DRV8307 User's Guide

This document is provided with the DRV8307 customer evaluation module (EVM) as a supplement to the DRV8307 datasheet (SLVSCK2). It details the hardware implementation of the EVM.

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1 Printed-Circuit Board (PCB) (Top 3D View)

Figure 1 illustrates the top view of the DRV8307 EVM PCB.

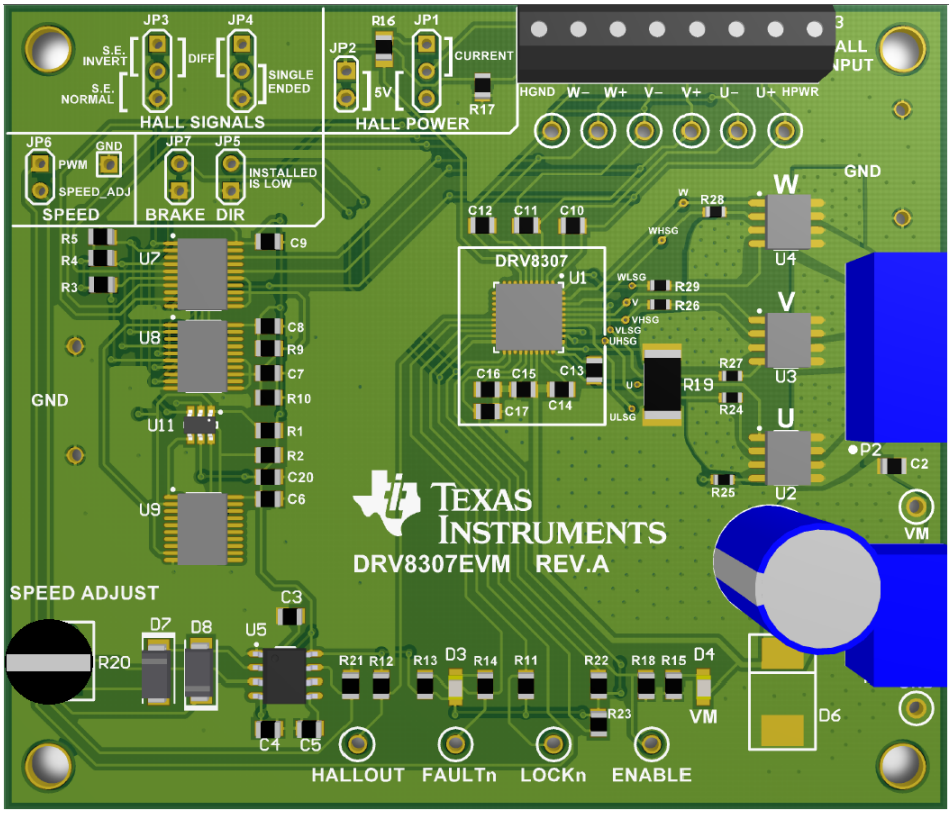


Figure 1. DRV8307EVM Top View

2 Introduction

The DRV8307EVM is a solution for evaluating the DRV8307, a brushless DC motor controller. It includes a TLC555 timer configuration to supply PWM to the DRV8307, 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 sensors. The EVM includes surface-mounted test pins for all important signals on the board. The DRV8307EVM is configured so that only connections to the motor, hall sensors and power supply are required.

2.1 Power Connectors

The DRV8307EVM uses a single power supply rail which must be connected to terminal P1. Minimum recommended VM of the EVM is 8.5 V and maximum is 32 V, with a current of at least 2A. A higher current setting is recommended to maintain a stable VM voltage. Please refer to the DRV8307 datasheet (SLVSCK2) for complete voltage range information. When power is supplied to the board, a green LED (D4) in the lower left corner should light up.

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2.2 Test Points

Test points are provided and labeled according to the inputs and outputs of the DRV8307 device. The signals brought out to test points are labeled HALLOUT, FAULTn, LOCKn, ENABLE, HU+/-, HV+/- HW+/- and GND (Figure 2).

