Quick Start Guide for EV-MCS-LVDRV-Z Motor Drive Evaluation Platform

Rev. 0.1

Created:	12/17/2014 12:17 PM
Author:	Dara O'Sullivan
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Modified by:	Dara O'Sullivan

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2 Revision History

Version	Modified By	Date	Comments
0.1	Dara O'Sullivan	1/6/2015	Document finalized.

3 Overview

This document will give a high level introduction to the EV-MCS-LVDRV motor control development platform and will provide a step-by-step approach that will get a motor up running. Instructions are provided on hardware setup, executable download, and graphical user interface (GUI) operation.

3.1 System requirements

Before you start working on the motor control platform, please make sure you have the hardware and software listed below.

Required Hardware

- ADSP-CM408F EZ-KIT rev 0.2 (This is ordered separately from the EV-MCS-LVDRV-Z)
- EV-MCS-LVDRV-Z power board, including BLY171D-24V-6000 motor with encoder, power supply and USB to serial cable

Optional Hardware

- Segger J-Link Lite debugger (This comes with the ADSP-CM408F Ezkit and can be used for executable download, and code development, but is not necessary for basic setup)

Required Software

- ADSP-CM40x SW Enablement Package version 1.2.0 (available here : http://sdk.analog.com/dw/sdks.aspx?file=ADUSC03)
- ADIMonitor Graphical User Interface (available here: https://ez.analog.com/docs/DOC-11971)
- Motor Control demo program executable and linker map file (also available here https://ez.analog.com/docs/DOC-11971)

Optional Software

- IAR Embedded Workbench (for code development, version 6.6 or higher)
- Segger J-Link Lite driver software

4 Hardware Setup

This section will describe how to setup the hardware. This only has to be performed once, when bringing up a new platform.

4.1 *Low Voltage Board*

Connect the EZ-kit to the Power Board as shown in Figure 1. Make sure both Samtec connectors mate completely. Also, note the location of Encoder, Power and Motor connectors.

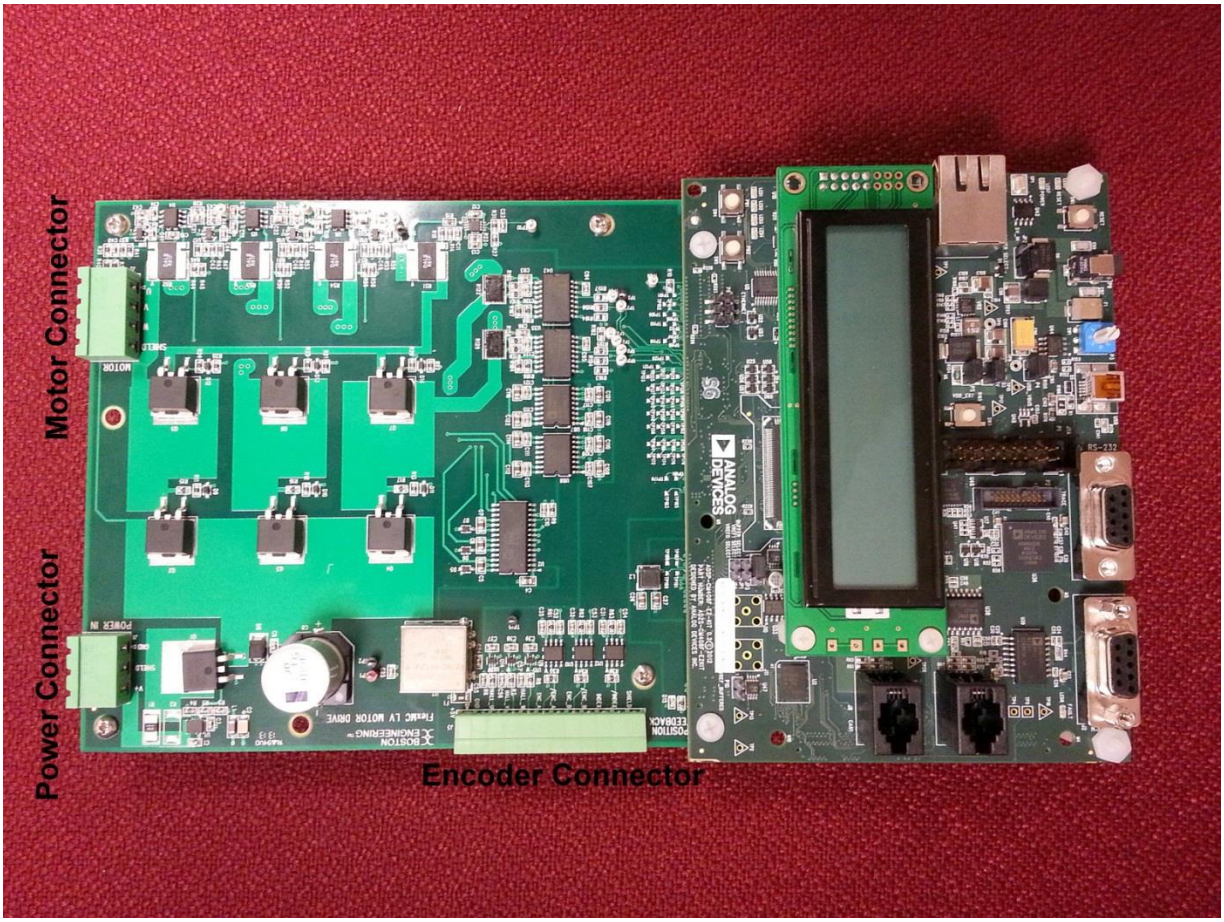


Figure 1 Low Voltage Power Board connected to CM408F EZ-kit.

Ensure that the Encoder connector is wired as shown in Figure 2 and Table 1.

