NEW & REVIEWED

Spotlight On: DIY DSP

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e.g. 3-Way Active Crossover

Digital Sound Processing

Modern audio equaliser with advanced audio control to upgrade an existing sound system or create your own bespoke amplifier.

- ICP1 Programming board (Required) connects to a Windows PC via USB

- Download the included DSP program or create your own unique custom design

- Disconnect the programmer and the module now works independently

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As Reviewed in DIYODE

DIYODE Magazine DIY-DSP Review
Issue #40 Nov. 2020

Online: View

DSP Board Modules

The powerful Analog Devices DSP chip ADAU1701 is now available from Dayton Audio in a complete assembled board for adding Digital Signal Processing to an existing system or your new audio project.

Class-D Amplifiers DSP

A pre-assembled amplifier board or module is a great alternative to starting from scratch. Add a suitable power supply, an enclosure (if required), along with the associated controls and interconnectivity, and you're ready to go.

SigmaStudio™

Explore almost limitless possibilities of precise EQ, filters, bass processing, time alignment and so much more with the SigmaStudio development tool.

DIY Made Simple

Dayton Audio DIY range of pre-assembled boards and modules are designed to help your next project be as easy as possible. Instructions included.
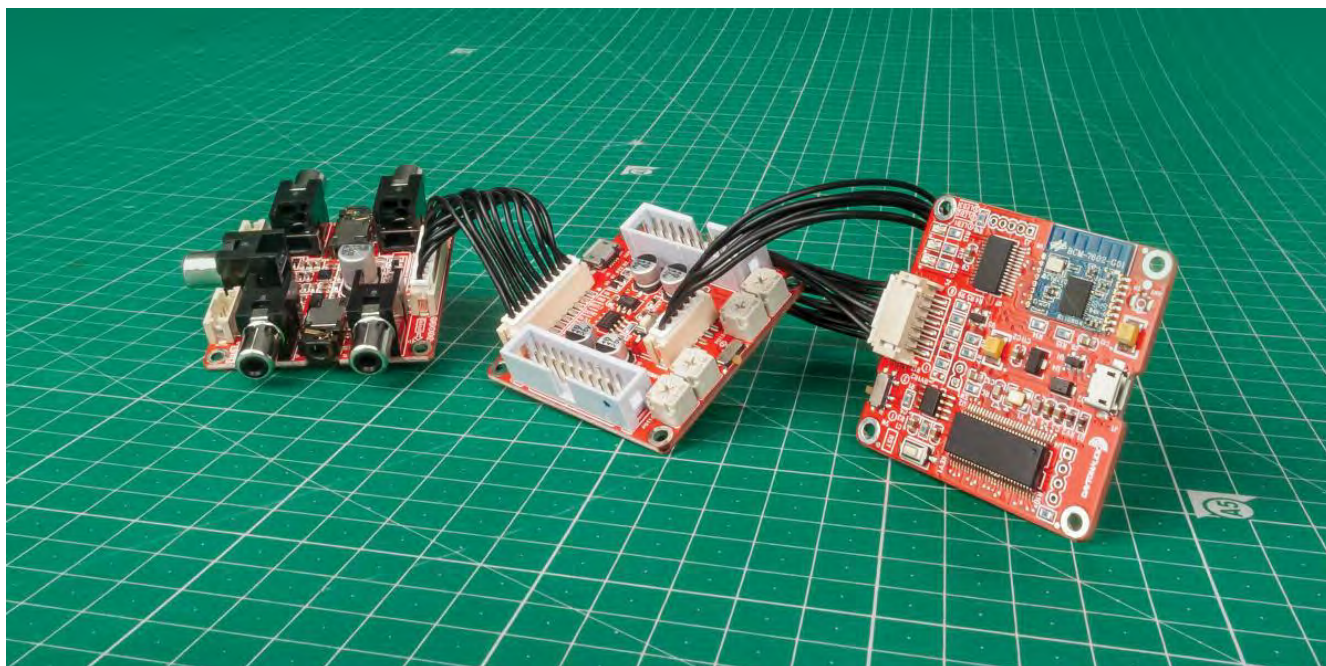
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Spotlight On: DIY DSP

High-Quality Digital Sound Processing in a project-level format from [Dayton Audio](#).

Digital Sound Processing (DSP) is something many of us would immediately think of as a production or studio task, and probably too complex for home use. However, it is something that can benefit any high-quality audio system. In analog days, many will remember using equalisers, which may have been a set of dials or a row of slider potentiometers which could adjust low, low-mid, mid-range, high-mid, and high frequencies. Some home systems even had 15-band equalisers.

In the transition to digital, often only basic software control was provided to adjust sound. Digital systems were marketed as far superior and not in need of such user control.

The reality was different, however. Most home theatre amplifiers now have much more control buried somewhere in a sub-menu.

That doesn't do much for people who still want to build their own customised audio systems. We are seeing a resurgence of high-quality components from amplifiers to speaker drivers available on the retail market.

That's where DSP comes in. DSP add-ons handle the job of signal conditioning with far more capability than was possible with manual equalisers. In addition, they can usually be plugged in to a computer for ultimate control.

Enter Dayton Audio, distributed by [Wagner Online](#). We have a trio of DSP partnered items to look at, which can be added onto Dayton Audio amplifiers or used inline with the input to other systems. The components of the set are complimentary, so we'll look at all three, but they could be used on their own if your needs are such.

THE SYSTEM

The modules we're reviewing are part of the bigger Dayton Audio system. It consists of signal processors, programmers, and a range of digital amplifiers which can be configured as active crossovers.

A traditional audio system consists of an amplifier which has, for a stereo system, a left and right channel. Some have a third channel for a subwoofer, or more for surround speakers. In any case, the amplified signal is fed to the speakers, which contain within their enclosures a network of inductors and capacitors so that the correct frequencies are sent to the tweeter, midrange, and woofer drivers of the speaker. This system has served for many years and still does.

However, with the Dayton Audio digital system, the amplifier boards can be programmed. Instead of crossovers, the enclosures have the amplifier boards mounted into them.

A 2 x 15W board, for example, would not be used as a stereo amplifier, but programmed so that one channel feeds certain frequencies to the tweeter, and one to the midrange or woofer. There are mono modules that can be added to give a third channel, so that a tweeter/midrange/woofer 3-way speaker can be constructed.

Battery power is an option for most of the range and Bluetooth is possible on some items as well. The programming can be done in a basic form by an app, or with the full range of options in Analog Devices' SigmaStudio program.
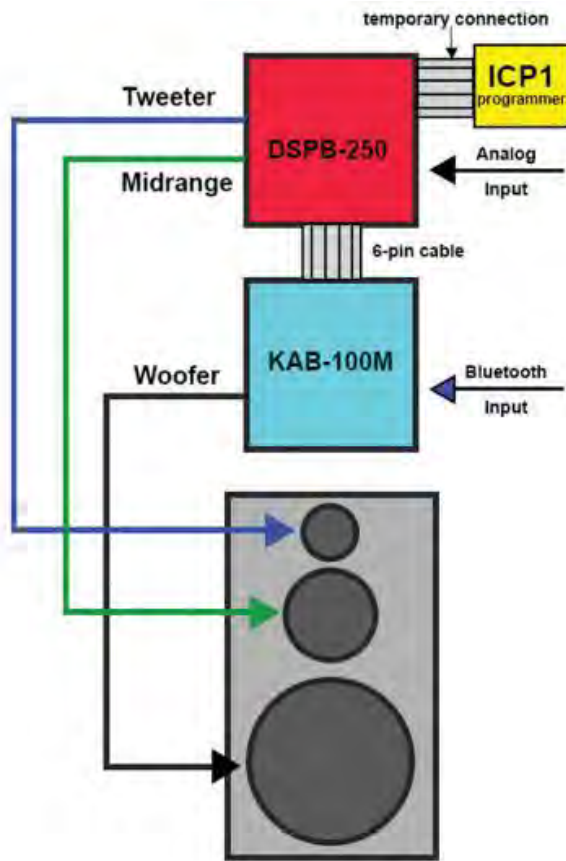
The Full Kit:

The items we received from Wagner Online are part of this system, but the Kernel Board and its Expansion Board can be used to provide DSP with a regular RCA (or 3.5mm) in/out arrangement, to a standard stereo signal. This means you can get the benefits of DSP and Sigma Studio on any amplifier, albeit without some of the possibilities of having the programmable amplifiers. The In-Circuit Programmer (ICP) works with these kits but is also used to program the amplifier boards.
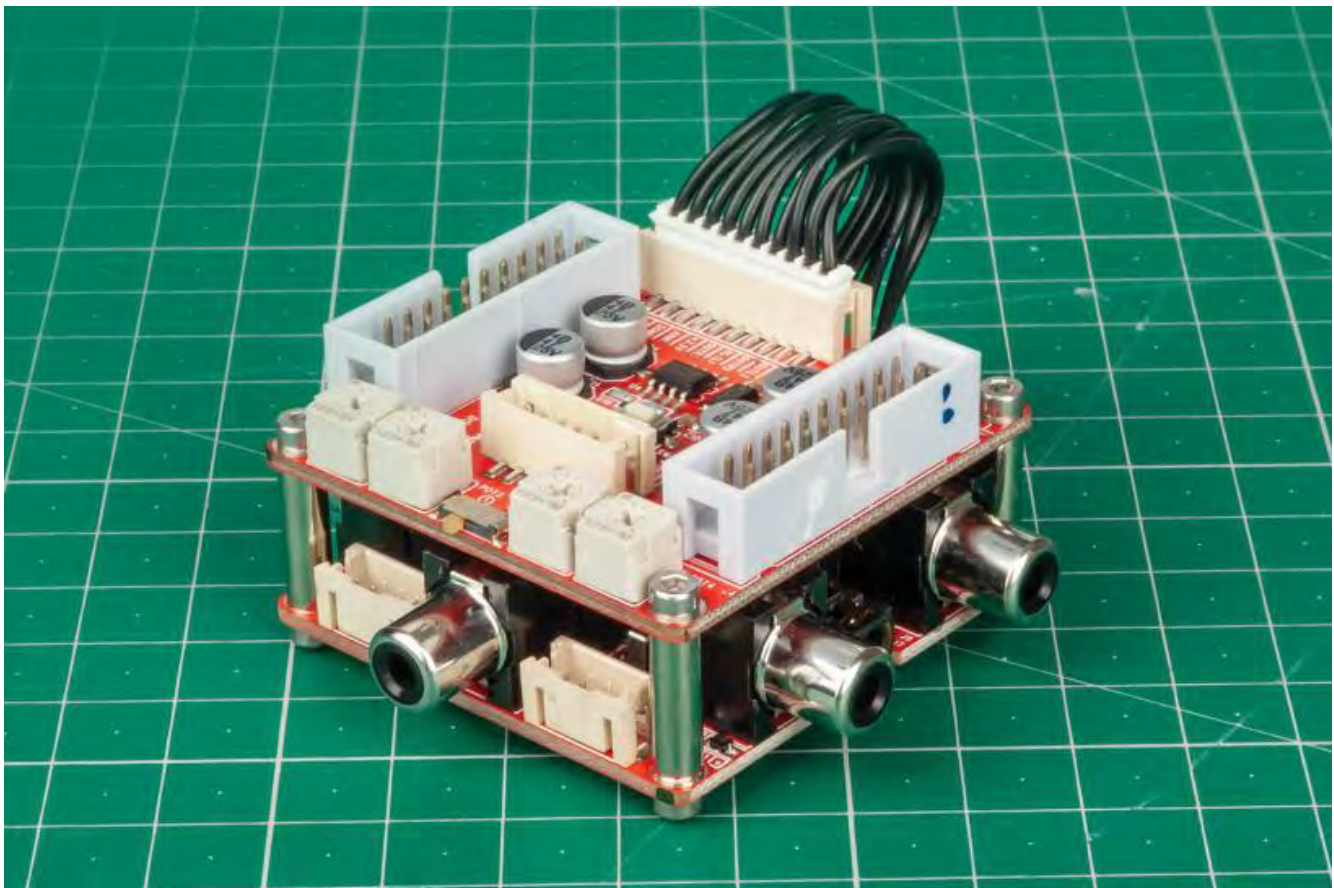
THE KERNEL BOARD

The word Kernel is well-known to many familiar with computers and coding, but its basic meaning is 'basis' or 'centre of'. It's also the soft part of a seed or nut, but if those are in your audio project, you have serious problems, and probably an ant nest.

The DSPB-K Kernel Board is the heart of this DSP set-up. It is based around Analog Devices' ADAU1701 audio processor, a popular and well-respected IC. This does most of the work, leaving the rest of the board populated by a few discrete components, some headers, and four trimpots.

The former provide connection to the ICP, Expansion Board (or amplifiers) and two 20-pin header 'control ports'. The documentation does not go into any further detail about these, there are no connectors the same style on any other board, and there are no adaptor cables in the range. They do, however, have pinout labels underneath. The trimpots provide subwoofer gain, subwoofer low pass adjustment, stereo high pass adjustment, and stereo gain.

The kernel board can be used without programming if these controls are all you need. However, it's likely that you'll want far more. There is a USB Micro-B socket on the board, but this is for power only. Programming is only possible by the ICP. There is a reset switch onboard should things hang or lock up, so you won't necessarily have to connect the ICP when things go wrong.
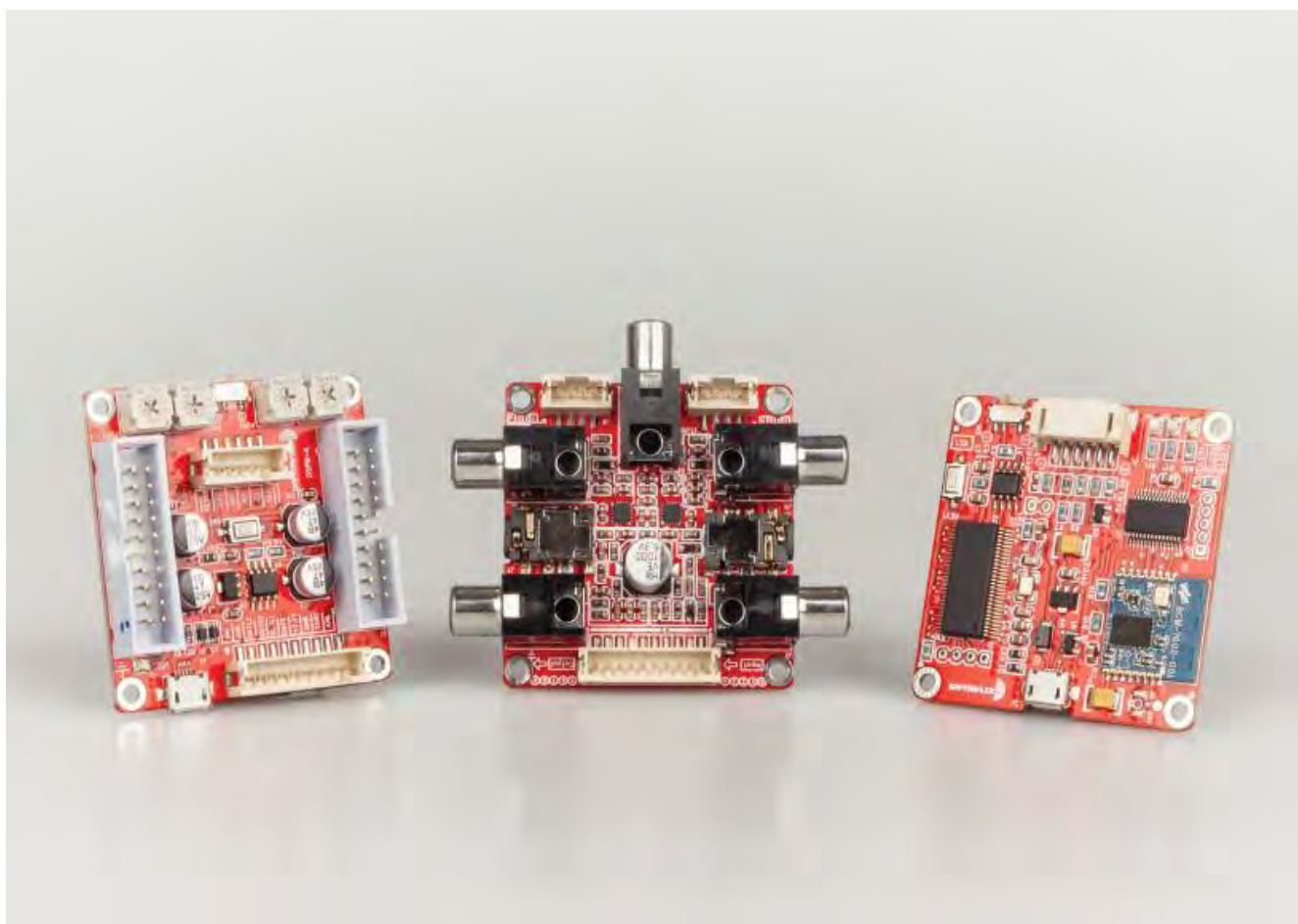
THE EXPANSION BOARD

The DSPB-KE 2-in 3-Out Kernel Expansion Board links to the kernel Board exclusively and provides inputs and outputs, but adds specific functionality as well. It consists of three headers, five RCA sockets, and two 3.5mm stereo sockets. One of the headers connects the Expansion Board to the kernel Board, while the other two are smaller and are break-outs for the same signals as the RCA and 3.5mm sockets.

Two RCAs are for Audio In Left and Right, two are for Out Left and Right, and one is for Subwoofer out. The 3.5mm sockets are for Audio In and Out. In its most basic functioning form, the Kernel and Expansion Board can function as a signal processor to take a subwoofer signal to a separate amplifier from a regular stereo source.

However, there are far more possibilities. After being appropriately programmed with the ICP and SigmaStudio, the combination of Kernel and Expansion Board can condition the passing stereo signal in any way that you can program it.

You might take out one resonant frequency that causes problems in a specific space. You might lift the bass or emphasise a range of midrange frequencies but not others, perhaps to compensate for lackluster sound processing in an otherwise impressive TV. The documentation also gives examples of how to use the combination to yield a three-way output signal - woofer, midrange, and tweeter - for separate amplification as an active crossover.

Left: Kernel Board, **Centre:** Expansion Board, **Right:** ICP Board

On the subject of documentation, we were only able to find one manual for the whole range of products and not an individual one for the items in question, which didn't help in trying to solve the above mystery of the 'control ports'.

The Expansion Board comes with a short 10-pin header cable for connecting the two boards, as well as four standoffs and eight cap screws to mount the two boards together in a very neat package. The Expansion Board is powered from the Kernel Board and cannot be powered on its own. Not that there would ever be a need to anyway.

