

EVM User's Guide: DS320PR1601-RSC-EVM

DS320PR1601RSC-EVM User's Guide



ABSTRACT

The DS320PR1601RSC-EVM evaluation module provides a complete high-bandwidth platform for evaluating the signal conditioning features of the Texas Instruments DS320PR1601 32-Channel PCI-Express 5.0 Linear Redriver. This evaluation board can be used for standard add-in card compliance testing, performance evaluation, and initial system prototyping.

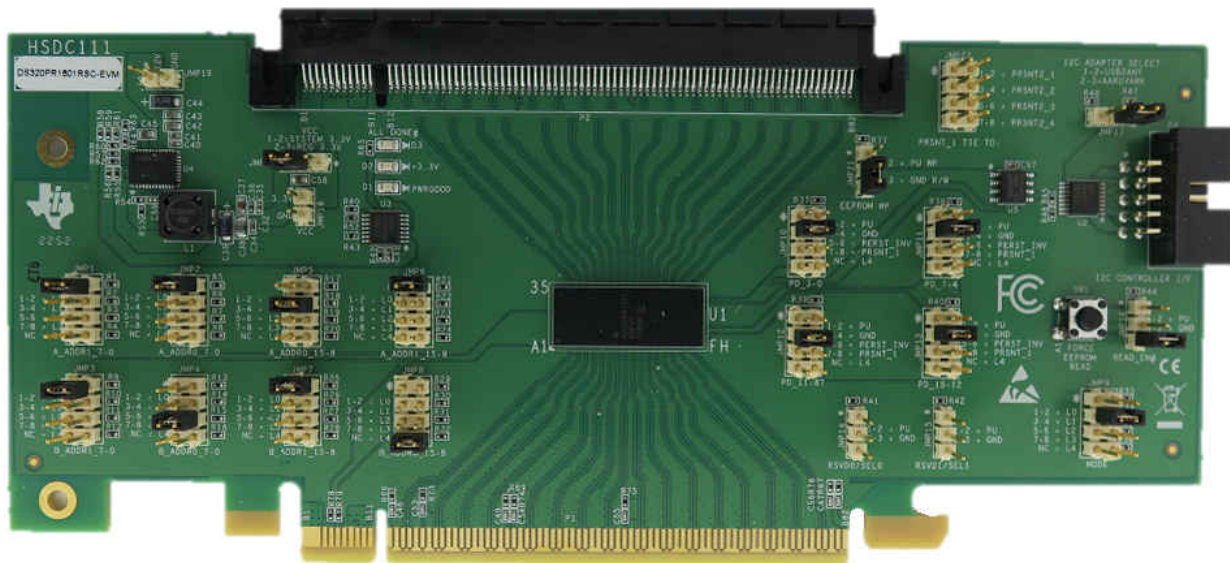


Figure 1-1. DS320PR1601RSC-EVM – Top Side View

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Trademarks

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1 Introduction

The DS320PR1601RSC-EVM evaluation module features one DS320PR1601 linear redriver that can extend the transmission distance of a PCIe Gen-5 x16 bus. It can directly be plugged into a PCIe slot on a server or PC motherboard using one end of the board, and paired with a PCIe add-in card using the straddle mount connector attached to the other end of the board.

1.1 Features

- PCIe x16 Riser Card with one 32-channel (16-Channel in each direction) linear redriver operating at rates up to 32 Gbps
- Linear equalization for seamless support of link training and PCIe channel extension
- CTLE boosts up to 24 dB at 16 GHz
- Programmable device configuration through EEPROM, I2C, or SMBus
- Onboard 12-V to 3.3-V, 2-A step-down DC/DC converter
- Flow-through layout P2P with Intel retimer common footprint

1.2 Applications

- PCI Express Gen 1, 2, 3, 4, and 5
- High-speed interfaces up to 32 Gbps
- Enterprise server motherboard, workstation
- Enterprise storage
- Enterprise add-in card, end-point

2 Description

2.1 DS320PR1601 5-Level I/O Control Inputs

The DS320PR1601 features 5-level input pins (A_ADDR0_7-0, A_ADDR0_15-8, B_ADDR0_7-0, B_ADDR0_15-8, A_ADDR1_7-0, A_ADDR1_15-8, B_ADDR1_7-0, B_ADDR1_15-8) that are used to control the configuration of the device. These 5-level inputs use a resistor divider to help set the five valid levels to provide a wider range of control settings.

Table 2-1. Five-Level Control Pin Settings

PIN LEVEL	PIN SETTING
L0	1 kΩ to GND
L1	8.25 kΩ to GND
L2	24.9 kΩ to GND
L3	75 kΩ to GND
L4	Float

2.2 DS320PR1601 Modes of Operation

The DS320PR1601 can be configured to operate in either SMBus with I2C Secondary mode, or SMBus with I2C Primary mode (EEPROM Self Load). As listed in [Table 2-2](#), the pin strap setting on the MODE pin determines the mode of operation of the DS320PR1601.

Table 2-2. Modes of Operation

MODE PIN LEVEL	MODE OF OPERATION
L0	RESERVED 250 Ω to GND
L1	SMBus mode or I2C Primary mode 2.062 kΩ to GND
L2	SMBus mode or I2C Secondary mode 6.25 kΩ to GND
L3	RESERVED 18.75 kΩ to GND
L4	RESERVED Float

2.3 DS320PR1601 SMBus / I2C Register Control Interface

The DS320PR1601 internal registers can be accessed through standard SMBus protocol. The DS320PR1601 features eight banks of channels, A_Bank 0 (Channels 0–3) and A_Bank 1 (Channels 4–7), A_Bank 0 (Channels 8-11), A_Bank 1 (Channels 12-15), B_Bank 0 (Channels 0–3) and B_Bank 1 (Channels 4–7), B_Bank 0 (Channels 8-11), B_Bank 1 (Channels 12-15) each featuring a separate register set and requiring a unique SMBus target address. The SMBus target address pairs (one for each channel bank) are determined at power up based on the configuration of the x_ADDR1_x and x_ADDR0_x pins. The pin state is read on power up, after the internal power-on reset signal is deasserted.

There are 16 unique SMBus target address pairs (one address for each channel bank) that can be assigned to the device by placing external resistor straps on the x_ADDR1_x and x_ADDR0_x pins as listed in [Table 2-3](#).

