EVM User's Guide: DS560DF810

DS560DF810 EVM User's Guide

ABSTRACT

The DS560DF810 evaluation board module (EVM) allows the user to quickly evaluate both the high-speed and low-speed functionality of the DS560DF810 retimer. The DS560DF810 is an 8-channel multi-rate retimer with integrated signal conditioning. It supports retimed operation for PAM4 and NRZ data rates from 19.6 to 28.9 GBd. Integrated physical AC coupling capacitors (both TX and RX) eliminate the need for external capacitors on the PCB. The DS560DF810 relies on two power supply voltages, 1.2 V and 1.8 V, managed on the EVM through an onboard power tree.

The advanced equalization features of the DS560DF810 include a low-jitter 4-tap transmit finite impulse response (FIR) filter, as well as receive adaptive continuous-time linear equalizer (CTLE), decision feedback equalizer (DFE) and feed forward equalizer. This comprehensive equalization enables reach extension for lossy interconnects and backplanes with multiple connectors as well as crosstalk. The integrated CDR function is ideal for front-port optical module applications to reset the jitter budget and retime the high-speed serial data. The DS560DF810 implements a 2×2 cross-point on each channel pair, providing the host with both lanes crossing and fanout options.

The DS560DF810 can be configured through its default I2C two-wire serial target mode, or it can configure itself from an external EEPROM through its controller mode. On-chip eye monitor and PRBS generator and checker functions allow for comprehensive in-system diagnostics.

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1 Hardware Description and Setup

Figure 1-1 shows how the DS560DF810EVM implements a power management solution to enable operation off of a single 5 V/3 A supply (the 5 V connector location is shown in the following figure). The EVM board uses Megtron-6 low-loss dielectric material for its high-speed differential inputs and outputs. The EVM by default implements a pair of MXP connectors to provide robust and high-quality connectivity to its first quad of high-speed channels (for example, retimer channels 0 thru 3.) The EVM also has provision for an EEPROM to be used to program the retimer device.

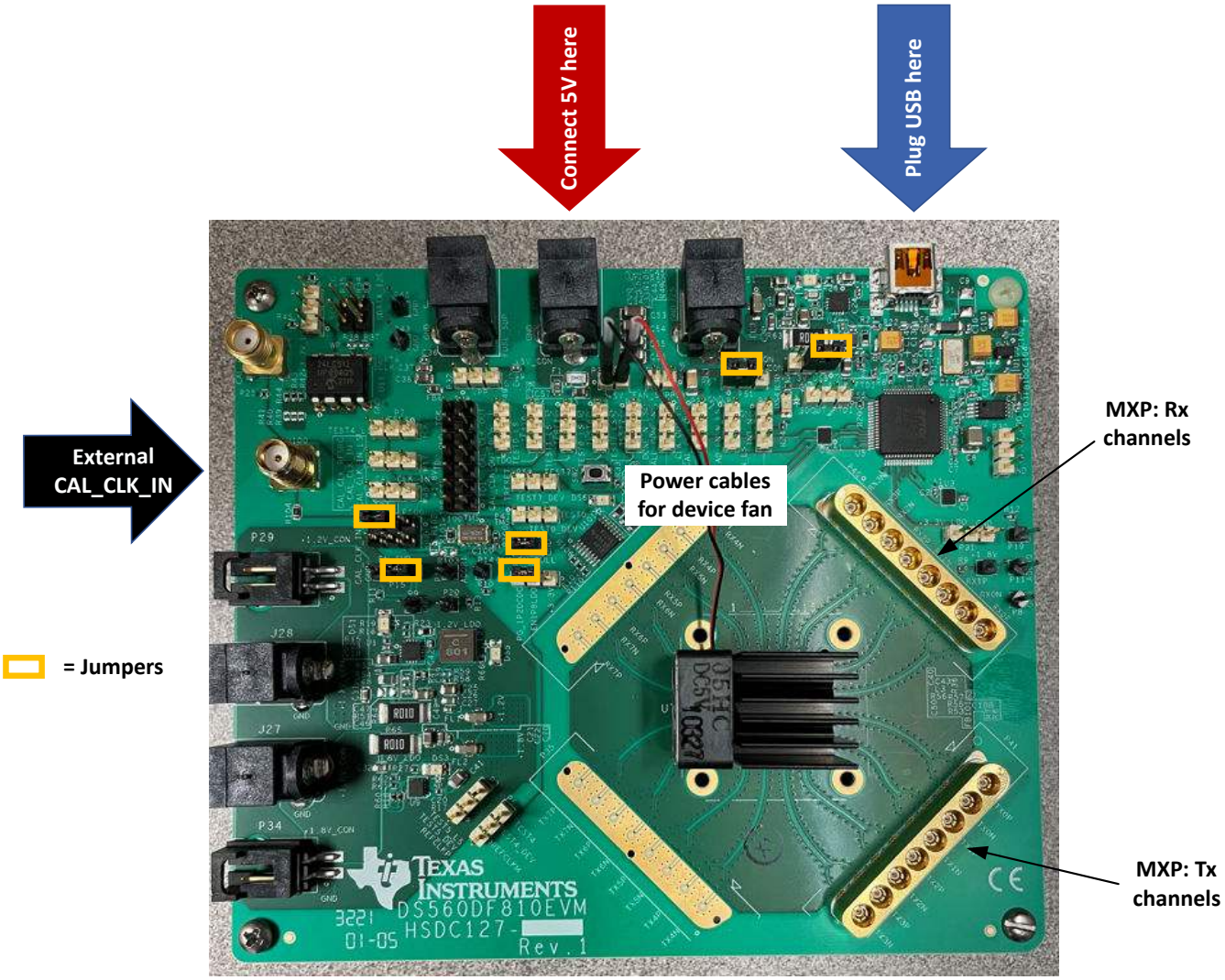

Figure 1-1. DS560DF810EVM Power, Low-Speed Communication, and High-Speed Signaling Connections

1.1 Required Hardware

- 5 V power supply with 3 A maximum current
  - Rev 1 requires external clock signal
  - Rev 2 and later have onboard CAL_CLK_IN 25 MHz oscillator option
- Power supply cable (included as part of EVM kit)
- USB 2.0 Mini-B cable (included as part of EVM kit)
- Heat sink plus fan assembly (for cooling retimer): comes pre-installed as part of EVM kit
- A PC supporting USB 2.0/3.0
- External 25 MHz clock signal for retimer calibration clock (for example, CAL_CLK_IN)
- (Recommended) BERT with PAM4 data generation and error checking capability
- (Recommended) A high-quality sampling scope for retimer transmitter output analysis

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1.2 General Hardware Test Setup Procedure

1. Check the EVM jumper settings to ensure they match Figure 1-1.
2. Connect a 5 V power supply to the power jack (PWR_JACK), connector **J26** on the DS560DF810EVM board.
3. Check the DS2 (PWR) LED. The LED light should be on.
4. Connect the USB Type Mini-B Cable from PC to the USB port (J1) of the EVM.
5. Check the DS4 (USB_PWR) LED.
6. The 5 V voltage is regulated down to 3.3 V on the EVM (refer to Figure 1-2).
   - The 3.3 V supply is used to derive the 1.2 V and 1.8 V rails for the DS560DF810 retimer.
   - In addition, the 3.3 V voltage directly powers up the EEPROM, FTDI USB interface chip and level shifter devices.
   - VDD 1.2 V is powered up first and secondly the VDD 1.8 V.
   - VDD 1.2 V uses DC-DC regulator, while the VDD 1.8 V regulation is done through LDO.
7. Check the DS1 LED (3.3 V) to confirm it is on.
8. The default EVM jumper settings are for using external CAL_CLK_IN signal. If using this setup case, connect the external clock signal to the retimer CAL_CLK_IN pin through the board connector **J100**.

