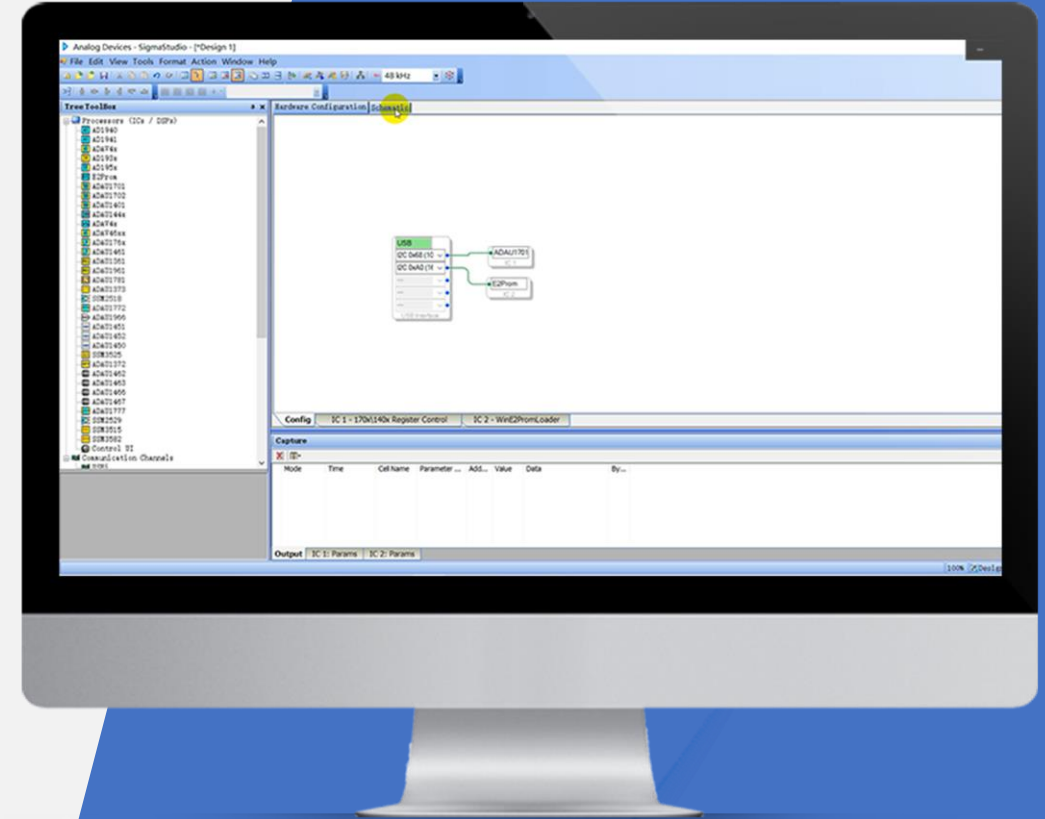


How to Program WONDOM Products with ADAU1701 through SigmaStudio

By Sure Electronics



Overview

ADAU1701 is a high performance digital signal processor of Analog Devices Inc. We have developed many products integrated with ADAU1701, which support programming via SigmaStudio after connection with our programming boards.

This document is meant to show you how to program WONDOM ADAU1701 DSP products with SigmaStudio.



Preparation

We need to know the products and software that we need before start.
In this part, we will focus on introduction of WONDOM products integrated with DSP and ICP programmers.



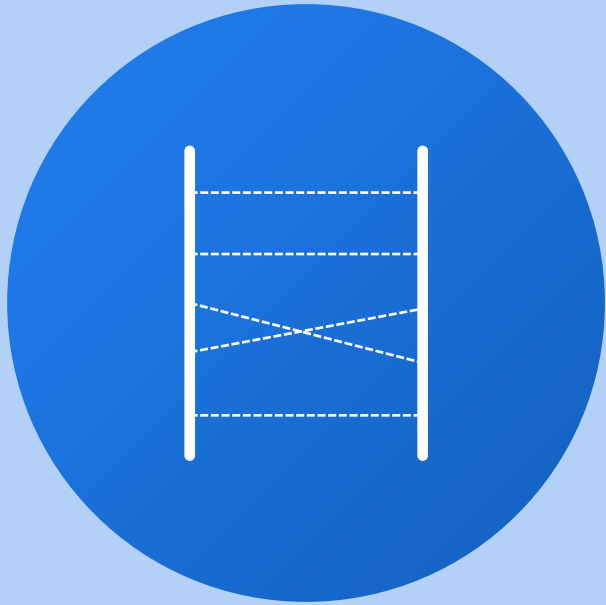
Configuration

In this part, we will give you a brief introduction of SigmaStudio interface and some documents you may need.



Examples

We will demonstrate to write basic programs based on WONDOM DSP products for your reference, so that you can get started quickly.



Preparation

We need to know the products and software that we need before start.

In this part, we will focus on introduction of WONDOM products integrated with DSP and ICP programmers.

Products List – with ADAU1701 DSP

The following are the products list of WONDOM products that are integrated with ADAU1701 DSP.

The functions vary to different products. Please select to your requirements.

| Model | Description | SS Program | APP Control | PC UI Control |
|-------|--|------------|-------------|---------------|
| APM2 | 2-in, 4-out ADAU1701 DSP Kernel Board | Y | Y | Y |
| JAB3 | Mono / Stereo Class D Audio Amplifier Board Integrated with ADAU1701 DSP | Y | Y | Y |
| JAB3+ | Mono / Stereo Audio Amplifier Board Integrated with ADAU1701 DSP & BT V5.0 | Y | N | Y |
| JAB4 | 4CH 30W Audio Amplifier Board Integrated with ADAU1701 DSP & BT V5.0, Supporting Configuration as 4.0 / 2.1 / 2.0 / 0.2 Output Mode | Y | N | Y |
| JAB5 | 4CH 100W Audio Amplifier Board Integrated with ADAU1701 DSP & BT V5.0, Supporting Configuration as 4.0 / 2.1 / 2.0 / 0.2 Output Mode | Y | N | Y |

Products List – ICP Series

Different ICP products support different functions. Please select to your requirements.

| Model | Description | SS Program | APP Control | PC UI Control |
|-------|---|------------|-------------|---------------|
| ICP1 | In-Circuit Programmer | Y | N | N |
| ICP3 | In-Circuit Programmer Integrated with Bluetooth BLE | Y | Y | N |
| ICP5 | In-Circuit Programmer Integrated with Bluetooth BLE & USB to UART | Y | Y* | Y |

* The function only works when both products with ADAU1701 DSP and the ICP board support it, i.e. JAB3+ doesn't support APP control, so even if you buy ICP3 or ICP5 that supports APP control, JAB3+ still cannot support APP control after connection.



Software - SigmaStudio

If you never install SigmaStudio, you can click the following link for download and installation.

<https://www.analog.com/sigmastudiowindow>

It's highly suggested that you remember the following link for official support. You can find algorithm information, tutorials, examples and other useful documentation as reference.

[SigmaStudio and SigmaDSP Documentation \[Analog Devices Wiki\]](https://www.analog.com/en/design-center/evaluation-modules/stm32/stm32f429-discovery-board/sigmastudio-and-sigmadsp-documentation.html)

SigmaStudio Toolbox

[Click here to return to the SigmaStudio and SigmaDSP Documentation top page.](#)

The Toolbox contains the building blocks for constructing a system design. The available blocks will depend on the [DSP](#) processor(s) used in the project.

Click a category to access detailed algorithm information. In most cases you can also select an algorithm in SigmaStudio, then press F1, to directly access its Wiki page.

- **System**
- **ADI Algorithms**
- **Advanced DSP**
 - Adaptive Mixer, Hilbert Transform
- **Basic DSP**
 - Delay, [DSP Functions](#), Arithmetic Operations, Gain Cells, Logic, Index Lookup Tables
- **Counters**
- **Dynamics Processors**
 - Single-Band Compressors, Multi-Band Compressors, Limiters
- **Filters**
 - FIR Filters, Adaptive FIR Filters, Second Order Filters, Parametric Filters, Crossover, Miscellaneous Filters
- **Frequency Domain** (ADAU145x, ADAU146x, [ADSP-2158x](#), and [ADSP-SC58x](#) only)
 - FFT, IFFT, Windows
- **GPIO Conditioning**
 - Pushbuttons, Volume Controls, Rotary Encoders, Debounce
- **Input / Output**
 - Input/Output from/to hardware: ASRC, SPDIF, GPIO, Serial Ports, Interface Write/Read
- **Integrating**

Documentation

Toolbox (Detailed Algorithm Information)
This section contains detailed

Tutorials, Examples, and Documentation
This section contains tutorials

Installation Procedure
This section describes how to install

Development Environment
This section contains information

Using SigmaStudio
This section describes the basic

SigmaDSP Architecture
This section contains details about

Supported ICs
This section describes the list of

Release Information
This section contains features and

| Table of Contents |
|--|
| • SigmaStudio and SigmaDSP Documentation |
| • Documentation Sections |
| • Getting Support |
| • Helpful Hints |
| • Feature Wishlist |

[Click here to return to the SigmaStudio and SigmaDSP Documentation top page.](#)

Click the left sidebar to navigate between topics.
[Analog Devices Wiki](#) support forum.

Support was also added for [SHARC](#) processors to add quality digital signal processing blocks at the same time focusing on more complex blocks, as in a schematic, and

digital ones; yet it is powerful enough to handle complex blocks without sacrificing quality or



Configuration

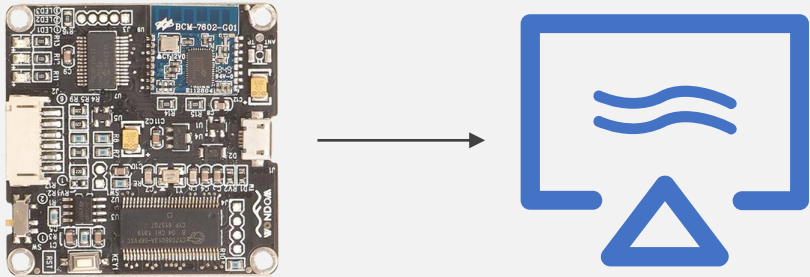
In this part, we will give you a brief introduction of SigmaStudio interface and some documents you may need.



