EVM User's Guide: TX7364EVM

TX7364 Evaluation Module

Description

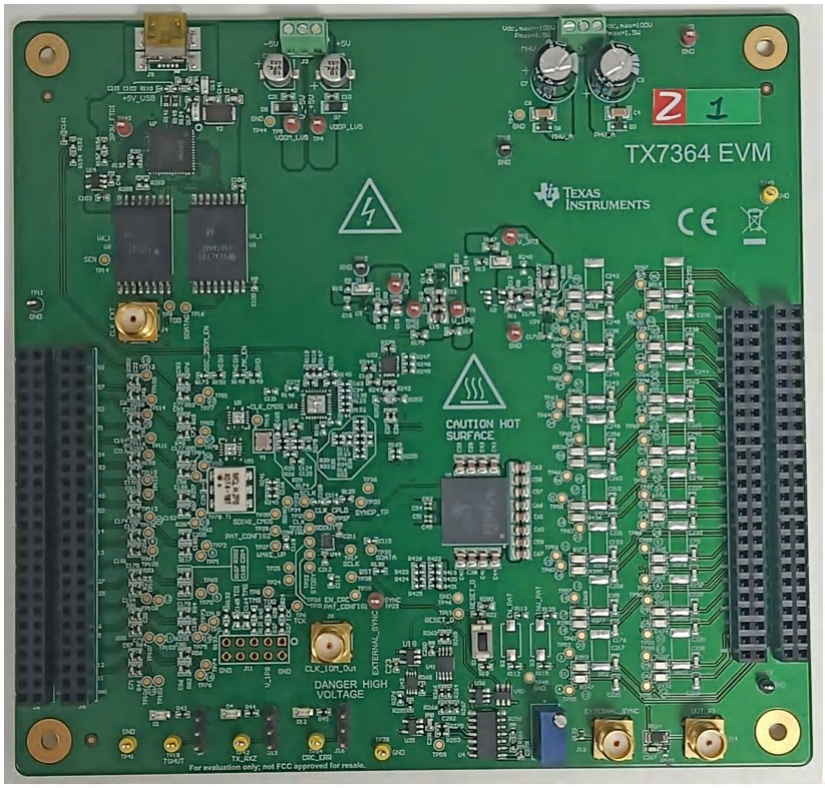
The TX7364EVM is used for the evaluation of TX7364 device under various drive strength, different voltage levels and different modes of the device. The EVM contains all necessary control signals and on-board power generation, which greatly reduces the need for external equipment. The evaluation system also includes GUI software for Microsoft® Windows® for easily programming various modes and patterns into the device.

Features

- Allows control of TX7364 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 user can switch between them easily in GUI
- 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



TX7364 EVM

Table of Contents

1 Evaluation Module Overview

1.1 Introduction

This user's guide refers to software TX7364 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 TX7364EVM evaluation module (EVM) and provides a general description of the features and functions to be considered while using this module. The TX7364EVM 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 TX7364EVM evaluation module. Therefore, do not leave the EVM powered when unattended to avoid potential injury.

The TX7364EVM 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 TX7364EVM kit contains the following items:

1. TX7364EVM
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

The device is a highly integrated, high performance transmitter design for ultrasound imaging system. The device integrates 64 channels to generate high voltage pulses and a transmit/receive (T/R) switch.

The pulser uses AVDDP_HV and AVDDM_HV supply, to generate high and low pulse respectively. The pulser circuits of the same channel are made active and tri-state in a mutually exclusive manner, and the outputs are multiplexed to a common output. Such an operation results in a 3-level output voltage: –100V, 0V and +100V.

The device supports only on-chip transmit beamforming mode. In the on-chip beamforming mode, the pulser transitions of 64 channels are controlled by delay and pattern stored in a RAM inside the device.

2 Hardware

2.1 Equipment Setup Overview

Figure 2-1 shows the equipment setup required to test the TX7364EVM.

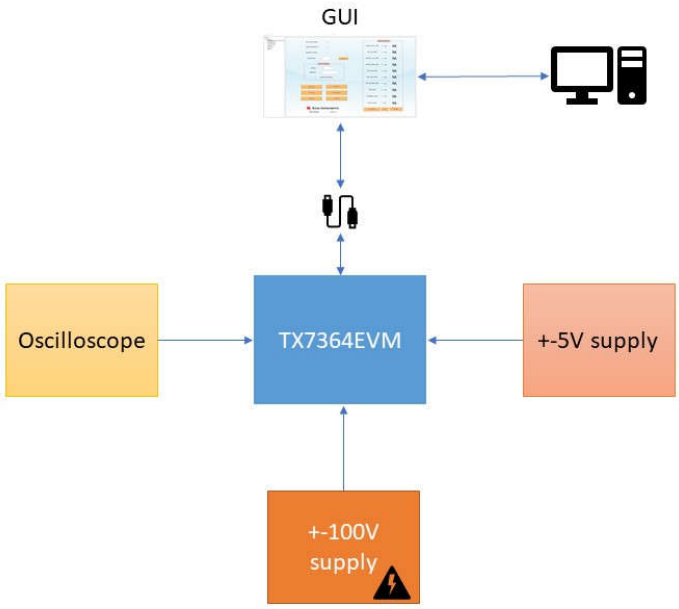


Figure 2-1. TX7364EVM Setup

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 TX7364EVM 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 TX7364EVM 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. TX7364EVM GUI Installation

   Download the TX7364EVM 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 TX7364EVM GUI installer window, click the *Next* > button.

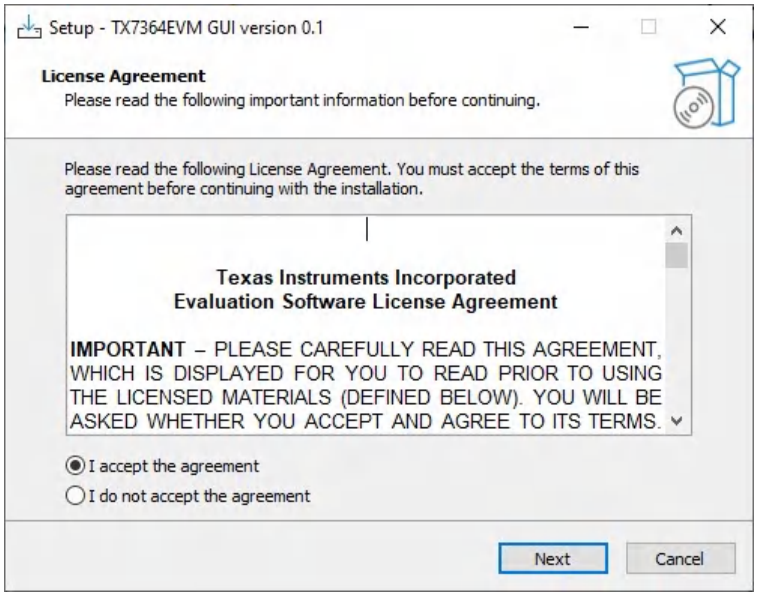


Figure 3-1. TX7364EVM GUI Install (License Agreement)

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

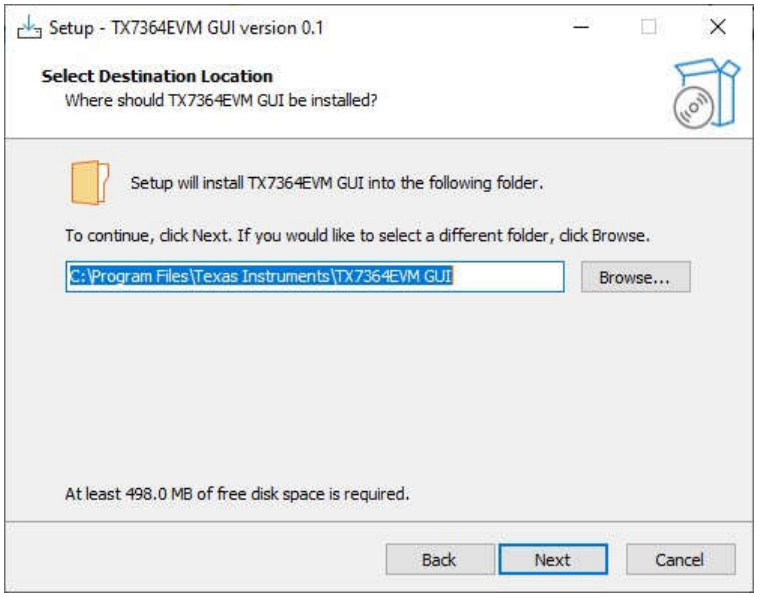


Figure 3-2. TX7364EVM GUI Install (Select Destination Location)

c. Select the destination folder where the software has to be installed and click *Next* >.

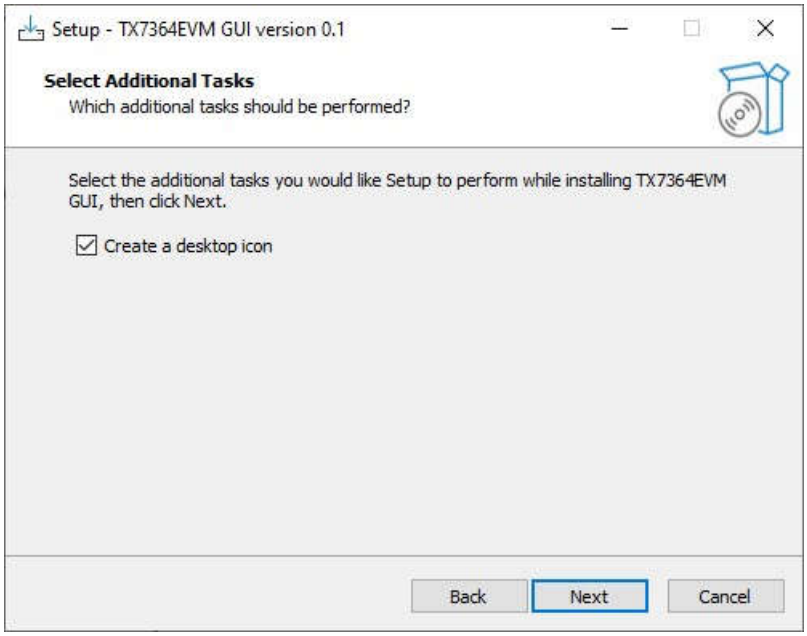


Figure 3-3. TX7364EVM GUI Install (Installation Ready)

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

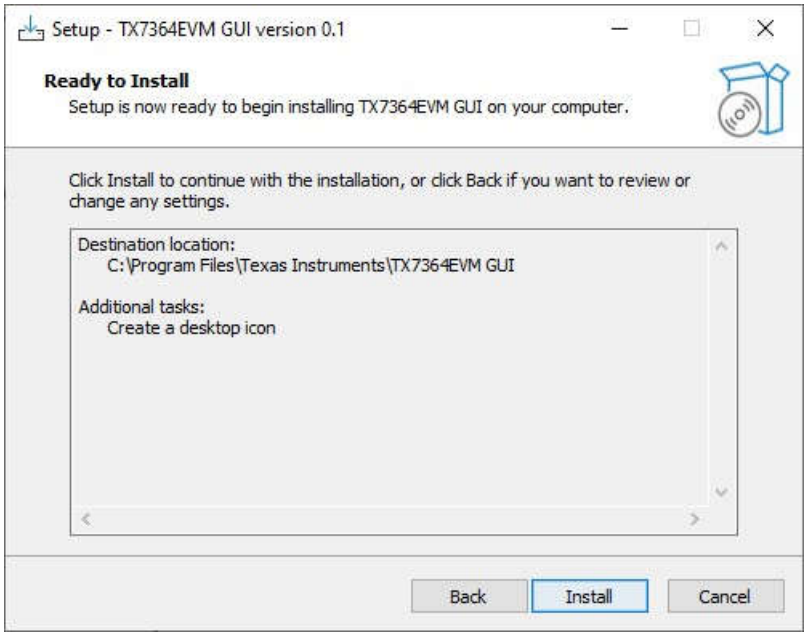


Figure 3-4. TX7364EVM (Ready to install)

e. Click *Install* and wait for installation.

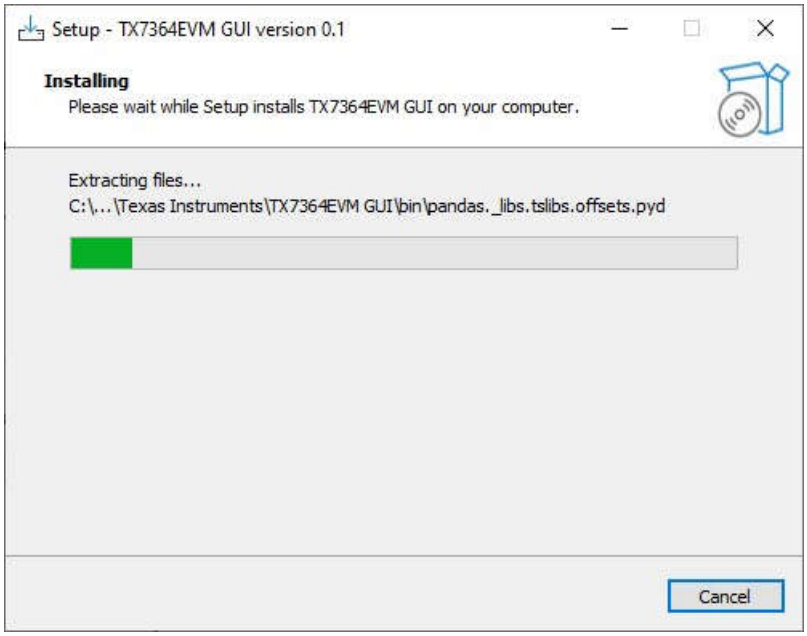


Figure 3-5. TX7364EVM (Ready to install)

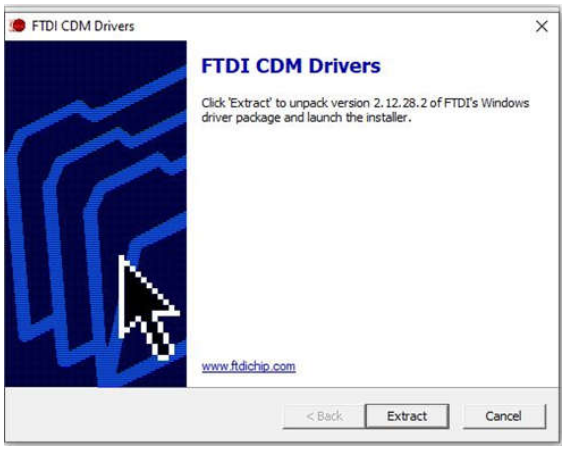


Figure 3-6. TX7364EVM GUI Install (FTDI CDM Drivers)

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

Figure 3-7. TX7364EVM GUI Install (Welcome to the Installation Wizard)

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

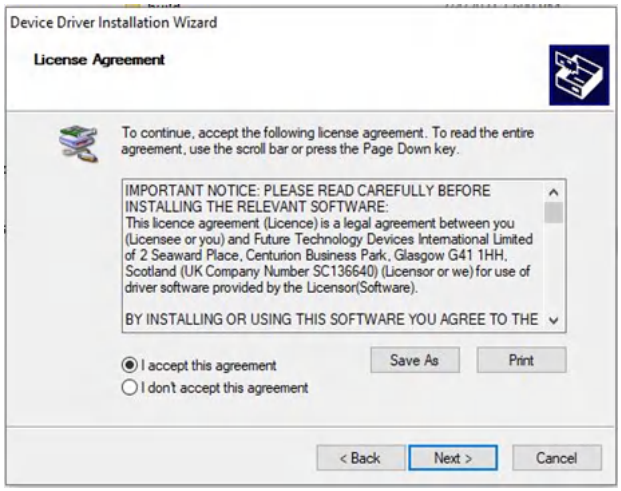


Figure 3-8. TX7364EVM GUI Install (License Agreement)

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

Figure 3-9. TX7316EVM GUI Install (Completing the Device Driver Installation Wizard)

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

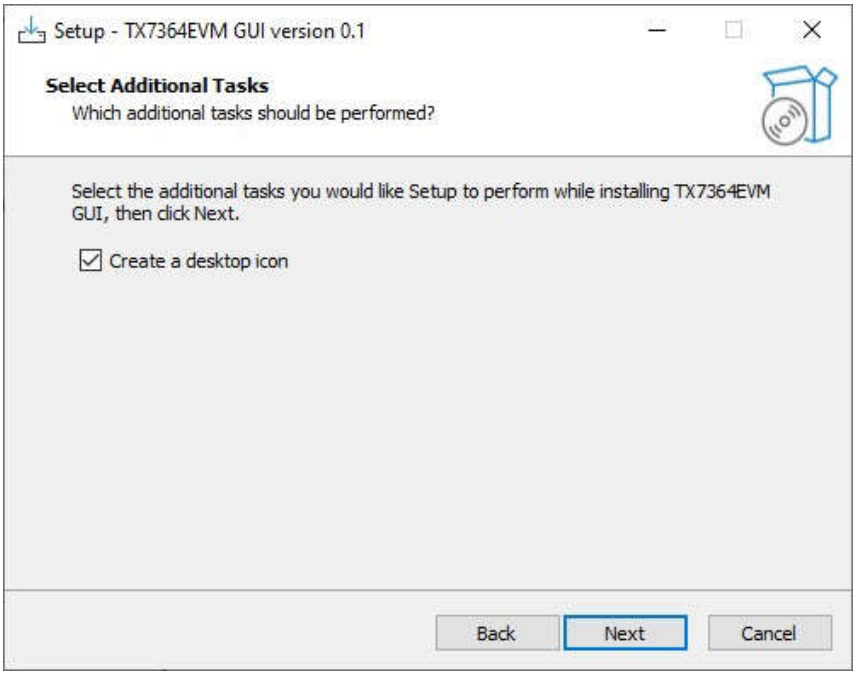


Figure 3-10. TX7316EVM GUI Install (Completing the TI-Latte Setup Wizard)

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 200mA)
- 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 D11: ON showing status of on board 2.5V 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)
+5 V	187	-5 V	1
+100 V	2.8	-100 V	2.8

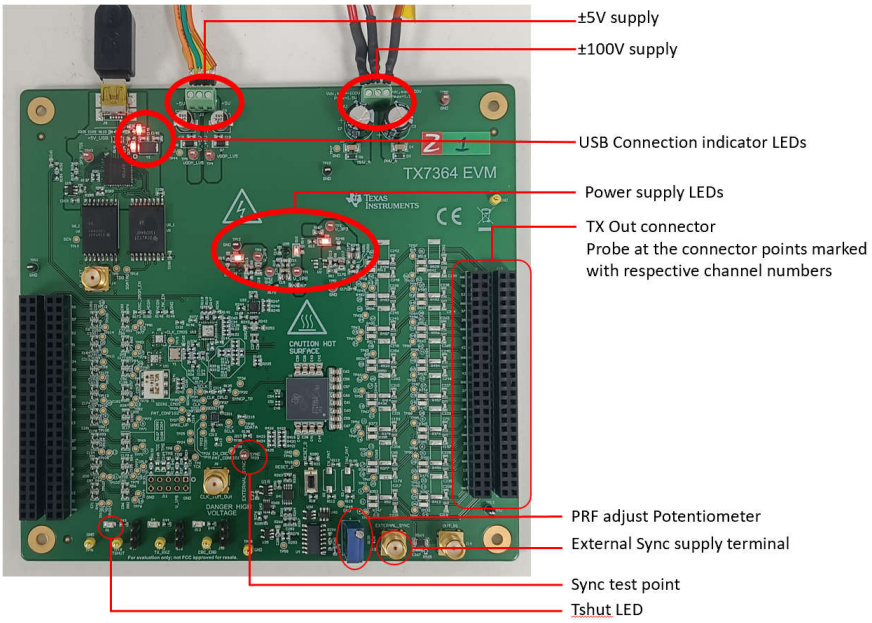


Figure 4-1. EVM Power Up State

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 TX7364-latte icon on Desktop or write TX7364-latte 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 -> TX7364 _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 4-3.
5. Select the TX7364_GUI under Tree View to navigate across pages.

