DRV8306EVM User's Guide

This document is provided with the DRV8306 customer evaluation module (EVM) as a supplement to the *DRV8306 38-V Brushless DC Motor Controller* data sheet. This user's guide details the hardware implementation of the EVM.

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1 Overview

The DRV8306 evaluation module (EVM) is an application board designed to allow easy evaluation of the DRV8306 device. The DRV8306 device is a gate driver IC for three-phase motor drive applications. The DRV8306 device provides three high-accuracy trimmed and temperature-compensated half bridge drivers, each capable of driving a high-side and low-side N-type MOSFET.

The DRV8306 device is used in motor control applications that require a high degree of integrated protection, diagnostics, and monitoring though fault reporting and flexible parameter settings, such as current control options for slew-rate control of the gate drivers and various protection features.

The DRV8306EVM uses a compact and modular form factor for ease of use and is designed as a standalone board to control BLDC motors. Figure 1 shows the top 3D view of the DRV8306 EVM PCB.

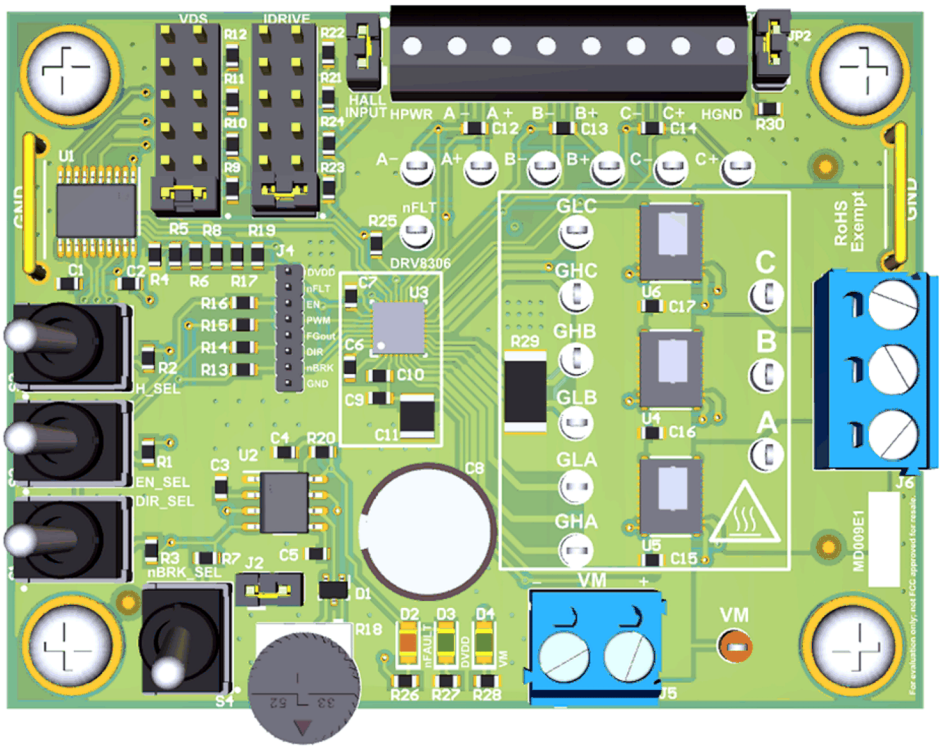


Figure 1. DRV8306EVM Top View

1.1 Purpose and Scope

This document is designed to be used as a guide to evaluate the DRV8306EVM. This document is intended for the engineers involved in the design, implementation, and validation of the DRV8306 device.

The scope of this document is to provide the user a guide to quickly evaluate the DRV8306 device explaining all hardware components and connections of the board.

2 Hardware Overview

The DRV8306EVM is a solution for evaluating the DRV8306 device, a brushless DC motor controller. The EVM includes a TLC555 timer configuration to supply PWM to the DRV8306 device, a potentiometer to adjust the speed of the motor by varying the duty cycle of the PWM, and an external PWM input pin. The EVM also supports differential and single-ended Hall effect sensors. The EVM includes surface-mounted test pins for all important signals on the board. The DRV8306EVM is configured so that only connections to the motor, Hall sensors, and power supply are required.