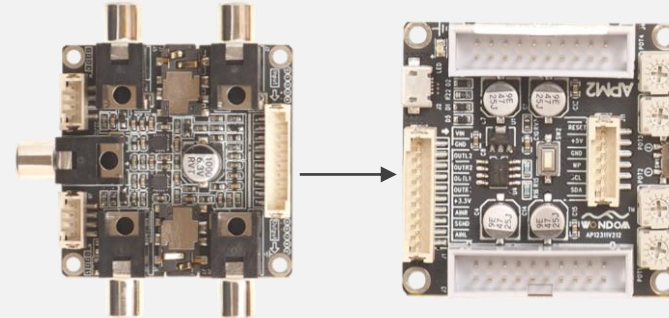
Hardware Connection

We will take connection of APM2 and ICP3 as an example here.
Connection based on other products are similar.

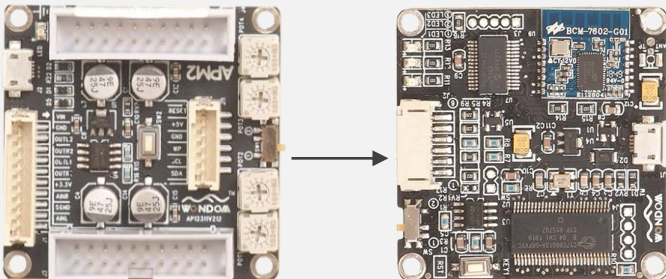
- ① Connect ICP3 to PC, run SigmaStudio, create a new project, drag “USBi”, “ADAU1701”, “E2Prom”, complete logic connection to see if ICP3 has been recognized successfully;



- ② Connect APM2 & APM3, connect audio source and speakers, power up the system



- ③ Connect APM2 with ICP3 through a 6-pin cable



- ④ Write program





Brief Interface Introduction

Devices

ICs/DSPs & USB
Communication
module

Hardware Configuration

Drag corresponding DSP & USB communication
module and complete logic connection



Brief Interface Introduction

Devices
ICs/DSPs & USB Communication module

Hardware Register
This page appears when ADAU1701 is dragged into hardware configuration section. GPIOs are set here.

The screenshot shows the SigmaStudio Hardware Configuration window for the ADAU1701. The left pane lists various components, including processors (ICs / DSPs) and USB communication modules. The main area displays the hardware configuration for the ADAU1701, including the DSP Core, Serial Input, Serial Output, and GPIO configuration. The GPIO configuration table is visible, showing pins MP0 through MP11, all set to Low, Input, with a 20ms debounce time. The bottom pane shows the Output section with IC 1: Params and IC 2: Params.

| Pin | Value | Direction | GPIO Debounce | Inv |
|------|-------|-----------|---------------|-----|
| MP0 | LOW | Input | GPIO Debounce | |
| MP1 | LOW | Input | GPIO Debounce | |
| MP2 | LOW | Input | GPIO Debounce | |
| MP3 | LOW | Input | GPIO Debounce | |
| MP4 | LOW | Input | GPIO Debounce | |
| MP5 | LOW | Input | GPIO Debounce | |
| MP6 | LOW | Input | GPIO Debounce | |
| MP7 | LOW | Input | GPIO Debounce | |
| MP8 | LOW | Input | GPIO Debounce | |
| MP9 | LOW | Input | GPIO Debounce | |
| MP10 | LOW | Input | GPIO Debounce | |
| MP11 | LOW | Input | GPIO Debounce | |

| Register | Address | Value |
|-------------|---------|------------------------------------|
| Core | 2076 | b 00000000011100 |
| SerialOut1 | 2078 | b 0000000000000000 |
| SerialInput | 2079 | b 000000 |
| MpCfg0 | 2080 | b 000000000000000000000000 |
| MpCfg1 | 2081 | b 00000000000000000000000000000000 |
| AnalogPower | 2082 | b 0000000000000000 |



Brief Interface Introduction

**Schematic
Toolbox
Algorithms
& Modules**

Schematic Design

Drag desired algorithm here and complete the logic connection

The screenshot displays the SigmaStudio software interface. The main workspace shows a schematic diagram with a multi-bit input (Input1) connected to a single-bit signal (Single1), which is then connected to two DACs (DAC0 and DAC1) labeled Output1 and Output2. The TreeToolBox on the left lists various components like Simulation Probe, Simulation Stimuli, I Connection, Speaker Response, ADI Algorithms, Advanced DSP, Basic DSP, Counters, Custom Algorithms, Dynamics Processors, GPIO, Input, Output, Level Detectors/Lookup Tables, Mixers/Splitters, Muxes/Demuxes, Sources, Volume Controls, Single/Multiple Controls, No Slew (Standard), Single Volume, Multiple Volume C, and Shared Slider. The Output panel on the right shows 'Action Output' and 'Action'. The bottom status bar indicates '100% Design Mode'.



DSP Products Pin Definition

WONDOM products integrated with ADAU1701 DSP are equipped with terminal interfaces for various functions. You can get the detailed introduction in datasheet. Please find the documentation in the detailed product page on our website.

| Model | Document |
|-------|---|
| APM2 | AA-AP23122 ADAU1701 Kernel Board |
| JAB3 | Audio Amplifier Boards Integrated with ADAU1701 DSP |
| JAB3+ | Audio Amplifier Boards Integrated with ADAU1701 DSP & Bluetooth V5.0 |
| JAB4 | 4CH 30W Audio Amplifier Boards Integrated with ADAU1701 DSP & Bluetooth V5.0 |
| JAB5 | 4CH 100W Audio Amplifier Boards Integrated with ADAU1701 DSP & Bluetooth V5.0 |



ICP Programmer Pin Definition

ICP series is self-developed programming board, which can be used with WONDOM DSP products. After connection with ICP programmer, DSP products can support programming and remote control (It's up to specific product). Please find the user guide in the detailed product page on our website.

| Model | Document | Video |
|-------|--|-----------------------|
| ICP1 | WODNOM ICP1 User Guide - Programming | - |
| ICP3 | WODNOM ICP3 User Guide – Programming & APP Control | Watch |
| ICP5 | WODNOM ICP5 User Guide – Programming, APP & PC UI Control | - |



Demo Programs for Programming

Here are the demo programs for the products. You can download them for reference. The demo program is only for demonstration of signal flow chart.

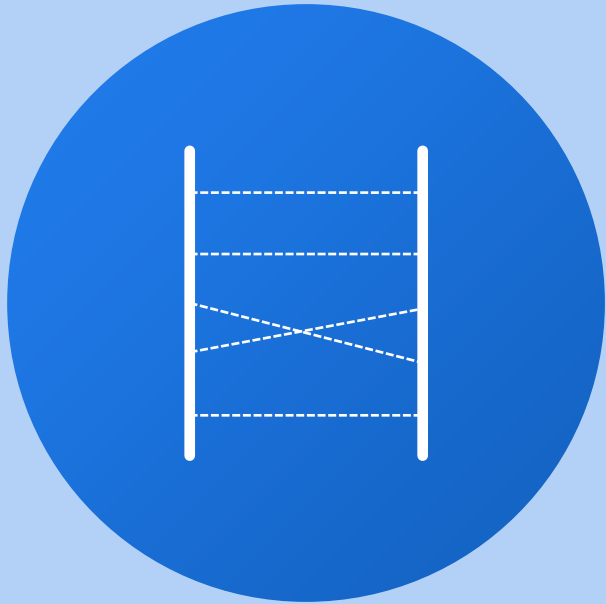
| Products | Demo Program | Document you may need |
|---------------|---|--------------------------|
| APM2 | APM2_SigmaStudio.dspproj | Download |
| JAB3 - Mono | JAB3_SigmaStudio_MONO.dspproj | Download |
| JAB3 - Stereo | JAB3_SigmaStudio_STEREO.dspproj | |
| JAB3+ | JAB3+_Stereo_ADAU1701_DEMOProgram.dspproj | Download |
| JAB4 | JAB4_ADAU1701_DEMOProgram.dspproj | - |
| JAB5 | JAB5_ADAU1701_DEMOProgram.dspproj | Download |



Resources Correspondence

WONDOM products are developed based on ADAU1701 DSP. We have made use of ADAU1701 resources to provide basic functions like audio input & output, control. Therefore, it's necessary for us to understand the correspondence relationship between the hardware and program for further development.

| Model | Document | Video |
|-------|--|-----------------------|
| APM2 | The correspondence between APM2 hardware and program | - |
| JAB3 | How to develop JAB3 & Integrated ADAU1701 DSP | Watch |
| JAB3+ | How to program JAB3+ through SigmaStudio | Watch |
| JAB5 | How to program JAB5 through SigmaStudio | Watch |



Examples

We will demonstrate to write basic programs based on WONDOM DSP products for your reference, so that you can get started quickly.

