DRV8711EVM User's Guide

This document is provided with the DRV8711 customer evaluation module (EVM) as a supplement to the DRV8711 (SLVSC40) datasheet. It details the hardware implementation of the EVM.

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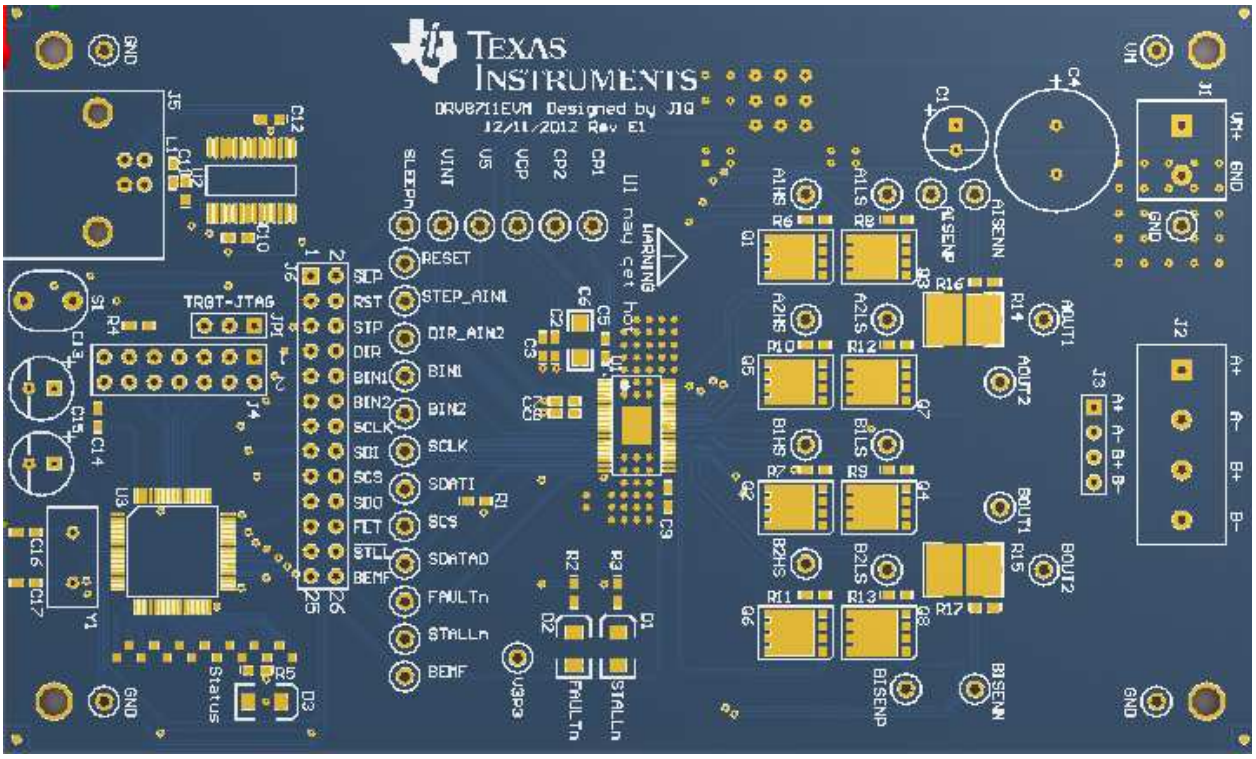


2 Introduction to PCB

The DRV8711EVM is a complete solution for evaluating the DRV8711 stepper motor controller. It includes a MSP430F2617 to control the DRV8711. Power is provided externally, up to 52 V, through the power header. The USB interface is provided to communicate with the MSP430F2617 through a graphical user interface (GUI).

The DRV8711EVM is configured such that only connections to the universal serial bus (USB), motor and power supply are required.

2.1 Connectors

The DRV8711EVM uses a combination of headers for the application and monitoring of power. For the EVM, a single power supply rail is necessary. The minimum recommended input voltage (VM+) for the EVM is 8 V and the maximum recommended input voltage is 52 V. Please see the DRV8711 datasheet for the complete voltage range information of the driver. When the USB is connected to the board a red LED (D3) in the lower left corner begins blinking.

Power for the DRV8711 is available through connector J1. The J1 connector is located on the top right of the EVM as shown in Figure 1.

The motor connections are provided through connectors J2 and J3. Connectors J2 and J3 are located on the lower right of the EVM.

The USB connection (J5) is located on the upper left of the EVM. It is used to connect the PC to the EVM. The GUI is used to control the stepper motor.

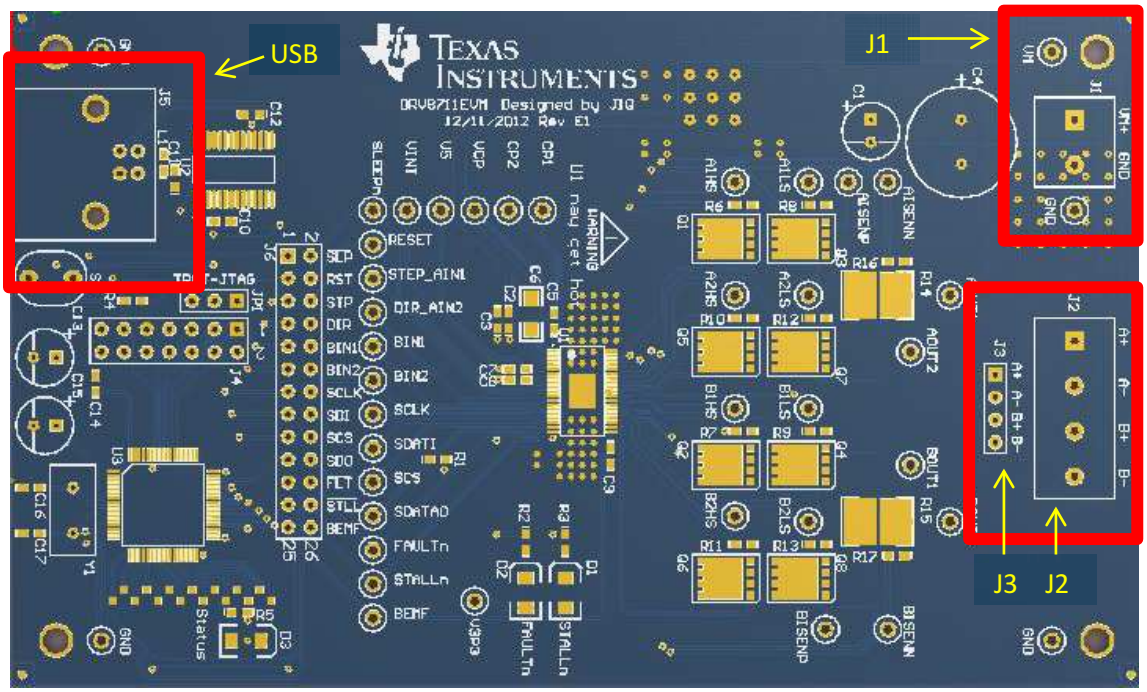


Figure 1. Connections

2.2 Test Points

Test points are provided and labeled according to the inputs and outputs of the DRV8711 motor driver. Test points are also provided to observe the power FET signals.

2.3 Jumpers

There are two jumpers (JP1 and J6) on the EVM that are normally installed.

Jumper JP1 is used to reprogram the MSP430F2617. It is normally connected from JTAG to the center pin.

Jumper J6 contains a row of 13 jumpers connecting the MSG430F2617 to the DRV8711 inputs and outputs. This allows the MSP430F2617 to control the DRV8711 through the supplied GUI.

For normal operation right out of the box jumpers JP1 and all of the jumpers of J6 should be installed. The jumpers can be removed to isolate the microcontroller (MCU).

If a signal is to be interfaced externally, the signal can be attached to either the test stakes or the driver side of J6.

