

Using the MSP430 Launchpad as a Standalone I2C Host for Audio Products

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ABSTRACT

This document and its associated files (MSP430 Audio Boot Code - [SLAC640](#)) give a foundation for customers to use the MSP430 Launchpad as a tool to evaluate and demonstrate TI Audio products, without the need to be connected to a computer.

This application code will take header files exported from TI Audio development tools and create standalone, bootable demo's – using the MSP430 as a host.

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1 Introduction

For many, moving from an evaluation board and software to a standalone platform is a daunting task.

Getting a self-booting demonstration requires significant time and effort to generate the correct I2C script and generate the code for the microcontroller that will eventually boot your device.

This project removes many of those barriers by providing a framework that *simple wakes up, and boots over I2C*. This framework is designed to work on the MSP430 Launchpad, a \$9.99 easy-to-use development tool.

Connection between the launchpad and the target hardware (your own hardware, or an evaluation board) is simple. You only need to connect the three wires and plug in the power. The framework also allows for a serial port terminal to be used to send additional I2C instructions after bootup, another useful debug point.

2 MSP430 Booting Demo Overview

The Audio Boot Platform requires two pieces of hardware. The MSP430 Launchpad (www.ti.com/lsds/ti/microcontroller/16-bit_msp430/overview.page) and the device under configuration (must be I2C controllable).

The code provides two kinds of the I2C configuration code. One is the GPIO_I2C (I2C over GPIO pins), the other is the USCI_I2C (I2C using the USCG peripheral).

The hardware connection only needs three wires, SCL, SDA and GND. The software development environment used is Code Composer Studio™.

The software project (downloaded from www.ti.com/tool/ccstudio-msp430) only has two files. One is the Main.c file, the other is the I2CBoot.h file.

Once your code is downloaded to the Launchpad, the LaunchPAD can self boot the demo through the I2C. You can also use the USB Serial port and the onboard Launchpad buttons to do additional debug and demos. [Figure 1](#) gives a visual overview of the platform from both a hardware and software point of view.

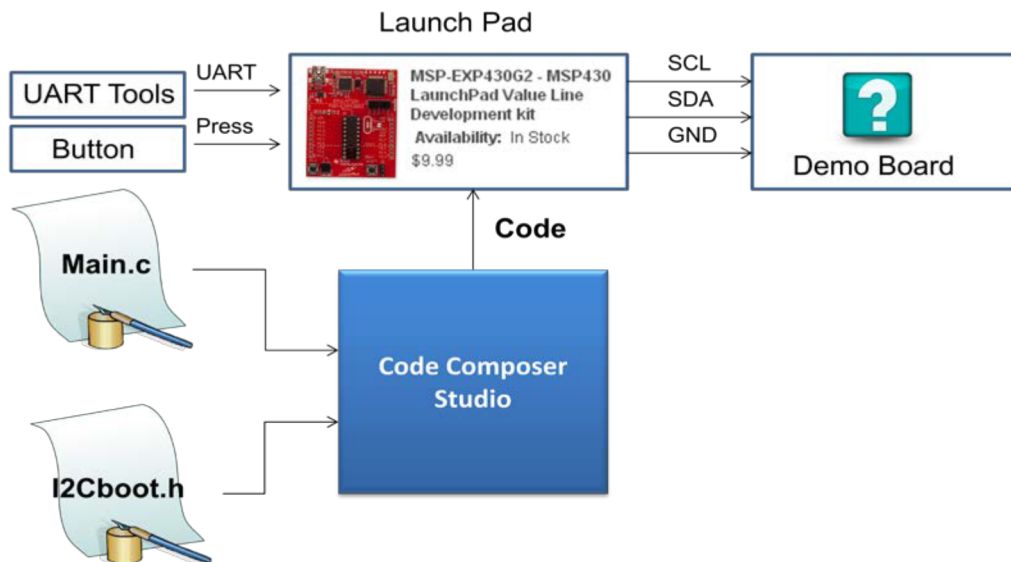


Figure 1. MSP430 Booting Demo Architecture

2.1 Main.c file

All the functions are defined in the Main.c file, like the I2C and UART.

