Mystery- EVM First Time Setup

Rev A2: 12/06/19

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 Mystery 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 Mystery evaluation board and GUI (Graphical User Interface) allow the customer to demonstrate and evaluate the Mystery performance and functionality.

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

1.1   Unpacking - Mystery EVM Contents

Please check the contents of the Mystery 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 1: Mystery EVM Contents

Qty	Description
1 ea.	Mystery EVM System (Zedboard FPGA and Mystery Loadboard)
1 ea.	Mystery EVM Getting Started (this document)
1 ea.	AC Adapter Power Plug
1 ea.	Elevate Semiconductor User Interface Program Installation Flash Drive
1 ea.	Micro - USB Cable

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 Mystery 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 2: Power Supply Requirements

Module	Supply	Current Rating
Mystery EVM/FPGA	+12V	3 A

1.2.2   PC Controller

To use the Mystery EVM User Interface Program (UIP), a PC with the following configuration is required:

- Windows 2010
- USB Port (a USB cable is provided)

1.2.3   Lab Equipment

The below lab equipment can be used for evaluation of the Mystery product along with any other equipment the user deems useful.
- Voltage and/or Current Source
- DMM
- Oscilloscope
- Pulse Generator
- Resistor/Capacitor Loads
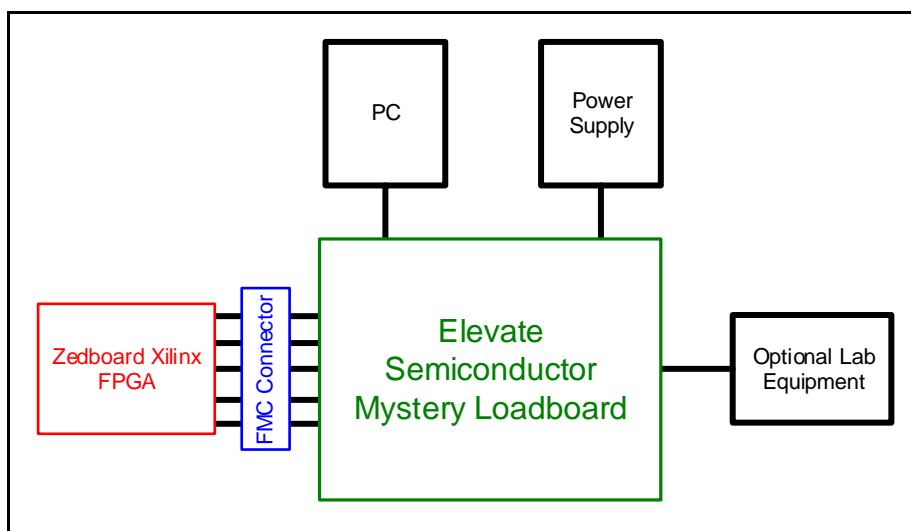
Figure 1: Mystery EVM Setup

1.3   Software Installation

The Mystery EVM includes self-installing software on the included 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.

Run the setup.exe located file located on the flash drive. If you have a prior version of the Mystery GUI, it may be necessary to un-install that version before installing the newer version.

The setup program will create or add files to two (2) directories. The user has the option to use the default values or browse to another directory. The two directories are shown below:
1.   A directory for the Mystery GUI program and support files.
2.   A directory for the National Instrument products that need to be installed.
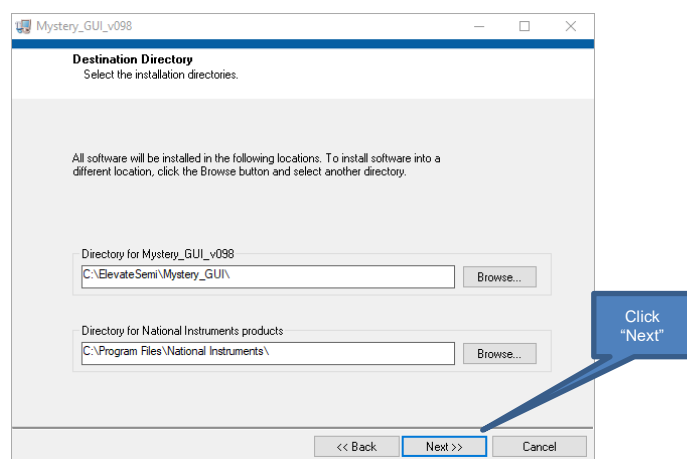
Figure 2: Setup Directories
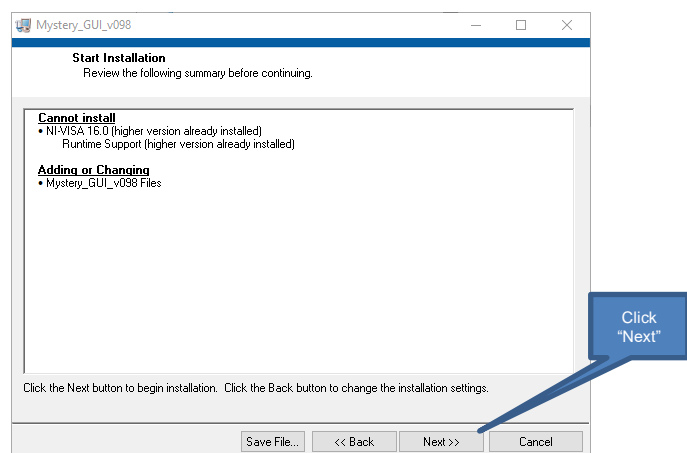
Figure 3: Start Installation
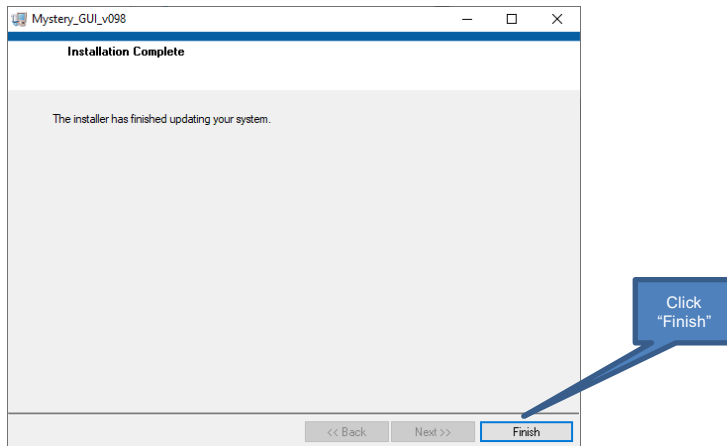
Figure 4: Installation Complete

The installation is now complete.

1.3.1 Reboot Your PC

After installing the Mystery EVM software, it may be required to re-boot your PC.

1.3.2 Launching the Elevate Semiconductor Program

The Mystery GUI software can be launched using the following 2 methods:
1. Start->Programs->Mystery_GUI_vXXX->Mystery_GUI
2. Navigate and run the installed executable: ../ElevateSemi/Mystery_GUI/Mystery_GUI_vXXX.exe

Note: The XXX above is used to designate the version of software currently running.

1.3.3 Software Un-Installation

The Elevate Semiconductor demonstration program may be un-installed using the **Add/Remove Program** from the Windows Control Panel.

2   Hardware

The Mystery EVM 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.

Note: Any external equipment providing digital signals into the Mystery device should only be enabled after the Mystery EVM is enabled and the Mystery device is powered on. The external equipment should also be disabled prior to disabling the Mystery EVM.
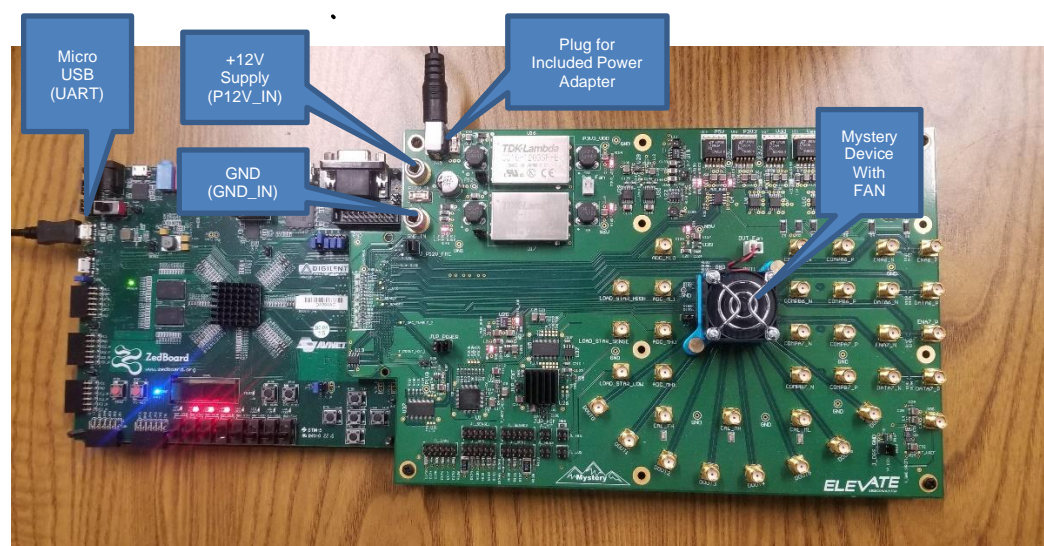
Figure 5: Overview of Evaluation Board

2.1   Caution

The Mystery Socket can get very hot even with the included fan running. The user should be cautious about handling the device or socket.

