User's Guide
SLVU361C–April 2010–Revised October 2018

DRV88xx Evaluation Modules

This document is provided as a supplement to the DRV8802, DRV8812, DRV8813, DRV8814, DRV8824, DRV8825, DRV8841 and DRV8843 datasheets. It details the hardware implementation of the CPG004 DRV88xxEVM Customer Evaluation Module (EVM). On this document, DRV88xx will be used interchangeably to refer to any of the aforementioned devices.

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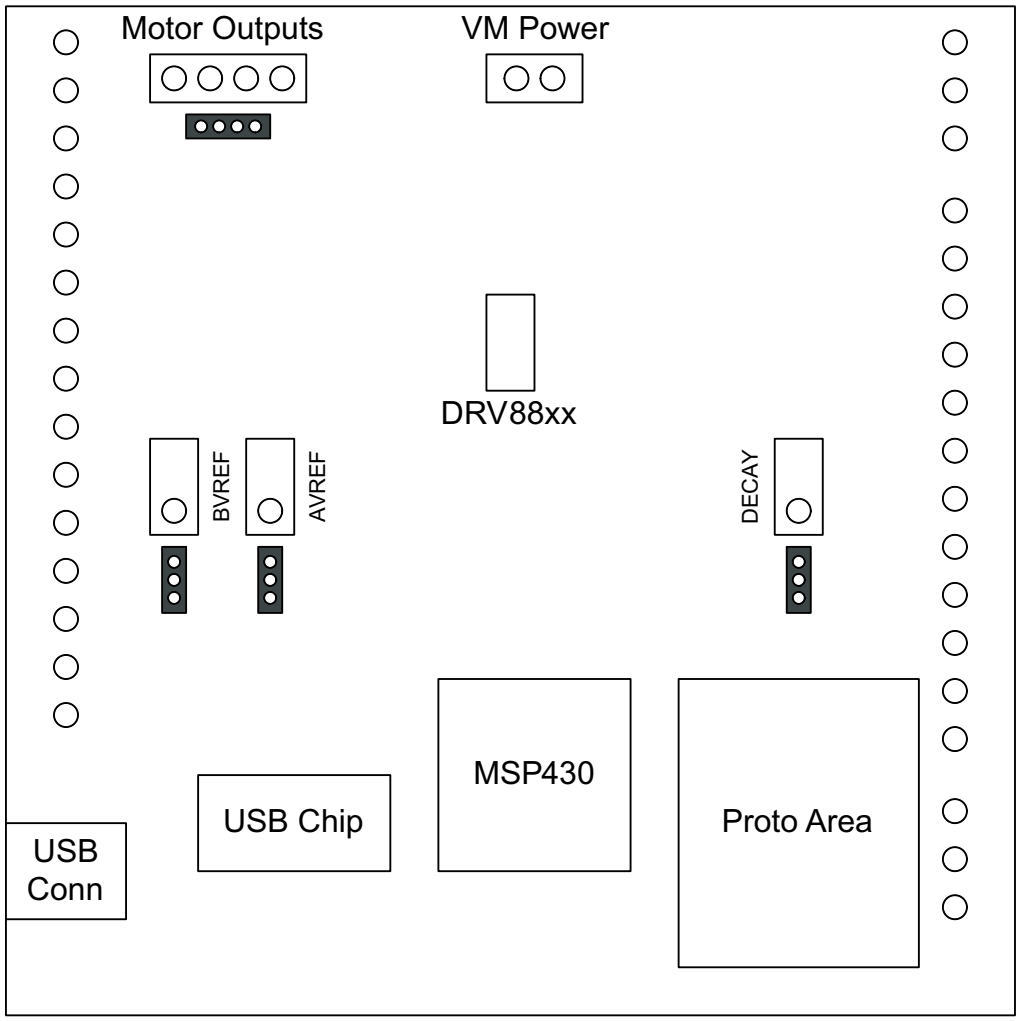
1 Block Diagram



Where DRV88xx stands for one of DRV8802, DRV8812, DRV8813, DRV8814, DRV8824, DRV8825, DRV8841 or DRV8843.

1.1 Power Connectors

The DRV88xx Customer EVM offers access to VM (Motor Voltage) power rail via a terminal block (J1). A set of test clips in parallel with the terminal block allows for the monitoring of the input power rail.

User must apply VM according to datasheet recommended parameters.

NOTE: VDD for logic and microcontroller is derived from USB interface.

1.2 Test Stakes

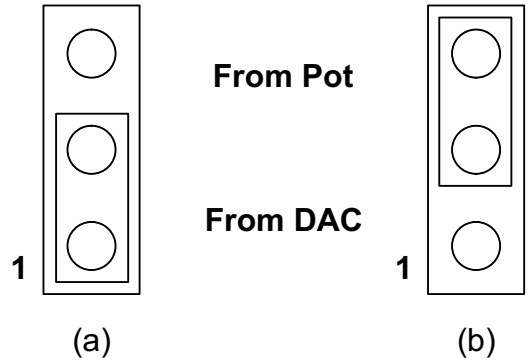
Every pin on the DRV88xx device has been brought out to a test stake. A label on the silkscreen identifies each signal.

For those pins that change functionality depending on device flavor, a table is provided with corresponding function name on its particular column.

1.3 Jumpers

There are only three jumpers the user must configure as detailed below. Default configuration assumes microcontroller resources are being utilized. As an alternative, a variable resistance is provided on the opposing jumper configuration.

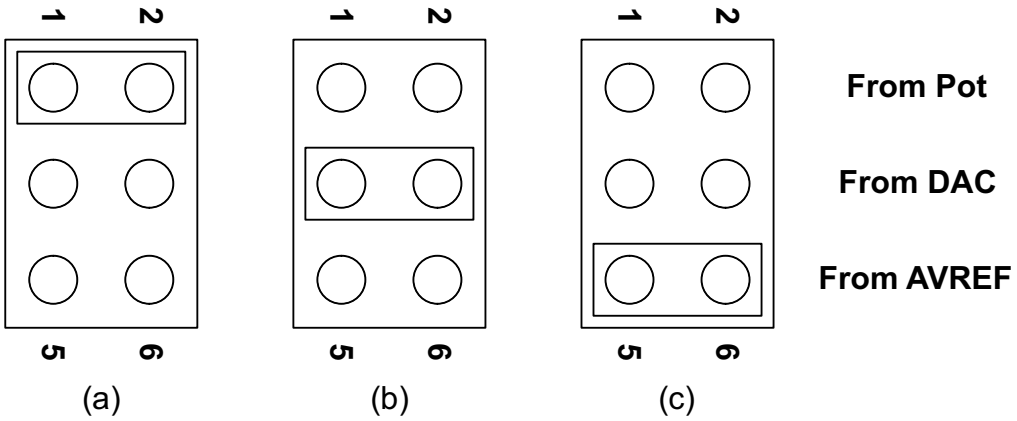
1.3.1 AVREF Select Jumper (JP2)



To configure the AVREF select jumper:
(a) Use position JP2-1:2 to select the MSP430 DAC output (default).
(b) Use position JP2-2:3 to select the respective variable resistance potentiometer. This jumper should not be left open as lack of reference voltage on the device will minimize current sourcing into the respective H Bridge, resulting in very poor motion or no motion at all.

Figure 1. AVREF Select Jumper Configuration

1.3.2 BVREF Select Jumper (JP1)



To configure the BVREF select jumper:
(a) Use position JP1-1:2 to select the respective variable resistance potentiometer.
(b) Use position JP1-2:3 to select the MSP430 DAC functionality.
(c) Use position JP1-5:6 to select AVREF as reference voltage source. This jumper should not be left open as lack of a reference voltage on the device will minimize current sourcing into the respective H Bridge, resulting in very poor motion or no motion at all.

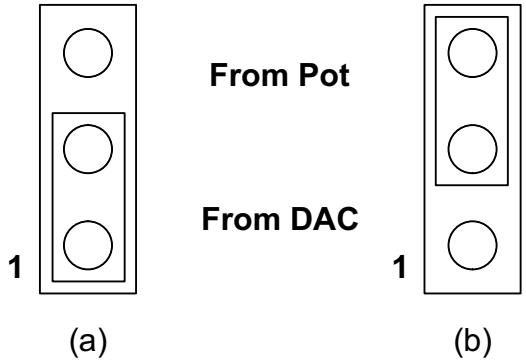
Figure 2. BVREF Select Jumper Configuration

1.3.2.1 BVREF Default Jumper Allocation

Table 1. BVREF Default Jumper Allocation on a Per Device Basis

DEVICE	BVREF JUMPER DEFAULT
DRV8802/12/13/14	JP1-3:4
DRV8824/25	JP1-5:6
DRV8841/43	JP1-3:4

1.3.3 DECAY Select Jumper (JP3)



To configure the DECAY select jumper:
(a) Use position JP3-1:2 to select the MSP430 GPIO functionality (default).
(b) Use position JP3-2:3 to select the respective variable resistance potentiometer. Allowing the jumper to not be placed, will result in the device operating under mixed decay mode.

Figure 3. DECAY Select Jumper Configuration

1.4 Motor Outputs

There are two ways of connecting the different motor styles (single bipolar stepper motor or two DC motors) into the CPG004_DRV88xx Evaluation Module: four pin header (J4) and four position terminal block (J3). Although feasible, we do not recommend the connection of any motor into the test clips as these are Kelvin connections and not rated for high current output.

2 GUI Software Installation

The following section explains the location and the procedure for installing the software correctly.

NOTE: Ensure that no USB connections are made to the EVM until the installation is completed. The installer also installs the LabVIEW RTE 2014 version and the FTDI Driver along with the GUI installation.

2.1 System Requirements

- Supported OS – Windows 7 and 10 (32 Bit,64 Bit)
- Recommended RAM - 4GB or higher
- Recommended CPU Operating Speed – 3.3 GHz or higher

2.2 Installation Procedure

The following procedure helps you install the DRV8813 GUI.

