

## **DP159RSB Evaluation Module**

This document describes how to use and configure the DP159RSBEVM along with recommendations for system hardware implementation. These recommendations are only guidelines and it is the designer's responsibility to consider all system characteristics and requirements. Engineers should refer to the datasheet for technical details such as device operation, terminal description, and so forth.

### **Contents**

1	Overview .....	2
	1.1 What is the DP159? .....	2
	1.2 What is the DP159RSBEVM? .....	2
	1.3 What is Included in the DP159RSBEVM? .....	2
	1.4 DP159RSBEVM Board .....	3
2	Hardware Description .....	3
	2.1 Video Connectors for DP159 Ports .....	4
	2.2 Enable/Reset .....	4
	2.3 Power .....	4
	2.4 Jumper Configuration .....	5
	2.5 Component Population Configuration .....	6
	2.6 Local I <sup>2</sup> C Access Through J5 .....	6
	2.7 Local I <sup>2</sup> C Access Through USB Interface via TUSB3410 .....	7
	2.8 Rsdj Potentiometer .....	10
3	Quick Start Guide .....	10
4	References .....	10
5	EVM Bill of Materials .....	11
6	EVM Schematics .....	13
7	EVM Layout .....	20

### **List of Figures**

1	DP159RSBEVM Board .....	3
2	DP159RSBEVM Block Diagram .....	3
3	Register Status / Control Tab .....	7
4	Eye Scan Tab .....	8
5	Sample Eyescan at HDMI2.0 Raw .....	9
6	Sample Eyescan at HDMI2.0 Interpreted .....	9
7	HDMI Input Connectors .....	13
8	DP159RSB .....	14
9	HDMI TX Connector .....	15
10	DP159RSBEVM Select Options .....	16
11	Reset .....	17
12	1.1- and 3.3-V Regulators .....	18
13	TUSB3410 .....	19
14	Layer 1 (Top) .....	20
15	Layer 2 (GND) .....	20
16	Layer 3 (Power) .....	21

Aardvark is a trademark of Total Phase, Inc.  
All other trademarks are the property of their respective owners.

17	Layer 4 (Power) .....	21
18	Layer 5 (GND) .....	22
19	Layer 6 (Bottom).....	22

### List of Tables

1	Jumper Settings.....	5
2	Aardvark I <sup>2</sup> C (J5) Pin-Out.....	6
3	DP159 Target I <sup>2</sup> C Address .....	7
4	DP159RSBEVM Bill of Materials .....	11

## 1 Overview

### 1.1 What is the DP159?

The DP159 is a Dual-Mode DisplayPort to Transition Minimized Differential Signal (TMDS) retimer supporting Digital Video Interface (DVI) 1.0 and High Definition Multimedia Interface (HDMI) 1.4b and 2.0 output signals. The DP159 supports the Dual-Mode Standard version 1.1 type 1 and type 2 through the DDC link. The DP159 supports data rates up to 6 Gbps per data lane to support UltraHD (4K x 2K / 60 Hz) 8 bits per color high resolution video and HDTV with 16-bit color depth at 1080p (1920 x 1080 / 60 Hz). The DP159 can automatically configure itself as a redriver at data rates < 1.0 Gbps or as a retimer above this data rate.

### 1.2 What is the DP159RSBEVM?

The DP159RSBEVM is a PCB created to help customers evaluate the DP159 device for video applications. This EVM can also be used as a hardware reference design for implementation of the DP159 in the RSB package. PCB design/layout files can be provided upon request to provide PCB design illustrations of the routing/placement rules.

Please note that the EVM design supports both the standard DP159 application and a DP159-thru-HDMI application, so it contains many components that would not be needed by a typical DP159 application. A separate reference design specific to the DP159 is available for customers.

### 1.3 What is Included in the DP159RSBEVM?

The major components of the EVM are as follows:

- DP159RSB
- Standard DP sink connector (connects to source)
- Standard HDMI source connector (connects to sink)
- DC power regulators
- I<sup>2</sup>C programming interface for external I<sup>2</sup>C host connection
- USB interface (I<sup>2</sup>C utility available)

## 1.4 DP159RSBEVM Board

Figure 1 illustrates the DP159RSBEVM board.

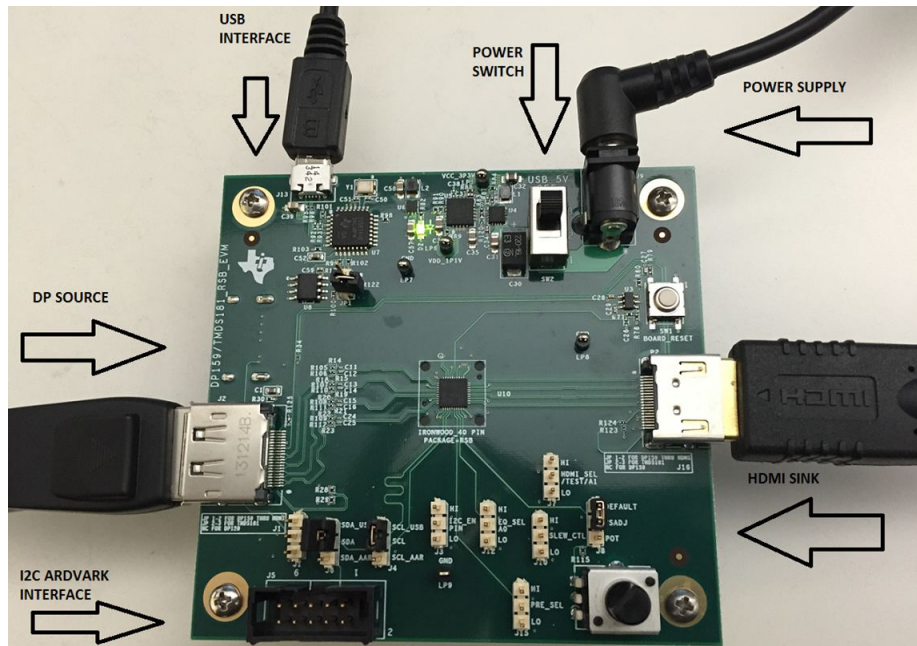
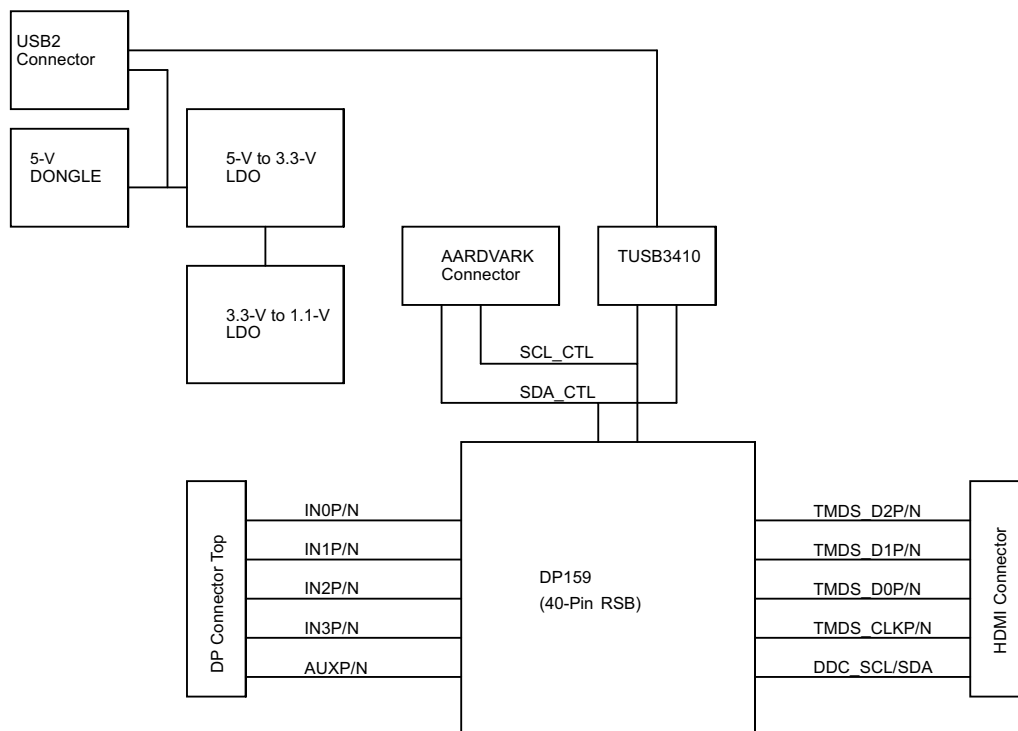


Figure 1. DP159RSBEVM Board

## 2 Hardware Description

Figure 2 shows the DP159RSBEVM block diagram.



100-Ω differential impedance for HDMI and DP differential pairs.

Figure 2. DP159RSBEVM Block Diagram

## 2.1 Video Connectors for DP159 Ports

The EVM has a DP connection for the source and a HDMI connection for the sink. J2 is a standard DP connector (Molex 47272-0001). P2 is a standard HDMI connector (Molex 4715-10001). There is a third video connection on the board for a HDMI source (P1), this function is not installed on the DP159RSBEVM.

## 2.2 Enable/Reset

There are three device enable/reset options to use with the EVM:

### A. Supervisor circuitry option

This is the default configuration on the DP159RSBEVM. The enable (EN) signal is held low until the power good (PG) from the 3.3-V voltage regulator reaches a stable high-voltage level then released high.

### B. RC timing option

C26 external capacitor and internal resistor are used to control the EN ramp time after the device is powered on. C26 is a Do Not Install (DNI option) by default. C26 needs to be installed and R77 needs to be uninstalled to enable this option.

