DRV8847EVM and DRV8847SEVM Software User's Guide

This document is provided with the DRV8847EVM and DRV8847SEVM customer evaluation modules (EVMs) as a supplement to the *DRV8847 Dual H-Bridge Motor Driver* data sheet and the *DRV8847EVM and DRV8847SEVM User's Guide* to describe the functionality of the software and how to use GUI application for the DRV8847EVM and DRV8847SEVM (referred to as DRV8847xEVM).

Contents

List of Figures

Trademarks

1 Overview

The DRV8847x customer EVM is a platform for evaluation of DRV8847 device, a low voltage dual H-bridge driver. This device is optimized to control one or two brushed DC motors, or a stepper motor or solenoids. The DRV8847 device can also be configured to drive a single brushed DC motor using both output stages in parallel mode to increase the drive current. The EVM has an MSP430™ microcontroller and an USB interface chip. The USB chip allows for serial communications from a PC where a Microsoft® Windows® application is used interface with GUI over serial communication. These commands can be used to control each of the device signals, and drive the motors at the desired rate. The microcontroller firmware outputs the control signals and PWM signals to move the motor. The firmware also monitors the nFAULT signal to alert the GUI that a FAULT has occurred and describes the nature of fault in case of DRV8847S device. This document describes the software and tools used to evaluate DRV8847 device for stepper motor and brushed DC operation on the DRV8847xEVM.

For more information on these modes, refer to the *DRV8847 Dual H-Bridge Motor Driver* data sheet.

2 Hardware and Software Setup

The hardware (HW) and software (SW) tools that follow are required for the evaluation of DRV8847 device:

- DRV8847x EVM
- Brushed motors, stepper motors and solenoids
- Voltage supply from 2.7 V to 18 V
- Jumper wires (for connections)
- Code Composer Studio™ software V6.0 and newer

This document only describes the installation and usage of the DRV8847x EVM GUI. For additional details on hardware connections refer to the *DRV8847EVM and DRV8847SEVM User's Guide*.

3 Software and Tools Overviews

3.1 GUI Application

3.1.1 Install the GUI

Download and run the installer file, Setup_DRV8847-1.0.0_EVM.exe, to install the GUI application.

3.1.2 Use the DRV8847x EVM GUI

Use the DRV8847x EVM and GUI to change various settings and to control brushed motors, stepper motors, and solenoids. The DRV8847x EVM GUI lets the user adjust the speed and direction of the motor, change parameters of the motor-control algorithm, and monitor the device status. Do these steps to get started with the GUI:

Step 1. Attach the brushed or stepper motors.

Step 2. Connect the micro-USB cable with the PC.

Step 3. Enable the motor power supply. For additional details on hardware connections refer to the *DRV8847x EVM User's Guide*.

Step 4. Click on DRV8847x EVM GUI shortcut either on the desktop or from the start menu to run the GUI application.

Step 5. Select the device variant to be used on the launch page shown in Figure 1.

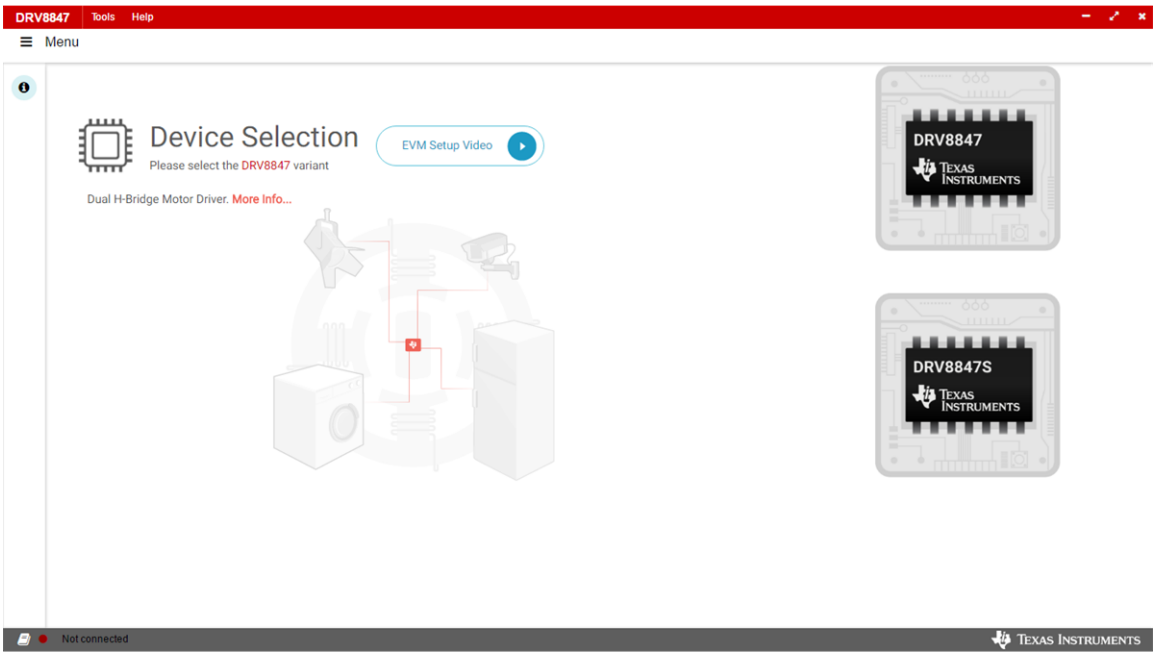

Figure 1. DRV8847x EVM GUI (Launch Page)

The first matching device (the device supported by the application for the selected variant) that gets connected to the PC is connected automatically. If multiple devices are connected go to the Serial Port page to manually select an available COM port. The Serial Port page shows the list of available COM ports. Use the connect and disconnect buttons on the Serial Port page to change the matching devices in the application as shown in Figure 2. If nothing is physically connected to the PC, the GUI shows a status of -- *No Device Connected* –. If the connected device needs to use a different COM port, click the *Disconnect* button in the connected COM port. Click the *Connect* button in the COM port that needs to be connected.

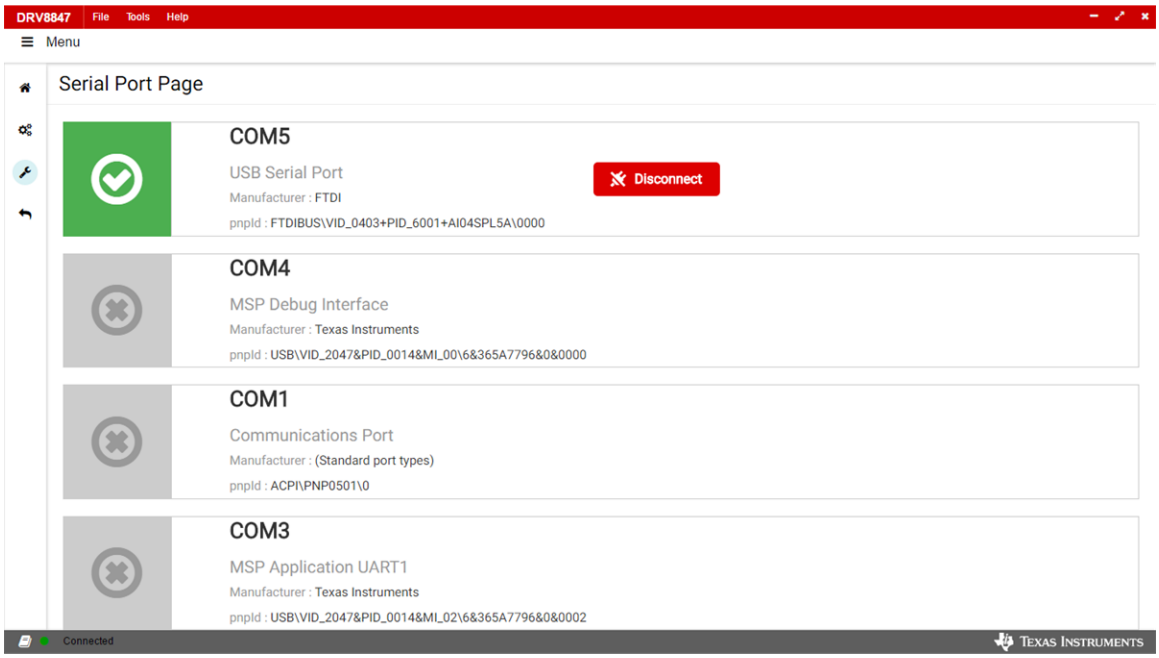

Figure 2. DRV8847x EVM GUI (Serial Port Page Showing the Required Friendly Name)

Step 6. Make sure that the GUI shows the *Connected* status after the GUI connects (see Figure 3).

The bottom-left corner of the status bar shows a green indicator to indicate the connection with the opened COM port and with the device.

Figure 3. DRV8847x EVM GUI (COM Opened)

3.1.2.1 Use the Side-Bar Menu

Click on the hamburger button in the top-left corner of the GUI to open the side-bar menu.

