# DS90UB96X-Q1EVM User's Guide

# User's Guide

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# DS90UB96X-Q1EVM User's Guide

## 1.1 General Description

The Texas Instruments DS90UB96X-Q1EVM evaluation module (EVM) is a functional board design for evaluating the FPD-Link III Deserializer to MIPI CSI-2 ADAS (Advanced Driver Assistance Systems) Hub. This kit will demonstrate the functionality and operation of the DS90UB96X-Q1 family of chipsets. The information provided in this document can be applied to devices such as DS90UB964-Q1. This EVM can also be used as a hardware reference design for any implementation of the DS90UB96X-Q1 series. Some portions and components in the EVM or in this document may include the references to DS90UB964-Q1 instead of addressing all part numbers. For the purposes of this document, the DS90UB964-Q1 is interchangeable with the DS90UB96X-Q1.

The DS90UB96X-Q1 is a versatile camera hub capable of connecting serialized camera data received from up to 4 independent video datastreams via an FPD-Link III interface using standard coaxial cables. When coupled with DS90UB913A/913Q serializers, the DS90UB964-Q1 receives data from 1-Megapixel imagers supporting HD 720p/800p/960p resolution at 30/60Hz frame rates. The DS90UB96X-Q1 merges and manages multiple data streams into a MIPI CSI-2 compliant output for interconnect to a downstream processor.

The EVM is a development add-on module to add surround view capability to any of a variety of video processor systems such as the TI TDA3x ADAS Processor, or an Applications Processor, Image Signal Processor (ISP), and SOC. The system consists of four cameras each of which receives control information and power through FAKRA coaxial cables, and uses the same cable to return the video information to an EVM board. 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.

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

The Texas Instruments DS90UB96X-Q1EVM helps to evaluate the operation and performance of the DS90UB964-Q1 and is available for order in two variants. See Table 1-1 of orderable EVM variants and configuration.

**Table 1-1. Orderable EVM Variants**

| EVM Orderable Name | EVM Variant | POC Network | Description |
|---|---|---|---|
| DS90UB964-Q1EVM | SV601176-001 | DS90UB913A Compatible | Samtec QSH connector |
| DS90UB964-Q1EVMTDA | SV601176-002 | DS90UB913A Compatible | Samtec QTH connector to TDA3X EVM |

## 1.2 Features

- Aggregates data from up to 4 cameras over FPD-Link III interface
- Supports 1-Megapixel sensors with HD 720P/800P/960P resolution at 30/60Hz frame rate (paired w/ DS90UB913A)
- 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 / 1.6 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
- Single +12V power supply for EVM

## 1.3 System Requirements

The major components of the DS90UB96X-Q1EVM are:

- DS90UB964-Q1
- On-board Power-over-Coax (POC) interface
- Four Fakra coax connectors for digital video, power, control and diagnostics
- Samtec QSH type connectors on CSI-2 interfaces
- On-board $I^2C$ programming interface

In order to demonstrate, the following is required (not included):

1. Four Omnivision sensor boards with DS90UB913A Serializer boards
   (a) TI DS90UB913A-CXEVM OR TI SAT0088 'MiniSer'
   AND
   (b) OV10635 P/N: OV10635-EAAE-AA0A OR OV10640 P/N: OV10640-EAAA-AA0A (DVP)
2. Four TIDA-00262 Aptina AR0140 sensor modules and DS90UB913A Serializer
3. Four DACAR/FAKRA coax cables
4. $I^2C$ host controller that support clock stretching
5. Applications Processor Card
6. Power supply for 12V @ 2A

## 1.4 Contents of the Demo Evaluation Kit

- One EVM board with the DS90UB96X-Q1

## 1.5 Applications Diagram

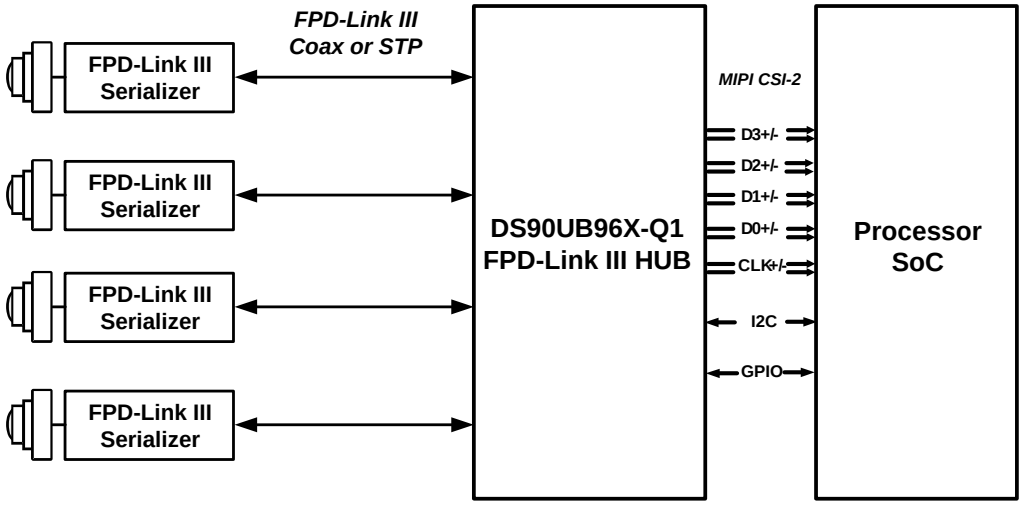



**Figure 1-1. Applications Diagram**

## 1.6 Typical Configuration

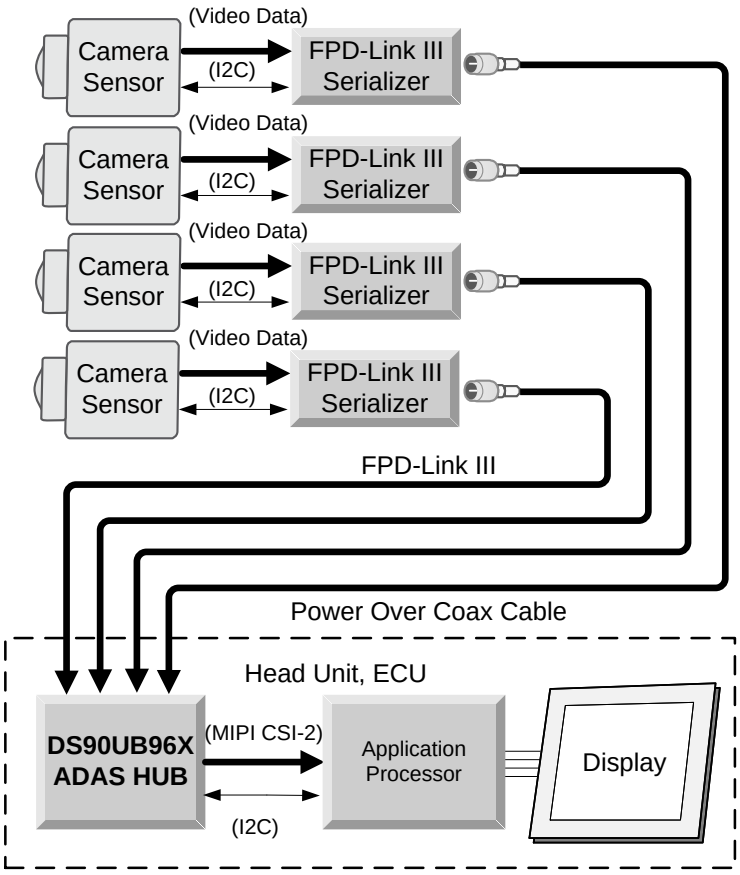



**Figure 1-2. Typical Configuration**

## 1.7 Quick Start Guide

1. Connect mini USB J36 to USB port for register programming
2. **Optional :** Connect an external $I^2C$ host adapter $I^2C$ signals on J4 port for register programming
3. Configure switches S1 and SW1 to set device's operating modes
4. Configure VFEED power supply for each channel of CN1, CN2, CN3, CN4 on J32 header
5. Plug the four sensors into the four DS90UB913A serializer boards to create four camera modules
6. Connect the four camera modules to channels 1, 2, 3, and 4 using coax cables on CN1, CN2, CN3, CN4
7. Interface MIPI CSI-2 output signals (J6 or J7) to application processor
8. Provide power to board on J24 (+12VDC)
   (a) Optional +1.1VDC power supply on J22
   (b) Optional +1.8VDC power supply on J28
   (c) Optional +3.3VDC power supply on J29
9. For details of pin-names and pin-functions, please refer to the DS90UB96X-Q1 datasheet.

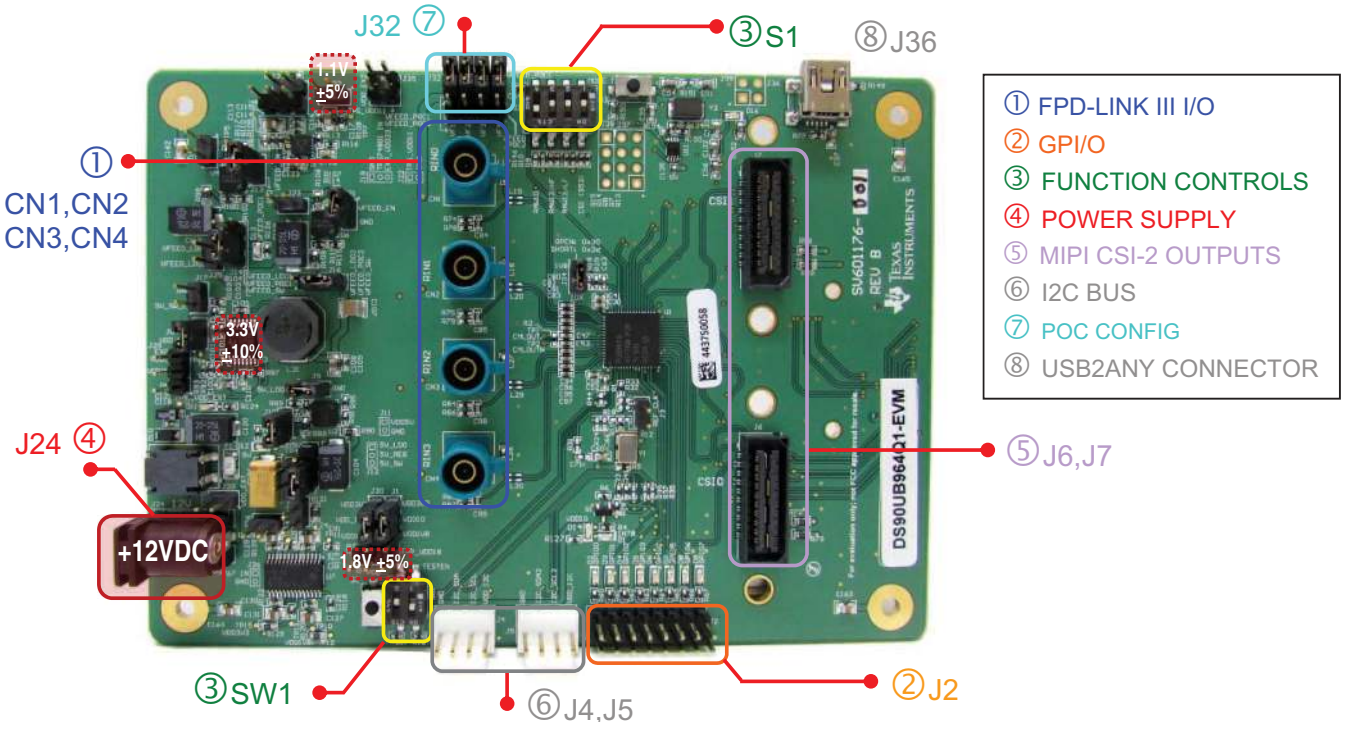



**Figure 1-3. Interfacing to the EVM**

## 1.8 Demo Board Connections

### *1.8.1 Power Supply*

**Table 1-2. Power Supply**

| Reference | Signal | Description |
|---|---|---|
| J20.1 | +12V | Main Power<br>Single +12VDC (nominal) power connector that supplies power to the entire board. |
| J22.1 (Optional) | +1.1V | 1.1V ±5%<br>Alternative to Main Power |

**Table 1-2. Power Supply (continued)**

| Reference | Signal | Description |
|---|---|---|
| J28.2 (Optional) | +1.8V | 1.8V ±5%<br>Alternative to Main Power |
| J29.2 (Optional) | +3.3V | 3.3V ±5%<br>Alternative to Main Power |

### 1.8.2 Power Over Coax Interface

The DS90UB96X-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, 5V power supply is applied over the coax cable. Refer Table 1-3 to for other POC configurations.

For power over coax (POC) on the EVM, the circuit uses a filter network as shown in Figure 1-4. The POC network frequency response corresponds to the bandwidth compatible with DS90UB913A chipsets.

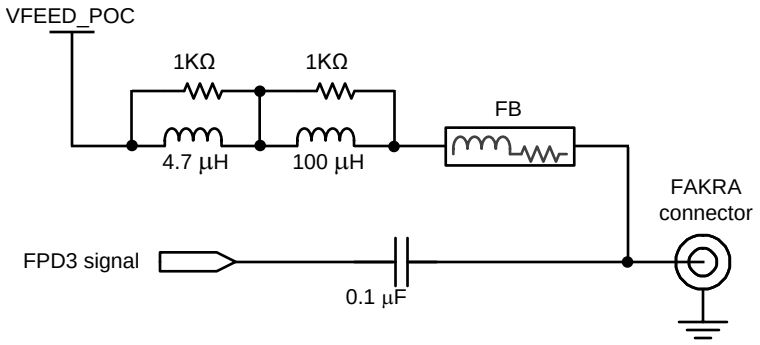



**Figure 1-4. Power Over Coax Network**

**WARNING**

**Verify that the power voltage is properly set before plugging into CN1, CN2, CN3, CN4. Power supply is not fused. Overvoltage will cause damage to boards directly connected due to incorrect input power supplies.**

**Table 1-3. Power Over Coax Power Supply Feed Configuration**

| Reference | Signal | Description |
|---|---|---|
| J14 | VFEED_POC1 | Power Over Coax Power Feed Selection 1 |
| | | Short pins 1-2: +9V power supply from VFEED_LDO1 |
| | | Short pins 2-3: +5V power supply from 5V_SW (Default) |
| J16 | VFEED_POC2 | Power Over Coax Power Feed Selection 2 |
| | | Short pins 1-2: +9V power supply from VFEED_LDO2 |
| | | Short pins 2-3: +5V power supply from 5V_SW (Default) |
| J35 | VDD_EXT | Power Over Coax Power Feed using +12V Main Power (J21)<br>**Note: J16 and J14 must to 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 |
| J32.1 | VFEED1 | Remote power supply connection to CN1 |
| | | Short J32.1-2: VFEED_POC1 (Default) |
| | | Short J32.1 & J33.1: VFEED_POC2 |
| J32.3 | VFEED2 | Remote power supply connection to CN2 |
| | | Short J32.3-4: VFEED_POC1 (Default) |
| | | Short J32.3 & J33.2: VFEED_POC2 |
| J32.5 | VFEED3 | Remote power supply connection to CN3 |
| | | Short J32.5-6: VFEED_POC1 (Default) |
| | | Short J32.5 & J33.3: VFEED_POC2 |
| J32.7 | VFEED4 | Remote power supply connection to CN4 |
| | | Short J32.7-8: VFEED_POC1 (Default) |
| | | Short J32.7 & J33.4: VFEED_POC2 |

### 1.8.3 MIPI CSI-2 Output Signals

Provided on the DS90UB96X-Q1EVM, J6 and J7 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 DS90UB96X-Q1. The J6 and J7 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 J6 & J7 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 1-4. MIPI CSI-2 (TX Port 0) Output Signals - J6 Pinout**

| Pin # | Signal Name | Pin # | Signal Name |
|---|---|---|---|
| 1 | NC | 2 | EXP_SCL0<br>(I2C_SCL or I2C_SCL2) |
| 3 | NC | 4 | EXP_SDA0<br>(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<br>(REFCLK) |
| 11 | CSI0_D0_N | 12 | GND |
| 13 | CSI0_D1_P | 14 | RESETn_0<br>(PDB) |

**Table 1-4. MIPI CSI-2 (TX Port 0) Output Signals - J6 Pinout (continued)**

| Pin # | Signal Name | Pin # | Signal Name |
|---|---|---|---|
| 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 1-5. MIPI CSI-2 (TX Port 1) Output Signals - J7 Pinout**

| Pin # | Signal Name | Pin # | Signal Name |
|---|---|---|---|
| 1 | NC | 2 | EXP_SCL1 (I2C_SCL or I2C_SCL2) |
| 3 | NC | 4 | EXP_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 |
| 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 1-6. MIPI CSI-2 (Assembly Variant SV601176-002) Output Signals - J31 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 |
| 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 R130-R145 for CSI-2 source connected to J6/J7 *

** Populate R130-R145 when source connected through J31 **

### 1.8.4 FPD-Link III Signals

**Table 1-7. FPD-Link III Signals**

| Reference | Signal | Description |
|---|---|---|
| CN1 | RIN0+ | FAKRA connector |
| CN2 | RIN1+ | FAKRA connector |
| CN3 | RIN2+ | FAKRA connector |
| CN4 | RIN3+ | FAKRA connector |

### 1.8.5 I²C Interface

A standalone external I²C host can connect via J4, J5 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 via CSI-2 connectors J6, J7, or J31. 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 1-8. IDx I²C Device Address Select - J34**

| Reference | Signal | Description |
|---|---|---|
| J34 | IDX | Selects I²C Device Address |
| | | Open: 0x30 (7'b) or 0x60 (8'b) |
| | | Short: 0x3D (7'b) or 0x7A (8'b) (Default) |

**Table 1-9. Primary I²C Interface Header - J4**

| Reference | Signal | Description |
|---|---|---|
| J4.1 | VDD_I2C | External I²C bus voltage |
| J4.2 | I2C_SCL | I²C Clock Interface for primary I²C bus |
| J4.3 | I2C_SDA | I²C Data Interface for primary I²C bus |
| J4.4 | GND | Ground |

**Table 1-10. Secondary I²C Interface Header - J5**

| Reference | Signal | Description |
|---|---|---|
| J5.1 | VDD_I2C | External I²C bus voltage |
| J5.2 | I2C_SCL2 | I²C Clock Interface for secondary I²C bus |
| J5.3 | I2C_SDA2 | I²C Data Interface for secondary I²C bus |
| J5.4 | GND | Ground |

**Table 1-11. I²C VDDIO Interface Header - J30**

| Reference | Signal | Description |
|---|---|---|
| J30 | VDD_I2C | Selects I²C IO bus voltage |
| | | Short pins 1-2: 3.3V IO (Default) |
| | | Short pins 2-3: 1.8V IO |

### *1.8.6 Control Interface*

**Table 1-12. VDDIO Interface Header - J1**

| Reference | Signal | Description |
|---|---|---|
| J1 | VDDIO | Selects VDDIO bus voltage |
| | | Short pins 1-2: 3.3V IO (Default) |
| | | Short pins 2-3: 1.8V IO |

**Table 1-13. GPIO Interface Header - J2**

| Reference | Signal | Description |
|---|---|---|
| J2.2 | GPIO0 | General Purpose Input/Output 0 |
| J2.4 | GPIO1 | General Purpose Input/Output 1 |
| J2.6 | GPIO2 | General Purpose Input/Output 2 |
| J2.8 | GPIO3 | General Purpose Input/Output 3 |
| J2.10 | GPIO4 | General Purpose Input/Output 4 |
| J2.12 | GPIO5 | General Purpose Input/Output 5 |
| J2.14 | GPIO6 | General Purpose Input/Output 6 |
| J2.16 | GPIO7 | General Purpose Input/Output 7 |

**Table 1-14. 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 1-15. Mode SW-DIP4 - S1 (1)**

| Reference | Mode | Description |
|---|---|---|
| S1.1 | 1 | CSI Mode (2-MP ADAS Tx compatible) (2) |
| S1.2 | 2 | RAW12 / LF (DS90UB913A compatible) |
| S1.3 | 3 | RAW12 / HF (DS90UB913A compatible) |
| S1.4 | 4 | RAW10 (DS90UB913A compatible) (Default) |

(1) Only set one ON.
(2) This function is only available with 2-MP ADAS chipsets.