### C. External control option

A push button (SW1) is provided for manual control of the DP159's EN/OE input.

## 2.3 Power

A DC power jack (J9) to accept a 5-V wall power adapter is provided on the EVM. The DC power jack (CUI Inc. PJ-202AH) has an inner diameter of 2.1 mm and an outer diameter of 5.5 mm. The tip of the +5-V power supply must be positive. A +5-V power supply of at least 1.5 A that meets the given requirements can be used to power the DP159RSBEVM. Power is provided to the EVM from the 5-V wall power adapter when SW2 is set to position 1.

### CAUTION

Care should be taken to not plug in any power source higher than the configured voltage (5 V).

Alternately, it is possible to power the EVM by connecting a USB Micro cable from J13 to a USB host and setting SW2 to position 3.

## 2.4 Jumper Configuration

Jumpers are provided to operate the device/EVM in different configurations. [Table 1](#) lists the jumper settings.

**Table 1. Jumper Settings**

Jumper	Signal Name	Description	Default Config
J1	HPD_SRC	JP 1-2 for DP159 thru HDMI JP 2-3 NOT USED NC for DP159	NC
J3	I2C_EN_PIN	JP 1-2 for I <sup>2</sup> C ENABLE JP 2-3 for PIN STRAP NC – PIN STRAP (internal pulldown)	NC
J4	SCL	JP 1-2 for USB IF TO I <sup>2</sup> C JP 2-3 for EXT IF TO I <sup>2</sup> C NC – N/A	JP 1-2: USB I <sup>2</sup> C Interface
J6	SDA	JP 1-2 for USB IF TO I <sup>2</sup> C JP 2-3 for EXT IF TO I <sup>2</sup> C NC – N/A	JP 1-2: USB I <sup>2</sup> C Interface
J7	HDMI_SEL_TEST_A1	JP 1-2 for: <ul style="list-style-type: none"> <li>• I<sup>2</sup>C Addr bit A1 = 1, when I2C_EN = H</li> <li>• Test mode, when I2C_EN = L</li> </ul> JP 2-3 for: <ul style="list-style-type: none"> <li>• I<sup>2</sup>C Addr bit A1 = 0, when I2C_EN = H</li> <li>• Normal mode, when I2C_EN = L</li> </ul> NC for weak internal pulldown (normal mode)	NC
J8	VSADJ	JP 1-2 for 6.5 k $\Omega$ JP 2-3 for adjustable resistance NC – N/A	JP 1-2: Default of 6.5 k $\Omega$
J10	SLEW_CTL	JP 1-2 for fastest data rate JP 2-3 for 20 ps slow NC for 40 ps slow	NC
J12	EQ_SEL_A0	JP 1-2 for: <ul style="list-style-type: none"> <li>• I<sup>2</sup>C Addr bit A0 = 1, when I2C_EN = H</li> <li>• Fixed EQ at 14 dB, when I2C_EN = L</li> </ul> JP 2-3 for: <ul style="list-style-type: none"> <li>• I<sup>2</sup>C Addr bit A0 = 0, when I2C_EN = H</li> <li>• Fixed EQ at 7.5 dB, when I2C_EN = L</li> </ul> NC for adaptive EQ	NC
J15	PRE_SEL	JP 1-2 NOT USED JP 2-3 for –2.5 dB NC for 0 dB	JP 2-3

## 2.5 Component Population Configuration

To allow the DP159RSBEVM to support both the default DP input as well as a HDMI test input, there are many components that need to be removed, placed, or modified depending on the board configuration. Here's a summary of the default component configuration for the DP159RSBEVM. In addition, the unused HDMI receptacle is depopulated.

Function	Reference Designator	DP159RSBEVM
Differential Pair - IN	C11, C12, C13, C14, C15, C16, C24, C25	populated with 0.1 $\mu$ F
Differential Pair - HDMI IN	R14, R15, R18, R19, R20, R21, R22, R23	not populated
SDA / SCL - HDMI	R16, R17, R24, R25, R134, R135	not populated
Differential Pair - DP IN	R112, R109, R111, R108, R110, R107, R106, R105	populated with 0 $\Omega$
SDA / SCL / HPD - DP	R33, R31, R32 (R126, R136, R140, R141 - snoop)	populated with 0 $\Omega$
Pullup Differential Pair HDMI IN	R1, R2, R3, R4, R6, R7, R8, R9	populated, but not connected

### 2.5.1 HPD Snoop Option

To accommodate systems that do not properly resend DDC commands after HPD goes low, we have implemented a HPD snoop mode on the DP159RSBEVM. This mode allows the HPD line to be routed around the DP159, but remain connected to the DP159 on the sink side to allow the DP159 to snoop its state. This snoop mode is disabled by default on the DP159RSBEVMs.

- Pop R131, no pop R129, R130, R139 for HPD on
- No pop R131, pop R129, R130, R139 for HPD snoop only

### 2.5.2 DDC Snoop Option – not Available for DP159RSB REV B

To accommodate systems that do not properly support clock stretching on the DDC lines, we have implemented a snoop mode on the DP159RSBEVM. This mode allows the DDC lines to be routed around the DP159RSB, but remain connected to the DP159RSB on the sink side to allow the DP159RSB to snoop the DDC traffic. This snoop mode is disabled by default on the DP159RSB REV B1 EVMs.

- Pop R126, R136, R140, R141. No pop R31, R32 – DP159RSB, DDC snoop only
- Pop R31, R32. No pop R126, R136, R140, R141- DP159RSB, DDC on

## 2.6 Local I<sup>2</sup>C Access Through J5

Access to DP159's local I<sup>2</sup>C signals is provided via the J5 input connector. Note that I<sup>2</sup>C signal levels should be at 3.3 V when I<sup>2</sup>C interface is accessed through the connector.

A standalone external I<sup>2</sup>C host can be connected via J5 for debug and control purposes. An example of an external I<sup>2</sup>C Host controller is the Total Phase Aardvark™ I<sup>2</sup>C/SPI Host Adapter (Total Phase Part#: [TP240141](#)). Sample scripts for this I<sup>2</sup>C Host controller are provided by request.

**Table 2. Aardvark I<sup>2</sup>C (J5) Pin-Out**

J5 pin #	Description	J5 pin #	Description
1	SCL_CTL	2	GND
3	SDA_CTL	4	NC
5	NC	6	NC
7	NC	8	NC
9	NC	10	GND

**Table 3. DP159 Target I<sup>2</sup>C Address<sup>(1)</sup>**

DP159 I <sup>2</sup> C Target Address							
Bit 7 (MSB)	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 (W/R)
A6	A5	A4	A3	A2	A1	A0	
1	0	1	1	1	1	0	0/1

<sup>(1)</sup> The target I<sup>2</sup>C address for DP159 can be modified by the EVM jumper settings.

**2.7 Local I<sup>2</sup>C Access Through USB Interface via TUSB3410**

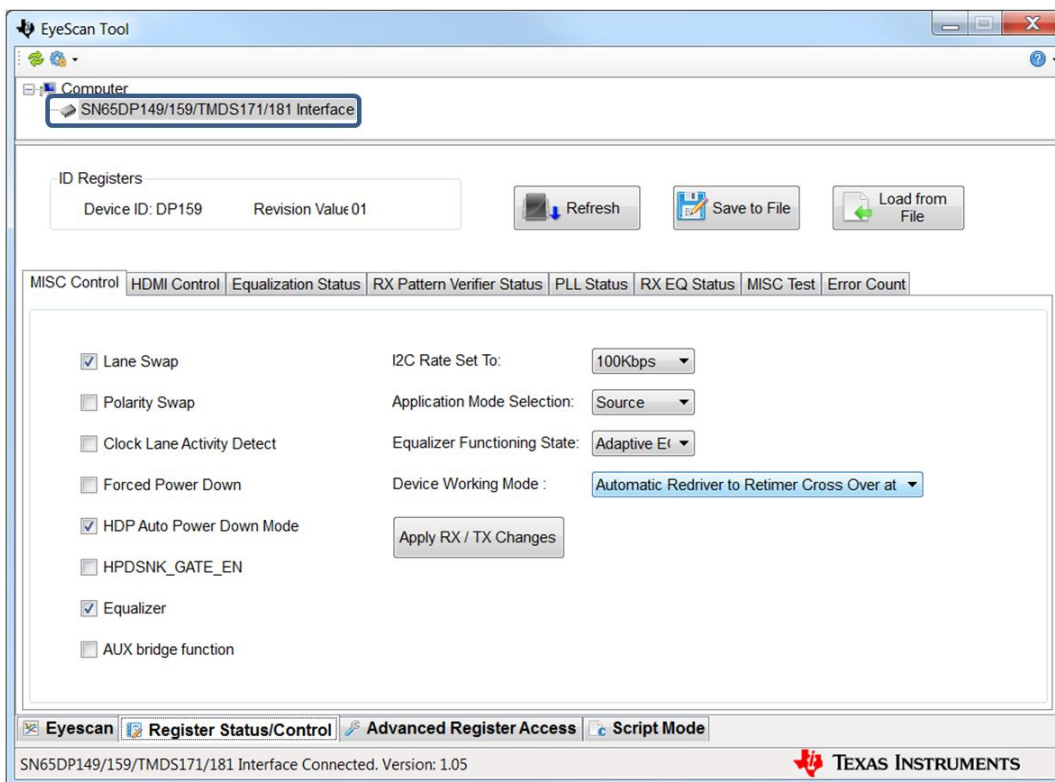
Access to DP159's local I<sup>2</sup>C signals is also provided through the TUSB3410 on the DP159RSBEVM using a USB TI Utility called Eye Scan. To use the utility:

- Install the Eye Scan software from Texas Instruments
- J6 must be set to SDA – SDA\_USB
- J4 must be set to SCL – SCL\_USB
- Attach USB micro cable to J13 and to the host computer

**NOTE:** The USB connection should be made prior to installing any DP or HDMI cables.

- Start the Eye Scan software

Figure 3 shows the Register Status / Control tab.