Table 2-3. DS320PR1601 SMBus Address Map

x_ADDR1_x Pin Level	x_ADDR0_x Pin Level	A/B Bank 0: 7-Bit Address [HEX]	A/B Bank 1: 7-Bit Address [HEX]
L0	L0	0x18	0x19
L0	L1	0x1A	0x1B
L0	L2	0x1C	0x1D
L0	L3	0x1E	0x1F
L1	L0	0x20	0x21
L1	L1	0x22	0x23
L1	L2	0x24	0x25
L1	L3	0x26	0x27
L2	L0	0x28	0x29
L2	L1	0x2A	0x2B
L2	L2	0x2C	0x2D
L2	L3	0x2E	0x2F
L3	L0	0x30	0x31
L3	L1	0x32	0x33
L3	L2	0x34	0x35
L3	L3	0x36	0x37

2.4 DS320PR1601 Channel Mapping

The DS320PR1601 divides the 32 channels of the device into 4 groups of 8 channels each. There are two Downstream groups and two Upstream groups. On the DS320PR1601RSC-EVM, the *Downstream* channels refer to channels where the data flows from CPU to DS320PR1601 to Endpoint. The *Upstream* channels refer to channels where the data flows from the Endpoint to DS320PR1601 to CPU. [Table 2-4](#) lists the Downstream channel mapping of the DS320PR1601. [Table 2-5](#) lists the Upstream channel mapping of the DS320PR1601.

Table 2-4. DS320PR1601 Downstream Channel Mapping

PCIe Lane	DS320PR1601 Channel	I2C ADDR CONFIG PINS		Channel Bank	Example I2C Address	Bank Channel#
0	A_PEx0	A_ADDR1_7-0 {Example Pin State = L0}	A_ADDR0_7-0 {Example Pin State = L0}	0	18h	0
1	A_PEx1				18h	1
2	A_PEx2				18h	2
3	A_PEx3				18h	3
4	A_PEx4			1	19h	4
5	A_PEx5				19h	5
6	A_PEx6				19h	6
7	A_PEx7				19h	7
8	A_PEx8	A_ADDR1_15-8 {Example Pin State = L0}	A_ADDR0_15-8 {Example Pin State = L1}	0	1Ah	0
9	A_PEx9				1Ah	1
10	A_PEx10				1Ah	2
11	A_PEx11				1Ah	3
12	A_PEx12			1	1Bh	4
13	A_PEx13				1Bh	5
14	A_PEx14				1Bh	6
15	A_PEx15				1Bh	7

Table 2-5. DS320PR1601 Upstream Channel Mapping

PCIe Lane	DS320PR1601 Channel	I2C ADDR CONFIG PINS		Channel Bank	Example I2C Address	Bank Channel#	PD pin control
0	B_PEx0	B_ADDR1_7-0 {Example Pin State = L0}	B_ADDR0_7-0 {Example Pin State = L2}	1	1Dh	7	PD_7_4
1	B_PEx1				1Dh	6	PD_7_4
2	B_PEx2				1Dh	5	PD_7_4
3	B_PEx3				1Dh	4	PD_7_4
4	B_PEx4			0	1Ch	3	PD_3_0
5	B_PEx5				1Ch	2	PD_3_0
6	B_PEx6				1Ch	1	PD_3_0
7	B_PEx7				1Ch	0	PD_3_0

Table 2-5. DS320PR1601 Upstream Channel Mapping (continued)

PCIe Lane	DS320PR1601 Channel	I2C ADDR CONFIG PINS		Channel Bank	Example I2C Address	Bank Channel#	PD pin control
8	B_PEx8	B_ADDR1_15-8 {Example Pin State = L0}	B_ADDR0_15-8 {Example Pin State = L3}	1	1Fh	7	PD_15_12
9	B_PEx9				1Fh	6	PD_15_12
10	B_PEx10				1Fh	5	PD_15_12
11	B_PEx11				1Fh	4	PD_15_12
12	B_PEx12			0	1Eh	3	PD_11_8
13	B_PEx13				1Eh	2	PD_11_8
14	B_PEx14				1Eh	1	PD_11_8
15	B_PEx15				1Eh	0	PD_11_8

Each channel of the DS320PR1601 features a continuous-time linear equalizer (CTLE) that applies high-frequency boost and low-frequency attenuation to help equalize the frequency-dependent insertion loss effects of the passive channel. Each channel has 20 equalization gain settings available through CTLE index selection. The equalization gain is set by writing registers in I2C mode. For more details, refer to the DS320PR1601 data sheet.

2.5 DS320PR1601 EVM Controls

Table 2-6 lists DS320PR1601RSC-EVM controls that configure the DS320PR1601 on the EVM.

Table 2-6. DS320PR1601 EVM Controls

Component	Name	Function
JMP1	A_ADDR1_7-0	Downstream A Channels 0-7 Address1 1-2: L0 3-4: L1 5-6: L2 7-8: L3 N/C: L4
JMP2	A_ADDR0_7-0	Downstream A Channels 0-7 Address0 1-2: L0 3-4: L1 5-6: L2 7-8: L3 N/C: L4
JMP3	B_ADDR1_7-0	Upstream B Channels 0-7 Address1 1-2: L0 3-4: L1 5-6: L2 7-8: L3 N/C: L4
JMP4	B_ADDR0_7-0	Upstream B Channels 0-7 Address0 1-2: L0 3-4: L1 5-6: L2 7-8: L3 N/C: L4
JMP5	A_ADDR0_15-8	Downstream A Channels 8-15 Address0 1-2: L0 3-4: L1 5-6: L2 7-8: L3 N/C: L4
JMP6	A_ADDR1_15-8	Downstream A Channels 8-15 Address1 1-2: L0 3-4: L1 5-6: L2 7-8: L3 N/C: L4
JMP7	B_ADDR1_15-8	Upstream B Channels 8-15 Address1 1-2: L0 3-4: L1 5-6: L2 7-8: L3 N/C: L4
JMP8	B_ADDR0_15-8	Upstream B Channels 8-15 Address0 1-2: L0 3-4: L1 5-6: L2 7-8: L3 N/C: L4

Table 2-6. DS320PR1601 EVM Controls (continued)

