

BeagleBone RS232 Cape



System Reference Manual

Revision A1
August 10th, 2012



THIS DOCUMENT

This work is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-sa/3.0/> or send a letter to Creative Commons, 171 Second Street, Suite 300, San Francisco, California, 94105, USA.

All derivative works are to be attributed to BeagleBoardtoys.com.

For more information, see <http://creativecommons.org/licenses/by-sa/3.0/>

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

BEAGLEBONE RS232 CAPE DESIGN

These design materials referred to in this document are ***NOT SUPPORTED*** and **DO NOT** constitute a reference design. Only “community” support is allowed via resources at Beagleboardtoys.com/support

THERE IS NO WARRANTY FOR THE DESIGN MATERIALS, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE DESIGN MATERIALS “AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE

ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE DESIGN MATERIALS IS WITH YOU. SHOULD THE DESIGN MATERIALS PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

We mean it; these design materials may be totally unsuitable for any purposes.

BeagleBoardToys provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by BeagleBoardtoys.com to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within **30 days** from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies BeagleBoardtoys.com from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

BeagleBoardtoys.com currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive**. BeagleBoardtoys.com assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein**.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on BeagleBoardtoys.com environmental and/or safety programs, please contact visit BeagleBoardtoys.com.

No license is granted under any patent right or other intellectual property right of BeagleBoard.org covering or relating to any machine, process, or combination in which such BeagleBoardtoys.com products or services might be or are used.

Mailing Address:

Beagleboardtoys.com
1380 Presidential Dr. #100
Richardson, TX 75081
U.S.A.



WARRANTY: *The BeagleBone RS232 Cape is warranted against defects in materials and workmanship for a period of 90 days from purchase. This warranty does not cover any problems occurring as a result of improper use, modifications, exposure to water, excessive voltages, abuse, or accidents. All boards will be returned via standard mail if an issue is found. If no issue is found or express return is needed, the customer will pay all shipping costs.*

Before returning the board, please visit Beagleboardtoys.com/support

To return a defective board, please request an RMA at <http://www.beagleboardtoys.com/support/rma>



Table of Contents

FIGURES	7
TABLES	7
1.0 INTRODUCTION	9
2.0 CHANGE HISTORY	10
2.1 CHANGE HISTORY.....	10
3.0 BEAGLEBONE RS232 CAPE OVERVIEW	11
3.1 DESCRIPTIONS.....	11
3.2 IN THE BOX	12
3.3 GETTING STARTED.....	12
3.4 REPAIRS	13
4.0 FEATURES AND SPECIFICATIONS	14
4.1 KEY COMPONENT LOCATIONS	15
4.2 RS232 INTERFACE	15
4.3 UART SELECTION	16
4.4 POWER INDICATOR	16
4.5 MECHANICAL SPECIFICATIONS	16
4.6 ELECTRICAL SPECIFICATIONS	16
5.0 SYSTEM ARCHITECTURE AND DESIGN	17
5.1 SYSTEM BLOCK DIAGRAM	17
5.2 RS232.....	17
5.3 UART	18
5.4 UART TO RS232	18
5.5 EEPROM	19
5.5.1 <i>EEPROM Address</i>	20
5.5.2 <i>I2C Bus</i>	20
6.0 MECHANICAL INFORMATION	21
7.0 DESIGN MATERIALS	22



Figures

Figure 1.	The BeagleBone RS232 Cape.....	11
Figure 2.	Key Components.....	15
Figure 3.	BeagleBone RS232 Cape High Level Block Diagram	17
Figure 4.	BeagleBone RS232 Cape UART Selection	18
Figure 5.	UART to RS232.....	19
Figure 6.	BeagleBone RS232 Cape EEPROM.....	20
Figure 7.	BeagleBone RS232 Cape Dimensions Drawing.....	21

Tables

Table 1.	Change History	10
Table 2.	BeagleBone RS232 Cape Features	14

1.0 Introduction

This document is the System Reference Manual for the BeagleBone RS232 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 RS232 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 RS232 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 RS232 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 RS232 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
A1	Initial release.	08/10/2012	BBT

3.0 BeagleBone RS232 Cape Overview

3.1 Descriptions

The BeagleBone RS232 Cape provides an RS232 interface to the BeagleBone via a standard D-Sub 9 female serial connector. This connector is located to the side so it doesn't interfere with any capes stacked above it. By default, the BeagleBone RS232 Cape uses UART2 port on the AM335x for RS232 connection; however, users will have the freedom to choose among UART1, UART2, UART4, and UART5 ports.

