ModusToolbox™ Motor Suite GUI

User guide

ModusToolbox™ Motor Suite GUI version v2.10.0

About this document

Scope and purpose

ModusToolbox™ Motor Suite GUI is a tool provided as part of the Motor Suite ecosystem that helps motor drive engineers quickly evaluate, run, and optimize motor control solutions. This document is a user guide for Motor Suite GUI. It helps developers understand how to use Motor Suite GUI in depth and learn the advanced features provided with it.

Intended audience

The intended audience for this document includes design engineers, developers of motor control systems, and any user of ModusToolbox™ Motor Suite GUI.

Table of contents

About this document **1**
Table of contents **2**
1 Introduction **4**
2 Getting started **5**
3 Creating a project **10**
4 Configurator **13**
4.1 General layout 13
4.2 6EDL Only Layout 27
4.2.1 Status Registers 32
4.2.2 Faults 33
4.2.3 Configurator Page Parameter Buttons 34
5 Test Bench **35**
5.1 Dashboard layout 35
5.1.1 Monitoring Panels 36
5.1.2 Profiler 36
5.1.3 Position Control 37
5.2 Diagram Layout 38
5.2.1 Motor Control Parameter Tuning 40
5.2.2 Faults 41
5.2.3 6EDL Status Registers 42
5.2.4 Control Panel 43
6 Tools **45**
6.1 LiveMonitor 45
6.2 Oscilloscope 45
6.2.1 Signal display 47
6.2.2 Auto Fit All Traces 47
6.2.3 Group Traces 48
6.2.4 Set Multiple Scales 48
6.2.5 Reset Statistics 49
6.2.6 Take a Snapshot 50
6.2.7 Dynamic Extend 50
6.2.8 Auto Scale buttons 51
6.2.9 Scale Inputs 51
6.2.10 Scope Settings 52
6.2.11 Channel Settings 53
6.2.12 Time base Configuration 53
6.2.13 Trigger Status 54
6.2.14 Scope Mode 54
6.2.15 Trigger Slope and Holdoff 55
6.2.16 Measure 55
6.2.17 Taskbar 58
6.2.18 Analyzer 60
6.2.19 Data Persistence 61
6.3 PID Tuner 61
6.4 Power Loss Estimator 65
6.4.1 System Operating Conditions and Estimated Consumption 66

Table of contents

6.4.2 Estimated 6EDL Power Loss 67
6.4.3 Suggested Configurations 68
6.5 MOSFET Slew Rate Configurator 70
6.5.1 System Operating Condition 71
6.5.2 MOSFET Slew Rate Tuning Diagram 74
6.5.3 MOSFET Slew Rate Controller – Target 75
6.5.4 MOSFET Slew Rate Controller Parameters 76
Glossary 80
Revision history 81
Disclaimer 82

1 Introduction

ModusToolbox™ Motor Suite GUI is a graphical user interface (GUI) for configuring motor control application parameters. The GUI is designed to configure, tune, and test motor control features on supported motor control boards. The GUI features include:

- **Project File Management:** Save configured parameters as project files (.imcsp) for future reference and reuse.
- **Parameter Description and Visualization:** Access graphical and text-based parameter descriptions for easier understanding and navigation.
- **Integrated Oscilloscope:** Monitor selected signals in real time using the built-in oscilloscope to visualize and analyze signal behavior.
- **Parameter Management:** Download parameters to device RAM and flash for flexible configuration management.
- **Device Flashing:** Use the integrated device flasher to download application hex files to device flash.
- **Gate Driver Register Management:** Read, write, and burn One-Time Programmable (OTP) registers for gate drivers.
- **Status Monitoring:** Monitor the status of motor kits using 6EDL gate drivers and gate-driver-only boards for real-time feedback and diagnostics.
- **Motor Parameter Polling:** Configure the motor parameter polling interval to suit application requirements (100 ms to 5 s).
- **Automatic Board Recognition and Connection:** Use automatic board recognition and connection to minimize setup time and effort.
- **Communication Protocol Support:** Support SWD and UART (for gate-driver-only devices) communication.
- **MOSFET Tuning and Simulation:** Validate and simulate MOSFET parameters using the MOSFET tuning tool to optimize performance and efficiency.
- **Power Loss Estimator:** Estimate power loss using the power loss estimator tool to support system design and optimization.
- **LiveMonitor:** Create custom user interfaces with the LiveMonitor tool to tailor the GUI to application requirements.
- **PID Tuner:** Manually tune PID parameters using the PID tuning tool to optimize control-loop performance.
- **Parameter Search:** Quickly locate parameters using the parameter search box to streamline navigation and configuration.
  Profiler Tool: Automatically extract motor, load, and control parameters using the Profiler tool to simplify configuration and optimization.

2 Getting started

The GUI tool is delivered through the Infineon Developer Center, which allows you to install and update ModusToolbox™ Motor Suite. If Infineon Developer Center is not already installed, download it: https://www.infineon.com/cms/en/design-support/tools/utilities/infineon-developer-center-idc-launcher
After opening Infineon Developer Center and signing in with your My Infineon account, locate ModusToolbox™ Motor Suite and click Install (Figure 1).

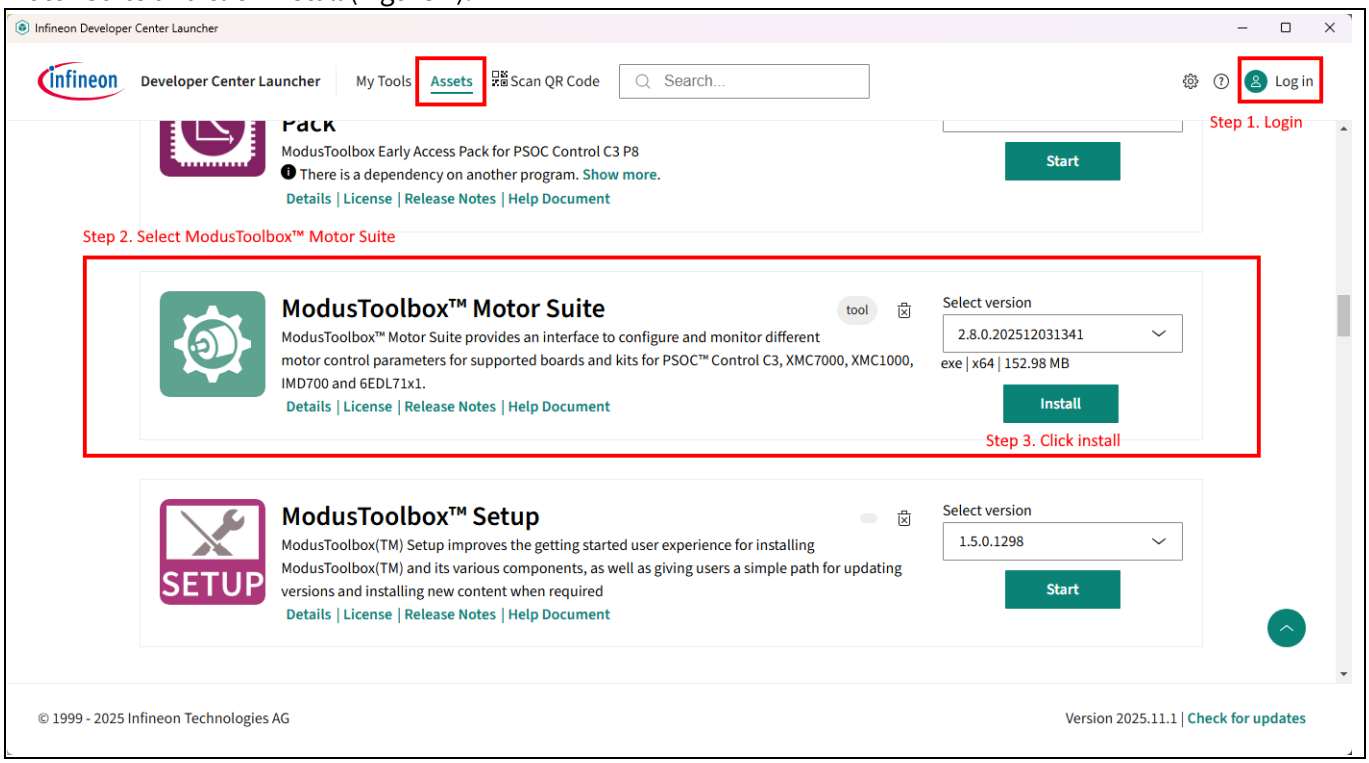

Figure 1 Infineon Developer Center

Once installation is complete, click Start to launch ModusToolbox™ Motor Suite **(Figure 2 and Figure 3).**

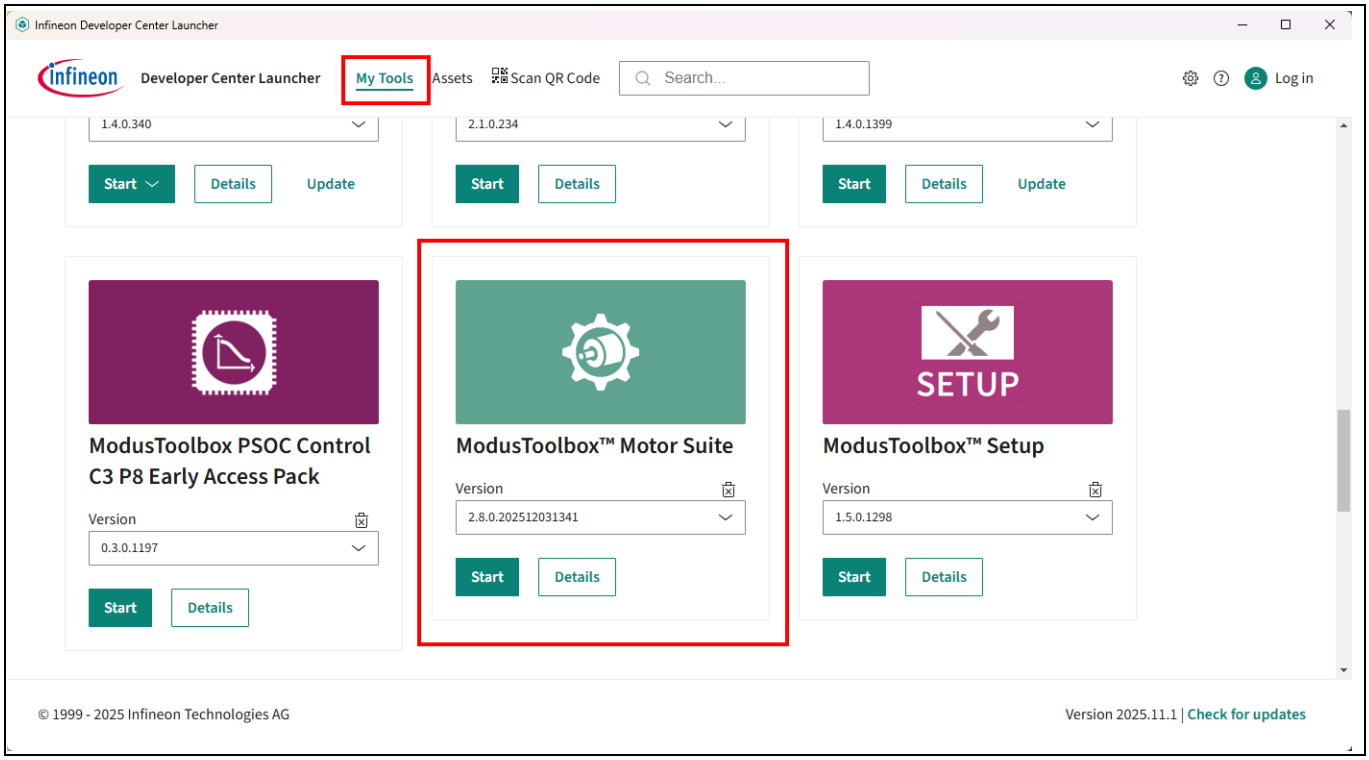

Figure 2 ModusToolbox™ Motor Suite in the developer center after installation

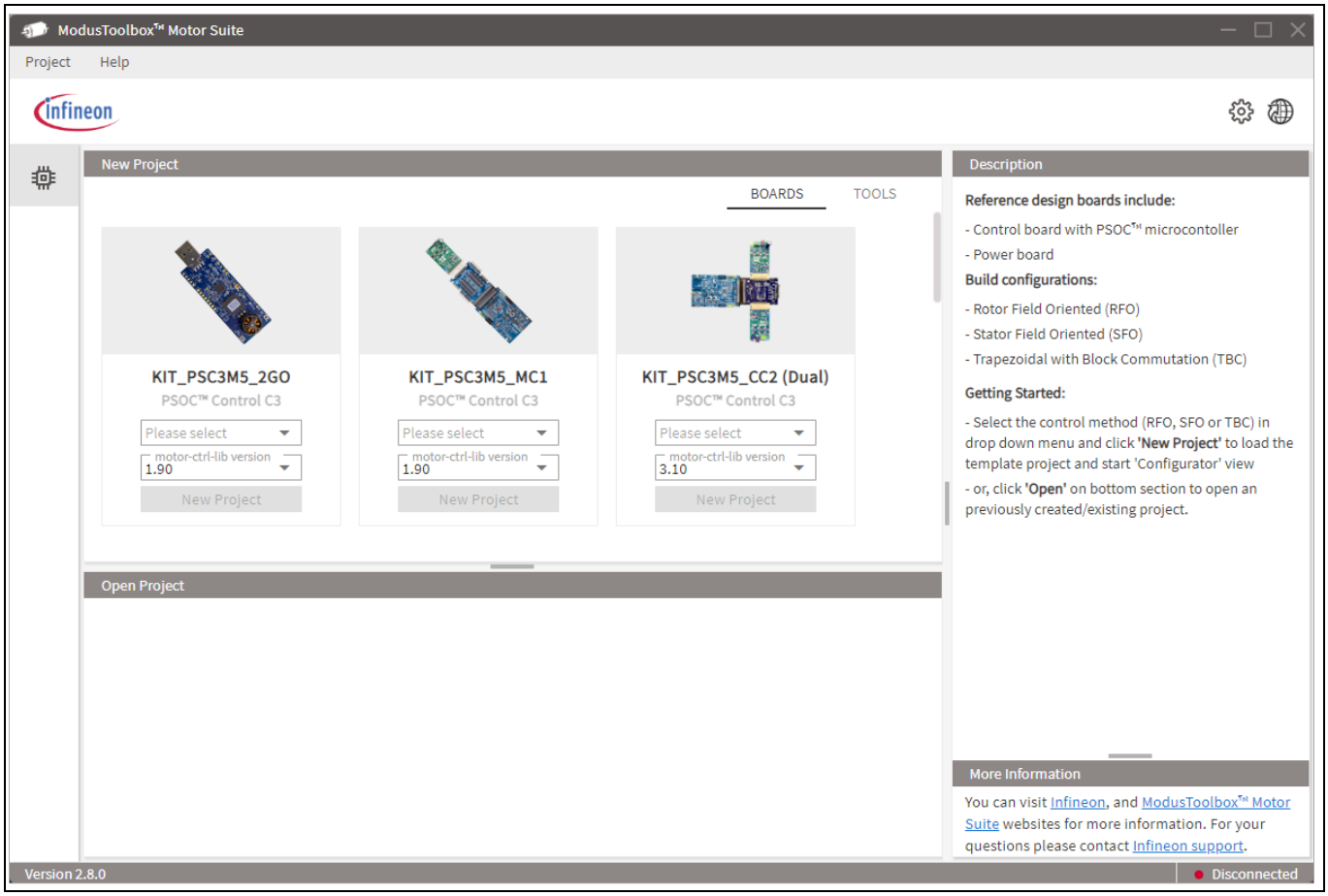

Figure 3 Getting Started page of Motor Suite

Another option is to install Motor Suite using the ModusToolbox™ Setup Tool. In the Setup Tool, select Motor Suite and click Next (see Figure 4). Follow the instructions to install and launch the GUI.

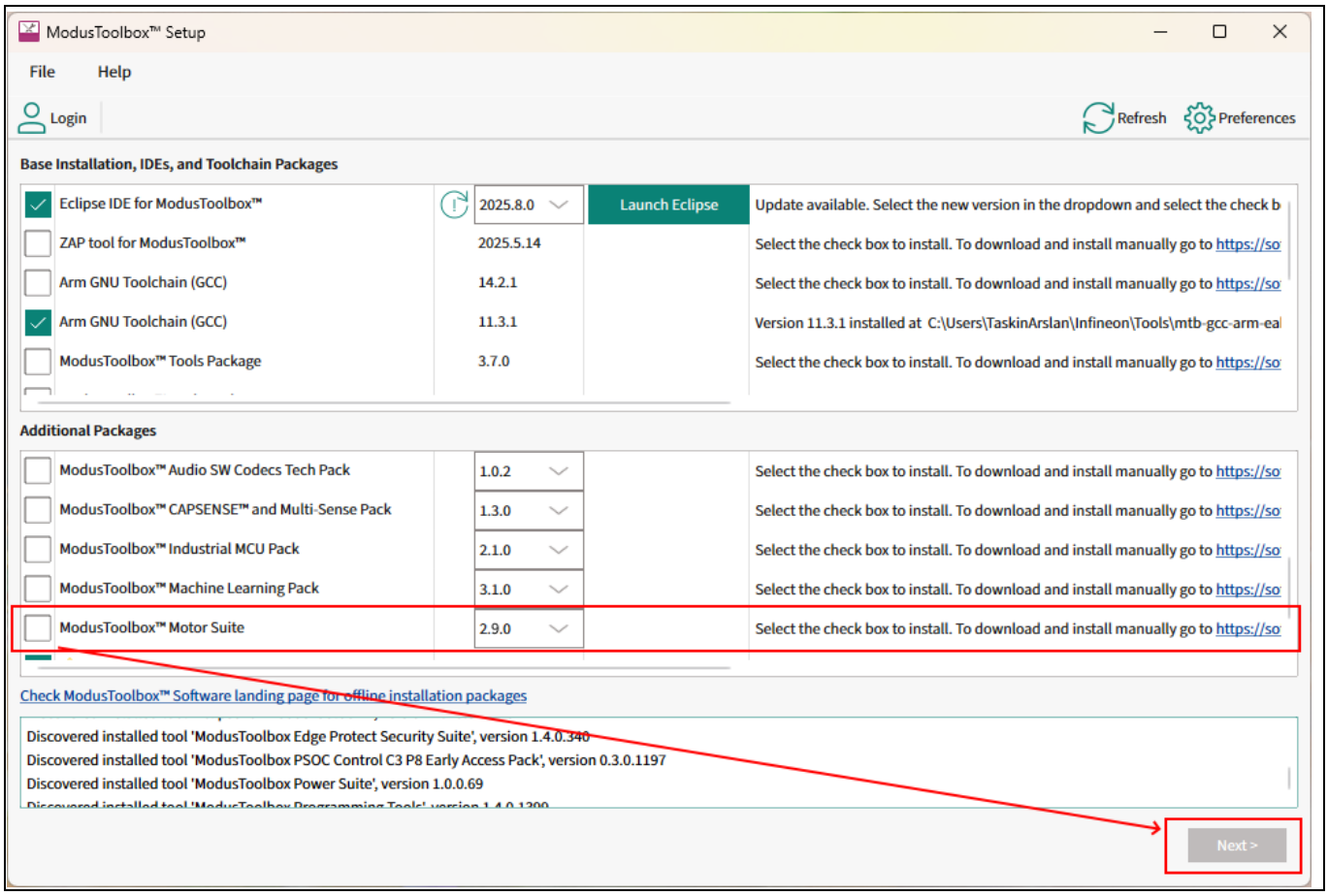

Figure 4 Install Motor Suite using ModusToolbox™ Setup Tool

ModusToolbox™ Motor Suite GUI has no additional software dependencies. However, after the first installation, the GUI checks for the J-Link USB driver. If the driver is missing, the GUI displays a pop-up window requesting installation confirmation (Figure 5). You must install this driver to communicate with the board; without it, device communication will not function.

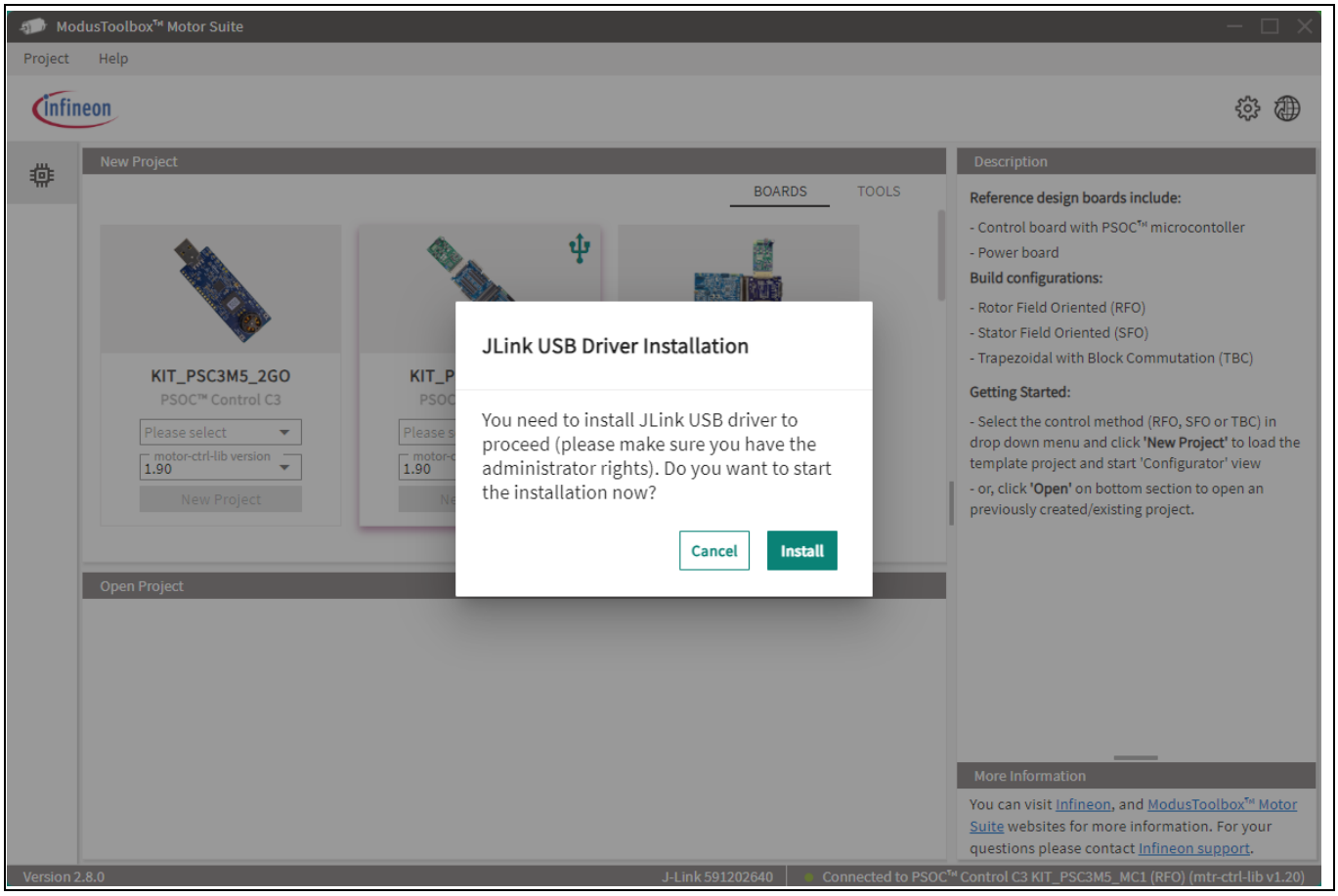

Figure 5 JLink driver must be installed to use the Motor Suite GUI

On first installation, an interactive user tour is displayed on each page (see Figure 6). The user tour introduces the user interface for first-time users.

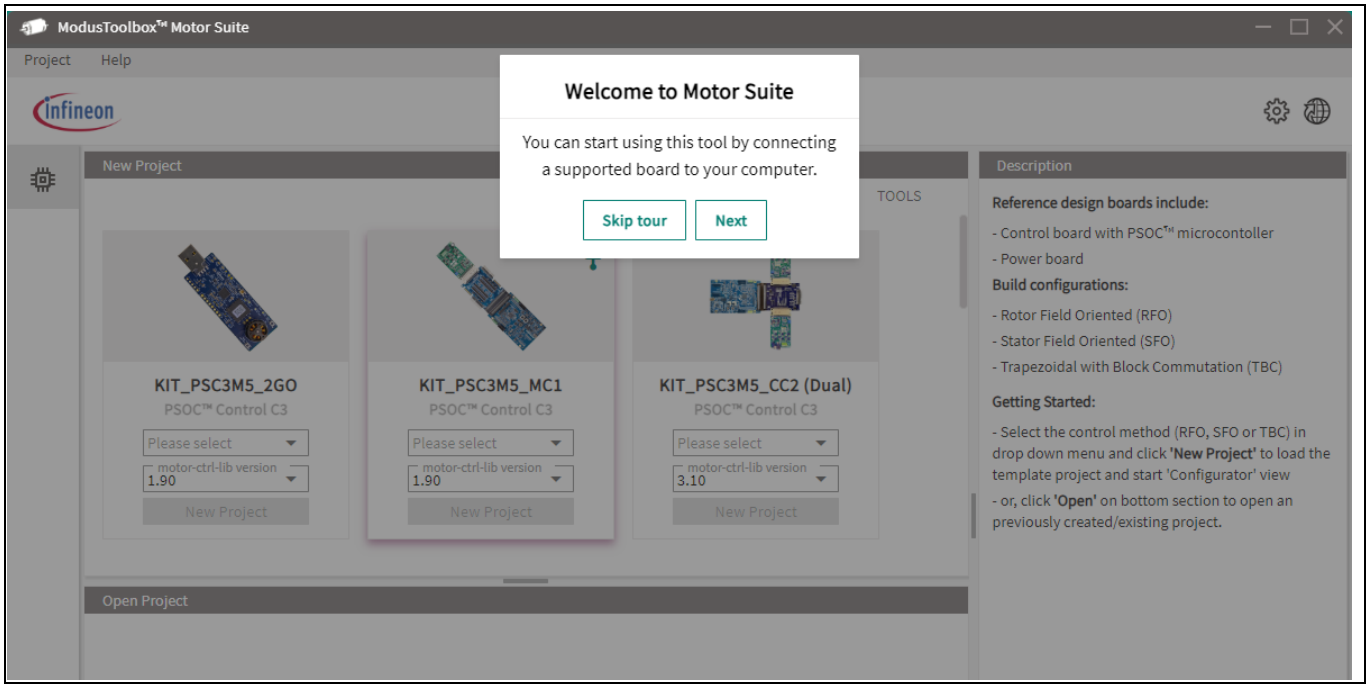

Figure 6 User tour for first time users

The user tour is shown only once. You can restart it for the active page from the Preferences window (Figure 7).

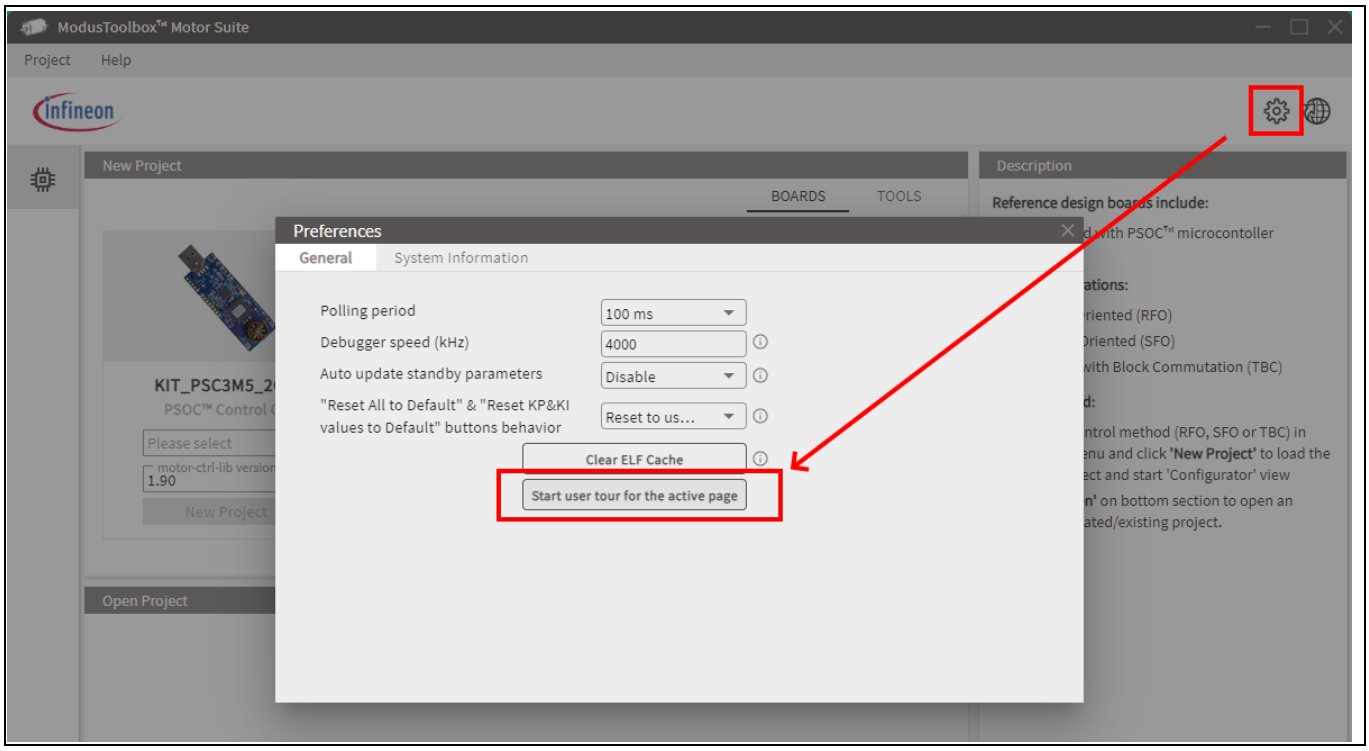

Figure 7 Start user tour for the active page

3 Creating a project

As the first step, connect the board to the PC using the USB cable. After you connect and power the board on, it will be displayed in the footer as “Connected with SN” (Figure 8), where SN is the serial number of the connected debugger. If you power the board on after opening the GUI, you need to select the SN using the dropdown at the bottom-right corner of the GUI. To display the dropdown, simply click on the “Disconnected” text.

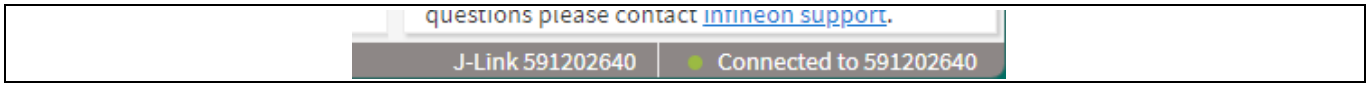

Figure 8 Board connection information

If one of the supported firmware images has already been flashed to the board, the GUI recognizes the firmware and shows the project type, firmware information, and debugger SN (Figure 9).



Figure 9 Board connection information if default firmware is flashed

If multiple boards are connected to the PC, the GUI connects to the first board it detects. If the selected board is not the board you want to work with, select the correct board manually. To disconnect from all boards, select the “Disconnect” option in the list (Figure 10).

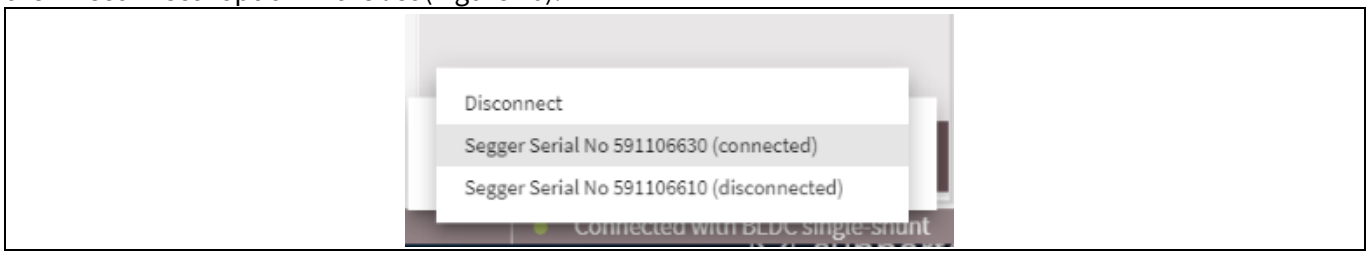

Figure 10 Board selection dropdown

You will also see that the project receives focus, and a USB icon is displayed at the top-right corner of the project card. This icon indicates that a board with one of the default firmware images is connected to the computer and that a connection is open (Figure 11).

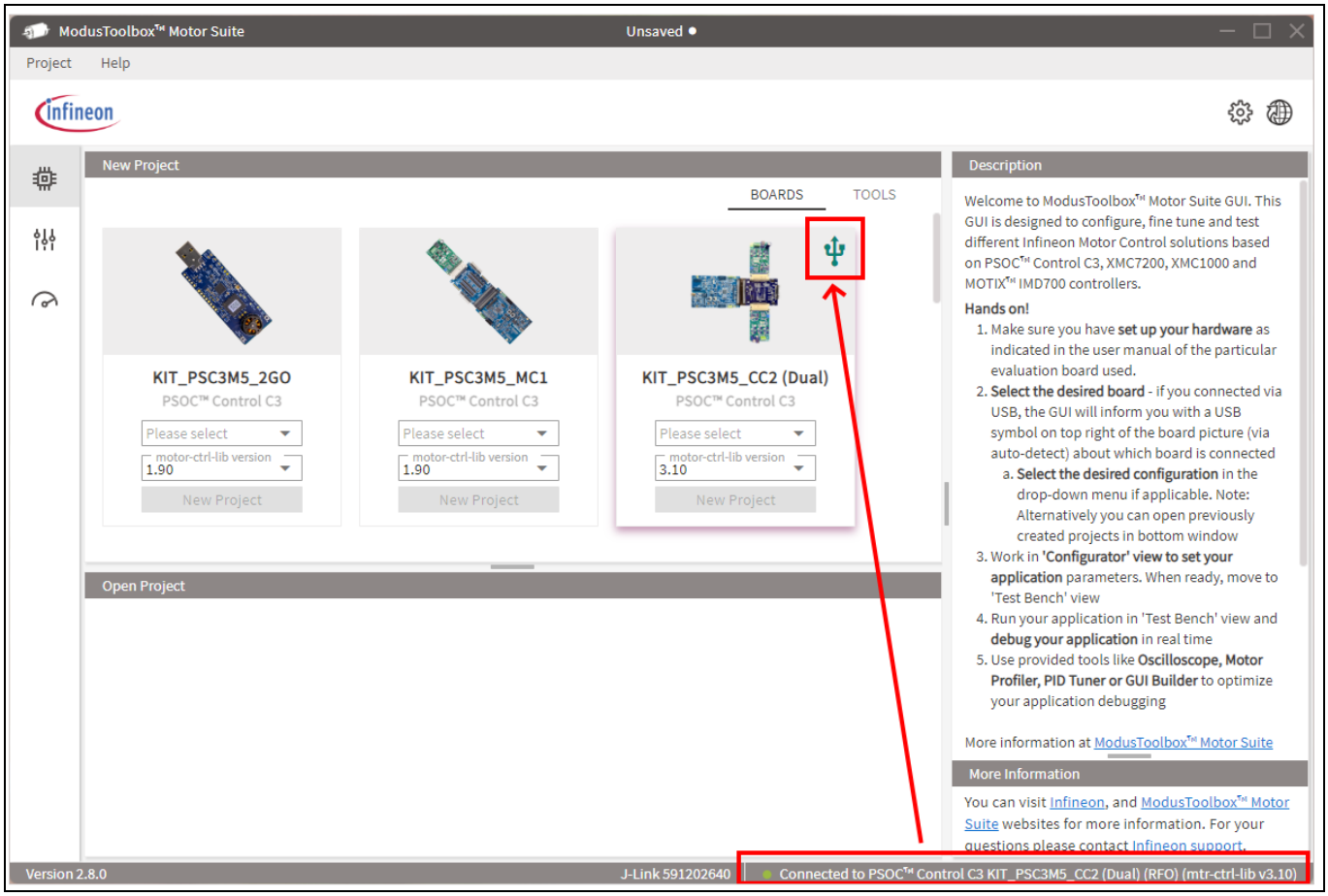

Figure 11 Icon shows that a board with one of the default firmware is connected

On the Getting Started page, after selecting one of the control methods (RFO, SFO, or TBC), click the New Project button under one of the projects (Figure 12). These three control methods are motor control options to choose from. RFO, SFO, and TBC stand for rotor frame-oriented, stator frame-oriented, and trapezoidal block commutation, respectively. Some projects provide more than one motor-ctrl-lib version. It is recommended to select the latest library version for new projects. Older versions are provided only for firmware projects that were already initiated with older library versions. To open an existing GUI project, select the project in the Open Project panel. For more information, see the Motor Control Library reference manual. To get started with the GUI, it is recommended to begin with RFO.

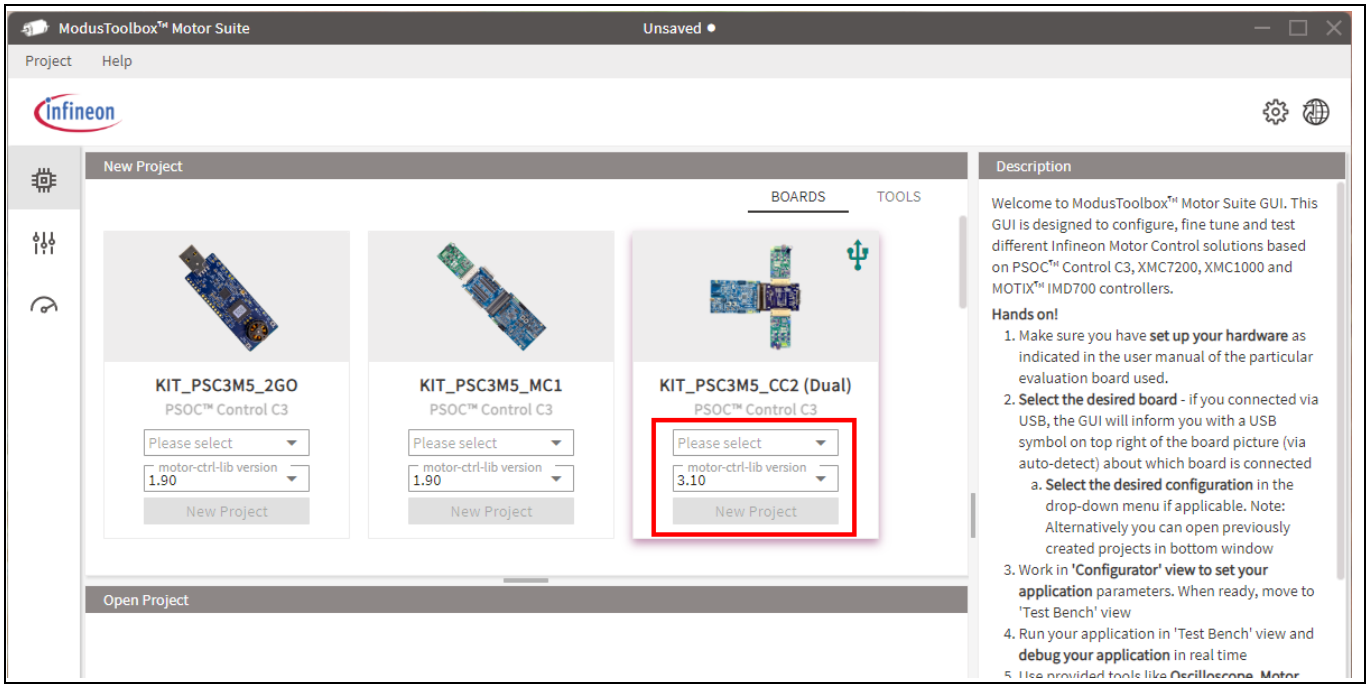

Figure 12 Creating a new project

4 Configurator

Use the Configurator page to configure the parameters of the selected project. There are two different layouts for the Configurator page. For 6EDL-only projects, you will see the 6EDL-only layout. For all other projects, you will see the general layout.

4.1 General layout

After clicking “New Project” button in the Getting Started page, the GUI will navigate to the Configurator page (Figure 13).

