MOTIX™ MCU Solution Designer

User guide

About this document

Scope and purpose

This document assists users who are working with the MOTIX™ MCU Solution Designer and those who want to run specific motor control evaluation boards.

The system functions using a hardware and software set-up to drive a BLDC motor, which is operated by different boards such as a TLE987x 3-phase bridge driver IC with an integrated Arm® Cortex M3 processor.

Intended audience

This document is intended for anyone who wants to test and become familiar with the MCTRL software. Specifically, for motor control developers to become familiar with Infineon evaluation boards such as the TLE987x Evaluation Kit.

***Note**:* *Read this user guide step-by-step to ensure that everything is connected correctly, and to ensure successful motor operation.*

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1 Introduction

MOTIX™ MCU Solution Designer is a tool designed to guide users in developing a motor control application and assists users in:

- Connecting to a selected target device
- Monitoring data signals (variables) of a connected target device
- Changing the run-time parameters of a connected target device
- Configuring base values and basic parameters
- Configuring all motor parameters

1.1 How to get the tool

The MOTIX™ MCU Solution Designer is available in the Infineon Developer Center (IDC). It can be opened with the corresponding icon in the upper right corner. Open this link to access the IDC. A detailed description on how to install and use is available here.

Once the tool is installed through the IDC, the following image is displayed and it is ready to start.

