The Texas Instruments DS90UB953-Q1EVM evaluation module (EVM) is a functional board design for evaluating the DS90UB953-Q1 FPD-Link III serializer. This document provides necessary details for the evaluation such as a brief product overview, quick-start guide, troubleshooting section, schematics, and printed-circuit board (PCB) layout details, and bill of materials (BOM).

The DS90UB953-Q1 serializer represents the next generation in FPD-III serializers and is designed to support high-speed raw data sensors including 2-MP imagers at 60 fps, as well as 4-MP, 30-fps cameras, satellite RADAR, LIDAR, and time-of-flight (ToF) sensors. The chip delivers a 4-Gbps+ forward channel and an ultra-low latency, 50-Mbps bidirectional control channel. The chip also supports power over a single coax (PoC) or shielded twisted-pair (STP) cable and connector. The DS90UB953-Q1 features advanced data protection and diagnostic features to support ADAS and autonomous driving. Together with a companion deserializer, the DS90UB953-Q1 delivers precise multi-camera sensor clock and sensor synchronization. For a full list of device characteristics, refer to the DS90UB953-Q1 product folder.
1 Introduction

NOTE: The demo board is not optimized 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.

Figure 1. DS90UB953-Q1EVM Top View
2 Quick Start Guide

The quick start guide is intended to get the DS90UB953-Q1EVM operational with the minimum amount of information.

2.1 System Requirements

The major components of the DS90UB953-Q1EVM are:
- DS90UB953 Serializer Board
- DS90UB953-DC1 Daughter Card
- On-board Power-over-Coax (PoC) interface
- FAKRA connector for digital video, power, and diagnostics
- On-board I2C programming interface

To demonstrate, TI recommends the following (not included):
- DS90UB954-Q1EVM
- One DACAR/FAKRA coax cable
- DC power supply for DS90UB954-Q1EVM only
- Power supply cables: for example, banana to coax, banana to grabber, and so forth.
- Two male USB-to-mini USB cables
- USB2ANY or an Aardvark I2C/SPI Host Adapter
- Analog LaunchPAD software (download Analog Launch PAD from TI.com (a myTI Login required). Steps for installation can be found in Section 3.3). This software is not required if an external ECU is used.

2.2 Application Block Diagram

Figure 2. Typical Application Block Diagram Using DS90UB953-Q1 and DS90UB954-Q1
2.3 Major Components of DS90UB953-Q1EVM

![DS90UB953-Q1EVM Major Components]

Figure 3. DS90UB953-Q1EVM Major Components

2.4 Demo Instructions for DS90UB953-Q1EVM

1. Ensure jumpers on J2, J4, and J15 for DS90UB953-Q1EVM are installed as shown in Figure 4

![DS90UB953-Q1EVM With Installed Jumpers]

Figure 4. DS90UB953-Q1EVM With Installed Jumpers

2. Install DS90UB953-DCA Daughter Card into J1 of the DS90UB953-Q1 Serializer board

3. Ensure jumpers and switches for DS90UB954-Q1EVM are configured like shown in Figure 5. See the DS90UB954-Q1EVM User’s Guide (SNLU223) for further details.
4. Connect the DACAR coax cable with FAKRA connector to RX0p from the DS90UB954-Q1EVM to J16 of the DS90UB953-Q1EVM
5. Connect a mini USB to J2 on the DS90UB954-Q1EVM and J9 on the DS90UB953-Q1EVM to a device with Analog LaunchPAD (ALP) software installed
6. Power the DS90UB954-Q1EVM with 12 V through J1
7. Open ALP and assign the correct DS90UB953 and DS90UB954 profiles to the appropriate USB IDs
8. The DS90UB953-Q1EVM and DS90UB954-Q1EVM should now be linked and have established connection. Go to information tab on the DS90UB954 device window and confirm that Pass Sts displays Pass and Linked has the appropriate frequency displayed. Also check if Pass and Lock LEDs are lit
9. Open the DS90UB954 Device window, go to the scripting tab, and run the P954_A0_RX0_CSI_Enable.py script
10. Navigate back to the scripting tab and run the ovt_1920_1080_REMOTE.py script to initialize the camera. Go back to the information tab and confirm the horizontal and vertical parameters read 1920 and 1080, respectively.
11. If there are any problems, consult Section 3.5 for an in-depth step-by-step guide to enable the pass and lock
3 Troubleshooting

3.1 Default Addresses
The default 9-bit I2C address of DS90UB953 is set to 0x30 (011 0000) using suitable resistor divider on ID[x] pin. Also, 8-bit I2C address of DS90UB954 is set to 0x7A (0111 1010) using suitable resistor dividers on pins IDX[0] and IDX[1].

