*Application Note*

# *Getting Started with MOTORSTUDIO*

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**ABSTRACT**

The MCF83xx portfolio of devices are TI's BLDC motor drivers integrated with Field-Oriented Control (FOC). The MCF83xx devices do not need any external coding for the algorithm to work, and there are multiple configurations available for the user to tune according to the application. This document provides a step-by-step guide in getting started with evaluating a given BLDC motor with TI's MCF83xx portfolio using the graphical user interface - MOTORSTUDIO.

The document is applicable for all the following devices (referred to as MCF83xx devices in this document):

- MCF8315A
- MCF8315C
- MCF8315C-Q1
- MCF8316A
- MCF8316C
- MCF8316C-Q1
- MCF8315D
- MCF8316D
- MCF8329A
- MCF8329A-Q1

## Table of Contents



## Trademarks

# 1 Introduction

MOTORSTUDIO is an easy-to-use graphical user interface (GUI) that simplifies the tuning process of TI's Brushless DC (BLDC) motor drivers to reduce device evaluation and product development time. The FOC algorithm requires the values of motor phase resistance, motor phase inductance and motor BEMF constant, etc to run the motor efficiently. This document describes how users can obtain these values and configure the MCF83xx to run a given motor. MOTORSTUDIO also enables users to quickly spin up BLDC motors and optimize various stages of motor operation to achieve highest motor performance, stable motor startup and minimal noise.

**Note**

This document is ONLY an introductory guide to getting started with MOTORSTUDIO. The document does not include any guide for the further optimizations.

# 2 Prerequisites to Run the Motor with MOTORSTUDIO

**Table 2-1. Prerequisites to Work With MOTORSTUDIO**

| Sl No | Requirements |
|---|---|
| 1 | Laptop installed with MOTORSTUDIO |
| 2 | .json file (refer this e2e FAQ for .json files) |
| 3 | MCF8329A/16A/16C/16D/15A/15C/15D EVM |
| 4 | BLDC Motor |
| 5 | DC power supply |
| 6 | USB Cable |
| 7 | Connecting wires |

Table 2-2 are the required parameters specific to the motor that the user needs to note down before starting next steps

**Table 2-2. Motor Parameters Required**

| Sl No | Required Parameters |
|---|---|
| 1 | Rated input DC voltage (V) |
| 2 | Maximum motor speed (RPM/Hz) |
| 3 | Rated motor phase peak current (A) |

# 3 Getting Started with MOTORSTUDIO

Figure 3-1 shows the the landing page (starting point) of the GUI with different sections marked. Table 3-1 explains different sections in the GUI according to Figure 3-1

