DRV8818EVM Evaluation Module

This document serves as a supplement to the DRV8818 data sheet. It details the hardware implementation of the DRV8818EVM evaluation module (EVM).

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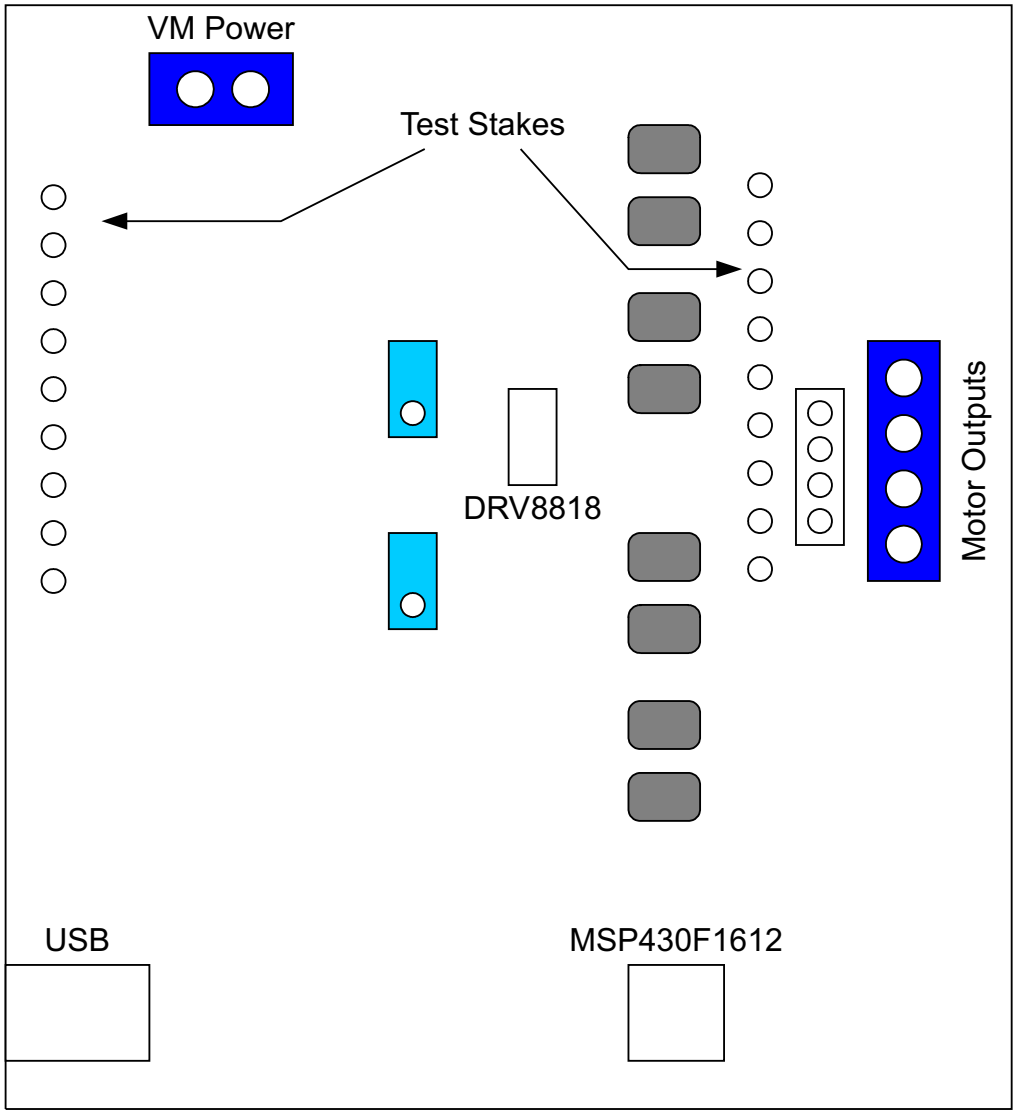
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1 Block Diagram



1.1 Introduction

The DRV8818EVM is a complete solution for evaluating the DRV8818 micro-stepping, bipolar stepper driver. It includes a USB link to provide easy control from a personal computer (PC), a MSP430 microcontroller that interprets serial commands from the PC and generates control signals to the driver device, and the DRV8818 device with access to all signals for a complete evaluation.

1.2 Power Connectors

The DRV8818EVM uses a combination of terminal blocks and test clips for the application and monitoring of power. The only power rail that the user must supply is VM for the device's power stage. VDD for logic levels is internally generated from the USB connection.

Users must apply VM (8 V to 35 V) according to data sheet 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.

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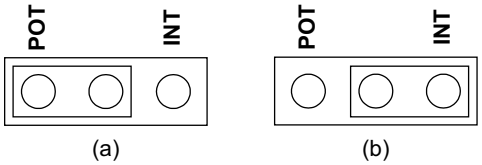
1.4 Jumpers

Two styles of jumpers are on the DRV8818EVM: two-pin jumpers and three-pin jumpers.

Users can configure three-pin jumpers independently from other two- or three-pin jumpers. However, two-pin jumpers must all be closed or left open.

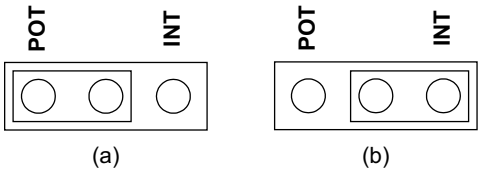
1.4.1 VREF SELECT, JP1

To configure the VREF SELECT jumper: (a) Select an analog voltage derived from VDD through a voltage divider implemented as a potentiometer R4. (b) Select an analog voltage derived from the MSP430's digital-to-analog converter (DAC) channel 0 (DAC0). Set as the following inset shows in (b) if you want to use the GUI to control the VREF voltage.



1.4.2 DECAY SELECT, JP6

To configure the DECAY SELECT jumper: (a) Select an analog voltage derived from VDD through a voltage divider implemented as a potentiometer R6. (b) Select an analog voltage derived from the MSP430's DAC channel 1 (DAC1). Set as the following inset shows in (b) if you want to use the GUI to control the DECAY modes.



1.5 Motor Outputs

Users can connect the bipolar stepper motor into the DRV8818EVM in three ways: four-pin header (J2), four-position terminal block (J3), or test clips. Each connection style offers identical connectivity to the device's output terminals. The recommended way, however, is to use the header or terminal block because the test stakes traces are of low-current handling capability.

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.

2.1 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 Installation Procedure

The following procedure helps you install the DRV8818 GUI

1. Double click on the **Setup_DRV8818_EVM.exe** as shown in Figure 1.

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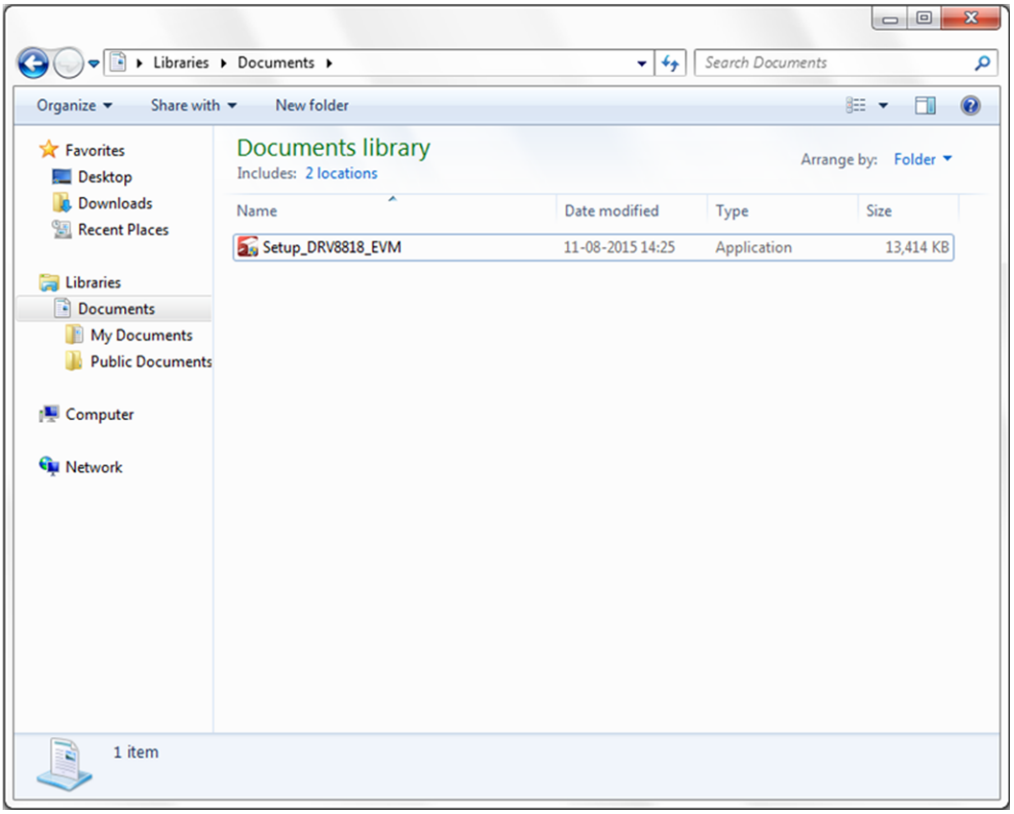


