User's Guide

DS90UB960-Q1EVM User's Guide

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ABSTRACT

The Texas Instruments DS90UB960-Q1EVM Evaluation Module (EVM) is a functional board design for evaluating the DS90UB960-Q1 FPD-Link III and TDES960 V^{3}Link deserializer hubs, which convert serialized sensor data to MIPI CSI-2 for processing. It is configured for communication with up to four DS90UB953-Q1 or TSER953 serializers using a Quad Mini-Fakra to 4x Single FAKRA cable assembly. An on-board MSP430 coupled with Analog LaunchPAD GUI tool enables interface to a PC for easy device evaluation.

Table of Contents

List of Figures

List of Tables

1 Introduction

The Texas Instruments DS90UB960-Q1EVM evaluation module (EVM) is a functional board design for evaluating the DS90UB960-Q1, which is a versatile deserializer hub capable of connecting serialized sensor data received from up to 4 independent data streams through an FPD-Link III interface using standard coaxial cables. When coupled with DS90UB953-Q1 serializer, the DS90UB960-Q1 receives data from 2-Megapixel imagers supporting full HD 1080p resolution at 60 Hz frame rates. The DS90UB960-Q1 merges and manages multiple data streams into a MIPI CSI-2 compliant output for interconnect to a downstream processor.

The DS90UB960-Q1EVM is configured for communication with up to four DS90UB953-Q1 serializers. It features a quad mini-FAKRA connector, a Quad Mini-Fakra to 4x Single FAKRA cable assembly, and configurable power-over-coax voltage for connecting up to four camera modules (not included). Each of the FPD-Link III interfaces also includes a separate low latency bi-directional control channel that conveys control information from an I^2C port. General purpose I/O signals such as those required for camera synchronization and functional safety features also make use of this bi-directional control channel to program registers in the DS90UB960-Q1 as well as the connected serializers and any remote I2C device attached to the serializers. The EVM also features an on-board MSP430 which functions as a USB2ANY bridge for interfacing with a PC for evaluation. The USB2ANY interfaces with the Analog LunchPAD GUI tool.

Note

The EVM is not intended for EMI testing. The EVM was designed for easy accessibility to device pins with tap points for monitoring or applying signals, additional pads for termination, and multiple connector options.

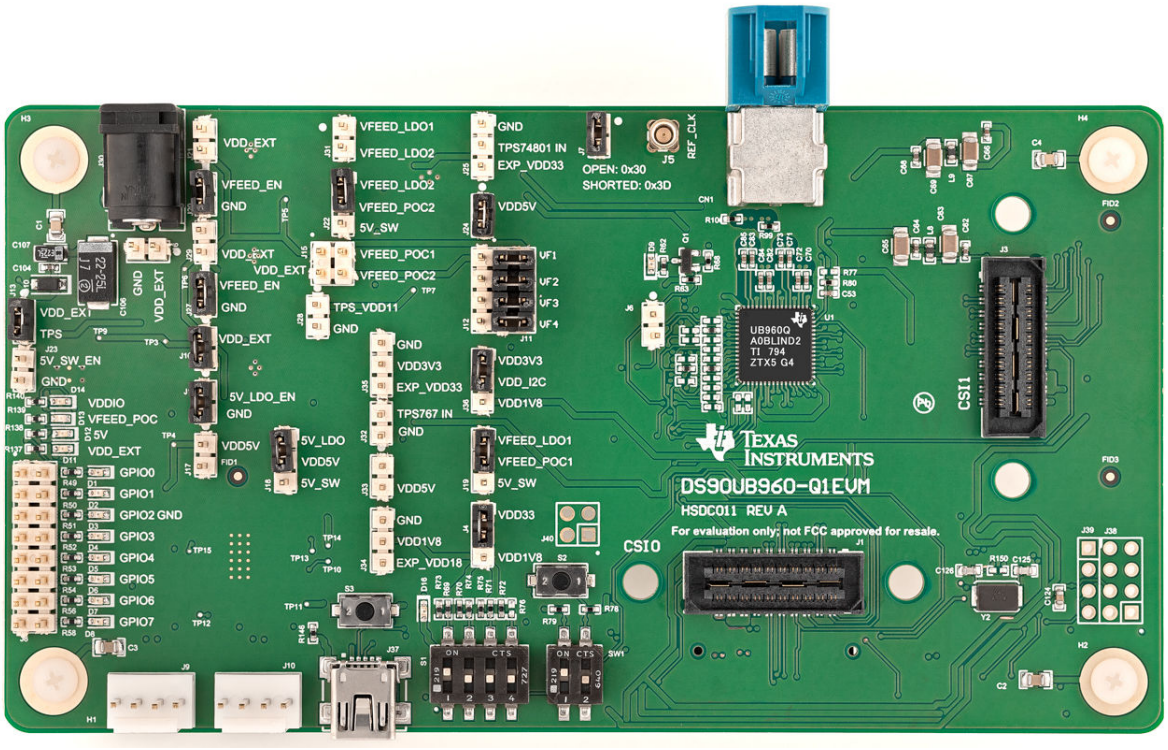


Figure 1-1. DS90UB960-Q1EVM

2 Features

The major components of the DS90UB960-Q1EVM are:

- DS90UB960-Q1
  - Aggregates data from up to 4 cameras over FPD-Link III interface
  - Supports 2-Megapixel sensors with HD 1080p resolution at 30/60Hz frame rate (when paired w/ DS90UB953-Q1)
  - Multi-camera synchronization
  - Supports MIPI DPHY 1.2 / CSI-2 Version 1.3 compliant
    - 2x CSI-2 output ports
    - Supports 1, 2, 3, 4 data lanes per CSI-2 port
    - CSI-2 data rate scalable for 400 Mbps / 800 Mbps / 1.2 Gbps / 1.6 Gbps per data lane
    - Programmable data types
    - Four Virtual Channels
    - ECC and CRC generation
  - Supports Single-ended Coax cable and Power-Over-Coax
  - Adaptive receive equalization
  - I^2C with Fast-mode Plus up to 1 Mbps
  - Flexible GPIOs for camera sync and functional safety
- On-board Power-over-Coax (POC) interface
- Quad Mini-Fakra connector and Quad Mini-Fakra to 4x Fakra coax cable assembly for FPD-Link III interfaces
- Samtec QSH type connectors for CSI-2 interfaces
- On-board I^2C programming interface

3 Application Diagram

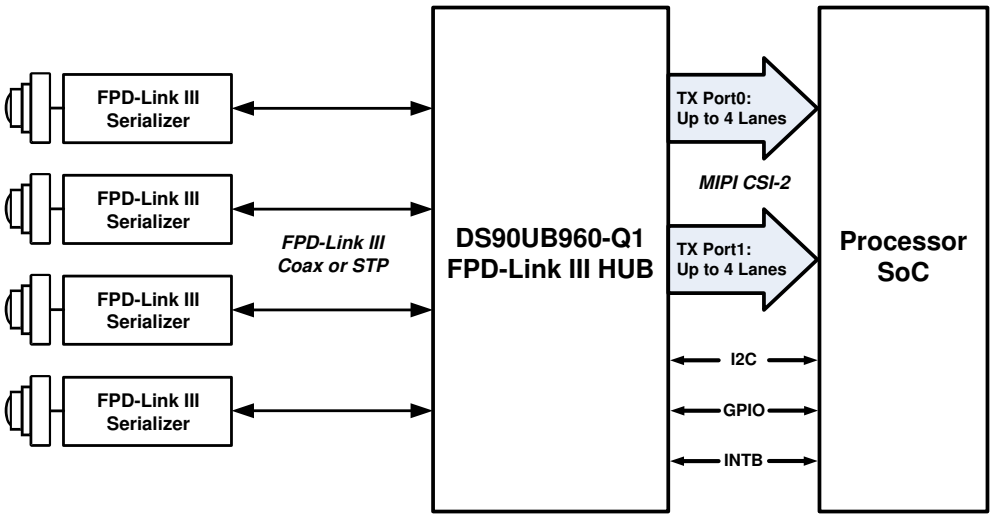


Figure 3-1. Applications Diagram

4 Major Components

Figure 4-1 illustrates major DS90UB960-Q1EVM components.

1. Quad Mini-Fakra connector for FPD-Link III interfaces. There is also a Quad Mini-Fakra to 4x Single Fakra coax cable assembly (not shown) for interfacing the EVM to up to four sensor modules
2. Samtec QSH type connectors for interfacing the CSI-2 I/Os to downstream processors
3. Switches for configuring DS90UB960-Q1 functional modes
4. USB2ANY connector for interfacing the EVM to a PC
5. Connectors for accessing DS90UB960-Q1 I2C Ports
6. Connectors for accessing DS90UB960-Q1 GPIOs
7. Barrel jack type connector for powering the DS90UB960-Q1EVM from a single 12V/1A supply
8. Connectors for selecting PoC voltage source

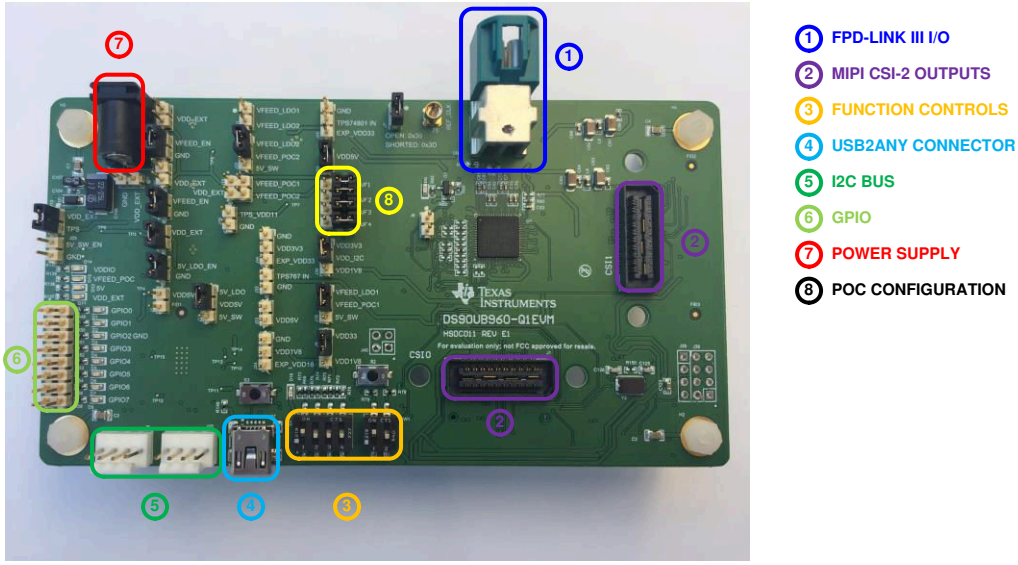


Figure 4-1. Interfacing to the EVM

To demonstrate the functionality, the following components are also required (not included):

1. At least one DS90UB953-Q1EVM or a camera module (Up to four may be used)
2. USB to Mini USB cable OR I^2C host controller that support clock stretching (Such As USB2ANY)
3. Power supply capable of supporting 12V, 1A load
4. Optional: MIPI-CSI-2 output analyzer or Host Processor

5 Quick Start Guide

1. Ensure all jumpers and switches are placed and configured as shown in Figure 5-1

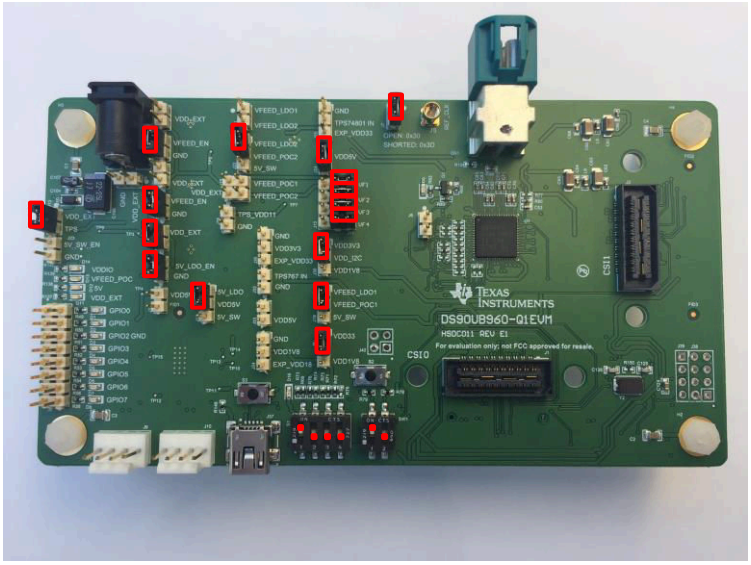


Figure 5-1. DS90UB960-Q1EVM Jumper and Switch Configuration

2. Connect mini USB J37 to USB port for register programming
3. **Optional:** Connect an external I^2C host adapter I^2C signals on J9 port for register programming
4. Connect DS90UB953-Q1EVM boards or camera modules to one of the channels on CN1 using Quad Mini-Fakra to 4x Single Fakra cable assembly
5. **Optional:** Interface MIPI CSI-2 output signals (J1 or J3) to application processor
6. Provide power to the board. TI recommends using current limited bench supply to provide power to J30 (barrel jack) or J26 (+12VDC)
   a. Optional +1.1VDC power supply on J28
   b. Optional +1.8VDC power supply on J34
   c. Optional +3.3VDC power supply on J35
7. Open Analog LaunchPAD. See Section 8 for details on installing and using Analog LaunchPAD.

6 Board Connections

6.1 Power Supply

Table 6-1. Power Supply

Reference	Signal	Description
J30.1 or J26.1	+12V	Main Power Single +12VDC (nominal) power connector that supplies power to the entire board.
J28.1 (Optional)	+1.1V	1.1V ±5% Alternative to Main Power
J34.2 (Optional)	+1.8V	1.8V ±5% Alternative to Main Power
J35.2 (Optional)	+3.3V	3.3V ±5% Alternative to Main Power

6.2 Power Over Coax Interface

The DS90UB960-Q1EVM offers four Power-over-Coax interfaces (PoC) to connect cameras through a coaxial cable with FAKRA connectors. Power is delivered on the same conductor that is used to transmit video and control channel between the host and the camera. By default, 9V power supply is applied over the coax cable from a 1A LDO (Max 250 mA per PoC interface). Refer to Table 6-3 for other PoC configurations.

Each PoC interface uses a filter network as shown in Figure 6-1. The PoC network frequency response corresponds to the bandwidth compatible with DS90UB935-Q1 and DS90UB953-Q1 serializers.

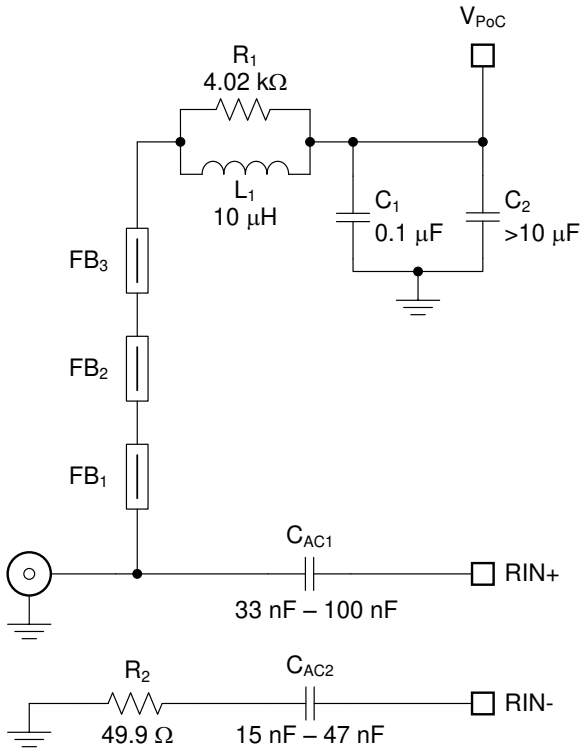


Figure 6-1. Power-over-Coax Network Compatible with DS90UB935-Q1 and DS90UB953-Q1

WARNING

Verify that the power voltage is properly set before plugging into CN1. Power supply is not fused. Over-voltage will cause damage to boards directly connected due to incorrect input power supplies.

When interfacing to DS90UB913A-Q1 and DS90UB933-Q1 serializers, the PoC filter needs to be adjusted to match the circuit shown in Figure 6-2. The required updates are summarized in Table 6-2.

