EVM User's Guide: TX73L64EVM

TX73L64 Evaluation Module

Description

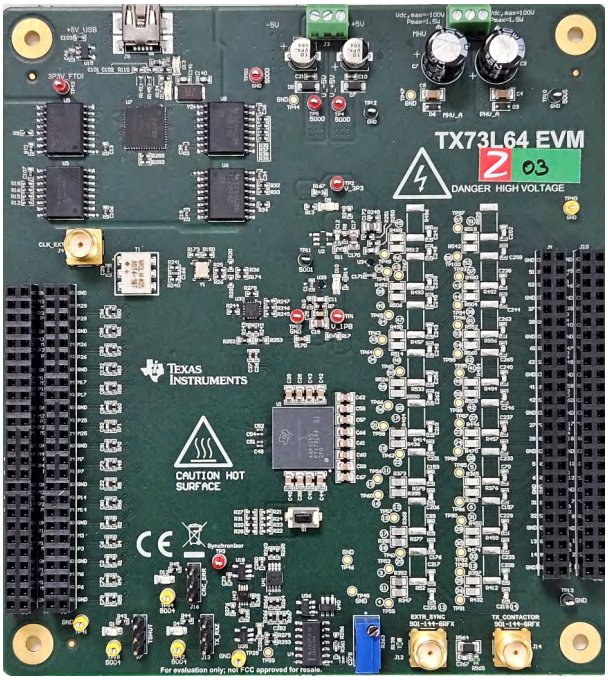
The TX73L64EVM is used for the evaluation of TX73L64 device under various drive strength, different voltage levels and different modes of the device. The EVM contains all necessary control signals and on-board power generation, which reduces the need for external equipment. The evaluation system also includes GUI software for Microsoft® Windows® for easily programming various modes and patterns into the device.

Features

- Allows control of TX73L64 device using simple GUI via USB
- B-mode or CW mode of transmit can be programmed
- Multiple pattern and Delay profiles can be stored, and the user can switch between them easily in GUI
- Low Noise Amplifier (LNA) and Digital Time Gain Compensation (DTGC) controls allow more control over the receive signal
- Clock and Sync generator present on board
- Sync frequency can be changed using onboard potentiometer
- Option to give external sync
- Uses CMOS serial programming interface
- Error flag register to detect faulty conditions and automatic thermal shutdown
- Evaluate Transmit Performance with 100pF||1kΩ load

Applications

- Ultrasound imaging system
- Piezoelectric driver
- In-probe ultrasound imaging



TX73L64 EVM

Table of Contents

1 Evaluation Module Overview

1.1 Introduction

This user's guide refers to software TX73L64 EVM GUI V.1.0 or higher and requires the MicrosoftWindows 7 operating system or above to function.

This user's guide gives a general overview of the TX73L64EVM evaluation module (EVM) and provides a general description of the features and functions to be considered while using this module. The TX73L64EVM provides a platform for evaluating the transmitter under various drive strength, different voltage levels and different modes of the device.

For any further questions regarding the EVM, GUI or device, contact TI support.

CAUTION

A high voltage DC supply is connected to the TX73L64EVM evaluation module. Therefore, do not leave the EVM powered when unattended to avoid potential injury.

The TX73L64EVM evaluation module is strictly for simulating ultrasound transducer interface development in electrical instrumentation/laboratory development environment. To minimize risk of possible electrical shock and/or radiation hazards, attachment of actual ultrasonic transducers and receivers is prohibited.

1.2 Kit Contents

The TX73L64EVM kit contains the following items:

1. TX73L64EVM
2. One mini-USB cable

1.3 Specification

The device operates with a ±5V, 500mA supply. The pulser requires ±100V, 500mA supplies.

1.4 Device Information

TX73L64 is a highly integrated, high-performance transmitter solution for ultrasound imaging system. The device has total 64 pulser circuits, 64 transmit/ receive switches (referred as T/R or TR switches), 32 LNA circuits, and supports on-chip beamformer (TxBF). The T/R switches also perform a 2:1 multiplexing operation to multiplex inputs of 2 channels to 1 LNA. The device also integrates on-chip floating power supplies that reduce the number of required high voltage power supplies.

TX73L64 has a pulser circuit that generates three-level high voltage pulses (up to ±100V) that is used to excite multiple channels of an ultrasound transducer. The device supports total 64 outputs. The maximum output current is 1A.

Device can be used as a transmitter solution for many applications like ultrasound imaging, non-destructive testing, SONAR, LIDAR, marine navigation system, brain imaging systems and so on.

2 Hardware

2.1 Equipment Setup Overview

Figure 2-1 shows the equipment setup required to test the TX73L64EVM.

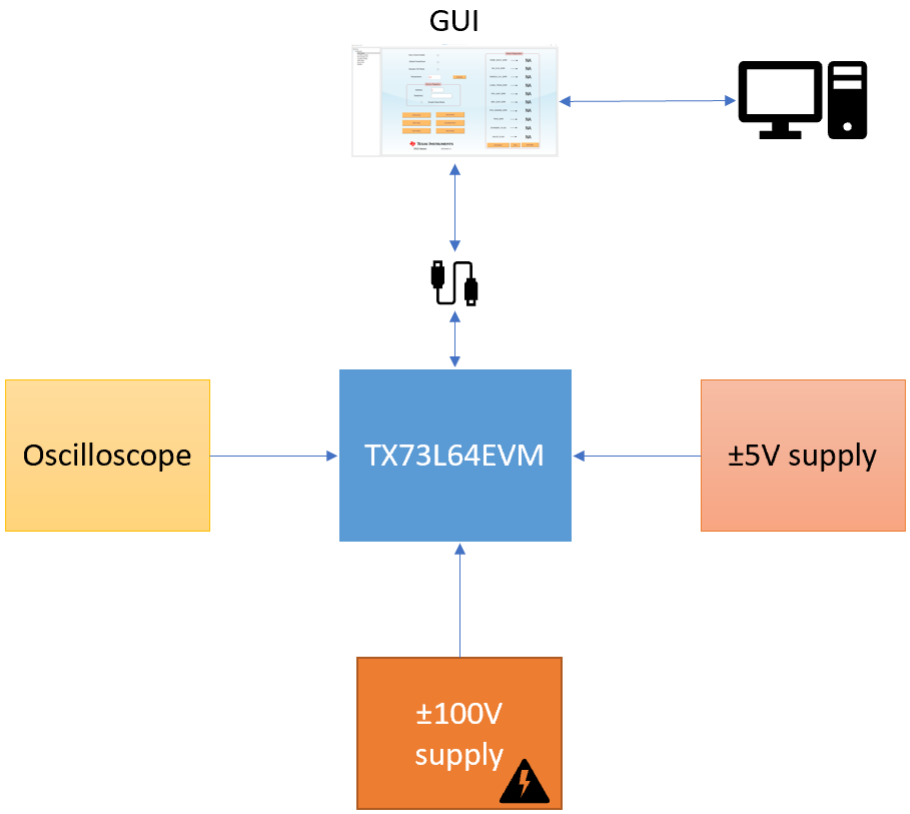


Figure 2-1. TX73L64EVM Setup

2.1.1 Power Supply

The EVM uses a screw-based connector for power supply ports. The EVM requires a ±5V supply and a high voltage ±100V supply with a 500mA current range.

2.1.2 USB Interface to PC

USB connection from the TX73L64EVM to the PC is used for communication between the GUI and the EVM. Both USB 2.0 and 3.0 ports are supported. The USB must be connected when testing the device.

3 Software

3.1 GUI Software Installation

The TX73L64EVM requires a software to be installed to check the on-chip features of the device. Make sure that no USB connection is made to the EVM until after the installation is complete.

3.2 GUI Installation

1. TX73L64EVM GUI Installation

   Download the TX73L64EVM GUI from the mySecureSoftware folder at *www.ti.com/securesoftware*.

   a. Unzip the saved file and run the installer executable as administrator by right clicking on the file and selecting *Run as Administrator*. In the TX73L64EVM GUI installer window, click the *Next* > button.

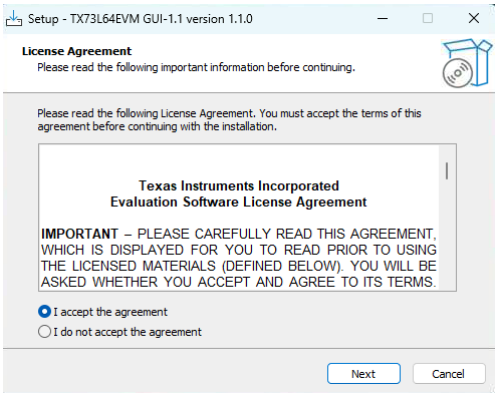


Figure 3-1. TX73L64EVM GUI Install (License Agreement)

   b. Read the Texas Instruments License Agreement. Select the *I accept the agreement* radio button, and then click the *Next* >button.

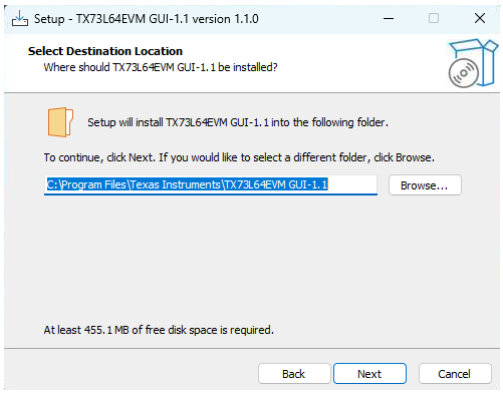


Figure 3-2. TX73L64EVM GUI Install (Select Destination Location)

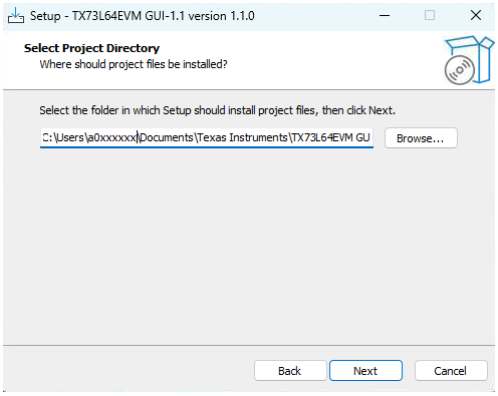


Figure 3-3. TX73L64EVM GUI Install (Select Project Folder)

c. Select the destination folder where the software has to be installed and where the project folder has to be placed (documents folder). Keeping default settings is preferred. The user created scripts are saved in the project folder by default.

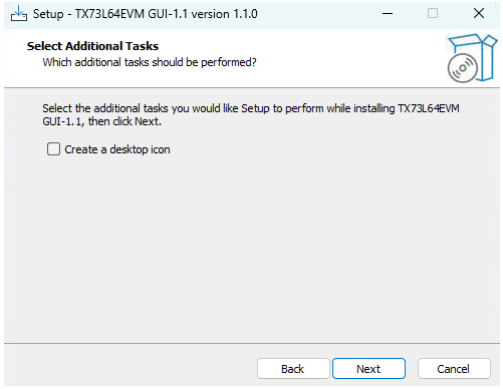


Figure 3-4. TX73L64EVM GUI Install (Installation Ready)

d. Create a desktop icon if desired. Click *Next* >.

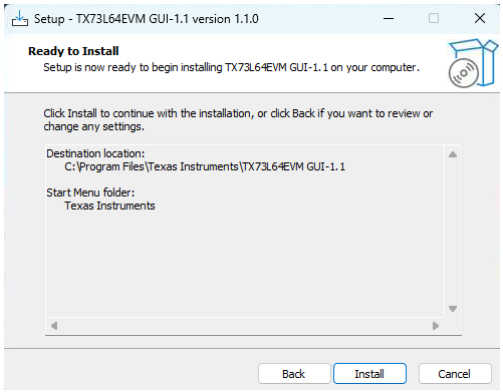


Figure 3-5. TX73L64EVM GUI Install (Ready to install)

e. Click *Install* and wait for installation.

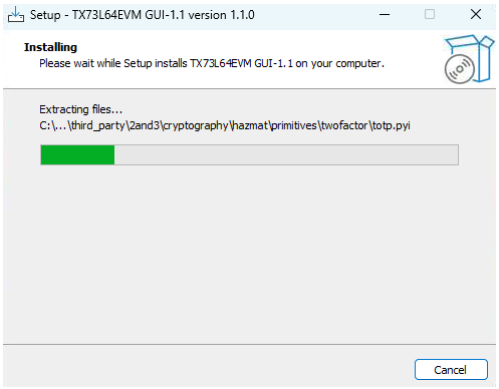


Figure 3-6. TX73L64EVM GUI Install (Installing)

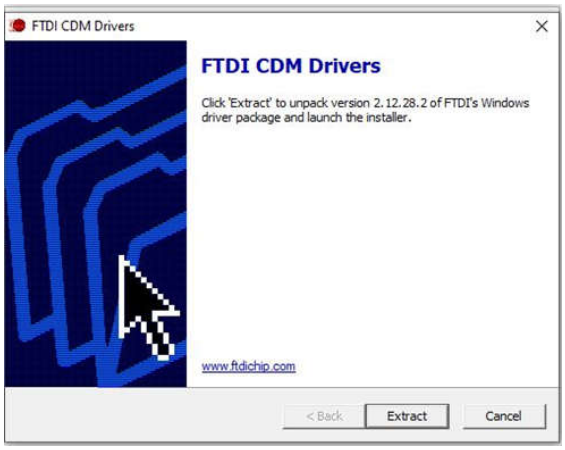


Figure 3-7. TX73L64EVM GUI Install (FTDI CDM Drivers)

f. Click *Extract* and go to the next page.

Figure 3-8. TX73L64EVM GUI Install (Welcome to the FTDI Installation Wizard)

g. Click *Next* > and go to the next page.

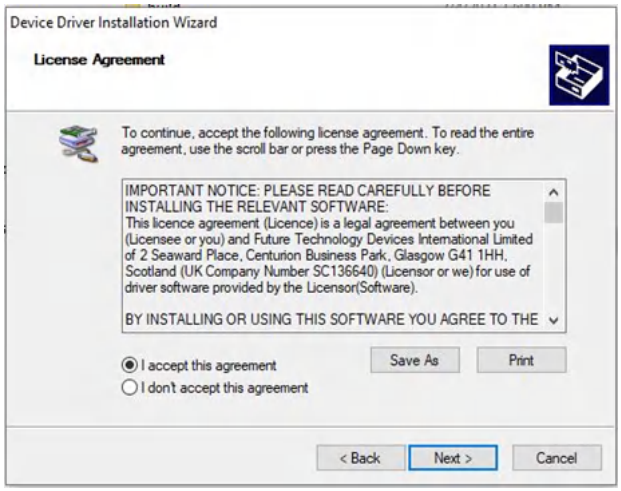


Figure 3-9. TX73L64EVM GUI Install (FTDI License Agreement)

h. Accept the license Agreement and click *Next* >.

Figure 3-10. TX7316EVM GUI Install (Completing the Device Driver Installation Wizard)

i. The FTDI drivers have been installed. Now, click *Finish*.

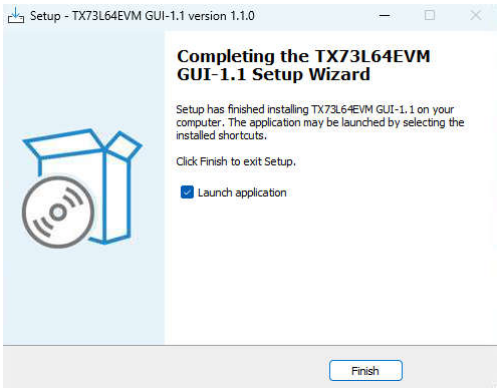


Figure 3-11. TX7316EVM GUI Install (Completing the TI-Latte Setup Wizard)

j. The GUI installation is complete. Click *Finish*.

4 Implementation Results

4.1 EVM Testing

EVM can be configured and tested in different modes using GUI.

4.1.1 EVM Connection

- Make sure that the power supplies are turned off before connecting to the board
- Apply ±5V to connector J3 (set the current limit of both the supplies to 500mA)
- Apply ±100V to connector J2 (supply can be any value between ±1.5V to ±100V). Set the current limit to 50mA
- Connect USB cable

4.1.2 Powering up EVM

Make the power supply connection as shown in Figure 2-1.

Connect the USB cable before powering up the EVM.

The EVM requires no specific power supply sequence. Set the ±5V and HV supplies to the expected values.

After powering up the supplies:

- LED D13: ON showing status of USB cable connection.
- LED D17: ON showing status of FTDI.
- LED D9: ON showing status of on board 3.3V LDO.
- LED D10: ON showing status of on board 1.8V LDO.
- LED D1: OFF showing status of device TSHUT pin.
- LED D4: OFF showing status of device TX_RXZ pin.
- LED D12: OFF showing status of device CRC_ERR pin.

Table 4-1 lists the expected supply current after power up and hardware reset that include both device and board current.

Table 4-1. Supply Currents

Supply	Current (mA)	Supply	Current (mA)
+5V	230	-5V	1
+100V	2.8	-100V	2.8

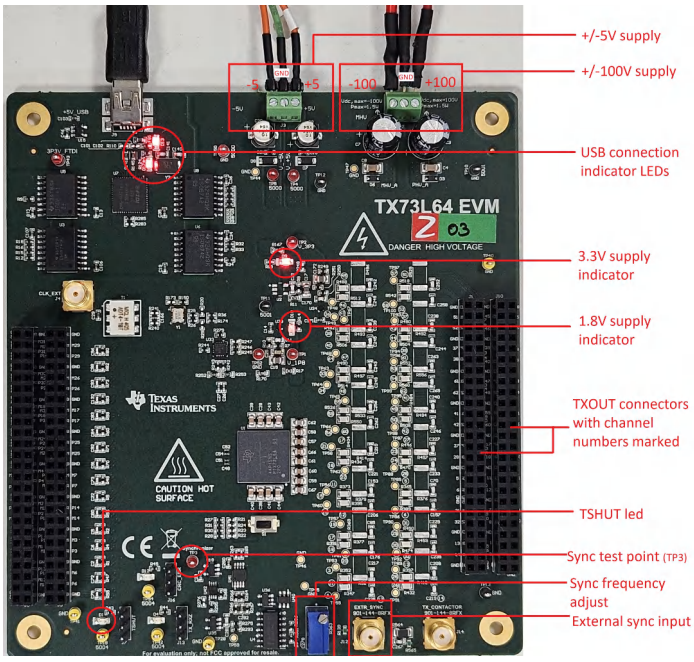


Figure 4-1. EVM Power Up State

4.1.3 Testing EVM

Power up the EVM before opening the GUI. Steps to open GUI:

1. To open the GUI, either click the TX73L64 GUI icon on Desktop or write TX73L64 GUI on start menu and click Open.
2. The latte software opens.
3. Go to scripts section in left corner of GUI and select file *Files > Project -> TX73L64 _GUI and select file devInit.py*.
4. Click the run -> buffer option as shown in Figure 4-2. Interactive GUI opens as shown in Figure 4-4. Check the logs section of the GUI. It should be similar to Figure 4-3.
5. Select the TX73L64_GUI under Tree View to navigate across pages.