2.2   Power Supply Options

There are 2 power options for the Mystery EVM. ***Only 1 of the following options is required***:

1. Wall power adapter (Included with Evaluation System).
2. +12V External Supply.
    a. Connect power supplies cables (not provided) from your power supply to the Elevate Semiconductor EVM Mystery board's +12V (P12V_IN) and GND (GND_IN) banana connectors.
    b. Set external power supplies voltage and current limits. Refer to Table 2 above.
    c. Enable the supplies.

Refer to Figure 5 above for board connections.

2.3   Micro-USB

Connect the included micro-USB cable from your PC to the micro-USB port on the Mystery EVM as show in Figure 5. This micro USB connector is labeled ***UART*** on the FPGA Zedboard.

3   GUI Overview

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

Figure 6: GUI Overview

1. Upon startup of the software (with the 1 of the power options connected) the EVM board is powered on, but the Mystery device will not be powered up. The EVM board contains DC-DC convertors which supply power to the Mystery device. The DC-DC convertors connected to the Mystery device are indicated on th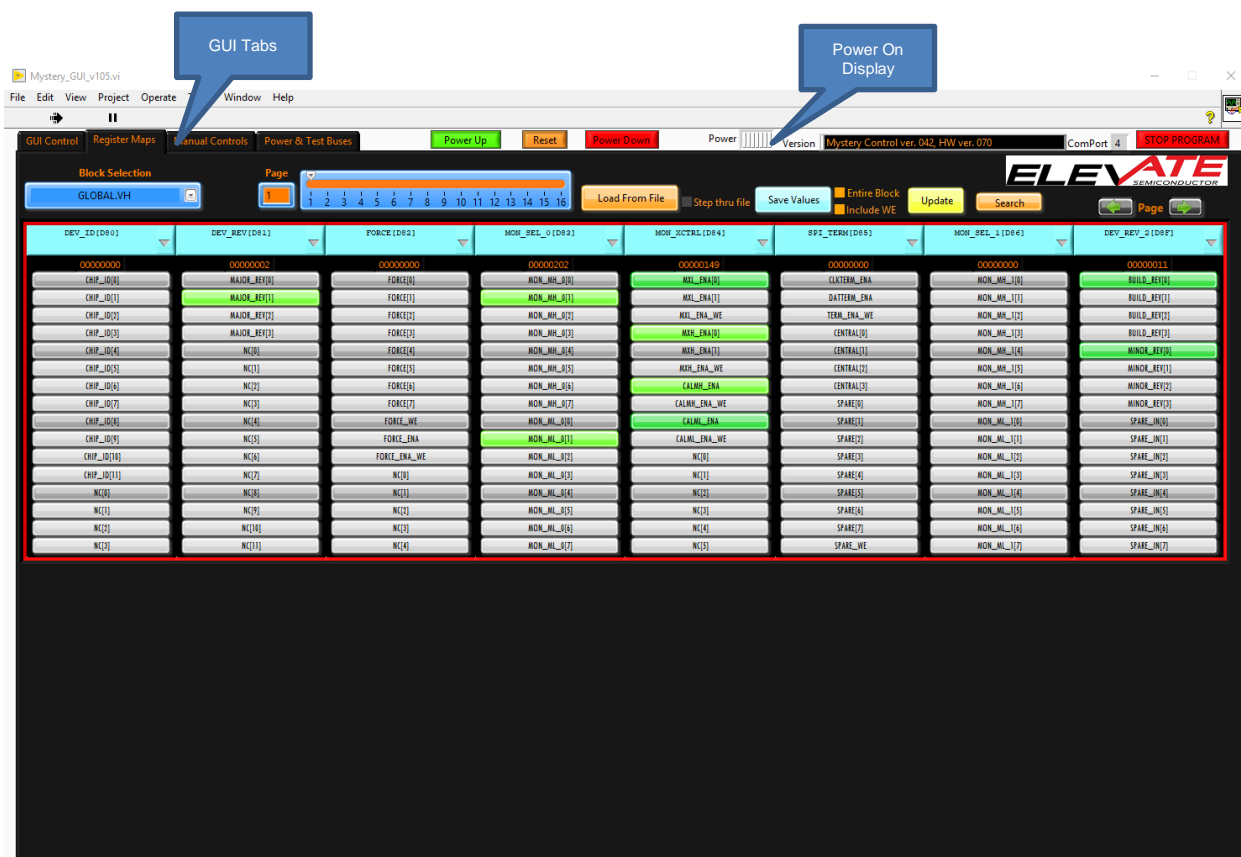e "Power On Display" as shown in Figure 6. At this time, the power output bars will be uncolored. After powering up the Mystery device, these bars will turn green. (The power up sequence is shown below in Section 4: Powering Up and Powering Down the Mystery Device).

2. The Elevate GUI software is broken up into 4 main tabs. Each of these tabs is briefly touched-on below and will be discussed in more depth later in this document.
    a. **GUI Control**: A graphical depiction of how the Mystery device is setup. There are setup sections for the Driver, Single Ended Comparator, Differential Comparator, PMU, and Active Load.
    b. **Register Maps**: The Mystery 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.
    c. **Manual Controls**: Generally used by advanced users only.
    d. **Power & Test Buses**: This page has options to set/measure power supply levels, measure the calibration/monitor pins, and measure the per channel temperature of the device.

3. Each of the GUI controls is a visual representation of a register in the Mystery device. Once the user moves a scroll bar, changes a pull down, etc., a register in the Mystery device will be programmed to match the corresponding GUI input.
   a. Internal Switches: Switches can be controlled by left-clicking on the switch. Once the switch position is selected, the updated connection will be shown on the GUI and written to the device.
   b. Measuring a voltage at DOUT: As soon as the mouse cursor is moved on the DC Value output box, the DOUT voltage will be measured by an onboard ADC and shown in the DC value box.

4   Powering Up and Powering Down the Mystery Device

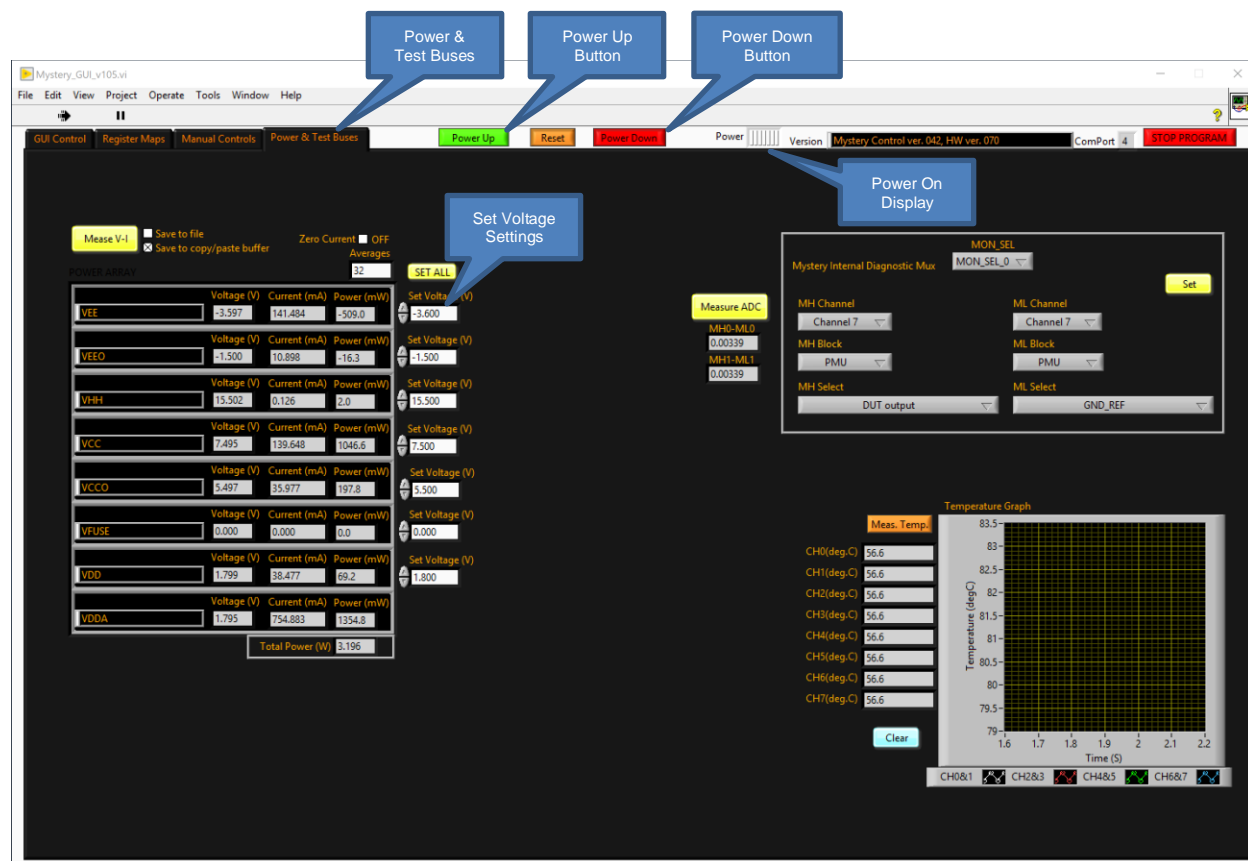This section is designed to show the user how to power up the Mystery Device.

