

Laser and Motor Drives

This document is provided as a supplement to the [DRV8811](#) datasheet. It details the hardware implementation of the DRV8811 customer evaluation module (EVM).

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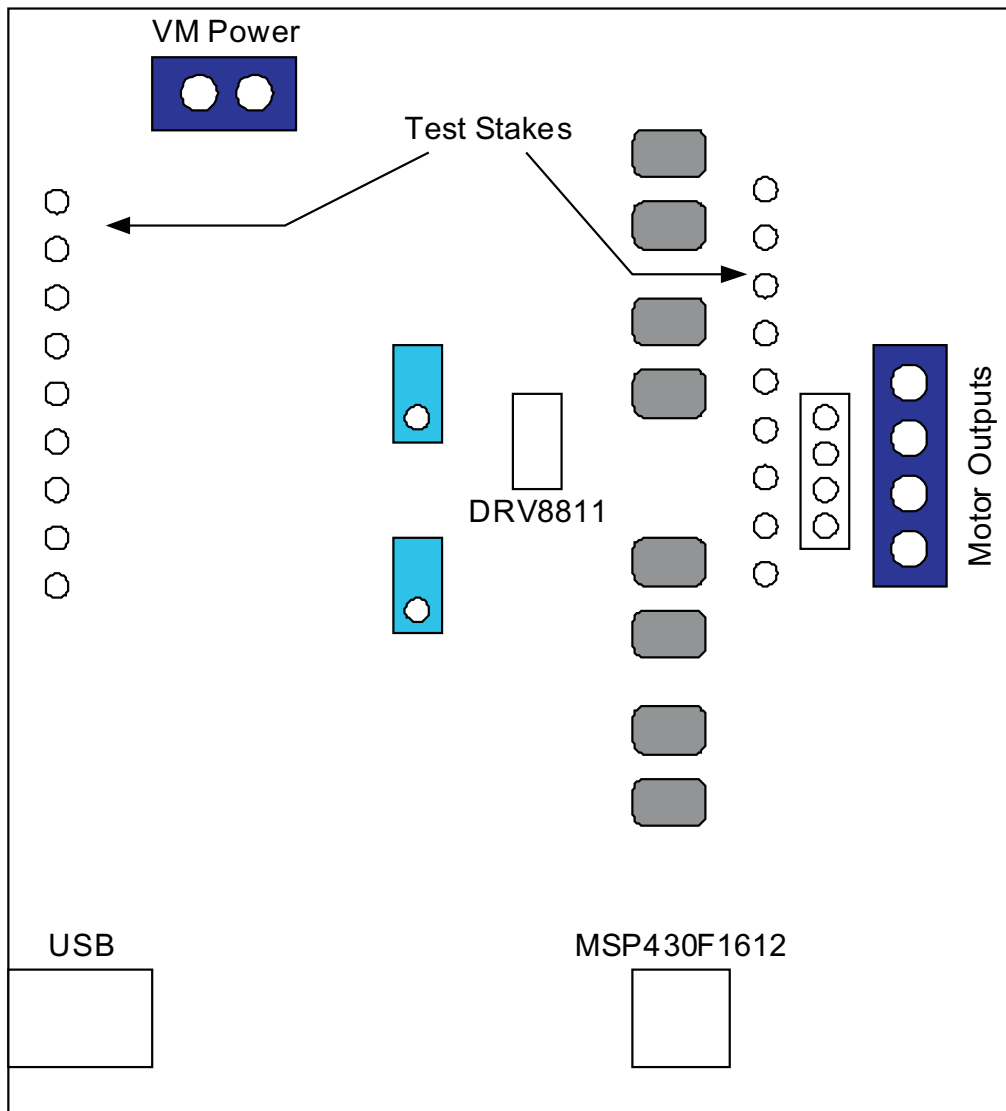
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1 Introduction

The DRV8811EVM-001 customer EVM is the complete solution to evaluating the DRV8811 microstepping bipolar stepper driver. It houses a USB link to provide easy control from a PC computer, an MSP430 microcontroller that interprets serial commands from the PC and generates control signals to the driver device, and the DRV8811 device with access to all signals for a complete evaluation.

1.1 Block Diagram



1.2 Power Connectors

The DRV8811 customer EVM uses a combination of terminal blocks and test clips for the application/monitoring of power. The only power rail the user must supply is VM for the device's power stage. VDD for logic levels is internally generated from the USB connection.

The user must apply VM according to datasheet recommended parameters.

1.3 Test Stakes

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

1.4 Jumpers

Three pin jumpers can be configured independently from the other two or three pin jumpers. However, two pin jumpers must either be closed or open. Two pin jumpers (JP2 to JP5) connect the diodes to the motor outputs and are used under asynchronous rectification (SR = LO).

1.4.1 VREF SELECT (JP1) Jumper

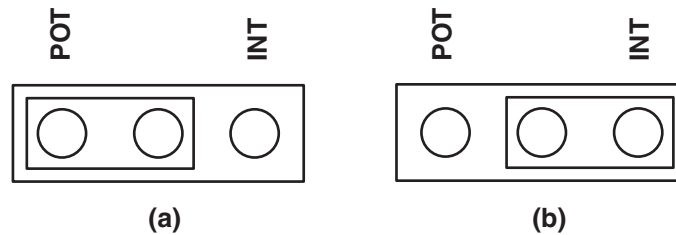


Figure 1. VREF SELECT Jumper

To configure the VREF SELECT jumper: [Figure 1 \(a\)](#) selects an analog voltage derived from VDD through a voltage divider implemented as a potentiometer R4. [Figure 1 \(b\)](#) selects an analog voltage derived from the MSP430's digital to analog converter channel 0 (DAC0).

1.4.2 DECAY SELECT (JP6) Jumper

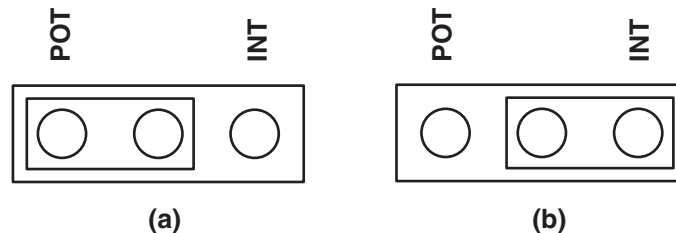


Figure 2. DECAY SELECT Jumper

To configure the DECAY SELECT jumper: [Figure 2 \(a\)](#) selects an analog voltage derived from VDD through a voltage divider implemented as a potentiometer R6. [Figure 2 \(b\)](#) selects an analog voltage derived from the MSP430's digital to analog converter channel 1 (DAC1).

1.5 Motor Outputs

There are three ways of connecting the bipolar stepper motor into the DRV8811 EVM: four pin header (J2), four position terminal block (J3) or test clips. Each connection style offers identical connectivity to the device's output terminals. It is recommended, however, to use the header or terminal block, as the test stakes traces are of low current handling capability.

2 Installing Drivers And Software

2.1 Installing the FTDI USB Driver

Instructions on how to install the FTDI USB driver on a Windows based computer are detailed in the "USB_Drivers_Install_Readme.pdf" file supplied with the CD inside the USB_Driver folder.

2.2 GUI Software Installation

The following section explains the location of files 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 will also install LabVIEW RTE 2014 and FTDI Driver, along with the GUI.

