UCD Sequencer Studio User's Guide - Rev. A

Table of Contents

1. Introduction

This guide is intended to demonstrate how to use the UCD Power Sequencer Studio to intuitively configure, control, and monitor system operating parameters on a supported UCD91xxx device. Supported devices are listed below in Section 2.

The UCD Power Sequencer Studio communicates with the UCD91xxx device via an I2C electrical interface using the PMBus™ command protocol. Users will be able to interact with the graphical user interface (GUI) provided to both send these commands to the device and also recieve data on the device status, displayed on the GUI, by following the steps below.

The supported general PMBus commands are outlined in the PMBus specification, specifically, the *PMBus Power System Management Protocol Specification Part II – Command Language*, Revision 1.2. The specification is published by the Power Management Bus Implementers Forum and is available here. Manufacturer specific status PMBus commands are also supported. A comprehensive list of these commands can be found in the UCD91xxx Sequencer and System Health Controller PMBus Command Reference User's Guide (pmbus_users_guide.pdf) located in this installer.

2. Prerequisites

The user is expected to have downloaded the following:

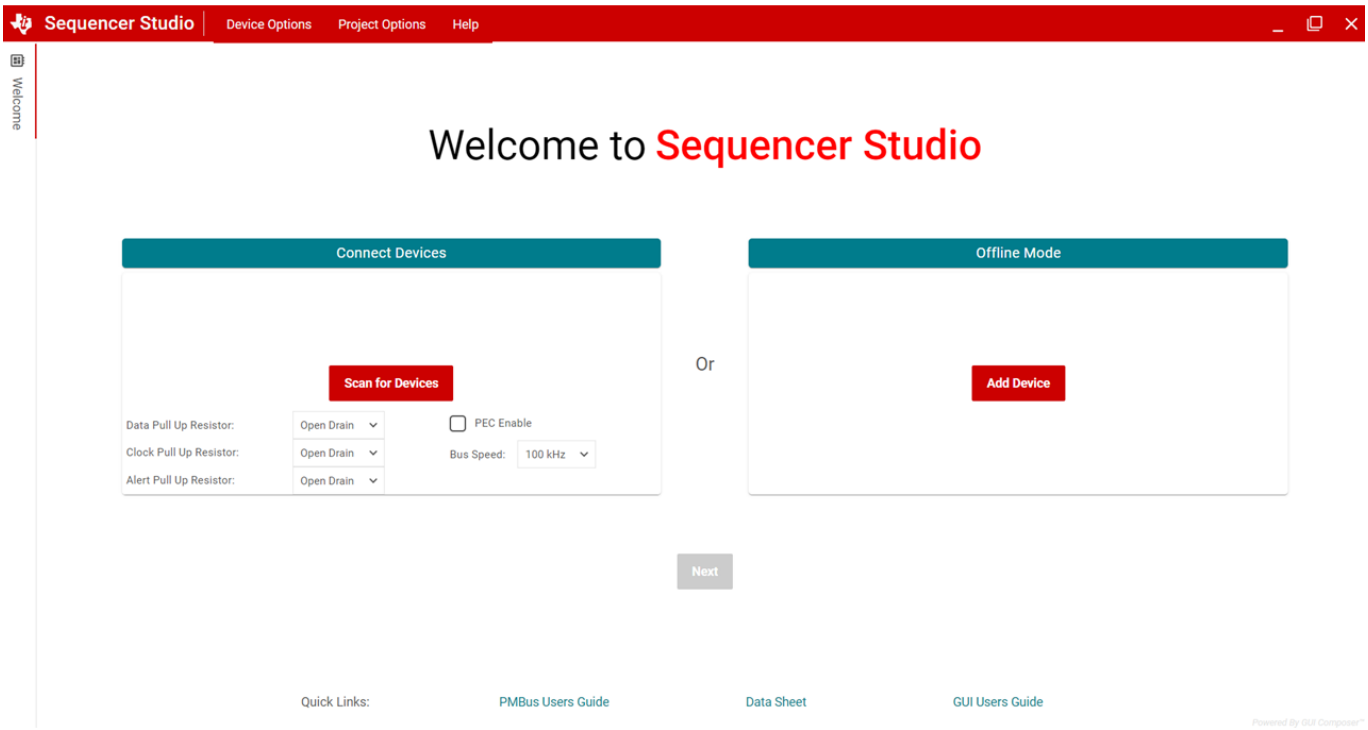
- UCD Power Sequencer Studio Installer found at support device's product page (linked below)

The user is expected to have the following hardware:

- Supported UCD91xxx EVM (currently supported options listed):
  - UCD91160
  - UCD91320
- USB-to-GPIO2 interface module

3. Welcome

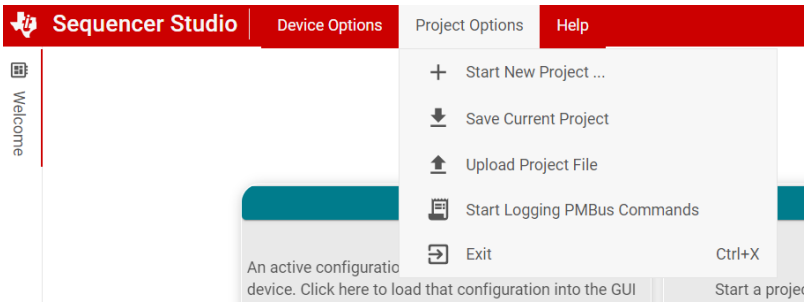
The welcome screen provides options for offline mode and online mode, as well as device and project options.



3.1 Project options

Project options are available at any time within the GUI.

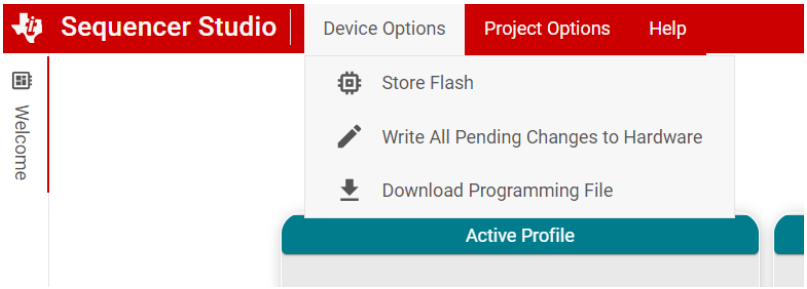
- **Start New Project**: use to start a new project with a new configuration.
- **Save Current Project**: use to save project file as a .syscfg file, which can be uploaded into the GUI as needed to upload a saved configuration.
- **Upload Project File**: use to upload a project file in .syscfg format from a previously saved configuration.
- **Start Logging PMBus Commands**: use to log PMBus commands. The first time this is clicked is when the PMBus commands start being logged. When this option is clicked again, a popup window will appear to save a .csv of all commands written to and received from device.



3.2 Device options

Device options are available at any time within the GUI.

- **Store Flash**: use to store the current configuration to the device's flash memory.
- **Write All Configurations to Hardware**: use to write all current configurations to hardware at once.
- **Download Programming File**: use to download a .csv file of the PMBus register map

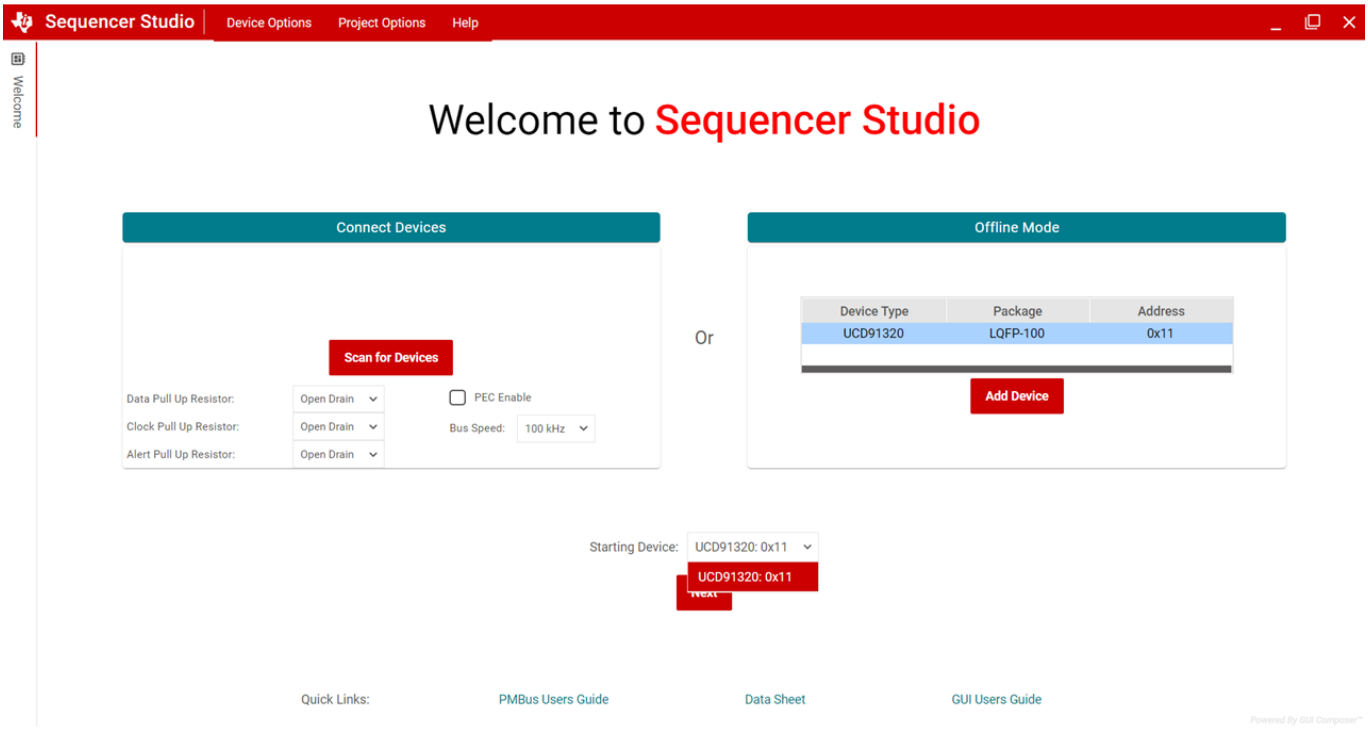


3.3 Quick Links:

View documentation by clicking on the corresponding link, found at the bottom of the Welcome screen.

3.4 Offline mode

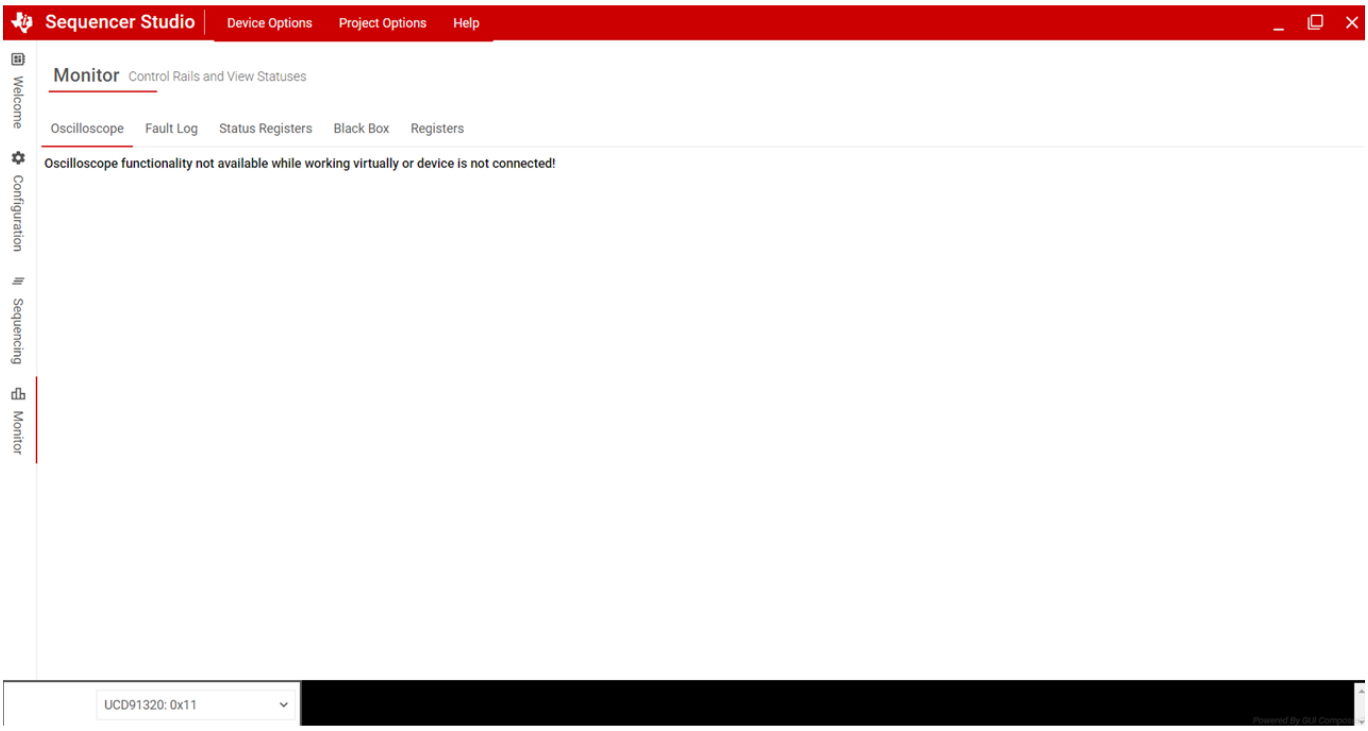
Offline mode can be used to create a configuration when a device is not connected. To use offline mode, click the `Add Device` button.



A device will appear in the grid. You can click on the grid to select device type, which will appear in the dropdown selection under Starting Device as well.

Once you have selected which device to use, click `Next`.

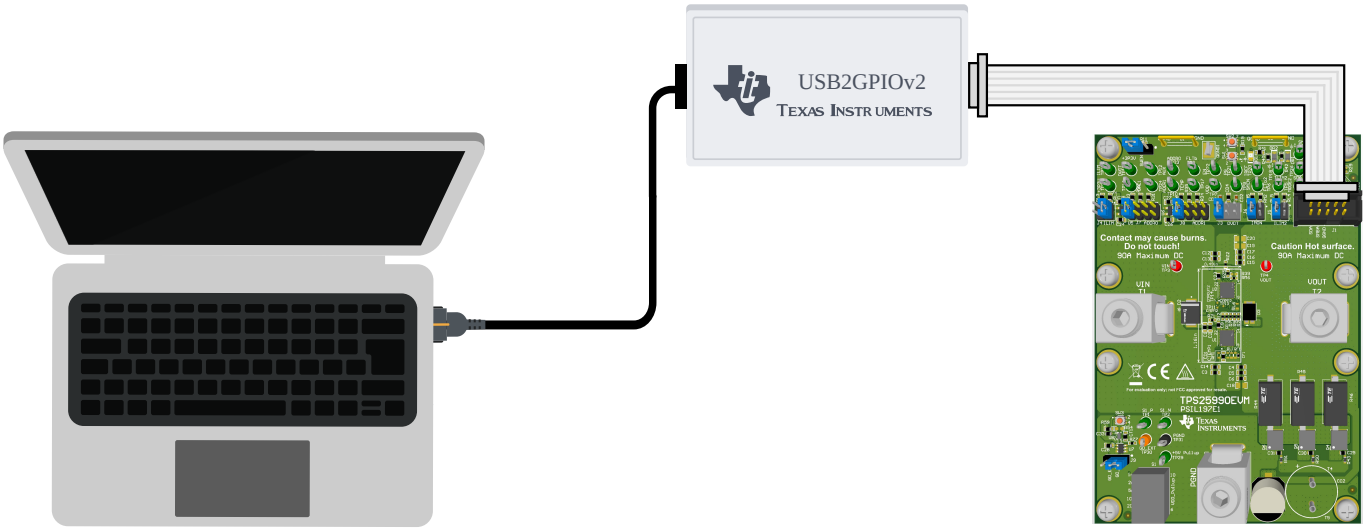
Note, some configurations that require the device to be connected will not be available in offline mode. An example warning message is shown below.



