFFFF)
2. A2B\_TRANSIENT\_ERROR\_COUNTER (16 bits, will not wrap if it hits 0xFFFF)

## Master Node Requirements

An A2B master node communicates to the Host module and one or more downstream slave nodes. The master node initiates all communication to/from the slave devices.

### Maximum Phantom Power Allocation

The Master Node can supply power to one or more slave units

HLSL\_A2B\_LINK\_REQ\_\_

The maximum amount of constant current a Master Node can supply is **300** mA.

Rationale: Power consumption can be controlled by using Powerdown Mode, Standby Mode or Control Mode within the Master Node. Analog Devices recommends a 500 mA regulator.

## Slave Node Requirements

An A2B Slave node communicates to a master, and optionally one or more slave nodes. A slave cannot independently send data to other slaves. The master shall be the source of data to all slaves.

Rationale: If a slave needs to send audio data to other slaves, the data must be returned to the master first, then the master will route the data to the other slave.

### Slave Node Communication

HLSL\_A2B\_LINK\_REQ\_\_

An A2B slave node communicates in one of four configurations:

1. To a Master on the upstream side and nothing on the downstream side.
2. To a Master on the upstream side and a Slave on the downstream side.
3. To a Slave on the upstream side and a Slave on the downstream side.
4. To a Slave on the upstream side and nothing on the downstream side.

### Last Slave Node

HLSL\_A2B\_LINK\_REQ\_\_

The last slave node in an A2B network needs to be properly terminated only on the upstream channel (differently than a Master or a slave which communicates to one or more downstream slaves).

Rationale: The last node in an A2B network will not need the downstream network physical layer.

### Slave Network Error Detection & Reporting

HLSL\_A2B\_LINK\_REQ\_\_

All slaves shall detect A2B Bit/Data errors from the A2B network. If the slave detects 128 bit errors (CAL\_SLAVE\_BITTHRESHOLD\_ERRORS=128) in a 5 second period (CAL\_SLAVE\_BITTHRESHOLD\_PERIOD=5000ms), the slave shall indicate this to the master by generating a slave interrupt with the appropriate error type (INTTYPE register set to TBD).

Rationale: The host is the only A2B node that can initialize and detect ALL A2B errors (Bit/Data Errors, Network Shorts, Opens, Intermittent, Missing or out of order slaves, etc.) and report these on the CAN network via a Diagnostic Trouble code, with the specific error and associated counters).

### Slave Peripheral Error Detection & Reporting

HLSL\_A2B\_LINK\_REQ\_\_

Slaves may detect errors related to the peripherals attached to it, and may report this information via A2B (via the slave interrupt), and/or using CAN. Slaves shall **NOT REPORT** peripheral errors using the **A2B** Network Error DTC (slaves should use an Audio System specific DTC).

### Slave Master Clock Error Detection and Reporting

HLSL\_A2B\_LINK\_REQ\_\_

See 3.4.10 Loss of Audio Master Clock Error Detection on Master and Slave Hosts.

## Peripheral Requirements

The Host, Master Nodes and Slave nodes are capable of communication to/from A2B peripherals. The Host communicates to the master, and the master can communicate to its peripherals, or its downstream slaves.

### Types of Peripherals

HLSL\_A2B\_LINK\_REQ\_\_

See Appendix.3 Approved A2B Peripherals

Rationale: The AVT/EESE Audio section shall maintain a list of approved peripheral devices..

# VERIFICATION METHODS

## Node conformance tests

All A2B network nodes must demonstrate conformance to the applicable tests defined in the conformance tests in table below.

|  |  |
| --- | --- |
| **Protocol** | **Conformance test** |
| Ford Component DV | Ref [9] |
| Ford Hardware Review DV | Ref [10] |

## Verification traceability

The following matrix itemizes all requirements specified herein and cross-references them to one of several means for verification. Due the criticality of a requirement there may be more than one procedure identified for verification. Below is a brief description of each of the verification methods:

ECU Level Test Plans Design Verification test where requiremens are verified on a specific ECU.

Vehicle Level Test Plans Design Verification test where requirements are verified at a Vehicle Level.

Hardware Review Inspection Inspection where requirements are verified during a Hardware Review. Reference [5], [6].