Figure 7: Power & Test Buses

4.1   Powering Up the Mystery Device

1. After installing the Elevate GUI software as shown in the Software Installation Section, run the Mystery GUI software.
    Note: When running the Mystery GUI software, it is best if the board is powered up and connected via USB to the PC.
2. Powering up the Mystery device uses the "Power & Test Buses" tab of the Mystery GUI. The remainder of the "Power & Test Buses" page will be discussed later in this guide.
3. Powering up Mystery Device,
    a. Select the "Power & Test Buses" Tab.
    b. Each of the supplies is pre-programmed with the nominal voltage value for each of the supplies. Both before and after the device is powered-up, the supply values can be changed by entering a new value in the "Set Voltage (V)" dialog box of each individual supply. Enter a new value and Hit 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.
    c. After setting the desired voltage, press the "Power Up" button on the top of the page to enable the supplies.
    d. Figure 8 below open. The measured voltage, current, and power for each supply are displayed.
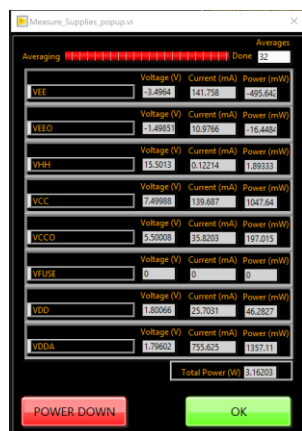
Figure 8: Supply Settings and Measurements

e. Hit the "OK" button to continue with the powering up the device or "POWER DOWN" to discontinue power-up.

f. After power up, the "Power On Display" indicator at the top of the GUI will change to green.

g. At this point, the device is now in a powered-up state and ready to start characterizing or testing.

h. 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.

4.2   Powering Down the Mystery Device

To power down the Mystery device, left-click the "Power Down" button as shown in Figure 7. The "Power On Display" indicator will change from green to no color. This will indicate Mystery no longer is powered up.

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. GUI Control.
2. Register Maps
3. Manual Controls
4. Power and Test buses.

5.1   GUI Control

As stated above, the "GUI Control" tab is a graphical depiction of how the Mystery device is setup. In this section, there are configuration pages for the Driver, Single Ended Comparator, Differential Comparator, PMU, and Active Load.
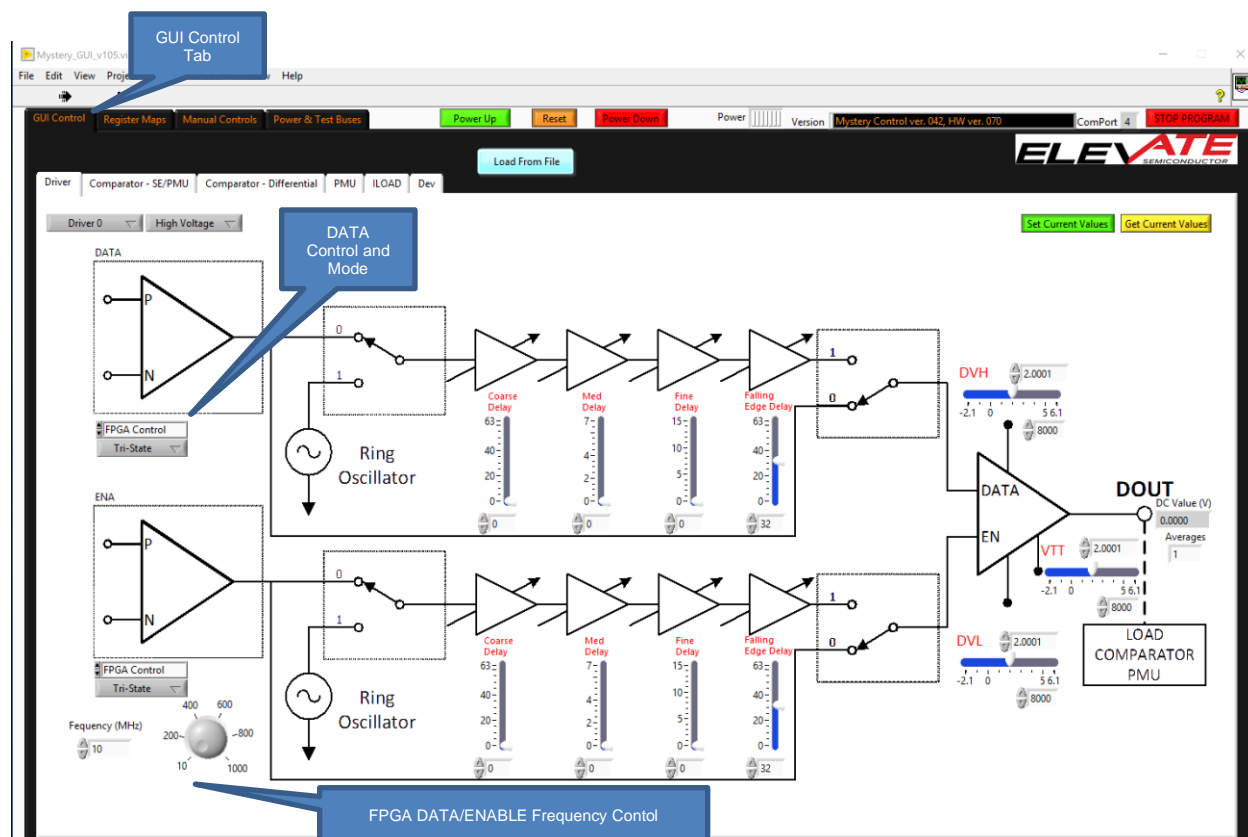
Figure 9: GUI Control – Driver

5.1.1   GUI Control - Driver

The Driver path includes the DATA/ENABLE pins, ring oscillator, deskews, driver levels, DOUT pins and options on how to control the state of these paths.

The logic level of the DATA/ENABLE paths can be controlled from the FPGA, internal Mystery Registers, or External Equipment. Depending on the Mystery channel chosen, there are different options on how to control each. A list of how each channel can be controlled is shown below in Table 3. The details can also be seen if Figure 21.

NOTE: The Mystery EVM hardware is setup in a way that not all channels can be accessed from the FPGA or SMA connectors (used to connect to external equipment). This is due to a limitation of the EVM board space and FPGA IO channels and not a limitation of the Mystery device.

Table 3: DATA/ENABLE Drive Options

DATA/ENABLE (Channel)	Register Control	FPGA Control	External Control via SMA connector
0, 1, 2, 3, 4	X		
4, 5	X	X	
6, 7	X		X

1. Register Control: The logic of these channels can only be controlled via the Mystery registers.
2. FPGA control: The pins controlled by the FPGA can be driven by a 50% duty clock input. The frequency of the pulse can be controlled by the Frequency input box or the Frequency knob.
3. External Control via SMA connector: An external device can be used to drive the input of these channels. Both the DATA and ENABLE pins can be driven by and external device.

5.1.2 GUI Control - Comparator – SE/PMU

This tab is used to control the Single Ended Comparator and the PMU Comparator.