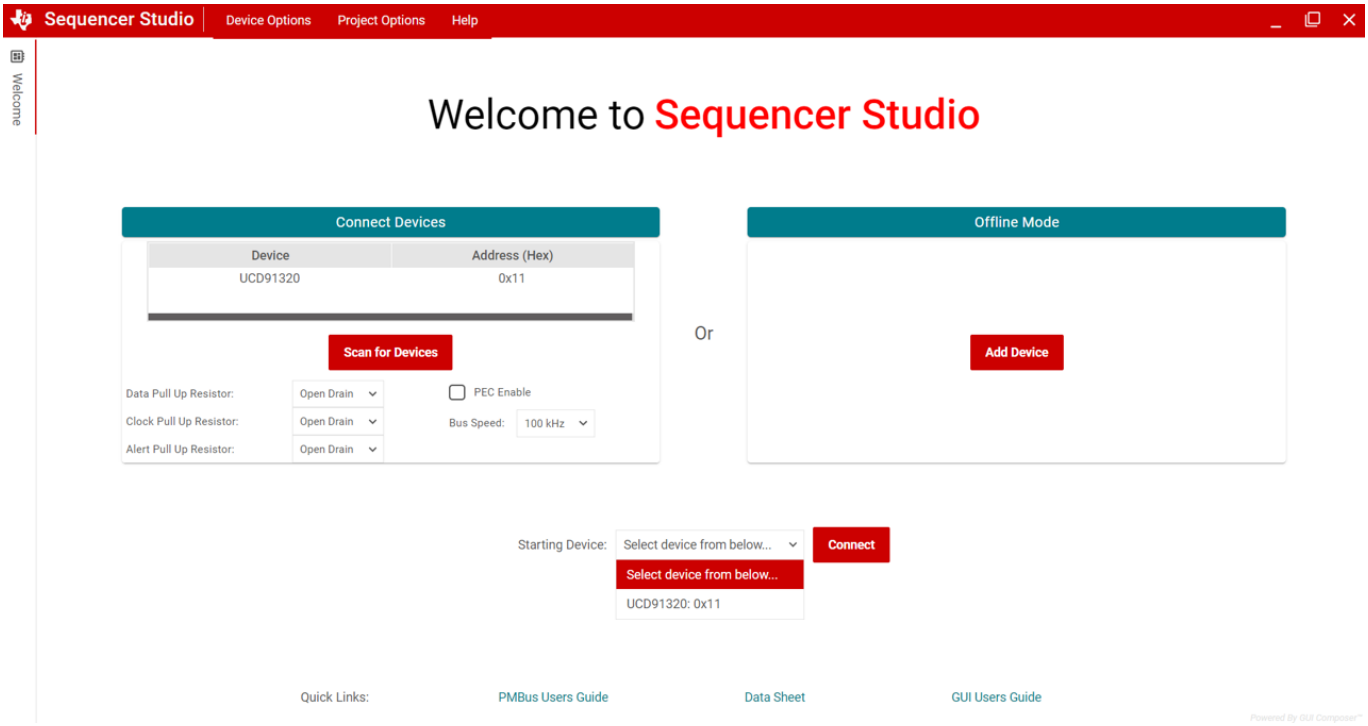
3.5 Online mode

Use online mode to actively configure and interface with a connected supported UCD91xxx device.

Connect EVM or board to a power source (computer) via the USB-to-GPIO2 interface module as shown in the image below.



Click `Scan for device` on the opening screen. If a device is connected, it will appear in the grid.



Use dropdowns under Connect Devices to configure properties of USB-to-GPIO2, PEC enable, and I2C bus speed.

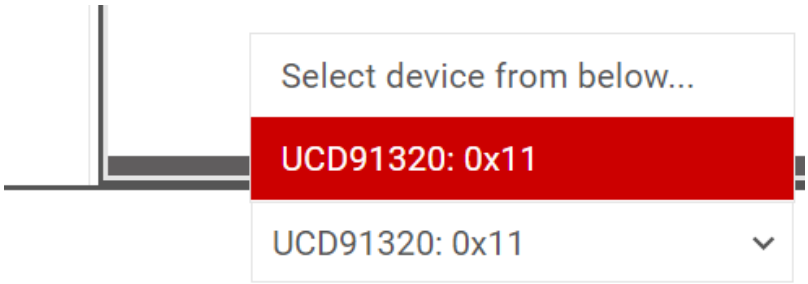
Once these properties are configured, select the device from the dropdown and click `Connect`. If there is an active configuration on the device, the GUI will read it during this time as well.

Once the device is connected, the `Next` button will turn red. Click this to go to the next screen.

Multi-device/cascading configuration:

- If configuring cascading/multiple devices, use one USB-to-GPIO2 connected to EVM #1 and connect EVM #1's PMBus clock and data pins to EVM #2's PMBus clock and data pins, and power EVM #2 with a Micro-USB cable

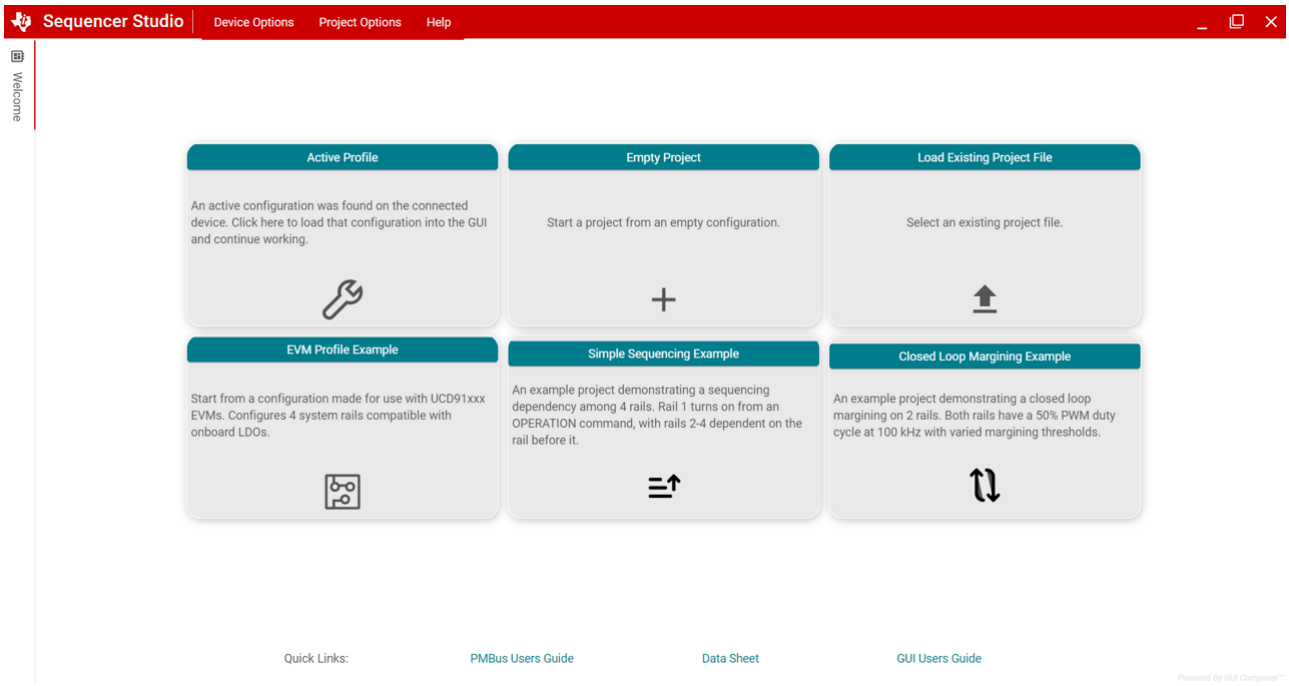
- If configuring multiple devices, when clicking `Scan for device`, multiple devices will appear in the Connected Devices table. Use the dropdown next to the `Connect` button to select which device to configure.
- If using multi-device/cascading configuration, device #2 will need to have a difference device address than device #1
- To switch between devices, use the dropdown at the bottom left of the screen



3.6 Select project

- Choose between multiple types of projects:
    - **Active profile** (will only appear if using online mode *abd* device has pre-existing configuration): if the device has an active configuration, select this to read the configuration into the GUI and pick up where you left off
    - **Empty project**: empty configuration
    - **Load existing project file**: select an existing .syscfg project file from your file system. This file must have been previously generated from the UCD Power Sequencer Studio GUI.
    - **Quickstart projects**:
        - **EVM profile example**: configure 4 system rails compatible with LDOs onboard EVM
        - **Simple sequencing example**: configure sequencing dependencies among 4 rails. Rail 1 turns on via OPERATION command, Rails 2-4 are dependent on the rail before it
        - **Closed loop margining example**: configure closed loop margining on 2 rails

  Note: if two or more devices detected when scanning for devices, all quickstart examples will be greyed out. To start with one of these examples, each device will need to be configured separately, i.e. only one device can be plugged in at once.



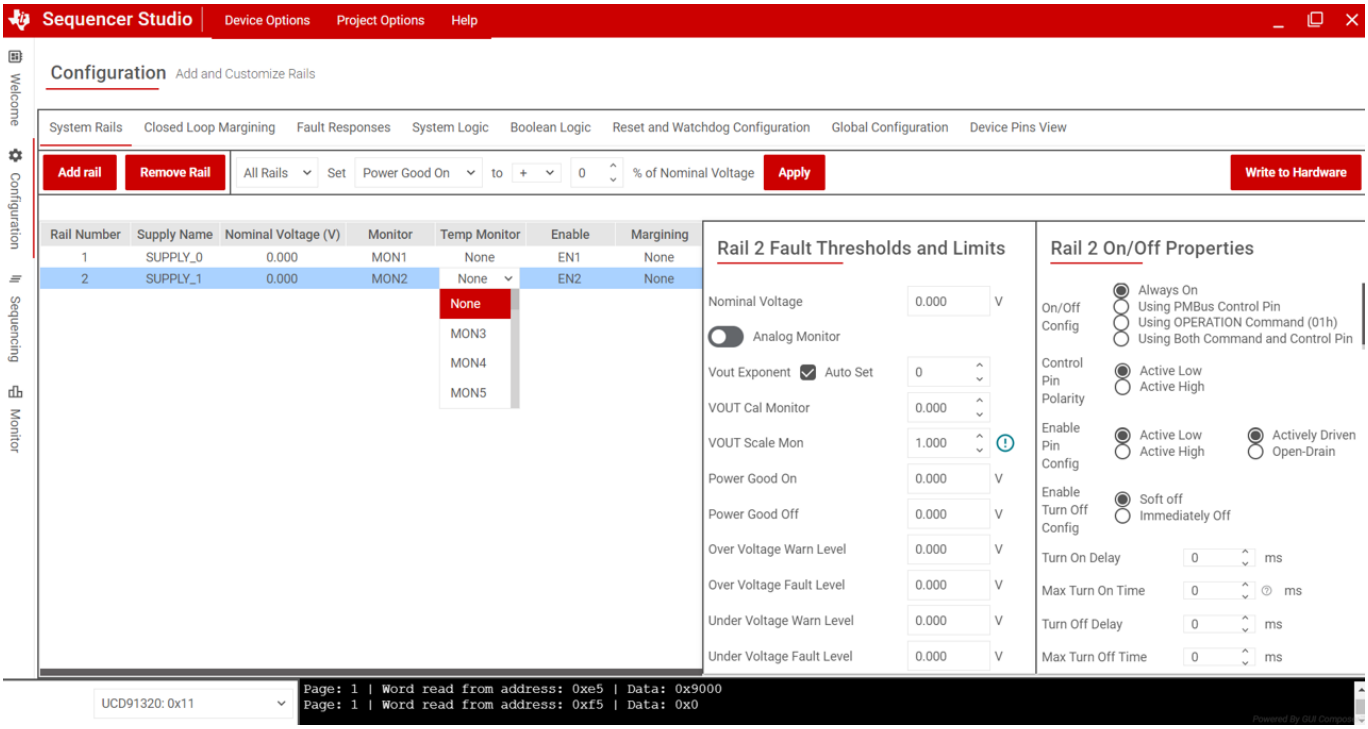
4. Configuration

4.1 System Rails

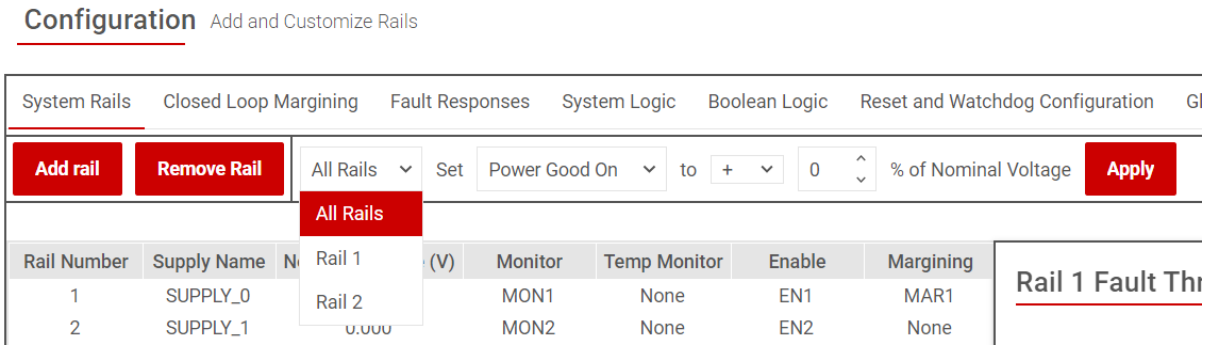
Add/remove rails

- Use red `Add rail` button to add rails. Maximum number of rails will be dependent on device.
- Use `Remove rail` button to remove rails.

View **rail properties** and edit associated pins by (1) clicking on cell and (2) using the dropdown options.

