ULCD7 Lite Rev A
System Reference Manual

Revision A
October 14, 2011

THIS DOCUMENT

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

ULCD7 LITE DESIGN

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Mailing Address:

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Please refer to sections 12 and 13 of this document for the board checkout procedures and troubleshooting guides.

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NOTES

1.0 Introduction

This document is the System Reference Manual for the ULCD7 Lite Display Panel, an add-on LCD peripheral for the BeagleBoard-xM.

This document provides detailed information on the overall design and usage of the ULCD7 Lite 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 ULCD7 Lite board.

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

Section 5.0-Product Contents
Describes what the ULCD7 Lite board 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 ULCD7 Lite board.

Section 7.0– System Architecture and Design
This section provides information on the overall architecture and design of the ULCD7 Lite board. This is a very detailed section that goes into the design of each circuit on the board.

Section 8.0– Connector Pinouts and Cables
The section describes each connector and cable used in the system. This will allow the user to create cables, purchase cables, or to perform debugging as needed.

Section 9.0– ULCD7 Lite Board Accessories
Covered in this section are a few of the accessories that may be used with ULCD7 Lite board. This is not an exhaustive list, but does provide an idea of the types of cables and accessories that can be supported and how to find them. It also provides a definition of what they need to be. It does not guarantee that these devices will work on all OS implementations.

Section 10.0 – Mechanical
Information is provided here on the dimensions of the ULCD7 Lite board.

Section 11.0 – Troubleshooting
Here is where you can find tips on troubleshooting the setup of the ULCD7 Lite board.

Section 12.0- ULCD7 Lite Board Components

This section provides information on the top and bottom side silkscreen of the ULCD7 Lite board showing the location of the components.

Section 13.0- ULCD7 Lite Board Schematics

These are the schematics for the ULCD7 Lite board and information on where to get the PDF and OrCAD files..

Section 14.0- Bills Of Material

This section describes where to get the latest Bill of Material for the ULCD7 Lite board.

Section 15.0- ULCD7 Lite Board PCB Information

This section describes where to get the PCB file information for the ULCD7 Lite board.

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.	10/14/2011	BBT

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3.0 ULCD7 Lite Board Overview

The ULCD7 Lite is designed to provide an 800x480 7” landscape LCD panel with a resistive touchscreen for use with the BeagleBoard-xM.

Following is a short list of the features of the ULCD7 Lite.

- 7” Landscape LCD panel 800x480
- Resistive Touch Panel
- LED backlight with variable intensity
- BeagleBoard-xM onboard expansion header

Figure 1 below is a picture of the board.

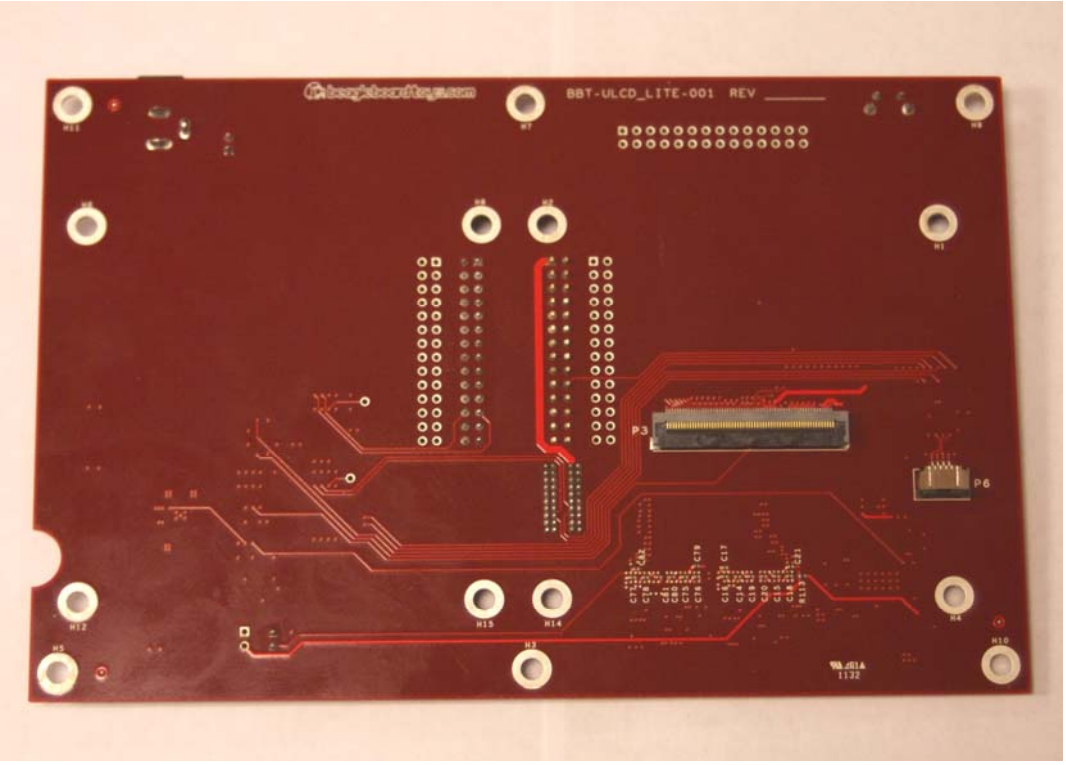

Figure 1. The ULCD7 Lite board

4.0 ULCD7 Lite Board Specification

This section covers the specifications of the ULCD7 Lite and provides a high level description of the major components and interfaces that make up the board.

4.1 ULCD7 Lite Board Features

Table 2 provides a list of the ULCD7 Lite's features.

Table 2. ULCD7 Lite Features

	Feature	
Display	ThreeFive TFC-S9700RTWV35TR-01	
LCD Size	7"	
Panel Type	a-Si TFT active matrix	
Resolution	800 x 480	
Colors	16.7M	
Interface	RGB 24b	
Touch Panel	Resistive	
Backlight	27 LEDs White	
Power	5VDC on board or supplied via BeagleBoard-xM	
PCB	4.5" x 6.9" (114 x 175mm)	6 layers
Indicators	Power LED	
EEPROM	Board ID EEPROM	
	EDID Compatible EEPROM	
Host Connectors	28 Pin BB-xM compatible connector	
	Dual LCD BB-xM compatible connectors	
Expansion Connector	28 Pin BB-xM compatible Expansion Header	

4.2 LCD Panel

The LCD Panel is supplied by ThreeFive. The Model number is S94029A-PT070WV. It is a WVGA 800x480 7 inch panel.

4.3 Indicators

There is one Power LED located on board. This Power LED indicates that power is applied to the board.

4.4 Expansion Header

A single 28 pin expansion header is provided to allow for expansion boards designed for the BeagleBoard-xM to be mounted. Pin 22 on the connector is used by the LCD so compatibility with all boards may not be possible.

4.5 Reset Button

A reset button is provided that when pressed and released, causes a power on reset of the host board.

4.6 Power Connector

A 5V DC power connector P1 is provided onboard. The board can be powered using this power connector or via the mounted BeagleBoard-xM.

4.7 Mechanical Specifications

Size:	4.5” x 6.9”
Max height:	TBM
Layers:	6
PCB thickness:	.062”
RoHS Compliant:	Yes
Weight:	TBW

4.8 Electrical Specifications

Table 3 is the electrical specification of the external interfaces to the ULCD7 Lite panel.

Table 3. ULCD7 Lite Electrical Rev A

Specification	Min	Typ	Max	Unit
Power				
Input Voltage DC	4.8	5	5.2	V
Current DC		2.0		A
Environmental				
Temperature range	0		+85	C

5.0 Product Contents

Under this section is a description of what comes in the box when the ULCD7 Lite Board is purchased.

5.1 Box

The final packaged ULCD7 Lite Rev A product will contain the following items:

- 1 box with the following items inside:
  - 1 ULCD7 Lite in an ESD bag

Figure 2. The ULCD7 Lite Box

Figure 3. ULCD7 Lite 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 Indicator Locations

There is one greed indicator on the ULCD7 Lite board. **Figure 4** shows the location of this indicator.

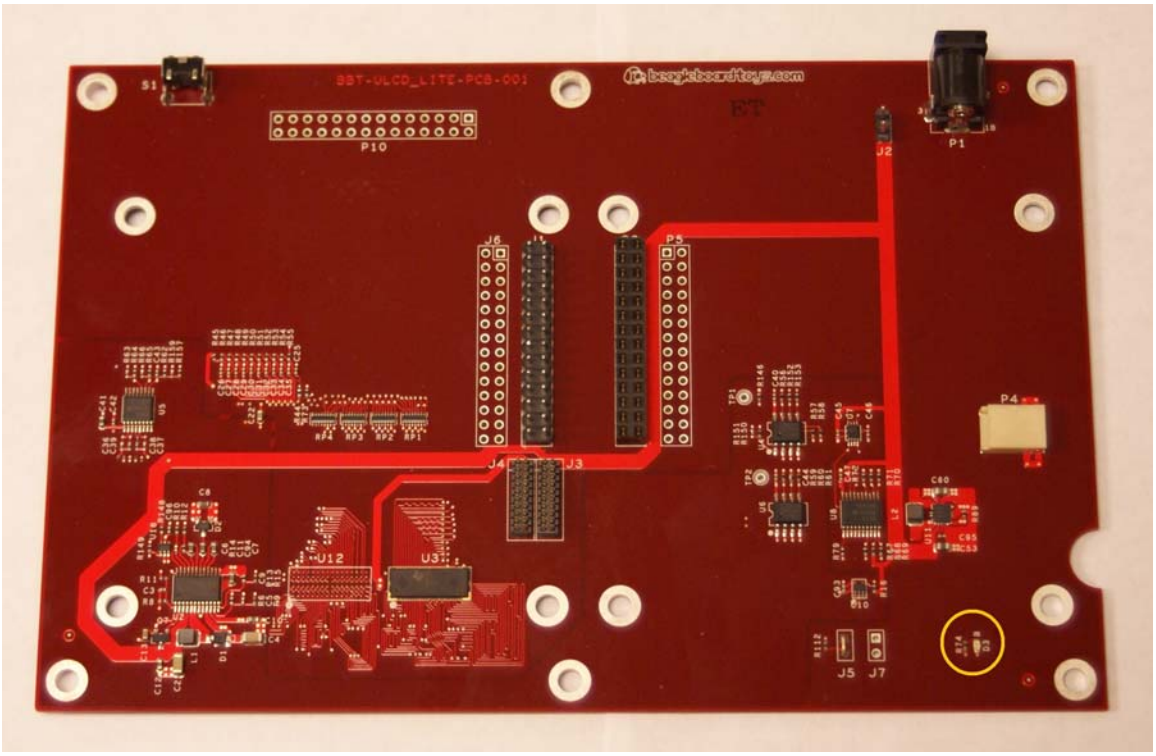

Figure 4. ULCD7 Lite Indicator Location

6.2 Host Connection Headers

The host connection headers can be used to connect to the BeagleBoard-xM. These headers include a dual LCD compatible connector and a 28 pin BeagleBoard-xM compatible connector. **Figure 5** shows the location of theses connection headers.

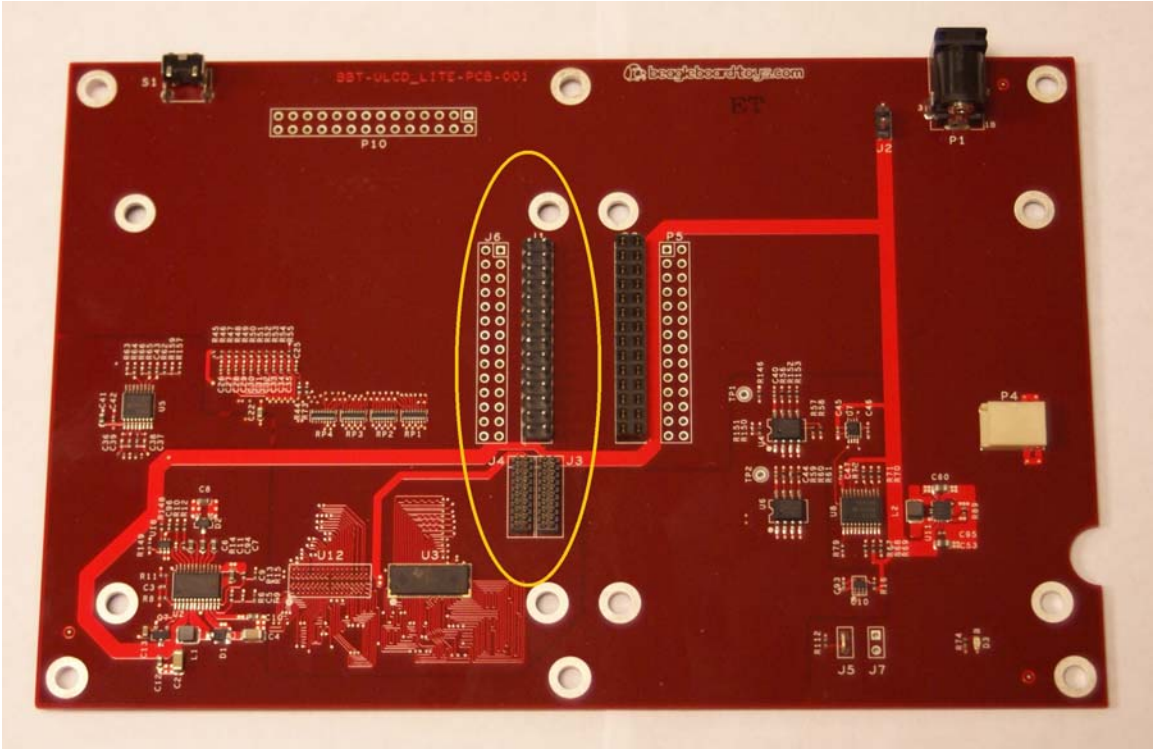

Figure 5. ULCD7 Lite Host Header Location

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6.3 Expansion Header

The expansion header can be used to connect an optional expansion card to the BeagleBoard-xM. However, pin 22 of this header is used to drive the LCD panel; therefore, not all boards are compatible. **Figure 6** shows the location of this expansion header.