There is a separate expansion cable pack available as a generic item that suits several products. It contains three terminated LEDs for use with the amplifier boards, as well as three-, four-, and six-pin header cables. This is the only source we can see of a cable that could be used with the Audio In/Out headers on the Expansion Board.

THE ICP

The In-Circuit Programmer is the heart of the range. This device connects to a computer via USB, but also has a Bluetooth module built in to connect to the phone app. It functions as a translator to convert the graphic, drag-and-drop style functions of the software, into language the audio processors can use.

The ICP plugs into boards via a six-pin header, and can connect to the Kernel Board as well as the range of DSPB and KAB amplifier boards. This part of the system is the true heart of the whole range, as without it, and the supporting software, the range is just a bunch of fancy amplifiers.

With it, they are powerful audio tools. All of the amplifiers can be programmed with their own crossover and cut-off characteristics among a myriad of other parameters, and the ICP is the tool that does this.

The ICP has the same footprint as the Kernel and Expansion Boards, so it could conceivably be mounted to them, but the standoffs for that are not in the range. You would need to source some M3 bolt-to-socket standoffs for that. However, you will rarely want the ICP anchored to a project, so it's really redundant. You would more likely be designing a custom 3D printed enclosure and mounting it in there.

Because SigmaStudio is a third-party product, we're not reviewing it here. That has been done and the results can be found easily enough. Or, because it's free, you can download it and play with it. Or can you? Dayton Audio's DSP Control app is available for Android and Apple phones, but the computer software? Gone are the days when Mac was for graphics and media people, and all serious work was done on PC.

Today, a great many computers today are running Mac OS software even if they are PC-based architecture. They are permeating even the traditional industrial and commercial territories owned by Linux-based PCs. Yet SigmaStudio, distributed by Analog devices, is available for PC only. Why?

The answer lies in the fact that it is built on Microsoft's Dot Net framework. This was likely a good and efficient design decision at the time, but times change fast and the Dot Net framework cannot be easily ported to Linux or Mac. This means that to support these platforms, Analog Devices will have to start from scratch, and that's a

very expensive, time-consuming exercise that will no doubt be dictated by sales volumes and demand.

WHAT DO WE THINK?

The Kernel and Expansion Boards are a versatile tool to adapt to many situation-specific audio circumstances and needs.They are very well built and presented, and quite user-friendly.

While the concept of active crossover has adherents and detractors, the signal conditioning aspects of the system are very useful, especially among modern consumer amplifiers which make so many assumptions and offer little customisation.

If you do want to control or enhance the sound in an existing amplifier and if you're not an audio engineer (or even if you are), or need a subwoofer output where there is currently none, then the Dayton Audio range from Wagner Online is very worthwhile.

We'll definitely be using these in a future project. Very high quality kit with some amazing potential.

DSPB Series User Manual

Table of Contents

1. What types of projects can be achieved with the DSPB series? What do I need to get started?

Each example project in section 3 has a required items list to achieve each project, but this section summarizes this information into one section.

A. DSPB Amplifiers Buying Guide / Examples

The thoughtful design of the DSPB series of amplifiers is that they will work together with the existing KAB line of amplifiers. The synergy of this relationship allows you to add Bluetooth to your DSPB, and DSP to your KAB. Depending on your design goals, you will need different items from the DSPB line and the KAB line to achieve those goals. The DSPB-250 is 2x50 watts, and the DSPB-100 is 1x100 watts.

The table below summarizes the different configurations that are possible with the DSPB amplifier and KAB amplifier line. Look for the type of configuration you want on the leftmost column, and then look to see which items you can use to achieve this in the following columns. There is available an example SigmaStudio project for each configuration. Note that you will need only 1 DSPB-ICP1 programmer board to program any number of amplifiers or preamps from the DSPB series. It can be thought of like the bridge between the DSPB amp/preamp and the computer. It will also require a Windows PC so you can use SigmaStudio. See the examples sections for more specifics about how these devices need to be programmed to achieve this.

Configuration	DSPB	KAB	DSP	Bluetooth	Examples
0.1	DSPB-100		✓		Powered Subwoofer with custom DSP
1.0	DSPB-100		✓		Mono Speaker with custom DSP
1.0		KAB-100M		✓	Mono Bluetooth Speaker
2.0	DSPB-250		✓		Mono 2-Way Speaker w/ active x-overs, Stereo 1-Way Speaker w/ DSP
2.0		KAB-250v3		✓	Stereo Bluetooth Speaker
2.0*	DSPB-100	KAB-100M	✓	✓	High Power Stereo Speaker w DSP and Bluetooth
2.1*	DSPB-100	KAB-250v3	✓	✓	Stereo Speaker w/ bluetooth, DSP and subwoofer **OR** 3-way speaker w/ active crossovers
2.1*	DSPB-250	KAB-100M	✓	✓	Stereo Speaker w/ bluetooth, DSP and subwoofer **OR** 3-way speaker w/ active crossovers
4.0*	DSPB-250	KAB-250v3	✓	✓	2-Way Stereo Speakers w/ active x-over, DSP and bluetooth

Note 1: * If a configuration requires both a DSPB amplifier and a KAB amplifier, the DSPB-EC Expansion Cables (part # 325-129) are required to make the proper connections, as outlined in section 2.C "Combining a DSPB Amplifier with a KAB Amplifier"

Note 2: This table uses KAB-100M and KAB-250v3 as examples of mono and stereo KAB boards, but previous and lower power versions of the KAB line are compatible with the DSPB series as well.

Note 3: See the examples section once you decide on a configuration. This will have more information about optional items you might want for specific scenarios.

Note 4: about 3-Way Amplified System with DSPB and KAB amplifiers

If you want to create a 3-way pair of speakers with all active crossovers and built in amplification, it is possible with the combination of DSPB and KAB amplifiers and programming within SigmaStudio. To create a powered, 3-way mono speaker, an example shopping list would be the following.

- DSPB-250 – Using 1 per 3-way speaker, these boards will power your tweeter and mid-woofer and also house the DSP to achieve the active 3-way crossover
- KAB-100M – Using 1 per 3-way speaker, these boards will power your woofer, and will receive its DSP / crossover from the DSPB-250.
- DSPB-ICP1 – This is the programmer board that acts as the bridge between your DSPB-250 and the computer, allowing you to program your device with SigmaStudio (more details in the following sections)
- DSPB-EC expansion cables – These cables are necessary to connect the DSPB-250 and KAB-100M together.

If you wish to create a <u>pair</u> of 3-way speakers with this setup, it is possible by purchasing an additional DSPB-250 and KAB-100M (you would need only 1 DSPB-ICP1), but note that you would not be able to utilize the bluetooth of the KAB boards as your input unless your source device is capable of streaming to multiple Bluetooth devices at the same time. Otherwise, you would need to split your analog input source. A more detailed guide can be found in the examples section.

B. DSPB-K/KE preamp with DSP Buying Guide / Examples

The combination of the DSPB-K with the DSP-KE adds the connections necessary to create a 2 in, 3 out DSP preamp system. This means that there are many possibilities for how to use them, which are listed in the table below. It is recommended to purchase the DSPB-KE along with the DSPB-K. It is possible to utilize the DSPB-K standalone, but Dayton Audio does not officially support means of making audio in/out connections without the DSPB-KE.

The DSP-K is preconfigured to have basic filter adjustments available with the on-board potentiometers, but to achieve more functions, a Dayton Audio DSPB-ICP1 is required along with a Windows PC, so Analog Devices' SigmaStudio software can be run to program the DSPB-K.

The table below shows the example configurations that the DSPB-K/KE can achieve. Project examples and programming advice/ instructions are found further in this document.

| Configuration	Examples
0.1	Add DSP to a powered subwoofer
1.0	Add DSP to a mono speaker / amplifier
2.0	Add DSP to a stereo amplifier
2.1	Add DSP and a subwoofer output to a stereo amplifier
3.0	Create a 3-way crossover using all DSP and no passive components

2. Quick Start Guides

The Dayton Audio DSPB series of boards leverages the powerful Analog Devices ADAU1701 DSP chip to allow for almost limitless possibilities for sound customization. Out of the box, a DSPB-100/250 or a DSPB-K will allow for quick adjustments with the convenient built in potentiometers, but to unlock the full potential of the ADAU1701 processor, combine your board with a Dayton Audio DSPB-ICP1 to connect directly to the SigmaStudio development tool provided by Analog Devices.

A. Before you start

1. Review the wiring diagrams found at the end of this document or on the product page for each device before using this quick start guide. Refer to these diagrams as you're following the quick start guides.
2. Review the "What do I need to purchase?" guide above to make sure you have everything needed to achieve your design goals.
3. Make sure that any speakers and input devices you plan on connecting to the DSPB are working properly.
4. If planning to use SigmaStudio to use the full potential of the DSP, make sure you have purchased at least one DSPB-ICP1, a micro USB cable capable of data transfer (some cables included with devices that use a micro USB port for power are power only, and do not connect the pins necessary for data transfer!), and make sure you have a Windows PC available to use the free SigmaStudio software.
5. Take care when attaching and especially removing jumper cables from the DSPB.
    a. A damaged cable can cause issues that are difficult to troubleshoot, such as noises like popping or clicking. A damaged cable can also cause programming issues.
6. To achieve increased power from a DSPB amplifier, try increasing the input volume before increasing the gain of the amp to max levels. This will generally result in a better response from the amp.
    a. For example, increase the volume of an attached mp3 player before adjusting the potentiometer on the board to increase output volume.
7. Note that there is a 'tips and troubleshooting' section at the bottom of this document.

B. DSPB-250 / DSPB-100 - Quick Start
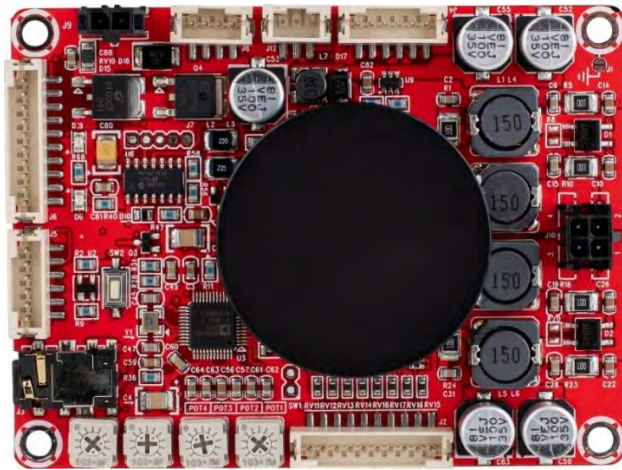
1. Connect the included 3.5mm jack to port J6 for audio input.
   a. Note – J3, the 3.5mm jack on the board, is **NOT** for audio input.

2. Connect speakers to J10 according to the wiring diagram or by following the labels on the back side of the board. This will be different for the DSP-250 vs. the DSPB-100.
   a. If using a DSPB-100 (mono), it is recommended to bridge the two positive wires together as well as the negative wires so they function like a thicker wire.
3. Connect power through either J9 if using a power adapter or use J8 if using a battery board.
   a. It is recommended to use a power supply of at least 12V but less than or equal to 24V.
4. Audio should now play if the above connections are made correctly.
   a. Troubleshooting
      i. Check the included 3.5mm jack is connected to the correct pins of J6.
      ii. Check the position of the on board potentiometers that affect gain and high pass filters.
      iii. Check that your audio source is functioning correctly.
      iv. Check the speaker connections match the corresponding diagram. There is a different diagram for the 250 (stereo) vs the 100 (mono).
      v. If you attached an ICP1, detach it and do a power cycle.
5. Adjusting the potentiometers on the board labelled POT1-4 will allow quick adjustments without any programming. See the potentiometers section (part E) for more details.
6. Once the basic connection is working, the DSPB is ready to be integrated into your project. Further customization can be done by using the methods below.
   a. App connection with the ICP1 for basic EQ or high and low pass filter adjustment
   b. Sigma Studio connection with the ICP1 for nearly infinite custom DSP possibilities.
   i. See the sample project files at the Parts Express Product page for your device.

c. Connection of a DSPB-250 or DSPB-100 with a Dayton Audio KAB board to utilize all 4 DSP outputs of the Analog Devices ADAU1701 processor. An example of this configuration is detailed in the Active 2-way guide below.

C. Combining a DSPB Amplifier with a KAB Amplifier – Quick Start

This section assumes you have already read the Quick Start guide for the DSPB-250/100 which is directly previous to this section.

1) **How to Power the Amplifiers**

   a) The easiest method is to parallel the power connectors that come with all DSPB and KAB amplifiers (physically tie the red wire for each connector together, and the same with the black wire), and wire them to a single DC power jack (while observing the proper polarity that your power supply requires).

       i) Alternatively, the end connector of a 12-24V power supply can be cut off and the red and black wires of the wiring harness' can be connected directly to the power supplies positive and negative wires. You might find this method to be useful during testing, if you want to quickly get them powered and are without a bench power supply, but likely not for a finished product.

   b) For battery power, it is recommended to use the KAB-BE battery board, connected to the KAB and DSPB in the way the diagram shows below. Note that J9, J10, and J11 all serve the same function on the KAB-BE, so you can connect your KAB or DSPB to any of these ports.

       i) NOTE: Only the KAB amplifier can charge the KAB-BE (through J3 on the KAB). The DSPB will not be able to charge the KAB-BE.
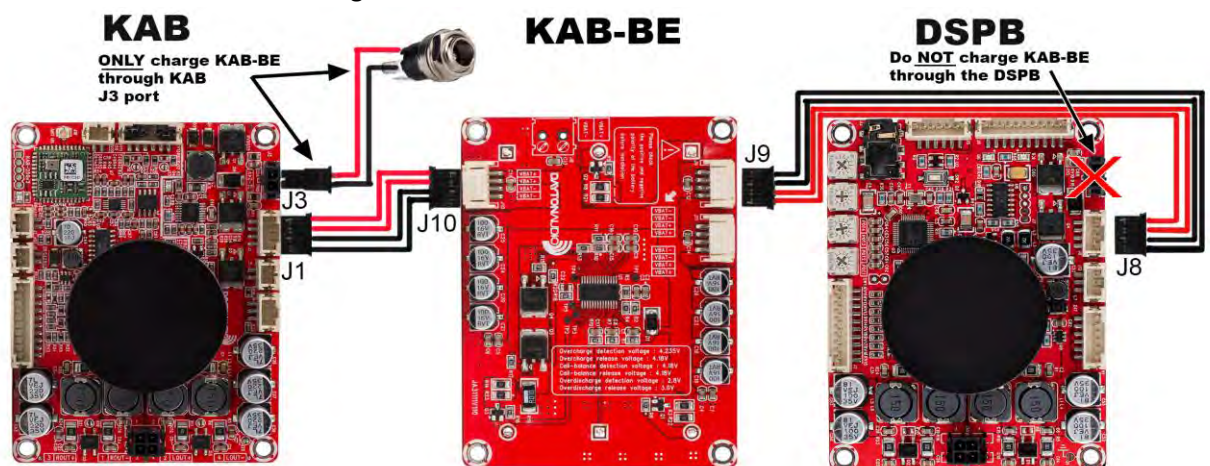
2) **Sharing Audio Between the Boards**

1. Connect J5 on the DSPB amplifier to J11 on KAB amplifier with a 6 pin cable (this connection shares the audio back and forth between the boards). (See the image below)

2. This connection allows for the following

   a. Bluetooth can be used as an input for the DSPB amplifier

   b. The KAB amplifier's powered outputs can receive processed signals from the DSPB, even when using Bluetooth as a source.

   c. The end result of this connection is up to 4 channels of individually processed audio. For an example of how to do this processing, see example 2.E or 2.F in the Sigma Studio Examples section for how to utilize the 4 channels of DSP, or simply use the built-on potentiometers to make basic adjustments without SigmaStudio.
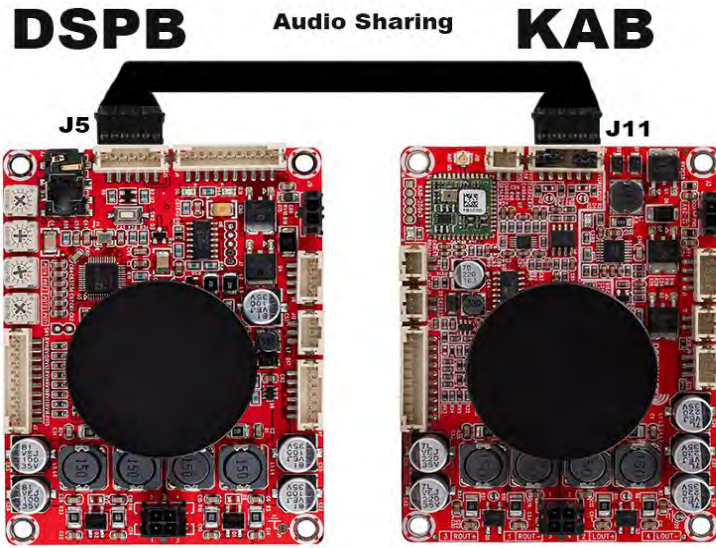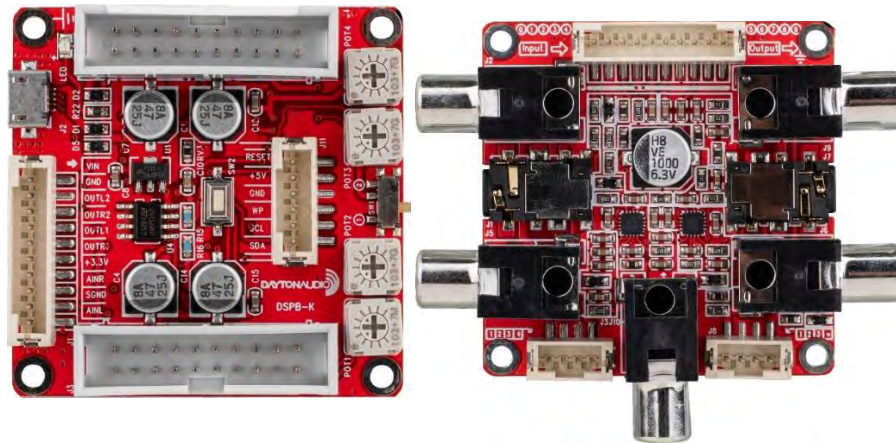
3) Switch Control

The following 3-pin connection is critical to make when using these boards together, because otherwise there will be a pop sound out of your speakers every few minutes. This connection prevents that.
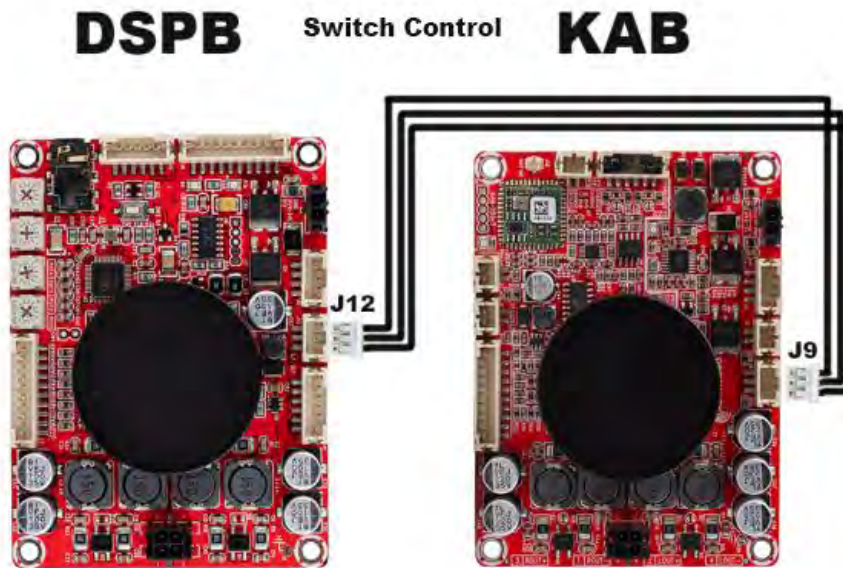
D. DSPB - K / DSPB - KE - Quick Start

1. Provide power to the micro-usb jack (J2)

   a. Note – the on board micro-usb jack will **not** provide access to Sigma Studio if hooked up to a computer (but it can provide the DSPB-K power), an ICP1 is required for programming with SigmaStudio or app control.

