# DRV10970 Evaluation Module

This document is provided with the DRV10970 customer evaluation module (EVM) as a supplement to the DRV10970 datasheet (SLVSCU7). It details the hardware implementation of the EVM and gives a step-by-step introduction to the device operation.

**Contents**



## 1 DRV10970 EVM Kit Contents

The DV10970 evaluation kit contains the DRV10970 EVM.

## 2 Introduction

The DRV10970 EVM is an evaluation platform for the DRV10970 three-phase brushless DC motor driver. The EVM includes a TLC555 timer configured to supply a PWM to the DRV10970 and potentiometer to adjust the speed of the motor by varying the duty cycle of the PWM.

This EVM has a wide power supply voltage range. Specific features of this EVM include adaptive driving angle adjustment, differential Hall-sensor inputs, braking mode, motor lock detection, and more. A number of protection features such as overcurrent, undervoltage, overtemperature, and locked rotor bolster system robustness. Most importantly, this EVM has Hall-sensor based commutation of the motor. The user has the ability to accept two modes of Hall input: differential or IC.

This document describes the kit details and explains the functions and locations of test points, jumpers, and connectors present on the kit. For detailed information about the DRV10970, refer to the DRV10970 data sheet (SLVSCU7).

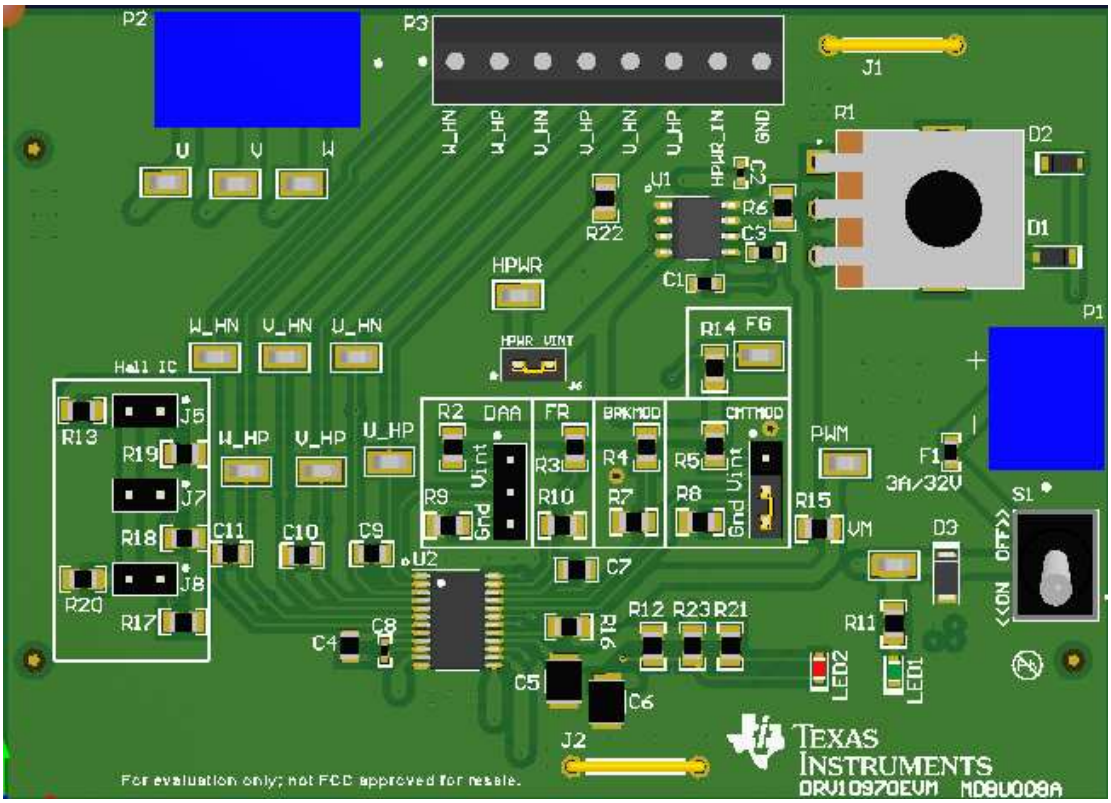



**Figure 1. DRV10970 EVM**

# 3 DRV10970 On-Board Connections

## 3.1 Power Input

DRV10970 requires an external power supply (5 V to 18 V) to operate. Connector P1 provides the required interface for external power supply. The pin assignment of terminal P1 is as follows:

