TEXAS INSTRUMENTS

PurePath Studio for Portable Audio

Graphical Development Environment User's Quick Start Guide

Quick Start User's Guide

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Read This First

About This Manual

This manual describes PurePath Studio GDE operation when used with a TLV320AIC3254/TLV320AIC36/TLV320ADC3x01/TLV320TLC2117/TLV320AIC31xx/TLV320DAC31xx EVM from Texas Instruments.

How to Use This Manual

This document contains the following information:

Overview, Quick Setup Guide, System Interfaces

Related Documentation from Texas Instruments

The following table contains a list of data manuals that have detailed descriptions of the integrated circuits used in conjunction with the AIC PurePath Studio GDE User's Guide. The data manuals can be obtained at the URL http://www.ti.com.

Table 1-1. Related Documentation from Texas Instruments

Part Number	Literature Number
TLV320AIC3254	SLAS549
TLV320AIC36	SBAS387
TLV320ADC3101	SLAS553A
TLV320ADC3001	SLAS548A
TLV320AIC3111	SLAS644B
TSC2117	SLAS550A

Additional Documentation

- AIC3254 Graphical Development Tool (GDE) (GDE ver. 3.20 or later)
- General Application Notes

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Chapter 1
Quick Start

TI's PurePath Studio (Portable Audio) Graphical Development Environment (GDE) is a powerful, easy-to-use tool designed specifically to simplify software development for the TLV320AIC3254/TLV320AIC36/TLV320ADC3x01/TLV320TLC2117/TLV320AIC31xx/TLV320 DAC31xx families of data converter with a miniDSP. The GDE consists of a library of common audio functions that can be dragged-and-dropped into an audio signal flow, graphically connected and assembled to produce a signal processing application. The application can then be downloaded to a target device where the audio processing functions can be interactively controlled by the GDE.

The GDE permits a miniDSP data converter to be programmed to support the processing requirements of a wide number of portable audio processing applications. The programming is done graphically using a library of low level and high level audio processing components. The GDE audio component library contains functions including a digital volume control, mixers, multiplexers, equalization, tone controls, loudness, dynamic range compression, bass boost and surround effects.

This release is version 4.8 of the PurePath Studio for Portable Audio converters. If you have a request or question please send us a message at *aicpps@list.ti.com*.

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1.1 GDE Features

- Flexible and easy to use minDSP programming interface
- Broad ranges of audio processing components
- Easy to use GUIs to support the configuration of complex components
- DSP programming experience is not required

1.2 GDE Software Installation

The miniDSP data converter is programmed and configured using the PurePath Studio Graphical Development Environment (GDE). The GDE permits the user to program the miniDSP using predefined signal processing components that are placed and connected graphically onto the GDE palette to produce a signal processing application.

1.2.1 Installation Requirements

Minimum

- 700 MHz PC
- 512 MB RAM
- Windows 2000 SP4 or later or
- .Net Framework 2.0 (SP1 is recommended)
- 1024x768 display with 16 bit color
- USB Port

Supported Operationg Systems

- Windows XP SP1 or later

1.2.2 Installing the GDE Software

1. If you have not done so already, save the installation program file to temporary directory. The PPS GDE installation file will have a name with the following format: setup_PurePath_Studio_Portable_Audio_v#.##_build#_rev####.exe and can be downloaded from http://pps.ext.ti.com.
2. From the temporary directory execute the installation program. Follow the installation prompts to compete the installation. The installation program will install the GDE at %ProgramFiles%\ Texas Instruments Inc\PurePath Studio Portable Audio.

The GDE installation will include several example process flows and application notes which are located in the following subdirectories of the installation path mentioned above.

Example process flows	..\ MyProcessFlows\Example Process Flows
Application Notes	..\ ApplicationNotes

The GDE installation program will create a short-cut for the GDE under:

All Programs→Texas Instruments Inc→PurePath Studio Portable ***Audio→PurePath*** Studio Portable Audio GDE.

1.3 TI EVMs

The miniDSP data converter family has two types of EVMs, EVM-K and EVM-U. The EVM-K (see Figure 0.1) is a larger two board EVM which allows the user to more easily observe signals as well as allow for easier connection of the TI EVM to other hardware.

The EVM-U (see Figure 0.2) is a smaller form factor the size of a USB thumb driver and is only presently available for the TLV320AIC3254. The EVM-U may require the user to set a property identifying the target board as an EVM-U. On older version of the software, a separate scripting file may be used in conjunction with the GDE.

Both EVM will connect to a host PC via a USB connection. This USB connection will be use by the GDE to download images to the EVM as well as the control path for the miniDSP application.

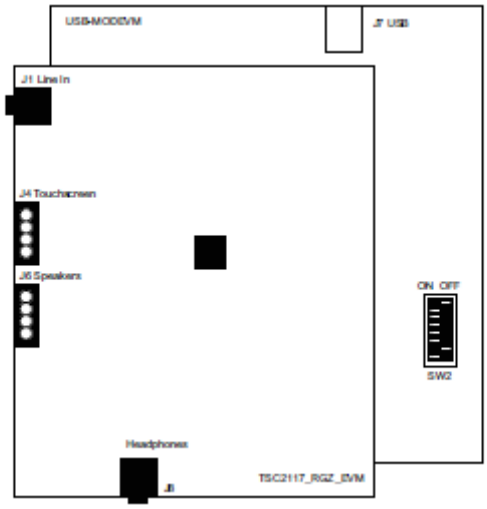

Figure 0.1. EVM-K

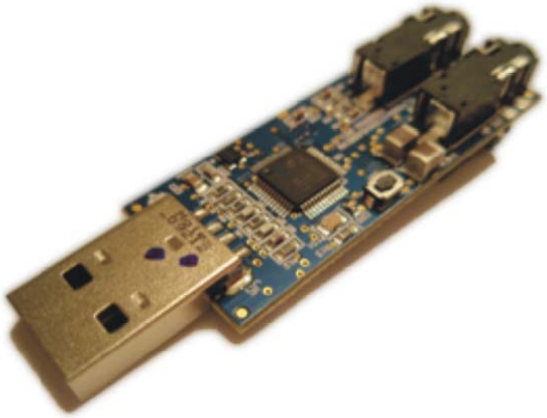

Figure 0.2. EVM-U

1.4 Programming the TLV320AIC3254 EVM-U

The rest of this document will illustrate some of the steps that are needed to construct and run an application on a miniDSP based data converter. For the purpose of illustration this document will discuss the process with regards to the TLV320AIC3254 and the TLV320AIC3254 EVM-U. Most of the discussion will apply directly to other miniDSP data converters and their respective EVMs.

1.4.1 The TLV320AIC3254

The TLV320AIC3254 is a device that contains a stereo ADC, a miniDSP for processing the ADC information, digital audio serial interfaces for receiving and transmitting, a miniDSP for processing the DAC information, and a stereo DAC. Figure 0.3 shows a simplified illustration of the device.

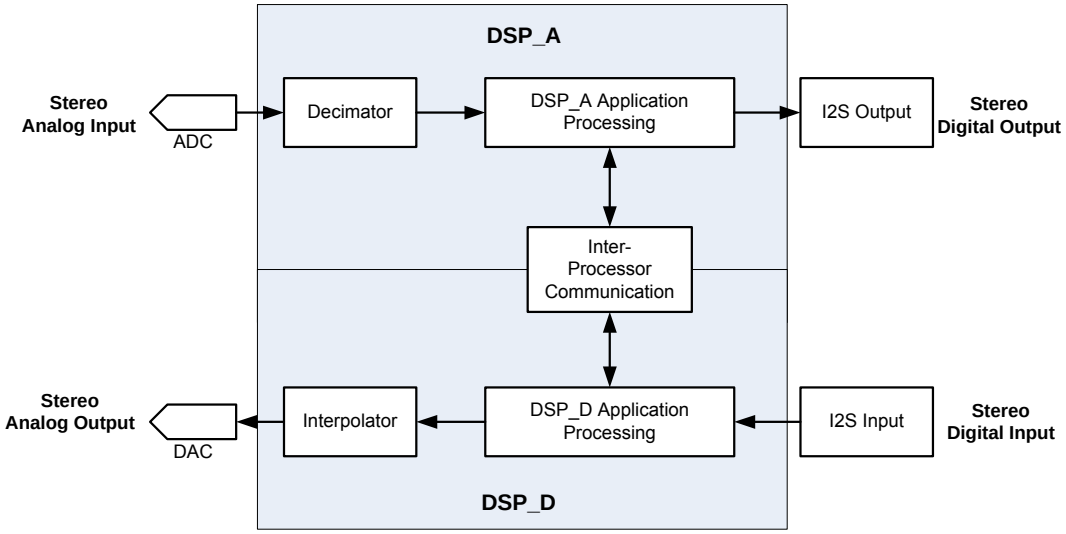

Figure 0.3. a miniDSP data converter Architecture

1.4.2 Starting the GDE

Now it is time to launch the PPS GDE. Select the shortcut at

All Programs→Texas Instruments Inc→PurePath Studio Portable Audio→PurePath Studio Portable Audio GDE.

This will bring up the GDE. If it is the first time you have open the GDE it may take several seconds for the application to fully come up.

1.4.3 Setting up the GDE for the TLV320AIC3254 EVM-U

If PurePath Studio does not detect the EVM type, the user may need to manually identify the target EVM as an EVM-U. The user can specify that an EVM-U is being used by setting the *TargetBoard* property of the AIC3254 framework component.

In order to set the target board type the user should first select the framework component. If the framework supports EVM-U setup, the property window will display a *TargetBoard* property. When using the EVM-U, the user should set the *TargetBoard* property to "TLV320AIC3254EVM-U". If an EVM-K is being used, the *TargetBoard* should be set to either "Unknown" or "TLV320AIC3254EVM-K".

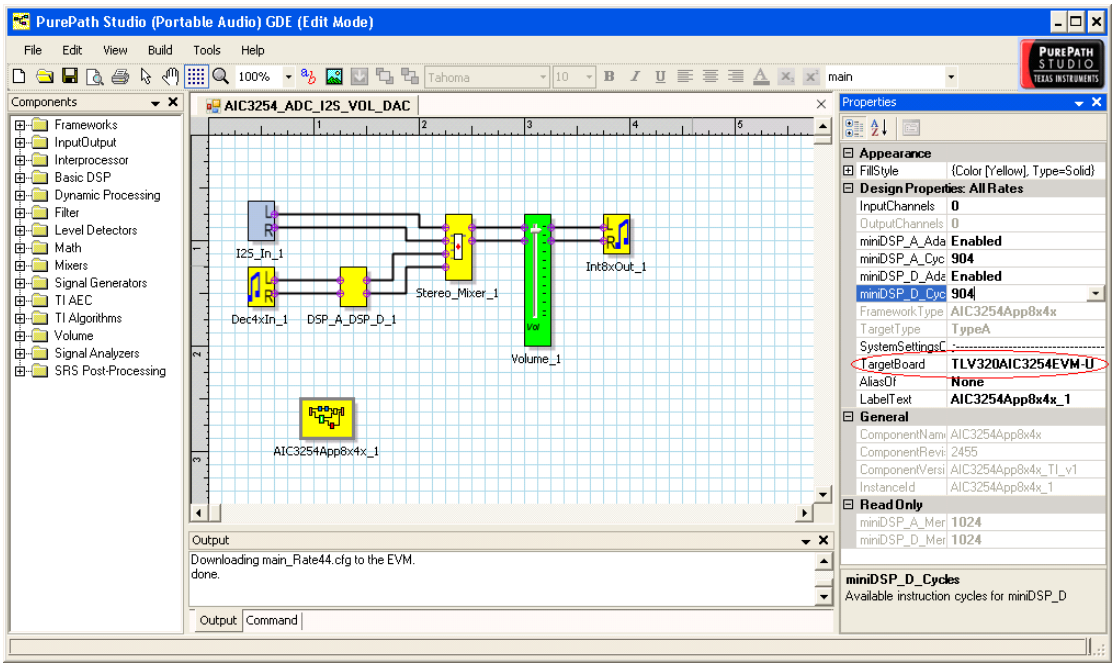

Figure 0.4. TargetBoard Property

If you are using an old AIC3254 framework (i.e. one without the *TargetBoard* property) with an EVM-U, the GDE will need to load a separate script file which enables the analog regulators and makes the EVM functional. The EVM-K will not require such a script file. The following section will describe the process for setting up the script file.