Figure 10: GUI Control - Comparator SE/PMU
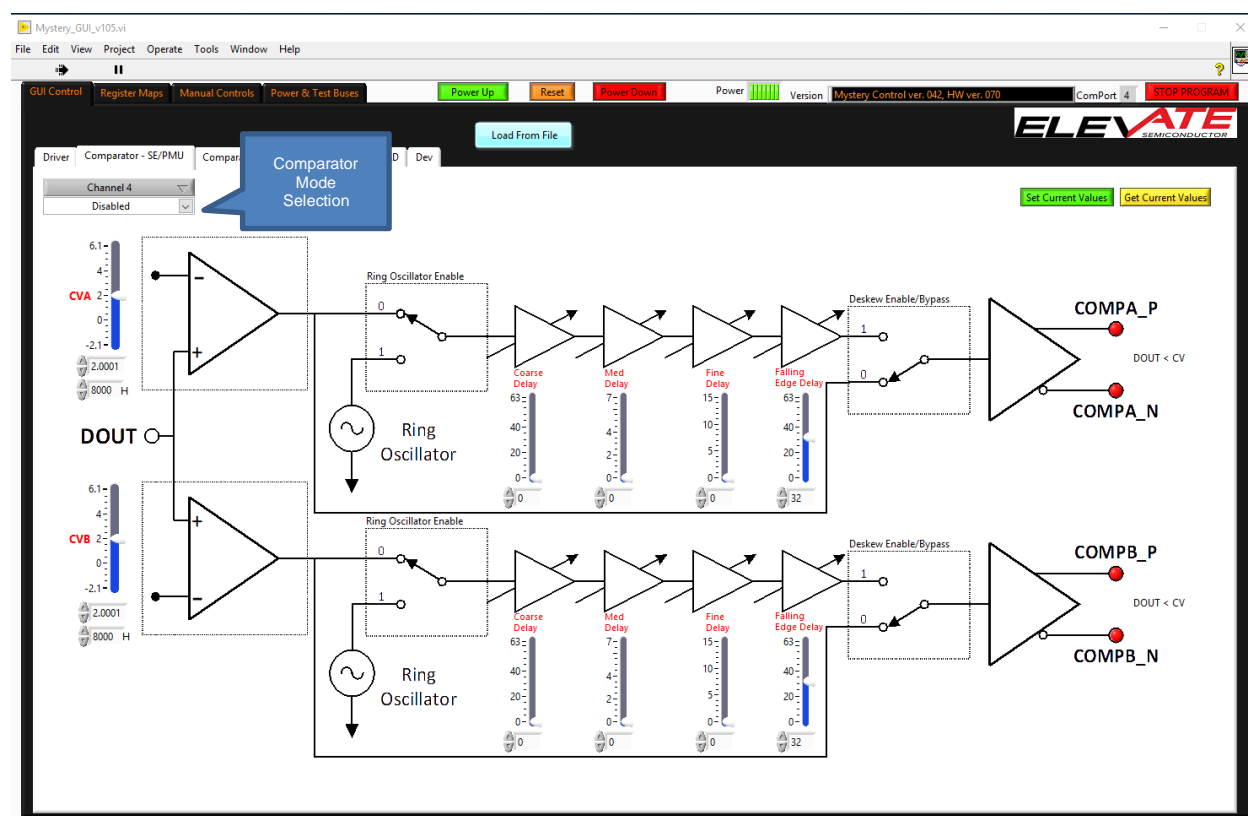
There are several comparator options to choose from:
1. Disabled
2. Single Ended Comparators
3. PMU Comparators MV (Measure Voltage)
4. PMU Comparators MI (Measure Current)
5. Differential Mode

As explained above, not all channels have external SMA access to both the COMPA/B pins and DOUT pins. For characterizing real time input signals on DOUT, these channels must be used.

5.1.3   GUI Control - Comparator – Differential

This tab is to control the Differential comparator mode. Comparator channels are chosen in pairs which are adjacent to each other.
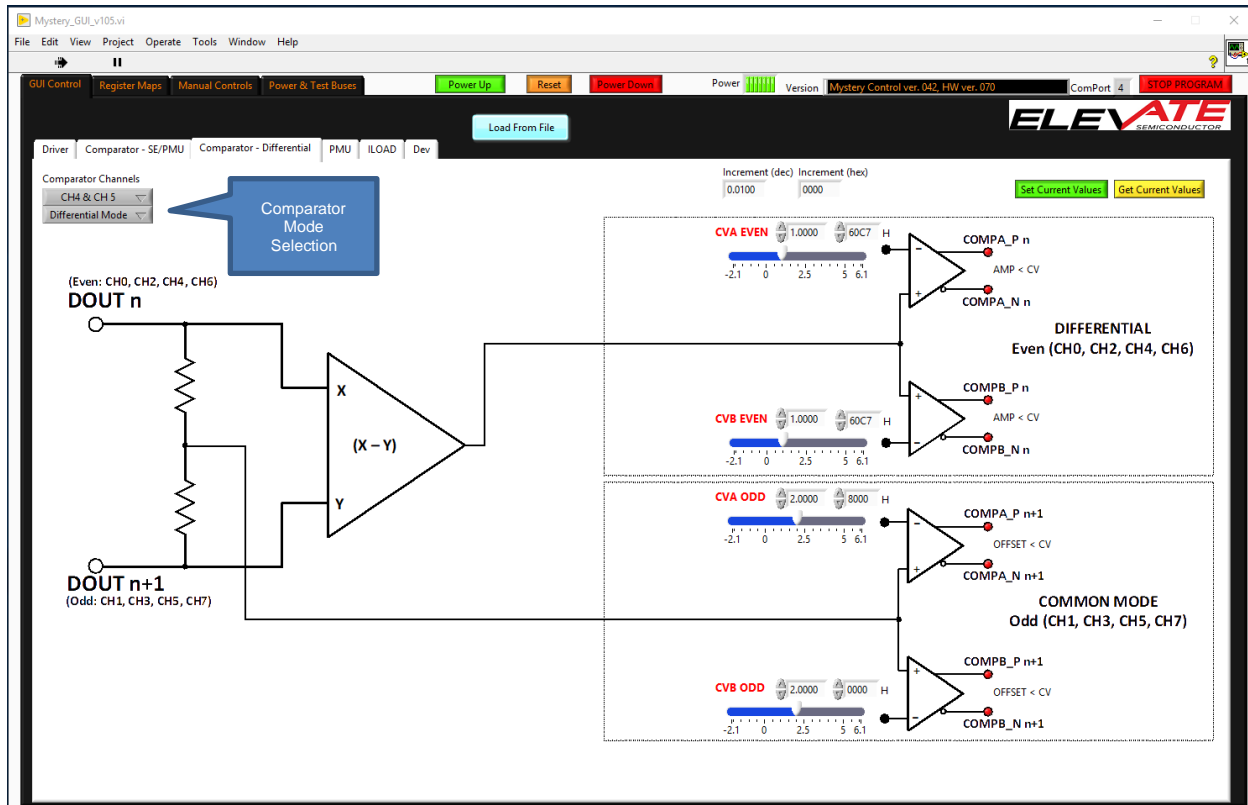
Figure 11: GUI Control - Comparator Differential

In the section there are only 2 mode to choose from:
1.   Disabled
2.   Differential Mode

5.1.4 GUI Control - PMU

This tab is to control the Per Pin Parametric Measurement Unit.

