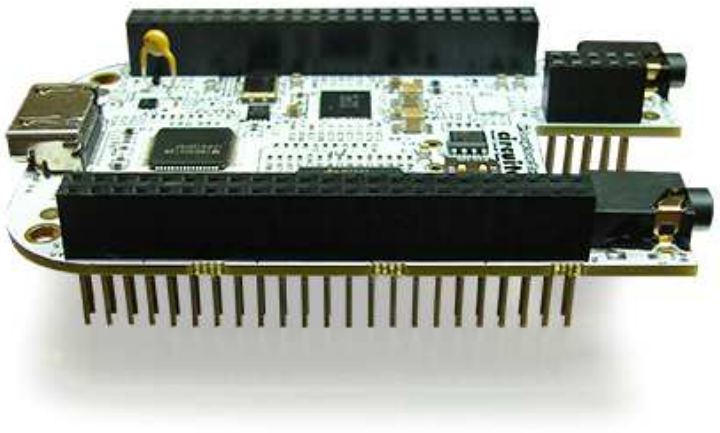

BeagleBone DVI-D with Audio Cape Rev A1 System Reference Manual

Revision A1
October 1st, 2012

THIS DOCUMENT

For any questions, concerns, or issues submit them to support@beagleboardtoys.com

BEAGLEBONE DVI-D WITH AUDIO CAPE DESIGN

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NOTES

1.0 Introduction

This document is the System Reference Manual for the BeagleBone DVI-D with Audio Cape, an add-on board for the BeagleBone.

This document provides detailed information on the overall design and usage of the BeagleBone DVI-D with Audio Cape from the system level perspective. It is not intended to provide detailed documentation of any other component used on the board. It is expected that the user will refer to the appropriate documents for these devices to access detailed information. It will provide information on how to interact with these components from an interface perspective. The perspective will be general in nature and not specific to any one board.

The key sections in this document are:

Section 2.0 – Change History
Provides tracking for the changes made to the System Reference Manual.

Section 3.0 – Overview
This is a high level overview of the BeagleBone DVI-D with Audio Cape.

Section 4.0 – Features and Specification
Provided here are the features and specifications of the board.

Section 5.0 – System Architecture and Design
This section provides information on the overall architecture and design of the BeagleBone DVI-D with Audio Cape. This is a very detailed section that goes into the design of each circuit on the board.

Section 6.0 – Mechanical
Information is provided here on the dimensions of the BeagleBone DVI-D with Audio Cape.

Section 7.0 – Design Materials
This section provides information on where to get the design files.

2.0 Change History

2.1 Change History

Table 1 tracks the changes made for each revision of this document.

Table 1. Change History

Rev	Changes	Date	By
A	Initial release.	08/25/2011	BBT
A1	1. Add Rev A vs. A1 section (2.2)	10/01/2012	BBT

2.2 Rev A vs. A1

The only changes in this revision are PCB silkscreens to accommodate the release of Audio Cape and DVI-D with Audio Cape. No design changes have been made for the BeagleBone DVI-D with Audio revision A1.

The PCB revision is also changed from BB-BONE-DVID-PCB-03 to BB-BONE-DVID-PCB -04.

3.0 BeagleBone DVI-D with Audio Cape Overview

3.1 Descriptions

The BeagleBone DVI-D with Audio Cape provides both DVI-D output and stereo audio input and output for the BeagleBone by using the TFP410 PanelBus digital transmitter and TLV320AIC3106 codec. Audio data is sampled at up to 96 kHz during recording or playback. The codec interfaces with the Multichannel Audio Serial Port of the AM335x via audio serial bus. The BeagleBone DVI-D with Audio Cape also features two standard 3.5mm audio jacks as audio input and output connectors.

Figure 1 below is a picture of the board.

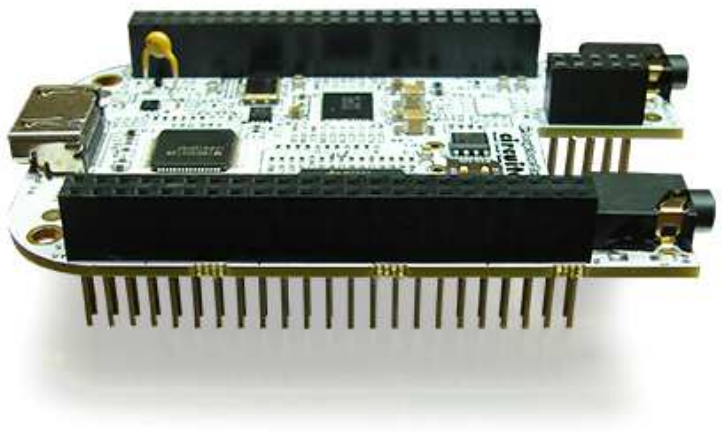

Figure 1. The BeagleBone DVI-D with Audio Cape

3.2 Box Content

The final packaged BeagleBone DVI-D with Audio Cape product will contain the following items:

- 1 BeagleBone DVI-D with Audio Cape

3.3 Getting Started

The BeagleBone DVI-D with Audio Cape should work right out of the box with latest Angstrom image for BeagleBone. Following the instructions below to verify the board is working:

1. Mount the BeagleBone DVI-D with Audio Cape on top of BeagleBone.
    - *Note: The Ethernet connector on BeagleBone should fit right into the cutback on BeagleBone DVI-D with Audio.*
2. Make sure the micro SD card using with BeagleBone has latest Angstrom image.
3. Connect the audio input jack of speakers to the audio output connector on the BeagleBone DVI-D with Audio.
4. Connect the audio output from PC to the audio input connector on the BeagleBone DVI-D with Audiousing a 3.5mm male to male audio cable.
5. Connect the BeagleBone DVI-D with Audio Cape to a DVI-D supported monitor using an HDMI-to-DVI-D cable. The HDMI end of the cable should be plugged into the HDMI port on the DVI-D with Audio Cape. The DVI-D end of the cable should be plugged into the DVI-D input of the monitor.
    - *Note: The DVI-D is hardcoded to provide an output resolution of 1024x768. Please ensure your monitor supports this resolution.*
    - *Note: Only plug in or unplug the HDMI cable when the board is not powered. Hot plugging or unplugging while the board is powered on may damage the board or cable.*
6. Open a media player on PC and play an audio file repeatedly.
7. Connect the BeagleBone to PC using a USB cable. Remember the port number of this connection.
    - *Note: In Windows, the serial port number can be viewed under "Ports (COM & LPT)" section inside "Device Manager". To open the "Device Manager" windows, right-click "My Computer", choose "Properties", select the "Hardware" tab, and click "Device Manager".*
8. You should see on the LCD monitor the BeagleBone logo, the Angstrom log-in prompt, and eventually the Angstrom desktop.
9. Open a terminal application (Teraterm, Hyperterminal, etc) and open new connection with following settings: baud rate - 115200, data – 8 bit, parity – none, stop – 1 bit, flow control – none. Select the port corresponding to the USB connection. Log in as root.
10. Change the ALSA mixer settings by running the command "alsamixer". A preset settings can also be downloaded here.
    - *To apply the preset settings for ALSA mixer, copy the preset file "asound.state" to /var/lib/alsa/ on SD card.*
11. Start the audio test script by running the command "testaudio".
12. The script will test the audio playback by playing a beep sound to speakers.

13. The script will record 1 second of the currently playing audio file on PC and play it back to speakers.

3.4 Repairs

If you feel the board is in need of repair, follow the RMA Request process found at http://www.beagleboardtoys.com/support/rma

Do not send the board in for repair until a RMA authorization has been provided.

Do not return the board to the distributor unless you want to get a refund. You must get authorization from the distributor before returning the board

4.0 Features and Specifications

This section covers the specifications of the BeagleBone DVI-D with Audio Cape and provides a high level description of the major components and interfaces that make up the board.

Table 2 provides a list of the BeagleBone DVI-D with Audio Cape's features.

Table 2. BeagleBone DVI-D with Audio Cape Features

	Feature
Power Supply	3.3V via expansion
	5V via expansion
Audio Connector	3.5mm standard stereo jack
DVI-D Connector	Standard HDMI connector
Indicator	Two user LEDs
EEPROM	Board ID EEPROM
Expansion Connector	46-position stackable connector
	10-position stackable connector

4.1 Key Component Locations

Figure 2 shows the location of the key components on the board.

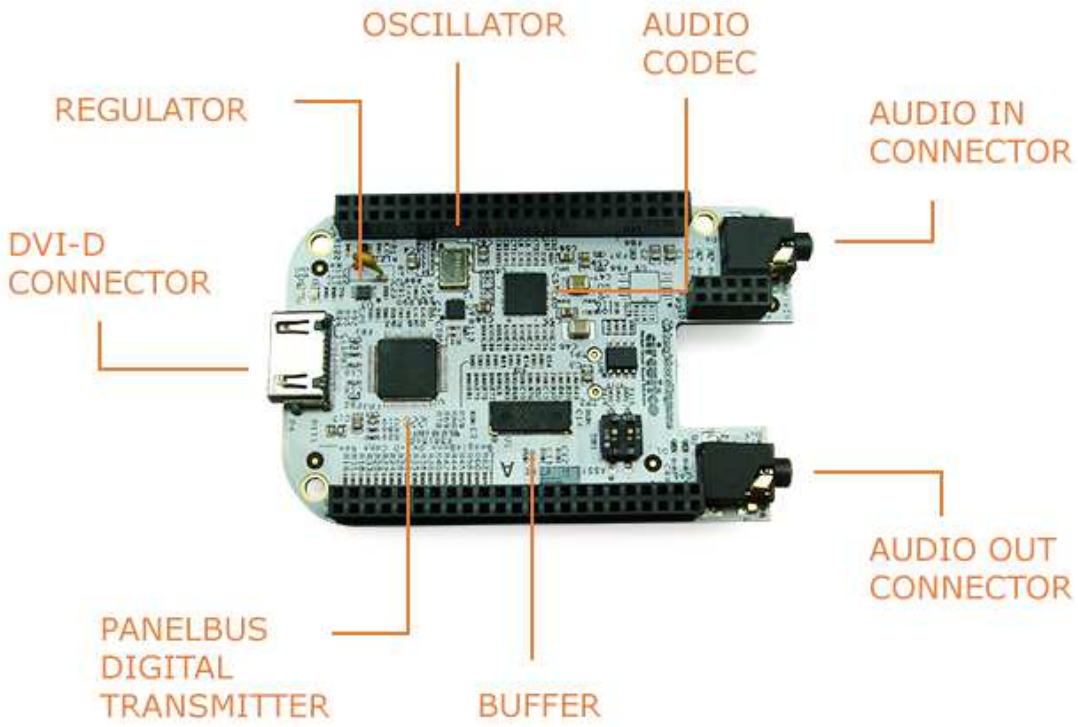

Figure 2. Major Components

4.2 DVI-D Interface

The BeagleBone DVI-D with Audio Cape can drive an LCD panel equipped with a DVI-D digital input. This is the standard LCD panel interface of the processor and will support 16-bit color output. DDC2B (Display Data Channel) or EDID (Enhanced Display ID) support over I2C is provided in order to allow for the identification of the LCD monitor type and the required settings.

