User's Guide

DS90UB95x-Q1 Serializer Evaluation Module

ABSTRACT

The Texas Instruments DS90UB95x-Q1EVM evaluation module (EVM) is a functional board design for evaluating the DS90UB953-Q1 FPD-Link III serializer, the DS90UB635-Q1 low-cost FPD-Link III serializer, and the TSER953 V^{3}Link serializer. This document provides necessary details for the evaluation, such as a brief product overview, quick-start guide, troubleshooting section, schematics, printed-circuit board (PCB) layout details, and bill of materials (BOM).

The DS90UB953-Q1, DS90UB635-Q1, and TSER953 serializers represent the next generation in FPD-Link III and V^{3}Link serializers and are 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, DS90UB635-Q1, and TSER953 feature advanced data protection and diagnostic features to support ADAS, autonomous driving, and industrial and medical imaging applications. Together with a companion deserializer, the chip delivers precise multi-camera sensor clock and sensor synchronization. For a full list of device characteristics, refer to the datasheet for each device.

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Trademarks

All trademarks are the property of their respective owners.

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.

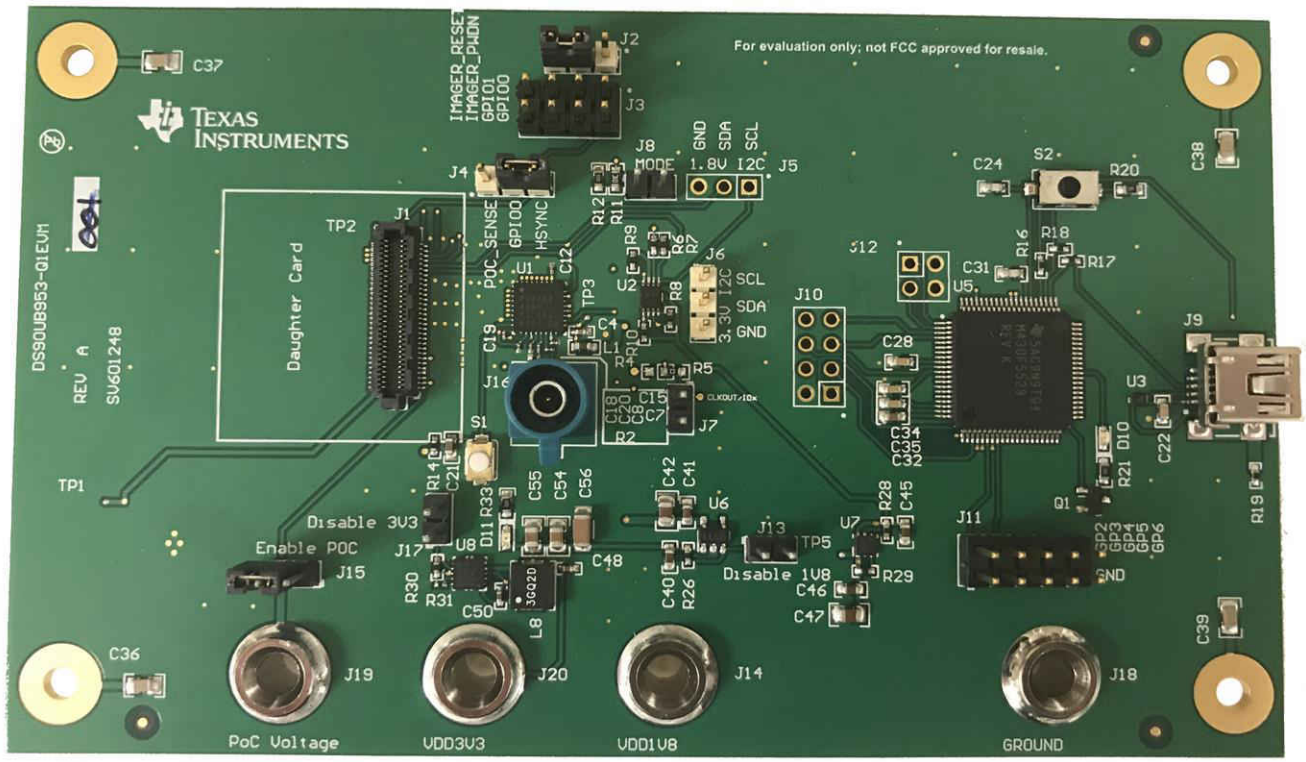


Figure 1-1. DS90UB95x-Q1EVM Top View

2 Quick Start Guide

The quick start guide is intended to get the DS90UB95x-Q1EVM operational with the minimum amount of information. See Section 3.5 in the troubleshooting section for in-depth, step-by-step instructions.

2.1 System Requirements

The major components of the DS90UB95x-Q1EVM are:

- DS90UB95x-Q1 Serializer Board
- 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 (or variant)
- One DACAR/FAKRA coax cable
- DC power supply for DS90UB954-Q1EVM (or variant) 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

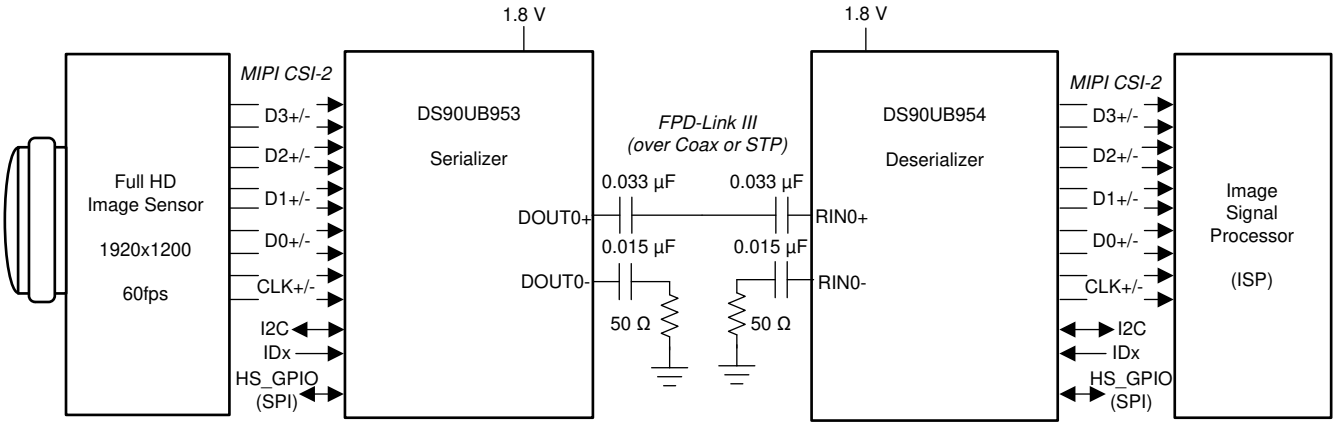


Figure 2-1. Typical Application Block Diagram Using DS90UB953-Q1 and DS90UB954-Q1 (or variant)

2.3 Major Components of DS90UB95x-Q1EVM

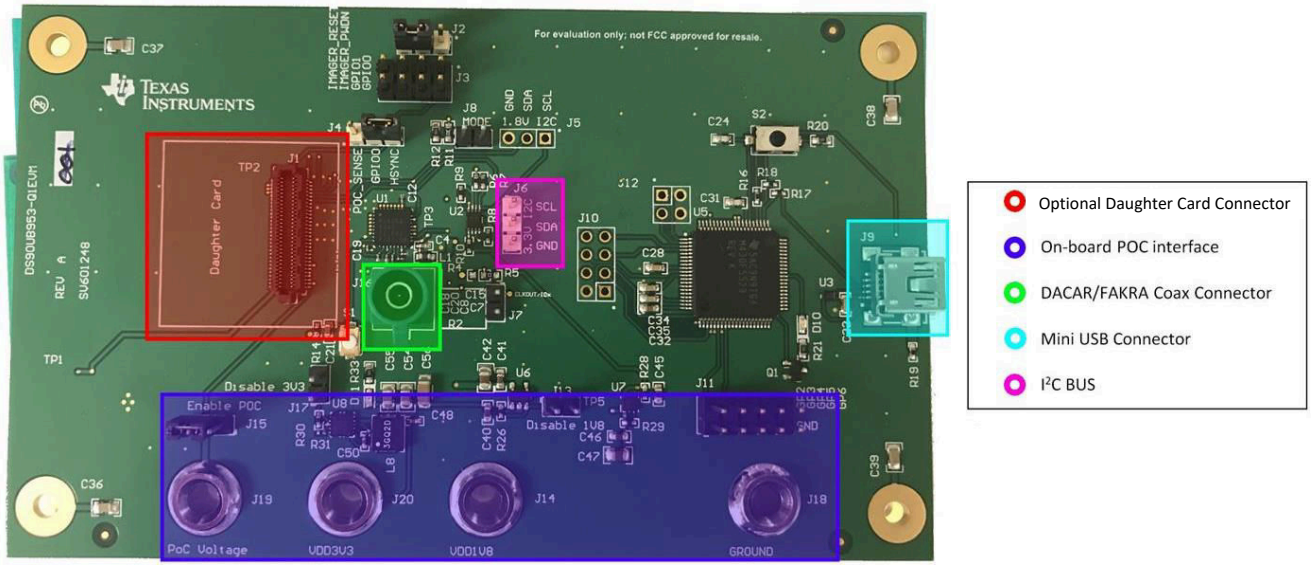


Figure 2-2. DS90UB95x-Q1EVM Major Components

2.4 Demo Instructions for DS90UB95x-Q1EVM

1. Ensure jumpers on J2, J4, and J15 for DS90UB95x-Q1EVM are installed as shown in Figure 2-3

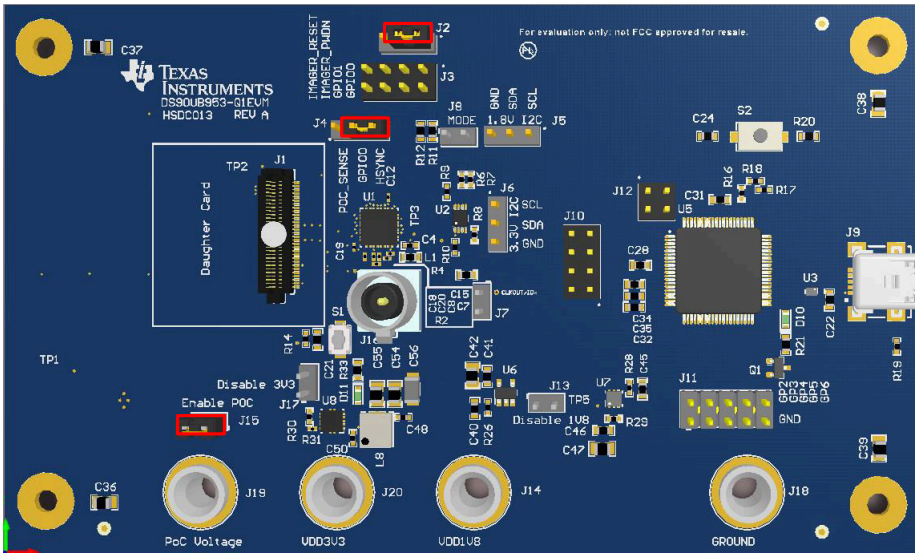


Figure 2-3. DS90UB95x-Q1EVM With Installed Jumpers

2. Ensure jumpers and switches for DS90UB954-Q1EVM (or variant) are configured like shown in Figure 2-4. See the *DS90UB954-Q1EVM User's Guide* (SNLU223) for further details.

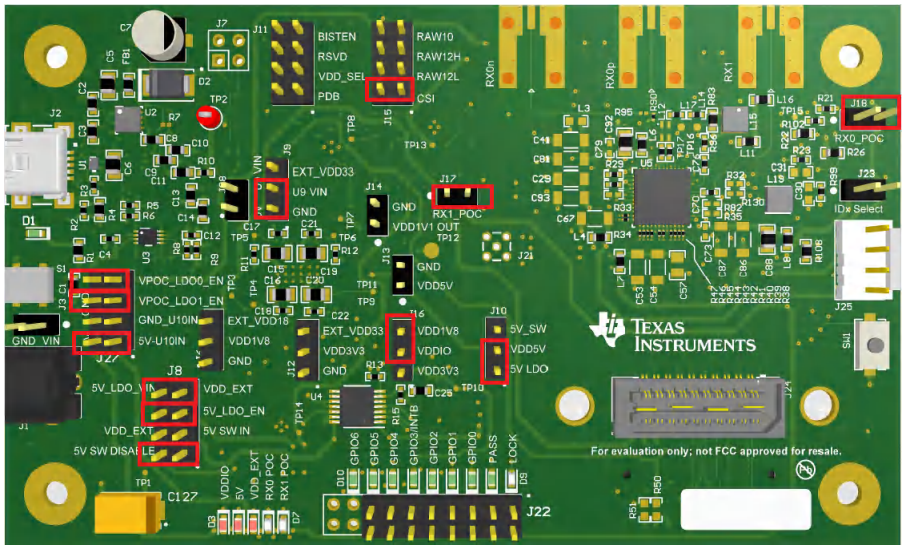


Figure 2-4. DS90UB954-Q1EVM (or variant) With Jumpers Highlighted

3. Connect the DACAR coax cable with FAKRA connector to RX0p from the DS90UB954-Q1EVM (or variant) to J16 of the DS90UB95x-Q1EVM
4. Connect a mini USB to J2 on the DS90UB954-Q1EVM (or variant) and J9 on the DS90UB95x-Q1EVM to a device with Analog LaunchPAD (ALP) software installed
5. Power the DS90UB954-Q1EVM (or variant) with 12 V through J1
6. Open ALP and assign the correct DS90UB953 and DS90UB954 (or variant) profiles to the appropriate USB IDs
7. The DS90UB95x-Q1EVM and DS90UB954-Q1EVM (or variant) should now be linked and have established connection. Go to information tab on the DS90UB954 (or variant) 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
8. Navigate back to the Scripting tab of the DS90UB954 (or variant) ALP profile and run the 953to954_patgen_YUV_1920x1080p-4Lanes-Working.py script to initialize a pattern generation test from the 953. The script may be found by clicking on the "Run PreDef Script" button. If the DS90UB954-Q1 (or variant) is not using an I2C address of 0x7A (8-bit form), the script should be modified to use the correct I2C address. Go back to the information tab of the DS90UB954-Q1 (or variant) and confirm the horizontal and vertical parameters read 3820 bytes and 1080 lines, respectively.
9. If there are any problems, consult Section 3.5 for an in-depth step-by-step guide to enable the pass and lock

2.5 Use With DS90UB935-Q1

The only modification required to use the DS90UB95x-Q1EVM to evaluate the DS90UB935-Q1 is to exchange the DS90UB953-Q1 with the DS90UB935-Q1. No additional rework is required.

3 Troubleshooting

3.1 Default Addresses

The default 9-bit I2C address of DS90UB95xis set to 0x30 (011 0000) using suitable resistor divider on ID[x] pin. Also, 8-bit I2C address of DS90UB954 (or variant) 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 work with any 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 3-1. It is powered through the USB port of computer.

Figure 3-1. USB2ANY

There are two methods to use the USB2ANY to communicate with the 953/954 EVMs. The first method is to simply connect the USB to Mini-USB cable to the USB port of your computer and the Mini-USB ports on the EVMs, J9 for the 953 EVM (see Figure 2-2) and J2 on the 954 EVM. If using the first method, skip to Section 3.3. The second method is to use the pinout of the USB2ANY. Figure 3-2 shows the USB2ANY pinout with the I2C pins highlighted. Typically, jumper wires are used to connect these to the 953/954 EVMs.

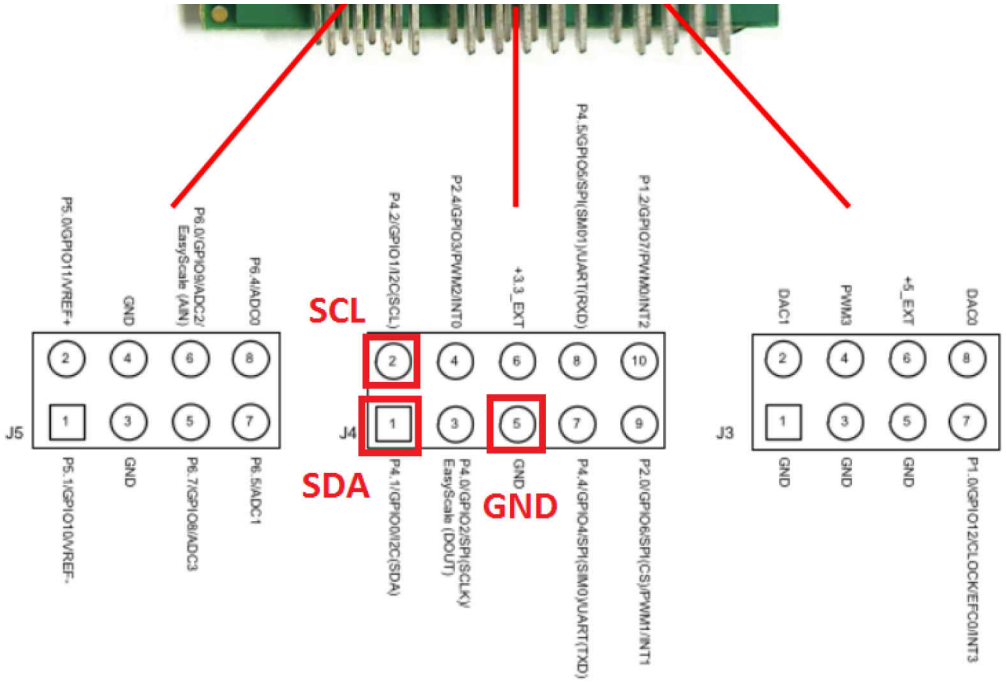


Figure 3-2. I2C Pinout of USB2ANY Connector

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

On the DS90UB95x-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, if the EVMs are configured to have 1.8 V I2C signal levels (see J5 on the 953 EVM and J16 on the 954 EVM), the USB2ANY must be configured to support the 1.8 V required by the DS90UB95x-Q1EVM and DS90UB954-Q1EVM (or variant). 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_lib.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 several FPD-Link parts. Specific screenshots may not be for the DS90UB954-Q1 or DS90UB953-Q1, however, the process remains the same for using the DS90UB95x-Q1EVM and DS90UB954-Q1EVM.

3.3.1 System Requirements

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

3.3.2 Download Contents

The 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 DS90UB95x-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 3-3. Launching ALP

The application should come up in the state shown in Figure 3-4. If it does not, see Section 3.4.

Under the Devices tab, click twice on the DS90UB95x to select the device to open the device profile and its associated tabs. If the incorrect profile is shown, consult Section 3.4.1.

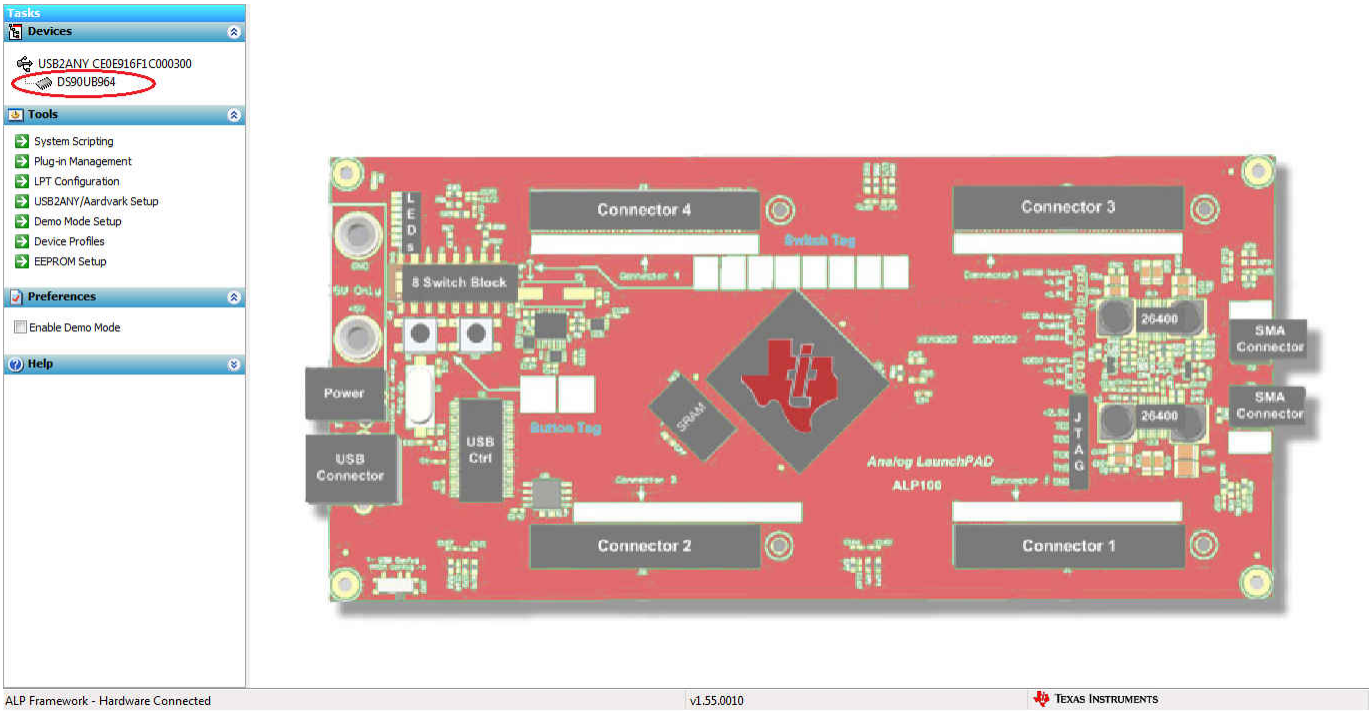


Figure 3-4. Initial ALP Screen

After selecting the DS90UB95x, the following screen shown in Figure 3-5 should appear.