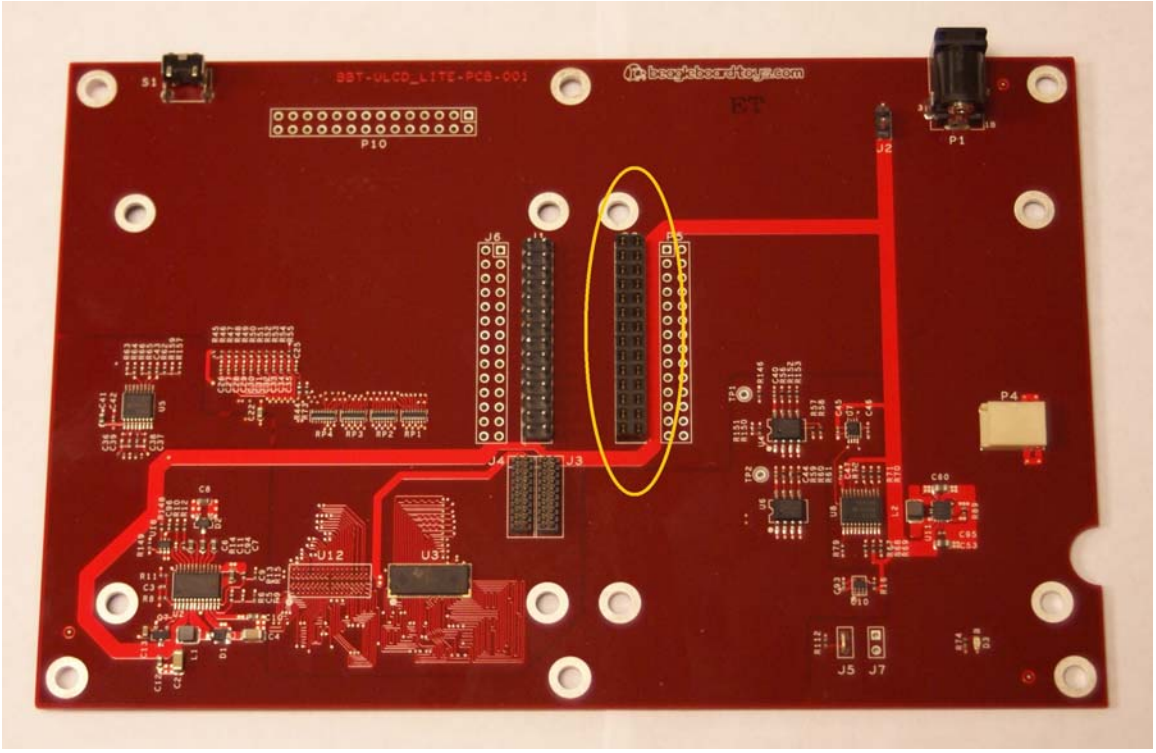

Figure 6. ULCD7 Lite Expansion Header Location

7.0 ULCD7 Lite System Architecture and Design

This section provides a high level description of the design of the ULCD and its overall architecture.

7.1 System Block Diagram

Figure 7 is the high level block diagram of the ULCD.

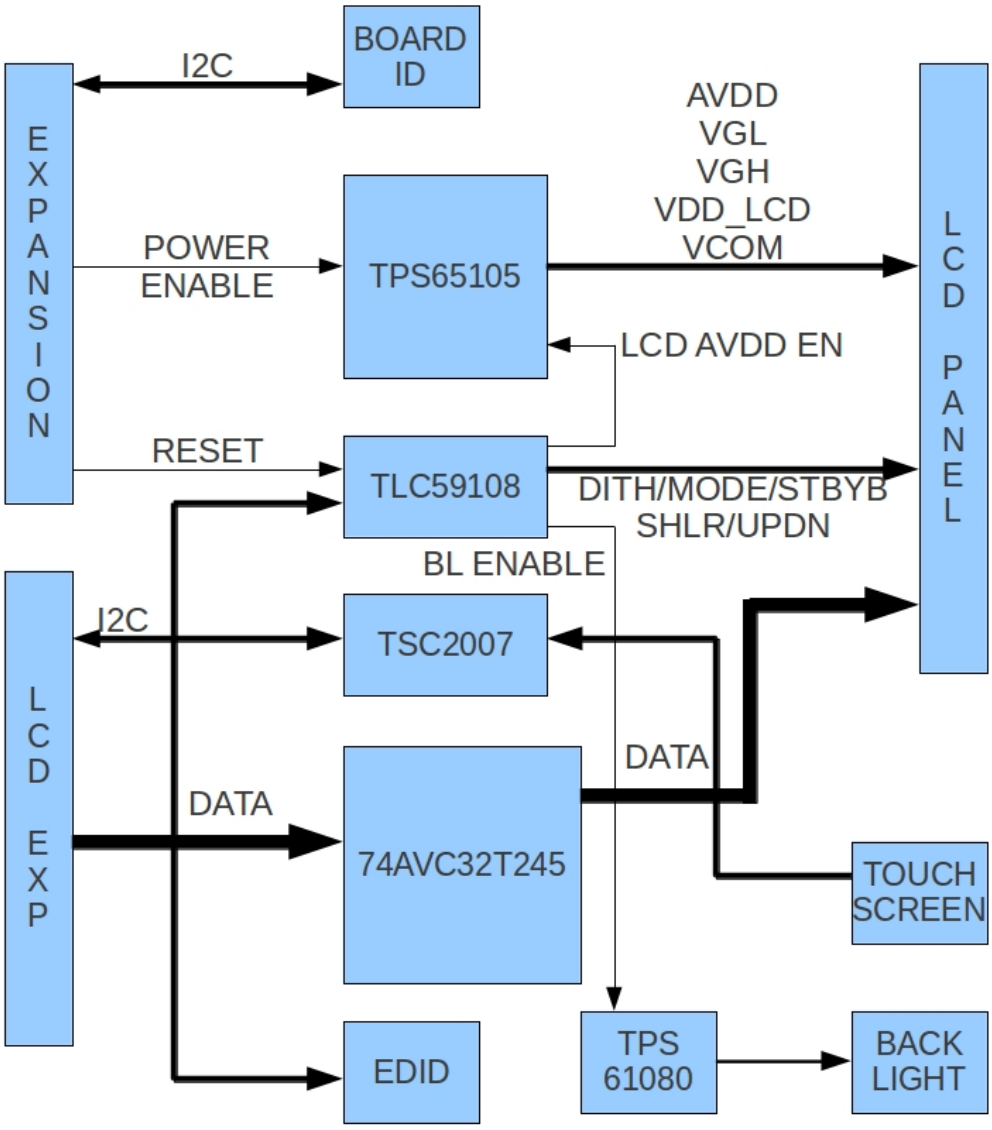

Figure 7. ULCD High Level Block Diagram

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

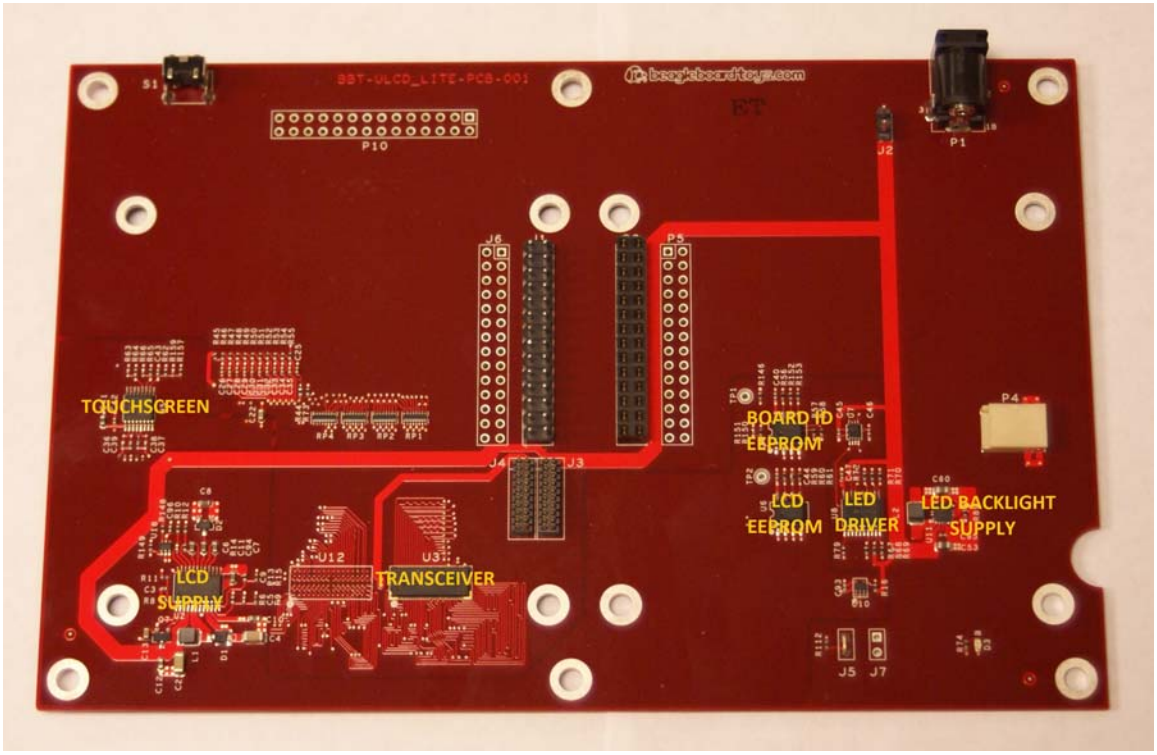

Figure 8. ULCD7 Lite Major Components

The information found in the remainder of this section describes in detail the architecture and design of the ULCD7 Lite.

7.2 Host Interface Connectors

The ULCD7 Lite supports BeagleBoard-xM as its host. A host is the board that plugs into the ULCD7 Lite and drives the LCD. The BeagleBoard-xM connects to the ULCD7 Lite via connector J1.

7.3 I2C Control Interface

A TLC59108 LED driver is used to control some of the functions on the ULCD7 Lite. The TLC59108 is an I2C bus controlled 8-bit LED driver that is optimized for red/green/blue/amber (RGBA) color mixing and backlight application for amusement products. Seven of the 8 outputs are used to control various functions on the ULCD7 Lite. These are:

- LCD Power Enable
- LCD Backlight Enable
- LCD Standby Power
- UP/DN LCD scanning direction control
- LCD Dithering Control
- LCD Mode
- LCD Left/Right scanning direction control

Figure 9 below is the TLC59108 interface that is used to control the operation of the ULCD.

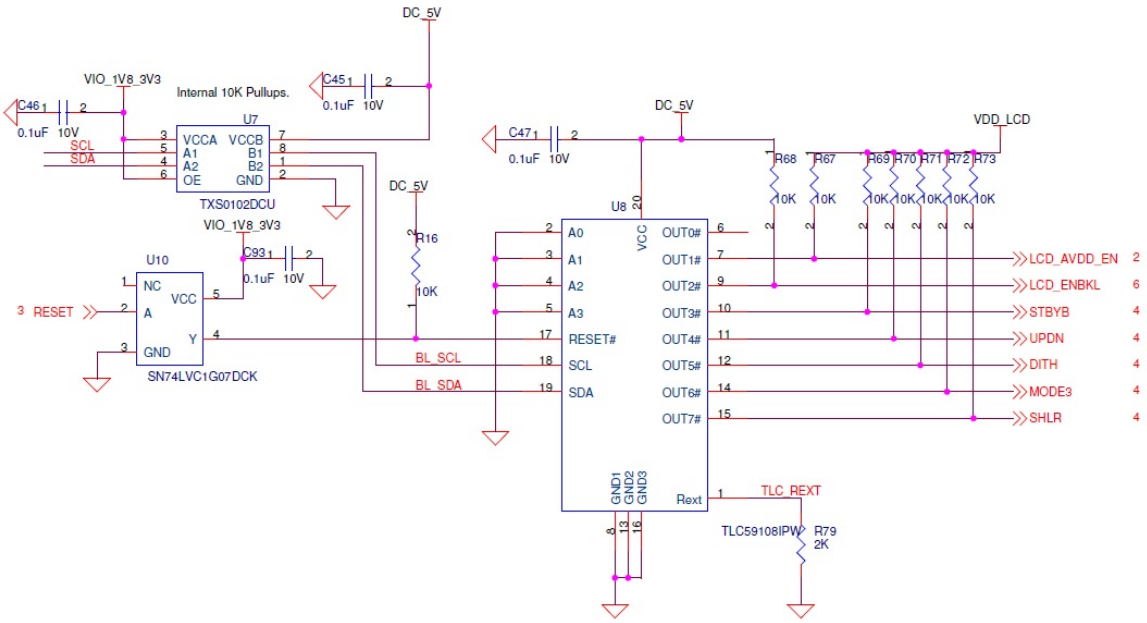

Figure 9. 2C Board Control Interface

U7 is a **TXS0102** level shifter that is used to convert from the 1.8V signal levels to the 5V signal levels used by the TLC59108. In order to support the BeagleBoard-xM, it is necessary to run the I/O rails at 1.8V.

