User Manual
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Easy Demo User Manual

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ABSTRACT

The Easy Demo platform is a combination of hardware and microcontroller software capable of self-booting and performing A/B comparisons. The newest revision of the PurePath™ Console Motherboard, Rev F, has the hardware necessary to perform these functions. This manual explains the operation of the available reference hardware and MSP430 code.

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1 General Overview

The Easy Demo platform is a simple way to perform quick demos using its on-board user interface. The newest revision of the PurePath™ Console Motherboard (PPCMB), Rev F, adds self-booting capabilities and this user interface to easily perform A/B comparisons. The PPCMB is already compatible with many of TI's audio evaluation modules (EVMs), making it a great choice for the Easy Demo platform. The Easy Demo push-button user interface is described in Chapter 2.

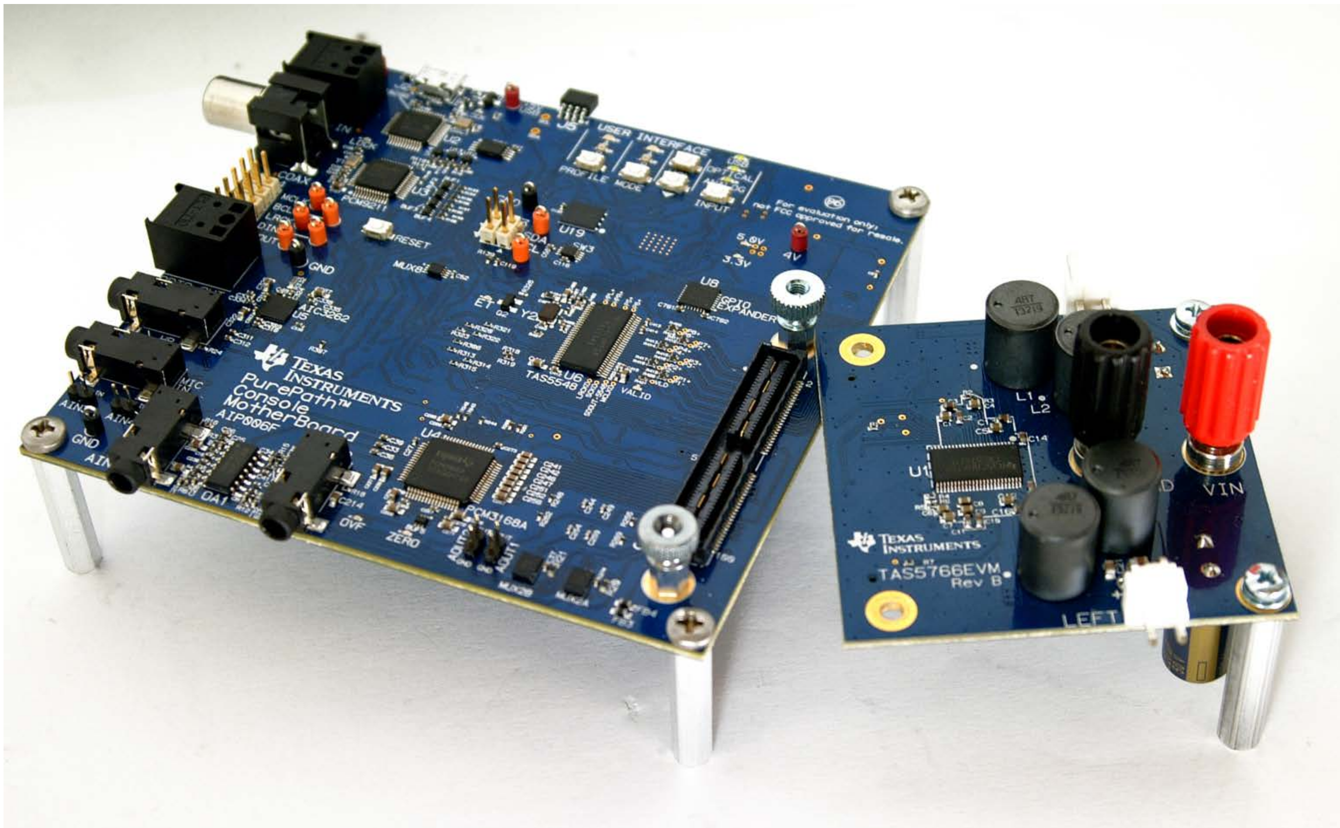


Figure 1. The PurePath Console™ Motherboard (Shown on the Left)

Chapter 3 lists the hardware and software tools necessary for development.

Chapter 4 describes the Easy Demo sample code.

Chapter 5 describes the TLV320AIC3262 signal processing flow.

2 The Easy Demo User Interface

The *Easy Demo User Interface* (UI) has several push-buttons and LEDs to easily perform A/B comparisons.

To activate the User Interface and begin the self-boot process, simply **push** any UI button. This will give the MSP430 control of the DUT I^2C bus.

