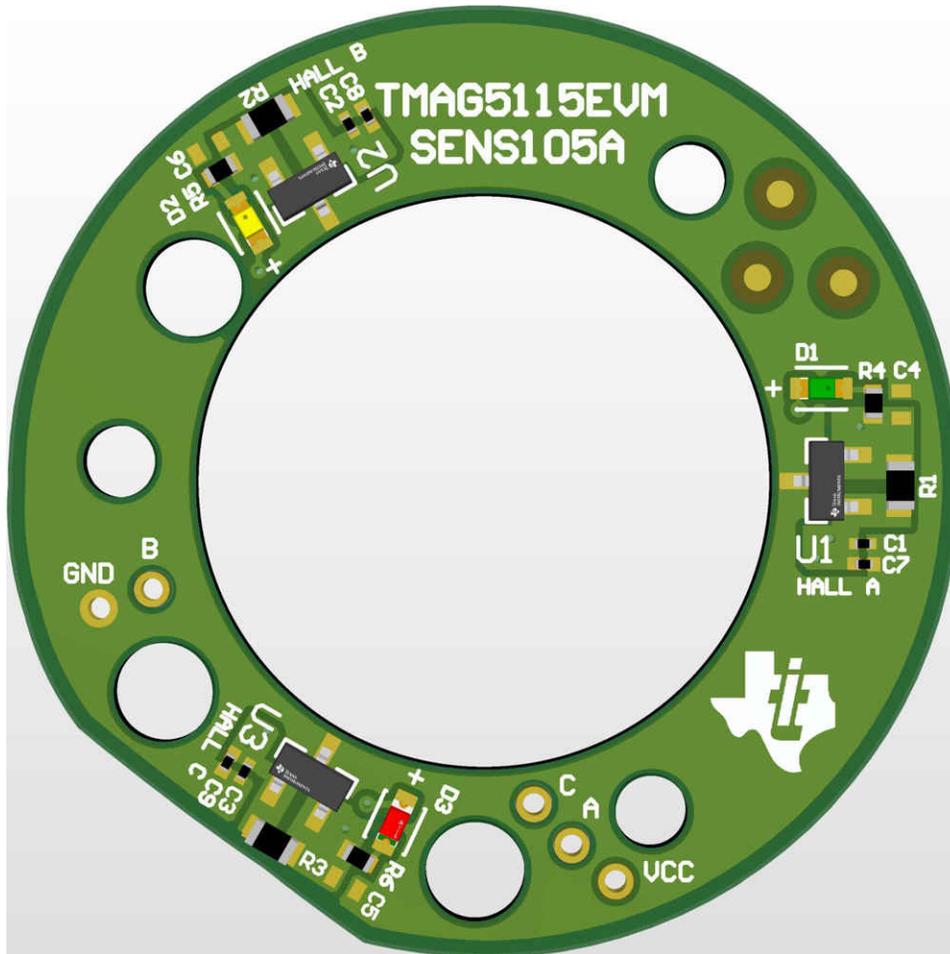


## ABSTRACT

This user's guide describes the characteristics, operation, and use of the TMAG5115 high performance Hall-effect latch evaluation module (EVM). This EVM is designed to evaluate the performance of the TMAG5115. This document includes a schematic, printed circuit board (PCB) layouts, and a complete bill of materials (BOM).



## Table of Contents

<b>1 Overview</b> .....	<b>2</b>
1.1 TMAG5115EVM Kit Contents.....	2
1.2 Related Documentation from Texas Instruments.....	2
<b>2 TMAG5115EVM Hardware</b> .....	<b>3</b>
<b>3 EVM Operation</b> .....	<b>3</b>
3.1 Quick Start Setup.....	3
3.2 BLDC Motor Operation.....	4
<b>4 BLDC Motor Manufacturers</b> .....	<b>13</b>
<b>5 TMAG5115EVM Circuitry</b> .....	<b>13</b>
<b>6 TMAG5115EVM Schematic and PCB Layout</b> .....	<b>14</b>

6.1 Schematic.....	14
6.2 PCB Layout.....	15
6.3 Bill of Materials.....	16

## Trademarks

All trademarks are the property of their respective owners.

## 1 Overview

The TMAG5115 is a family of high-performance, wide input voltage, low-output delay and low-jitter Hall-effect latch sensors. Designed for system challenges where higher magnetic precision is needed, each device variant exhibits a different magnetic sensitivity. If the field strength is greater than  $B_{OP}$ , then the output is pulled low. If the field strength is less than  $B_{RP}$ , then the output is released. When the applied magnetic flux density exceeds the magnetic release point ( $B_{RP}$ ) threshold, the device output returns to a high voltage state. The TMAG5115EVM comes prepopulated with TMAG5115B1 variant for out of the box evaluation. Other variants can be sampled from [www.ti.com](http://www.ti.com). Table 1-1 lists the different device variants in the TMAG5115 family. TMAG5115 devices can operate with a VCC range of 2.5 V to 26 V and is available in a standard SOT-23 package.

