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S5U13513R00C100
User Manual

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SEIKO EPSON CORPORATION

Rev.1.1

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1. Introduction

This manual describes the setup and configuration of the S5U13513R00C100 evaluation board. The S5U13513R00C100 is designed to provide an evaluation platform for both the S1D13513 LCD controller and the S1D13L04 Simple LCD controller. The S5U13513R00C100 includes an Epson S1D13513 LCD Controller, but can also be used to evaluate the S1D13L04 which has a similar feature set.

The S5U13513R00C100 can support WVGA (800x480), WQVGA (480x272), or LVDS (1024x600 with signal translator) LCD displays.

The *S1D13513 Hardware Functional Specification*, document number X78C-A-001-xx, and *S1D13L04 Hardware Functional Specification*, document number XB3A-A-001-xx were used as references for writing this document.

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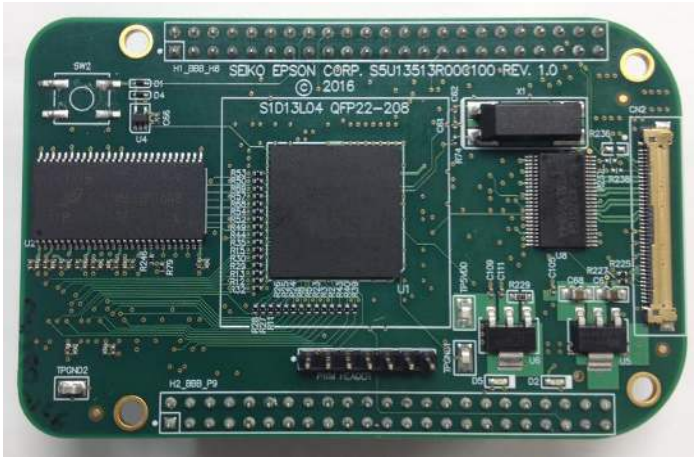
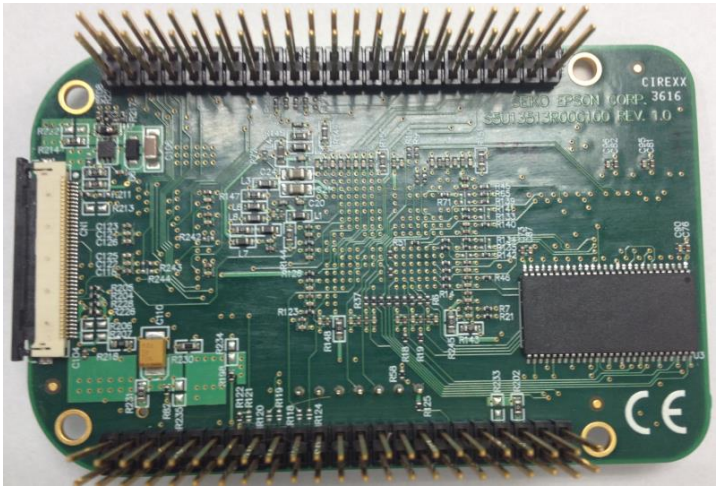


Top Side View



Bottom Side View

2. Bus Interface Support

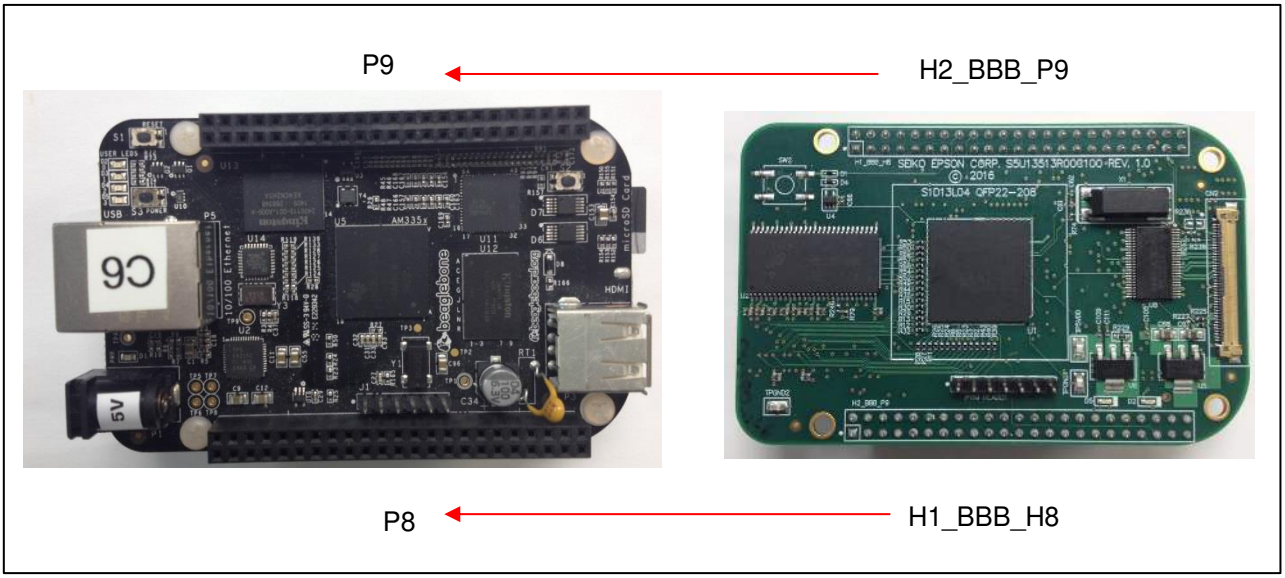
2.1 BeagleBone Black Board

The S5U13513R00C100 evaluation board is designed as a Cape for the BeagleBone Black development platform. It can be used with BeagleBone Black boards from revision A5A upward. The S5U13513R00C100 default setting is the "Parallel Indirect 80 Type 1" bus interface configuration (CNF6 – CNF0 = 1000110) supported by both the S1D13513 and S1D13L04.

The S5U13513R00C100 evaluation board connects to the BeagleBone Black board using the GPIOs on the P8 and P9 connectors. The BeagleBone Black board also provides 5V and 3.3V to the S5U13513R00C100 board through its P9 connector.

2.1.1 Connecting the Beagle Black Bone Board

As the S5U13513R00C100 evaluation board is designed as a Cape, the connectors H1_BBB_H8 and H2_BBB_P9 can be directly inserted into connectors P8 and P9 of the BeagleBone Black board. The following image shows the connectors on each board.



BeagleBone Black to S5U13513R00C100 Connection

For further details on the BeagleBone Black development platform, visit the BeagleBone Black webpage at http://beagleboard.org/Products/BeagleBone%20Black.

2.1.2 Pin Assignments

P8 Pin#	BBB P8 Name	H1_BBB_H8 Name	Descriptions (from S1D13513)
1	GND	GND	Signal ground
2	GND	GND	Signal ground
3-6	-	NC	NC
7	GPIO2_2	DB1	Data bus bit 1
8	GPIO2_3	DB2	Data bus bit 2
9	GPIO2_5	DB4	Data bus bit 4
10	GPIO2_4	DB3	Data bus bit 3
11	GPIO1_13	WE1#	Upper byte enable
12	GPIO1_12	WE0#	Lower byte enable
13-14	-	NC	NC
15	GPIO1_15	Reserved	Reserved
16	GPIO1_14	HOST_RESETn	Reset# (through U4) to S1D13513
17	-	NC	NC
18	GPIO2_1	DB0	Data bus bit 0
19-26	-	NC	NC
27	GPIO2_22	RD#	Read enable
28	GPIO2_24	AB1	Address bit 1
29	GPIO2_23	RD/WR#	Write enable
30	GPIO2_25	Reserved	Reserved
31-33	-	NC	NC
34	GPIO2_17	AB2	Address bit 2
35	-	NC	NC
36	GPIO2_16	DB15	Data bus bit 15
37	GPIO2_14	DB13	Data bus bit 13
38	GPIO2_15	DB14	Data bus bit 14
39	GPIO2_12	DB11	Data bus bit 11
40	GPIO2_13	DB12	Data bus bit 12
41	GPIO2_10	DB9	Data bus bit 9
42	GPIO2_11	DB10	Data bus bit 10
43	GPIO2_8	DB7	Data bus bit 7
44	GPIO2_9	DB8	Data bus bit 8
45	GPIO2_6	DB5	Data bus bit 5
46	GPIO2_7	DB6	Data bus bit 6

P9 Pin#	BBB P9 Name	H2_BBB_P9 Name	Descriptions (from S1D13513)
1-2	GND	GND	Signal ground
3-4	VDD3V3B	VDD3V3B	3.3 V power supply (250mA)
5-6	VDD5V	VDD5V	5V power supply (1000mA)
7-8	SYS_5V	SYS_5V	5 V power supply (250mA)
9	-	NC	NC
10	SYS_RESETn	SYS_RESETn	Reset# (through U4) to S1D13513
11	GPIO1_8	WAIT#	Wait state signal
12-24	-	NC	NC
25	GPIO3_21	Reserved	Reserved
26-27	-	NC	NC
28-31	GPIO3_17-14	Reserved	Reserved
32-40	-	NC	NC
41	GPIO0_20	INT1#	Primary IRQ output from S1D13513
42	-	NC	NC
43-46	GND	GND	Signal ground

2.2. SPI Host

2.2.1 Description

The S5U13513R00C100 evaluation board can support a “Serial on HVDD1” type SPI host interface. **Note that this interface is not directly supported for the BeagleBone Black development platform**. When the SPI type interface is configured, the S5U13513R00C100 should be configured and connected as shown in the following sections.

