TMDS171 RGZ EVM

This document describes how to use and configure the TMDS171 RGZ EVM and provides 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 TMDS171 datasheet (SLLSEN7) for technical details such as device operation, terminal description, and so forth.

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1 Overview

1.1 What is the TMDS171?

The TMDS171 is a digital video interface (DVI) or high-definition multimedia interface (HDMI®) retimer. The TMDS171 supports four TMDS channels, audio return channel (SPDIF_IN/ARC_OUT), and digital display control (DDC) interfaces. The TMDS171 supports signaling rates up to 6Gbps to allow for the highest resolutions of 4k/2k/60p 24-bits per pixel and up to WUXGA 16-bit color depth or 1080p with higher refresh rates. The TMDS171 can be configured to support the HDMI standard. The TMDS171 will automatically configure itself as a re-driver at low data rate (< 1.0Gbps) or as a re-timer above this data rate by default, or it can be set to re-driver-only or re-timer-only modes.

1.2 What is the TMDS171 EVM?

The TMDS171 EVM is a printed-circuit board (PCB) created to help customers evaluate the TMDS171 device for video applications with HDMI interfaces. This EVM can also be used as a hardware reference design for implementation of the TMDS171 in the RGZ package. PCB design and layout files can be provided upon request to provide PCB design illustrations of the routing and placement rules with a TMDS171 or DP159 RGZ component.

Note that the EVM design supports the TMDS171, DP159, and DP159 thru HDMI applications, so it contains many components that would not be needed by a typical TMDS171 application. A separate reference design specific to TMDS171 and DP159 are available for customers.

1.3 What is Included in the TMDS171 EVM?

The major components of the EVM are as below:

- TMDS171RGZ
- Standard HDMI source connector (receptacle)
- Standard HDMI sink connector (receptacle)
- DC power regulators
- I²C programming interface for external I²C host connection
- USB interface (utility available)

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1.4 What Does This EVM Look Like?

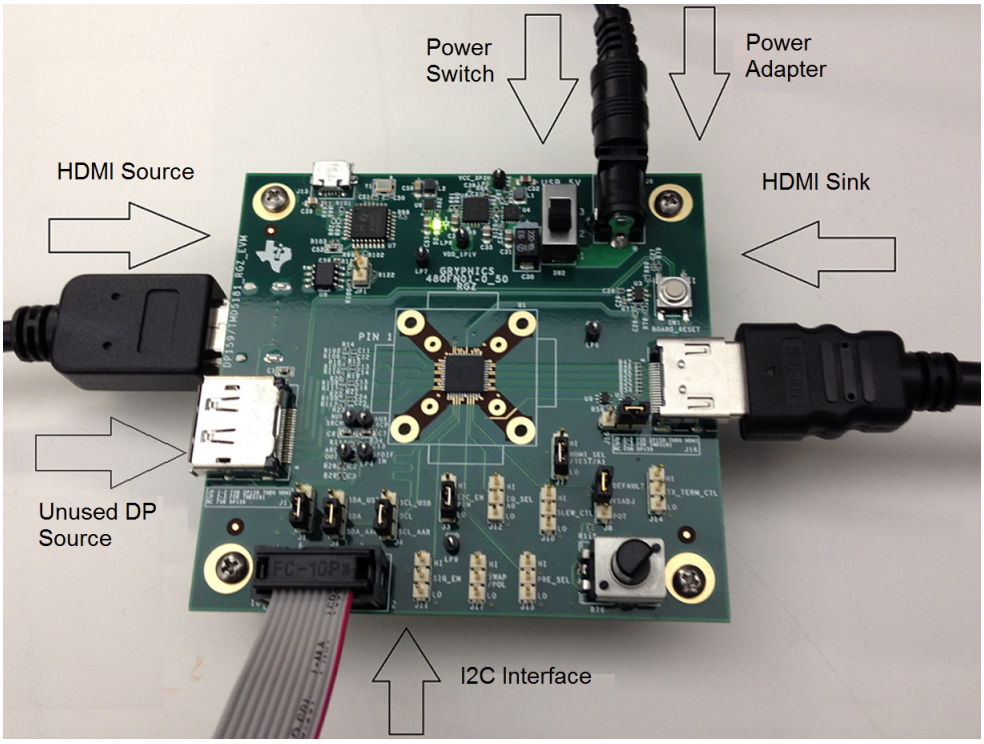


Figure 1. TMDS171 RGZ EVM

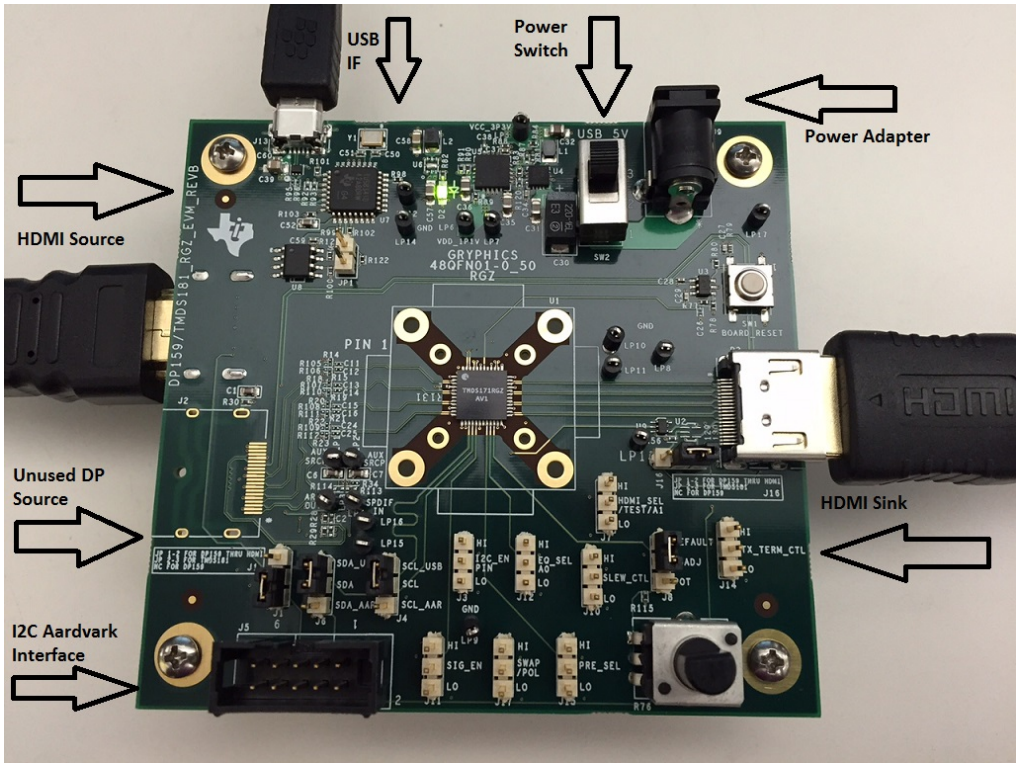


Figure 2. TMDS171 RGZ EVM REVB

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2 Hardware Description

Figure 3 illustrates the EVM block diagram.

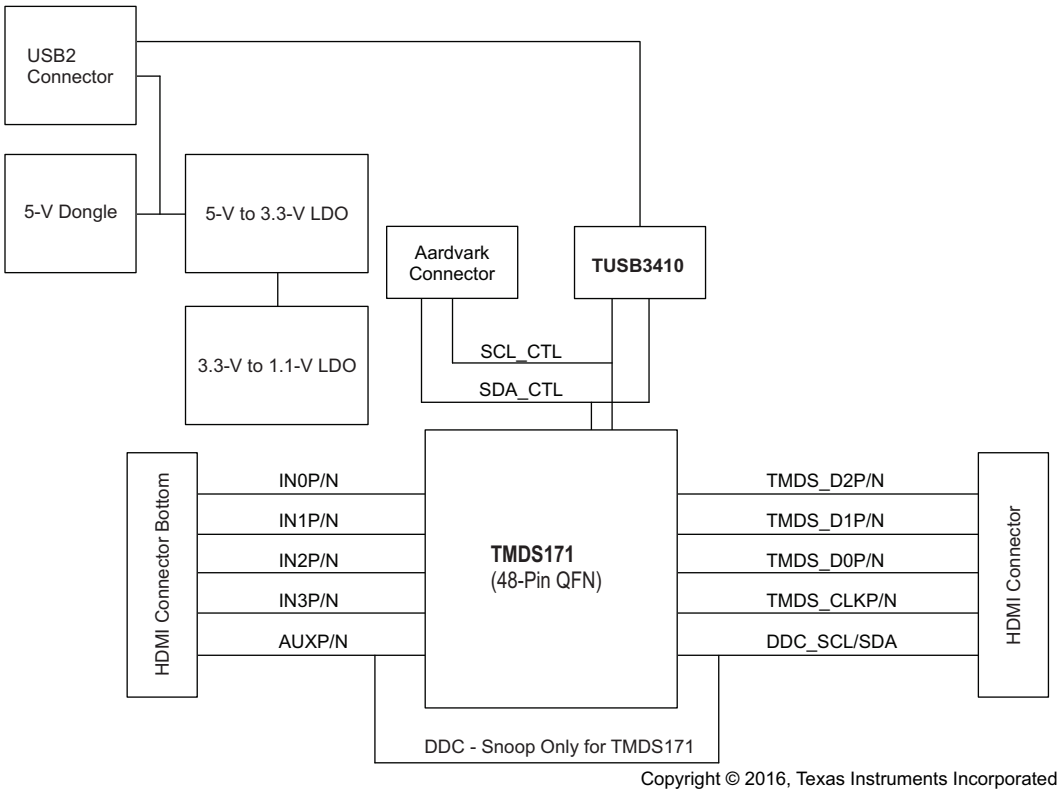


Figure 3. TMDS171 RGZ EVM Block Diagram

2.1 Video Connectors for TMDS171 Ports

The EVM has two HDMI connections for video. P1 and P2 are standard HDMI connectors (Molex 4715-10001). There is a third video connection on the board for DisplayPort (J2), this function is not supported on the TMDS171RGZ EVM.

