



EVAL-AD2428WG1BZ A²B Evaluation Board User Guide

Contributed by A²B Applications Team

Rev 1 – October 8, 2019

Features

- Local-Powered A²B[®] Slave Transceiver (AD2428W)
 - 1.2 A, Step-Down Switching Regulator (LT3505)
 - 1.1 A, Low Noise, Low Dropout Linear Regulator (LT1965)
- Stereo Audio Codec/SigmaDSP[®] (ADAU1761)
- EEPROM
- LED and Push-Button on GPIO/IRQ/Power
- Test Points for Digital and Analog Signals

Included Equipment

- Universal Wall-Mount Power Supply (12V DC, 1.5A)
- 1.8 m Twisted-Pair Cable (CAT5e-Rated, with DuraClik[™] Connectors)
- Rubber Feet

Equipment Needed

- Audio 3.5 mm TRS Plug Male-Male Adapter
- Headphone with Cable and 3.5 mm TRS Plug
- Analog Line-Level Audio Source (for example, a Smartphone)
- EVAL-AD2428WD1BZ A²B Master Node Evaluation Board
- Additional A²B Slave Nodes (Optional)
 - EVAL-AD2428WB1BZ
 - EVAL-AD2428WC1BZ

Documents Needed

- Transceiver Data Sheet^[1]
- Transceiver Technical Reference^[2]
- EVAL-AD2428WG1BZ Hardware Design Files^[3]

Software Needed

- SigmaStudio[®] Rev. 4.4 or later
- Software Distribution for A²B Rev 19.3.0 or later, DLLs

General Description

This evaluation board provides locally-powered A²B slave node functionality in an A²B network, including support for serial I²S/TDM communication. Unlike bus-powered A²B slave nodes, locally-powered A²B slave nodes do not derive their power supply from the bias voltage on the A²B lines. However, the EVAL-AD2428WG1BZ evaluation board can use the A²B bias voltage as an isolated power enable signal for its on-board LT3505 and LT1965 voltage regulators.

An audio codec/SigmaDSP (ADAU1761) with stereo analog ADC inputs can feed both the upstream and downstream A²B bus slots, while the DAC outputs may consume A²B bus slots. The SigmaDSP can also perform digital pre- or post-processing.

A pushbutton can be used to generate an interrupt (IRQ) to the A²B system. Five LEDs provide power, GPIO, and IRQ status information.

A standard 0.1-inch (2.54 mm) pin distance, dual-row header provides direct connectivity to I²S/TDM and ground signals for testing or interfacing to local serial devices. All power supplies are easily accessible at test points.

For the board schematics, assembly/layout files, and bill of materials (BOM), see the EVAL-AD2428WG1BZ Hardware Design Files ZIP archive associated with this EE-note.^[3]

Evaluation Board Hardware

[Figure 1](#) identifies the important components and connection points on the EVAL-AD2428WG1BZ evaluation board.