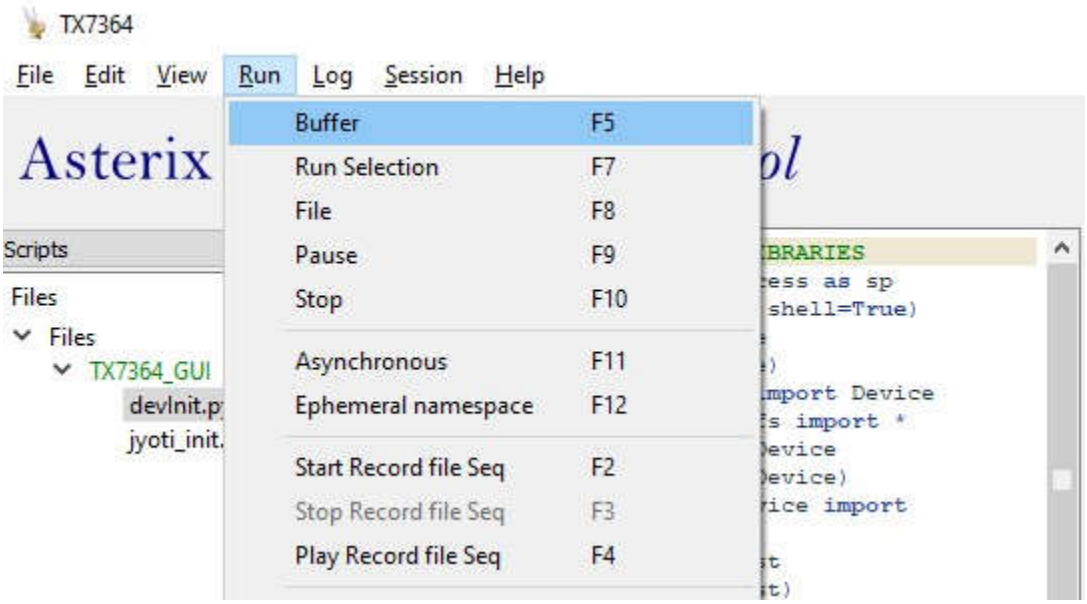


Figure 4-2. Latte GUI Window

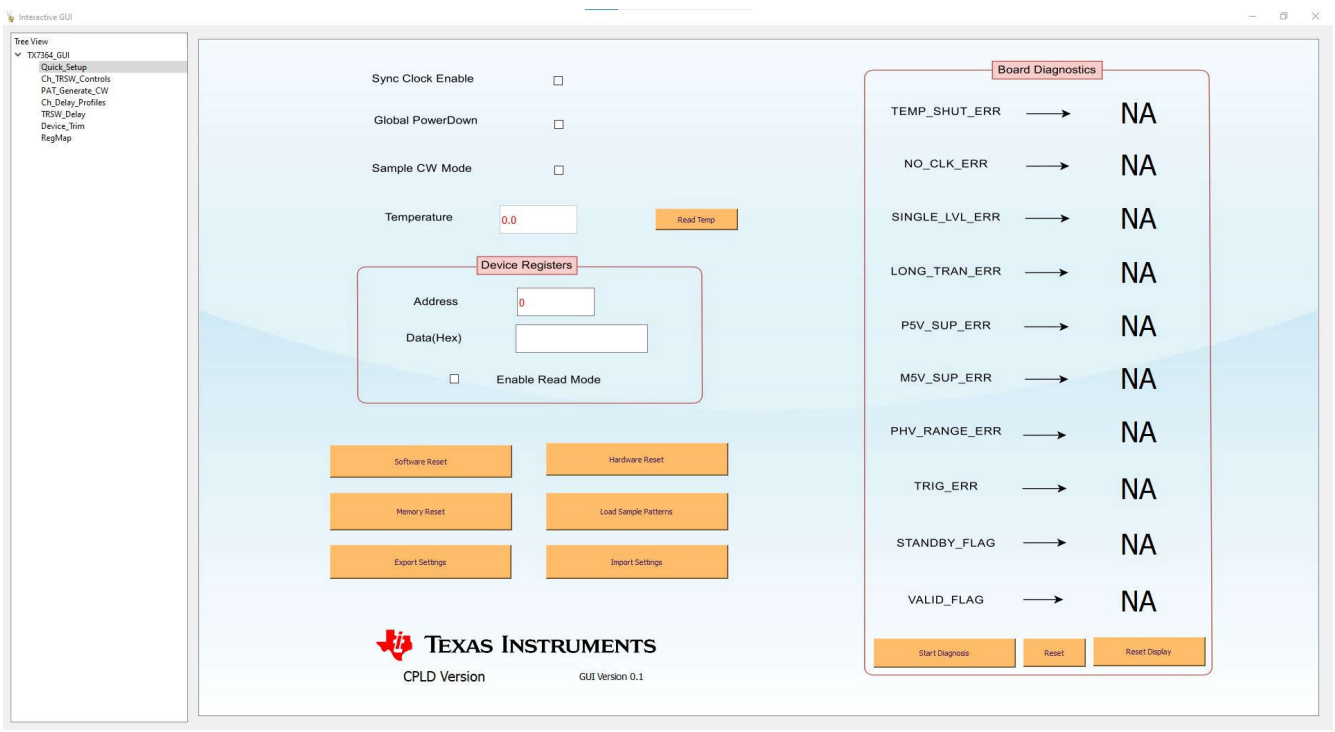


Figure 4-3. TX7364 Interactive GUI

4.1.3.1 Initializing Device

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

1. Navigate to the *Quick Setup* page and click on *Memory Reset* once after power up. 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.
2. Then click *Hardware Reset*. This resets any previous settings on the device to the default values and takes another 20 seconds. The GUI displays a pop-up message after the hardware is reset.
3. Click the *Load Sample Patterns* button. This loads a set of predefined patterns into the device.

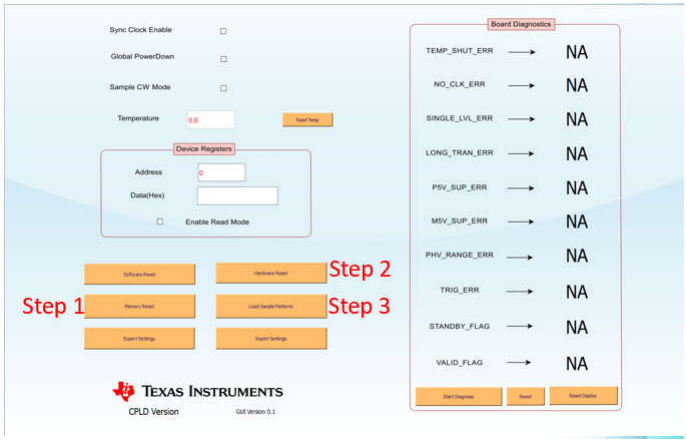


Figure 4-4. Device Initialization Steps

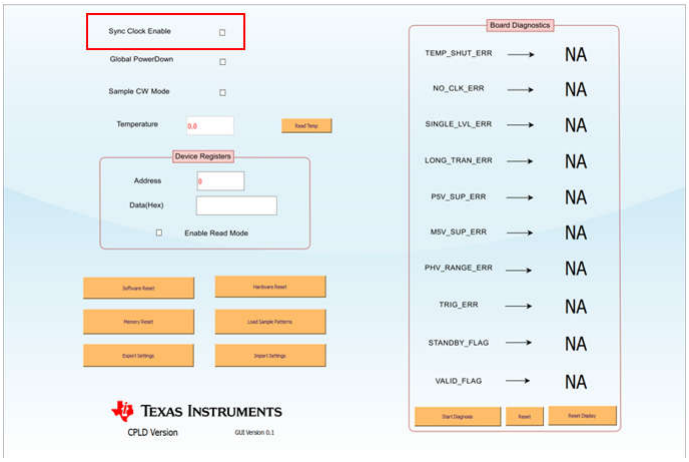


Figure 4-5. Enabling Sync

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.

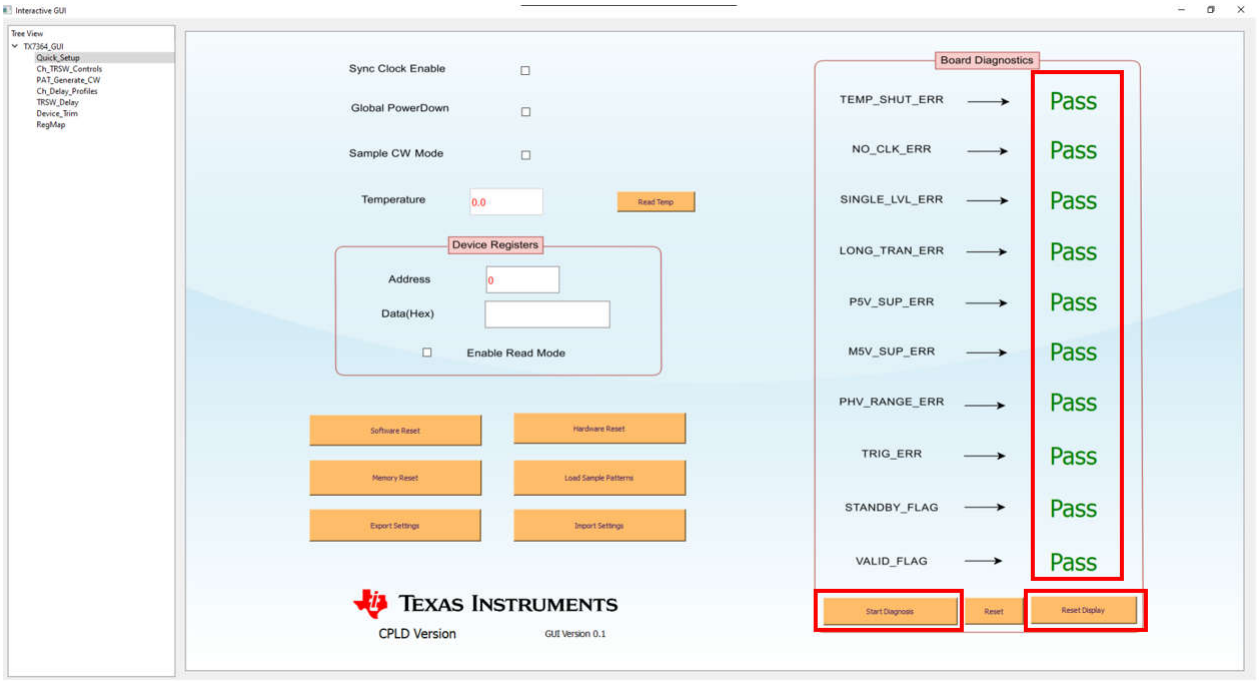


Figure 4-6. Checking Error Flags

Setting the sync PRF:

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

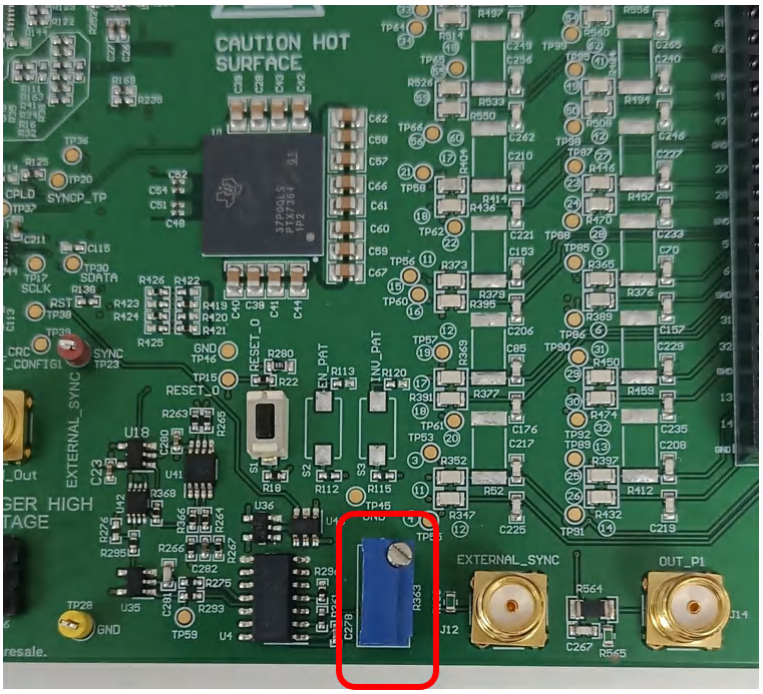


Figure 4-7. Changing Sync PRF on EVM

2. Set the sync PRF to as expected by rotating the potentiometer controlling R363.
3. Then click *Sync Clock Enable* in the *Quick Setup* page.

4.1.3.2 Loading Sample Pattern

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

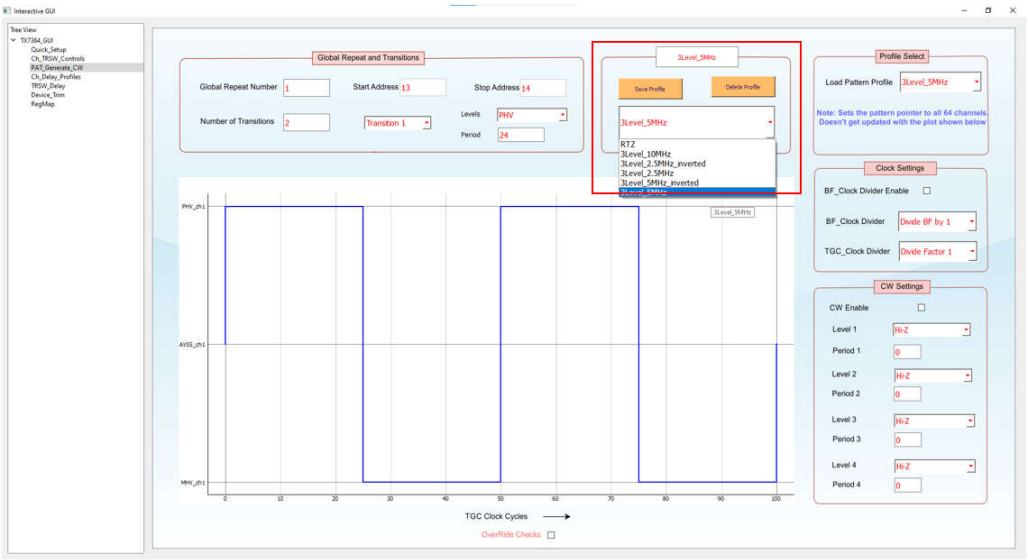


Figure 4-8. Pattern Profile Select Page

4.1.4 GUI Control

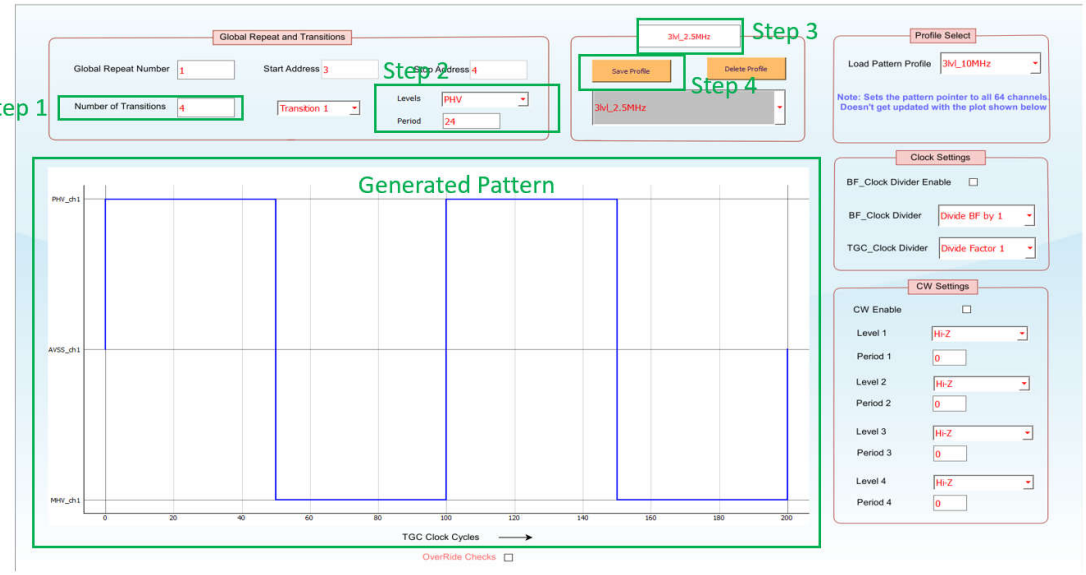
4.1.4.1 Generating New Patterns

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

Steps to define new pattern.

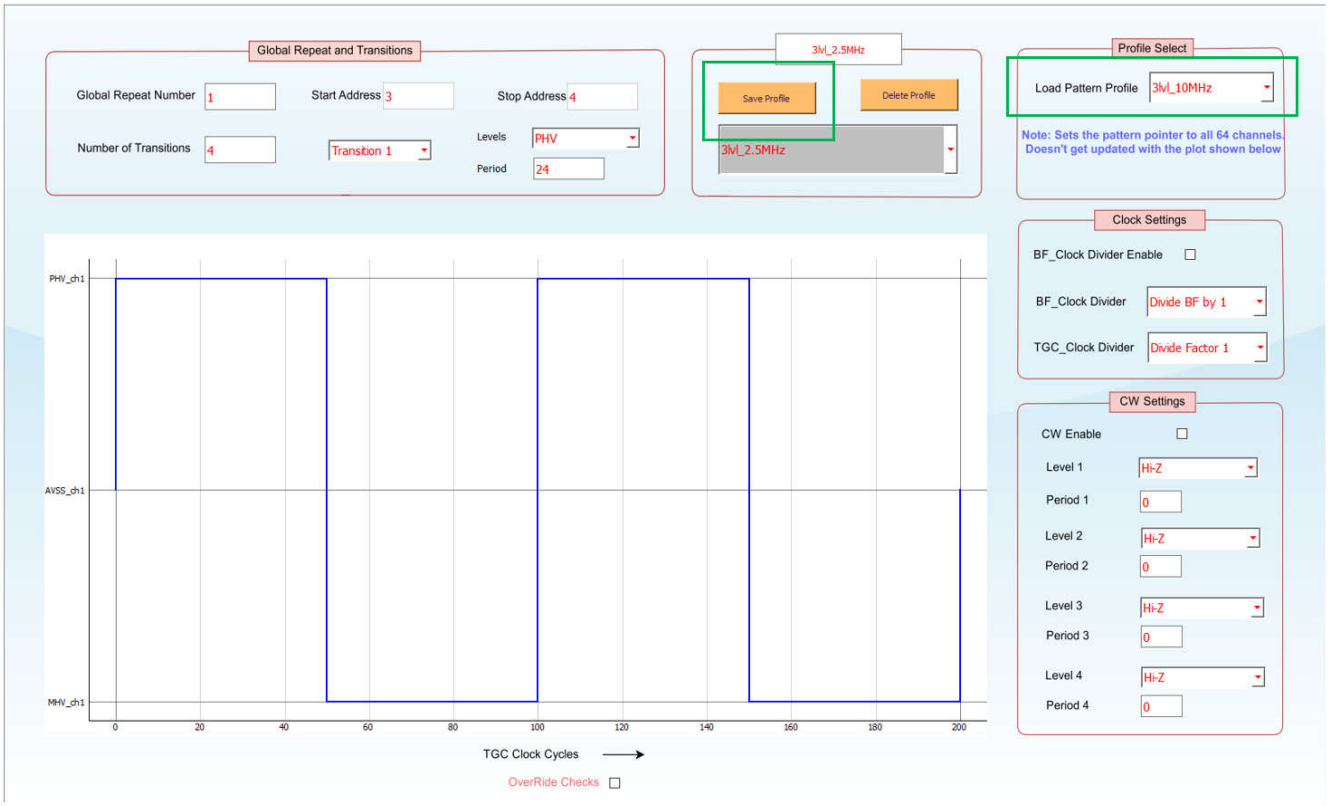
1. Enter number of transitions.
2. Program required level and duration of each transitions. The effective duration of each transition is programmed value + 1 clock cycle.
3. Give the pattern a name.
4. Press *Save Profile*.

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 the next section).



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

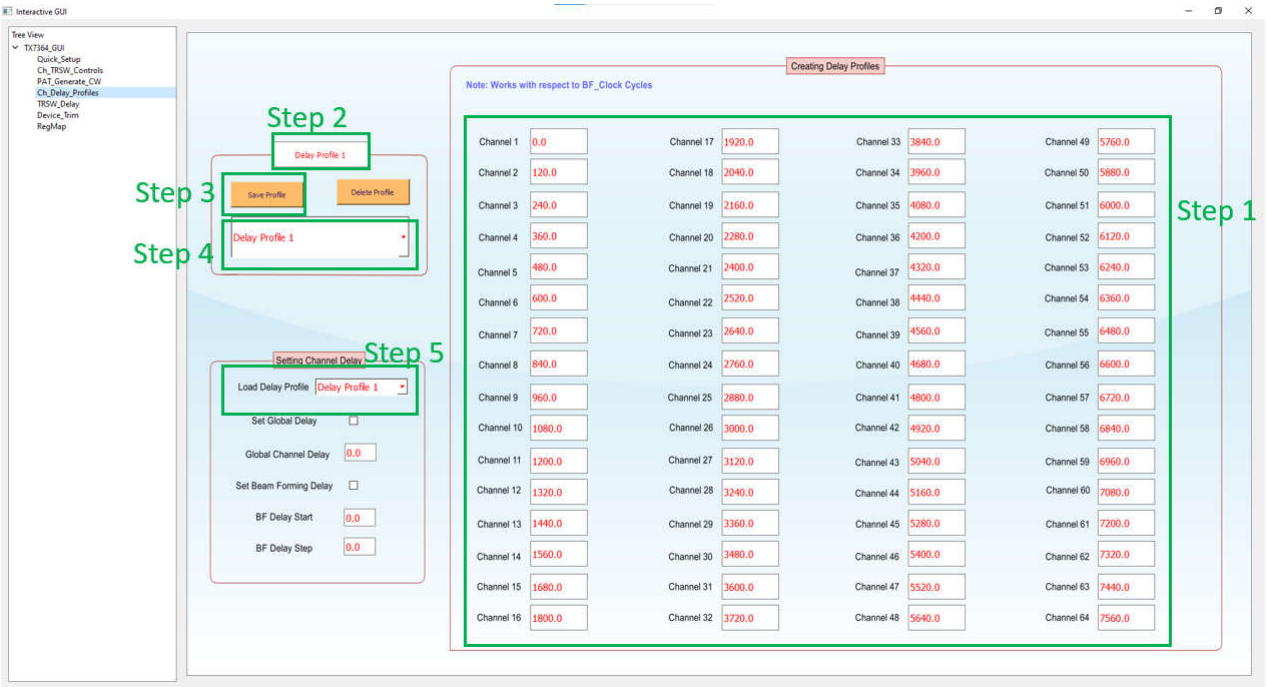
The *Ch_Delay_Profiles* section can be used to store and load multiple delay profiles.

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.