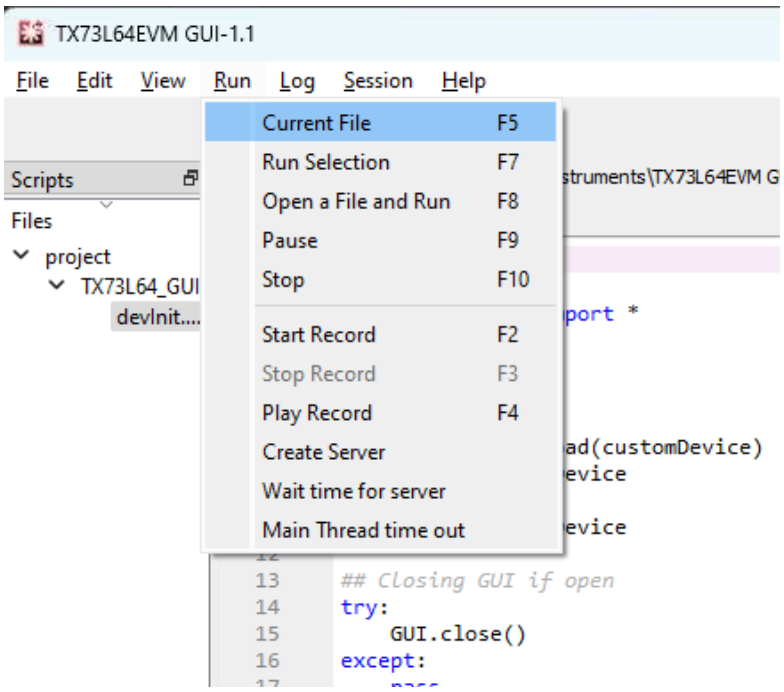


Figure 4-2. Latte GUI Window

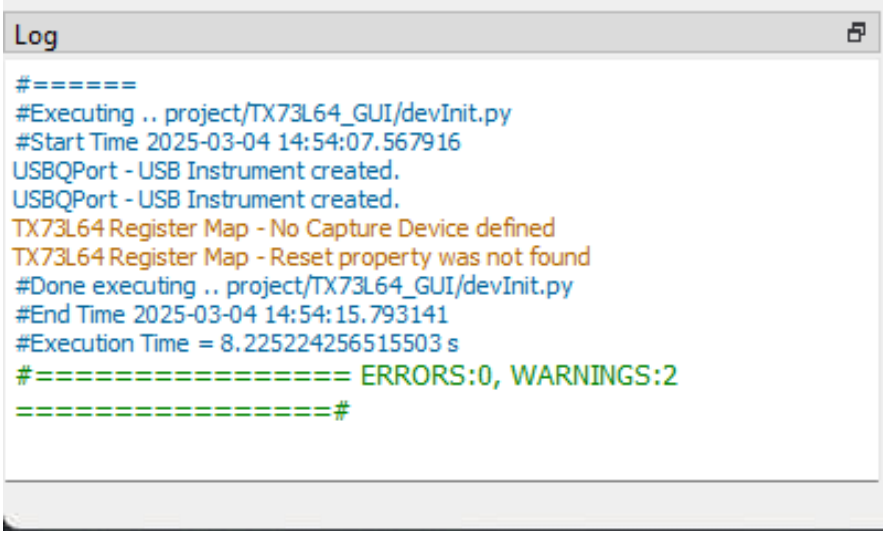


Figure 4-3. Device initialization Logs

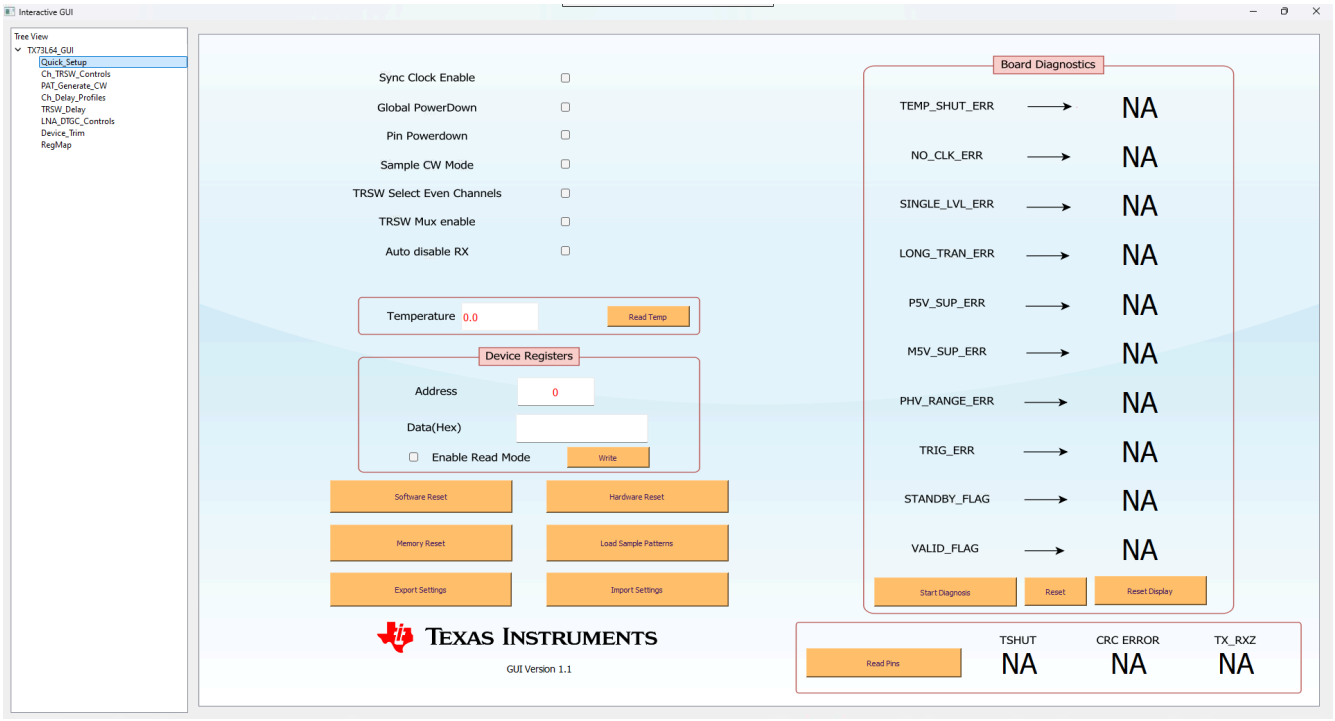


Figure 4-4. TX73L64 Interactive GUI

4.1.3.1 Initializing Device

Follow below steps to load and generate known pattern from the device.

1. Navigate to the *Quick Setup* page and click on *Hardware Reset*. This resets any previous settings on the device to the default values and takes approximately 20 seconds. The GUI displays a pop-up message after the hardware is reset.
2. Then click on *Memory Reset* (once per power up cycle is enough). Memory on power up is not reset and contains undefined data. Clicking memory reset button writes 0 to all the memory location. Resetting the memory takes around 10 seconds. The GUI displays a pop-up message after the memory is reset.
3. Click the *Load Sample Patterns* button. This loads a set of predefined patterns into the device.

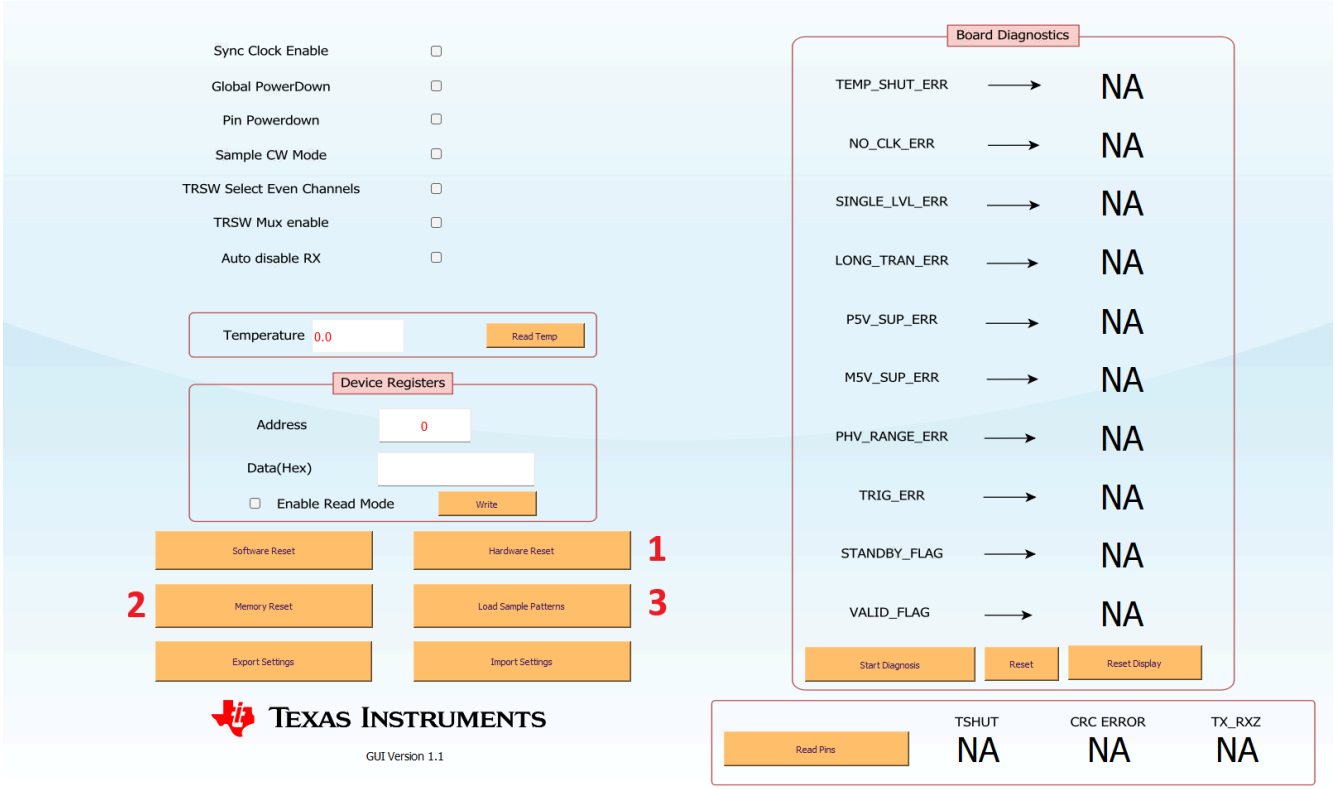


Figure 4-5. Device Initialization Steps

4. Now check the Board Diagnostics Block. First click the *Reset Display* button and then click *Start Diagnosis*. All the flags must pass the test. The user can also read the device status pins TSHUT, CRC ERROR and TX RXZ by clicking the *Read Pins* button below the Board Diagnostics section.

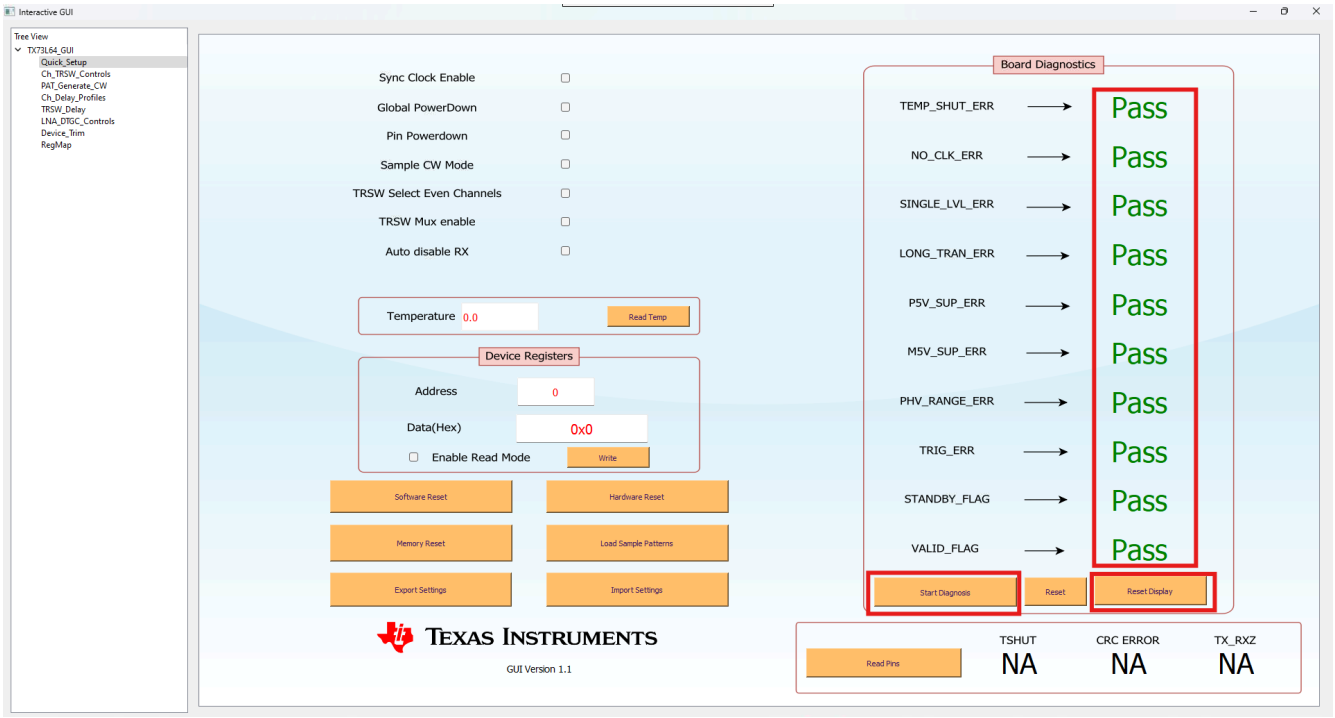
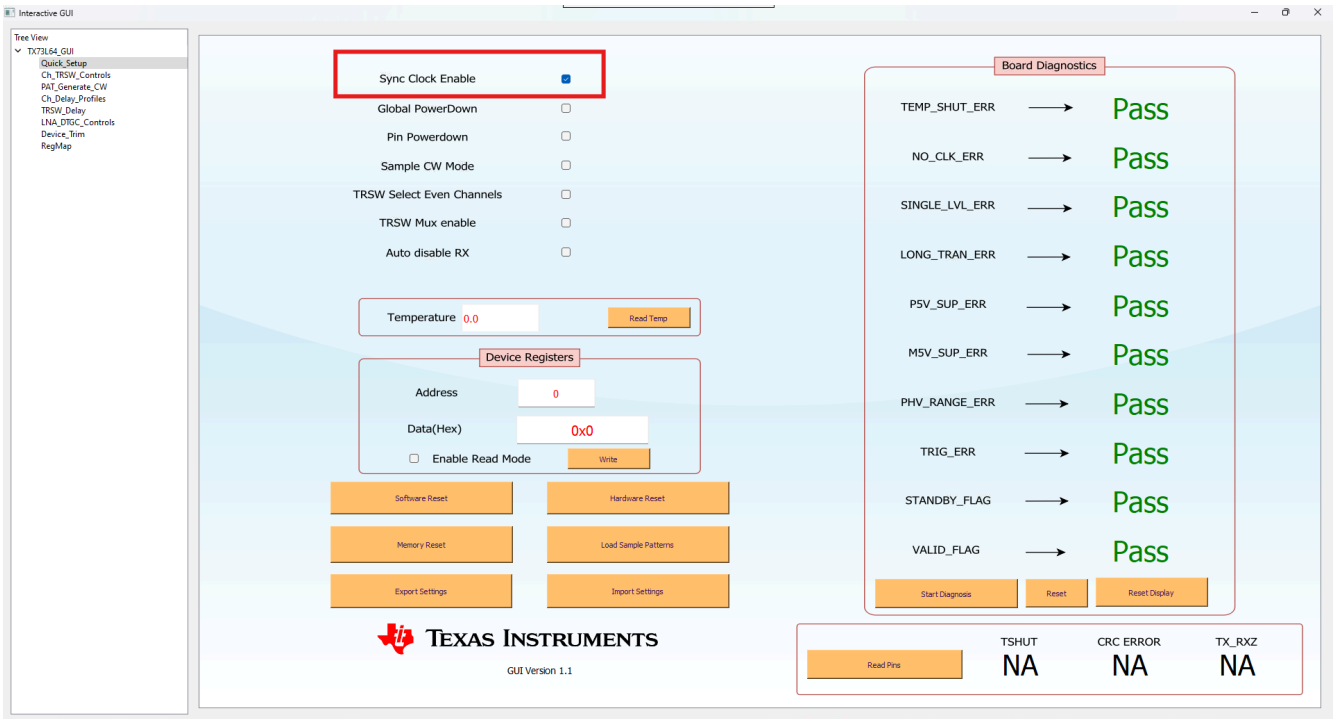


Figure 4-6. Checking Error Flags

5. Selecting the *Sync Clock Enable* check box will enable sync. This provides continuous sync signals to the device, and the device starts to transmit the default loaded pattern if HV supply is provided before this step.

   It is best to keep the sync disabled until the user is ready to transmit.



Setting the sync PRF:

1. The frequency of sync signal is controlled by the resistance R363.

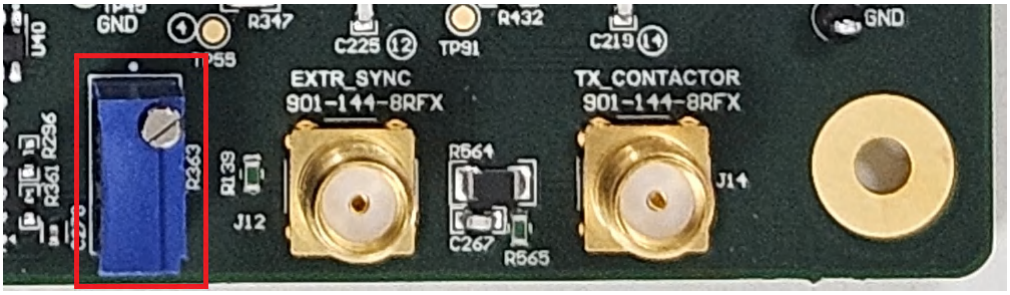


Figure 4-7. Changing Sync PRF on EVM

2. Set the sync PRF to as expected by rotating the potentiometer controlling R363.
3. This can be done while probing the Sync test point (TP3) to see the change in PRF live on the scope and adjust accordingly. Make sure to turn off the HV supply when doing this.

4.1.3.2 Loading Sample Pattern

After the GUI loads the predefined pattern in the device, select the pattern from the *Profile Select* drop-down menu in the *PAT_Generate_CW* page and the figure shows the pattern information. If the sync is enabled, the selected pattern can be probed at the TX test points.