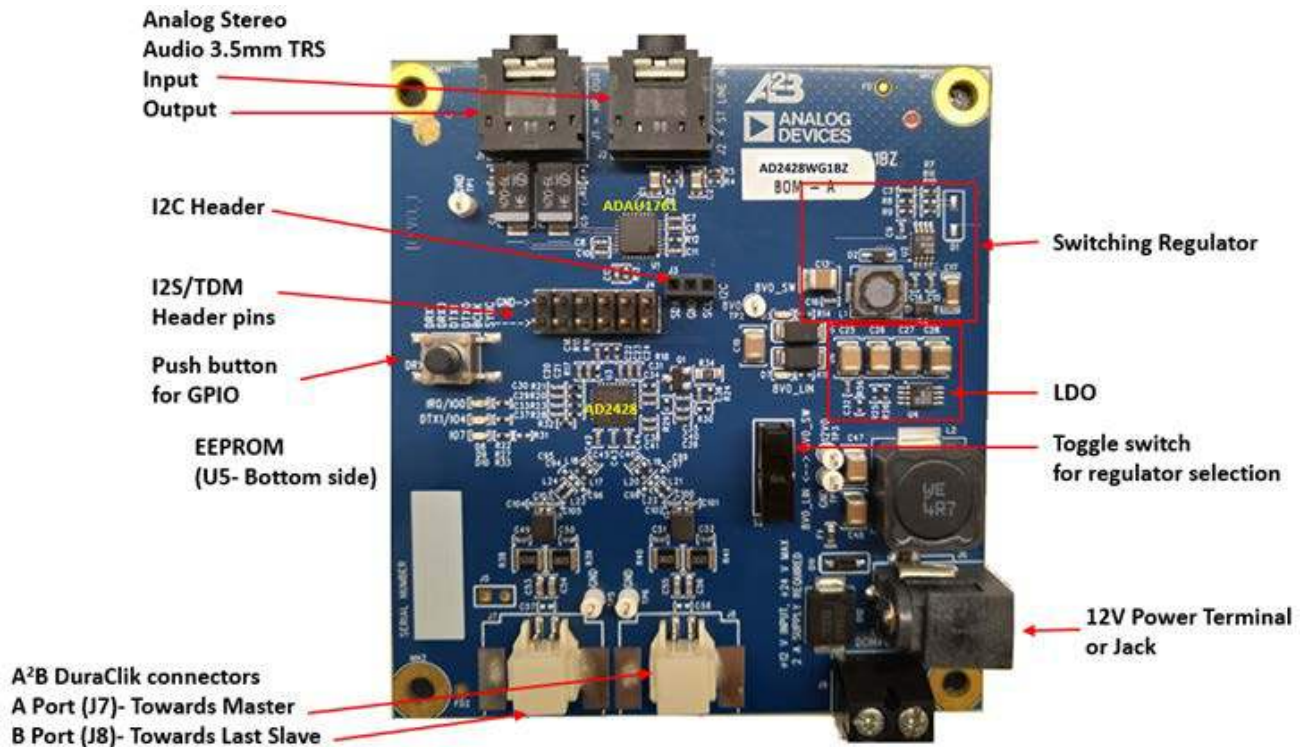


Figure 1. Board Overview

Power Supplies (J6 and J9)

Ensure that all connections are in place before applying power to the board. The wall-mount 12 V transformer power supply (1.5 A) provided with the EVAL-AD2428WG1BZ evaluation board plugs directly into connector J6. Alternatively, the terminal connector J9 allows connection to a nominal 10 V (maximum 20 V) power supply.

LT3505 - 1.2A, Step-Down Switching Regulator

The LT3505 is a current mode PWM step-down DC/DC converter with an internal 1.4A power switch. The wide operating input range of 3.6V to 36V (40V maximum) makes the LT3505 ideal for regulating power from a wide variety of sources, including unregulated wall transformers, 24V industrial supplies, and automotive batteries. The oscillator can be programmed for high frequency operation allowing the use of tiny, low cost external components. It can also be programmed for lower frequency operation to maximize efficiency.

Cycle-by-cycle current limit provides protection against shorted outputs. A soft-start eliminates input current surge during start-up. The low current ($< 2 \mu\text{A}$) shutdown mode provides output disconnect, enabling easy power management in battery-powered systems.

LT1965 - 1.1A, Low Noise, Low Dropout Linear Regulator

The LT1965 series are low noise, low dropout linear regulators. The devices supply 1.1A of output current with a 310mV typical dropout voltage. Operating quiescent current is 500 μA for the adjustable version, reducing to $< 1 \mu\text{A}$ in shutdown. Quiescent current is well controlled; it does not rise in dropout like many other regulators. The LT1965 regulators have very low output noise which makes them ideal for sensitive RF and DSP supply applications.

