

# APPNOTE 002

## A<sup>2</sup>B MASTER NODE WITH USB AUDIO INTERFACE

Using an off-the-shelf USB to I<sup>2</sup>S interface card to provide up to 16 input and 16 output channels for A<sup>2</sup>B from Windows or Mac host

Rev 3

7-Apr-21



<http://clk.works/>

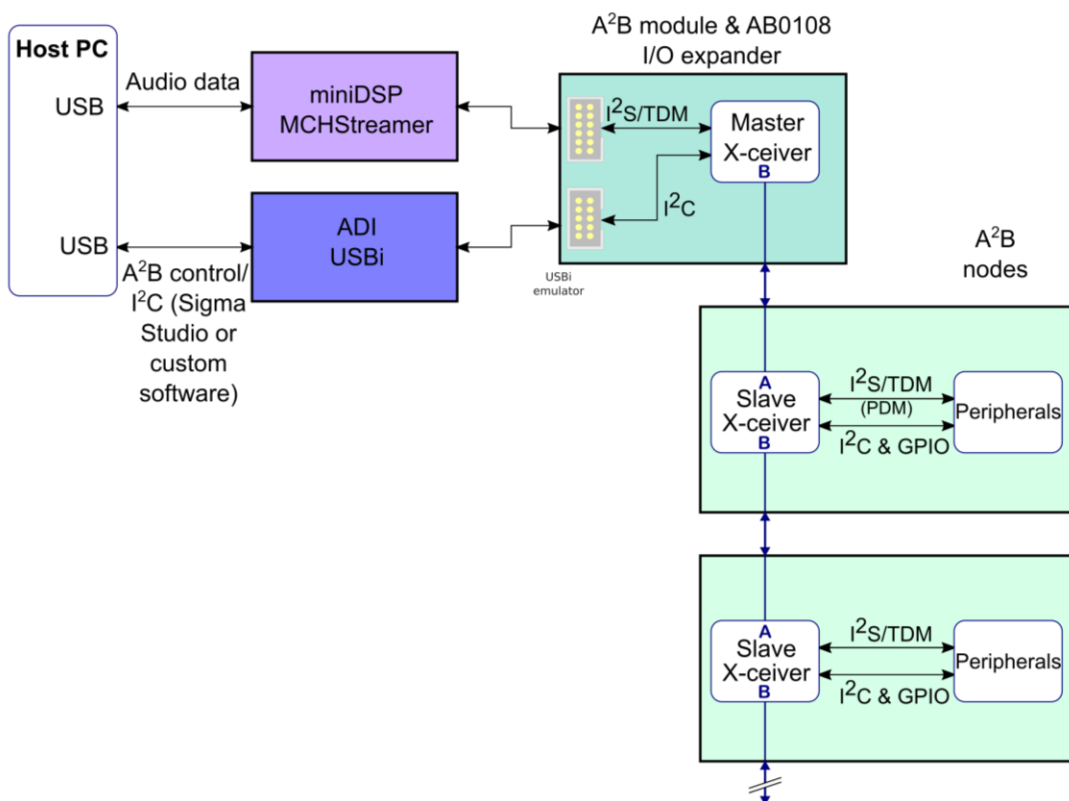
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# 1 INTRODUCTION

During development of an A<sup>2</sup>B based audio system it can be convenient to send audio from a host desktop computer system in to the A<sup>2</sup>B network or receive data back. Figure 1 illustrates the basic components and signal flow that are described by this application note.



**Figure 1 PC to A<sup>2</sup>B audio system diagram (note SigmaStudio & USBi are only supported from Windows)**

A simple method for this use can be created with the readily available miniDSP MCH streamer (Figure 2) to act as the USB to I<sup>2</sup>S interface, and the Clockworks AB0003 A<sup>2</sup>B to I<sup>2</sup>S module (Figure 3) mated to the AB0108 externally clocked master node I/O expander (Figure 4).

This allows up to 16 channels of 24 bit 48 kHz data from the A<sup>2</sup>B network to be sent to a host PC or from the PC to the A<sup>2</sup>B network. Root node AD2428 devices always operate at 48 kHz sample rate. Higher rate data can be exchanged with a host PC but would need to be repacked from 48 kHz streams.

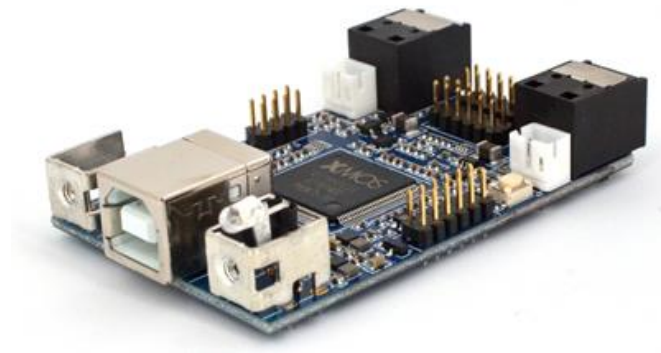


Figure 2 miniDSP MCHStreamer board



Figure 3 OEM A2B module – locally powered version (AB0003L)



Figure 4 AB0108 root node, external clock, I/O expander (mates with OEM A<sup>2</sup>B module)

## 1.1 REFERENCES

### 1.1.1 DOCUMENTATION

- *OEM A2B MODULE AND EVM KIT USER MANUAL* (AB0108 connection information) available from [Clockworks website](#)
- *MULTI-CHANNEL MULTI-PROTOCOL USB AUDIO INTERFACE User Manual* available from [miniDSP website](#)
- Analog Devices A<sup>2</sup>B hardware and support software documentation, available from [ADI website](#).