2.2 Local I^2C Access

The J5 input connector provides access to the local I^2C signal of the TMDS171. Note that I^2C signal levels should be at 3.3 V when the I^2C interface is accessed through the connector.

A standalone external I^2C host can be connected via J5 for debug and control purposes. An example of an external I^2C Host controller is the Total Phase™ Aardvark I2C/SPI™ Host Adapter (Total Phase Part#: TP240141). Sample scripts for this I^2C host controller are provided by request.

Table 1. Aardvark I2C (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

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Table 2. TMDS171 Target I²C Address

TMDS171 I²C[1] 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
7 Bit Address = 5Eh							

(1) The target I²C address for TMDS171 can be modified by the EVM jumper settings.

2.3 Enable/Reset

There are three device enable or reset options to use with the EVM.

1. Supervisor circuitry option

   This is the default configuration on the TMDS171 EVM. 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 and then is released high.

2. 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 DNI (Do Not Install option), by default. C26 must be installed and R77 must be uninstalled to enable this option.

3. External control option

   A push button (SW1) is provided for manual control of the TMDS171 EN/OE input.

2.4 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 1.0 A that meets the above requirements can be used to power the TMDS171 RGZ EVM. Power is provided to the EVM when SW2 is set to position 1.

CAUTION

Do 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 to a host and setting SW2 to position 3. Using the EVM in this manner may exceed USB compliance requirements for power consumption.

Note that to prevent any back-driving of 5 V in the system, most TMDS171 EVMs have been modified to receive 5 V from the HDMI source connection to drive the Board_5V. This has been done by removing U6 and installing R104 on the EVMs.

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2.5 Jumper Configuration

Jumpers are provided to operate the device and EVM in different configurations.

Table 3. SW1 DIP Switch Setting

DIP SW No	Signal Name	Description	Default Config
J1	HPD_SRC	JP 1–2 for DP159 thru HDMI JP 2–3 for TMDS171 NC for DP159	JP 2–3 Allows for 3.3 V to 5 V transition of HPD_SRC signal
J3	I2_EN_PIN	JP 1–2 for I2C ENABLE JP 2–3 for PIN STRAP NC – N/A	JP 2–3 Enables device configuration from I^2C or pin straps
J4	SCL	JP 1–2 for USB IF to I2C JP 2–3 for EXT IF to I2C NC – N/A	JP 1–2 USB I^2C Interface
J6	SDA	JP 1–2 for USB IF to I2C JP 2–3 for EXT IF to I2C NC – N/A	JP 1–2 USB I^2C Interface
J7	HDMI_SEL_TEST_A1	JP 1–2 for: • I2C Addr bit A1 = 1, when I2C_EN = H • Test mode, when I2C_EN = L JP 2–3 for: • I2C Addr bit A1 = 0, when I2C_EN = H • Normal mode, when I2C_EN = L NC for weak internal pulldown (Normal mode)	JP 2–3
J8	VSADJ	JP 1–2 for 7 k JP 2–3 for adjustable resistance NC – N/A	JP 1–2 *The default value is 4.64 kΩ early EVMs (prior to revision B)*
J10	SLEW_CTL	JP 1–2 for fastest data rate JP 2–3 for 20 ps slow NC for 40 ps slow	NC
J11	SIG_EN	JP 1–2 for Signal Detect Enabled JP 2–3 for Signal Detect Disabled NC for internal pulldown (Signal Detect Disabled)	NC
J12	EQ_SEL_A0	JP 1–2 for: • I2C Addr bit A0 = 1, when I2C_EN = H • Fixed EQ at 14 dB at 3G, when I2C_EN = L JP 2–3 for: • I2C Addr bit A0 = 0, when I2C_EN = H • Fixed EQ at 7.5 dB at 3G, when I2C_EN = L NC for Adaptive EQ	NC
J14	TX_TERM_CTL	JP 1–2 for no transmit term JP 2–3 for transmit term in 150–300 ohm NC for auto select of term	NC
J15	PRE_SEL	JP 1–2 for –5 dB JP 2–3 for –2.5 dB NC for 0 dB	NC
J16	CEC CTL	JP 1–2 for DP159 thru HDMI JP 2–3 for TMDS171 NC for DP159	JP 2–3 Shorts HDMI_CEC_SRC to HDMI_CEC_SINK
J17	SWAP_POL	JP 1–2 for RX Polarity Swap (Retimer Mode Only) JP 2–3 for RX Lane Swap NC for normal	NC

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2.6 Component Population Configuration

To allow the TMDS171 EVM to support both the TMDS171 RGZ device and the DP159 RGZ device, there are many components that must be removed, placed, or modified, depending on the board configuration. Here is a summary of the component configuration for the TMDS171. In addition, the unused source receptacle can be depopulated.

Function	Reference Designator	TMDS171
DIFFERENTIAL PAIR - IN	C11, C12, C13, C14, C15, C16, C24, C25	populated with 0 Ω
DIFFERENTIAL PAIR - HDMI IN	R14, R15, R18, R19, R20, R21, R22, R23	populated with 0 Ω
SDA / SCL - HDMI	R24, R25	populated with 0 Ω
DIFFERENTIAL PAIR - DP IN	R112, R109, R111, R108, R110, R107, R106, R105	not populated
SDA / SCL / HPD - DP	R33, R31, R32	not populated
ARC / SPDIF to DP	C2, C3	not populated
ARC / SPDIF to HDMI	C4, C5, C6, C7, R34	populated with 1 µF / 0 Ω
ARC / SPDIF SHORT	R113, R114	not populated
PULL UP DIFFERENTIAL PAIR HDMI OUT (not on revision B)	R37, R38, R39, R40, R41, R42, R43, R44	not populated
DIFFERENTIAL PAIR - HDMI OUT (not on revision B)	R47, R48, R49, R50, R51, R52, R53, R54	populated with 0 Ω
PULL UP DIFFERENTIAL PAIR HDMI IN	R1, R2, R3, R4, R6, R7, R8, R9	not populated

2.6.1 HPD Snoop Option – not available prior to Revision B EVM

To accommodate systems that do not properly resend DDC commands after HPD goes low, TI has implemented an HPD snoop mode on the TMDS171RGZ revision B EVM. This mode allows the HPD line to be routed around the TMDS171, but remain connected to the TMDS171 on the sink side to allow the TMDS171 to snoop its state. This snoop mode is disabled by default on the TMDS171RGZ revision B EVMs.

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

2.6.2 DDC Snoop Option – not available prior to Revision B EVM

To accommodate systems that do not properly support clock stretching on the DDC lines, TI implemented a snoop mode on the TMDS171RGZ revision B EVM. This mode allows the DDC lines to be routed around the TMDS171, but remain connected to the TMDS171 on the sink side to allow the TMDS171 to snoop the DDC traffic. This snoop mode is enabled by default on the TMDS171RGZ revision B EVMs.

- Pop R16, R17, R24, R25. No pop R123, R124, R125, R126 - TMDS171, DDC on
- No pop R16, R17, R24, R25. Pop R123, R124, R125, R126 - TMDS171, DDC snoop only

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2.7 USB Interface via TUSB3410

- Install the Eye Scan software from TI
- J6 must be set to SDA – SDA_USB
- J4 must be set to SCL – SCL_USB
- Attached the USB micro cable to J13 and to the host computer
- Start the Eye Scan software

Figure 4 illustrates the *Eye Scan* opening tab.