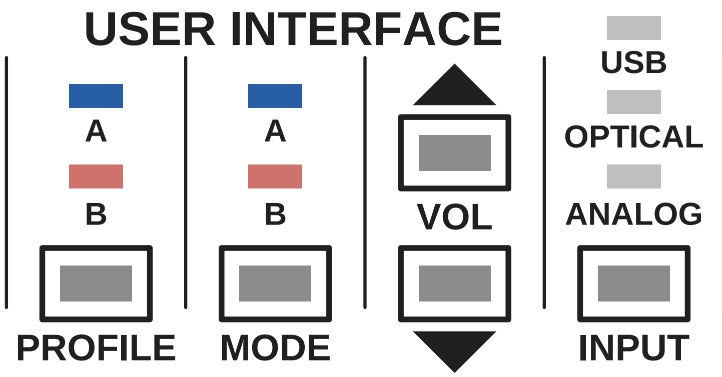


Figure 2. The Easy Demo User Interface

The *User Interface* consists of:

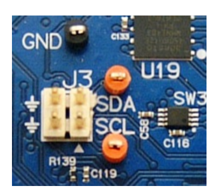
1. A **Profile** is meant to hold different demos. For example, Profile A might be a stereo enhancement demo, while Profile B might be a bass boost demo.
2. Within each Profile, there are **Modes**. Each Mode is meant to change an option within a Profile. For example, if performing a stereo enhancement demo, Mode A is bypass and Mode B enables the enhancement.

Table 1. Example Demo Layout

Profile	Profile Name	Mode	Mode Name
A	Stereo Enhancement	A	Disabled
		B	Enabled
B	Bass Boost	A	Disabled
		B	Enabled

3. The **Volume** button (VOL) controls the volume level of the system. The volume range can be defined by the user.
4. The **Input** button selects between PPCMB input sources: USB, Optical and Analog.

The Easy Demo UI can also be controlled remotely via USB or an external I^2C interface by sending simple I^2C commands.



3 Development Tools

This section covers the recommended hardware and software tools for development.

3.1 Hardware Tools

A list of the recommended hardware collateral follows:

- **PurePath™ Console Motherboard (PPCMB)** – Can be obtained here: http://www.ti.com/tool/purepath-cmbevm. A PPCMB-compatible EVM is needed to perform demos.

- **eZ430 USB Debugging Interface** – Older versions are not compatible with the MSP430F5510 on-board the PPCMB. The eZ430 Chronos has the latest version and can be obtained here: http://www.ti.com/tool/EZ430-CHRONOS

- **MSP-FET Flash Emulation Tool (optional)** – Requires hand-wiring Spy-Bi-Wire connections between the debugger and the PPCMB. Can be obtained here: http://www.ti.com/tool/msp-fet430uif

3.2 Software Tools

A list of recommended tools to download before starting evaluation follows:

- **Code Composer Studio** – for MSP430 firmware debugging and programming. Download here: http://www.ti.com/tool/ccstudio.
- **PurePath™ Studio GDE (Portable Audio)** – generates and downloads miniDSP code into the on-board TLV320AIC3262. Download here: http://www.ti.com/tool/aicpurepath_studio.
- **PurePath™ Console** – generates and downloads miniDSP code to EVM boards connected to the PPCMB. Download here: http://www.ti.com/tool/PUREPATHCONSOLE.

4 Easy Demo Sample Code

The Easy Demo sample code handles the user interface and sends I^2C/SPI commands to on-board peripherals and EVM connected to the PurePath™ Console Motherboard. The code is divided into 3 software layers:

1. The **Application** layer contains the main event handler, initialization code, interrupt service routines (ISRs) for port interrupts, and so forth.
2. The **API** layer contains the Audio API which handles the configuration of the audio devices for each *profile*, *mode*, *volume*, and *input* selection.
3. The **Driver** layer translates the audio commands into I^2C and SPI commands. It also implements low-level functions such as delays and the I^2C slave interface.