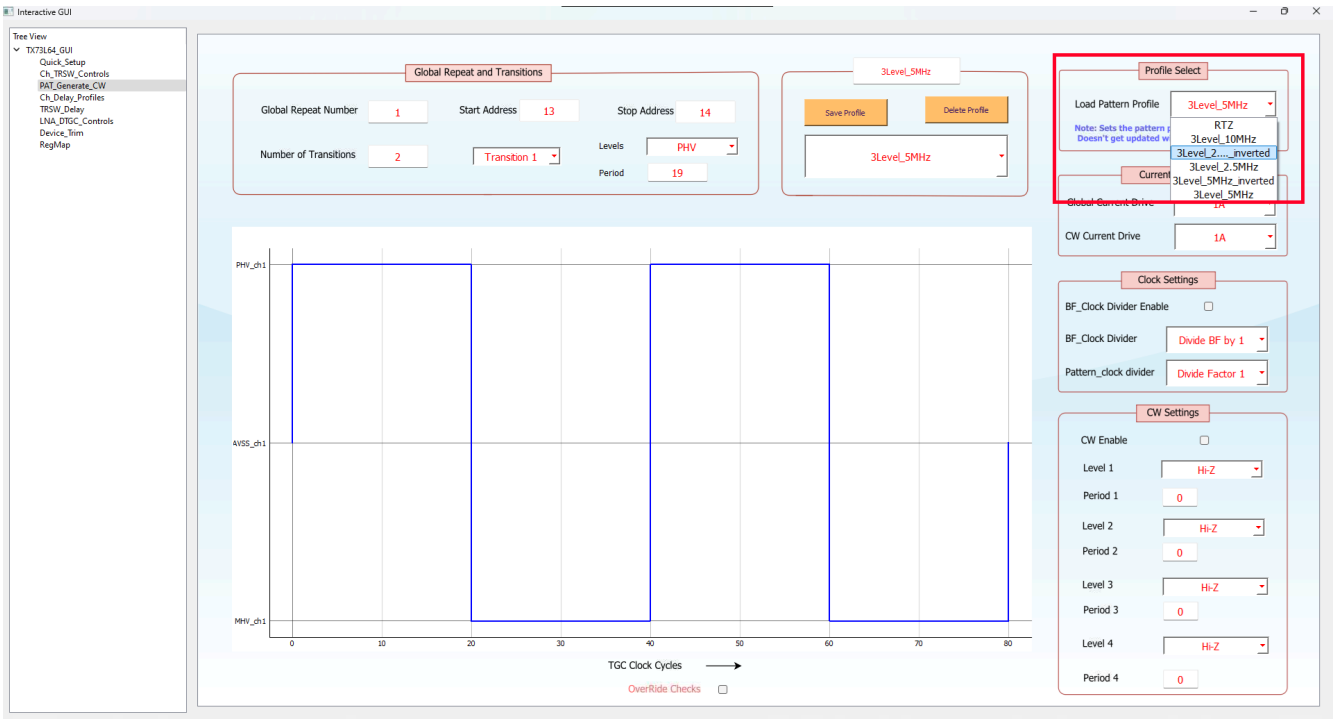


Figure 4-8. Pattern Profile Select Page

4.1.4 GUI Control

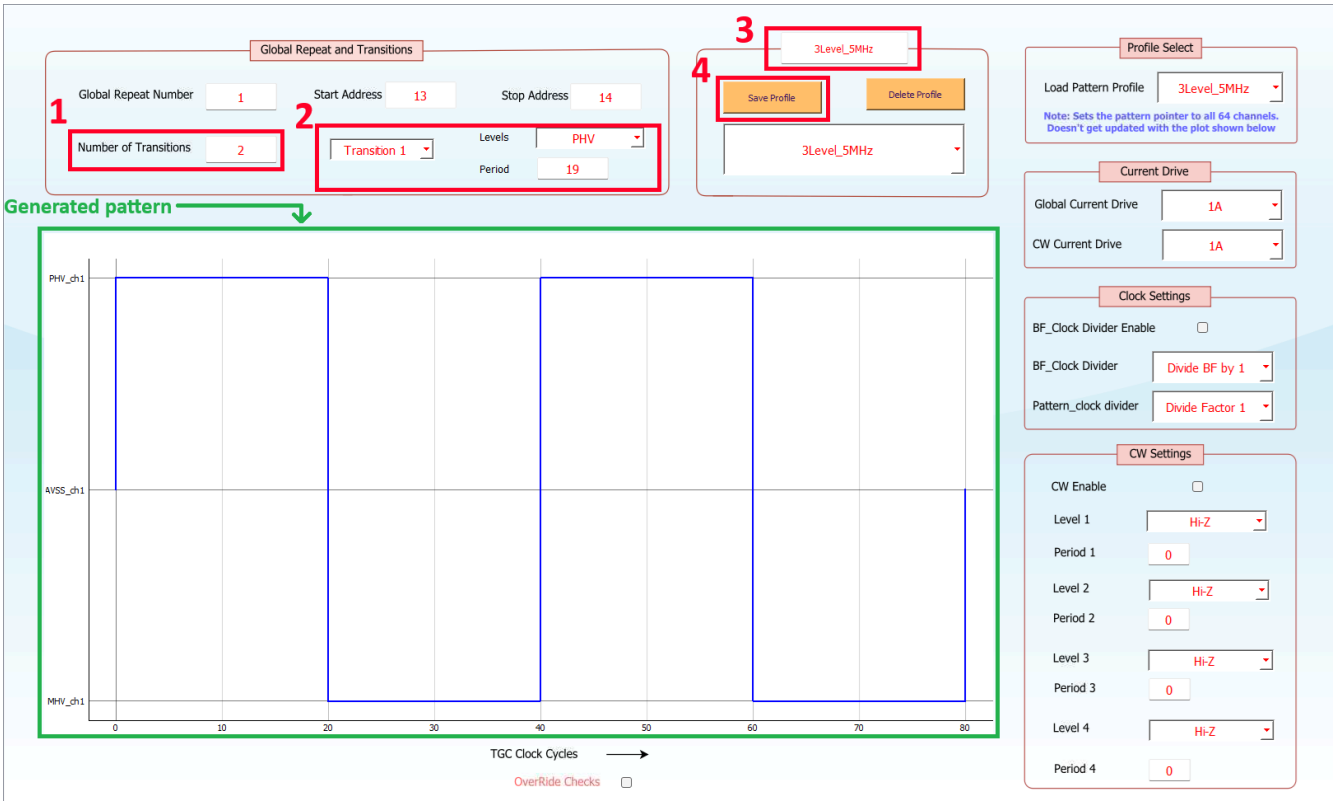
4.1.4.1 Generating New Patterns

Users can define the choice of pulser output pattern in B-mode using *PAT_Generate_CW* section.

Steps to define new pattern.

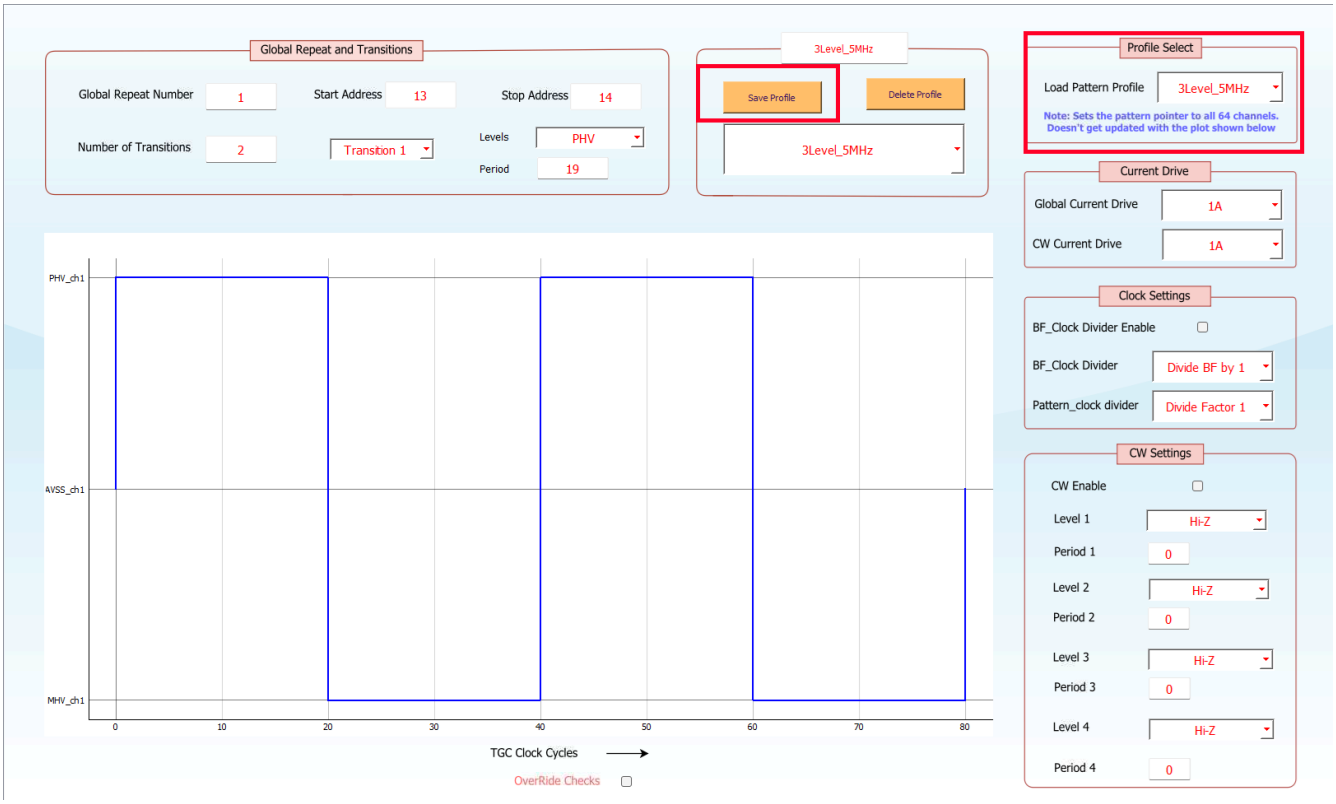
1. Enter number of transitions.
2. Program required level and duration of each transitions. The effective duration of each transition is programmed value + 1 clock cycle.
3. Give the pattern a name.
4. Press *Save Profile*.

By default, the pattern pointer points to the last saved pattern. To enable a different pattern, choose the required profile name from the load pattern profile section (explained in Saving and Loading Patterns).



4.1.4.2 Saving and Loading Patterns

The GUI has separate options to edit or save pattern profile and to set the pattern pointer. Save profile button writes the pattern data to all 16 pages in memory. The load pattern profile button sets the pattern pointer to the chosen pattern and all 64 channels transmit that specific pattern. This allows the user to save multiple commonly used profiles and quickly switch between different profiles.



4.1.4.3 Setting Channel Controls

The *Ch_TRSW_Controls* section allows the user to program settings on specific channels like powering up the pulsers, inverting the pattern and permanently enabling/disabling the TR Switch. Controls are grouped for 4 channels in a widget and every widget takes a 4-bit string as input.

Example: Writing the string *0101* in Ch 4-1 PowerDown powers down channels 1 and 3. Note that the value entered in the field is automatically treated as a string and there is no need to provide the ‘’ for the input to specify the string.

To apply a setting to all channels, click the tick box at the top of every column. The individual widgets can still be modified. For example, to power down all channels and power up only channel 1, use all channels power down and then write *1110* in *Ch 4-1 PowerDown* field.

4.1.4.4 Setting Delay Profile

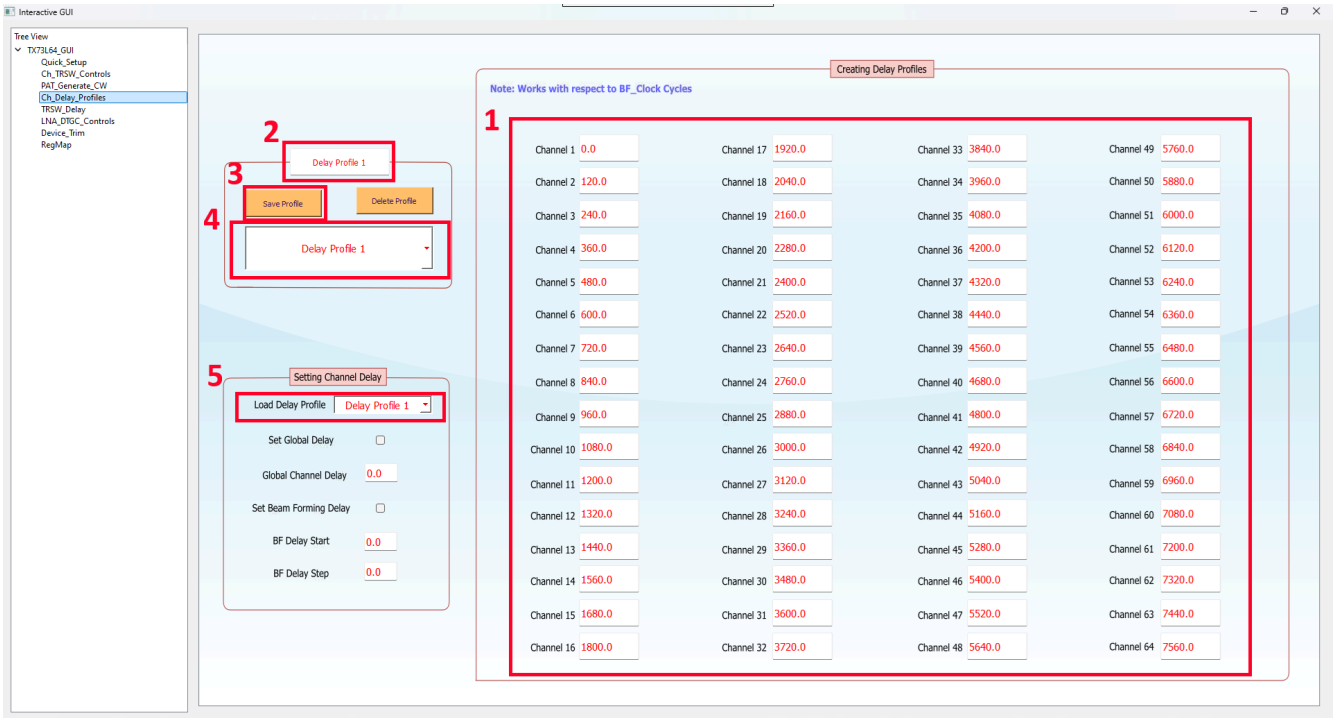
The *Ch_Delay_Profiles* section can be used to store and load multiple delay profiles.

Steps to define a new profile:

1. Enter the required delay for every channel in the corresponding widget. Half clock delays are allowed. Any other decimal value entered is rounded off to the nearest valid value.
2. Give the delay profile a name.
3. Click *Save Profile*. This writes all the delay profiles into device memory.
4. Previously saved profiles can be edited by choosing the required profile, updating the delay values of the required channels and saving again. The profile to edit can be chosen from the drop-down box.
5. Load the required delay profile. This sets the delay pointer to the required profile.

Note

Just entering a delay value in for a specific channel in the widget does not be reflect on the device. The corresponding profile has to be saved and then loaded for the change to take effect.



To help with setting the delay value for all 64 channels, the GUI supports global delay mode and beamforming delay mode. This updates the channel delay widgets.

These are just software level options in the GUI. The device has no such specific operation modes.

1. For global delay mode:
   a. Enable *set global delay*.
   b. Set the expected value in ‘global channel delay.
2. For beamforming delay mode:
   a. Enable *set Beam Forming delay*.
   b. Set the expected beamforming start value and incremental step size.

To update the delay of a specific channel after using either of these modes, just deselect the *set global/ beamforming delay* check boxes and set the required value in the corresponding widgets for the channel. Then save the profile for the changes to take effect.

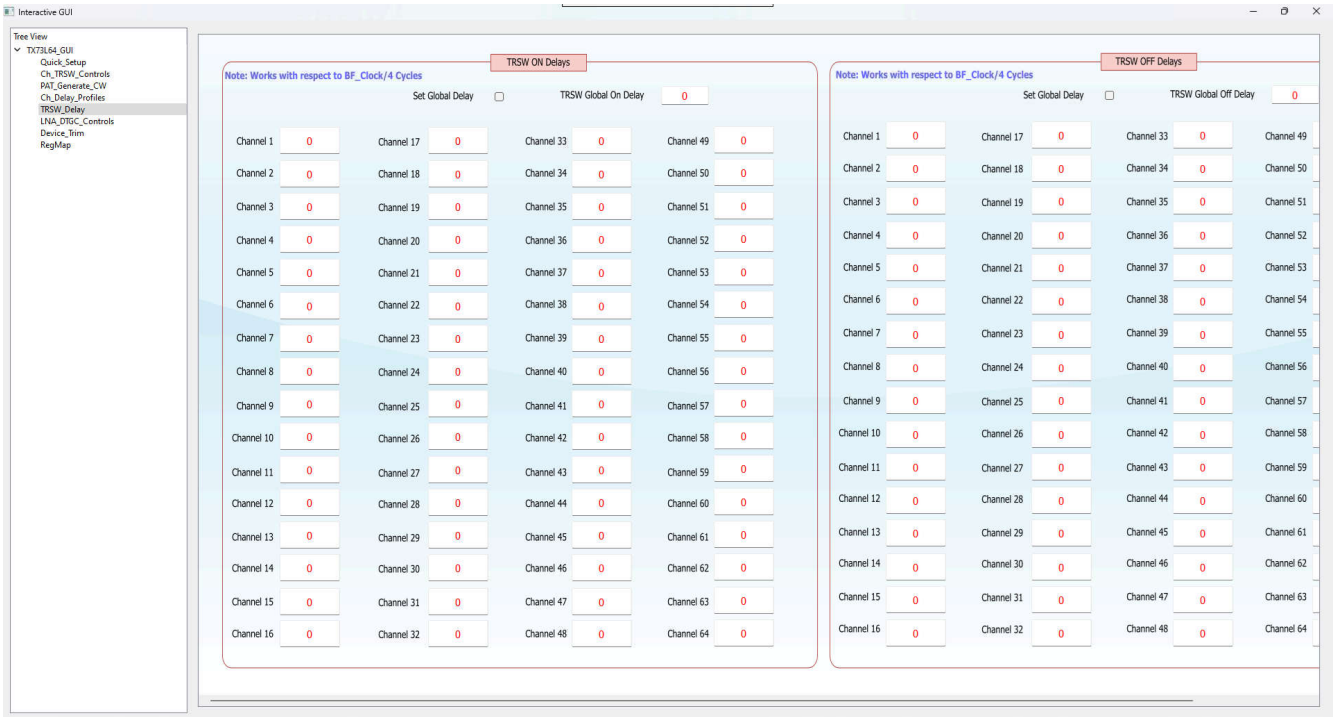
4.1.4.5 Setting T/R Switch Delays

The *TRSW_Delay* section can be used to set the TR Switch On and Off delays.

Unlike channel delay, updating the delay value for a widget of a specific channel updates into the device and the change takes effect.

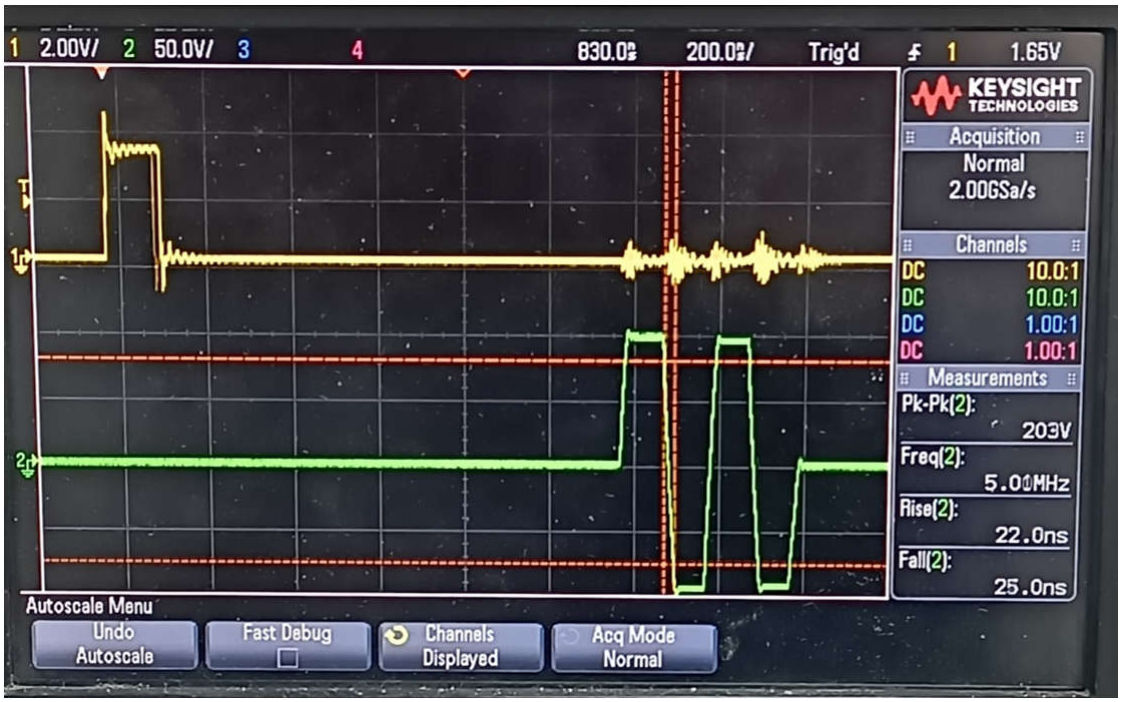
To set the same value to all channels, use the *set global delay* checkbox and enter required value in the corresponding global delay widget.

To update further, clear the check box and edit the delay values for the required channels alone.



4.1.4.6 Sample B-mode Pattern

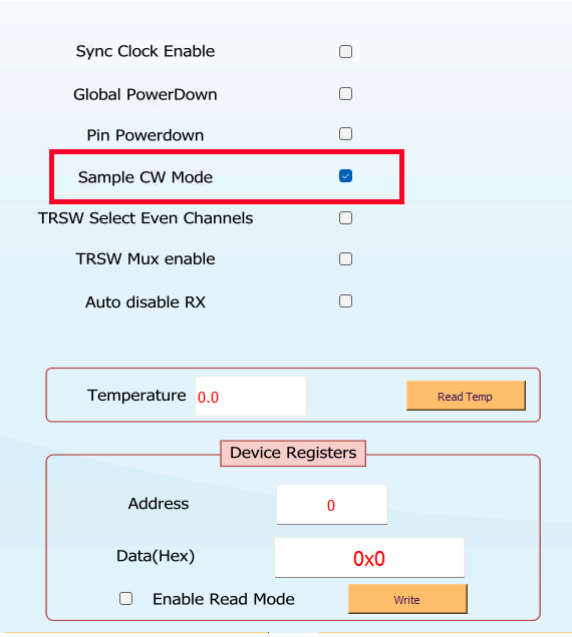
Loading a 3-level, 5MHz pattern from the sample patterns looks like this:



4.1.4.7 Sample CW Pattern

1. Set the HV supply to < 10V to prevent thermal shutdown.
2. Keep supply current limit as 500mA.
3. In the GUI, navigate to *Quick_Setup* page and check the *Sample CW Mode* checkbox.