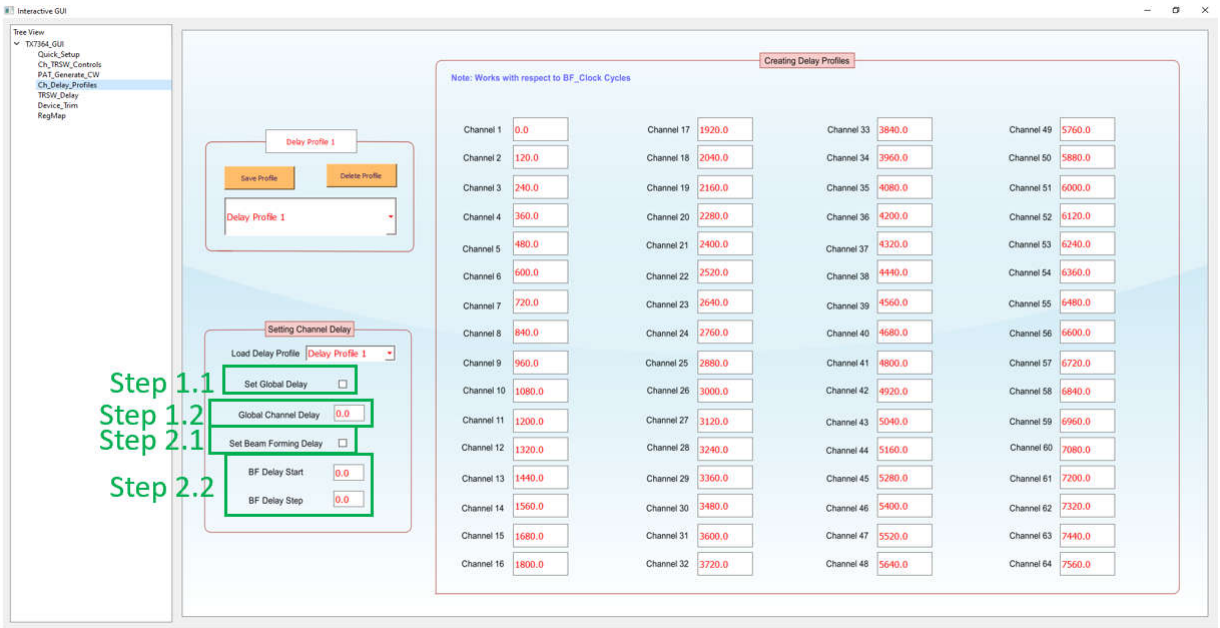


To help with setting the delay value for all 64 channels, the GUI supports global delay mode and beamforming delay mode. This updates the channel delay widgets.

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.



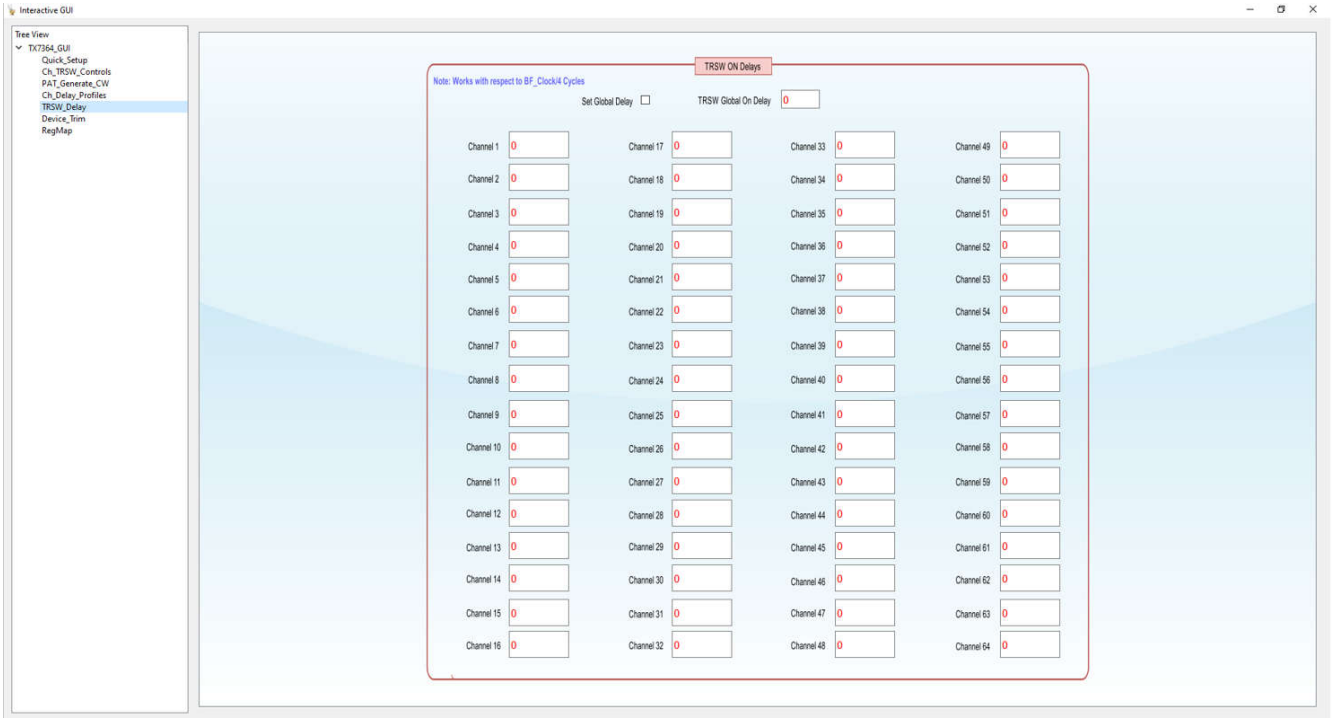
4.1.4.5 Setting T/R Switch Delays

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



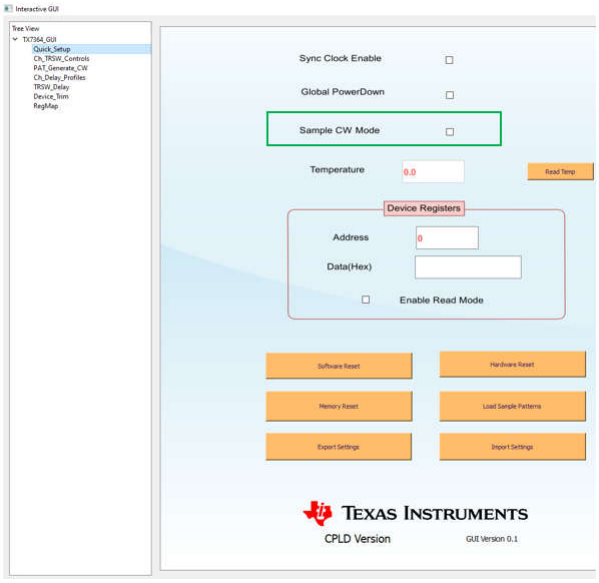
4.1.4.6 Sample B-mode Pattern

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 GUI follow below steps:
   a. Navigate to *Quick_Setup* page.
   b. Check the box *Sample CW Mode*.

This enables a 5MHz 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.

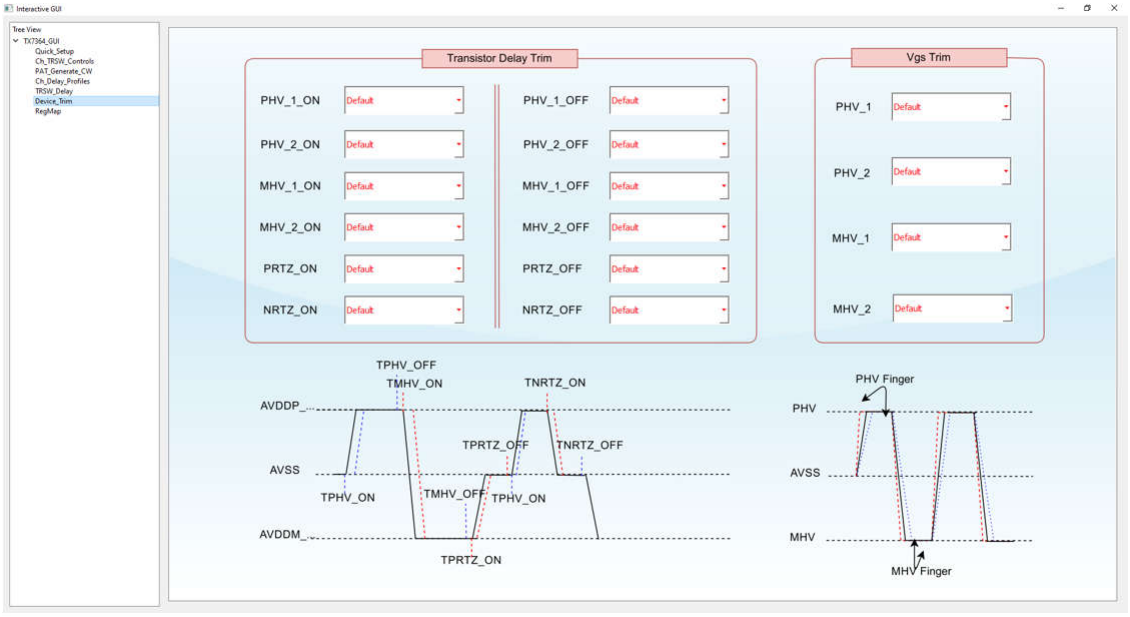
To change the pattern settings, uncheck *CW Enable* widget, update the level period information and select *CW Enable* once again.

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.A TX7364EVM Automation

4.1.A.1 Automation using Latte based TX7364 GUI

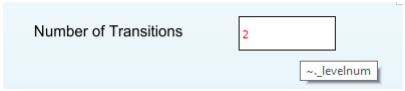
4.1.A.1.1 Widgets

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*.

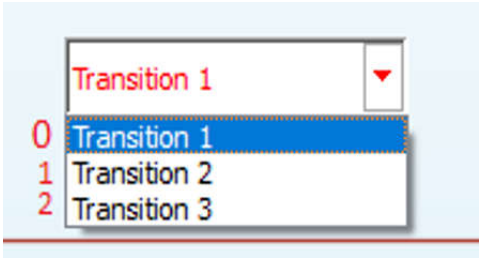


Figure A-10. Transitions

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

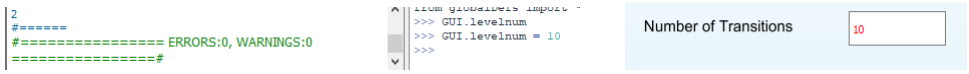
The button widget is used to execute a set of instructions in the background. This does not have a choice. If the button is clicked, then the GUI assumes the user wants to execute something in the function which is pre-defined by the GUI programmer. In Figure A-11, if the Load Sample Pattern is pressed,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

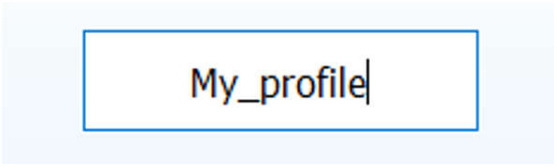
Example: GUI.levelnum = 10 sets the sync Number of levels to 10.



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

This is possible to programmatically read and write into the device register.

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:

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 TX7364 GUI

Follow the procedure below to generate automation scripts.

1. Open the TX7364 GUI from the Latte and run *devInit.py* (Run ➔ Buffer).
2. Right-click the TX7364_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.

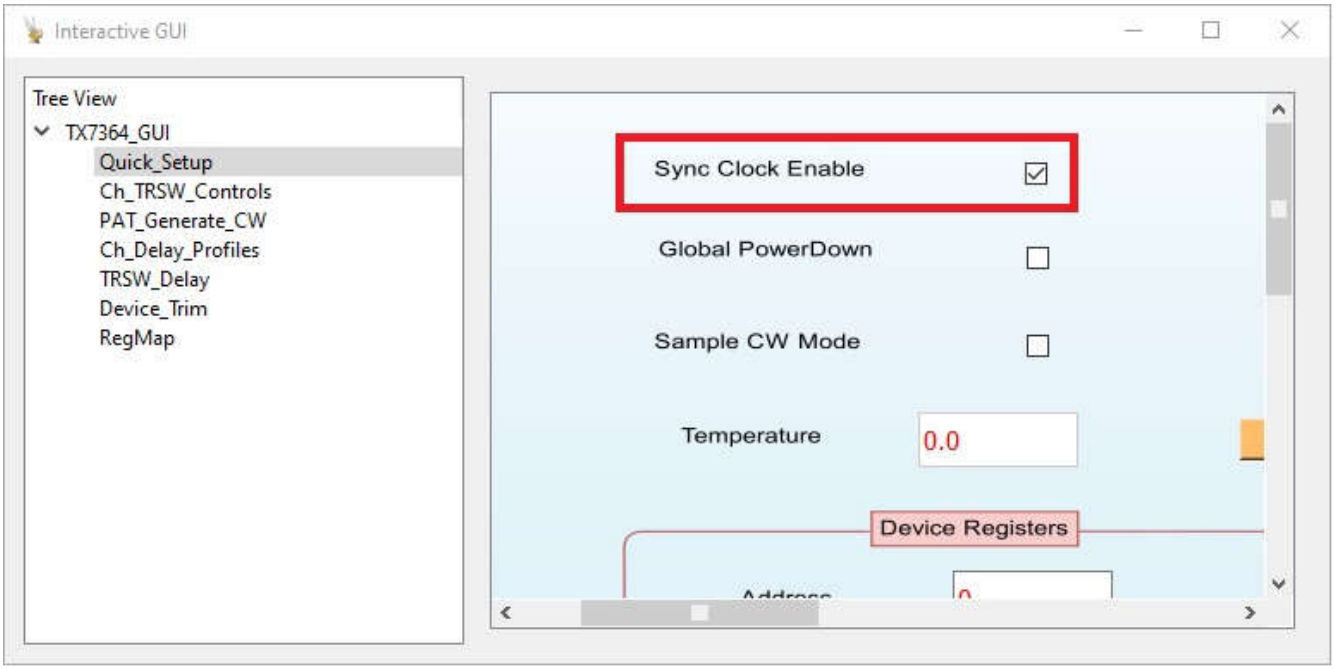


Figure A-12. Quick Setup Tab

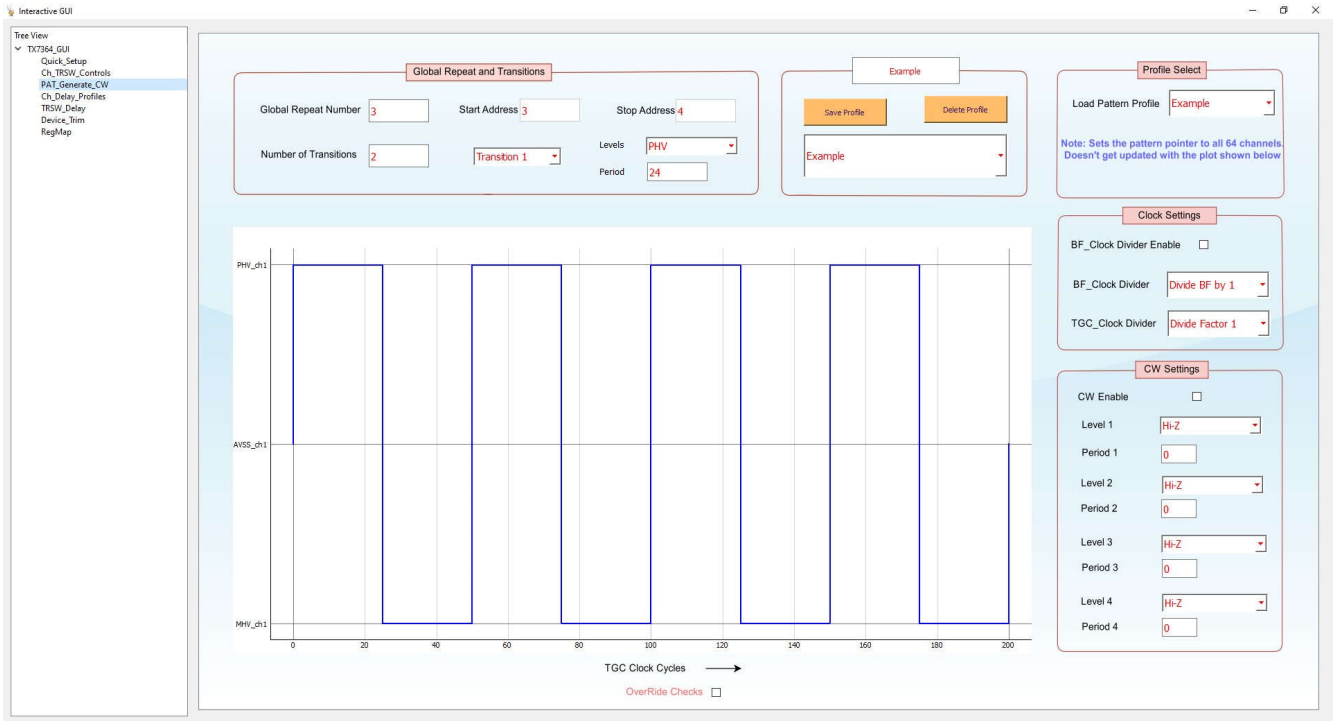


Figure A-13. PAT_Generate_CW Tab

Figure A-14. Ch_TRSW_Controls Tab

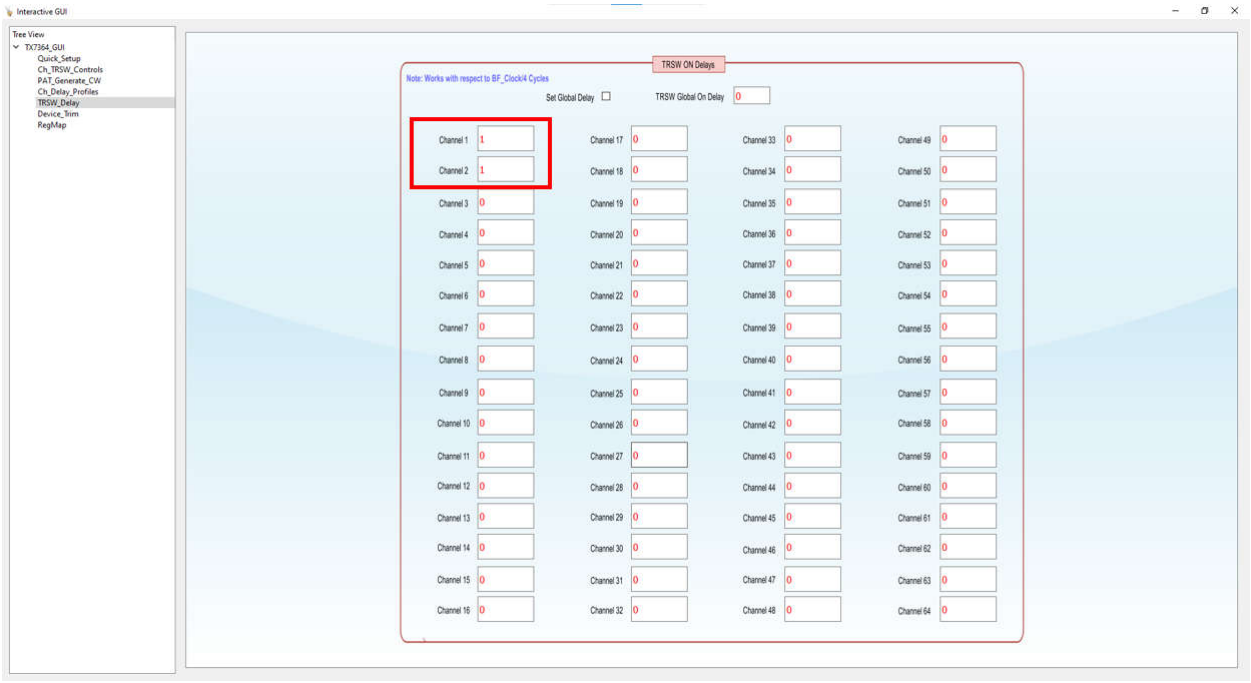


Figure A-15. TRSW_Delay Tab

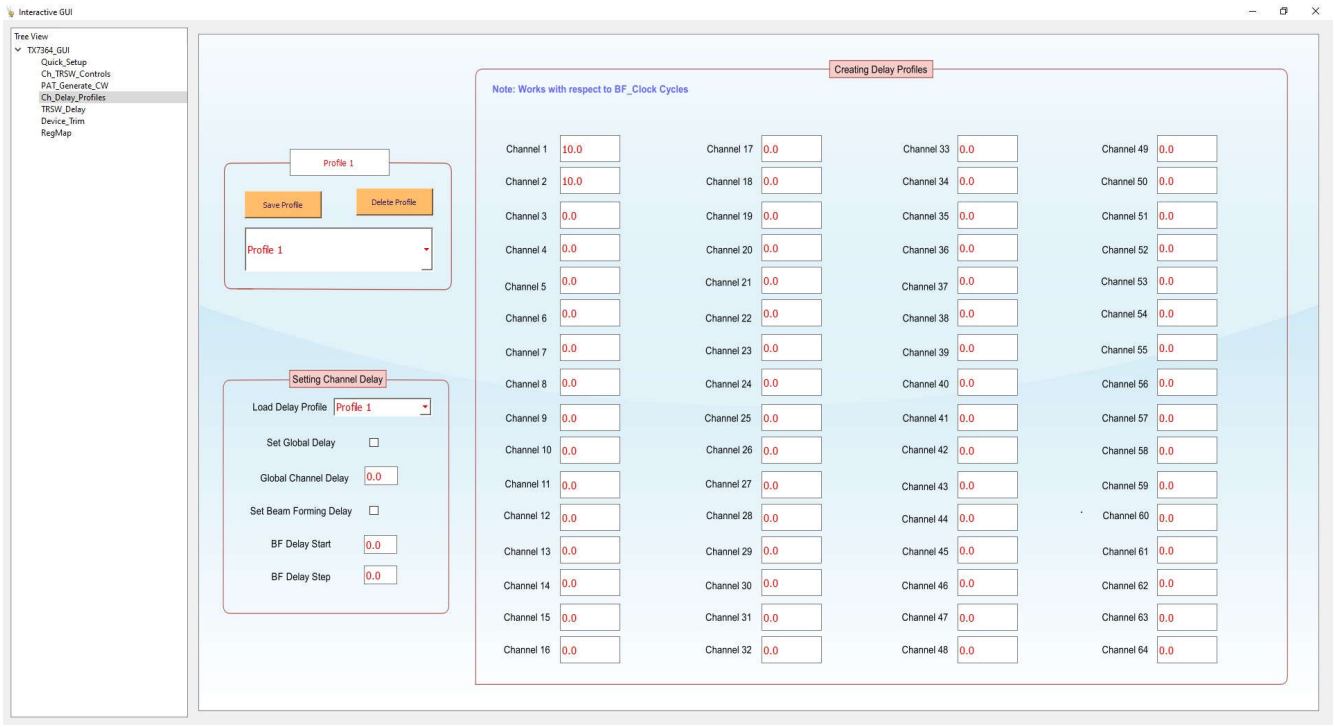
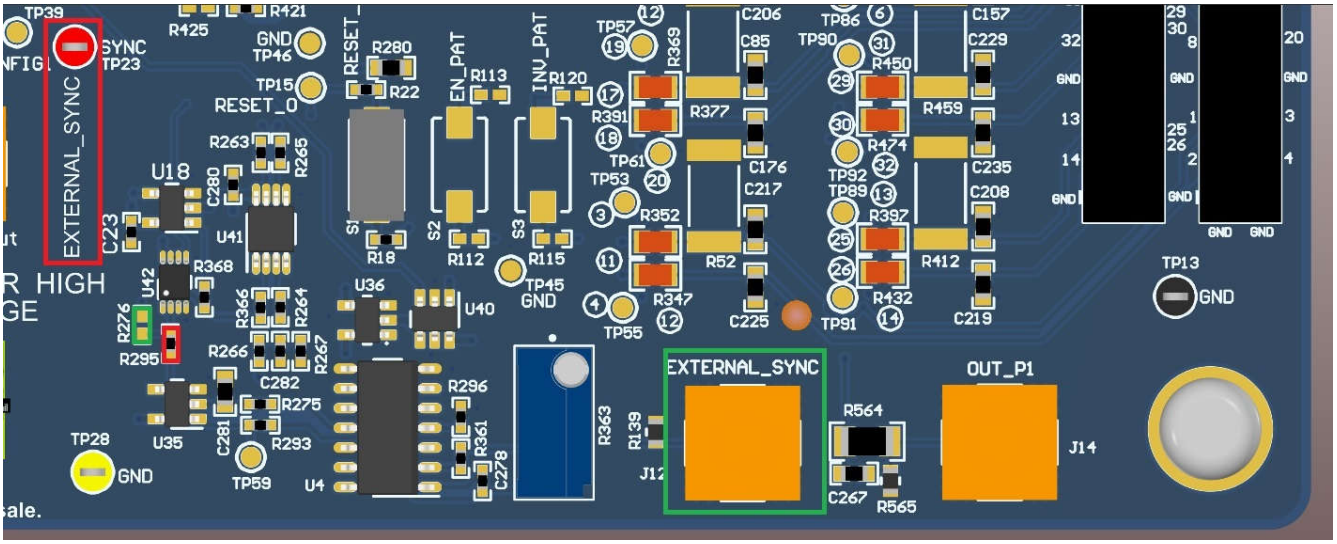