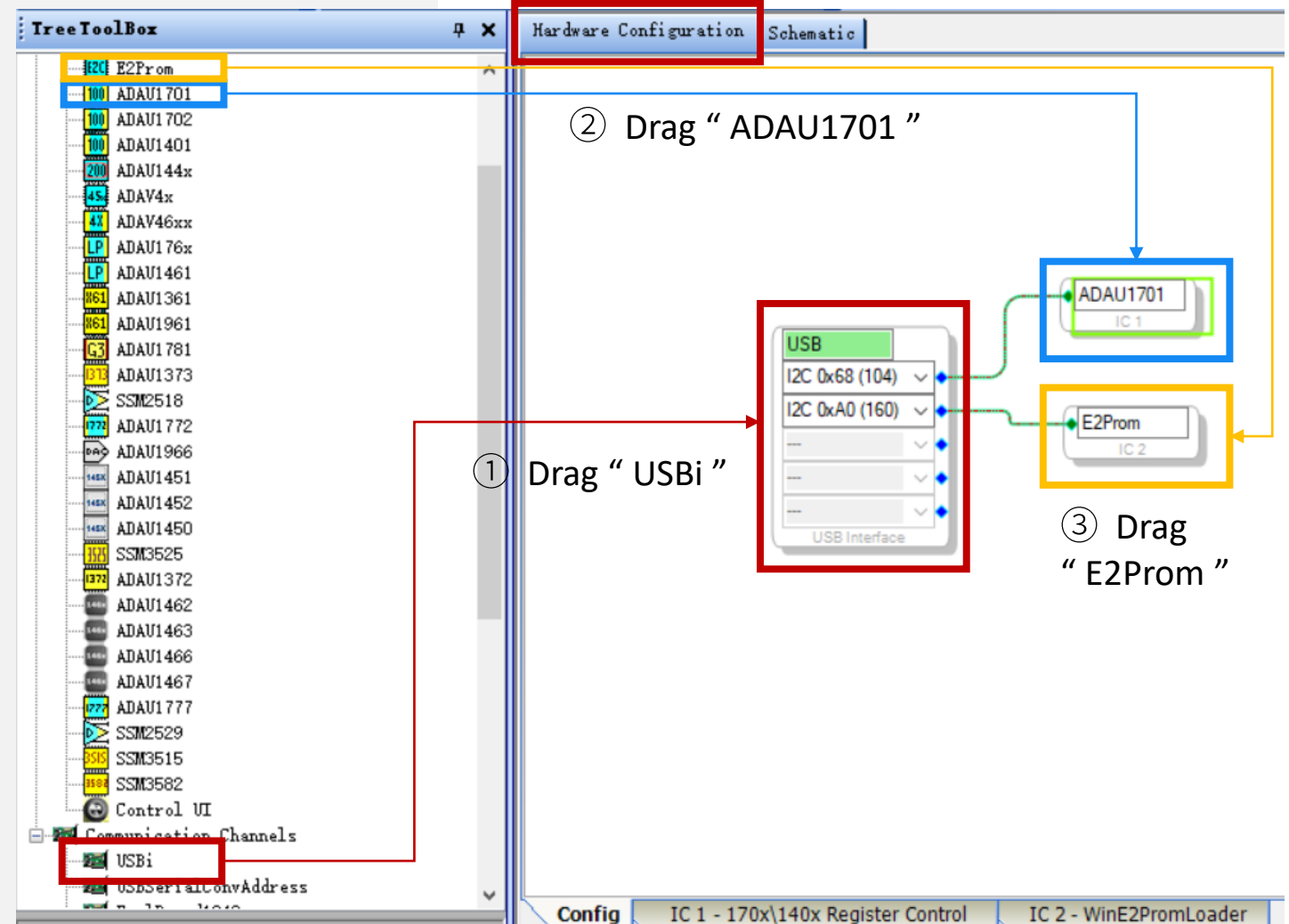


Basic Program

First step, double click to run SigmaStudio. Then click “File”-->“New Project” to create a new project.

Second step, after connecting ICP programmer to PC, find “USBi”、 “ADAU1701”、 “E2Prom” in “TreeToolBox” and then drag them into “config” section. Please pay attention to order to ensure that ADAU1701 shows IC1 and E2Prom shows IC2.

If USBi displays in green, it means ICP has been recognized successfully; If it's orange, please try to reconnect ICP.

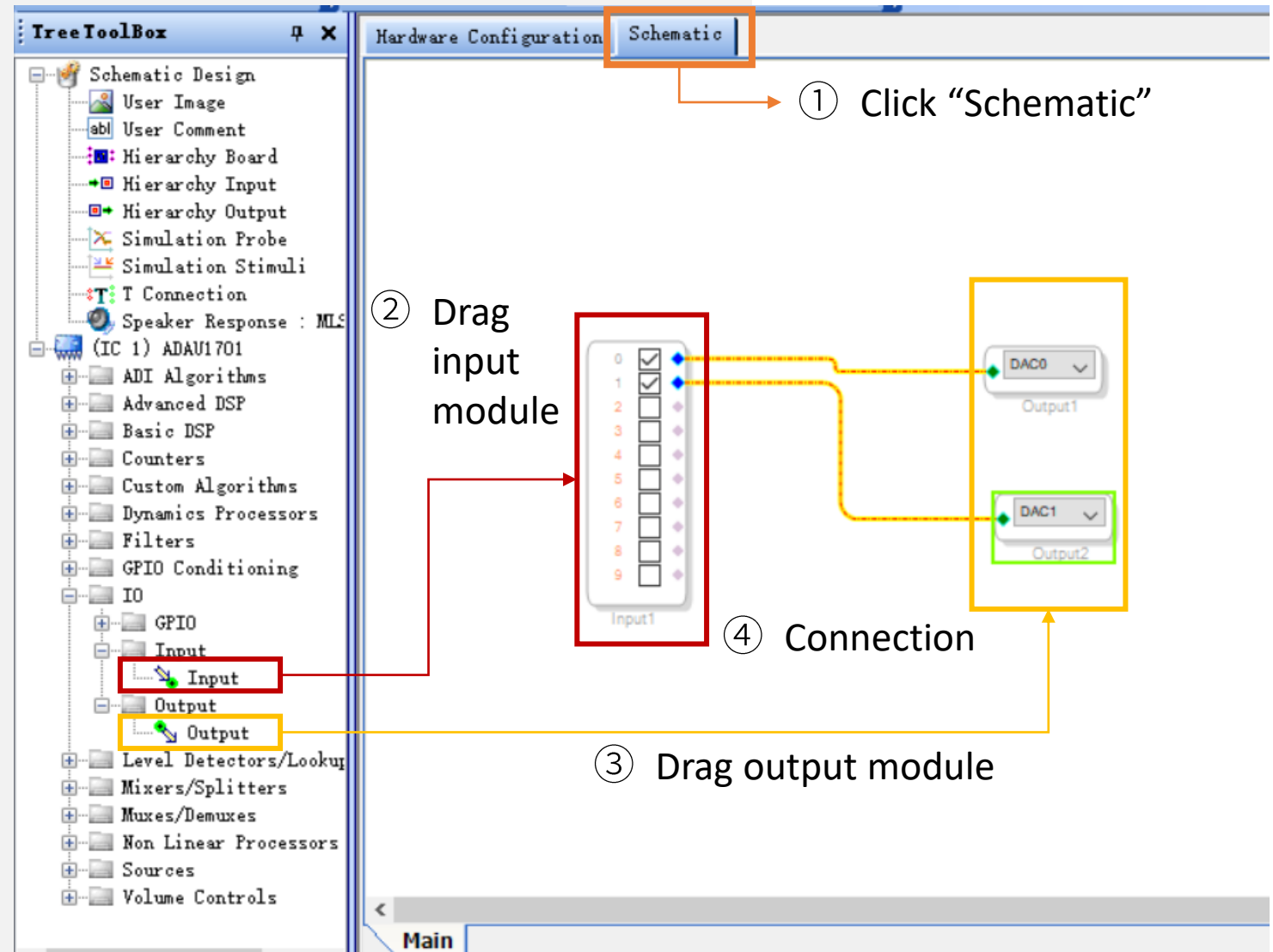




Basic Program – Bypass

Let's write a bypass program at first.

- ① Click "Schematic" to enter schematic design section
- ② Drag "IO"- "Input"- "Input" to design section from "TreeToolBox" . We can see 0 & 1 of input module are ticked. They are for analog input.
- ③ Drag "IO"- "Output"- "Output" . We want stereo output, so we need to drag two output modules. Stereo output on APM3 are corresponded with DAC0 & DAC1.
- ④ Complete logic connection between input and output modules.



(编写程序)



Basic Program – Bypass

Download finished program into DSP. Please note, here, download refers to online simulation under debug mode. The program will be lost once the power is off. If you need to operate offline, please refer to “Program Writing” chapter.

- ⑤ Click “Link Compile Download” on the menu to download program into ADAU1701, as shown below
- ⑥ If it shows “Active: Downloaded” at the bottom right corner, program is downloaded successfully
- ⑦ Play music to see if there is music playing from speakers



(Program Download)