**Figure 3. Register Status / Control Tab**

Confirm that the SN65DP149/159/TMDS171/181 Interface is present and selected at the top. If it is not, check the USB connection and confirm that the driver is loaded in Device Manager. It may take a moment for the USB driver to load, if the DP159RSB does not appear, hit the Refresh button. This tab can be used to read and write the status and control registers of the device.

Figure 4 shows the Eye Scan tab.

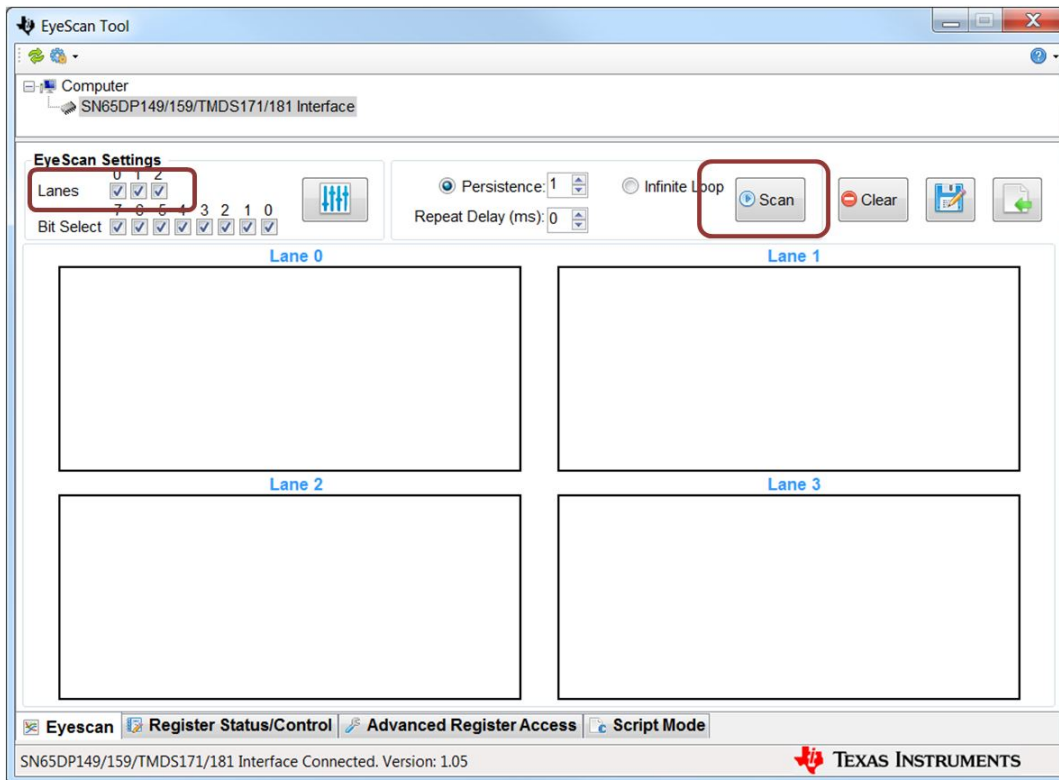


Figure 4. Eye Scan Tab

To run an Eye Scan, select the Eye Scan tab, select the relevant lanes, and press scan. Note that Eye Scan cannot be performed when the device is in retimer mode, it does not function in redriver mode.



Note that at HDMI 2.0 speeds there is a bug that causes invalid eyescan results. Results that look like this:

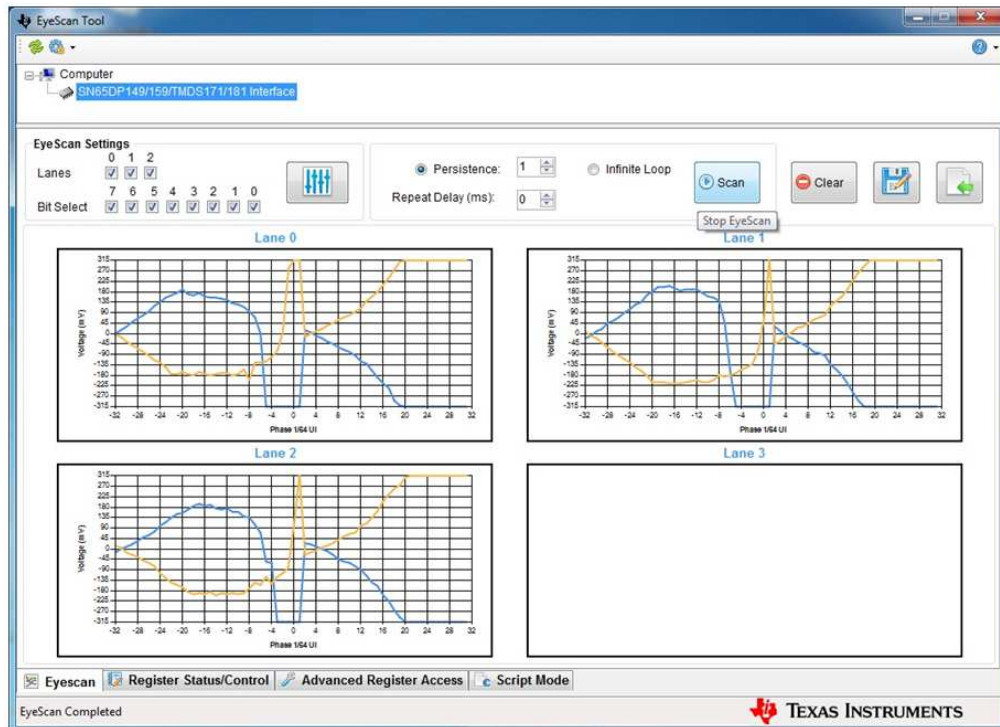


Figure 5. Sample Eyescan at HDMI2.0 Raw

Should be interpreted as this:

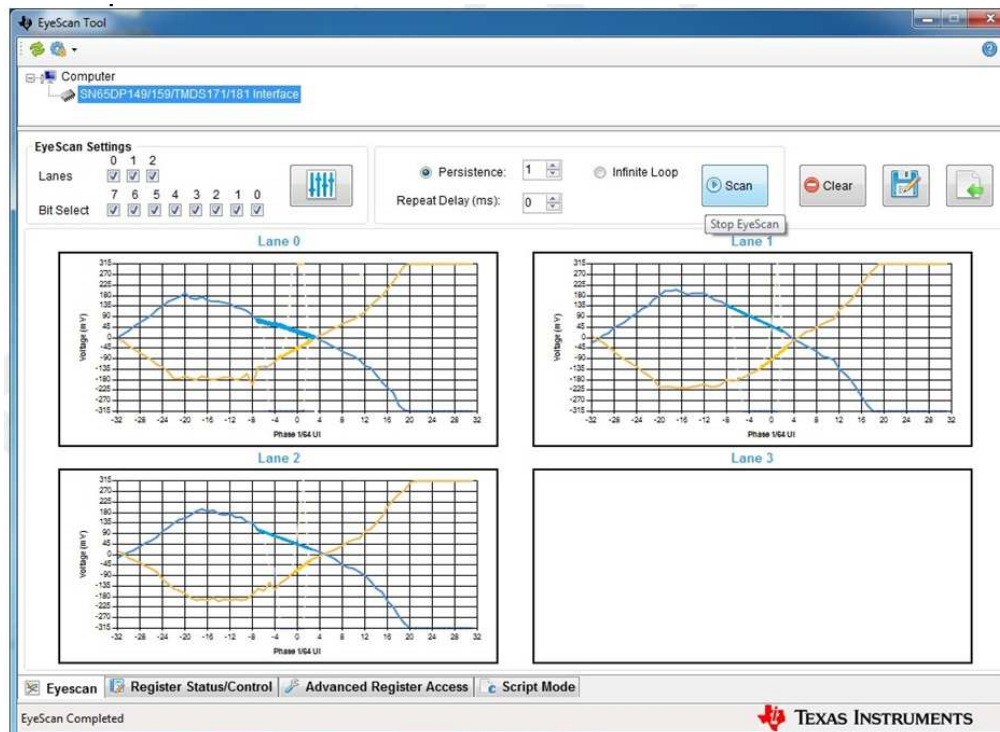


Figure 6. Sample Eyescan at HDMI2.0 Interpreted

## 2.8 Rsadj Potentiometer

The default Rsadj value on the DP159RSBEVM is 6.5 k $\Omega$ . The optimal value for an application may vary from 4.7 k $\Omega$  to 7 k $\Omega$ . To allow customers to test the effects of various Rsadj values, there is a potentiometer on the EVM at R76. The Rsadj value can be varied by turning the knob and setting J8 to [2,3].

## 3 Quick Start Guide

The following steps provide quick start instructions:

1. Connect USB cable from J13 to a USB host, set SW2 to 3. LED D2 should light up.  
Option: Apply 5-V power to J9, set SW2 to 1. LED D2 should light up.
2. If using external I<sup>2</sup>C adapter instead of pin straps, please configure the DP159 at this step using J5 or through the USB interface.
3. Plug in a DP source using a standard DP cable into J2 (Standard DP connector).
4. Plug in an HDMI video sink device into P2 (standard HDMI connector) using a standard HDMI cable.
5. Video output on HDMI sink should be observed.