U8 is the **TLC59108**.

7.3.1 Control Interface Default Settings

Each output can have its own 8-bit resolution (256 steps) fixed-frequency individual PWM controller that operates at 97 kHz, with a duty cycle that is adjustable from 0% to 99.6%. The individual PWM controller allows each output to be set to a specific brightness value. This feature is only used for control of the Backlight output, which allows it to control the brightness of the backlight by switching the LEDS in the backlight on and off at different frequencies. All other outputs are used as on/off controlled interfaces. Each of these outputs can be set to either on or off. On power up all of the outputs are Off (Logic Level 1). **Table 4** describes each of these signals, their settings, and their default value. SW default column is the setting that will be used for normal operation.

Table 4. Controller Default Settings

ADDR	SIGNAL	DESCRIPTION	00	01	10	BITS	PWUP	INIT
0Ch	NC	Not connected	X	X	X	0	0	X
						1	0	X
	LCD_AVDD_EN	LCD Power enable	On	Off	X	2	0	1
						3	0	0
	LCD_ENBKL	Controls LCD backlight supply	On	Off	PWM	4	0	0
						5	0	1
	STBYB	LCD in the standby mode.	Norm	STBY	X	6	0	0
						7	0	0
0Dh	UPDN	Up/Dn scan control	Dn	Up	X	0	0	1
						1	0	0
	DITH	Sets dithering for 6 bit mode	Off	On	X	2	0	1
						3	0	0
	MODE3	Sets DE/Sync Mode vs. HS/VS	HS/VS	DE/Sync	X	4	0	1
						5	0	0
	SHLR	Left or right sequence control	Left	Right	X	6	0	0
						7	0	0

7.3.2 I2C Control Registers

This section describes the registers in the TLC59108 and how are they used on the ULCD. **Table 5** is a list of the I2C based registers found in the TLC59108.

Table 5. Controller Default Settings

REGISTER NUMBER (HEX)	NAME	ACCESS(1)	DESCRIPTION
00	MODE1	R/W	Mode 1
01	MODE2	R/W	Mode 2
02	PWM0	R/W	Brightness control LED0
03	PWM1	R/W	Brightness control LED1
04	PWM2	R/W	Brightness control LED2
05	PWM3	R/W	Brightness control LED3
06	PWM4	R/W	Brightness control LED4
07	PWM5	R/W	Brightness control LED5
08	PWM6	R/W	Brightness control LED6
09	PWM7	R/W	Brightness control LED7
0A	GRPPWM	R/W	Group duty cycle control
0B	GRPFREQ	R/W	Group frequency
0C	LEDOUT0	R/W	LED output state 0
0D	LEDOUT1	R/W	LED output state 1
0E	SUBADR1	R/W	I^2C bus subaddress 1
0F	SUBADR2	R/W	I^2C bus subaddress 2
10	SUBADR3	R/W	I^2C bus subaddress 3
11	ALLCALLADR	R/W	LED All Call I^2C bus address
12	IREF	R/W	IREF configuration
13	EFLAG	R	Error flag

(1) R = read, W = write

7.3.3 Mode 1 Control Registers

Table 6 is the description of the Mode register 1 register. The Address is added to the base address of 0x40.

Table 6. Mode Register 1 (Address 00h)

BIT	SYMBOL	ACCESS[1]	VALUE	DESCRIPTION
7	AI2	R	0[2]	Register Auto-Increment disabled
			1	Register Auto-Increment enabled
6	AI1	R	0[2]	Auto-Increment bit 1 = 0
			1	Auto-Increment bit 1 = 1
5	AI0	R	0[2]	Auto-Increment bit 0 = 0
			1	Auto-Increment bit 0 = 1
4	SLEEP	R/W	0	Normal mode[3]
			1[2]	Low power mode. Oscillator off[4].
3	SUB1	R/W	0[2]	Device does not respond to I^2C bus subaddress 1.
			1	Device responds to I^2C bus subaddress 1.
2	SUB2	R/W	0[2]	Device does not respond to I^2C bus subaddress 2.
			1	Device responds to I^2C bus subaddress 2.
1	SUB3	R/W	0[2]	Device does not respond to I^2C bus subaddress 3.
			1	Device responds to I^2C bus subaddress 3.
0	ALLCALL	R/W	0	Device does not respond to LED All Call I^2C bus address.
			1[2]	Device responds to LED All Call I^2C bus address.

(1) R = read, W = write
(2) Default value
(3) Requires 500 µs maximum for the oscillator to be up and running once SLEEP bit has been set to logic 1. Timings on LED outputs are not guaranteed if PWMx, GRPPWM, or GRPFREQ registers are accessed within the 100 µs window.
(4) No blinking or dimming is possible when the oscillator is off.

For proper operation of the ULCD, this register should be set to 0x00 as in Table 7.

Table 7. Mode Register 1 Settings

Bit 0	Bit 1	Bit 2	Bit3	Bit4	Bit 5	Bit	Bit7
0	0	0	0	0	0	0	0

7.3.4 Mode 2 Control Register

Table 8 is the description of the Mode register 2 register and **Table 9** is the required settings for proper operation.

Table 8. Mode Register 2 (Address 01h)

BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
7	EFCLR	R/W	0(2)	Enable error status flag
			1	Clear error status flag
6		R	0(2)	Reserved
5	DMBLNK	R/W	0(2)	Group control = dimming
			1	Group control = blinking
4		R	0(2)	Reserved
3	OCH	R/W	0(2)	Outputs change on Stop command(3)
			1	Outputs change on ACK
2:0		R	000(2)	Reserved

(1) R = read, W = write
(2) Default value
(3) Change of the outputs at the Stop command allows synchronizing outputs of more than one TLC59108. Applicable to registers from 02h (PWM0) to 0Dh (LEDOUT) only.

For proper operation of the ULCD, this register should be set to the default settings. None of these features are used on the ULCD.

Table 9. Mode Register 1 Settings

Bit 0	Bit 1	Bit 2	Bit3	Bit4	Bit 5	Bit	Bit7
0	0	0	0	0	0	0	0

7.3.5 Brightness Control Registers

Table 10 is the description of the Brightness Control Registers for each of the outputs. Only register PWM2 is used for control of the backlight. All other registers should be kept at 0. The Address is added to the base address of 0x40.

Table 10. PWM 0 to 7 (Address 02h to 09h)

ADDRESS	REGISTER	BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
02h	PWM0	7:0	IDC0[7:0]	R/W	0000 0000(2)	PWM0 individual duty cycle
03h	PWM1	7:0	IDC1[7:0]	R/W	0000 0000(2)	PWM1 individual duty cycle
04h	PWM2	7:0	IDC2[7:0]	R/W	0000 0000(2)	PWM2 individual duty cycle
05h	PWM3	7:0	IDC3[7:0]	R/W	0000 0000(2)	PWM3 individual duty cycle
06h	PWM4	7:0	IDC4[7:0]	R/W	0000 0000(2)	PWM4 individual duty cycle
07h	PWM5	7:0	IDC5[7:0]	R/W	0000 0000(2)	PWM5 individual duty cycle
08h	PWM6	7:0	IDC6[7:0]	R/W	0000 0000(2)	PWM6 individual duty cycle
09h	PWM7	7:0	IDC7[7:0]	R/W	0000 0000(2)	PWM7 individual duty cycle

(1) R = read, W = write
(2) Default value

The values set in register PWM2 can be 0 to FFh. SW may specify any number of steps as required. To control the backlight PWM, write the desired value to address 04h.

7.3.6 Group Duty Cycle Control Register

This register is not used and should be left at the default value. The Address is added to the base address of 0x40.

Table 11. Group Brightness Control register (Address 0Ah)

ADDRESS	REGISTER	BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
0Ah	GRPPWM	7:0	GDC0[7:0]	R/W	1111 1111(2)	GRPPWM register

(1) R = read, W = write
(2) Default value

7.3.7 Group Frequency Control Register

This register is not used and should be left at the default value. The Address is added to the base address of 0x40.

Table 12. Group Brightness Control register (Address 0Ah)

ADDRESS	REGISTER	BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
0Bh	GRPFREQ	7:0	GFRQ[7:0]	R/W	0000 0000(2)	GRPFREQ register

(1) R = read, W = write
(2) Default value

7.3.8 LEDOUT0 and LEDOUT1 LED Control Register

These two registers are the main registers used to control the ULCD board over the I2C. You can set the IO ports to on or off and also enable the backlight for PWM control. Specifics of each pin and function are covered in separate sections.

Table 13. LED Driver Output State Register (Address 0Ch and ODh)

ADDRESS	REGISTER	BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
0Ch	LEDOUT0	7:6	LDR3[1:0]	R/W	00(2)	LED3 output state control
		5:4	LDR2[1:0]	R/W	00(2)	LED2 output state control
		3:2	LDR1[1:0]	R/W	00(2)	LED1 output state control
		1:0	LDR0[1:0]	R/W	00(2)	LED0 output state control
0Dh	LEDOUT1	7:6	LDR7[1:0]	R/W	00(2)	LED7 output state control
		5:4	LDR6[1:0]	R/W	00(2)	LED6 output state control
		3:2	LDR5[1:0]	R/W	00(2)	LED5 output state control
		1:0	LDR4[1:0]	R/W	00(2)	LED4 output state control

(1) R = read, W = write
(2) Default value

LDRx = 00: LED driver x is off (default power-up state).

LDRx = 01: LED driver x is fully on (individual brightness and group dimming/blinking not controlled).

LDRx = 10: LED driver x is individual brightness can be controlled through its PWMx register.

LDRx = 11: LED driver x is individual brightness and group dimming/blinking can be controlled through its PWMx register and the GRPPWM registers.

7.3.9 Subaddress Registers

These registers are not used and should be left at their default value.

Table 14. I2C Bus Subaddress Registers 1 to 3 (Address 0Eh to 10h)

ADDRESS	REGISTER	BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
0Eh	SUBADR1	7:5	A1[7:5]	R	100(2)	Reserved
		4:1	A1[4:1]	R/W	1001(2)	I^2C bus subaddress 1
		0	A1[0]	R	0(2)	Reserved
0Fh	SUBADR2	7:5	A2[7:1]	R	100(2)	Reserved
		4:1	A2[4:1]	R/W	1010(2)	I^2C bus subaddress 2
		0	A2[0]	R	0(2)	Reserved
10h	SUBADR3	7:5	A3[7:1]	R	100(2)	Reserved
		4:1	A3[4:1]	R/W	1100(2)	I^2C bus subaddress 3
		0	A3[0]	R	0(2)	Reserved

(1) R = read, W = write
(2) Default value

7.3.10 LED All Call I2C Address Registers

These registers are not used and should be left at their default value. The Address is added to the base address of 0x40.

Table 15. LED All Call I2C Address Registers (Address 11h)

ADDRESS	REGISTER	BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
11h	ALLCALLADR	7:5	AC[7:5]	R	100(2)	Reserved
		4:1	AC[4:1]	R/W	1000(2)	All Call I^2C bus address register
		0	AC[0]	R	0(2)	Reserved

(1) R = read, W = write
(2) Default value

7.3.11 Output Gain Control Registers

These registers are not used and should be left at their default value. The Address is added to the base address of 0x40.

Table 16. Output Gain Control Register(Address 12h)

ADDRESS	REGISTER	BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
11h	ALLCALLADR	7	CM	R/W	1(2)	High/low current multiplier
		6	HC	R/W	1(2)	Subcurrent
		5:0	CC[5:0]	R/W	11 1111(2)	Current multiplier

(1) R = read, W = write
(2) Default value

7.3.12 Error Flags Registers

These registers are not used and should be left at their default value. The Address is added to the base address of 0x40.