I2C is driven either by GPIO Pins or by using the USCI peripheral integrated on the device. The I2C method is decided by the Parameter GPIO. (A variable in the code).

If the GPIO is 1, the I2C Init() is initialized by the GPIO_I2C function. If the GPIO is not 1, the I2C Init() is initialized by the USCI_I2C function.

NOTE: Using the USB Serial UART for additional debugging requires configuring the device to use GPIO mode for I2C.

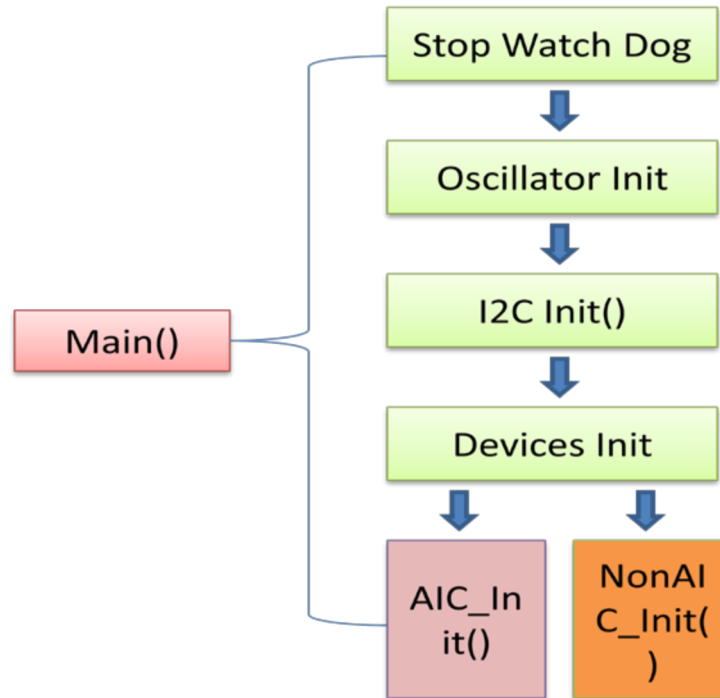


Figure 2. Main.c File Function Flow

Figure 2 shows the Main.c file function flow. There are two different kinds of I2C write available in this implementation.

The non-miniDSP based devices that just require a simple register configuration, (for example, TAS5717 or PCM9211, and so forth) can use the NonAIC_Init(). It simply takes an array for data and downloads it via I2C.

The miniDSP based devices (such as AIC3254, PCM514x and so forth) use multiple registers for peripherals and others for coefficients and instruction memory. Some additional logic is required to decode the I2C addresses into additional delay instructions to allow configuration to take place.

2.2 I2Cboot.h File

The I2Cboot.h file contains the register and register's value. When the MSP430 is booting, the I2C command will use the I2Cboot.h's content to configure the demo board.

```

3  *
4  * Created on: 2013-5-1
5  * Author: a0219299
6  */
7
8  #ifndef AIC_H_
9  #define AIC_H_
10
11
12 static const reg_value REG_Section_program[] = {
13
14 { 0,0x00},
15 // # reg[ 0][ 1] = 0x01 ; Initialize the device through software reset
16 { 1,0x01},
17 {254,0x0A},
18 { 0,0x01},
19 // # reg[ 1][ 1] = 0x08 ; Power up AVDD LDO; Disable weak AVDD to DVDD co
20 { 1,0x08},
21 // # reg[ 1][ 2] = 0x00 ; Enable Master Analog Power Control
22 { 2,0x00},
23 // # reg[ 1][ 71] = 0x32 ; Set the input power-up time to 3.1ms
24 { 71,0x32},
25 // # reg[ 1][123] = 0x01 ; Set REF charging time to 40ms (automatic)
26 {123,0x01},
27 {255,0x00},
28 {255,0x01},
29 { 0,0x00},
30 // # reg[ 0][ 60] = 0x00 ; DAC prog Mode: miniDSP_A and miniDSP_D NOT p
31 { 60,0x00},
    
```

Figure 3. I2Cboot.h Example

3 How to Connect the Hardware

The MSP430 booting demo's hardware connection is very easy. You only need to connect three wires, including SCL, SDA, and GND.

