

Quick Start Guide - REF_36V_220W_SLFOC

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Table of contents

1 System overview

2 Board

- Borad overview
- Board connection

3 Software tools

4 Firmware

- Obtain the firmware
- Create the project
- Parameters configuration
- Build and Debug

5 Demo GUI

- Demo overview
- GUI operation

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System overview and features

Board specification

Parameters	Symbol	Values			Unit	Notes
		Min	Nom	Max		
Supply voltage	V_{in}	12	36	50	V	Disable firmware UVP. Because firmware UVP is set at 21.6 V
Max output current	I_{out_max}		5		A	Ambient temperature: 25°C, 10 minutes, continuous, RMS
Max output power	P_{out_max}		220		W	Ambient temperature: 25°C, 10 minutes, continuous
Peak output current	I_{out_peak}		9		A	Ambient temperature: 25°C, 30 seconds, RMS
Peak output power	P_{out_peak}		380		W	Ambient temperature: 25°C, 30 seconds
Number of shunts			3			Current sensing shunt
Board outer diameter	D_{outer}		40		mm	Circular board outer diameter
Board Inner hole diameter	D_{inner}		9		mm	Circular board inner hole diameter
Switching frequency	F_{PWM}		20		kHz	

Key features and benefits

- Generic motor control with speed control scheme
- Robotic wheel application with position control scheme
- Equation based stall detection
- High efficiency
- Compact design
- High power density

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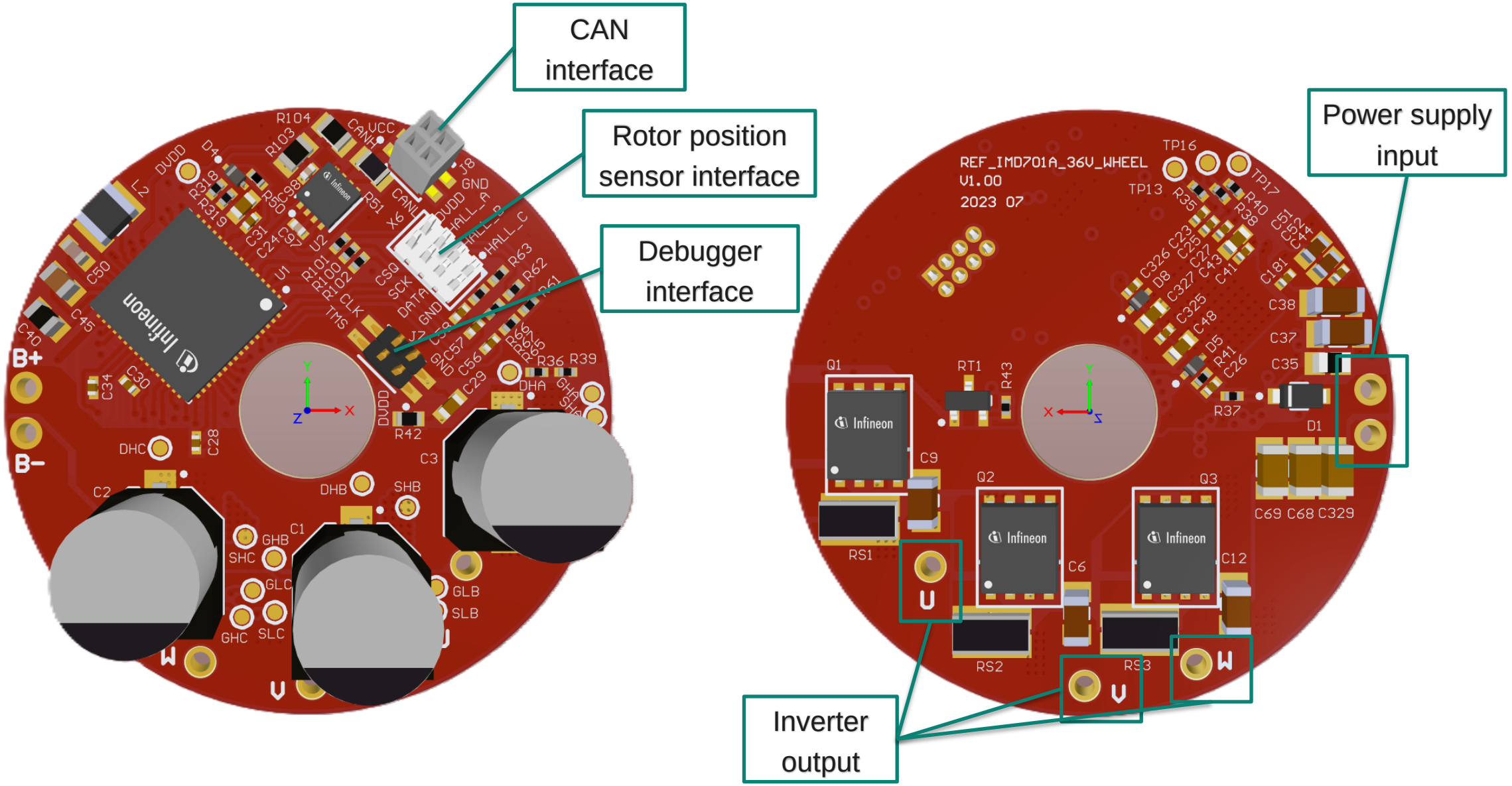
Board connection
- Overview



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Board connection
- Debugger

- An external debugger must be connected to the board for
  - Debugging/programing
  - GUI demonstration
- XMC™ Link is validated and is suggested as the external debugger
  - Use the first 4 pins of the 10-pin connector to connect to the board connector