Table 17. Error Flags Register (Address 13h)

Table 12. EFLAG – Error Flags Register (Address 13h) Bit Description

ADDRESS	REGISTER	BIT	SYMBOL	ACCESS(1)	VALUE	DESCRIPTION
13h	EFLAG	7:0	EFLAG[7:0]	R	1111 1111(2)	Error flag status by channel

(1) R = read, W = write
(2) Default value

7.4 LCD Power

Power for the LCD panel is provided by **U2** a **TPS65105** which provides the three voltages required by the LCD panel, 15V, 10V, and -7V. Figure 10 is the design of the LCD power circuitry. Additional circuitry is provided to control the power sequencing of the power rails as required by the LCD. An LED is provided to indicate that power is applied to the board.

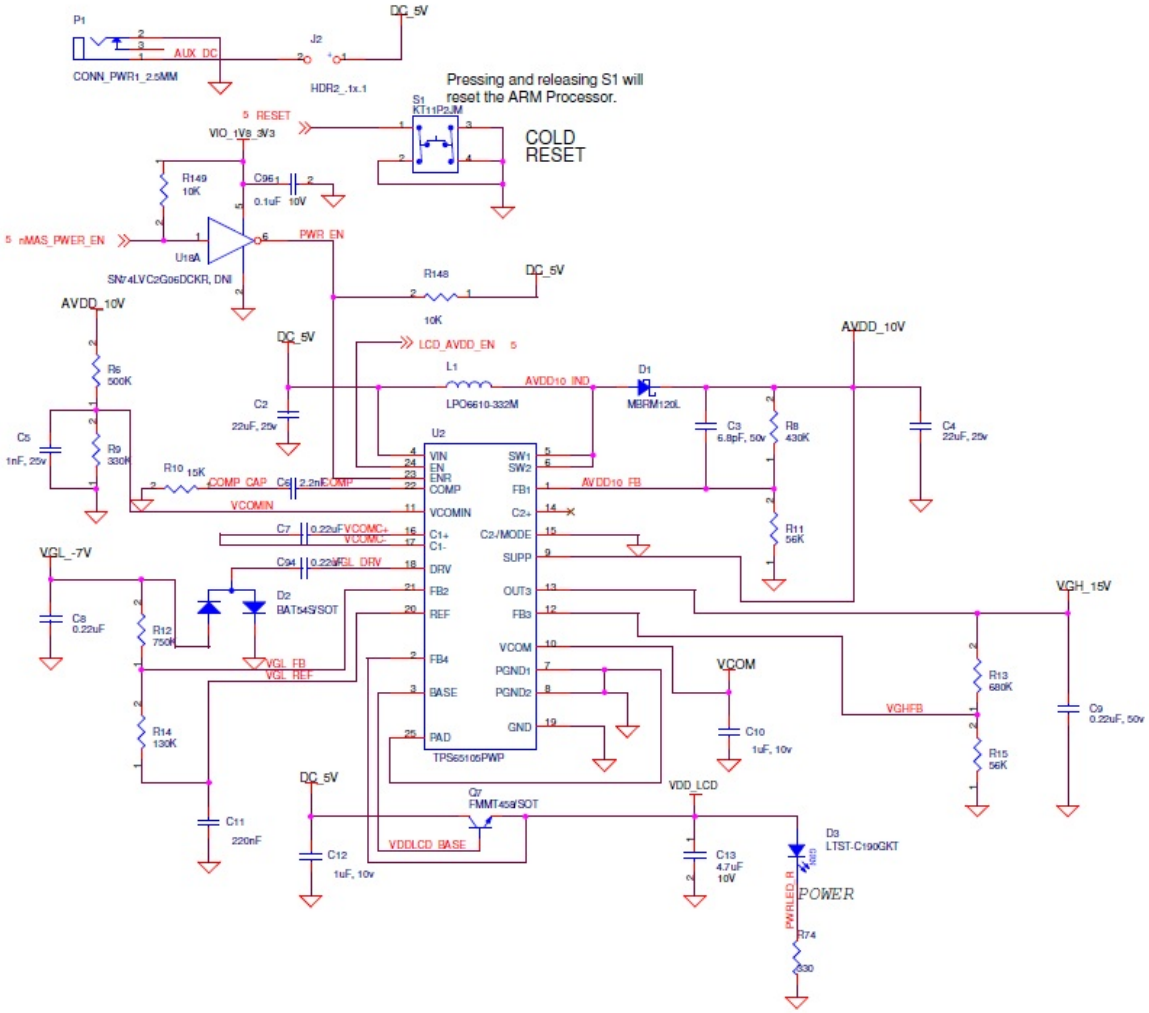

Figure 10. LCD Power Section

7.4.1 LCD On/Off Power Design

Control of the LCD power circuitry is controlled via a GPIO pin on the expansion connector. The GPIO pin used to control this will vary by board. **Figure 10** shows the nMAS_PWR_EN signal. **Table 18** shows the assignment of the GPIO pin based on the host.

Table 18. Master Power Enable GPIO pin Assignment

Board	GPIO
Beagle-xM	GPIO_156

In order for power to be turned on, these pins need to be taken LO. When done, the LED **D3** should turn on.

7.4.2 LCD On/Off Control

The LCD Power can be turned on or off via the I2C bus by controlling signal LCD_AVDD_EN going to the pin Enable of TPS65105. The following commands can be used to control the power. Be careful not to disturb other bits in the registers in order to prevent unintended events.

I2C write to address **4Ch** (base address 0x40 and sub address is 0x0C) changing bits 3:2 will control this signal:

00 = LCD Power **ON**.
01 = LCD Power **OFF**.

Table 19. LCD On/Off Control Register Configuration

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	-	-	X	X	-	-

7.5 LCD Backlight

The LCD Backlight can be turned on or off via the I2C bus by controlling signal LCD_ENBKL going to the pin Enable of TPS61080. The following commands can be used to control the power.

I2C write to address **4Ch** (base address 0x40 and sub address is 0x0C) changing bits 5:4 will control this signal:

00 = LCD Backlight **ON**.
01 = LCD Backlight **OFF**.
10 = PWM control (brightness depends on value written to 0x04 register)

Table 20. LCD Backlight Register Configuration

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	X	X	-	-	-	-

7.6 LCD Control Pins

There are several pins on the LCD that can be used to control various modes of operation on the LCD. This section discusses these control signals.

7.6.1 LCD Standby

The LCD can be put in a low power standby mode by controlling signal STBYB to the LCD panel. Normal operation is to set the Standby output to 0, which is the default mode. In order to go into Standby, the output should be activated by taking it 1,

I2C write to address **4Ch** (base address 0x40 and sub address is 0x0C) changing bits 7:6 will control this signal:

00 = Normal Operation.
01 = Standby Mode.

Table 21. LCD Standby Register Configuration

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
X	X	-	-	-	-	-	-

7.6.2 LCD Direction Up/Down

The signal UPDN controls the orientation of the LCD in an Up and Down direction. Default is Down and the desired path is Up. SW should set the orientation to Down during initialization.

I2C write to address **4Dh** (base address 0x40 and sub address is 0x0D) changing bits 1:0 will control this signal:

00 = Down.
01 = Up.

Table 22. LCD Direction Up/Down Register Configuration

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	-	-	-	-	X	X

7.6.3 LCD Dither

This is provided for future use for those applications requiring 18b data. Default mode for the ULCD7 Lite is 24 bit. Dither signal to the LCD panel should be set to off by the SW during initialization for 24b mode which is the default mode.

I2C write to address **4Dh** (base address 0x40 and sub address is 0x0D) changing bits 3:2 will control this signal:

00 = Dither **OFF**.
01 = Dither **ON**.

Table 23. LCD Dither Register Configuration

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	-	-	X	X	-	-

7.6.4 LCD Mode

This sets the mode of operation of the LCD based on DE/SYNC or HS/VS control. The correct setting will depend on the mode that the SW is using on the LCD interface. Default mode is expected to be 01 for DE.

I2C write to address **4Dh** (base address 0x40 and sub address is 0x0D) changing bits 5:4 will control this signal:

00 = HS/VS Mode.
01 = DE/SYNC Mode.

Table 24. LCD Mode Register Configuration

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	-	X	X	-	-	-	-

7.6.5 LCD Direction L/R

This sets the direction the data is displayed on the screen. Another way to look at it is mirrored vs. normal. The mode should be set for RIGHT mode

I2C write to address **4Dh** (base address 0x40 and sub address is 0x0D) changing bits 7:6 will control this signal:

00 = LEFT Mode
01 = RIGHT Mode

Table 25. LCD Direction L/R Register Configuration

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
X	X	-	-	-	-	-	-

8.0 Connector Pinouts and Cables

This section provides a definition of the pinouts and cables to be used with all of the connectors and headers on the BeagleBoard-xM.

THERE ARE NO CABLES SUPPLIED WITH THE ULCD7 LITE BOARD.

8.1 Power Connector

Figure 11 is a picture of the ULCD7 Lite power connector with the pins identified. The supply must have a 2.1mm center hot connector with a 5.5mm outside diameter.

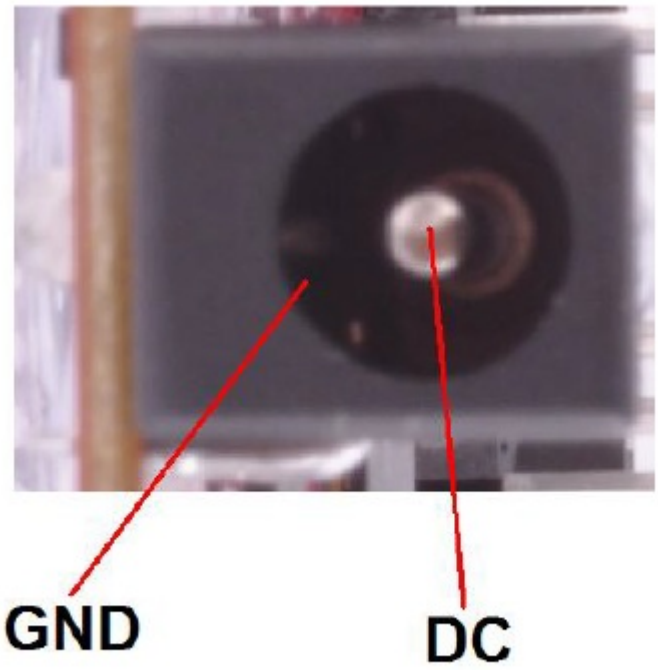

Figure 11. LCD Power Connector

8.2 Host Connectors

This section covers the pair of headers that provide access to the LCD panel as well as the 28 pin header that connects to the BeagleBoard-xM.

8.2.1 Dual LCD header

Table 26 and **Table 27** define the pin-outs of the dual LCD header. All signal levels are 1.8V with the exception of DVI_PUP signal which is 3.3V.

Table 26. J3 LCD Signals

Pin#	Signal	I/O	Description
1	DC_5V	PWR	DC rail from the Main DC supply
2	DC_5V	PWR	DC rail from the Main DC supply
3	DVI_DATA1	O	LCD Pixel Data bit
4	DVI_DATA0	O	LCD Pixel Data bit
5	DVI_DATA3	O	LCD Pixel Data bit
6	DVI_DATA2	O	LCD Pixel Data bit
7	DVI_DATA5	O	LCD Pixel Data bit
8	DVI_DATA4	O	LCD Pixel Data bit
9	DVI_DATA12	O	LCD Pixel Data bit
10	DVI_DATA10	O	LCD Pixel Data bit
11	DVI_DATA23	O	LCD Pixel Data bit
12	DVI_DATA14	O	LCD Pixel Data bit
13	DVI_DATA19	O	LCD Pixel Data bit
14	DVI_DATA22	O	LCD Pixel Data bit
15	I2C3_SDA	I/O	I2C3 Data Line
16	DVI_DATA11	O	LCD Pixel Data bit
17	DVI_VSYNC	O	LCD Vertical Sync Signal
18	DVI_PUP	O	Control signal for the DVI controller. When Hi, DVI is enabled. Can be used to activate circuitry on adapter board if desired.
19	GND	PWR	Ground bus
20	GND	PWR	Ground bus

Table 27. J4 LCD Signals

Pin#	Signal	I/O	Description
1	3.3V	PWR	3.3V reference rail
2	VIO_1V8	PWR	1.8V buffer reference rail.
3	DVI_DATA20	O	LCD Pixel Data bit
4	DVI_DATA21	O	LCD Pixel Data bit
5	DVI_DATA17	O	LCD Pixel Data bit
6	DVI_DATA18	O	LCD Pixel Data bit
7	DVI_DATA15	O	LCD Pixel Data bit
8	DVI_DATA16	O	LCD Pixel Data bit
9	DVI_DATA7	O	LCD Pixel Data bit
10	DVI_DATA13	O	LCD Pixel Data bit
11	DVI_DATA8	O	LCD Pixel Data bit
12	NC		No connect
13	DVI_DATA9		LCD Pixel Data bit
14	I2C3_SCL	I/O	I2C3 Clock Line
15	DVI_DATA6	O	LCD Pixel Data bit
16	DVI_CLK+	O	DVI Clock
17	DVI_DEN	O	Data Enable
18	DVI_HSYNC	O	Horizontal Sync
19	GND	PWR	Ground bus
20	GND	PWR	Ground bus

Figure 12 shows where pins 1 and 2 are located on each connector, front and back sides shown.