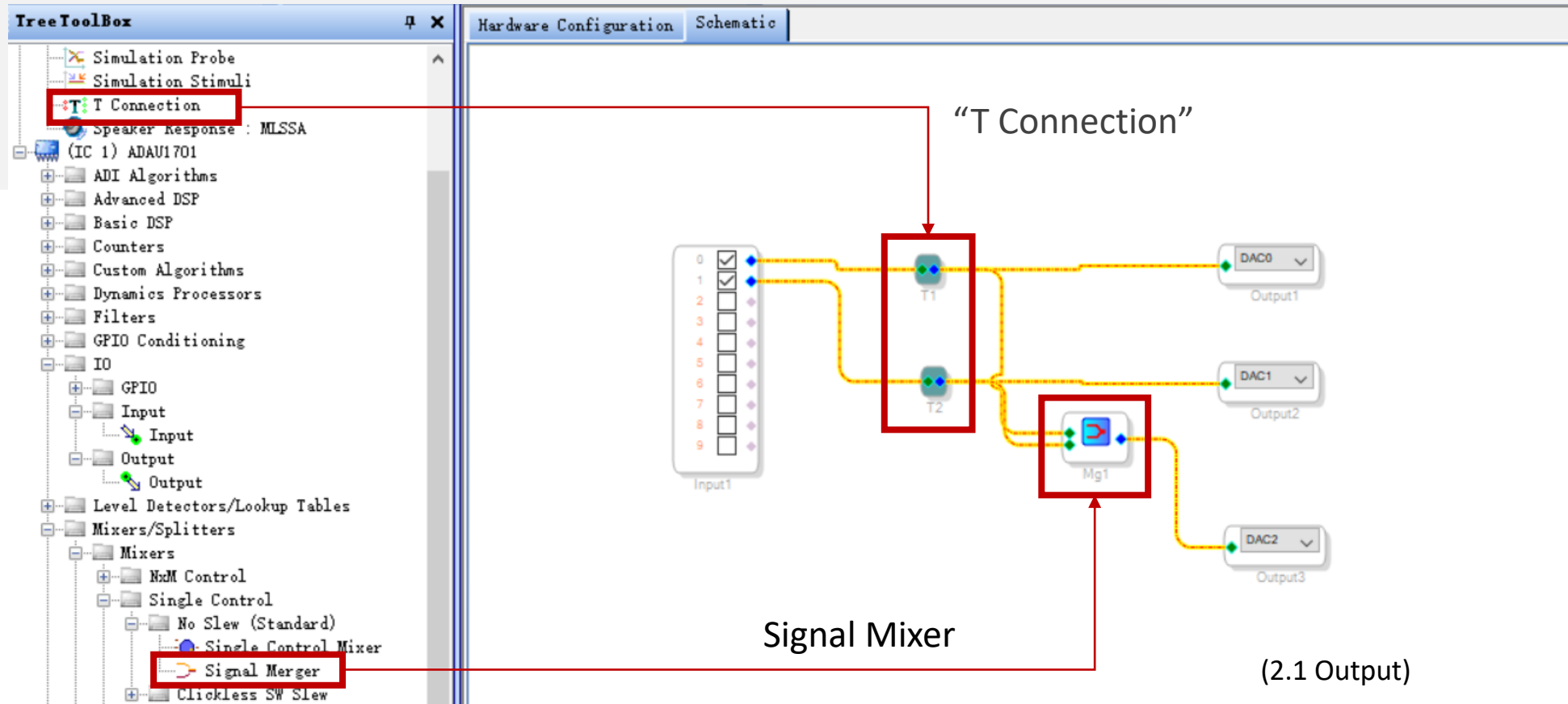


(Download Success)



Basic Program – Bypass

APM2 is the kernel board and APM3 is the matched 2-in, 3-out interface board. In last example, we write stereo output. What if we want subwoofer output for 2.1 system? We can drag another output module, then mix left and right channel.





Basic Program – Volume Control

How to adjust overall volume? We need to make use of “Volume Controls” modules. There are many functions in this module group. We will use one for demonstration only. You can explore other modules on your own.

Put volume control module into design section as below. You can adjust overall volume by dragging the slider. Put cursor on this module, then right click without selecting it, you will find detailed settings of volume control, such as max value, steps, etc.

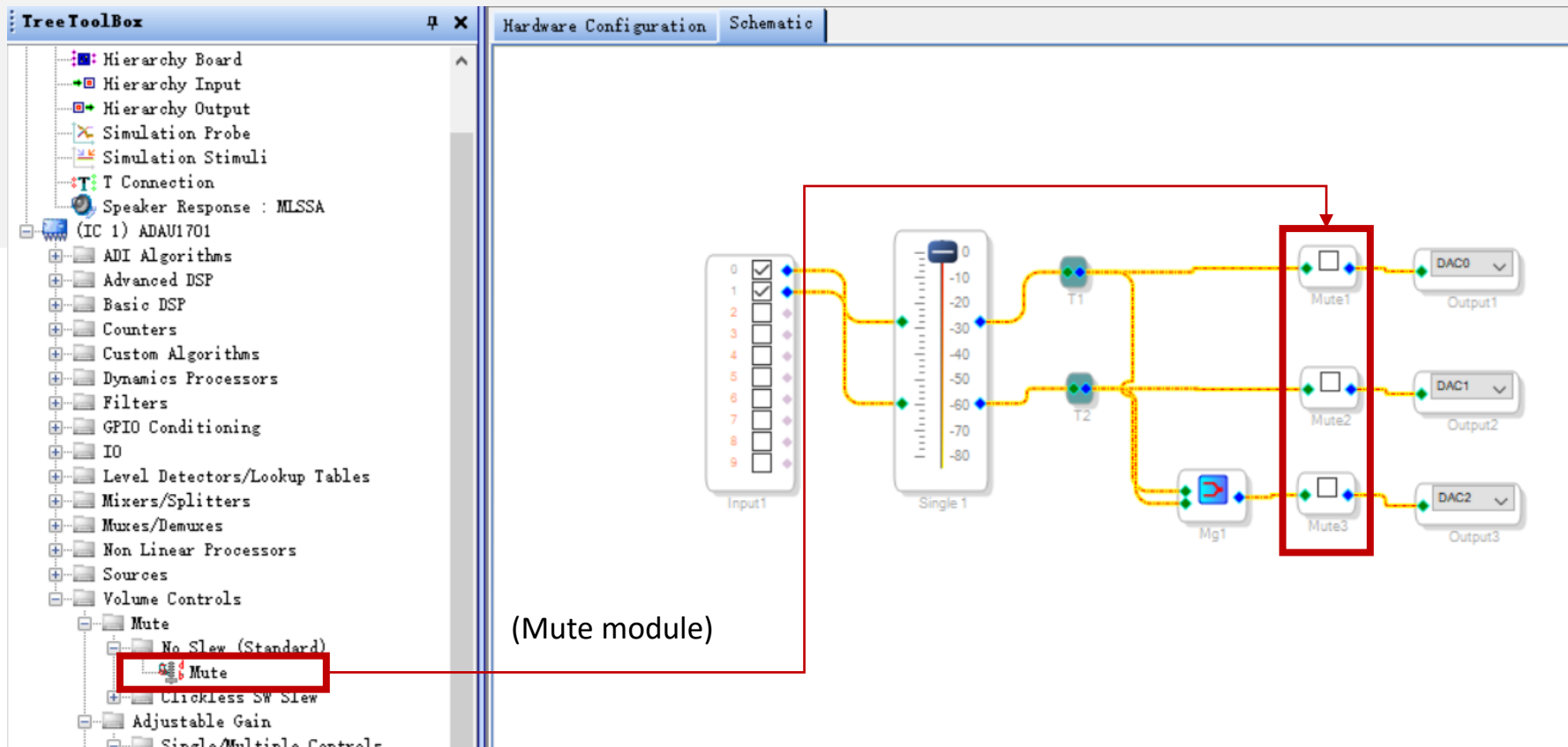
The screenshot shows the hardware configuration software interface. On the left is the 'TreeToolBox' containing various modules. Under 'Volume Controls', 'Single Volume' is highlighted with a red box. A red arrow points from this box to a 'Single 1' volume control module in the schematic diagram, with the text '(Drag input module)' below it. The schematic diagram shows 'Input1' connected to 'Single 1', which is then connected to two mixers 'T1' and 'T2'. 'T1' is connected to 'DAC0' (Output1), and 'T2' is connected to 'DAC1' (Output2) and 'Mg1' (Output3). A context menu is open over the 'Single 1' module, showing options like 'Cell Settings', 'Add Algorithm', 'Remove Algorithm', 'Delete', 'Cut', 'Copy', 'Paste', 'ZoomToSelection', 'Exclude from Export Files', 'Algorithm Version History', and 'Disable This Control'. The 'Add Algorithm' option is selected, and a sub-menu shows 'IC 1' and 'Gain (no slew)'. To the right of the context menu, the text '(Add connection point)' is displayed. A blue box at the bottom right contains the text: 'There is only one connect point in input module. Select the module, right click and add points.'



Basic Program – Volume Control

I want to control whether a channel is mute or unmute, what should I do?

This function can be realized by “Mute” module in the “Volume Controls” group. The connection is as follows.



If the mute module is unticked, this channel plays music normally.

If it's ticked, this channel will be mute.

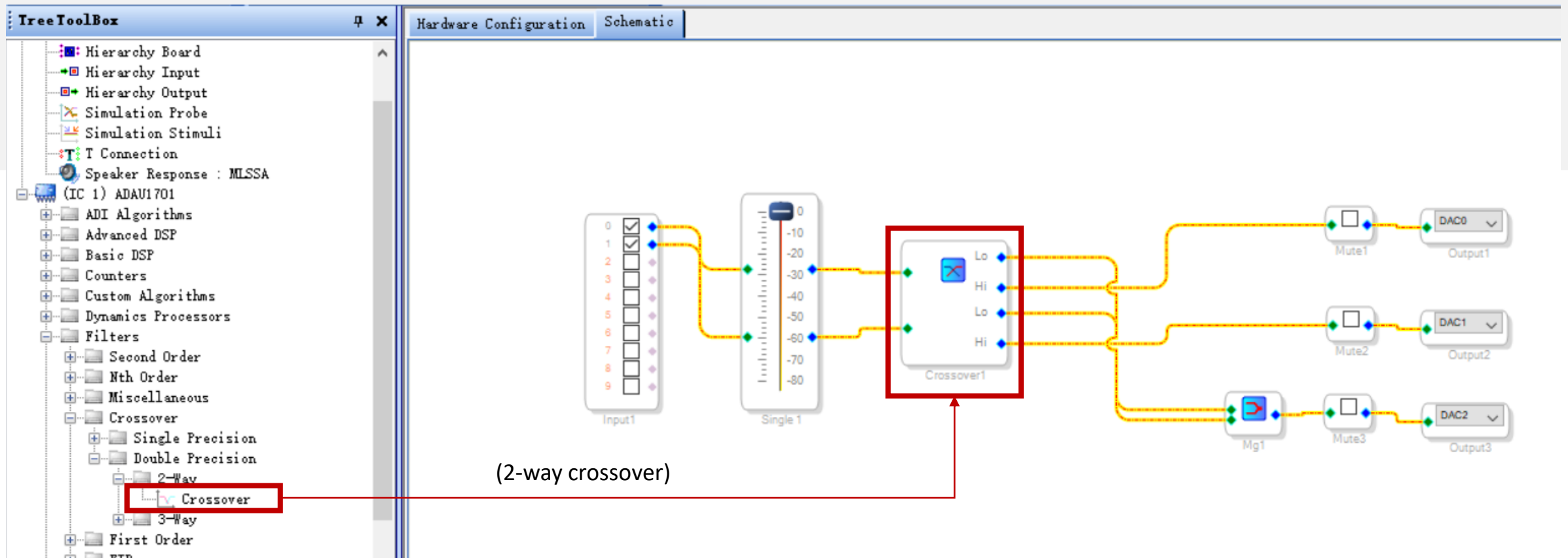
It's usually used to check if each channel works.