2. If using a DSPB-KE, using the provided 10 pin cable, connect J1 of the DSPB-K to J4 of the DSPB-KE.

   a. Follow the wiring diagram to make the desired input and output connections to the DSPB-KE. There are many possibilities for connections, including 3.5mm, RCA, and headers. Each port is clearly labelled on the bottom of the board for easy connection.

   If not using the DSPB-KE, a custom solution will be required to get input and output from the DSPB-K. All inputs and outputs are exposed through the J2 header, and each pin has a clear label on the board under this header.

3. Set the switch on the DSPB-K to '1' for playback mode.

4. If all of the correct connections are made and power is connected, the device should be functioning. If not –

   a. Press the reset button on the DSPB-K.
   b. Check the position of the potentiometers.
   c. Check that your output device is functioning correctly.
   d. Check the connection between the DSPB-K and DSPB-KE is secure on each board.
   e. Check the 10 pin cable that connects the DSPB-K to the DSPB-KE
   f. Check that your input device is functioning correctly
   g. Check that the switch on the DSP-K is set to '1'.

5. Adjusting the potentiometers on the board labelled POT1-4 will allow quick adjustments without any programming.

   a. POT1 – Subwoofer Gain Control (this affects the output from J10 of the DSPB-KE, the sub out port)
   b. POT2 – Subwoofer Low Pass Frequency Adjustment
   c. POT3 – Stereo High Pass Frequency Adjustment
   d. POT4 – Stereo Gain Control

6. Once the basic connection is working, the DSPB is ready to be integrated into your project. Further customization can be done by using the methods below.
    a. App connection with the ICP1 for basic EQ or high and low pass filter adjustment
    b. Sigma Studio connection with the ICP1 for nearly infinite, custom DSP possibilities.
        i. There are sample project files available on the product pages for the devices. See the SigmaStudio examples section of this document for further explanation.
    c. Connection of a DSPB-250 or DSPB-100 with a Dayton Audio KAB board to utilize all 4 DSP outputs of the Analog Devices ADAU1701 processor. An example of this configuration is detailed in the Active 2-way guide.

E. Potentiometer Controls

The following table puts all of the default potentiometer controls into one location. Note that these controls are only guaranteed to be valid if Sigma Studio has not been connected to the DSPB. If you program your DSPB with your own program, the potentiometers will work based on how you assigned them in your project.

	DSPB-250 / DSPB-100 (High Pass Filter Control)	DSPB-100	DSPB-K (Band Pass Filter Control)
POT1	Gain Control – J3 & J5	Gain Control -J3 & J5	Sub Gain
POT2	High Pass Filter Control - J3&J5	Band Pass Control – J3&J5	Sub Low Pass Adjustment
POT3	High Pass Filter Control for Speaker Output – J10	Band Pass Filter Control for Speaker Output – J10	Stereo High Pass Adjustment
POT4	Master Gain Control – J10, J5, J3	Master Gain Control – J3, J5, J10	Stereo Gain

All filters are second order butterworth filters.

| Device	Function	Frequency Range
DSPB-250	High Pass Filter (J10)	250-2kHz
DSPB-100	Band Pass Filter (J10)	(See Graph Below)
DSPB-K	High Pass Filter (OUTR, OUTL)	60-120 Hz
DSPB-K	Low Pass Filter (SUB)	200-400 Hz
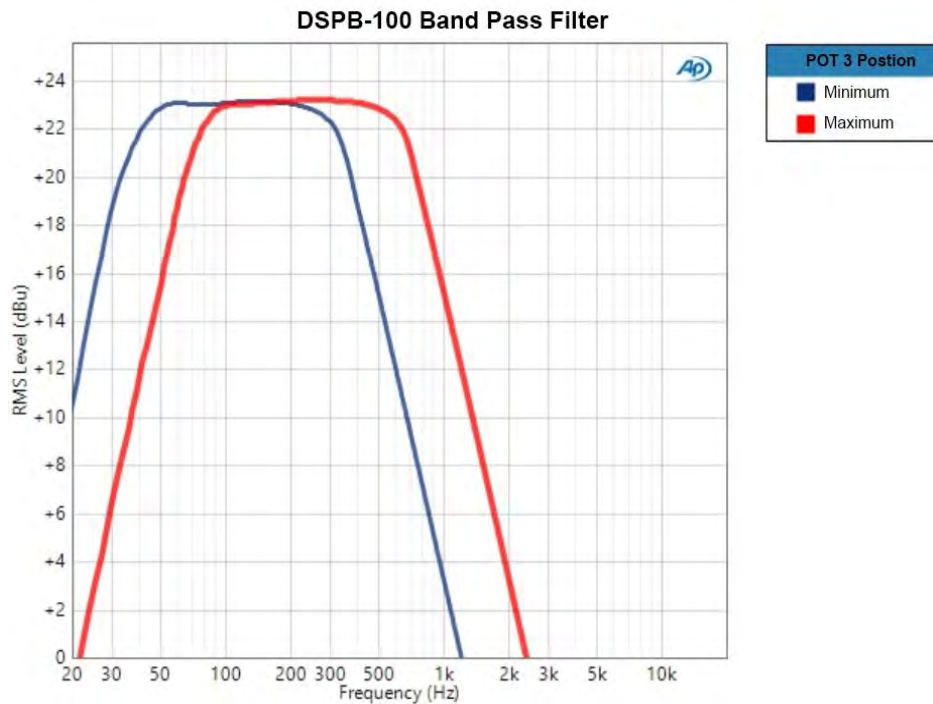
## F. DSPB-ICP1 Sigma Studio Connection - Quick Start

Note: Sigma Studio connection requires a Windows PC. This guide requires a basic knowledge of computer operation, but it is not overly complex if the directions are closely followed.

1. Download and install the most recent version of SigmaStudio to your system
2. Make sure your ICP1 is disconnected from USB and from your DSPB before starting, to ensure the proper steps are taken.
3. Open an example project from parts-express.com on any of the DSPB series product pages, or use the following steps to setup the 'hardware configuration' menu in SigmaStudio. If using an example project, skip to step 6 after opening it in Sigma Studio with File > Open.
4. Find the "USBi" block in the Communication Channels section of the tree toolbox and drag it in to the white space like shown below.
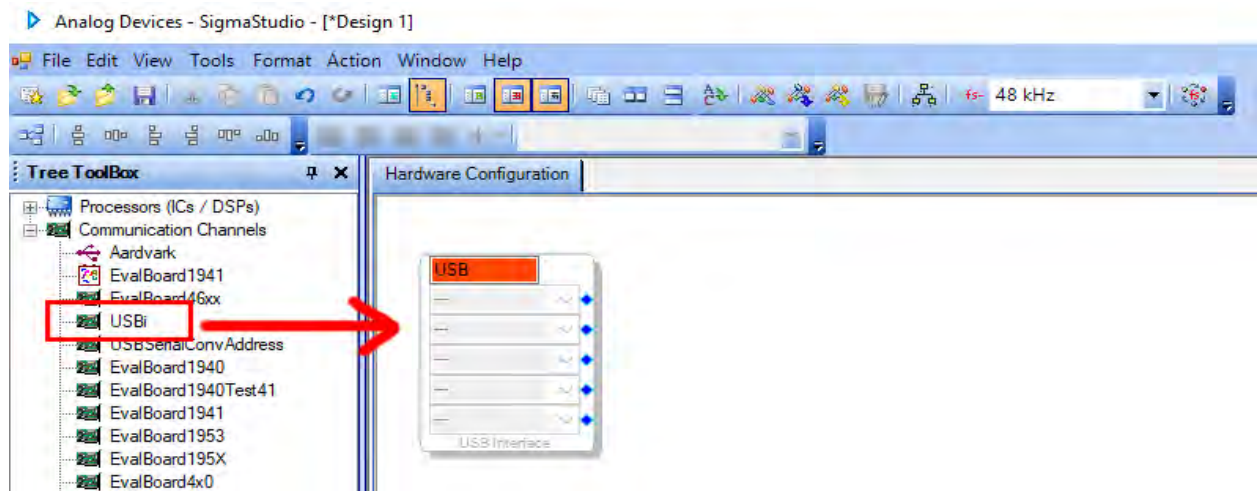

5. Find the ADAU1701 and E2Prom blocks in the "Processors (ICs / DSPs)" section of the tree toolbox and drag them into the white space like shown below. Then make the connections to the USB block. The I2C addresses in the USB block will automatically populate correctly, there is no need to change them.
   a. Note: In this image below, the "USB Interface" represents your ICP1, the ADAU1701 is the processor on your DSPB, and E2Prom is non-volatile memory on the DSPB that programs ultimately will be written to.
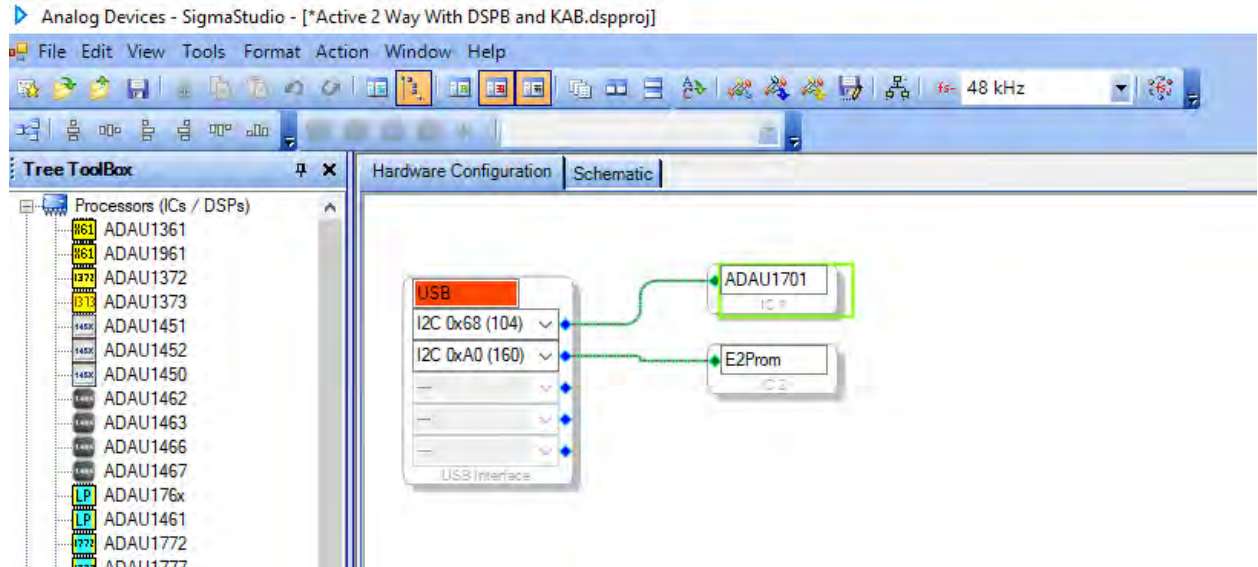
6. Ensure that your ICP1 is **not** yet connected to the DSPB, and ensure that its switch is set to '1'.
7. Plug a micro USB cable into the PC running SigmaStudio, and then connect the cable to your ICP1.
    a. Note: If the connection below is not successful, it is imperative to try a different USB cable. Many micro USB cables endure a lot of abuse from charging devices, and although they might still provide power, they might have issues transferring data. Some micro USB cables struggle to ever work properly with data at all.
8. If all is correct, you will see the USB block turn green, like below.
    a. Note that this means that SigmaStudio recognises your ICP1, it does not indicate that SigmaStudio recognises your DSPB.
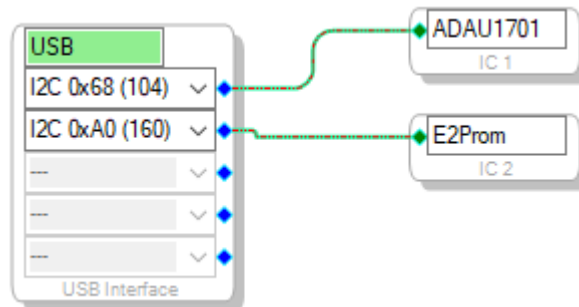

9. If not already, make sure your DSPB is connected to its own power source. If the ICP1 is plugged into the DSPB, but your DSPB does not have its own power, it will light up LEDs on the DSPB (making it look like it is powered), but it will fail to program and function.
10. Once the USB block is green, plug the 6-pin connector on the ICP1 to the 6-pin programming port on the DSPB (J8 for DSPB-100 or DSPB-250, J11 for DSPB-K). Your ICP1 will come with this cable.
11. Following these steps, you should be ready to create custom configurations for your DSPB.
12. If using a completely new SigmaStudio project, usage of the potentiometers on the board requires additional configuration. If using a sample project from Dayton Audio, this should already be configured, but is worth checking anyway.

a. Enter the "hardware configuration tab". This is where you will see the green USB block like above.
b. Towards the bottom of your screen, select the "IC 1 – 170x\140x Register Control" Tab
c. Configure the section labelled with the red box in the image below as the image shows. Without this step, the potentiometers will not work.

The DAC assignment table below is also elsewhere in this document, but will be useful if you intend to create your own SigmaStudio project or modify a sample project.

<div align="center">DAC Assignment Table</div>

	DSPB-250	DSPB-100	DSPB-KE
DAC0	J10	J10	OUTR
DAC1	J10		OUTL
DAC2	J3 or J5	J3 or J5	N/A
DAC3	J3 or J5	J3 or J5	SUB
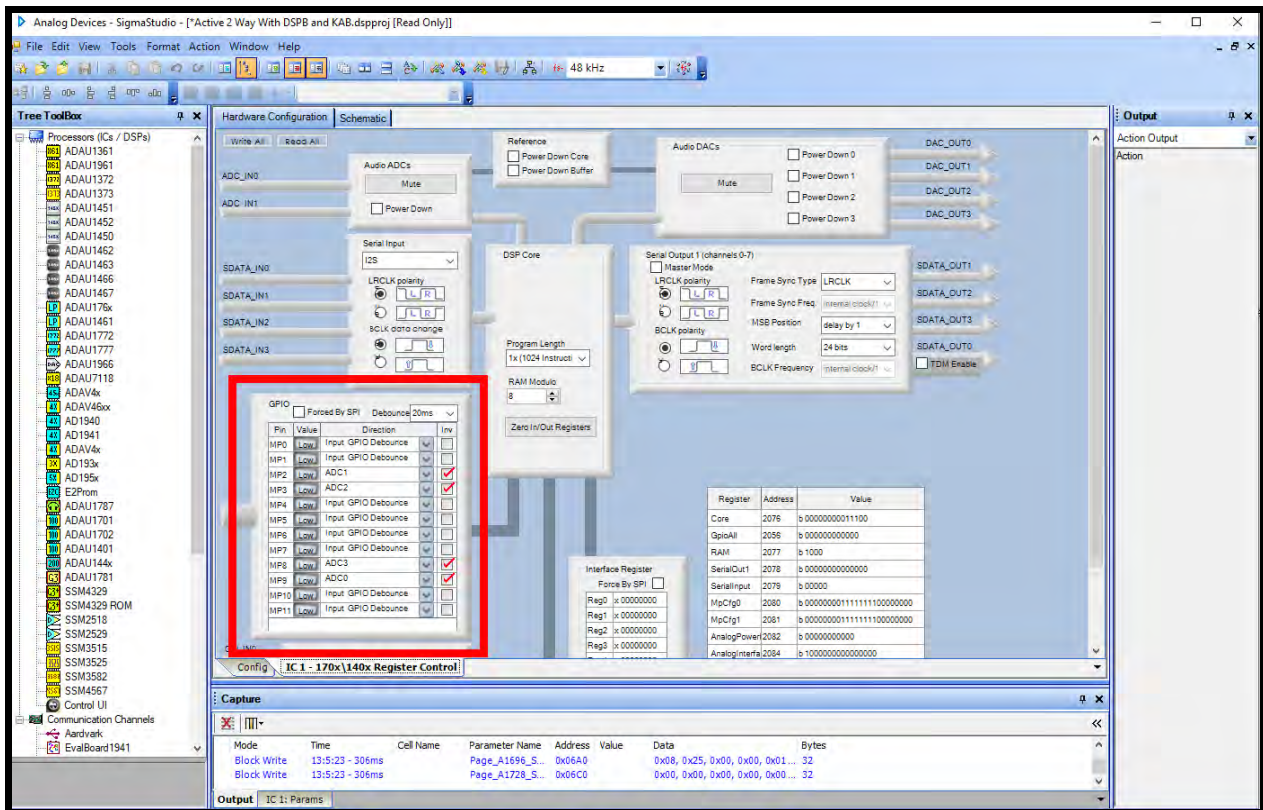
3. Project examples using SigmaStudio

Warning: The PEQ filter used in the following project examples has a bug that can cause damage to your tweeters or small speakers. To avoid this bug, do not add new bands of EQ while your DSPB is connected. If you must add new bands, disconnect your DSPB first! If you add a new band while programming, it will cause a very loud sound until you reprogram the device. This filter block otherwise works fine and is safe for your speakers. This only applies to the


"PEQ" block.