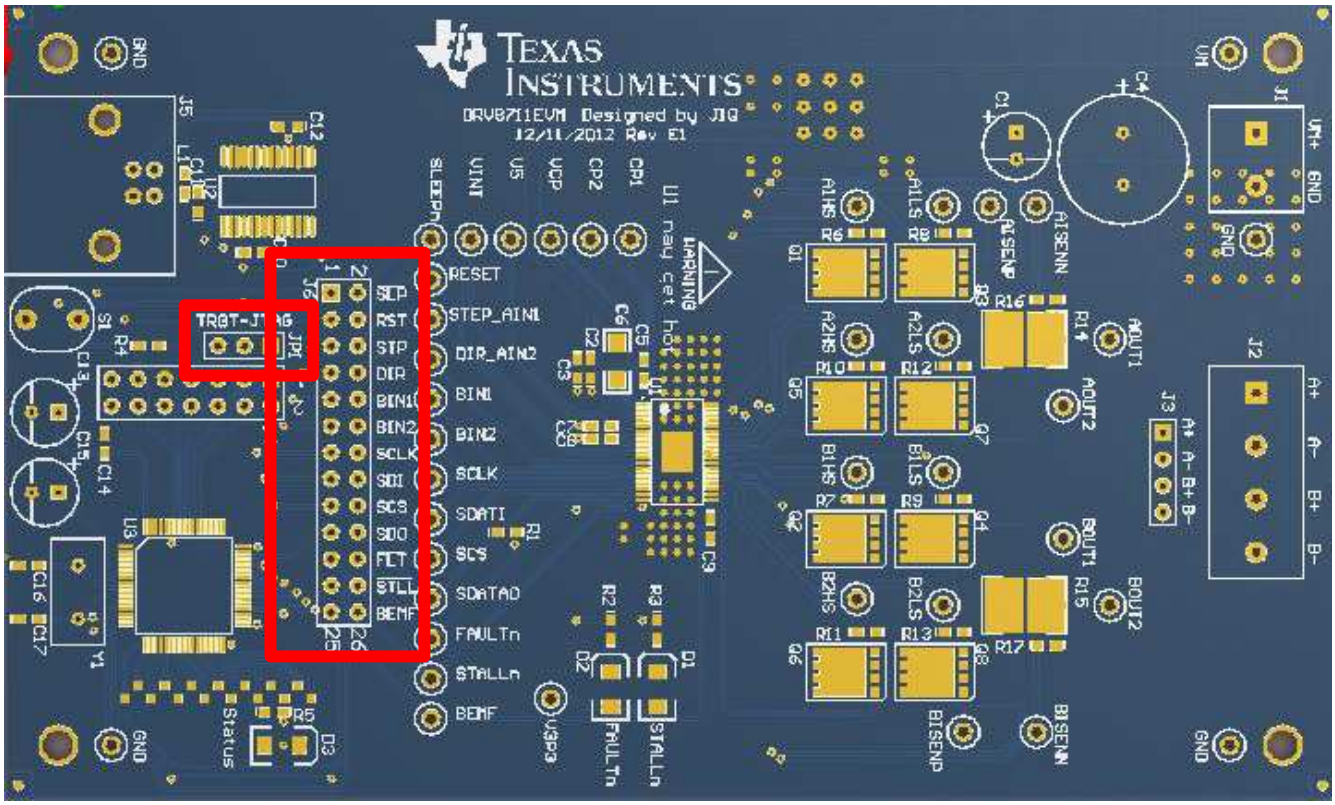


Figure 2. Jumpers

2.4 Motor Outputs

Two motor connectors are provided. Headers J2 and J3 are available as shown in Figure 3.

Header J2 is intended to be used with the supplied motor. To connect the supplied motor to header J2, connect the black and green wires of the stepper motor to terminals A+ and A-, and the red and blue wires of the stepper motor to terminals B+ and B-.

An alternate connection is provided through header J3. Connect the motor to pins A+, A-, B+, and B- of header J3.

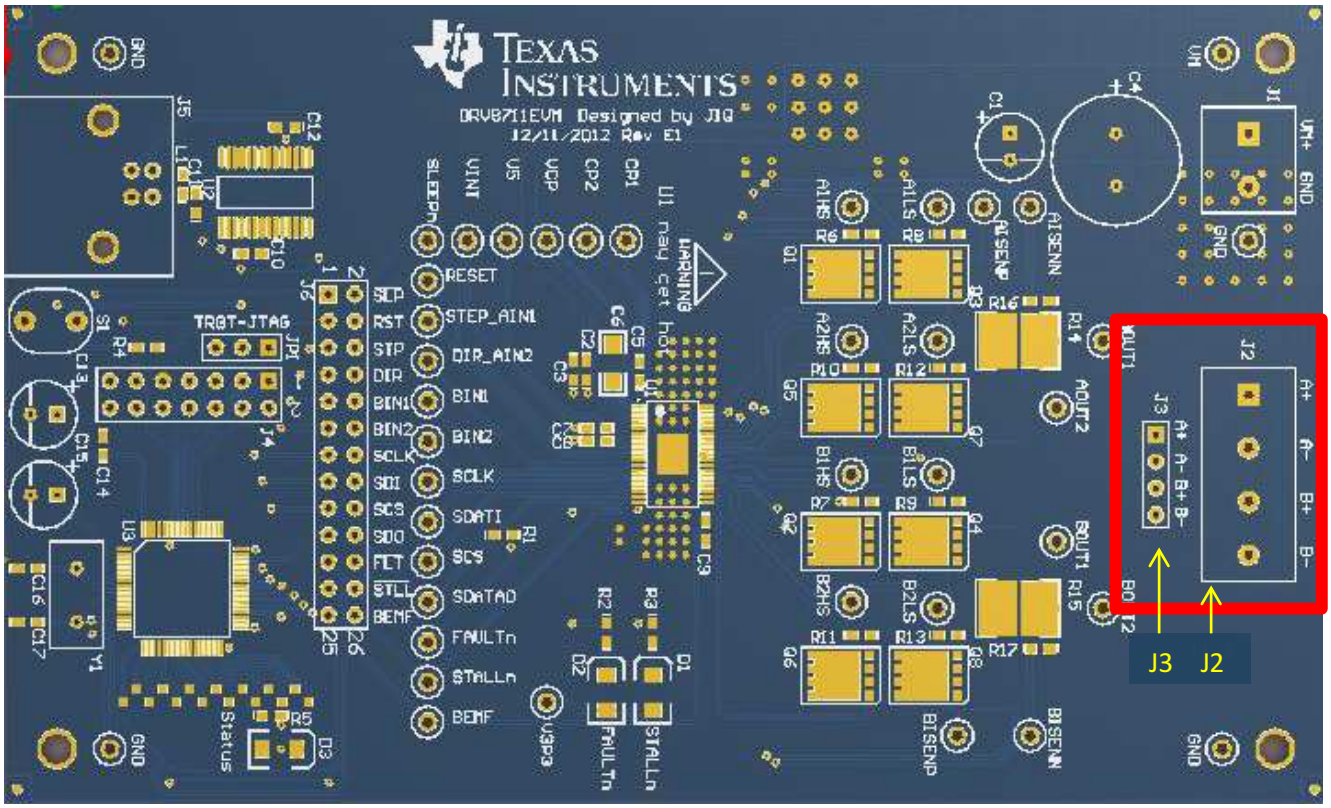


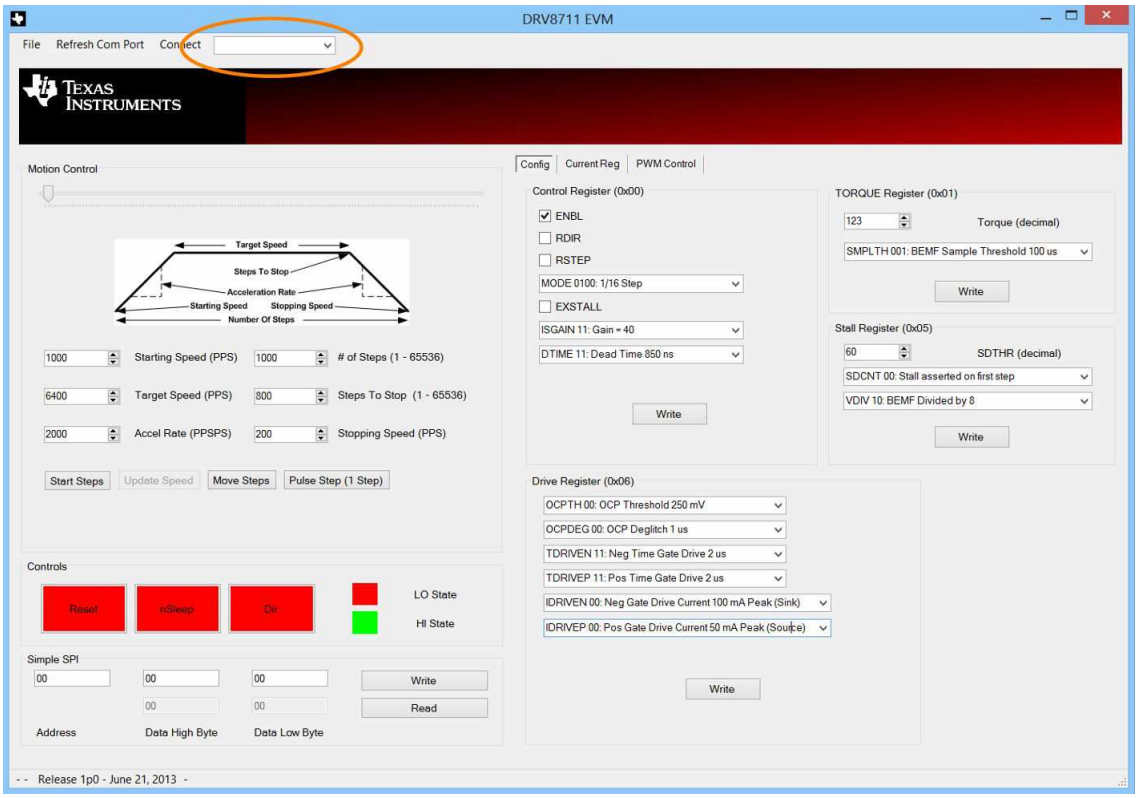
Figure 3. Motor Outputs

3 Operating the EVM

This section acts as a quick start guide to allow the user to run the supplied motor. Please refer to Appendix A for more detailed information about the GUI. Appendix B allows the user to adjust the motor settings.