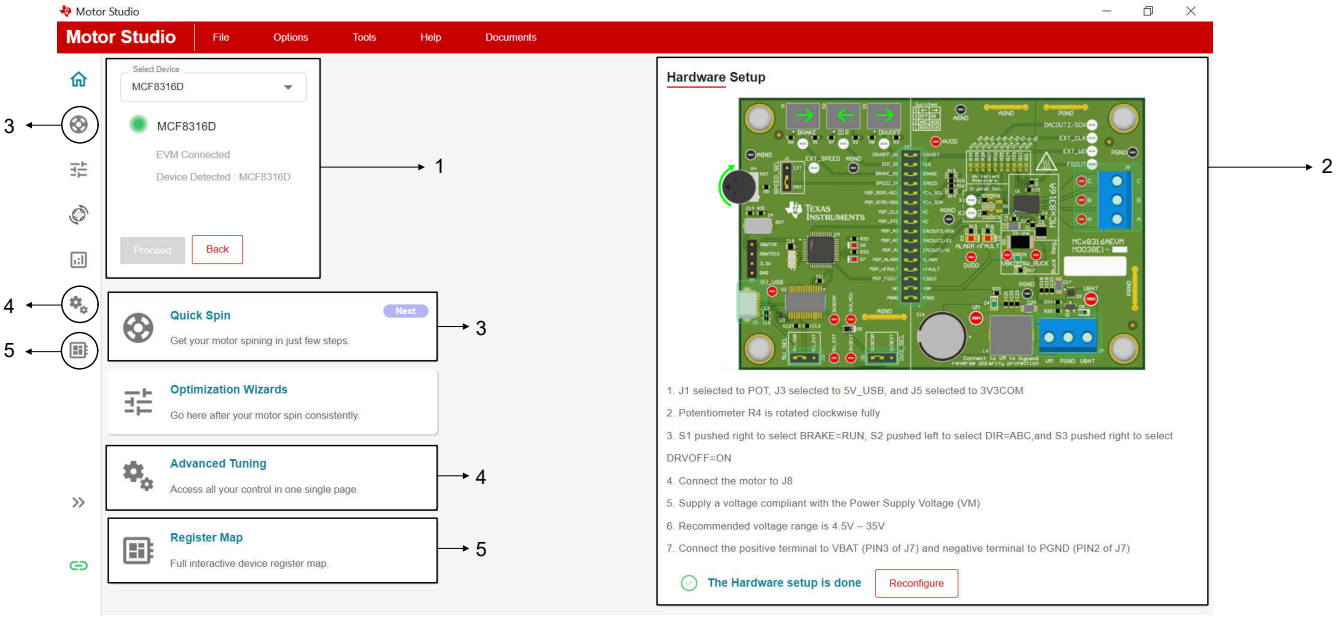


**Figure 3-1. Landing Page Information**

**Table 3-1. Different sections in MOTORSTUDIO**

| Section Number | Section | Description |
|---|---|---|
| 1 | Device Connection | Indicates the device selected and the device connection status. |
| 2 | Hardware Setup | Follow the instructions in this section to setup the EVM as per recommendations from TI |
| 3 | Quick Spin | This section enables the user to quickly spin the motor by following the recommendations on screen. Designed for users who want to quickly spin the motor without any advanced knowledge. |
| 4 | Advanced Tuning | Use this page to control all the register map settings at one place in a user friendly way |
| 5 | Register Map | Access the whole register map with each bit field accessible to the user to modify. Typically for advanced users |

Use the following steps to get started:

**Step 1:** Power the EVM by connecting a DC Power supply between *VBAT* and *PGND*. Set the supply voltage to be equal to the rated input DC voltage. Turn ON the DC Power supply.

**Step 2:** Launch MOTORSTUDIO (download from here).

**Step 3:** Select your device and click *Proceed*. A window similar to Figure 3-1. opens up for the selected device.

**Step 4:** Follow the instructions in the *Hardware Setup* section for selected device (Figure 3-1 is for reference only) by clicking on "Setup Now".