## A. Creating a basic SigmaStudio project for any product from the DSPB series.

This is the tutorial to follow if you want to learn how to start from scratch building a SigmaStudio project. If you would like to start out with a premade project, see the following sections for examples of premade projects.

The simplest project you could create in Sigma Studio is a project that directly routs the inputs to the outputs, but in this brief tutorial we will also add a master gain control. Please follow the ICP1 SigmaStudio connection guide and quick start guide for your specific DSPB (found in the previous section) before following these instructions.

1. Enter the "schematic" tab near the top of the screen. This is assuming your hardware configuration is already complete from the ICP1 connection to SigmaStudio guide.
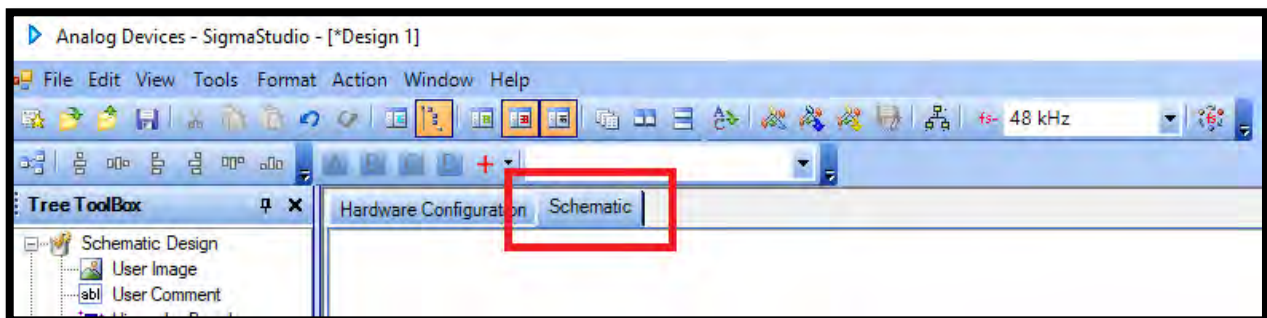

2. Find "Input" and "Output" under the IO folder in the Tree Toolbox ion the left side of your screen. Drag 1 input and 2 outputs to the whitespace in the schematic tab.
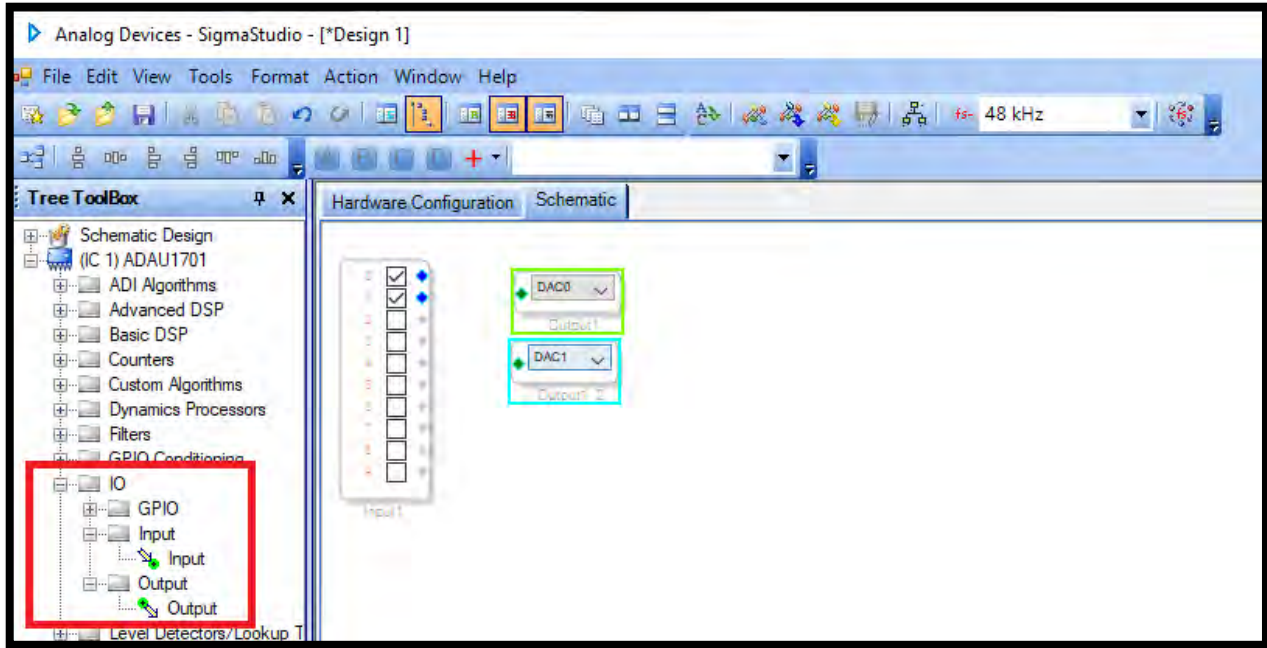
DAC Assignment Table

	DSPB-250	DSPB-100	DSPB-KE
DAC0	J10	J10	OUTR
DAC1	J10		OUTL
DAC2	J3 or J5	J3 or J5	N/A
DAC3	J3 or J5	J3 or J5	SUB

3. It is recommended to add hardware-controlled gain on any project. There are multiple types of volume controls, but for this tutorial we will use a control that can be controlled with one of the onboard potentiometers. From the tree toolbox, find "Single slew ext vol" under Volume Controls > Adjustable Gain > Ext Control > Clickless SW Slew. Drag this item into the schematic whitespace.
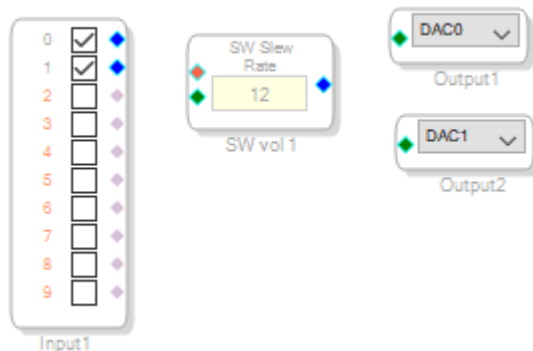
4. Right click the SW vol 1 control, and grow the algorithm by 1 like shown below. This will allow us to pass both input 0 and input 1 through the same volume control by adding an additional input and output.
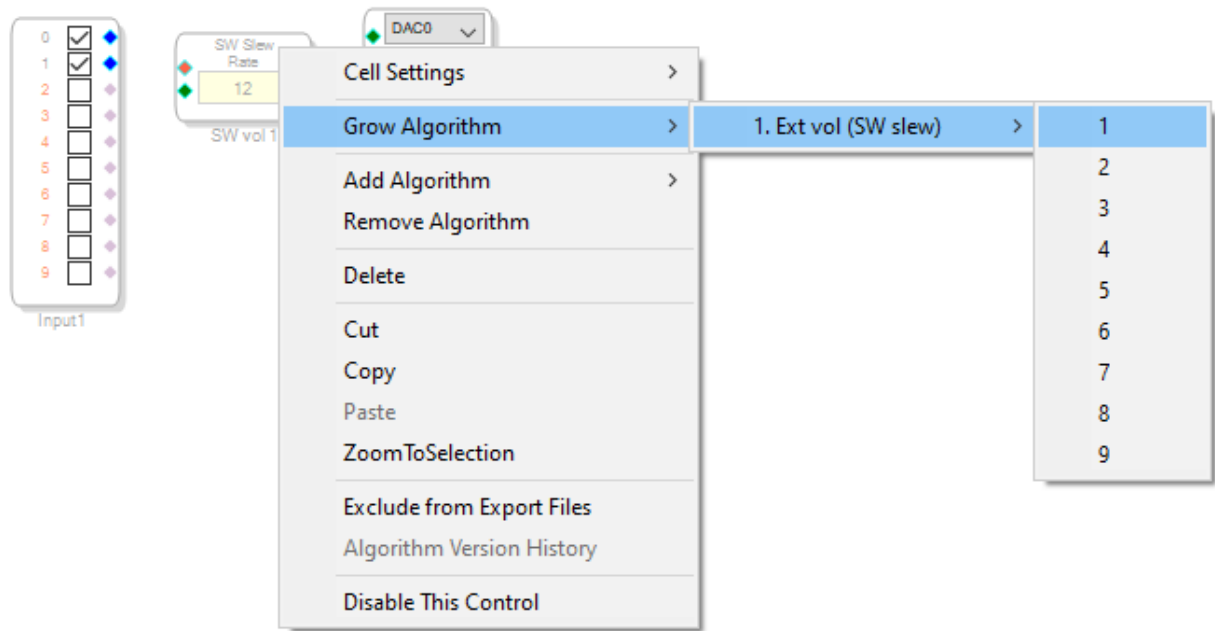
5. Find "Auxiliary ADC Input" in the tree toolbox under IO>GPIO>Input. Drag this control into the project, and then connect everything together as shown below.
   a. Note: If you have not followed the exact steps of the ICP1 SigmaStudio connection guide, your potentiometers might not work, as they require additional configuration.
   b. Note: We are using AUX_ADC_0 for this, which corresponds to POT1, but any POT could be used using the drop down menu for the ADC block.
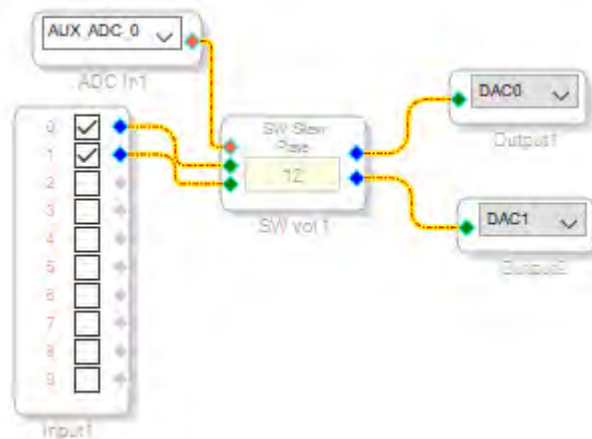
6. It is now time to test the program. Press the "Link Compile Download" button shown below.
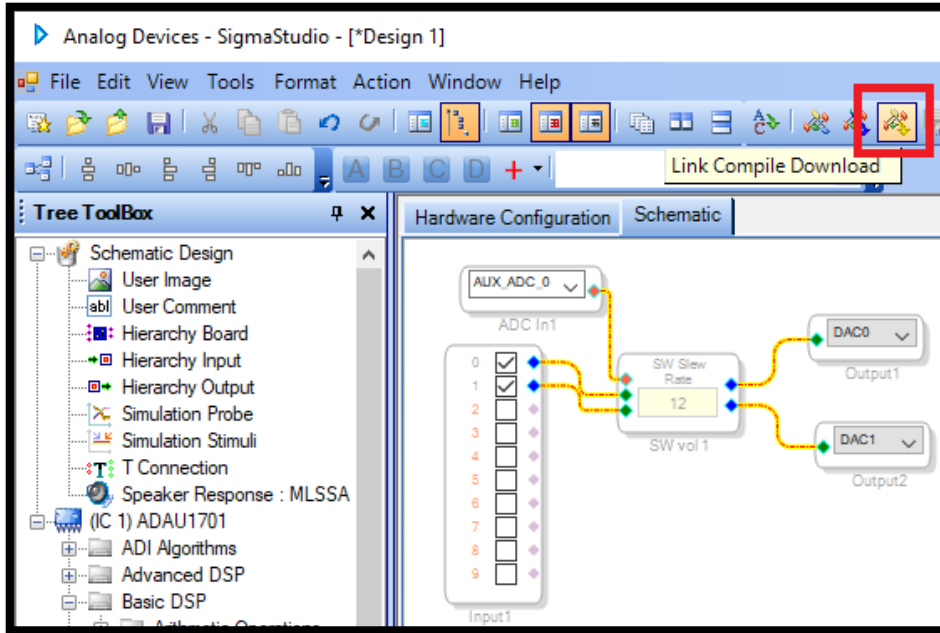
7. If everything has been done correctly, you will see "Active: Downloaded" in the bottom right corner of your window.

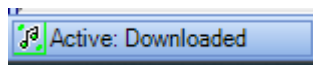8. If the error message below is seen, please refollow the ICP1 SigmaStudio Connection Guide section and ensure that all steps have been followed in the proper order. This message can occur by connecting the USB cable and 6 pin programming connector to the DSPB in the wrong order. If refollowing that guide does not fix the error, see the troubleshooting section at the end of the document.
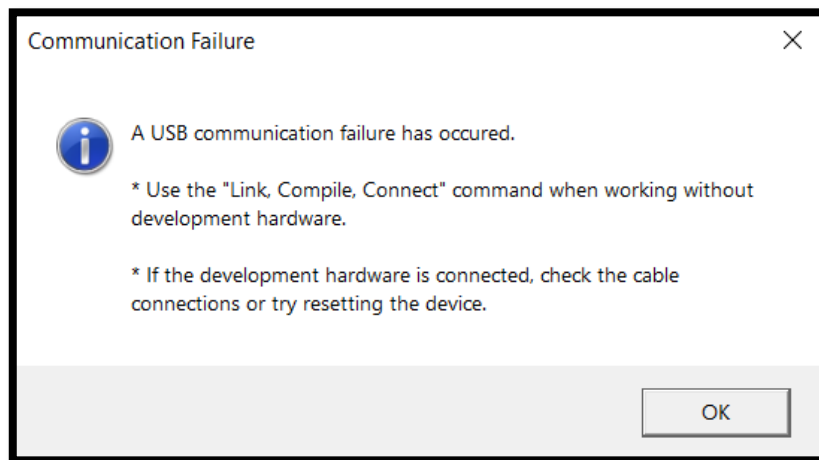
9. Once you have a design that you like, by pressing "link compile download" that design is only saved to your DSP until the next power cycle. To permanently save your program, follow the next section to save your program to E2Prom. To restore the original DSPB firmware (if writing

to E2Prom has not been completed), remove power from the DSPB, disconnect the ICP1 and reconnect power to the DSPB.

B. Writing to E2Prom – Burning custom SigmaStudio programs to non-volatile (non-temporary) memory

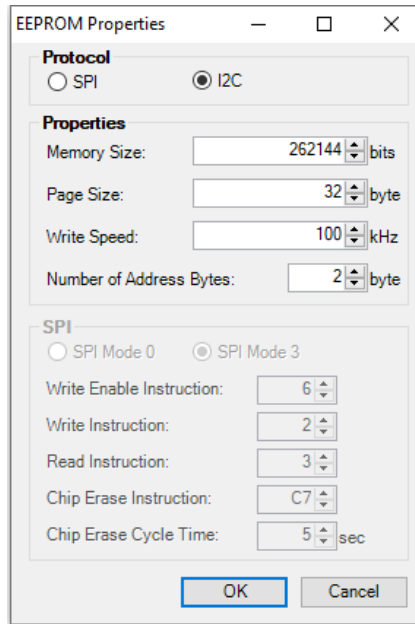This step writes your custom program to non-volatile memory on the DSPB, which ensures that your custom program runs on the DSP upon a new boot. This is essential for long term use, because when you are connected to SigmaStudio testing configurations, that current program is stored in memory that is volatile or temporary, meaning it is lost when there is a power cycle. If you find that your program is lost on a power cycle, it means you have not written the program to E2Prom.

IMPORTANT – This step will erase the stock configuration of the board! This means that the default functions of POT1-4 will reprogrammed or removed, depending on the SigmaStudio project that is loaded. There is a project file on the website called "Stock_Firmware.dspproj" that will restore the original firmware if you need It.

1. If choosing to do this step, it is highly recommended to tie one of the potentiometers of the board to a master gain control (demonstrated in "Creating a basic SigmaStudio project for the DSPB" above). Without this, it will not be possible to control gain without reconnecting to SigmaStudio.
2. By this step, you should have successfully created a project and programmed it onto your DSPB during the same session of SigmaStudio during which you will be writing to E2Prom. If you have not successfully used the "Link Compile Download" button, you must before moving foward.
3. Right click your "ADAU1701" block and click "Write Latest Compilation to E2PROM"
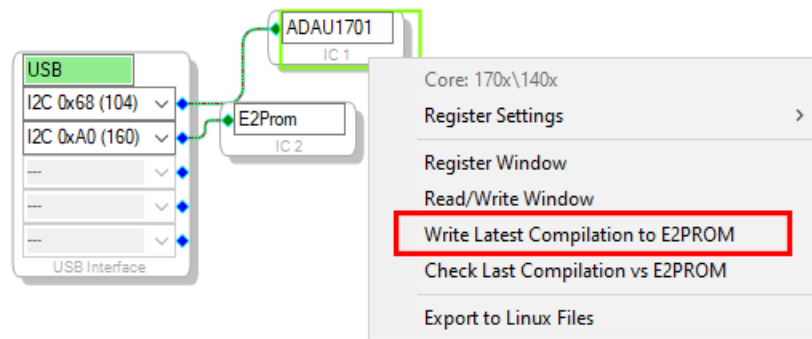
4. In the window that opens, make sure the settings match what is in the screenshot below (they are the default settings), and press OK.
    a. NOTE: The ICP1 switch's position **must** be at '1' for this to work properly. If you get to this point and realize it is set to '2', you might be required to refollow the ICP1 sigma studio connection guide again in order to write to E2Prom. Alternatively, try pressing the reset button on the ICP1 after switching to '1'.

EEPROM Properties   —   □   ✕

Protocol
○ SPI   ◉ I2C

Properties

Memory Size: 262144 ⬍ bits

Page Size: 32 ⬍ byte

Write Speed: 100 ⬍ kHz

Number of Address Bytes: 2 ⬍ byte

SPI
○ SPI Mode 0   ◉ SPI Mode 3

Write Enable Instruction: 6 ⬍

Write Instruction: 2 ⬍

Read Instruction: 3 ⬍

Chip Erase Instruction: C7 ⬍

Chip Erase Cycle Time: 5 ⬍ sec

OK   Cancel

5. The program should now be written to E2PROM after it finishes programming. This means you can remove your ICP1 from the DSPB, and your program should remain after power cycling the DSPB.