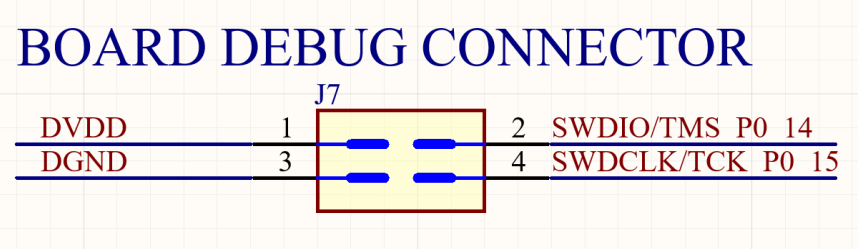

Table 2 Pinout of the 10-pin Cortex™ debug connector

Pin	Function	XMC1000 Connection (Pin name)	XMC4000 Connection (Pin name)
1	VCC	Power Supply 2.5 V – 5.5 V (VDD)	Power Supply VDDP 3.3 V (VDDP)
2	SWIO/TMS	Serial Wire Data (P0.14 | P1.3)	Serial Wire Data, JTAG-TMS (TMS)
3	GND	Ground (VSS)	Ground (VSS)
4	SWCLK/TCK	Serial Wire Clock (P0.15 | P1.2)	Serial Wire Clock, JTAG-TCK (TCK)
5	GND	Ground (VSS)	Ground (VSS)
6	SWO/TDO	Not connected	Serial Wire Output, JTAG-TDO (P2.1) (optional)
7	KEY	Not connected	Not connected
8	TDI	Not connected	JTAG-TDI (P0.7)(optional)
9	GNDDetect	Can be used to switch off an on-board debug probe (PORST# of OBD) (optional)	
10	RESET#	Not connected	PORST# (mandatory)



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Board connection - Motor

A planetary gear motor Z42BLDPN is used for testing. Connect the motor terminals (U, V and W) to the board inverter output.

Parameters	Value	Unit	Notes
Nominal input voltage	24	V	The input voltage for the test is 36 VDC
Nominal phase current	2.4	A	–
Pole pairs	2	–	–
Phase resistance	0.85	Ohm	–
Phase Inductance	1414	uH	–
Max speed	4500	RPM	At 24 VDC
	7100	RPM	At 36 VDC
Gear ratio	58.22	–	–



Some motor parameters should be modified in the firmware if a different motor is used.

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Software Tools

Tools	Version	Description
Infineon Developer Center	2024.8.0	One stop shop for engineers for downloading and design-in of all Infineon development tools, embedded software, services and solutions
ModusToolbox™	3.2.0.16028	A modern, extensible development ecosystem supporting a wide range of Infineon microcontroller devices. It can be downloaded from “Infineon Developer Center”
Micriμm μC/Probe XMC™	4.3.0.90	A Windows application designed to read and write the memory of the controller during run-time. In this project it is used to run the motor and read the status
J-Link	7.96d	The widely used line of debug probes. It is used for debug/programming and communication between the PC and the board

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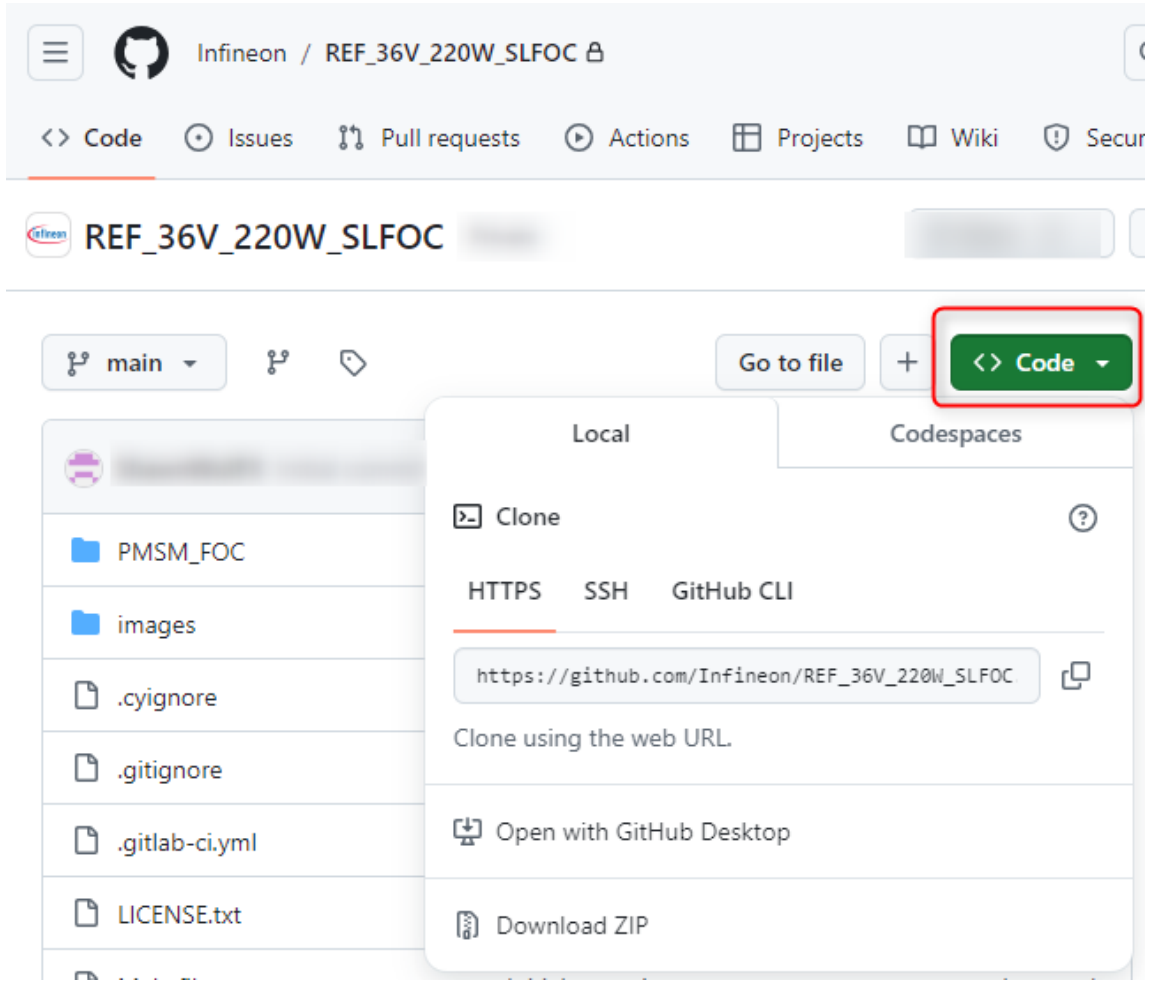
Firmware
- Obtain the firmware

