

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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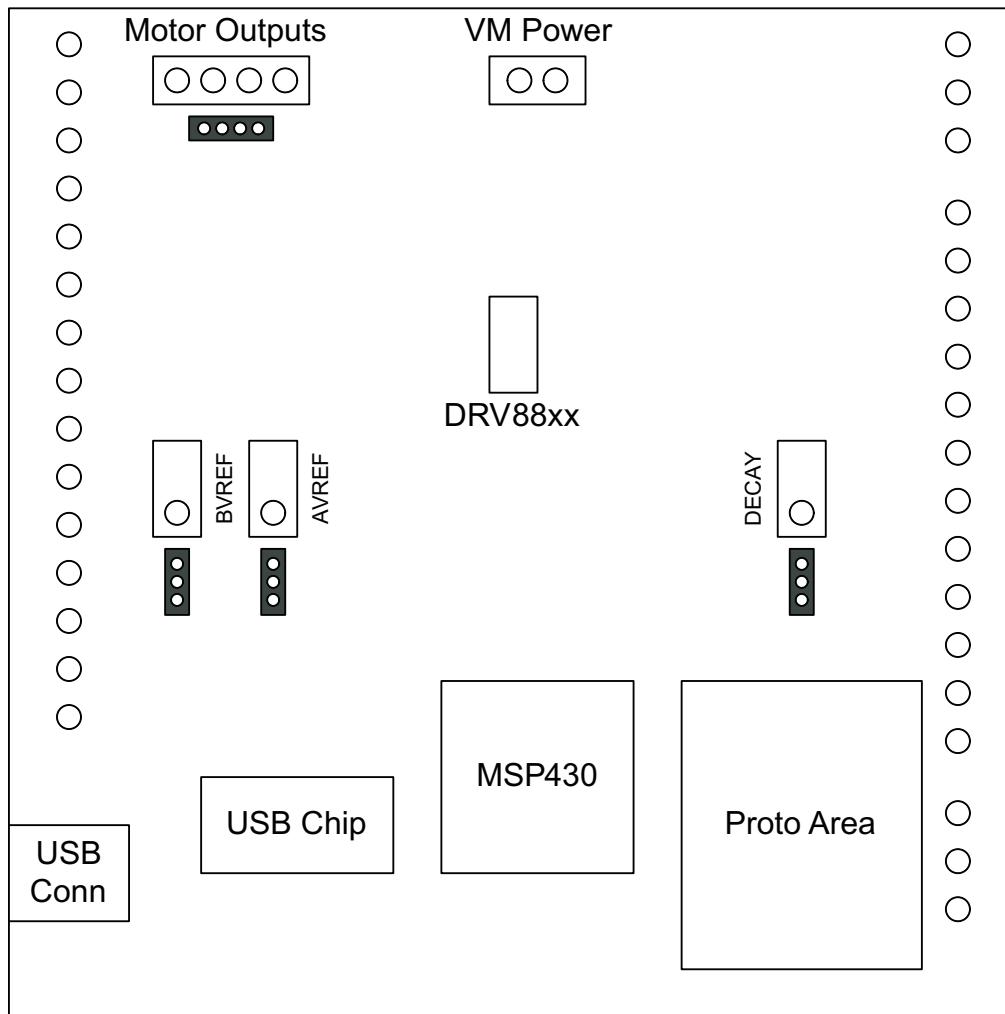
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1 Block Diagram



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

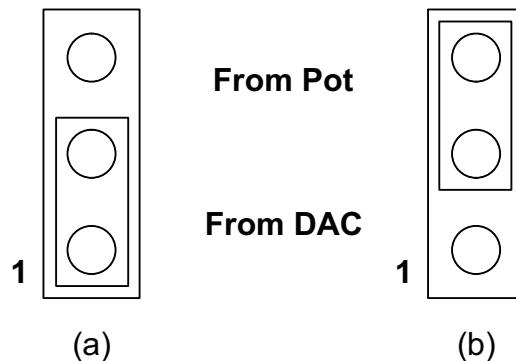
Every pin on the DRV88xx device has been brought out to a test stake. A label on the silkscreen identifies each signal.

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)

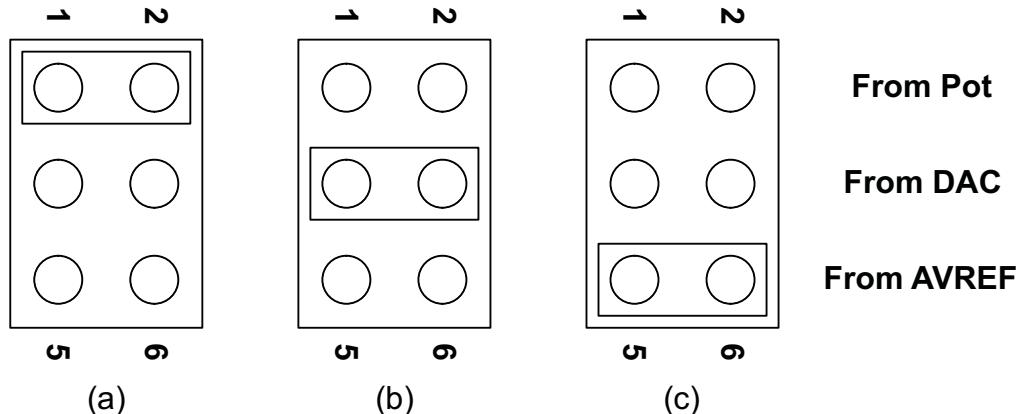


To configure the AVREF select jumper:

- Use position JP2-1:2 to select the MSP430 DAC output (default).
- 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:

- Use position JP1-1:2 to select the respective variable resistance potentiometer.
- Use position JP1-2:3 to select the MSP430 DAC functionality.
- 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.

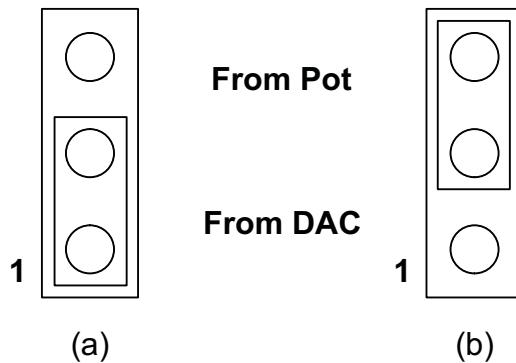
Figure 2. BVREF Select Jumper Configuration

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 DECRY Select Jumper (JP3)



To configure the DECRY 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. DECRY 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.