C. Example –2.0 Channel Sigma Studio Project.

This basic example project can be used with a DSPB-250, DSPB-K/KE, or even with a DSPB-100 + KAB-100M (for a higher powered 2 channel system, and or to add Bluetooth to the system). Follow the quick start guides above for your particular setup, and then read the ICP1 Sigma Studio guides above for how to use the project file **"2.0 System.dspproj"**, which is available as part of a zip of all project files on the product page. See below for a description of each labelled section, and note that this is only an example of what you can do in SigmaStudio. You are encouraged to explore the program yourself, and also to view other ADAU1701 projects and advice that can be found by searching the web.
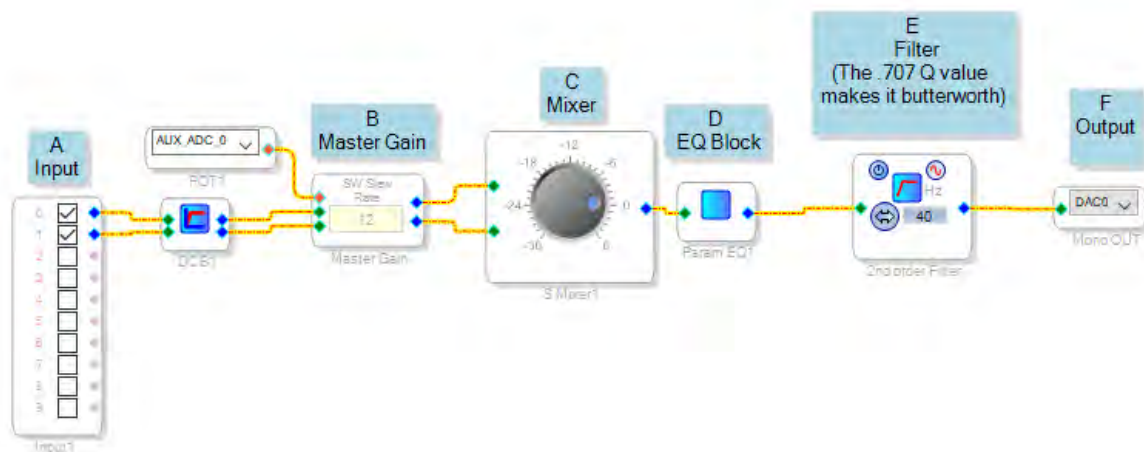

A. Input – Inputs 0 and 1 will correspond to the left and right channel of any audio input. For this example, we assume a Bluetooth KAB board is not connected, so this input will correspond only to the 3.5 mm jack hooked up to J6.

B. Gain Control – This master gain control is connected to POT1 on the DSPB.
   a. It is recommended to make gain controllable with hardware, but this could be changed to a slider type of control if desired.
   b. If you want to use a different potentiometer for master gain, simply change AUX_ADC_0 to any of the other options in the dropdown menu.

C. EQ Section – SigmaStudio has many possibilities for this section, available by navigating through the Tree Toolbox and paying special attention to the filters section. The parametric EQ found in Filters > Second Order > Multichannel allows for visual adjustment of filters and is what we use here as it is the most user friendly, but there are many other ways to achieve EQ. Click the blue icon in the block ⬜ to adjust the PEQ.
   a. Note: You might need to reflash your board by hitting the "Link Compile Download" button to hear the results of adding a new filter in the PEQ mode.
   b. Results with this PEQ can be dramatic. Take caution to avoid overloading speakers.
   c. **Warning – Read the warning at the beginning of section 3 about this block.**

D. Filter Section – Here we have a high pass filter on each channel, acting as a subsonic filter to get better output out of our ported speakers, but remove this filter altogether if it does not fit your speakers.

E. Output Section –DAC0 and DAC1 represent the powered outputs of the DSPB, or the L and R channels of your DSPB-K. If using a DSPB+KAB, You will need to change DAC1 to either DAC2 or DAC3 to send the right channel to the KAB board.

F. Super Bass Block – This is one of the many advanced algorithms from Analog Devices that can be used on your DSPB. This block uses psychoacoustics to increase the perception of bass by adding harmonic content to an existing bass signal. Simply delete it and reroute the wires if it is not wanted. For further descriptions of this or any other block, explore Analog Devices' SigmaStudio documentation [here.](#)

D. Example – DSPB-100 Mono DSPB Sigma Studio Project.

This basic example project is intended to be used with a DSPB-100 mono board, and can be configured to power a subwoofer or simply a full range mono speaker. Just change the filter appropriately. Follow the quick start guide above for your DSPB, and then read the ICP1 Sigma Studio guides above for how to use the project file "DSPB-100 Mono System.dspproj" that is available in a zip file on the product page. See below for a description of each labelled section, and note that this is only an example of what you can do in SigmaStudio. You are encouraged to explore the program yourself, and also to view other ADAU1701 projects and advice that can be found by searching the web.

A. Input – Inputs 0 and 1 will correspond to the left and right channel of any audio input. For this example, we assume a Bluetooth KAB board is not connected, so this input will correspond only to the 3.5 mm jack hooked up to J6.

B. Gain Control – This master gain control is connected to POT1 on the DSPB.
   a. It is recommended to make gain controllable with hardware, but this could be changed to a slider type of control if desired.
   b. If you want to use a different potentiometer for master gain, simply change AUX_ADC_0 to any of the other options in the dropdown menu.

C. Mixer – This section mixes the left and right channels to make a mono signal.

D. EQ Section – SigmaStudio has many possibilities for this section, available by navigating through the Tree Toolbox and paying special attention to the filters section. The parametric EQ found in Filters > Second Order > Multichannel allows for visual adjustment of filters and is what we use here as it is the most user friendly, but there are many other ways to achieve EQ. Click the blue icon in the block ⬜ to adjust the PEQ.
   a. Note: You might need to reflash your board by hitting the "Link Compile Download" button to hear the results of adding a new filter in the PEQ mode.
   b. Results with this PEQ can be dramatic. Take caution to avoid overloading speakers.
   c. **Warning – Read the warning at the beginning of section 3 about this block.**

E. Filter Section – Here we have a high pass filter as an example for a "1.0" mono system. If you want to use this setup as an 0.1 system (just as a sub), change the high pass filter to a low pass filter by clicking ⬛

F. Output Section –DAC0 or DAC1 represents the powered output on your DSPB-100.

E. Example - DSPB-250 + KAB250v3 – Active 2-Way Speaker, 4.0 System

An active 2-way system can be achieved by utilizing a DSPB-250 and any 2 channel KAB board tied together. This setup not only allows the crossovers to be done digitally, it also allows nearly infinite possibilities for EQ, precise time alignment, bass enhancement and more. This allows for the usage of aux in (through J6 on the DSPB) or Bluetooth audio from the KAB board. Do not rely on only this document to explore the possibilities for this setup, as any documentation online that applies to the ADAU1701 should apply here as well.
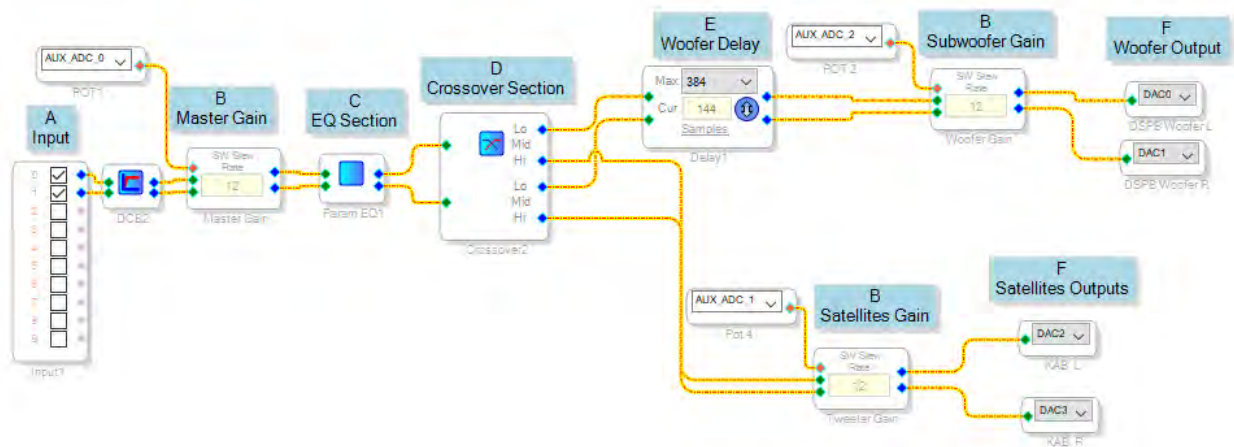
Note: The KAB board's Bluetooth connection **cannot** be used to connect to the DSPB app, it is only for audio streaming.

Required Items:
1. 1 x Dayton Audio DSPB-250
2. 1 x Dayton Audio KAB-250v3 (other models could be used for this)
3. 1 x Dayton Audio Dayton Audio ICP1
4. 1 x DSPB-EC Expansion Cables
5. A power supply.
   a. This could be a single battery board, a single 24V power supply, or 2 identical power supplies 15-24V.
6. 1 x Windows Computer Running SigmaStudio
7. *PC Board M3 Standoff Kit (optional) this allows the board to be connected together physically.*

Steps:
1. Follow all steps of the quick start guide "Combining a DSPB amplifier with a KAB amplifier"
2. Download the zip file of example projects from the product website, unzip it, and find "DSPB-250 + KAB 250v3 4.0 System.dspproj"
3. Follow the "ICP1 Sigma Studio Connection - Quick Start" guide found above, utilizing the project file you just downloaded.
4. Modify the project file to suit your project. To program it to your DSPB, follow the "ICP1 Sigma Studio Quick Start" Guide found above, and then follow "Writing to E2Prom**"** to make sure your custom program persists after a power cycle.
5. See below for a screen capture of the SigmaStudio project with descriptions of each section.

A. Input – Inputs 0 and 1 will correspond to the left and right channel of any audio input. This could be could through an aux jack on the DSPB, or using the KAB215v3's Bluetooth streaming (if both inputs are present, inputs will mix)

B. Gain Controls – These controls are set up to hardware controlled. AUX_ADC_# blocks connected to each volume control correspond to the potentiometers on the DSPB. The number in the volume block is the slew rate time constant NOT volume. It is recommended to keep it at 12.
   a. It is recommended to make gain controllable with hardware, but these could be changed to a slider type of control.

C. EQ Section – SigmaStudio has many possibilities for this section, available by navigating through the Tree Toolbox and paying special attention to the filters section. The parametric EQ found in Filters > Second Order > Multichannel allows for visual adjustment of filters and is what we use here as it is the most user friendly, but there are many other ways to achieve EQ. Click the blue icon in the block ▢ to adjust the PEQ.
   a. Note: You might need to reflash your board by hitting the "Link Compile Download" button to hear the results of adding a new filter in the PEQ mode.
   b. Results with this PEQ can be dramatic. Take caution to avoid overloading speakers.
   c. **Warning – Read the warning at the beginning of section 3 about this block.**

D. Crossover Section – This section is preconfigured for a test bench set of speakers, but it is fully customizable by clicking the blue icon in the block ▣ . This will bring up the appropriate menu.

E. Delay Section – You might find it useful to have a delay block to time align your woofers with your tweeter. In this case, the woofer sits further back from the tweeter, so we put a delay on the woofer. Press 'samples' in this block to switch the representation to milliseconds. Please note that this will affect your phase relationships.

F. Output Section – This might need changed depending on how you have wired your speakers. This example uses one board for the left channel, and one board for the right channel. DAC0 and DAC1 represent the outputs of the DSPB, and DAC2 and DAC3 represent the outputs of the KAB board. It could also be configured that one board is woofers, one board is tweeters.

F. Example - DSPB-100 + KAB-250v3 or DSPB-250 + KAB-100M– 2.1 System

A 2.1 system can be achieved by utilizing a DSPB-100 and any 2 channel KAB board tied together. It can also be achieved by using a DSPB-250 and KAB100M together (if using this configuration, you just need to change the output section). It is also possible to use this project with the DSPB-K with minimal modification, but there is a separate guide and project for that. This setup allows nearly infinite possibilities for EQ, precise time alignment, bass enhancement and more. This allows for the usage of aux in (through J6 on the DSPB) or Bluetooth audio from the KAB board. Do not rely on only this document to explore the possibilities for this setup, as any documentation online that applies to the ADAU1701 should apply here as well.
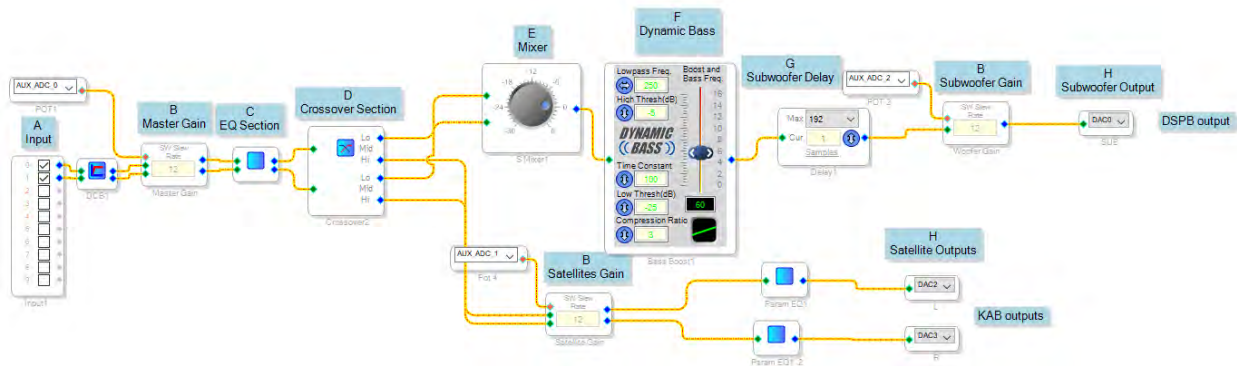
Note: The KAB board's Bluetooth connection **cannot** be used to connect to the DSPB app, it is only for audio streaming.

Required Items:

1. 1 x Dayton Audio DSPB-100 (or DSPB-250)
2. 1 x Dayton Audio KAB-250v3 (or KAB-100M)
3. 1 x Dayton Audio Dayton Audio ICP1
4. 1 x DSPB-EC Expansion Cables
5. A power supply.
   a. This could be a single battery board, a single 24V power supply, or 2 identical power supplies 15-24V.
6. 1 x Windows Computer Running SigmaStudio
7. *PC Board M3 Standoff Kit (optional) this allows the board to be connected together physically.*

Steps:

1. Follow all steps of the quick start guide "Combining a DSPB amplifier with a KAB amplifier"
2. Download the zip file of example projects from the product website, unzip it, and find "DSPB + KAB 2.1 System.dspproj"
3. Follow the "ICP1 Sigma Studio Connection - Quick Start" guide found above, utilizing the project file you just downloaded.
4. Modify the project file to suit your project. To program it to your DSPB, follow the "ICP1 Sigma Studio Quick Start" Guide found above, and then follow "Writing to E2Prom**"** to make sure your custom program persists after a power cycle.
5. See below for a screen capture of the SigmaStudio project with descriptions of each section.

A. Input – Inputs 0 and 1 will correspond to the left and right channel of any audio input. This could be could through an aux jack on the DSPB, or using the KAB250v3's Bluetooth streaming (if both inputs are present, inputs will mix)

B. Gain Controls – These controls are set up to hardware controlled. AUX_ADC_# blocks connected to each volume control correspond to the potentiometers on the DSPB. The number in the volume block is the slew rate time constant NOT volume. It is recommended to keep it at 12.

    a. It is recommended to make gain controllable with hardware, but these could be changed to a slider type of control.

C. EQ Section – SigmaStudio has many possibilities for this section, available by navigating through the Tree Toolbox and paying special attention to the filters section. The parametric EQ found in Filters > Second Order > Multichannel allows for visual adjustment of filters and is what we use here as it is the most user friendly, but there are many other ways to achieve EQ. Click the blue icon in the block 🔲 to adjust the PEQ.

    a. Note: You might need to reflash your board by hitting the "Link Compile Download" button to hear the results of adding a new filter in the PEQ mode.

    b. Results with this PEQ can be dramatic. Take caution to avoid overloading speakers.

    c. **Warning – Read the warning at the beginning of section 3 about this block.**

D. Crossover Section – This section is preconfigured for our test speakers, but it is fully customizable by clicking the blue icon in the block ❎. This will bring up the appropriate menu.

E. Mixer – This block mixes the L and R signals together to create a mono channel for your sub.

F. Dynamic Bass Block – This is one of the many advanced algorithms from Analog Devices that can be used on your DSPB. Simply delete it and reroute the wires if it is not wanted. For further descriptions of this or any other block, explore Analog Devices' SigmaStudio documentation here.

G. Delay Section – You might find it useful to have a delay block to time align your subwoofer. Please note that this will affect your phase relationships.

H. Output Section – This section is configured with the assumption that you are using a DSPB-100 as your subwoofer and your KAB board for your satellites. DAC0 is the output from the DSPB-100 (or DAC1, but we use DAC0 in this case), and DAC2 and DAC3 are the outputs from your attached KAB board. Change this section accordingly if you're using a DSPB-250 with a mono KAB board instead.

G. Example – 3 Way Active System With DSPB-250 and KAB-100M

It is possible to make a 3-way system with completely active crossovers with the DSPB+KAB series of amplifiers. The diagram below shows how this can be achieved for a single speaker

There are multiple preset project files available for this setup. They include a file for a 3-way mono speaker, one for the left channel 3-way speaker, and one for the right channel. These files are available from any of the DSPB product pages, and they are clearly labelled within the zip file of all of the project files. If you intend on making a stereo pair of 3-way speakers with this design, please note that you will not be able to utilize the Bluetooth input of the KAB board, unless your source device is capable of streaming audio to multiple devices.
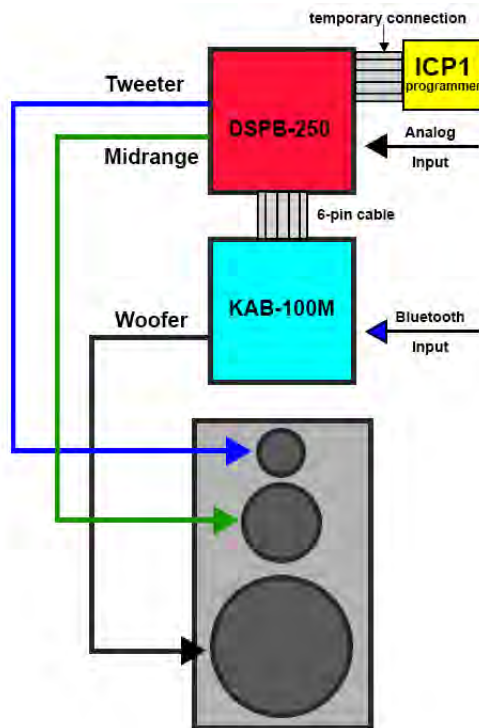
The image above demonstrates the setup for a 3-way speaker. By following the quick start guides listed above, you should be ready to start programming your DSPB to create the proper crossovers and other tuning you might like to do within SigmaStudio. Note that instead of using the DSPB-250 powered outputs as left and right channels, they will be used as tweeter and midrange outputs in this setup.