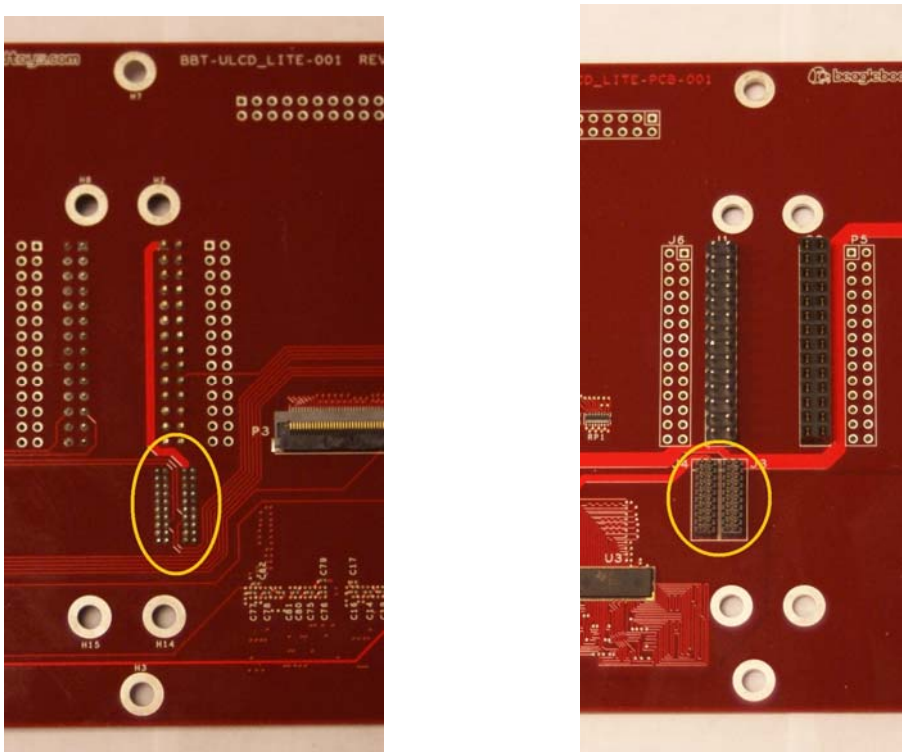

Figure 12. Dual LCD Connector Pins: topside (left) and bottomside

8.2.2 BeagleBoard-xM Expansion Connector

Table 28 shows all of the signals that are on the 28 pin expansion header. As the processor of BeagleBoard-xM has a multiplexing feature, multiple signals can be connected to certain pins to add additional options as it pertains to the signal available. Each pin can be set individually for a different mux mode. This allows any of the listed mux modes to be set on a pin by pin basis by writing to the pin mux register in software. Following is the legend for **Table 28.**

X = there is no signal connected when this mode is selected
Z = this is the safe mode meaning neither input to output. This is the default mode on power up.
** = this indicates that there is a signal connected when this mode is selected, but it has no useful purpose without other pins being available. Access to these other pins is not provided on the expansion connector.*

The first column is the pin number of the expansion connector.

The second column is the pin number of the processor.
The columns labeled 0-7 represent each of the pin mux modes for that pin. By setting this

value in the control register, this signal will be routed to the corresponding pin of the expansion connector. These setting are on a pin by pin basis. Any pin can be set with the mux register setting, and the applicable signal will be routed to the pin on the expansion connector.

Table 28. 28 Pin BeagleBoard-xM Expansion Connector

EXP	Processor	0	1	2	3	4	5	6	7
1		VIO_1V8							
2		DC_5V							
3	AE3	MMC2_DAT7	*	*	*	GPIO_139	*	*	Z
4	AB26	UART2_CTS	McBSP3_DX	GPT9_PWMEVT	X	GPIO_144	X	X	Z
5	AF3	MMC2_DAT6	*	*	*	GPIO_138	*	X	Z
6	AA25	UART2_TX	McBSP3_CLKX	GPT11_PWMEVT	X	GPIO_146	X	X	Z
7	AH3	MMC2_DAT5	*	*	*	GPIO_137	*	X	Z
8	AE5	McBSP3_FSX	UART2_RX	X	X	GPIO_143	*	X	Z
9	AE4	MMC2_DAT4	*	X	*	GPIO_136	X	X	Z
10	AB25	UART2_RTS	McBSP3_DR	GPT10_PWMEVT	X	GPIO_145	X	X	Z
11	AF4	MMC2_DAT3	McSPI3_CS0	X	X	GPIO_135	X	X	Z
12	V21	McBSP1_DX	McSPI4_SIMO	McBSP3_DX	X	GPIO_158	X	X	Z
13	AG4	MMC2_DAT2	McSPI3_CS1	X	X	GPIO_134	X	X	Z
14	W21	McBSP1_CLKX	X	McBSP3_CLKX	X	GPIO_162	X	X	Z
15	AH4	MMC2_DAT1	X	X	X	GPIO_133	X	X	Z
16	K26	McBSP1_FSX	McSPI4_CS0	McBSP3_FSX	x	GPIO_161	X	X	Z
17	AH5	MMC2_DAT0	McSPI3_SOMI	X	X	GPIO_132	X	X	Z
18	U21	McBSP1_DR	McSPI4_SOMI	McBSP3_DR	X	GPIO_159	X	X	Z
19	AG5	MMC2_CMD	McSPI3_SIMO	X	X	GPIO_131	X	X	Z
20	Y21	McBSP1_CLKR	McSPI4_CLK	X	X	GPIO_156	X	X	Z
21	AE2	MMC2_CLKO	McSPI3_CLK	X	X	GPIO_130	X	X	Z
22	AA21	McBSP1_FSR	X	*	Z	GPIO_157	X	X	Z
23	AE15	I2C2_SDA	X	X	X	GPIO_183	X	X	Z
24	AF15	I2C2_SCL	X	X	X	GPIO_168	X	X	Z
25	25	REGEN							
26	26	Nreset							
27	27	GND							
28	28	GND							

8.3 LCD Panel Connectors

This section covers the LCD module connector, the backlight connector, and the touchscreen connector.

8.3.1 LCD Module Connector

Table 29 shows the pin-outs of the LCD module connector (P3).

Table 29. LCD Module Connector

PIN NO.	SYMBOL	I/O FUNCTION	DESCRIPTIONS
1	AGND	P	Analog Ground
2	AVDD	P	Analog Power
3	VCC	P	Digital Power
4	R0	I	Data Input(LSB)
5	R1	I	Data Input
6	R2	I	Data Input
7	R3	I	Data Input
8	R4	I	Data Input
9	R5	I	Data Input
10	R6	I	Data Input
11	R7	I	Data Input(MSB)
12	G0	I	Data Input(LSB)
13	G1	I	Data Input
14	G2	I	Data Input
15	G3	I	Data Input
16	G4	I	Data Input
17	G5	I	Data Input
18	G6	I	Data Input
19	G7	I	Data Input(MSB)
20	B0	I	Data Input(LSB)
21	B1	I	Data Input
22	B2	I	Data Input
23	B3	I	Data Input
24	B4	I	Data Input
25	B5	I	Data Input
26	B6	I	Data Input
27	B7	I	Data Input(MSB)
28	DCLK	I	Clock input
29	DE	I	Data Enable signal
30	HSD	I	Horizontal sync input. Negative polarity
31	VSD	I	Vertical sync input. Negative polarity
32	MODE3	I	DE/SYNC mode select .normally pull high H:DE mode. L:HSD/VSD mode
33	RSTB	I	global reset pin.Active low to enter reset state.suggest to connecting with an RC reset circuit for stability .normally pull high.
34	STBYB	I	standby mode,normally pull high STBYB="1",normal operation STBYB="0",timming control ,soruce driver will turn off,all output are high-Z

35	SHLR	I	Source right or left sequence control.SHLR="L",shift left:last data=S1<-S2…S1200=first data SHLR="H",shift right:first data=S1->SS2…S1200=last data
36	VCC	P	Digital Power
37	UPDN	I	gate up or down scan control. UPDN="L" , DOWN shift : G1->G2…->G480 ; UPDN="H", up shift: G1<-G2…<-G480
38	GND	P	Digital Ground
39	AGND	P	Analog Ground
40	AVDD	P	Analog Power
41	VCOMin	I	For external VCOM DC input(Optional)
42	DITH	I	Dithering setting DITH="H" 6bit resolution (last 2 bits of input data turncated) DITH="L" 8bit resolution (default setting)
43	NC	-	Not connect
44	NC	-	Not connect
45	V10	P	Gamma correction voltage reference
46	V9	P	Gamma correction voltage reference
47	V8	P	Gamma correction voltage reference
48	V7	P	Gamma correction voltage reference
49	V6	P	Gamma correction voltage reference
50	V5	P	Gamma correction voltage reference
51	V4	P	Gamma correction voltage reference
52	V3	P	Gamma correction voltage reference
53	V2	P	Gamma correction voltage reference
54	V1	P	Gamma correction voltage reference
55	NC	-	Not connect
56	VGH	P	Positive Power for TFT
57	VCC	P	Digital Power
58	VGL	P	Negative Power for TFT
59	GND	P	Digital Ground
60	NC	-	Not connect

8.3.2 Backlight Connector

Table 30 shows the pin-pouts of the Backlight connector (P4).

Table 30. Backlight Connector

Terminal No.	Symbol	Function
1	VL (Red)	LED power supply (high voltage)
2	GL (Black)	LED power supply (low voltage)

8.3.3 Touchscreen Connector

Table 31 shows the pin-outs of the Touchscreen connector (P6)

Table 31. Touchscreen Connector

Termial No.	Symbol
1	X-
2	Y-
3	X+
4	Y+

9.0 ULCD7 Lite Board Accessories

This section covers accessories that can be added to the standard ULCD7 Lite package.

9.1 DC Power Supply

Tabletop or wall plug supplies can be used to power BeagleBoard. **Table 32** provides the specifications for the BeagleBoard DC supply. Supplies that provide additional current than what is specified can be used if additional current is needed for add on accessories.

Table 32. DC Power Supply Specifications

Specification	Requirement	Unit
Voltage	5.0	V
Current	2.0	A
Connector	2.1mm x 5.5mm Center hot	

It is recommended that a supply higher than 1.5A be used if higher current peripherals are expected to be used or if expansion boards are added.

9.2 Bracket Stands

In addition to the default stands that shipped with the ULCD7 Lite box, users have an option to purchase a set of bracket stands. These stands are made of aluminum and anodized by a black matte layer. Since the bracket stands are made for the ULCD7 Lite, users can enjoy the view of their LCD screens at a much better angle than the default stands, whereas the comfort of touchscreen usage is still not compromised. **Figure 13** shows the ULCD7 Lite with the aluminum bracket stands.

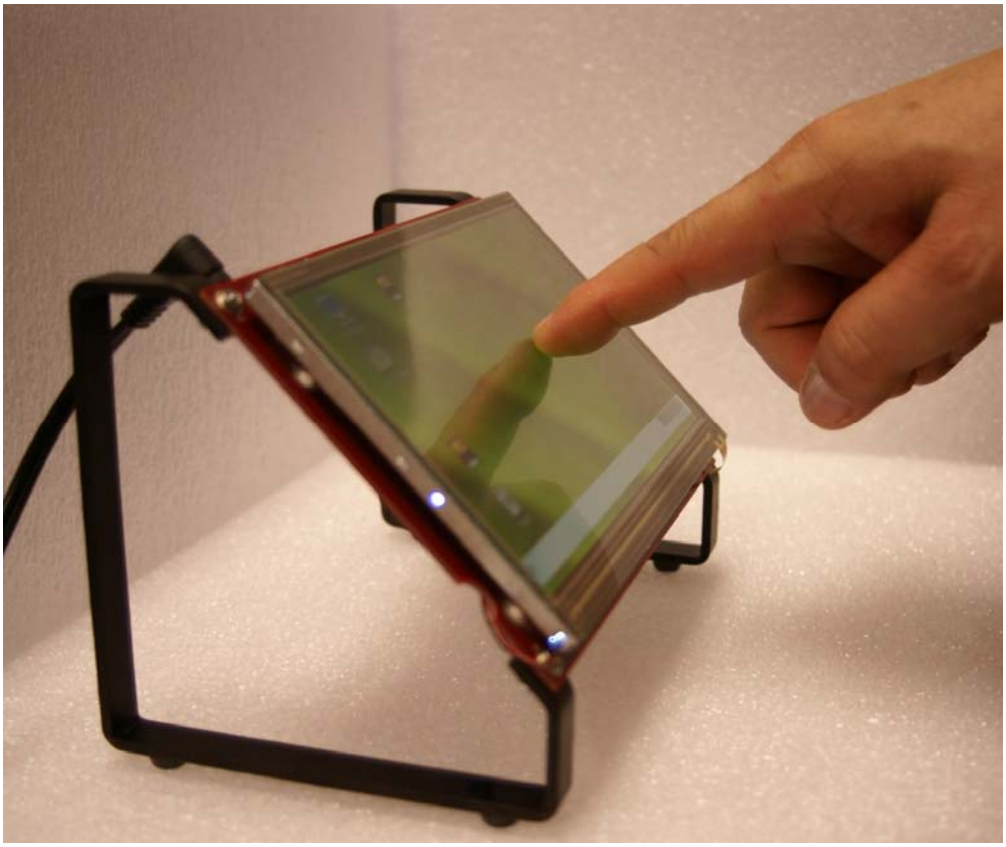

Figure 13. ULCD7 Lite with Bracket Stands

10.0 Mechanical Information

10.1 ULCD7 Lite Board Dimensions

This section provides information on the mechanical aspect of the ULCD7 Lite board. **Figure 14** is the dimensions of the ULCD7 Lite board.