Recommended CAL_CLK_IN external signal characteristics

- 1.8 V LVCMOS compatible clock or sinusoidal signal
- 25 MHz frequency ± 100 PPM

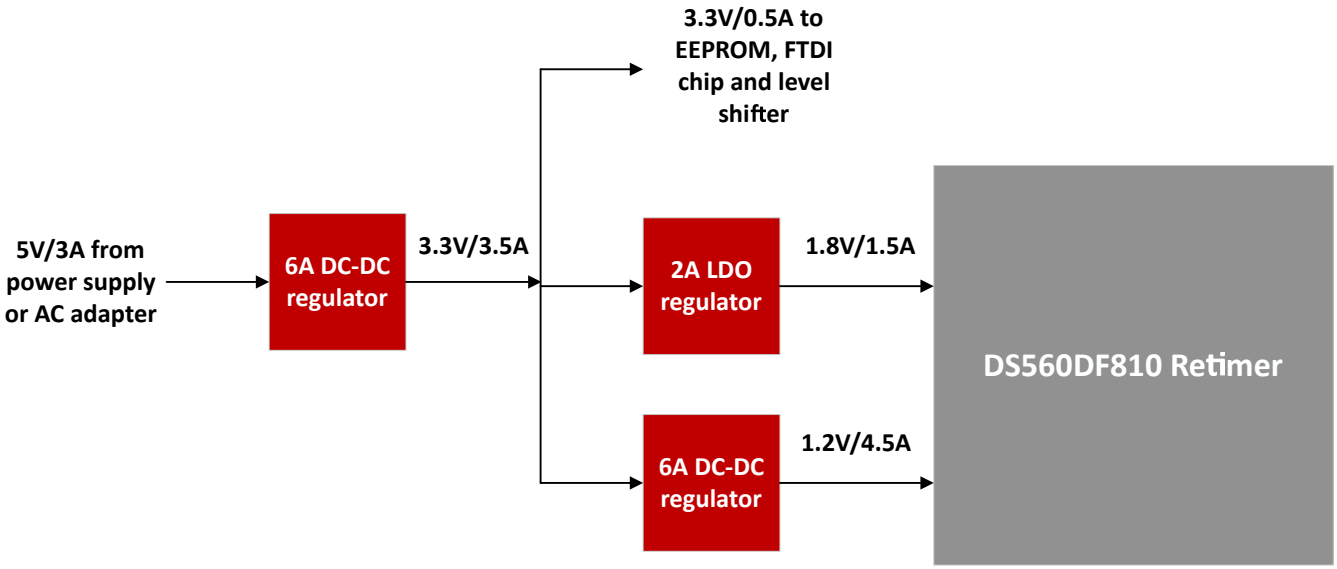

Figure 1-2. DS560DF810EVM Power Tree

1.3 Hardware Configuration to use Onboard 25 MHz Oscillator for CAL_CLK_IN

Figure 1-3 shows the schematic segment for CAL_CLK_IN. As per the schematic, different jumper placements are used to enable implementation of external CAL_CLK_IN signal or onboard 25 MHz oscillator respectively. For EVM version Rev 2 or later the end user may implement an onboard oscillator to supply the 25 MHz signal for the retimer CAL_CLK_IN input. The EVM version is listed on the bottom right corner of the evaluation board (Figure 1-1 shows the location).

Default jumper settings: External CAL_CLK_IN

- P101 header populated, to turn off the onboard oscillator.
- On P100 header, jumper placed between pins 3 and 5 to connect the J100 SMA connector signal to the retimer CAL_CLK_IN input pin..

Jumper settings to enable onboard CAL_CLK_IN option

- Remove the jumper from P101 header.

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- On P100 header:
  - Remove the jumper connecting pins 3 and 5.
  - Place jumper to connect pins 1 and 3, to connect the onboard oscillator output to the retimer CAL_CLK_IN input.

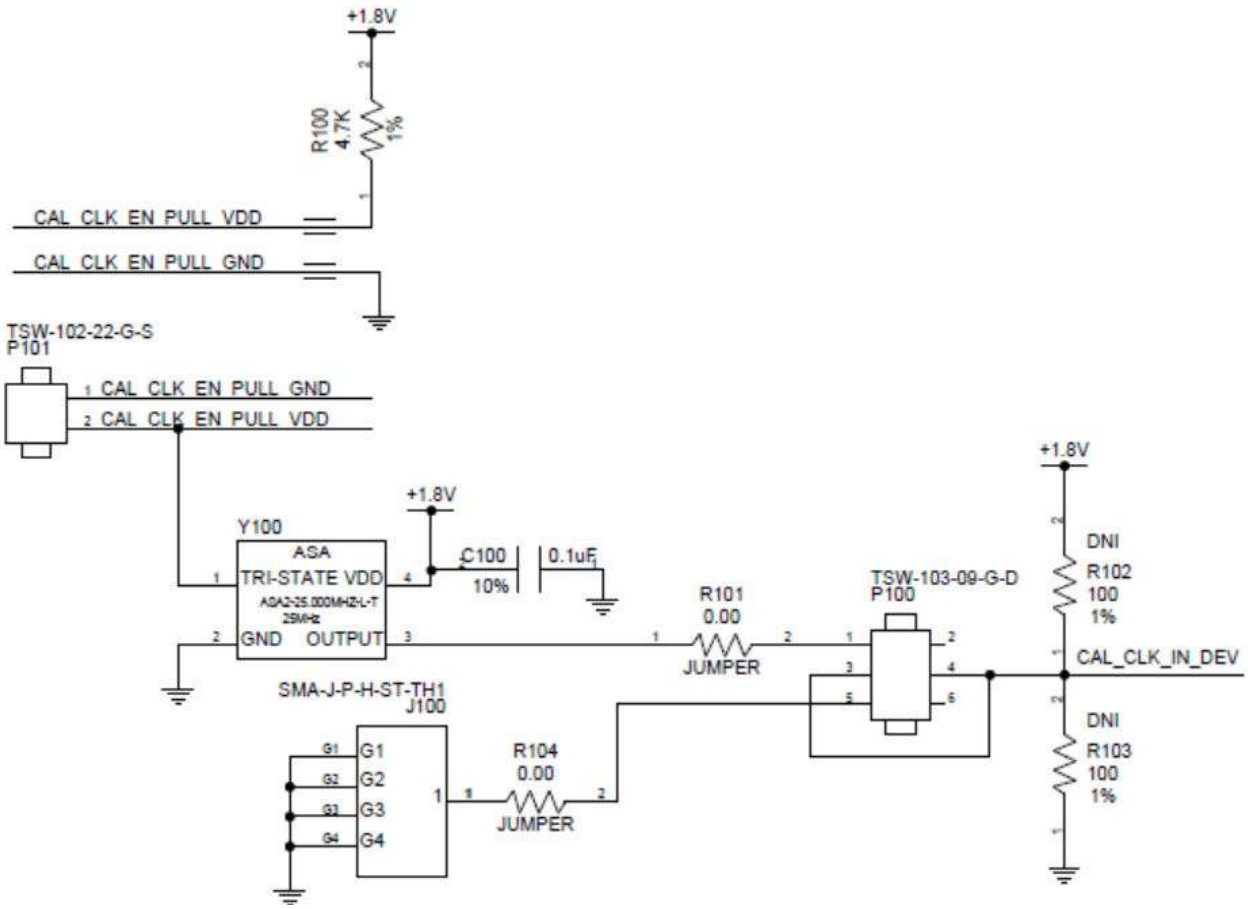

Figure 1-3. DS560DF810EVM Schematic Portion for CAL_CLK_IN Input Circuit; Applies to EVM Version Rev 2 and Later

2 Software Description

The software used to configure the DS560DF810EVM is a TI developed GUI called *Latte*. The latest version of Latte is available for download by request through TI's website. There are two installation files that the user needs to download and execute: The Latte framework installer file and the Latte libraries updater. As of this publication, the latest Latte installation files are the following:

- Main installer: *TI-DS560-Latte_V0p2.exe*
- Libraries updater: *TI-DS560Lib_V3p1.exe*

2.1 Software Installation Sequence

1. Install the TI Latte main installer. Follow all the instructions within the installer execution process. The installer will install the following:
   - Latte 5.2.3 - Core
   - FTDI Driver (CDM21228_Setup.exe)