Component	Name	Function
JMP9	MODE	MODE Pin Configuration 1-2: L0 RSVD 3-4: L1 EEPROM Load/I2C 5-6: L2 I2C 7-8: L3 RSVD N/C: L4 RSVD
JMP10	PD_3-0	Power Down Control Channels 0-3 1-2: Pull-Up (Power Down) 3-4: GND (Normal Operation) 5-6: Control PD by System PERST# (PERST_INV) 7-8: Control PD by PRSNT_1 N/C: Internal Pull-down
JMP11	PD_7-4	Power Down Control Channels 4-7 1-2: Pull-Up (Power Down) 3-4: GND (Normal Operation) 5-6: Control PD by System PERST# (PERST_INV) 7-8: Control PD by PRSNT_1 N/C: Internal Pull-down
JMP12	PD_11-8	Power Down Control Channels 8-11 1-2: Pull-Up (Power Down) 3-4: GND (Normal Operation) 5-6: Control PD by System PERST# (PERST_INV) 7-8: Control PD by PRSNT_1 N/C: Internal Pull-down
JMP13	PD_15-12	Power Down Control Channels 12-15 1-2: Pull-Up (Power Down) 3-4: GND (Normal Operation) 5-6: Control PD by System PERST# (PERST_INV) 7-8: Control PD by PRSNT_1 N/C: Internal Pull-down
JMP14	RSVD0	Reserved0 Leave as N/C 1-2: Pull-up 2-3: GND
JMP15	RSVD1	Reserved1 Leave as N/C 1-2: Pull-up 2-3: GND
JMP16/SW1	READ_EN#	READ_EN# Pushbutton SW1 to force EEPROM Read 1-2: Pull-up (Default N/C) 2-3: GND (Default N/C)
JMP17	I2C Adapter Select	Select I2C Adapter to Plug into Connector P4 1-2: TI USB2ANY Controller 2-3: Aardvark Controller
JMP18	3.3 V VCC	VCC 1: VCC 2: GND

Table 2-6. DS320PR1601 EVM Controls (continued)

Component	Name	Function
JMP19	12 V	PCIe 12 V 1: 12 V 2: GND
JMP20	3.3 V VCC Source Select	VCC Source 1-2: System PCIe 3.3 V 2-3: Regulator 3.3 V Out
JMP21	EEPROM Write Protect	EEPROM WP 1-2: PU Write Protect 2-3: PD Read/Write
JMP22	PRSNT_1 Option	PRSNT1_Config Option 1-2: Tie PRSNT_1 to PRSNT2_1 3-4: Tie PRSNT_1 to PRSNT2_2 5-6: Tie PRSNT_1 to PRSNT2_3 7-8: Tie PRSNT_1 to PRSNT2_4

2.6 Quick-Start Guide

- Configure the DS320PR1601 to operate in the I2C Primary or Secondary mode by setting the MODE pins to the L1 or L2 level (L1 will first load the EEPROM, then return to I2C Secondary mode, L2 will place the device directly in I2C Secondary mode). This is accomplished by placing a shunt on JMP9 L1 or L2 location.
- Set a unique I2C Secondary address for each channel group by placing shunts in the following arrangement (This will configure the Downstream A channels to 0x18, 0x19, 0x1A and 0x1B, and the Upstream B channels to 0x1C, 0x1D, 0x1E and 0x1F):
 - JMP1 1-2
 - JMP2 1-2
 - JMP3 1-2
 - JMP4 5-6
 - JMP5 3-4
 - JMP6 1-2
 - JMP7 1-2
 - JMP8 7-8
- Configure JMP20 to either 1-2 or 2-3 to select 3.3 V from system PCIe 3.3 V or on-board regulator.
- Enable all channels by pulling their PWDN pins to GND. This is accomplished by placing a shunt on pins 3-4 on JMP10, JMP11, JMP12, and JMP13.
- Verify that no shunts are placed on JMP22.
- Select the appropriate adapter using JMP17 and connect the USB2ANY or Aardvark Adapter to connector P4 (Note: neither Adapter is supplied with the DS320PR1601EVM-RSC).
- Install [SigCon Architect](#) Version 3.0.1.0 (Or latest) application and the DS320PR1601 profile.
Please contact a local FAE for download instructions.
- Plug the EVM into a PCIe x16 server motherboard slot. Ensure the motherboard is powered down before installing the EVM or configured for hot-plug operation.
- Install a compatible PCIe endpoint card into the straddle connector of the EVM.
- Power-up the motherboard.
- Start the SigCon Architect application.
- Select the DS320PR1601 Configuration Page and select the *Apply* box to enable the device profile. If necessary, edit channel addresses in the Edit Device Addresses box.
- In the DS320PR1601 High Level Page, select Block Diagram as shown in [Figure 2-1](#).
- Select the desired EQ Settings and Driver Flat Gain.
- Select *Apply to All Channels* to apply the select settings to the select channels.

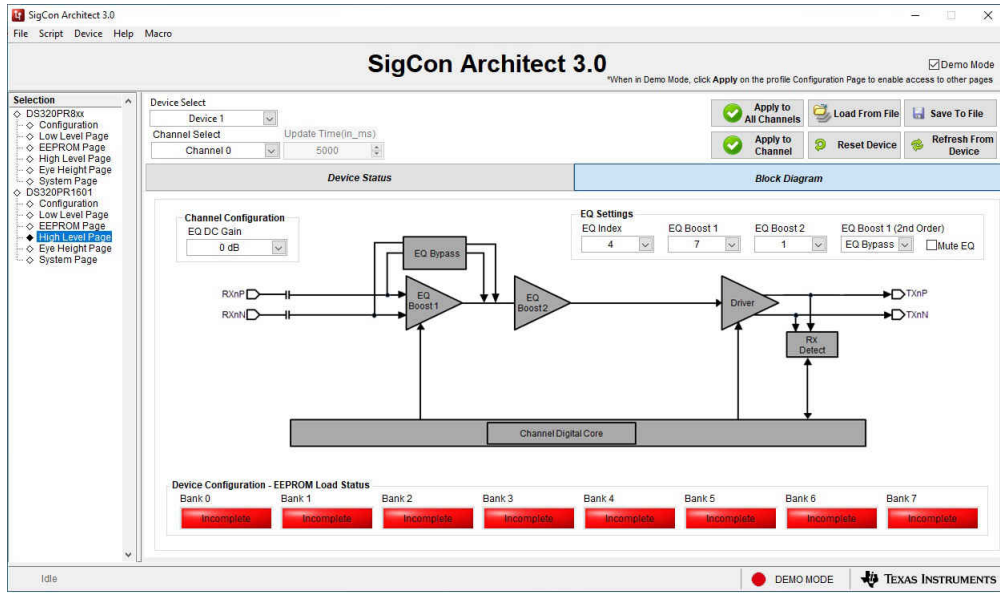


Figure 2-1. SigCon Architect DS320PR1601 High Level Page

3 Schematics

Figure 3-1 through Figure 3-6 show the EVM schematics.