**Table 1-16. 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 1-17. LEDs**

| Reference | LED Name | Description |
|---|---|---|
| D2 | GPIO0 | Illuminates if GPIO0 is ON |
| D3 | GPIO1 | Illuminates if GPIO1 is ON |
| D4 | GPIO2 | Illuminates if GPIO2 is ON |
| D5 | GPIO3 | Illuminates if GPIO3 is ON |
| D6 | GPIO4 | Illuminates if GPIO48 is ON |
| D7 | GPIO5 | Illuminates if GPIO5 is ON |
| D8 | GPIO6 | Illuminates if GPIO6 is ON |
| D9 | GPIO7 | Illuminates if GPIO7 is ON |
| D11 | VDD_EXT | Illuminates if 12V Power is applied to DC-IN J24 |
| D12 | VDD5V | Illuminates on +5V |
| D13 | VFEED_POC | Illuminates if VFEED_POC Power is ON |
| D14 | VDDIO | Illuminates on VDDIO Power |

## 1.9 Enable and Reset

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

- RC timing option: The C65 external capacitor and R17 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.

## 1.10 ALP Software Setup

### 1.10.1 System Requirements

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

### 1.10.2 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.

### 1.10.3 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 DS90UB96X-Q1 EVM board with a 12 VDC power supply.

### 1.10.4 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 1-5. Launching ALP**

The application should come up in the state shown in the figure below. If it does not, see Section 1.11, “Troubleshooting ALP Software”.

Under the Devices tab click on “DS90UB96X” to select the device and open up the device profile and its associated tabs.

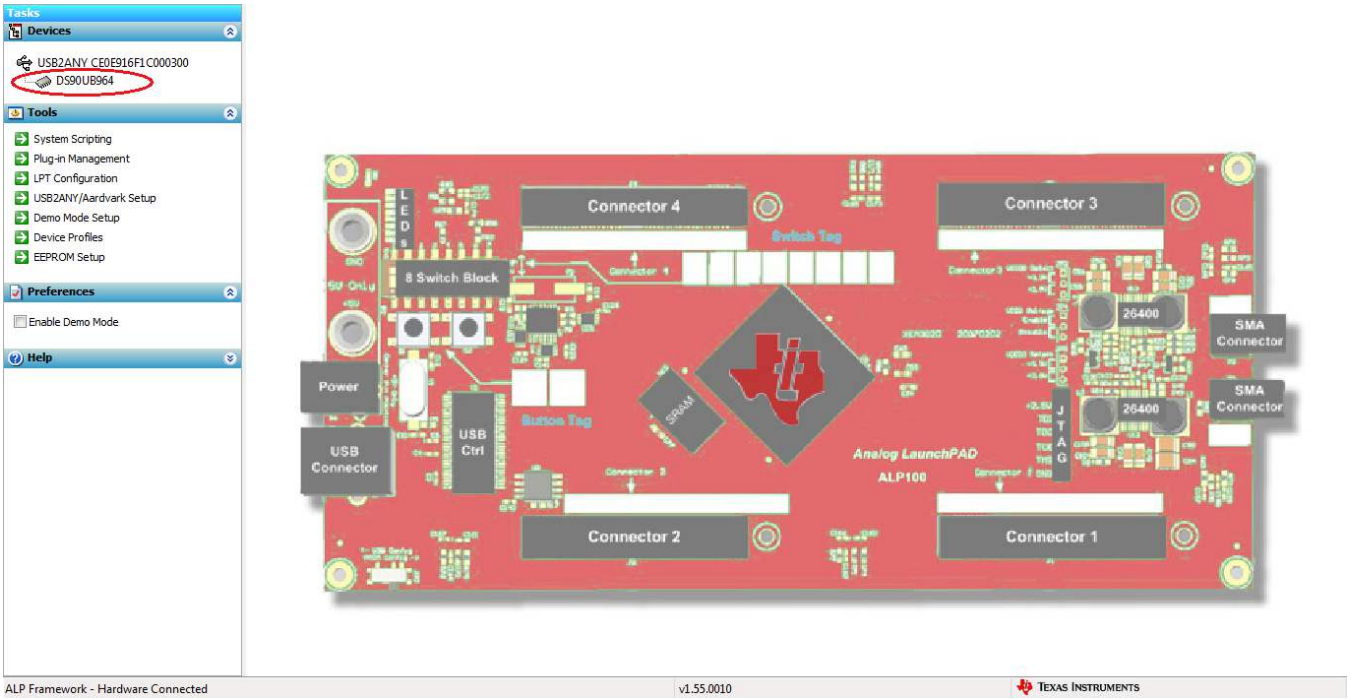



**Figure 1-6. Initial ALP Screen**

After selecting the DS90UB96X, the following screen shown in Figure 1-7 should appear.

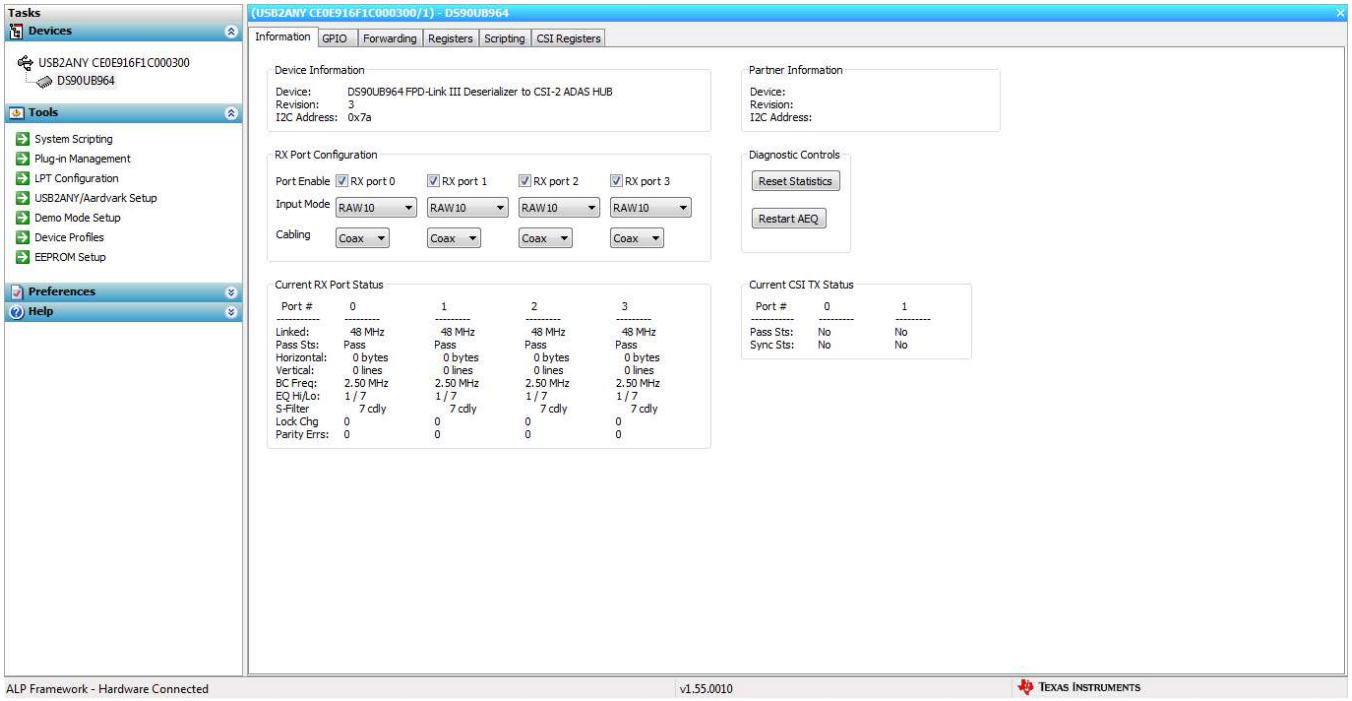



**Figure 1-7. Follow-up Screen**

### *1.10.5 Information Tab*

The Information tab is shown below.

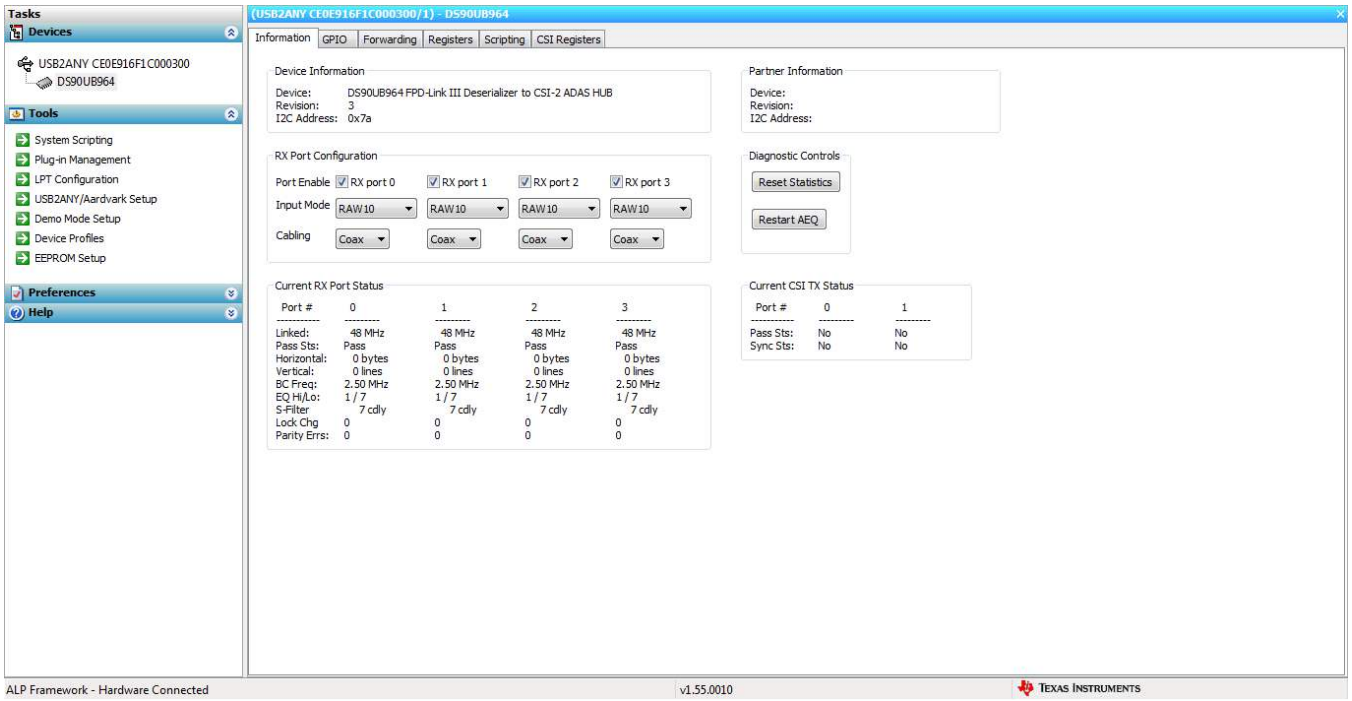



**Figure 1-8. ALP Information Tab**

### 1.10.6 Registers Tab

The Register tab is shown in Figure 1-9.

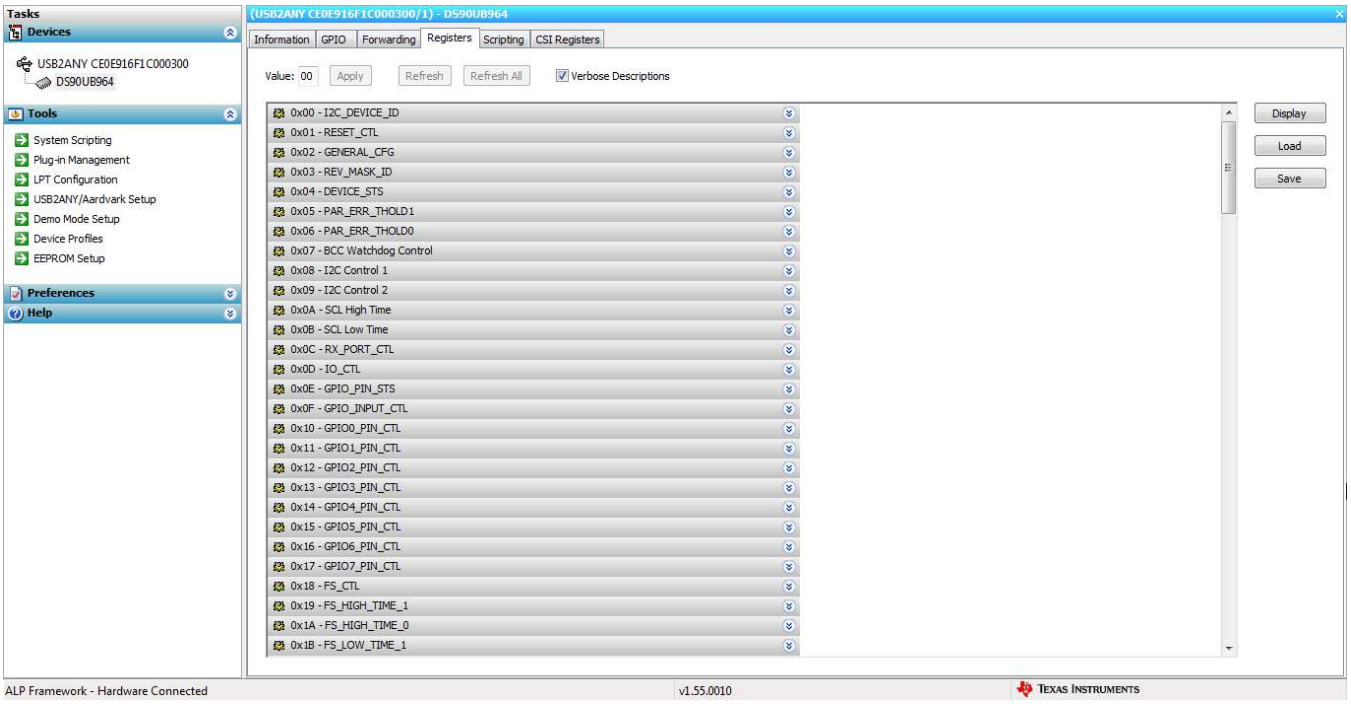



**Figure 1-9. ALP Registers Tab**

### 1.10.7 Registers Tab - Address 0x00 Selected

Address 0x00 selected as shown in Figure 1-10. Note that the “Value:” box, 

, will now show the hex value of that register.

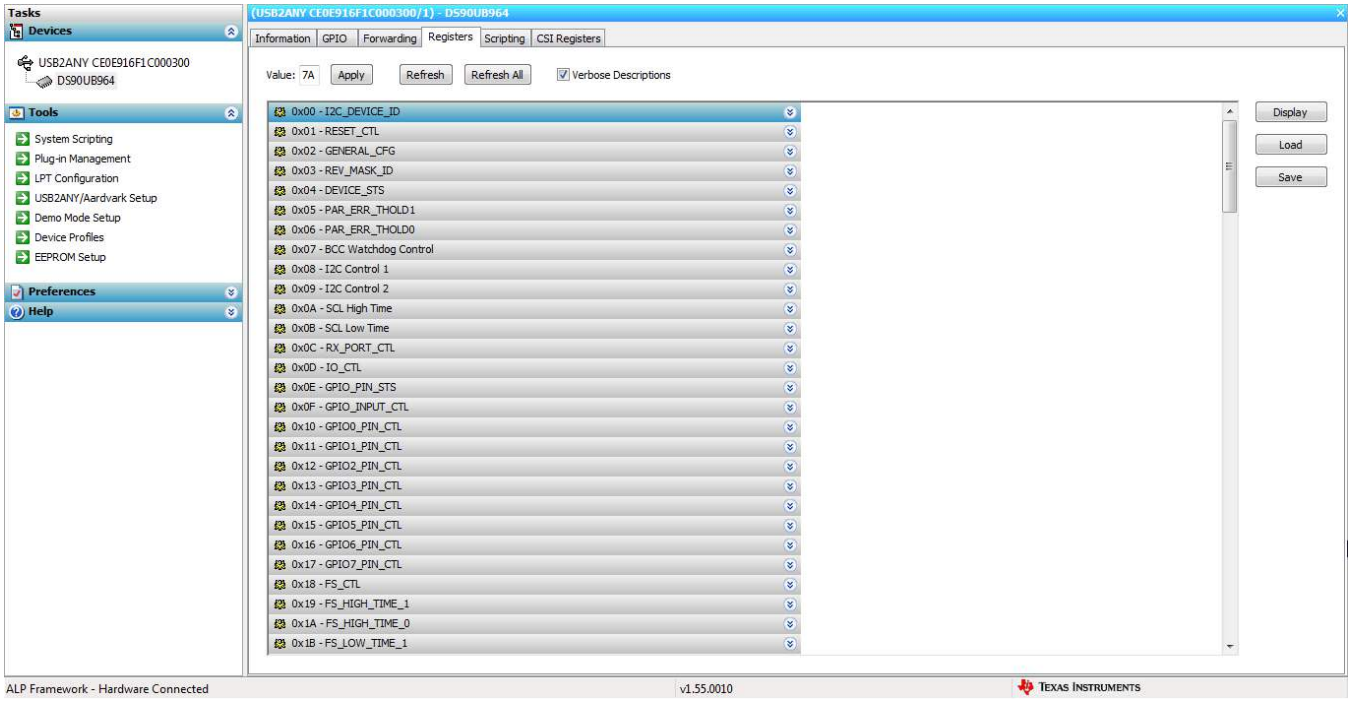



**Figure 1-10. ALP Device ID Selected**

### 1.10.8 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.

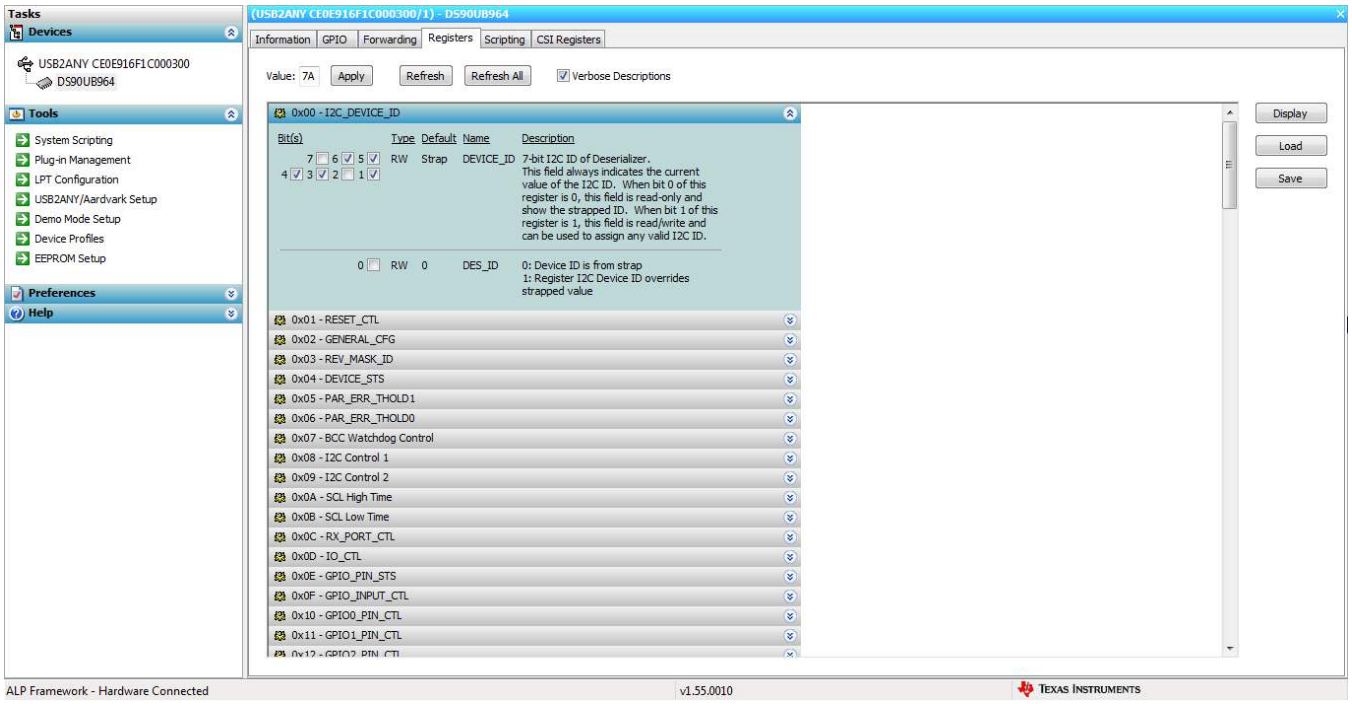
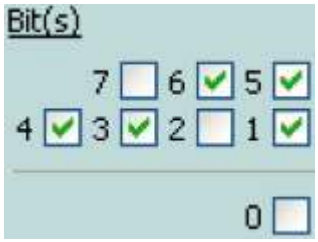



**Figure 1-11. ALP Device ID Expanded**

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.