Figure 1. Setup_DRV8818_EVM.exe

2. The screen shown in Figure 2 appears, indicating installer initialization. Click the **Next** button.

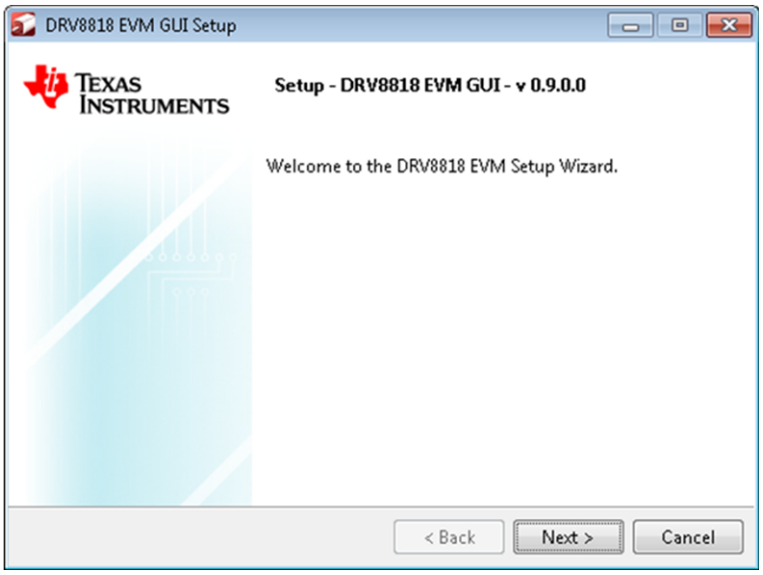


Figure 2. Installation Initialization

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**.

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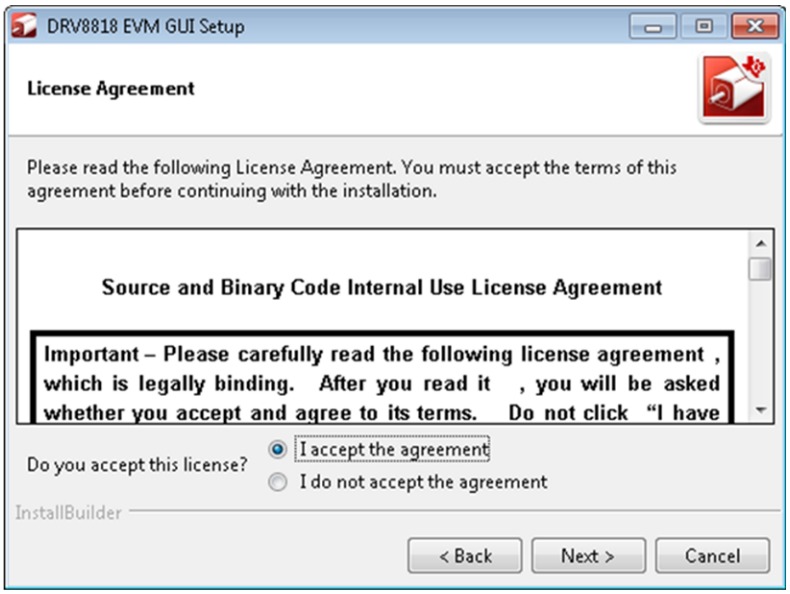


Figure 3. License Agreement

4. A screen as shown in Figure 4 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.

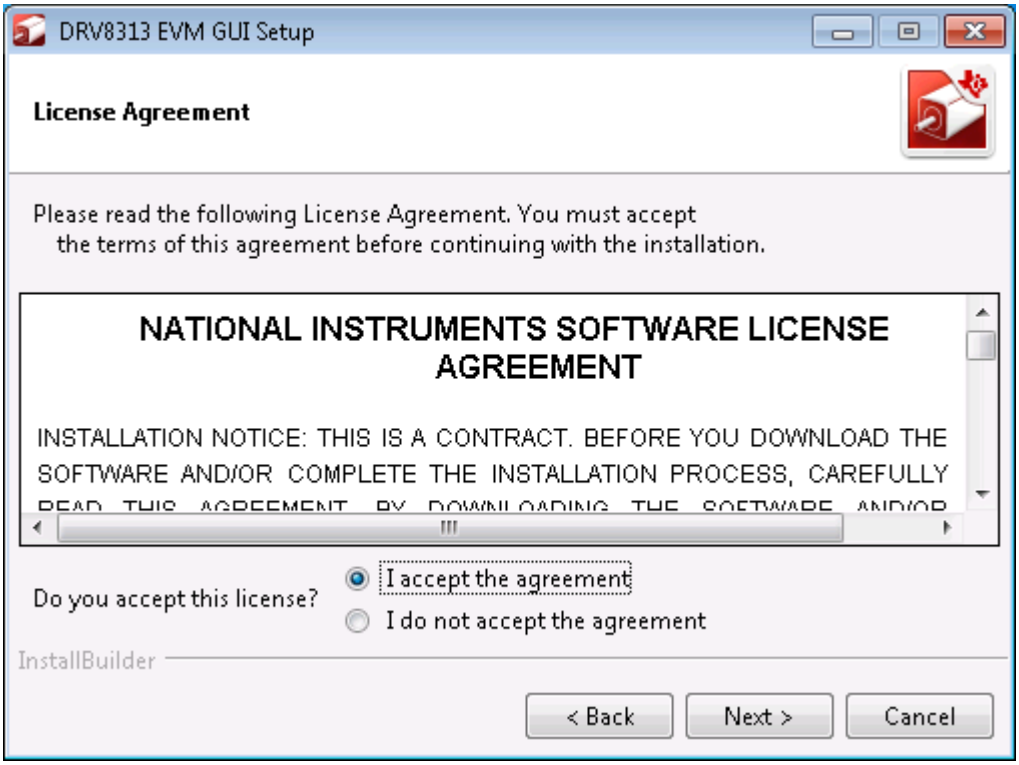


Figure 4. NI License Agreement

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

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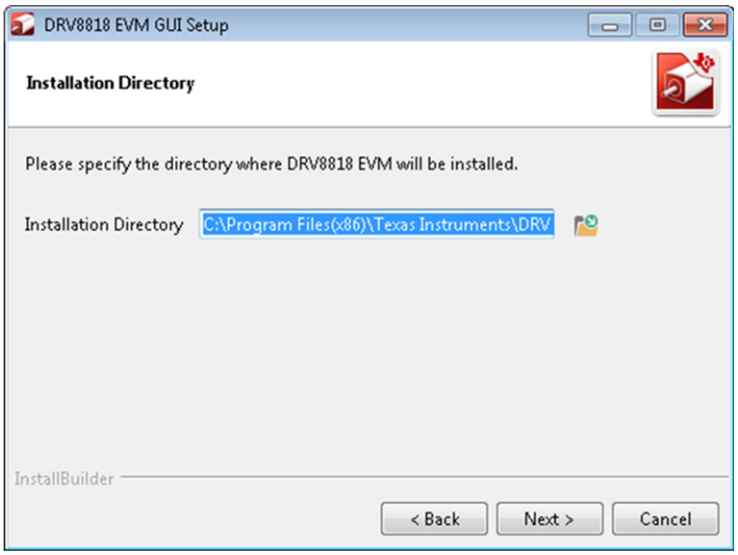


Figure 5. Installation Directory Screen

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

6. A screen as shown in Figure 6 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.

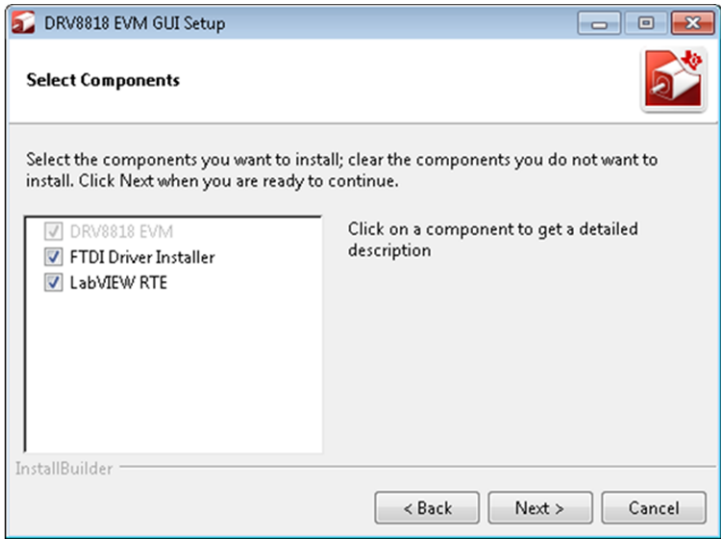


Figure 6. Component Selection

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

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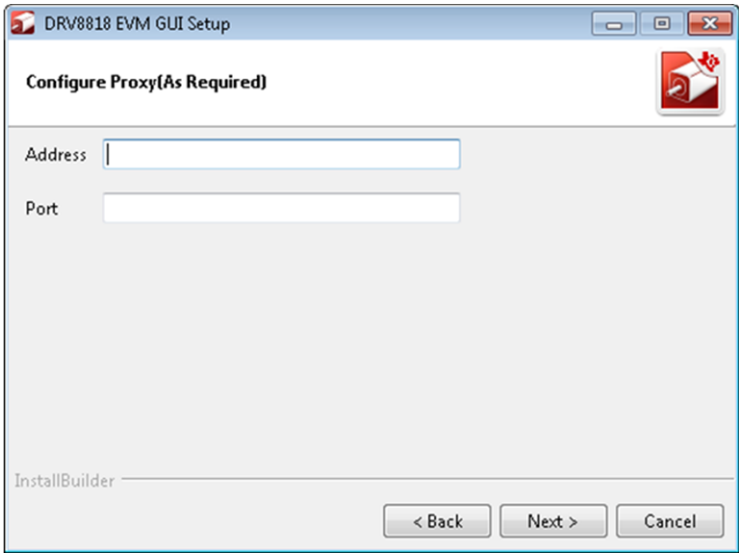


