This document contains information on a product under development and the material is subject to change.
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1. Introduction

Congratulations on your purchase of an Elevate Semiconductor evaluation system. You will find that it serves as an invaluable development platform to help get your product to market in the shortest possible time. The evaluation board and GUI (Graphical User Interface) allow the customer to demonstrate and evaluate the performance and functionality.

This document provides the instructions to install, setup, and operate the EVM (Evaluation Module).

1.1 Unpacking - EVM Contents

Please check the contents of the EVM shipping carton to make sure you have received all the items listed in Table 1. The EVM system ships ready to operate except for a PC with USB port and connections to optional test equipment.

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 each</td>
<td>Rainier EVM System (Zedboard FPGA and Rainier Loadboard)</td>
</tr>
<tr>
<td>1 each</td>
<td>Rainier EVM# GUI Guide (this document)</td>
</tr>
<tr>
<td>1 each</td>
<td>Rainier Device Guide</td>
</tr>
<tr>
<td>1 each</td>
<td>Rainier EVM Calibration Guide</td>
</tr>
<tr>
<td>1 each</td>
<td>AC Adapter Power Plug</td>
</tr>
<tr>
<td>1 each</td>
<td>Elevate Semiconductor User Interface Program Installation Flash Drive</td>
</tr>
<tr>
<td>1 each</td>
<td>Micro - USB Cable</td>
</tr>
</tbody>
</table>

1.2 Recommended Test and Measurement Setup

1.2.1 Power Supply

The included power adapter provides all the power needed for the evaluation system (FPGA plus Rainier loadboard). If the power adapter becomes lost or does not work, a +12V supply can be used to optionally provide power to the evaluation system. Table 2 provides the required power supply and current rating. The external power supply is connected to the board using standard banana plugs (not provided).

<table>
<thead>
<tr>
<th>Module</th>
<th>Supply</th>
<th>Current Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainier EVM/FPGA</td>
<td>+12V</td>
<td>3 A</td>
</tr>
</tbody>
</table>

1.2.2 PC Controller

To use the Rainier EVM User Interface Program (UIP), a PC with the following configuration is required:
- Windows 10
- USB Port (a USB cable is provided)
1.2.3 Lab Equipment

The below lab equipment can be used for evaluation of the Rainier product along with any other equipment the user deems useful.

- Voltage and/or Current Source
- DMM
- Oscilloscope
- Pulse Generator
- Resistor/Capacitor Loads

---

**FIGURE 1: RAINIER EVM SETUP**
1.3 Software Installation

The Rainier EVM software is on the included GUI flash drive. To ensure the evaluation board is correctly recognized when connected to the PC, the software should be installed before connecting the board to the PC’s USB port.

First plug in the provided USB.

From the USB, run the .NET Framework application located on the flash drive to Local Disk C: It is also available for web download at: https://dotnet.microsoft.com/en-us/download/dotnet-framework/thank-you/net472-web-installer.

Once the .NET Framework is installed, unzip the Testbench software to Local Disk C:, create a new folder named “Elevate”:

![FIGURE 2: USB FILES IN TESTBENCH FOLDER](image)

You may also create a shortcut on your Desktop to connect to the file location on the Local Disk drive.

![FIGURE 3: DESKTOP WITH TESTBENCH SHORTCUT](image)
Once unzipped to your desired location, select the Testbench Application to launch the software:

The installation is now complete.
2 Hardware

The Rainier EVM2 is shipped with several pre-configured states and a user interface program that allows a customer to evaluate the Pin Electronics, PPMU (Per-Pin Parametric Measurement Unit (Force Voltage/Current - Measure Voltage/Current), Comparators, Active Loads, and other features. See Section 5.5 for details on loadboard hookup.

Note: Any external equipment providing digital signals into the Rainier device should only be enabled after the Rainier EVM is enabled and the Rainier device is powered on. Any external equipment should also be disabled prior to disabling the Rainier EVM.

![Overview of Rainier Evaluation Board](image-url)

**FIGURE 5: OVERVIEW OF RAINIER EVALUATION BOARD**
2.1 Micro-USB
Connect the included micro-USB cable from your PC to the micro-USB port on the Rainier EVM as show in Figure 5. This micro-USB connector is labeled UART (J14) on the FPGA Zedboard. This connector is small and can break off the Zedboard with lateral movement of the USB cable. Take caution when connecting the cable to avoid damage to the board.

2.2 Power Supply Options
There are 2 power options for the Rainier EVM. **Only 1 of the following options is required:**

1. Wall power adapter (Included with Evaluation System).
   a. Connect wall adapter to the 12V power barrel connector, J8.