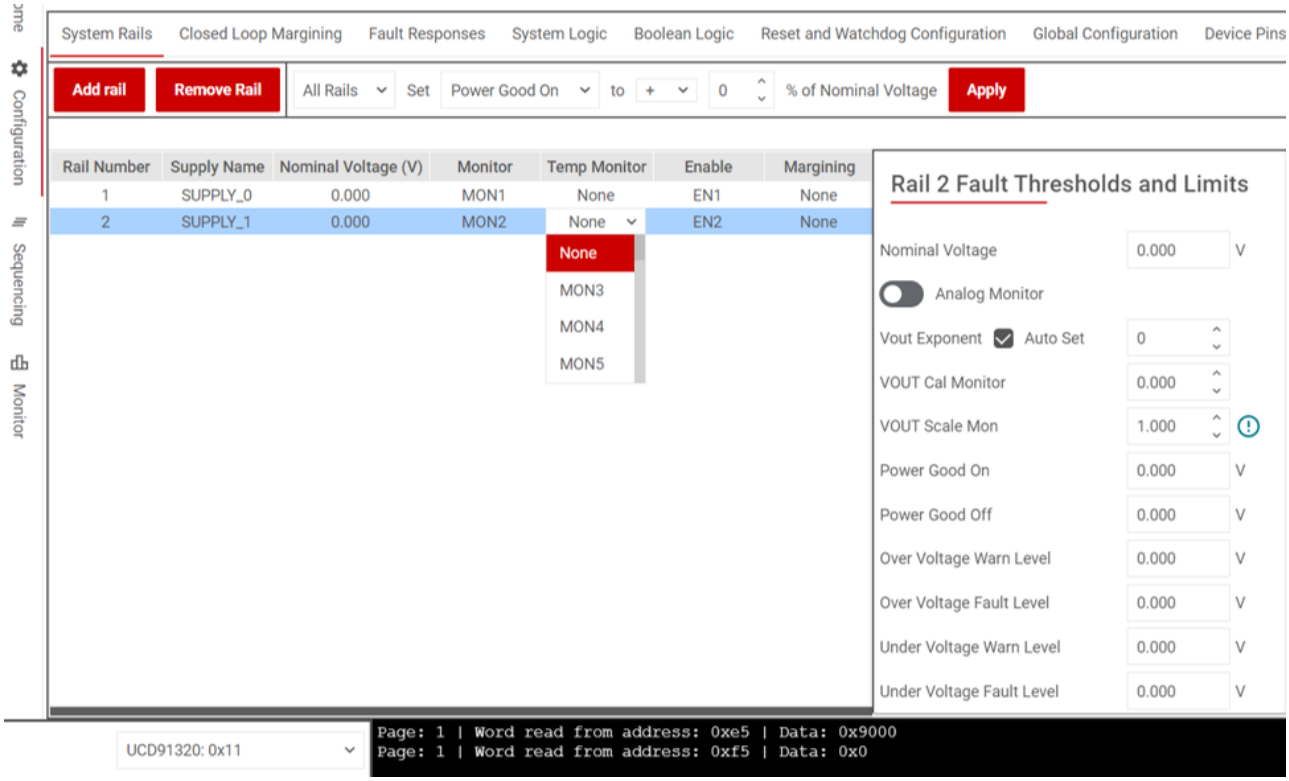


Quick set fault thresholds/limits Select rail, threshold to set, and percentage of nominal voltage for the threshold. Click red `Apply` button to apply to selected rail.



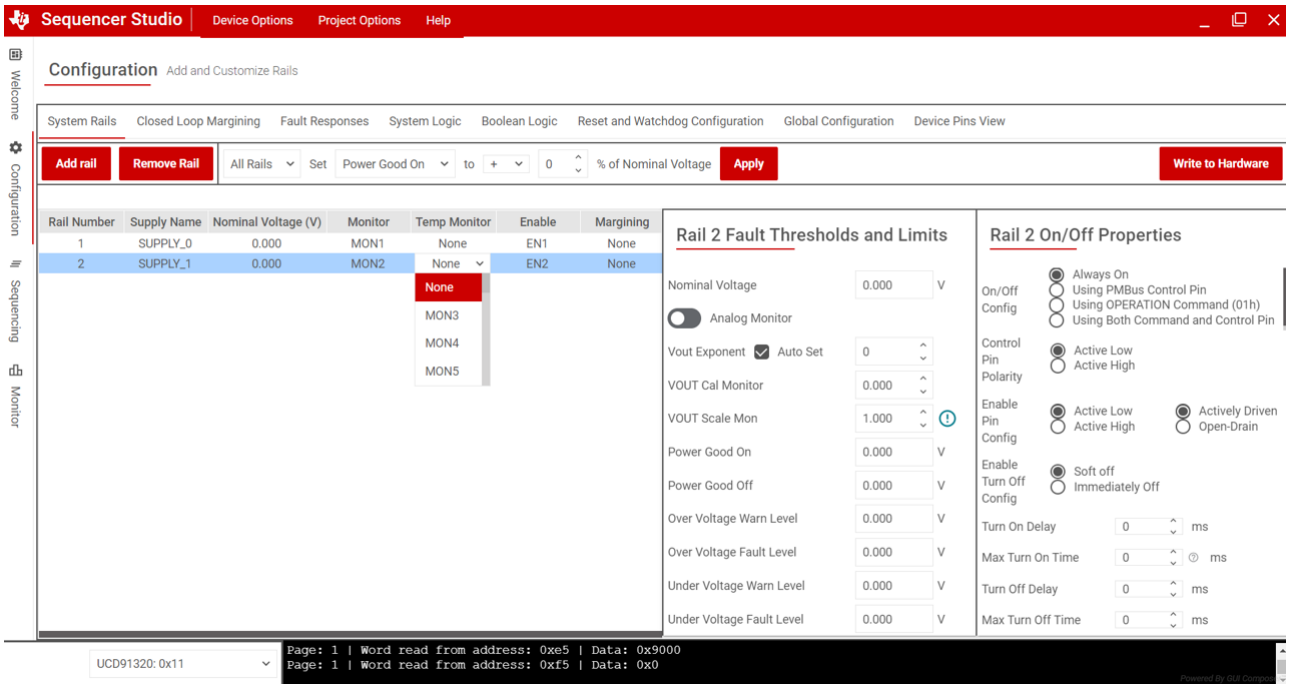
Fault thresholds and limits

- Set for a selected rail. Click on rail row in table to refresh these properties for a given rail.
- These options will only be available if a monitor pin is assigned to the selected rail.
- If a temperature monitor is added, the following configurable fields will be added to this section:
    - Temp cal gain (C/V)
    - Temp cal offset (C)
    - Over temperature warn level (C)
    - Over temperature fault level (C)



Rail on/off properties

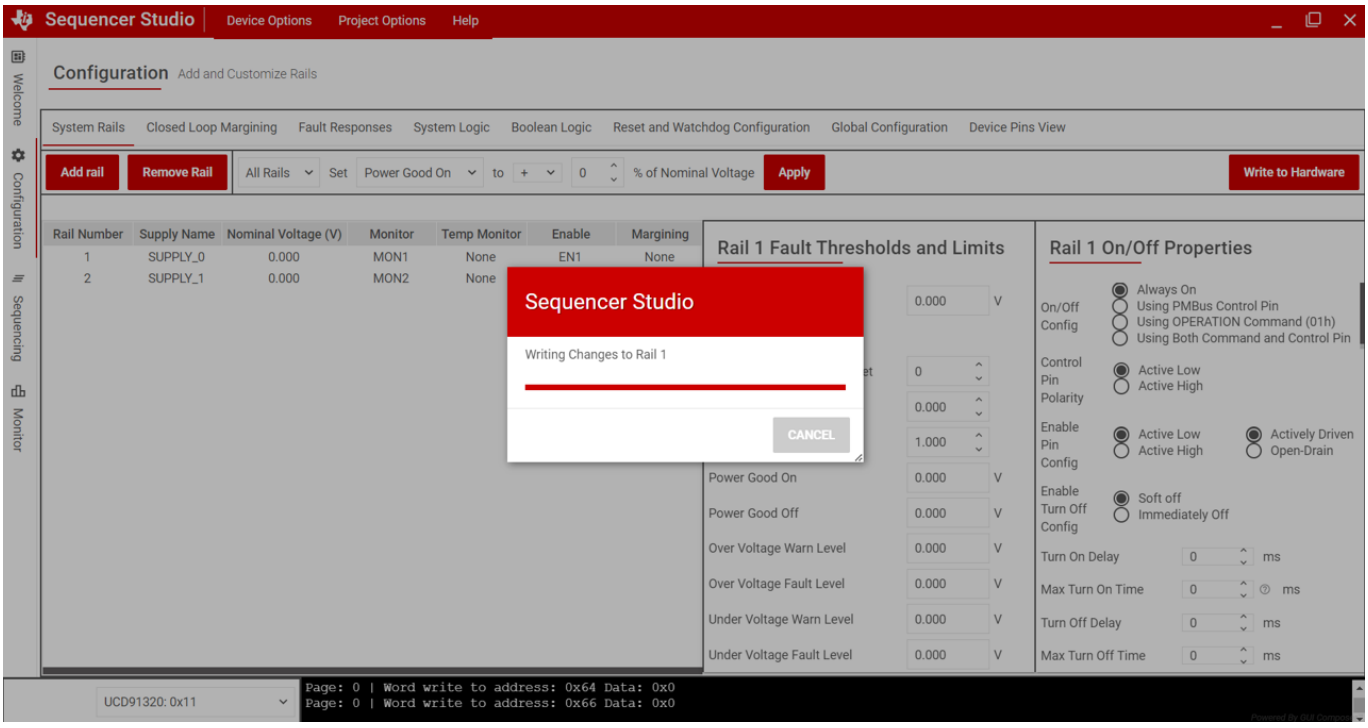
- Set for a selected rail. Click on rail row in table to refresh these properties for a given rail.
- These options will only be available if an enable pin or a margining pin is assigned to the selected rail.
- If `Using Operation Command` is selected under On/Off Config, the OPERATION command can be sent via the Monitor > Oscilloscope tab via the dropdown select and the `Send OPERATION (01h)` button.



Click `Write to hardware` to write rail configuration changes to device. This will **only** write changes for the selected rail to the device, so to write multiple rails, either (1) select each rail individually and click `Write to hardware` for each rail or (2) go to Device Options > Write All Configurations to Hardware.

*Note, writing all configurations to hardware will write **all** configurations, not just rail configurations.*

Image below showing writing only one rail configuration to hardware when the `Write to Hardware` button used.



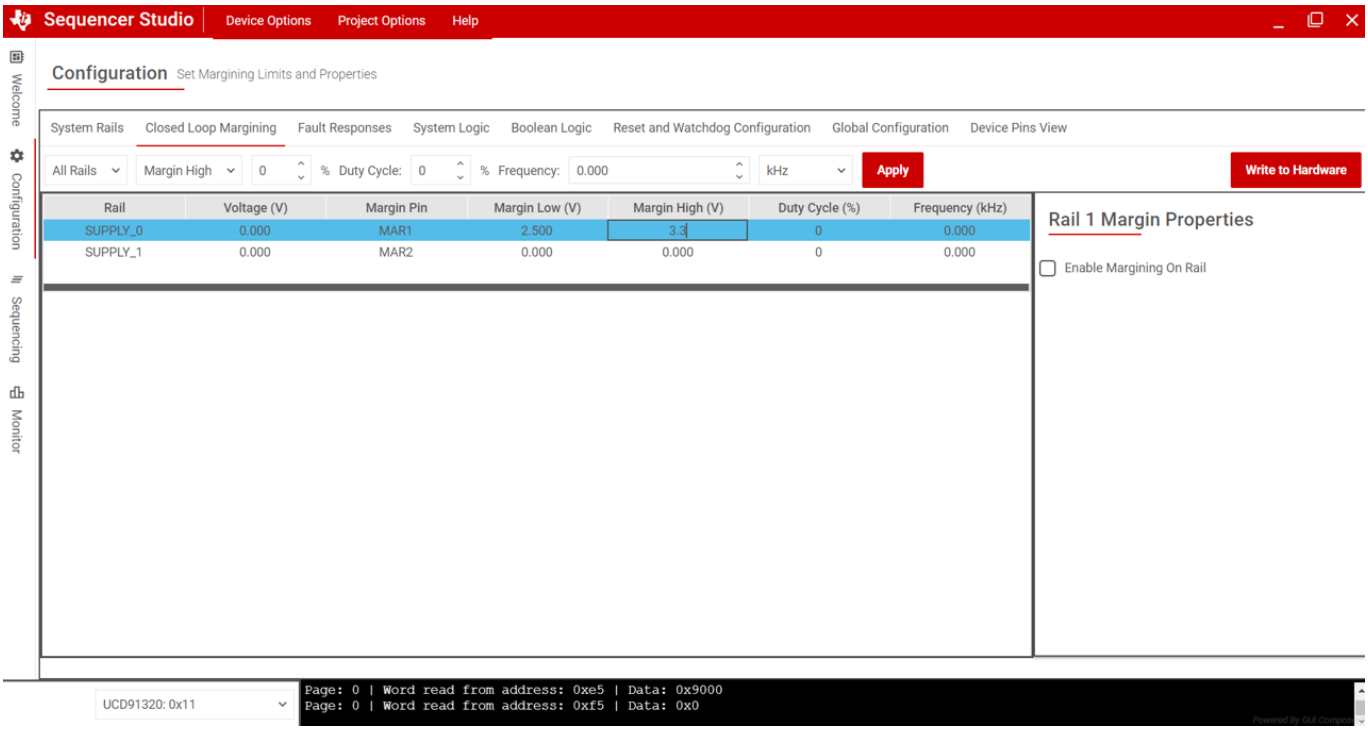
4.2 Closed Loop Margining

System rails that have a margining pin configured in the System Rails tab will appear in this tab.

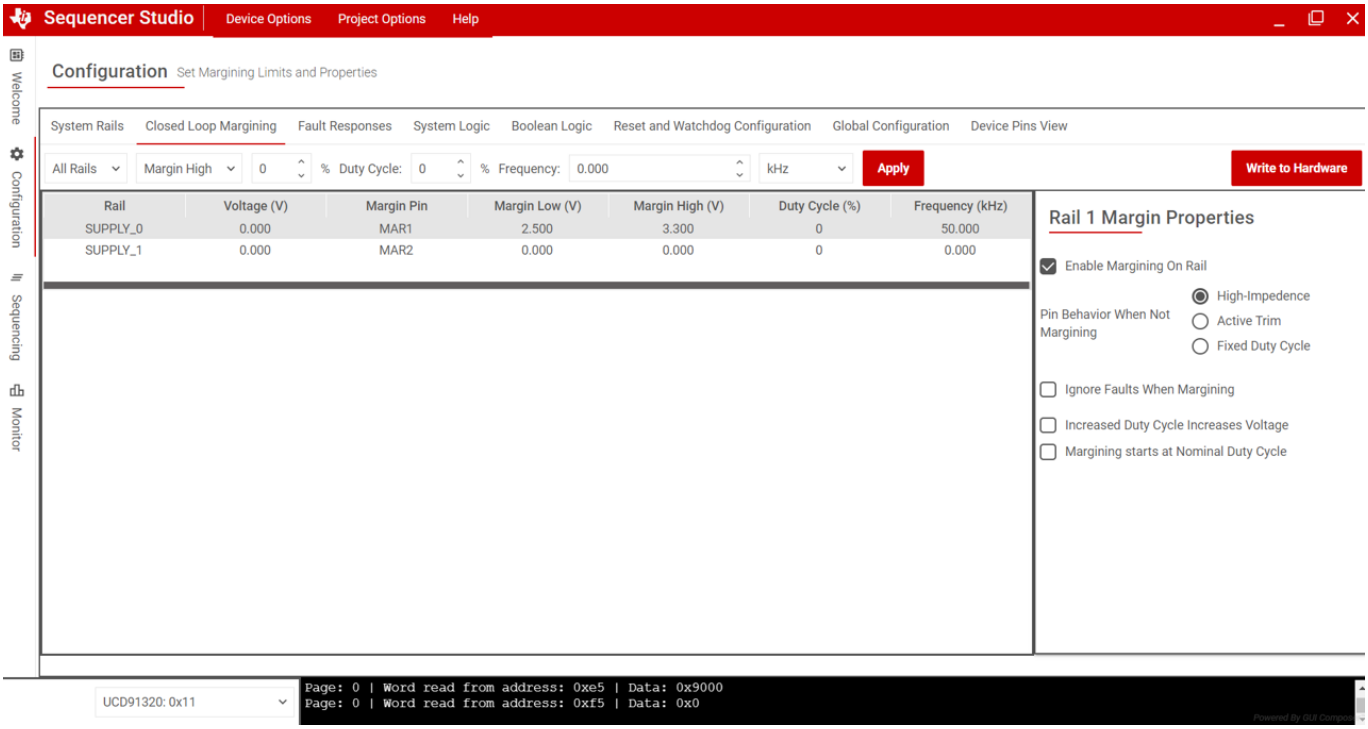
Table view

- View **rail margining properties**:
  - Non-configurable properties: carried over from System Rails tab
    - Rail #
    - Margin (pin)
  - Configurable properties: can be configured by clicking on a cell in the row for a given rail
    - Nominal Voltage
    - Margin low (V)
    - Margin high (V)
    - Duty cycle (%)
    - Frequency (kHz)

Rail "X" margin properties: when the row for a rail is clicked, the margin properties window changes to reflect properties specific to the selected rail

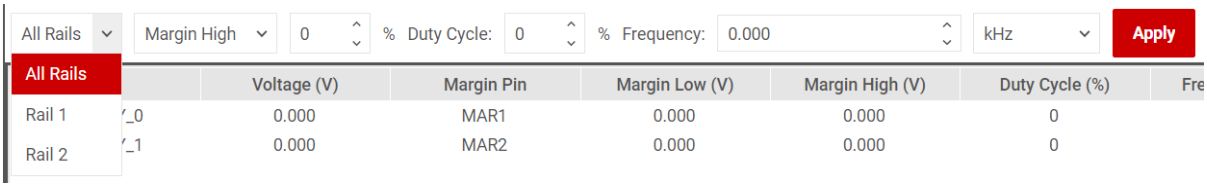


When `Enable Margining On Rail` is checked, more margining properties will appear



Quick set margin thresholds

- Select rail, threshold to set, and percentage of nominal voltage for the threshold. Click red `Apply` button to apply to selected rail.