Figure 1 below is a picture of the board.

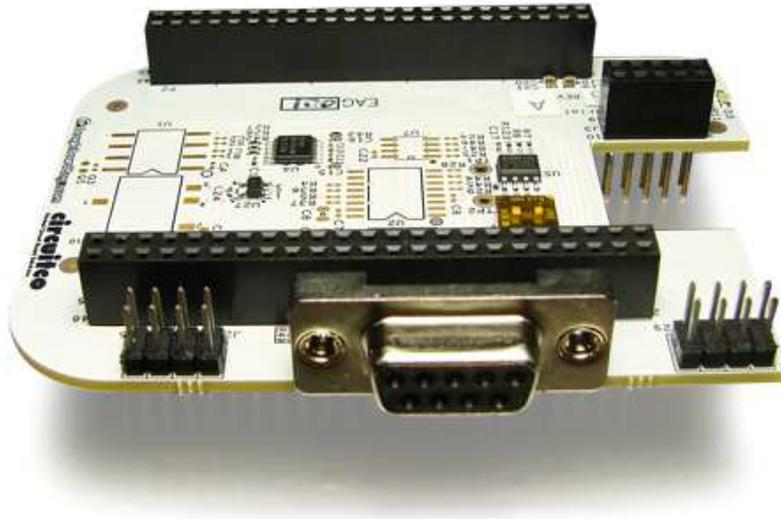


Figure 1. The BeagleBone RS232 Cape

3.2 In The Box

The final packaged BeagleBone RS232 Cape Rev A1 product will contain the following items:

- 1 BeagleBone RS232 Cape
- 1 Wiki information card

3.3 Getting Started

Following the instructions below to start using your BeagleBone RS232 Cape:

- 1) Mount the BeagleBone RS232 on top of BeagleBone
- 2) Make sure the micro SD card using with BeagleBone has latest Angstrom image.
- 3) Connect the BeagleBone RS232 Cape to the computer using a RS232-compatible serial 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”.

- 4) Connect the BeagleBone to the computer using a USB cable. Remember the port number of this connection. This will also power up the BeagleBone.
- 5) 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 RS232 connection.
- 6) Open a second instance of the terminal application and connect to the USB serial connection using the same settings as above.
- 7) Hit the reset switch S1 on the BeagleBone. The BeagleBone is now rebooting inside the USB serial terminal window.
- 8) Press “Enter” to stop the booting process at UBoot. If missed, hit the reset switch again and press “Enter” before the UBoot count down stops at zero.
- 9) At UBoot, run the following commands to temporarily use the RS232 connection:
setenv console ttyO2,115200n8
boot
- 10) BeagleBone will continue the booting process; however, the kernel messages will not show up inside the RS232 terminal window. You can now start using the RS232 connection via UART2.

Note: This RS232 connection is temporary. To permanently use the RS232 connection, you need to change the environment variables of UBoot.

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 RS232 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 RS232 Cape's features.

Table 2. BeagleBone RS232 Cape Features

Compatible Serial Port	UART1 UART2 (default) UART4 UART5
Power	3.3 V via expansion header
Indicator	Power LED
Connector	Two 46-position connectors
	One 10-position connector
	One D-Sub9 serial connector