**Step 5:** Make sure the device connection status is green before proceeding further.

**Step 6:** Click *File* on top and click on *Load register*.

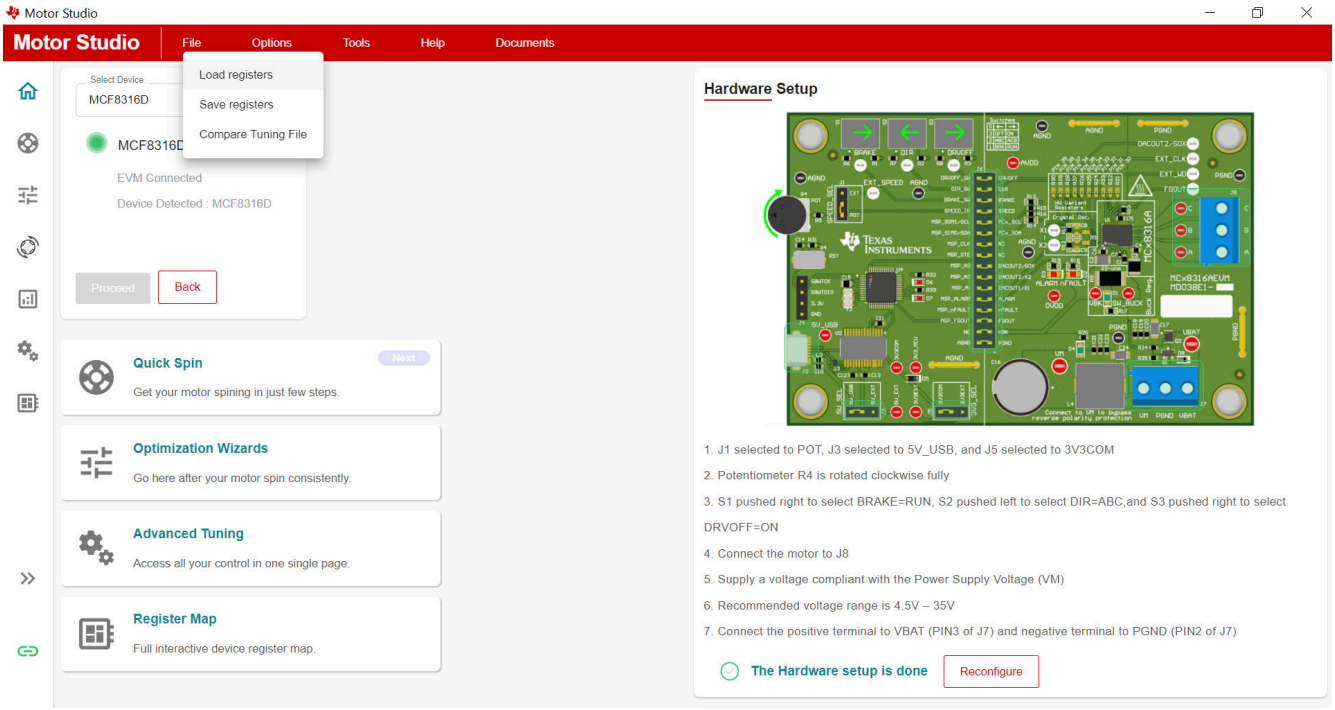


**Figure 3-2. Loading Registers From .json File**

**Step 6:** Load an appropriate *JSON* file with respect to the required application or specifications.

**Note**

Pick a .json file that matches your specifications from the E2E FAQ, if you do not already have a .json file.

## 3.1 Motor Parameters

Apart from the parameters mentioned in the Table 2-2 , the device also requires additional electrical and mechanical parameters of the motor to be measured. These parameters are measured as follows:

1. Manual measurements
2. MPET (Motor Parameter Extraction Tool) measurements

### *3.1.1 Manual Measurements*

In manual measurements, use lab equipment and motor data sheet to identify the motor parameters as mentioned in Table 3-2.

**Table 3-2. Manual Measurements and How to Measure Them**

| Manual Measurements | How to Measure |
|---|---|
| Motor phase resistance | Using the instructions in the Motor Parameters FAQ measure the phase resistance and inductance along with the BEMF constant of the motor |
| Motor phase inductance | |
| Motor BEMF constant | |
| BASE_CURRENT (applicable for MCF8329A only) | This register setting depends on the shunt resistor used on the board. Refer the MCF8329A Tuning Guide for calculating BASE_CURRENT |
| Rated speed of the motor (MAX_SPEED) | The maximum rated speed of the 3-phase BLDC motor (in Hz). Typically found in the data sheet of the motor. If the mechanical speed is in RPM (N) convert the value to electrical frequency (f in Hz) using the formula: f = P x N / 120. P is the number of rotor poles |
| Rated current of the motor | The rated peak phase current value for the 3-phase BLDC motor when this is driven at rated speed and rated voltage with load. Typically found in the data sheet of the motor. |

**Note**

For the MCF8329A, the motor phase resistance and phase inductance has to be measured manually. For MCF8315C/16C, motor phase resistance and phase inductance can be measured automatically in MOTORSTUDIO using MPET. Table 3-2 shows instructions for manual measurements only. However the Motor BEMF constant can be measured either manually or using the MPET for all devices in MOTORSTUDIO.

#### 3.1.1.1 Entering Manual Measurements Into MOTORSTUDIO

Manual measurements done in the previous section (Table 3-2) can now be entered into MOTORSTUDIO. Expand the left panel as shown in Figure 3-3 to navigate between sections in MOTORSTUDIO