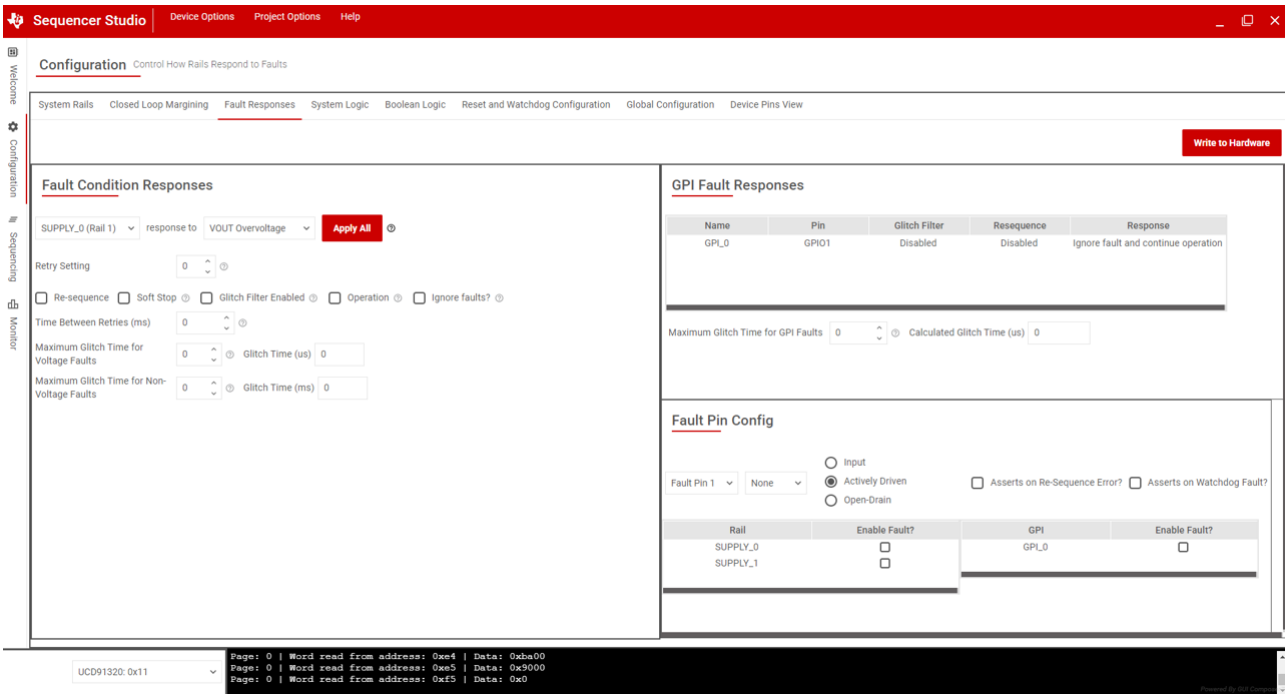
Click `Write to Hardware` to write active changes for a selected rail to the device. This will **only** write changes for the selected rail to the device, so to write multiple rails, either (1) select each rail individually and click `Write to hardware` for each rail or (2) go to Device Options > Write All Configurations to Hardware.

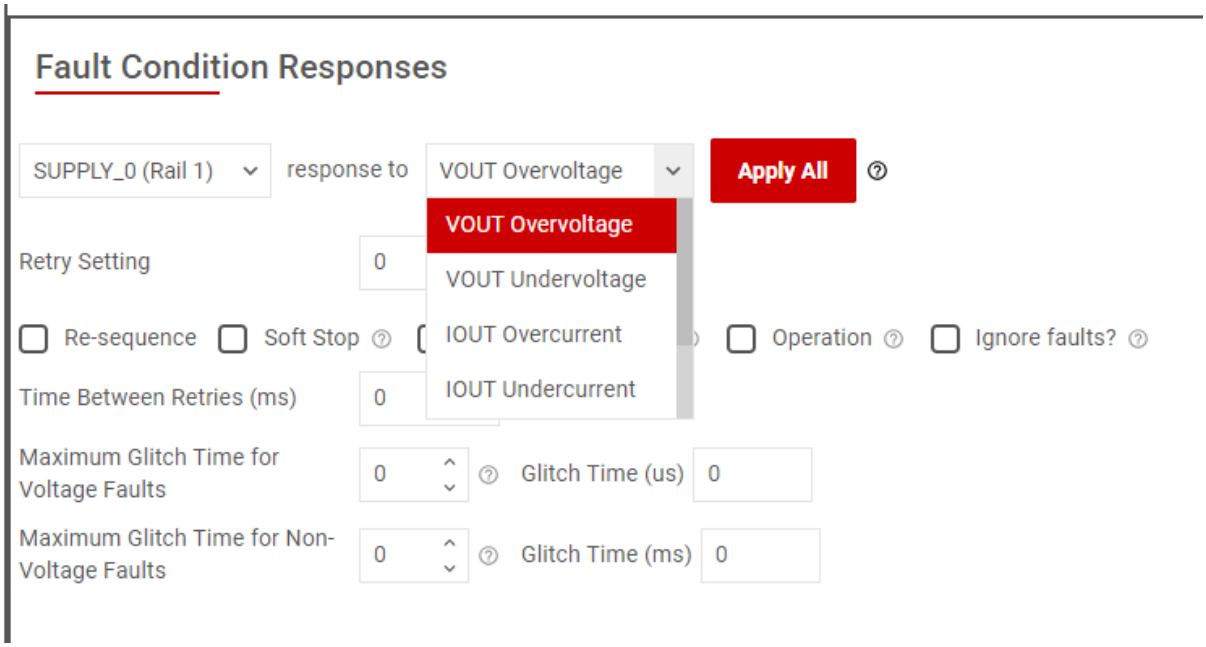
*Note, writing all configurations to hardware will write **all** configurations, not just rail configurations.*

4.3 Fault Responses

Fault condition responses: configured rails will appear in the dropdown tab for fault condition response configuration

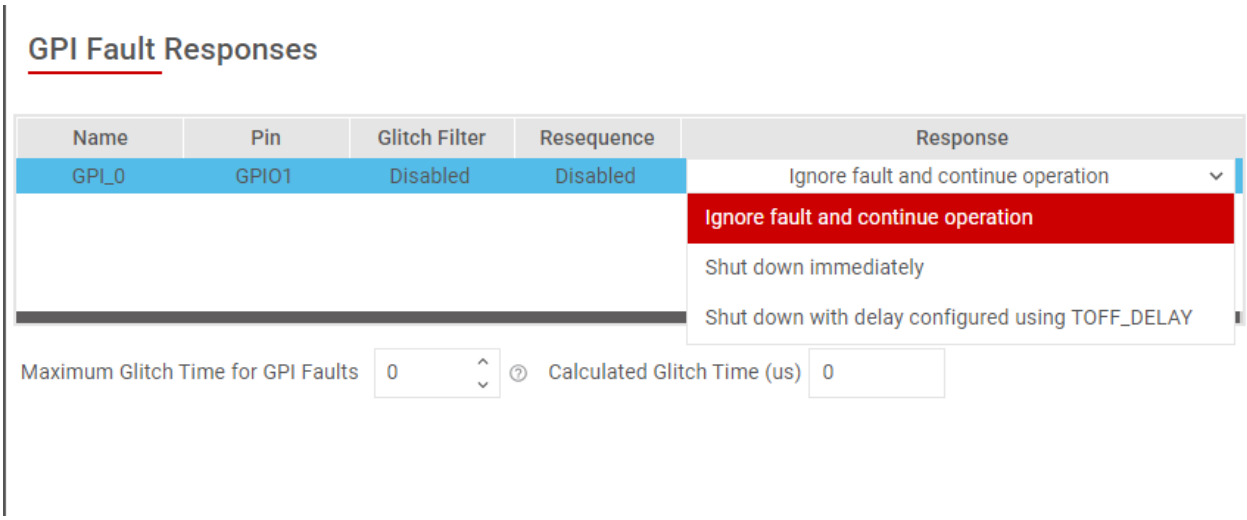
1. Select rail for which to configure fault condition responses
2. Select type of fault
3. Configure fault properties





GPI fault responses: GPIs configured in the "System Logic" tab will appear in this table

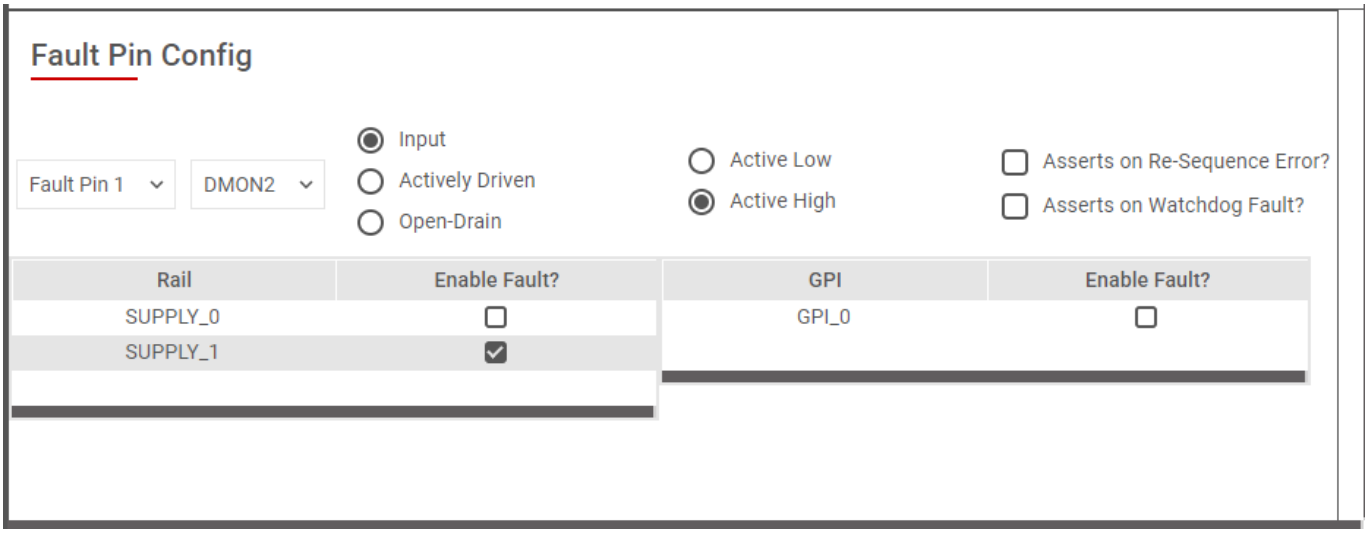
- Use table to configure GPI fault response properties. If there are no GPIs configured, a warning message will appear prompting GPIs to be added.
- When GPIs are added in the System Logic tab, they will appear in the Fault Responses tab for configuration



Fault pin configuration: Configure up to 4 fault pins for cascading operation. Fault pins can either be inputs or outputs.

Note: selecting a fault pin will not reserve that pin, so it can be used for other configurations. E.g. if DMON1 is used for fault pin 1, DMON1 can also be used for a GPIO.

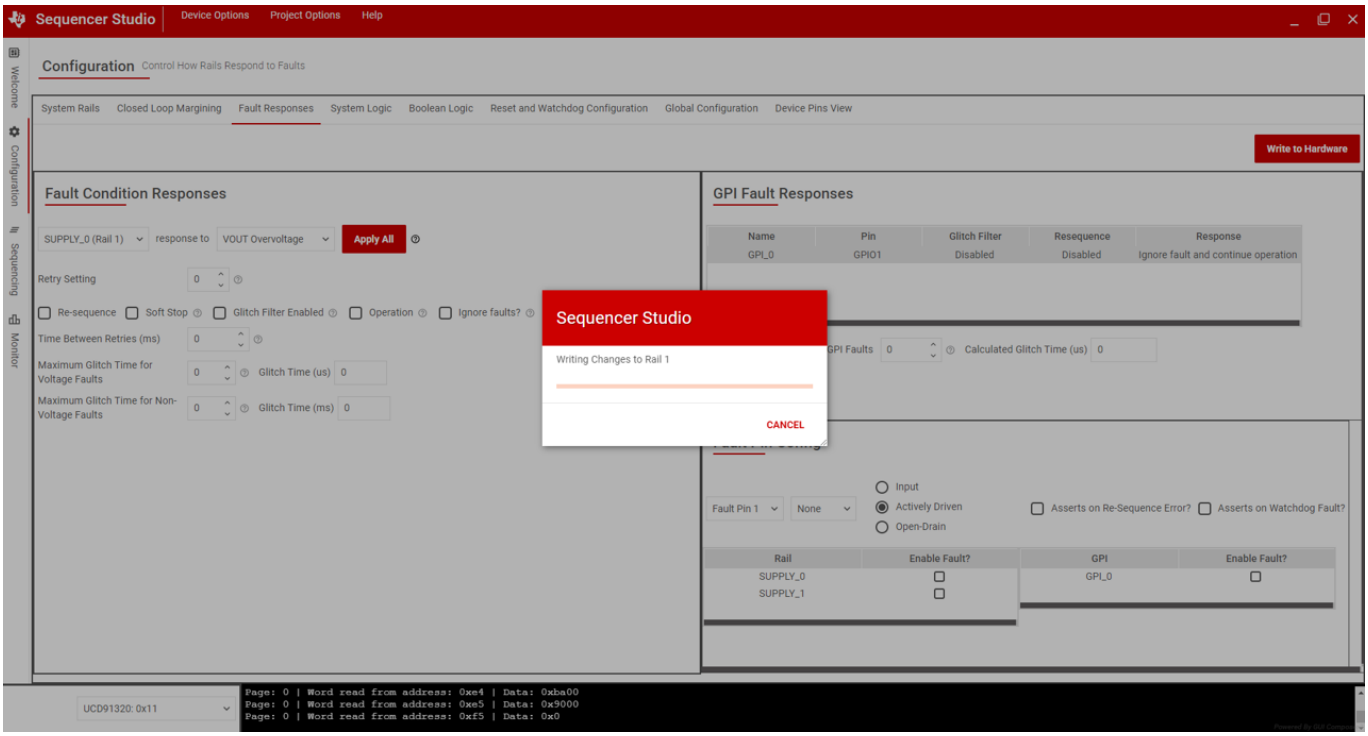
Configure fault pin configuration properties and enable faults for previously configured rails (in System Rails tab) and GPIs (in System Logic tab).