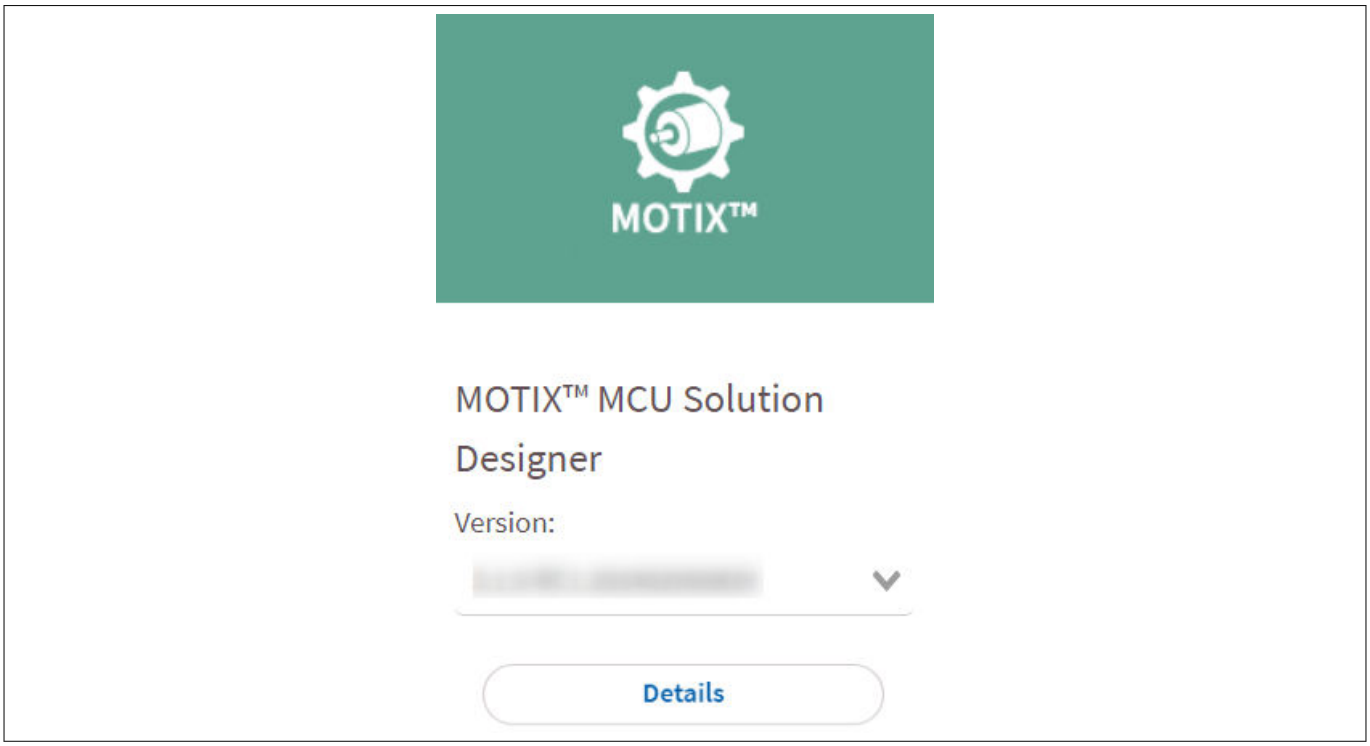


Figure 1 MOTIX™ MCU Solution Designer tool in IDC

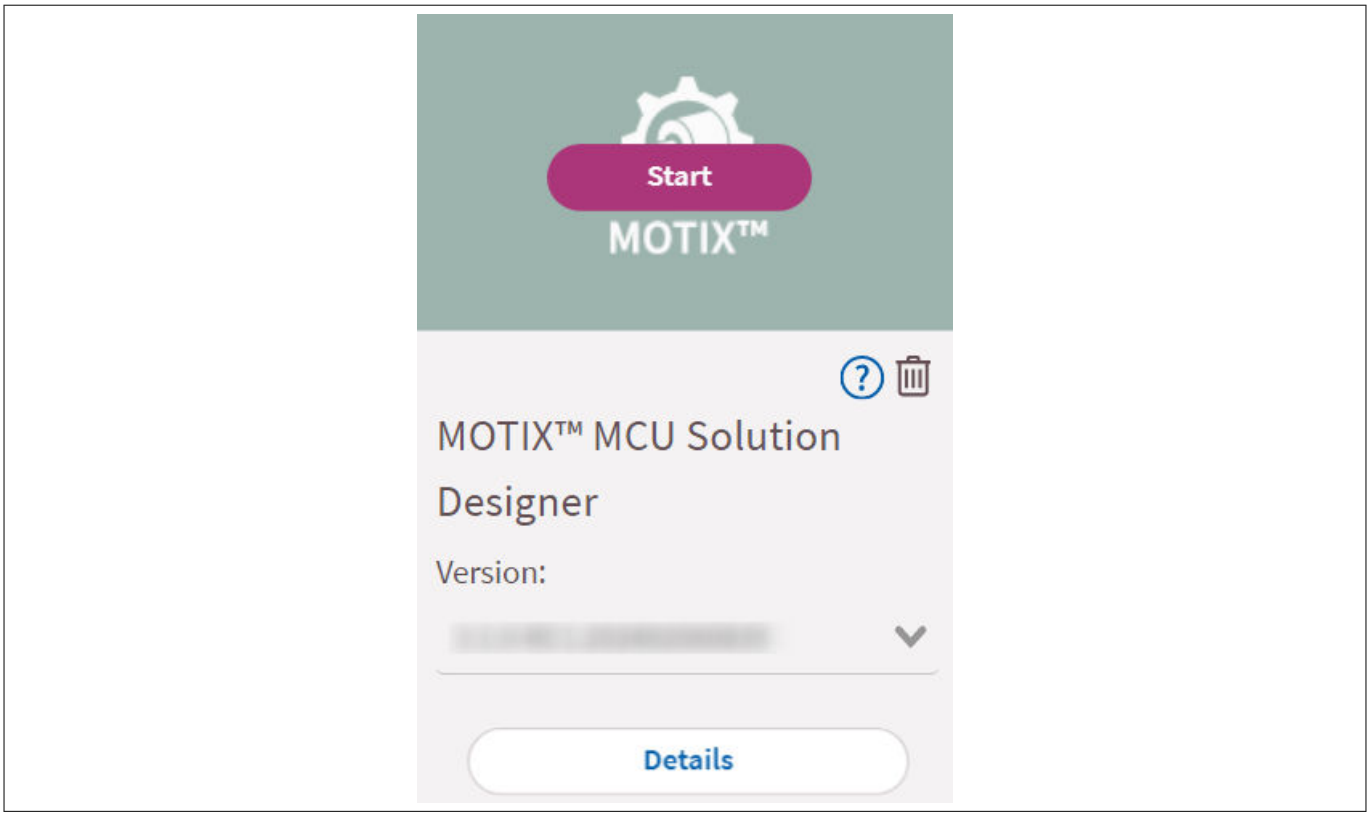


Figure 2 Start the MOTIX™ MCU Solution Designer

1.2 Getting help

The tool header bar offers various ways of getting help on the tool. You can access help from any screen in the tool.



	Access the support page, including expert help
	Access the tool forum to exchange information with peers
	Open the tool user guide

1.3 Required components

The following table shows an overview of all the hardware and software components that are required for motor-control operation.

Table 1 Required hardware and software components

Component	Part	Link
Hardware	Motor	• Flange NEMA: 17 • Flange: 31 mm • Rated torque/peak: 0.0625 Nm/0.19 • Torque constant: 0.035 Nm/A • DC voltage: 24 V • Current no load/rated/peak: 0.2/1.79/5.4 A • Poles per phase: 8/3 • Rated speed/no load: 4000 rpm/6200 rpm • Rated power: 26 W • Width: 42 mm • Height: 42 mm • Length: 41 mm • Weight: 300 g • Phase-phase resistance: 1.5 Ohm • Phase-phase inductance: 2.1 mH @ 1 kHz • Inertia: 2.4 x 10^{-6} kgm^2 ***Note**: Every motor with a similar parameter set can be driven.*
	Brake	Mobac HB-50M-2
	Evaluation board	• https://www.infineon.com/cms/de/product/microcontroller/embedded-power-ics-system-on-chip-/3-phase-bridge-driver-integrated-arm-cortex-m3/ • https://www.infineon.com/cms/de/product/evaluation-boards/tle9879-evalkit/
	MOTIX™ Motor Bench	• https://hu.mouser.com/new/infineon/infineon-motix-motor-bench/https://www.infineon.com/cms/de/product/evaluation-boards/motix_motor_bench/
	12 V power supply	12 V, 2 A (two connectors: female banana plug 4 mm)
	Cables	Connectors: male banana plug 4 mm
	PC (minimum system requirements)	• Windows 10, 64-bit • 2 GB RAM • Intel Celeron 1.1 GHz CPU • 1920x1080 (100%) resolution
Software	MOTIX™ MCU Solution Designer	https://softwaretools.infineon.com/tools/com.ifx.tb.tool.motixsd

1.4 Getting started set-up

The image below shows the required components to set-up.

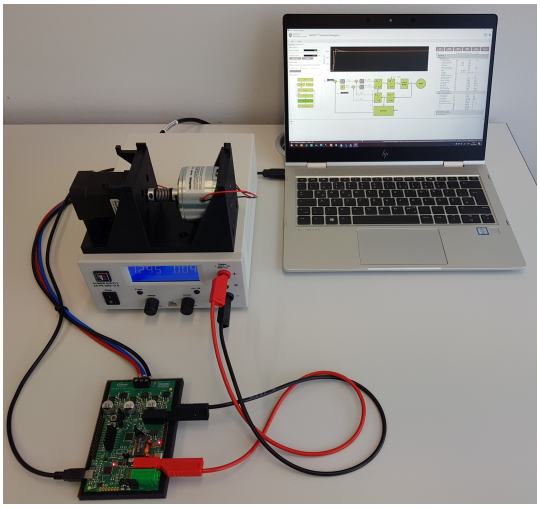


Figure 3 Component set-up

2 User interface overview

The figure below shows the user interface overview.