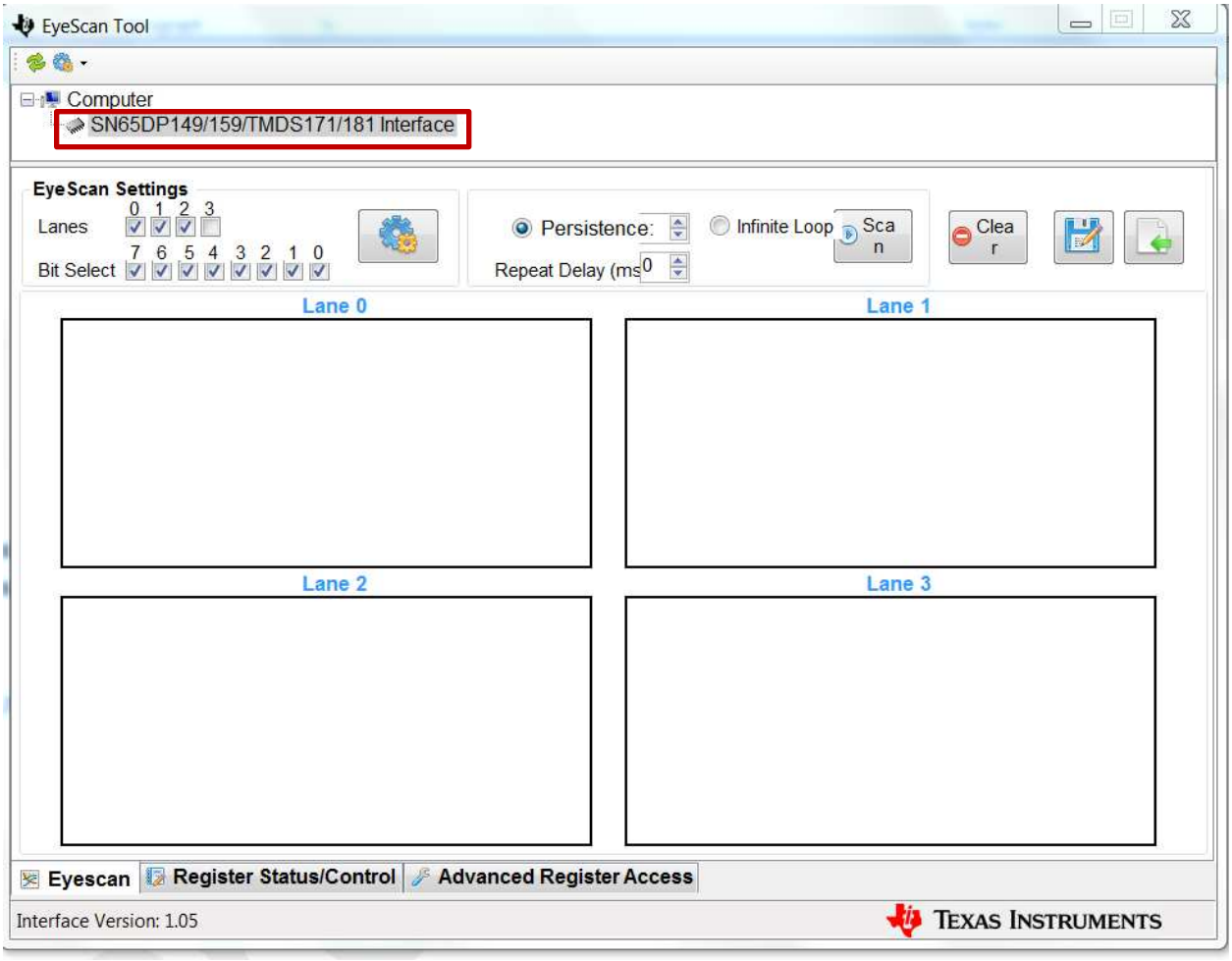


Figure 4. Eye Scan Opening Tab

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Confirm that the SN65DP149/159/TMDS171/171 interface is present and selected. If it is not, check the USB connection and confirm that the driver is loaded in *Device Manager*.

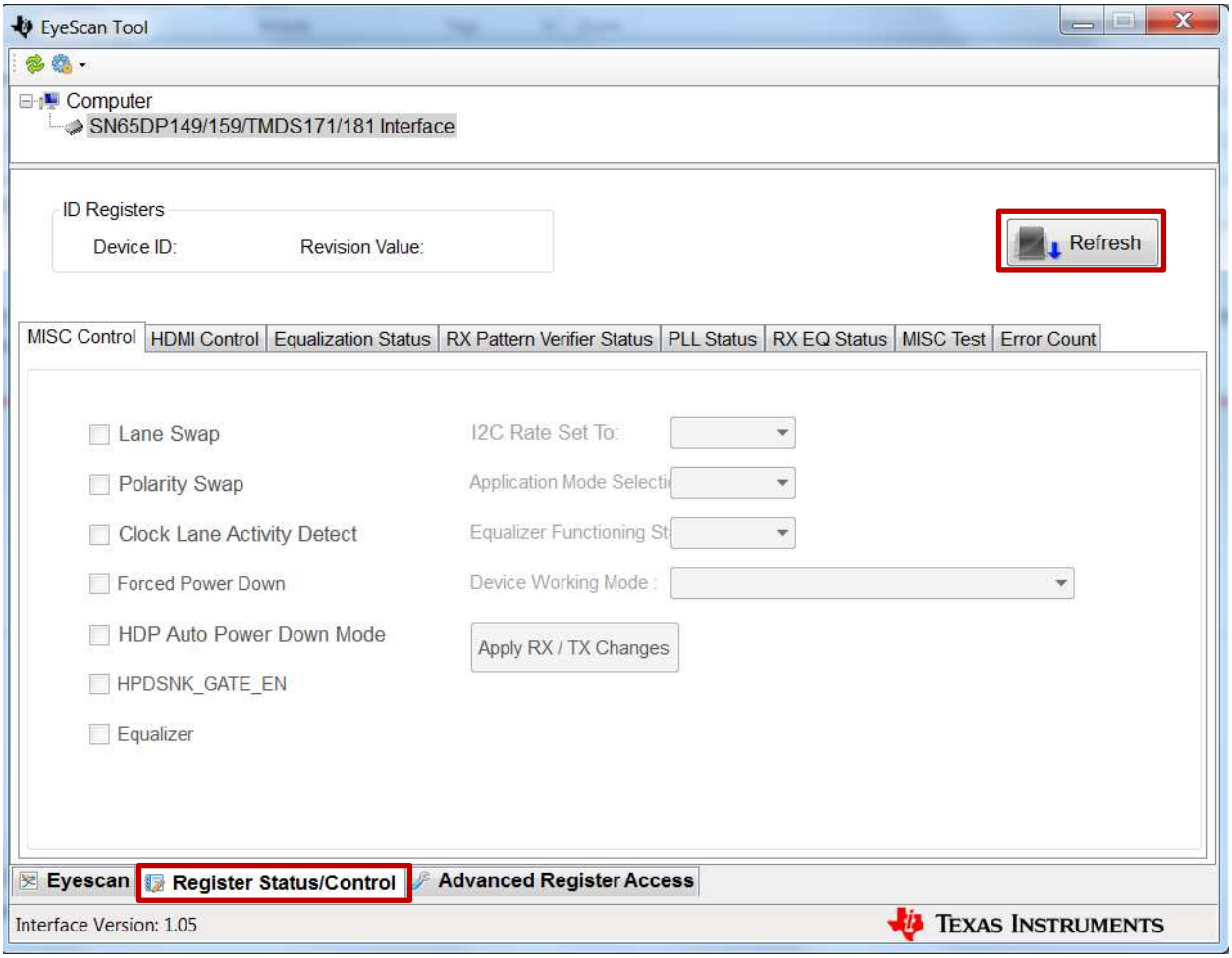


Figure 5. Register Status/Control Tab

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Select the *Register Status/Control* tab and click *Refresh*.

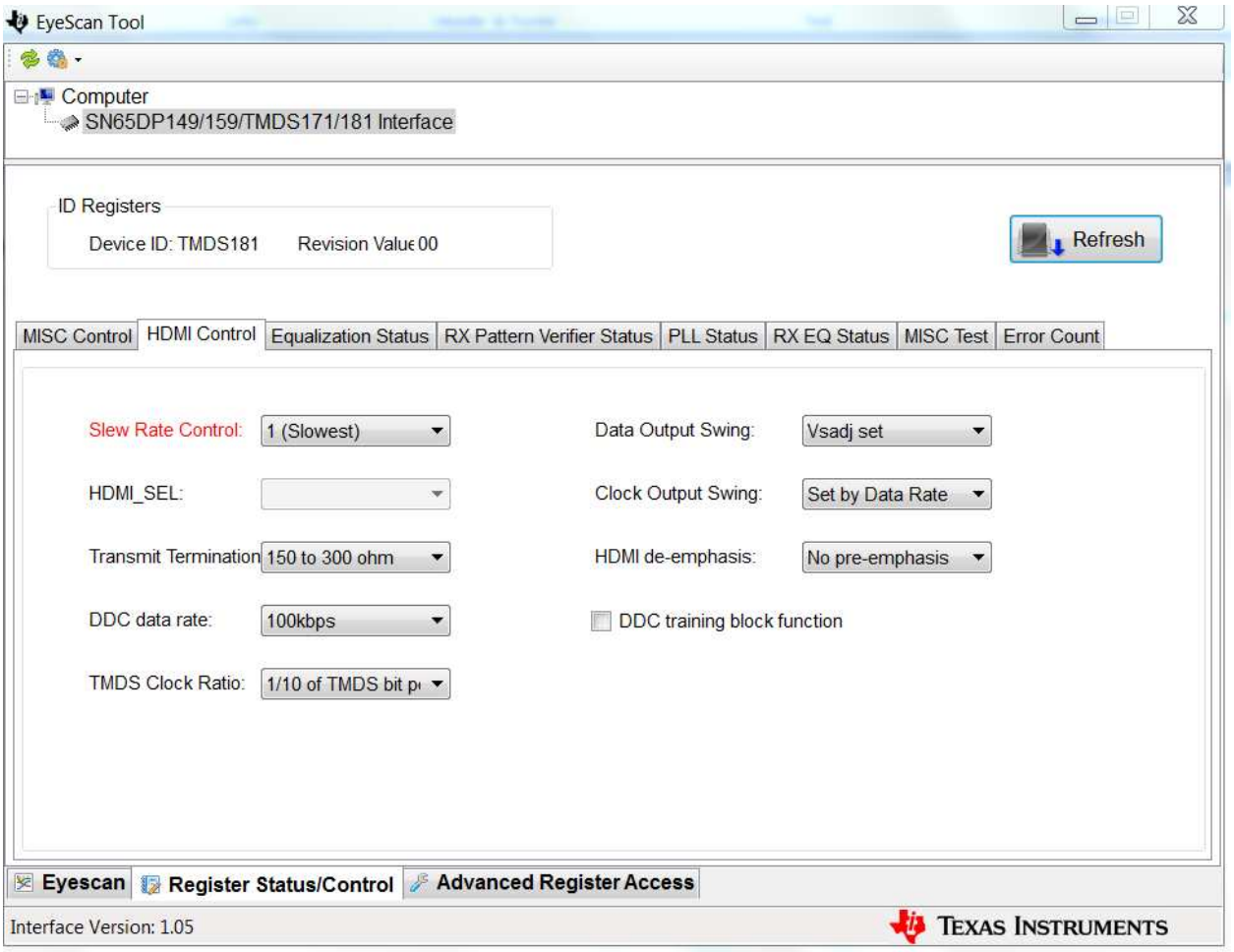


Figure 6. TMDS171 Device with TMDS Clock Ratio set to 1/10

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If using a generator or source that does not support DDC clock stretching per the I²C specification, when running at HDMI speeds it may be necessary to force the *TMDS Clock Ratio Bit*. Select the *HDMI Control* tab and check the *DDC clock training block function*, change the *TMDS Clock Ratio:* to 1/40.