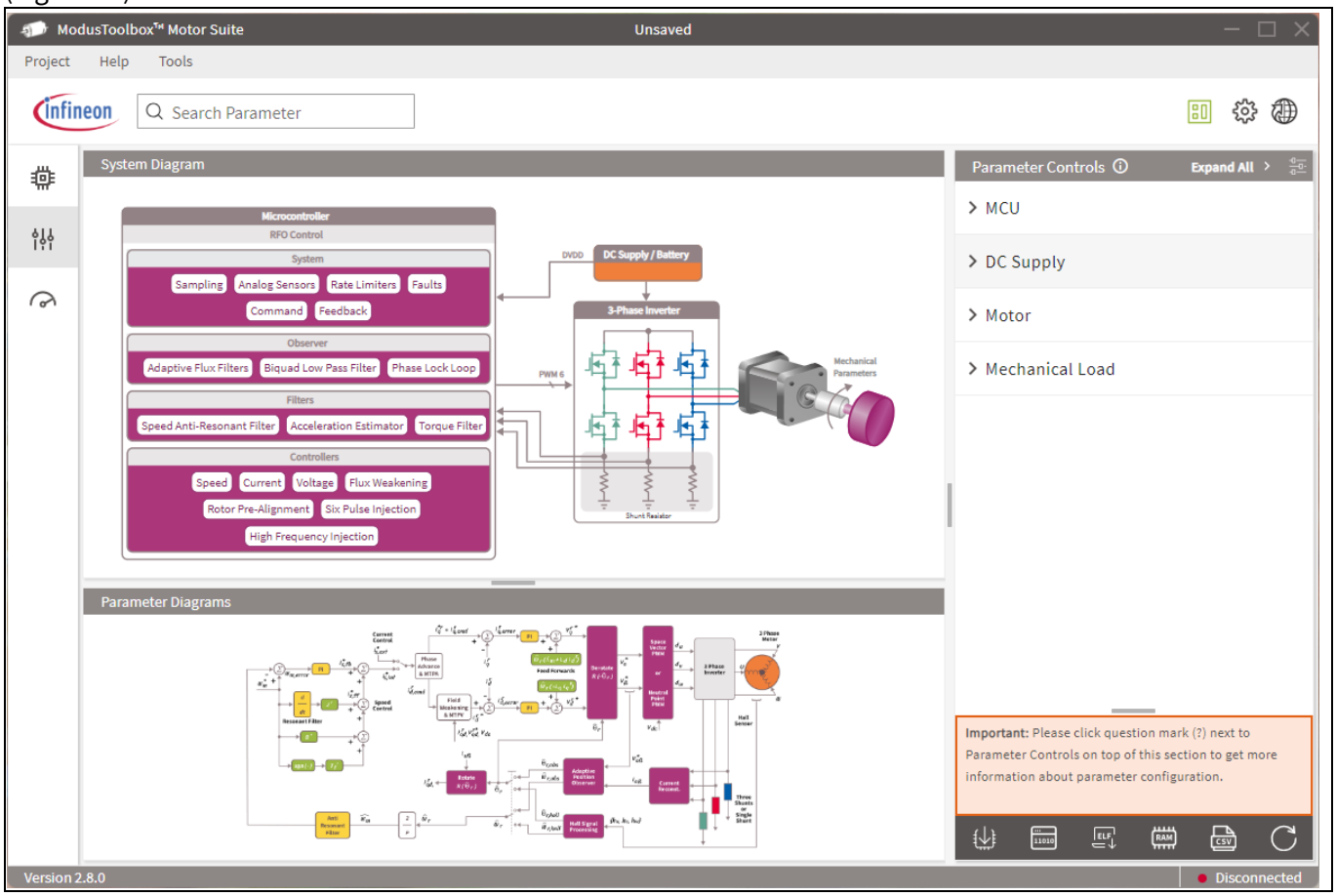

Figure 13 Configurator page

For projects that support multiple motors, a dropdown is displayed at the top-right of the Configurator and Test Bench pages (Figure 14). Use this dropdown to select the active configuration. For multiple-motor projects, all parameters hold multiple values for different motor configurations. On the Configurator and Test Bench pages, the values displayed in parameter inputs, gauges, indicators, text fields, and other components are for the active motor and configuration.

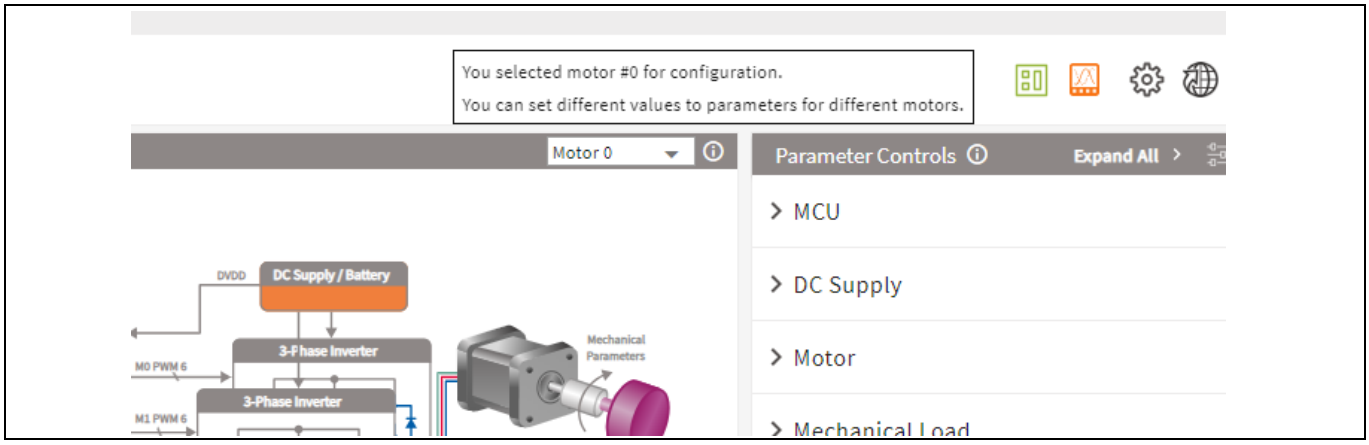

Figure 14 Select configuration for multiple motors supported project

On the Configurator page, there is a high-level block diagram of the motor control system. This diagram shows the main components, such as the microcontroller component, the blocks of these components, such as the observer block, and the subblocks of these blocks, such as the phase lock loop subblock. The components, blocks, and subblocks displayed in the system diagram are clickable; clicking one expands the corresponding parameters for that component, block, or subblock (Figure 15).

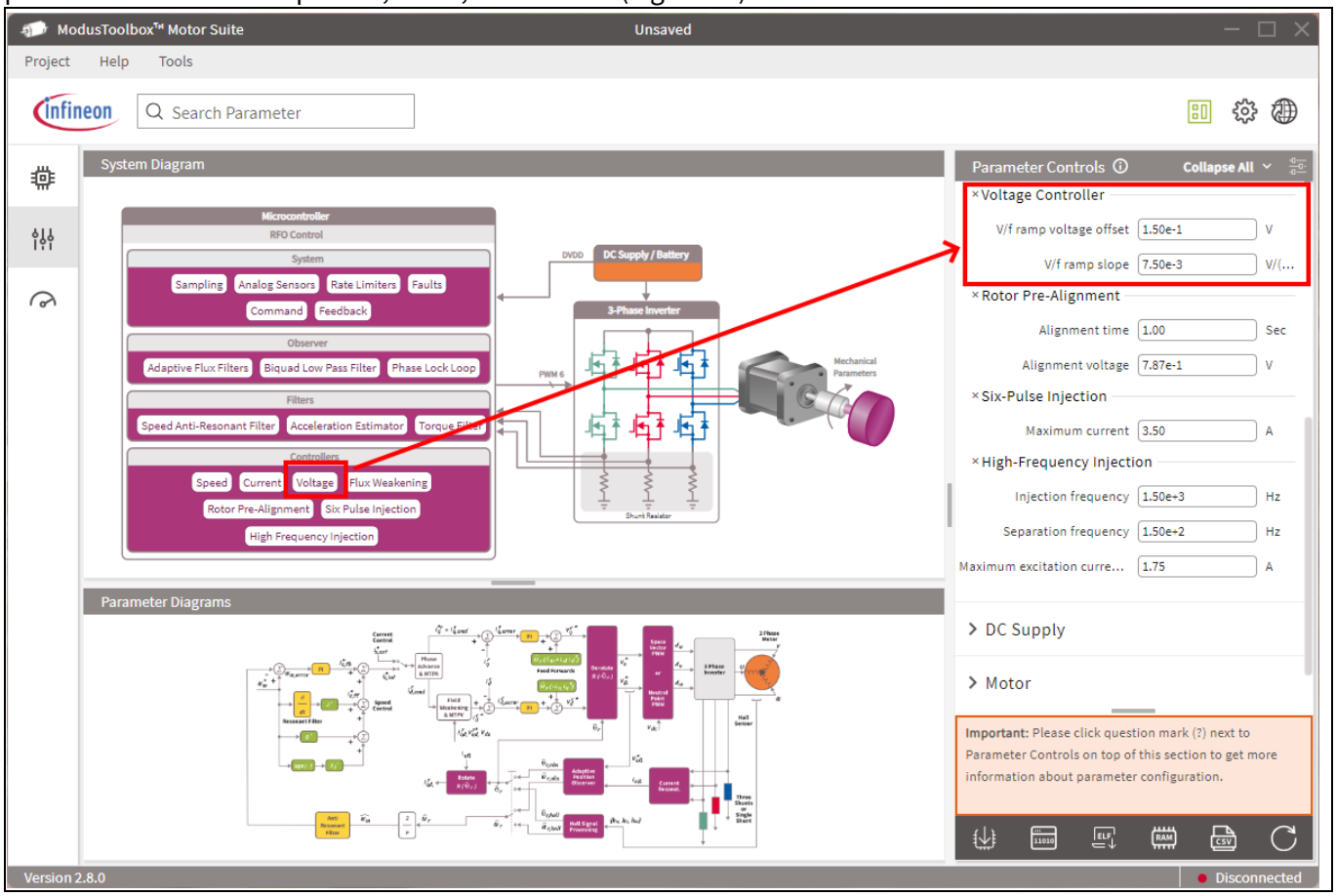

Figure 15 Open the parameter group by clicking the Voltage subblock

Clicking on “Expand All (Collapse All)” button expands (collapses) all the parameters in the panel (Figure 16).

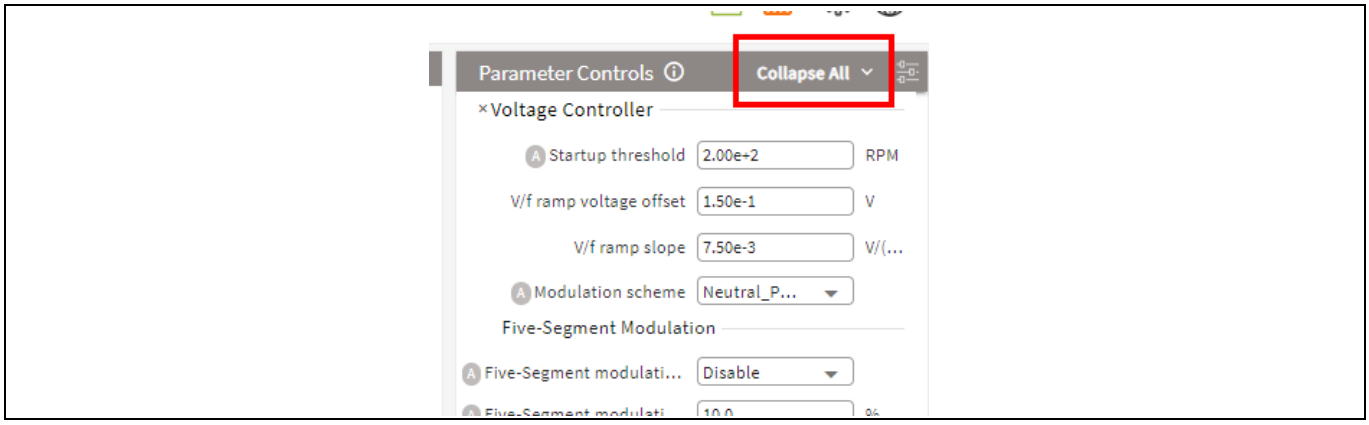

Figure 16 Expand/collapse parameter panel

There are 2 different parameter classes (Figure 17): Direct and Dependent.

- Direct Parameters: These are the parameters directly set by the user.
- Dependent Parameters: The values of these parameters are calculated automatically from the Direct Parameters.

The GUI displays parameters in two modes. The user selects one of these two views:

- Basic view: In this view mode, only direct parameters are shown. The user sets these parameters directly.
- Advanced view: This view mode is for advanced users only. The parameters shown in this view include all parameters shown in the basic view, dependent parameters marked with “DEP,” and advanced parameters marked with “A.” In advanced view mode, dependent parameters cannot be changed directly. Every time you change direct parameters and write them to the board, the dependent parameters change accordingly on the board. Click the “Read Parameters” button to read them and sync with the board.

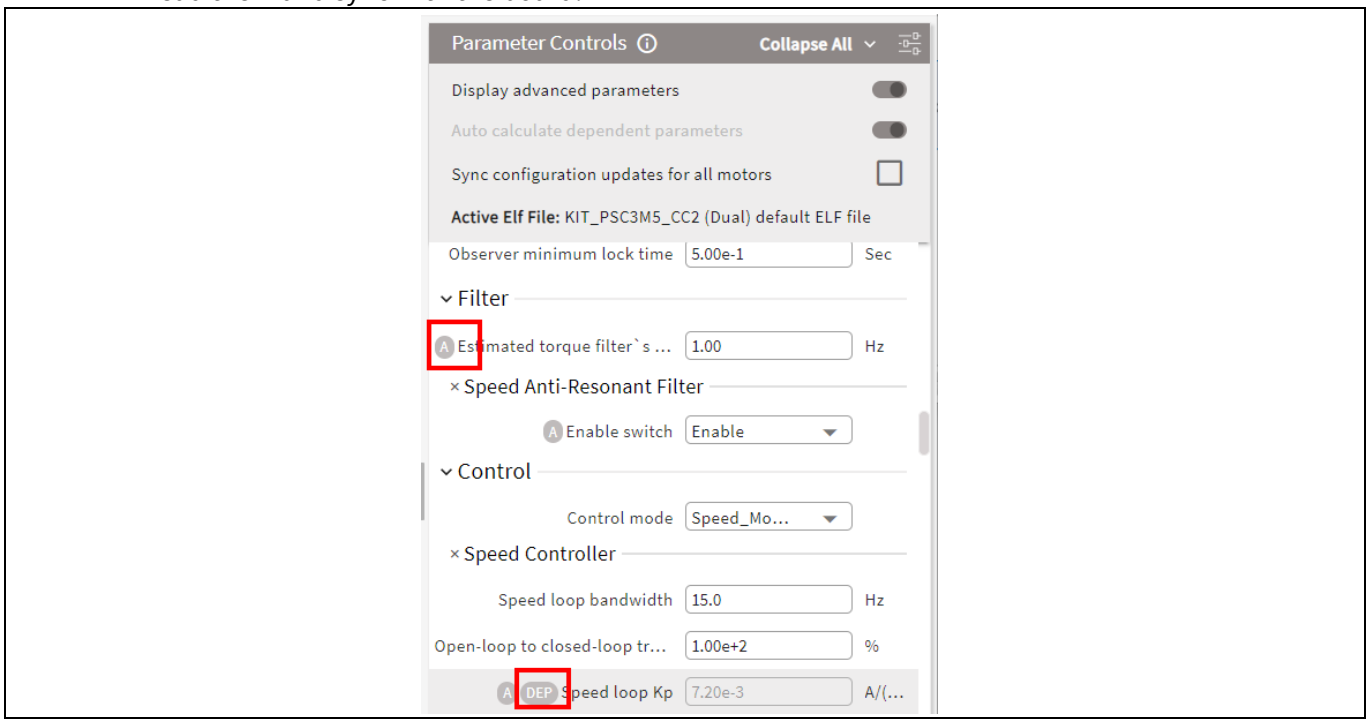

Figure 17 Parameter classes are shown with an icon next to parameter name

When you select a parameter, parameter description and class descriptions are shown in the description panel (Figure 18).

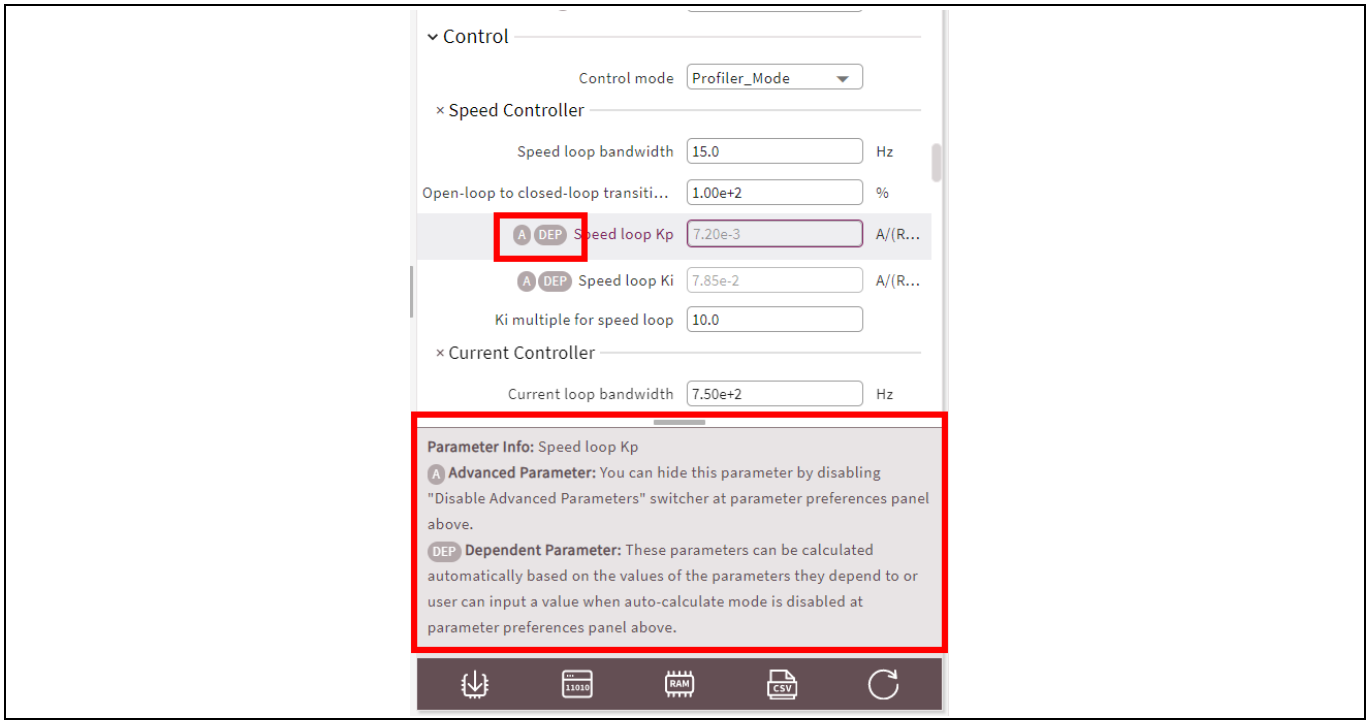

Figure 18 Further information on the selected parameter is displayed in the description panel

By default, Basic view is displayed. Switch to advanced view by clicking on the “Display Advanced Parameters” switcher (Figure 19).

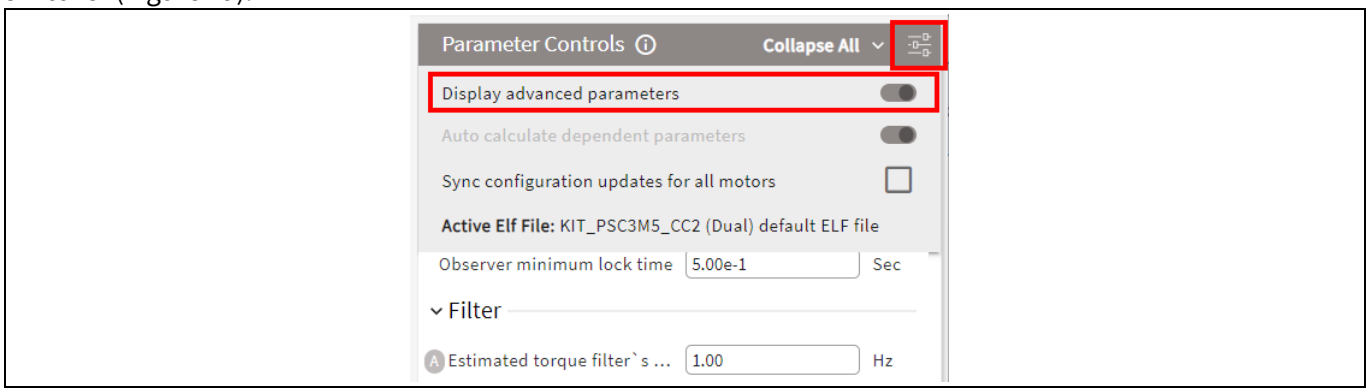

Figure 19 Display advanced parameters switcher

After clicking “Display Advanced Parameters”, all the parameters will be visible. Hide them again by switching off the same switcher.
For projects that support multiple motors, there is another preference in this section. If the user wants to update all configurations together, the “Sync configuration updates for all motors” checkbox must be selected (Figure 20). Parameter changes after this action will affect all configurations. Keep in mind that synchronous updates begin only after this setting is activated. No previous differences will be affected.

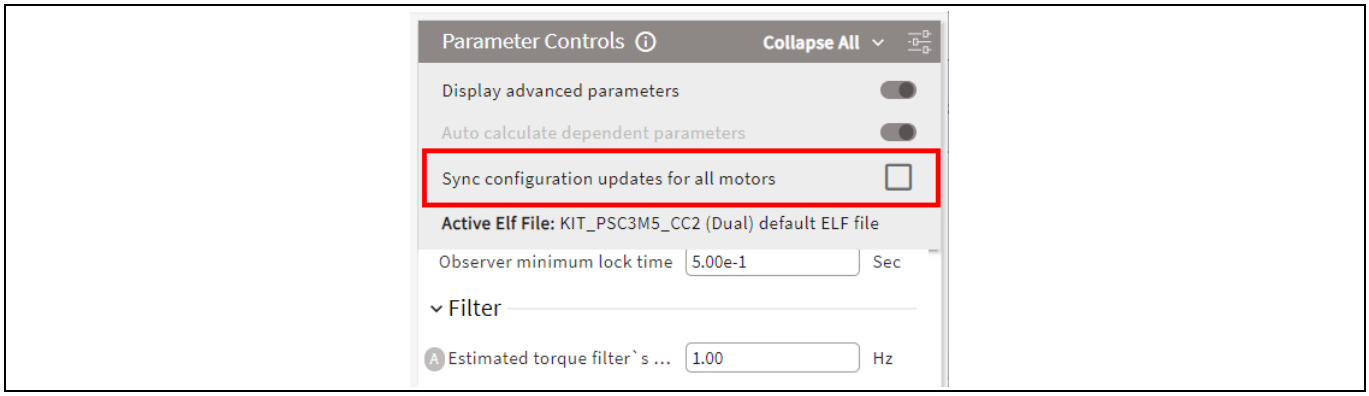

Figure 20 Sync parameter updates for multiple motor configurations

Default values are assigned to the parameters initially. Update them as required. To update, click the parameter and select the value from the dropdown list (Figure 21).

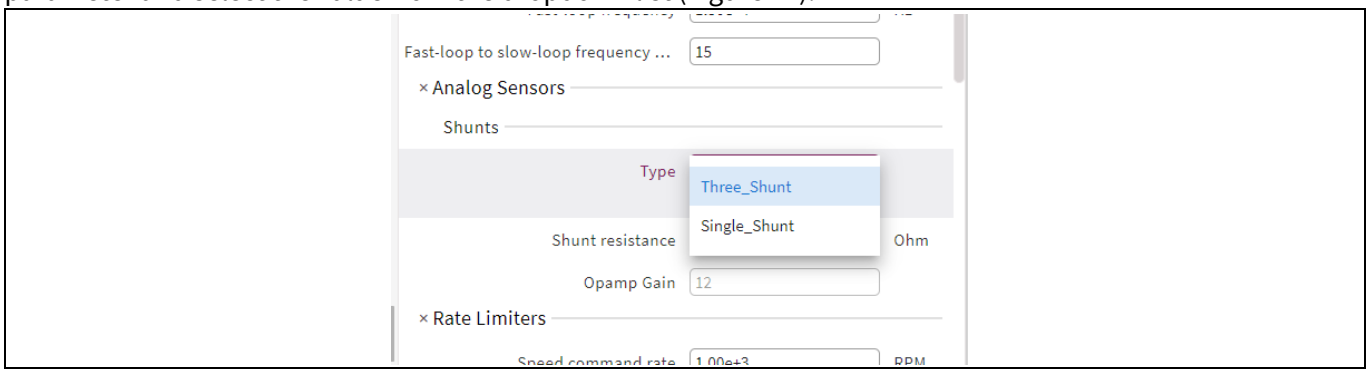

Figure 21 Change the default parameter values

For some parameters, numeric values must be entered within the minimum and maximum range. Click the parameter label to display the range of the selected parameter and enter a value manually within the range shown. You can also set the value by clicking the default, min, and max buttons (Figure 22).

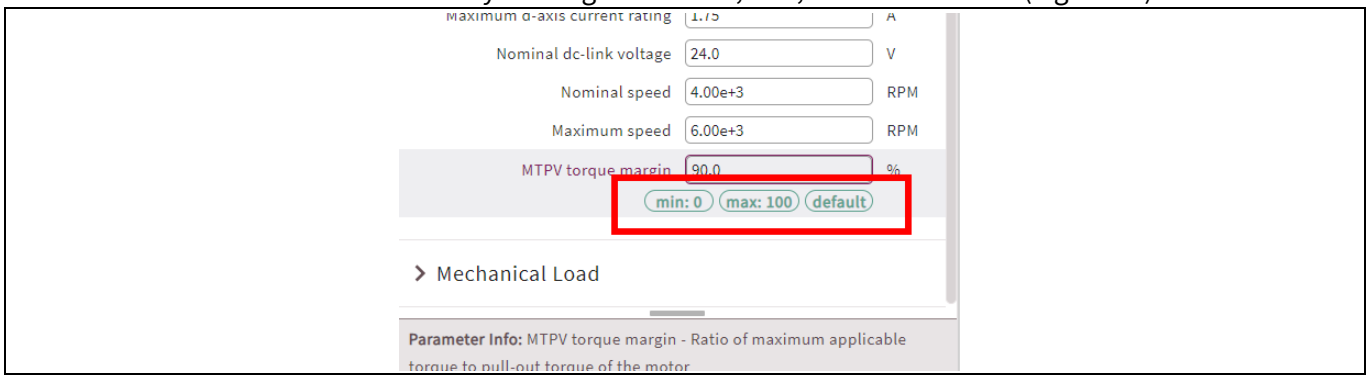

Figure 22 Min/Max values help user to input correct value

If a parameter value is different from the last saved value, or from the default value if the project has not been saved yet, a dirty-state marker is displayed next to the parameter label, on its parent block label if present, and on its parent component label (Figure 23). If at least one parameter is dirty, the project is also marked as dirty and must be saved to keep the latest changes.

Note: Dirty marker does not show the difference between the board value and the GUI value.

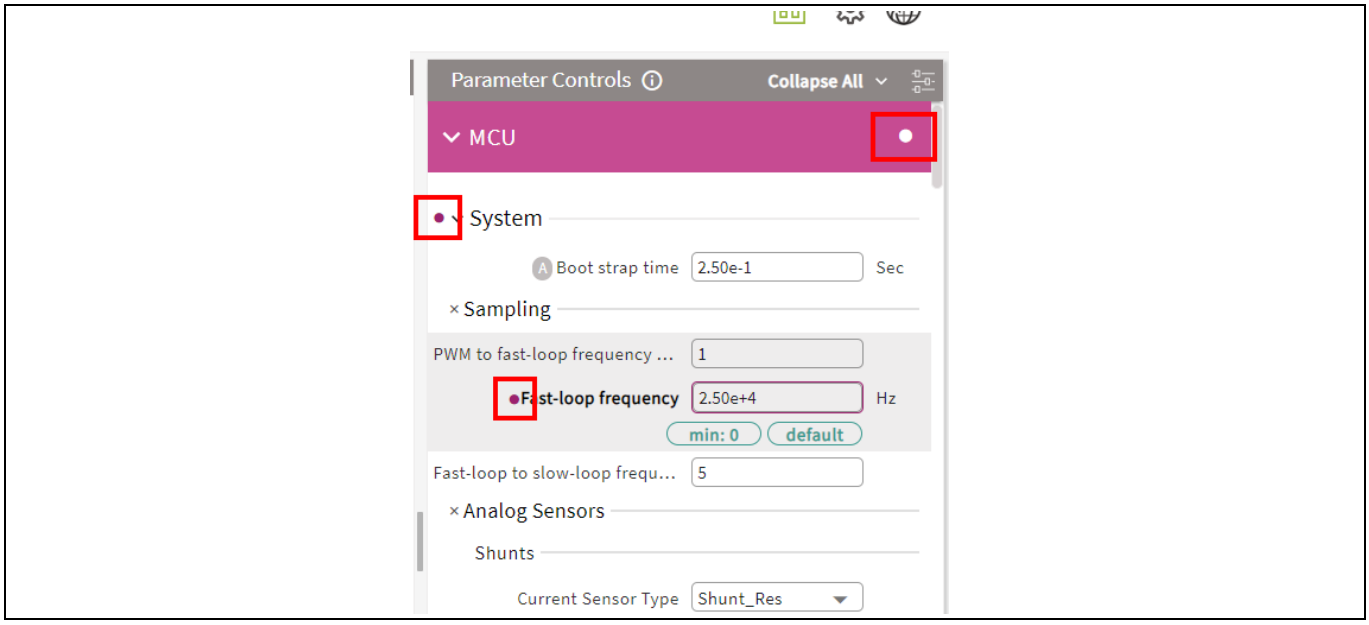

Figure 23 Dirty markers indicate that the parameters are different than the last saved values.

Reset the edited parameters back to default values by clicking “default” button (Figure 24). This button always resets the value to the initial project value, assigned after creating a new project.

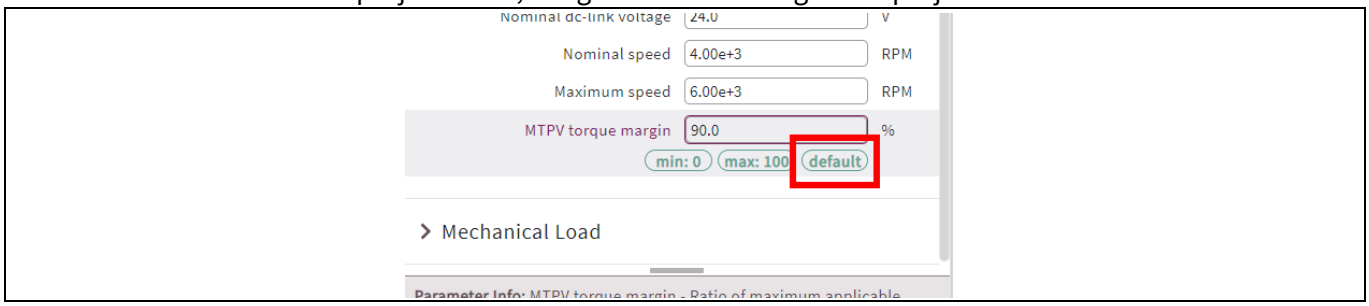

Figure 24 “default” button is used to reset the changed value to the default value.

Some parameters have information diagrams shown under the block diagram (Figure 25). View the diagram for the parameter by clicking on the parameter.

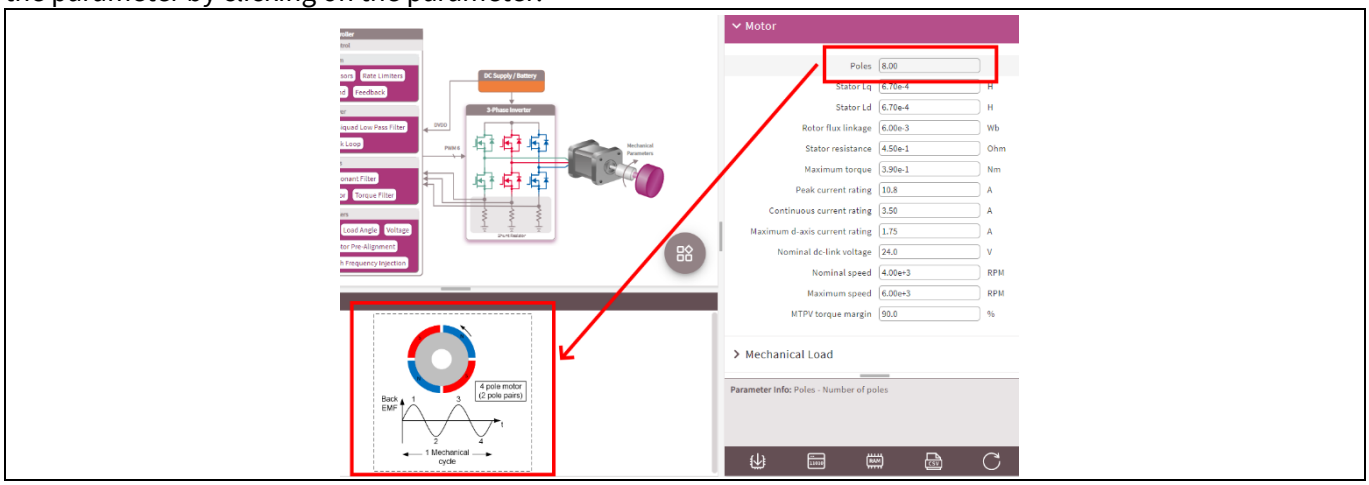

Figure 25 Image showing the Parameter Diagram for Poles.

For more information about how to configure parameters, click on the question mark icon next to the panel header (Figure 26).

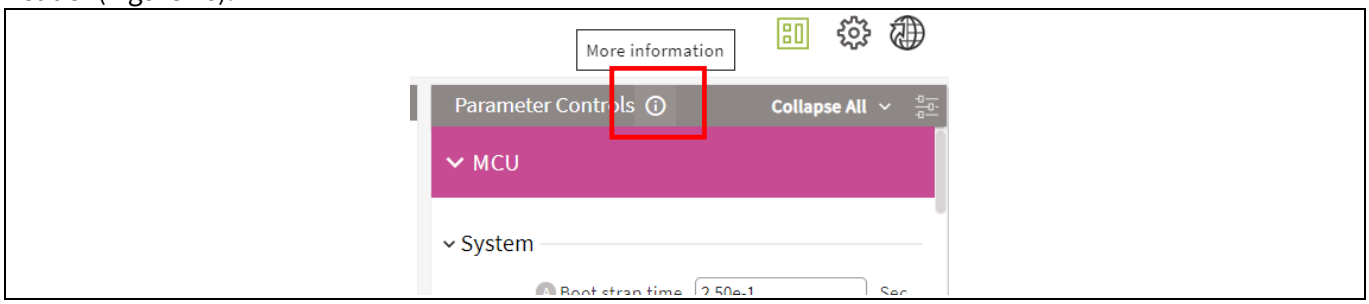

Figure 26 Click the icon for more information about configuring the parameters

A new window, with further information about configuring the parameters, will be displayed after clicking this icon (Figure 27).

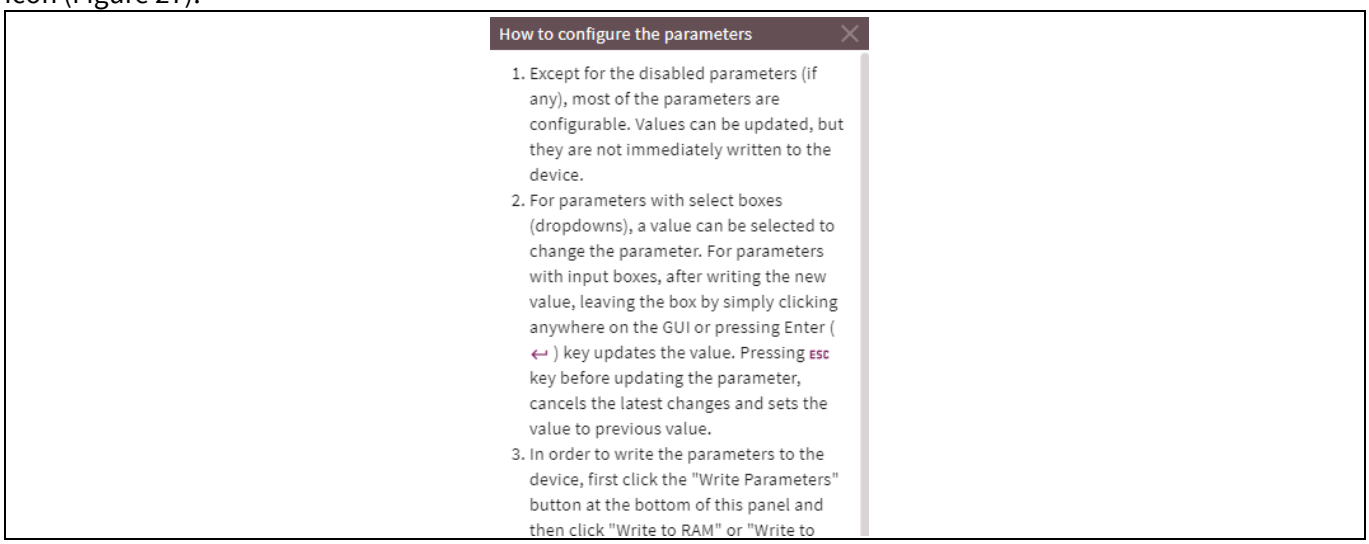

Figure 27 More information window

Once all the parameters are updated, save the project by opening the “Project” menu at the menu bar, and click the “Save” button (Figure 28). Use keyboard shortcut Control + S as an alternative.

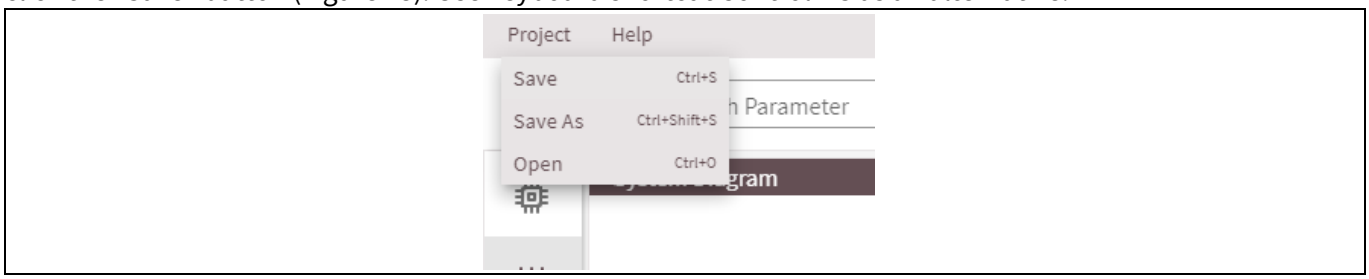

Figure 28 Save the configured parameters

Before writing the parameters, the default firmware must be flashed to the board. To flash the default project .hex file, click “Flash Firmware” button (Figure 29).



Figure 29 Flash application firmware

A popup message is displayed as shown below (Figure 30). Click ‘‘Default’ button to flash the default project ".hex" file to the board.

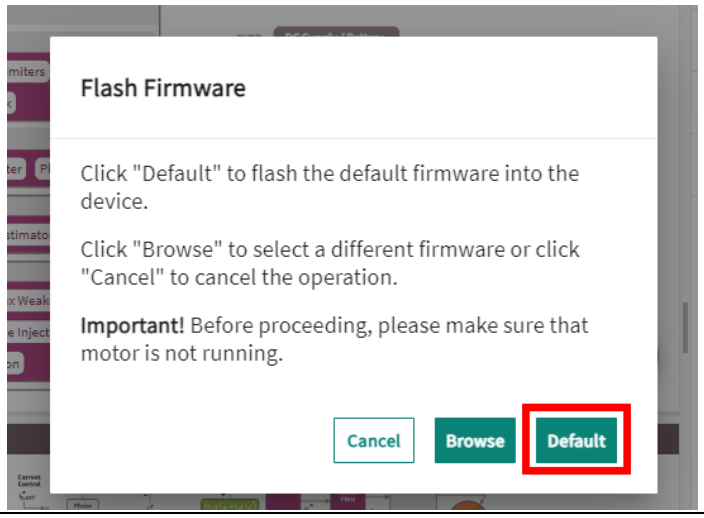

Figure 30 Flash default application firmware into the board

A confirmation message is displayed stating that flash is successful at the bottom-right (Figure 31) after successfully completing programming the device.

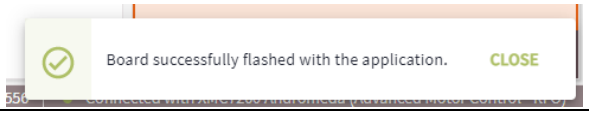

Figure 31 Image showing "flash is successful" message

To flash other .hex files to the board click "Browse" button and select the hex file (Figure 32 and Figure 33).