Use the side-bar menu to navigate to the following pages or sub-pages at any time. The pages that follow are in context of the launched device:

- Home
- Registers
- Stepper Motor/Dual H Bridge Control
- Serial Port
- Back

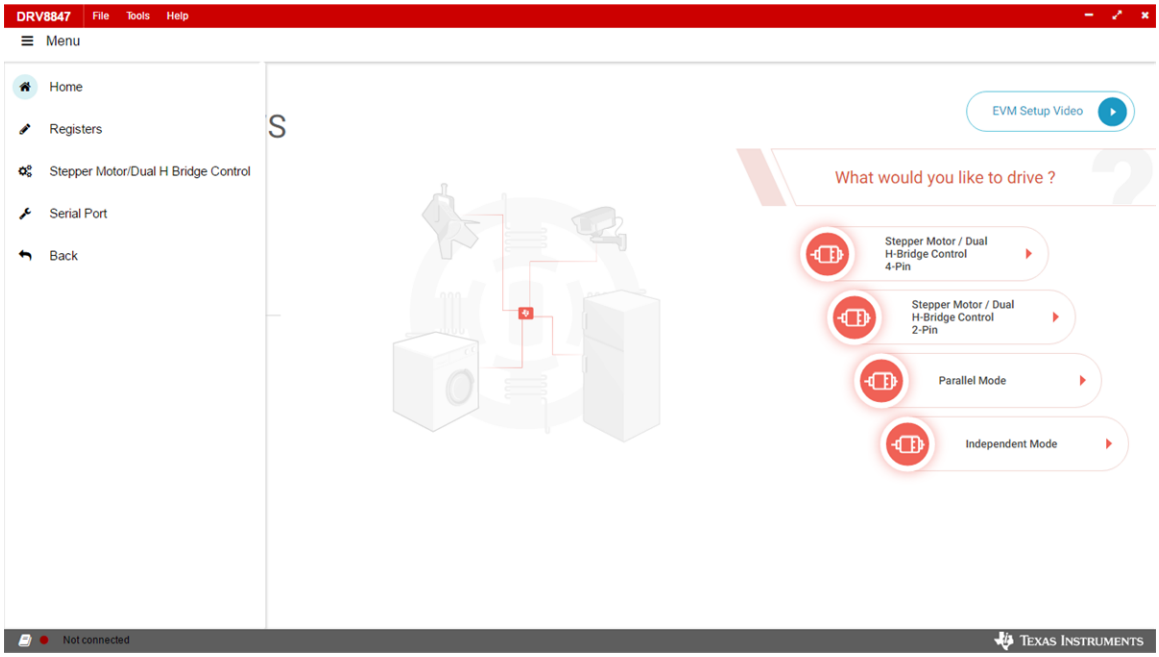

Figure 4. DRV8847x EVM GUI (Menu)

3.1.2.1.1 Home Page

Click the home icon to go to the Home page. The Home page has the general information about the DRV8847x EVM device and links to additional information.

- Click the *EVM Setup Video* button to play the video that explains the EVM Setup process.
- Click the *Register Map* link to open the Register Map page.
- Click any of the four buttons under the *What would you like to drive?* section to open the Motor Control page under the corresponding mode.

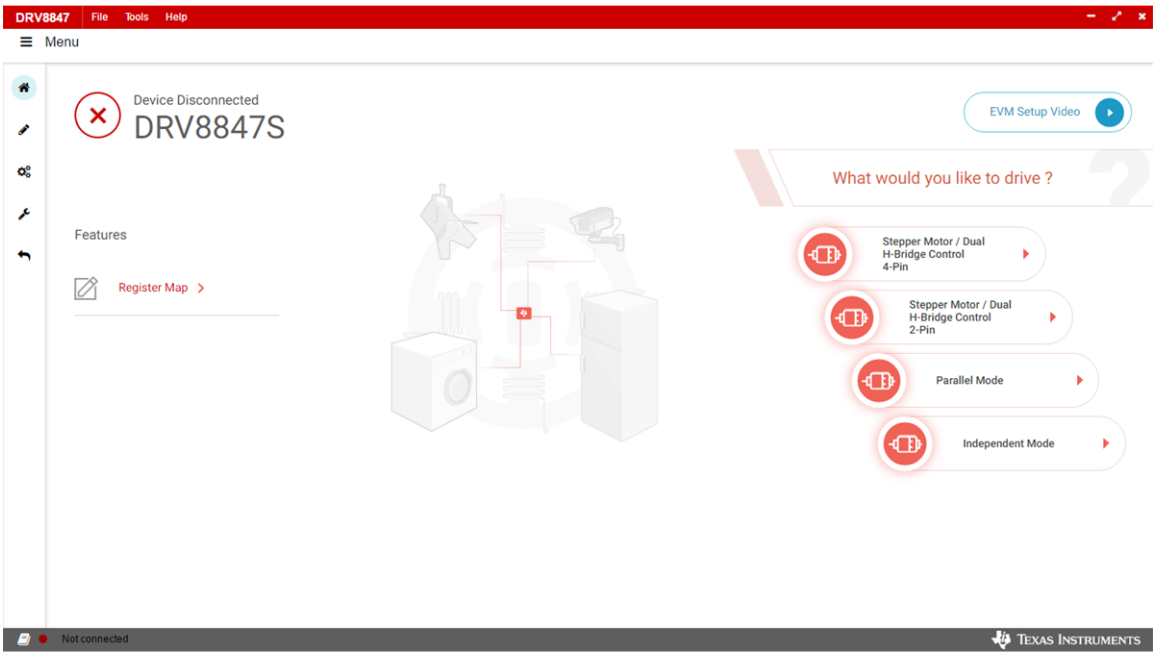

Figure 5. DRV8847x EVM GUI (Introduction Page)

3.1.2.1.2 Register Map Page

The Register Map page shows all the registers and their fields on the DRV8847 device. The Register Map page lets the user read and write to any register, field, or bit. Click on the question mark icon on any register or field to get in-place data sheet help. The Register Map page is available only for the S variant of the DRV8847 device.

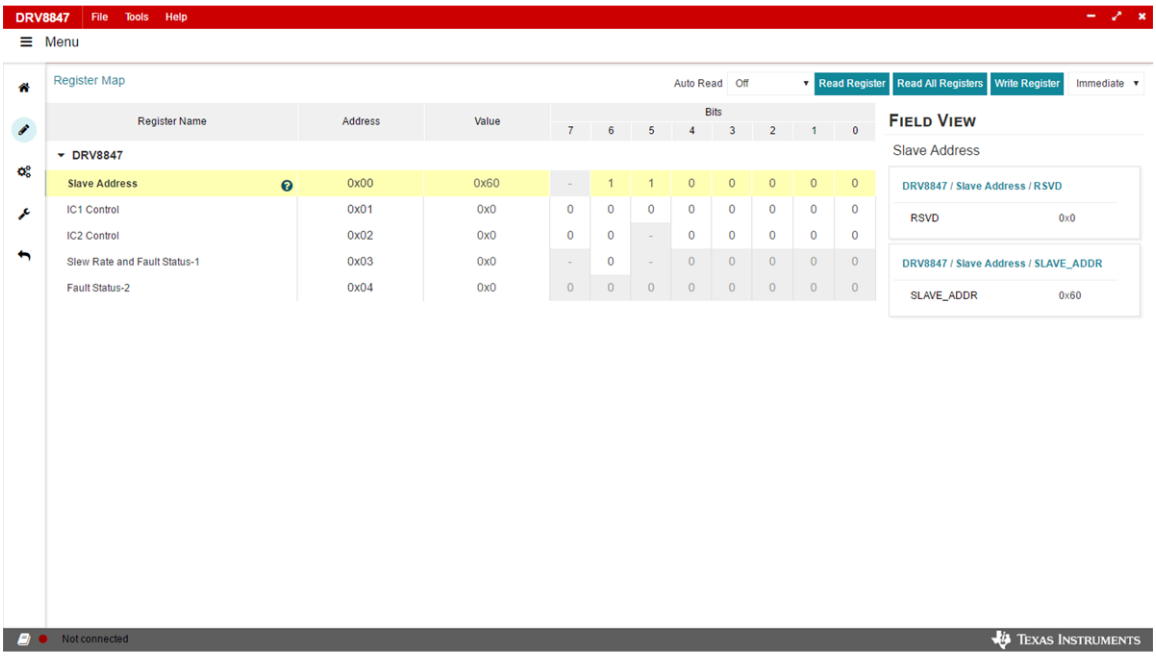

Figure 6. DRV8847x EVM GUI (Registers Page)

3.1.2.1.3 Motor Control Page

The Motor Control page has four pages for motor control:

- Stepper Mode / Dual H-Bridge Control – 4-pin
- Stepper Mode / Dual H-Bridge Control – 2-Pin
- Independent Mode
- Parallel Mode

The correct page is shown automatically. The Motor Control page and the side-bar menu change based on the type of bridge control mode that is selected.

Each page has different widget controls to control the motor and tune its parameters.

3.1.2.1.3.1 Stepper Mode/Dual H-Bridge Control-4-Pin

The Stepper Mode/Dual H-Bridge Control-4-Pin page has different widget controls to control the motor and tune the parameters as shown in Figure 7.