This enables a 4MHz NRZ waveform in CW mode in the pulsars of channels 1-8.



The CW waveform can be modified using *CW settings* registers.

By default only 8 channels are enabled as shown below. Having all the 64 channels enabled increases power can cause the device to go in thermal shutdown mode depending on applied supply voltage.

To change the pattern settings, uncheck *CW Enable* widget, update the level period information and select *CW Enable* once again.

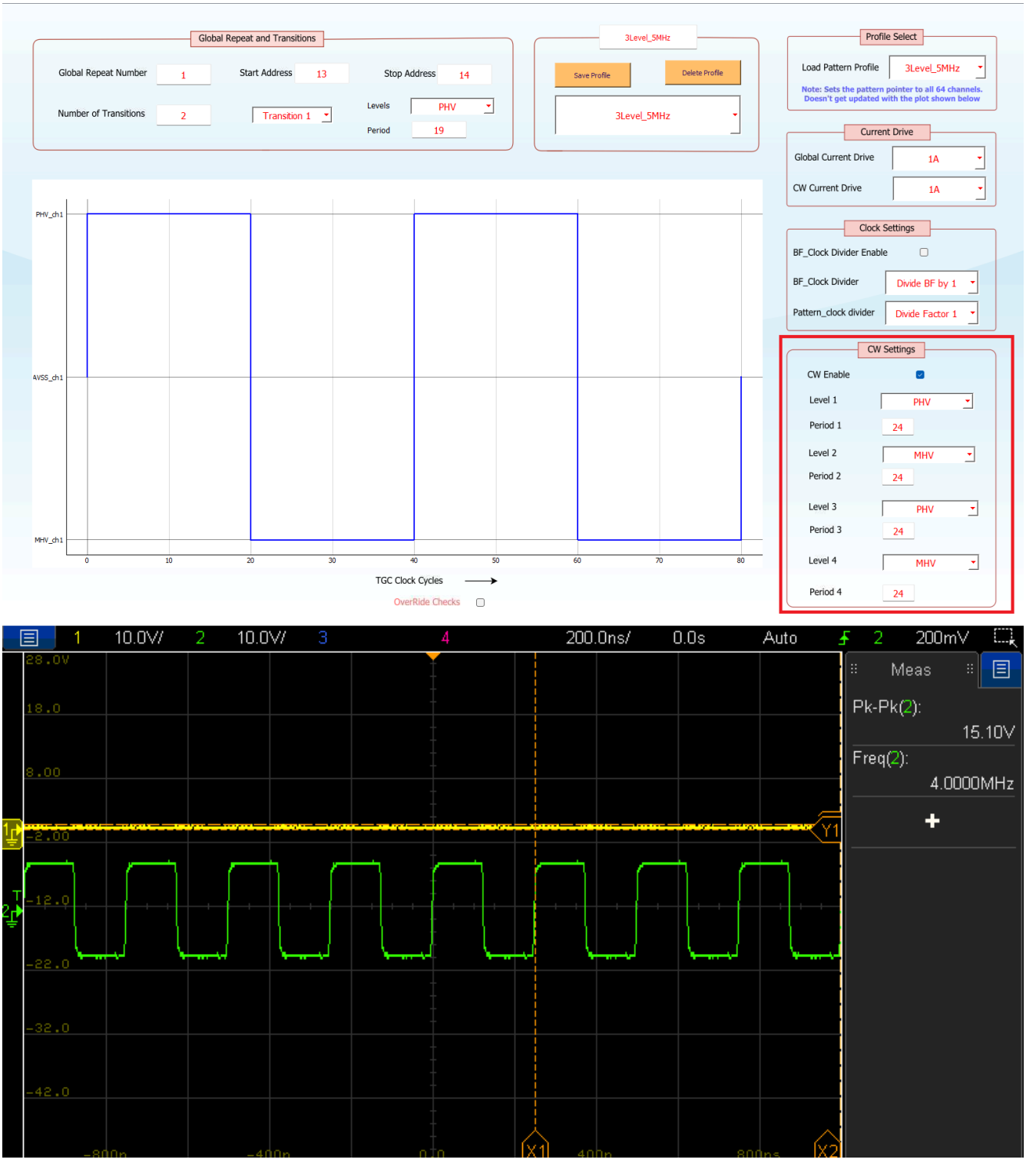
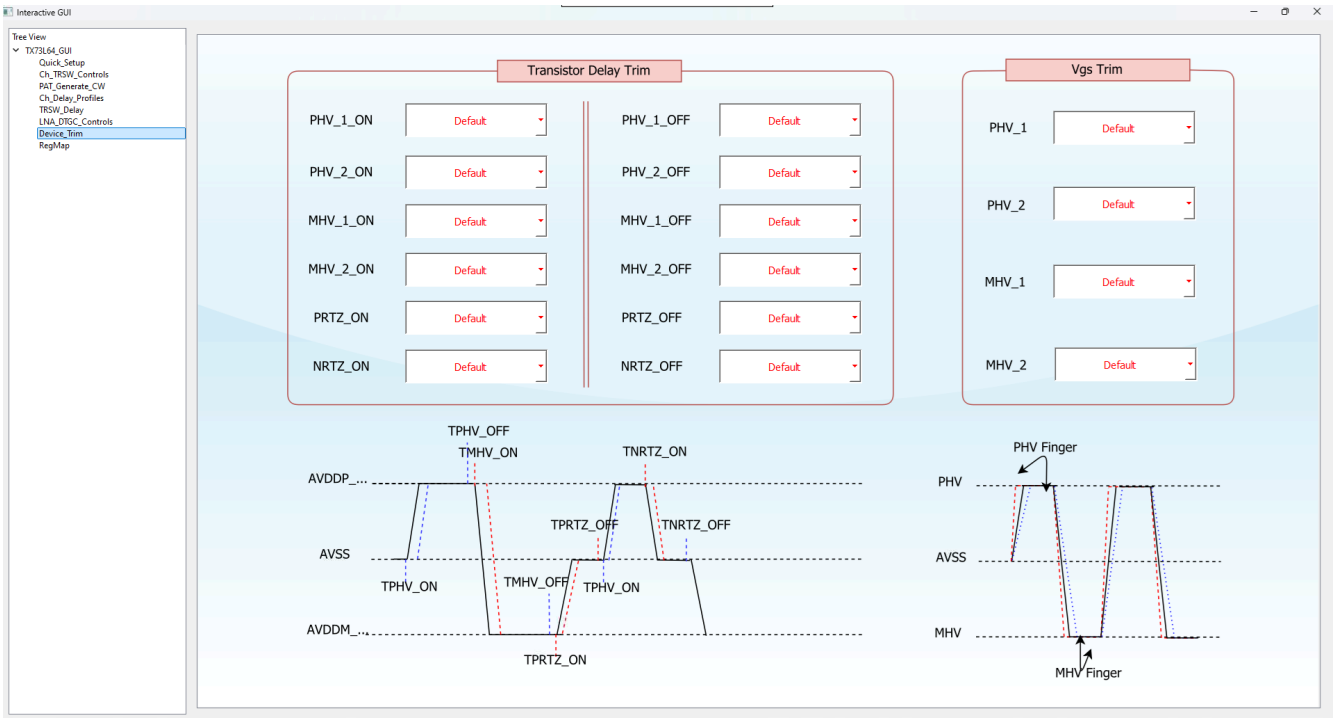


Figure 4-9. CW Pattern with Supply of 8V on Scope

4.1.4.8 Setting Trim Options

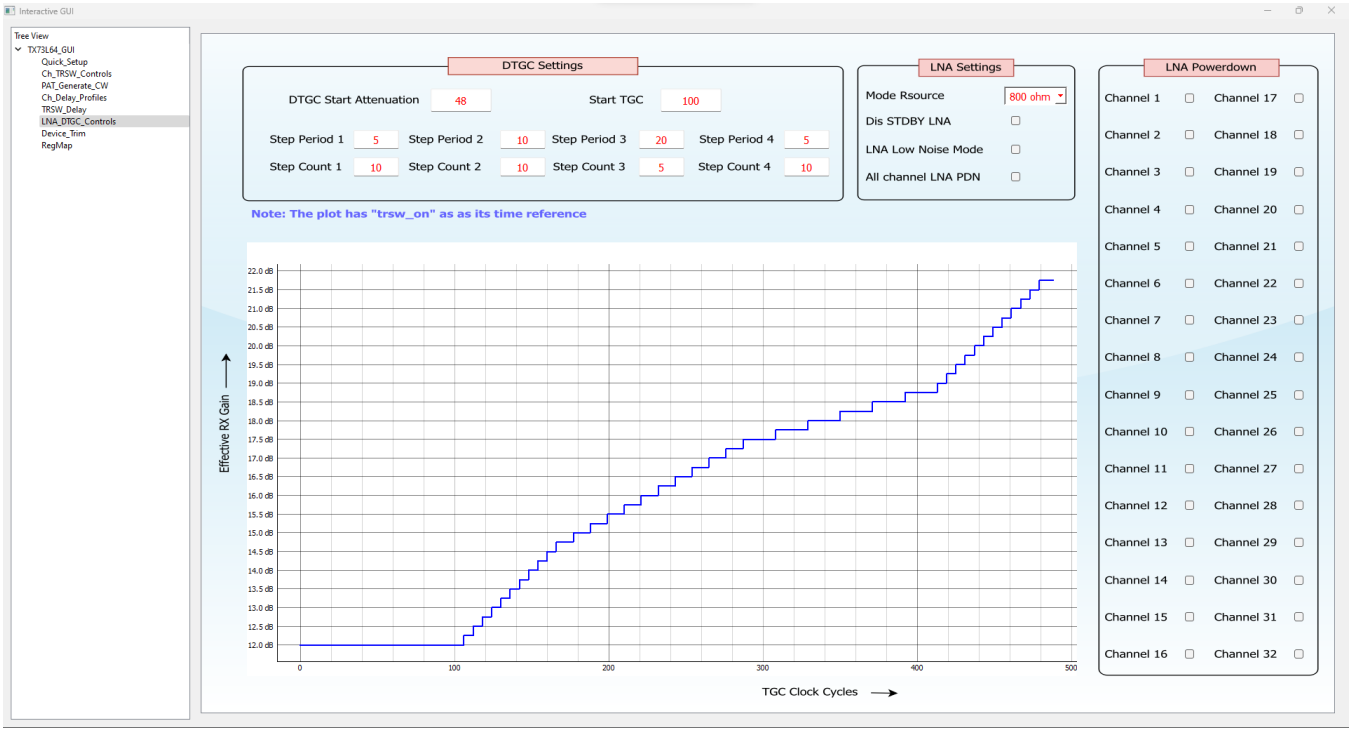
The transistor delays and Vgs values can be trimmed from the GUI to meet user specifications if required.

Separate drop down menus show available trim options for the transistors connected to each supply.



4.1.4.9 LNA and DTGC Settings

The LNA_DTGC_Controls page in the GUI has various LNA controls and also allows programing the TGC (Time gain compensation) engine of the device. Refer data sheet to understand how to program the TGC engine and various LNA controls.



4.1.4.10 Reading and Writing Device Registers

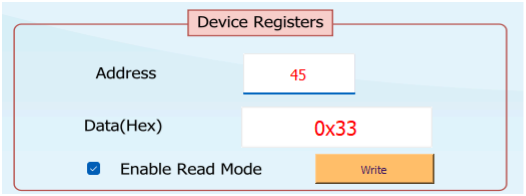
The GUI allows user to read and write to device registers by address. For the register addresses and their functionality, refer the data sheet for TX73L64.

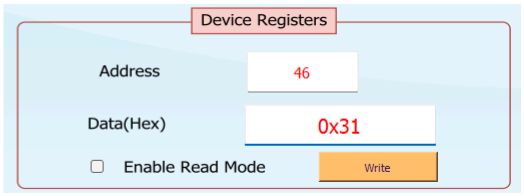
To write to device registers, follow the below steps:

1. In the Device Registers section in Quick_Setup tab, enter the register address (in decimal) in the Address field and the value to write (in hexadecimal) in the Data field.
2. Click the *Write* button.The user can check the logs for the details of the register write.

To read from device registers, follow the below steps:

1. In the Device Registers section in *Quick_Setup* tab, select the *Enable Read Mode* check box.
2. Enter the register address (in decimal) in the Address field.
3. Press enter. The read value is displayed in the Data field in hexadecimal.





4.1.A TX73L64EVM Automation

4.1.A.1 Automation using Latte based TX73L64 GUI

4.1.A.1.1 Widgets

Widgets are the elements of interaction in the GUI.

To automate GUI, knowing the name of the widget is important. The widget name can be known by hovering over a particular widget with the cursor.

Example:

- When hovering over the level number widget, the widget name is observed as *~. _levelnum*.
- Ignore *~. _* and only consider *levelnum* as the widget name.
- GUI.levelnum returns the value of the widget.

There are four types of widgets.

- Choice widget
- Text-box widget
- Button widget
- Check-box widget

Each widget has a different way of value declaration and are identified by looking at the widgets.

4.1.A.1.1.1 Choice Widget

This type of widget has a drop-down as shown. To programmatically set a value to the widget, use the following syntax:

GUI.widget_name = index

Example: GUI.transitionsBox = 1 selects *Transition 2*.

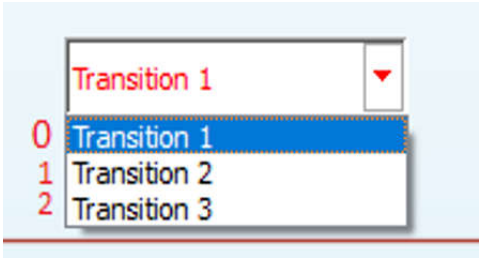


Figure A-10. Transitions

Accessing the choice widget using the string inside the drop-down is not possible at the moment. Hence, accessing the choice widget using the index number is preferable and safe. To know the index of the string in the drop-down, expand the drop-down as shown in Figure A-10 and start numbering the string starting from 0. Then use the number and assign the value to the GUI.widget_name = number. This works for all the widgets which are of drop-down type or choice type.

4.1.A.1.1.2 Button Widget

This type of widget looks like a button. To programmatically click a button, use the following syntax:

GUI.widget_name = True

Example: GUI.loadSamplePattern = True triggers the saving of profile in the device.

Figure A-11. Load Sample Patterns

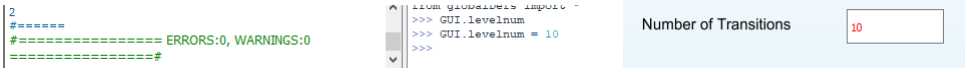
The button widget is used to execute a set of instructions in the background. This does not have a choice. If the button is clicked, then the GUI assumes the user wants to execute something in the function which is pre-defined by the GUI programmer. In Figure A-11, if the Load Sample Pattern is pressed, this means the user intends to configure the device with sample patterns.

4.1.A.1.1.3 Text-Box Widget

This type of widget has a box as shown. To programmatically set a value to the widget, use the following syntax:

GUI.widget_name = value

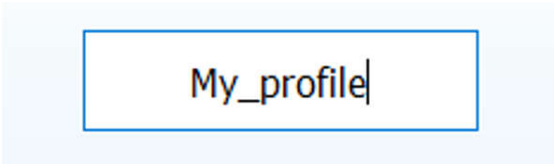
Example: GUI.levelnum = 10 sets the sync Number of levels to 10.



Note

Strings must be enclosed in “ ” while integers can be given directly.

GUI.profileName = "*My_profile*” names the profile.



4.1.A.1.1.4 Checkbox Widget

This type of widget has a square box.

To programmatically enable the widget, use the following syntax:

GUI.widget_name = True

To programmatically disable the widget, use the following syntax:

GUI.widget_name = False

Example: GUI.syncClk = True enables sync.

4.1.A.1.2 Register Operations

It is possible to read and write into the device register by the GUI Device Registers section or by script. To read and write by scripting, follow the below steps.

This skips most of the background functions and directly gets written into or read from the device.

4.1.A.1.2.1 Writing into a Device Register

The syntax for writing into the device is:

demoTest.jyoti_dev.RawWriteReg(addr, data)

where:

addr = Address of the register in the device.

Data = Data to be written.

Refer to the data sheet to see which register corresponds to which functionality in the device.

4.1.A.1.2.2 Reading from a Device Register

The syntax for writing into the device is:

Value = GUI.JyotiRead(addr)

where:

addr = Address of the register in the device.

Value = Variable which contains the data inside the register of the device.

4.1.A.1.3 Generating Scripts for Automation through TX73L64 GUI

Follow the procedure below to generate automation scripts.

1. Open the TX73L64 GUI from the Latte and run *devInit.py* (Run ➔ Buffer).
2. Right-click the TX73L64_GUI profile as shown below, select *Add Script* and double-click to rename to *Automation_script.py*.

Consider the following example:

1. Initialize the GUI.
2. Enable the Sync.
3. Generate a 4 cycle PHV to MHV transition waveform of 5MHz.
4. Name the profile as *Example*.
5. Power down all the channels except channel 1 and 2.
6. Invert the pattern in channel 2.
7. Set channel 1,2 Delay to 40 nanoseconds (assuming the beamformer clock frequency to be 250MHz).
8. Set the pattern pointer to point to Example by using the index.
9. Set TRSW Delays to 16ns.

4.1.A.1.4 Automation Script

```
setattr (GUI,"memReset", True)     #memory reset the device
setattr (GUI,"hardReset", True)  #hardware reset the device
#delay(1) ##Give an optional delay of 1 second
### Assuming beam-former clock of 250MHz, one cycle is 4 Nano-second(1/250MHz
###Enter the transitions information. 5MHz waveform has 200ns period, which is 50 clock cycles
setattr (GUI,"levelnum",2) ## Enter the number of Transitions
setattr (GUI,"transitionsBox",0) ## Select "Transition 1" in the box
setattr (GUI,"level","PHV") ## Set the level to PHV
setattr (GUI,"period",24) ## Set the period to 100nSec by giving 24
setattr (GUI,"transitionsBox",1) ## Select "Transition 2" in the box.
setattr (GUI,"level","MHV") ## Set the level to MHV
setattr (GUI,"period",24) ## Set the period to 100nSec by giving 25
setattr (GUI,"globalRepeat",3) ## Repeating the pattern three more times
setattr (GUI,"profileName","Example") ## Save with a name "Example"
setattr (GUI,"saveProfile", True) ## Saving the profile in device and GUI
setattr (GUI,"allChPdn", True) ## Power down all the channels at once
setattr (GUI,"ch4p1Pdn", "1100") ## Power up Channels 1,2
setattr (GUI,"ch4p1Inv", "0010") ## Invert pattern in Channel 2
###Enter the channel delay information. 40 Nano-second delay is 10 clock cycles
setattr (GUI,"ch1delay", 10)               ## Set Channel 1 delay
setattr (GUI,"ch2delay", 10)               ## Set Channel 2 delay
setattr (GUI,"delProfileName","Profile 1") ## Save with a name "Profile 1"
setattr (GUI,"saveDelProfile", True)       ## Saving the profile in device and GUI
###Enter the TRSW delay information. 16 Nano-second delay is 1 clock cycle (divided)
setattr (GUI,"ch1TRon",1)  ## Set Channel 1 ON Delay to 16 Nano-Second
setattr (GUI,"ch2TRon",1)  ## Set Channel 2 ON Delay to 16 Nano-Second
setattr (GUI,"syncClk", True) ##Enable Sync
```

Copy and paste the above script into the created file and run the file (Run -> Buffer)

4.1.A.1.5 Automation Results

The GUI is updated in the following steps.