Figure 12: GUI Control – PMU
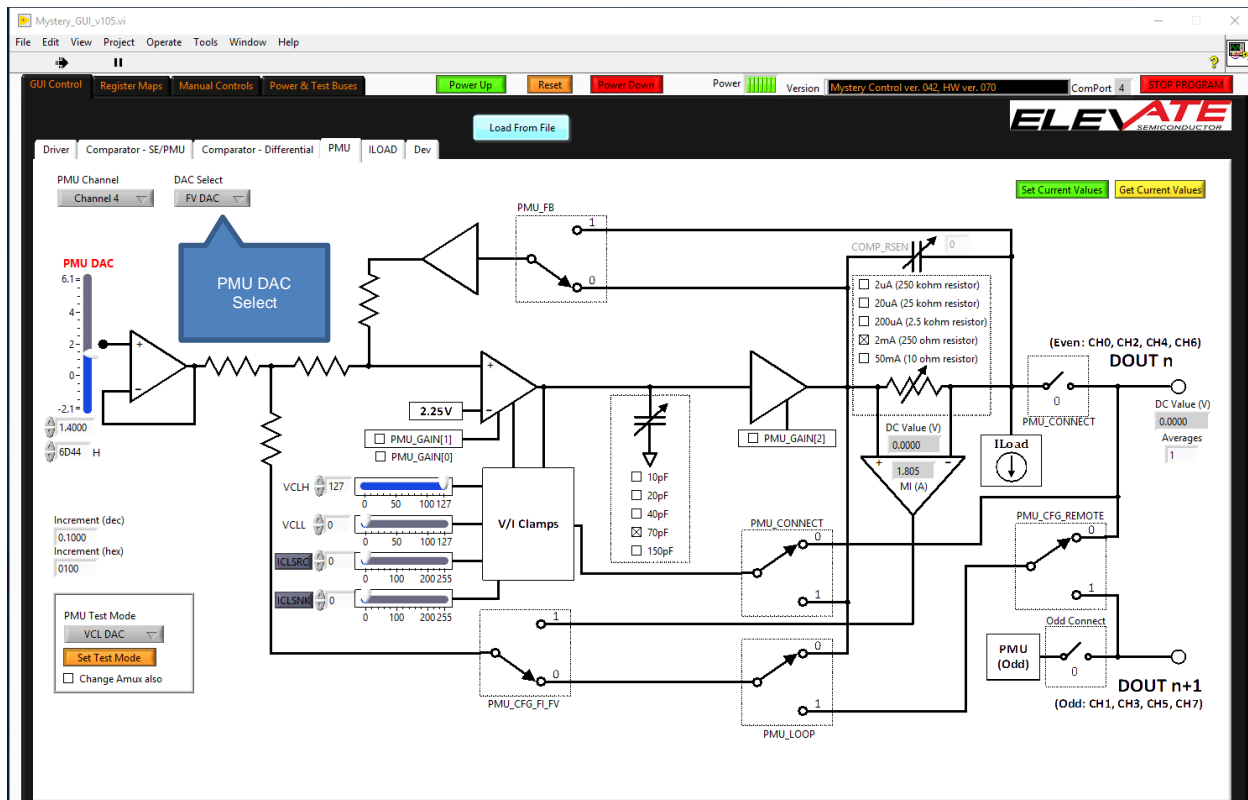
The PMU can be used in Force Voltage Mode or Force Current Mode. This is selected using the DAC select pull down menu. In Force Voltage Mode, there is also an option to connect remote sensing.

5.1.5 GUI Control - Iload

This tab is to control the Active Load.
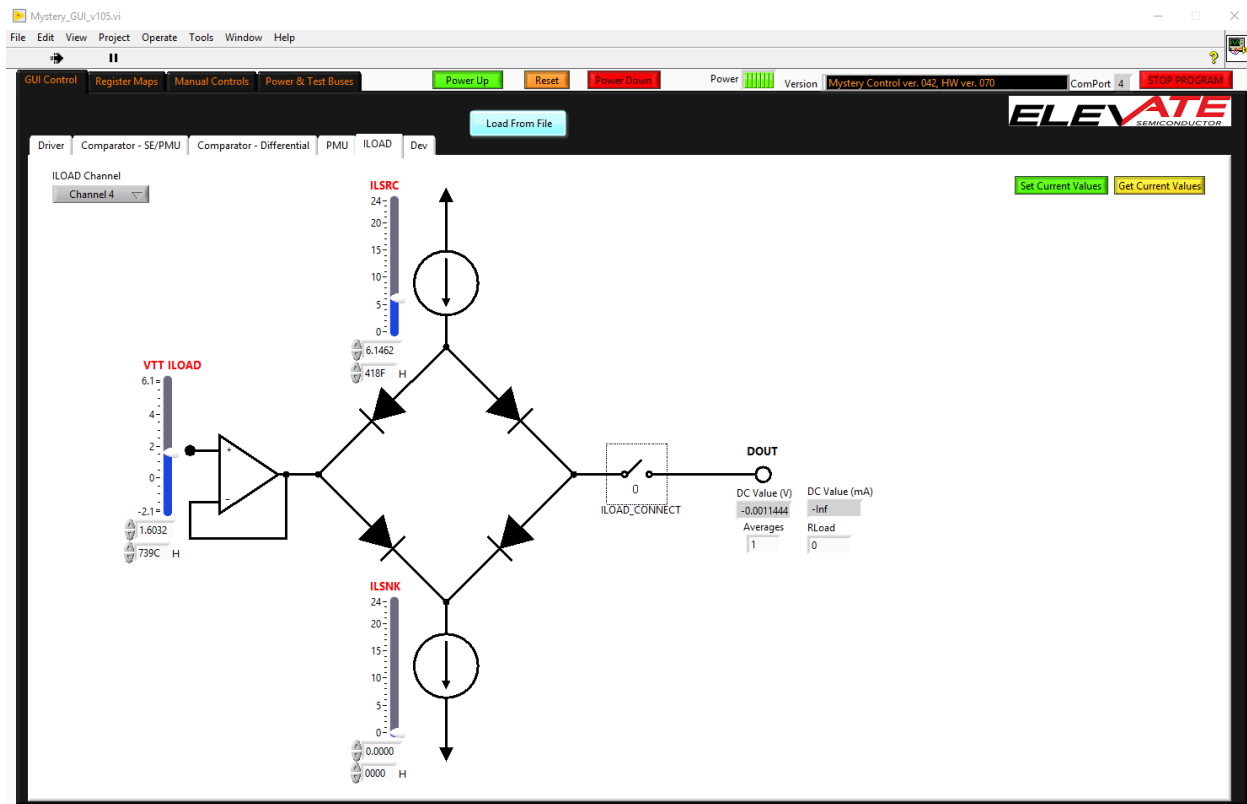
Figure 13: GUI Control - Iload

5.2   Register Maps

The Mystery device can also 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 Mystery device in a known configuration.
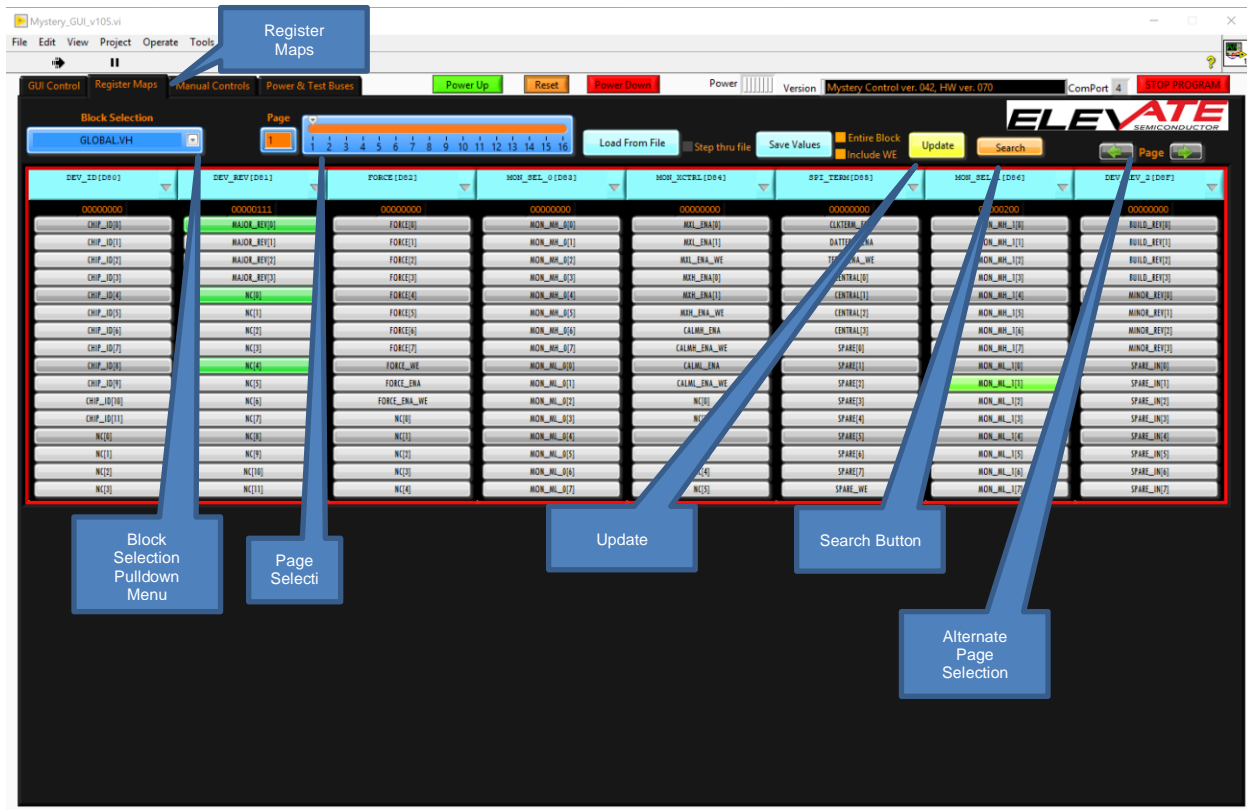