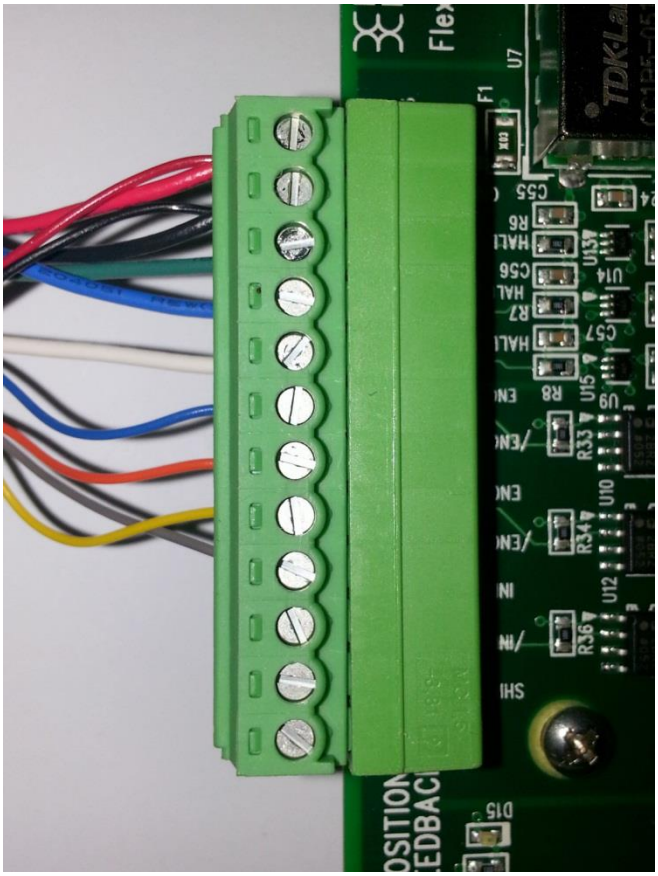


Figure 2 Wiring of Encoder Connector.

Pin	Color	Signal
1	Red (thick and thin wire)	+5V
2	Black (thick and thin wire)	GND
3	Green	HALL_U
4	Blue (thick)	HALL_V
5	White	HALL_W
6	Blue (thin)	ENC_A+
7	Orange	ENC_A-
8	Yellow	ENC_B+

9	*Grey*	*ENC_B-*
10	*NC*	*INDEX+*
11	*NC*	*INDEX-*
12	*NC*	*Shield*

Table 1 Encoder Connector

Ensure that the Motor and Power Connectors are wired as shown in *Figure 3*, *Table 2* and *Table 3*.

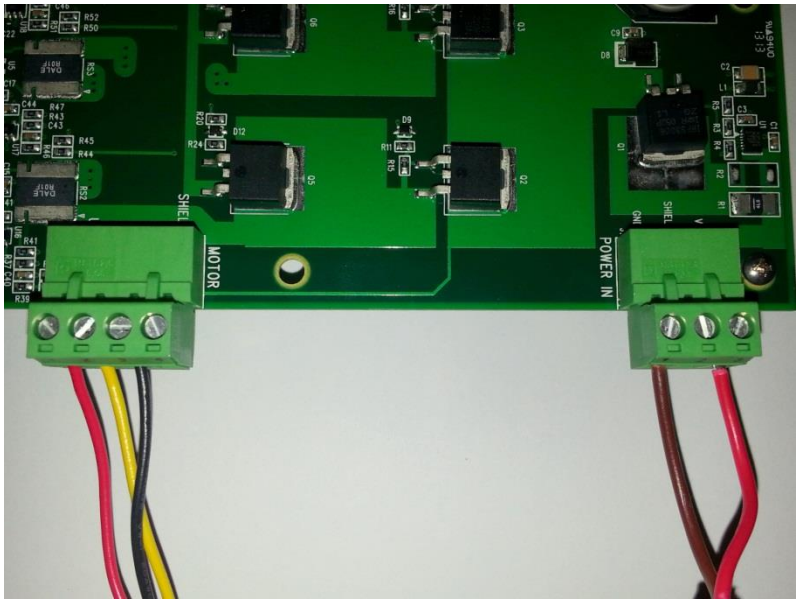


Figure 3 Wiring of Motor- and Power Connector.

Pin	Color	Signal
1	*Red*	*Motor phase U*
2	*Yellow*	*Motor phase V*
3	*Black*	*Motor phase W*
4	*NC*	*Shield*

Table 2 Motor Connector

Pin	Color	Signal
1	Brown	GND
2	NC	Shield
3	Red	+24V

Table 3 Power Connector

5 Software Setup

The software setup steps are as follows:

1. Download and install the ADSP-CM40x SW Enablement Package version 1.2.0 from the link shown previously in "SW Requirements". This includes the serial boot-loader which is needed for download of the executable to the processor.
2. Download and install the GUI from the Engineer Zone link provided in "SW Requirements". This requires the .NET framework to be on the PC and it will prompt the user to download this if it is not detected.
3. Download the motor control demo executable program from the Engineer Zone link provided in "SW Requirements" and program this to the processor board (ADSP-CM408 EZkit).

The first two steps are fairly self-explanatory. The third step – programming of the executable to the processor – can be carried out in two alternate ways. These are detailed in this section.