### 1.1.2 HARDWARE USED

- Clockworks part number [EVMA2B03MX-NA](#) Root node local clock EVM kit (order -INT for 9V supply with universal plug kit)
- miniDSP part number [MCHStreamer Kit](#) USB to I<sup>2</sup>S board with cables/connectors.
- Analog Devices [EVAL-ADUSB2EBZ](#) USBi interface (or equivalent)
- I<sup>2</sup>S 2mm to .1" cable assembly (directions to assemble described in this document)

The supplied Sigma Studio example uses a Clockworks [EVMA2B01-NA](#) A<sup>2</sup>B and EVM kit for stereo analog audio, but different I/O cards can be used with appropriate adjustment to the Sigma Studio schematic.

## 2 HARDWARE SETUP

Section 2.1 describes making the interconnect cable using the connector and wires that comes with the MCH Streamer board for the 2mm connector and the a 0.1" socket and scrap piece of perf board from your junk drawer.

Section 5 describes an alternate cable construction using connectors and precrimped wires that can be purchased. It still requires a little bit of basic soldering. Clockworks has assembled some of these for those without access such things. Please contact us for more information.

### 2.1 I<sup>2</sup>S CABLE

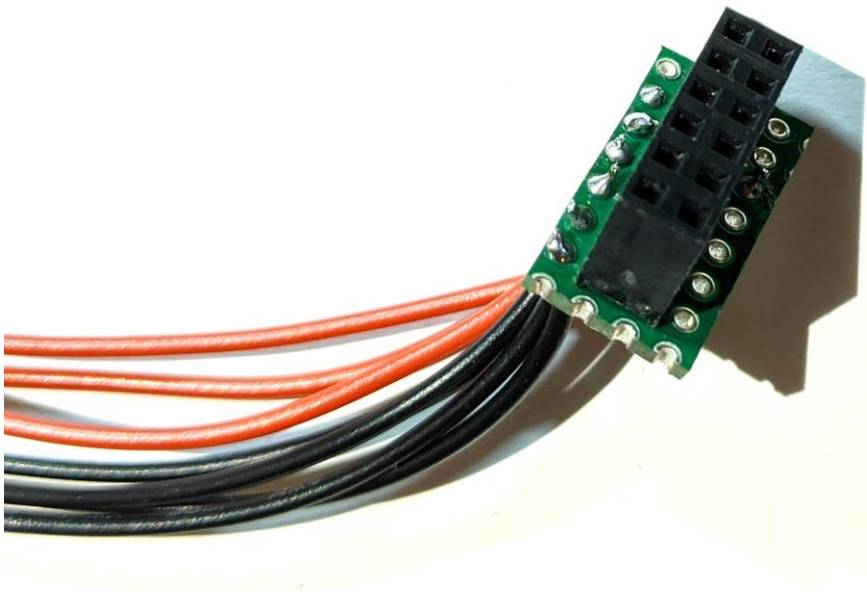
The MCHStreamer comes with a 12 pin 2mm connector shell and wires with pins. This is used to connect to J1 on the MCHStreamer. The other end needs to be connected to a 12 pin .1" (2.54mm) female connector. The cable is not a 1:1 cable. The example shown here (Figure 5 and Figure 6)

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uses a cut off piece of a prototyping PCB to mount the .1" connector and solder the wires in, but any reasonable solution from your junk drawer should work.

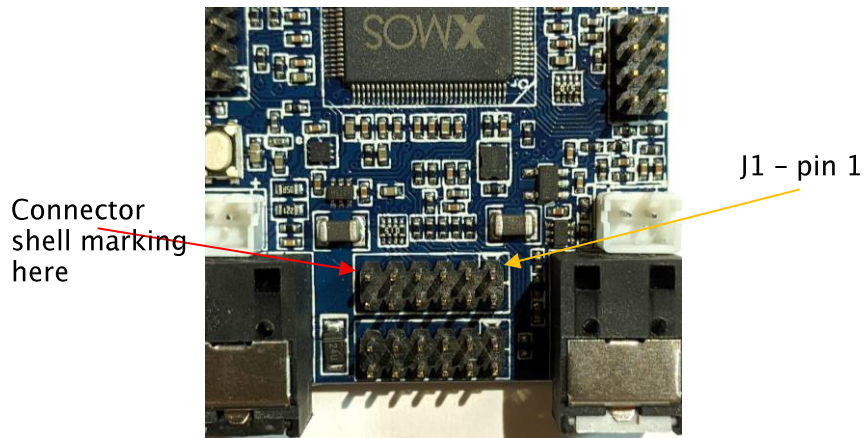


**Figure 5 I<sup>2</sup>S cable example to connect MCHStreamer board to AB0108**



**Figure 6 .1" socket mounting detail**

When assembling the cable note that what appears to be the pin 1 indicator on the 2mm connector shell is not the correct location for the actual pin 1 orientation of J1 on the MCHStreamer, see Figure 7.