The EVM-U script file is named AIC3254EVM-U_PPS_GDE.txt and is available on the PurePath Studio web page (http://pps.ext.ti.com/). Copy the file to the PPS GDE subdirectory ..\MyProcessFlows\.. Rename the file AIC3254EVM-U_PPS_GDE.txt to AIC3254EVM-U_PPS_GDE.cfg

1.4.3.1 Setting up the EVM-U Script File

Note: This section is applicable only if the framework does not support the *TargetBoard* property.

We can specify the command file that will be used every time the EVM-U is reset. We specify the I2C command file to be loaded by the GDE by using the I2C command File Tool (Tools→ I2C Command File).

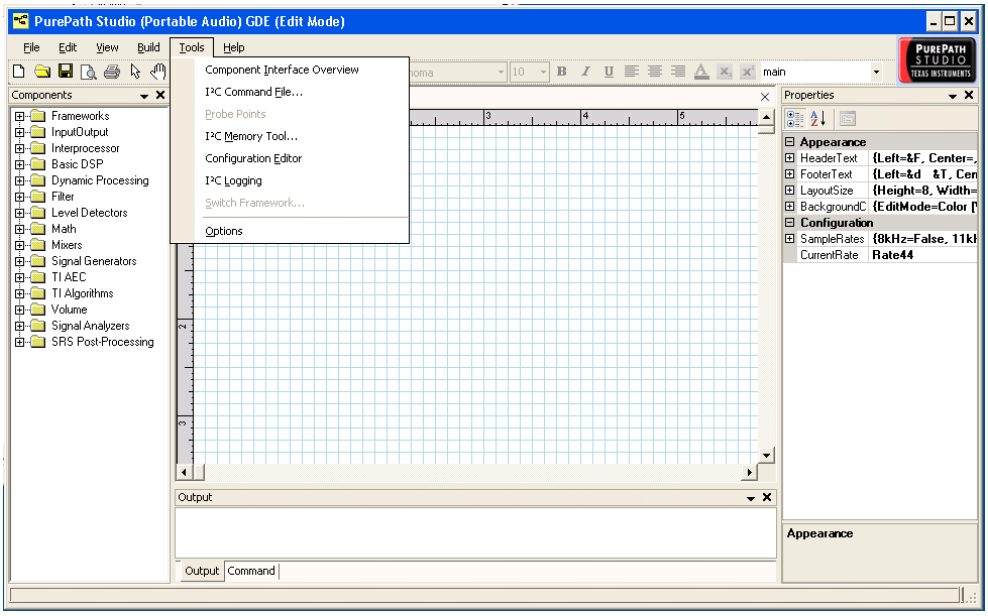

Figure 0.5. I²C Command file

Use the I2C Command file tool to select the AIC3254EVM-U_PPS_GDE.cfg file. Also check the “Execute on reset”. By checking the “Execute on reset” we ensure that this command will be executed whenever the miniDSP code is downloaded to the EVM.

This configuration will be saved by the GDE until the software is uninstalled or different setting is entered in the I2C command file window.

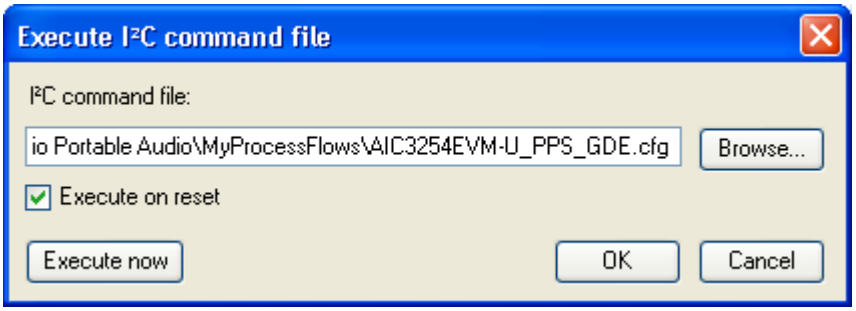

Figure 0.6. I²C Command file entry

1.4.4 Loading an Existing PurePath Studio Application

Select ***File→Open*** and navigate to the subdirectory ..\MyProcessFlows\Example Process Flows\AIC3254_ADC_I2S_VOL_DAC

Select the process flow AIC3254_ADC_I2S_VOL_DAC.pfw in the AIC3254_ADC_I2S_VOL_DAC subdirectory.

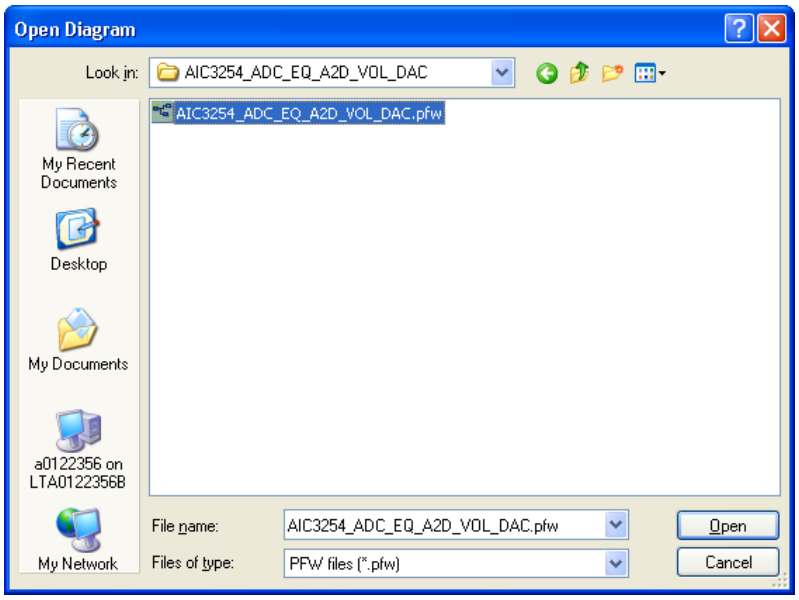

Figure 0.7. Loading a Process flow

This will load a process flow that will stream a signal from the ADC or I2S inputs to the DAC output. The

The ADC miniDSP will execute the following processing elements:

- Stereo 4 x decimator for the ADC
- Inter-processor port from the ADC miniDSP to the DAC miniDSP

While the DAC miniDSP will execute the following processing elements:

- Inter-processor port from the ADC miniDSP to the DAC miniDSP
- Stereo Mixer
- Stereo Volume Control
- Stereo 8x interpolator for the DAC

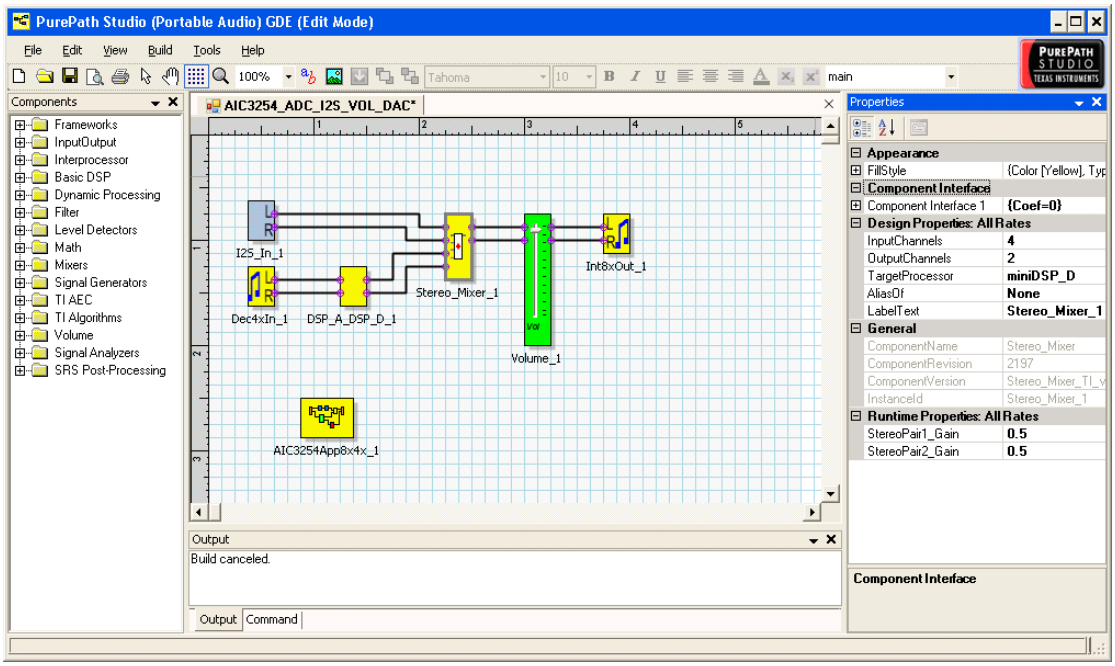

Figure 0.8. Example Process flow - Mixer

Figure 0.8 shows the process flow on the palette with the Stereo Mixer selected. The properties for the Stereo Mixer are shown in the right hand properties window. In this window you can see that the component is defined as having four input channels and two mixed output channels, it is a DAC miniDSP (miniDSP_D) component and that the gains for each stereo channel pair are 0.5.

Figure 0.9 shows the process flow on the palette with the Volume selected. The properties for the Volume are shown in the right hand properties window. In this window you can see that the component is defined as having two channels, it is a miniDSP_D component and that the gain is 0.0 dB.