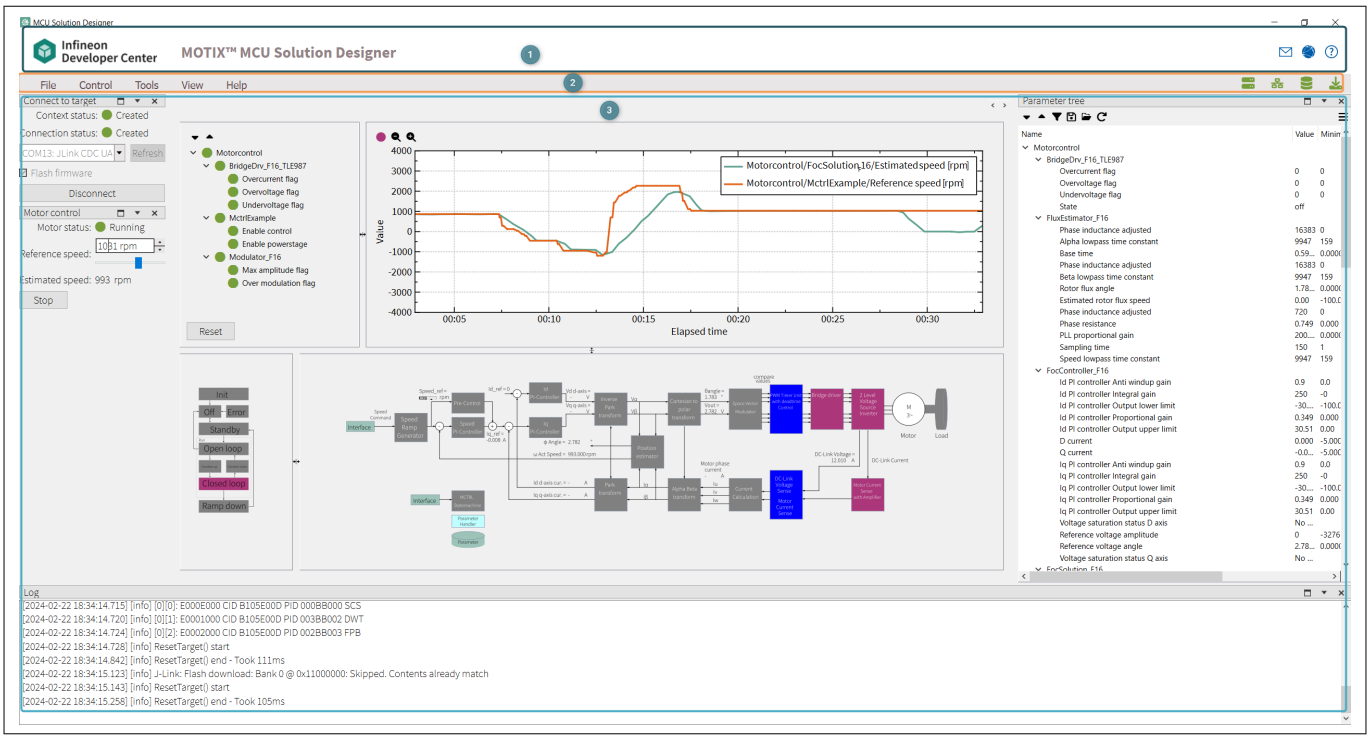


Figure 4 User interface overview

The layout of the MOTIX™ MCU Solution Designer consists of following components:

1. Getting help
2. Menu bar
3. Content area

2.1 Content area

In the MOTIX™MCU Solution Designer tool, you begin by selecting an option from the dialog box: **Project configuration**, **Getting started** or **Parameter XML**.

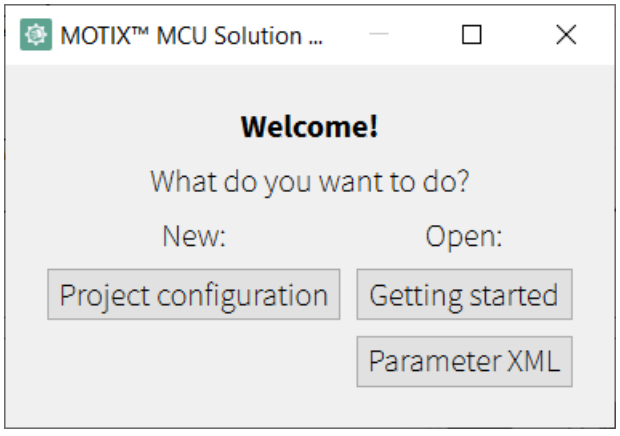


Figure 5 Welcome! - select an option

If you select **Getting started**, the following dialog box will open to select a device and a firmware version.