   Select the destination location for latte core as ***"C:\Program Files\Texas Instruments\DS560Latte".***

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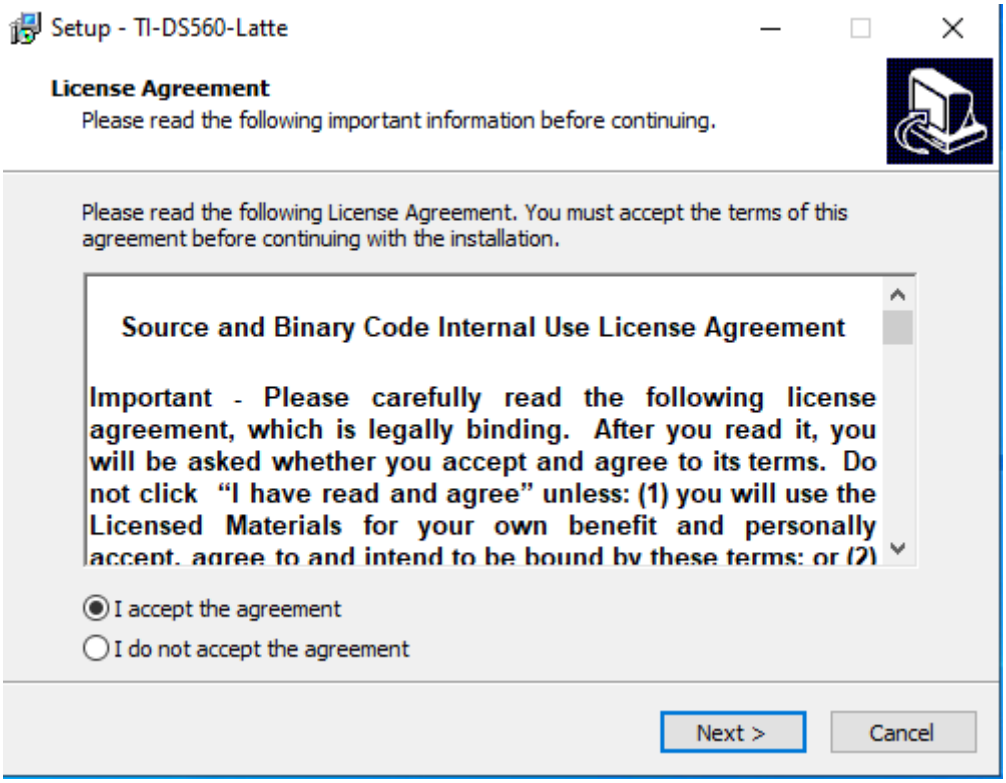

Figure 2-1. Latte Installer Window to Start Process

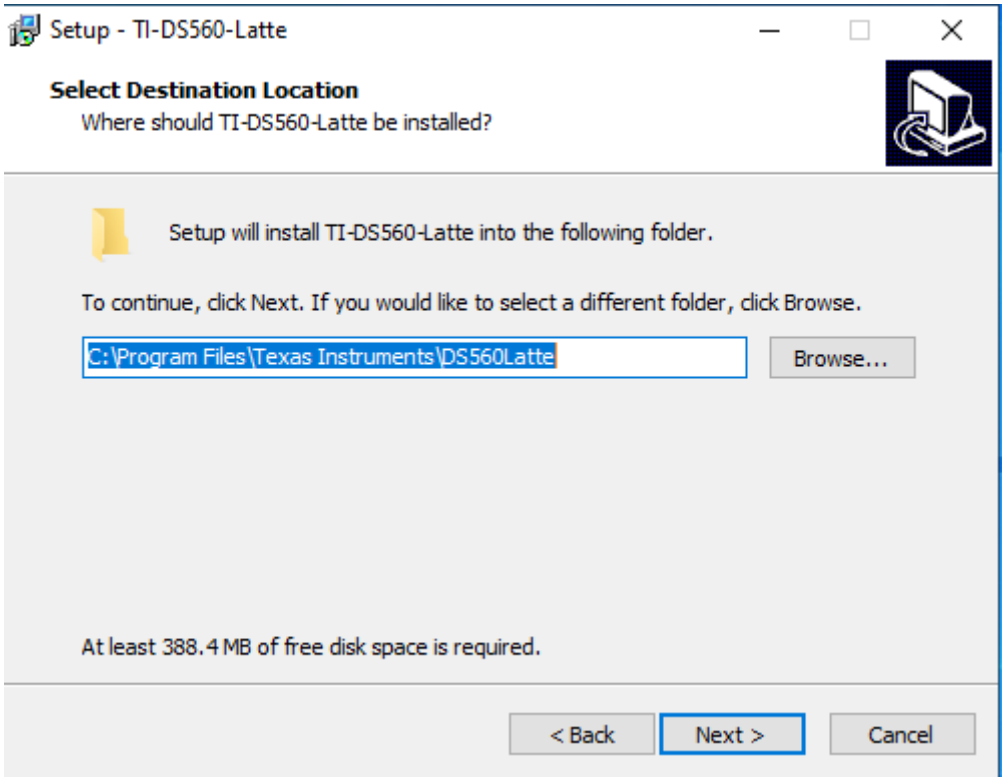

Figure 2-2. Latte Installer Window to Select the Destination Folder

Select project directory as *"C:\Users\<User ID>\Documents\Texas Instruments\DS560Latte"*.

Replace the *<User ID>* with the proper Windows login ID.

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Continue the installation setup to complete FTDI Driver installation

2.

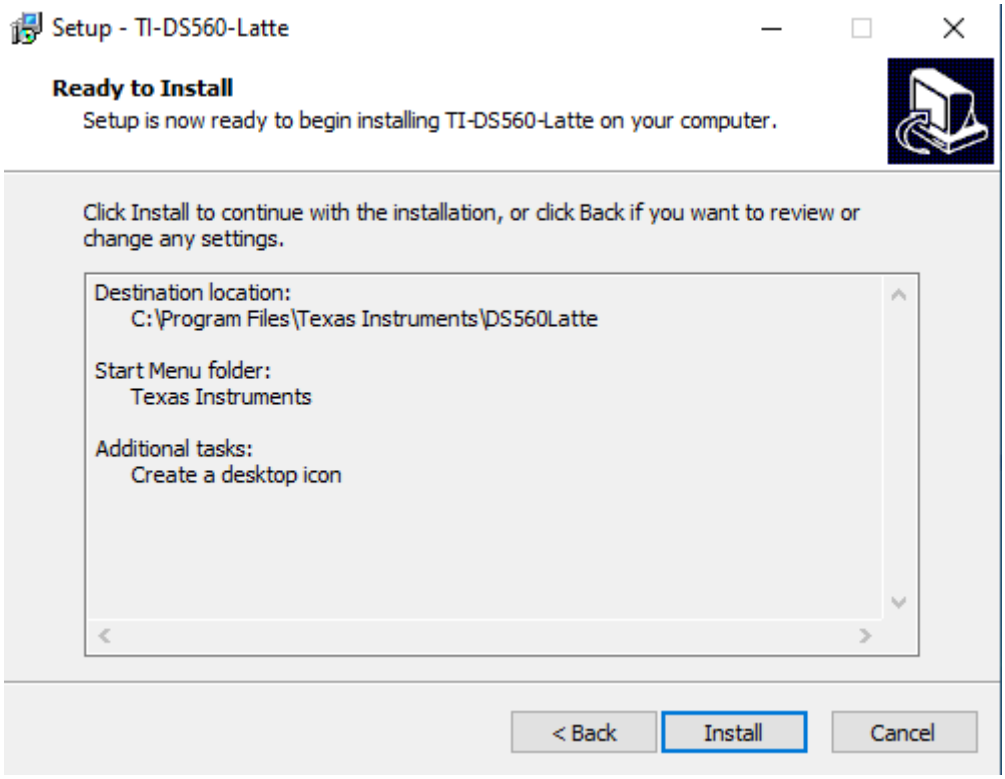

Figure 2-3. Latte Installation Window Prior to Launch of "Install"

Install the Latte Libraries updater. Follow all the instructions within the installer execution process. The installer will install the Latte device library required for configuring DS560DF810EVM

Select project directory as *"C:\Users\<User ID>\Documents\Texas Instruments\DS560Latte"*.

