BeagleBone DVI-D Cape Rev A System Reference Manual

Revision 0.2
January 25, 2012

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BEAGLEBONE DVI-D CAPE DESIGN

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Table of Contents

FIGURES 7

TABLES 7

1.0 INTRODUCTION 9

2.0 CHANGE HISTORY 10

2.1 CHANGE HISTORY 10

3.0 BEAGLEBONE DVI-D CAPE OVERVIEW 11

4.0 BEAGLEBONE DVI-D CAPE SPECIFICATION 12

4.1 BEAGLEBONE DVI-D CAPE FEATURES 12
4.2 DVI-D INTERFACE 12
4.3 MECHANICAL SPECIFICATIONS 13

5.0 PRODUCT CONTENTS 14

5.1 BOX 14
5.2 REPAIRS 15

6.0 CONNECTIONS 16

6.1 HDMI CONNECTOR 16
6.2 MAIN EXPANSION HEADER 17
6.3 BATTERY EXPANSION HEADER 17

7.0 BEAGLEBONE DVI-D CAPE SYSTEM ARCHITECTURE AND DESIGN 19

7.1 SYSTEM BLOCK DIAGRAM 19
7.2 DVI-D INTERFACE 21
7.2.1 Main Expansion Headers *21*
7.2.2 Bus Transceiver *21*
7.2.3 Digital Transmitter *22*
7.3 EEPROM 23
7.3.1 EEPROM Address *24*
7.3.2 I2C Bus *24*
7.4 USER LED'S 25

8.0 MECHANICAL INFORMATION 27

8.1 BEAGLEBONE DVI-D CAPE DIMENSIONS 27
8.2 DVI_PDN JUMPER 27

9.0 TROUBLESHOOTING 28

10.0 BEAGLEBONE DVI-D CAPE SCHEMATICS 28

11.0 BILLS OF MATERIAL 35

12.0 PCB INFORMATION 36

Figures

Figure 1. The BeagleBone DVI-D Cape 11
Figure 2. The BeagleBone DVI-D Cape Box 14
Figure 3. BeagleBone DVI-D Cape Box Contents 15
Figure 4. HDMI Connector 16
Figure 5. Stackable Main Expansion Connector 17
Figure 6. Stackable Battery Expansion Connector 18
Figure 7. BeagleBone DVI-D Cape High Level Block Diagram 19
Figure 8. BeagleBone DVI-D Cape Major Components 20
Figure 9. BeagleBone DVI-D Cape Pin Usage 21
Figure 10. Bus Transceiver 22
Figure 11. Digital Transmitter and 2-Bit Voltage Translator 23
Figure 12. BeagleBone DVI-D Cape EEPROM 24
Figure 13. User LED's 25
Figure 14. BeagleBone DVI-D Cape Dimensions Drawing 27

Tables

Table 1. Change History 10
Table 2. BeagleBone DVI-D Cape Features 12
Table 3. User LED Control 26

NOTES

1.0 Introduction

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

This document provides detailed information on the overall design and usage of the BeagleBone DVI-D 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 Cape.

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

Section 5.0 - Product Contents
Describes what the BeagleBone DVI-D Cape package looks like and what is included in the box.

Section 6.0 – Connections
Covered here is how to connect the various cables to the BeagleBone DVI-D Cape.

Section 7.0 – System Architecture and Design
This section provides information on the overall architecture and design of the BeagleBone DVI-D Cape. This is a very detailed section that goes into the design of each circuit on the board.

Section 8.0 – Mechanical
Information is provided here on the dimensions of the BeagleBone DVI-D Cape.

Section 9.0 - Schematics
These are the schematics for the BeagleBone DVI-D Cape and information on where to get the PDF and OrCAD files.

Section 10.0 - Bills Of Material
This section describes where to get the latest Bill of Material for the BeagleBone DVI-D Cape.

Section 11.0 - PCB Information
This section describes where to get the PCB file information for the BeagleBone DVI-D Cape.

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
0.1	Initial release.	12/14/2011	BBT
0.2	1. Updated photos 2. DVI_PDn jumper 3. EEPROM troubleshooting	2/2/2012	BBT

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3.0 BeagleBone DVI-D Cape Overview

The BeagleBone DVI-D Cape is designed to provide DVI-D interface for BeagleBone boards. This board features a standard HDMI connector, which can be connected to a DVI-D monitor using a HDMI-to-DVI-D cable. The BeagleBone DVI-D Cape is mounted on the BeagleBone via its stackable 46-pin connector.

Figure 1 below is a picture of the board.

Figure 1. The BeagleBone DVI-D Cape

4.0 BeagleBone DVI-D Cape Specification

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

4.1 BeagleBone DVI-D Cape Features

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

Table 2. BeagleBone DVI-D Cape Features

	Feature	
Interface	DVI-D	
Connector Type	HDMI	
Color Depth	RGB 16-bit	
Panel Type	Board ID EEPROM	
Power Supply	3.3V (via expansion)	
	5V (via expansion)	
PCB	2.15" x 3.40" (54.6mm x 86.4mm)	6 layers
Indicators	Power LED	
EEPROM	Board ID EEPROM	
Expansion Connector	46-pin main expansion headers	
	10-pin battery expansion header	

4.2 DVI-D Interface

The BeagleBone DVI-D 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 Mechanical Specifications

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

5.0 Product Contents

Under this section is a description of what comes in the box when the BeagleBone DVI-D Cape is purchased.

5.1 Box

The final packaged BeagleBone DVI-D Cape Rev A product will contain the following items:

- 1 box with the following items inside:
  - 1 BeagleBone DVI-D Cape in an ESD bag
  - 1 Reference card

Figure 2. The BeagleBone DVI-D Cape Box

Figure 3. BeagleBone DVI-D Cape Box Contents

5.2 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

6.0 Connections

6.1 HDMI Connector

The BeagleBone DVI-D 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 Cape. A standard HDMI cable can be used when connecting to a monitor with an HDMI connector. **Figure 4** is a picture of the HDMI connector.