1. Double click on the Setup_DRV88xx_EVM.exe as shown below.

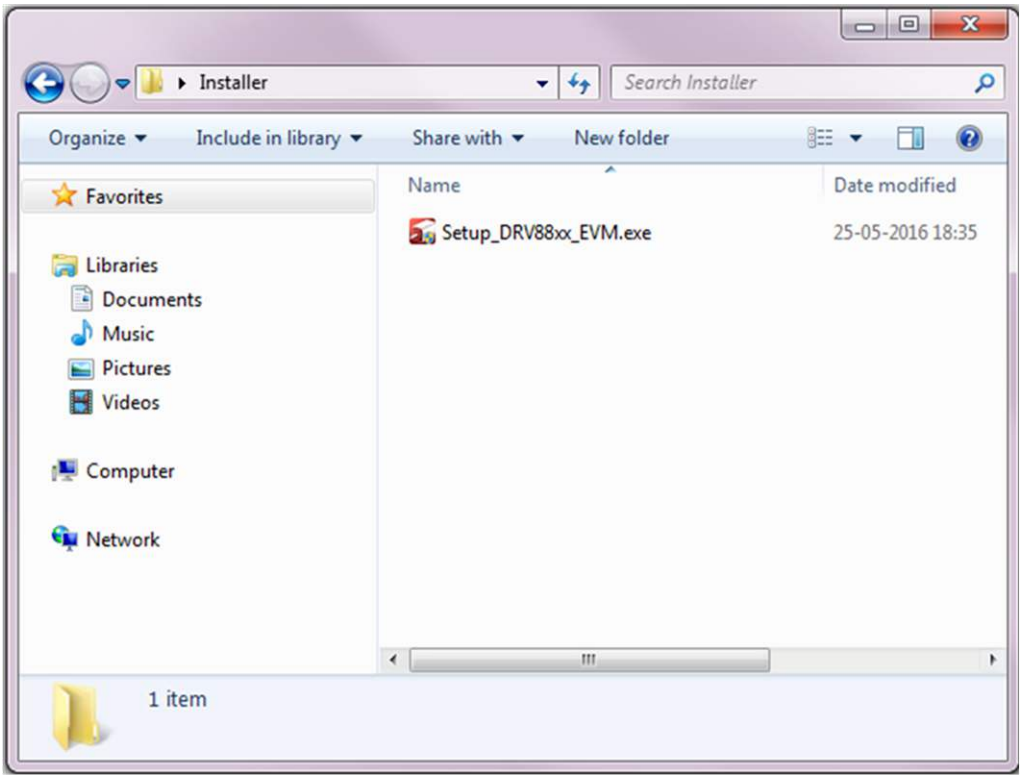


Figure 4. Setup_DRV88xx_EVM.exe

2. A screen shown below appears and it indicates installer initialization. Click Next button.

Figure 5. Installation Initialization

3. The License Agreements appear.
   a. A Screen as shown will appear, displaying the license agreement of DRV88xx EVM GUI. Please read through the agreement carefully and enable the “I Accept the License Agreement” radio button and press the Next button.

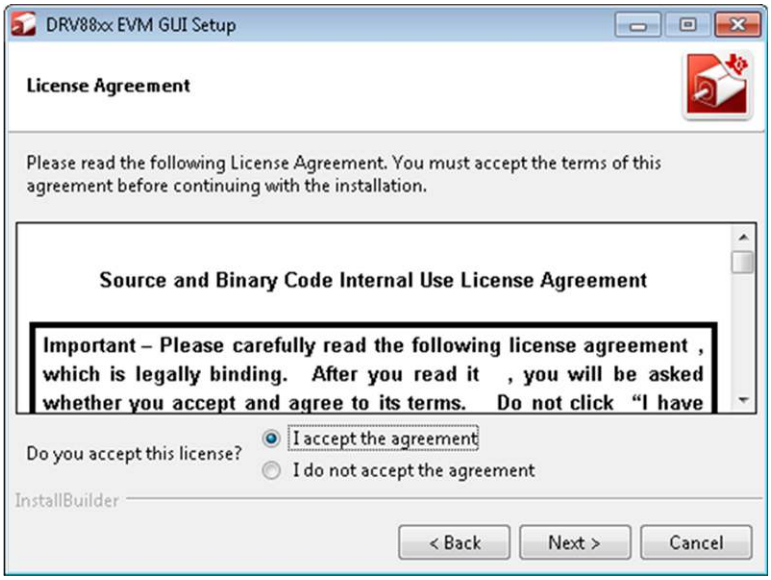


Figure 6. License Agreement

   b. A Screen as shown below will appear, displaying the license agreement of National Instruments. Please read through the agreement carefully and enable the “I Accept the License Agreement” radio button and press the Next button.

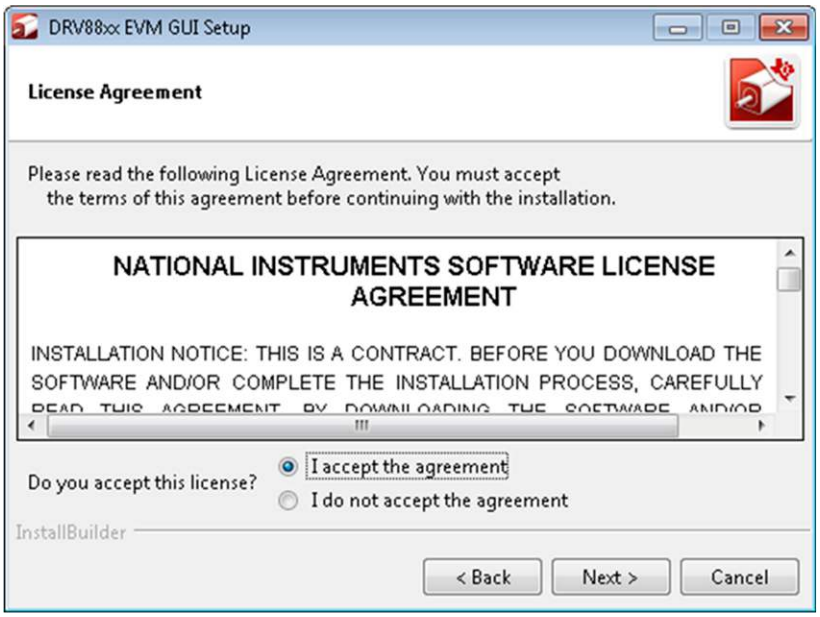


Figure 7. National Instruments License Agreement

4. Set the default directory for the GUI installation and press the Next button.

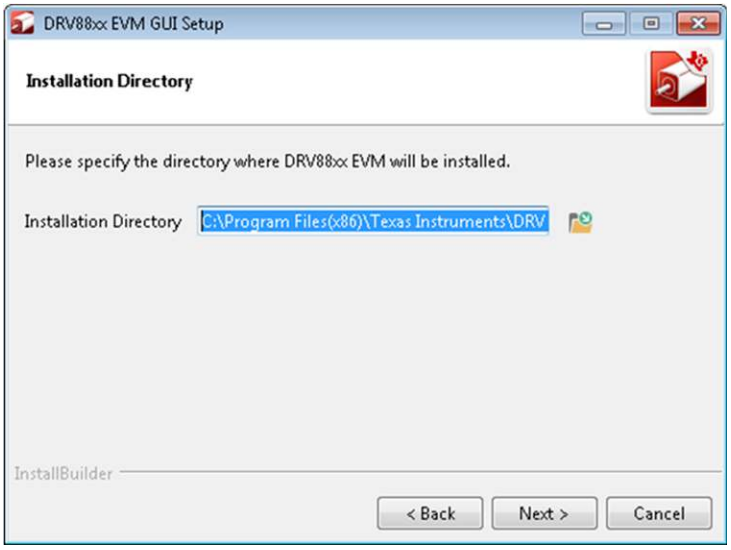


Figure 8. Installation Directory

NOTE: It is highly recommended to keep the default values as provided in the installer.

5. A screen as shown will appear. This is to select the components to install. Select the Components to install and Click Next to continue installation. The LabVIEW RTE component will be checked out if the LabVIEW RTE 2014 is already installed on the PC.

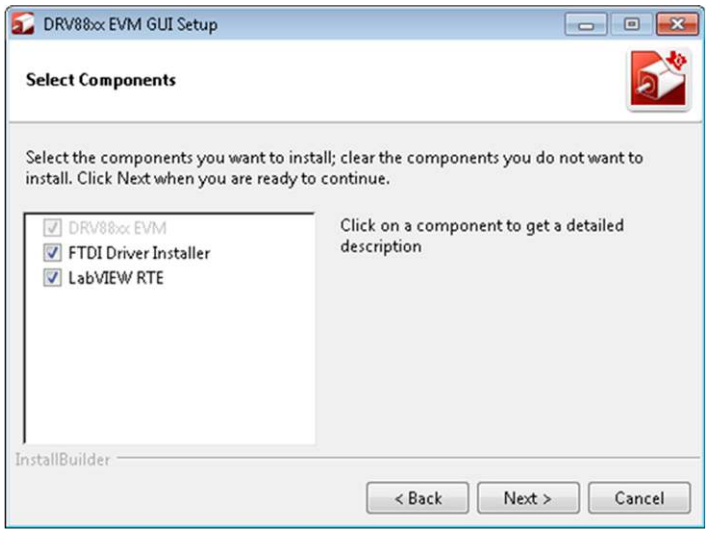


Figure 9. Component Selection

6. If LabVIEW RTE is selected as a component to install, a screen will appear as shown below. Configure the proxy settings as required. This is to download the LabVIEW RTE 2014 from ni.com, Click Next> to continue the installation.