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2.1 Board Components

The DRV8306EVM uses a single-power supply rail which must be connected to the J5 terminal. The minimum recommended VM supply voltage of the EVM is 6 V and the maximum is 38 V, with a current of at least 2 A. A higher current setting is recommended to maintain a stable VM voltage. For complete voltage range information, refer to the *DRV8306 38-V Brushless DC Motor Controller* data sheet. Figure 2 shows the main components of the DRV8306EVM.

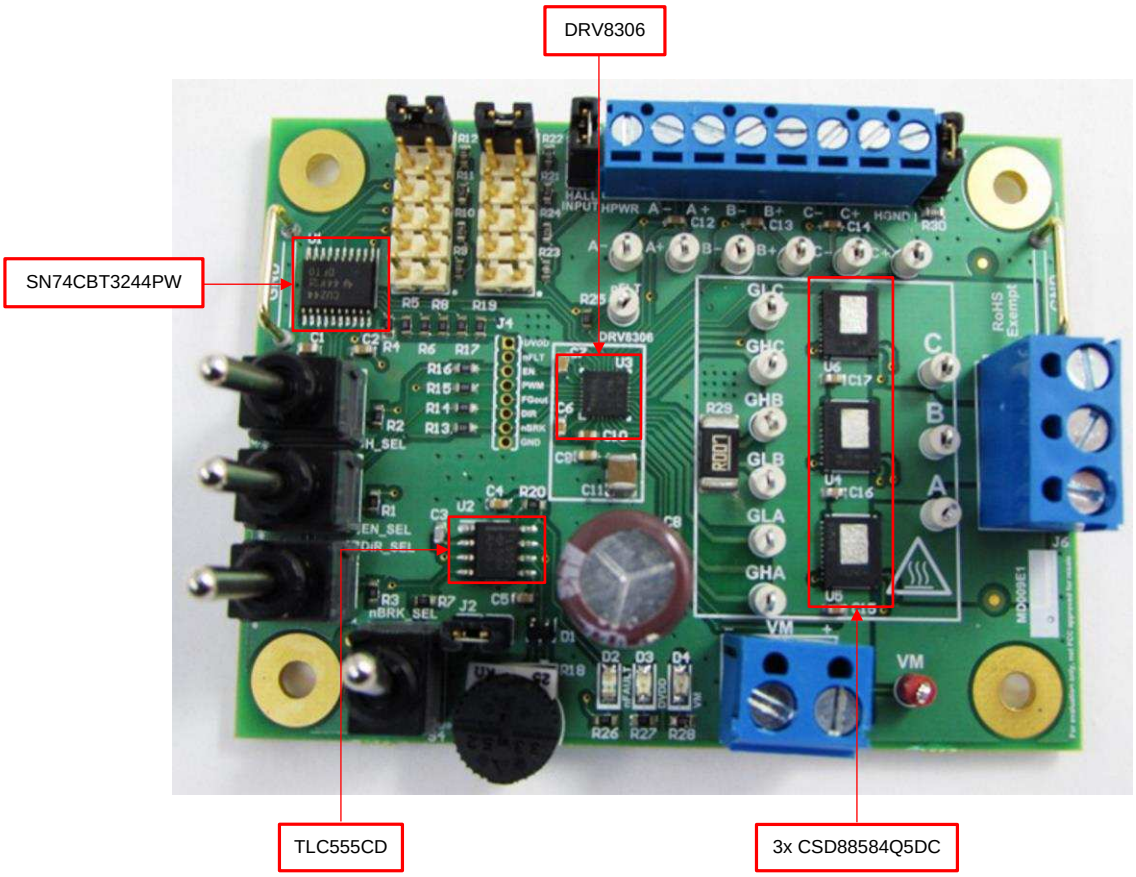


Figure 2. DRV8306EVM Board Overview

- **DRV8306 (U3):** 3 Phase gate driver with three integrated current shunt amplifiers.
- **Drive Stage (U4, U5, U6):** 3X CSD88584Q5DC N-channel NexFETs driven by the gate driver.
- **TLC555CD (U2):** 555 Timer providing PWM input to the driver.
- **SN74CBT3244PW (U1):** Octal FET bus switch for hall sensor options.