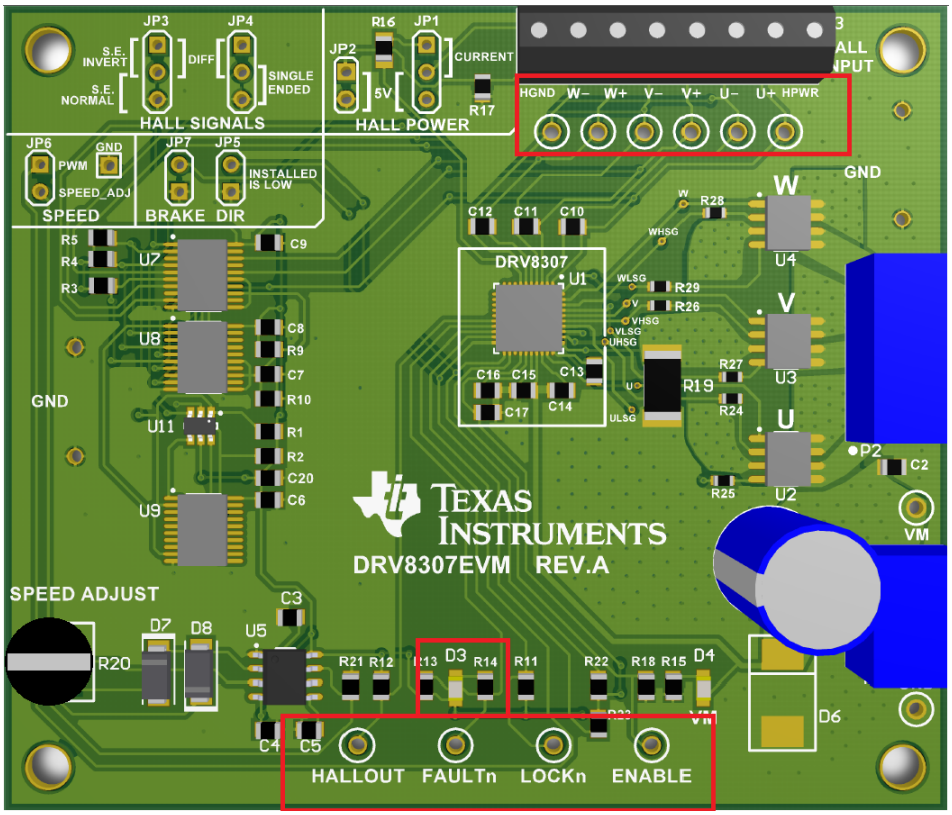


Figure 2. DRV8307EVM Test Points and FAULTn LED

The HALLOUT signal represents the motor speed and phase information.

$$RPM = (HALLOUT \times 60) / pole\ pairs \quad (1)$$

The FAULTn and LOCKn signals represent DRV8307 outputs and indicate a fault or lock condition of the driver or motor. If there is a fault condition present, a red LED (D3) lights up. LOCKn indicates whether the speed loop is locked.

The HU+/-, HV+/- HW+/- represent the corresponding hall signals. The ENABLE pin represents whether the DRV8307 is active or off.

The ENABLE signal is active low. The DRV8307 can be disabled by applying a high voltage to this pin.

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2.3 Jumpers

Seven jumpers (JP1–JP7) are installed by default on the EVM.

Table 1. Jumper Descriptions

Jumper	Description
JP1	**HALL POWER**: Hall sensor power is “5V” or “current”
JP2	
JP3	**HALL SIGNALS**: Hall Signals are “Differential” or “Single Ended”
JP4	
JP5	**DIRECTION**: Motor direction is “forward” or “reverse”
JP7	**BRAKE**: Motor brake “ON” or “OFF”
JP6	**SPEED**: Speed input is from supplied “external” or “potentiometer”

The default jumper settings are JP1 2-3, JP2, JP3 1-2, JP4 2-3 and JP5, JP6, JP7 all installed. This supports "inverse" single-ended hall sensors supplied with 5 V. Speed is supplied from the potentiometer and the motor spins in a forward direction and is not braked.