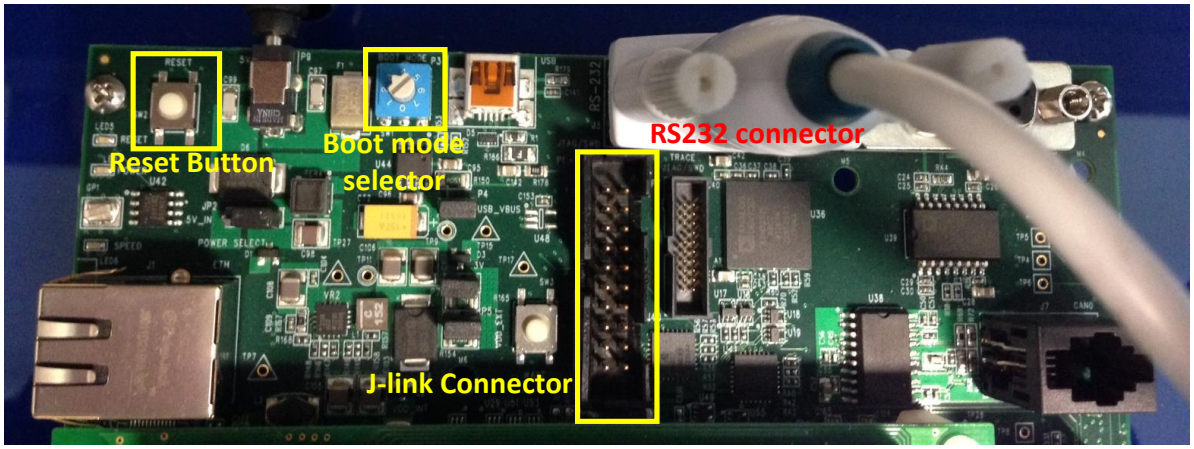
5.1 *Programming with Serial Downloader*

The serial downloader ("wsd.exe") is provided as part of the ADSP-CM408 SW Enablement Package and once this has been installed, assuming default installation directory structures, the downloader is found in C:\Analog Devices\ADSP-CM40x\CM403F_CM408F_EZ-KIT\tool\UARTFlashProgrammer. This method uses the **MC_Demo.hex** executable provided at the Engineer Zone link.

Steps:

1. Connect the EZ-kit to the PC using the USB-UART cable: UART (RS-232) connector on the EZkit, USB on the PC

2. Select Boot Mode 3 (UART Boot) on the EZkit using the selector switch P3 (adjacent to the power connector)



3. Power up the EZkit

4. Open the Windows Serial Downloader (wsd.exe) and select the appropriate options:

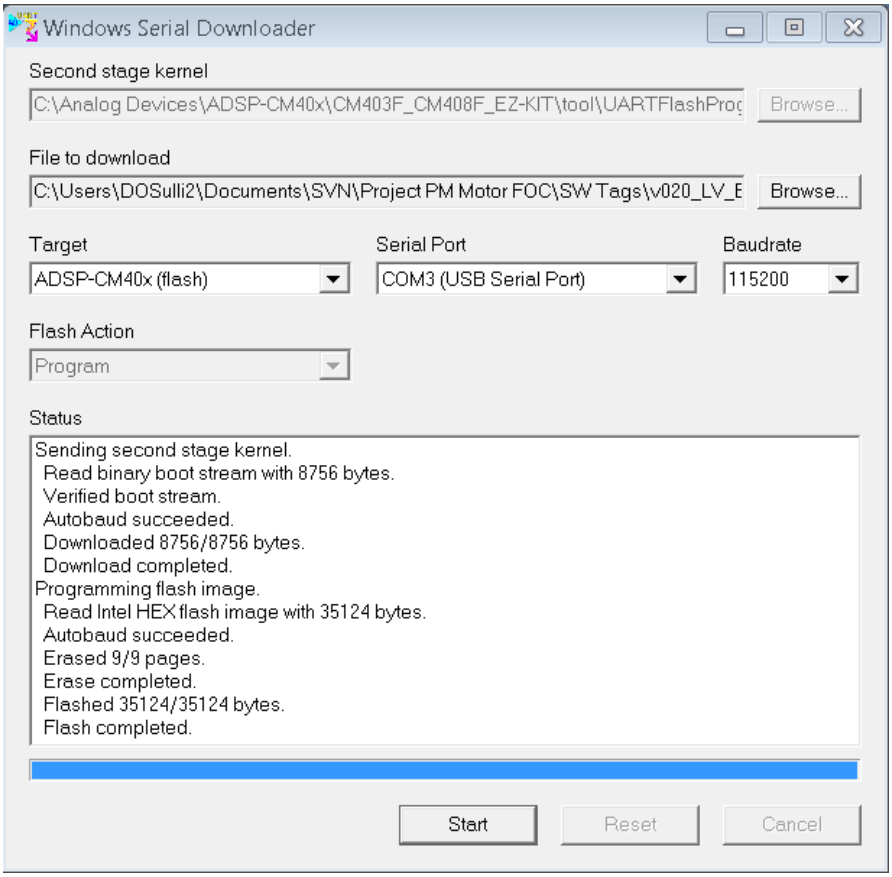
Target: ADSP-CM40x (flash)

Serial Port: Select the COM port to which the USB-serial cable is connected (if in doubt, check under ‘Device Manager->Ports’

Baudrate: 115200

5. Click "Browse" under "File to download" and navigate to the provided executable “MC_demo.hex”

6. Select "Start"



7. Once the operation completes, select Boot Mode 1 (SPI Flash Boot) on the EZkit, using the selector switch P3 (adjacent to the power connector)

8. Reset the EZkit (SW2 adjacent to power connector)

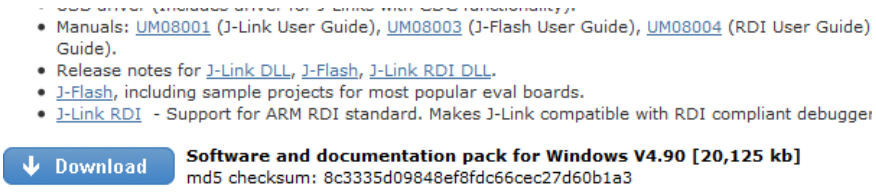
At this point the application should now be executing or loaded from flash, and the GUI can be connected to run the motor.

5.2 *Programming with Segger J-Link*

This method uses the JLink software and the debugger provided with the EZkit to program the processor flash memory.

