BeagleBone Audio Cape Rev A
System Reference Manual

Revision A
August 20th, 2012

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

BEAGLEBONE AUDIO CAPE DESIGN

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Table of Contents

Figures

Tables

NOTES

1.0 Introduction

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

This document provides detailed information on the overall design and usage of the BeagleBone 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 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 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 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.	08/20/2011	BBT

3.0 BeagleBone Audio Cape Overview

3.1 Descriptions

The BeagleBone Audio Cape provides stereo audio input and output for the BeagleBone by using the 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 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 Audio Cape

3.2 Box Content

The final packaged BeagleBone Audio Cape Rev A2 product will contain the following items:

- 1 BeagleBone Audio Cape

3.3 Getting Started

The BeagleBone 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 Audio Cape on top of BeagleBone.
   - *Note: The Ethernet connector on BeagleBone should fit right into the cutback on BeagleBone 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 Audio.
4. Connect the audio output from PC to the audio input connector on the BeagleBone Audio using a 3.5mm male to male audio cable.
5. Open a media player on PC and play an audio file repeatedly.
6. 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".*
7. 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.
8. Change the ALSA mixer settings by running the command "alsamixer.
9. Start the audio test script by running the command "testaudio".
10. The script will test the audio playback by playing a beep sound to speakers.
11. 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 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 Audio Cape's features.

Table 2. BeagleBone Audio Cape Features

	Feature
Power Supply	3.3V via expansion
	5V via expansion
Audio Connector	3.5mm standard stereo jack
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.

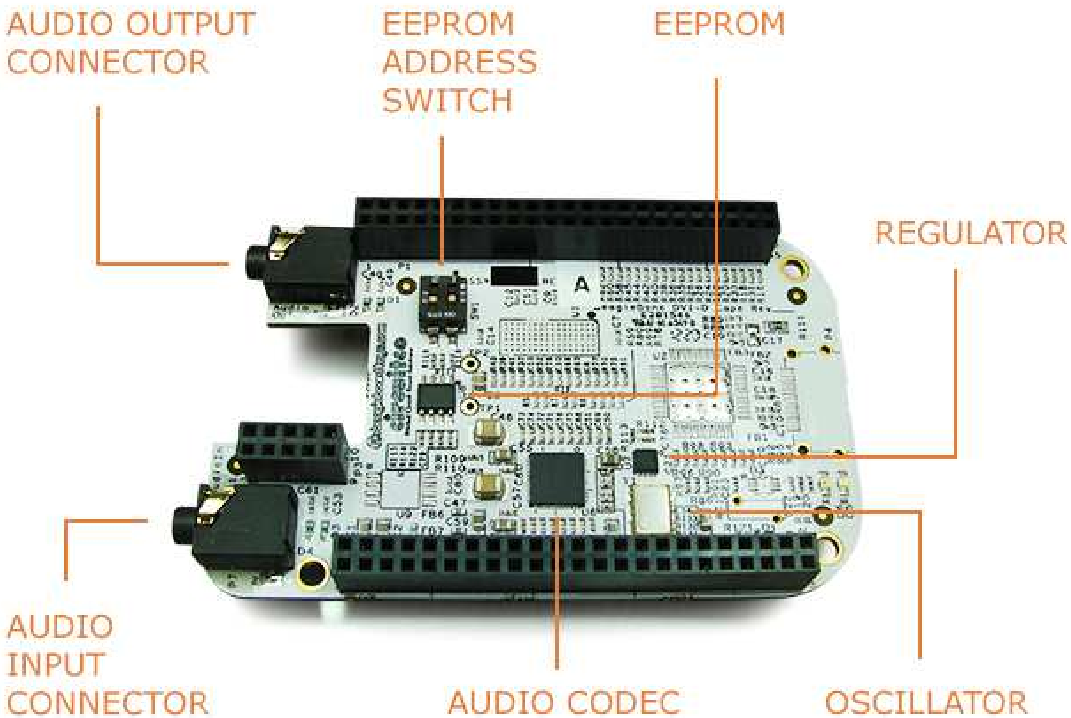

Figure 2. Major Components

4.2 Audio Codec

The BeagleBone 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.

4.3 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.

4.4 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.

4.5 Expansion Connectors

There are three stackable expansion connectors on the BeagleBone Audio Cape. These connectors are used to stack the 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.

4.6 Mechanical Specifications

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

5.0 BeagleBone Audio Cape System Architecture and Design

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

5.1 System Block Diagram

Figure 3 is the high level block diagram of the BeagleBone Audio Cape.