4.3 HDMI Connector

The BeagleBone DVI-D with Audio Cape uses an HDMI connector that was selected for smaller size. **It does not support the full HDMI interface and is used to provide the DVI-D interface portion only**. Users must use an HDMI to DVI-D cable or adapter to connect to an LCD monitor. This cable or adapter is not provided with the BeagleBone DVI-D with Audio Cape. A standard HDMI cable can be used when connecting to a monitor with an HDMI connector.

4.4 Audio Codec

The BeagleBone DVI-D with Audio Cape uses the TLV320AIC3106 codec for audio record and playback. Audio data is transferred between the codec and AM335x via the audio serial interface. The TLV320AIC3106 supports ADC and DAC sampling rates of up to 96 kHz.

4.5 Stereo Audio Ports

Two 3.5mm standard audio jacks are used for audio input port and output port. Audio input port is used for recording; audio output port is used for playback.

4.6 Indicators

There are two user LED's on the board. Both are green when lit and can be controlled via software by setting the GPIO ports.

4.7 Expansion Connectors

There are three stackable expansion connectors on the BeagleBone DVI-D with Audio Cape. These connectors are used to stack the DVI-D with Audio Cape on the BeagleBone. Two 46-position connectors will stack on top of the expansion connectors of BeagleBone. The 10-position connector will stack on top of the backlight expansion connector of BeagleBone.

4.8 Mechanical Specifications

Size:	2.15" x 3.40"
Layers:	4
PCB thickness:	.062"
RoHS Compliant:	Yes
Weight:	TBW

5.0 BeagleBone DVI-D with Audio Cape System Architecture and Design

This section provides a high level description of the design of the BeagleBone DVI-D with Audio Cape and its overall architecture.

5.1 System Block Diagram

Figure 3 is the high level block diagram of the BeagleBone DVI-D with Audio Cape.

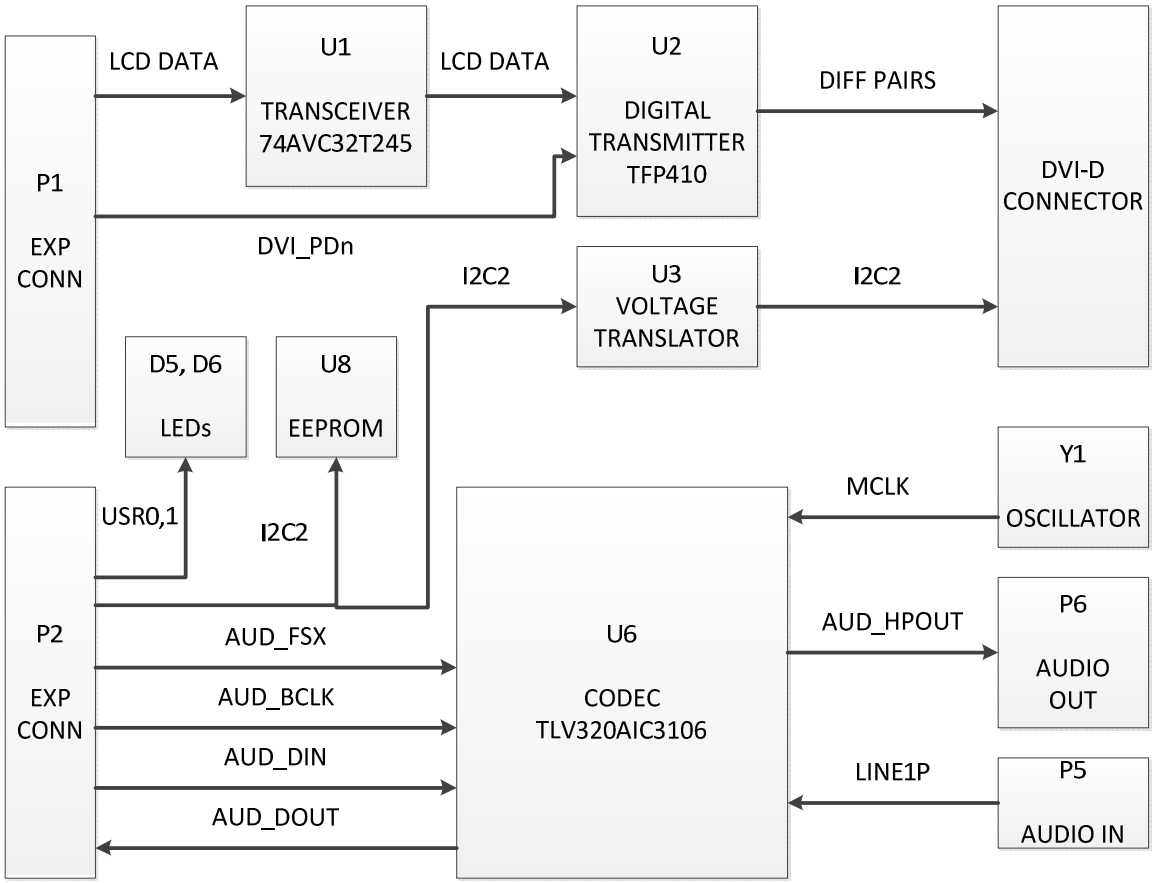

Figure 3. BeagleBone DVI-D with Audio Cape High Level Block Diagram

5.2 DVI-D Interface

5.2.1 Main Expansion Headers

The BeagleBone DVI-D with Audio Cape reduces the number of LCD data signals from 24 to 16. The output quality of 16-bit color is very similar to a 24-bit; however, more signals on the expansion header can be available for other capes.