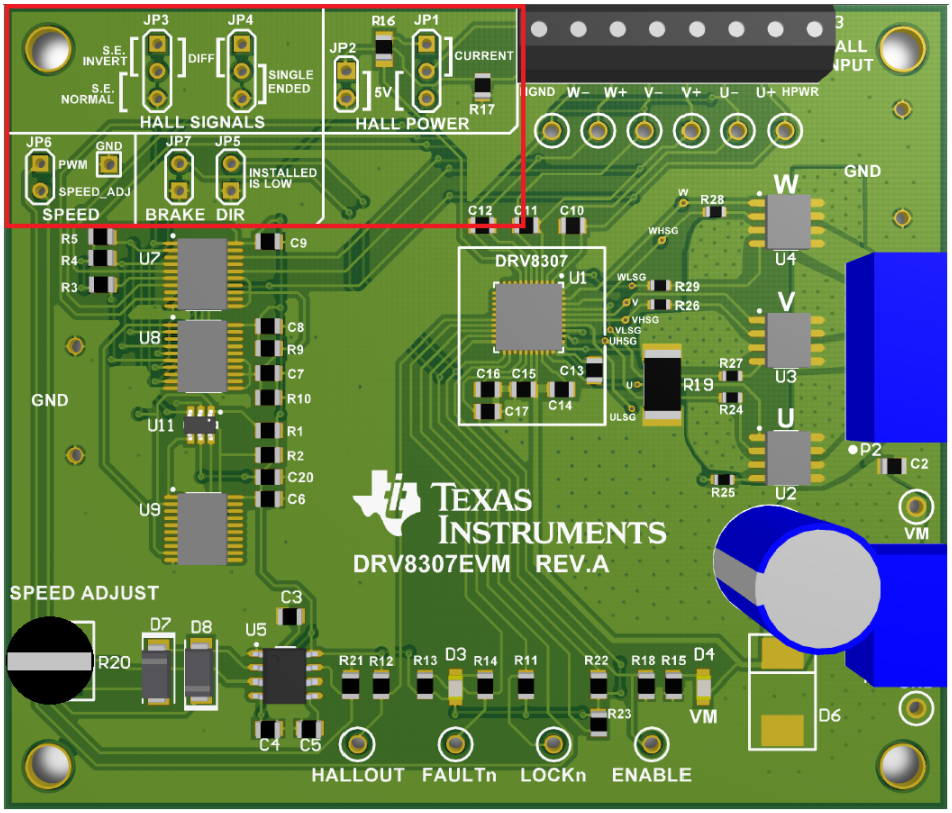


Figure 3. DRV8308EVM Jumpers

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2.3.1 HALL POWER Configuration (JP1/JP2) Jumpers

Sensored BLDC motors typically use either Hall ICs or Hall elements. Most ICs can use 5-V power, while elements typically have power pins that have an equivalent circuit of a resistor, and current must be limited to about 10 mA. In order to support both Hall sensor types the hall power needs to be configured on the DRV8307EVM.

When installing JP1 2-3 and JP2, a 5-V power is supplied to terminal P3 to power the ICs. The used (VREG) voltage is only present when DRV8307 is enabled and regulated from VM (Figure 4).

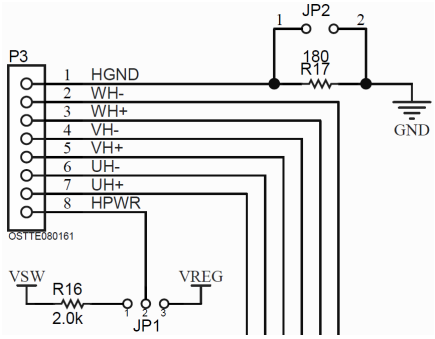


Figure 4. Hall PWR/GND Circuits

By installing JP1 1-2 and uninstalling JP2, the circuit illustrated in Figure 5 is available for the Hall elements. The used (VSW) voltage is only present when DRV8307 is enabled. VSW equals VM.