Application Testing Testing performed on the application software, by (sub)system engineering group which verifies the requirement.

| **Requirement** | **Component Level DV** | **A2B HW Inspection** |
| --- | --- | --- |
| HLSL\_A2B\_LINK\_REQ\_\_3.1.1.1  The network sampling rate shall be set to 48kHz, support for 96kHz and 192Khz will be supported by using multiple A2B slots. Need address that the Slave to Peripheral TDM interface runs at 48kHz also. | Assigned to: Host Software  Via: BDD from Sigma Studio or XSe Tool |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.1.2.1  The A2B network will support a limited number of slots depending on the channel (stream) size and the sampling rate. Each pre-defined audio stream (which shall be selected from the Digital Audio Bus SPSS 1.1 SR-REQ-086676/B-A2B Audio Stream ID assignments) will be mapped to one or more A2B slots. All audio streams shall be documented and approved by the AVT/EESE Audio Section. | Assigned to Host Software.  Via:  BDD from Sigma Studio or XSe Tool |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.1.3.1  Each audio stream shall be encoded in single channel size which shall be set at 24 bits for all channels. | Assigned to Host Software.  Via:  BDD from Sigma Studio or XSe Tool |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.2.1  The total maximum A2B bus bandwidth shall not exceed 90% of the total available bandwidth of 1024 x 48kHz = 49.158 Mbps. | Assigned to Host Software.  Via:  BDD from Sigma Studio or XSe Tool |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.3.1.1  The Automotive Audio bus link consists of one twisted pair wire cables (bus) running from one Master ECU to one Slave Node or from one Slave Node to the next Slave Node. The entire network will consist of one or more bus links. See 2.1 Automotive Audio Network Examples. |  | Assigned to:  All A2B Nodes and Wiring Topology |
| HLSL\_A2B\_LINK\_REQ\_\_3.3.2.1  The maximum number of Master and Slave Nodes for the entire network shall be 7 (1 Master and a maximum of 6 slaves).. |  | Assigned to: Master and Slave Nodes  BDD from Sigma Studio or XSe Tool |
| HLSL\_A2B\_LINK\_REQ\_\_3.3.3.1  An A2B network shall be constructed from the one or more of the following approved devices |  | Assigned to: Master and Slave Nodes  BDD from Sigma Studio or XSe Too.l |
| HLSL\_A2B\_LINK\_REQ\_\_3.3.4.1  All A2B hosts, masters and slaves shall be connected to a single common wakeup source | . | Assigned to Master and Slave Nodes |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.1.1  The host interface to the master A2B device interface shall be specified according to ANALOG DEVICES A2B standard, ref [2, 3]. Currently it can be an I2C or I2S connection | Assigned to: Host Software Review |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.2.1  The Host ECU shall utilize an approved A2B Software driver to communicate to/from the A2B master.  This software shall be derived from the Analog Devices Recommended Porting Guide [Ref: AE\_09\_A2B\_PortingGuide.pdf], and shall be reviewed/approved by the AVT/EESE Audio Section. | Assigned to: Host Software Review |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.3.1  The host shall be capable of completing initialization of the A2B network within 350ms (50ms for Master, and 50ms for up to 6 Slaves) of a wakeup event. | Assigned to: Host Software Review  Hardware timing from “wakeup’ to ‘discovery complete’ via ‘analysis tool’ |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.3.2  The host shall be capable of shutting down the A2B network within 250ms of sleep or power off event. | Assigned to: Host Software Review  Hardware timing from “sleep’ to ‘master clock’ off’ via ‘analysis tool’ |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.4.1  Each Master, Slave or Peripheral device shall identify its specific needs for “register initialization” in the form of one or more specifically defined .XML files TBD reference [?]. This information shall be passed from the Host to the Master, then from the Master to one or more slaves at startup/EOL, or from the master to the slaves. | Assigned to:  Master and Slave, Peripheral devices.  Via: BDD from Sigma Studio or XSe Tool |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.5.1  The A2B network host shall be capable of determining A2B network errors on the master, or any of its slaves. The Host shall set a Diagnostic DTC, identifying the specific node and type of error. | Assigned to: Host/Master  BDD from Sigma Studio or XSe Tool **(specific set of test vectors, short, open and CAN DTC’s and DID’s)** |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.6.1  The A2B network host shall be capable of determining A2B network errors on the master, or any of its slaves or peripherals. The Host shall set an A2B Network Specific Diagnostic DTC, and an additional code identifying the specific node and/or type of error. | Assigned to:  A2B Host Software review. |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.7.1  The A2B network host shall support detection and reporting of the following A2B network errors:  1. Errors during Host A2B Network Configuration (w/ Diagnostic Command Response Code) [A2BCONFIG\_ERROR]  2. Hard Network Errors counts during operation of the A2B network (w/ Non-volatile DID support) [A2BHARD\_NETWORK\_ERROR\_CTR]  3. Transient Errors counts during operation of the A2B network (w/ Non-volatile DID support) [A2BTRANSIENT\_NETWORK\_ERROR\_CTR] | Assigned to:  A2B Host Software review.**(specific set of test vectors, short, open and CAN DTC’s and DID’s)** |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.8.1  The A2B network host shall support the following error handling procedures: | Assigned to:  A2B Host Software Review. |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.9.1  The network host shall support supplying the Audio Master Clock to the Master A2B chip within 50ms of power up (see 3.4.3 Host A2B Network Startup/Shutdown Time). This clock steam is required even if the Audio system is not on or functional. Confirm time. | Assigned to:  A2B Host Software Review |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.4.10.1  Loss of Master Clock (from the Host to the Master, Master to Slave, or Slave to Slave), will result in the AD2410 transceiver going into RESET within 100us to 600us. This will result in the following actions: | Assigned to:  A2B Host Software, Master and Slave Nodes. |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.6.1.1  The maximum amount of current a Master Node can supply is 300 mA. Phanthom Power Budget) | Assigned to:A2B Master Node. |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.7.1.1  An A2B slave node communicates in one of four configurations: | Assigned to:  Slave Nodes.  BDD from Sigma Studio or XSe Tool | **Yes** |
| HLSL\_A2B\_LINK\_REQ\_\_3.7.2.1  The last slave node in an A2B network needs to be properly terminated only on the upstream channel (differently than a Master or a slave which communicates to one or more downstream slaves). | Assigned to:  Slave Nodes  BDD from Sigma Studio or XSe Tool |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.7.3.1  All slaves shall detect A2B Bit/Data errors from the A2B network. If the slave detects 128 bit errors (CAL\_SLAVE\_BITTHRESHOLD\_ERRORS=128) in a 5 second period (CAL\_SLAVE\_BITTHRESHOLD\_PERIOD=5000ms), the slave shall indicate this to the master by generating a slave interrupt with the appropriate error type | Assigned to:  Slave Nodes |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.7.4.1  Slaves may detect errors related to the peripherals attached to it, and may report this information via A2B (via the slave interrupt), and/or using CAN. Slaves shall NOT REPORT peripheral errors using the A2B Network Error DTC (slaves should use an Audio System specific DTC). |  |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.8.1.1  See Appendix.3 Approved A2B Peripherals |  | **Y** |
| HLSL\_A2B\_LINK\_REQ\_\_3.8.1  If the A2B network fails, the Host ECU shall support one or more Diagnostic Trouble Codes via the CAN network. | **Y** |  |
| HLSL\_A2B\_LINK\_REQ\_\_3.9.1  If the A2B network fails, the Host ECU shall support one or more Diagnostic Trouble Codes via the CAN network. | **Y** |  |
|  |  |  |
|  |  |  |
|  |  |  |

