BeagleBone Weather Cape

System Reference Manual

Revision A
August 1st, 2012

THIS DOCUMENT

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

BEAGLEBONE WEATHER CAPE DESIGN

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To return a defective board, please request an RMA at
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Table of Contents

Figures

Tables

NOTES

1.0 Introduction

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

This document is intended as a guide to assist anyone purchasing or who are considering purchasing the board to understand the overall design and usage of the BeagleBone Weather Cape from the system level perspective.

The design is subject to change without notice as we will work to keep improving the design as the product matures.

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 Weather Cape.

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

Section 5.0 – System Architecture and Design
This section provides information on the overall architecture and design of the BeagleBone Weather 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 Weather 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.	08/01/2012	BBT

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3.0 BeagleBone Weather Cape Overview

3.1 Descriptions

The BeagleBone Weather Cape provides weather data for the BeagleBone including temperature, barometric pressure, humidity, and ambient light. These weather input data can be accessed via I2C bus. The BeagleBone Weather Cape also features an LED to indicate that power is applied.

Figure 1 below is a picture of the board.

Figure 1. The BeagleBone Weather Cape

3.2 In The Box

The final packaged BeagleBone Weather Cape Rev A1 product will contain the following items:

- 1 BeagleBone Weather Cape
- 1 Wiki information card

3.3 Getting Started

Following the instructions below to start using your BeagleBone Weather Cape:

1) Mount the BeagleBone Weather on top of BeagleBone
2) Make sure the micro SD card using with BeagleBone has latest Angstrom image.
3) Power up the BeagleBone using a 5V DC power supply.
4) Connect the BeagleBone to a computer via USB cable.
5) Open a Terminal application (Teraterm, Hyperterminal, etc) and open a new connection with following settings: baud rate - 115200, data – 8 bit, parity – none, stop – 1 bit, flow control – none.
6) You should see an Angstrom log in prompt on the terminal window. If not, press Enter to show the log in prompt
7) Run the following command to display the outputs of all sensors:

```
for sensor in /sys/devices/platform/omap/omap_i2c.3/i2c-3/*/*_input ; do echo -n
"$(basename $sensor): " ; cat $sensor ; done
```

8) You should see something like this on the terminal window:

```
lux1_input: 27
humidity1_input: 38143
temp1_input: 26927
pressure0_input: 101264
temp0_input: 270
```

9) The I2C outputs are interpreted as 27 lux, 38% humidity, 27 degrees C and 1013 millibar.

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 an 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 Weather 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 Weather Cape's features.

Table 2. BeagleBone Weather Cape Features

Sensor Data	Temperature (operating range: 0 – 65°C) Barometric pressure (300 – 1100 hPa or millibar) Humidity (0 – 100 % RH) Ambient light
Data Interface	Two-wire
Power	3.3 V via expansion header
Indicator	Power LED
Connectors	Two 46-position connectors
	One 10-position connector