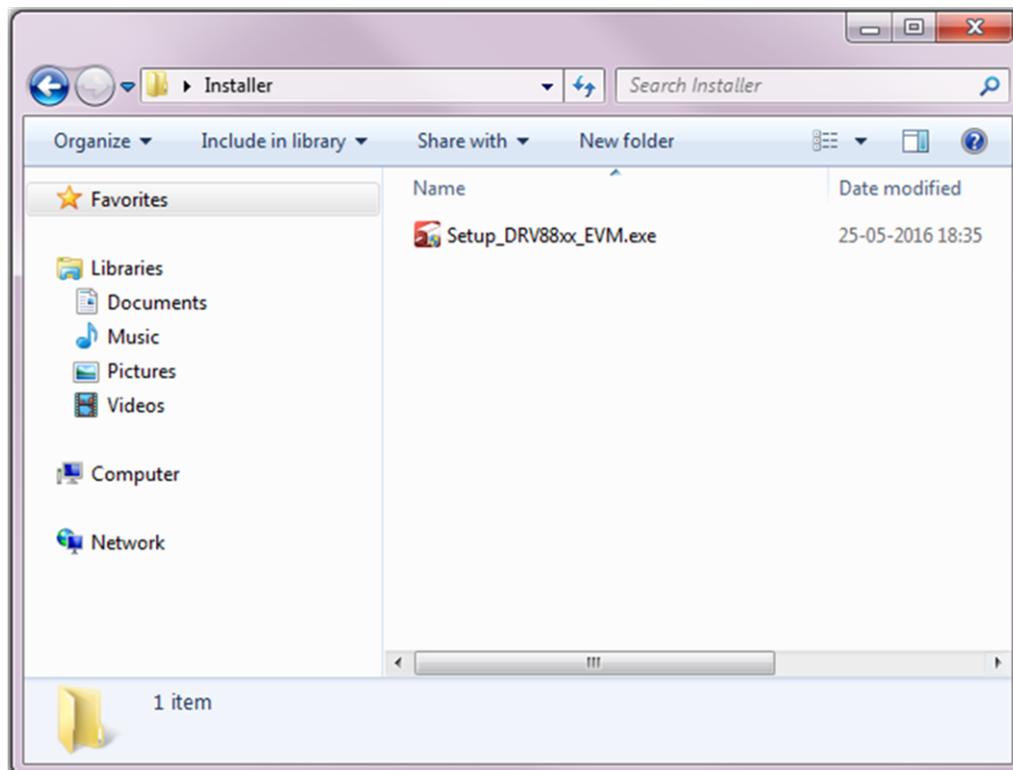


Figure 4. Setup_DRV88xx_EVM.exe

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

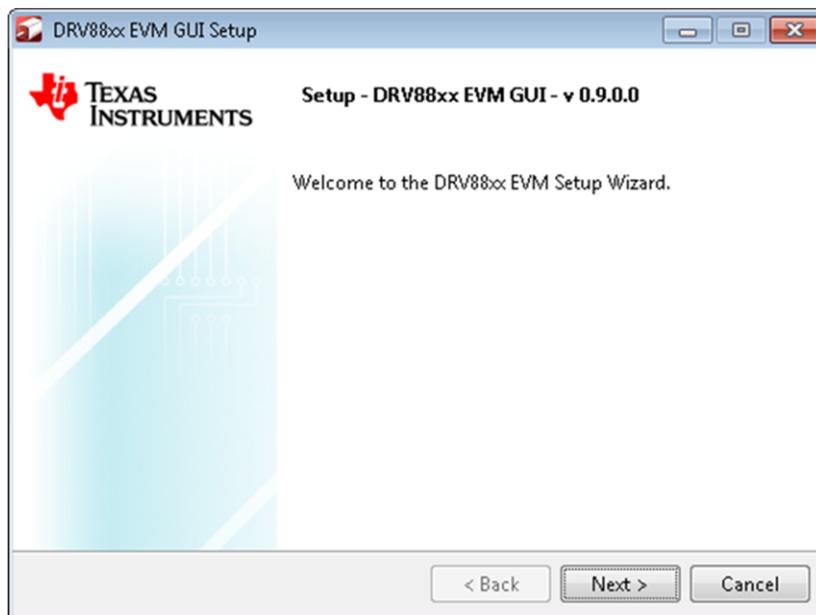


Figure 5. Installation Initialization

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.

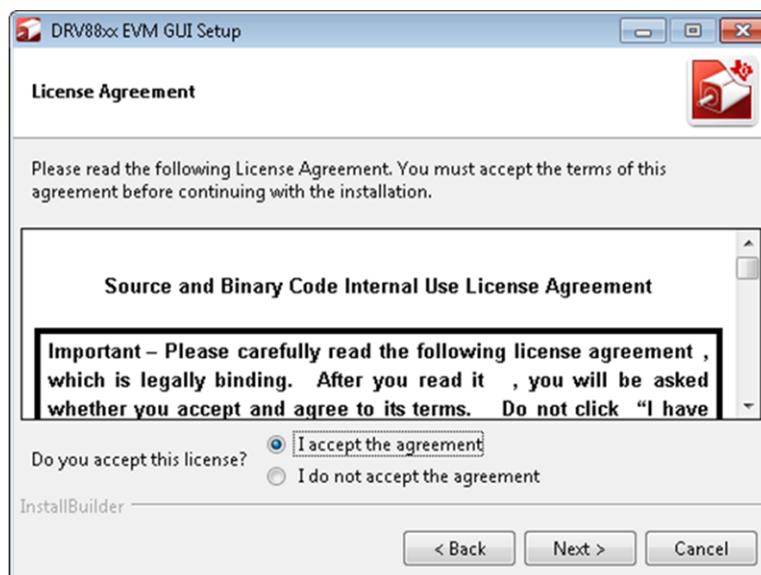


Figure 6. License Agreement

- 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.

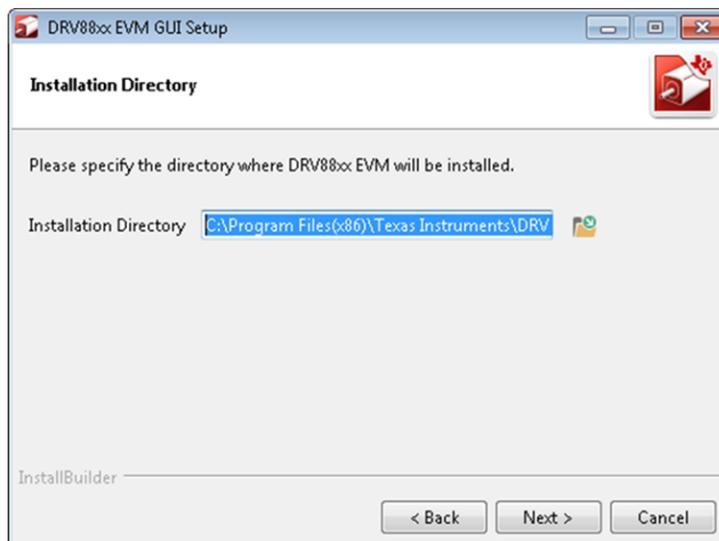


Figure 8. Installation Directory

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.

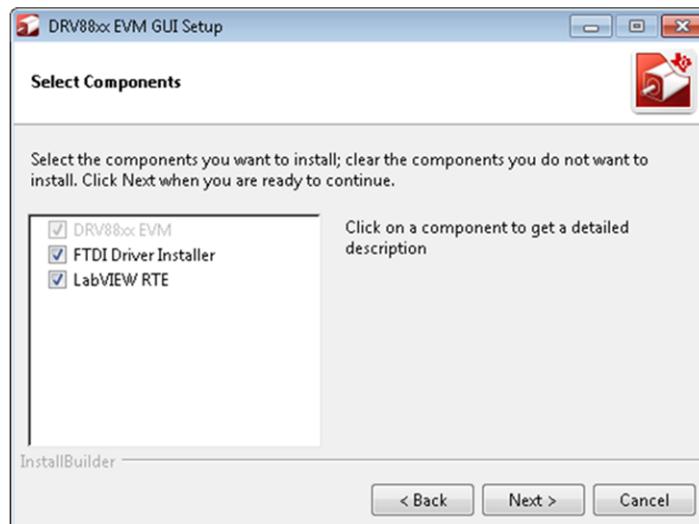


Figure 9. Component Selection

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.