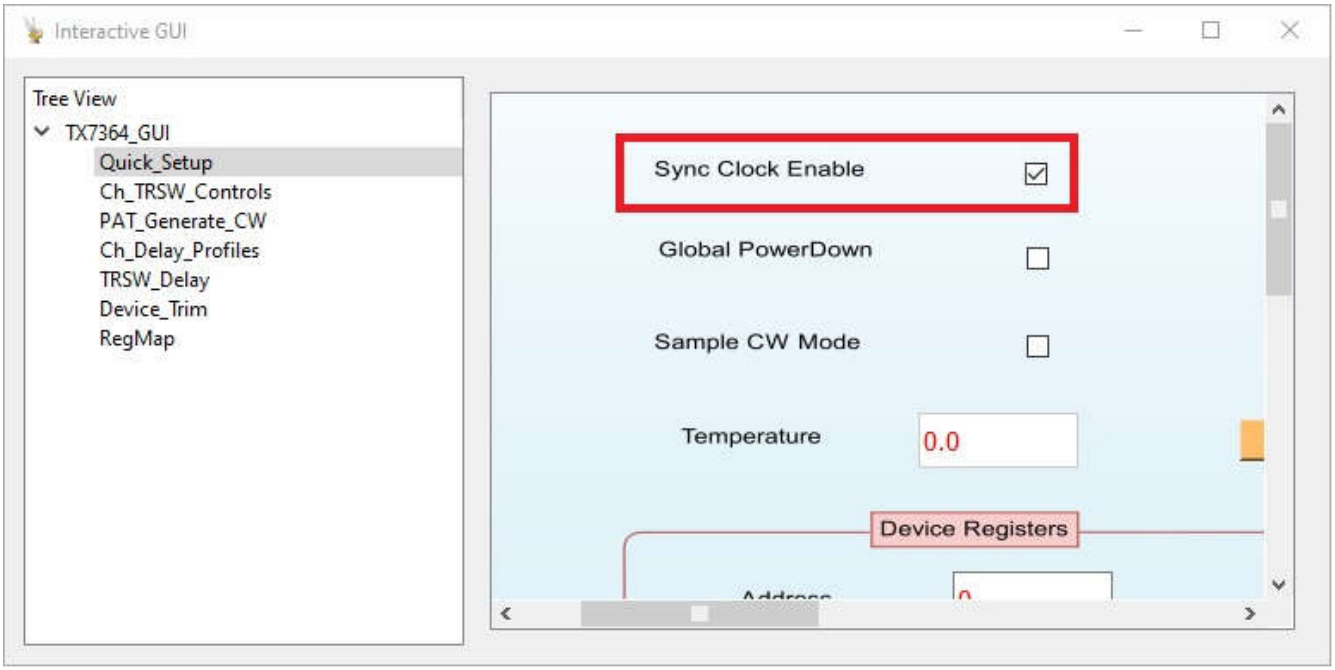
Figure A-16. Ch_Delay_Profiles Tab

4.1.B Procedure to Apply External TR_BF_SYNC Signal to EVM

1. Open the TX7364 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 enable *Sync Clock Enable* box.



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

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 ±100-V output swing, the thresholds used for the measurement must be ±80 V.

4.2.2 Linearity

Linearity is a very important parameter of the device and can be 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 5-10 show the functional block diagram of EVM and the schematics.