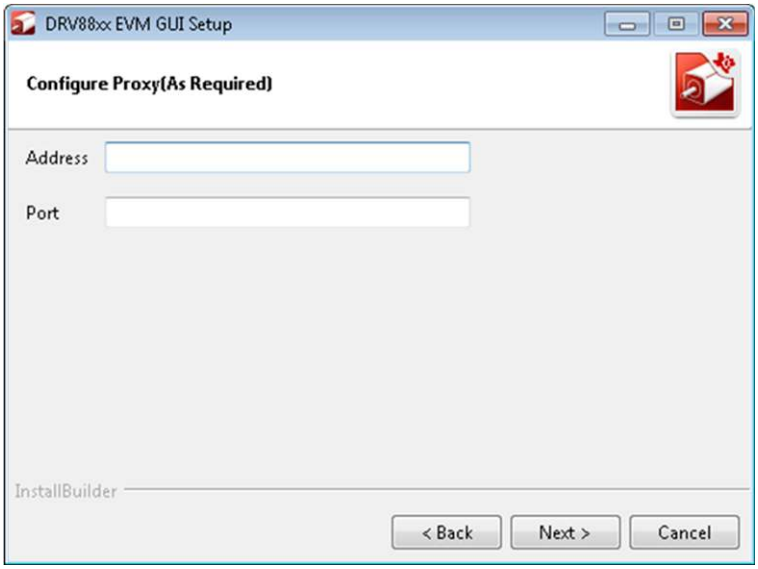


Figure 10. Configure Proxy

7. A screen as shown will appear. Click Next to begin the installation.

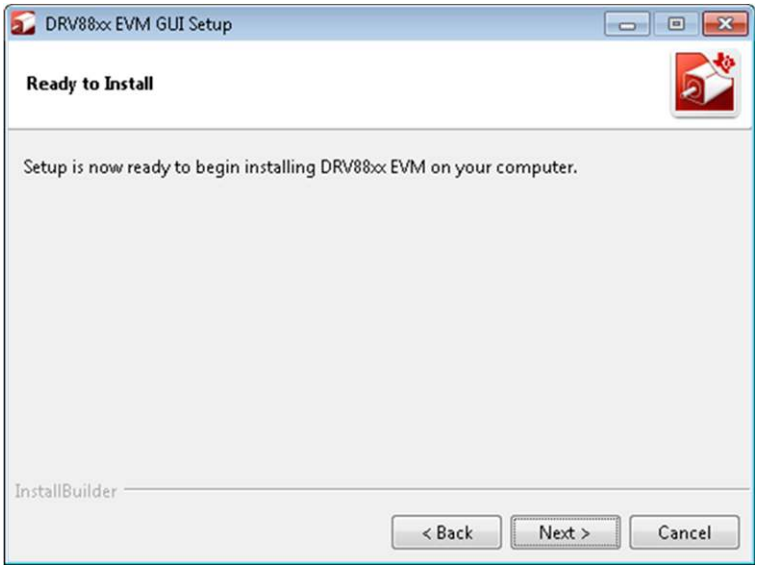


Figure 11. Ready to Install

8. If the LabVIEW RTE 2014 is selected as a component to install, LabVIEW RTE will be downloaded and performs a silent mode installation.

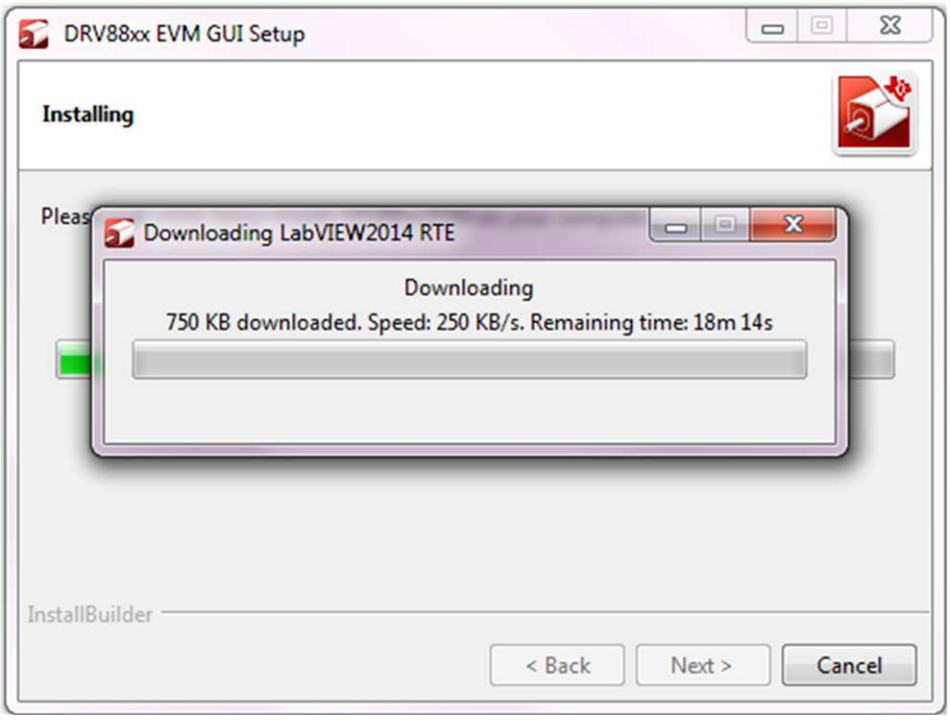


Figure 12. Downloading RTE

9. RTE Installation
   a. Once the Download is completed, LabVIEW will begin with the self-extraction as shown below.

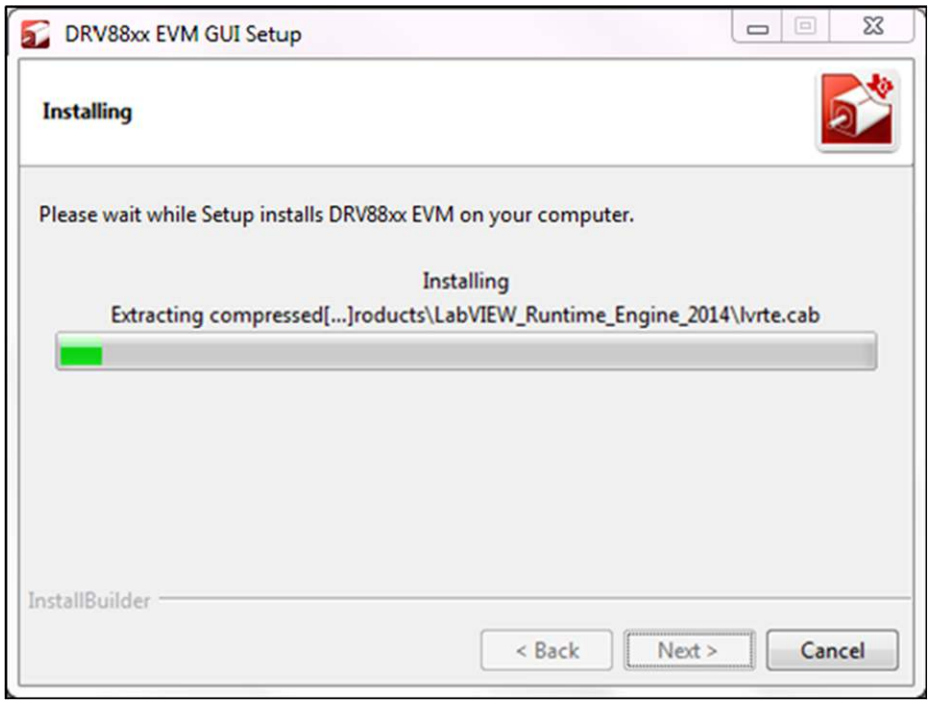


Figure 13. LabVIEW Self-Extraction

b. A Screen will appear as shown below. It initializes the LabVIEW RTE Installation.

Figure 14. LabVIEW RTE Installation Initialization

c. A display as shown below will appear which indicates the progress of LabVIEW RTE installation.

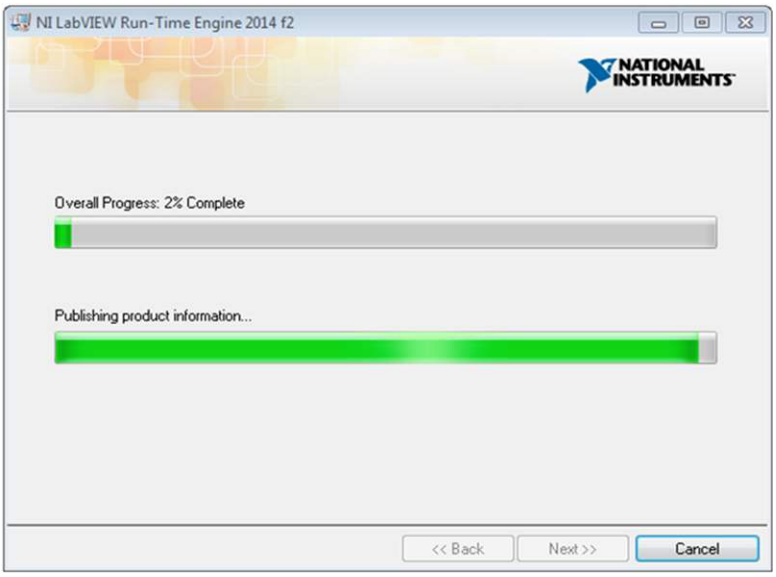


Figure 15. Installation of LabVIEW RTE in Progress

10. Once the LabVIEW RTE 2014 is installed, DRV88xx EVM GUI component will be installed.
11. After DRV88xx Installation, FTDI Installation will begin. A screen as shown in the figure will appear, click Extract to proceed.