Required Items:

Item Needed	Quantity for Mono	Quantity for Stereo
Dayton Audio DSPB-100 (or DSPB-250)	1	2
Dayton Audio KAB-250v3 (or KAB-100M)	1	2
Dayton Audio Dayton Audio ICP1	1	1
DSPB-EC Expansion Cables	1	2
Power supply. This could be a battery board or a power supply 12-24V	1	Usually 2

Windows Computer Running SigmaStudio	1	1
PC Board M3 Standoff Kit (optional) this allows the board to be connected together physically.	1	Usually 2

Steps:

1. Follow the quick start guides for the DSPB-250/100, combining DSPB amplifier with a KAB amplifier, and DSPB-ICP1 SigmaStudio connection before proceeding with this section. All quick start guides are in the previous section of this document.
2. Download the zip file of example projects from the product website, unzip it, and find the 3-way crossovers folder.
3. Follow the "ICP1 Sigma Studio Connection - Quick Start" guide found above, utilizing the project file you just downloaded that is appropriate for your setup.
4. Modify the project file to suit your application. To program it to your DSPB-250/100, follow the "ICP1 Sigma Studio Quick Start" Guide found above, and then follow "Writing to E2Prom**"** to make sure your custom program persists after a power cycle.

The screen capture below is the mono version of the 3-way project preset, and has descriptions of each section below. The left or right channel versions of this project type are very similar, and are just without the mixer block.

A. Input – Inputs 0 and 1 will correspond to the left and right channel of any audio input. This could be could through an aux jack on the DSPB, or using the KAB250v3's Bluetooth streaming (if both inputs are present, inputs will mix)
B. Gain Controls – These controls are set up to hardware controlled. AUX_ADC_# blocks connected to each volume control correspond to the potentiometers on the DSPB. The number in the volume block is the slew rate time constant NOT volume. It is recommended to keep it at 12.
   a. It is recommended to make gain controllable with hardware, but these could be changed to a slider type of control.
C. EQ Section – SigmaStudio has many possibilities for this section, available by navigating through the Tree Toolbox and paying special attention to the filters section. The parametric EQ found in

Filters > Second Order > Multichannel allows for visual adjustment of filters and is what we use here as it is the most user friendly, but there are many other ways to achieve EQ. Click the blue icon in the block to adjust the PEQ.

- a. Note: You might need to reflash your board by hitting the "Link Compile Download" button to hear the results of adding a new filter in the PEQ mode.
- b. Results with this PEQ can be dramatic. Take caution to avoid overloading speakers.
- c. **Warning – Read the warning at the beginning of section 3 about this block.**

D. Crossover Section – This section is preconfigured for our test speakers, but it is fully customizable by clicking the blue icon in the block . This will bring up the appropriate menu that can be seen below

E. Output Section – This section is configured with the assumption that you are using a DSPB-100 as your woofer and your KAB board for your tweeter + midwoofer. DAC0 is the output from the DSPB-100 (or DAC1, but we use DAC0 in this case), and DAC2 and DAC3 are the outputs from your attached KAB board. Change this section accordingly if you're using a DSPB-250 with a mono KAB board instead.

H. Example – DSPB-K + DSPB-KE – 2.1 System
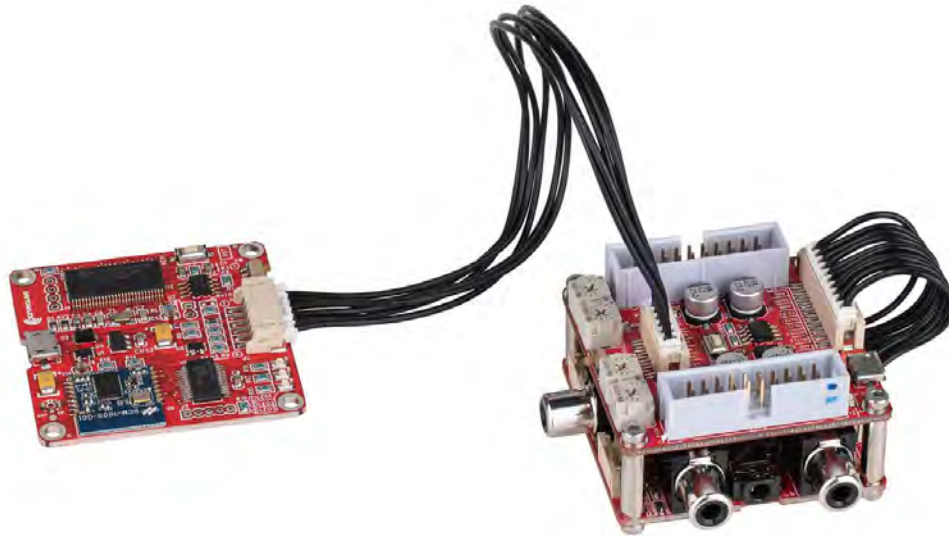
By connecting an ICP1 up to a DSPB-K, it is possible to add all of the functionality of the Analog Devices ADAU1701 DSP to a system with an external amplifier. This setup allows nearly infinite possibilities for EQ, precise time alignment, bass enhancement and more. Do not rely on only this document to explore the possibilities for this setup, as most documentation online that applies to the ADAU1701 should apply here as well.

   Note: The micro-usb port on the DSPB-K cannot be used to connect to SigmaStudio, an ICP1 is necessary to make this connection.

Required Items:
1. 1 x Dayton Audio DSPB-K
2. 1 x Dayton Audio DSPB-KE
3. 1 x Dayton Audio Dayton Audio ICP1
4. 1 x Micro USB Cable and a power supply. Because of the USB connection, this could be a laptop, TV, dedicated power brick or anything else. If you experience issues, it's recommended to use a dedicated USB power brick.
5. 1 x Stereo Amplifier with RCA or 3.5mm inputs
6. 1 x Amplifier connect to a subwoofer with RCA input
7. 1 x Windows Computer Running SigmaStudio

Steps:
1. Follow the quick start guide above for the DSPB-K / DSPB-KE
2. Make sure your DSPB-K's switch is set to 1.
3. Download the zip file of example projects from the product website, unzip it, and find "DSPB-K and KE 2.1 System.dspproj"
4. Follow the "ICP1 Sigma Studio Connection - Quick Start" guide found above, utilizing the project file you just downloaded.

5. Modify the project file to suit your application. To program it to your DSPB-K, follow the "ICP1 Sigma Studio Quick Start" Guide found above, and then follow "Writing to E2Prom" to make sure your custom program persists after a power cycle.

6. See below for a screen capture of the SigmaStudio project with descriptions of each section.
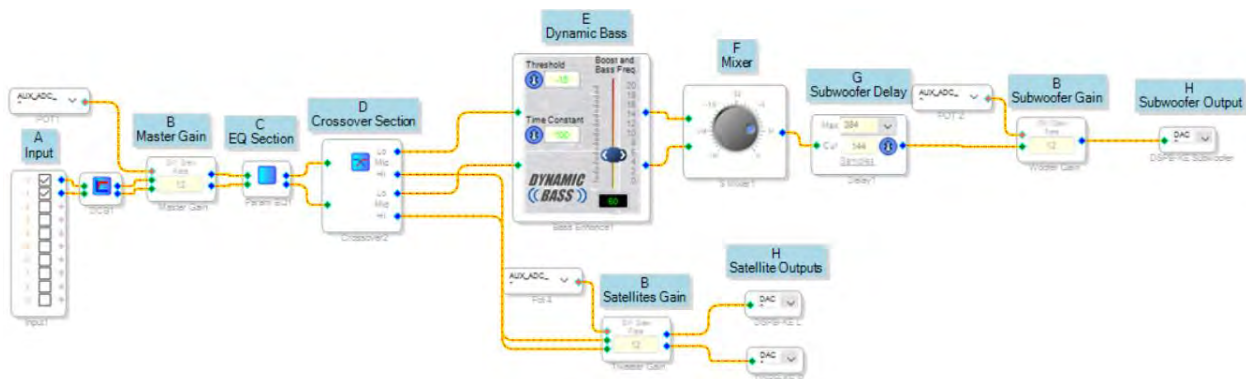
A. Input – Inputs 0 and 1 will correspond to the left and right channel of your audio input. This is labelled AINL and AINR or the 3.5mm jack between them on the DSPB-KE.
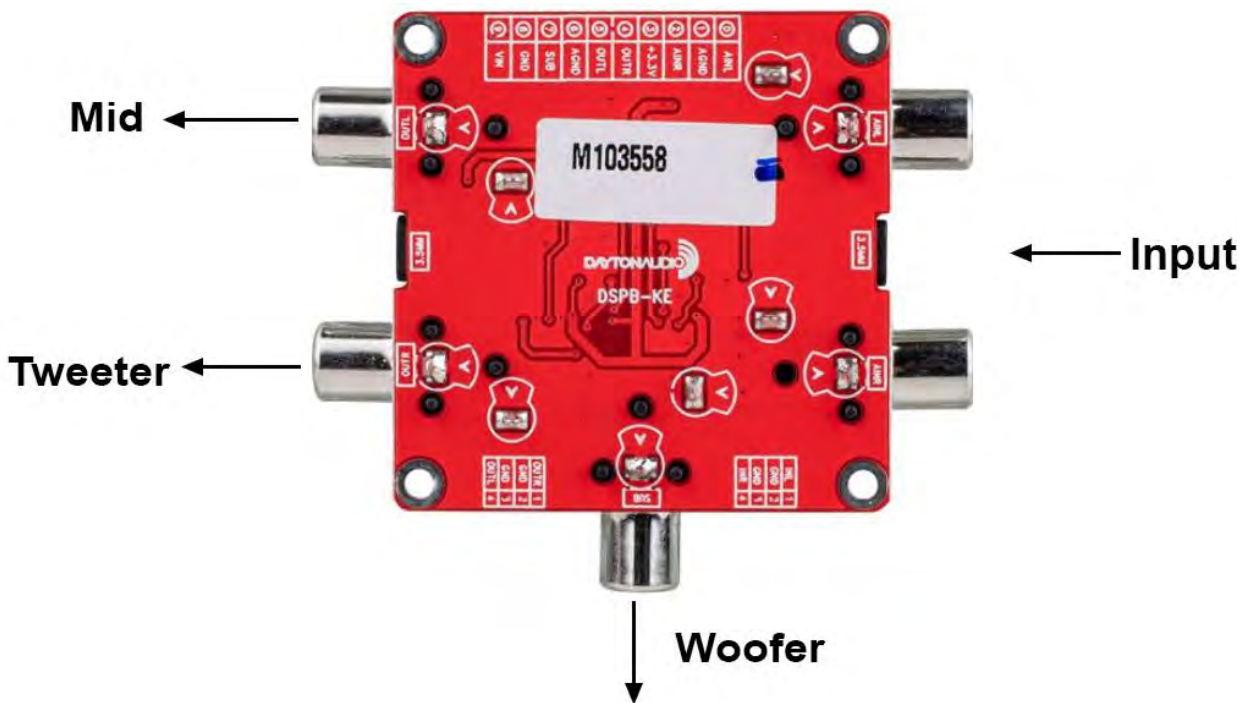
B. Gain Controls – These controls are set up to hardware controlled. AUX_ADC_# blocks connected to each volume control correspond to the potentiometers on the DSPB. The number in the volume block is the slew rate time constant NOT volume. It is recommended to keep it at 12.

   a. It is recommended to make gain controllable with hardware, but these could be changed to a slider type of control.

C. EQ Section – There is extensive flexibility for this section. You are encouraged to explore SigmaStudio's possibilities for this block, by navigating through the Tree Toolbox and paying special attention to the filters section. The parametric EQ found in Filters > Second Order > Multichannel allows for visual adjustment of filters and is what we use here, but there are many other ways to achieve EQ. Click the blue icon in the block to adjust EQ.

   a. **Warning – Read the warning at the beginning of section 3 about this block.**

D. Crossover Section – This section is preconfigured for a test bench set of speakers, but it is fully customizable by clicking the blue icon in the block . This will bring up the menu below.

E. Dynamic Bass Block – This is one of the many advanced algorithms from Analog Devices that can be used on your DSPB. Simply delete it and reroute the wires if it is not wanted. For further descriptions of this or any other block, explore Analog Devices' SigmaStudio documentation here.

F. Mixer – This section mixes the left and right channels to make a mono signal for the sub.

G. Delay Section – You might find it useful to have a delay block to time align your subwoofer. In this case, the woofer sits further back from the tweeter, so we put a delay on the woofer. Press 'samples' in this block to switch the representation to milliseconds if desired. You might find it useful to use a calibrated measurement mic, taking measurements in real time and adjusting the delay sample by sample until you see what you want in the crossover region.

H. Output Section – This section is configured with the assumption that you are using a DSPB-100 as your subwoofer and your KAB board for your satellites. DAC0 is the output from the DSPB-100 (or DAC1, but we use DAC0 in this case), and DAC2 and DAC3 are the outputs from your attached KAB board.

I. Example – DSPB-K + DSPB-KE – 3-Way Crossover

This example demonstrates how you can utilize 2 sets of DSPB-K/KE to achieve a 3-way crossover for a stereo set of speakers. Instead of using the DSPB-K/KE as DSP for left, right, and sub, you can reprogram the boards in SigmaStudio and achieve a 3-way crossover by using the connections below and a sample project that is also described below. Instead of using the DSPB-KE for left, right and subwoofer signals, you instead use them for tweeter, mid-woofer, and woofer signals. Eliminating the need for assembling complicated crossover circuits, a 3-way crossover can be achieved in a small form factor and changed in real time with SigmaStudio.

Required Items:

Item Needed	Quantity for mono	Quantity for stereo
Dayton Audio DSPB-K	1	2
Dayton Audio DSPB-KE	1	2
Dayton Audio Dayton Audio ICP1	1	1
Micro USB Cable and a 5V power supply. Because of the USB connection, this could be a laptop, TV, dedicated power brick or anything else. If you experience issues, it's recommended to use a dedicated USB power brick.	1	Usually 2
1 x Stereo Amplifier with RCA or 3.5mm inputs	1	2

Amplifier connect to a subwoofer with RCA input	1	2
Windows Computer Running SigmaStudio	1	1

Steps:

1. Follow the quick start guide above for the DSPB-K / DSPB-KE
2. Make sure your DSPB-K's switch is set to 1.
3. Download the zip file of example projects from the product website, unzip it, and find the 3-way crossover folder.
4. Follow the "ICP1 Sigma Studio Connection - Quick Start" guide found above, utilizing either the mono project, or left and right channel projects.
5. Modify the project file to suit your application. To program it to your DSPB-K, follow the "ICP1 Sigma Studio Quick Start" Guide found above, and then follow "Writing to E2Prom" to make sure your custom program persists after a power cycle.

The screen capture below is the mono version of the 3-way project preset, and has descriptions of each section below. The left or right channel versions of this project type are very similar, and are just without the mixer block.
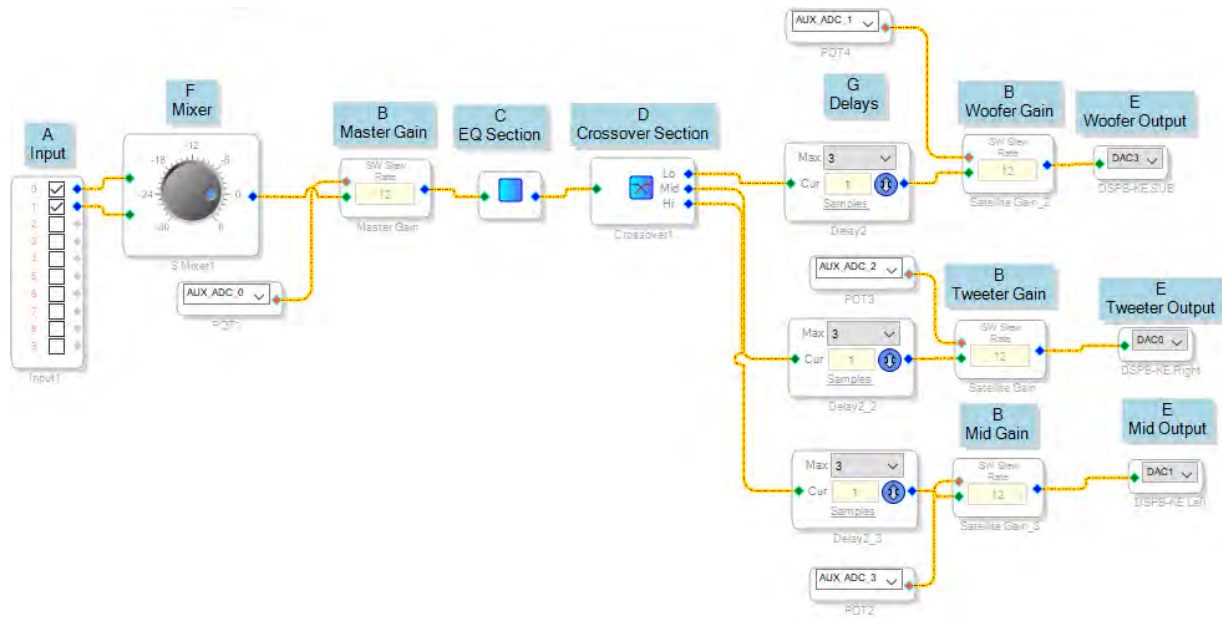
A. Input – Input 0 will refer to the left input on your DSPB-KE, whereas Input 1 will refer to your right channel input. In the mono project, these are fed into a mixer block. For strictly left or right channel projects, the project files bypass the mixer block and are fed directly into the EQ block.
B. Gain Controls – These controls are set up to be hardware controlled. AUX_ADC_# blocks connected to each volume control correspond to the potentiometers on the DSPB. The number

in the volume block is the slew rate time constant NOT volume. It is recommended to keep it at 12.

    a. It is recommended to make gain controllable with hardware, but these could be changed to a slider type of control.

C. EQ Section – There is extensive flexibility for this section. You are encouraged to explore SigmaStudio's possibilities for this block, by navigating through the Tree Toolbox and paying special attention to the filters section. The parametric EQ found in Filters > Second Order > Multichannel allows for visual adjustment of filters and is what we use here, but there are many other ways to achieve EQ. Click the blue icon in the block to adjust EQ. Note that the default scaling of the PEQ menu is 20 dB per division, so be careful not to make dramatic changes and blow a driver.

    a. **Warning – Read the warning at the beginning of section 3 about this block.**

D. Crossover Section – This section is preconfigured for a test bench set of speakers, but it is fully customizable by clicking the blue icon in the block .