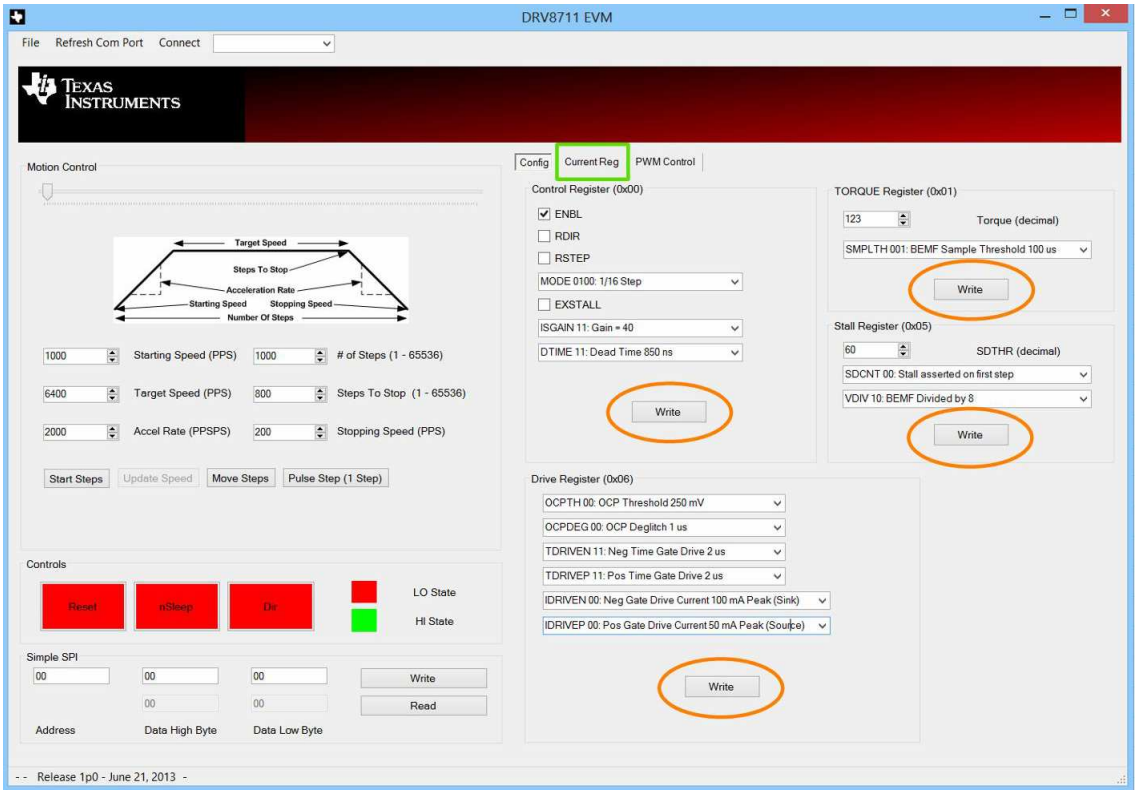
1. This section acts as a quick start guide to allow the user to run the supplied motor. Please refer to Appendix A for more detailed information about the GUI. Appendix B allows the user to adjust the motor settings.
2. Connect the black and green wires of the stepper motor to terminals A+ and A-, and the red and blue wires of the stepper motor to terminals B+ and B-.
3. Connect the VM power supply but do not apply power at this step.
4. Connect the USB between the PC and the EVM. Open the DRV8711EVM GUI.

   (a) Once the USB connection is established, the status light emitting diode (LED) begins blinking.
5. Apply 24 V to the VM+ and GND connections. The D2, FAULTn LED remains on until Step 11 when the part is taken out of sleep.
6. Connect the GUI to the PC by selecting the proper COM port. Typically the COM port is the only one in the pulldown menu circled. Once the COM port is selected, left click the Connect button (to the left of the pulldown COM port).

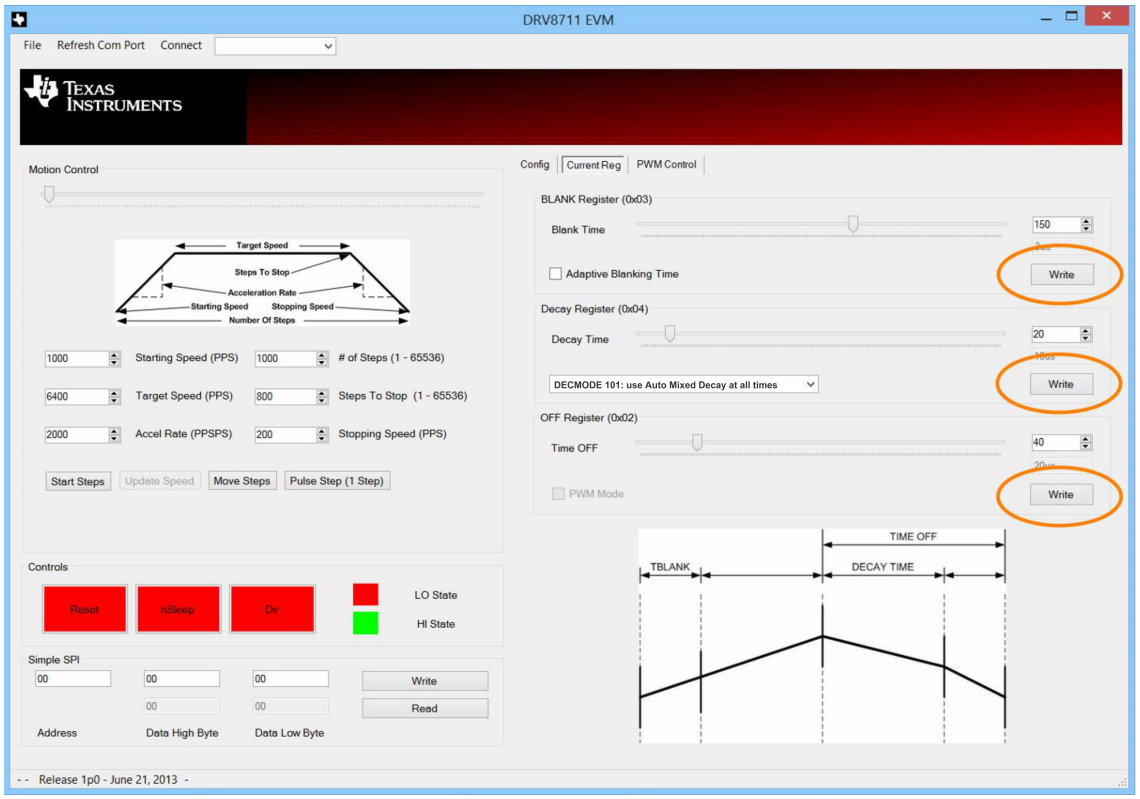


7. All defaults have been preset for a 16-step operation using the supplied motor. Click the four write buttons on the Config page as shown below.

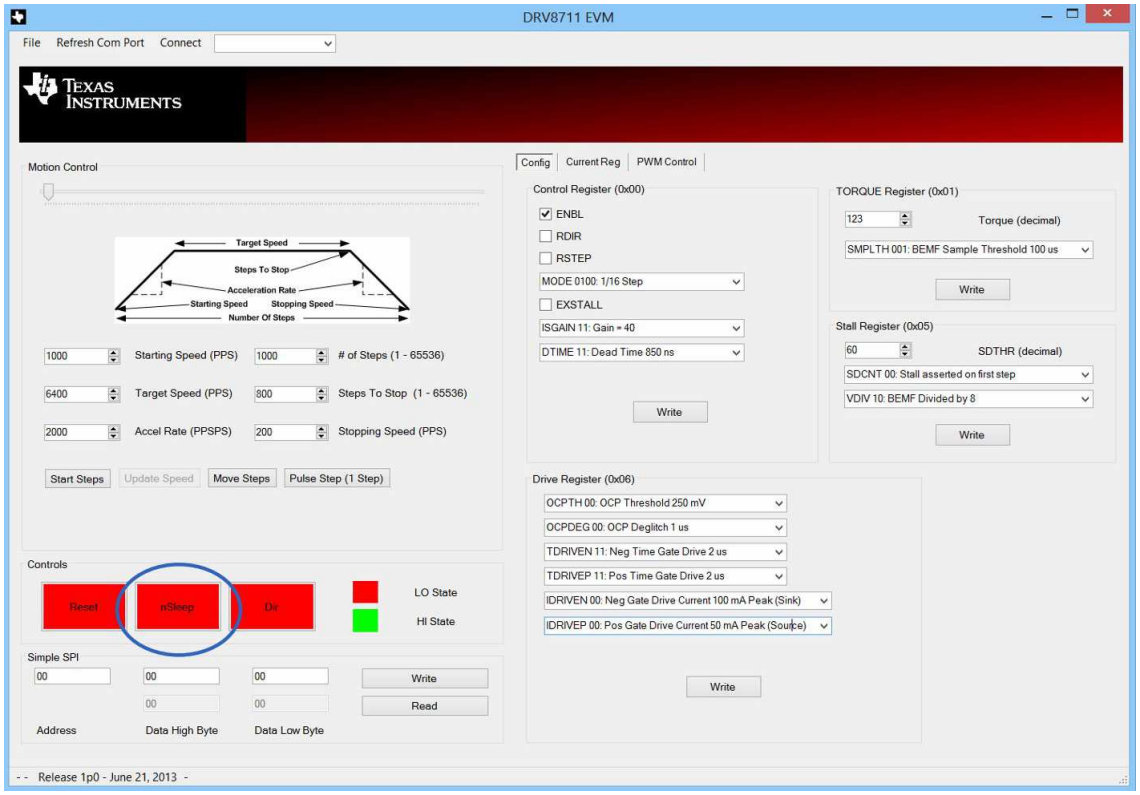
   (a) Once all four write buttons are clicked, select the Current Reg button to switch to the Current Reg page (shown in the rectangle below).