4.1 Key Component Locations

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

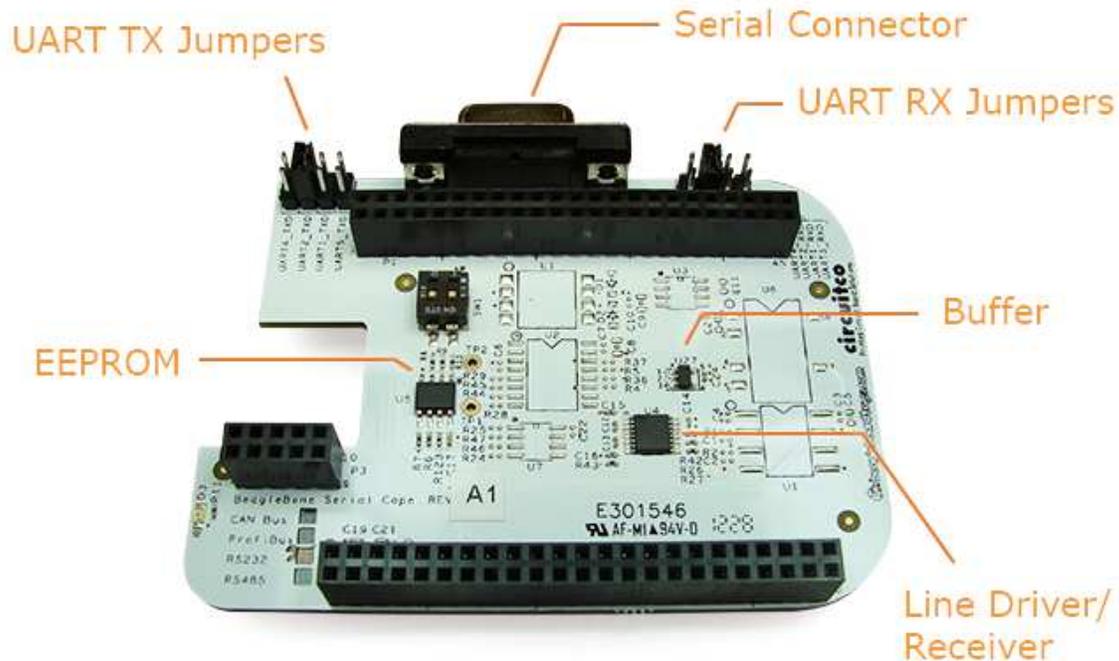


Figure 2. Key Components

4.2 RS232 Interface

The BeagleBone RS232 Cape uses the SN65C322EPW to provide an RS232 serial interface for BeagleBone. SN65C322EPW features one line driver and one line receiver to translate data from RS232 level to UART level and vice versa. The RS232 signals are connected to TX and RX pins of D-Sub9 serial connector on the board. The UART signals are connected to four different UART ports on the BeagleBone via selection jumpers.

4.3 UART Selection

The BeagleBone RS232 Cape provides an option for users to choose among four UART ports from AM335x (UART1, 2, 4, and 5). The TXD and RXD signals are connected to the corresponding signal of each UART via jumper headers. The default selection is UART2. If one wishes to use a UART port, ensure the jumper for that port is installed.

4.4 Power Indicator

The BeagleBone RS232 Cape features an LED (D3) to indicate that power is applied to the cape. This LED is green when lit.

4.5 Mechanical Specifications

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

4.6 Electrical Specifications

Table 3 is the electrical specification of the external interfaces to the BeagleBone RS232 panel.

Table 3. BeagleBone RS232 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 RS232 Cape and its overall architecture.

5.1 System Block Diagram

Figure 3 is the high level block diagram of the BeagleBone RS232 Cape.