2 User interface overview

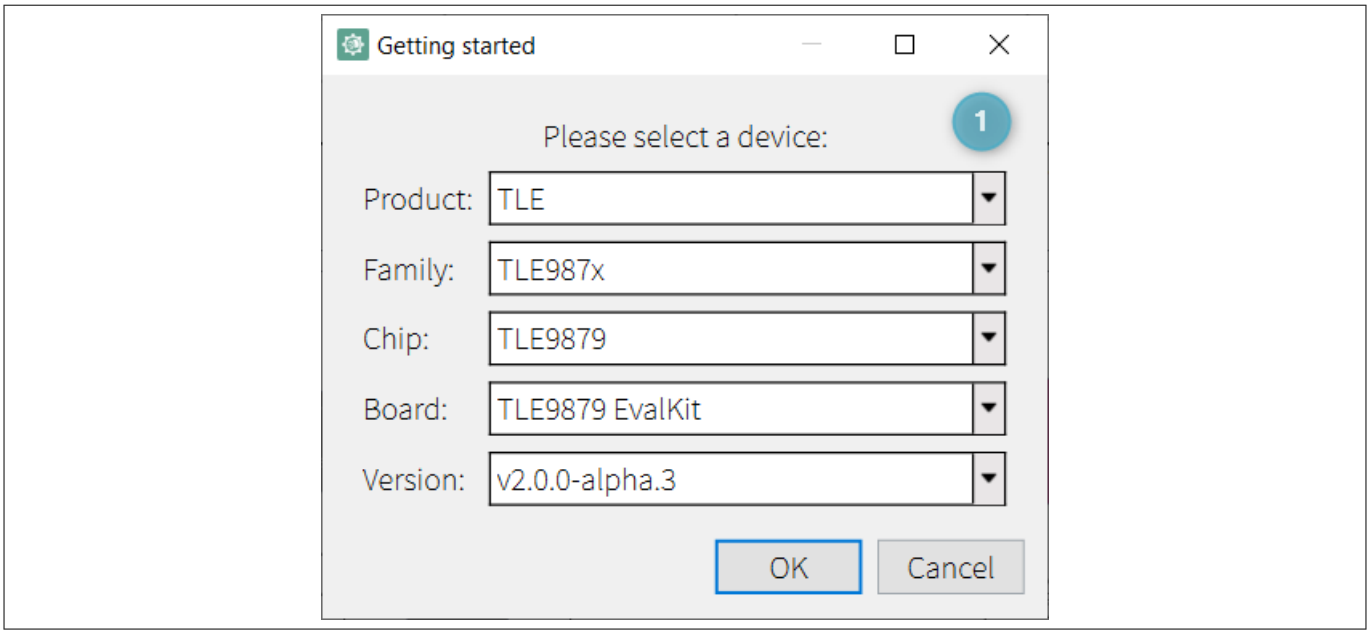


Figure 6 Getting started device selection

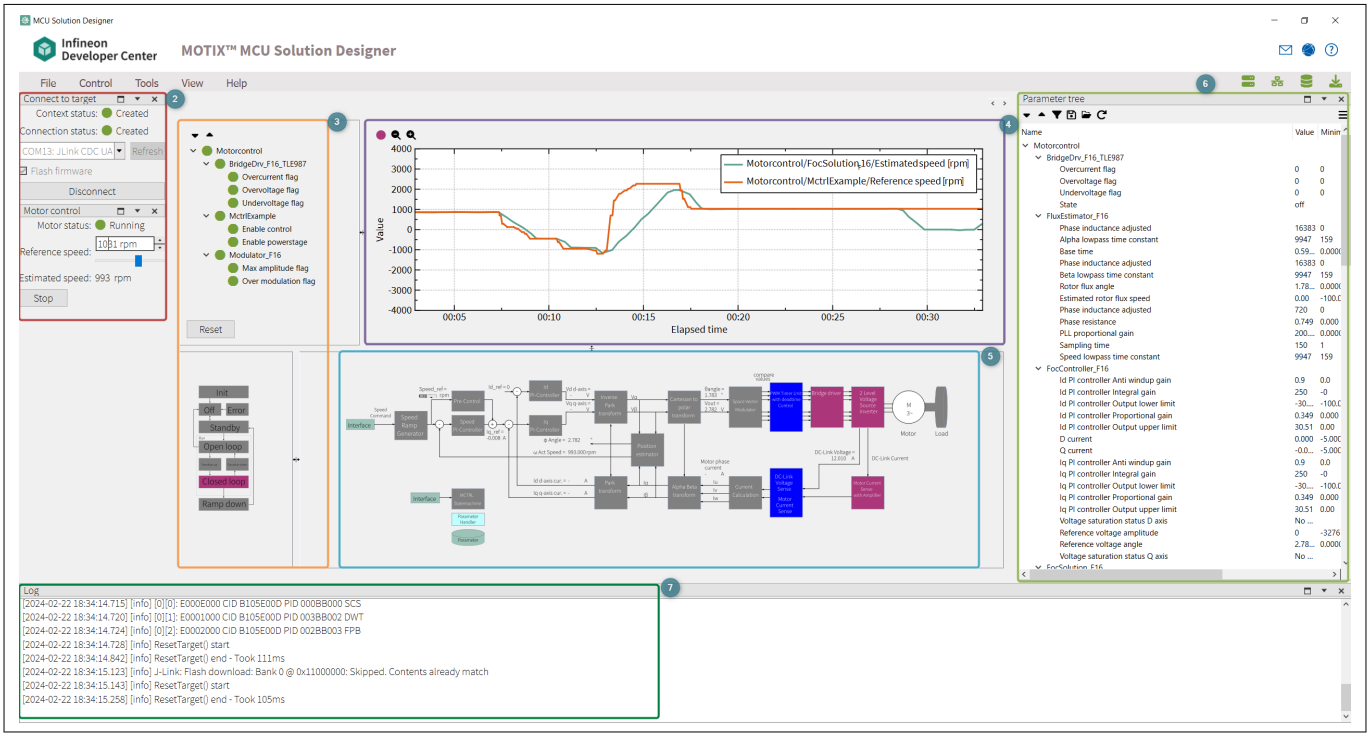


Figure 7 Content area overview

The content area includes:

1. Device selection
2. Connect to target and Motor control
3. System state and State machine
4. Plot area
5. Signal flow
6. Parameter tree
7. Logging area

2.1.1 General overview

The block diagram below shows the interaction between the hardware and software components to enable the user application.

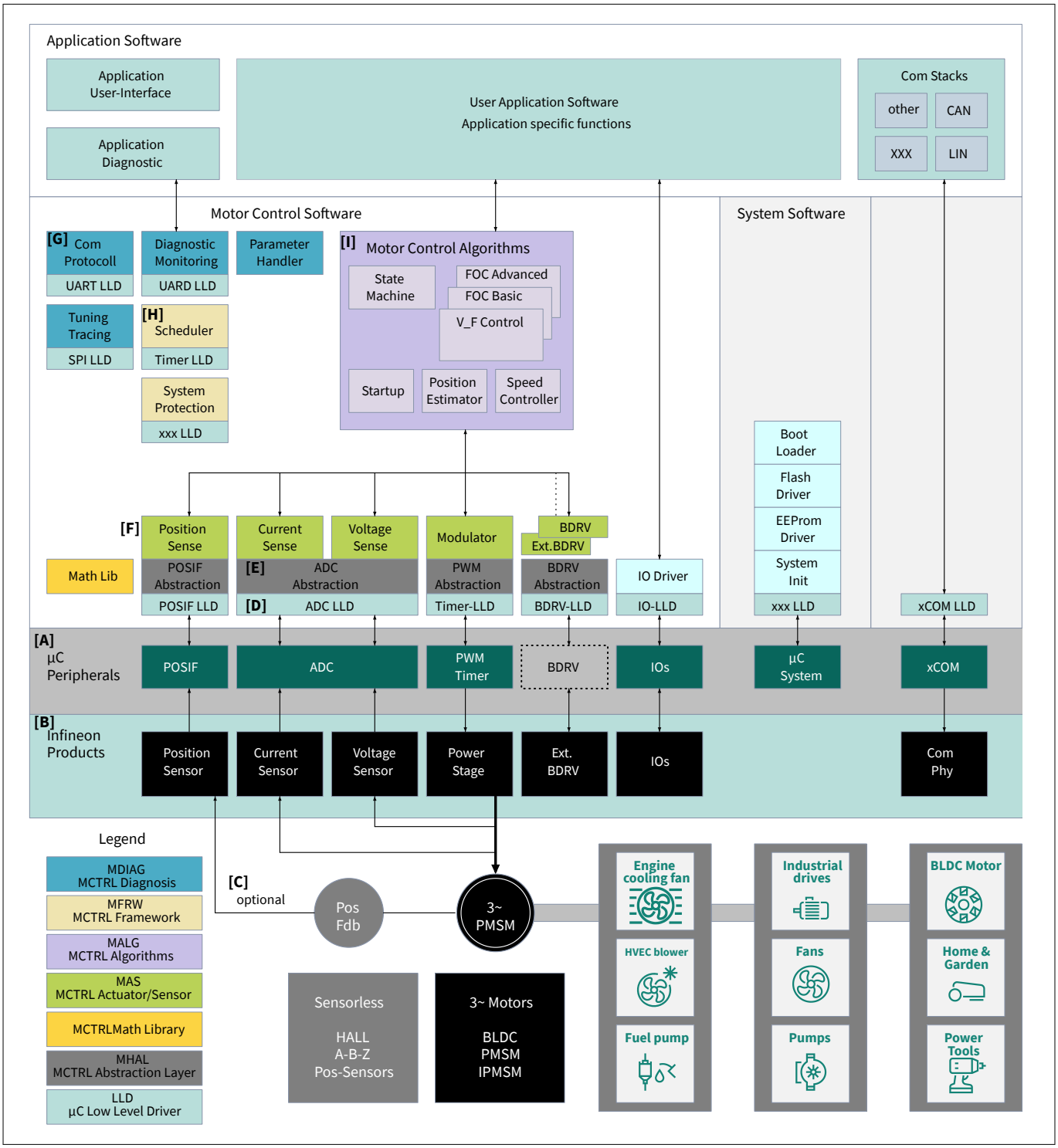


Figure 8 General overview of software and hardware components

The table below describes each block.

Table 2 Hardware component description

Item	Description
[A]	Peripherals inside the microcontroller: port pins, PWM timer, ADC, UART
[B]	Infineon hardware products including: power switches IGBTs, MOSFETs, bridge drivers, position and current sensors, com-drivers and microcontrollers
[C]	Motor control user application, which support automotive, industrial and consumer markets. Major hardware components are motor with or without position feedback and the supported motors are 3~ “BLDC” PMSM or IPMS.