**Table 1-1. TMAG5115 Device Summary**

DEVICE	$B_{OP\_MIN}$	$B_{OP\_MAX}$
TMAG5115A1	0.5 mT	1.5 mT
TMAG5115B1	2 mT	4 mT

### 1.1 TMAG5115EVM Kit Contents

Table 1-2 lists the contents of the TMAG5115EVM kit. Contact the [Texas Instruments Product Information Center](http://www.ti.com) if any components are missing. TI highly recommends checking the TMAG5115 family product folder on the TI website at [www.ti.com](http://www.ti.com) for further information regarding this product.

**Table 1-2. TMAG5115EVM Kit Contents**

ITEM	QUANTITY
TMAG5115EVM test board	1
Handheld Magnet (D3X8)	1

### 1.2 Related Documentation from Texas Instruments

The following document provides information regarding TI's integrated circuits used in the assembly of the TMAG5115EVM. This user's guide is available from the TI website under literature number [SBAU410](http://www.ti.com). Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions are available from [www.ti.com](http://www.ti.com) or the Texas Instruments' Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

**Table 1-3. Related Documentation**

DOCUMENT	LITERATURE NUMBER
TMAG5115 product data sheet	<a href="http://www.ti.com">SBASAJ1</a>

## 2 TMAG5115EVM Hardware

The TMAG5115EVM is a simple to use platform for evaluating the main features and performance of the TMAG5115. The EVM features a couple of methods of device evaluation, the first being quick visual feedback to the user in the form of LED indication. When the device's  $B_{OP}$  and  $B_{RP}$  thresholds are crossed, their respective LED lights turn on and off. An alternative way of evaluating the TMAG5115 is by using the EVM to commutate a brushless direct current (BLDC) motor. The TMAG5115EVM follows a standard form factor for the Hall-effect sensor boards found in various NEMA17 BLDC motors. This means the EVM can be used as a direct drop-in replacement for these boards and can be used to evaluate device performance in this way.

Features:

- Standard sensor control board dimensions for drop-in replacement in most NEMA17 42-mm BLDC motors
- Includes a handheld D3X8 magnet for manual testing
- Provides LED feedback to quickly determine the output state from the TMAG5115

## 3 EVM Operation

The following instructions are to set up and use the TMAG5115EVM:

### 3.1 Quick Start Setup

1. Power up the EVM using a variable power supply:
  - a. Set the power supply voltage to the desired setting between 3 V and 12 V. Do not turn on the power yet.
  - b. Connect the power supply V- terminal to the black GND wire connected to the EVM.
  - c. Connect the power supply V+ terminal to the red VCC wire connected to the EVM.
  - d. Turn on the power supply
2. At power up, the device default state is high and the LEDs stay in the off state. Place the handheld D3X8 magnet over one of the three TMAG5115 devices found on the EVM. Depending on the polarity of the magnet, you may see the LED turn on or remain in the off state.
3. Rotate the magnet to the opposite orientation. If the threshold is met, the device should have the opposing reaction than it did in the previous step. A South field over the  $B_{OP}$  will turn on the LED while a North field less than the  $B_{RP}$  threshold will turn off the LED. See [Figure 3-1](#) for the magnetic response of a Hall-effect latch.

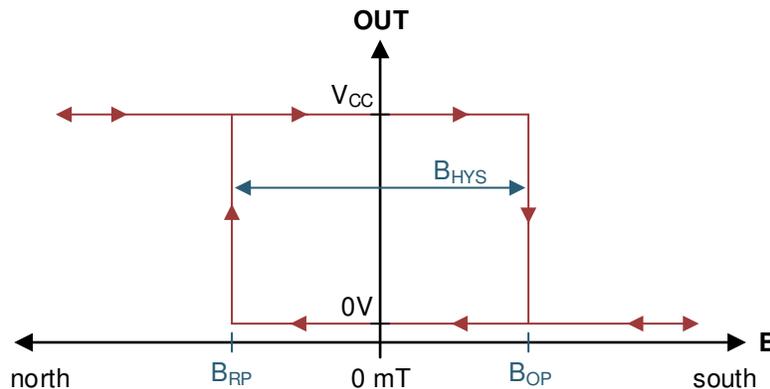


Figure 3-1. Hall Latch Output

### 3.2 BLDC Motor Operation

The TMAG5115EVM is intended to be a direct drop-in replacement for the Hall-effect sensor modules found in NEMA17 BLDC motors (see [Figure 3-2](#)). The EVM features three functionally independent circuits, one for each of the TMAG5115 devices on the PC board, with each sensor spaced  $120^\circ$  apart. The three sensors and the specific  $120^\circ$  spacing yield what is commonly referred to as a six-step commutation sequence, a common motor commutation algorithm for sensored motor control. The TMAG5115 reacts to the magnetic field generated by the permanent magnets located on the rotor of the magnet. As the motor spins, the three Hall sensors create a distinct state every  $60^\circ$  electrical degrees. Each unique state lets the motor controller know the motor's position and determine how the stator coils must be excited within the BLDC motor to keep the rotor spinning. [Figure 3-3](#) shows a typical six-step control scheme example.