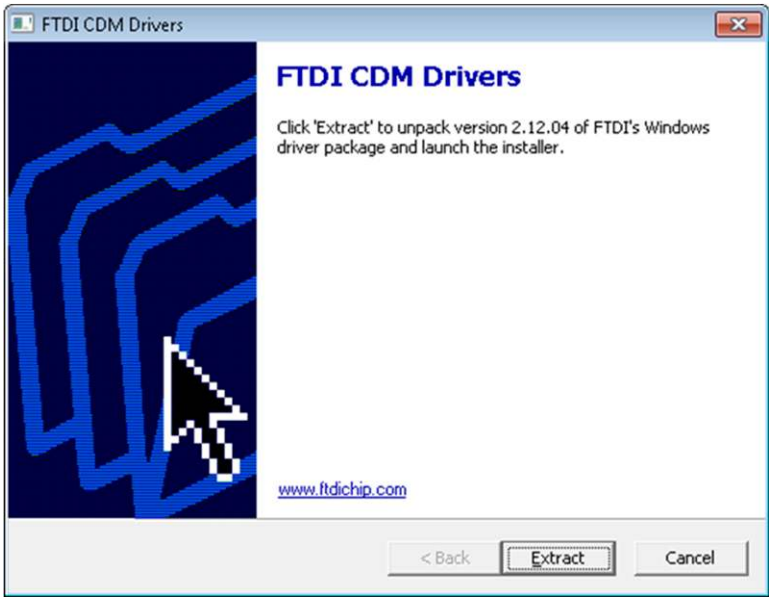


Figure 16. FTDI Installation Initialization

12. A screen as shown in the figure will appear, click Next to proceed.

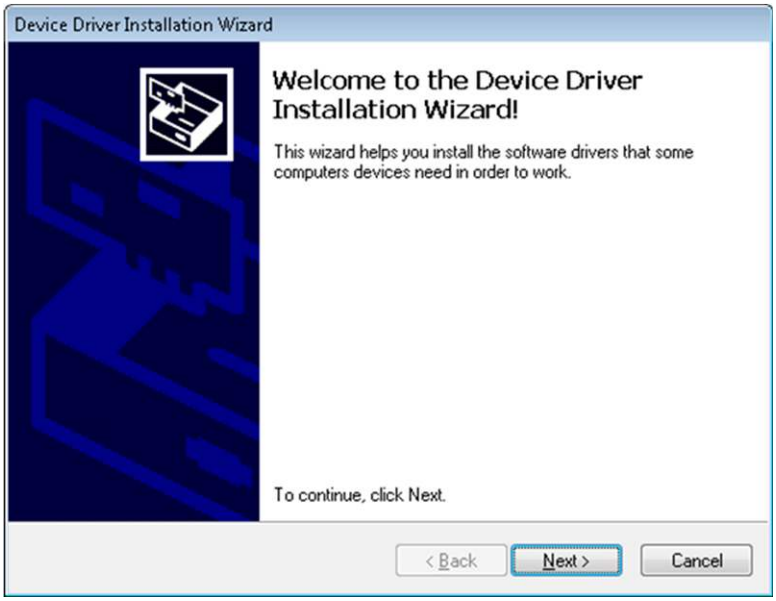


Figure 17. Driver Installation Wizard

13. The License Agreement will appear on screen as shown below.
    a. Read through the License Agreement carefully and Enable the “I Accept this Agreement” radio button and Click on Next.

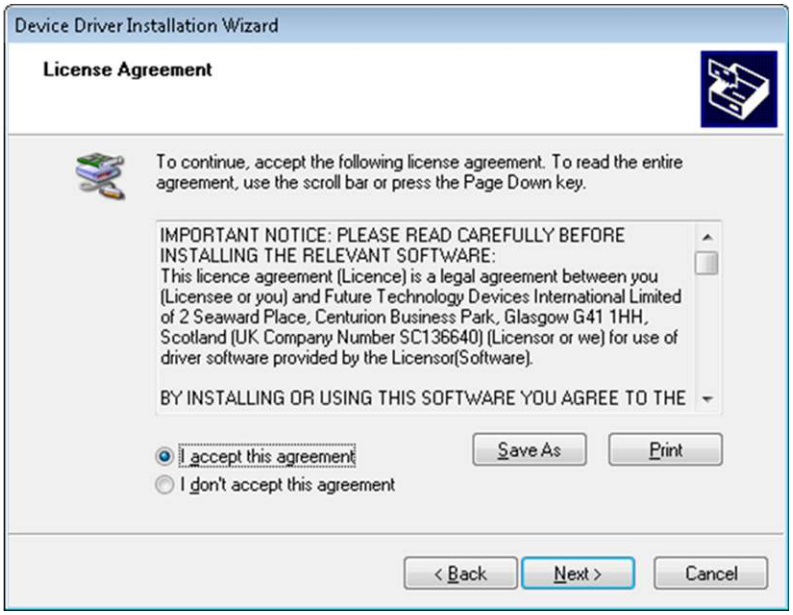


Figure 18. License Agreement for FTDI Driver

14. Click Finish to complete the Driver Installation.

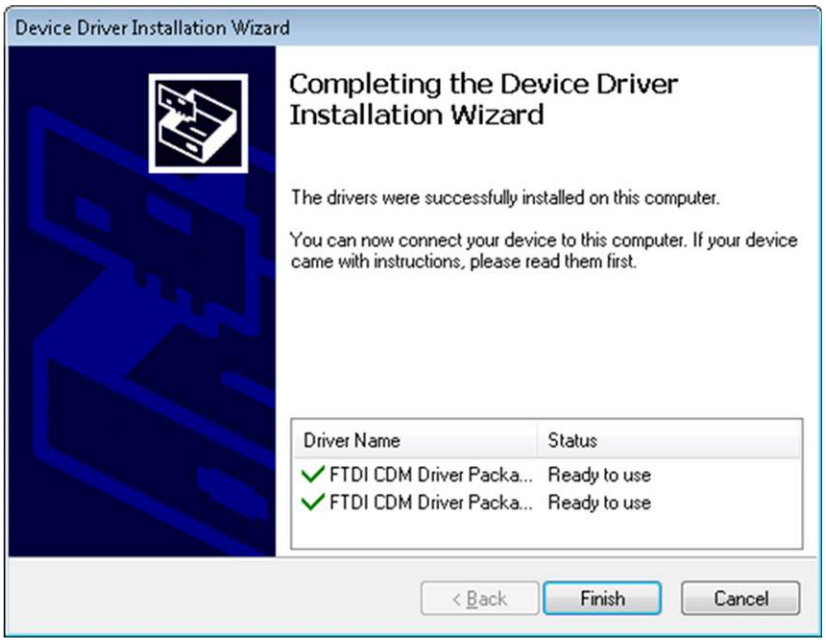


Figure 19. Driver Installation Completion

15. The following screen will appear denoting the completion of DRV88xx EVM GUI Installation. Click Finish.

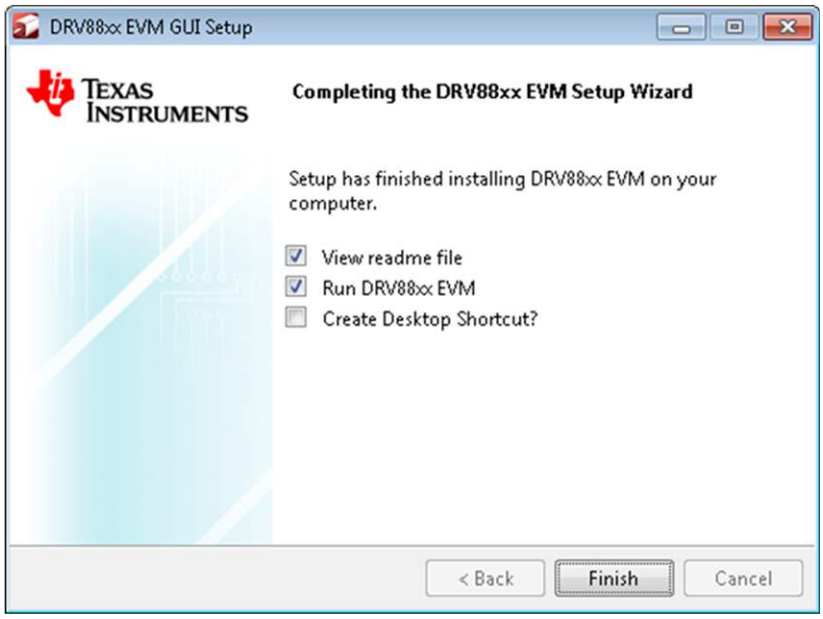


Figure 20. Installation Complete

16. A Readme window as shown below will appear displaying the link for LV 2014 RTE.

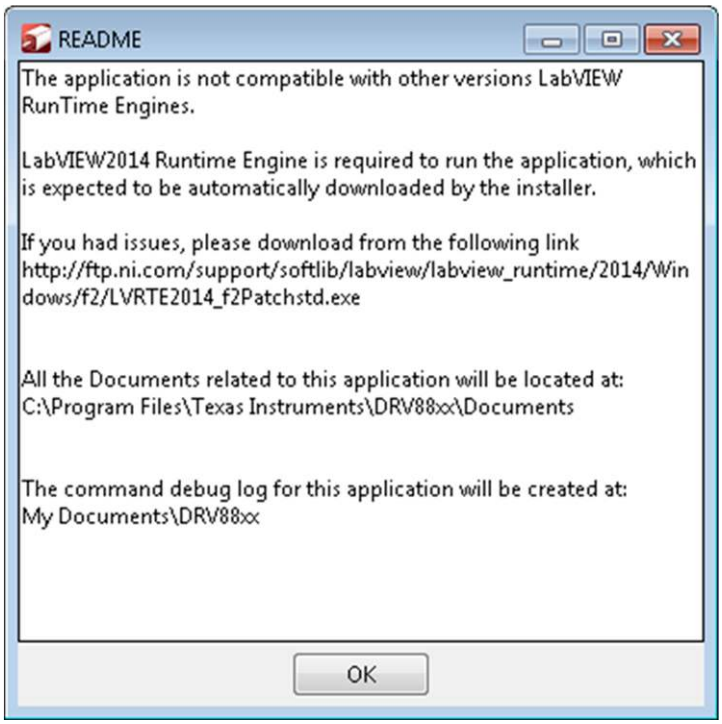


Figure 21. Readme Window

WARNING

The DRV88xx EVM GUI requires the LabVIEW Run Time Engine 2014 to be installed before the GUI is executed. Please, note the application is not compatible with other versions of LabVIEW Runtime Engine.

You can download the National Instruments LabVIEW Run TIme Engine 2014 from the link below:

http://www.ni.com/download/labview-run-time-engine-2014/4887/en/

NOTE: DRV88xx EVM GUI executable has been built in LabVIEW 2014 (32-bit) version, and it expects the LabVIEW Run Time Engine version to be LabVIEW Run Time Engine 2014 (32-bit) version.