Table 3 Motor control software component description

Item	Description
[D]	Low level driver (LLD) for microcontroller peripherals
[E]	Motor control hardware abstraction for various Infineon microcontrollers
[F]	Actuator and sensor software building blocks for motor control: PWM-modulation, current and position sensors
[G]	Supporting functions for parameter handling, diagnostic and monitoring
[H]	Supporting functions for task scheduling, and system protection
[I]	Motor control algorithms including V2f and FOC state-machines, current and speed controller

2.1.2 Device selection

In **Getting started**, you can select a specific device. Click **File → Open → Getting started**, and select the device.

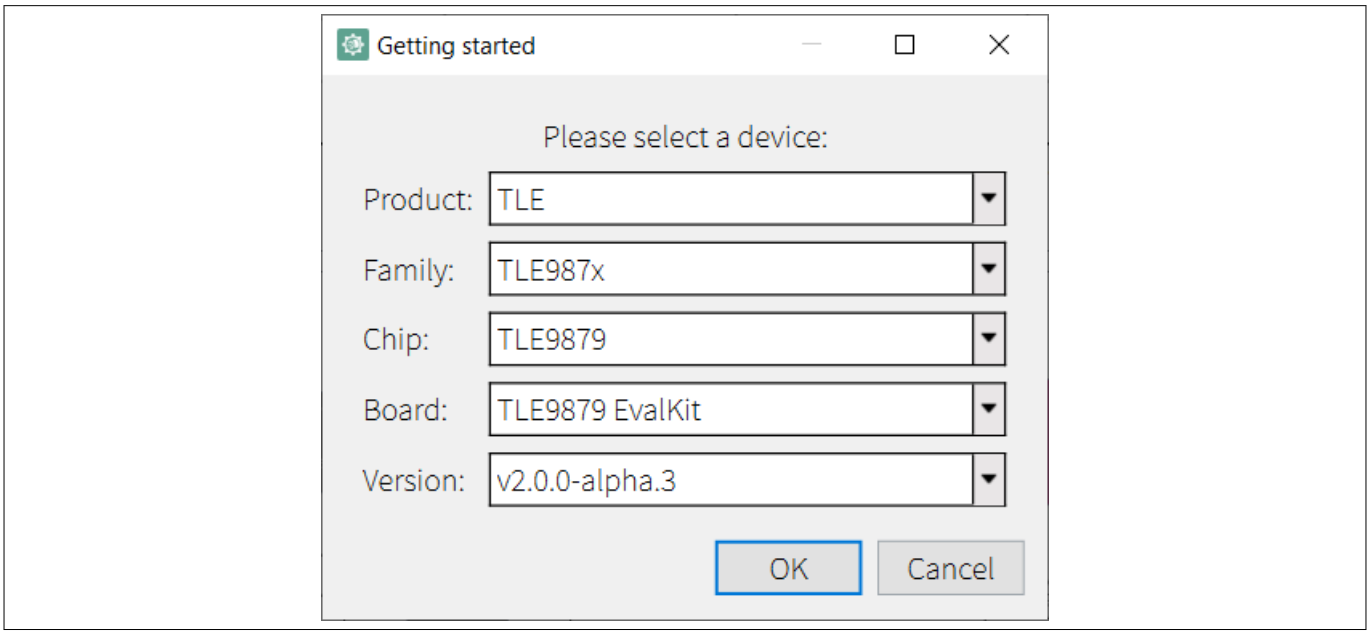


Figure 9 Getting started device selection

2.1.3 Connect to target

Before starting the motor, the user interface has to be connected to one target (see Getting started set-up).

After plugging in all of the required components, the connection can be established by clicking **Connect** after selecting the required target in the **Getting started** dialog box. The target firmware must be valid to start the motor.

2.1.4 Motor control

The **Motor control** section includes all of the functions required to input information to the system for the following actions:

- Start and stop the motor
- Set a **Reference speed** and a direction
- Watch the **Estimated speed** from the motor-control system

Attention**: **If the motor is not connected, do not rely on the estimated speed value.

The colors representing the **Reference speed** and the **Estimated speed** values act as a guide for the plot that is visible in the Signal flow.

To start the motor, click **Start motor** and set the **Reference speed** slider to the desired value.

To stop the motor, click **Stop motor**.

2.1.5 System state

The **System state** contains all of the information relating to warnings, controls and failure states. Additionally, it includes information on how to get the system running, for example: enable control, enable power stage and clear fault. The following colors indicate the status:

- Red: Indicates a state has an error
- Yellow: Indicates a warning
- Green: Indicates the system is up and running

In case of errors, click **Reset**.

2.1.6 State machine

The **State machine** section contains all information about the current motor-control state using highlighted fields when the corresponding state is active. It contains the following states:

- Init (initiation)
- Off
- Standby
- Open loop
- Transition up
- Transition down
- Closed loop
- Ramp down
- Fault

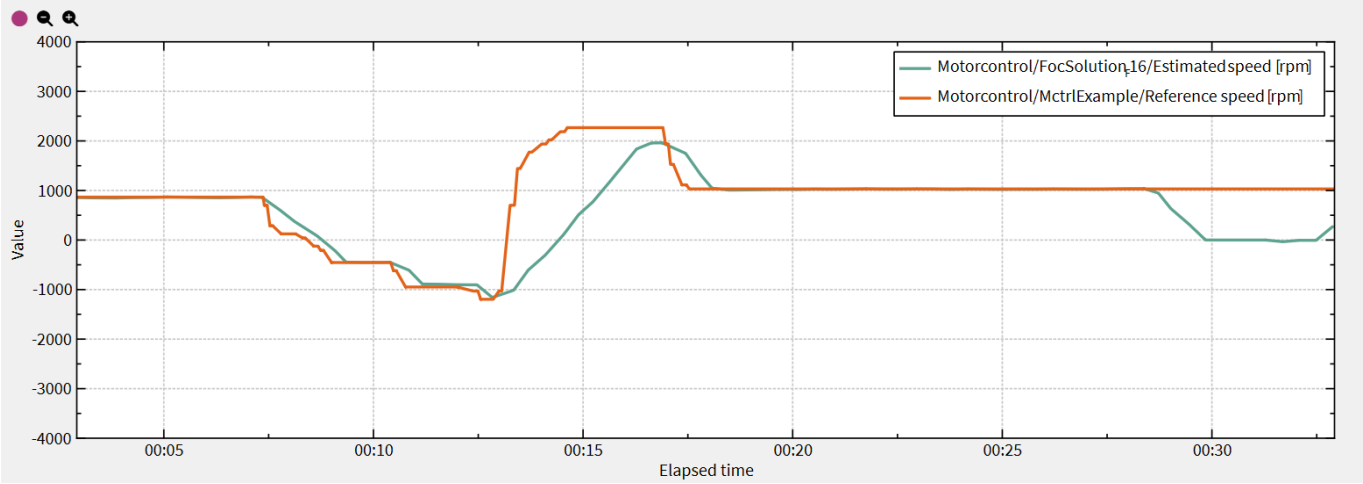
2.1.7 Plot area

The plot area, by default, displays the two following parameters:

- Current reference speed
- Estimated speed, which reflects the current speed of the motor

Refer to the image below to see the parameters that are being recorded.