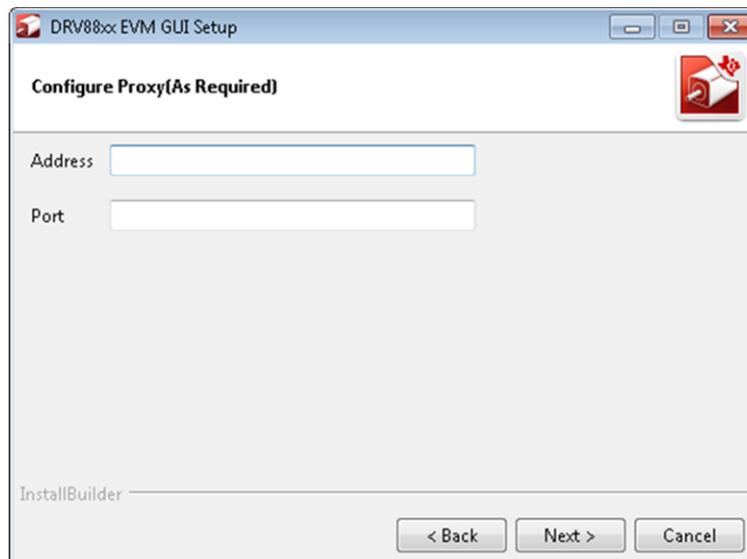


Figure 10. Configure Proxy

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

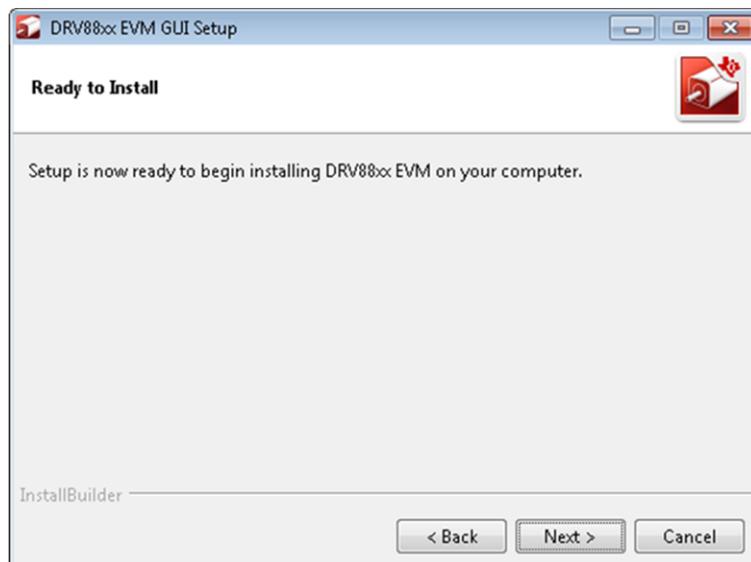


Figure 11. Ready to Install

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

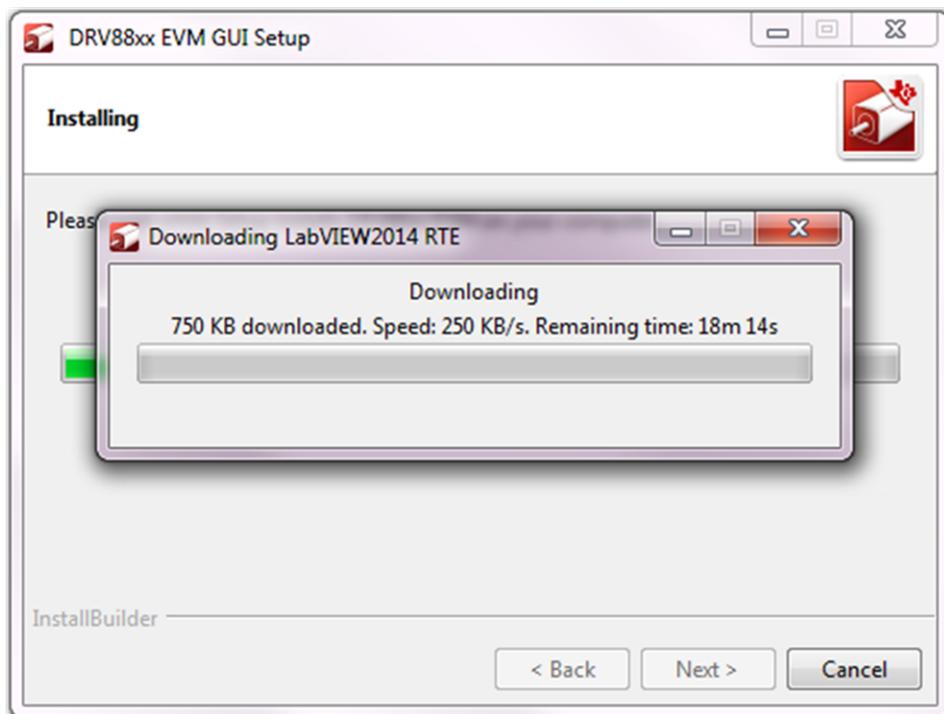


Figure 12. Downloading RTE

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

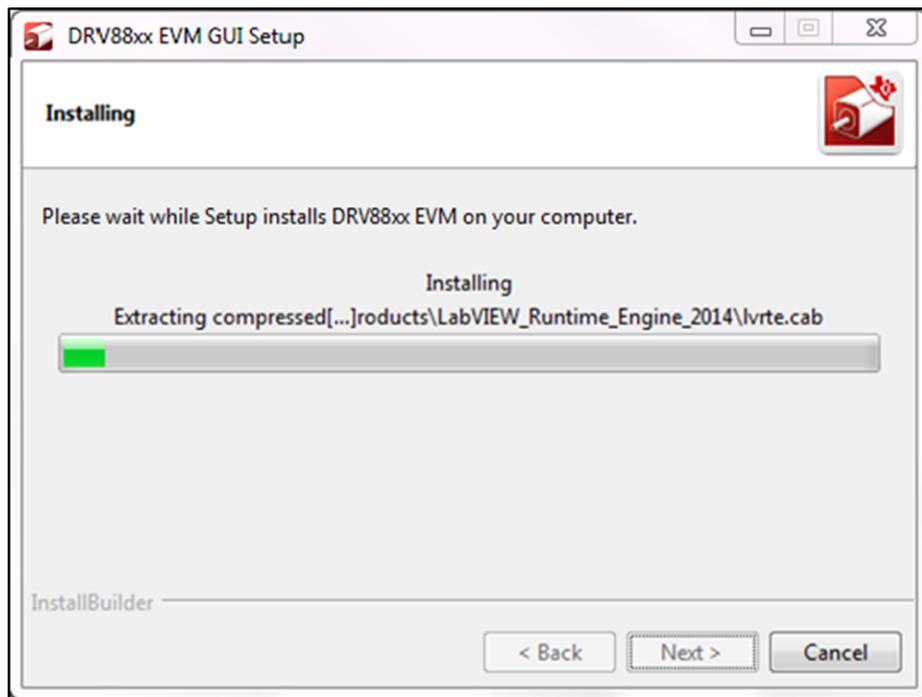


Figure 13. LabVIEW Self-Extraction

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.

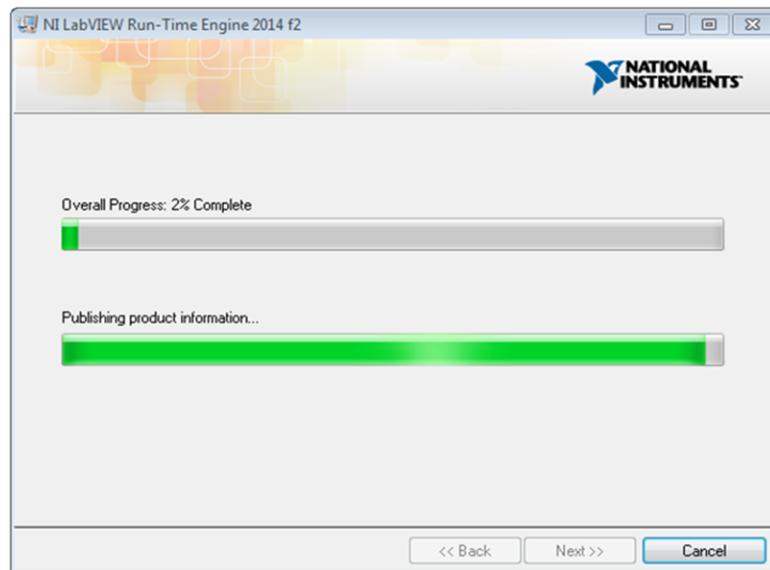


Figure 15. Installation of LabVIEW RTE in Progress

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.