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2.2 Connections and Test Points

Figure 3 shows the various connections and test points labels on the DRV8306.

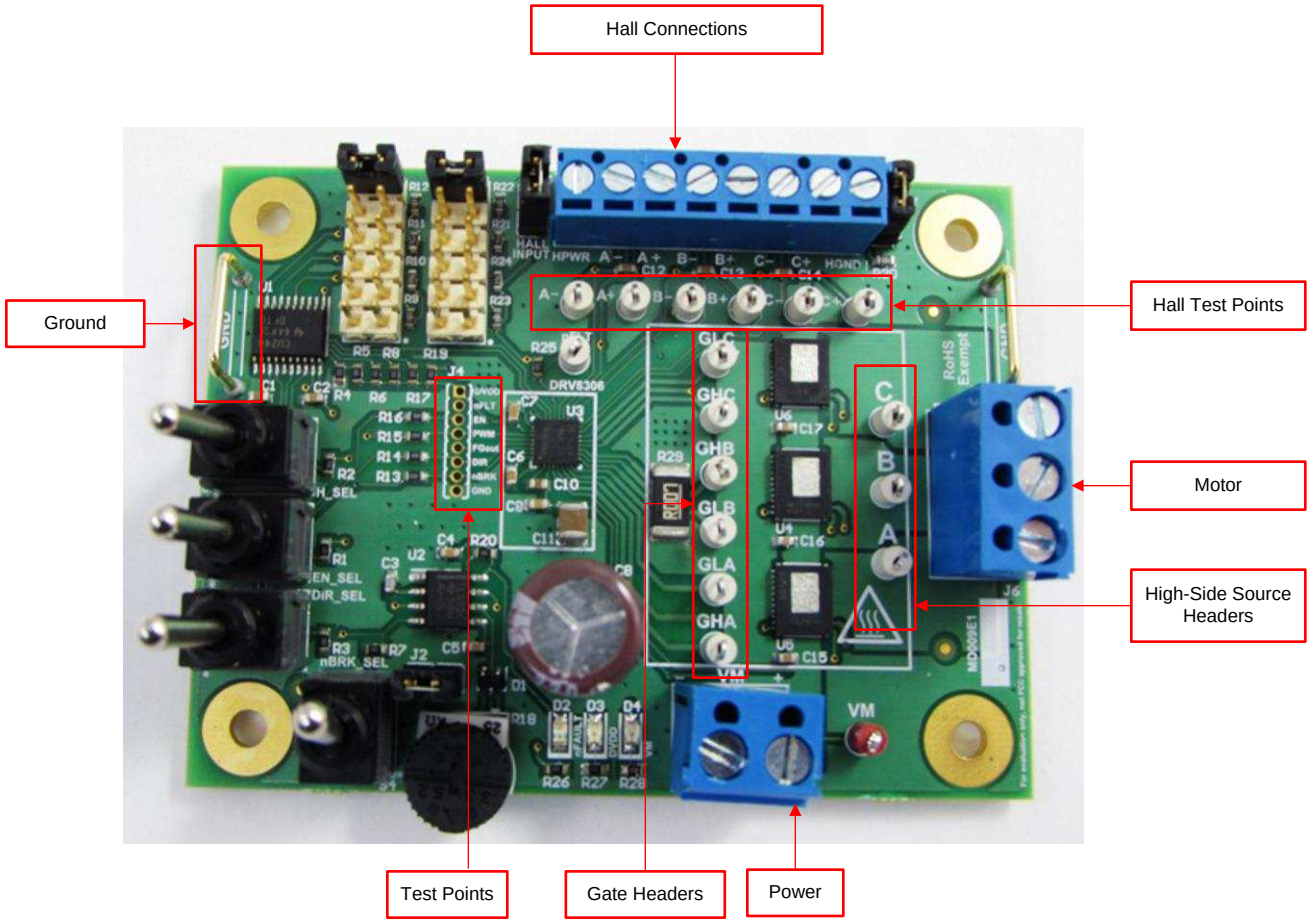


Figure 3. DRV8306EVM Connections and Test Points

Power Supply (J5)—Valid input supply voltages from 6 to 38V from a battery or a DC voltage source.

To Motor (J6)—Switching nodes of the 3-phase bridges for motor connection.

Hall Connections (P1)—Hall sensors or hall elements connection.

Test Points (J4)—Control input/output test points.

Test points are provided and labeled according to the inputs and outputs of the DRV8306 device. The signals brought out to the test points are labeled as nFLT, EN, PWM, FGOut, DIR, nBRK, A+, A–, B+, B–, C+, C–, GLA, GHA, GLB, GHB, GLC, GHC,and GND (see Figure 3).

When power is supplied to the board, a green LED (D4) in the lower mid section lights up.

The nFAULT and FGout signals represent the DRV8306 outputs. nFAULT pins reports a fault condition of the driver or motor. If a fault condition is present, a red LED (D2) lights up. The FGout signal indicates the measurement of the commutation frequency which can be used for implementing closed-loop speed control.

The A+, A–, B+, B–, C+, and C– signals represent the corresponding Hall signals. The ENABLE pin represents whether the DRV8306 device is active or off.

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2.3 Control Settings