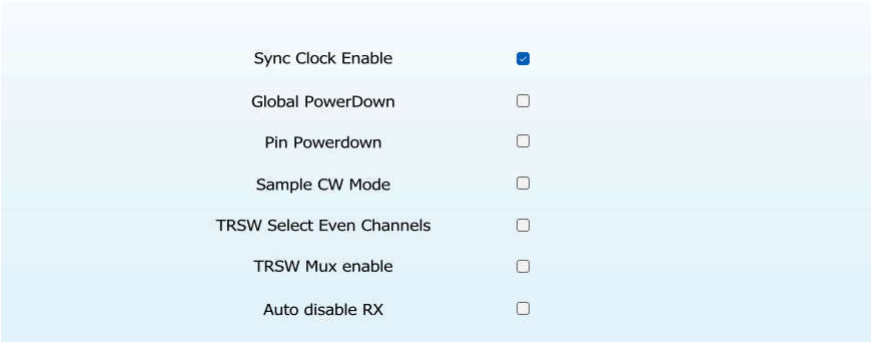


Figure A-12. Quick Setup Tab

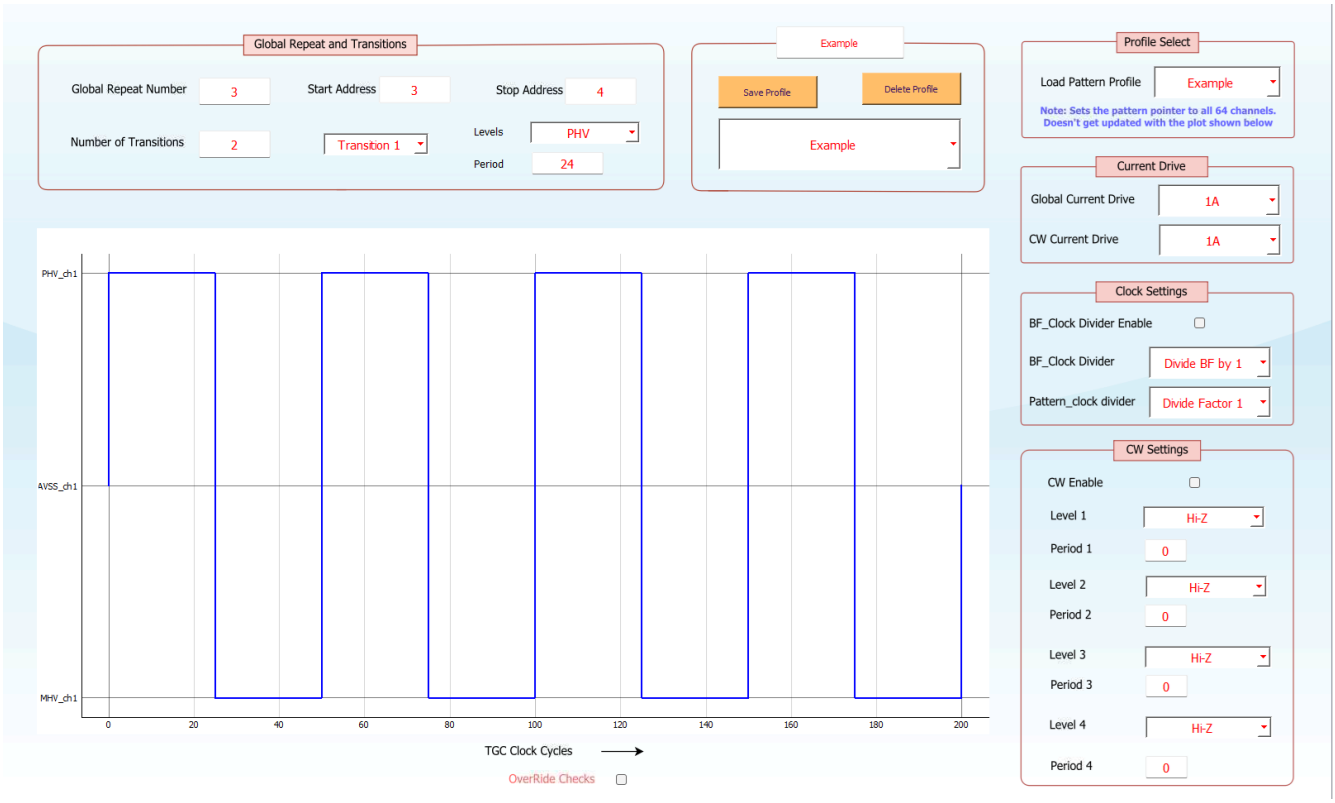


Figure A-13. PAT_Generate_CW Tab

Figure A-14. Ch_TRSW_Controls Tab

Figure A-15. TRSW_Delay Tab

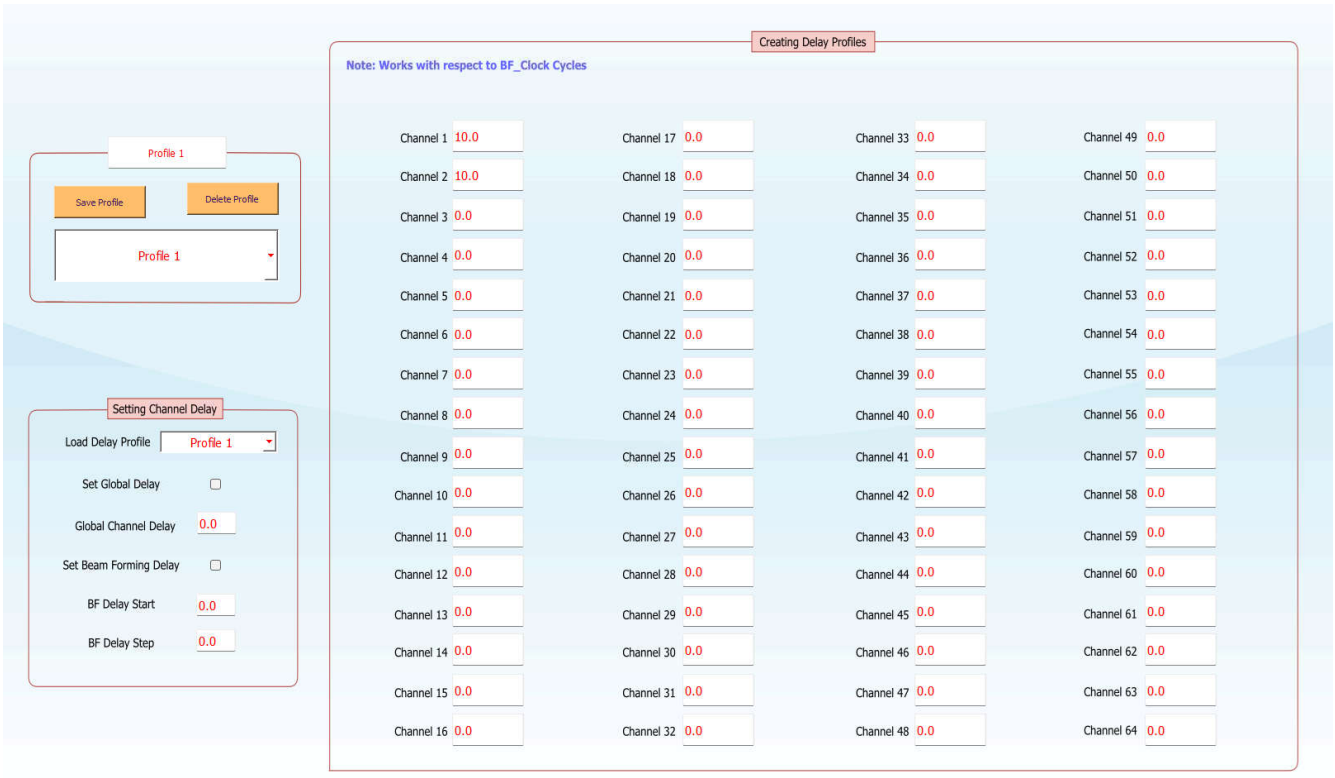
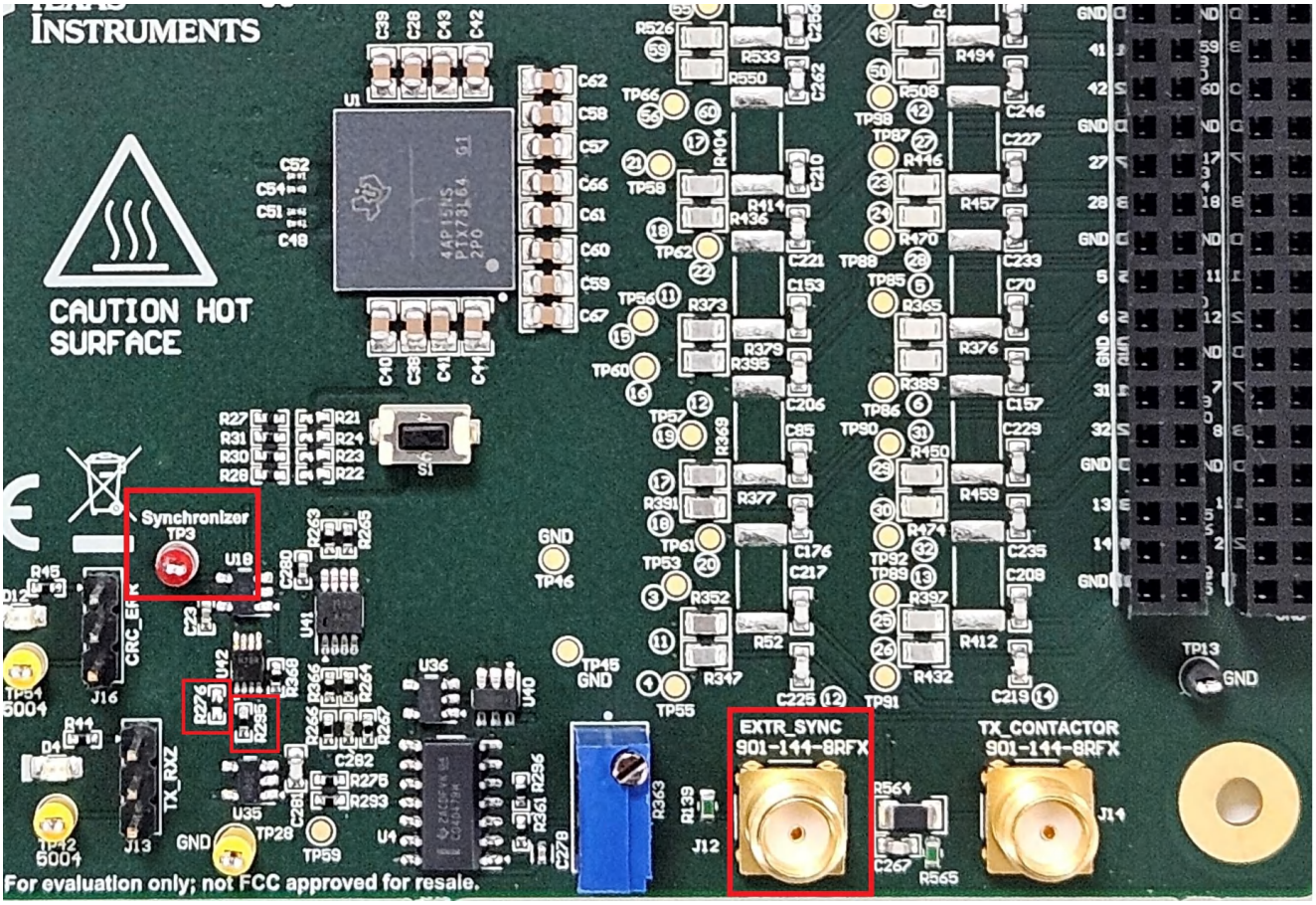


Figure A-16. Ch_Delay_Profiles Tab

4.1.6 Procedure to Apply External TR_BF_SYNC Signal to EVM

1. Open the TX73L64 GUI from the Latte and run *devInit.py* (Run ➔ Buffer(F5).
2. De-solder the 0Ω resistor R295 and solder a 0Ω resistor at R276
3. Now, connect a signal generator (3.3Vpp) to J12 as shown. Make sure the resistor pads R139 is populated with a 50Ω resistor to act as termination resistor and helpful for better signal integrity.



4. Connect the signal generator (in this context, an arbitrary waveform generator has been used) to J12 to apply external TR_BF_SYNC signal.
5. Now go to *Quick_Setup* tab and check the *Sync Clock Enable* box.

The user can observe the TR_BF_SYNC signal applied to the device on pin (Synchronizer TP3).

4.2 Measurement Techniques

The following subsections describe the measurement techniques to be used while testing the device.

4.2.1 Rise and Fall Times

Rise and fall times of the device must be measured from 10% to 90% of the peak to peak output voltage. For example, for a ±100V output swing, the thresholds used for the measurement must be ±80V.

4.2.2 Linearity

Linearity is an important parameter of the device, and is measured by following these steps:

1. Configure the device in the required output pattern.
2. Capture the device output on the oscilloscope by triggering TR_BF_SYNC signal.
3. Invert the output pattern.
4. Again capture the device output on the oscilloscope by triggering TR_BF_SYNC signal.
5. Post process the data for pulse cancellation and take the FFT to check the linearity.

5 Hardware Design Files

5.1 Schematics

Figure 5-1 through Figure 5-8 show the functional block diagram of EVM and the schematics.