Figure 7. Configure Proxy

8. A screen as shown in Figure 8 appears. Click **Next** to begin the installation.

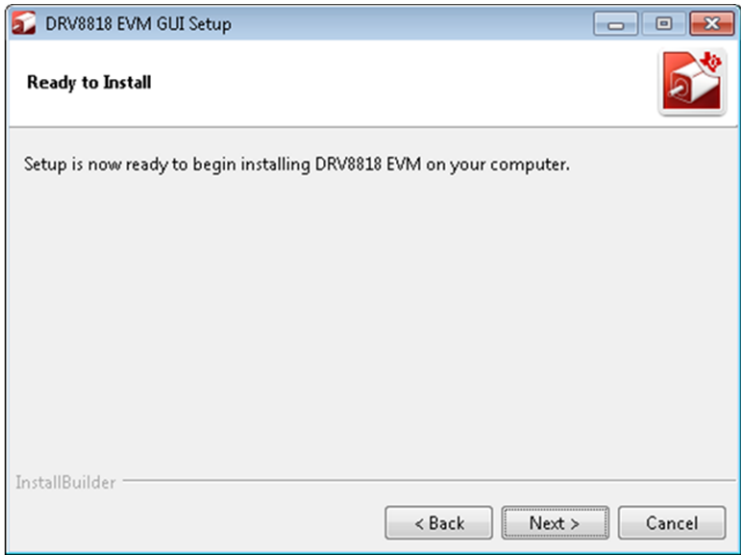


Figure 8. Ready to Install

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

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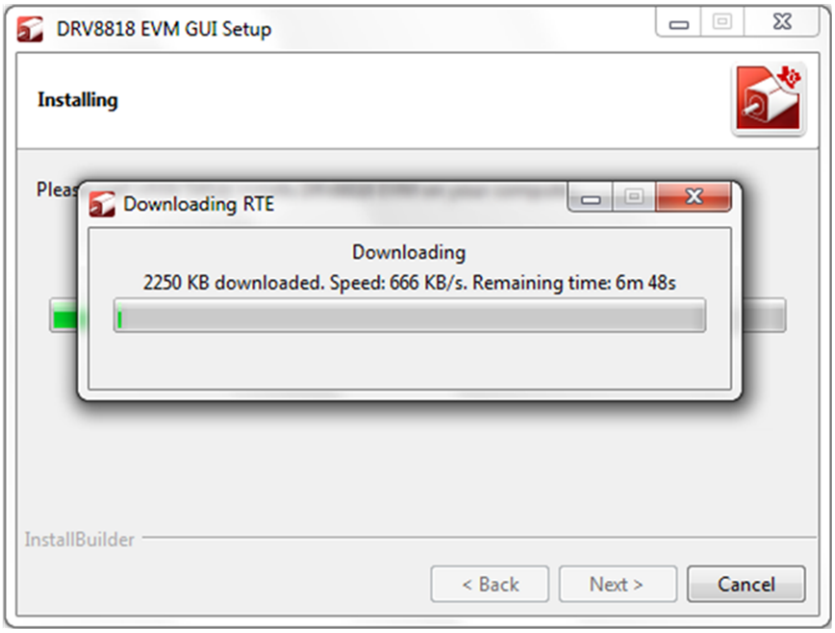


Figure 9. Downloading RTE

10. Once the Download completes, LabVIEW begins with the self-extraction as shown in Figure 10.

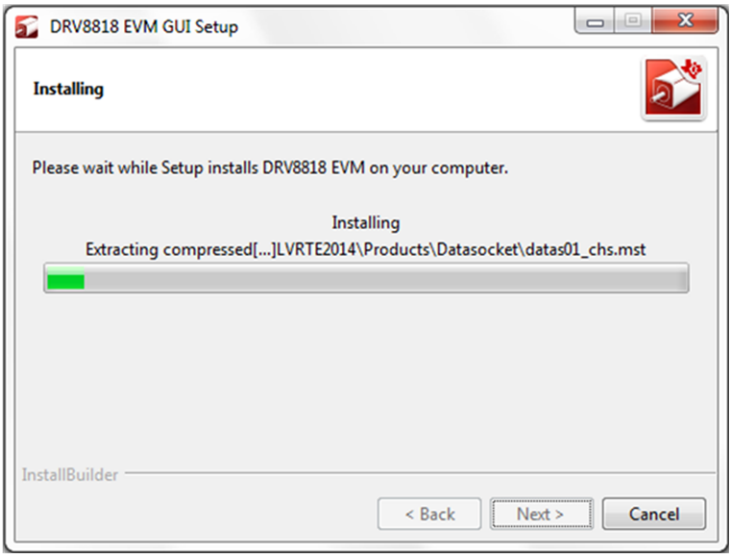


Figure 10. LabVIEW RTE Self Extraction

11. A Screen appears as shown in Figure 11. It initializes the LabVIEW RTE Installation.

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Figure 11. LabVIEW RTE Installation Initialization

12. A display as shown in Figure 12 appears which indicates the progress of LabVIEW RTE installation.

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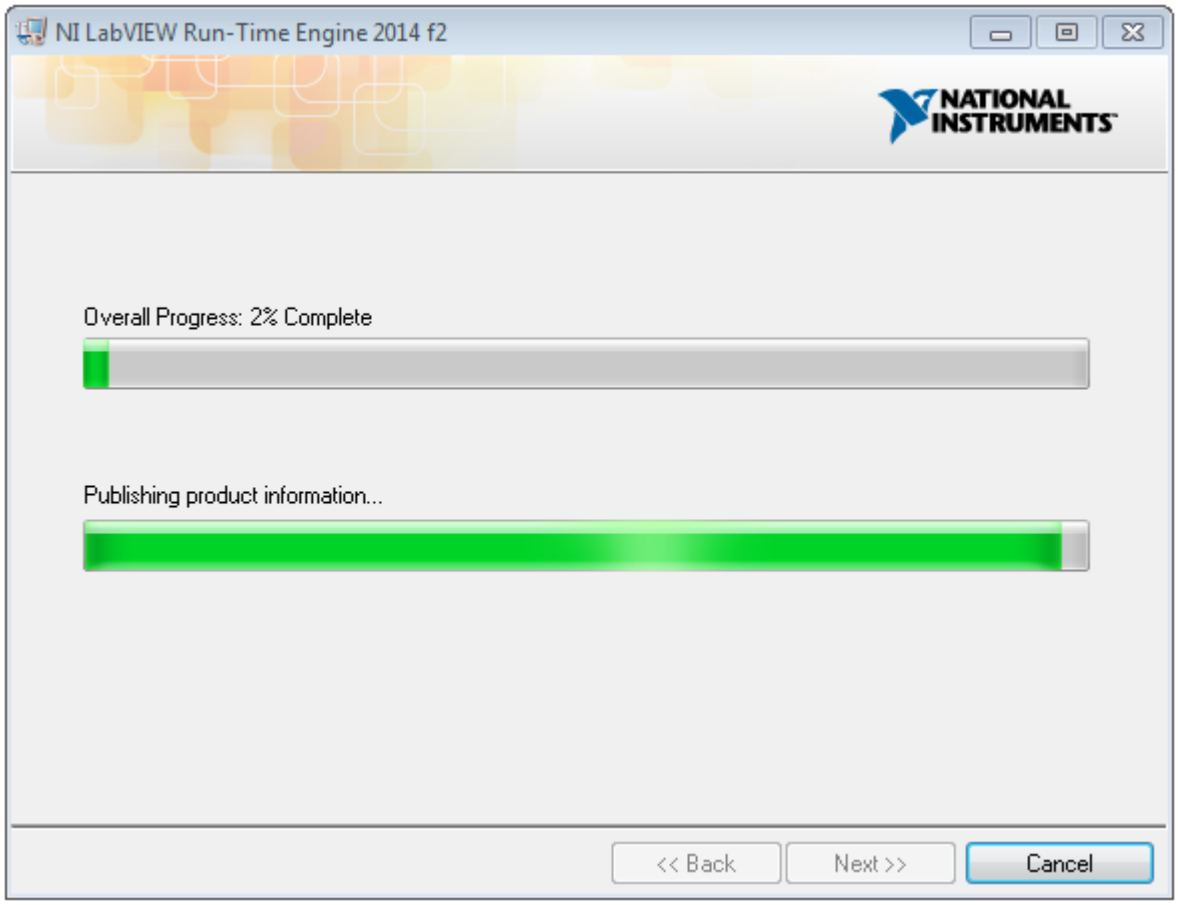


Figure 12. Installation of LabVIEW RTE in Progress

13. Once the LabVIEW RTE 2014 is installed, DRV 8818 EVM GUI component installs.
14. After DRV8818 Installation, FTDI Installation begins. A screen as shown in Figure 13 appears, click **Extract** to proceed.