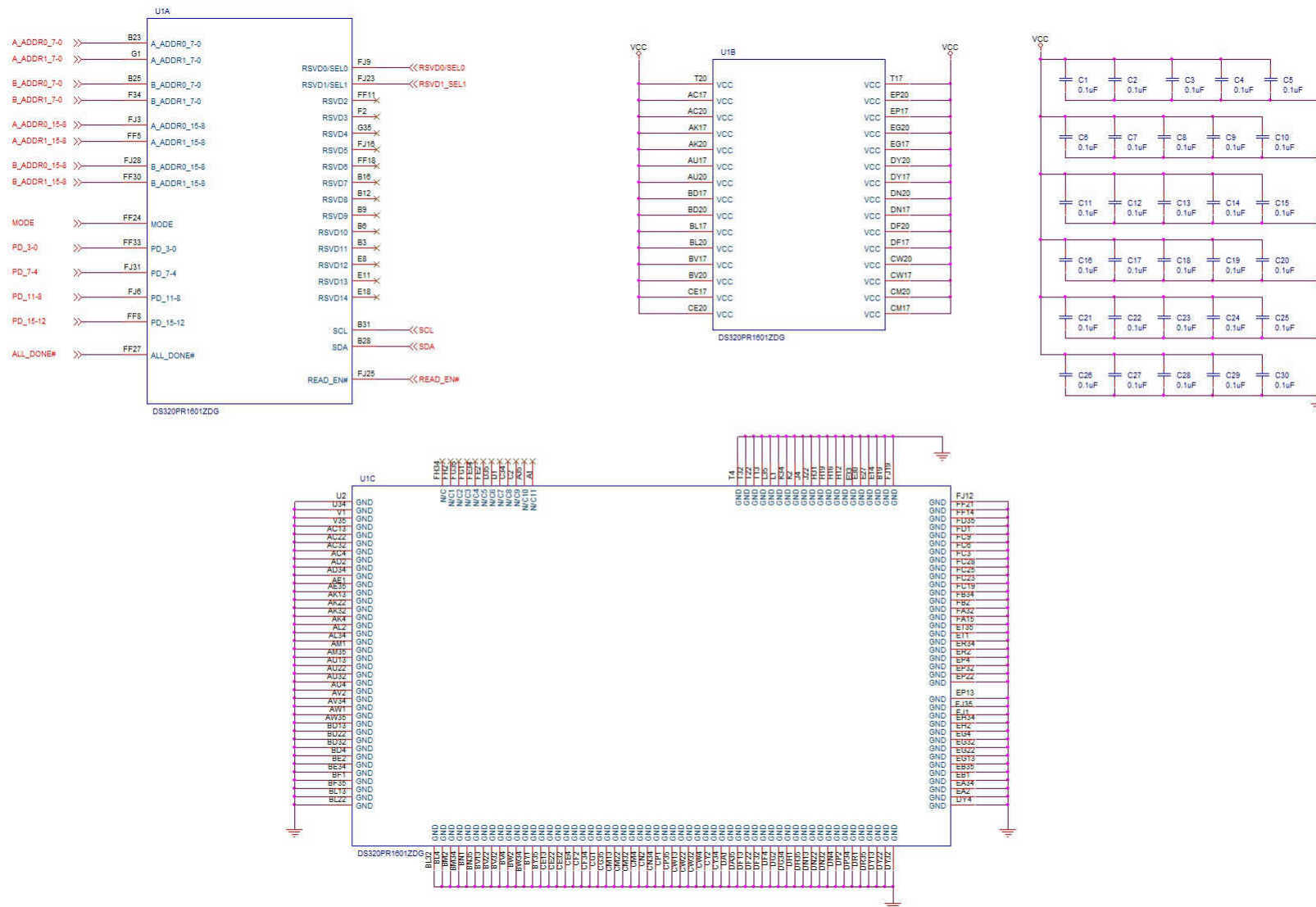


Figure 3-1. DS320PR1601 Control/MISC Pin Schematic Page

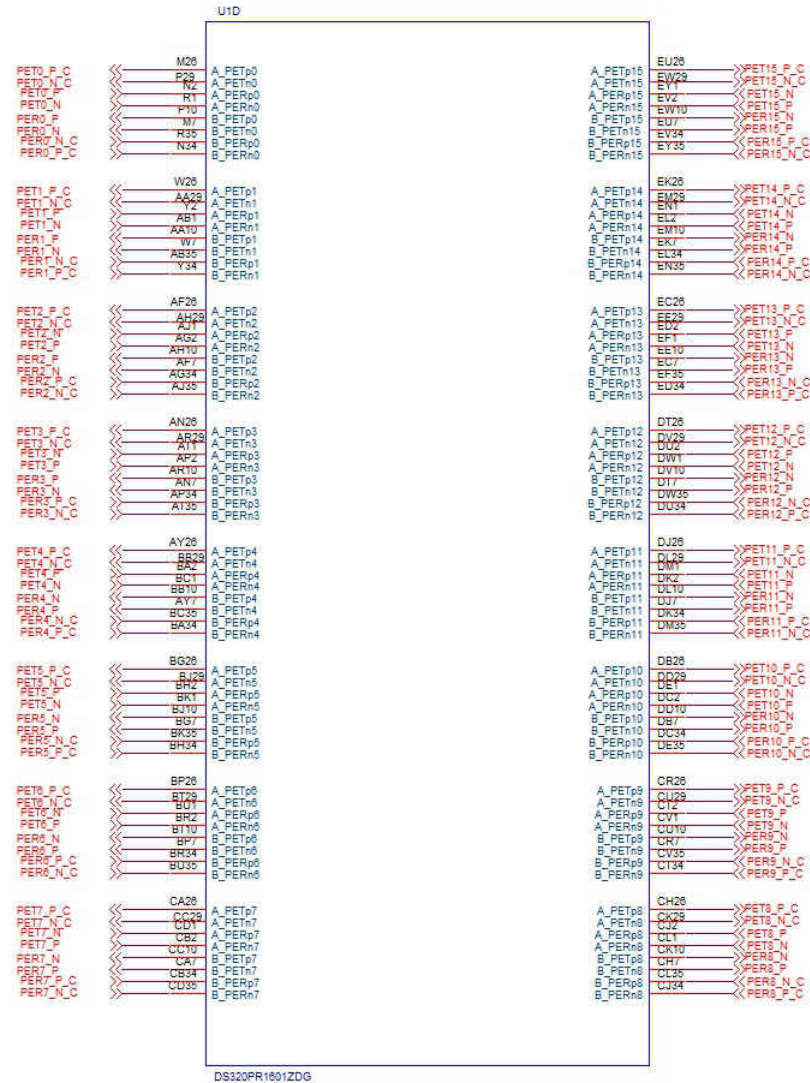


Figure 3-2. DS320PR1601 High-Speed Pin Schematic Page