**Figure 3-2. NEMA17 42-mm BLDC Motor**

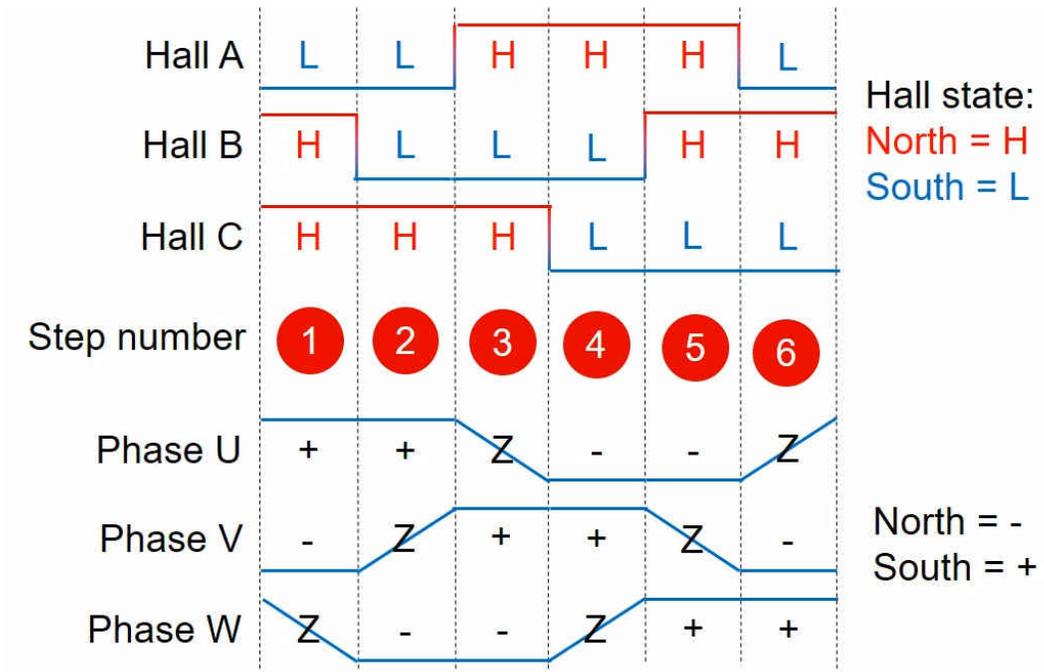


Figure 3-3. Six-Step Motor Commutation Control Scheme

### 3.2.1 Replacing Sensor Control Board With TMAG5115EVM

This section lists steps for replacing the sensor control board found in the NEMA17 BLDC motors with the TMAG5115EVM:

1. Remove the backplate from the motor. To remove the backplate, remove the four screws found on the backside of the motor, opposite to the motor's shaft. See [Figure 3-4](#). After the screws are removed, the backplate of the motor should come loose.



**Figure 3-4. BLDC Motor (Bottom)**

2. Remove the three screws that currently hold the sensors to the bottom of the housing and remove the board. See [Figure 3-5](#).



**Figure 3-5. Hall Sensor Board Removal**

3. Place the TMAG5115EVM inside the housing. The round plastic base will ensure proper alignment to the motor housing. Return the screws that were removed in the previous step and tighten. See [Figure 3-6](#) for TMAG5115EVM alignment inside the motor.



**Figure 3-6. TMAG5115EVM on NEMA17 Motor Module**

4. Align the base so that the wires of the sensor board and the wires of the motor are all facing the direction of the opening on the motor enclosure. Return the screws that were removed in Step 1 and tighten. See [Figure 3-7](#).



**Figure 3-7. BLDC Motor Connections**

### 3.2.2 Connecting TMAG5115EVM to a motor driver

The following connections must be made from TMAG5115EVM to a motor driver or motor controller in order to commutate a motor:

1. Connect the black GND wire to GND or the V- connection to the power supply.
2. Connect the red VCC wire to VCC or the V+ connection to the power supply.
3. Connect the blue wire (Hall A) to the phase A connection.
4. Connect the green wire (Hall B) to the phase B connection.
5. Connect the white wire (Hall C) to the phase C connection.
6. No external pullup resistors are required with TMAG5115EVM because the necessary pullup resistors are populated on the EVM board.
  - a. You can remove the pullup resistors on the TMAG5115EVM if your motor driver includes pullup resistors for the Hall-effect sensor inputs.

