# DRV8889-Q1EVM GUI User's Guide

This document is provided with the DRV8889-Q1 customer evaluation module (EVM) as a supplement to the DRV8889-Q1 Automotive Stepper Motor Driver datasheet. This document only describes the installation and usage of the DRV8889-Q1EVM GUI. For additional details on hardware connections refer to the DRV8889-Q1EVM User's Guide.

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# 1 Overview

The DRV8889-Q1EVM is a platform to support prototyping and evaluation for the DRV8889-Q1, a medium-voltage dual H-bridge driver for stepper-driving applications. The DRV8889-Q1 drives a single bipolar stepper with microstep settings ranging from full-stepping to 1/256 resolution with internally-regulated microstep levels. It provides a variety of programmable decay settings and can detect stall conditions while driving.

The EVM uses an MSP430™ microcontroller and a USB interface chip to manage communication from the GUI software application installed on a PC computer with Windows®. The GUI sends serial commands to the MSP430 to control the device signals, monitor faults, read and write SPI registers, and drive a stepper motor by issuing the step commands at the desired rate. This document describes the software and tools used to evaluate DRV8889-Q1 device for stepper motor driving on the DRV8889-Q1EVM.

# 2 Hardware and Software Setup

The hardware (HW) and software (SW) tools that follow are required for the evaluation of DRV8889-Q1:

- DRV8889-Q1EVM
- Stepper motor
- Voltage supply from 4.5 V to 45 V

This document only describes the installation and usage of the DRV8889-Q1EVM GUI. For additional details on hardware connections refer to the DRV8889-Q1EVM User's Guide.

# 3 GUI Application

## 3.1 Installation

Installation (For Desktop Version Only)

- Download the installable DRV8889-Q1_x.y.z_installer_win.zip file (x.y.z is GUI revision number: 1.0.0 for the EVM were ordered before August, 2019; 1.1.1 or up for the EVM were ordered after Sempter, 2019.).
- Extract the zip file.
- Double click on the installer to install the GUI Application. Install it.

## 3.2 Getting Started with DRV8889-Q1EVM GUI

The DRV8889-Q1EVM GUI and DRV8889-Q1EVM allows the user to configure various settings required for stepper motor driving. The DRV8889-Q1EVM GUI lets the user adjust the motor speed, control the direction, control the step movement, configure various device settings, and monitor the device status.

Perform the following steps to begin using the GUI:

- Connect the stepper motor to the EVM.
- Plug in the micro-USB cable to the PC.
- Enable the motor power supply. For additional details on hardware connections refer to the DRV8889-Q1EVM User's Guide.

Click on DRV8889-Q1EVM GUI shortcut either on the desktop or from the start menu to run the GUI application.

## 3.3 Use the DRV8889-Q1EVM GUI

- The Application opens with launch page shown in Figure 1.



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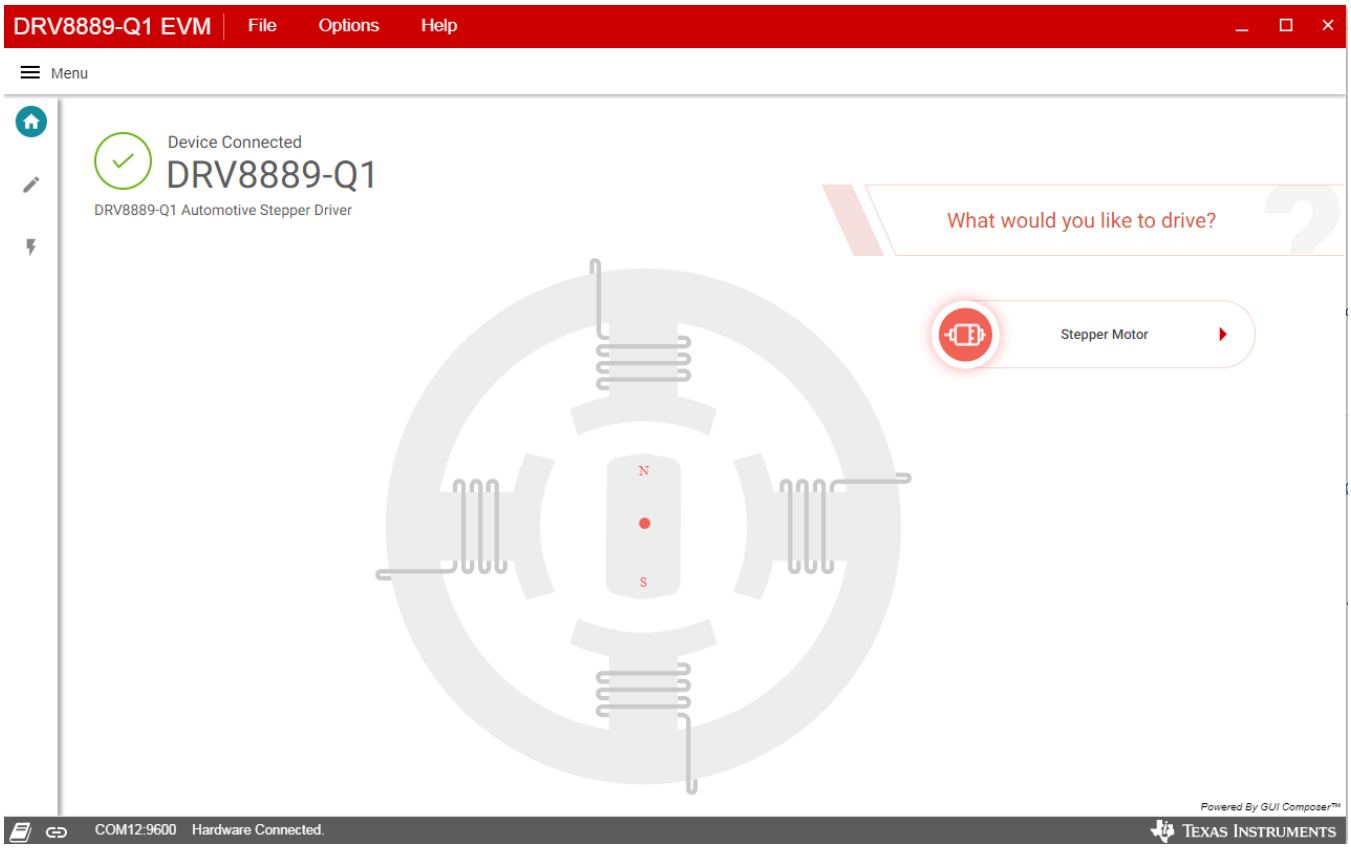