3.2 USB2ANY
The USB2ANY is required to use interactive GUI over I2C, such as ALP (Analog LaunchPAD). Download and install ALP from: http://www.ti.com/tool/ALP.

The USB2ANY is shown in Figure 6. It is powered through the USB port of computer.

![Figure 6. USB2ANY](image)

Figure 7 shows the USB2ANY pinout with the I2C pins highlighted. Typically, jumper wires are used to connect these to the 953/954 EVMs.

Figure 7
On the DS90UB954-Q1EVM, connect the other ends of the corresponding wires to pins 2, 3, and 4 of J25 labeled SCL, SDA, and GND, respectively.

On the DS90UB953-Q1EVM, connect the other ends of the corresponding wires to pins 1, 2, and 3 of J5 for 1.8 V, or J6 for 3.3 V labeled SCL, SDA, and GND, respectively. Note that these voltages refer to the pullup voltage used in I2C communication. As a result, check the mode of the I2C adapter before plugging in to the adapter.

Connecting the Mini USB to USB cable from the port of the USB2ANY to the computer should allow ALP to communicate with the EVM. However, the USB2ANY must be configured to support the 1.8 V required by the DS90UB953-Q1EVM and DS90UB954-Q1EVM. To do this, the user must navigate to the USB2ANY.py script and change the code. The path to the file is given below:

```
C:\Program Files (x86)\Texas Instruments\Analog LaunchPAD v1.56.0010\Drivers\i2c_controllers\usb2any\python
```

Once the USB2ANY.py script is found, open the script in a text editing program (for example, Notepad, Wordpad, Notepad++, and so forth) and replace Line 61 from:

```
self.usb2anydll.u2aI2C_Control(self.u2ahandle,1,0,0)
```

To the following:

```
self.usb2anydll.u2aI2C_Control(self.u2ahandle,1,0,1)
self.usb2anydll.u2aPower_WriteControl(self.u2ahandle,1,0)
```

Save the script, close the program, and ALP will now recognize the connection from the board to the USB2ANY.
3.3 **ALP Software Setup**

**NOTE:** The ALP Software Setup example used in this section refers to the DS90UB96X. Addresses shown in screenshots will be different, however, the process remains the same for using the DS90UB953-Q1EVM and DS90UB954-Q1EVM.

### 3.3.1 System Requirements

<table>
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<th>Windows 7 64-bit</th>
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</thead>
<tbody>
<tr>
<td>USB:</td>
<td>USB2ANY</td>
</tr>
<tr>
<td>USB2ANY Firmware Version:</td>
<td>2.5.2.0</td>
</tr>
<tr>
<td>USB:</td>
<td>Aardvark I²C/SPI host adapter p/n TP240141</td>
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</table>

### 3.3.2 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.

### 3.3.3 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.

### 3.3.4 Start-Up - 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. Launching ALP

The application should come up in the state shown in Figure 9. If it does not, see Section 3.4. Under the Devices tab, click twice on the DS90UB96X to select the device to open the device profile and its associated tabs. If the incorrect profile is shown, consult Section 3.4.1.

Figure 9. Initial ALP Screen

After selecting the DS90UB96X, the following screen shown in Figure 10 should appear.
3.3.5 Information Tab

The Information tab is shown in Figure 11.
3.3.6 Registers Tab

The Register tab is shown in Figure 12.

Figure 12. ALP Registers Tab
3.3.7 Registers Tab - Address 0x00 Selected

Figure 13 shows Address 0x00 selected. Note that the Value: box, [Value: 7A], will now show the hex value of that register.

Figure 13. ALP Device ID Selected
3.3.8 Registers Tab - Address 0x00 Expanded

By double clicking on the Address bar or a single click on , the expanded Address 0x00 reveals contents by bits. Any register address displayed can be expanded.

![ALP Device ID Expanded](image1)

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.

![Writing to Register 0x00 by Checking Bits in ALP](image2)

The box toggles on every mouse click.
3.3.9 Scripting Tab

The Scripting tab is shown in Figure 16.