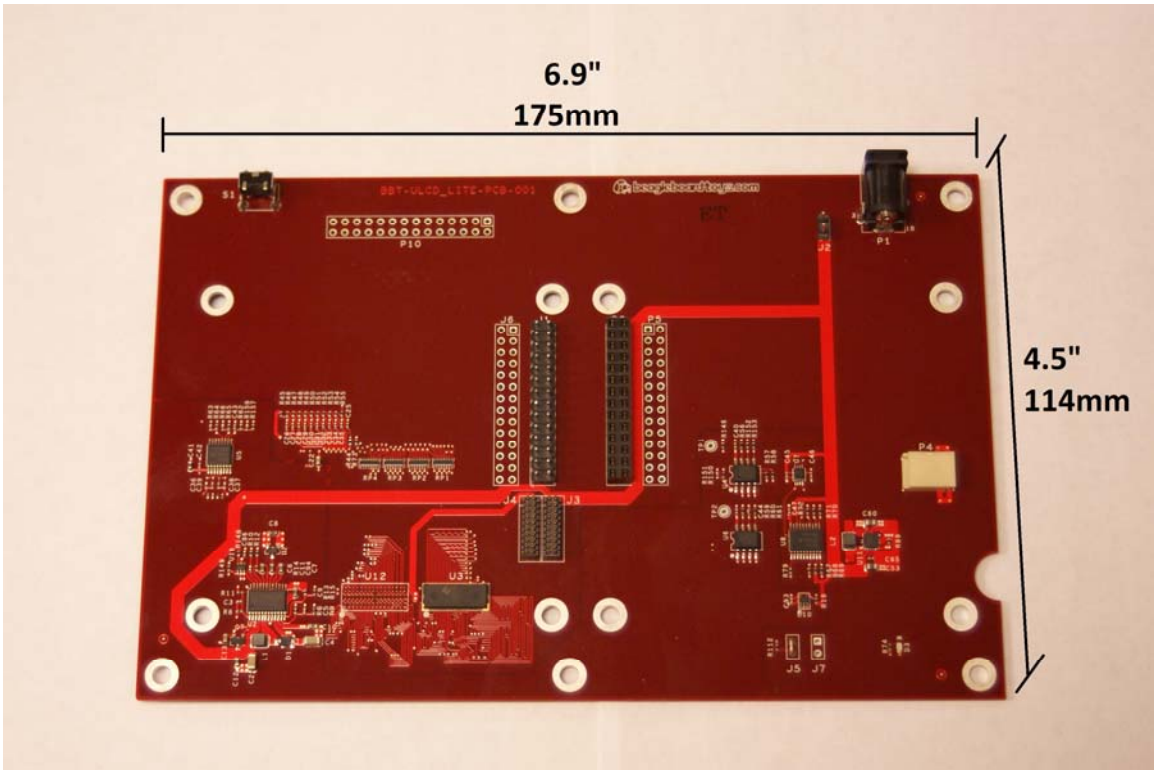

Figure 14. ULCD7 Lite Dimensions Drawing

11.0 Troubleshooting

The ULCD7 Lite is designed for use with the BeagleBoard-xM; therefore, an EEPROM is required. The EEPROM allows for the identification of the card by the Software in order to set the pin muxing on the expansion connector to be compatible with the ULCD7 Lite.

The schematic for the EEPROM is in **Figure 15** below.

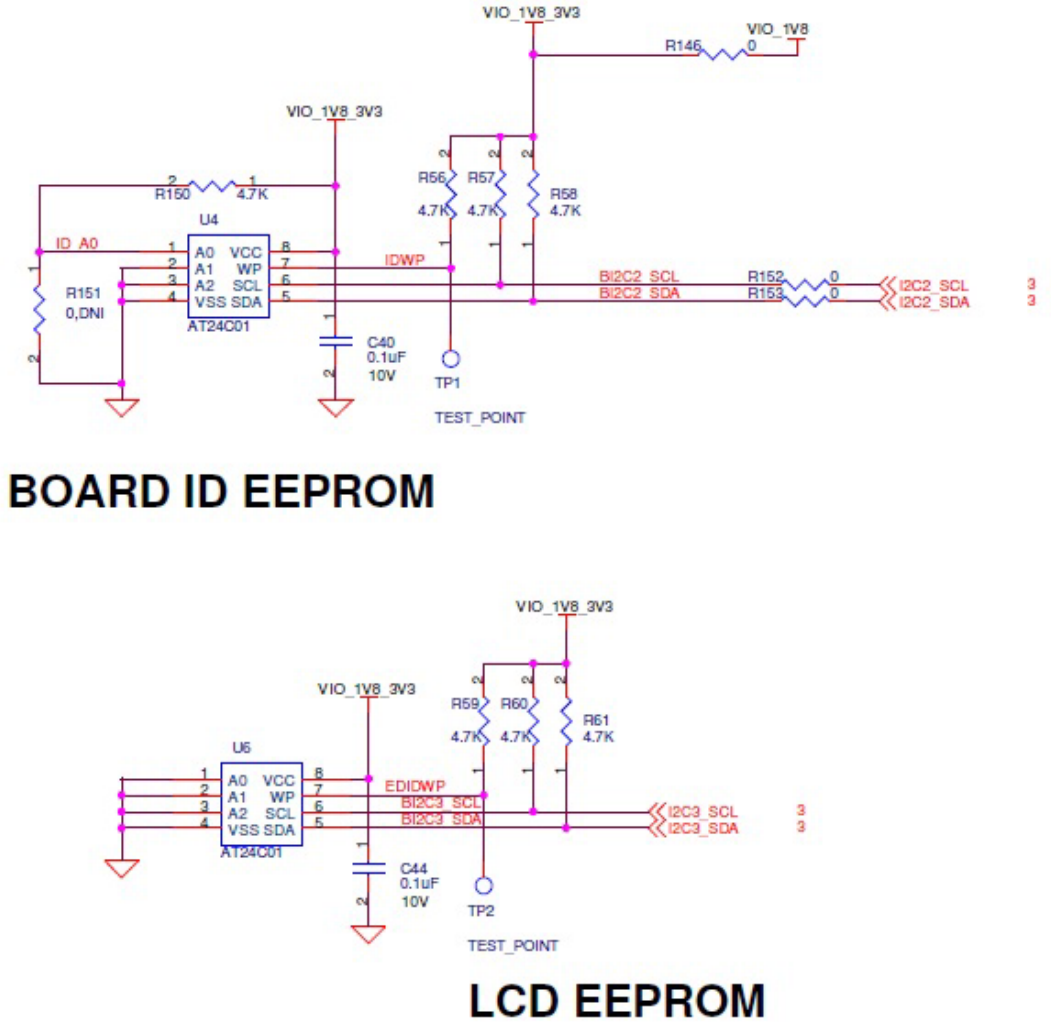

Figure 15. EEPROM on the ULCD7 Lite

The EEPROM must be write protected. It is suggested that a testpoint be used to allow the WP to be disabled during test to allow the required data to be written to the EEPROM.

There are 2 test points that may be useful if it becomes necessary to troubleshoot the ULCD7 Lite board. **Figure 16** shows the bottom side test points.

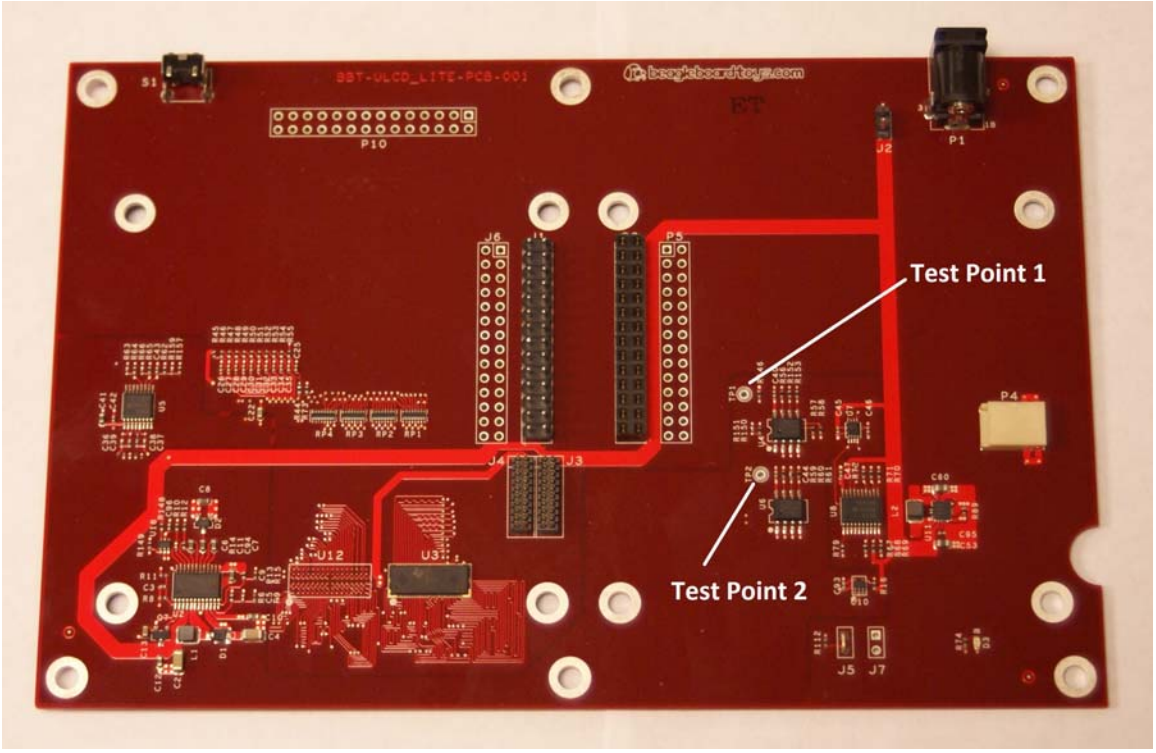

Figure 16. ULCD7 Lite Test Points

12.0 ULCD7 Lite Board Components

Figure 17 and **Figure 18** contain the bottom and top side component locations of the ULCD7 Lite board.