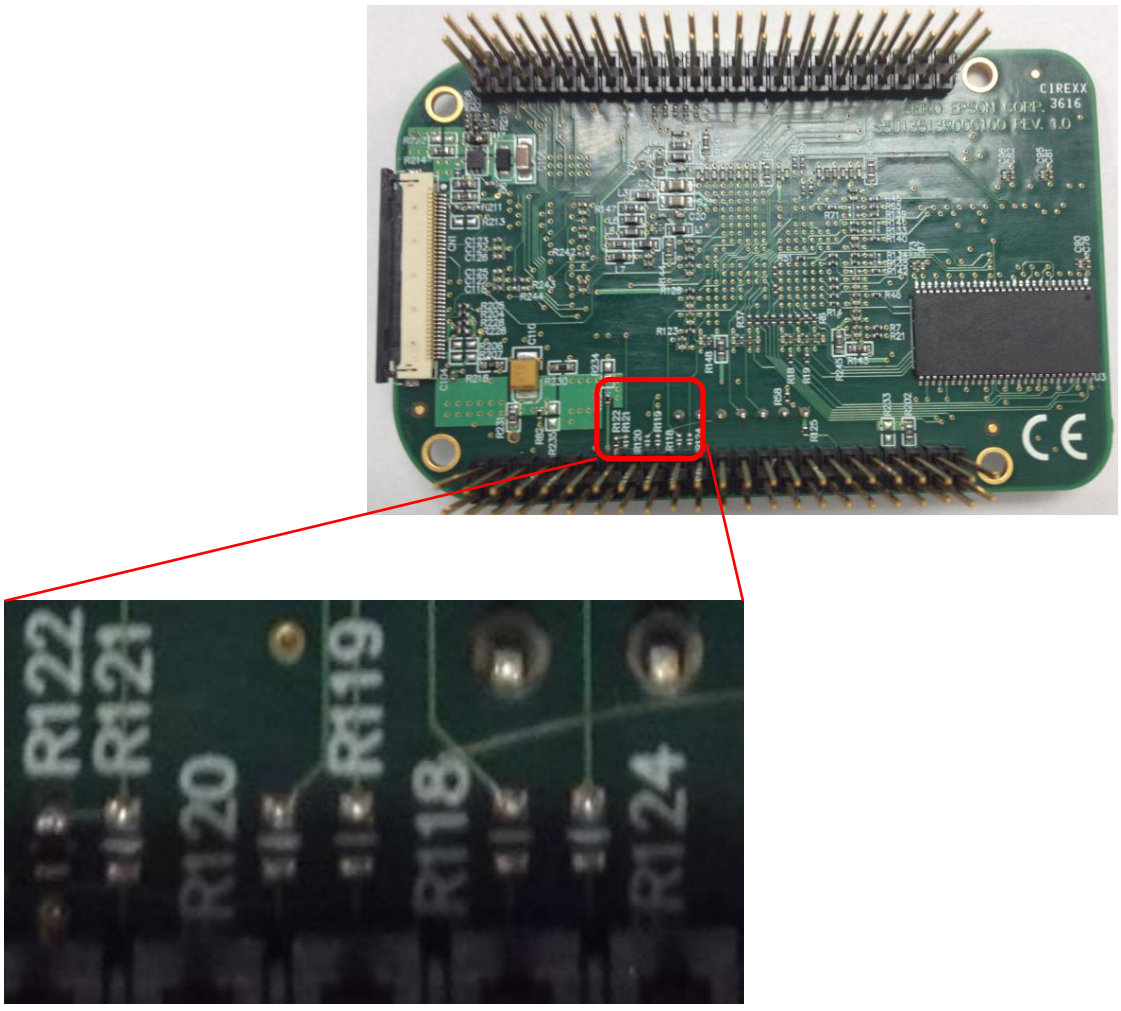
For details on the Serial Interface supported by the S5U13513R00C100, refer to the *S1D13513 Hardware Functional Specification*, document number X78C-A-001-xx, or the *S1D13L04 Hardware Functional Specification*, document number XB3A-A-001-xx.

2.2.2 Board Modifications

To use a SPI host on the H2_BBB_P9 connector, the following modifications must be done to the S5U13513R00C100 evaluation board.

- solder R118, R119, R120, R121 and R124 with 0 ohm resistors

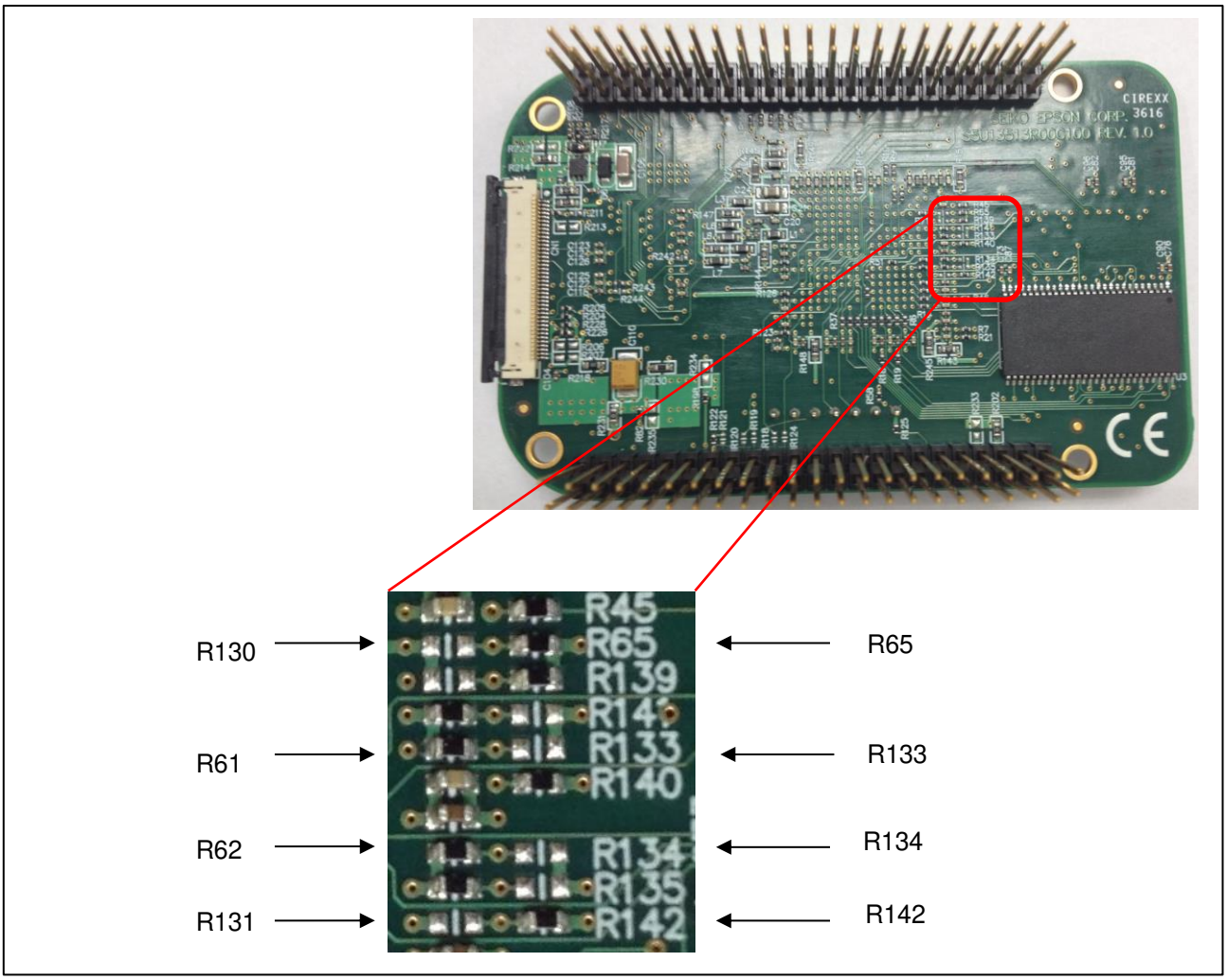
The following image shows the location of the resistors on the S5U13513R00C100 evaluation board.



SPI Interface Modifications: Resistor Locations

In order to configure the S1D13513/S1D13L04 to "Serial on HVDD1" type SPI host interface, the configuration pins, CNF6 ~ CNF0, must to be changed from 1000110 to 1010000 (data valid on falling edge) or 1011000 (data valid on rising edge). This can be done by performing the following modifications to the S5U13513R00C100 based on the desired configuration.

- For data valid on falling edge HVDD1 type, CNF6 to CNF0 = 1010000.
  Remove R61, R65 and R142 0 ohm resistors. Solder R133, R130 and R131 with 0 ohm resistors.
- For data valid on rising edge HVDD1 type, CNF6 to CNF0 = 1011000.
  Remove R61, R62, R65 and R142 0 ohm resistors. Solder R133, R134, R130 and R131 with 0 ohm resistors.