## 4 References

1. DP159 Data Sheet
2. [Aardvark Adapter User Manual](#)
3. High-Definition Multimedia Interface Specification Version 1.4b.
4. High-Definition Multimedia Interface Specification Version 2.0.

## 5 EVM Bill of Materials

Table 4 lists the DP159RSBEVM BOM.

**Table 4. DP159RSBEVM Bill of Materials**

Item	Qty	Reference	Part	PCB Footprint	Manufacturer	Part Number
1	2	C1,C52	1 uF	603	Taiyo Yuden	LMK107B7105KA-T
2	12	C9,C10,C17,C18,C19, C21,C23,C29,C40, C46,C59,C60	0.1uF	402	Yageo	CC0402KRX5R6BB104
3	5	C8,C20,C35,C36,C57	10uF	805	TDK	C2012X5R1A106K125AB
63	1	C31	10uF	805	TDK	C2012X5R1C106K085AC
4	8	C11,C12,C13,C14,C15, C16,C24,C25	0.1uF	201	TDK	C0603X5R0J104M
5	5	C22,C37,C41,C42,C47	0.01uF	402		
6	1	C26 - DNI	DNI_200nF	402		
7	1	C27	18pF	402	AVX	04025A180JAT2A
8	1	C28	220pF	402		
9	1	C30	220uF	7343	Kemet	T491D227K016AT
10	1	C34	3.3 nF	402		
11	1	C32	22uF	805		
12	2	C39,C58	2.2uF	805		
13	0	C38,R14,R15,R16,R17, R18,R19,R20,R21,R22, R23,R24,R25,R34,R87, R92,R93,R104,R120, R123,R125,R134,R135, R129,R130,R139,R126, R136,R140,R141	DNI	402 / 201		
14	2	C45,C49	22pF	402		
15	2	C50,C51	33pF	402		
16	1	D1	Zener 6V	SOT23	Diodes Inc.	MMBZ5233B-FDICT-ND
17	1	D2	LED Green 0805	805	Lite On	LTST-C171GKT
18	1	JP1	JUMPER	HDR_THVT_1x2_100		
19	9	J1,J3,J4,J6,J7,J8,J10,J12, J15	HDR3X1 M .1	HDR_THVT_1x3_100	3M	961103-6404-AR
20	1	J2	Display_Port_Connector_S ink_0	DISPLAYPORT	Molex	47272-0001
21	1	J5	Header 5x2 0.1" thru-hole	con_thvt_shrd_2x5_100_m	3M	N2510-6002-RB
22	1	J9	2.1 mm x 5.5 mm	PJ-202AH	CUI Inc.	PJ-202AH (PJ-002AH)
23	1	J13	USB Micro B	USB Micro B	FCI	10103592-0001LF
24	12	LP5,LP6,LP7,LP8,LP9, LP10,LP11,LP12,LP13, LP15,LP16,LP17	LP	TESTLOOP	KOBIKONN	151-103-RC
25	1	L1	2.2 uH	1008	TDK	VLS252010ET-2R2M
26	1	L2	1 uH	1008	TDK	NLCV25T-1R0M-EFR
27	4	L3, L4, L5, L6	CHOKE	805	Murata	DLW21SN900HQ2L
28	1	P1 - DNI	HDMI_IN	CON_HDMI_RT_19_0p50mm	Molex	471510001
29	1	P2	HDMI_OUT	CON_HDMI_RT_19_0p50mm	Molex	471510001
30	2	Q1,Q2	FDV301N_NFET_8V	SOT23	Fairchild Semiconductor	FD301N
31	8	R1,R2,R3,R4,R6,R7,R8, R9	50	201		
32	1	R5	100	402		
33	6	R10,R11,R99,R100,R101, R121	1K	402		
34	3	R12,R27,R81	100K	402		
35	1	R13	10	402		
36	12	R31,R32,R33,R105,R106, R107,R108,R109,R110, R111,R112,R124	0	201		

**Table 4. DP159RSBEVM Bill of Materials (continued)**

Item	Qty	Reference	Part	PCB Footprint	Manufacturer	Part Number
37	6	R28,R29,R45,R46,R58, R59	2K	402		
38	7	R77,R80,R83,R84,R89, R122,R131	0	402		
39	1	R30	1M	402		
40	10	R57,R60,R63,R64,R65, R66,R67,R68,R69,R70	65K	402		
41	1	R75	6.5K	402		
42	1	R76	PTV09 10K POT	THRUHOLE	BOURNS	PTV09A-4015F-B103
43	3	R78,R98,R102	10K	402		
44	2	R79,R88	4.7K	402		
45	1	R82	500	402		
46	1	R85	750K	402		
47	1	R86	240K	402		
48	1	R90	1.87K	402		
49	1	R91	4.99K	402		
50	1	R94	1.5K	402		
51	2	R95,R96	33	201		
52	1	R103	15K	402		
53	1	R115	47K	402		
54	1	SW1	PB_SWITCH	SW_MOM_2NO	OMRON	B3SN-3012P
55	1	SW2	3POS_SPDT	THRUHOLE_3POS	NKK Switches	MS13ANW03
56	1	U10	DP159RSB	40_RSB	TI	
57	1	U3	TPS3808G30DBVT	6DBV	TI	TPS3808G30DBVT
58	1	U4	TPS62150A	RGT16	TI	TPS62150ARGTT
59	1	U6	TPS61240	6DRV	TI	TPS61240DRVT
60	1	U5	TPS74201RGWT	RGW20	TI	TPS74201RGWT
61	1	U7	TUSB3410	LQFP32	TI	TUSB3410VF
62	1	U8	24LC256	8SOIC	ON Semiconductor	CAT24C256W
64	1	U16	TPD2E001	drl_5pin	TI	TPD2E001
65	1	Y1	12 MHz Crystal	ECX-32	ECS Inc.	ECS-120-20-33-TR

## 6 EVM Schematics

Figure 7 through Figure 13 show the DP159RSBEVM schematics.