The firmware is shared via GitHub.

1. Access to the repository with this link
2. Clone or download the firmware



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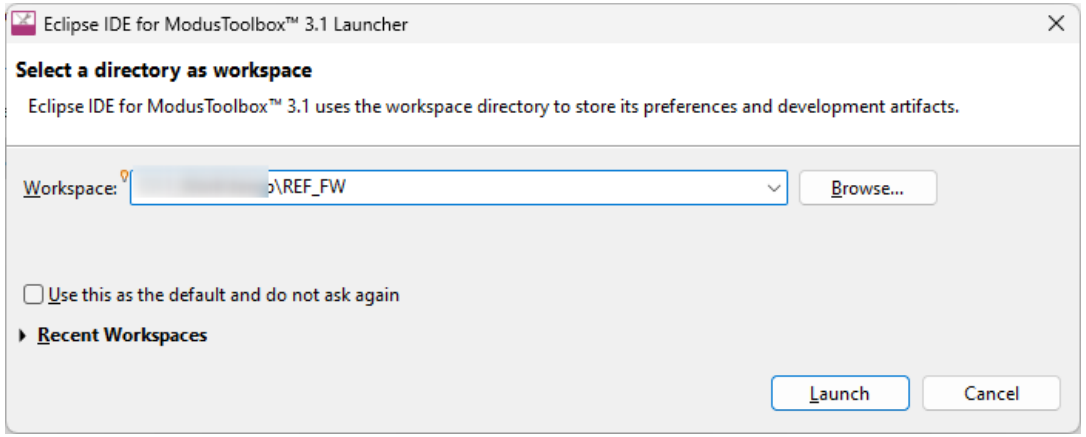
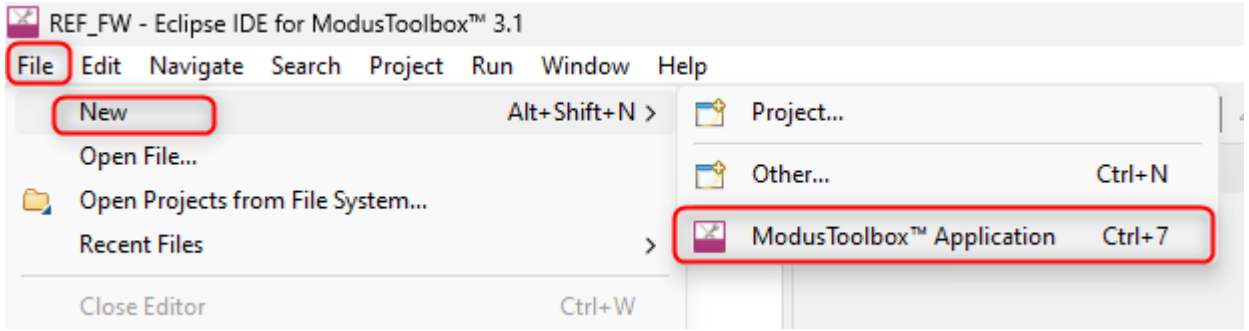
Firmware
- Create the project (1/4)