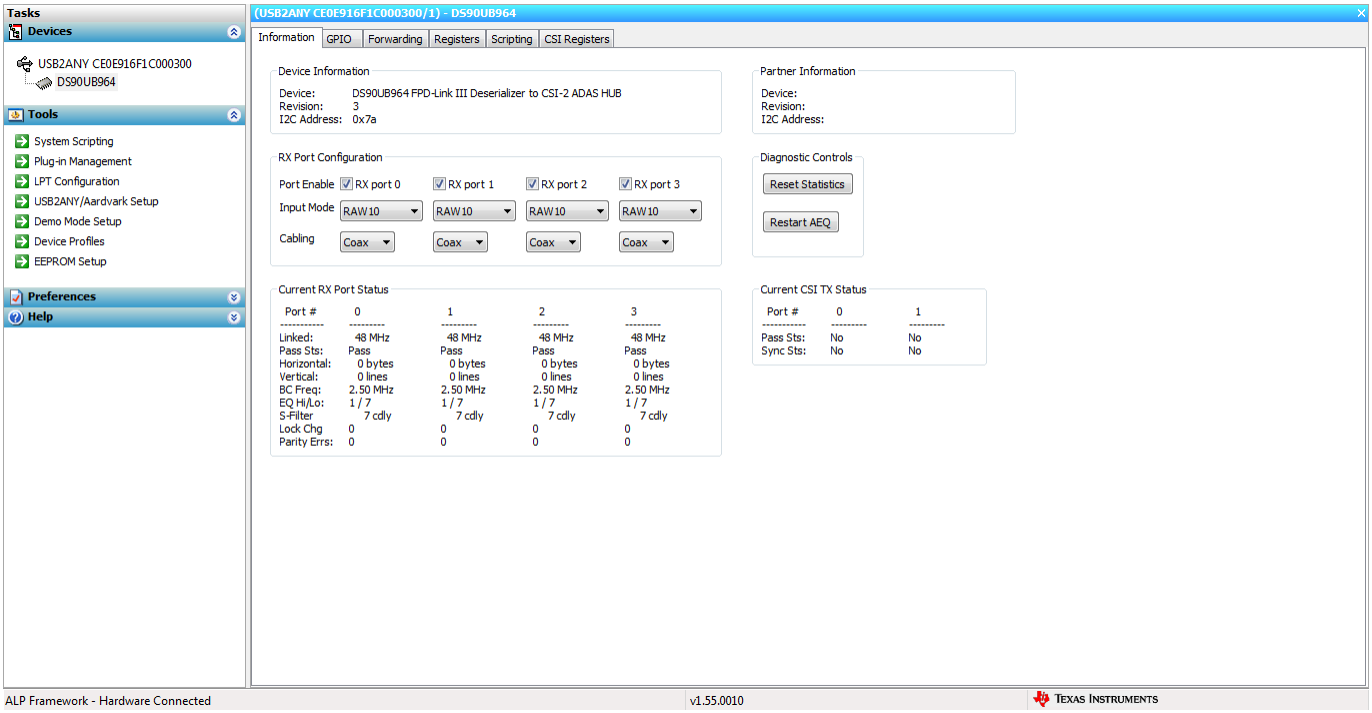


Figure 3-5. Follow-Up Screen

3.3.5 Information Tab

The Information tab is shown in Figure 3-6.

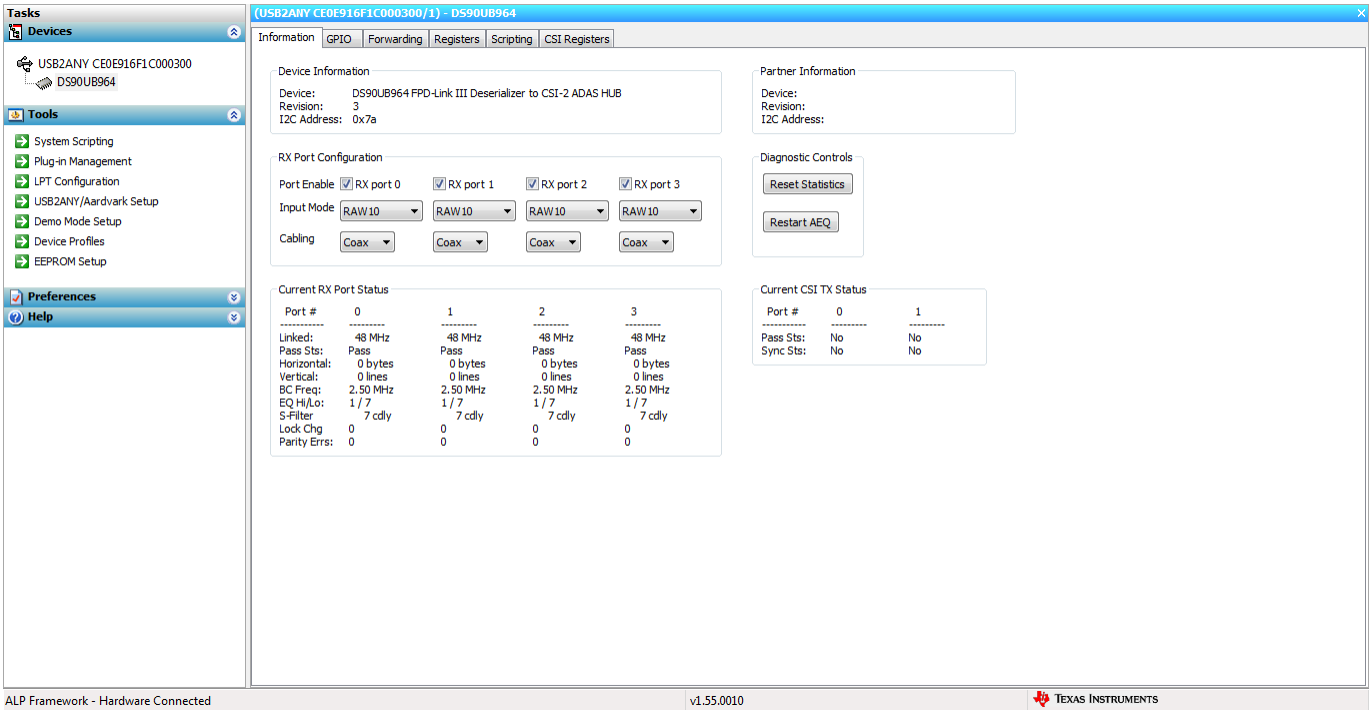


Figure 3-6. ALP Information Tab

3.3.6 Registers Tab

The Register tab is shown in Figure 3-7.

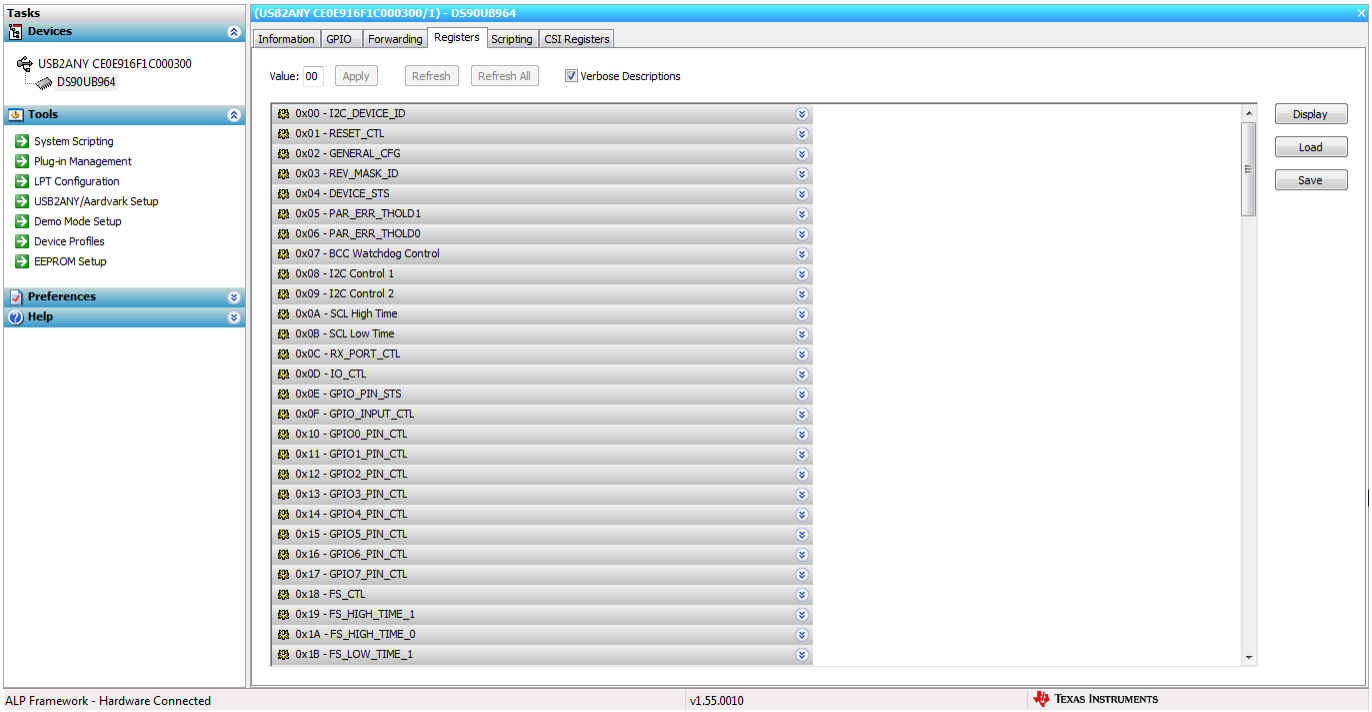


Figure 3-7. ALP Registers Tab

3.3.7 Registers Tab - Address 0x00 Selected

Figure 3-8 shows Address 0x00 selected. Note that the *Value:* box, 

, will now show the hex value of that register.

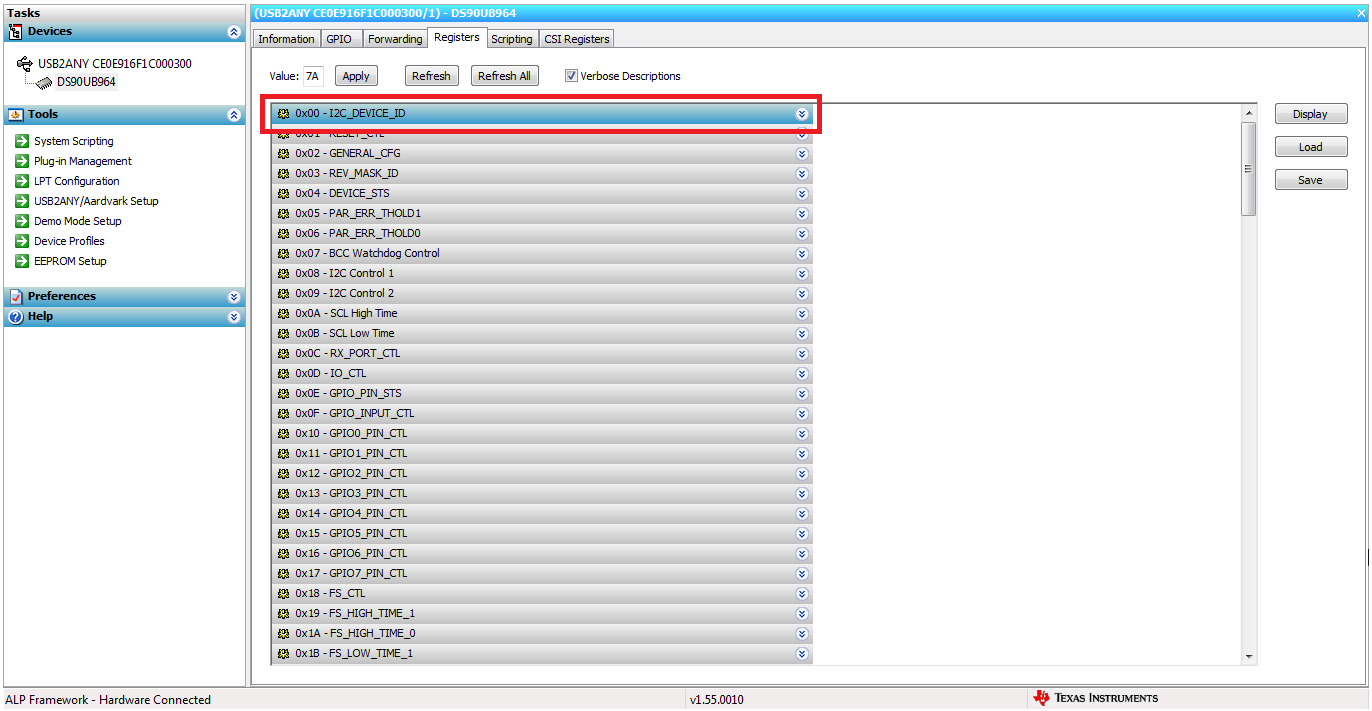


Figure 3-8. ALP Device ID Selected

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.

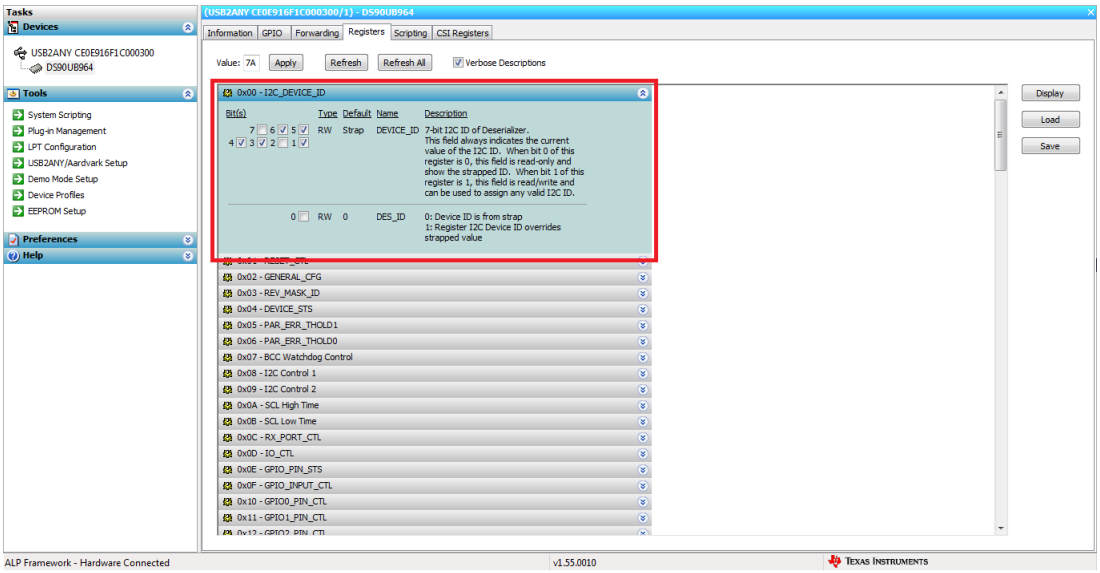
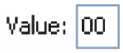


Figure 3-9. ALP Device ID Expanded

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.

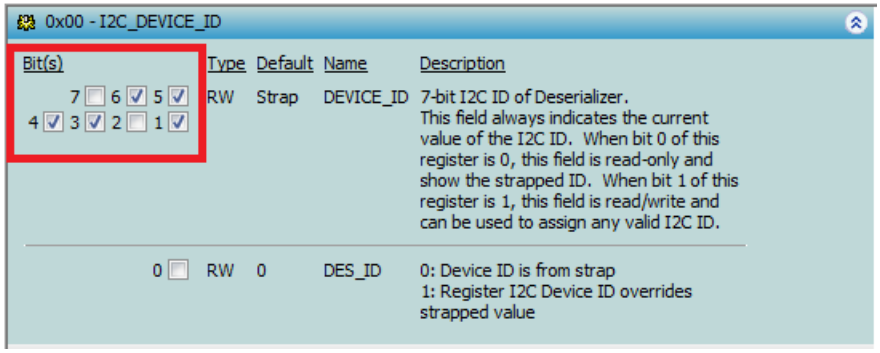


Figure 3-10. Writing to Register 0x00 by Checking Bits in ALP

The box toggles on every mouse click.

3.3.9 Scripting Tab

Figure 3-11 shows the 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. Commands may be written directly into the Scripting tab or may be run from a .py file using the "Run" button. Example scripts may be found using the "Run PreDef Script" button.