2.3.1 Switches and Jumpers

Five jumpers, four switches and one potentiometer are installed by default on the EVM. Table 1 lists the jumper descriptions.

Table 1. Jumper Descriptions

Jumper	Description
JP1	**Hall Power**: Hall sensor power selected to DVDD 3.3V or external Hall supply.
JP2	**Hall Ground**: Hall sensor ground, directly connected or through limit resistor.
J2	**PWM**: PWM jumper connected to the timer or from external source.
VDS	**VDS**: Seven level VDS monitor trip point setting.
IDRIVE	**IDRIVE**: Seven level gate drive current setting.

The default jumper settings are JP1, JP2, J2 all installed, and VDS and IDRIVE with no jumpers. The DRV8306EVM is controlled by four switches. Table 2 lists the switches descriptions.

Table 2. Switch Descriptions

Switch	Description
S1	**Direction**: Sets direction of the motor forward or reverse.
S2	**Enable**: Gate driver enable or disabled.
S3	**Hall Select**: Hall selection either a differential signal pair or single-ended signal.
S4	**nBrake**: Motor brake ON or OFF.

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The default jumper settings support single-ended Hall sensors, switch S3 must be set to the *Sin* position in order for the DRV8306EVM to commutate a motor with single ended hall sensors.

Speed is supplied from the potentiometer and the motor spins in a forward direction. Figure 4 shows all control switches and jumpers of the DRV8306EVM.