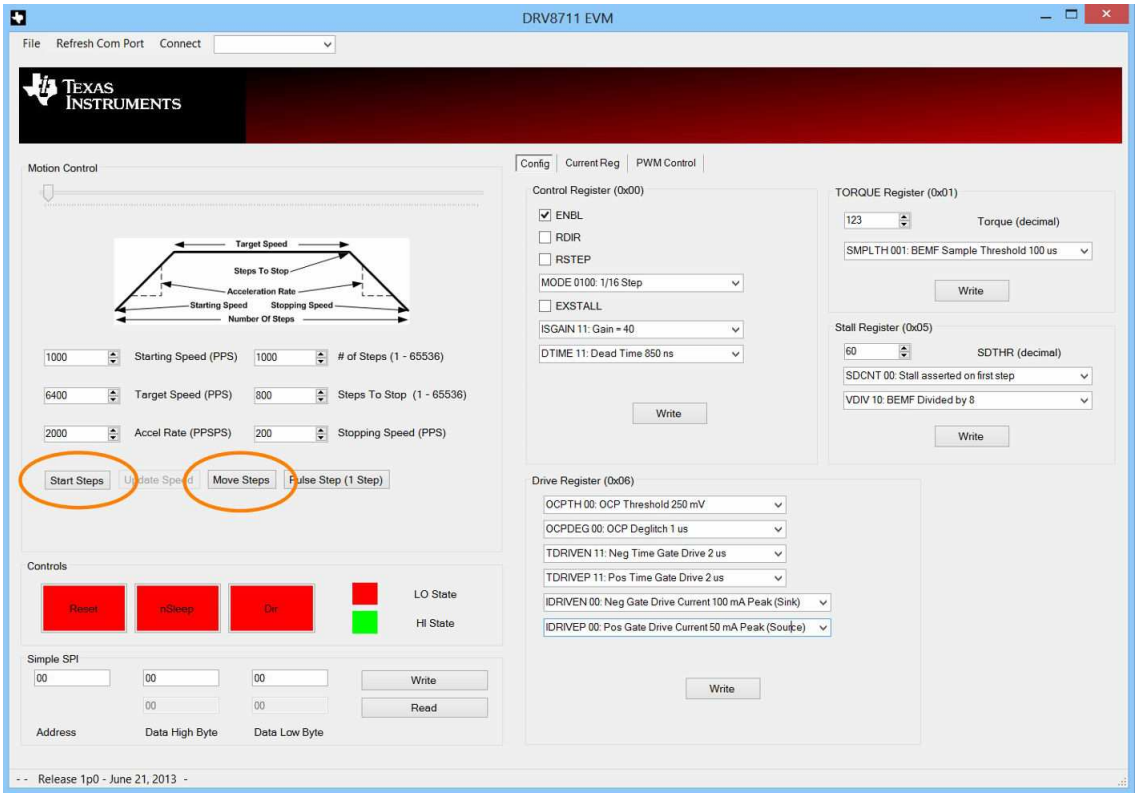
8. Click the three write buttons highlighted on the Current Reg page.
   (a) Return to the Config page by selecting the Config button.



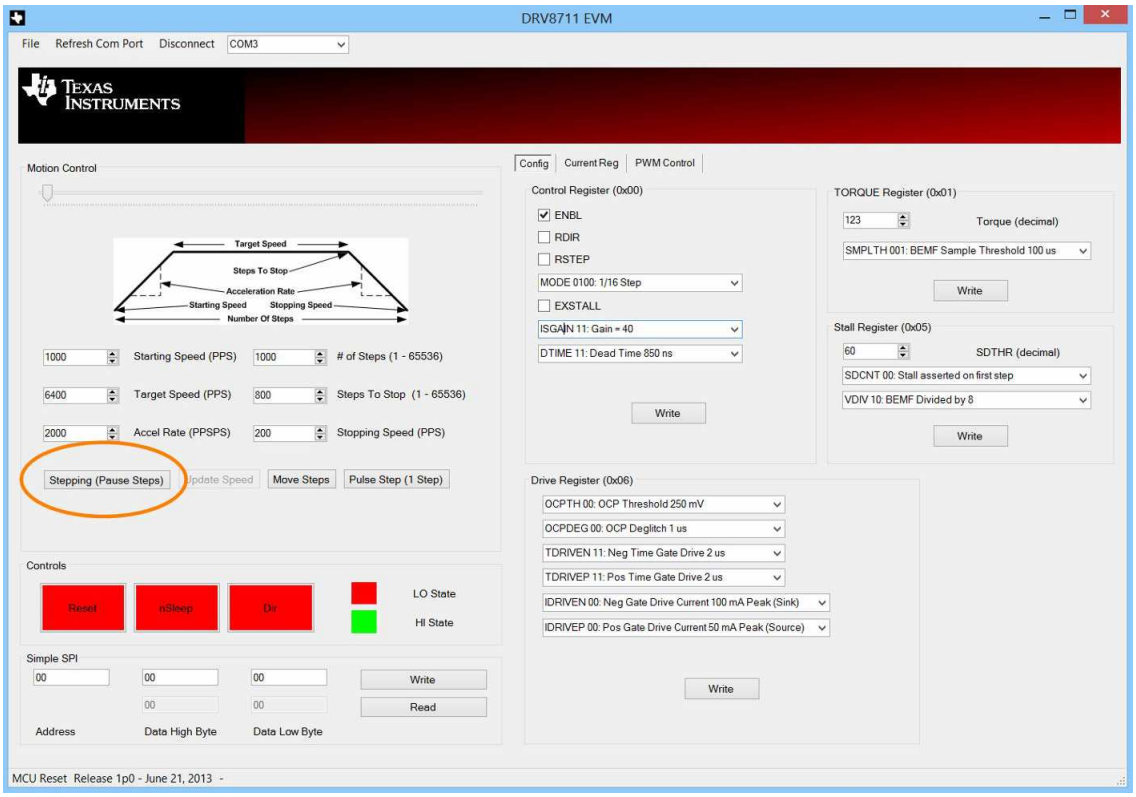
9. Wake the device by clicking the nSleep button; it should turn green.



10. The DRV8711 is now awake and can be commanded to turn the motor by either selecting Start Steps or Move Steps. If Start Steps is selected, the button changes to Stepping (Pause Steps). Please note that D2, FAULTn LED, remains lit up until the part is taken out of the sleep state in this step.