Replace the *<User ID>* with the proper Windows login ID.

Note

Both the base Latte software and the DS560 Latte Library can be updated by TI to add features and optimizations.

2.2 Latte Functional Overview

The user may launch the "DS560Latte" GUI through the desktop shortcut icon or select "App - DS560Latte". Figure 2-4 shows the Latte GUI main window. The Latte user interface is split into eight windows (labeled 1 to 8 on Figure 2-4) with the following functionality:

- **Window 1:**

  This window (also called *Scripts*) shows the list of python scripts available that generate the register commands to configure the DS560EVM. The script files shown are located in the `..\Documents\Texas Instruments\DS560Latte\projects\DS560\` folder. You can modify and create new scripts as necessary, which appear in this sub-window when you restart Latte.
- **Window 2:**

  This window (also called *Editor*) shows the code in the script currently selected and can be used to modify and save the code as necessary.
- **Window 3 to 6:**

  These windows get updated with status information as the user runs the scripts to configure the DS560DF810.

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- **Window 7:**

  This window (also called *Command Line*) is used to enter and run individual commands. Examples of such commands include changing the TX swing, pre/post emphasis settings, configuring PRBS generator/checker and so on.
- **Window 8:**

  This window (also called *Log*) displays messages during execution of scripts to display the current status. This window is also used for troubleshooting.

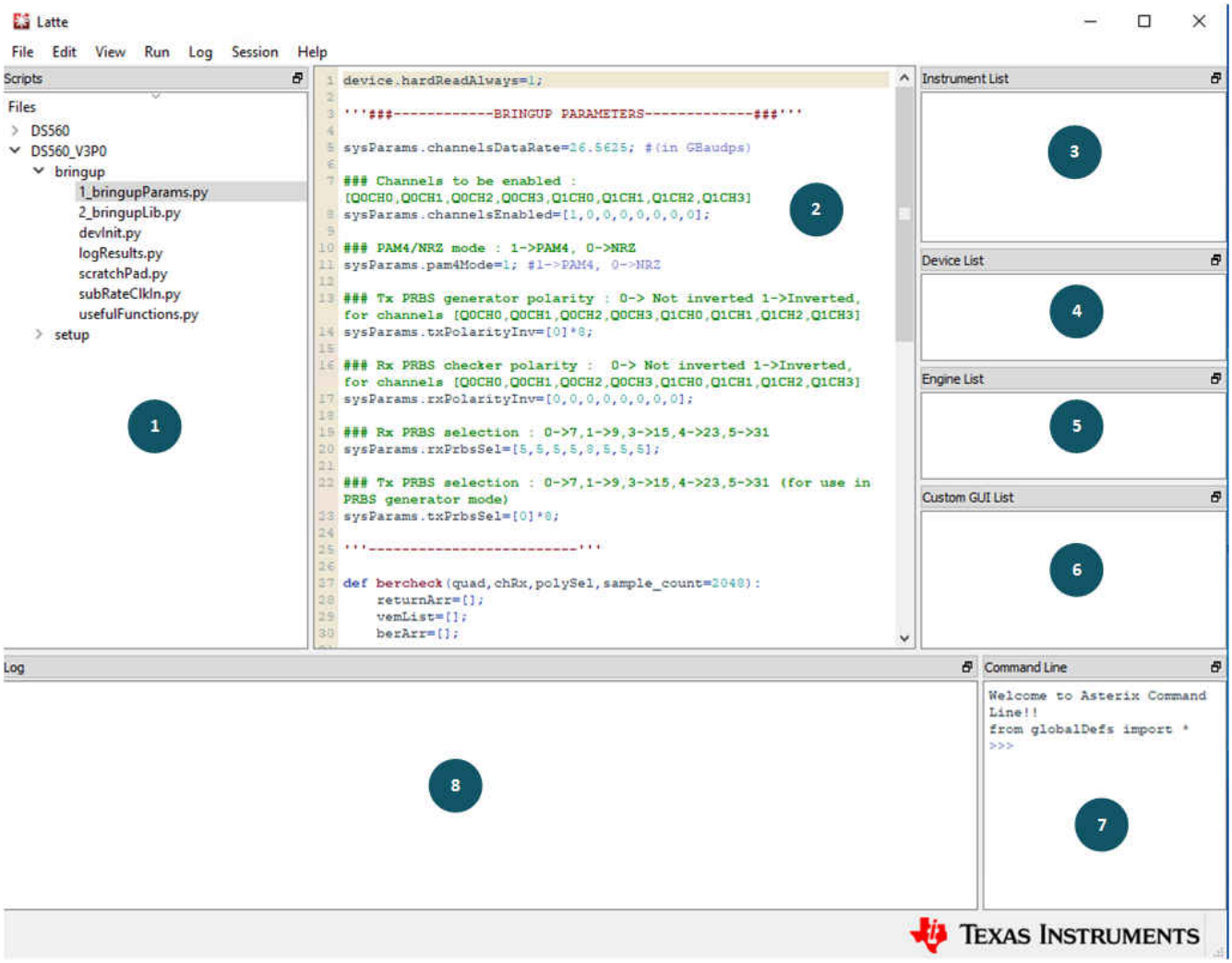

Figure 2-4. Latte GUI Overview

2.3 Useful Latte Short-Cuts

Run Script file: Run a script file by first selecting the file in the Scripts window and then by pressing F5 (or selecting *Run* and then *Buffer* in the menu bar).

Run part of script: Run part of a script file by selecting the lines in the Editor window and then by pressing F7 (or selecting *Run* and then *Run Selection* in the menu bar).

Stop Execution: Stop the current execution by pressing F10 (or selecting *Run* and then *Stop* in the menu bar).

Clear Session: The current session can be cleared to reset the Latte UI to its initial state by pressing Ctrl-T (or selecting *Session* and then *Clear Session* in the menu bar). This process is equivalent to a restart and can be used to restart a session without closing the GUI.

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2.4 DS560DF810EVM Initialization Through the Latte GUI

The sequence of steps for initializing the DS560DF810EVM through the Latte GUI is provided in the following sections:

2.4.1 Connect Latte to Board

This step establishes a connection between the PC running Latte and the DS560DF810EVM. The DS560DF810EVM should be powered for this step.

1. In the scripts window of Latte, under *setup* section, select *setup.py.*
2. Press F5 to run the program.
3. Check the Log window to ensure there are no errors where the following line should be displayed

   i2c - USB Instrument created.

   Gpio Programmer - USB Instrument created.

Missing or obsolete drivers for the FTDI chip in the DS560DF810EVM is a common error source. Windows Device Manager may be used to verify the connection between the PC and the EVM by checking the USB instantiations. The user may update PC with the appropriate driver if necessary.

Note

There are two places in *setup.py* that use the word "Dual" in lines 34 and 42. These need to be replaced with the word "Quad" for the script to run without errors.

Additionally, make sure *devIdentifier* on line 2 is set to a value of 2 for DS560DF810.

2.4.2 Compile Libraries

In this step, the library of scripts packaged with the Latte GUI is compiled.

1. In the scripts window, under *setup* section, select *devInit.py*
2. Press F5 to run the program
3. Check the Log window for status and errors.

2.4.3 Example: Programming DS560DF810EVM for 26.5625 GBd PAM4 Test Case

In this step, the retimer device on the DS560DF810EVM is programmed. The procedure to program the EVM are as follows:

1. Ensure CAL_CLK_IN has 25 MHz input clock signal.
2. Provide a valid input signal to the DUT retimer channel.
3. Execute “setup.py” (user may select file on side panel and click F5).
4. Execute “devinit.py” (user may select file on side panel and click F5).
5. Execute “1_bringupParams.py” after entering the desired 26.5625 GBd retimer settings for the “Bringup Parameters” (see Figure 2-5).
   - Data rate is entered in unit of GBd.
   - PAM4 mode is enabled by setting system variable to 1.
   - For this case, PRBS31Q pattern is selected for Tx and Rx PRBS functions through value of 5.
6. Execute the “bringupLib.py” script. This will load and apply a ROM patch before initializing all enabled retimer channels (see Figure 2-6).