2.2.3 Pin Assignments

Pin name	S1D13513 / S1D13L04 Pin Name	Pin Assignment on header H2_BBB_P9	Descriptions
SPI_CS0	CS#	28	Chip Select
SPI_SCLK	BUSCLK	31	Serial Clock Input
SPI_D0	DB0	29	SI - Serial data in
SPI_D1	DB1	30	SO – serial data out
AB0	AB0	25	Address 0 – command# / data

3 LCD Displays Support

S5U13513R00C100 evaluation board does not include an LCD display. The board has FPC connectors, CN1 and CN2, which allow direct connection of LVDS (with signal translator on board), WVGA, or WQVGA LCD displays.

3.1 WVGA and WQVGA Displays

The S5U13513R00C100 evaluation board supports the following RGB digital panels.

WVGA (800x480) LCD displays supported:

- Newhaven Display NHD-5.0-800480TF-ATXL#

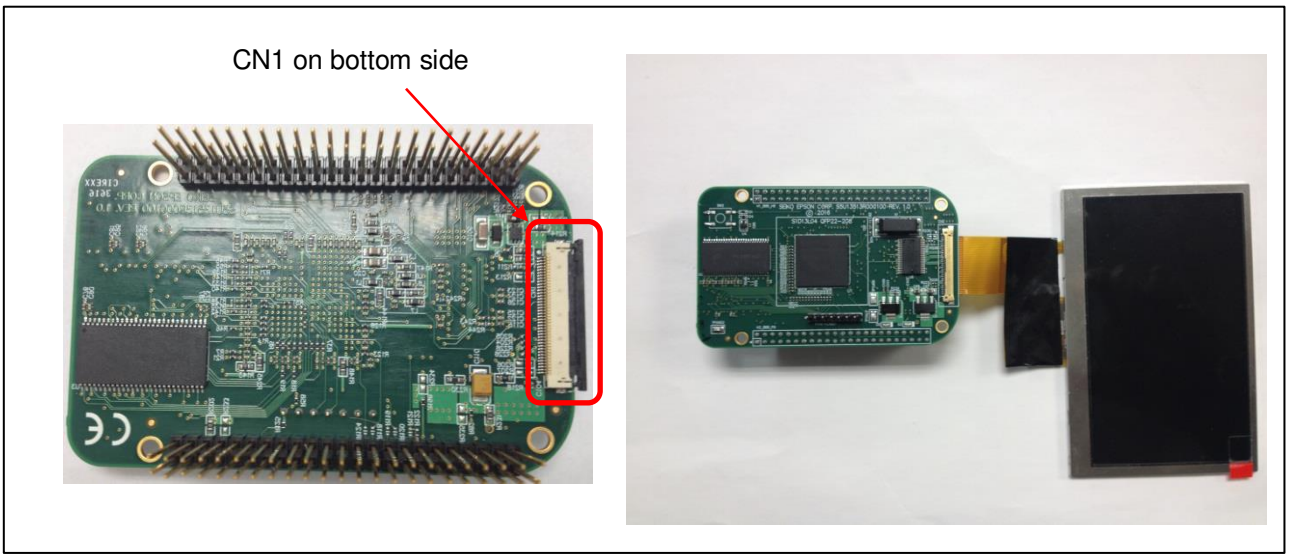
WQVGA (480x272) LCD displays supported:

- Newhaven Display NHD-4.3-480272MF-ATXI#-1
- Kyocera TCG043WQLBAANN-GN00
- KOE TX11D06VM2AAA
- Tianma TM043NDH02
- Tianma TM043NBH02
- Imagin Orient IO04310006_v2
- Hantronix HDA430-3GH-1 (requires some hardware changes to move 0 ohm resistors – see details below)
- All Shore ASI-X-48027B43Q-R-VWD/H
- AZ Displays ATM0430D5(-T)

NOTE: For designs that use the S1D13L04 with a 24-bit RGB panel, the 2 LSBs of each RGB digital input must be connected to VSS. This is because the S1D13L04 only supports 18-bit RGB digital panels.

WVGA or WQVGA displays should be connected to the S5U13513R00C100 using connector CN1. The connector is located on the bottom side of the board. When installed, the panel flex cable should have the contact pads toward the PCB.

The following image shows the location of connector CN1, and how the S5U13513R00C100 board with a connected panel should look.

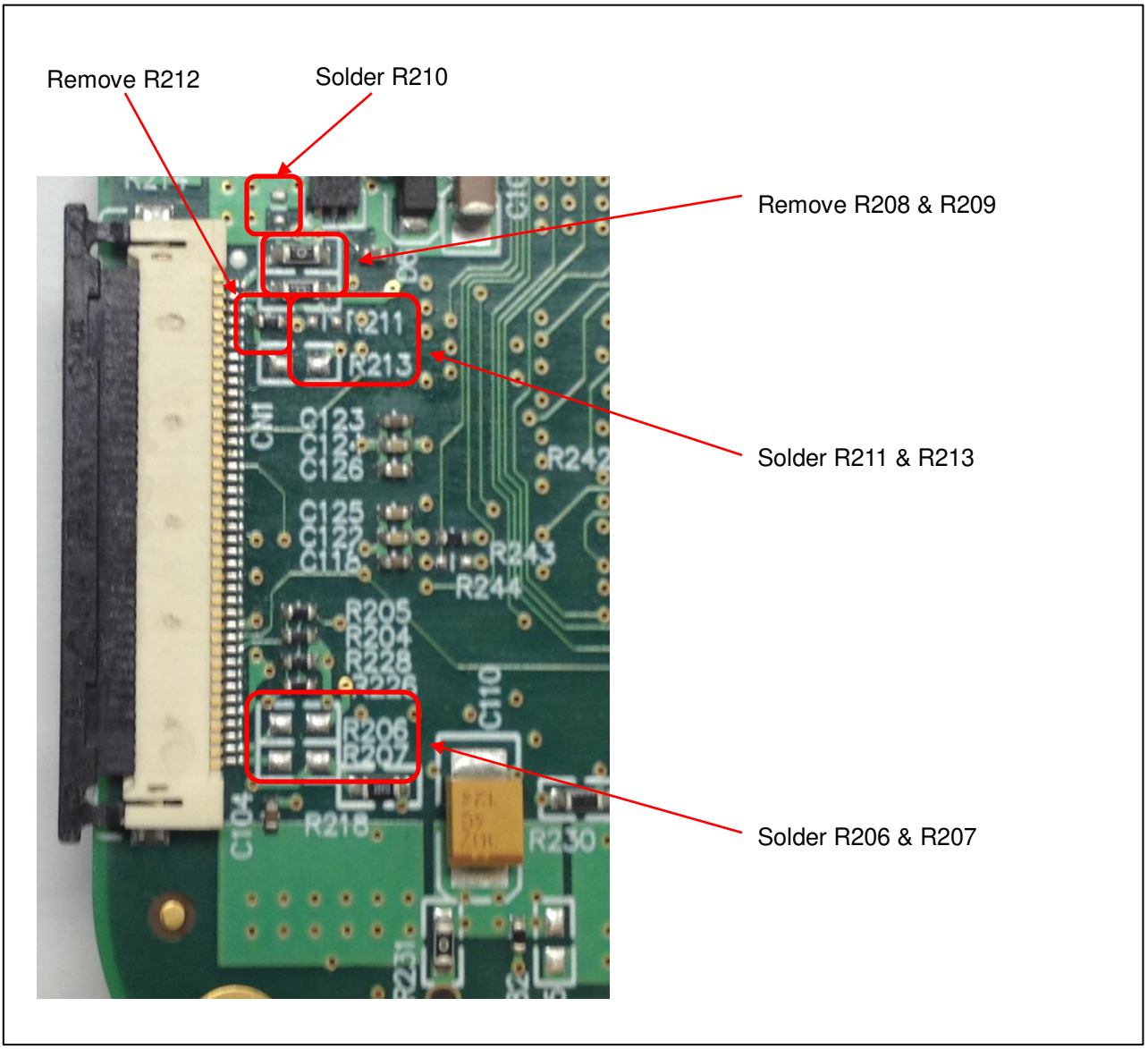


CN1 Location and Panel Connection Example

3.1.1 Modifications for Hantronix HDA430-3GH-1

In order to use the Hantronix HDA430-3GH-1 WQVGA display, some modifications to the S5U13513R00C100 evaluation board are required:

- Remove 0 ohm resistors R208, R209 and R212
- Solder 0 ohm resistors R206, R207, R210, R211 and R213.
  These resistors are all located on the bottom side of the board.