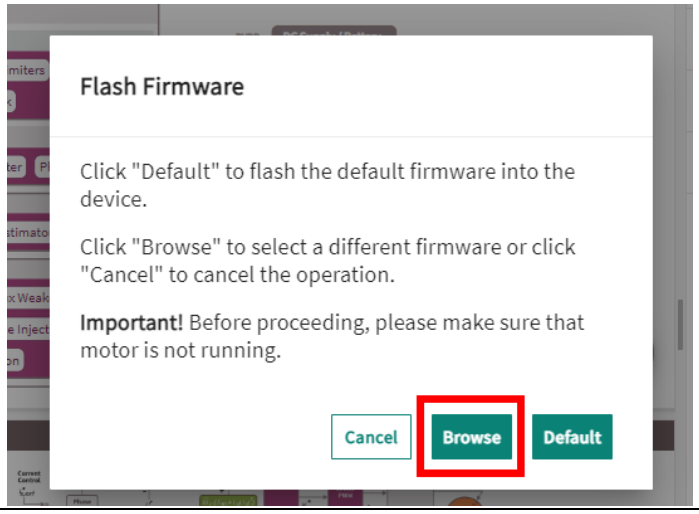

Figure 32 Image showing Browse button to select a different hex file

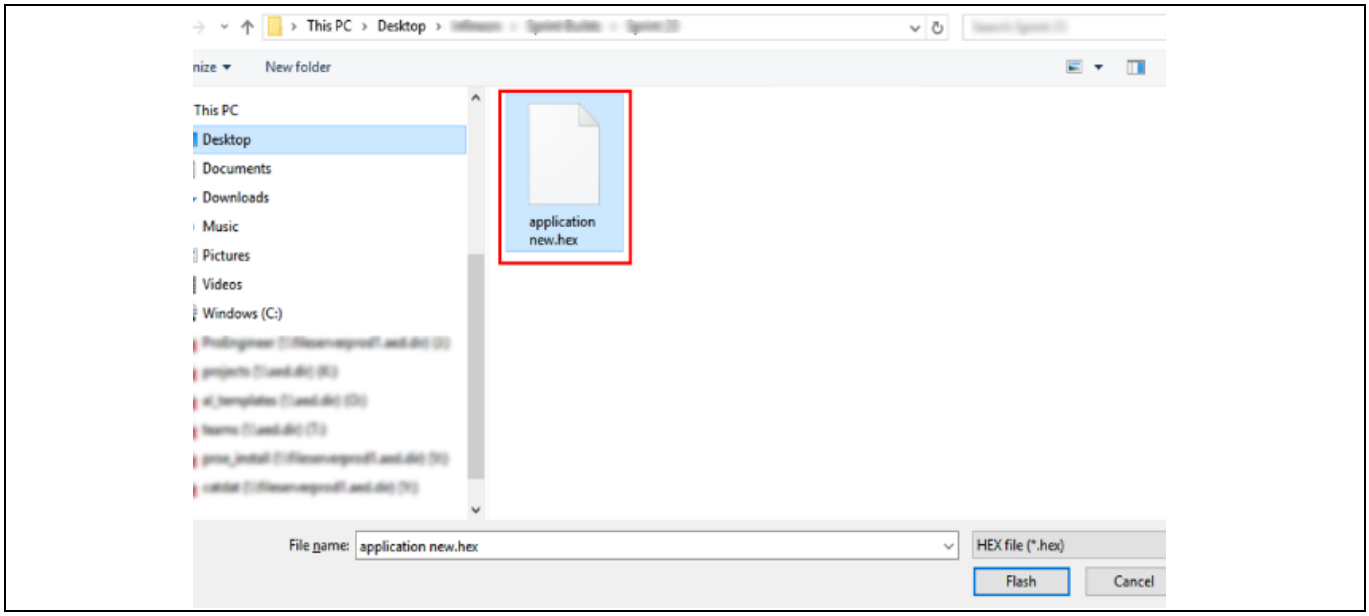

Figure 33 Select the .hex file to flash the board

After successful flash, GUI displays a second window to select the ELF file for the flashed firmware (Figure 34).

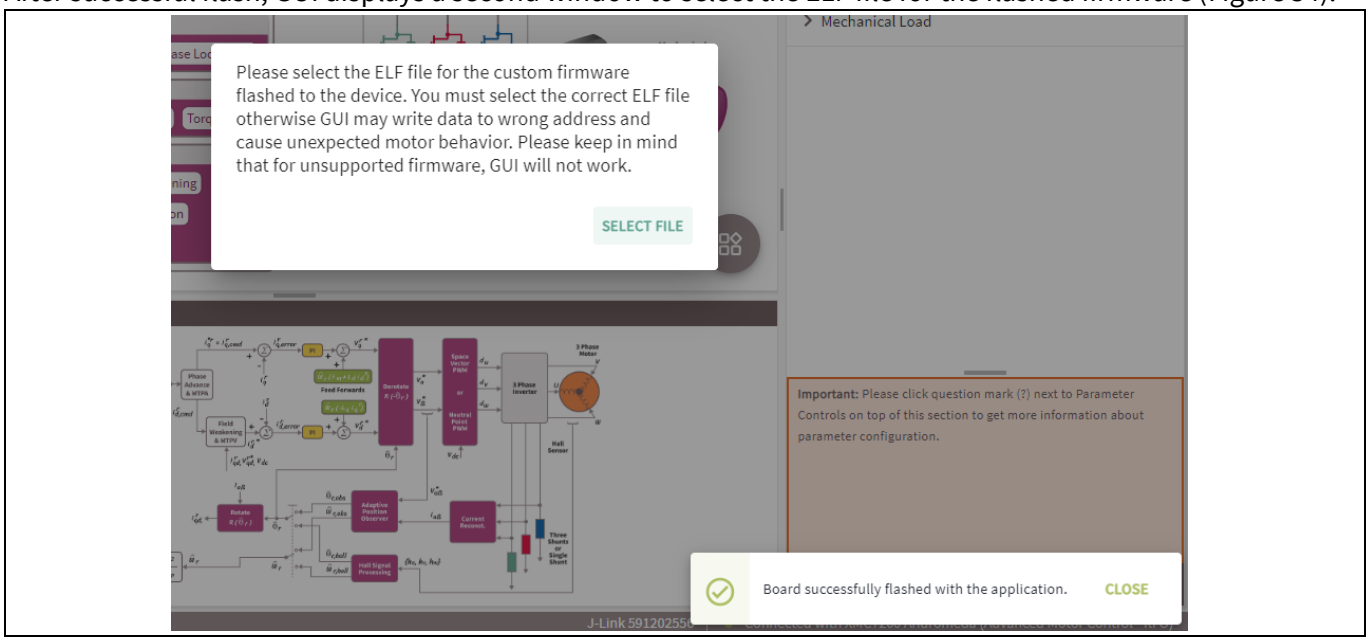

Figure 34 Select the ELF file for the flashed custom firmware

After selecting the ELF file, GUI tries to read the information from the ELF file (Figure 35) and displays a success message if parsing is successful (Figure 36).

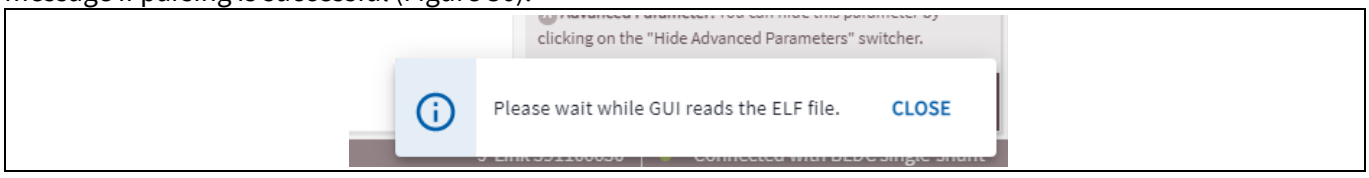

Figure 35 Wait while GUI reads the ELF file

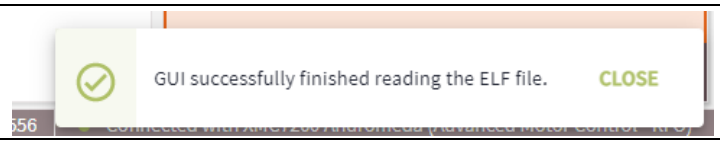

Figure 36 ELF reading completed

When working with custom firmware, GUI watches the ELF file for changes. If changes are detected, a popup window appears asking to reload the ELF data (Figure 37). If board is already programmed with the updated firmware, use the “Reload” button to update the ELF data in the GUI.

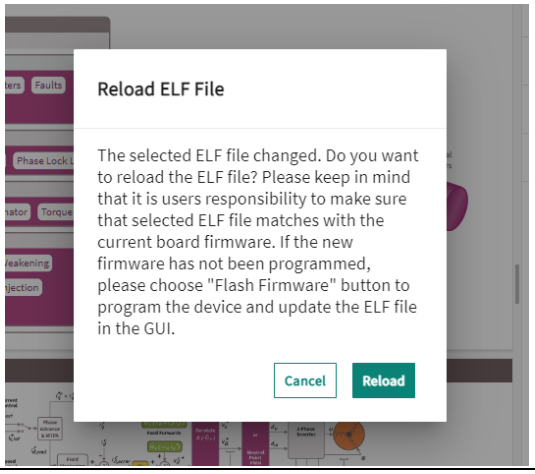

Figure 37 ELF file change detection

Even if no change is detected for the custom firmware, when ELF data needs to be updated, use the “Select ELF File” button to update the ELF data (Figure 38).

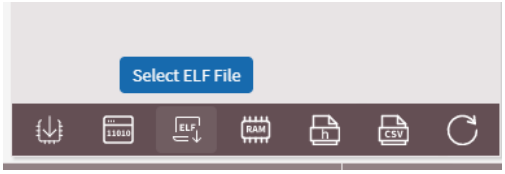

Figure 38 Select a different ELF file

The selected active ELF file is displayed in the parameter preferences panel. The GUI can have only one active ELF file at a time. All projects and tools, such as the oscilloscope and LiveMonitor, use the same selected ELF file.

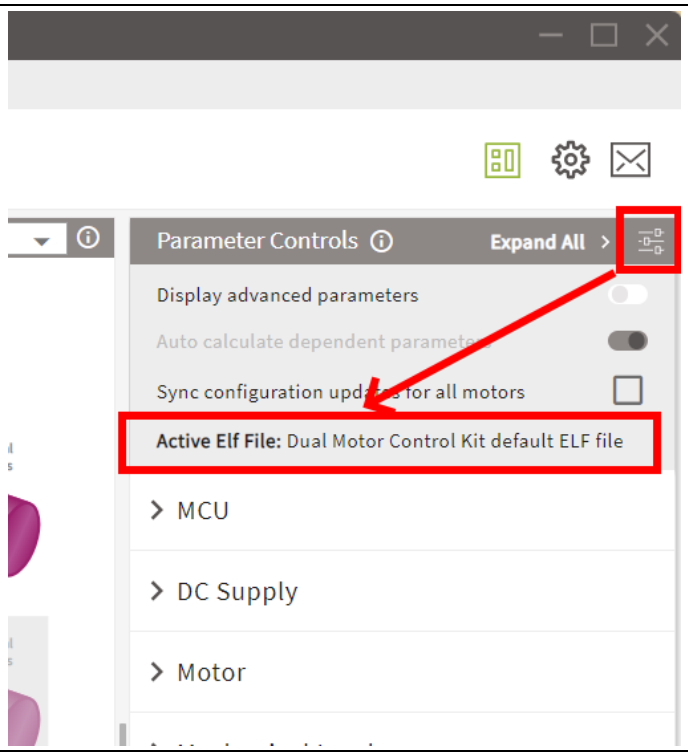

Figure 39 Display active ELF file

You also have an option to reset all the parameters to the default values. In order to reset all the parameter values to the default values, click on “Reset All to Default” button (Figure 40).



Figure 40 Reset all configured values back to default values

Initially default values are the values defined as the initial project values in GUI. After saving the project, default values are the saved values. If you still want to reset back to original GUI defaults, you can change the behavior of “Reset All to Default” button in the preferences window (Figure 41).

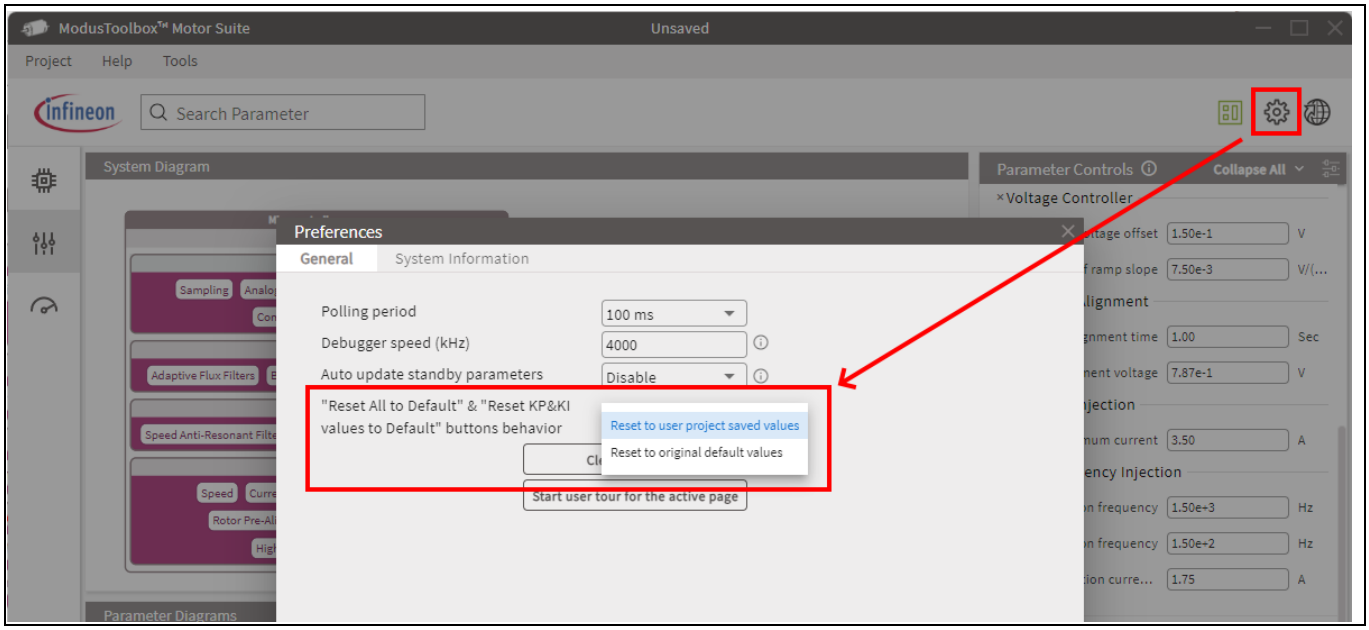

Figure 41 Change reset all behavior in preferences window

To read the values in the board, use “Read Device” button (Figure 42). The values seen in the GUI are project values. These values are either previously saved values, or default values (if the project has not been saved yet). Click this button to retrieve the values from the device. This button will sync the values between the GUI and the board.

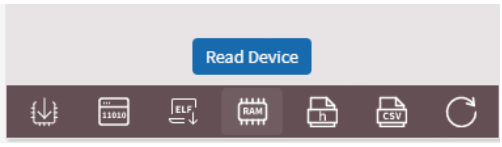

Figure 42 Read parameters from the device

To write the parameter values to the board, click “Write Parameters” button (Figure 43).



Figure 43 Write values to the device

A pop-up window is displayed highlighting the firmware parameter names, existing values in the board and new values if different than the existing values (Figure 44).

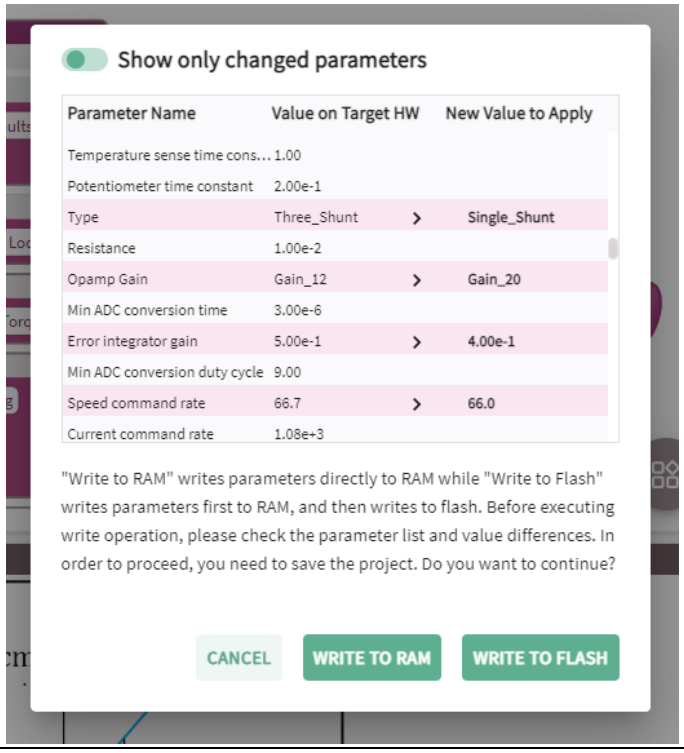

Figure 44 Parameter list to show the value updates

Display only the changed parameters by clicking on “Show only changed parameters” switch (Figure 45).

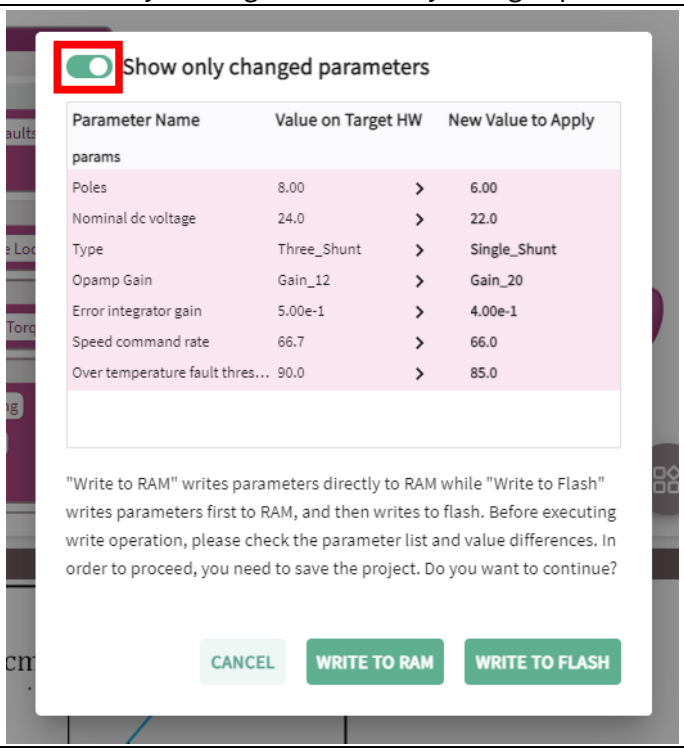

Figure 45 Parameter list to show the value updates

“Write to RAM” writes values to RAM on the board, while “Write to Flash” first writes the values to RAM and then saves them in flash. Click the “Write to RAM” button. If the operation is successful for all parameters, a confirmation message is displayed (Figure 46).

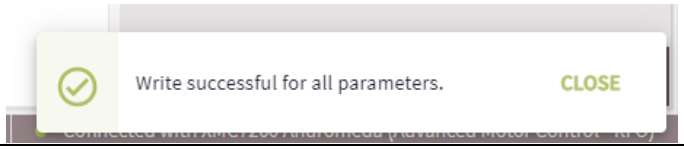

Figure 46 Writing is successful

Note: ***Motor must be stopped before writing the parameters****, otherwise, a warning dialog window will be displayed.*

At this step, disable the drive and continue writing, or cancel the operation (Figure 47).

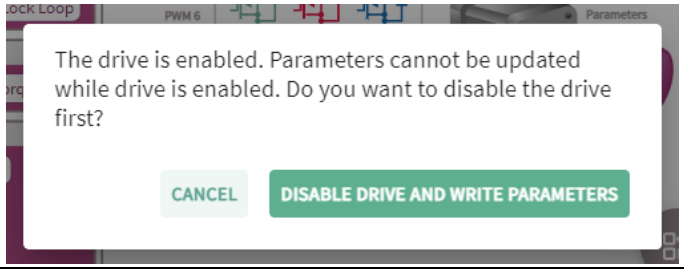

Figure 47 Warning to prevent updating parameters when motor is running

To export parameter values as a comma-separated file (csv) file, click on “Export as .csv” button (Figure 48). Parameters and their values will be saved as a “.csv” file to the selected location. Open the .csv file using a spreadsheet application or a text editor.



Figure 48 Export parameters to a .csv file.

For the supported projects, export the parameters as a header, or as a c file. To export parameter values as a header file (h) file, click on “Export as .h” button (Figure 49). Parameters and their values will be saved as a “.h” file to the selected location. Use this file inside the firmware project (i.e. BSP code examples in ModusToolbox™ IDE).

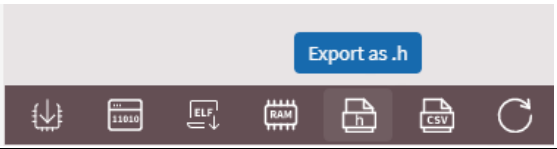

Figure 49 Export parameters as a .h file

For projects supporting multiple motors, there’s another button (Compare Configurations - Figure 50) to compare different configurations. Configure each motor parameter separately. Use this button to see the differences between configurations. In the popup window displayed after pressing this button (Figure 51), copy the values from one configuration to the other for selected parameters. There’ll be an active checkbox next to the parameters having different values for selected configurations. If you want to copy this value (value displayed in the 1st column) to the selected configuration (2nd column), select the checkbox and click the “Update selected parameters” button.

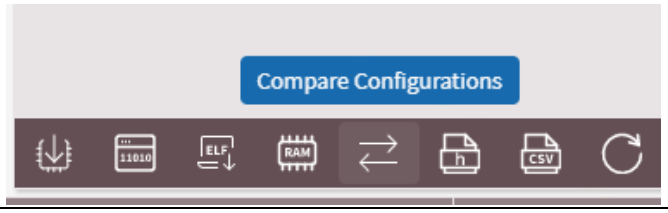

Figure 50 Compare selected configurations

Select the checkbox on the top (“show only parameters with different configurations”) to display only the parameters with different values.

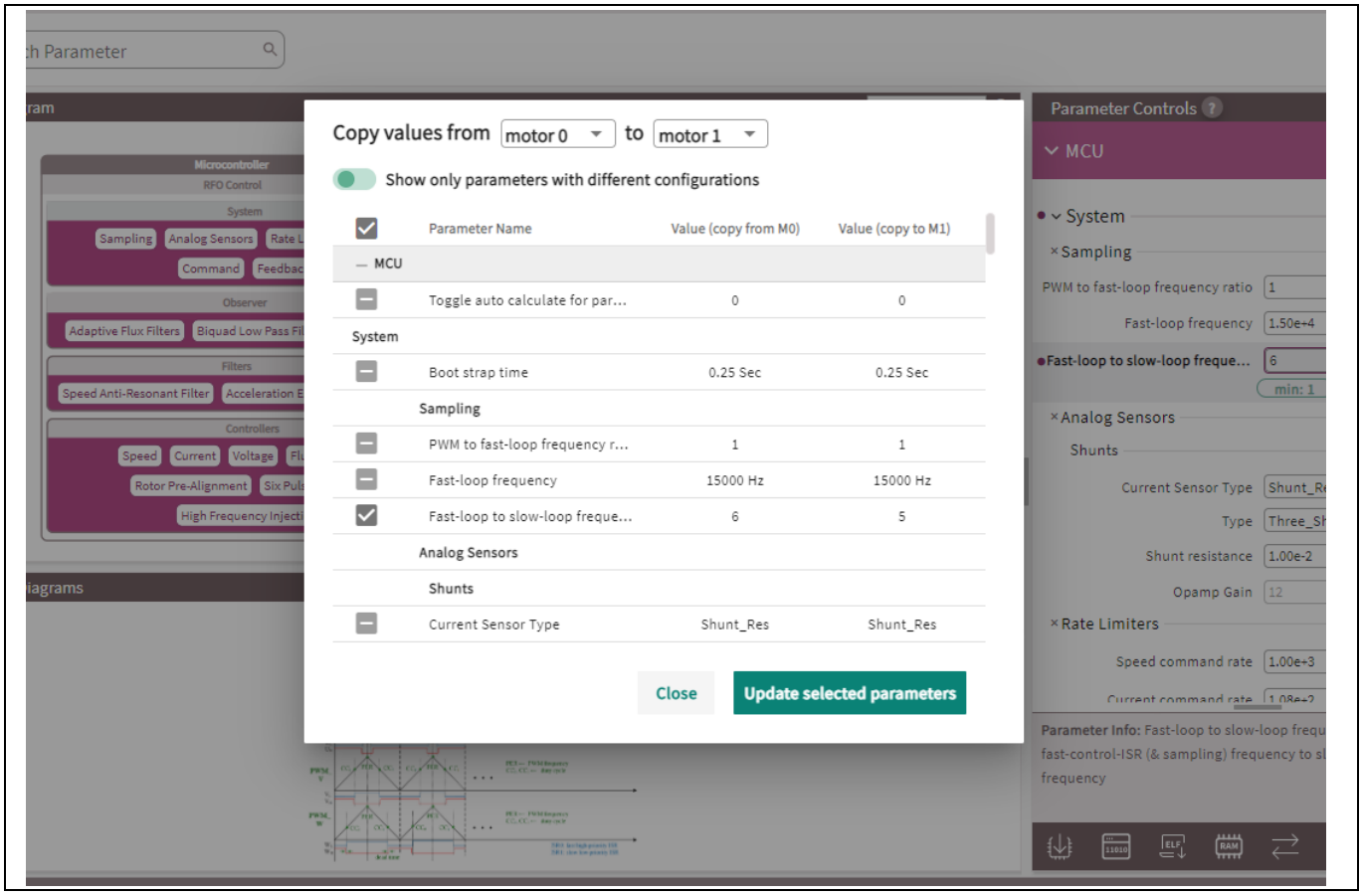

Figure 51 Selected configurations are compared in the window

4.2 6EDL Only Layout

After clicking new project button in Getting Started page, the Configurator page will be automatically displayed. If you are using SPI Link to connect your board or if you are using XMC™ Link and board is not flashed already with the default firmware, a popup window will be displayed for choosing the board type you’re using (Figure 52).

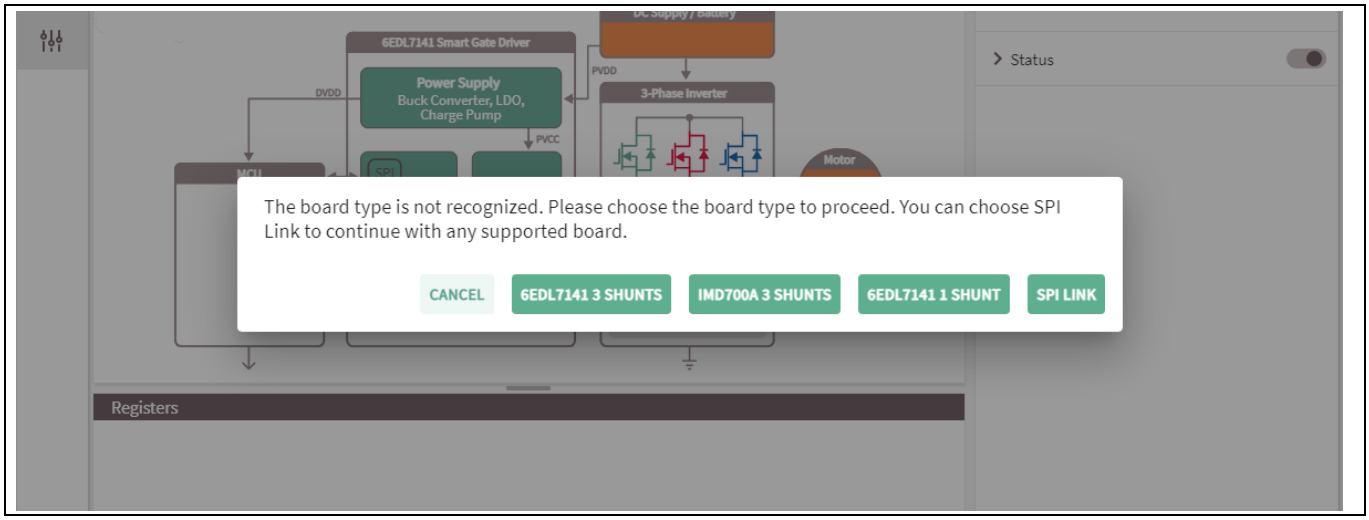

Figure 52 Board type selection popup

If you are using XMC™ Link with a supported board, select the correct project supported by your board. After selecting the board type, a second dialog will be displayed asking you to flash the default firmware (Figure 53). If you choose yes, the default firmware will be flashed to the board.

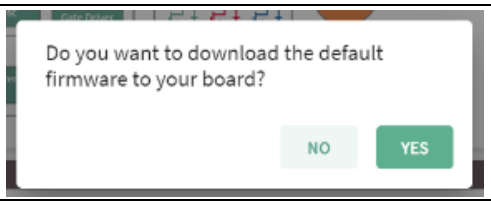

Figure 53 Default firmware flash popup

If you are using SPI Link, then select SPI Link. After selecting SPI Link, an information message will be displayed, and a dropdown input will be visible in the header bar (Figure 54). To start an UART connection, select the correct COM Port from the list of available COM Ports.

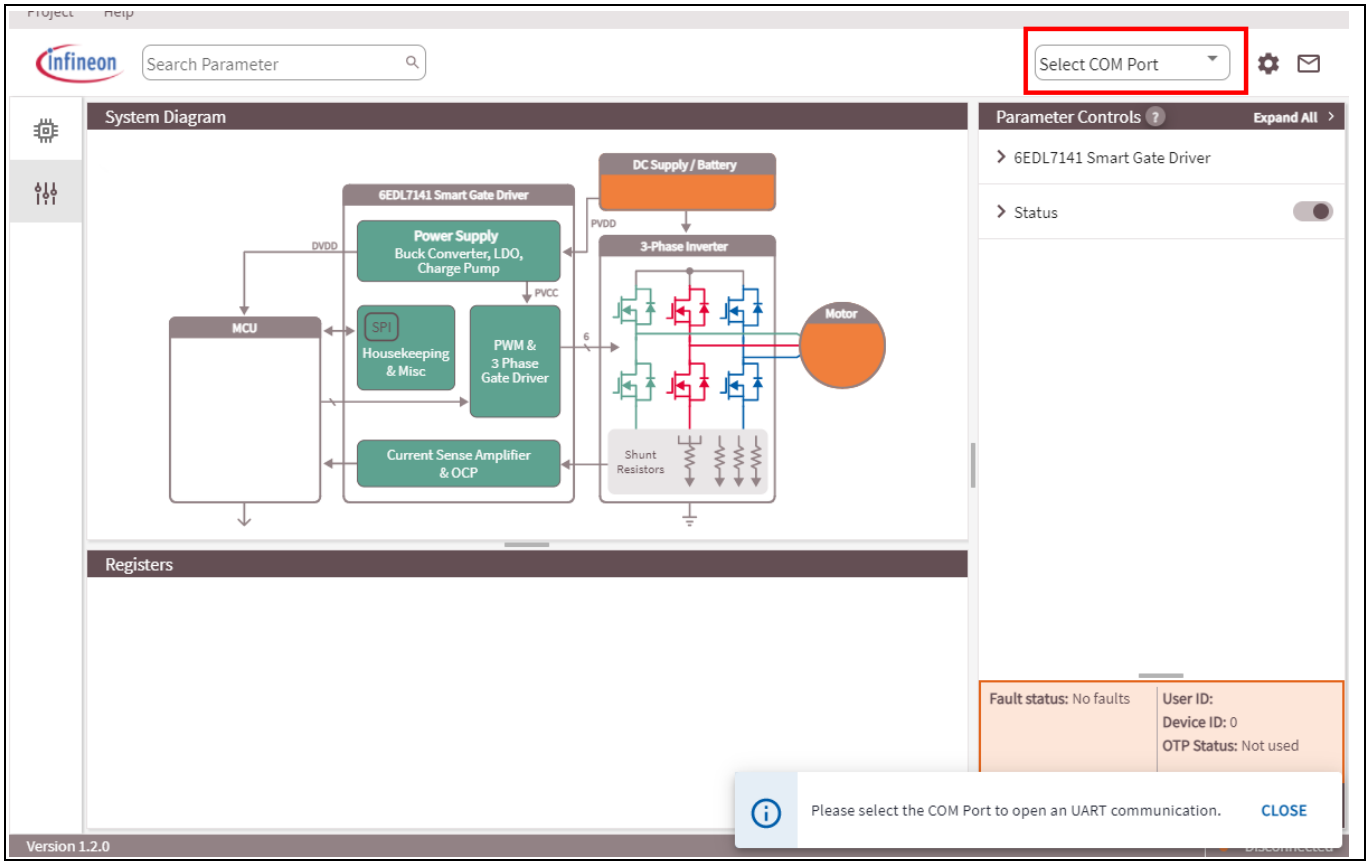

Figure 54 Port selection dropdown

After selecting a COM Port, from which a board with SPI Link is connected, you will see a connection message in the footer (Figure 55).



Figure 55 Connection message for SPI Link

If a wrong COM Port is selected, after 3s, the connection will be lost and a warning message will be displayed (Figure 56).

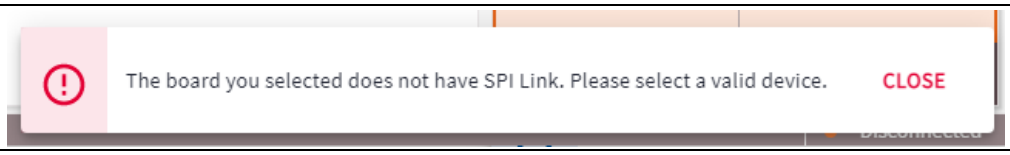

Figure 56 Unsuccessful UART connection message

If a default firmware is already flashed to the board, or an UART connection is established, the project will start polling status registers, and all board interaction buttons (read, write…etc.) will be enabled (Figure 57).

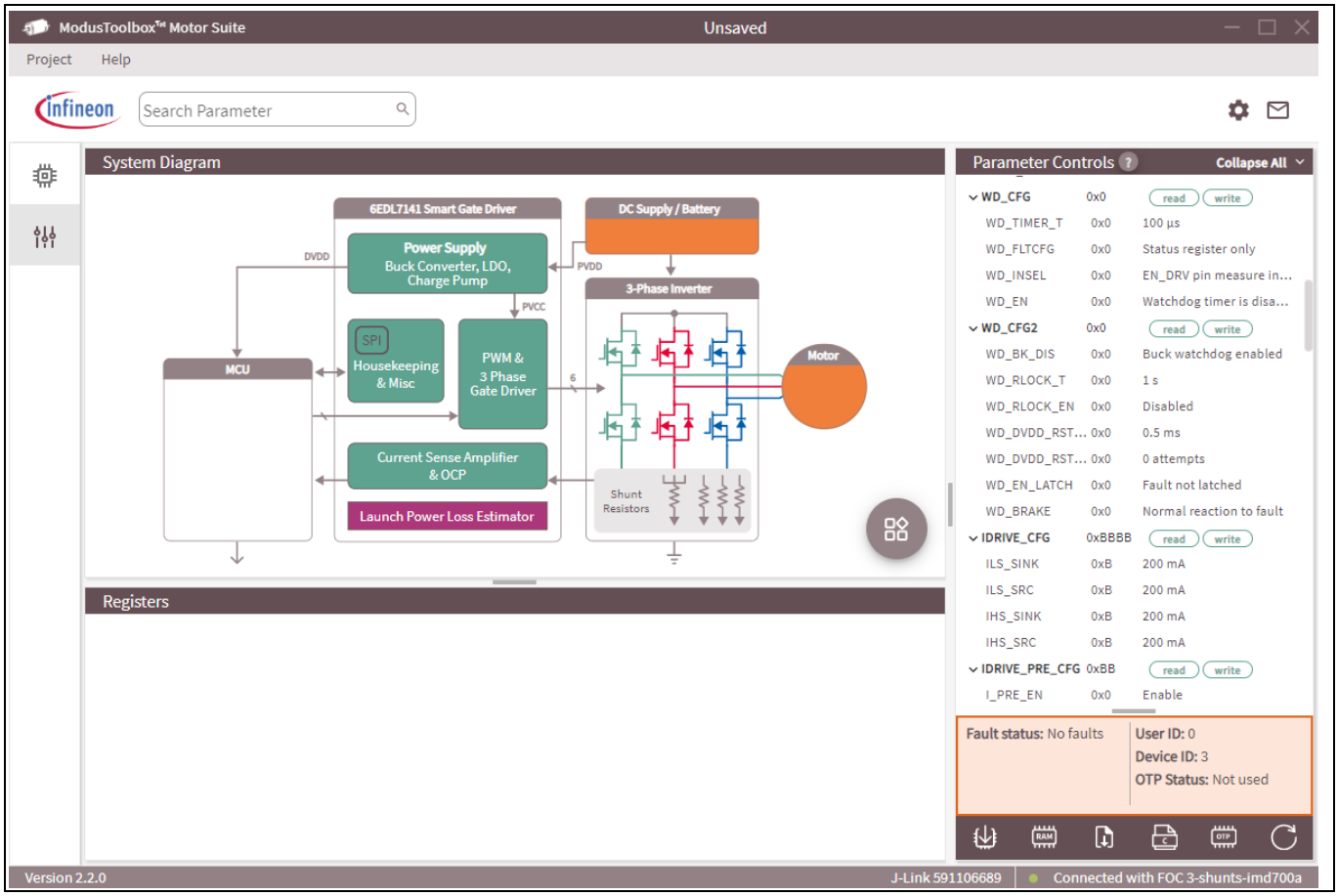

Figure 57 Configurator Page 6EDL7141

The 6EDL7141 Smart Gate Driver component displayed in the system diagram is clickable and clicking on the component expands the parameters relevant to this component (Figure 58).

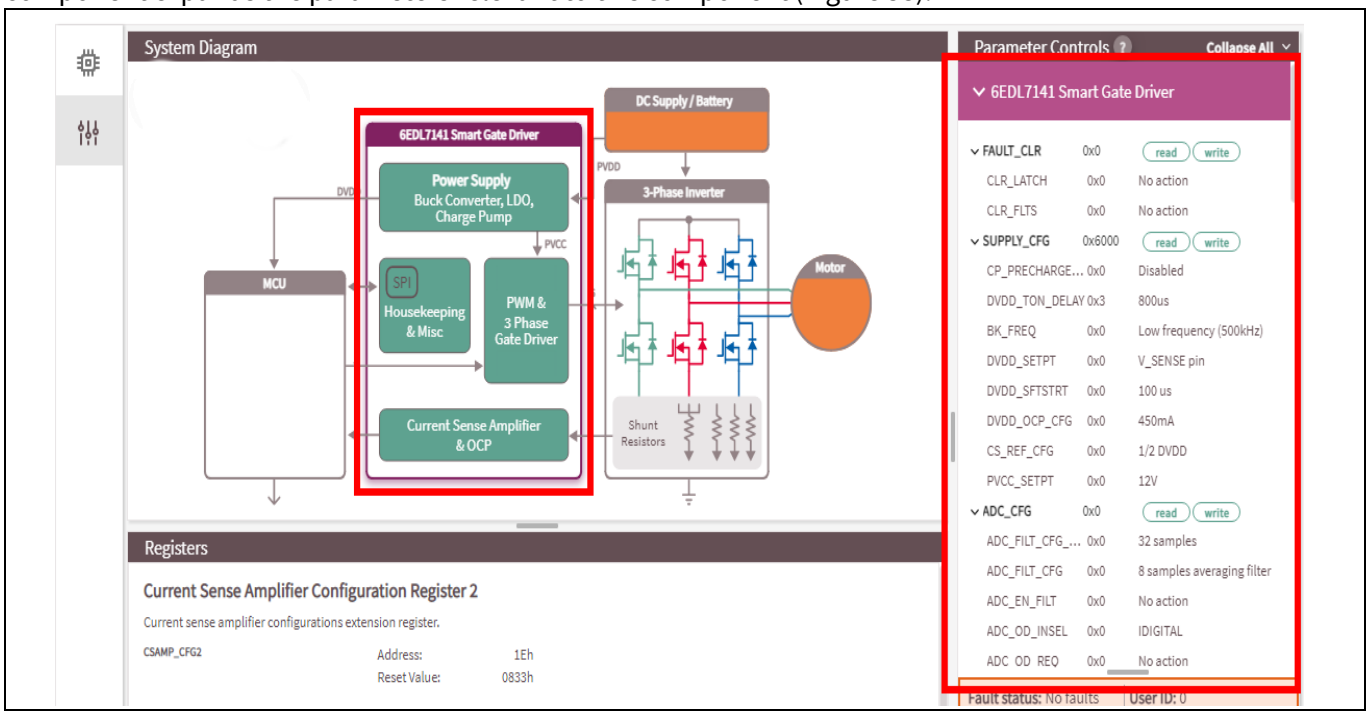

Figure 58 Open parameter group by clicking on 6EDL7141 Smart Gate Driver component

Clicking on “Expand All” / “Collapse All” button expands / collapses all the parameters in the panel (Figure 59).