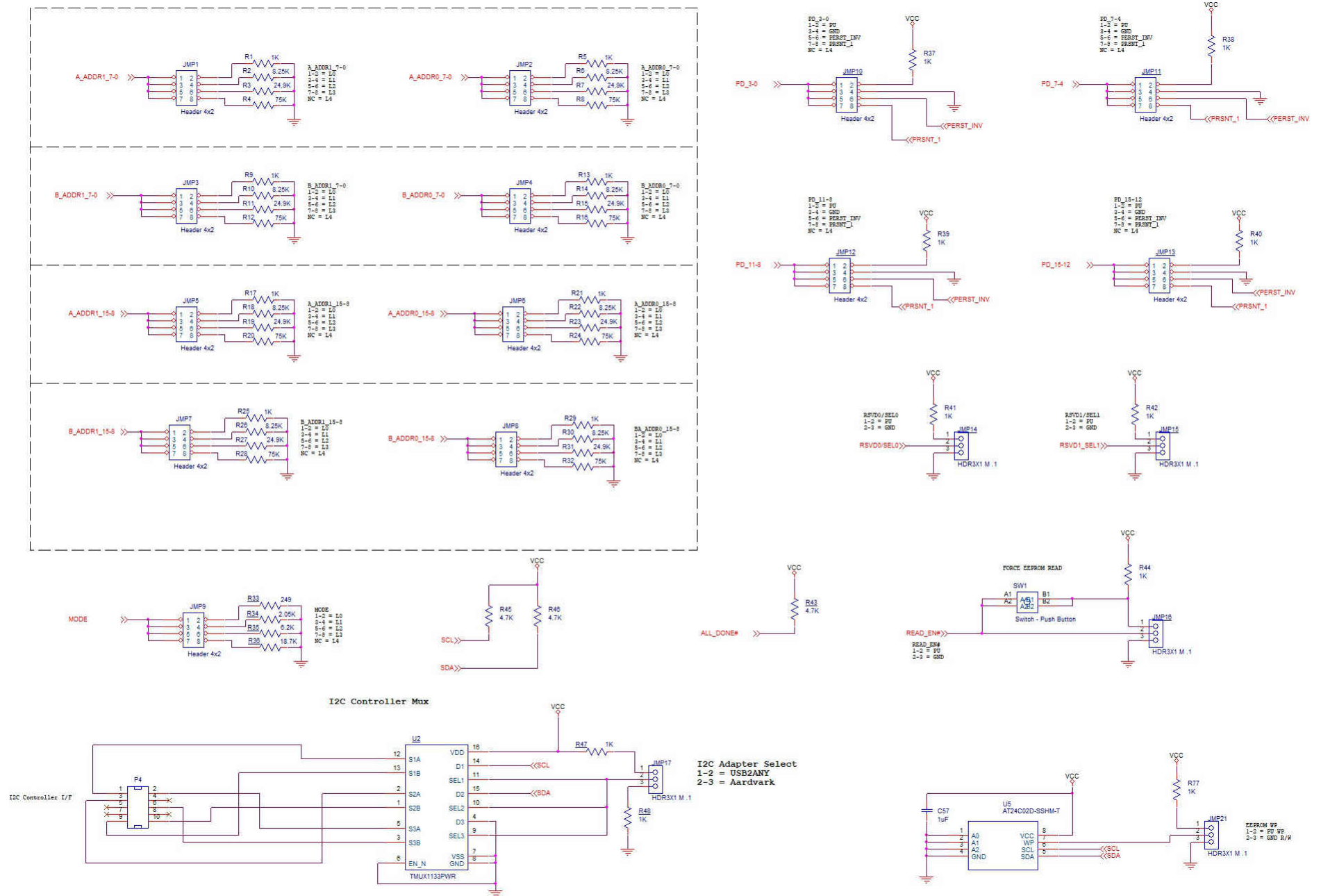


Figure 3-3. Control Pin Configuration Schematic Page

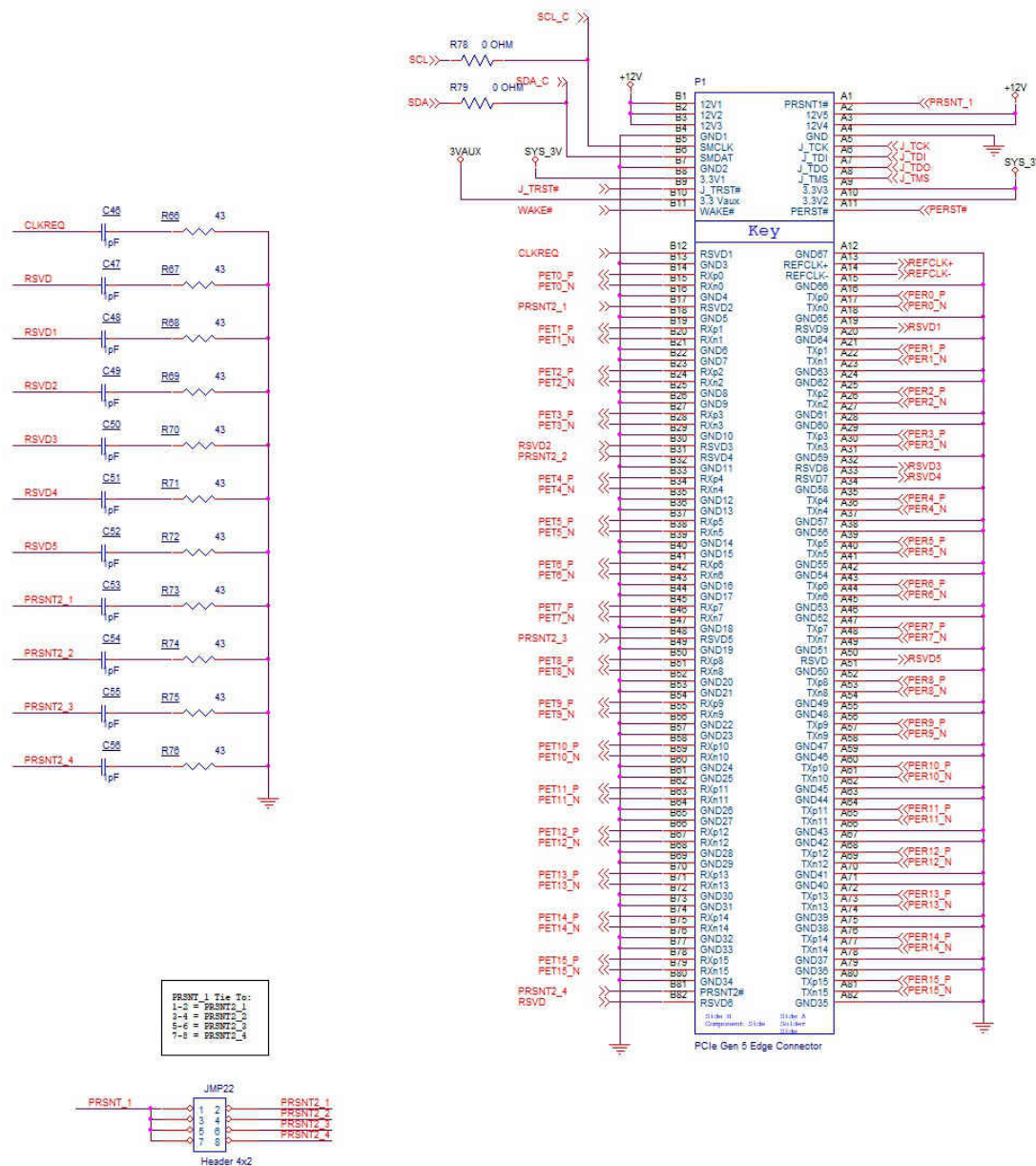


Figure 3-4. Gold Finger Edge Connector Schematic Page

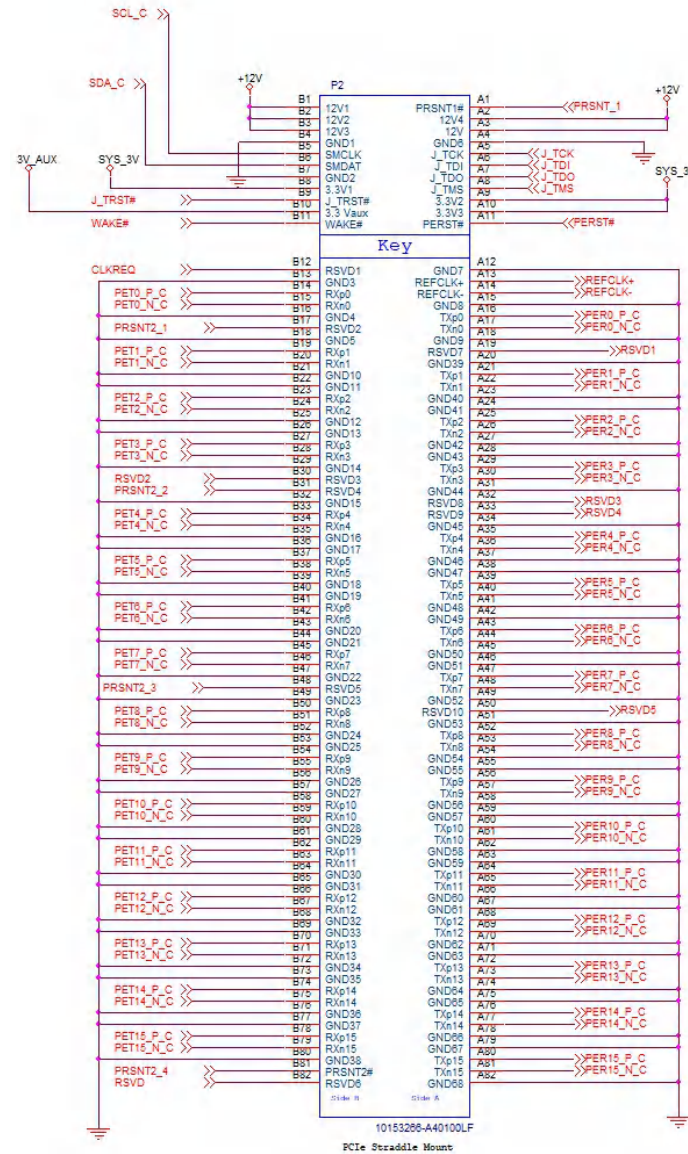