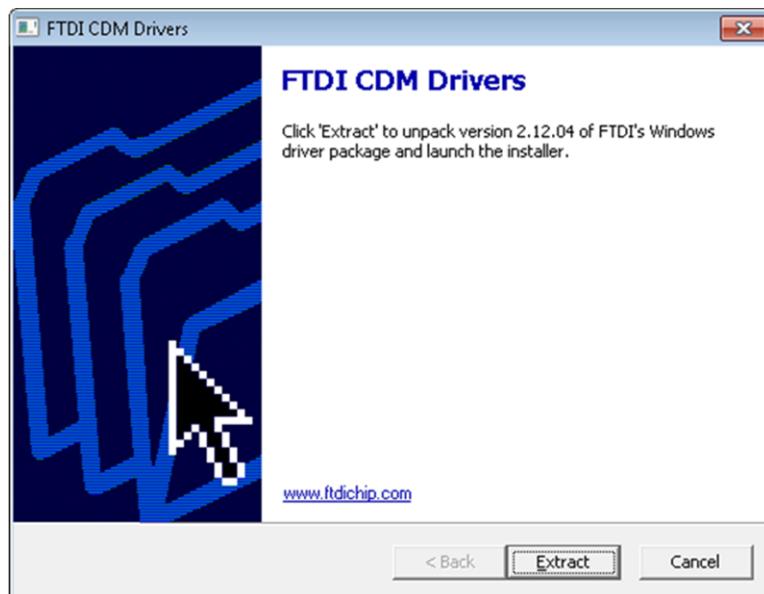


Figure 16. FTDI Installation Initialization

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

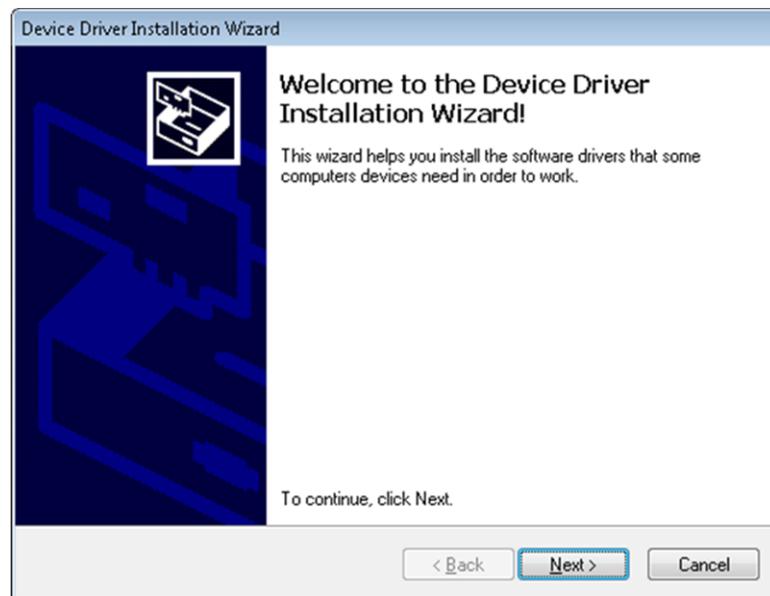


Figure 17. Driver Installation Wizard

13. The License Agreement will appear on screen as shown below.

- Read through the License Agreement carefully and Enable the “I Accept this Agreement” radio button and Click on Next.

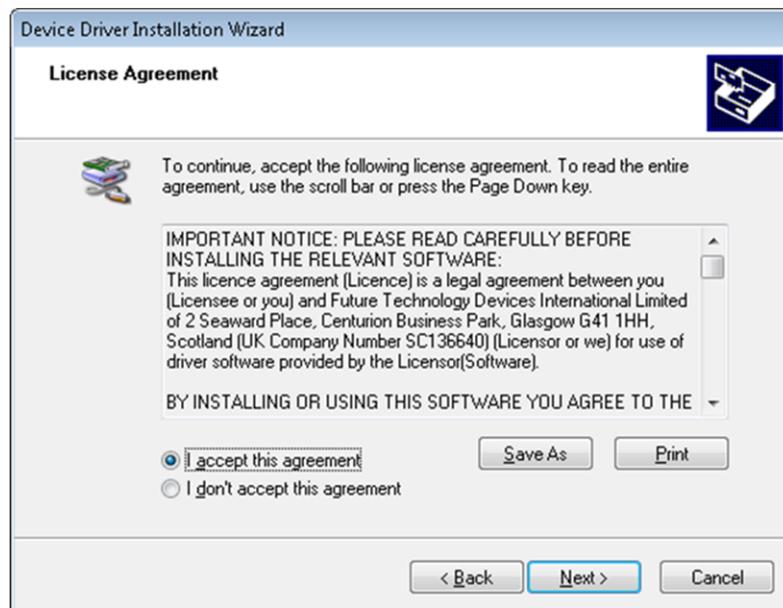


Figure 18. License Agreement for FTDI Driver

14. Click Finish to complete the Driver Installation.

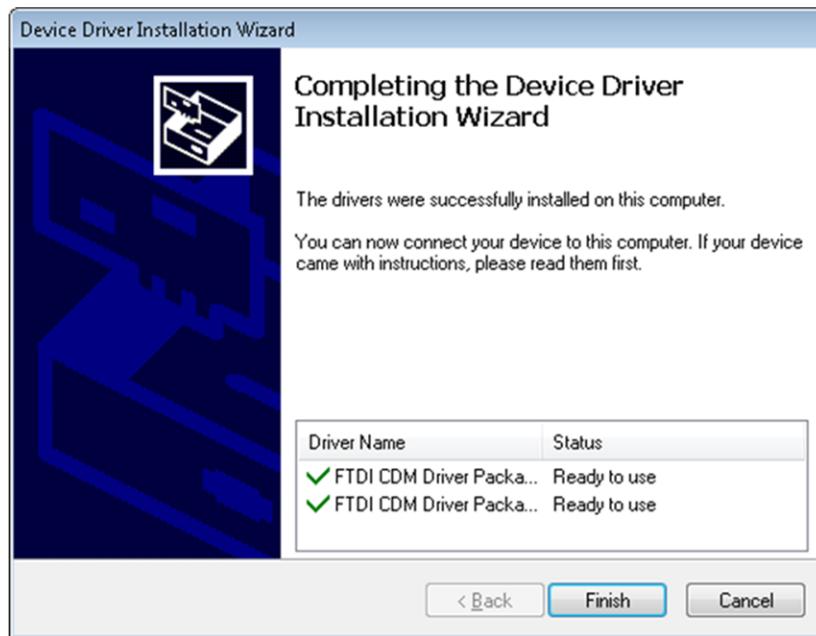


Figure 19. Driver Installation Completion

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

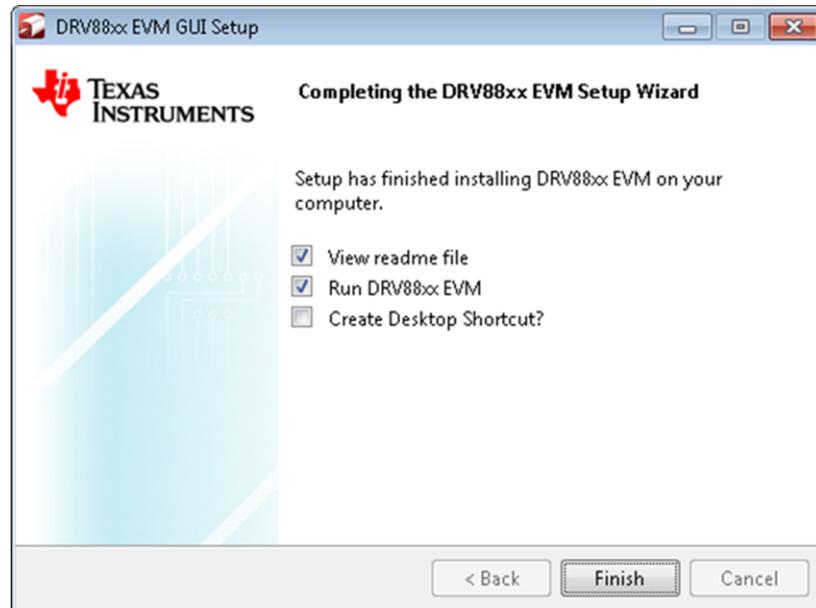


Figure 20. Installation Complete

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

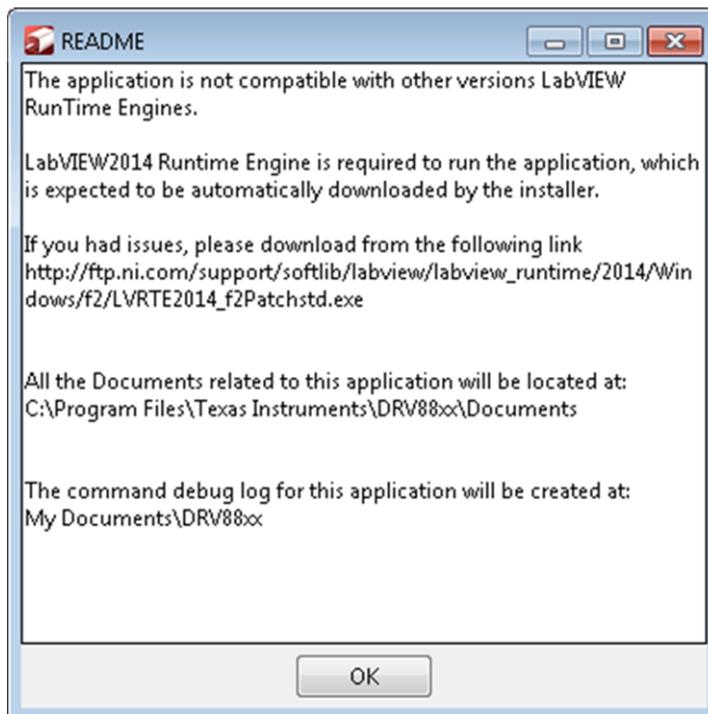


Figure 21. Readme Window

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.