**Table 1. DRV10970**

| Pin | Description |
|---|---|
| 1 | GND |
| 2 | VM |

## 3.2 Interface Connectors (P2 and P3) for Phases of Motor and Hall Inputs

Connectors P2 and P3 are used to interface the U, V, and W phases and Hall-sensor inputs. The pin assignments are as follows:

**Table 2. Connector P2: 3-Terminal Connector to Connect 3-Phase BLDC Motor**

| Pin | Description |
|---|---|
| 1 | Phase-W |
| 2 | Phase-V |
| 3 | Phase-U |

**Table 3. Connector P3: Hall-Sensor Inputs**

| Pin | Description |
|---|---|
| 1 | W negative |
| 2 | W positive |
| 3 | V negative |
| 4 | V positive |
| 5 | U negative |
| 6 | U positive |
| 7 | Hall Power (HPWR) |
| 8 | GND |

### 3.3 TLC555 Pins

Table 4 lists the TLB555 pin descriptions.

**Table 4. TLC555 Pins**

| Pin | Description |
|---|---|
| 1 | GND |
| 2 | TRIG |
| 3 | OUT |
| 4 | RESET |
| 5 | CONT |
| 6 | THRES |
| 7 | DISCH |
| 8 | VCC |

## 4 DRV10970 Package

The DRV10970 pin-out is listed in Table 5.

**Table 5. DRV10970 Pin-Out**

| Pin | Description |
|---|---|
| 1 | DAA |
| 2 | U_HP |
| 3 | U_HN |
| 4 | V_HP |
| 5 | V_HN |
| 6 | W_HP |
| 7 | W_HN |
| 8 | VCP |
| 9 | CPP |
| 10 | CPN |
| 11 | W |
| 12 | GND |
| 13 | V |
| 14 | U |
| 15 | VM |
| 16 | VINT |
| 17 | CS |
| 18 | RD |

**Table 5. DRV10970 Pin-Out (continued)**

| Pin | Description |
|---|---|
| 19 | PWM |
| 20 | CMTMOD |
| 21 | BRKM OD |
| 22 | RETRY |
| 23 | FR |
| 24 | FG |

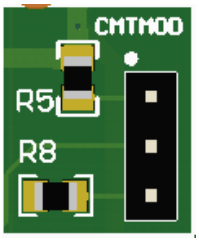
The DRV10970 is packaged in a 24-pin, TSSOP package. For detailed information about the DRV10970, refer to the DRV10970 data sheet (SLVSCU7).

# 5 User Interface

## 5.1 Jumpers

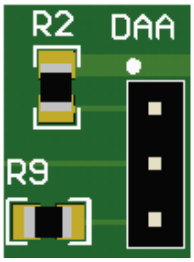
Descriptions for the jumpers are provided in the following list:

- **BRKMOD** is the brake mode setting. It is pulled high to VINT through R4. R7 (not populated) allows BRKMOD to be pulled to GND. When the motor is not driven, either in lock condition or when PWM equals zero, the state of the BRKMOD pin sets the spin down of the motor. The BRKMOD pin can be low (coasting during spin down) or high (braking during spin down). Because R7 is not populated, by default is it braking.
- **CMTMOD** is the commutation mode setting. This signal is connected to jumper J3. When pulled high, there is sinusoidal operation mode with 30° Hall placement. When low, there is sinusoidal operation mode with 0° Hall placement. When the jumper is floating, there is trapezoidal mode with 30° Hall placement.



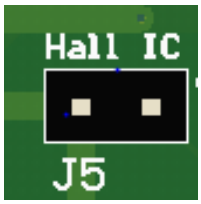

| J3 Connection | Description |
|---|---|
| 1–2 | CMTMOD connected to VINT – sinusoidal operation mode with 30° Hall placement |
| 2–3 | CMTMOD connected to GND – sinusoidal operation mode with 0° Hall placement |
| Unconnected (floating) | Trapezoidal mode with 30° Hall placement |

- **DAA** is the drive angle adjustment configuration pin. This signal is connected to jumper J4. When driven high, 5° drive angle adjustment takes place; whereas when driven low, 10° drive angle adjustment takes place. When floating, there is adaptive drive angle adjustment. The adaptive driving angle adjustment (ADAA) achieves the most optimized efficiency regardless of the motor load condition for motors with 0 (symbol of degree) Hall placement.




| J4 Connection | Description |
|---|---|
| 1–2 | DAA connected to VINT – 5° drive angle adjustment |
| 2–3 | DAA connected to GND – 10° drive angle adjustment |
| Unconnected (floating) | Adaptive driving angle adjustment. |