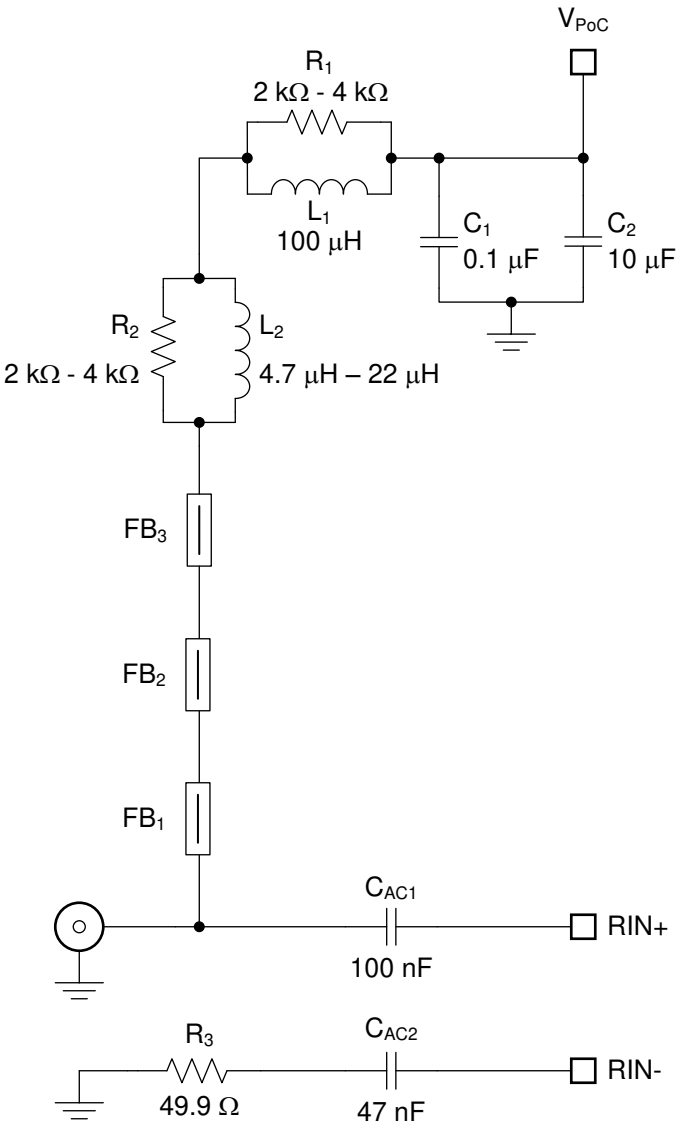


Figure 6-2. Power-over-Coax Network Compatible with DS90UB913A-Q1, DS90UB933-Q1, DS90UB935-Q1, and DS90UB953-Q1

Table 6-2. Required PoC Network Updates for Compatibility to DS90UB913A-Q1 and DS90UB933-Q1 Serializers

RX Port	Description of the Required Change
RX Port0	Install L11 (100 µH).
	Update R90 to 4.02 kΩ
	Update C70 to 100 nF, C72 to 47 nF
RX Port1	Install L13 (100 µH).
	Update R92 to 4.02 kΩ
	Update C71 to 100 nF, C73 to 47 nF
RX Port2	Install L23 (100 µH).
	Update R96 to 4.02 kΩ
	Update C82 to 100 nF, C84 to 47 nF
RX Port3	Install L25 (100 µH).
	Update R98 to 4.02 kΩ
	Update C83 to 100 nF, C85 to 47 nF

Table 6-3. Power-Over-Coax Power Supply Feed Configuration

Reference	Signal	Description
J19	VFEED_POC1	Power Over Coax Power Feed Selection 1
		Short pins 1-2: +9V power supply from VFEED_LDO1 (Default)
		Short pins 2-3: +5V power supply from 5V_SW
J22	VFEED_POC2	Power Over Coax Power Feed Selection 2
		Short pins 1-2: +9V power supply from VFEED_LDO2 (Default)
		Short pins 2-3: +5V power supply from 5V_SW
J15	VDD_EXT	Power Over Coax Power Feed using +12V Main Power (J21) **Note: J16 and J14 must be left OPEN if using this configuration**
		Short pins 1-2: +12V power supply to VFEED_POC1
		Short pins 2-3: +12V power supply to VFEED_POC2
J11.1	VFEED1	Remote power supply connection to CN1
		Short J11.1-2: VFEED_POC1 (Default)
		Short J11.1 & J12.1: VFEED_POC2
J11.3	VFEED2	Remote power supply connection to CN2
		Short J11.3-4: VFEED_POC1 (Default)
		Short J11.3 & J12.2: VFEED_POC2
J11.5	VFEED3	Remote power supply connection to CN3
		Short J11.5-6: VFEED_POC1 (Default)
		Short J11.5 & J12.3: VFEED_POC2
J11.7	VFEED4	Remote power supply connection to CN4
		Short J11.7-8: VFEED_POC1 (Default)
		Short J11.7 & J12.4: VFEED_POC2

6.3 MIPI CSI-2 Output Signals

Provided on the DS90UB960-Q1EVM, J1 and J3 are Samtec QSH-type connectors that can be mated with a matching QTH type connector on the top. This Samtec connector provides a means to route CSI-2 signals out of the DS90UB960-Q1. The J1 and J3 corresponds to CSI0 Port and CSI1 Port output connection signals respectively, and includes access to I^2C and other miscellaneous GPIO signals. Zero ohm resistor pads are available if a connection to other signals is required. The mating connector part number is QTH-020-01-H-D-DP-A.

There are third party solutions like the HDR-128291-XX breakout board from Samtec which can be used. The HDR- 128291-XX is a breakout board with a mating connector to J1 & J3 and standard SMA male connectors.

More info on this breakout board can be obtained from Samtec website. Another third party option is the ZX100 by Zebax Technologies. More information on this board can be obtained from Zebax website.

Table 6-4. MIPI CSI-2 (TX Port 0) Output Signals - J1 Pinout

Pin #	Signal Name	Pin #	Signal Name
1	NC	2	EXT_SCL0 (I2C_SCL or I2C_SCL2)
3	NC	4	EXT_SDA0 (I2C_SDA or I2C_SDA2)
5	CSI0_CLK_P	6	NC
7	CSI0_CLK_N	8	NC
9	CSI0_D0_P	10	EXP_REF_CLK0 (REFCLK)
11	CSI0_D0_N	12	GND
13	CSI0_D1_P	14	RESETn_0 (PDB)
15	CSI0_D1_N	16	GND
17	CSI0_D2_P	18	SPI_MOSI_0 (GPIO0 or GPIO3)
19	CSI0_D2_N	20	SPI_SCLK_0 (GPIO1 or GPIO4)
21	CSI0_D3_P	22	SPI_CSn_0 (GPIO2 or GPIO5)
23	CSI0_D3_N	24	GND
25	NC	26	NC
27	NC	28	NC
29	NC	30	VDD_3V3
31	NC	32	VDD_3V3
33	NC	34	VDD_3V3
35	NC	36	VDD_3V3
37	NC	38	VDD_1V8
39	NC	40	VDD_1V8

Table 6-5. MIPI CSI-2 (TX Port 1) Output Signals - J3 Pinout

Pin #	Signal Name	Pin #	Signal Name
1	NC	2	EXT_SCL1 (I2C_SCL or I2C_SCL2)
3	NC	4	EXT_SDA1 (I2C_SDA or I2C_SDA2)
5	CSI1_CLK_P	6	NC
7	CSI1_CLK_N	8	NC
9	CSI1_D0_P	10	EXP_REF_CLK1 (REFCLK)
11	CSI1_D0_N	12	GND

Table 6-5. MIPI CSI-2 (TX Port 1) Output Signals - J3 Pinout (continued)

Pin #	Signal Name	Pin #	Signal Name
13	CSI1_D1_P	14	RESETn_1 (PDB)
15	CSI1_D1_N	16	GND
17	CSI1_D2_P	18	SPI_MOSI_1 (GPIO0 or GPIO3)
19	CSI1_D2_N	20	SPI_SCLK_1 (GPIO1 or GPIO4)
21	CSI1_D3_P	22	SPI_CSn_1 (GPIO2 or GPIO5)
23	CSI1_D3_N	24	GND
25	NC	26	NC
27	NC	28	NC
29	NC	30	VDD_3V3
31	NC	32	VDD_3V3
33	NC	34	VDD_3V3
35	NC	36	VDD_3V3
37	NC	38	VDD_1V8
39	NC	40	VDD_1V8

Table 6-6. MIPI CSI-2 Output Signals - J2 Pinout

Pin #	Signal Name	Pin #	Signal Name
1	NC	2	EXP_SCL0 (I2C_SCL or I2C_SCL2)
3	NC	4	EXP_SDA0 (I2C_SDA or I2C_SDA2)
5	CSI0_CLK_P	6	NC
7	CSI0_CLK_N	8	NC
9	CSI0_D0_P	10	EXP_REF_CLK0 (REFCLK)
11	CSI0_D0_N	12	GND
13	CSI0_D1_P	14	RESETn_0 (PDB)
15	CSI0_D1_N	16	GND
17	CSI0_D2_P	18	SPI_MOSI_0 (GPIO0 or GPIO3)
19	CSI0_D2_N	20	SPI_SCLK_0 (GPIO1 or GPIO4)
21	CSI0_D3_P	22	SPI_CSn_0 (GPIO2 or GPIO5)
23	CSI0_D3_N	24	GND
25	CSI1_CLK_P	26	NC
27	CSI1_CLK_N	28	NC
29	CSI1_D0_P	30	VDD_3V3

Table 6-6. MIPI CSI-2 Output Signals - J2 Pinout (continued)

Pin #	Signal Name	Pin #	Signal Name
31	CSI1_D0_N	32	VDD_3V3
33	CSI1_D1_P	34	VDD_3V3
35	CSI1_D1_N	36	VDD_3V3
37	NC	38	VDD_1V8
39	NC	40	VDD_1V8

Note

* Remove R7, R9, R11, R12, R15, R16, R17, R19, R21, R22, R25, R27, R31, R33, R35, R37, R40 and R42 for CSI-2 source connected to J1/J3 (Default) *

** Populate R7, R9, R11, R12, R15, R16, R17, R19, R21, R22, R25, R27, R31, R33, R35, R37, R40 and R42 when source connected through J2 **

6.4 FPD-Link III Signals

Table 6-7. FPD-Link III Signals

Reference	Signal	Description
CN1.1	RIN0+	Quad Mini-FAKRA connector
CN1.2	RIN1+	Quad Mini-FAKRA connector
CN1.3	RIN2+	Quad Mini-FAKRA connector
CN1.4	RIN3+	Quad Mini-FAKRA connector

6.5 I²C Interface

A standalone external I²C host can connect throughJ9, J10 for programming purposes. Examples of external I²C host controllers are Texas Instruments USB2ANY and Total Phase Aardvark I²C/SPI host adapter (Total Phase Part#: TP240141).

Optional access to I²C signals are also available throughCSI-2 connectors J1, J2, or J3. I²C signal levels can be configured through J30 to be at 1.8V or 3.3V when the I²C interface is accessed through connectors J4, J5.

Table 6-8. IDx I²C Device Address Select - J34

Reference	Signal	Description
J7	IDX	Selects I²C Device Address
		Open: 0x30 (7'b) or 0x60 (8'b)
		Short: 0x3D (7'b) or 0x7A (8'b) (Default)

Table 6-9. Primary I²C Interface Header - J4

Reference	Signal	Description
J9.1	VDD_I2C	External I²C bus voltage
J9.2	I2C_SCL	I²C Clock Interface for primary I²C bus
J9.3	I2C_SDA	I²C Data Interface for primary I²C bus
J9.4	GND	Ground

Table 6-10. Secondary I²C Interface Header - J5

Reference	Signal	Description
J10.1	VDD_I2C	External I²C bus voltage
J10.2	I2C_SCL2	I²C Clock Interface for secondary I²C bus

Table 6-10. Secondary I²C Interface Header - J5 (continued)

Reference	Signal	Description
J10.3	I2C_SDA2	I²C Data Interface for secondary I²C bus
J10.4	GND	Ground

Table 6-11. I²C VDDIO Interface Header - J30

Reference	Signal	Description
J36	VDD_I2C	Selects I²C IO bus voltage
		Short pins 1-2: 3.3V IO (Default)
		Short pins 2-3: 1.8V IO

6.6 Control Interface

Table 6-12. VDDIO Interface Header - J1

Reference	Signal	Description
J4	VDDIO	Selects VDDIO bus voltage
		Short pins 1-2: 3.3V IO (Default)
		Short pins 2-3: 1.8V IO

Table 6-13. GPIO Interface Header - J8

Reference	Signal	Description
J8.2	GPIO0	General Purpose Input/Output 0
J8.4	GPIO1	General Purpose Input/Output 1
J8.6	GPIO2	General Purpose Input/Output 2
J8.8	GPIO3	General Purpose Input/Output 3
J8.10	GPIO4	General Purpose Input/Output 4
J8.12	GPIO5	General Purpose Input/Output 5
J8.14	GPIO6	General Purpose Input/Output 6
J8.16	GPIO7	General Purpose Input/Output 7

Table 6-14. CMLOUTP Output Signals

Reference	Signal	Description
TP1	CMLOUTP	Test Pad for Channel Monitor Loop-through Driver
TP2	CMLOUTN	Test Pad for Channel Monitor Loop-through Driver

Table 6-15. Mode SW-DIP4 - S1

Reference	Mode	Description
S1.1	1	CSI Mode (DS90UB953 compatible) (Default)
S1.2	2	RAW12 / LF (DS90UB913A / 933 compatible)
S1.3	3	RAW12 / HF (DS90UB913A / 933 compatible)
S1.4	4	RAW10 (DS90UB913A / 933 compatible)

Table 6-16. Control SW-DIP2 - SW1

Reference	Signal	Input = L	Input = H	Description
SW1.1	TESTEN	For Normal operation (Default)	Test Mode enable	Test Mode
SW1.2	PDB	Device is powered down	Device is enabled (Default)	Power-down Mode

Table 6-17. LEDs

Reference	LED Name	Description
D1	GPIO0	Illuminates if GPIO0 is ON
D2	GPIO1	Illuminates if GPIO1 is ON
D3	GPIO2	Illuminates if GPIO2 is ON

Table 6-17. LEDs (continued)

Reference	LED Name	Description
D4	GPIO3	Illuminates if GPIO3 is ON
D5	GPIO4	Illuminates if GPIO48 is ON
D6	GPIO5	Illuminates if GPIO5 is ON
D7	GPIO6	Illuminates if GPIO6 is ON
D8	GPIO7	Illuminates if GPIO7 is ON
D11	VDD_EXT	Illuminates if 12V Power is applied to DC-IN J30
D12	VDD5V	Illuminates on +5V
D13	VFEED_POC	Illuminates if VFEED_POC Power is ON
D14	VDDIO	Illuminates on VDDIO Power

7 Enable and Reset

There are two device enable and reset/power-down options for the EVM.

- RC timing option: The C57 external capacitor and R78 pull-up resistor connected to the PDB pin ramp time after the device is powered on.
- External control option: A push-button (S2) or SW1 position 2 is available for the manual control of the PBD signal.

8 ALP Software Setup

8.1 System Requirements

Operating System:	Windows 7 64-bit
USB:	USB2ANY
USB2ANY Firmware Version:	2.5.2.0
USB:	Aardvark I^2C/SPI host adapter p/n TP240141

8.2 Download Contents

Latest TI Analog LaunchPAD can be downloaded from: http://www.ti.com/tool/alp.

Download and extract the zip file to a temporary location that can be deleted later.

The following installation instructions are for a PC running Windows 7 64-bit Operating System.

8.3 Installation of the ALP Software

Execute the ALP Setup Wizard program called “ALPF_setup_v_x_x_x.exe” that was extracted to a temporary location on the local drive of your PC.

There are 7 steps to the installation once the setup wizard is started:

1. Select the "Next" button.
2. Select “I accept the agreement” and then select the “Next” button.
3. Select the location to install the ALP software and then select the “Next” button.
4. Select the location for the start menu shortcut and then select the “Next” button.
5. There will then be a screen that allows the creation of a desktop icon. After selecting the desired choices select the “Next” button.
6. Select the “Install” button, and the software will then be installed to the selected location.
7. Uncheck “Launch Analog LaunchPAD” and select the “Finish” button. The ALP software will start if “Launch Analog LaunchPAD” is checked, but it will not be useful until the USB driver is installed and board is attached.

Power the DS90UB960-Q1 EVM board with a 12 VDC power supply.

8.4 Startup - Software Description

Make sure all the software has been installed and the hardware is powered on and connected to the PC. Execute “Analog LaunchPAD” shortcut from the start menu. The default start menu location is under All Programs > Texas Instruments > Analog LaunchPAD vx.x.x > Analog LaunchPAD to start MainGUI.exe.

Figure 8-1. Launching ALP

The application must come up in the state shown in Figure 8-2. If it does not, see Section 9, “Troubleshooting ALP Software”.

Under the Devices tab click on “DS90UB960” or "DS90UB960_ENG" to select the device and open up the device profile and its associated tabs.

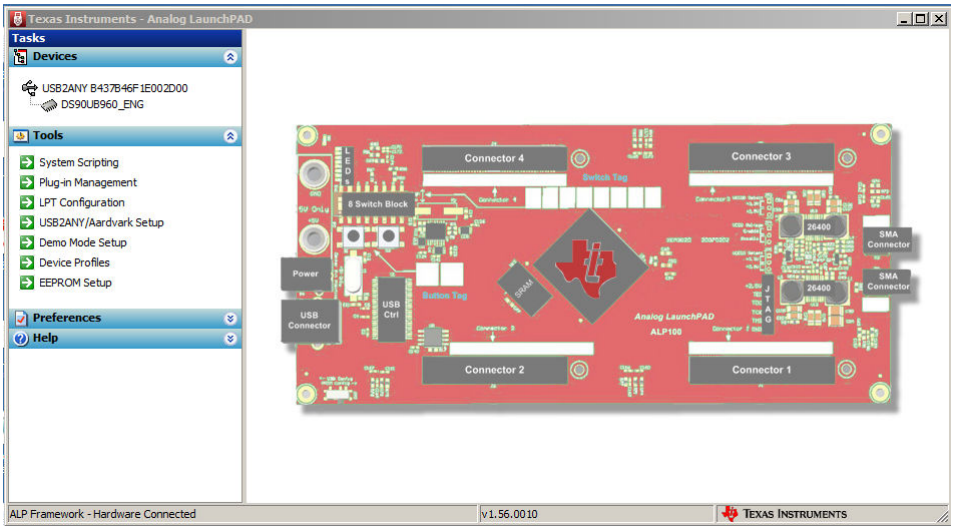


Figure 8-2. Initial ALP Screen

After selecting the “DS90UB960” or "DS90UB960_ENG", the following screen shown in Figure 8-3 must appear provided four camera modules with DS90UB953-Q1 are connected to the EVM.