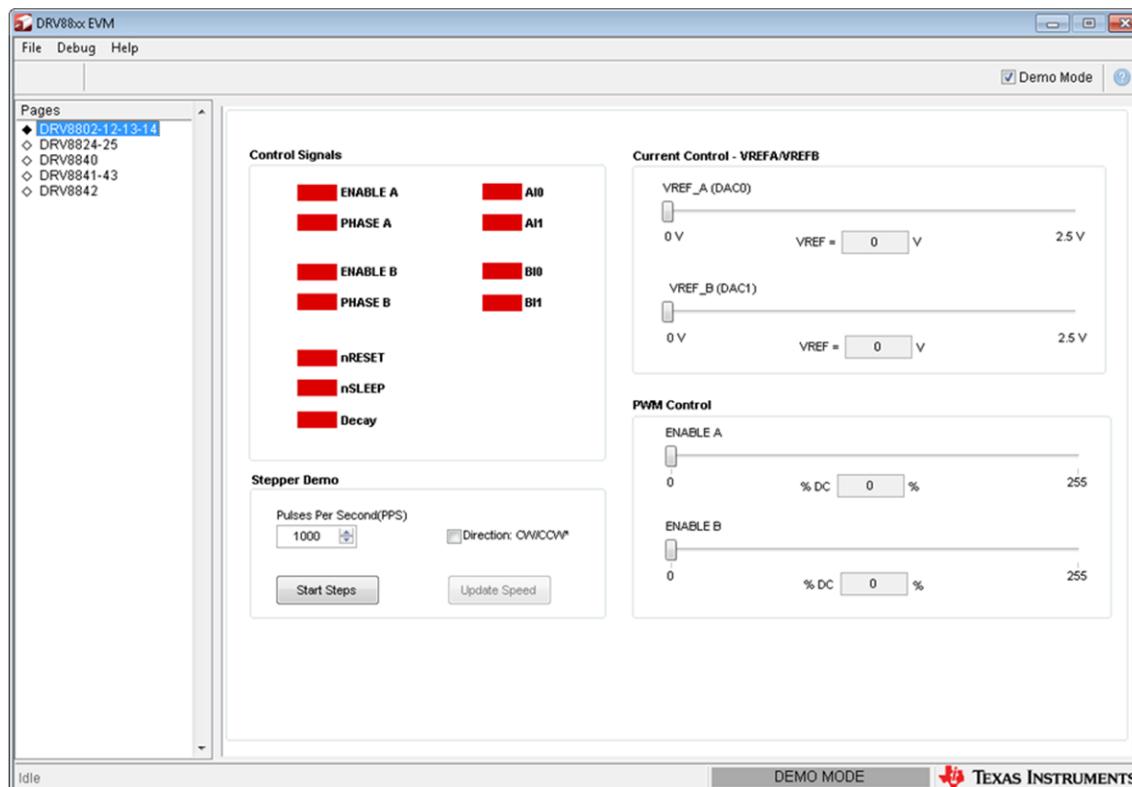


Figure 22. DRV8802-12-13-14 Tab

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 (A_{lx} and B_{lx}). 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-resolution micro 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).

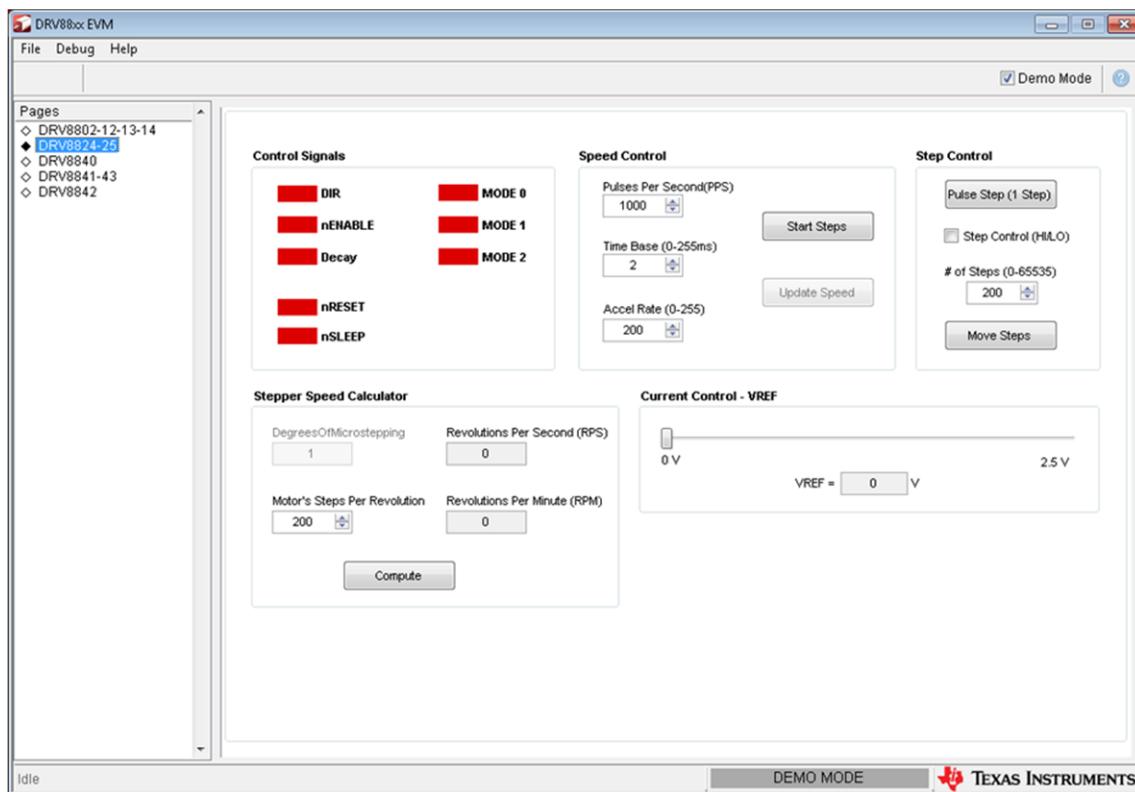


Figure 23. DRV8824-25 Tab

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.

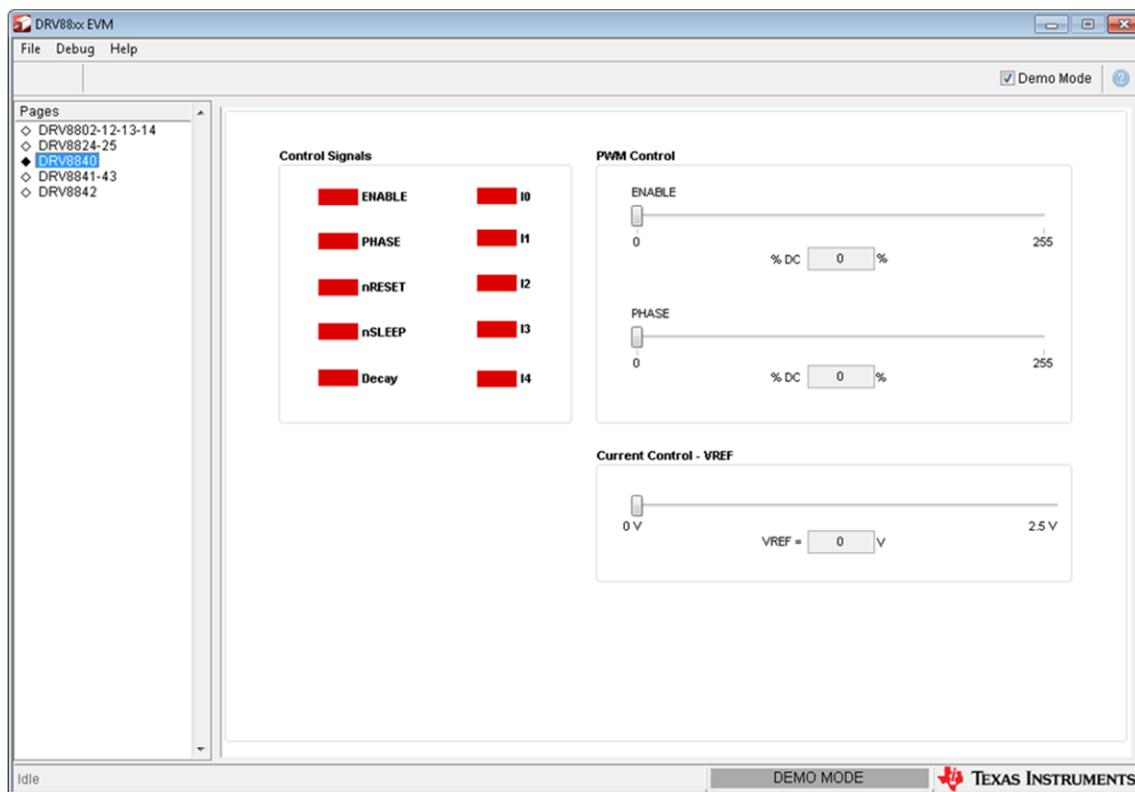


Figure 24. DRV8840 Tab

The DRV8840 tab contains the controls for updating the PWM, current control, I_x 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 AIN_x pins (instead of PHASE and ENABLE). In this tab, the four I_{Nx} signals have a respective PWM slider in order to provide speed control per H Bridge on both directions per H Bridge.