Output voltage ranges from 1.20V to 19.5V. The LT1965 regulators are stable with output capacitors as low as 10 μF . Internal protection circuitry includes reverse-battery protection, current limiting with foldback, thermal limiting and reverse-current protection. The LT1965 series are available in fixed output voltages of 1.5V, 1.8V, 2.5V, 3.3V, and as an adjustable device with a 1.20V reference voltage. The package offerings include the 5-lead TO-220, 5-lead DD-Pak as well as the thermally enhanced 8-lead MSOP and low profile (0.75mm) 8-lead 3mm \times 3mmDFN.

A²B Bus Connections (J7 and J8)

The 2-pin Molex DuraClik connector (J7) allows a single twisted-pair A²B cable to attach to the A-side of the AD2428W transceiver such that the opposite end of the A²B cable can attach to the B-side of either the master transceiver or the next slave node transceiver closer to the master node.

The 2-pin Molex DuraClik connector (J8) allows a single twisted-pair A²B cable to attach to the B-side of the AD2428W transceiver such that the opposite end of the A²B cable can attach to the A-side of the next slave node transceiver, including the last-in-line slave.

I²C Header (J3)

The 3-pin I²C header (J3) provides access to the I²C SDA and SCL signals, as well as GND, allowing both debug and control access to the AD2428W transceiver.

Analog Audio Input (J2)

The EVAL-AD2428WG1BZ evaluation board provides a 3.5 mm TRS connection (J2) to a stereo, single-ended input signal that conforms to audio line levels. Audio sources, such as MP3 players (for example, an iPod®) or smartphones, can directly feed this AC-coupled input to the ADAU1761 SigmaDSP ADC. Alternatively, the input can come from a non-audio source, provided the peak-to-peak input signal swing is less than 2.8 V.

When nothing is connected to the audio input and audio output (J1) jacks, the analog audio output routes to the analog audio input of the ADAU1761 SigmaDSP. This design facilitates analog loopback testing.

Analog Audio Output (J1)

The EVAL-AD2428WG1BZ evaluation board provides a 3.5mm TRS connection (J1) to the stereo output signals from the ADAU1761 SigmaDSP DAC. This connection drives line-level signals for active speakers or amplifiers. The audio output can also directly drive a headset but will show limited low frequency response due to the combination of the small AC coupling capacitor on the EVAL- AD2428WG1BZ board and the low impedance of a headset.

When nothing is connected to the audio input (J2) and audio output jacks, the analog audio output routes to the analog audio input of the ADAU1761 SigmaDSP. This design facilitates analog loopback testing.

I²S/TDM Header (J4)

This dual-row header (J4) provides access to the clock, synchronization, and data signals of the I²S/TDM interface on the AD2428W transceiver. The header allows connection to other PCBs (direct mount or fly-wire) and signal monitoring using a logic analyzer or a digital audio analyzer. One side of the header has ground connections to improve signal integrity for shielded- or twisted-wire connections.

LEDs

Refer to the silkscreen and schematics for LED placement on the EVAL-AD2428WG1BZ evaluation boards. The LEDs reflect power and I/O pin status, as summarized by [Table 1](#).

| LED | Description |
|-----|---|
| D3 | Power from LT3505 Switching Regulator Indicator (S2 = 2) |
| D7 | Power from LT1965 LDO Linear Regulator Indicator (S2 = 1) |
| D8 | AD2428W IRQ/IO0 Pin Status |
| D9 | AD2428W DTX1/IO4 Pin Status |
| D10 | AD2428W PDMCLK/IO7 Pin Status |

Table 1. EVAL-AD2428WG1BZ Evaluation Board LED Summary

Test Points (TP1 – TP12)

The test points are well-marked on the silkscreen of the PCB, providing access to signals and power supplies, as summarized in [Table 2](#). Refer to the schematics to locate the probe points.