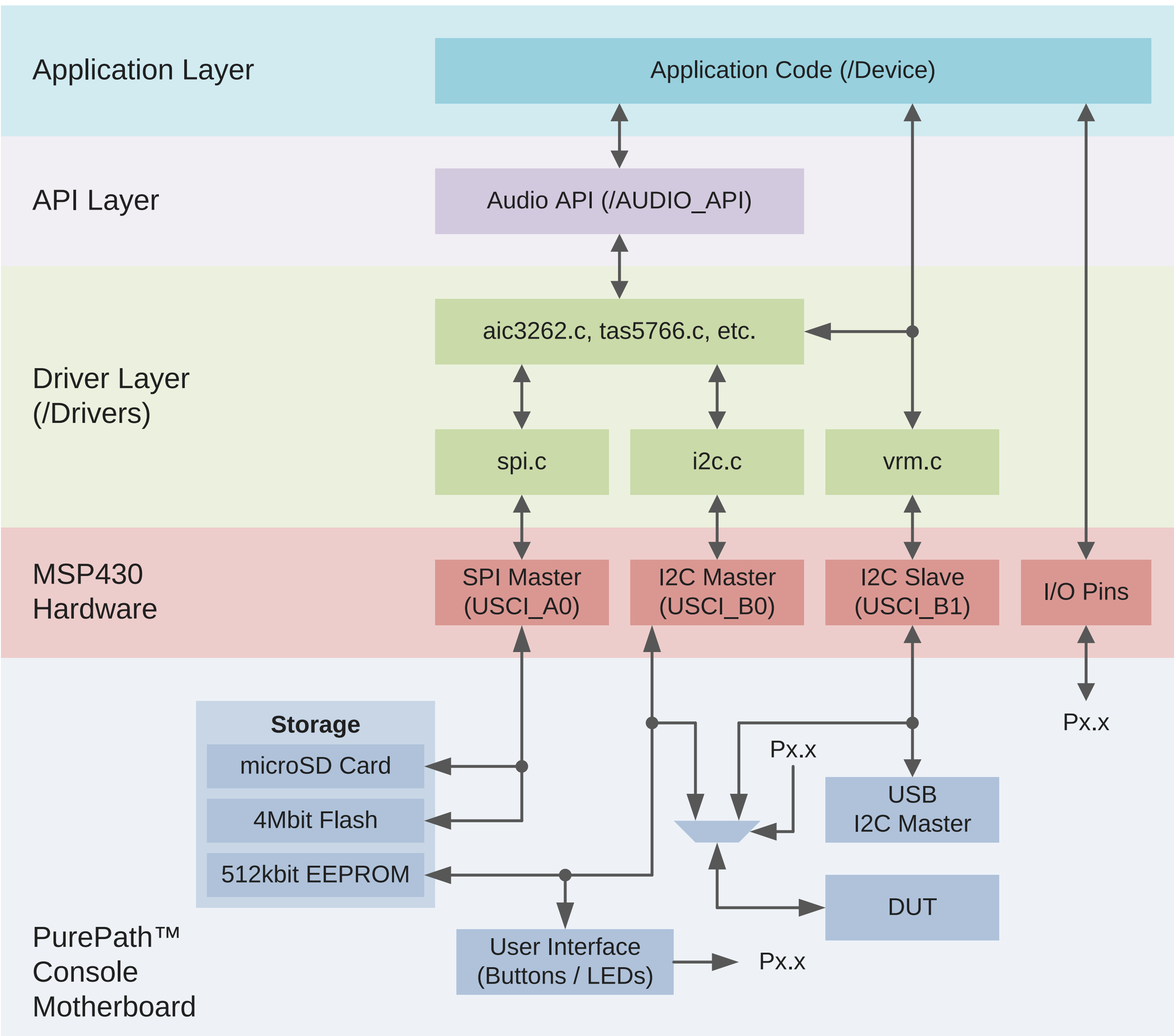


Figure 3. Software and Hardware Layer Stack-up

The PPCMB has an MSP430F5510 microcontroller to perform the self-booting and user interface tasks. It also has 4 methods to store data: MSP430 flash, on-board I^2C EEPROM, on-board SPI flash, and an SPI microSD card slot. Currently, the MSP430 flash and I^2C EEPROM are the only methods being used.