![Figure 16. ALP Scripting Tab](image)

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.
3.3.10 Sample ALP Python Script

3.3.10.1 Remotely Enabled SER GPIO1 and GPIO3 Script

```python
## GPIO1_3_High_to_Low_Remote.py
##
## revision 1.0 June 6, 2017
##
## History
##
## 1.0 Inital Draft
##
#Makes 953 GPIO1 and GPIO3 high and low by remote enabling them

print "\n"
import time

# Define 954 and 953 Adresses
UB953 = 0x18 #953 SER Alias ID, check 0x5C on 954 for confirmation
UB954 = 0x60 #954 Device ID, check 0x00 on 954 for confirmation

# Alias ID of SER
board.WriteI2C(UB954,0x5C,0x18)

# Be sure to check Passthrough Settings in 0x58, BCC CONFIG
#board.WriteI2C(UB954,0x58,0x58)

# Port Select to enable writes to Port0
board.WriteI2C(UB954,0x4C,0x01)

# Enable GPIO0-3 as outputs on 953
board.WriteI2C(UB953,0x0E,0xF0)

# Remote Enable GPIO0-3 on 953
board.WriteI2C(UB953,0x0D,0xF0) #Linking 953 SER GPIOs to 954 BC GPIOs

for y in range(0,300):
    board.WriteI2C(UB954,0x6E,0x88) #Switch GPIO0 and GPIO1 to low or 0
    board.WriteI2C(UB954,0x6F,0x88) #Switch GPIO2 and GPIO3 to low or 0
    time.sleep(0.0000024)

    board.WriteI2C(UB954,0x6E,0x99) #Switch GPIO0 and GPIO1 to high or 1
    board.WriteI2C(UB954,0x6F,0x99) #Switch GPIO2 and GPIO3 to high or 1
    time.sleep(0.0000024)
```

This script defines two GPIOs (GPIO1 and GPIO3) on the DS90UB953-Q1EVM and enables them remotely. It switches the GPIOs between high and low states, demonstrating how to control GPIOs remotely on the DS90UB953-Q1EVM.
3.4 Troubleshooting ALP Software

3.4.1 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.

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

Find the correct profile under the Select a Daughter Board list, highlight the profile and press Add.
Select Ok and the correct profile should now be loaded.

**Figure 19. Add Correct Profile**

**Figure 20. Finish Setup**
3.4.2 ALP Does Not Detect the EVM

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

![ALP No Devices Error](image1)

Figure 21. 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.

![Windows 7, ALP USB2ANY Driver](image2)

Figure 22. Windows 7, ALP USB2ANY Driver
The software should start with only DS90UB96X in the *Devices* drop-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 23. ALP in Demo Mode](image.png)

Disable the demo mode by selecting the *Preferences* drop-down menu and unchecking *Enable Demo Mode*.

![Figure 24. ALP Preferences Menu](image.png)

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* drop-down menu.
3.4.3 Error When Opening ALP: One Instance of this Application Can Be Active

Figure 25 shows the error message that states *only one instance of this application can be active*. This occurs when ALP fails to shutdown correctly.

![Error Message](image)

Figure 25. Error that States One Instance of This Application Can Be Active in ALP

To fix the error, first click OK to continue. Access your task manager by pressing CTRL + Shift + ESC or CTRL + ALT + DELETE and selecting task manager. Then, go to the processes tab, select the MainGUI.exe *32 process, click end process shown in Figure 26.

![Task Manager](image)

Figure 26. Ending MainGUI.exe in Task Manager

You should now be able to open ALP normally. If the problem persists, restart your machine and follow the steps again.
3.4.4 Error Referring to USB2ANY Firmware Update

Figure 27 shows the error message that states that the connected USB2ANY does not have the correct firmware. To update the firmware, follow the steps below:

![USB2ANY Firmware Update](image)

**Figure 27. Error That States That USB2ANY Firmware Must be Updated**

**NOTE:** Newer versions of the USB2ANY API Library (USB2ANY.DLL) automatically check the firmware version running on the USB2ANY and update it to the required version automatically, when necessary. That is the preferred method.

In most cases, the USB2ANY Firmware Loader program is no longer required or recommended. It is provided only for legacy applications.
1. Run the **USB2ANY Firmware Loader** program. The installation program will normally create an icon for it on your desktop. By default, the program will be located in the bin folder of the TI USB2ANY SDK folder (for example, `C:\Program Files (x86)\TI USB2ANY SDK\bin`).

   The program dialog will look like this:

   ![USB2ANY Firmware Loader Program Dialog](image)

   **Figure 28. USB2ANY Firmware Loader Program Dialog**

2. Near the top of the dialog, you should see a list of available devices (there is usually only one device), with the first device highlighted.

3. If more than one device is displayed, select the desired device using the mouse or arrow keys. If you connect, re-connect, or change devices while the program is running, click the **Refresh List** button to update the displayed list.

4. By default, the program will show the recommended firmware version in the **Update to firmware version** drop-down list box. If you want to load an older version of firmware, click the down-arrow button to the right of the list box to display a list of other available versions.