This cape uses the power rail SYS_5V to power the User LED's, EDID I2C signals to the DVI-D (HDMI) connector and the connector itself. The remaining components are powered by power rail VDD_3V3. In addition to the monitor EDID, the Board ID EEPROM on the DVI-D cape can also be accessed via I2C2 signals.

5.2.2 Bus Transceiver

LCD data and control signals are buffered through 74AVC32T245 which is a 32-bit dual supply bus transceiver. The 74AVC32T245 also features configurable voltage translation and can operate within voltage range of 1.4V-3.6V. Direction-control (DIR) and output-enable (OE) inputs determine which direction the device transmits data. LCD signals from the main expansion headers are at 3.3V level and the buffered output from the 74AVC32T245 are also at 3.3V; thus, no voltage stepping up or down is needed. **Figure 4** shows the LCD signals buffered through 74AVC32T245.

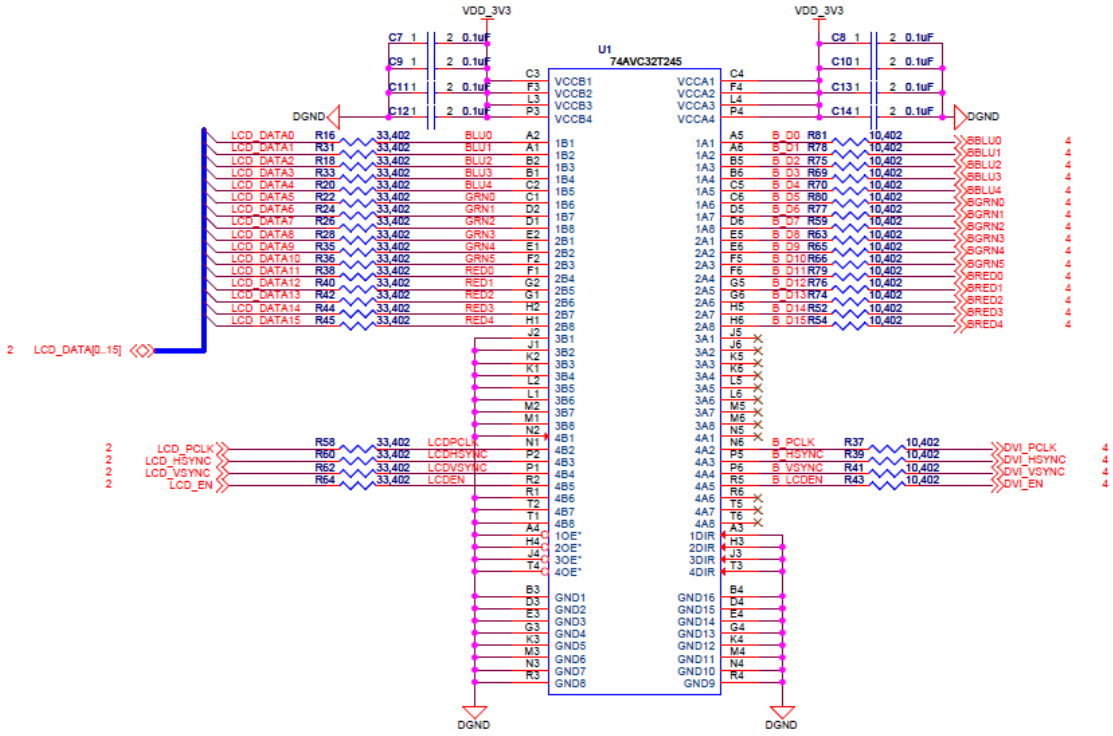

Figure 4. 32-bit Transceiver

5.2.3 Digital Transmitter

TFP410 is a digital transmitter which transmits LCD signals to the HDMI port. The DVI power down signal is connected to the active-low power down pin (PD) of the transmitter. The TFP410 transmits three pairs of differential signal outputs and one pair of differential output clock to the HDMI connector. The EDID I2C signals that goes to the HDMI connector is at 5V; thus, a 2-bit bi-directional voltage translator TXS0102DCU is required to step up the EDID I2C signals from main expansion header P2 to 5V. **Figure 5** shows the TFP410 and TXS0102DCU in the schematic.