### 3.2.3 Example Using MCT8316ZTEVM

Texas Instruments offers several motor drivers that can be used to spin BLDC motors. This section explains what connections must be made to spin a motor using the MCT8316ZTEVM:

#### 3.2.3.1 MCT8316Z Overview

The MCT8316Z is an integrated three-phase gate driver IC with sensored trapezoidal control for motor drive applications. The device provides three integrated half-bridges and a sensored trapezoidal algorithm capable of directly driving a 3-phase brushless-DC motor. The algorithm is included in the IC, therefore there is no need to create your own commutation algorithm to spin a BLDC motor. The MCT8316Z simply takes the inputs of the Hall-effect sensors and uses them to drive the motor appropriately.

### 3.2.3.2 MCT8316ZTEVM Quick Start Guide

The MCT8316ZTEVM requires a power supply source, which has a recommended operating range from a 4.5 V to 35 V. To setup and power the EVM, use the following the sequence:

1. Connect motor phases to A, B, and C on connector J13.
2. Connect Hall sensors to J11 and use HALL\_PWR\_SEL jumper J12 to select the supply as 3.3 V from buck or use an external supply on connected to J12. Ensure the MODE resistors are set correctly to use the appropriate Hall sensor configuration as described in [MCT8316Z datasheet](#).
  - a. If using the boards pullup resistors, populate J8–J10 with shunt jumpers to enable pullups. Connect the single-ended inputs to only the HPx pins on connector J11. This is the default of the MCT8316ZTEVM.
3. Ensure resistors are populated in H/W variant resistors for desired hardware settings.
4. DO NOT TURN ON the power supply yet. Connect the motor supply to VBAT or VM and PGND on connector J7.
  - a. To enable reverse polarity protection and Pi filter, connect to VBAT.
  - b. To disable reverse-polarity protection and the Pi filter, connect to VM.
5. Select J3 to 5V\_USB and J5 to 3V3COM to power MSP430 from USB power supply.
6. Connect the micro-USB cable to the computer.
7. Turn the potentiometer fully clockwise to set the motor to zero speed upon power up.
8. Turn on the motor power supply.
9. Use the potentiometer to control the speed of the motor and the switches to disable the motor driver, change the direction, or apply a brake to the motor. Optionally, use the GUI (as shown in the [MCT8316ZTEVM User's Guide](#)) to monitor real-time speed of the motor, put the MCT8316ZT into a low-power sleep mode, and read status of the LEDs.