1. Run ModusToolbox™
2. Create a new workspace or use an existing workspace
3. Create a new application:

   File -> New -> ModusToolbos™ Application





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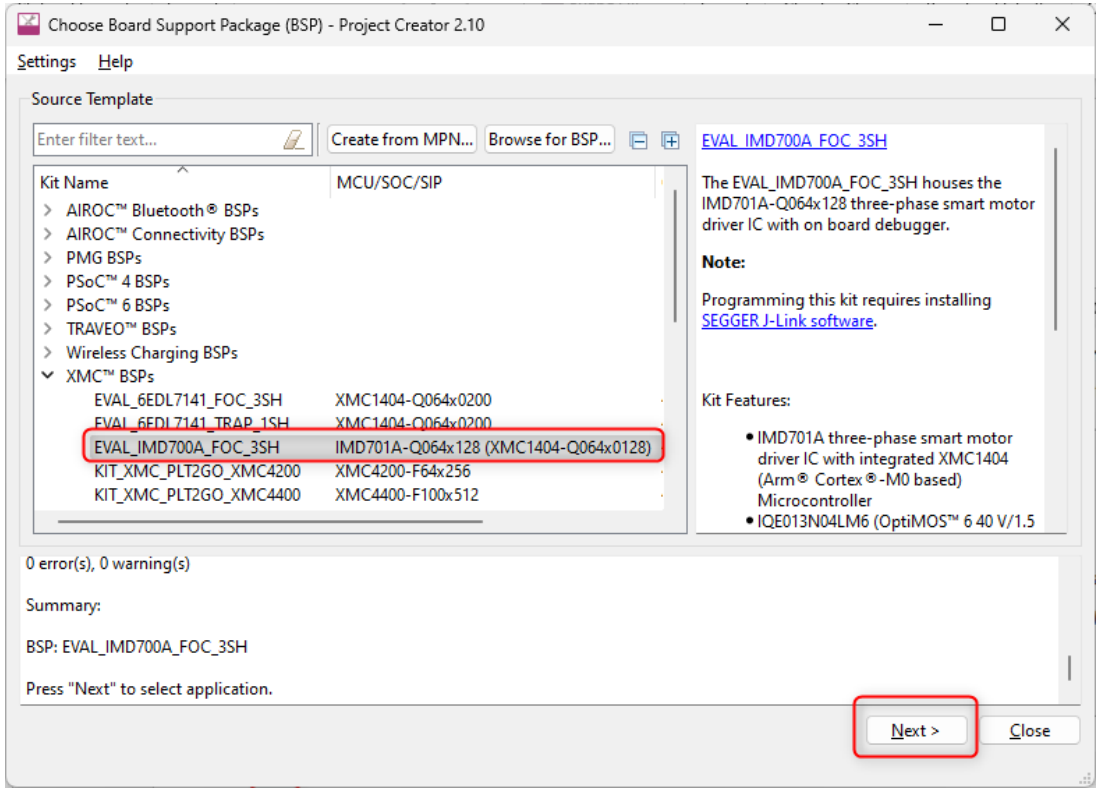
Firmware
- Create the project (2/4)

4. “Project Creator” pops up
5. Choose the “Board Support Package (BSP)”. Select “EVAL_IMD700A_FOC_3SH”, as the REF board is based on this EVAL board
6. Click on “Next”



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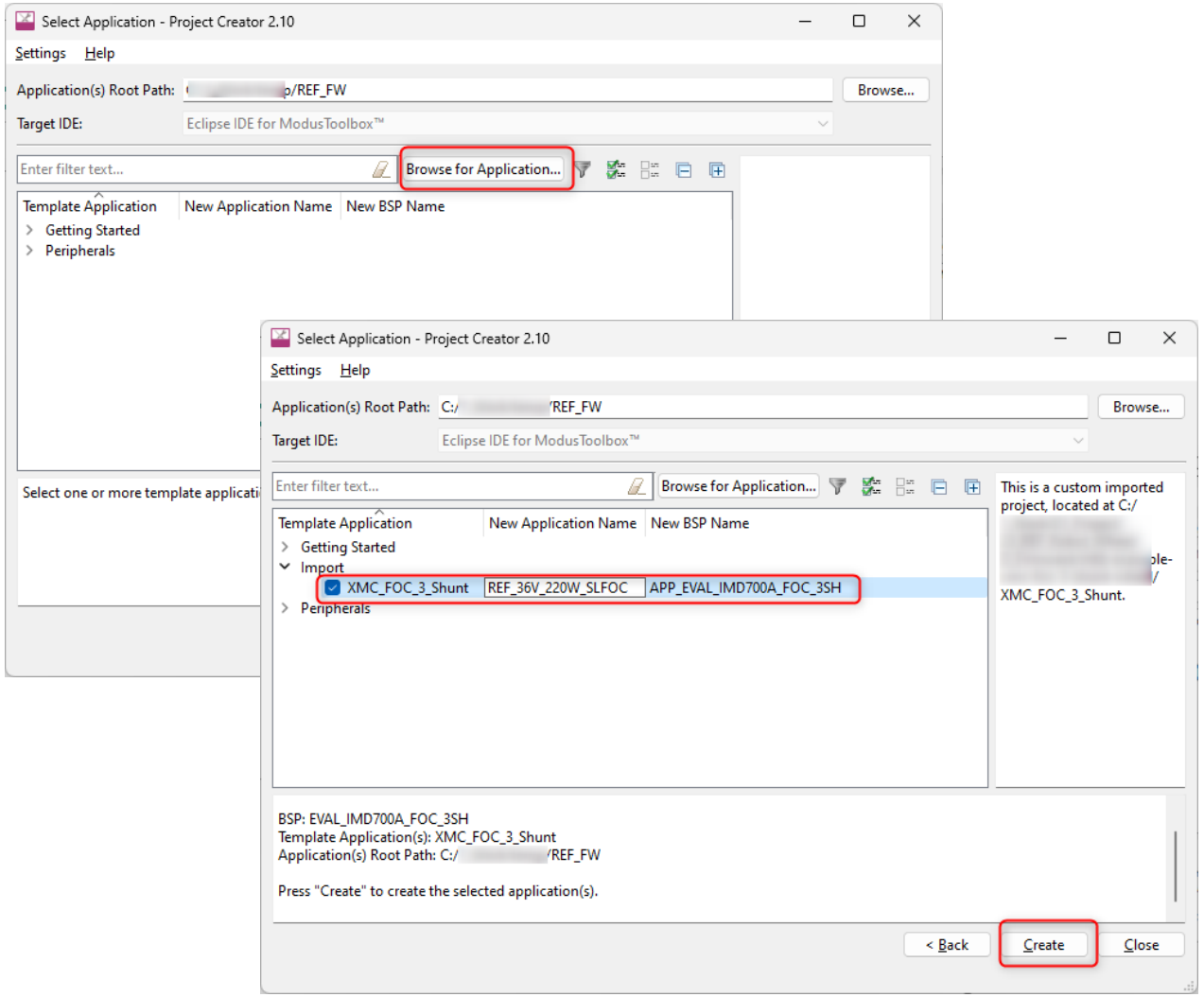
Firmware
- Create the project (3/4)