Figure 4 shows a typical setup, an MSP430 Launchpad board booting a TLV320AIC3254 codec. The only interface between both boards are the I2C pins (SDA, SCL) and GND.

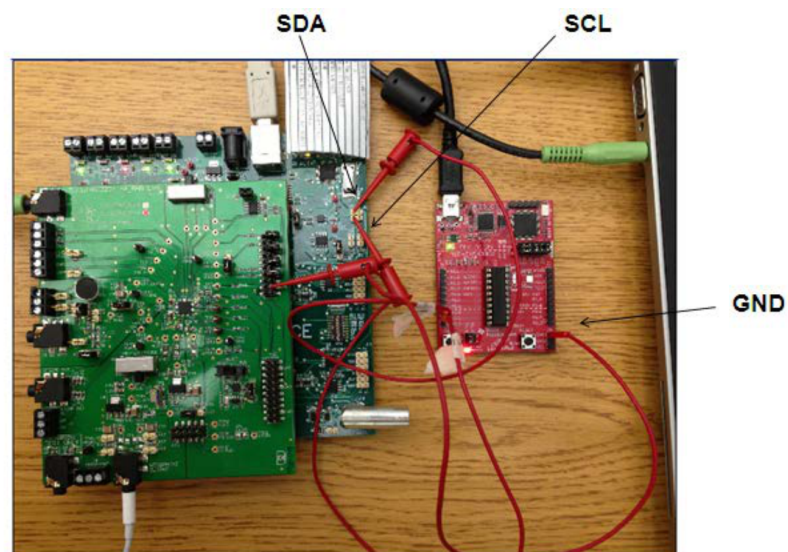


Figure 4. Hardware Connection

4 I2CBoot.h file Create and Modify

In this section, the I2Cboot.h file is illustrated with an example, using the AIC3254 device (miniDSP device) and the TAS5717 (non-miniDSP device).

4.1 MiniDSP Device

The majority of miniDSP devices use a development tool called PurePath™ Studio. PurePath Studio (PPS) has the ability to export header files that can be integrated into an embedded system.

Exporting the header file and importing it correctly into your code composer studio project is done with the following steps:

Step 1: PurePath Studio→Tools→Option→Build→Generate Device Driver Interface

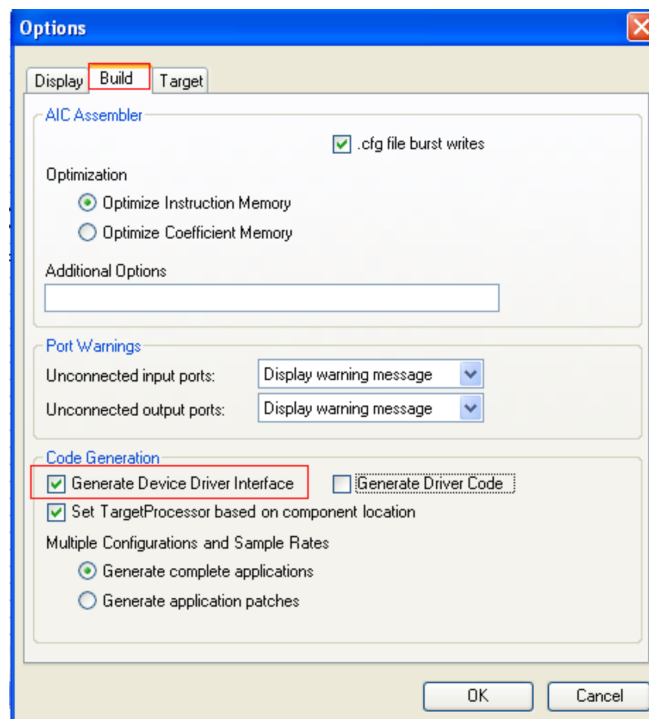
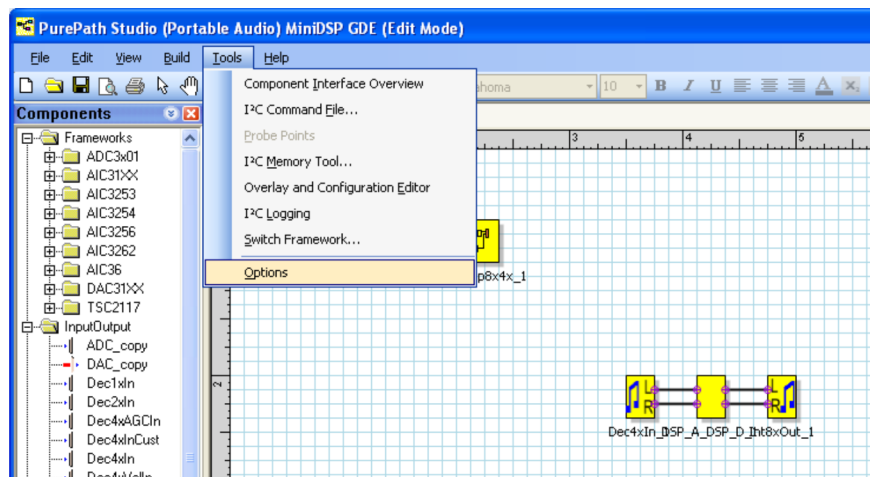


Figure 5. Configure the Option in the PPS

Step 2: Build→Generate Code

The base_main_Rate44_pps_driver.h file is found in the project folder.

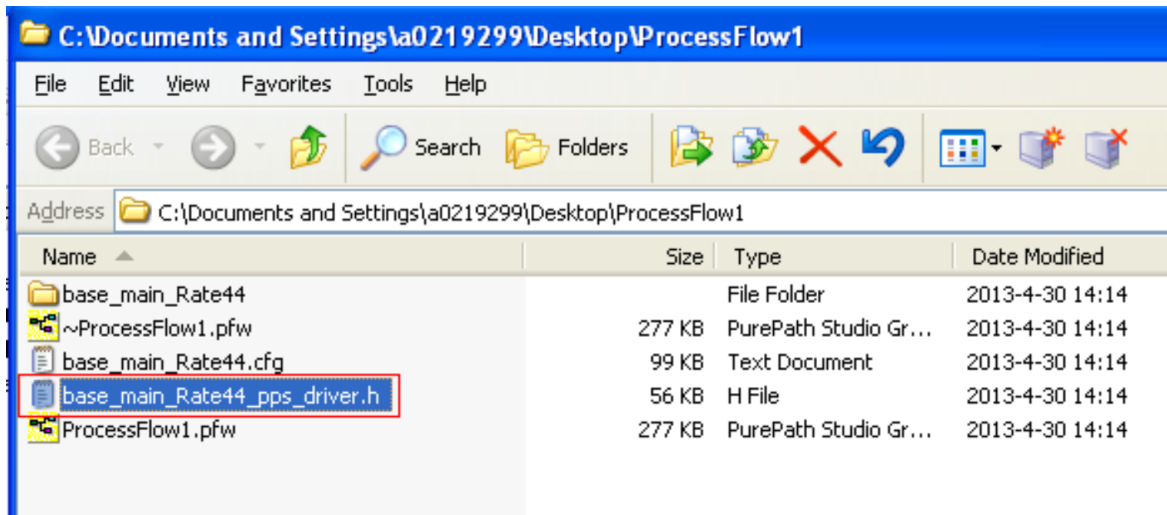


Figure 6. Generate the Configure File Through PPS

Step 3: Modify the base_main_Rate44_pps_driver.h file:

Remove the definition except the three definitions and the lengths.