Note

At the end of the bring-up scripts, the variables “quad” and “ch” will be set corresponding to the last retimer channel enabled. The variables can be re-assigned according to the channel of interest by manually entering values in one of the Latte scripts.

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```
'''###------------BRINGUP PARAMETERS-------------###'''

sysParams.channelsDataRate=26.5625; #(in GBaudps)

### Channels to be enabled :
[Q0CH0,Q0CH1,Q0CH2,Q0CH3,Q1CH0,Q1CH1,Q1CH2,Q1CH3]
sysParams.channelsEnabled=[1,0,0,0,0,0,0,0];

### PAM4/NRZ mode : 1->PAM4, 0->NRZ
sysParams.pam4Mode=1; #1->PAM4, 0->NRZ

### Tx PRBS generator polarity : 0-> Not inverted 1->Inverted,
for channels [Q0CH0,Q0CH1,Q0CH2,Q0CH3,Q1CH0,Q1CH1,Q1CH2,Q1CH3]
sysParams.txPolarityInv=[0]*8;

### Rx PRBS checker polarity :  0-> Not inverted 1->Inverted,
for channels [Q0CH0,Q0CH1,Q0CH2,Q0CH3,Q1CH0,Q1CH1,Q1CH2,Q1CH3]
sysParams.rxPolarityInv=[0]*8;

### Rx PRBS selection : 0->7,1->9,3->15,4->23,5->31
sysParams.rxPrbsSel=[5]*8;

### Tx PRBS selection : 0->7,1->9,3->15,4->23,5->31 (for use in
PRBS generator mode)
sysParams.txPrbsSel=[5]*8;
```

Figure 2-5. Latte GUI Snapshot Showing the User Configurable Retimer Parameters from the "1_bringupParams.py" Script

```
#================= ERRORS:0, WARNINGS:0 =================#
#=======
#Executing .. DS560_V3P0/bringup/2_bringupLib.py
#Start Time 2022-10-21 12:58:53.457000
Device - Device registers reset.
chipType: 0x0
chipId: 0x20
chipVersion: 0x9
vendorId: 0x3
Quad0 : Autoload passed
Loading patch ...
ROM Patch version : 0x150b1e16
ROM Patch identifier : 0xafd2
ROM Patch version : 0x150b1e16
ROM Patch identifier : 0xafd2
FW Patch version : 0x0
FW Patch identifier : 0x100d
FW Patch version : 0x0
FW Patch identifier : 0x100d
Patch apply completed successfully
----QUAD : 0-----CH : 0-----
Channel Initialization is in progress...
#Done executing .. DS560_V3P0/bringup/2_bringupLib.py
#End Time 2022-10-21 12:59:06.740000
#Execution Time = 13.2829999924 s
#================= ERRORS:0, WARNINGS:0 =================#
```

Figure 2-6. Example Latte GUI Log Window Snapshot Showing ROM Patch Load and Channel Initialization

7. If the retimer channel in question is intended to serve as Tx PRBS generator for retimer Tx to retimer Rx link tests, the "usefulFunctions.py" script may be used to configure this channel accordingly (see Figure 2-7).
   - Go to "Configure transmitter" section of "`usefulFunctions.py`".
   - Set parameter mode=2 for "transmit PRBS pattern".
   - Set the numeric value for the "pattern" variable for the desired pattern.

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- The user may highlight the “configure transmitter” command lines on the Latte window and click on F7 to execute only those commands.

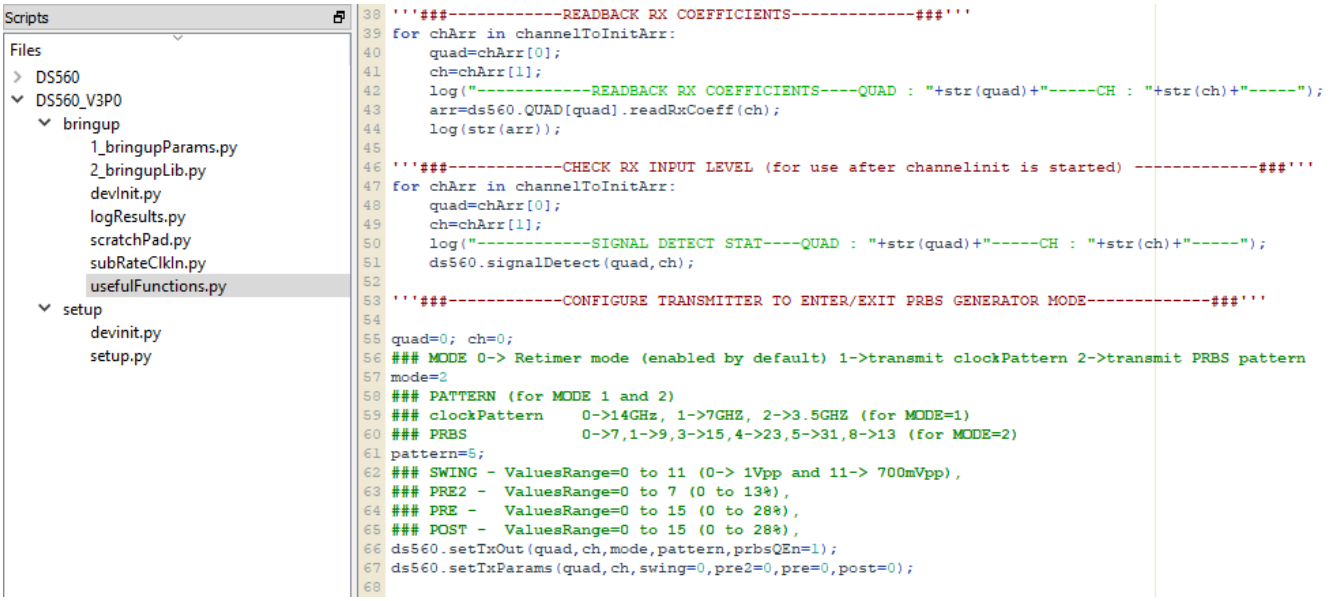

Figure 2-7. Latte GUI Snapshot Showing the “usefulFunctions.py” User Parameters

8. In the case that a sub rate clock input is supplied to the retimer channel, an alternate script “subRateClkIn.py” should be run in place of “2_bringupLib.py”. This allows the retimer channel to always observe CDR lock in cases where phase lock is achieved prior to frequency lock.

subRateClkIn.py (for use in Latte scripting window).