5. Click the **Update Firmware** button.

6. A confirmation dialog box will display the firmware version selected for the update and prompt to verify that you want to proceed. Click the **Yes** button to continue.

7. A new dialog will appear. If the first line of text says **The USB2ANY is ready for download**, proceed to step 9 (that is, skip step 8).

8. The dialog will display instructions for preparing the USB2ANY for the firmware download. Follow the instructions, referring to **Figure 29** and **Figure 30** for locations of the BSL button (S1 switch) and USB connector. If the USB2ANY is in an enclosure, you will need to insert an implement (a paper clip works great) into the small hole to press the button.
9. When the Update Firmware button appears, the USB2ANY is ready to be updated with the new firmware. Click the Update Firmware button to start the update process.

10. The message Done! will appear in the status area when the update completes successfully.
11. Click the Close button to return to the previous dialog. If you want to update the firmware on another USB2ANY, go back to Step 2.
12. When finished updating firmware, click the Done button.

3.4.5 Identifying USB IDs and Corresponding Devices

If you connected both devices to the same machine and are having trouble identifying which device belongs to which USB port, close the USB2ANY/Aardvark Setup, and unplug one of the USB cables from the computer. ALP should automatically update which USB port is still in use. Take note of the remaining USB ID and note whether the 954EVM or 953EVM is connected to the port. Reconnect the other USB cable and assign the appropriate profile to each ID.
Alternatively, arbitrarily assign profiles to each of the USB IDs and open the device page that is assigned to the 953 by double clicking the name. Select the registers tab, click register 0x00 label I2C_DEVICE_ID, and read the value, shown in Figure 31.

![Figure 31. Verifying DS90UB953 Register](image)

The default I2C Device ID for the 953 is 0x30. If the value is 0x00 instead of 0x30, you need to switch the profiles for the assigned USB ID and re-verify the Device ID.

### 3.4.6 Set up File for Loading Scripts and Create Buttons for Each Script

ALP has a feature that allows the user to load multiple scripts by using one file and create buttons that run the scripts when clicked. To configure this file, go to the scripting tab in DS90UB954 device page. After navigating to the scripting tab, click Setup.

After clicking Add in the new window, ALP will bring up another separate window with Button Name and Script fields. Using the Browse button, navigate to the script you would like to add and double click the file. In the Button Name field, write in a name the script—note that this name will show up on the button that is created. For example, in Figure 32, the script P954_SETUP_A0_4G is named Setup_4G.

![Figure 32. Window for Setting up Scripts in ALP](image)

After adding every script with an appropriate name, click save as and save the setup file in an appropriate location. Whenever you open the program again, you can open this file and every script will be added to the setup window. When done saving and adding scripts, press OK. The buttons should be added to the right-hand side of the window under the Setup and Run buttons in the script tab.
### Additional Troubleshooting – Step-by-Step Guide

#### 3.5.1 EVM Equipment

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>SPECIFICATIONS</th>
<th>RECOMMENDED MODEL</th>
<th>PICTURE</th>
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<tbody>
<tr>
<td>DS90UB953-Q1EVM REV A1</td>
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<td></td>
<td></td>
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<tr>
<td>DS90UB954-Q1EVM REV A1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camera Sensor</td>
<td>1920p × 1080p</td>
<td>DS90UB953-DC1 (Featuring OVT10460)</td>
<td></td>
</tr>
<tr>
<td>DC Power Supply</td>
<td></td>
<td>HP E3610A (or any DC Power Supply capable of delivering 12 V)</td>
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<td>DACAR/FAKRA coax cable</td>
<td>1 – Male DACAR/ FAKRA coax to DACAR/ FAKRA coax cable</td>
<td>USB2ANY (optional) 3 – Jumper Wires: 1 blue, 1 green, and 1 yellow (colors do not matter)</td>
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<tr>
<td>USB2ANY (optional)</td>
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<td>USB2ANY</td>
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Table 1. Equipment (continued)

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<td>2 – Male USB to Mini USB cables</td>
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<td></td>
</tr>
<tr>
<td>Banana to Coaxial cable</td>
<td>1 – Male, red and black banana to male coax</td>
<td>(Alternatively, use two male banana to grabber wires, more information in step 5 of Section 2.4).</td>
<td></td>
</tr>
</tbody>
</table>