| Test Point | Provides Access To (A ² B Transceiver Pin, If Applicable) |
|------------|--|
| TP1 | EVAL-AD2428WG1BZ Board Ground Potential |
| TP2 | LT3505 Output Voltage |
| TP3 | Main 12V DC Supply Voltage |
| TP4 | EVAL-AD2428WG1BZ Board Ground Potential |
| TP5 | EVAL-AD2428WG1BZ Board Ground Potential |
| TP6 | EVAL-AD2428WG1BZ Board Ground Potential |
| TP7 | AD2428W VOUT1 Output Voltage (PLLVDD/DVDD) |
| TP8 | AD2428W VOUT2 Output Voltage (ATRXVDD/BTRXVDD) |
| TP9 | VBUS Low - Negative Bus Bias Recovered on this Node |
| TP10 | VBUS High - Positive Bus Bias Recovered on this Node |
| TP11 | AD2428W Next Slave Power Sense (SENSE) |
| TP12 | AD2428W Return Current for Next Slave (VSSN) |

Table 2. EVAL-AD2428WG1BZ Evaluation Board LED Summary

ADAU1761 SigmaDSP (U1)

The non-automotive-qualified ADAU1761 SigmaDSP is functionally equivalent to the obsolete automotive-qualified ADAU1461. This device is also pin-compatible with the automotive-qualified ADAU1361 and ADAU1961 products, which do not include a SigmaDSP processor core for digital audio pre- and post- processing.

Pushbutton (S1)

The AD2428W DRX1/IO6 pin is pulled high to IOVDD through resistor R47, such that depressing the pushbutton (S1) can generate an active-low interrupt request (IRQ) to the AD2428W transceiver, provided the DRX1/IO6 pin is configured as an active low GPIO input with interrupt capabilities. The R47 resistor must be removed if the DRX1/IO6 pin is configured for data.

EEPROM (U5)

The default EEPROM content for this board is described in [Table 3](#):

| Address | Data | Content |
|---------|------|--------------------------------|
| 0x0000 | 0xAB | Configuration Memory Indicator |
| 0x0001 | 0xAD | Module Vendor ID |
| 0x0002 | 0x28 | Module Product ID |
| 0x0003 | 0xD2 | Module Version ID |
| 0x0004 | 0x12 | RESERVED (Ignore) |
| 0x0005 | 0x00 | Number of Configuration Blocks |

Table 3. EEPROM Settings for AD2428W Transceiver

I²C Device Addresses in 7-bit Format

The I²C device address in 7-bit format does not include the read-write (R/W) bit. The schematics tab in the SigmaStudio A²B window uses the 7-bit address representation for configuration, as summarized in [Table 4](#). Both devices are 16-bit addressable and utilize 8-bit data.

| Device | 7-Bit I ² C Device Address |
|------------------------------|---------------------------------------|
| ADAU1761 SigmaDSP with Codec | 0x39 |
| 24FC256 EEPROM | 0x50 |

Table 4. 7-Bit I²C Device Addresses

Evaluation Board Software Quick Start Procedure

The EVAL-AD2428WG1BZ evaluation board is intended to be connected within an existing A²B system, where at least a master node exists for the on-board AD2428W transceiver to be a slave to on the A²B bus. A host processor on the master node interfaces directly with the A²B master transceiver, through which it programs and reads the register spaces of all discovered slave transceivers. This configuration allows a full system initialization at start-up and monitoring of status during operation.

The examples furnished with the complementary EVAL-AD2428WD1BZ A²B master evaluation board assume a connection to specific slave boards, as noted in the following sections.

Connection to EVAL-AD2428WD1BZ Master Board

For master board setup instructions, refer to the *EVAL-AD2428WD1BZ A²B Evaluation Board Manual*^[4]. Ensure that the master board jumpers are installed in their default positions.