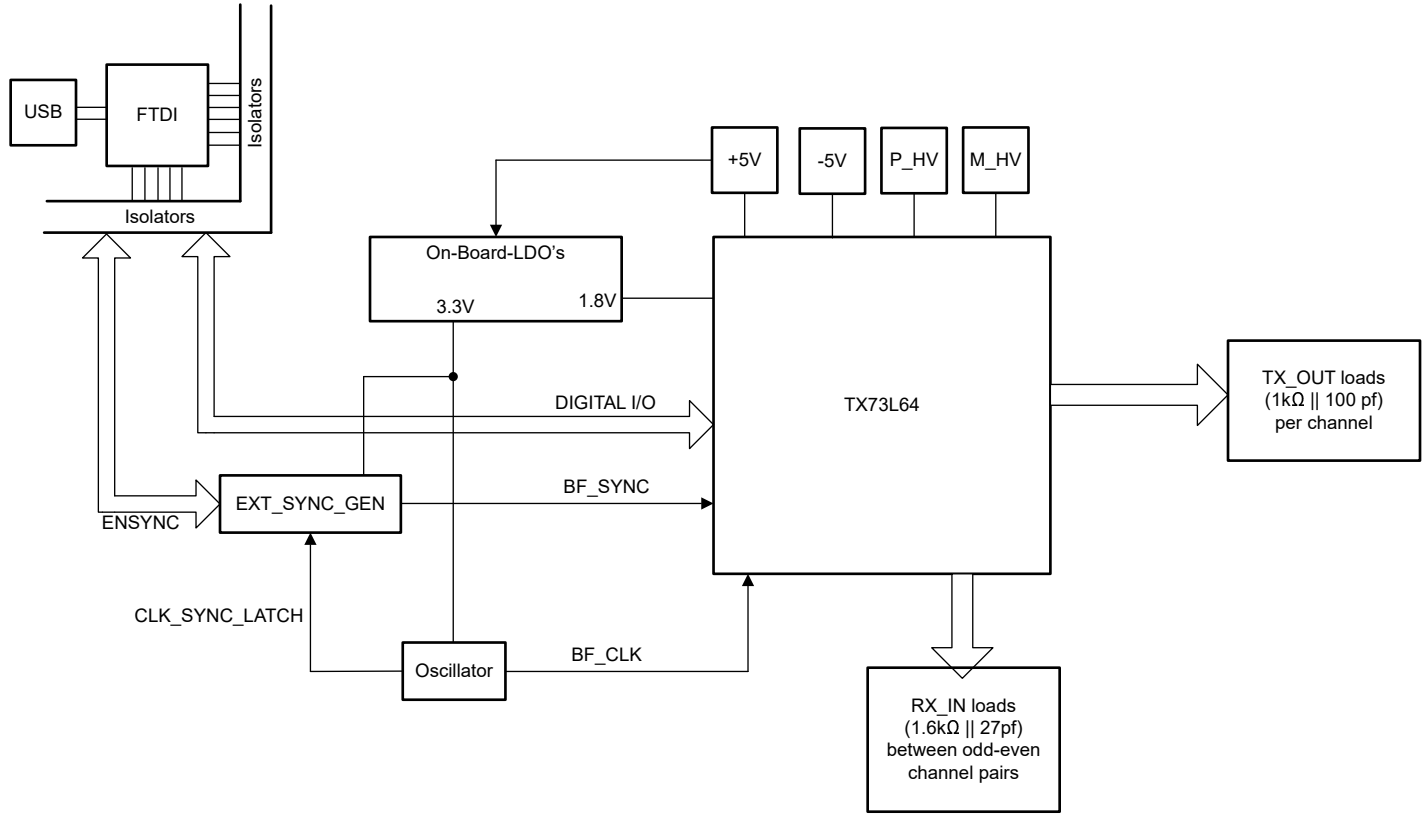


Figure 5-1. Functional Block Diagram

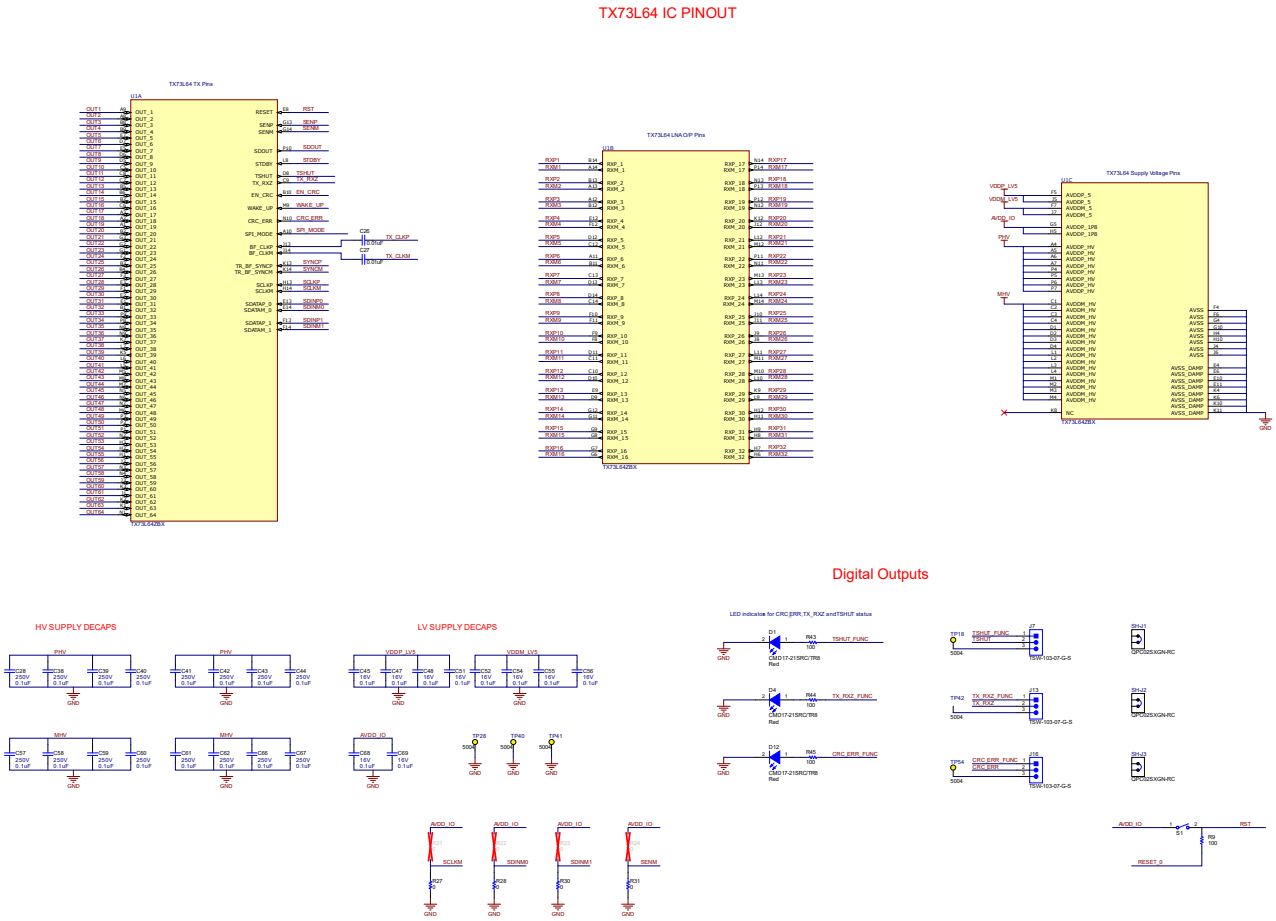


Figure 5-2. Schematic 1

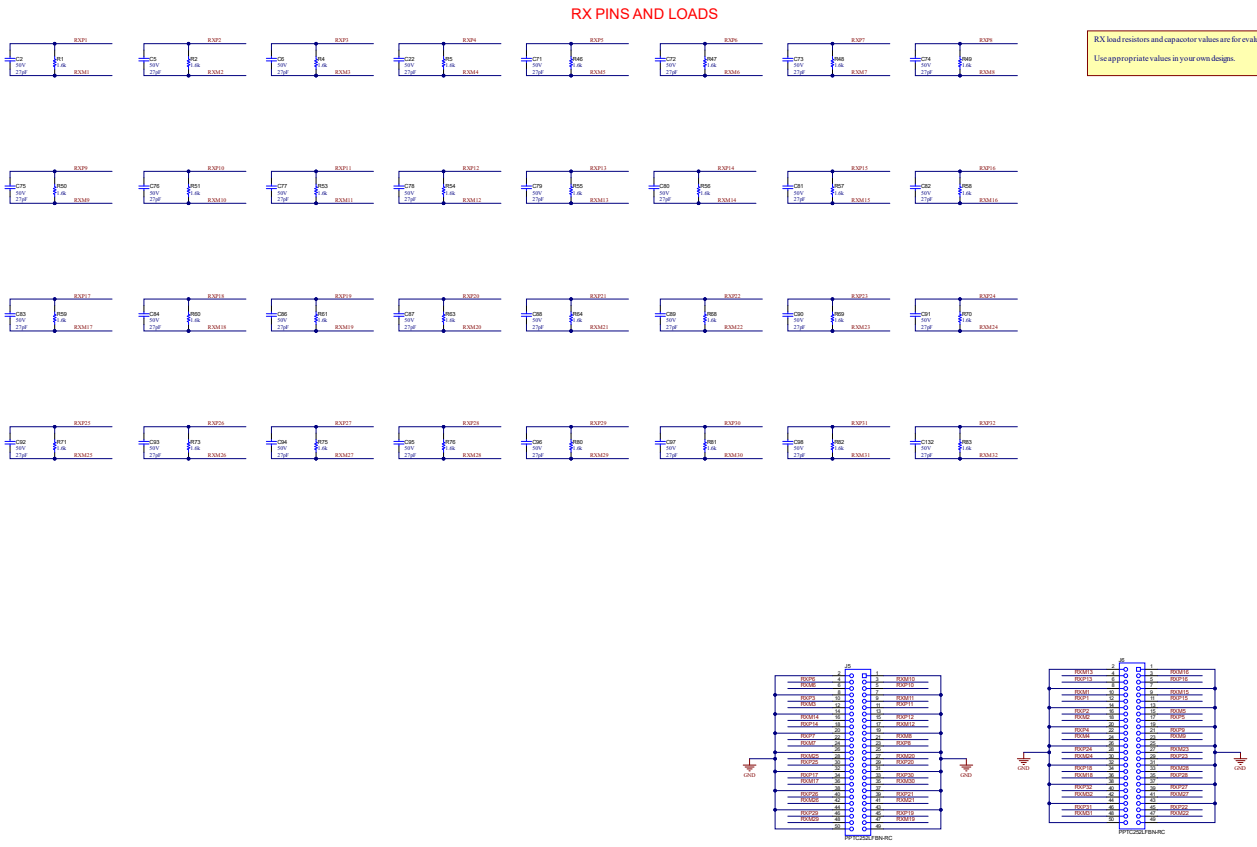


Figure 5-3. Schematic 2

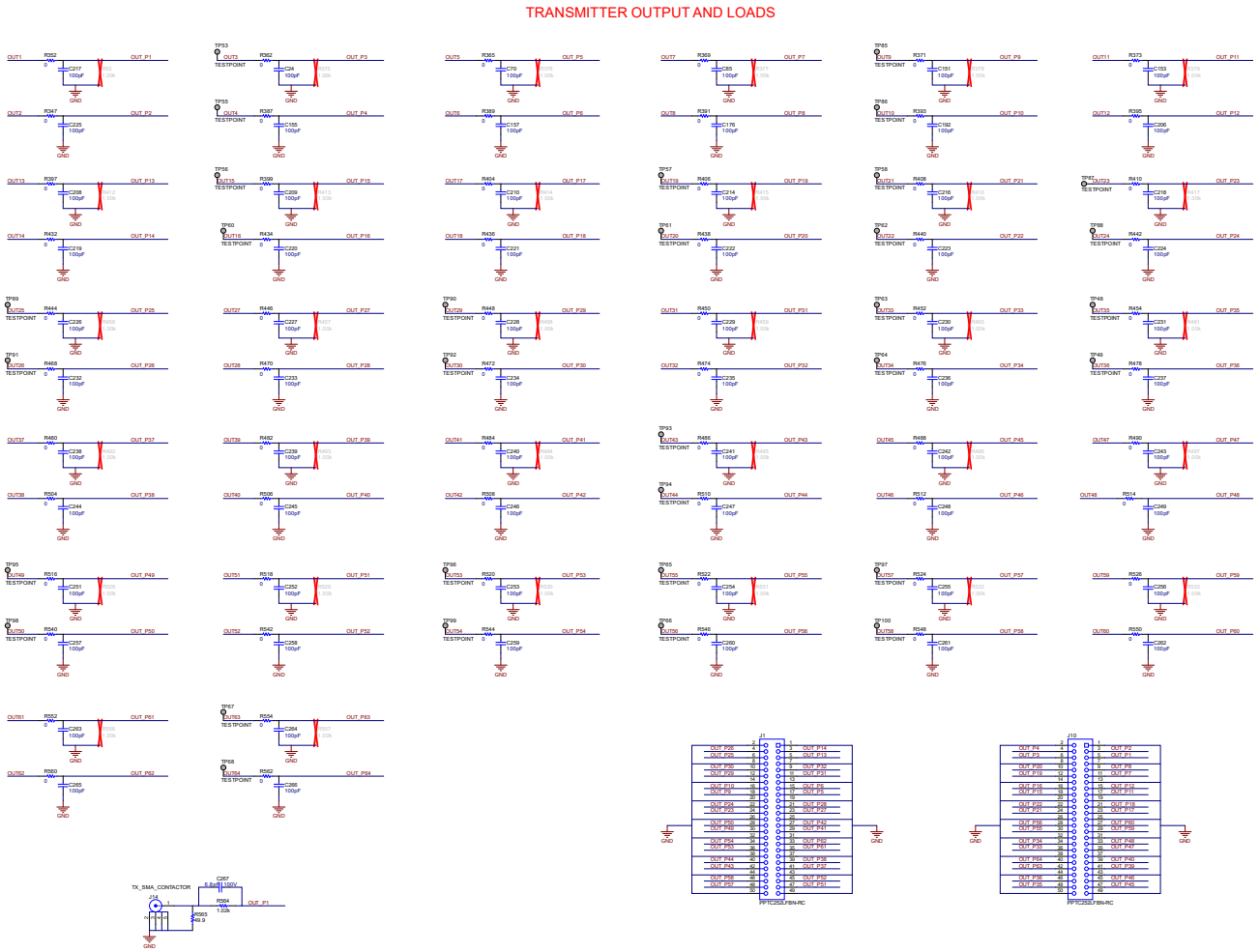


Figure 5-4. Schematic 3

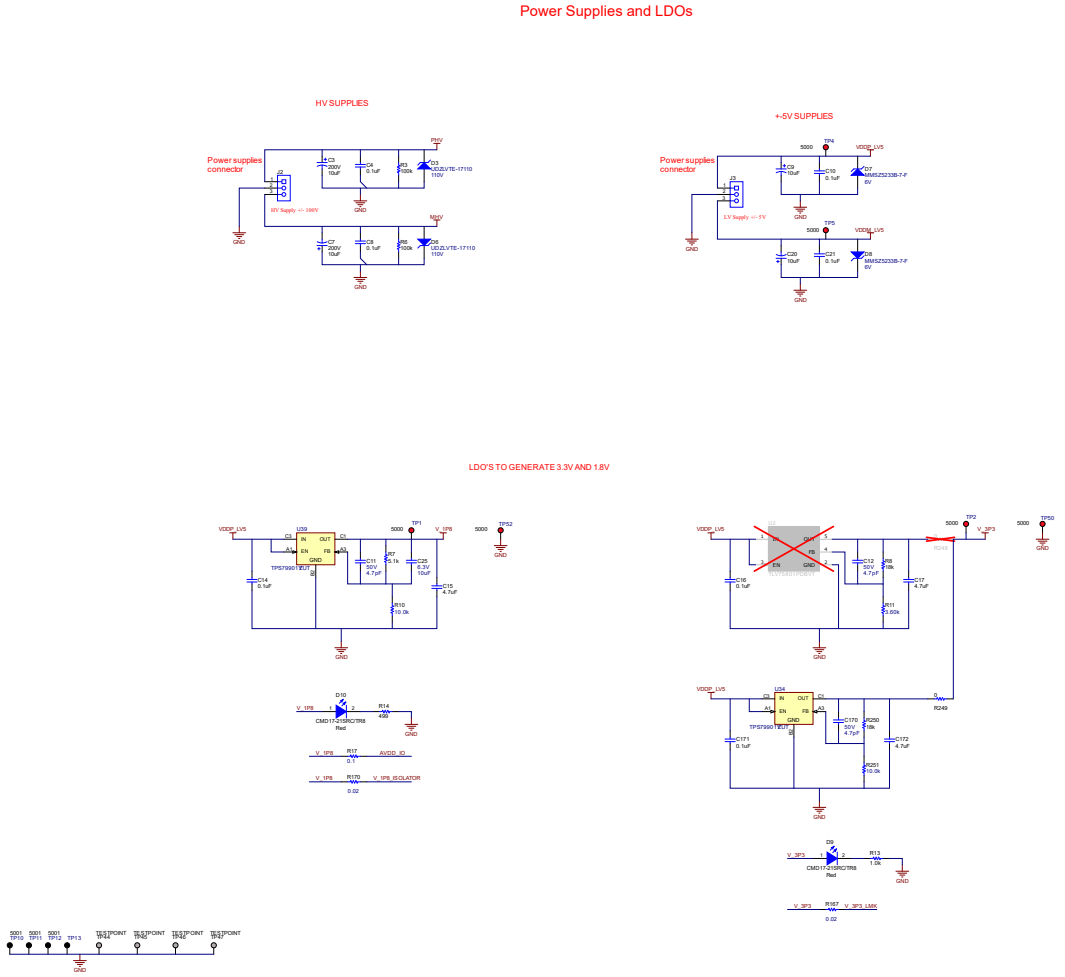


Figure 5-5. Schematic 4

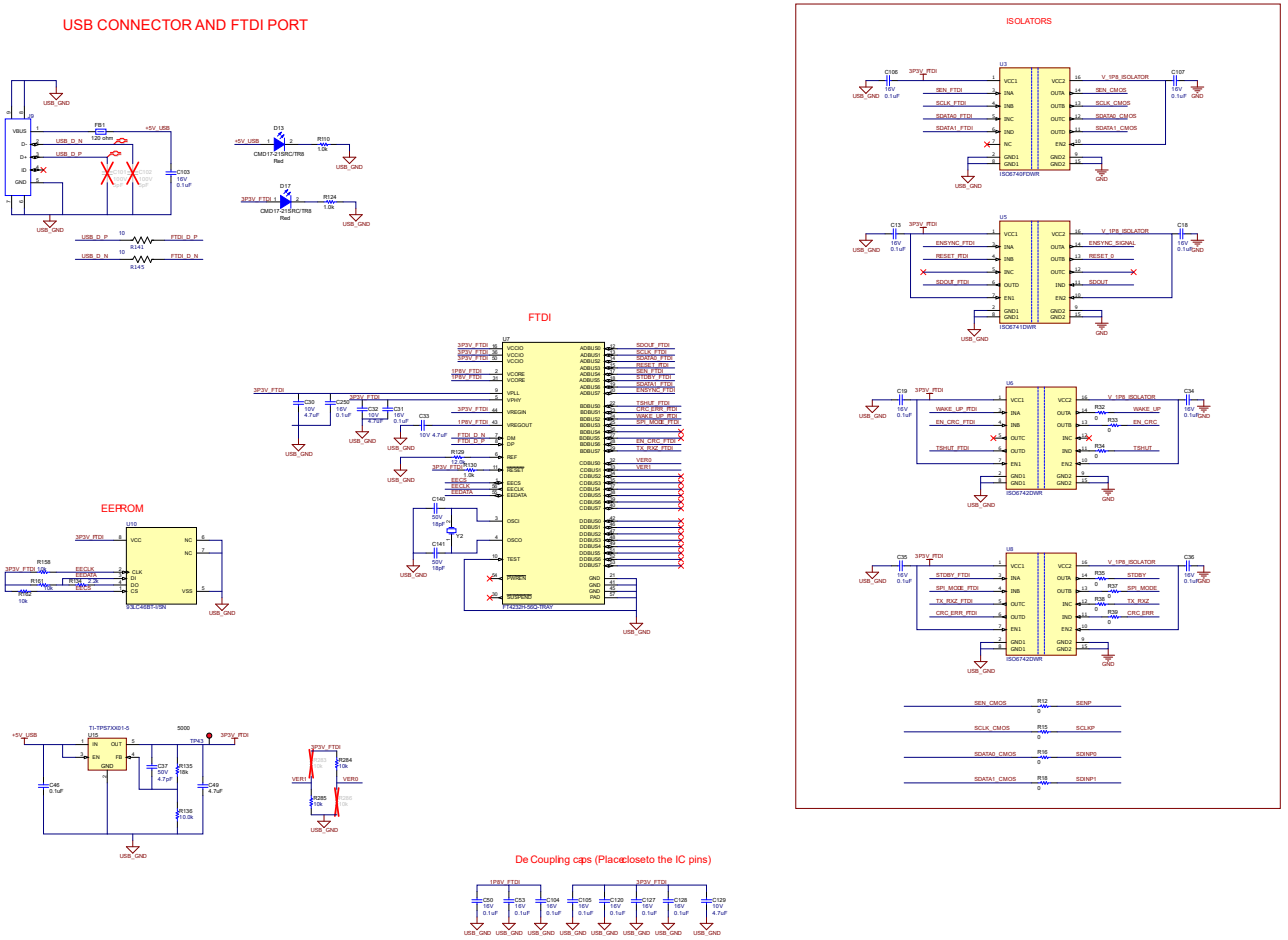


Figure 5-6. Schematic 5

CLK Generation

Clocking options in TX73L64

Clocking Option 1 : OSC_250MHz
Install R25, R26, R150 and uninstall R20, R29, R173.
The clock frequency is fixed to 200.0MHz

Clocking Option 2 : External Clock
Install R20,R29,R173 and uninstall R25,R26,R150.
Provide a CMOS clock (0V->2.5V) to J4 SMA

External SYNC : Solder Resistor R276 and desolder R295
Provide CMOS SYNC signal to J13 (0V->2.5V)

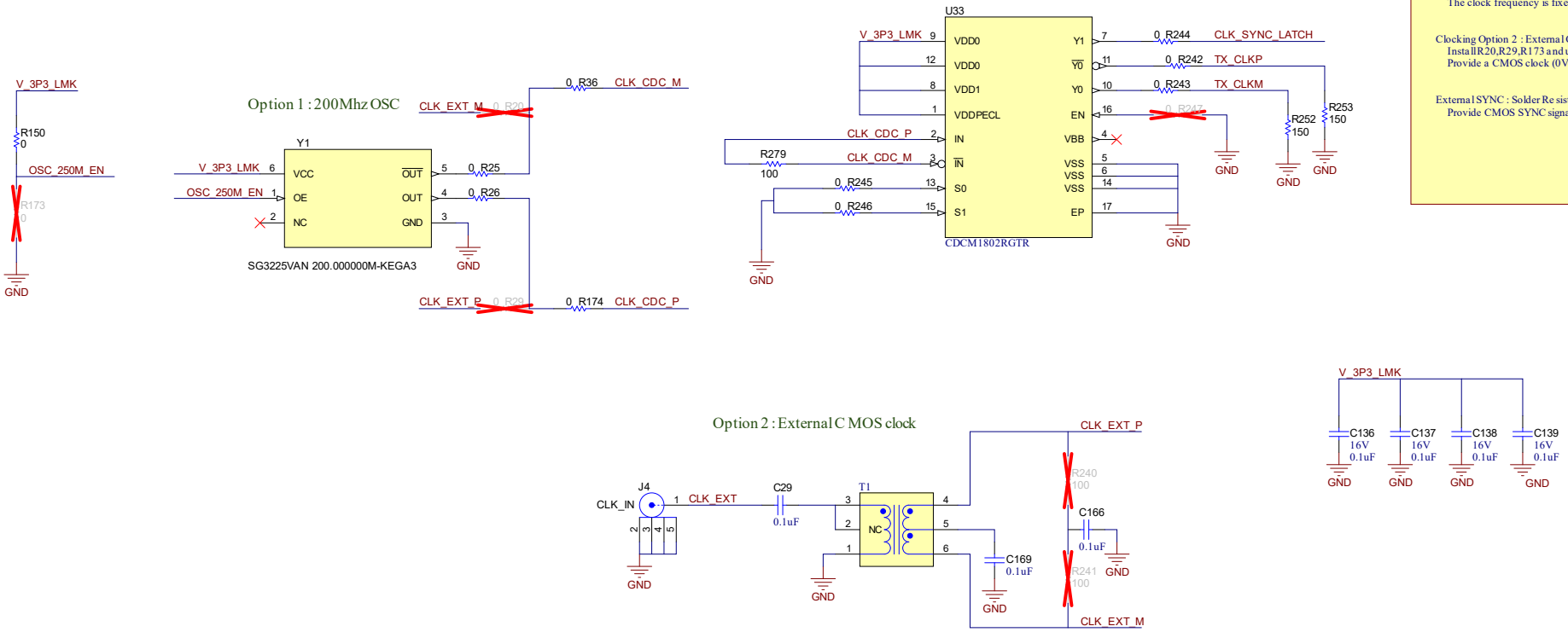


Figure 5-7. Schematic 6

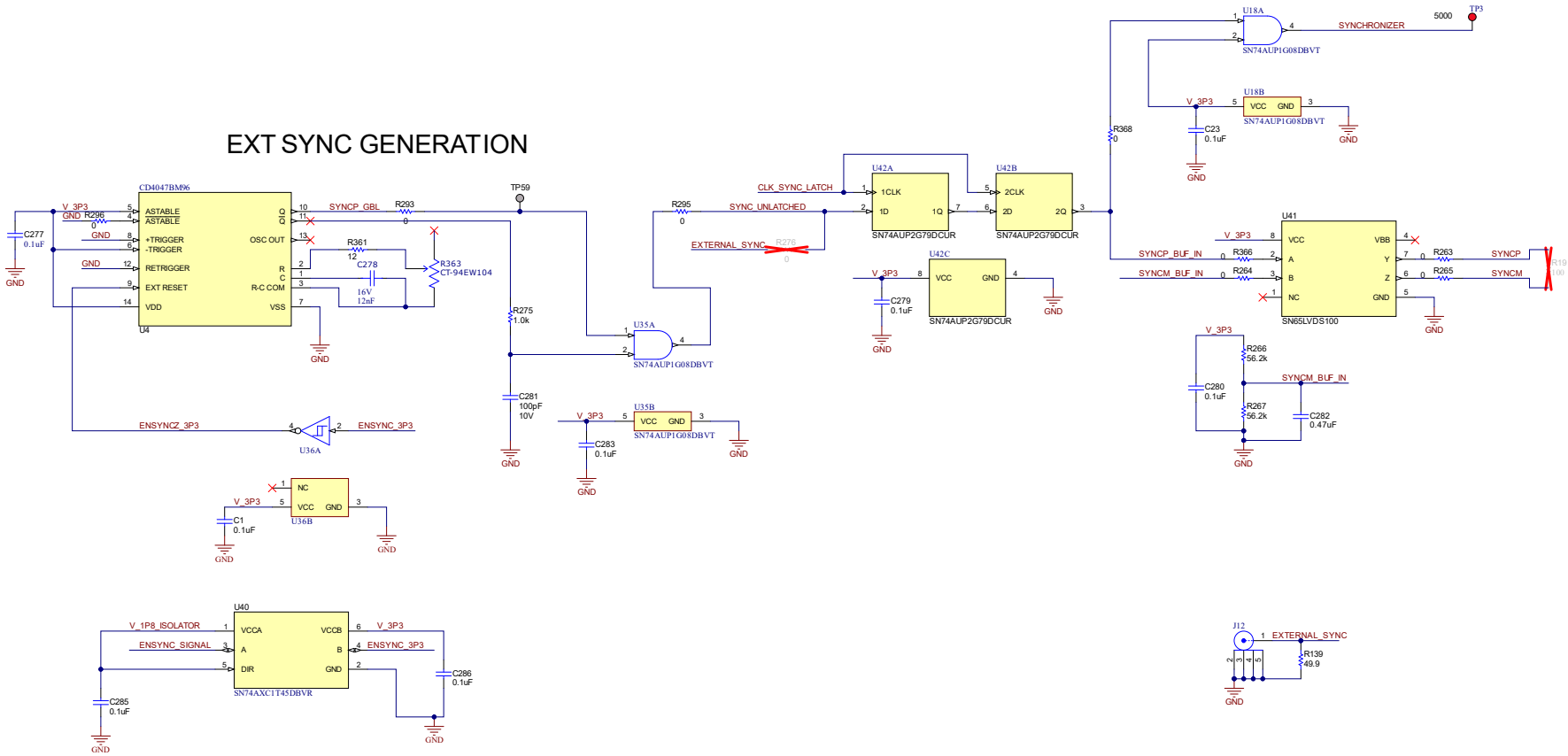


Figure 5-8. Schematic 7

5.2 PCB Layouts

Figure 5-9 to Figure 5-22 show the different PCB layers.