Figure 3-5. Straddle-Mount Connector Schematic Page

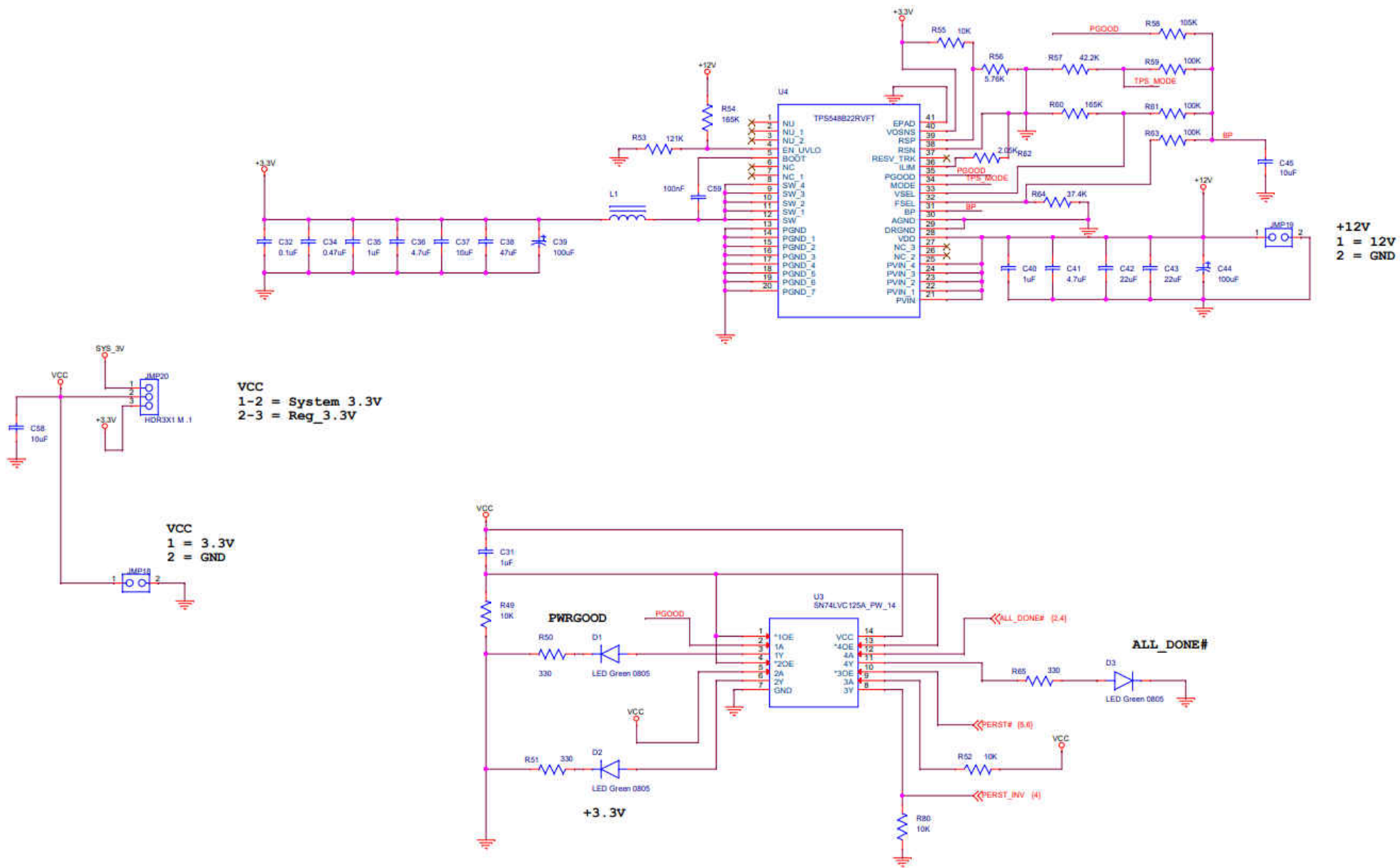


Figure 3-6. Voltage Regulator Schematic Page

4 Board Layout

Figure 4-1 and Figure 4-2 show the EVM board layouts.

