
SmartFusion2 Dual-Axis Motor Control Starter Kit

DG0598 Demo Guide

July 2015



Revision History

Date	Revision	Change
15 July 2015	3	Third release
4 May 2015	2	Second release
19 February 2015	1	First release

Confidentiality Status

This is a non-confidential document.

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Preface

About this document

This demo is for Microsemi[®] SmartFusion[®]2 system-on-chip (SoC) field programmable gate array (FPGA) dual-axis motor control starter kit. It provides instructions about how to use the corresponding reference design.

Intended Audience

SmartFusion2 dual-axis motor control starter kits are used by:

- FPGA designers
- Embedded designers
- System-level designers

References

Microsemi Publications

For a complete and up-to-date listing of motor control documentation, visit:
<http://www.microsemi.com/applications/motor-control#resources>

SmartFusion2 Dual-Axis Motor Control Starter Kit

Introduction

The SmartFusion2 Dual-Axis Motor Control Starter Kit gives designers a starting point to evaluate time-saving and proven motor control reference designs. The kit is supplied with the hardware IP blocks and software. A fully integrated solution along with a powerful and easy to use GUI that enables designers to quickly prototype the design is also provided. The kit helps designers in customizing and developing dual-axis motor control solution on the SmartFusion2 device for a specific application and reduces time-to-market. This document provides details about the hardware setup and connections for running the demo design.

Design Requirements

Table 1 shows the design requirements.

Table 1 • Design Requirements

Design Requirements	Description
Hardware Requirements	
SmartFusion2 Dual-Axis Motor Control Starter Kit Board (SF2-MC-STARTER-KIT-SA) with SOM	–
FlashPro4 programmer or later	–
Brushless DC (BLDC) motor (QBL4208-41-04-006)	One
Stepper motor (QSH4218-35-10-027)	One
USB A to mini-B USB cable	–
Power adapter (ETSA240270UDC-P5P-SZ)	24 V
Operating System	Any 64-bit or 32-bit Windows 7 or Later Operating System
Software Requirements	
Libero [®] System-on-Chip (SoC)	v11.5
Microsemi Motor Control GUI	v4.2
USB drivers for GUI	–
FlashPro programming software	v11.5

Demo Design

Introduction

The demo design files are available for downloading from the following path in the Microsemi website:
http://soc.microsemi.com/download/rsc/?f=m2s_dg0598_liberov11p5_gui_and_pf

The demo design files include:

- GUI installer
- STAPL programming file
- readme.txt

Figure 1 shows the top-level structure of the design files. For further details, refer to the `readme.txt` file.

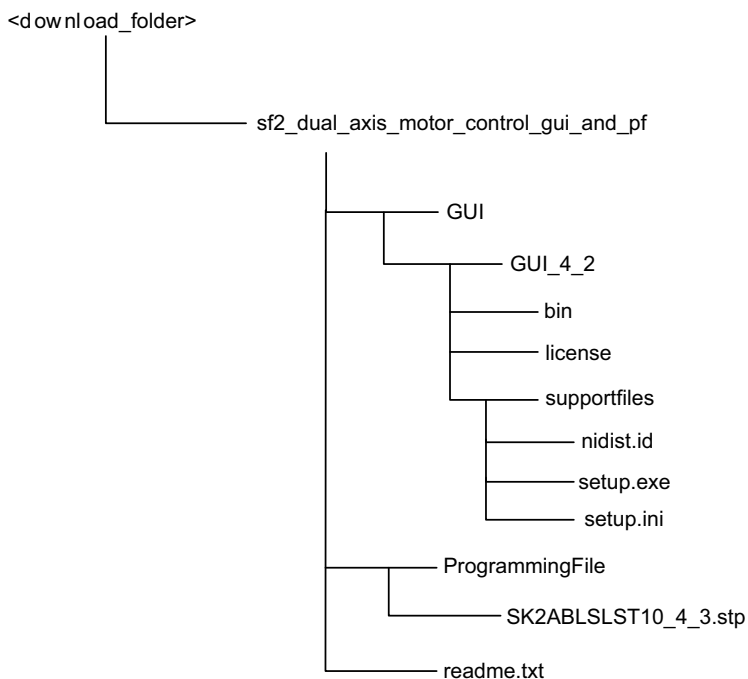


Figure 1 • Demo Design Files Top-Level Structure

Demo Design Features

The demo design runs:

- A single permanent-magnet synchronous motor (PMSM) using sensorless field oriented control (FOC) algorithm
- A single stepper motor using the micro-stepping algorithm

The GUI provided with the demo is used to configure and control the motors. The GUI can also plot certain debug variables, and display motor speed and current values.

Setting Up the Demo Design

This section has the following subsections:

- Setting Up the Hardware
- Installing the Motor Control GUI
- GUI Driver Configuration

Setting Up the Hardware

Figure 2 shows the hardware setup for one BLDC motor in Sensorless FOC and a stepper motor in FOC.

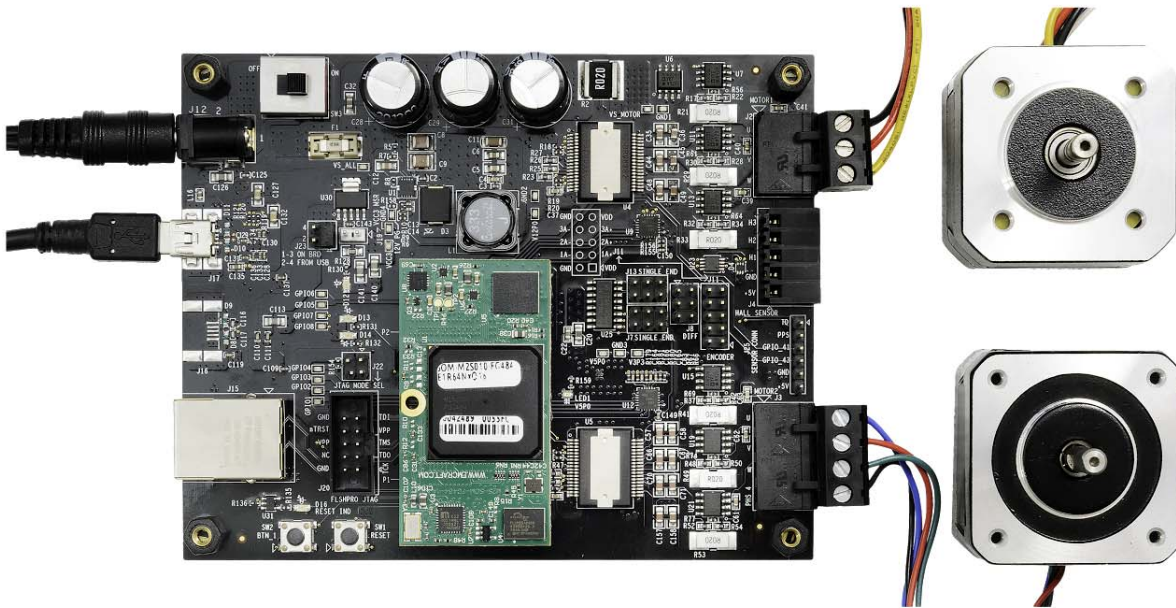


Figure 2 • SmartFusion2 Dual Axis Motor Control Demo Hardware Setup

Connecting the Board

1. Connect the 24 V power supply to J12 connector.
2. Connect the BLDC motor (QBL4208-41-04-006) to J2 connector on the board as shown in Figure 2.
 - Black wire - U-Phase of the motor
 - Red wire - V-Phase of the motor
 - Yellow wire - W-Phase of the motor

3. Connect the Stepper motor (QSH4218-35-10-027) to **J3** connector on the board as shown in [Figure 2 on page 7](#).
 - Black wire - A1 of the motor to be connected to PHS4
 - Green wire - A2 of the motor to be connected to W
 - Red wire - B1 of the motor to be connected to V
 - Blue wire - B2 of the motor to be connected to U
4. Set the required jumpers on the board. For information on jumper settings, refer to [Table 2 on page 31](#).
5. Switch ON the **SW3** power supply switch on the board.
6. Connect the FlashPro JTAG to the FP header.
7. Open FlashPro software and program the STAPL file (SK2ABLSLST10_4_3.stp).
8. Power cycle the board using **SW3**.

Install the motor control GUI as described in the following section.

Installing the Motor Control GUI

The following steps describe how to install the Motor Control GUI:

1. From the downloaded folder, open the **\GUI\ GUI_4_2** folder and run **setup.exe**.
2. Click **Yes** for any message from User Account Control. Setup window is displayed with the default locations.
3. Click **Next**.
 - Accept the license agreement and click **Next**.
 - Confirm the installation location in the installation dialog box and click **Next**.

A progress bar appears that shows the progress of the installation. On successful installation, the following message is displayed: *Installation Complete*.

4. Click **Finish** to exit the installation wizard.
5. Restart the Host PC.

Check the device manager to see if the USB drivers are already configured on the Host machine. To check if the drivers are configured correctly, after ensuring that the hardware is powered ON and connected to the Host PC using USB cable (**J17** connector on board). Check if NI-VISA USB devices appears in the device manager as shown in [Figure 3](#). If they are configured, skip to "[Running the Demo Design](#)" section on page 19.

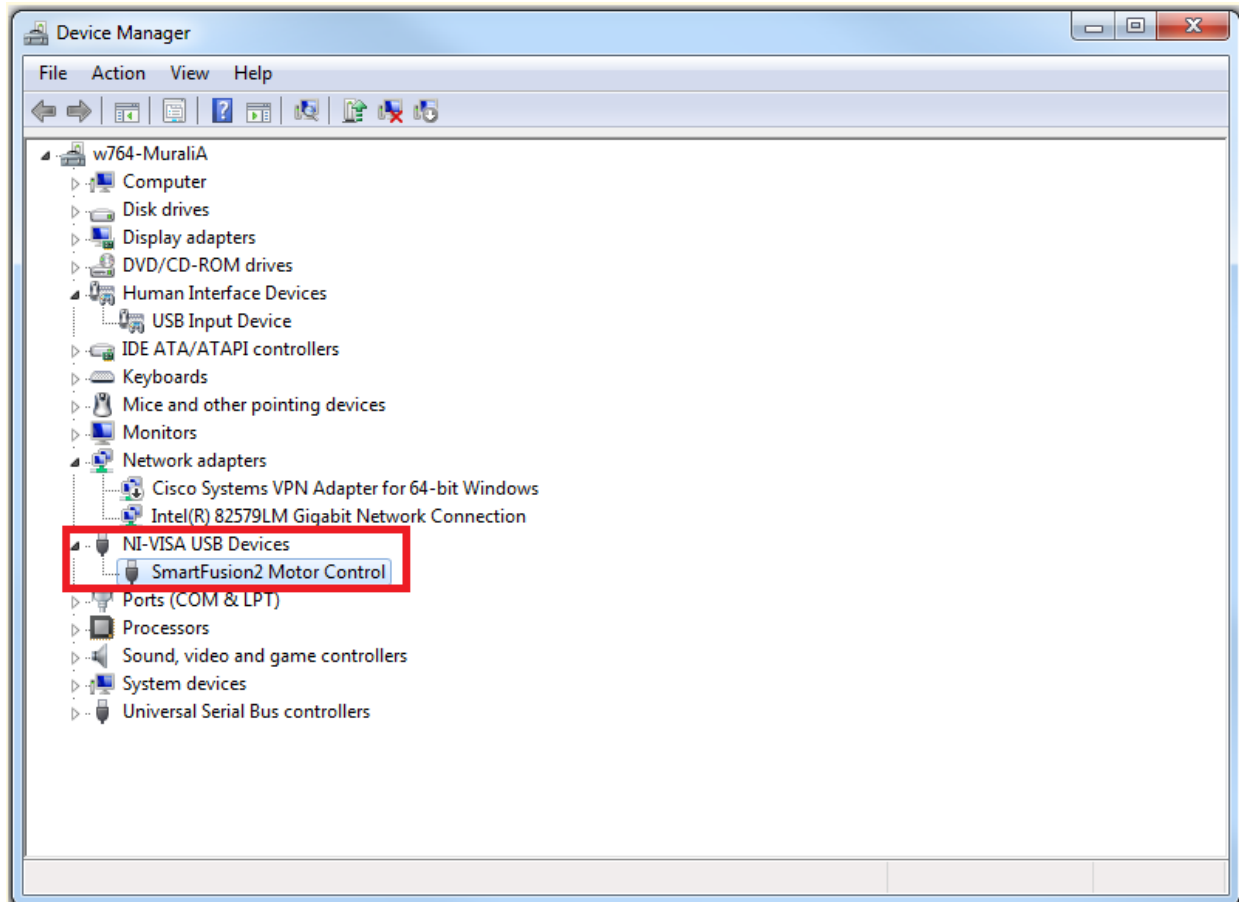


Figure 3 • Identifying the SmartFusion2 Motor Control Kit USB Driver

GUI Driver Configuration

The following steps describe how to install the GUI driver on the Host PC that has Windows 7 installed. For Host PCs having Windows 8 installed, refer to "[Appendix 2: Installing GUI on Windows 8](#)" section on [page 32](#) before following the procedure in this section. The downloaded programming file must be programmed on the board before proceeding for driver installation.