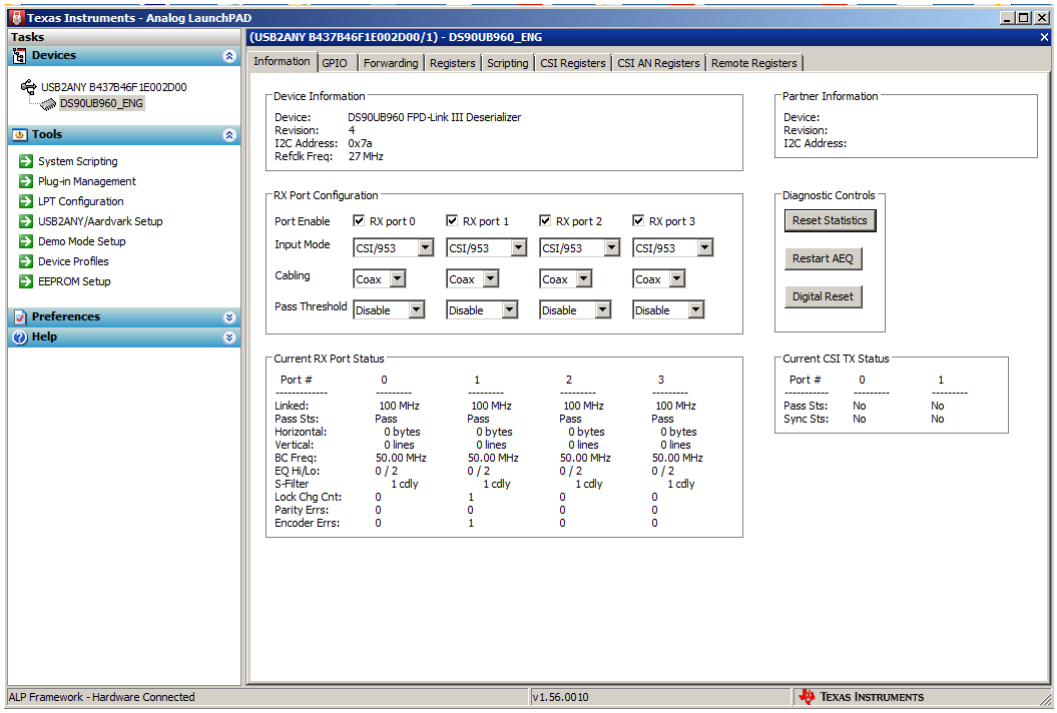


Figure 8-3. Follow-up Screen

8.5 Information Tab

The Information tab is shown below.

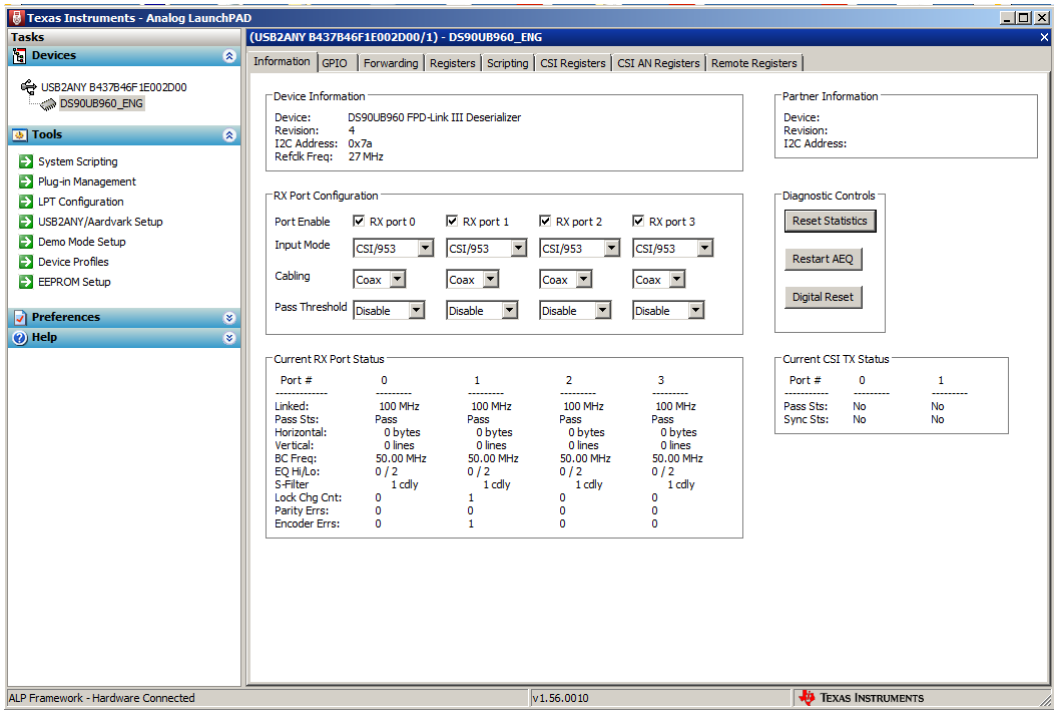


Figure 8-4. ALP Information Tab

8.6 Registers Tab

The Register tab is shown in Figure 8-5.

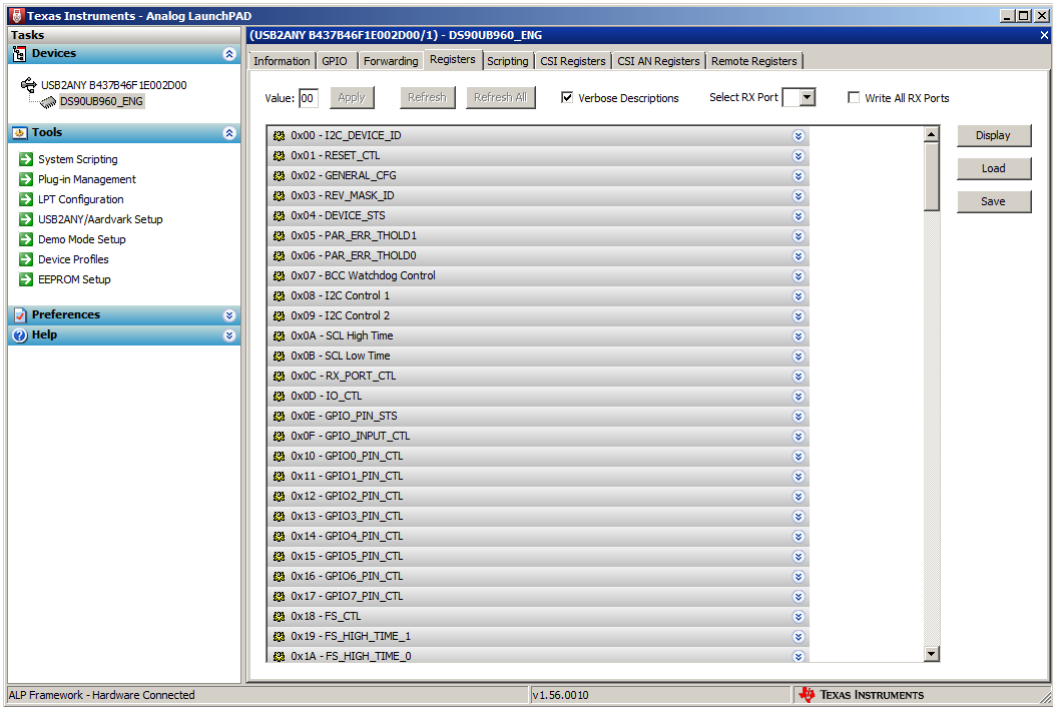


Figure 8-5. ALP Registers Tab

8.7 Registers Tab - Address 0x00 Selected

Address 0x00 selected as shown in Figure 8-6. Note that the “Value:” box, 

, will now show the hex value of that register.

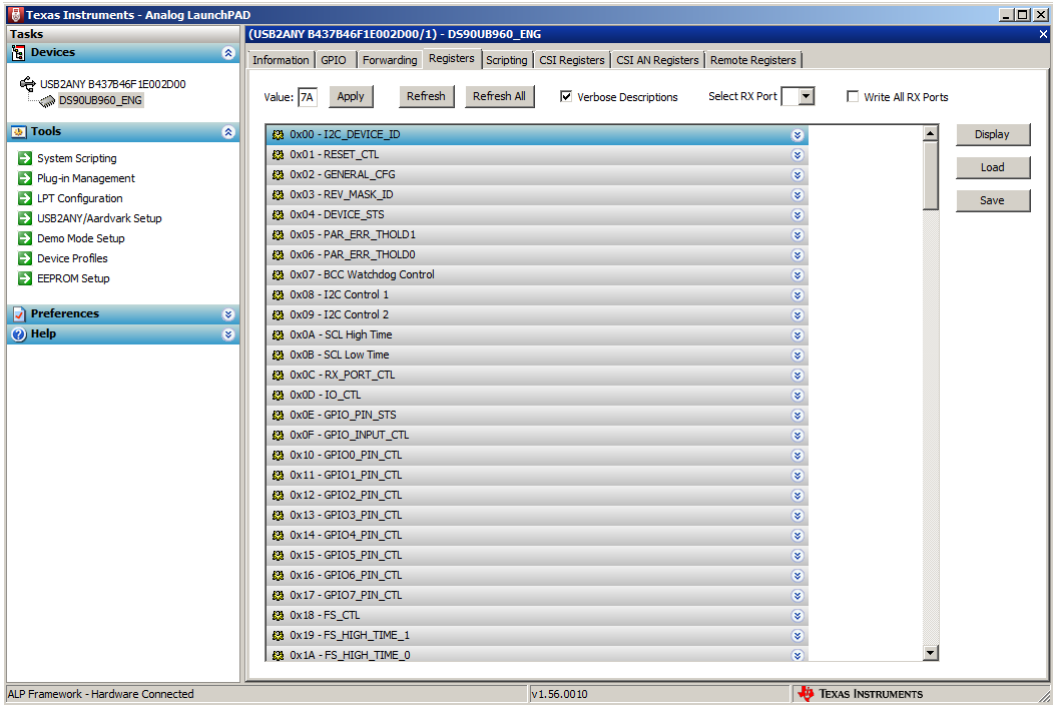


Figure 8-6. ALP Device ID Selected

8.8 Registers Tab - Address 0x00 Expanded

By double clicking on the Address bar

or a single click on  . Address 0x00 expanded reveals contents by bits. Any register address displayed can be expanded.

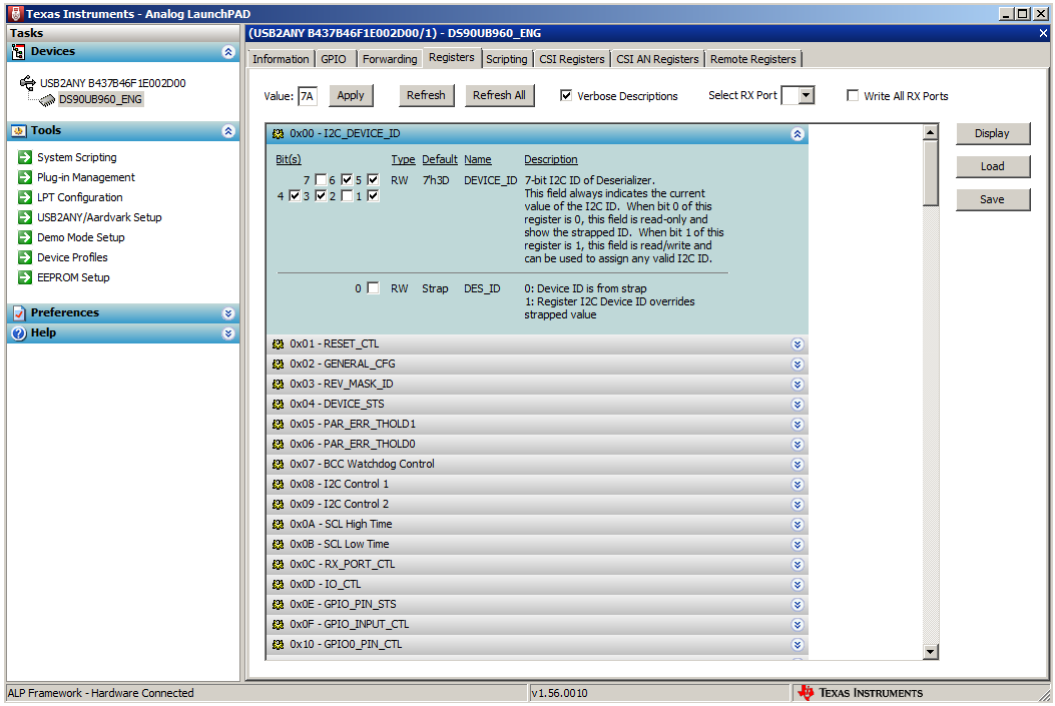
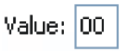
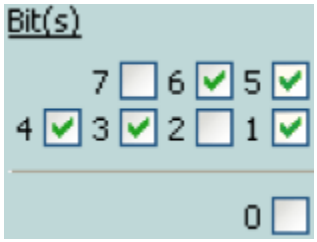


Figure 8-7. ALP Device ID Expanded

Any RW Type register, 

, can be written into by writing the hex value into the “Value:” box, 

or putting the pointer into the individual register bit(s) box by a left mouse click to put a check mark (indicating a “1”) or unchecking to remove the check mark (indicating a “0”). Click the “Apply” button to write to the register, and “refresh” to see the new value of the selected (highlighted) register.



The box toggles on every mouse click.

8.9 Scripting Tab

The Scripting tab is shown below.

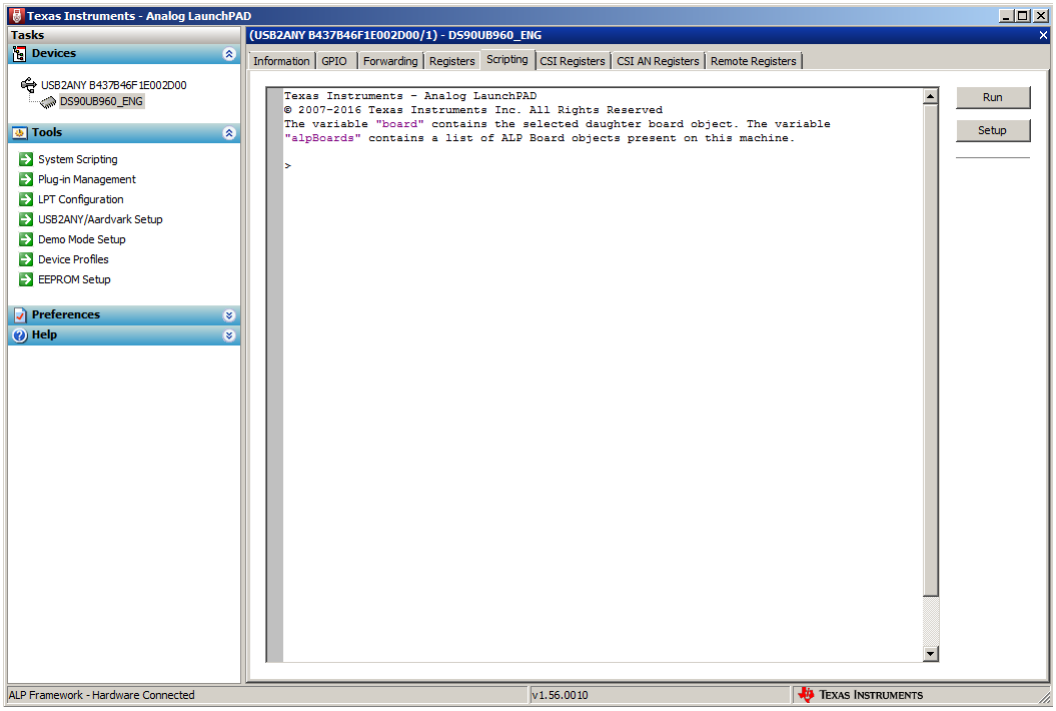


Figure 8-8. ALP Scripting Tab

The script window provides a full Python scripting environment which can be for running scripts and interacting with the device in an interactive or automated fashion.

> **WARNING**
>
> Directly interacting with devices either through register modifications or calling device support library functions can effect the performance and/or functionality of the user interface and may even crash the ALP Framework application.