**Figure 1. DRV8889-Q1 EVM GUI (Home Page)**

- For GUI 1.0.0, the application will try to establish communication with the device connected. A message showing ‘Connected to Cloud Agent. Connecting to target…’ will be displayed in the hardware connection status pane at the bottom of the screen. G1.0.0 serial port baud rate has to be 9600. If the connection is successful, ‘COMxx:9600 Connected to Target’ message appears as shown in Figure 2 below.




**Figure 2. Figure 2. DRV8889-Q1 EVM GUI (Device Connection pane)**

- For GUI 1.1.1 or later version, the application won't need network connection to "Cloud Agent" and serial port baud rate has to be 115200.
- If the GUI fails to connect to the EVM, the hardware connection status pane will show the message ‘Hardware Not Connected.’
- If the GUI is opened without connecting the EVM, the hardware connection status pane will show ‘Error: no serial ports found.’
- If there are more than one DRV8889-Q1EVM boards connected, the first matching device will be connected automatically. In order to switch to another EVM,
  - Click Options -> Serial Port. A serial port configuration popup is displayed as shown below in Figure 3.
  - Choose the appropriate port and baud rate: G1.0.0 baud rate has to be 9600. GUI1.1.1 or later version baud rate has to be 115200.
  - Click OK.


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**Figure 3. Serial port configuration**

- Once the correct device is connected, the home page will show a message 'Device Connected' with a green check mark as shown in Figure 1.
- Click on the 'Stepper Motor' button to open the stepper control page.

### 3.3.1 Stepper Control Page

The Stepper Control page (shown in Figure 4) includes various controls to sleep/wake the driver, control the stepper motor, and configure various parameters such as slew rate, torque, full scale current, and so forth. Hovering over the (?) icon to the right of a control displays a brief description about the control.