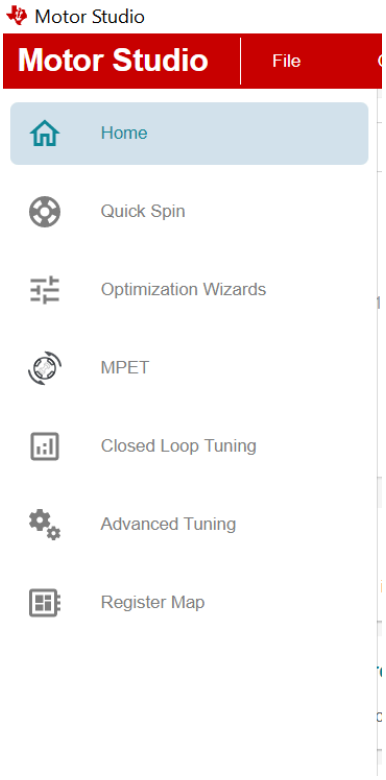


**Figure 3-3. Sections in MOTORSTUDIO**

**Table 3-3. Entering Values Into MOTORSTUDIO**

| Steps | Section | Sub-section | MCF8329A | MCF8315C/6C |
|---|---|---|---|---|
| Step 1 | Advanced Tuning | Control Configuration - Motor Parameters | Enter Motor Phase Resistance [MOTOR_RES] in Ω, Motor Phase Inductance [MOTOR_IND] in mH, Maximum motor speed [MAX_SPEED] in Hz | |
| Step 2 | Register Map (Field View) | Hardware Configuration-GD_CONFIG2 | Enter BASE_CURRENT in "Field View" | NA |
| | | Algorithm Configuration-MOTOR_STARTUP2 | Set OL_ILIMIT = 60% | Select OL_ILIMIT = 60% of the rated current (or the closest available value) |
| | | Fault Configuration - FAULT_CONFIG1 | Set ILIMIT = 70% | Select ILIMIT = 70% of the rated current (or the closest available value) |
| | | | Set HW_LOCK_LIMIT 90% | HW_LOCK_LIMIT = 90% of the rated current (or the closest available value) |
| | | | Set LOCK_LIMIT = 80% | LOCK_LIMIT = 80% of rated current (or the closest available value) |

### 3.1.2 Motor Parameter Extraction Tool Measurements

MOTORSTUDIO has capability of automatically measuring motor parameters in offline state, rather than having the user enter the values themselves. The Motor Parameter Extraction Tool (MPET) routine measures motor winding resistance, inductance, back EMF constant and mechanical load inertia and frictional coefficients. Offline measurement of parameters, when enabled, takes place before normal motor operation

#### 3.1.2.1 Motor BEMF Constant Measurement Through MPET – Along With Motor Resistance and Motor Inductance for MCF8315C, 16C

**Step 1**: Click *MPET* (Refer Figure 3-3 ) .

**Step 2**: Follow Figure 3-4 or Figure 3-5 settings in *MPET Select*.

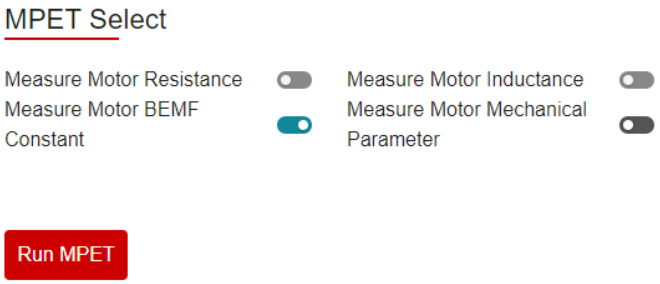


**Figure 3-4. Settings for BEMF Measurement - MCF8329A**

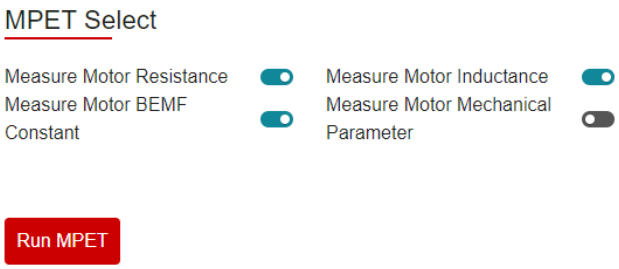


**Figure 3-5. Settings for R, L and BEMF Measurement - MCF8315C, 6C**

**Note**

Disable Measure Motor Resistance and Measure Motor Inductance in this step if you have measured and entered the values manually using Table 3-3 already.