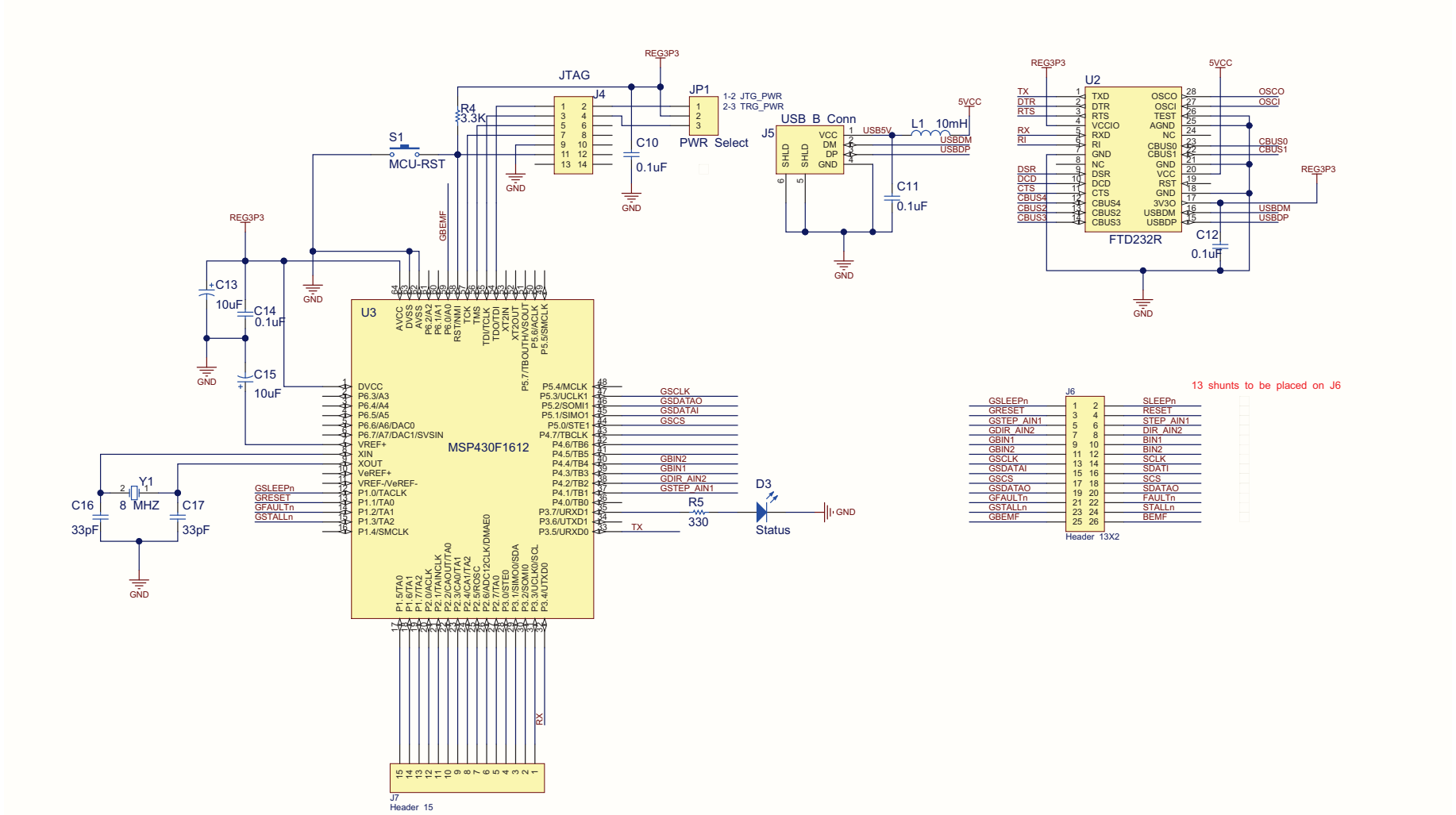
11. When stopping the motor, select Stepping (Pause Steps).

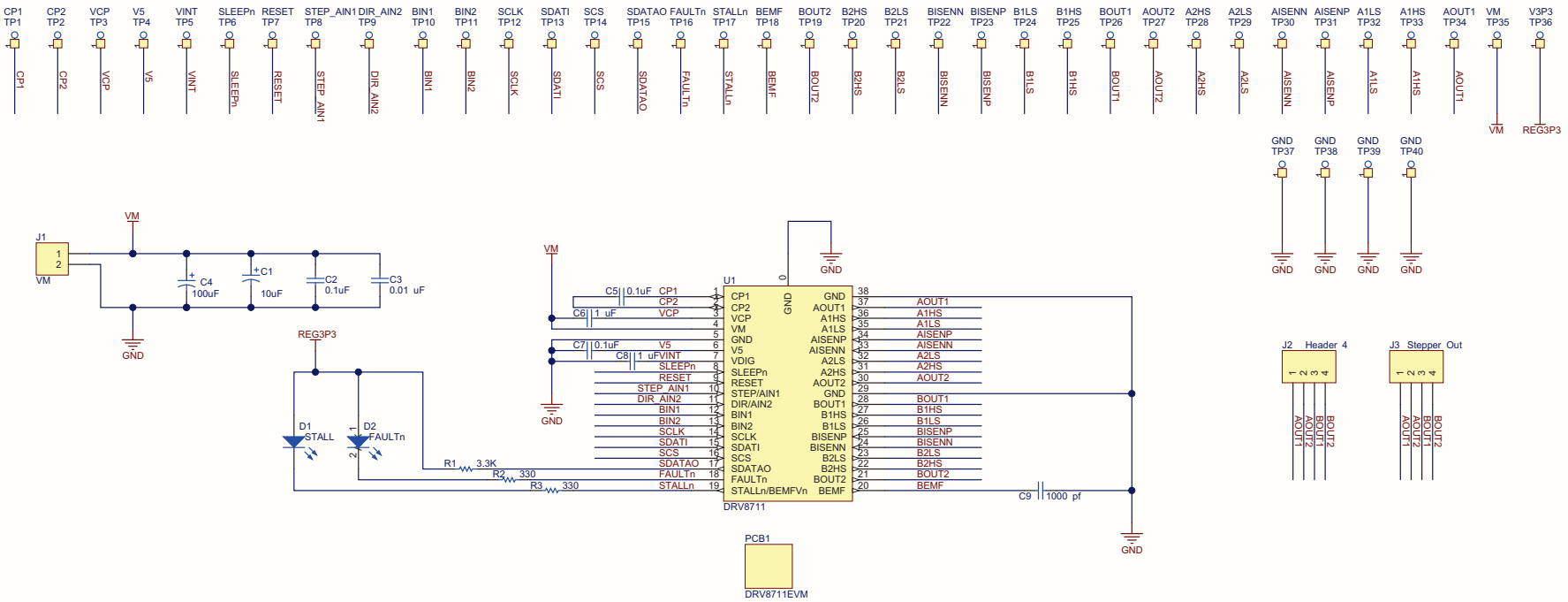


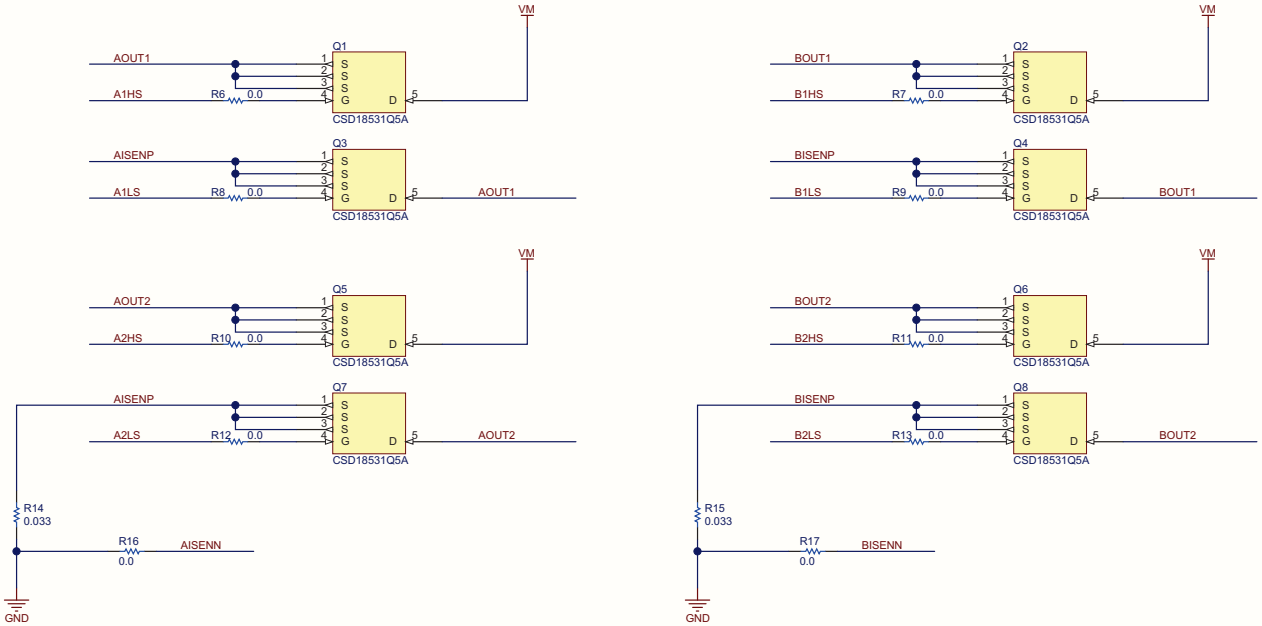
Below is an example of the current using the above settings.

3.1 Schematic

See the following pages for the schematics. The PDFs of these schematics are also available for download as part of the zipped software package in the DRV8711EVM product folder.