3 DRV88xx EVM GUI Overview

The CPG004_DRV88xx EVM Windows application is the software counterpart for the CPG004_DRV88xx EVM. It allows the PC computer to connect to the MSP430F1612 microcontroller through an USB interface chip. Once the connection is established, and commands are sent, microcontroller takes care of configuring control signals and administering certain levels of automation, such as micro stepping generation for (DRV8812/13), STEP and DIR control (for DRV8824/25) or PWM output (for DRV8812/13/14/40/41/42/43).

The graphical user interface (GUI) has been designed to allow for all of the DRV88xx device's functionality to be tested without having to intervene with the hardware, except for the proper configuration of jumpers, when needed.

The application has five tabs: one for each one of the five available device flavors.

The GUI has five pages

- DRV8802-12-13-14
- DRV882-25
- DRV8840
- DRV8841-43
- DRV8842

Each page has GPIO control for the control signals, stepper motor control for start/stop and speed, and current/decay control through the MSP430 DACs.

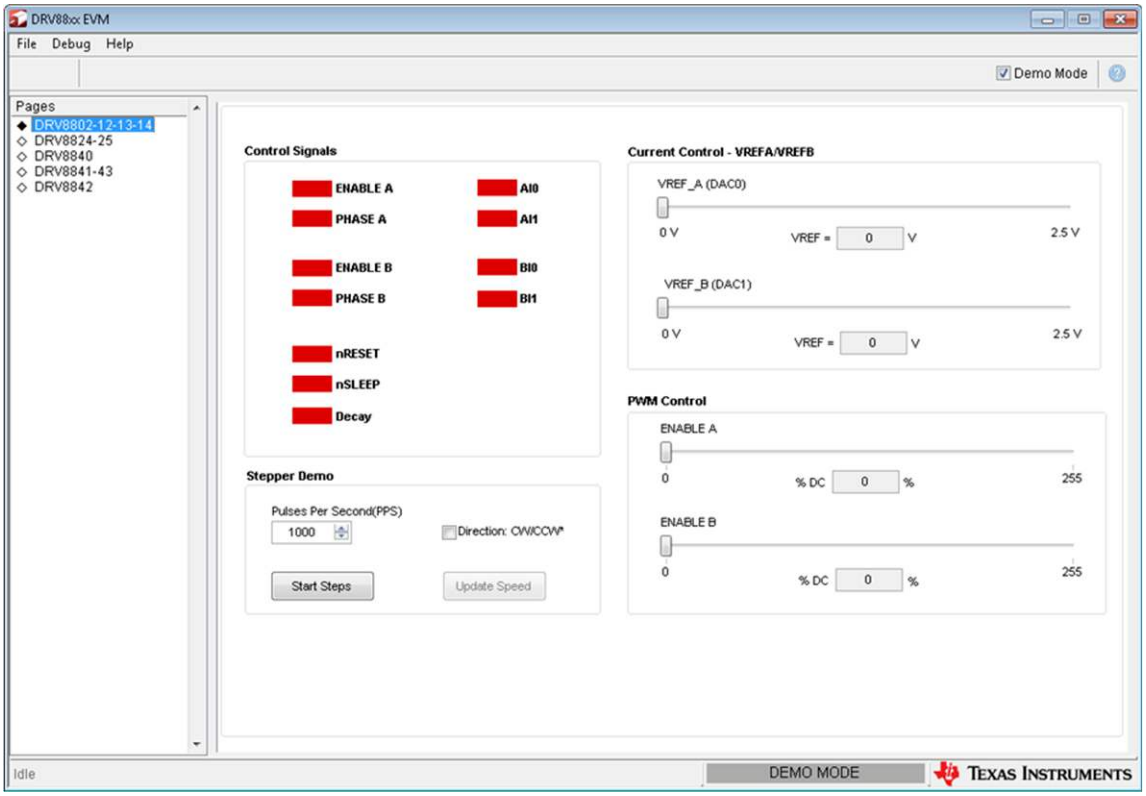


Figure 22. DRV8802-12-13-14 Tab

The DRV8802-12-13-14 tab contains all the control signals needed to control motor enablement (ENABLE A, ENABLE B), the direction of rotation (PHASE A, PHASE B) and current control (AIx and BIx). Access to both DAC generating VREF analog voltages is achieved by moving sliders. Another set of sliders allows the control of PWM duty cycle on ENABLE x pins. This is intended for motion control.

A simple stepper demo allows hooking a bipolar stepper to the DRV8812 EVM and has its speed and direction controlled by an algorithm which modulates the VREF current in a high-resolutionmicro stepping style. This function is achieved by using both MSP430 DAC outputs and is only available if several jumpers are set for dual DAC connection (as default).

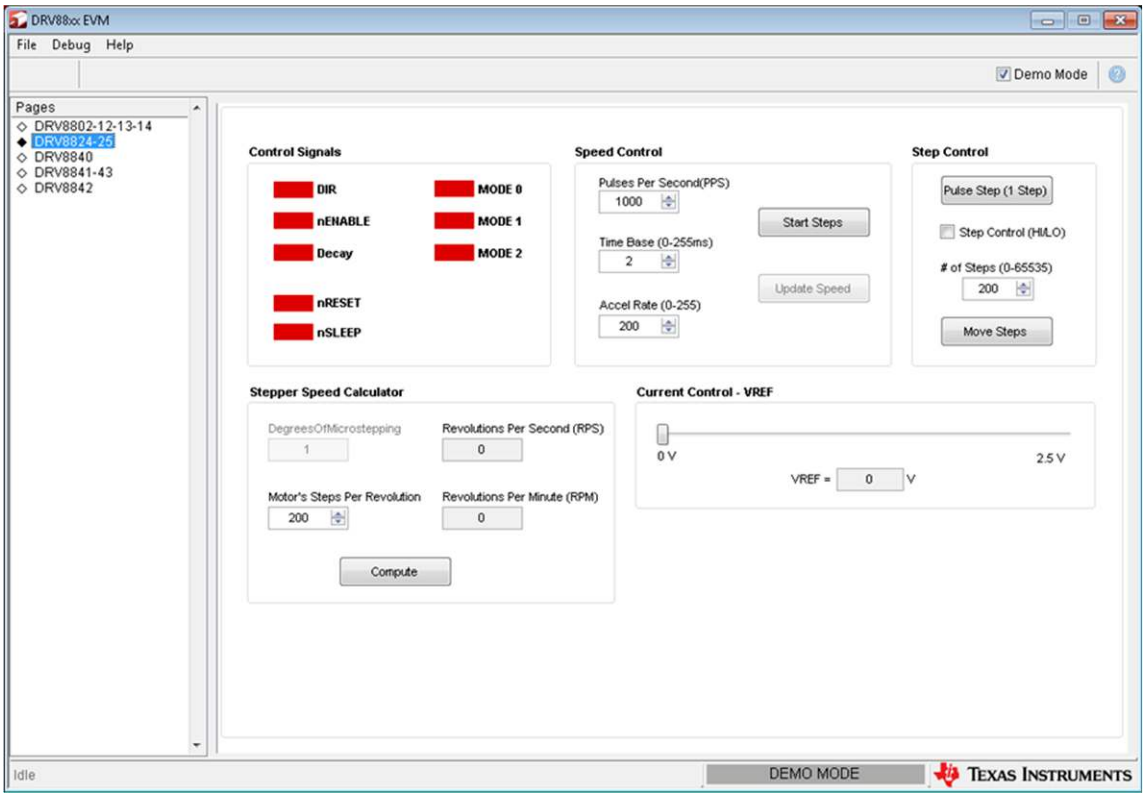


Figure 23. DRV8824-25 Tab

The DRV8824-25 has an updated GUI that contains all the necessary control signals for driving a bipolar stepper. Important aspects to control are enablement, direction of rotation, speed, number of steps, reference voltage (for maximum current) and degrees of microstepping.

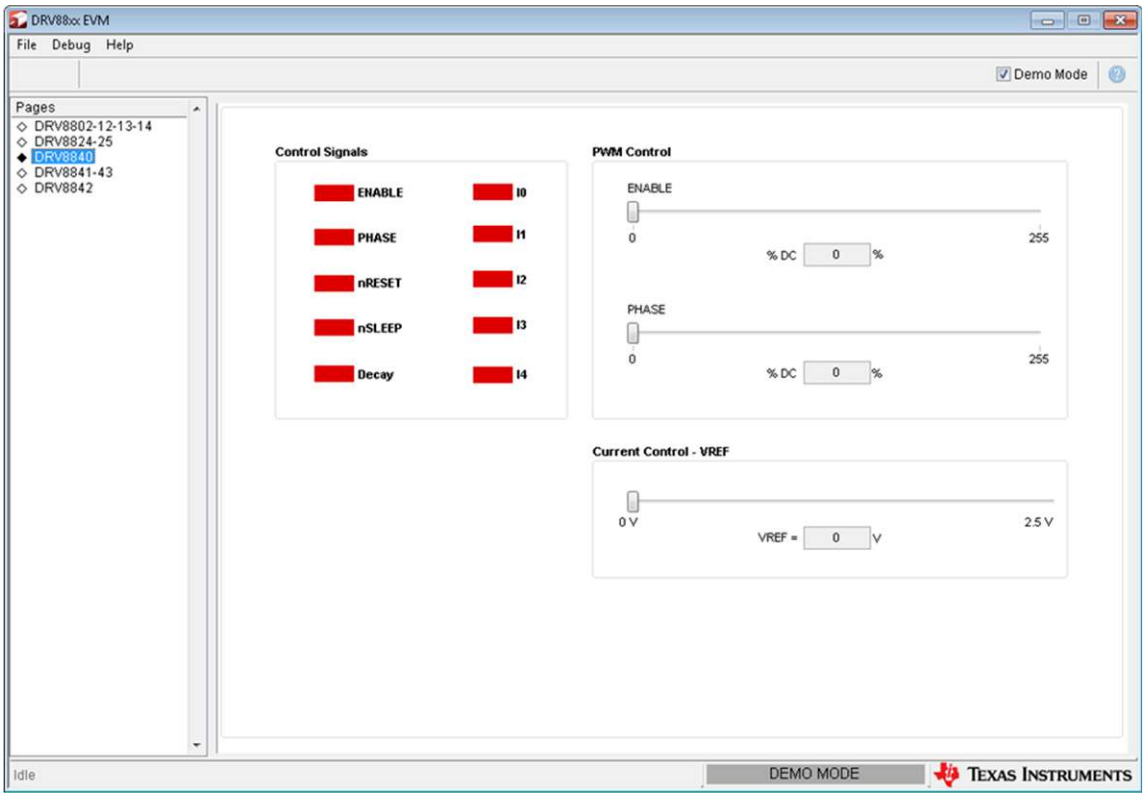


Figure 24. DRV8840 Tab

The DRV8840 tab contains the controls for updating the PWM, current control, Ix pins and general controls (Enable, Phase, nReset, nSleep & Decay).