### 1.10.9 Scripting Tab

The Scripting tab is shown below.

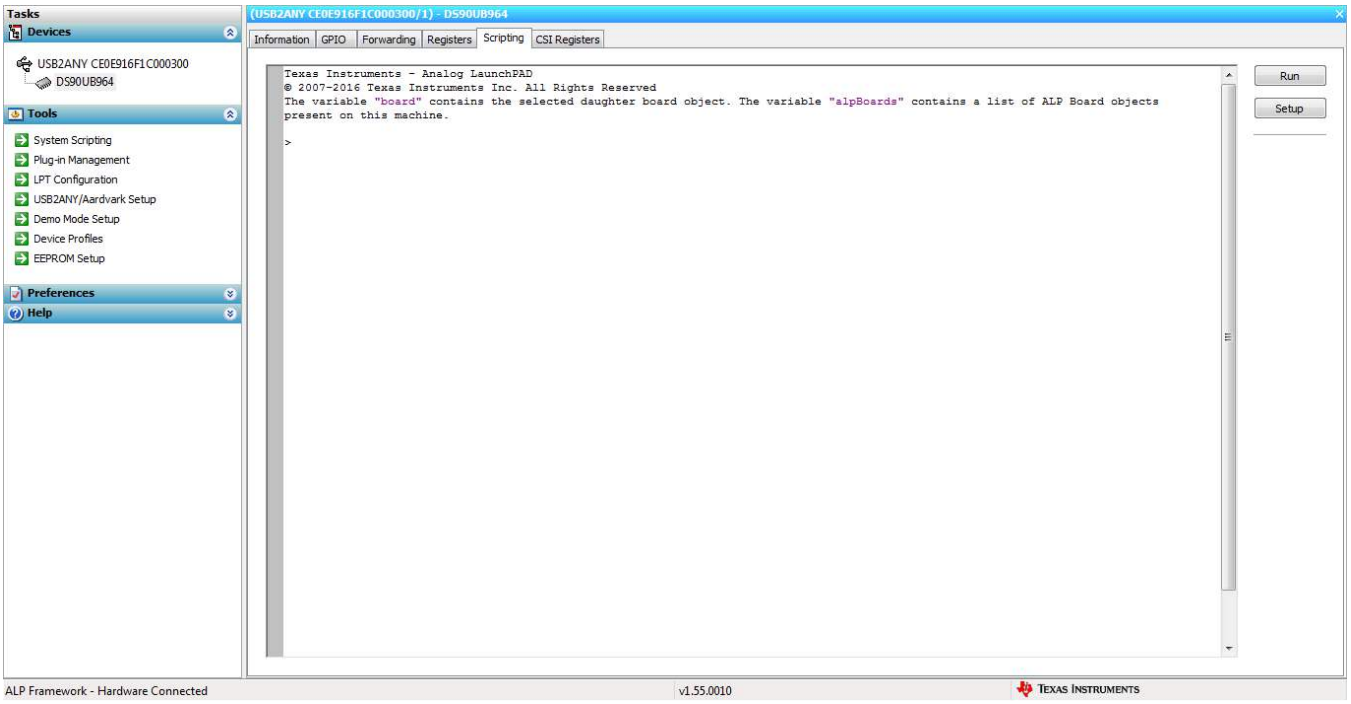



**Figure 1-12. ALP Scripting Tab**

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.**

### 1.10.10 Sample ALP Python Script

#### 1.10.10.1 Initialization

```
# 964_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)

print  "FV_POLARITY"
board.WriteReg(0x7c,0x01) # FV active low
time.sleep(0.1)

print  "YUV422 DT"
board.WriteReg(0x70,0x1f) # VC0 and CSI0 datatype 0x1f yuv422_10b
time.sleep(0.1)

print  "FPD_MODE"
board.WriteReg(0x6d,0x7f) # 913A 10-bit mode
time.sleep(0.1)

############################################################
# 964_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)

print  "FV_POLARITY"
board.WriteReg(0x7c,0x01) # FV active low
time.sleep(0.1)

print  "YUV422 DT"
board.WriteReg(0x70,0x5f) # VC1 and CSI0 datatype 0x1f yuv422_10b
time.sleep(0.1)

print  "FPD_MODE"
board.WriteReg(0x6d,0x7f) # 913A 10-bit mode
time.sleep(0.1)

############################################################
# 964_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)

print  "FV_POLARITY"
board.WriteReg(0x7c,0x01) # FV active low
time.sleep(0.1)

print  "YUV422 DT"
board.WriteReg(0x70,0x9f) # VC2 and CSI0 datatype 0x1f yuv422_10b
time.sleep(0.1)

print  "FPD_MODE"
board.WriteReg(0x6d,0x7f) # 913A 10-bit mode
time.sleep(0.1)

############################################################
# 964_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)
```

```
print  "FV_POLARITY"
board.WriteReg(0x7c,0x01) #
time.sleep(0.1)

print  "YUV422 DT"
board.WriteReg(0x70,0xdf) # VC3 and CSI0 datatype 0x1f yuv422_10b
time.sleep(0.1)

print  "FPD_MODE"
board.WriteReg(0x6d,0x7f) # 913A 10-bit mode
time.sleep(0.1)

############################################################
```

## 1.11 Troubleshooting ALP Software

### 1.11.1 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.

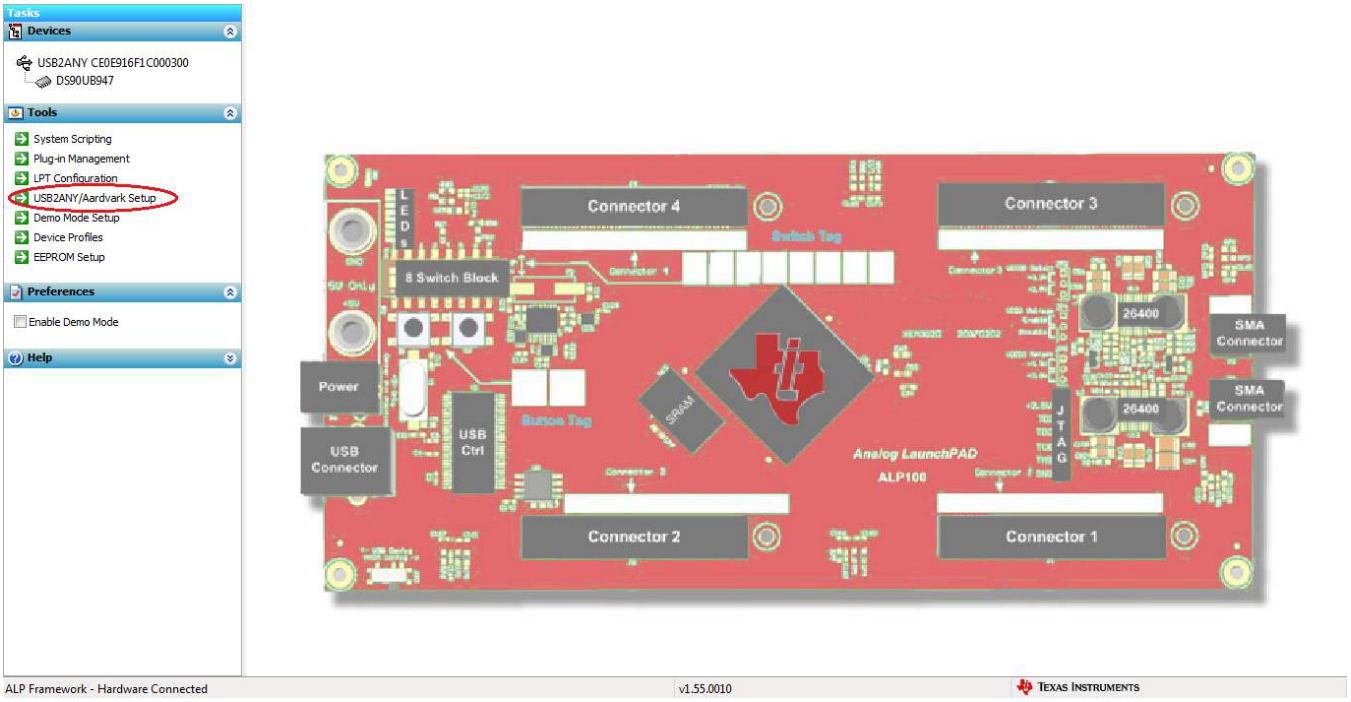



**Figure 1-13. USB2ANY Setup**

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

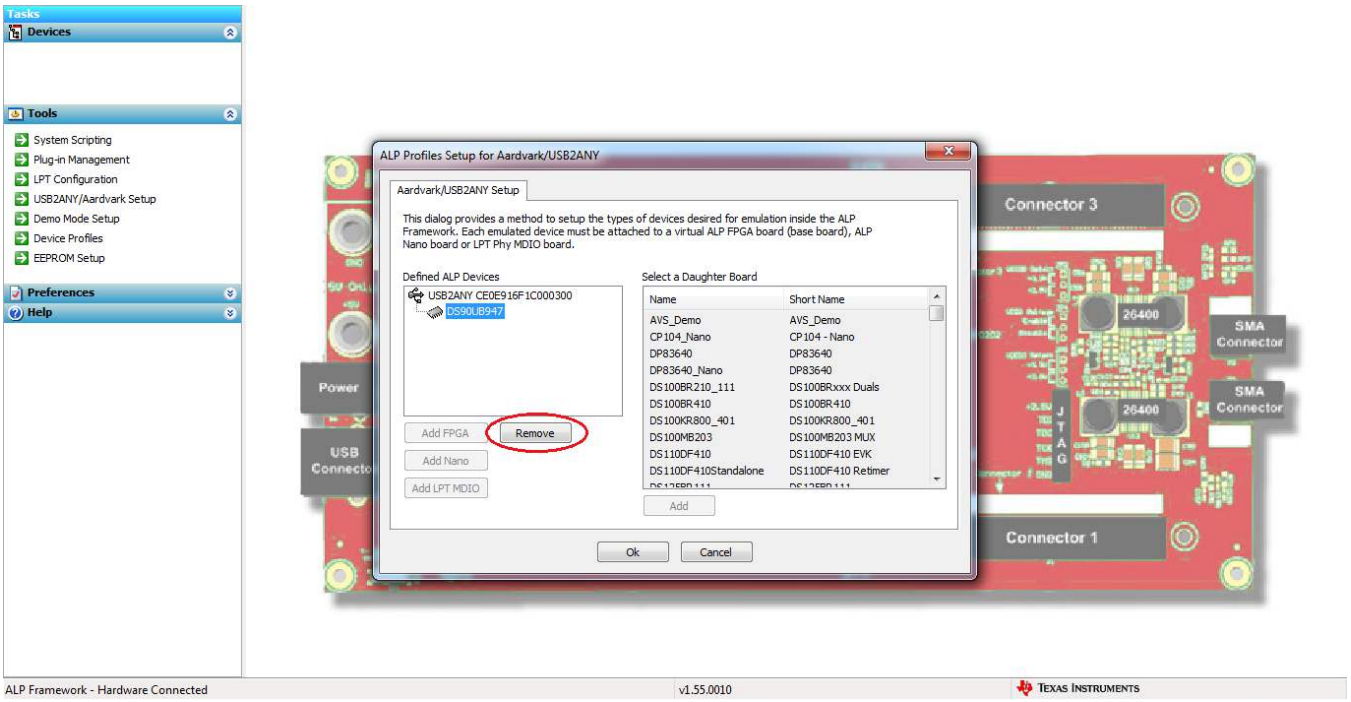



**Figure 1-14. Remove Incorrect Profile**

Find the correct profile under the Select a Daughter Board list, highlight the profile and press Add.

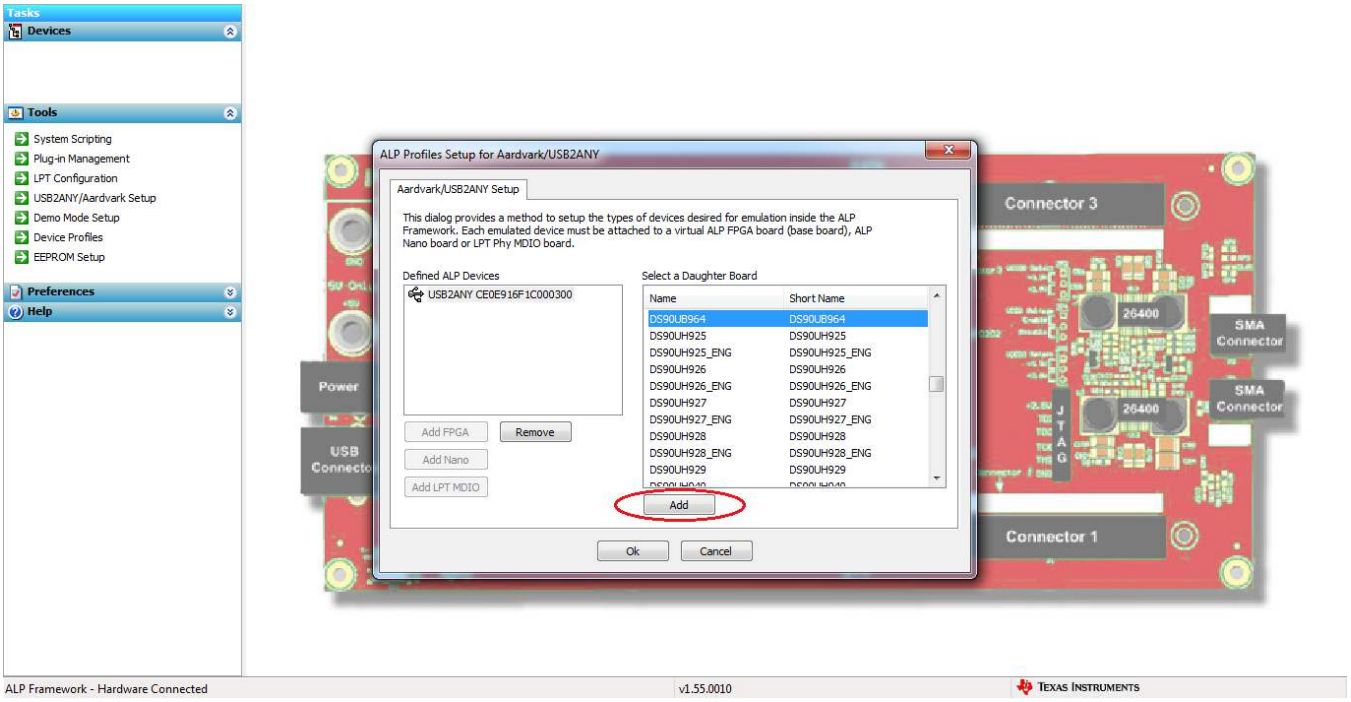



**Figure 1-15. Add Correct Profile**

Select Ok and the correct profile should now be loaded.

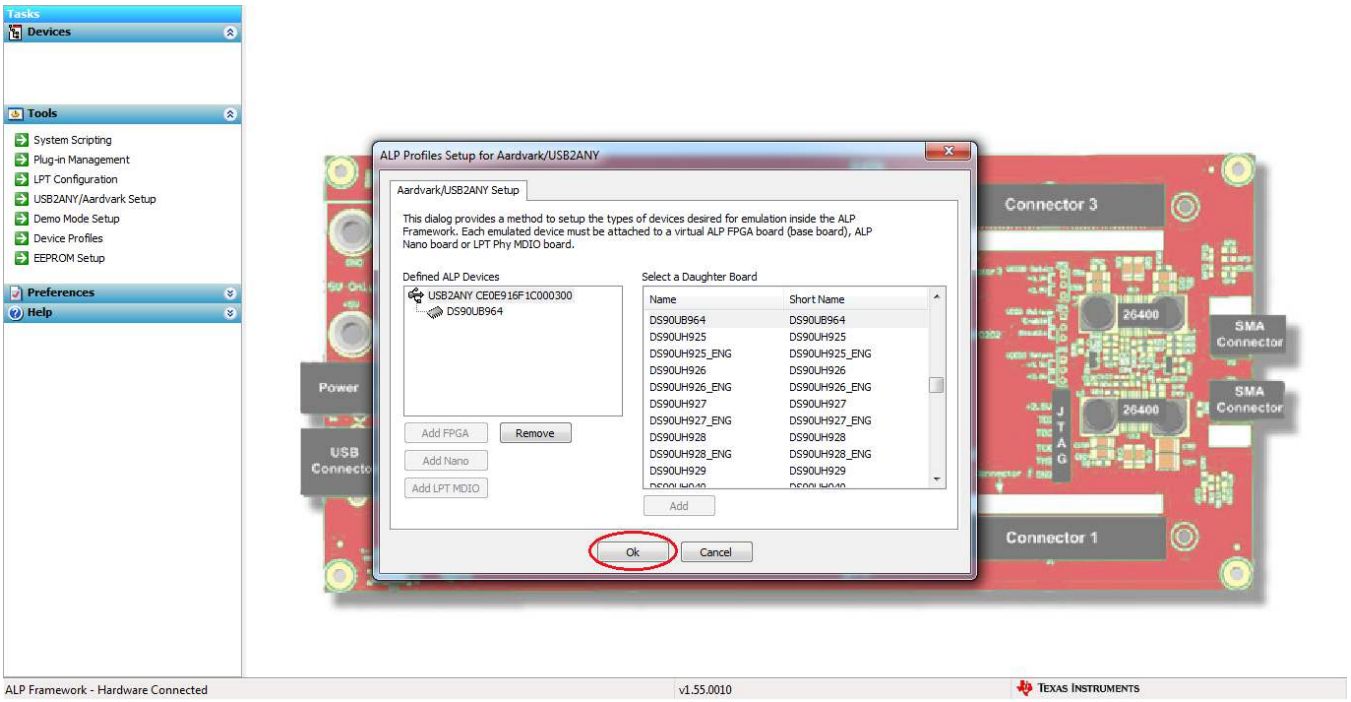



**Figure 1-16. Finish Setup**

### 1.11.2 ALP does not detect the EVM

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

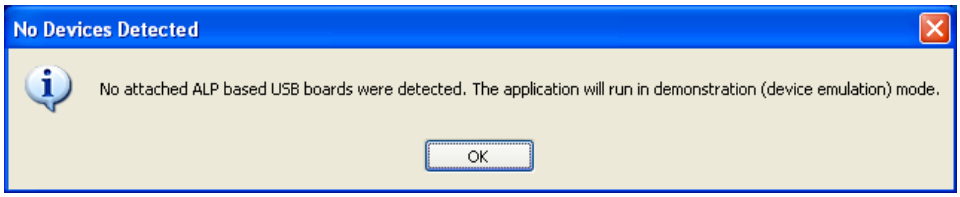



**Figure 1-17. ALP No Devices Error**

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

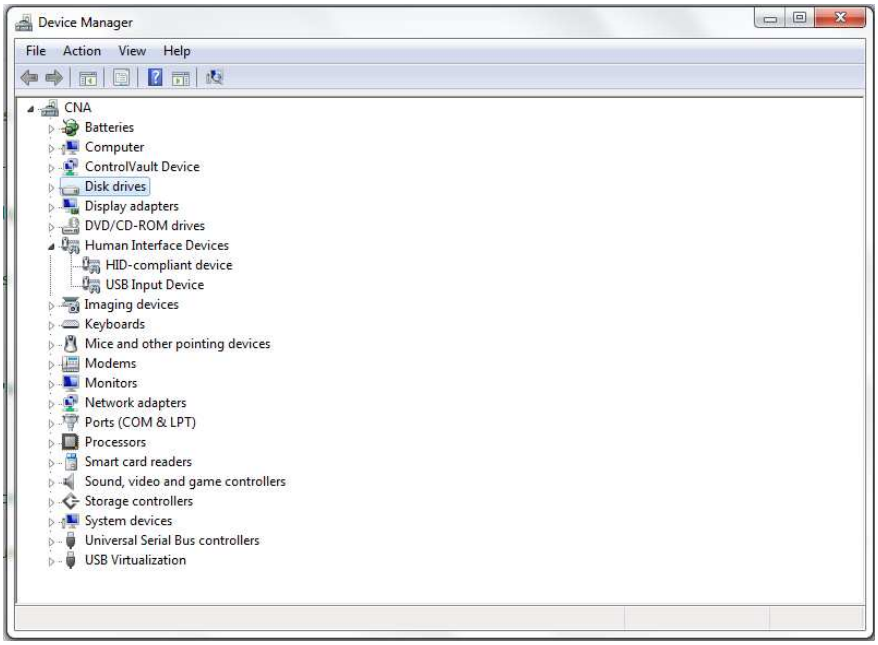



**Figure 1-18. Windows 7, ALP USB2ANY Driver**

The software should start with only "DS90UB96X" 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.