2.2.1 System Requirements

- Supported OS – Windows 7 (32 Bit, 64 Bit). The window text size should be Smaller-100% (Default)
- Recommended RAM - 4 GB or higher
- Recommended CPU Operating Speed – 3.3 GHz or higher

2.2.2 Installation Procedure

The following procedure helps you install the DRV8811 GUI

1. Double click on the **Setup_DRV8811_EVM.exe** as shown in [Figure 3](#).

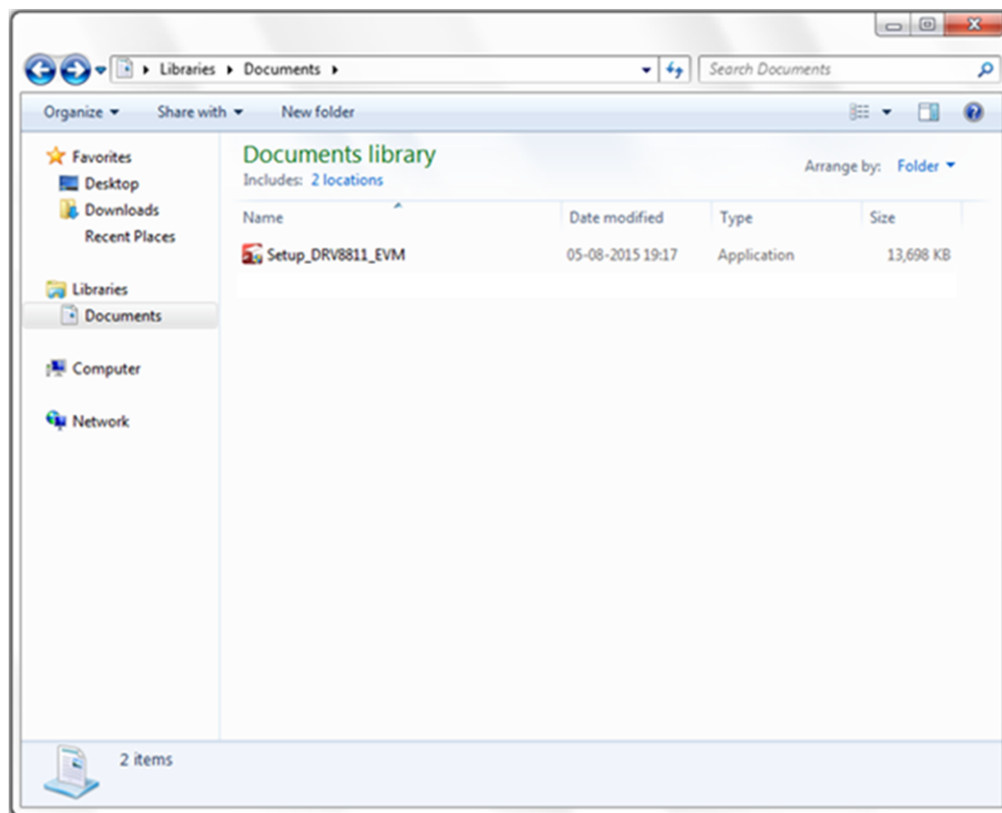


Figure 3. Setup_DRV8811_EVM.exe

2. The screen shown in [Figure 4](#) appears, indicating installer initialization. Click the **Next** button.

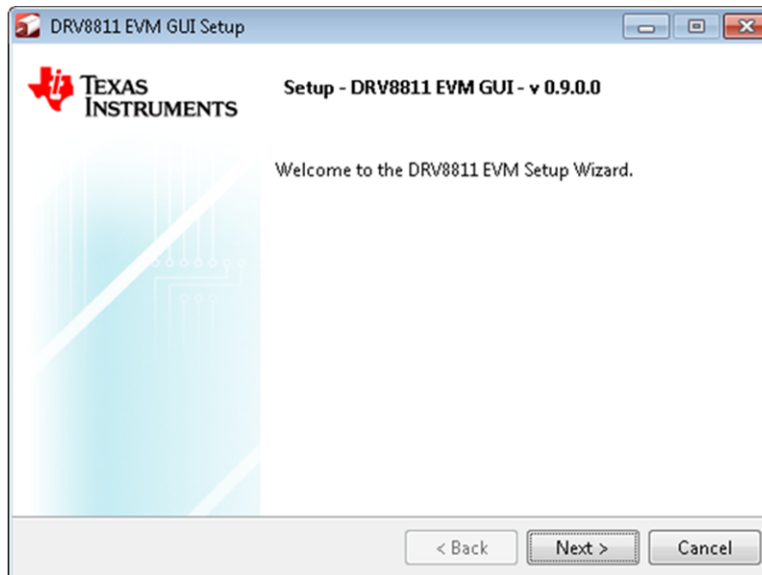


Figure 4. Installation Initialization

3. In the newly open installation pop-up window, click **Next**. The license agreement will be displayed. Please, read through it carefully and enable the "I Accept the Agreement" radio button and press **Next**.