- **FR** is the motor direction control pin. It is pulled high to VINT through R3, which provides a motor operation direction of U-V-W. Each phase leads the previous phase by 120°.
- **FG** and **RD** are open-drain outputs that are externally pulled high to VINT. The **FG** pin indicates the speed of the motor; it toggles high and low every electrical cycle. The **RD** pin indicates the lock condition; it is pulled low when the motor is locked
- Headers **J5**, **J7**, and **J8** allow moving from Hall-differential mode to Hall-IC mode. By default, the DRV10970 EVM operates in Hall-differential mode (jumpers are not populated). Refer to section 9 of the datasheet for more information on Hall-IC connection.




| J5 Connection | Description |
|---|---|
| Connected | U_HN connected to VINT/2 |
| Unconnected | U_HN is floating |


| J7 Connection | Description |
|---|---|
| Connected | V_HN connected to VINT/2 |
| Unconnected | V_HN is floating |


| J8 Connection | Description |
|---|---|
| Connected | W_HN connected to VINT/2 |
| Unconnected | W_HN is floating |

- **J6** is a 2-pin header that connects V_HALL to VINT (5-V internal regulator voltage). If the jumper is not connected, connect an external supply for V_HALL to HPWR. Short pins of J6 using jumper header so that VINT can be used to power the Hall sensors as the default connection.


| J6 Connection | Description |
|---|---|
| Connected | V_HALL connected to VINT |
| Unconnected | V_HALL is floating |

- **J1** and **J2** are shorting bridges allowing a connection to ground.

## 5.2 LEDs, Switch, Retry

**LED1 (Green)** turns ON when VM is supplied to the board. **LED2 (Red)** turns ON when the motor is locked.

The **S1** switch allows the applied power supply voltage to reach the rest of the board. A fuse is used to protect the device from overcurrent. Turn the Switch to the “On” position to power the EVM.

**C7** is the capacitor for retry timing and isadjustable in the event of a motor lock. Changing C7 alters retry timing. The capacitor value used in the EVM is 0.1 µF, which corresponds to a retry time of 1.5 seconds.

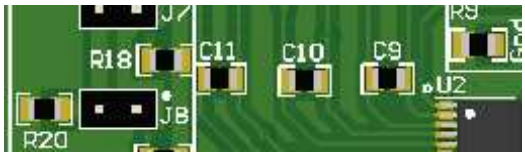
## 5.3 Hall ICs

Populate **R17**, **R18**, and **R19** with a user-selected pull-up resistor for the Hall-sensor IC with open-drain output.

**R22 (currently 0 Ω)** is a current-limiting resistor for Hall-element sensors and is configurable to the application.

## 5.4 Capacitors for Differential Hall Signals

There are options for populating capacitors across differential Hall signals to filter out noise on the Hall-element output. Noise on the Hall signal degrades the performance of the device. Noise can be minimized by using noise-filtering capacitors (C11, C10, and C9) across the x_HP and x_HN pins as shown in the following image. The value of the capacitor can be chosen such that RC time constant is in the range of 0.1–2 µs. For example, to achieve a time constant of 1-µs for application with a Hall sensor with an internal impedance between the Hall output to ground of 1 kΩ; capacitor with a value of 1 µF can be populated.




## 5.5 PWM Configuration With the TLC555 Timer

The PWM signal is generated by circuitry based on TI's TLC555 low-power timer. PWM is generated based on input from the potentiometer. In order to provide an external PWM signal to the motor driver, remove the 0-Ω resistor (R15) and connect the external PWM signal to the PWM test point. By default, **R15** is populated on the board. The PWM signal generated by the circuitry on the EVM is approximately 25 kHz and is adjustable from 5% to 95% duty cycle using the potentiometer (**R1**).