Table : Traceability Matrix

# Appendixes

## Appendix.1 Approved A2B Host Processors

The following table identifies the currently approved A2B host processors. Approval of host processors will be addressed by the EESE Automotive Audio Section.

|  |  |  |  |
| --- | --- | --- | --- |
| **Ref Des** | **Type** | **Supplier** | **Part Number** |
| BF527 | Host Microprocessor | Analog Devices | TBD |
| TBD | Host Microprocessor | TBD | TBD |
|  |  |  |  |

## Appendix.2 Approved A2B Masters/Slaves

The following table identifies the currently approved A2B Master Nodes. Approval of A2B masters shall be addressed by the EESE Automotive Audio Section.

**Reference Only: Approved Master Nodes** See [REF 7] for the Master List approved Master/Slave Nodes.

|  |  |  |  |
| --- | --- | --- | --- |
| **Ref Des** | **Type** | **Supplier** | **Part Number** |
| AD2410 | Master | Analog Devices | AD2410 |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## Appendix.3 Approved A2B Peripherals

The following table identifies the currently approved A2B peripherals. Approval of A2B peripherals shall be addressed by the EESE Automotive Audio Section.

**Approved A2B Peripherals**

|  |  |  |  |
| --- | --- | --- | --- |
| **Ref Des** | **Type** | **Supplier** | **Part Number** |
| Microphones | Peripheral |  |  |
| Codec | Peripheral |  |  |
| EEPROM | Peripheral |  |  |
| DSP’s | Peripheral |  |  |
| ADC’s | Peripheral |  |  |
| DAC’s | Peripheral |  |  |
|  |  |  |  |
|  |  |  |  |

## A.4 Current Questions/Answers

[Question: Can a single audio channel be routed to multiple downstream slaves? (Yes broadcast is available but it has to be encoded in the first slots) 8](#_Toc390675817)

[Question: How do we indicate to slaves the Stream to Frame/slot mapping.Slaves and Masters will indicate Stream Inputs and Outputs in order within the ‘architecture tool’ 8](#_Toc390675818)

[Question: API support for determining Network Errors (Net Up, Down, Transients, Slave Errors) Device Driver will support Error Detection (shorts, opens, slave sequenceing errors etc.) 12](#_Toc390675819)

[Question: How many ‘errors’ til we re-init network, or take it down till next key cycle. (How many frames/superframes can be lost until user will notice audio issues).Proposed 50 errors in a 5 second interval) 12](#_Toc390675820)

[Question: How do slaves indicate an error (interrupt?), and indicate specific type (Register number, and list of values)? (Slave generates interrupt, host/master reads registers). 13](#_Toc390675821)

[Question: How long before the A2B link is considered failed? (Proposed 5 seconds) 14](#_Toc390675822)

[Question: How to handle intermittent failures (try inifinite times, over 300 ms periods). 14](#_Toc390675823)