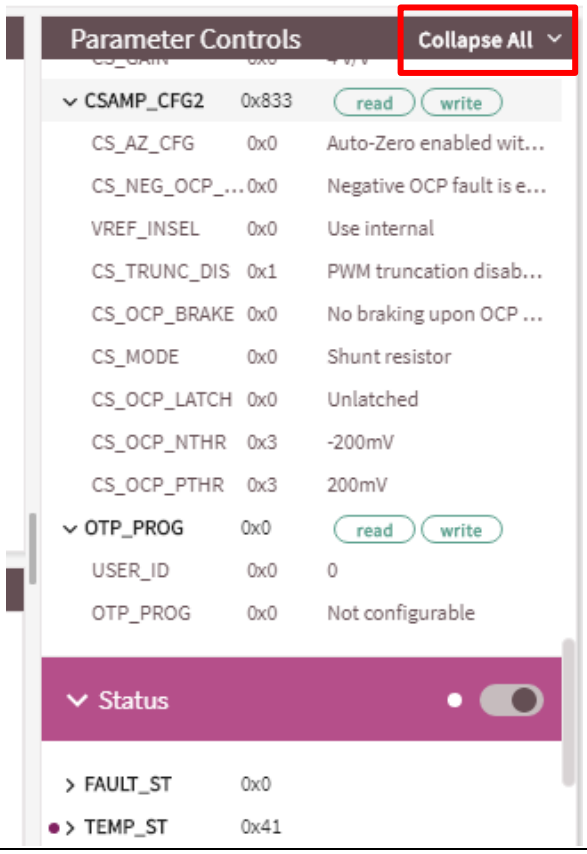

Figure 59 Expand/collapse parameter panel

Edit the register parameters by clicking on the hexadecimal value, and select the option from the drop-down list (Figure 60). Once the register parameter value is edited, the hexadecimal value and its meaning is displayed side by side. The register value is automatically calculated and updated.
Register information of the selected register is displayed when you click on the register label (Figure 60). There are two tables, one for the register parameters with bit fields and one for the selected register parameter. Clicking on each register parameter label highlights the bits on the first table. For more information check the second table.

Note: 1. The Register parameters under “Status” section are read-only.

Note: 2. Dirty state is shown when a parameter is edited, it is cleared once the project is saved.

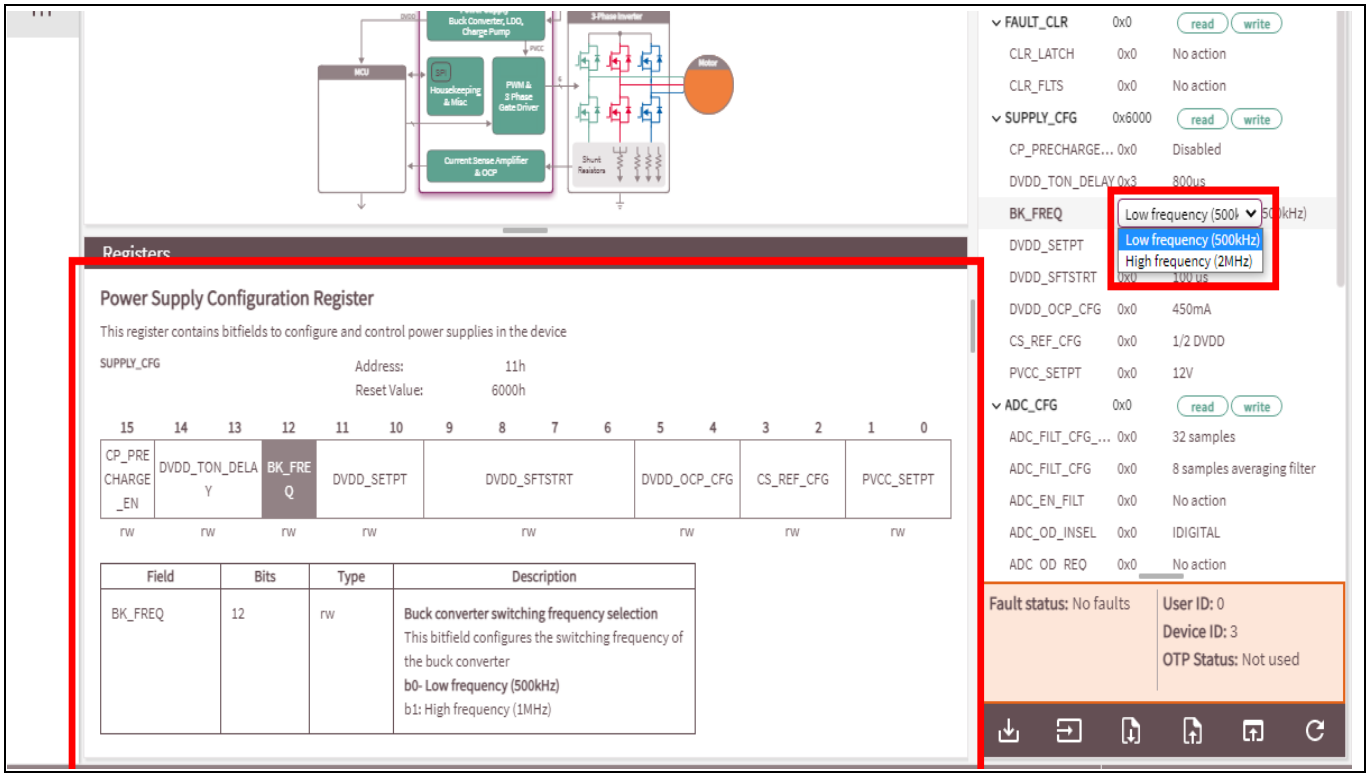

Figure 60 Editing the register parameter value and register information panel

Clicking on “read” button, next to the register name, reads the value from the board, and clicking on “write” button writes the value to the board (Figure 61).

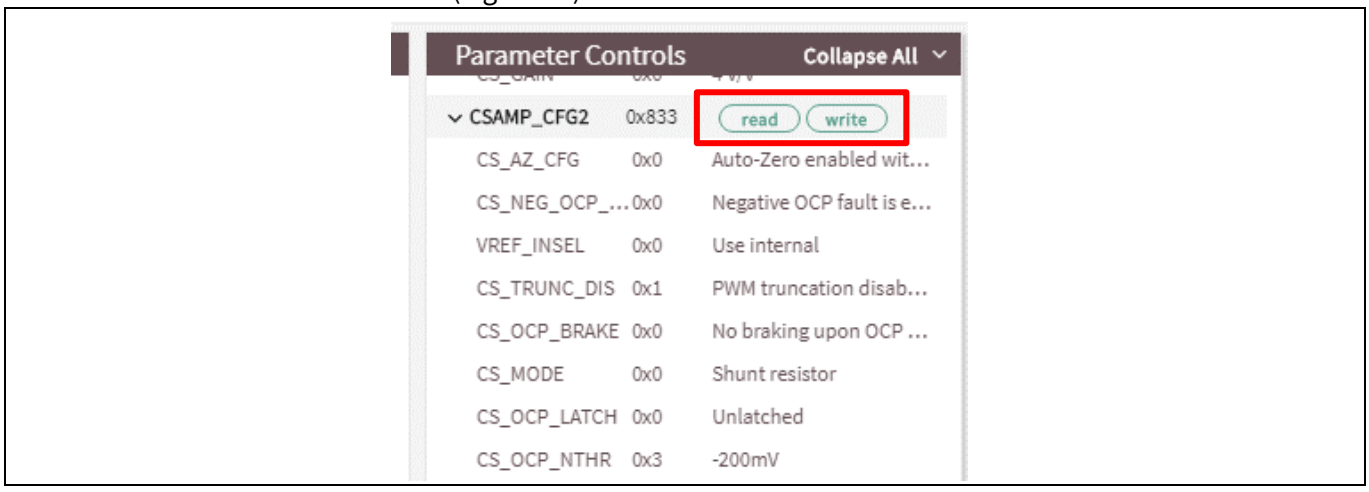

Figure 61 Image showing Read and Write Buttons of a register

4.2.1 Status Registers

Display the Status Register details under Status section (Figure 62). The values for these registers are updated automatically.

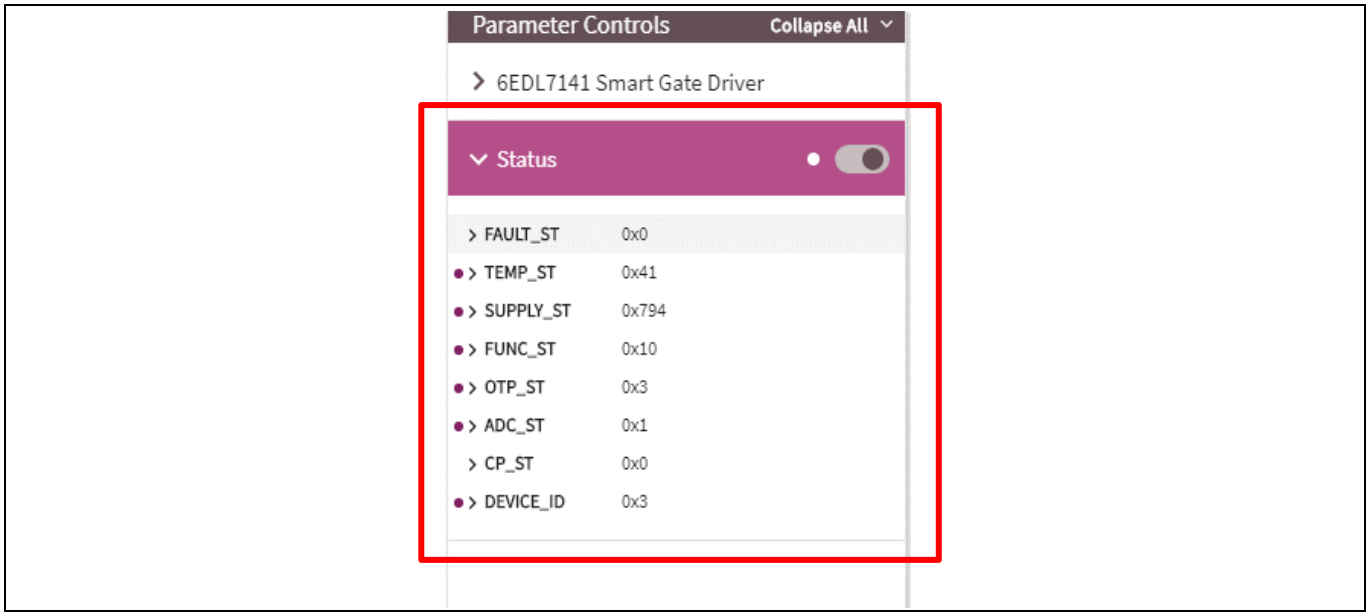

Figure 62 Image showing Status Registers

Start and stop the polling of the Status Registers by using Start/Stop Polling slider (Figure 63).

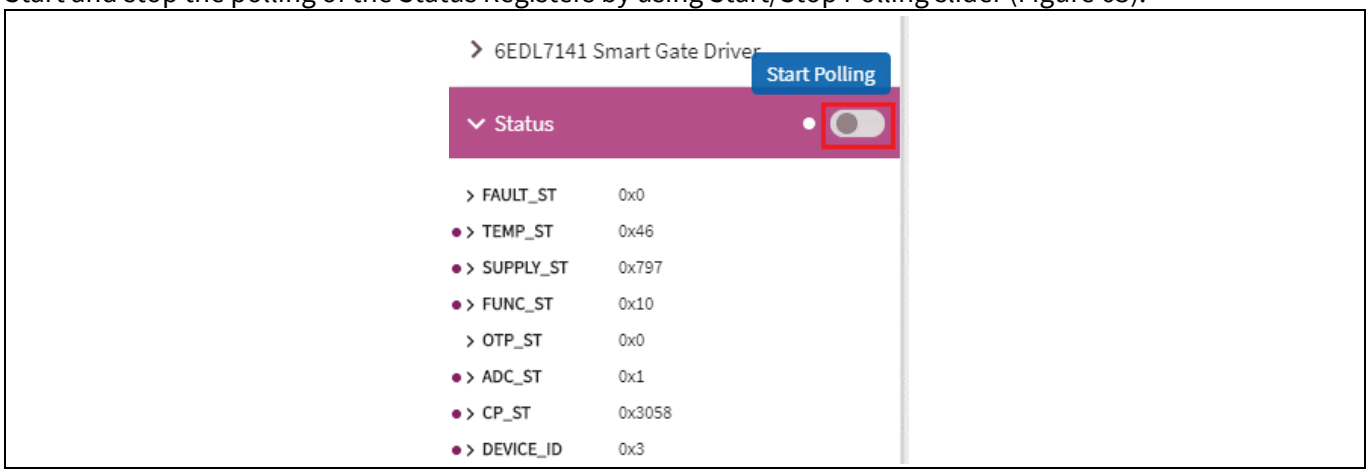

Figure 63 Image showing Start/Stop Polling Slider

4.2.2 Faults

Any faults that occur while writing the parameters are displayed in the faults section. These faults can be cleared by clicking on “Clear All” button (Figure 64).

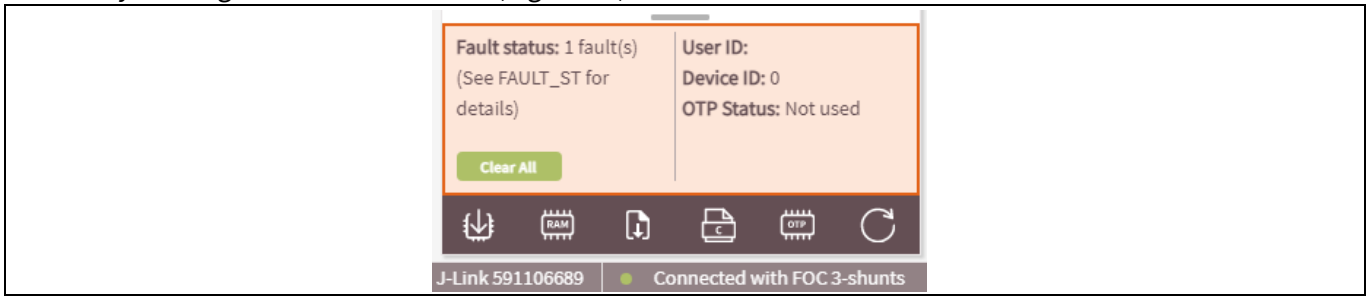

Figure 64 Image showing Faults section and Clear All button

4.2.3 Configurator Page Parameter Buttons

The configurator page contains six buttons as shown below (Figure 64) which perform a specific action when clicked. Below are the details of each button.

- **Write Parameters**: Clicking on Write Device button, writes all the parameters to the board.
- **Read Device**: Clicking on Read Device button, reads all the parameters in the board.
- **Import**: Clicking on Import button imports the parameter values from h file to the application.
- **Export**: This button is used to export the register parameters to a .h file.
- **Burn 6EDL7141 OTP**: This button is used to burn the OTP of the board

Attention: Please be aware that the burn action is not reversible.

Attention: Reset All: Clicking this button resets all the register parameters to the default values

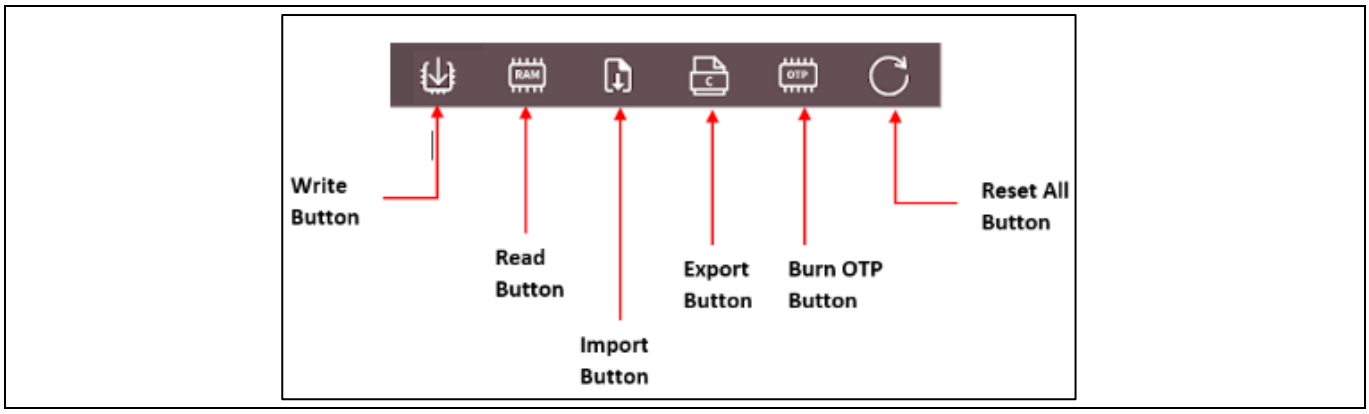

Figure 65 Configurator page parameter buttons

5 Test Bench

Use test bench page to monitor and tune the values of selected parameters and run real-time tests. To navigate to test bench page, click test bench icon in the left navigation panel (Figure 66).

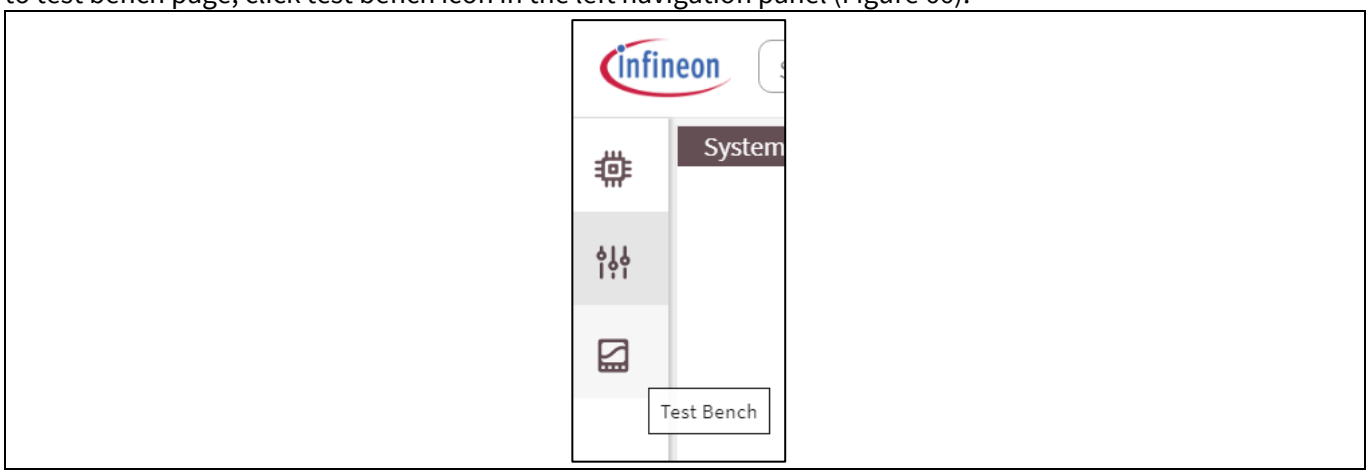

Figure 66 Click test bench icon in navigation panel

There are 2 different layouts for testbench page. Each project supports only one of these layouts.

5.1 Dashboard layout

GUI will navigate to test bench page after clicking the navigation bar test bench icon (Figure 65).

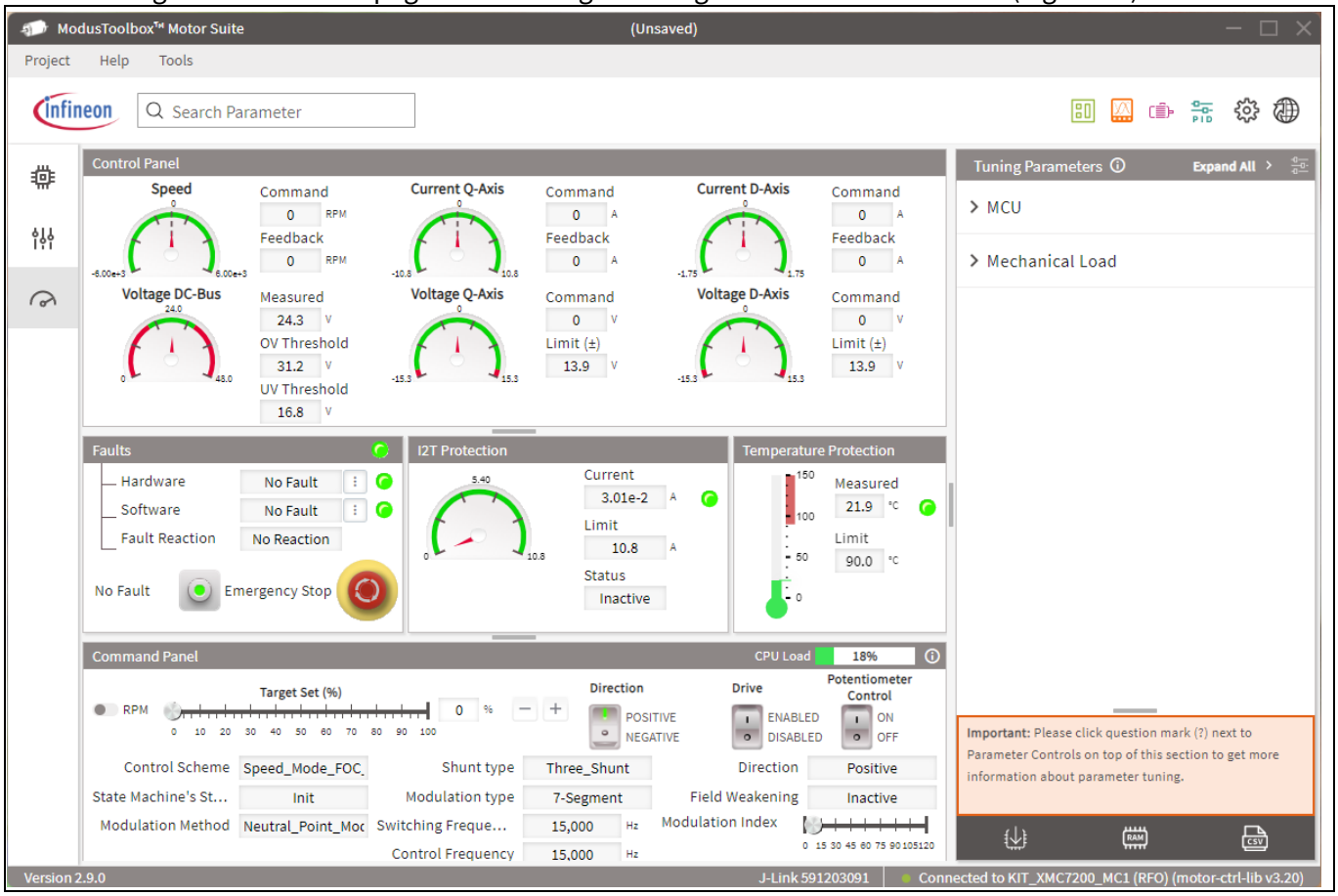

Figure 67 Test Bench page

The polling starts automatically after testbench page is activated. The parameters in the gauges, text fields, sliders and buttons are updated every 100ms (default). In testbench page tuning parameters section, only the tuning parameters are available.
Set the polling period to a different value by clicking on the preferences icon, and opening “General” tab (Figure 68). By default, polling period is set to 100 ms. Update it by clicking on the dropdown and by selecting one of 0.1, 0.5, 1, 2 or 5 seconds.

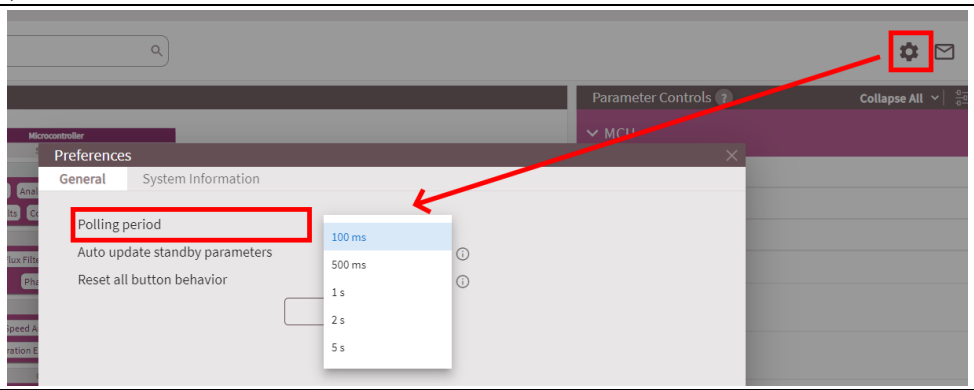

Figure 68 Changing parameter polling period

5.1.1 Monitoring Panels

The control panel displays the expected and observed values of the selected measurements using gauges and text fields. Expected values are displayed inside “Command” boxes, and in gauges with a dashed line, while observed values are displayed inside “Feedback” boxes and with the needles inside gauges.
Faults section displays fault state. If a fault occurs, a red led is displayed next to the panel header and depending on the fault type, displayed next to “Hardware” or “Software”. There is an emergency stop button in this section to stop/restart the motor and clear the faults. Faults can also be cleared using the “Clear Faults” button. “Clear Faults” button becomes enabled only after a fault occurs. Clicking this button clears the faults when potentiometer is set to external control (I.e. pot button set to off). There is a limit on how many times user can clear the faults. This limit can be changed. The default maximum number of fault clearing tries (this is an advanced parameter in the GUI, “Number of tries for clearing faults”) is 10. That means if a fault keeps happening even after clearing, the user can clear it up to 10 times.
I2T and Temperature protection panels display protection information using gauges, similar to the control panel.
Use the Command panel to enable/disable the drive and set the target set. There are other fields to monitor such as motor spinning direction, shunt type, state machine state, etc.

5.1.2 Profiler

Use the profiler to extract the parameters of the motor, mechanical load and some control parameters. To run the profiler, open the profiler window, set the speed to a value larger than the threshold value, and enable the drive (Figure 69 and Figure 70). The profiler will start extracting parameters (some peculiar noise can be heard while this is happening). The profiler window also has an option for the user to select how fast of dynamic response is desired. User can select among four options: Slow, Moderate, Fast, and Custom. Default values for slow, moderate, and fast responses are already populated in the inputs.

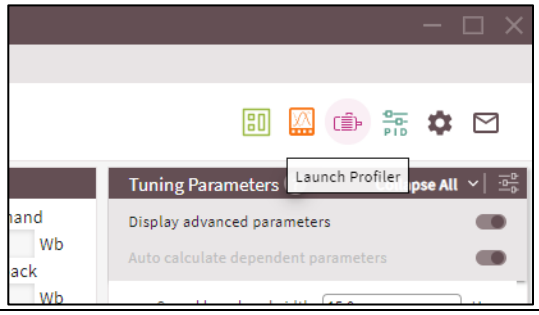

Figure 69 Launch profiler

Change the values of input parameters by selecting “Custom” from the dropdown in Dynamic Response section. If the drive has not been enabled yet, these parameter boxes will be enabled for user input. As soon as user changes a value, the new value is written to the board.

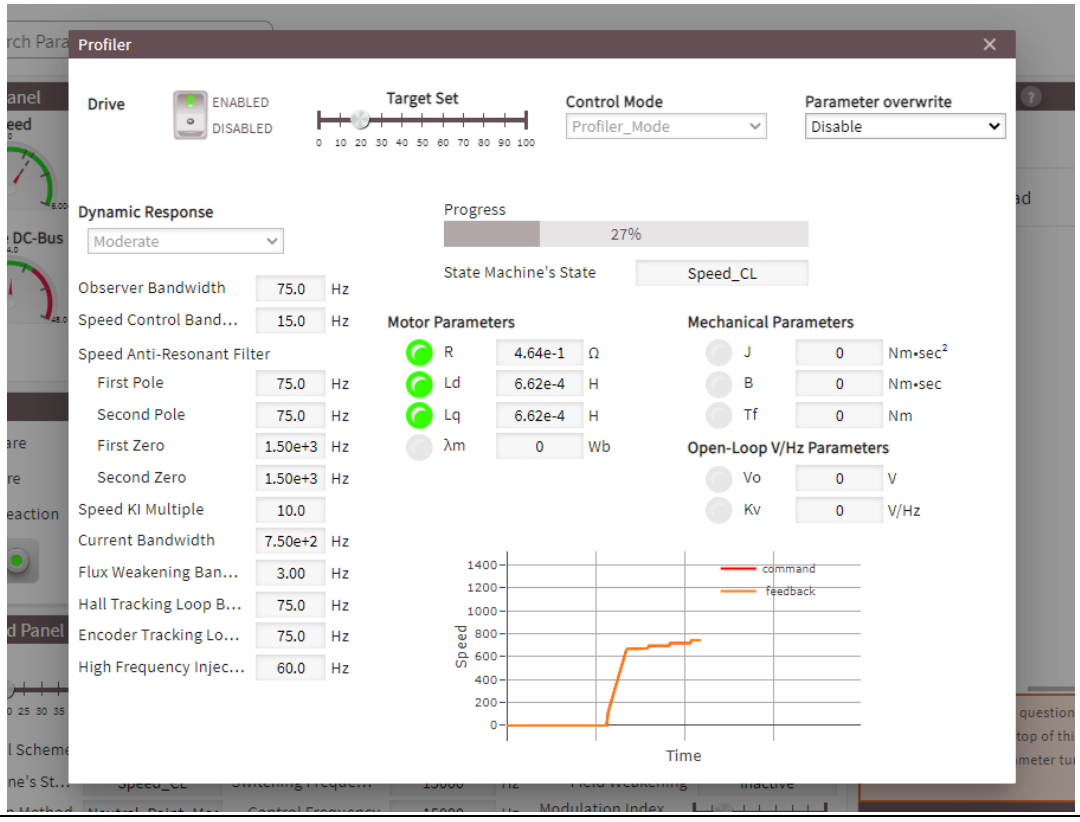

Figure 70 Profiler window

After profiler finishes running the algorithm, the final values are displayed under Motor Parameters, Mechanical Parameters and Open-Loop V/Hz Parameters sections. When LEDs turn to green, the textboxes display the final results.
If you Enable “Parameter overwrite”, the new calculated parameter values will be updated in the board, and in the GUI project.

5.1.3 Position Control

A new control mode is added to motor-ctrl-lib v3, position control mode. When user selects this mode, the testbench interface is slightly updated (Figure 71). A new gauge that displays the rotation angle of the motor is added to the control panel. User changes the rotation using the position control input in the command panel.

As soon as the value is entered, the revolution and degree of the input is displayed next to the input control. But the updated value is written to the board only after user presses “Enter” key in the keyboard, or focuses something different than the input itself (by clicking anywhere else but the input).

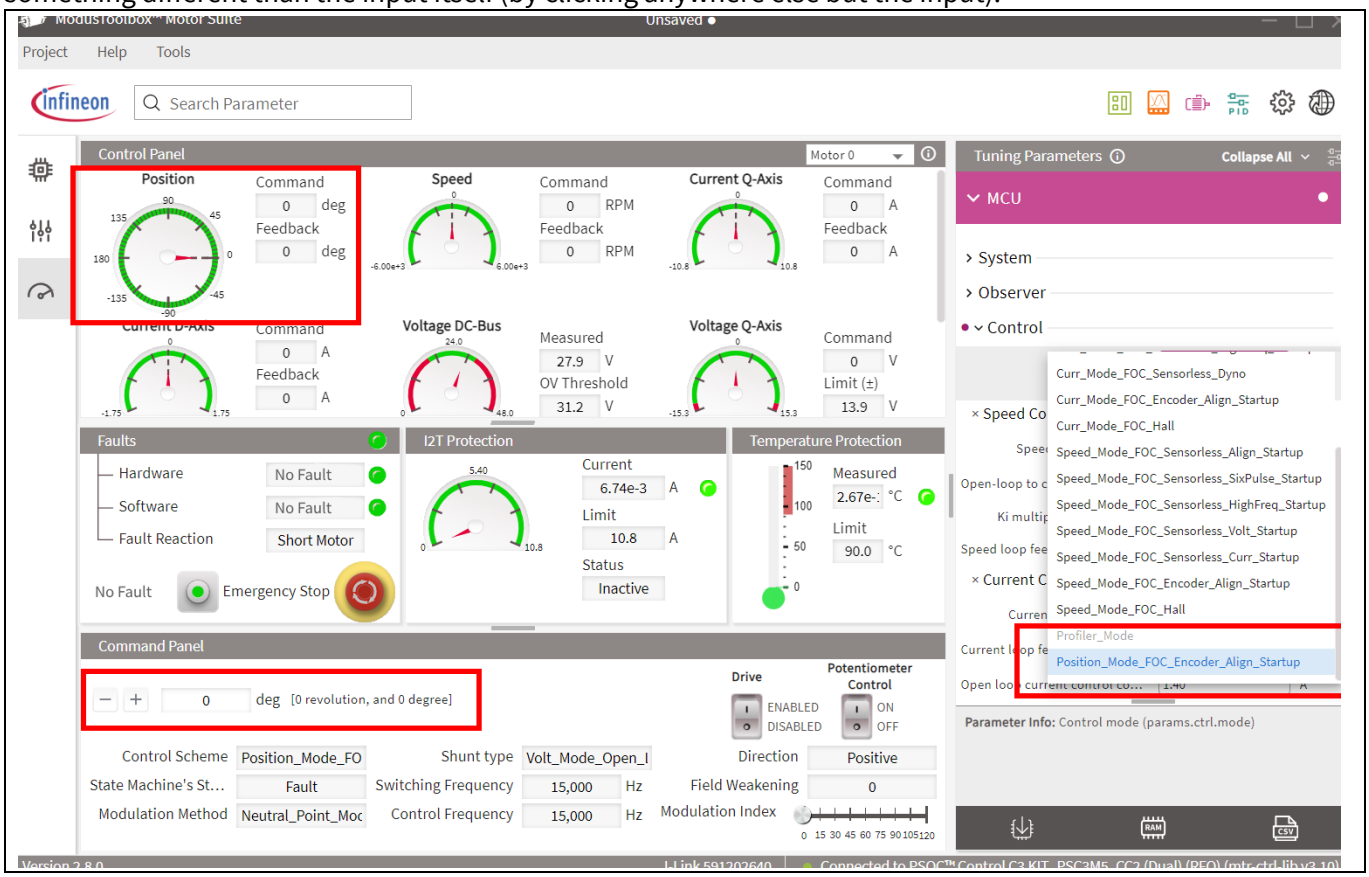

Figure 71 Position control interface

5.2 Diagram Layout

This layout is used in legacy projects supporting XMC1000 family boards. After clicking the navigation bar test bench icon, GUI will navigate to test bench page (Figure 69).

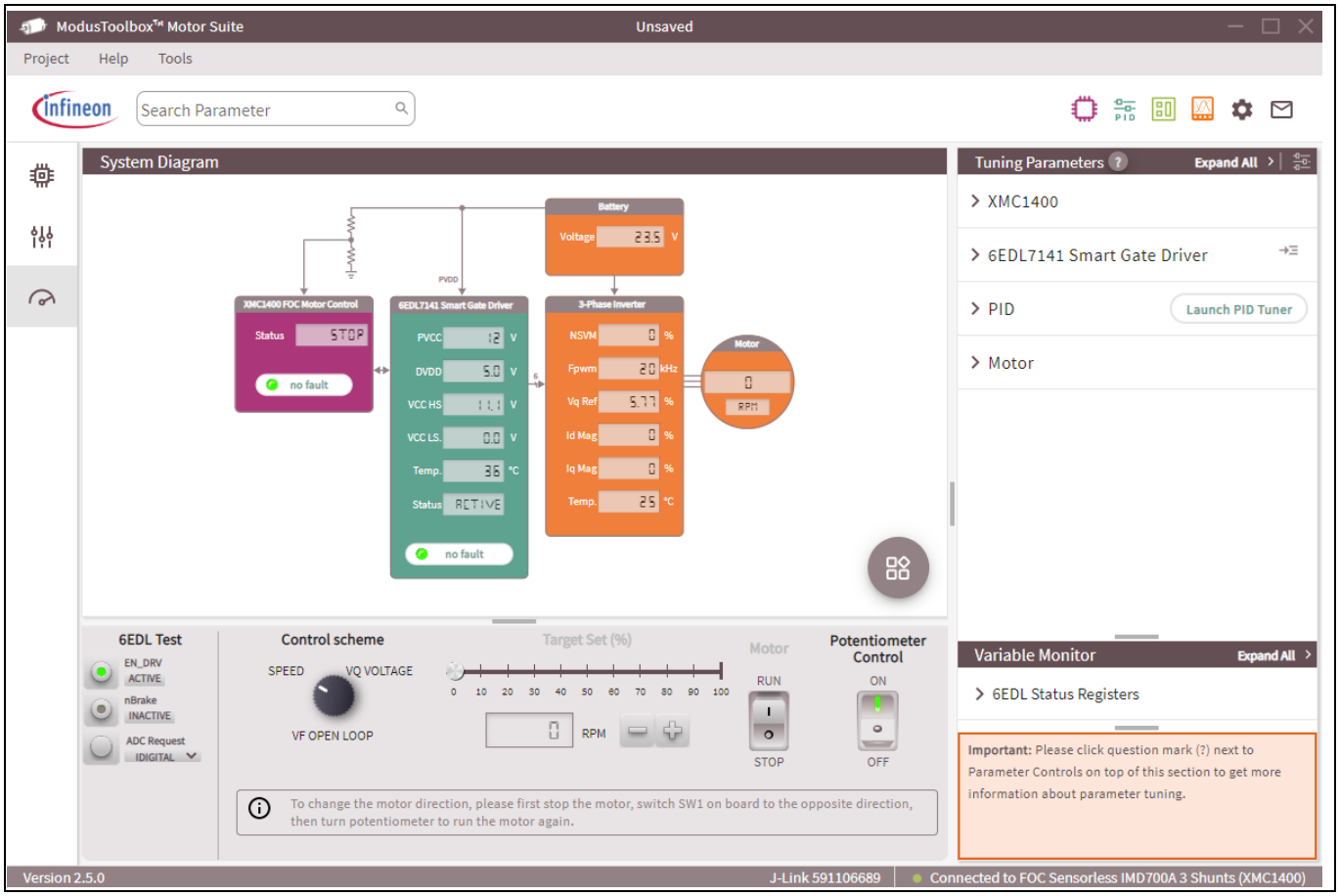

Figure 72 Test Bench page

The blocks displayed in the system diagram are clickable and clicking on the block expands the subsequent parameters relevant to the block. In the below example, 6EDL7141 Gate Driver block has been expanded after clicking on the subsequent block (Figure 72).

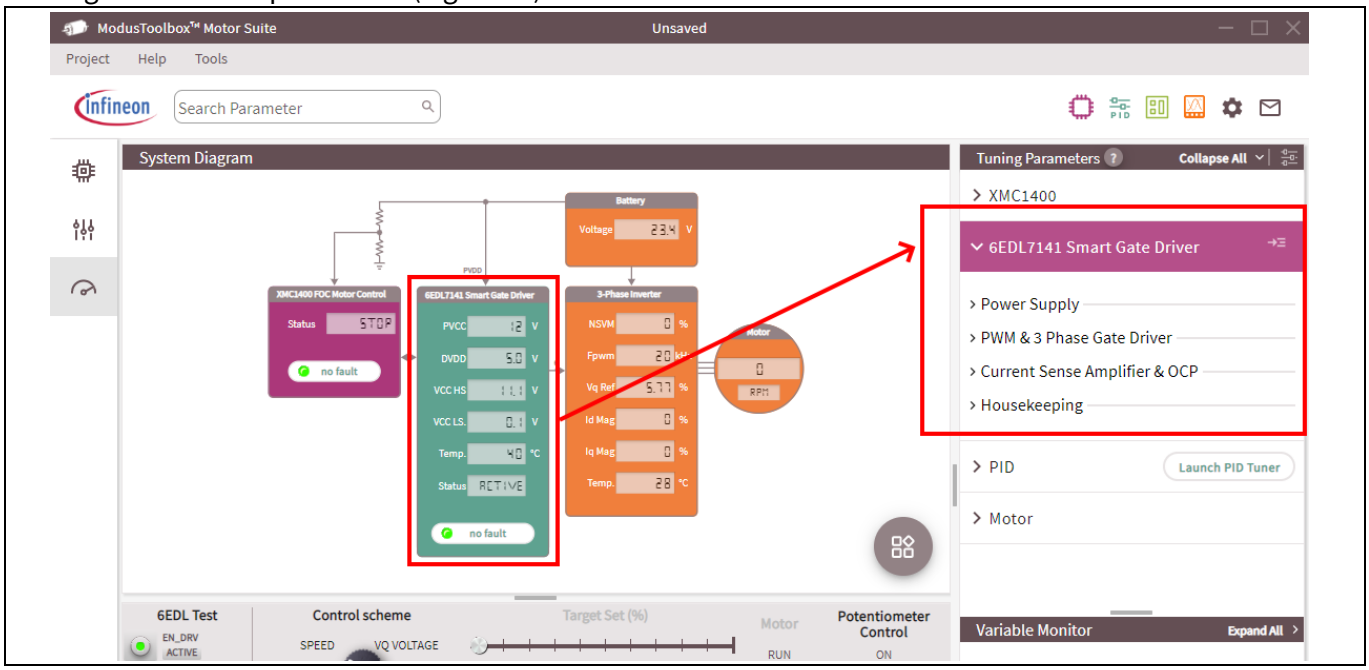

Figure 73 Open parameter group by clicking component in system diagram

The default values are assigned to the parameters initially. However, they can be updated as required. To update, click the parameter to be updated and select the value from the drop list (Figure 74).