Hantronix HDA430-3GH-1 Modifications: Resistor Locations

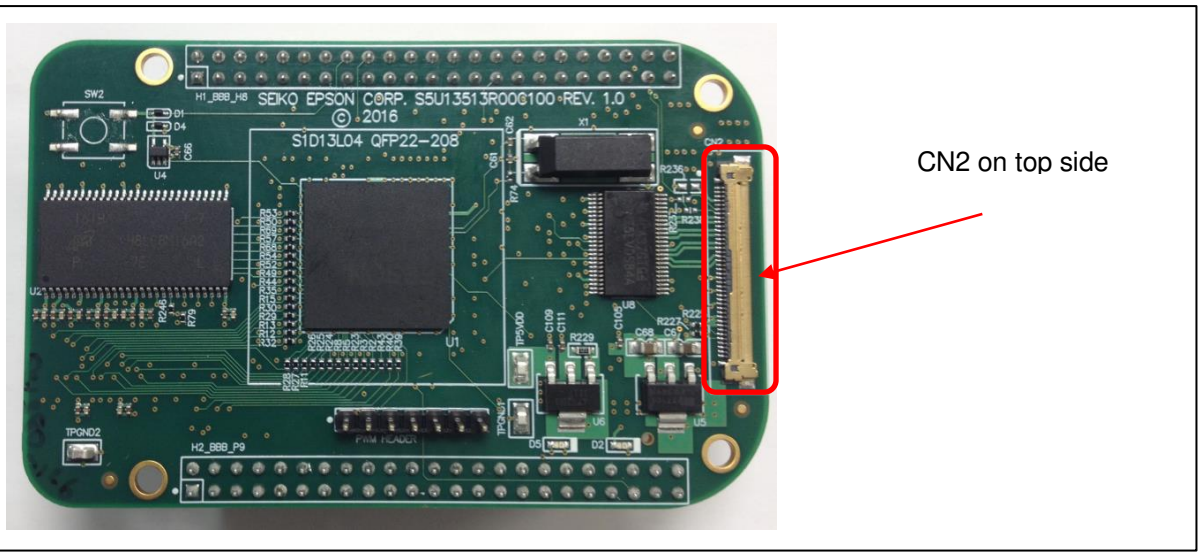
3.2 LVDS Displays

The S5U13513R00C100 evaluation board supports the following LVDS (1024x600) LCD displays.

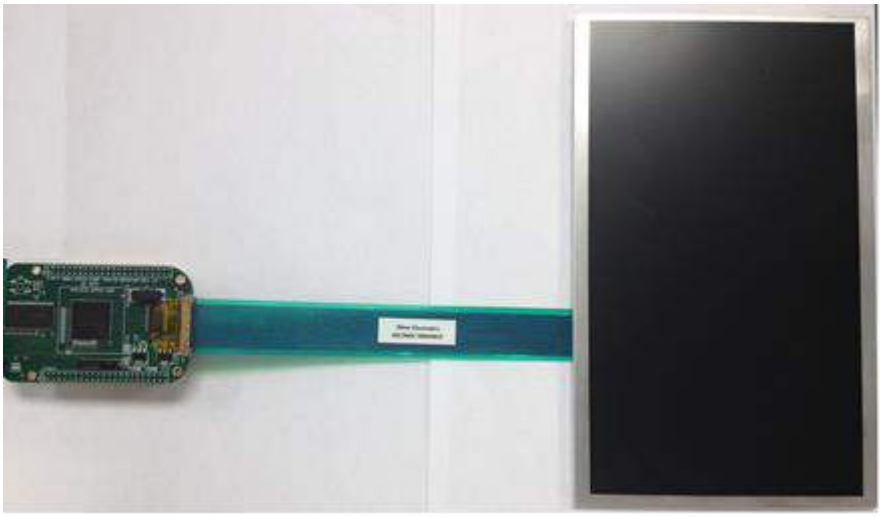
- Kyocera Display TVL-55682D101U-LW-I-AAN

The LVDS display should be connected to the S5U13513R00C100 using connector CN2 which is located on the top side of the board. The LVDS panel must be connected using an I-PEX flex cable (Mitas part# ME2008C2004001P with shell and pull-bar). The cable needs to be purchased separately and should insert and lock into the CN2 connector

The following image shows the location of connector CN2.



CN2 Location



LVDS Panel Connection Example

4 PWM Header

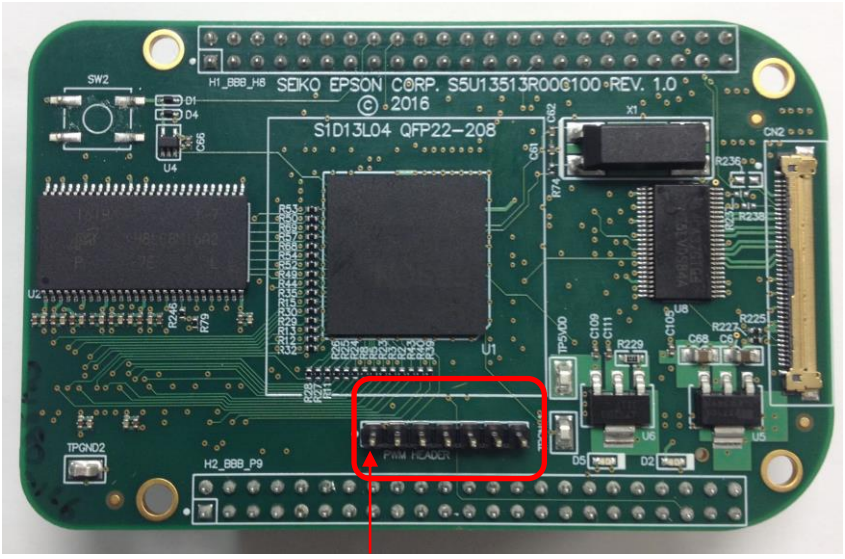
4.1 Description

The S5U13513R00C100 evaluation board has Red, Green, Blue, and White PWM outputs that can be used to pulse the LEDs from completely off to the duty cycle programmed in the S1D13513/S1D13L04 PWM Duty Cycle register. The RGB PWM outputs are enabled at the same time whereas the White PWM output can be enabled separately.

The Audio input pin offers further control over the PWM outputs by providing an external input pin. This input pin combined with its associated enable bit directly controls the PWM output stage after the PWM circuit. If not used as PWM outputs and Audio input, they can be used as GPIO.

For details on PWM Functionality, refer to the *S1D13513 Hardware Functional Specification*, document number X78C-A-001-xx, and *S1D13L04 Hardware Functional Specification*, document number XB3A-A-001-xx.

The following image shows the location of the PWM Header.



PWM Header Location

4.2 Pin Assignments

The following table lists the functionality for the PWM Header.

Pin Name	PWM Header Pin Number	Reset State
3.3VDD	1	-
Red Output	2	GPIOA7 Input
Green Output	3	GPIOA6 Input
Blue Output	4	GPIOA5 Input
White Output	5	GPIOB7 Input
Audio Input	6	GPIOD3 Input
GND	7	-

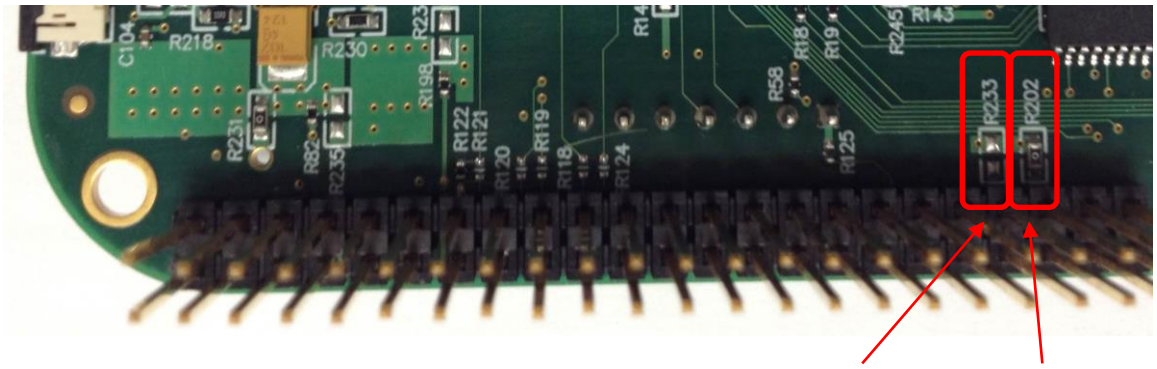
5 Power, Clock and Reset

5.1 Power

The S5U13513R00C100 evaluation board requires two power sources, 5V and 3.3V. By default, the BeagleBone Black development platform will supply both the 5V and 3.3V through connector P9. Pins 5, 6 provide 5V (VDD_5V) and pins 3, 4 provide 3.3V (VDD_3V3B).

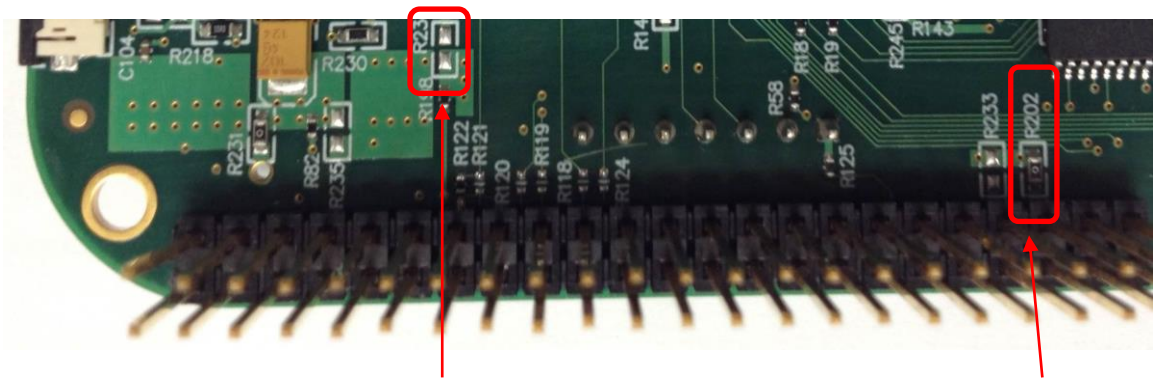
5.1.1 5V Power

If the BeagleBone Black will only use the USB connector as the power source (will not use the included 5V AC adaptor), pins 7, 8 (SYS_5V) of its P9 connector should be used. In this case, resistor R202 should be removed and a zero ohm resistor should be soldered at R233. **However, in this configuration, supply current may not be enough for certain kind of LCD panels.**