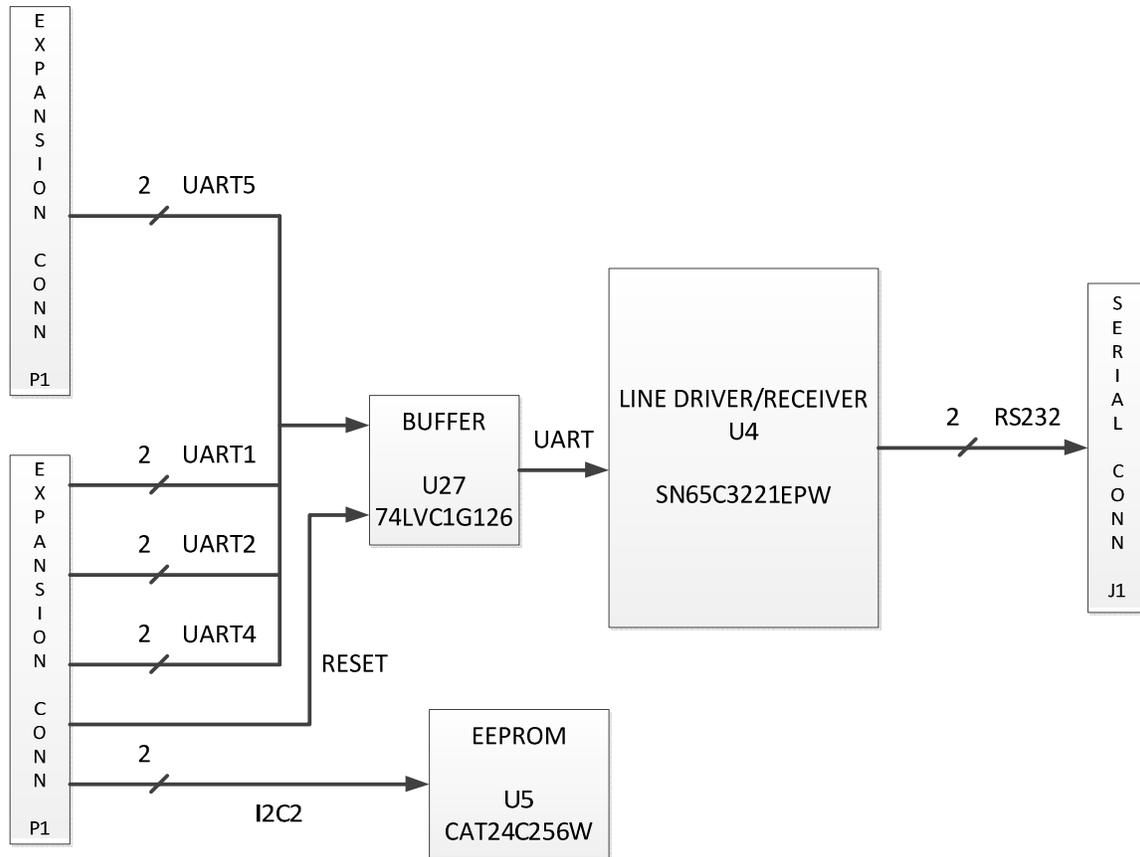


Figure 3. BeagleBone RS232 Cape High Level Block Diagram

5.2 RS232

The BeagleBone RS232 Cape uses a D-Sub 9 female serial connector to provide RS232 connection. The TX, RX, and GND signals of RS232 interface are connected to pin 2, 3, and 5 of D-Sub connector J1. A compatible serial cable is required to communicate via RS232 interface. RS232 data are transmitted or received by SN65C322EPW, which translate data between UART and RS232.

5.3 UART

There are four UART ports available on the expansion header of BeagleBone; each of these ports can be used by the RS232 Cape. The TXD and RXD signals of SN65C322EPW can be connected to the corresponding signals of UART1, 2, 4, and 5 by installing jumpers for that signal. The default connection is UART2. This UART port is also supported by software. If user wishes to use a different UART port, the TX and RX jumpers for that port are required to be installed. User will also need to rebuild the kernel to support that UART port in software.

A buffer is used to ensure the UART signals do not conflict with BeagleBone's booting process. **Figure 4** shows the UART selection circuit on the RS232 Cape.