8.10 Sample ALP Python Script

8.10.1 Initialization

```
# 960_RX0_init_CSI0.py
# board.devAddr = 0x7a
# To configure GPIO0 to bring out Lock for Port0,
print  "configure GPIO0 to bring out Lock for Port0"
board.WriteReg(0x10,0x81)
time.sleep(0.1)
# To configure GPIO1 to bring out Lock for Port1,
print  "configure GPIO1 to bring out Lock for Port1"
board.WriteReg(0x11,0x85)
time.sleep(0.1)
# To configure GPIO2 to bring out Lock for Port2,
print  "configure GPIO2 to bring out Lock for Port2"
board.WriteReg(0x12,0x89)
time.sleep(0.1)
# To configure GPIO3 to bring out Lock for Port3,
print  "configure GPIO3 to bring out Lock for Port3"
board.WriteReg(0x13,0x8D)
time.sleep(0.1)
print  "CSI_PORT_SEL"
board.WriteReg(0x32,0x01) # CSI0 select
time.sleep(0.1)
print  "CSI_PLL_CTL"
```

```
board.WriteReg(0x1f,0x02) # CSI0 800mbps
time.sleep(0.1)
print  "CSI_EN"
board.WriteReg(0x33,0x1) # CSI_EN & CSI0 4L
time.sleep(0.1)
print  "FWD_PORT"
board.WriteReg(0x20,0xe0) # forwarding of RX 0 to CSI0
time.sleep(0.1)
print  "FPD3_PORT_SEL"
board.WriteReg(0x4c,0x01) # RX_PORT0
time.sleep(0.1)
print  "enable pass throu"
board.WriteReg(0x58,0x58) # enable pass throu
time.sleep(0.1)
board.WriteReg(0x5c,0x18) #
print  "SER_ALIAS_ID 0x5c value ", hex(board.ReadReg(0x5c))
time.sleep(0.1)
board.WriteReg(0x5d,0x60) #
print  "SlaveID[0] 0x5d value ", hex(board.ReadReg(0x5d))
time.sleep(0.1)
board.WriteReg(0x65,0x60) #
print  "SlaveAlias[0] 0x65 value ", hex(board.ReadReg(0x65))
time.sleep(0.1)
```

##

```
# 960_RX1_init_CSI0.py
print  "CSI_PORT_SEL"
board.WriteReg(0x32,0x01) # CSI0 select
time.sleep(0.1)
print  "CSI_PLL_CTL"
board.WriteReg(0x1f,0x02) # CSI0 800mbps
time.sleep(0.1)
print  "CSI_EN"
board.WriteReg(0x33,0x1) # CSI_EN & CSI0 4L
time.sleep(0.1)
print  "FWD_PORT"
board.WriteReg(0x20,0xd0) # forwarding of RX 1 to CSI0
time.sleep(0.1)
print  "FPD3_PORT_SEL"
board.WriteReg(0x4c,0x12) # RX_PORT1
time.sleep(0.1)
print  "enable pass throu"
board.WriteReg(0x58,0x58) # enable pass throu
time.sleep(0.1)
board.WriteReg(0x5c,0x1a) #
print  "SER_ALIAS_ID 0x5c value ", hex(board.ReadReg(0x5c))
time.sleep(0.1)
board.WriteReg(0x5d,0x60) #
print  "SlaveID[0] 0x5d value ", hex(board.ReadReg(0x5d))
time.sleep(0.1)
board.WriteReg(0x65,0x62) #
print  "SlaveAlias[0] 0x65 value ", hex(board.ReadReg(0x65))
time.sleep(0.1)
```

##

```
# 960_RX2_init_CSI0.py
print  "CSI_PORT_SEL"
board.WriteReg(0x32,0x01) # CSI0 select
time.sleep(0.1)
print  "CSI_PLL_CTL"
board.WriteReg(0x1f,0x02) # CSI0 800mbps
time.sleep(0.1)
print  "CSI_EN"
board.WriteReg(0x33,0x1) # CSI_EN & CSI0 4L
time.sleep(0.1)
print  "FWD_PORT"
board.WriteReg(0x20,0xb0) # forwarding of RX 2 to CSI0
time.sleep(0.1)
print  "FPD3_PORT_SEL"
board.WriteReg(0x4c,0x24) # RX_PORT2
time.sleep(0.1)
print  "enable pass throu"
board.WriteReg(0x58,0x58) # enable pass throu
time.sleep(0.1)
```

```
board.WriteReg(0x5c,0x1c) #
print  "SER_ALIAS_ID 0x5c value ", hex(board.ReadReg(0x5c))
time.sleep(0.1)
board.WriteReg(0x5d,0x60) #
print  "SlaveID[0] 0x5d value ", hex(board.ReadReg(0x5d))
time.sleep(0.1)
board.WriteReg(0x65,0x66) #
print  "SlaveAlias[0] 0x65 value ", hex(board.ReadReg(0x65))
time.sleep(0.1)
```

##

```
# 960_RX3_init_CSI0.py
print  "CSI_PORT_SEL"
board.WriteReg(0x32,0x01) # CSI0 select
time.sleep(0.1)
print  "CSI_PLL_CTL"
board.WriteReg(0x1f,0x02) # CSI0 800mbps
time.sleep(0.1)
print  "CSI_EN"
board.WriteReg(0x33,0x1) # CSI_EN & CSI0 4L
time.sleep(0.1)
print  "FWD_PORT"
board.WriteReg(0x20,0x70) # forwarding of RX 3 to CSI0
time.sleep(0.1)
print  "FPD3_PORT_SEL"
board.WriteReg(0x4c,0x38) # RX_PORT3
time.sleep(0.1)
print  "enable pass throu"
board.WriteReg(0x58,0x58) # enable pass throu
time.sleep(0.1)
board.WriteReg(0x5c,0x1e) #
print  "SER_ALIAS_ID 0x5c value ", hex(board.ReadReg(0x5c))
time.sleep(0.1)
board.WriteReg(0x5d,0x60) #
print  "SlaveID[0] 0x5d value ", hex(board.ReadReg(0x5d))
time.sleep(0.1)
board.WriteReg(0x65,0x68) #
print  "SlaveAlias[0] 0x65 value ", hex(board.ReadReg(0x65))
time.sleep(0.1)
##########################################################
```

9 Troubleshooting ALP Software

9.1 ALP Loads the Incorrect Profile

If ALP opens with the incorrect profile loaded the correct profile can be loaded from the USB2ANY/Aardvark Setup found under the tools menu.

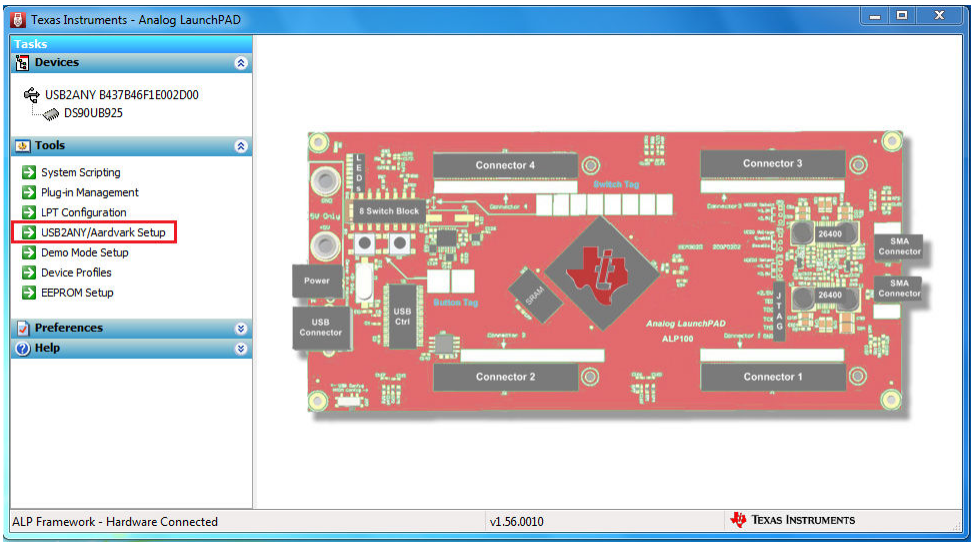


Figure 9-1. USB2ANY Setup

Highlight the incorrect profile in the Defined ALP Devices list and press the remove button.

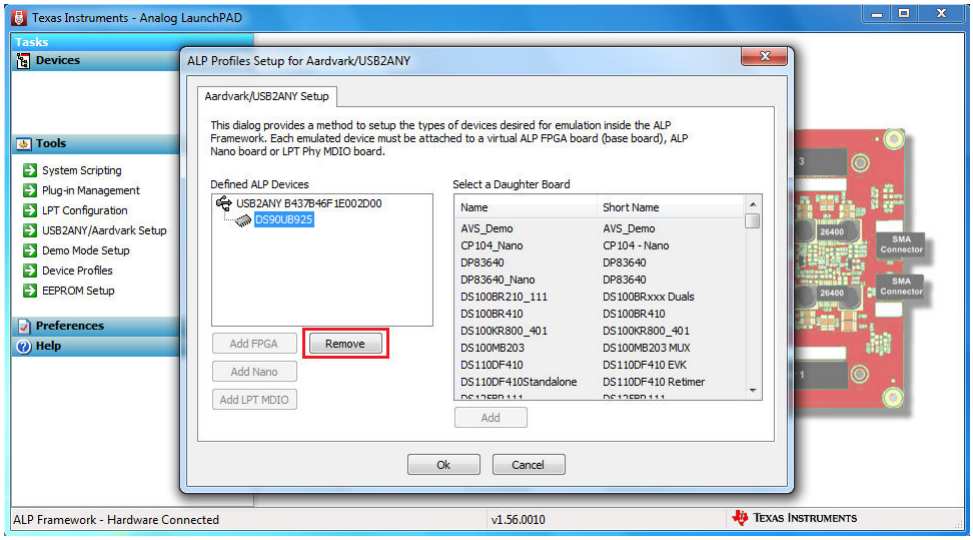


Figure 9-2. Remove Incorrect Profile

Find the correct profile under the Select a Daughter Board list, highlight the profile and press Add. If DS90UB960 ALP profile is not listed, contact your TI representative to obtain it. The ALP profiles are typically located in the ALP installation directory such as "C:\Program Files (x86)\Texas Instruments\Analog LaunchPAD v1.56.0010\Profiles\".

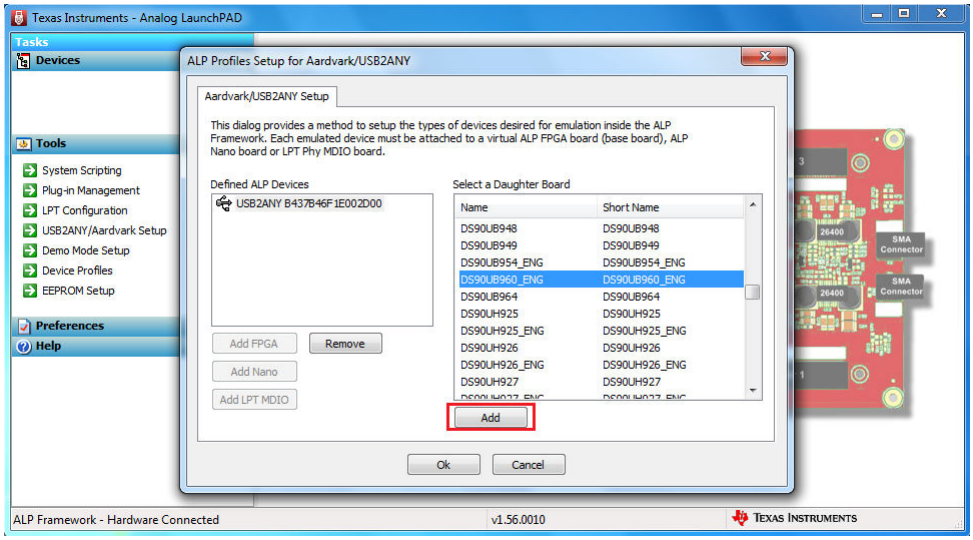


Figure 9-3. Add Correct Profile

Select Ok and the correct profile must now be loaded.

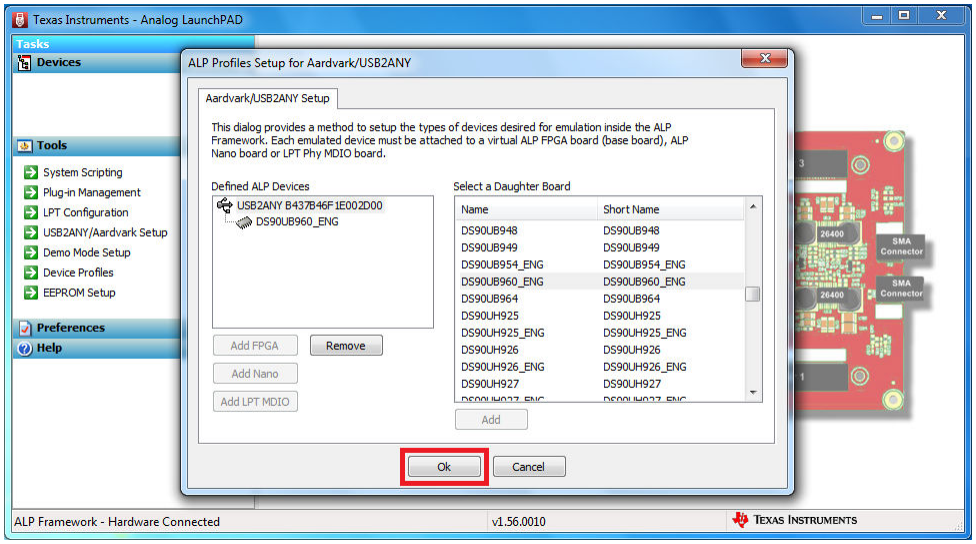


Figure 9-4. Finish Setup

9.2 ALP does not detect the EVM

If the following window opens after starting the ALP software, double check the hardware setup.

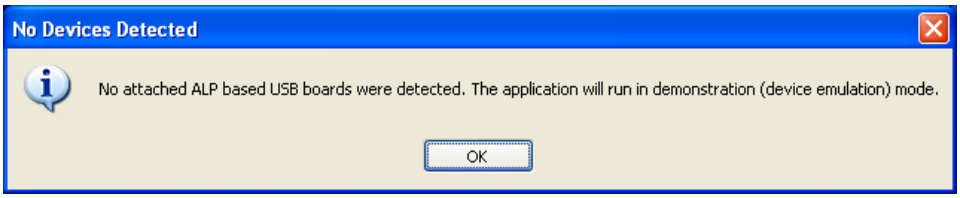


Figure 9-5. ALP No Devices Error

It may also be that the USB2ANY driver is not installed. Check the device manager. There must be a “HID-compliant device” under the “Human Interface Devices” as shown below.

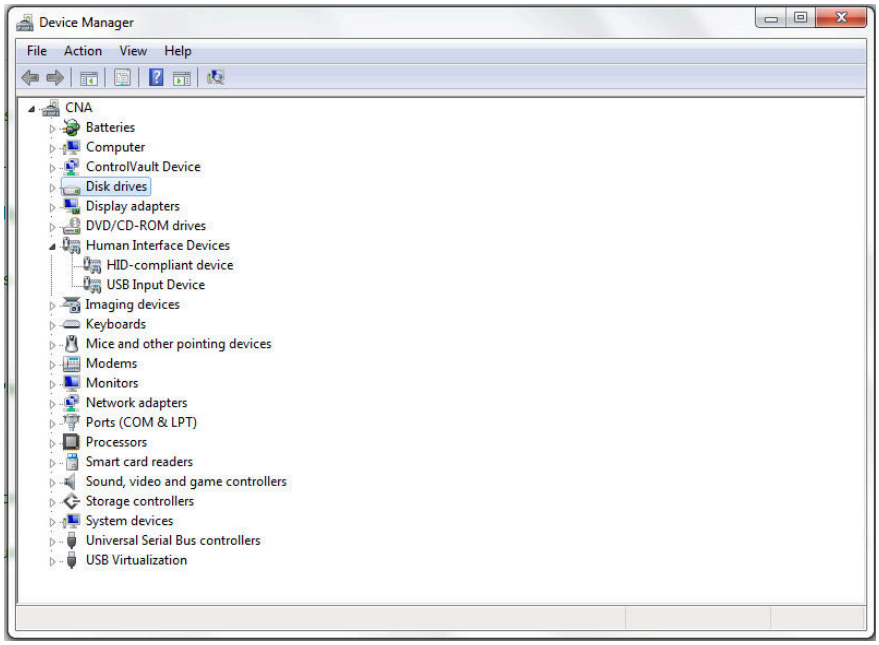


Figure 9-6. Windows 7, ALP USB2ANY Driver

The software must start with only “DS90UB960” or “DS90UB960_ENG” in the “Devices” pull down menu. If there are more devices then the software is most likely in demo mode. When the ALP is operating in demo mode there is a “(Demo Mode)” indication in the lower left of the application status bar as shown below.