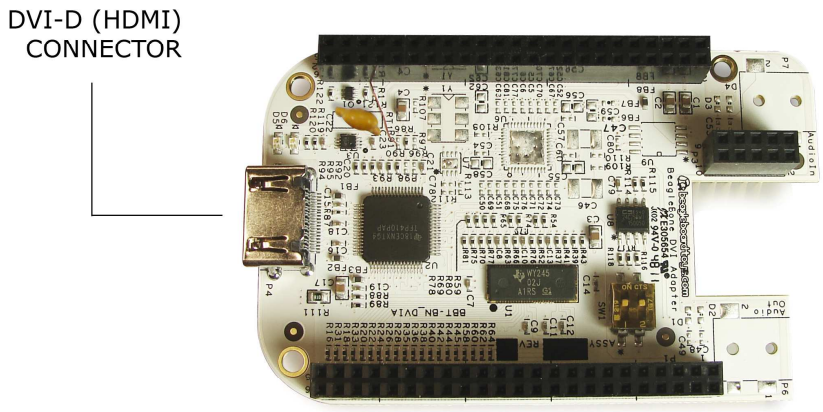

Figure 4. HDMI Connector

6.2 Main Expansion Header

The BeagleBone DVI-D Cape uses two dual row 46 position connectors. These connectors are from MLE and stackable. The part number of these connectors is SSHQ-123-D-08-F-LF. **Figure 5** is a picture of the connector.

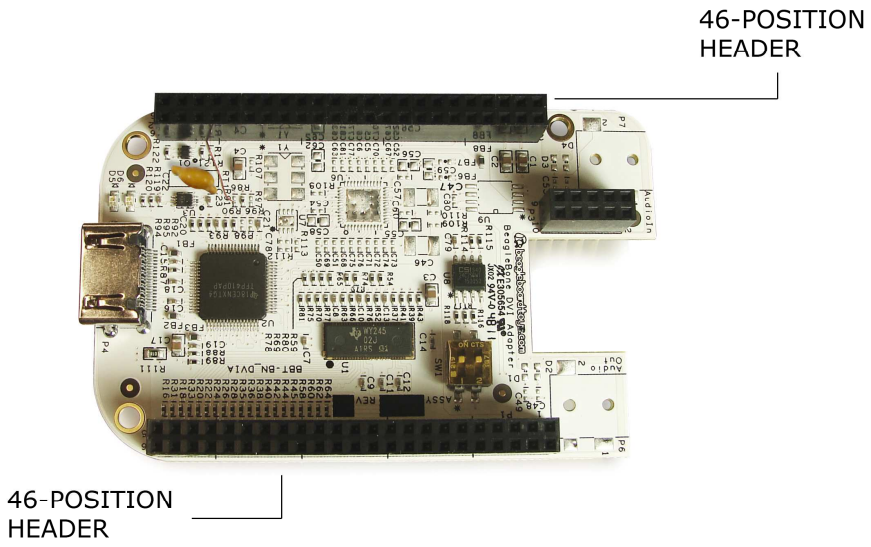

Figure 5. Stackable Main Expansion Connector

6.3 Battery Expansion Header

This connector is a single two 10-pin expansion header. This is a dual row 10 position 2.54mm x 2.54mm connector and is the same as the main connector except with less position. **Figure 6** is a picture of the connector.

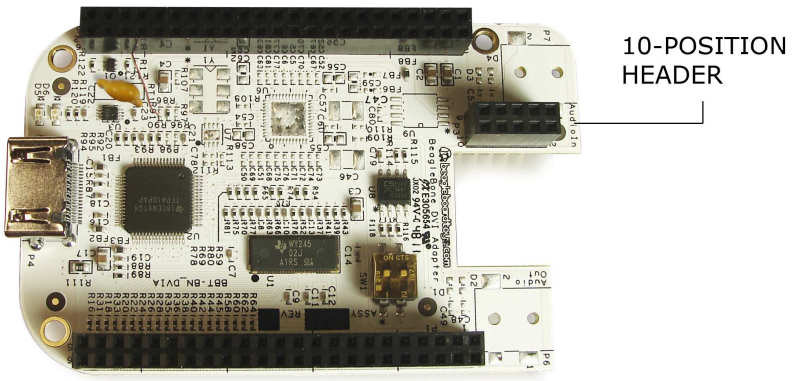

Figure 6. Stackable Battery Expansion Connector

7.0 BeagleBone DVI-D Cape System Architecture and Design

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

7.1 System Block Diagram

Figure 7 is the high level block diagram of the BeagleBone DVI-D Cape.