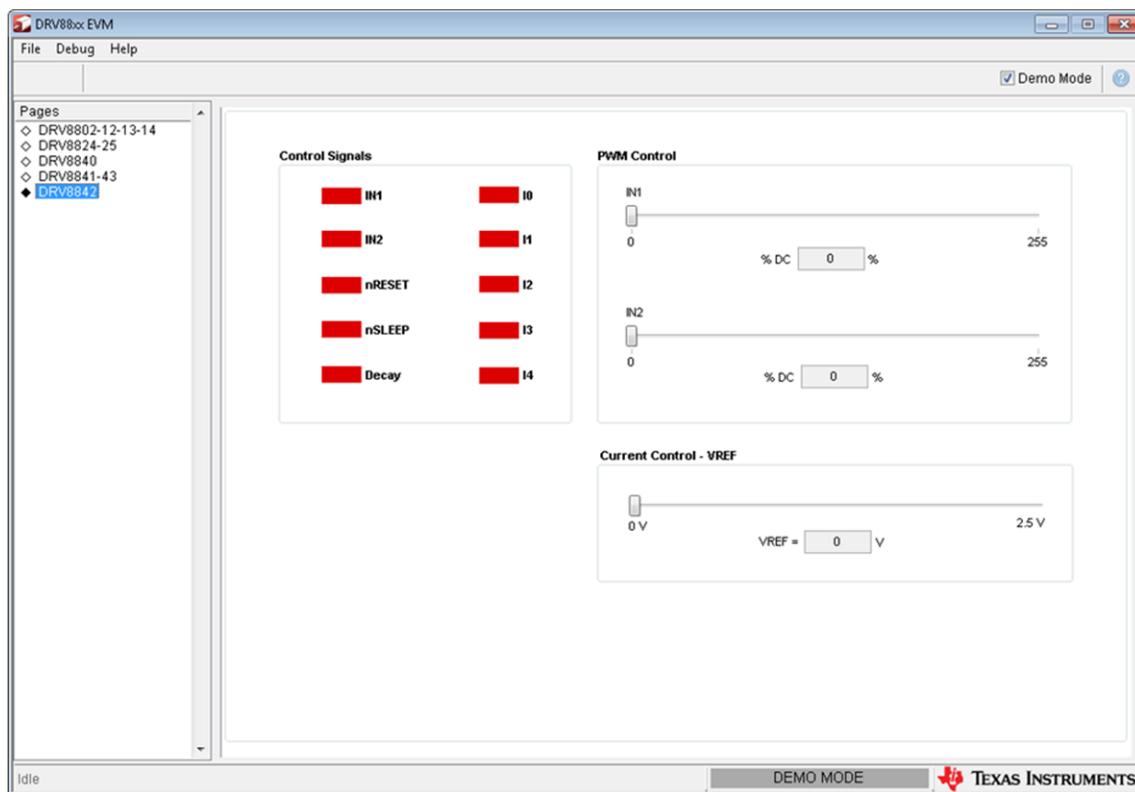


Figure 25. DRV8842 Tab

The DRV8842 tab contains the controls for updating the PWM, current control, I_x & IN_x 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

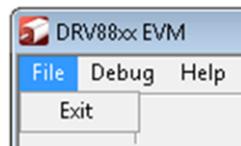


Figure 26. DRV88xx File Menu

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.

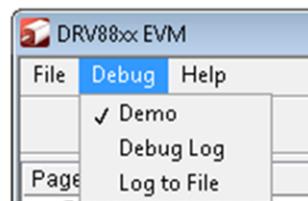


Figure 27. DRV88xx Debug Menu

Help:

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

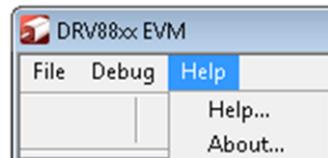


Figure 28. DRV88xx Help Menu



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.

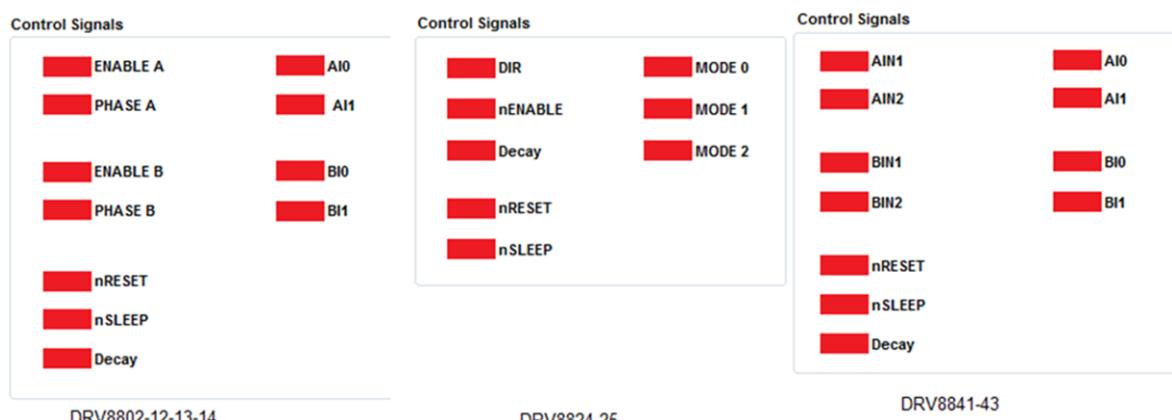


Figure 30. GPIO Control Signals

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:

$$VREF = DAC_VALUE \cdot \frac{2.5}{4095} \quad (1)$$

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.

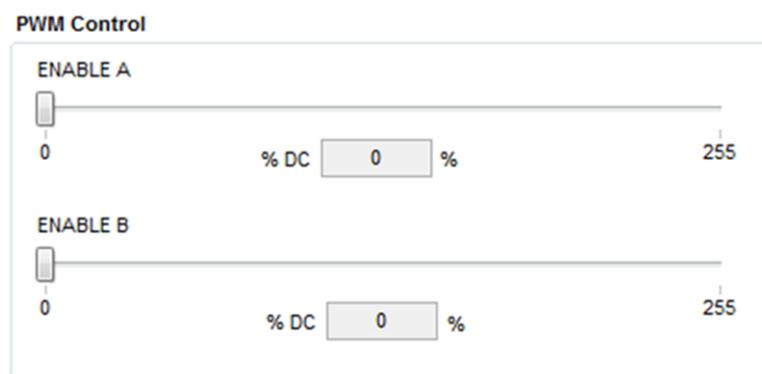


Figure 32. Duty Cycle Indicator

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:

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

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

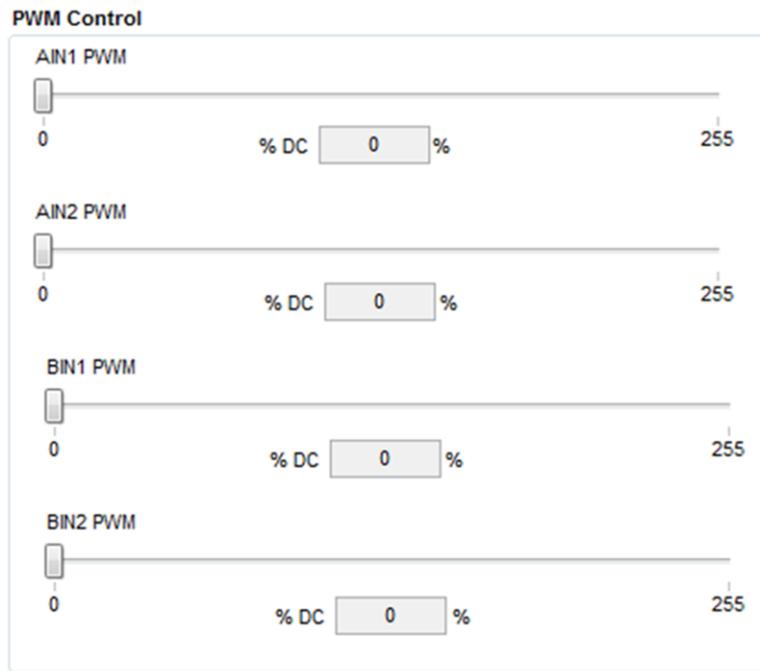


Figure 33. PWM Signal on INx Pins

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.