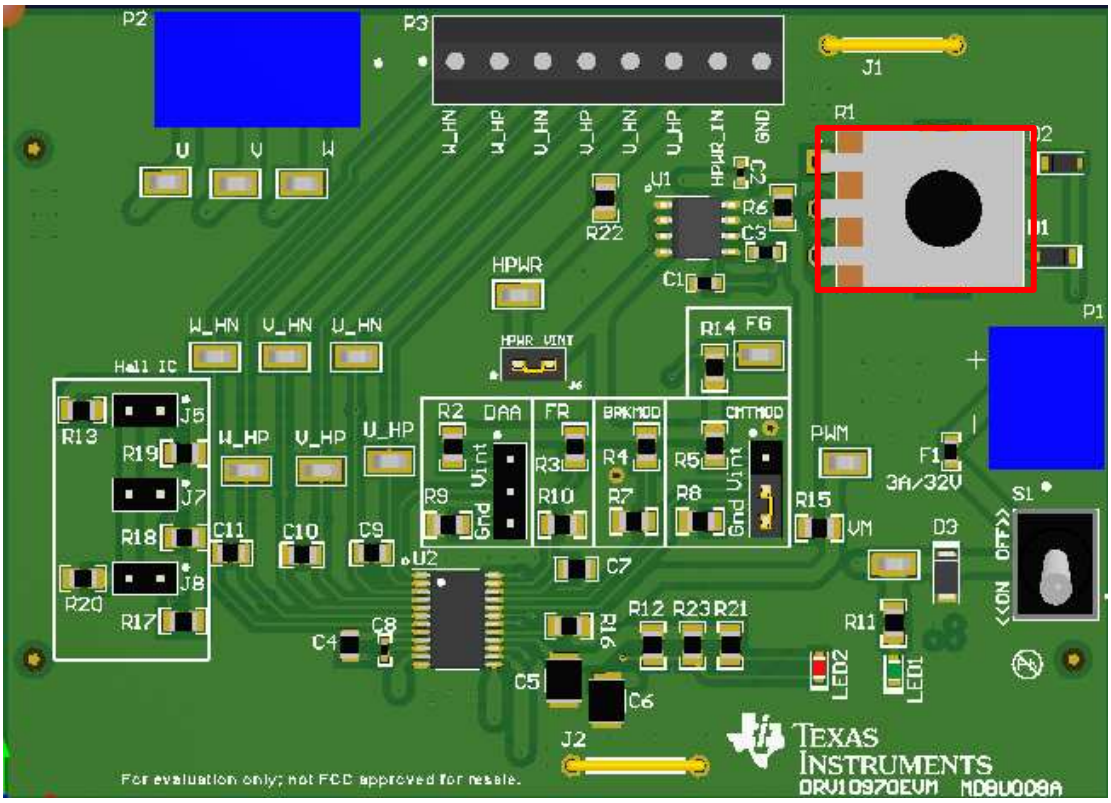



**Figure 2. Potentiometer on DRV10970 EVM**

The potentiometer adjusts the duty cycle of the PWM signal, which in turn adjusts the speed of the motor. A lower duty cycle gives a lower speed and a higher duty cycle provides a higher speed. Turning the potentiometer clockwise lowers the speed, and turning it counterclockwise increases the speed.

The DRV10970 enters sleep mode when PWM equals zero for Tsleep. In sleep mode, VINT shuts down. PWM can be pulled to 0% by removing R15 (0-Ω resistor) and shorting PWM to ground using the test point.

For more information on the PWM input required by the DRV10970, refer to the datasheet (SLVSCU7).

### 5.6 Test Points

Test points are provided and labeled according to the inputs and outputs of the DRV10970 motor driver (see Table 6).

**Table 6. Test Point Descriptions**

| Test Points | Description | Test Points | Description |
|---|---|---|---|
| TP 1 | VM – Supply Voltage | TP 8 | W_HN |
| TP 2 | FG | TP 9 | W_HP |
| TP 3 | PWM input | TP 10 | V_HN |
| TP 4 | Motor U phase | TP 11 | V_HP |
| TP 5 | V_HALL | TP 12 | U_HN |
| TP 6 | Motor V phase | TP 13 | U_HP |
| TP 7 | Motor W phase | | |

**CAUTION**

Do not apply power to the board before you have read through Section 6!

## 6 Powering-Up the EVM

The DRV10970 EVM requires a VM power supply source, which has a recommended operating range from 5 to 18 V. Use the following sequence to power-up the EVM:

1. Connect the power supply Ground to pin 1 (GND) and a voltage between 5 to 18 V to pin 2 of connector P1 (VM). Set the current limit on the power supply to 1.5 A and make sure switch S1 is in the OFF position
2. **Jumper position for DAA and CMTMODE:** The default jumper position for DAA is **position 2–3 (10° mode)** and **CMTMODE is position 1–2 (sine-30° mode)**. Based on the relation between Hall signals and BEMF, the setting for jumpers must be configured
   **Sine 30 mode:** In this mode, when the motor is spinning in a clockwise direction, zero crossing for Hall signals is trailing BEMF zero crossing by 30°. If Hall-element output is as shown in Figure 3, then the default setting for jumpers is recommended. If trapezoidal mode is desired, then set the CMTMODE jumper to floating.