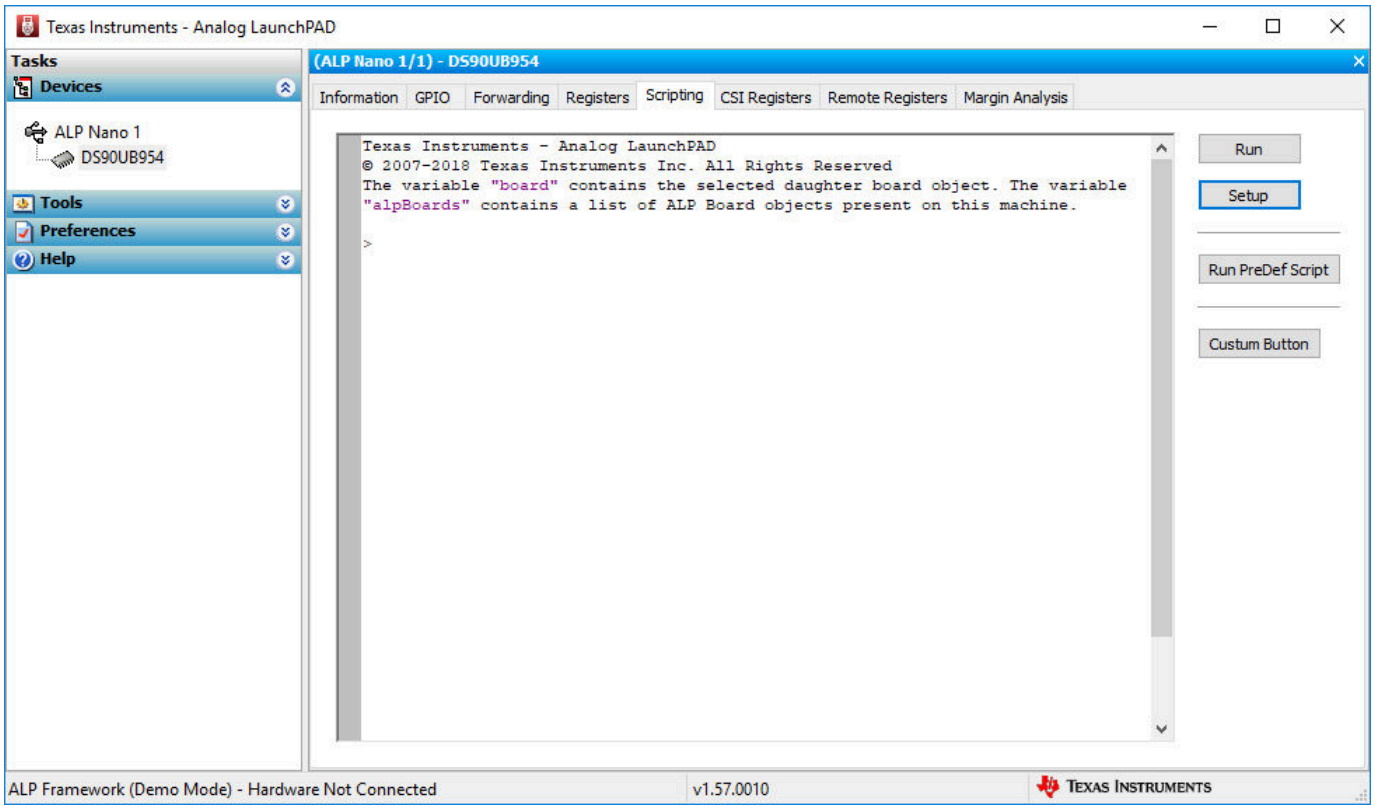


Figure 3-11. ALP Scripting Tab

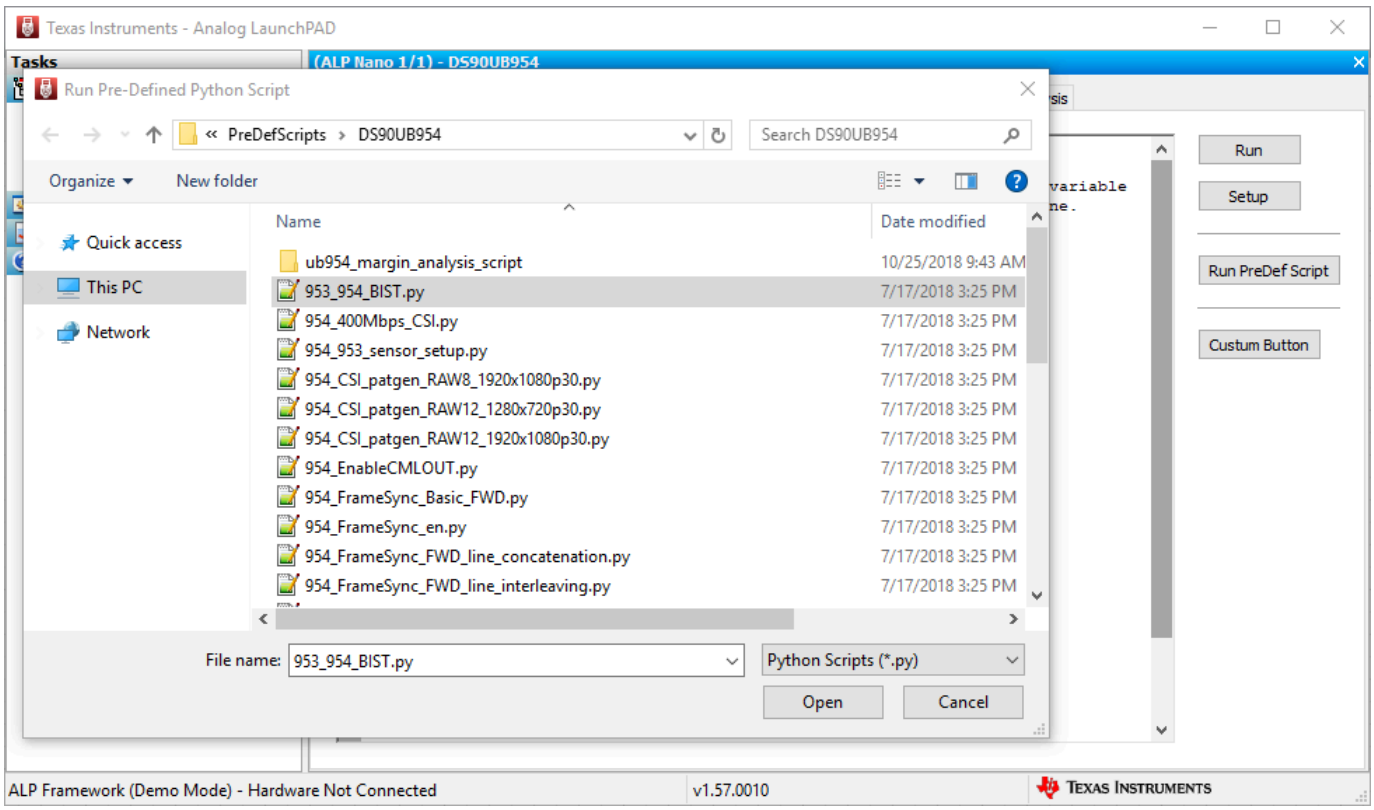


Figure 3-12. Pre-Defined Scripts

It is also possible to create custom buttons on the Scripting tab to run a desired script. To do so, click on the "Setup" button, then say "Add", and select the desired name and script. To make the button appear in future instances of ALP, click the "Set As Default" button.

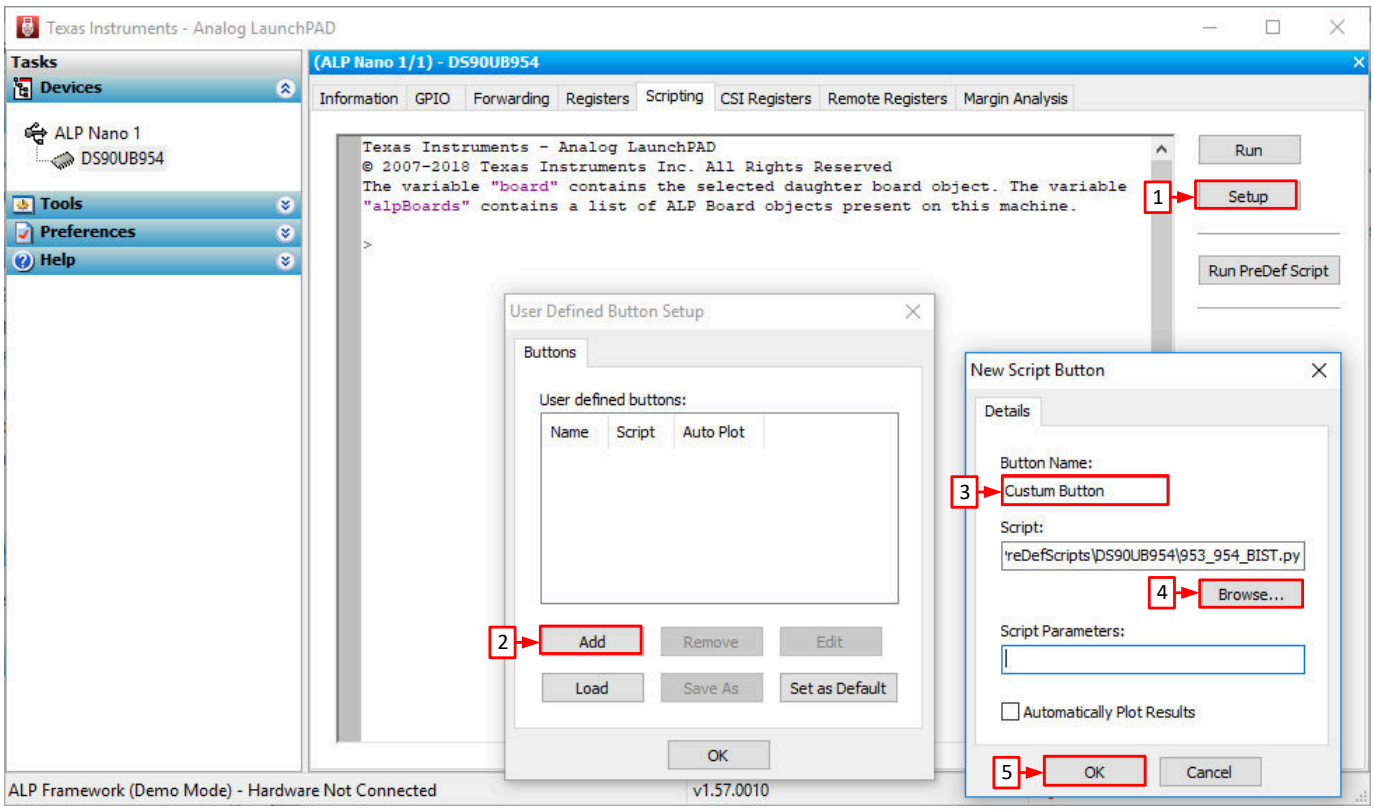


Figure 3-13. Custom Button Creation Step 1

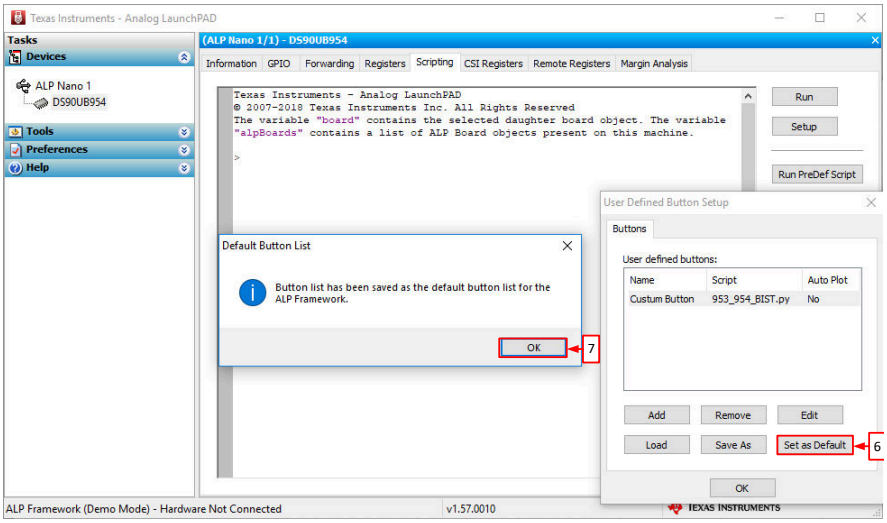


Figure 3-14. Custom Button Creation Step 2

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.

3.3.9.1 Example Functions

The following are Python functions commonly used to interact with FPD-Link devices.

3.3.9.1.1 Local I2C Reads/Writes

These functions will perform reads and writes only for the I2C assigned to board.devAddr, which by default will be the detected address for the DS90UB954-Q1 (or variant).

board.ReadReg(Register Address , # of Bytes) OR board.ReadReg(Register Address)	I2C Read Command • Accepts both hex & decimal inputs • Number of bytes will default to 1 if omitted • Ex: board.ReadReg(0x00) will return the value in Register 0 for the local device
board.WriteReg(Register Address , Data)	I2C Write Command • Accepts both hex & decimal inputs • Ex: board.WriteReg(0x01, 0x01) will set Register 0 to have a value of 1
board.devAddr = [I2C Address]	Assigns I2C address to be used for board.ReadReg and board.WriteReg commands • Accepts both hex & decimal inputs • Uses the 8-bit form of the I2C address • Can be used to shorten read/write commands • Ex: board.devAddress = 0x60 sets the board address to 0x60

3.3.9.1.2 General I2C Reads/Writes:

These I2C commands will work for any I2C address on the local bus and remote devices configured in the Target ID and Target alias registers of the device. The 8-bit form of I2C addresses should be used.

board.ReadI2C(Device Address, Register Address , # of Bytes) OR board.ReadI2C(Device Address, Register Address)	I2C Read Command • Accepts both hex & decimal inputs • Number of bytes will default to 1 if omitted • Ex: board.ReadI2C(0x60, 0x00) will return the value in Register 0 for the device with address 0x60 (8-bit form)
board.WriteI2C(Device Address, Register Address , Data)	I2C Write Command • Accepts both hex & decimal inputs • Ex: board.WriteI2C(0x60, 0x01, 0x01) will set Register 1 of the device with address 0x60 (8-bit form) to have a value of 1

3.3.9.1.3 I2C Reads/Writes with Multi-Byte Register Addresses

These I2C commands will work for any I2C address on the local bus and remote devices configured in the Target ID and Target alias registers of the device. The 8-bit form of I2C addresses should be used.

board.ReadI2C(Device Address, Register Address Byte 2,[Register Address Byte 1, # of Bytes]) OR board.ReadI2C(Device Address, Register Address Byte 2, [Register Address Byte 1])	I2C Read Command for devices with multi-byte register addresses • Accepts both hex & decimal inputs • Number of bytes will default to 1 if omitted • Ex: board.ReadI2C(0x60, 0x30, [0x00]) will return the value in Register 0x3000 for the device with address 0x60 (8-bit form)
board.WriteI2C(Device Address, Register Address Byte 2, [Register Address Byte 1, Data])	I2C Write Command for devices with multi-byte register addresses • Accepts both hex & decimal inputs • Number of bytes will default to 1 if omitted • • Ex: board.WriteI2C(0x60, 0x30, [0x01, 0x01]) will set Register 0x3000 of the device with address 0x60 (8-bit form) to have a value of 1

3.3.10 Scripting Tab

The Scripting tab is shown in Figure 3-15.

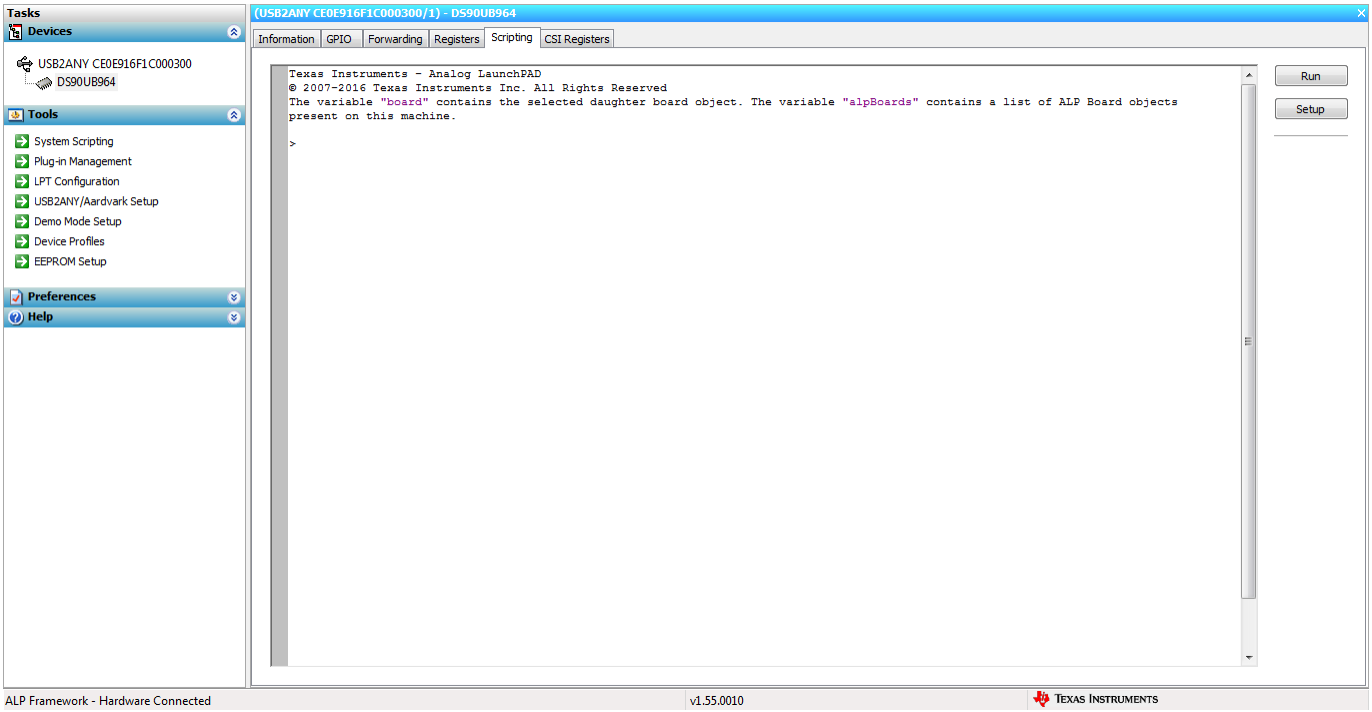


Figure 3-15. ALP Scripting Tab

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.

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.