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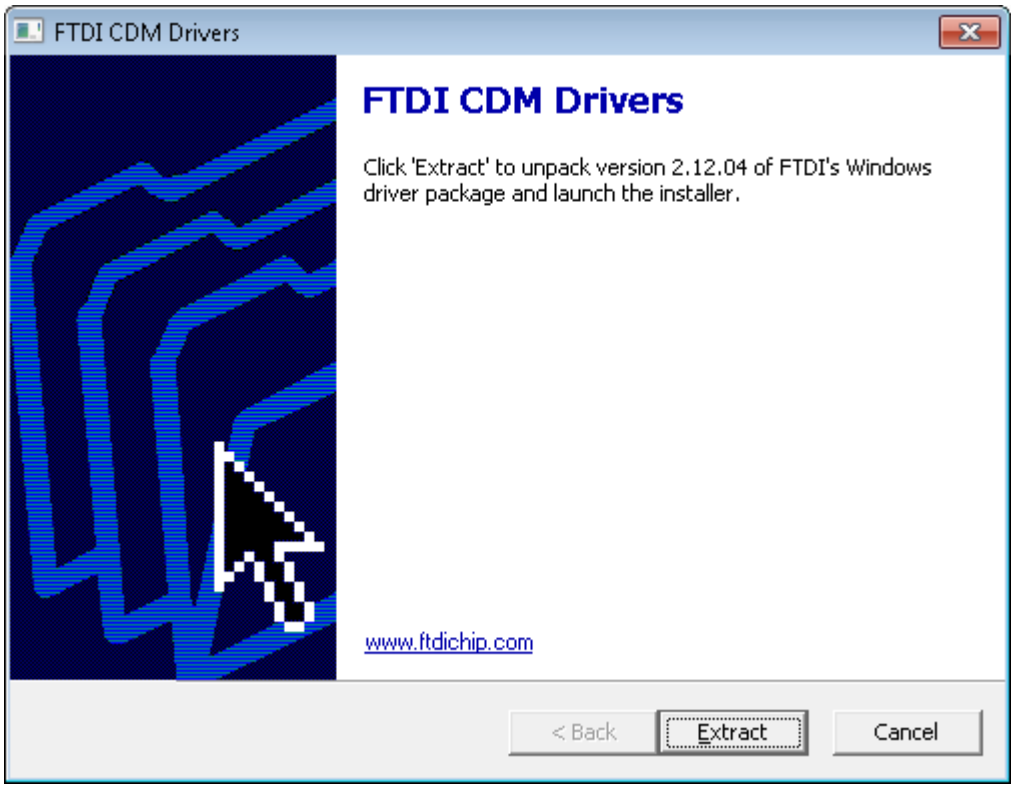


Figure 13. FTDI Installation Initialization

15. A screen as shown in Figure 14 appears, click **Next** to proceed.

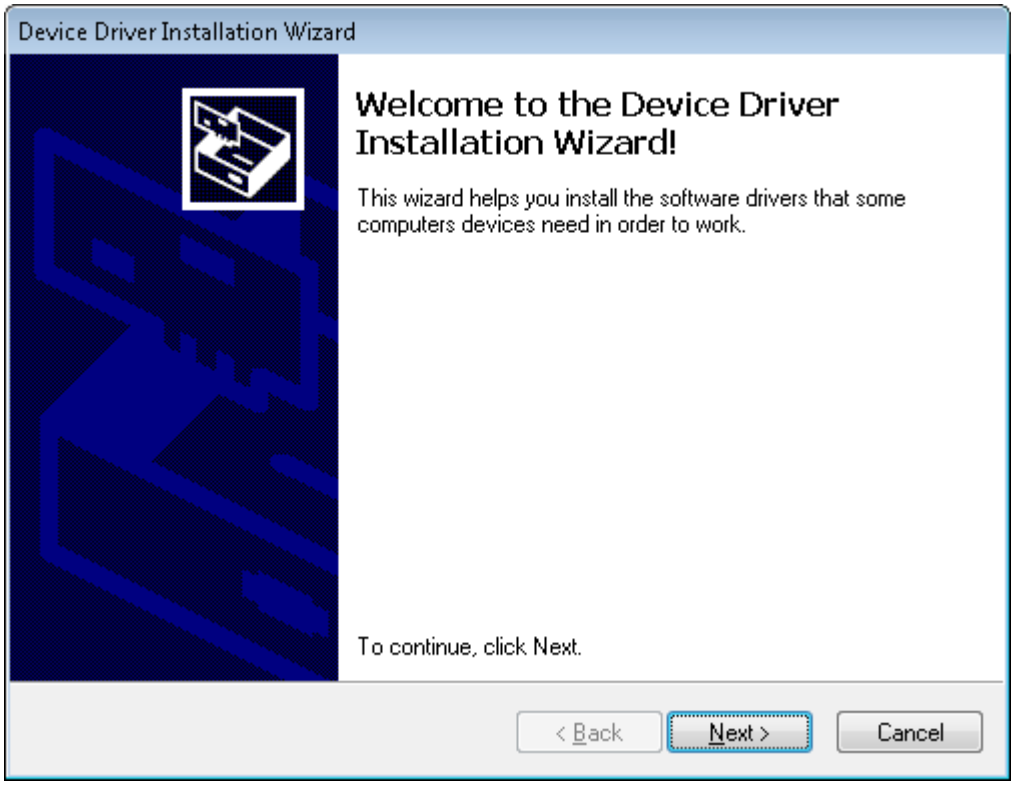


Figure 14. Driver Installation Wizard

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16. The License Agreement appears on screen as shown in Figure 15.
17. Read through the License Agreement carefully and enable the “I Accept this Agreement” radio button and Click on **Next.**