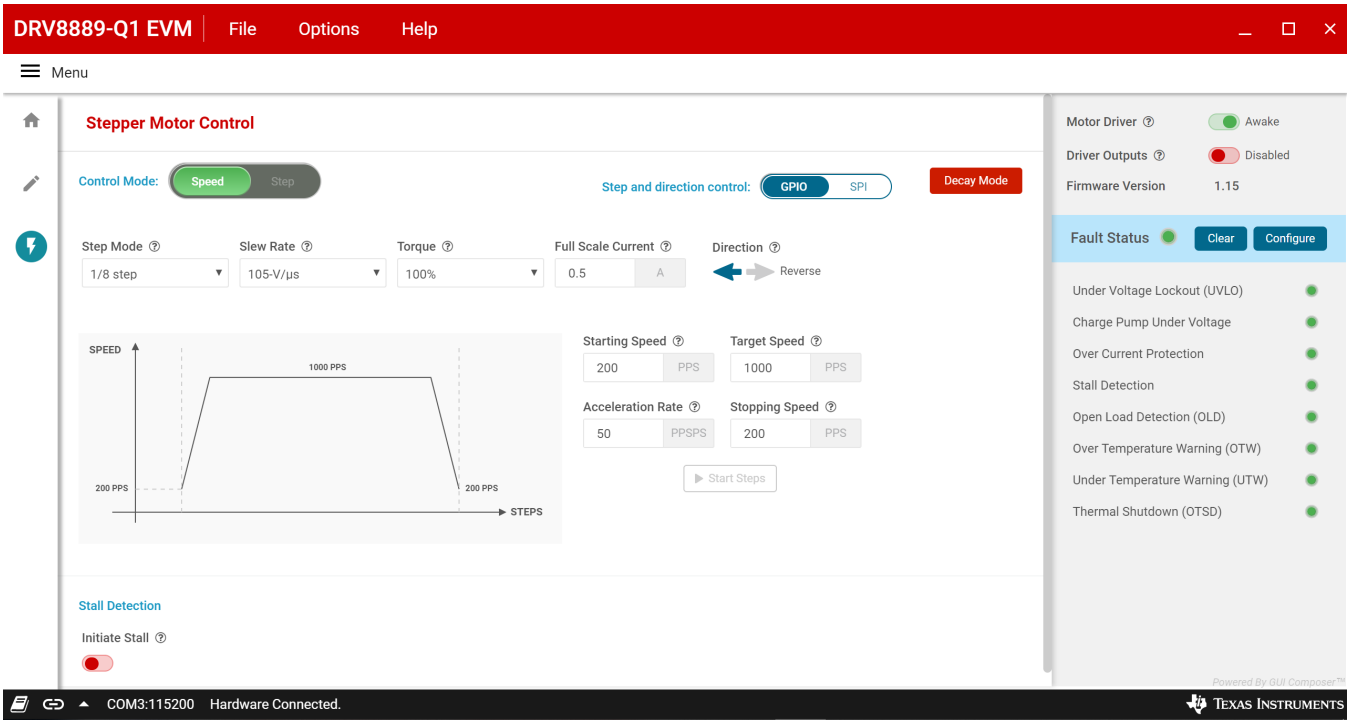



**Figure 4. DRV8889-Q1 EVM GUI (Stepper Motor Control page)**

#### *3.3.1.1 Stepper Control Modes*

The GUI allows the user to control the stepper motion profile in two modes – Speed Mode and Step Mode. To toggle between the modes, use the toggle button at the top of the screen.



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#### 3.3.1.1.1 Speed Mode

Speed Mode allows the user to spin the stepper motor continuously at a desired speed. The user configures the starting speed, stopping speed, acceleration rate, and target speed. Stepper controls are enabled only when 'Motor Driver' control is enabled in other words, DRVOFF pin is set to low. The ‘Start Steps’ button is enabled only when ‘Driver Outputs' control is enabled for example, DRVOFF pin is set to low. When the ‘Start Steps’ button is clicked, the motor begins spinning at the starting speed and accelerates to the target speed according to the configured acceleration rate. The acceleration profile in the microcontroller firmware accepts the starting-speed and target-speed PPS values and calculates the appropriate PWM clock period to create the stepping signal on the STEP pin. When the ‘Start steps’ button is clicked, the PWM timer generates steps at a rate specified by the 'Starting Speed' PPS parameter. When ‘Stop Steps’ is clicked, the motor starts decelerating at the ‘Acceleration Rate’ configured to reach the stopping speed and eventually stop. The configuration is visualized by the embedded graph shown on the GUI screen (Figure 5).

When accelerating or decelerating, the PPS signal is adjusted every 32 ms based on the integer value of PPSPS / 32 ms. Acceleration rates must be between 1 and 65,535 PPSPS. The step rate increases by the calculated value until the target speed is reached.

The starting speed must be less than or equal to the target speed. If the starting speed and target speed are equal, the EVM firmware will not perform an acceleration routine. The stopping speed must also be less than or equal to the target speed. The target speed is limited to a range between 50 and 65,535 PPS.

The 'Start Steps' command computes how frequently automatic speed updates are issued and a second timer is used to change the speed according to the programmed acceleration rate profile. Once clicked, the motor will begin spinning according to the parameters set in the GUI.

When the target speed PPS value is reached, the acceleration profile ends, and the motor continues running at the target speed until the 'Stop Steps' button is clicked. When the stepper is commanded to stop, the controller performs the same actions as it did while accelerating, but in reverse order, to decelerate until the stopping speed PPS value is reached. At this point, the motor fully stops.




**Figure 5. Controls available for Speed Mode**

#### 3.3.1.1.2 Step Mode

Step Mode allows the user to move the stepper motor a configured number of steps. Stepper controls are enabled only when the 'Motor Driver' control is enabled for example, DRVOFF pin is set to low. When the ‘Start Steps’ button is clicked, the motor starts spinning at the starting speed and accelerates at the rate configured. When the number of steps is reached, the motor stops.

The acceleration and deceleration profiles work similarly as before, except when the deceleration routine starts and when the motor stops are a function of the 'Steps to Stop' and deceleration rate parameters. The configuration can be visualized in the graph embedded in the GUI. If the "Reciprocate" button is enabled, the stepper will travel the set number of steps, then reverse direction. It will do this continuously until 'Stop Steps' is clicked. Figure 6 shows the controls available in Step Mode