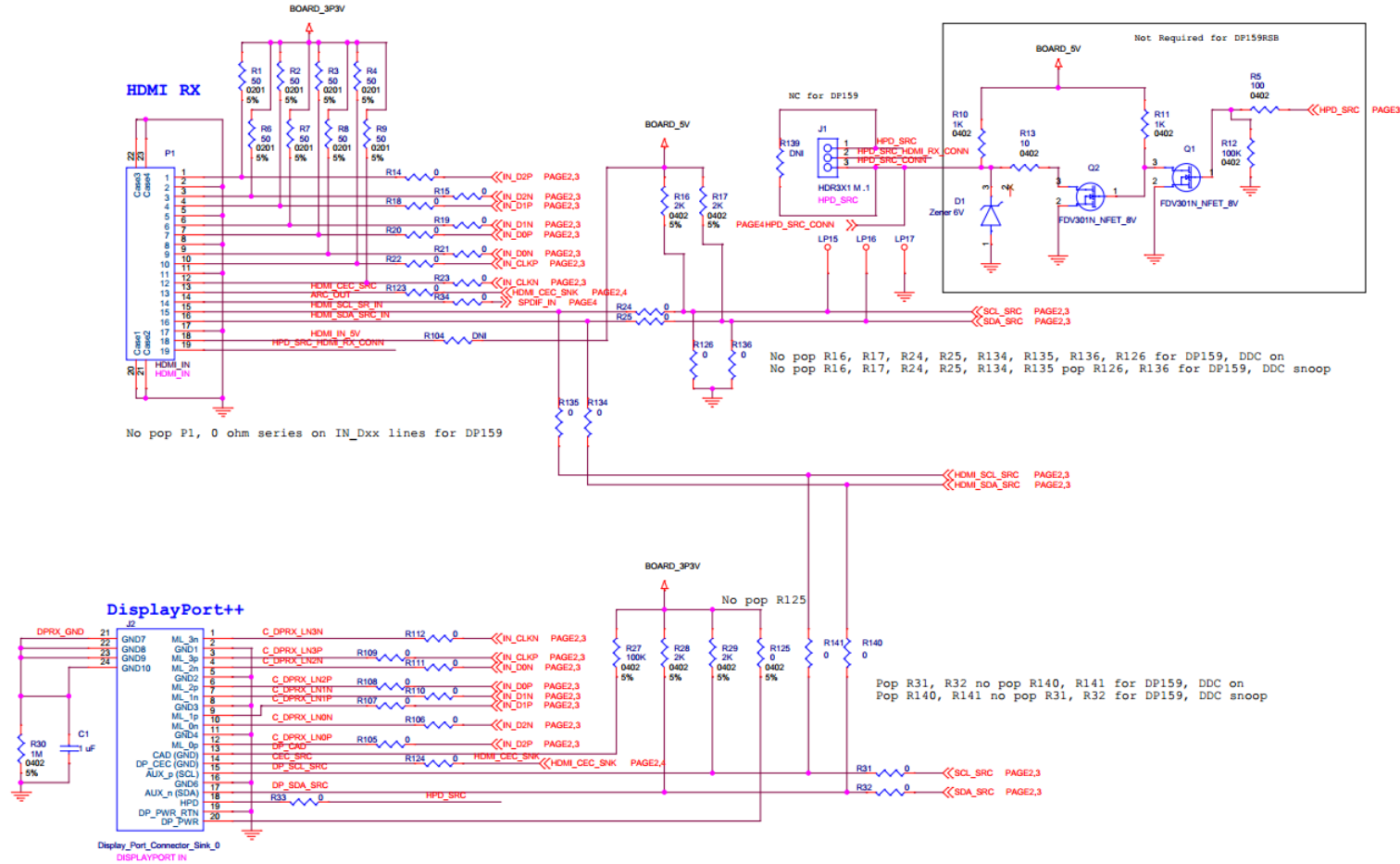


Figure 7. HDMI Input Connectors

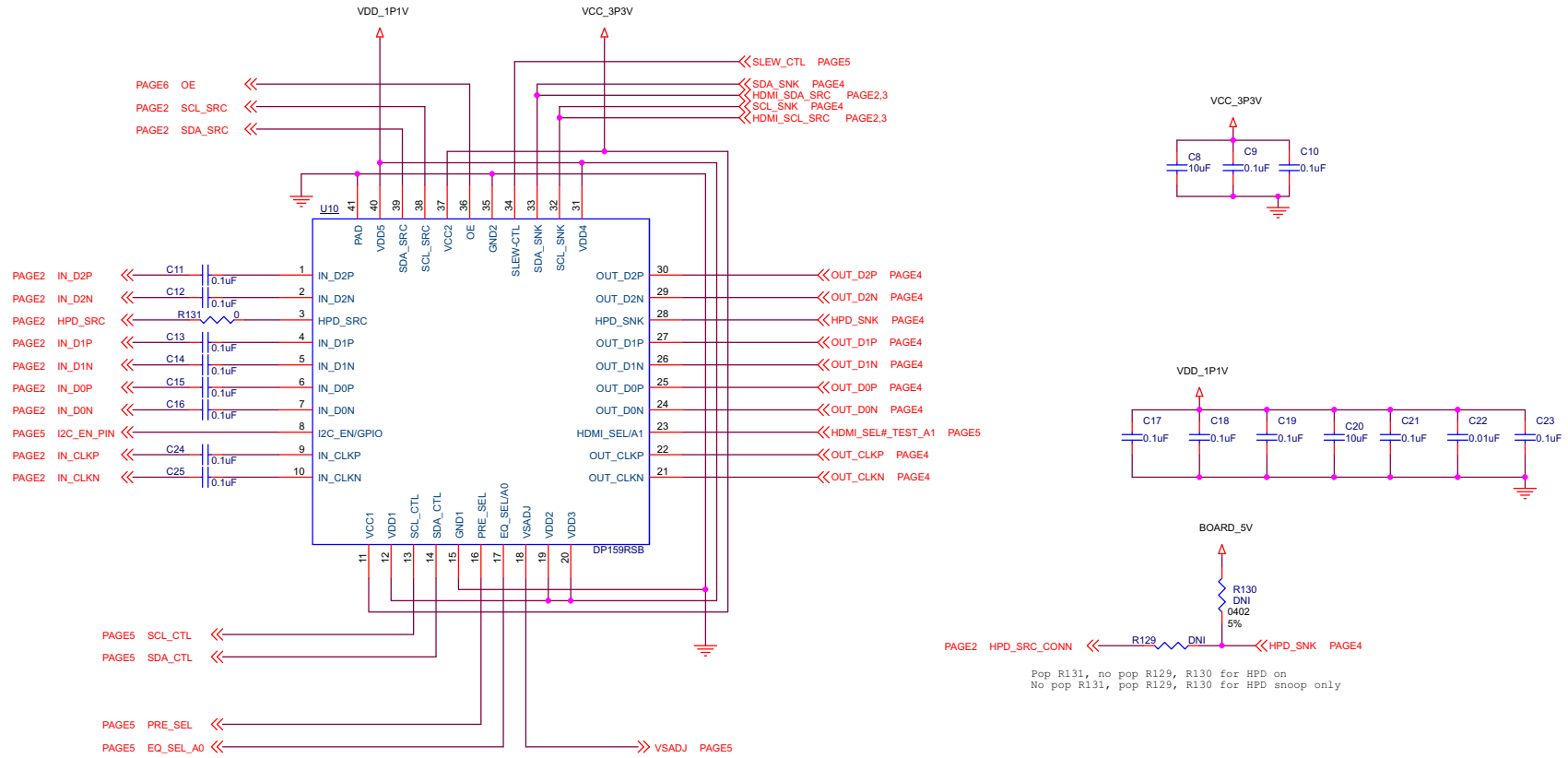


Figure 8. DP159RSB

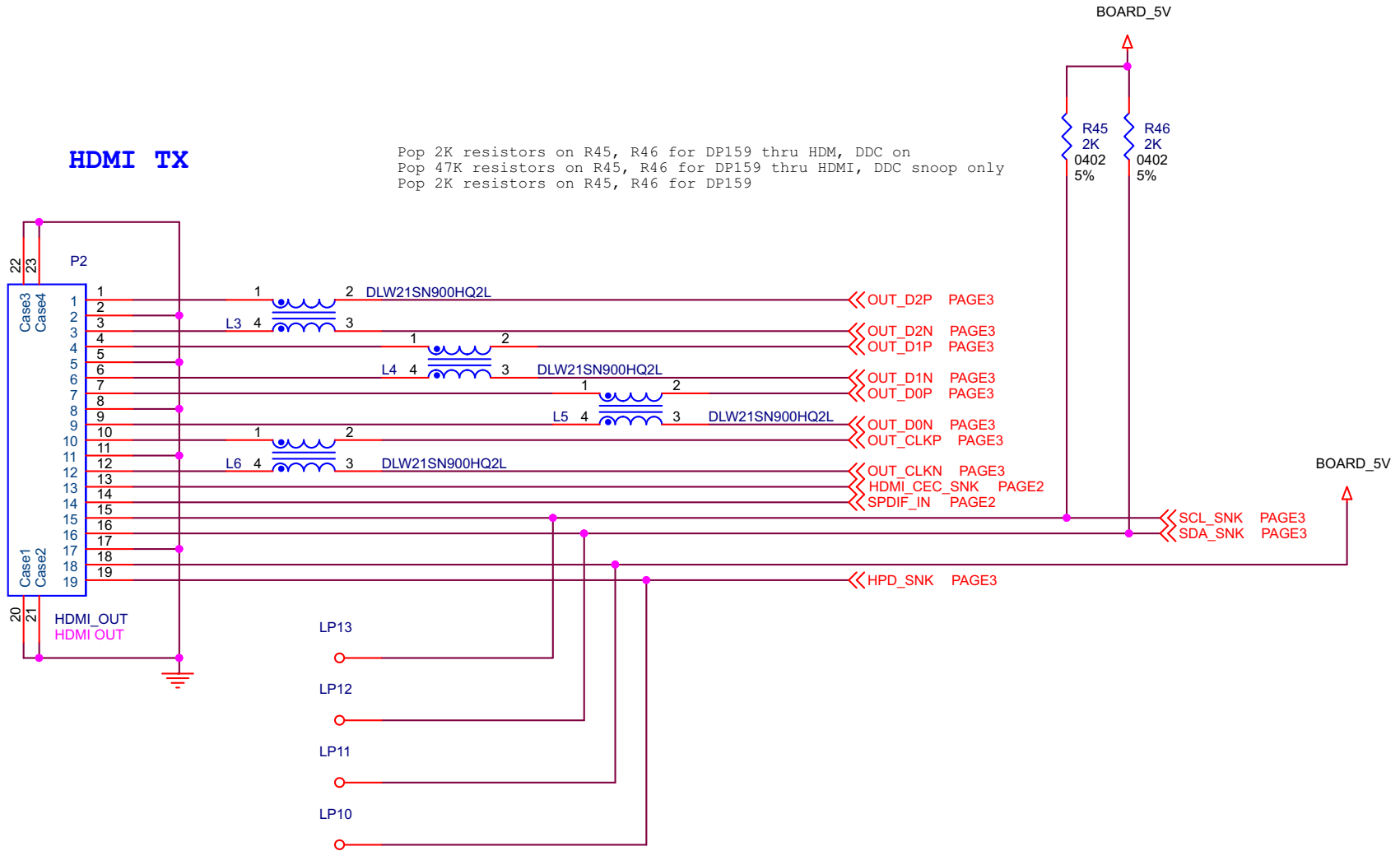


Figure 9. HDMI TX Connector

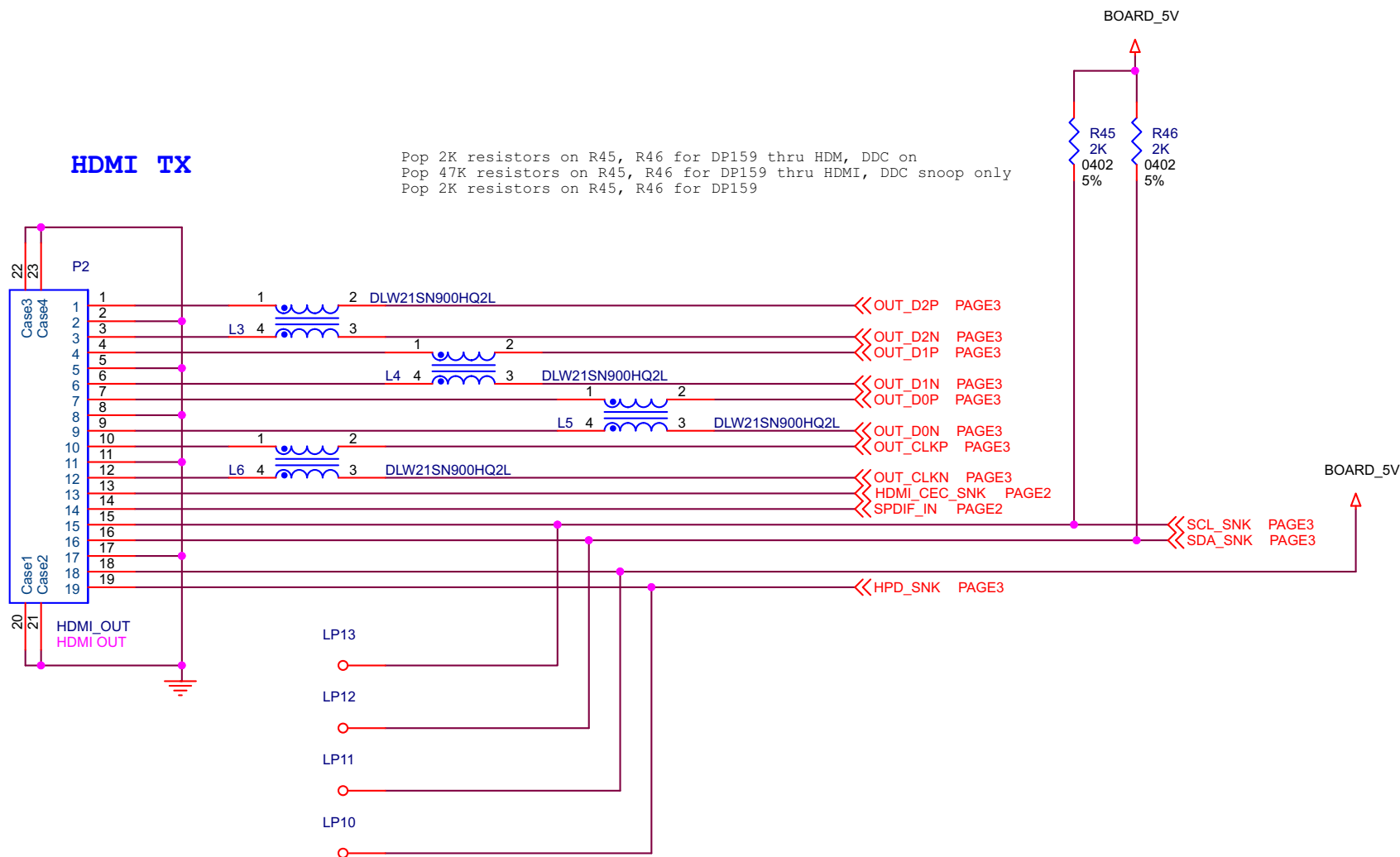