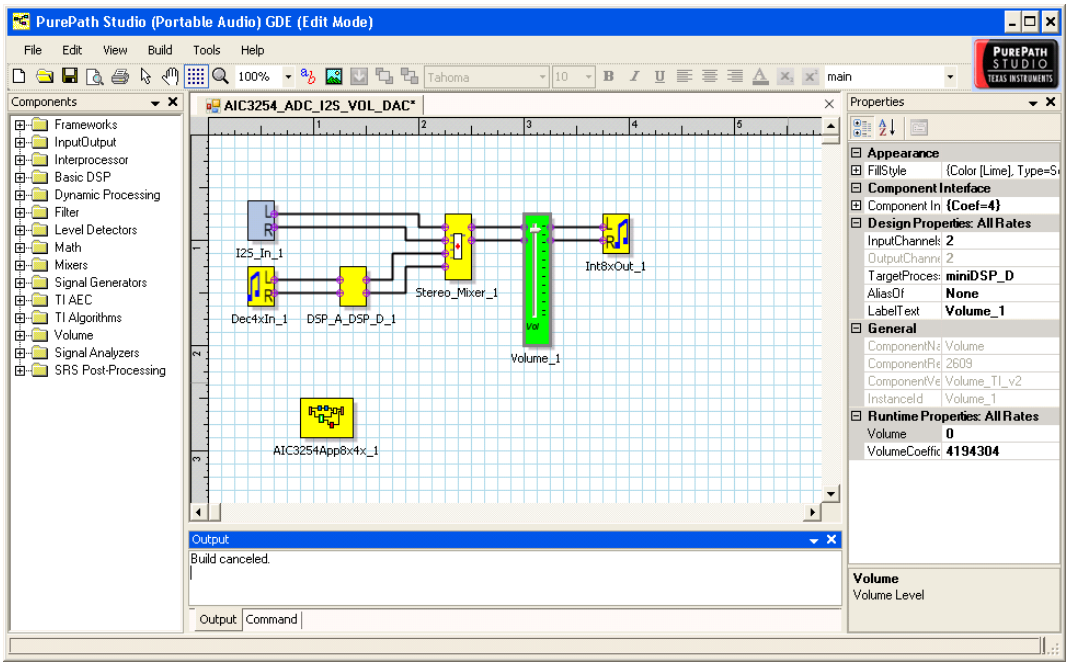

Figure 0.9 Example Process flow - Volume

To build this process flow we select: ***Build→Generate Code***

The status of the code generation will be indicated in the output window below the palette. If successful, the output window will terminate the output text with "…Done." See Figure 0.10.

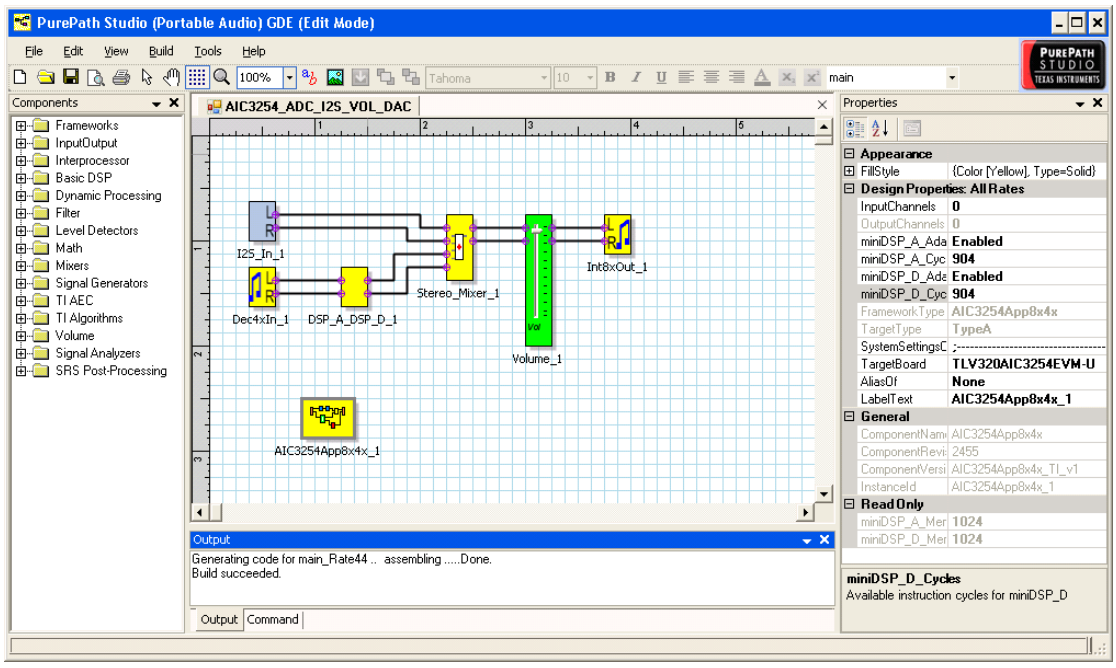

Figure 0.10. Code Generated

To download the code into the EVM and start execution, select ***Build→Download Code***.

The PurePath Studio will take a minute for the download to occur. When the download is complete the palette background will turn light blue and the output window will indicate successful download. See Figure 0.11

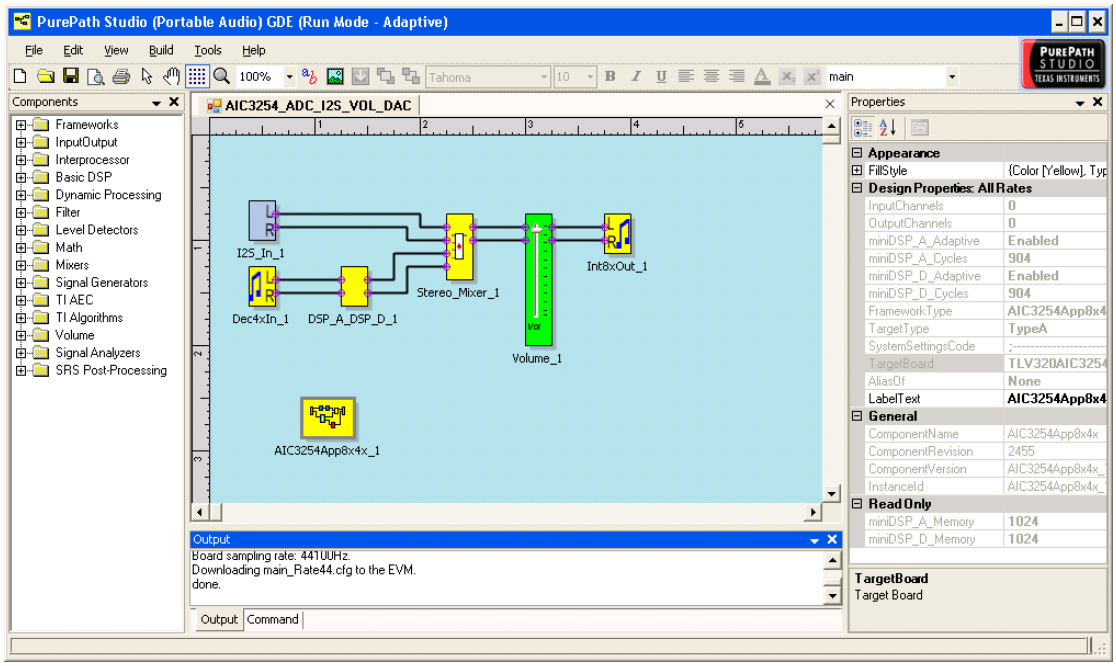

Figure 0.11. Code Downloaded

At this point the EVM should be streaming audio. To adjust the component runtime parameters, make the changes on the component GUI or in the properties window and press the “write state” button ( ). This will update the parameters in memory. These changes will be reflected in the signal processing.

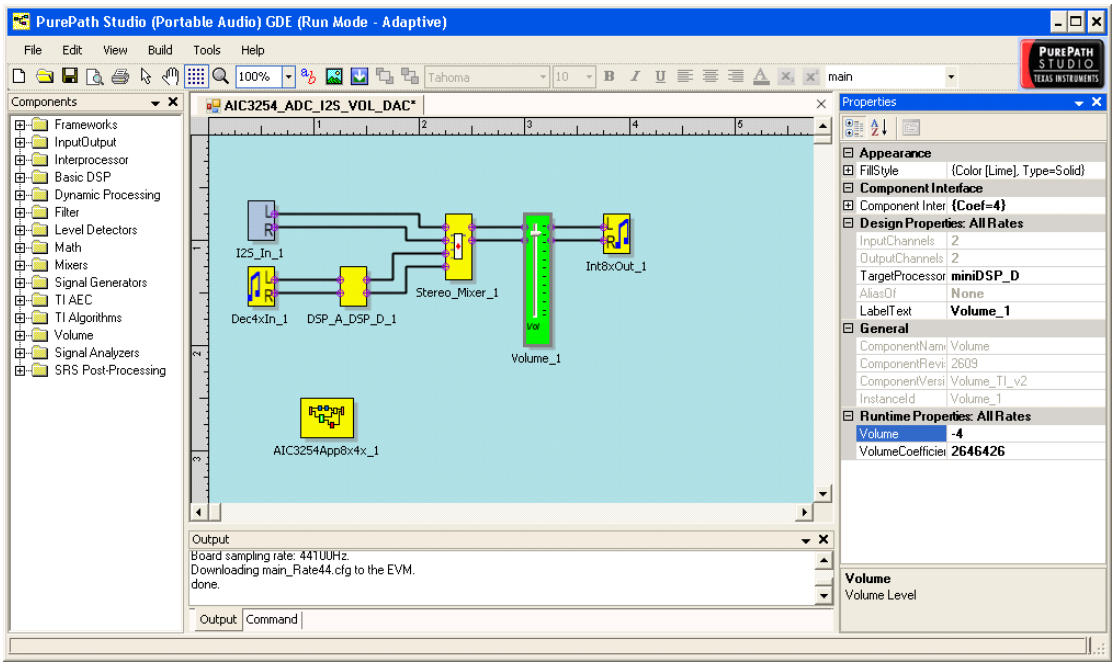

Figure 0.12. Runtime Control

To exit the run mode select ***Build→Disconnect***.

1.4.5 Building a PurePath Studio Application From Scratch

The first step to build an application is to place a framework onto the palette.

There are three main fixed frameworks that can be selected for the TLV320AIC3254. These frameworks have fixed clock rates with a fixed maximum number of cycles.

Since the EVM as shipped is configured to support a 44.1 kHz sample rate, we will use the AIC3254 8x4x framework. This framework supports sample rates of 8 kHz to 48 kHz. This framework provides 904 clocks per FS with an 8x interpolator for the DAC output and a 4x decimator for the ADC input.

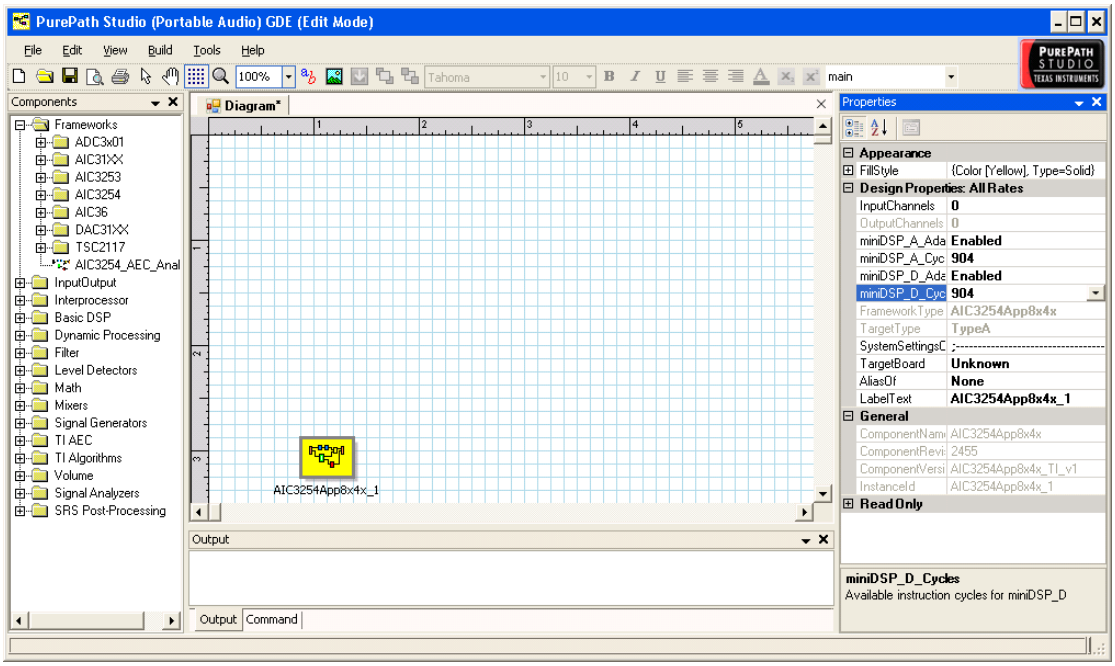

Figure 0.13 Selecting a Framework

The default configuration of the GDE is for the AIC3254 to be operated in adaptive mode. When the AIC3254 is operated in adaptive mode, half of the coefficient memory is accessible via I^2C while the other half of the coefficient memory is being used by the miniDSP. This configuration will apply to both the minDSP_A on the ADC side as well as the miniDSP_D on the DAC side.