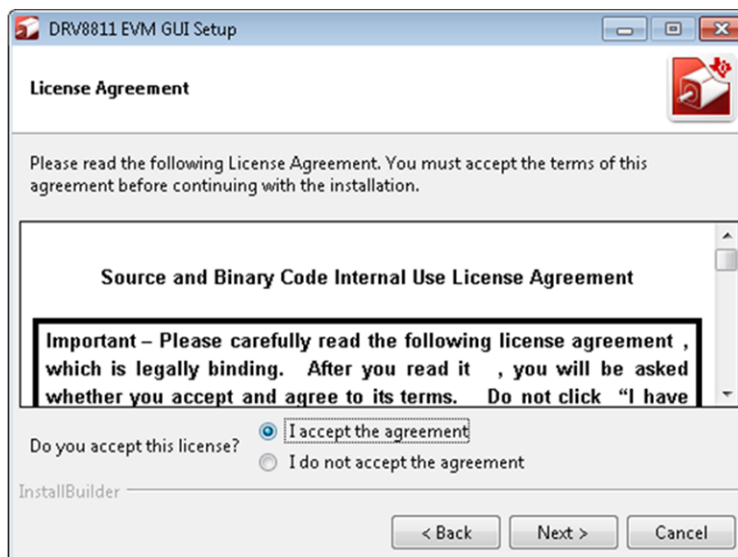


Figure 5. License Agreement

4. A screen as shown in [Figure 6](#) appears, 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.

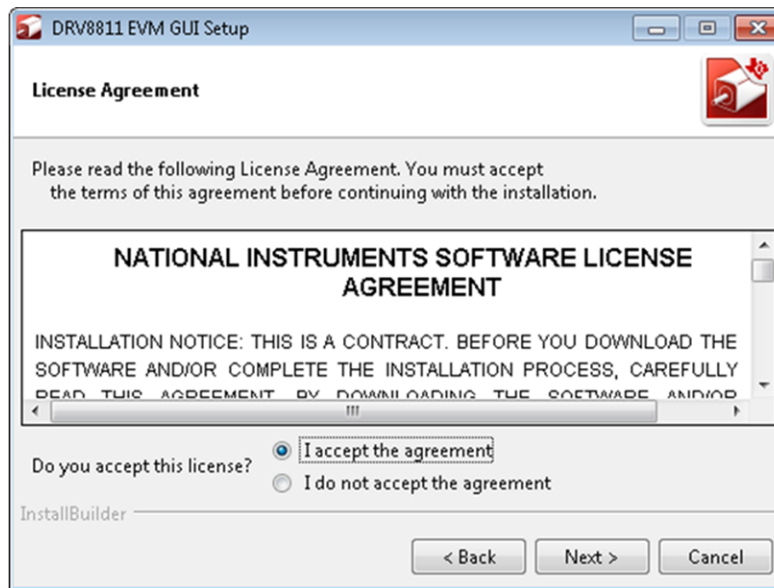


Figure 6. NI License Agreement

5. Set the default directory for the GUI Installation and click **Next**.

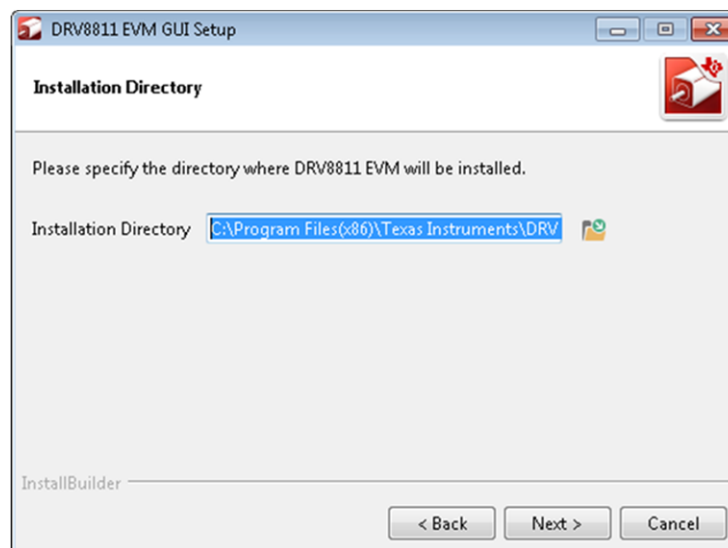


Figure 7. Installation Directory Screen

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

6. A screen as shown in [Figure 8](#) appears. This screen is to select the components to install. Select the Components to Install and Click **Next** to continue installation. The LabVIEW RTE component checks out if the LabVIEW RTE 2014 is already installed on the PC.

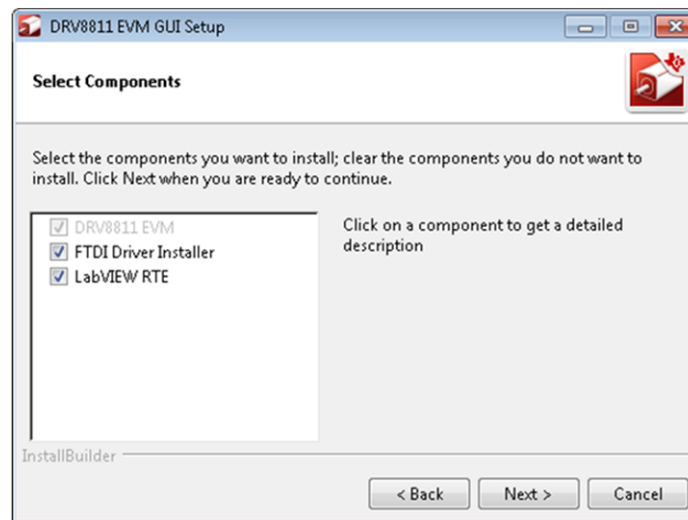


Figure 8. Component Selection

7. If LabVIEW RTE is selected as a component to install, a screen appears as shown in [Figure 9](#). Configure the proxy settings as required. This screen is to download the LabVIEW RTE 2014 from ni.com, Click **Next** to continue the installation.

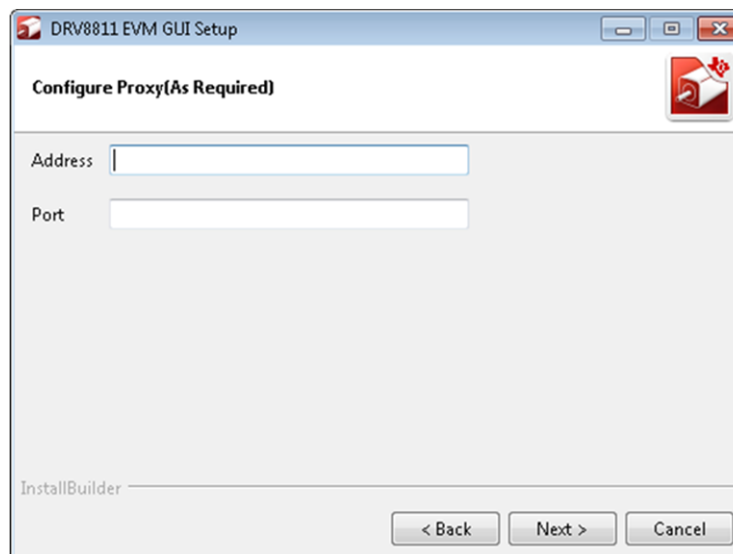


Figure 9. Configure Proxy

8. A screen as shown in [Figure 10](#) appears. Click **Next** to begin the installation.

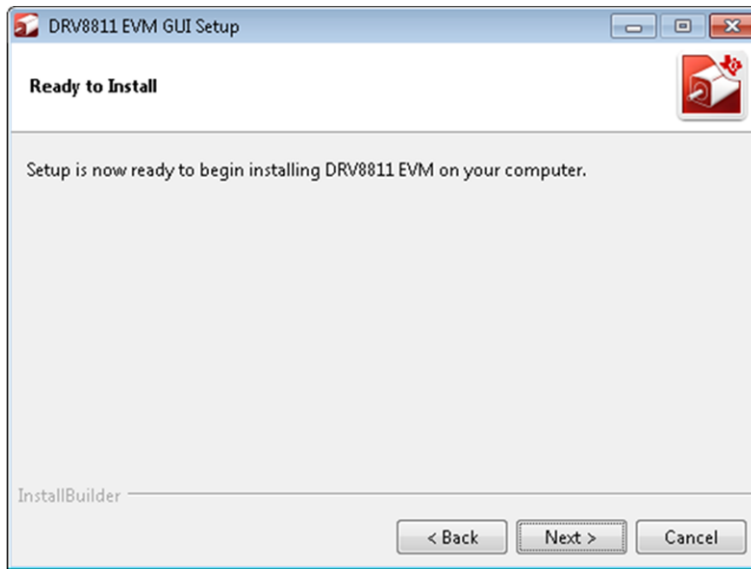


Figure 10. Ready to Install

9. If the LabVIEW RTE 2014 is selected as a component to install, LabVIEW RTE downloads and performs a silent mode installation.