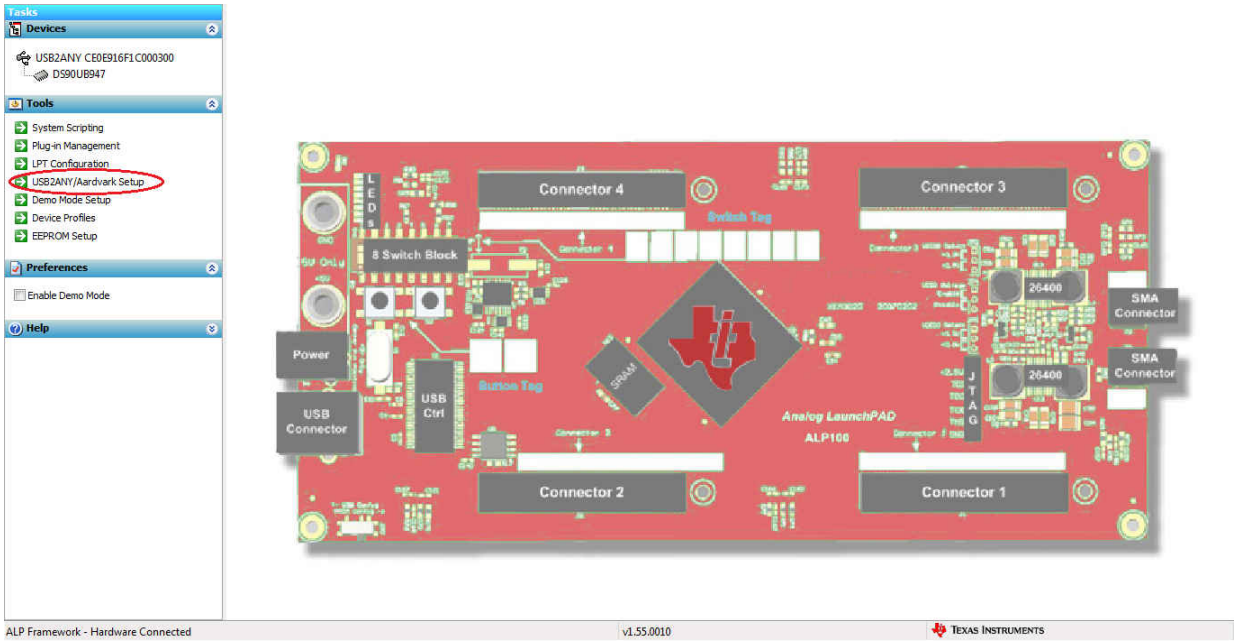


Figure 3-16. USB2ANY Setup

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

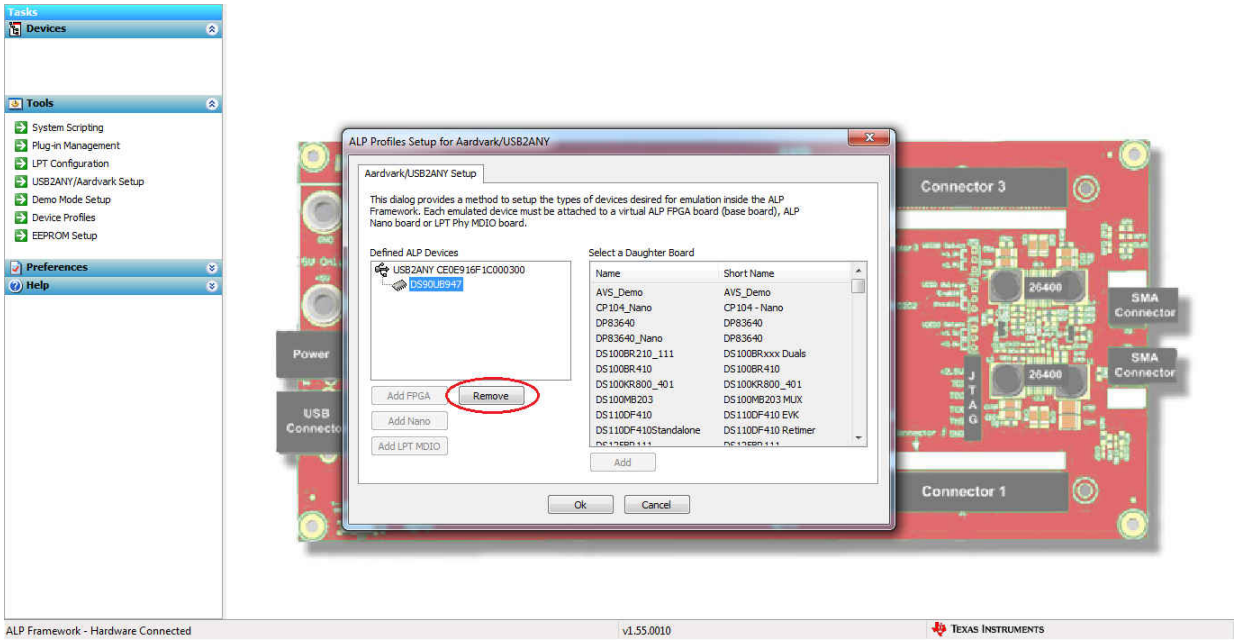


Figure 3-17. Remove Incorrect Profile

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

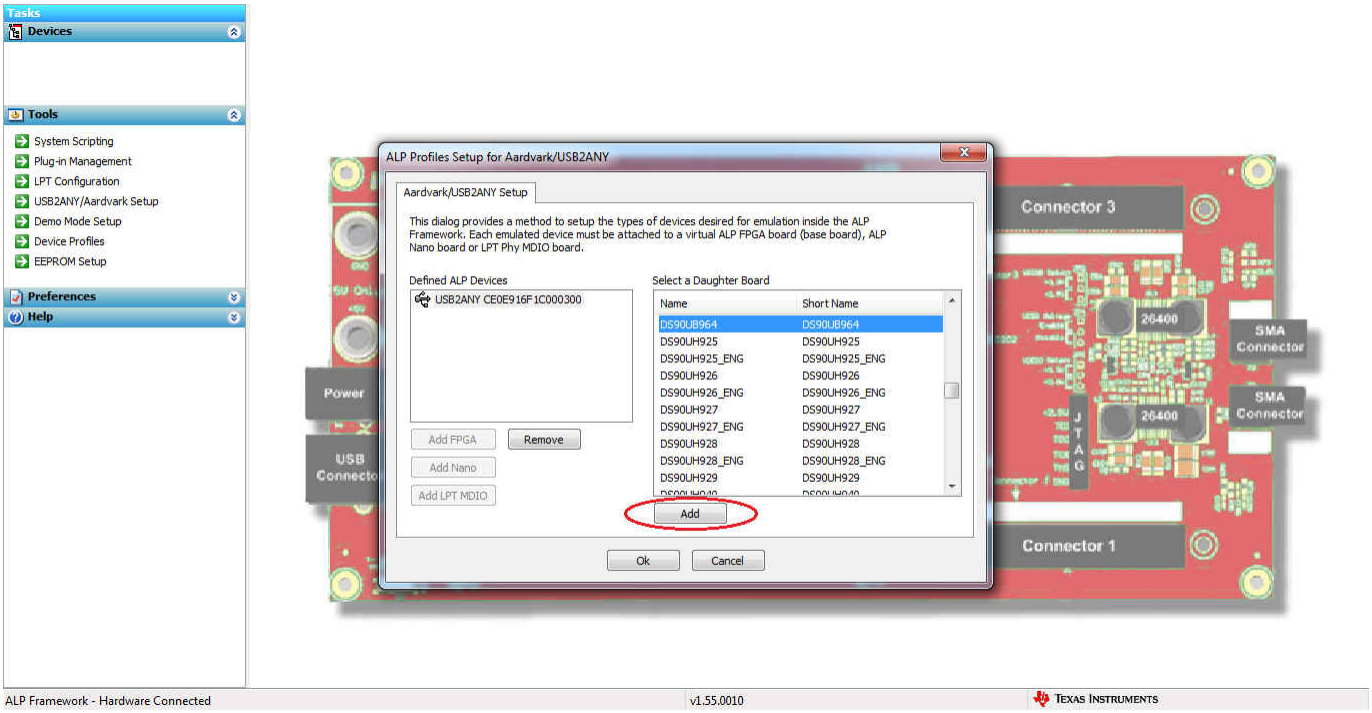


Figure 3-18. Add Correct Profile

Select Ok and the correct profile should now be loaded.

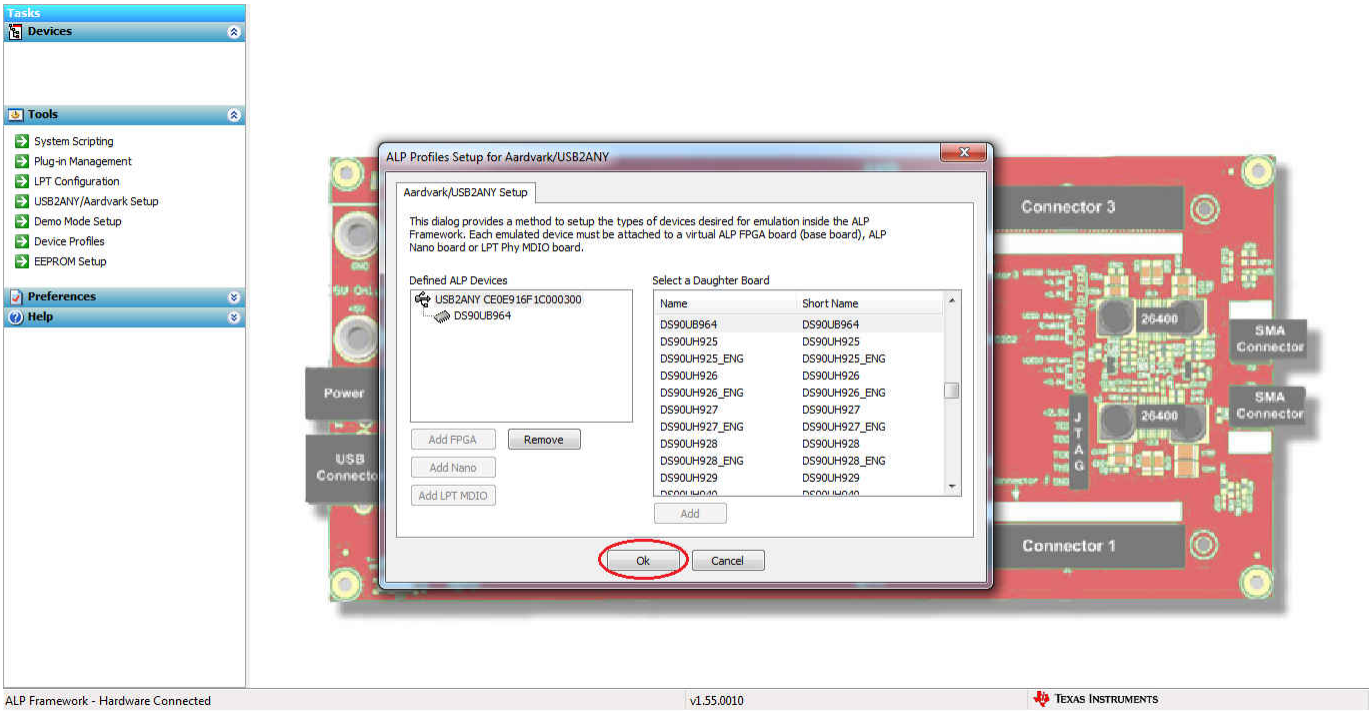


Figure 3-19. Finish Setup

3.4.2 ALP Does Not Detect the EVM

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

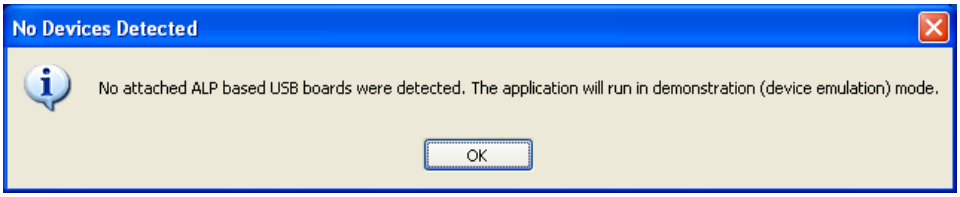


Figure 3-20. ALP No Devices Error

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.

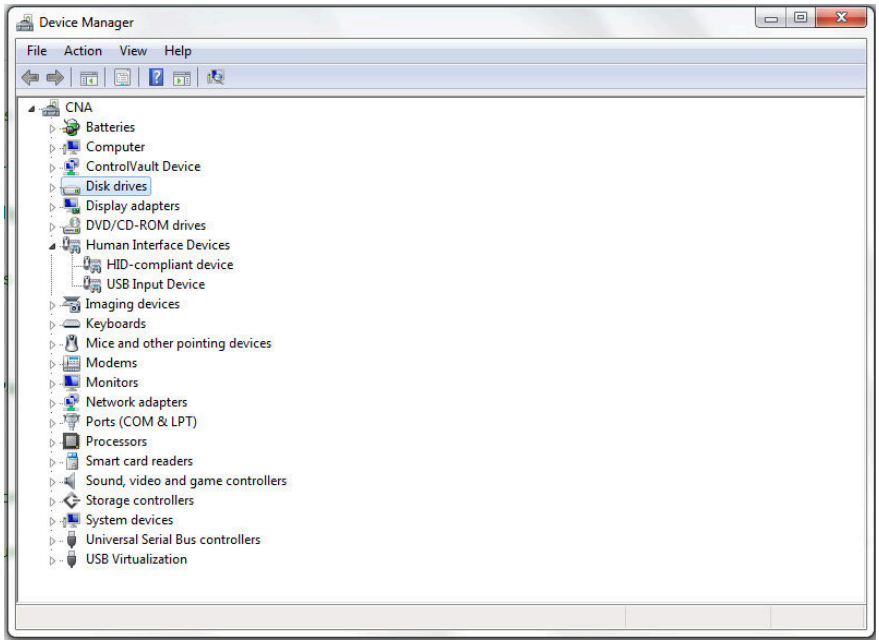


Figure 3-21. Windows 7, ALP USB2ANY Driver

The software should start with only *DS90UB95x* 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.

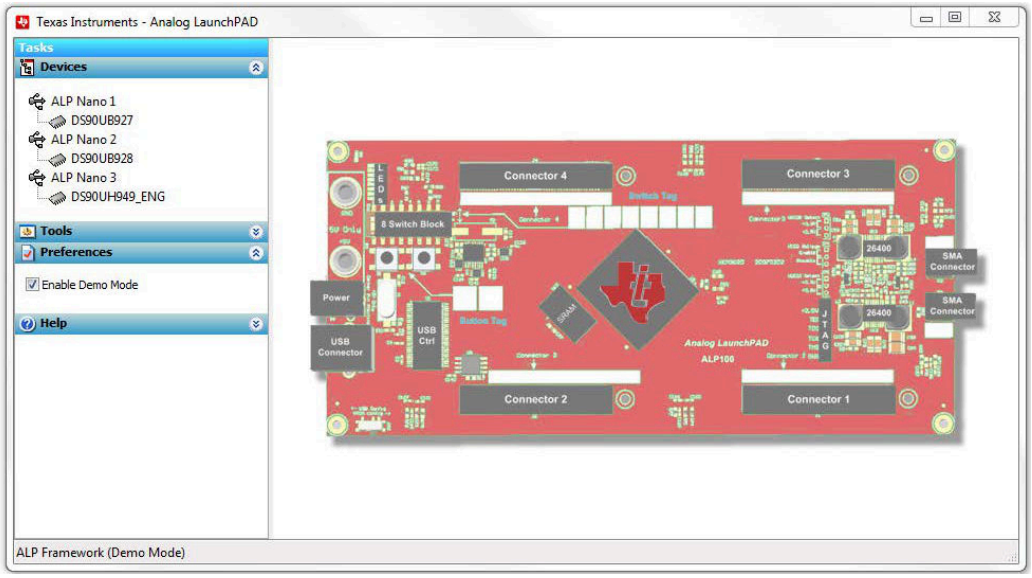


Figure 3-22. ALP in Demo Mode

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

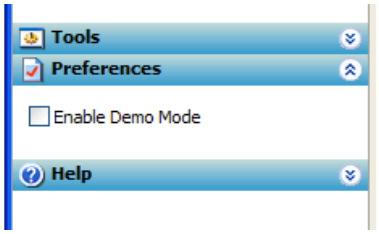


Figure 3-23. ALP Preferences Menu

After demo mode is disabled, the ALP software will poll the ALP hardware. The ALP software will update and have only *DS90UB95x* under the *Devices* drop-down menu.

3.4.3 Error When Opening ALP: One Instance of this Application Can Be Active

Figure 3-24 shows the error message that states *only one instance of this application can be active*. This occurs when ALP fails to shutdown correctly.

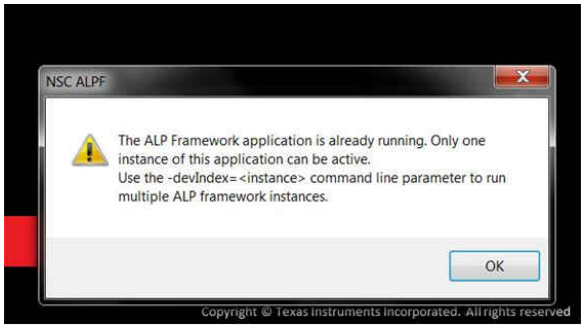


Figure 3-24. Error that States One Instance of This Application Can Be Active in ALP

To fix the error, 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 3-25.

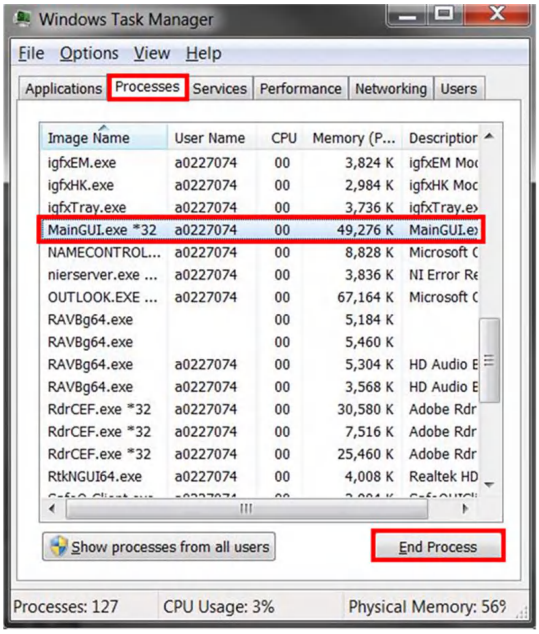


Figure 3-25. Ending MainGUI.exe in Task Manager

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 3-26 shows the error message that states that the connected USB2ANY does not have the correct firmware. To update the firmware, follow the steps below:

Figure 3-26. 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:

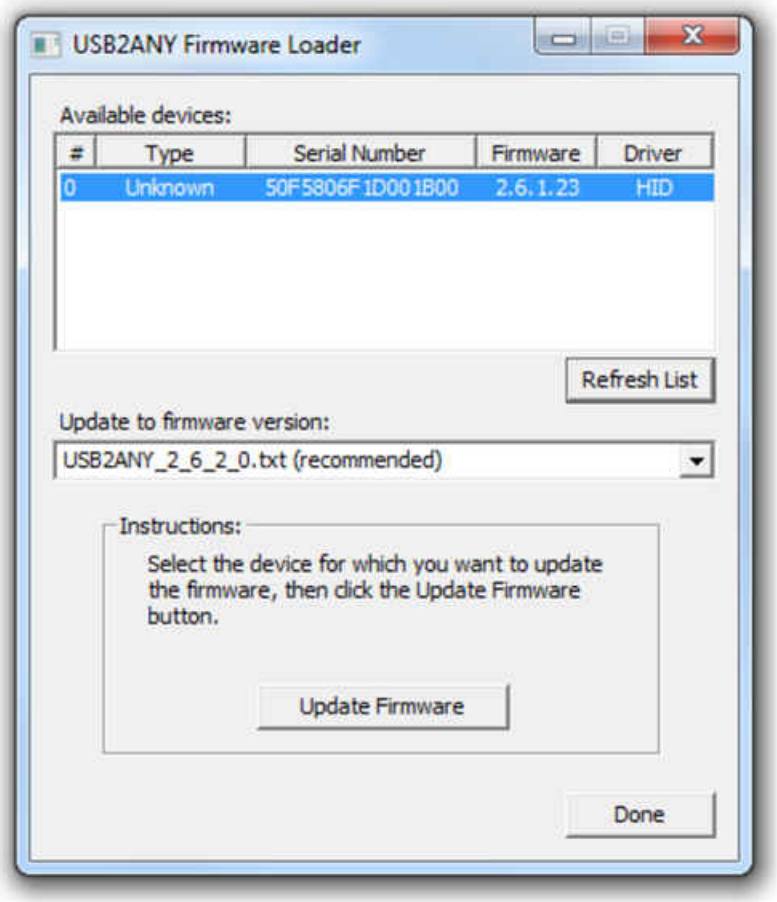


Figure 3-27. USB2ANY Firmware Loader Program Dialog

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 3-28 and Figure 3-29 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.

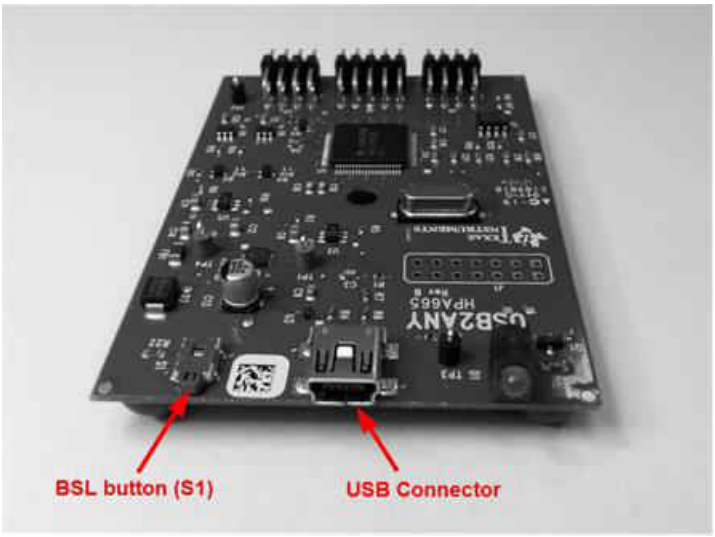


Figure 3-28. USB2ANY Without Enclosure

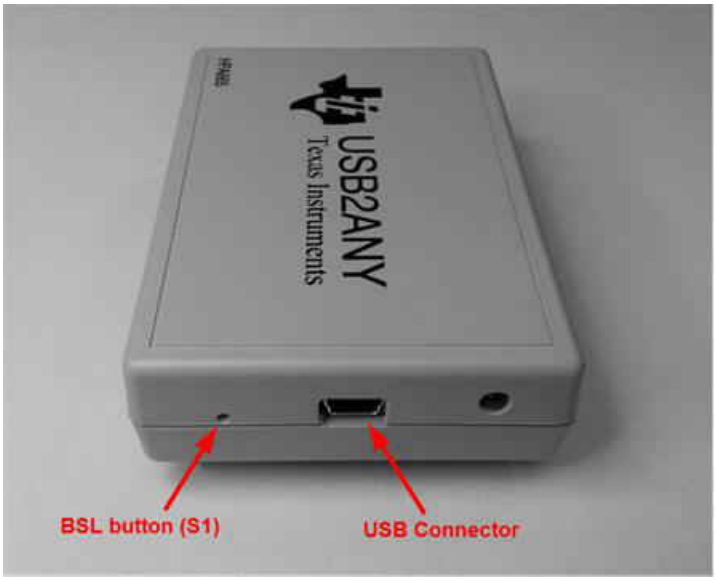


Figure 3-29. USB2ANY With Enclosure

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 3-30.

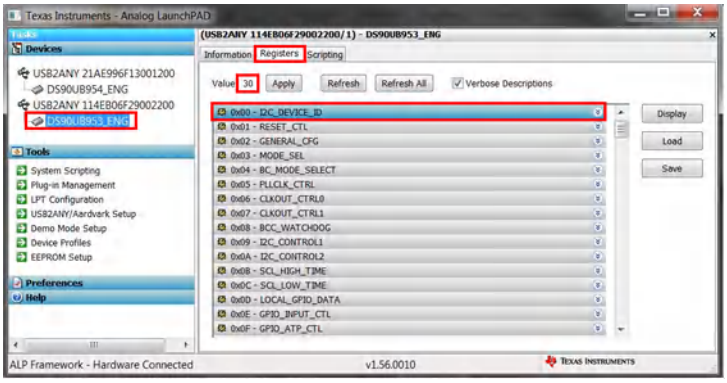


Figure 3-30. Verifying DS90UB95x Register

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 the scripting tab in DS90UB954 (or variant) 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 3-31, the script P954_SETUP_A0_4G is named Setup_4G.