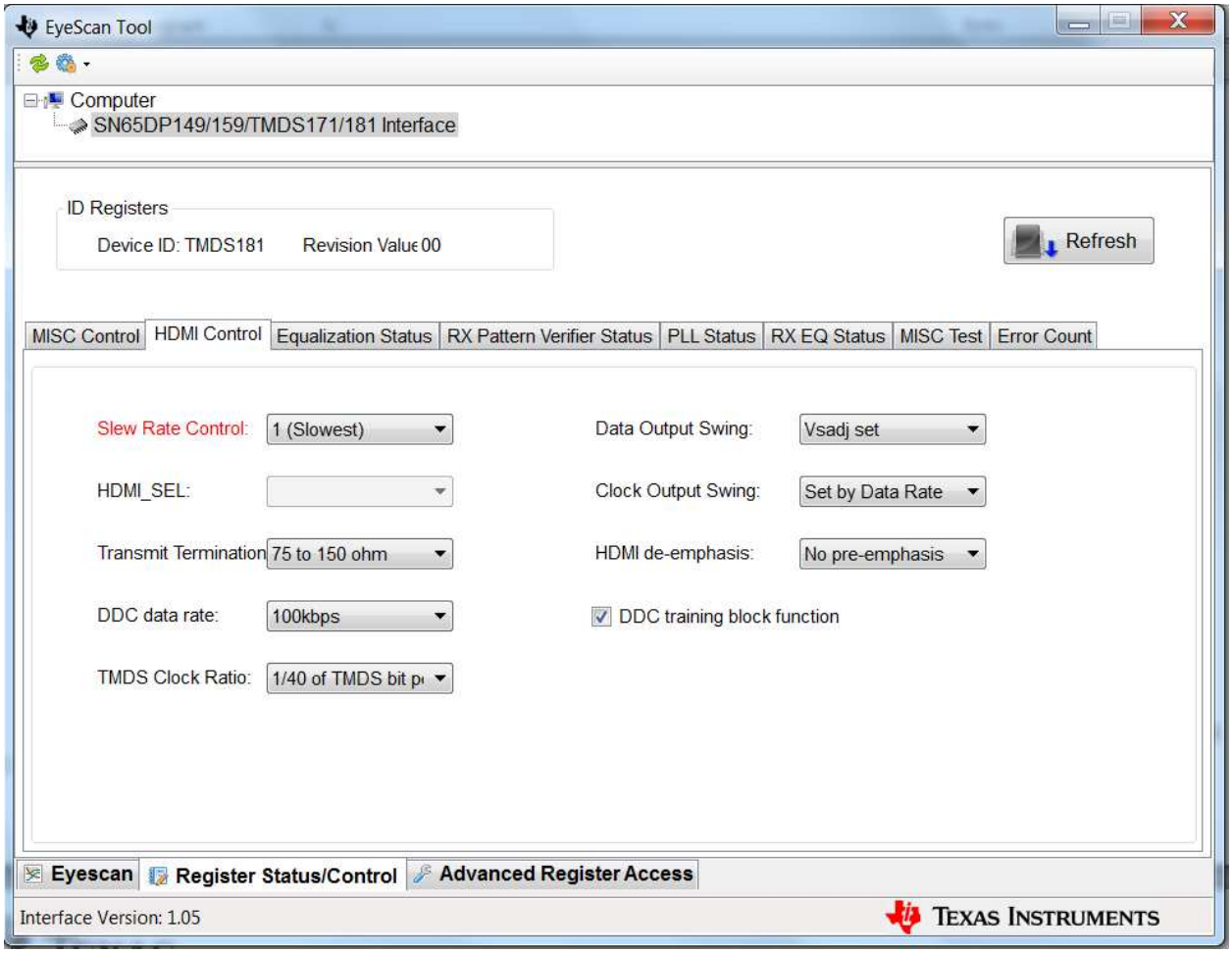


Figure 7. TMDS171 Device with TMDS Clock Ratio set to 1/40

3 Quick Start Guide

1. Apply 5-V power to the EVM, turn on SW2. LED D2 should light up.
2. If using external I²C adapter instead of pin straps, please configure the TMDS171 at this step.
3. Plug in an HDMI source using a standard HDMI cable into P1 (Standard HDMI 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. TMDS171 Product Preview
2. Aardvark I2C/SPI Host Adapter User Manual
3. High-Definition Multimedia Interface Specification Version 1.4b.
4. High-Definition Multimedia Interface Specification Version 2.0

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5 EVM Bill of Materials

Table 4. EVM Bill of Materials

QTY	Reference	Part	PCB Footprint	Manufacturer	Part Number
6	C1, C4, C5, C6, C7, C52	1 µF	603	Taiyo Yuden	LMK107B7105KA-T
12	C9, C10, C17, C18, C19, C21, C23, C29, C40, C46, C59, C60	0.1 µF	402	Yageo	CC0402KRX5R6BB104
5	C8, C20, C35, C36, C57	10 µF	805	TDK	C2012X5R1A106K125AB
1	C31	10 µF	805	TDK	C2012X5R1C106K085AC
8	C11, C12, C13, C14, C15, C16, C24, C25	0 Ω resistors	201	TDK	C0603X5R0J104M
5	C22, C37, C41, C42, C47	0.01 µF	402		
1	C26 - DNI	DNI_200 nF	402		
1	C27	18 pF	402	AVX	04025A180JAT2A
1	C28	220 pF	402		
1	C30	220 µF	7343	Kemet	T495X337K010ATE060
1	C34	3.3 nF	402		
1	C32	22 µF	805		
2	C39, C58	2.2 µF	805		
27	R31, R32, R33, R35, R87, R92, R93, R105, R106, R107, R108, R109, R110, R111, R112, R113, R114, R120, C2, C3, C38, R129, R130, R24, R25, R16, R17	DNI	402 / 201		
2	C45, C49	22 pF	402		
2	C50, C51	33 pF	402		
1	D1	Zener 6V	SOT23	Diodes Inc.	MMBZ5233B-FDICT-ND
1	D2	LED Green 0805	805	Lite On	LTST-C171GKT
1	JP1	JUMPER	HDR_THVT_1x2_100		
13	J1, J3, J4, J6, J7, J8, J10, J11, J12, J14, J15, J16, J17	HDR3X1 M 0.1	HDR_THVT_1x3_100	3M	961103-6404-AR
1	J2	Display_Port_Connector_Sink_0	DISPLAYPORT	Molex	47272-0001
1	J5	Header 5x2 0.1" thru-hole	con_thvt_shrd_2x5_100_m	3M	N2510-6002-RB
1	J9	2.1mm x 5.5mm	PJ-202AH	CUI Inc.	PJ-202AH (PJ-002AH)
1	J13	USB Micro B	USB Micro B	FCI	10103592-0001LF
17	LP1, LP2, LP3, LP4, LP5, LP6, LP7, LP8, LP9, LP10, LP11, LP12, LP13, LP14, LP15, LP16, LP17	LP	TESTLOOP	KOBIKONN	151-103-RC
1	L1	2.2 µH	1008	TDK	VLS252010ET-2R2M
1	L2	1 µH	1008	TDK	NLCV25T-1R0M-EFR
1	P1	HDMI_IN	CON_HDMI_RT_19_0p50mm	Molex	471510001
1	P2	HDMI_OUT	CON_HDMI_RT_19_0p50mm	Molex	471510001
2	Q1, Q2	FDV301N_NFET_8V	SOT23	Fairchild Semiconductor	FD301N
8	R1, R2, R3, R4, R6, R7, R8, R9 - DNI	DNI	201		
1	R5	100	402		
6	R10, R11, R99, R100, R101, R121	1K	402		
3	R12, R27, R81	100K	402		
1	R13	10	402		
13	R14, R15, R18, R19, R20, R21, R22, R23, R34, R123, R124, R125, R126	0	201		
4	R28, R29, R58, R59	2K	402		
8	R77, R80, R83, R84, R89, R104, R122, R131	0	402		
1	R30	1M	402		
1	R127	500K	402		
1	R36	75	402		
1	R56	27K	402		
16	R57, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69, R70, R71, R72, R73, R74	65K	402		

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Table 4. EVM Bill of Materials (continued)

QTY	Reference	Part	PCB Footprint	Manufacturer	Part Number
1	R75	7K	402		
1	R76	PTV09 10K POT	THRUHOLE	BOURNS	PTV09A-4015F-B103
3	R78, R98, R102	10K	402		
2	R79, R88	4.7K	402		
1	R82	500	402		
1	R85	750K	402		
1	R86	240K	402		
1	R90	1.87K	402		
1	R91	4.42K	402		
1	R94	1.5K	402		
2	R95, R96	33	201		
1	R103	15K	402		
3	R45, R46, R115	47K	402		
1	SW1	PB_SWITCH	SW_MOM_2NO	OMRON	B3SN-3012P
1	SW2	3POS_SPDT	THRUHOLE_3POS	NKK Switches	MS13ANW03
1	U1	TMDS171RGZ	48_RGZ	TI	
1	U9	SN74AUP1G04	DCK	TI	SN74AUP1G04DCKR
1	U2 - DNI	SN74CBT1G125 - DNI	DCK	TI	SN74CBT1G125DCKR
1	U3	TPS3808G30DBVT	6DBV	TI	TPS3808G30DBVT
1	U4	TPS62150A	RGT16	TI	TPS62150ARGTT
1	U6 - DNI	TPS61240 - DNI	6DRV	TI	TPS61240DRVT
1	U5	TPS74201RGWT	RGW20	TI	TPS74201RGWT
1	U7	TUSB3410	LQFP32	TI	TUSB3410VF
1	U8	24LC256	8SOIC	ON Semiconductor	CAT24C256W
1	Y1	12 MHz Crystal	ECX-32	ECS Inc.	ECS-120-20-33-TR
1	U16	TPD2E001	drl_5pin	TI	TPD2E001

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6 EVM Schematics

Figure 8 through Figure 14 illustrate the EVM schematics.