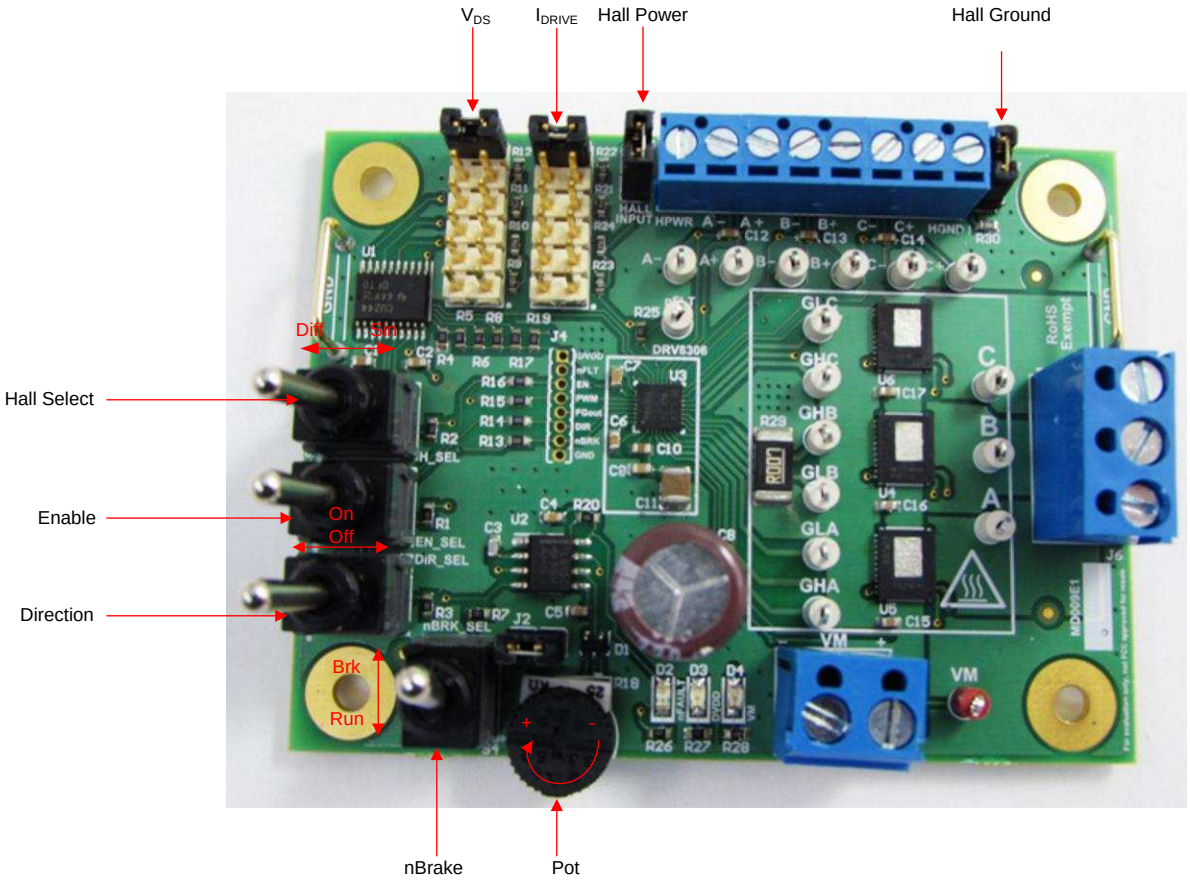


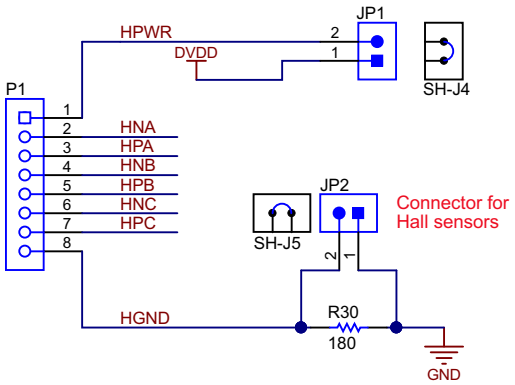
Figure 4. DRV8306EVM Control Switches and Jumpers

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2.3.2 HALL POWER Configuration (JP1/JP2) Jumpers

Sensored BLDC motors typically use either Hall integrated circuits (ICs) or Hall elements. Most ICs can use 3.3-V or 5-V power, while elements typically have power pins that have an equivalent circuit of a resistor, and current must be limited. To support both types of Hall sensors, the Hall power must be configured on the DRV8306EVM.

When installing JP1 and JP2, a 3.3-V power is supplied to the P1 terminal to power the ICs. If halls require a different voltage supply, remove JP1 and supply external voltage to JP1-2. Figure 5 shows the Hall power (HPWR) and Hall ground (HGND) connections.