Attention: The parameter values updated in test bench page are instantly written to the board. Please be careful when modifying the values to avoid board damage.

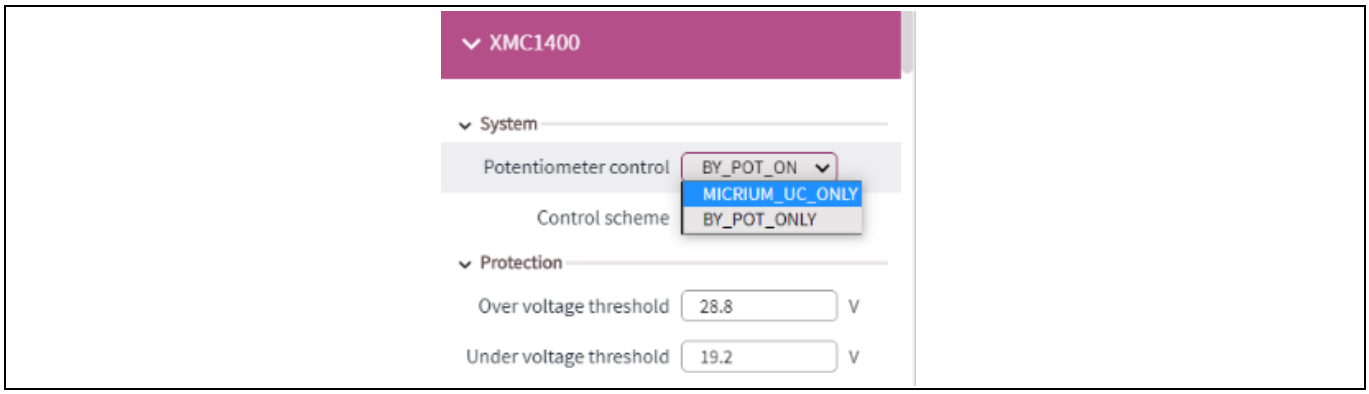

Figure 74 Setting potentiometer control parameter in test bench page (The new values will be immediately written to board)

5.2.1 Motor Control Parameter Tuning

The parameter polling starts automatically after testbench page is activated. The parameters in the diagram, PID parameters, status registers and if potentiometer is on, the target set value are updated every 100 ms (default) (Figure 75).

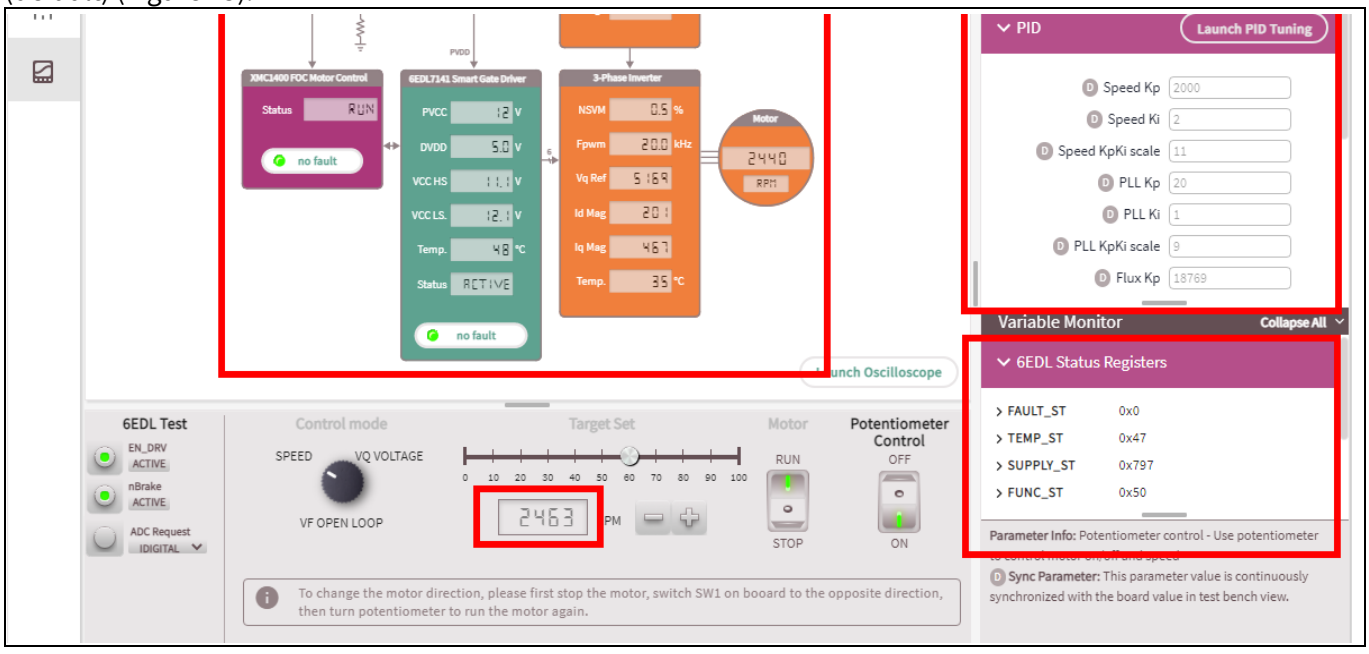

Figure 75 Test bench page parameter polling

You also have the flexibility to modify the polling period. To change the period of polling, click on preferences icon and open “General” tab (Figure 68Figure 76). By default, polling period is set to 100 ms. You can update it by clicking on the dropdown and selecting one of 0.5, 1, 2 or 5 seconds.

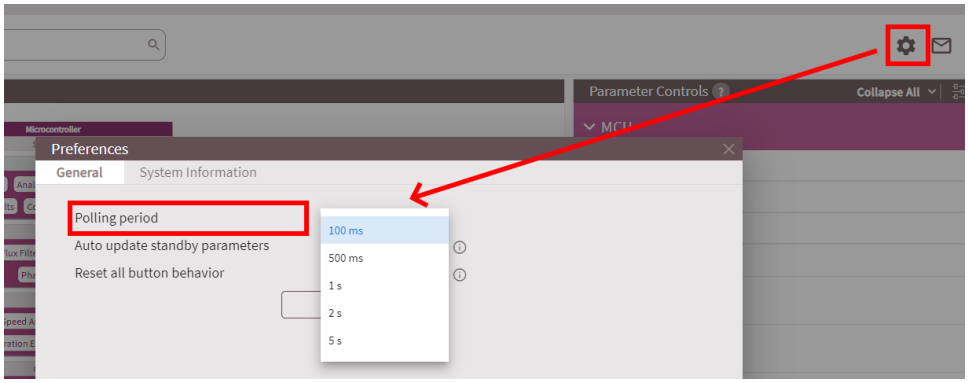

Figure 76 Changing parameter polling period

5.2.2 Faults

Status on system diagram is displayed as fault if there are errors after the parameters are updated in the board (Figure 77Figure 77).

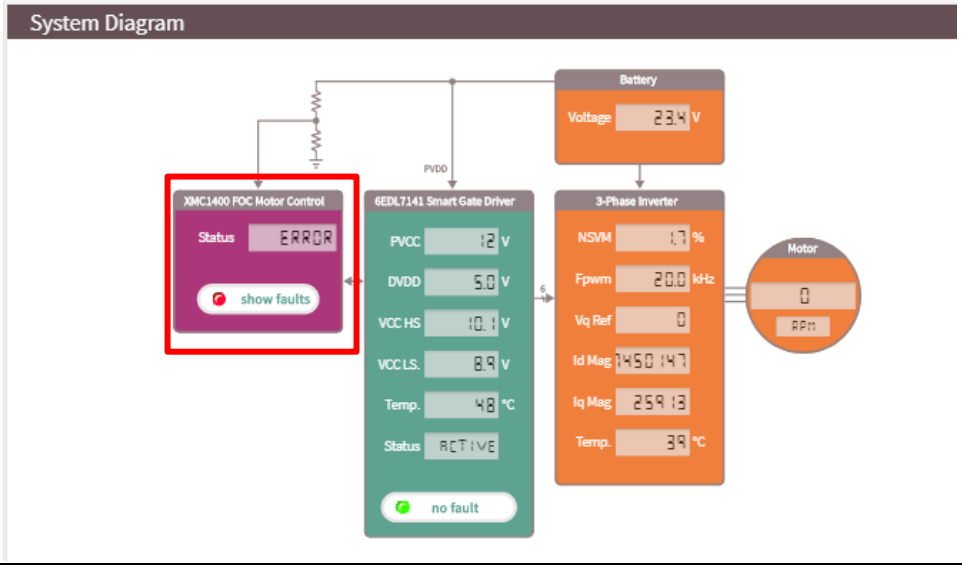

Figure 77 Indication of fault status

To view the fault(s)' details in the info panel, click "Show Faults" button as shown in Figure 77. To clear the faults, after fixing the problem, click "Clear Faults" button (Figure 78).

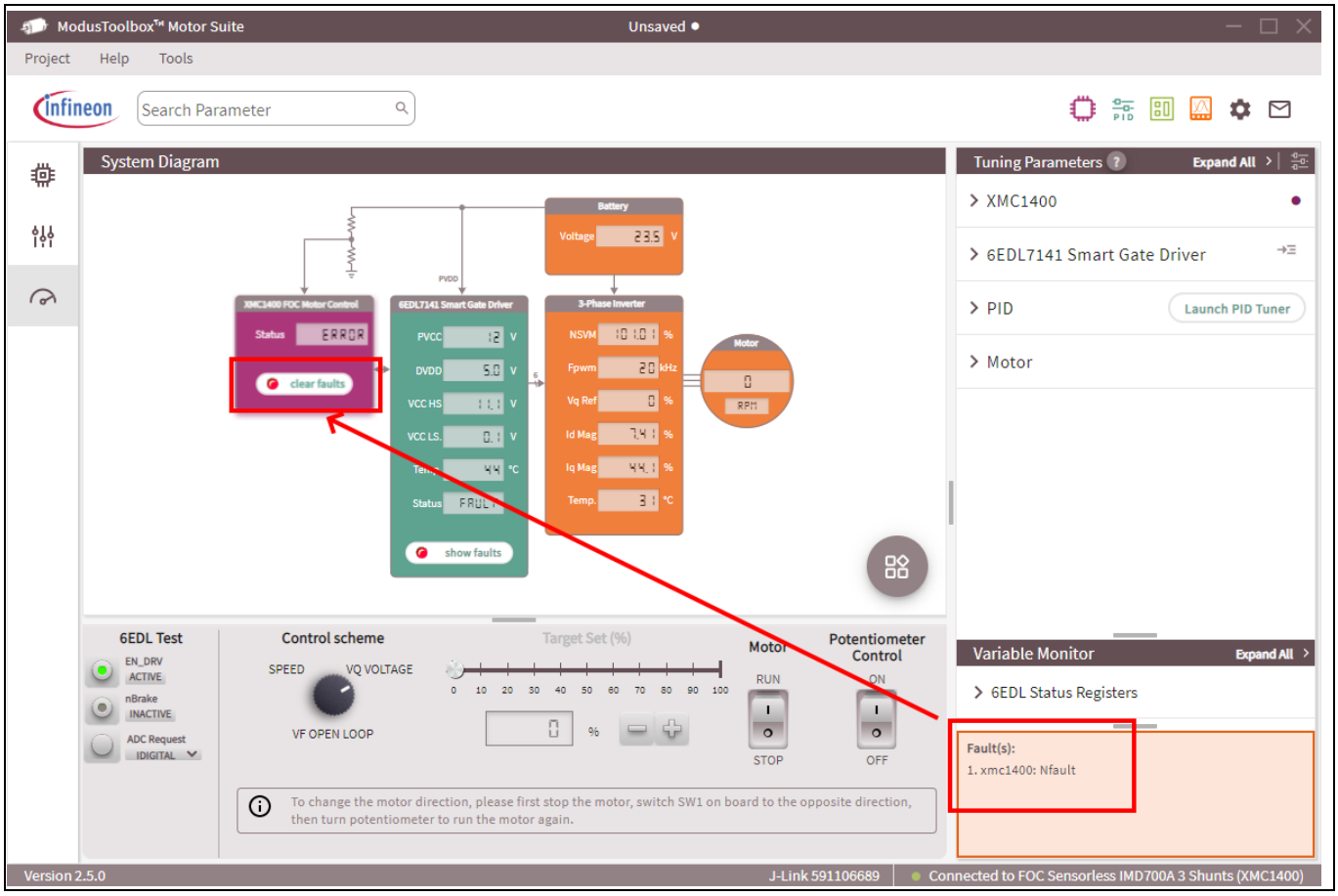

Figure 78 Show and clear fault(s)

5.2.3 6EDL Status Registers

To display the 6EDL Status Register details under “Variable Monitor” section, expand 6EDL Status Registers group. The values for these registers are updated automatically (Figure 79).

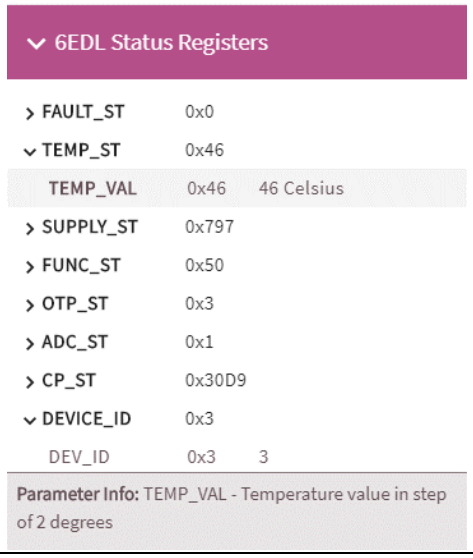

Figure 79 6EDL Status Registers

5.2.4 Control Panel

Test bench page “Control Panel” contains the options to control the motor. By default, “Potentiometer Control” switch is switched on as shown below (Figure 80) and Target Set value is synchronized with the position of the potentiometer knob on the board.

Note: When potentiometer control switch is ON, other controls are disabled, except for 6EDL Test buttons.

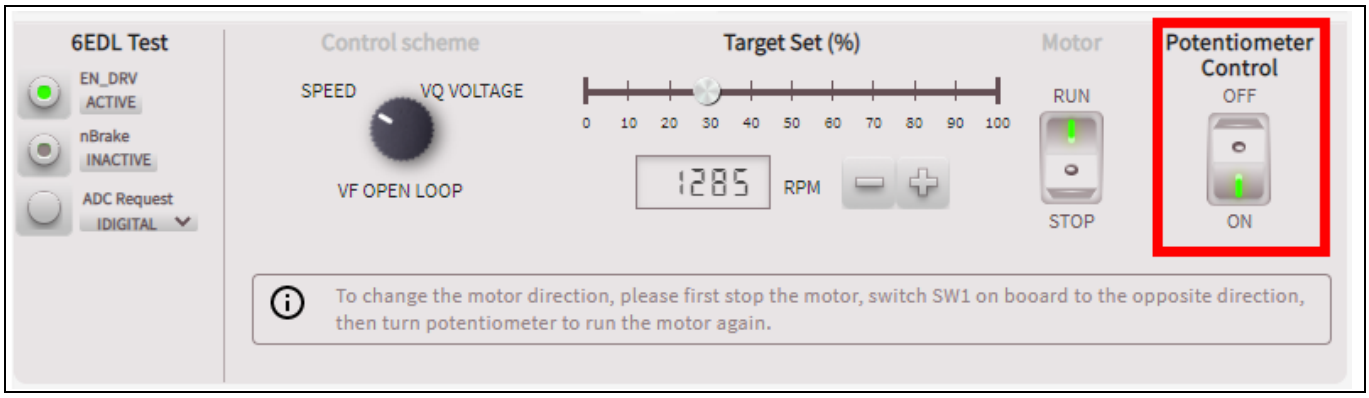

Figure 80 Control panel: Potentiometer control (If Potentiometer control is ON, most of the buttons in control panel are disabled.)

In order to control the motor from the control panel, switch off the Potentiometer Control and run the Motor Switch (Figure 81). Target Set slider is used to increase/decrease the values for speed (Figure 82). The spinning speed of the motor depends on the value set in Target Slider. Change the target value by using “-/+” buttons, or by inputting the value directly into the input box.

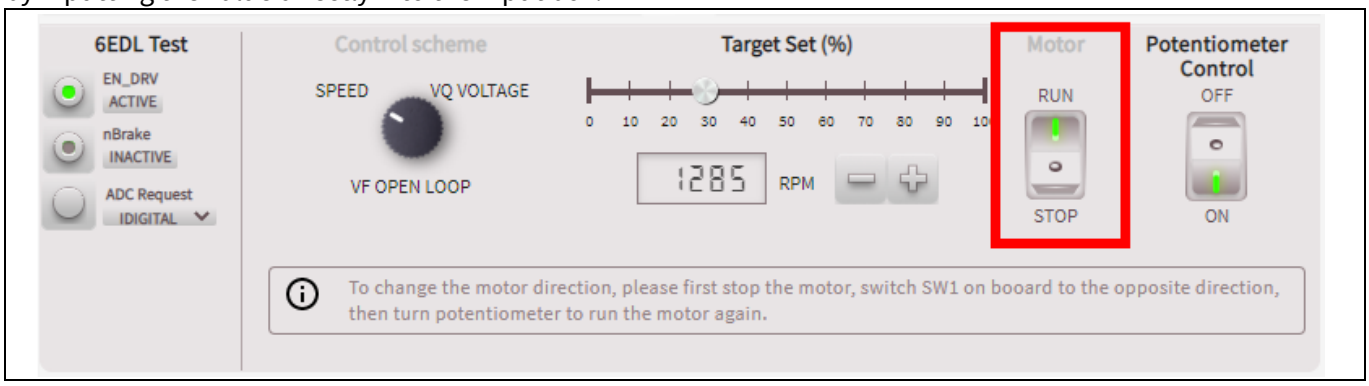

Figure 81 Control panel: Motor control (start/stop motor)

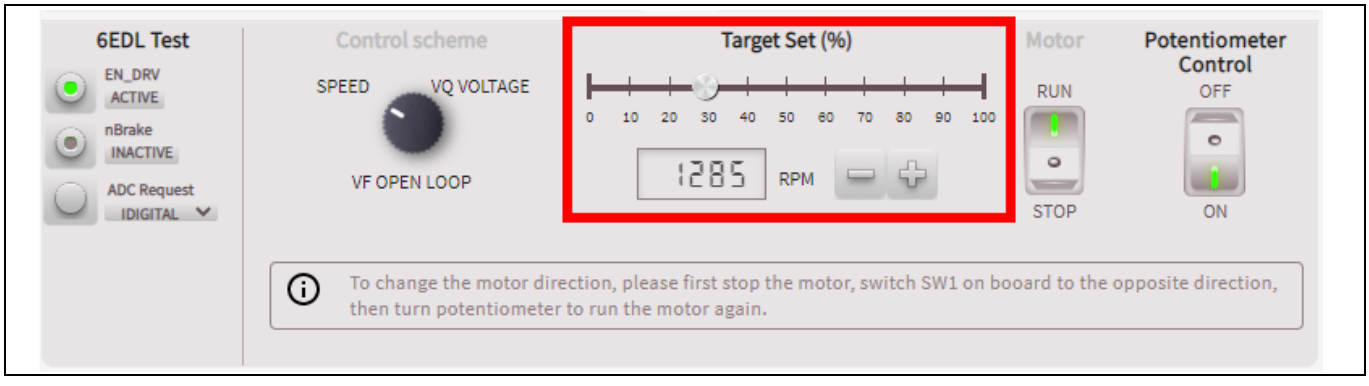

Figure 82 Control panel: set target speed

Select a control mode by using the control scheme button (Figure 83). There are 3 control modes for FOC 3 shunts boards: Speed, VQ and VF controls.

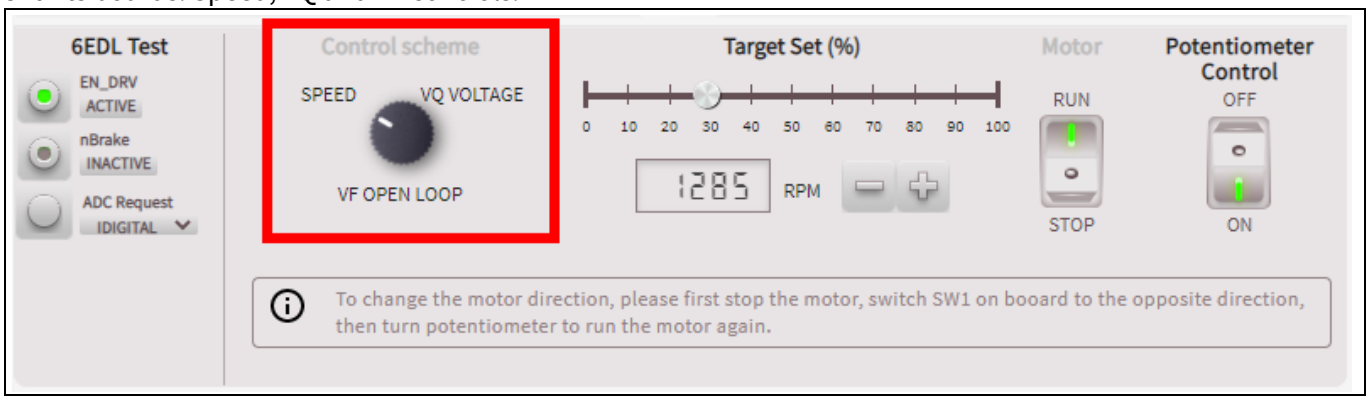

Figure 83 Control panel: control scheme

Perform 6EDL Tests from the Test Bench page Control Panel. EN_DRV and nBrake values can be updated to Active/Inactive status by clicking on the switch and the value for ADC Request can be updated by selecting the value (IDIGITAL/DVDD/VDDB) from the dropdown list (Figure 84).

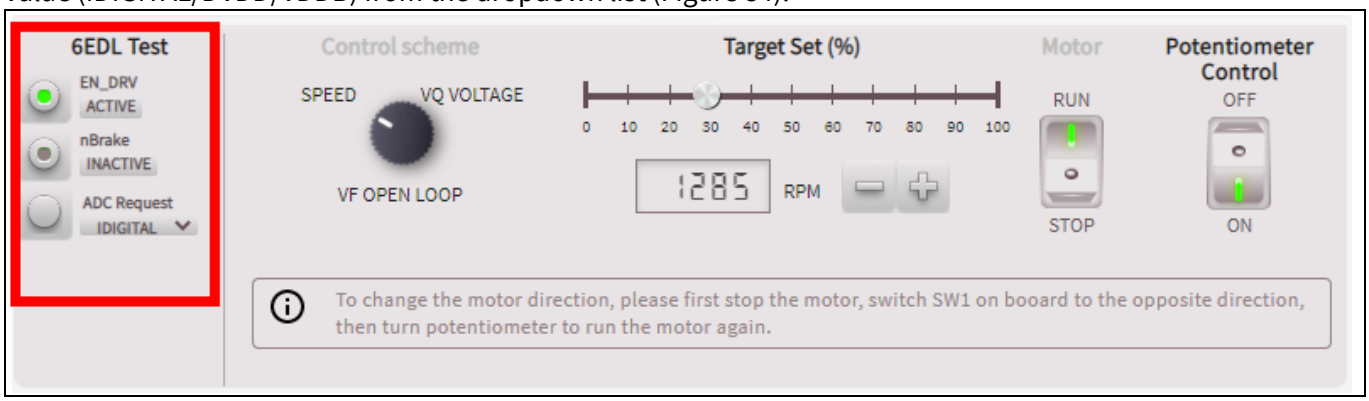

Figure 84 6EDL7141 test buttons

6 Tools

There are multiple support tools to calculate and optimize parameters, to monitor your system. Table 1 displays projects and supported tools.

Table 1 Tools support table by MCU product

	LiveMonitor	Oscilloscope	MOSFET Tuner	Power Loss Estimator	PID Tuner (Custom Tuner)	Profiler
KIT_PSC3M5_2GO	✓	✓			✓	✓
KIT_PSC3M5_MC1	✓	✓			✓	✓
KIT_PSC3M5_CC2 (Dual)	✓	✓			✓	✓
KIT_XMC7200_MC1	✓	✓			✓	✓
KIT_TRAVEO_T2G_B_H_MC1	✓	✓			✓	✓
REF_48V_2X1KW_ASFOC (Dual)	✓	✓			✓	✓
REF_MTR_48V30A_PSC3_GAN	✓	✓			✓	
REF_80VDC_3.5kW_OPE2	✓	✓			✓	✓
REF_HUMA_MTR_48V_25A	✓	✓			✓	✓
RAK-GaN	✓	✓			✓	✓
EVAL_6EDL7141_FOC_3SH	✓	✓	✓	✓	✓	
EVAL_IMD700A_FOC_3SH	✓	✓	✓	✓	✓	
EVAL_6EDL7141_TRAP_1SH	✓	✓	✓	✓		
EVAL_6EDL7151_36V_1KW	✓	✓	✓	✓	✓ (when FOC firmware is used)	
Standalone support (w/o selecting a board from getting started)	✓		✓	✓		

6.1 LiveMonitor

Use LiveMonitor to create a simple interface that does not exist in the standard GUI window. To launch it, click on “Launch MTB LiveMonitor” button.

Note: MTB LiveMonitor needs to be installed separately. If it is not installed yet, you will see a warning message.

For more information, please visit MTB LiveMonitor user guide.

6.2 Oscilloscope

An oscilloscope is integrated into GUI. To launch the Oscilloscope, click on “Launch Oscilloscope” icon (Figure 85 and Figure 86).

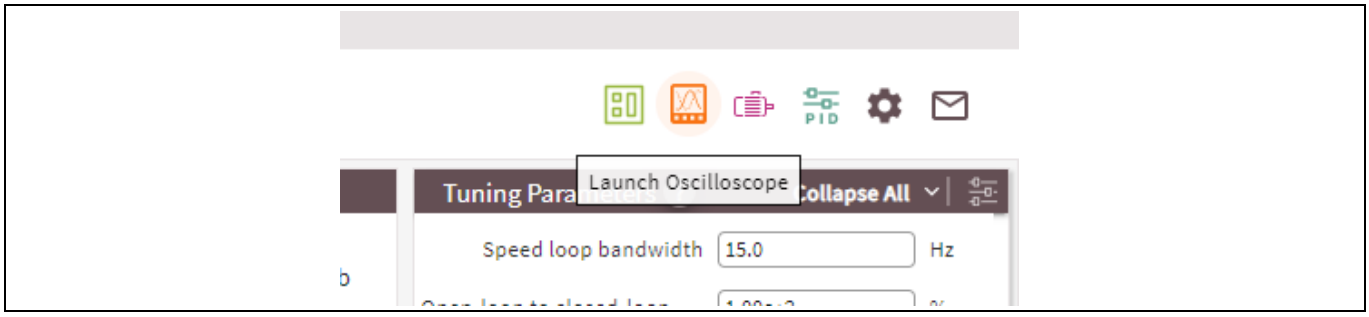

Figure 85 Launch oscilloscope

ModusToolbox™ Motor Suite Oscilloscope is a graphical user interface (GUI) with signal display and scope settings. It is part of the ModusToolbox™ Motor Suite GUI, and it reads signals from the active device in the Motor Suite GUI. Following is the list of oscilloscope features:

- Signal display for the selected traces through a line chart
- Controls and buttons to rescale the axes for the channels
- Trace assignment to 4 different channels
- Channel enabling and disabling
- Real-time signal statistics display
- Frequency changing through divider manipulation
- Time unit display setting
- 4 different scope modes to stop or control sampling procedure
- Trigger slope and position settings
- Measurements with cursors
- Exporting and importing data as CSV files
- Board connection control

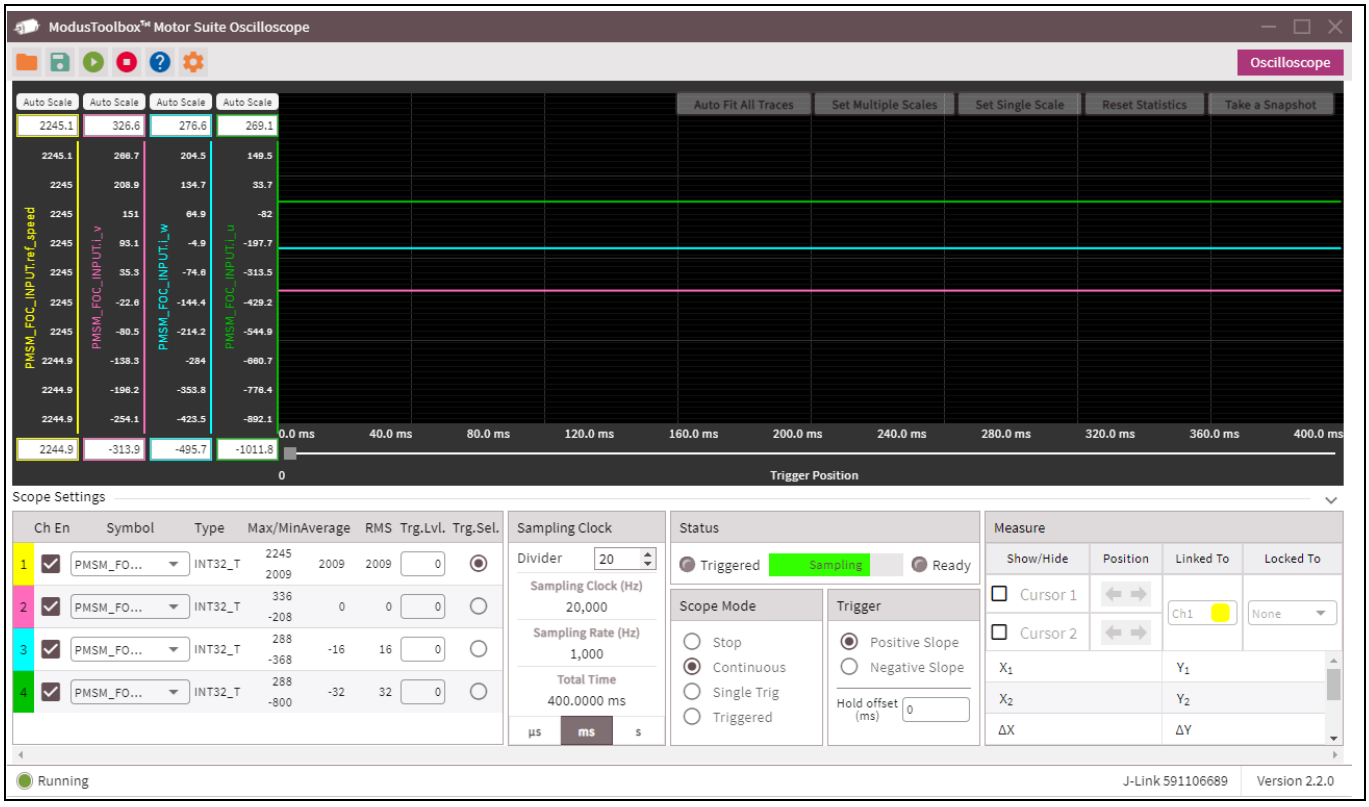

Figure 86 Oscilloscope window

The necessary information to read the signals is sent from the Motor Suite GUI. This important information is the device ID to connect to and the path for the ELF file to read the address and type of the traces are sent. Device ID is displayed at the bottom right corner of the window.

6.2.1 Signal display

After establishing a successful connection, the connection indicator in the footer becomes green with the text “Running” and traces are sampled periodically. The chart displays the traces for all channels (Figure 87). Each set of samples contains 400 or 500 data points by default.



Figure 87 Chart section

The first 4 buttons on the upper right corner are used for fast rescaling of all axes, fifth button for resetting the statistics for all channels and the last one for saving the latest frame as an image file (Figure 88).

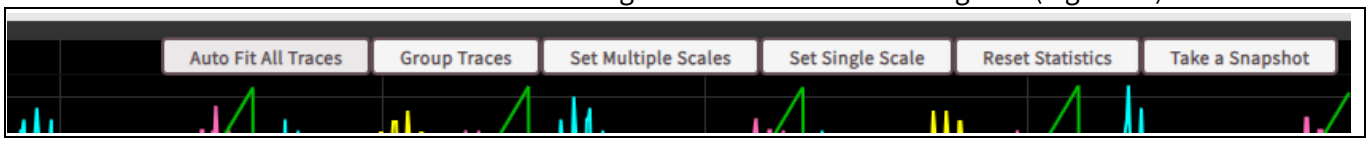

Figure 88 Quick action buttons

6.2.2 Auto Fit All Traces

This button can be used to auto fit all traces to the chart window so that traces do not overlap (Figure 89). Traces are separated from each other for a clear display.

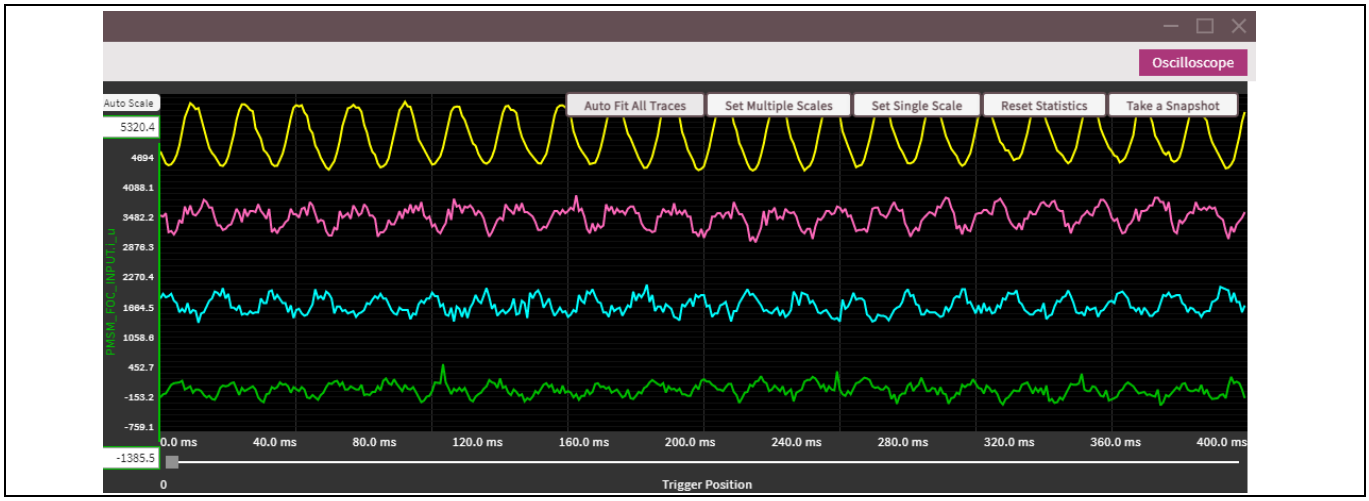

Figure 89 Auto fit all traces

6.2.3 Group Traces

Use this button to group the traces in the chart. Use the group inputs at channel settings panel to give name to your groups (Figure 90).

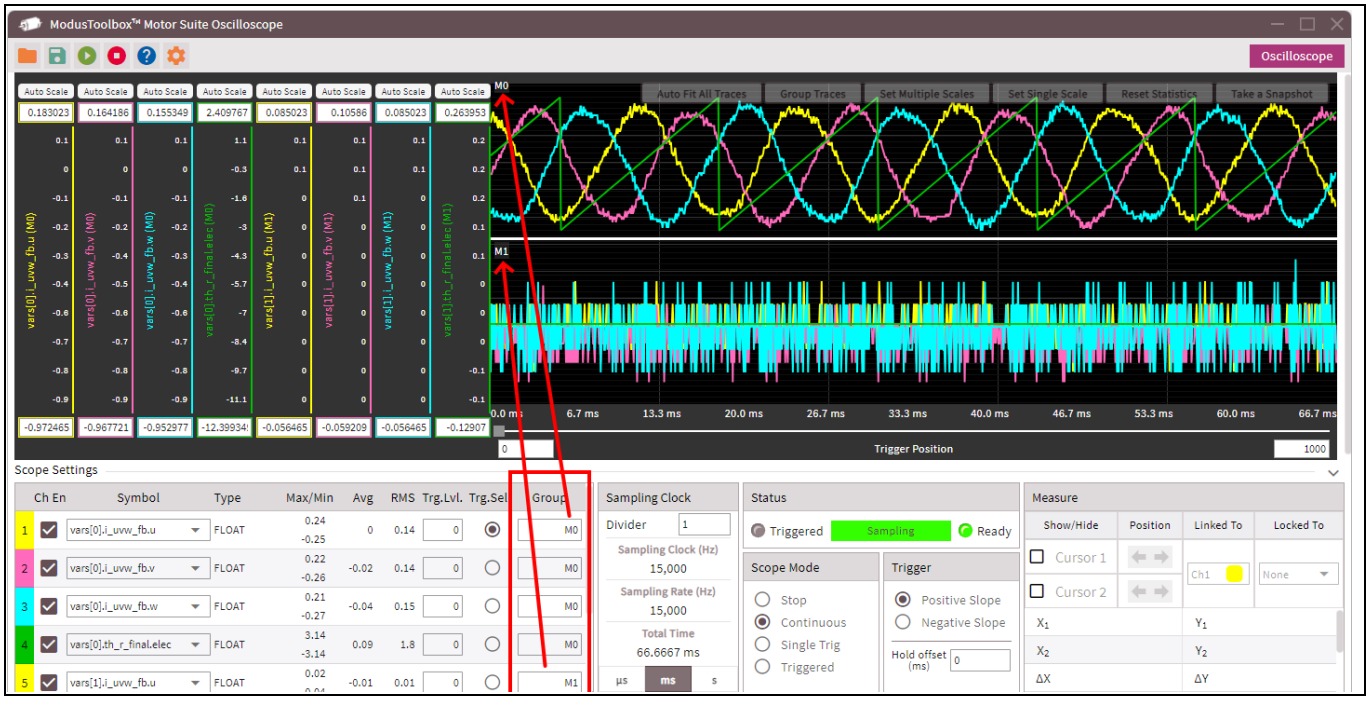

Figure 90 Group traces

6.2.4 Set Multiple Scales

This button fits the traces independently to the chart area with a small margin on top and bottom (Figure 91).

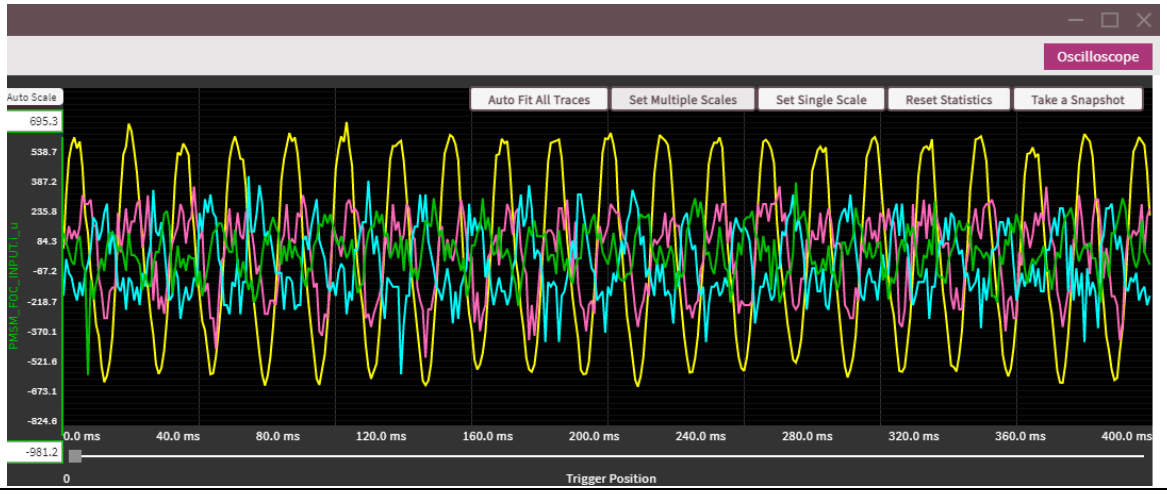

Figure 91 Set multiple scales

Set Single Scale: This button positions the traces such a way that all vertical axes use the same scale (Figure 92). The display is helpful for comparison of signals using a single scale.