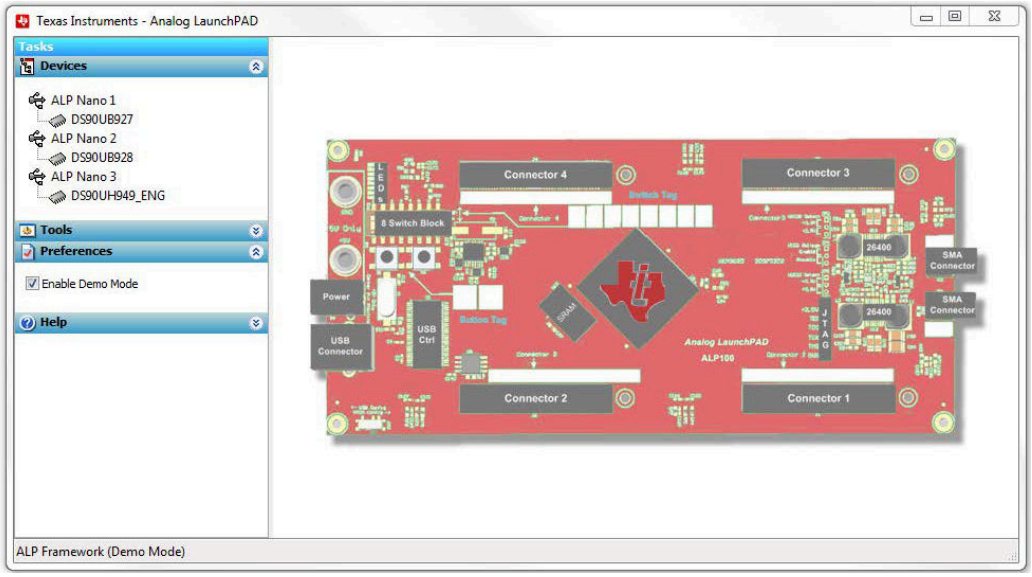


Figure 9-7. ALP in Demo Mode

Disable the demo mode by selecting the “Preferences” pull down menu and un-checking “Enable Demo Mode”.

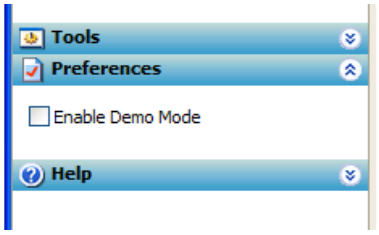


Figure 9-8. ALP Preferences Menu

After demo mode is disabled, the ALP software will poll the ALP hardware. The ALP software will update and have only “DS90UB960” or “DS90UB960_ENG” under the “Devices” pull down menu.

For additional information about using ALP software with FPD-Link III device, review the following training material: Use of Analog Launch Pad (ALP) GUI to configure the FPD-Link EVMs

10 Typical Connection and Test Equipment

The following is a list of typical test equipment that may be used to monitor the MIPI CSI-2 signals from the DS90UB960-Q1:

1. Logic Analyzer
2. Any SCOPE with a bandwidth of at least 4 GHz for observing differential signals.
3. UNH-IOL MIPI D-PHY Reference Termination Board (RTB)
4. UNH-IOL MIPI D-PHY/CSI/DSI Probing Board
5. UNH-IOL CSIGUI Tool

11 Termination Device

A termination device is required to properly monitor and measure the transmission of the MIPI DPHY signals. The termination device must support the change of signals as it switches between LP and HS modes. This can be provided by either a CSI-2 receiver or a dedicated dynamic termination board. TI recommends the termination board is the UNH-IOL MIPI D-PHY Reference Termination Board (RTB).

12 Typical Test Setup

Figure 12-1 and Figure 12-2 illustrate the typical test setups used to measure and evaluate DS90UB96X-Q1.

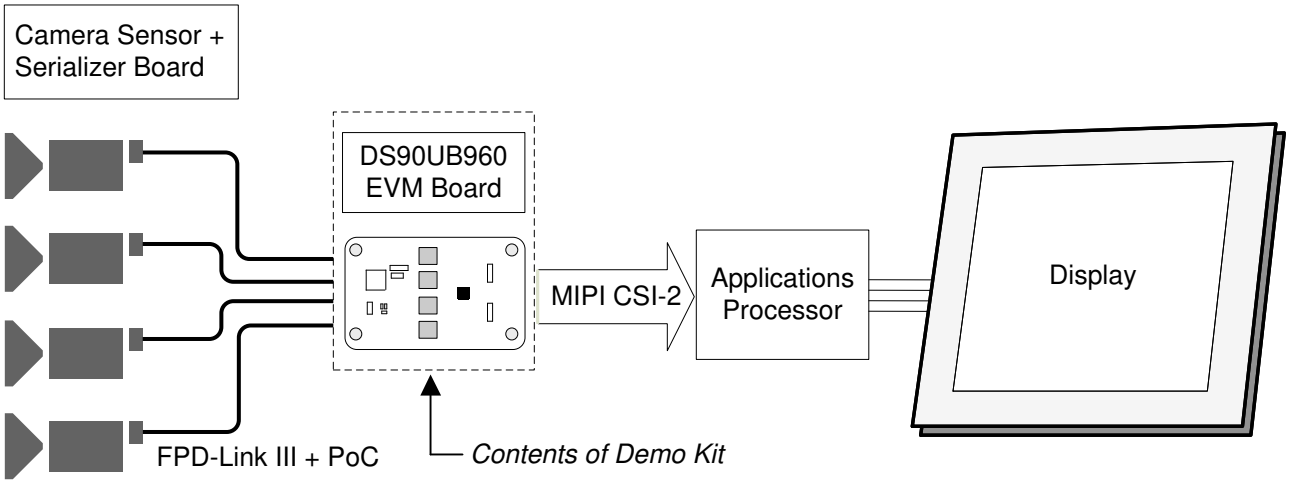


Figure 12-1. Typical Test Setup for Application

The picture below shows a typical test set up using a video generator and logic analyzer.

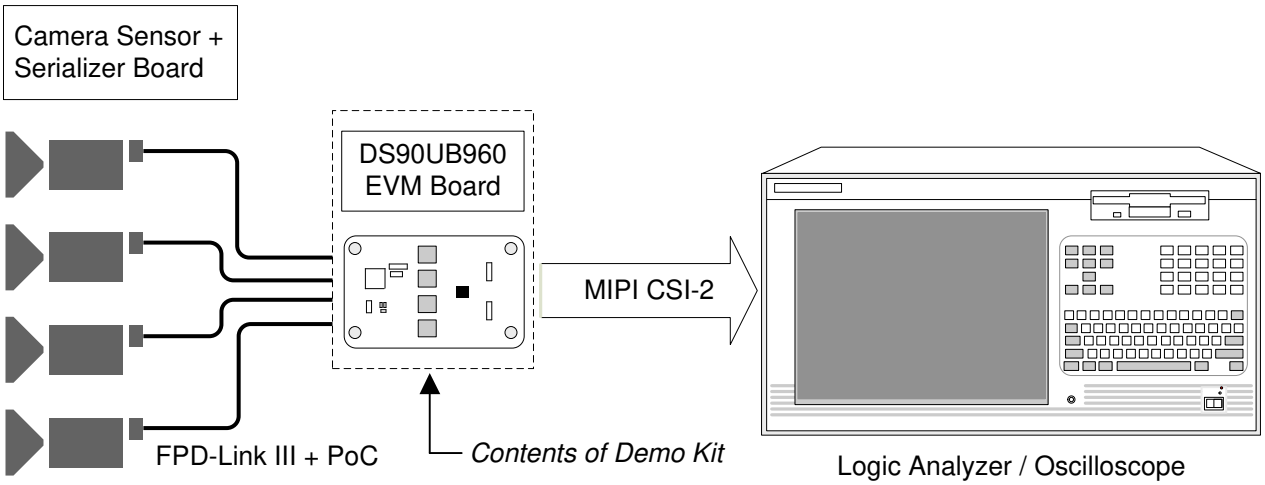


Figure 12-2. Typical Test Setup for Evaluation

13 Equipment References

Note

Please note that the following references are supplied only as a courtesy to our valued customers. It is not intended to be an endorsement of any particular equipment or supplier.

Logic Analyzer:

Keysight Technologies

www.keysight.com

MIPI Test Fixtures:

University of New Hampshire InterOperability Laboratory (UNH-IOL)

www.iol.unh.edu/services/testing/mipi/fixtures.php

Aardvark I^2C/SPI Host Adapter Part Number: TP240141

www.totalphase.com/products/aardvark_i2cspi

14 Cable References

FAKRA coaxial cable:

www.leoni-automotive-cables.com

Rosenberger FAKRA connector:

http://www.rosenberger.com/en/products/automotive/fakra.php

15 Bill of Materials

Table 15-1. BOM for DS90UB960-Q1EVM

Item	Quantity	Designator	Part Number	Manufacturer	Description
1	1	!PCB1	HSDC011	Any	Printed Circuit Board
2	4	C1, C2, C3, C4	08051C472KAT2A	AVX	CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805
3	9	C5, C10, C16, C17, C24, C30, C38, C44, C45	CL21A106KAFN3NE	Samsung	CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805
4	8	C7, C12, C18, C26, C32, C40, C46, C100	C1005JB1V105K050BC	TDK	CAP, CERM, 1 µF, 35 V, +/- 10%, JB, 0402
5	9	C8, C13, C19, C27, C33, C41, C47, C53, C56	CGA2B3X7R1H104K050BB	TDK	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402
6	16	C9, C14, C15, C20, C21, C22, C23, C28, C29, C34, C35, C36, C37, C42, C43, C48	GCM155R71H103KA55D	MuRata	CAP, CERM, 0.01uF, 50V, +/-10%, C0G/NP0, 0402
7	6	C49, C50, C70, C71, C82, C83	CGA2B3X7R1H333K050BB	TDK	CAP, CERM, 0.033 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402
8	5	C51, C118, C124, C132, C133	0603YC104JAT2A	AVX	CAP, CERM, 0.1 µF, 16 V, +/- 5%, X7R, 0603
9	1	C52	06031C103KAT2A	AVX	CAP, CERM, 0.01 µF, 100 V, +/- 10%, X7R, 0603
10	15	C54, C55, C87, C88, C91, C95, C101, C102, C104, C111, C112, C115, C116, C127, C128	GRM155R71C104KA88D	MuRata	CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0402
11	5	C57, C94, C103, C113, C117	GRM21BR71A106KE51L	MuRata	CAP, CERM, 10uF, 10V, +/-10%, X7R, 0805
12	4	C58, C59, C60, C61	GRM1555C1E4R7CA01D	MuRata	CAP, CERM, 4.7pF, 25V, +/-5%, C0G/NP0, 0402
13	8	C62, C64, C66, C68, C74, C76, C78, C80	C1005X7R1H104K050BB	TDK	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0402
14	8	C63, C65, C67, C69, C75, C77, C79, C81	GRT31CR61H106KE01L	MuRata	CAP, CERM, 10 µF, 50 V, +/- 10%, X5R, AEC-Q200 Grade 1, 1206
15	4	C72, C73, C84, C85	CGA2B3X7R1H153K050BB	TDK	CAP, CERM, 0.015 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402
16	1	C86	GRM1555C1H100JA01D	MuRata	CAP, CERM, 10pF, 50V, +/-5%, C0G/NP0, 0402
17	2	C89, C97	C1608X7R1C105K	TDK	CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603
18	5	C90, C98, C105, C106, C121	293D226X0025D2TE3	Vishay-Sprague	CAP, TA, 22uF, 25V, +/-20%, 0.7 ohm, SMD

Table 15-1. BOM for DS90UB960-Q1EVM (continued)

Item	Quantity	Designator	Part Number	Manufacturer	Description
19	1	C92	T495D107M016ATE100	Kemet	CAP, TA, 100uF, 16V, +/-20%, 0.1 ohm, SMD
20	1	C93	GRM32ER61C476ME15L	MuRata	CAP, CERM, 47uF, 16V, +/-20%, X5R, 1210
21	1	C96	GRM155R71H332KA01D	MuRata	CAP, CERM, 3300pF, 50V, +/-10%, X7R, 0402
22	4	C99, C109, C110, C114	GRM21BR71C475KA73L	MuRata	CAP, CERM, 4.7uF, 16V, +/-10%, X7R, 0805
23	1	C107	293D225X9025A2TE3	Vishay-Sprague	CAP, TA, 2.2uF, 25V, +/-10%, 6.3 ohm, SMD
24	1	C108	06031C103JAT2A	AVX	CAP, CERM, 0.01uF, 100V, +/-5%, X7R, 0603
25	1	C119	0805YD225KAT2A	AVX	CAP, CERM, 2.2uF, 16V, +/-10%, X5R, 0805
26	1	C120	C1608X7R1H103K080AA	TDK	CAP, CERM, 0.01 µF, 50 V, +/- 10%, X7R, 0603
27	1	C122	GRM21BR71C105KA01L	MuRata	CAP, CERM, 1 µF, 16 V, +/- 10%, X7R, 0805
28	2	C123, C129	06035A221FAT2A	AVX	CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603
29	2	C125, C126	GRM1885C2A300JA01D	MuRata	CAP, CERM, 30 pF, 100 V, +/- 5%, C0G/NP0, 0603
30	1	C130	GRM188R71A474KA61D	MuRata	CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603
31	1	C131	C0603X222K5RACTU	Kemet	CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603
32	1	CN1	AMS22D-40MZ5-Z	Rosenberger	Plug, 50 Ohm, R/A, Gold, TH
33	10	D1, D2, D3, D4, D5, D6, D7, D8, D9, D16	150060VS75000	Wurth Elektronik eiSos	LED, Green, SMD
34	1	D10	1N5819HW-7-F	Diodes Inc.	Diode, Schottky, 40V, 1A, SOD-123
35	3	D11, D12, D14	150060SS75000	Wurth Elektronik eiSos	LED, Super Red, SMD
36	1	D13	LTST-C190KFKT	Lite-On	LED, Orange, SMD
37	1	D15	1SMB5922BT3G	ON Semiconductor	Diode, Zener, 7.5 V, 550 mW, SMB
38	1	F1	0440002.WR	Littelfuse	Fuse, 2 A, 32 V, SMD
39	1	FB1	BK1608HS600-T	Taiyo Yuden	Ferrite Bead, 60 ohm @ 100 MHz, 0.8 A, 0603
40	4	H1, H2, H3, H4	NY PMS 440 0025 PH	B and F Fastener Supply	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead

Table 15-1. BOM for DS90UB960-Q1EVM (continued)

Item	Quantity	Designator	Part Number	Manufacturer	Description
41	4	H5, H6, H7, H8	1902E	Keystone	Standoff, Hex, 1"L #4-40 Nylon
42	1	H9	LM4-308-0300-Z-ZZZZ	Rosenberger	Cable Assembly
43	1	HS1	BMI-S-201-F	Laird-Signal Integrity Products	EMI SHIELD, 13.66 x 12.70 mm, SMT
44	2	J1, J3	QSH-020-01-H-D-DP-A	Samtec	Receptacle, Differential, 0.5mm, 10 pair x2, Gold, SMT
45	1	J2	QTH-020-04-L-D-DP-A	Samtec	Header(shrouded), 0.5mm, 10 pair x 2, Gold, SMT
46	8	J4, J18, J19, J22, J25, J34, J35, J36	TSW-103-07-G-S	Samtec, Inc.	Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator
47	1	J5	MMCX-J-P-H-ST-TH1	Samtec	Connector, MMCX 50 ohm, TH
48	17	J6, J7, J13, J14, J16, J17, J20, J21, J23, J24, J26, J27, J28, J29, J31, J32, J33	5-146261-1	TE Connectivity	Header, 100mil, 2x1, Gold plated, TH
49	1	J8	TSW-108-07-G-D	Samtec	Header, 100mil, 8x2, Gold, TH
50	2	J9, J10	0022112042	Molex	Header, 100mil, 4x1, White, TH
51	1	J11	TSW-104-07-G-D	Samtec	Header, 100mil, 4x2, Gold, TH
52	1	J12	TSW-104-07-G-S	Samtec	Header, 100mil, 4x1, Gold, TH
53	1	J15	TSW-102-07-G-D	Samtec	Header, 100mil, 2x2, Gold, TH
54	1	J30	PJ-102A	CUI Inc.	Connector, DC Jack 2.1X5.5 mm, TH
55	1	J37	1734035-2	TE Connectivity	Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT
56	7	L1, L2, L3, L4, L5, L6, L7	BLM18SG121TN1D	MuRata	Ferrite Bead, 120 ohm @ 100 MHz, 3 A, 0603
57	4	L8, L9, L20, L21	BLM18AG102SN1D	MuRata	Ferrite Bead, 1000 ohm @ 100 MHz, 0.4 A, 0603
58	4	L10, L12, L22, L24	LQH3NPZ100MJRL	MuRata	Inductor, Wirewound, Ferrite, 10 µH, 0.81 A, 0.288 ohm, AEC-Q200 Grade 1, SMD
59	12	L14, L15, L16, L17, L18, L19, L26, L27, L28, L29, L30, L31	BLM18HE152SN1D	MuRata	Ferrite Bead, 1500 ohm @ 100 MHz, 0.5 A, 0603
60	1	L32	7440650047	Wurth Elektronik	Inductor, Shielded Drum Core, Ferrite, 4.7 µH, 4.2 A, 0.02 ohm, SMD
61	2	Q1, Q2	BSS138	Fairchild Semiconductor	MOSFET, N-CH, 50 V, 0.22 A, SOT-23

Table 15-1. BOM for DS90UB960-Q1EVM (continued)