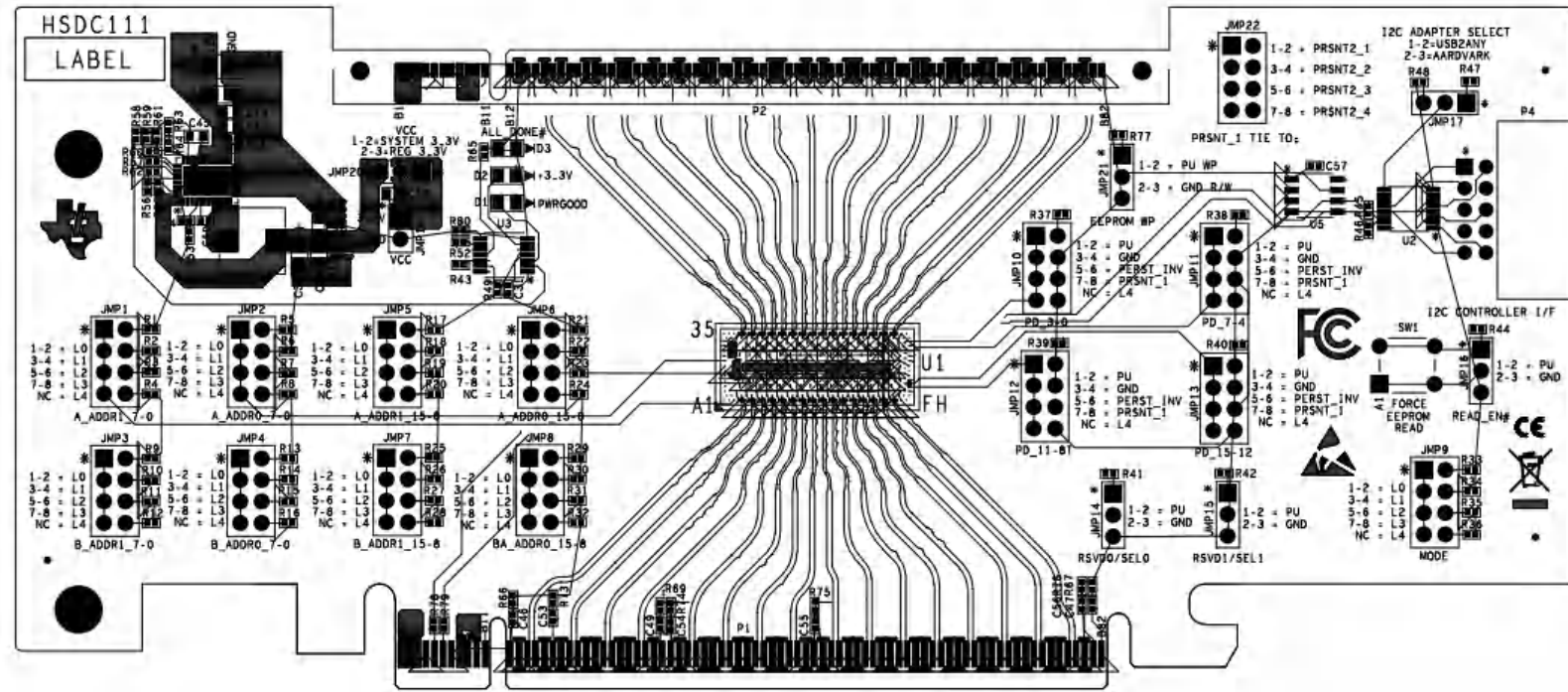


Figure 4-1. Top Layer

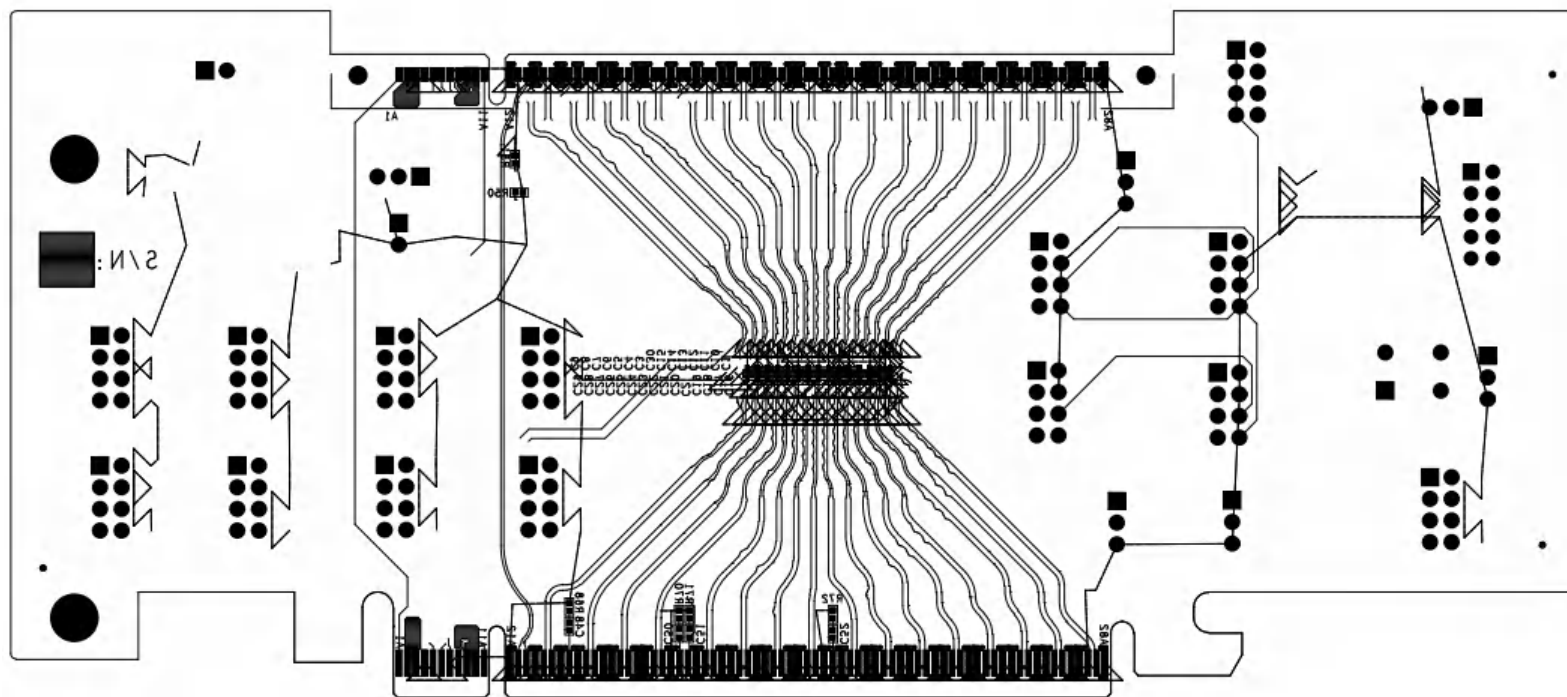


Figure 4-2. Bottom Layer

5 Bill of Materials

Table 5-1 lists the EVM bill of materials.

Table 5-1. DS320PR1601RSC-EVM Bill of Materials

Designator	Quantity	Value	Manufacturer	Part Number
C1, C2, C4, C5, C7, C8, C10, C12, C13, C15, C17, C18, C20, C22, C23, C25, C26, C28, C29, C30, C32	21	0.1 μ F	Kyocera AVX	0201ZD104KAT2A
C31, C35, C40, C57	4	1 μ F	Yageo	CC0402KRX5R6BB105
C34	1	0.47 μ F	Murata Electronics	GRM155R60J474KE19D
C16, C19, C21, C24, C27, C11, C14, C3, C6, C9	10	4.7 μ F	Murata Electronics	GRM035R60J475ME15D
C36, C41	2	4.7 μ F	Murata Electronics	GRM155R60J475ME47D
C37, C45, C58	3	10 μ F	Murata Electronics	GRM188R61A106KE69D
C38	1	47 μ F	Taiyo Yuden	JMK212BJ476MG-T
C39,C44	2	100 μ F	KEMET	T520A107M006ATE070
C42,C43	2	22 μ F	Murata	GRM188C80G226MEA0D
C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56	11	1 pF	Murata Electronics	GRM1555C1H1R0CA01D
C59	1	100 nF	Taiyo Yuden	TMK105B7104MV-FR
D1, D2, D3	3	LED Green 0805	Arrow (Lumex)	670-1006 (SML_LX0805GC)
JMP1, JMP2, JMP3, JMP4, JMP5, JMP6, JMP7, JMP8, JMP9, JMP10, JMP11, JMP12, JMP13	13	Header 4x2	AMP	103322-4
JMP14, JMP15, JMP16, JMP17, JMP20, JMP21	6	HDR3X1 M .1	AMP	103321-3
JMP18, JMP19	2	HDR2X1 M .1	AMP	103321-2
JMP22	1	Header 4x2	AMP	103322-4
LB1	1	THD-47-478-10	Brady	THT-14-423-10
L1	1	6.8 μ H	Eaton	DRA73-6R8-R
P2	1	PCIe Gen 5 Connector	Amphenol FCI	10153266-A40100LF
P4	1	Header 5x2 0.1" Shroud RA thru-hole	3M	30310-5002HB
R1, R5, R9, R13, R17, R21, R25, R29, R37, R38, R39, R40, R41, R42, R44, R47, R48, R77	18	1K	Panasonic Electronic Components	ERJ-2GEJ102X
R2, R6, R10, R14, R18, R22, R26, R30	8	8.25K	Panasonic Electronic Components	ERJ-2RKF8251X
R3, R7, R11, R15, R19, R23, R27, R31	8	24.9K	Panasonic Electronic Components	ERA-2AEB2492X
R4, R8, R12, R16, R20, R24, R28, R32	8	75K	Panasonic Electronic Components	ERA-2AED753X