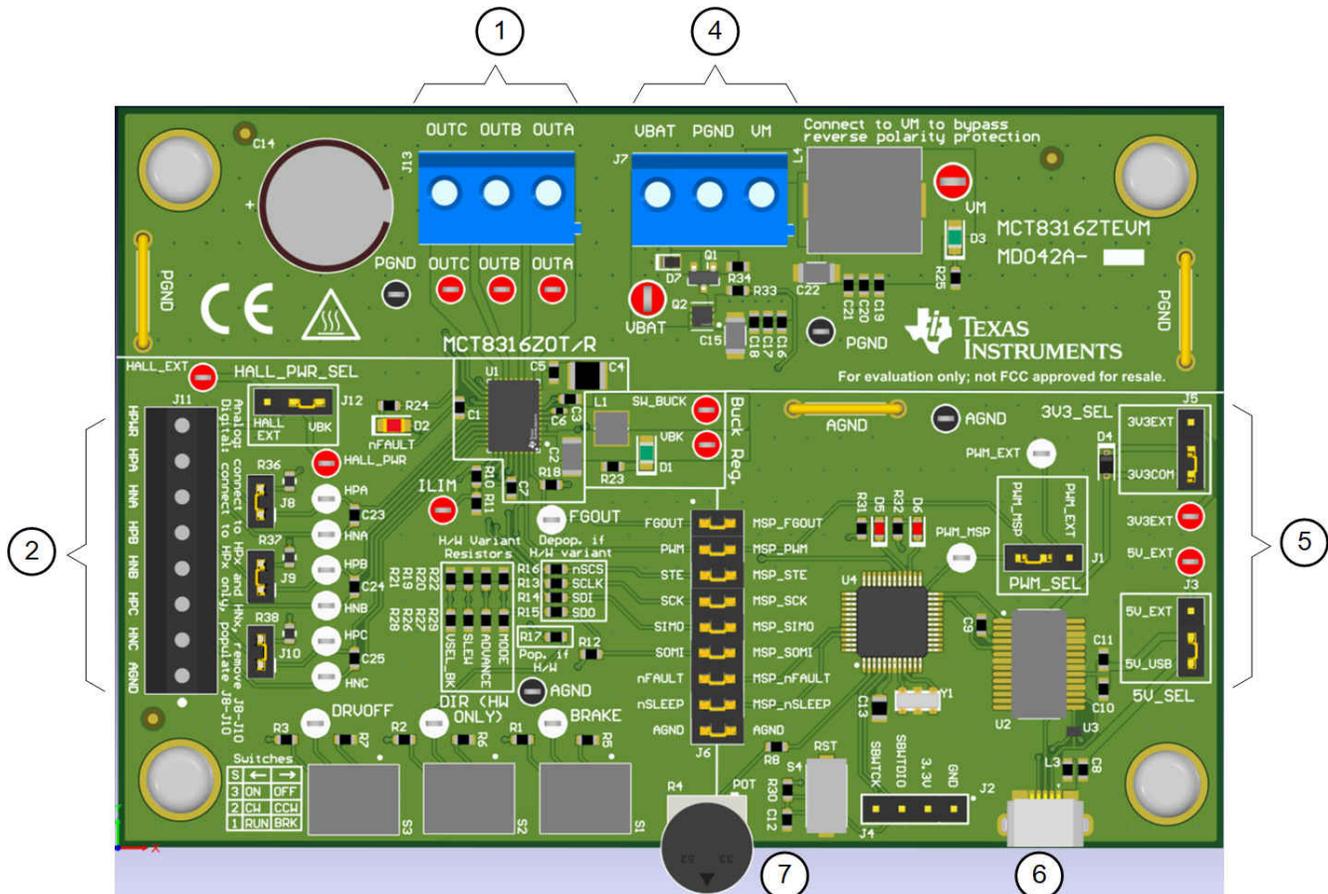


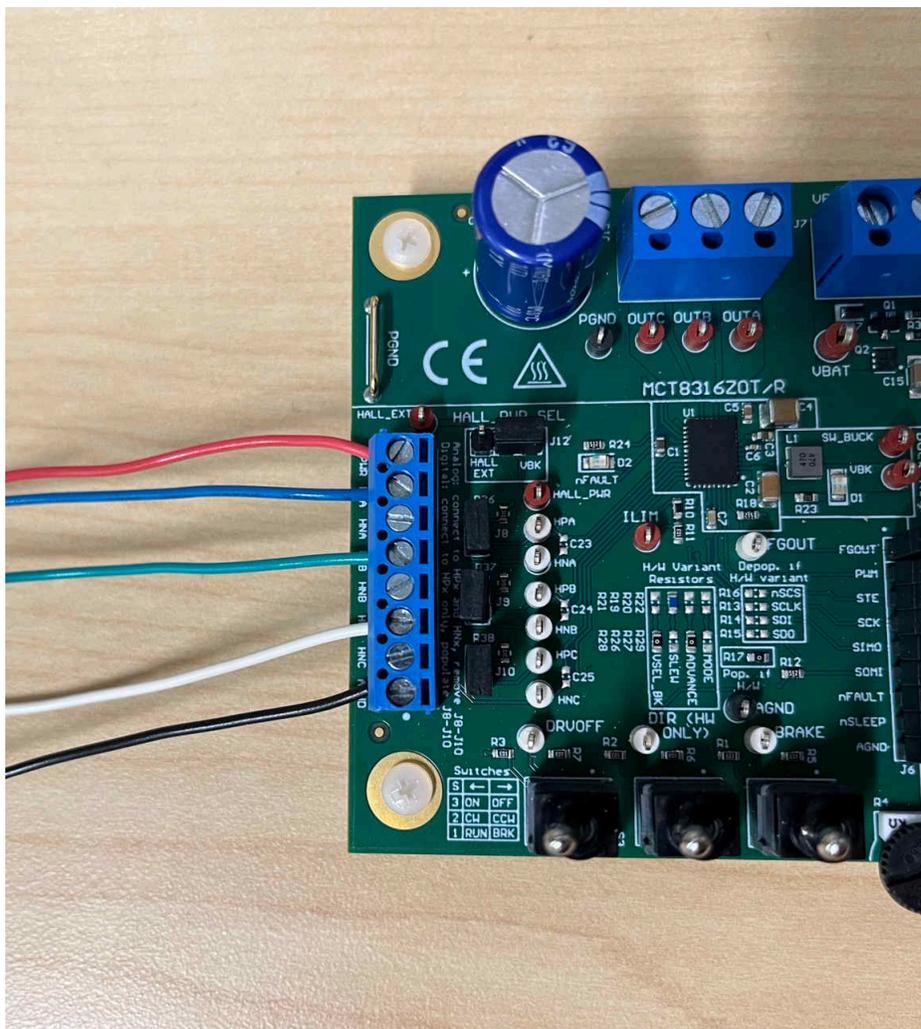
Figure 3-8. Reference for MCT8316ZTEVM Quick Start Guide

### 3.2.3.3 Connecting TMAG5115EVM to MCT8316ZTEVM

Follow these steps to connect the TMAG5115EVM to the MCT8316ZTEVM:

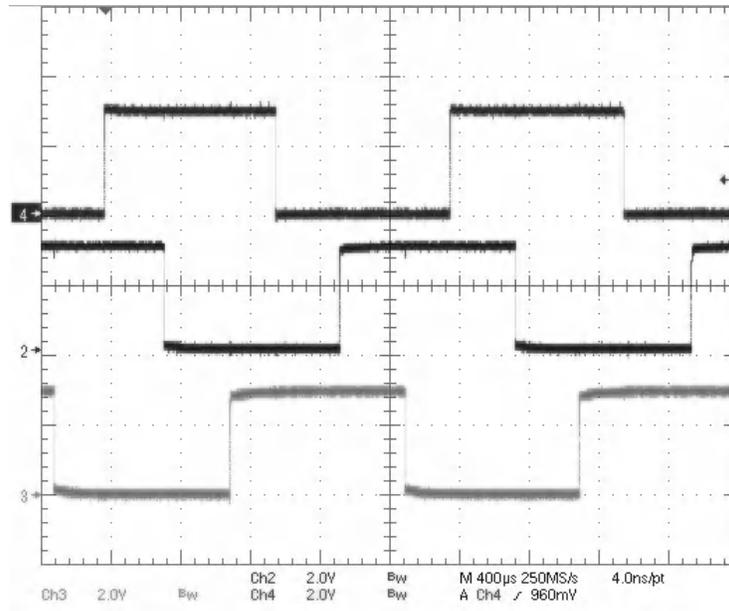
1. Determine which pullup resistors are required for your use case. The TMAG5115EVM comes with pullup resistors populated out of the box, which means it is not required to use the pullup resistors located on the MCT8316ZTEVM. Therefore, jumpers J8-J10 on the MCT8316ZTEVM do not need to be populated.
  - a. If external pullups are preferred, resistors R1-R3 can be removed from the TMAG5115EVM. If this is done, ensure to follow steps 2-a from the above section.
2. Connect the TMAG5115EVM wires into connector J11 on MCT8315ZTEVM:
  - a. Connect the black GND wire to AGND.
  - b. Connect the red VCC wire to HPWR.
  - c. Connect the blue wire Hall A to HPA.
  - d. Connect the green wire Hall B to HPB.
  - e. Connect the white wire Hall C to HPC.

Figure 3-9 demonstrates the connections mentioned in steps 2-a through 2-e.



**Figure 3-9. MCT8316ZTEVM Connections**

Figure 3-10 shows the output of all three Hall-effect sensors in the TMAG5115EVM during motor operation.



**Figure 3-10. TMAG5115EVM Output**

For more information on the MCT8316ZTEVM, refer to the [MCT8316ZTEVM User's Guide](#) and the MCT8316Z product page. For more information on other TI BLDC motor drivers, go to [ti.com/BLDC](http://ti.com/BLDC).

## 4 BLDC Motor Manufacturers

Table 4-1 contains a list of motor manufacturers that sell NEMA17 BLDC motors compatible with the TMAG5115EVM.

**Table 4-1. BLDC Motor Manufacturers**

MANUFACTURER	MODEL/SERIES	WEBSITE LINK
Anaheim Automation	BLY17 Series	<a href="#">Manufacturer Link</a>
Orbex Group	EC42XX-XX	<a href="#">Manufacturer Link</a>
Phidgets	42DMW61	<a href="#">Manufacturer Link</a>
Stepper Online	42BLSx-24-01	<a href="#">Manufacturer Link</a>
OSMTEC	42BLSX-24-01	<a href="#">Manufacturer Link</a>
Trinamic	QBL4208-61-04-013	<a href="#">Mouser Link</a> <a href="#">Newark Link</a>
Trinamic	QBL4208-41-04-006	<a href="#">Mouser Link</a> <a href="#">Newark Link</a>

## 5 TMAG5115EVM Circuitry

This section summarizes the TMAG5115EVM components:

R1, R2, and R3 function as pullup resistors for the open-drain output of the TMAG5115.

R4, R5, and R6 are current-limiting resistors to control the output intensity of the signal diodes D1, D2, and D3.

While not populated out of the box, capacitors C4, C5, and C6 offer an optional surface mount pads for capacitor placement. These capacitors form a first-order, low-pass filter with their respective pullup resistor.