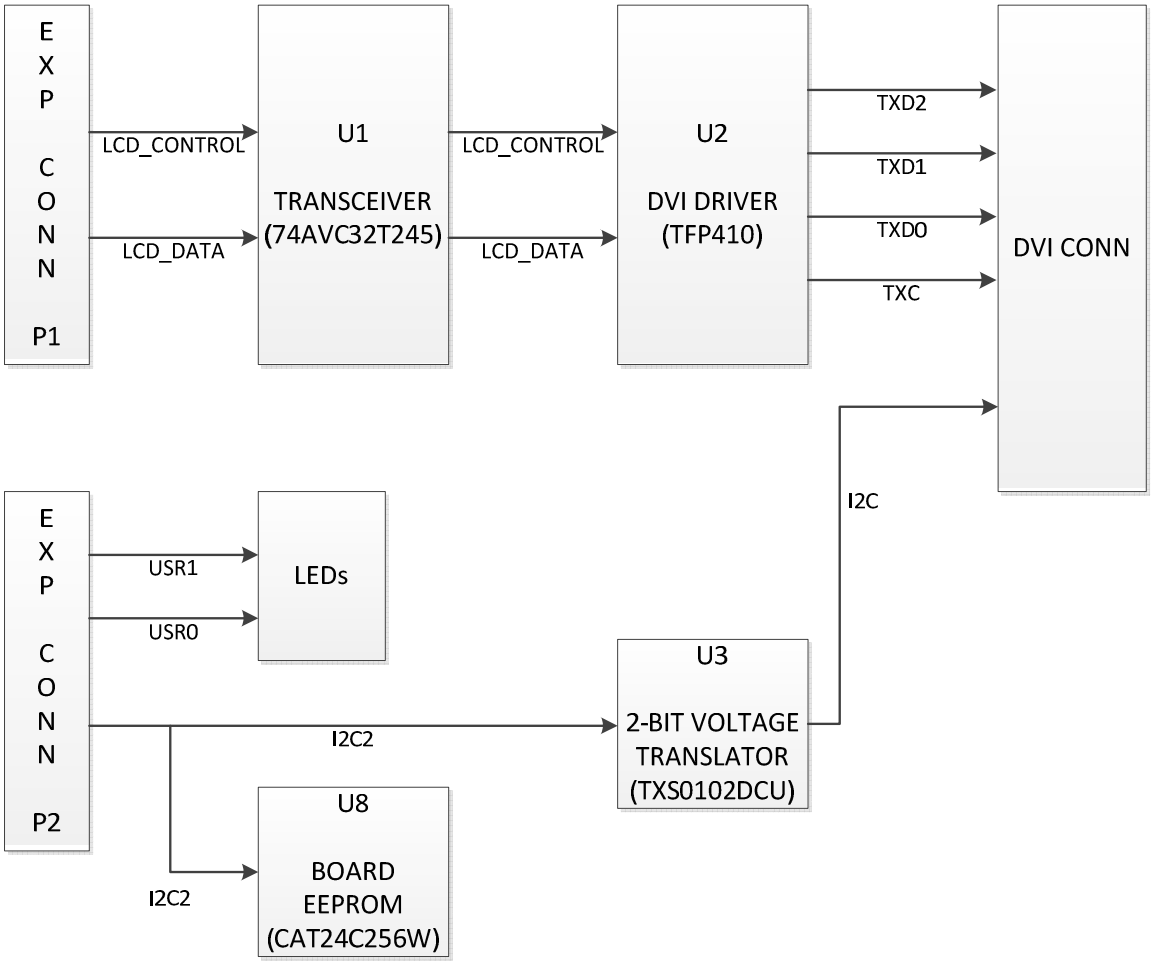

Figure 7. BeagleBone DVI-D Cape High Level Block Diagram

Figure 8 shows the location of the key components on the board.

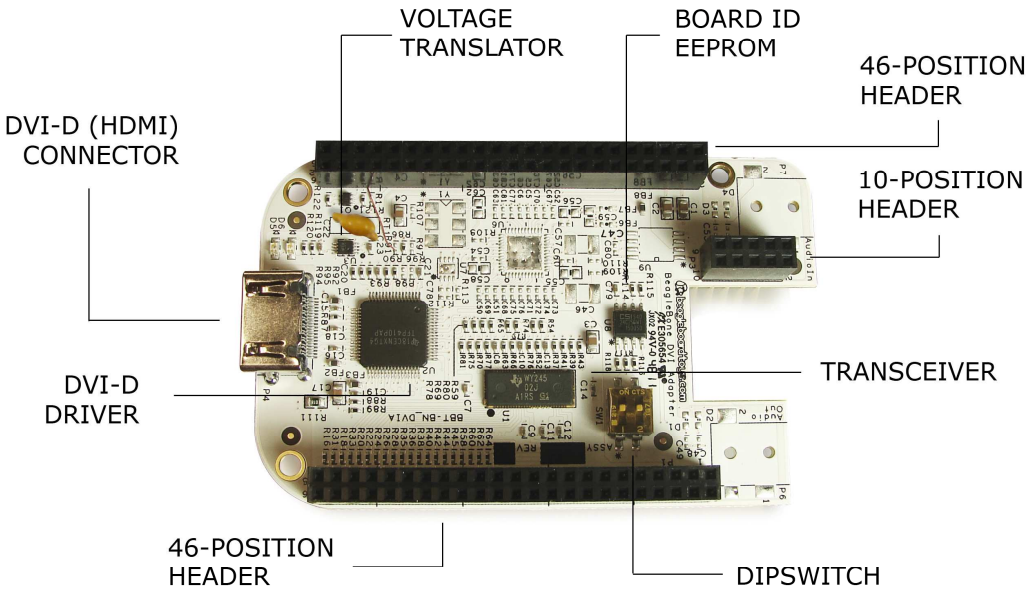

Figure 8. BeagleBone DVI-D Cape Major Components

The information found in the remainder of this section describes in detail the architecture and design of the BeagleBone DVI-D Cape.

7.2 DVI-D Interface

7.2.1 Main Expansion Headers

The BeagleBone DVI-D Cape reserves 21 pins from the expansion headers including 16 LCD data signals, 4 LCD control signals, and a DVI power down signal. The DVI-D 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.

Figure 9 illustrates the number of pins dedicated for the BeagleBone DVI-D Cape.

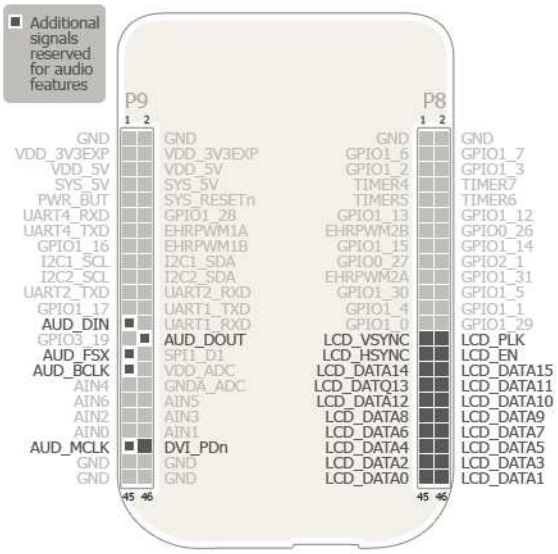

Figure 9. BeagleBone DVI-D Cape Pin Usage

7.2.2 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 10** shows the LCD signals buffered through 74AVC32T245.