The next step is to select the input and output components, in this case, an interpolator and decimator.

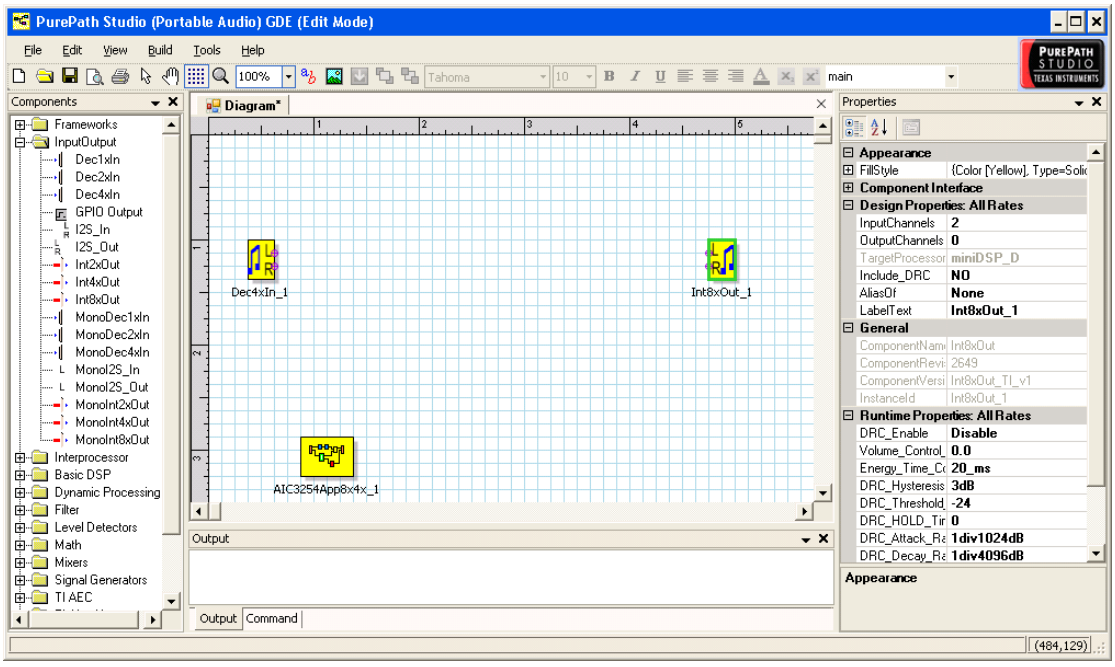

Figure 0.14. Selecting Input and Output Component

After selecting the input and output components, we select the components that will be used for the application. In this case let's add an AGC component.

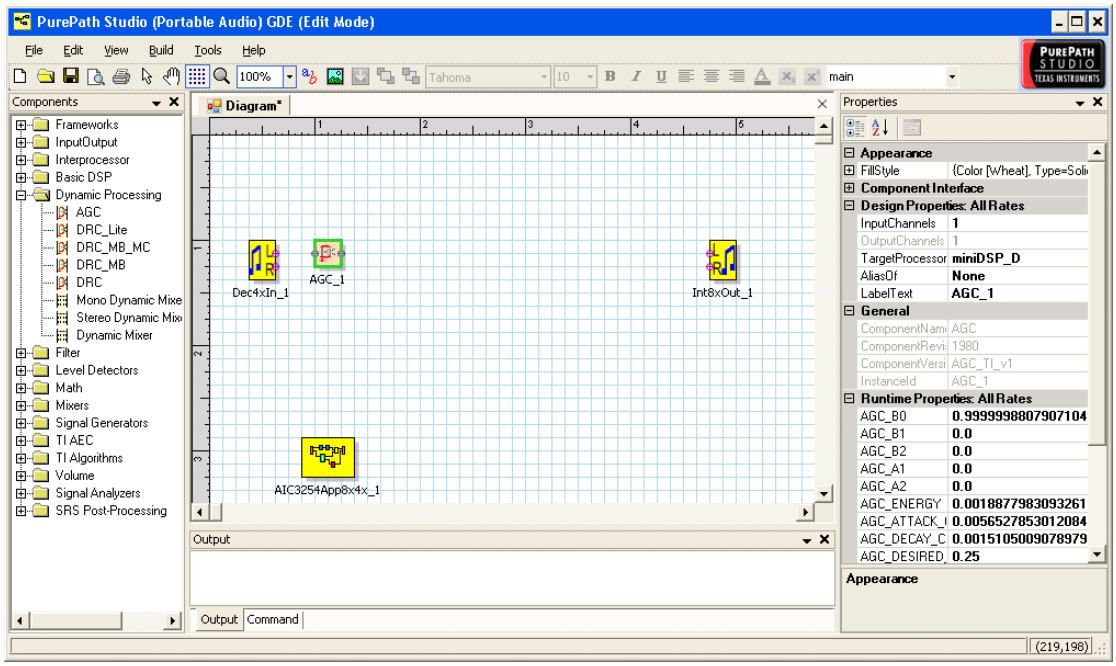

Figure 0.15. Selecting a Processing Component

Selecting a component followed by a right mouse click brings up a popup menu that shows a help selection. Selecting the Help item will bring up the help screen associated with the component. The help screen will explains the operation of the component.

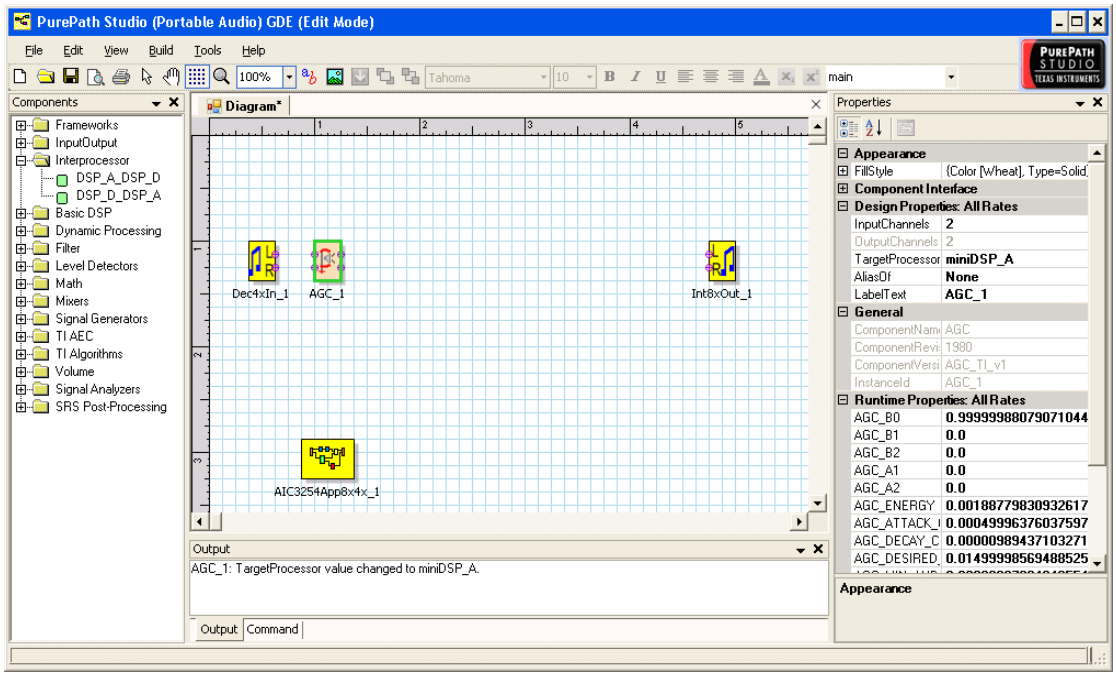

Figure 0.16. Component Help File

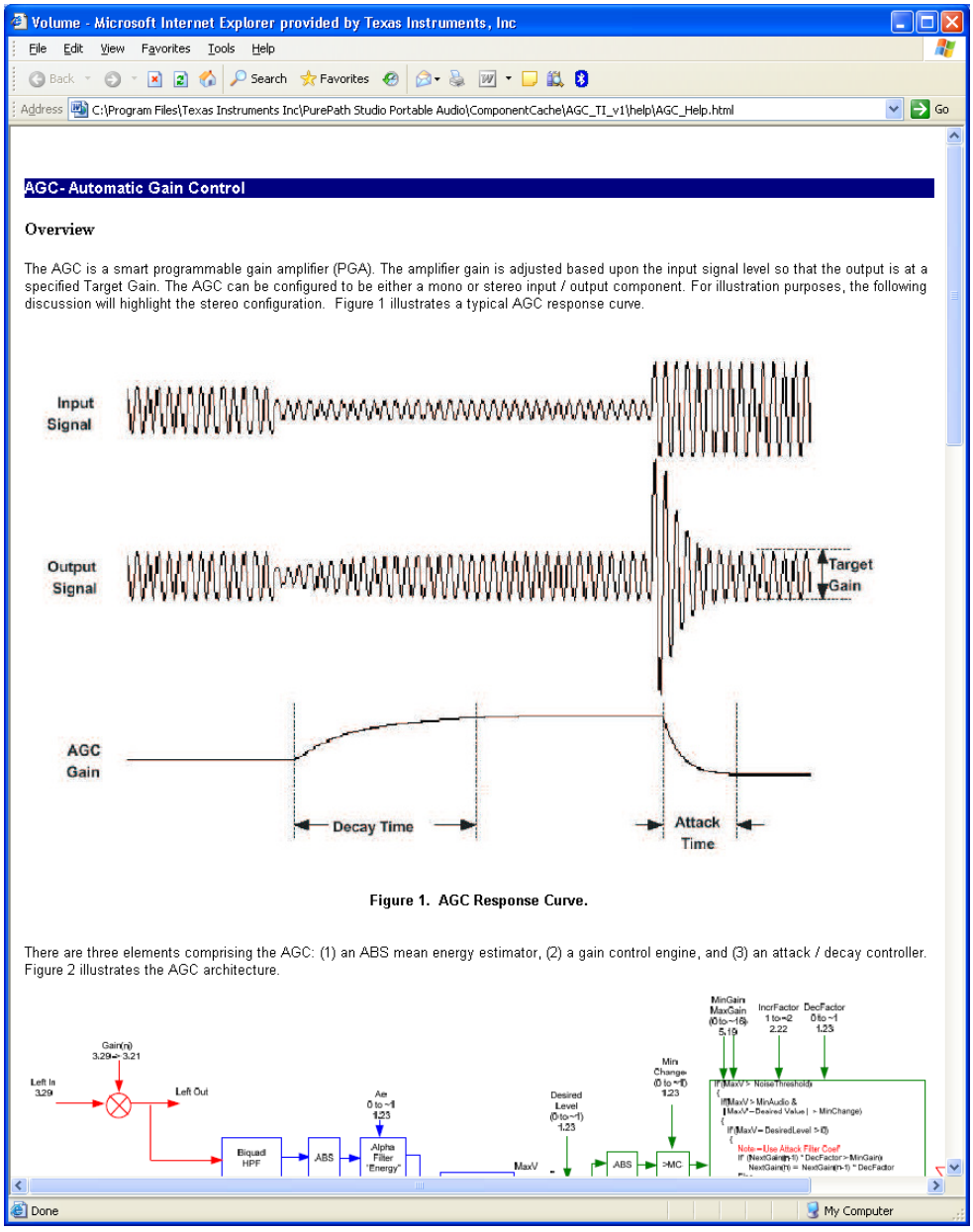

Figure 0.17. Help File

To configure this component we first must configure the design time properties. The design time properties can only be changed at design time prior to building the process flow. Design time properties will be fixed once the process flow is built and cannot be changed at runtime. For the AGC the design time properties are the number of inputs and the target processor. The number of inputs is two since this is a stereo component. The target processor is the ADC mini DSP. However we do not need to set this value manually. The GDE will set this parameter when the component is connected to other components.