The DRV8841-43 tab is very similar to the DRV8802-12-13-14 tab, except correct naming conventions have been followed to showcase the AINx pins (instead of PHASE and ENABLE). In this tab, the four INx signals have a respective PWM slider in order to provide speed control per H Bridge on both directions per H Bridge.

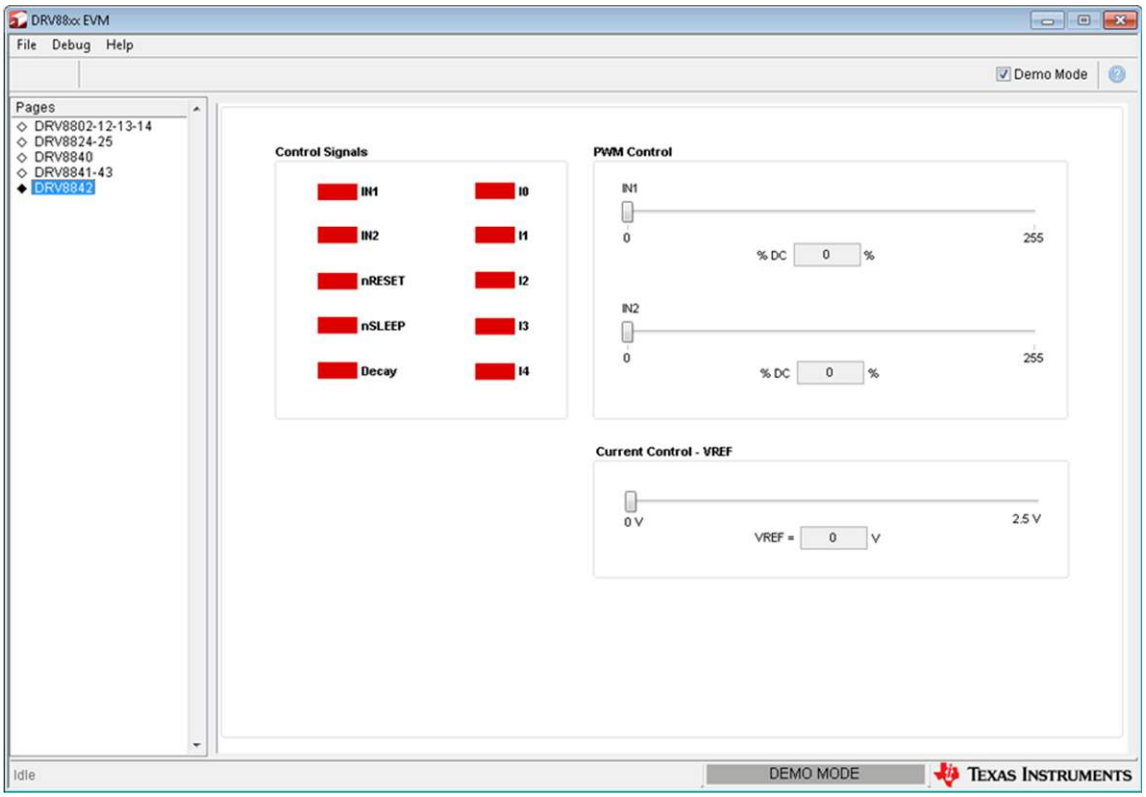


Figure 25. DRV8842 Tab

The DRV8842 tab contains the controls for updating the PWM, current control, Ix & INx pins and general controls (nReset, nSleep & Decay).

3.1 The Menu

The File menu contains the options as shown in the below figure. Each of the options is explained below.

File:

- Exit – Terminates the application

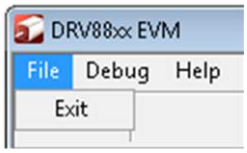


Figure 26. DRV88xx File Menu

Debug:

- Demo – By selecting the Demo in the submenu, the GUI will run in simulation mode, and by unselecting it, the GUI will run in connected mode.
- Log to File - The log to file submenu is used to log the GUI activities to a log file that is specified.
- Debug Log - The Debug log option will enable to log all the activities of the user. If that is not selected, only the high-level operations will be logged.

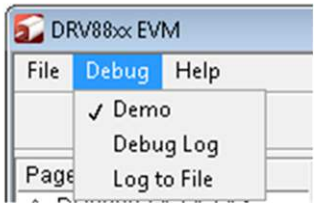


Figure 27. DRV88xx Debug Menu

Help:

- About... - The About Page provides the details like the Name of the GUI, GUI version, Supported OS and Copyright Information.

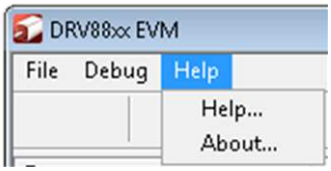


Figure 28. DRV88xx Help Menu

Figure 29. DRV88xx About Page

3.2 DRV88xx GPIO Control Signals

Once the application is communicating with the interface board, the control signals can be actuated by checking or un-checking check boxes on the Signals frame. Each tab will have a different set of control signals as depending on the device being interface on. nSLEEP and nRESET control signals will be on all tabs.

Functionality of control signals is identical across the platform. A checked checkbox translates to a HI level on the respective control signal. Unchecked checkboxes translates to a LO level on the respective control signals.

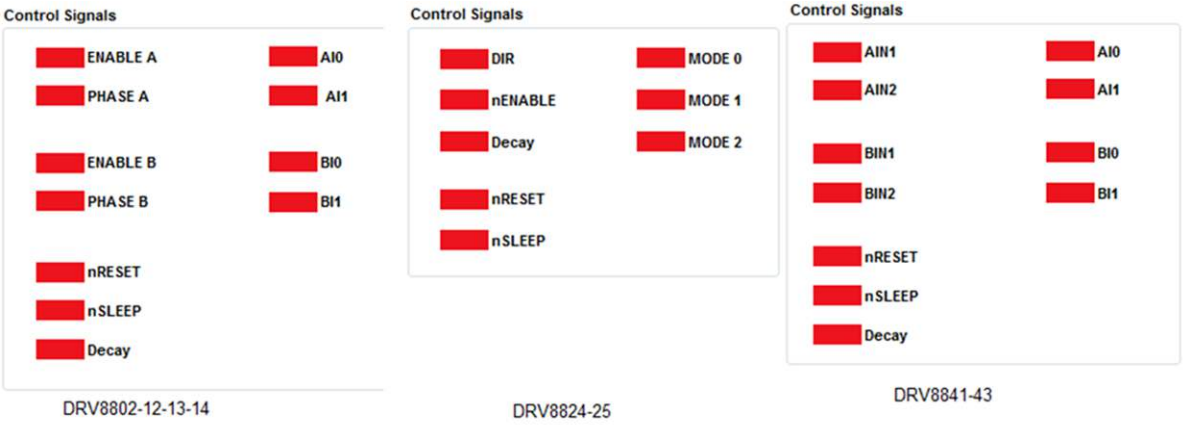


Figure 30. GPIO Control Signals

3.2.1 About DECAY

The DECAY pin is in reality a triple state input. The GPIO operates as HI and LO according to the checkbox. To have the DECAY pin floating, engaging mixed decay mode, simply remove the decay jumper JP3.

3.3 Updating DAC Output for Current Control (VREFA and VREFB)

If the DRV88xx has been configured to accept VREF analog voltages through the microcontroller DAC outputs (refer to Jumpers section), then the slider bar on the Current Control frame can be used to set the VREF voltage.

Figure 31. Current Control

The 12-bit DAC channels 0/1 are connected to the DRV88xx VREF analog inputs ABVREF and CDVREF. Changing the DAC digital value from 0 to 4095, changes the analog voltage at the respective VREF pin from 0 V to 2.5 V respectively, following the equation:

$$VREF = DAC\_VALUE \bullet \frac{2.5\ V}{4095} \quad (1)$$

Where:

VREF is the output voltage.

DAC_VALUE is a number from 0 to 4095.

Moving the sliders will update the “VREF = xV” caption below each respective slider with the result of the previous equation giving the user an idea of what analog voltage is being presented at the reference voltage input.

3.4 DC Motor Speed Control (PWM)

The DRV8802-14 can be utilized to control DC motors. For the purpose to control DC motor speed, a slider is provided which applies a PWM to the ENABLE line. The PWM slider consists of an 8-bit number so position from 0 to 255 are obtained. The MSP430 directly transforms this 8 bit number into the respective duty cycle. PWM frequency is around 31.25 kHz.

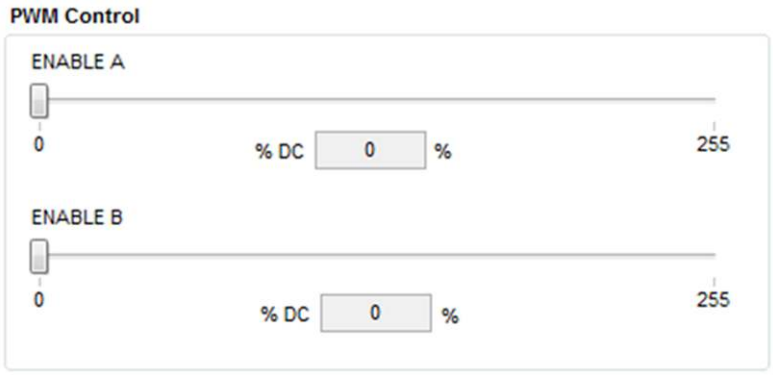


Figure 32. Duty Cycle Indicator

When the slider bar is moved across, the Duty Cycle indicator is updated accordingly. Resulting duty cycle is an integer number between 0 and 100 and it is computed according to the equation:

$$\%Duty\ Cycle = \frac{PWM}{255 \bullet 100} \quad (2)$$

The DRV8841-43 will offer the same ability to apply a PWM signal to each one of the INx pins.