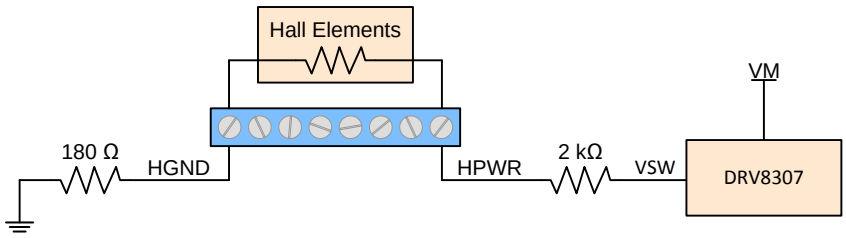


Figure 5. Circuit when Setting Hall Power to "Current"

The current can be calculated as follows: If VM is 24 V, and 3 Hall elements having a resistance of 400 Ω are connected in parallel, 10.4 mA is supplied. Always refer to your 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, since the DRV8307 requires VICM between 1.5 V to 3.5 V.

If you are unsure of your motor's Hall type, measure the resistance between the Hall power and ground wires. If it is < 250 Ω, they are likely Hall elements. Hall sensors are easily damaged if incorrect power is applied.

2.3.2 HALL SIGNAL Configuration (JP3/JP4) Jumpers

Hall sensors output either a differential signal pair, or a single-ended signal. You can tell which type your motor uses simply by counting the number of wires; a sensored BLDC typically has 3 phase wires, 2 Hall power wires, and 3 or 6 Hall signal wires, so 8 total means single-ended, and 11 total means differential.

The DRV8307 has differential comparators on the Hall inputs, and they 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 DRV8307 pins.

When using single-ended Halls, they require pull-ups. The DRV8307 comparator "-" pins should be biased with a middle voltage, so that a single-ended swing on the "+" pin is detected like a differential voltage. Connect single-ended hall wires to the "+" pins at P3 for normal Hall sensor types or to "-" pins for inverse Hall sensors.

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In order to support both single ended and differential hall signals on the DRV8307EVM, the circuit in Figure 6 is implemented:

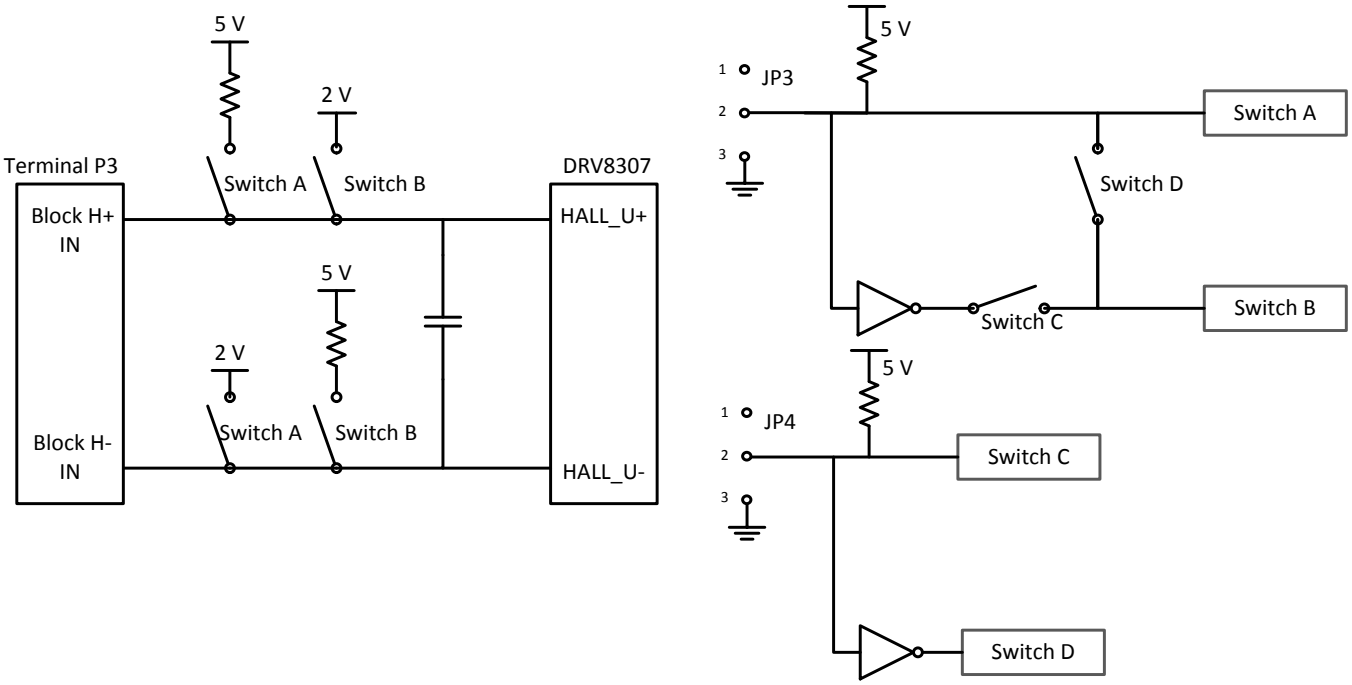


Figure 6. Switching Logic to Support Single-Ended and Differential-Hall Signals

Table 2 shows the configuration possibilities supporting a variety of hall sensors.

Table 2. Hall Sensors

Configuration	JP3	JP4	Comment	Terminal Installation
Differential Hall (Normal)	1-2	1-2	Switches A+B open	Hall wires in normal order
Differential Hall (Inverse)	1-2	1-2	Switches A+B open	Swap external Hall wires
Single Ended (Normal)	2-3	2-3	Switch A closed, B open	Hall wires to "+" pins
Single Ended (Inverse)	1-2	2-3	Switch A open, B close	Swap external Hall wires and connect to "-" pins
RESERVED	2-3	1-2	NOT ALLOWED	

2.3.3 DIR Direction (JP5) Jumper

Installing the jumper JP5 connects the DIR pin on the DRV8307 to GND. When the DIR pin is tied to GND, the DRV8307 connected motor is set to spin in the forward direction. When removed, the pin is pulled high and the motor spins in the reverse direction.

2.3.4 BRAKE (JP7) Jumper

Installing the jumper JP7 connects the BRAKE pin on the DRV8307 to GND. When the BRAKE pin is tied to GND, the DRV8307 connected motor is spinning normal without any brake action. When removed, the pin is pulled high and the motor will be braked by the DRV8307 brake functionality.

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2.4 SPEED ADJUSTMENT (JP6) Jumper and (R20) Potentiometer

The DRV8307 has a dedicated speed input pin (PWM) that supplies a duty cycle to the DRV8307 to control motor speed.