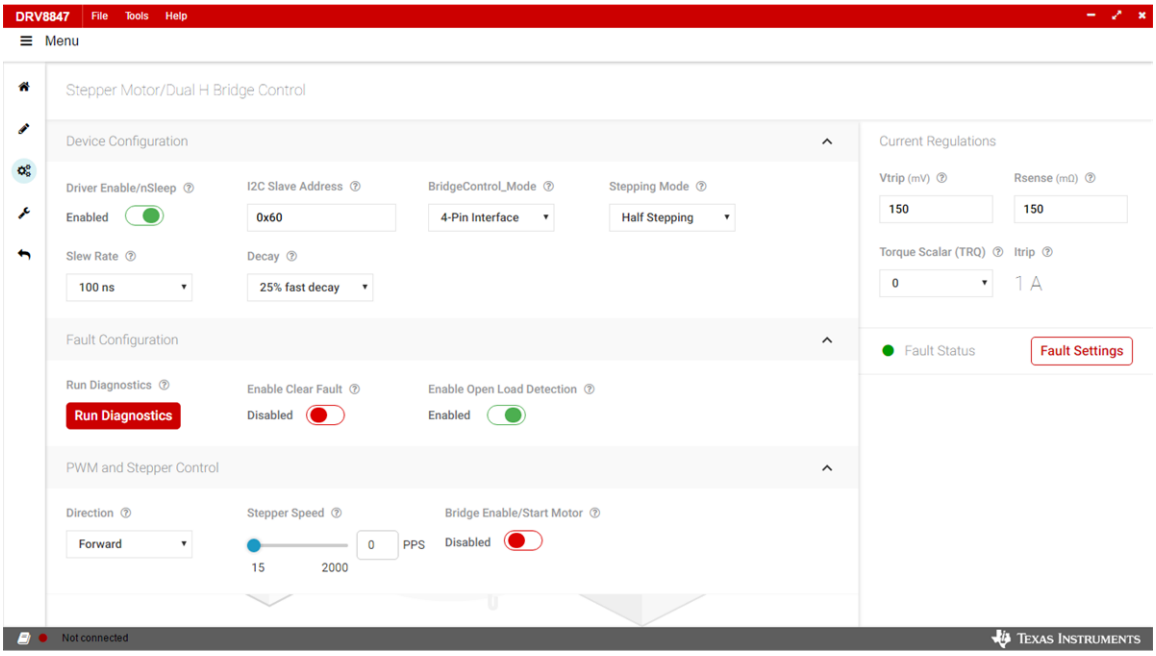

Figure 7. DRV8847x EVM GUI—Stepper Mode/Dual H-Bridge Control-4-Pin Mode Page

Click on the question mark icon for each of the controls in the GUI to learn about the operation and range of input values of that particular widget.

Do these steps to run the motor in 4-pin mode:

Step 1. Click on the *Driver Enable* toggle button to enable the driver. The driver must be enabled first before other controls are enabled.

Step 2. If necessary, write the values to the registers from the Register Page. If the driver is disabled, register read-write (R/W) operations are disabled.

Step 3. If necessary, set the I^2C slave address.

Step 4. Set the Bridge Control Mode to 4-Pin Interface.

Step 5. Set the Stepping Mode to Half Stepping or Independent Bridge. The controls under the PWM Control tab change based on the selection of the Stepping Mode.

Step 6. Set the PWM Switching Frequency applied to the motor. This configuration is available only when the Stepping Mode is set to Independent Bridge.

Step 7. If any fault occurs, the FAULT STATUS section on the right side of the GUI reports the fault.

Step 8. Do the necessary actions to clear the fault. For example, change the motor parameter values related to the fault.

Step 9. Use the widgets under the Fault Configuration tab to do the fault-related operations.

Step 10. Click the *Bridge Enable/Start Motor* toggle button or *FET Enable* toggle button to start the motor. These buttons are available based on the selected Stepping Mode. When these buttons are enabled, all the register controls, Driver Enable, Bridge Control Mode, and Stepping Mode change to non-editable mode until the *Bridge Enable/Start Motor* or *FET Enable* toggle buttons are disabled.

Step 11. Use the other widgets on the PWM Control tab to tune the motor.

Step 12. Use the Current Regulations Tab on the right side to calculate the ITRIP value.

Step 13. Click the *Fault Settings* button to display the *Fault Settings* tab. This tab is available only for the S variant of the DRV8847 device.

3.1.2.1.3.2 Stepper Mode/Dual H-Bridge Control-2-Pin

The Stepper Mode/Dual H-Bridge Control-2-Pin page has different widget controls to control the motor and tune the parameters as shown in Figure 8.

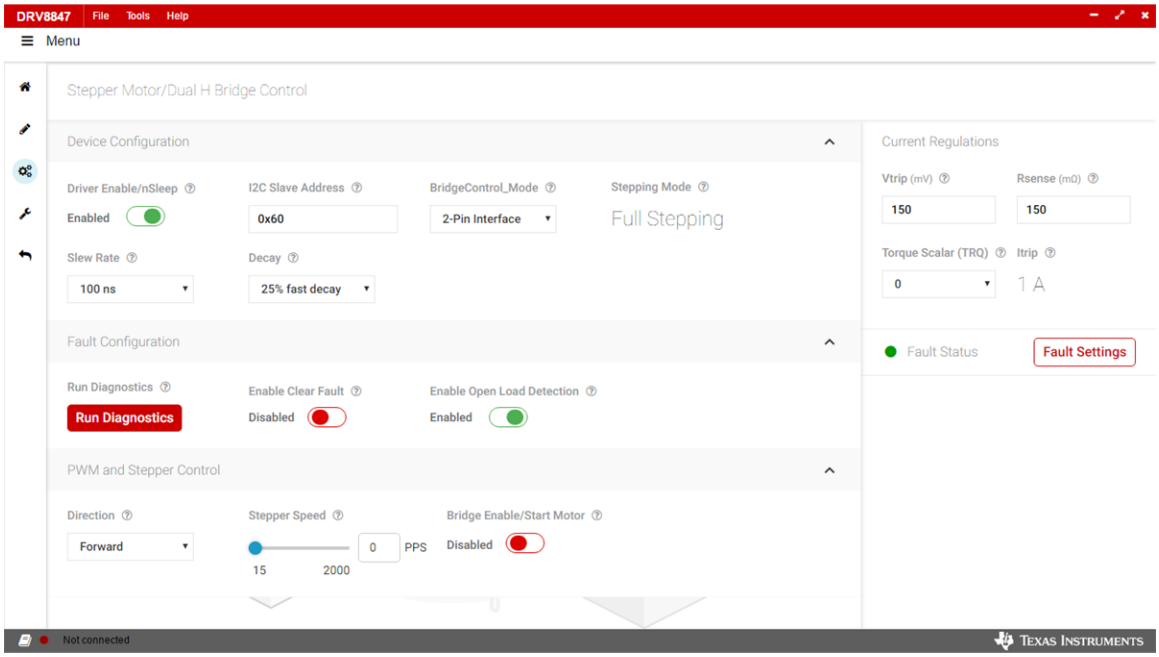

Figure 8. DRV8847x EVM GUI—Stepper Mode/Dual H-Bridge Control-2-Pin Mode Page

Click on the question mark icon for each of the controls in the GUI to learn about the operation and range of input values of that particular widget.

Do these steps to run the motor with a 2-pin mode:

Step 1. Click on the *Driver Enable* toggle button to enable the driver. The driver must be enabled first before other controls are enabled.

Step 2. If necessary, write the values to the registers from the Register Page. If the driver is disabled, register read-write (R/W) operations are disabled.

Step 3. If necessary, set the I^2C slave address.

Step 4. Set the Bridge Control Mode to 2-Pin Interface.

Step 5. If any fault occurs, the FAULT STATUS section on the right side of the GUI reports the fault.

Step 6. Do the necessary actions to clear the fault. For example, change the motor parameter values related to the fault.

Step 7. Use the widgets under the Fault Configuration tab to do the fault-related operations.

Step 8. Click the *Bridge Enable/Start Motor* toggle button to start the motor. When this button is enabled, all the register controls, Driver Enable, and Bridge Control Mode change to non-editable mode until the *Bridge Enable/Start Motor* or *FET Enable* toggle buttons are disabled.

Step 9. Use the other widgets on the PWM Control tab to tune the motor.

Step 10. Use the Current Regulations Tab on the right side to calculate the ITRIP value.

Step 11. Click the *Fault Settings* button to display the *Fault Settings* tab. This tab is available only for the S variant of the DRV8847 device.

3.1.2.1.3.3 Parallel Mode

The Parallel Mode page has different widget controls to control the motor and tune the parameters as shown in Figure 9.

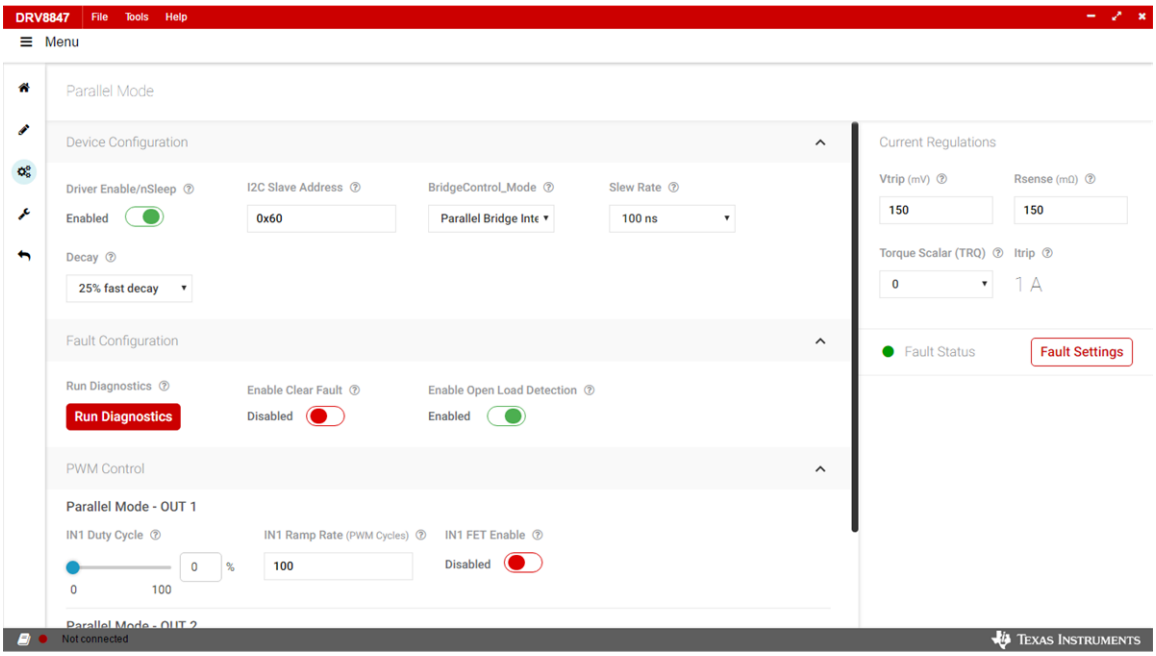

Figure 9. DRV8847x EVM GUI—Parallel Mode Page

Click on the question mark icon for each of the controls in the GUI to learn about the operation and range of input values of that particular widget.