Basic Program – Crossover

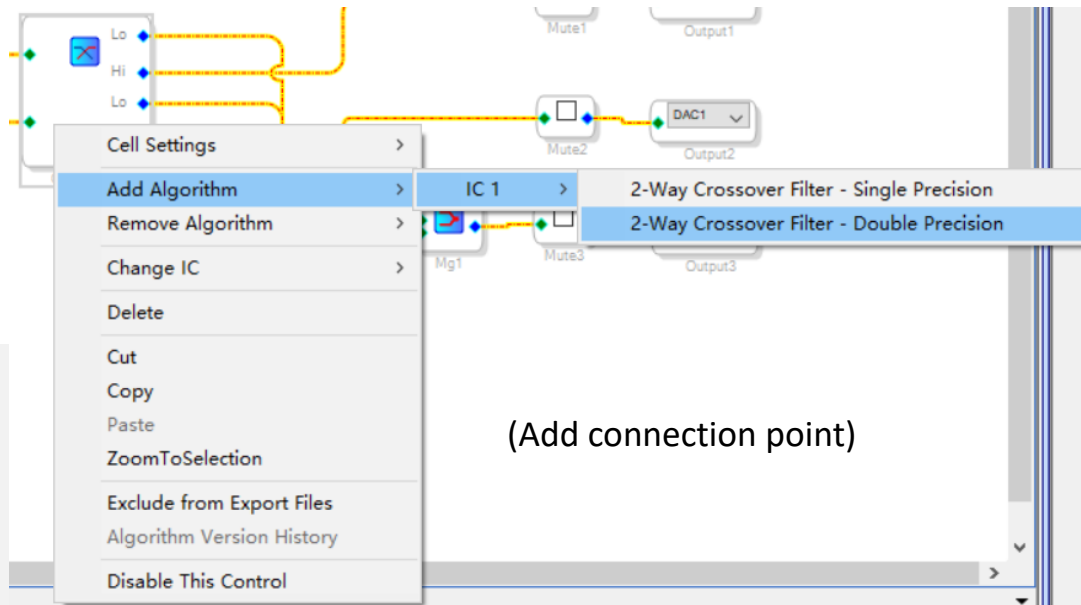
This time, let's add crossover function. We employ “Filters”-“Crossover”-“Double Precision”-“2 -Way”-“Crossover” module here. You can try other modules by yourself.

Signal Flow: Input left and right channel signal, go through volume control, each channel is split into high frequency and low frequency. The high is transmitted to stereo output while the low is mixed and transferred to subwoofer output.

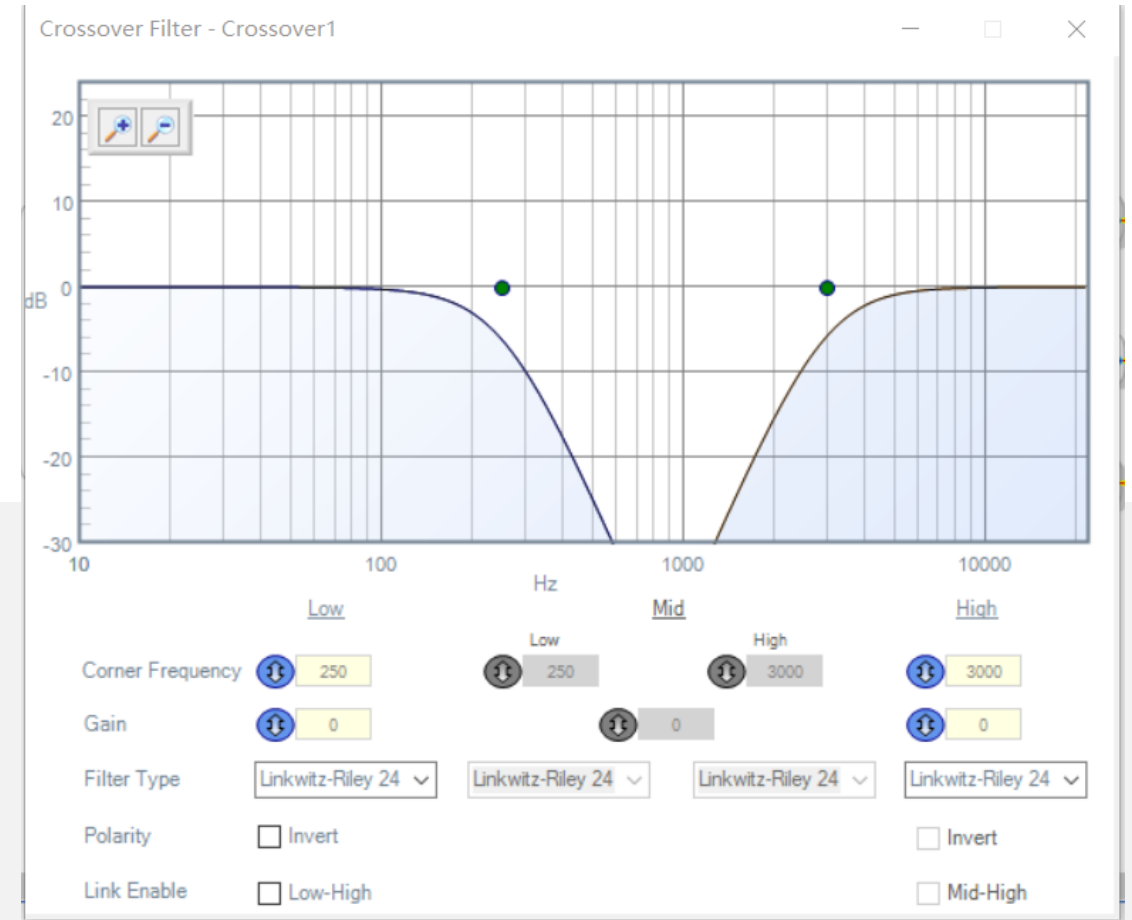




Basic Program – Crossover



If crossover module doesn't have enough the connection points, you can select the module and right click, then choose "Add Algorithm".

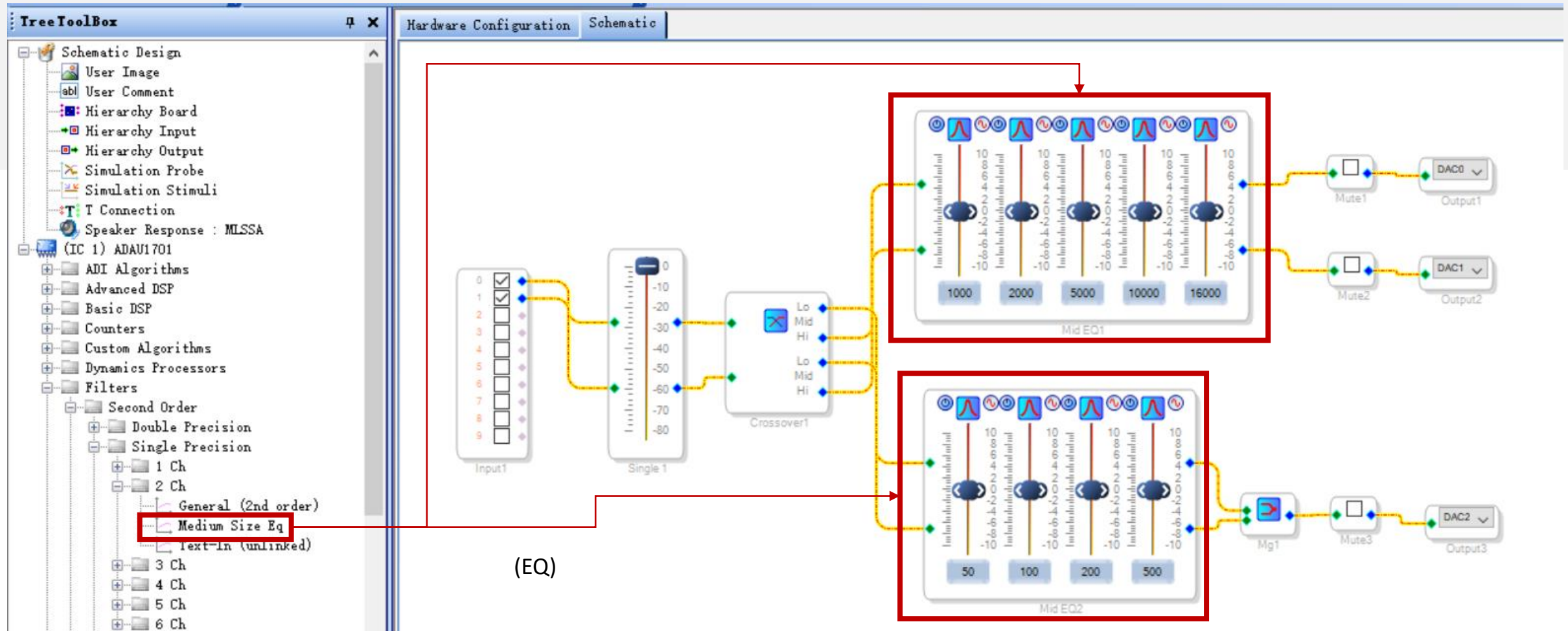


Click the curve icon of the crossover module, you can see detailed settings. You can adjust cut-off frequency, gain, filter type and polarity.