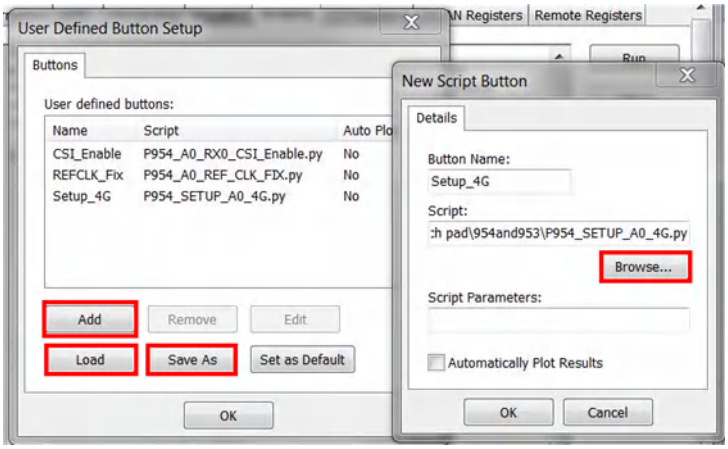


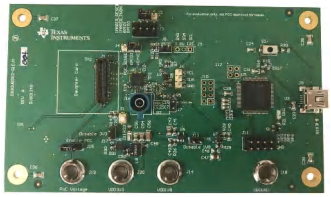
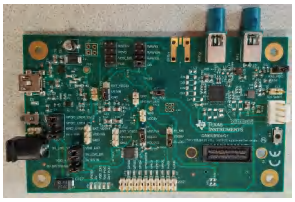
Figure 3-31. Window for Setting up Scripts in ALP

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.

3.5 Additional Troubleshooting – Step-by-Step Guide

3.5.1 EVM Equipment

Table 3-1. Equipment

EQUIPMENT	SPECIFICATIONS	RECOMMENDED MODEL	PICTURE
DS90UB95x-Q1EVM		REV A1	
DS90UB954-Q1EVM (or variant)		REV A1	
DC Power Supply		HP E3610A (or any DC Power Supply capable of delivering 12 V)	
DACAR/FAKRA coax cable	1 – Male DACAR/ FAKRA coax to DACAR/ FAKRA coax cable		
USB2ANY (optional)	3 – Jumper Wires: 1 blue, 1 green, and 1 yellow (colors do not matter)	USB2ANY	
USB to Mini USB Cables	2 – Male USB to Mini USB cables		
Banana to Coaxial cable	1 – Male, red and black banana to male coax	(Alternatively, use two male banana to grabber wires, more information in step 5 of Section 2.4).	

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 (or variant) 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 (or variant) labeled GND and VDD_EXT near the lower left side of the board.
7. Connect the FPD Link III cable from CN1 on the DS90UB954EVM (or variant) to J11 on the DS90UB953EVM. Ensure there is a click when connecting the cable to the connectors.
8. Connect the Mini USB to USB cable from J5 on the DS90UB954EVM (or variant) to the computer that will use Analog Launch Pad (ALP).
9. Connect the Mini USB to USB cable from J9 on the DS90UB953EVM to the computer that will use Analog Launch Pad (ALP).

10. On the DS90UB954EVM (or variant), ensure that all jumpers are correctly covering the headers highlighted in Figure 3-32.

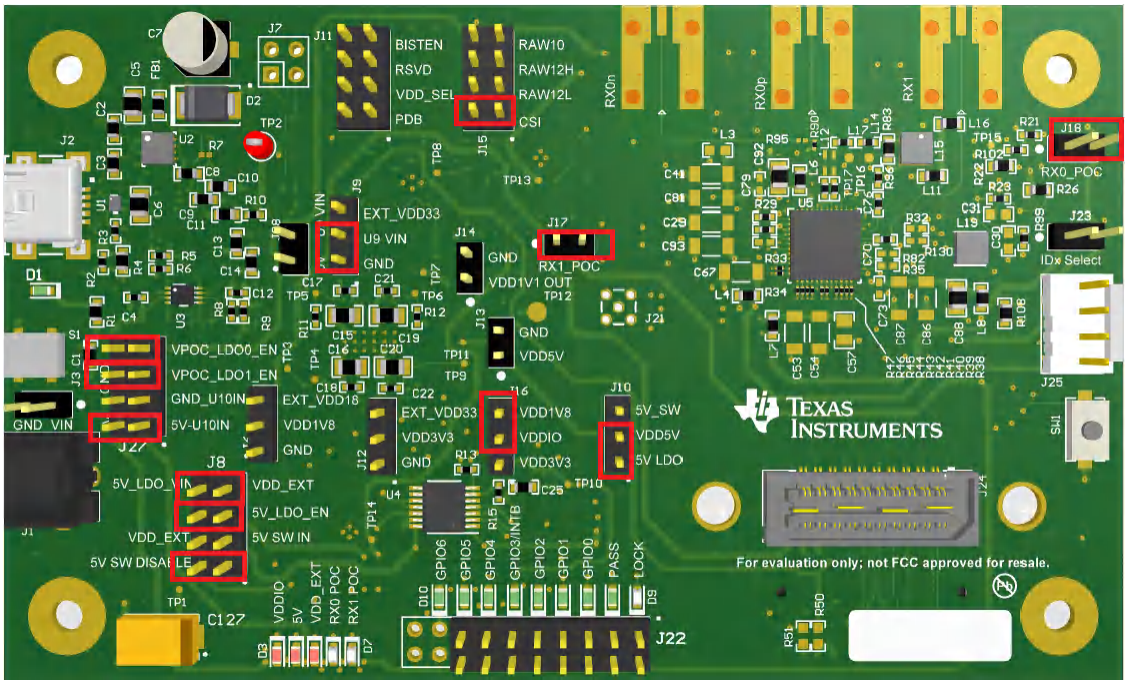


Figure 3-32. DS90UB954-Q1EVM (or variant) With Highlighted Jumpers

11. On the DS90UB953EVM, ensure that jumpers are covering the headers as shown in Figure 3-33.

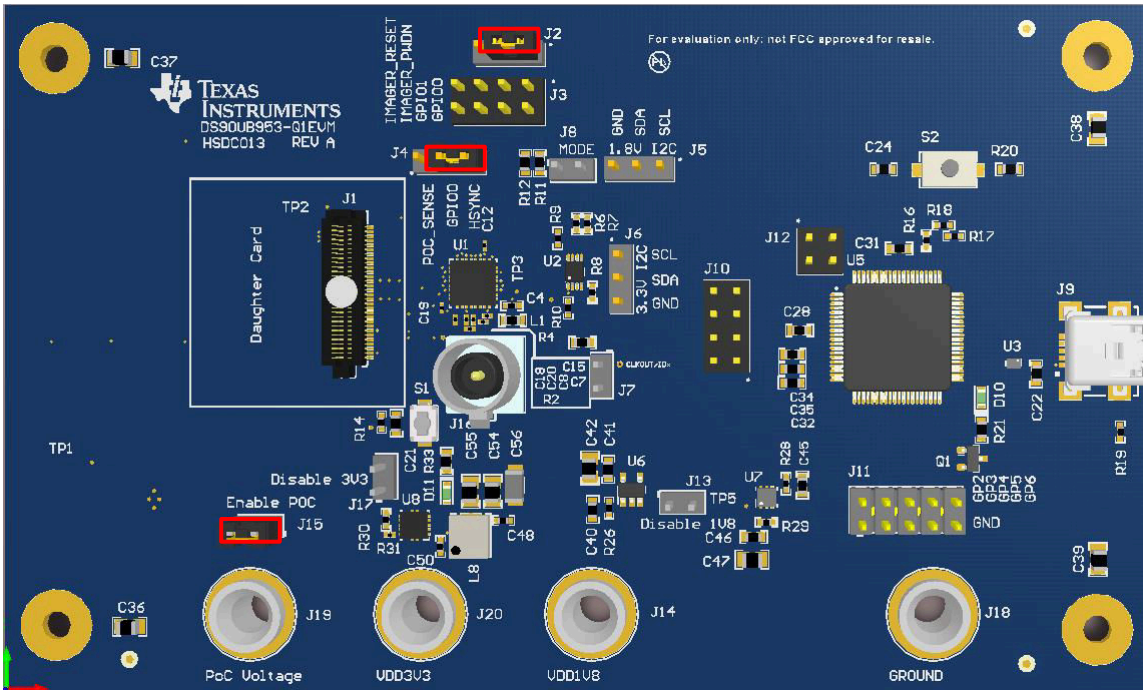


Figure 3-33. DS90UB95x-Q1EVM With Installed Jumpers

12. Power ON the HP E3610A.
13. 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.

14. The setup should now look like what is shown in the Figure 3-34.

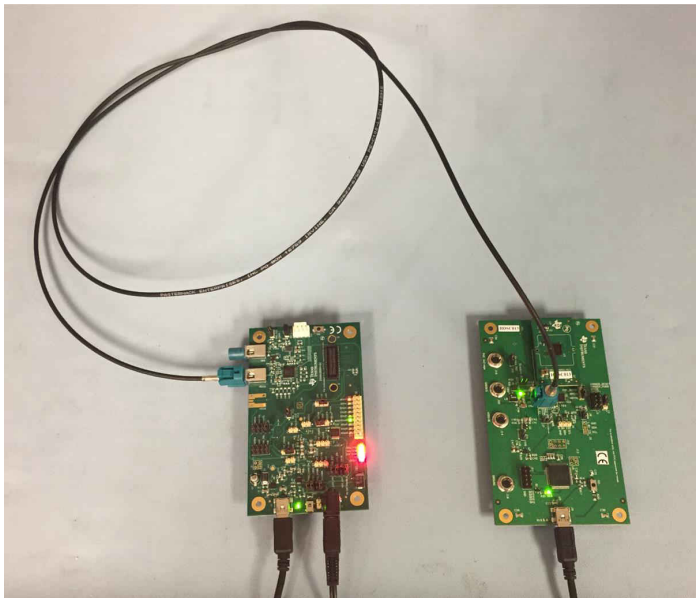


Figure 3-34. Test Setup

15. 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
16. 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.
17. 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 3-35.

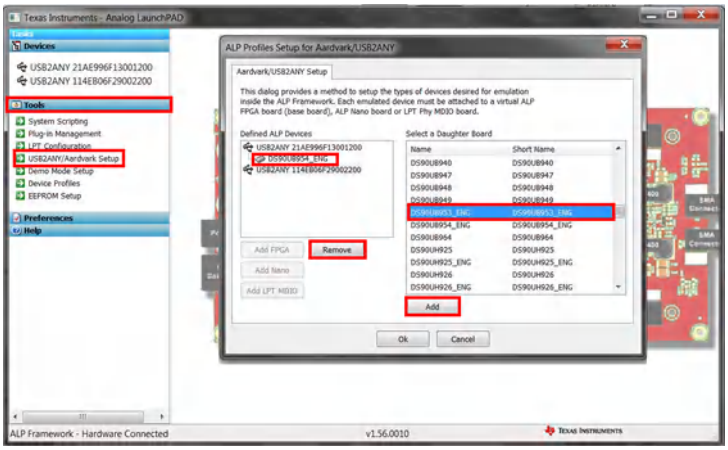


Figure 3-35. Setting up Device Profiles in ALP

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

3.5.3 Procedure

1. Open the DS90UB954 (or variant) device window by double clicking the profile and selecting to the scripting tab as shown in Figure 3-36.

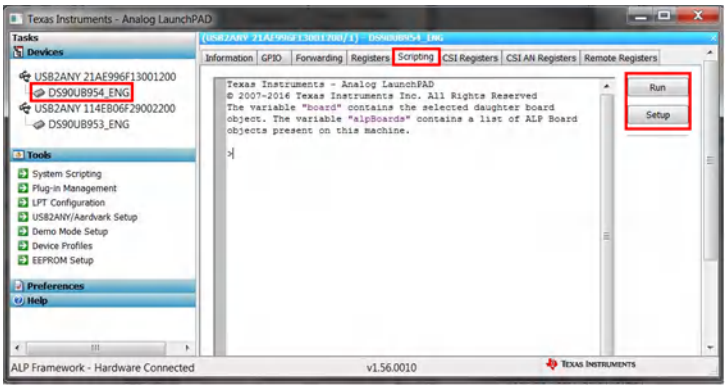


Figure 3-36. Navigating to DS90UB954 (or variant) Scripting Tab in ALP

2. 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.

3. 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

4. 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 3-37. 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.

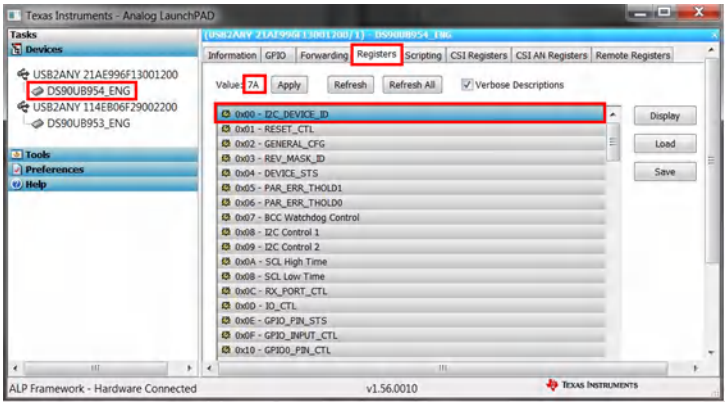


Figure 3-37. Reading I2C Device ID Within the Register Tab

5. Ensure that the devices are setup properly by checking that Pass Sts: displays Pass and Linked has a frequency listed like shown in Figure 3-38. In addition, be sure that D3, labeled Lock, and D15 label Pass, are illuminated on the DS90UB954EVM (or variant).

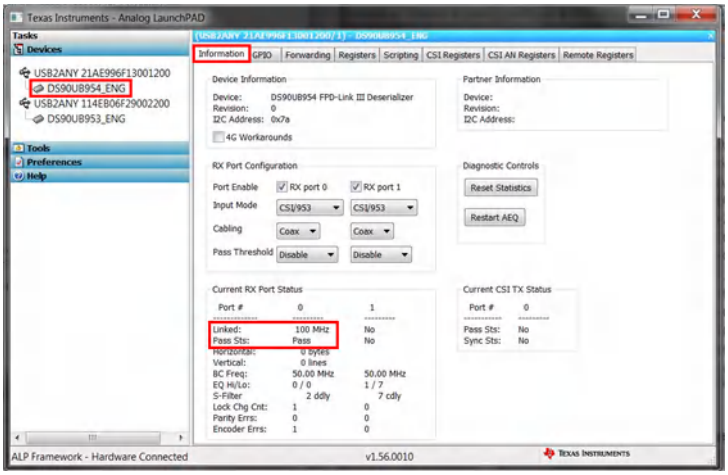


Figure 3-38. Verifying Pass and Lock for DS90UB954 (or variant) in ALP

6. Navigate back to the Scripting tab of the DS90UB954 (or variant) ALP profile and run the 953to954_patgen_YUV_1920x1080p-4Lanes-Working.py script to initialize a pattern generation from 953->954. The script may be found by clicking on the "Run PreDef Script" button. If the DS90UB954-Q1 (or variant) is not using an I2C address of 0x7A (8-bit form), the script should be modified to use the correct I2C address.

7. Verify that the pattern has been enabled navigating to the information tab on the DS90UB954 (or variant), and checking to the horizontal and vertical parameters for the appropriate resolution defined by the camera. Figure 3-39 shows 3840 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.

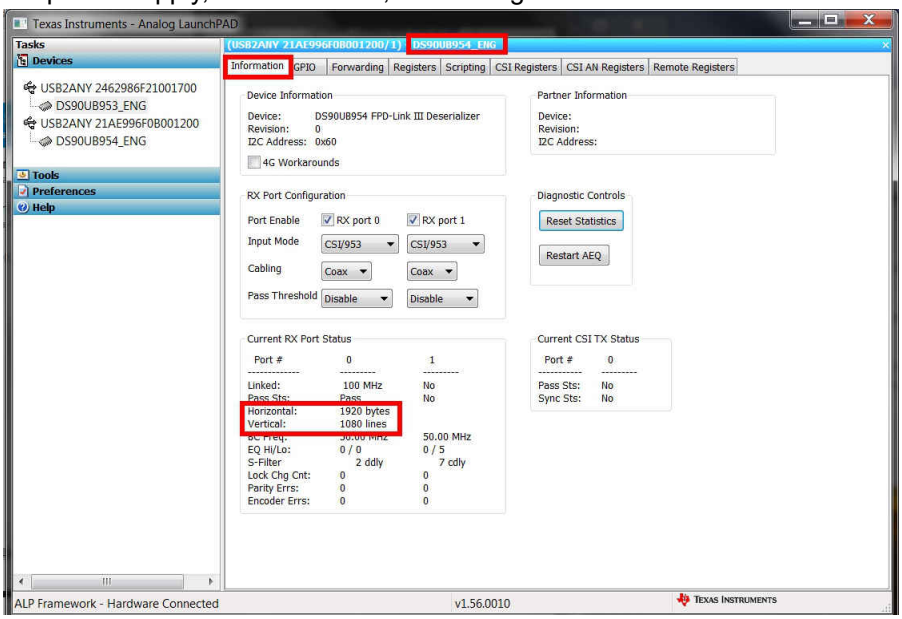


Figure 3-39. Verifying Camera Initialization in ALP

4 Bill of Materials

Table 4-1. Bill of Materials

DESIGNATOR	QTY.	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
!PCB1	1		Printed-Circuit Board		Printed-Circuit Board	Any
C1, C2, C3	3	1uF	CAP, CERM, 1 µF, 6.3 V, +/- 20%, X7R, 0402	0402	GRM155R70J105MA12D	MuRata
C4, C5, C6, C9, C48, C64	6	0.01uF	CAP, CERM, 0.01 µF, 50 V, +/- 5%, X7R, 0402	0402	C0402C103J5RACTU	Kemet
C7	1	0.033uF	CAP, CERM, 0.033 µF, 6.3 V, +/- 10%, X5R, 0201	0201	GRM033R60J333KE01D	MuRata
C8	1	0.015uF	CAP, CERM, 0.015 µF, 6.3 V, +/- 10%, X5R, 0201	0201	GRM033R60J153KE01D	MuRata
C10, C13, C16, C54, C55, C62, C63	7	10uF	CAP, CERM, 10 µF, 6.3 V, +/- 10%, X7R, 0805	0805_HV	GRM21BR70J106KE76L	MuRata
C11, C14, C17	3	0.1uF	CAP, CERM, 0.1 µF, 50 V, +/- 20%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H104M050BB	TDK
C12, C15, C18	3	0.01uF	CAP, CERM, 0.01 µF, 10 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0201	0201_033	CGA1A2X7R1A103K030BA	TDK
C19	1	0.022uF	CAP, CERM, 0.022 µF, 6.3 V, +/- 10%, X5R, 0201	0201	GRM033R60J223KE01D	MuRata
C20	1	0.1uF	CAP, CERM, 0.1 µF, 6.3 V, +/- 10%, X5R, 0201	0201	C0603X5R0J104K030BC	TDK
C21, C40, C41, C45, C46, C49, C60	7	1uF	CAP, CERM, 1 µF, 16 V, +/- 10%, X7R, 0603	0603	C1608X7R1C105K080AC	TDK
C22, C28, C34, C35	4	0.1uF	CAP, CERM, 0.1 µF, 16 V, +/- 5%, X7R, 0603	0603	0603YC104JAT2A	AVX
C23	1	2.2uF	CAP, CERM, 2.2 µF, 16 V, +/- 10%, X5R, 0805	0805_HV	0805YD225KAT2A	AVX
C24, C31	2	220pF	CAP, CERM, 220 pF, 50 V, +/- 1%, C0G/NP0, 0603	0603	06035A221FAT2A	AVX
C25	1	0.01uF	CAP, CERM, 0.01 µF, 50 V, +/- 10%, X7R, 0603	0603	C1608X7R1H103K080AA	TDK
C26	1	22uF	CAP, TA, 22uF, 25V, +/-20%, 0.7 ohm, SMD	7343-31	293D226X0025D2TE3	Vishay-Sprague
C27	1	1uF	CAP, CERM, 1 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	0805_HV	CGA4J3X7R1H105K125AB	TDK
C29, C30	2	30pF	CAP, CERM, 30 pF, 100 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C2A300JA01D	MuRata
C32	1	0.47uF	CAP, CERM, 0.47 µF, 10 V, +/- 10%, X7R, 0603	0603	GRM188R71A474KA61D	MuRata
C33	1	2200pF	CAP, CERM, 2200 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603X222K5RACTU	Kemet
C36, C37, C38, C39	4	4700pF	CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0805	0805_HV	08051C472KAT2A	AVX
C42, C47	2	10uF	CAP, CERM, 10 µF, 16 V, +/- 10%, X7S, AEC-Q200 Grade 1, 0805	0805_HV	CGA4J1X7S1C106K125AC	TDK
C43, C52, C58	3	4.7uF	CAP, CERM, 4.7 µF, 16 V, +/- 10%, X7R, 0805	0805_HV	GRM21BR71C475KA73L	MuRata