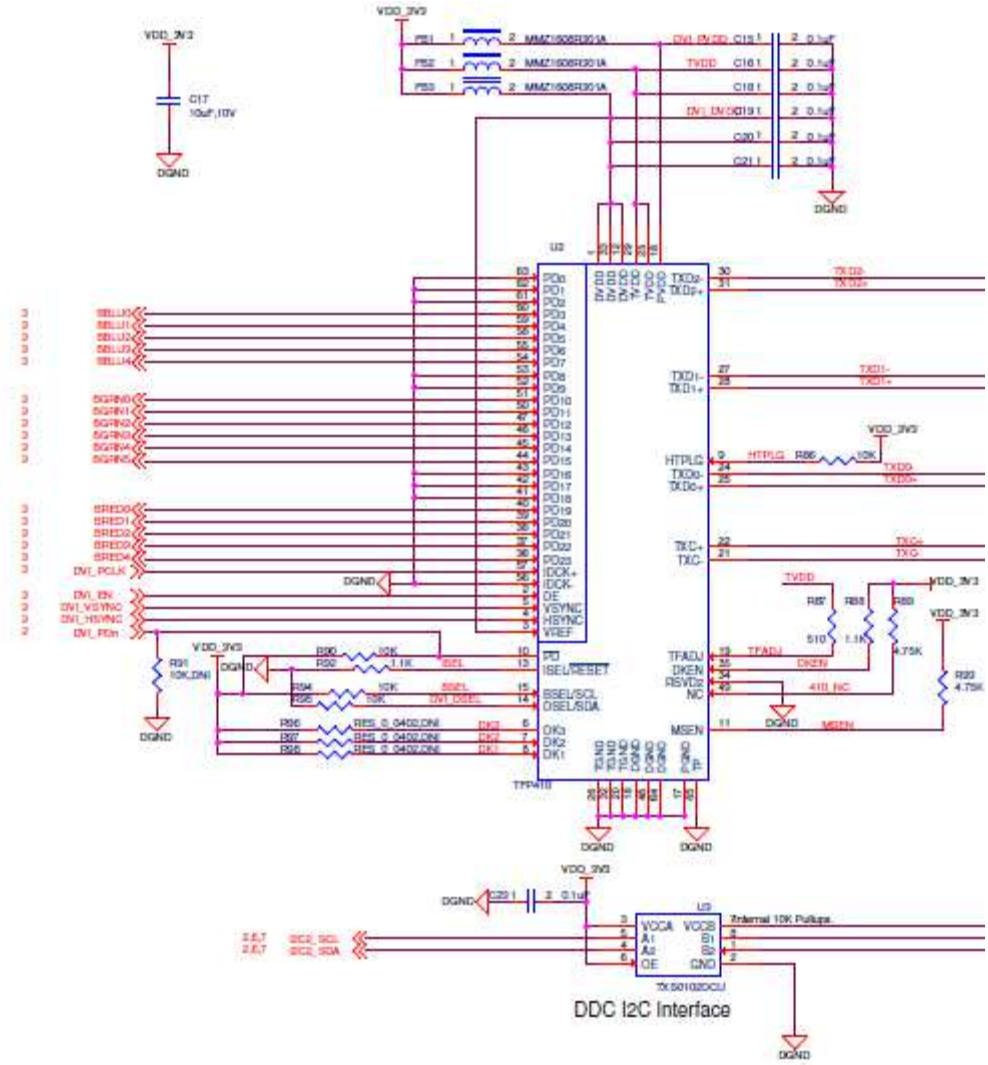

Figure 5. DVI-D PanelBus Digital Transmitter and Voltage Translator

5.3 Audio Interface

5.3.1 Power Supply

The VDD_3V3 power rail from the BeagleBone is used to power the analog and I/O voltage supplies for the codec. The TLV320AIC3106 codec also requires a digital core voltage supply of 1.8V. This supply is provided by a low-dropout (LDO) regulator TPS73701.

5.3.2 Record Path

The TLV320AIC3106 codec can be figured to record from up to four differential pairs or six single-ended audio inputs; however, the BeagleBone DVI-D with Audio Cape only supports two single-ended audio inputs. Each input is passed through a programmable gain amplifier (PGA), which allows gain control from 0 dB to +59.5 dB in steps of 0.5 dB, before sampled by the ADC. The ADC can sample up to 96 kHz in dual-rate mode. An automatic gain control (AGC) is provided to maintain nominally constant output signal amplitude. **Figure 6** shows the record path of TLV320AIC3106.

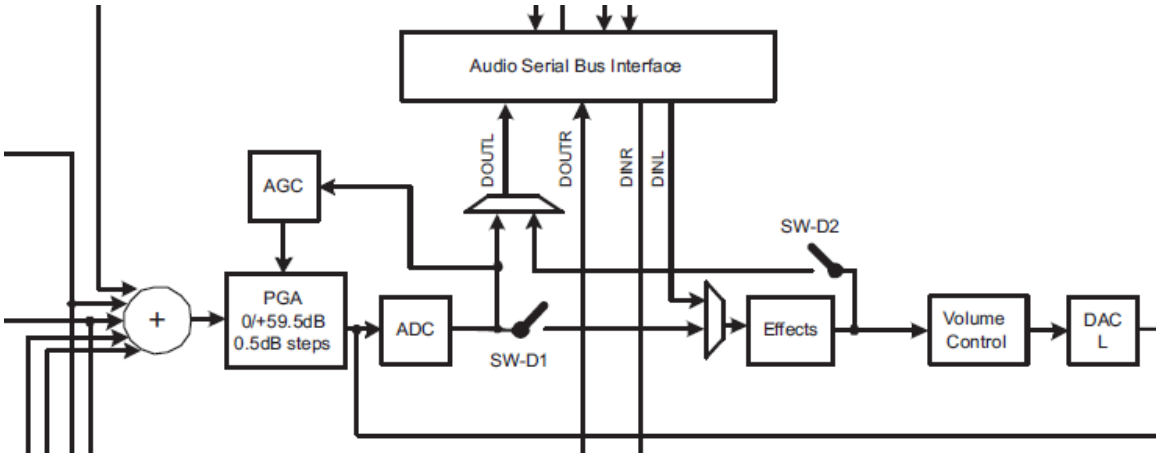

Figure 6. The Record Path of TLV320AIC3106

The codec also supports digital audio processing for the record path if no audio playback is selected. In this mode the signal processing blocks of the playback path can be used to provide different filters for the record path.