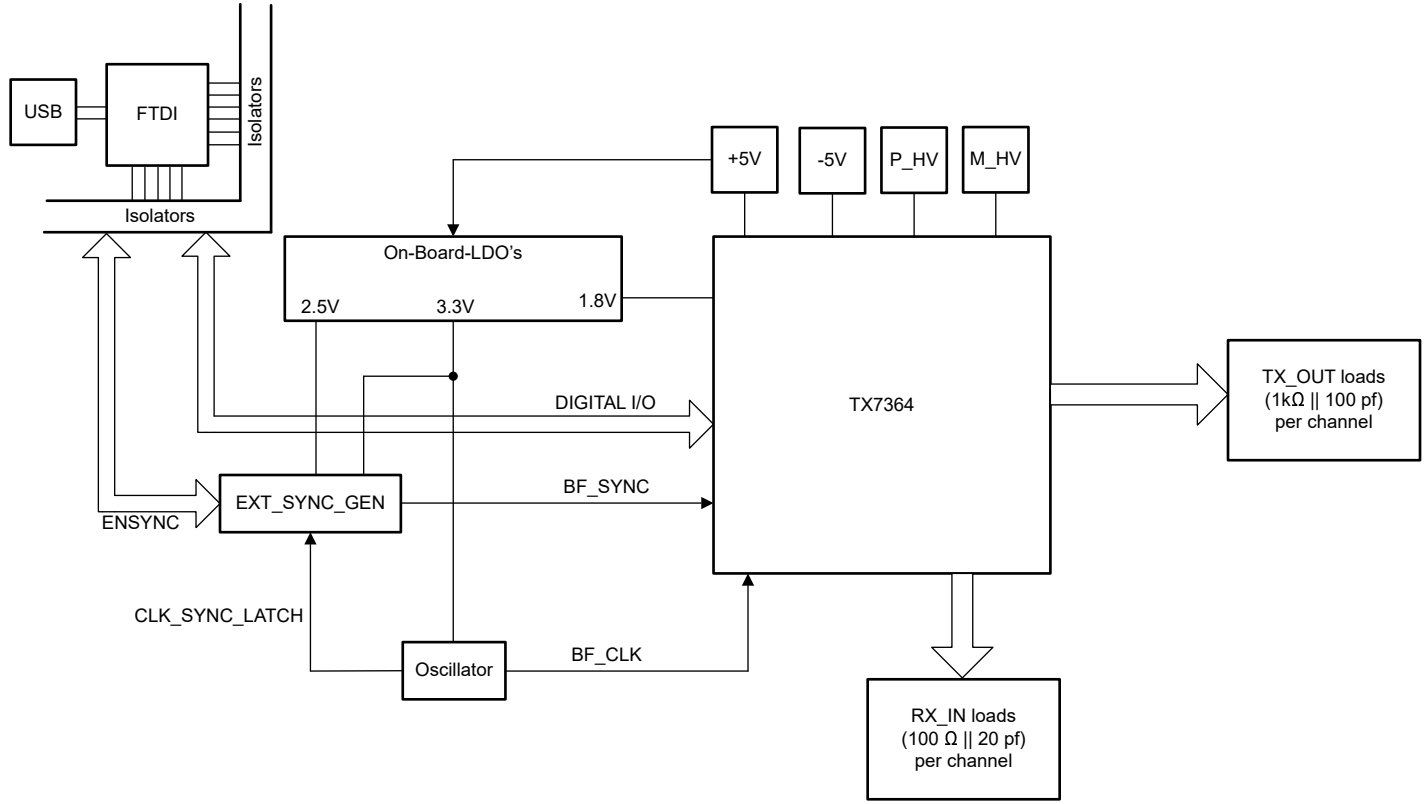


Figure 5-1. Functional Block Diagram

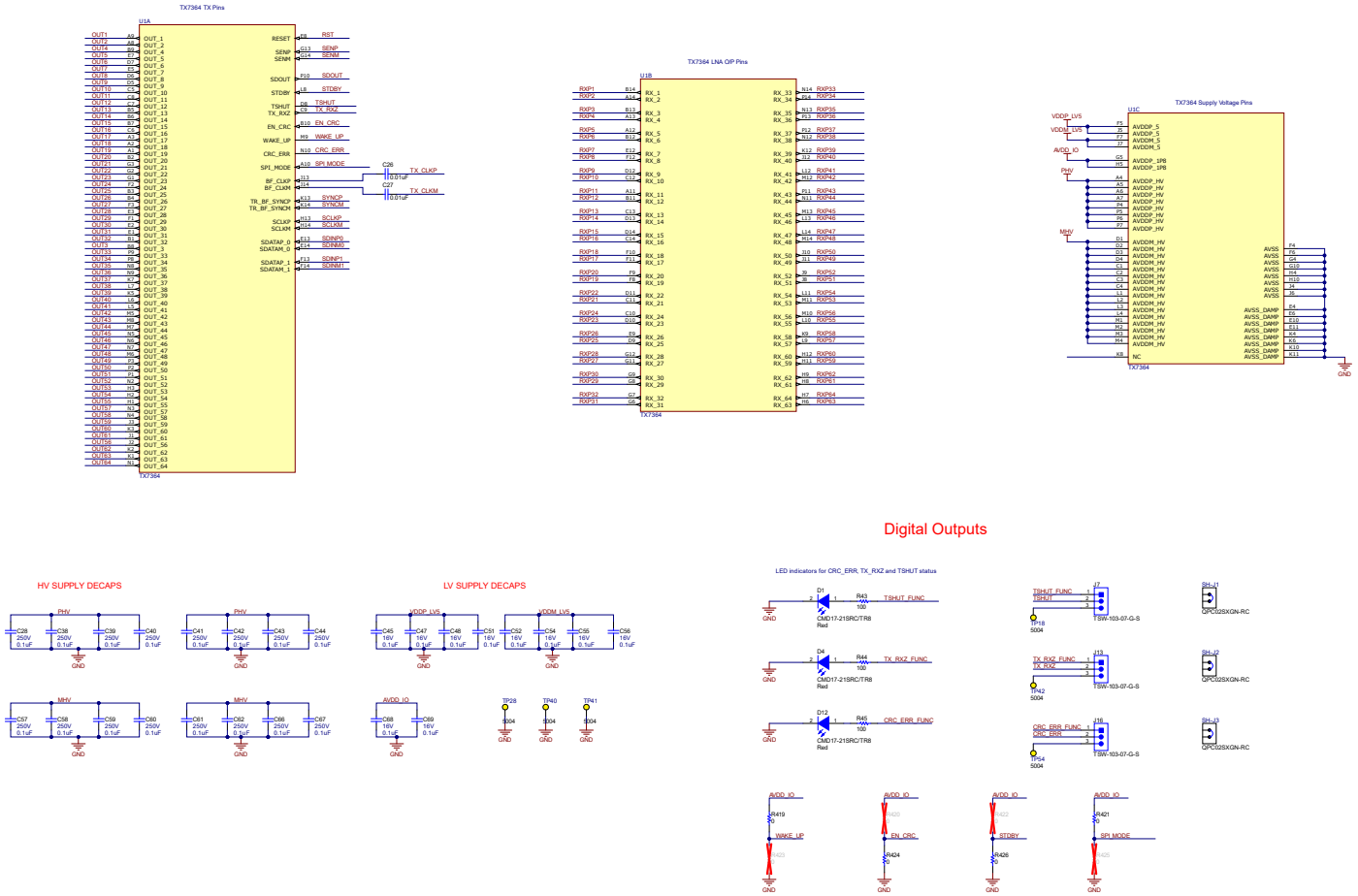


Figure 5-2. Schematic 1

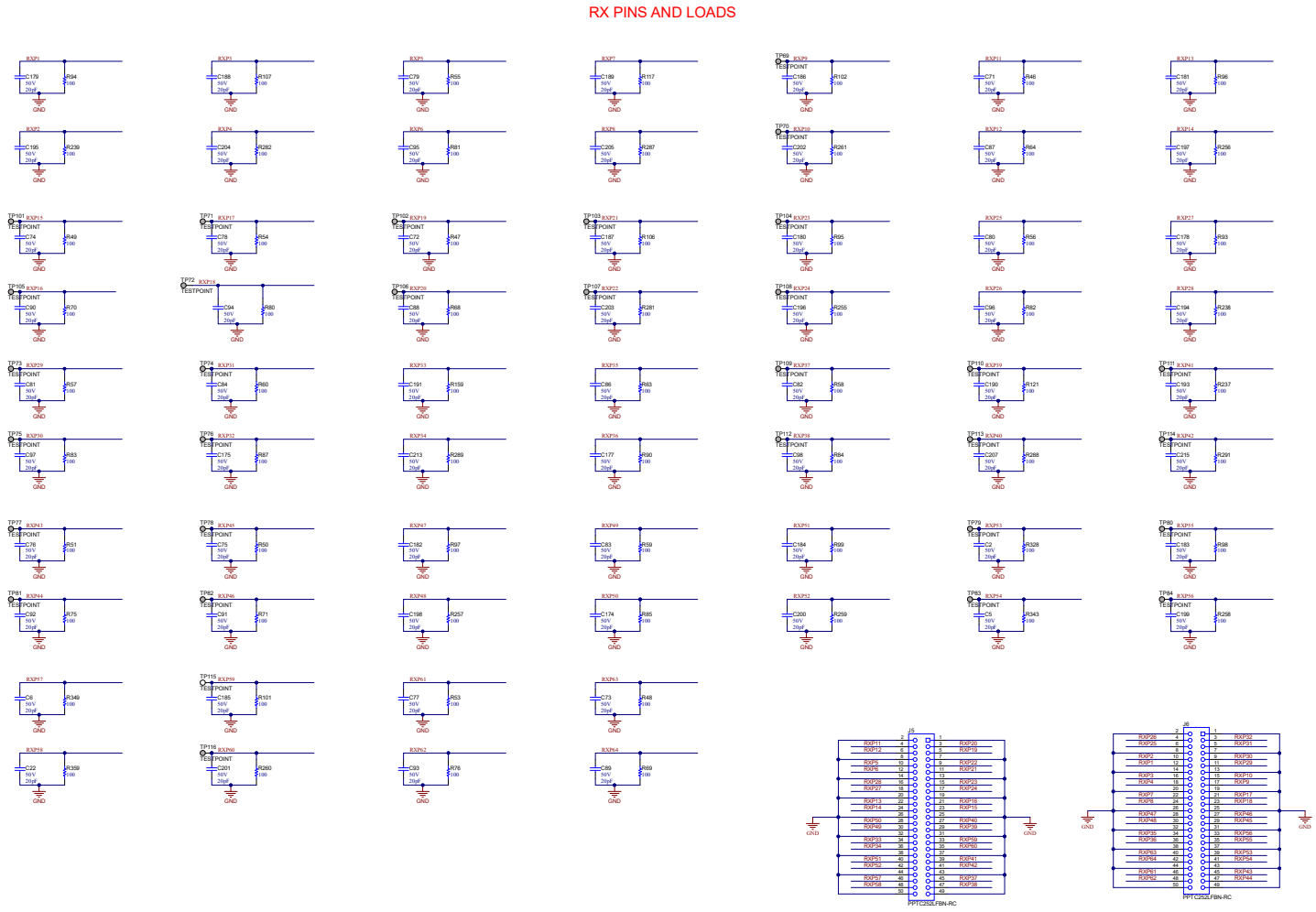


Figure 5-3. Schematic 2

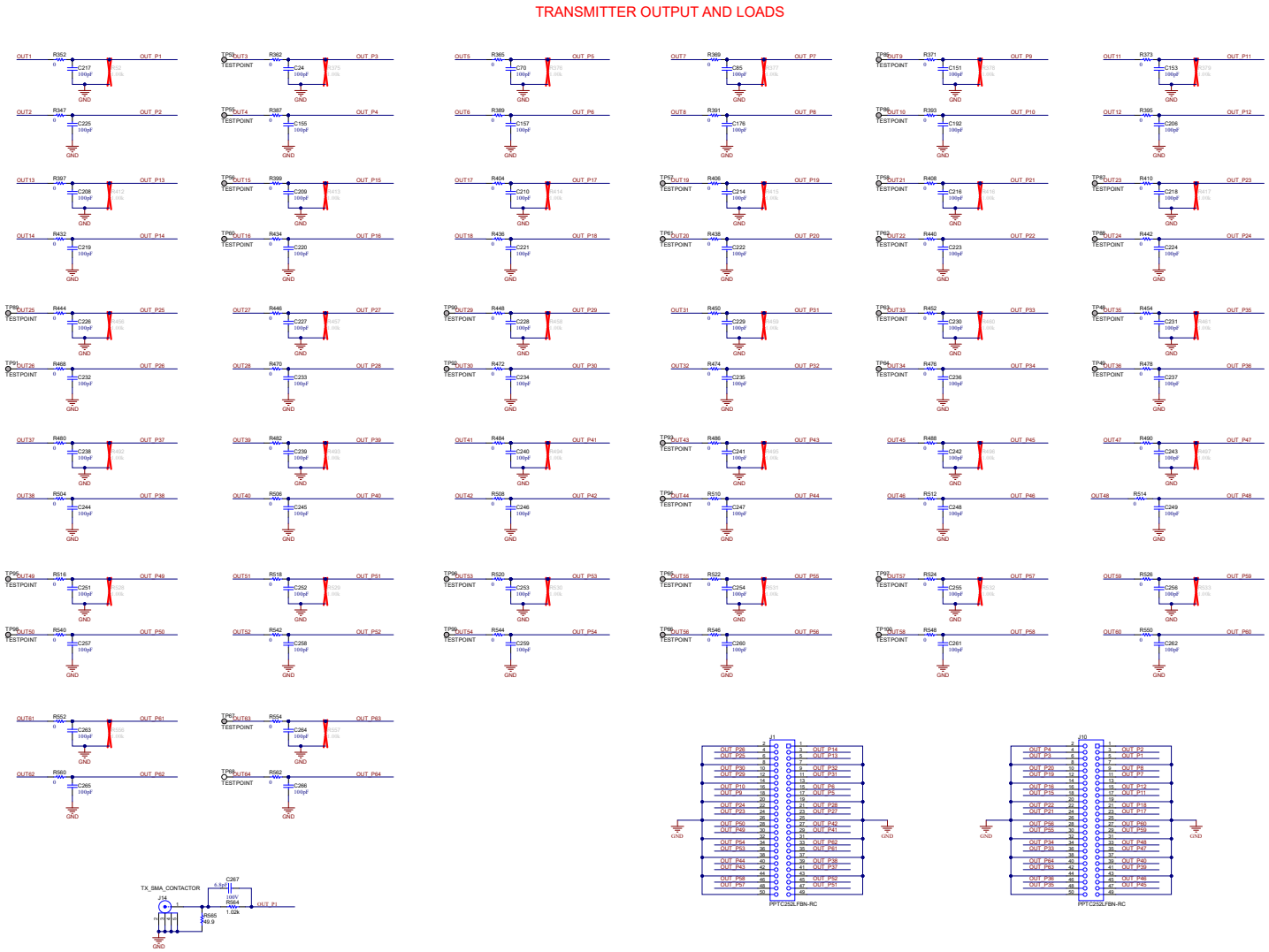


Figure 5-4. Schematic 3

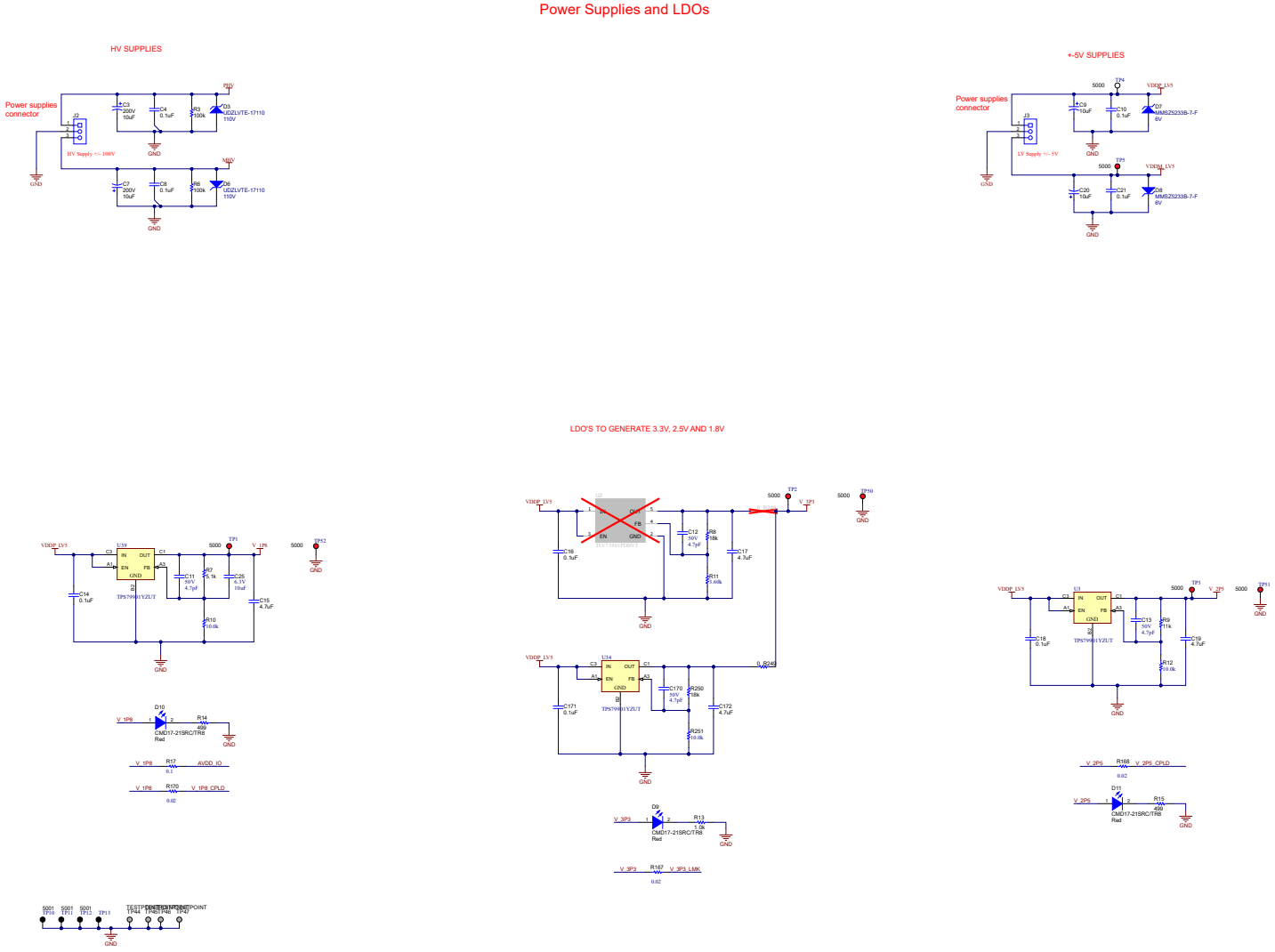


Figure 5-5. Schematic 4

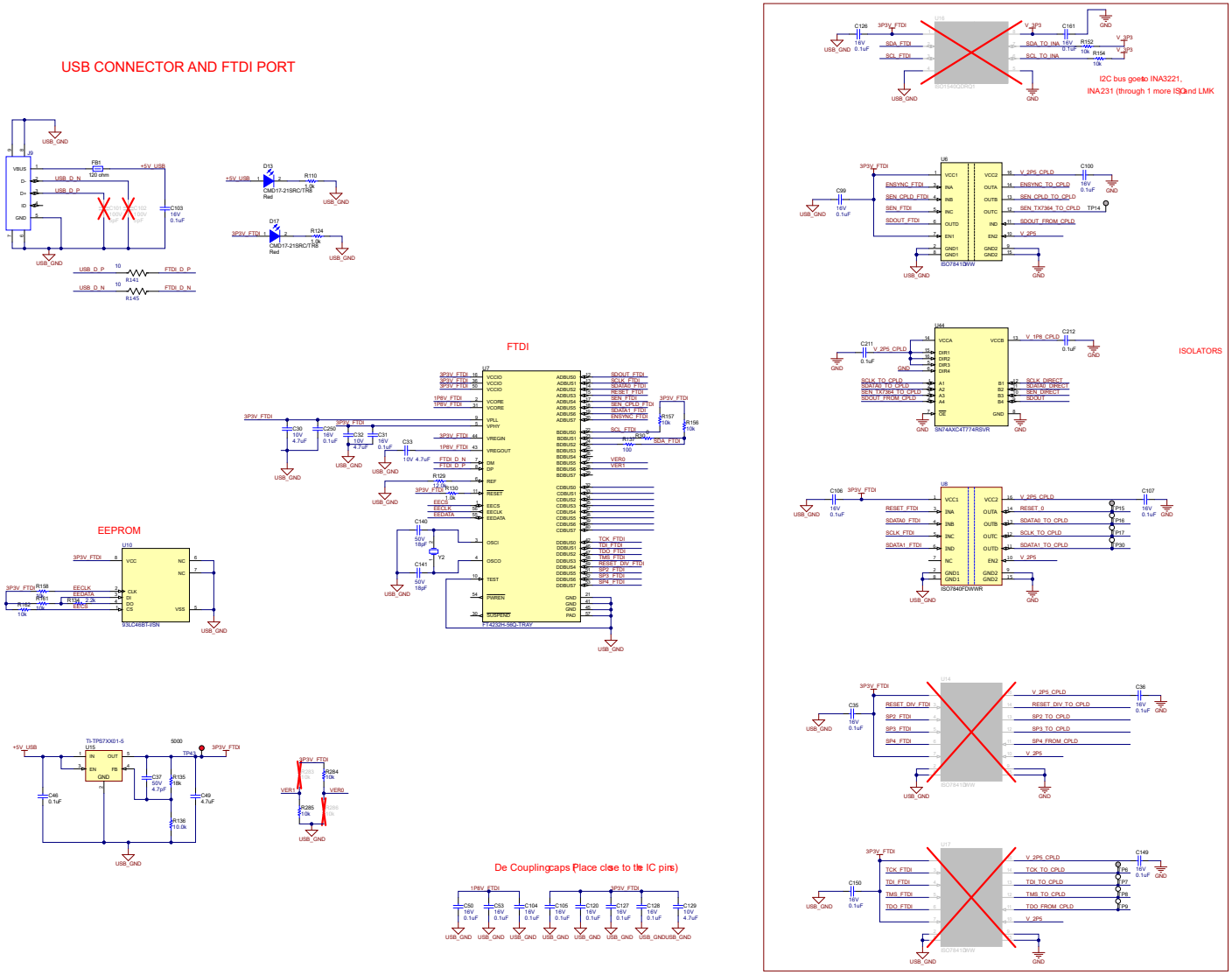


Figure 5-6. Schematic 5

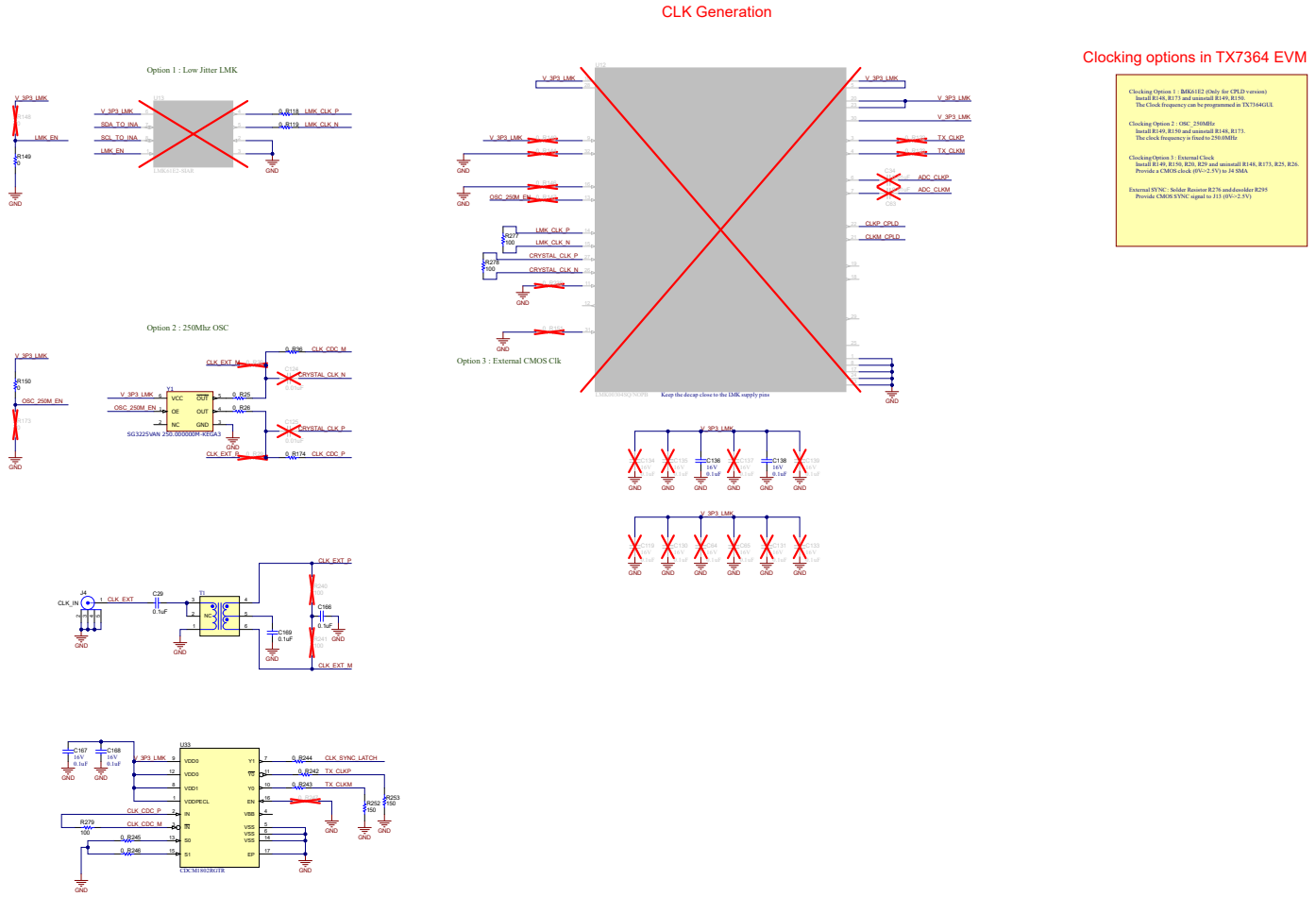


Figure 5-7. Schematic 6

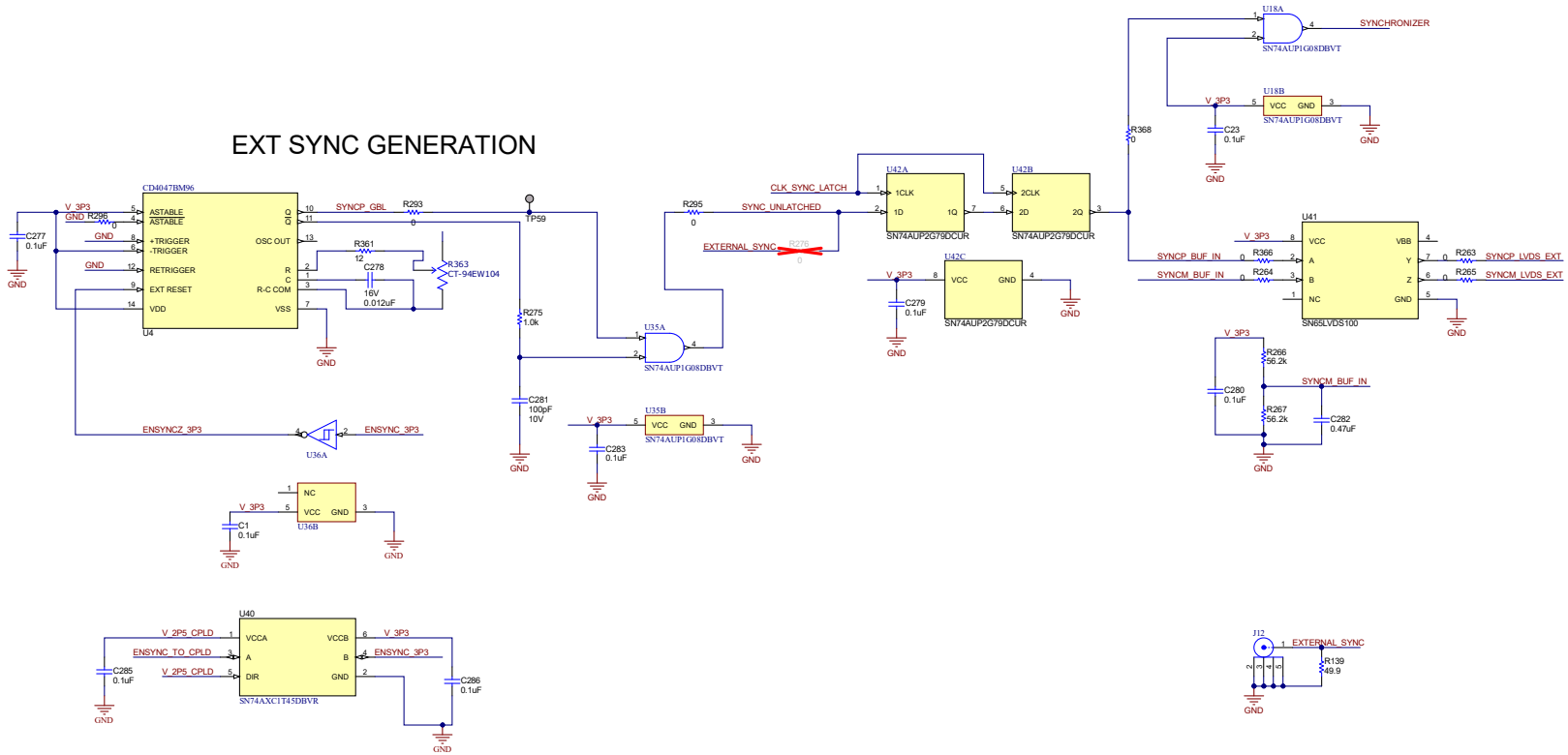


Figure 5-8. Schematic 7

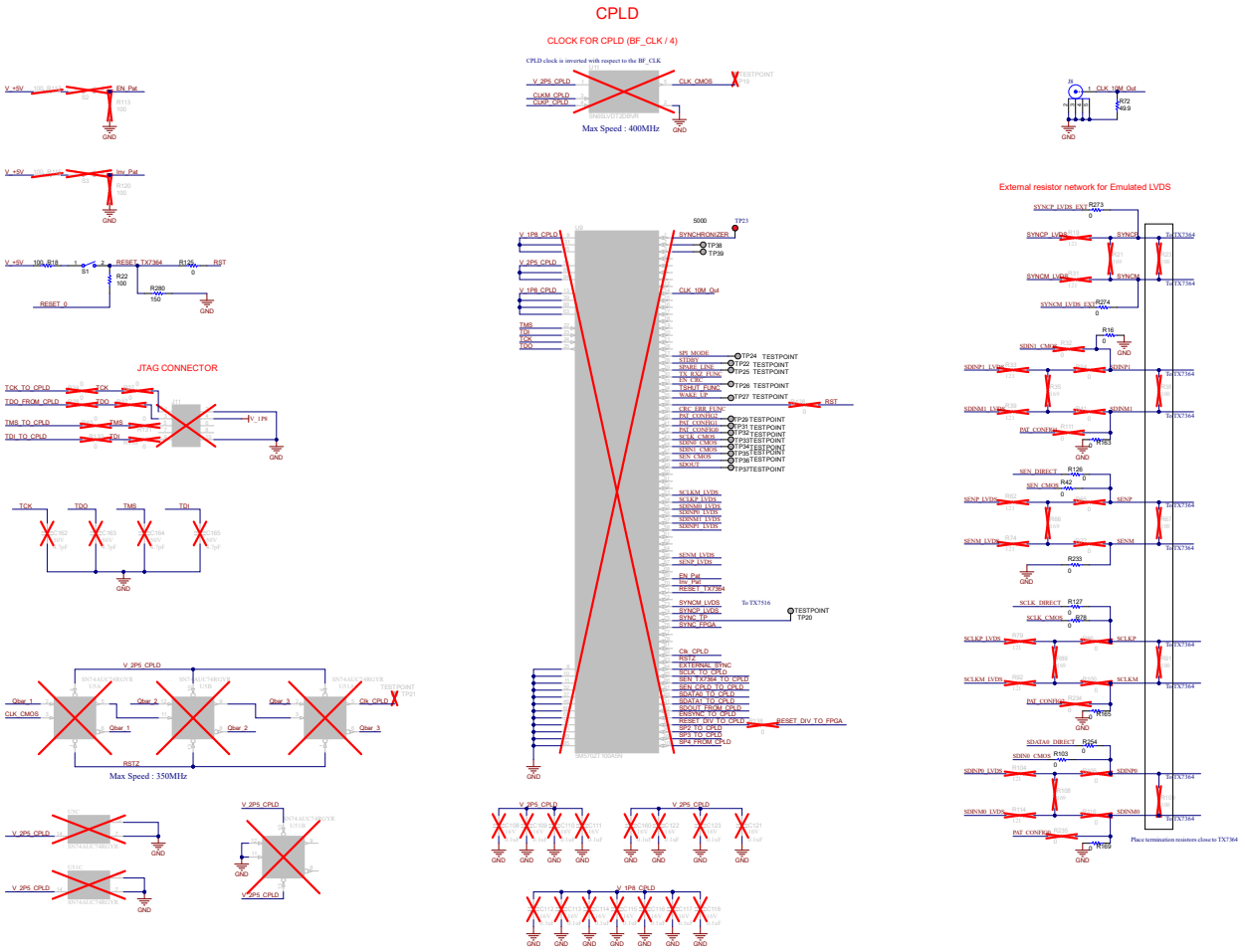


Figure 5-9. Schematic 8

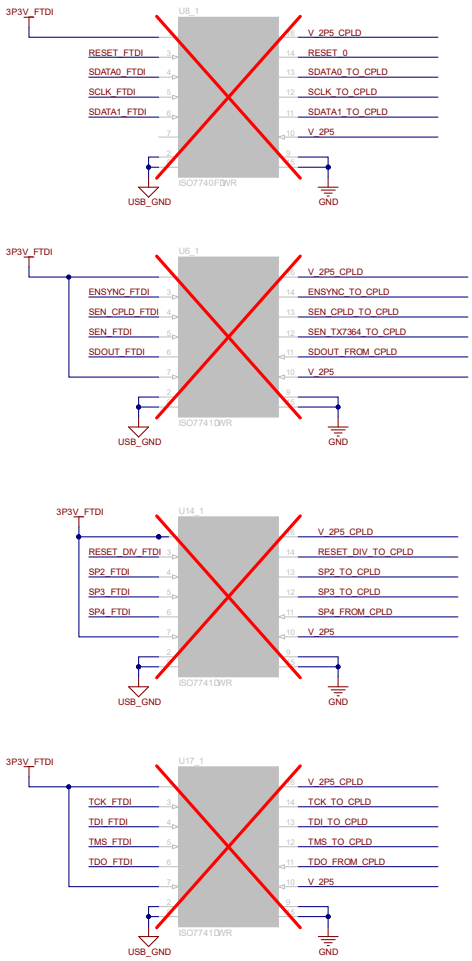


Figure 5-10. Schematic 9

5.2 PCB Layouts

Figure 5-11 to Figure 5-28 show the different PCB layers.