Table 4-1. Bill of Materials (continued)

DESIGNATOR	QTY.	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
C44, C50, C53, C57, C59	5	0.1uF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0402	0402	C1005X7R1H104K050BB	TDK
C51	1	10uF	CAP, CERM, 10 µF, 35 V, +/- 10%, X7R, 1206_190	1206_190	GMK316AB7106KL-TR	Taiyo Yuden
C56	1	22uF	CAP, CERM, 22 µF, 6.3 V, +/- 10%, X7R, AEC-Q200 Grade 1, 1206	1206_180	CGA5L1X7R0J226M160AC	TDK
C61	1	47pF	CAP, CERM, 47 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	885012005044	Wurth Elektronik
D9	1	7.5V	Diode, Zener, 7.5 V, 550 mW, SMB	SMB	1SMB5922BT3G	ON Semiconductor
D10, D11	2	Green	LED, Green, SMD	WL-SMCW_GREEN	150060VS75000	Wurth Elektronik eiSos
FB1	1	60 ohm	Ferrite Bead, 60 ohm @ 100 MHz, 0.8 A, 0603	0603	BK1608HS600-T	Taiyo Yuden
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	Fiducial10-20	Fiducial	N/A
J1	1		Receptacle, 0.5mm, 30x2, Gold, SMT	Samtec_SS5-30-3_50-x-D-K	SS5-30-3.50-L-D-K-TR	Samtec
J2, J4	2		Header, 100mil, 3x1, Gold, TH	Samtec_HTSW-103-07-G-S	I2C	Samtec
J3, J10	2		Header, 100mil, 4x2, Gold, TH	TSW-104-07-G-D	TSW-104-07-G-D	Samtec
J5	1		Header, 100mil, 3x1, Gold, TH	Samtec_HTSW-103-07-G-S	1.8V I2C	Samtec
J6	1		Header, 100mil, 3x1, Gold, TH	Samtec_HTSW-103-07-G-S	3.3V I2C	Samtec
J7	1		Header, 100mil, 2x1, Tin, TH	TE_5-146278-2	IDx/CLK_OUT	TE Connectivity
J8	1		Header, 100mil, 2x1, Tin, TH	TE_5-146278-2	MODE	TE Connectivity
J9	1		Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT	CONN_USB-Mini-B-1734035-2	USB Mini Type B	TE Connectivity
J11	1		Header, 2.54mm, 5x2, Gold, Black, TH	Samtec_TSW-105-07-x-D	TSW-105-07-F-D	Samtec
J12	1		Header, 100mil, 2x2, Gold, TH	TSW-102-07-G-D	TSW-102-07-G-D	Samtec
J13	1		Header, 100mil, 2x1, Tin, TH	TE_5-146278-2	Disable 1V8	TE Connectivity
J14	1		Standard Banana Jack, Uninsulated, 8.9mm	Keystone575-8	VDD1V8	Keystone
J15	1		Header, 100mil, 2x1, Tin, TH	TE_5-146278-2	Enable PoC	TE Connectivity
J16	1		Connector, HF, 50 Ohm, TH	Rosenberger_59S10H-40ML5-Z	59S10H-40ML5-Z	Rosenberger
J17	1		Header, 100mil, 2x1, Tin, TH	TE_5-146278-2	Disable 3V3	TE Connectivity
J18	1		Standard Banana Jack, Uninsulated, 8.9mm	Keystone575-8	GROUND	Keystone
J19	1		Standard Banana Jack, Uninsulated, 8.9mm	Keystone575-8	PoC Voltage	Keystone
J20	1		Standard Banana Jack, Uninsulated, 8.9mm	Keystone575-8	VDD3V3	Keystone
L1, L2, L3	3	1000 ohm	Ferrite Bead, 1000 ohm @ 100 MHz, 0.4 A, 0603	0603	BLM18AG102SN1D	MuRata
L4	1	47 ohm	Ferrite Bead, 47 ohm @ 100 MHz, 0.45 A, 0402	0402	MPZ1005F470ETD25	TDK
L5	1	330 ohm	Ferrite Bead, 330 ohm @ 100 MHz, 0.7 A, 0402	0402	MPZ1005S331ETD25	TDK
L6, R4, R5	3	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale

Table 4-1. Bill of Materials (continued)

DESIGNATOR	QTY.	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
L7	1	10uH	Inductor, Wirewound, Ferrite, 10 µH, 0.5 A, 0.57 ohm, SMD	LQH3NP_G0	LQH3NPN100NG0	MuRata
L8, L9	2	4.7uH	Inductor, Shielded, ?, 4.7uH, 2.3A, 0.092 ohm, SMD	MPI4040R3	MPI4040R3-4R7-R	Coiltronics
Q1	1	50V	MOSFET, N-CH, 50 V, 0.22 A, SOT-23	SOT-23	BSS138	Fairchild Semiconductor
R1	1	0	RES, 0, 5%, 0.05 W, 0201	0201M	ERJ-1GE0R00C	Panasonic
R2	1	49.9	RES, 49.9, 1%, 0.05 W, 0201	0201M	ERJ-1GEF49R9C	Panasonic
R3, R29	2	10.0k	RES, 10.0 k, 0.5%, 0.063 W, 0402	0402	CRCW040210K0DHEDP	Vishay-Dale
R6, R14	2	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	CRCW040210K0FKED	Vishay-Dale
R7, R8	2	1.21k	RES, 1.21 k, 1%, 0.063 W, 0402	0402	CRCW04021K21FKED	Vishay-Dale
R9, R10	2	4.7k	RES, 4.7 k, 5%, 0.063 W, 0402	0402	CRCW04024K70JNED	Vishay-Dale
R11, R15	2	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R12	1	402	RES, 402, 1%, 0.1 W, 0603	0603	CRCW0603402RFKEA	Vishay-Dale
R13	1	40.2k	RES, 40.2 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD0740K2L	Yageo America
R16, R17	2	33	RES, 33 ohm, 5%, 0.063W, 0402	0402	CRCW040233R0JNED	Vishay-Dale
R18	1	1.5k	RES, 1.5k ohm, 5%, 0.063W, 0402	0402	CRCW04021K50JNED	Vishay-Dale
R19, R23	2	33k	RES, 33k ohm, 5%, 0.063W, 0402	0402	CRCW040233K0JNED	Vishay-Dale
R20	1	1.2Meg	RES, 1.2 M, 5%, 0.1 W, 0603	0603	CRCW06031M20JNEA	Vishay-Dale
R21, R33	2	200	RES, 200, 1%, 0.1 W, 0603	0603	CRCW0603200RFKEA	Vishay-Dale
R22	1	0	RES, 0, 5%, 0.063 W, 0402	0402	ERJ-2GE0R00X	Panasonic
R24, R26, R28, R30	4	10.0k	RES, 10.0 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1002X	Panasonic
R25	1	4.02k	RES, 4.02 k, 1%, 0.1 W, 0603	0603	CRCW06034K02FKEA	Vishay-Dale
R27	1	1.00k	RES, 1.00 k, 1%, 0.063 W, 0402	0402	CRCW04021K00FKED	Vishay-Dale
R31	1	100k	RES, 100 k, 1%, 0.05 W, 0201	0201M	CRCW0201100KFKED	Vishay-Dale
R32	1	100k	RES, 100 k, 1%, 0.063 W, 0402	0402	CRCW0402100KFKED	Vishay-Dale
R34	1	40.2k	RES, 40.2 k, 1%, 0.063 W, 0402	0402	CRCW040240K2FKED	Vishay-Dale
S1	1		Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	SW_TL1015AF160QG	TL1015AF160QG	E-Switch
S2	1		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C and K Components
SH-J1, SH-J2, SH-J3	3	1x2	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G	969102-0000-DA	3M
U1	1		FPD-Link III SerDes with CSI-2 interfaces for 2.3MP/60fps camera, RHB0032P (VQFN-32)	RHB0032P	DS90UB953QRHBQ1	Texas Instruments
U2	1		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)	DCU0008A_N	TCA9406DCUR	Texas Instruments
U3	1		ESD-Protection Array for High-Speed Data Interfaces, 4 Channels, -40 to +85 degC, 6-pin SON (DRY), Green (RoHS & no Sb/Br)	DRY0006A	TPD4E004DRYR	Texas Instruments

Table 4-1. Bill of Materials (continued)

DESIGNATOR	QTY.	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
U4	1		500mA, Low Quiescent Current, Ultra-Low Noise, High PSRR Low-Dropout Linear Regulator, DRB0008A	DRB0008A	TPS73533DRBR	Texas Instruments
U5	1		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)	PN0080A_N	MSP430F5529IPN	Texas Instruments
U6	1		ULTRA LOW-NOISE, 250-mA LINEAR REGULATOR FOR RF AND ANALOG CIRCUITS REQUIRES NO BYPASS CAPACITOR, DBV0005A	DBV0005A_N	LP5907MFX-1.8/NOPB	Texas Instruments
U7	1		Ultra Low-Noise, 500-mA Linear Regulator for RF and Analog Circuits - Requires No Bypass Capacitor, DRV0006A (WSON-6)	DRV0006A	LP5912-1.8DRVR	Texas Instruments
U8	1		Synchronous Buck Regulator for 650mA Space Constraint Applications, DSX0010A	DSX0010A	LM536003QDSXRQ1	Texas Instruments
U9	1		Synchronous Buck Regulator for 650mA Space Constraint Applications, DSX0010A	DSX0010A	LM53600AQDSXRQ1	Texas Instruments
Y1	1		OSC, 50MHz, 1.8 to 3.3V, SMD	Abracon_ASDMB	ASDMB-50.000MHZ-LC-T	Abracon Corportation
Y2	1		Crystal, 24 MHz, 18 pF, SMD	XTAL_ABM3	ABM3-24.000MHZ-D2Y-T	Abracon Corporation