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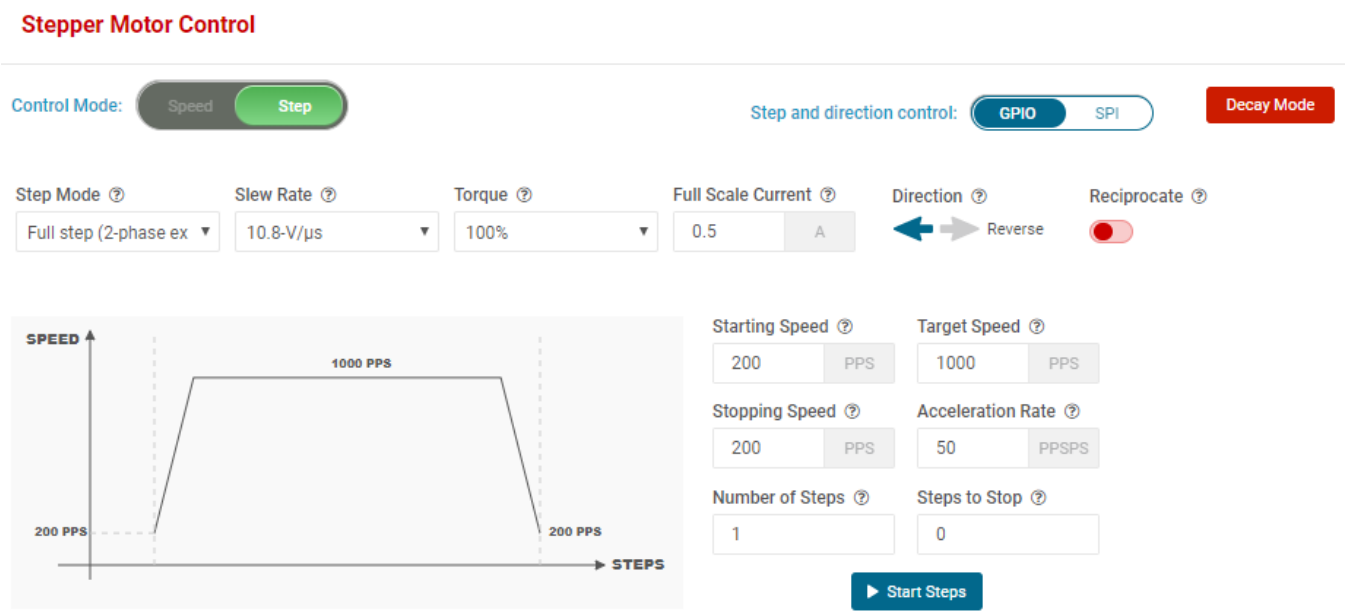



**Figure 6. Controls for Step Mode**

The parameters from 'Speed Mode' are reused as well, and they operate the same as described in Section 3.3.1.1.1. Two new parameters have been added to properly control the limited number of steps actuation. These parameters are described as follows:

**Number of Steps —** This parameter is the number of steps that the controller will issue.

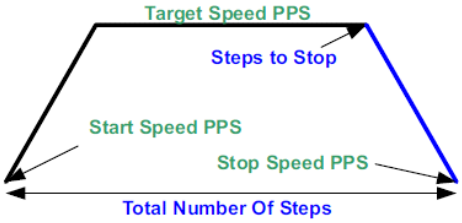
**Steps to Stop —** The controller is continuously monitoring the step being issued and when the current step is equal to the 'Steps to Stop' parameter, a deceleration profile is issued. If the value of the 'Steps to Stop' parameter is larger than the number of steps, then the motor stops abruptly and without undergoing a deceleration profile.

When a deceleration profile is issued, the controller decreases the speed until reaching the 'Stopping Speed' value. If the 'Number of Steps' parameter is met before the deceleration profile is complete, then the motor stops at the current speed. If the stopping speed is met before all the number of steps is issued, then the motor rotates at the stopping speed value until all the steps are executed.

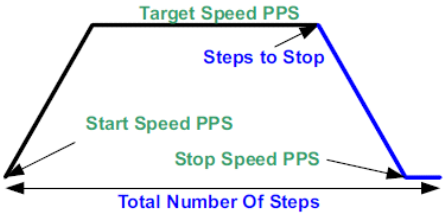
Ideally, the system should resemble the case in which the controller executes all the commanded steps at a speed as close as possible to the stop speed. In the event this is not possible because of the particular parameters that were selected, stopping the motor at a speed very close to the 'Stopping Speed' parameter is often good enough to ensure good motion quality and application performance.

Figure 7 shows the three conditions possible when stopping and the action taken.

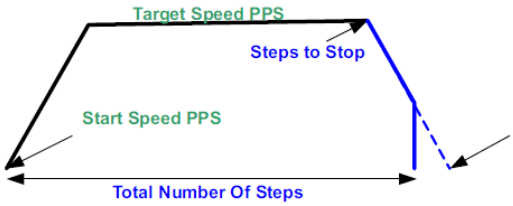

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1. Motor reaches stop speed at the stop speed.




2. Motor reaches stop speed before the stop speed is reached.




3. Motor runs out of steps before reaching stop speed.

**Figure 7. Stop conditions**


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### 3.3.2 Decay Mode

Decay refers to how the driving currents recirculate in H-bridge FETs during the off time. Using the GUI, the user configure the decay mode. To configure,

- Click the Decay Mode button at the top center-right of the screen. A popup appears as shown below in Figure 8.