Item	Quantity	Designator	Part Number	Manufacturer	Description
62	15	R3, R5, R10, R14, R59, R61, R64, R85, R86, R87, R88, R124, R132, R141, R151	ERJ-2GE0R00X	Panasonic	RES, 0, 5%, 0.063 W, 0402
63	15	R30, R39, R55, R57, R101, R104, R109, R112, R119, R121, R122, R123, R133, R134, R142	CRCW06030000Z0EA	Vishay-Dale	RES, 0 ohm, 5%, 0.1W, 0603
64	11	R49, R50, R51, R52, R53, R54, R56, R58, R138, R139, R140	CRCW0402220RJNED	Vishay-Dale	RES, 220, 5%, 0.063 W, AEC-Q200 Grade 0, 0402
65	1	R60	CRCW0402100RFKED	Vishay-Dale	RES, 100 ohm, 1%, 0.063W, 0402
66	1	R62	CRCW0402470RJNED	Vishay-Dale	RES, 470 ohm, 5%, 0.063W, 0402
67	7	R63, R81, R82, R83, R84, R115, R128	CRCW04024K70JNED	Vishay-Dale	RES, 4.7k ohm, 5%, 0.063W, 0402
68	3	R65, R78, R79	CRCW040210K0JNED	Vishay-Dale	RES, 10k ohm, 5%, 0.063W, 0402
69	5	R68, R110, R118, R131, R135	CRCW0402100KJNED	Vishay-Dale	RES, 100k ohm, 5%, 0.063W, 0402
70	2	R69, R74	CRCW040278K7FKED	Vishay-Dale	RES, 78.7 k, 1%, 0.063 W, 0402
71	1	R70	CRCW040239K2FKED	Vishay-Dale	RES, 39.2 k, 1%, 0.063 W, 0402
72	1	R71	CRCW040225K5FKED	Vishay-Dale	RES, 25.5 k, 1%, 0.063 W, 0402
73	7	R72, R103, R108, R111, R116, R120, R149	CRCW040210K0FKED	Vishay-Dale	RES, 10.0 k, 1%, 0.063 W, 0402
74	1	R73	CRCW040297K6FKED	Vishay-Dale	RES, 97.6 k, 1%, 0.063 W, 0402
75	1	R75	CRCW040295K3FKED	Vishay-Dale	RES, 95.3 k, 1%, 0.063 W, 0402
76	1	R80	CRCW040240K2FKED	Vishay-Dale	RES, 40.2 k, 1%, 0.063 W, 0402
77	4	R89, R91, R95, R97	CRCW06034K02FKEA	Vishay-Dale	RES, 4.02 k, 1%, 0.1 W, 0603
78	4	R90, R92, R96, R98	RMCF0603ZT0R00	Stackpole Electronics Inc	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603
79	4	R93, R94, R99, R100	CRCW040249R9FKED	Vishay-Dale	RES, 49.9, 1%, 0.063 W, 0402
80	1	R102	CRCW040222K1FKED	Vishay-Dale	RES, 22.1k ohm, 1%, 0.063W, 0402
81	3	R105, R113, R125	CRCW040229K4FKED	Vishay-Dale	RES, 29.4 k, 1%, 0.063 W, 0402
82	1	R106	CRCW0402124KFKED	Vishay-Dale	RES, 124k ohm, 1%, 0.063W, 0402
83	4	R107, R114, R117, R127	CRCW04023K24FKED	Vishay-Dale	RES, 3.24k ohm, 1%, 0.063W, 0402
84	1	R126	CRCW04021K87FKED	Vishay-Dale	RES, 1.87k ohm, 1%, 0.063W, 0402
85	1	R129	CRCW04024K99FKED	Vishay-Dale	RES, 4.99k ohm, 1%, 0.063W, 0402

Table 15-1. BOM for DS90UB960-Q1EVM (continued)

Item	Quantity	Designator	Part Number	Manufacturer	Description
86	2	R136, R137	CRCW04022K40JNED	Vishay-Dale	RES, 2.4 k, 5%, 0.063 W, 0402
87	2	R143, R144	CRCW040233R0JNED	Vishay-Dale	RES, 33 ohm, 5%, 0.063W, 0402
88	1	R145	CRCW04021K50JNED	Vishay-Dale	RES, 1.5k ohm, 5%, 0.063W, 0402
89	2	R146, R152	CRCW040233K0JNED	Vishay-Dale	RES, 33k ohm, 5%, 0.063W, 0402
90	1	R147	CRCW06031M20JNEA	Vishay-Dale	RES, 1.2Meg ohm, 5%, 0.1W, 0603
91	1	R148	CRCW0603200RFKEA	Vishay-Dale	RES, 200 ohm, 1%, 0.1W, 0603
92	1	S1	219-4LPST	CTS Electrocomponents	Switch, SPST 4 Pos, Top Actuated, SMT
93	2	S2, S3	KSR221GLFS	C and K Components	Switch, Normally open, 2.3N force, 200k operations, SMD
94	16	SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13, SH-J14, SH-J15, SH-J16	SPC02SYAN	Sullins Connector Solutions	Shunt, 100mil, Flash Gold, Black
95	1	SW1	219-2LPST	CTS Electrocomponents	Switch, Slide, SPST 2 poles, SMT
96	1	T1	ACM9070-701-2PL-TL01	TDK	Coupled inductor, 5 A, 0.01 ohm, SMD
97	1	U1	DS90UB960WRTDRQ1	Texas Instruments	FPD-Link III Camera Hub Deserializer, RTD0064F (VQFNP-64)
98	3	U2, U4, U6	LM2941LD/NOPB	Texas Instruments	1A Low Dropout Adjustable Regulator, 8-pin LLP, Pb-Free
99	1	U3	TPS54225PWPR	Texas Instruments	4.5V to 18V Input, 2-A Synchronous Step-Down SWIFT™ Converter, PWP0014E
100	1	U5	TPS74801TDRCRQ1	Texas Instruments	Single Output LDO, 1.5 A, Adjustable 0.8 to 3.6 V Output, 0.8 to 5.5 V Input, with Programmable Soft Start, 10-pin SON (DRC), -40 to 105 degC, Green (RoHS, no Sb/Br)
101	1	U7	TPS767D318PWP	Texas Instruments	Dual Output LDO, 1 A, Fixed 1.8, 3.3 V Output, 2.7 to 10 V Input, 28-pin HTSSOP (PWP), -40 to 125 degC, Green (RoHS, no Sb/Br)

Table 15-1. BOM for DS90UB960-Q1EVM (continued)

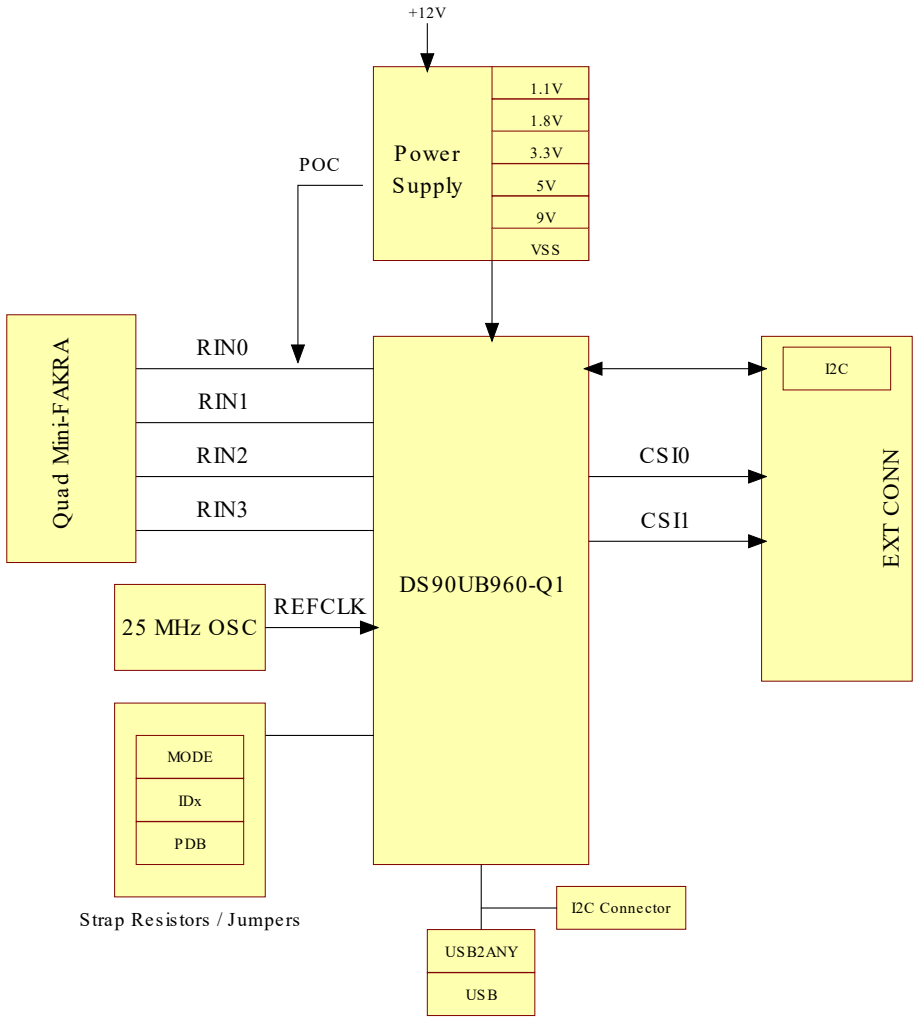
Item	Quantity	Designator	Part Number	Manufacturer	Description
102	1	U8	TPS73533DRBR	Texas Instruments	500mA, Low Quiescent Current, Ultra-Low Noise, High PSRR Low-Dropout Linear Regulator, DRB0008A
103	1	U9	TPD4E004DRYR	Texas Instruments	ESD-Protection Array for High-Speed Data Interfaces, 4 Channels, -40 to +85 degC, 6-pin SON (DRY), Green (RoHS, no Sb/Br)
104	1	U10	MSP430F5529IPN	Texas Instruments	25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 80-pin QFP (PN), Green (RoHS, no Sb/Br)
105	1	U11	TCA9406DCUR	Texas Instruments	TCA9406 Dual Bidirectional 1-MHz I2C-BUS and SMBus Voltage Level-Translator, 1.65 to 3.6 V, -40 to 85 degC, 8-pin US8 (DCU), Green (RoHS, no Sb/Br)
106	1	Y1	SG-210STF25.000000MHZY	Epson	OSC, 25 MHz, 1.6 to 3.6 V, SMD
107	1	Y2	ABM3-24.000MHZ-D2Y-T	Abracon Corporation	Crystal, 24 MHz, 18 pF, SMD
108	0	C6, C11, C25, C31, C39	CL21A106KAFN3NE	Samsung Electro-Mechanics	CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805
109	0	FID1, FID2, FID3, FID4, FID5, FID6	N/A	N/A	Fiducial mark. There is nothing to buy or mount.
110	0	J38	TSW-104-07-G-D	Samtec	Header, 100mil, 4x2, Gold, TH
111	0	J39	TSW-104-07-G-S	Samtec	Header, 100mil, 4x1, Gold, TH
112	0	J40	TSW-102-07-G-D	Samtec	Header, 100mil, 2x2, Gold, TH
113	0	L11, L13, L23, L25	MSS7341T-104MLB	Coilcraft	Inductor, Shielded Drum Core, Ferrite, 100 µH, 0.7 A, 0.28 ohm, SMD
114	0	R1, R2, R4, R6, R8, R13, R18, R20, R23, R24, R29, R32, R36, R38, R43, R44, R45, R46, R47, R48, R67, R76, R77, R150, R153, R154	ERJ-2GE0R00X	Panasonic	RES, 0, 5%, 0.063 W, 0402
115	0	R7, R9, R11, R12, R15, R16, R17, R19, R21, R22, R25, R26, R27, R28, R31, R33, R35, R37, R40, R42	CRCW02010000Z0ED	Vishay-Dale	RES, 0, 5%, 0.05 W, 0201

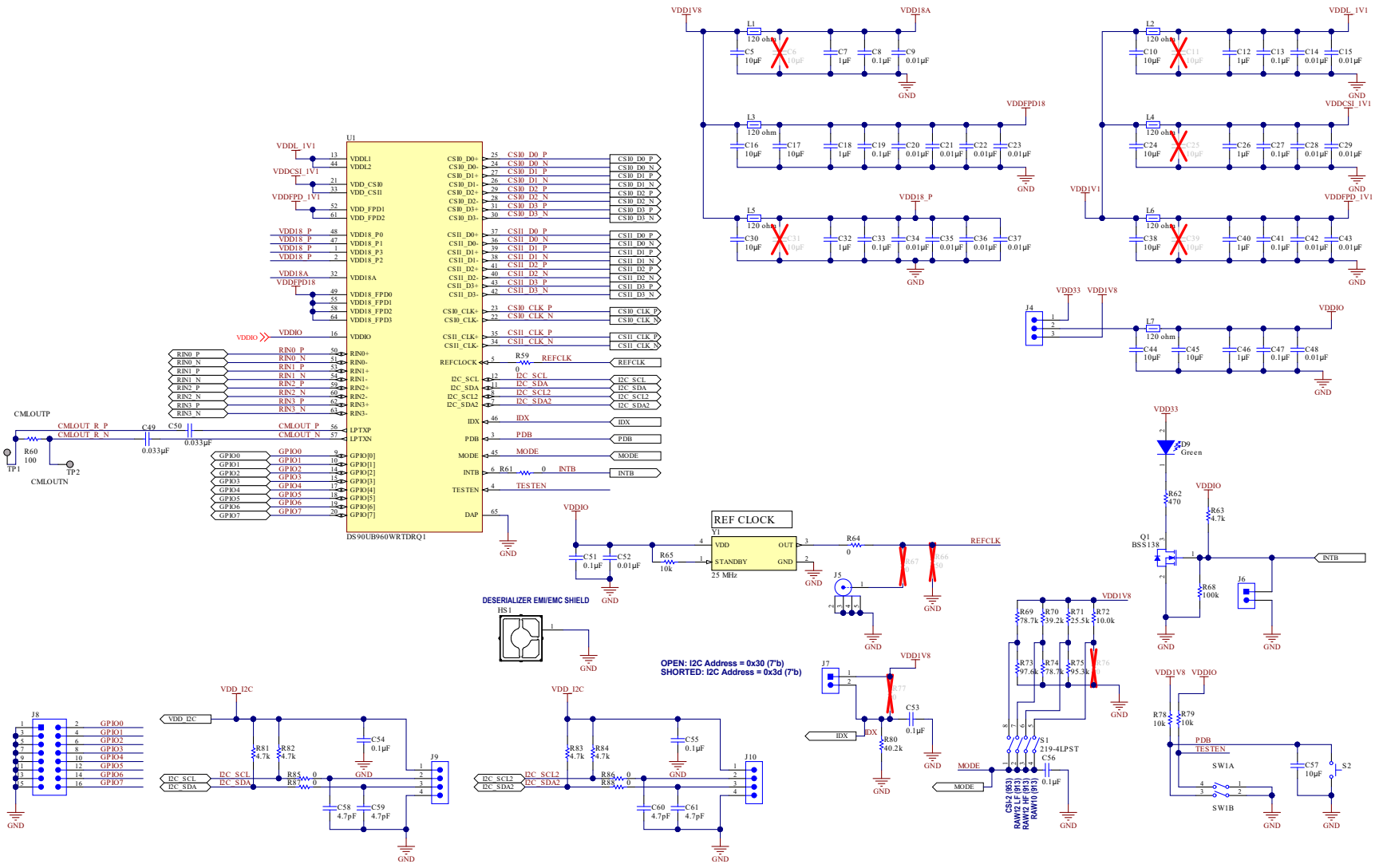
Table 15-1. BOM for DS90UB960-Q1EVM (continued)

Item	Quantity	Designator	Part Number	Manufacturer	Description
116	0	R34, R41	CRCW06030000Z0EA	Vishay-Dale	RES, 0 ohm, 5%, 0.1W, 0603
117	0	R66	504L50R0FTNCFT	AT Ceramics	RES, 50, 1%, 0.125 W, AEC-Q200 Grade 1, 0402
118	0	R130	CRCW040210K0FKED	Vishay-Dale	RES, 10.0k ohm, 1%, 0.063W, 0402