Figure 10. DP159RSBEVM Select Options



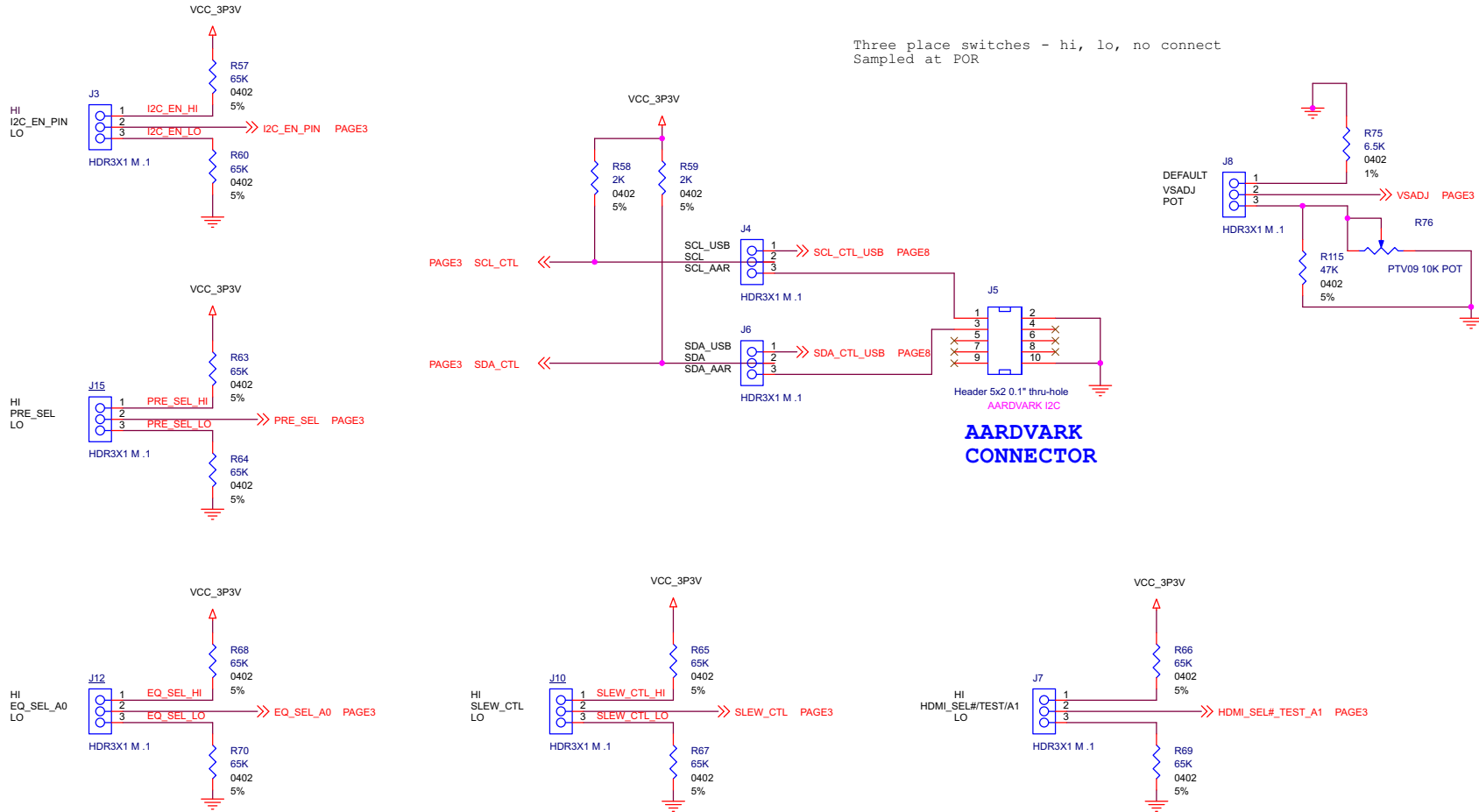


Figure 11. Reset

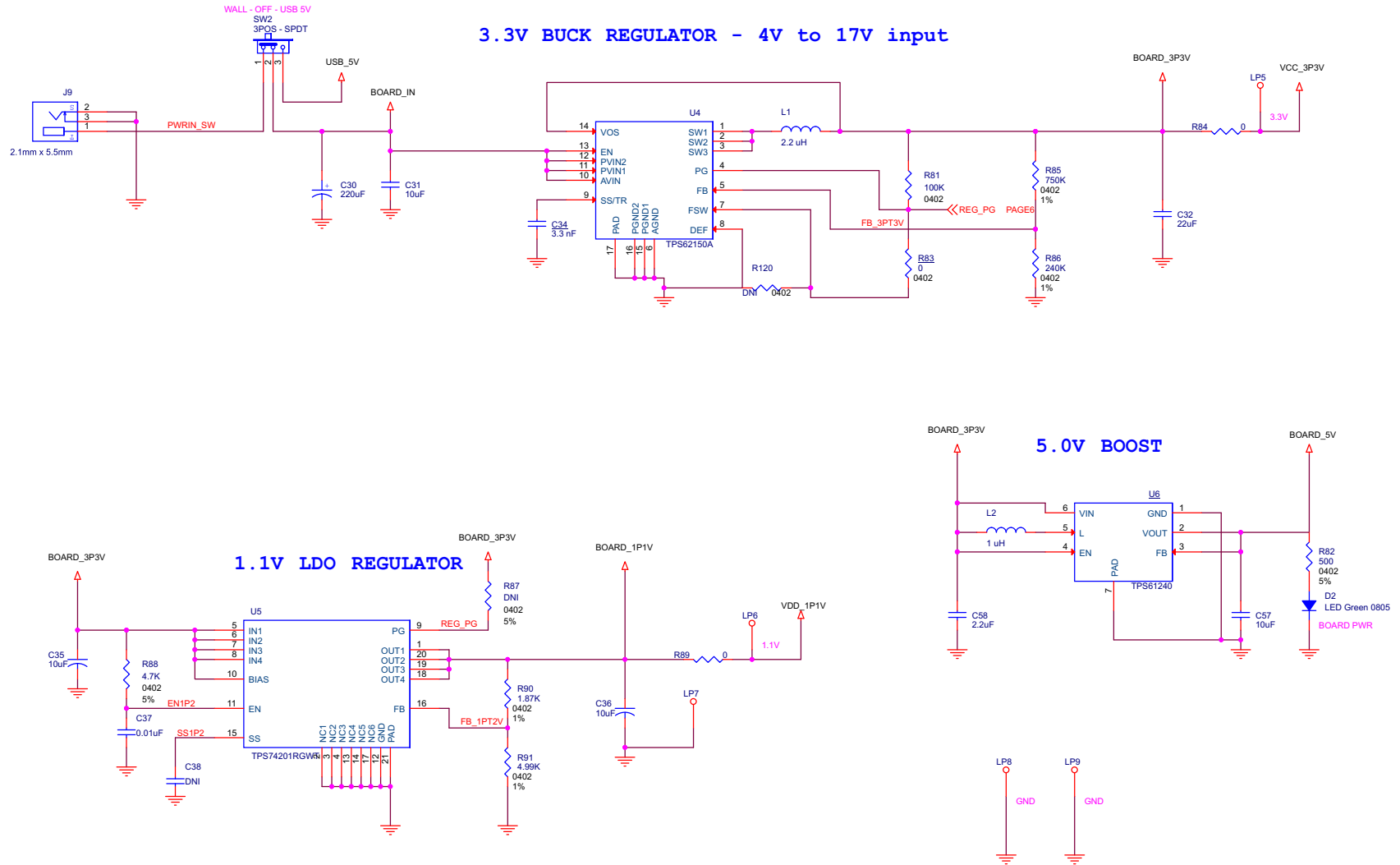


Figure 12. 1.1- and 3.3-V Regulators

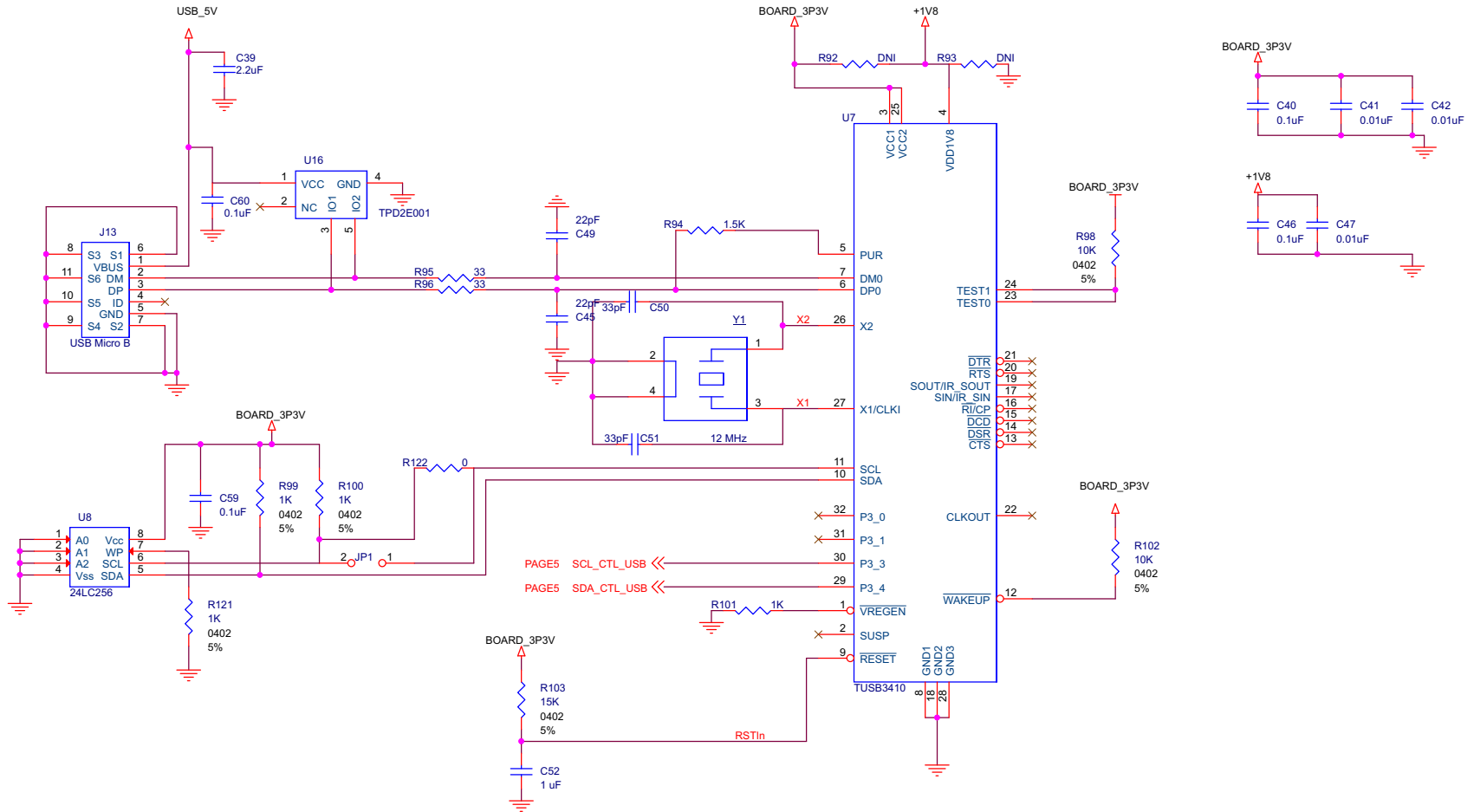