Hardware Setup for a 3-Node A²B System

- Assemble the example A²B system by connecting the indicated A²B evaluation boards as follows:
 - Master (EVAL-AD2428WD1BZ) – Connect the B-side (P2) to the A-side on the slave0 board (J7).
 - Slave0 (EVAL-AD2428WC1BZ) – Connect the B-side (J8) to the A-side on the slave1 board (J7).
 - Slave1 (EVAL-AD2428WG1BZ)
- Connect the PC over a USB cable and using the EVAL-ADUSB2EBZ USBi I²C programmer to the SigmaStudio header (P1) on the master board.
- Connect an audio source to the stereo line input of the master board (J3).
- Connect headphones to the audio output of the slave1 board (J1).
- Plug the wall-mount 12V power supply (1.5 A) into an outlet and connect it to the power jack on the master board (P4).
- Plug the wall-mount 12V power supply (1.5 A) into an outlet and connect it to the power jack on the slave1 board (J6).

Software Setup and Operation

- Install the SigmaStudio (Rev. 4.4 or later) and A²B Software for Windows/Baremetal (Rev 19.3.0) software from the [EVAL-AD2428WG1BZ product page](#).

- Copy the A2B.dll and A2Bstack.dll driver files from the installation directory (default C:\Analog Devices\ADI_A2B_Software-Rel19.3.0\GUI\x86_x64) into the SigmaStudio installation (default C:\Program Files\Analog Devices\SigmaStudio 4.4). Start SigmaStudio and verify that the A2B.dll file is selected under Tools→AddInsBrowser. Save before exiting.
- Open the adi_a2b_3NodeSampleDemo.dspproj example project, which is located in the (default) C:\Analog Devices\ADI_A2B_Software-Rel19.3.0\Schematics\BF\A2BSchematics directory. Click the *Link-Compile-Download* icon, as shown in [Figure 2](#).

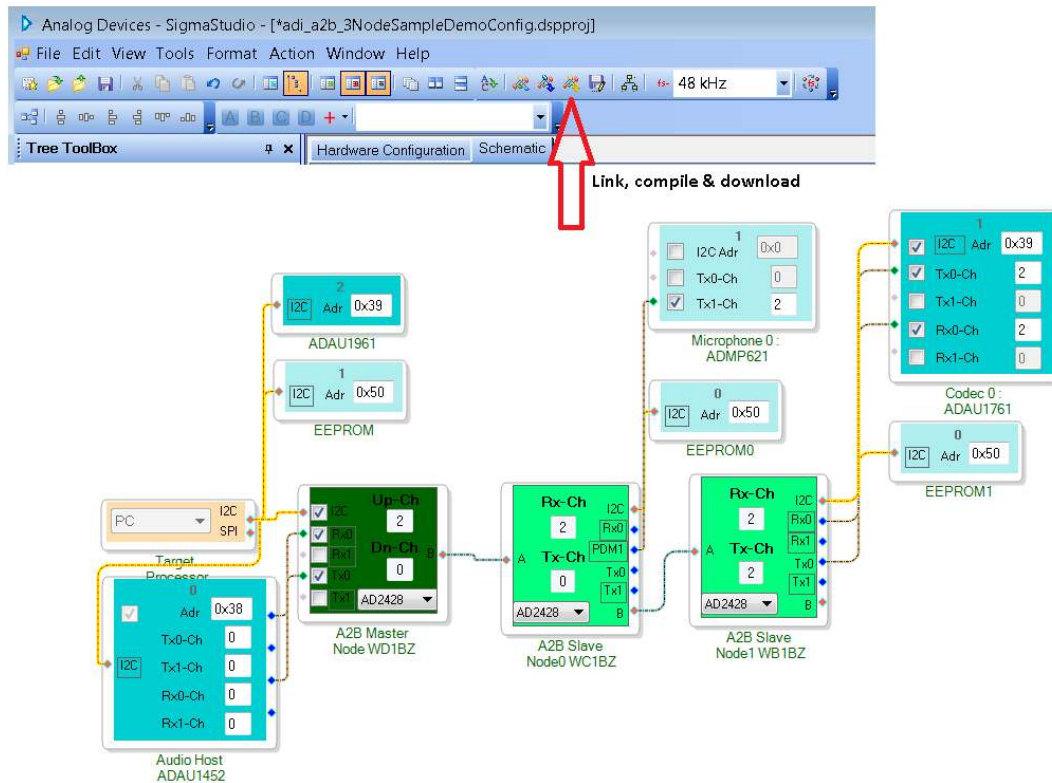


Figure 2. Software Schematic for adi_a2b_3NodeSampleDemoConfig.dspproj A²B Example Project