7. Click on “Browse for Application”
   - ➢ Then select the application code in the package as the template application
   - ➢ The imported application can be found in the “Import” drop-down menu. A new application name can be assigned.
8. The new project will be created by clicking on the “Create” button.



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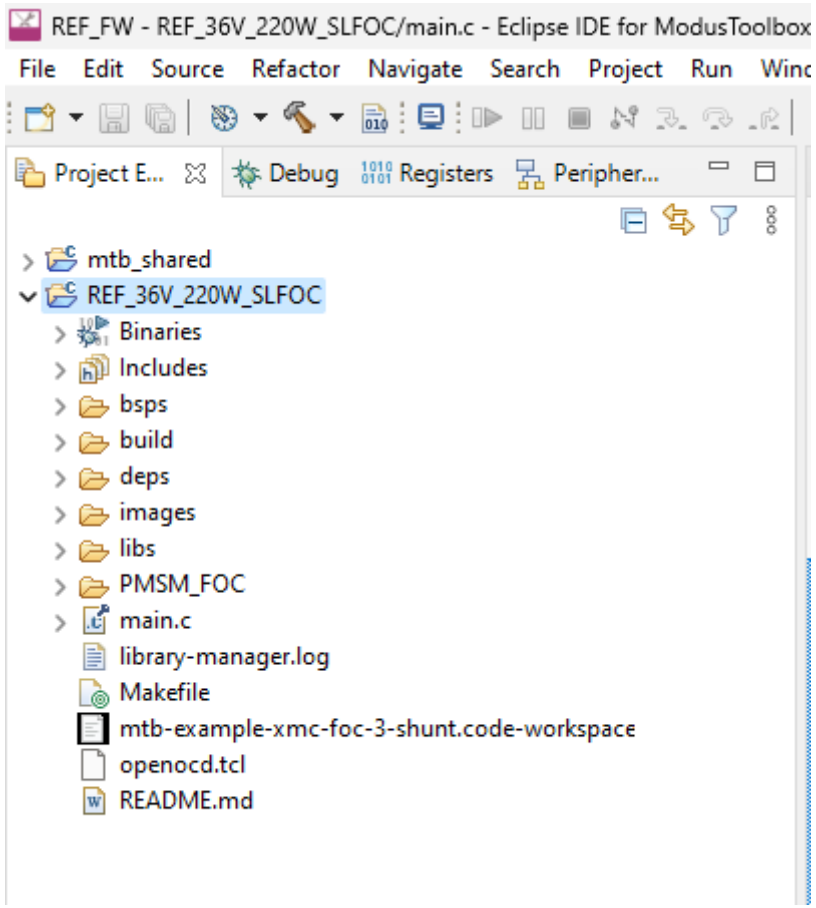
Firmware
- Create the project (4/4)

9. After the project is created, “mtb_shared” and the application example can be found on the “Project Explorer”.



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Firmware
- Parameters configuration

- The most important parameters are defined in the header file - *PMSM_FOC\Configuration\pmsm_foc_user_input_config_xxx.h*.
  _xxx is for differentiating the configurations for different motors. The motor for this project is defined in the file *PMSM_FOC\Configuration\pmsm_foc_user_input_config.h*.
- If a different motor is used, the parameters in the motor group should be modified.
- Other parameters (e.g. control loops) in the header file should be modified if necessary.

```
/*****************************
 * Motor group
 *****************************/
#ifdef   MOTOR0_PMSM_FOC_MOTOR
#define  USER_MOTOR_R_PER_PHASE_OHM          (0.85f)      /*!< Motor Resistance per phase in Ohm for PMSM Motor */
#define  USER_MOTOR_LS_PER_PHASE_uH          (1414.0f)     /*!< Motor Inductance Ls per phase in uH  */
#define  USER_MOTOR_POLE_PAIR                (2.0f)       /*!< Motor Pole Pairs */
#define  USER_SPEED_HIGH_LIMIT_RPM           (3500U)      /*!< Maximum Speed of the motor for the application*/
#define  USER_SPEED_LOW_LIMIT_RPM            (200U)       /*!< Min Speed of User Motor, original 200U*/
#define  NO_LOAD_SPEED_RPM                   (8000.0f)    /* No-load speed for calculation of the BEMF constant */
#define  STALL_TORQUE_NM                      (0.05f)      /* Stall torque threshold */
#define  GEAR_RATIO                          (58.22f)     /* Define the ratio if there is a gearbox. Otherwise define as 1.0f */
#endif