3.5.2 EVM Equipment Setup

1. Power ON the HP E3610A.
2. Verify that CC SET is not on which is indicated by the illuminated light next to CV.
3. Verify that RANGE is in 2-A mode which is indicated by the depressed RANGE button.
4. Use the Voltage knob to adjust the voltage to 12 V.
5. Power OFF the HP E3610A
6. Connect the red and black banana to coax cable from the + and – output of the HP E3610A, respectively, to the coax jack, J24, on the DS90UB954EVM labeled 12 V. Alternatively, use the red and black banana to grabber cables from the “+” and “-” output of the supply to pin 1 and 2, respectively, of J20, on the DS90UB954EVM labeled GND and VDD_EXT near the lower left side of the board.
7. Connect the DS90UB953-DC1 to the connector, J1, on the DS90UB953EVM labeled Daughter Card. Press firmly until card rests on level with the stands on the board.
8. Connect the FPD Link III cable from CN1 on the DS90UB954EVM to J11 on the DS90UB953EVM. Ensure there is a click when connecting the cable to the connectors.
9. Connect the Mini USB to USB cable from J5 on the DS90UB954EVM to the computer that will use Analog Launch Pad (ALP).
10. Connect the Mini USB to USB cable from J9 on the DS90UB953EVM to the computer that will use Analog Launch Pad (ALP).
11. On the DS90UB954EVM, ensure that all jumpers are correctly covering the headers highlighted in Figure 33.
12. On the DS90UB953EVM, ensure that jumpers are covering the headers as shown in Figure 34.

![Figure 34. DS90UB953-Q1EVM With Installed Jumpers](image_url)

13. Power ON the HP E3610A.

14. Verify that DS90UB953EVM is correctly powered by probing the banana jacks labeled PoC Voltage, VDD3V3, and VDD1V8 using a Digital Multi-meter (DMM). The voltages should approximately read ≥7 V, 3.3 V, and 1.8 V, respectively.

15. The setup should now look like what is shown in the Figure 35.
Figure 35. Test Setup
16. Ensure Analog Launch PAD (ALP) software is downloaded and installed correctly. One can download Analog Launch PAD from TI.com; note this requires a myTI Login. Steps for installation can be found in Section 3.3

17. Open the ALP software. If you receive an error message about running the device in demonstration mode consult Section 3.4.2. If you receive an error message about MainGUI.exe or having one instance of the application open at once, consult Section 3.4.3.

If you receive an error message about updating the USB2ANY firmware, consult Section 3.4.4.

18. Double click the Tools bar, then the USB2ANY/Aardvark Setup, remove any devices that are not the 954 or 953 profiles by selecting them and clicking remove.

**NOTE:** Be sure NOT to remove the USB ID or you will have to consult Section 3.4.2.

Then select the appropriate device profile for the appropriate USB port using the scrolling menu on the right and clicking add as shown in Figure 36.

![Figure 36. Setting up Device Profiles in ALP](image)

19. If you are having trouble identifying which USB ID corresponds to a connected device, consult Section 3.4.5.

### 3.5.3 Procedure

1. Download P954_SETUP_A0_4G.py, P954_A0_RX0_CSI_Enable.py, and ovt_1280_1080_30fps_REMOTE.py scripts. If ALP crashes at any point in this process, you do not need to rerun any of the scripts that you have verified are working.

2. Open the DS90UB954 device window by double clicking the profile and selecting to the scripting tab as shown in Figure 37.

![Figure 37. Navigating to DS90UB954 Scripting Tab in ALP](image)
3. If you would like to set up a file that loads all of the scripts and creates a button for running each script, consult Section 3.4.6. Otherwise, you can run scripts by clicking the Run button and navigating to their file location.

4. If you would like to place the scripts in the default ALP script folder, move them to the file location:

   \C:\Program Files (x86)\Texas Instruments\Analog LaunchPAD 1.56.0010

5. Verify there is successful local I2C communication that the script worked by going to the register tab, selecting register 0x00 labeled I2C_DEVICE_ID, and reading the value as shown in Figure 38. If the value is not 0x7A, then the correct profile has not been assigned to the correct USB2ANY ID. Consult Section 3.4.5 for more information.

   ![Figure 38. Reading I2C Device ID Within the Register Tab](image)

6. Run the P954_A0_RX0_CSI_Enable.py script.

7. Verify that the script worked by going to the information tab of the DS90UB954 and ensuring that the Pass Sts: displays Pass and Linked has a frequency listed like shown in Figure 39. In addition, be sure that D3, labeled Lock, and D15 label Pass, are illuminated on the DS90UB954EVM.

   ![Figure 39. Verifying Pass and Lock for DS90UB954 in ALP](image)

8. While still in the DS90UB954 device window, go to the scripting tab, and run ovt_1920_1080_30fps_REMOTE.py. This script will take as much as 12 seconds to finish running. Here we are activating the camera remotely from the deserializer (DS90UB954EVM).
9. Verify that the camera has been enabled navigating to the information tab on the DS90UB954, and checking to the horizontal and vertical parameters for the appropriate resolution defined by the camera. Figure 40 shows 1920 bytes and 1080 lines for the horizontal and vertical parameters, respectively. Also, verify that the DC power supply, the HP E3610, is sourcing more current.