The adi_a2b_3NodeSampleDemo.dspproj example project assumes a connection from the A²B master EVAL-AD2428WD1BZ evaluation board to the slave0 EVAL-AD2428WC1BZ evaluation board, followed by a connection to the slave1 EVAL-AD2428WB1BZ evaluation board. However, the EVAL-AD2428WG1BZ evaluation board can be substituted for the EVAL-AD2428WB1BZ as the slave1 node using the same project.

- Plug the headphones into the slave1 EVAL-AD2428WG1BZ board (J1). The PDM microphone audio input from the microphones of the slave0 EVAL-AD2428WC1BZ board can be heard.
If the audio source is plugged into the input of the slave1 EVAL-AD2428WG1BZ board (J2), the slave1 input stream can be heard through headphones connected to the audio line out of the EVAL-AD2428WD1BZ master board (J4).

Audio flow, as programmed into the ADAU1452 SigmaDSP during A²B bus discovery and initialization, can be changed in the `adi_a2b_master_ADAU1452` SigmaStudio project file. Once the bus is discovered and the window is switched to that file, click the *Link-Compile-Connect* icon to activate the ADAU1452 interactive programming GUI, as shown in [Figure 3](#). The *Link-Compile-Connect* function assumes that the pre-loaded memory and register settings in the ADAU1452 SigmaDSP exactly match the GUI. It re-establishes the I²C link so that GUI changes take effect from there.