4.1 Key Component Locations

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

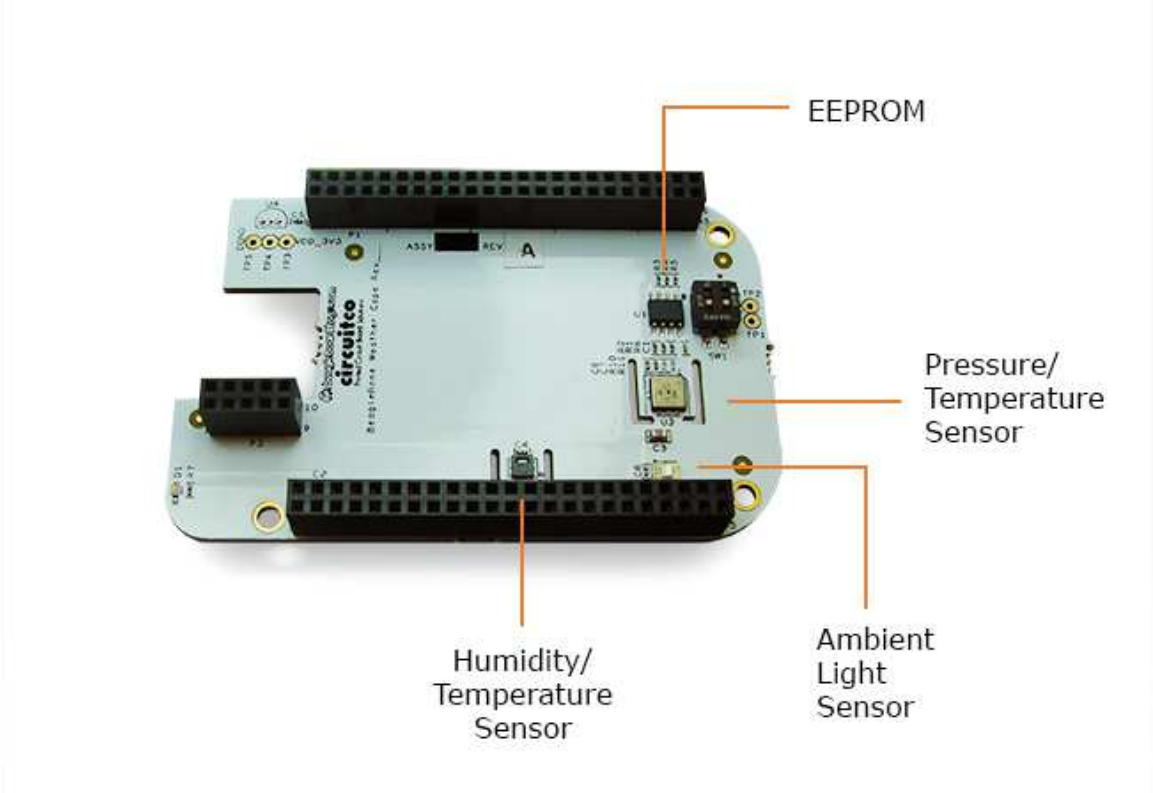

Figure 2. Key Components

4.2 Temperature and Barometric pressure sensor

The BeagleBone Weather Cape uses the BMP085 to measure the temperature and barometric pressure. BMP085 is an ultra-low power barometric pressure sensor capable of measuring between 300 and 1100 hPa (or millibar) and providing an output data in steps of 0.01 hPa. It can also measure the temperature between 0 and 65°C at 0.1°C resolution. BMP085 has a flexible supply voltage range, provides low noise measurements at high accuracy via two-wire interface.

4.3 Relative humidity and Temperature sensor

The BeagleBone Weather Cape utilizes the RH sensor SHT21 to measure the relative humidity. SHT21 is operating between 0 and 100% RH and -40 and 125°C and is capable of providing an output resolution at 0.04 % RH and 0.01°C. SHT21 has a small footprint,

requires low power consumption, and transmits data digitally to BeagleBone via I2C interface.

4.4 Ambient light sensor

The BeagleBone Weather Cape captures ambient light data using an ambient light sensor TSL2550. TSL2550 features two photodiodes, an analog-to-digital (ADC) converter and transmits ambient light measurements over a two-wire SMBus serial interface. The ambient light data is provided in “Lux”, which is a commonly used illuminance unit.

4.5 Expansion Header

There are three stackable connectors on the BeagleBone Weather Cape. The 46-position and 20-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 Power Indicator

The BeagleBone Weather Cape features an LED to indicate that power is applied to the cape. This LED is green when lit.

4.7 Mechanical Specifications

Size:	4.00” x 2.50”
Layers:	4
PCB thickness:	.062”
RoHS Compliant:	Yes

4.8 Electrical Specifications

Table 3 is the electrical specification of the external interfaces to the BeagleBone Weather panel.