![Figure 40. Verifying Camera Initialization in ALP](image)

4 Bill of Materials

<table>
<thead>
<tr>
<th>DESIGNATOR</th>
<th>QTY.</th>
<th>VALUE</th>
<th>DESCRIPTION</th>
<th>PACKAGE REFERENCE</th>
<th>PART NUMBER</th>
<th>MANUFACTURER</th>
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<td>CAP, CERM, 0.01 µF, 50 V, +/-5%, X7R, 0402</td>
<td>0402</td>
<td>C0402C103J5RAC T0</td>
<td>Kemet</td>
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<tr>
<td>C7</td>
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<td>0.033uF</td>
<td>CAP, CERM, 0.033 µF, 6.3 V, +/-10%, X5R, 0201</td>
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<td>GRM033R60J333K E01D</td>
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<td>C8</td>
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<td>GRM033R60J153K E01D</td>
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<td>C10, C13, C16, C54, C55, C62, C63</td>
<td>7</td>
<td>10uF</td>
<td>CAP, CERM, 10 µF, 6.3 V, +/-10%, X7R, 0805</td>
<td>0805_HV</td>
<td>GRM21BR70J106 KE76L</td>
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<td>C11, C14, C17</td>
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<td>0.1uF</td>
<td>CAP, CERM, 0.1 µF, 50 V, +/-20%, X7R, AEC-Q200 Grade 1, 0402</td>
<td>0402</td>
<td>CGA2B3X7R1H10 4M050BB</td>
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<td>C12, C15, C18</td>
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<td>CAP, CERM, 0.01 µF, 10 µF, +/-10%, X7R, AEC-Q200 Grade 1, 0201</td>
<td>0201_033</td>
<td>CGA1A2X7R1A10 3K030BA</td>
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<td>C19</td>
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<td>GRM033R60J223K E01D</td>
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<td>CAP, CERM, 0.1 µF, 6.3 V, +/-10%, X5R, 0201</td>
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<td>C0603X5R0J104K 030BC</td>
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<td>C21, C40, C41, C45, C46, C49, C60</td>
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<td>1uF</td>
<td>CAP, CERM, 1 µF, 16 V, +/-10%, X7R, 0603</td>
<td>0603</td>
<td>C1608X7R1C105K 080AC</td>
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<td>C22, C28, C34, C35</td>
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<td>CAP, CERM, 0.1 µF, 16 V, +/-5%, X7R, 0603</td>
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<td>0805_HV</td>
<td>0805YD225KAT2A</td>
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<td>C24, C31</td>
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<td>CAP, CERM, 220 pF, 50 V, +/-1%, C0G/NP0, 0603</td>
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<td>CAP, TA, 22uF, 25V, +/-20%, 0.7 ohm, SMD</td>
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<td>C27</td>
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<td>1uF</td>
<td>CAP, CERM, 1 µF, 50 V, +/-10%, X7R, AEC-Q200 Grade 1, 0805</td>
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<td>CGA4J3X7R1H105K125AB</td>
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<td>30pF</td>
<td>CAP, CERM, 30 pF, 100 V, +/-5%, C0G/NP0, 0603</td>
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<td>CAP, CERM, 0.47 µF, 10 V, +/-10%, X7R, 0805</td>
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<td>GRM188R71A475K125AC</td>
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<td>C33</td>
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<td>CAP, CERM, 2200 pF, 50 V, +/-10%, X7R, 0805</td>
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<td>0805_HV</td>
<td>CGA4J1X7S1C106K125AC</td>
<td>TDK</td>
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<td>C44, C50, C53, C57, C59</td>
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<td>CAP, CERM, 0.1 µF, 50 V, +/-10%, X7R, 0402</td>
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<td>C1005X7R1H104K050BB</td>
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<td>150060VS75000</td>
<td>Wurth Elektronik</td>
<td>eiSos</td>
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<td>D10, D11</td>
<td>2</td>
<td>Green</td>
<td>LED, Green, SMD</td>
<td>150060VS75000</td>
<td>Wurth Elektronik</td>
<td>eSos</td>
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<td>FB1</td>
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<td>60 ohm</td>
<td>Ferrite Bead, 60 ohm @ 100 MHz, 0.8 A, 0603</td>
<td>0603</td>
<td>BK1608HS600-T</td>
<td>Taiyo Yuden</td>
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<td>FID1, FID2, FID3</td>
<td>3</td>
<td>Fiducial mark. There is nothing to buy or mount.</td>
<td>Fiducial10-20</td>
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<tr>
<td>J1</td>
<td>1</td>
<td>Receptacle, 0.5mm, 30x2, Gold, SMT</td>
<td>Samtec_S5S-30-3_50-x-D-K</td>
<td>S5S-30-3.50-L-D-K</td>
<td>Samtec</td>
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<tr>