```


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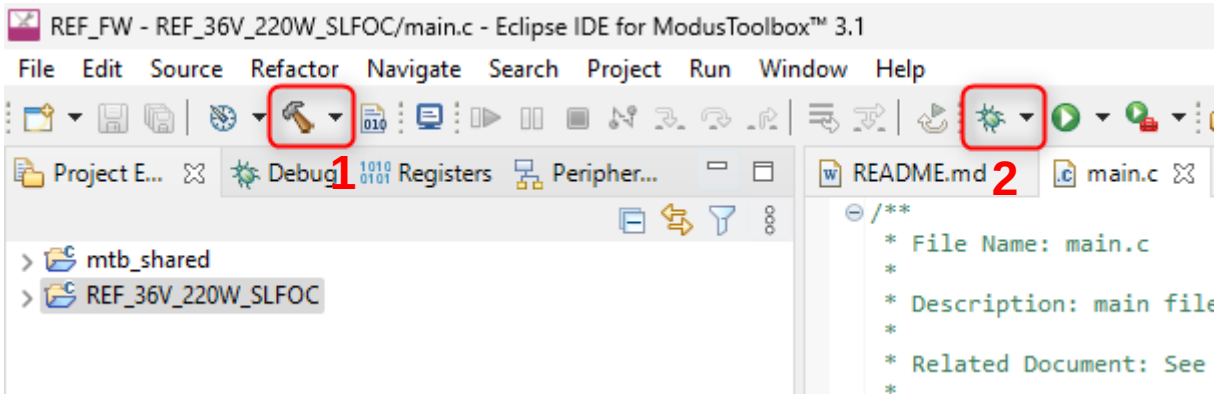
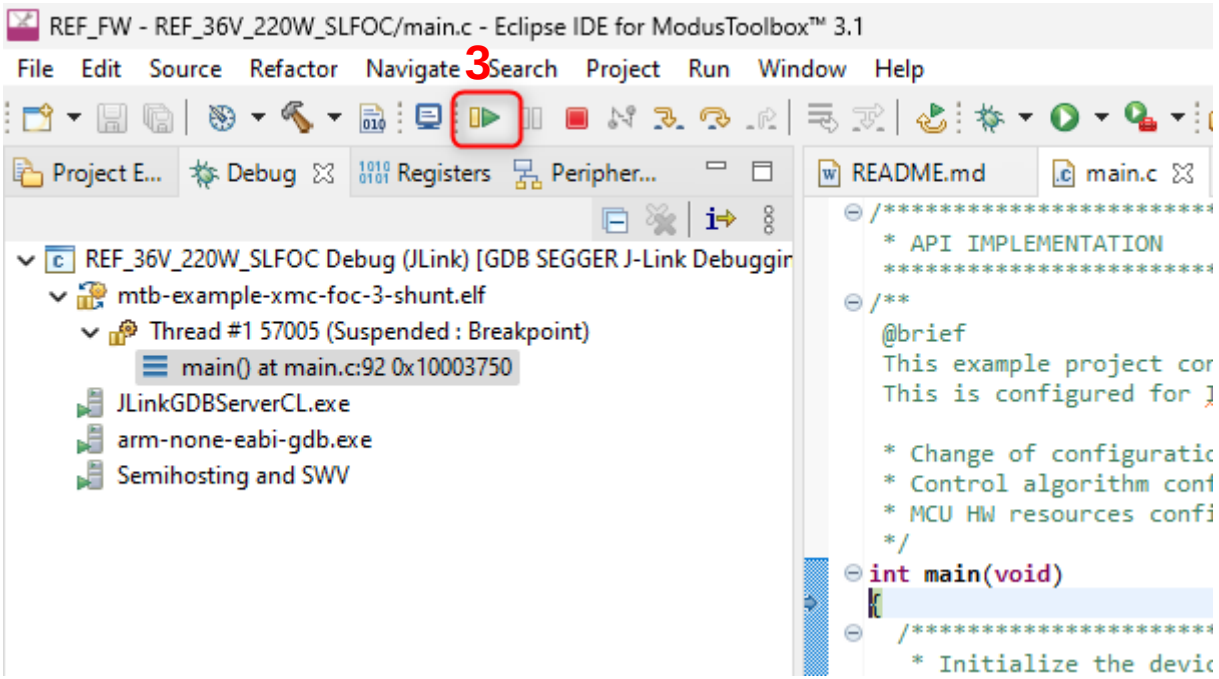
Firmware
- Build and Debug