5.3.3 Playback Path

The playback audio signals of each channel are filtered through digital audio processing blocks and a digital volume control before sampled by the DAC. The volume control block is programmable and can provide a digital gain from 0 dB to -63.5 dB in 0.5-dB steps. The DAC of the codec supports sampling rates of up to 96 kHz. The TLV320AIC3106 codec supports up to three differential output drivers and four high power single-ended output signals; however, the board design limits to only two single-ended output signals. The output stage of the codec provides the capability to mix/mux between DAC and bypass PGA outputs as well as an output level control for each output channel. If no mixings are required, an output playback signals with highest DAC quality can be provided by using a direct connection for DAC outputs. The analog volume control allows gain adjustment up to +9 dB. **Figure 7** shows the playback path of TLV320AIC3106.

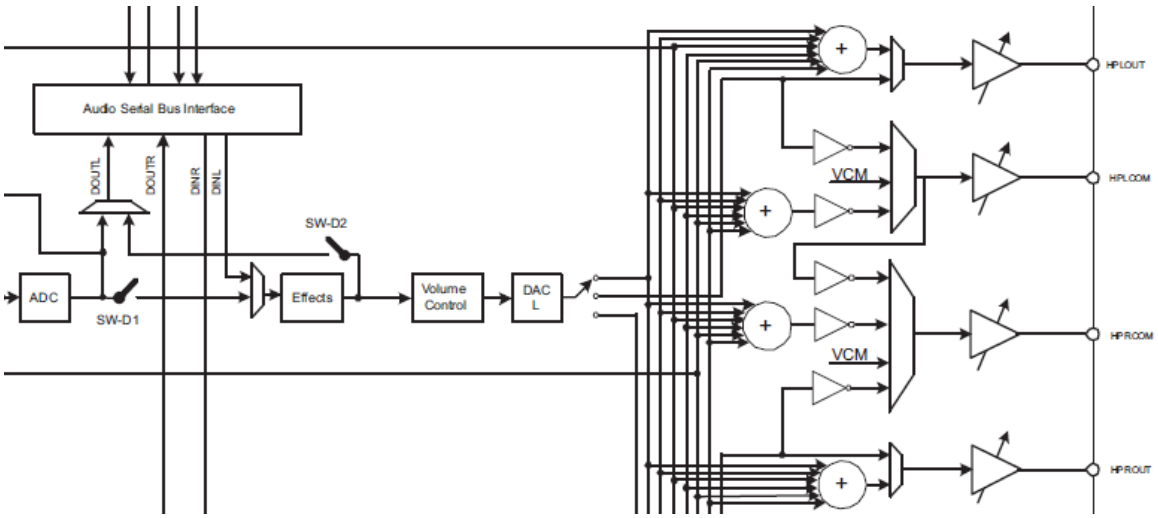

Figure 7. The Playback Path of TLV320AIC3106

5.3.4 Audio Serial Bus Interface

Audio data is transferred between the TLV320AIC3106 and the Multichannel Audio Serial Port (McASP0) of the AM335x via the audio serial bus interface. This interface can be configured to support different modes of operation including the Inter-Integrated sound (I2S) protocols or time-division multiplexed (TDM) stream. Each data frame is synchronized by the transmit frame sync signal (AUD_FSX) from the McASP. This signal is connected to the word clock pin (WCLK), which is used to define the start of a frame. The digital audio data transfer is clocked by a bit clock (BCLK) received from the

AM335x. Data is transmitted or received by the McASP serializers. **Figure 8** shows the Audio Serial Bus Interface between the codec and the microprocessor.

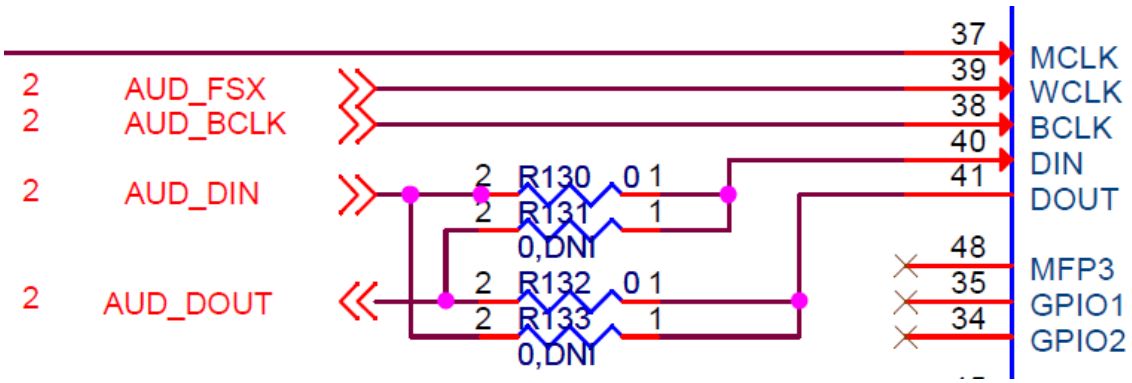

Figure 8. Audio Serial Bus Interface

5.3.5 TLV320AIC3106 Codec

The TLV320AIC3106 codec requires a hardware reset after power-up in order to respond properly to register changes in values. Its reset signal is active low and tied to the system reset signal SYS_RESETn. The TLV320AIC3106 on the BeagleBone DVI-D with Audio Cape is digitally controlled via I2C serial interface. This I2C protocol supports both standard and fast modes and has a 7-bit address of 0011011. An external oscillator is used to provide a 12MHz clock signal to the master clock input (MCLK) of the codec.

5.4 EEPROM

The BeagleBone DVI-D with Audio Cape has an EEPROM containing information that will allow the SW to identify the board and to configure the expansion headers pins as needed. EEPROMs are required for all Capes sold in order for them to operate correctly when plugged in the BeagleBone.