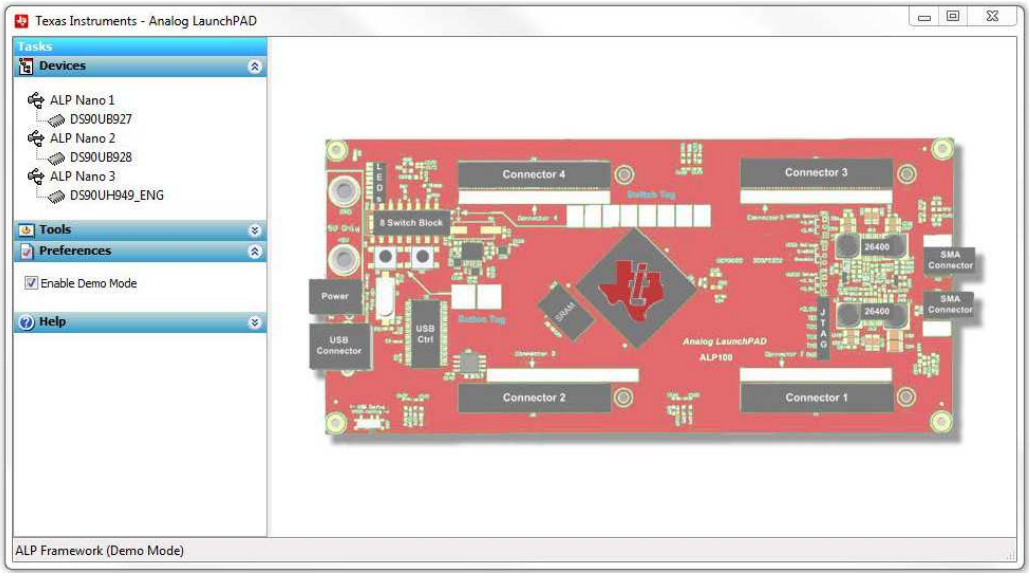



**Figure 1-19. ALP in Demo Mode**

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

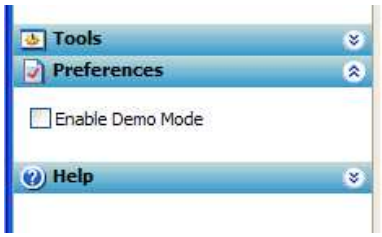



**Figure 1-20. ALP Preferences Menu**

After demo mode is disabled, the ALP software will poll the ALP hardware. The ALP software will update and have only “DS90UB96X” under the “Devices” pull down menu.

## 1.12 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 DS90UB96X-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

## 1.13 Termination Device

A termination device is required in order to properly monitor and measure the transmission of the MIPI DPHY signals. The termination device should 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. The recommended termination board is the UNH-IOL MIPI D-PHY Reference Termination Board (RTB).

## 1.14 Typical Test Setup

Figure 1-21 and Figure 1-22 illustrate the typical test setups used to measure and evaluate DS90UB96X-Q1.

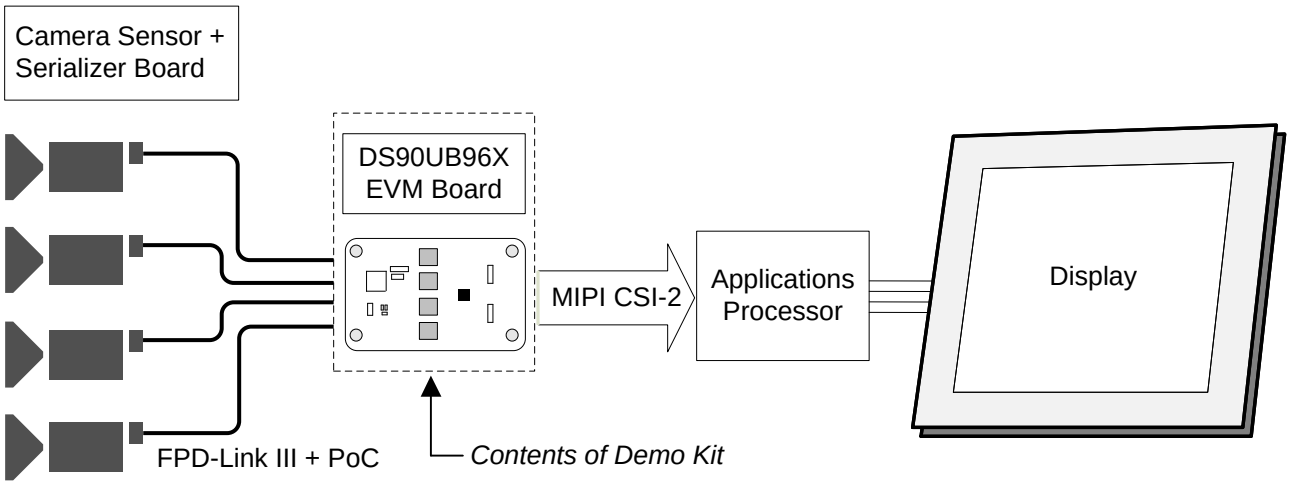



**Figure 1-21. Typical Test Setup for Application**

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

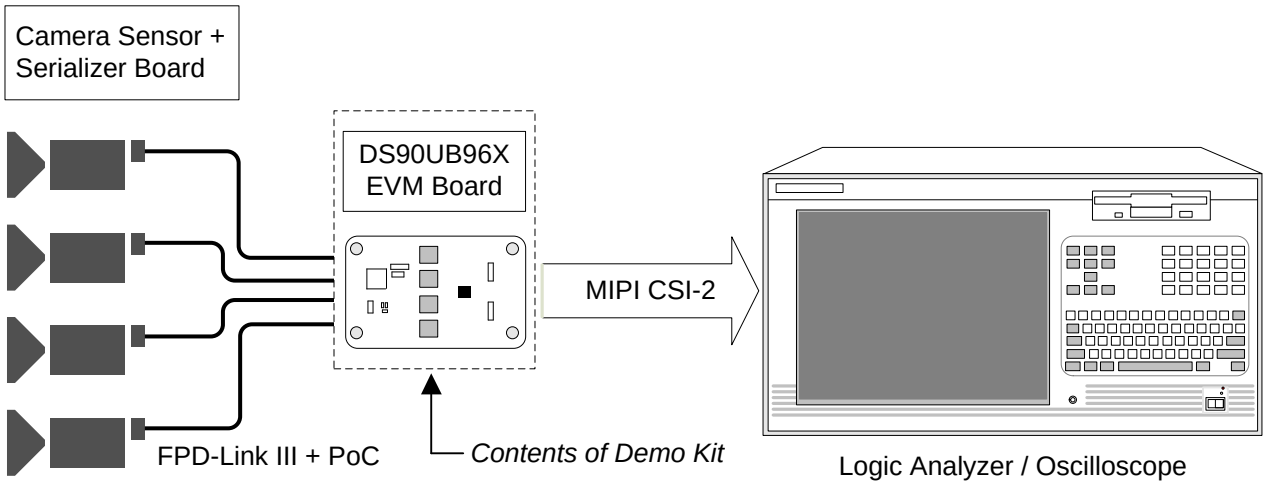



**Figure 1-22. Typical Test Setup for Evaluation**

## 1.15 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

## 1.16 Cable References

**FAKRA coaxial cable:**

www.leoni-automotive-cables.com

**Rosenberger FAKRA connector:**

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

## 1.17 Bill of Materials

**Table 1-18. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-001**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 1 | 1 | PCB | SV601176 | Any | Printed Circuit Board |
| 2 | 8 | C1, C6, C12, C20, C26, C31, C42, C43 | CL21A106KAFN3NE | Samsung Electro-Mechanics | CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805 |
| 3 | 8 | C3, C8, C14, C22, C28, C33, C44, C114 | C1005JB1V105K050BC | TDK | CAP, CERM, 1 µF, 35 V, +/- 10%, JB, 0402 |
| 4 | 15 | C4, C9, C15, C23, C29, C34, C45, C47, C53, C63, C64, C80, C81, C94, C95 | CGA2B3X7R1H104K050 BB | TDK | CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402 |
| 5 | 16 | C5, C10, C11, C16, C17, C18, C19, C24, C25, C30, C35, C36, C41, C46, C52, C58 | GCM155R71H103KA55D | MuRata | CAP, CERM, 0.01uF, 50V, +/-10%, C0G/NP0, 0402 |
| 6 | 5 | C37, C50, C59, C132, C133 | 0603YC104JAT2A | AVX | CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603 |
| 7 | 1 | C38 | 0805YD225KAT2A | AVX | CAP, CERM, 2.2uF, 16V, +/-10%, X5R, 0805 |
| 8 | 2 | C39, C55 | 06035A221FAT2A | AVX | CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603 |
| 9 | 1 | C40 | C1608X7R1H103K080AA | TDK | CAP, CERM, 0.01 µF, 50 V, +/- 10%, X7R, 0603 |
| 10 | 5 | C48, C104, C112, C119, C120 | 293D226X0025D2TE3 | Vishay-Sprague | CAP, TA, 22uF, 25V, +/- 20%, 0.7 ohm, SMD |
| 11 | 1 | C49 | GRM21BR71C105KA01L | MuRata | CAP, CERM, 1 µF, 16 V, +/- 10%, X7R, 0805 |
| 12 | 2 | C51, C54 | GRM1885C2A300JA01D | MuRata | CAP, CERM, 30pF, 100V, +/-5%, C0G/NP0, 0603 |
| 13 | 1 | C56 | GRM188R71A474KA61D | MuRata | CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603 |
| 14 | 1 | C57 | C0603X222K5RACTU | Kemet | CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603 |
| 15 | 1 | C60 | 06031C103KAT2A | AVX | CAP, CERM, 0.01 µF, 100 V, +/- 10%, X7R, 0603 |
| 16 | 15 | C61, C62, C101, C103, C105, C109, C115, C116, C118, C125, C126, C129, C130, C134, C135 | GRM155R71C104KA88D | MuRata | CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0402 |
| 17 | 5 | C65, C108, C117, C127, C131 | GRM21BR71A106KE51L | MuRata | CAP, CERM, 10uF, 10V, +/-10%, X7R, 0805 |
| 18 | 4 | C67, C68, C69, C70 | GRM1555C1E4R7CA01D | MuRata | CAP, CERM, 4.7pF, 25V, +/-5%, C0G/NP0, 0402 |
| 19 | 8 | C72, C74, C76, C78, C86, C88, C90, C92 | C1005X7R1H104K050BB | TDK | CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0402 |
| 20 | 8 | C73, C75, C77, C79, C87, C89, C91, C93 | GRM188R61E475KE11D | Murata Electronics North America | CAP CER 4.7UF 25V 10% X5R 0603 |
| 21 | 4 | C82, C83, C96, C97 | C1005X7R1H473K050BB | TDK | CAP, CERM, 0.047 µF, 50 V, +/- 10%, X7R, 0402 |
| 22 | 4 | C84, C85, C98, C99 | GRM1555C1H241JA01D | MuRata | CAP, CERM, 240 pF, 50 V, +/- 5%, C0G/NP0, 0402 |
| 23 | 1 | C100 | GRM1555C1H100JA01D | MuRata | CAP, CERM, 10pF, 50V, +/-5%, C0G/NP0, 0402 |
| 24 | 2 | C102, C111 | C1608X7R1C105K | TDK | CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603 |

**Table 1-18. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-001 (continued)**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 25 | 1 | C106 | T495D107M016ATE100 | Kemet | CAP, TA, 100uF, 16V, +/-20%, 0.1 ohm, SMD |
| 26 | 1 | C107 | GRM32ER61C476ME15L | MuRata | CAP, CERM, 47uF, 16V, +/-20%, X5R, 1210 |
| 27 | 1 | C110 | GRM155R71H332KA01D | MuRata | CAP, CERM, 3300pF, 50V, +/-10%, X7R, 0402 |
| 28 | 4 | C113, C123, C124, C128 | GRM21BR71C475KA73L | MuRata | CAP, CERM, 4.7uF, 16V, +/-10%, X7R, 0805 |
| 29 | 1 | C121 | 293D225X9025A2TE3 | Vishay-Sprague | CAP, TA, 2.2uF, 25V, +/-10%, 6.3 ohm, SMD |
| 30 | 1 | C122 | 06031C103JAT2A | AVX | CAP, CERM, 0.01uF, 100V, +/-5%, X7R, 0603 |
| 31 | 4 | C162, C163, C164, C165 | 08051C472KAT2A | AVX | CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805 |
| 32 | 4 | CN1, CN2, CN3, CN4 | 59S10H-40ML5-Z | Rosenberger | Connector, HF, 50 Ohm, 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 | 8 | J1, J12, J14, J16, J19, J28, J29, J30 | TSW-103-07-G-S | Samtec, Inc. | Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator |
| 41 | 1 | J2 | TSW-108-07-G-D | Samtec | Header, 100mil, 8x2, Gold, TH |
| 42 | 17 | J3, J8, J9, J10, J11, J13, J15, J17, J18, J20, J21, J22, J23, J25, J26, J27, J34 | 5-146261-1 | TE Connectivity | Header, 100mil, 2x1, Gold plated, TH |
| 43 | 2 | J4, J5 | 0022112042 | Molex | Header, 100mil, 4x1, White, TH |
| 44 | 2 | J6, J7 | QSH-020-01-H-D-DP-A | Samtec | Receptacle, Differential, 0.5mm, 10 pair x2, Gold, SMT |
| 45 | 1 | J24 | PJ-102A | CUI Inc. | Connector, DC Jack 2.1X5.5 mm, TH |
| 46 | 1 | J32 | TSW-104-07-G-D | Samtec | Header, 100mil, 4x2, Gold, TH |
| 47 | 1 | J33 | TSW-104-07-G-S | Samtec | Header, 100mil, 4x1, Gold, TH |
| 48 | 1 | J35 | TSW-102-07-G-D | Samtec | Header, 100mil, 2x2, Gold, TH |
| 49 | 1 | J36 | 1734035-2 | TE Connectivity | Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT |
| 50 | 7 | L1, L2, L3, L4, L5, L6, L8 | BLM18SG121TN1D | MuRata | Ferrite Bead, 120 ohm @ 100 MHz, 3 A, 0603 |
| 51 | 4 | L11, L12, L21, L22 | BLM18AG102SN1D | MuRata | Ferrite Bead, 1000 ohm @ 100 MHz, 0.4 A, 0603 |

**Table 1-18. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-001 (continued)**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 52 | 4 | L13, L15, L23, L25 | 1008PS-472KLB | Coilcraft | Inductor, Shielded, Ferrite, 4.7 µH, 0.7 A, 0.35 ohm, SMD |
| 53 | 4 | L14, L16, L24, L26 | MSS7341T-104MLB | Coilcraft | Inductor, Shielded Drum Core, Ferrite, 100 µH, 0.7 A, 0.28 ohm, SMD |
| 54 | 4 | L17, L18, L27, L28 | BLM15HD182SN1D | MuRata | Ferrite Bead, 1800 ohm @ 100 MHz, 0.2 A, 0402 |
| 55 | 1 | L31 | 7440650047 | Wurth Elektronik | Inductor, Shielded Drum Core, Ferrite, 4.7 µH, 4.2 A, 0.02 ohm, SMD |
| 56 | 1 | LBL1 | THT-13-457-10 | Brady | Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll |
| 57 | 2 | Q1, Q2 | BSS138 | Fairchild Semiconductor | MOSFET, N-CH, 50 V, 0.22 A, SOT-23 |
| 58 | 14 | R1, R3, R11, R25, R26, R27, R28, R34, R36, R41, R110, R119, R128, R155 | ERJ-2GE0R00X | Panasonic | RES, 0 ohm, 5%, 0.063W, 0402 |
| 59 | 1 | R2 | CRCW0402100RFKED | Vishay-Dale | RES, 100 ohm, 1%, 0.063W, 0402 |
| 60 | 1 | R4 | CRCW0402470RJNED | Vishay-Dale | RES, 470 ohm, 5%, 0.063W, 0402 |
| 61 | 3 | R5, R16, R17 | CRCW040210K0JNED | Vishay-Dale | RES, 10k ohm, 5%, 0.063W, 0402 |
| 62 | 5 | R6, R97, R105, R118, R122 | CRCW0402100KJNED | Vishay-Dale | RES, 100k ohm, 5%, 0.063W, 0402 |
| 63 | 1 | R7 | CRCW040282K5FKED | Vishay-Dale | RES, 82.5 k, 1%, 0.063 W, 0402 |
| 64 | 1 | R8 | CRCW040268K1FKED | Vishay-Dale | RES, 68.1 k, 1%, 0.063 W, 0402 |
| 65 | 1 | R9 | CRCW040256K2FKED | Vishay-Dale | RES, 56.2 k, 1%, 0.063 W, 0402 |
| 66 | 1 | R10 | CRCW040213K3FKED | Vishay-Dale | RES, 13.3 k, 1%, 0.063 W, 0402 |
| 67 | 1 | R13 | CRCW0402102KFKED | Vishay-Dale | RES, 102 k, 1%, 0.063 W, 0402 |
| 68 | 1 | R14 | CRCW0402137KFKED | Vishay-Dale | RES, 137 k, 1%, 0.063 W, 0402 |
| 69 | 1 | R15 | CRCW0402210KFKED | Vishay-Dale | RES, 210 k, 1%, 0.063 W, 0402 |
| 70 | 7 | R20, R21, R22, R23, R76, R102, R115 | CRCW04024K70JNED | Vishay-Dale | RES, 4.7k ohm, 5%, 0.063W, 0402 |
| 71 | 1 | R29 | CRCW040240K2FKED | Vishay-Dale | RES, 40.2 k, 1%, 0.063 W, 0402 |
| 72 | 15 | R58, R59, R72, R73, R88, R90, R96, R99, R106, R108, R109, R112, R120, R121, R129 | CRCW06030000Z0EA | Vishay-Dale | RES, 0 ohm, 5%, 0.1W, 0603 |
| 73 | 11 | R60, R61, R62, R63, R64, R65, R66, R67, R125, R126, R127 | CRCW0402220RJNED | Vishay-Dale | RES, 220, 5%, 0.063 W, 0402 |
| 74 | 8 | R68, R69, R70, R71, R80, R81, R82, R83 | ERJ-3EKF1001V | Panasonic | RES, 1.00 k, 1%, 0.1 W, 0603 |
| 75 | 4 | R74, R75, R84, R85 | CRCW040257R6FKED | Vishay-Dale | RES, 57.6, 1%, 0.063 W, 0402 |