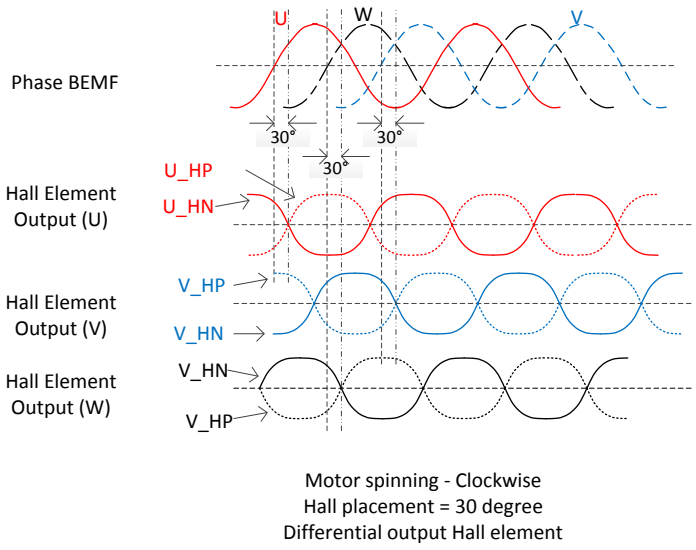



**Figure 3. Hall-Element Output With Respect to BEMF Zero Crossing for Default Jumper Setting (30°)**

**Sine 0 mode:** In this mode, when the motor is spinning in a clockwise direction, zero crossing for Hall signals is exactly at the same time as BEMF zero crossing. If Hall-element output is as shown in Figure 4, then change CMTMODE jumper to position 1–2 (0° mode). If the Hall placement is precisely at 0°, with respect to BEMF zero crossing and BEMF is sinusoidal, then ADAA mode is recommended. ADAA mode can be configured by configuring the DAA jumper setting to floating.

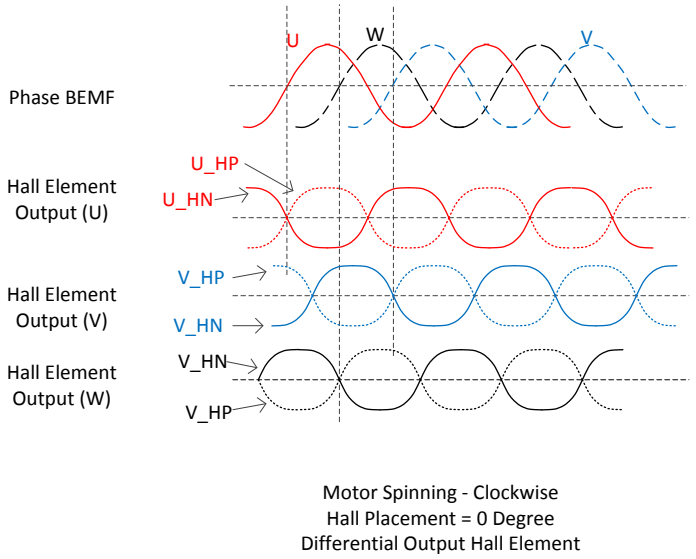



**Figure 4. Hall-Element Output With Respect to BEMF Zero Crossing for Sine 0° Mode**

3. Turn the POT-R1 fully CCW (counterclockwise). This keeps the speed PWM input to the minimum value.
4. Connect the 3-phase terminal of the motor to connector P2 and Hall input to P3 on the EVM. Refer to Section 3.2 *Interface Connectors (P2 and P3) for Phases of Motor and Hall Inputs* for details about pin connection for P2 and P3. Refer to the datasheet for details on how to identify U-V-W phase for particular motor and corresponding Hall input.
5. Power up the board and turn the switch S1 to the “On” position. LED1 should turn green. LED2 should only turn on when the motor is locked.
6. Rotate the potentiometer to different positions to change the speed of motor