The Runtime properties of a component can be changed either during the design of the process flow or at runtime after the process flow has been built and is executing.

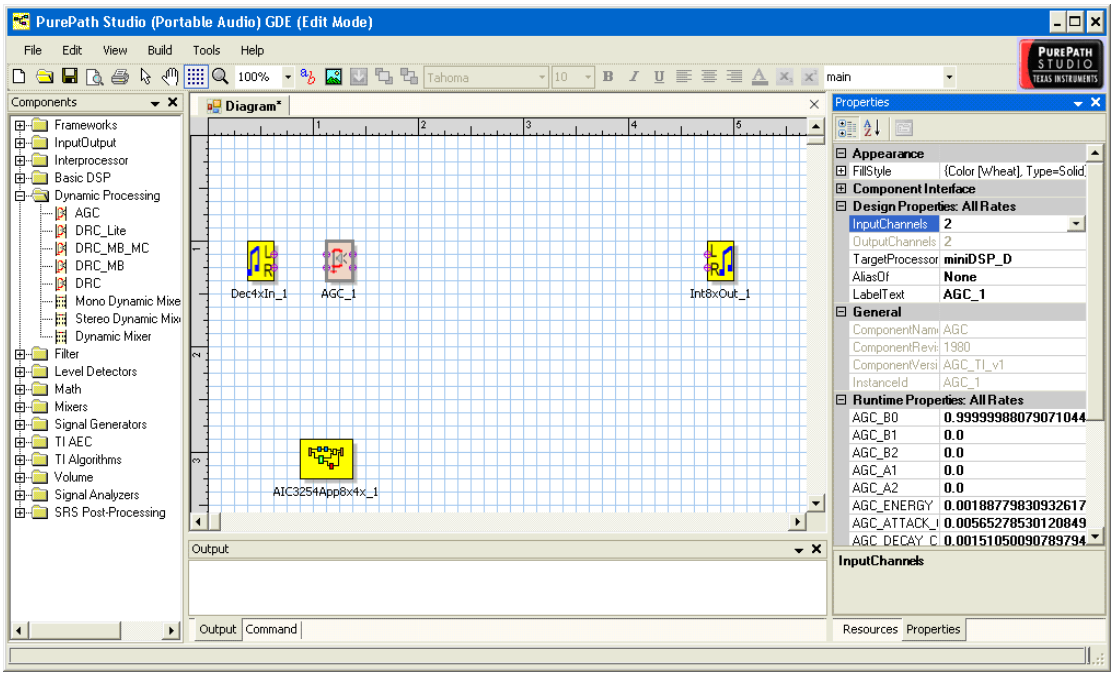

Figure 0.18. Configuring a AGC Component

In this case for listening to music we could set the

ACG Attack time Coefficient to roughly 0.0005

AGC Decay time Coefficient to roughly 0.00001

AGC Desired Level to roughly 0.015

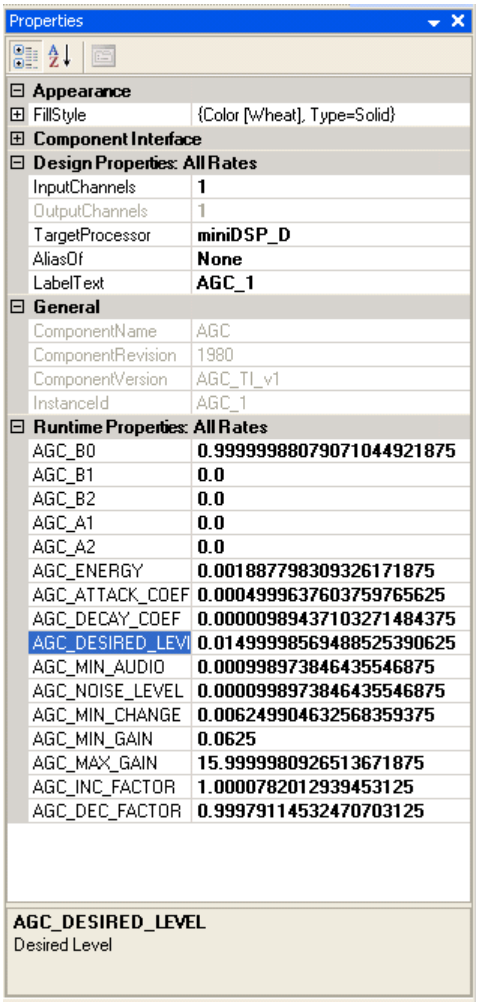

Figure 0.19. Configuring a AGC Component cont

We then add an ADC to DAC miniDSP inter-processor communication port. This component will allow data to be transferred from one miniDSP to the other. It also provides information to the GDE regarding where components should be executing.

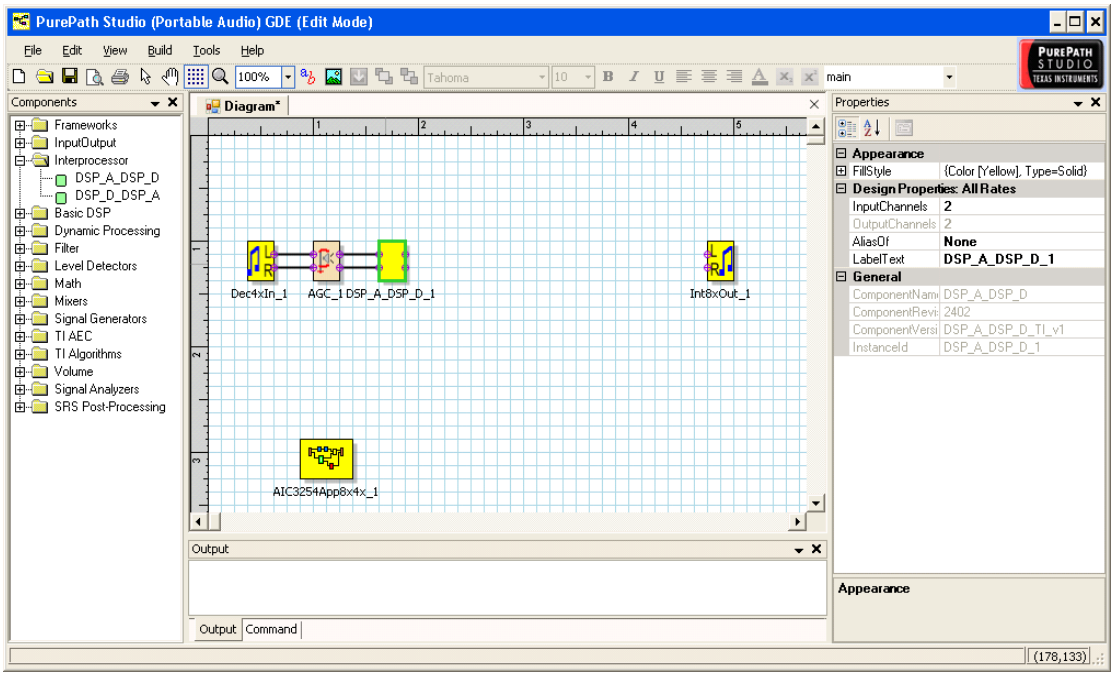

Figure 0.20. Adding a Interprocessor Block

After adding the interprocessor component, we can add and configure additional processing components that will run on miniDSP_D. In this case we will add a biquad to the DAC miniDSP side and configure it to be 5 biquads in series.

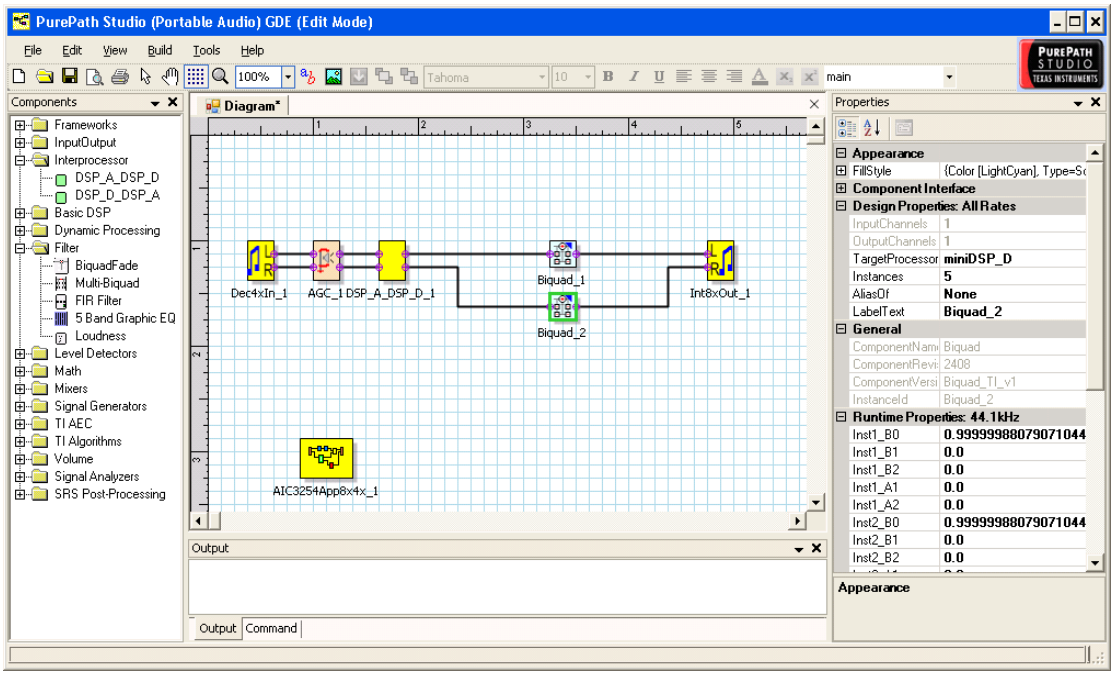

Figure 0.21. Adding a 5 Element Biquad for Loudspeaker Equalization

A copy of a component can be created by selecting a component and using CTRL-C/CTRL-V (copy/paste).

A component can be defined to be an “alias” of another component of the same type by selecting the appropriate instance of a component from the “AliaseOf” design property. Components that are aliased share coefficients. A change to the coefficients of one of the components will affect both.