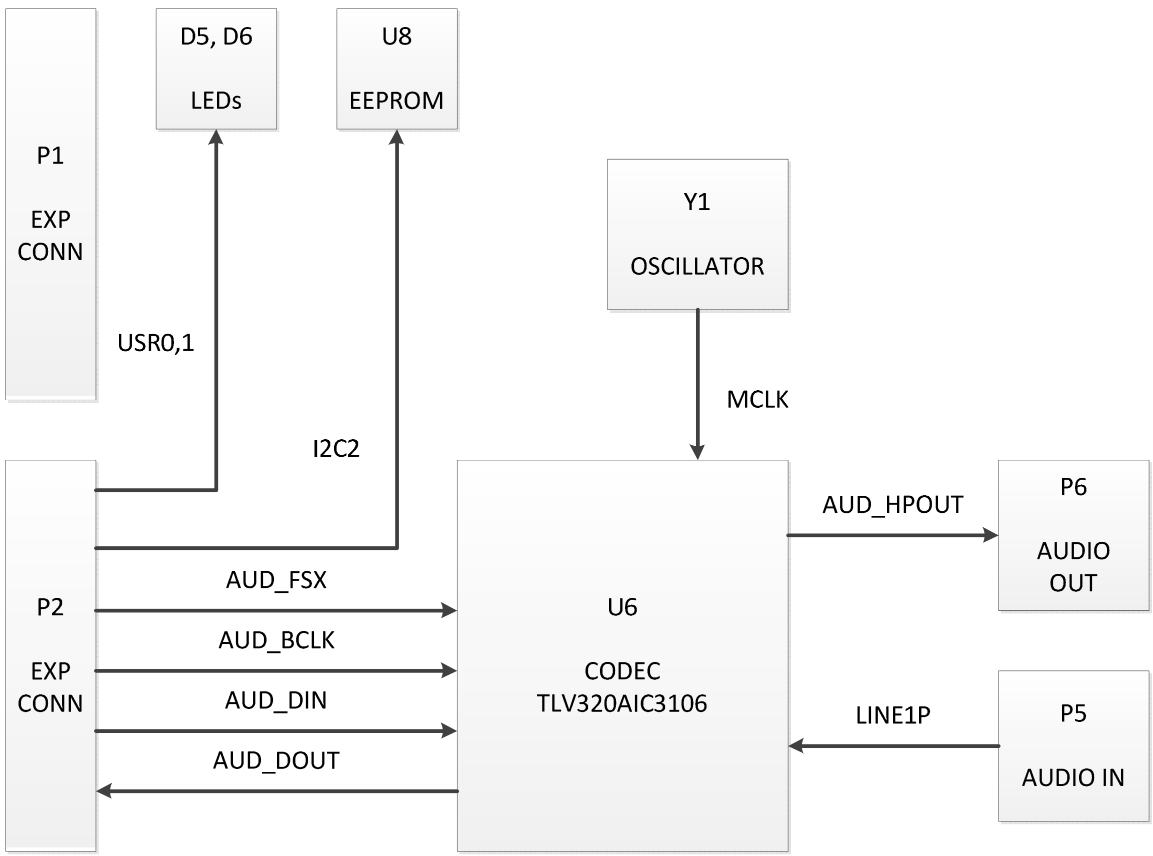

Figure 3. BeagleBone Audio Cape High Level Block Diagram

5.2 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 Audio Interface

5.3.1 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 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 4** shows the record path of TLV320AIC3106.