1. Download and install Segger JLink Software (http://www.segger.com/jlink-software.html)

2. Click the blue download button under Windows. The version number may be different from the one shown below.



3. Enter your Segger JLink Lite serial number in the next box. This number is printed on the microcontroller on the debugger board.

4. Click the confirmation box on the next screen, download the software and install (default location is C:\Program Files(x86)\Segger)

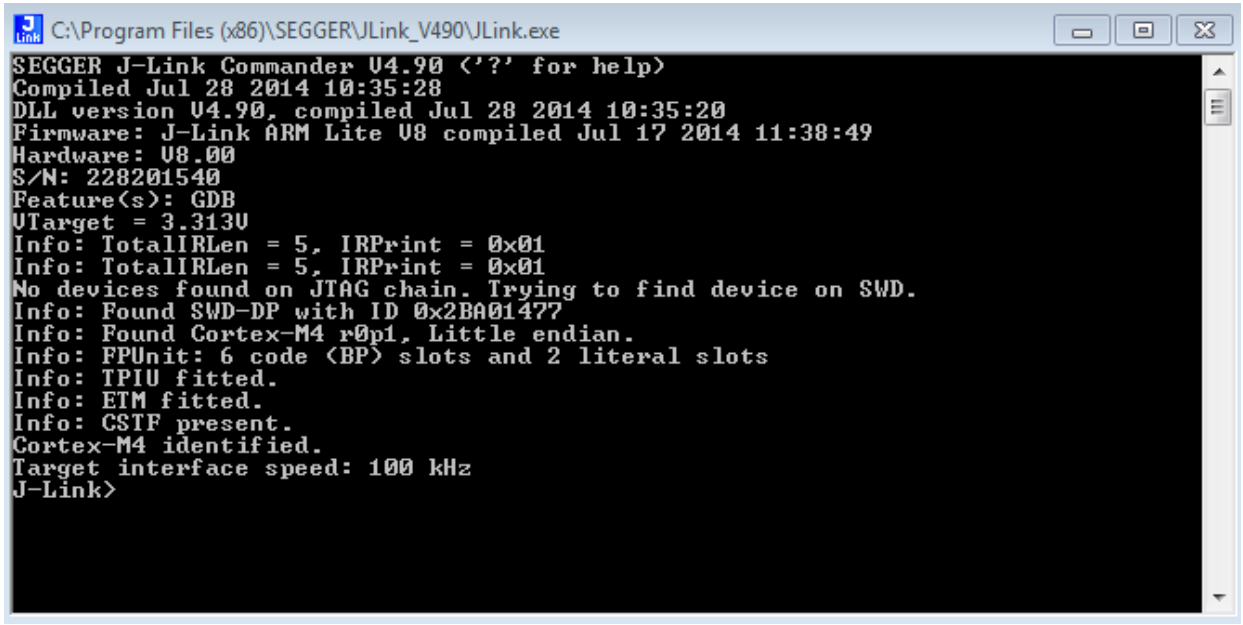
5. Connect the JLink to the PC USB port and the other end to the 20 pin connector on the CM40x board.

6. The PC will start automatically start installing drivers for your Jlink . Let it complete and turn on power to the EZkit.

7. Turn on power to the CM408x board.

8. Go to the location where Segger was installed and click on JLink .exe. In this case it is in: C:\Program Files (x86)\SEGGER\JLink_V490 (The version number and folder name may be different to the one in this example.)

9. The following should be displayed in the Jlink window. It should identify that a Cortex-M4 is connected to the Jlink .



1. Enter the following at the prompt:
   exec device = ADSP-CM408BSWZ-BF
   The following will be displayed indicating that the chip has been identified correctly:

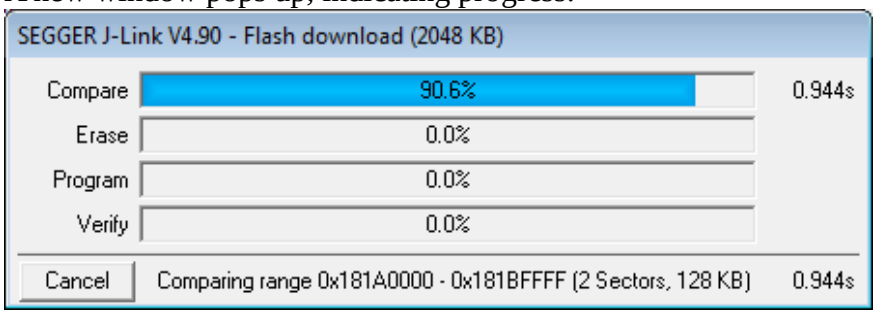
```
J-Link>exec device = ADSP-CM408BSWZ-BF
Info: Device "ADSP-CM408BSWZ-BF" selected (2048 KB flash, 64 KB RAM).
```

2. Copy the binary file you need to load into the CM40x in a known location. For this example, we will be placing the file **MC_demo.bin** in C:\temp

3. In the JLink window, type the following to load the binary code at address 0x1800 0000, which is the start of flash.
   loadbin c:\temp\MC_demo.bin, 0x18000000

```
J-Link>exec device= ADSP-CM408BSWZ-BF
Info: Device "ADSP-CM408BSWZ-BF" selected (2048 KB flash, 64 KB RAM).
J-Link>loadbin c:\temp\MC_demo.bin, 0x18000000
```

   A new window pops up, indicating progress:



   The JLink window will also show information about the flash procedure.

```
J-Link>loadbin c:\temp\MC_demo.bin, 0x18000000
Halting CPU for downloading file.
Downloading file... [c:\temp\MC_demo.bin]
Info: J-Link: Flash download: Flash programming performed for 1 range (65536 by
es)
Info: J-Link: Flash download: Total time needed: 6.429s (Prepare: 0.665s, Compar
e: 0.009s, Erase: 0.712s, Program: 4.971s, Verify: 0.015s, Restore: 0.055s)
J-Link>
```

4. Reset the EZkit (SW2 adjacent to power connector)

At this point the application should now be executing or loaded from flash, and the GUI can be connected to run the motor.