Some more complex components will have a custom component GUI associated with the components. In order to bring up the custom component GUI, select the component and right click. Select custom GUI item. In the case of the biquad components, the right mouse click will bring up the popup menu with an item for “Biquad GUI.”

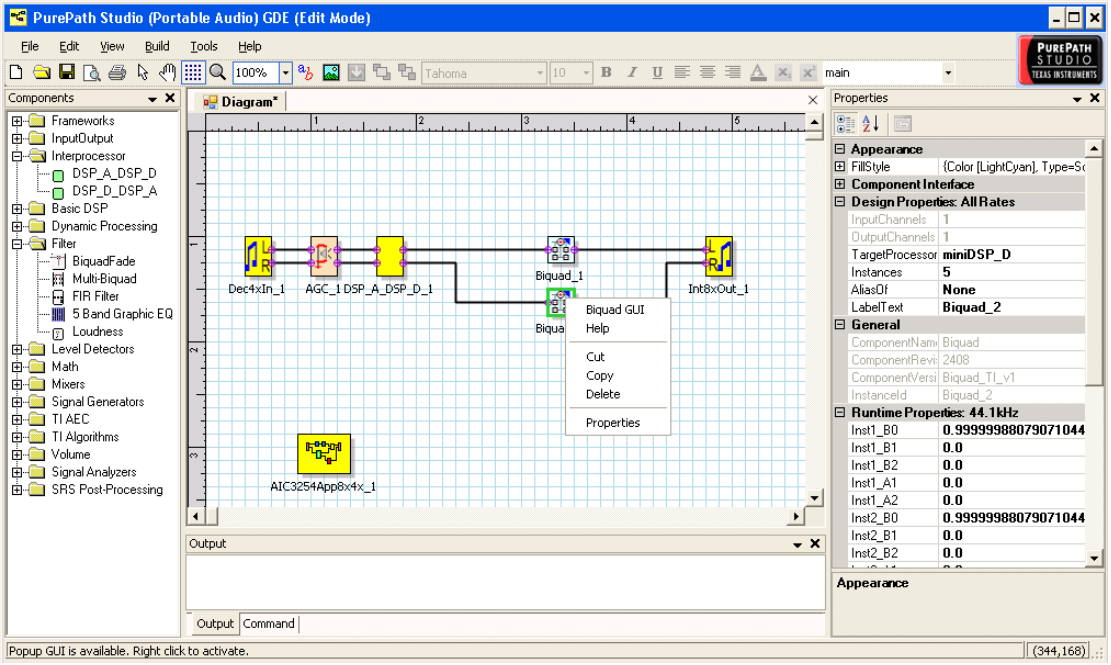

Figure 0.22. The Biquad GUI

The biquad GUI will provides an interface to easily define the filter types associated with the biquad.

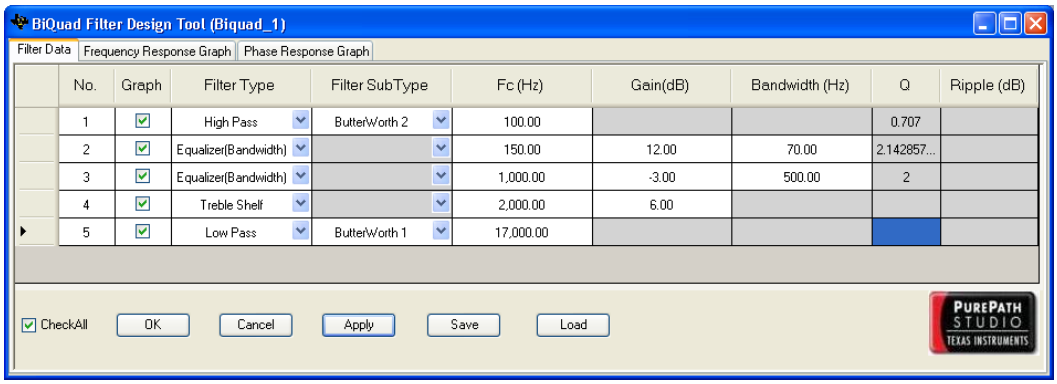

Figure 0.23. The Biquad GUI – Filter Data

The biquad GUI will also allow you to check the frequency response of one or all of the selected fiters by selecting the “Frequency Response Graph” tab (see Figure 0.24). The frequency response can also be adjusted directly from this tab (see Figure 0.25)

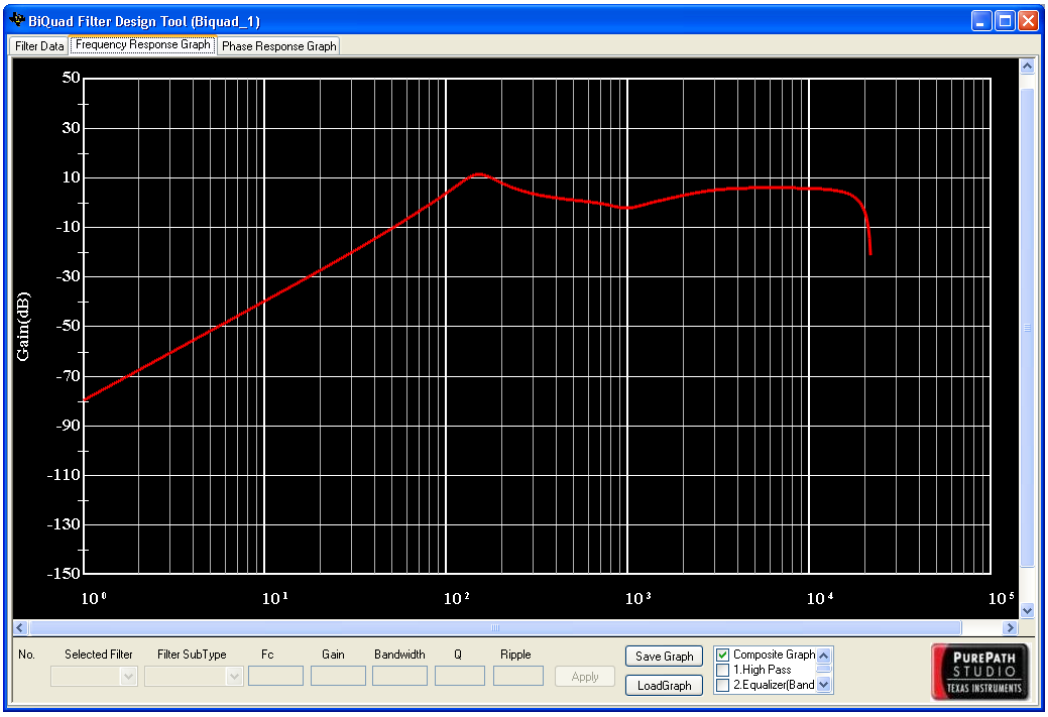

Figure 0.24. The Biquad GUI – Frequency Response

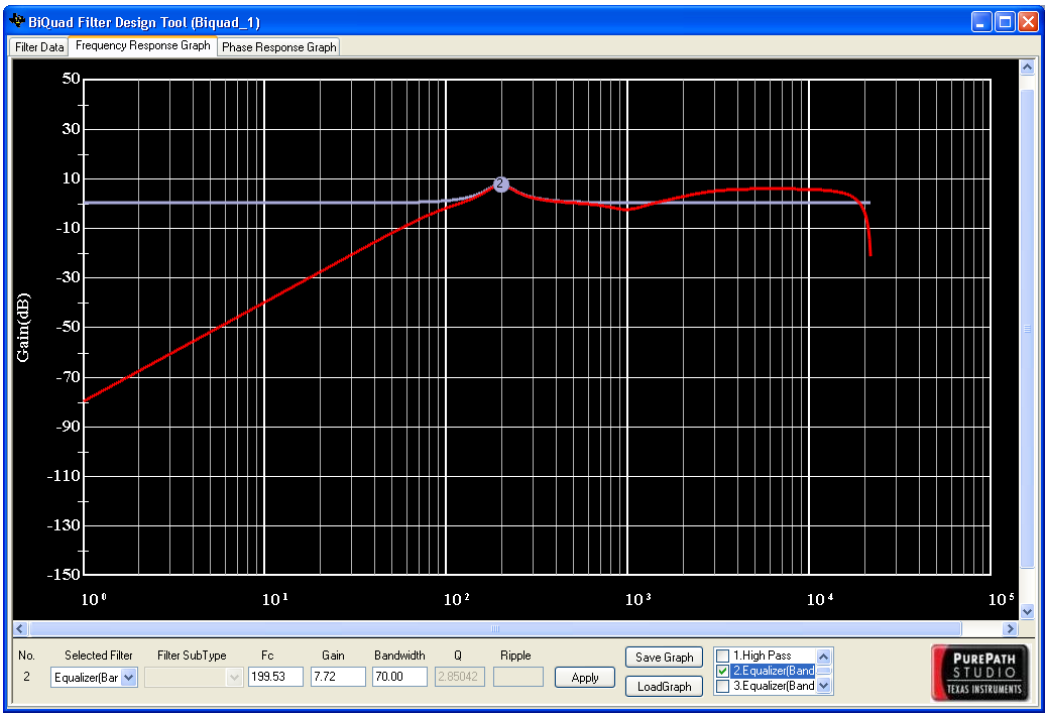

Figure 0.25. The Biquad GUI – Individual Frequency Response

Selecting “Apply” button on the biquad GUI will send the changes to the biquad filter coefficients.

Next a Volume Control is added and configured.

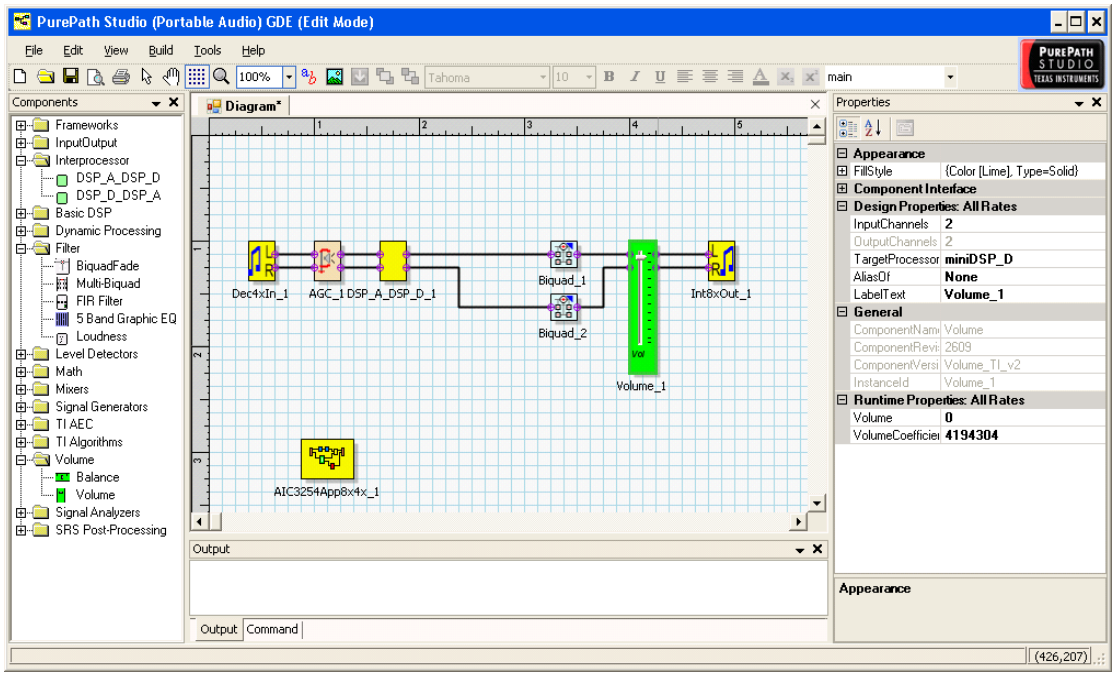

Figure 0.26. A Volume Component

After adding the volume control, the process flow can be saved (***File→Save As***). The default location for the new process flow will be the ..\MyProcessFlow subdirectory.