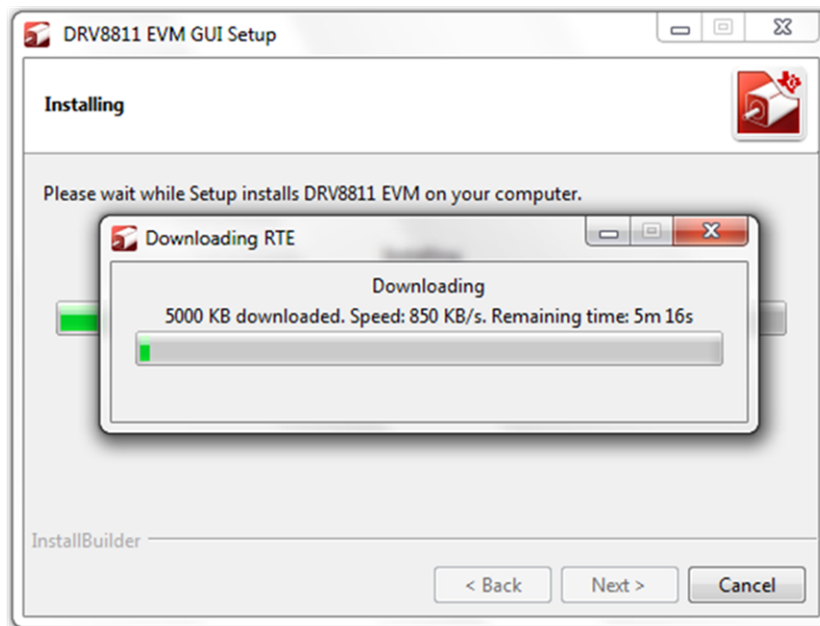


Figure 11. Downloading RTE

10. Once the download completes, LabVIEW begins with the self-extraction as shown in [Figure 12](#).

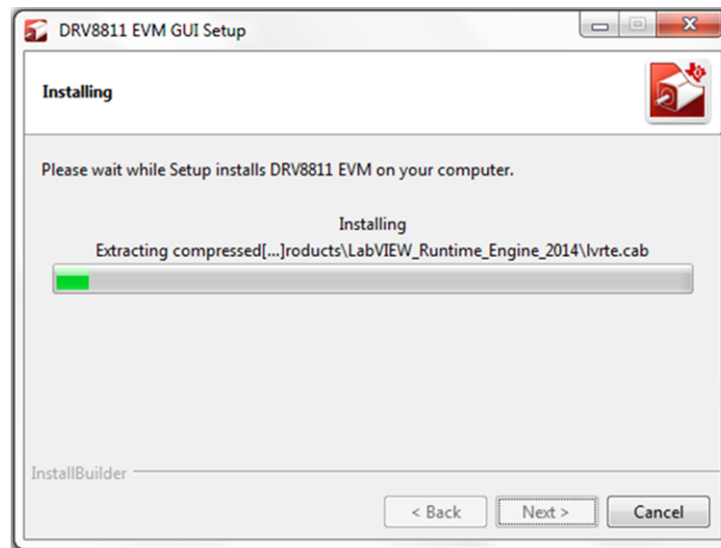


Figure 12. LabVIEW RTE Self Extraction

11. A Screen appears as shown in [Figure 13](#). It initializes the LabVIEW RTE Installation.

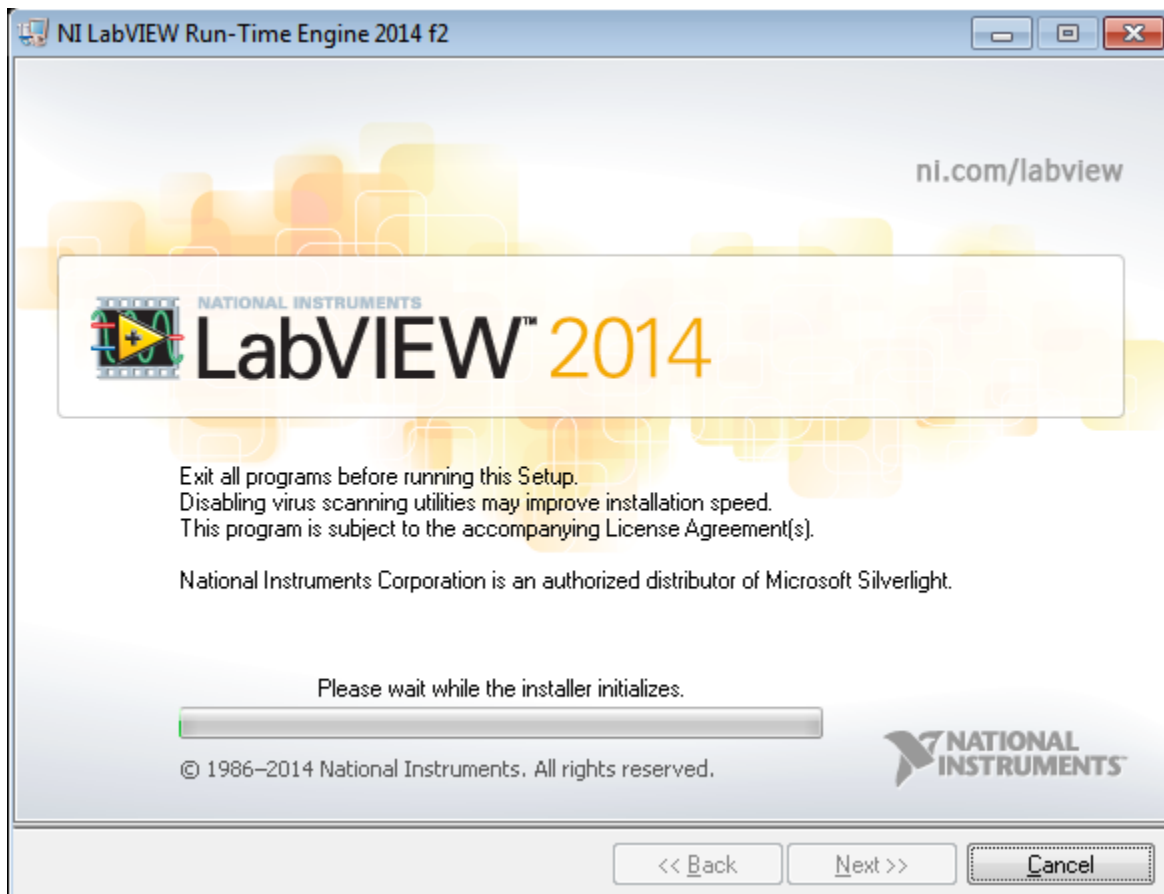


Figure 13. LabVIEW RTE Installation Initialization

12. A display as shown in [Figure 14](#) appears which indicates the progress of LabVIEW RTE installation.

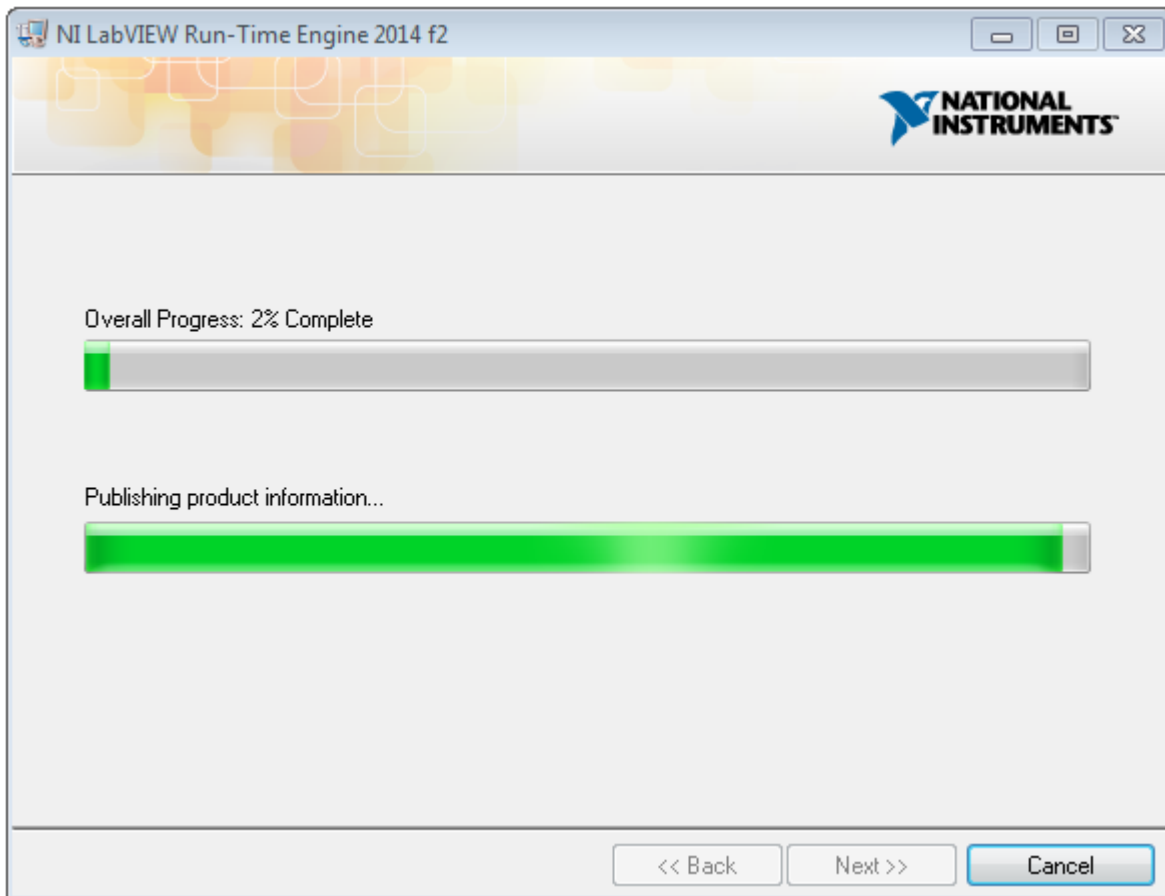


Figure 14. Installation of LabVIEW RTE in Progress