**Figure 7 MCHStreamer pin 1 location – pay attention to this orientation when building your cable**

The pinout for the MCHStreamer (from page 10 of the manual) is:

J1 (I2S mode)	
Pin	Description
1	I2S data OUT Ch 1&2
2	I2S data IN Ch 1&2
3	I2S data OUT Ch 3&4
4	I2S data IN Ch 3&4
5	I2S data OUT Ch 5&6
6	I2S data IN Ch 5&6
7	I2S data OUT Ch 7&8
8	I2S data IN Ch 7&8
9	Master clock (MCLK OUT)
10	Bit clock out (BCLK)
11	Ground (GND)
12	I2S frame sync (LRCLK)

**Figure 8 MCHStreamer J1 pinout for default "AllRate" firmware**

For the AB0108 end of the connection the pinout is:

2	BCLK (input)
4	SYNC (input)
6	DTX0 (to DACs)
8	DTX1
10	DRX0 (from ADC)
12	DRX1
1, ..., 11	GND (odd pins)

**Figure 9 AB0108 I<sup>2</sup>S connector pinout**

There are just two I<sup>2</sup>S lines in each direction on the AD2428 A<sup>2</sup>B transceiver. Therefore only 4 channels in each direction are possible when using the I<sup>2</sup>S in a stereo (TDM2) mode default of the MCHStreamer *AllRate* firmware. The *TDM* firmware can be used for a TDM8 mode, which uses just a single data pin for 8 channels. With two datapins available this provides 16 channels in each direction. See Section 6 for using TDM mode.

Bit depth and channel counts are determined by the AD2428's maximum BCLK rate of 25 MHz. The root/master node of an AD2428 based system always operates with a frame rate of 48 kHz (44.1 kHz is also possible but there's no reason to use that in most systems). 2x or 4x audio rate (96/192 kHz) can be passed by the root but the data needs to be packed/unpacked on the host processor.

MCHStreamer pin	Signal direction	AB0108 pin	Name (For default <i>AllRate</i> firmware)
1	→	10	USB out ch 1&2
3	→	12	USB out ch 3&4
2	←	6	USB in ch 1&2
4	←	8	USB in ch 3&4
10	→	2	BCLK
12	→	4	SYNC
11	-	Any odd pin	GND



Figure 10 I<sup>2</sup>S cable wiring chart (MCHStreamer pin # based on PCB layout, not connector shell markings)

### 2.1.1 I<sup>2</sup>S CLOCKS

The AD2428 does not use MCLK (pin 9 on the MCHStreamer). The MCHStreamer only operates as an I<sup>2</sup>S clock master, i.e. it sources BCLK and FSYNC. This means it can only be connected to an A<sup>2</sup>B root (master) node as all client (slave) nodes require that the peripherals receive the clock signals from the AD2428 transceiver.

### 2.1.2 I<sup>2</sup>S FORMATS

The MCHStreamer User Manual provides a lot of information on the I<sup>2</sup>S signal setup and clock frequencies. The main point to remember is the first sample delayed one bit position, as illustrated in the following capture from the set up described here.