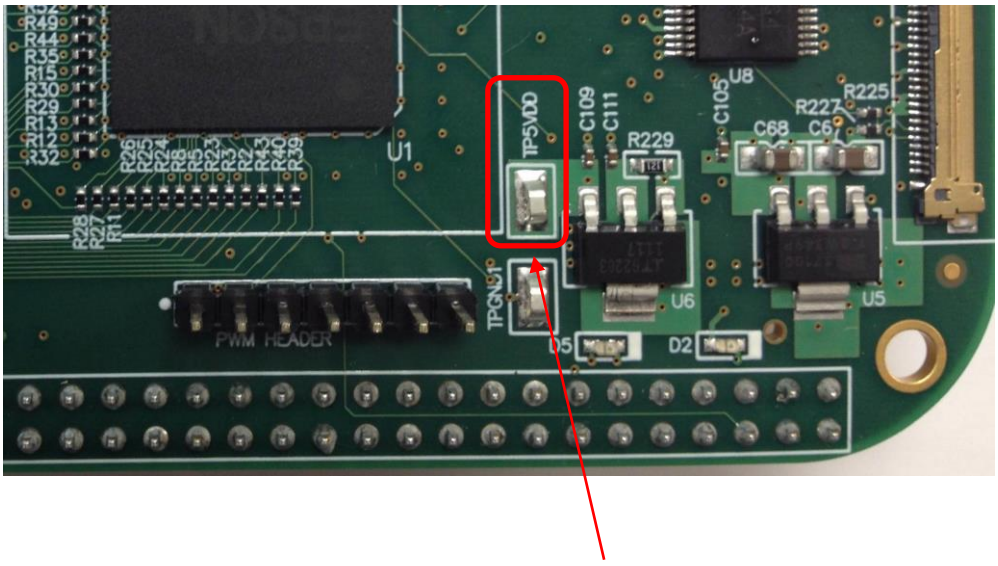
Modifications for USB Power Only

When an external 5V supply is used to support certain kinds of LCD panels, a 5V power supply can be directly connected to TP5VDD of the S5U13513R00C100 evaluation board. Before connecting to an external 5V power supply, remove resistor R202 and solder a zero ohm resistor at R234.



Modifications for External 5V Supply

The following image shows the location of TP5VDD on the S5U13513R00C100 evaluation board.



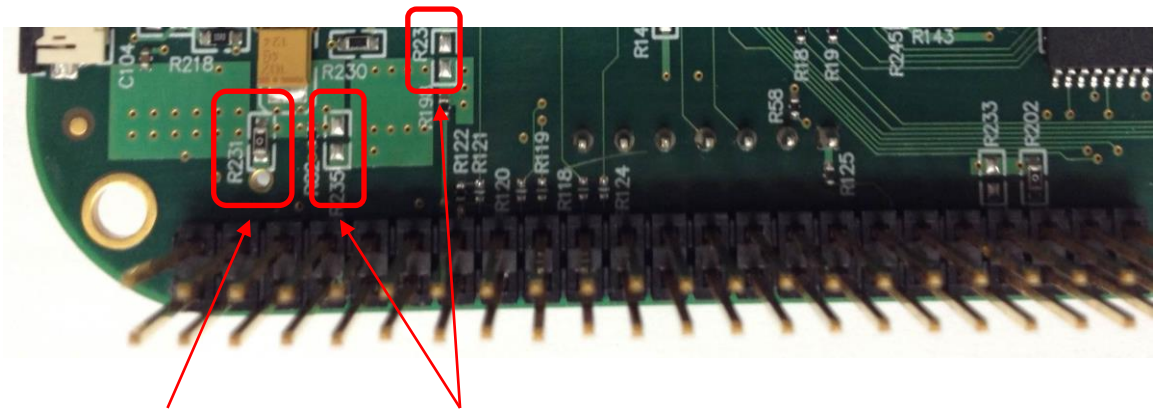
TP5VDD Location

When 5V is applied, LED D5 will light up on the S5U13513R00C100 evaluation board.

NOTE: R202, R233, and R234 are 0 ohm resistors located on the bottom side of the S5U13513R00C100.

5.1.2 3.3V Power

The BeagleBone Black typically provides 3.3V power to the S5U13513R00C100 evaluation board. If it becomes necessary to provide a separate 3.3V source, the S5U13513R00C100 evaluation board includes an on board 3.3V 800mA low dropout regulator. To enable the regulator, remove resistor R231 and solder zero ohm resistors at both R234 and R235.



Modifications to Enable On-board 3.3V Regulator

When 3.3V is applied, LED D2 will light up on the S5U13513R00C100 evaluation board.

NOTE: R231, R234, and R235 are 0 ohm resistors located on the bottom side of the S5U13513R00C100.

5.2 Clock

The LCD controller has an operating clock provided by an Epson 10MHz oscillator.

5.3 Reset

The S5U13513R00C100 evaluation board has various reset methods as follows:

- The S1D13513/S1D13L04 can be reset using a reset button on the board (SW2), optional.
- The S1D13513/S1D13L04 can be reset through pin 16 (GPIO1_14) of the P8 header on the BeagleBone Black development platform.
- The S1D13513/S1D13L04 will perform a system reset when power up through pin 10 (SYS_RESETn) of the P9 header on the BeagleBone Black development platform.

6 Parts List

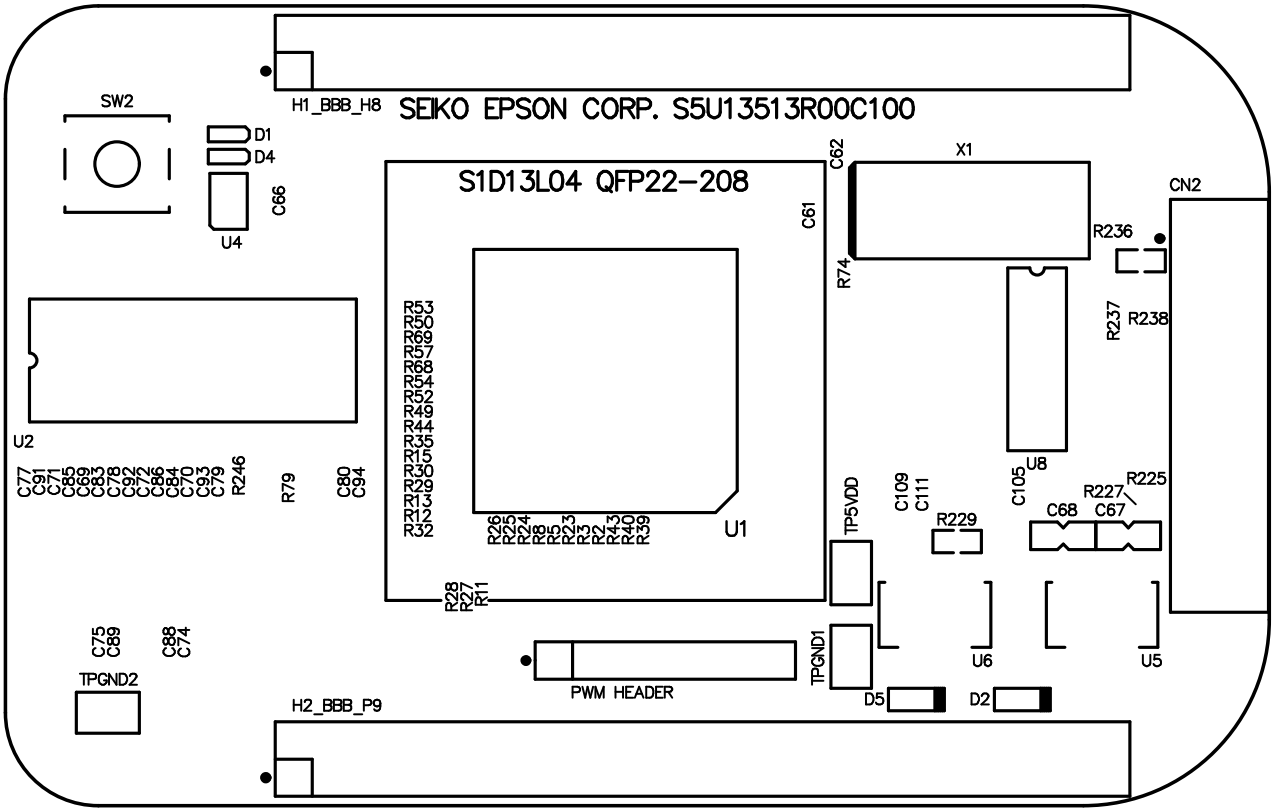
Item	Qty	Reference	Part	Description	Manufacturer Part No. / Comments
1	1	CN1	40 pins FPC	CONN FFC BOTTOM 40POS 0.50MM R/A	Molex - 0541324062
2	1	CN2	IPEX-20455-040E-76	LVDS connector	IPEX - 20455-040E-76
3	53	C1,C2,C3,C4,C5,C6, C7,C8,C9,C19,C22, C26,C28,C29,C30,C31 ,C32,C33,C34,C35, C43,C44,C45,C46,C47 ,C48,C49,C50,C51, C66,C69,C70,C71,C72 ,C73,C74,C75,C76, C77,C78,C79,C80,C81 ,C82,C104,C105,C109, C111,C112,C113,C114, C118,C123	0.1uF	CAP CER 0.1UF 16V 10% Y5V 0402	Yageo America CC0402ZRY5V7BB104 or equivalent
4	46	C10,C11,C12,C13,C14, C15,C16,C17,C18,C25 ,C27,C36,C37,C38 ,C39,C40,C41,C42, C52,C53,C54,C55,C56 ,C57,C58,C59,C60, C83,C84,C85,C86,C87 ,C88,C89,C90,C91, C92,C93,C94,C95,C96 ,C115,C116,C117, C122,C124	0.01uF	CAP CER 0.01UF 16V 10% Y5V 0402	Yageo America CC0402ZRY5V7BB103 or equivalent
5	2	C20,C23	1nF	CAP CER 1NF 50V 10% X7R 0402	Yageo America C0402KRX7R9BB102 or equivalent
6	2	C21,C2	10uF	CAP CER 10UF 6.3V X5R 20% 0805	Panasonic - ECJ-CV50J106M or equivalent
7	2	C61,C62	18pF	CAP CER 18PF 50V 5% C0G 0402	Panasonic -ECJ-0EC1H180J or equivalent
8	2	C67,C68	10uF	CAP CER 10UF 10V X5R 10% 0805	Panasonic -ECJ-2FB1A106K or equivalent
9	1	C106	1uF	CAP CER 1UF 50V 10% X7R 1206	TDK C3216X7R1H105K or equivalent
10	1	C107	0.22uF	CAP CER 0.22UF 25V 10% X5R 0402	TDK C1005X5R1E224K050BC or equivalent
11	1	C108	1uF	CAP CER 1UF 16V 10% X5R 0402	TDK C1005X5R1C105K050BC or equivalent
12	1	C110	100uF	CAP CER 100UF 4V 20% 1411	Kemet T494B107M004AS or equivalent
13	2	C125,C126	0.001uF	CAP CER 0.001UF 6.3V 10% X7R 0402	Kemet C0402C102K9RACTU or equivalent
14	2	D1, D4	DIODE SCHOTTKY 30V 100MA	DIODE SCHOTTKY 20V100MA SSSMINI2 SOD723	Micro Commercial Co.RB521G-30-T
15	1	D2	3.3V Power LED green	LED SMARTLED GREEN 570NM 0603	Osram LG L29K-G2J1-24-Z
16	1	D5	5.0 V Power LED green	LED SMARTLED GREEN 570NM 0603	Osram LG L29K-G2J1-24-Z
17	1	D6	CRS04	DIODE SCHOTTKY 40V 1A SFLAT	Toshiba CRS04(TE85L,Q,M)
18	2	H1_BBB_H8, H2_BBB_P9	Male Terminal Strips 23X2	23x2 2.54mm pitch, minimum 0.62`` mating length and soldered on the top side	Samtec TSW-123-17-G-D or equivalent