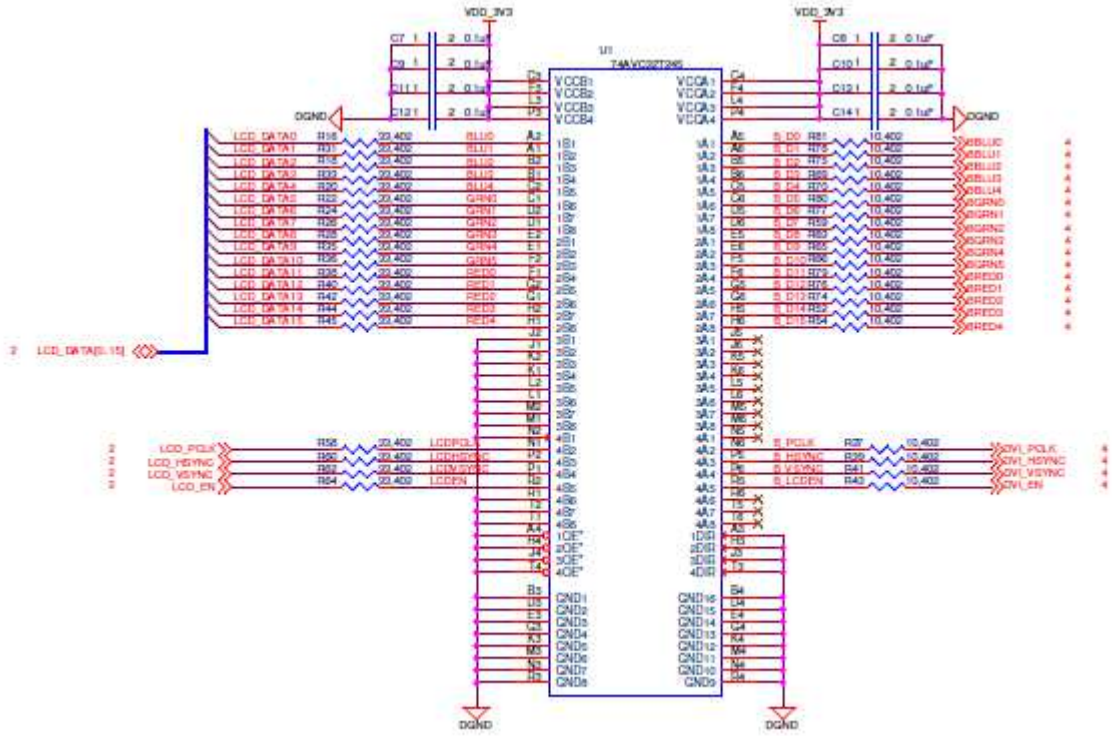

Figure 10. Bus Transceiver

7.2.3 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 11** shows the TFP410 and TXS0102DCU in the schematic.

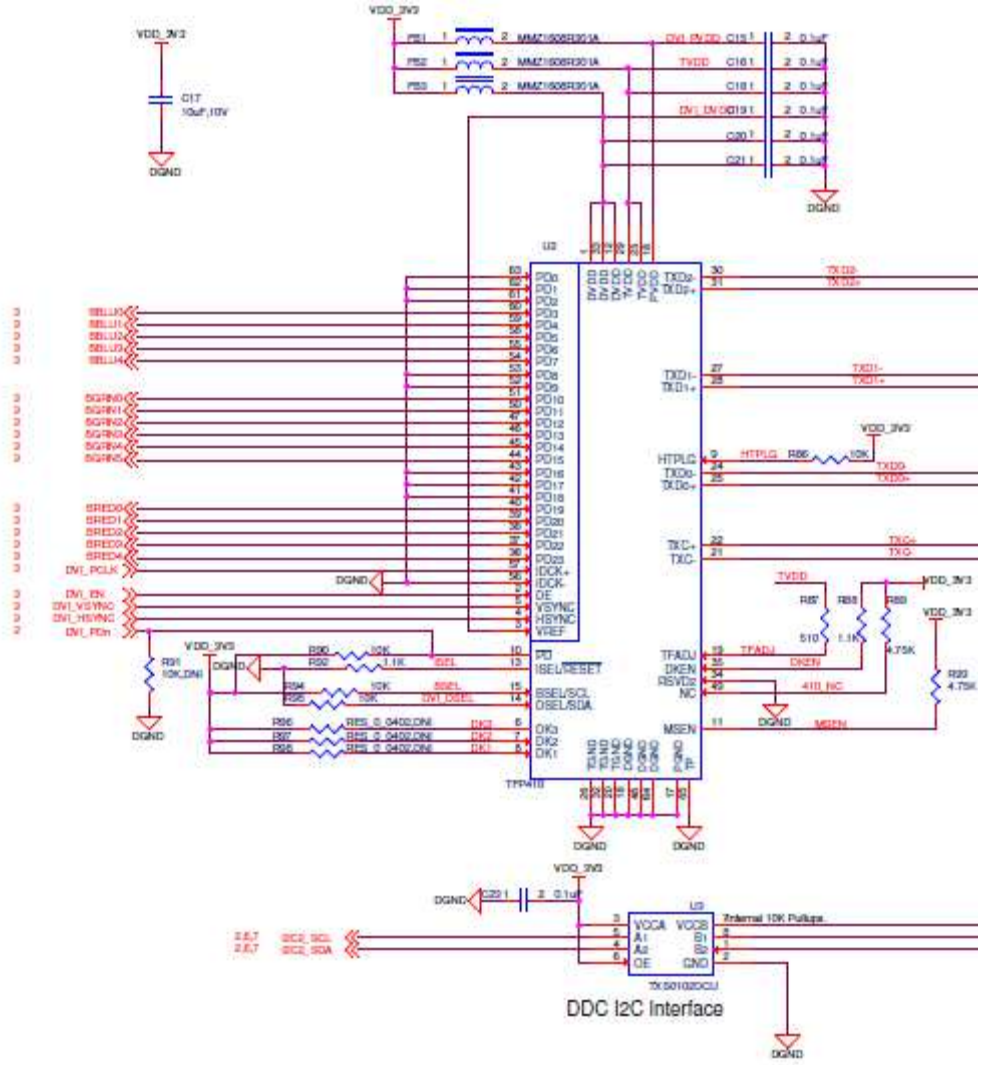

Figure 11. Digital Transmitter and 2-Bit Voltage Translator

7.3 EEPROM

The BeagleBone DVI-D 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 12** is the design of the EEPROM circuit.

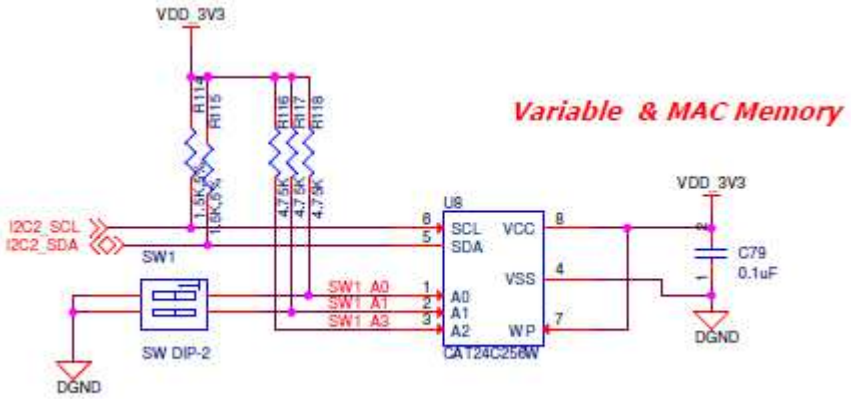

Figure 12. BeagleBone DVI-D Cape EEPROM

7.3.1 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.

7.3.2 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.

7.4 User LED's

The BeagleBone DVI-D 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 13** shows the LED circuitry.