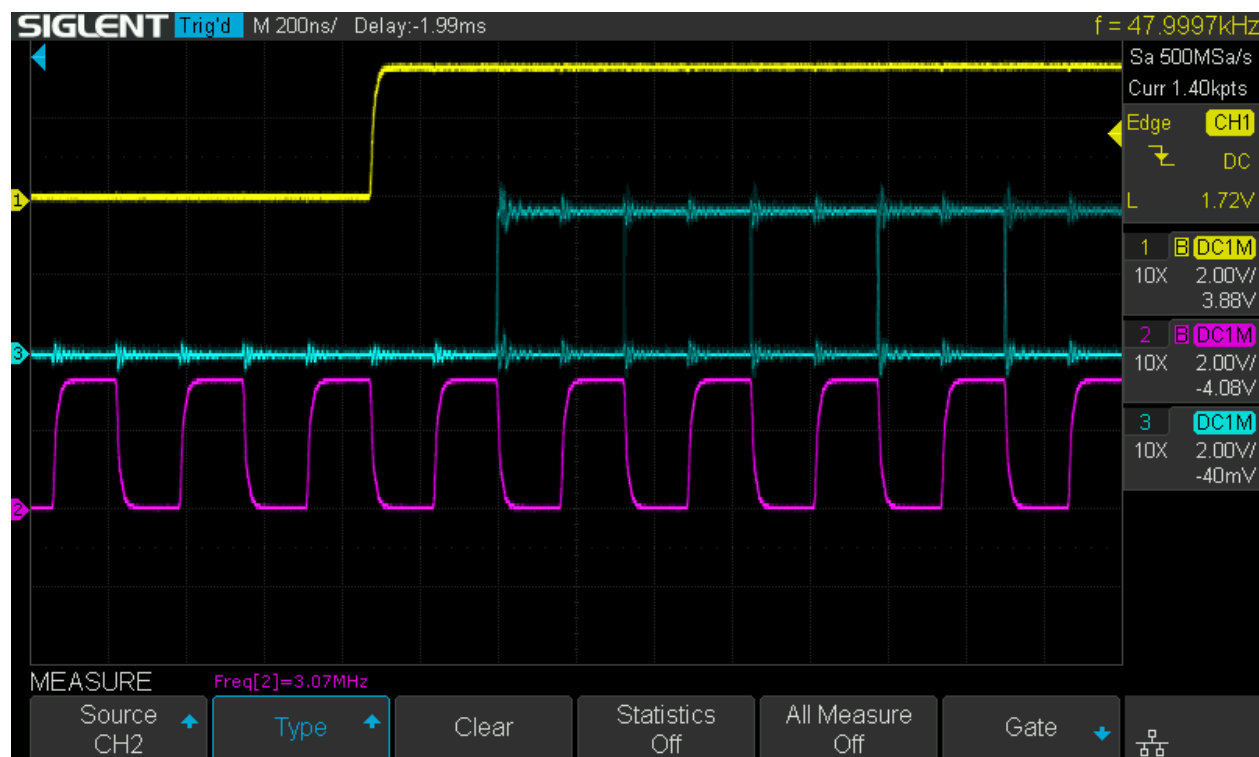


Figure 11 I<sup>2</sup>S signal capture from example setup. Yellow–FSYNC, Purple–BCLK, Blue–Data

## 2.2 EXAMPLE CONFIGURATION

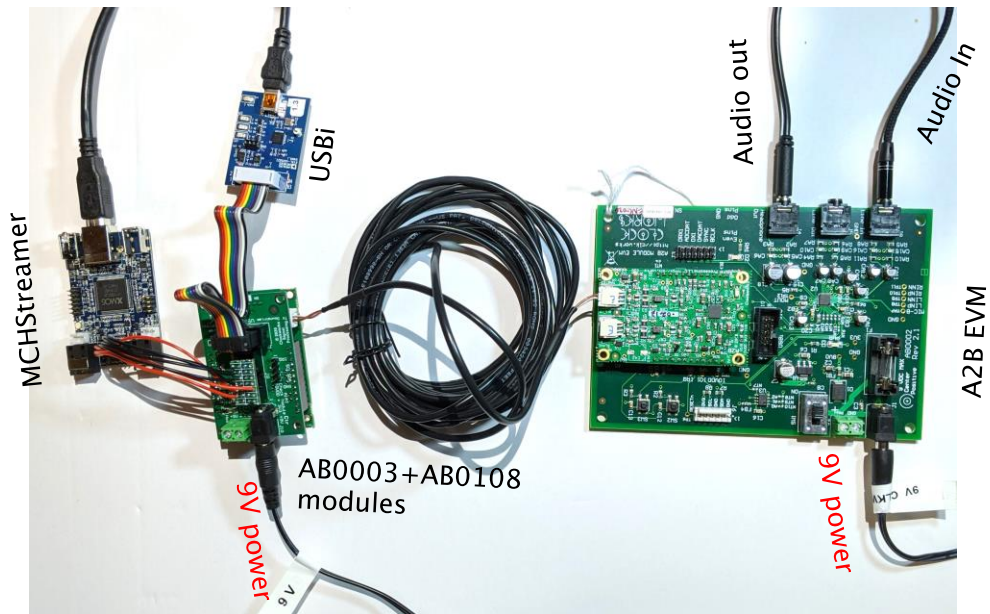
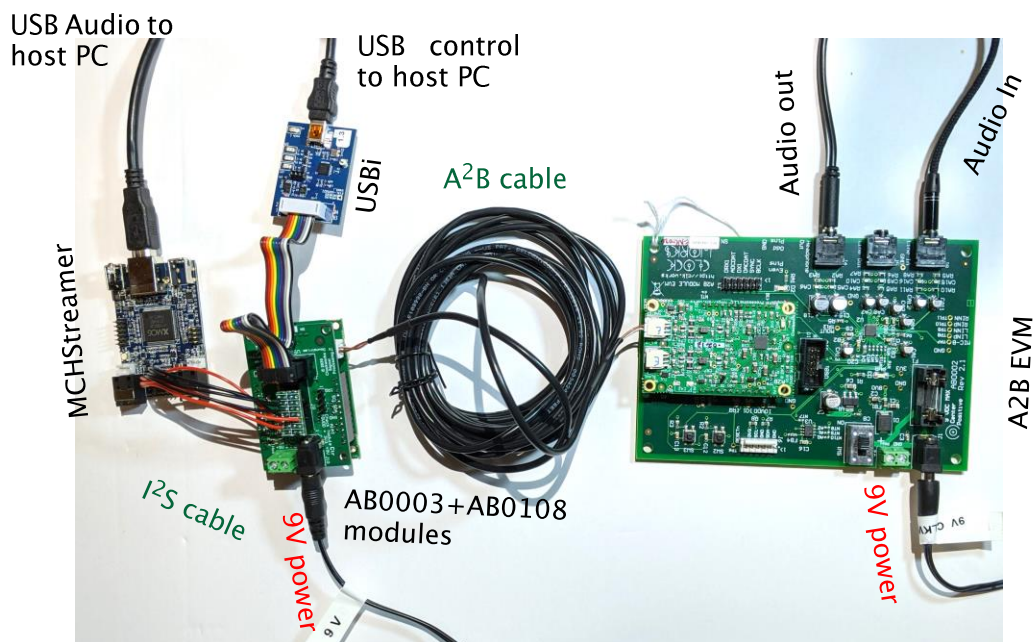


Figure 12 illustrates the example configuration that is used to illustrate integration of the MCHStreamer and the A<sup>2</sup>B hardware.