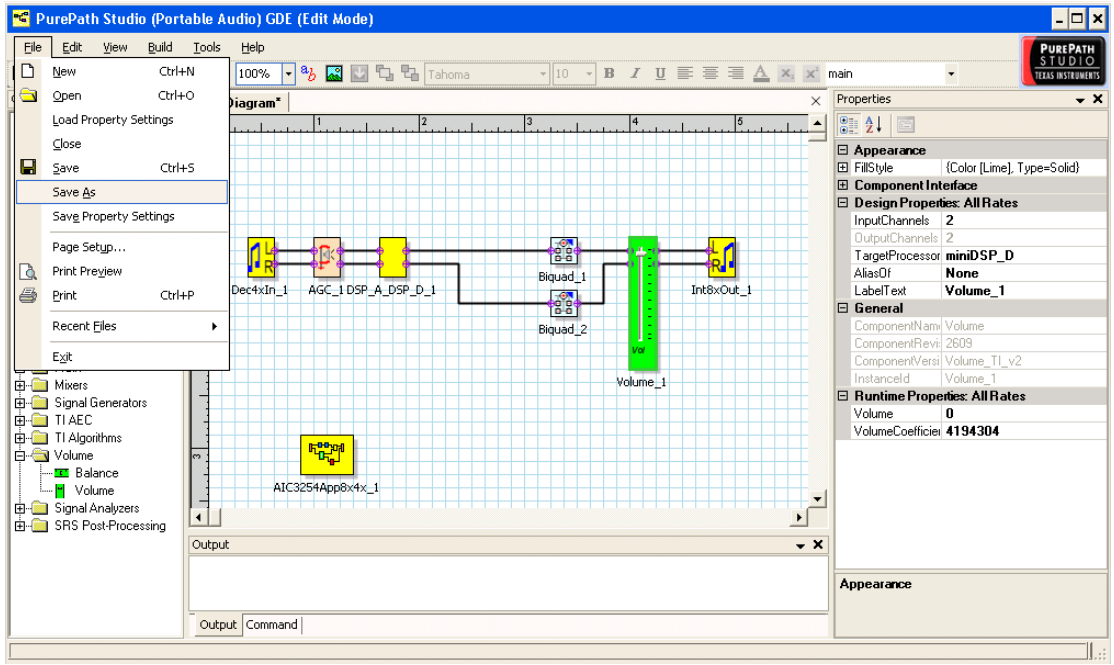

Figure 0.27. Save as

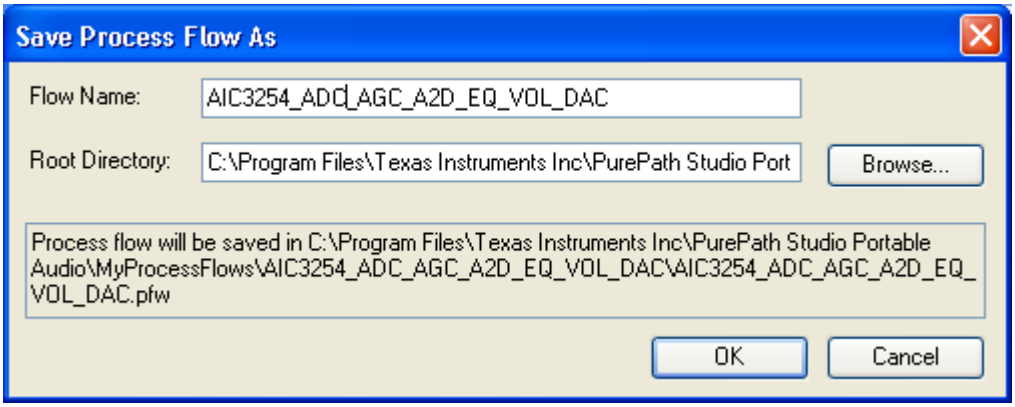

Figure 0.28. Save as

Once saved, we can generate the application by selecting ***Build→Generate*** Code.

The GDE will report the status of the code generation in the Output window.

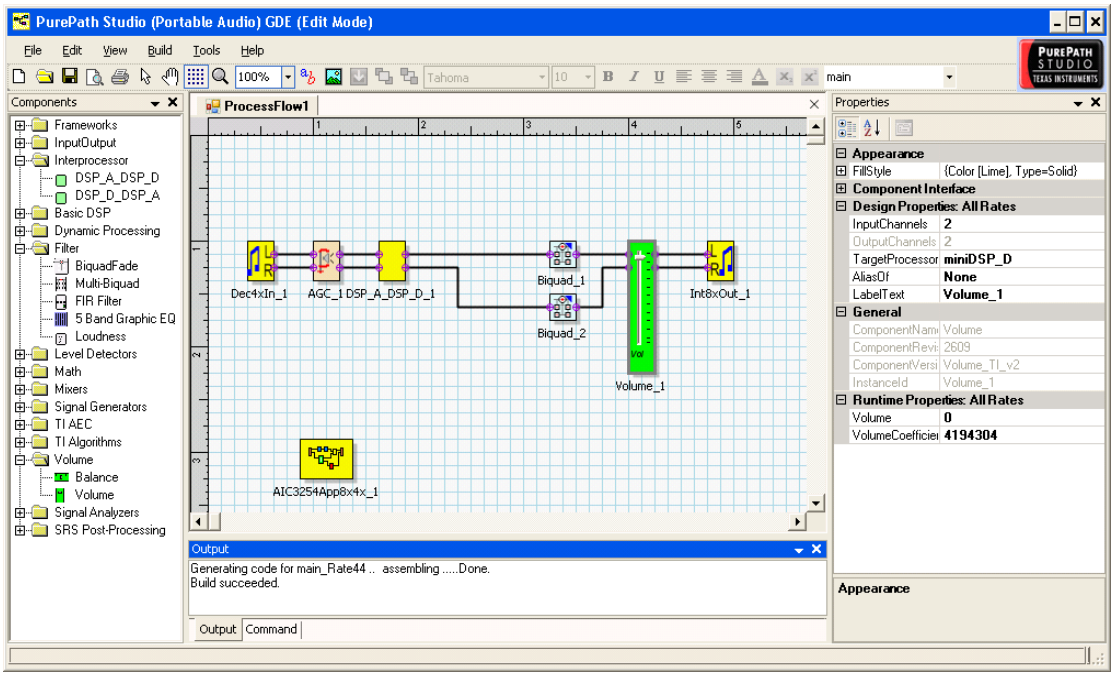

Figure 0.29. Generate Code.

The resources window (View→Resource Window) will show what processing resources have been used by the application.

Note because the frameworks sizes are fixed the processor resources will be shown to be at 100%

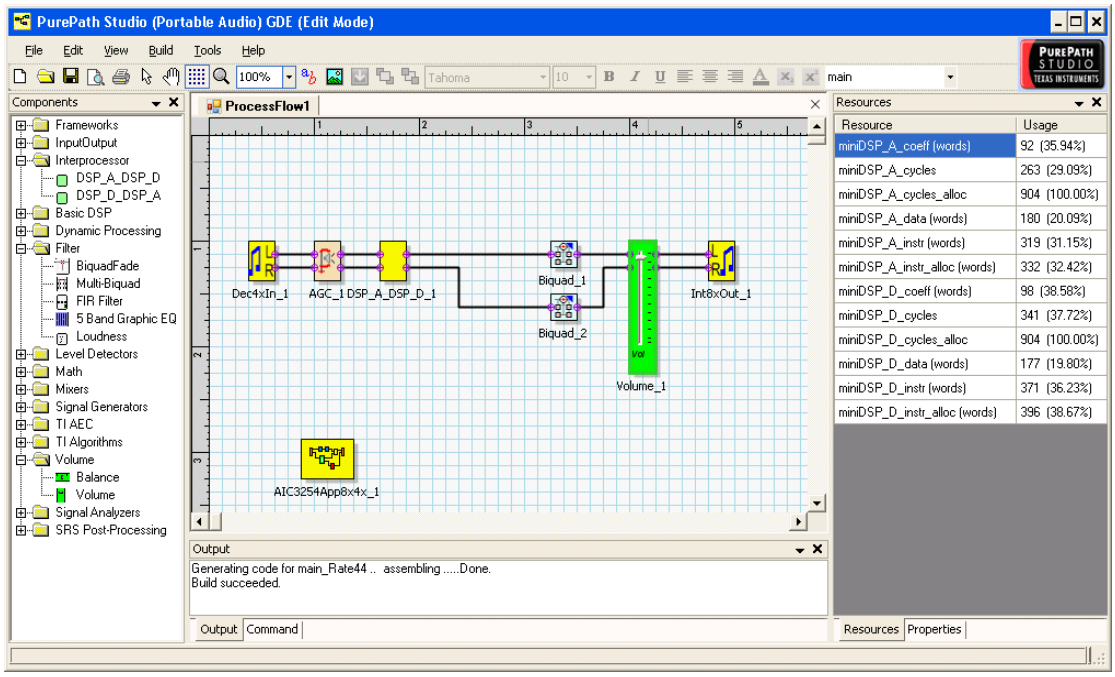

Figure 0.30. Resources Used.

The program can be downloaded and executed on the EVM by selecting ***Build→Download Code***. Depending on if the process flow must be saved or recompiled the download may take a half a minute or so.

1.4.6 Run Environment.

At this point the EVM should be streaming audio

To make a change to one of the runtime parameters, make the desired changes and select the “write state” button or wait a few seconds and the GDE will automatically generate a “write state”. The “write state” will update the parameters in memory. These changes will be reflected in the signal processing.