Figure 14: Register Maps Tab

Figure 15: Remote_3.VH Block selection

5.2.1 Manually selecting registers

1. The Register Maps GUI tab for the Mystery Device is broken into 3 sections. Blocks, Pages, and Registers. Blocks and pages are only terms used in the GUI and are not part of the device. Each of these concepts is explained below:
    a. Block Selection: Blocks are just a term for a grouping of registers that are related in the Mystery 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 Mystery are shown in the "Block Selection" pulldown menu.
        i. Per Chip Blocks: This selection affects the central section of the device. The GLOBAL.VH section of the register map is per-chip selection and is shown above. The GLOBAL.VH 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 REMOTE_0.VH will only affect channel 0. The Per-channel selections will be indicated by: "Block Name_" + "_" + "channel number" + ".VH".
        iii. All channel Blocks: Selecting this block will affect all channels when a register is written. For example, REMOTE_ALL.VH: The All-channel selections will be indicated by: "Block Name" + "_" + "ALL" + ".VH".
    b. Page: Each Block Selection is further broken into 16 pages. The 16 pages of each block can be selected using the slider bar as shown above. Each page holds up to 8 individual registers. Although each block can be broken into 16 pages, none of the blocks have enough registers to fill all 16 pages (8 registers a page). For this reason, only as many pages as needed are populated.
    c. Registers: The registers in Mystery are all 16-bit registers. As an example, Page 1 of the REMOTE_3.VH Register Block is shown in Figure 15 above.
        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 next to 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).
        iii. If a register bit is written as a '0', the register bit is gray. If the register bit is a '1', the register is Green.
        iv. Many registers have multiple smaller bit fields that can 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. Any bit fields whose WE bit is set to "0" during a write to that register will not be changed. Not all register have WE bits. The user should read the datasheet to get more information about these bits.
            1. Register Fields with no associated 'WE' bit: Left click to change the bit from a '0' to a '1' or from a '1' to a '0'. This will be shown when the register bit changes color.
            2. Register Fields with as associated 'WE' bit.
                a. 'Ctrl key' + left click bit name
                b. Release 'Ctrl key'
                c. Left click 'WE' bit associated with the bit name.
        v. The user should press the "Update" button after writing registers to make sure the correct registers were written.

5.2.2 Load and Save Register setups.

The "Save Values" and "Load From File" buttons can be used to save and load register settings. These 2 selections are discussed below:

1. "Save Values" button:
    a. "Entire Block" checkbox:

    i.   Selected: This will save the entire selected block when saving.
    ii. Not selected: Only the viewed page will be saved.
  b. "Include WE" checkbox:
    i.   Selected: Include the WE bits when saving.
    ii. Not selected: Will not include the WE bits when saving.
2. " Load From File" button:
    i.   Selected: Step through the selected setup file selected and will wait between each write command for the user to continue. Shown below in Figure 16 and Figure 17.
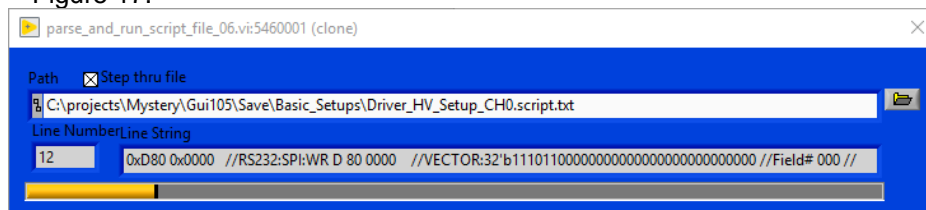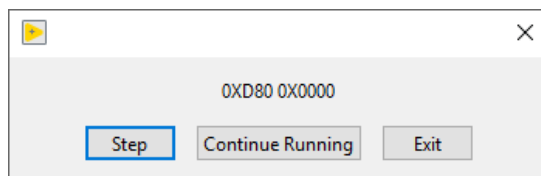

Figure 16: Load From File

Figure 17: Load from File Step/Continue

    ii. Not selected: Runs the entire setup file selected and writes all the registers at one time.

5.2.3 Search

The search button can be used to search for specific registers in the register map. To search for a register as seen in the datasheet, select the "Search" button. Type in part of the name of the register and hit 'return'. A dialog box will appear with the name of any found registers. To see a list of all found registers, hit the right-most triangle to show a pull-down menu. An example of searching for the ILOAD_EN is shown below.

1. Select the "Search" button on the "Register Maps" tab.

2. Type in the name of the register to search for.
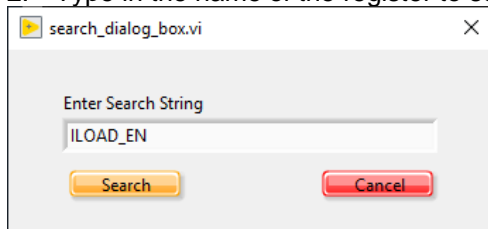

Figure 18: Search Dialog Box

3. Left click the triangle at the right to show all matching registers. Channel registers will show multiple times in the pull-down menu since they are located in every channel.
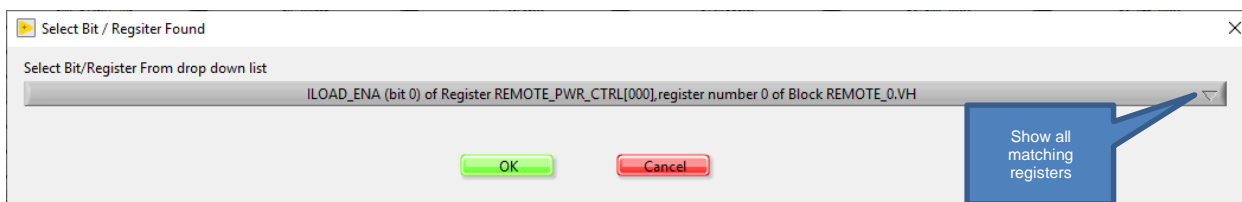
Figure 19: Select Register Dialog Box

4.   Hit the "OK" button to show the selected register. Or "Cancel" to cancel the search.

5.3   Power & Test Buses

The "Power & Test Buses" tab is used for a variety of tasks. These will be discussed below.
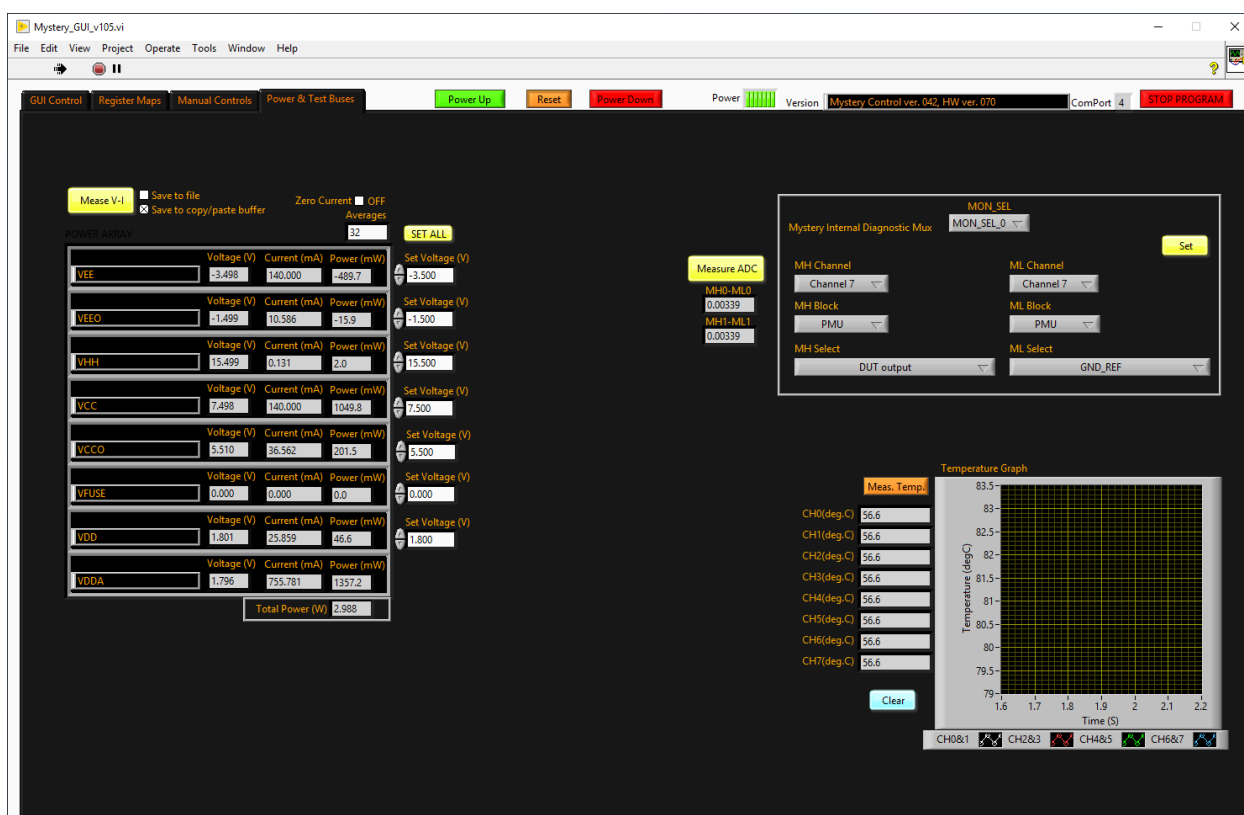

Figure 20: Power & Test Buses

5.3.1 Mystery device power up and measurement:

The left side of the tab has been mostly discussed in Section 4: "Powering up the Mystery Device".