1. Connect the Host PC to the J17 connector on the SmartFusion2 Motor Control Kit using the USB A to mini-B USB cable.
2. Connect the power adapter to the kit and switch ON **SW3** switch.
3. Open Device Manager of the Host PC and select **USB Input Device** under **Human Interface Devices** as shown in [Figure 4](#).

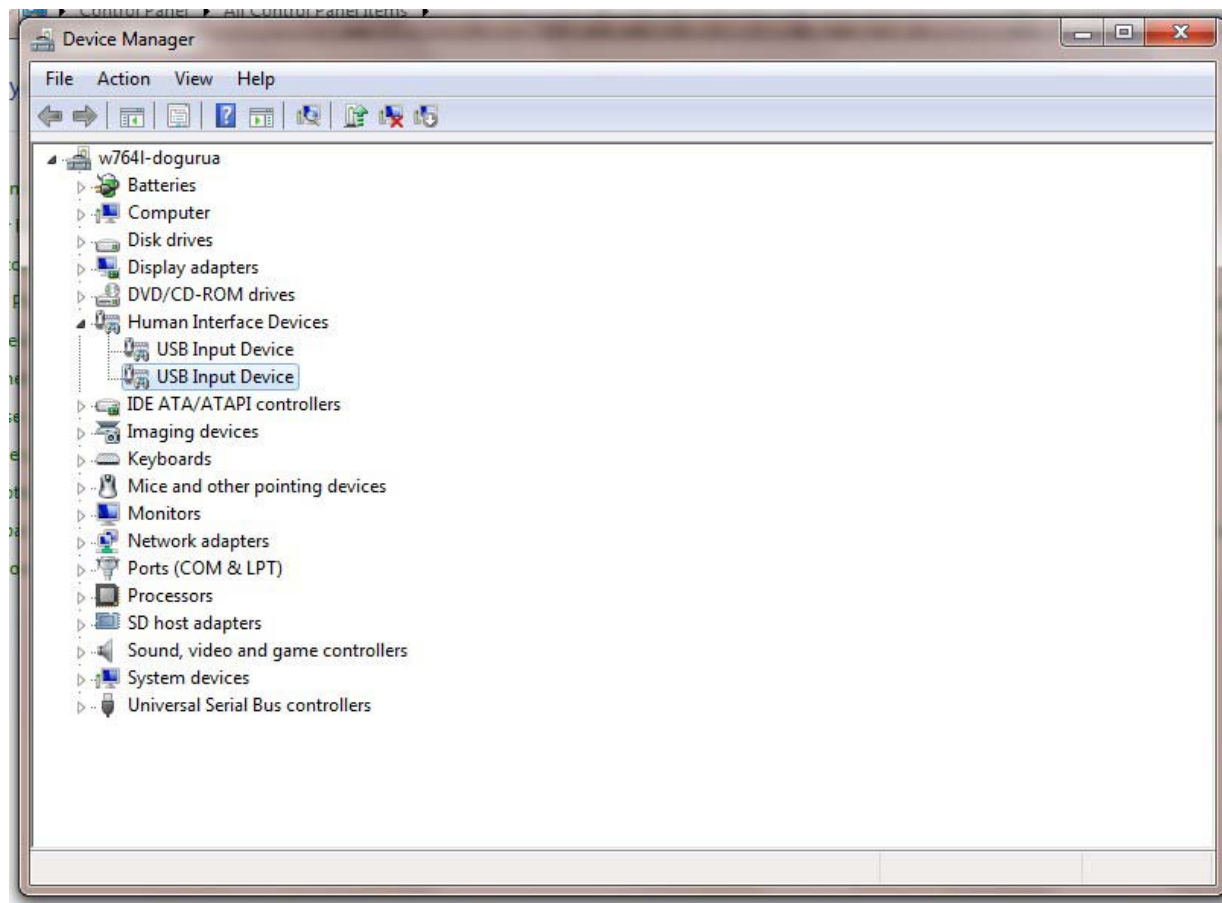


Figure 4 • Device Manager

4. Right-click on the **USB Input Device** and select **Properties** as shown in Figure 5.

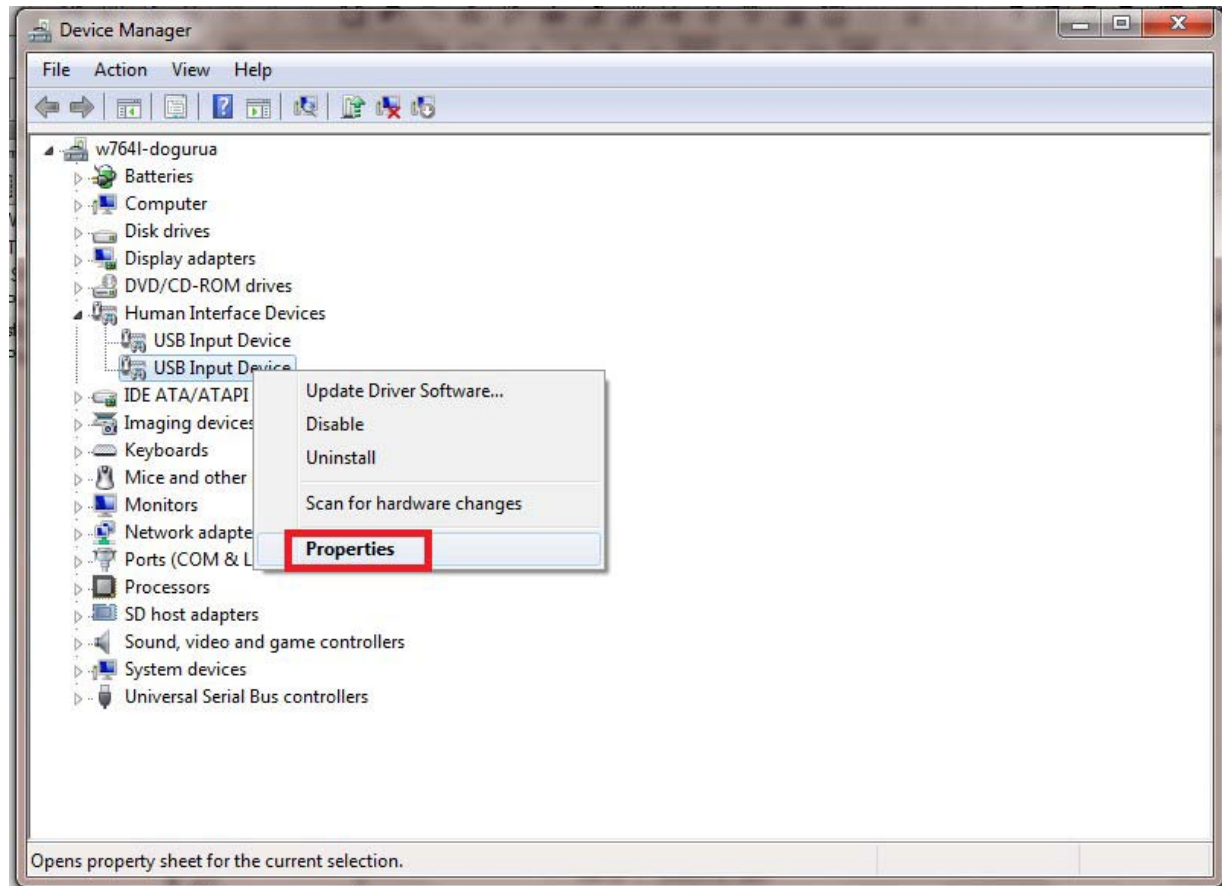


Figure 5 • Installing the USB Driver - Opening the Properties Window

- Figure 6 shows the **USB Input Device Properties** window.
5. In the **Details** tab, select **Hardware Ids** under **Property**.

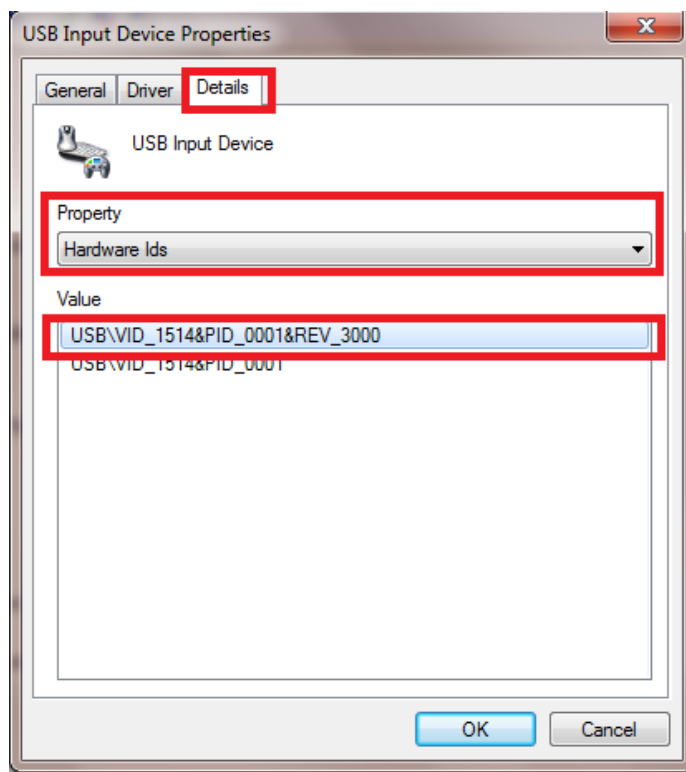


Figure 6 • Selecting the Right VID Number in the Properties Window

6. Select the appropriate VID number under **Value** and click **OK**. The VID number must have 1514, as shown in Figure 6.

7. In the **Device Manager** window, right-click on the **USB Input Device** with the specified VID number and select **Update Driver Software**. Refer to [Figure 7](#).