**Table 1-18. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-001 (continued)**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 76 | 2 | R77, R147 | CRCW040233R0JNED | Vishay-Dale | RES, 33 ohm, 5%, 0.063W, 0402 |
| 77 | 4 | R78, R79, R86, R87 | CRCW0402200RJNED | Vishay-Dale | RES, 200, 5%, 0.063 W, 0402 |
| 78 | 6 | R89, R95, R98, R103, R107, R154 | CRCW040210K0FKED | Vishay-Dale | RES, 10.0k ohm, 1%, 0.063W, 0402 |
| 79 | 3 | R91, R100, R111 | CRCW040229K4FKED | Vishay-Dale | RES, 29.4 k, 1%, 0.063 W, 0402 |
| 80 | 1 | R92 | CRCW0402124KFKED | Vishay-Dale | RES, 124k ohm, 1%, 0.063W, 0402 |
| 81 | 1 | R93 | CRCW040222K1FKED | Vishay-Dale | RES, 22.1k ohm, 1%, 0.063W, 0402 |
| 82 | 4 | R94, R101, R104, R114 | CRCW04023K24FKED | Vishay-Dale | RES, 3.24k ohm, 1%, 0.063W, 0402 |
| 83 | 1 | R113 | CRCW04021K87FKED | Vishay-Dale | RES, 1.87k ohm, 1%, 0.063W, 0402 |
| 84 | 1 | R116 | CRCW04024K99FKED | Vishay-Dale | RES, 4.99k ohm, 1%, 0.063W, 0402 |
| 85 | 2 | R123, R124 | CRCW04022K40JNED | Vishay-Dale | RES, 2.4 k, 5%, 0.063 W, 0402 |
| 86 | 1 | R148 | CRCW04021K50JNED | Vishay-Dale | RES, 1.5k ohm, 5%, 0.063W, 0402 |
| 87 | 2 | R149, R153 | CRCW040233K0JNED | Vishay-Dale | RES, 33k ohm, 5%, 0.063W, 0402 |
| 88 | 1 | R150 | CRCW06031M20JNEA | Vishay-Dale | RES, 1.2Meg ohm, 5%, 0.1W, 0603 |
| 89 | 1 | R152 | CRCW0603200RFKEA | Vishay-Dale | RES, 200 ohm, 1%, 0.1W, 0603 |
| 90 | 1 | S1 | 219-4LPST | CTS Electrocomponents | Switch, SPST 4 Pos, Top Actuated, SMT |
| 91 | 2 | S2, S3 | KSR221GLFS | C and K Components | Switch, Normally open, 2.3N force, 200k operations, SMD |
| 92 | 15 | 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 | SPC02SYAN | Sullins Connector Solutions | Shunt, 100mil, Flash Gold, Black |
| 93 | 1 | SW1 | 219-2LPST | CTS Electrocomponents | Switch, Slide, SPST 2 poles, SMT |
| 94 | 1 | T1 | ACM9070-701-2PL | TDK | Common Mode Filter for Power Line |
| 95 | 1 | U1 | DS90UB964TRGCRQ1 | Texas Instruments | FPD-Link III Camera Hub Deserializer, RGC0064G |
| 96 | 3 | U2, U4, U6 | LM2941LD/NOPB | Texas Instruments | 1A Low Dropout Adjustable Regulator, 8-pin LLP, Pb-Free |
| 97 | 1 | U3 | TPS54225PWPR | Texas Instruments | 4.5V to 18V Input, 2-A Synchronous Step-Down SWIFT™ Converter, PWP0014E |
| 98 | 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) |

**Table 1-18. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-001 (continued)**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 99 | 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) |
| 100 | 1 | U8 | 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) |
| 101 | 1 | U9 | TPS73533DRBR | Texas Instruments | 500mA, Low Quiescent Current, Ultra-Low Noise, High PSRR Low-Dropout Linear Regulator, DRB0008A |
| 102 | 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) |
| 103 | 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) |
| 104 | 1 | Y1 | KC5032A25.0000CMGE00 | AVX | OSC, 25 MHz, 1.6 to 5.5 V, SMD |
| 105 | 1 | Y2 | ABM3-25.000MHZ-D2Y-T | Abracon Corporation | Crystal, 25 MHz, 18 pF, SMD |
| 106 | 1 | Y3 | ABM3-24.000MHZ-D2Y-T | Abracon Corporation | Crystal, 24 MHz, 18 pF, SMD |
| 107 | 0 | C2, C7, C13, C21, C27, C32 | CL21A106KAFN3NE | Samsung Electro-Mechanics | CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805 |
| 108 | 0 | C66, C71 | GRM1555C1H270JA01D | MuRata | CAP, CERM, 27 pF, 50 V, +/- 5%, C0G/NP0, 0402 |
| 109 | 0 | J31 | QTH-020-04-L-D-DP-A | Samtec | Header(shrouded), 0.5mm, 10 pair x 2, Gold, SMT |
| 110 | 0 | J37 | TSW-104-07-G-D | Samtec | Header, 100mil, 4x2, Gold, TH |
| 111 | 0 | J38 | TSW-104-07-G-S | Samtec | Header, 100mil, 4x1, Gold, TH |
| 112 | 0 | J39 | TSW-102-07-G-D | Samtec | Header, 100mil, 2x2, Gold, TH |
| 113 | 0 | L19, L20, L29, L30 | DLW21SN900HQ2L | MuRata | Coupled inductor, 0.28 A, 0.41 ohm, +/- 25%, SMD |
| 114 | 0 | R12, R18, R19, R31, R32, R33, R35, R37, R38, R39, R40, R43, R44, R45, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R57, R146, R151 | ERJ-2GE0R00X | Panasonic | RES, 0 ohm, 5%, 0.063W, 0402 |
| 115 | 0 | R24, R30, R117 | CRCW040210K0FKED | Vishay-Dale | RES, 10.0k ohm, 1%, 0.063W, 0402 |

**Table 1-18. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-001 (continued)**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 116 | 0 | R42, R46 | CRCW06030000Z0EA | Vishay-Dale | RES, 0 ohm, 5%, 0.1W, 0603 |
| 117 | 0 | R130, R131, R132, R133, R134, R135, R136, R137, R138, R139, R140, R141, R142, R143, R144, R145 | ERJ-1GE0R00C | Panasonic | RES, 0, 5%, 0.05 W, 0201 |

**Table 1-19. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-002**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 1 | 1 | PCB | SV601176 | Any | Printed Circuit Board |
| 2 | 7 | C1, C6, C12, C20, C26, C31, C42 | CL21A106KAFN3NE | Samsung | CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805 |
| 3 | 8 | C3, C8, C14, C22, C28, C33, C44, C114 | C1005JB1V105K050BC | TDK | CAP, CERM, 1 µF, 35 V, +/- 10%, JB, 0402 |
| 4 | 15 | C4, C9, C15, C23, C29, C34, C45, C47, C53, C63, C64, C80, C81, C94, C95 | CGA2B3X7R1H104K050BB | TDK | CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402 |
| 5 | 16 | C5, C10, C11, C16, C17, C18, C19, C24, C25, C30, C35, C36, C41, C46, C52, C58 | GCM155R71H103KA55D | MuRata | CAP, CERM, 0.01uF, 50V, +/-10%, C0G/NP0, 0402 |
| 6 | 5 | C37, C50, C59, C132, C133 | 0603YC104JAT2A | AVX | CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603 |
| 7 | 1 | C38 | 0805YD225KAT2A | AVX | CAP, CERM, 2.2uF, 16V, +/-10%, X5R, 0805 |
| 8 | 2 | C39, C55 | 06035A221FAT2A | AVX | CAP, CERM, 220pF, 50V, +/-1%, C0G/NP0, 0603 |
| 9 | 1 | C40 | C1608X7R1H103K080AA | TDK | CAP, CERM, 0.01 µF, 50 V, +/- 10%, X7R, 0603 |
| 10 | 5 | C48, C104, C112, C119, C120 | 293D226X0025D2TE3 | Vishay-Sprague | CAP, TA, 22uF, 25V, +/- 20%, 0.7 ohm, SMD |
| 11 | 1 | C49 | GRM21BR71C105KA01L | MuRata | CAP, CERM, 1 µF, 16 V, +/- 10%, X7R, 0805 |
| 12 | 2 | C51, C54 | GRM1885C2A300JA01D | MuRata | CAP, CERM, 30pF, 100V, +/-5%, C0G/NP0, 0603 |
| 13 | 1 | C56 | GRM188R71A474KA61D | MuRata | CAP, CERM, 0.47uF, 10V, +/-10%, X7R, 0603 |
| 14 | 1 | C57 | C0603X222K5RACTU | Kemet | CAP, CERM, 2200pF, 50V, +/-10%, X7R, 0603 |
| 15 | 1 | C60 | 06031C103KAT2A | AVX | CAP, CERM, 0.01 µF, 100 V, +/- 10%, X7R, 0603 |
| 16 | 15 | C61, C62, C101, C103, C105, C109, C115, C116, C118, C125, C126, C129, C130, C134, C135 | GRM155R71C104KA88D | MuRata | CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0402 |
| 17 | 5 | C65, C108, C117, C127, C131 | GRM21BR71A106KE51L | MuRata | CAP, CERM, 10uF, 10V, +/-10%, X7R, 0805 |
| 18 | 4 | C67, C68, C69, C70 | GRM1555C1E4R7CA01D | MuRata | CAP, CERM, 4.7pF, 25V, +/-5%, C0G/NP0, 0402 |
| 19 | 8 | C72, C74, C76, C78, C86, C88, C90, C92 | C1005X7R1H104K050BB | TDK | CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0402 |
| 20 | 8 | C73, C75, C77, C79, C87, C89, C91, C93 | GRM188R61E475KE11D | Murata Electronics North America | CAP CER 4.7UF 25V 10% X5R 0603 |
| 21 | 4 | C82, C83, C96, C97 | C1005X7R1H473K050BB | TDK | CAP, CERM, 0.047 µF, 50 V, +/- 10%, X7R, 0402 |
| 22 | 4 | C84, C85, C98, C99 | GRM1555C1H241JA01D | MuRata | CAP, CERM, 240 pF, 50 V, +/- 5%, C0G/NP0, 0402 |
| 23 | 1 | C100 | GRM1555C1H100JA01D | MuRata | CAP, CERM, 10pF, 50V, +/-5%, C0G/NP0, 0402 |
| 24 | 2 | C102, C111 | C1608X7R1C105K | TDK | CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603 |
| 25 | 1 | C106 | T495D107M016ATE100 | Kemet | CAP, TA, 100uF, 16V, +/-20%, 0.1 ohm, SMD |
| 26 | 1 | C107 | GRM32ER61C476ME15L | MuRata | CAP, CERM, 47uF, 16V, +/-20%, X5R, 1210 |

**Table 1-19. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-002 (continued)**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 27 | 1 | C110 | GRM155R71H332KA01D | MuRata | CAP, CERM, 3300pF, 50V, +/-10%, X7R, 0402 |
| 28 | 4 | C113, C123, C124, C128 | GRM21BR71C475KA73L | MuRata | CAP, CERM, 4.7uF, 16V, +/-10%, X7R, 0805 |
| 29 | 1 | C121 | 293D225X9025A2TE3 | Vishay-Sprague | CAP, TA, 2.2uF, 25V, +/-10%, 6.3 ohm, SMD |
| 30 | 1 | C122 | 06031C103JAT2A | AVX | CAP, CERM, 0.01uF, 100V, +/-5%, X7R, 0603 |
| 31 | 4 | C162, C163, C164, C165 | 08051C472KAT2A | AVX | CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805 |
| 32 | 4 | CN1, CN2, CN3, CN4 | 59S10H-40ML5-Z | Rosenberger | Connector, HF, 50 Ohm, 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 | 8 | J1, J12, J14, J16, J19, J28, J29, J30 | TSW-103-07-G-S | Samtec, Inc. | Header, TH, 100mil, 3x1, Gold plated, 230 mil above insulator |
| 41 | 1 | J2 | TSW-108-07-G-D | Samtec | Header, 100mil, 8x2, Gold, TH |
| 42 | 17 | J3, J8, J9, J10, J11, J13, J15, J17, J18, J20, J21, J22, J23, J25, J26, J27, J34 | 5-146261-1 | TE Connectivity | Header, 100mil, 2x1, Gold plated, TH |
| 43 | 2 | J4, J5 | 0022112042 | Molex | Header, 100mil, 4x1, White, TH |
| 44 | 2 | J6, J7 | QSH-020-01-H-D-DP-A | Samtec | Receptacle, Differential, 0.5mm, 10 pair x2, Gold, SMT |
| 45 | 1 | J24 | PJ-102A | CUI Inc. | Connector, DC Jack 2.1X5.5 mm, TH |
| 46 | 1 | J31 | QTH-020-04-L-D-DP-A | Samtec | Header(shrouded), 0.5mm, 10 pair x 2, Gold, SMT |
| 47 | 1 | J32 | TSW-104-07-G-D | Samtec | Header, 100mil, 4x2, Gold, TH |
| 48 | 1 | J33 | TSW-104-07-G-S | Samtec | Header, 100mil, 4x1, Gold, TH |
| 49 | 1 | J35 | TSW-102-07-G-D | Samtec | Header, 100mil, 2x2, Gold, TH |
| 50 | 1 | J36 | 1734035-2 | TE Connectivity | Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT |
| 51 | 7 | L1, L2, L3, L4, L5, L6, L8 | BLM18SG121TN1D | MuRata | Ferrite Bead, 120 ohm @ 100 MHz, 3 A, 0603 |
| 52 | 4 | L11, L12, L21, L22 | BLM18AG102SN1D | MuRata | Ferrite Bead, 1000 ohm @ 100 MHz, 0.4 A, 0603 |
| 53 | 4 | L13, L15, L23, L25 | 1008PS-472KLB | Coilcraft | Inductor, Shielded, Ferrite, 4.7 µH, 0.7 A, 0.35 ohm, SMD |

**Table 1-19. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-002 (continued)**

| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 54 | 4 | L14, L16, L24, L26 | MSS7341T-104MLB | Coilcraft | Inductor, Shielded Drum Core, Ferrite, 100 µH, 0.7 A, 0.28 ohm, SMD |
| 55 | 4 | L17, L18, L27, L28 | BLM15HD182SN1D | MuRata | Ferrite Bead, 1800 ohm @ 100 MHz, 0.2 A, 0402 |
| 56 | 1 | L31 | 7440650047 | Wurth Elektronik | Inductor, Shielded Drum Core, Ferrite, 4.7 µH, 4.2 A, 0.02 ohm, SMD |
| 57 | 1 | LBL1 | THT-13-457-10 | Brady | Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll |
| 58 | 2 | Q1, Q2 | BSS138 | Fairchild Semiconductor | MOSFET, N-CH, 50 V, 0.22 A, SOT-23 |
| 59 | 15 | R1, R3, R11, R25, R26, R27, R28, R34, R36, R39, R41, R110, R119, R128, R155 | ERJ-2GE0R00X | Panasonic | RES, 0 ohm, 5%, 0.063W, 0402 |
| 60 | 1 | R2 | CRCW0402100RFKED | Vishay-Dale | RES, 100 ohm, 1%, 0.063W, 0402 |
| 61 | 1 | R4 | CRCW0402470RJNED | Vishay-Dale | RES, 470 ohm, 5%, 0.063W, 0402 |
| 62 | 3 | R5, R16, R17 | CRCW040210K0JNED | Vishay-Dale | RES, 10k ohm, 5%, 0.063W, 0402 |
| 63 | 5 | R6, R97, R105, R118, R122 | CRCW0402100KJNED | Vishay-Dale | RES, 100k ohm, 5%, 0.063W, 0402 |
| 64 | 1 | R7 | CRCW040282K5FKED | Vishay-Dale | RES, 82.5 k, 1%, 0.063 W, 0402 |
| 65 | 1 | R8 | CRCW040268K1FKED | Vishay-Dale | RES, 68.1 k, 1%, 0.063 W, 0402 |
| 66 | 1 | R9 | CRCW040256K2FKED | Vishay-Dale | RES, 56.2 k, 1%, 0.063 W, 0402 |
| 67 | 1 | R10 | CRCW040213K3FKED | Vishay-Dale | RES, 13.3 k, 1%, 0.063 W, 0402 |
| 68 | 1 | R13 | CRCW0402102KFKED | Vishay-Dale | RES, 102 k, 1%, 0.063 W, 0402 |
| 69 | 1 | R14 | CRCW0402137KFKED | Vishay-Dale | RES, 137 k, 1%, 0.063 W, 0402 |
| 70 | 1 | R15 | CRCW0402210KFKED | Vishay-Dale | RES, 210 k, 1%, 0.063 W, 0402 |
| 71 | 7 | R20, R21, R22, R23, R76, R102, R115 | CRCW04024K70JNED | Vishay-Dale | RES, 4.7k ohm, 5%, 0.063W, 0402 |
| 72 | 1 | R29 | CRCW040240K2FKED | Vishay-Dale | RES, 40.2 k, 1%, 0.063 W, 0402 |
| 73 | 15 | R58, R59, R72, R73, R88, R90, R96, R99, R106, R108, R109, R112, R120, R121, R129 | CRCW06030000Z0EA | Vishay-Dale | RES, 0 ohm, 5%, 0.1W, 0603 |
| 74 | 11 | R60, R61, R62, R63, R64, R65, R66, R67, R125, R126, R127 | CRCW0402220RJNED | Vishay-Dale | RES, 220, 5%, 0.063 W, 0402 |
| 75 | 8 | R68, R69, R70, R71, R80, R81, R82, R83 | ERJ-3EKF1001V | Panasonic | RES, 1.00 k, 1%, 0.1 W, 0603 |
| 76 | 4 | R74, R75, R84, R85 | CRCW040257R6FKED | Vishay-Dale | RES, 57.6, 1%, 0.063 W, 0402 |
| 77 | 2 | R77, R147 | CRCW040233R0JNED | Vishay-Dale | RES, 33 ohm, 5%, 0.063W, 0402 |
| 78 | 4 | R78, R79, R86, R87 | CRCW0402200RJNED | Vishay-Dale | RES, 200, 5%, 0.063 W, 0402 |

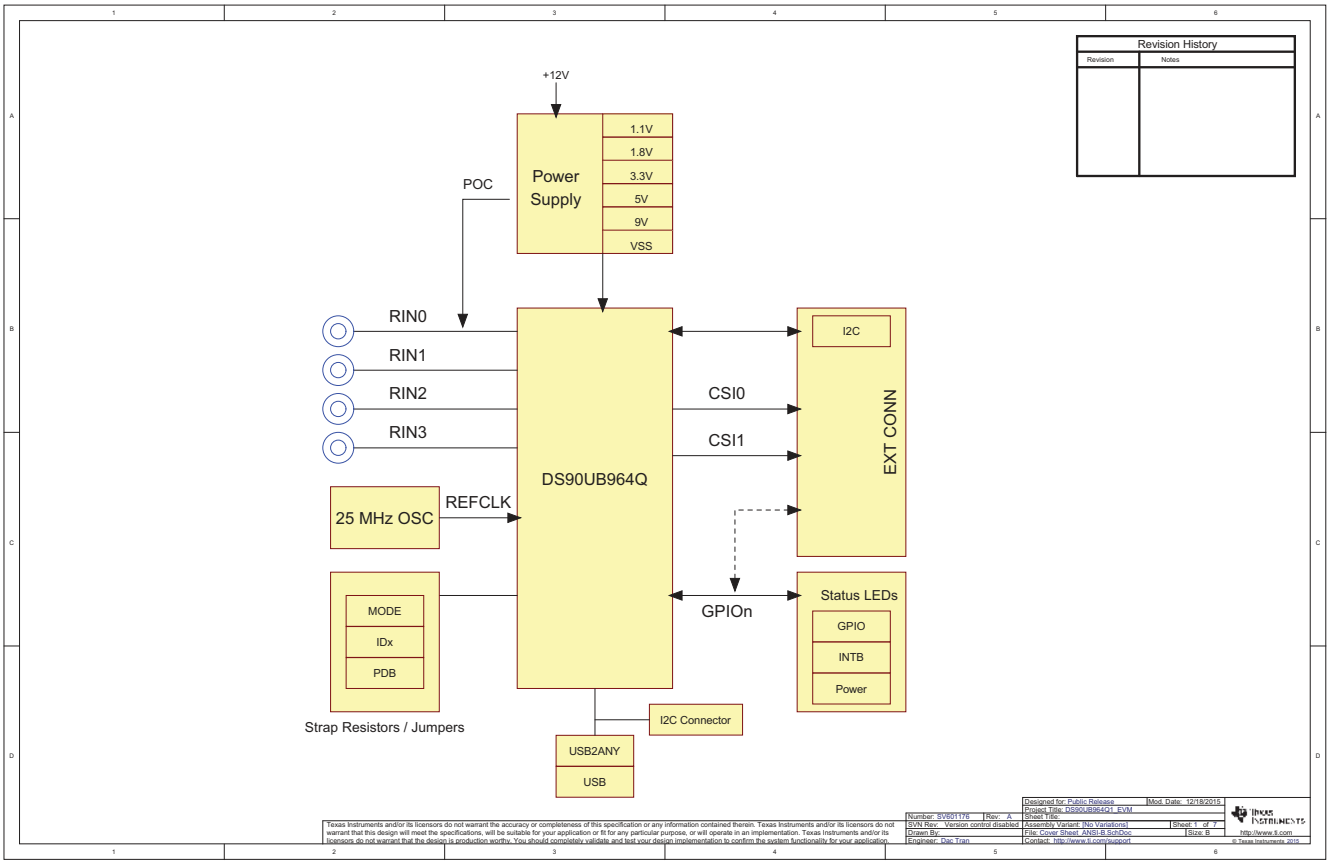
**Table 1-19. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-002 (continued)**