13. Once the LabVIEW RTE 2014 is installed, DRV 8811 EVM GUI component installs.
14. After DRV8811 Installation, FTDI Installation begins. A screen as shown in [Figure 15](#) appears, click **Extract** to proceed.

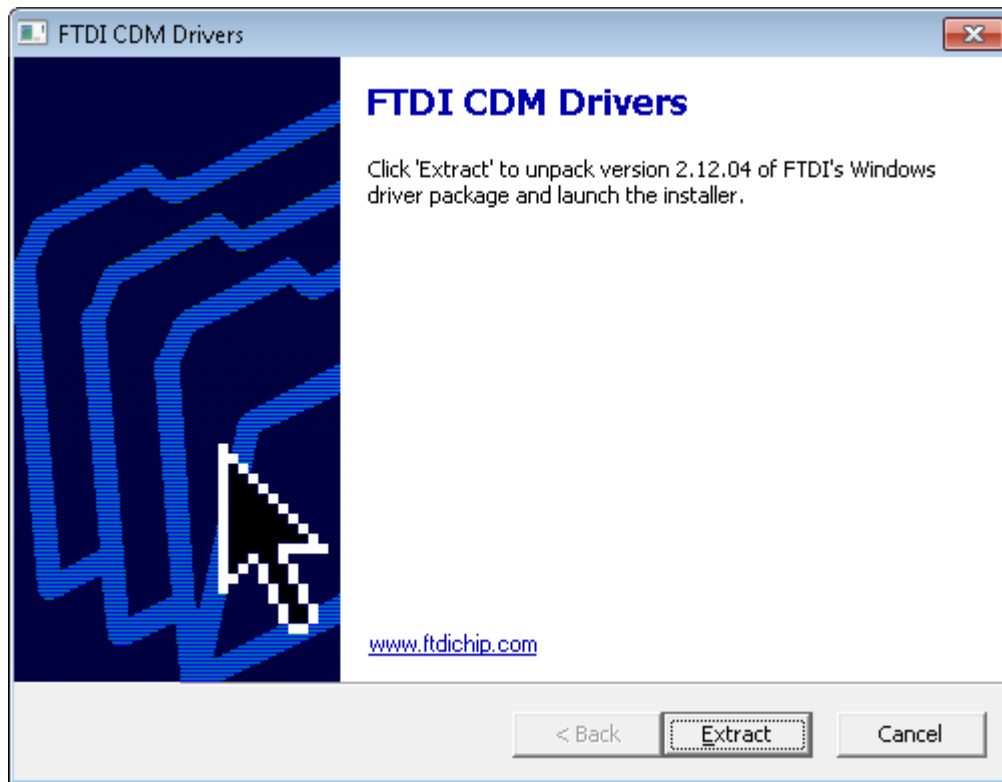


Figure 15. FTDI Installation Initialization

15. A screen as shown in Figure 16 appears, click **Next** to proceed.

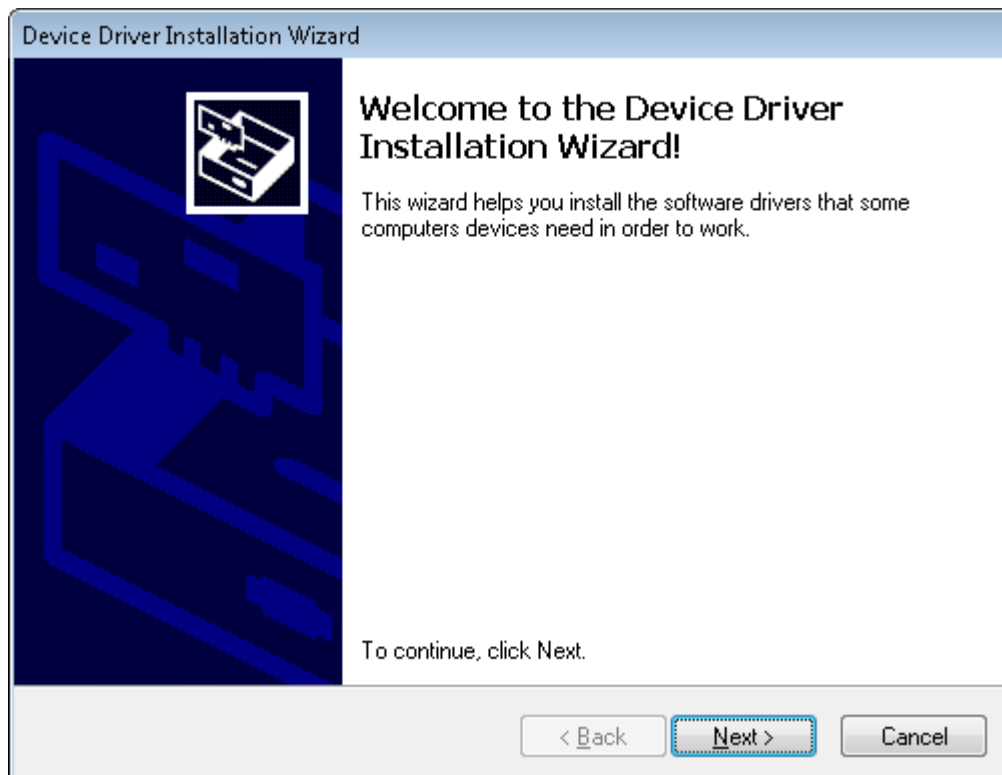


Figure 16. Driver Installation Wizard

16. The License Agreement appears on screen as shown in [Figure 17](#).
17. Read through the License Agreement carefully and enable the "I Accept this Agreement" radio button and Click on **Next**.