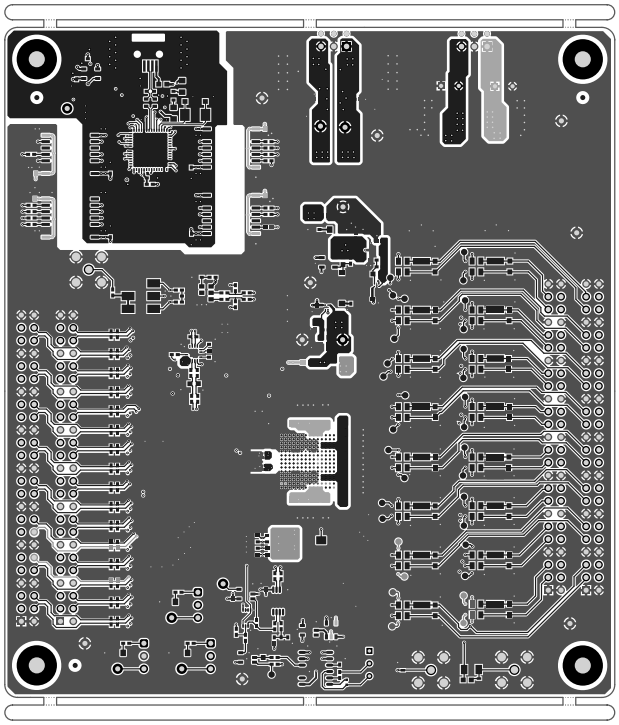


Figure 5-9. PCB Layer 1 (Top Assembly Drawing)

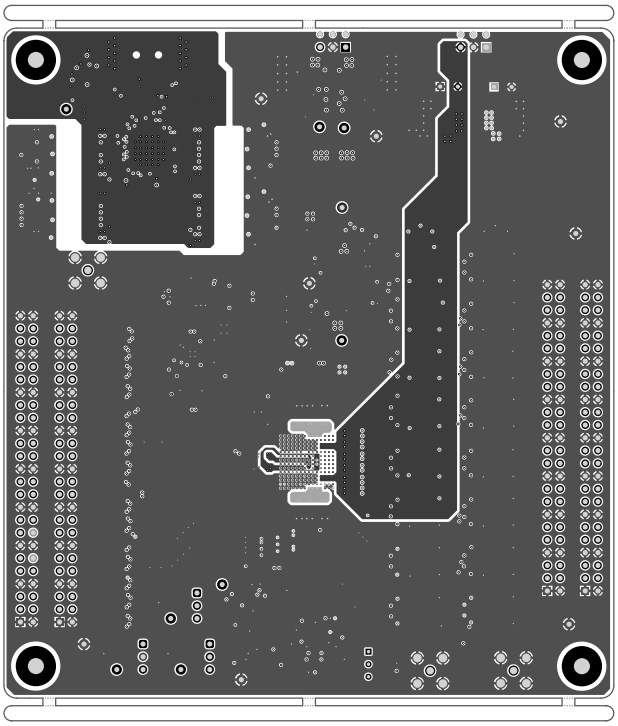


Figure 5-10. PCB Layer 2 (Bottom Assembly Drawing)

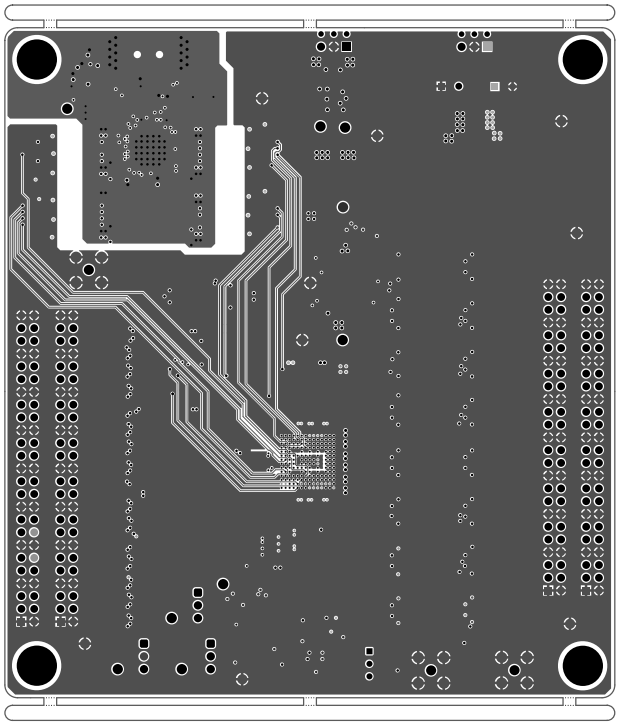


Figure 5-11. PCB Layer 3 (Signal 1)

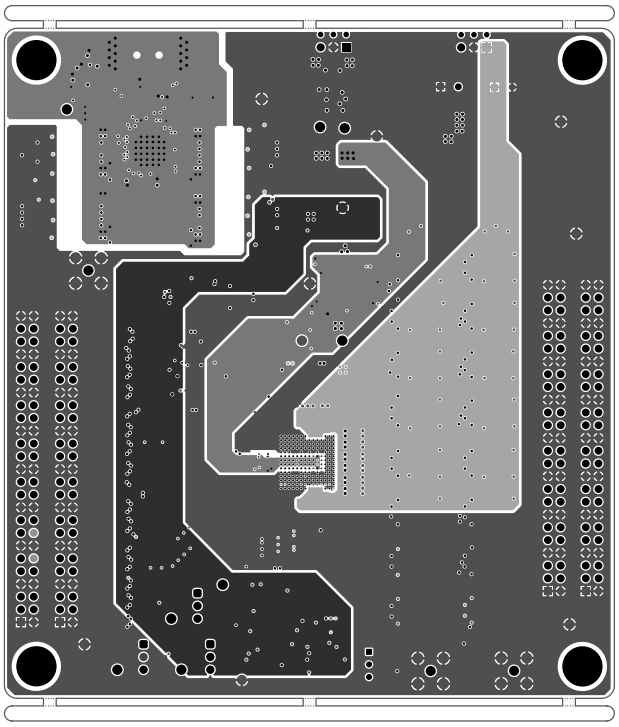


Figure 5-12. PCB Layer 4 (Ground2/Power 1)

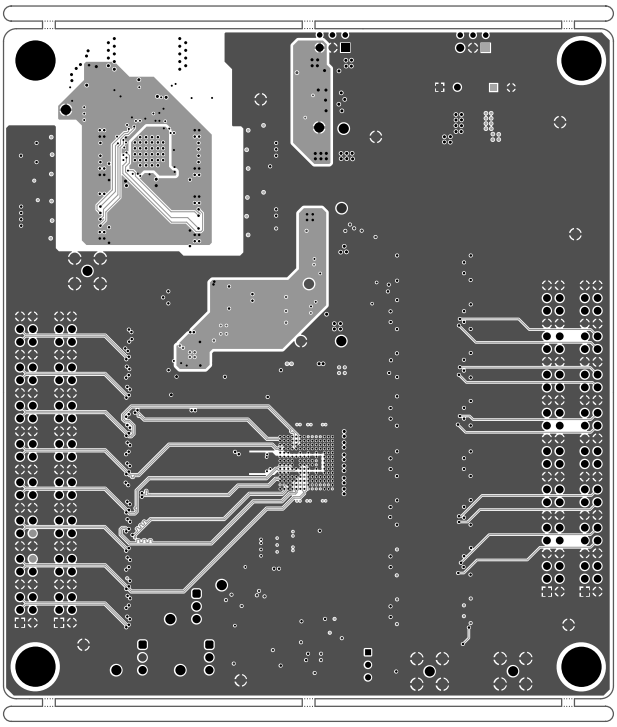


Figure 5-13. PCB Layer 5 (Signal 2)

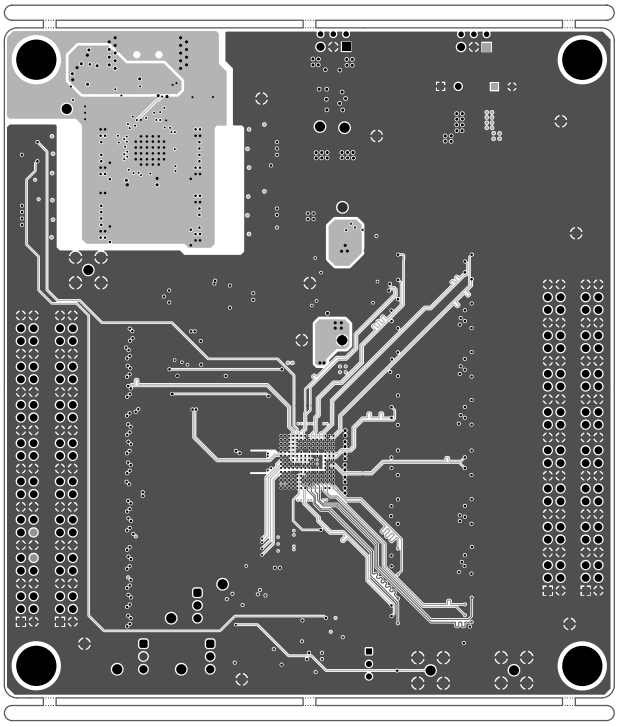


Figure 5-14. PCB Layer 6 (Ground 3/Signal 3)

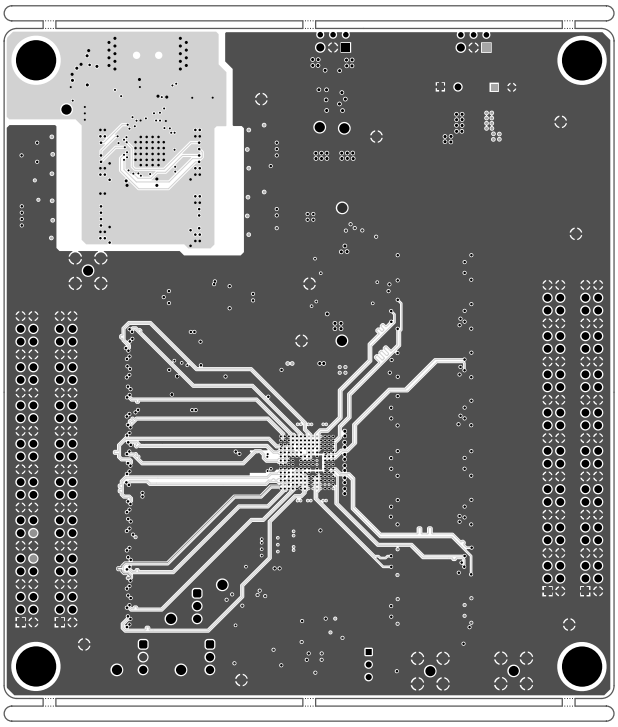


Figure 5-15. PCB Layer 7 (Ground 4/Signal 4)

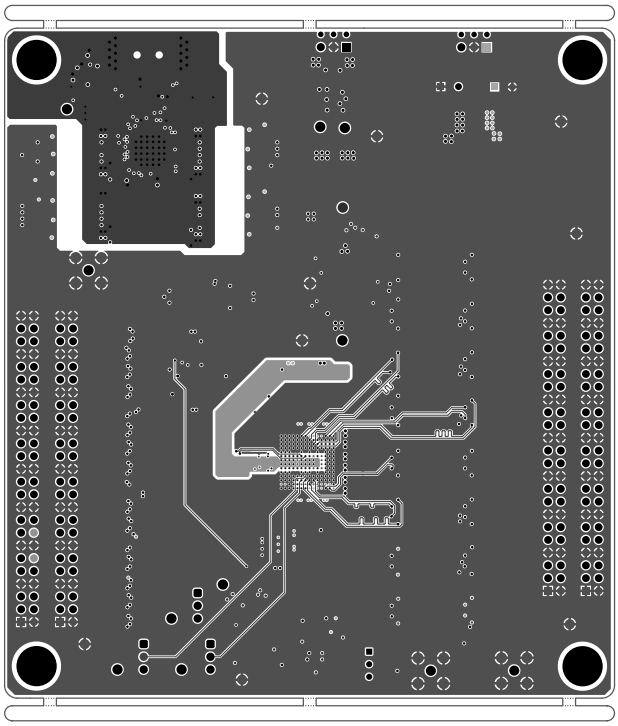


Figure 5-16. PCB Layer 8 (Signal 5)

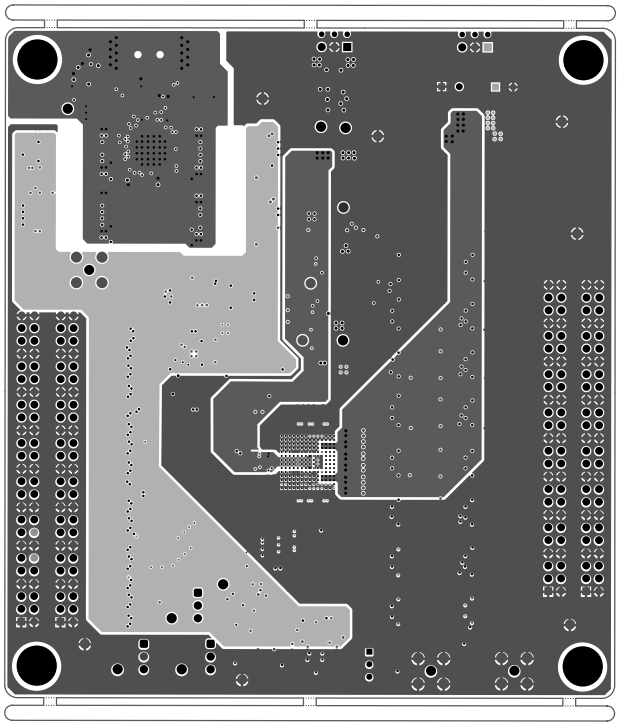


Figure 5-17. PCB Layer 9 (Ground 5/Power 2)

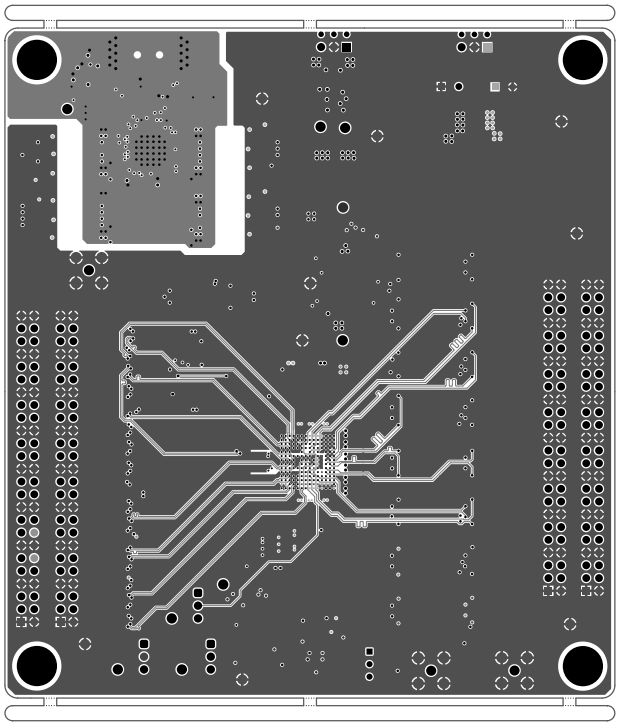


Figure 5-18. PCB Layer 10 (Signal 6)

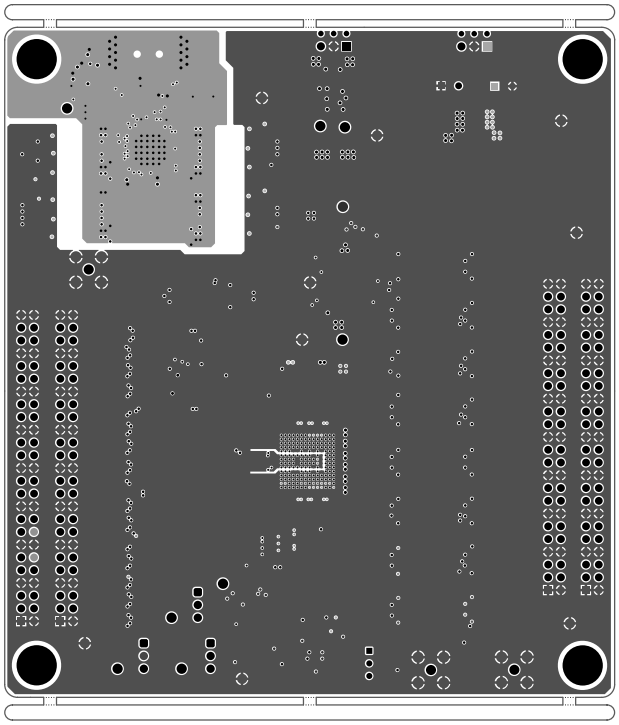


Figure 5-19. PCB Layer 11 (Ground 6)

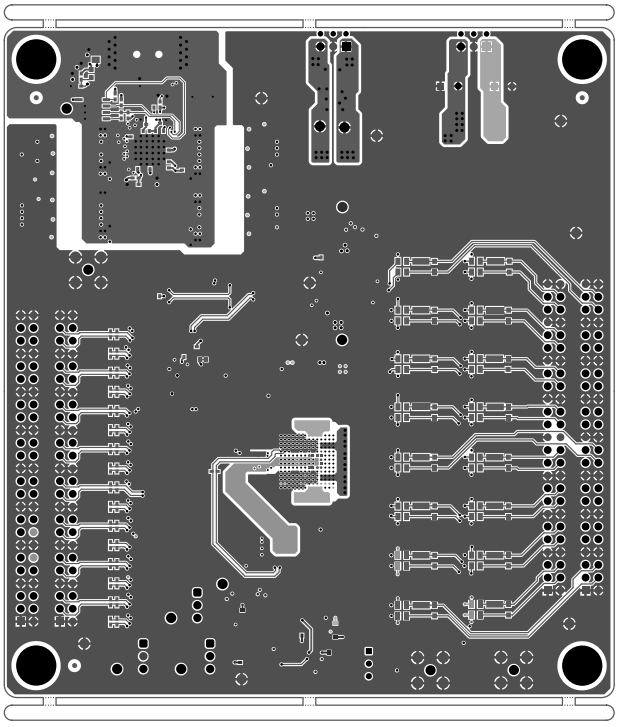


Figure 5-20. PCB Layer 12 (Bottom Layer)