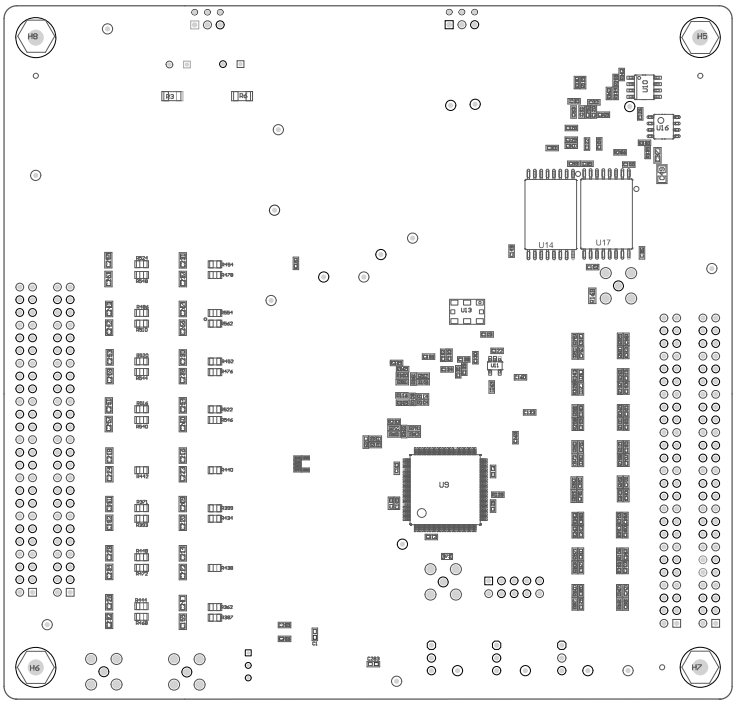


Figure 5-11. PCB Layer 1

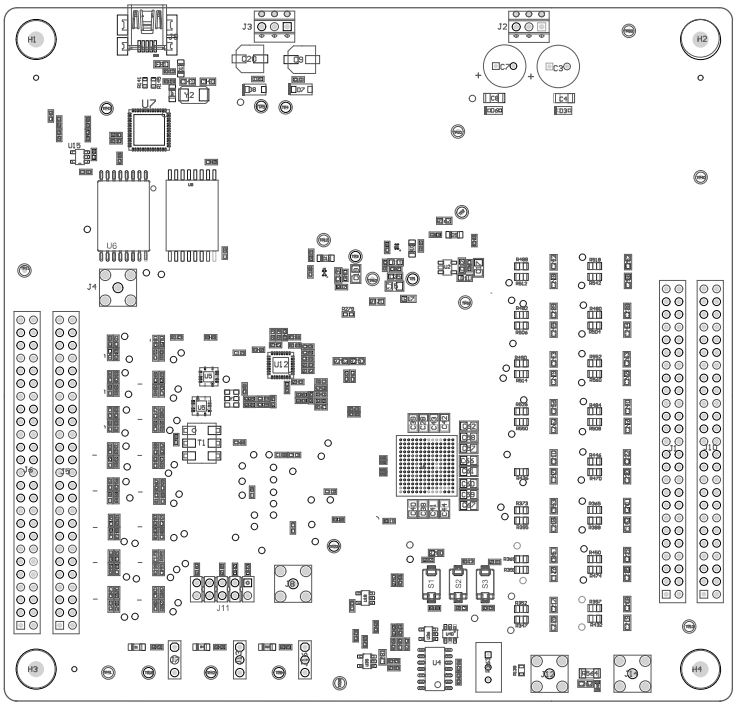


Figure 5-12. PCB Layer 2

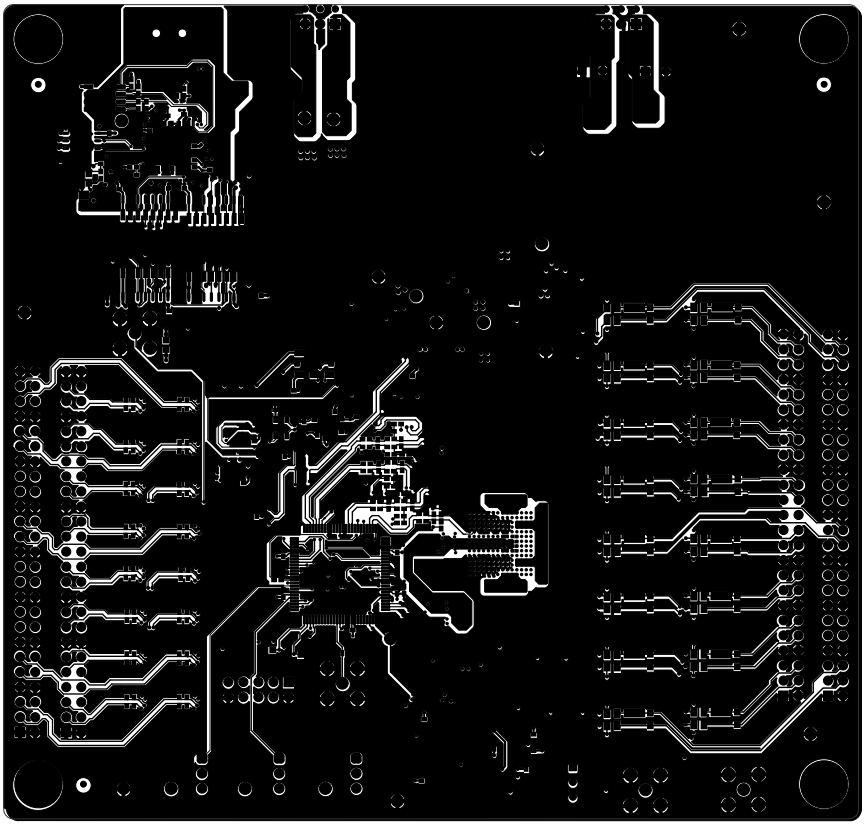


Figure 5-13. PCB Layer 3

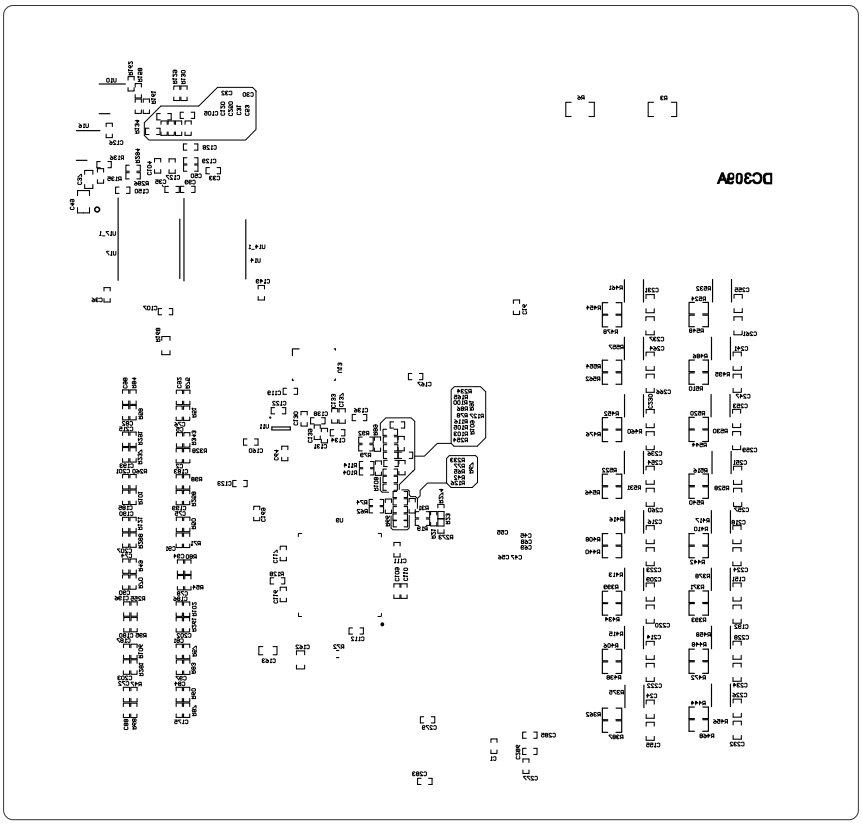


Figure 5-14. PCB Layer 4

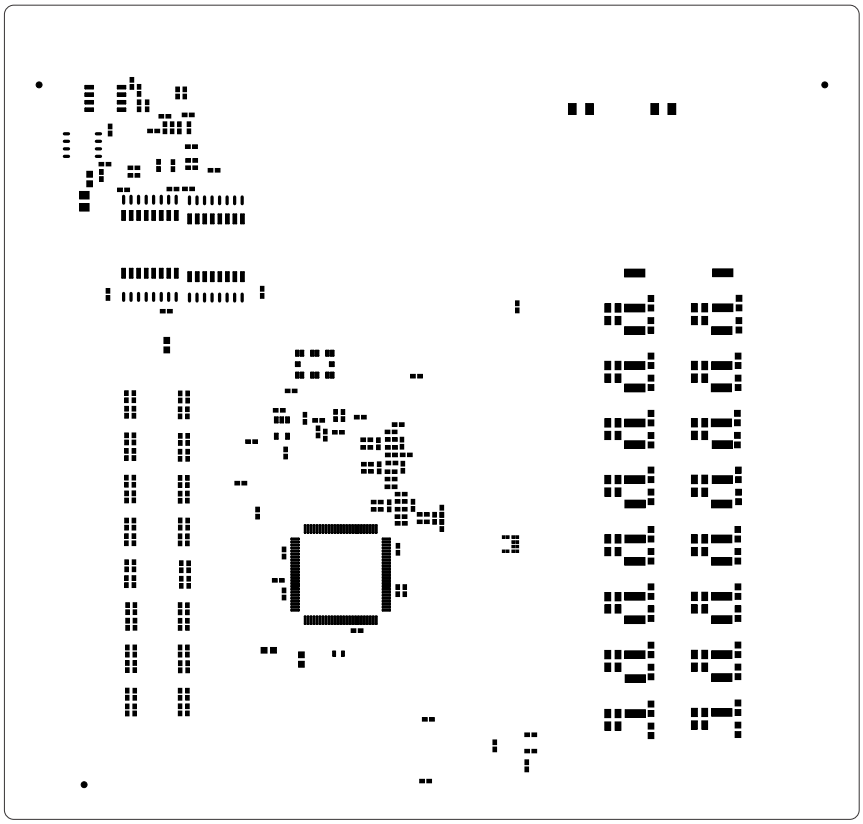


Figure 5-15. PCB Layer 5

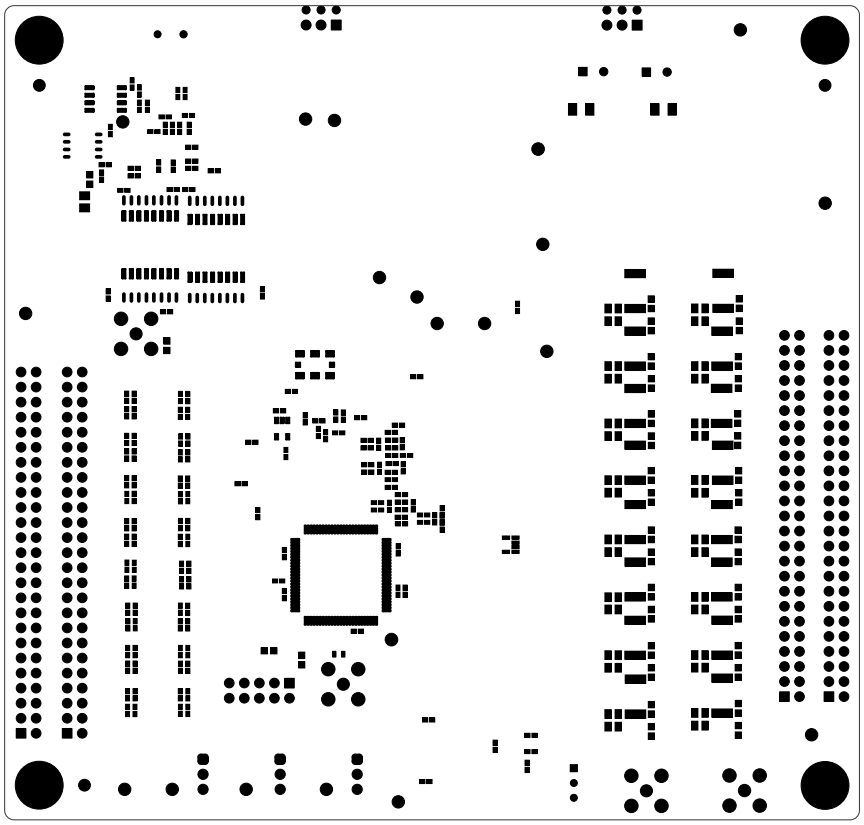


Figure 5-16. PCB Layer 6

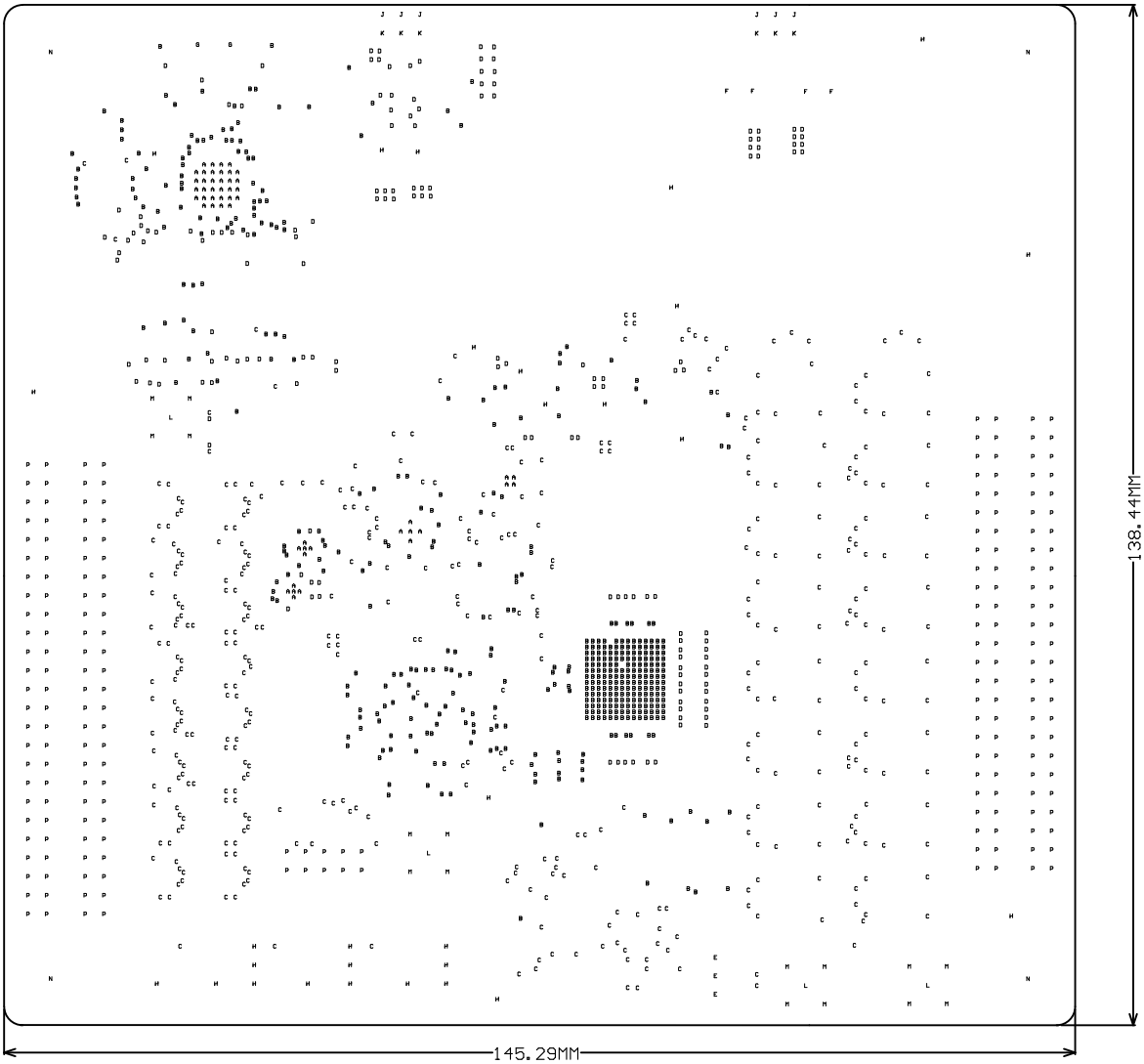


Figure 5-17. PCB Layer 7

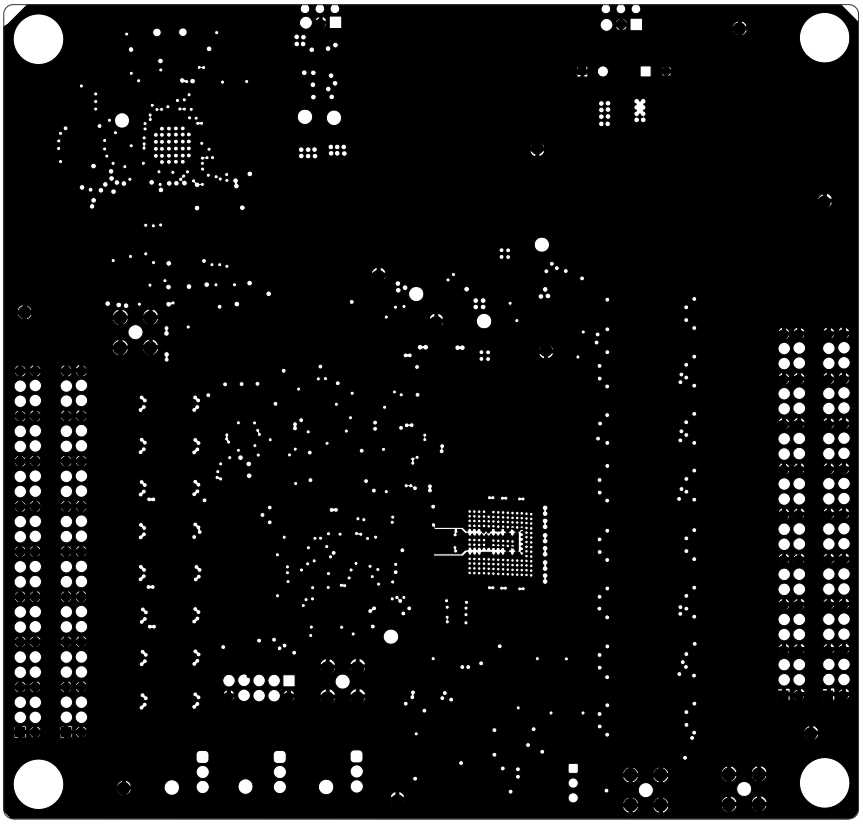


Figure 5-18. PCB Layer 8

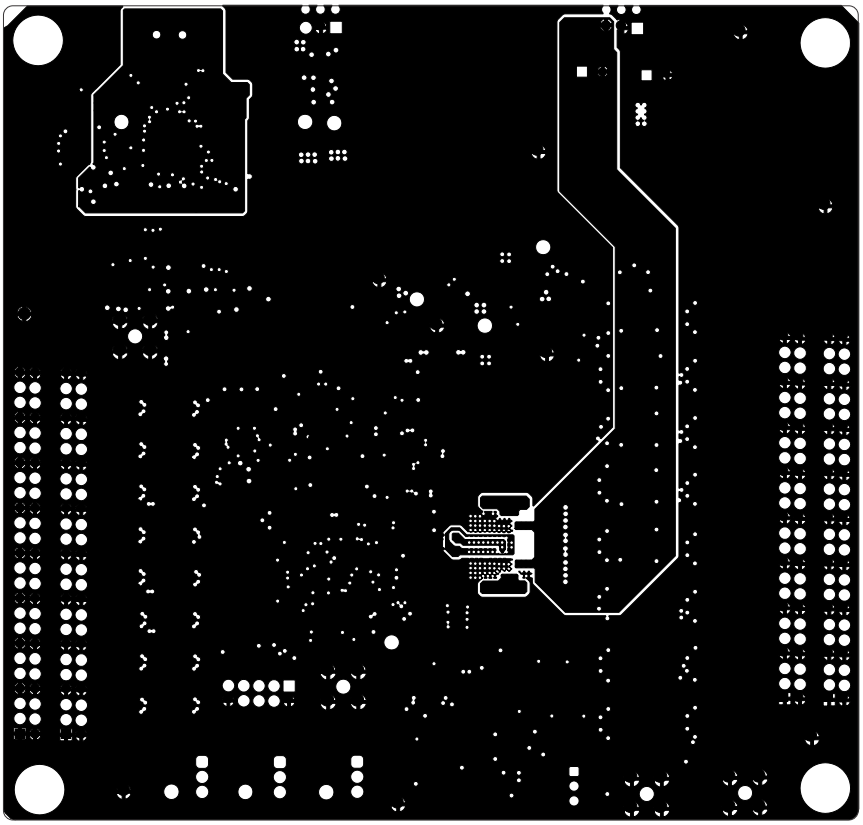


Figure 5-19. PCB Layer 9

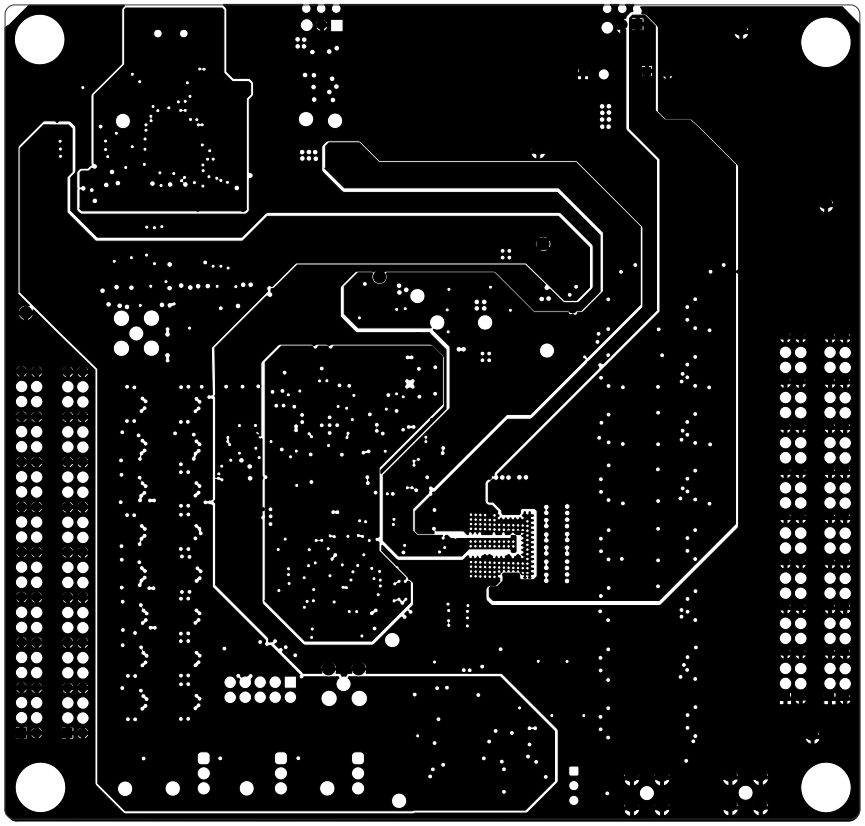


Figure 5-20. PCB Layer 10

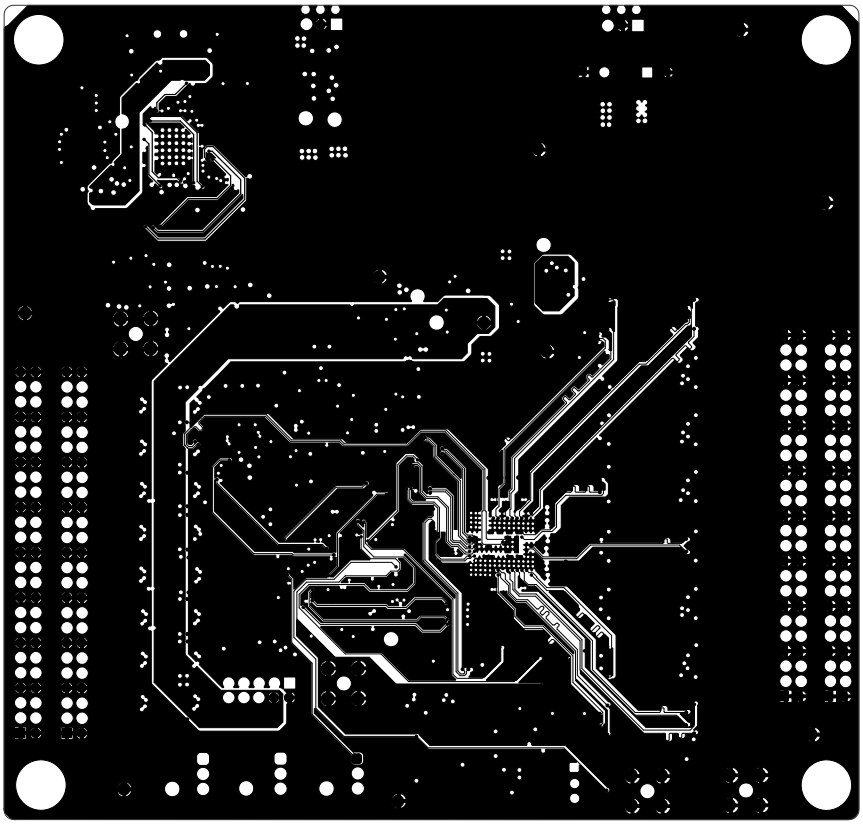


Figure 5-21. PCB Layer 11

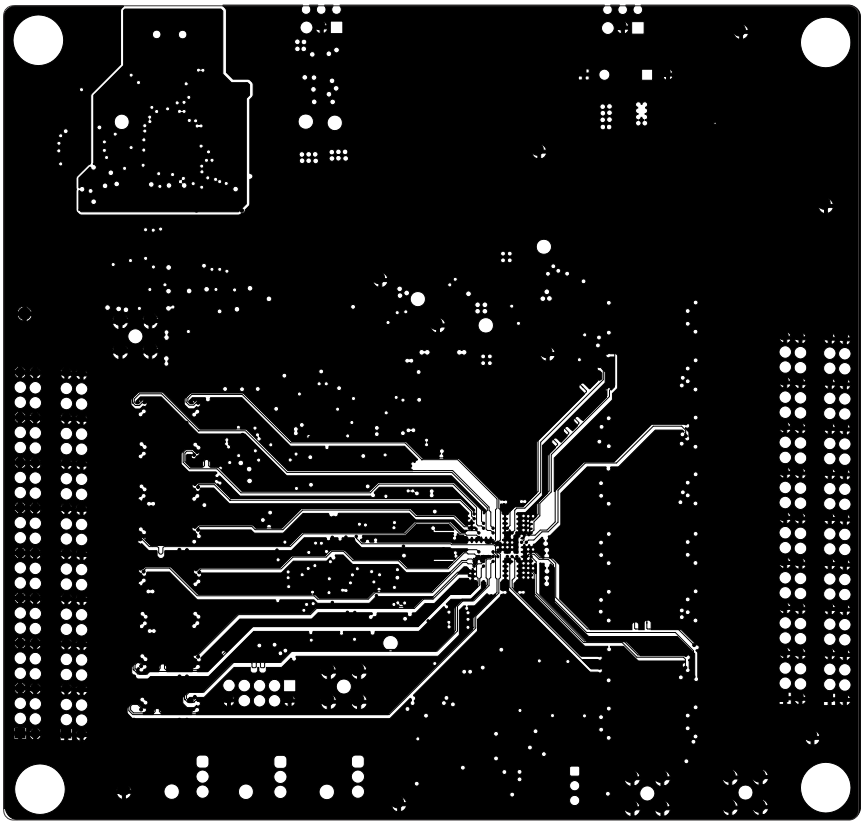


Figure 5-22. PCB Layer 12

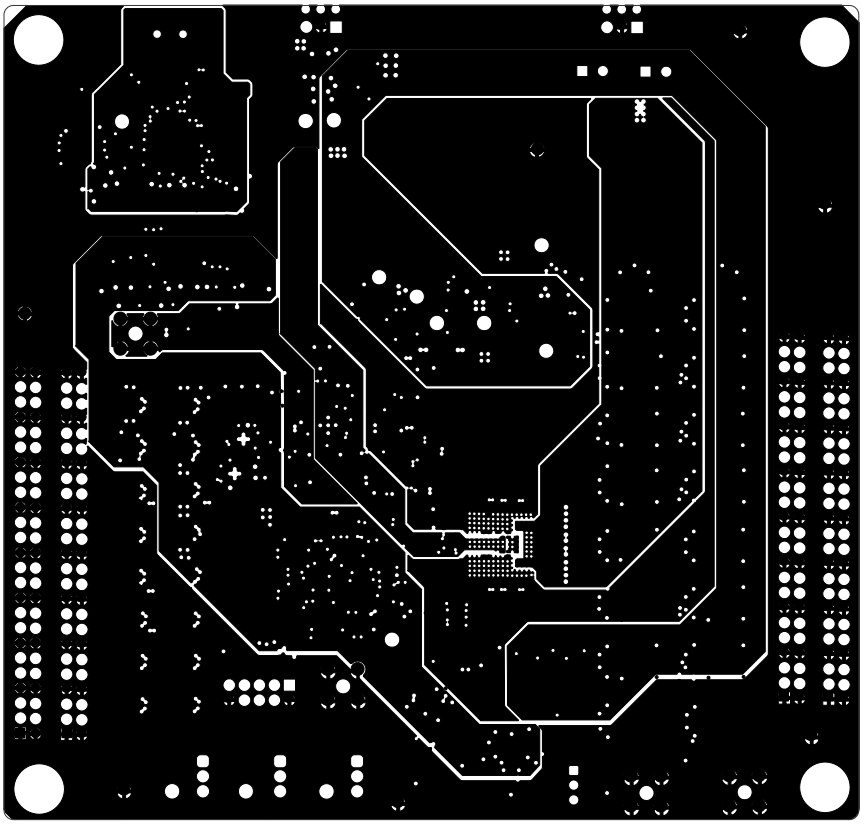


Figure 5-23. PCB Layer 13

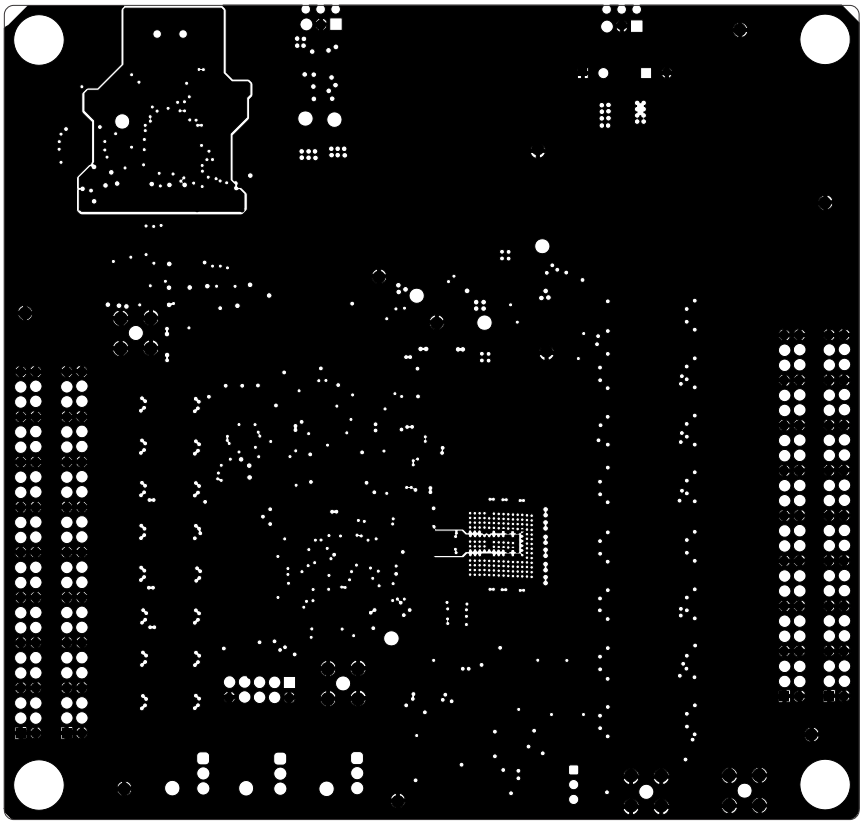


Figure 5-24. PCB Layer 14

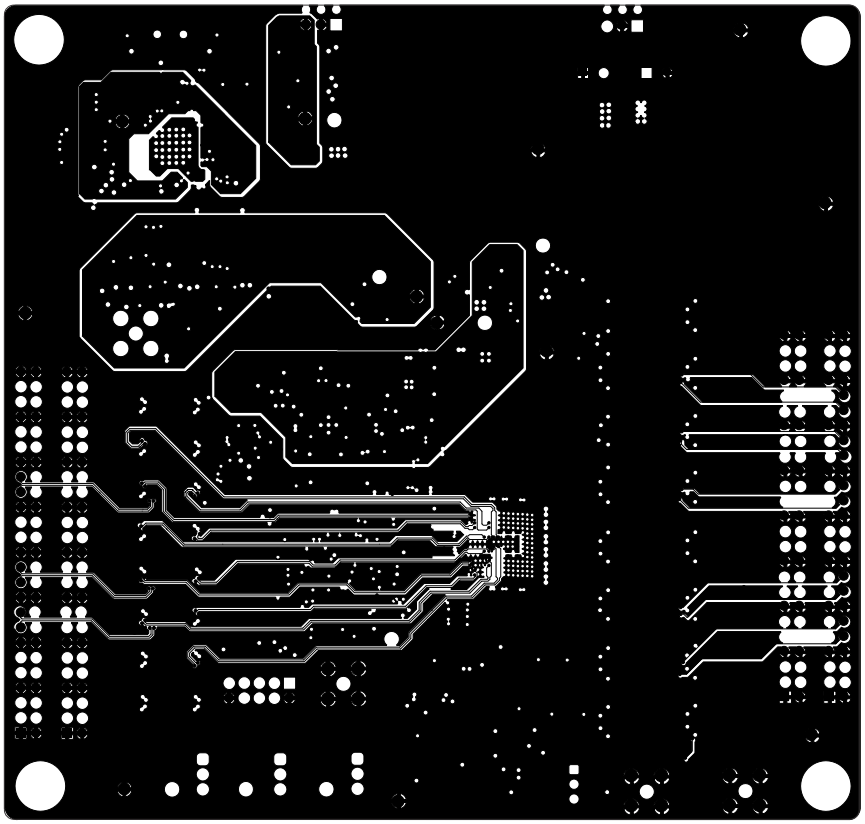


Figure 5-25. PCB Layer 15

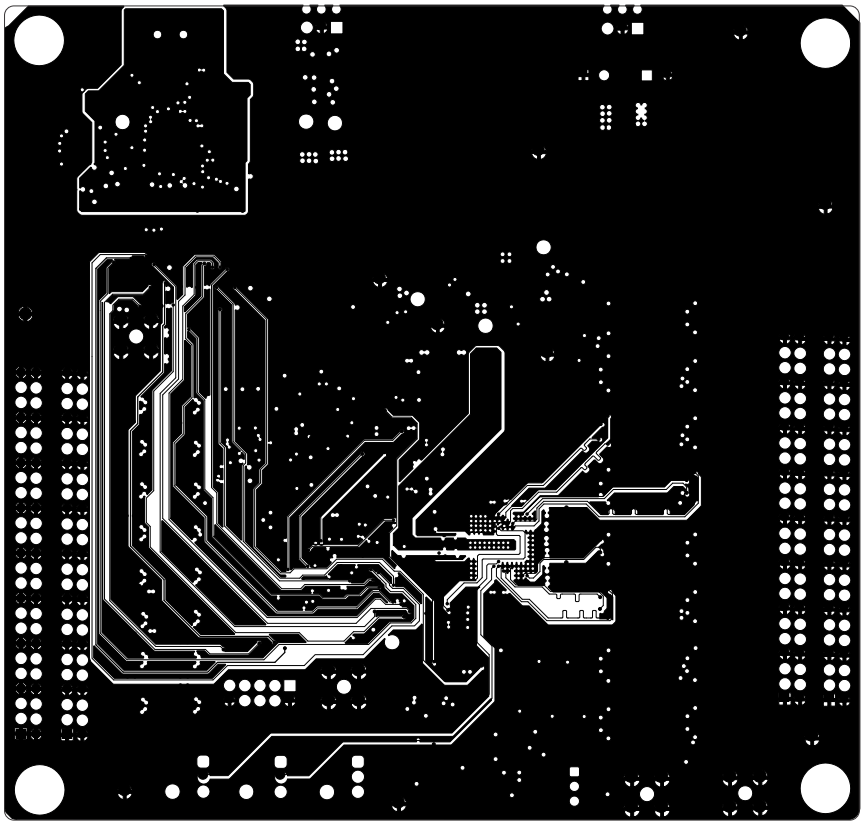


Figure 5-26. PCB Layer 16

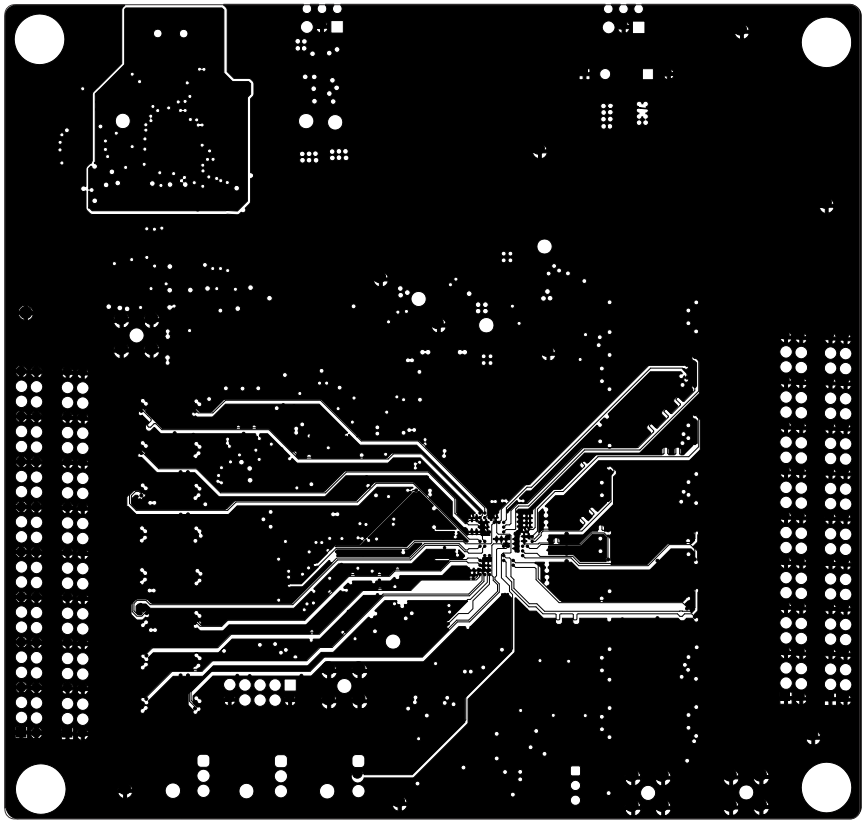


Figure 5-27. PCB Layer 17

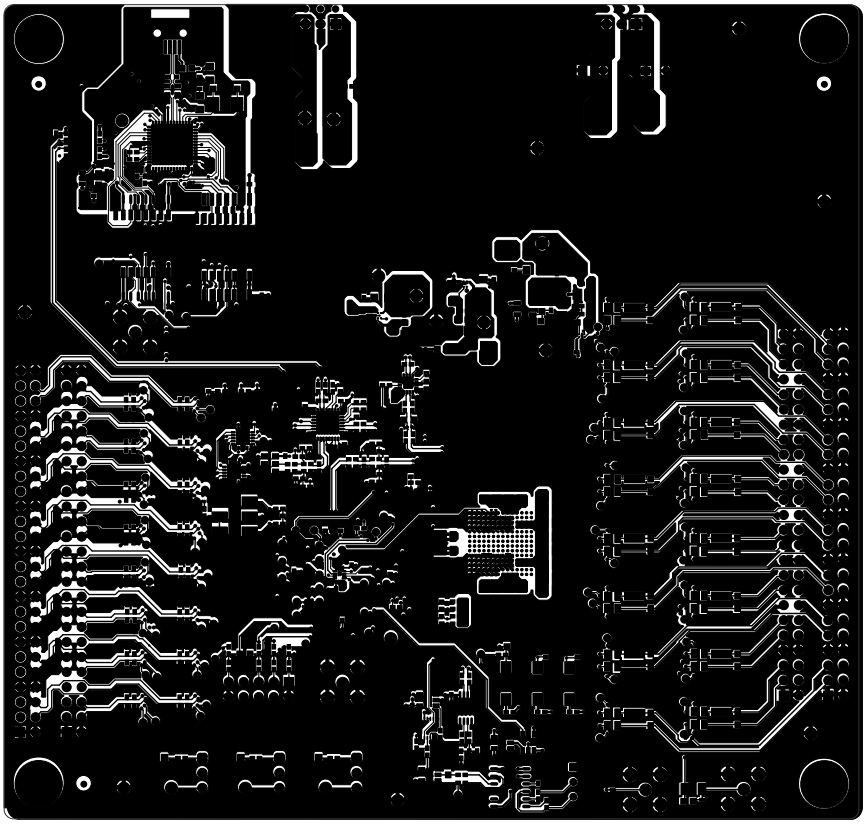


Figure 5-28. PCB Layer 18

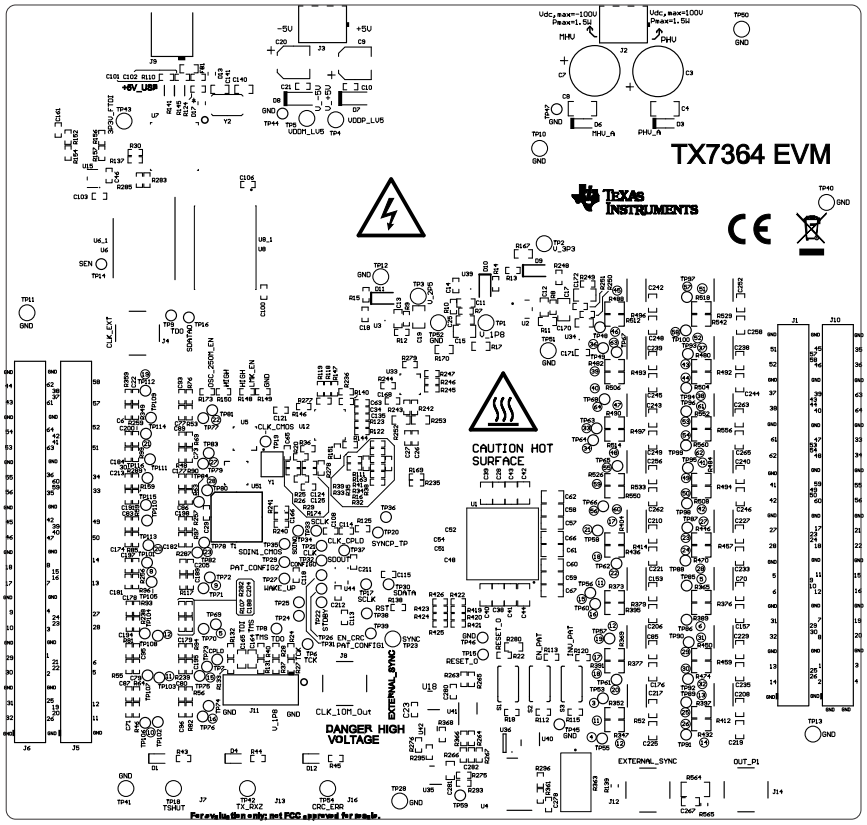


Figure 5-29. PCB Layer 19

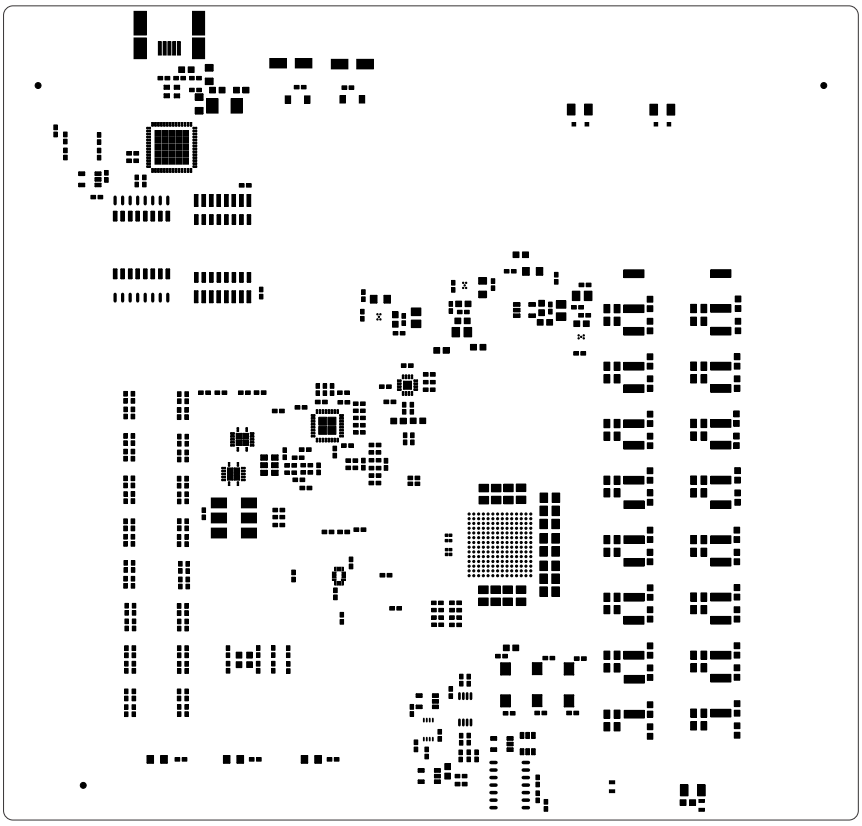


Figure 5-30. PCB Layer 20

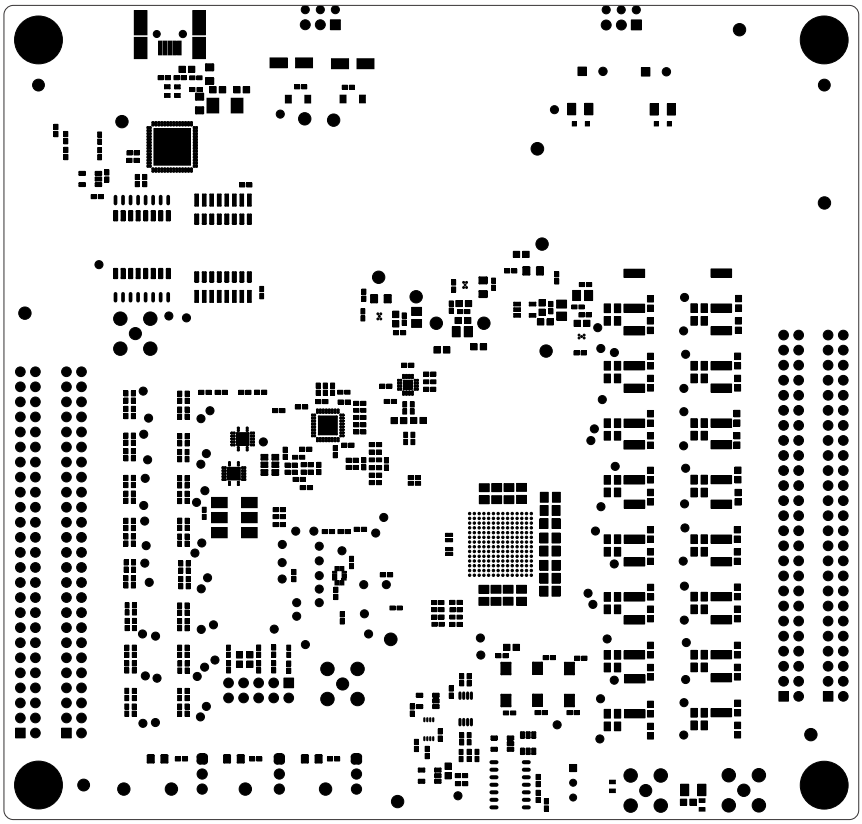


Figure 5-31. PCB Layer 21

5.3 Bill of Materials

Table 5-1. Bill of Materials

Designator	Quantity	Value	Description	Part Number	Package Reference	ManµFacturer
!PCB1	1		Printed Circuit Board	DC309		Any
C1, C211, C212, C285, C286	5	0.1µF	CAP, CERM, 0.1µF, 16V, ±10%, X7R, 0402	GRM155R71C104KA88D	0402	MuRata
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, C174, C175, C177, C178, C179, C180, C181, C182, C183, C184, C185, C186, C187, C188, C189, C190, C191, C193, C194, C195, C196, C197, C198, C199, C200, C201, C202, C203, C204, C205, C207, C213, C215	64	20pF	CAP, CERM, 20pF, 50V, ±5%, C0G/NP0, 0402	C0402C200J5GACTU	0402	Kemet
C3, C7	2	10µF	CAP, AL, 10µF, 200V, ±20%, TH	200LLE10MEFC8X11.5	RCAP_8x11.5mm	Rubycon
C4, C8	2	0.1µF	CAP, CERM, 0.1µF, 200V, ±10%, X7R, 1206	C1206C104K2RACTU	1206	Kemet
C9, C20	2	10µF	CAP, AL, 10µF, 35V, ±20%, 0.7Ω, AEC-Q200 Grade 2, SMD	EEE-FK1V100R	SMT Radial C	Panasonic
C10, C14, C16, C18, C21, C23, C31, C35, C36, C46, C50, C53, C99, C100, C103, C104, C105, C106, C107, C120, C126, C127, C128, C136, C138, C149, C150, C161, C167, C168, C171, C250, C279, C280, C283	35	0.1µF	CAP, CERM, 0.1µF, 16V, ±10%, X7R, 0402	0402YC104KAT2A	0402	AVX
C11, C12, C13, C37, C170	5	4.7pF	CAP, CERM, 4.7pF, 50V, ±5%, C0G/NP0, 0603	06035A4R7CAT2A	0603	AVX
C15, C17, C19, C49, C172	5	4.7µF	CAP, CERM, 4.7µF, 25V, ±10%, X5R, 0805	C0805C475K3PACTU	0805	Kemet

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	ManµFacturer
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	CAP, CERM, 100pF, 250V,±5%, C0G/NP0, AEC-Q200 Grade 1, 0603	AC0603JRNPOYBN101	0603	Yageo
C25	1	10µF	CAP, CERM, 10µF, 6.3V, ±20%, X5R, 0603	GRM188R60J106ME47D	0603	MuRata
C26, C27	2	0.01µF	CAP, CERM, 0.01µF, 16V, ±10%, X7R, 0402	520L103KT16T	0402	AT Ceramics
C28, C38, C39, C40, C41, C42, C43, C44, C57, C58, C59, C60, C61, C62, C66, C67	16	0.1µF	CAP, CERM, 0.1µF, 250V, ±10%, X7T, 0805	C2012X7T2E104K125AA	0805	TDK
C29, C166, C169, C277	4	0.1µF	CAP, CERM, 0.1µF, 6.3V, ±10%, X5R, 0402	C1005X5R0J104K050BA	0402	TDK
C30, C32, C33, C129	4	4.7µF	CAP, CERM, 4.7µF, 10V, ±20%, X5R, 0402	CL05A475MP5NRNC	0402	Samsung Electro-Mechanics
C45, C47, C48, C51, C52, C54, C55, C56, C68, C69	10	0.1µF	CAP, CERM, 0.1µF, 16V, ±10%, X6S, 0201	C0603X6S1C104K030BC	0201	TDK
C140, C141	2	18pF	CAP, CERM, 18pF, 50V, ±5%, C0G/NP0, 0603	06035A180JAT2A	0603	AVX
C267	1	6.8pF	CAP, CERM, 6.8pF, 100V,±3.7%, C0G/NP0, 0603	CC0603CRNPO0BN6R8	0603	Yageo
C278	1	0.012µF	CAP, CERM, 0.012µF, 16V, ±10%, X7R, 0402	GRM155R71C123KA01D	0402	MuRata
C281	1	100pF	CAP, CERM, 100pF, 10V, ±10%, X7R, 0603	0603ZC101KAT2A	0603	AVX
C282	1	0.47µF	CAP, CERM, 0.47µF, 6.3V, ±10%, X5R, 0402	04026D474KAT2A	0402	AVX
D1, D4, D9, D10, D11, D12, D13, D17	8	Red	LED, Red, SMD	CMD17-21SRC/TR8	2x1.25mm	Visual Communications Company, LLC

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	ManµFacturer
D3, D6	2	110V	Diode, Zener, 110V, 200mW, SOD-323F	UDZLVTE-17110	SOD-323F	Rohm
D7, D8	2	6V	Diode, Zener, 6V, 500mW, SOD-123	MMSZ5233B-7-F	SOD-123	Diodes Inc.
FB1	1	120Ω	Ferrite Bead, 120Ω @ 100MHz, 3A, 0603	BLM18SG121TN1D	0603	MuRata
FID1, FID2, FID3, FID4, FID5, FID6	6		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	Screw	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Standoff	Keystone
H9	1		Cable, USB-A to micro USB-B, 0.3m	AK67421-0.3		Assman WSW
J1, J5, J6, J10	4		Receptacle, 2.54mm, 25x2, Tin, TH	PPTC252LFBN-RC	Receptacle, 2.54mm, 25x2, TH	Sullins Connector Solutions
J2, J3	2		Terminal Block, 3x1, 2.54mm, TH	1725669	Terminal Block, 3x1, 2.54mm, TH	Phoenix Contact