2. +12V External Supply.
   a. Connect power supplies cables (not provided) from your power supply to the Elevate Semiconductor EVM Rainier board’s +12V (P2) and GND (GND1) banana connectors.

2.3 Single-Ended or Differential Mode Hardware Setup
As shown above in Figure 5, the user may connect the jumper on PROD0 to VDDIO to operate the EVM in single-ended mode or connect PROD0 to GND to operate in Differential mode. The current board status will be displayed in the Global Block, in the DEV_REV register. This is a read only register and cannot be written.
The user may check if the device is set up to the desired state in the Global Block, Dev_Rev register:
   - When the “Single_Ended_State” bit is HIGH the EVM operates in single-ended mode.
   - When the “Single_Ended_State” bit is LOW the EVM operates differential operation.
2.4 Caution

The Rainier Socket may get hot even with the included fan running. The user should be cautious about handling the device or socket.
3 GUI Overview

This section is an overview of what is contained in the Testbench GUI. Powering up the device and details about specific pages are discussed later in this document.

1. Upon startup of the software, the EVM board is powered on, but it is not yet connected to the GUI. In the EVM Status box, the user can connect the software to the device by either selecting which “COM” port to look at from the drop-down menu or selecting “auto” then clicking the “Connect” button. The EVM Communication TX and RX indicators will blink green to show the software is talking to the EVM, then the “Connected” box will turn green once the program is successfully connected.

2. Once the GUI is connected to the EVM, the device will not be powered up as the DUT power box will be uncolored. After powering up the Rainier device, this box will turn green. (The power up sequence is shown below in section 4).

3. The Elevate GUI software is broken up into 5 main tabs:
   a. Registers: The Rainier device can be programmed using register settings versus graphical setup. There are options to set register bits and DAC levels for individual channels or all channels. There are also options to save and load setups from files.
   b. Power Controls: Allows user to change power rails. Also contains temperature measurements for central diode and for each channel.
   c. ADC/Relays: This page has options to measure the calibration/monitor pins. There is also the feature to set the EVM relays to route an ADC channel to the on-board passive loads (Load_Star_High SMA) circuit on the EVM.
d. MON: Contains a GUI of the Monitor path. Users can use the drop-down menus to select the Monitor channel, set SEL_MON to different modes, and set the Diagnostic buses for different measurements.

e. Fuses: Contains Serial Number Decoder and other fuse bits used in calibration. **NOTE: ADVANCED USERS ONLY. Use with caution, burned fuses are permanent. Cannot be undone.**

4. Each of the GUI controls is a visual representation of a register in the Rainier device. Once the user moves tabs, selects a register block etc., a register in the Rainier device will be programmed to match the corresponding GUI input.
4 Connecting the EVM and Powering the Rainier Device

This section is designed to show the user how to connect and power up the Rainier device.

4.1 Connecting to the EVM

1. Users must connect the GUI to the EVM before operating the device. In the EVM Status section, use the drop-down menu to select which COM port to connect to then click the “Connect” button.
   a. Users can see what COM the EVM connects to by viewing Device Manger > Ports (COM & LPT).

   ![FIGURE 8: DEVICE MANAGER WINDOW](image)

   b. If the EVM option is not available on the drop-down menu, try selecting the “Refresh” button or select “auto” from the menu.

2. When the software tries to connect the EVM, the EVM Communication section will display TX and RX indicators flashing in green to give user feedback that the software is working.

3. When the connection is successful, the “Connected” indicator box will appear green, and the “Connect” button will now say “Disconnect” so it may now be used to sever the connection between the GUI and the EVM.
4.2 Powering Up the Rainier Device

1. After connecting the EVM board and installing the Elevate GUI software as shown in the Software Installation Section, you can power on the Rainier device.
FIGURE 10: POWER AND CONNECTION BLOCK OVERVIEW

2. Powering up the Rainier device uses the “DUT status” section of the Registers tab of the Rainier GUI.

3. Powering up Rainier Device:
   a. Select the Power ON button.
   b. Wait for the TX and RX indicators to finish flashing.
   c. When the device is successfully powered on, the DUT Power indicator will turn green, the Device SN will appear under Device ID. The “Power On” button will change to read “Power Off” and now may be used to turn the device off when finished.
   d. The measured voltage, current, and power for each supply are displayed in the Power Rails section.
   e. At this point, the device is now in a powered-up state and ready to start characterizing or testing. Note that the GUI automatically obeys the power up sequence guidelines.