Table 3. BeagleBone Weather Electrical Specifications

Specification	Min	Typ	Max	Unit
Power				
Input Voltage DC		3.3		V
Environmental				
Temperature range	0		+85	C

5.0 System Architecture and Design

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

5.1 System Block Diagram

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

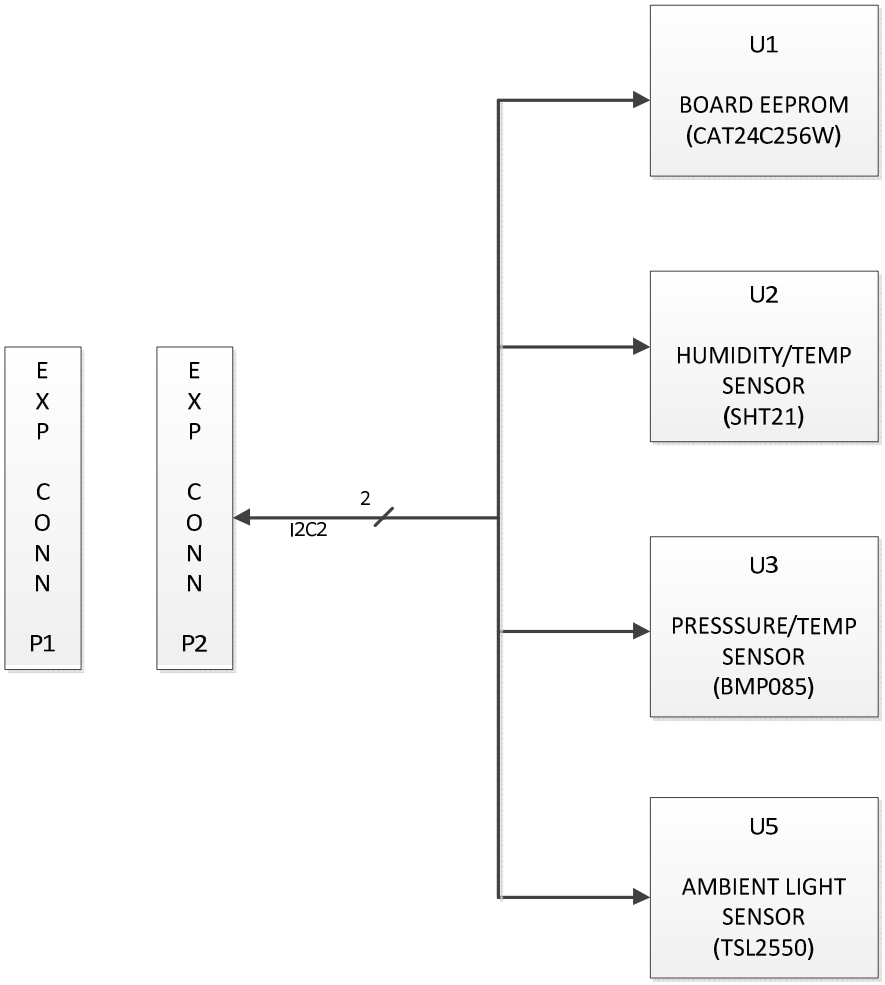

Figure 3. BeagleBone Weather Cape High Level Block Diagram

5.2 Temperature and Barometric Pressure Sensor

The BMP085 uses piezo-resistive technology to provide high accuracy measurements. Temperature and pressure data can be sampled up to 128 samples per second and are converted digitally via an ADC before being transmitted over I2C interface. The output data is provided in ^{o}C and hPa (millibar) using calibration data stored inside BMP085 EEPROM. **Figure 4** shows a high-level block diagram for BMP085.