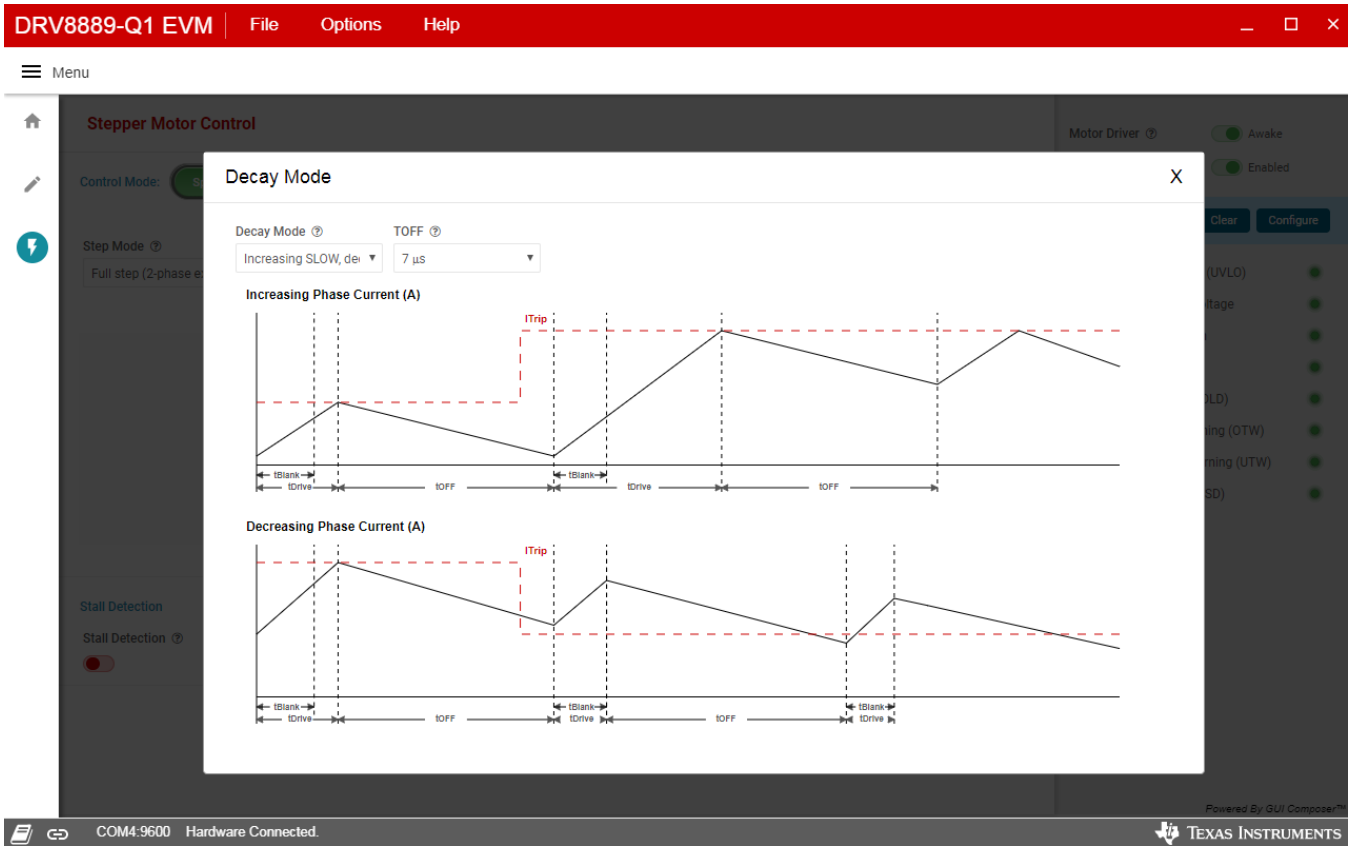



**Figure 8. DRV8889-Q1 EVM GUI (Decay mode)**

- Decay mode and appropriate TOFF values can be configured in the popup. The configurations can be visualized in the graph shown. For information about the different decay modes, refer to the DRV8889-Q1 Automotive Stepper Motor Driver datasheet.

### 3.3.3 Fault Monitoring

The fault monitor section at the right side of the screen allows the user to configure monitor the various device faults. The LED staying green indicates 'No Fault'. When the LED turns red, it indicates that a fault has occurred. The user can also configure Fault reporting options by clicking the 'Configure' button.

### 3.3.4 Register Map

- Enabling the Motor Driver enables the Register page.
- The page can be opened by clicking 'Pencil' icon from the side-bar menu
- This page displays all the registers and their fields present on the DRV8889-Q1 device.
- The page allows reading and writing any register, field, or bit.
- To read a particular register, click on the register and click 'Read Register' button.
- To read all the registers, click 'Read All Registers' button
- To update the register values:
  - Edit the 'Value' field directly to update a register's hex value.



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  - Change the field value from the field view at the right of the screen.
  - Double click on any of the register bit to flip the bit (from 0 to 1 or vice versa).
- By default, the write mode is Immediate which writes values to the registers immediately upon change.
- Write mode can be changed to ‘Deferred’ which will write queue all changes and update the device registers only when ‘Write Register’ or ‘Write All Registers’ is clicked.
- Click on the question mark icon on any register or field to get in-place data sheet help.