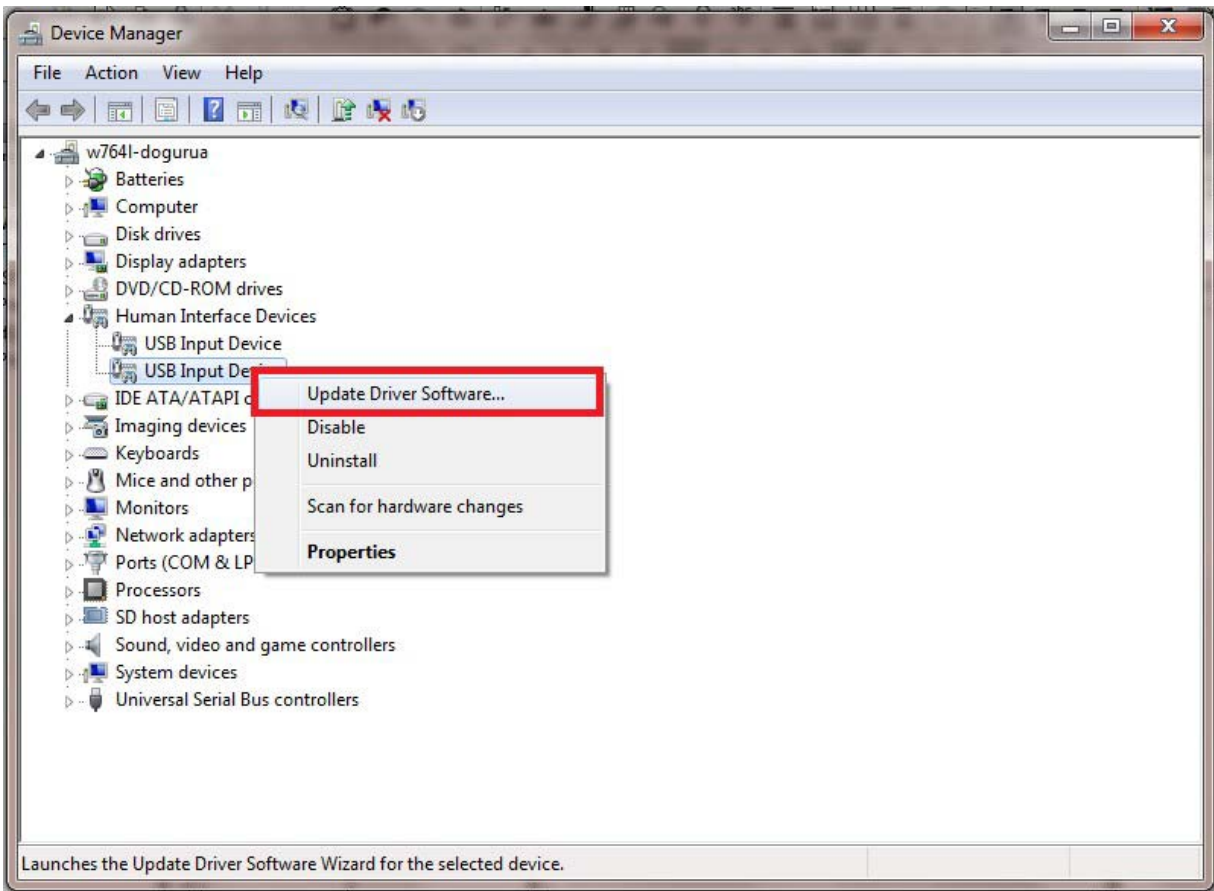


Figure 7 • Updating Driver Software

8. Select **Browse my computer for driver software** from the **Update Driver Software - USB Input Device** window as shown in [Figure 8](#).

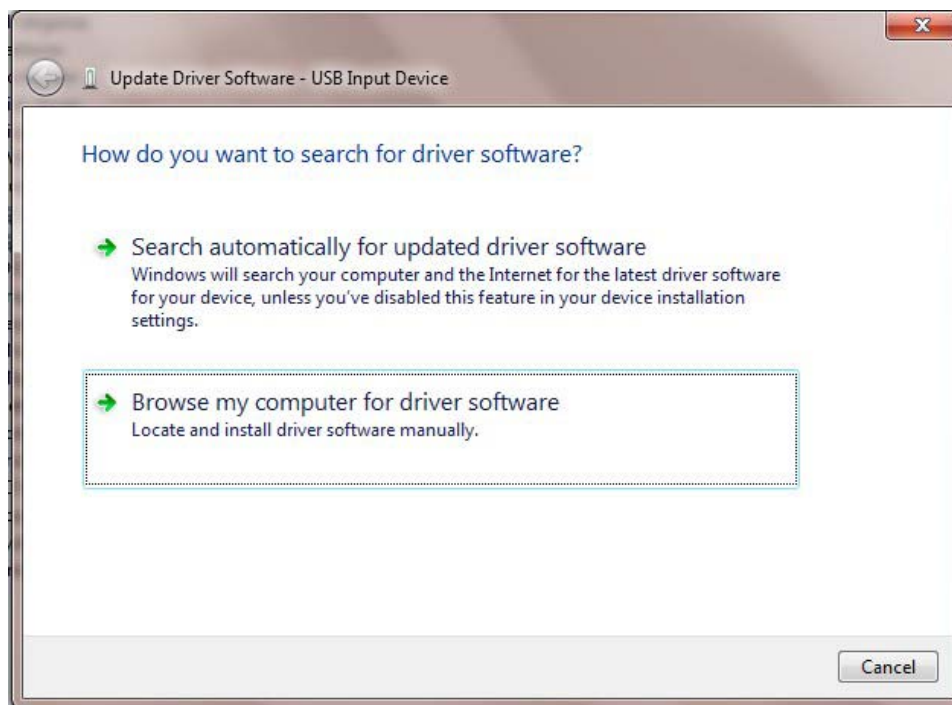


Figure 8 • Updating Driver Software - Locate and Install the Driver Software Manually

9. Click **Let me pick from a list of device drivers on my computer** and click **Next** as shown in Figure 9.

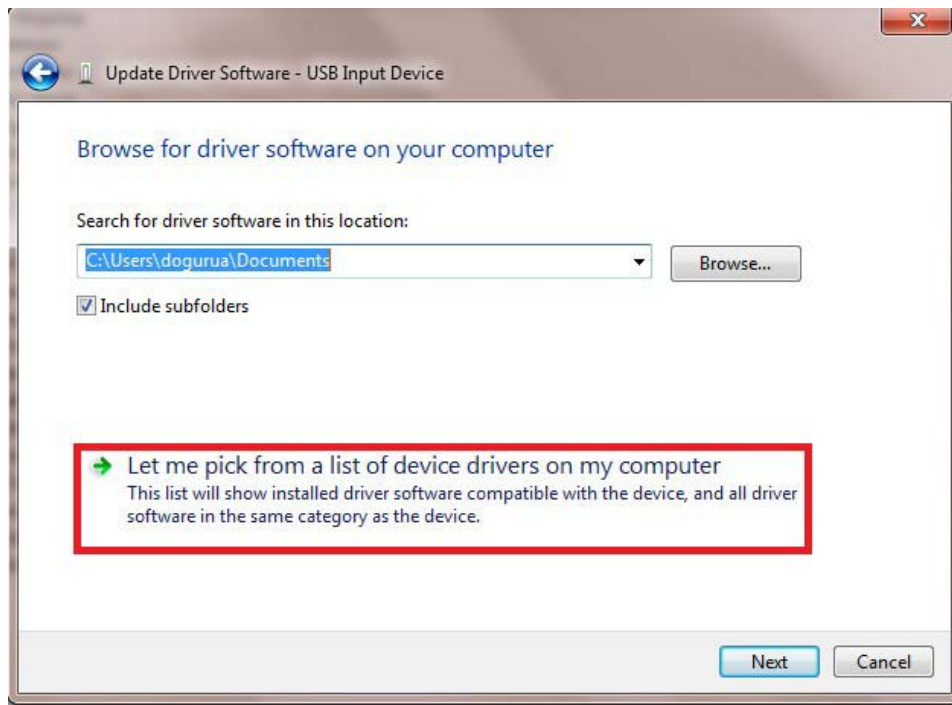


Figure 9 • Updating Driver Software - Selecting the Driver Location

10. Click **SmartFusion2 Motor Control** and click **Have Disk** as shown in Figure 10.

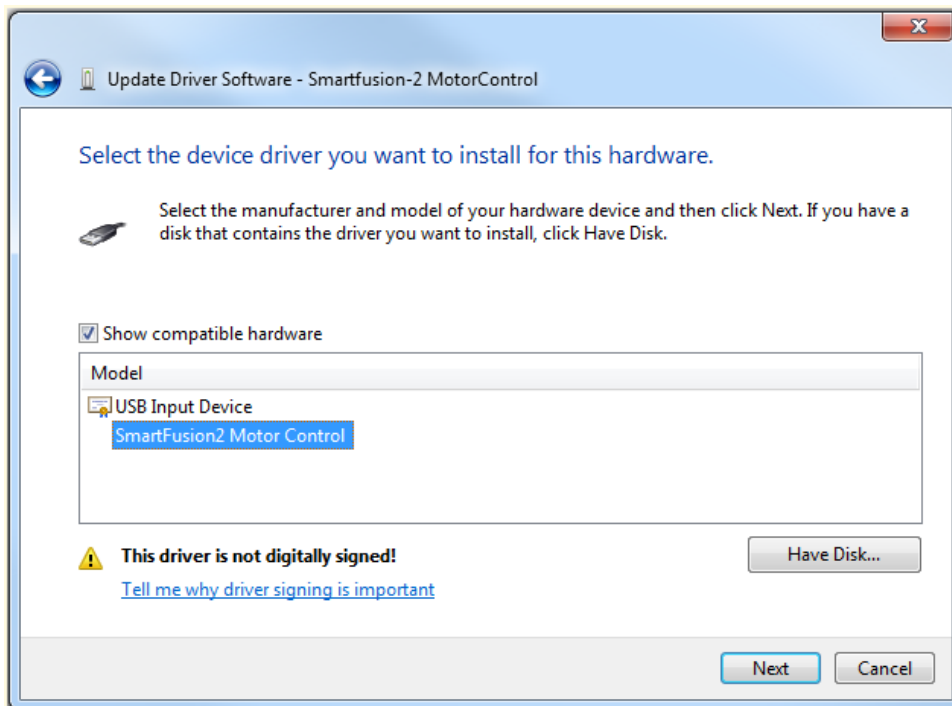


Figure 10 • Selecting the Device Driver

11. Click **Browse** in the **Install From Disk** window shown in Figure 11 and go to **C:\WINDOWS\inf**.

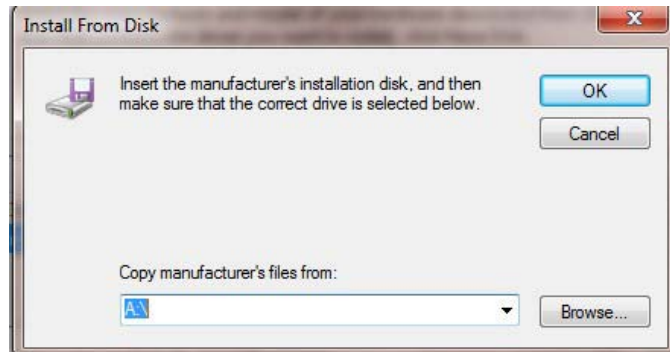


Figure 11 • Locating the Device Driver

12. Select **SF2USB_vista&7.inf** for Window7/Vista system and click **Open** as shown in Figure 12.
Note: Select **SF2USB.inf** for Windows XP system.