Figure 10 Plot area: estimated and reference speed



2.1.8 Signal flow

For more information on the signal flow, refer to the image and description table below.

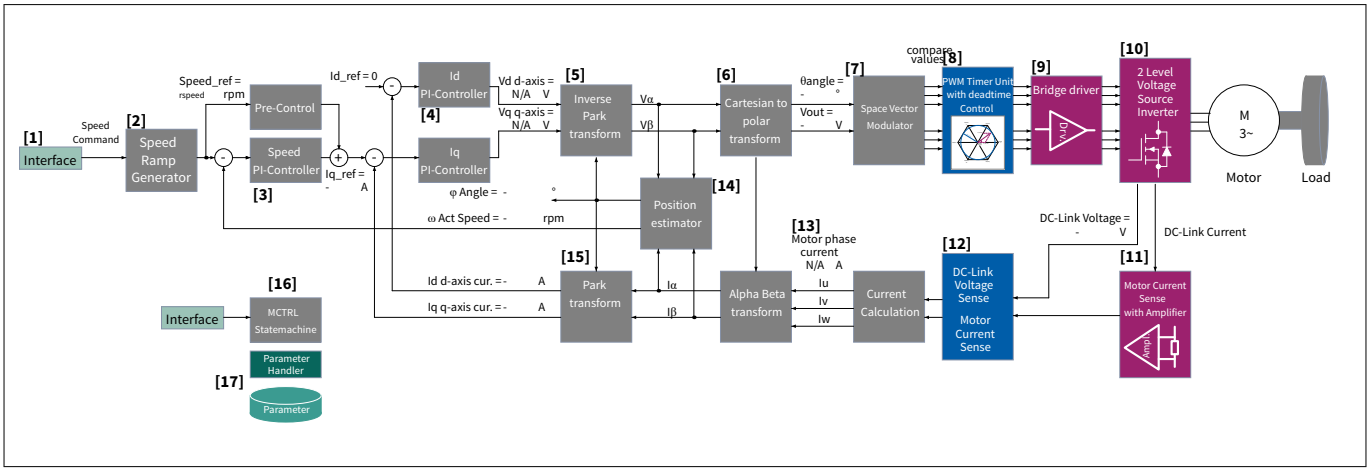


Figure 11 Signal flow description

Table 4 Block description

Item	Description
1	Application command interface
2	Speed command ramp generator with adjustable up/down ramps
3	PI controller for speed with adjustable output limits and anti-windup
4	PI controller for d-q-axis currents with adjustable output limits and anti-windup
5	Forward transformation from d-q to alpha-beta reference frame
6	Transformation from Cartesian (alpha, beta) to polar (amplitude, angle)
7	Space vector modulator with the calculation of current trigger event
8	Microcontroller PWM timer unit (multiple microcontroller derivatives are supported via MHAL)
9	Bridge driver device (multiple types and topologies are supported)
10	B6 power bridge – 2-level voltage source inverter
11	Motor current sense (multiple topologies are supported)

(table continues...)

Table 4 (continued) Block description

Item	Description
12	Microcontroller ADC for voltage/current sense (multiple microcontroller derivatives are supported via MHAL)
13	Calculation of current reconstruction based on used current sense topology
14	Position and speed estimator for sensor-less motor control (sensor-less FOC)
15	The backward transformation from alpha-beta to d-q reference frame
16	Motor control state machine
17	A component in software <parameter handler> that has access to a parameter memory

2.1.9 Parameter tree

The parameter tree contains a list of readable and writable system parameters, and is used for configuring the dynamic parameters. The functions of the parameter tree are described in the table below:

Table 5 Parameter tree functions

Icon	Name	Description
	Expand and Collapse	Expand and collapse all parameters or groups of parameters
	Filter	Filters a specific parameter to show in the tree view
	Refresh	Reads the current parameter values from the target
	Save	Saves the parameter changes to a file
	Load	Load parameters from a file
	Show/hide columns	Click to show or hide columns in the parameter tree view

When selecting the **Getting started** setup, only a subset of parameters from the different libraries are supported for configuration.

To influence the motor dynamics users can directly adjust several parameters using the parameter tree. The changes in a parameter value force an update of the value on the target, and is visible after releasing the tab.

2.1.10 Logging area

The logging area contains information about the ongoing background actions of the system.

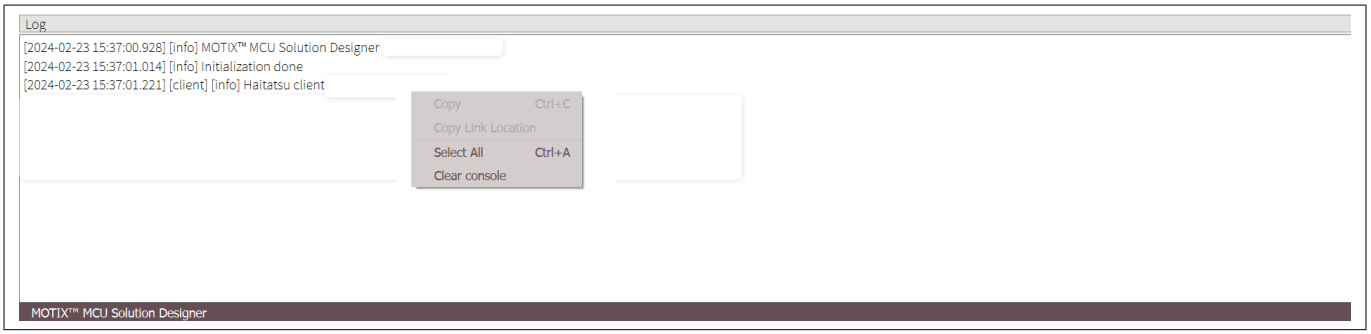


Figure 12 Logging area

2.2 Menu bar

2.2.1 Project configuration

To run a project configuration, a specific project specification xml - *.psxml must be loaded. You can export the required files to configure the solution. To do this, go to **File → New → Project configuration**. By using the export function, you can:

- Generate component configurations
- Generate the parameter table configurations
- Generate the parameter XML
- Generate all dynamic configuration files