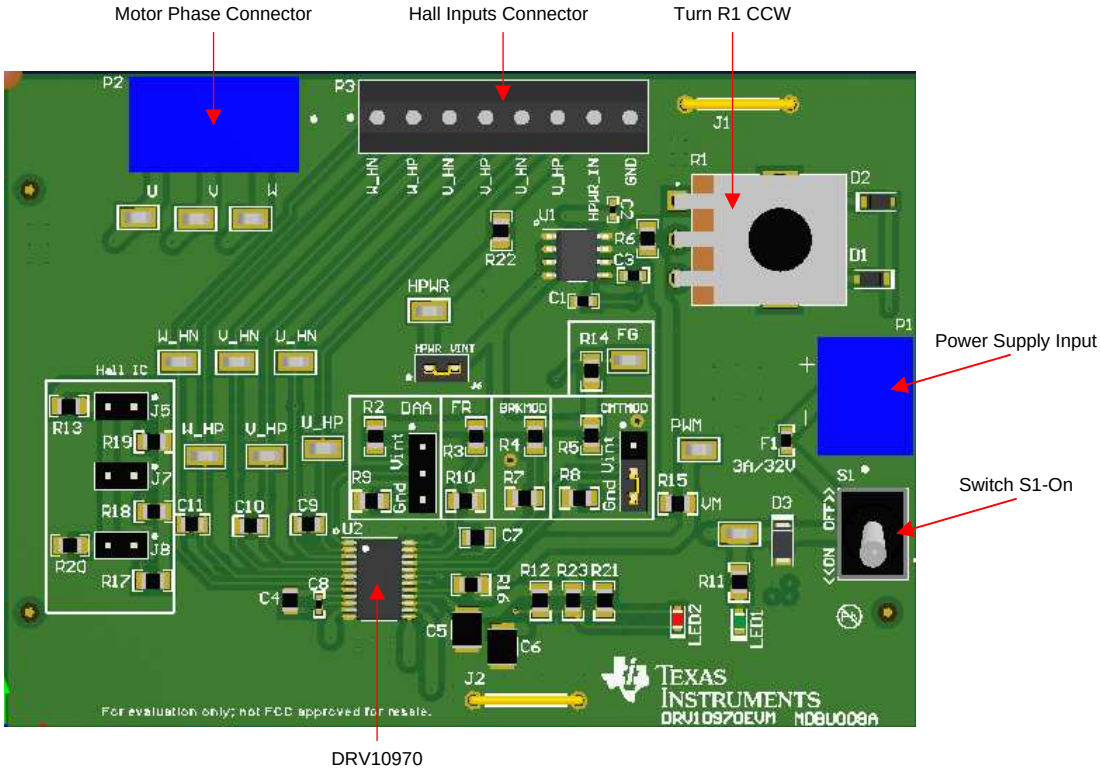



**Figure 5. DRV10970 EVM With Various Connections and User Interface**

## 7 Single Hall Mode

The DRV10970EVM can be configured to single Hall mode simply by disconnecting V_HP,V_HN, W_HP and W_HN signals. DRV10970 automatically switches to single Hall mode when it senses that there is no connection on the V_HP, V_HN, W_HP, and W_HN pins.

## 8 Configuration for Motors With HALL IC

Configure the DRV10970 EVM for use with HALL ICs by populating jumpers for J5, J7, and J8 and resistors R19, R18, and R17 with appropriate values for HALL ICs with open drain as shown in Figure 6.

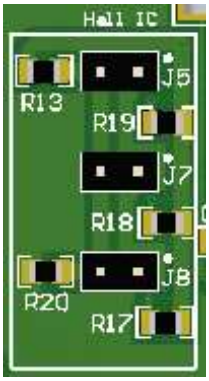



**Figure 6. Configuration for Motor With HALL IC**

## 8.1 DAA and CMTMODE Jumper Position for Motor With HALL IC

The default jumper setting for DAA is position 2–3 (10° mode) and for CMTMODE is position 1–2 (sine 30° mode). Based on the relation between Hall signals and BEMF, the jumper settings must be configured.

**Sine 30 mode:** In this mode, when the motor is spinning in a clockwise direction, zero crossing for Hall signals is trailing BEMF zero crossing by 30°. If output for Hall ICs is as shown in Figure 7, then the default setting for jumpers is recommended. If trapezoidal mode is desired, then set the CMTMODE jumper setting as floating.