Do these steps to run the motor with a parallel mode.

Step 1. Click on the *Driver Enable* toggle button to enable the driver. The driver must be enabled first before other controls are enabled.

Step 2. If necessary, write the values to the registers from the Register Page. If the driver is disabled, register read-write (R/W) operations are disabled.

Step 3. If necessary, set the I^2C slave address.

Step 4. Set the Bridge Control Mode to Parallel Bridge Interface.

Step 5. If any fault occurs, the FAULT STATUS section on the right side of the GUI reports the fault.

Step 6. Do the necessary actions to clear the fault. For example, change the motor parameter values related to the fault.

Step 7. Use the widgets under the Fault Configuration tab to do the fault-related operations.

Step 8. Click the *FET Enable* toggle button to start the motor. When this button is enabled, all the register controls, Driver Enable, and Bridge Control Mode change to non-editable mode until the *Bridge Enable/Start Motor* or *FET Enable* toggle buttons are disabled.

Step 9. Use the other widgets on the PWM Control tab to tune the motor.

Step 10. Use the Current Regulations Tab on the right side to calculate the ITRIP value.

Step 11. Click the *Fault Settings* button to display the *Fault Settings* tab. This tab is available only for the S variant of the DRV8847 device.

3.1.2.1.3.4 Independent Mode

The Independent Mode page has different widget controls to control the motor and tune the parameters as shown in Figure 10.

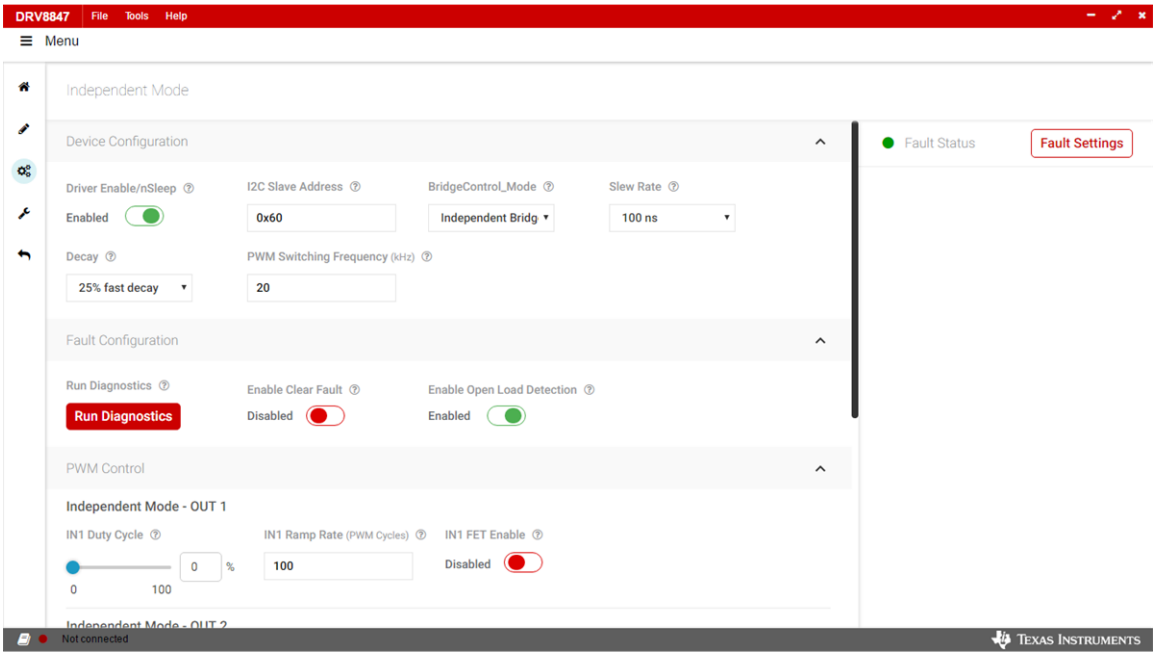

Figure 10. DRV8847x EVM GUI—Independent Mode Page

Click on the question mark icon for each of the controls in the GUI to learn about the operation and range of input values of that particular widget.

Do these steps to run the motor with independent mode:

Step 1. Click on the *Driver Enable* toggle button to enable the driver. The driver must be enabled first before other controls are enabled.

Step 2. If necessary, write the values to the registers from the Register Page. If the driver is disabled, register read-write (R/W) operations are disabled.

Step 3. If necessary, set the I^2C slave address.

Step 4. Set the Bridge Control Mode to Independent Bridge Interface.

Step 5. Set the PWM Switching Frequency applied to the motor.

Step 6. If any fault occurs, the FAULT STATUS section on the right side of the GUI reports the fault.

Step 7. Do the necessary actions to clear the fault. For example, change the motor parameter values related to the fault.

Step 8. Use the widgets under the Fault Configuration tab to do the fault-related operations.

Step 9. If necessary, click the *FET Enable* toggle button for each OUT to start the motor. When this button is enabled, all the register controls, Driver Enable, and Bridge Control Mode change to non-editable mode until the *Bridge Enable/Start Motor* or *FET Enable* toggle buttons are disabled.

Step 10. Use the other widgets on the PWM Control tab to tune the motor.

Step 11. Click the *Fault Settings* button to display the *Fault Settings* tab. This tab is available only for the S variant of the DRV8847 device.

3.1.2.1.4 Toolbar Options

The toolbar menu has these options:

- File
- Tools
- Help

3.1.2.1.4.1 File Menu

The File menu has different options to load the configuration from a file into the GUI and save the current configuration in the GUI into a file. The GUI has options to load and save registers and motor controls as shown in Figure 11.

NOTE: The user can save (and load) a particular configuration of the registers and the Motor Control parameters (as set on the Motor Control pages). This feature can also be used when no EVM is connected to the computer.

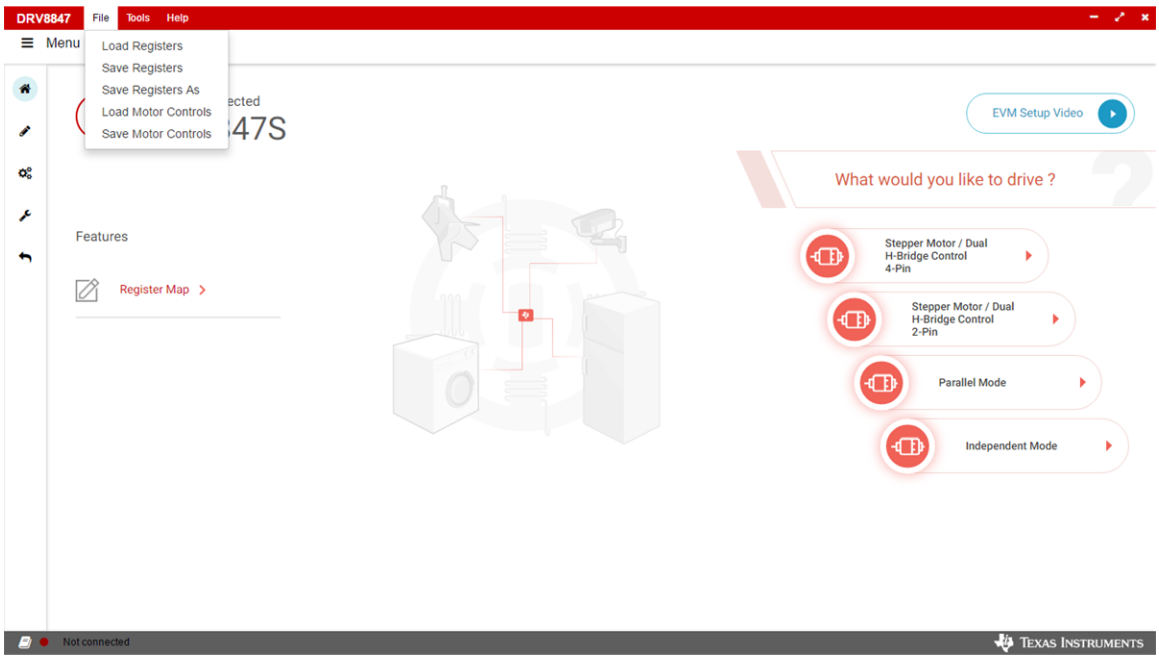

Figure 11. BOOSTXL-DRV8847x EVM GUI—File Toolbar Menu

3.1.2.1.4.2 Tools Menu

The Tools menu has only one option to open a log page at the bottom of the GUI. The log page shows different logs for information, warning, error, and debug.