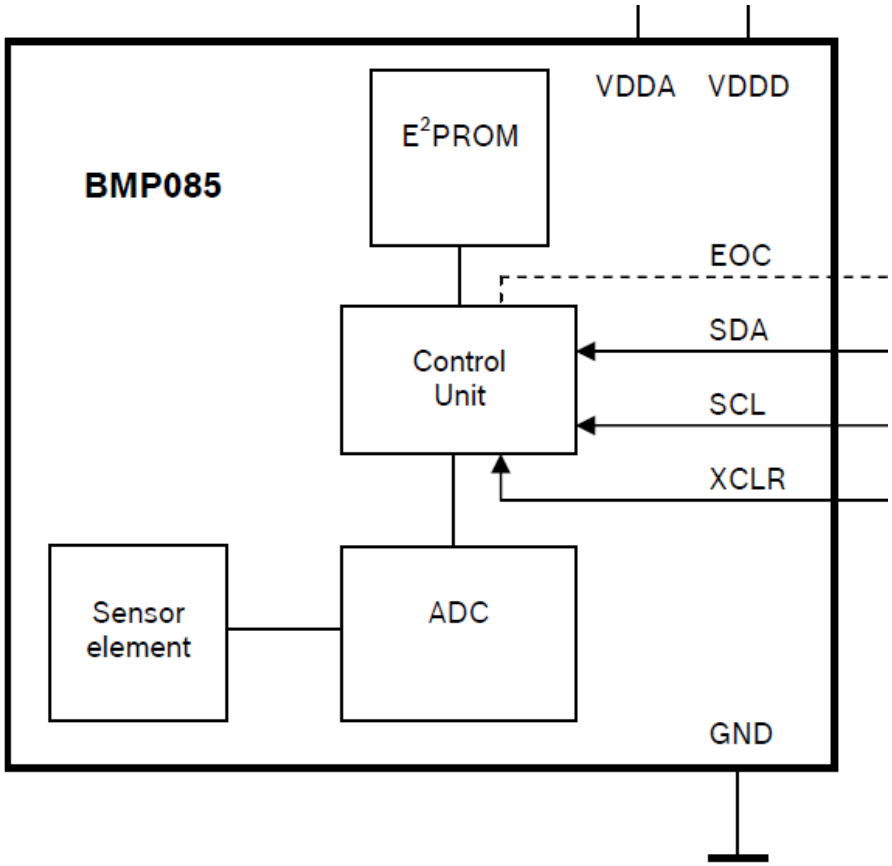

Figure 4. BMP085 Block Diagram

The BMP085 is powered by the power rail VDD_3V3 and transmits sensor measurements to the BeagleBone via I2C2 bus. The I2C2 data and clock signals can be accessed at pin 19 and 20 of connector P2. BMP085 also features an active low master clear input (XCLR) to reset the device and an end of conversion output (EOC) to check whether the conversion is complete. These two pins are left floating on the BeagleBone Weather Cape. **Figure 5** below shows the BMP085 in the BeagleBone Weather Cape schematic.