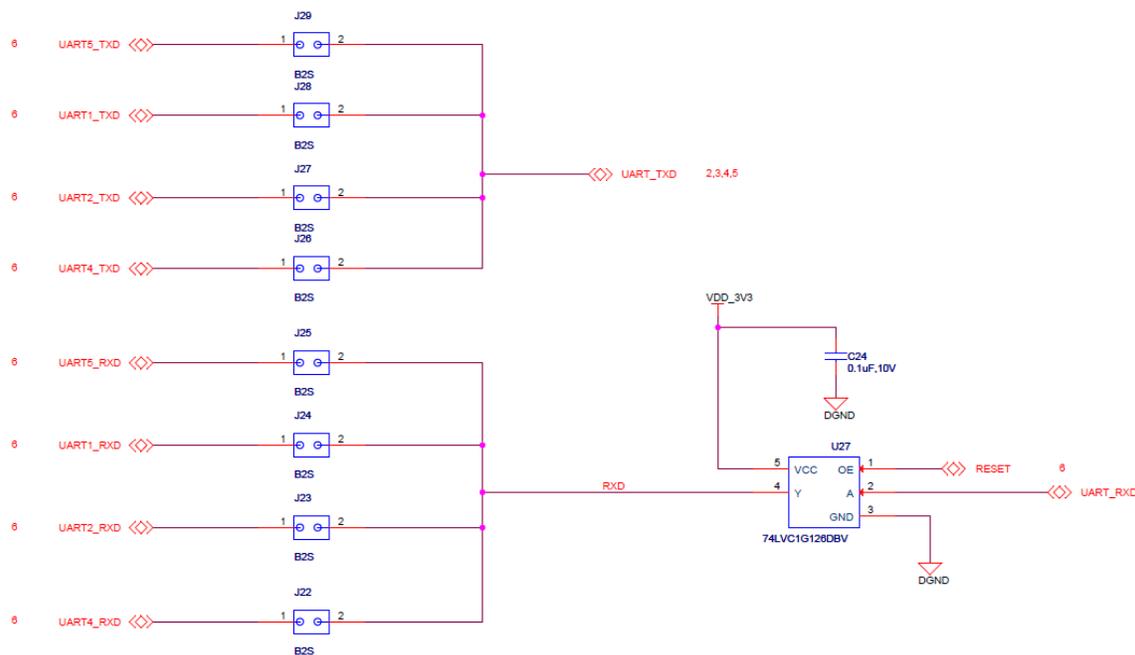


Figure 4. BeagleBone RS232 Cape UART Selection

5.4 UART to RS232

The BeagleBone RS232 Cape features an SN65C322EPW to translate data from RS232 level to UART level. SN65C322EPW is a single-channel line driver and receiver that can operate from 3.3V to 5V. RX signal of RS232 interface from the D-Sub 9 serial

connector J1 is received by the SN65C322EPW and transmitted as UART data. Similarly, UART data from BeagleBone is translated to RS232 before transmitted to the D-Sub 9 connector. The data signaling rate can go up to 1 Mbps.

On the BeagleBone RS232 Cape, enable signal (EN) is pulled low and FORCEOFF is high to enable the data translation between RS232 and UART.

Figure 5 shows SN65C322EPW in RS232 schematic.

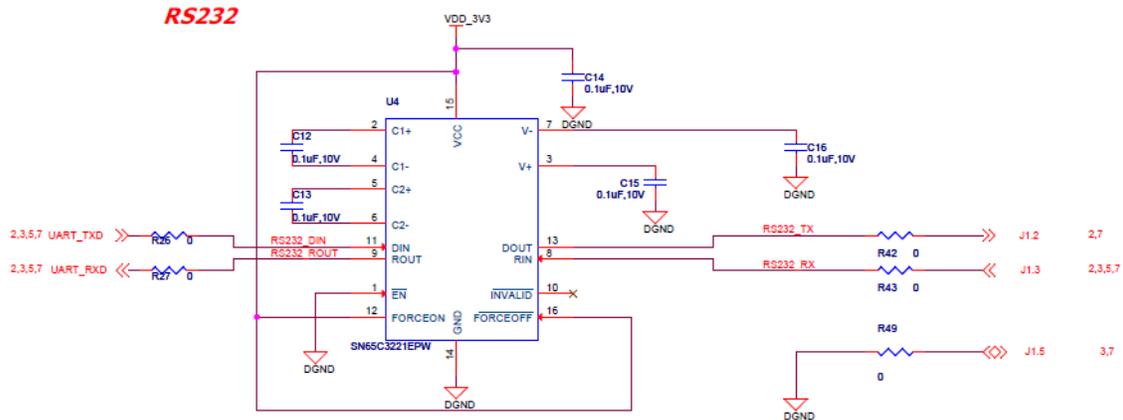


Figure 5. UART to RS232

5.5 EEPROM

The BeagleBone RS232 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 6** is the design of the EEPROM circuit.