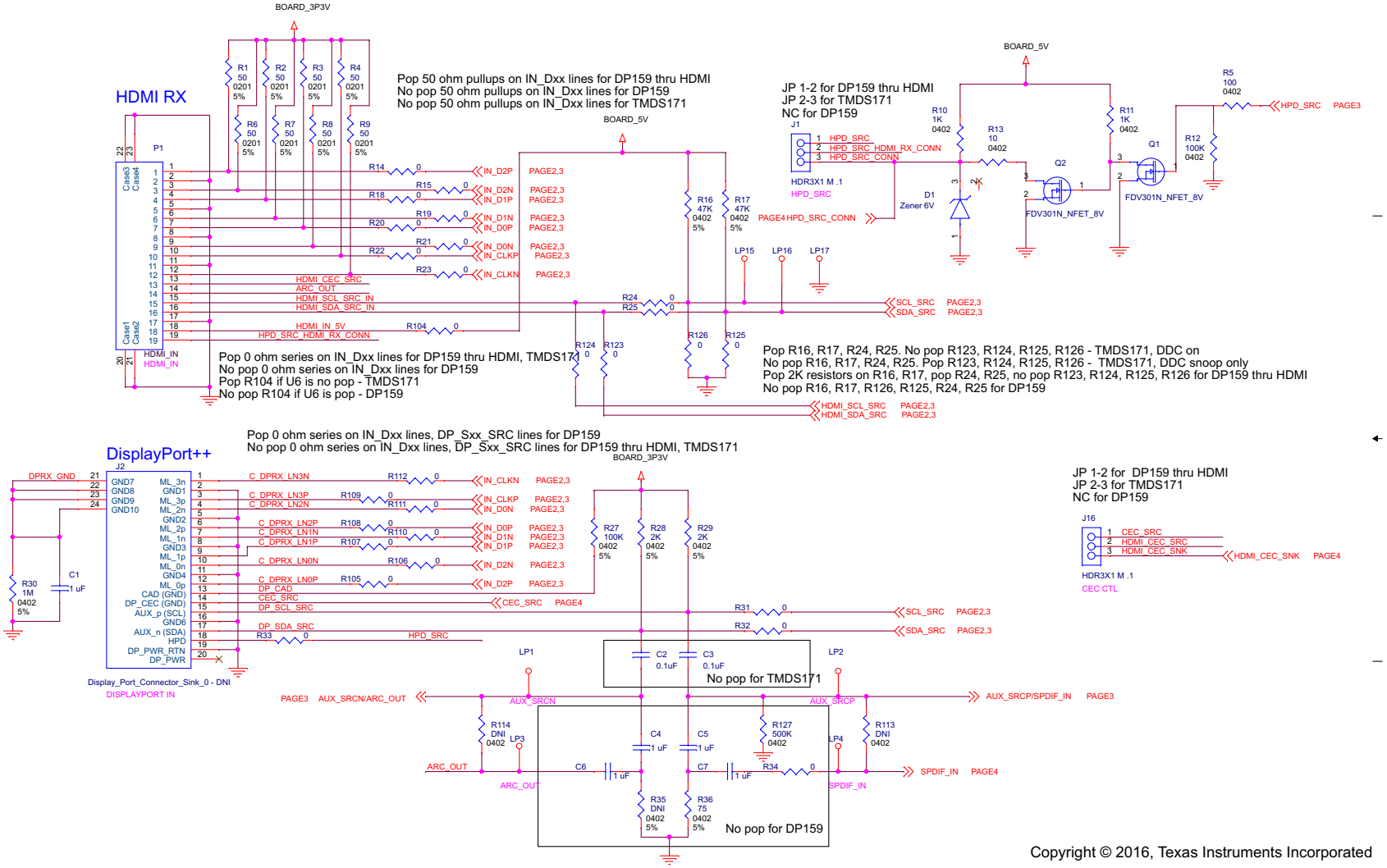
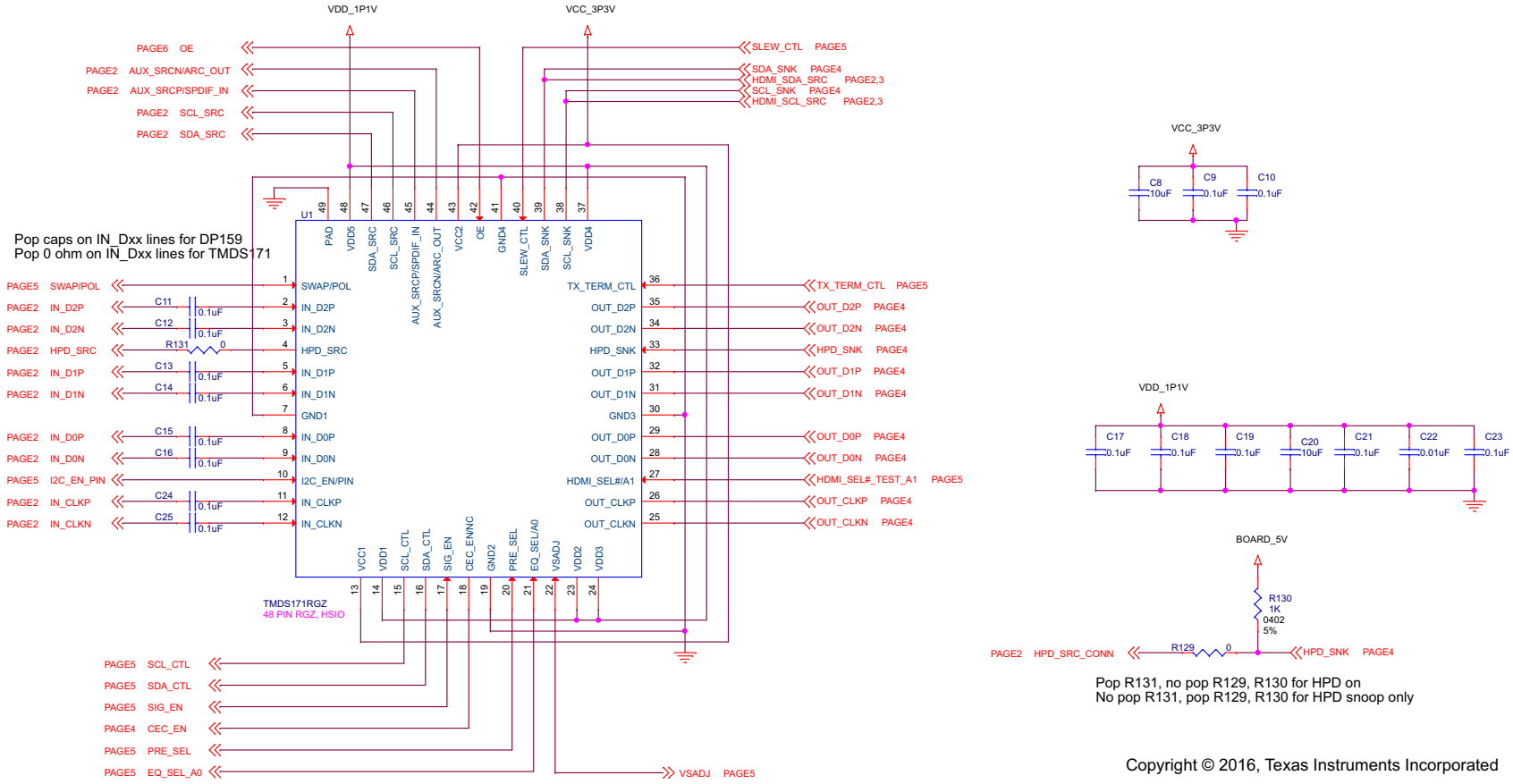


Figure 8. HDMI Input Connector

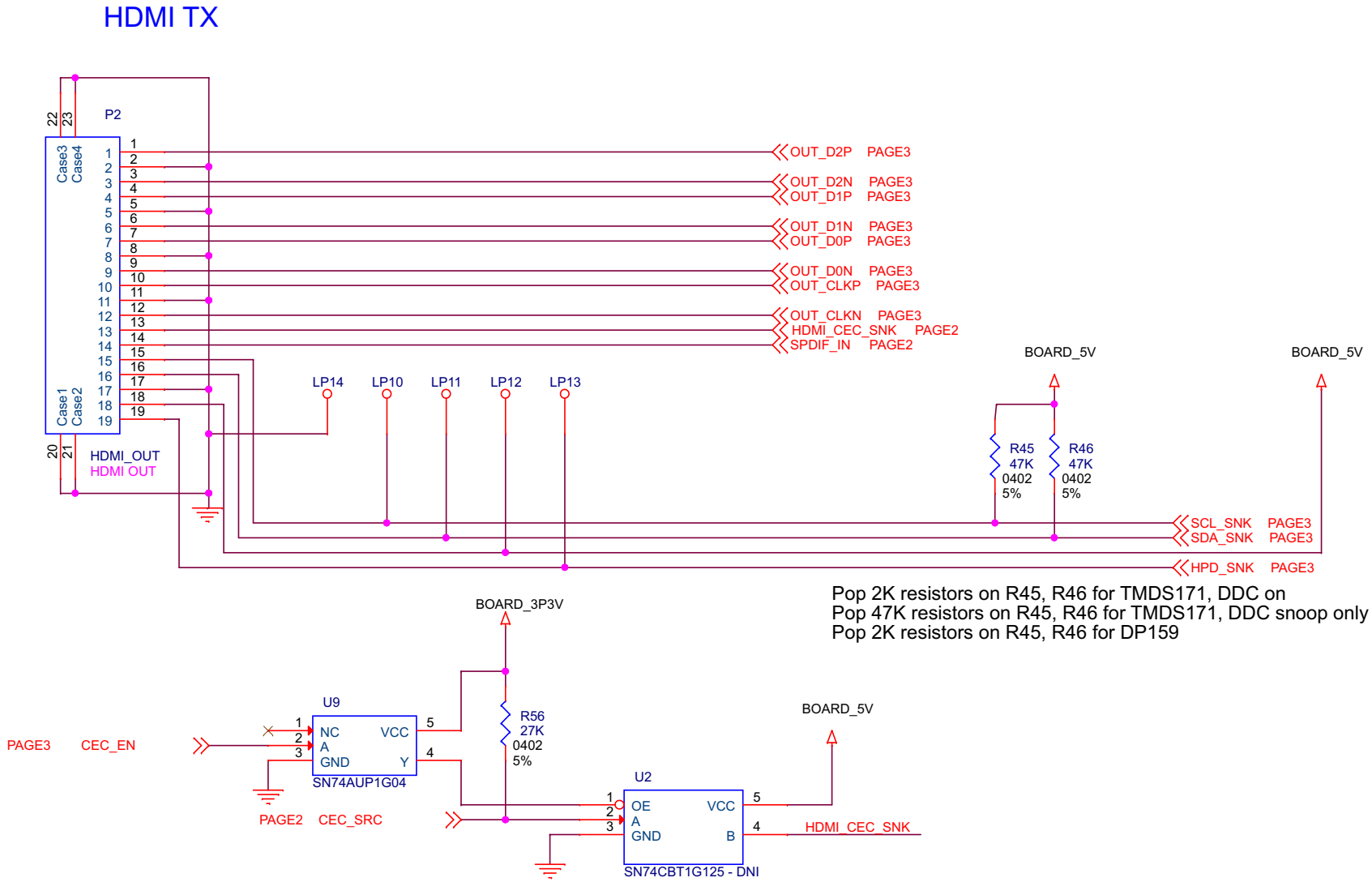
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Figure 9. TMDS171 RGZ Schematic (48-Pin QFN)