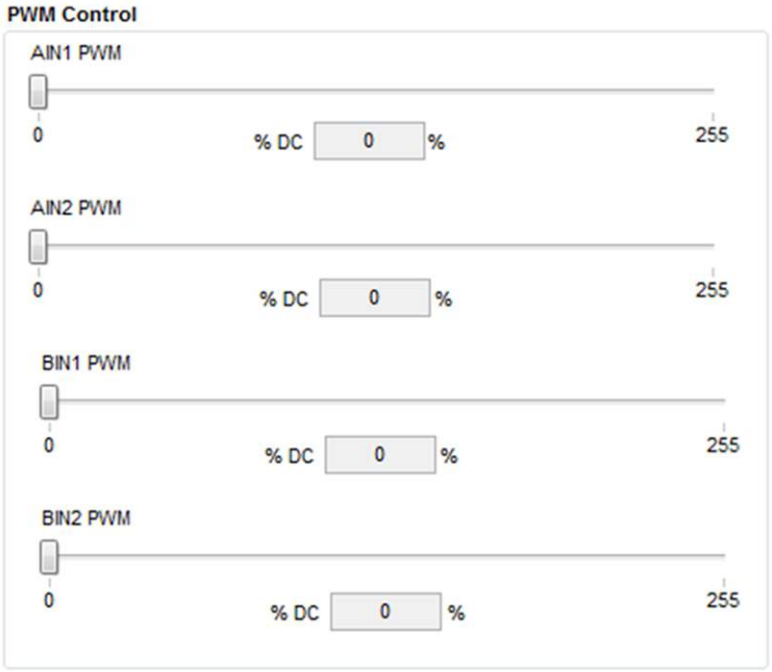


Figure 33. PWM Signal on INx Pins

3.5 Operating the Stepper Motor (DRV8824)

3.5.1 Turning the Stepper Motor

The Windows application, in conjunction with the MSP430F1612 microcontroller, utilizes a series of timers to coordinate the rate of steps sent to the device. Once all the control signals are configured accordingly, (ENABLEn = LO, SLEEPn = HI, RESETn = HI; DIR, USMx can be HI or LO depending on preferred mode of operation), the motor is ready to be turned.

The DRV88xx EVM allows for the possibility of coordinating step rates such that accelerating and decelerating profiles are achieved. Both acceleration and deceleration are controlled by the same parameters, acceleration rate and time base.

When the motor starts, it always starts at the slowed PPS speed (62 pulses per second). The controller will accelerate the motor in order to reach the PPS speed. Acceleration rate is an 8-bit number (0 to 255) that gets added to the current PPS speed and time base is an 8-bit number (0 to 255) that specifies how many milliseconds will elapse from one speed increase to the next. Once the specified PPS speed has been achieved, the acceleration stops.

When the motor stops, the inverse of the above description occurs.

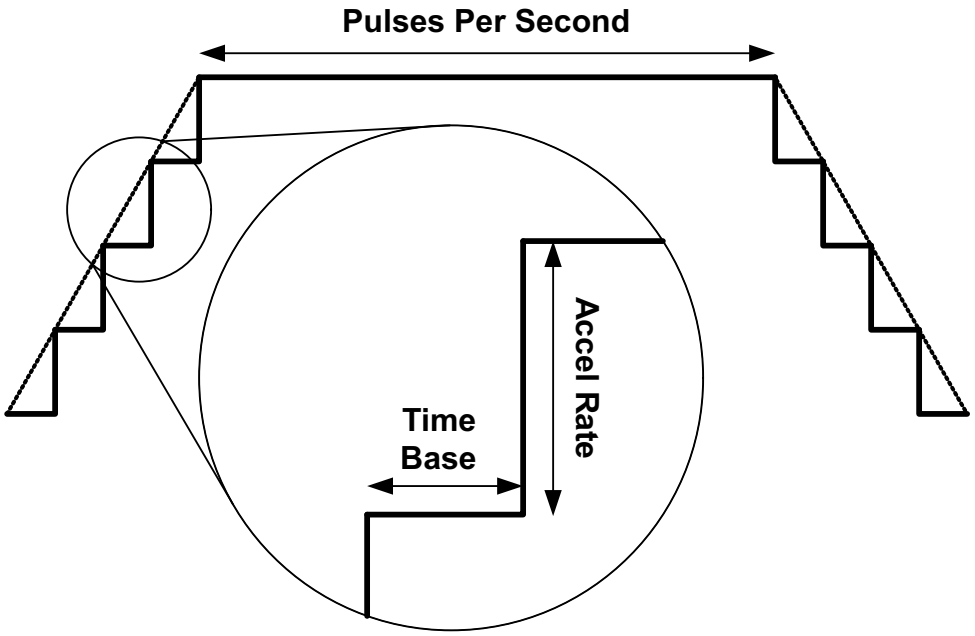


Figure 34. Turning the Stepper Motor

The Windows application frame to control speed, acceleration and deceleration, as well as motor start and stop, is shown in Figure 35.

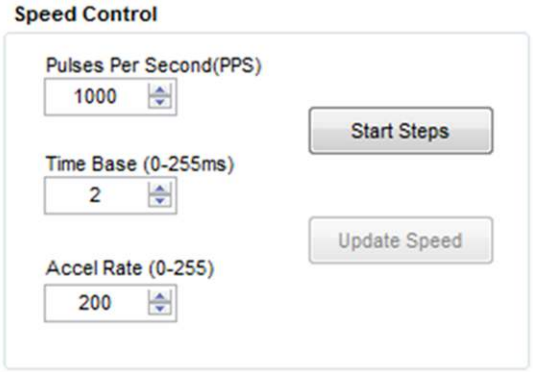


Figure 35. Speed Control

Pressing the “Start Steps” button, will start the timer and pulses will be generated at the rate specified by the decimal number at the PPS text box. Once the “Start Steps” button is pressed it becomes the “Stepping” button. Press the “Stepping” button to stop the stepper motion.

When the motor is stepping, the “Update Speed” button becomes enabled. Speed can be updated by modifying the PPS text box and then pressing the “Update Speed” button. The “Speed Button is disabled every time the motor is not turning because the stepping has been halted by pressing the “Stepping” button.

3.5.2 Step by Step Control

The step control frame has a series of tools to control the stepping of the motor on a predetermined number of steps fashion.

The “Pulse Step” button allows for a single step to be issued. Remember that a STEP takes place when STEP goes from LO to HI.

Figure 36. Step Control

To move the motor a number of steps and then stop, fill the # of Steps text box with a decimal number from 0 to 65535 and the motor will move that number of steps at the speed specified on the PPS text box. No acceleration or deceleration takes place under this function.

3.5.3 Stepper Speed Calculator

In order to easily translate steps per second to actual angular velocity, a simple calculator is provided. The calculator extracts step resolution information from the Mode x pins values and STEP frequency from the PPS text box. The user must then provide number of steps per resolution the motor has been manufactured to achieve. For example, a 1.8 degrees stepper motor would have 200 steps per revolution, and so on.

By pressing the Compute button, the calculator reports the revolutions per second and revolutions per minute parameters. For example, on the picture below, the stepping rate was set to 4000 steps per second. While microstepping with 4 degrees of microstepping, a motor with 200 steps per revolution should be moving at 5 revolutions per second or 300 revolutions per minute.