After powering up the Mystery device, there are options to:
1.   Measure the Voltage and current: Use the "Meas V-I" button to measure the current value of the Mystery supplies.
2.   Save the Measure Voltage and Current to a file (.csv format). Select the "Save to File" checkbox before the "Meas V-I" button is selected and the values will be save to a file.

3. Measure current relative to previous measurements. Select the "Zero Current" checkbox before the "Meas V-I" button is selected and the Measure Current and Measure Voltage values will be measured relative to the current measured values.

5.3.2 Measure Analog Mux (Diagnostic Mux)

On the right side of the "Power and Test Buses" tab are options to Measure the Analog Mux using an ADC located on the Mystery EVM. Options for the Voltages that can be measured on the Internal Analog Mux are described in the Mystery datasheet.

5.3.3 Measure Die Temperature

There is also an option to measure the internal temperature of the Mystery device. The die temperature of Mystery is measured between adjacent channels. Channels 0&1, 2&3, 4&5, 6&7 share Internal temperature diodes. Therefore, the temperature measurements on adjacent channels will be the same.

6   Mystery EVM Loadboard Description

6.1   EVM Loadboard

Figure 21 below illustrates a high-level view of the Mystery EVM loadboard. The loadboard contains the Mystery device as well as all the necessary surrounding circuitry to validate and characterize the device in the bench environment.
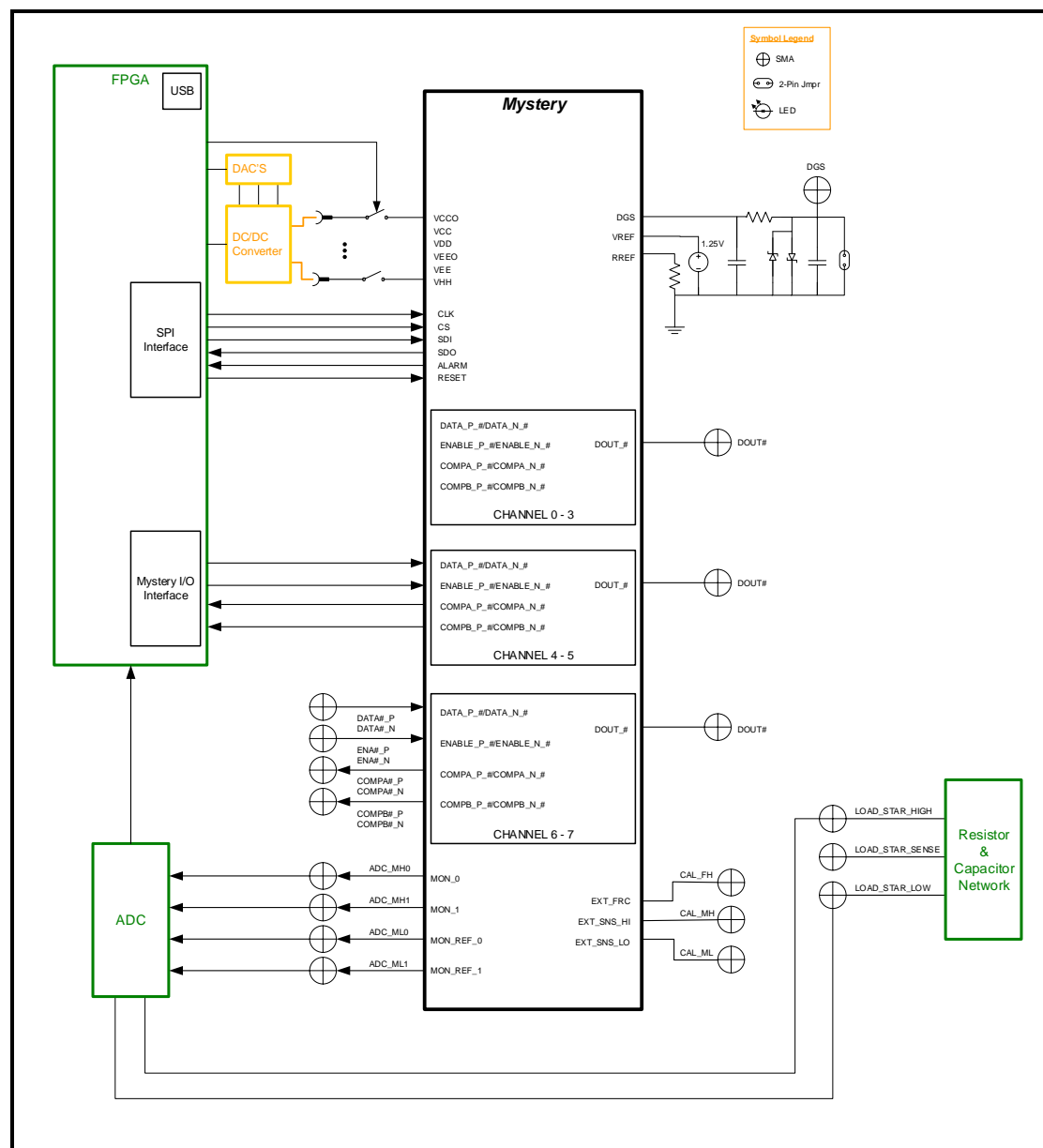

Figure 21: EVM HARDWARE

6.2   EVM Resistor/Capacitor Network

Figure 22 below illustrates the resistor/capacitor network located on the EVM board. To use this network, the channel to be tested needs to be connected via SMA cables from the DOUT_# SMA to the LOAD_STAR_HIGH SMA. If using REMOTE sense, the LOAD_STAR_SENSE SMA needs to also be connected to the adjacent DOUT_# channel. This network can optionally be connected to the onboard

ADC using the JL_HIF jumper using pins 1 and 2. Each of the resistors/capacitors is connected using the 2 pin jumper connectors.
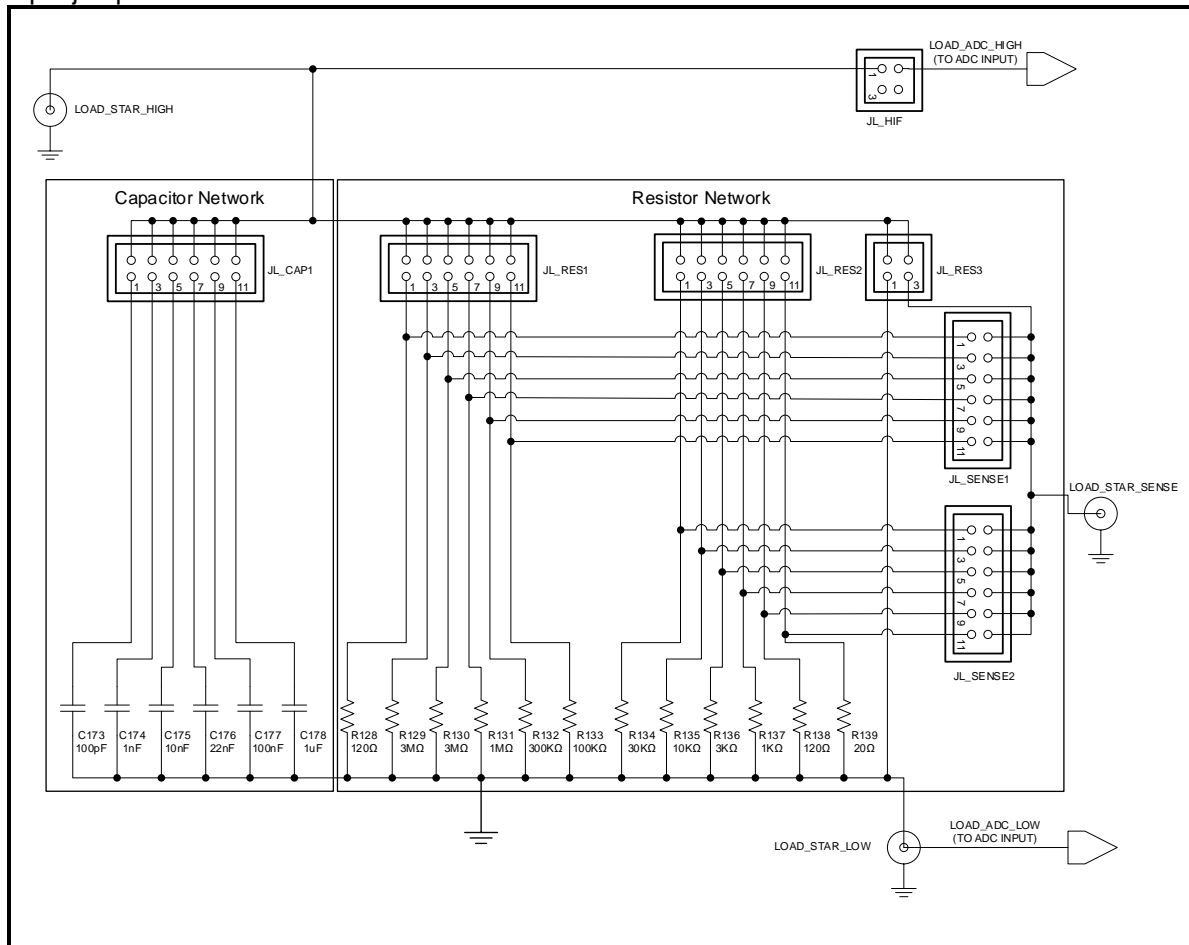
Figure 22: RESISTOR CAPACITOR NETWORK