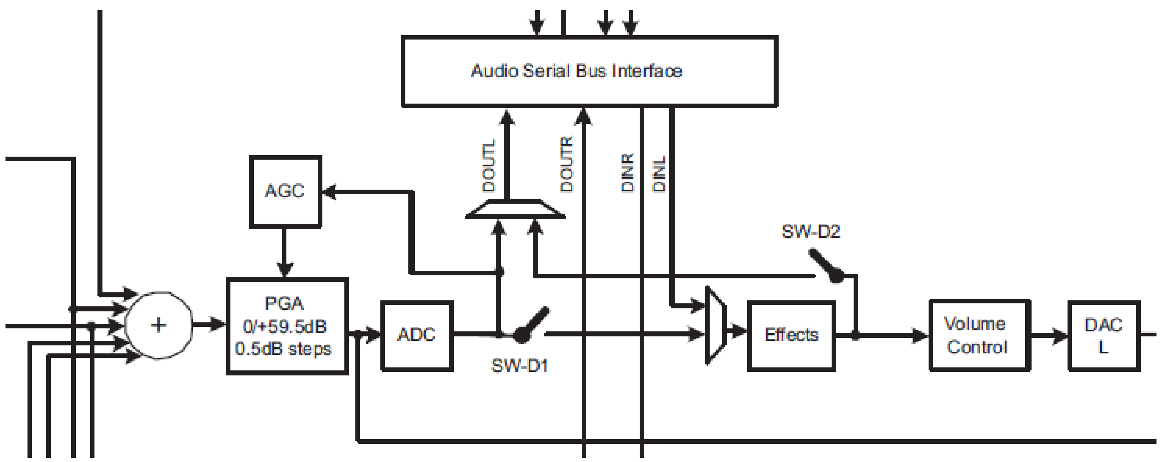

Figure 4. The Record Path of TLV320AIC3106

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.

5.3.2 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 5** shows the playback path of TLV320AIC3106.

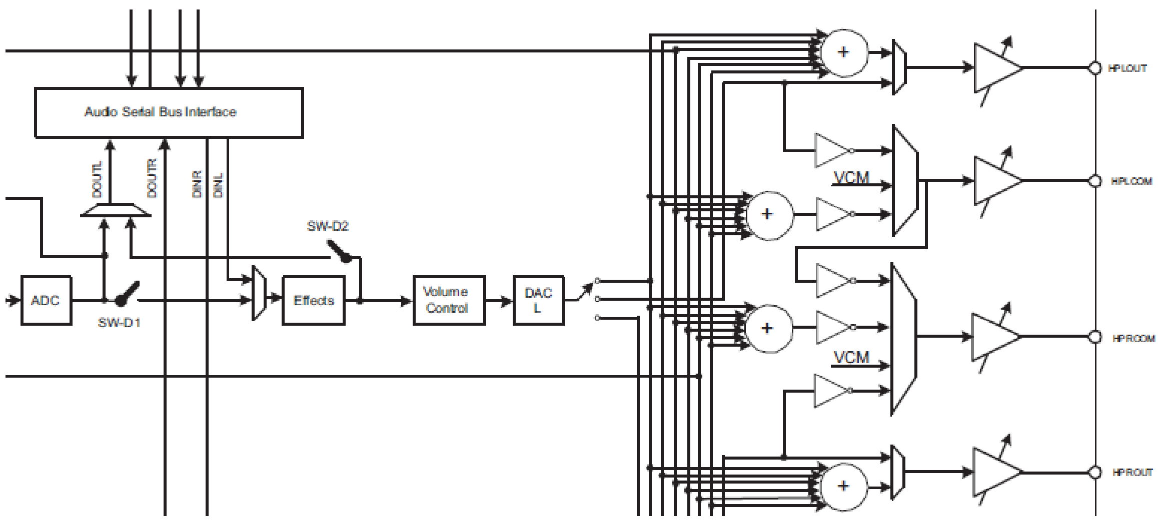

Figure 5. The Playback Path of TLV320AIC3106

5.3.3 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 6** shows the Audio Serial Bus Interface between the codec and the microprocessor.

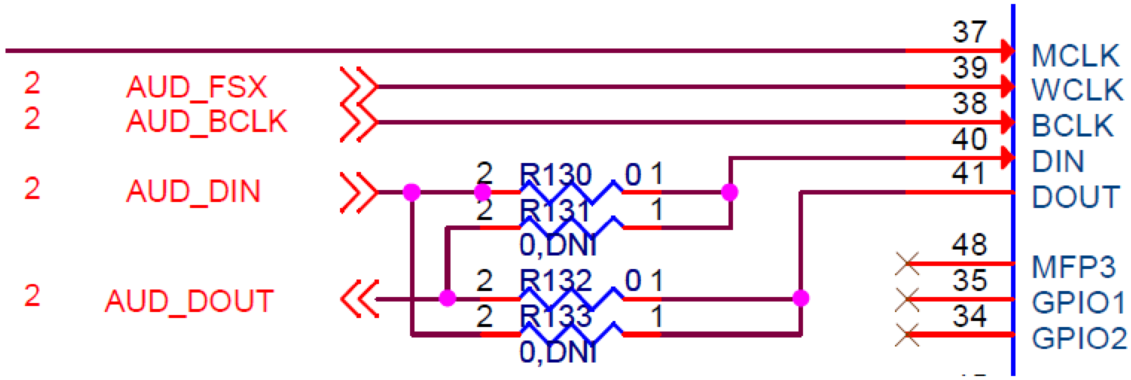

Figure 6. Audio Serial Bus Interface

5.3.4 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 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 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 7** is the design of the EEPROM circuit.