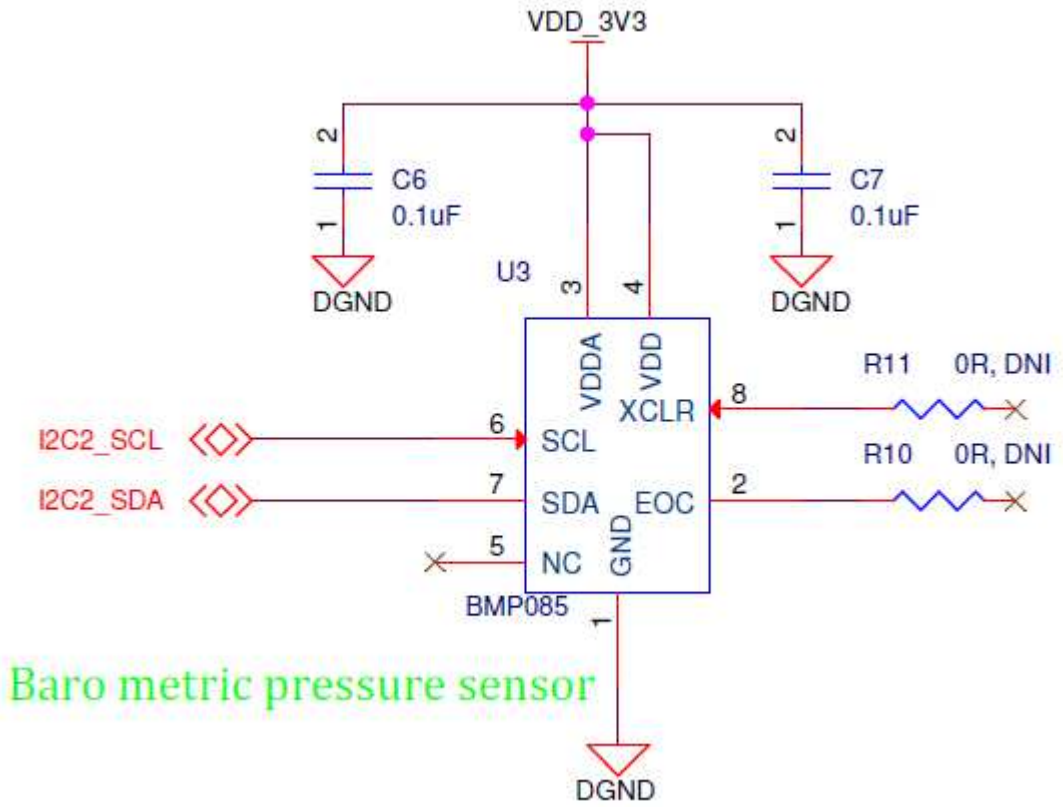

Figure 5. Barometric pressure sensor Schematic

5.3 Relative humidity sensor

The SHT21 uses a generation 4C CMOSens chip to provide reliable and precise relative humidity measurements. Temperature sensor and capacitive humidity sensor are integrated into a single unit on CMOSens chip along with a signal amplifier unit, ADC, OTP memory and a digital processing unit. Relative humidity and temperature data are transmitted at respectively 12-bit and 14-bit resolution to BeagleBone over I2C2 bus. These output data are calculated in ^{o}C and %RH. SHT21 is powered by the power rail VDD_3V3 on the Weather Cape. **Figure 6** below shows SHT21 on the Weather Cape schematic.

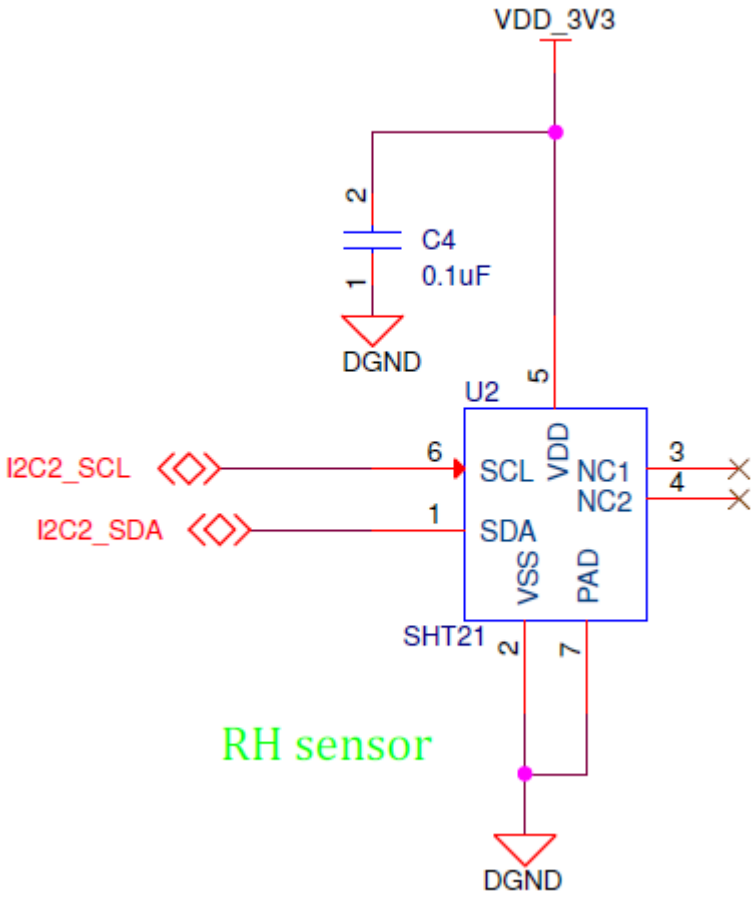

Figure 6. RH sensor Schematic

5.4 Ambient light sensor

The TSL2550 features two photodiodes and an ADC on a single CMOS integrated circuit to provide 12-bit light measurements. Ambient light is converted into currents by the photodiodes and eventually to digital outputs by the ADC. One photodiode of TSL2550 is sensitive primarily to infrared light; therefore, the digital output from this photodiode is used to compensate the infrared effect on the digital output of the other photodiode, which is sensitive to both visible and infrared light. The final output data calculated in a commonly used illuminance unit of Lux. These data are transmitted to BeagleBone via I2C2 bus. TSL2550 is powered by the power rail VDD_3V3. **Figure 7** shows the TSL2550 in the BeagleBone Weather Cape schematic.