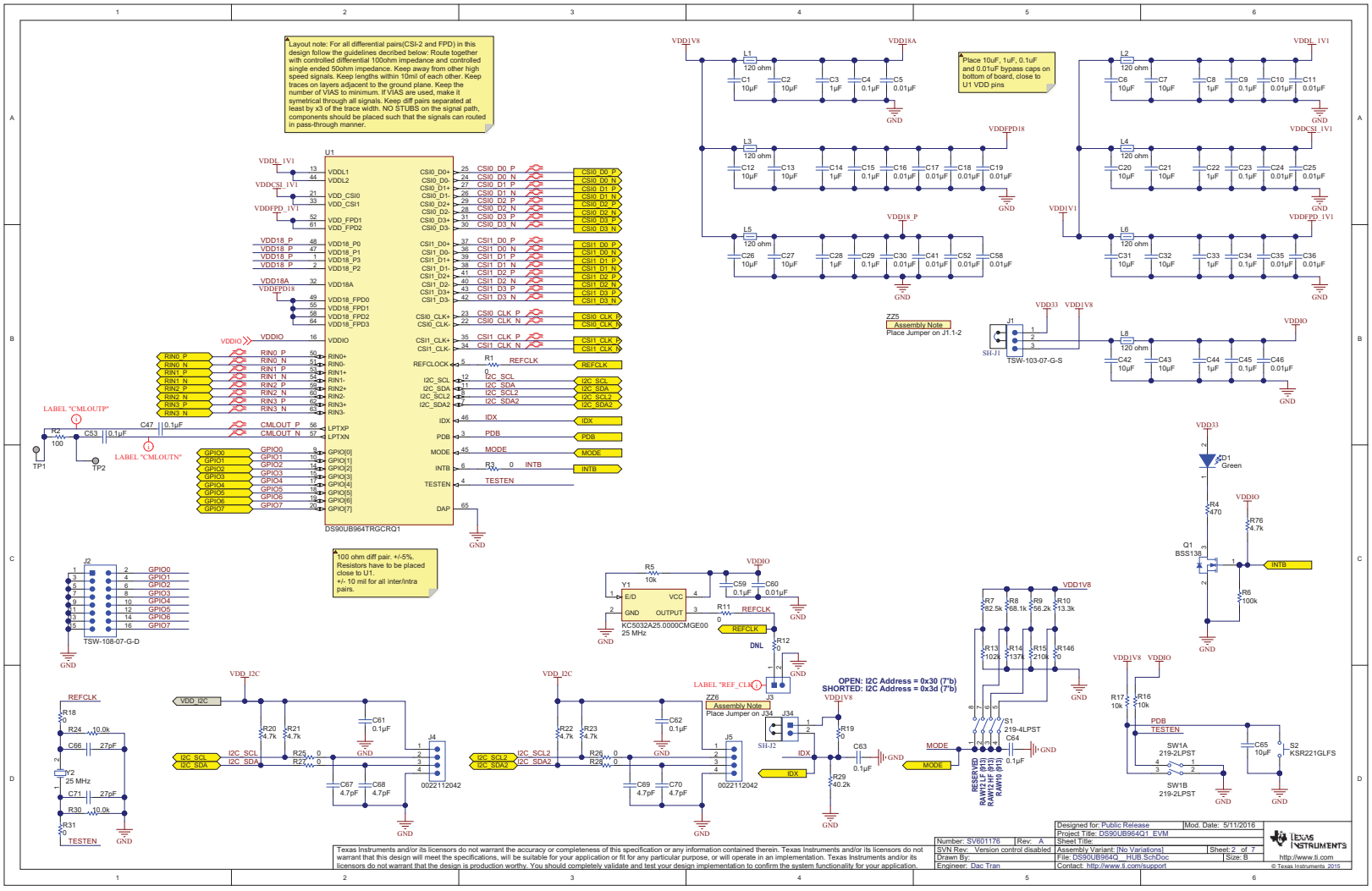
| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 79 | 6 | R89, R95, R98, R103, R107, R154 | CRCW040210K0FKED | Vishay-Dale | RES, 10.0k ohm, 1%, 0.063W, 0402 |
| 80 | 3 | R91, R100, R111 | CRCW040229K4FKED | Vishay-Dale | RES, 29.4 k, 1%, 0.063 W, 0402 |
| 81 | 1 | R92 | CRCW0402124KFKED | Vishay-Dale | RES, 124k ohm, 1%, 0.063W, 0402 |
| 82 | 1 | R93 | CRCW040222K1FKED | Vishay-Dale | RES, 22.1k ohm, 1%, 0.063W, 0402 |
| 83 | 4 | R94, R101, R104, R114 | CRCW04023K24FKED | Vishay-Dale | RES, 3.24k ohm, 1%, 0.063W, 0402 |
| 84 | 1 | R113 | CRCW04021K87FKED | Vishay-Dale | RES, 1.87k ohm, 1%, 0.063W, 0402 |
| 85 | 1 | R116 | CRCW04024K99FKED | Vishay-Dale | RES, 4.99k ohm, 1%, 0.063W, 0402 |
| 86 | 2 | R123, R124 | CRCW04022K40JNED | Vishay-Dale | RES, 2.4 k, 5%, 0.063 W, 0402 |
| 87 | 16 | R130, R131, R132, R133, R134, R135, R136, R137, R138, R139, R140, R141, R142, R143, R144, R145 | ERJ-1GE0R00C | Panasonic | RES, 0, 5%, 0.05 W, 0201 |
| 88 | 1 | R148 | CRCW04021K50JNED | Vishay-Dale | RES, 1.5k ohm, 5%, 0.063W, 0402 |
| 89 | 2 | R149, R153 | CRCW040233K0JNED | Vishay-Dale | RES, 33k ohm, 5%, 0.063W, 0402 |
| 90 | 1 | R150 | CRCW06031M20JNEA | Vishay-Dale | RES, 1.2Meg ohm, 5%, 0.1W, 0603 |
| 91 | 1 | R152 | 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 | 15 | 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 | 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 | TDK | Common Mode Filter for Power Line |
| 97 | 1 | U1 | DS90UB964TRGCRQ1 | Texas Instruments | FPD-Link III Camera Hub Deserializer, RGC0064G |
| 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) |

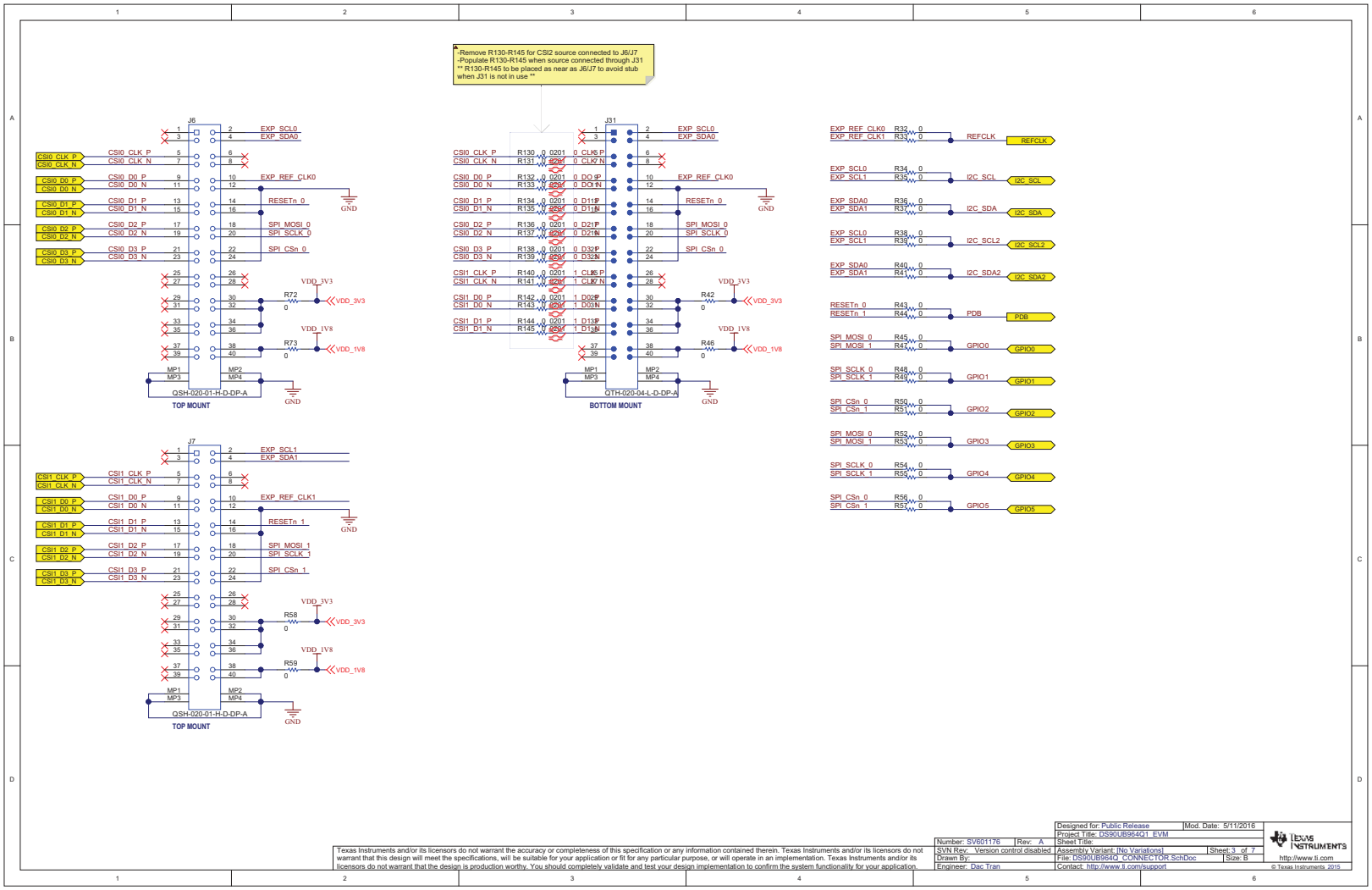
**Table 1-19. BOM for DS90UB96X-Q1EVM Assembly Variant SV601176-002 (continued)**

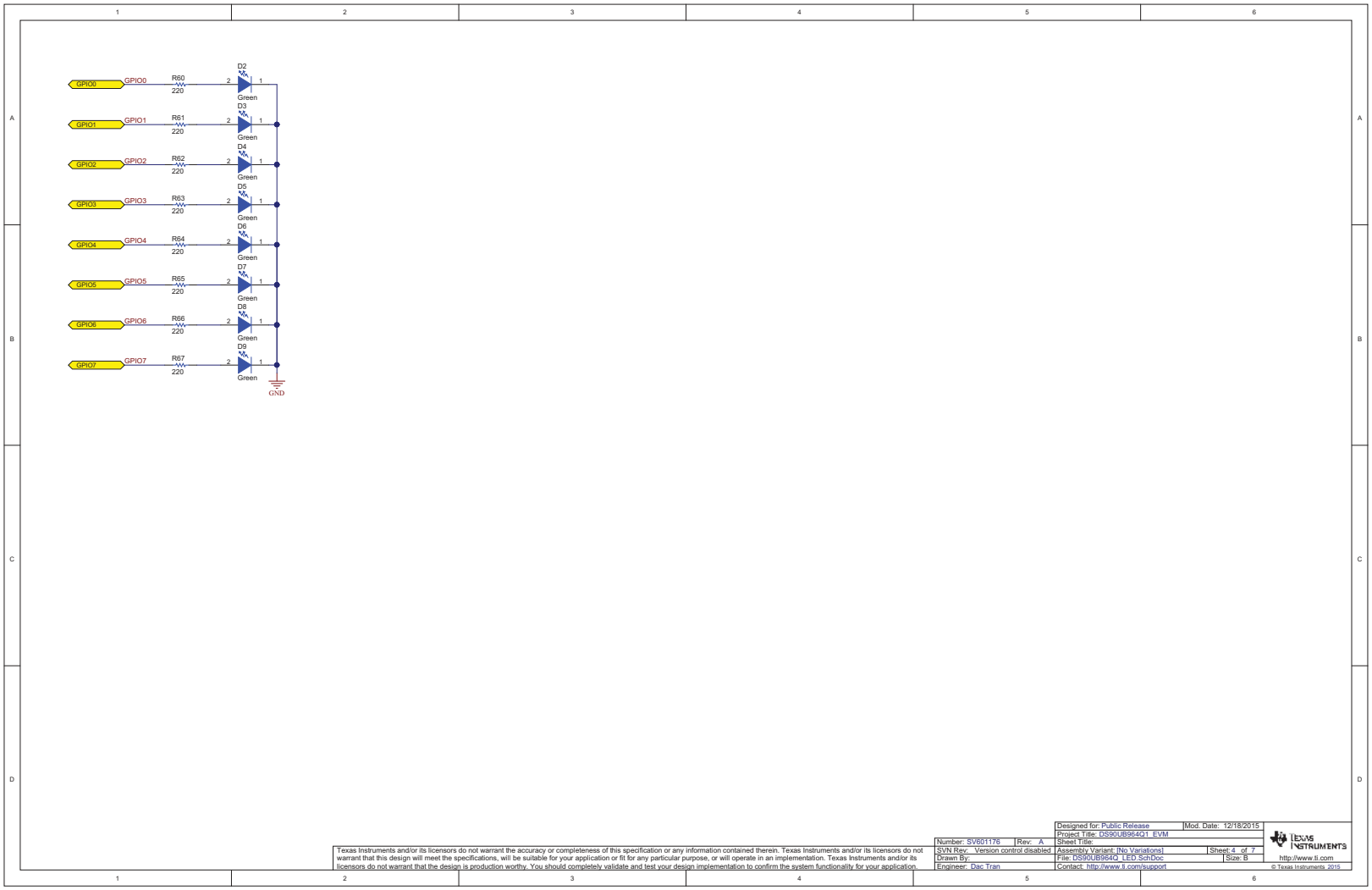
| Item | Qty | Designator | Part Number | Manufacturer | Description |
|---|---|---|---|---|---|
| 101 | 1 | U7 | TPS767D318PWP | Texas Instruments | Dual Output LDO, 1 A, Fixed 1.8, 3.3 V Output, 2.7 to 10 V Input, 28-pin HTSSOP (PWP), -40 to 125 degC, Green (RoHS & no Sb/Br) |
| 102 | 1 | U8 | TPD4E004DRYR | 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) |
| 103 | 1 | U9 | TPS73533DRBR | Texas Instruments | 500mA, Low Quiescent Current, Ultra-Low Noise, High PSRR Low-Dropout Linear Regulator, DRB0008A |
| 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 | KC5032A25.0000CMGE00 | AVX | OSC, 25 MHz, 1.6 to 5.5 V, SMD |
| 107 | 1 | Y2 | ABM3-25.000MHZ-D2Y-T | Abracon Corporation | Crystal, 25 MHz, 18 pF, SMD |
| 108 | 1 | Y3 | ABM3-24.000MHZ-D2Y-T | Abracon Corporation | Crystal, 24 MHz, 18 pF, SMD |
| 109 | 0 | C2, C7, C13, C21, C27, C32, C43 | CL21A106KAFN3NE | Samsung Electro-Mechanics | CAP, CERM, 10 µF, 25 V, +/- 10%, X5R, 0805 |
| 110 | 0 | C66, C71 | GRM1555C1H270JA01D | MuRata | CAP, CERM, 27 pF, 50 V, +/- 5%, C0G/NP0, 0402 |
| 111 | 0 | J37 | TSW-104-07-G-D | Samtec | Header, 100mil, 4x2, Gold, TH |
| 112 | 0 | J38 | TSW-104-07-G-S | Samtec | Header, 100mil, 4x1, Gold, TH |
| 113 | 0 | J39 | TSW-102-07-G-D | Samtec | Header, 100mil, 2x2, Gold, TH |
| 114 | 0 | L19, L20, L29, L30 | DLW21SN900HQ2L | MuRata | Coupled inductor, 0.28 A, 0.41 ohm, +/- 25%, SMD |
| 115 | 0 | R12, R18, R19, R31, R32, R33, R35, R37, R38, R40, R43, R44, R45, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R57, R146, R151 | ERJ-2GE0R00X | Panasonic | RES, 0 ohm, 5%, 0.063W, 0402 |
| 116 | 0 | R24, R30, R117 | CRCW040210K0FKED | Vishay-Dale | RES, 10.0k ohm, 1%, 0.063W, 0402 |
| 117 | 0 | R42, R46 | CRCW06030000Z0EA | Vishay-Dale | RES, 0 ohm, 5%, 0.1W, 0603 |