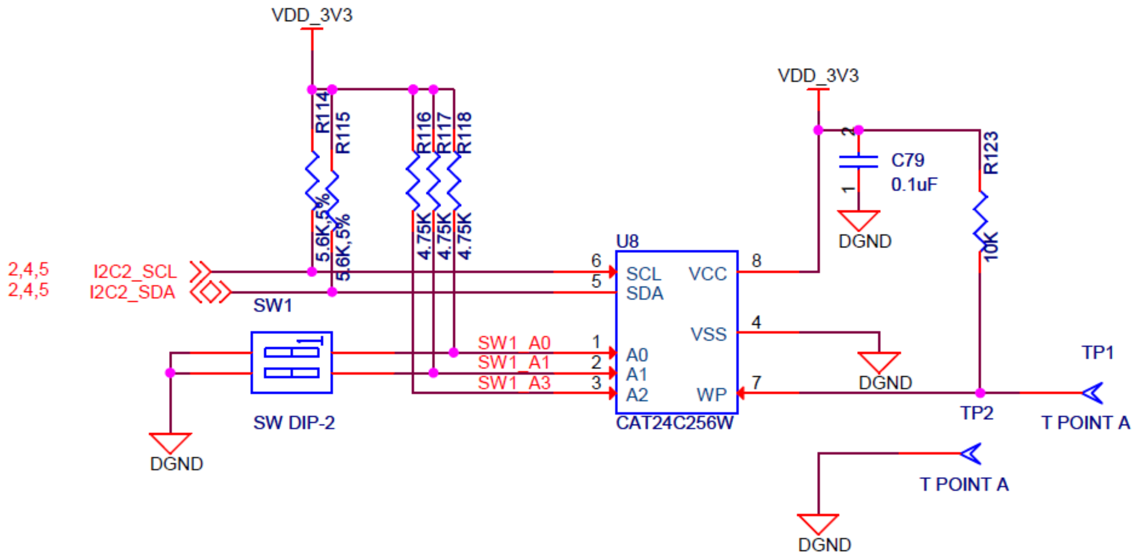

Figure 7. BeagleBone Audio Cape EEPROM

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 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 8** shows the LED circuitry.