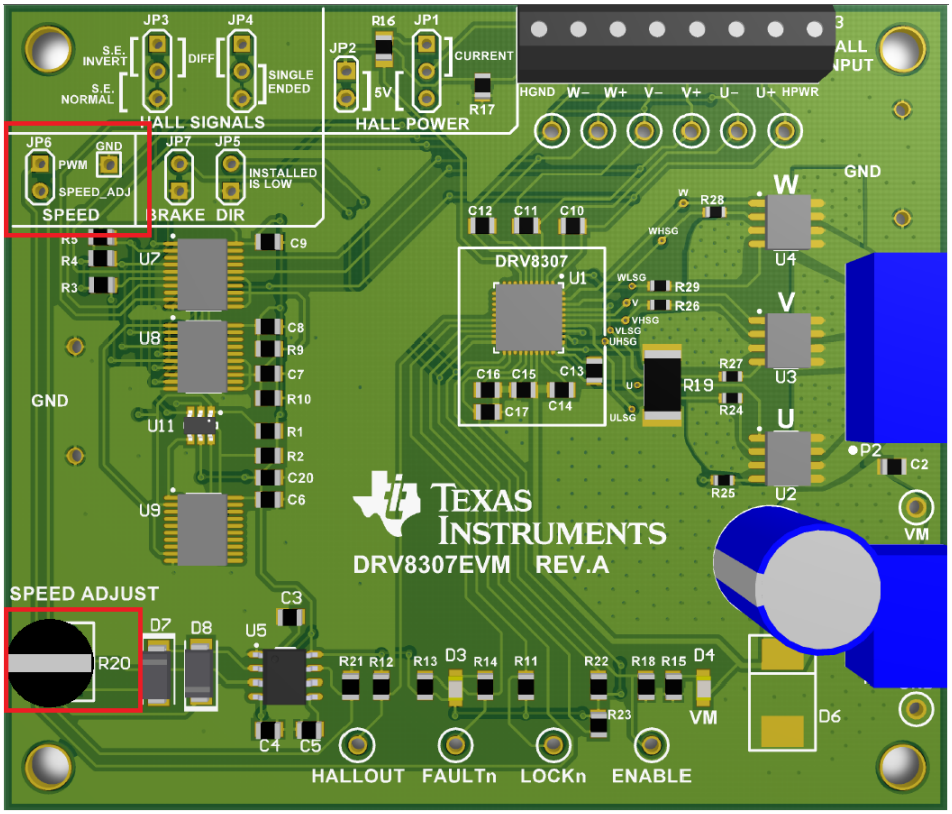


Figure 7. SPEED Adjustment Configuration

The DRV8307EVM offers two possibilities to supply this PWM input, controlled by jumper JP6.

Installing JP6 uses the speed adjust potentiometer SPEED ADJUST (R20) as shown in Figure 7 as PWM speed input. The potentiometer adjusts the duty cycle of the PWM signal which, in turn, adjusts the speed of the motor. The lower the duty cycle, therefore, the lower the speed, by turning the potentiometer counter-clockwise. In order to increase the duty cycle, thus increase the speed, turn the potentiometer clockwise.

The onboard PWM signal for the DRV8307 is generated by a circuit based upon TI's TLC555 Low-Power Timer. It is capable of approximately a 25-kHz output that can be adjusted from 5% to 95% duty cycle. This square output signal will switch from 0 V to VREG.

In order to provide an external PWM signal to the DRV8307, remove JP6 and connect the external PWM signal to JP6 pin 1 and the GND pin next to it. For more information on the PWM input required by the DRV8307, please refer to the DRV8307 datasheet (SLVSCK2).

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2.5 Operation of the EVM

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

1. Connect a three-phase BLDC motor to terminal P2.
2. Connect the hall signals, either single ended or differential, to terminal P3.
3. Configure JP1-JP4 in order to supply the hall signals in the right manner to the DRV8307.
4. Adjust the Speed potentiometer, R20, to minimum voltage by turning it all the way counterclockwise. This minimizes the motor speed. Otherwise, connect your external PWM input to the JP6 PWM pin.
5. Check JP5 and JP7 to be installed.
6. Apply power to VM terminal P1.
7. Adjust the potentiometer clockwise or turn your external PWM source ON to increase the speed of the motor, continue adjusting as desired.
8. To change direction, uninstall JP5.
9. To start braking, uninstall JP7.

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3 Schematic and Bill of Materials

Figure 8 illustrates the DRV8307EVM schematic and Table 3 is the DRV8307EVM BOM.