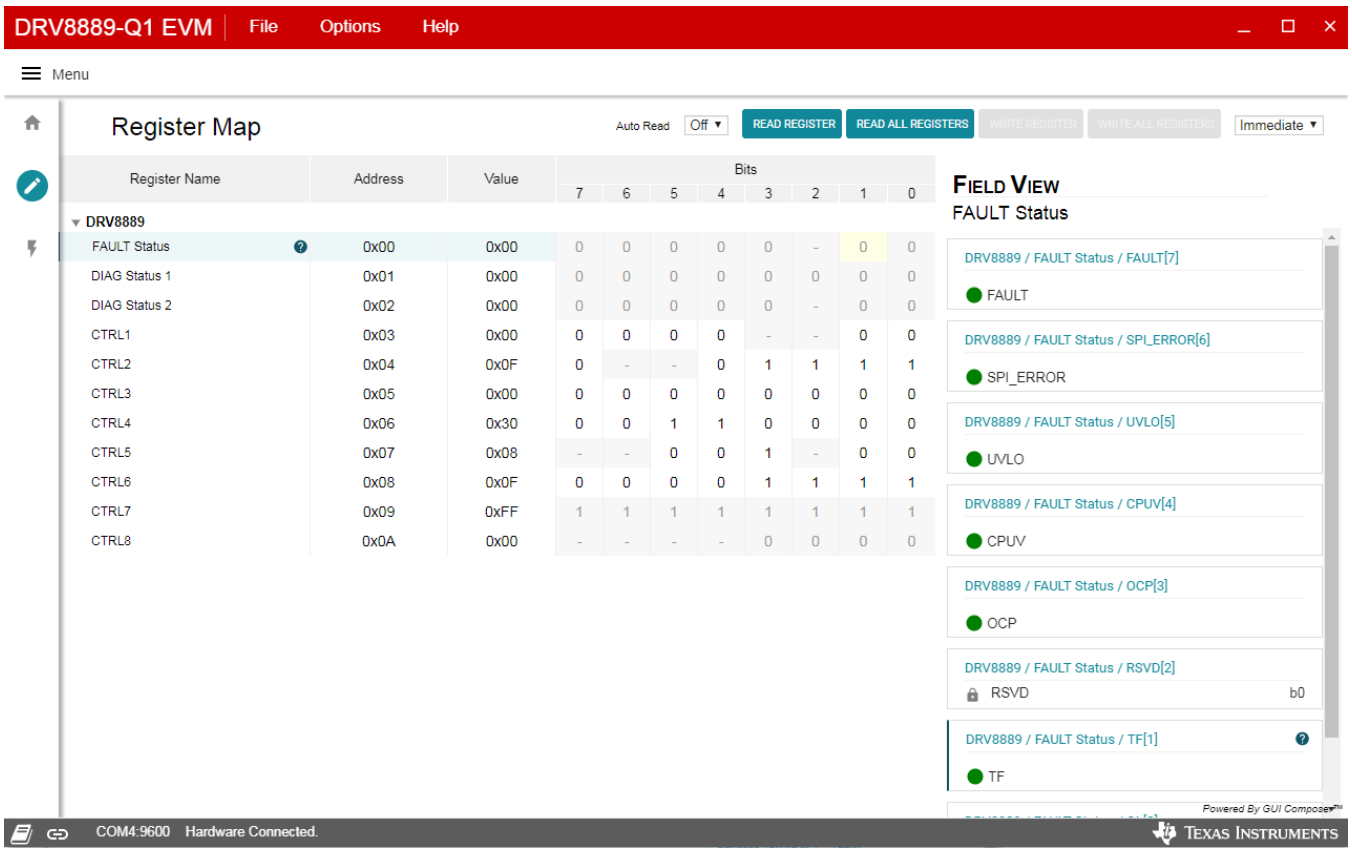



**Figure 9. DRV8889-Q1 EVM GUI (Registers Page)**

### 3.3.5 Stall Detection

This section covers three different ways to evaluate stall detection using the DRV8889-Q1EVM GUI.

#### *3.3.5.1 Automatically Learn Stall Threshold*

1. Configure desired motion profile in the GUI in Speed Mode. The stall detection will not be available for Step Mode.
2. Configure device settings as desired. The default values should be acceptable for immediate evaluation. If motor torque is too high while evaluating, change the 'Full-Scale Current' setting or 'Torque' setting to reduce it.
3. Click 'Start Steps' to begin spinning the motor.
4. Enable ‘Stall Detection’ toggle button available on the ‘Stall Detection Panel’.
5. By default, ‘Stall Detection Mode’ is set to ‘Automatic Mode’.
6. Once the target speed is reached, the microcontroller will write the STL_LRN bit to begin learning the stall threshold value, STALL_TH.
7. After 16 electrical cycles, the GUI displays the message “Please stall motor to complete Stall Threshold learning sequence.” At this point, the user must physically stall the stepper motor.


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8. Once the motor stalls, The nFAULT pin asserts low which turns the Fault indicator on the right panel of the GUI to RED. If this happens, the STL_LRN_OK and STALL bits should be set, and the GUI displays the message “Stall Threshold learning sequence complete”.
9. To reset the stall fault, remove the stall condition from the motor so it spins again, or click 'Stop Steps' to stop the motor. Then click on ‘Clear Fault’ button to clear the stall fault.

For demonstration purposes, click the 'Reverse direction on stall fault' toggle button. After learning the stall threshold, this EVM feature will drive the motor until it stalls. After a stall event occurs, the motor will pause briefly, then begin driving in the opposite direction.

If for some reason stall threshold (STALL_TH) is not properly learned, clicking the ‘Relearn Stall Threshold’ button will tell the EVM to re-run the learning algorithm starting at step 6 in the list above. If the motor is physically stalled, but the GUI continues to display “Please stall motor to complete Stall Threshold learning sequence,” the DRV8889 may not have properly learned the stall detection threshold. This can happen at low motor speeds, which cause the stepper back EMF to be low, and a valid STALL_TH value may not be determined.

‘Stall Threshold Graph’ shown in periodically plots the Torque Count (TRQ_COUNT) and Stall Threshold (STALL_TH) values.