Click `Write to hardware` to write fault response changes to device. Note that this will only write the fault responses for the rail selected under Fault Condition Responses. To write fault responses for multiple rails, either (1) select each rail individually and click `Write to hardware` for each rail or (2) go to Device Options > Write All Configurations to Hardware.

*Note, writing all configurations to hardware will write **all** configurations, not just fault response configurations.*

Example of writing fault configurations for single rail to hardware below.

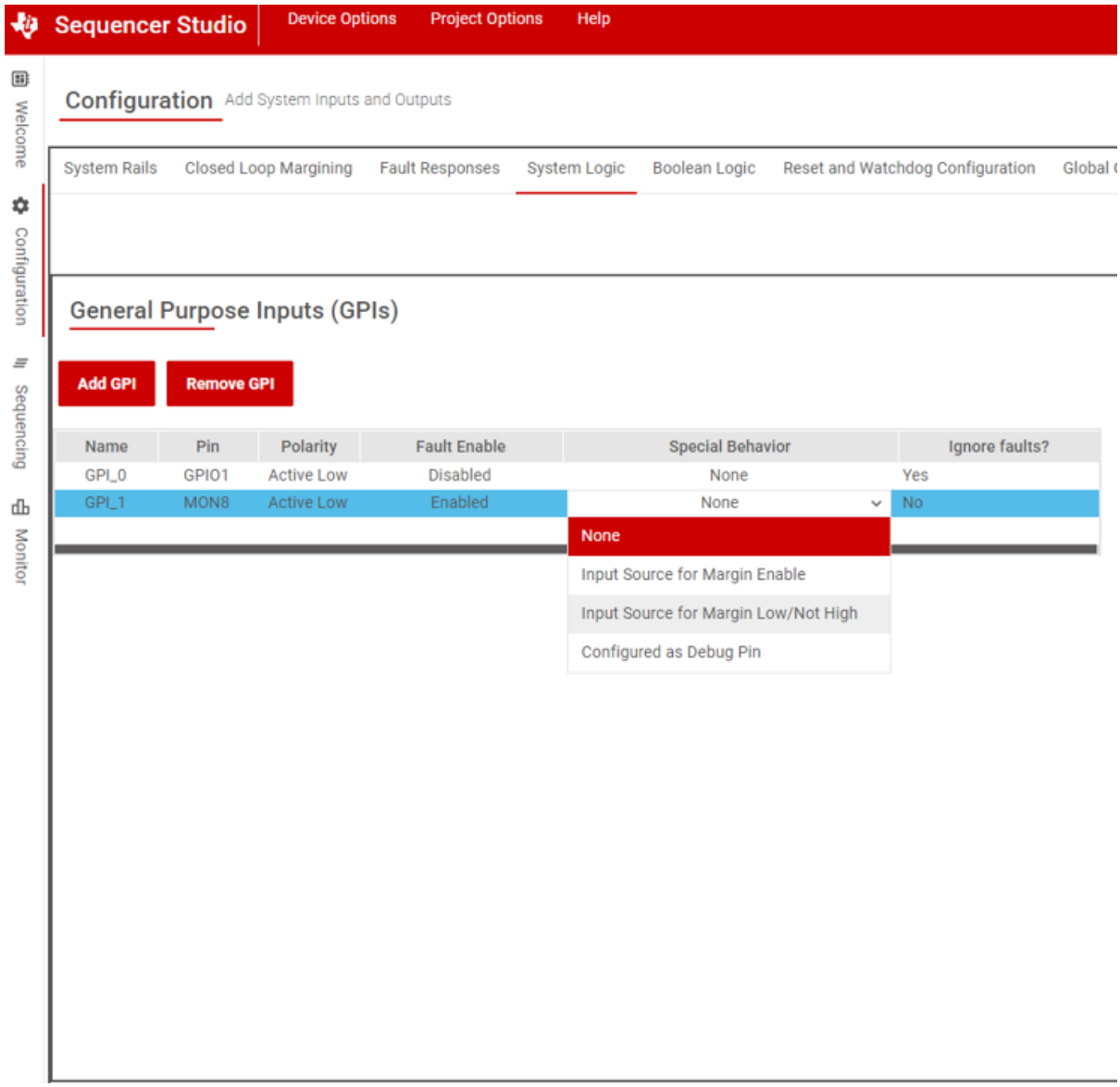


4.4 System Logic

General purpose inputs (GPIs)

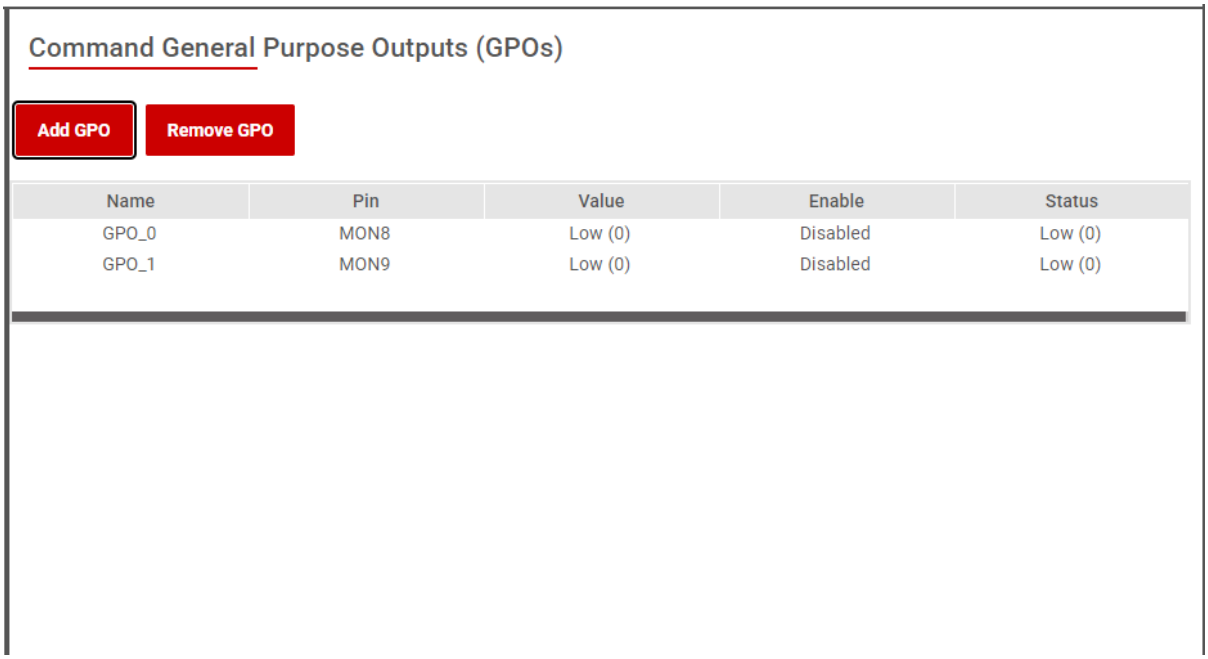
- Click the red `Add GPI` button to add GPI. Remove GPI using the `Remove GPI` button. Click on a cell in the table for a specified GPI to configure properties.
- **GPI properties**
  - **GPI name**
  - **Associated pin**
  - **Polarity**
  - **Fault enable**
  - **Special behavior**: only one GPI can be selected per special behavior (e.g. two GPIs can be set as "Input Source for Margin Enable").
  - **Ignore faults?**: defaults to `No`, meaning that by default, faults related to the GPI are logged. If changed to `Yes`, faults related to this GPI will not be logged.

Note: when a GPI is added or removed, a warning will appear to check sequencing dependencies. Please check sequencing dependencies after changing the number of GPIs, as the dependencies might change.



Command controller general purpose outputs (GPOs)

- Click the red `Add GPO` button to add GPO. Remove GPO using the `Remove GPO` button. Click on cell for a specified GPO to configure properties.
- **GPO properties**
  - GPO name
  - Associated pin
  - Value
  - Enable
  - Status

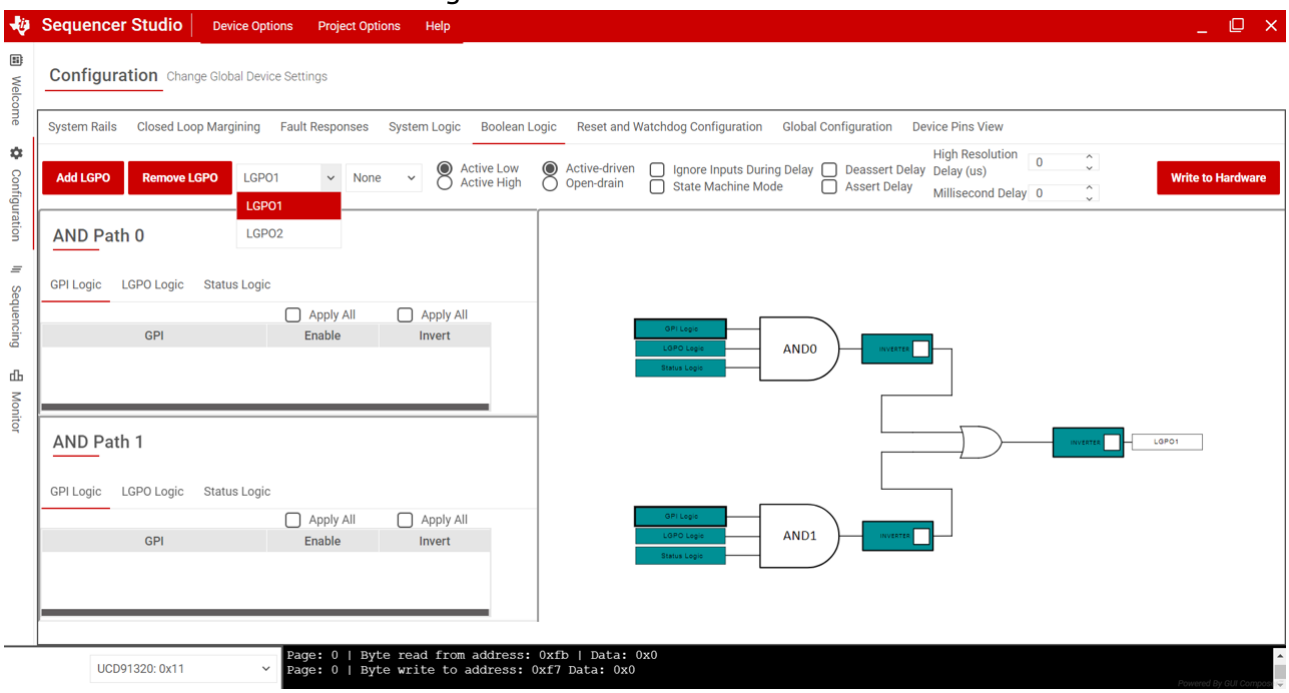


Click `Write to hardware` to write all system logic changes to device. All GPIs and CCGPOs are written at once when this button is clicked. Removing a GPI or CCGPO will automatically write this change to the device.

4.5 Boolean Logic

Add **logical general-purpose outputs (LGPOs)** using the `Add LGPO` button. Remove LGPOs using the `Remove LGPO` button.

1. Configure inputs to each AND gate by either (a) clicking the blue, logic type button on the block diagram or (b) clicking the appropriate tab on the left hand side for each AND path.
    - E.g. clicking the blue `Status Logic` box feeding into AND0 will automatically shift the AND Path 0 table to the Status Logic tab.



2. Select which previously configured GPIs, LGPOs, or rails (Status Logic) will be enabled as an input to the AND paths using the table on the left hand side. Invert input states by clicking corresponding

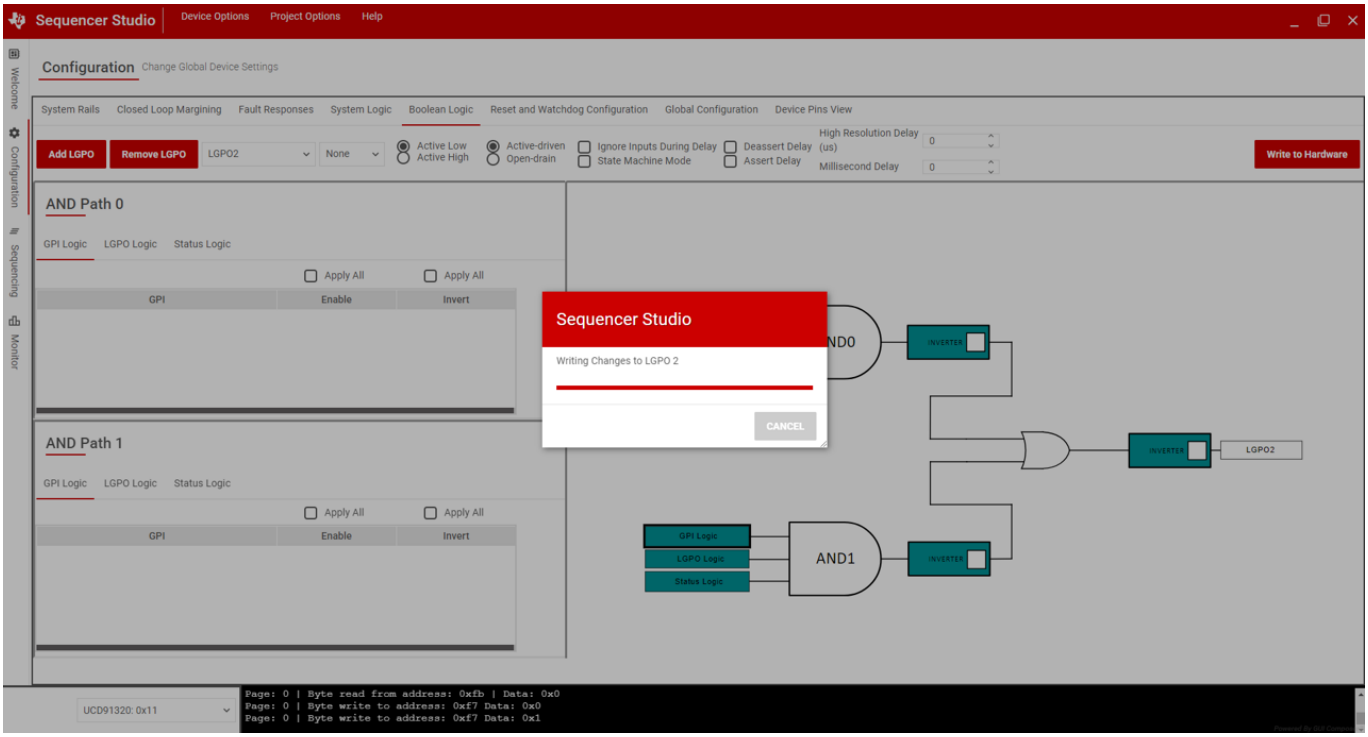
checkboxes.

3. Invert outputs for AND paths or OR gate by clicking corresponding checkboxes on the block diagram.
4. Additional configuration properties are found at the top of the tab.
5. Switch between LGPOs by using the dropdown at the top of the tab.

Note: when an LGPO is added or removed, a warning will appear to check sequencing dependencies. Please check sequencing dependencies after changing the number of LGPOs, as the dependencies might change.

Click `Write to hardware` to write LGPO changes to device. Note that this will only write the configuration for the selected LGPO. To write configurations for multiple LGPOs, either (1) select each LGPO individually and click `Write to hardware` for each LGPO or (2) go to Device Options > Write All Configurations to Hardware.