J4, J8, J12, J14	4		SMA Straight Jack, Gold, 50Ω, TH	901-144-8RFX	SMA Straight Jack, TH	Amphenol RF
J7, J13, J16	3		Header, 100mil, 3x1, Gold, TH	TSW-103-07-G-S	3x1 Header	Samtec
J9	1		Connector, Receptacle, USB - mini AB, R/A, SMD	67803-8020	Receptacle, 5-Leads, Body 9.9x9mm, R/A	Molex
R3, R6	2	100k	RES, 100 k, 0.1%, 0.25 W, AEC-Q200 Grade 1, 1206	TNPW1206100KBEEA	1206	Vishay-Dale
R7	1	5.1k	RES, 5.1 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04025K10JNED	0402	Vishay-Dale
R8, R135, R250	3	18k	RES, 18 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040218K0JNED	0402	Vishay-Dale
R9	1	11k	RES, 11 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040211K0JNED	0402	Vishay-Dale
R10, R12, R136, R251	4	10.0k	RES, 10.0 k, 0.5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040210K0DHEDP	0402	Vishay-Dale
R11	1	3.60k	RES, 3.60 k, 0.1%, 0.1 W, 0603	RG1608P-362-B-T5	0603	Susumu Co Ltd
R13, R110, R124, R130	4	1.0k	RES, 1.0 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04021K00JNED	0402	Vishay-Dale
R14, R15	2	499	RES, 499, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402499RFKED	0402	Vishay-Dale
R16, R30, R42, R78, R103, R125, R126, R127, R163, R165, R169, R233, R254, R263, R264, R265, R273, R274, R293, R295, R366, R368	22	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	0402	Panasonic

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	ManµFacturer
R17	1	0.1	RES, 0.1, 1%, 0.1 W, AEC-Q200 Grade 1, 0603	ERJ-L03KF10CV	0603	Panasonic
R18, R22	2	100	RES, 100, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402100RJNED	0402	Vishay-Dale
R25, R26, R36, R118, R119, R149, R150, R174, R242, R243, R244, R245, R246, R249, R419, R421, R424, R426	18		RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	0402	Panasonic
R43, R44, R45, R277, R278, R279	6	100	RES, 100, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ101X	0402	Panasonic
R46, R47, R48, R49, R50, R51, R53, R54, R55, R56, R57, R58, R59, R60, R63, R64, R68, R69, R70, R71, R75, R76, R80, R81, R82, R83, R84, R85, R87, R90, R93, R94, R95, R96, R97, R98, R99, R101, R102, R106, R107, R117, R121, R159, R237, R238, R239, R255, R256, R257, R258, R259, R260, R261, R281, R282, R287, R288, R289, R291, R328, R343, R349, R359	64	100	RES, 100, 0.1%, 0.063 W, 0402	RG1005P-101-B-T5	0402	Susumu Co Ltd
R72, R139, R565	3	49.9	RES, 49.9, 0.1%, 0.1 W, AEC-Q200 Grade 1, 0603	TNPW060349R9BEEA	0603	Vishay-Dale
R129	1	12.0k	RES, 12.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040212K0FKED	0402	Vishay-Dale
R134	1	2.2k	RES, 2.2 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04022K20JNED	0402	Vishay-Dale
R137	1	100	RES, 100, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402100RFKED	0402	Vishay-Dale
R141, R145	2		Thick Film Resistors - SMD 0603 10ohms 5% AEC-Q200	ERJ-3GEYJ100V	0603	Panasonic
R152, R154, R156, R157, R158, R161, R162, R284, R285	9	10k	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ103X	0402	Panasonic

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	ManµFacturer
R167, R168, R170	3	0.02	RES, 0.02, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	RL0603FR-070R02L	0603	Yageo America
R252, R253, R280	3	150	RES, 150, 0.1%, 0.1 W, 0603	RT0603BRD07150RL	0603	Yageo America
R266, R267	2	56.2k	RES, 56.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040256K2FKED	0402	Vishay-Dale
R275	1	1.0k	RES, 1.0 k, 5%, 0.063 W, 0402	CRCW04021K00JNED	0402	Vishay-Dale
R296	1	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04020000Z0ED	0402	Vishay-Dale
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	RES, 0, 1%, 0.5 W, 0805	5106	0805	Keystone
R361	1	12	RES, 12, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040212R0JNED	0402	Vishay-Dale
R363	1	100kΩ	100 kOhms 0.5W, 1/2W PC Pins Through Hole Trimmer Potentiometer Cermet 18.0 Turn Top Adjustment	CT-94EW104	PTH_POTEN_9MM6_4MM8	Nidec Components
R564	1	1.02k	RES, 1.02 k, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	CRCW12061K02FKEA	1206	Vishay-Dale
S1	1		Switch, SPST-NO, Off-Mom, 0.05A, 12 VDC, SMD	EVQ-5PN04K	6x3.5mm	Panasonic
SH-J1, SH-J2, SH-J3	3		CONN JUMPER S2 (1 x 2) Position Shunt Connector Black Open Top 0.100" (2.54mm) GoldHORTING .100" GOLD	QPC02SXGN-RC	JUMPER	Sullins
T1	1		RF Transformer, 50Ω, 2 to 775MHz, SMT	ADT4-1WT+	CD542	Minicircuits

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	ManµFacturer
TP1, TP2, TP3, TP4, TP5, TP23, TP43, TP50, TP51, TP52	10		Test Point, Miniature, Red, TH	5000	Red Miniature Testpoint	Keystone Electronics
TP10, TP11, TP12, TP13	4		Test Point, Miniature, Black, TH	5001	Black Miniature Testpoint	Keystone Electronics
TP18, TP28, TP40, TP41, TP42, TP54	6		Test Point, Miniature, Yellow, TH	5004	Yellow Miniature Testpoint	Keystone Electronics
U1	1		TX7364	TX7364	FCBGA196	Texas Instruments
U3, U34, U39	3		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 degC, Green (RoHS & no Sb/Br)	TPS79901YZUT	YZU0005AEBC	Texas Instruments