## 6 TMAG5115EVM Schematic and PCB Layout

### 6.1 Schematic

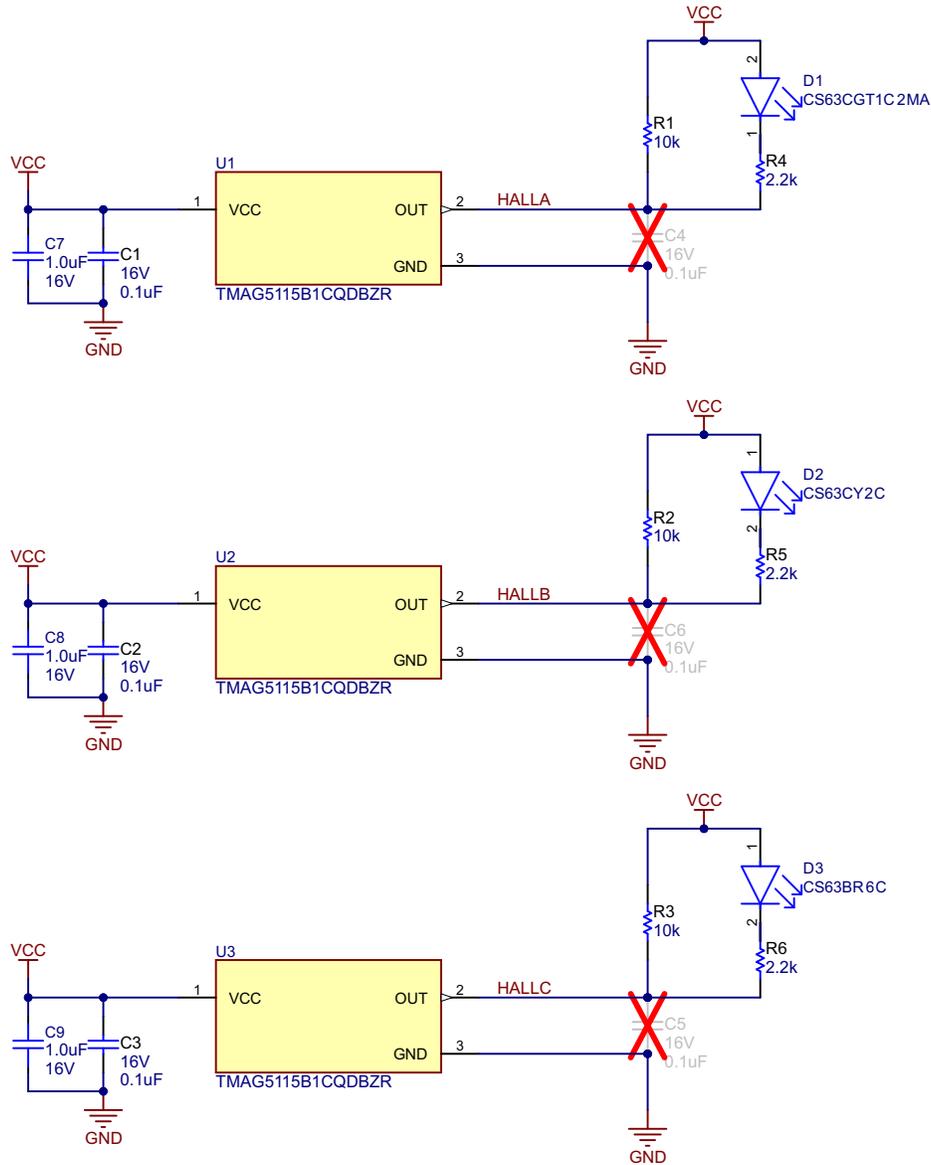


Figure 6-1. TMAG5115EVM Schematic

## 6.2 PCB Layout

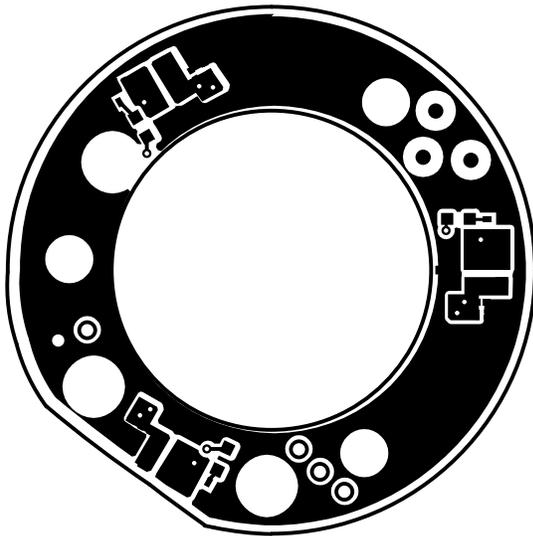


Figure 6-2. TMAG5115EVM Top Copper

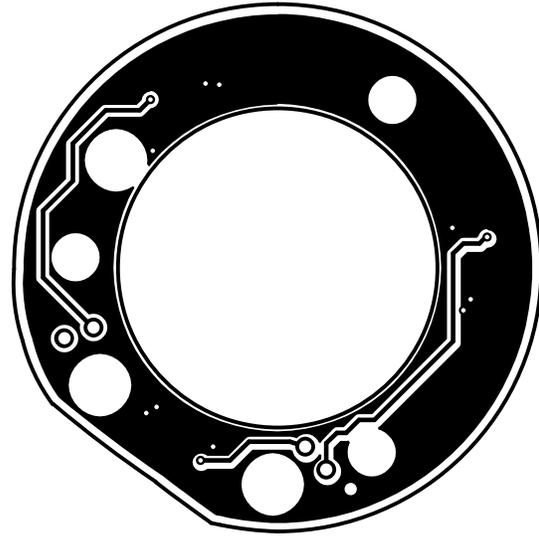


Figure 6-3. TMAG5115EVM Bottom Copper

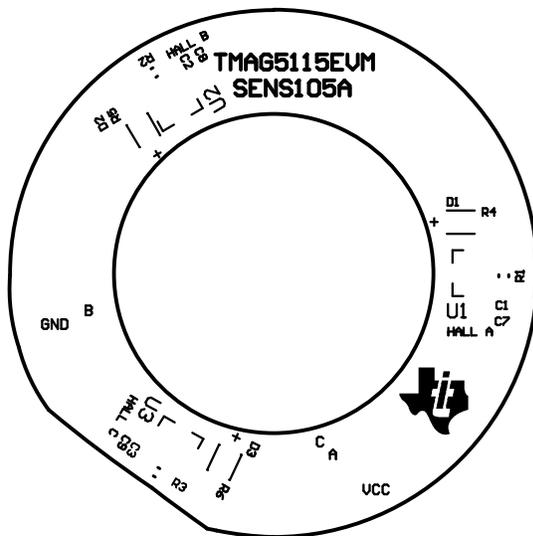


Figure 6-4. TMAG5115EVM Top Overlay

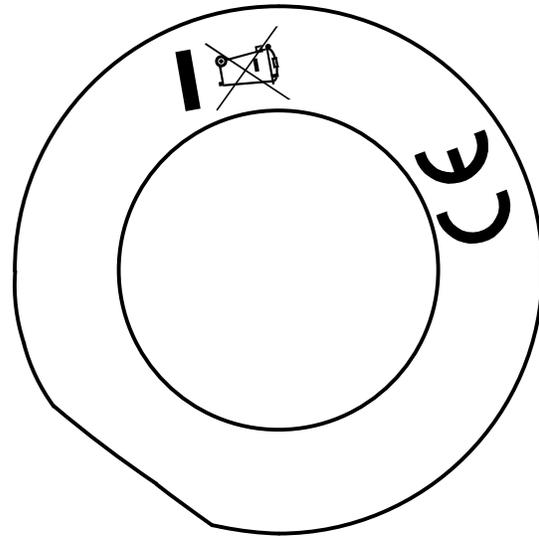


Figure 6-5. TMAG5115EVM Bottom Overlay

## 6.3 Bill of Materials

**Table 6-1. Bill of Materials (BOM)**

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PARTNUMBER	MANUFACTURER	ALTERNATE MANUFACTURER	ALTERNATE PARTNUMBER
!PCB1	1		Printed Circuit Board		SENS105	Any		
C1, C2, C3	3	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X5R, 0201	0201	GRM033C71C104KE14D	MuRata		
C7, C8, C9	3	1uF	CAP, CERM, 1 uF, 16 V, +/- 20%, X5R, 0201	0201	GRM033R61C105ME15D	MuRata		
D1	1		Green 525nm LED Indication - Discrete 2.9V 0603 (1608 Metric)	0603	CS63CGT1C2MA	ChromeLED		
D2	1		Yellow 595nm LED Indication - Discrete 2V 0603 (1608 Metric)	0603	CS63CY2C	ChromeLED		
D3	1		Red 625nm LED Indication - Discrete 2V 0603 (1608 Metric)	0603	CS63BR6C	ChromeLED		
R1, R2, R3	3	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC1608J103CS	Samsung Electro-Mechanics		
R4, R5, R6	3	2.2k	RES, 2.2 k, 5%, 0.063 W, 0402	0402	CRCW04022K20JNED	Vishay-Dale		
U1, U2, U3	3		Digital-Latch Hall Effect Sensor	SOT23-3	TMAG5115B1CQDBZR	Texas Instruments		
C4, C5, C6	0	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	C0402C104K4RACAUTO	Kemet		
GND	1		Black Wire 22AWG, 40cm	Black Wire	3051 BK005	Alpha Wire		
B	1		Green Wire 22AWG, 40cm	Green Wire	3051 GR005	Alpha Wire		
C	1		White Wire 22AWG, 40cm	White Wire	3051 WH005	Alpha Wire		
A	1		Blue Wire 22AWG, 40cm	Blue Wire	3051 BL005	Alpha Wire		
VCC	1		Red Wire 22AWG, 40cm	Red Wire	3051 RD005	Alpha Wire		

## STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
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  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
  - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
  - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
  - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

### **WARNING**

**Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.**

**User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

**NOTE:**

**EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.**

### 3 Regulatory Notices:

#### 3.1 United States

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

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

##### 3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

#### **CAUTION**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

#### **FCC Interference Statement for Class A EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

#### **FCC Interference Statement for Class B EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

#### 3.2 Canada

##### 3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

#### **Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

#### **Concernant les EVMs avec appareils radio:**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### **Concerning EVMs Including Detachable Antennas:**

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

### Concernant les EVMs avec antennes détachables

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

#### 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page)

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号  
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page) 電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。  
[http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)

#### 3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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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.
  6. *Disclaimers:*
    - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
    - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
  7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL 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 HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.
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8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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