1. Add "static const" before the arrays;
2. After modification, the base_main_Rate44_pps_driver.h is as illustrated in [Figure 7](#):

```

12 static const reg_value REG_Section_program[] = {
13
14     { 0,0x00},
15 //     # reg[ 0][ 1] = 0x01 ; Initialize
16     { 1,0x01},
17     {254,0x0A},
18     { 0,0x01},
19 //     # reg[ 1][ 1] = 0x08 ; Power up AV
20     { 1,0x08},
21 //     # reg[ 1][ 2] = 0x00 ; Enable Mast
22     { 2,0x00},
23
24     •
25     •
26     •
27
28     167 static const reg_value miniDSP_A_reg_values[] = {
29         { 0,0x08},
30         { 8,0x00},
31         { 9,0xB7},
32         { 10,0x98},
33         { 11,0x00},
34
35         •
36         •
37         •
38
39     1590 #define miniDSP_A_reg_values_COEFF_START    0
40     1591 #define miniDSP_A_reg_values_COEFF_SIZE    590
41     1592 #define miniDSP_A_reg_values_INST_START    590
42     1593 #define miniDSP_A_reg_values_INST_SIZE    831
43     1594
44     1595 static const reg_value miniDSP_D_reg_values[] = {
45         { 0,0x2C},
46         { 8,0xFF},
47         { 9,0xFF},
48         { 10,0xFF},
49         { 11,0x00},
50         { 12,0x80},
51
52         •
53         •
54         •
55
56     3136     {102,0xFF},
57     3137     {103,0x00},
58     3138 };
59     3139 #define miniDSP_D_reg_values_COEFF_START    0
60     3140 #define miniDSP_D_reg_values_COEFF_SIZE    356
61     3141 #define miniDSP_D_reg_values_INST_START    356
62     3142 #define miniDSP_D_reg_values_INST_SIZE    1186

```

Figure 7. miniDSP Device I2Cboot.h File Example

4.2 Non-MiniDSP Device

For non-miniDSP devices, the header file can include a much simpler array. The import flow is as follows:

Step 1: Generate a new header file. The header file name can be the device name. For example: Tas5717.h.

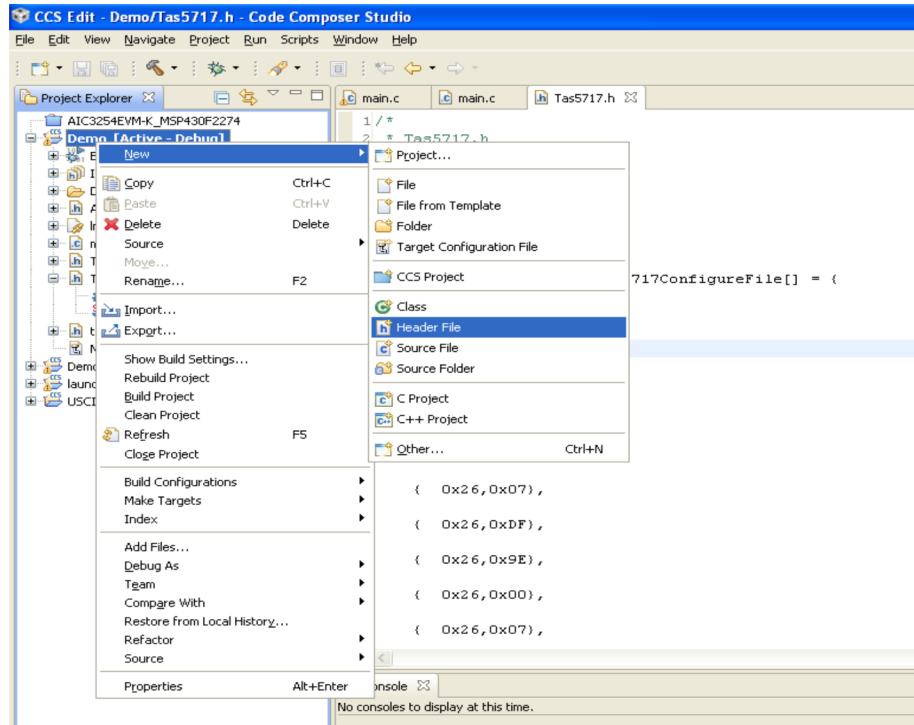


Figure 8. Generate the I2Cboot.h File in CCS

Step 2: Write an array with a format like the following:

Tas5717ConfigureFile is the name which is used in the main function.