1. Build the project
2. Debug the project
3. Click on “Resume” to run the project



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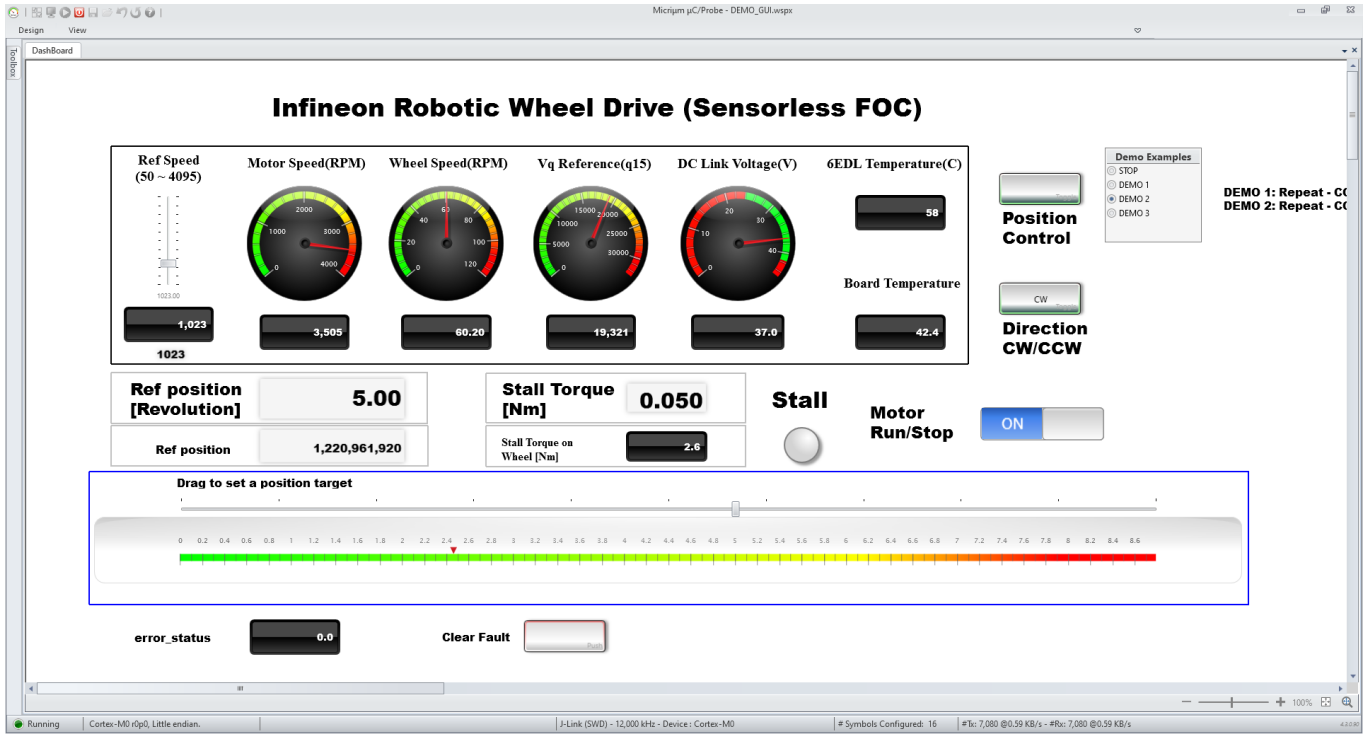
Demo GUI
- Overview

- Micriμm μC/Probe XMC™ is used for demonstration and control of the motor
- The layout of the GUI is designed for the robotic wheel drive application with this specific motor
- If the motor parameters (e.g. the pole-pair number, the gear ratio…) is changed, the scaling in the GUI may need to be changed in order to display the values correctly.



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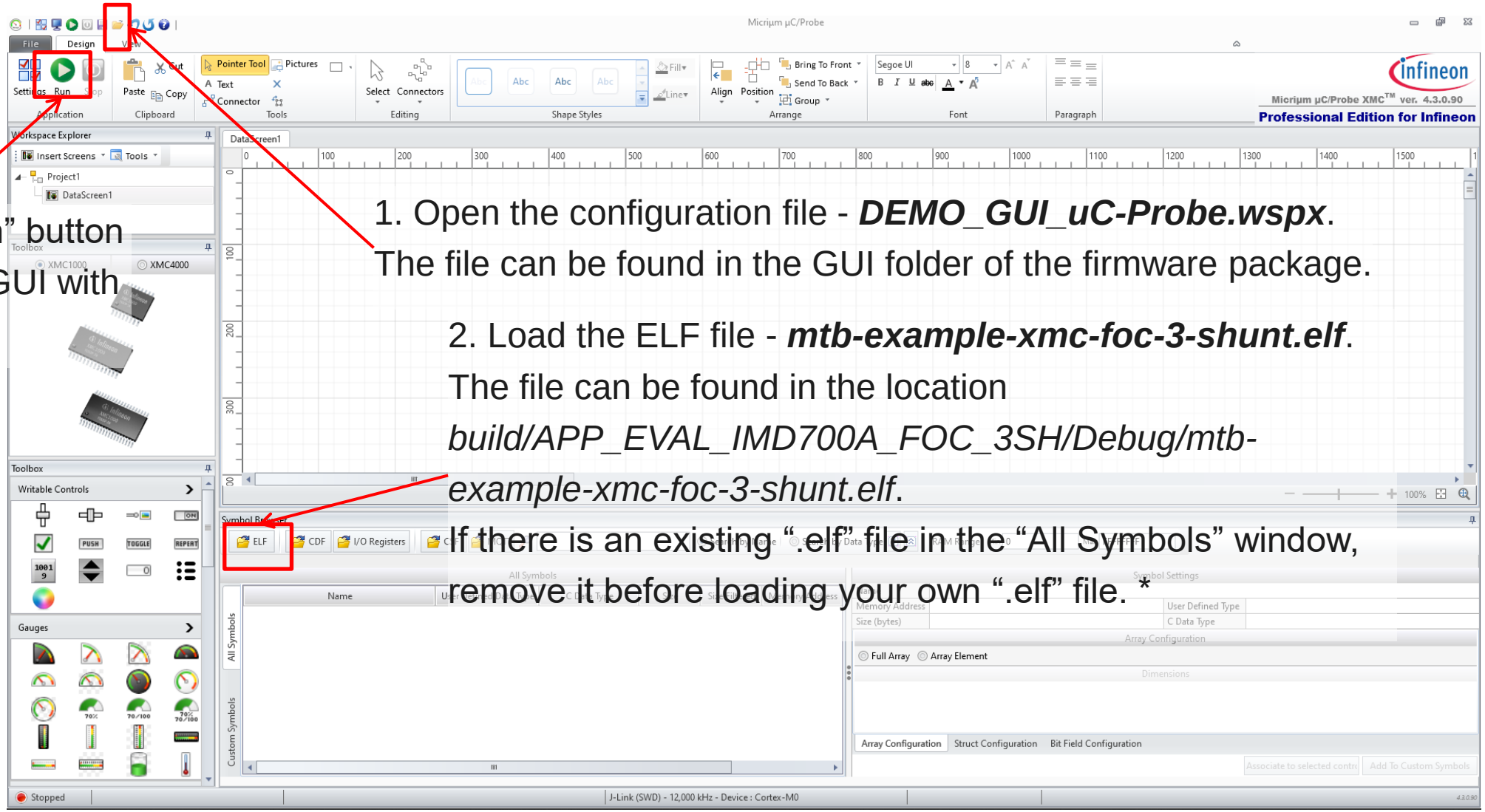
Demo GUI
- GUI operation