4.3 Powering Down the Rainier Device

To power down the Rainier device, left click the “Power Off” button. The “DUT Power” indicator will change from green to no color. This will indicate Rainier is no longer powered up. Again, via the GUI, the order will be correct.
5 Main GUI Tabs

Each of the major GUI tab sections will be discussed below. The are 4 major sections of the Graphical User Interface as stated in the GUI overview section. Each will be discussed or shown below:

1. Registers
2. Power Controls
3. ADC/Relays
4. MON
5. Fuses

5.1 Register Maps

The Rainier device can be programmed using register settings. There are options to set register bits and DAC levels for individual channels or all channels. There is also the option to save register setups and load register setups from files. These are used to set and save the Rainier device in a known configuration.
5.1.1 Manually Selecting Registers

1. The Registers tab for the Rainier Device is broken into 3 sections. **Blocks, Registers, and Bits**. Blocks are only terms used in the GUI and are not part of the device. Each of these concepts is explained below:

   a. **Blocks**: Blocks are just a term for a grouping of registers that are related in the Rainier device. Each of the blocks can have many registers or just a few. Each block of registers controls a separate section of the device. All blocks related to the Rainier are shown in the “Block Selection” pulldown menu.

      I. **Per Chip Blocks**: This selection affects the central section of the device. The GLOBAL section of the register map is per-chip selection and is shown above. The GLOBAL block selection is a section of the register map that is central to the device and is not specific to any channel.

      II. **Per Channel Blocks**: These block selections will only affect 1 channel. For example, CHAN_0 will only affect channel 0. The Per-channel selections will be indicated by: “Block Name” + “_” + “channel number”.

      III. **All channel Blocks**: Selecting this block will affect all channels when a register is written. For example, CHAN_ALL: The All-channel selections will be indicated by: “Block Name” + “_” + “ALL”.

   b. **Registers**: The registers in Rainier are all 16-bit registers. As an example, all the Registers Blocks are set to CHAN_3 and the first five registers are shown in Figure 12.

      I. **Register Name**: This matches the register map name in the datasheet. PWR_CTRL in the above example.

      II. **Register Address**: The address of the register is below the Register name. Address 300 in the above example. The first number in the address matches the channel number (channel 3). The second 2 numbers match the REG ADR in the datasheet (address 00).

   c. **Bits**: Each Block Selection is further broken into 16 Bits. The 16 bits of each block can be selected by clicking on the desired bit button.

---

**FIGURE 12: REGISTERS TAB, CHANNEL 3 EXAMPLE**
I. If a register bit is written as a ‘0’, the register bit is gray. If the register bit is a ‘1’, the register is blue.

II. The user should press the “Update” button after writing registers to make sure the correct registers were written.

III. There are bits within certain registers that can be written independently without affecting the other bit fields in that register. For these registers each independent bit field has a WE (write enable) bit defined that must be set to “1” for those bits to be affected by a write.
   i. This GUI considers the WE bit as ‘1’ by default. When saving a script, the WE bit is by default saved as a “1” so when the script loads all desired bits field are set correctly.

5.1.2 Load and Save Register Setups

The “Save Script” and “Load Script” buttons can be used to save and load register settings. These 2 selections are discussed below:

![FIGURE 13: SAVE REGISTERS WINDOW]

1. “Save Script” button:
   a. “All Registers” checkbox: Will save every register and bit value in sequential order by register address.
   b. “Delta from POR” checkbox: Will only save registers that have values different than the power on reset register values.
   c. “Specific register banks”: Allows the user to select desired registers to be saved.
   d. “All”: Selects all register checkbox selections
   e. “None”: Clears all register checkbox selections

2. “Load Script” button: Runs the entire setup file selected and writes all the registers at one time. Note that saving off an entire register map can take about 1 minute. If the Tx/Rx lights are green, the save is in progress.
FIGURE 14: NOTICE OF SCRIPT LOAD SUCCESS
5.2 Power Controls

Each of the supplies is pre-programmed with the nominal voltage value for each of the supplies. After the device is powered-up, the supply values can be changed by entering a new value in the “Power Rail Control” dialog box of each individual supply located in the “Power Controls” tab.

![Power Controls Tab Overview](image)

FIGURE 15: POWER CONTROLS TAB OVERVIEW

Enter a new value and press the Enter key. If an invalid number is written to one of the Set Voltage dialog boxes, the dialog box will flash red and set the closest valid value. The user can go back to this page as needed and enter new voltage settings into the set voltage dialog boxes to change the power supplies. The Power Rails display in the sidebar will update with the new measured voltages/currents after hitting the “Refresh” button.

The user can measure die temperature after calibrating the Monitor Buffer. See Section 5.4.2 Measure Die Temperature and Rainier EVM Calibration Guide for more details.

NOTE: DO NOT MEASURE TEMPERATURE BEFORE CALIBRATING MONITOR BUS
5.3 ADC/Relays

5.3.1 Measure Analog Mux (Diagnostic Mux)
On the left side of the “ADC/Relays” tab are options to Measure the Analog Mux using an ADC located on the Rainier EVM. Options for the Voltages that can be measured on the Internal Analog Mux are described in the Rainier data sheet.