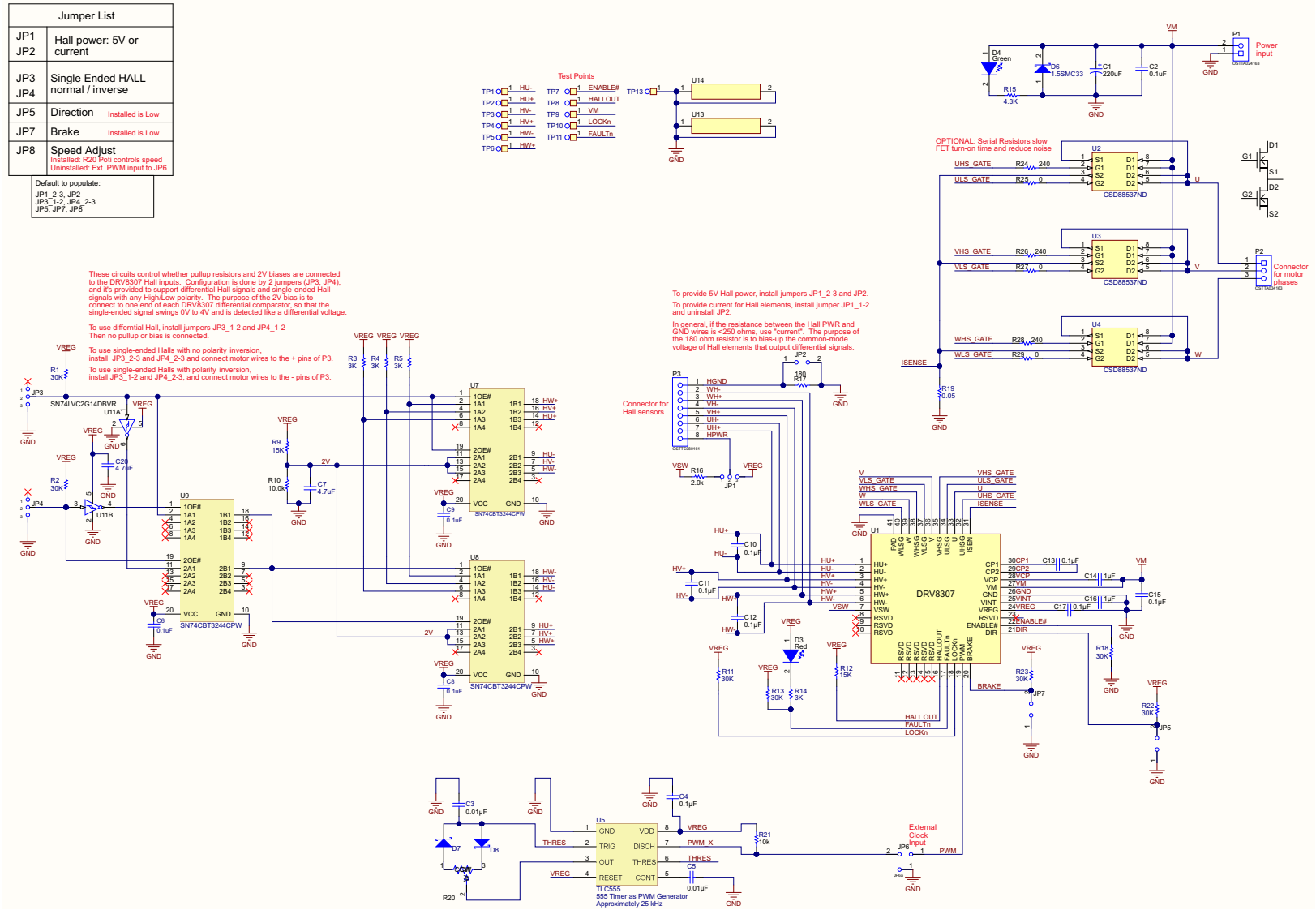


Figure 8. DRV8307EVM Schematic

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Table 3. DRV8307EVM Bill of Materials