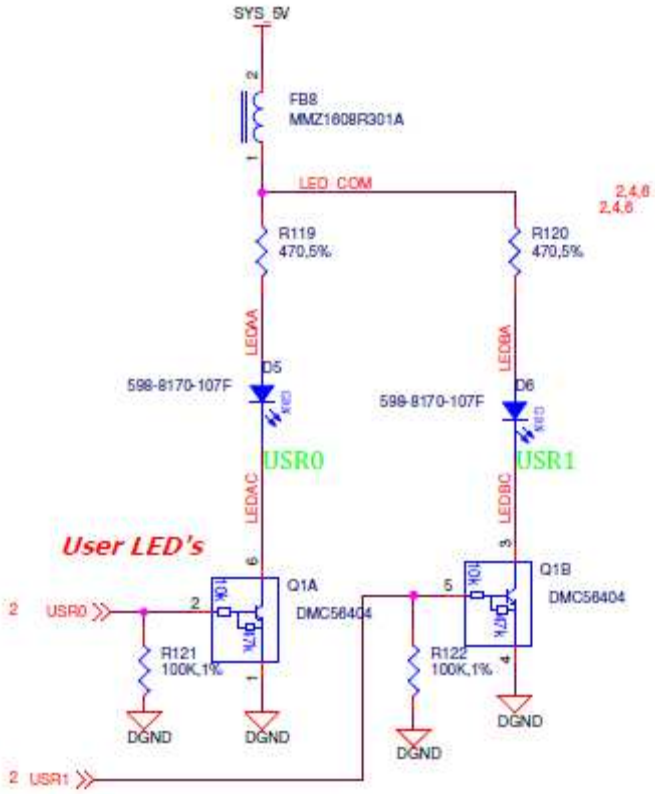

Figure 13. User LED's

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

8.0 Mechanical Information

8.1 BeagleBone DVI-D Cape Dimensions

This section provides information on the mechanical aspect of the BeagleBone DVI-D Cape. **Figure 14** is the dimensions of the BeagleBone DVI-D Cape.

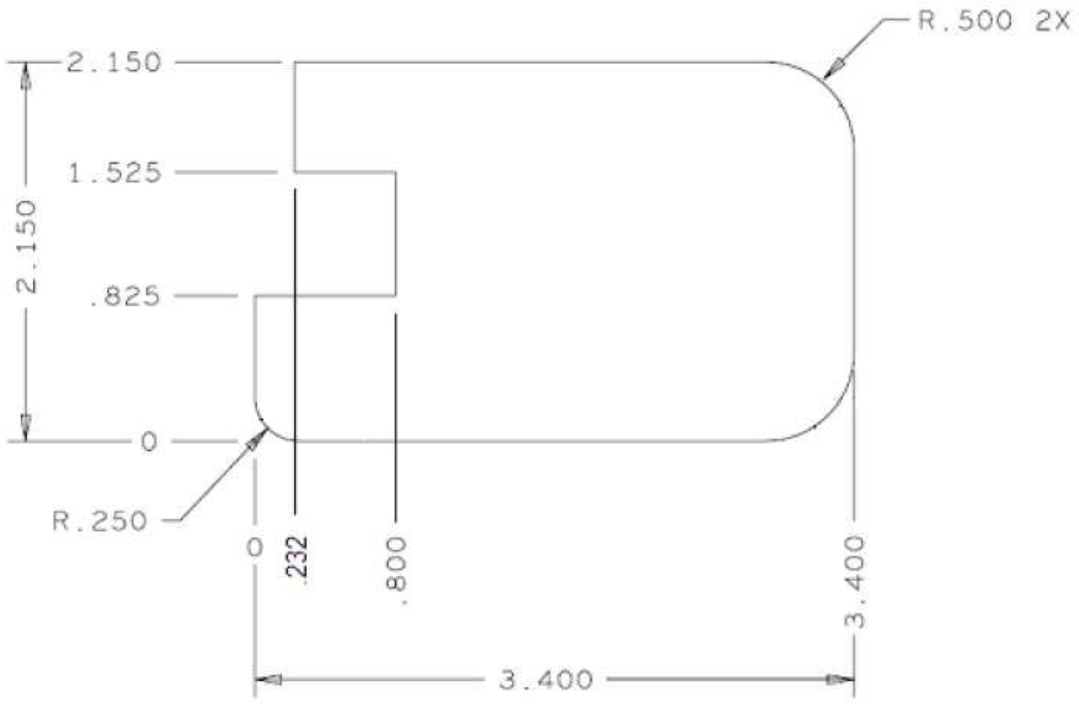

Figure 14. BeagleBone DVI-D Cape Dimensions Drawing

8.2 DVI_PDn Jumper

On current BeagleBone DVI-D Cape there is a jumper connecting from pin 42 of connector P2 to R9 (which is DNI). This is the DVI_PDn signal that goes from the main connector to the DVI-D driver unit on the board. The PCBs of these boards are labeled "PCB RevA" in the back. Future releases of BeagleBone DVI-D Cape will have their PCB modified so no more jumpers are required.

9.0 Troubleshooting

The BeagleBone DVI-D Cape is designed for use with the BeagleBone; therefore, an EEPROM is required. The EEPROM allows for the identification of the cape by the Software in order to set the pin muxing on the expansion connector to be compatible with the BeagleBone.

The EEPROM must be write protected. In order to allow the required data to be written to the EEPROM, the WP needs to be disabled. On BeagleBone DVI-D Capes that are labeled "PCB RevA" on the back, WP can be disabled by physically lifting pin 7 of U8. This can be done by using a very good knife or a soldering iron in addition to a magnifier.

Future releases will have the WP of the EEPROM chip pulled up. Thus, the WP pin can be disabled by using a jumper wire to connect this pin to GND.

10.0 BeagleBone DVI-D Cape Schematics

The following pages contain the PDF schematics for the BeagleBone DVI-D Cape. This manual will be periodically updated. The latest documentations can also be found at