5 PCB Schematics

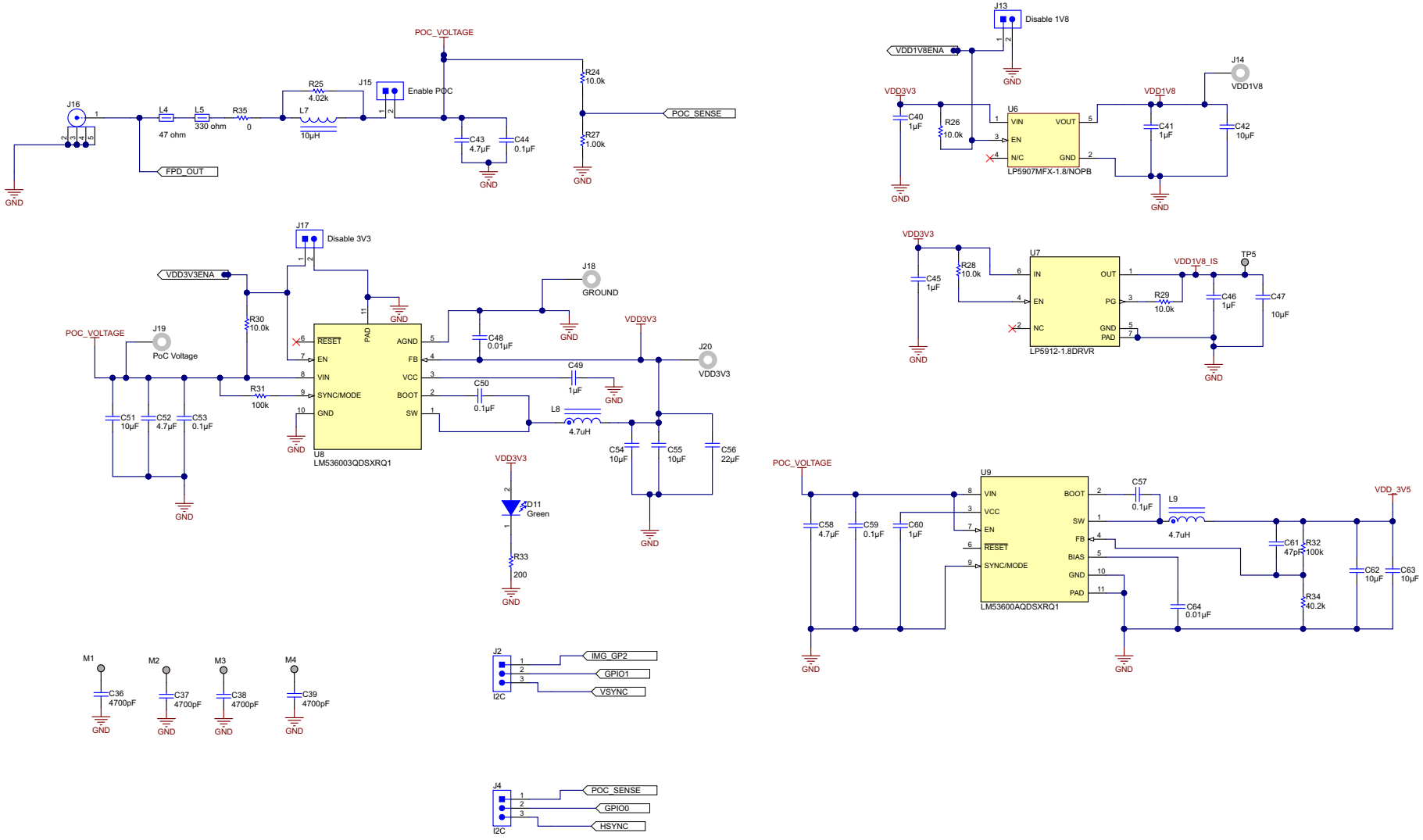


Figure 5-1. DS90UB95x-Q1EVM Schematic 1

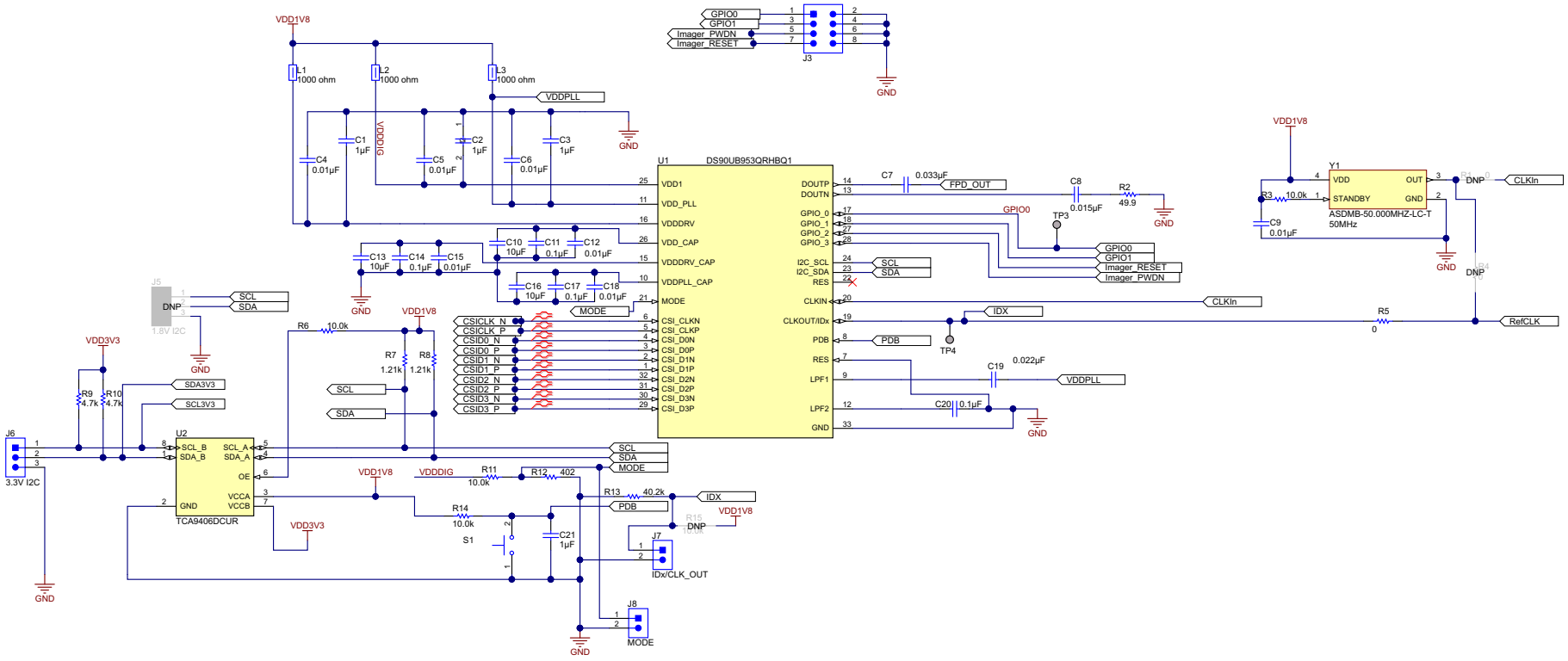


Figure 5-2. DS90UB95x-Q1EVM Schematic 2

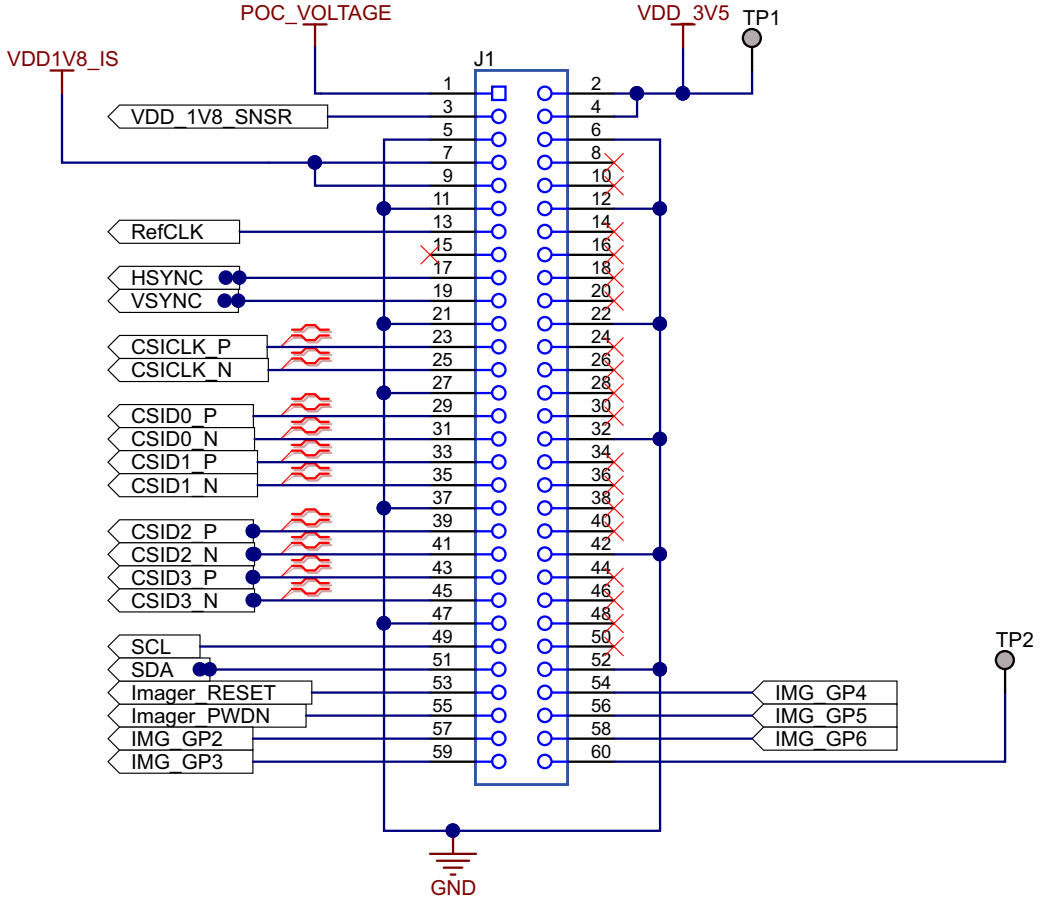


Figure 5-3. DS90UB95x-Q1EVM Schematic 3

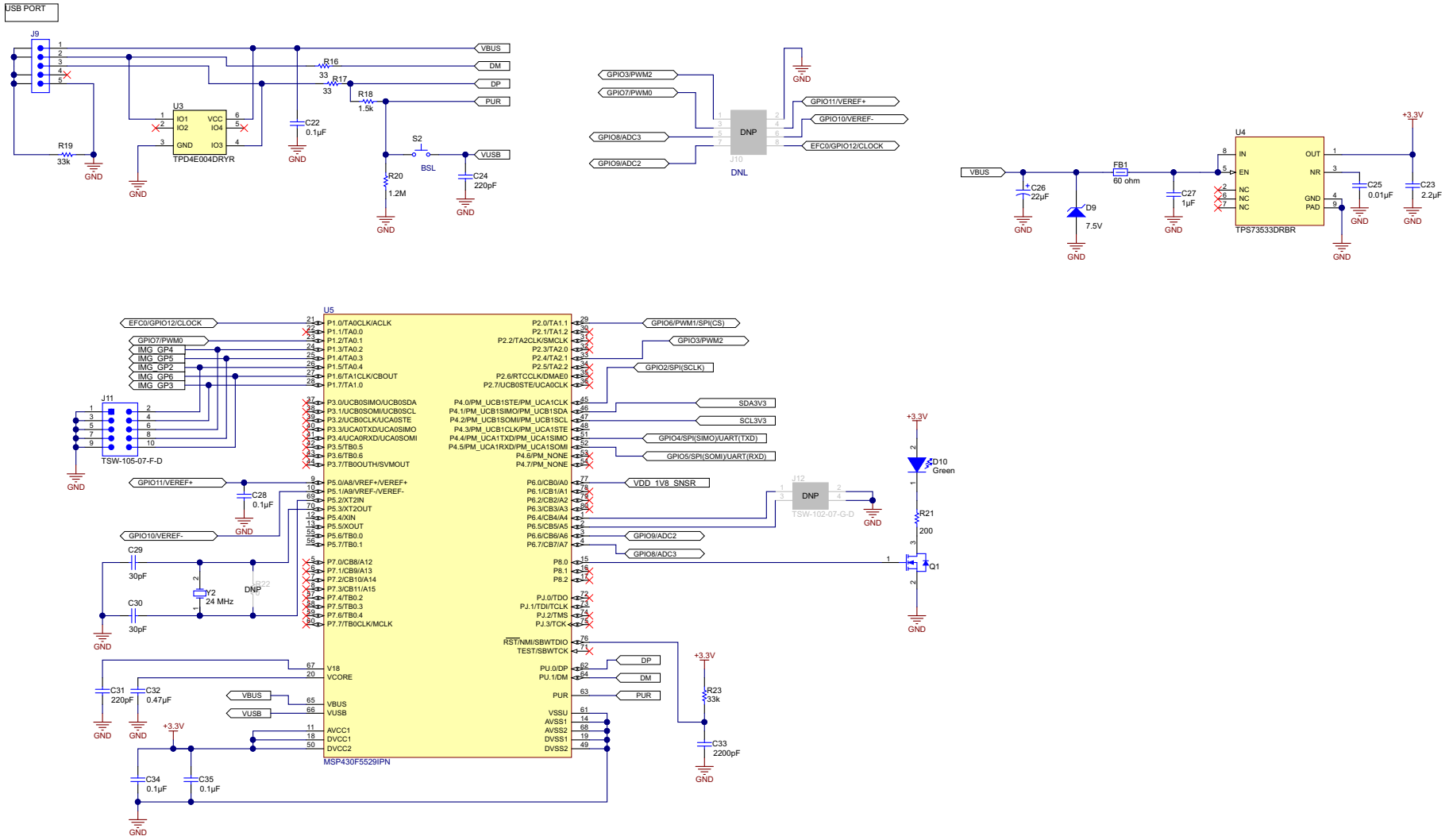


Figure 5-4. DS90UB95x-Q1EVM Schematic 4

6 Board Layout

The board layout for the DS90UB95x-Q1EVM is shown in Figure 6-1 through Figure 6-12.