Figure 92 Set single scale

6.2.5 Reset Statistics

This button resets the statistics for all channels. Min and max value of the channel is updated using the latest data frame. Min and max statistics are updated globally after every frame. Retrieving data for a long time increases the [min, max] range and signal scaling becomes inaccurate when using the action buttons. Clicking this button and clicking one of the scaling buttons re-adjusts the scaling and gives a more user-friendly display with more details in the chart.



Figure 93 Reset Statistics updates the statistics (before and after above)

6.2.6 Take a Snapshot

This button captures the latest frame and saves the image as a PNG file.

6.2.7 Dynamic Extend

The dynamic extend button is used to activate the dynamic scaling feature. When activated, the background color turns to green, and if the sampled data goes beyond the current scale, it modifies the scale so that chart displays all data points. When activated, this feature only increases the scale range, it never shrinks it. So the chart always displays the sampled data points.

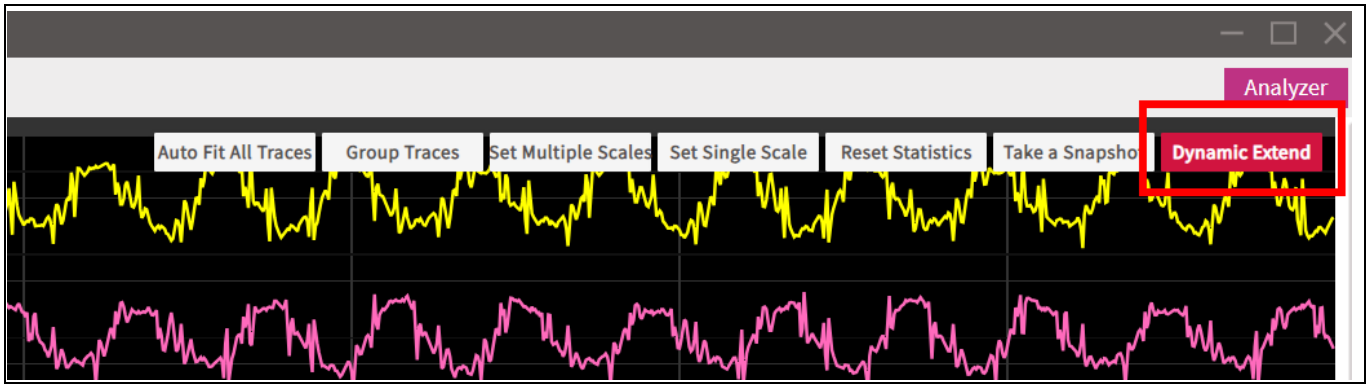

Figure 94 Dynamic extend button

There are also other controls which can be used to scale a single vertical axis.

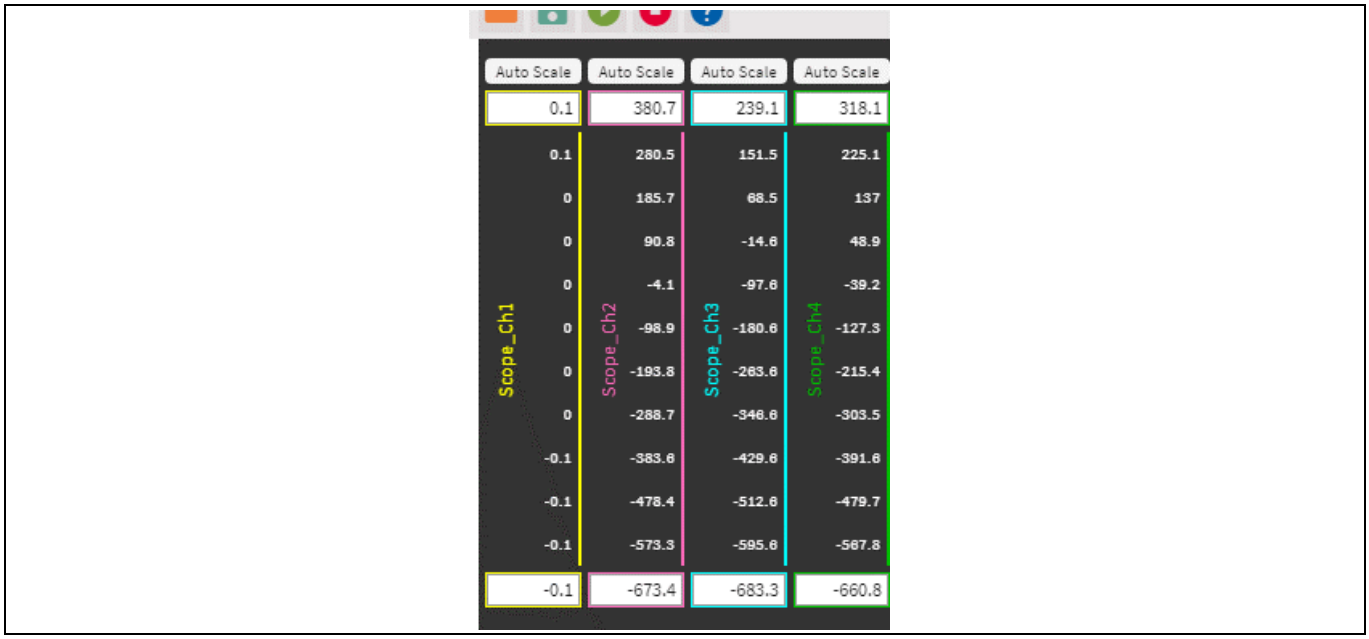

Figure 95 Vertical axes, auto scale buttons and scale inputs

6.2.8 Auto Scale buttons

These buttons are used to auto scale the corresponding axis using the range of the signal and a small margin on the top and bottom.

6.2.9 Scale Inputs

Use these inputs to apply custom limits to the corresponding axis.
The horizontal axis shows the time scale with the selected time units (Horizontal axis).

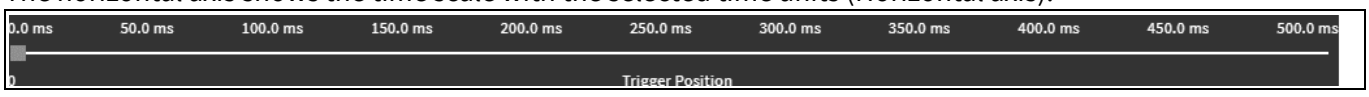

Figure 96 Horizontal axis

Under horizontal axis there is the trigger position slider. Use this slider to set the trigger position so that in single trig and triggered modes, this position can be referenced to sample data (Figure 97).

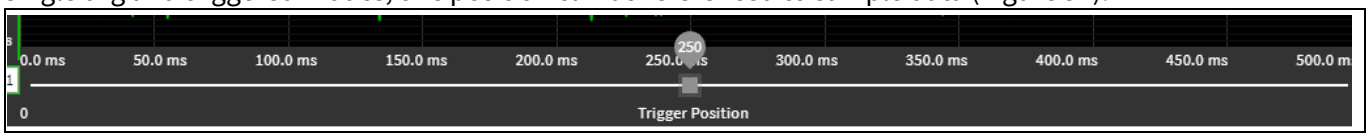

Figure 97 Trigger position slider

Another way to change the trigger position and the level is using the chart controls. When continuous mode is closed, if measurement cursors are not enabled, 2 dashed lines (one vertical and one horizontal) will be displayed on the chart. Use these lines to change the trigger position and trigger level.

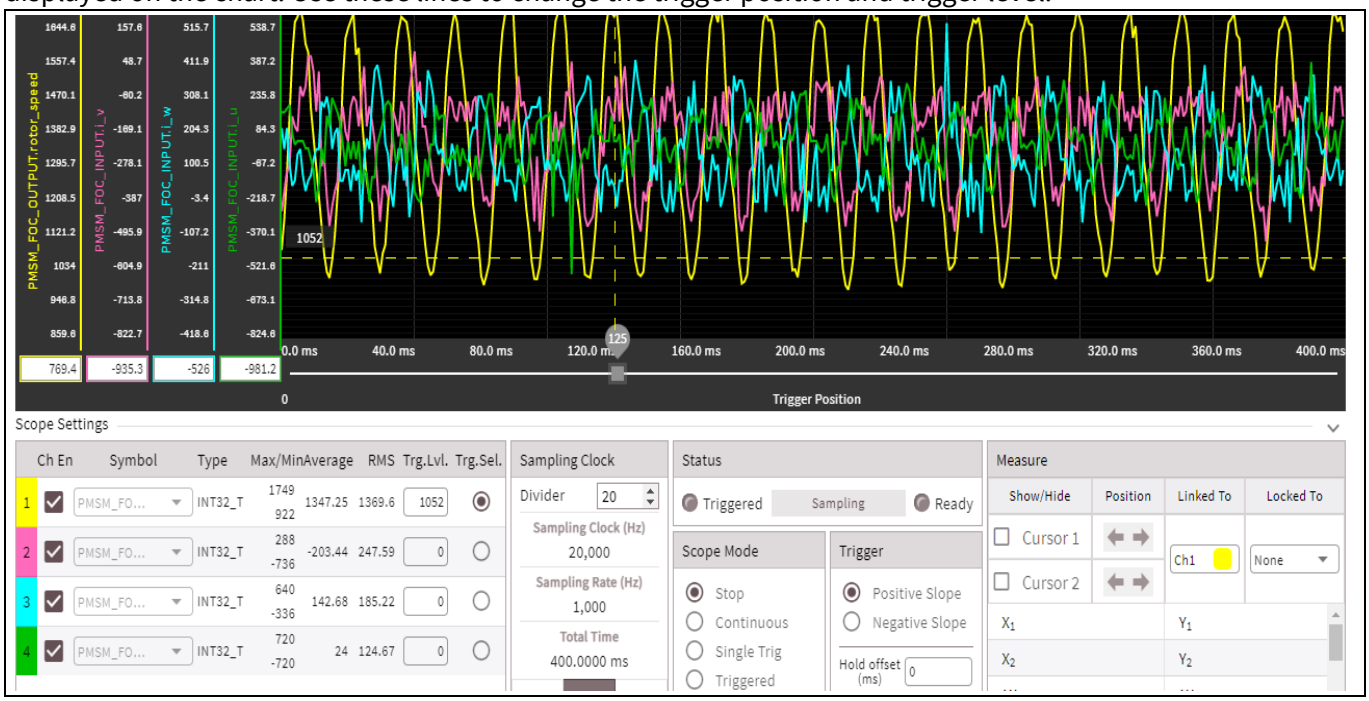

Figure 98 Use dashed lines to reposition the trigger level and the position

6.2.10 Scope Settings

Use scope settings to adjust the settings for channels, trigger options and measurements. There are 6 group of settings in this section. Channel Settings, Timebase Configuration, Status Indicator, Scope Mode selector, Trigger slope and offset setter and Measure settings.

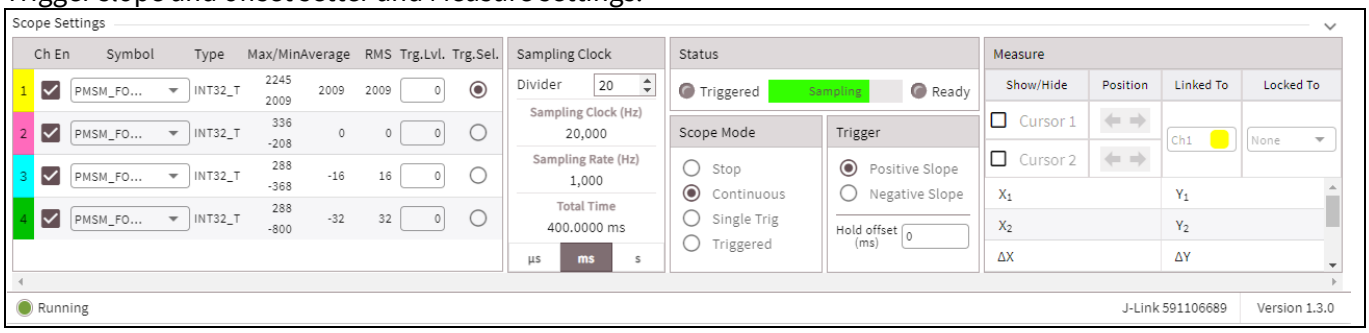

Figure 99 Scope settings

6.2.11 Channel Settings

In this panel, enable or disable the channels, assign new traces to the channels, see sampling statistics, and set the trigger channel, and the trigger level (Figure 100). To disable a channel, the Ch En checkbox should be unchecked, or to enable it back, the checkbox should be checked (Figure 101). To assign a new trace to the channel, select a trace name from the list of symbols in the Symbol select box. The rest of the columns in the table are simply the type information and some statistics about the samples. Max and Min values are calculated based on all previous samplings while average and root mean squared (RMS) are calculated based on the latest data set.

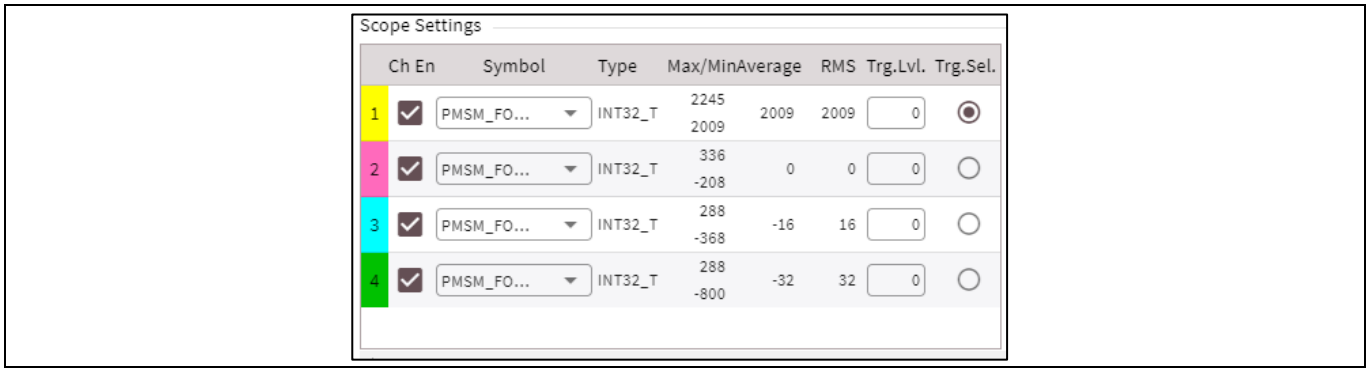

Figure 100 Channel settings

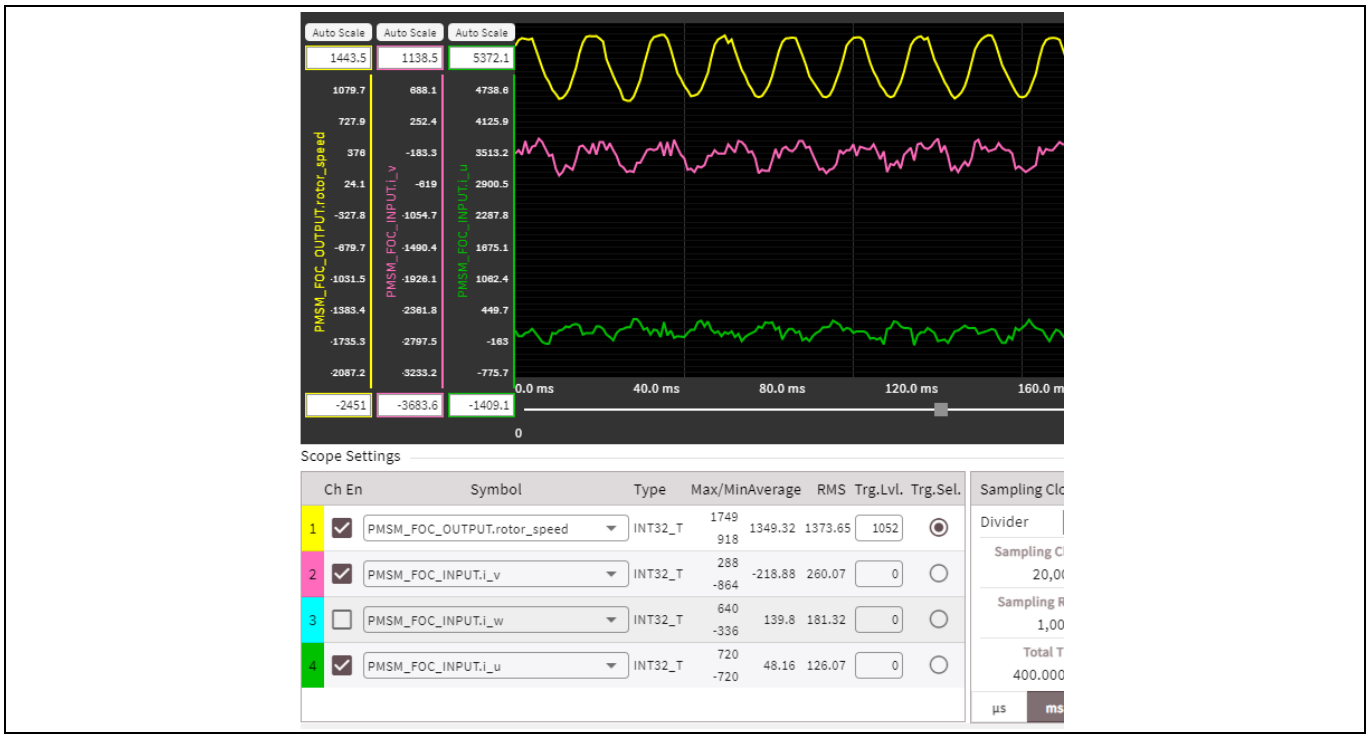

Figure 101 Disabling channel 3 removes the signal and the axis

6.2.12 Time base Configuration

In time base configuration panel (Figure 102), update the sampling clock and rate by changing divider value. After entering a number between 1 and 100, both sampling clock and sampling rate values are updated and the change in the speed of the sampling can be observed in the chart.

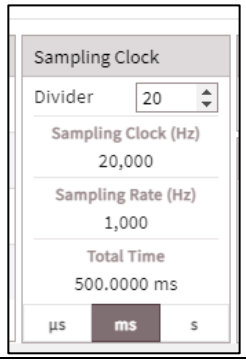

Figure 102 Time base configuration

Change the time unit used in the oscilloscope in this section. The available units are µs, ms and s. By default, ms is selected. After changing the value, the axis ticks in the horizontal axis and other time related data statistics (information boxes, measures…etc.) are updated (Figure 103).

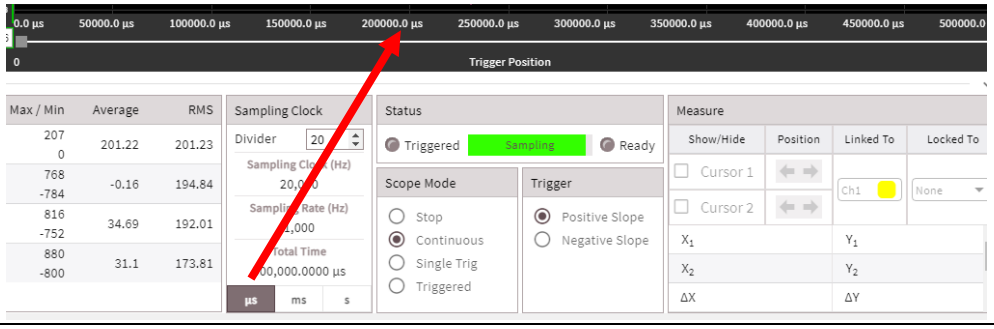

Figure 103 Changing time unit

6.2.13 Trigger Status

Trigger status indicator displays the sampling state using a progress bar animation. If single trigger or triggered modes selected but the trigger conditions are not met, then the progress bar stops at 100%. If trigger conditions met and new data is sampled, for single trigger mode, the mode changes to stop state and progress bar goes to grey state. In the same scenario for triggered mode, the animation continues for each new sampling (Figure 104).



Figure 104 Trigger state animation

6.2.14 Scope Mode

There are 4 different scope modes (Figure 105). Stop mode stops new data sampling while continuous mode samples new data continuously. In single trig mode, data is sampled only if the trigger conditions (trigger slope, trigger position…etc.) are met. Triggered mode works similar to single trig mode but samples new data continuously if trigger conditions are met. The trigger channel is channel 1 so single trig and triggered modes tests the conditions only for channel 1.

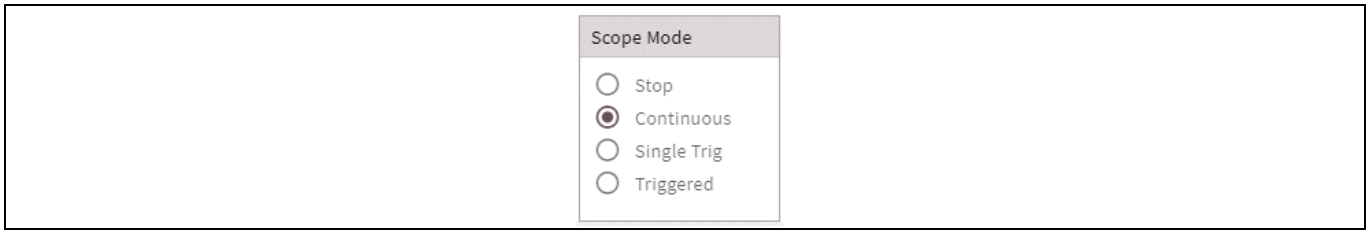

Figure 105 Scope Mode

6.2.15 Trigger Slope and Holdoff

Select the trigger slope using trigger slope radio buttons (Figure 106). Single trig and triggered modes check the slope condition and wait until this condition is met, before sampling new data.

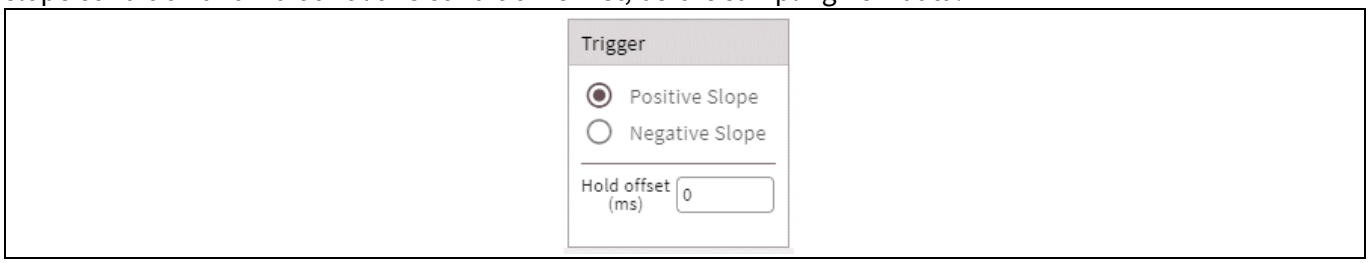

Figure 106 Trigger slope and holdoff

6.2.16 Measure

Measure section provides tools to capture statistical data about the traces (Figure 107). There are 2 parts in this section. At the top there are the controls and at the bottom there is a statistics table. This section does not work in continuous scope mode. First select a different mode to activate the control in this section.

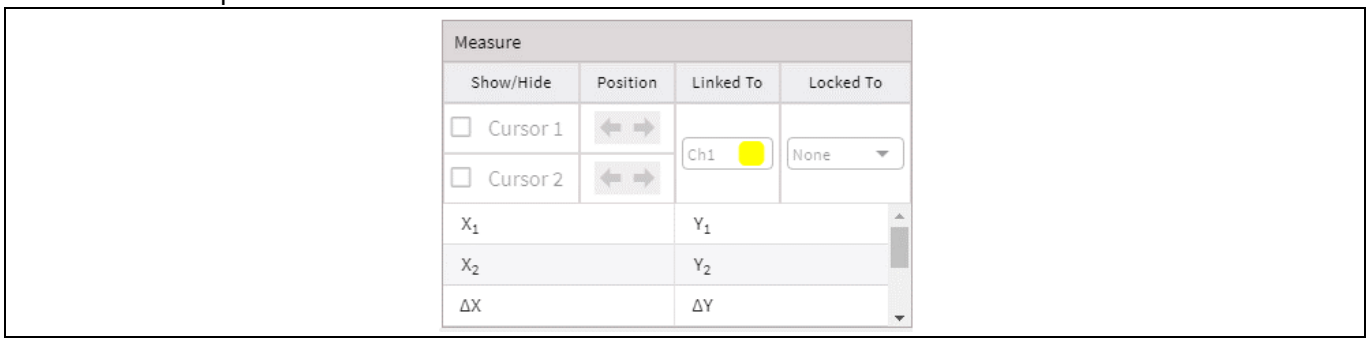

Figure 107 Measure

There are 2 cursors. Activate one of them or both of them by selecting the checkboxes under Show/Hide column. These cursors are displayed in the chart as soon as they are activated (Figure 108). Cursors show the position for the linked channel signal.

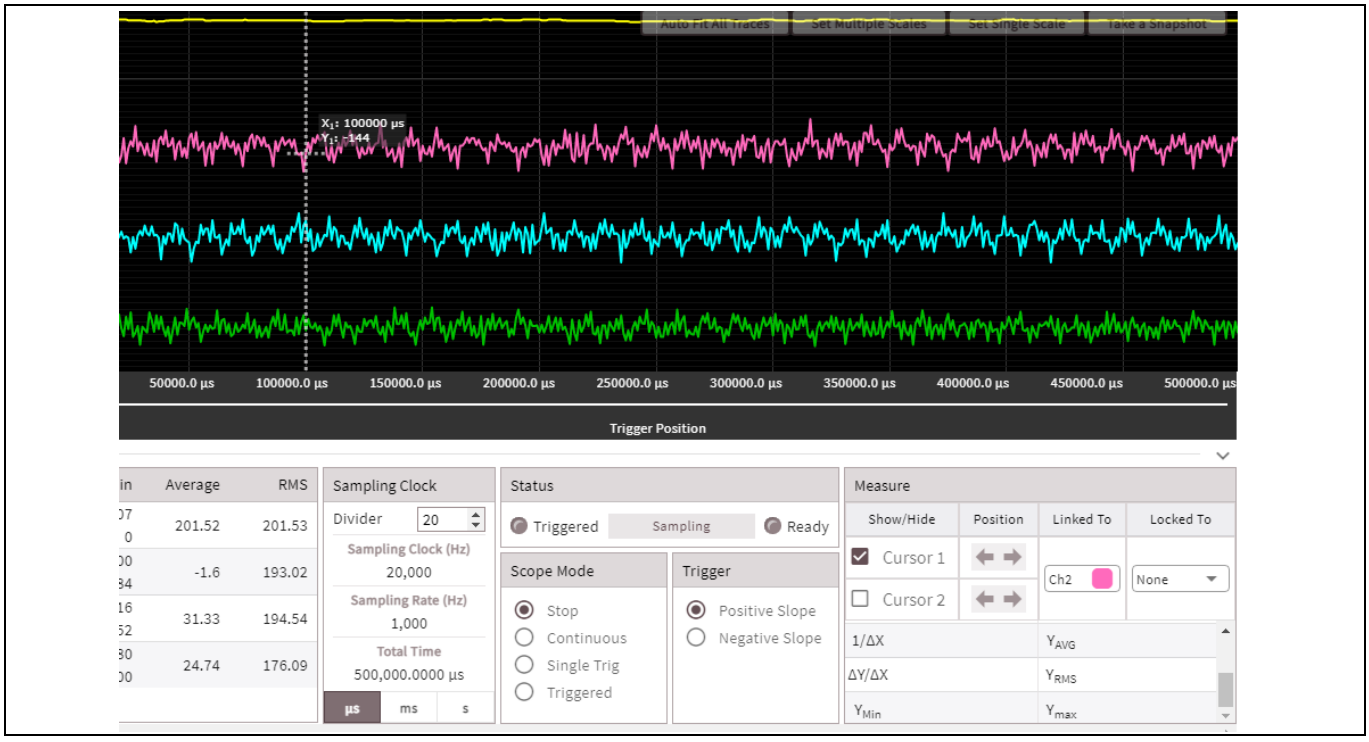

Figure 108 Activating the first cursor

When only one cursor is activated, a single cursor is displayed in the chart area. If both of the cursors are activated, both cursors and a summary box is shown in the chart. Also, the statistics are calculated and displayed in the statistics table below the measure controls (Figure 109).

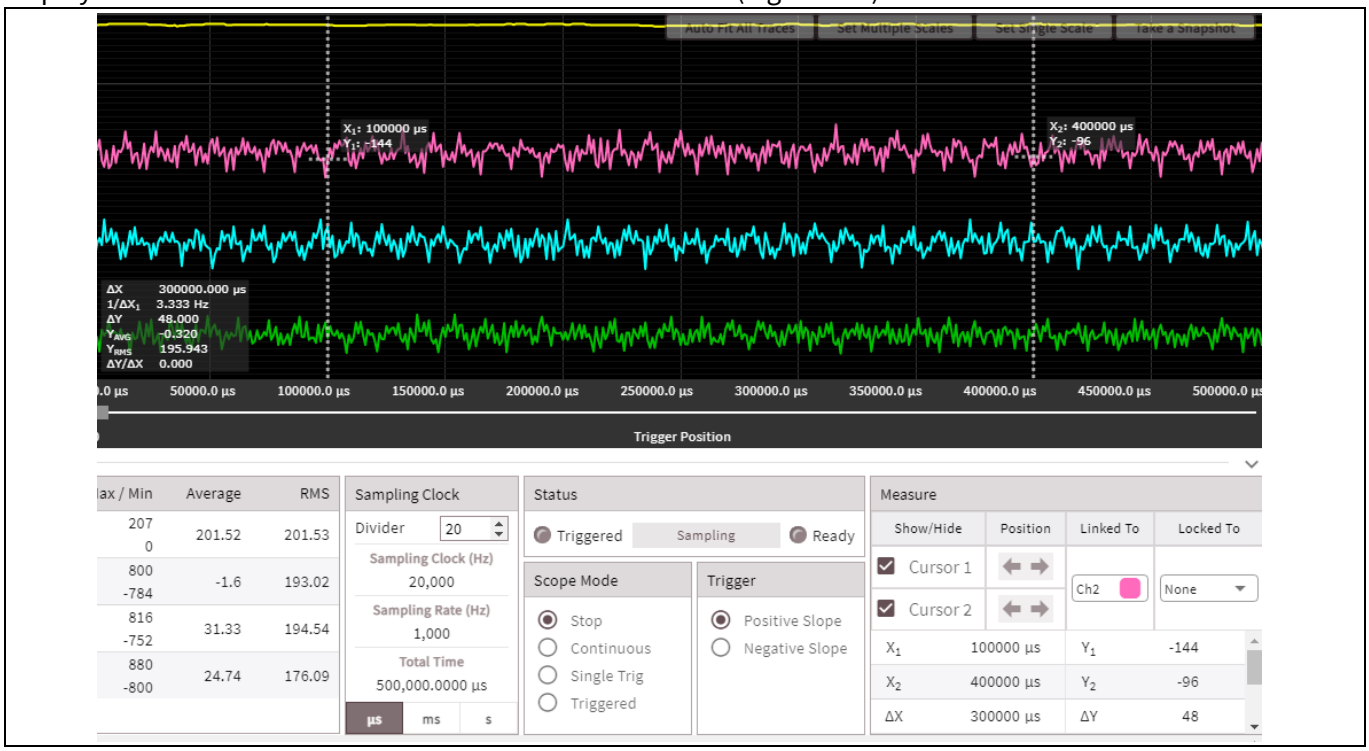

Figure 109 Activating both cursors

The statistics displayed in the table are the X and Y values of cursors and the difference between the two cursor positions. Also, the average, min, max and RMS values of the Y values between the cursors are displayed in this table.
Change the cursors positions either by using the arrow keys in the position column or by dragging the cursors in the chart area (Figure 110).



Figure 110 Repositioning cursors

Link the cursors to different channels. To select a different channel to link the cursors, select the channel name from the linked to select box (Figure 111).

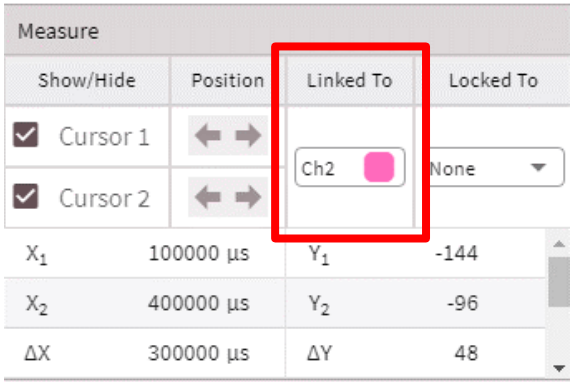

Figure 111 Linking a channel to cursors

Lock cursors so that the distance between the cursors are preserved. If cursor 2 is locked, then moving cursor one updates the position of cursor 2. The distance between the cursors is always preserved. To change the distance, change the position of the locked cursor. If the position of cursor 2 is changed when it is locked, the position of cursor 1 is not affected (Figure 112).



Figure 112 The distance between cursors remain same when positioning cursor 1 while it is locked to cursor 2

6.2.17 Taskbar

There are 6 buttons in the taskbar. The first two buttons are used to import and export one frame of sampling data as a csv file. The next two buttons are used for opening or closing the device connection. Fifth button is used to open the user guide. Last button open preferences window to set chart display preferences for the current session.



Figure 113 Taskbar buttons

These are the buttons with the display order:

6.2.17.1 Import data button

Use import button to import a previously exported csv file. Only the csv files exported by the oscilloscope is supported. Importing a file preserves the state of the export conditions so that the scales and the channel settings are displayed same as the time of the export (Figure 114). As soon as a file is imported, scope mode changes to Stop mode. To continue sampling real time data, select the continuous mode again. The date of import and the firmware name are shown in the corner of the chart area as a support information.

Note: Imported data and settings are temporary. When you return to sampling mode, all configurations are restored to the settings that were active before the import.



Figure 114 Displaying imported data

6.2.17.2 Export data button

Use this button to export the current frame. Export button does not work in continuous scope mode, so select another mode before exporting the data.

Note: This button does not save the current state. To save the state, close the oscillosope window, then save the project from the main window.

6.2.17.3 Connect button

Connect button opens a connection to the device in case the connection is lost. When there is a connection the connection indicator in the footer bar shows Running with a green led icon (Figure 115).

6.2.17.4 Disconnect button

Similar to the connect button, use the disconnect button to close the connection to the device. When the connection is closed the connection indicator in the footer bar shows Stopped with a red led icon (Figure 115).

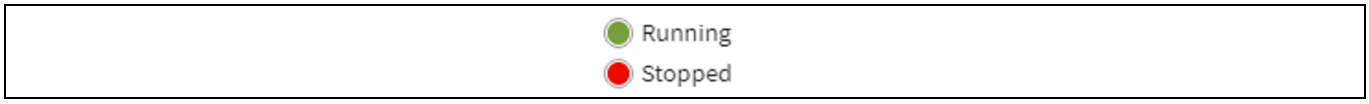

Figure 115 Connection status indicator

6.2.17.5 User manual button

This button opens a separate window with the user manual (this document).

6.2.17.6 Preferences button

Preferences button opens preferences window. In this window change the trace display mode, interpolation, line width, color and marker size. Apply these changes to one or more channels for some of the preferences. All these changes are applied during the session and are not saved for future use.

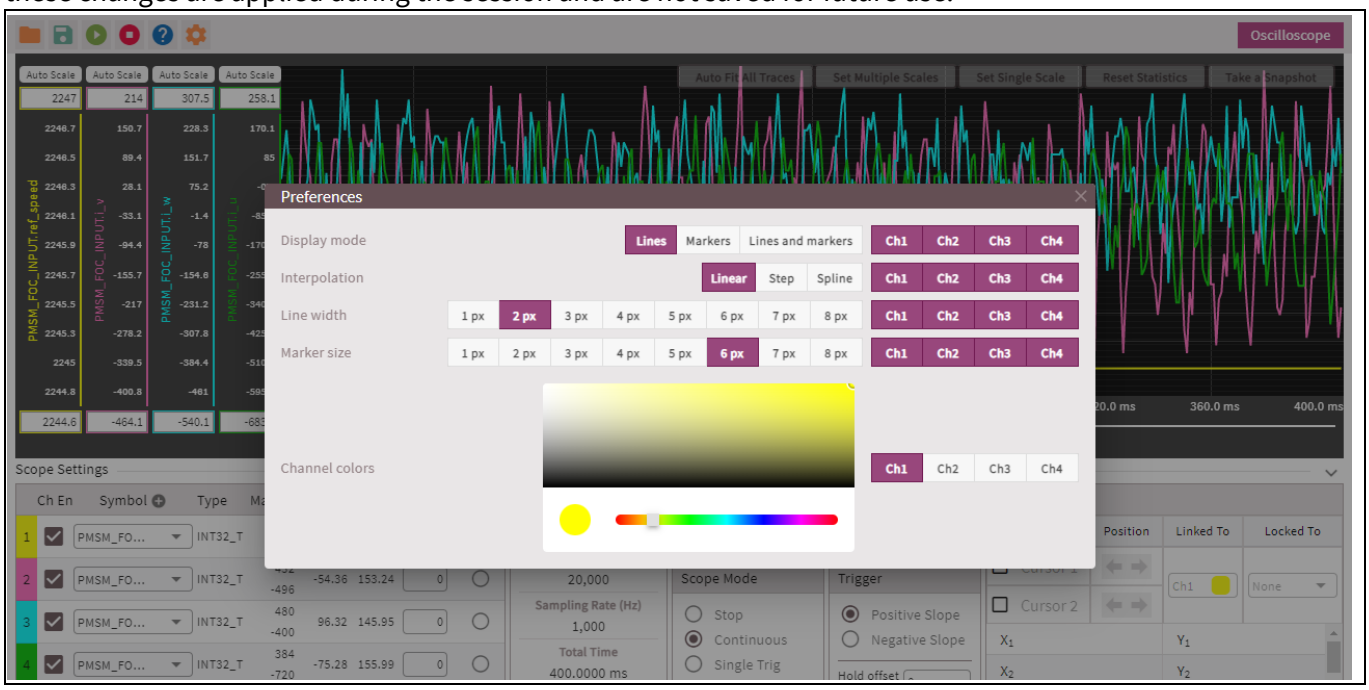

Figure 116 Preferences window

6.2.18 Analyzer

Oscilloscope have the analyzer feature to automatically update the value of a selected variable, and see the changes on a channel, or on a formula based on the channels.



Figure 117 Preferences window

Users select a single variable from the input dropdown, and set the initial and final values of this variable. Watch statement is a formula, it accepts all math operators and channel samplings as “Ch1”. Write a formula using a single channel or, multiple channels as watch formula (i.e. 2 * Ch2 – Ch1). The formula will be calculated on the set of sampled data (readings as a vector), and averaged to a single number after the calculation. Number of steps and frames per step can be set too. Frames per step is the number of samplings to add to sampling output before calculating the watch statement. This setting also affects the time per step. Depending on oscilloscope settings, time per step changes. If you set a larger number of frames for a single step, the time for you to observe the signal changes will be larger.
After changing the input variable value, oscilloscope can set the value back to the value before analyzer started, or keep the final value. To keep the last value, select “Keep Last?” checkbox.
After starting analyzer, a chart will display the watch statement values at every step, and log statements will be displayed in the log box. If you want to keep the input value that minimizes, or maximizes the watch statement, use the buttons after analyzer is completed.

6.2.19 Data Persistence

After closing the oscilloscope, latest data and channel preferences are saved to temporary memory. During the session, channel selections, trigger settings and divider value will be reapplied, so that new oscilloscope session starts with the previous setup. When user saves a project, these oscilloscope data are also saved to the project file for future use.

6.3 PID Tuner

PID tuner is used to tune PID parameters. In this window, there are signal charts to monitor the motor behavior based on one or more signals. To open this window, click “Launch PID Tuner” icon button at the right-hand side of header bar (Figure 118).