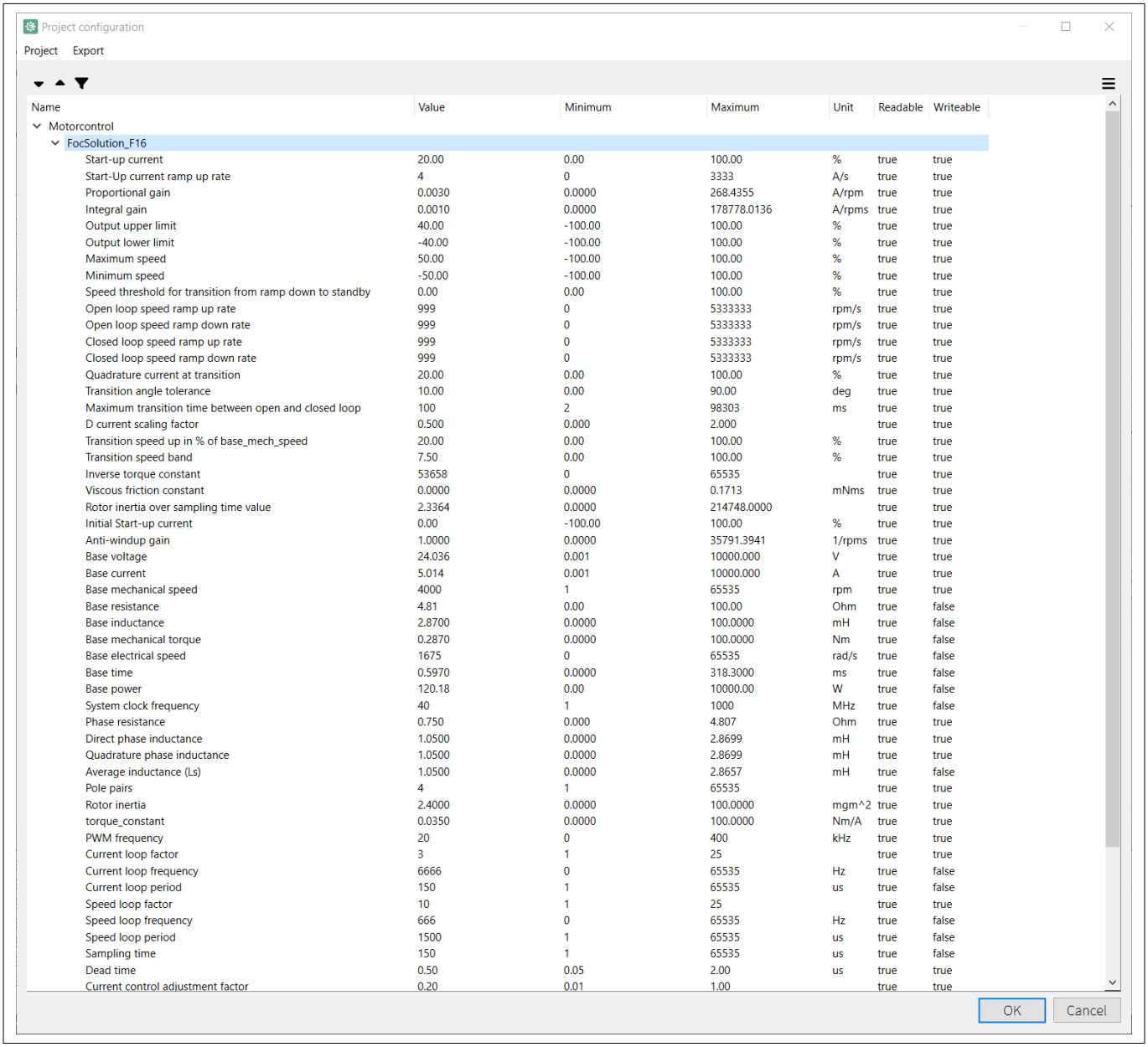


Figure 13 Example of project specification file

An example of a log output:

- [timestamp-1] [info] Generating component configuration files

- [timestamp-2] [info] Successfully generated component configuration files
- [timestamp-3] [info] Output files were written to C:\t..\tle987x_FOC_BASIC_Sensorless_Example\./Cfg/

***Note**: The log window shows where the files are located. If there is no path specified in the project configuration specification -psxml, the files are available in the folder generated in the tool directory.*

2.2.2 Controls

2.2.3 Tools menu bar

To use the **Oscilloscope** and **TraceBox Configuration Tool**, open the **Tools** menu.

Each tool has a corresponding embedded user guide that can be accessed by clicking the help icon in the corresponding tools, or in Chapter 5.

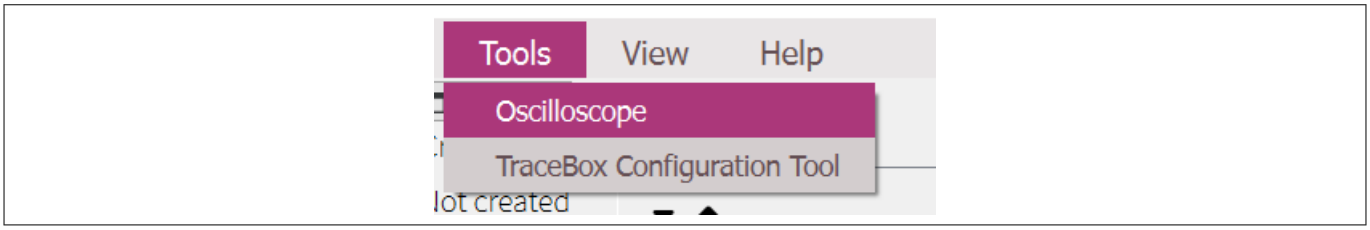


Figure 14 Tools menu bar with drop-down list

3 How to run a motor

The purpose of the first evaluation is to run a motor with an evaluation board, without needing to write source code. First, read Getting started set-up and then follow these steps:

1. Connect the power supply
2. Connect the PC and target via SWD – Segger Debug-interface (Debugger onboard the Eval-Kit)
3. Start the tool MOTIX™ MCU Solution Designer
4. Connect to the board (deployed software is downloaded to Eval hardware)

If you want use and work in the source code, click IDC to download the demo code.