6 Parts List

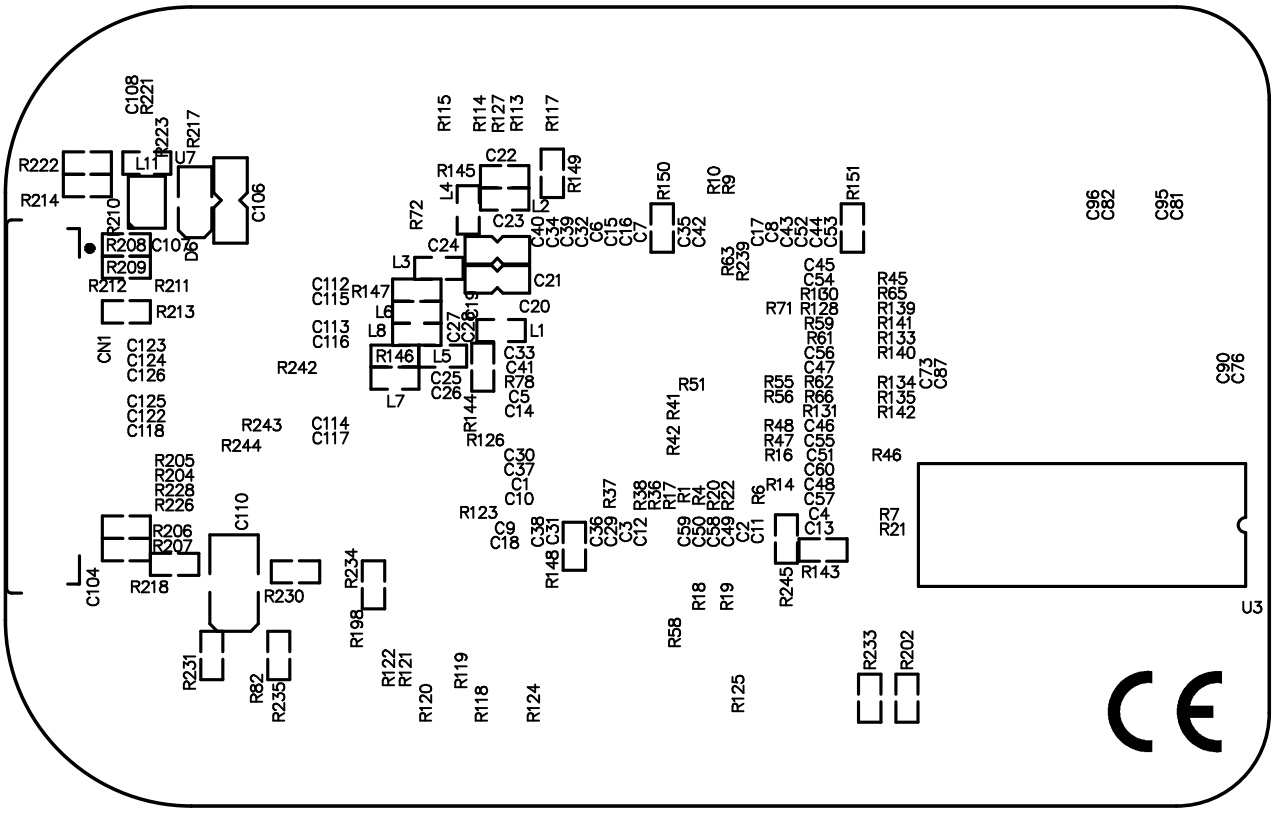
Item	Qty	Reference	Part	Description	Manufacturer Part No. / Comments
19	8	L1,L2,L3,L4,L5,L6,L7, L8	Ferrite	FERRITE 200MA 938 OHMS 0603 SMD	Steward HZ0603B751R-10 or equivalent
20	1	L11	22uH MLZ1608N220LT0 00	FIXED IND 22UH 300MA 145 MOHM	TDK MLZ1608N220LT000
21	1	PWM Header	MALE CONN HEADER 7POS	SIP7 2.54mm pitch	Sullins Connector Solutions PRPC007SAAN-RC or equivalent
22	57	R1,R2,R3,R4,R5,R6, R7,R8,R9,R10,R11, R12,R13,R14,R15,R16 ,R17,R18,R19,R20, R21,R22,R23,R24,R25 ,R26,R27,R28,R29, R30,R32,R35,R36,R37 ,R38,R39,R40,R41, R42,R43,R44,R45,R46 ,R47,R48,R49,R50, R51,R52,R53,R54,R55 ,R56,R57,R58,R68, R69	33 ohms	RES 33 OHM 1% 1/16W 0402 SMD	Vishay CRCW040233R0FKED
23	20	R59,R61,R62,R63,R65 ,R66,R78,R79,R113, R115,R122,R123,R125 ,R126,R139,R140, R142,R204,R227,R228	10K ohms	RES 10K OHM 1% 1/16W 0402 SMD	Vishay CRCW040210K0FKE
24	10	R71,R114,R127,R205, R212,R217,R225,R226 ,R239,R246	0 ohms	RES 0 OHM 1/16W 0402 SMD	Vishay CRCW04020000Z0ED
25	1	R72	1M ohms	RES 1M OHM 1% 1/16W 0402 SMD	Vishay - CRCW04021M00FKED
26	1	R74	220 ohms	RES 220 OHM 1% 1/16W 0402 SMD	Yageo America - RC0402FR-07220RL
27	1	R82	270 ohms	RES 270 OHM 1% 1/16W 0402 SMD	Vishay - CRCW0402270RFKED
28	10	R117,R118,R119,R120, R121,R124,R210,R211 ,R237,R238	NP_0	RES 0 OHM 1% 1/16W 0402 SMD	Do not buy, do not populate
29	9	R128,R130,R131,R133 ,R134,R135,R141, R223,R24	NP_10K	RES 10.0K OHM 1% 1/16W 0402 SMD	Do not buy, do not populate
30	15	R143,R144,R145,R146 ,R147,R148,R149, R150,R151,R202,R208 ,R209,R214,R231, R245	0 ohms	RES 0 OHM,0.1%,0.1W 0603 SMD	Vishay - CRCW06030000Z0EAHP
31	1	R198	470 ohms	RES 470 OHM 1% 1/16W 0402 SMD	Vishay - RC0402FR-07470RL
32	8	R206,R207,R213,R222 ,R233,R234,R235, R236	NP_0	RES 0.0 OHM 0603 SMD	Do not buy, do not populate
33	1	R218	10	RES 10.0 OHM 1% 1/16W 0402 SMD	Vishay - CRCW060310R00FKEAHP
34	2	R221,R243	100k	RES 100K OHM 11% 1/16W 0402 SMD	Vishay - CRCW0402100KFKED