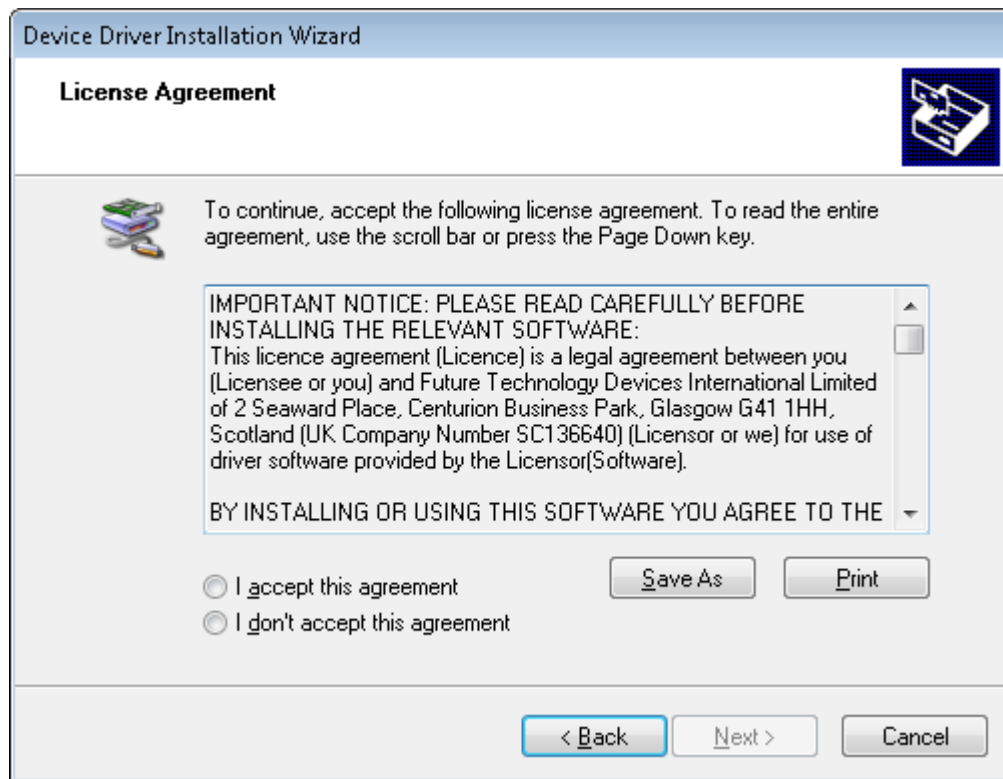


Figure 17. License Agreement for FTDI Driver

18. Click **Finish** to complete the Driver Installation.

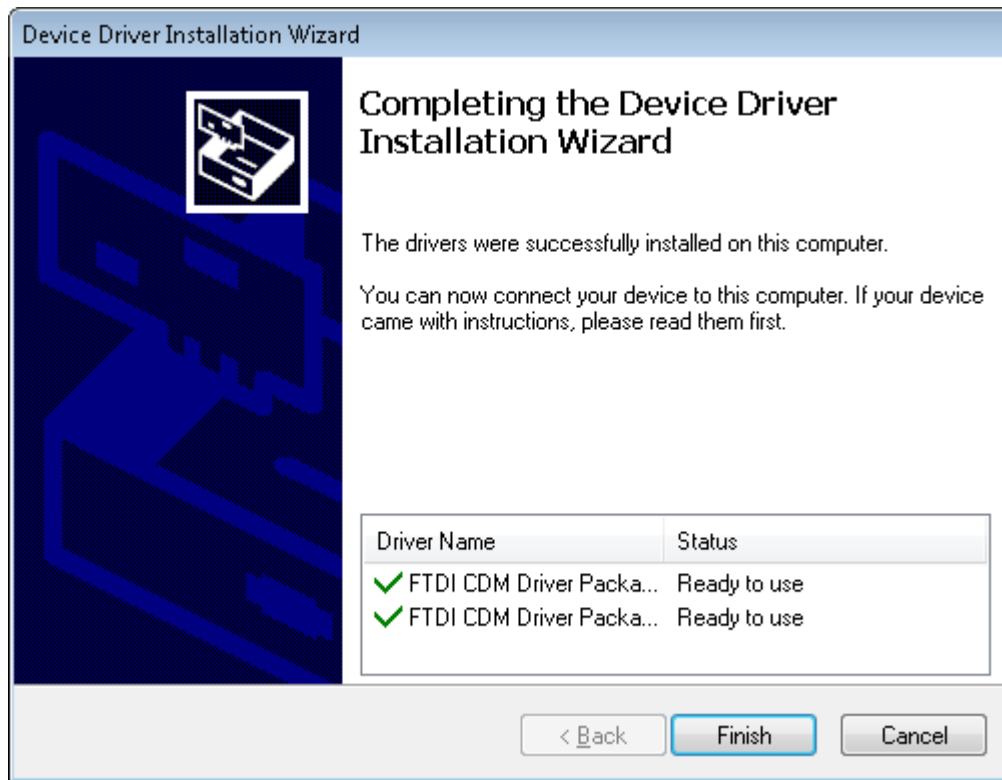


Figure 18. Driver Installation Completion

19. [Figure 19](#) appears denoting the completion of DRV8811 EVM GUI Installation. Click **Finish**.

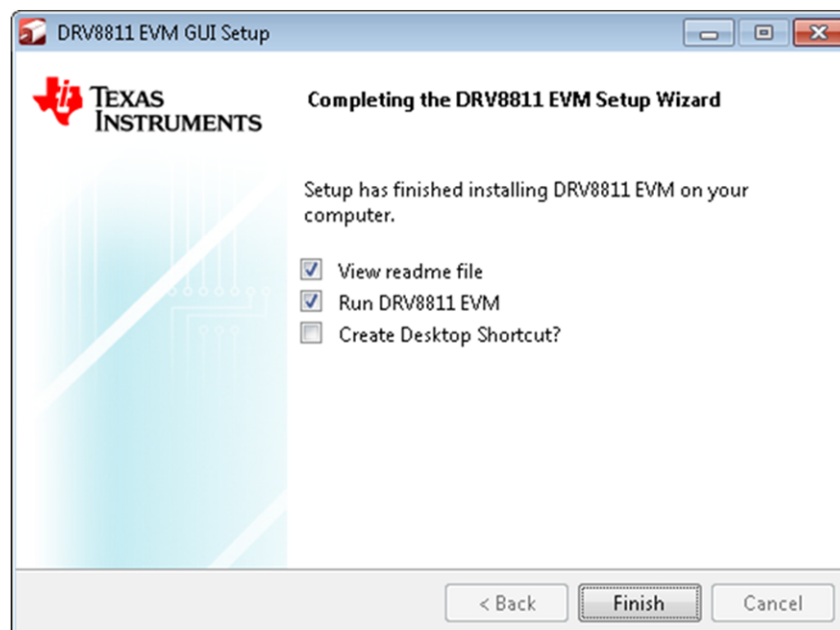


Figure 19. Installation Complete

20. A Readme window as shown in [Figure 20](#) appears displaying the link for LV 2014 RTE.

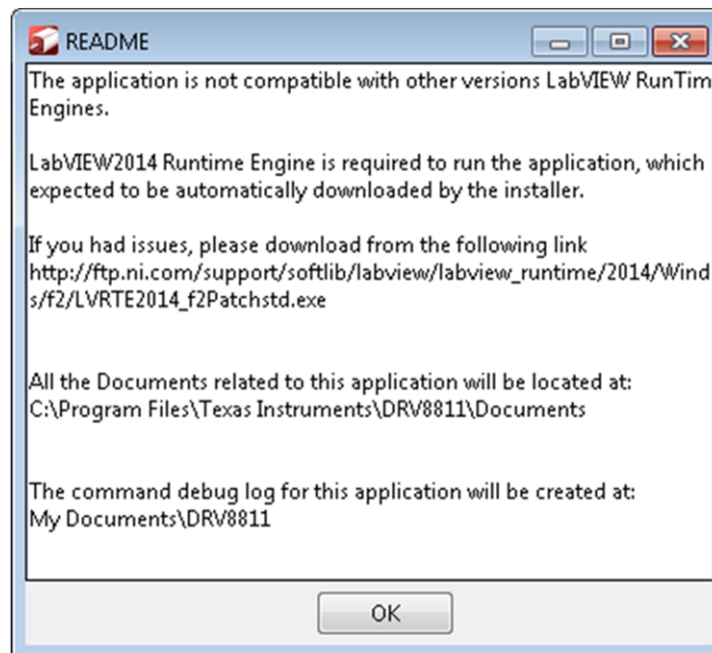


Figure 20. Readme Window

WARNING

The DRV8811 EVM GUI requires the LabVIEW Run-Time Engine 2014 to be installed before the GUI executes. Please note the application is not compatible with other versions of LabVIEW Runtime Engine.