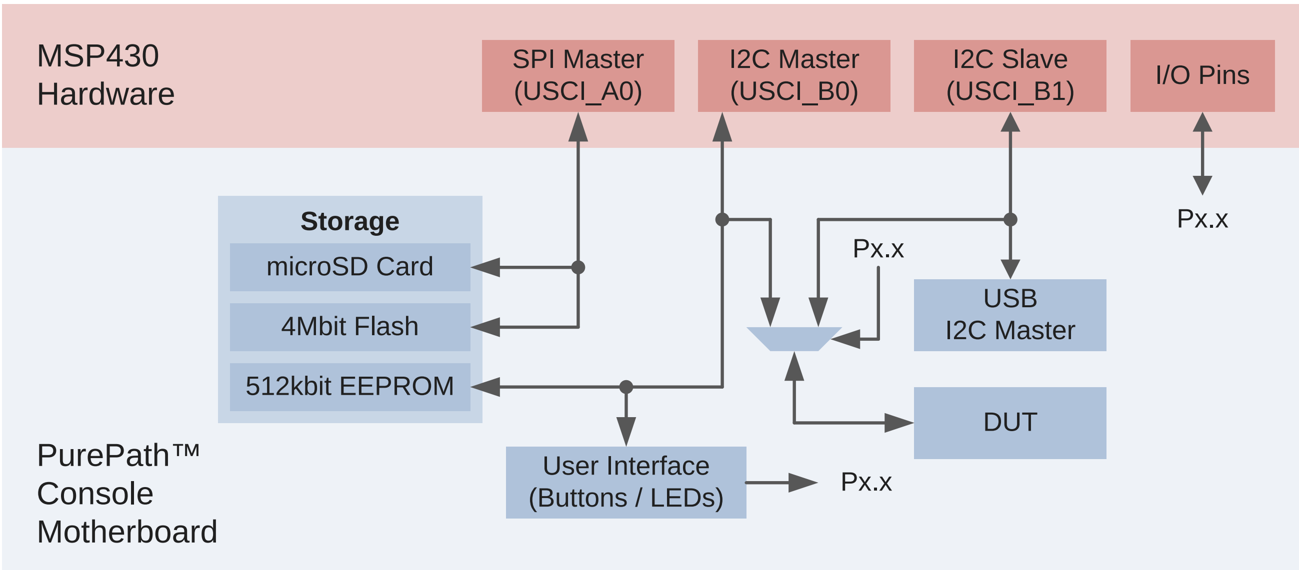


Figure 4. Hardware Layer Stack-up

The Easy Demo code has a *Virtual Register Map* (VRM) that is controlled by the *Application* layer or the *I^2C Slave* port. The I^2C Slave port allows configuring the User Interface via USB or remotely without having to use the on-board User Interface. This is handled in */Device/vrm.c*. Additional details can be found in Appendix A. Note that the Virtual Register Map is stored in the first few registers of the I^2C EEPROM.

The DUT can be controlled via I^2C by the on-board TAS1020B USB controller or the MSP430F5510. To prevent I^2C contention issues, the bus is multiplexed and controlled by a GPIO pin (see Figure 4). As mentioned in Chapter 2, the MSP430 waits for the user to push a UI button to begin initialization. This will give the MSP430 control of the DUT I^2C bus. DUT control can return to the TAS1020B or external interface by sending 0x01 to the VRM Register 1. Pushing the on-board *Reset* button will also return DUT control back to the TAS1020B or external interface.

4.1 The Easy Demo Project

The folder structure is quite simple. The execution begins in main.c. The 3 software layers are organized in folders: Device, AUDIO_API, and Drivers. The changelog.txt file provides a list of changes from previous revisions. The rest of the files and folders are automatically generated by the Code Composer Studio compiler.

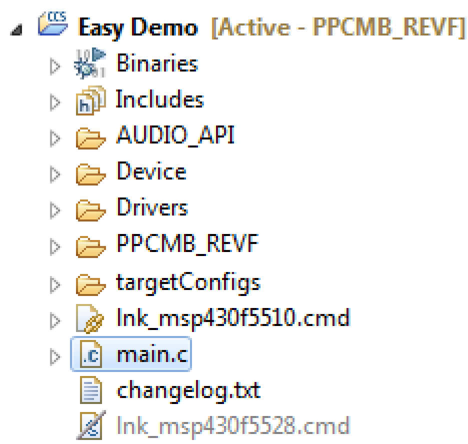


Figure 5. Easy Demo Project

For the PPCMB, select PPCMB_REVx under *Properties > CCS General*. This selects the MSP430F5510 as the MCU.

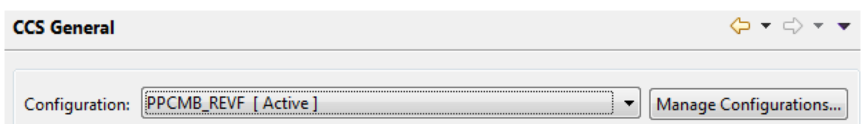


Figure 6. Project Configuration Selection

The PPCMB_REVx also sets the __PPCMB_REVF__ flag under *Properties > C/C++ General > Paths and Symbols*. This symbol is used throughout the project to identify the configuration.

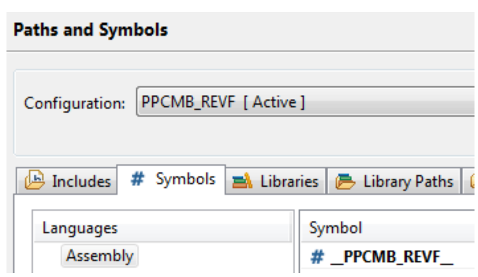


Figure 7. Project Configuration Selection

4.2 The Application Layer (/Device)

The Application code uses an event-driven architecture. The event handler can be found in *Device/Device_eventHandler.c*. Its state machine is shown in Figure 8. Text in capital letters indicates states. Each state will call an output function upon entry. Before exiting the state, flags (in blue) will be set for other states to perform actions.