Item	Qty	Reference	Part	Description	Manufacturer Part No. / Comments
35	1	R229	120 ohms	RES 120 OHM 0.1%,0.1W SMD 0603	Panasonic – ECG ERA-3YEB121V
36	1	R230	187 ohms	RES 187 OHM 0.1%,0.1W SMD 0603	Panasonic – ECG ERJ-3EKF1870V
37	1	R242	4.7K	NP_4.7K R0402	DO NOT populate
38	1	SW2	SW TACT-SPST	SWITCH TACT SILVER PLT GULLWING	C&K Components RS-282G05A3-SM RT or equivalent – DO NOT POPULATE
39	3	TPGND1,TPGND2, TP5VDD	TP_1206	PC TEST POINT MINIATURE SMT	Keystone 5015
40	1	U1	S1D13513	Epson S1D13513 PBGA256	Epson S1D13513F00A
41	2	U2&U3	IS42S16800D-7TL	IS42S16800D-7TL TSOPII-54	ISSI IS42S16800D-7TL / alternate Micron MT48LC8M16A2P-7E
42	1	U4	TPS3801L30DCKR	2.64V SUPPLY MON SOT-323-5	Texas Instruments TPS3801L30DCKR
43	1	U5	MIC37100-1.8WS	LDO 1.8 SOT-223	Micrel MIC37100-1.8WS, alternate MIC39100-1.8WS
44	1	U6	T1117CST	LDO REG ADJUSTBL 800MA SOT223	Linear Technology LT1117CST
45	1	U7	TPS61161A	IC LED DRIVER WHITE BCKLGT 6SON	Texas Instruments TPS61161ADRVT
46	1	U8	SN75LVDS84a	TFT to LVDS conversion TSSOP48	Texas Instruments SN75LVDS84ADGG
47	1	X1	MA-506 10.0000M	CRYSTAL 10.0000MHz 18PF SMD	Epson MA-506 10.0000M-C0:ROHS

7 Board Layout

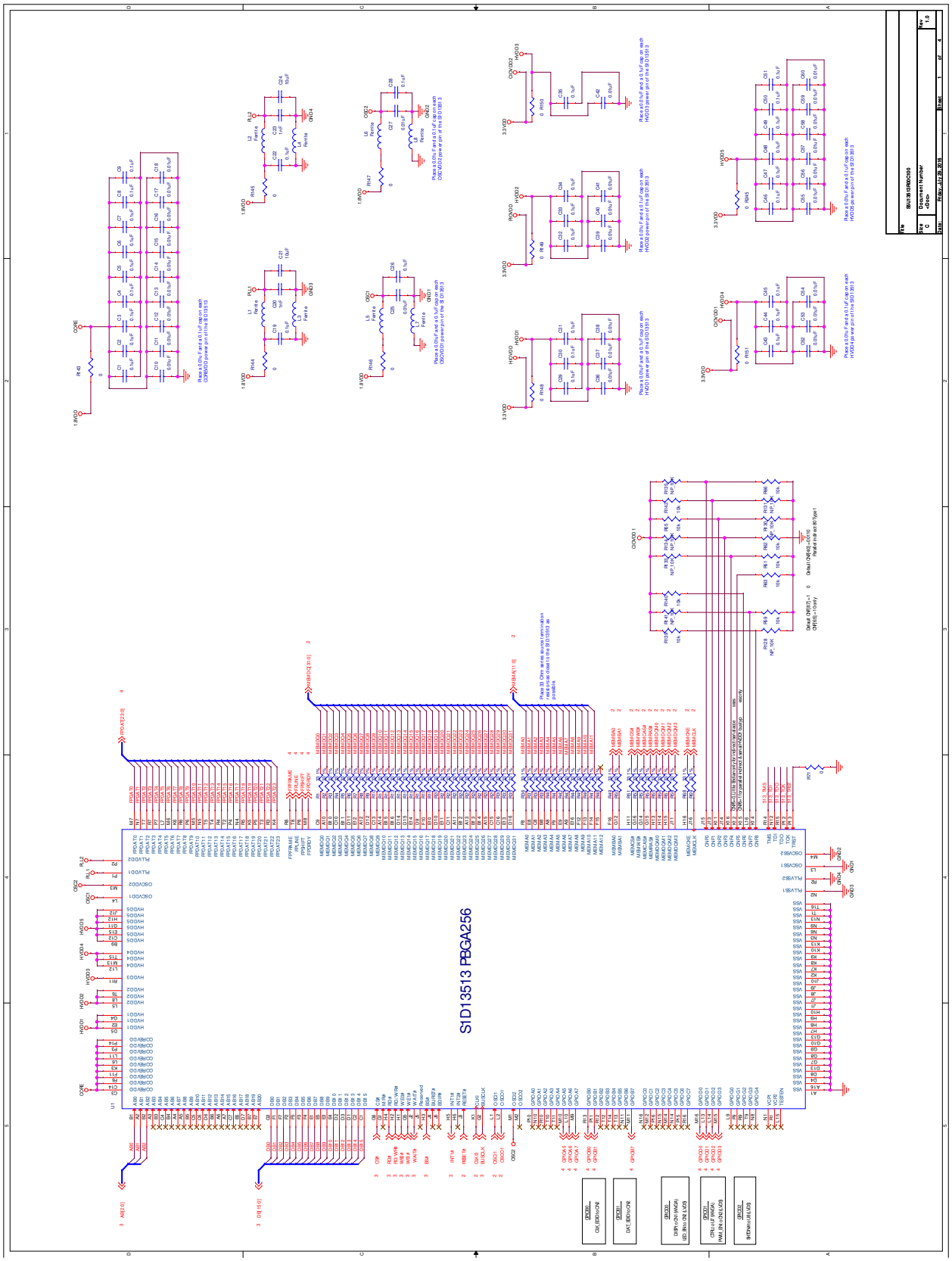


S5U13513R00C100 Board Layout (Top)

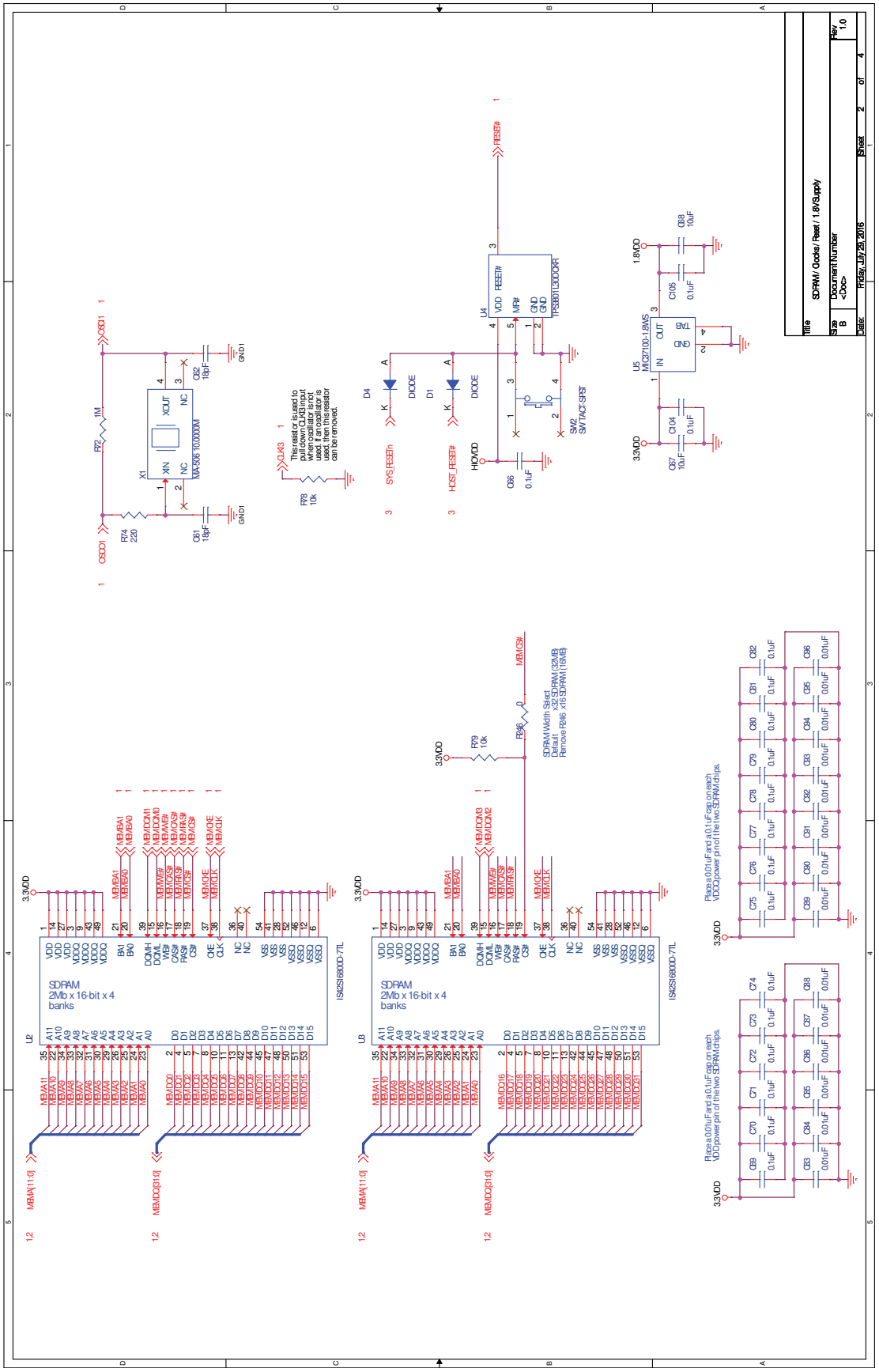


S5U13513R00C100 Board Layout (Bottom)