Basic Program – EQ

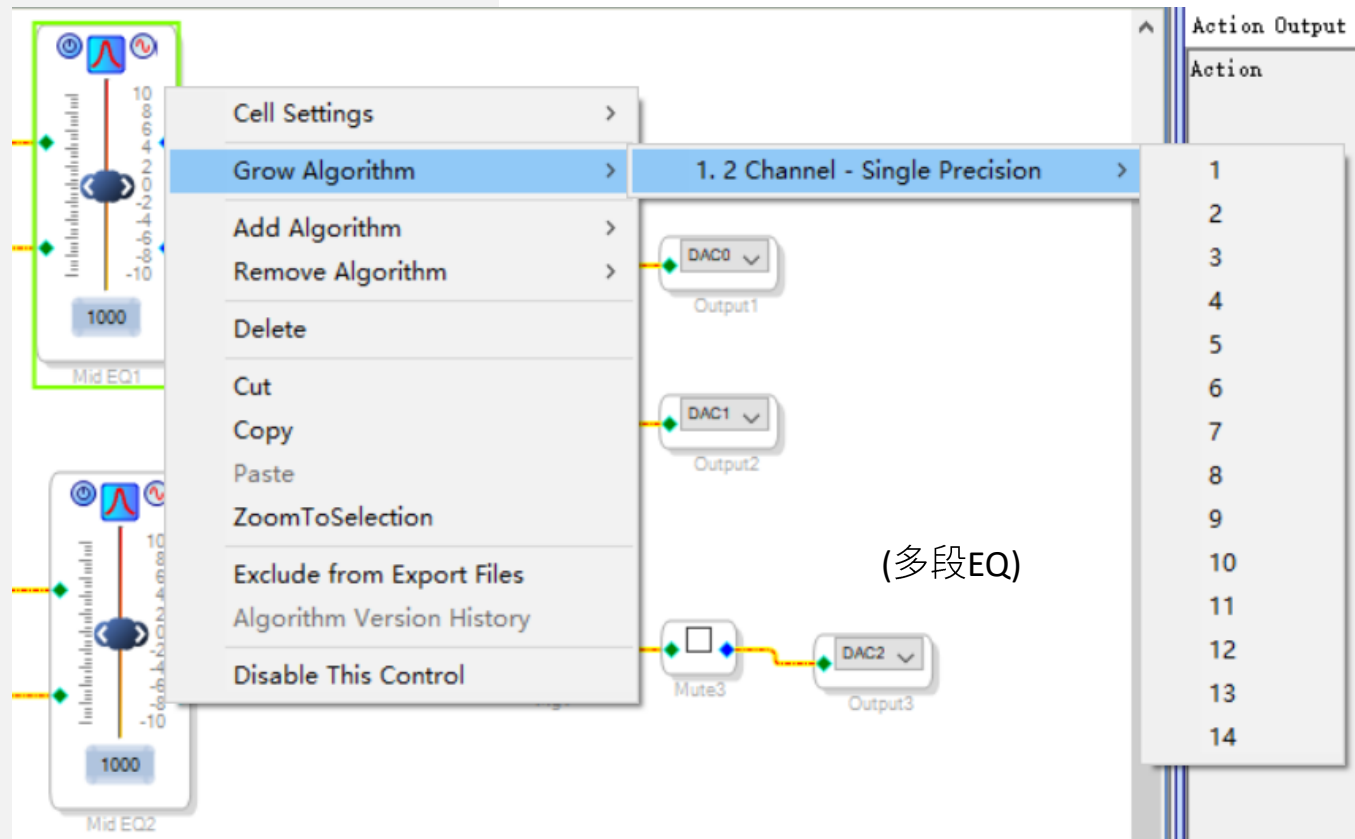
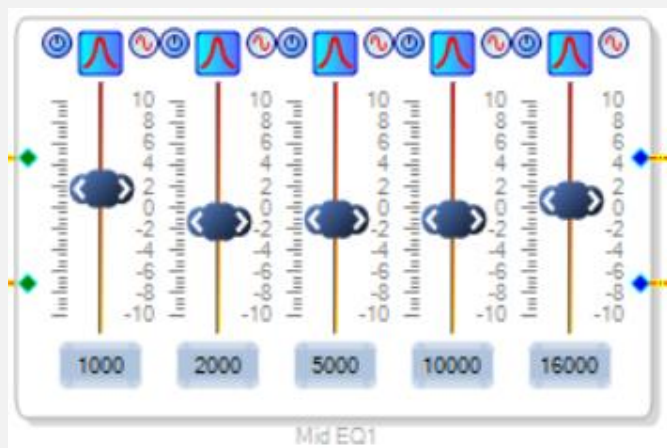
Now, we want to add EQ based on finished program, through which we can adjust gain of each frequency to achieve desired effects. Here we use “Filters”-“Second Order”-“Single Precision”-“2ch”-“Medium Size Eq” module.





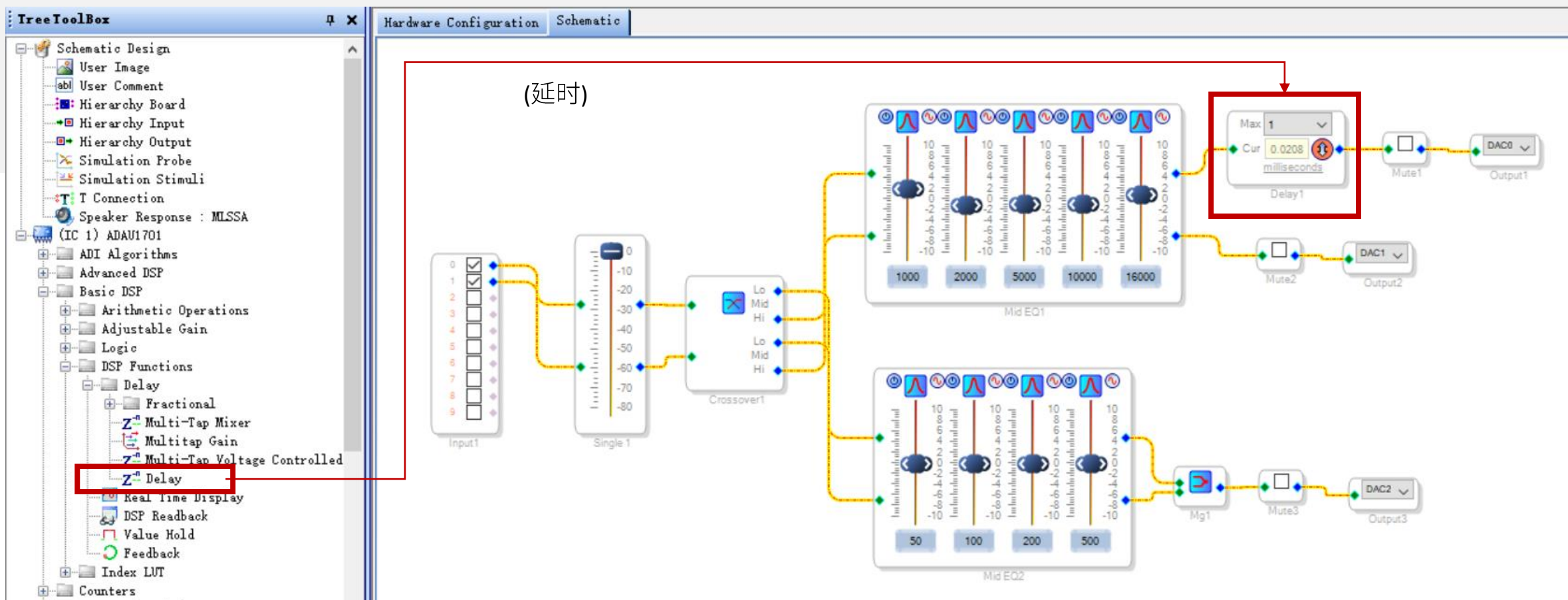
Basic Program – EQ

There is only one frequency band of the module. We can right click with it selected and choose how many bands you want. Each center frequency and gain are adjustable. Here is just for example.





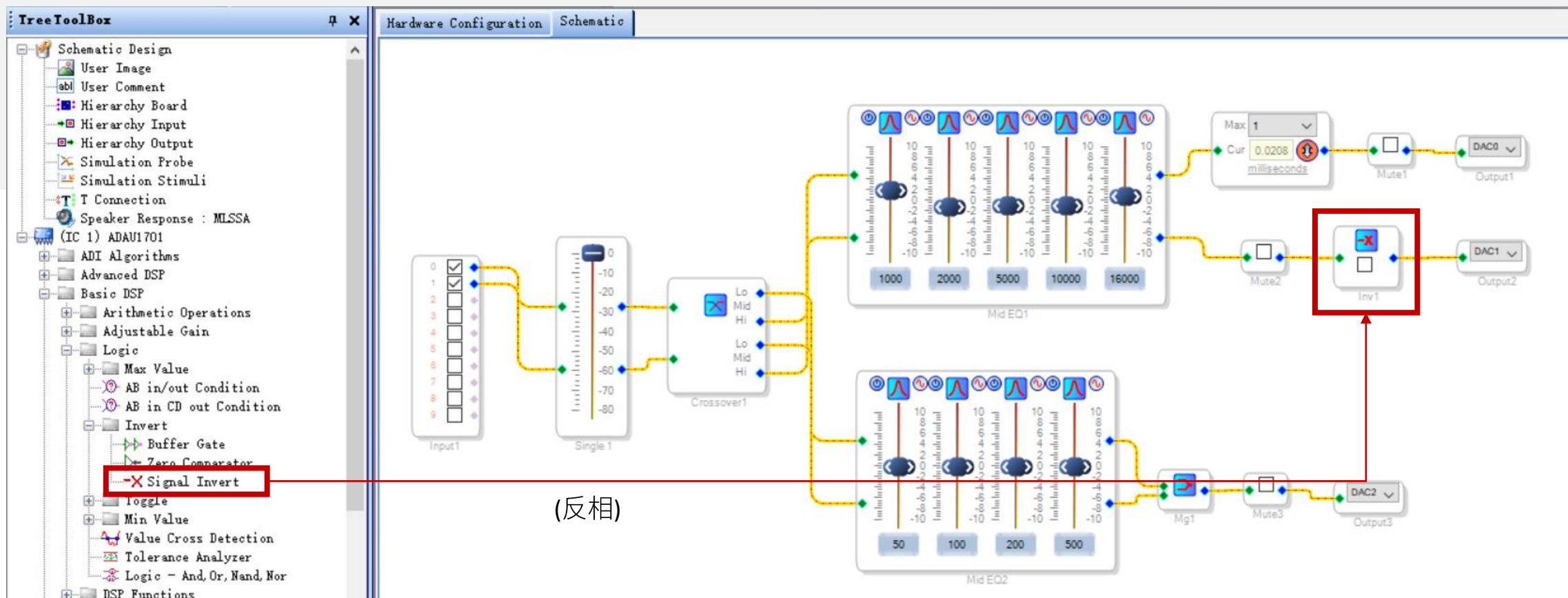
(延时)