<td>J2, J4</td>
<td>2</td>
<td>Header, 100mil, 3x1, Gold, TH</td>
<td>Samtec_HTSW-103-07-G-S</td>
<td>i2C</td>
<td>Samtec</td>
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<tr>
<td>J3, J10</td>
<td>2</td>
<td>Header, 100mil, 4x2, Gold, TH</td>
<td>TSW-104-07-G-D</td>
<td>TSW-104-07-G-D</td>
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<td>J5</td>
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<td>Header, 100mil, 3x1, Gold, TH</td>
<td>Samtec_HTSW-103-07-G-S</td>
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<td>J6</td>
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<td>Samtec_HTSW-103-07-G-S</td>
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<tr>
<td>J7</td>
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<td>TE_5-146278-2</td>
<td>I2C_CLK_OUT</td>
<td>TE Connectivity</td>
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<td>J8</td>
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<td>Header, 100mil, 2x1, Tin, TH</td>
<td>TE_5-146278-2</td>
<td>MODE</td>
<td>TE Connectivity</td>
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<td>J9</td>
<td>1</td>
<td>Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMB</td>
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<td>USB Mini Type B</td>
<td>TE Connectivity</td>
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<td>J11</td>
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<td>Header, 2.54mm, 5x2, Gold, Black, TH</td>
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<td>TSW-105-07-F-D</td>
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<td>J12</td>
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<td>Header, 100mil, 2x2, Gold, TH</td>
<td>TSW-102-07-G-D</td>
<td>TSW-102-07-G-D</td>
<td>Samtec</td>
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<td>J13</td>
<td>1</td>
<td>Header, 100mil, 2x1, Tin, TH</td>
<td>TE_5-146278-2</td>
<td>Disable 1V8</td>
<td>TE Connectivity</td>
<td></td>
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<tr>
<td>J14</td>
<td>1</td>
<td>Standard Banana Jack, Uninsulated, 8.9mm</td>
<td>Keystone575-8</td>
<td>VDD1V8</td>
<td>Keystone</td>
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<td>DESIGNATOR</td>
<td>QTY.</td>
<td>VALUE</td>
<td>DESCRIPTION</td>
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<td>J15</td>
<td>1</td>
<td>Header, 100mil, 2x1, Tin, TH</td>
<td>TE_5-146278-2</td>
<td>Enable PoC</td>
<td>TE Connectivity</td>
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<tr>
<td>J16</td>
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<td>Connector, HF, 50 Ohm, TH</td>
<td>Rosenberger_59S10H-40ML5-Z</td>
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<td>J17</td>
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<td>Header, 100mil, 2x1, Tin, TH</td>
<td>TE_5-146278-2</td>
<td>Disable 3V3</td>
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<tr>
<td>J18</td>
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<td>Standard Banana Jack, Uninsulated, 8.9mm</td>
<td>Keystone575-8</td>
<td>GROUND</td>
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<tr>
<td>J19</td>
<td>1</td>
<td>Standard Banana Jack, Uninsulated, 8.9mm</td>
<td>Keystone575-8</td>
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<td>L1, L2, L3</td>
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<td>1000 ohm</td>
<td>Ferrite Bead, 1000 ohm @ 100 MHz, 0.4 A, 0603</td>
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<td>330 ohm</td>
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<td>L6, R4, R5</td>
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<td>RES, 0, 5%, 0.1 W, 0603</td>
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<td>R1</td>
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<td>RES, 0, 5%, 0.05 W, 0201</td>
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<tr>
<td>R3, R29</td>
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<td>RES, 10.0 k, 0.5%, 0.063 W, 0402</td>
<td>CRCW040210K0DF</td>
<td>Vishay-Dale</td>
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<tr>
<td>R4</td>
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<td>RES, 4.02 k, 1%, 0.1 W, 0603</td>
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<td>4.7k</td>
<td>RES, 4.7 k, 5%, 0.063 W, 0402</td>
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<td>RES, 402, 1%, 0.1 W, 0603</td>
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<td>R14, R17</td>
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<td>RES, 33 ohm, 5%, 0.063W, 0402</td>
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<td>R15</td>
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<td>RES, 1.2 M, 5%, 0.1 W, 0603</td>
<td>CRCW06031M20J</td>
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<td>R20</td>