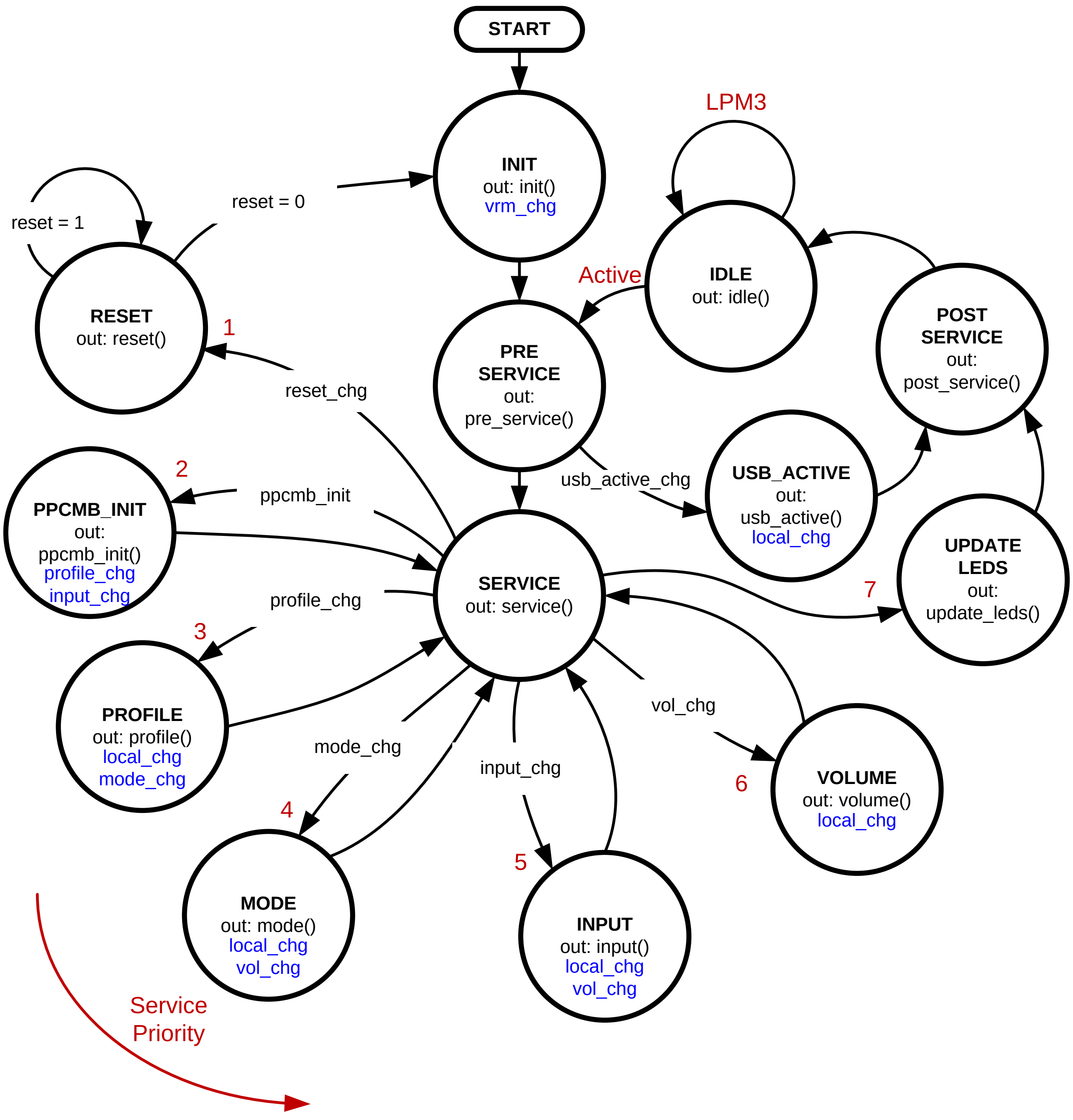


Figure 8. Event Handler State Machine

4.3 The Audio API Layer (/AUDIO_API)

The Audio API makes loading audio device configurations easy. The Application Layer simply needs to call a function with a parameter and value. For example, if it is desired to change the volume, simply send the following command.

```
Audio(AUDIO_VOLUME, &Device.status.volume);
```

The second parameter passes the address of a volume variable.

Note that the second parameter is of type void *, therefore, any type is compatible with the Audio() function. The advantage of this approach is that the Audio API can change the volume at the Application Layer in case the value exceeds the maximum level specified in the Audio API.

The Application Layer should only have access to *AUDIO_API/Audio.h*.

The AUDIO_API is structured to support any parser type (for example, EEPROM, header, sdcard, and so forth). However, loading scripts from a header file is the only method that has been implemented at this moment.

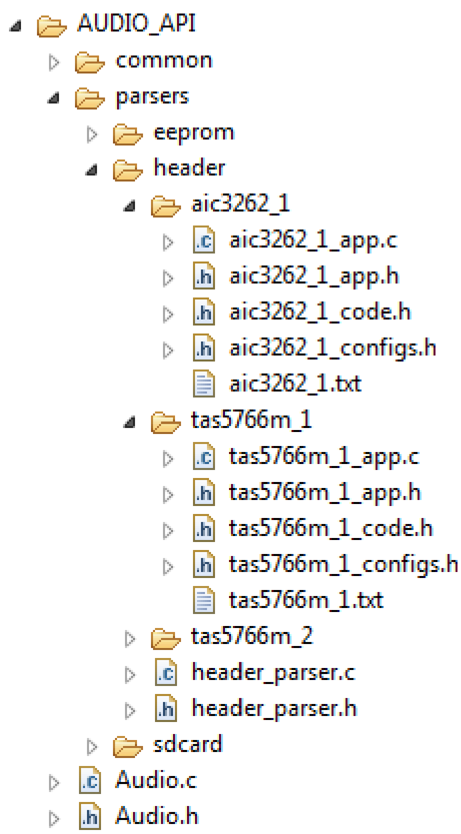


Figure 9. Audio API Folder Structure

4.3.1 Audio Header File Generation

The Audio API currently parses header files that originate from PurePath™ Studio GDE and PurePath™ Console software. Refer to the documentation of each software tool for details.