If the device you are writing to uses multibyte registers, the same register should be written to many times. Each write moves the position of that particular write within that register.

For example, the register 0x07 is two bytes in the TAS5717 device. You should write twice. [Figure 9](#) shows the array to write a multi-byte register.

```
static const reg_value Tas5717ConfigureFile[] = {
    { 0x1B,0x00},
    { 0x05,0x00},
    { 0x07,0x00},
    { 0x07,0x30},
    { 0x26,0x00},
    { 0x26,0x07},
    { 0x26,0xDF},
    { 0x26,0x9E},

```

Figure 9. Non-miniDSP Device I2Cboot.h File Example

Step 3: Include "Tas5717.h" at the main function.

```

/*****
/*      Include
/*****
#include "msp430g2553.h"
#include "AIC.h"
#include "type.h"
#include "Tas5717.h"

```

Figure 10. Non-miniDSP Device Head File

Step 4: Define the device address.

If using GPIO_I2C, use the data sheet address (0x30). If using USCI_I2C, modify the address (right-shift). 0x30→0x18

```

/*****
#define DIR      P2DIR
#define OUTP     P2OUT
#define IN       P2IN      //For I2C
#define SCL      BIT1      //Bit 1 (SCL)
#define SDA      BIT0      //Bit 0 (SDA)
#define AIC3254  0x30      //Address
#define Tas5717  0x54      //Address

```

Figure 11. Non-miniDSP Device I2C Address

Step 5: Modify the function:

```
NonAIC_Init(Tas5717ConfigureFile,sizeof(Tas5717ConfigureFile)/2,Tas5717);
```

Where:

Tas5717ConfigureFile is the array's name.

Sizeof(Tas5717ConfigureFile)/2 is the array's length.

Tas5717 is the device's name.

Figure 12 shows an example of the main() function used to boot both an AIC3254 miniDSP and a TAS5717 digital amplifier from the same microcontroller.

```

4/*****
5 void main(void) {
6
7     WDTCTL = WDTPW + WDTHOLD;           // Stop WDT
8     I2C_METHOD = GPIO;
9     // If the I2C_METHOD is 1, the code will use the GPIO I2C mode. And if the I2C I
0     if(I2C_METHOD == 1)
1     {
2         BCSCTL1 = CALBC1_1MHZ;
3         DCOCTL = CALDCO_1MHZ;
4         GPIO_I2C_Init();
5         Delay_ms(10);
6         AIC_Init(AIC3254);
7         NonAIC_Init(Tas5717ConfigureFile,sizeof(Tas5717ConfigureFile)/2,Tas5717);
8         Delay_ms(20);

```

Figure 12. Non-miniDSP Device NonAIC_Init

5 Summary

This hardware and software platform provides a quick and easy process to demonstrate and debug your project, in a system or on a standalone demonstration board. Developers can go from a system that sounds good on the EVM and PC development tools, to a standalone booting platform in a matter of minutes.

Both common I2C devices, and miniDSP-based devices are supported on the demo hardware, as well as the ability to boot using USCI or using GPIO's on the MSP430. Buttons on the launchpad can be used to do things like "audio effect on, audio effect off", making demonstration and debugging easy and effective.