Designator	Description	Value	DigiKey Part#	Manufacturer	Qty
C1	220uF	220uF	493-1356-ND	Nichicon	1
C4, C6, C8, C9, C10, C11,C12, C13, C17	CAP CER 0.1UF 50V 10% X7R 0805	0.1uF	399-1170-2-ND	Kemet	9
C3, C5	CAP, CERM, 0.01uF, 10V, +/-10%, X5R, 0805	0.01uF	399-1158-2-ND	Kemet	2
C14, C16	CAP CER 1UF 50V 10% X7R 0805	1uF	399-7409-2-ND	Kemet	2
C7, C20	CAP CER 4.7UF 25V 10% X5R 0805	4.7uF	399-5505-2-ND	Kemet	2
C2, C15	CAP CER 0.1UF 100V 10% X7R 0805	0.1uF	399-3486-2-ND	Kemet	2
D3	LED, Red, SMD	Red	160-1415-1-ND	Lite-On	1
D4	LED, Green, SMD	Green	160-1423-1-ND	Lite-On	1
D6	Zener diode	TVS ZENER UNIDIR 1500W 33V SMC	1.5SMC33AT3GOSCT-ND	On Semiconductor	1
D7, D8	Diode, Schottky, 10V, 2A, SMA	10V	MBRA210LT3GOSCT-ND	ON Semiconductor	2
JP1, JP3, JP4	Three Pin Header	CONN HEADR BRKWAY .100 3POS STR	5-146280-3-ND	TE Connectivity	3
JP2, JP6, JP7, JP5	Two Pin Header	CONN HEADER 2POS STR .100" GOLD	3M11970-ND	3M	4
JP6a	1x1 header	CONN HEADR BRKWAY .100 1POS STR	A107006-ND	TE Connectivity	1
P1	Terminal block	TERM BLOCK 5.08MM VERT 2POS PCB	ED2580-ND	On-Shore Tech.	1
P2	Terminal block	TERM BLOCK 5.08MM VERT 3POS PCB	ED2581-ND	'On-Shore Tech.	1
P3	Terminal block	TERM BLOCK 3.5MM VERT 8POS PCB	ED2641-ND	'On-Shore Tech.	1
R1, R2, R11, R13, R18, R22,R23	RES 30K OHM 1/8W 5% 0805 SMD	30K	311-30KARTR-ND	Yageo	7
R3, R4, R5, R14	RES 3.0K OHM 1/8W 5% 0805 SMD	3K	311-3.0KARTR-ND	Yageo	4
R12, R9	RES 15K OHM 1/8W 5% 0805 SMD	15K	311-15KARCT-ND	Yageo	2
R10, R21	RES 10K OHM 1/8W 5% 0805 SMD	10K	311-10KARTR-ND	Yageo	2
R15	RES 4.3K OHM 1/4W 5% 0805 SMD	4.3K	P4.3KADCT-ND	Panasonic	1
R16	RES 2K OHM 1/8W 1% 0805 SMD	2K	P2.00KCCT-ND	Panasonic	1
R17	RES 180 OHM 1/8W 1% 0805 SMD	180	311-180CRCT-ND	Yageo	1
R19	RES 0.05 OHM 2W 1% 2512	0.05	CSRN2512FK50L0CT-ND	Stackpole El.	1
R20	POT 5.0K OHM THUMBWHEEL CERM ST	5K	3352T-502LF-ND	Bourns	1
R24, R26, R28	RES 240 OHM 1/10W 5% 0603 SMD	240	311-240GRTR-ND	Yageo	3
R25, R27, R29	RES 0.0 OHM 1/10W JUMP 0603 SMD	0	311-0.0GRTR-ND	Yageo	3
TP1, TP2, TP3, TP4, TP5,TP6, TP7, TP8, TP9, TP10, TP11	Test point	TEST POINT PC MINI .040"D ORANGE	5003K-ND	Keystone El.	11
TP13	Test point	TEST POINT PC MINI .040"D BLACK	5001K-ND	Keystone El.	1
U7, U8, U9	FET switch	IC SWITCH BUS OCTAL FET 20-TSSOP	296-19197-1-ND	Texas Instruments	3
U13, U14	1MM UNINSULATED SHORTING PLUG		952-1873-ND	HARWIN	2
U2, U3, U4	Power FET	Dual 60-V N-Channel Power MOSFETs	296-37303-2-ND	Texas Instruments	3
U5	IC OSC MONO TIMING 2.1MHZ 8-SOIC	555 Timer	296-10341-1-ND	Texas Instruments	1
U11	DUAL SCHMITT-TRIGGER INVERTER		296-13010-2-ND	Texas Instruments	1
N/A	Jumper	SHUNT JUMPER .1" BLACK GOLD	3M9580-ND	3M	7
N/A	Screw	MACHINE SCREW PAN SLOTTED M3	29311K-ND	Keystone El.	4
N/A	Standoff	HEX STANDOFF M3 ALUMINUM 10MM	24433K-ND	Keystone El.	4
U1	Motor controller	BRUSHLESS DC MOTOR PREDRIVER	supplied from TI	Texas Instruments	1

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      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

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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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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.

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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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