4 Bill of Materials

Description	Designator	Digikey Part Number	Quantity
SHUNT JUMPER, .1 in., BLACK GOLD	SHNT2, SHNT3, SHNT4, SHNT5, SHNT6, SHNT7, SHNT8, SHNT9, SHNT10, SHNT11, SHNT12, SHNT13, SHNT14	3M9580-ND	13
FERRITE, 1.5 A, 40 Ω, 0805, SMD	L1	240-2389-1-ND	1
IC, MCU, 16 BIT, 92K, FLASH, 64-LQFP	U3	296-22695-6-ND	1
RES, 330 Ω, 1/8 W, 5%, 0805, SMD, Resistor	R2, R3, R5	311-330GRCT-ND	3
Capacitor	C9	311-1342-1-ND	1
CAP, .10 µF, 50 V, CERAMIC, X7R, 0805, Capacitor	C7, C10, C11, C12, C14	311-1343-1-ND	5
Capacitor	C3	445-1304-1-ND	1
Capacitor	C8	445-1328-1-ND	1
Capacitor	C6	445-1423-1-ND	1
Capacitor	C2, C5	445-5202-1-ND	2
CAP, CERAMIC, 33 PF, 50 V, NP0, 0805	C16, C17	478-6211-1-ND	2
CAP, ALUM, 10 µF, 25 V, 20%, RADIAL	C13, C15	493-1057-ND	2
CAP, ALUM, 10 µF, 100 V, 20%, RADIAL	C1	493-6066-ND	1
IC, USB, FS, SERIAL, UART, 28 SSOP	U2	768-1007-1-ND	1
TEST POINT PC COMPACT .063 in. D RED	TP35, TP36	5005K-ND	2
TEST POINT PC COMPACT .063 in. D BLK	TP37, TP38, TP39, TP40	5006K-ND	4
TEST POINT PC COMPACT .063 in. D WHT	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34	5007K-ND	34
CONN HEADER, .100 SNGL, STR, 3POS	JP1	929647-09-03-ND	1
CONN HEADER, .100 SNGL, STR, 4POS	J3	929647-09-04-ND	1
CONN HEADER, .100 DUAL, STR, 14POS	J4	929665-09-07-ND	1
CONN HEADER, .100 DUAL, STR, 26POS	J6	929665-09-13-ND	1
MOSFET N-CH, 60-V, 8 SON	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8	CSD18531Q5A	8
TERM BLOCK, 5.08 mm, VERT, 2 POS PCB	J1	ED2580-ND	1
TERM BLOCK, 5.08 mm, VERT, 4 POS PCB	J2	ED2582-ND	1
Pre Driver Stepper Motor Controller	U1	N/A	1
RES, 0 Ω, 1/10 W, 0603, SMD	R6, R7, R8, R9, R10, R11, R12, R13, R16, R17	P0.0GCT-ND	10
RES, 3.3 kΩ, 1/10 W, 5%, 0603, SMD	R1, R4	P3.3KGCT-ND	2
CAP, ALUM, 100 µF, 100 V, 20%, RADIAL	C4	P5313-ND	1
SWITCH TACTILE SPST-NO, 0.02 A, 15 V	S1	P8070SCT-ND	1
LED, RED, FACE UP, 1206	D1, D2, D3	P11532CT-ND	3
CONN, USB, RT ANG, RECPT, TYPE B, BLK	J5	WM17113-ND	1
Resistor	R14, R15	WSHA-.033CT-ND	2
CRYSTAL, 8 MHz, 20 PF, 49 µs	Y1	X165-ND	1

Appendix A

A.1 Driver and GUI Installation Instructions

The USB driver and GUI installation instructions are included in a Readme file located in the downloadable software package available in the DRV8711EVM product folder.

Appendix B

B.1 GUI Details

The DRV8711EVM GUI application is the software counterpart for the DRV8711EVM. It allows the PC computer to connect to the MSP430F2617 MCU though a USB interface chip. Once connection is established and commands are sent, the MCU takes care of configuring control signals, running the stepper through acceleration and deceleration profiles, sending serial peripheral interface (SPI) data packets and pulse-width modulation (PWM) generation, and so forth.

The GUI is designed to allow testing without hardware intervention for all of the DRV8711 device functionality.

Figure 4 shows the DRV8711EVM main screen.

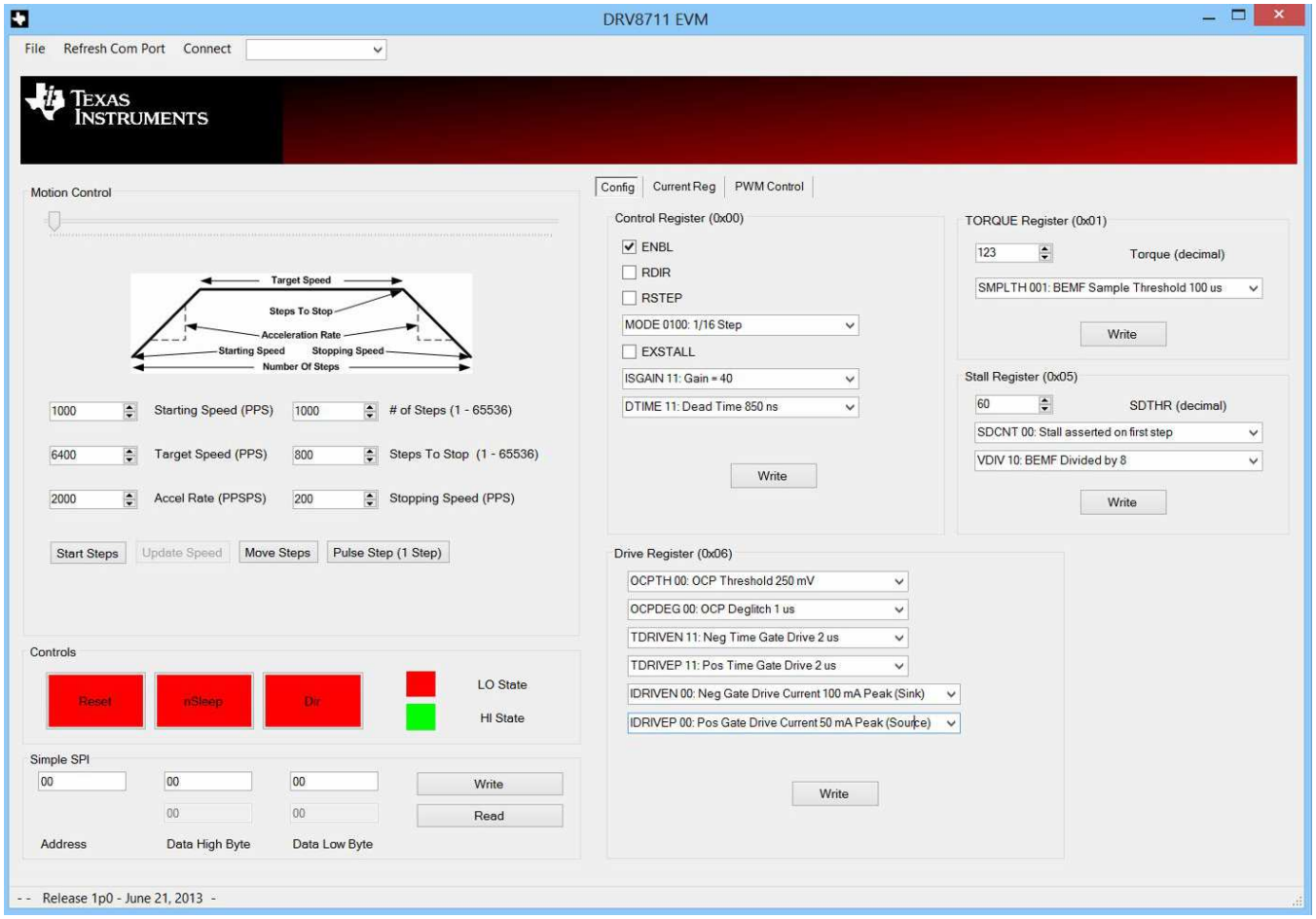


Figure 4. DRV8711EVM Main Screen

On DRV8711, most of the control signals are available through internal SPI registers. Easy access to these SPI registers is spread among three different tabs. These tabs and their respective register content are detailed in the subsequent sections.

Control signals such as nSLEEP, DIR and RESET are available throughout the main screen. A simple SPI frame is provided in case the user wants to send particular SPI packets to the available registers.

Each time the application is started, fields are filled with default values.

B.2 The Menu

The menu at the top of the application offers a series of quick options for how the COM port is to behave.

File— Exit – Terminates the application

Connect— Opens the serial port. Pressing this menu item changes its caption to Disconnect.

Disconnect— Closes the serial port. Pressing this menu item changes its caption to Connect.

COMx— A series of available COM ports are shown. To determine which COM port is the VCP, the user can go into the Windows Device Manager and determine which one of the enumerated COM ports is using the FTDI driver.

After opening the application, the order of events should be:

1. Select the COM port from the COMx drop down box.
2. Press Connect. If COM ports are available, the application searches for the EVM. If no EVM is found, an error message notifies the user. If the port is available and communications are successfully made, the menu item changes its Connect caption to Disconnect. Press Disconnect to disable the serial communications.
3. After pressing any SPI command button, <1><0><0> should return on the bottom status bar as an acknowledgment of proper communications taking place with the board. On SPI based buttons (labeled Write), the bottom status bar returns the last SPI data read from the SPI bus.
4. The application is now ready for use.
5. Closing down the application (through the Close X or through File → Exit) closes the serial port connection, so it is not necessary to press Disconnect before closing down the application.

B.3 DRV8711 GPIO Control Signals

Once the application is communicating with the interface board, the control signals can be actuated by clicking on the respective command button. A signal with a logic LO state is represented with the color red, whereas the same signal is represented with the color green once its state is switched to logic HI. The available control signals are RESET, nSLEEP and DIR.