6 GUI Configuration

Once the installation zip file is extracted, the GUI application is loaded by running the installer executable "ADIMonitorGUI.exe". This GUI requires the .NET framework and this will be downloaded if it is not already on the PC. The first step is to set up the serial port (having connected the USB-serial converter to the EZkit RS232 port). This is accomplished by right-clicking the bottom right-hand corner of the GUI and selecting *Connect.* The program should automatically select the correct COM port, but if several options are available, right-click *Configure* and select the correct one. Once this is selected press, *Save* and then *Connect.*

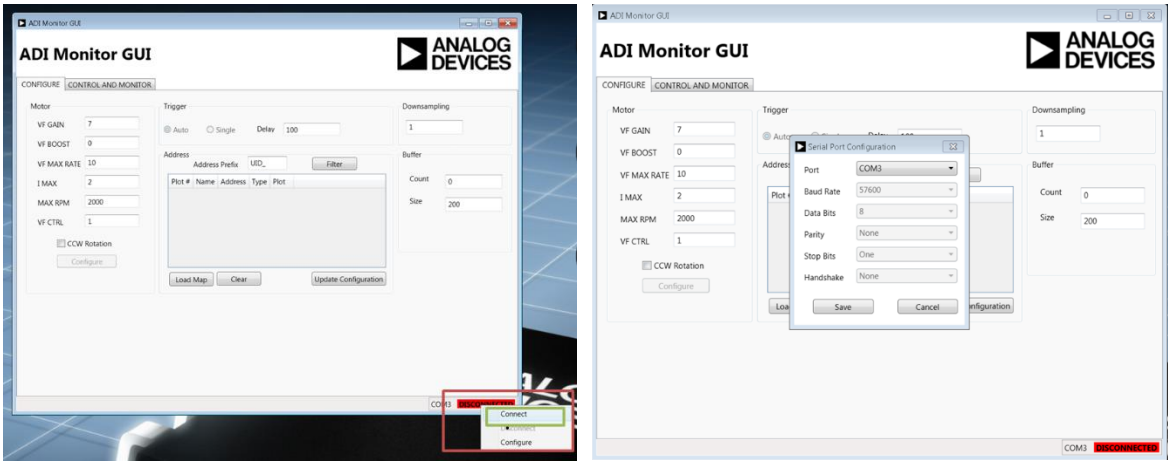


Figure 4: Serial Port Setup

The next step is to configure the motor control settings. These are listed in *Table 4*, along with an explanation of their relevance. The default settings are for open loop Volts/Hz control. Closed loop field-oriented control (FOC) can also be selected by changing the setting for VF_CTRL. (The executable provided will run in either mode; however, sample C code is only provided and supported for open loop mode).

Parameter	Open Loop V/f control	Closed loop FOC
VF_GAIN	Volts per Hz representation	Only used for open loop
VF_BOOST	Low speed boost voltage representation	Only used for open loop
VF_MAX_RATE	RPM change per 0.1 ms sample	Only used for open loop
I_MAX	Not used	Not used
MAX_RPM	Max rpm	
VF_CTRL	Set to 1 for open loop V/f	Set to 0 for closed loop FOC
CCW rotation	Check for CCW rotation. Uncheck for CW rotation. When looking into shaft end of motor.	
Speed reference	Speed reference	

Table 4: Motor Control Settings

Once the configuration settings have been entered, press *Configure*. Typical settings for open loop control are depicted in *Figure 5*. Please note that the VF_GAIN and VF_BOOST settings do not directly refer to volts/Hz or volts quantities. Care should be taken when setting the VF_GAIN quantity. If it is set too high, the motor will draw large currents and an overcurrent trip may occur. Also if the VF_MAX_RATE is set too high, the applied motor voltage and frequency will ramp too quickly – especially if a large step change in speed reference occurs – potentially causing an overcurrent trip. If an overcurrent or PWM trip occurs, set the GUI start/stop command to *Stop* and reset the EZkit using the reset switch. Reduce VF_GAIN or VF_MAX_RATE to limit the steady state and transient current amplitudes.