E. Dynamic Bass Block – This is one of the many advanced algorithms from Analog Devices that can be used on your DSPB. Simply delete it and reroute the wires if it is not wanted. For further descriptions of this or any other block, explore Analog Devices' SigmaStudio documentation here.

F. Mixer – This section mixes the left and right channels to make a mono signal for the sub.

G. Delay Section – You might find it useful to have a delay block to time align your drivers. Delete these blocks if they are not needed, as they will always delay the signal by at least 1 sample when they are on. You can use a calibrated measurement mic, taking measurements in real time and adjusting the delay sample by sample until you see what you want in the crossover region(s).

H. Output Section – This section is preconfigured to match the connections for the DSPB-KE as outlined in the above section. DAC0 corresponds to OUTR (tweeter), DAC1 to OUTL (mid), and DAC3 to SUB (woofer).

4. Wiring Diagrams

DSPB-100

100W Class D Mono Audio Amplifier Board with DSP
Quick Start Wiring Guide
Model: DSPB-100

1. 3.5 mm Headphone Jack – J3
2. Audio Expansion Port – J5
3. Reset Switch – SW2
4. AUX IN Port – J6
5. Power Supply Port – J9
6. Battery Board Port – J8
7. Switch Control Port – J12

8. Programming Port – J4
9. Speaker Output Port – J10
10. DSP Expansion Port – J2
11. POT1: Output Audio Gain Control – J3 & J5
12. POT2: High-pass Filter Control – J3 & J5
13. POT3: High-pass Filter Control for Speaker Output – J10
14. POT4: Master Volume Control – J10, J5, J3

Speaker Output Connector:
J10 MOLEX-4PIN-3MM

Pin	Definition
1	OUT-
2	OUT+
3	OUT-
4	OUT+

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Audio Output Connector:
J3, 3.5mm Headphone Connector

Speaker Output Connector:
J10 MOLEX-4PIN-3MM

Pin	Definition
1	OUT -
2	OUT+
3	OUT-
4	OUT+

Switch Control Connector*:
J12 PH-3PIN-2MM

Pin	Definition
1	STBY
2	GND
3	MUTE

Programming Port:
J4 PH-6PIN-2MM

Pin	Definition
1	SDA
2	SCL
3	WP
4	GND
5	VIN
6	RST

3.5mm AUX IN Connector:
J6 PH-10PIN-2MM

Pin	Definition
1	VCC
2	VCC
3	GND
4	LED1
5	KEY1
6	LIN
7	GND
8	RIN
9	KEY2
10	LED2

Audio Extension and Compatible Port:
J5 PH-6PIN-2MM

Pin	Definition
1	LIN
2	LOUT
3	GND
4	GND
5	ROUT
6	RIN

DSP Extension Port:
J2 PH-10PIN-2MM

Pin	Definition	Pin	Definition
1	GND	6	MP00
2	DATA	7	MP01
3	LRCLK	8	MP05
4	BCLK	9	MP04
5	MP07	10	+3.3V

Power Connector:
J9 MOLEX-2PIN-3MM

Pin	Definition
1	VCC
2	GND

Battery Board Connector:
J8 PH-4PIN-2MM

Pin	Definition
1	VBAT
2	VBAT
3	GND
4	GND

DSPB-250

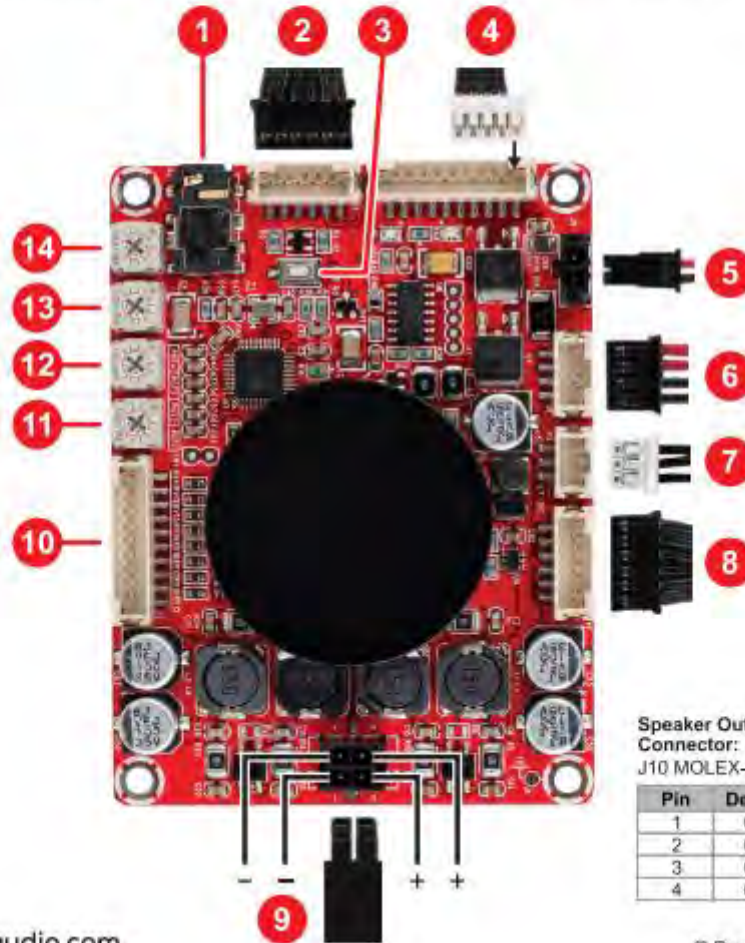## 2x50W Class D Audio Amplifier Board with DSP
Quick Start Wiring Guide
Model: DSPB-250

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1. 3.5 mm Headphone Jack – J3
2. Audio Expansion Port – J5
3. Reset Switch – SW2
4. AUX IN Port – J6
5. Power Supply Port – J9
6. Battery Board Port – J8
7. Switch Control Port – J12

8. Programming Port – J4
9. Speaker Output Port – J10
10. DSP Expansion Port – J2
11. POT1: Output Audio Gain Control – J3 & J5
12. POT2: High-pass Filter Control – J3 & J5
13. POT3: High-pass Filter Control for Speaker Output – J10
14. POT4: Master Volume Control – J10, J5, J3

R+ R-   L+ L-

Speaker Output Connector:
J10 MOLEX-4PIN-3MM

Pin	Definition
1	R OUT-
2	L OUT+
3	R OUT+
4	L OUT-

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Audio Output Connector:
J3, 3.5mm Headphone Connector

Speaker Output Connector:
J10 MOLEX-4PIN-3MM

Pin	Definition
1	LOUT+
2	ROUT+
3	LOUT-
4	ROUT-

Switch Control Connector*:
J12 PH-3PIN-2MM

Pin	Definition
1	STBY
2	GND
3	MUTE

Programming Port:
J4 PH-6PIN-2MM

Pin	Definition
1	SDA
2	SCL
3	WP
4	GND
5	VIN
6	RST

3.5mm AUX IN Connector:
J6 PH-10PIN-2MM

Pin	Definition
1	VCC
2	VCC
3	GND
4	LED1
5	KEY1
6	LIN
7	GND
8	RIN
9	KEY2
10	LED2

Audio Extension and Compatible Port:
J5 PH-6PIN-2MM

Pin	Definition
1	LIN
2	LOUT
3	GND
4	GND
5	ROUT
6	RIN

DSP Extension Port:
J2 PH-10PIN-2MM

Pin	Definition	Pin	Definition
1	GND	6	MP00
2	DATA	7	MP01
3	LRCLK	8	MP05
4	BCLK	9	MP04
5	MP07	10	+3.3V

Power Connector:
J9 MOLEX-2PIN-3MM

Pin	Definition
1	VCC
2	GND

Battery Board Connector:
J8 PH-4PIN-2MM

Pin	Definition
1	VBAT
2	VBAT
3	GND
4	GND

DAYTONAUDIO

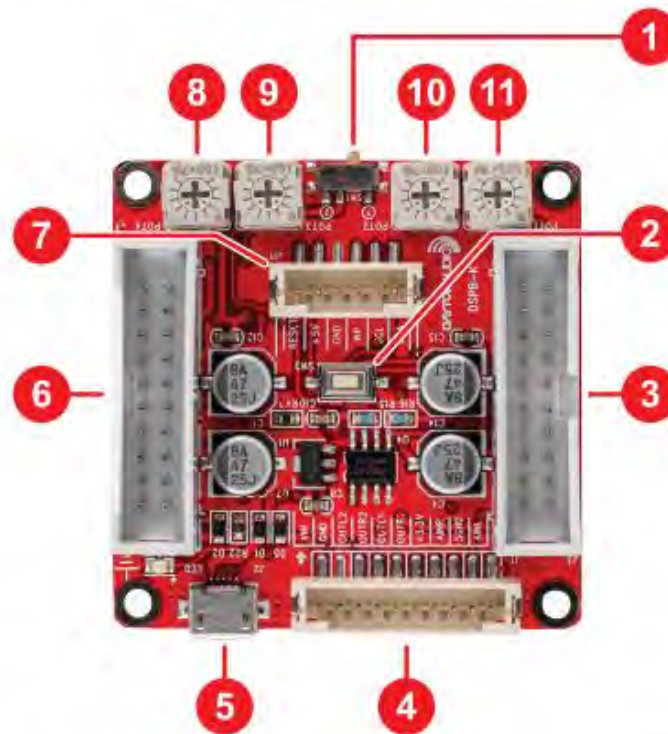**DSP Kernel Board**
Quick Start Wiring Guide
Model: DSPB-K

1. Run or Program Mode – SW1
2. Reset Switch – SW2
3. Control Port – J3
4. Connection Port (DSPB-KE) – J1
5. Micro USB Power Port – J2
6. Control Port – J4
7. Programming Port – J11
8. POT4: Stereo Gain
9. POT3: Stereo High-pass Adjustment
10. POT2: Sub Low-pass Adjustment
11. POT1: Sub Gain

SW1	MODE	FUNCTION
①	RUN	Audio Output
②	PROG	Programming

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Extension Kit Connector:
J1 PH-10PIN-2MM

Pin	Definition
1	AINI
2	SGND
3	AINR
4	+3.3V
5	OUTR1
6	OUTL1
7	OUTR2
8	OUTL2
9	GND
10	VIN

Program Port:
J11 PH-6PIN-2MM

Pin	Definition
1	SDA
2	SCL
3	WP
4	GND
5	SBOOT
6	RESET

Control Port:
J3

Pin	Definition	Pin	Definition
1	AD0	2	GND
3	AD1	4	GND
5	SCL	6	WB
7	SDA	8	WP
9	RST	10	OR1
11	MP2	12	OL1
13	MP3	14	OR2
15	MP8	16	OL2
17	MP9	18	GND
19	DPW	20	3.3V

Control Port:
J4

| Pin	Definition	Pin	Definition
1	GND	2	MCLK
3	GND	4	MP11
5	GND	6	MP10
7	GND	8	MP6
9	GND	10	MP7
11	GND	12	MP0
13	GND	14	MP1
15	GND	16	MP5
17	GND	18	MP4
19	GND	20	VIN

DSPB-KE

Kernel DSP Expansion 2-In 3-Out
Quick Start Wiring Guide
Model: DSPB-KE

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1. Connection Port (DSPB-K) – J4
2. RCA Out Left – J9
3. 3.5mm Output – J7
4. RCA Out Right – J6
5. Audio Output Header – J8
6. RCA Out Sub – J10
7. Audio Input Header – J3
8. RCA Input Right – J5
9. 3.5mm Input – J1
10. RCA Input Left – J2
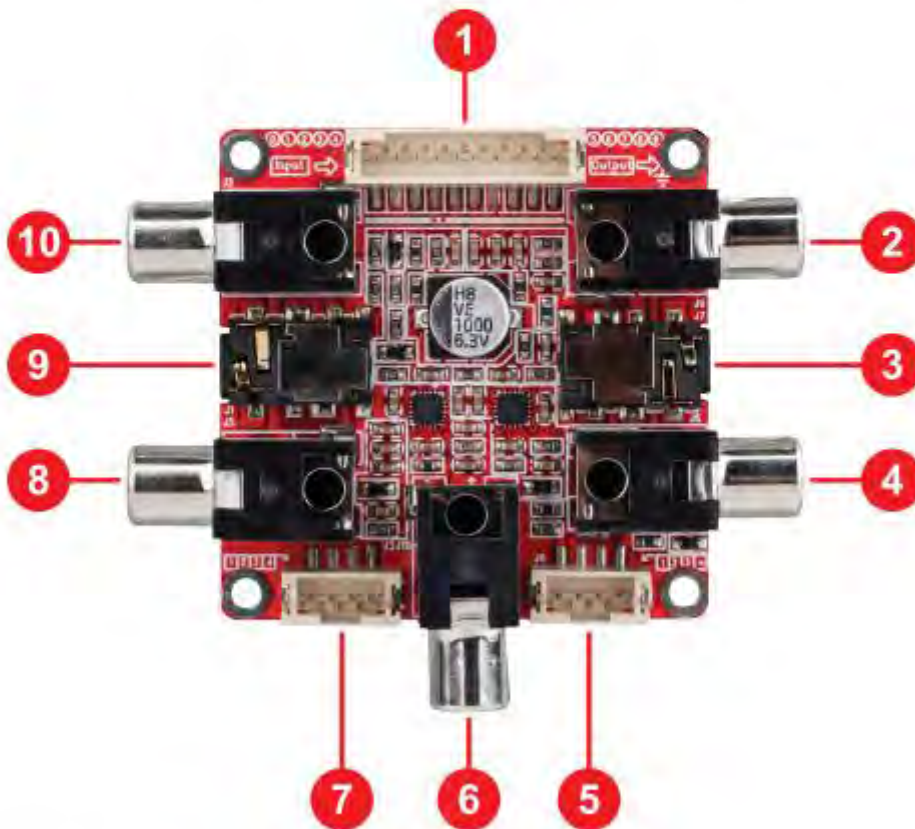
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AUX In:
J1 3.5mm AUX Jack

Headphone Output:
J7 3.5mm Headphone Output Jack

RCA Right Input:
J2 RCA Jack

RCA Left Input:
J5 RCA Jack

RCA Left Output:
J6 RCA Jack

RCA Right Output:
J9 RCA Jack

Subwoofer Output:
J10 RCA Jack

Input (PH):
J3 PH-4Pin-2mm
Vertical Header

Pin	Definition
1	INI
2	GND
3	GND
4	INR

Output (PH):
J3 PH-4Pin-2mm
Vertical Header

| Pin	Definition
1	OUTR
2	GND
3	GND
4	OUTL

DSPB-ICP1

In-Circuit Programmer USB and BLE Connection
Quick Start Wiring Guide
Model: DSPB-ICP1

1. Reset Button – KEY1
2. Control Switch for APP or SigmaStudio Control Mode – SW
3. Programming Port for DSPB – J2
4. Bluetooth BLE Module
5. Micro USB Port for PC Connection with SigmaStudio – J1

SW1	MODE	FUNCTION
①	USB	SigmaStudio
②	BLE	APP

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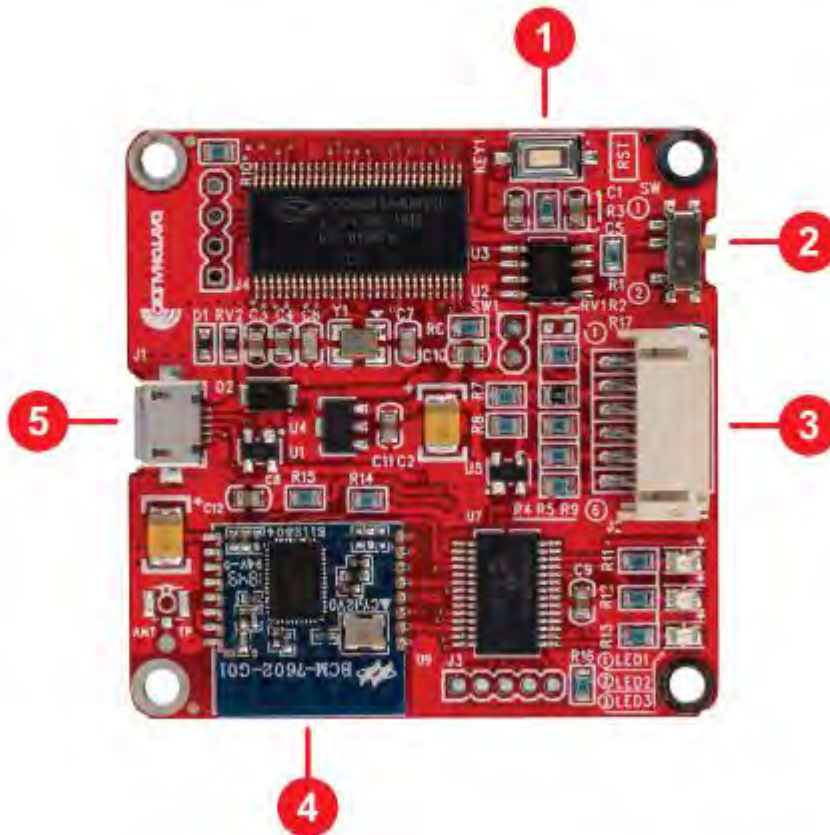
5. Tips and Troubleshooting

A. DSPB Tips and Troubleshooting

1. Noise
   a. If a DSPB is connected to an ICP1, and that ICP1 is plugged into a computer, sometimes noise can be picked up from the computer's USB port. If this occurs, try a different USB port and make sure to unplug your ICP1 from the PC when it is not in use.
   b. If using a laptop, try disconnecting it from power if possible.
   c. Turn the amp gain down and turn the input volume up. With the gain all of the way up, it is expected to have more noise than with it at a lower gain.
   d. Check to make sure there is not any damage to cables or ports.
2. The DSPB worked fine before powering it off, but powering it back on there is no sound.
   a. This can happen if an ICP1 is connected to a PC, and that ICP1 is connected to a DSPB, but the DSPB and PC are turned off. When both get turned back on, you might get no audio.
   b. The fix is simple, just unhook your ICP1 from the DSPB and plug it back in if desired. Press the reset button on the DSPB if sound still does not come on when removing the ICP1.
3. In general, pressing the reset button on the products in the DSPB series can help solve problems
   a. Power cycling can help, as an alternative.
4. My DSPB doesn't sound like a normal amplifier, something sounds wrong.
   a. Try adjusting the potentiometers corresponding to the high pass filters on the board.
   b. If using a stereo board, make sure to carefully follow the wiring diagram to ensure your speakers are in phase with each other. Wiring speakers out of phase will make them sound incorrect.
5. Follow the guides above closely.