Figure 5. Control Signals

B.3.1 Motion Control Frame

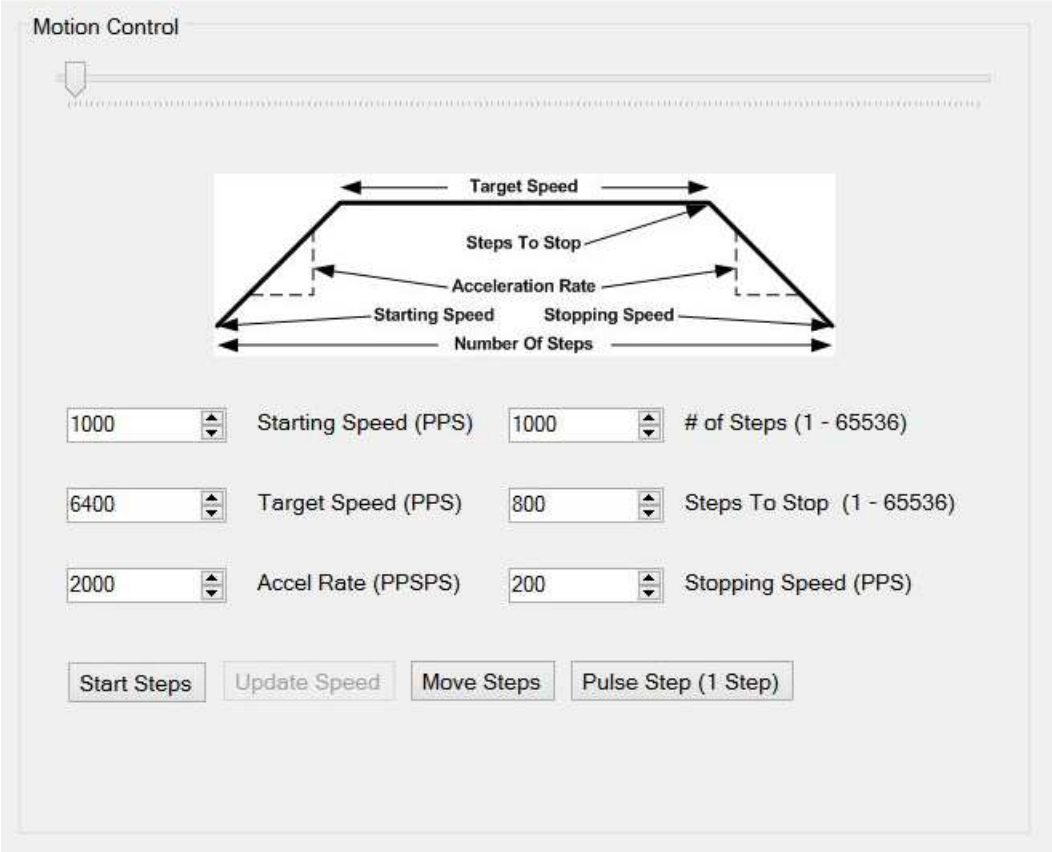


Figure 6. Motion Control Frame

This frame allows the configuration and running of the stepper with the direction specified by the DIR command button, and the other parameters such as current, decay mode, and microstepping resolution, are set by writing to their respective SPI registers.

The motion control frame gathers user information regarding stepping rate, or motor speed. An acceleration profile is employed to start at a programmable speed and increase stepping rate until reaching the programmable desired speed.

An internal 8-MHz timer is used to measure time and generate the steps in a timely manner. The Windows application transforms the entered number of PPS into the respective clock cycles needed for the timer to generate accurate STEP pulse timing.

The acceleration profile is coded inside of the MCU to accept both the Start Speed pulse per second (PPS) and Target Speed PPS as a clock cycle number. When the Start Steps command is issued (by pressing the Starts Step button), an Interrupt Service Routine (ISR) generates steps at a rate specified by the Start Speed PPS parameter.

The very same Starts Step command computes how frequent automatic speed updates are issued and a second timer is used to change the speed according to the programmed acceleration rate profile.

Once the Target Speed PPS is reached, the acceleration profile ends and the motor stays running until the Stop Stepper command is issued (by pressing the Stop Stepper button). When the stepper is commanded to stop, the controller does exactly as it did while accelerating, but in reverse to achieve deceleration until the Stop Speed PPS is reached, in which case the motor fully stops.

A second motor actuation is provided by the Move Steps command in which a programmed number of steps are issued and then the motor is stopped. The acceleration and deceleration profiles work similarly as before, except when the deceleration starts to happen and when the motor actually stops are a function of the Steps to Stop and Deceleration Rate parameters.

Figure 7 shows the acceleration profile and the role each parameter plays during speed computation.

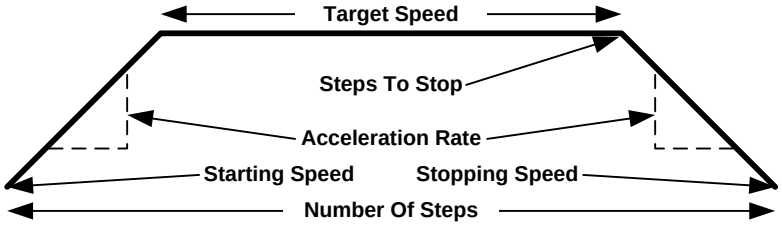


Figure 7. Acceleration Profile

The following controls are available within the motor control frame:

Start Speed PPS— Number of pulses per second (or full steps per second) at which the motor rotates in the beginning of an operation. The SW only allows a number as small as 200 PPS and can be taken to a number as large as 65535 PPS.

Target Speed PPS— Number of desired pulses per second (or full steps per second) at which the motor operates. The acceleration profile starts from the Start Speed PPS and increases stepping rate until reaching the Desired Speed PPS. The SW only allows a number as small as 200 PPS and can be taken to a number as large as 32000 PPS.

Acceleration Rate (0-5000)— A number from 0 to 5000 which acts as a stepping rate modifier to increase the Start Speed PPS up to Target Speed PPS.

Stop Speed PPS— Number of pulses per second (or full steps per second) at which the motor stops rotating after the Stop Stepper command is invoked and the deceleration profile is issued. The deceleration profile modifies the stepper speed from the Target Speed and into the Stop Speed.

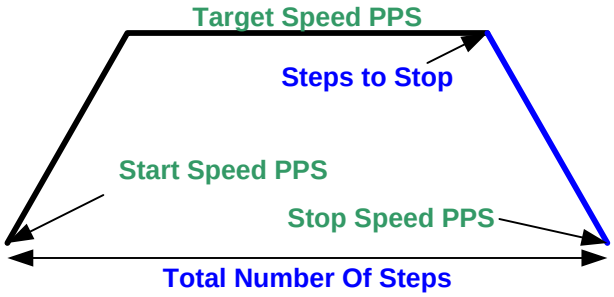
If the user desires to move the stepper a certain number of steps, this can be easily accomplished by using the Move Steps function. Parameters from the other frames are reused and its utilization is as previously explained. Two new parameters have been added to properly control the limited number of steps actuation.

Number Of Steps— How many steps the controller issues.

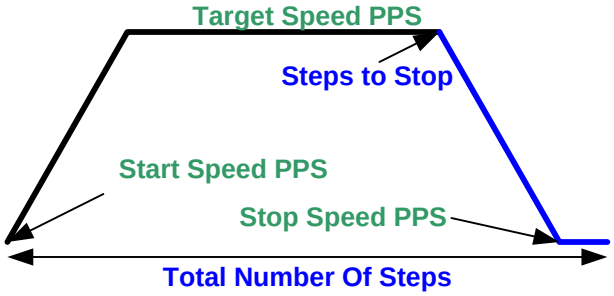
Steps To Stop— The controller is continuously monitoring the step being issued and when the current step is equal to the Steps To Stop parameter, a deceleration profile is issued. If Steps To Stop is larger than the Number Of Steps, then the motor stops abruptly without undergoing a deceleration profile.

When a deceleration profile is issued, the controller decreases the speed until reaching the Stop Speed value. If the Number Of Steps parameter is met before the deceleration profile is complete, then the motor stops at the current speed. If the Stop Speed is met before all the Number of Steps are issued, then the motor rotates at the Stop Speed value until all the steps are executed.

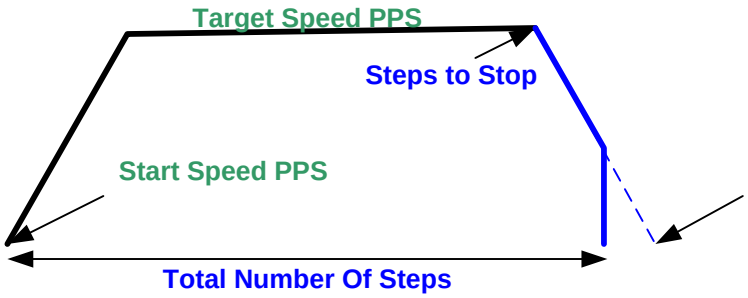
Ideally, the system must be tuned to resemble a case in which the controller executes all the commanded steps at a speed as close as possible to the Stop Speed. In the event this is not possible, due to the particular parameters being chosen, stopping the motor at a speed very close to the Stop Speed is often good enough to ensure good motion quality and application performance.