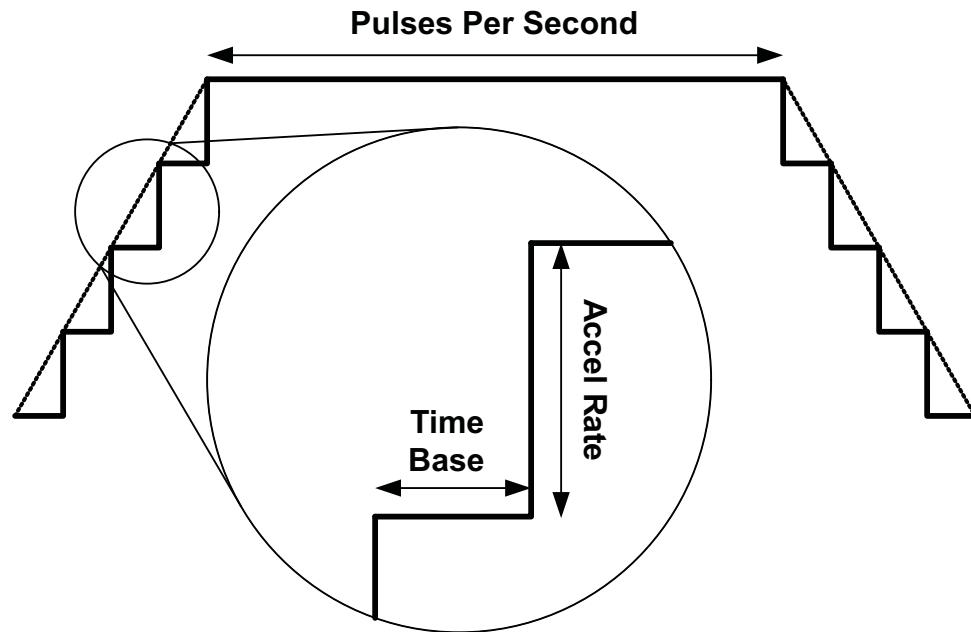


Figure 34. Turning the Stepper Motor

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

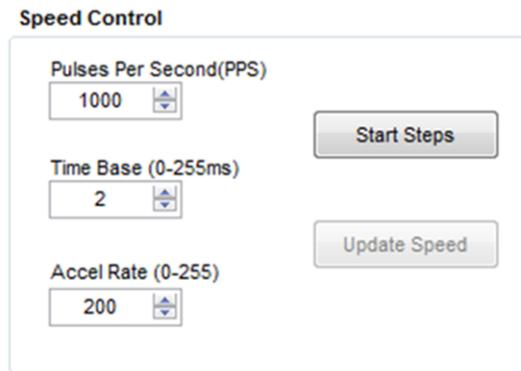


Figure 35. Speed Control

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.

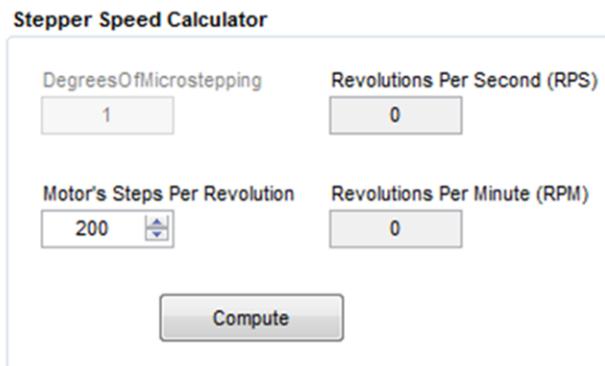
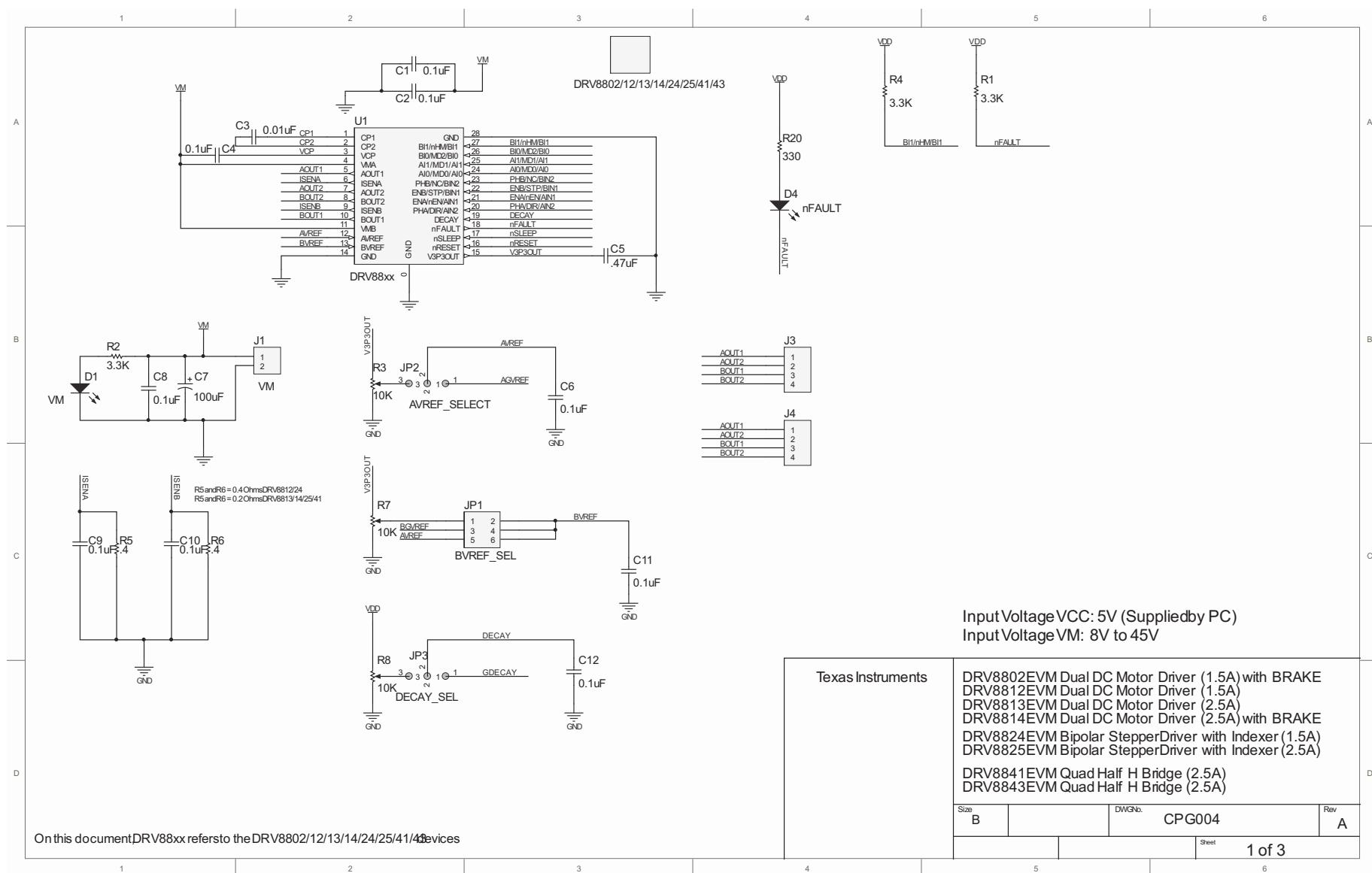
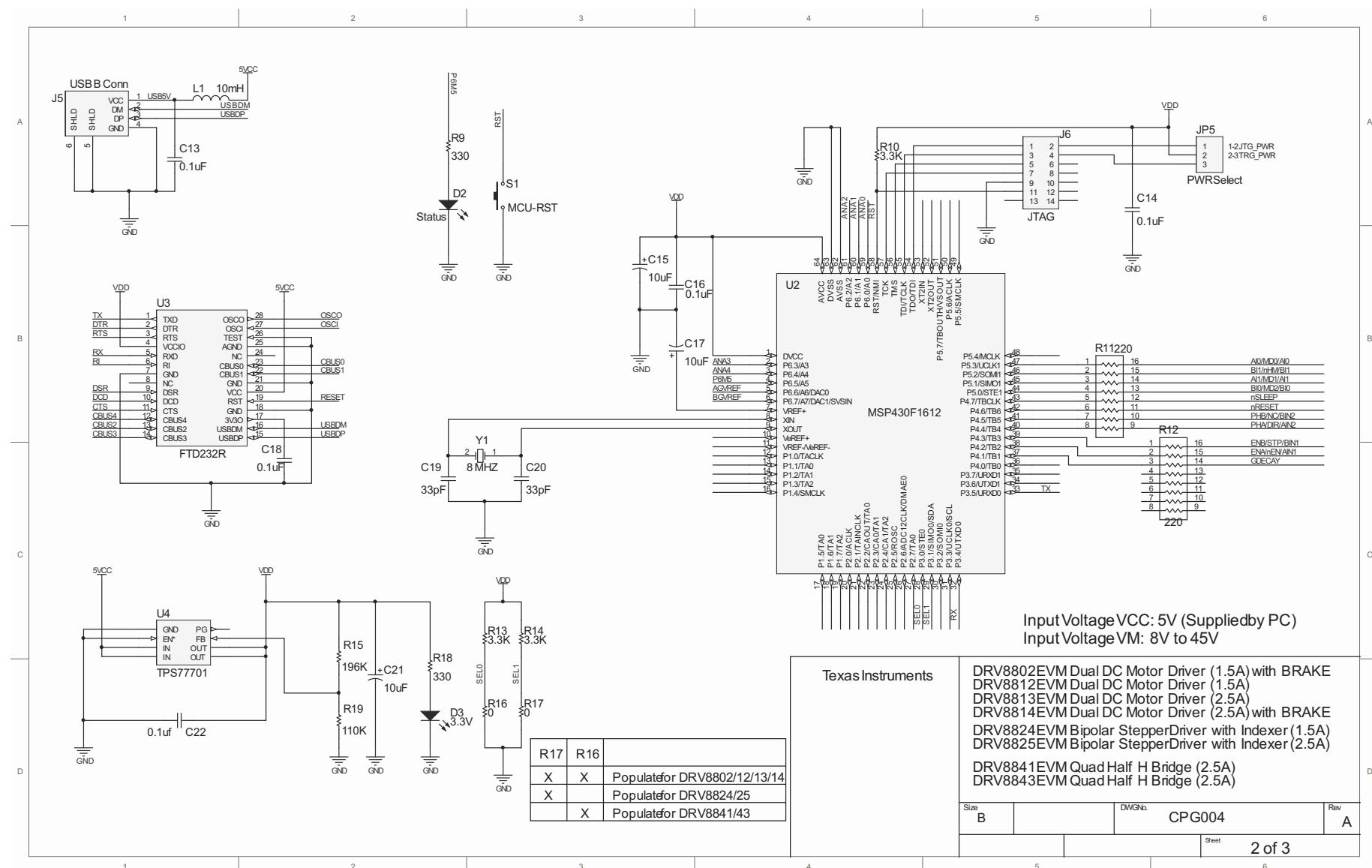