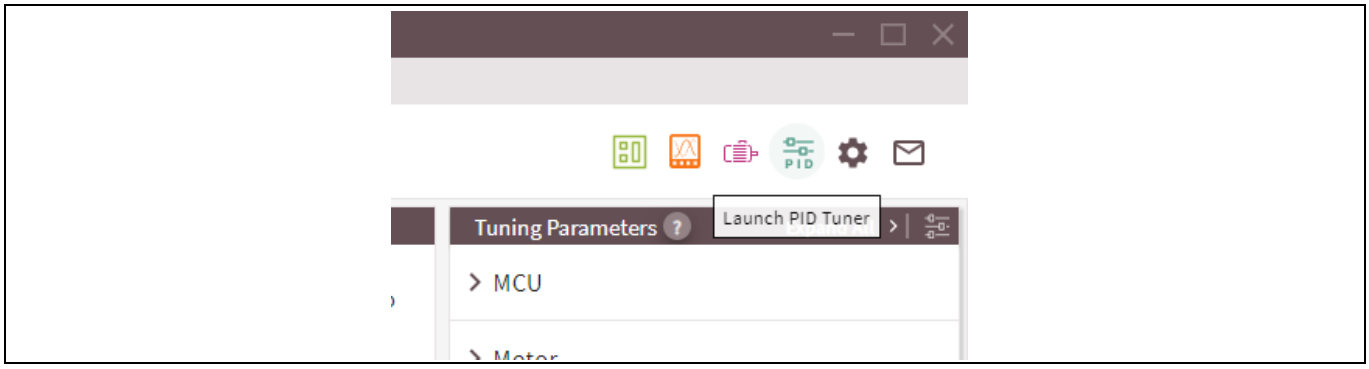

Figure 118 PID Tuner icon

PID tuning window will be displayed after clicking the button (Figure 119). For XMC1400 FOC projects there are 4 charts:

- Flux
- PLL
- Speed
- Torque

For PSoC™ Control C3, Traveo and XMC7200 projects there are 3 charts:

- Torque
- Flux
- Speed

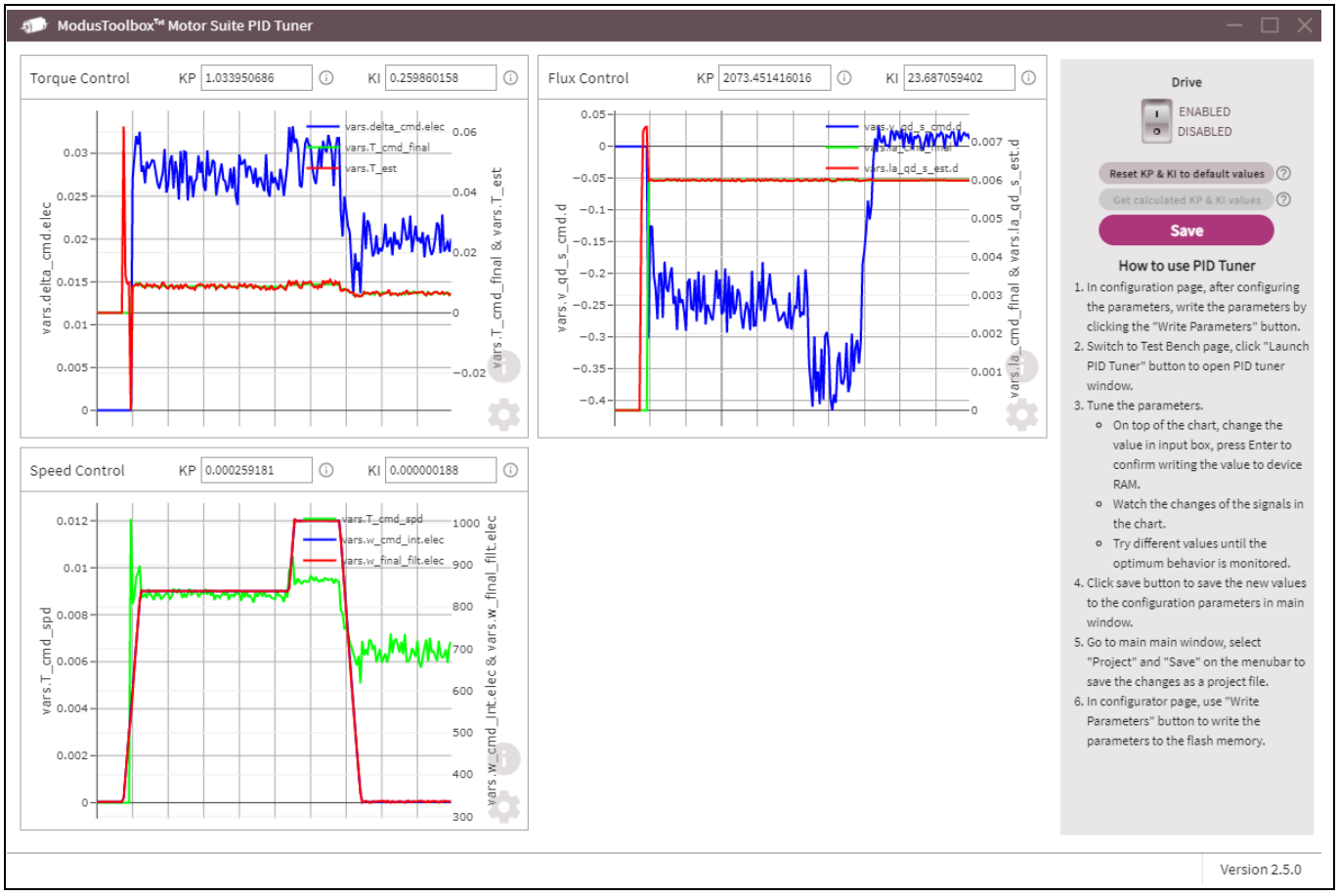

Figure 119 PID Tuning window

For each of these charts there are 2 or 3 input parameters. Structures are configured through these members:

- KP
- KI
- Scale (in XMC1400 FOC projects)

To tune these parameters simply input a value in the corresponding input box and press Enter key (Figure 120). As soon as Enter key is pressed, the value will be written to the board. Then the signal can be watched in the chart for changes.

Attention: It is important to know that the values will not be written to the board if "Enter" key is not pressed. This behavior can be changed at PID preferences.

Update the value in the input box, but the signals will still display the motor behavior based on the old values, since new values are not written to the board.



Figure 120 Input panel of the charts

Chart display shows latest 200 readings from the board. Horizontal axis is the time axis and when all 200 data points retrieved, the chart starts rolling to the right, removing earlier values from the display. If a straight line is seen in the chart area, it means the motor is most possibly in stop state or a fault occurred during tuning. In this case test bench page can be used to identify and fix the problem.
If vertical axis is not sufficient for watching the signal changes, drag it up or down using the mouse. When hovered over the axis, mouse cursor turns into a resizer. Shift the axis at this state by clicking and dragging the axis (Figure 120). This translates the scale. To transform the scale, repeat the same action while hovering on the axis, closer to the top or bottom.

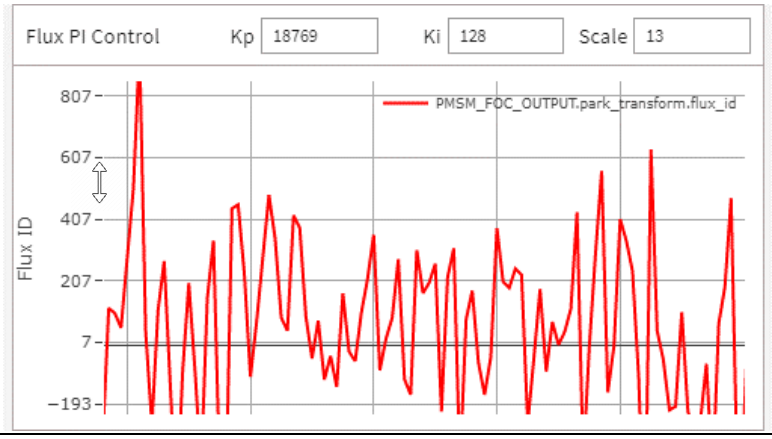

Figure 121 Shifting axis up or down

By selecting a point and dragging on the chart, it is also possible to zoom into that area (Figure 122). To zoom out to initial size, simply double click on an empty area on the chart.

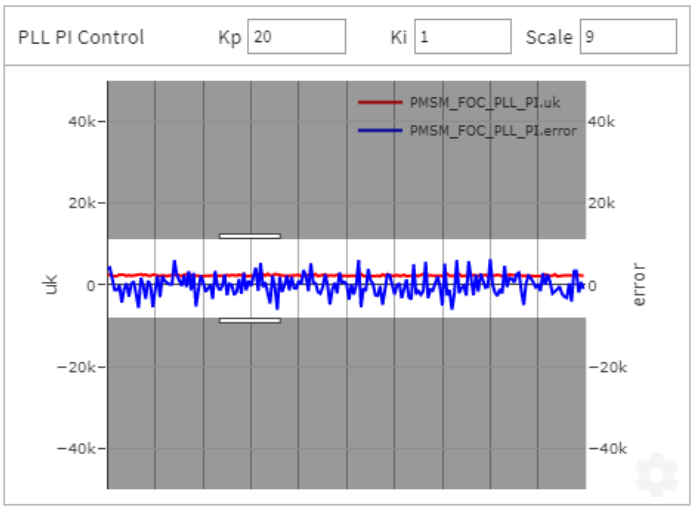

Figure 122 Zooming in a specific area on the chart

These are all chart scale, filter and zoom actions:

- Move vertical axis by clicking on the middle of the axis and drag
- Change vertical axis by clicking on the top or the bottom end of the axis and drag
- Zoom in by selecting a region on the chart
- Double click to set the vertical axis to dynamic optimum display, the vertical range will always fit to readings dynamically
- Double click to set the axis back to default range, after altering the scale
- Select a signal from the legend to enable/disable the signal display

For all the parameters, calculate the values by clicking on “Get calculated KP & KI values” button. This button calculates the values of these parameters based on the values of other parameters. Use these values as a starting point while tuning the parameters.
To get the default values, click on the “Reset KP & KI to default values” button(Figure 123). This button retrieves the default values, which is either initial GUI defaults (default behavior) or last saved project values, the values previously saved in the project file (.imcsp). If the project has not been saved yet, this button will bring the default values. Set the behavior of this button in the preferences window of main GUI window.
After tuning the parameters, to save the latest values, simply click the “Save” button on the right-hand-side panel (Figure 123). This button will send the values to the GUI and the parameter values under PID component in test bench page will be updated with the latest values.
Stop the motor using “Drive” button. This button is only available in PSoC™ Control C3, Traveo and XMC7200 projects.
When the "Write Parameters" button is clicked in the configurator page in the main GUI window, PID values are calculated using dependent parameters, until the PID values are saved. Saving the values means that PID values are decided, so they will no longer be calculated. The saved values can always be changed later by entering custom values directly or by clicking get calculated values button in PID window.

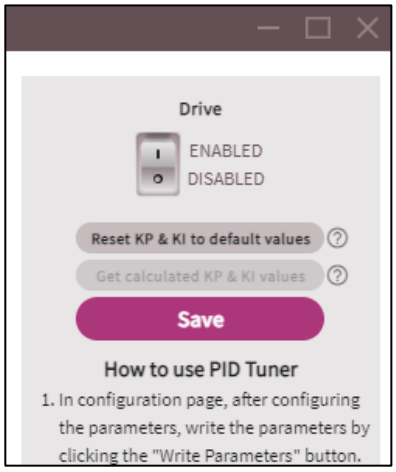

Figure 123 Use save button to save the updated values

6.4 Power Loss Estimator

ModusToolbox™ Motor Suite Power Loss Estimator is a graphical user interface (GUI) where power loss estimations for different components can be calculated based on the selected configuration. These are the power loss estimator window features:

- Easy-to-use graphical user interface
- Loss estimations by components
- Loss and configuration comparison visualizations
- Suggested configurations for lower power consumption
- Parameter synchronization for saving final parameter values in the project file

Start the Power Loss Estimator window by clicking on “Launch Power Loss Estimator” icon at tool icons in configurator page of ModusToolbox™ Motor Suite application (Figure 124).

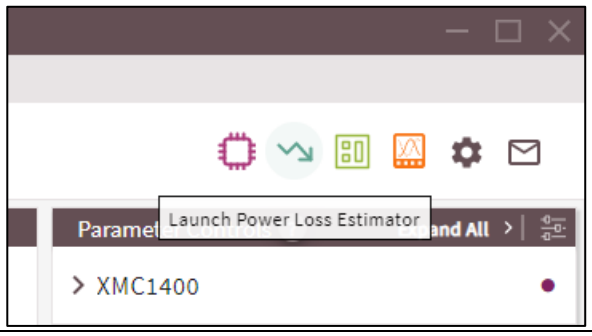

Figure 124 6EDL Launch Power Loss Estimator

Another way to start the Power Loss Estimator window is clicking the “New Project” button under the 6EDL71x1 Power Loss Estimator Stand-alone project at Getting Started view (Figure 125).

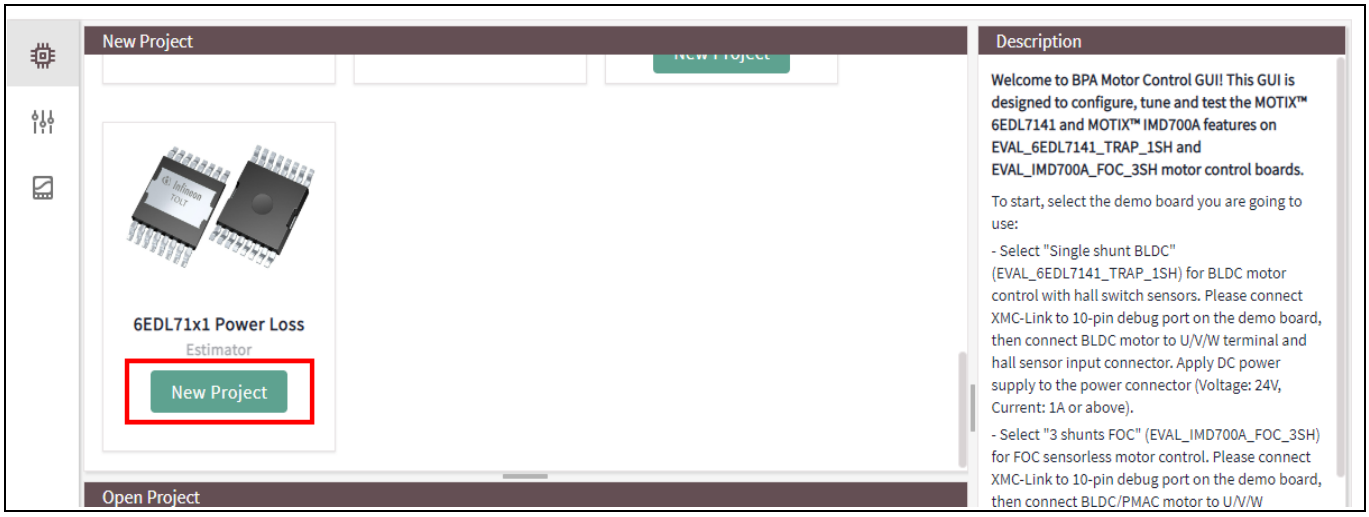

Figure 125 6EDL Power Loss stand-alone project

After clicking one of these buttons, a new window will be opened (Figure 126).

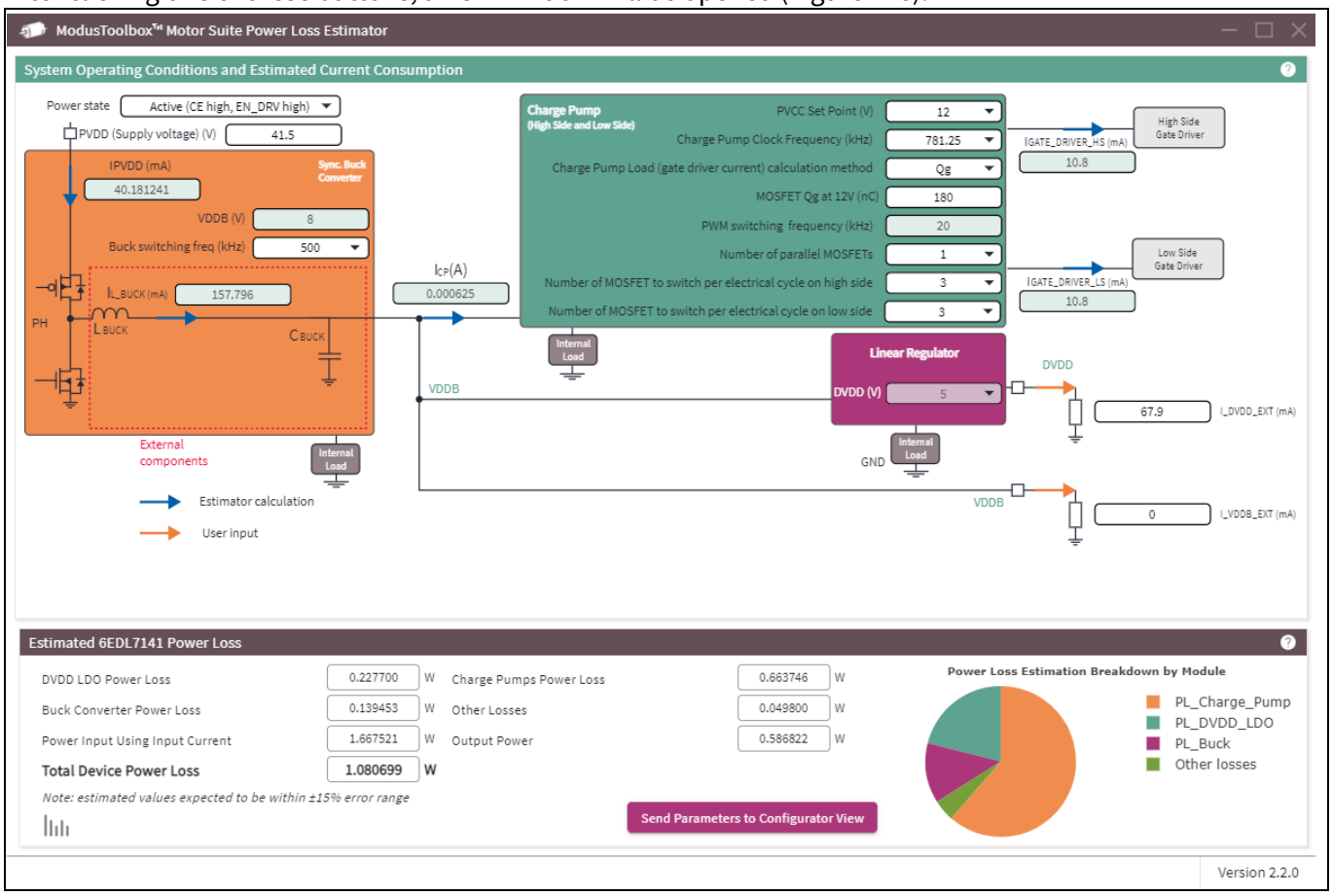

Figure 126 6EDL Power Loss Estimator window

6.4.1 System Operating Conditions and Estimated Consumption

In this section set the operating conditions by entering / selecting the values using the input fields.

Configurable parameters have white background color while computed values and disabled parameters have light green background color. As soon as the value of one parameter changes, the estimated loss computations below are updated.
If a value out of accepted boundary is entered to the input boxes, the value will be increased or reduced to the closest boundary. For computed values, if computation result is bigger than maximum safe operation value, a warning message will be displayed and the values with the out-of-boundary values are highlighted (Figure 127).

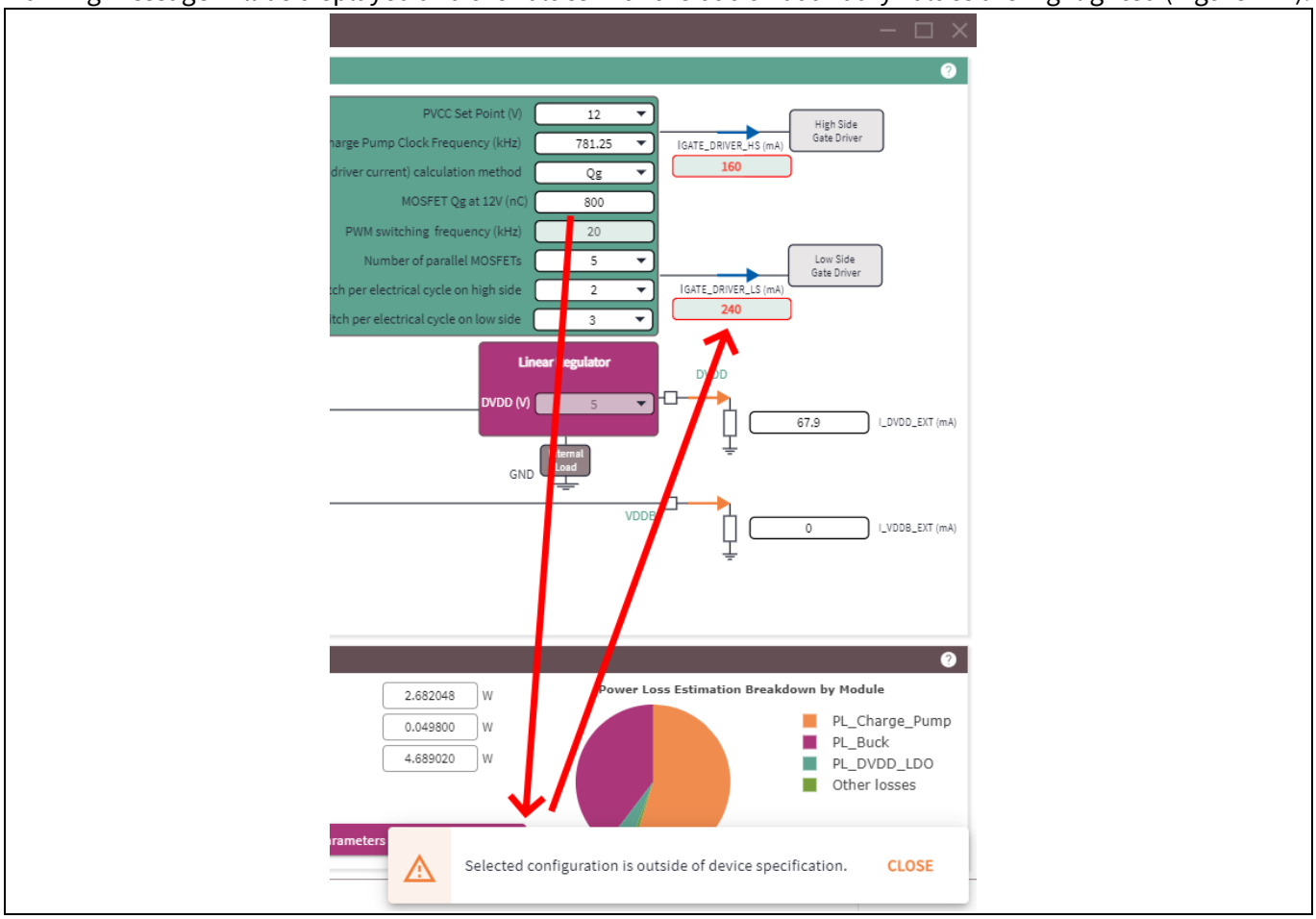

Figure 127 If an input results with an out-of-boundary calculation, a warning window is displayed

6.4.2 Estimated 6EDL Power Loss

In this section different estimated losses are displayed (Figure 128). Total loss is the sum of DVDD LDO, Charge Pumps, Buck Converters and other losses.

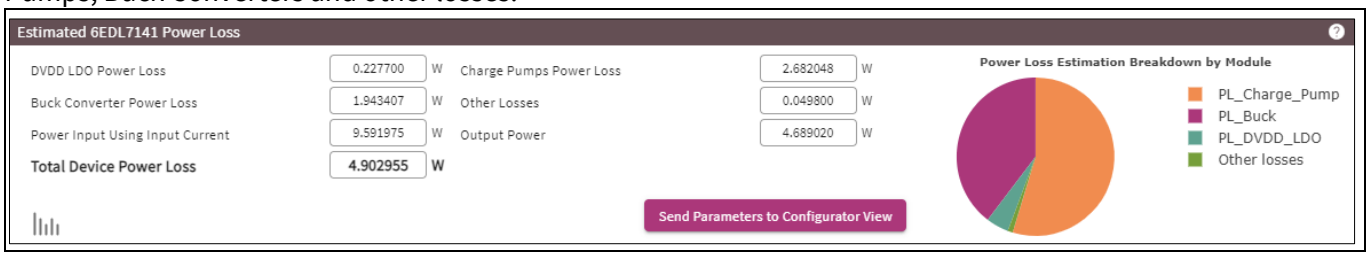

Figure 128 Estimated power loss section

The values in this section are not editable. They only display the estimated losses.

Use the pie chart for the comparison of different component losses. Clicking on the legend items (right to the pie chart) will filter out the loss. Double clicking will only keep the selected loss. Use these features to compare selected losses.
After deciding which configuration to use, send selected parameters back to configurator window by clicking on the "Send Parameters to Configurator View" button. Only the parameters that exist in the selected project can be sent to configurator page. In the configurator page, these values then will be saved as a project file.
To open suggested configurations section, click the bar chart icon in the left bottom corner of this section (Figure 129).

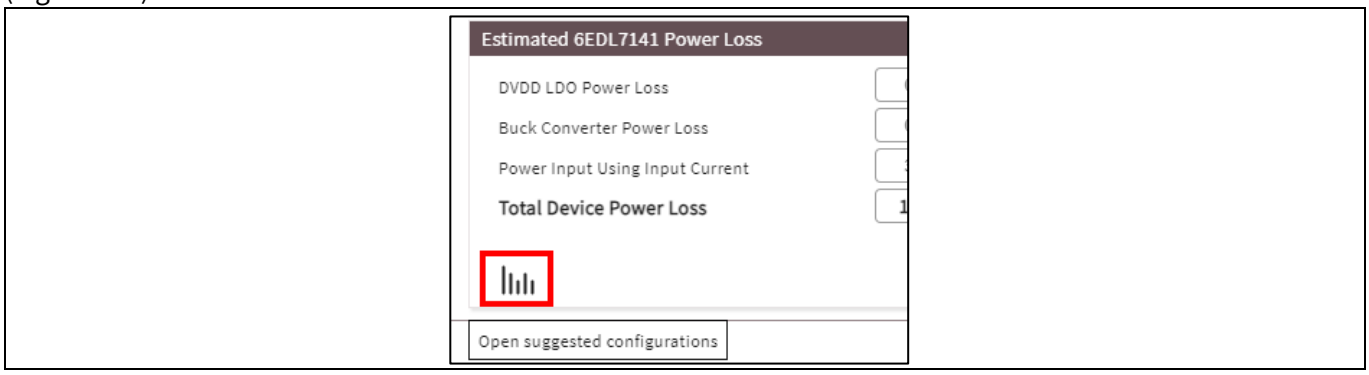

Figure 129 Click the icon to display suggested configurations section

6.4.3 Suggested Configurations

Each configuration, represented by a bar in the chart in this section (Figure 130), is a slightly altered version of the configuration selected in the operating conditions. See the bar names to understand what is different in that configuration. The black bar (the last bar) represents the user configuration and displays the total loss value estimated by user selected values.

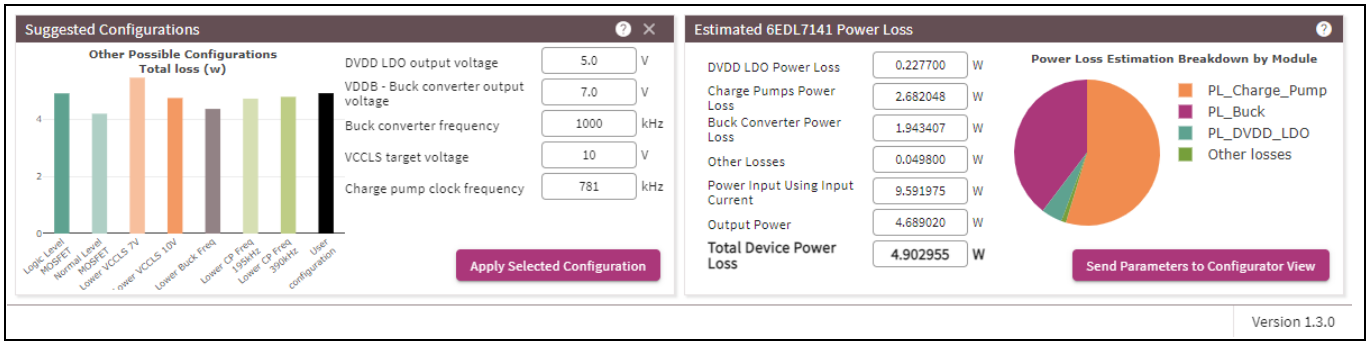

Figure 130 Suggested configurations section

Also, if a bar is clicked, the values of the selected parameters for the selected configuration are displayed in the right-hand-side (Figure 131).

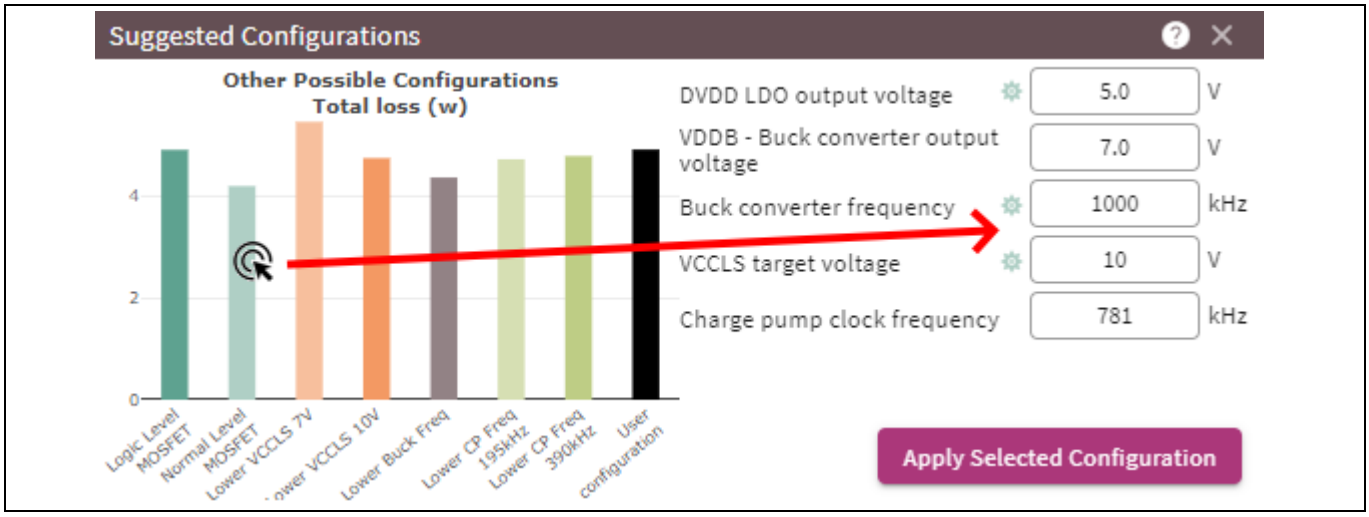

Figure 131 Clicking on a bar sets the configuration parameters' values

All configuration alternatives use a different value for either one or more of these selected parameters. If one of these alternatives is preferred, after clicking on the corresponding bar, clicking "Apply Selected Configuration" button will set the new values for the selected parameters to the user configuration in the operating conditions and estimated current consumption diagram (Figure 132). This button sets the values in the right-hand-set to the same parameter in that section.

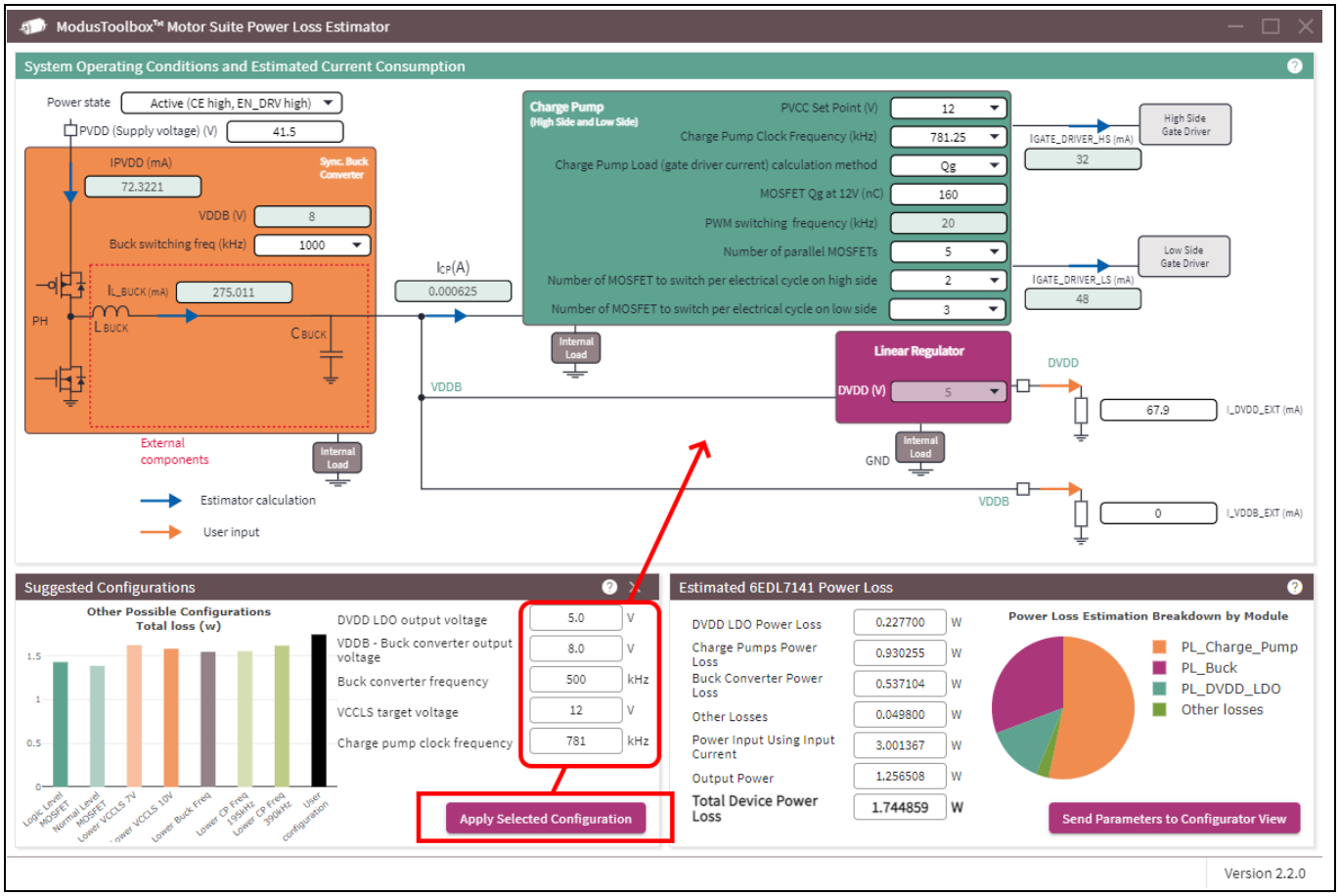

Figure 132 Selected configuration values can be applied to the user configuration

6.5 MOSFET Slew Rate Configurator

ModusToolbox™ Motor Suite MOSFET Slew Rate Configurator is a graphical user interface (GUI) where you select a MOSFET product, optimize the parameters and send back the parameters to the main GUI and save for future use. Following is the list of MOSFET configurator window features:

- Provides up-to-date list of MOSFET products
- Calculates MOSFET parameters based on the selected product and initial conditions
- Calculates slew rate controller parameters
- Sends the values to main window to save them for future use

Start the MOSFET configurator window by clicking the “Launch MOSFET Tuning” icon in configurator page (Figure 133).

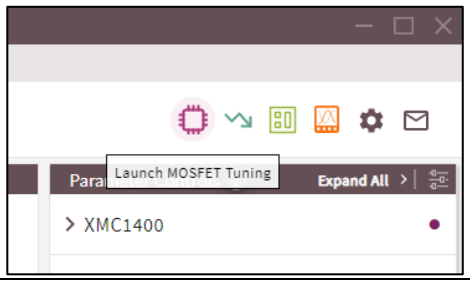

Figure 133 Launch MOSFET Tuning

Another way to start the MOSFET window is by clicking the “New Project” button under the MOSFET Slew Rate Configurator project at Getting Started view (Figure 134).



Figure 134 MOSFET Stand-alone project

After clicking one of these buttons, a new window will be opened (Figure 135).

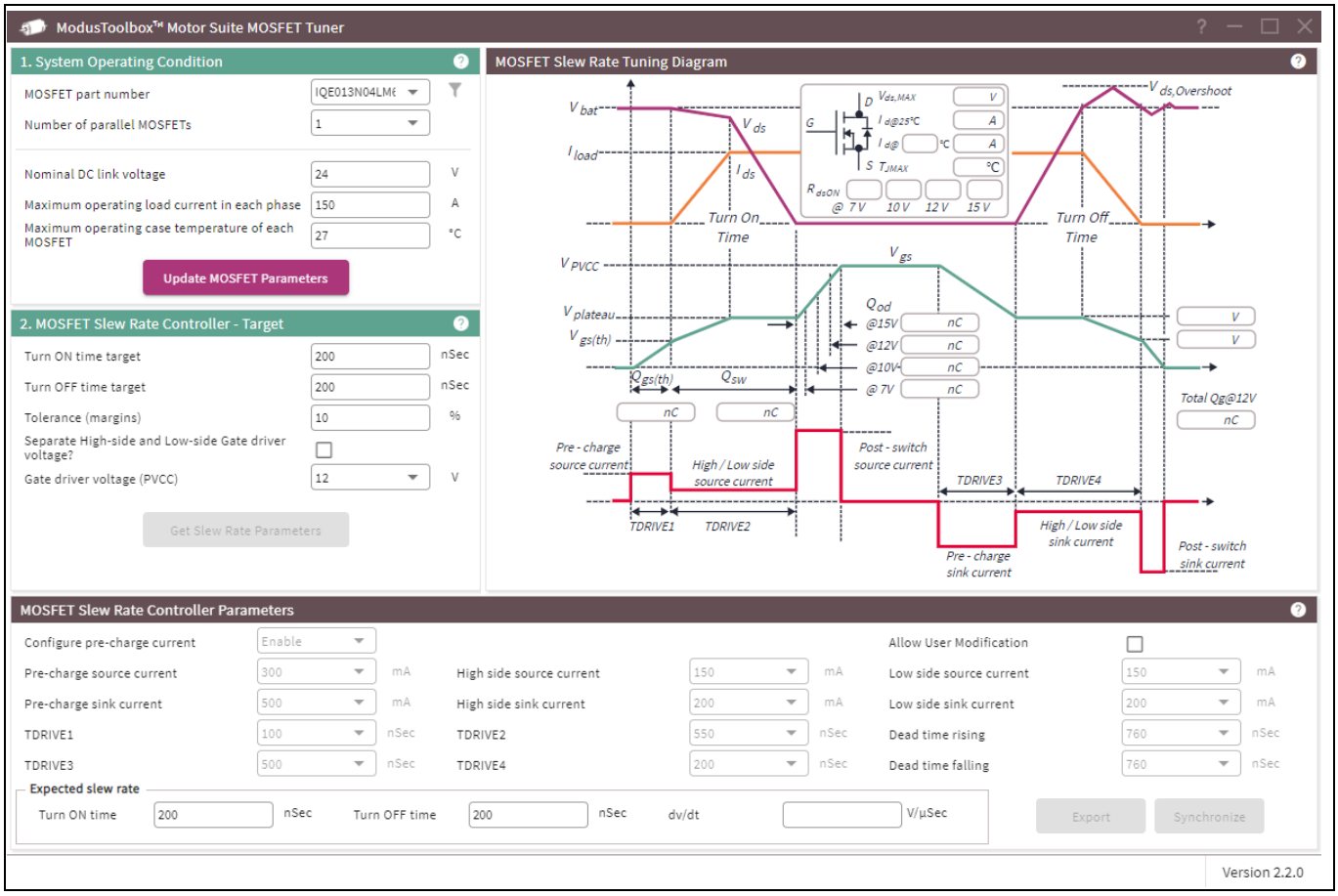

Figure 135 MOSFET window

When first opened, the option lists for MOSFET part number, breakdown voltage and package selection parameters (System Operating Condition section) are updated. This might take some time depending on your internet connection.

6.5.1 System Operating Condition

In this block set the operating conditions by entering / selecting the operating conditions using the input fields (Figure 136). These values are used to validate the MOSFET selection and calculate the MOSFET parameters' values.

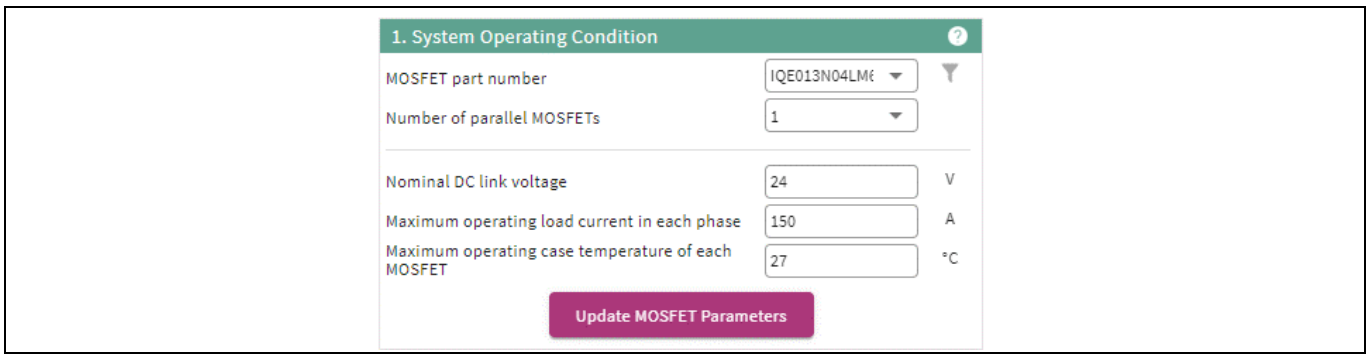

Figure 136 System Operating Condition

The upper and lower limits for each input field will be visible if you input an invalid value (Figure 137).