4 How to run your own motor

After performing an evaluation with the MOTIX™ Motor Bench, you can use your own motor. To do so, the following parameters require configuration:

1. New system base values for voltage, current, and speed
   a. The new minimum and maximum limits of several dynamic parameters are calculated automatically via MOTIX™ MCU Solution Designer
2. Gain settings for current and voltage sense, scaling, and configuration of signal resolution
   a. Scaling of voltage sense, CSA-Gain, limits for over- and under-voltage detection
   b. Configuration of math-configuration, and table size
3. Configuration of Power stage, PWM-timer, Bridge Driver, MOSFET deadtime
   a. Use MOTIX™ Configuration Wizard for MCU for configuration of low-level drivers and peripherals
   b. Use MOTIX™ MCU Solution Designer for configuration of Motor Control Solution (emb SW- Libs)

Download the example code from IDC and then follow these instructions:

1. Open pack file in Keil pack manager:
   a. Select the code from the example list
   b. Copy the code to the user workspace
   c. Open Keil Project to edit and compile
2. The project can be flash downloaded/debugged using the SWD-Interface
   a. For example: J-Link, U-Link, XMC-Link
3. Connect MOTIX™ MCU Solution Designer to control motor and display parameters

To configure the system to run your own motor:

1. Configure base values and basic parameters
2. Configure all motor parameters
3. Configure power stage
4. Configure measurements

***Note**: Set these parameters to the appropriate value for the use case.*

To prepare your environment for a test in V2f-mode, the tables below show an overview of the parameters to be configured. All parameters are available at Project configuration, from there they are configurable. Use the filter to navigate through the table and configure the section you require.

Table 6 Configuration table: base values and basic parameters

Parameter name	Configuration use case
Base voltage [V]	Maximum voltage
Base current [A]	Maximum current

(table continues...)

Table 6 (continued) Configuration table: base values and basic parameters

Parameter name	Configuration use case
Base speed [rpm]	Maximum speed
PWM frequency [kHz]	PWM frequency – range 12-32 kHz, depending on application requirements, audible noise, EMC, current smoothness
Current loop factor [-/-]	Cycle time of the current loop, depending on application needs for current control, audible noise, control dynamic, CPU load
Speed loop factor [-/-]	Cycle time of the speed loop, depending on application needs, speed control dynamic, CPU load

Table 7 Configuration table: motor parameters

Parameter name	Configuration use case
Motor phase resistance R	Phase resistance is used for FOC – Parameter value = 50% of line to line value
Motor phase inductance Ld, Lq	Phase inductance is used for FOC – Parameter value = 50% of line to line value (50% of identified Ld, Lq)
Motor rated speed/frequency	Motor rated speed used for maximum limitation and electrical frequency is used for V2f – curve setting (corner speed)
Motor rated voltage [V]	Motor rated voltage used for maximum limitation and electrical frequency is used for V2f – curve setting (corner voltage)
Motor rated current [A]	Motor rated current used for maximum limitation
Motor number of polpairs [-/-]	Number of polpairs used for speed to electrical frequency calculation
Rotor inertia [kg cm^2]	Inertia of the system (motor + load) to compensate via speed pre-control (optional)
Torque constant [Nm/A]	Motor constant Nm per Amp used for diagnostic calculations (optional)

Table 8 Configuration table: power stage parameters

Parameter name	Configuration use case
Power stage dead time [ns]	High side-low side shoot through protection of the power stage, typically 200 … 900 ns

(table continues...)

Table 8 (continued) Configuration table: power stage parameters

Parameter name	Configuration use case
Trap reaction	Fast switch-off in case of power stage errors due to TRAP-Signal. ***Note**: Configure the gate driver level in case of TRAP and TRAP release, for example: pull down to low, tristate or resync to PWM when TRAP release*
Gate driver configuration	Individual settings for gate control depending on MOSFET type, power supply, application requirements, EMC, noise, heat dissipation
Gate driver enable	Gate driver enable signal configuration (pin, level, timings)
Gate driver fault signal	Gate driver enable signal configuration (pin, level, timings)
Gate control signals	Gate driver enable signal configuration (pin, level, timings)
Gate driver configuration via SPI	SPI - configuration for configuration of ext. gate driver

Table 9 Configuration table: measurements

Parameter name	Configuration use case
Shunt resistor [mΩ]	For shunt-based measurements
Current sense topology	Single DC-Shunt, 2x LegShunt, 3x LegShunt, MotorPhase, …
Current amplification factor	Scaling from physical measured current to Q15 scaled software value
Voltage amplification factor	Scaling from physical measured current to Q15 scaled software value
Current zero offset calibration	Zero calibration of current sense path
Voltage zero offset calibration	Zero calibration of current sense path
Voltage sense filter	Filter time constant for voltage sense

4.1 Command line interface

The command line interface (CLI) enables the user or developers to start the tool from the command line and set the arguments as needed for automated integration. Refer to the description of the argument given in the table below:

Table 10 Command line guide

Command	Explanation
-v, --version	Displays version information.
-?, -h, --help	Displays help on command line options

(table continues...)

Table 10 (continued) Command line guide

Command	Explanation
--help-all	Displays help including Qt specific options
-- generatePxml <psxmlFileName>	Generate PXML
--generateParameterTables <psxmlFileName>	Generate parameter tables
--outputPath <outputPath>	The output path for the generation (default is './generated').

An example of how to insert the arguments:

1. Using --outputPath:$ ./MOTIXMCUSolutionDesigner.exe --generatePxml C:/../example_device.psxml --outputPath=c:/testtest -> generate it into c:/testtest
2. Using absolute path from PSXML:
   $ grep -E "cfgOutputFolder" C:/../example_device.psxml
   <cfgOutputFolder>c:/${test1}</cfgOutputFolder>
   $ test1="Hello" ./MOTIXMCUSolutionDesigner.exe --generatePxml C:/../example_device.psxml -> generate it into c:/Hello

4.2 Dynamic parameter

To identify if a parameter is dynamic, right-click on the header of the parameter tree table and select the column **Part of dynamic configuration**.

4.3 Static parameter

To identify if a parameter is static, right-click on the header of the parameter tree table and select the column **Part of static configuration**.

5 Embedded tools

The user guides for the following embedded tools are available when clicking on the help icon in the corresponding tool:

- Infineon Oscilloscope Tool
- TraceBox Configuration Tool

The TraceBox Configuration tool allows you to configure the MOTEON TraceBox. For more information, click https://www.infineon.com/cms/en/product/evaluation-boards/moteon-tracebox/.

6 Contact us

To get in contact with our support about the following topics, click the link www.infineon.com/services:

- A bug
- An improvement idea
- A new feature request
- A support request

Revision history

Document version	Date of release	Description of changes
1.11	2024-02-26	• Text, formatting and screenshots updated throughout the document
1.10	2023-10-27	• Chapter Menu bar added
1.04	2023-09-28	• Inserted introduction of tools menu in the header bar
1.03	2023-01-30	• Text, formatting and screenshots updated according to multi-board support (MOTIX™ MCU Solution Designer 2.0.0)
1.02	2022-09-30	• Getting help updated
1.01	2022-03-15	• About this document updated • Table 1 updated (Link → replaced by further parameter information) • User interface overview updated • Command line interface updated • Figures updated throughout the document
1.00	2021-12-15	• Initial document release

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Do you have a question about any aspect of this document?

Email: erratum@infineon.com

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