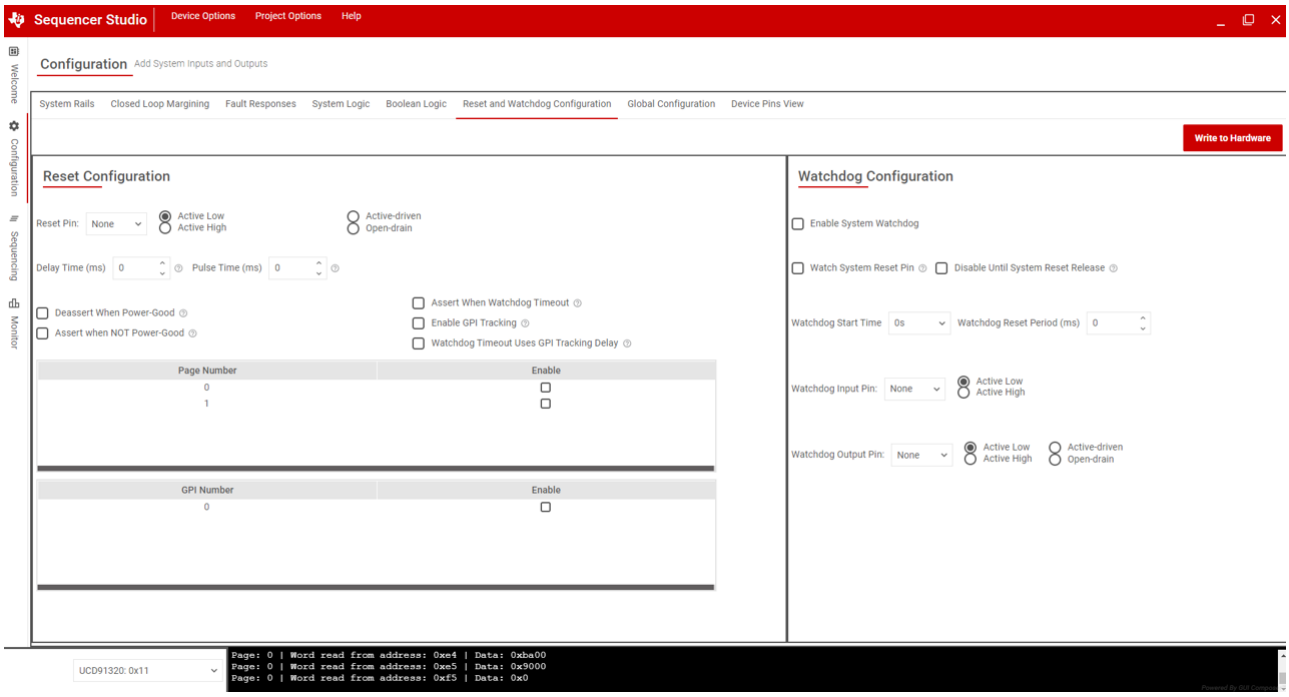
*Note, writing all configurations to hardware will write **all** configurations, not just LGPO configurations.*



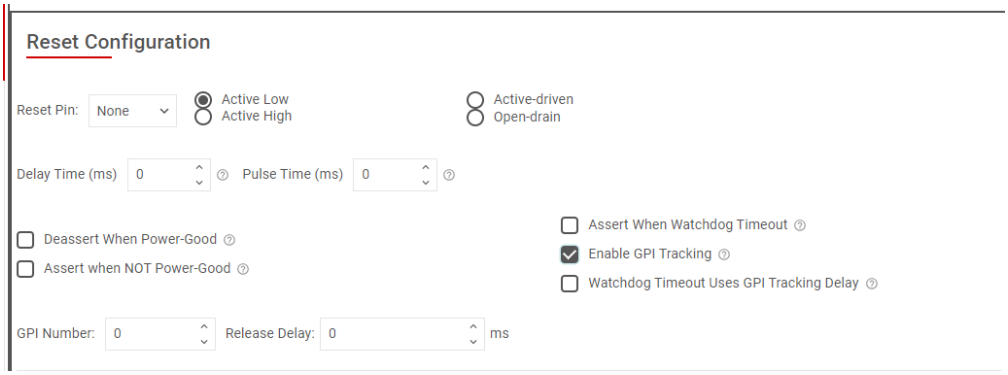
4.6 Reset and Watchdog Configuration

Reset Configuration

1. Select a Reset Pin from the dropdown of available pins.



2. Configure Reset Pin using the left hand side of the tab. Previously configured Pages (Rails) and GPIs will appear in the tables.
    - Selecting `Enable GPI Tracking` will display an additional set of options for previously configured GPIs that can be used for GPI tracking.



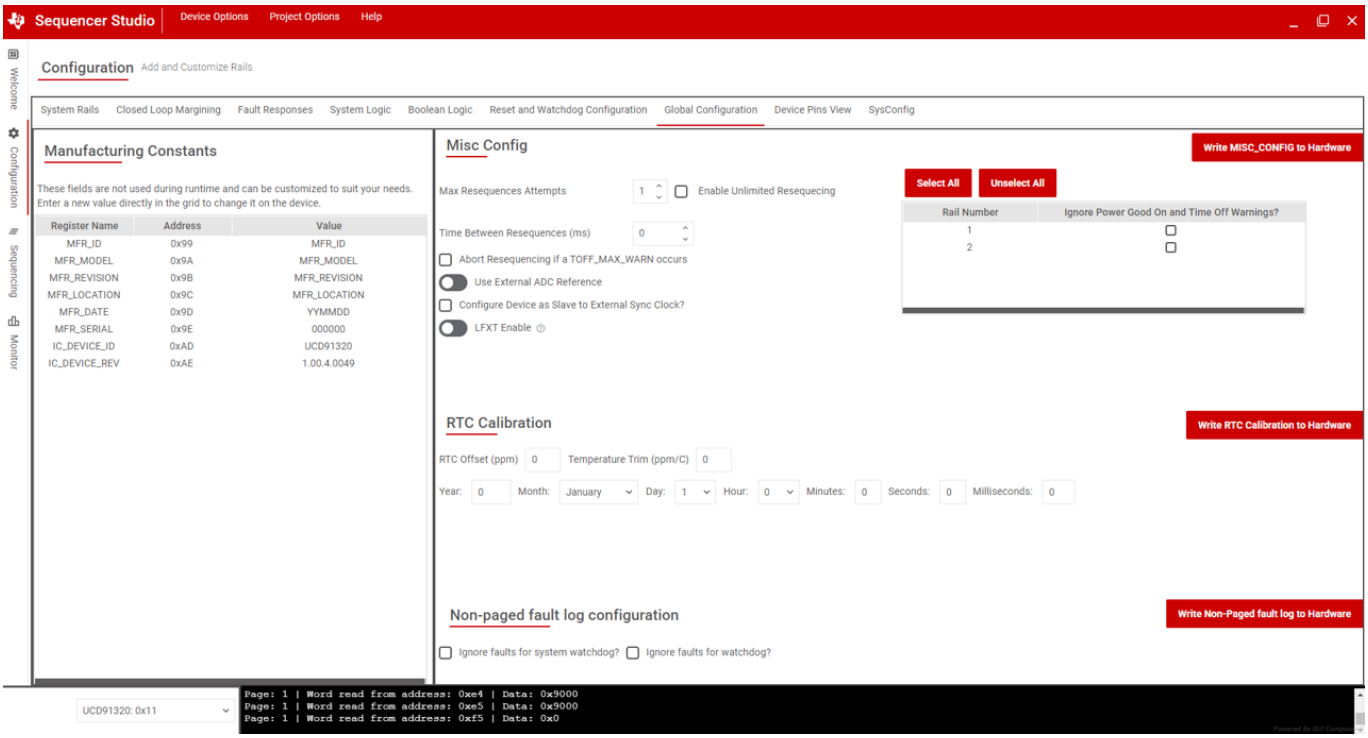
Watchdog Configuration

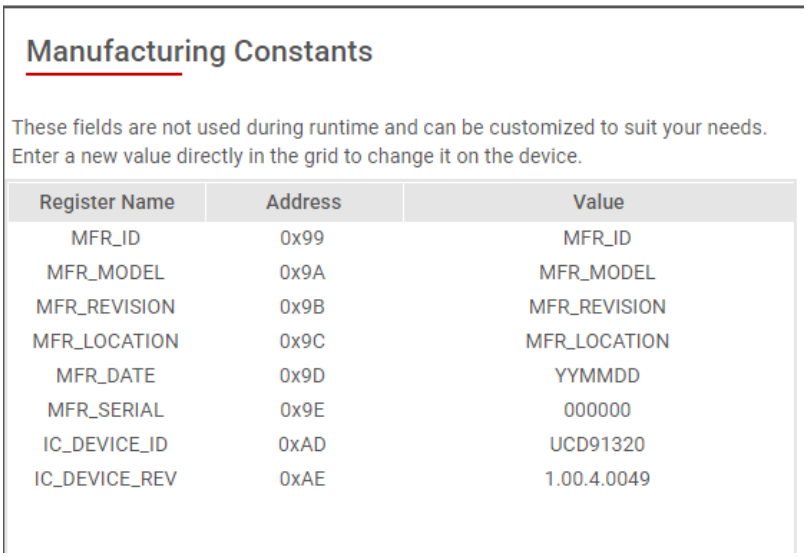
1. Configure System Watchdog properties using the right hand side of the tab.

Click `Write to Hardware` to write both system reset and system watchdog changes to the device.

4.7 Global Configuration

Configure **manufacturing constants** to suit your needs (these fields are not used at runtime)





Manufacturing Constants

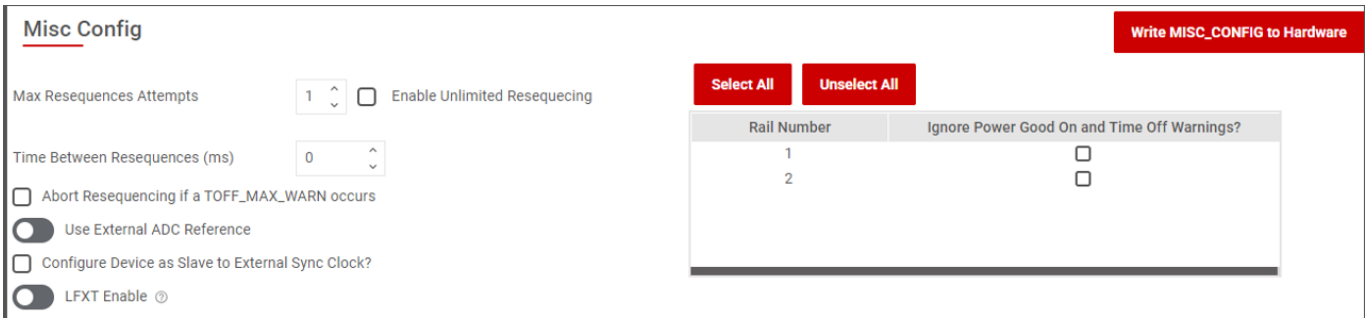
These fields are not used during runtime and can be customized to suit your needs.
Enter a new value directly in the grid to change it on the device.

Register Name	Address	Value
MFR_ID	0x99	MFR_ID
MFR_MODEL	0x9A	MFR_MODEL
MFR_REVISION	0x9B	MFR_REVISION
MFR_LOCATION	0x9C	MFR_LOCATION
MFR_DATE	0x9D	YYMMDD
MFR_SERIAL	0x9E	000000
IC_DEVICE_ID	0xAD	UCD91320
IC_DEVICE_REV	0xAE	1.00.4.0049

Configure **MISC_CONFIG** command. Previously configured rails will appear in the table.

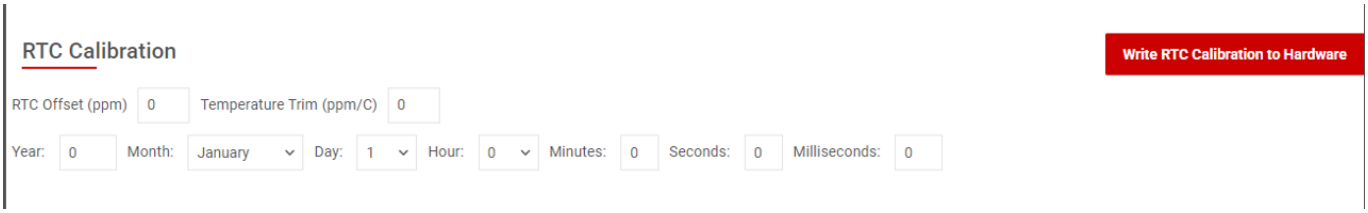
- Maximum resequencing attempts
- Enable unlimited resequencing
- Time between resequences
- Abort resequencing if a TOFF_MAX_WARN occurs
- Use external ADC reference + reference voltage if selected
- Ignore Power Good On/Time Off warnings for a rail
- LFXT enable: If using LFXT enable, device will need to be reset for this to take effect.

Click `Write MISC_CONFIG to Hardware` to write changes to the device. This will *only* write the MISC_CONFIG command to the device, *not* the other configurations on this tab.



Configure **Run Time Clock**.

Click `Write RTC Calibration to Hardware` to write changes to the device. This will only write the commands relevant to the run time clock to the device, *not* the other configurations on this tab.

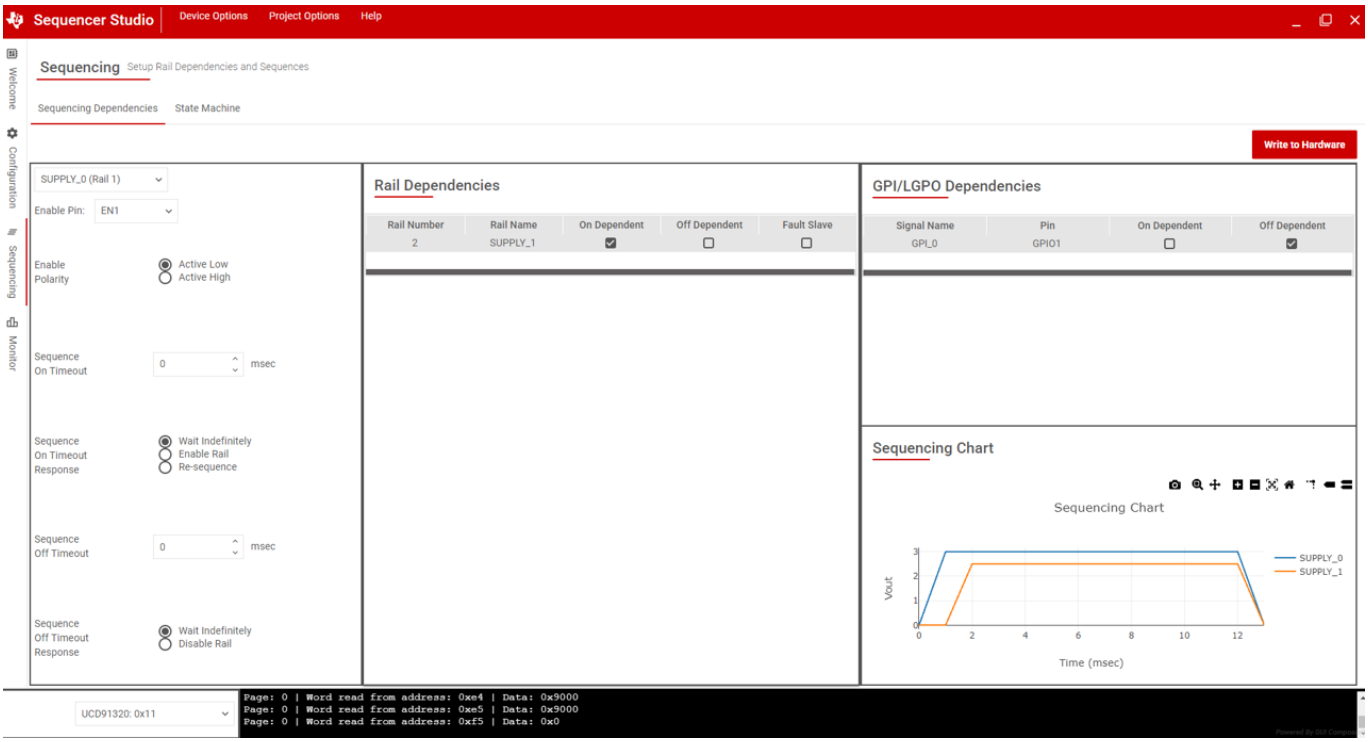


Configure **fault ignores for non-paged faults**. In order to ignore faults logged for either system watchdog timeout or watchdog timeout, check the respective boxes at the bottom of the tab and Click `Write Non-paged fault log to hardware`. If the box is checked, the respective fault will not be logged if they occur.