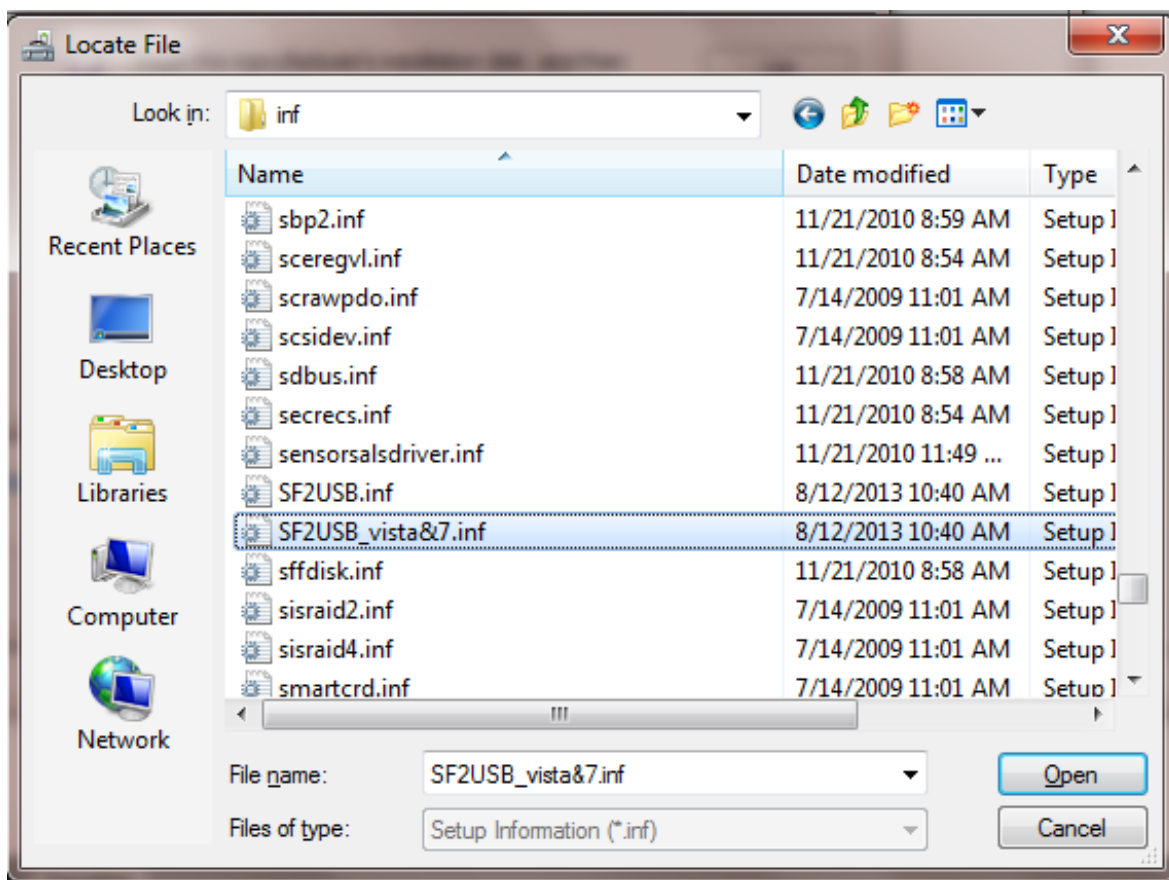


Figure 12 • Selecting the Installation File

13. Click **OK** to close the **Install from Disk** window. Refer to Figure 11 on page 16.
14. In **Update Driver Software - USB Input Device** window, select **SmartFusion2 Motor Control** and click **Next**.

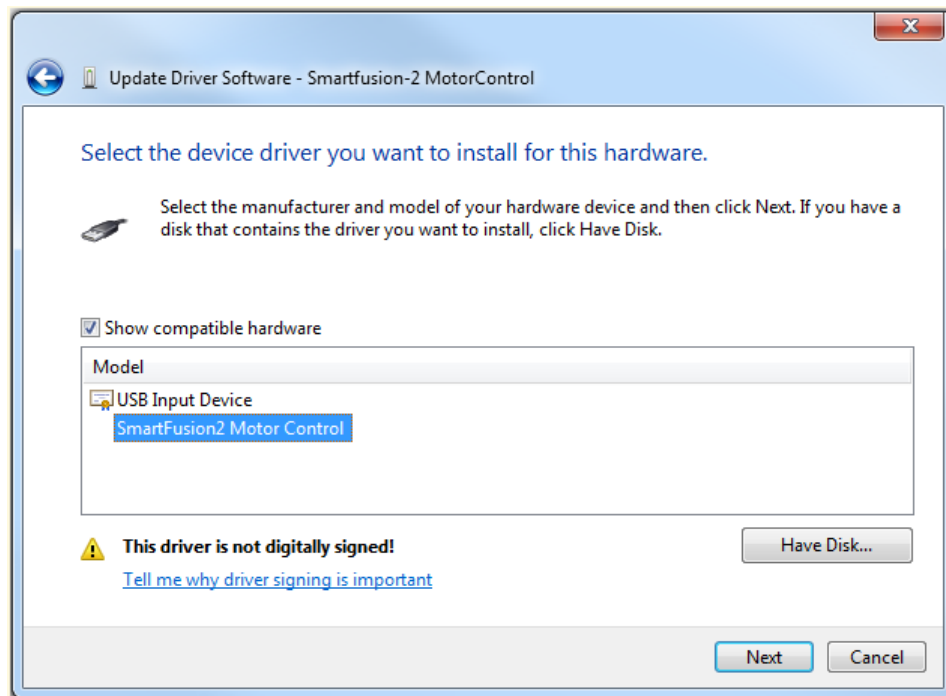


Figure 13 • Completing Installation of the Driver Software

15. A Windows Security message is displayed as shown in Figure 14. Click **Install this driver software anyway**.

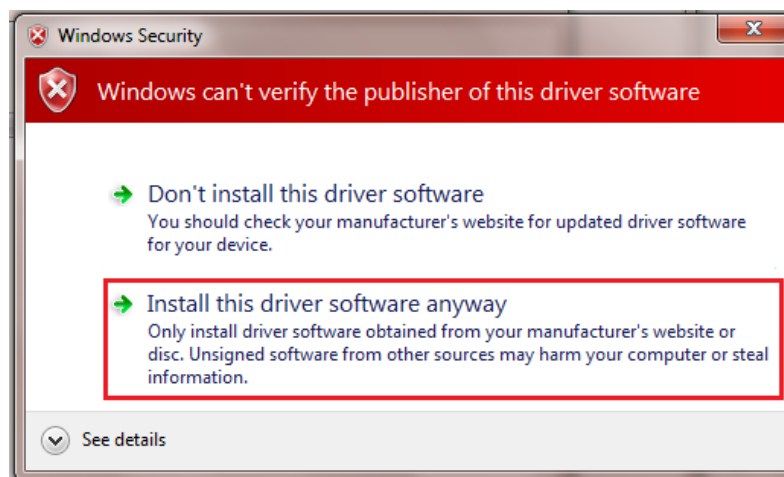


Figure 14 • Windows Security Message

On successful installation of the drivers, a message is displayed.

16. Check for **NI-VISA-USB Devices** in the **Device Manager** window to ensure that the driver is installed successfully as shown in [Figure 15](#).

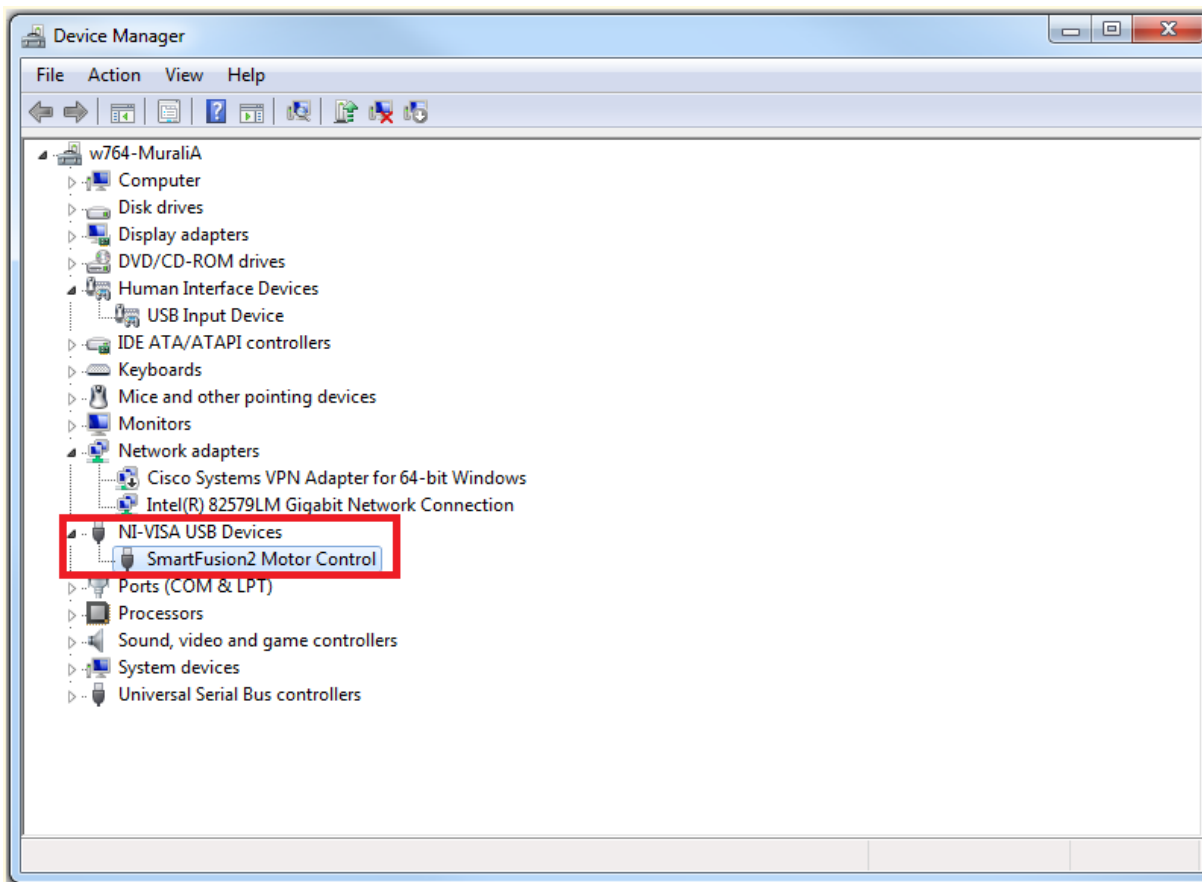


Figure 15 • Verifying the Installed Driver Software

Running the Demo Design

1. After installing the GUI, go to **Start** menu and select **SF2 Dual Axis Motor ControlGUI** to open the GUI as shown in [Figure 16](#).

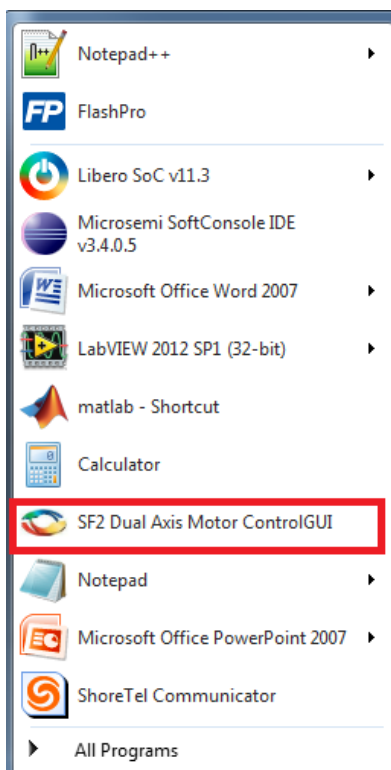


Figure 16 • Launching the SmartFusion2 Dual-Axis Motor Control GUI

2. In the SmartFusion2 Motor Control GUI, select the **USB device** with VID 0x1514 and PID 0x0001 (USB0::0x1514::0x0001...) from the **USB DEVICE** drop-down list.