**Figure 12 Example configuration hardware interconnection**

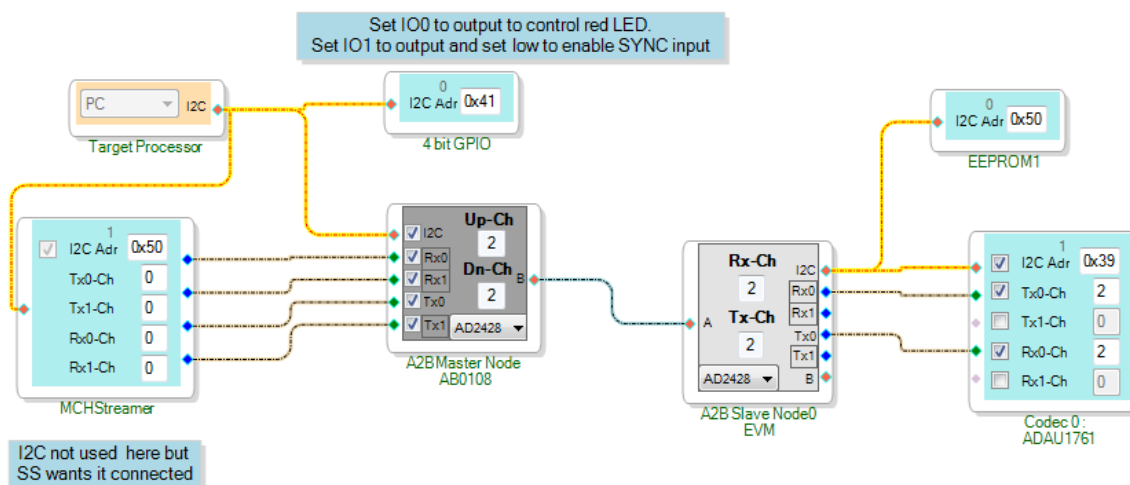
When connecting the MCHStreamer to AB0108 be careful of the pin 1 location and also to not misregister the connector on the AB0108 end. Ensure that only 9V power supplies are used to power the two Clockworks boards, a 12V supply will release the magic smoke.

Follow ADI's directions for installing SigmaStudio and the USBi. If using a Windows system likewise follow miniDSP's manual for installing the MCHStreamer ASIO driver. To be able to load different firmware on the MCHStreamer you will need to follow the directions in miniDSP's manual.

It's not a requirement to use the USBi for I<sup>2</sup>C. For example if you already have software developed for A<sup>2</sup>B network control you could bridge your host system's I<sup>2</sup>C to the AB0108. Though there is a clear advantage to use SigmaStudio in that changing signal routing to accommodate different audio paths is a very fast and simple undertaking. It is possible to use both USBi and your own host, but there are a lot of potential interactions that must be considered.

### 3 SIGMA STUDIO EXAMPLE

This example is based around the hardware setup in Figure 12.



**Figure 13 SigmaStudio example for stereo audio with MCHStreamer**

A root node peripheral block is used to represent the I<sup>2</sup>S data path to/from the MCHStreamer. SigmaStudio treated it as an error if the I<sup>2</sup>C connection in the schematic was left unconnected; in real life there is no I<sup>2</sup>C data sent to the MCHStreamer.

If you're using a different audio I/O configuration with the MCHStreamer the root (master) node's audio settings will need to be adjusted. Figure 14 shows the settings for the standard 2 channel mode used in this example.

Figure 15 and Figure 16 show the stream settings (right click on the `Target Processor` block and select `Stream Config`) for the default stereo example, these will need to be changed if you use a different configuration.