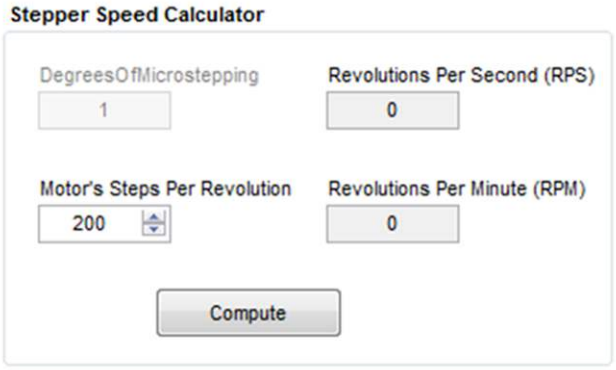
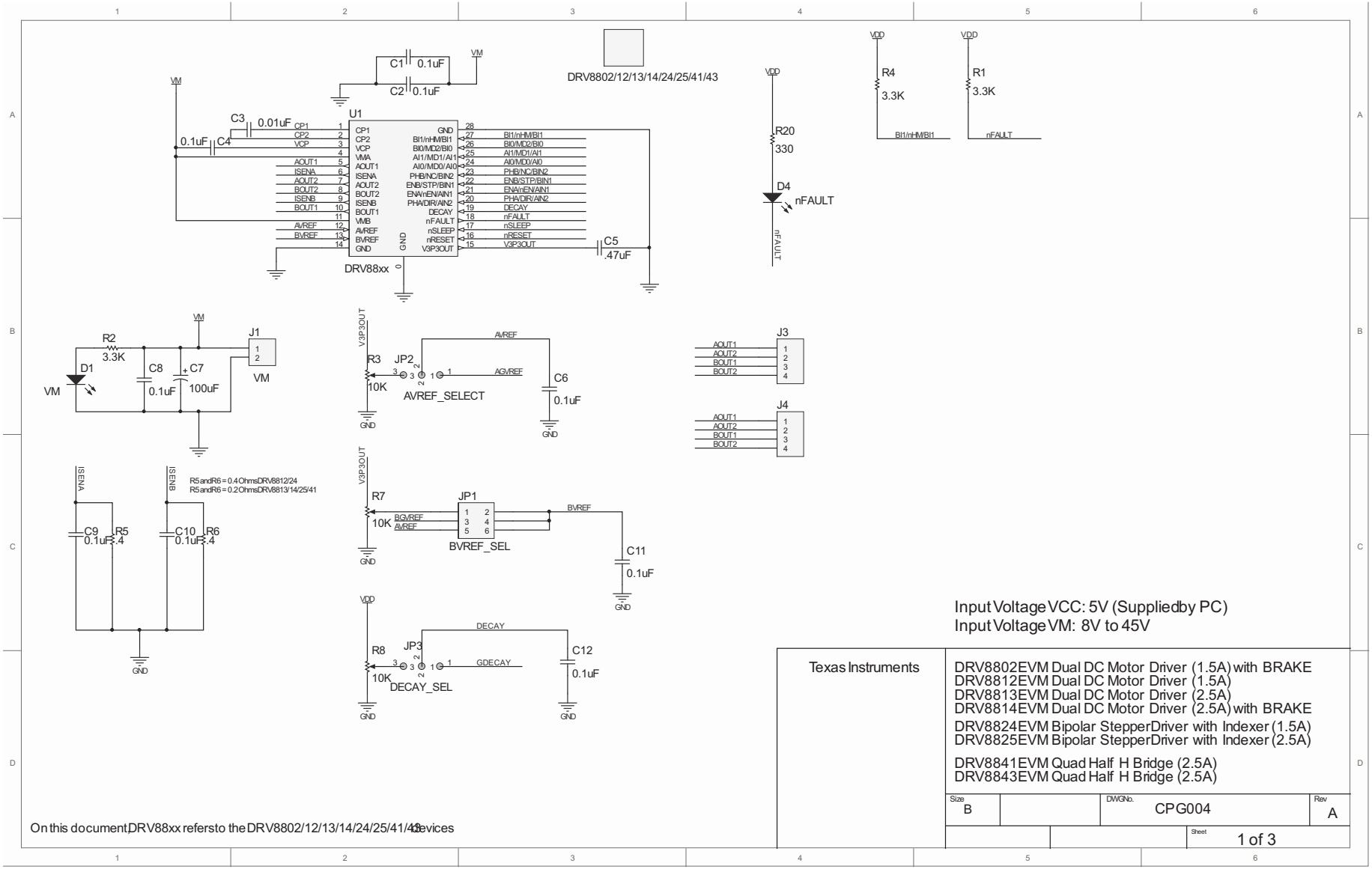
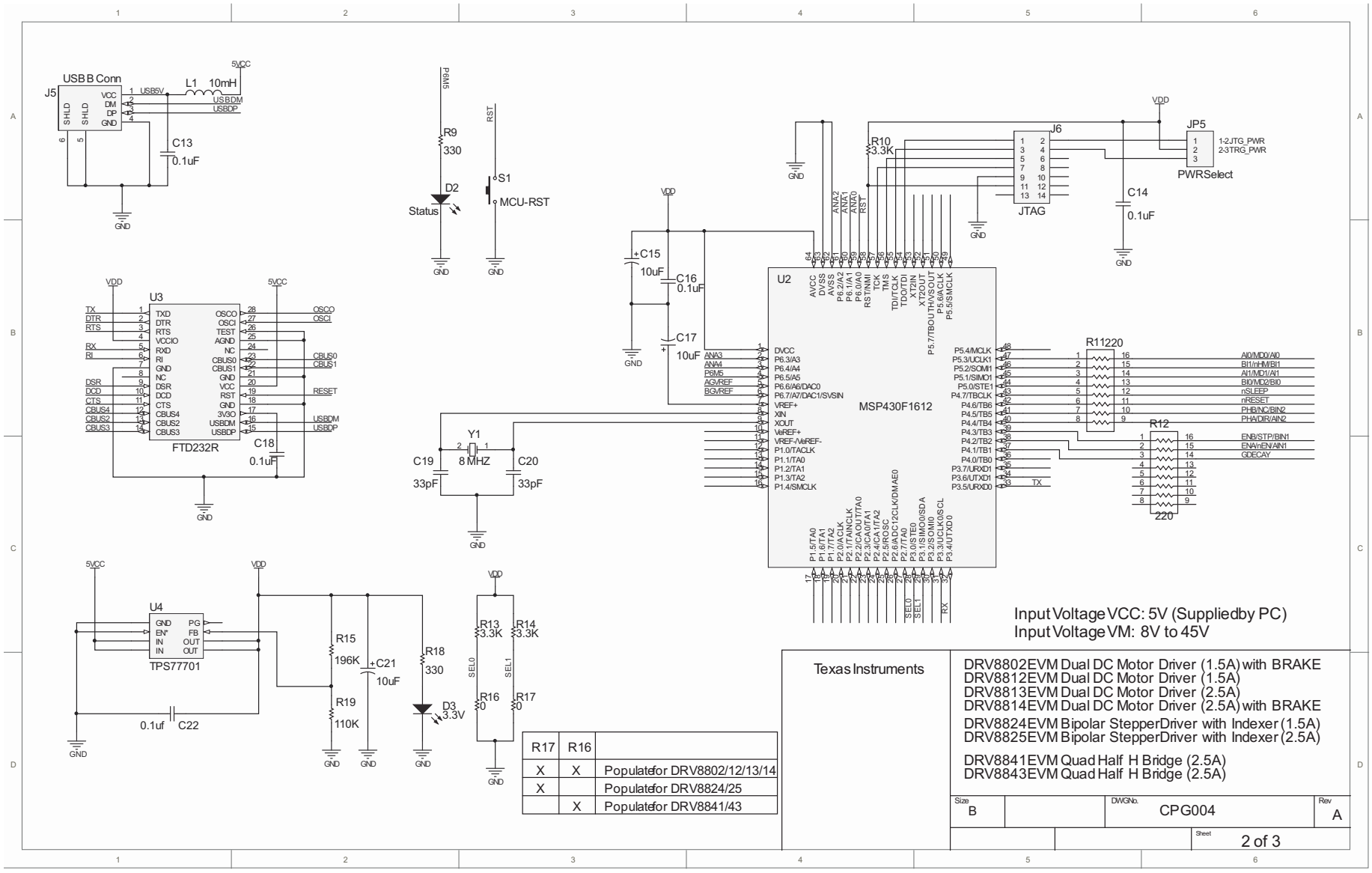


Figure 37. Stepper Speed Calculator

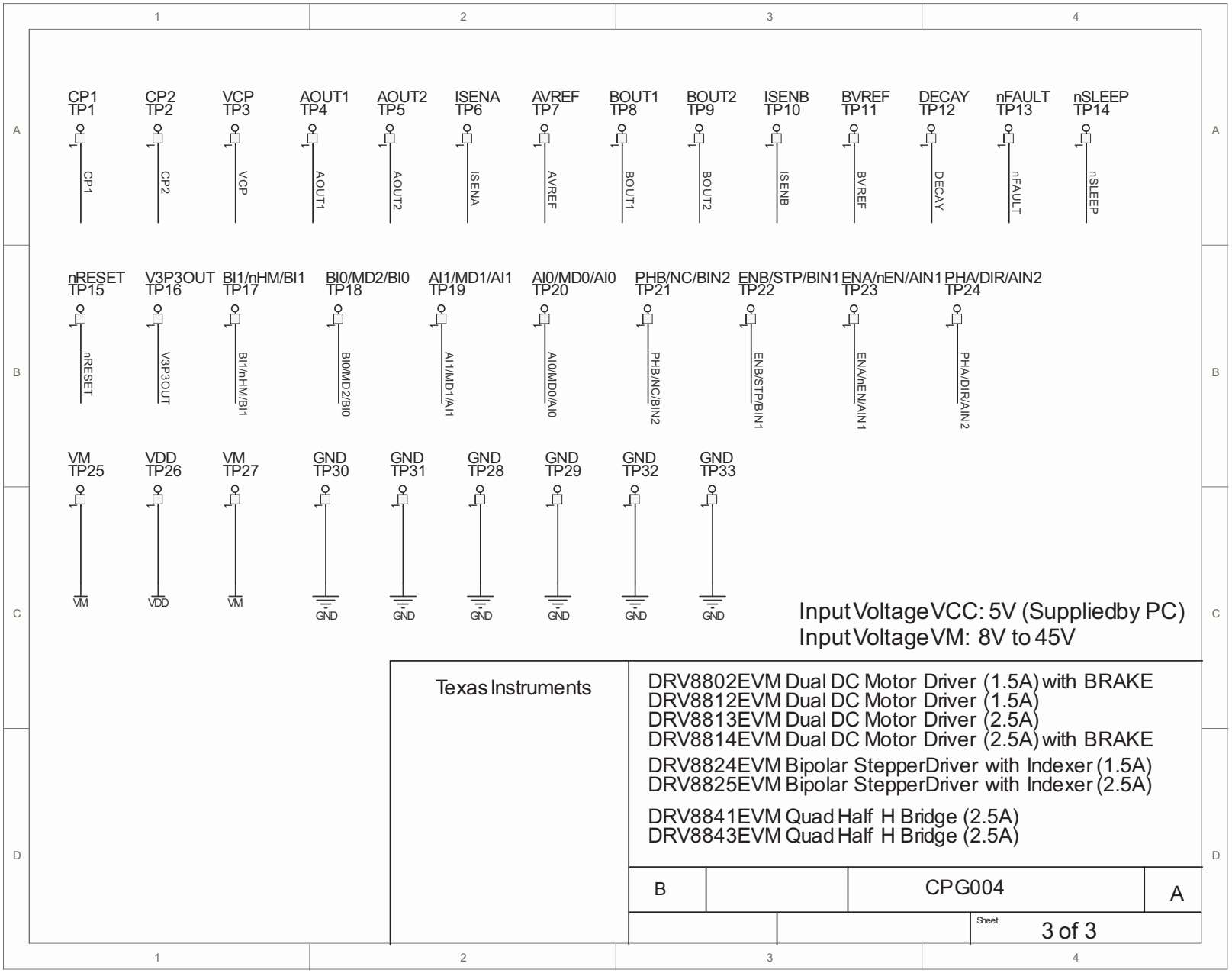
4 Schematics

See the following pages for schematics.





R17	R16	
X	X	Populatefor DRV8802/12/13/14
X		Populatefor DRV8824/25
	X	Populatefor DRV8841/43



Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from A Revision (June, 2011) to B Revision	Page
• Changed figure 5 and supporting text below image	17

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      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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