```
### Hardware reset
if(setupInfo==0):
    ds560.hardReset();
delay(0.5);

### Software reset and I2C check
resetStat=ds560.softReset();

### Device bringup Call

[quadToOn,channelToInitArr]=ds560.getChannelArr();

if(resetStat):
    bringupStat=ds560.deviceBringup();

quad=0;ch=0;
ds560.channelInitSubRateInput(quad,ch);
```

2.4.4 Retimer Configuration

The example in the previous section configures the DS560DF810EVM with the default modes set in Latte. The user may change the mode and channel by modifying the parameters in the *“1_bringupParams.py”* Latte script.

- ***Data rate:*** Data rate can be configured using system variable ***channelsDataRate.*** Reset of the device is recommended with this change
- ***Channel selection and initialization:*** Channels to be initialized can be selected using the system variable ***channelsEnabled*** array. Enable a specific retimer channel by setting the bit corresponding to it in the array (where channel order is sequential, from 0 to 7) to “1”
- ***PAM4 / NRZ mode:*** Change the system variable ***pam4Mode***, to switch between PAM4 and NRZ modes. A reset of the device is recommended once the mode is changed
- ***PRBS generator / checker polarity:*** To change the polarity of Tx PRBS generator, use variable ***txPolarityInv***. To change the polarity of Rx PRBS checker, use variable ***rxPolarityInv***
- ***PRBS selection:*** The PRBS pattern may be set through system variables ***rxPrbsSel*** and ***txPrbsSel.*** Enter the number corresponding to the desired pattern

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- ***Channel type:*** The channel type can be selected with system variable ***channelType.*** Set this variable to “1” for use with a DAC cable or “0” for default mode

2.4.5 Retimer “Useful Functions” (Contained in the usefulFunctions.py Latte Script)

- ***Readback channel init status/lock status:*** The CDR lock status for the selected channel can be read using the below function.
- ***Get tempsense result:*** The user may perform a coarse reading of the retimer internal temperature.
- ***Readback channel init info:*** Channel initialization info such as CTLE settings and bringup stage statuses can be read using the below function.
- ***Readback FOM:*** The internal figure of merit used by the retimer to guide the EQ auto adaptation process can be read by the user.
- ***Readback BER:*** The internal BER checker for the retimer channel currently selected can be used when the length of the PRBS data is known a priori. The ***prbsBERCheck*** function prints the BER and the total number of bits over which it is computed.

Note

Observing “Total bits = 1” on the log window means PRBS sync is not achieved. Change the input data to one of the supported PRBS patterns

- ***Readback RX coefficients:*** Can be used to read the weights of several FFE and DFE EQ taps.
- ***Check RX input level:*** After the channel initialization process has been completed, the signalDetect function can be used to check presence of signal at the Rx input of the selected retimer channel