You can download National Instruments LabVIEW Run-Time Engine 2014 from the below link:
[LabVIEW Run-Time Engine 2014](http://ftp.ni.com/support/softlib/labview/labview_runtime/2014/Windos/f2/LVRTE2014_f2Patchstd.exe)

NOTE: DRV8811 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 (32-bit version).

2.3 Running the Windows Application Software

To run the application, search for the desktop shortcut of the application or search for the DRV8811EVM GUI in your Programs or its installation directory.

3 Windows Application

The DRV8811 Windows Application is the software counterpart for the DRV8811 EVM. It is in charge of connecting to the MSP430 microcontroller via a USB connection which in turn selects the proper logic state for the DRV8811 control signals.

The graphical user interface (GUI) has been designed to allow for all of the DRV8811 device's functionality to be tested without having to intervene with the hardware, except for the proper configuration of jumpers when needed.

Figure 21 shows the GUI main screen. It contains menu items to configure and enable/disable the serial port, frames with GPIO control for the DRV8811 control signals, stepper motor control for start/stop and speed, and current/decay control through the MSP430 DACs.

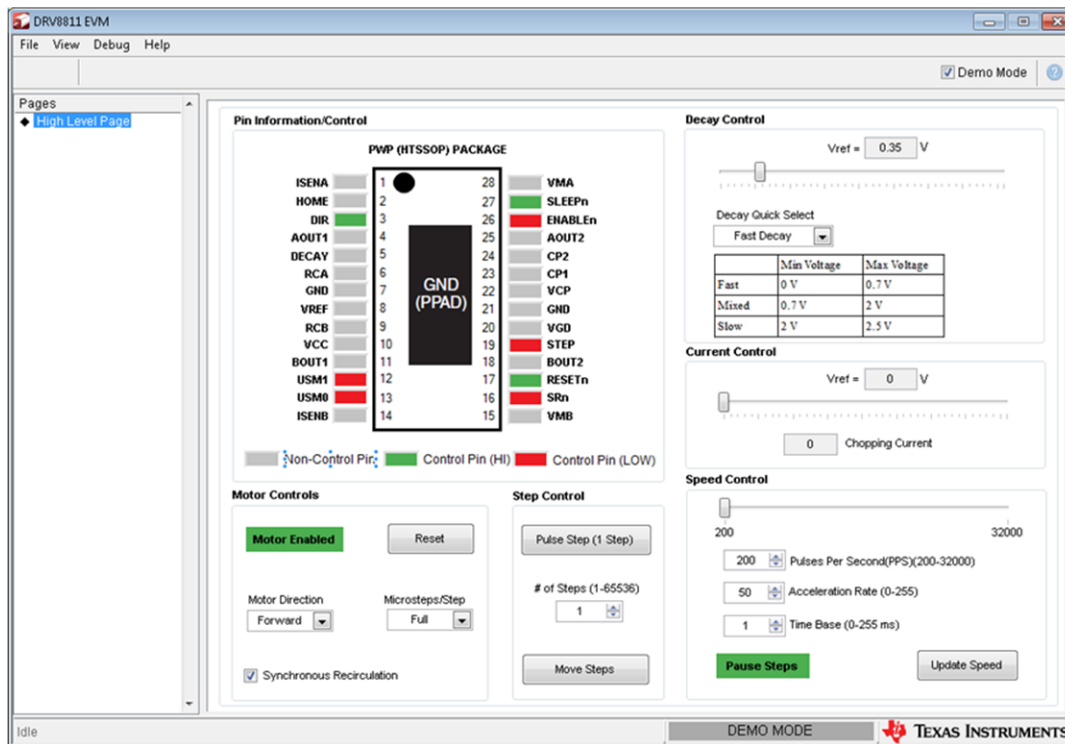


Figure 21. DRV8811EVM-001_R1p0.exe Main Screen

3.1 Menu

- File - The File menu contains the option Exit as shown in Figure 22 below.

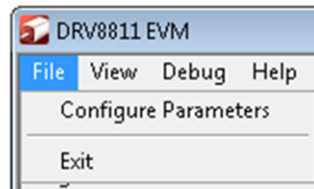


Figure 22. File Menu

- Debug - The Debug option can be used for the following operations.

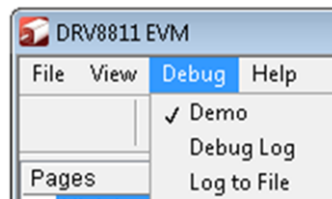


Figure 23. Debug Menu

- - Demo - By selecting the Demo in the submenu, the GUI runs in simulation mode, and by unselecting it, the GUI runs 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 enables to log all the activities of the user. If that is not selected, only the high-level operations log.
- View - Select View-> Schematics->DRV8811 to view the GUIs schematics

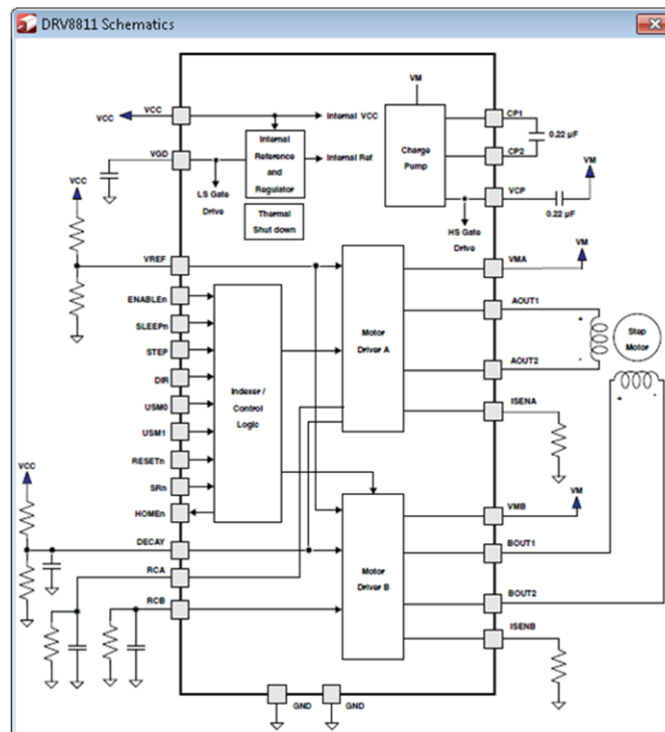


Figure 24. Schematic

- Help
 - Clicking the About in the Help Menu

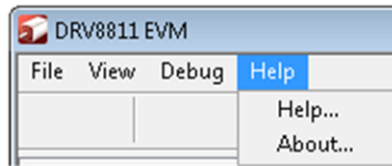


Figure 25. Help Menu

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



Figure 26. About Page

3.2 *DRV8811 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.