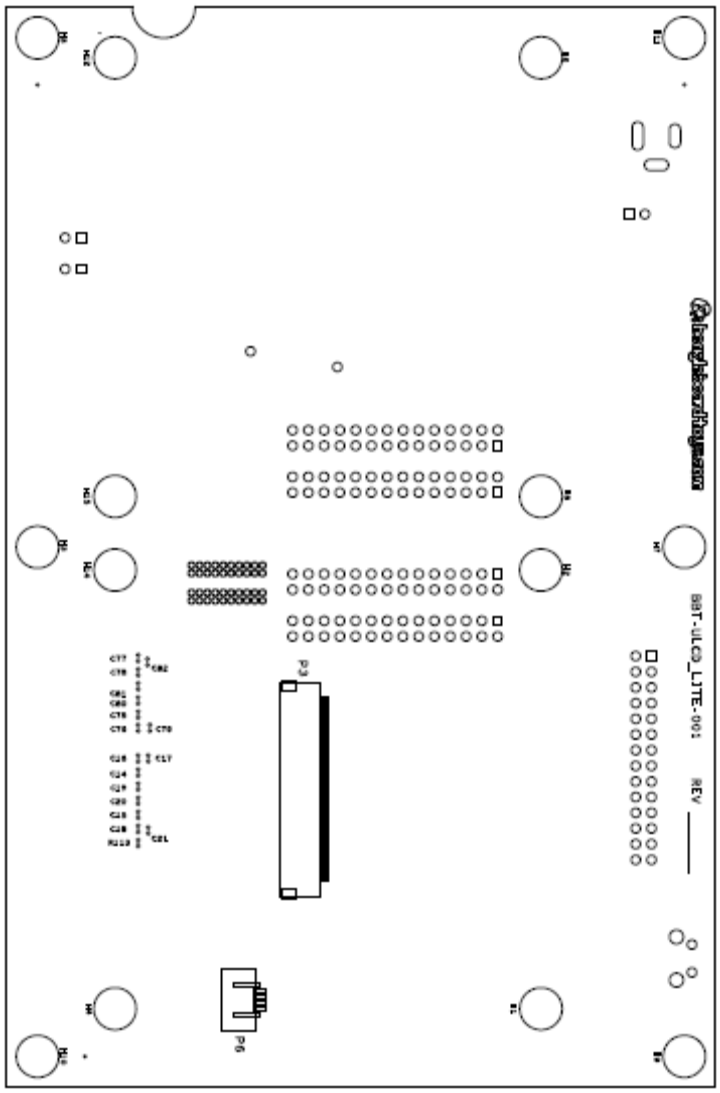

Figure 17. Top Side Components

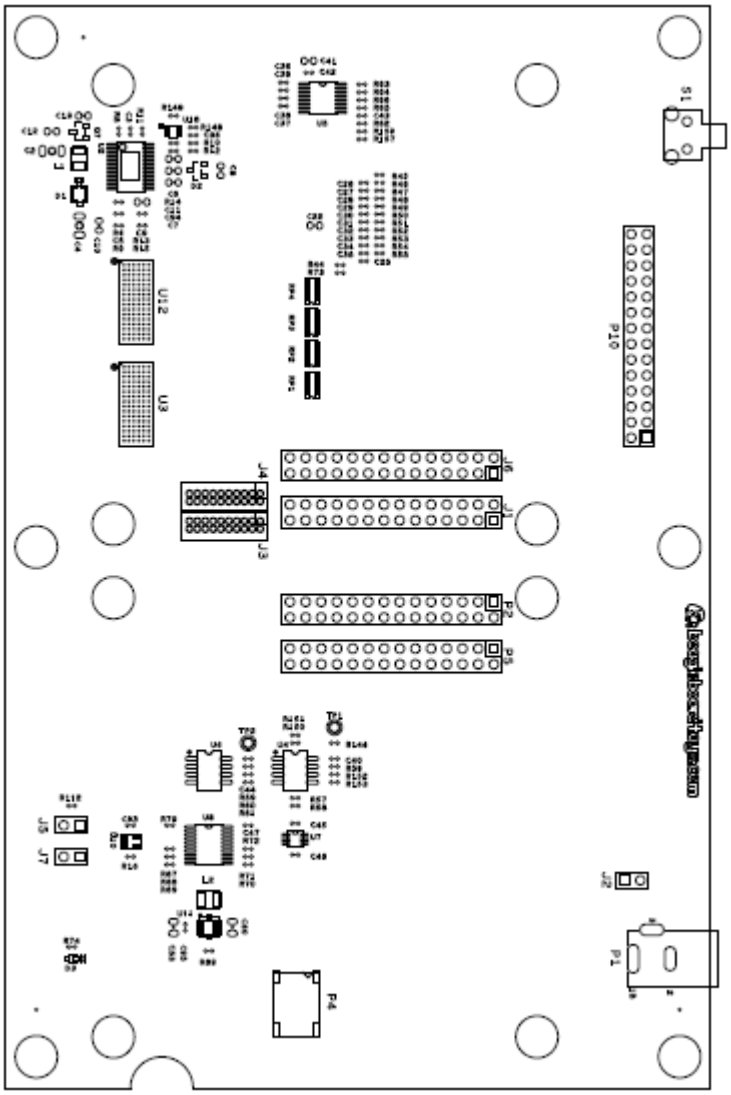

Figure 18. Bottom Side Components

13.0 ULCD7 Lite Board Schematics

The following pages contain the PDF schematics for the ULCD7 Lite board. This manual will be periodically updated, but for the latest documentation be sure and check beagleboardtoys.com wiki for the latest schematics.

OrCAD source files are provided for BeagleBoard on BeagleBoard.org at the following link.

http://beagleboardtoys.com/wiki/ulcd7/

*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.

REV	DATE	BY	CHANGE
A	6/14/2011	BBT	Initial cutdown release from original design.

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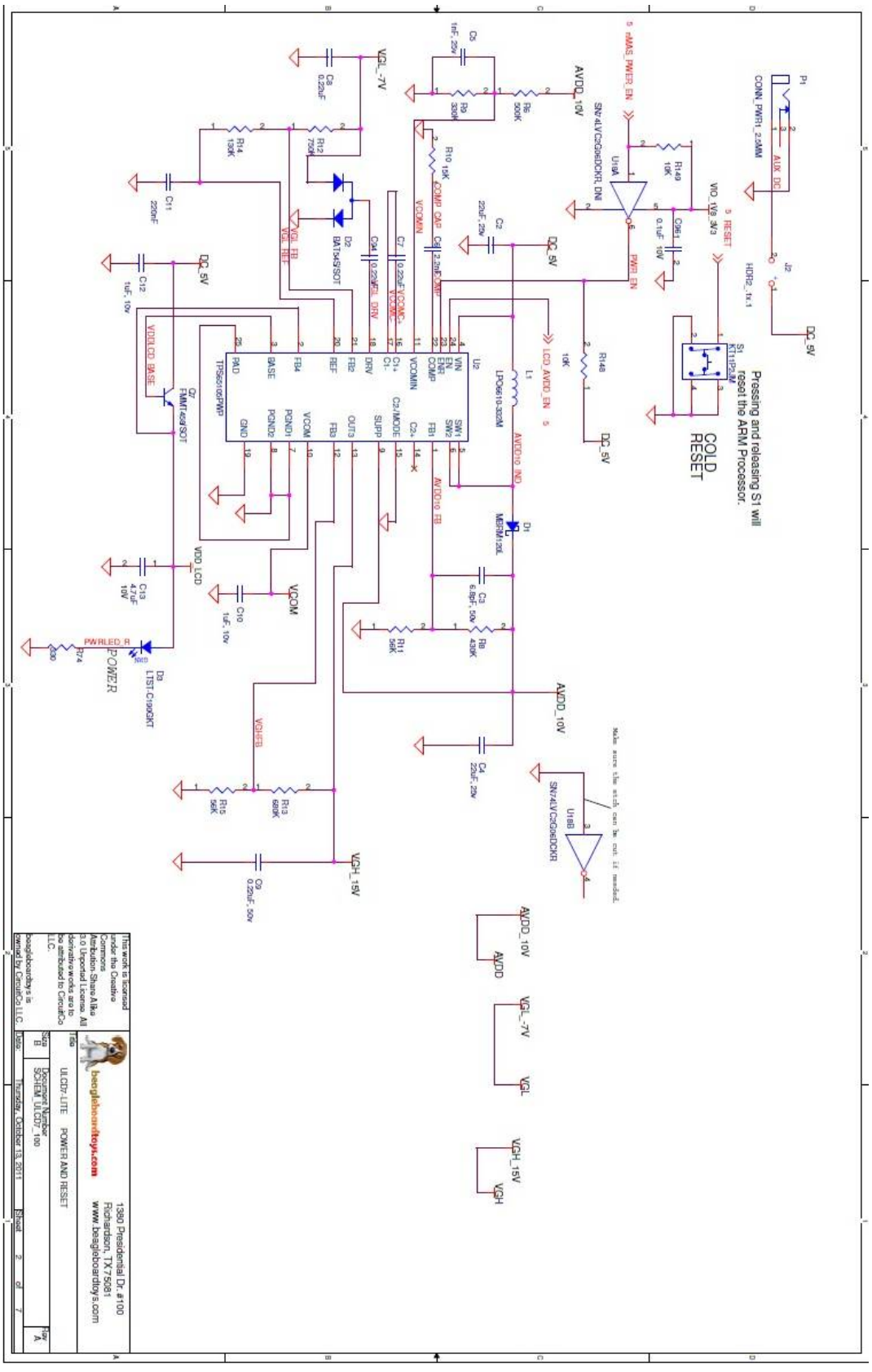
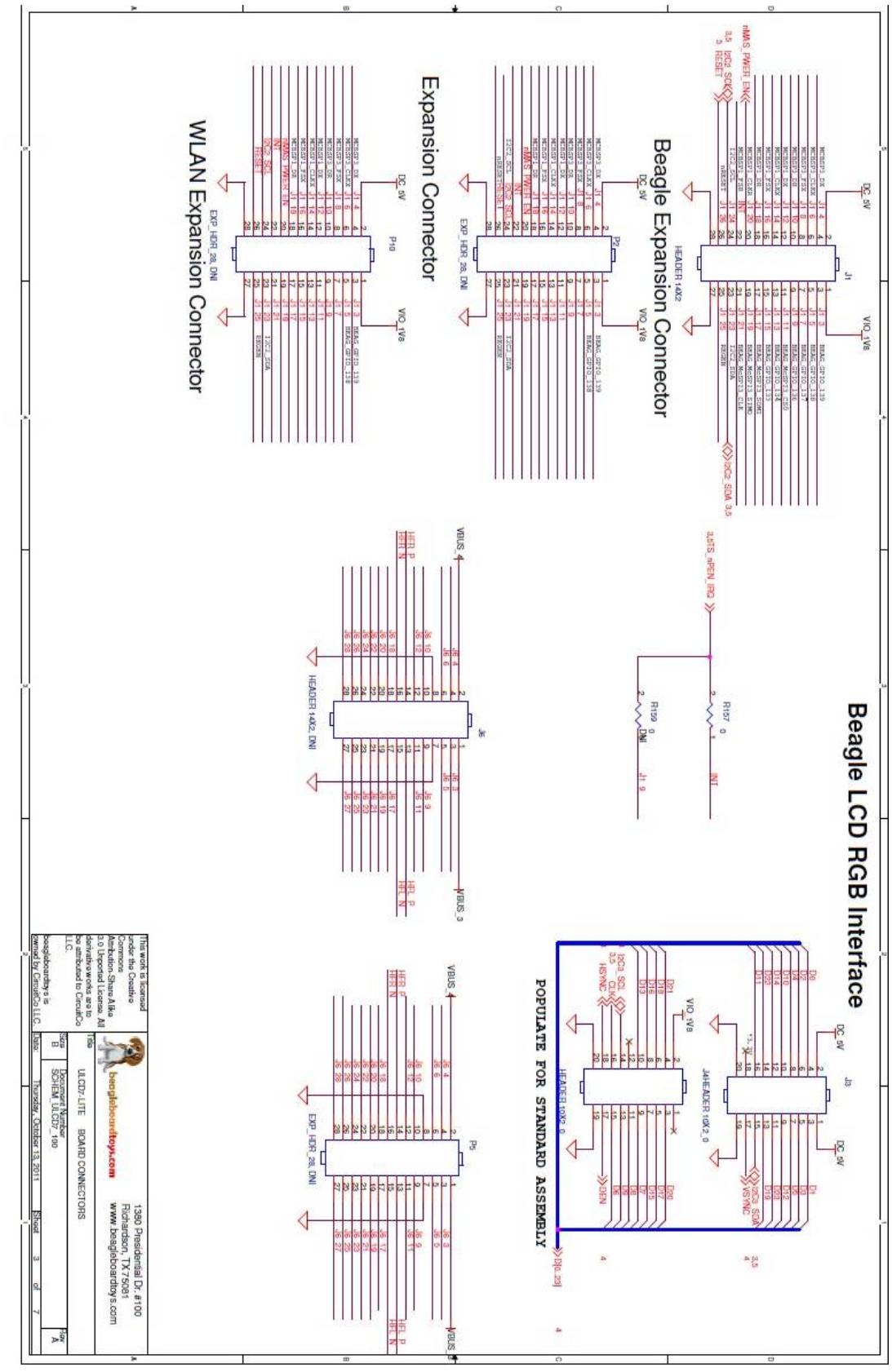
	Title: ULCD7-LITE COVER PAGE	
	Size: B — Document Number: SCHEM_ULCD7_100	Rev: A
	Date: Thursday, October 13, 2011	Sheet 1 of 7


Pressing and releasing S1 will reset the ARM Processor.
COLD RESET
POWER
ULCD7-LITE POWER AND RESET
beagleboardtoys.com
1380 Presidential Dr. #100
Richardson, TX 75081
www.beagleboardtoys.com