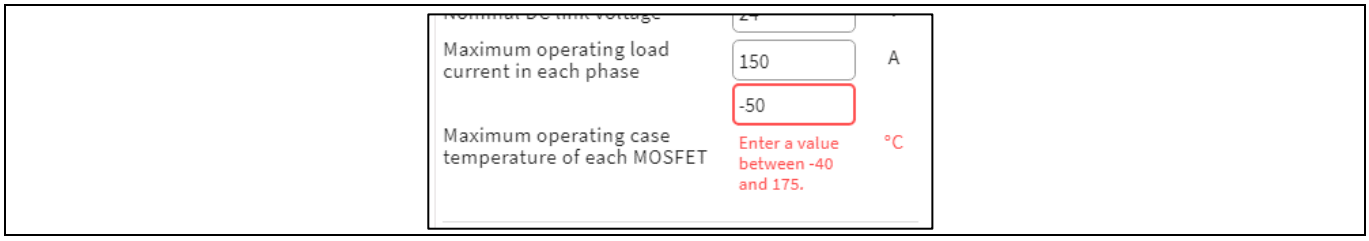

Figure 137 Valid input range will be displayed when you enter an invalid value

In this block, select a MOSFET from the “MOSFET part number” dropdown or by typing in the MOSFET name if already known.
If you open the MOSFET window from the configurator view of one of the projects, the MOSFET of the supported board is known for that project and pre-selected at the MOSFET dropdown.
To filter the list of MOSFETs before selection, click the filter icon next to MOSFET part number parameter. This will activate the three optional filter parameters:

1. Breakdown voltage
2. Continuous drain current (Id) @25 °C at least
3. Package selection

As soon as you change the value for any one of the parameters, the list in the "MOSFET part number" dropdown will get updated, after the update select a MOSFET. The dropdown will be empty if no MOSFET is found to match the selection criteria.
After you select a MOSFET, the application will then validate whether the selected MOSFET is suitable for the provided system operating conditions or not, based on the following criteria:

- Breakdown Voltage >= 1.5*Nominal DC Link Voltage
- Continuous drain current (Id) @ 25°C > (Max operating load current in each phase /No. of parallel MOSFETs)
- Continuous drain current (Id) @ operating temperature > (Max operating load current in each phase /No. of parallel MOSFETs)
- Maximum Junction temperature > Maximum operating case temperature of each MOSFET

If validation criteria are not met, you will see a “Warning” message (Figure 138). Either proceed with failing validations or choose a different MOSFET. It is recommended to choose a different MOSFET that meets the criteria for safe operation.

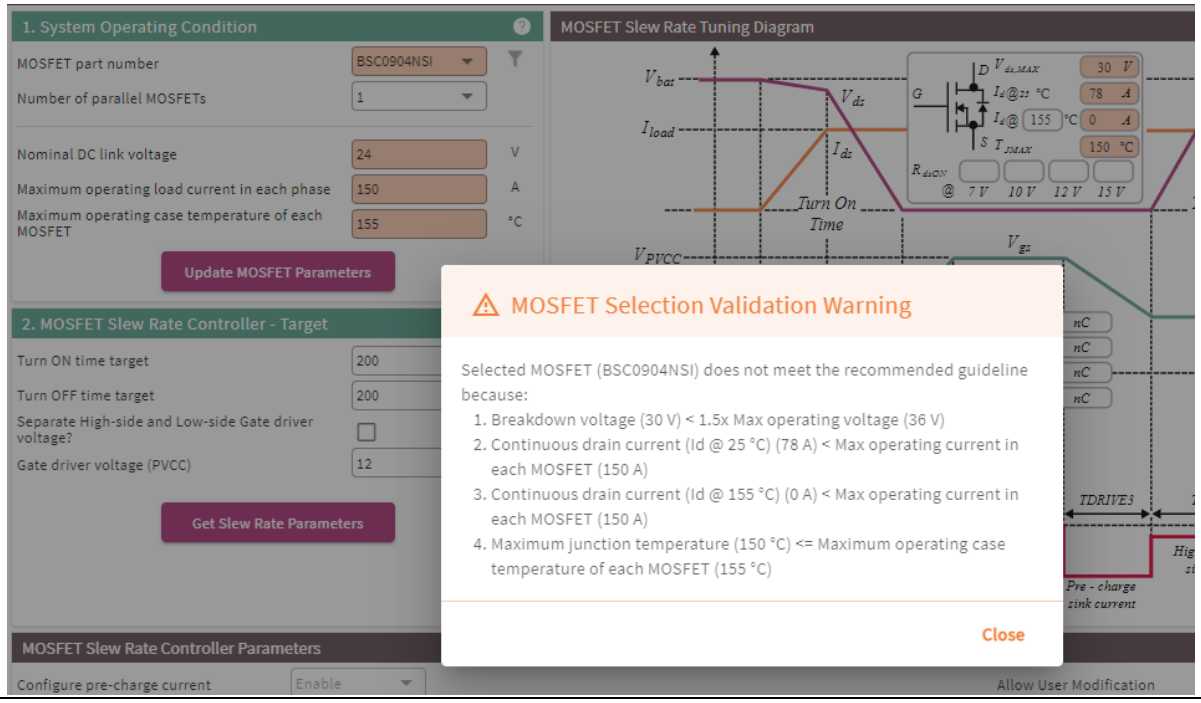

Figure 138 Warning window is displayed when selected MOSFET is not validated

- **Number of parallel MOSFETs:** Select a value from the dropdown. A maximum of 10 parallel MOSFETs is currently supported by the application for calculation.
- **Nominal DC link voltage:** This is the nominal battery voltage. The initial value for this parameter comes from the parameter with same name in the main GUI. Change the value here and the corresponding parameter in main GUI can be updated by clicking “Synchronize” button.
- **Maximum operating load current in each phase:** This is the expected maximum load current peak in each phase (not the RMS).
- **Maximum operating case temperature of each MOSFET:** This is the expected maximum temperature of the MOSFET, typically observed on the device surface during operation. The junction temperature would always be higher than the case temperature.

Click on the “Update MOSFET Parameters” button and wait for the application to calculate the parameters (Figure 139). This might take some time.

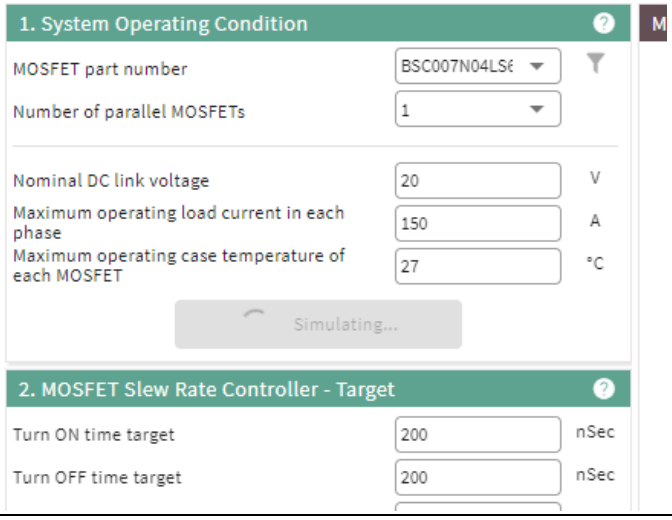

Figure 139 Wait for MOSFET parameters calculation

The MOSFET parameters are calculated for a single MOSFET assuming the load current is uniformly distributed in each parallel branch.

6.5.2 MOSFET Slew Rate Tuning Diagram

The calculated MOSFET parameters are displayed in this block on the tuning diagram (Figure 140).

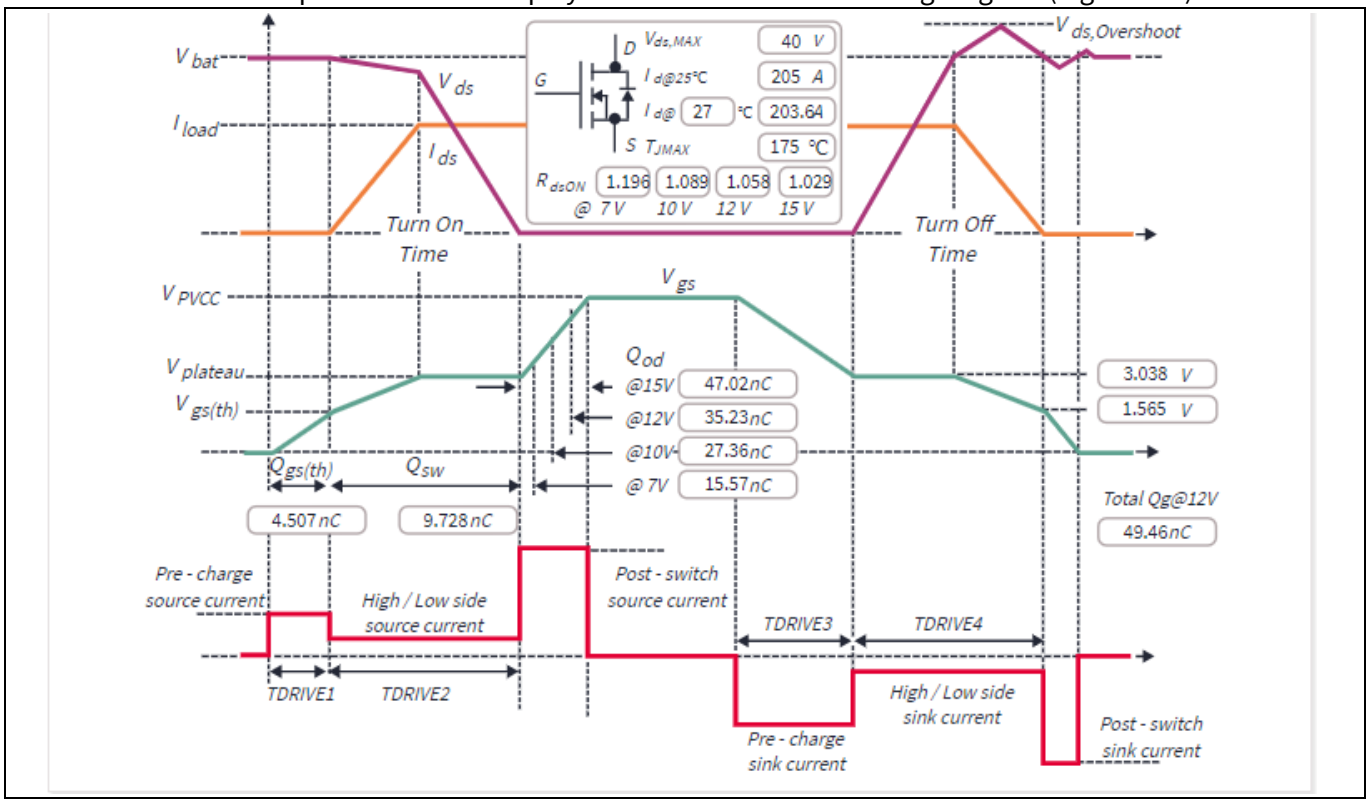

Figure 140 MOSFET parameters displayed on tuning diagram

If you change any of the "System Operating Condition" parameters, you need to click on the "Update MOSFET Parameters" button again to recalculate the parameters.
The RDS_ON and QOD values at different values of gate driver voltage (PVCC) can be used as a reference for deciding the gate driver voltage in the "MOSFET Slew Rate Controller - Target". A higher RDS_ON value would cause higher conduction loss. And higher QOD value would cause the turn-on post-charge and turn-off pre-charge to be higher, thus increasing the overall deadtime.
The following parameters are calculated for a single MOSFET at the specified operating conditions assuming the load current is equally distributed in each parallel branch:

- **$V_{gs(th)}$:** Threshold voltage
- **$V_{plateau}$:** Miller plateau voltage
- **$Q_{gs(th)}$,** also referred to Qgs1, is the gate charge required for gate-to-source voltage to reach **$V_{gs(th)}$**
- **Q_{sw}** is the total gate charge required during switching. It includes the gate charge required for gate-to-source voltage to transition from **$V_{gs(th)}$** to **$V_{plateau}$,** referred to as **Q_{gs2}** and the gate charge required in Miller region, referred to as **Q_{gd},** i.e. **$Q_{sw} = Q_{gs2} + Q_{gd}$.**
- **Q_{od}** is the additional gate charge required for the gate-to-source voltage to reach the set voltage (PVCC) from **$V_{plateau}$.**

After clicking “Synchronize” button, the MOSFET parameters under the MOSFET component in the main GUI will be updated.

6.5.3 MOSFET Slew Rate Controller – Target

In this block, provide the target turn-on and target turn-off time for the MOSFET (Figure 141).

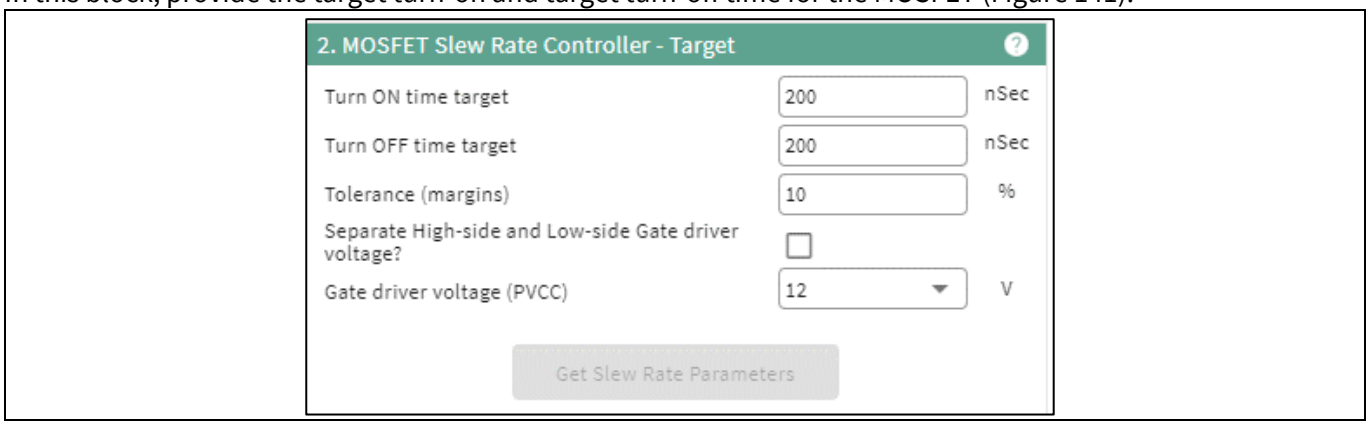

Figure 141 MOSFET Slew Rate Controller - Target

Turn-on time refers to the time required for transition of drain-to-source voltage from 100% to 0% of steady-state value. And turn-off time refers to the time required for drain-to-source voltage to transition from 0% to 100% of steady state value after the first overshoot. The oscillations after the first overshoot are ignored while measuring the turn-off time. So, the turn-on and turn-off times simply refer to the di/dt and dv/dt regions, thus directly controlling the slew rate of the MOSFET. In terms of gate charge, turn-on and turn-off times refer to time required for the gate driver to supply, **Qsw**. It does not include the threshold charge, **Qth** or the over-drive charge, **Qod**. You can also enter a Tolerance (margin) percentage to account for the part-to-part gate charge variations and gate driver non-idealities. A 10% tolerance margin is recommended, and you will see a warning message if you enter a margin below 10%, but you can still proceed with any value (Figure 142).

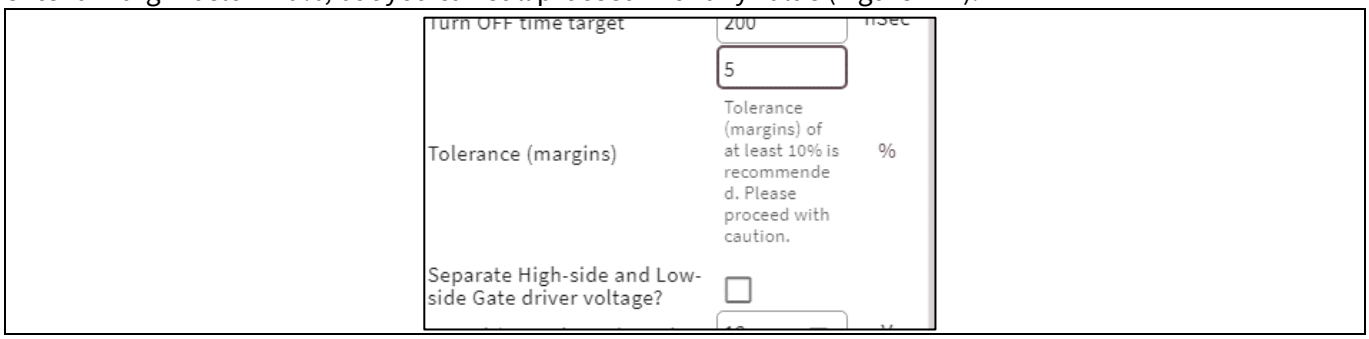

Figure 142 A warning message is displayed if tolerance is too small

Select a "Gate driver voltage (PVCC)" from the dropdown based on RDS_ON and QOD values in “MOSFET Parameters” block. 6EDL7141 gate drivers are known to have a lower high-side voltage than the low-side voltage due to internal circuitry. So, if the high-side and low-side gate-to-source voltage has already been observed from initial hardware testing, you can check the “Separate High-side and Low-side gate driver voltage?” checkbox. This will make the "HS Gate driver voltage (VCCH)" and “LS Gate driver voltage (VCCL)” textboxes visible. You can then directly provide the known values of high-side and low-side gate driver voltages separately (Figure 143).

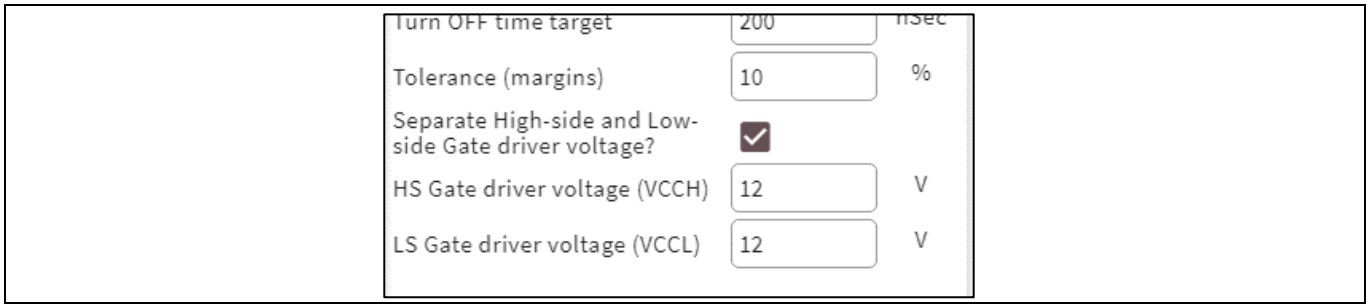

Figure 143 You can provide high-side and low-side values separately

You will receive an error message if HS Gate driver voltage (VCCH) is set higher than LS Gate driver voltage (VCCL) and the “Get Slew Rate Parameters” button will get disabled. It will be re-enabled only when the values are configured correctly.
After clicking “Synchronize” button, the “PVCC Set Point” parameter under “6EDL7141 Smart Gate Driver” component and “Power Supply” block, in the main window, will be updated. If hide-side and low-side separated, the value closest to the range is selected, otherwise the same value is used to update main window parameter.
Click on the "Get Slew Rate Parameters" button to calculate the "MOSFET Slew Rate Controller Parameters". The "Get Slew Rate Parameters" is activated only after the MOSFET parameters are calculated by clicking on the "Get MOSFET Parameters" button (Figure 144).

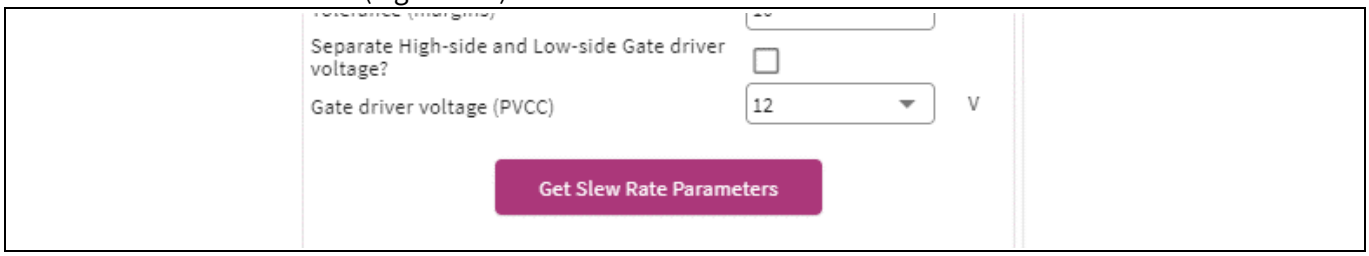

Figure 144 This button is activated only after MOSFET parameters are calculated

6.5.4 MOSFET Slew Rate Controller Parameters

In this block, the calculated gate driver current and time settings are displayed (Figure 145).

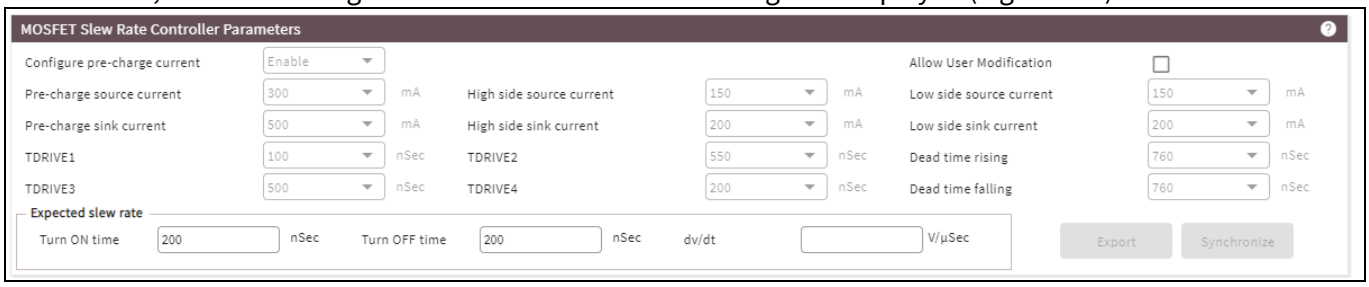

Figure 145 MOSFET Slew Rate Controller Parameters

The application calculates the closest possible gate driver current and time settings to meet the user selected conditions. However, the “Turn-ON time” and “Turn-OFF time” in the “Expected slew rate” sub-section might not exactly match with the “Turn-ON time target” and “Turn-OFF time target” respectively in the “MOSFET Slew Rate Controller - Target” section (Figure 141). You will see a warning message if the values are off by more than 50%. This happens when the required gate driver current to meet the target switching time for the selected parameters exceeds the permissible capability of the gate driver. You can still proceed with the calculated parameters.
The initial values in this block are from the corresponding parameters with same name in the main GUI (Figure 146).

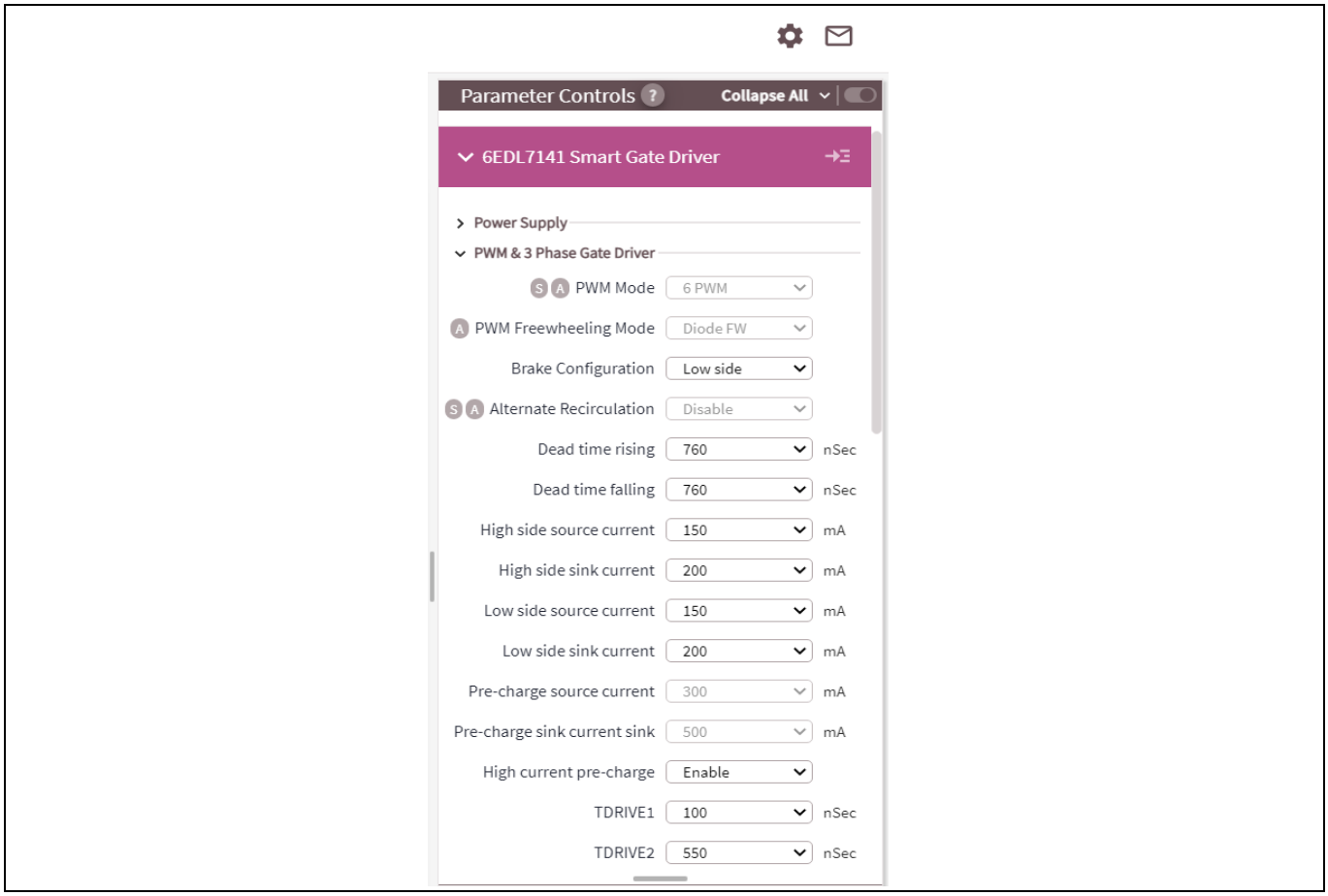

Figure 146 Initial values come from the main window and can be synced back

Update the parameter values in the main GUI by clicking on the "Synchronize" button. Click the "Synchronize" button if you want to keep the calculated values, else the values will be lost upon closing the GUI.
If you want to make changes to any of the calculated values, check "Allow User Modification" checkbox first (Figure 147). Then change values for a gate driver current or time setting from its dropdown menu.

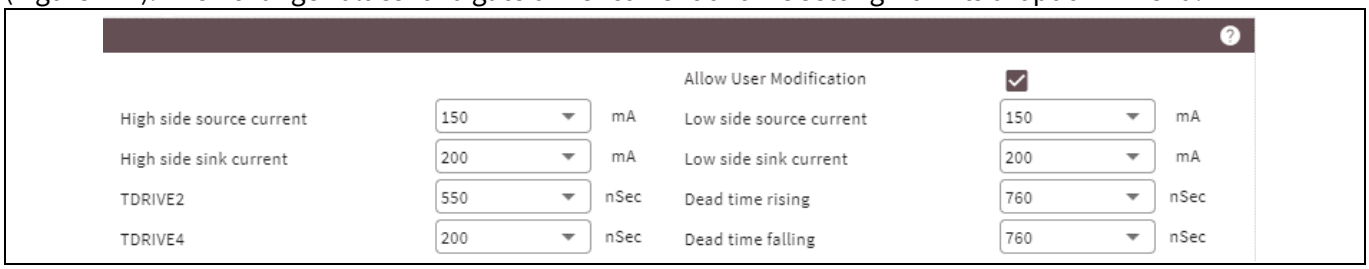

Figure 147 Input fields are enabled after checking allow user modification box

If you “Disable” Configure pre-charge current, the pre-charge source current and pre-charge sink current will automatically be set to 1.5A (1500 A) and you will not be able to change them. The values displayed in this section are only for user-information. If you “Enable” Configure pre-charge current, you will not be able to set pre-charge source/sink current to 1500A.

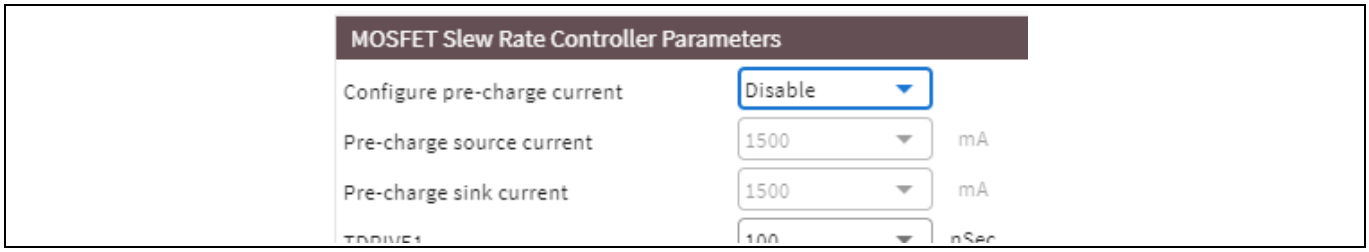

Figure 148 Pre-charge parameters are set to 1.5A after selecting Enable for High current pre-charge

There are a few rules that need to be followed while selecting the gate driver time parameters:

- TDRIVE1 and TDRIVE2 cannot be set to zero at the same time.
- TDRIVE3 and TDRIVE4 cannot be set to zero at the same time.
- Deadtime rising and Deadtime falling cannot be set to a value less than the sum of Tdrive3 and Tdrive4.

You will see an error message if any of the above rules are violated (Figure 149). Modify the selections to remove the error message or reset by clicking on “Get Slew Rate Parameters” in MOSFET Slew Rate Controller - Target” section, see Figure 144

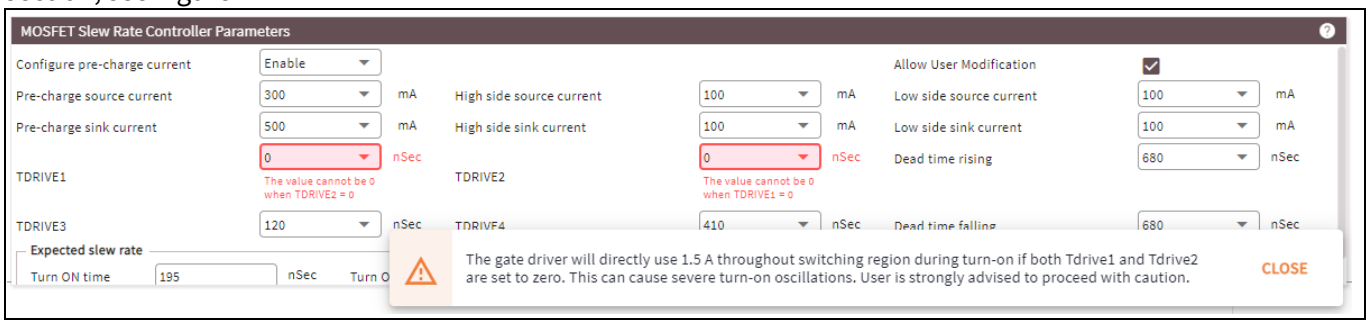

Figure 149 TDRIVE1 - TDRIVE2 and TDRIVE3 - TDRIVE4 cannot be 0 at the same time

Apart from the above, the following are some of the guiding principles for user-modifications:

- If TDRIVE1 region is observed to overlap into the di/dt region during turn-on, reduce TDRIVE1. If TDRIVE1 cannot be reduced any further, reduce IDRIVE1 and adjust TDRIVE1 according to the gate charge value.
- If TDRIVE3 region is observed to overlap into the dv/dt region during turn-off, reduce TDRIVE3.
- If TDRIVE2 region finishes before v_{ds} transition during turn-on is complete, increase TDRIVE2.
- If TRIVE4 region finishes before v_{ds} transition during turn-off is complete, increase TDRIVE4.
- Reduce High-side/Low-side sink current to reduce turn-off overshoot. Increase TDRIVE4 at the same time to ensure the required gate charge is supplied.
- Reduce High-side/Low-side source current to reduce turn-on parasitic oscillations. Increase TDRIVE2 at the same time to ensure the required gate charge is supplied.

You will observe that the values displayed in "Expected Slew Rate" sub-block will get updated whenever you change the values of High/Low Source/Sink current (Figure 150). You will get a warning message if the expected turn-on/off times are off from the target turn-on/off times by 50%, as described earlier. Use this as a reference to see if the changes meet your required turn-on/off times and dv/dt limitations and decide whether to proceed or not.

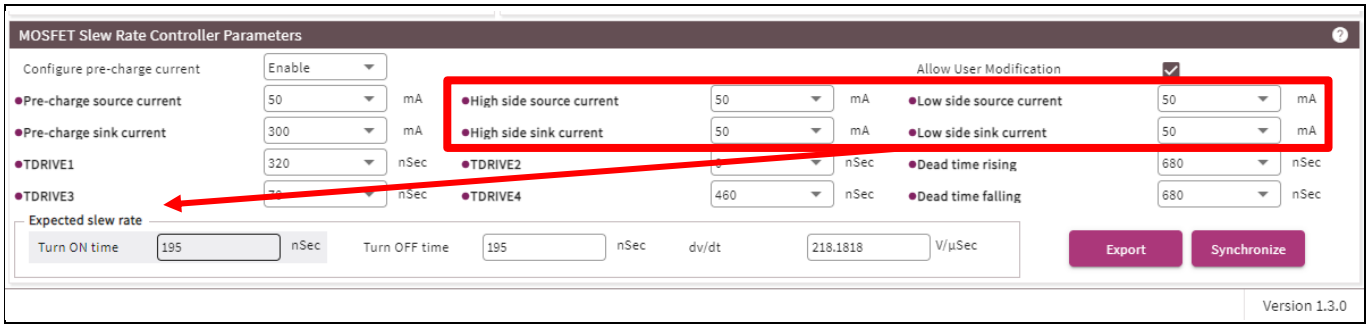

Figure 150 Changing high/low side source/sink current parameters updates the expected slew rate

After clicking on “Synchronize” button, the application will run a check to see if the modified values match with the gate charge requirements of the selected MOSFET. If any of the gate charge requirements are not met, you will receive a message describing the potential violation. You can still proceed if you are sure of the modifications. You will have to click the "Synchronize" button after making the changes before closing the GUI (Figure 151).

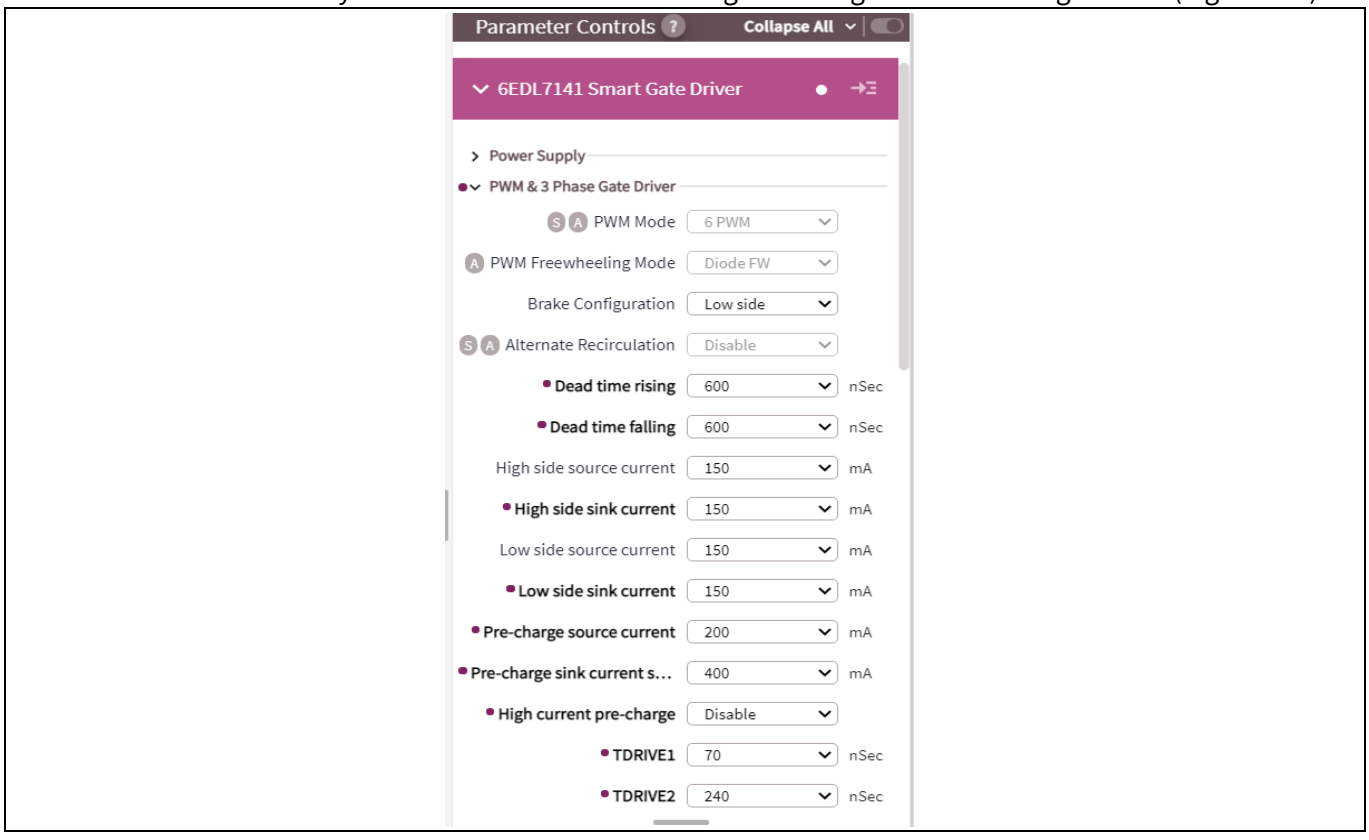

Figure 151 Sync back the values to the main window by clicking "Synchronize" button

Export button exports the parameters as a CSV file. In this file, the initial values and the latest values of slew rate parameters can be seen. You can compare the changes with the old values, after changing the initial values.

Glossary

BLDC
Brushless Direct Current (BLDC)

COM
Communications port (COM)

CSV
Comma Separated Values (CSV)

FOC
Field-Oriented Control (FOC)

GUI
Graphical User Interface (GUI)

MOSFET
Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET)

OTP
One-Time-Programmable memory (OTP)

PC
Personal Computer (PC)

PID
Proportional Integral Derivative controller (PID)

RFO
Rotor Frame-Oriented (RFO)

SFO
Stator Frame-Oriented (SFO)

SN
Serial Number (SN)

SWD
Serial Wire Debug (SWD)

TBC
Trapezoidal Block Commutation (TBC)

UART
Universal Asynchronous Receiver/Transmitter (UART)

USB
Universal Serial Bus (USB)

Revision history

Document revision	Date	Description of changes
**	2025-04-15	Initial release
*A	2025-07-15	New version release of ModusToolbox™ Motor Suite GUI v2.6.0: 1. Added dual motor configuration selection. 2. Added dual motor parameter entry sync preference. 3. Added compare configuration button. 4. Updated table 1 to include Dual Motor Kit and new kit. 5. Editorial improvements
*B	2025-08-08	New version release of ModusToolbox™ Motor Suite GUI v2.6.1: 1. Updated getting started page images. 2. Added oscilloscope group traces section. 3. Editorial improvements
*C	2025-12-08	New version release of ModusToolbox™ Motor Suite GUI v2.8.0: 1. Added a first-time installation paragraph at the end of getting started section. 2. Added a paragraph for the new “display active ELF path” feature. 3. Added a new section for the position control mode. 4. Added oscilloscope dynamic extend button information. 5. Added oscilloscope analyzer section. 6. Updated screenshots to match the latest design.
*D	2026-04-20	New version release of ModusToolbox™ Motor Suite GUI v2.9.0: 1. Added a first-time installation from MTB Setup Tool paragraph at the end of getting started section. 2. Updated wording in the getting started section 3. Updated testbench page image. 4. Added “Components” and “Using formula attributes” sections under GUI Builder section
*E	2026-09-16	New version release of ModusToolbox™ Motor Suite GUI v2.10.0: 1. Fixed grammar and styling mistakes. 2. Replaced GUI Builder section with a short LiveMonitor section. 3. Updated the supported boards and tools table.

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