**Step 3**: Enable *Auto read motor status* in Motor Status section on the right most pane.

**Step 4**: Click *Controls* tab on right most pane and enable *Speed Control via I2C*.

**Step 5**: In the same tab set the slider below *I2C Speed Command Percentage* to zero.

**Step 6**: Click *Faults* tab on right most pane and enable *Auto read fault status*. Click on *Clear Faults* if there are any existing faults.

**Step 7**: Click *Run MPET* below *MPET Select* .

**Step 8**: Once Motor BEMF measurement is completed (refer Logs window), click *Write MPET results to Shadow registers*.

#### 3.1.2.2 Mechanical Parameters (SPD_LOOP_KP, SPD_LOOP_KI) Measurement Through MPET

**Step 1**: Use the following settings in *MPET Select*.

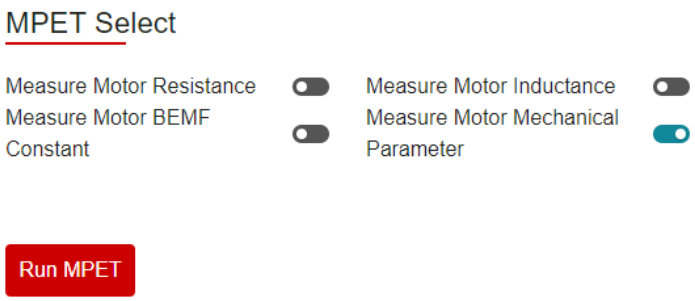


**Figure 3-6. Settings for SPD_LOOP_KP and SPD_LOOP_KI Measurement**

**Step 2**: Once Motor Mechanical Parameter measurement is completed (refer Logs window), click *Write MPET results to Shadow registers* in the Results Section.

This completes all the measurements.

**Note**

Refer TO this E2E FAQ if you run into errors during MPET.

## 4 Motor Runs

Use the right panel to run the motor now.

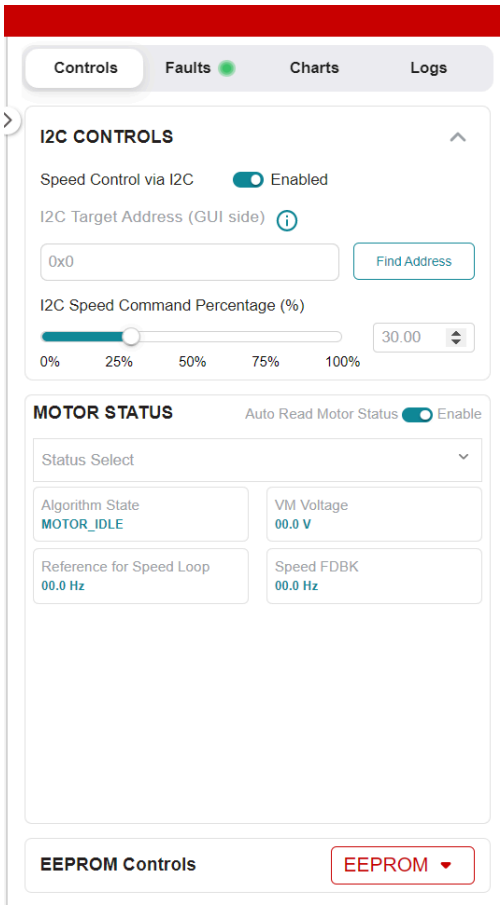


**Figure 4-1. Motor Runs Right Panel**

- Enable I2C Speed Command Percentage till 30%, make sure faults status is green.
- Motor spins according to the set speed.
- I2C speed command can be increased now as desired.
- Click *Write to EEPROM* under EEPROM Controls to write the configured values into EEPROM.

## 5 Summary

Driving BLDC motors efficiently with Field-Oriented Control (FOC) requires precise control over the three motor phase voltages and currents. The MCF83xx portfolio integrates this function into the device, offering a code-free control for BLDC motors. This document provides an initial guide in using MCF83xx devices to control your BLDC motor using MOTORSTUDIO.

## 6 References


- Texas Instruments, *MCF8316C-Q1 Sensorless Field Oriented Control (FOC) Integrated FET BLDC Driver*, data sheet.
- Texas Instruments, *MCF8329A Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver*, data sheet.

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