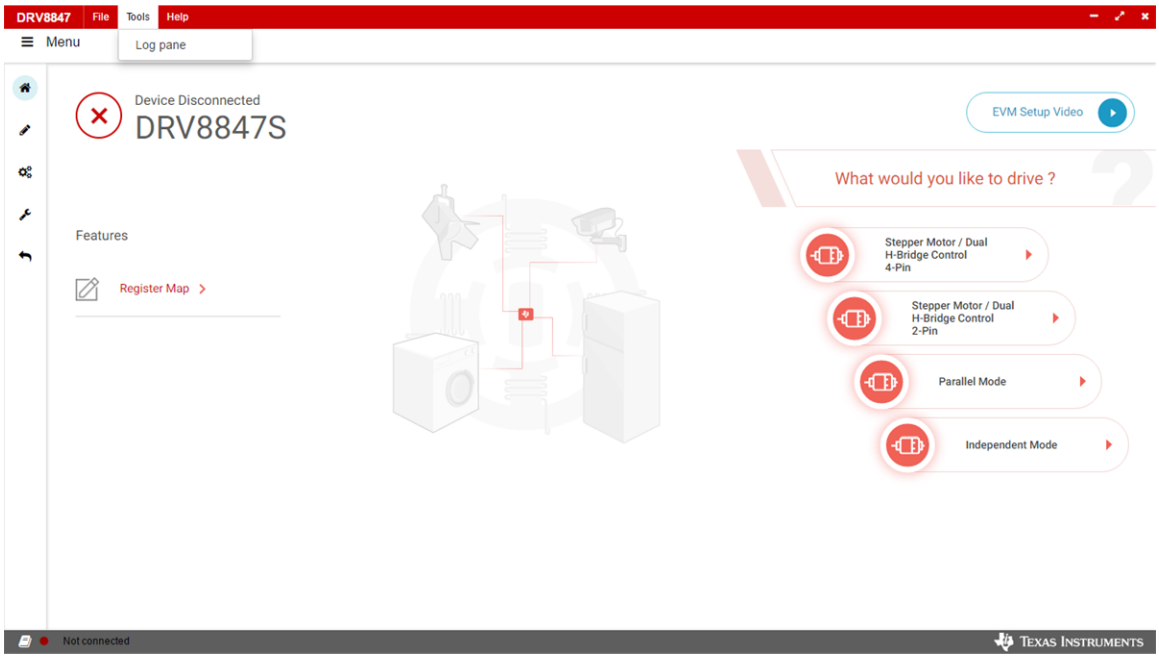

Figure 12. DRV8847x EVM GUI—Tools Toolbar Menu

3.1.2.1.4.3 Help Menu

The Help menu shows the information about this GUI application under the *About* option.

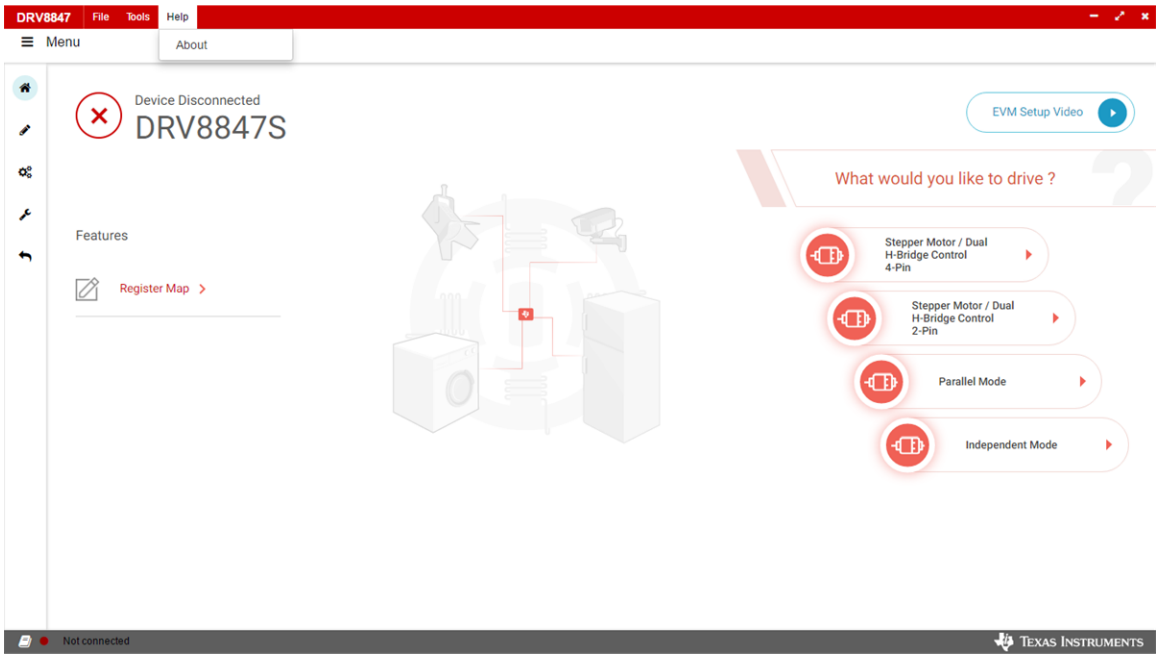

Figure 13. DRV8847x EVM GUI—Help Toolbar Menu

3.2 Installing Code Composer Studio™ IDE for Software Evaluation

For detailed steps for installation and setup of the Code Composer Studio™ software, go to: http://software-dl.ti.com/trainingTTO/trainingTTO_public_sw/MSP430_LaunchPad_Workshop/v2.20/MSP430_Workshop_Installation_Guide_v2.22.pdf

3.3 Instal the DRV8847x Reference Software Development Package

The DRV8847x reference software has files required to program DRV8847 device in addition to TMS320G2553 using Code Composer Studio (CCS) software version 6.2.X. All of these files are included in the installation package. To get access to this package, contact the DRV8847 applications team or the respective field sales engineer.

To install the reference software development package, follow these steps:

1. Double click the executable file (.exe) for the DRV8847x reference software installer (see Figure 14).

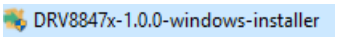

Figure 14. DRV8847 Firmware Installer Executable File

2. Follow the prompts to select another language from the default of English (see Figure 15).

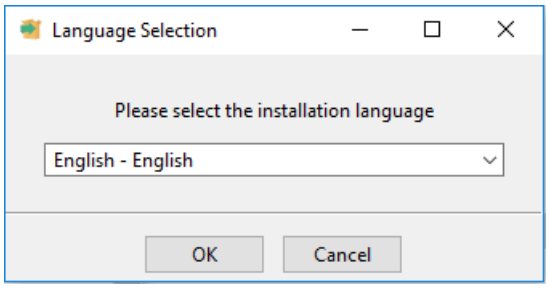

Figure 15. Language Selection

3. Read through and accept the license agreement to proceed with the installation.

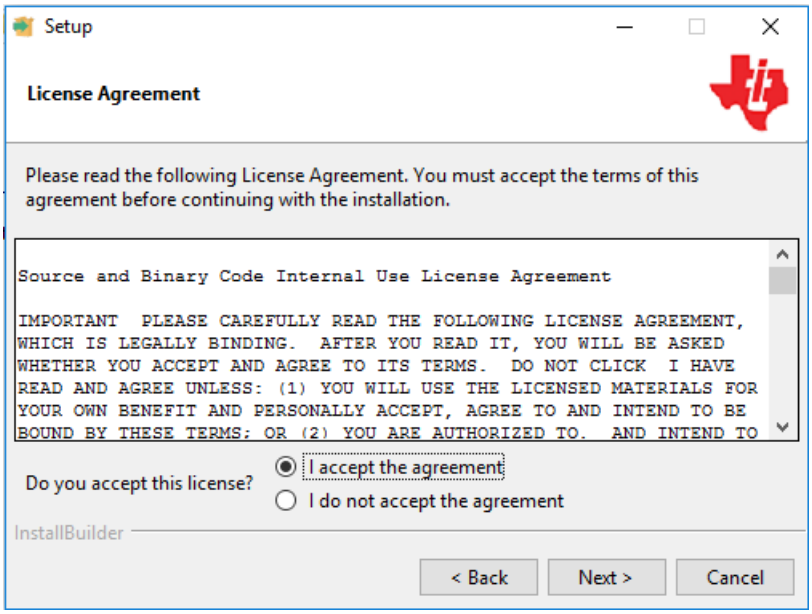

Figure 16. Software License Agreement

4. Select the destination location for the example CCS projects and the documentation. This destination can be set to any location in the PC.