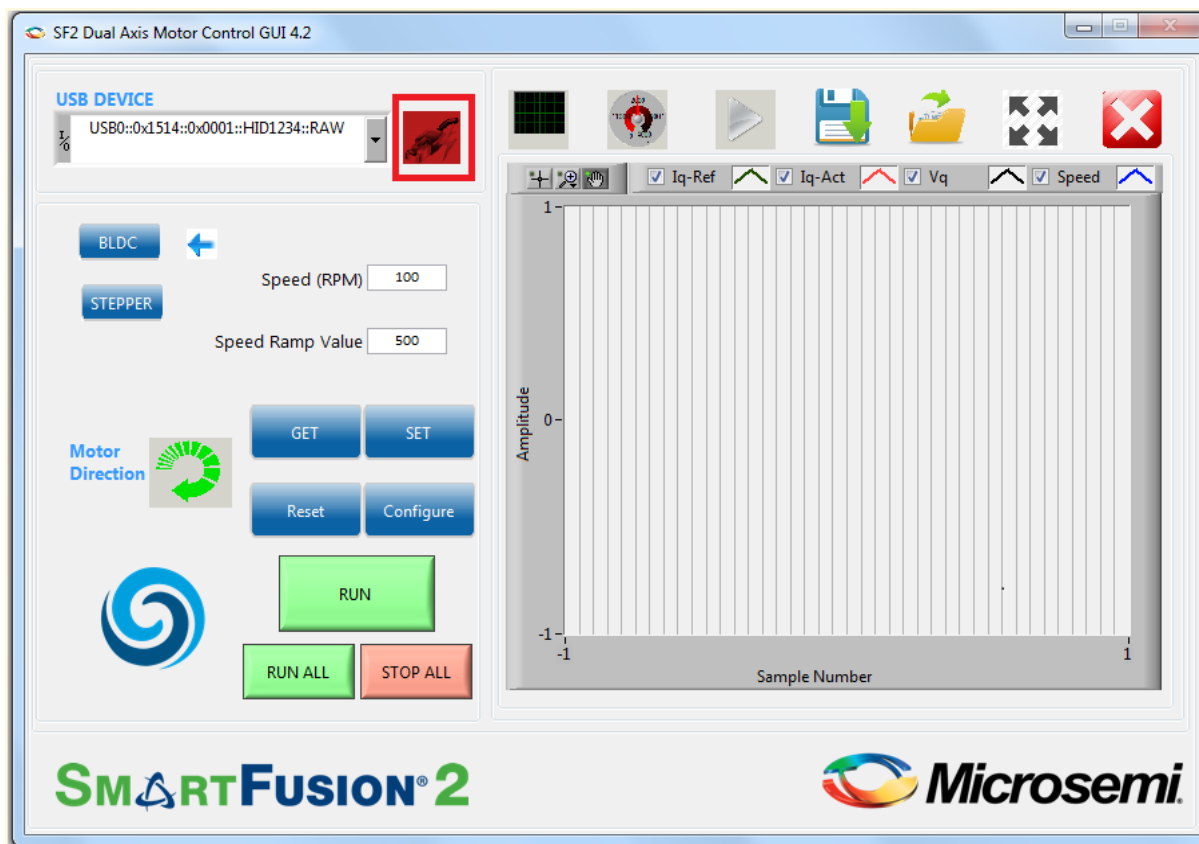


Figure 17 • SmartFusion2 Motor Control GUI - Launch Window

3. Click **Connect** as shown in Figure 17.
On successful connection, the Connect button (highlighted in Figure 17) turns to green.

Running the BLDC Motors

Use the **GET** and **SET** options to modify or verify the motor speed, motor ramp rate, current and speed loop PI controller parameters, and angle correction PI parameters. Click **Configure** to invoke the **Configure Motor Parameters** window.

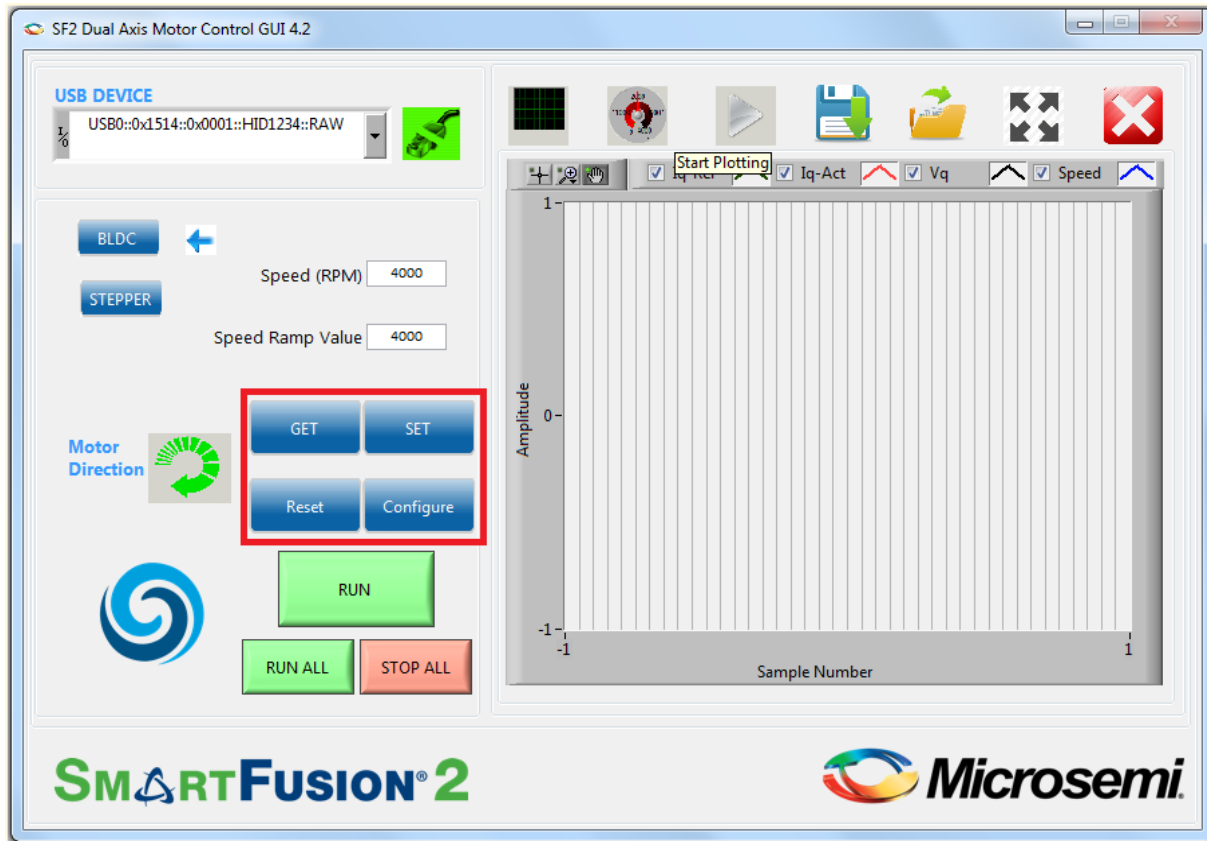


Figure 18 • SmartFusion2 Motor Control GUI - BLDC Motor Screen

The PI controller parameters (K_p , K_i values) can be modified using the **Configure Motor Parameters** window shown in Figure 19.

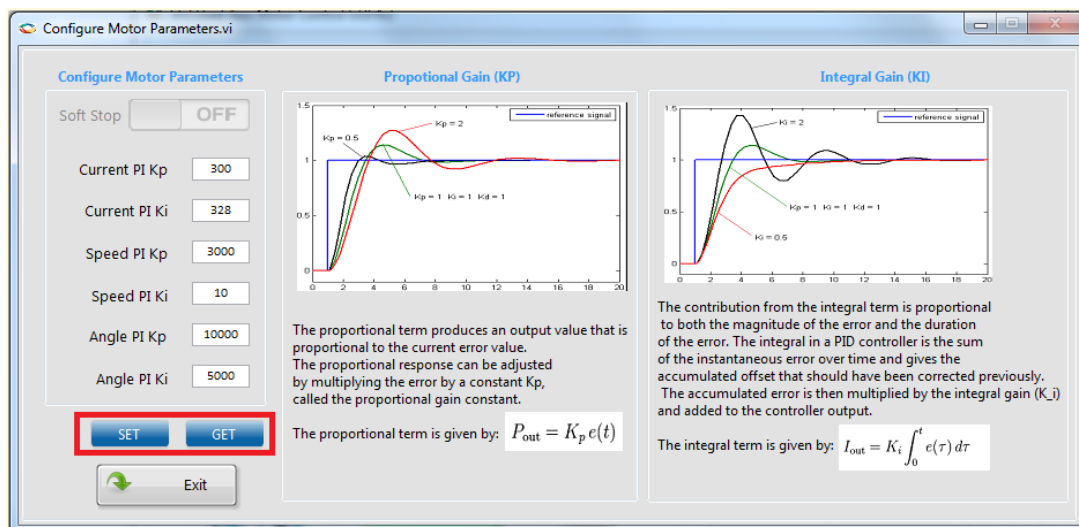


Figure 19 • Configuring Motor Parameters Window

- To modify a parameter, change the required field and click **SET**.
- To check the data in the hardware corresponding to each parameter, click **GET**.
- To run the motor, click **RUN** and to stop the motor, click **STOP**.

4. Click **Run All** to run all the motors and click **Stop All** to stop all the running motors. These buttons are highlighted in Figure 20.

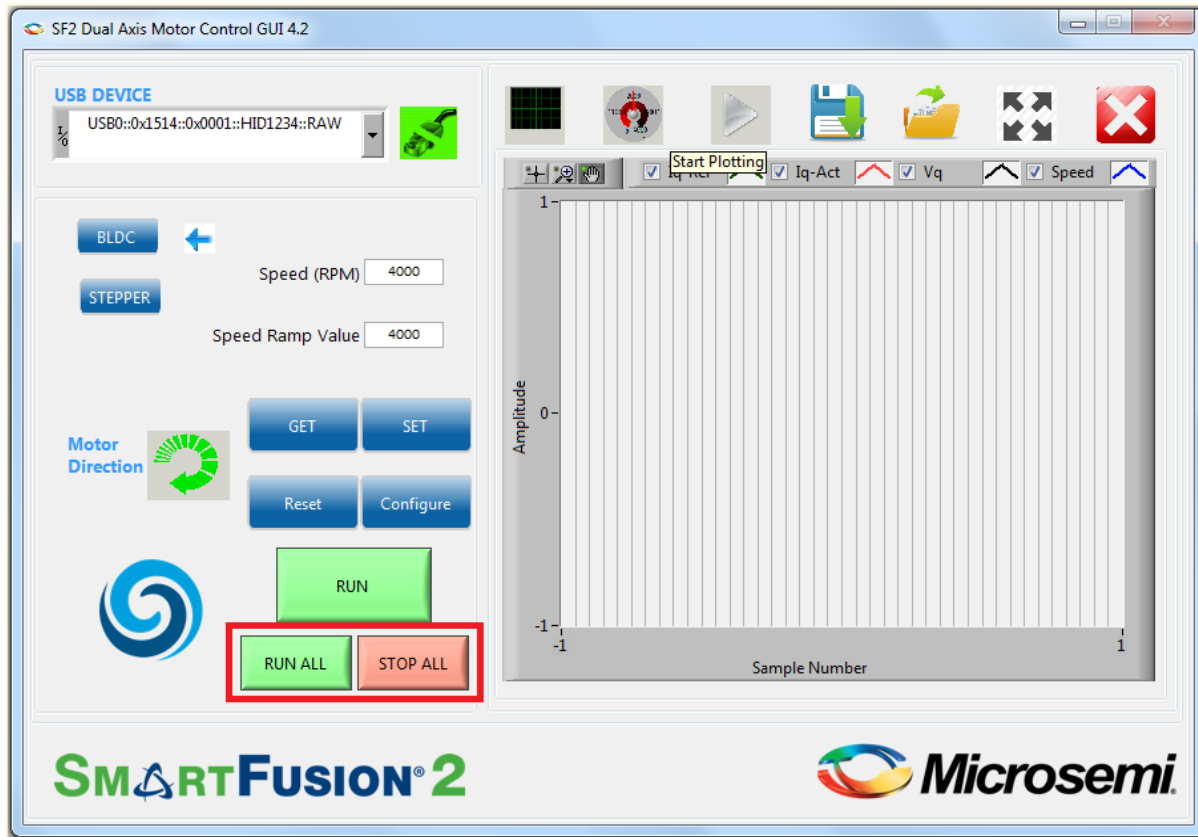


Figure 20 • SmartFusion2 Motor Control GUI - Run or Stop All Motors

- Click **Motor Direction** to set the motor direction. This button also indicates the current motor direction.

5. The GUI automatically plots waveforms when motor starts running. The plotting can be paused by clicking the pause button highlighted in [Figure 21](#).