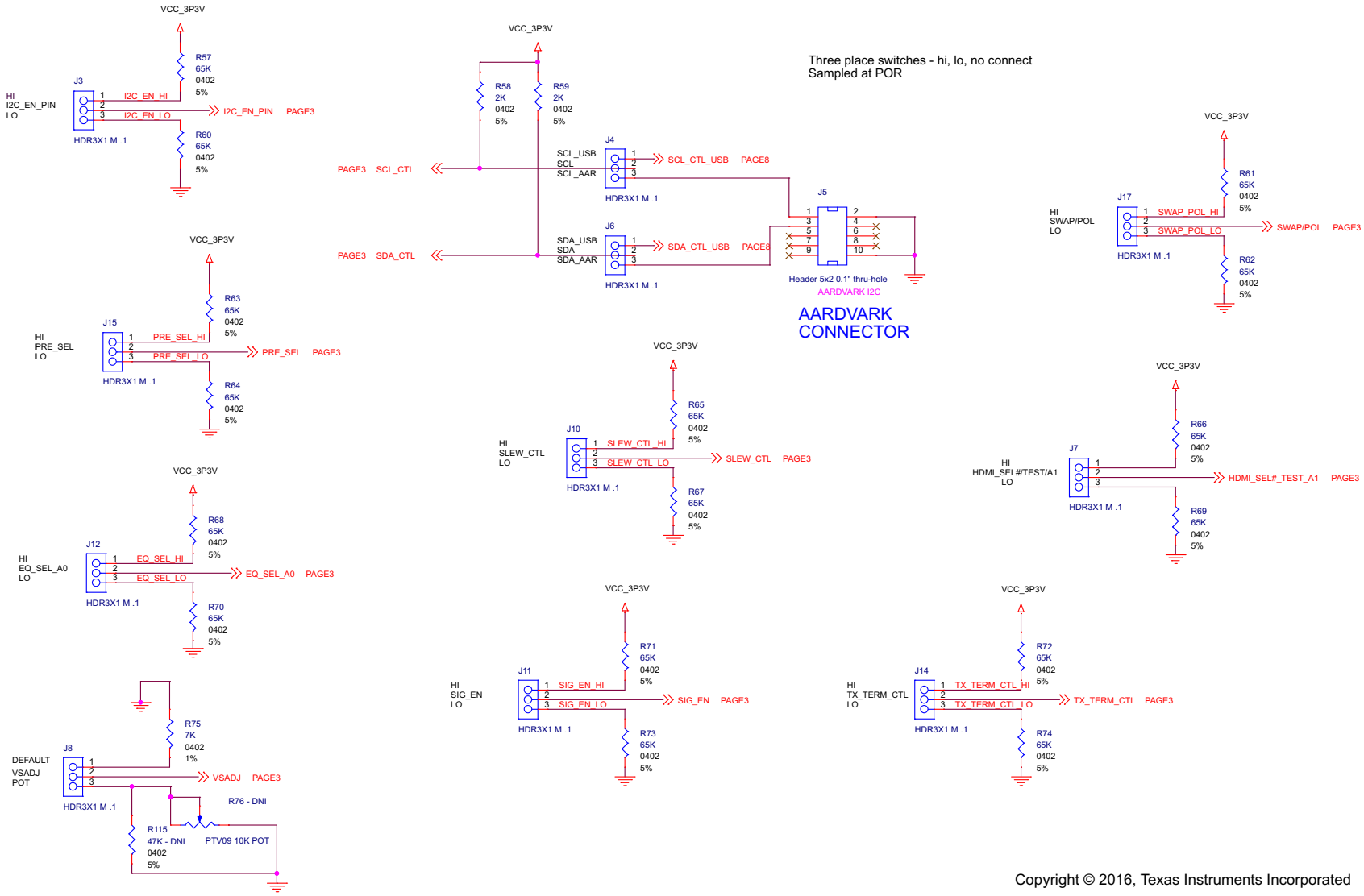
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Figure 10. HDMI TX Connector

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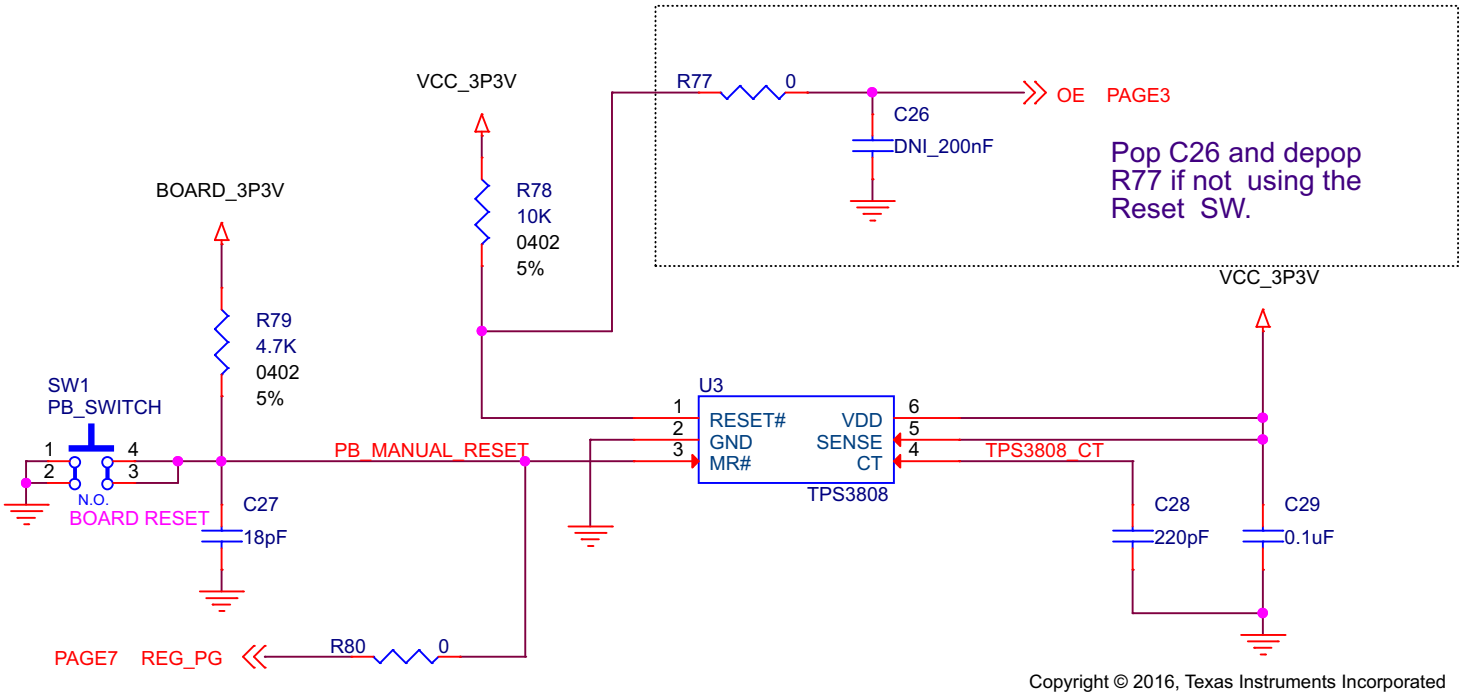


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Figure 11. TMDS171 Select Options