5. Sequencing

5.1 Sequencing Dependencies

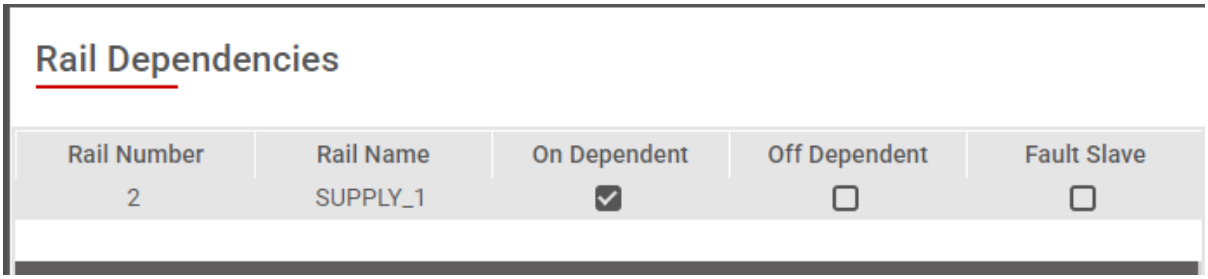
Rails that have been added in the Configuration > System Rails tab will appear in the dropdown selection. Rails that do not have an enable pin will have configuration properties greyed out.



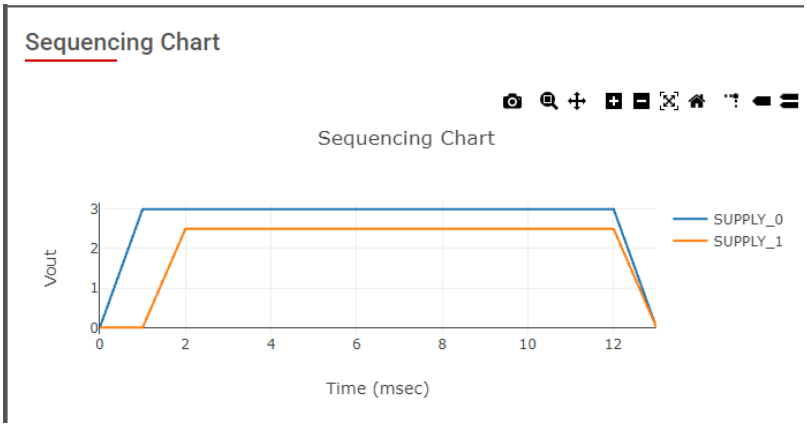
Rail dependencies

All rails other than the rail being configured will appear on the Rail Dependencies table as shown. Configure if the rails shown in the table will being (a) on dependent (b) off dependent (c) fault slave (or any combination of the options) on the rail specified in the dropdown selection.

- For example, if Rail 1 should be on dependent on Rail 2, (1) go to Rail 1 using the dropdown, (2) select the box in the Rail 2 row for On Dependent



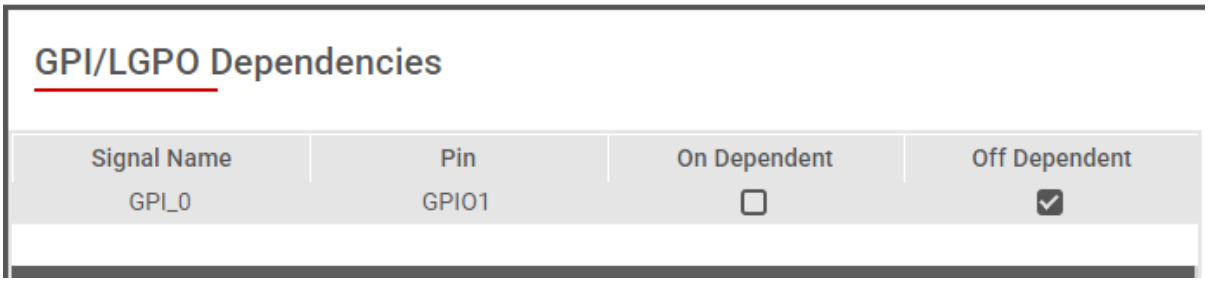
The rail sequencing dependencies will appear in the Sequencing Chart to visually demonstrate the configured on/off sequence.



GPI/LGPO dependencies

Previously configured GPIs and LGPOs will appear in the GPI/LGPO Dependencies table shown. Configure whether these GPIs/LGPOs are on or off dependent on the selected rail using the table.

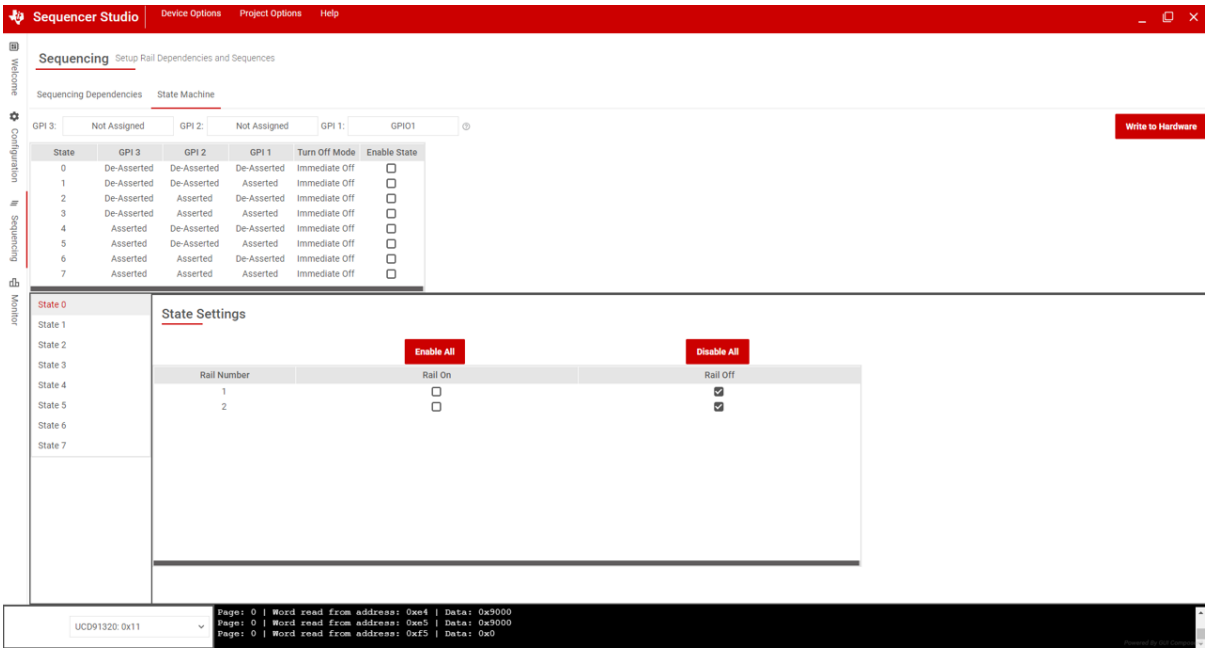
- For example, if Rail 1 should be on dependent on GPI_0, (1) go to Rail 1 using the dropdown, (2) select the box in the GPI_0 row for On Dependent



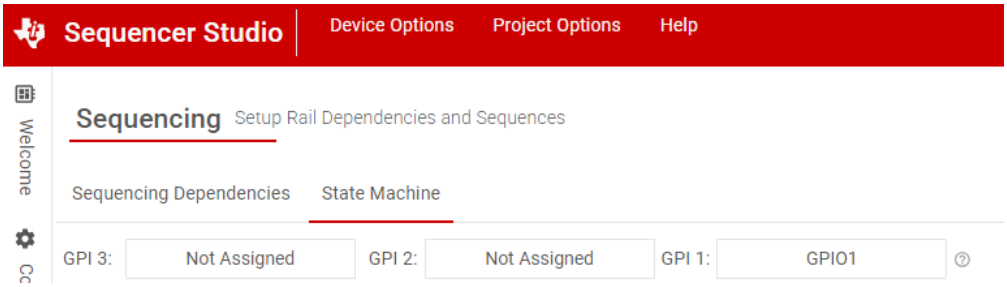
Click `Write to hardware` to commit all sequencing dependency changes for a selected rail to device. Note that this will only write the sequencing configuration for the selected rail. To write configurations for multiple rails, either (1) select each rail individually and click `Write to hardware` for each rail or (2) go to Device Options > Write All Configurations to Hardware.

*Note, writing all configurations to hardware will write **all** configurations, not just rail sequencing configurations.*

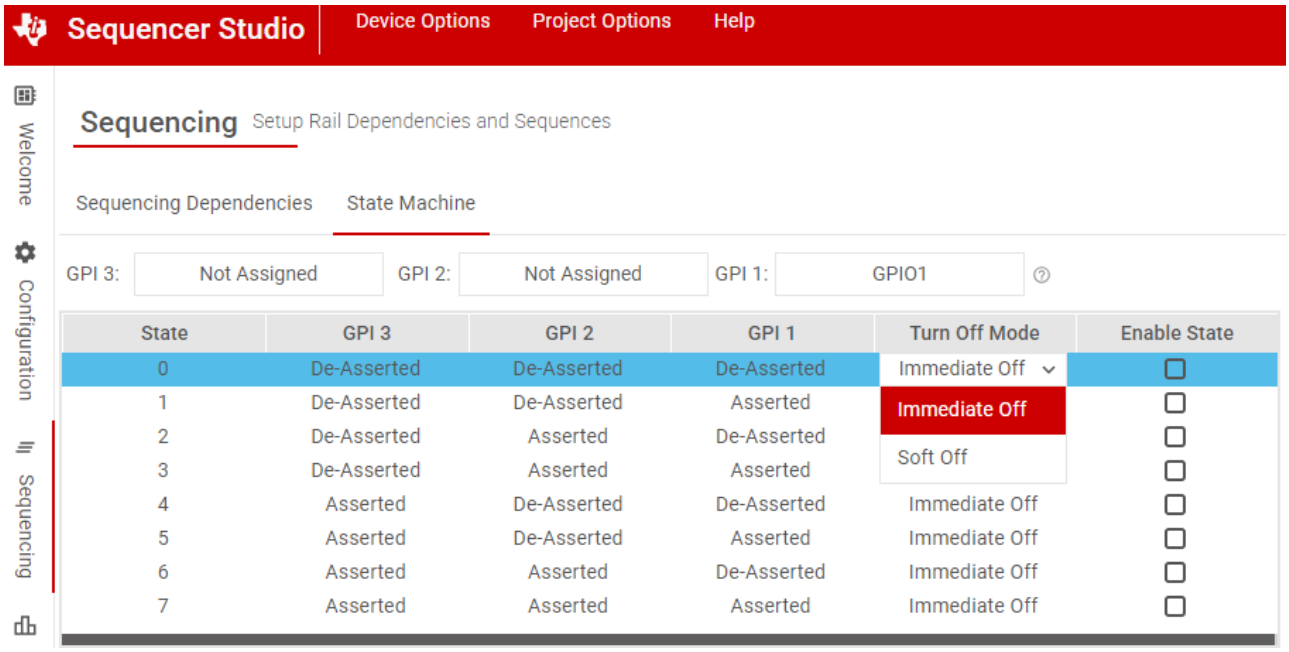
5.2 State Machine



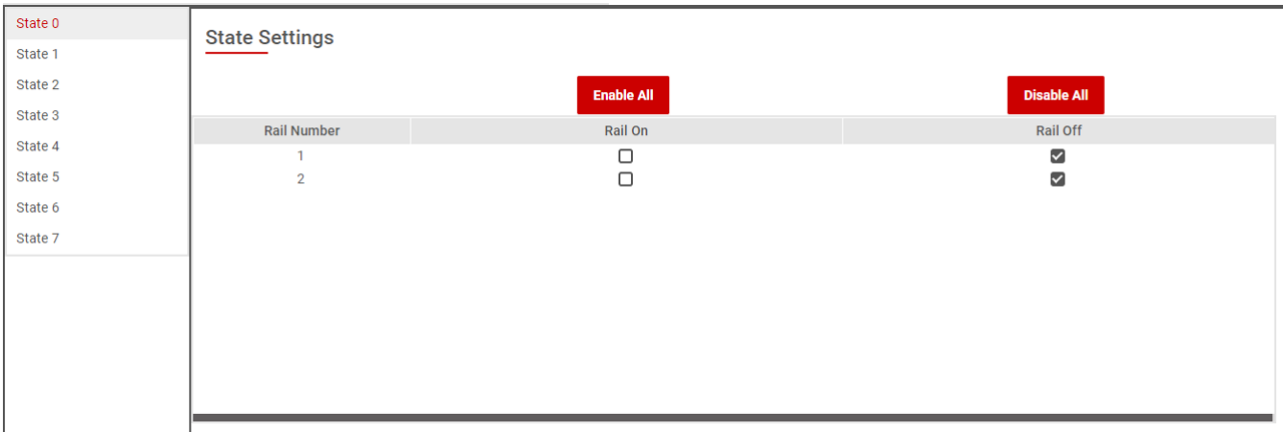
The first three GPIs that have been configured in the "System Logic" tab will be used for the state machine. If three GPIs have not been configured, GPI will be marked as "not assigned."



1. Select turn off mode for a specific state and choose to enable state if desired using table.



2. Use the "State Settings" table to configure if a configured rail will be on/off for a given state. Click on a state to adjust state settings

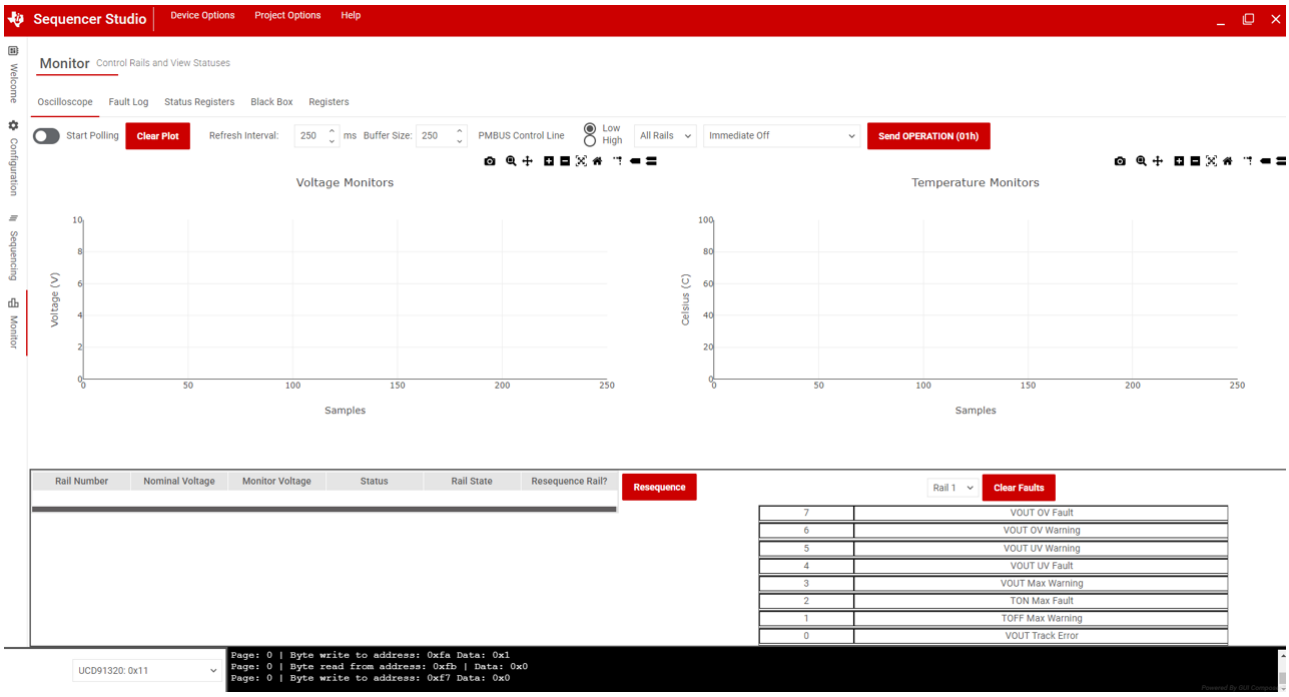


Click `Write to Hardware` to write all state machine changes to the device.