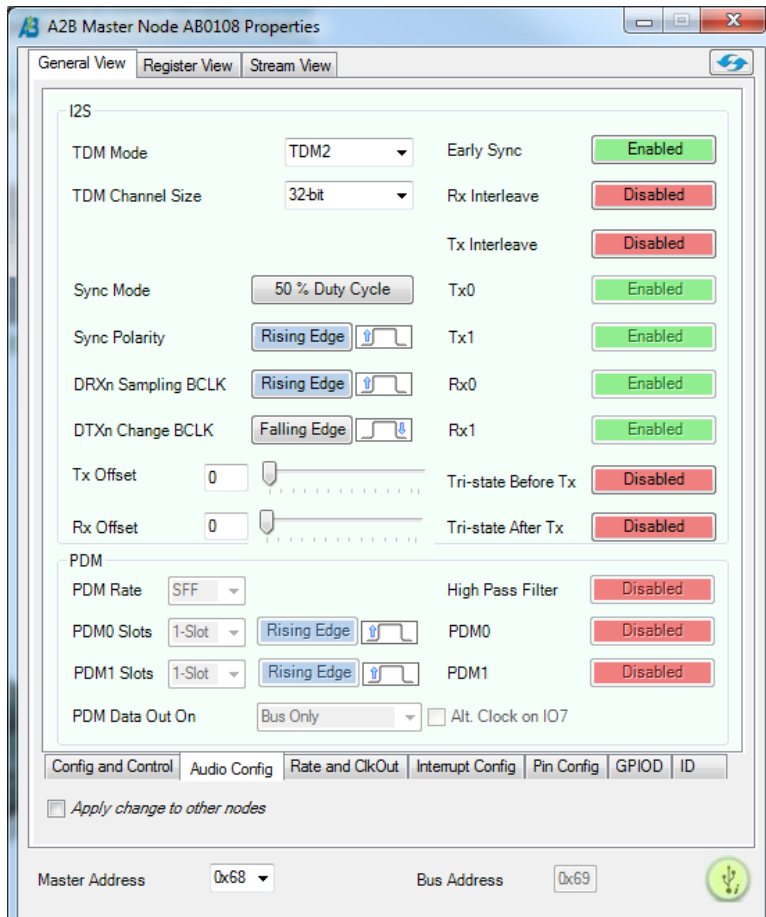


Figure 14 Audio settings for root node for stereo data to/from MCHStreamer

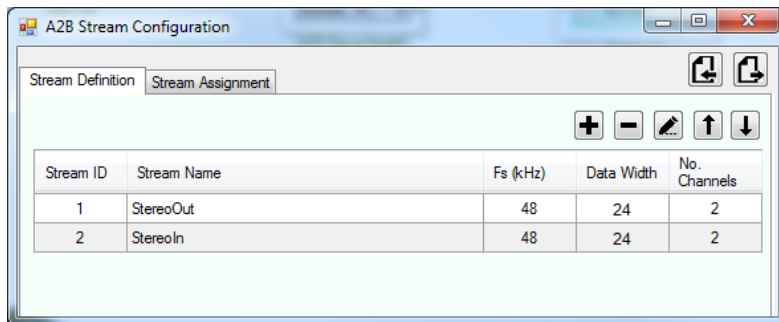


Figure 15 Stream definitions for stereo example

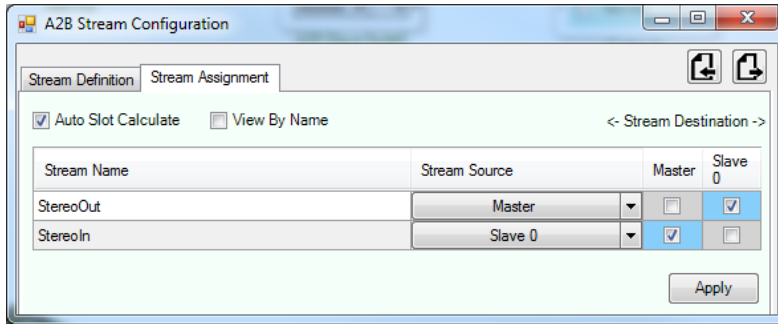


Figure 16 Stream routing for stereo example

The AB0108 module has two functions controlled by a PCA9356 GPIO port expander located at I<sup>2</sup>C address 0x41 (see Figure 17). One is a user LED (IO0) and the other (IO1) enables the SYNC signal to the AD2428, which is used to force a reset of the AD2428 in to master mode. For more on that topic please see the AD2428 Technical Reference Manual, as well as check [Clockworks Blog post](#) about some apparent differences between the documentation and how the AD2428 seems to actually behave.

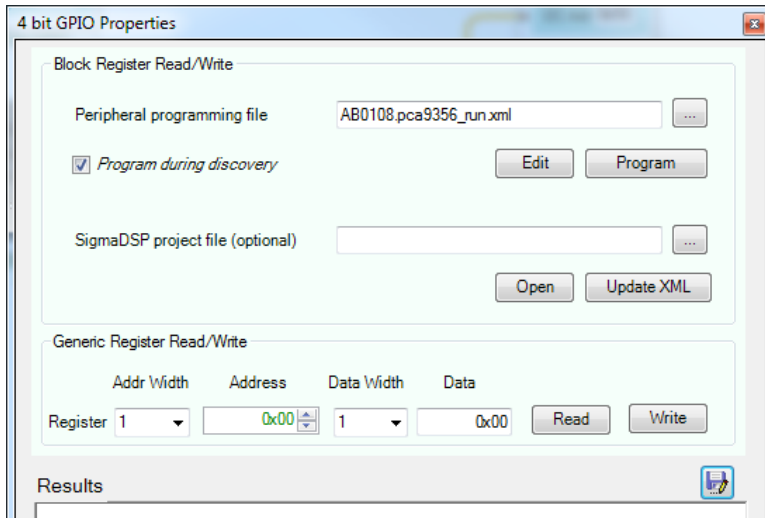


Figure 17 GPIO defaults

## 4 NEXT

This app note serves as a basic introduction to integrating the MCHStreamer in to an A<sup>2</sup>B system to provide audio I/O to a host computer. Obvious extensions are to operate at higher channel counts or enable modes where the MCHStreamer's digital audio interfaces can also be used.