R33	1	249	Panasonic Electronic Components	ERJ-2RKF2490X

Table 5-1. DS320PR1601RSC-EVM Bill of Materials (continued)

Designator	Quantity	Value	Manufacturer	Part Number
R34, R62	1	2.05K	Panasonic Electronic Components	ERJ-2RKF2051X
R35	1	6.2K	Panasonic Electronic Components	ERJ-2RKF6201X
R36	1	18.7K	Panasonic Electronic Components	ERJ-2RKF1872X
R43, R45, R46	3	4.7K	Panasonic Electronic Components	ERJ-2GEJ472X
R49, R52, R55, R80	4	10K	Panasonic Electronic Components	ERA-2AED103X
R50, R51, R65	3	330	Panasonic Electronic Components	ERA-2AEB331X
R53	1	121K	Yageo	RC0402FR-07121KL
R54, R60	2	165K	Panasonic Electronic Components	ERJ-2RKF1653X
R56	1	5.76K	Panasonic Electronic Components	ERJ-2RKF5761X
R57	1	42.2K	Panasonic Electronic Components	ERJ-2RKF4222X
R58	1	105K	Panasonic Electronic Components	ERJ-2RKF1053X
R59, R61, R63	3	100K	Panasonic Electronic Components	ERJ-2GEJ104X
R64	1	37.4K	Panasonic Electronic Components	ERJ-2RKF3742X
R66, R67, R68, R69, R70, R71, R72, R73, R74, R75, R76	11	43	Panasonic	ERA-2AKD430X
R78, R79	2	0 OHM	Panasonic Electronic Components	ERJ-S020R00X
SHNT1, SHNT2, SHNT3, SHNT4, SHNT5, SHNT6, SHNT7, SHNT8, SHNT9, SHNT10, SHNT11, SHNT12, SHNT13, SHNT14, SHNT15, SHNT16, SHNT17	17	QPC02SXGN-RC	Sullins Connector Solutions	QPC02SXGN-RC
SW1	1	Switch - Push Button	Panasonic	EVQ-PAD05RSwitch - Push Button
U1	1	DS320PR1601ZDG	Texas Instruments	DS320PR1601ZDG
U2	1	TMUX1133PWR	Texas Instruments	TMUX1133PWR
U3	1	SN74LVC125A_PW_14	Texas Instruments	SN74LVC125AQPWRQ1
U4	1	TPS548B22RVFT	Texas Instruments	TPS548B22RVFT
U5	1	AT24C02D-SSHM-T	Microchip Technology	AT24C02D-SSHM-T

6 References

For additional references, visit TI.com to search for the DS320PR1601 data sheet and other collateral.

7 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (January 2023) to Revision A (February 2023)

Page

-
- First public release of *EVM User's Guide* [2](#)
-

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