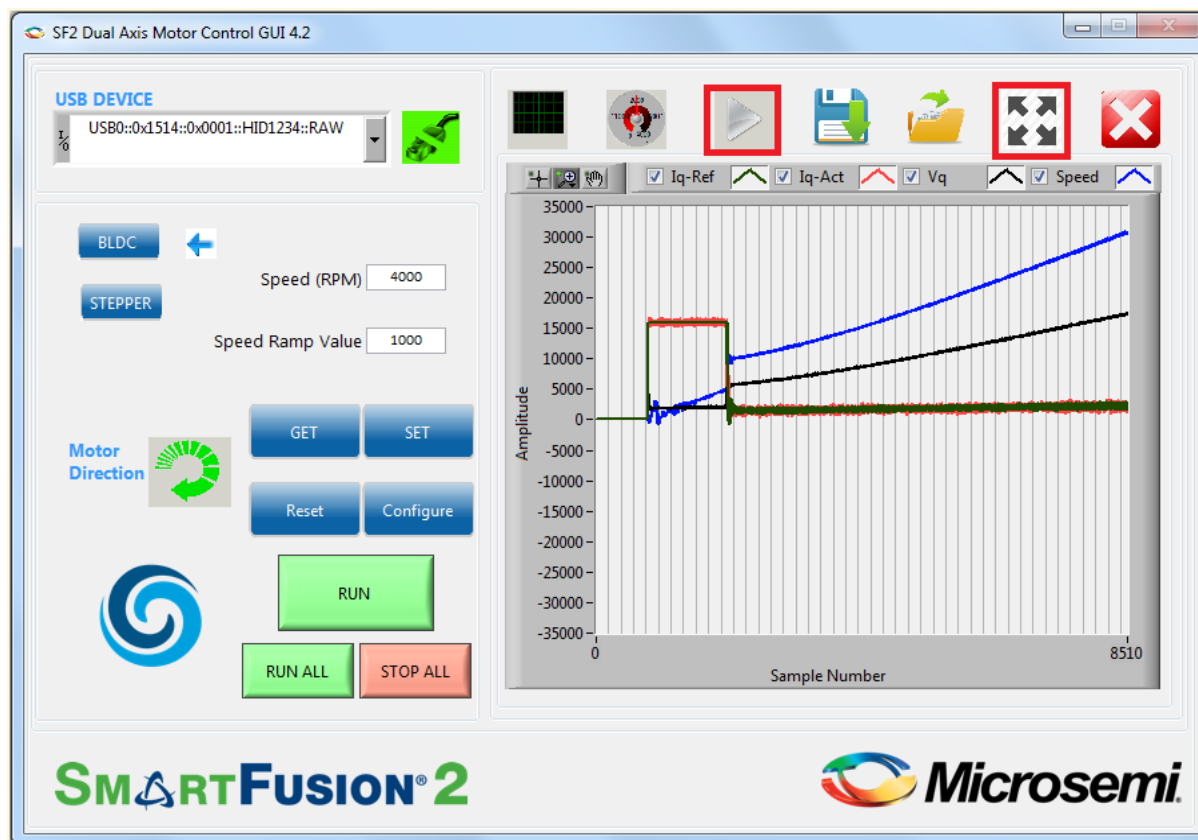


Figure 21 • SmartFusion2 Motor Control GUI - Start Plotting

6. Click **Zoom** to display the debug waveforms in a separate window as shown in Figure 22. Use the Graph Palette highlighted in Figure 22 to expand and analyze the waveforms.

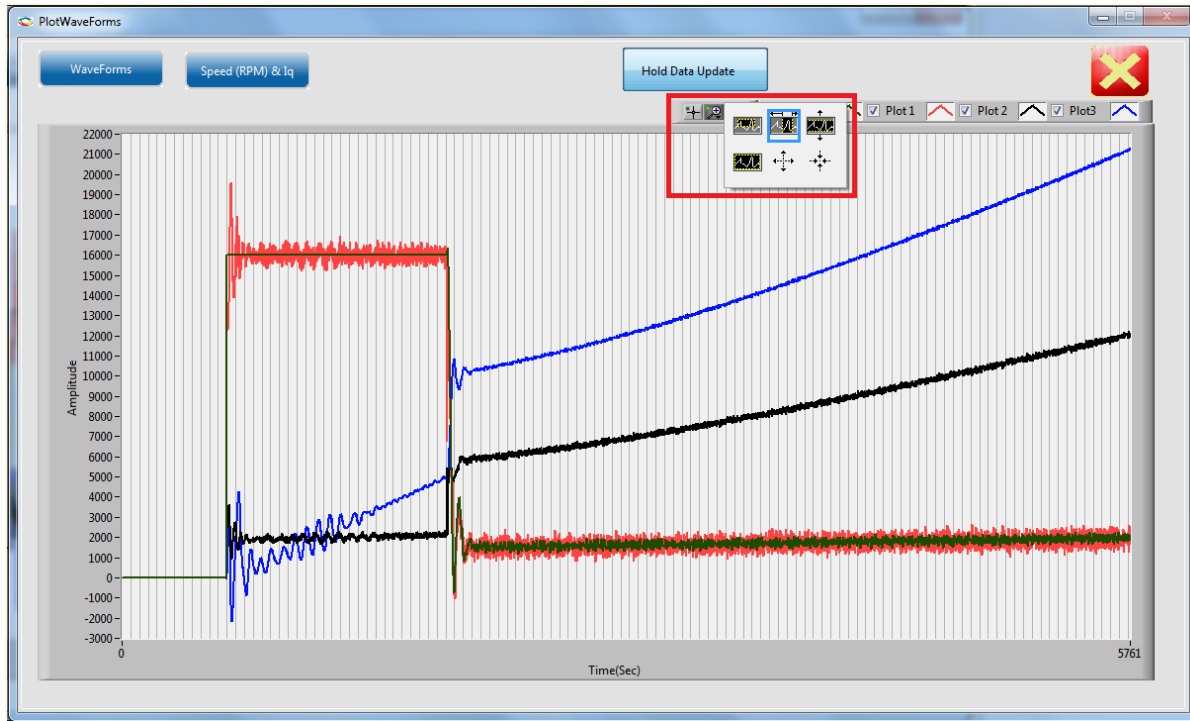


Figure 22 • Debug Waveforms Window

In Figure 23, Plot 0 corresponds to the speed PI output, while Plot 1 corresponds to the q-axis current. Plot 2 represents the I_q PI output while plot 3 represents the angle PI output. All plots are in per unit where a value of 32768 represents rated value.

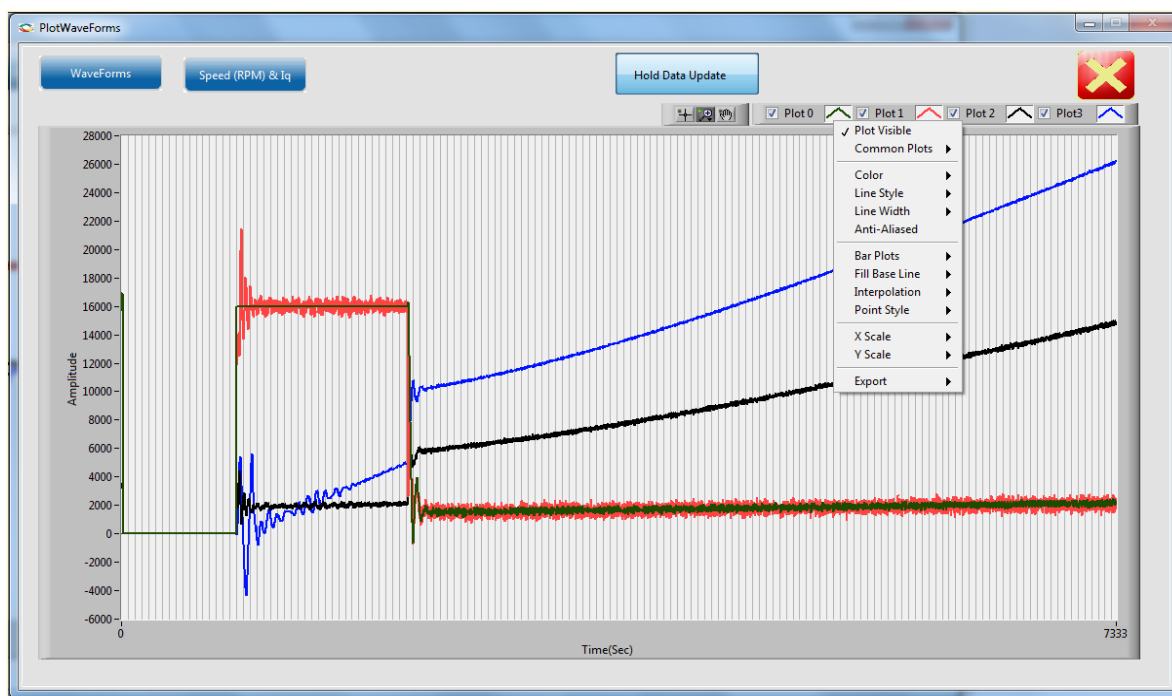



Figure 23 • Debug Waveforms Window with Options

Right-click on the plot menu to invoke the following options:

- a. Click  next to each plot to use the available options.
- b. Use the graph palette highlighted in Figure 22 on page 25 to move cursors, zoom, or pan the display. The graph palette appears with the following options, in order from left to right:
 - **Cursor Movement Tool:** Moves the cursor on the display.
 - **Zoom:** Zooms in and out of the display.
 - **Panning Tool:** Picks up the plot and moves it around the display.
7. Click **Close Zoom view** to close the waveforms window.
8. To view the motor speed on a tachometer dial, click **RPM and Current** as highlighted in Figure 24 on page 27.

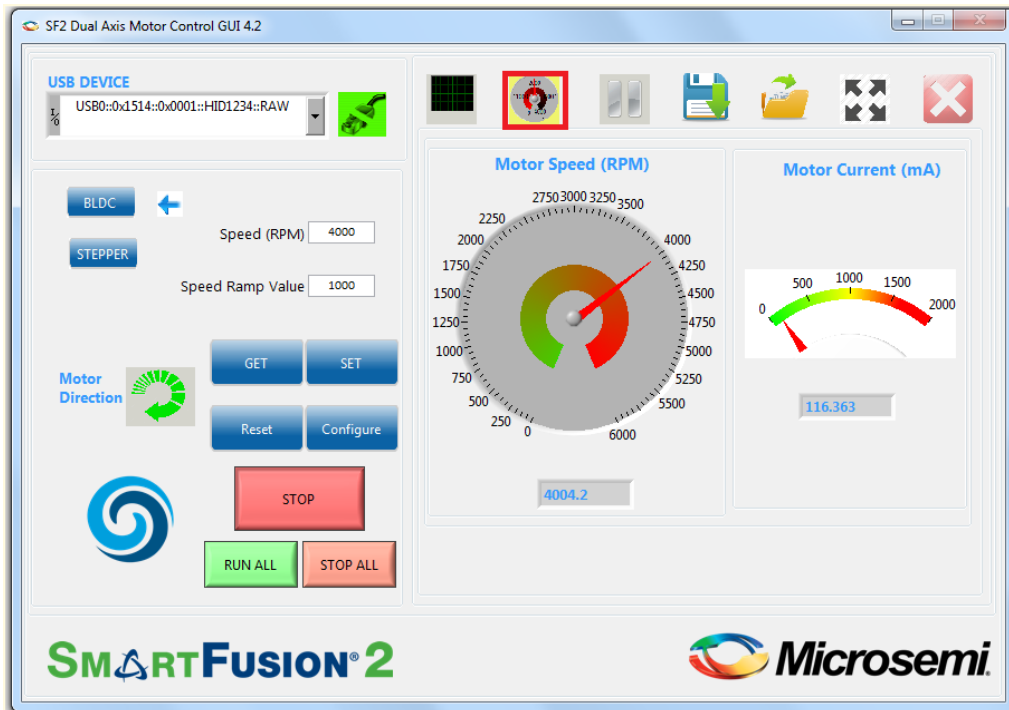


Figure 24 • SmartFusion2 Motor Control GUI - Displaying Speed and Current

- Click **Save Waveform** to save the current waveform in the GUI as a .tdms file. The saved waveform can be reloaded by using the **Load Waveform** option and loading the .tdms file.