3. Click on “Run” button to connect the GUI with the board.



1. Open the configuration file - ***DEMO_GUI_uC-Probe.wspx***.
The file can be found in the GUI folder of the firmware package.

2. Load the ELF file - ***mtb-example-xmc-foc-3-shunt.elf***.
The file can be found in the location *build/APP_EVAL_IMD700A_FOC_3SH/Debug/mtb-example-xmc-foc-3-shunt.elf*.
If there is an existing “.elf” file in the “All Symbols” window, remove it before loading your own “.elf” file. *

Note: * Because the existing file path may be different with the file on your local machine.

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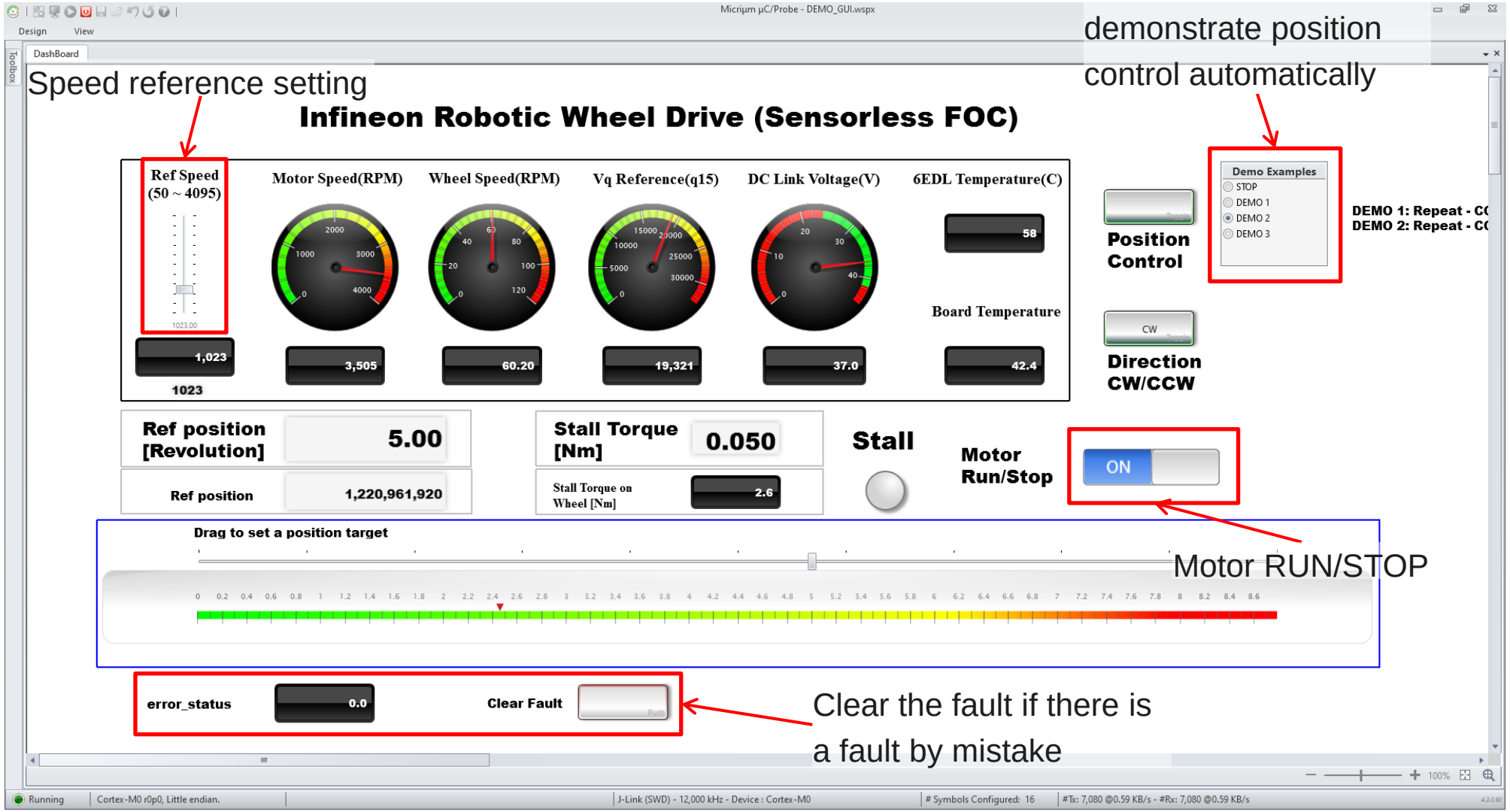
Demo GUI
- GUI operation



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Revision history

Document revision	Date	Description of changes
V1.0	18-Sept-2024	Initial release

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