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<td>CRCW0603402RF</td>
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<tr>
<td>R27</td>
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<td>1.00k</td>
<td>RES, 1.00 k, 1%, 0.063 W, 0402</td>
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<td>CRCW040240K2F</td>
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<td>Switch, Tactile, SPST-NO, 0.05A, 12V, SMT</td>
<td>SW_TL1015AF160QG</td>
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<td>Switch, Normally open, 2.3N force, 200k operations, SMD</td>
<td>KSR</td>
<td>KSR221GLFS</td>
<td>C and K Components</td>
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<td>SH-J1, SH-J2, SH-J3</td>
<td>3</td>
<td>1x2</td>
<td>Shunt, 100mil, Gold plated, Black</td>
<td>SNT-100-BK-G</td>
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<td>FPD-Link III SerDes with CSI-2 interfaces for 2.3MP/60fps camera, RH80032P (VQFN-32)</td>
<td>RHB00032P</td>
<td>DS90UB953QHBQ1</td>
<td>Texas Instruments</td>
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<td>U2</td>
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<td>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 &amp; no Sb/Br)</td>
<td>DCA00190A_N</td>
<td>TCA9406DCUR</td>
<td>Texas Instruments</td>
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<tr>
<td>U3</td>
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<td>ESD-Protection Array for High-Speed Data Interfaces, 4 Channels, -40 to +85 degC, 6-pin SON (DRY), Green (RoHS &amp; no Sb/Br)</td>
<td>DRY0006A</td>
<td>TPD4E004DRYR</td>
<td>Texas Instruments</td>
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<td>U4</td>
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<td>500mA, Low Quiescent Current, Ultra-Low Noise, High PSRR Low-Dropout Linear Regulator, DRB0008A</td>
<td>DRB0008A</td>
<td>TPS73533DRBR</td>
<td>Texas Instruments</td>
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<td>U5</td>
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<td>25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 8-pin QFP (PN), Green (RoHS &amp; no Sb/Br)</td>
<td>PN0080A_N</td>
<td>MSP430F5529IPN</td>
<td>Texas Instruments</td>
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<td>ULTRA LOW-NOISE, 250-mA LINEAR REGULATOR FOR RF AND ANALOG CIRCUITS REQUIRES NO BYPASS CAPACITOR, DDB0005A</td>
<td>DBV0005A</td>
<td>LP5907MFX-1.8/NOPB</td>
<td>Texas Instruments</td>
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<td>Ultra Low-Noise, 500-mA Linear Regulator for RF and Analog Circuits - Requires No Bypass Capacitor, DRV0006A (WSON-6)</td>
<td>DRV0006A</td>
<td>LP5912-1.8DRVR</td>
<td>Texas Instruments</td>
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<td>Synchronous Buck Regulator for 650mA Space Constraint Applications, DSX0010A</td>
<td>DSX0010A</td>
<td>LMS36003CDSXRQ1</td>
<td>Texas Instruments</td>
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<td>Synchronous Buck Regulator for 650mA Space Constraint Applications, DSX0010A</td>
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<td>LMS3600AQDSXRQ1</td>
<td>Texas Instruments</td>
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<td>OSC, 50MHz, 1.8 to 3.3V, SMD</td>
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<td>ASDMB-50.000MHZ-LC-T</td>
<td>Abracon Corporation</td>
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<td>Crystal, 24 MHz, 18 pF, SMD</td>
<td>XTAL_ABM3</td>
<td>ABM3-24.000MHZ-D2Y-T</td>
<td>Abracon Corporation</td>
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Figure 41. DS90UB953-Q1EVM Schematic 1
Figure 42. DS90UB953-Q1EVM Schematic 2
Figure 43. DS90UB953-Q1EVM Schematic 3
Figure 44. DS90UB953-Q1EVM Schematic 4
Figure 45. DC-1 Daughter Card Schematic 1
Figure 46. DC-1 Daughter Card Schematic 2
Figure 47. DC-1 Daughter Card Schematic 3
6 Board Layout

The board layout for the DS90UB953-Q1EVM is shown in Figure 48 through Figure 59.
Figure 52. Signal Layer 1

Figure 53. Signal Layer 2
Figure 54. Signal Layer 3

Figure 55. Signal Layer 4
Figure 56. Bottom Layer PCB Layout

Figure 57. Bottom Overlay
Figure 58. Bottom Paste

Figure 59. Bottom Solder
7 Related Documentation

7.1 References

- DS90UB953-Q1
- DS90UB954-Q1
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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.

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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/lds/it_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/lds/it_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.
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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.
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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.
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