Basic Program – Signal Invert

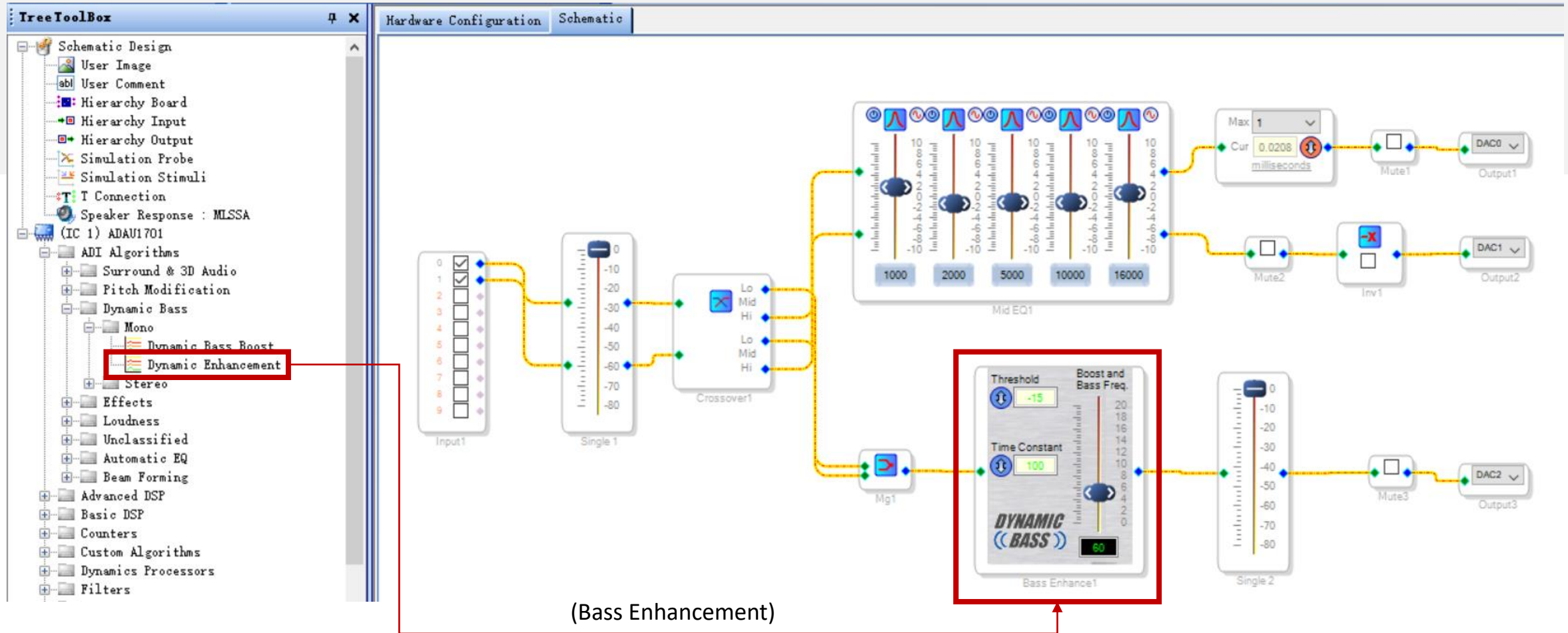
We may connect speakers reversely by accident and sometimes we don't want to reconnect. Then, we can use signal invert module. We use "Basic DSP"- "Logic"- "Invert"- "Signal Invert" module. Signal will be inverted after ticked.





Basic Program – Bass Enhancement

Many customers want bass enhancement. We can get this function through “ADI Algorithms”-“Dynamic Bass” module. You can set the parameters according to the requirements of your audio project.

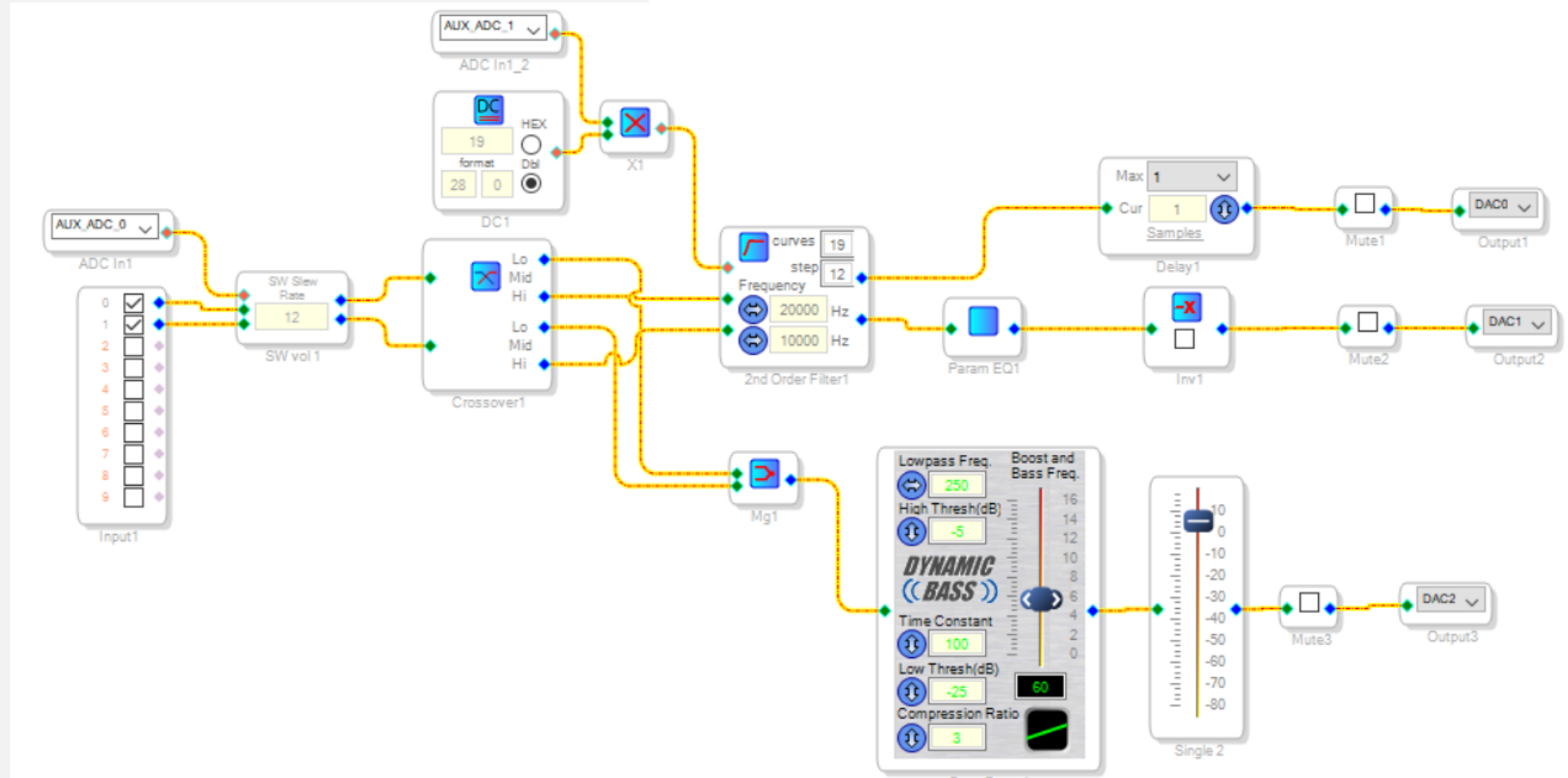




Basic Program – Potentiometers

APM2 provides four on-board potentiometers by extending resources of ADAU1701 DSP. You can use them for desired functions. Here is just for example.

Please note, if you add potentiometer modules, beside logic connection in schematic design section, you need to configure GPIO in hardware register section.