The miniDSP code for the on-board TLV320AIC3262 chip is already included as part of the project. It does not need to be modified. The PurePath™ Studio process flow that was used to generate that code is explained in Chapter 5.

4.3.2 Loading a PurePath Studio/Console Header File into the Audio API

The *AUDIO_API/header* folder of the MSP430 code contains custom miniDSP header files. Once the code is compiled, the header file data should be pasted in xxxxx_x_code.h. This header file usually contains the default configuration that is loaded when a **Profile** is selected.

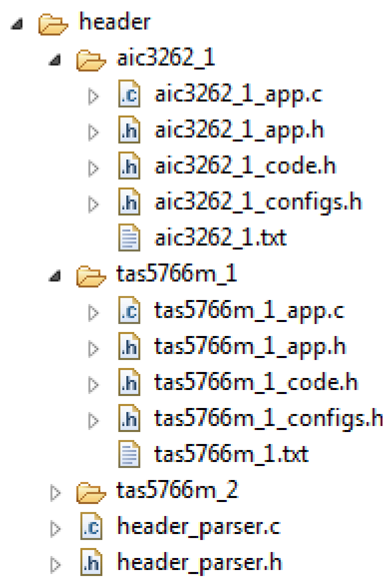


Figure 10. Header Parser Folder Structure

The xxxxx_x_configs.h files contain configurations such as coefficients for A/B comparison, sleep, wake, and other commands. This header file usually contains the configurations loaded when a **Mode** is selected.

Small changes need to be done to the PurePath Studio/Console output header file when integrating into the MSP430 code:

1. Header guards should be added.
2. The header_parser.h file should be included.
3. The cfg_reg/reg_value name should be re-defined to be const so it is loaded into the MSP430 ROM and not RAM.

A PurePath™ Studio example is shown in Figure 11:

```
// (c)2015 by Texas Instruments Incorporated, All Rights Reserved.

#ifndef AIC3262_1_CODE_H_
#define AIC3262_1_CODE_H_

#include "../header_parser.h"

#define cfg_reg static const cfg_reg
#define reg_value cfg_reg

reg_value REG_Section_program[] = {
    {  0,0x0},
    {  0x7F,0x00},
    {121,0x01},
    {  1,0x01},
    {254,0x01},
    {  0x7F,0x78},
...
...
};

#endif /* AIC3262_1_CODE_H_ */
```

Figure 11. PurePath™ Studio Header File Example

Figure 12 shows a PurePath™ Console Example:

```
// (c)2015 by Texas Instruments Incorporated, All Rights Reserved.

#ifndef TAS5766M_1_CODE_H_
#define TAS5766M_1_CODE_H_

#include "../header_parser.h"

#define cfg_reg static const cfg_reg
#define reg_value cfg_reg

// Paste PurePath Console generated configuration here:

cfg_reg registers[] = {
// Select Page 0
    { 0x00, 0x00 },
// Set the device into Powerdown
    { 0x02, 0x11 },
// Reset Device
    { 0x01, 0x11 },
...
...
};

#endif /* TAS5766M_1_CODE_H_ */
```

Figure 12. PurePath™ Console Header File Example

5 TLV320AIC3262 PurePath™ Studio Example Process Flow

In the PurePath™ Console Motherboard, audio can be sourced from USB, Optical, or Analog. This signal is then fed to the TLV320AIC3262 Audio Codec with miniDSP. The codec then sends a digital signal to the target EVM via I^{2}S and an analog signal to the HP OUT audio jack. Refer to the schematics for details (Rev F+).

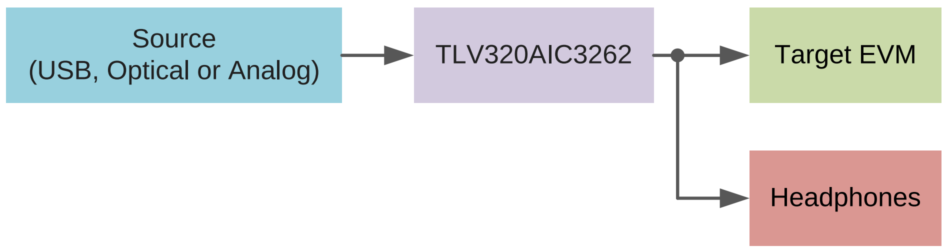


Figure 13. Audio Signal Flow

The PurePath™ Studio process flow shows such implementation. For cases where it is desired to limit the main volume (for example, to protect a speaker based on power level), the **Limit_1** component can be adjusted relative to full-scale. Volume is controlled indirectly using the **Main_Vol_1** component. 0 dB is obtained by writing 0x400000.