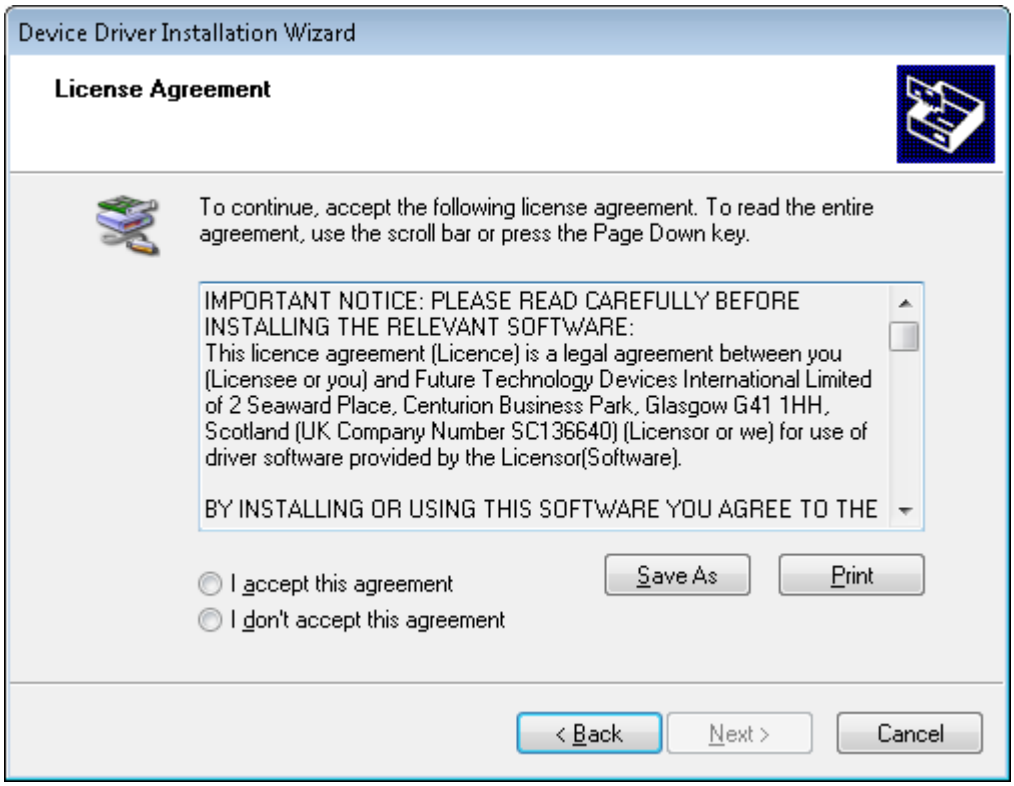


Figure 15. License Agreement for FTDI Driver

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

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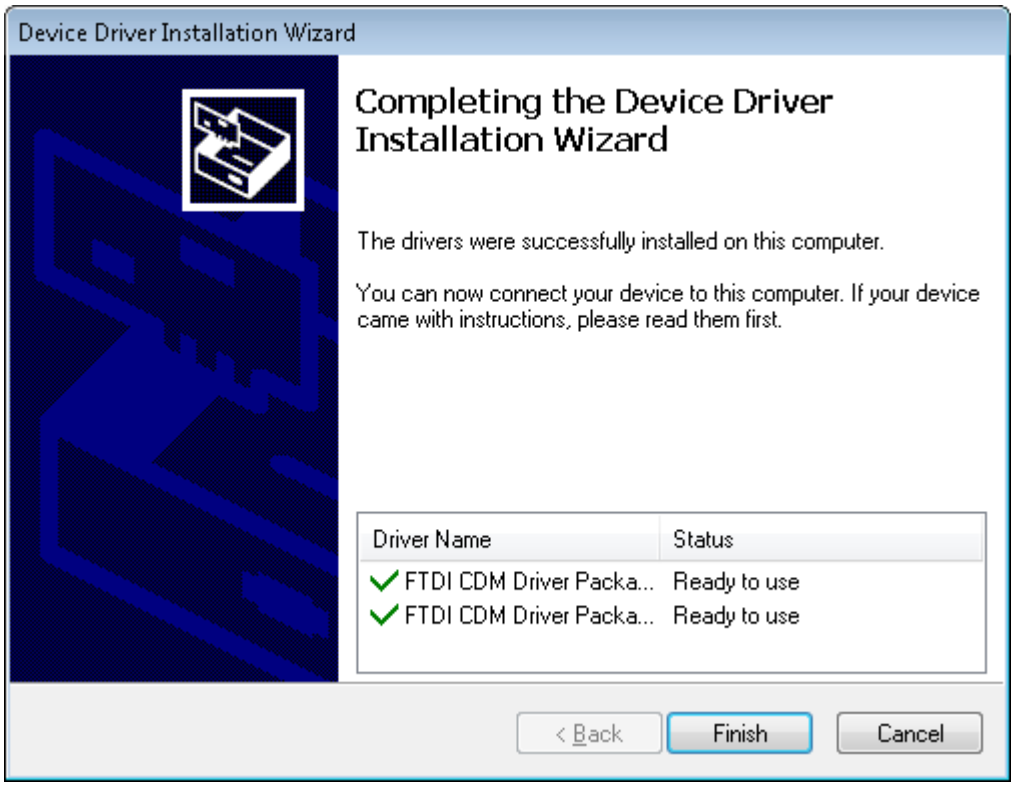


Figure 16. Driver Installation Completion

19. Figure 17 appears denoting the completion of DRV8818 EVM GUI Installation. Click **Finish**.

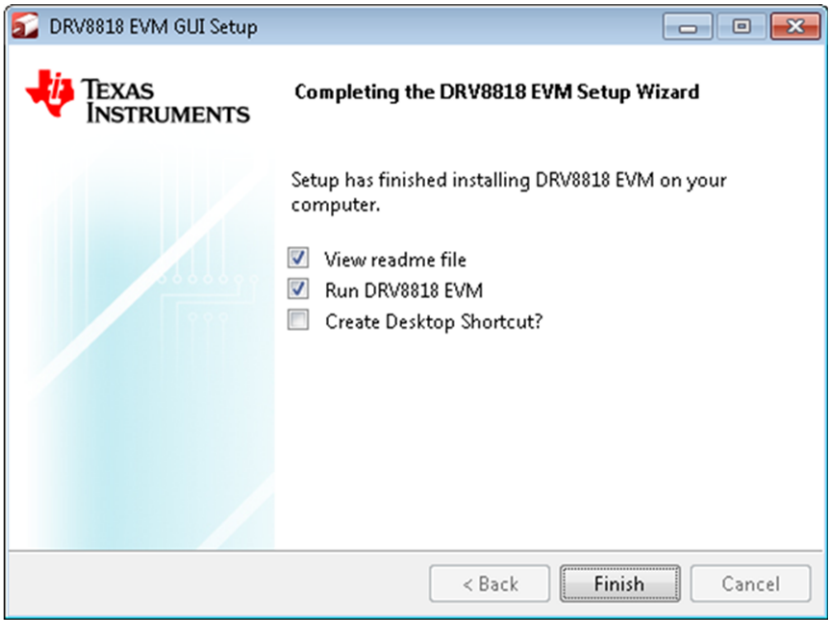


Figure 17. Installation Complete

20. A readme window as shown in Figure 18 appears displaying the link for LV 2014 RTE.

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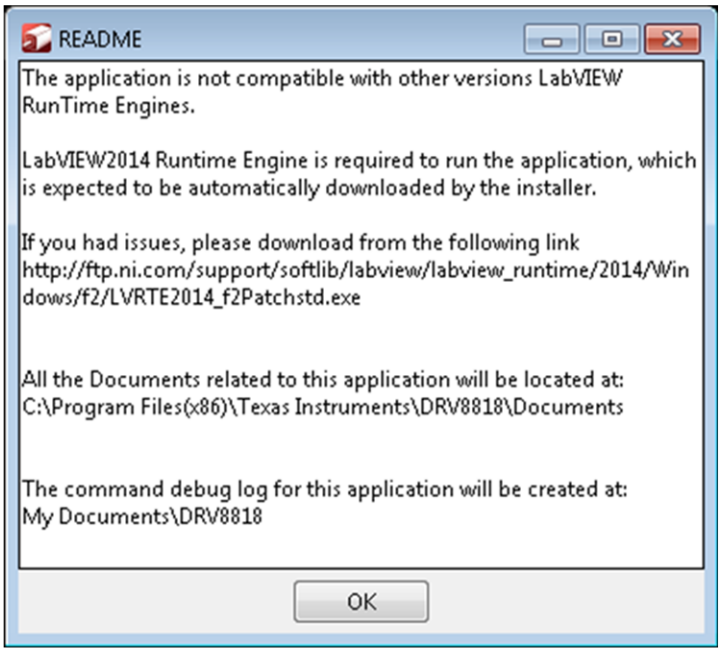


Figure 18. Readme Window

WARNING

The DRV8818 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

NOTE: DRV8818 EVM GGUI 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).

3 Menu Options

- File - The File menu contains the option Exit as shown in Figure 19 below.

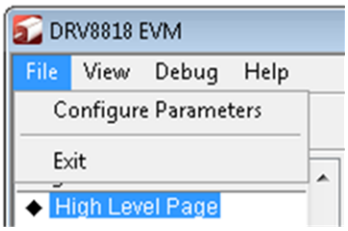


Figure 19. File Menu

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

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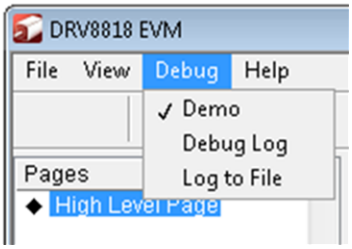


Figure 20. Debug Menu

-
  - 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->DRV8818 to view the GUIs schematics

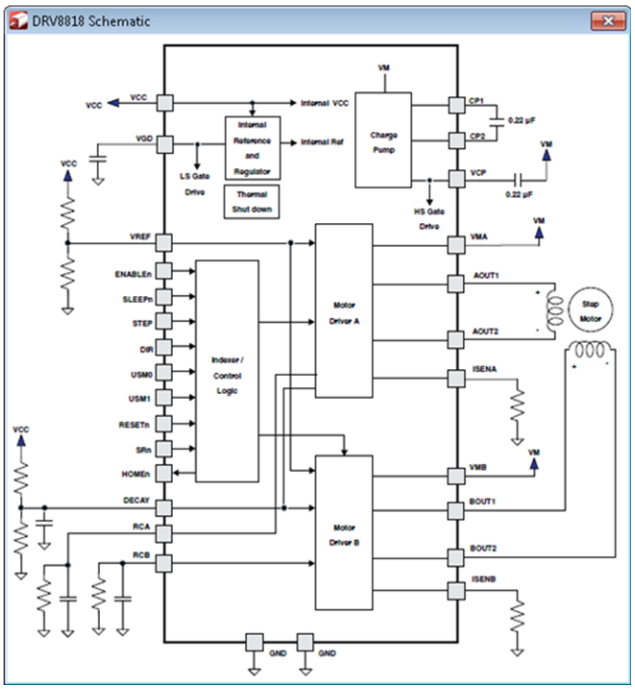


Figure 21. Schematic

- Help
  - Clicking the About in the Help Menu

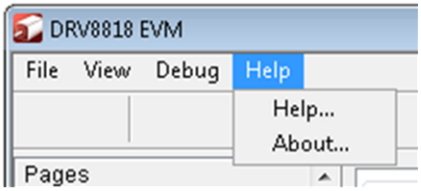


Figure 22. Help Menu

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

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Copyright Information.



Figure 23. About Page

4 Windows Application

The DRV8818 Windows application is the software counterpart for the DRV8818EVM. This application is in charge of connecting to the MSP430 microcontroller by an USB connection, which in turn selects the proper logic state for the DRV8818 control signals.

The design of the graphical user interface (GUI) allows for all of the DRV8818 device's functionality to be tested without having to intervene with the hardware, except for the proper configuration of jumpers, when necessary.

Figure 24 shows the DRV8818EVM.exe main screen. It contains menu items to configure and enable and disable the serial port, frames with GPIO control for the DRV8818 Control Signals, Stepper Motor control for start and stop and speed, and current and decay control through the MSP430 DACs.