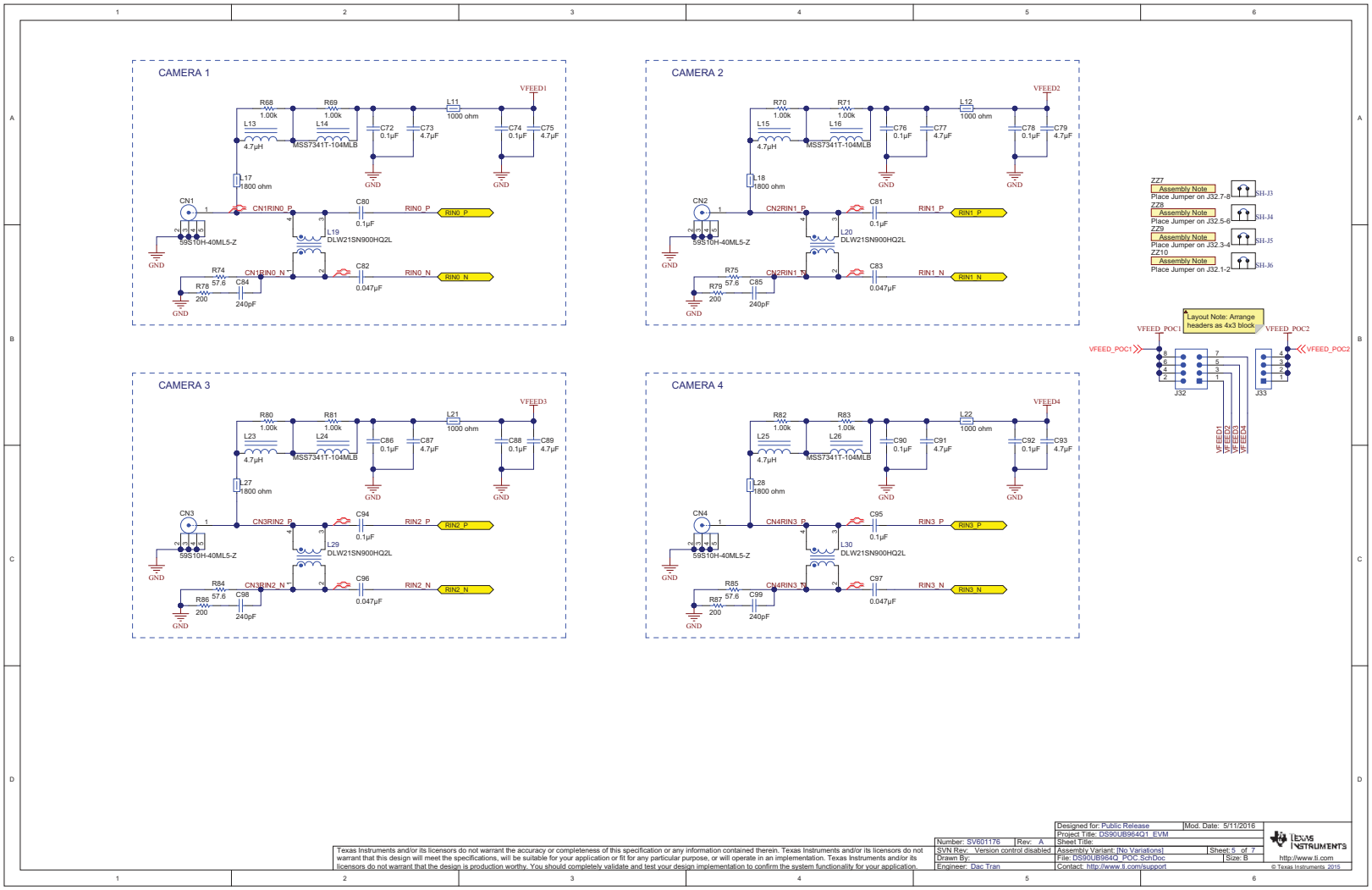
# PCB Schematics

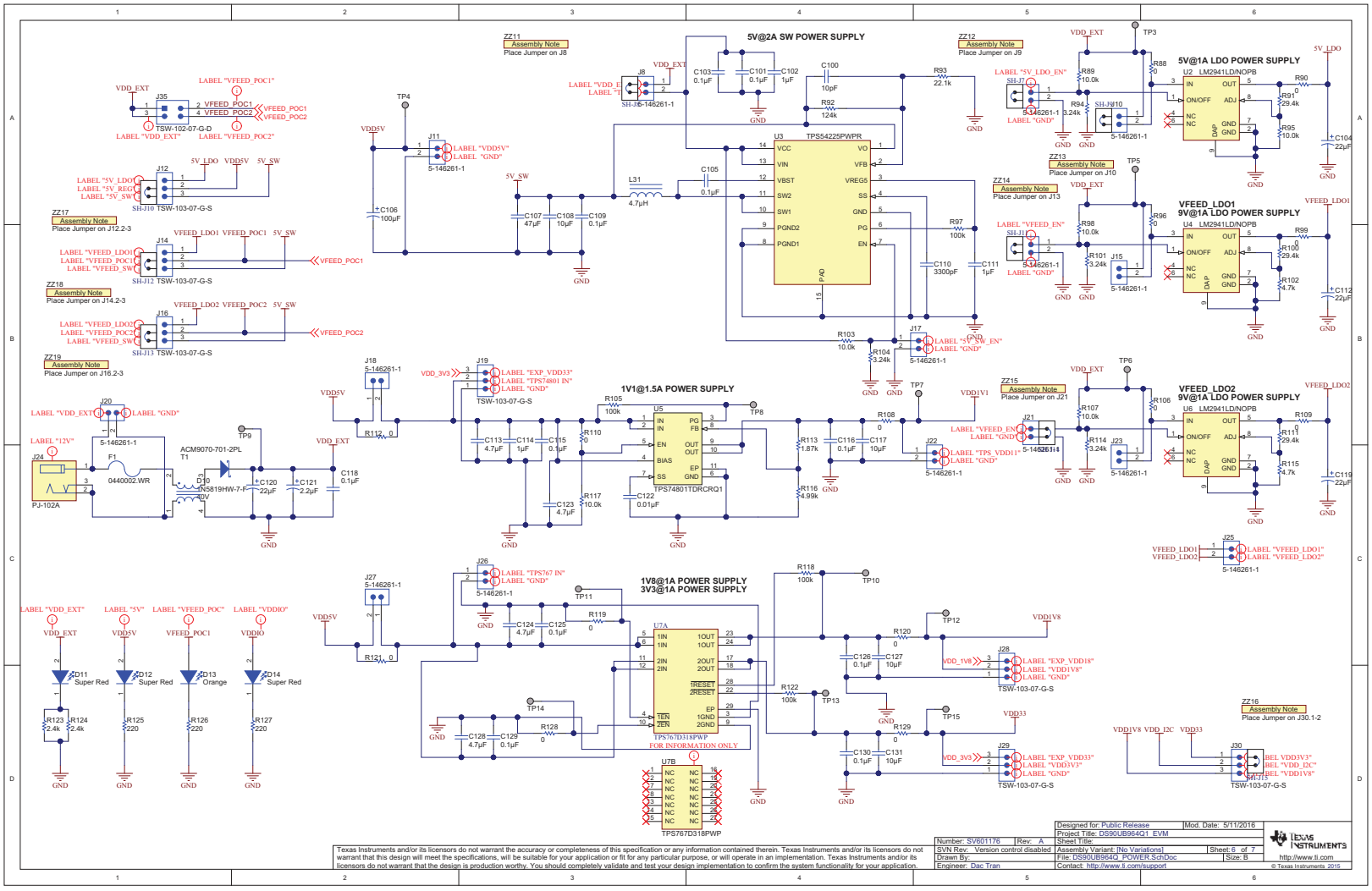


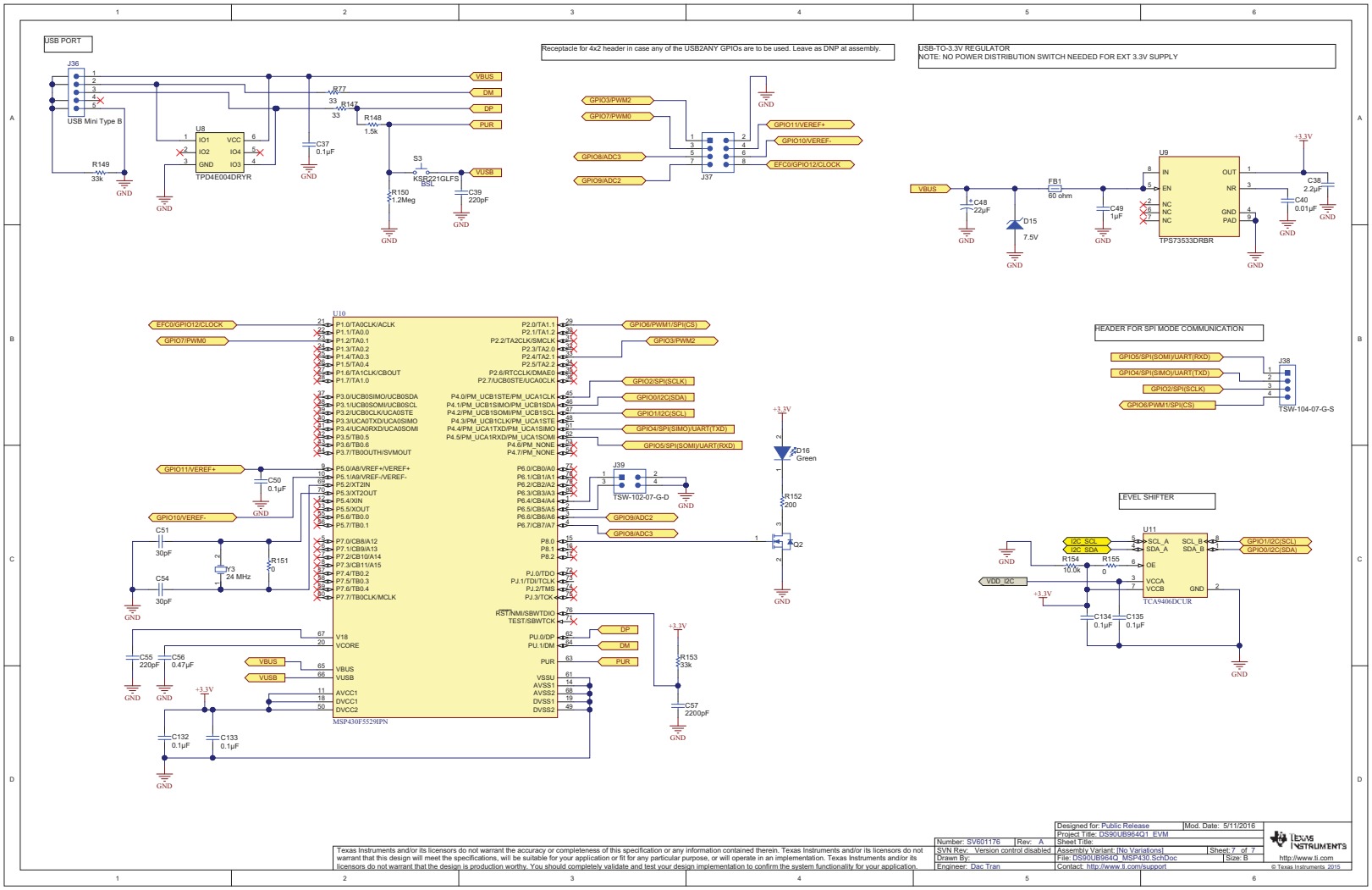












# Board Layout

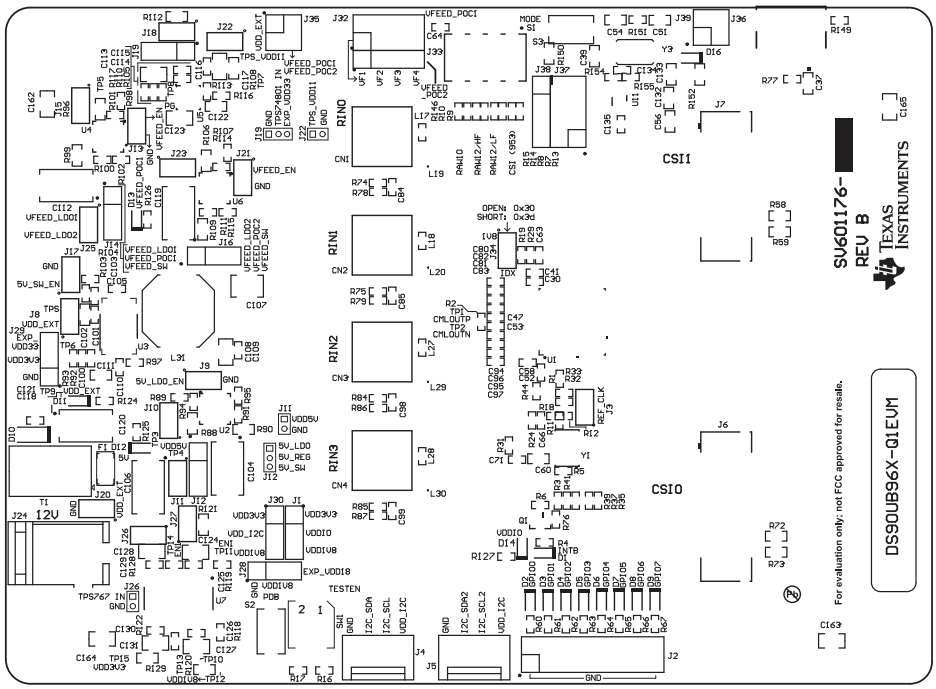



**Figure 3-1. Top Overlay**

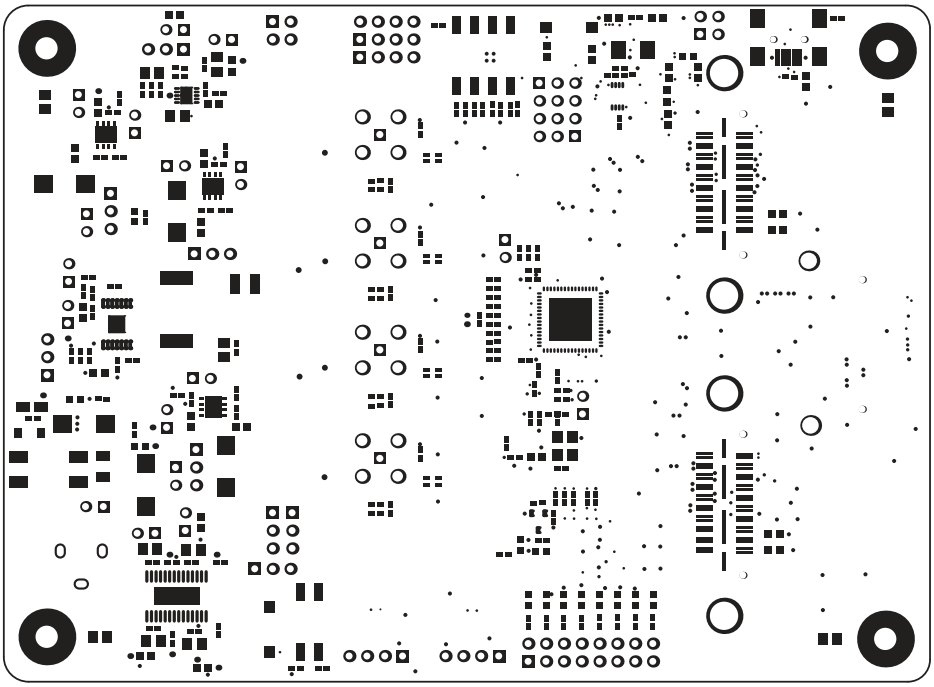


**Figure 3-2. Top Solder**

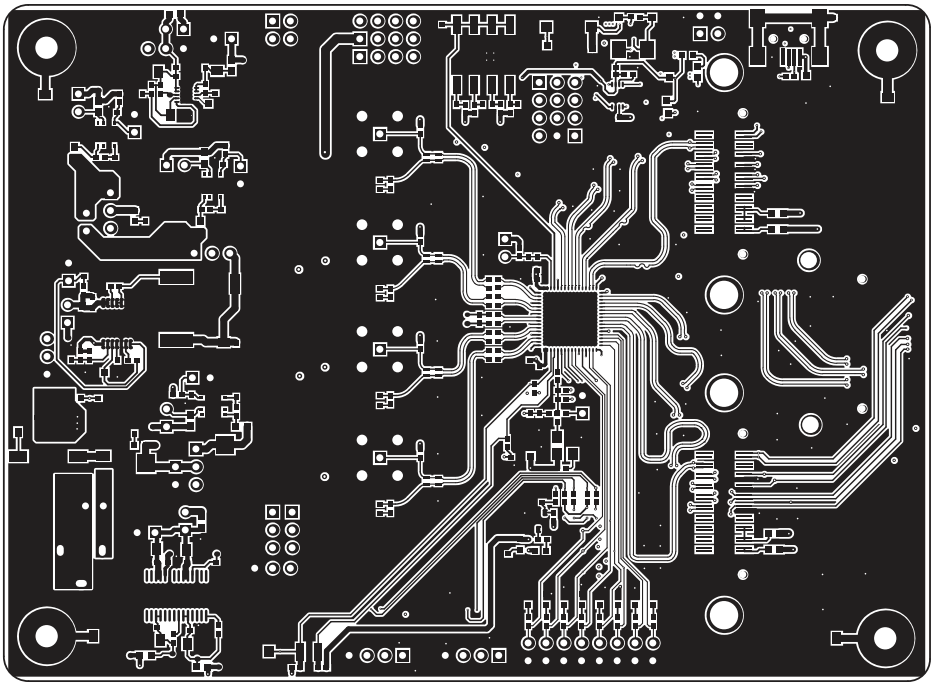


**Figure 3-3. Top Layer 1**

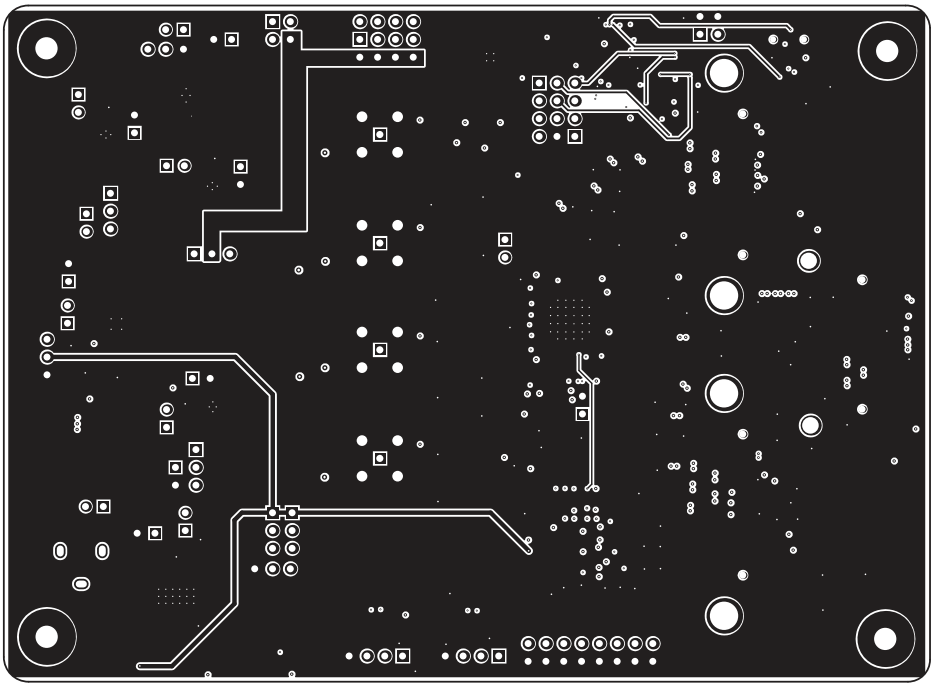


**Figure 3-4. Layer 2**

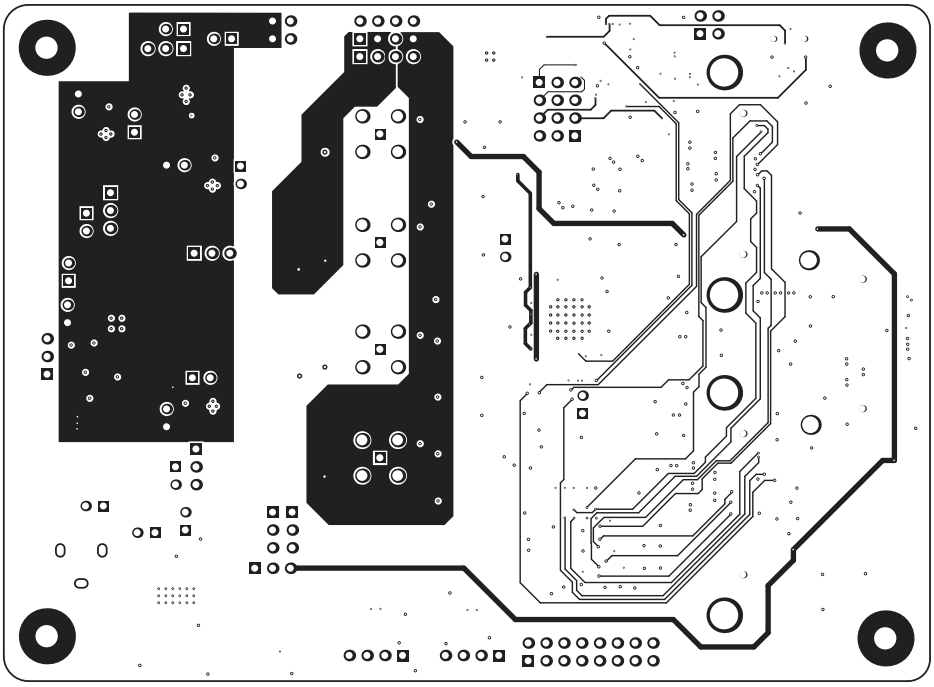


**Figure 3-5. Layer 3**

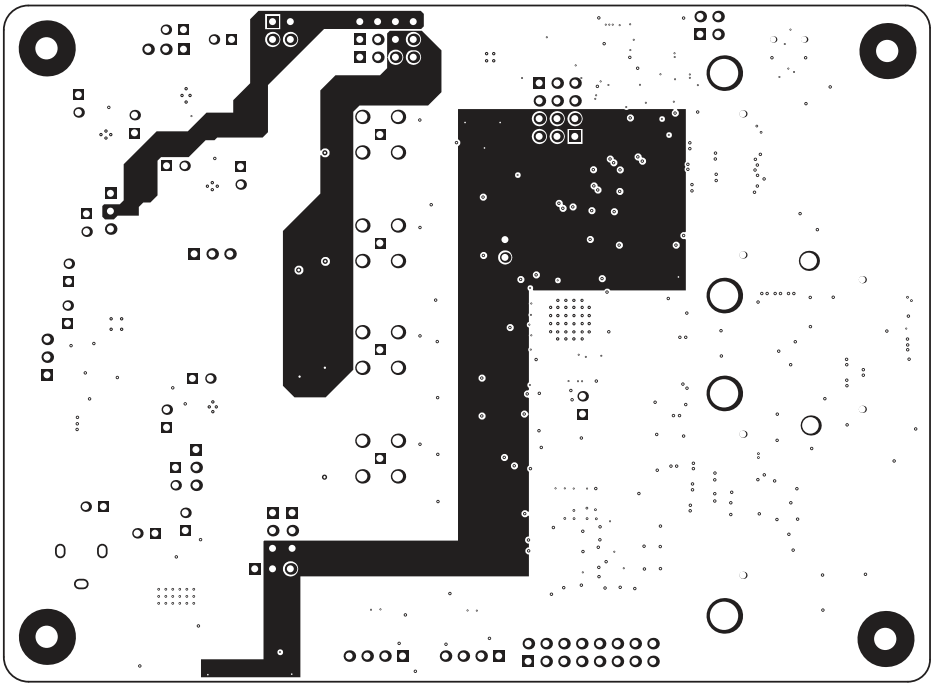


**Figure 3-6. Layer 4**

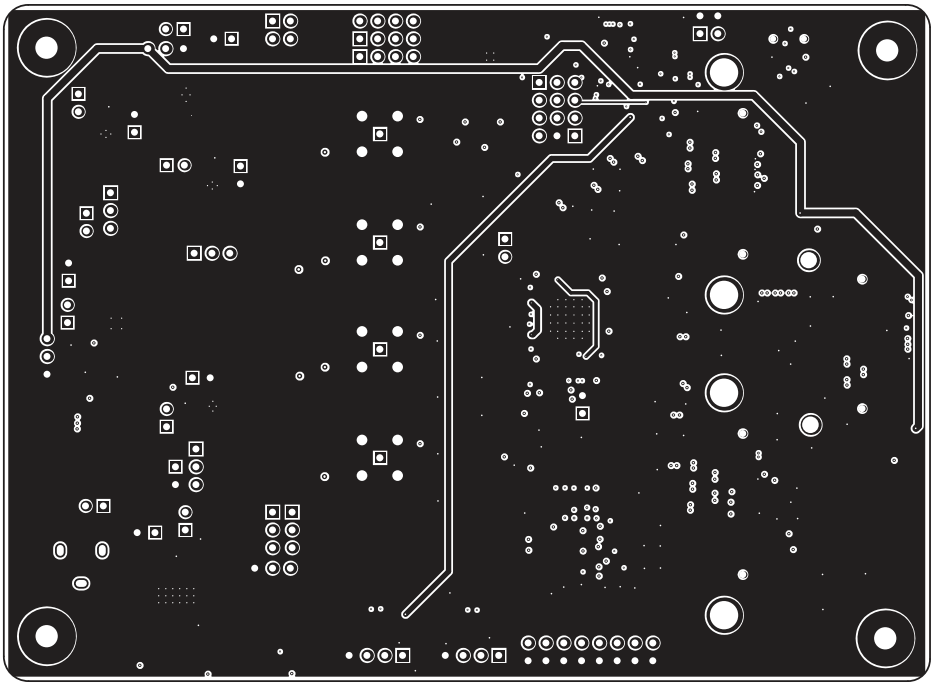


**Figure 3-7. Layer 5**

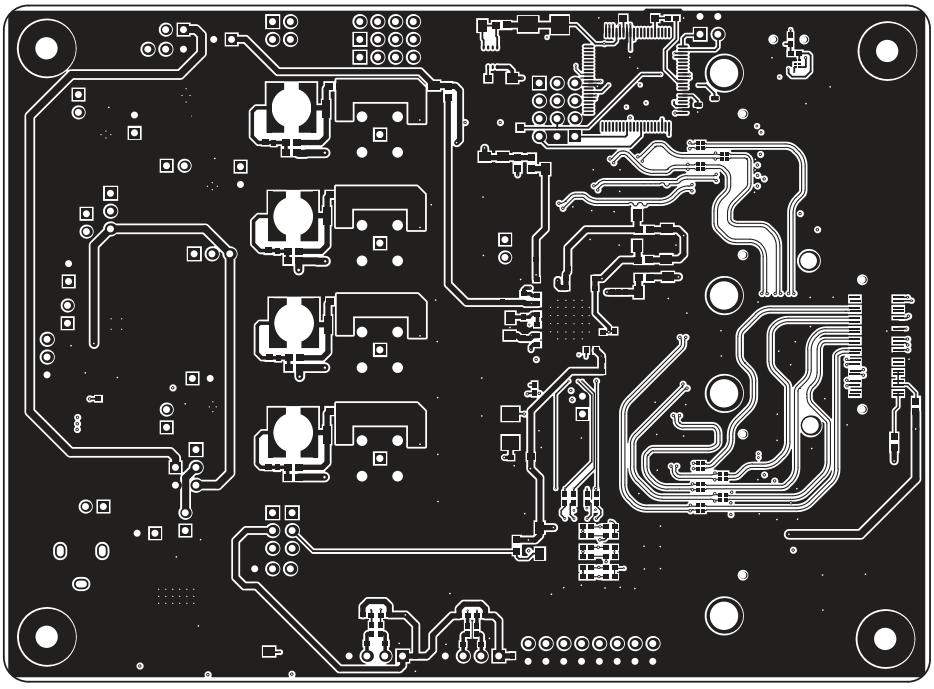


**Figure 3-8. Bottom Layer 6**

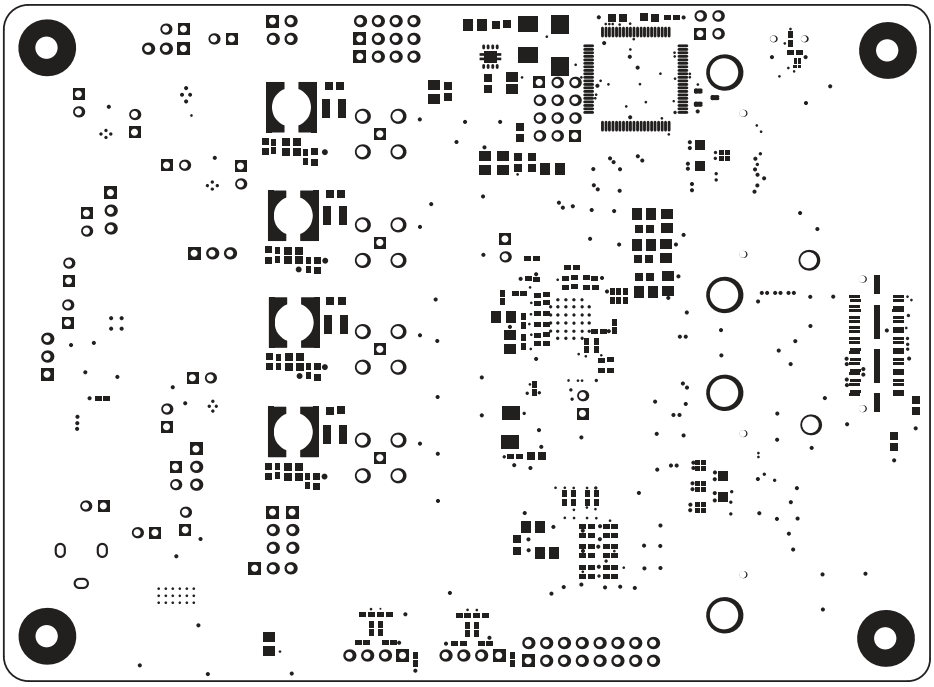


**Figure 3-9. Bottom solder**

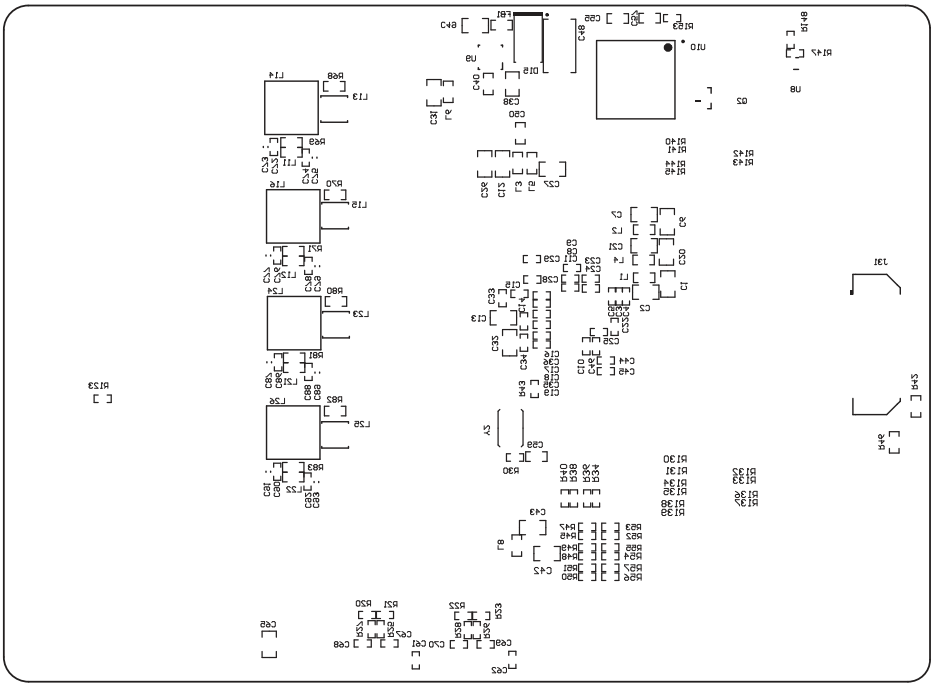
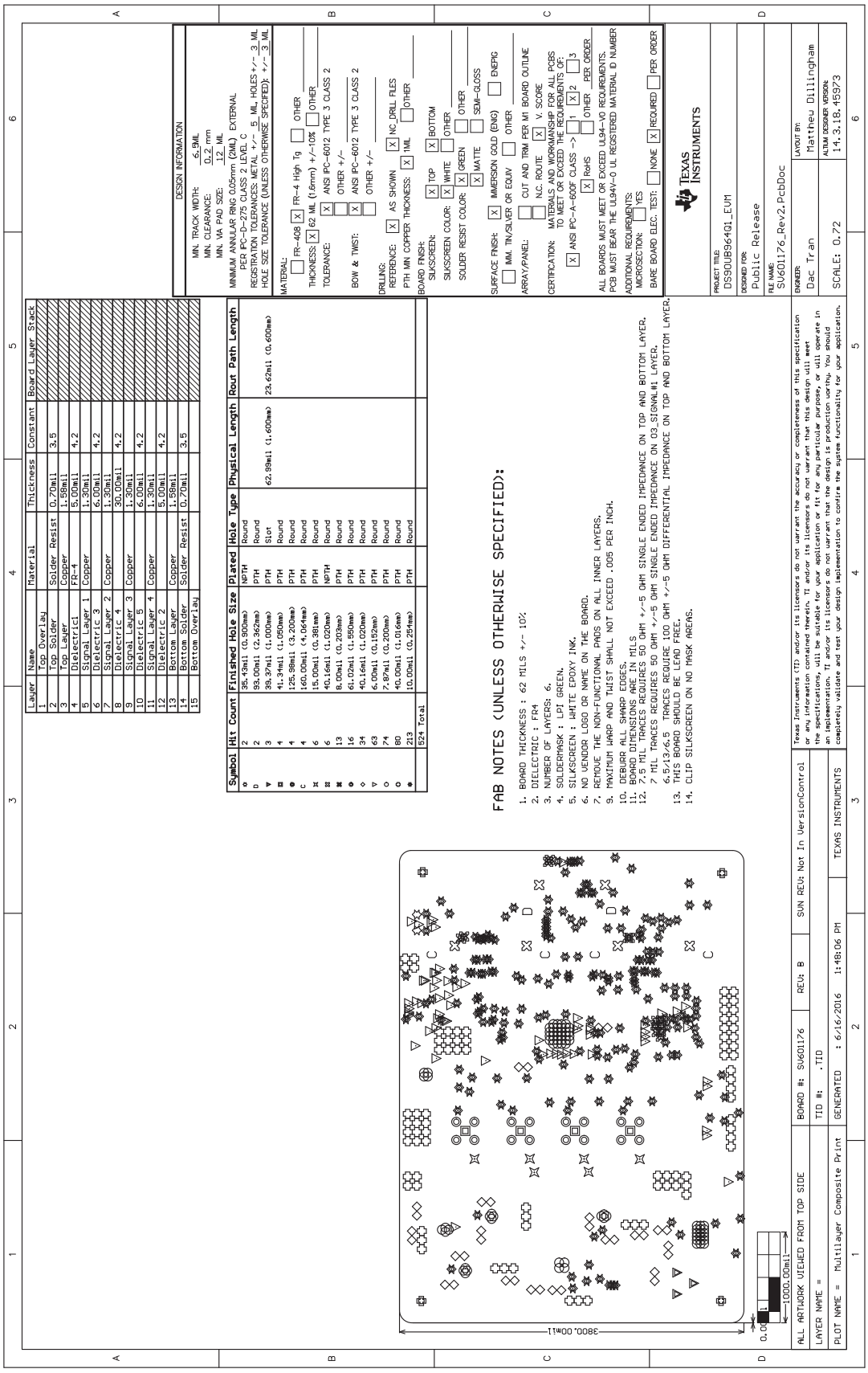


**Figure 3-10. Bottom Overlay**



| Layer | Name | Material | Thickness | Constant | Board Layer Stack |
|---|---|---|---|---|---|
| 1 | Top Overlay | | | | |
| 2 | Top Solder | Solder Resist | 0.70mil | 3.5 | |
| 3 | Top Layer | Copper | 1.58mil | | |
| 4 | Dielectric1 | FR-4 | 5.00mil | 4.2 | |
| 5 | Signal Layer 1 | Copper | 1.30mil | | |
| 6 | Dielectric 3 | | 6.00mil | 4.2 | |
| 7 | Signal Layer 2 | Copper | 1.30mil | | |
| 8 | Dielectric 4 | | 30.00mil | 4.2 | |
| 9 | Signal Layer 3 | Copper | 1.30mil | | |
| 10 | Dielectric 5 | | 6.00mil | 4.2 | |
| 11 | Signal Layer 4 | Copper | 1.30mil | | |
| 12 | Dielectric 2 | | 5.00mil | 4.2 | |
| 13 | Bottom Layer | Copper | 1.58mil | | |
| 14 | Bottom Solder | Solder Resist | 0.70mil | 3.5 | |
| 15 | Bottom Overlay | | | | |

| Symbol | Hit Count | Finished Hole Size | Plated | Hole Type | Physical Length | Rout Path Length |
|---|---|---|---|---|---|---|
| + | 2 | 35.43mil (0.900mm) | NPTH | Round | | |
| □ | 2 | 93.00mil (2.362mm) | PTH | Round | | |
| ▼ | 3 | 39.37mil (1.000mm) | PTH | Slot | 62.99mil (1.600mm) | 23.62mil (0.600mm) |
| ■ | 4 | 41.34mil (1.050mm) | PTH | Round | | |
| ● | 4 | 125.98mil (3.200mm) | PTH | Round | | |
| ○ | 4 | 160.00mil (4.064mm) | PTH | Round | | |
| ⊠ | 6 | 15.00mil (0.381mm) | PTH | Round | | |
| ⊠ | 6 | 40.16mil (1.020mm) | NPTH | Round | | |
| ⊠ | 13 | 8.00mil (0.203mm) | PTH | Round | | |
| ● | 16 | 61.02mil (1.550mm) | PTH | Round | | |
| ◇ | 34 | 40.16mil (1.020mm) | PTH | Round | | |
| ▽ | 63 | 6.00mil (0.152mm) | PTH | Round | | |
| ○ | 74 | 7.87mil (0.200mm) | PTH | Round | | |
| ○ | 80 | 40.00mil (1.016mm) | PTH | Round | | |
| ○ | 213 | 10.00mil (0.254mm) | PTH | Round | | |
| | 524 Total | | | | | |

FAB NOTES (UNLESS OTHERWISE SPECIFIED):

1. BOARD THICKNESS : 62 MILS +/- 10%
2. DIELECTRIC : FR4
3. NUMBER OF LAYERS: 6.
4. SOLDERMASK : LPI GREEN.
5. SILKSCREEN : WHITE EPOXY INK.
6. NO VENDOR LOGO OR NAME ON THE BOARD.
7. REMOVE THE NON-FUNCTIONAL PADS ON ALL INNER LAYERS.
8. MAXIMUM WARP AND TWIST SHALL NOT EXCEED .005 PER INCH.
9. DEBURR ALL SHARP EDGES.
10. BOARD DIMENSIONS ARE IN MILS.