The EEPROM used on this cape is the same one as is used on the BeagleBone, a CAT24C256. The CAT24C256 is a 256 kb Serial CMOS EEPROM, internally organized as 32,768 words of 8 bits each. It features a 64-byte page write buffer and supports the Standard (100 kHz), Fast (400 kHz) and Fast-Plus (1 MHz) I2C protocol. **Figure 9** is the design of the EEPROM circuit.

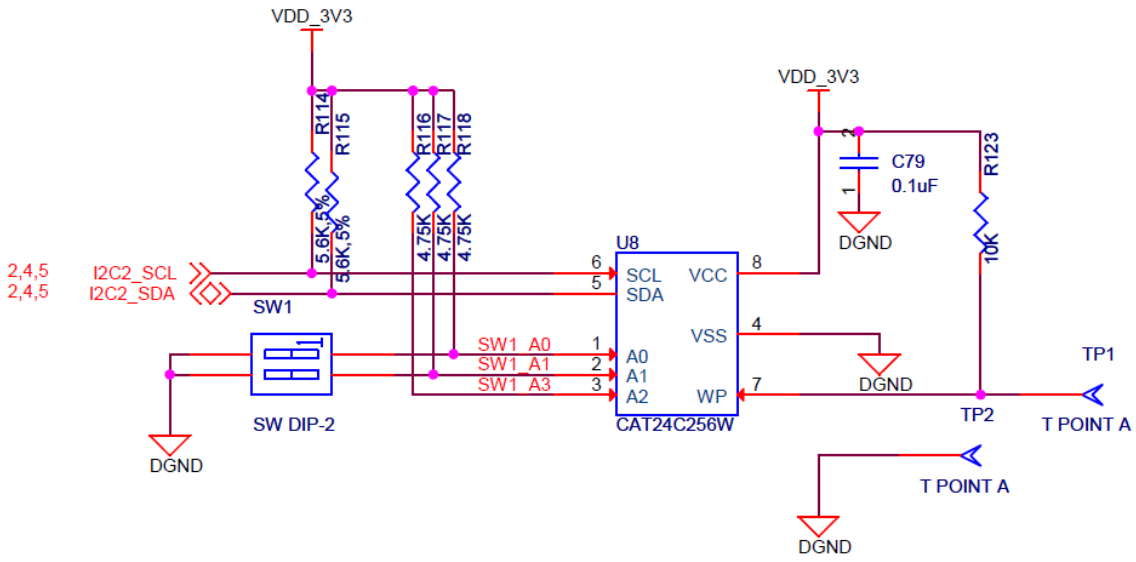

Figure 9. BeagleBone DVI-D with Audio Cape EEPROM

5.4.1 EEPROM Address

In order for each Cape to have a unique address, a board ID scheme is used that sets the address to be different depending on the order in which it is stacked onto the main board. A two position dipswitch or jumpers is used to set the address pins of the EEPROM. It is the responsibility of user to set the proper address for each board. Address line A2 is always tied high. This sets the allowable address range for the expansion cards to 0x54 to 0x57.All other I2C addresses can be used by the user in the design of their Capes. But, these addresses must not be used other than for the board EEPROM information.

5.4.2 I2C Bus

The EEPROMs on each expansion board is connected to I2C2. For this reason I2C2 must always be left connected and should not be changed by SW to remove it from the expansion header pin mux. The I2C signals require pull-up resistors. Each board must have a 5.6K resistor on these signals. With four resistors this will be an affective resistance of 1.4K if all Capes were installed.

5.5 User LED's

The BeagleBone DVI-D with Audio Cape features two user LED's which are same as D2 and D3 on the BeagleBone boards. These two LED's can be access via GPIO pins on the processor. **Figure 10** shows the LED circuitry.