5.3.2 EVM Relays
On the right side of the “ADC/Relays” tab are options to connect different channels to the passive loads (“Load_Star_High”) section of the EVM which includes load resistors and capacitors.
5.4 MON

5.4.1 MON/Diag GUI

The MON tab controls the monitor buffer of the device. There are a variety of diagnostic measurements that can be taken as described in the datasheet. The main function is to provide a simple interface to connect a channel monitor to its corresponding ADC and display the voltage on both the MON_# pin and the ADC/Relays. The Monitor may be used in bypass mode, or through a buffer. Using the buffer will require Gain and Offset calibrations for full accuracy. Refer to Rainier EVM Calibration Guide for instructions on how to calibrate the Monitor Buffer.

5.4.2 Measure Die Temperature

There is an option to measure the internal temperature of the Rainier device using the MON tab GUI and ADC voltage measurement via SEL_MON.
FIGURE 18: SEL_MON SET TO TJ_P AND TJ_N FOR TEMPERATURE MEASUREMENT

Measure temperature procedure:

1. Set monitor to point at TJ_Diag P and TJ_Diag N differentially through Mon_OE buffer
   1. Select “Apply to All Channels” button, select “Yes” to Continue.
2. Wait for Loading Status image to complete, select “OK” after successfully loading settings message. Then select Refresh to load measured voltages on ADCs.
3. Use measured voltages to calculate temperature using the following equation [accuracy within ± 5(°C)]

\[ x = \text{ADC voltage.} \]

\[ \text{Temperature (°C)} = (−675.42x^2 + 1956.1x − 322.66) \]

**NOTE:** User must calibrate Monitor buffer before using voltage measurements in this equation. See Rainier EVM Calibration Guide for more details.
5.5 Fuses

5.5.1 Serial Number Fuses
This section controls the DUT Serial Number Fuses. The device serial number is already burned in. Users may select the “Query Serial Number” button or select “DUT info” button in DUT status to read the SN.
The SN is based on a time stamp, once queried the SN can be decoded into [yyyy-mm-dd hour-min-sec]

5.5.2 Channel Calibration Fuses
This section controls channel fuse bits in CHANCAL tabs. Permanent values can be burned after calibration.
NOTE: Use caution, burned bits set permanent, unreversible values.

5.5.3 Individual Fuse Bits
This section controls individual bits located in CHANOTP registers. See Datasheet for more details.
6 Rainier EVM Loadboard Description

6.1 EVM Loadboard

Figure 20 illustrates a high-level view of the Rainier EVM loadboard. The loadboard contains the Rainier device as well as all the necessary surrounding circuitry to validate and characterize the device in the bench environment. It is important to note that the PROD0 jumper (J26) sets the part into Single Ended (jumped to VDDIO) or differential (jumped to GND mode. Also, the DGS jumper must be installed to ground unless it is truly used to sense a far-away ground. Minor edits have been performed on this board to fix PCB issues (blue wires). However, the schematic found with the delivery is functionally correct, only some components have been swapped out and an external 3V supply is required.
7 Basic Setups

Included with the EVM software are setups that can help the user program the Rainier product into some basic configurations to evaluate the part. Below are some of the setups included.

7.1 Driver/Comparator Modes

Figure 21 illustrates the recommended EVM configuration for driving real time data (Input signals from the DATA pins to the DUT pins, then back through the COMP pins). This option sources data to the DATA pins from a Pulse Generator. The ENA pins have internal pull-ups and are not connected but are programmed to an enable state. The DATA input term is set to 50Ω terminated to VSS for the test instrument. To see the part, go in and out of HiZ or VTT mode, external enable signals would be connected to the ENA SMA pins (ENA_#P and ENA_#N).

This setup can be used for driver modes, internal/external loopback, active load circuit, and comparator modes. Example device register scripts are included in the Rainier Device Guide.doc (See Driver_0-1.5VAsyncResult for more details). If comparator ONLY is desired, the signal generator should be connected to the DUT pins.

7.2 PMU

Figure 22 illustrates the recommended configuration for PMU FV or FI. An external SMU (source measurement unit) should be configured in the opposite mode as Rainier. See Table 3.
After the configuration is complete, use the PMU FV/VI levels GUI interface to change the Rainier output levels and configuration.

The setup can be used for various PMU functions. Example device register scripts are included in the Rainier Device Guide.doc (See DUT_ALL_FIMV.script and DUT_ALL_FVMI.script for more details). The monitor pins (MON_#) may also be observed through the GUI software on the ADC page.