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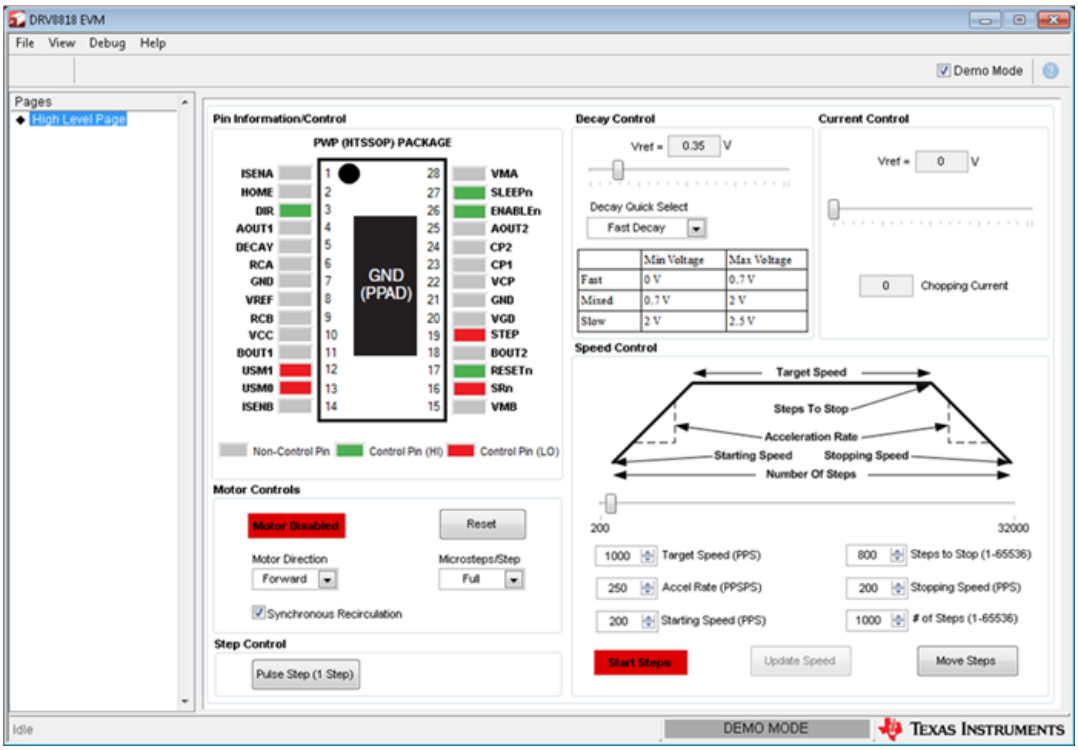


Figure 24. DRV8818EVM.exe Main Screen

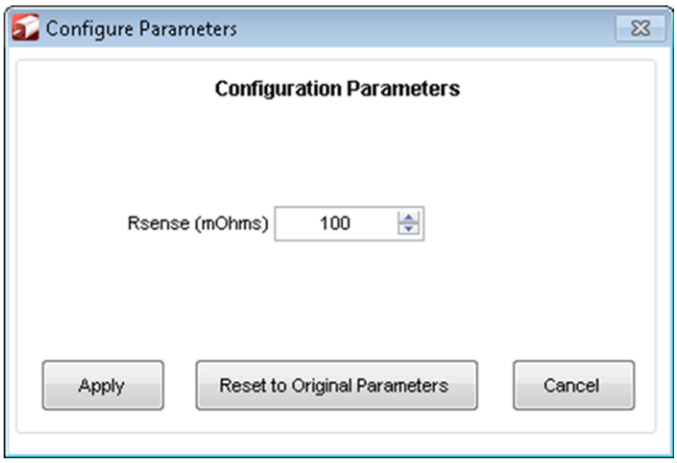
4.1 Connecting the EVM

The GUI auto-detects the port to which the USB has connected on connection of the USB cable between the EVM and an available port on your PC. This is displayed in the window. Click the *Connect* button. If this does not work, possible sources of error are as follows:

- FTDI drivers were not installed properly and the FTDI-USB chip is not recognized. Check for connection in *Control Panel→System→Hardware→Device Manager→Ports* for a valid connection.
- Close the GUI, and reopen it to properly identify the open port.

4.2 Initial Configuration

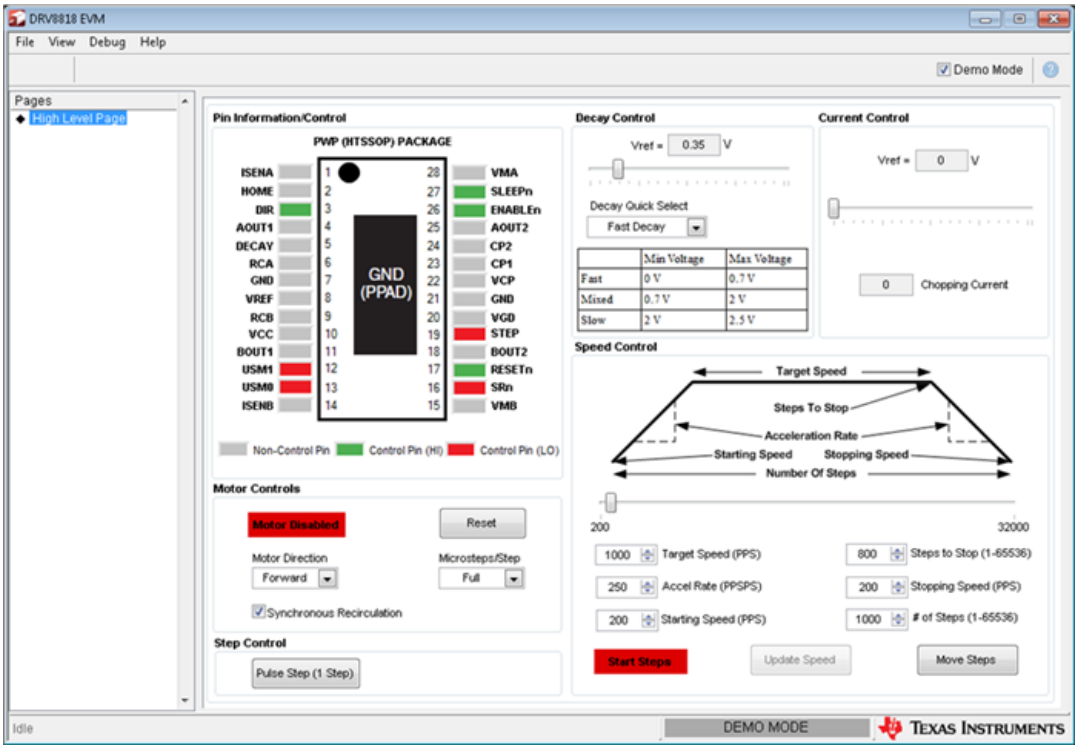
First, go into the File menu. Select File→Configure Parameters, and the following box displays:



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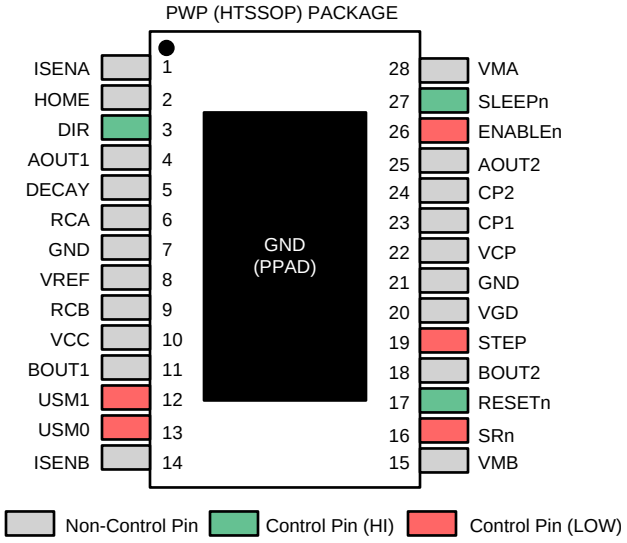
Rsense shows the default of *100*. If any modifications are made to the EVM, be sure to change these fields so that current is properly regulated.

4.3 Operating the GUI



4.3.1 Pin Information Control

Control pins appear in RED or GREEN. Click on these pins to change the state of the pin; this shows the current state. Using the following key, you can see that a RED color indicates that the pin is a logic low, and a GREEN color indicates it is logic high.

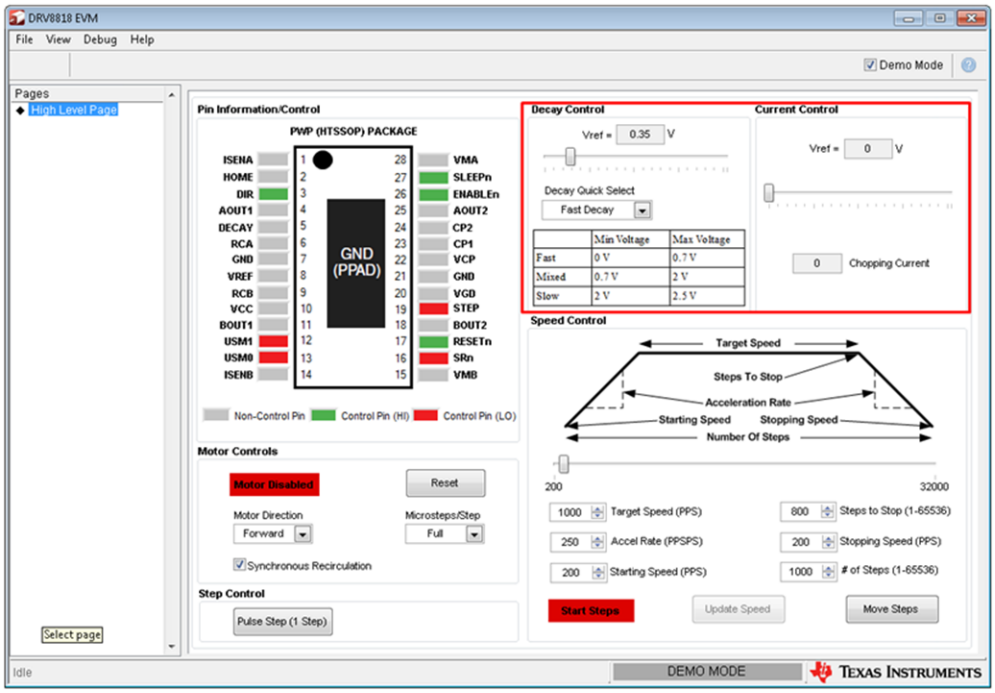


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4.3.2 Basic Configuration and Control Buttons

Whereas clicking the individual pins changes the state of the pins, you can also use the control boxes at the bottom to change the state of the pins.