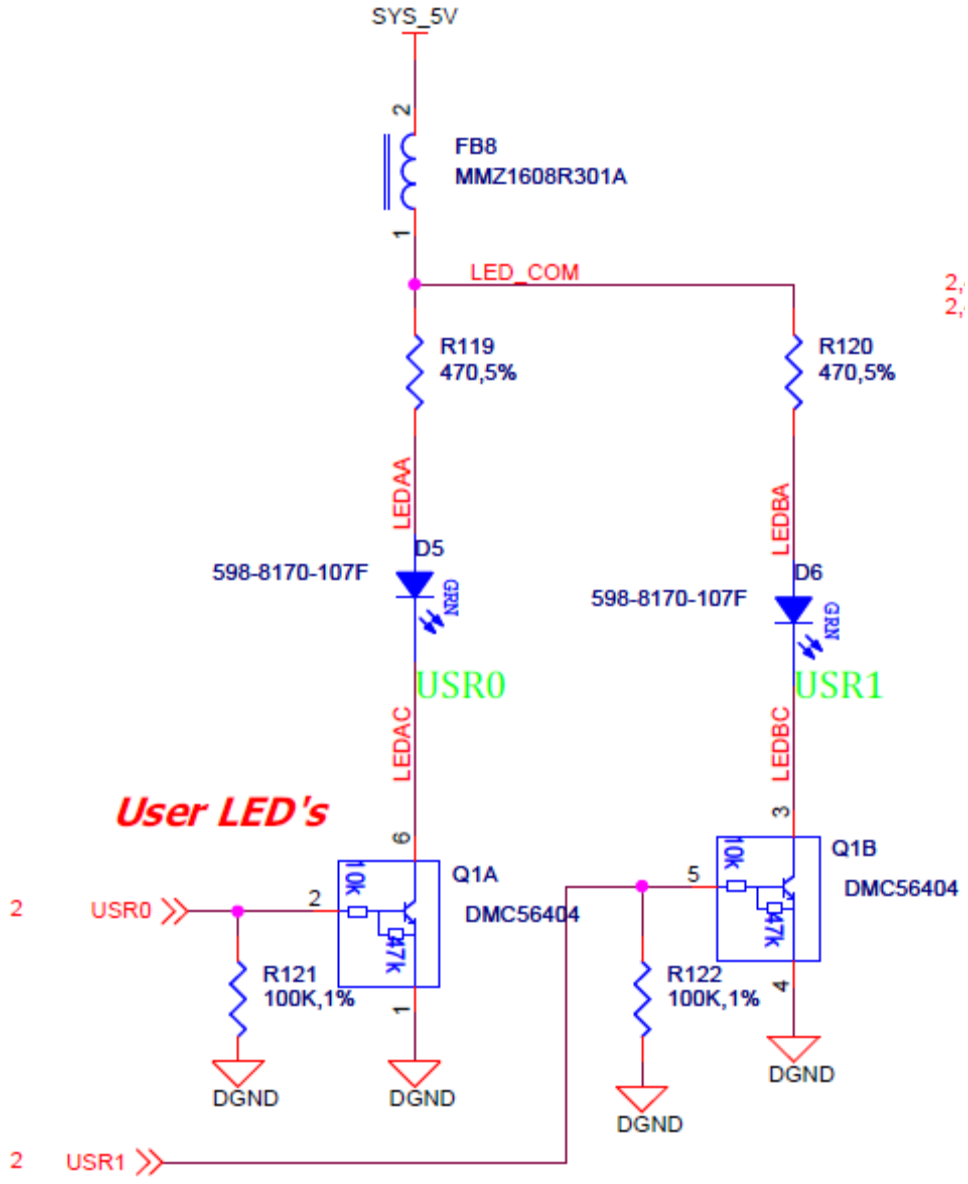

Figure 10. User LED's

Q1 provides level shifting from the processor to drive the LED's that are connected to SYS_5V rail. FB8 provides noise immunity to the system by the LED's which can be a source of noise back into the system rail. Each LED is controlled by settings the appropriate GPIO bit HI. At power up all LED's are off. **Table 3** is the GPIO User LED assignments.

Table 3. User LED Control

LED	GPIO
User 0	GPIO1_21
User 1	GPIO1_22

6.0 Mechanical Information

6.1 BeagleBone DVI-D with Audio Cape Dimensions

This section provides information on the mechanical aspect of the BeagleBone DVI-D with Audio Cape. **Figure 11** is the dimensions of the BeagleBone DVI-D with Audio Cape.

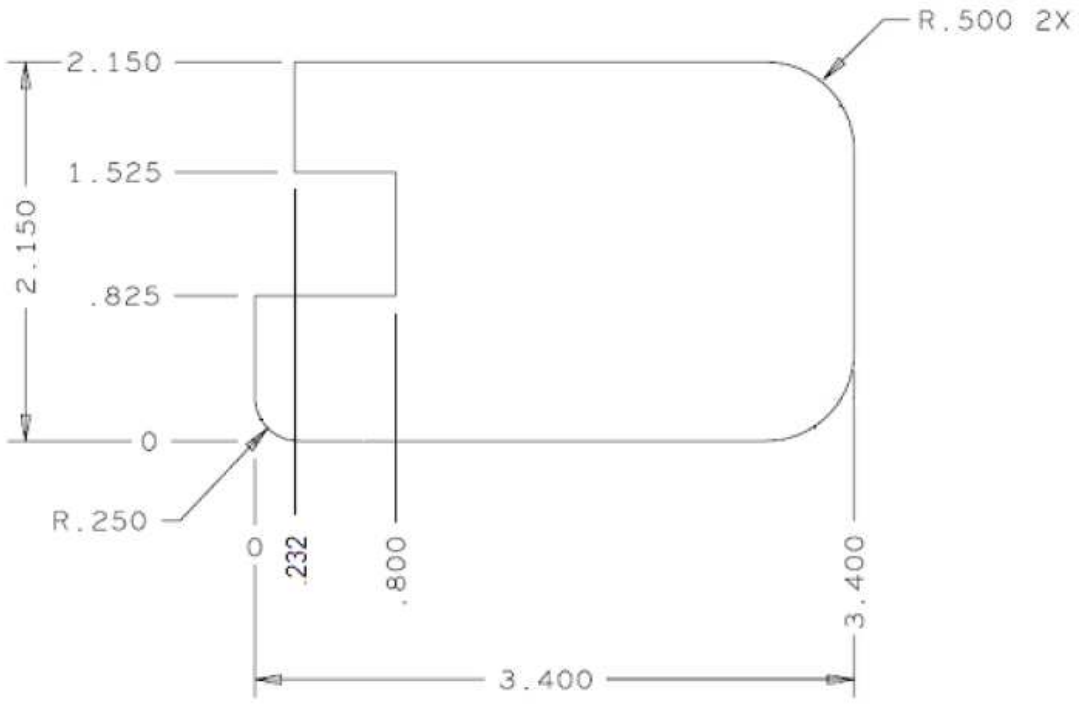

Figure 11. BeagleBone DVI-D with Audio Cape Dimensions Drawing

7.0 Design Materials

Design information can be found at BeagleBoardToys wiki:
http://beagleboardtoys.com/wiki/index.php?title=BeagleBone_DVI-D_with_Audio

Provided there is:

- Schematic in PDF
- Schematic in OrCAD
- Manufacturing files
  - PCB Gerber
  - PCB Layout (Allegro)
- Bill of Materials
- System Reference Manual (This document)

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