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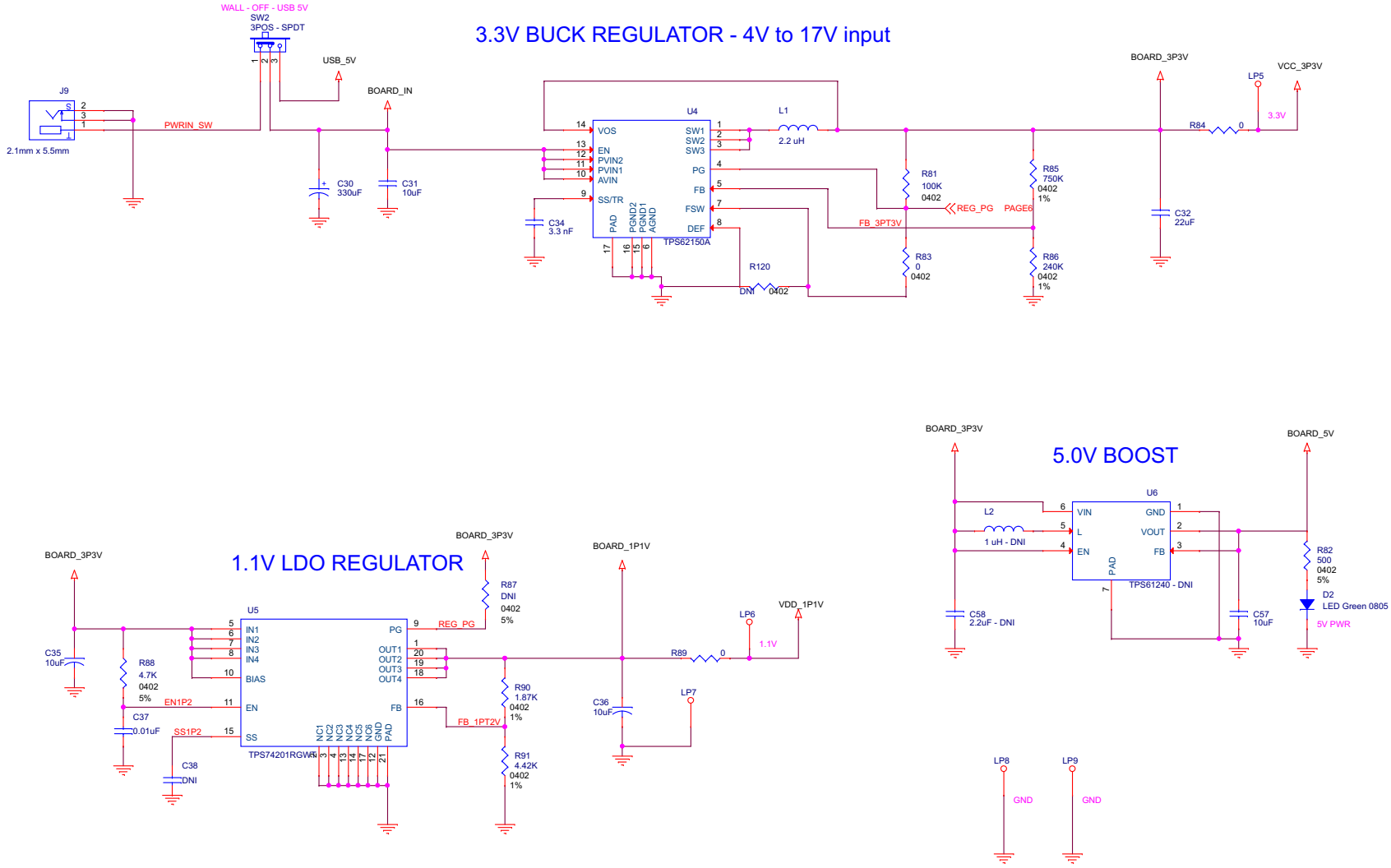
RESET CIRCUIT



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Figure 12. RESET Circuit

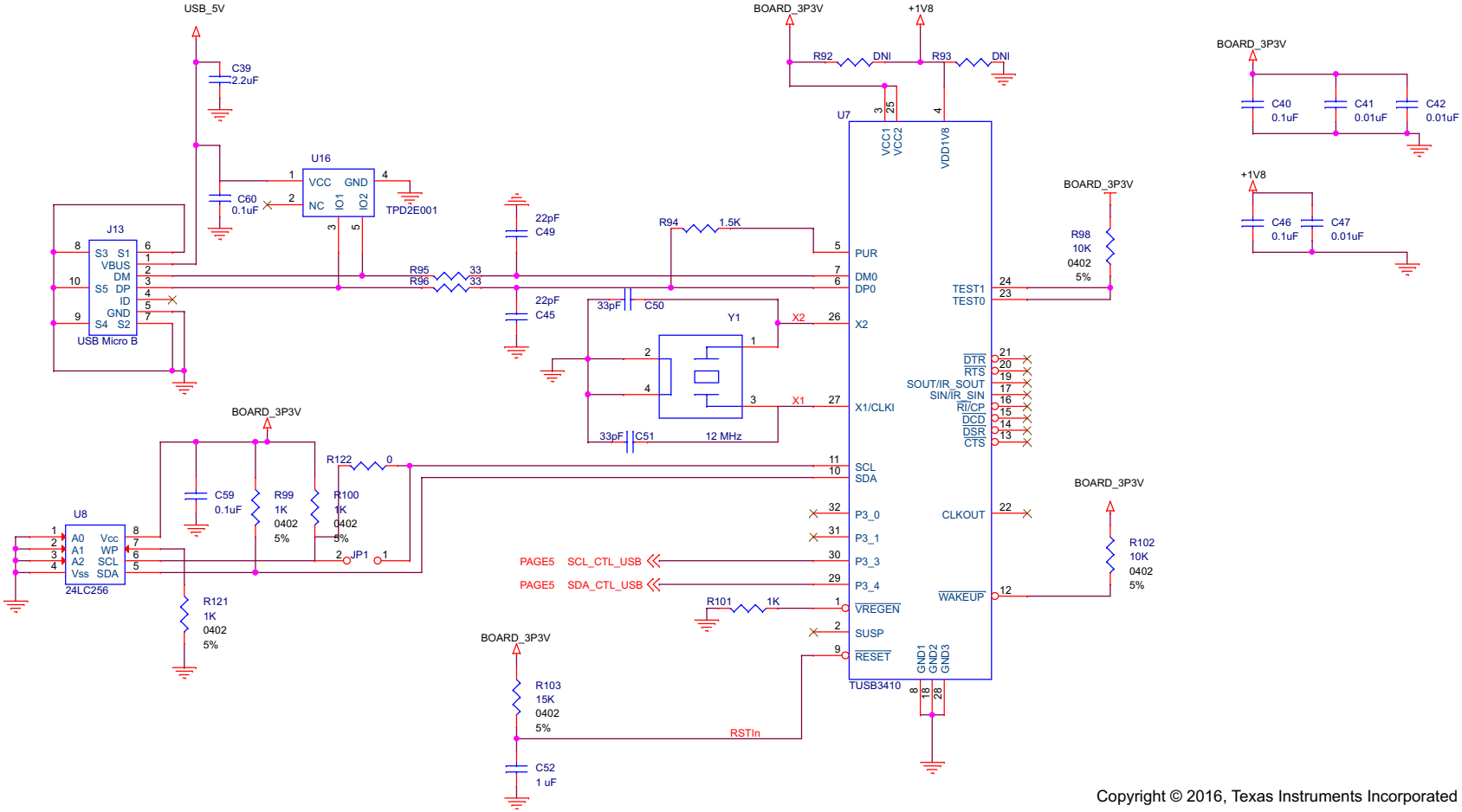
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Figure 13. Power Schematics (1.1-V and 3.3-V Regulators)

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Figure 14. TUSB3410 Schematic

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7 EVM Layout

Figure 15 through Figure 20 illustrate the PCB layout images for the EVM.

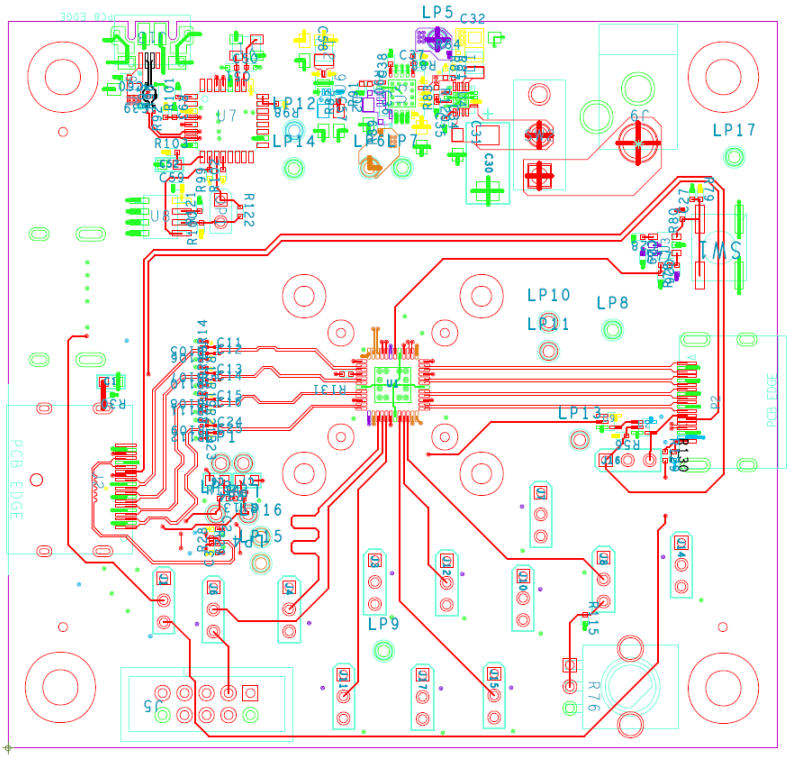


Figure 15. Layer 1 (Top)

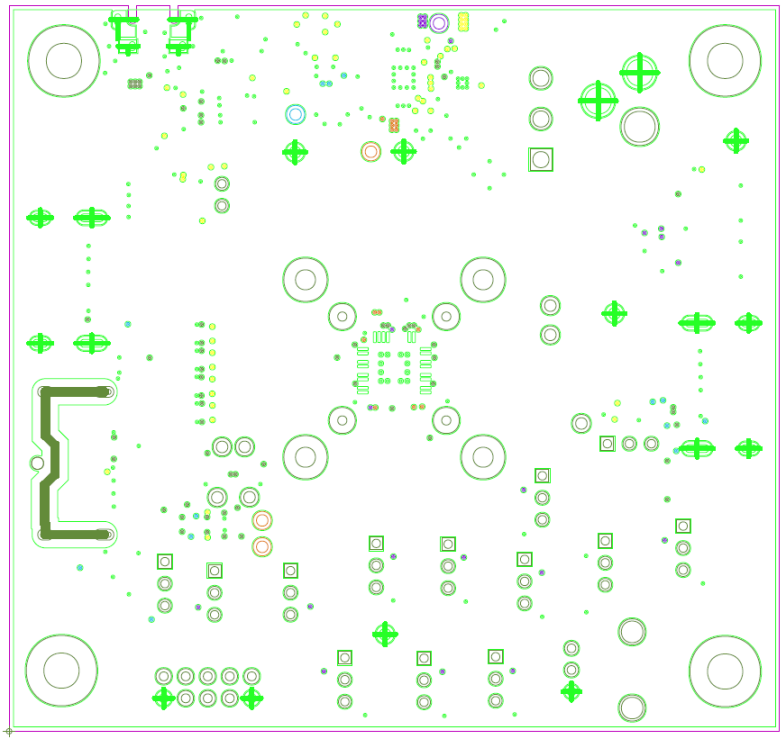


Figure 16. Layer 2 (GND)