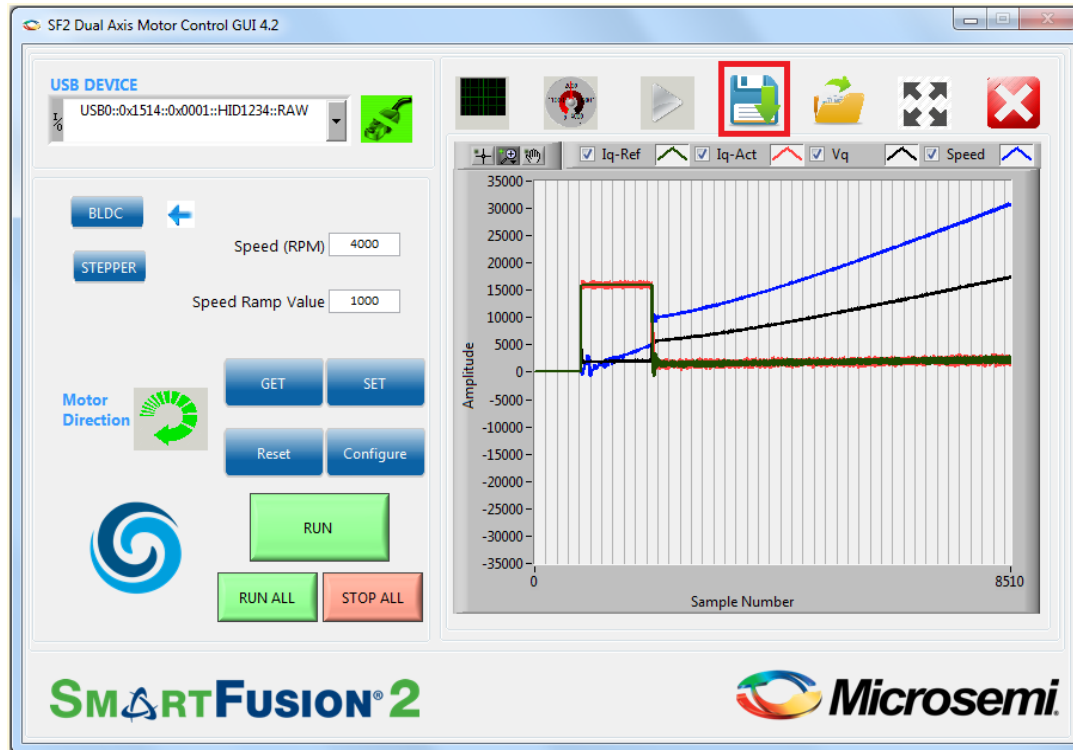


Figure 25 • SmartFusion2 Motor Control GUI - Saving and Loading Waveforms

Running Stepper Motors

This design runs stepper motors in:

- Speed Mode
- Position Mode

The Continuous Mode is selected by default.

Speed Mode

In Speed mode, the motor rotates continuously in a speed that is set. Click **Stop** to stop the running motor.

1. Click **Stepper** to select the stepper motor.
2. Verify that the Speed mode option is selected. Figure 26 shows the **SmartFusion2 Motor Control GUI - Stepper motor** window.
3. Click **GET** to see the current parameters. Click **Configure** to open a list of configurable parameters. Refer to Figure 26.

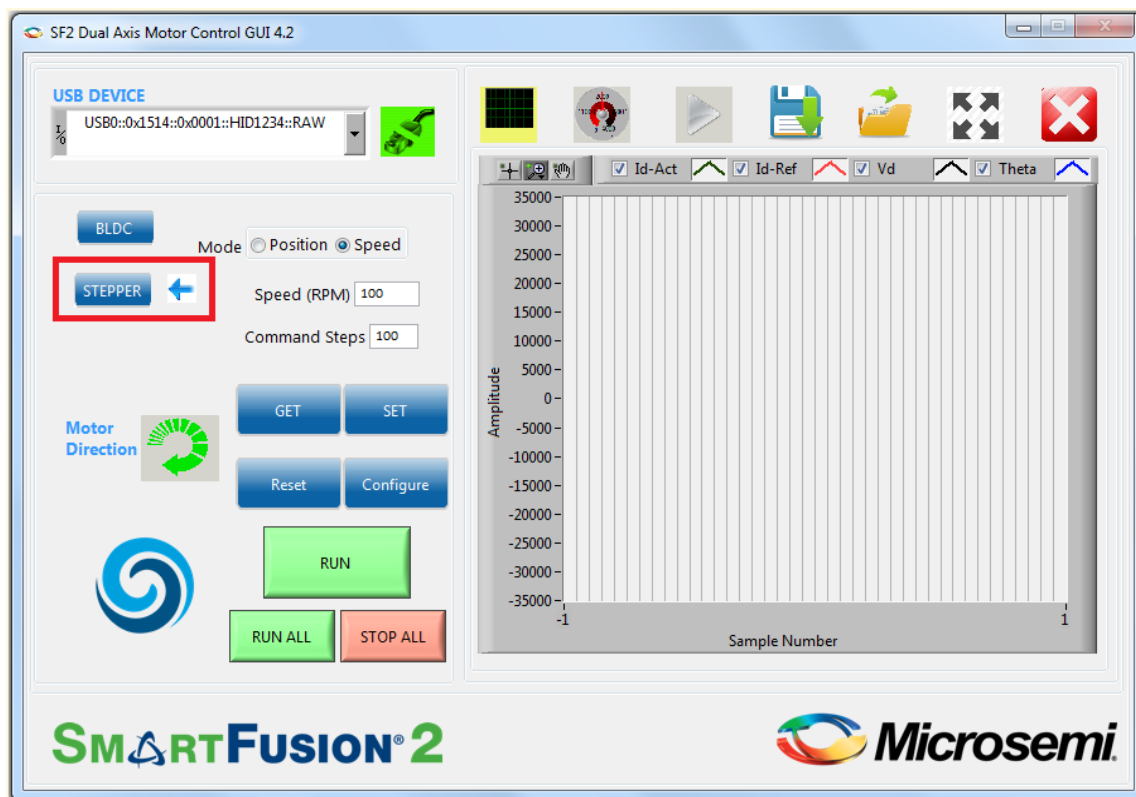


Figure 26 • SmartFusion2 Motor Control GUI - Stepper Motor Window

- Click **Reset** to reset all the stepper parameters to their default values in the GUI, but it does not enter them into the system.
 - Click **SET** to enter the current values into the system.
4. Click **RUN** to run the motor with the current parameters.
 5. Select step resolution value from the **Step Resolution** drop-down list.
 6. Enter a speed value between 1 and 200 RPM in **Speed (RPM)** and then click **SET**.

Notes:

- It is not necessary to stop the motor to change motor speed or the step resolution.
- To change the direction of the motor, click **Motor Direction**.

7. To increase motor torque, increase the current reference and click **SET**.

Caution: Increasing the current scaling value increases the motor current and the motor can get heated if it is run for a long time.

8. Click **STOP** to stop the motor.

Position Mode

In Position mode, the motor rotates and stops as per the command steps. It rotates in a speed that is set.

1. Select **Position mode** option and click **SET**.
2. Enter the required (absolute) position in **Command Steps**.
 - a. The motor provided with the kit has a step number of 200 by default. To run the motor through one revolution, enter 200 in **Command Steps**.
 - b. Click **SET**.
 - c. Click **RUN**. The motor runs through the specified number of steps.
 - In the Position mode, the motor moves through a fixed number of steps after which the motor stops rotating, but remains energized.
 - To move to a different position, enter the new position and click **SET**.
 - Click **STOP** to de-energize the motor. When the motor is de-energized, the current position is lost.

Plotting debug parameters by clicking **Plot Waveforms**, displays I_d PI output as plot 0, d-axis motor current (I_d) as plot 1, the number of steps moved (step count) as plot 2, and the angle generated as plot 3. Figure 27 shows the GUI in position mode.

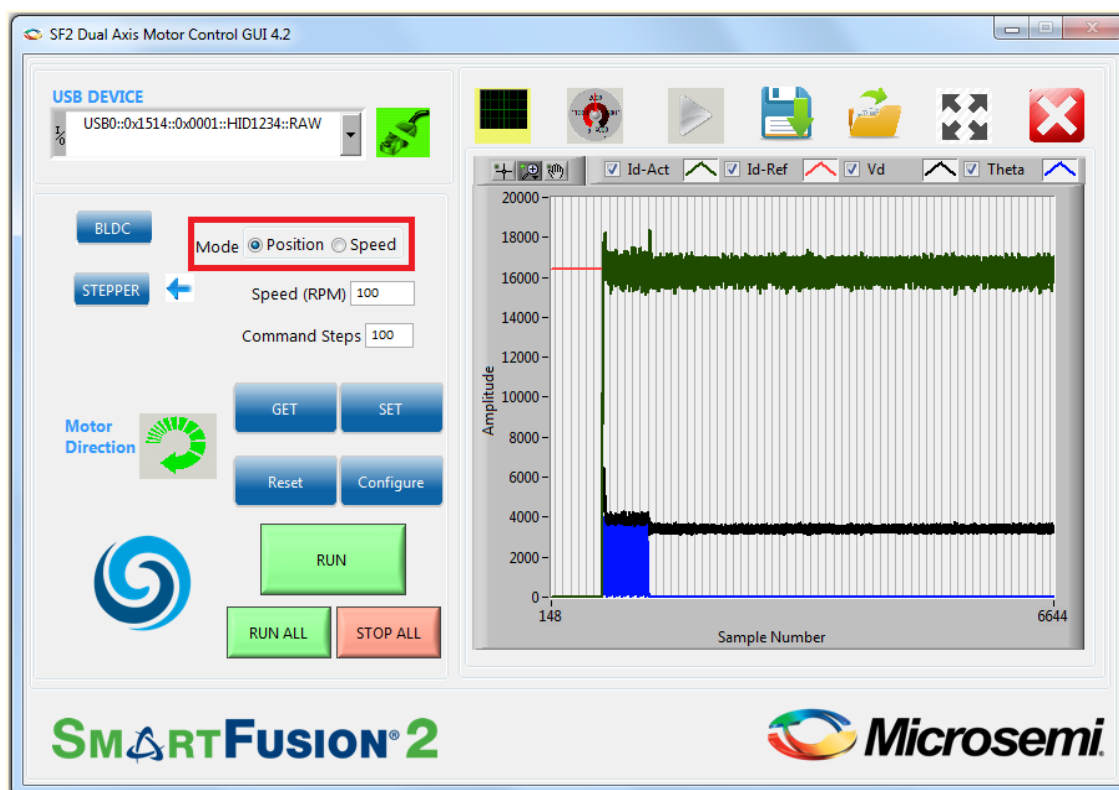


Figure 27 • SmartFusion2 Motor Control GUI - Stepper Motor in Position Mode

The motor runs at the specified speed through the number of steps.

3. Click **STOP** to stop the motor/de-energize the motor.
4. Click **EXIT** to exit the SmartFusion2 Motor Control GUI.

Appendix 1: Jumper Settings

Table 2 shows all the jumpers that are required to set on the SmartFusion2 Starter Kit board.

Table 2 • Jumper Settings on the SmartFusion2 Starter Kit Board

Jumper	Function	Default Settings	Notes
Power Supply			
J23	SOM power source	1-3 Closed	On-board power to SOM
J22	JTAG Mode	3-4 Closed	JTAG VPP to 3.3 V
J7, J13	Encoder - Single Ended selection	Open	To be set for single ended encoder
J8	Encoder – Differential selection	Open	To be set for differential encoder
J19	Shunt resistor for power measurement	Open	Voltage can be measured across shunt
J11	Encoder	Open	Port to connect encoder

Note: Figure 28 shows the jumper settings on the SmartFusion2 Starter Kit.