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Figure 5. Hall PWR and GND Connections

By removing JP1 and JP2, the circuit shown in Figure 6 is available for the Hall elements. Supply external power supply to the HPWR connection JP1-2.

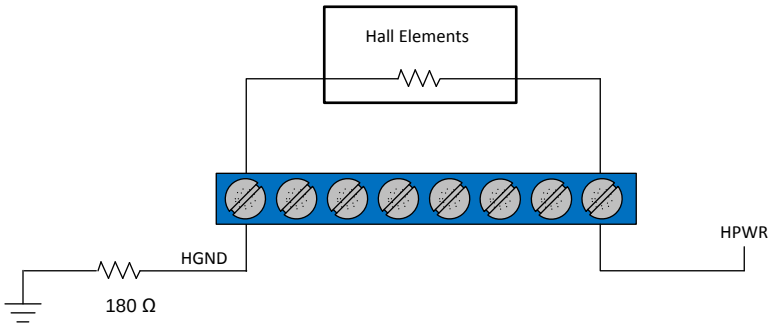


Figure 6. Hall Element Connections

The current can be calculated as follows: If the voltage is 5-V and connected to HPWR, and three Hall elements having a resistance of 400 Ω are connected in parallel, around 15 mA is supplied. Always refer to the Hall element specifications to understand the proper current. The purpose of the 180-Ω resistor is to bias-up the common-mode voltage of Hall-element differential signals because the DRV8306 device requires a V_{ICM} voltage from 1.5 V to 3.5 V. Modify the resistor value according to the type of hall elements in used and power supplied to the HPWR pin.

If unsure of the Hall type of the motor, measure the resistance between the Hall power and ground wires. If the measured resistance is less than 250 Ω, the Hall type is most likely a Hall element. Hall sensors are easily damaged if incorrect power is applied.

2.3.3 HALL SIGNAL Configuration (S3 Switch)

Hall sensors output either a differential signal pair or a single-ended signal. To identify which type of output the motor uses, count the number of wires; a sensored BLDC typically has 3 phase wires, 2 Hall power wires, and 3 or 6 Hall signal wires. A total of 8 indicates the output single-ended and a total of 11 indicates the output is differential.

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The DRV8306 device has differential comparators on the Hall inputs. The comparators can also accommodate single-ended signals with the use of a few passive components. When using differential Halls, directly connect the 6 Hall signals to the DRV8306 pins.

Using single-ended Halls signals requires pullup resistors. The negative (–) pins of the DRV8306 comparator should be biased with a middle voltage so that a single-ended swing on the positive (+) pin is detected similarly to a differential voltage. Connect single-ended Hall wires to the + pins at the P1 terminal. Figure 7 shows the circuit for single ended and differential hall selection.

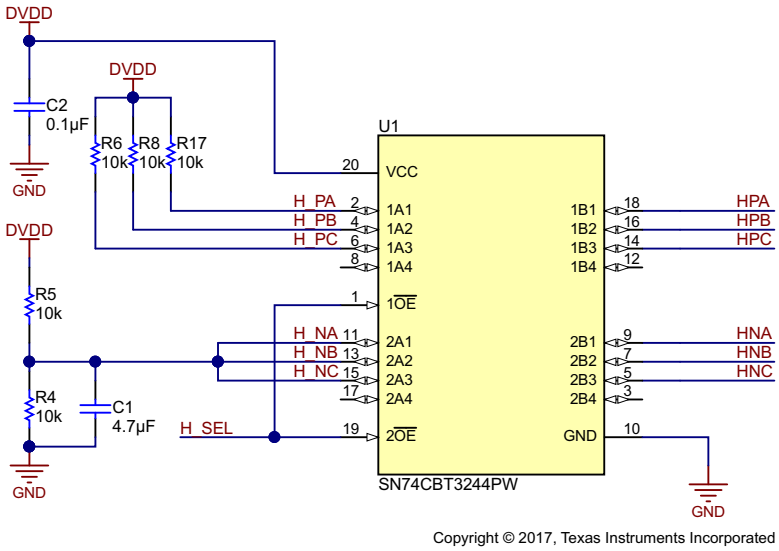


Figure 7. Single-Ended and Differential Hall Selection Circuit

The DRV8306EVM supports both single-ended and differential Hall signals through the Octal-line FET switch (SN74CBT3244). By setting S3 on the *Sin* position, the DRV8306EVM gets configured as single ended hall signals. For single ended, make JP1 and JP2 jumpers are installed.