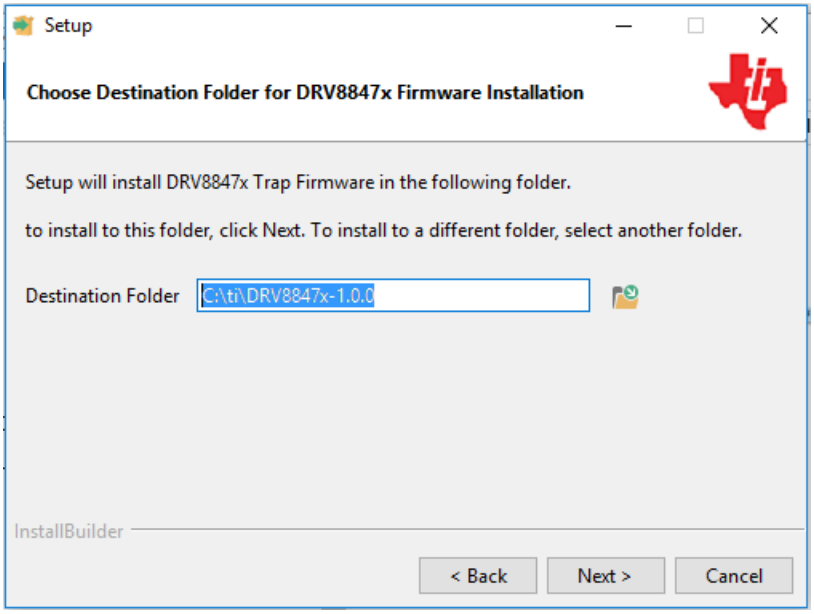

Figure 17. Installation Directory Path Selection

5. Select the DRV8847x components to install.

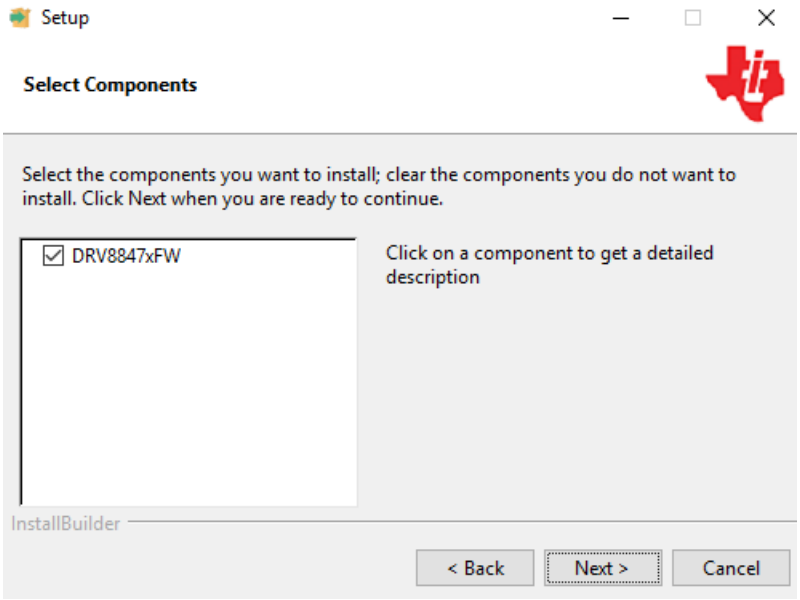

Figure 18. Components to Install

6. Make sure all running instances of CCS are closed.

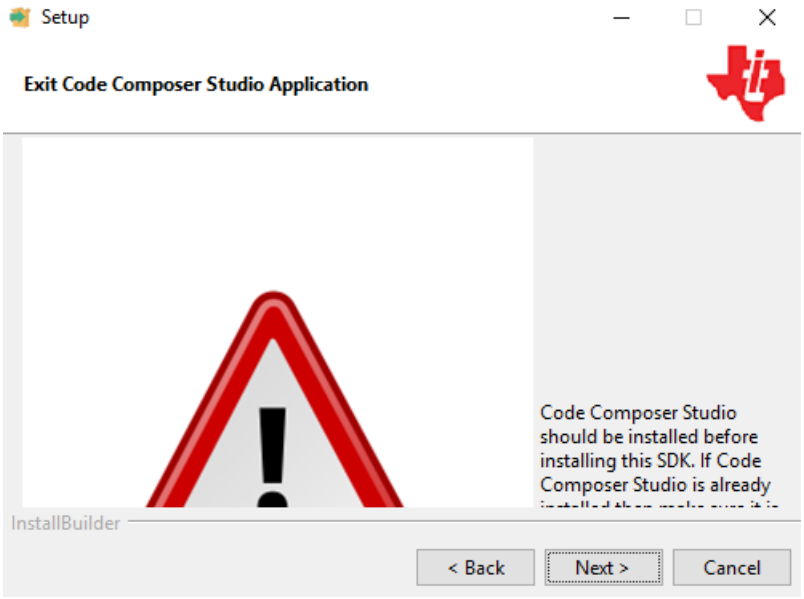

Figure 19. Warning Message to Close CCS

7. Continue with the installation process.
8. Click the *Next* button to install after reviewing the settings.
9. Click the *Finish* button when the files are successfully installed in the destination folder.

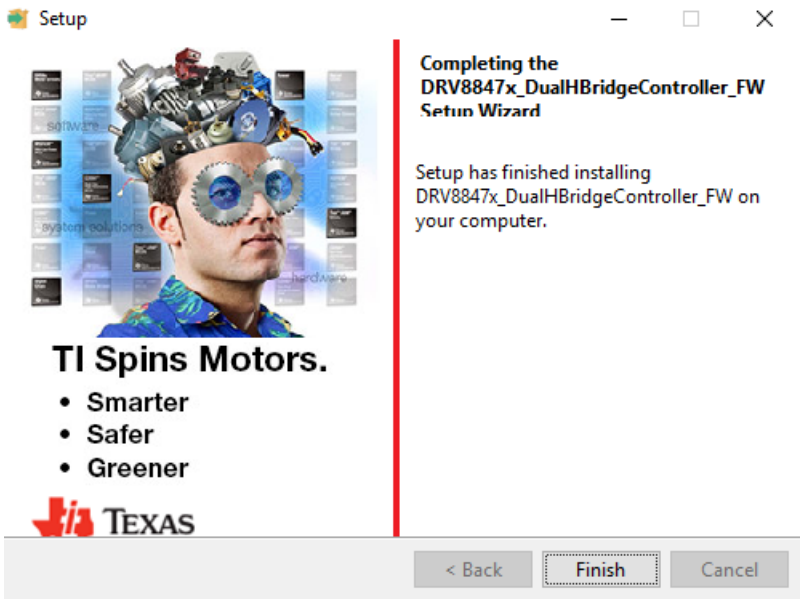

Figure 20. FW Package Installation Finish

3.4 Importing a DRV8847x Project into CCS

When the CCS software is started, the user must first select a workspace. A workspace is the structure in which projects are stored. Multiple projects can be saved in one workspace. Texas Instruments recommends starting with the project for the specific DRV8x device. After importing an existing project, the user can explore the features of CCS to become familiar with the IDE.

Follow these steps to import a DRV8847x project:

Step 1. Double click the CCS icon to open the application(a CCS icon is added to the desktop after installation).

Step 2. Select the location and name of the workspace. The location and naming convention can be changed based on the user's preference.

Step 3. Click the *OK* button to accept.

Step 4. Import a project either from the welcome menu by selecting *Import Project* or go to the *Project* menu and select *Import Existing CCS Eclipse Project*.

Step 5. Make sure that the project appears in the *Project Explorer* window after the projects are imported to the workspace as shown in Figure 21.

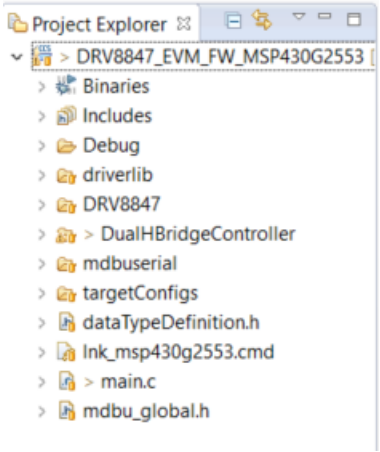

Figure 21. Project Explorer

Step 6. Explore the project files, build the project to create an image to be downloaded on the TMS320G2553 device, and download the project from the *Project Explorer* window. Make sure the DRV8847xEVM is connected to the PC through the USB interface before downloading the code.

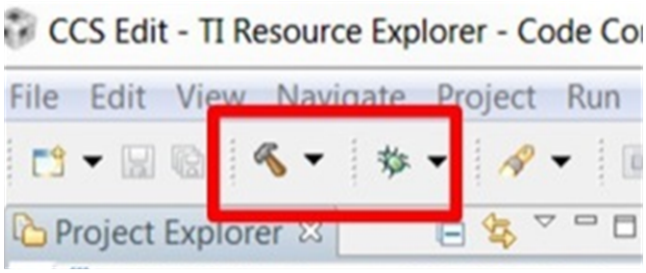

Figure 22. Build Project Files Buttons

Step 7. When the CCS software is connected to the device, run the program from the CCS IDE to execute the program in hardware by clicking the green play button (see Figure 23). Click the red stop button (see Figure 23) to disconnect the MSP-FET430UIF from the EVM.

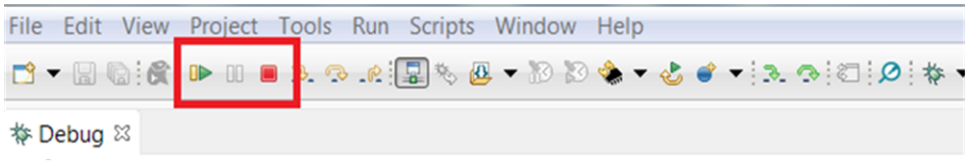

Figure 23. Execute Buttons

4 Software for Motor Control

4.1 Overview of Motor Control

The DRV8847 device integrates two H-bridges to drive two DC motors, a bipolar stepper motor, or the solenoid loads. The device can be configured in four different operating modes depending on user requirements. Depending on the selected interface (4-pin interface, 2-pin interface, parallel bridge interface, or the independent bridge interface) the input pins of theDRV8847 device are driven with the correct sequence required for H-bridge operation which is done by a microcontroller. The software controls the inputs (IN1, IN2, IN3, and IN4) of the DRV8847 device for different modes and interfaces and, therefore, controls the speed of the connected motor. The software also enables start and stop of the motor using the GUI.

The stepper motor can be controlled in full-stepping and half-stepping mode using the 2-pin or 4-pin interface respectively. All four modes can be used to control a single or dual BDC motor. The DRV8847 device supports operation of solenoids and relays using an independent interface. For more information, refer to the *DRV8847 Dual H-Bridge Motor Driver* data sheet.

The speed of the stepper motor is represented in pulses per seconds (PPS). Use Equation 2 to calculate the PPS, or speed of the motor, which is determined by number of steps per 360 degrees of revolution (see Equation 1).

$$\text{Number of steps per revolution} = \frac{360^\circ}{\text{Angle for one step}} \quad (1)$$

$$\text{Number of pulses per second (PPS)} = \left(\frac{\text{Desired RPM}}{60}\right) \times \text{Number of steps per revolution} \quad (2)$$

The PPS value is programmed as the *Timer* value in the software to generate interrupts at a periodic interval. The timer interrupt service routine drives current through each winding depending on the sequence programmed for full stepping or half stepping mode.