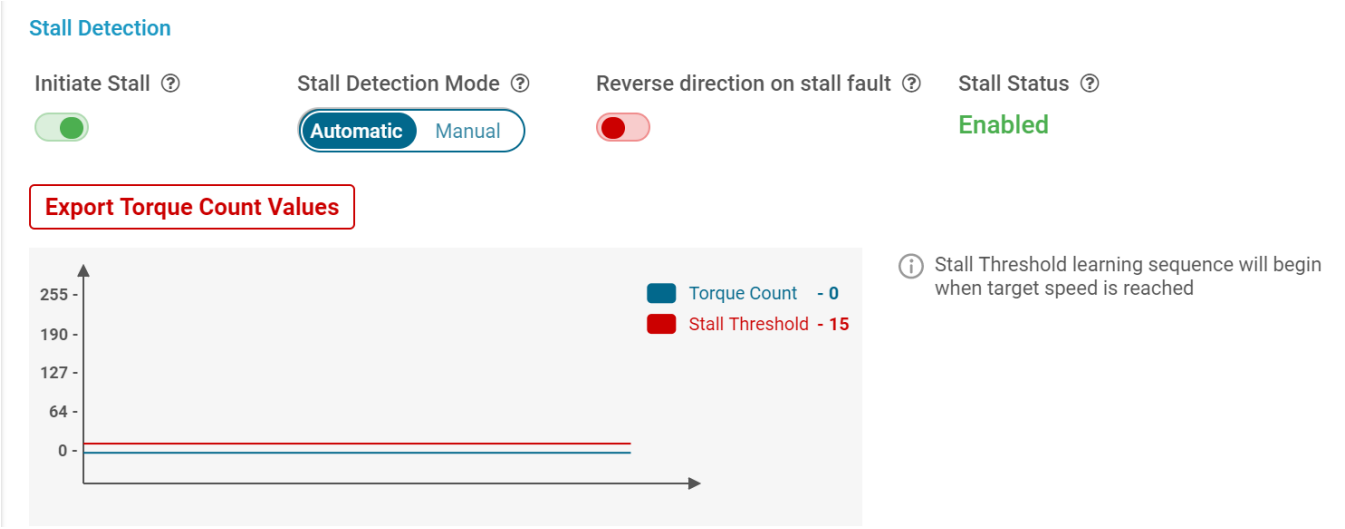



**Figure 10. Stall detection configuration panel in Automatic Mode**

### 3.3.5.2 *Manually Set Stall Threshold*

The stall threshold can be manually set by switching to Manual Mode using the ‘Stall Detection Mode’ control. In this mode, the user sets the stall threshold to any desired value. If a valid stall threshold is chosen, the stall fault will be reported as described in the previous section Section 3.3.5.1. To correctly detect a stall, the stall threshold should be less than the torque count while the motor is spinning. If the stall threshold value is too close to torque count value, then false stalls may be detected as the motor torque increases. The 'Reverse direction on stall fault' toggle button operates the same way in Manual Mode as described in the previous section. Figure 11 shows the Stall Detection panel in Manual Mode.


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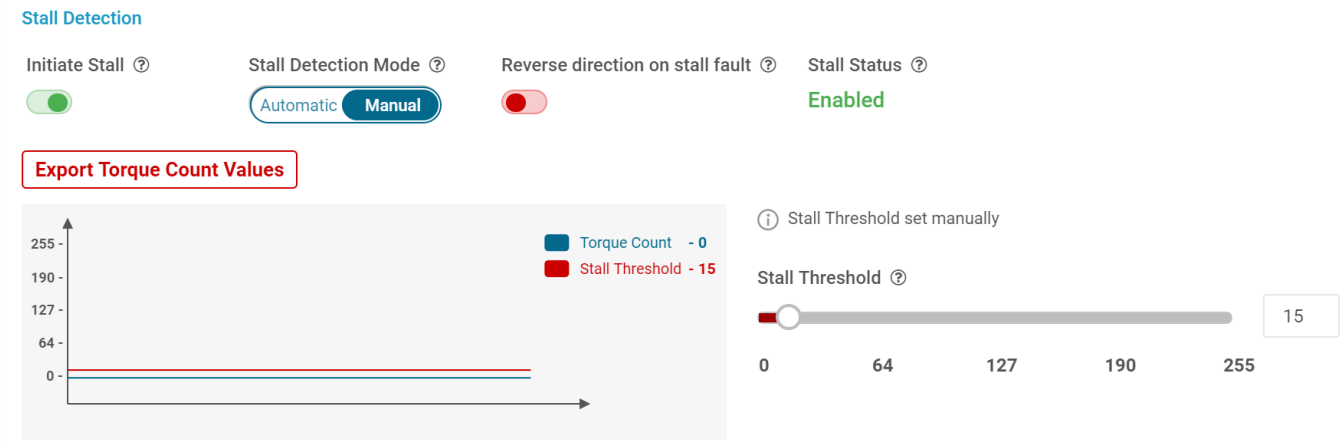