16 PCB Schematics

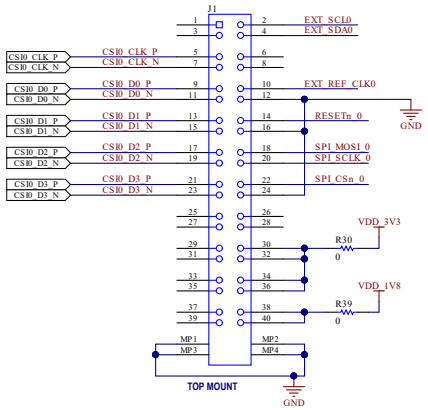
Revision History	
Revision	Notes

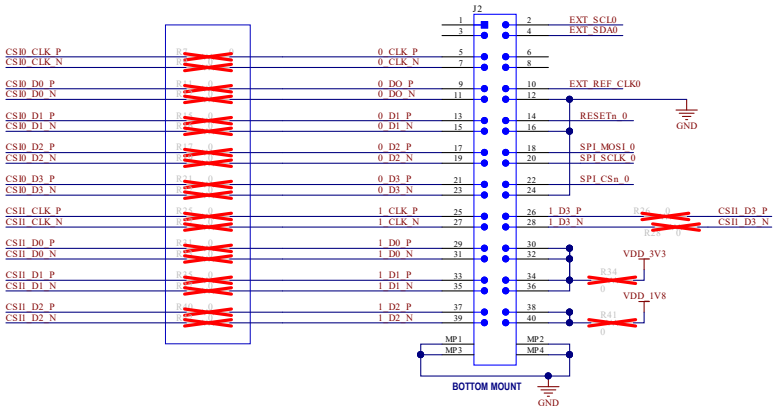




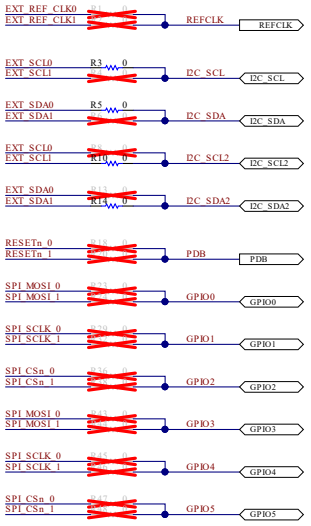
MIPI CSI-2 Output Connectors

Top Side CSI-2 Connector 0

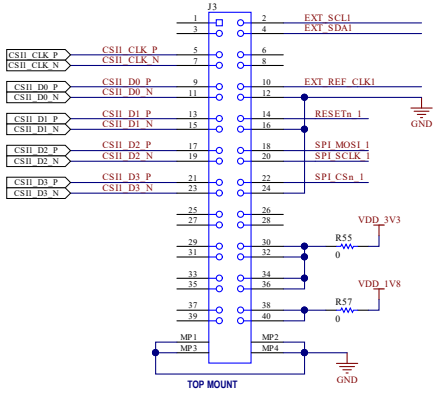


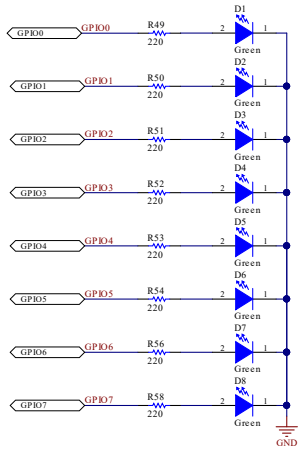


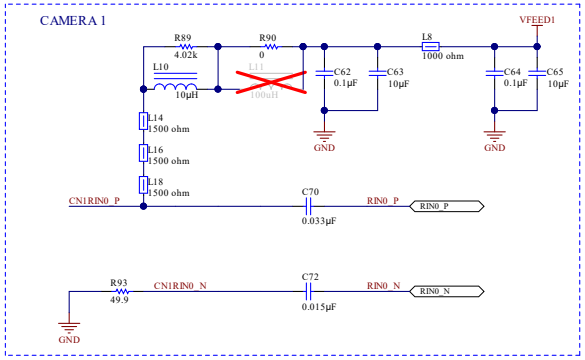
Bottom Side Connector Interface to J6+ EVM