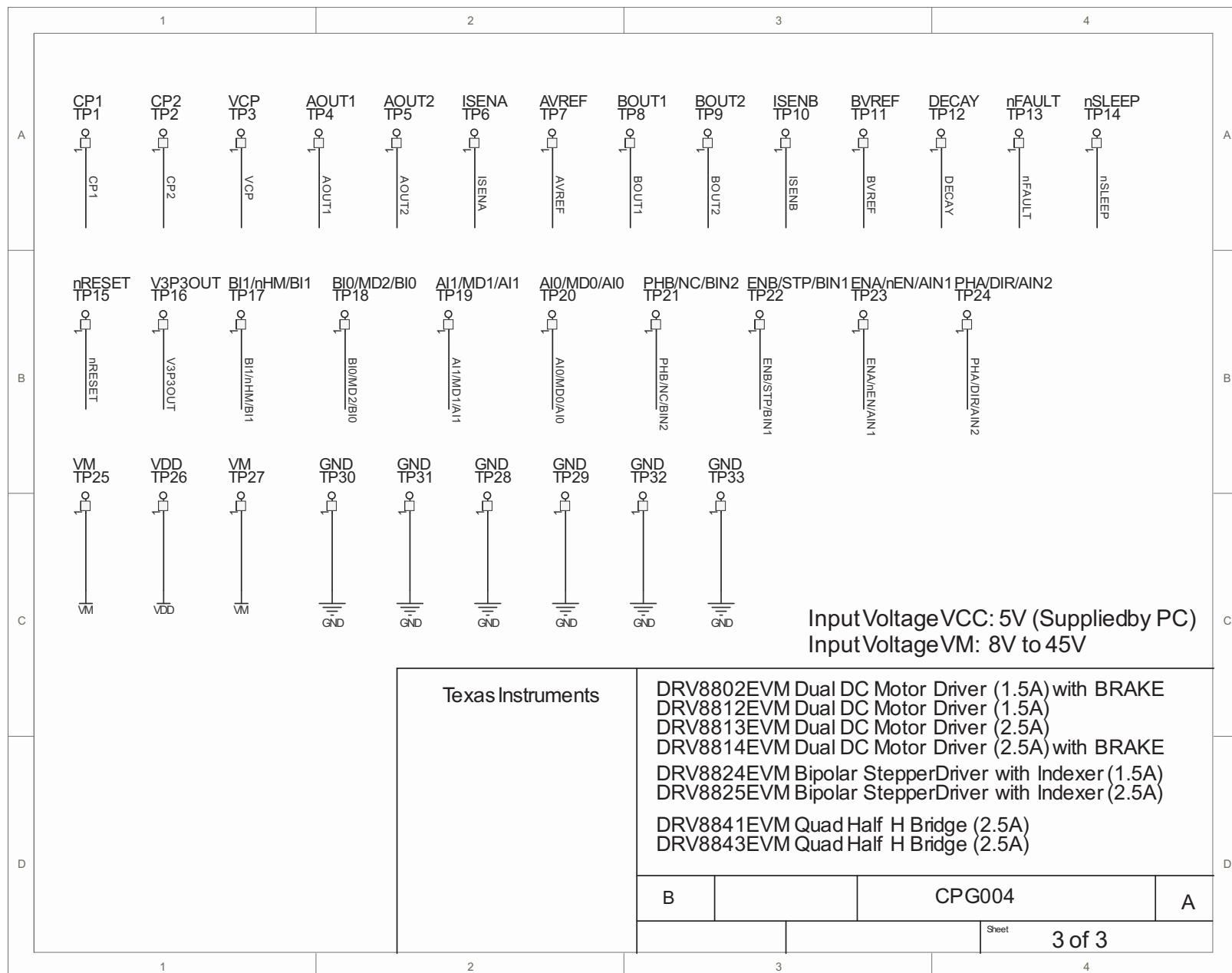
Figure 37. Stepper Speed Calculator

4 Schematics

See the following pages for schematics.







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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STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
- 2 *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 Regulatory Notices:

3.1 United States

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

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

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *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.*

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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.

3.3 Japan

3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。 http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 Notice for Users of EVMs Considered "Radio Frequency Products" in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
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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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsts/ti_ja/general/eStore/notice_02.page
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsts/ti_ja/general/eStore/notice_02.page

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 EVM Use Restrictions and Warnings:

- 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
- 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
- 4.3 *Safety-Related Warnings and Restrictions:*
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
- 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*
 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
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 - 8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.
 - 8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.
9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.
10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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