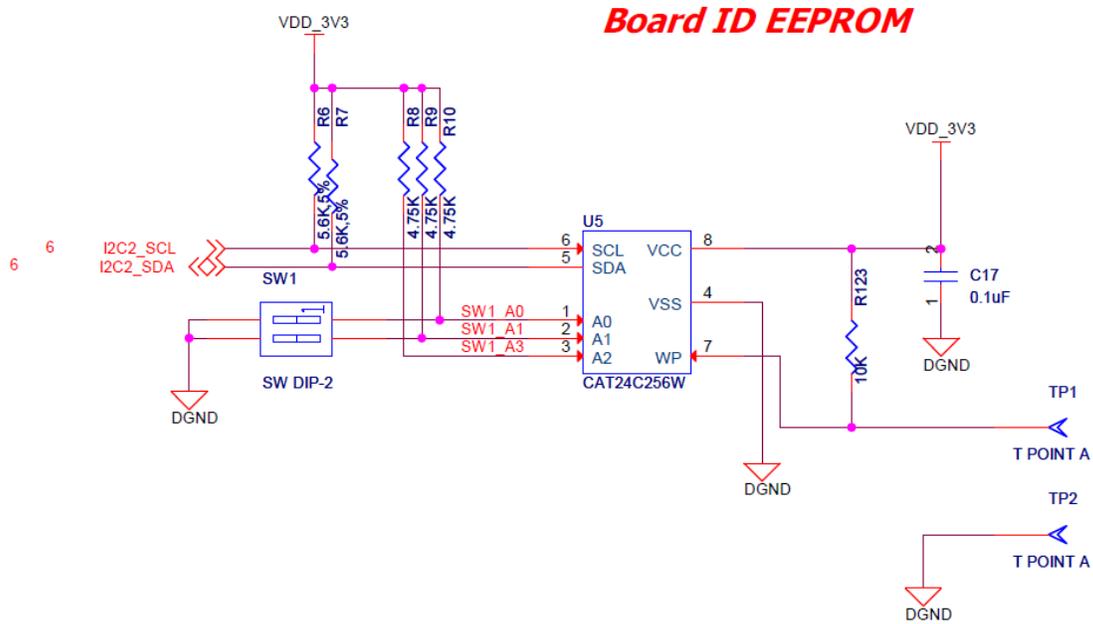


Figure 6. BeagleBone RS232 Cape EEPROM

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 I2C. 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 RS232 Cape. **Figure 7** is the dimensions of the BeagleBone RS232 Cape.

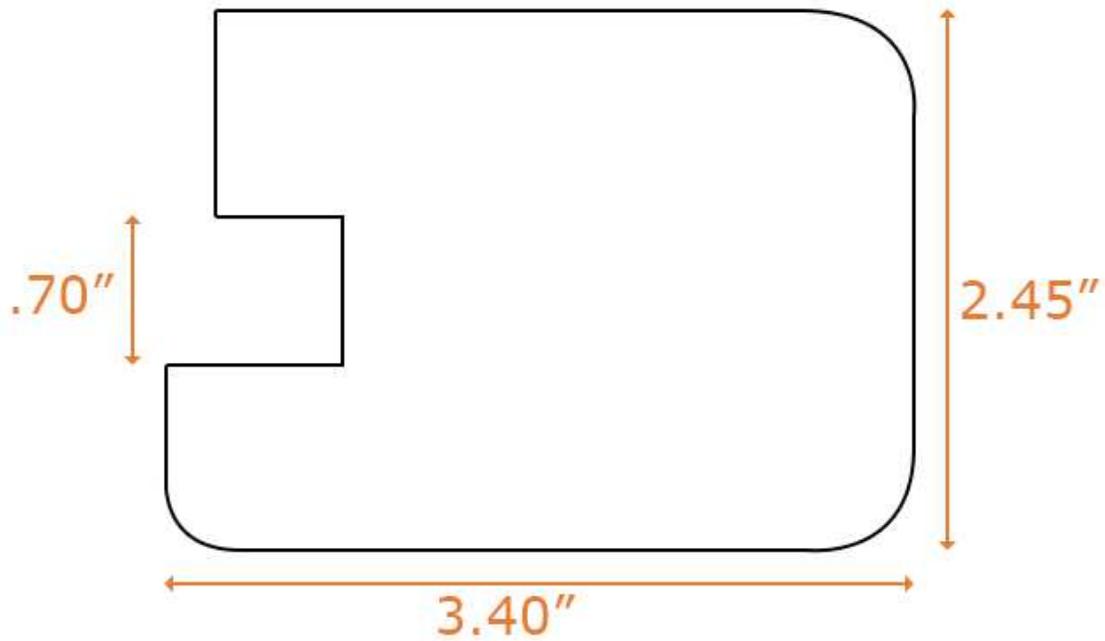


Figure 7. BeagleBone RS232 Cape Dimensions Drawing

7.0 Design Materials

Design information can be found at BeagleBoardToys wiki:

http://beagleboardtoys.com/wiki/index.php?title=BeagleBone_RS232

Provided there is:

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

*These design materials are ***NOT SUPPORTED*** and **DO NOT** constitute a reference design. Only “community” support is allowed via resources at BeagleBoard.org/discuss. THERE IS NO WARRANTY FOR THE DESIGN MATERIALS, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE DESIGN MATERIALS “AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE DESIGN MATERIALS IS WITH YOU. SHOULD THE DESIGN MATERIALS PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.*

We mean it, these design materials may be totally unsuitable for any purposes.