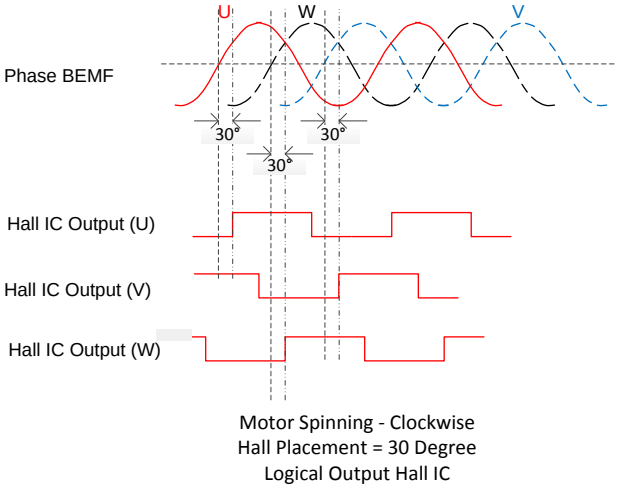



**Figure 7. Hall-IC Output With Respect to BEMF Zero Crossing for Default Jumper Setting (30°)**

**Sine 0 mode:** In this mode, when the motor is spinning in a clockwise direction, zero crossing for Hall signals is exactly at same time as BEMF zero crossing. If the output of Hall IC is as shown in Figure 8, then change the CMTMODE jumper to position 1–2 (0° mode). If the Hall placement is precisely at 0° with respect to BEMF zero crossing and BEMF is sinusoidal, then ADAA mode is recommended. ADAA mode can be configured by configuring the ADAA jumper setting to floating.

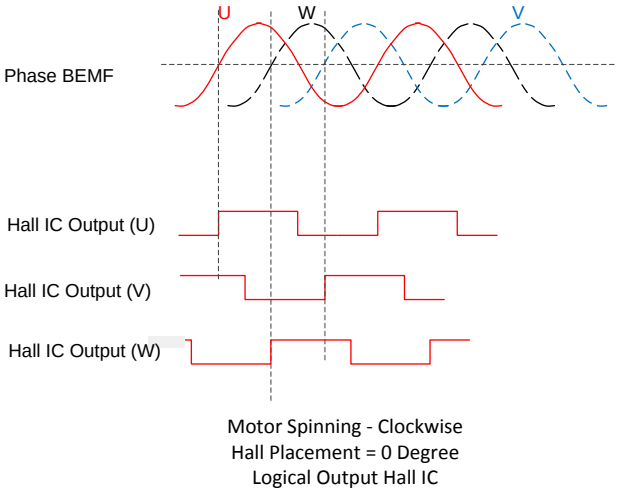



**Figure 8. Hall IC Output With Respect to BEMF Zero Crossing for Sine 0° Mode**

# 9 Changes in EVM for Inverted Hall Signals

**Inverted 30° Sine mode:** In this mode, when motor is spinning in clockwise direction, zero crossing for hall signals is inverted and lagging 30° with respect to BEMF zero crossing. If output of hall IC is as shown in Figure 9, then default jumper settings is recommended. If 30° trapezoidal mode is desired, then CMTMODE jumper setting should be floating and DAA setting can be 2-3 (10° mode).

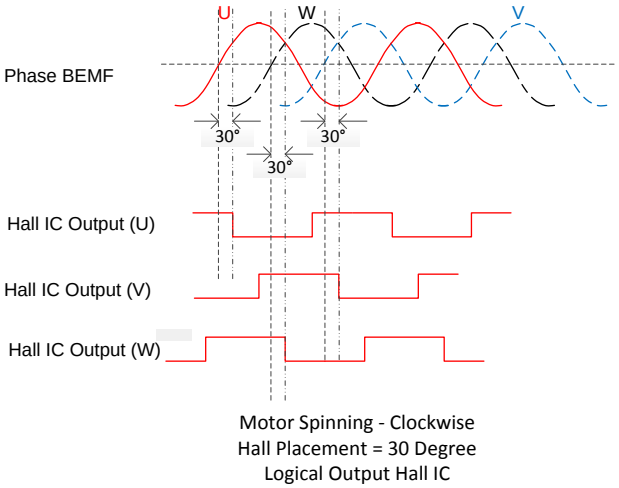



**Figure 9. Hall IC Output With Respect to BEMF Zero Crossing for Inverted Sine 30° Mode**

Since Hall signals are inverted, configure the DRV10970 as shown in Figure 10. Inputs from the Hall IC is connected to internal comparator, so Hall input and reference VINT/2 signals connection to DRV10970 needs to be switched. So now output of Hall IC needs to be connected to x_HN and reference needs to be connected to x_HP (x represents phases U, V and W).