## 5 ALTERNATE CABLE

If your junk drawer is lacking the things described in Section 2.1 or you've wired up the cable from miniDSP differently and now need to make the configuration described here, you can purchase the parts and make up cable as follows. These are built with precrimped wires but you could also order the terminals and wire and do the entire thing from scratch. You do need a decent crimping tool; the official Molex ones are a few hundred dollars but a generic one like the Engineer brand PA-09 and/or PA-20 work well and at \$50 are affordable. Do not waste your money on the < \$20 ones.

Clockworks may have these available for purchase as a completed cable, please contact us for more information.

### 5.1 MCH STREAMER CONNECTOR

2mm 12 position (2x6) shell: Molex 0511101260. This shell has pin one in the expected position that matches the PCB layout.

Precrimped wires can be purchased from Digikey in different colors. Note the minimum quantity of each is 10. Other suppliers may offer similar options. We used 6 colors (white is used twice) only because we left purple out of the order by mistake.

- 0503948051-06-L6 Blue
- 0503948051-06-B6 Black
- 0503948051-06-N6 Brown
- 0503948051-06-R6 Red
- 0503948051-06-W6 White
- 0503948051-06-A6 Orange

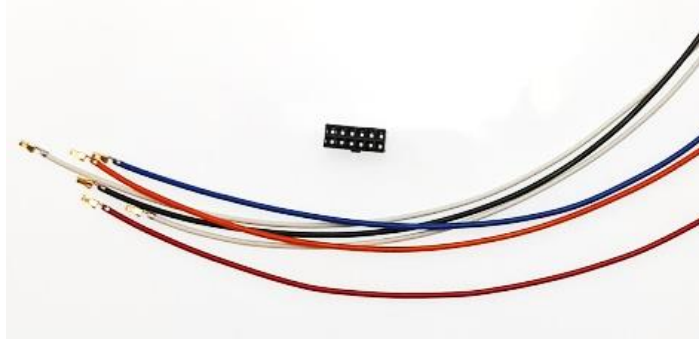


Figure 18 Typical 2mm shell and precrimped wires

## 5.2 AB0108 CONNECTION

This end uses a 0.1" header and is easier to find as that size still dominates low cost/common connector types.

The shells and precrimped wires can be purchased from Pololu in a convenient rainbow pack:

50 piece 10 color, 6" female-female ends: #1800

Crimp housing, 0.1", 12 pin (2x6): #1914



Figure 19 Typical .1" shell and precrimped wires (these are crimped both ends)



### 5.3 CABLE CONSTRUCTION

This is the same table as before where we've added the wire color used to make the example shown here. The precrimped .1" wires in this example have the connector pins on both ends so we can cut them in half and use the second half in another cable.

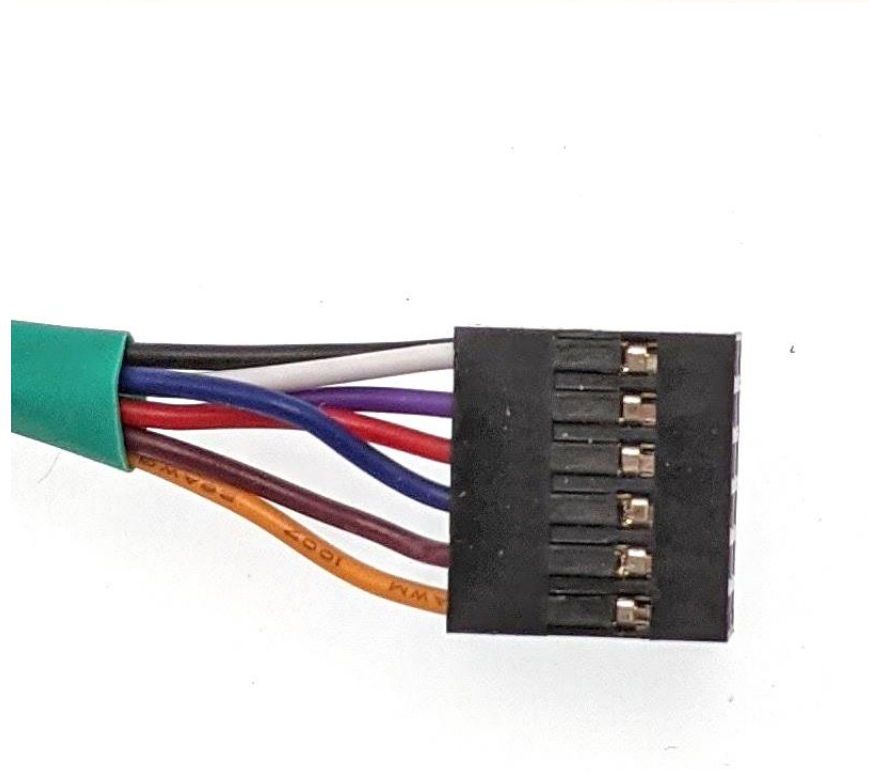
MCHStreamer pin	Signal direction	Wire Color	AB0108 pin	Name (For default <i>AllRate</i> firmware)
1	→	Brown	10	USB out ch 1&2
3	→	Orange	12	USB out ch 3&4
2	←	Red	6	USB in ch 1&2
4	←	Blue	8	USB in ch 3&4
10	→	White	2	BCLK
12	→	White/Purple	4	SYNC
11	-	Black	Any odd pin	GND

**Figure 20 I<sup>2</sup>S cable wiring chart (MCHStreamer pin # based on PCB layout, not connector shell markings) built with precrimped wires**

Pay attention to the Pin 1 orientation. It's been noted that some shells have them opposite from the normal convention. So far this has been observed in the shells that come with the MCHStreamer kit and the shells used in this example from Pololu.