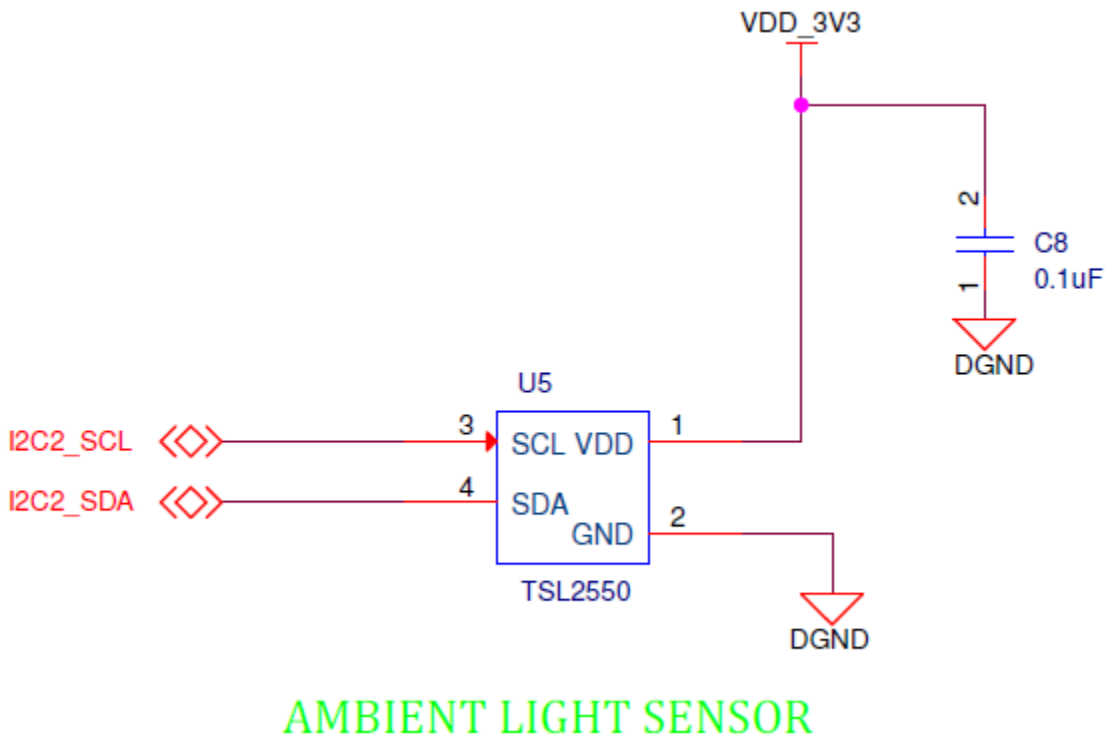

Figure 7. Ambient light sensor Schematic

5.5 EEPROM

The BeagleBone Weather 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 8** is the design of the EEPROM circuit.