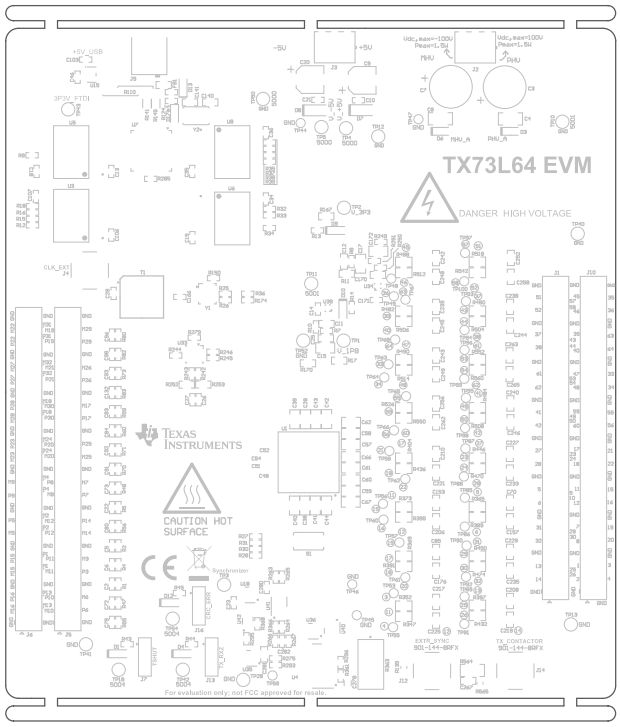


Figure 5-21. PCB Layer (Top Overlay)

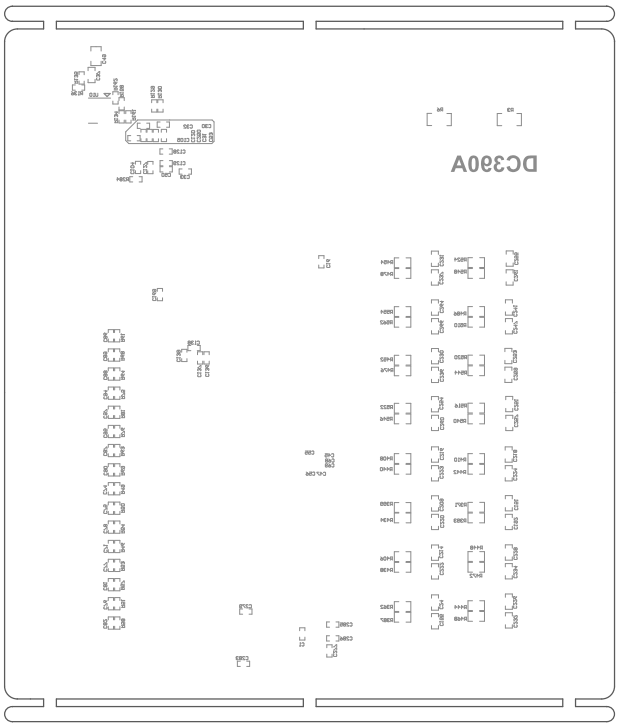


Figure 5-22. PCB Layer (Bottom Overlay)

5.3 Bill of Materials

Table 5-1. Bill of Materials

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference	Fitted
!PCB1	1		DC390	Any	Printed Circuit Board		Fitted
C1, C285, C286	3	0.1µF	GRM155R71C104KA88D	MuRata	CAP, CERM, 0.1µF, 16V, ±10%, X7R, 0402	0402	Fitted
C2, C5, C6, C22, C71, C72, C73, C74, C75, C76, C77, C78, C79, C80, C81, C82, C83, C84, C86, C87, C88, C89, C90, C91, C92, C93, C94, C95, C96, C97, C98, C132	32	27pF	C0402C270J5GACTU	Kemet	CAP, CERM, 27pF, 50V, ±5%, C0G/NP0, 0402	0402	Fitted
C3, C7	2	10µF	200LLE10MEFC8X11.5	Rubycon	CAP, AL, 10µF, 200V, ±20%, TH	RCAP_8x11.5mm	Fitted
C4, C8	2	0.1µF	C1206C104K2RACTU	Kemet	CAP, CERM, 0.1µF, 200V, ±10%, X7R, 1206	1206	Fitted
C9, C20	2	10µF	EEE-FK1V100R	Panasonic	CAP, AL, 10µF, 35V, ±20%, 0.7Ω, AEC-Q200 Grade 2, SMD	SMT Radial C	Fitted
C10, C13, C14, C16, C18, C19, C21, C23, C31, C34, C35, C36, C46, C50, C53, C103, C104, C105, C106, C107, C120, C127, C128, C136, C137, C138, C139, C171, C250, C279, C280, C283	32	0.1µF	0402YC104KAT2A	AVX	CAP, CERM, 0.1µF, 16V, ±10%, X7R, 0402	0402	Fitted
C11, C12, C37, C170	4	4.7pF	06035A4R7CAT2A	AVX	CAP, CERM, 4.7µF, 50V, ±5%, C0G/NP0, 0603	0603	Fitted
C15, C17, C49, C172	4	4.7µF	C0805C475K3PACTU	Kemet	CAP, CERM, 4.7µF, 25V, ±10%, X5R, 0805	0805	Fitted

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference	Fitted
C24, C70, C85, C151, C153, C155, C157, C176, C192, C206, C208, C209, C210, C214, C216, C217, C218, C219, C220, C221, C222, C223, C224, C225, C226, C227, C228, C229, C230, C231, C232, C233, C234, C235, C236, C237, C238, C239, C240, C241, C242, C243, C244, C245, C246, C247, C248, C249, C251, C252, C253, C254, C255, C256, C257, C258, C259, C260, C261, C262, C263, C264, C265, C266	64	100pF	AC0603JRNPOYBN101	Yageo	CAP, CERM, 100pF, 250V, ±5%, C0G/NP0, AEC-Q200 Grade 1, 0603	0603	Fitted
C25	1	10µF	GRM188R60J106ME47D	MuRata	CAP, CERM, 10µF, 6.3V, ±20%, X5R, 0603	0603	Fitted
C26, C27	2	0.01µF	520L103KT16T	AT Ceramics	CAP, CERM, 0.01µF, 16V, ±10%, X7R, 0402	0402	Fitted
C28, C38, C39, C40, C41, C42, C43, C44, C57, C58, C59, C60, C61, C62, C66, C67	16	0.1µF	C2012X7T2E104K125AA	TDK	CAP, CERM, 0.1µF, 250V, ±10%, X7T, 0805	0805	Fitted
C29, C166, C169, C277	4	0.1µF	C1005X5R1A104K050BA	TDK	CAP, CERM, 0.1µF, 10V, ±10%, X5R, 0402	0402	Fitted
C30, C32, C33, C129	4	4.7µF	CL05A475MP5NRNC	Samsung Electro-Mechanics	CAP, CERM, 4.7µF, 10V, ±20%, X5R, 0402	0402	Fitted
C45, C47, C48, C51, C52, C54, C55, C56, C68, C69	10	0.1µF	C0603X6S1C104K030BC	TDK	CAP, CERM, 0.1µF, 16V, ±10%, X6S, 0201	0201	Fitted
C140, C141	2	18pF	06035A180JAT2A	AVX	CAP, CERM, 18pF, 50V, ±5%, C0G/NP0, 0603	0603	Fitted
C267	1	6.8pF	CC0603CRNPO0BN6R8	Yageo	CAP, CERM, 6.8pF, 100V, ±3.7%, C0G/NP0, 0603	0603	Fitted
C278	1	12nF	CC0402KRX7R7BB123	Yageo	0.012µF ±10% 16V Ceramic Capacitor X7R 0402 (1005 Metric)	0402	Fitted
C281	1	100pF	0603ZC101KAT2A	AVX	CAP, CERM, 100pF, 10V, ±10%, X7R, 0603	0603	Fitted
C282	1	0.47µF	04026D474KAT2A	AVX	CAP, CERM, 0.47µF, 6.3V, ±10%, X5R, 0402	0402	Fitted
D1, D4, D9, D10, D12, D13, D17	7	Red	CMD17-21SRC/TR8	Visual Communications Company, LLC	LED, Red, SMD	2x1.25mm	Fitted

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference	Fitted
D3, D6	2	110V	UDZLVTE-17110	Rohm	Diode, Zener, 110V, 200mW, SOD-323F	SOD-323F	Fitted
D7, D8	2	6V	MMSZ5233B-7-F	Diodes Inc.	Diode, Zener, 6V, 500mW, SOD-123	SOD-123	Fitted
FB1	1	120Ω	BLM18SG121TN1D	MuRata	Ferrite Bead, 120Ω @ 100MHz, 3A, 0603	0603	Fitted
H1, H2, H3, H4	4		NY PMS 440 0025 PH	B&F Fastener Supply	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	Fitted
H5, H6, H7, H8	4		1902C	Keystone	Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	Fitted
J1, J5, J6, J10	4		PPTC252LFBN-RC	Sullins Connector Solutions	Receptacle, 2.54mm, 25x2, Tin, TH	Receptacle, 2.54mm, 25x2, TH	Fitted
J2, J3	2		1725669	Phoenix Contact	Terminal Block, 3x1, 2.54mm, TH	Terminal Block, 3x1, 2.54mm, TH	Fitted
J4, J12, J14	3		901-144-8RFX	Amphenol RF	SMA Straight Jack, Gold, 50Ω, TH	SMA Straight Jack, TH	Fitted
J7, J13, J16	3		TSW-103-07-G-S	Samtec	Header, 100mil, 3x1, Gold, TH	3x1 Header	Fitted
J9	1		67803-8020	Molex	Connector, Receptacle, USB - mini AB, R/A, SMD	Receptacle, 5-Leads, Body 9.9x9mm, R/A	Fitted
R1, R2, R4, R5, R46, R47, R48, R49, R50, R51, R53, R54, R55, R56, R57, R58, R59, R60, R61, R63, R64, R68, R69, R70, R71, R73, R75, R76, R80, R81, R82, R83	32	1.6k	CRCW04021K60JNED	Vishay-Dale	RES, 1.6 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R3, R6	2	100k	TNPW1206100KBEEA	Vishay-Dale	RES, 100 k, 0.1%, 0.25 W, AEC-Q200 Grade 1, 1206	1206	Fitted
R7	1	5.1k	CRCW04025K10JNED	Vishay-Dale	RES, 5.1 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R8, R135, R250	3	18k	CRCW040218K0JNED	Vishay-Dale	RES, 18 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R9	1	100	CRCW0402100RJNED	Vishay-Dale	RES, 100, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R10, R136, R251	3	10.0k	CRCW040210K0DHEDP	Vishay-Dale	RES, 10.0 k, 0.5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R11	1	3.60k	RG1608P-362-B-T5	Susumu Co Ltd	RES, 3.60 k, 0.1%, 0.1 W, 0603	0603	Fitted

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference	Fitted
R12, R15, R16, R18, R25, R26, R27, R28, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R150, R174, R242, R243, R244, R245, R246, R249	26		ERJ-2GE0R00X	Panasonic	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R13, R110, R124, R130	4	1.0k	CRCW04021K00JNED	Vishay-Dale	RES, 1.0 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R14	1	499	CRCW0402499RFKED	Vishay-Dale	RES, 499, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R17	1	0.1	ERJ-L03KF10CV	Panasonic	RES, 0.1, 1%, 0.1 W, AEC-Q200 Grade 1, 0603	0603	Fitted
R43, R44, R45, R279	4	100	ERJ-2GEJ101X	Panasonic	RES, 100, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R129	1	12.0k	CRCW040212K0FKED	Vishay-Dale	RES, 12.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R134	1	2.2k	CRCW04022K20JNED	Vishay-Dale	RES, 2.2 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R139, R565	2	49.9	TNPW060349R9BEEA	Vishay-Dale	RES, 49.9, 0.1%, 0.1 W, AEC-Q200 Grade 1, 0603	0603	Fitted
R141, R145	2		ERJ-3GEYJ100V	Panasonic	Thick Film Resistors - SMD 0603 10ohms 5% AEC-Q200	0603	Fitted
R158, R161, R162, R284, R285	5	10k	ERJ-2GEJ103X	Panasonic	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R167, R170	2	0.02	RL0603FR-070R02L	Yageo America	RES, 0.02, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	Fitted
R252, R253	2	150	RT0603BRD07150RL	Yageo America	RES, 150, 0.1%, 0.1 W, 0603	0603	Fitted
R263, R264, R265, R293, R295, R366, R368	7	0	ERJ-2GE0R00X	Panasonic	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R266, R267	2	56.2k	CRCW040256K2FKED	Vishay-Dale	RES, 56.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R275	1	1.0k	CRCW04021K00JNED	Vishay-Dale	RES, 1.0 k, 5%, 0.063 W, 0402	0402	Fitted
R296	1	0	CRCW04020000Z0ED	Vishay-Dale	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference	Fitted
R347, R352, R362, R365, R369, R371, R373, R387, R389, R391, R393, R395, R397, R399, R404, R406, R408, R410, R432, R434, R436, R438, R440, R442, R444, R446, R448, R450, R452, R454, R468, R470, R472, R474, R476, R478, R480, R482, R484, R486, R488, R490, R504, R506, R508, R510, R512, R514, R516, R518, R520, R522, R524, R526, R540, R542, R544, R546, R548, R550, R552, R554, R560, R562	64	0	5106	Keystone	RES, 0, 1%, 0.5 W, 0805	0805	Fitted
R361	1	12	CRCW040212R0JNED	Vishay-Dale	RES, 12, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Fitted
R363	1	100kΩ	CT-94EW104	Nidec Components	100kΩ 0.5W, 1/2W PC Pins Through Hole Trimmer Potentiometer Cermet 18.0 Turn Top Adjustment	PTH_POTEN_9MM6_4MM8	Fitted
R564	1	1.02k	CRCW12061K02FKEA	Vishay-Dale	RES, 1.02 k, 1%, 0.25W, AEC-Q200 Grade 0, 1206	1206	Fitted
S1	1		EVQ-5PN04K	Panasonic	Switch, SPST-NO, Off-Mom, 0.05A, 12 VDC, SMD	6x3.5mm	Fitted
SH-J1, SH-J2, SH-J3	3		QPC02SXGN-RC	Sullins	CONN JUMPER S2 (1 x 2) Position Shunt Connector Black Open Top 0.100" (2.54mm) GoldHORTING .100" GOLD	JUMPER	Fitted
T1	1		ADT4-1WT+	Minicircuits	RF Transformer, 50Ω, 2 to 775MHz, SMT	CD542	Fitted
TP1, TP2, TP3, TP4, TP5, TP43, TP50, TP52	8		5000	Keystone Electronics	Test Point, Miniature, Red, TH	Red Miniature Testpoint	Fitted
TP10, TP11, TP12, TP13	4		5001	Keystone Electronics	Test Point, Miniature, Black, TH	Black Miniature Testpoint	Fitted
TP18, TP28, TP40, TP41, TP42, TP54	6		5004	Keystone Electronics	Test Point, Miniature, Yellow, TH	Yellow Miniature Testpoint	Fitted
U1	1		TX73L64ZBX	Texas Instruments	3-Level, 64-Channel Transmitter with On-Chip Beamformer, T/R Switch, 32 Channel Multiplexed receivers with LNA	FCBGA196	Fitted

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference	Fitted
U3	1		ISO6740FDWR	Texas Instruments	General-purpose, quad-channel, 4/0 digital isolator 16-SOIC -40 to 125	SOIC16	Fitted
U4	1			Texas Instruments	CMOS Low-Power Monostable/Astable Multivibrator, D0014A, LARGE T&R	D0014A	Fitted
U5	1		ISO6741DWR	Texas Instruments	General-purpose, quad-channel, 3/1 digital isolator 16-SOIC -40 to 125	SOIC16	Fitted
U6, U8	2		ISO6742DWR	Texas Instruments	General-purpose, quad-channel, 2/2 digital isolator	SOIC16	Fitted
U7	1		FT4232H-56Q-TRAY	FTDI	Future Technology Devices International Ltd FT4232H Quad High Speed USB to Multipurpose UART/MPSSE IC, VQFN-56	VQFN-56	Fitted
U10	1		93LC46BT-I/SN	Microchip	1K Microwire Compatible Serial EEPROM	SOIC-8	Fitted
U15	1		TPS79901DDCR	Texas Instruments	Single Output High PSRR LDO, 200mA, Adjustable 1.2 to 6.5V Output, 2.7 to 6.5V Input, with Low IQ, 5-pin SOT (DDC), -40 to 85°C, Green (RoHS & no Sb/Br)	DDC0005A	Fitted
U18, U35	2		SN74AUP1G08DBVT	Texas Instruments	Low-Power Single 2-Input Positive-AND Gate, DBV0005A (SOT-23-5)	DBV0005A	Fitted
U33	1		CDCM1802RGTR	Texas Instruments	Clock Buffer w/Programmable Divider, LVPECL I/O + addl LVCMOS output, RGT0016A (VQFN-16)	RGT0016A	Fitted
U34, U39	2		TPS79901YZUT	Texas Instruments	Single Output High PSRR LDO, 200mA, Adjustable 1.2 to 6.5V Output, 2.7 to 6.5V Input, with Low IQ, 5-pin DSBGA (YZU), -40 to 85 °C, Green (RoHS & no Sb/Br)	YZU0005AEBC	Fitted
U36	1			Texas Instruments	Single Schmitt-Trigger Inverter, DBV0005A, LARGE T&R	DBV0005A	Fitted
U40	1		SN74AXC1T45DBVR	Texas Instruments	Single-Bit Dual-Supply Bus Transceiver, DBV0006A (SOT-23-6)	DBV0006A	Fitted

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference	Fitted
U41	1		SN65LVDS100DGKR	Texas Instruments	2Gbps LVDS/LVPECL/CML to LVDS Buffer/Repeater/ Translator, DGK0008A (VSSOP-8)	DGK0008A	Fitted
U42	1		SN74AUP2G79DCUR	Texas Instruments	Low-Power Dual Positive-Edge-Triggered D-Type Flip-Flop, DCU0008A (VSSOP-8)	DCU0008A	Fitted
Y1	1		SG3225VAN 200.000000M-KEGA3	Epson	Crystal Oscillator, 200MHz, LVDS, 2.5 to 3.3V, SMD	3.2x2.5mm	Fitted
Y2	1		ABM3-12.000MHZ-D2Y-T	Abracon Corporation	Crystal, 12MHz, 18pF, SMD	ABM3	Fitted
C101, C102	0	5pF	CBR04C509B1GAC	Kemet	CAP, CERM, 5pF, 100V, ±2%, C0G/NP0, 0402	0402	Not Fitted
FID1, FID2, FID3, FID4, FID5, FID6	0		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A	Not Fitted
R19	0	100	CRCW0402100RFKED	Vishay-Dale	RES, 100, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	Not Fitted
R20, R21, R22, R23, R24, R29, R173, R247, R248	0		ERJ-2GE0R00X	Panasonic	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	Not Fitted
R52, R375, R376, R377, R378, R379, R412, R413, R414, R415, R416, R417, R456, R457, R458, R459, R460, R461, R492, R493, R494, R495, R496, R497, R528, R529, R530, R531, R532, R533, R556, R557	0	1.00k	CRCW25121K00FKEG	Vishay-Dale	RES, 1.00 k, 1%, 1 W, AEC-Q200 Grade 0, 2512	2512	Not Fitted
R240, R241	0	100	ERJ-2GEJ101X	Panasonic	RES, 100, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	Not Fitted
R276	0	0	ERJ-2GE0R00X	Panasonic	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	Not Fitted
R283, R286	0	10k	ERJ-2GEJ103X	Panasonic	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	Not Fitted
U2	0		TLV75801PDBVT	Texas Instruments	Linear Voltage Regulator IC 1 Output 500mA SOT-23-5	SOT-23-5	Not Fitted

6 Additional Information

6.1 Troubleshooting

The following steps describe the ways to debug, if the EVM does not perform as expected.

1. Power supplies: Check all the power supplies and LDO voltages at the test point (See Section 4.1.2) and make sure the power supplies and LDO voltages are as expected.
2. Clock: Check the BF_CLK_CMOS test point and make sure that 250MHz clock is present.
3. Thermal shutdown: If the temperature of the device exceeds 110°C, then the device enters thermal shutdown, and the device functionality is disabled. TSHUT pin of the device is pulled low when this happens. This pin is connected to LED D12, and this LED glows if the device enters thermal shutdown. Reset the device to bring out of thermal shutdown.

6.2 Trademarks

Microsoft® and Windows® are registered trademarks of Microsoft Corporation.
All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

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