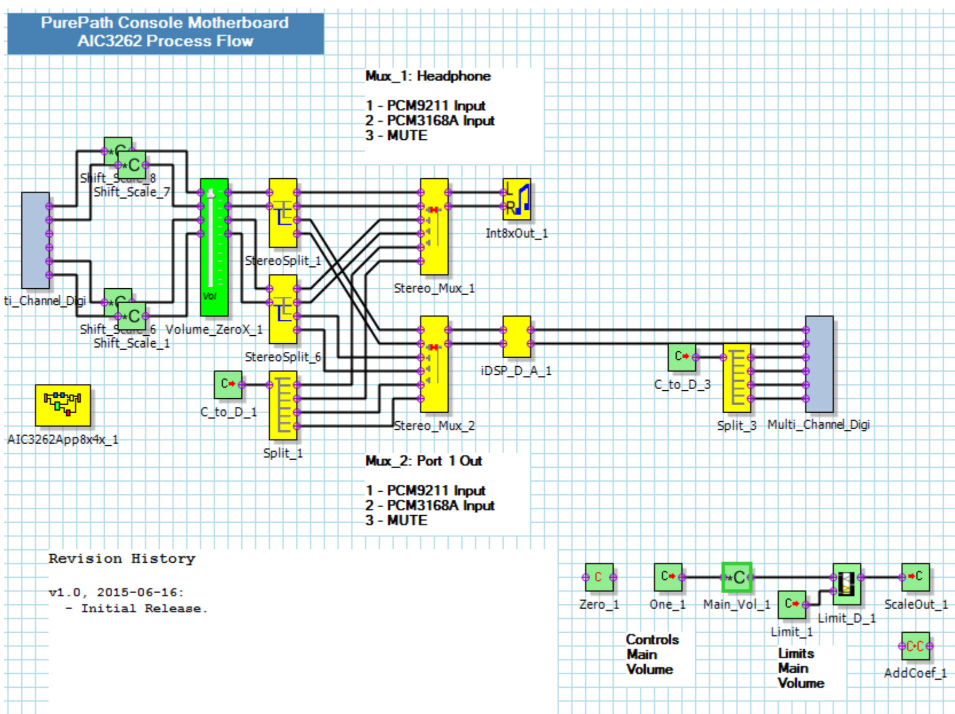


Figure 14. PPCMB AIC3262 Process Flow

Appendix A. Easy Demo Virtual Register Map

The Easy Demo Virtual Register Map (VRM) contains 128 pages of 8-bit registers. Each register corresponds to an *on-board 64kB (512kbit) EEPROM memory location*. The external I2C master sends I2C commands through USCI_B1 to program these virtual registers.

The device can be controlled by writing to certain locations in Page 0 and Page 1 of the VRM. Figure 15 is an example command that can be sent through I2C by the host PC.

```
w 30 02 01 # Increment Mode
d 500
w 30 02 02 # Increment Audio Input Source
d 500
w 30 02 04 # Increment Volume+
d 500
w 30 02 08 # Increment Volume-
d 500
w 30 02 10 # Increment Profile+
d 500
w 30 02 1F # Increment All
d 500
w 30 03 01 # Set Profile to 1
d 500
w 30 03 00 # Set Profile to 0
```

Figure 15. Set Volume, Input, and Mode Example

The I^{2}C Write Protocol

`[S][I2C Slave Address/W][ACK][Register Offset][ACK][Data(0)][ACK]...[Data(n)][ACK][P]`

The I2C master must perform ACK polling to allow the MSP430 time to process its data after each write. To perform ACK polling, send the I2C slave address along with a write command. If a NACK is returned as in the following, then issue a stop command (P).

`[S][I2C Slave Address/W][NACK][P]`

If an ACK is received, issue a stop and then proceed with the full command.

`[S][I2C Slave Address/W][ACK][P]`

The I^{2}C Read Protocol

A read is performed using repeated starts (Sr) by first writing the register offset and then issuing a read command.

`[S][I2C Slave Address/W][ACK][Register Offset][ACK]`

`[Sr][I2C Slave Address/R][ACK][Data(0)][ACK]...[Data(n)][NACK][P]`

A page is selected similar to an AIC device, by writing Register 0 of any page.

A.1 Register Map Summary

Table 2 summarizes the VRM.

Table 2. Easy Demo Virtual Register Map Summary

PAGE NO.	REG. NO.	DESCRIPTION
ANY	240 (0xF0)	Device Select Register
0 (0x00)	0 (0x00)	Page Select Register
0 (0x00)	1 (0x01)	USB DUT Control Register
0 (0x00)	2 (0x02)	Demo Increment Register
0 (0x00)	3 (0x03)	Active Profile Control Register
0 (0x00)	4 (0x04)	Active Mode Control Register
0 (0x00)	5 (0x05)	Volume Level Control Register
0 (0x00)	6 (0x06)	Active Audio Input Control Register
0 (0x00)	7 (0x07)	Reserved
0 (0x00)	…	…
0 (0x00)	127 (0x7F)	VRM Options
1 (0x01)	0 (0x00)	Page Select Register
1 (0x01)	1 (0x01)	Reserved
1 (0x01)	…	…
1 (0x01)	127 (0x7F)	Reserved
…	…	…

A.2 Virtual Register Map

A.2.1 Page 0 Registers

A.2.1.0 Page 0 (0x00) / Register 0 (0x00): Page Select Register

Selects active VRM Page.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7-D0	R/W	0000 0000	Page Select Register 0: Selects Page 0 of the Register Map. 1: Selects Page 1 of the Register Map. 2: Selects Page 2 of the Register Map. … 254: Selects Page 254 of the Register Map. 255: Selects Page 255 of the Register Map.