For example, click on the *Full Step* radio button in the bottom right corner of the highlighted box. What happens to the picture on the top?



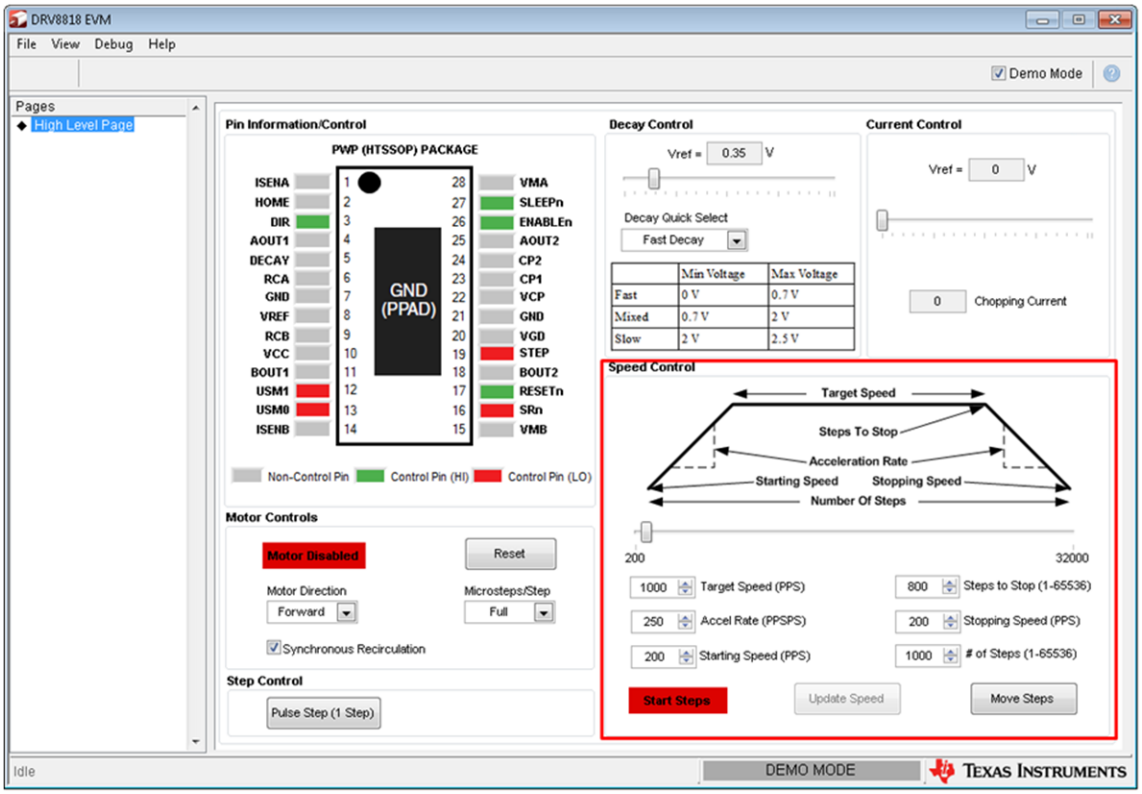
4.3.3 Current Control and Decay Modes

This set of boxes controls the reference current and the current decay modes once this current threshold is reached.

- **Decay Control:** The slider allows you to control the voltage on the DECAY pin. This controls which mode the device is in when the current is decreasing through the load on the falling edge of the sinusoidal current. In FULL Step mode, this control does not apply. The table shows the modes as it corresponds to the voltage applied on the DECAY pin. For example, a voltage less than 0.7 V fixes the device in a Fast decay mode. A voltage greater than 2 V puts the device in a Slow decay more. A voltage between 0.7 V and 2 V selects a mixed decay with a ratio of fast decay followed by slow decay depending on the voltage set between 0.7 V and 2 V. This is easier to see on an oscilloscope capture.
- **Current Control:** This slider sets the voltage on VREF. The current displays on the screen based on the following calculation:

  $I_{ref} = V_{ref} / 8 \times R_{sense}$

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4.3.4 Motion Control

Constant Speed Mode:

- **Starting Speed (PPS):** The following discussion defines pulses-per-second or PPS. A pulse is a single step in the logic table. This is not necessarily a mechanical step. If you change micro-stepping modes, you must double this for the same speed (in 1/2 step), x4 for 1/4 step, and so on.
- **Desired Speed (PPS):** This is the final speed that the motor ramps to and holds, otherwise known as the target speed.
- **Acceleration Rate (PPSPS):** This is how fast the device ramps from the starting speed to the desired speed. This is also the deceleration rate once you pause stepping.
- **Start Steps Button:** Press this button to spin. Press it again to stop, or pause, spinning.
- **Update Speed Button:** While spinning, you can change the *Desired Speed* field and nothing will happen until you click *Update Speed*.

Indexing Mode:

- **# of Steps:** In Full Step mode, this is the number of mechanical steps you want to take. For example, if the motor on your bench has 200 steps in a revolution and you want to move one revolution, you choose 200 steps. If you are in 1/2 step mode, you need to double this to 400 for a full revolution.
- **Steps To Stop:** When the number of steps taken achieves this point, the motor starts to decelerate at the rate given in the *Acceleration Rate* field.
- **Stopping Speed:** After the steps in the *Steps To Stop* field is reached and the motor begins to decelerate, the motor rotates at this speed (once it is reached) until the value in the *# of Steps* is reached.
- **Move Steps Button:** Click this to begin indexing. Once indexing is complete, you can click it again to repeat the cycle.

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5 Schematic and Bill of Materials