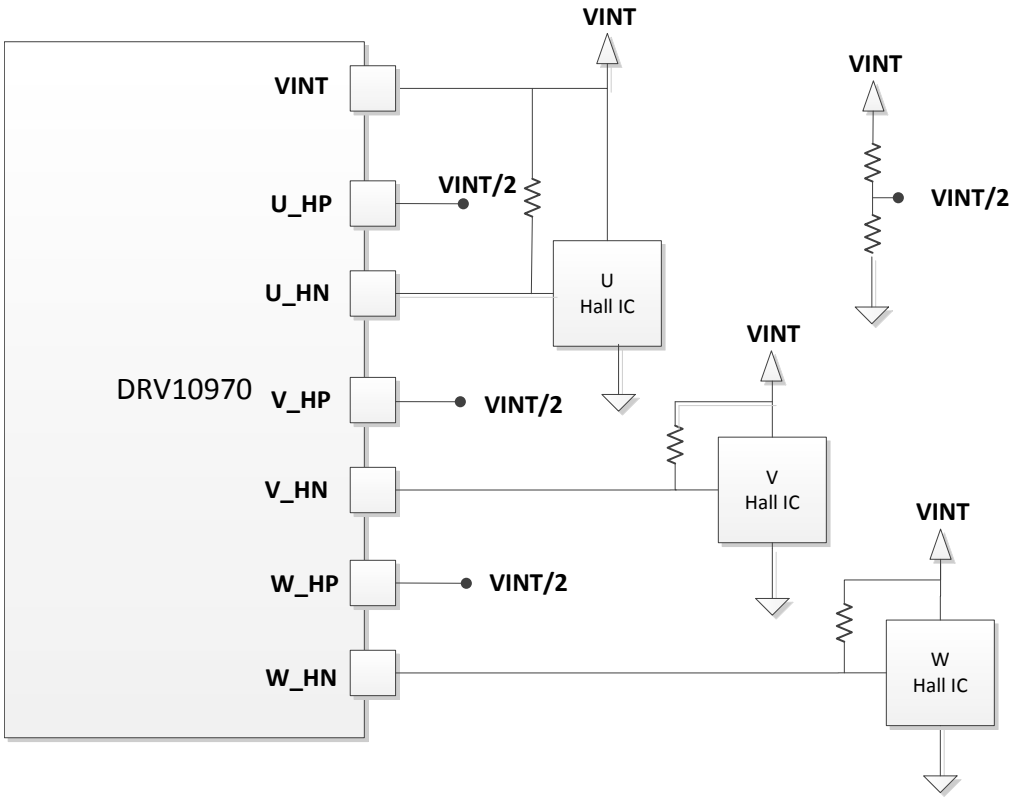



**Figure 10. Connection Between DRV10970 and Hall Signals for Sine 30° Mode**

Make the following modifications on the DRV10970EVM to configure the DRV10970 for inverted 30° sine mode.

- Ensure R17, R18, and R19 are not populated
- Remove R20
- Replace R13 with 0-Ω resistor
- Add three external pulls resistors for hall input across three jumpers J5, J7, and J8
- Connect the external VINT/2 voltage (approximately 2.5 Vdc ) to U_HP, V_HP, and W_HP

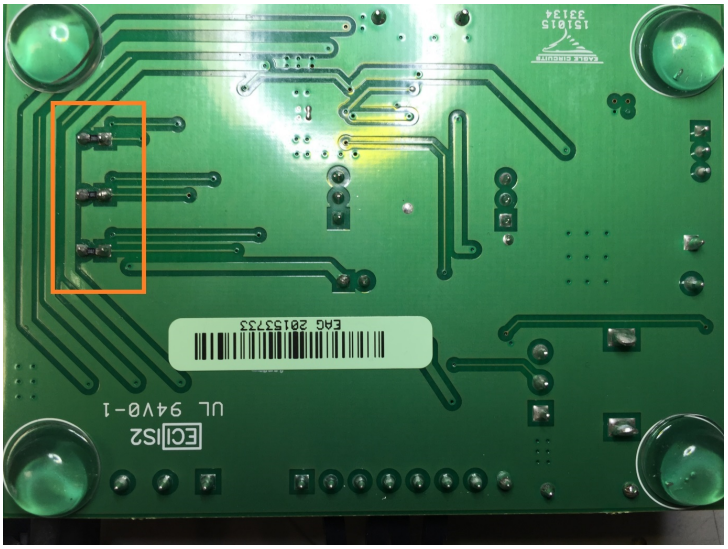


**Figure 11. External Resistors Added to EVM for Inverter Sine 30 (Symbol of Degree) Mode**

## 10 EVM Documentation

The EVM schematics, layout, and bill of materials (BOM) are provided in the hardware file (SLVXXX)

# STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

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   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

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

      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*

**Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-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.

**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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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

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