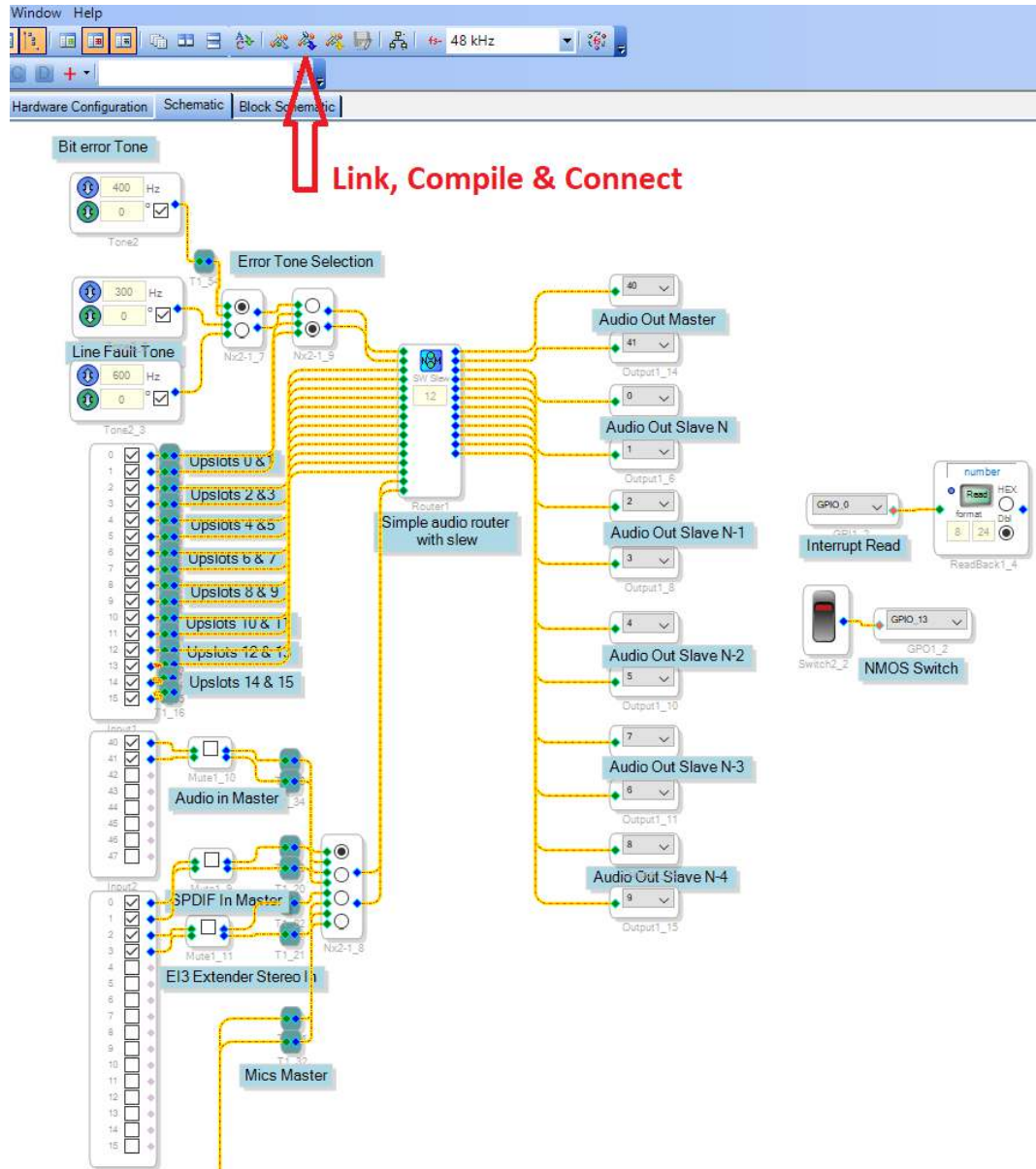


Figure 2: Software Schematics for `adi_a2b_master_ADAU1452.dspproj` A²B Example Project



Do **not** use the *Link-Compile-Download* function mentioned in previous steps. The ADAU1452 SigmaDSP on the master EVAL-AD2428WD1BZ board supplies the clock (SYNC) to the AD2428W transceiver. Clicking *Link-Compile-Download* reprograms the ADAU1452 SigmaDSP and resets the A²B bus by temporarily disconnecting the clock to the SYNC pin of the AD2428W transceiver.

For development of customized ADAU1452 audio flows, the automatic programming of the ADAU1452 SigmaDSP during discovery must be disabled in the A²B software schematics in [Figure 2](#) by right-clicking on the ADAU1452 block and selecting *Peripheral Properties*.



It is then necessary to **always** configure the ADAU1452 SigmaDSP to send a SYNC signal **before** programming the AD2428W transceiver and initiating A²B bus discovery.

Refer to the *Quick Start Guide*^[5] from the A²B software distribution for an explanation on how to modify the software.

References

- [1] *AD2420(W)/AD2426(W)/AD2427(W)/AD2428(W)/ AD2429(W) Automotive Audio Bus A²B Transceiver Data Sheet*. Rev A, October 2019. Analog Devices, Inc.
- [2] *AD2420(W)/6(W)/7(W)/8(W)/9(W) Automotive Audio Bus A²B Transceiver Technical Reference*. Rev 1.1, October 2019. Analog Devices, Inc.
- [3] *Associated ZIP File (EE421v01.zip) for EVAL-AD2428WG1BZ A²B Evaluation Board User Guide (EE-421)*. October 2019. Analog Devices, Inc.
- [4] *EVAL-AD2428WD1BZ A²B Evaluation Board Manual*. Rev 1.1, October 2019. Analog Devices, Inc.
- [5] *A²B Quick Start Guide*. Revision 25.0, October 2019. Analog Devices, Inc.

Document History

| Revision | Description |
|---|-----------------|
| <i>Rev 1 – October 17, 2019 by A²B Applications Team</i> | Initial Release |