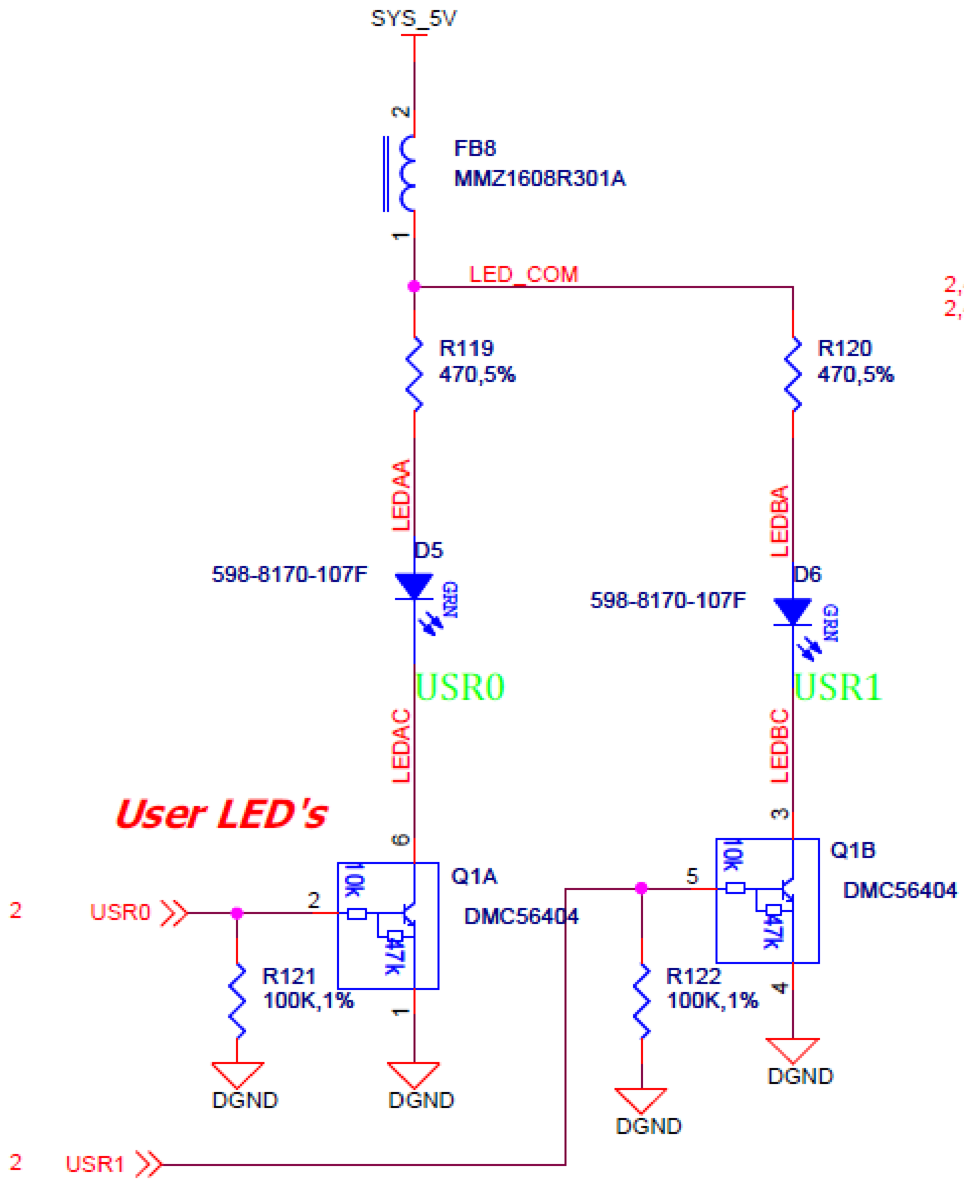

Figure 8. User LED's

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 Audio Cape Dimensions

This section provides information on the mechanical aspect of the BeagleBone Audio Cape. **Figure 9** is the dimensions of the BeagleBone Audio Cape.

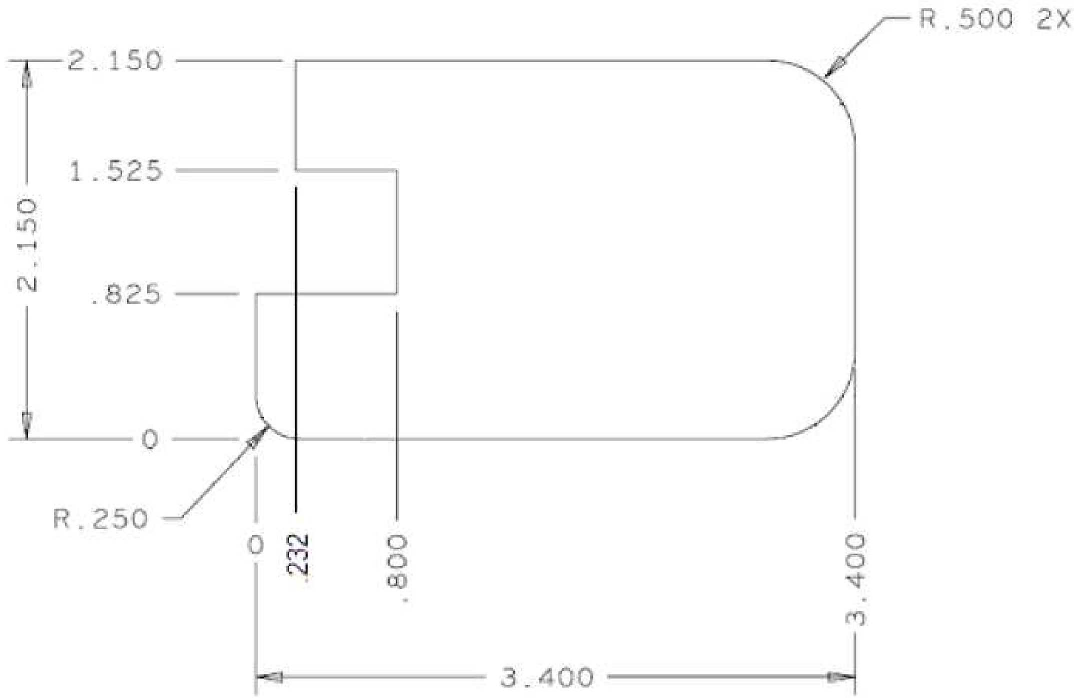

Figure 9. BeagleBone Audio Cape Dimensions Drawing

7.0 Design Materials

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