- ***Configure Transmitter***: The transmit data can be configured by ***mode*** and ***pattern*** variables
  - ***mode*** = *0:* Transmits re-timed data irrespective of the ***pattern*** variable
  - ***mode*** = *1:* Transmits clock pattern, frequency of which is determined by the ***pattern*** variable
  - ***mode*** = *2:* Set transmitter to PRBS pattern generator
  - ***pattern:*** Select the desired pattern by entering numeric value (see table below)

Table 2-1. PRBS Pattern Codes

Pattern:	PRBS:
0	7
1	9
3	15
4	23
5	31
8	13

PRBSQ pattern can be enabled by setting ***prbsQEn***=1. To configure transmitter to send PRBS13Q pattern, set ***mode=2, pattern=8 and prbsQEn=1***. This is only applicable to PAM4.

- Swing and the pre/post emphasis setting of the transmitter can be controlled by the function ***ds560.setTxParams***.
  - ***swing***:
    - 0 -> 1 V
    - 1 -> 880 mV
    - 3 -> 760 mV
  - ***pre2***: value of 0 to 7 correspond to 0 to 15%.
  - ***pre***: value of 0 to 15 correspond to 0 to 31.25%.
  - ***post:*** value of 0 to 15 correspond to 0 to 31.25%.

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2.4.6 Vertical Eye Monitor

To implement the retimer internal eye monitor function the user needs to load the Latte “custom GUI” shell. The steps are as follows:

1. In the menu bar of Latte, select ***Session-> Load session***.
2. Select file “`C:\Users\<User ID>\Documents\Texas Instruments\DS560Latte\projects\DS560_V3P0\setup\customGUI.astx`”.

(Replace the *<User ID>* with proper Windows login ID.)

1. You can now see ***“CGui_CGui_CGui_VerticalEyeMonitor”*** reflect in ***“Custom GUI List”*** (Window 6) of Latte.

Once the customGUI is loaded the vertical eye histogram of the received data across 64 bins can be plotted in Latte as shown in Figure 2-8 below. Data can be captured in a finite set of approximately 64k samples or continuously.

1. Under ***controls*** tab***, channel*** has to be set to desired one (valid range is 0 to 3).
2. Set ***Capture type*** to ***Continuous*** or ***Finite samples*** from the drop-down mode.
3. Click on ***Start Capture*** to get the vertical eye in the ***“Plot Eye data”*** tab.

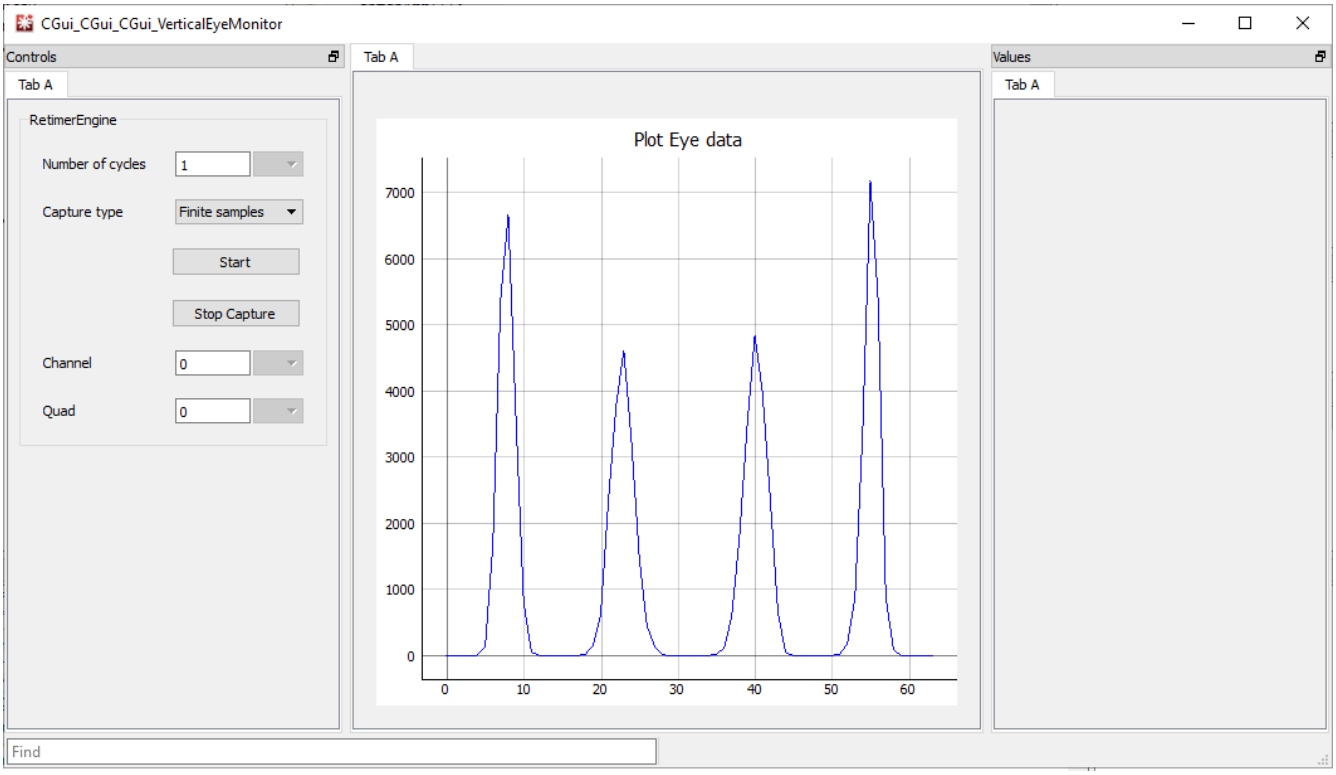

Figure 2-8. Vertical Eye Monitor GUI

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3 Test Case Examples

3.1 Transmitter Test Case – EVM Board Output Evaluation for 26.5625 GBd PAM4 Data

The following is an example retimer Tx test case with results collected using this EVM. This basic test setup involves measurement of the retimer output straight out of the EVM. The retimer Tx output channel is comprised of the EVM board trace plus the MXP connector and cable.

- **Data Rate**: 26.5625 GBd PAM4
- **Data pattern**: PRBS15
- **Total EVM output channel insertion loss**: **−2.6 dB at 13.28 GHz**
- **Retimer Tx settings: swing=0, post1=-5, pre1=-3**
  - These Tx settings correspond to VOD=1 Vpp, pre1 around −2 dB and post1 around −3 dB.

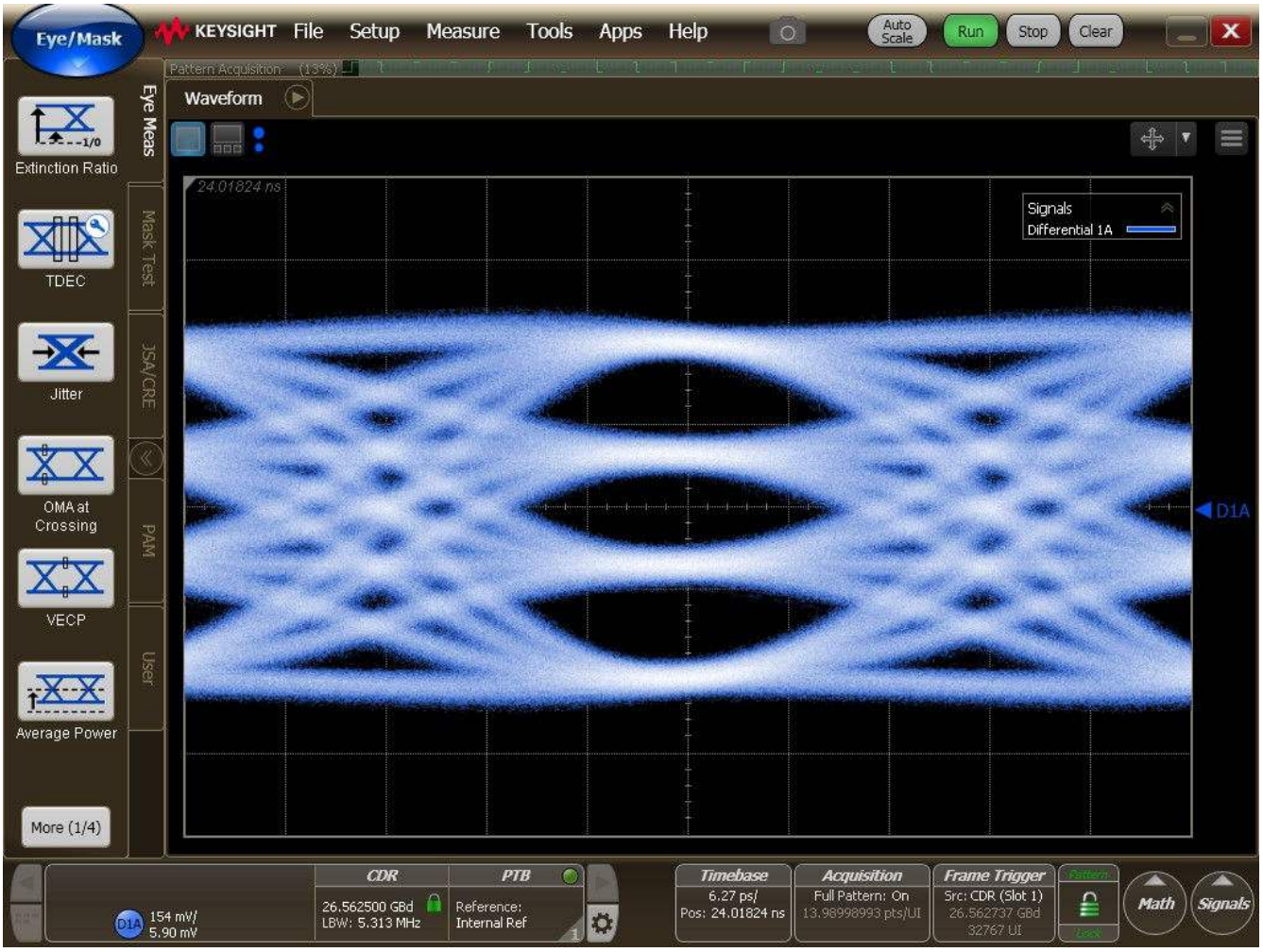

Figure 3-1. Retimer Output Eye Diagram for Transmitter Test Case; No Reference CTLE Applied on the Keysight DCA-X

Table 3-1. Keysight DCA-X Jitter Mode Results