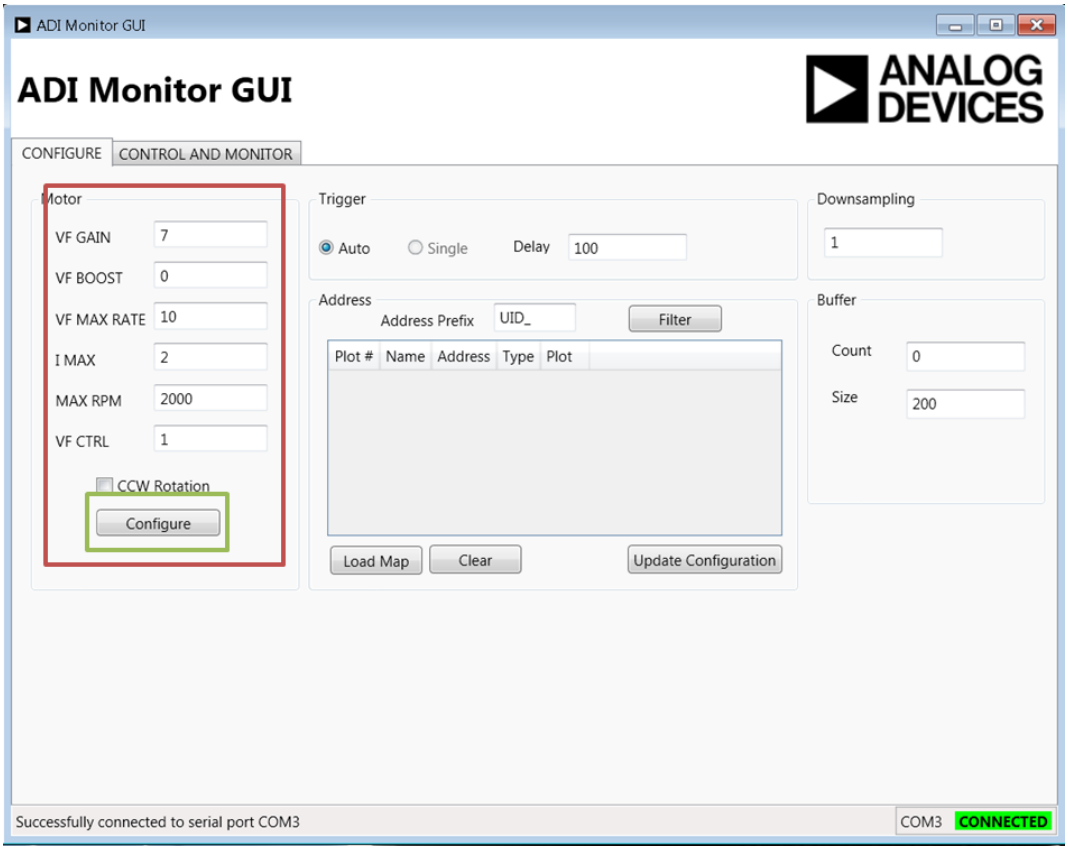


Figure 5: Motor Control Configuration – Typical open loop settings.

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7 Running the Motor

In order to control the motor, navigate to the *Control and Monitor* tab. From here, the motor can be started by pressing the *Start* button, and the speed varied by moving the slider or entering a speed in the numeric box. This is illustrated in Figure 6.

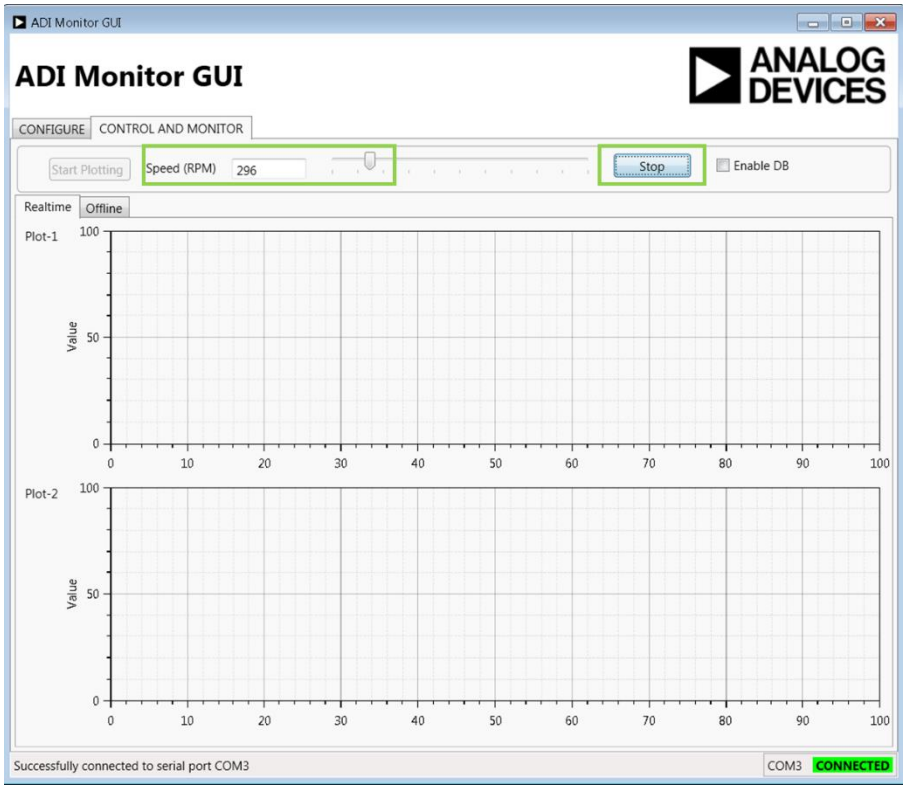

Figure 6: Motor Run Screen

8 Data Visualization

In order to import visualization data into the GUI, the linker map file (**MC_demo.map**) provided with the demo C code or executable must be loaded. This is selected from the *Configure* tab as illustrated in Figure 7 with the resultant variable list shown in Figure 8. The variables provided by default have a UID_ prefix in the map file and are listed in the Table below, along with their data types. It should be noted that the GUI cannot determine from the map file if a variable has signed or unsigned type, so if a variable is of signed type (e.g. duty_a) it is necessary to manually change the Type from UINT16 to SINT16 in the relevant column of Figure 8.

Variable Name	Variable	Data Type
Idc_LV	DC bus current in Amps	SINGLE
Idc_LV_adc	DC bus current – ADC value	UINT16
Vd	D-axis motor voltage per unit	SINGLE
Vdc_LV	DC bus voltage in Volts	SINGLE
Vdc_LV_adc	DC bus voltage – ADC value	UINT16
Vq	Q-axis motor voltage per unit	SINGLE
Vu_LV	U-phase motor voltage (filtered) in Volts	SINGLE
Vu_LV_adc	U-phase motor voltage (filtered) – ADC value	UINT16