For technical questions and discussions, visit the audio amplifiers forum at e2e.ti.com

Appendix A miniDSP Device Head File

A.1 miniDSP Head File Structure

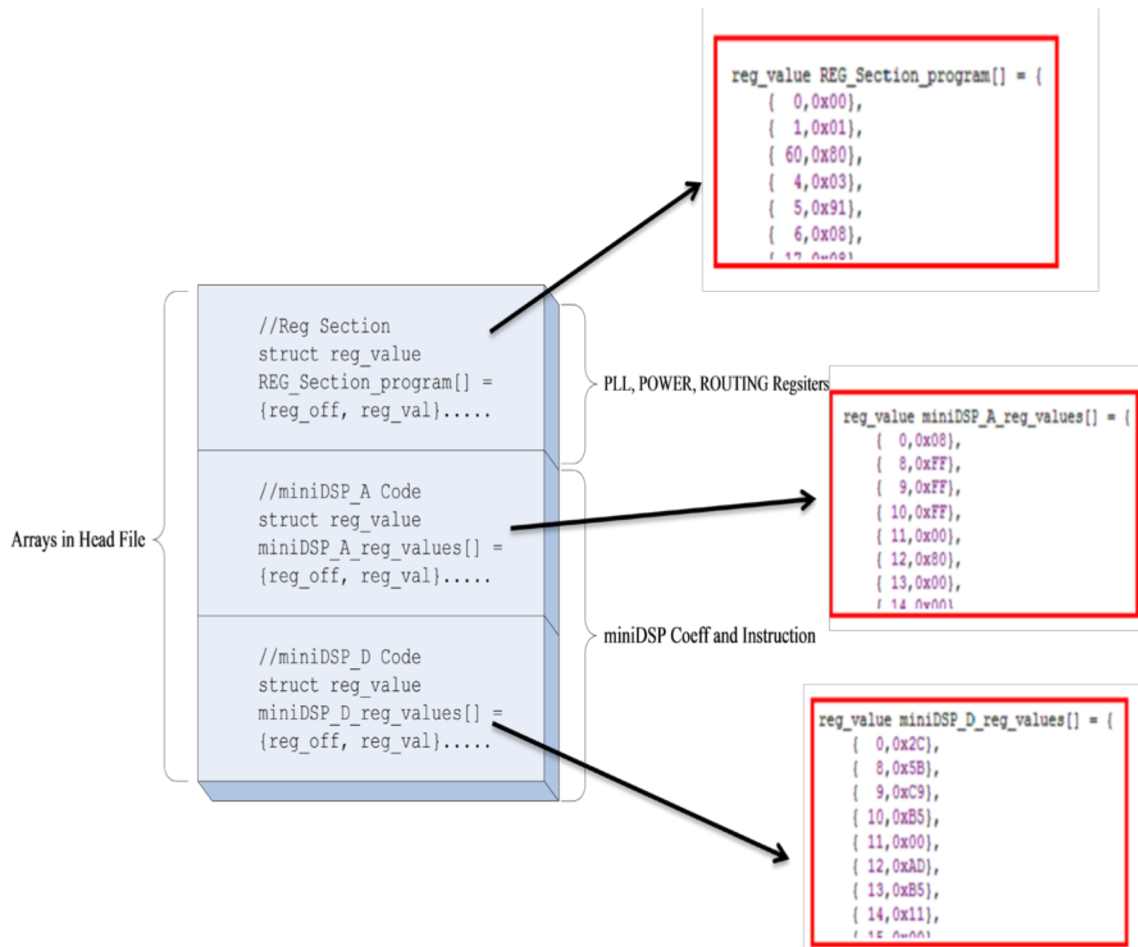


Figure 13. miniDSP Head File Structure

A.2 miniDSP Device Flow Chart for Reg_Section

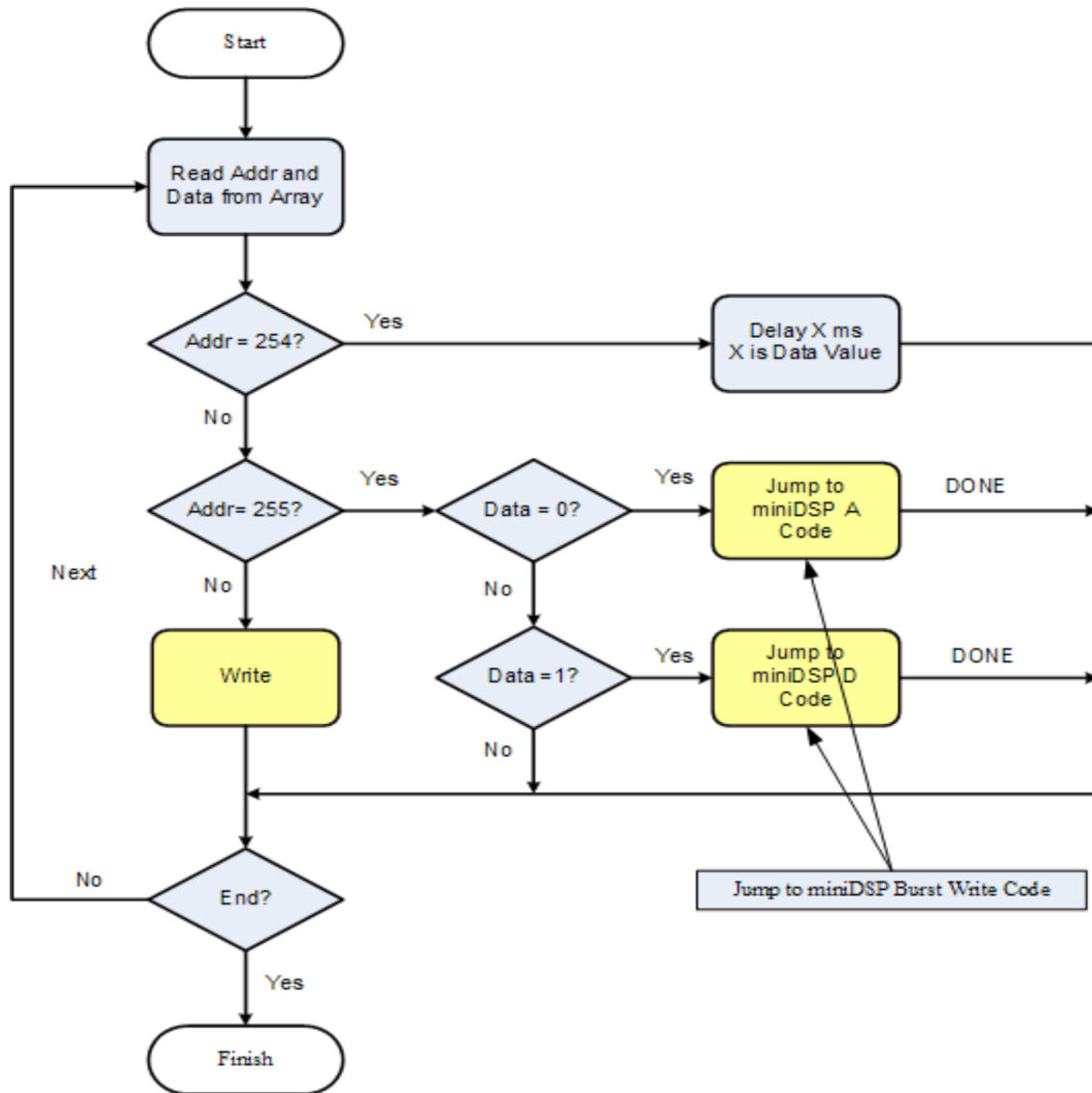


Figure 14. Decoder for Reg Section

Decoder for Reg Section:

If reg = 254 : Command for delay. The delay time is the value of data (ms).

If reg = 255 , data=0 : command for jump to miniDSP-A programming.

If reg = 255 , data=1 : command for jump to miniDSP-D programming.

Revision History

Changes from Original (October, 2013) to A Revision

Page

- Added link to MSP430 Audio Boot Code (SLAC640) 1

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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