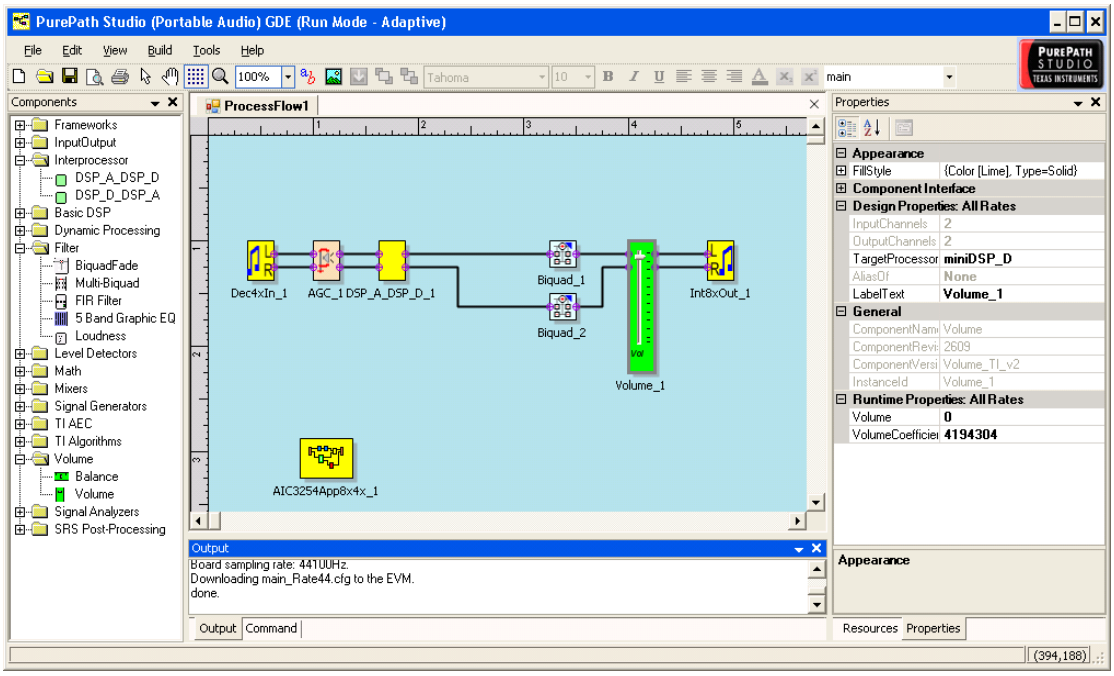

Figure 0.31. Changing Parameters During Run

We could also change the Biquad filter response during run time. Let’s open the Biquad GUI, select the frequency tab and zoom in.

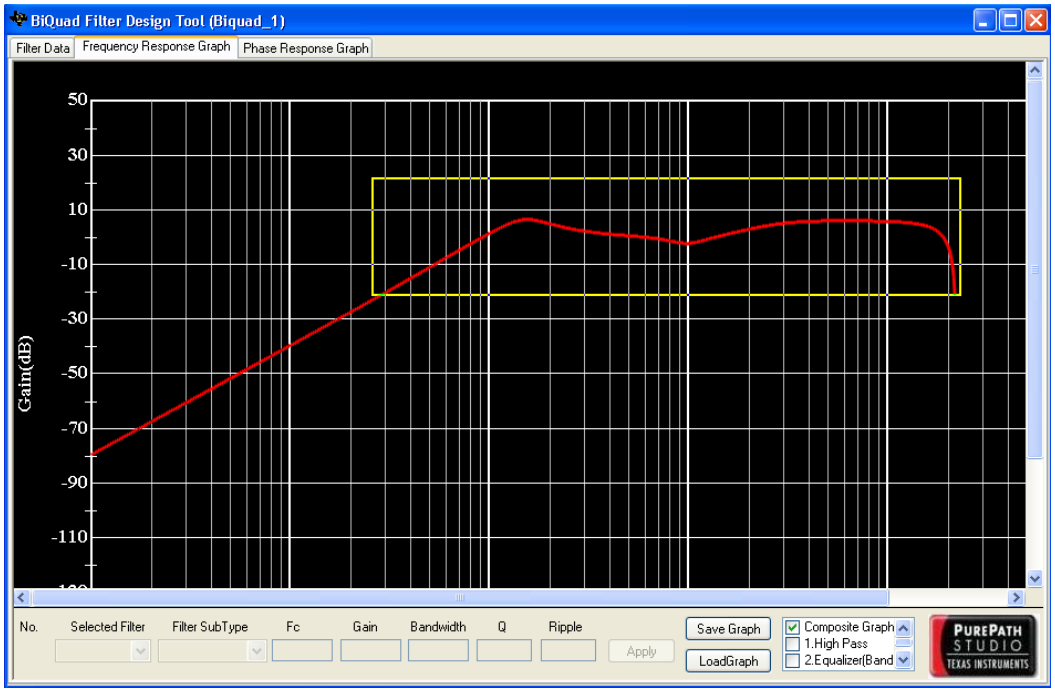

Figure 0.32. Changing Biquad Parameters During Run.

Each of the individual plots can be shown by checking the appropriate checkbox in the scrolling checkbox list at the bottome of the Frequency Response Graph dialog.

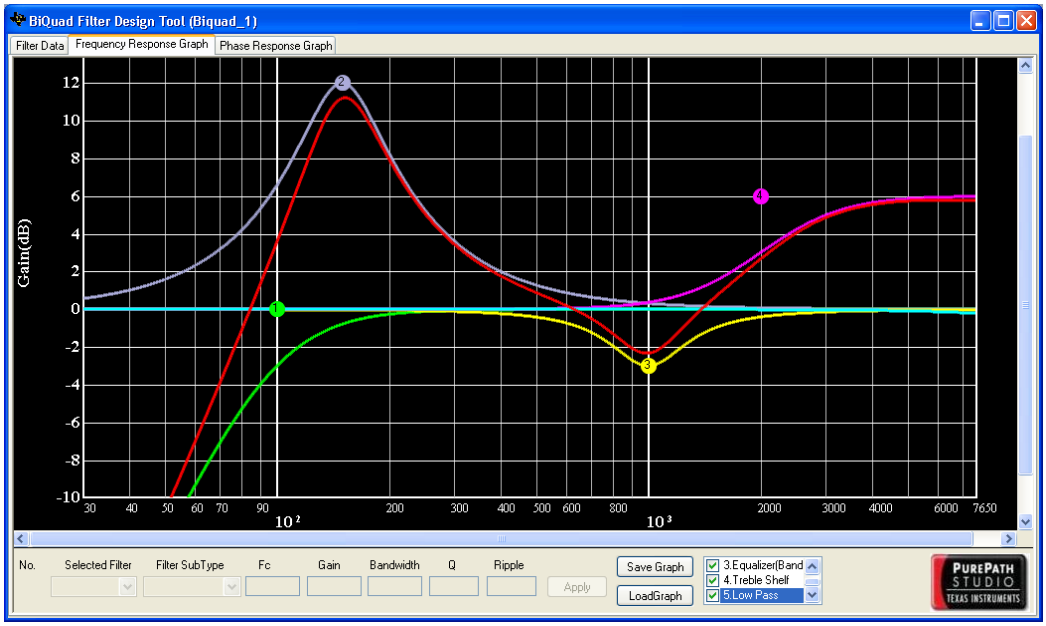

Figure 0.33. Changing Biquad Parameters During Run. Con.

We can change the filer response by dragging the response and then selecting Apply, followed by selecting the write state button on the PurePath window or wait a few seconds for the GDE to automatically perform the automatic “write state”.

To exit the run mode select ***Build→Disconnect***.

1.5 Important notes

The MiniDSP architecture is an auto indexing architecture. If you have a component with unused inputs, these inputs will not be zero but will be of some value

To avoid inputting noise into unused inputs, always terminate an unused input with a constant value. The easiest way to do this is to attach a coefficient to data converter to the unused input. Set the coefficient value of this component to zero.

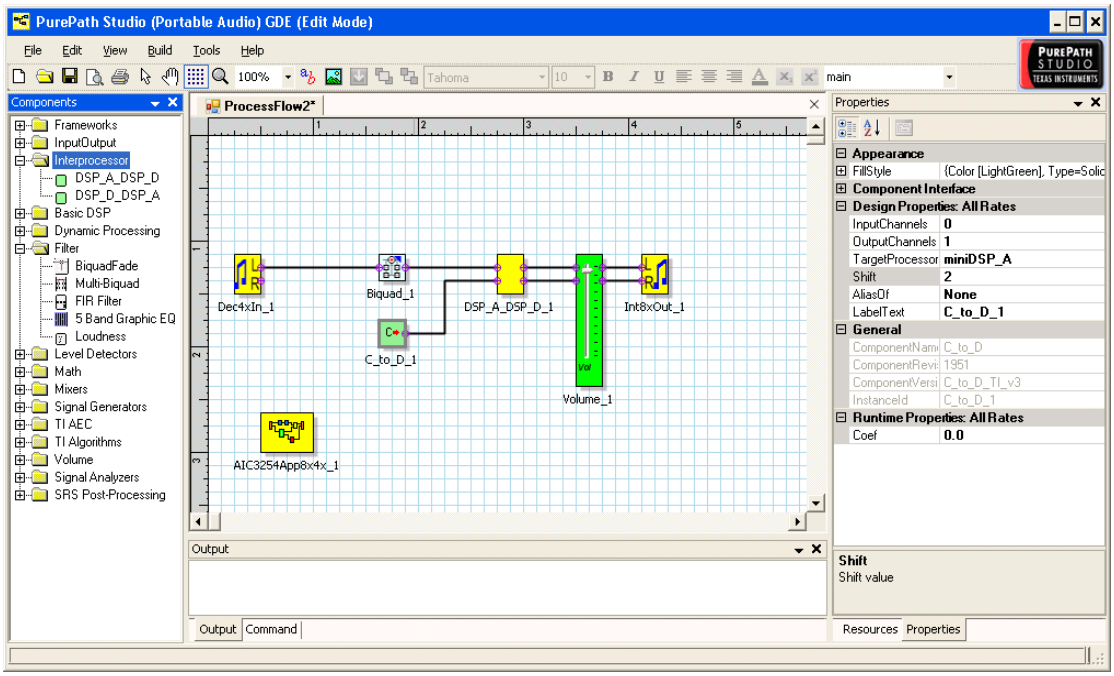

Figure 0.34. Constant values.

Once a process flow is saved, the GDE will automatically save the process flow whenever the Generate function is used. If you are modifying a process flow and you wish to retain the previous process flow, please save it under a different name before selecting Generate.

1.6 Programming the EVM to Support other sample rates

The EVM is preprogrammed to enumerate as a 44.1 kHz sample rate device on a Windows XP PC. If another sample rate is desired, the EVM firmware can be updated by a configuration program that is contained in %ProgramFiles%\Texas Instruments Inc\PurePath Studio Portable Audio\USBFirmware. This directory contains documentation that describes the firmware programming procedure. Please note – the Echo Canceller framework is configured to operate at 8 kHz. However the other PurePath frameworks are configured for only 44.1 kHz sampling rate, at the present time.

To operate the standard frameworks at other sample rates, a script file must be executed when PurePath downloads the process flow information into the AIC3254. These script files can be obtained by sending a message to aicpps@list.ti.com

The script to be loaded is specified using the I^{2}C Tool (***Tools→ I^{2}C Command File***). We then specify the desired configuration file (in this case configure8kHz.cfg) to load.

We also enable the enable the “Execute on reset” to cause this configuration file to be loaded whenever a build is performed.

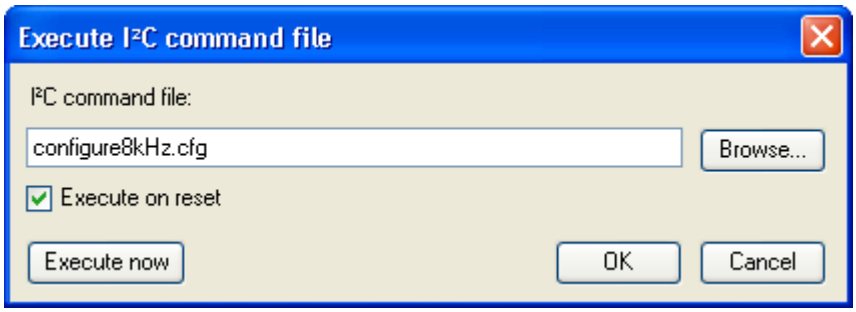

Figure 0.35. Script file specification

1.7 Advanced Information and Help

For more advanced use of the GDE please refer to GDE online help, GDE Release notes, and GDE User Guide.