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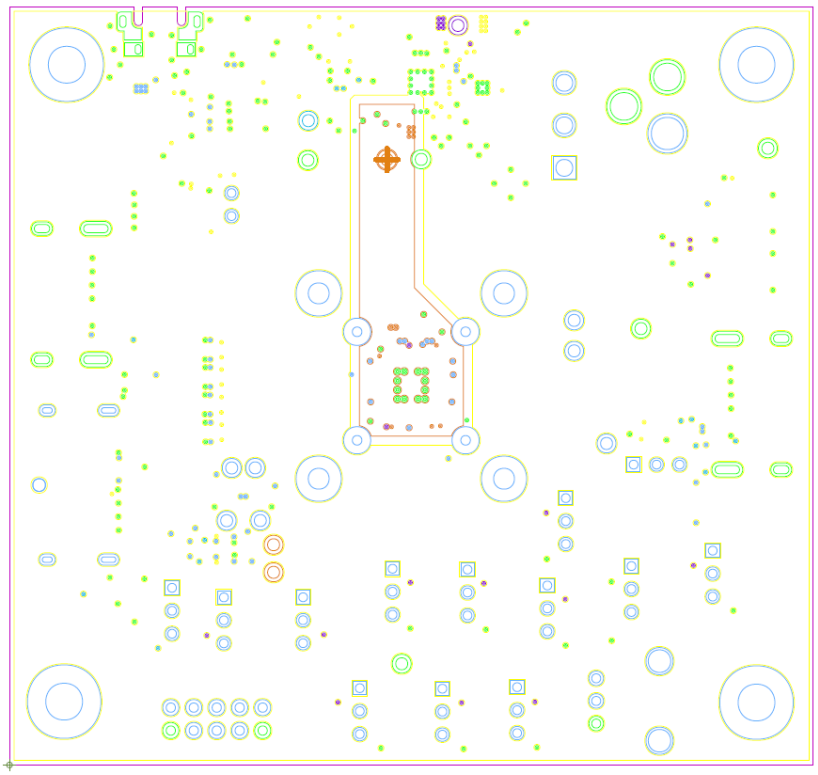


Figure 17. Layer 3 (Power)

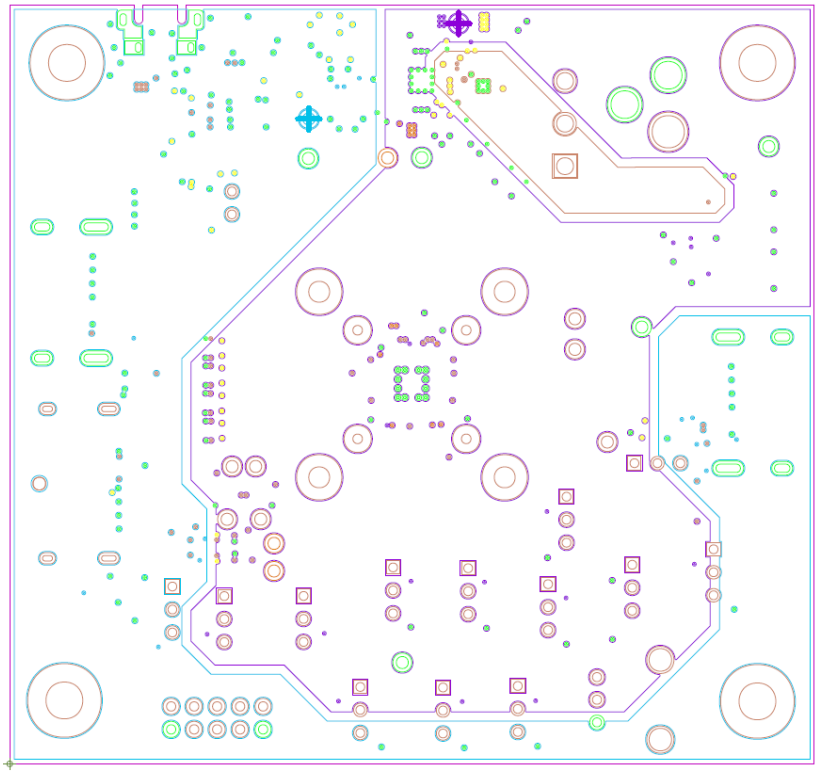


Figure 18. Layer 4 (Power)

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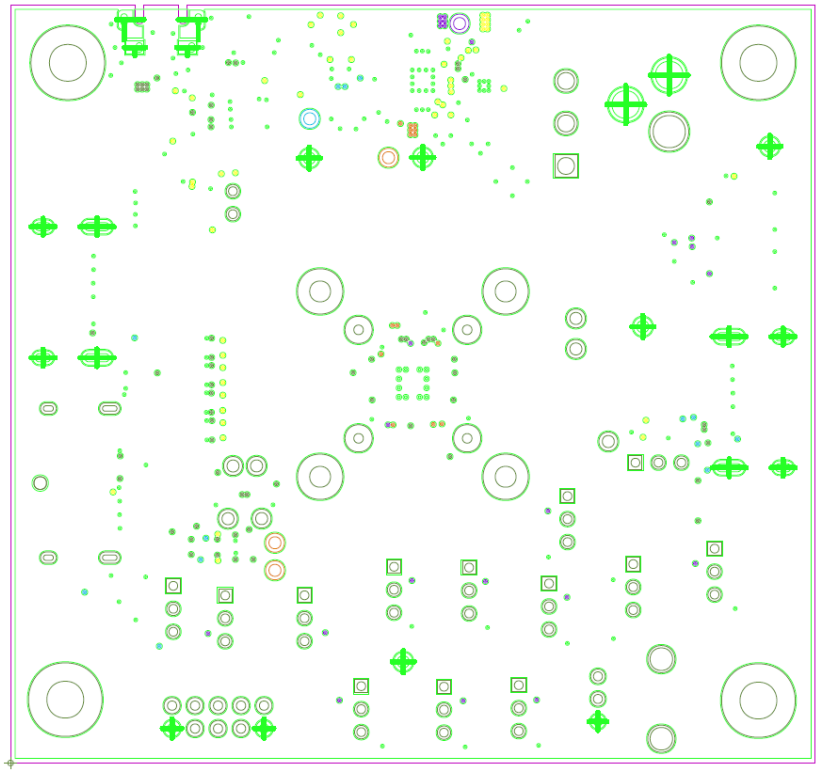


Figure 19. Layer 5 (GND)

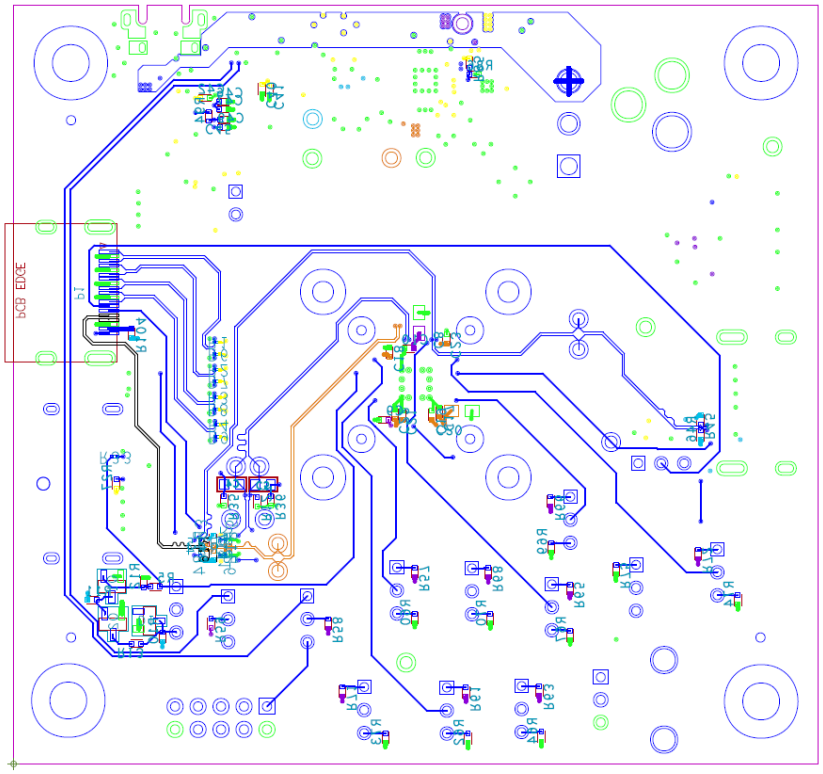


Figure 20. Layer 6 (Bottom)

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8 Total Phase Aardvark I2C Host Adapter Scripts

Request the latest scripts from your TI representative.

Revision History

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

Changes from Original (April, 2015) to A Revision	Page
• Changed signal rate to 6Gbps and resolutions support to 4k/2k/60p in the *What is the TMDS171?* section.	2
• Changed and added text, added *TMDS171 Device with TMDS Clock Ratio set to 1/40* image and changed all other GUI images in the *USB Interface via TUSB3410* section.	8

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      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

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FCC Interference Statement for Class B EVM devices

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- *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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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.

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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

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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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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.

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