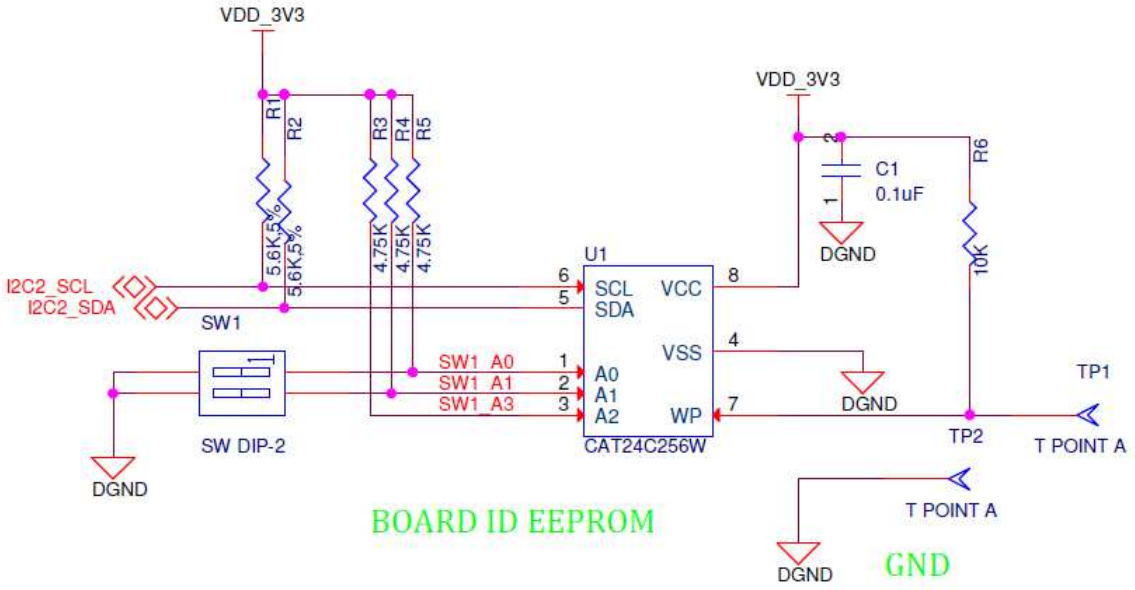

Figure 8. BeagleBone Weather Cape EEPROM

5.5.1 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.

5.5.2 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.

6.0 Mechanical Information

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

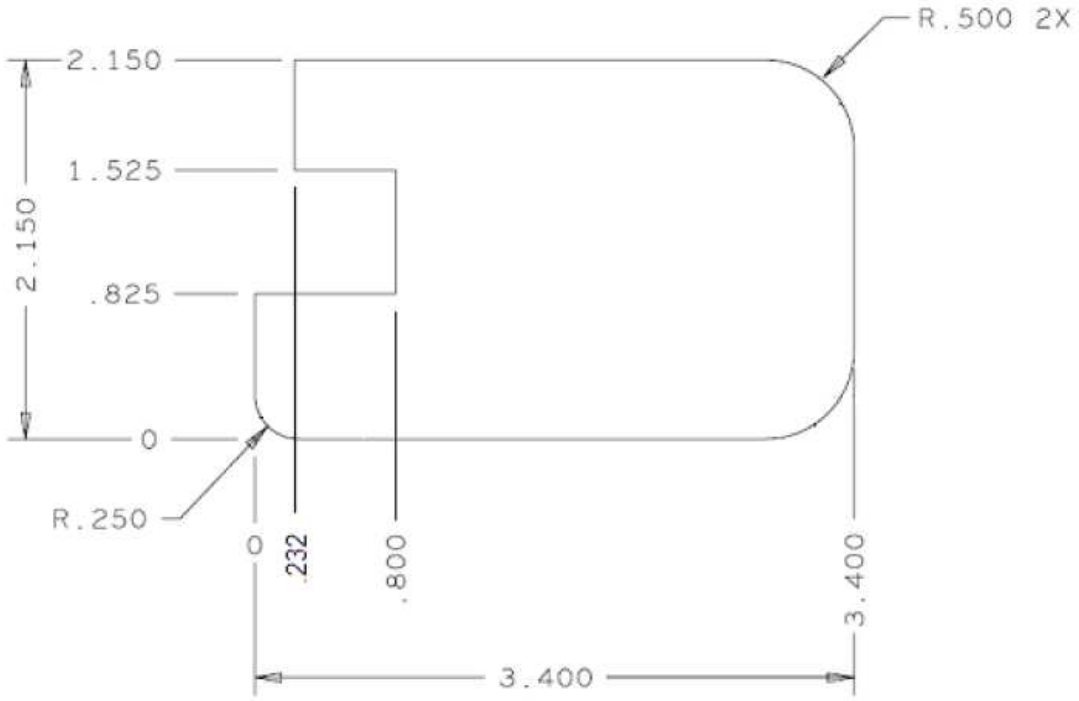

Figure 9. BeagleBone Weather Cape Dimensions Drawing

7.0 Design Materials

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

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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