Motor Reaches Stop Speed at the Stop Speed



Motor Reaches Stop Speed before the Stop Speed is reached



Motor runs out of Steps before reaching Stop Speed

Figure 8. Motion Control Examples

B.4 Configuration Tab

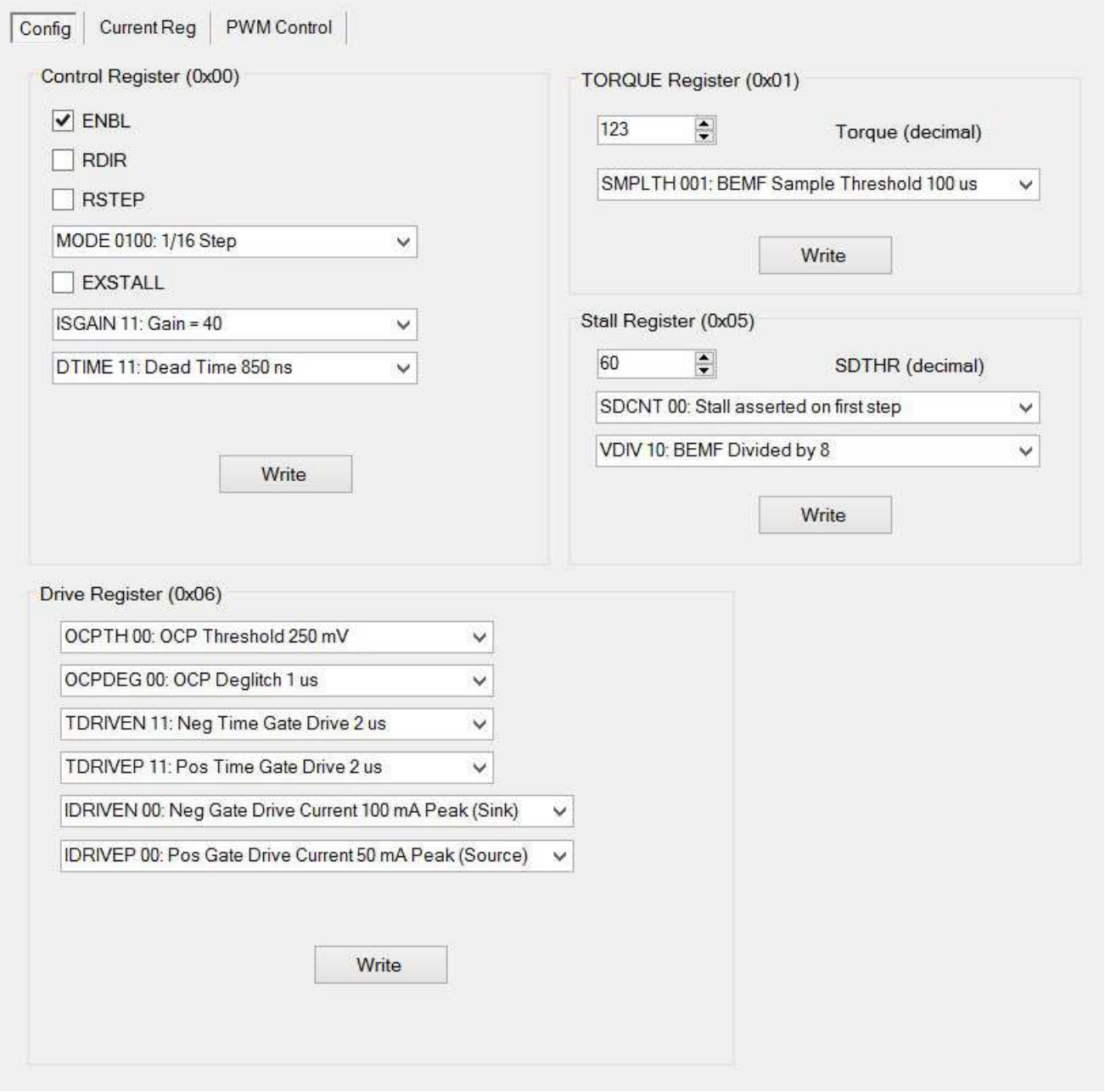


Figure 9. Configuration Tab

The configuration tab offers access to the Control, Torque, Stall and Drive Registers. A detailed explanation of these registers can be found in the datasheet (SLVSC40).

Check boxes are supplied for single bit fields, whereas drop down combo boxes are supplied for bit fields larger than one size. On all check boxes, a checked states implies HI, whereas an unchecked state implies LO.

B.5 Current Regulation Tab

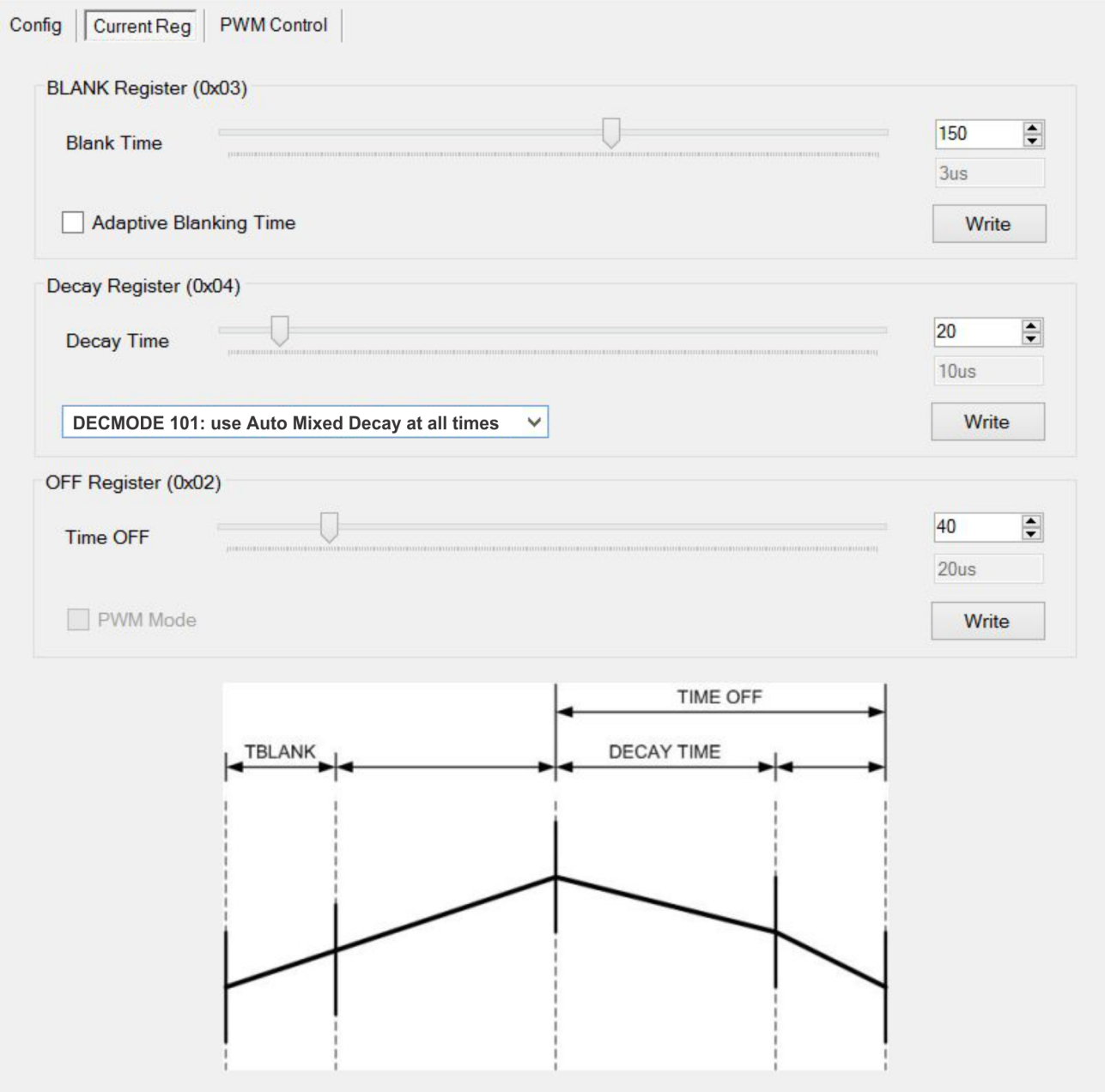


Figure 10. Current Regulation Tab

The current regulation tab offers access to the Tblank, Decay and TimeOff registers. In order to make the current regulation selection easier, a diagram with text boxes and sliders is available. For each register, the respective numeric box, slider and text box are linked. That is, the three fields are updated whenever either the numeric box or the slider are actuated. The numeric box displays information in decimal, whereas the text box offers the respective timing equivalent in micro seconds.

B.6 PWM Control

The PWM tab gives access to the four INx signals which can be pulse-width-modulated to apply speed and direction control to a pair of brushed DC motors. In order to enable the PWM mode, the PWM mode check box must be checked. This check box is actually a bit in the Time OFF register, so to effectively enter PWM mode, communications must have been set. Checking and unchecking the PWM mode check box signals the MCU to send the respective SPI packet.

The four PWM sliders are enabled once the PWM mode is engaged. The user can adjust PWM duty cycle by moving the respective slider bar.

Figure 11. PWM Control

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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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). 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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of EVMs for RF Products in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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本開発キットは技術基準適合証明を受けておりません。

本製品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。

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2. 実験局の免許を取得後ご使用いただく。
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EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM’s electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI’s recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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