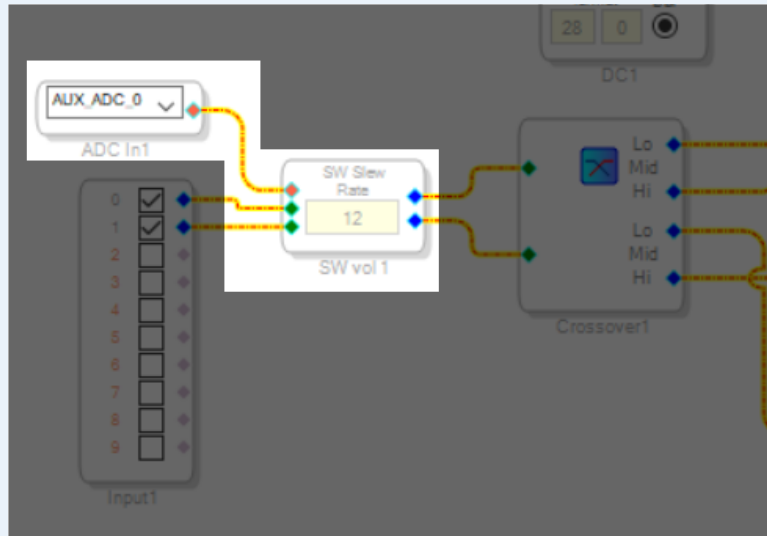




Basic Program – Potentiometers

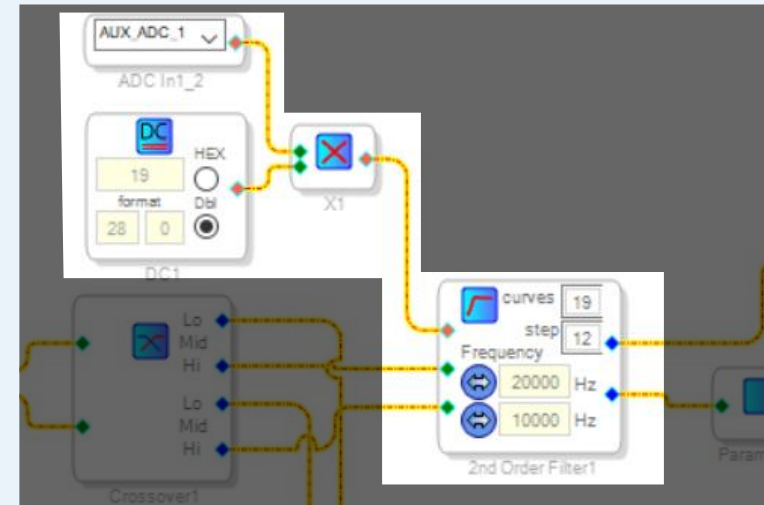
The potentiometers need to read hardware parameters then transmit to related modules for signal processing. Therefore, we need to adopt modules with control parameters.

① Overall Gain Adjustment



Employ gain control module with control parameters, drag “Auxiliary ADC Input” module, and complete logic connection

② High-pass Filter



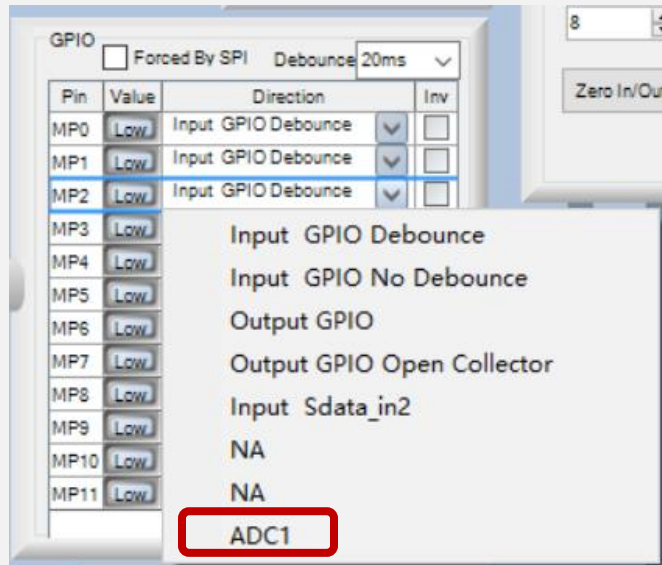
This potentiometer works as high-pass filter of stereo. The filter module divides 10k-20kHz frequency into 19 curves. The potentiometer reads hardware voltage and multiply with the value of DC input Block to convert into frequency signal, which is transferred to filter to choose corresponding curve.



Basic Program – Potentiometers

After schematic is done, we need to set GPIO in hardware register section. Otherwise, the potentiometers won't work normally.

Find the GPIO and choose the corresponding ADC in the drop-down menu.



Hardware Configuration Schematic

SDATA_IN1, SDATA_IN2, SDATA_IN3, BCLK data change

Program Length: 1x (1024 Instructi...)

RAM Module: 8

Zero In/Out Registers

GPIO

| Pin | Value | Direction | Inv |
|------|-------|---------------------|-----|
| MP0 | Low | Input GPIO Debounce | |
| MP1 | Low | Input GPIO Debounce | |
| MP2 | Low | ADC1 | |
| MP3 | Low | Input GPIO Debounce | |
| MP4 | Low | Input GPIO Debounce | |
| MP5 | Low | Input GPIO Debounce | |
| MP6 | Low | Input GPIO Debounce | |
| MP7 | Low | Input GPIO Debounce | |
| MP8 | Low | Input GPIO Debounce | |
| MP9 | Low | ADC0 | |
| MP10 | Low | Input GPIO Debounce | |
| MP11 | Low | Input GPIO Debounce | |

Ctrl_IN0, Ctrl_IN1, Ctrl_IN2, Ctrl_IN3

Control ADC

Enable: ☒ Forced by SPI: ☐

Input Filter: 4-bit Hyste...

ADC0: b 00000000, ADC1: b 00000000, ADC2: b 00000000, ADC3: b 00000000

Interface Register

Force By SPI: ☐

| Register | Address | Value |
|---------------|---------|----------------------------|
| Core | 2076 | b 00000000011100 |
| GpioAll | 2056 | b 000000000000 |
| RAM | 2077 | b 1000 |
| SerialOut1 | 2078 | b 00000000000000 |
| SerialInput | 2079 | b 00000 |
| MpCfg0 | 2080 | b 000000000000111100000000 |
| MpCfg1 | 2081 | b 000000001111100000000000 |
| AnalogPower | 2082 | b 000000000000 |
| AnalogInterfa | 2084 | b 1000000000000000 |
| AnalogInterfa | 2085 | b 00000000000000 |

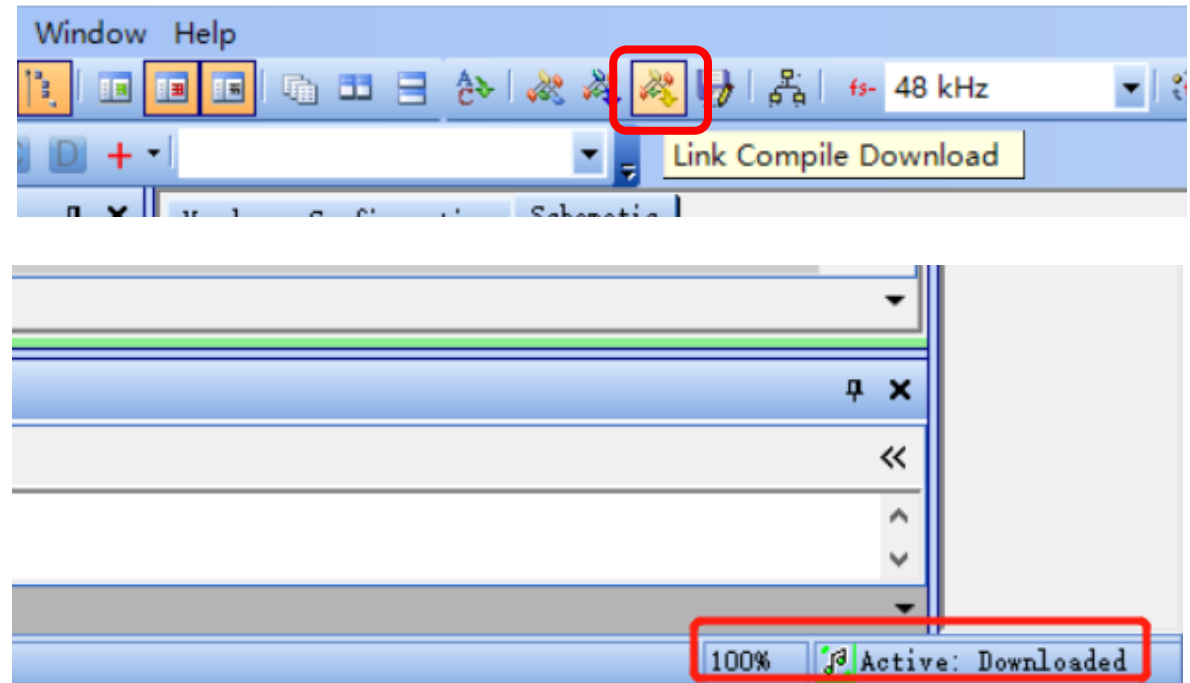
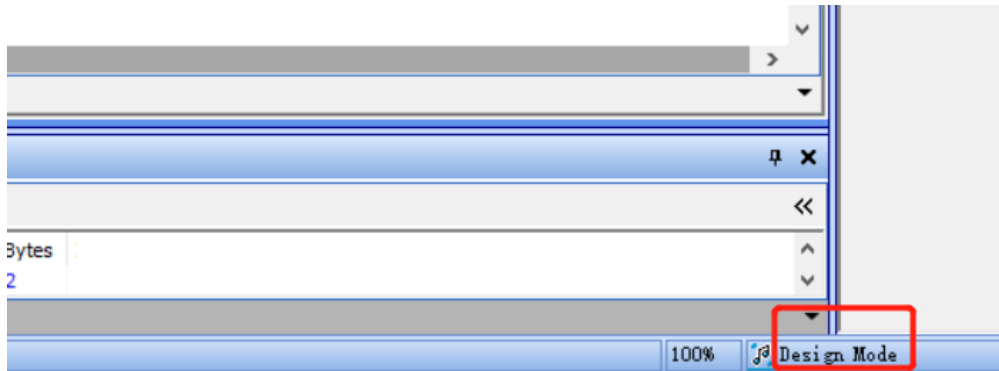
Config IC 1 - 170x\140x Register Control IC 2 - WinE2PromLoader



Basic Program – Program Writing

How to run finished programs offline? We must write them into E2Prom.

- ① If it shows “Design Mode” at the bottom right corner, you need to click “Link Compile Download”. When it shows “Active: Downloaded”, we can move on to next step.





Basic Program – Program Writing

- ② Click “Hardware Configuration”
- ③ Select “ADAU1701” module and then right click
- ④ Choose “Write Latest Compilation to E2PROM”, you will see the right window. Click “OK” and wait for finish.