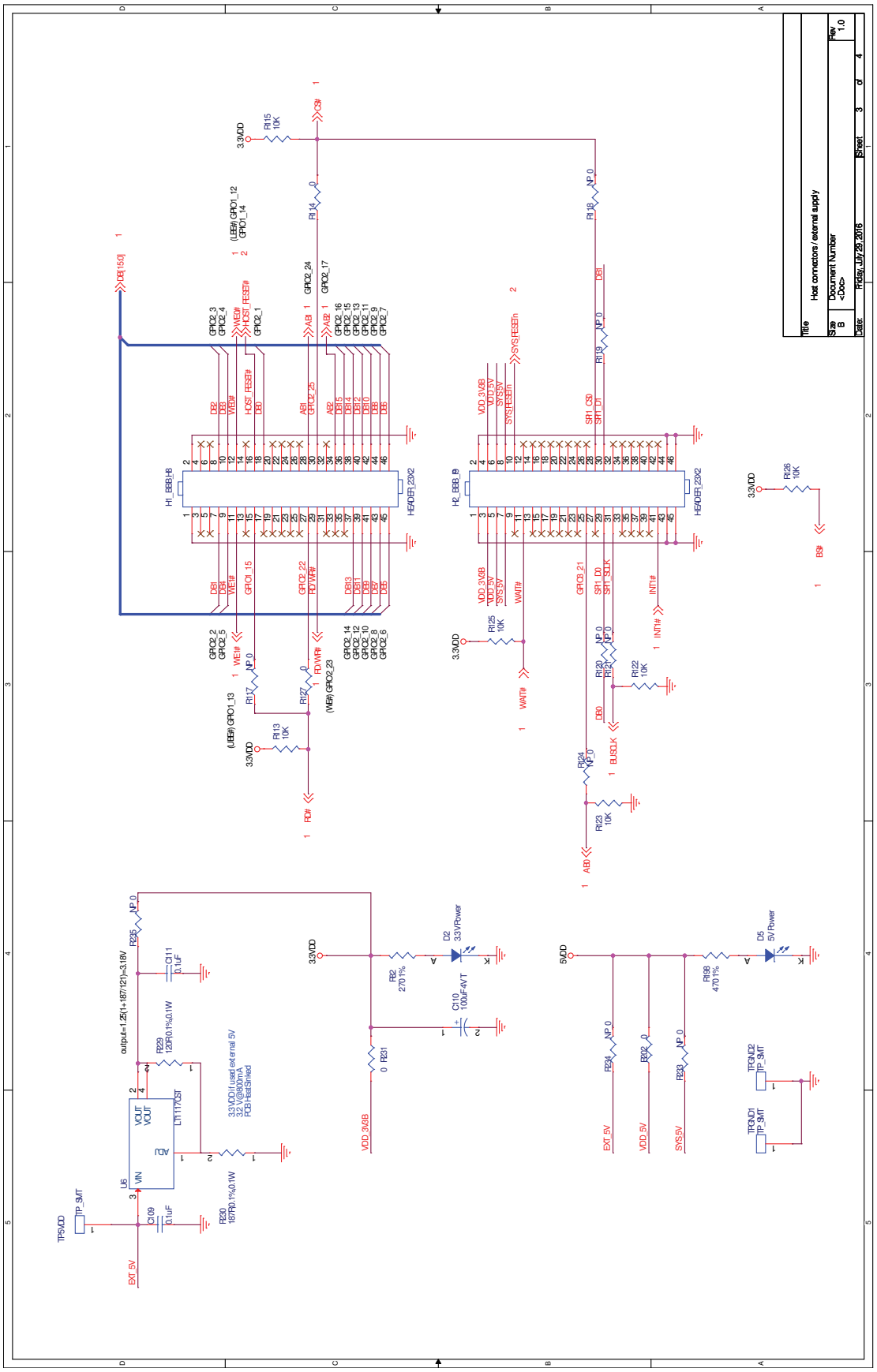
8 Schematic Diagrams



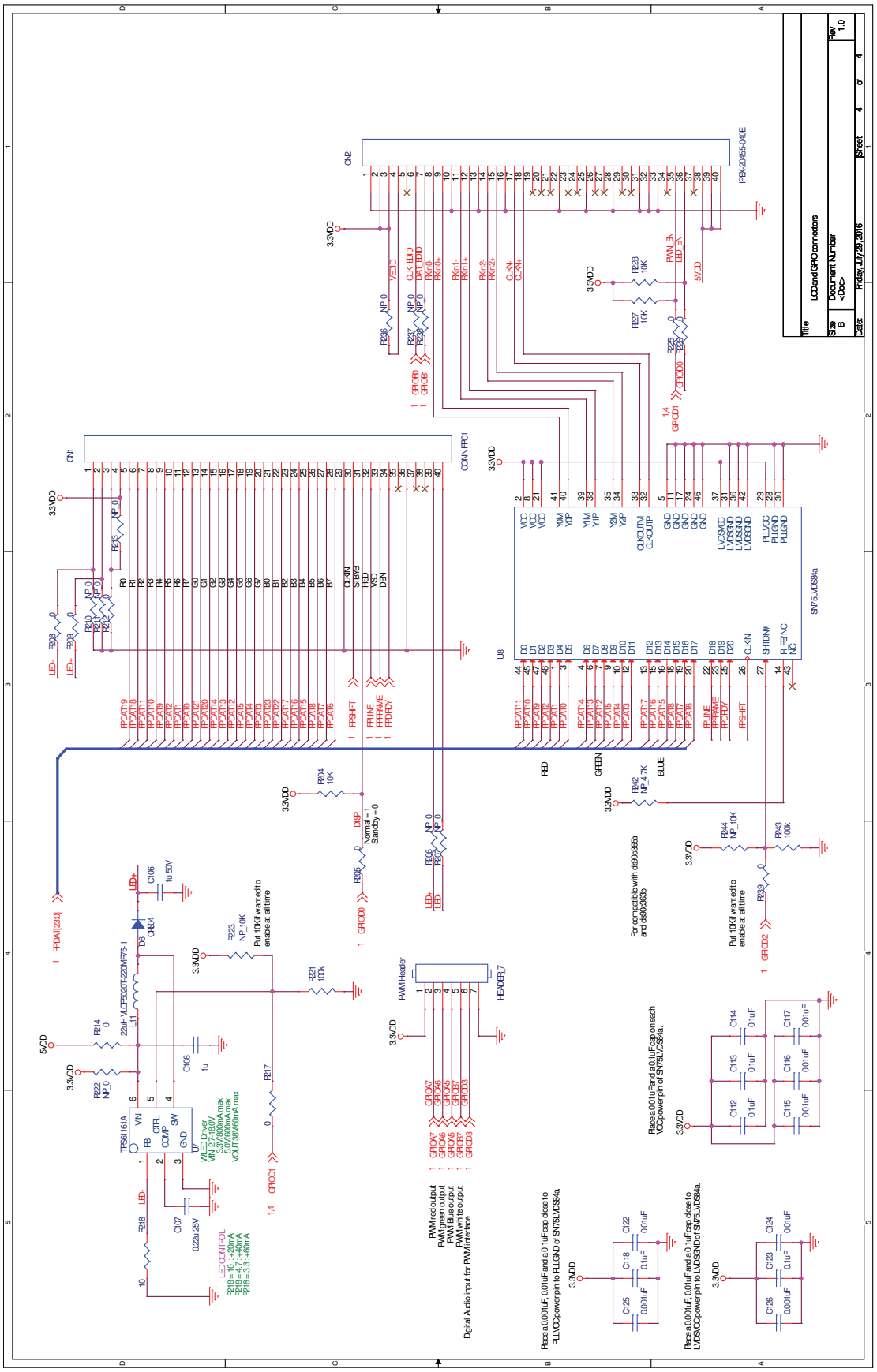
S5U13513R00C100 Schematic (1 of 4)



S5U13513R00C100 Schematic (2 of 4)



S5U13513R00C100 Schematic (3 of 4)



S5U13513R00C100 Schematic (4 of 4)

Revision History

X78A-G-004-01 Revision 1.1 - Issued: June 27, 2017

- Section 7, add Board Layout section
- Section 8, change schematic diagram images to vector from bitmap
- Updated Epson Shanghai branch address

X78A-G-004-01 Revision 1.0 - Issued: October 21, 2016

- Section 3.1.1, changed R208 & R209 reference in diagram from “Solder” to “Remove”
- Section 3.2, added image of LVDS panel connection

X78A-G-004-00 Revision 0.01 - Issued: October 4, 2016

- Initial draft of the document

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