**Figure 11. Stall detection configuration panel in Manual Mode**

#### 3.3.5.3 *Using Register Map*

1. Configure desired motion profile in the GUI in Speed Mode. The default values will be acceptable for immediate evaluation. When configuring stall detection using the register map, it is not necessary to click the 'Stall Detection' toggle button on the Speed Control page.
2. Configure device and motion profile settings as desired. The default values should be acceptable for immediate evaluation. If motor torque is too high while evaluating, change the 'Full-Scale Current' setting or 'Torque' setting to reduce it.
3. Click 'Start Steps' to begin spinning the motor.
4. Go to the Register Map page, and click 'CLR_FLT' in CTRL4 to clear any existing faults. Click 'READ ALL REGISTERS' to refresh the register map.
5. Once the stepper reaches the target speed, set the STL_LRN bit in the CTRL5 register in the register map. This will begin the algorithm that learns the stall threshold.
6. After a few seconds, stall the motor. The Fault LED on the board should light, if the STL_REP bit in CTRL5 is set to 1 (default). The STL bit in the FAULT Status register, and the STALL bit in the DIAG Status 2 register will also set when a stall condition is detected. Click 'READ ALL REGISTERS' to refresh the register map in the GUI to see these bits change.
7. To reset the stall fault, remove the stall condition from the motor so it spins again, or click 'Stop Steps' to stop the motor. Then click 'CLR_FLT' in CTRL4 to clear the stall fault.

After "Initiate Stall" turns to green, "Stall status" synchonizes to register EN_STL bit.

Clicking "Export Torque Count Values" can allow up to half hour Torque_count values (8ms/sample) save to torque_values.csv.

### 3.3.6 Use the Side-Bar Menu

Use the side-bar menu in the left pane to navigate to the different pages at any time. Click on the hamburger button in the top-left corner of the GUI to expand the side-bar menu. The following pages that are displayed in the side-bar menu:

- Home
- Registers
- Stepper Motor Control

### 3.3.7 Menu bar Options

The following menus are available in the menu bar displayed at the top of the GUI as shown in Figure 12.


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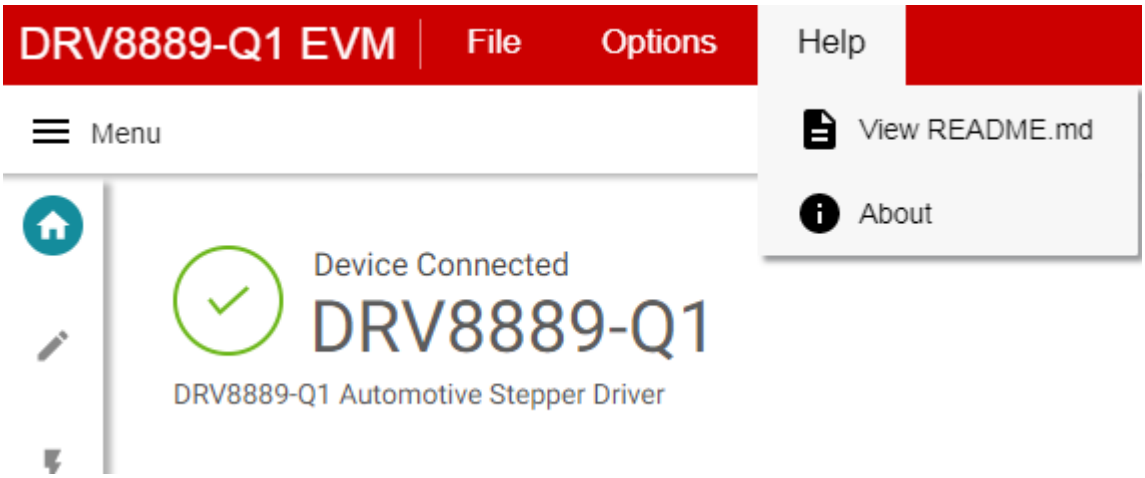



**Figure 12. DRV8889-Q1 EVM GUI (Menu bar – Help Option)**

#### *3.3.7.1 File Menu*

The File Menu has the following options:

- **Program Device** - The user can load the firmware (.out) file onto the device by clicking this option. For the firmware load to work, MSP430 FET needs to be plugged into the J2 connector on the EVM board.
- **Load/Save Registers** – The user can save (and load) a particular configuration of the registers. This saves time when the user need to reconfigure the registers after power cycle.

#### *3.3.7.2 Options Menu*

This menu provides the option to configure the serial port communication settings.

#### *3.3.7.3 Help Menu*

The Help Menu contains options to view Readme File and About Section. The about section displays the installed software information including the application version.

## 4 Errata

This section outlines known errata with the DRV8889-Q1EVM and GUI.

1. When the board is powered, and the "Motor Driver" status is set to "Awake", UVLO and CPUV faults will display in the fault monitor and in the register map for 1p0 sample (CTRL8 register=0000b). These do not interfere with the operation of the EVM, and they can be cleared by setting the CLR_FLT bit in the register map. If the UVLO fault is not be clear after try 2 or 3 time Clear command, please re-start the GUI.
2. There is 1-4 seconds delay between the GUI and EVM when updating settings between the GUI and the board. If the setting is not gone through or is ignored, please try updating settings multiple times in register map page. Updates and faults may not occur immediately in the GUI, but the EVM board will display faults on the nFAULT LED in real time. STALL_TH and TRQ_COUNT updates in the 'Stall Threshold Graph' are also delayed.
3. If 'Step and direction control' is set to 'SPI' and a high step rate is chosen for 'Target Speed,' the GUI may lose communication with the EVM due to the large number of SPI transactions in a given amount of time.


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