U4	1		CMOS Low-Power Monostable/Astable Multivibrator, D0014A, LARGE T&R		D0014A	Texas Instruments
U6	1		High-Immunity, 5.7kVRMS Reinforced Quad-Channel 3/1 Digital Isolator, 100Mbps, DWW0016A (SOIC-16)	ISO7841DWW	DWW0016A	Texas Instruments
U7	1		Future Technology Devices International Ltd FT4232H Quad High Speed USB to Multipurpose UART/MPSSE IC, VQFN-56	FT4232H-56Q-TRAY	VQFN-56	FTDI
U8	1		High-Performance, 8000-VPK Reinforced Quad-Channel Digital Isolator	ISO7840FDWWR	SOIC16	Texas Instruments
U10	1		1K Microwire Compatible Serial EEPROM	93LC46BT-I/SN	SOIC-8	Microchip
U15	1		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 degC, Green (RoHS & no Sb/Br)	TPS79901DDCR	DDC0005A	Texas Instruments
U18, U35	2		Low-Power Single 2-Input Positive-AND Gate, DBV0005A (SOT-23-5)	SN74AUP1G08DBVT	DBV0005A	Texas Instruments
U33	1		Clock BµFfer w/Programmable Divider, LVPECL I/O + addl LVCMOS output, RGT0016A (VQFN-16)	CDCM1802RGTR	RGT0016A	Texas Instruments
U36	1		Single Schmitt-Trigger Inverter, DBV0005A, LARGE T&R		DBV0005A	Texas Instruments
U40	1		Single-Bit Dual-Supply Bus Transceiver, DBV0006A (SOT-23-6)	SN74AXC1T45DBVR	DBV0006A	Texas Instruments
U41	1		2Gbps LVDS/LVPECL/CML to LVDS BµFfer/ Repeater/Translator, DGK0008A (VSSOP-8)	SN65LVDS100DGKR	DGK0008A	Texas Instruments
U42	1		Low-Power Dual Positive-Edge-Triggered D-Type Flip-Flop, DCU0008A (VSSOP-8)	SN74AUP2G79DCUR	DCU0008A	Texas Instruments

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	ManµFacturer
U44	1		4 Bit Direction Controlled Level Translator, RSV0016A (UQFN-16)	SN74AXC4T774RSVR	RSV0016A	Texas Instruments
Y1	1		XTAL OSC XO 250.0000MHZ LVDS SMD	SG3225VAN 250.000000M-KEGA3	XTAL_SMD_3MM2_2MM5	EPSON
Y2	1		Crystal, 12MHz, 18pF, SMD	ABM3-12.000MHZ-D2Y-T	ABM3	Abracon Corporation
C34, C63, C124, C125	0	0.01µF	CAP, CERM, 0.01µF, 16V, ±10%, X7R, 0402	520L103KT16T	0402	AT Ceramics
C64, C65, C108, C109, C110, C111, C112, C113, C114, C115, C116, C117, C118, C119, C121, C122, C123, C130, C131, C133, C134, C135, C137, C139, C160	0	0.1µF	CAP, CERM, 0.1µF, 16V, ±10%, X7R, 0402	0402YC104KAT2A	0402	AVX
C101, C102	0	5pF	CAP, CERM, 5pF, 100V, ±2%, C0G/NP0, 0402	CBR04C509B1GAC	0402	Kemet
C162, C163, C164, C165	0	4.7pF	CAP, CERM, 4.7pF, 50V, ±5%, C0G/NP0, 0603	06035A4R7CAT2A	0603	AVX
J11	0		Header, 2.54mm, 5x2, Gold, Black, TH	TSW-105-07-F-D	Header, 2.54mm, 5x2, TH	Samtec
R19, R31, R33, R39, R62, R74, R79, R92, R104, R114	0	121	RES, 121, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402121RFKED	0402	Vishay-Dale
R20, R29, R122, R123, R140, R144, R146, R147, R148, R151, R173, R236, R247, R248, R420, R422, R423, R425	0		RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	0402	Panasonic
R21, R35, R66, R89, R108	0	169	RES, 169, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402169RFKED	0402	Vishay-Dale
R23, R38, R67, R91, R109	0	100	RES, 100, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402100RFKED	0402	Vishay-Dale
R24, R27, R28, R32, R34, R37, R40, R41, R65, R77, R86, R100, R105, R111, R116, R128, R131, R132, R133, R138, R234, R235, R276	0	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GE0R00X	0402	Panasonic

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	ManµFacturer
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	RES, 1.00 k, 1%, 1 W, AEC-Q200 Grade 0, 2512	CRCW25121K00FKEG	2512	Vishay-Dale
R112, R113, R115, R120	0	100	RES, 100, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402100RJNED	0402	Vishay-Dale
R240, R241	0	100	RES, 100, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ101X	0402	Panasonic
R283, R286	0	10k	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ103X	0402	Panasonic
S2, S3	0		Switch, SPST-NO, Off-Mom, 0.05A, 12 VDC, SMD	EVQ-5PN04K	6x3.5mm	Panasonic
U2	0		Linear Voltage Regulator IC 1 Output 500mA SOT-23-5	TLV75801PDBVT	SOT-23-5	Texas Instruments
U5, U51	0		Dual Positive-Edge-Triggered D-Type Flip-Flops with Clear and Preset, RGY0014A, LARGE T&R	SN74AUC74RGYR	RGY0014A	Texas Instruments
U6_1, U14_1, U17_1	0		High-Speed, Low-Power, Robust EMC Quad-Channel Digital Isolator, DW0016B (SOIC-16)	ISO7741DWR	DW0016B	Texas Instruments
U8_1	0		High-Speed, Low-Power, Robust EMC Quad-Channel Digital Isolator, DW0016B (SOIC-16)	ISO7740FDWR	DW0016B	Texas Instruments
U9	0		IC CPLD 440MC, TQFP-100	5M570ZT100A5N	14x14mm	Altera
U11	0		Single LVDS Receiver, DBV0005A (SOT-23-5)	SN65LVDT2DBVR	DBV0005A	Texas Instruments
U12	0		3.1GHz Differential Clock BµFfer/Level Translator, RTV0032A (WQFN-32)	LMK00304SQ/NOPB	RTV0032A	Texas Instruments
U13	0		Ultra-Low Jitter Fully Programmable Oscillator, Integrated EEPROM, ±50ppm, SIA0008B (QFM-8)	LMK61E2-SIAR	SIA0008B	Texas Instruments
U14, U17	0		High-Immunity, 5.7kVRMS Reinforced Quad-Channel 3/1 Digital Isolator, 100Mbps, DWW0016A (SOIC-16)	ISO7841DWW	DWW0016A	Texas Instruments
U16	0		Low-Power Bidirectional I2C Isolators, D0008B (SOIC-8)	ISO1540QDRQ1	D0008B	Texas Instruments

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.

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