A.2.1.1 Page 0 (0x00) / Register 1 (0x01): USB DUT Control Register

By default, the TAS1020B USB Controller has control of the DUT. When a User Interface button is pressed, the DUT control is given to the MSP430. To give control back to the TAS1020B, write a ‘1’ to D0.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7-D1	R/W	0000 000	Reserved. Write only reset values.
D0	R/W	0	Control DUT via USB 0: USB DUT control command has already been sent. 1: Activate USB Control of the DUT (self-clearing).

A.2.1.2 Page 0 (0x00) / Register 2 (0x02): Demo Increment Register

This register controls Volume, Input, and Mode and Profile in the same way the on-board push buttons control these.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7-D5	R/W	000	Reserved. Write only reset values.
D4	R/W	0	Increment Profile 0: Profile has been already incremented. 1: Increment Profile (self-clearing).
D3	R/W	0	Increment Vol- 0: Vol- has been already incremented. 1: Increment Vol- (self-clearing).
D2	R/W	0	Increment Vol+ 0: Vol+ has been already incremented. 1: Increment Vol+ (self-clearing).
D1	R/W	0	Increment Audio Input Select

A.2.1.2 Page 0 (0x00) / Register 2 (0x02): Demo Increment Register

This register controls Volume, Input, and Mode and Profile in the same way the on-board push buttons control these.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
			0: Audio Input has already been incremented. 1: Increment Audio Input (self-clearing).
D0	R/W	0	Increment Mode 0: Mode has been already incremented. 1: Increment Mode (self-clearing).

A.2.1.3 Page 0 (0x00) / Register 3 (0x03): Active Profile Control Register

This register directly controls the Active Profile.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7	R/W	0	Reserved. Write only reset values.
D6-D0	R/W	000 0000	Active Profile 0: Profile A 1: Profile B 2: Profile 2 … 127: Profile 127 (Maximum)

A.2.1.4 Page 0 (0x00) / Register 4 (0x04): Active Mode Control Register

This register directly controls the Active Mode.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7	R/W	0	Reserved. Write only reset values.
D6-D0	R/W	000 0000	Active Mode 0: Mode A 1: Mode B 2: Mode 2 … 127: Mode 127 (Maximum)

A.2.1.5 Page 0 (0x00) / Register 5 (0x05): Volume Level Control Register

This register directly controls the Volume Level.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7	R/W	0	Reserved. Write only reset values.
D6-D0	R/W	000 1000	Volume Level

A.2.1.5 Page 0 (0x00) / Register 5 (0x05): Volume Level Control Register

This register directly controls the Volume Level.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
			000 0000: Mute 000 0001: Level 1 … 000 1000: Level 8 (Default) … 000 1110: Level 14 000 1111: Level 15 (Recommended maximum) 001 0000: Custom 16 … 111 1111: Custom 127 (Maximum)

A.2.1.6 Page 0 (0x00) / Register 6 (0x06): Active Audio Input Control Register

This register directly controls the Active Audio Input.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7	R/W	0	Reserved. Write only reset values.
D6-D0	R/W	000 0000	Active Audio Input 0: USB 1: Optical 2: Analog … 127: Custom 255 (Maximum)

A.2.1.7 Page 0 (0x00) / Registers 7-126 (0x05-0x7E): Reserved Registers

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7-D0	R/W	1111 1111	Reserved. Write only reset values.

A.2.1.8 Page 0 (0x00) / Register 127 (0x7F): VRM Options

TBD.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7-D1	R/W	1111 111	Reserved. Write only reset values.
D0	R/W	0	VRM Default Settings Control 0: Normal operation. 1: VRM Page 0 and Page 1 registers will be reset to defaults upon RESET or power cycle

A.2.1.8 Page 0 (0x00) / Register 127 (0x7F): VRM Options

TBD.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
			(self-clearing bit).

A.2.2 Page 1 Registers

A.2.2.1 Page 1 (0x01) / Register 0 (0x00): Page Select Register

Selects active VRM Page.

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7-D0	R/W	0000 0000	Page Select Register 0: Selects Page 0 of the Register Map. 1: Selects Page 1 of the Register Map. 2: Selects Page 2 of the Register Map. … 254: Selects Page 254 of the Register Map. 255: Selects Page 255 of the Register Map.

A.2.2.2 Page 1 (0x01) / Registers 1-127 (0x01-0x7F): Reserved Registers

BIT	READ / WRITE	RESET VALUE	DESCRIPTION
D7-D0	R/W	1111 1111	Reserved. Write only reset values.