4.1.1 Half Stepping Mode Using 4-Pin Interface for Stepper Motor

The DRV8847 device can control a stepper motor in half stepping mode. The user selects the interface as 4-pin and selects the stepper mode as half step mode. The speed of the stepper motor is determined by the PPS. The number of steps per revolution in this case is 8, and therefore the timer interval is programmed appropriately. The timer service routine sequences the PWM inputs connected to the IN1, IN2, IN3, and IN4 pins as shown in the DRV8847 data sheet.

The motor can be started and stopped by the *Bridge Enable/Motor Start* button and *Bridge Disable/Motor Stop* button respectively.

4.1.2 Full Stepping Mode Using 2-Pin Interface for Stepper Motor

The DRV8847 device can control a stepper motor in full stepping mode. The user selects the interface as 2-pin which sets the stepper mode as full step mode. The speed of the stepper motor is determined by the PPS. The number of steps per revolution in this case is 4, and therefore the timer interval is programmed appropriately. The timer service routine sequences the PWM inputs connected to the IN1 and IN2 pins as shown in the DRV8847 data sheet.

The motor can be started and stopped by the *Bridge Enable/Motor Start* button and *Bridge Disable/Motor Stop* button respectively.

4.1.3 Independent Mode Using 4-Pin Interface for Brushed DC Motor

The software can run relay or solenoid coils connected to the VM pin or ground and a single or dual BDC motor. The user selects the interface as 4-pin and selects the stepper mode as independent mode. The PWM duty cycle can be adjusted through the slider in the GUI with a minimum duty cycle that is greater than 10%. The Timer A1 is used to generate PWM inputs to the IN1, IN2, IN3, and IN4 pins independently. The RAMP_RATE_DELAY parameter in the GUI sets the number of PWM_PERIOD interrupts that must occur before adjusting the duty cycle. Changing this value changes how fast the duty cycle is adjusted

4.1.4 Parallel Bridge Interface to Drive a Higher Current Brushed DC Motor

The software can run a higher-current BDC motor. The user selects the interface as parallel mode. The PWM duty cycle can be adjusted through the slider in the GUI with a minimum duty cycle that is greater than 10%. The Timer A1 is used to generate PWM inputs to the IN1 and IN2 pins. The RAMP_RATE_DELAY parameter in the GUI sets the number of PWM_PERIOD interrupts that must occur before adjusting the duty cycle. Changing this value changes how fast the duty cycle is adjusted

4.1.5 Independent Bridge Interface

The software can run relay or solenoid coils connected to the VM pin or ground and a single or dual BDC motor. The user selects the interface as Independent half bridge interface and selects the stepper mode as independent mode. The PWM duty cycle can be adjusted through the slider in the GUI with a minimum duty cycle that is greater than 10%. The Timer A1 is used to generate PWM inputs to the IN1, IN2, IN3, and IN4 pins independently. The RAMP_RATE_DELAY parameter in the GUI sets the number of PWM_PERIOD interrupts that must occur before adjusting the duty cycle. Changing this value changes how fast the duty cycle is adjusted.

4.2 Software Flow Chart

The software starts from the main.c file in the project.

4.2.1 Main, DRV8x State Machine and Port Interrupt Service Routine

Figure 24 shows the flow chart of the DRV8847x software.

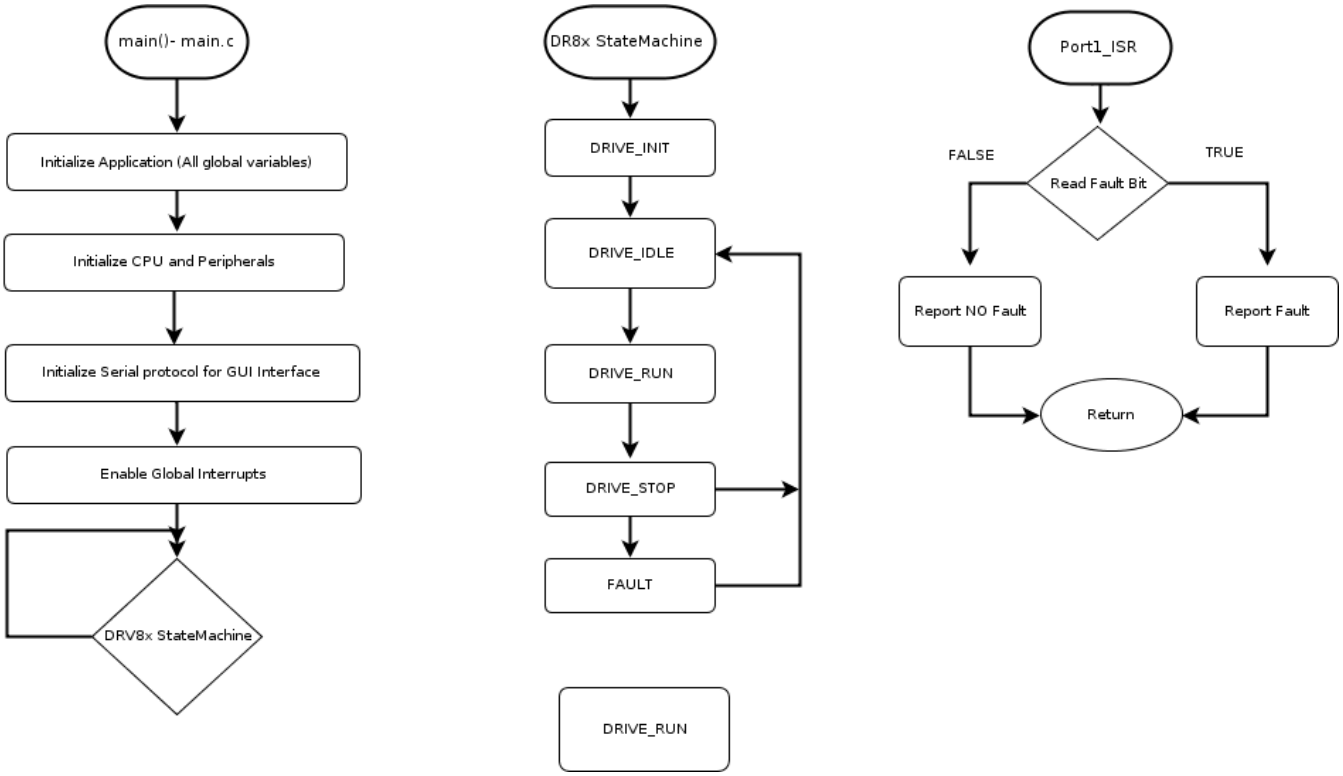

Figure 24. DRV8847x Software Flow Chart

4.2.2 UART Receive and Transmit ISR

Figure 25 shows the interrupt flow chart for the UART.

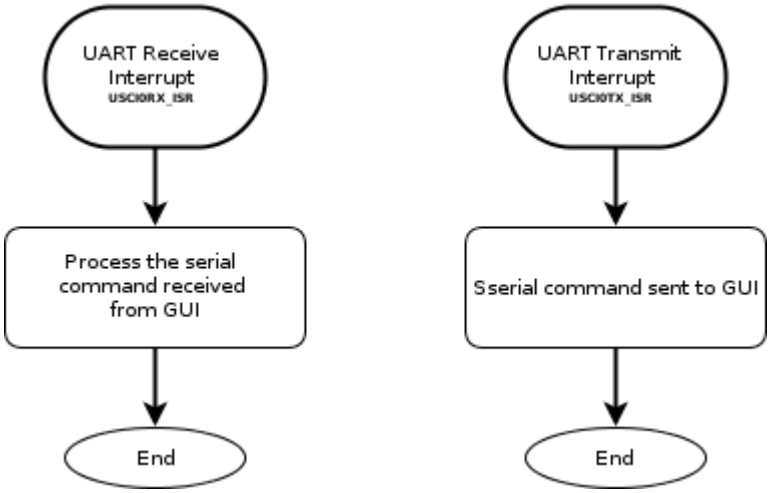

Figure 25. DRV8847x UART Interrupt Flow Chart

4.2.3 Timer0_A0 Interrput ISR

Figure 26 shows the interrupt flow chart for Timer0_A.