## B. ICP1 Sigma Studio Troubleshooting

1. Many problems, especially connection problems, can be solved with a reboot of your Windows PC and then following the connection guide steps exactly from the start.
2. I cannot get my ICP1 to program.
   a. Follow the ICP1 Sigma Studio Connection guide under the quick start section of this guide. It is not enough to just make the correct connections, it is required to do the steps in order to have consistent connection results.
   b. It is important to **try a different micro USB cable**. Many micro USB cables endure a lot of abuse from charging devices, and although they might still provide power, they might have issues transferring data. Some micro USB cables don't have the connections necessary for data connection to begin with, and were manufactured strictly for power. These cables are often included with devices that strictly use a micro USB port for power, and are not intended to be controlled with a PC.
3. I have my potentiometers set correctly in my SigmaStudio schematic, but they don't work.
   a. Ensure that the register control menu is set correctly to utilize the potentiometers. See the section "ICP1 Sigma Studio Connection - Quick Start"

4. If I disconnect power from my DSPB, I lose my sigma studio configuration (the configuration returns to default)
    a. Ensure that you are writing the program to E2Prom once you are finished with configuration. See section "Writing to E2Prom"

C. Sigma Studio Tips

1. The best tip available for SigmaStudio is to use search engines to your advantage. If you type your question and add "sigmastudio" or "adau1701" to the end of it, you will often find you are not the first person to have that question. The ADAU1701 has a large community of engineers that use it, and also is very common, so support topics are plentiful.
2. Explore the program, especially the toolbox. There are a wide variety of blocks available in the toolbox, everything from the most basic DSP functions like delays and signal addition, to advanced dynamics processing, bass enhancement, esoteric filter types and more.
3. Right clicking schematic blocks often reveals additional control for the block
    a. Example, a volume controller can be "grown" to allow for multiple inputs and outputs to pass through a single volume controller. This is done in step 4 of the "Creating a basic SigmaStudio project for the DSPB" guide.
    b. Right clicking any slider allows exact values to be entered
4. Hovering over elements in SigmaStudio project files can often reveal useful context about whatever is being hovered over.
    a. Example: Hovering over a "pin" of a block will reveal what that pin is.
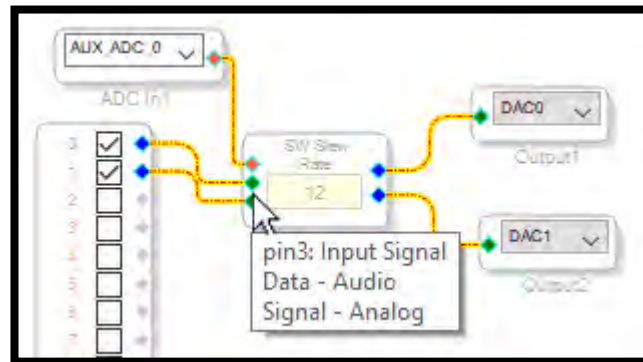
5. Holding control and dragging a block allows quick duplication of that block
6. Right click any block and "Disable" the cell for quick comparison tests. You will need to link compile download after doing this.
    a. Note: The default password is blank, just press OK when prompted for a password.
7. Viewing Project Responses in Sigma Studio
    a. Utilizing stimulus and probe functions allow you to see the response and phase of *your project without needing to take measurements! Add stimulus to input, and probe to output anywhere in your project, press the "stimulus" button, and then open the "probe" button to view this response.
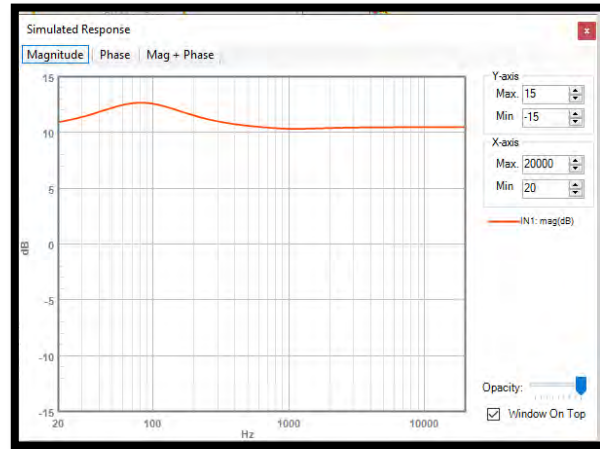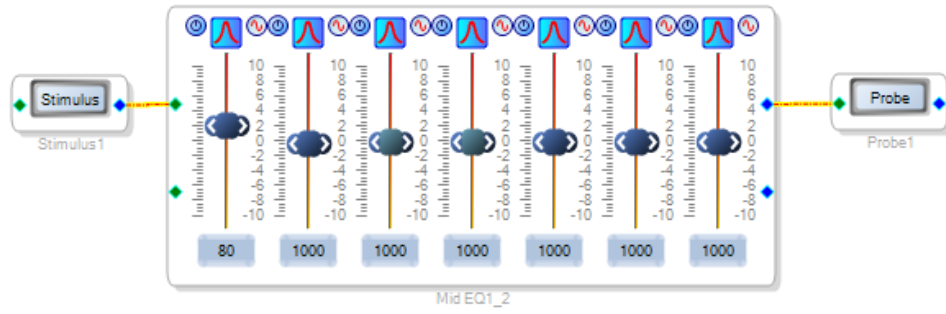
Revision Log

V1.0 – Initial Guide

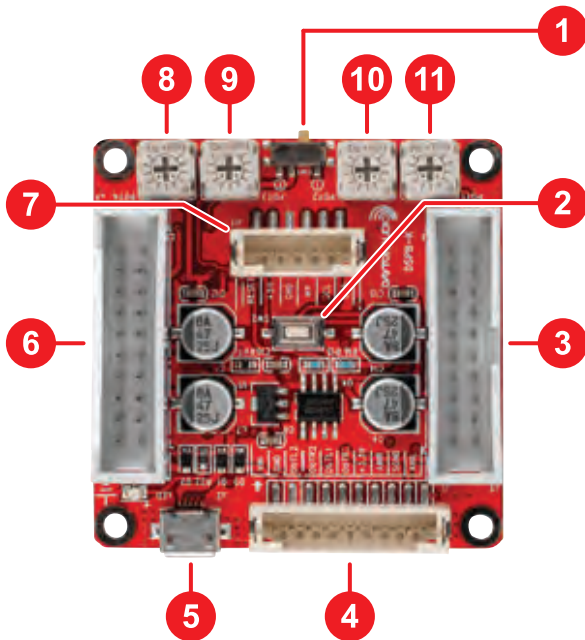V1.1 – Rephrasing and rewriting of some sections

V1.2 –Overhaul of existing sections, including additional content, troubleshooting, edits for clarity and more. Addition of new project files and revision of previous project files. Addition of the following guide sections

- What types of projects can be achieved with the DSPB series? What do I need to get started?
- Combining a DSPB amplifier with a KAB amplifier
- 3-Way Crossover Examples for DSPB-250/100 and DSPB-K
- Addition of pinout descriptions for each wiring diagram
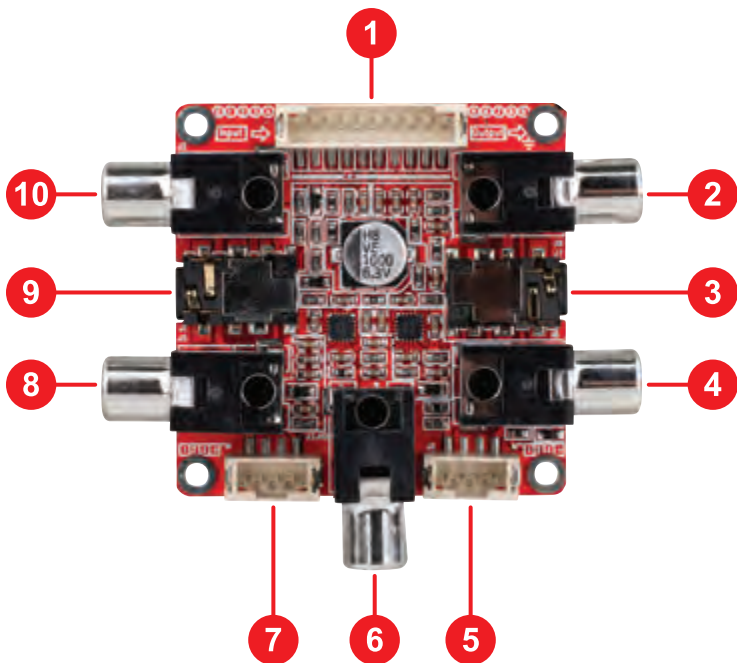- Addition of information about default potentiometer controls

V1.21 – Added a warning about the PEQ block

DSP Kernel Board
Quick Start Wiring Guide
Model: DSPB-K

1. Run or Program Mode – SW1
2. Reset Switch – SW2
3. Control Port – J3
4. Connection Port (DSPB-KE) – J1
5. Micro USB Power Port – J2
6. Control Port – J4
7. Programming Port – J11
8. POT4: Stereo Gain
9. POT3: Stereo High-pass Adjustment
10. POT2: Sub Low-pass Adjustment
11. POT1: Sub Gain

SW1	MODE	FUNCTION
①	RUN	Audio Output
②	PROG	Programming

Kernel DSP Expansion 2-In 3-Out

Quick Start Wiring Guide
Model: DSPB-KE

1. Connection Port (DSPB-K) – J4
2. RCA Out Left – J9
3. 3.5mm Output – J7
4. RCA Out Right – J6
5. Audio Output Header – J8
6. RCA Out Sub – J10
7. Audio Input Header – J3
8. RCA Input Right – J5
9. 3.5mm Input – J1
10. RCA Input Left – J2

DSP Kernel Board
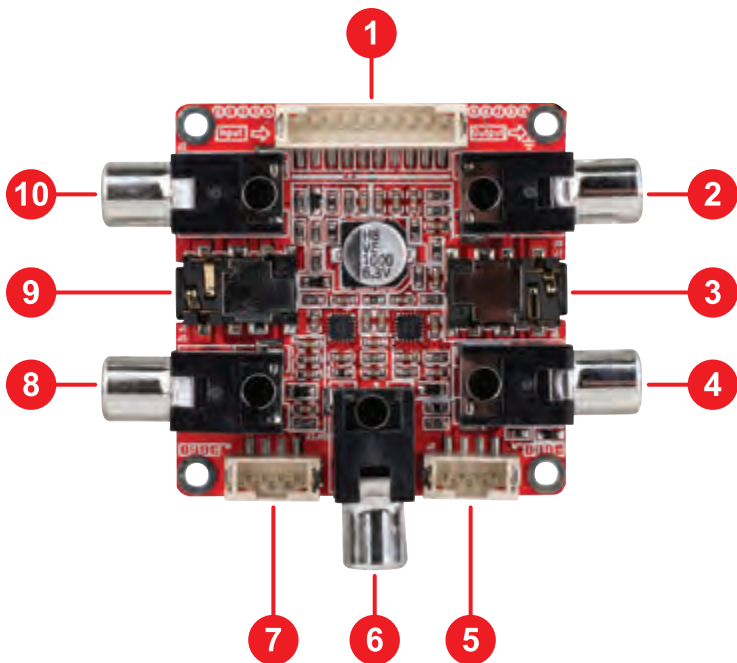## Quick Start Wiring Guide
Model: DSPB-K

1. Run or Program Mode – SW1
2. Reset Switch – SW2
3. Control Port – J3
4. Connection Port (DSPB-KE) – J1
5. Micro USB Power Port – J2
6. Control Port – J4
7. Programming Port – J11
8. POT4: Stereo Gain
9. POT3: Stereo High-pass Adjustment
10. POT2: Sub Low-pass Adjustment
11. POT1: Sub Gain

SW1	MODE	FUNCTION
①	RUN	Audio Output
②	PROG	Programming

Kernel DSP Expansion 2-In 3-Out
Quick Start Wiring Guide
Model: DSPB-KE

1. Connection Port (DSPB-K) – J4
2. RCA Out Left – J9
3. 3.5mm Output – J7
4. RCA Out Right – J6
5. Audio Output Header – J8
6. RCA Out Sub – J10
7. Audio Input Header – J3
8. RCA Input Right – J5
9. 3.5mm Input – J1
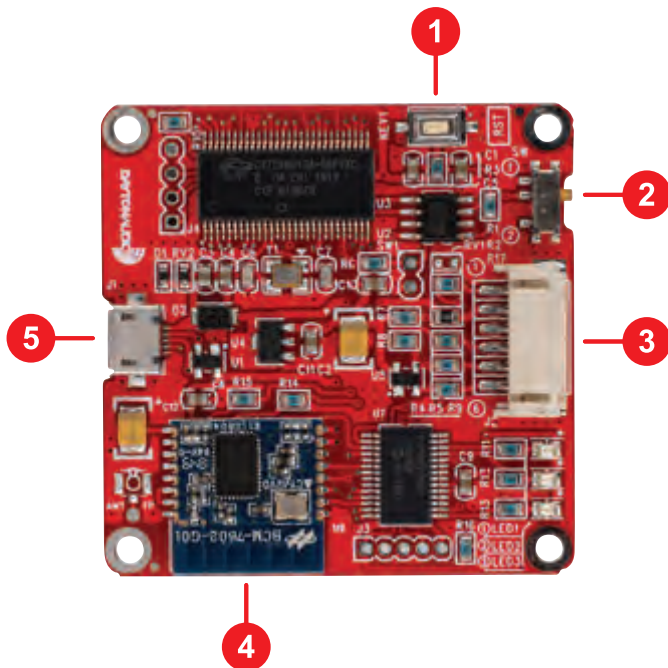10. RCA Input Left – J2

In-Circuit Programmer USB and BLE Connection
Quick Start Wiring Guide
Model: DSPB-ICP1

1. Reset Button – KEY1
2. Control Switch for APP or SigmaStudio Control Mode – SW
3. Programming Port for DSPB – J2
4. Bluetooth BLE Module
5. Micro USB Port for PC Connection with SigmaStudio – J1

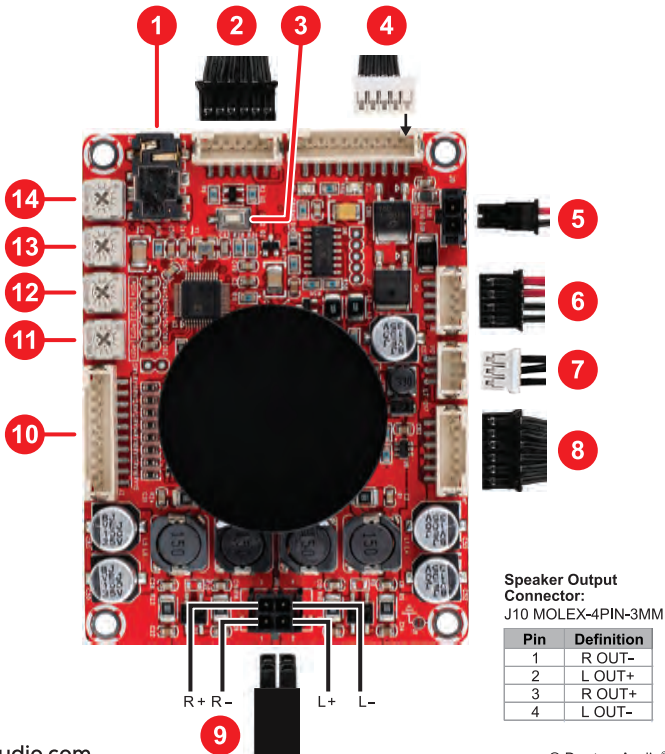| SW1	MODE	FUNCTION
①	USB	SigmaStudio
②	BLE	APP

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2x50W Class D Audio Amplifier Board with DSP
Quick Start Wiring Guide
Model: DSPB-250

1. 3.5 mm Headphone Jack – J3
2. Audio Expansion Port – J5
3. Reset Switch – SW2
4. AUX IN Port – J6
5. Power Supply Port – J9
6. Battery Board Port – J8
7. Switch Control Port – J12

8. Programming Port – J4
9. Speaker Output Port – J10
10. DSP Expansion Port – J2
11. POT1: Output Audio Gain Control – J3 & J5
12. POT2: High-pass Filter Control – J3 & J5
13. POT3: High-pass Filter Control for Speaker Output – J10
14. POT4: Master Volume Control – J10, J5, J3

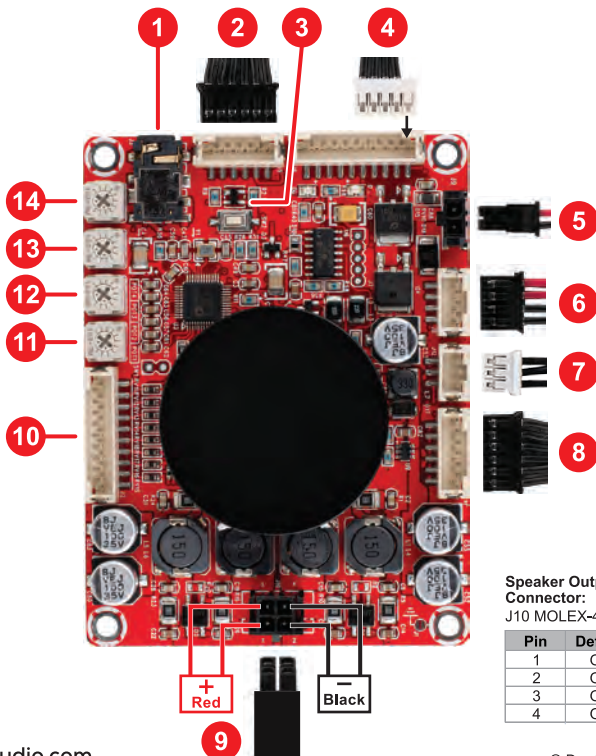R + R −   L+   L−

Speaker Output Connector:
J10 MOLEX-4PIN-3MM

Pin	Definition
1	R OUT−
2	L OUT+
3	R OUT+
4	L OUT−

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100W Class D Mono Audio Amplifier Board with DSP
Quick Start Wiring Guide
Model: DSPB-100

1. 3.5mm Line Output Port – J3
2. Audio Expansion Port – J5
3. Reset Switch – SW2
4. AUX IN Port – J6
5. Power Supply Port – J9
6. Battery Board Port – J8
7. Switch Control Port – J12
8. Programming Port – J4
9. Speaker Output Port – J10
10. DSP Expansion Port – J2
11. POT1: Output Audio Gain Control – J3 & J5
12. POT2: High-pass Filter Control – J3 & J5
13. POT3: Band Pass Filter Control for Speaker Output – J10
14. POT4: Master Volume Control – J10, J5, J3

Speaker Output Connector:
J10 MOLEX-4PIN-3MM

Pin	Definition
1	OUT+
2	OUT-
3	OUT+
4	OUT-

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