Vv_LV	V-phase motor voltage (filtered) in Volts	SINGLE
Vv_LV_adc	V-phase motor voltage (filtered) – ADC value	UINT16
Vw_LV	W-phase motor voltage (filtered) in Volts	SINGLE
Vw_LV_adc	W-phase motor voltage (filtered) – ADC value	UINT16
duty_a	A phase duty cycle counter	SINT16
duty_b	B phase duty cycle counter	SINT16
duty_c	C phase duty cycle counter	SINT16
hall_state_monitor	Hall signals code	UINT16
ia_adc	U phase current – SAR ADC value	UINT16
ia_sar	U phase current – SAR Amps value	SINGLE
ia_sinc	U phase current – SINC Amps value	SINGLE
ib_adc	V phase current – SAR ADC value	UINT16
ib_sar	V phase current – SAR Amps value	SINGLE
ib_sinc	V phase current – SINC Amps value	SINGLE
ib_sinc_raw	V phase current – SINC ADC value	SINT16
ic_adc	W phase current – SAR ADC value	UINT16
ic_sar	W phase current – SAR Amps value	SINGLE
ic_sinc	W phase current – SINC Amps value	SINGLE
ic_sinc_raw	W phase current – SINC ADC value	SINT16
qep_cnt_monitor	Quadrature encoder count	UINT16
speed_fil	Speed in rpm (filtered)	SINGLE
speed_raw	Speed in rpm (unfiltered)	SINGLE
theta_enc	Electrical angle from encoder	SINGLE
theta_vf	Open loop electrical angle	SINGLE

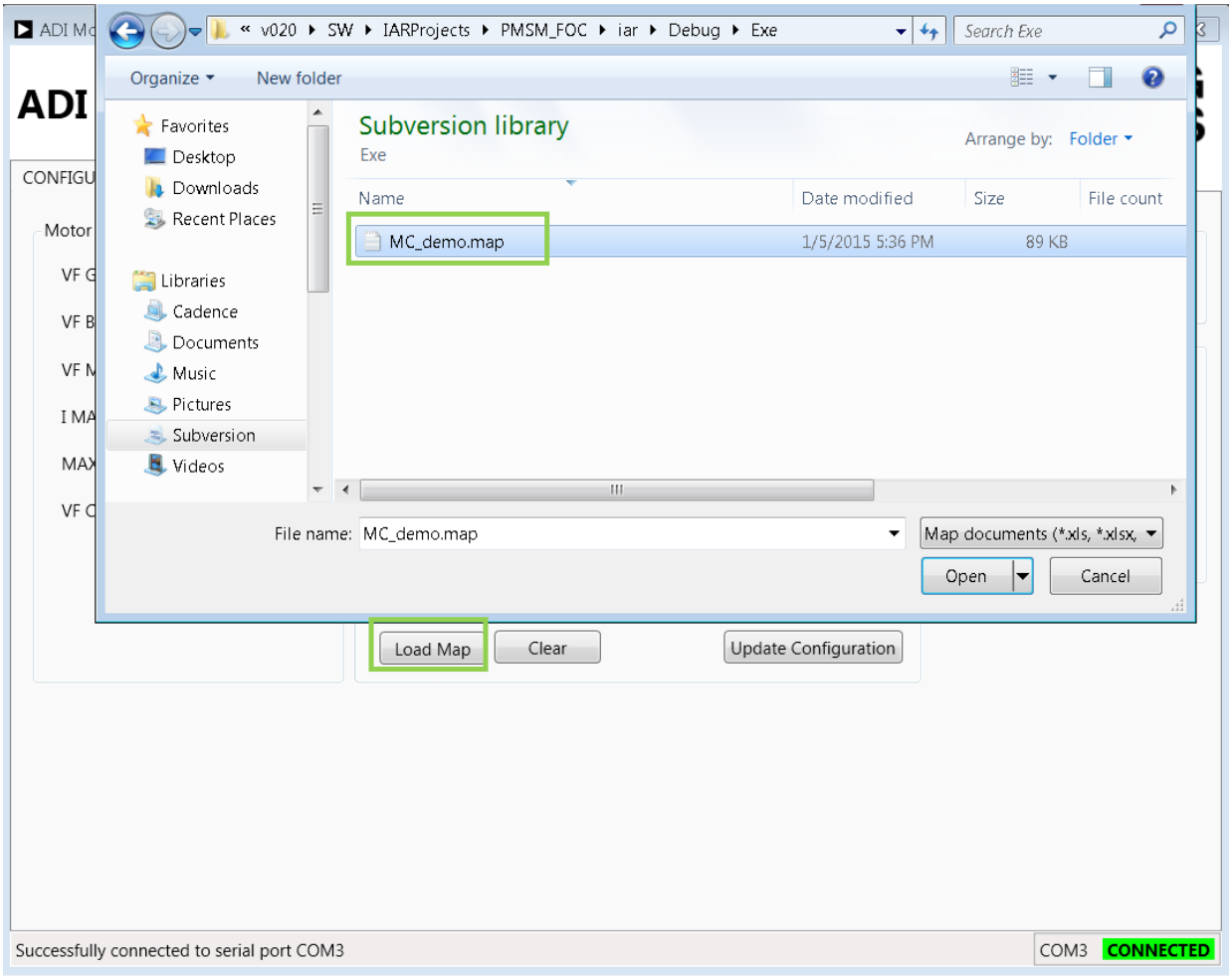

Figure 7: Load Map file for Data Visualization

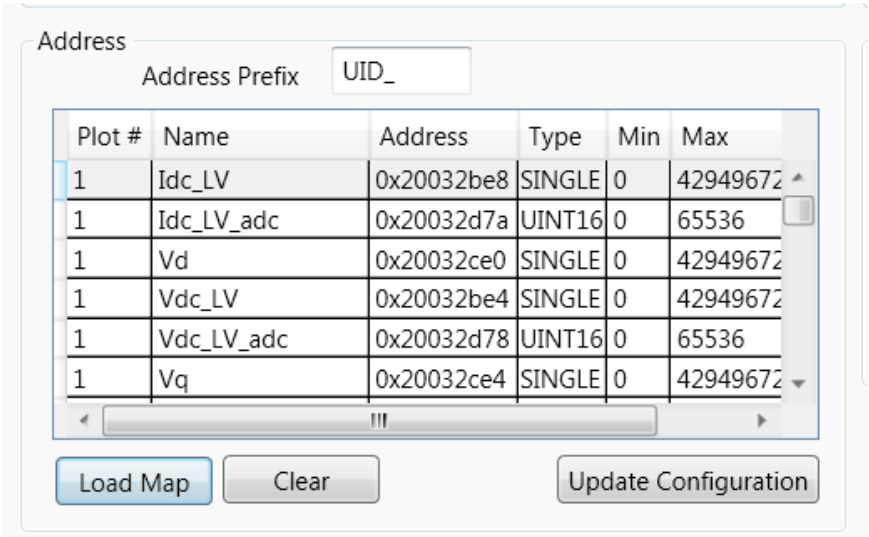

Figure 8: Visualization Variables

In order to select a variable for plotting, selection is by means of the check-box in the Plot column. The