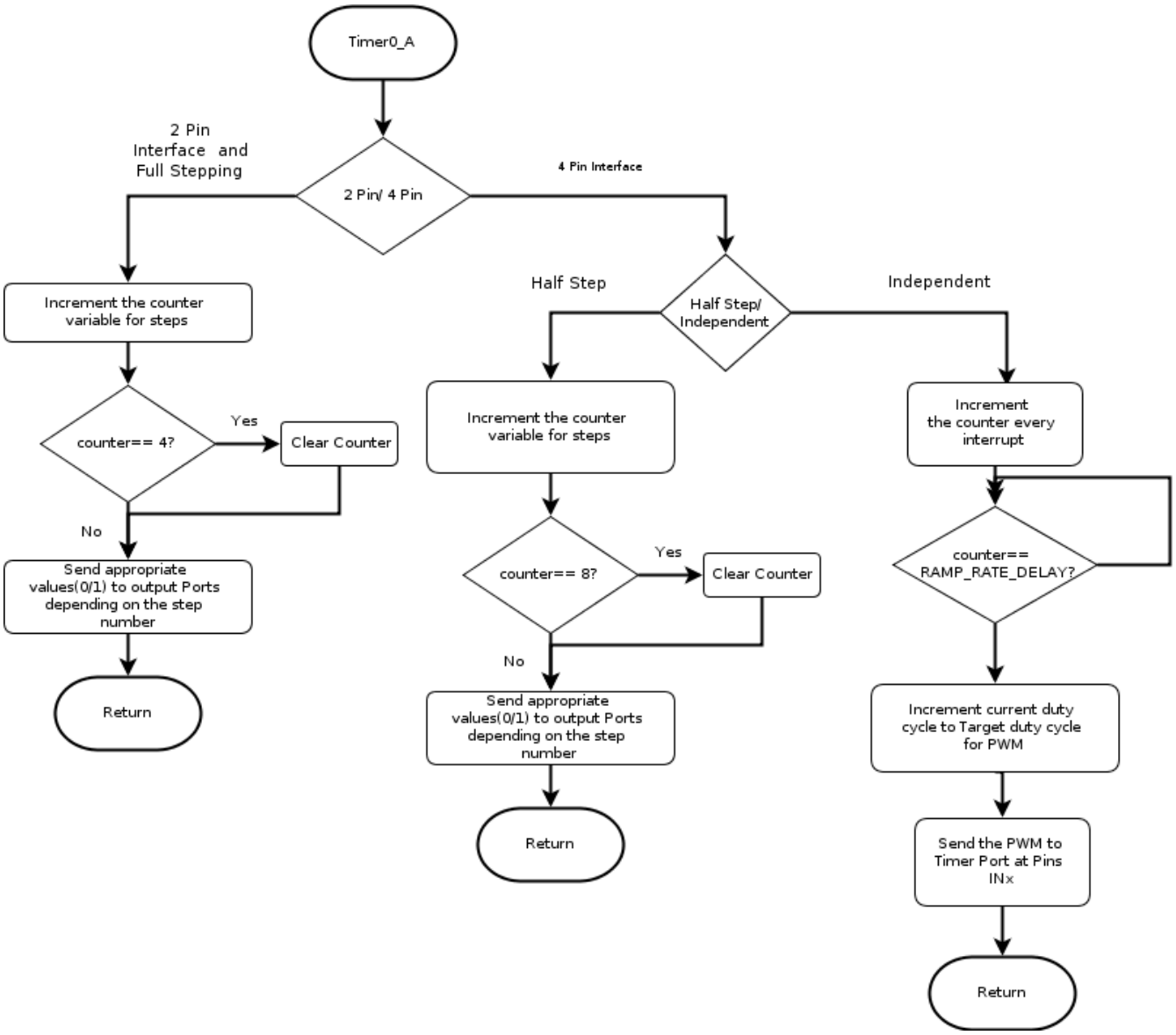

Figure 26. DRV8847x Timer0_A Interrupt Flow Chart

4.2.4 Timer1_A Interrput ISR

Figure 27 shows the interrupt flow chart for Timer1_A.

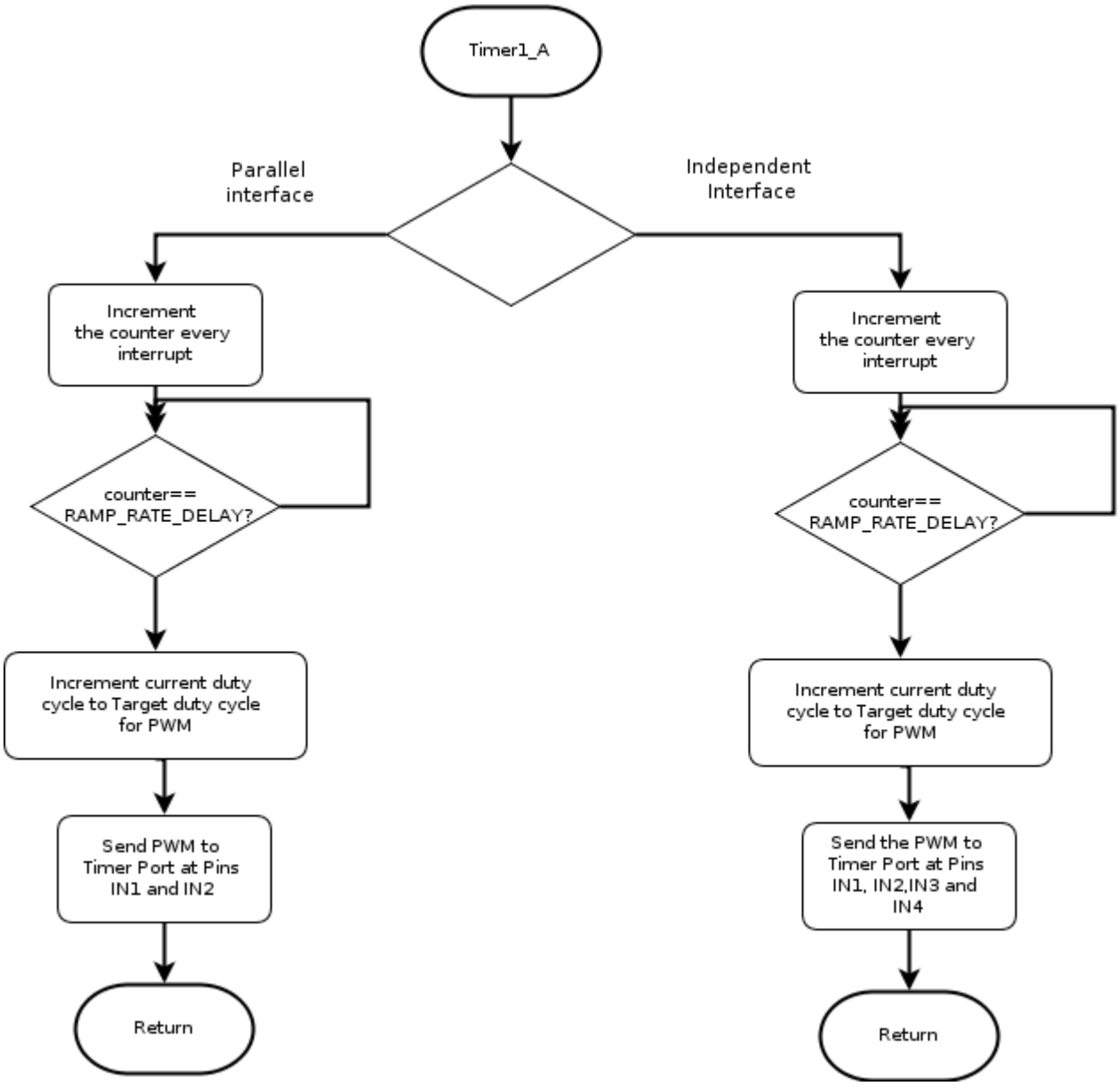

Figure 27. DRV8847x Timer1_A Interrupt Flow Chart

5 Customize I²C Register User Parameters

Set the I²C register settings of the DRV8847 device as described in the *DRV8847 Dual H-Bridge Motor Driver* data sheet. Adjust the register settings on the register map page in the GUI.

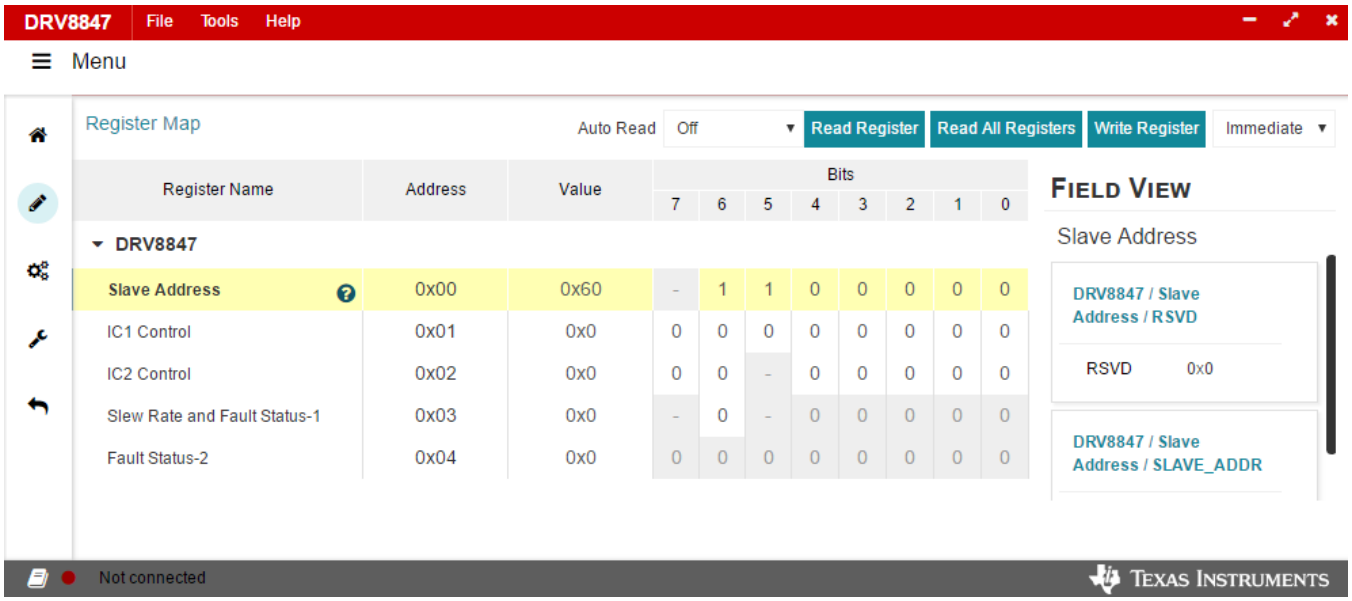

Figure 28. DRV8847S I²C Register Map

6 Run the Project in Code Composer Studio

Do these steps to run the project in CCS:

1. Modify the project for a specific motor as needed.
2. Compile the modified project.
3. Run the project in CCS.
4. Connect the GUI.
5. Control the selected motor on a specific interface.

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265