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

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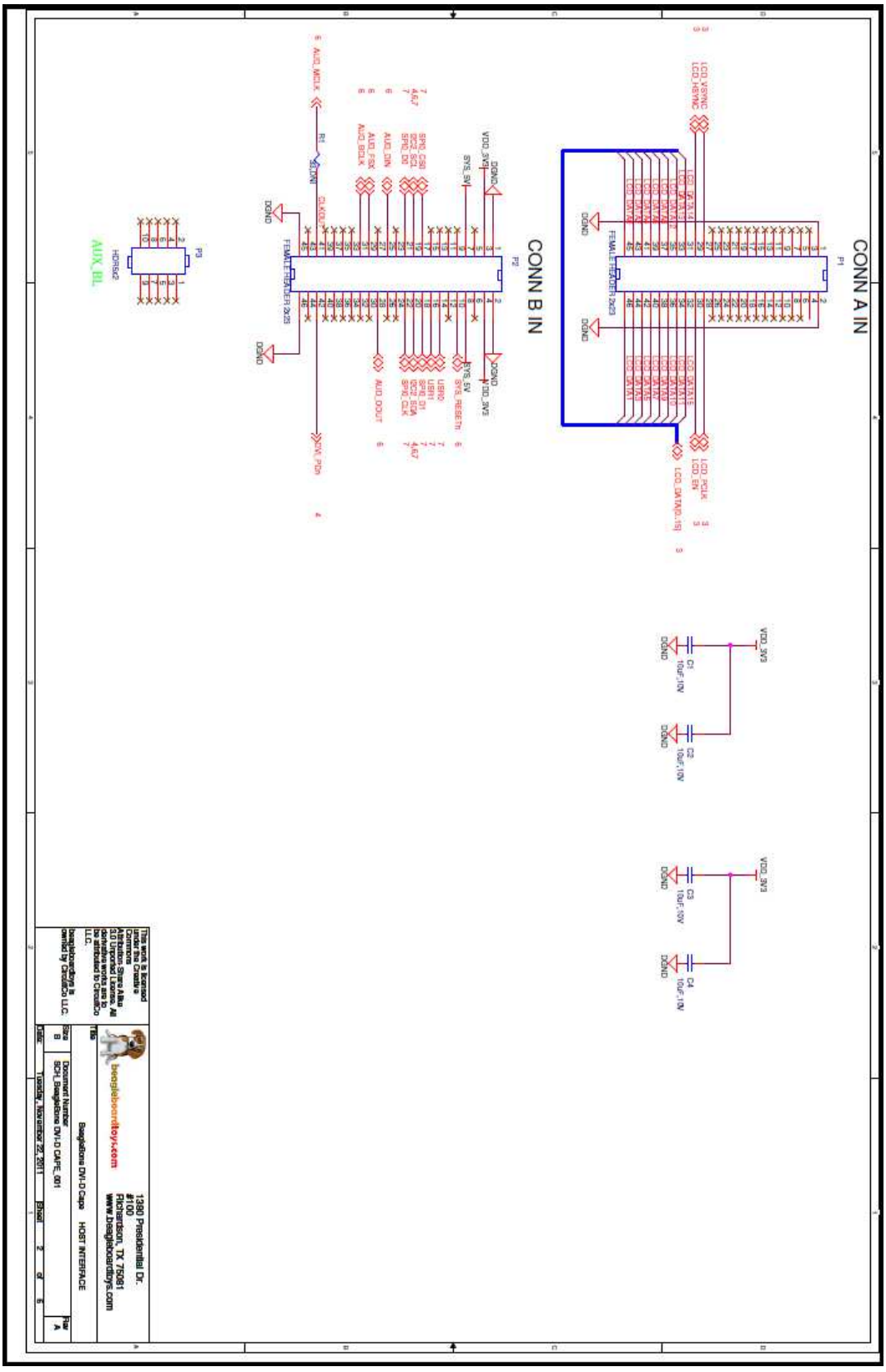
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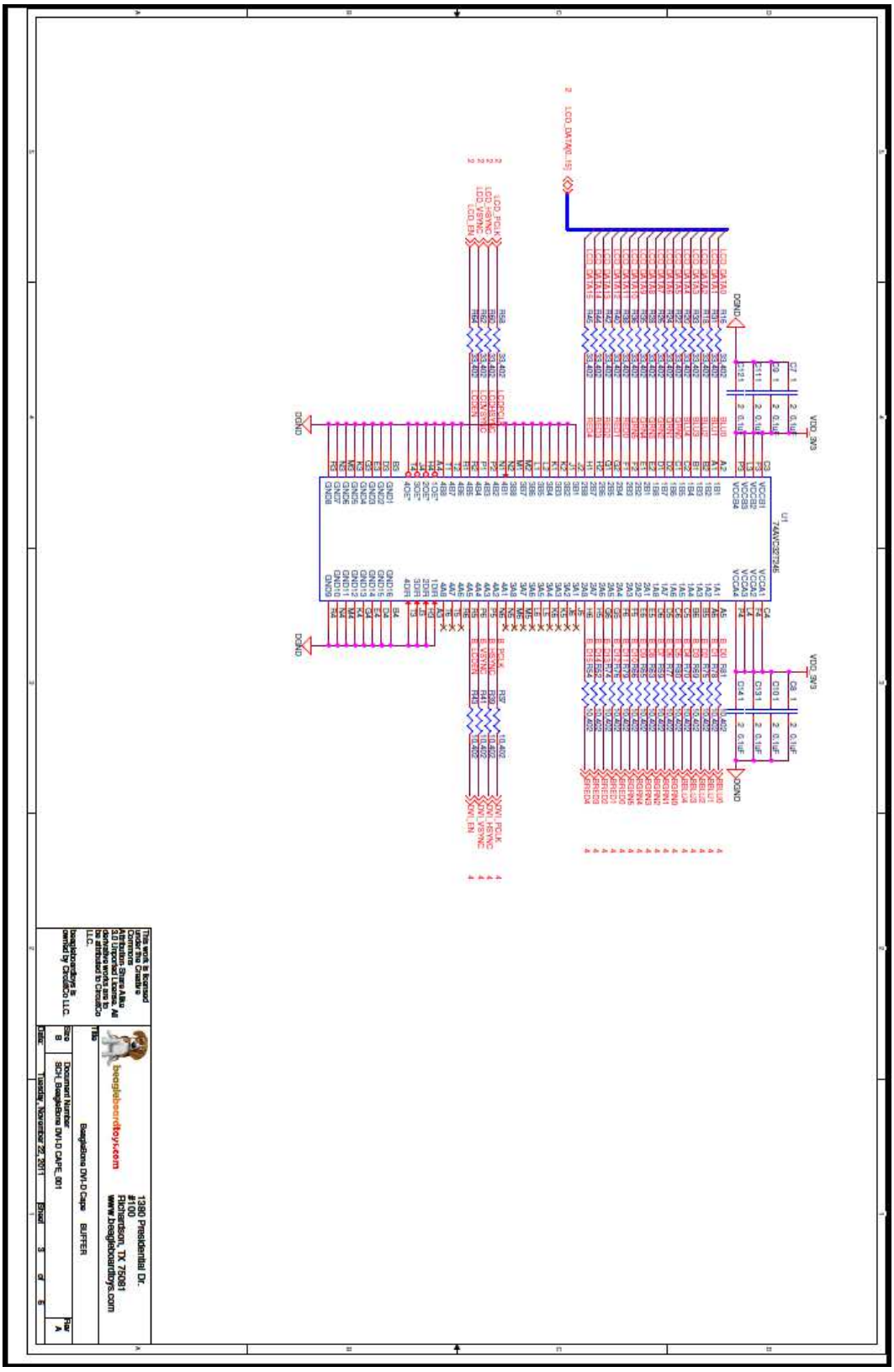