5.1 Schematics

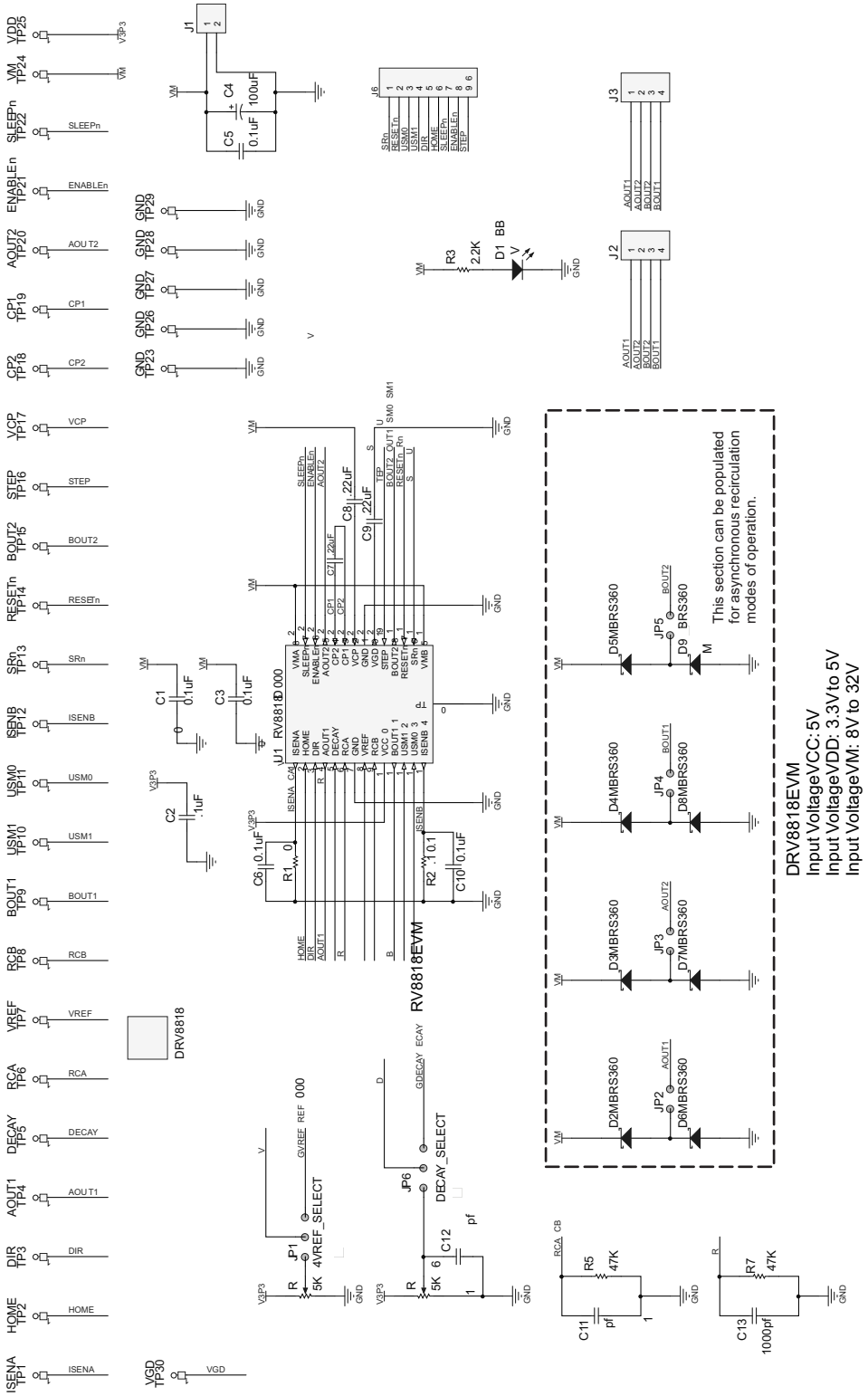


Figure 25. Schematic 1 of 2

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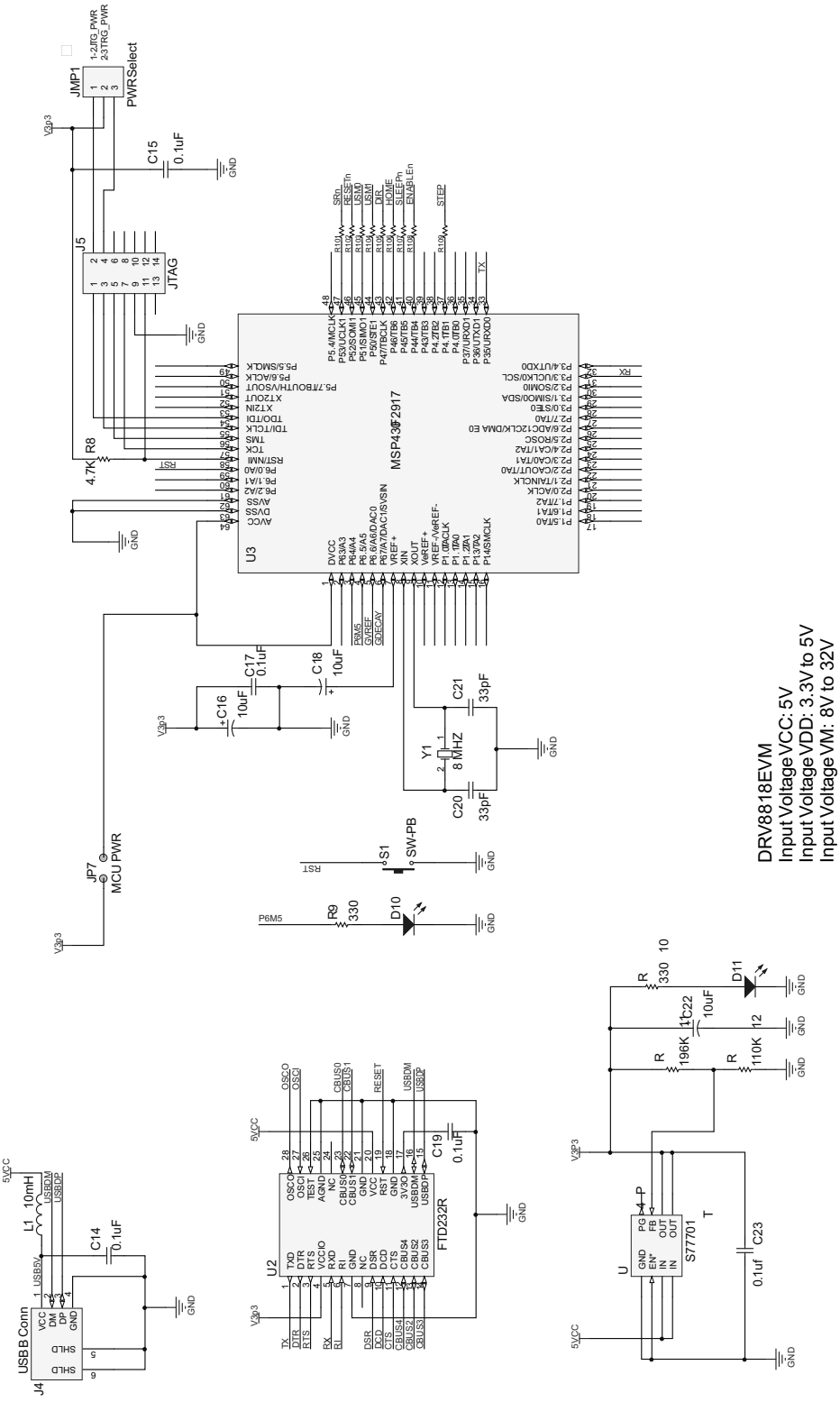


Figure 26. Schematic 2 of 2

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5.2 Bill of Materials

QTY	Designator	Value	Description	Manufacturer	MFG Part Number
11	C1, C2, C3, C5, C6, C10, C14, C15, C17, C19, C23	0.1 uF	Capacitor	Kemet	C0805C104K5RACTU
1	C4	100 uF	100 uF, 50 V Electrolytic Cap	Panasonic	ECA-1HM101
3	C7, C8, C9	.22 uF	Capacitor	Kemet	C0805C224K5RACTU
3	C11, C12, C13	1000 pf	Capacitor	Kemet	C0805C102K5RACTU
3	C16, C18, C22	10 uF	10 uF, 25 V Electrolytic Cap (Radial)	Nichicon	UVR1E100MDD
2	C20, C21	33 pF	Capacitor	Yageo	CC0805JRNP09BN330
3	D1, D10, D11	LED RED	LED RED Clear 1206 SMD	Stanley Electric & Co	HBR1105W-TR
DNI	D2, D3, D4, D5, D6, D7, D8, D9	MBR360	3 A, 60 V, Schottky Diode	On Semiconductor	MBRS360T3G
1	J1	2 Pos	Terminal Block, 2 Pos, 200 mil pitch	On Shore Technology Inc.	OSTTA024163
1	J2	4 Pos Header	Single Line, 4 Pos, 100 mil pitch Header Connector	Sullins	PBC04SAAN
1	J3	4 Pos	Terminal Block, 4 Pos, 200 mil pitch	On Shore Technology Inc.	OSTTA044163
1	J4	USB B	USB B Style Connector	Molex	67068-8000
1	J5	14 Pos Header	Header, 7-Pin, Dual row, Right Angle	Sullins	PBC07DAAN
1	J6	9 Pos Header	Control	Sullins Connector Solutions	PBC09SAAN
1	JMP1	3 Pos Header	Single Line, 3 Pos, 100 mil pitch Header Connector	Sullins	PBC03SAAN
2	JP1, JP6	3 Pos Header	Single Line, 3 Pos, 100 mil pitch Header Connector	Sullins	PBC03SAAN
DNI	JP2, JP3, JP4, JP5	2 Pos Header	Single Line, 2 Pos, 100 mil pitch Header Connector	Sullins	PBC02SAAN
1	JP14	0.230" (5.84mm)	Two Pin Jumper	Sullins Connector Solutions	PBC02SAAN
1	L1	10 mH	Ferrite Bead 1.5A 40 ohm 0805 SMD	Steward	MI0805K400R-10
1	PCB1	N/A	CPG001 PCB Bare Board	N/A	N/A
2	R1, R2	0.1	Resistor	Bourns	CRA2512-FZ-R100ELF
1	R3	2.2 K	Resistor	Yageo	RC0805JR-072K2L
2	R4, R6	5 K	Potentiometer	Murata Electronics	PV37Y502C01B00
2	R5, R7	47 K	Resistor	Yageo	RC0805JR-0747KL
1	R8	4.7 K	Resistor	Yageo	RC0805JR-074K7L
2	R9, R10	330	Resistor	Yageo	RC0805JR-07330RL
1	R11	196 K	Resistor	Yageo	9C08052A1963FKHFT
1	R12	110 K	Resistor	Yageo	RC0805JR-07110KL
9	R101, R102, R103, R104, R105, R106, R107, R108, R109	3300	Resistor	Yageo	RC0603FR-073K3L
1	S1	Push Button	Switch	Panasonic	EVQ-11A04M

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QTY	Designator	Value	Description	Manufacturer	MFG Part Number
23	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP30	Test Stake White	Glass Beaded Test Point	Kobiconn	151-101-RC
5	TP23, TP26, TP27, TP28, TP29	Test Stake Black	Glass Beaded Test Point	Kobiconn	151-103-RC
2	TP24, TP25	Test Stake Red	Glass Beaded Test Point	Kobiconn	151-107-RC
1	U1	Driver	Bipolar Stepper Motor Driver With Indexer	Texas Instruments	DRV8818PWP
1	U2	USB Driver	USB Chip	FTDI	604-00043
1	U3	MSP430 MCU	MSp430 Microcontroller	Texas Instruments	MSP430F2617TPMR
1	U4	LDO	750 mA LDO 8-SOIC	Texas Instruments	TPS77701D
1	Y1	Crystal	Crystal Oscillator	ECS Inc.	ECS-80-20-4

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   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.

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 DEGREDATION 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/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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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.

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