Here are pictures of the completed cable:

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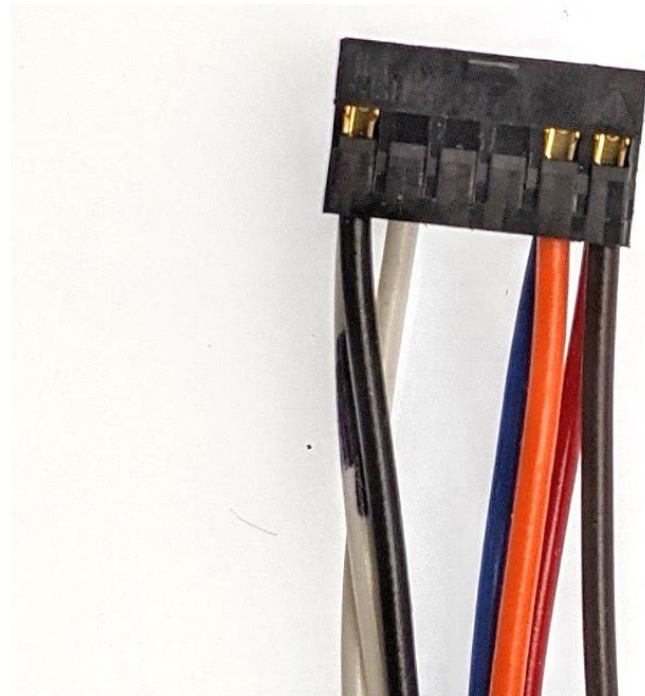


Figure 21 (a,b,c) Completed cable assembly

## 6 MCHSTREAMER TDM MODE FOR 16 CHANNELS

Details of the TDM mode can be found in the miniDSP MCHStreamer user guide. Follow the directions in that guide to install the TDM firmware. At the time this app note was written the firmware is MCHStreamer\_16i16o\_sn10\_tdm8\_v1.7\_up.bin (or sn11 to have a second device).

All of the previously described setup information described for stereo still applies. The only difference is the root node audio configuration, which should be changed to match the next figure to match the MCHStreamer timing.

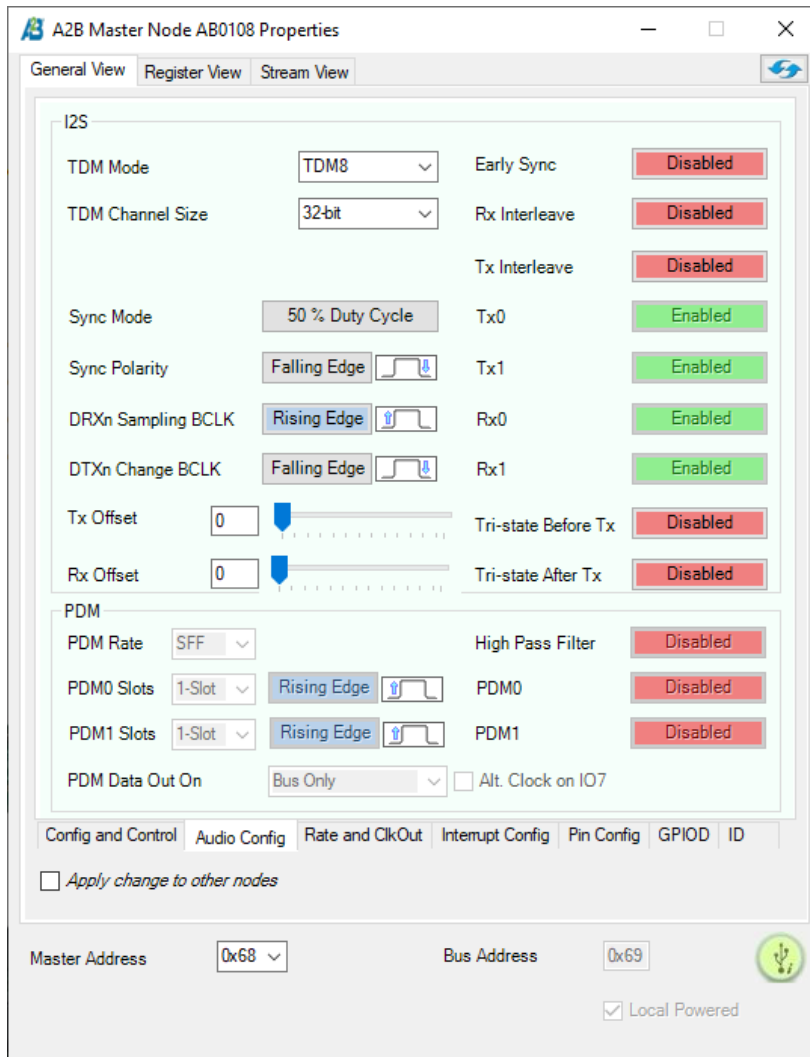


Figure 22 Root node settings for MCHStreamer TDM mode