7   Basic Setups

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

7.1   Real Time Data

Figure 23 below illustrates the recommended EVM configuration for driving real time data (Input signals from the DATA pins to the COMP pins). This option sources data to the DATAP and DATAN pins from a Pulse Generator. The ENA# is set to use Register Control which is programmed to the enable state ('1'). The DATA#_P/DATA#_N input term is set to 100 Ω. This option works best with a differential pulse generator with at least a 200mV swing.

Note: Channels 6 and 7 are the only 2 channels on the EVM board which can be driven by external DATA/ENABLE signals using the DATA#_P/DATA#_N SMA connectors. Channel 6 and 7 are also the only 2 channels with COMPA#_P/COMPB#_N SMA connectors.

If the user only has a single ended pulse generator, then the DATA#_N can be tied to 1.0V (Vterm); the Vterm must be able to handle any current flow required for proper termination. Set the pulse generator to a 0.0V to 3.0V swing. The DATA# input term should be set to 50Ω.
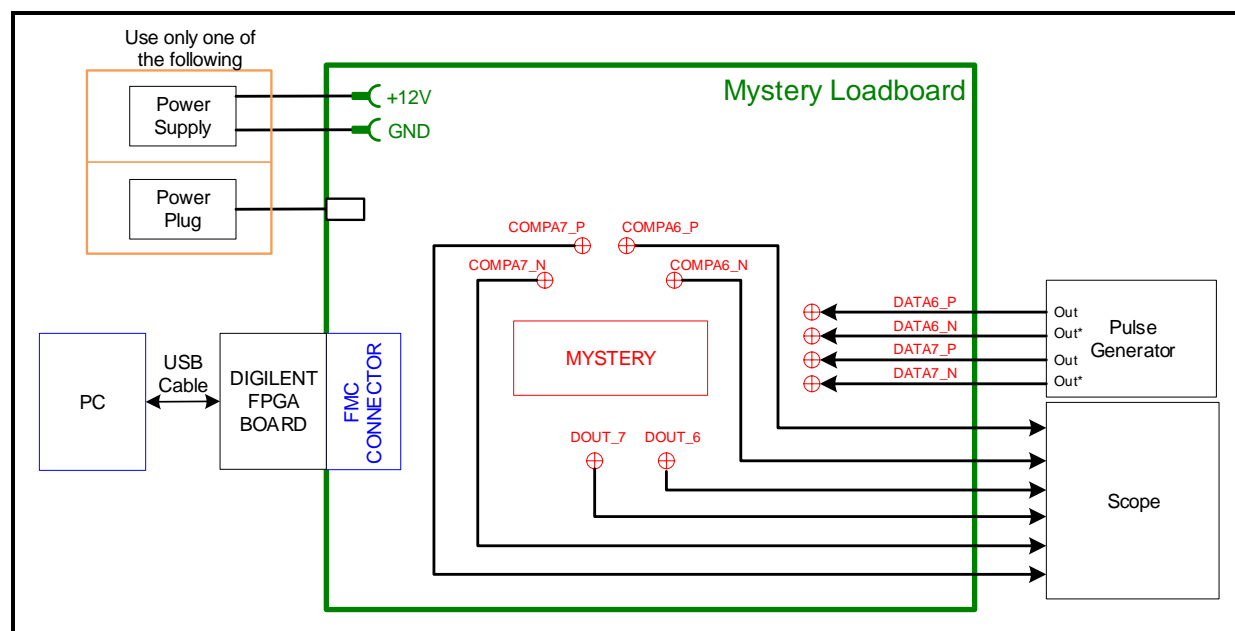

Figure 23: Real Time Data Setup

The following setups can be selected using the "Load From File" button:

1. High Speed with deskews – TBD
2. High Speed without deskews - TBD
3. High Voltage with deskews - TBD
4. High Voltage without deskews - TBD

7.2 PMU

Figure 24 illustrates the recommended configuration for PMU FV or FI. An external SMU (source measurement unit) should be configured in the opposite mode as Mystery. See below:

Table 4: Mystery PMU - SMU Configuration

Mystery Configuration	SMU Configuration
FVMI	FIMV
FIMV	FVMI

After the configuration is complete, use the PMU FV/VI levels GUI interface to change the Mystery output levels and configuration.

If a SMU is not available, the user can connect to the onboard capacitor/resistor network. An SMA cable is required to connect the DOUT_# pin to the LOAD_STAR_HIGH SMA.

Note: The Comparator output pins can only be used on channels 6 and 7 as they are the only comparator pins to be brought out to SMA connectors. The Comparator pins can be used to compare measure voltage levels and measure current levels against set comparator levels.
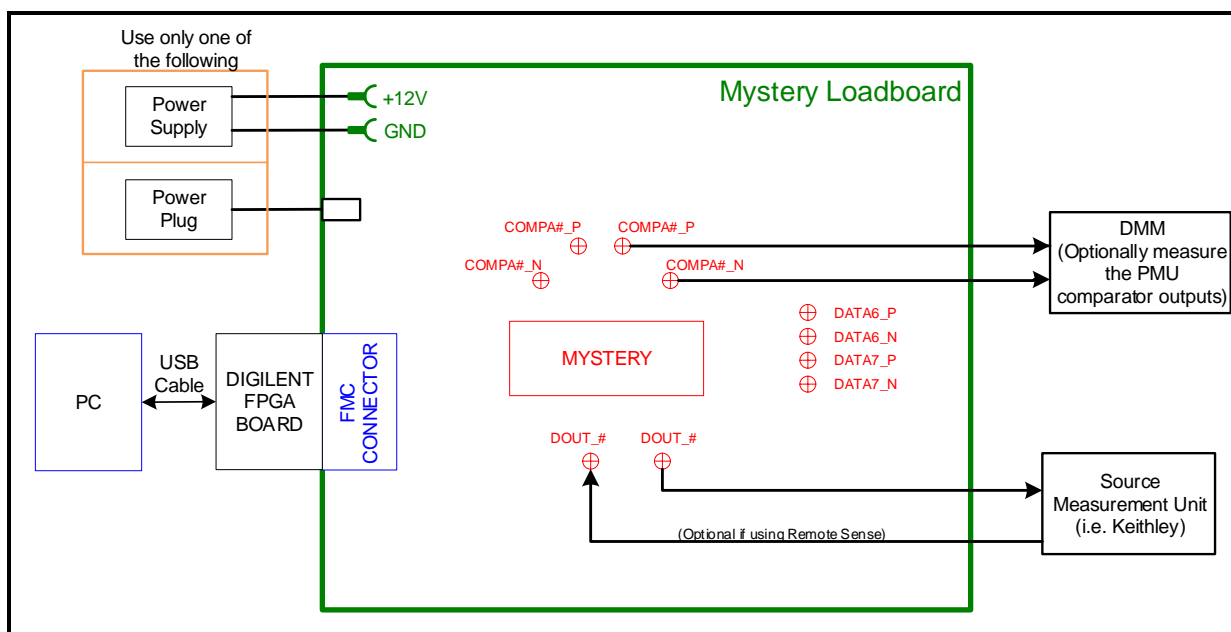

Figure 24: PMU Setup

The following setups can be selected using the "Load From File" button:
1. FV – TBD
2. FV with remote sense - TBD

8   Document Revision History

Revision	Date	Description
A1	11/11/2019	Initial Release
A2	12/06/2019	Added power down to section 4