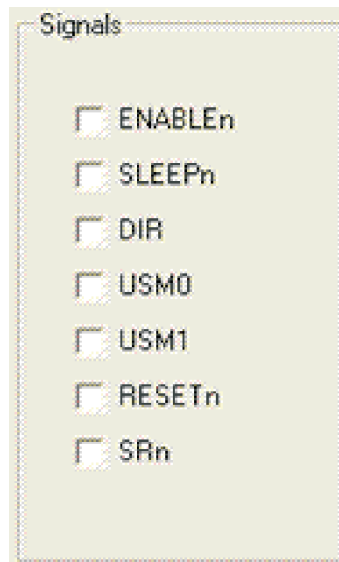


Figure 27. Signals Frame

A checked checkbox translates to a HI level on the respective control signal. A un-checked checkbox translates to a LO level on the respective control signal.

3.3 Updating DAC Output for Current Control (VREF/DECAY)

If the DRV8811 EVM has been configured to accept VREF analog voltages through the MSP430 microcontroller interface (JP1 is set to INT), then the slider bar on the Current Control frame can be used to set the VREF voltage.

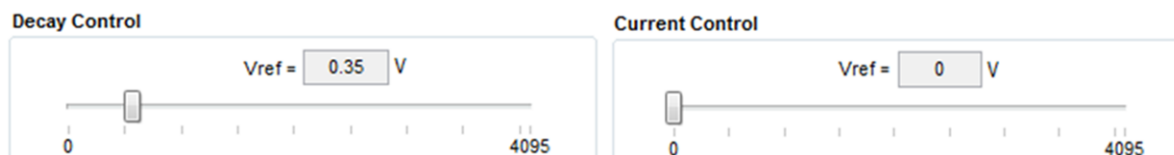


Figure 28. Current Control Frame

The MSP430F1612 12-bit DAC channel 0 is connected to the DRV8811 VREF analog input. Changing the DAC digital value from 0 to 4095, changes the analog voltage at the VREF/DECAY pin from 0 V to 2.5 V respectively. See [Equation 1](#).

$$V_{REF} = DAC_VALUE \cdot \frac{2.5 V}{4095} \tag{1}$$

Where VREF is the output voltage and DAC_VALUE is a number from 0 to 4095.

3.4 Updating DAC Output for Decay Control (DECAY)

If the DRV8811 EVM has been configured to accept DECAY analog voltages through the MSP430 microcontroller interface (JP6 is set to INT), then the slider bar on the Current Control frame can be used to set the DECAY voltage.

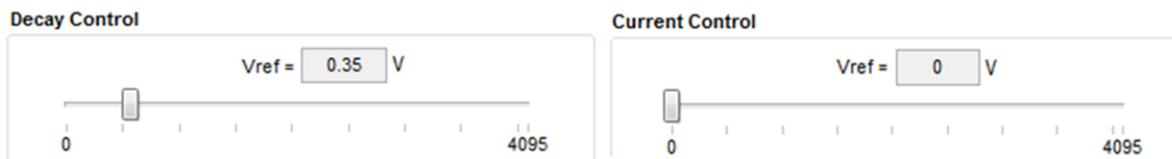


Figure 29. Current Control Frame

The MSP430F1612 12 bit DAC channel 1 is connected to the DRV8811 DECAY analog input. Changing the DAC digital value from 0 to 4095, changes the analog voltage at the DECAY pin from 0 V to 2.5 V respectively. See Equation 2.

$$DECAY = DAC_VALUE \cdot \frac{2.5 V}{4095} \tag{2}$$

Where DECAY is the output voltage and DAC_VALUE is a number from 0 to 4095.

3.5 Operating the Stepper Motor

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 (ENABLE_n = LO, SLEEP_n = HI, RESET_n = HI; DIR, USM0 and USM1 can be HI or LO depending on preferred mode of operation; SR_n must be L, if external diodes are not populated), the motor is ready to be turned.

The DRV8811EVM-001 customer 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 pulses per second (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.

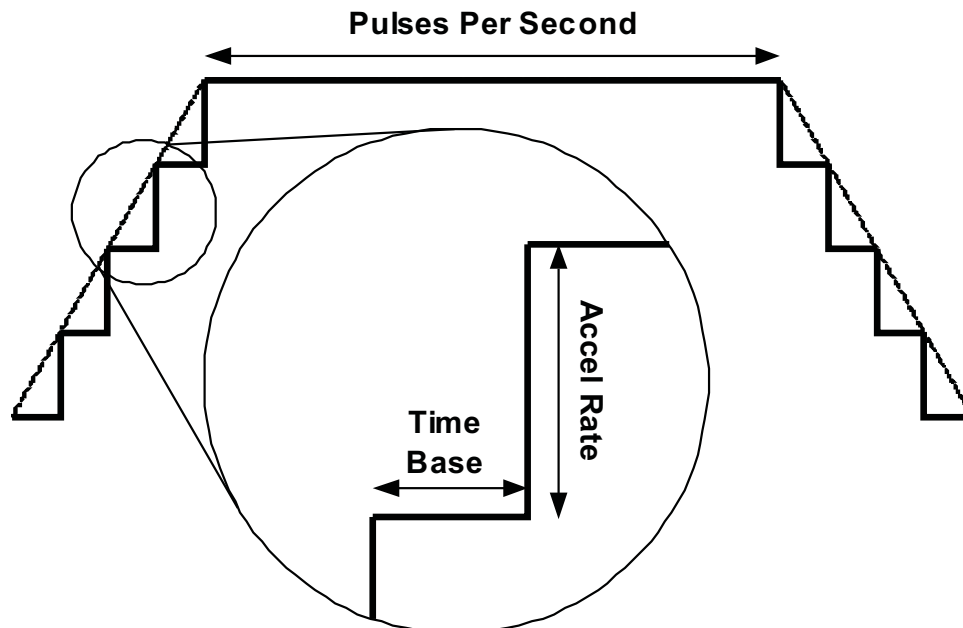


Figure 30. Step Rate

When the motor is commanded to stop, the inverse of the description above occurs.

The Windows Application frame to control speed, acceleration and deceleration, as well as motor start and stop, looks as portrayed in [Figure 31](#).

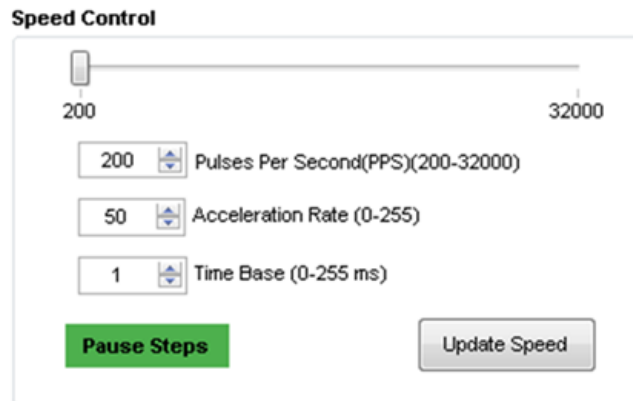


Figure 31. Speed Control Frame

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 Update 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. At the same time, the STEP Control check box allows the control of the STEP signal in the same fashion that other GPIO signals on the Signals frame could be set and cleared. Checked stands for HI and unchecked for LO. Remember that a STEP takes place when STEP goes from LO to HI.



Figure 32. Step Control Frame

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.

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.
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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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

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/lstds/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/lstds/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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/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/lstds/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.

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- 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.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
 7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.
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8. *Limitations on Damages and Liability:*

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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