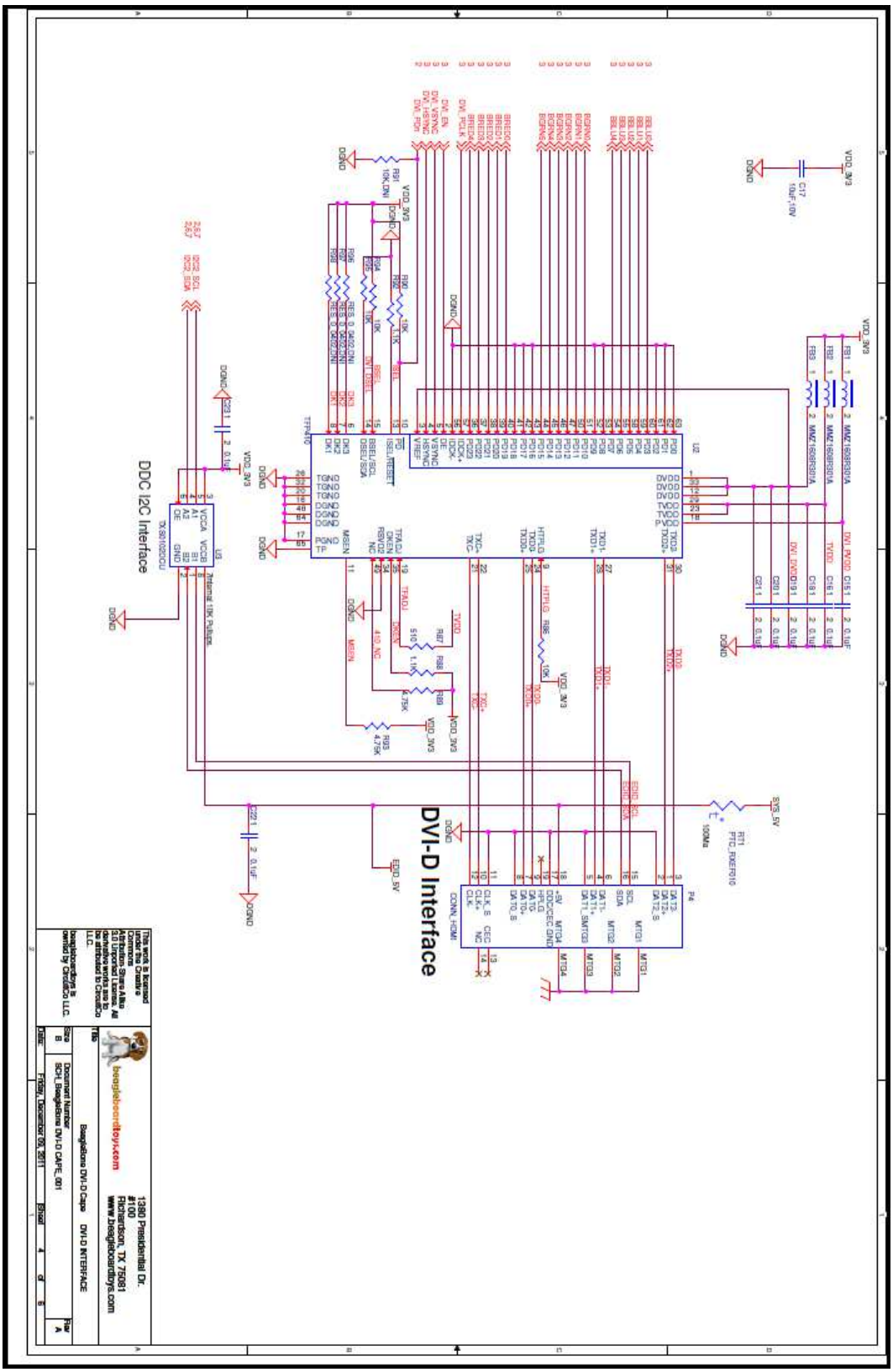
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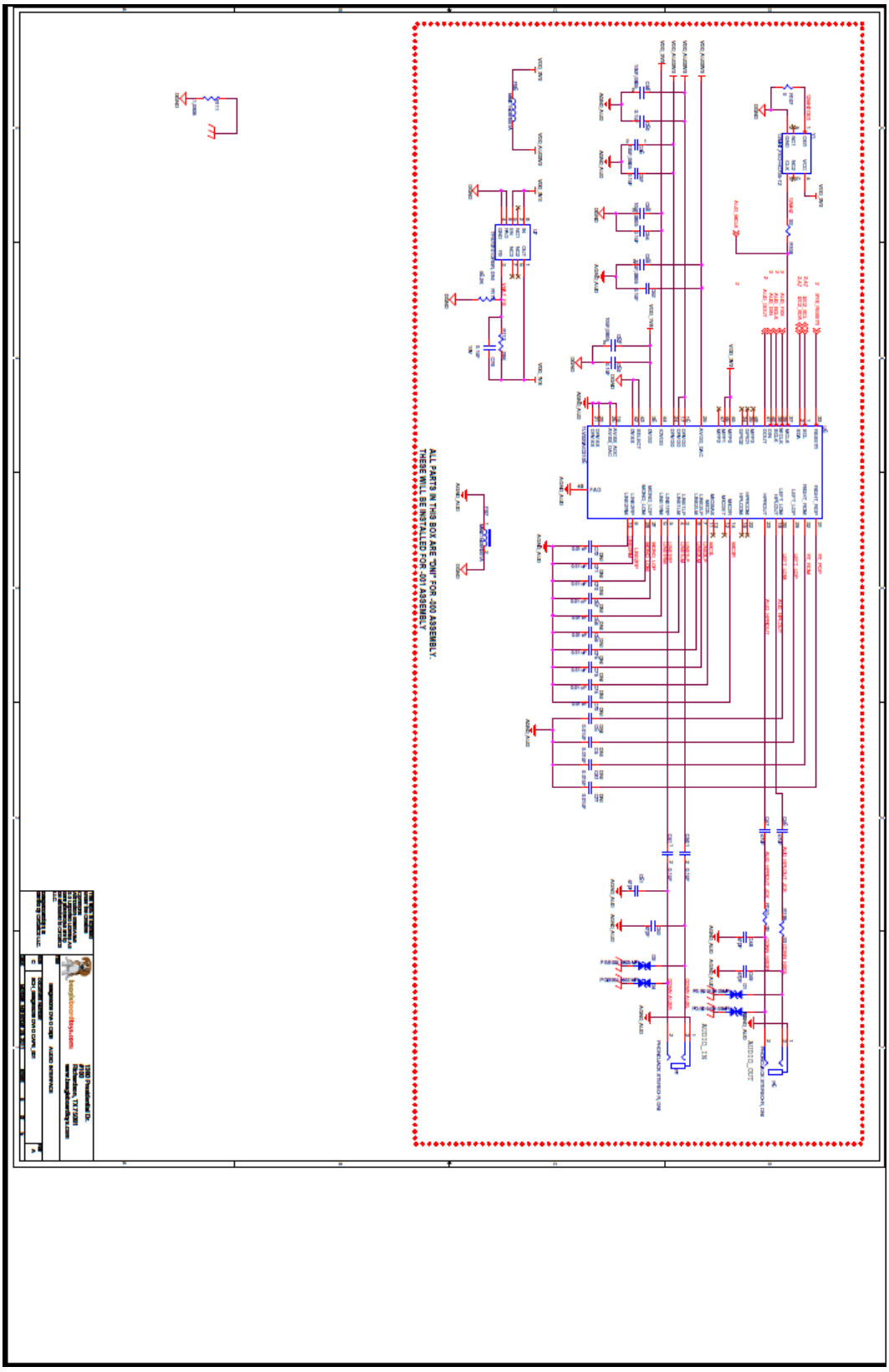
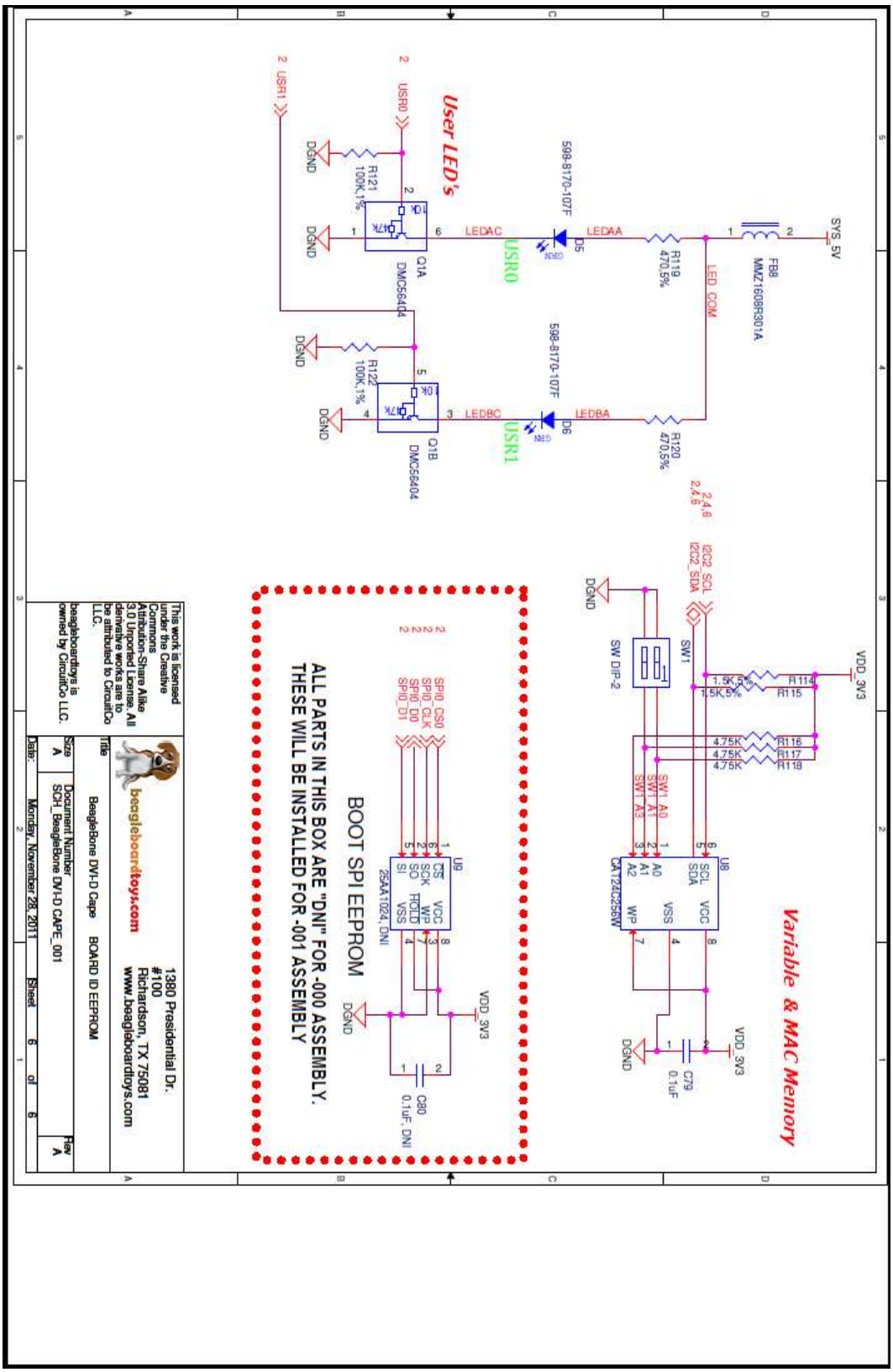

ALL PARTS IN THIS BOX ARE 'DNF' FOR -000 ASSEMBLY.
THESE WILL BE INSTALLED FOR -001 ASSEMBLY


User LED's
Variable & MAC Memory
BOOT SPI EEPROM
ALL PARTS IN THIS BOX ARE "DNI" FOR -000 ASSEMBLY.
THESE WILL BE INSTALLED FOR -001 ASSEMBLY
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BeagleBone DVI-D Cape
BOARD ID EEPROM
Document Number
SCH_BeagleBone DVI-D CAPE_001
Monday, November 28, 2011

11.0 Bills of Material

The Bill of Material for the BeagleBone DVI-D Cape is provided at beagleboardtoys.com at the following location:

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

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12.0 PCB Information

Gerber files and Allegro source files are available on beagleboardtoys.com at the following address:

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

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