variable can be plotted in Plot 1 or Plot 2 (see Figure 6). There are certain constraints on the number of bytes and buffers that can be streamed using the GUI. The program will limit the total buffer size to 1.7k bytes. The number of variables plotted can be increased by reducing the buffer size, which is maximum 200, although a total maximum selected variable size of 8 bytes is allowed (e.g. 2xSINGLE or 4xINT16, or 1xSINGLE+2xINT16 etc).

The steps to prepare for plotting of variables are (refer to Figure 9):

1. Select all of the variables to be plotted and whether each one is to be on Plot 1 or Plot 2, bearing in mind the maximum buffer memory size (1.7k) and the maximum byte count per buffer (8).
2. Down Sampling factor – the buffer time slice length equals the PWM switching period x Down Sampling ratio, so for a down sampling ratio of 1, the sampling period will be 100μs, and with a buffer length of 200, the plot time slices will be of 20ms length. To look at longer time slices, increase the down sampling factor.
3. Press *Update Configuration*
4. On the *Control and Monitor* tab, press *Start Plotting.*
5. If the variables are to be changed, press *Stop Plotting* and return to the *Configure* tab to change the configured variables.

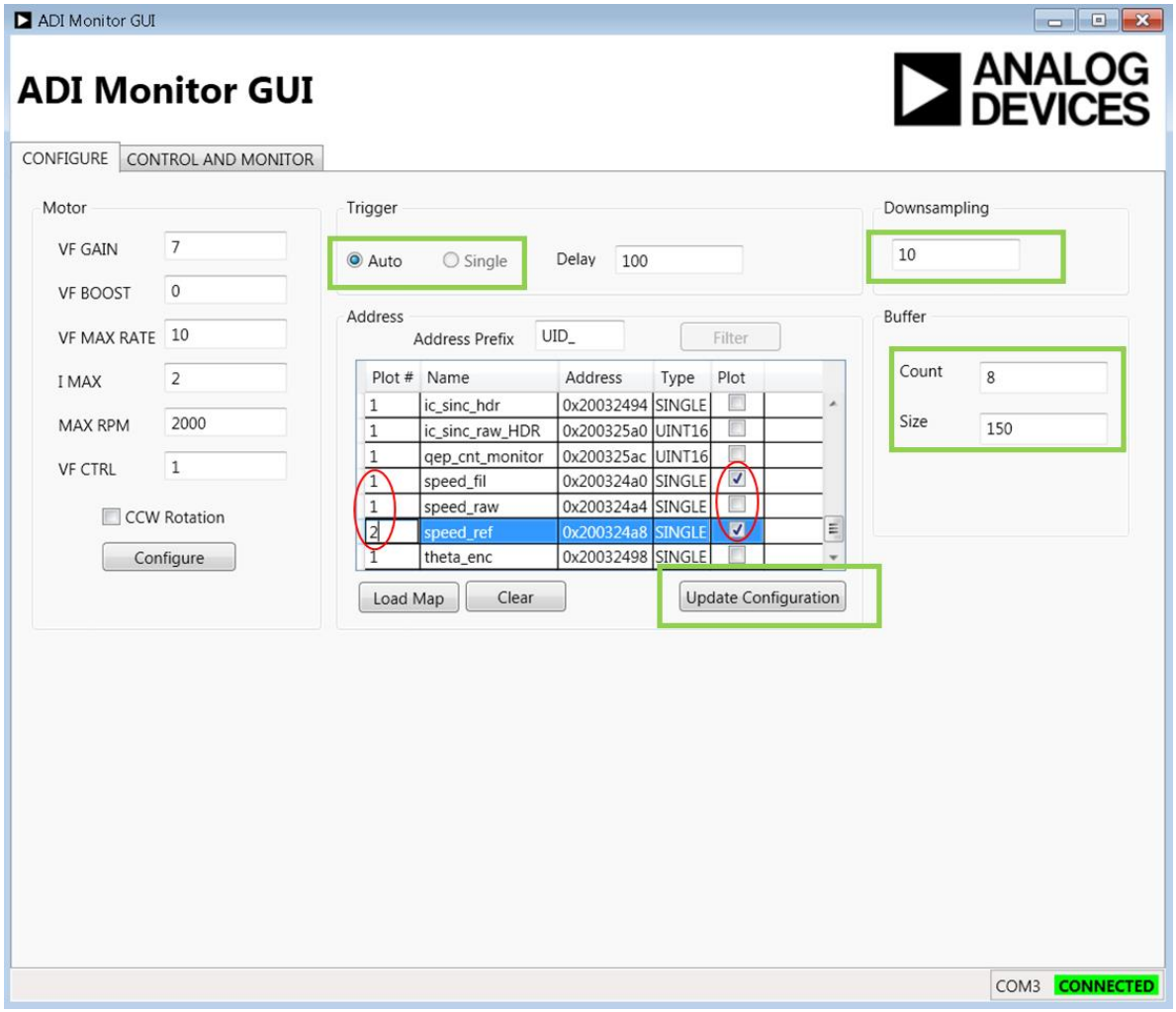

Figure 9: Setup of Variables for Plotting

The variables will start to plot in the *Control and Monitor* tab as illustrated in Figure 10.