Figure 13. TUSB3410

## 7 EVM Layout

Figure 14 through Figure 19 illustrate the DP159RSBEVM PCB layouts.

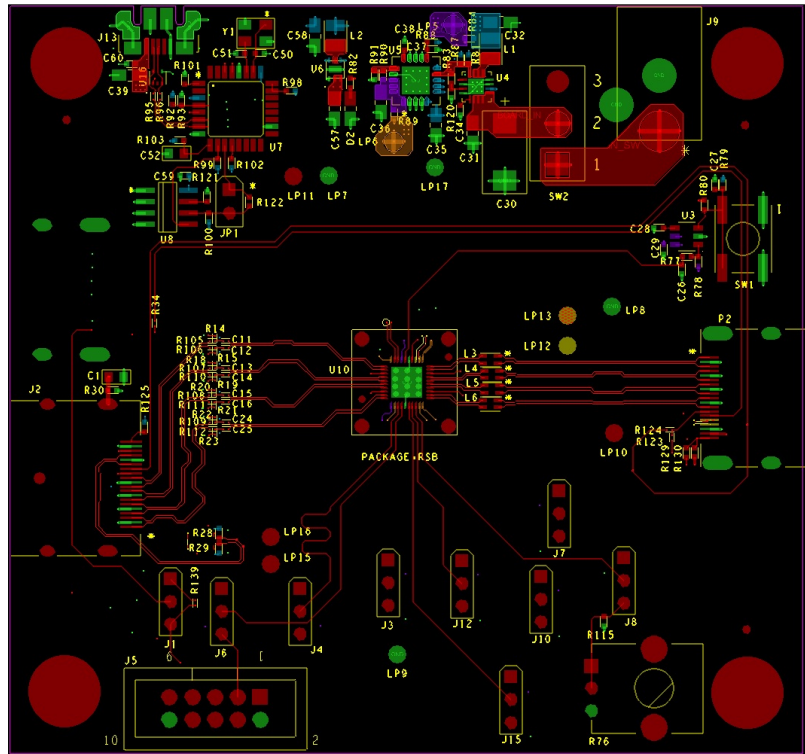


Figure 14. Layer 1 (Top)

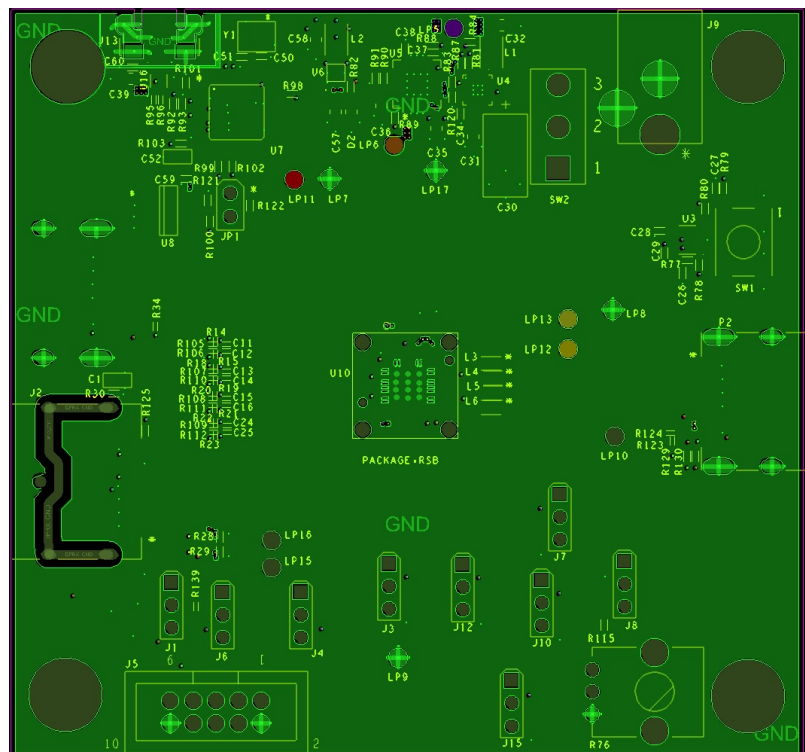


Figure 15. Layer 2 (GND)