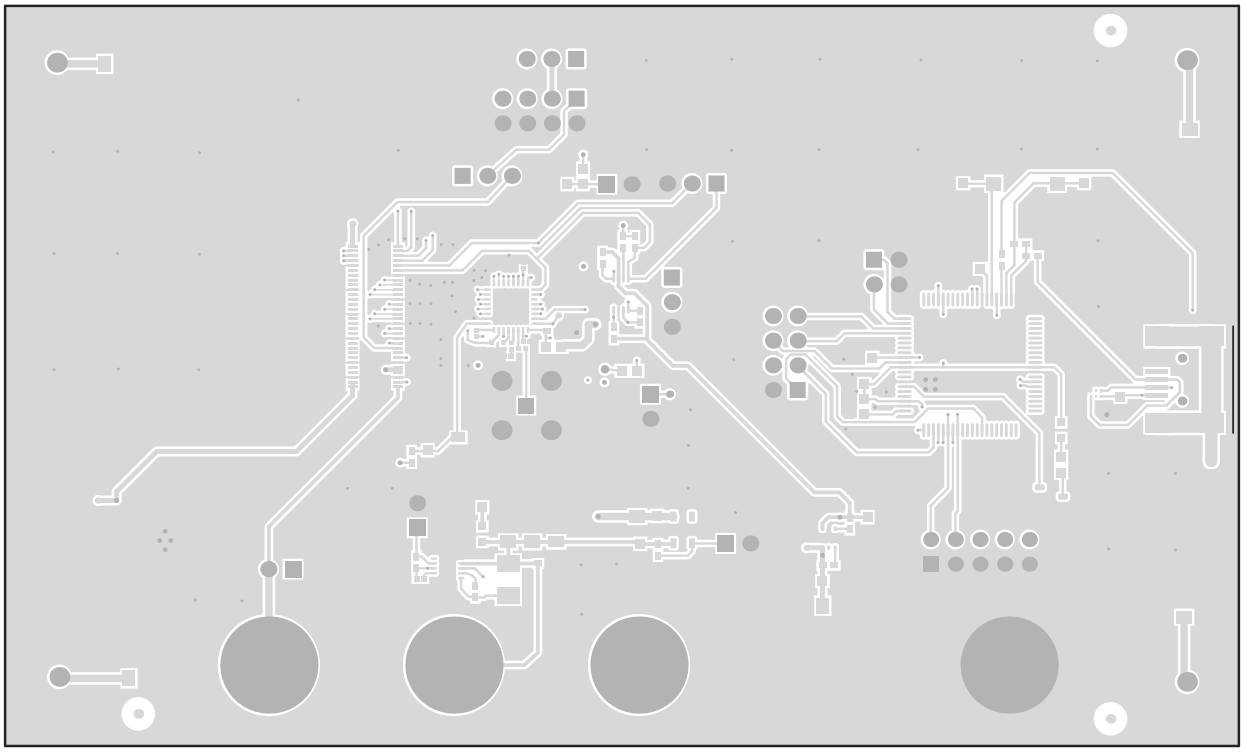


Figure 6-1. Top Layer PCB Layout

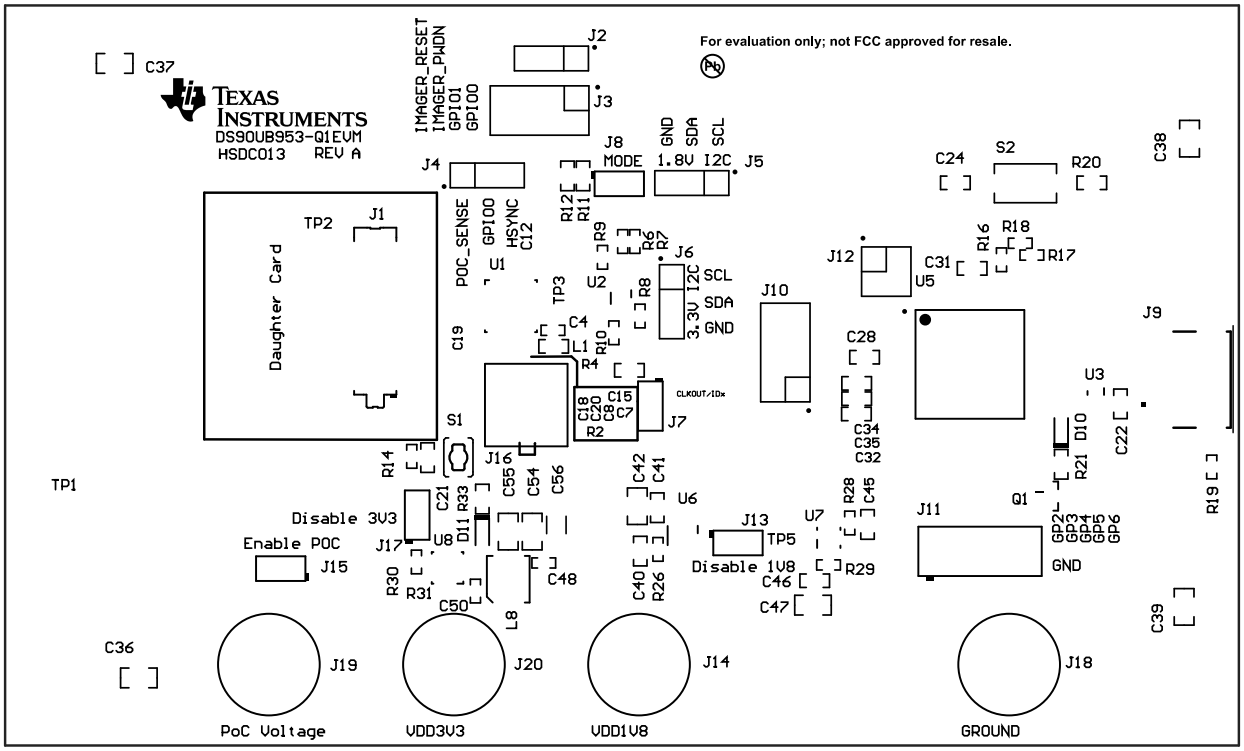


Figure 6-2. Top Overlay

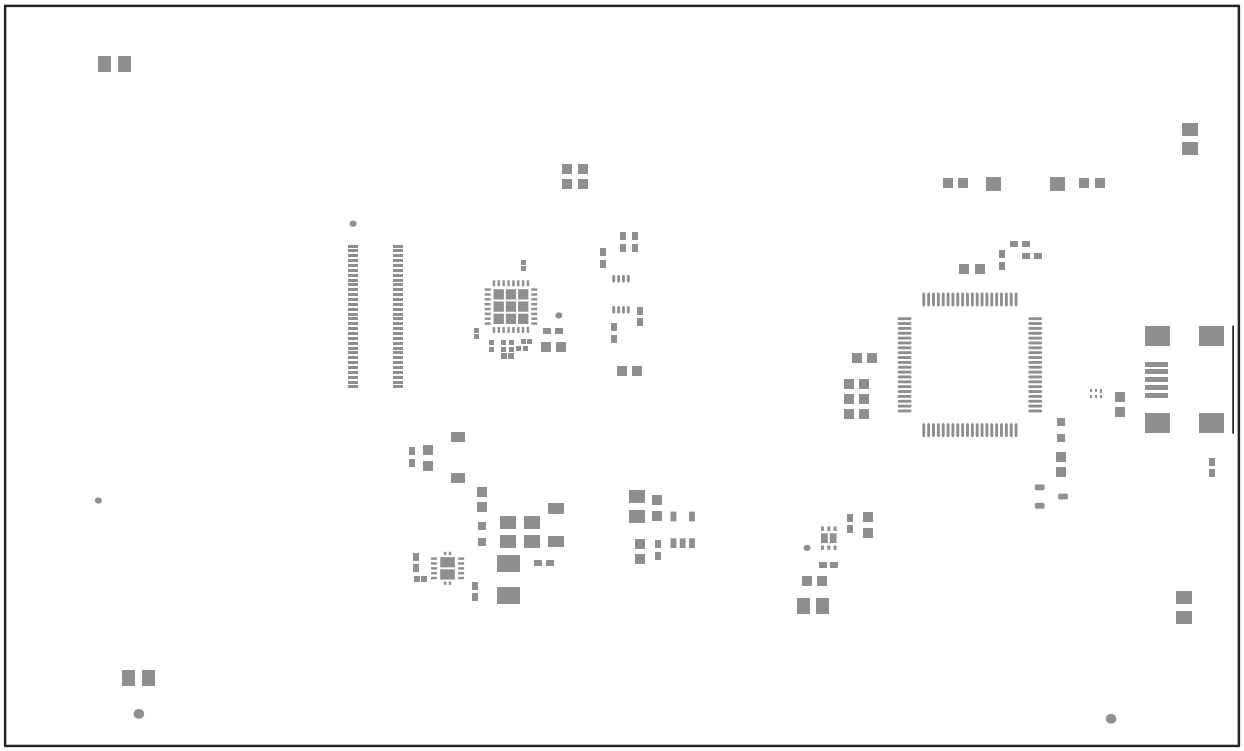


Figure 6-3. Top Paste

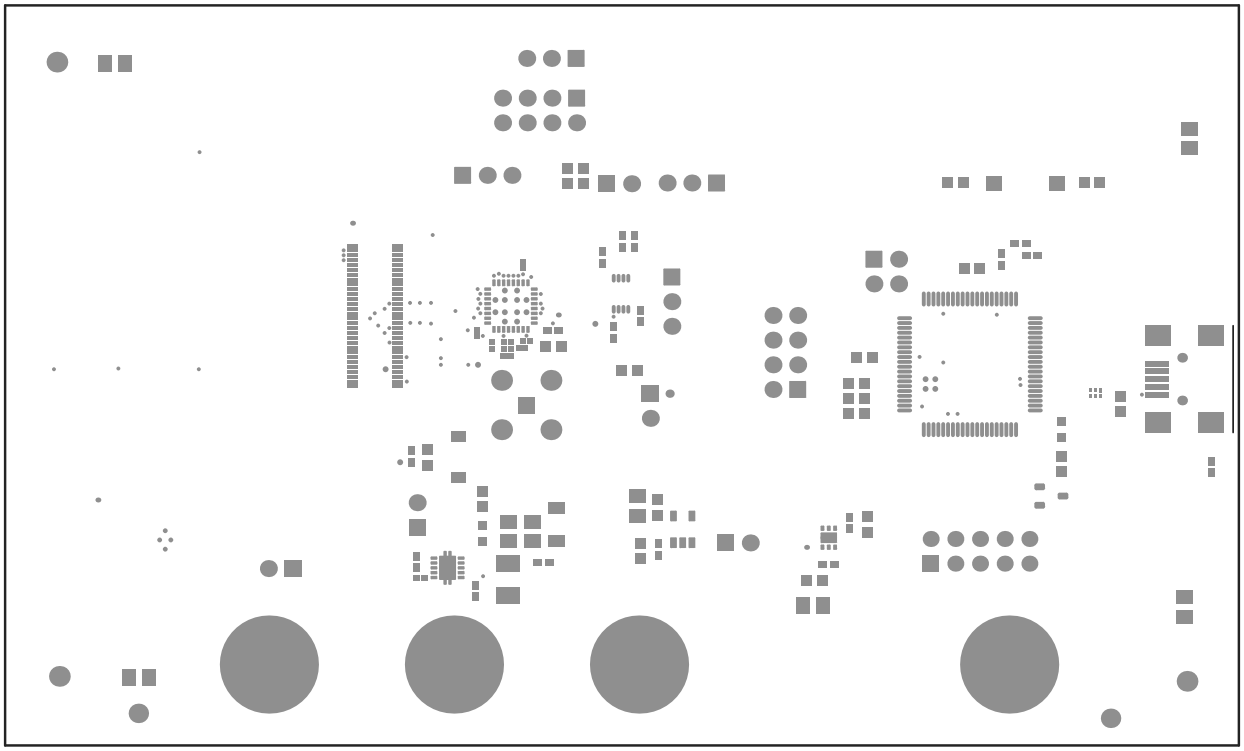


Figure 6-4. Top Solder

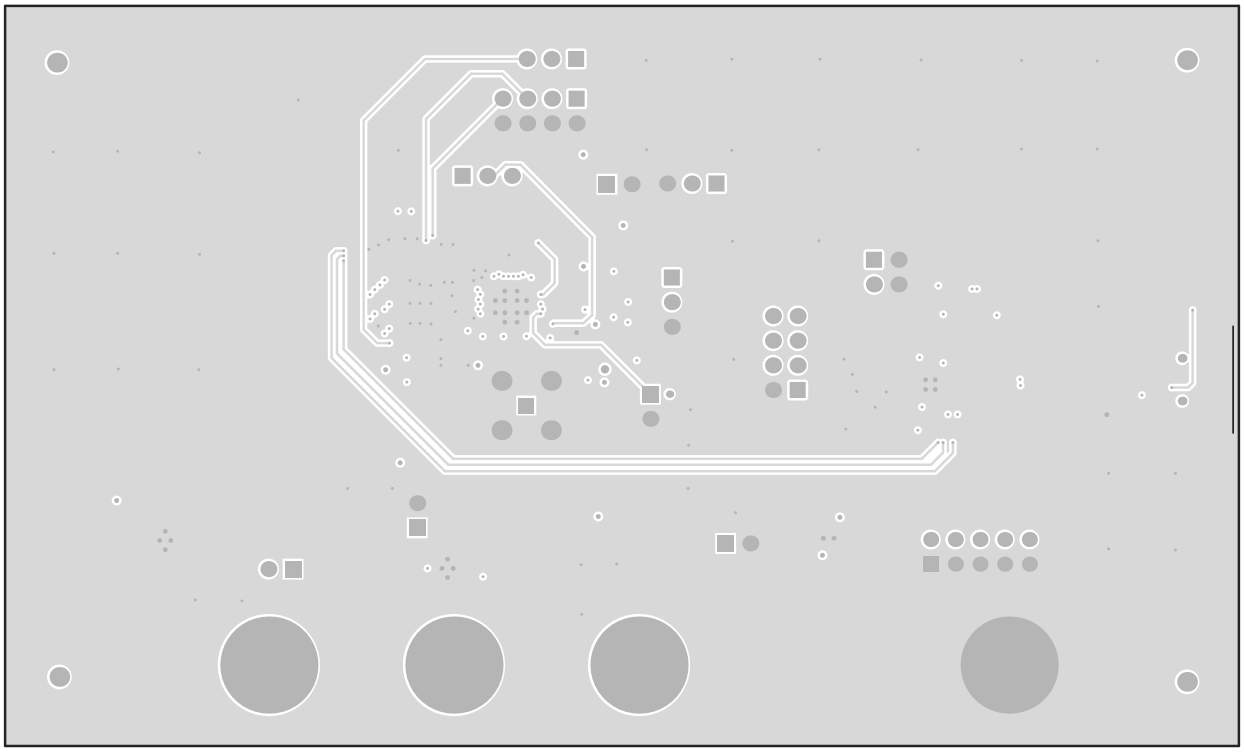


Figure 6-5. Signal Layer 1

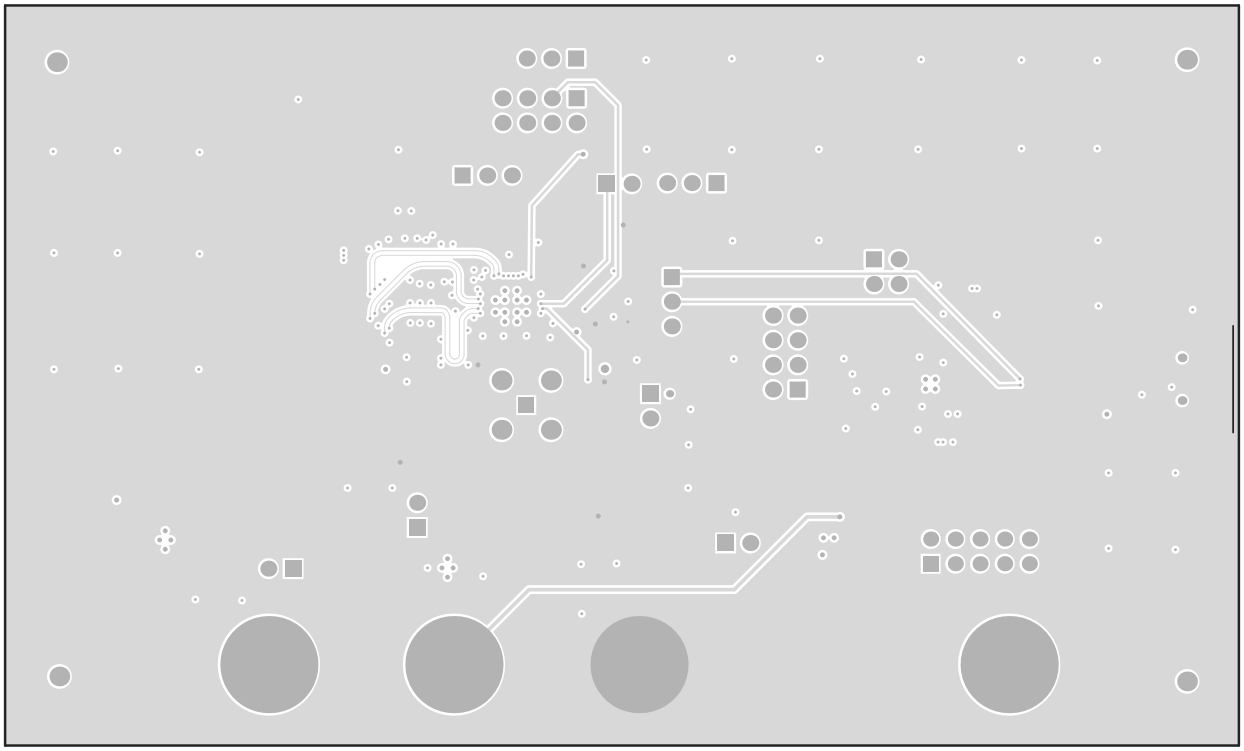


Figure 6-6. Signal Layer 2

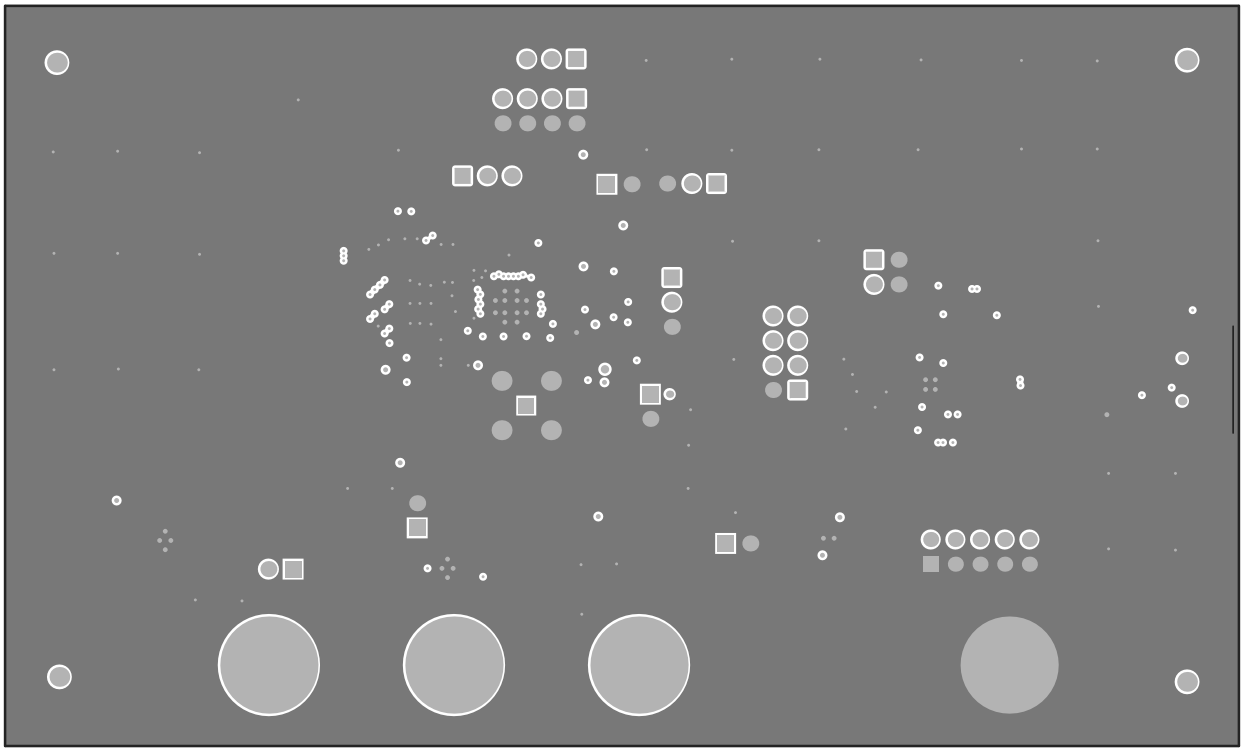


Figure 6-7. Signal Layer 3

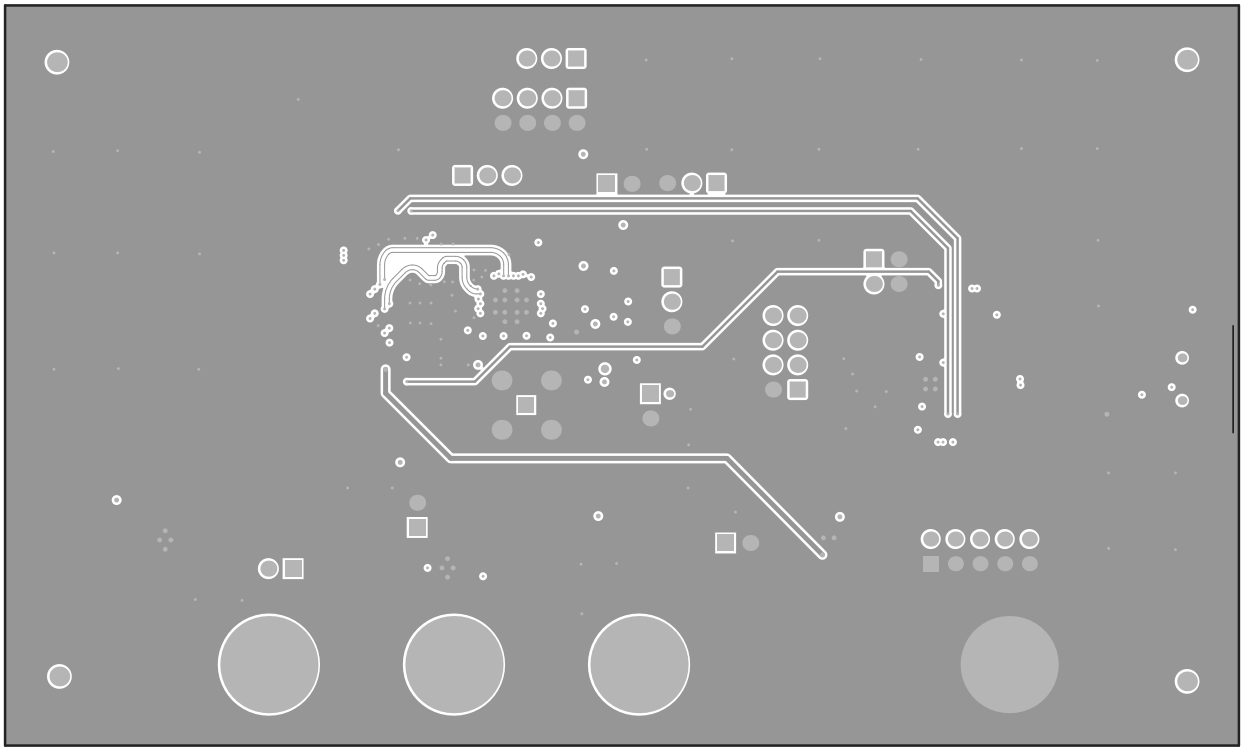


Figure 6-8. Signal Layer 4

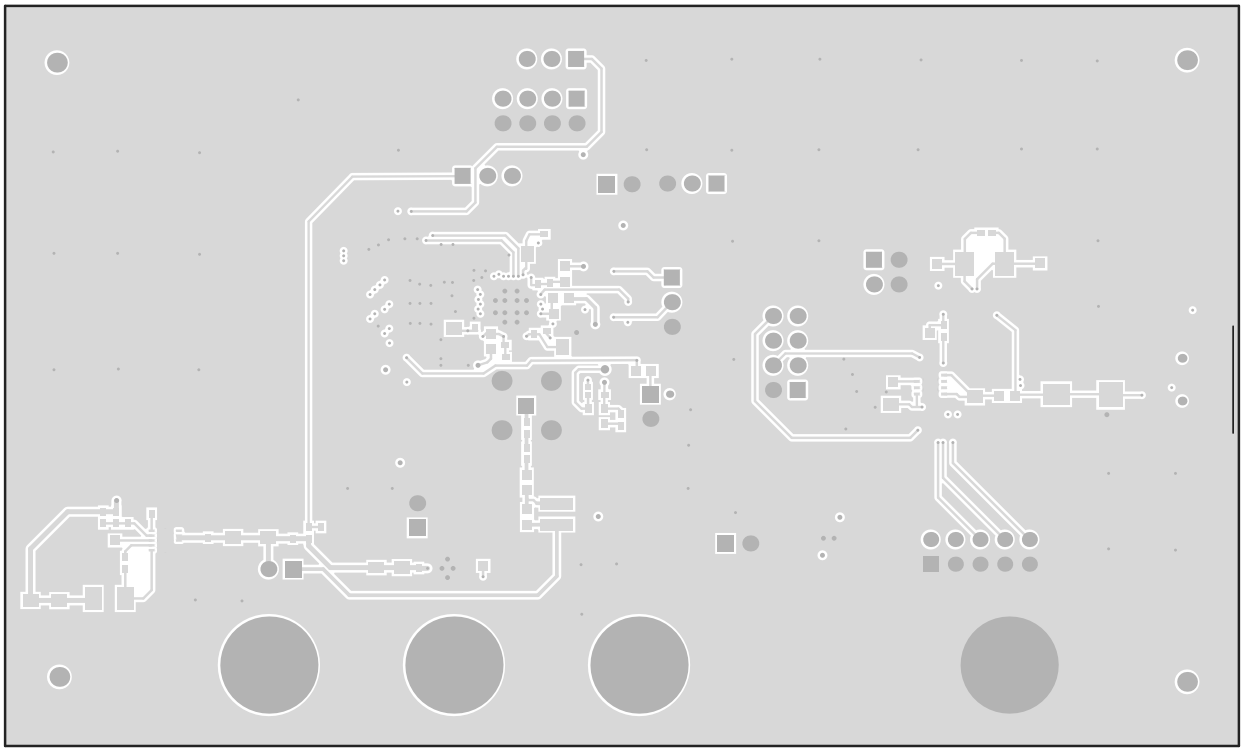


Figure 6-9. Bottom Layer PCB Layout

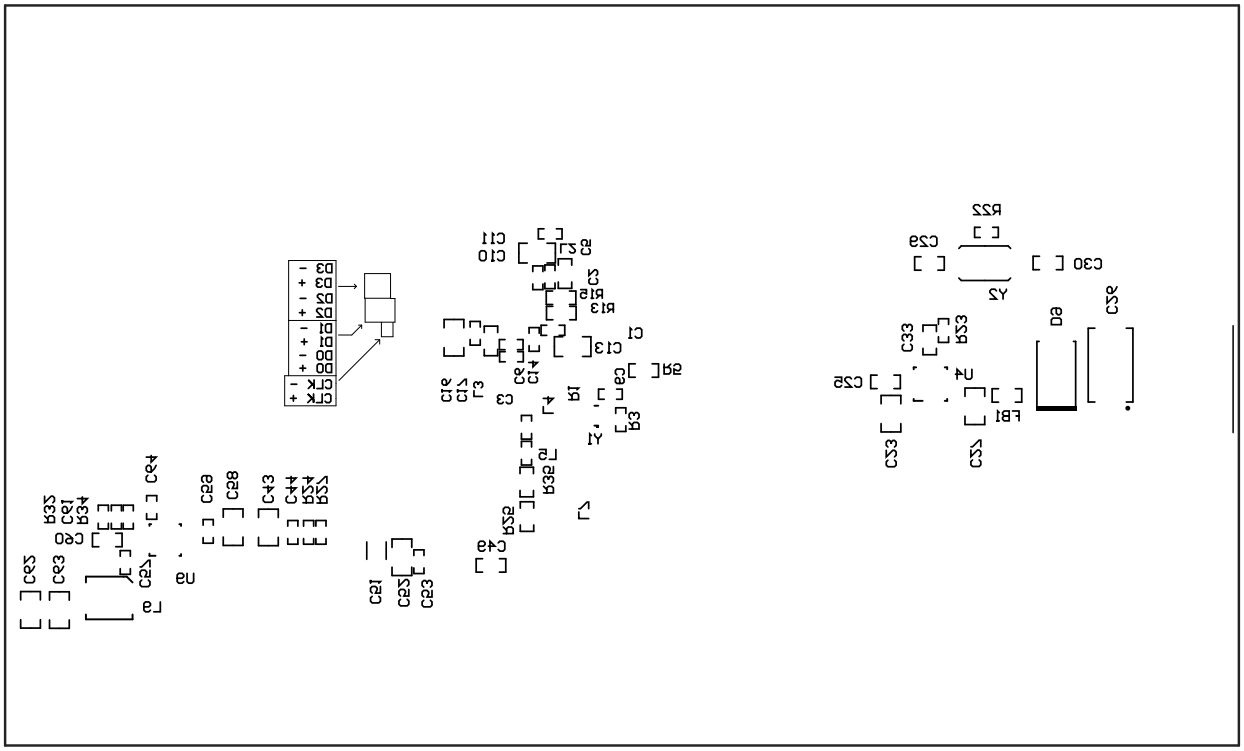


Figure 6-10. Bottom Overlay

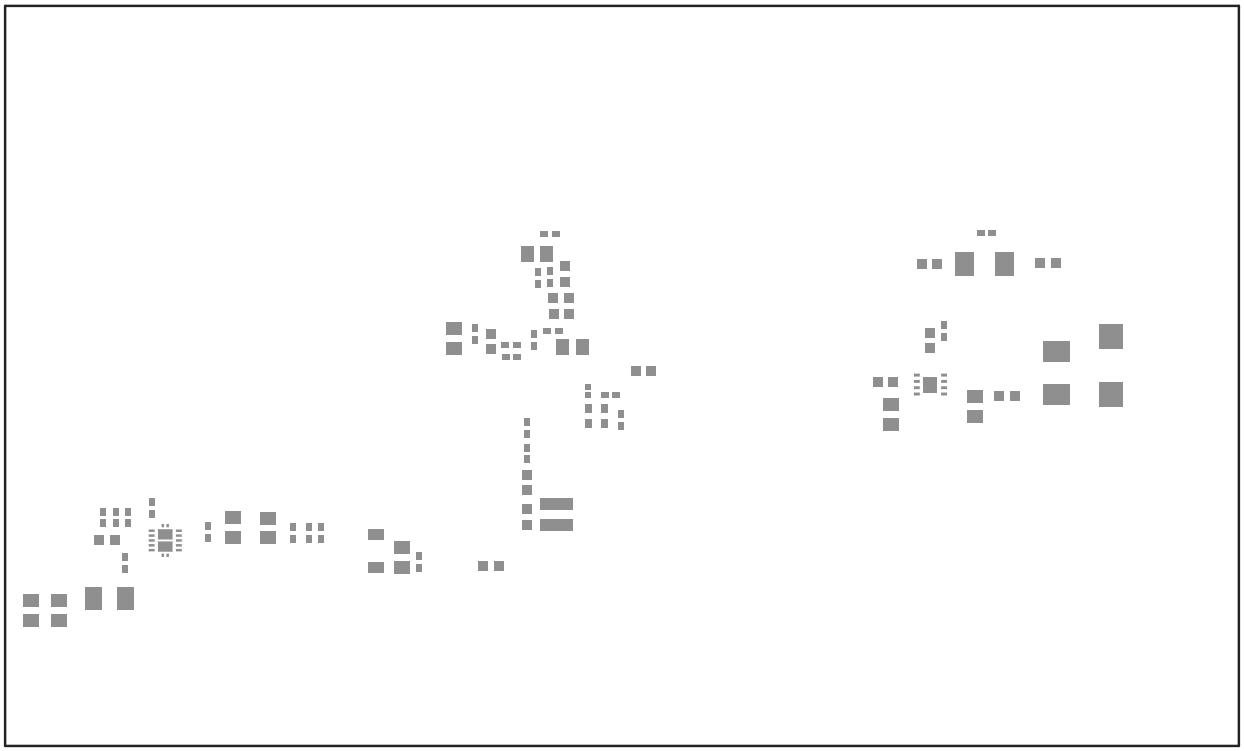


Figure 6-11. Bottom Paste

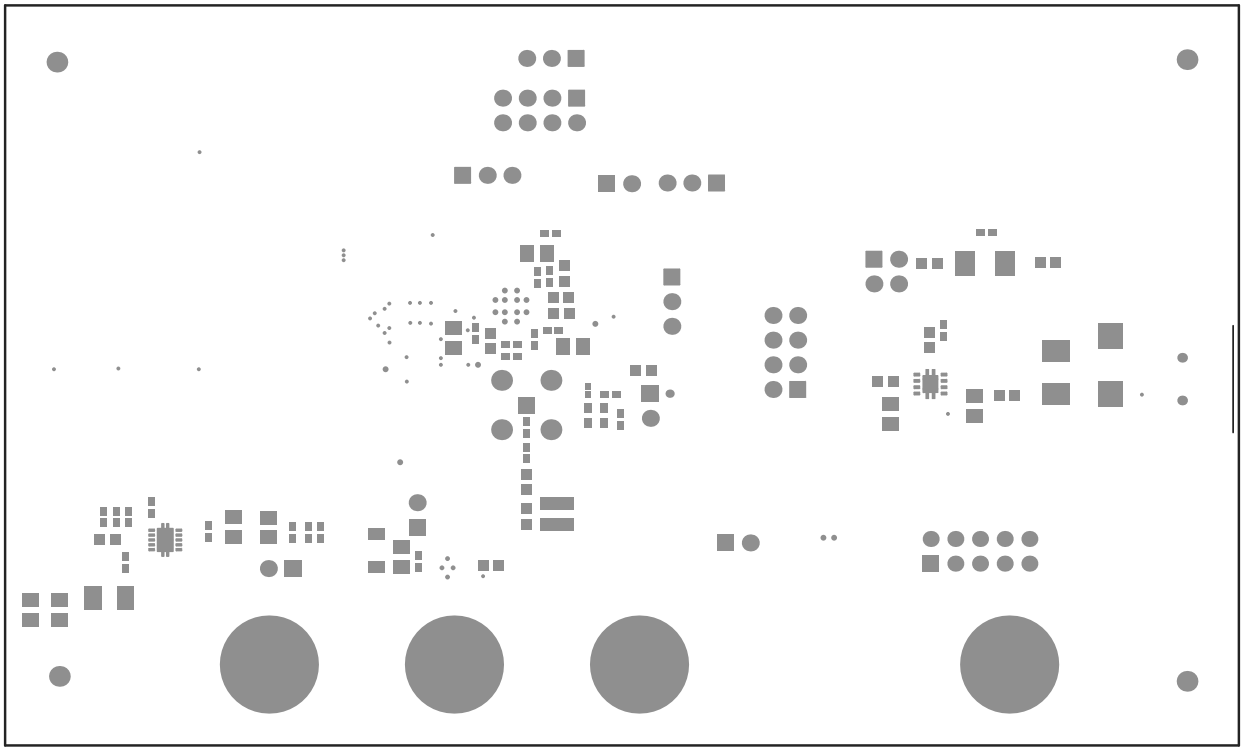


Figure 6-12. Bottom Solder

7 Related Documentation

7.1 References

- DS90UB953-Q1
- DS90UB953A-Q1
- DS90UB635-Q1
- DS90UB954-Q1
- TSER953

8 Revision History

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

Changes from Revision C (April 2021) to Revision D (February 2023)	Page
• Updated Abstract section to include DS90UB635-Q1	1
• Changed all instances of legacy terminology to controller and target where I2C is mentioned.	3
• Updated I2C terminology to align with latest inclusivity guidelines	19
• Added link to DS90UB635-Q1 product page	53

Changes from Revision B (September 2020) to Revision C (April 2021)	Page
• Updated Abstract section to include V^{3}Link TSER953	1
• Added link to TSER953 product page	53

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1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

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

2 *Limited Warranty and Related Remedies/Disclaimers*:

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

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

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

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

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

NOTE:

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

3 *Regulatory Notices:*

3.1 *United States*

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

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

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

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

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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

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上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

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