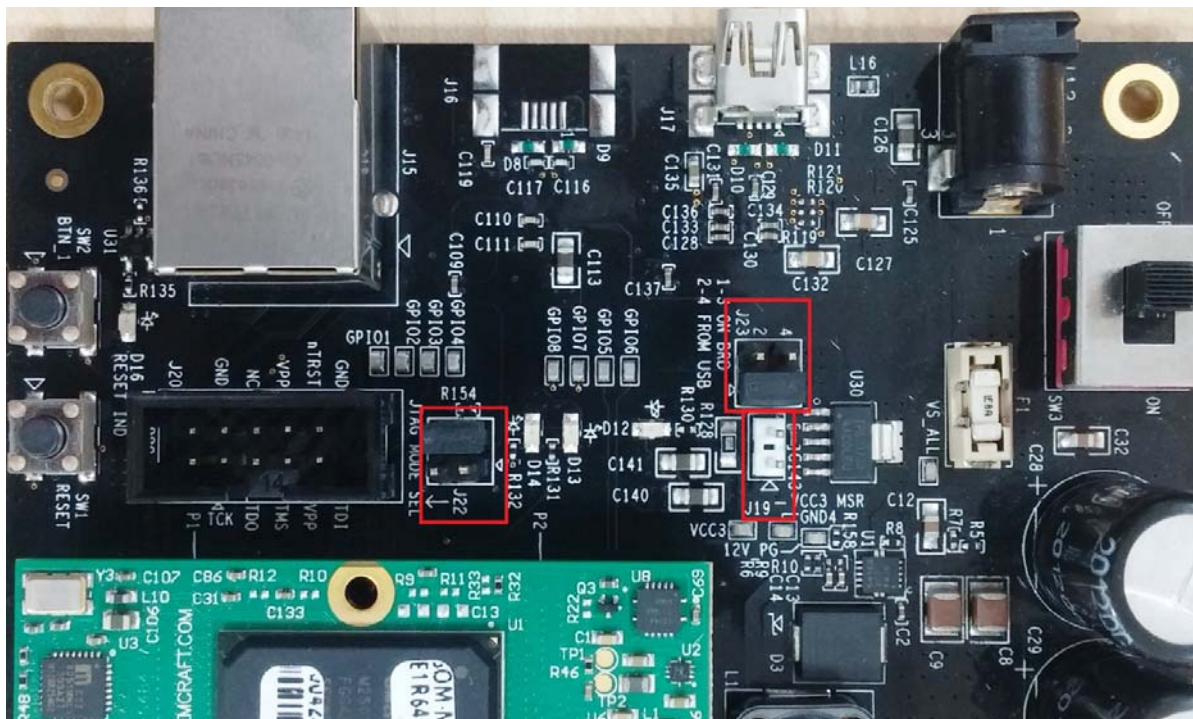


Figure 28 • Jumpers on SmartFusion2 Starter Kit

Appendix 2: Installing GUI on Windows 8

The following steps describe the procedure to be followed before following the steps in the ["GUI Driver Configuration" section on page 10](#).

1. Login using an administrator account.
2. Go to the **Settings** menu.
3. Click **Change PC Settings** at the bottom of the menu.
4. Click the **General** tab and scroll to the bottom and select **Restart Now** under Advanced Startup.
5. Select **Troubleshooting**.
6. Select **Advanced Options**.
7. Select **Startup Settings**.
8. Select **Restart**.
9. Press **7** to disable signature requirements on the menu that comes up during the restart process.
10. Login back using the same account used in the ["GUI Driver Configuration" section on page 10](#) procedure and complete the instructions in that section.

These steps eliminate the problems that you might encounter when trying to load the unsigned driver in Windows 8 machines.

Appendix 3: Connecting the Motor Terminals

BLDC Motor Connections

The following steps describe how to connect to the BLDC motor:

1. Identify and isolate the **BLDC Motor Terminals** (set of 3) and **Hall Sensor Terminals** (set of 5), as shown in Figure 29. These terminals are tied together.
2. Connect the **BLDC Motor Terminals** to the three pin plug, as shown in Figure 29.
3. Connect the **Hall Sensor Terminals** to the five pin plug, as shown in Figure 29.

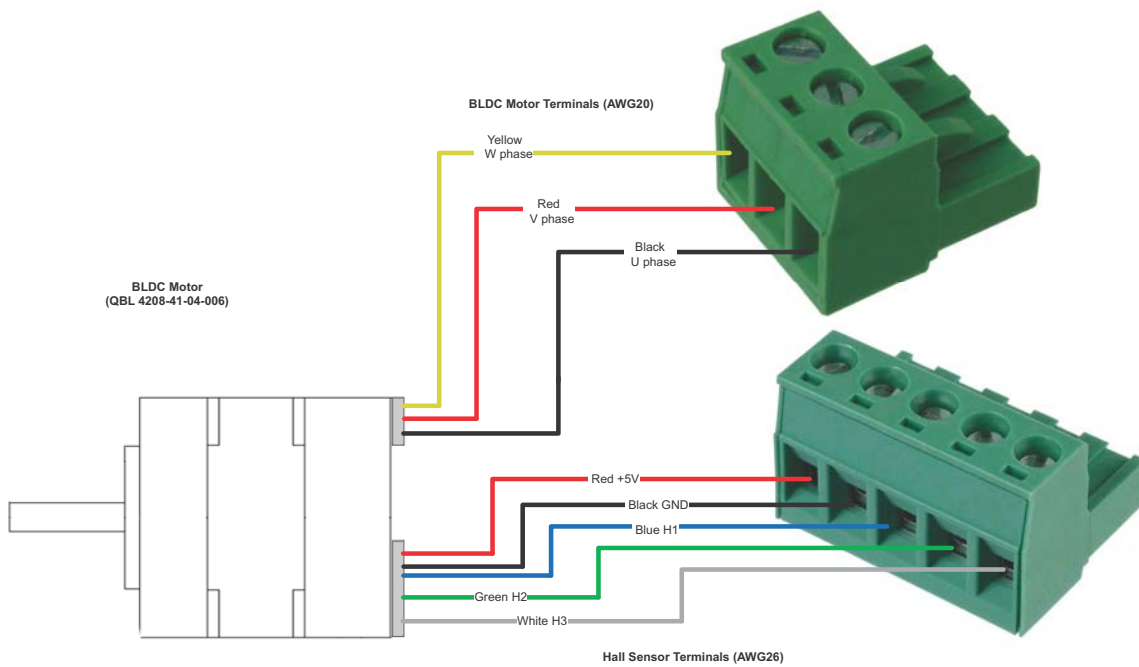


Figure 29 • Wiring Diagram for BLDC Motor Connectors

Stepper Motor Connections

The stepper motor has four terminals. The motor terminals of the stepper motor must be connected to the four pin plug, as shown in Figure 30.

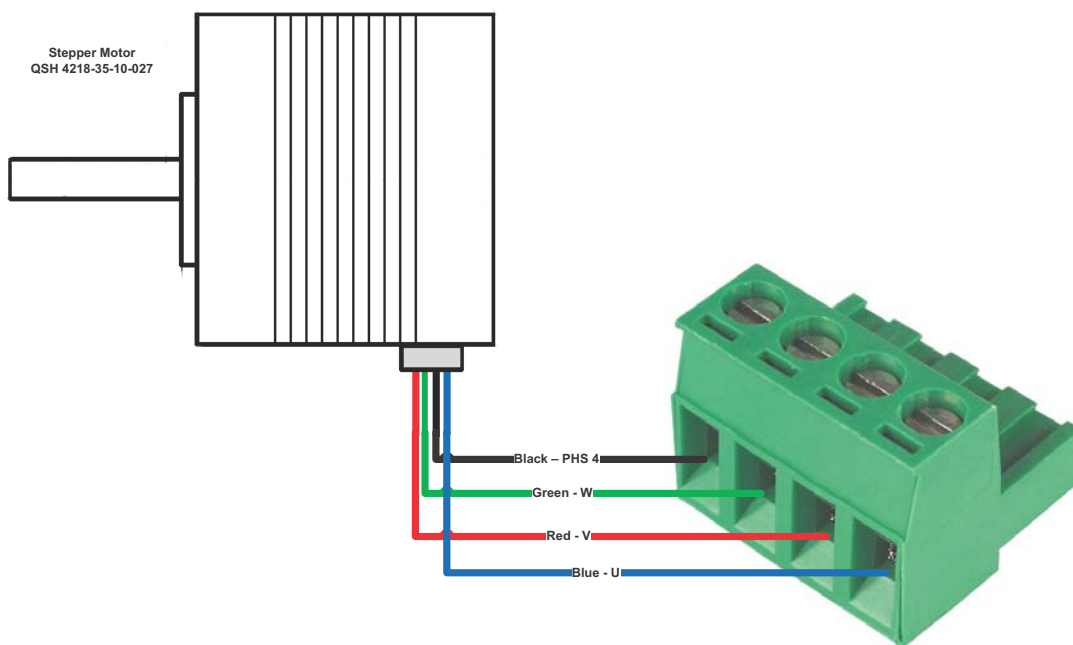


Figure 30 • Wiring Diagram for Stepper Motor Connectors

List of Changes

The following table shows important changes made in this document for each revision.

Date	Changes	Page
Revision 3 (July 2015)	Added " Appendix 3: Connecting the Motor Terminals " section on page 33 (SAR 69108).	33
Revision 2 (May 2015)	Updated Table 2 and added Figure 28 to update jumper settings (SAR 66381).	31 and 31
Revision 1 (February 2015)	Initial release.	NA

Product Support

Microsemi SoC Products Group backs its products with various support services, including Customer Service, Customer Technical Support Center, a website, electronic mail, and worldwide sales offices. This appendix contains information about contacting Microsemi SoC Products Group and using these support services.

Customer Service

Contact Customer Service for non-technical product support, such as product pricing, product upgrades, update information, order status, and authorization.

From North America, call 800.262.1060

From the rest of the world, call 650.318.4460

Fax, from anywhere in the world, 408.643.6913

Customer Technical Support Center

Microsemi SoC Products Group staffs its Customer Technical Support Center with highly skilled engineers who can help answer your hardware, software, and design questions about Microsemi SoC Products. The Customer Technical Support Center spends a great deal of time creating application notes, answers to common design cycle questions, documentation of known issues, and various FAQs. So, before you contact us, please visit our online resources. It is very likely we have already answered your questions.

Technical Support

For Microsemi SoC Products Support, visit

<http://www.microsemi.com/products/fpga-soc/design-support/fpga-soc-support>.

Website

You can browse a variety of technical and non-technical information on the SoC home page, at www.microsemi.com/soc.

Contacting the Customer Technical Support Center

Highly skilled engineers staff the Technical Support Center. The Technical Support Center can be contacted by email or through the Microsemi SoC Products Group website.

Email

You can communicate your technical questions to our email address and receive answers back by email, fax, or phone. Also, if you have design problems, you can email your design files to receive assistance. We constantly monitor the email account throughout the day. When sending your request to us, please be sure to include your full name, company name, and your contact information for efficient processing of your request.

The technical support email address is soc_tech@microsemi.com.

My Cases

Microsemi SoC Products Group customers may submit and track technical cases online by going to [My Cases](#).

Outside the U.S.

Customers needing assistance outside the US time zones can either contact technical support via email (soc_tech@microsemi.com) or contact a local sales office. [Sales office listings](#) can be found at www.microsemi.com/soc/company/contact/default.aspx.

ITAR Technical Support

For technical support on RH and RT FPGAs that are regulated by International Traffic in Arms Regulations (ITAR), contact us via soc_tech_itar@microsemi.com. Alternatively, within [My Cases](#), select **Yes** in the ITAR drop-down list. For a complete list of ITAR-regulated Microsemi FPGAs, visit the [ITAR](#) web page.



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