2.3.4 DIR Direction (S1 Switch)

The S1 switch is labeled as *DIR_SEL* on the DRV8306EVM. The motor is set to spin in the forward direction when switch is set to the *On* position. In the on position, the DIR pin is puled up to DVDD. When switch is set to the *Off* position, the motor spins in the reverse direction. In this position the DIR pin is tied to GND.

2.3.5 ENABLE (S2 Switch)

The S2 switch is label as *EN_SEL* on the DRV8306EVM. The gate driver of the DRV8306 device is enabled and the motor starts spinning when the switch is set to the *On* position. In the on position the ENABLE pin is floating and the internal pullup resistor of the DRV8306 device enables the motor. When the switch is set to the *Off* position, the gate driver is disable, and motor stops. In this position the ENABLE pin is tied to GND and the device enters a low-power sleep mode.

2.3.6 BRAKE (S4 Switch)

The S4 switch is labeled as *nBRK_SEL* on the DRV8306EVM. The motor is braked by the DRV8306 brake functionality when the S4 switch is set to the *Brk* position, in this position nBRAKE pin is tied to GND. When switch is set to the *Run* position, the motor spins in the configured direction. In the run position the nBRAKE pin on the DRV8306 device is pulled up to DVDD.

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2.4 SPEED ADJUSTMENT (J2) Jumper and (R18) Potentiometer

The DRV8306 device has a dedicated, speed input pin (PWM) that supplies a duty cycle to the device to control motor speed.

The DRV8306EVM offers two options to supply this PWM input which is controlled by the J2 jumper.

Installing the J2 jumper uses the speed adjust potentiometer, SPEED ADJUST (R18), for the PWM speed input as shown in Figure 4. The potentiometer adjusts the duty cycle of the PWM signal which, in turn, adjusts the speed of the motor. The lower the duty cycle, the lower the speed. To increase the duty cycle, increase the speed by turning the potentiometer clockwise.

The on-board PWM signal for the DRV8306 device is generated by a circuit based upon TI's TLC555 low-power timer. The TLC555 timer is capable of approximately a 25-kHz output that can be adjusted from 5% to 95% duty cycle. This square output signal switches from 0 V to the DVDD voltage.

To provide an external PWM signal to the DRV8306 device, remove the J2 jumper and connect the external PWM signal to pin 1 (J2-1) of the J2 jumper and GND connection (see location next to POT in Figure 4). For more information on the PWM input required by the DRV8306, refer to the *DRV8306 38-V Brushless DC Motor Controller* data sheet.

2.5 Operation of the EVM

The following steps provide instructions for the operation of the EVM:

Step 1. Connect a 3-phase BLDC motor to the J6 terminal.

Step 2. Connect the Hall signals in either single-ended or differential configuration to the P1 terminal.

Step 3. Configure all jumpers and switches to supply the Hall signals in the correct manner to the DRV8306 device.

Step 4. Adjust the speed potentiometer, R18, to minimum voltage by turning it all the way counterclockwise. This adjustment minimizes the motor speed. Otherwise, connect the external PWM input to the JP6 PWM pin.

Step 5. Apply power to the VM (J5) terminal.

Step 6. Adjust the potentiometer clockwise or turn the external PWM source on to increase the speed of the motor and continue adjusting as desired.

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      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:

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(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.

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

Concernant les EVMs avec antennes détachables

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

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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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3.4.1 *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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4.1 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:*

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