6. Monitor

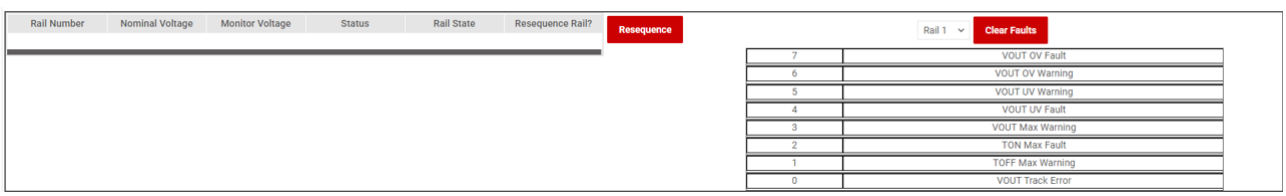
6.1 Oscilloscope & Status

- Set **refresh interval (ms)** and toggle `Start Polling` switch to begin oscilloscope monitoring and display data on `Voltage Monitors` graph and/or `Temperature Monitors` plot depending on which rails have respective monitor pins configured.



- Configure plot refresh interval, plot buffer size, and PMBus Control Line polarity at the top of the tab as well.
- **Send OPERATION command to rail**: use dropdowns to select rail and behavior. The click the `Send OPERATION (01h)` button to send the corresponding OPERATION command for the specified rail.

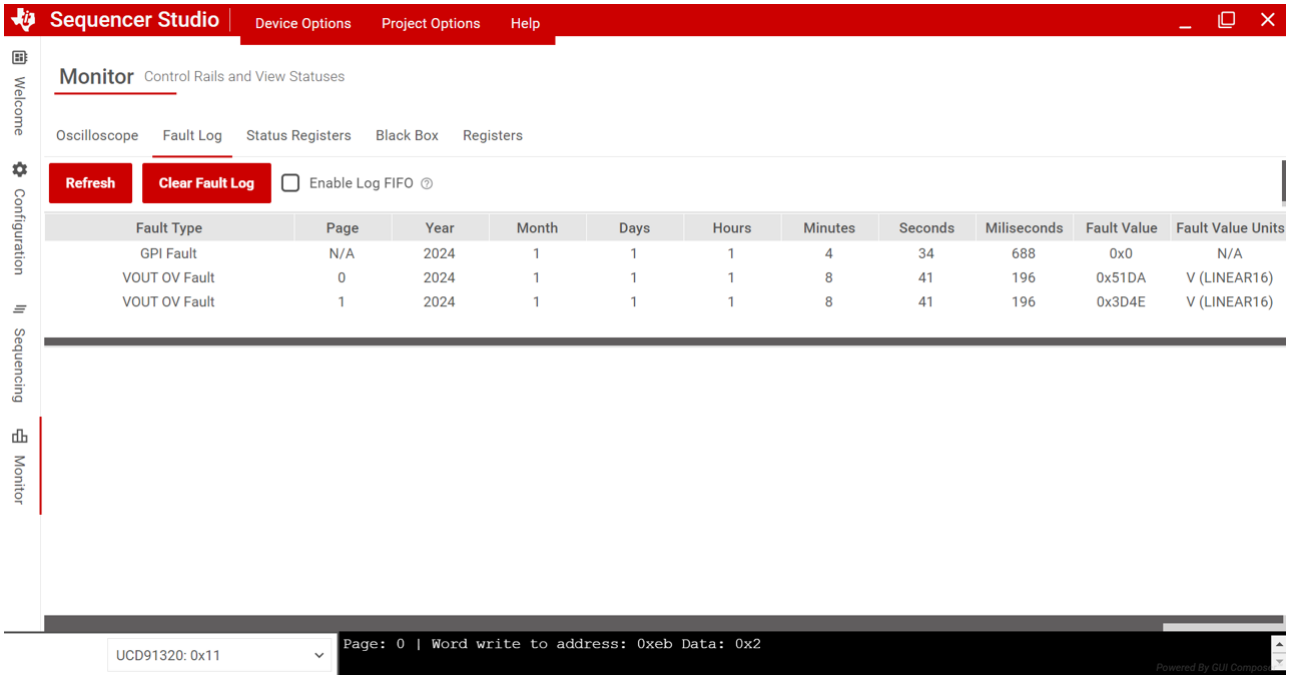
- **Table view**
  - Rail number
  - Nominal voltage
  - Monitor voltage
  - Status
  - Rail state: Unknown, Idle, SEQ On, Start Delay, Ramp Up, Regulation, SEQ Off, Stop Delay, Ramp Down
  - Resequence Rail?: Check this box for a rail and click `Resequence` button to resequence a specified rail
- **Faults for a specified rail**: use dropdowns to select rail. The corresponding faults logged for that rail will be highlighted in the table shown. The numbers correspond to bit fields. Use the `Clear Faults` button to send clear fault status command for a specified rail.

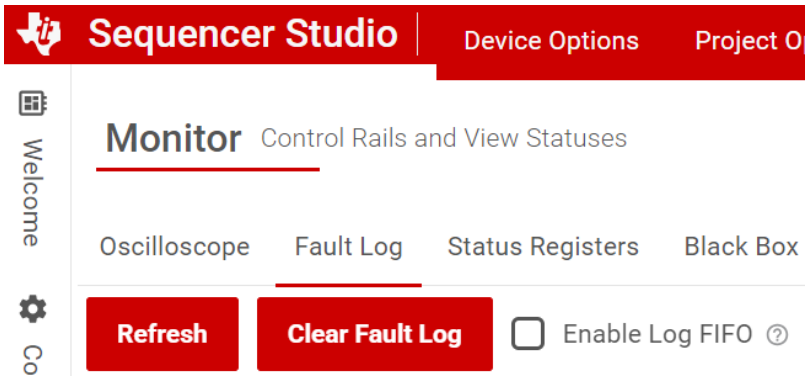


6.2 Fault Log

Fault log table

1. Refresh fault logs shown in table by clicking the `Refresh` button
2. Clear fault log shown in table by clicking the `Clear Fault Log` button
3. Enable log FIFO shown in table by checking the `Enable Log FIFO` box. After 100 faults are logged, the 101th fault will replace the 1st fault log in the table



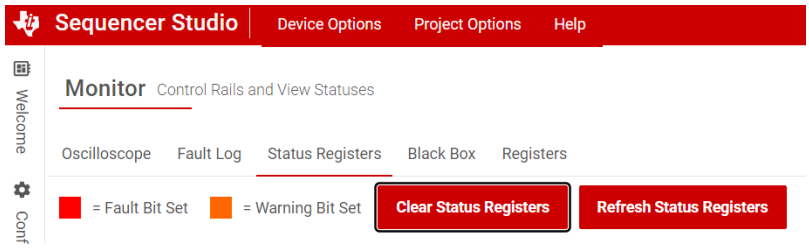


6.3 Status Registers

View STATUS and MFR Status registers

All faults and warnings logged will appear in this tab. If a fault bit is set, the bit field will be highlighted in red. If a warning bit is set, the bit field will be highlighted in orange.

Click `Refresh Status Registers` to re-read all statuses and refresh flags.



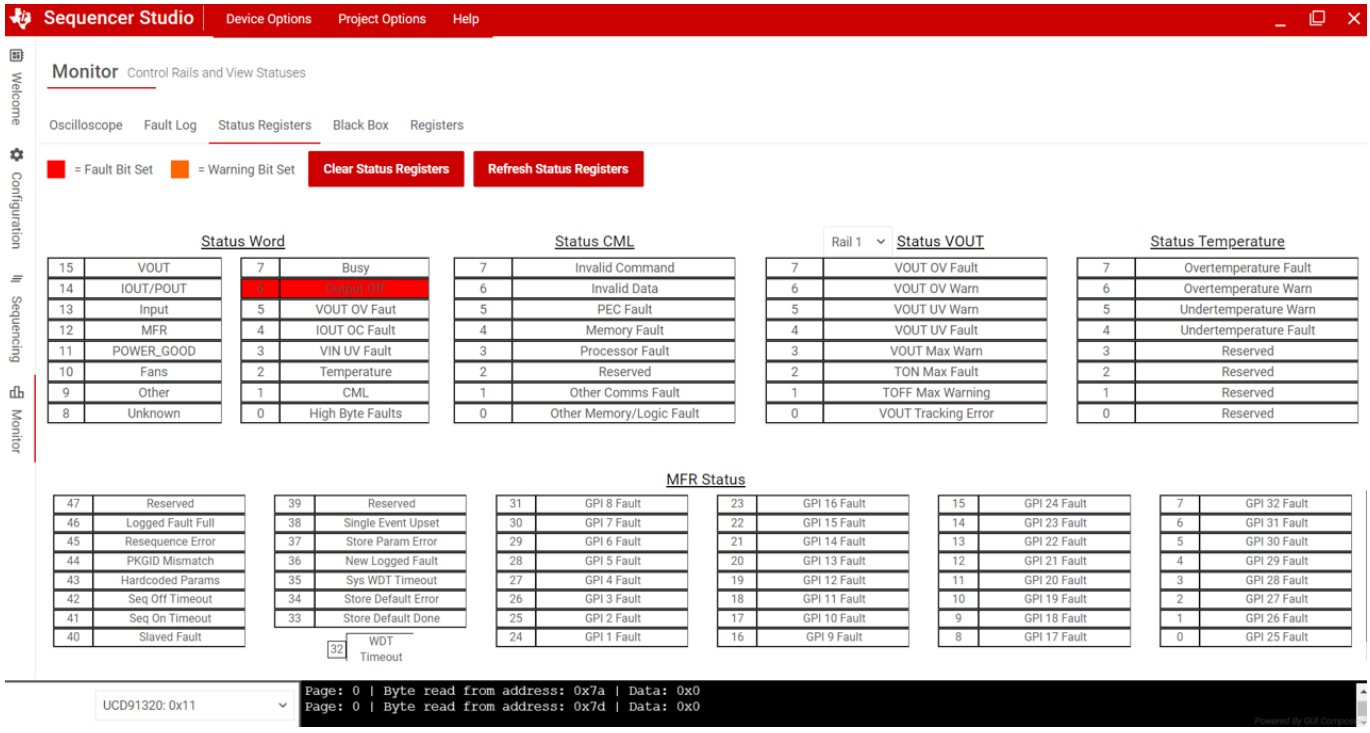
Use the dropdown to select a rail and view the Status VOUT and Status Temperature faults for that specified rail.

Rail 1 (Rail 1 / Rail 2)

	Status VOUT
7	VOUT OV Fault
6	VOUT OV Warn
5	VOUT UV Warn
4	VOUT UV Fault
3	VOUT Max Warn
2	TON Max Fault
1	TOFF Max Warning
0	VOUT Tracking Error

	Status Temperature
7	Overtemperature Fault
6	Overtemperature Warn
5	Undertemperature Warn
4	Undertemperature Fault
3	Reserved
2	Reserved
1	Reserved
0	Reserved

View MFR status registers at the bottom of the tab.



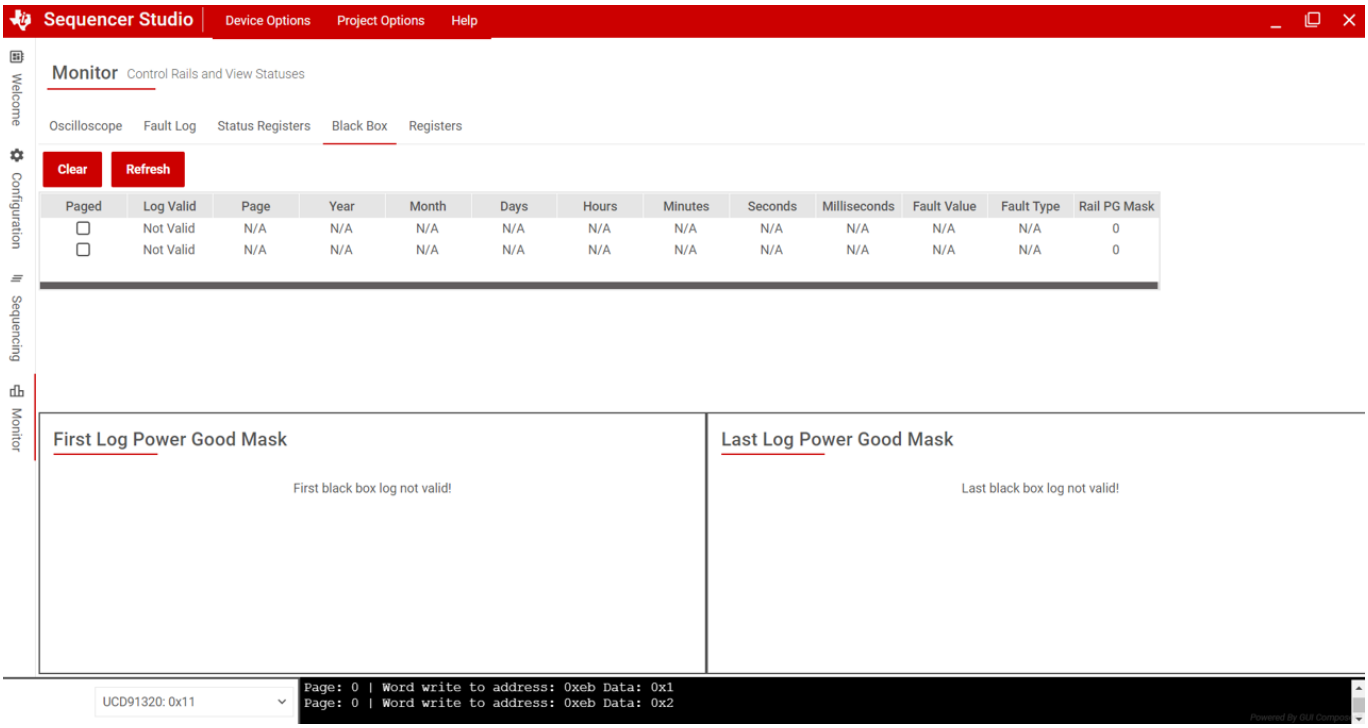
6.4 Black Box

First and last faults will be logged in the Black Box fault log view. Detailed information of the faults given includes:

- Time stamp in RTC format
- Whether or not the fault is page specific
- The page or GPI that triggered the fault (when applicable)
- Fault type
- Status of all rail power good for rails

Use the `Clear` button to clear black box log entries (first and last). Use the `Refresh` button to refresh black box fault log table.

First and last log power good masks will appear at the bottom of the tab once the first and/or last black box faults are logged.



6.5 Registers

View all of the PMBus command register values.

When changes are made applicable to any register on another tab, the "Value" field in table will be underlined to indicate that was a recent change.