Beagle LCD RGB Interface
Beagle Expansion Connector
Expansion Connector
WLAN Expansion Connector
POPULATE FOR STANDARD ASSEMBLY
HEADER 14X2
HEADER 14X2_DNI
EXP_HDR_28_DNI
JAHEADER 10X2_0
R157 0
R159 0 DNI
ULCD7-LITE BOARD CONNECTORS
SCHEM_ULCD7_100
Thursday, October 13, 2011
1360 Presidential Dr. #100
Richardson, TX 75081
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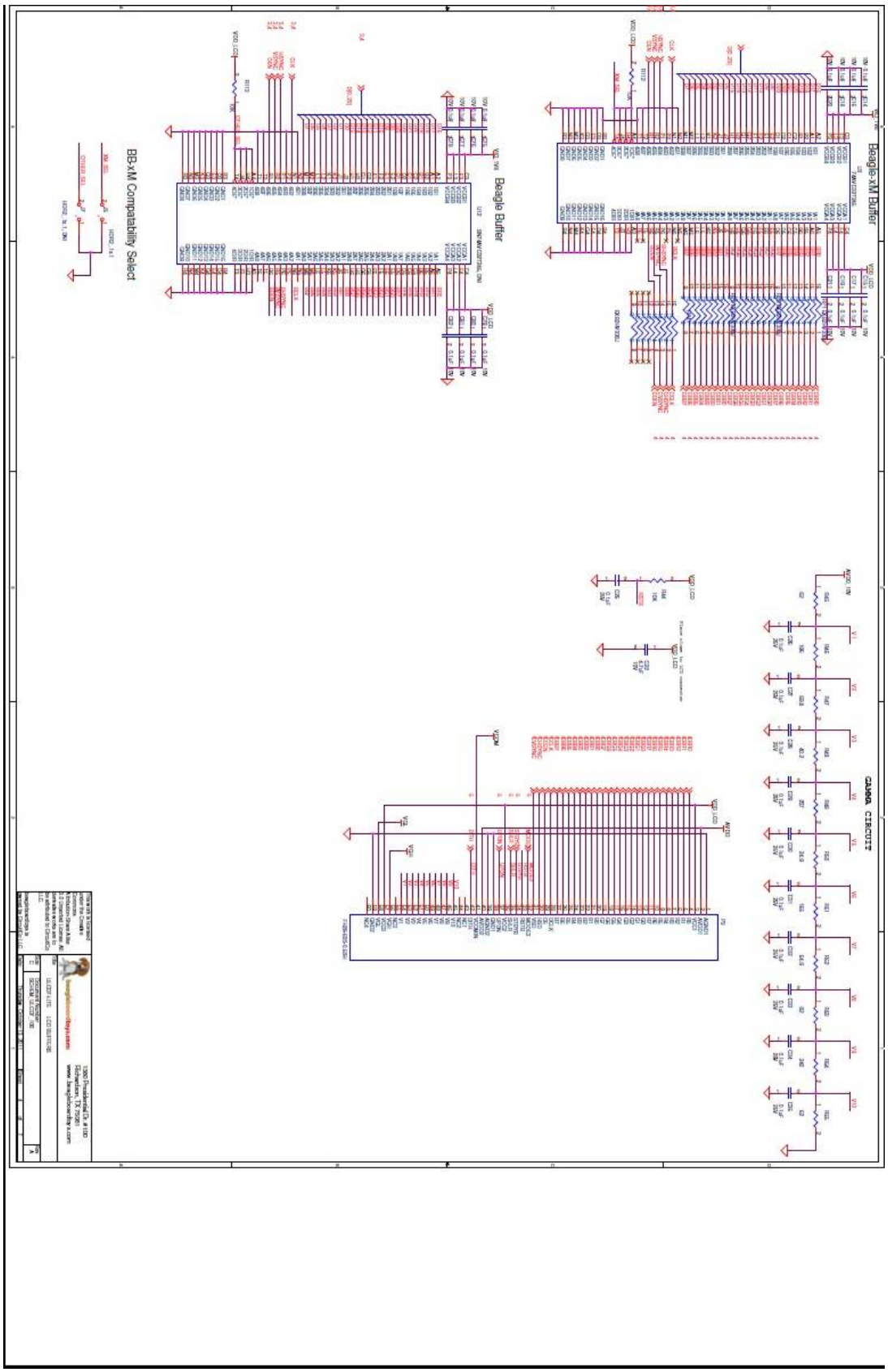
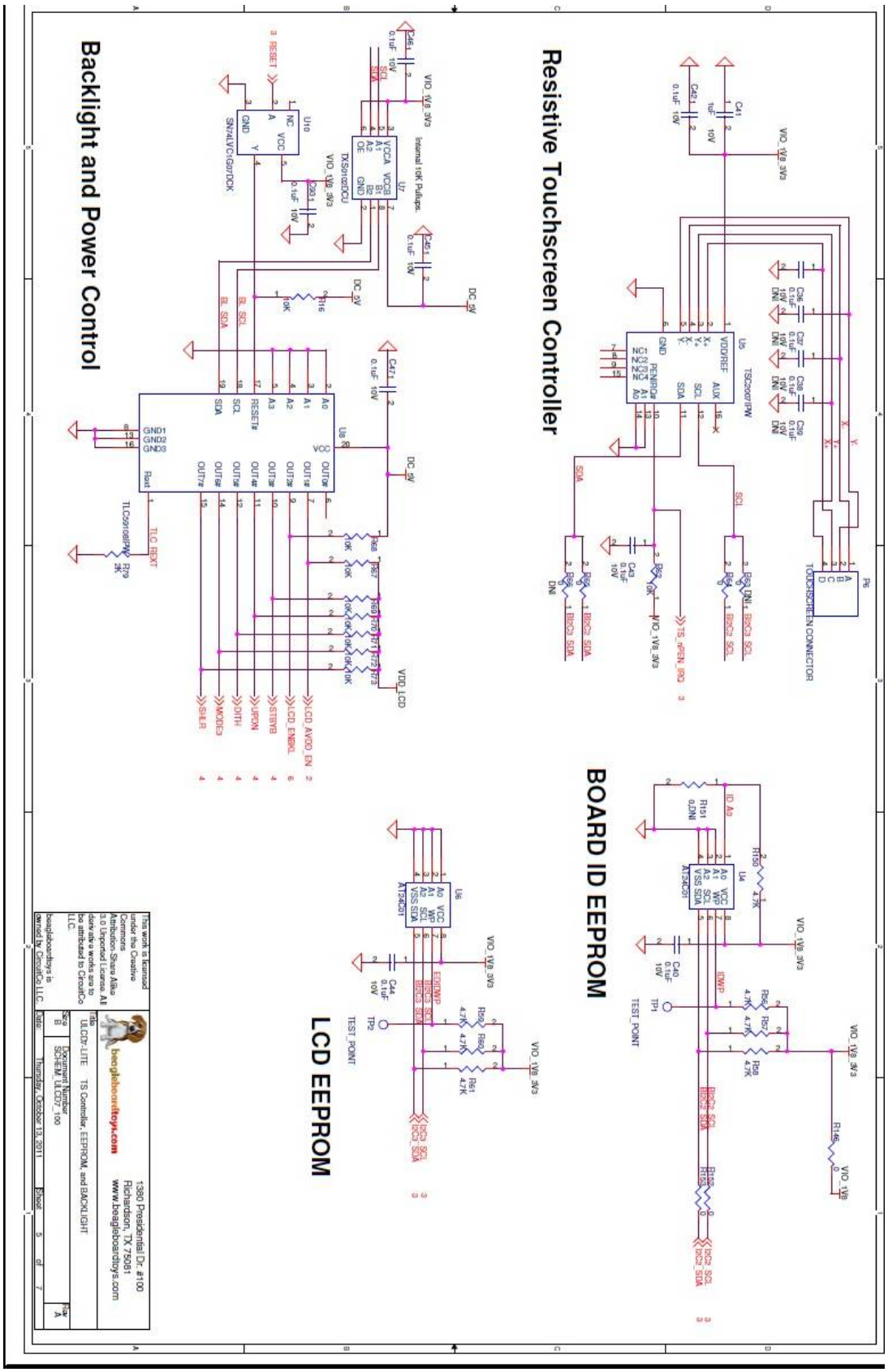
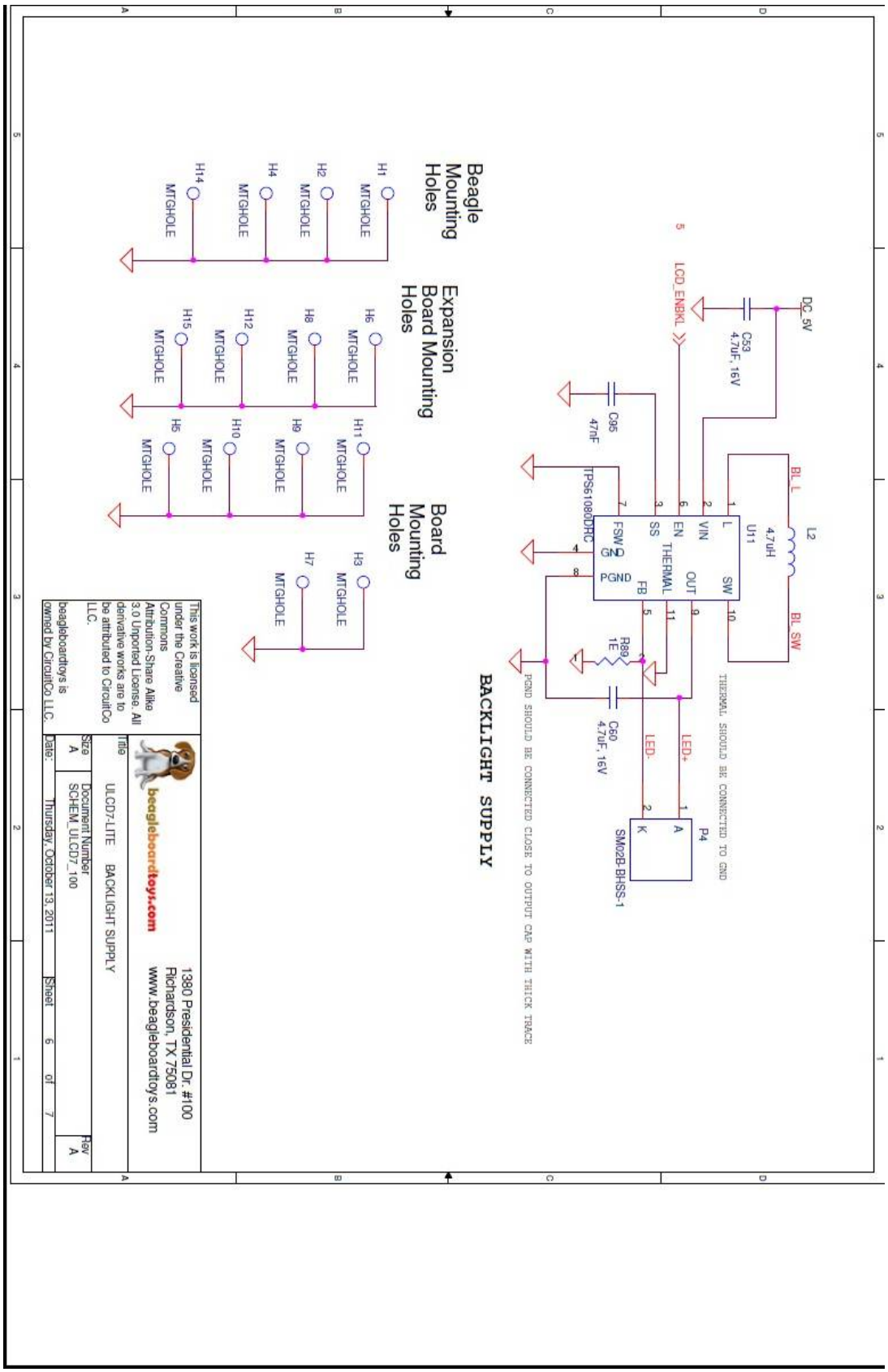

BE-xM Compatability Select
Beagle Buffer
Beagle-xM Buffer
CAMERA CIRCUIT


Backlight and Power Control
Resistive Touchscreen Controller
BOARD ID EEPROM
LCD EEPROM
TOUCHSCREEN CONNECTOR
TSC2007IPW
AT24C01
SN74LVC1G07DCK
TLC5916IPWR
beagleboardtoys.com
1380 Presidential Dr. #100
Richardson, TX 75081
www.beagleboardtoys.com
ULCD7-LITE
TS Controller, EEPROM, and BACKLIGHT
Document Number
SCHEM_ULCD7_100
Thursday, October 13, 2011


BACKLIGHT SUPPLY
Beagle Mounting Holes
Expansion Board Mounting Holes
Board Mounting Holes
H1 MTGHOLE
H2 MTGHOLE
H4 MTGHOLE
H14 MTGHOLE
H6 MTGHOLE
H8 MTGHOLE
H12 MTGHOLE
H15 MTGHOLE
H11 MTGHOLE
H9 MTGHOLE
H10 MTGHOLE
H5 MTGHOLE
H3 MTGHOLE
H7 MTGHOLE
DC_5V
C53 4.7uF, 16V
LCD_ENBKL
C95 47nF
TPS61080DRC
U11
L2 4.7uH
BL_L
BL_SW
VIN
EN
SS
THERMAL
FSW
GND
PGND
FB
L
SW
OUT
R89 1E
C60 4.7uF, 16V
LED+
LED-
P4
SM02B-BHSS-1
THERMAL SHOULD BE CONNECTED TO GND
PGND SHOULD BE CONNECTED CLOSE TO OUTPUT CAP WITH THICK TRACE
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Title: ULCD7-LITE BACKLIGHT SUPPLY
Size: A
Document Number: SCHEM_ULCD7_100
Rev: A
Date: Thursday, October 13, 2011
Sheet 6 of 7

14.0 Bills of Material

The Bill of Material for the ULCD7 Lite Board is provided at beagleboardtoys.com at the following location:

http://beagleboardtoys.com/wiki/ulcd7/

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15.0 PCB Information

The following pages contain the PDF PCB layers for the ULCD7 Lite Board. Gerber files and Allegro source files are available on beagleboardtoys.com at the following address:

http://beagleboardtoys.com/wiki/ulcd7/

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