11. 2.5 MIL TRACES REQUIRES 50 OHM +/-5 OHM SINGLE ENDED IMPEDANCE ON TOP AND BOTTOM LAYER.
12. 7 MIL TRACES REQUIRES 50 OHM +/-5 OHM SINGLE ENDED IMPEDANCE ON 03_SIGNAL#1 LAYER.
    6.5/13/6.5 TRACES REQUIRE 100 OHM +/-5 OHM DIFFERENTIAL IMPEDANCE ON TOP AND BOTTOM LAYER.
13. THIS BOARD SHOULD BE LEAD FREE.
14. CLIP SILKSCREEN ON NO MASK AREAS.

DESIGN INFORMATION

MIN. TRACK WIDTH: 6.9MIL
MIN. CLEARANCE: 0.2 mm
MIN. VIA PAD SIZE: 12 MIL
MINIMUM ANNULAR RING 0.05mm (2MIL) EXTERNAL
PER IPC-D-275 CLASS 2 LEVEL C
REGISTRATION TOLERANCES: METAL +/- .5 MIL HOLES +/- .3 MIL
HOLE SIZE TOLERANCE: (UNLESS OTHERWISE SPECIFIED): +/- .3 MIL

MATERIAL:
[ ] FR-408 [X] FR-4 High Tg [ ] OTHER
THICKNESS: [X] 62 MIL (1.6mm) +/-10% [ ] OTHER
TOLERANCE: [X] ANSI IPC-6012 TYPE 3 CLASS 2
[ ] OTHER +/-
BOW & TWIST: [X] ANSI IPC-6012 TYPE 3 CLASS 2
[ ] OTHER +/-
DRILLING:
REFERENCE: [X] AS SHOWN [X] NC_DRILL FILES
PTH MIN COPPER THICKNESS: [X] 1MIL [ ] OTHER
BOARD FINISH: [X] TOP [X] BOTTOM
SILKSCREEN:
SILKSCREEN COLOR: [X] WHITE [ ] OTHER
SOLDER RESIST COLOR: [X] GREEN [ ] OTHER
[X] MATTE [ ] SEMI-GLOSS
SURFACE FINISH: [X] IMMERSION GOLD (ENIG) [ ] ENEPIG
[ ] NWI TIN/SILVER OR EQUIV [ ] OTHER
ARRAY/PANEL: [ ] CUT AND TRM PER M1 BOARD OUTLINE
[ ] N.C. ROUTE [X] V. SCORE
CERTIFICATION: MATERIALS AND WORKMANSHIP FOR ALL PCBS
TO MEET OR EXCEED THE REQUIREMENTS OF:
[X] ANSI IPC-A-600F CLASS -> [ ] 1 [X] 2 [ ] 3
[X] RoHS [ ] OTHER _PER ORDER
ALL BOARDS MUST MEET OR EXCEED UL94-V0 REQUIREMENTS.
PCB MUST BEAR THE UL94V-0 UL REGISTERED MATERIAL ID NUMBER
ADDITIONAL REQUIREMENTS:
MICROSECTION: [ ] YES
BARE BOARD ELEC. TEST: [ ] NONE [X] REQUIRED [ ] PER ORDER

TEXAS INSTRUMENTS

PROJECT TITLE: DS90UB964Q1_EVM
DESIGNED FOR: Public Release
FILE NAME: SV601176_Rev2.PcbDoc
ENGINEER: Dac Tran
LAYOUT BY: Matthew Dillingham
SCALE: 0.72
ALTIUM DESIGNER VERSION: 14.3.18.45973

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ALL ARTWORK VIEWED FROM TOP SIDE | BOARD #: SV601176 | REV: B | SUN REV: Not In VersionControl
LAYER NAME = | TID #: .TID
PLOT NAME = Multilayer Composite Print | GENERATED : 6/16/2016 1:48:06 PM | TEXAS INSTRUMENTS

# STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      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*

**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.

**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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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 WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (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 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.

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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 ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, 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 ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS 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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