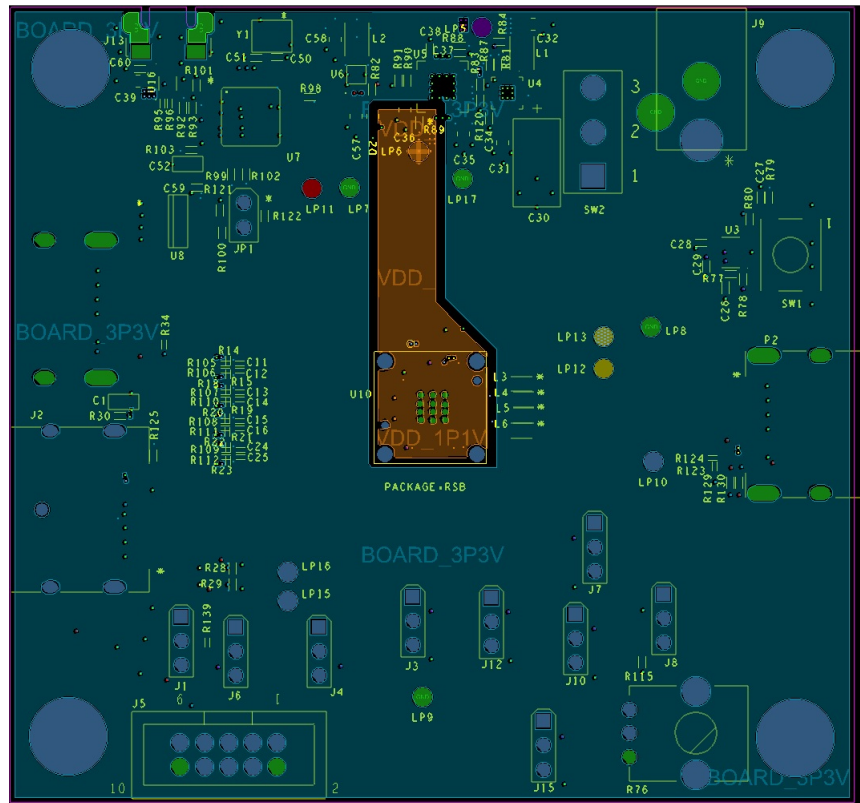


Figure 16. Layer 3 (Power)

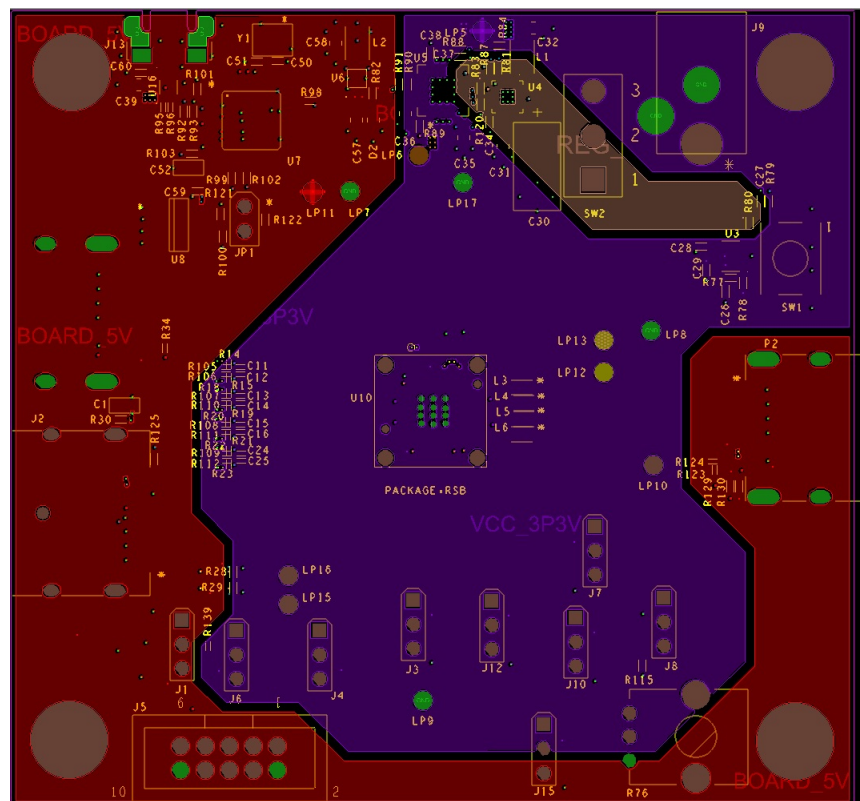


Figure 17. Layer 4 (Power)

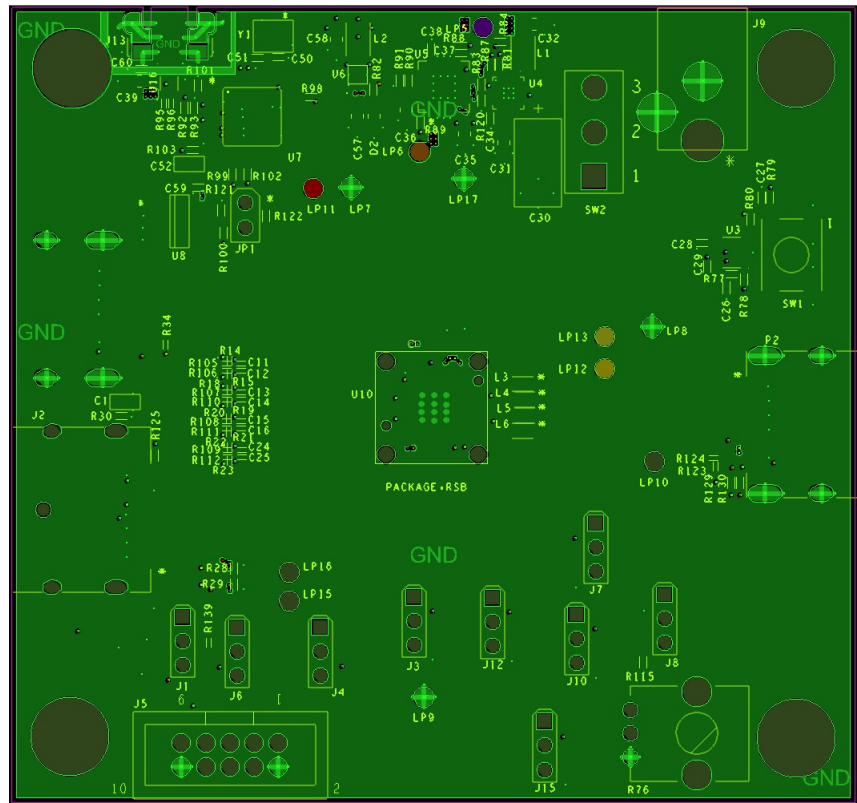


Figure 18. Layer 5 (GND)

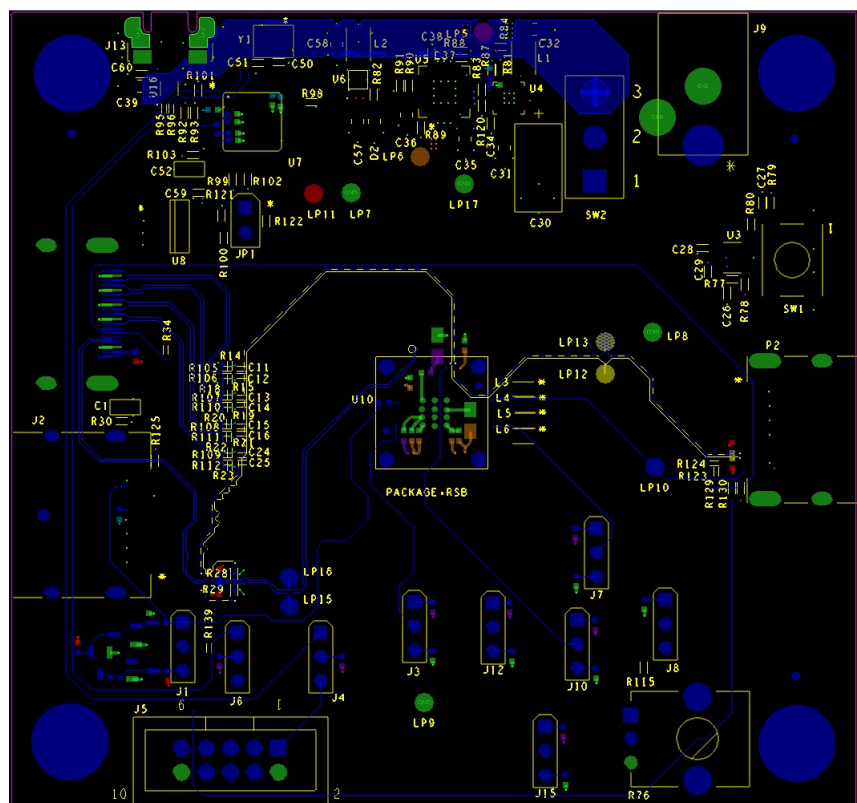


Figure 19. Layer 6 (Bottom)

### Revision History

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

<b>Changes from A Revision (October 2015) to B Revision</b>	<b>Page</b>
• Added text and <a href="#">Figure 5</a> and <a href="#">Figure 6</a> .....	9

### Revision History

<b>Changes from Original (August 2015) to A Revision</b>	<b>Page</b>
• Changed the following rows in the <i>Jumper Settings</i> table: J1, J2, J15. ....	5
• Changed Qty and Reference columns in Item 13 and 36 of the <i>DP159RSBEVM Bill of Materials</i> table. ....	11
• Changed <i>HDMI Input Connectors</i> schematic image. ....	13

## STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
  - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductor products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
  - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
  - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
  - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.
3. *Regulatory Notices:*
  - 3.1 *United States*
    - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.
    - 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

### CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### FCC Interference Statement for Class A EVM devices

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*



## FCC Interference Statement for Class B EVM devices

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### 3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

#### Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

#### Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

#### Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

### 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。  
[http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page)

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・インスツルメンツ株式会社  
東京都新宿区西新宿 6 丁目 2 4 番 1 号  
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)  
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。 [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)

#### 3.4 *European Union*

##### 3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

#### 4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

##### 4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

## IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated ("TI") technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications that include TI products, you will thoroughly test such applications and the functionality of such TI products as used in such applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your non-compliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include; without limitation, TI's standard terms for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>), [evaluation modules](#), and [samples](http://www.ti.com/sc/docs/sampterm.htm) (<http://www.ti.com/sc/docs/sampterm.htm>).

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2018, Texas Instruments Incorporated