Measurement	Eye 0/1	Eye 1/2	Eye 2/3
Eye Width (1E-6)	346 mUI	399 mUI	318 mUI
Eye Height (1E-6)	115.8 mV	108.8 mV	118.0 mV

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3.2 Receiver Test Case – High Loss Input Channel to Retimer EVM, 26.5625 GBd PAM4

The following is an example retimer Rx test case with results collected using this EVM.

- **Data Rate**: 26.5625 GBd PAM4
- **Data pattern**: PRBS31
- **Total input channel insertion loss**: **−32.46 dB at 13.28 GHz**
  - 15-inch 5mil FR4 test trace: −27.26 dB at 13.28 GHz
  - DS560DF810EVM board level channels (Tx + Rx): −5.2 dB at 13.28 GHz

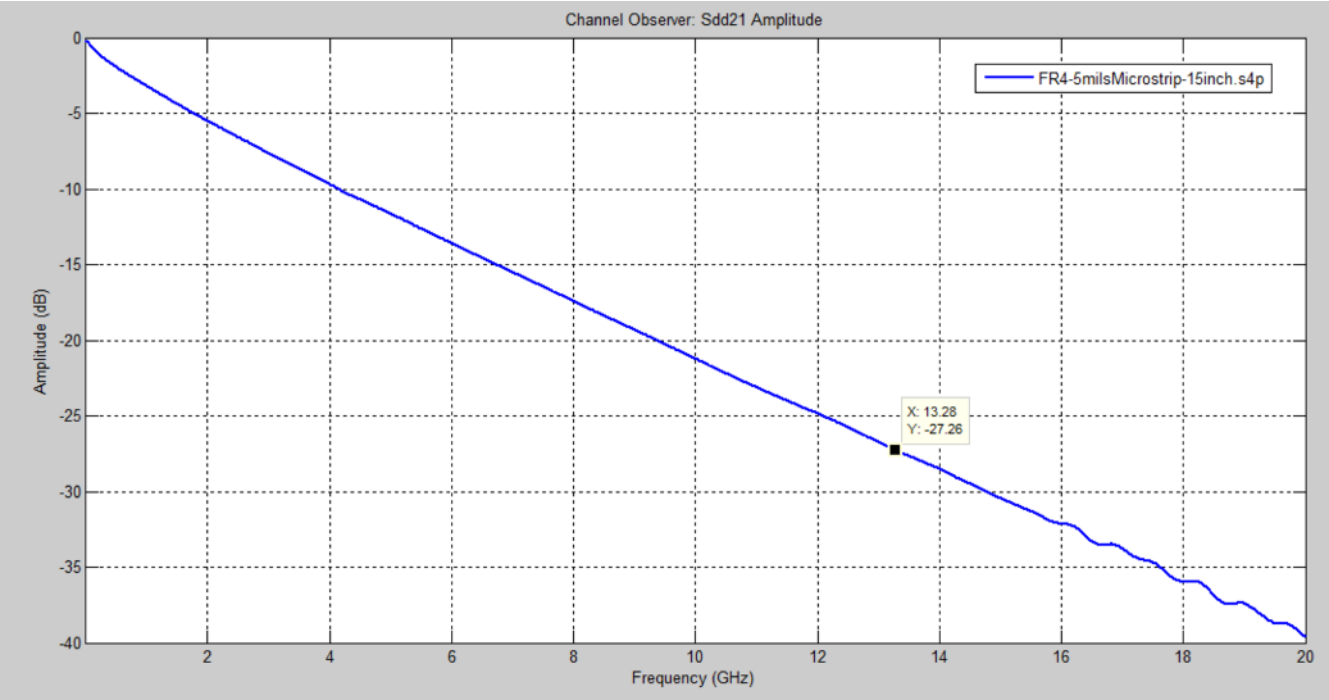

Figure 3-2. SDD21 for the 15-Inch FR4 PCB Test Trace Used at Input Channel for the Receiver Test Case

Result summary

Total Bits : 137170649088

Num Errors : 920791

BER : 6.71E-06

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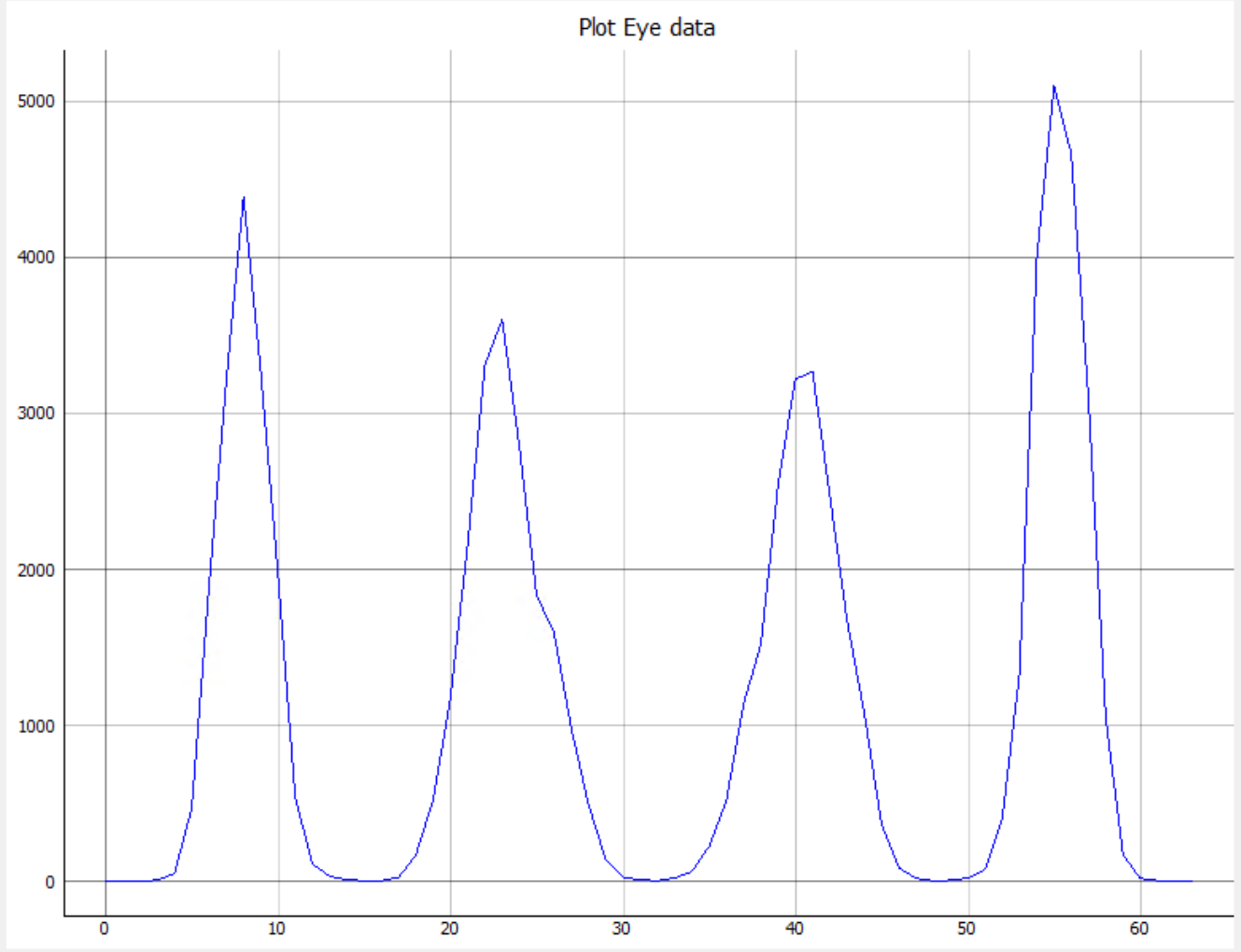

Figure 3-3. Vertical Eye Monitor Capture for Receiver Test Case

4 Supplemental Documents

All the EVM design, layout, and other files which are relevant to this EVM are listed in the following table. These documents may be downloaded through access request on the DS560DF810 TI.com product page.

File Description	File Name
Schematic PDF	DS560DF810EVM_REV2_schematic.pdf
Board layout file	DS560DF810EVM_REV2_layout.brd
Board Gerbers	DS560DF810EVM_REV2_gerbers.zip
Board s-parameters folder	EVM/s_parameters/

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5 EVM Cable Assemblies

This evaluation module uses Huber+Suhner 1x8 MXP cable assemblies.

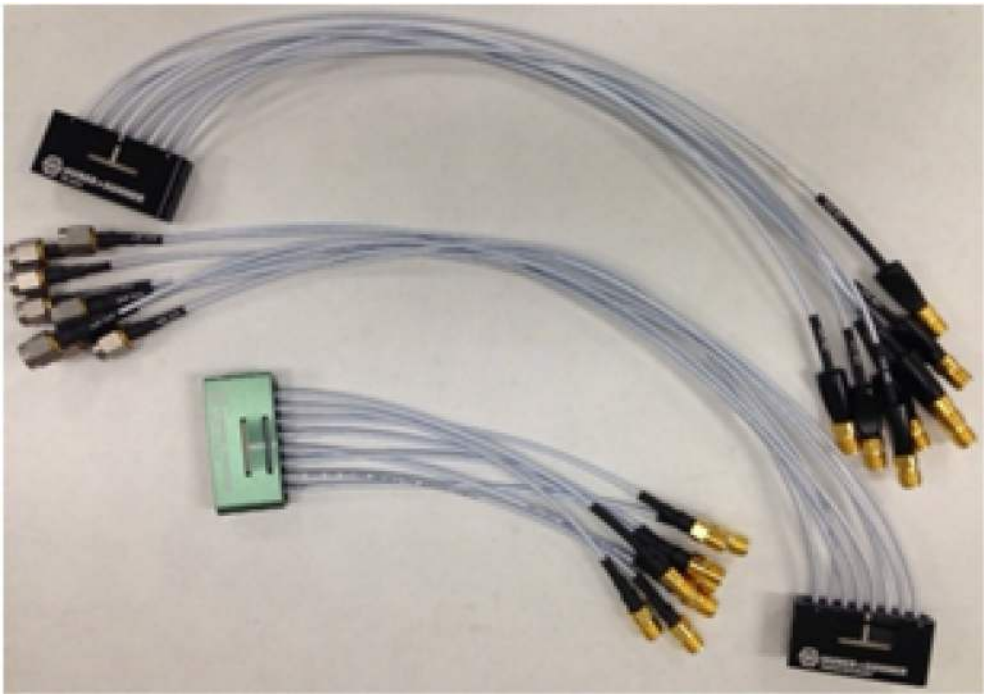

Figure 5-1. Huber+Suhner MXP cable assemblies

To inquire about purchasing cable assemblies from Huber+Suhner, contact:

Info.us@hubersuhner.com

HUBER+SUHNER Inc.

8530 Steele Creek Place Drive, Suite H

Charlotte-NC- 28273

+1 704-790-7300

There are three part numbers that TI suggests using with this EVM:

1. 85014420, MF53/1x8A_21MXP/21SMA/152: “MXP-15 cable assembly”. This is a lower cost cable assembly compared to the MXP-40, but the SI performance is very good and more than adequate for 25 Gbps operation.
2. 84099607, MF53/1x8A_21MXP/11SK/305: “MXP-40 cable assembly”. This cable assembly is designed specifically for 40+ GHz. It features a male cable end and longer cable length options.
3. 84098900, MF53/1x8A_21MXP/21SK_ergo/305: “MXP-40 cable assembly”. This cable assembly is designed specifically for 40+ GHz. It features a female cable end and longer cable length options.

6 Revision History

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

Changes from Revision * (December 2022) to Revision A (December 2022)	Page
• First public release of EVM user's guide	3

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   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。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required 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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3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

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