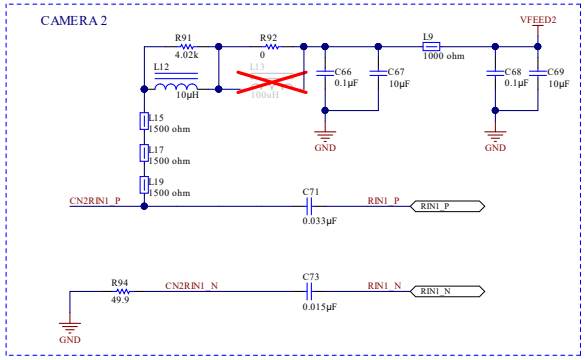


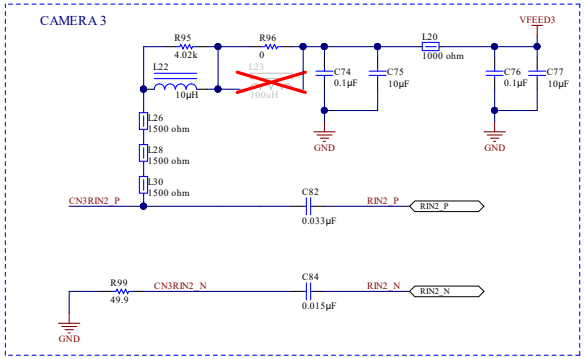
Top Side CSI-2 Connector 1

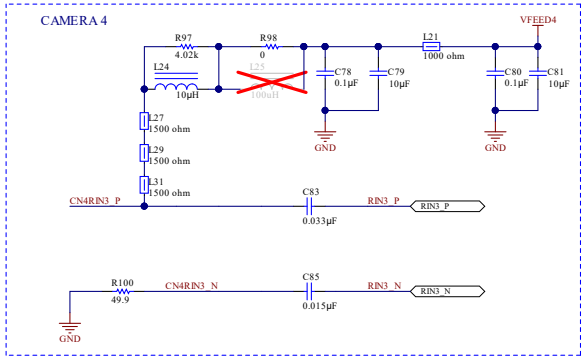


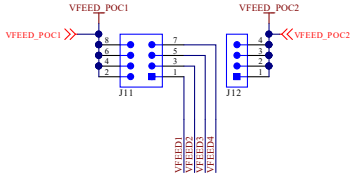


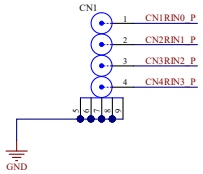


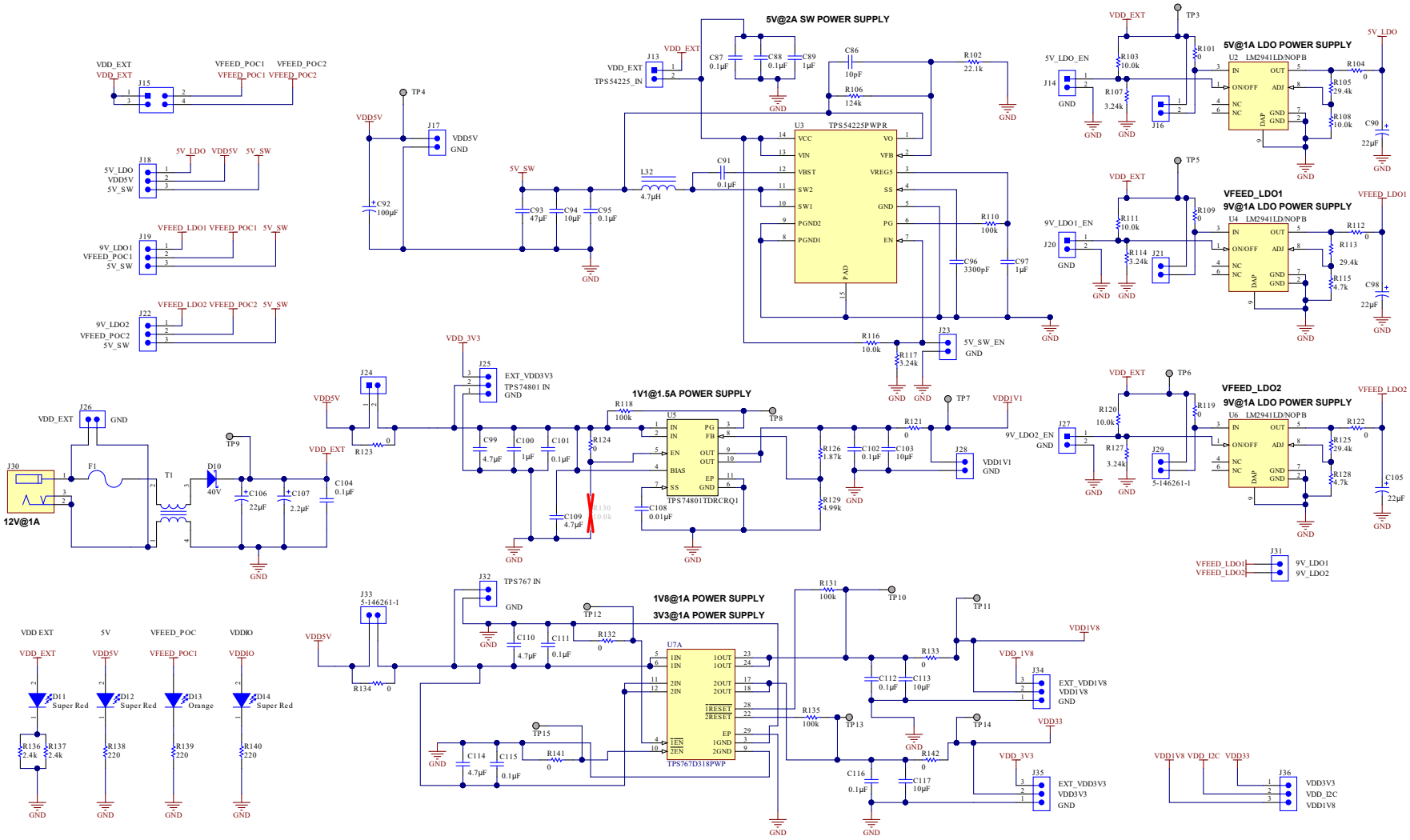




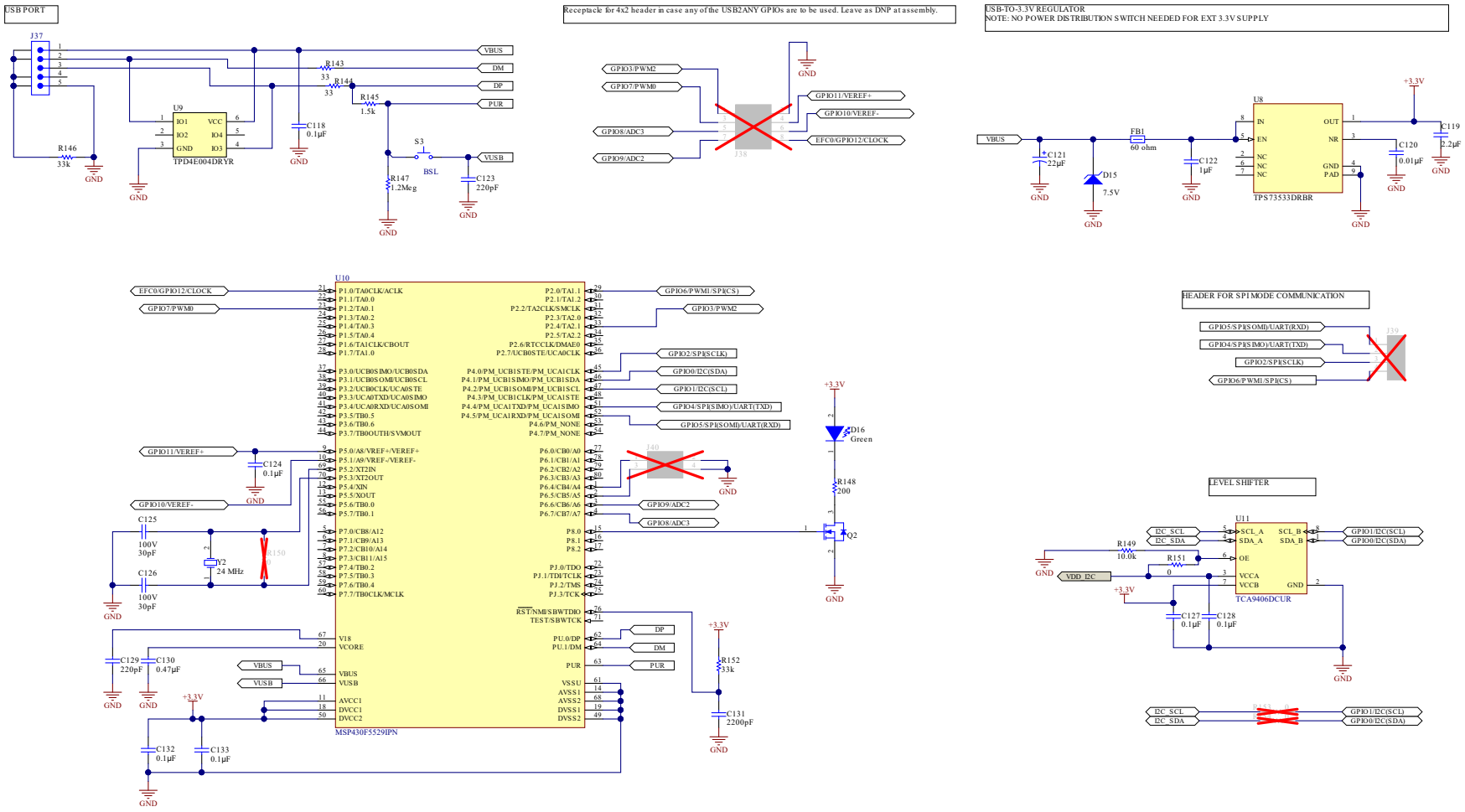


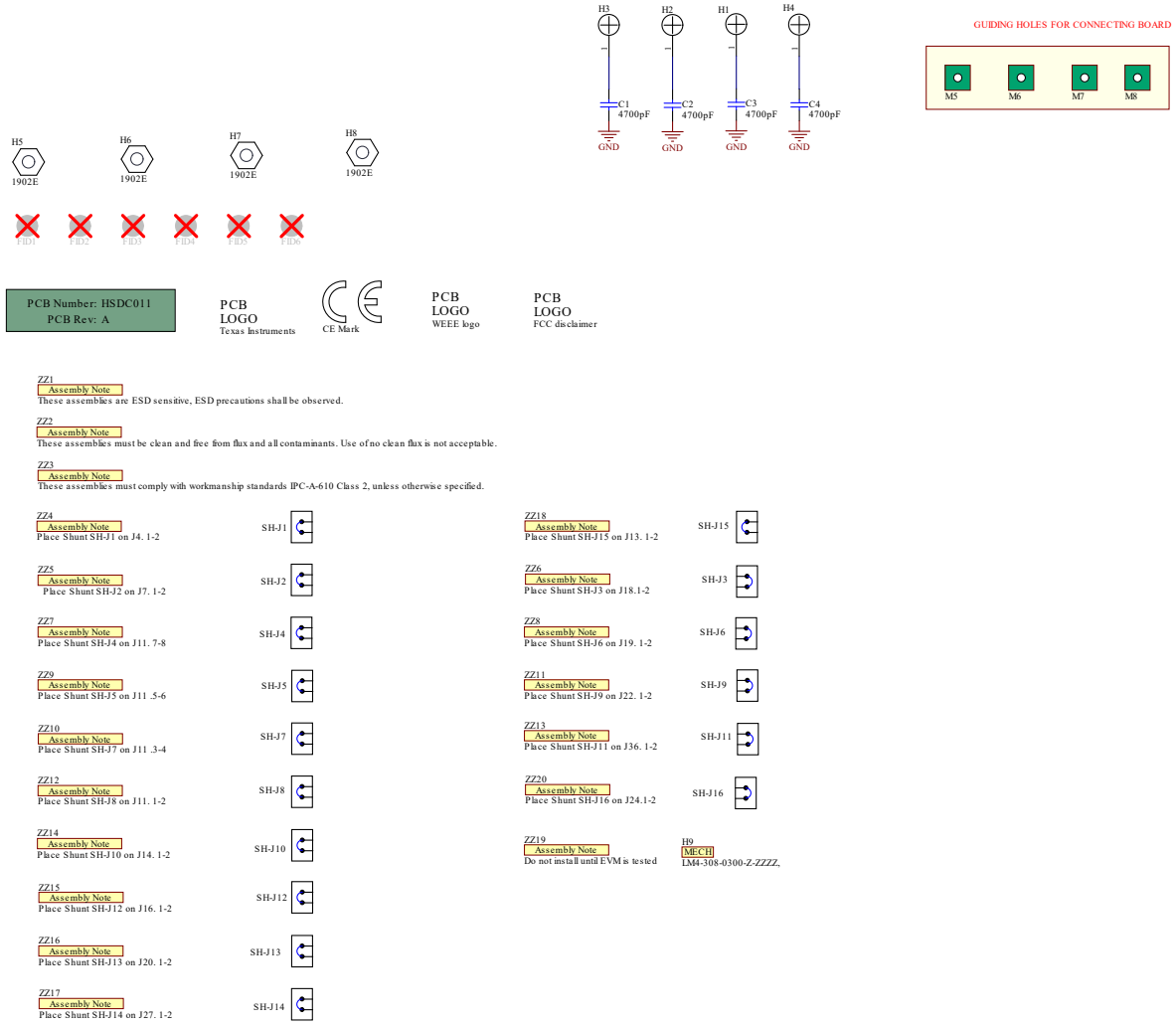






On-Board USB2ANY





17 Board Layout

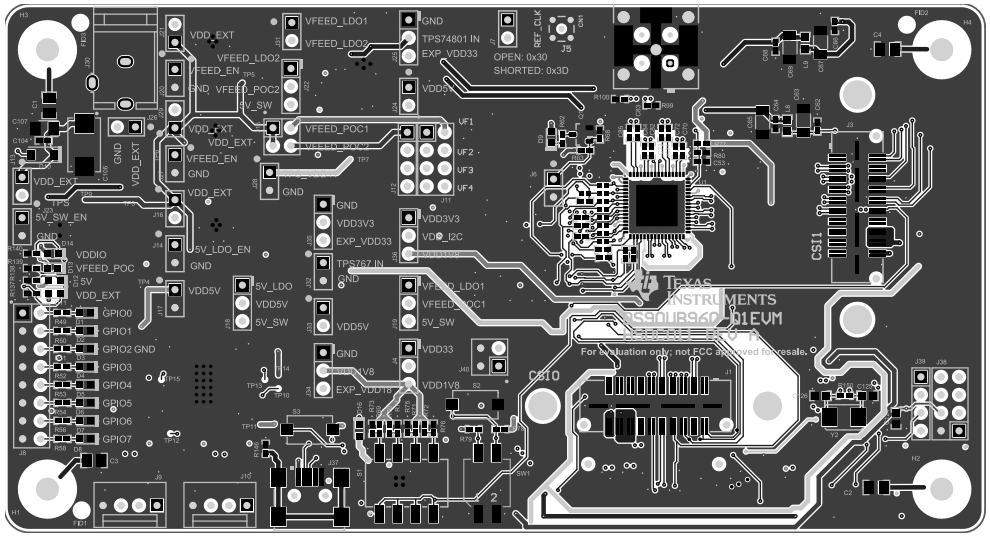


Figure 17-1. Top View Composite

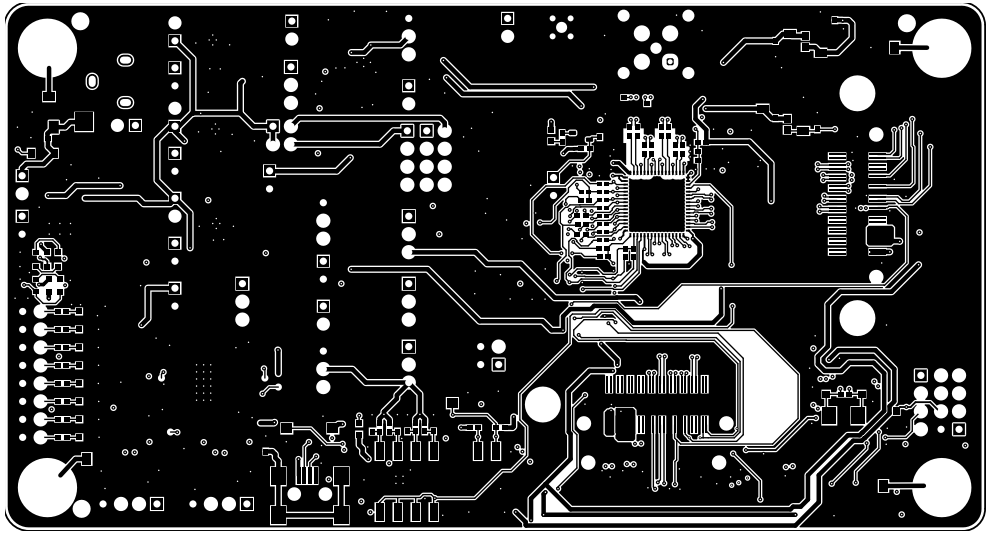


Figure 17-2. Layer 1: Top Signal Layer

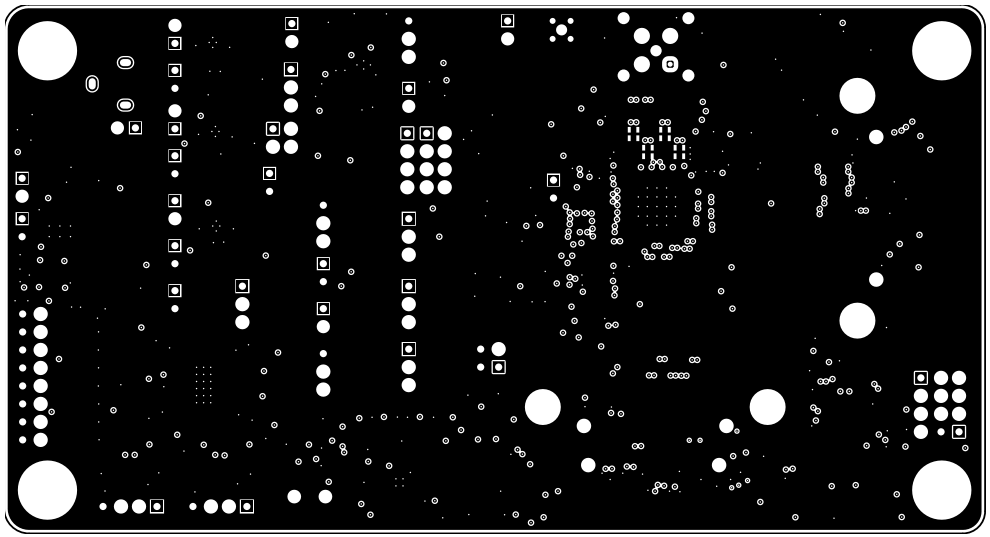


Figure 17-3. Layer 2: GND 1 Layer

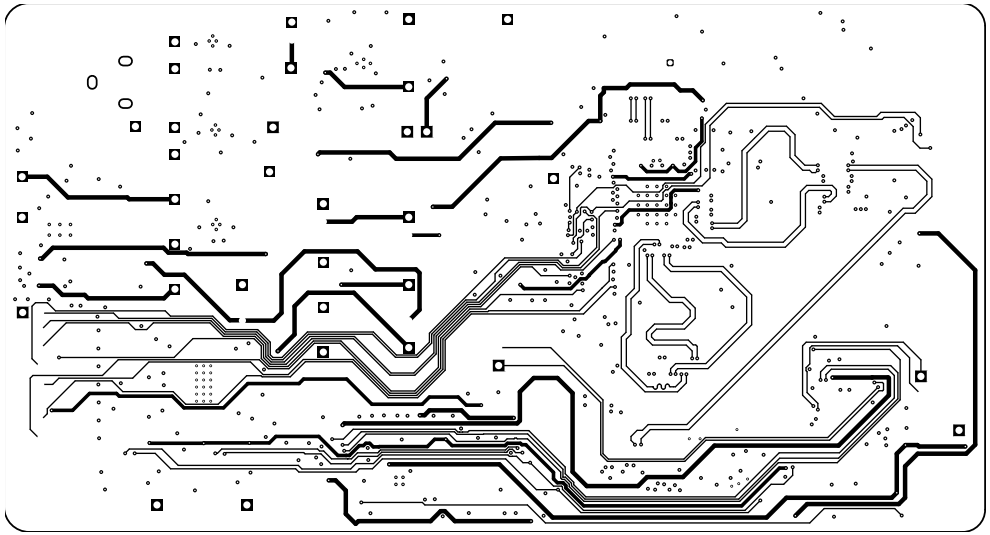


Figure 17-4. Layer 3: Inner Signal 1 Layer

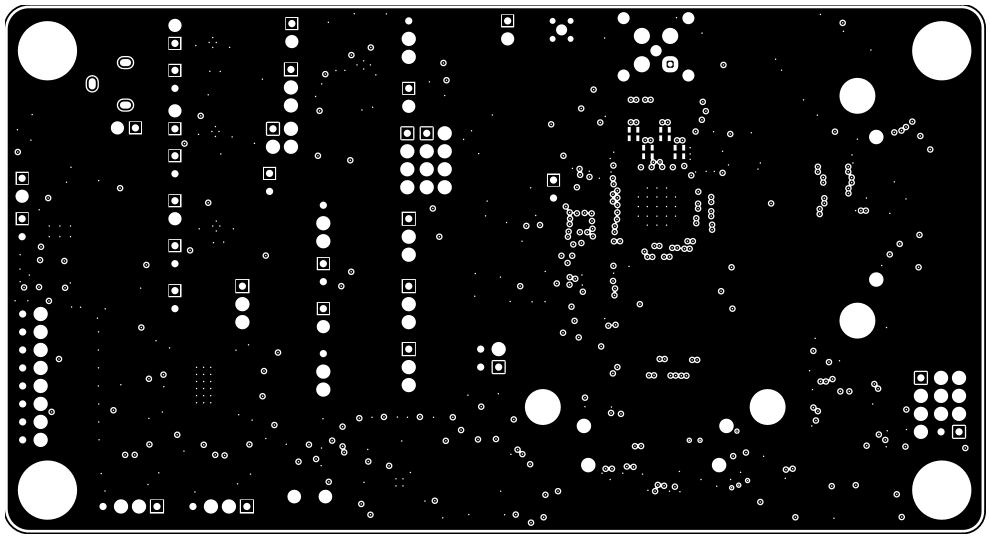


Figure 17-5. Layer 4: GND 2 Layer

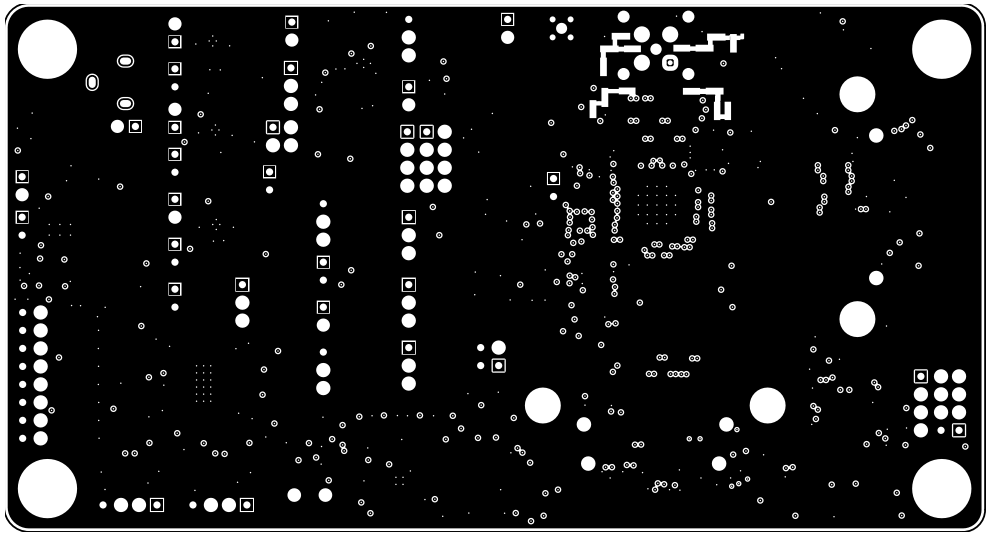


Figure 17-6. Layer 5: GND 3 Layer

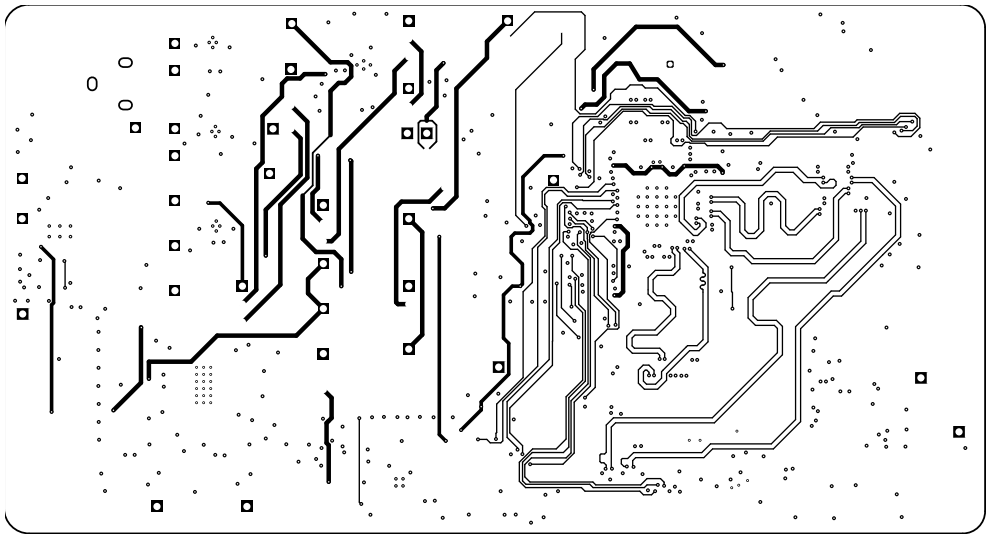


Figure 17-7. Layer 6: Inner Signal 2 Layer

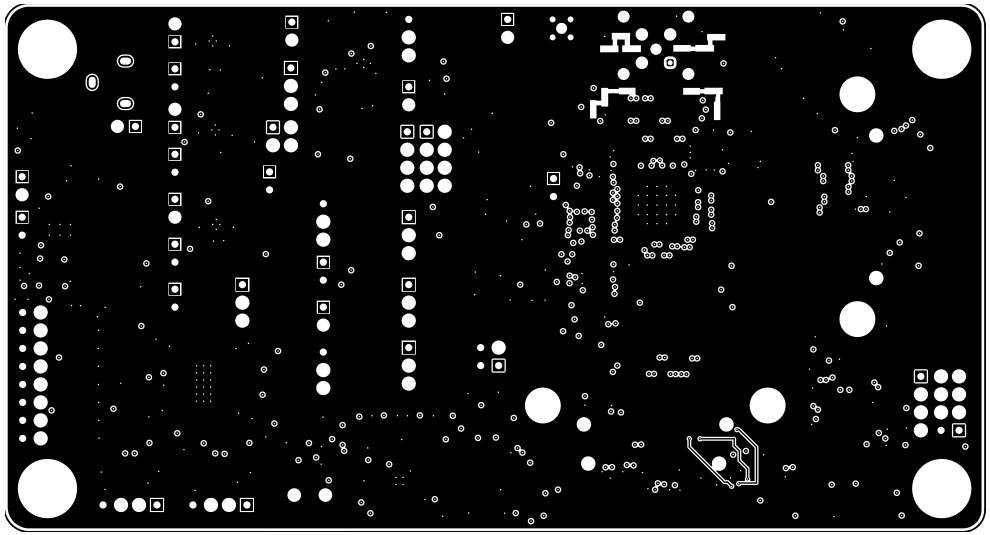


Figure 17-8. Layer 7: GND 4 Layer

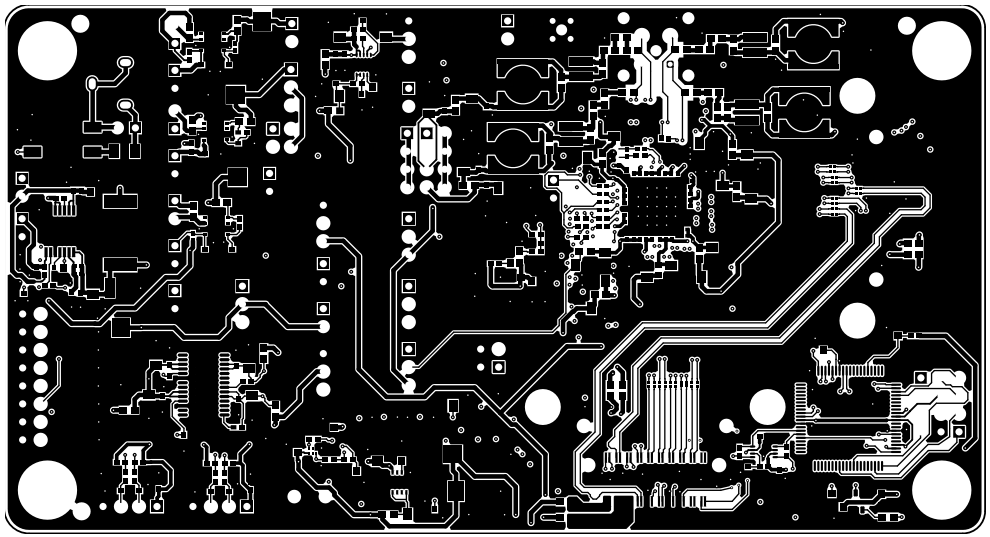


Figure 17-9. Layer 8: Bottom Signal Layer

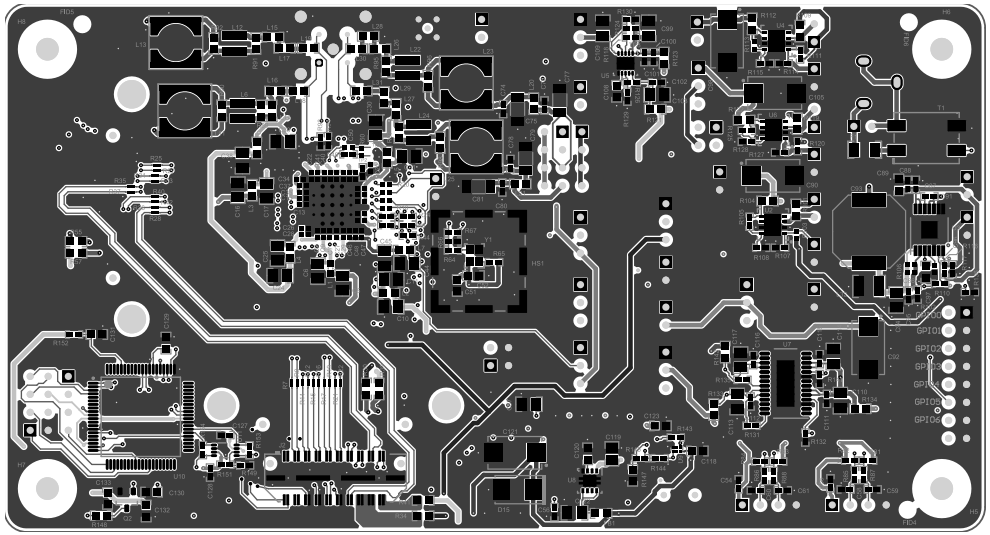


Figure 17-10. Bottom Overlay

18 Revision History

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

Changes from Revision A (March 2018) to Revision B (April 2021)	Page
• Updated Abstract section to include V^{3}Link TDES960	1

Changes from Revision * (February 2018) to Revision A (March 2018)	Page
• Changed advance information to production data	3
• Added a note to update PoC filters when interfacing to DS90UB913A-Q1 and DS90UB933-Q1 serializers.	7
• Added Figure 6-2	7
• Added Table 6-2	7
• Updated Bill of Materials	29
• Updated PCB Schematics	36
• Updated Board Layout	43

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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 semiconductors 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.

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   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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

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/lsds/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/lsds/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。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page
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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, INDEMITY 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.

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