

# TMAG6180-6181 Evaluation Module



## ABSTRACT

This user's guide describes the characteristics, operation, and use of the TMAG6180-6181 evaluation module (EVM). This EVM is designed to evaluate the performance of both TMAG6180 and TMAG6181. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the TMAG6180-6181EVM. This document includes a schematic, reference printed circuit board (PCB) layouts, and a complete bill of materials (BOM).

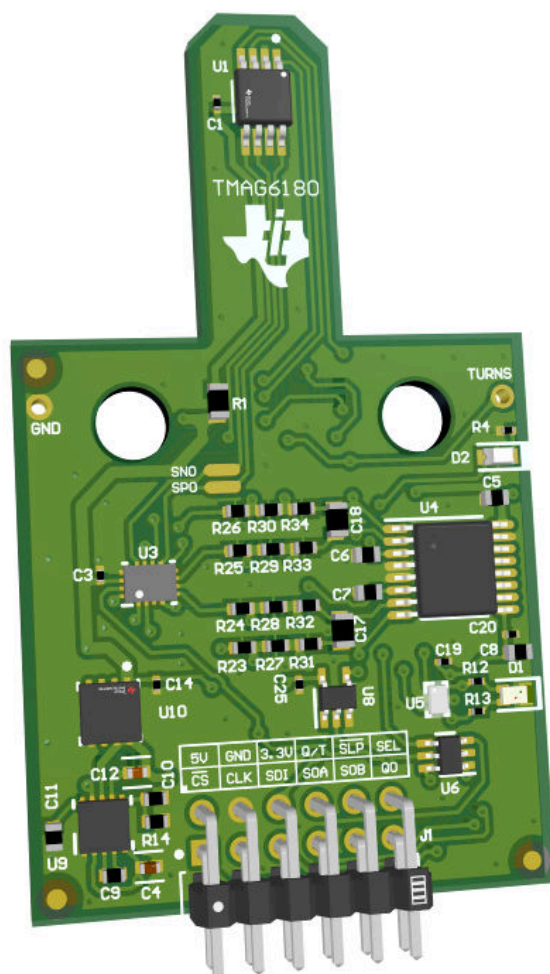


Figure 1-1. TMAG6180-6181EVM

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## 1 Overview

TMAG6180 and TMAG6181 are each magnetic sensors built on anisotropic magnetoresistive (AMR) sensing technology. Typically, AMR sensors are only able to resolve 180 degree rotation, but with additional integrated Hall-effect sensing, each sensor produces both sine and cosine differential outputs which are used to measure the absolute angular position of a rotating magnet. Each sensor is capable of detecting a full 360 degree rotation unlike typical AMR sensors. TMAG6180 provides additional outputs Q0 and Q1 which can be used to determine the quadrant of rotation, while TMAG6181 provides a pulse width modulated (PWM) turns counter output that increments or decrements at each quadrant change. Using the information from these outputs, extending the 180 degree output to a full 360 position calculation is possible.

**Table 1-1. TMAG6180 Device Summary**

PRODUCT	INPUT RANGE	ANALOG OUTPUTS	DIGITAL OUTPUTS	SUPPLY VOLTAGE RANGE
TMAG6180-Q1	20 mT - 1T	Differential Sine and Cosine	Q0 and Q1 Quadrant	2.7 V - 5.5 V
TMAG6181-Q1	20 mT - 1T	Differential Sine and Cosine	TURNS	2.7 V - 5.5 V

TMAG6180 is installed on the top side of the EVM and TMAG6181 is installed directly opposite on the bottom. During use with the EVM Graphical User Interface (GUI) differential outputs are sampled by an on-board [ADS8354](#) which transmits the output readings over SPI to the TI sensor control board (TI-SCB).

### 1.1 Kit Contents

[Kit Contents](#) lists the contents of the EVM kit. Contact the nearest [Texas Instruments Product Information Center](#) if any component is missing.

**Table 1-2. Kit Contents**

ITEM	QUANTITY
TMAG6180-6181EVM	1
3D-printed Rotate & Push module	1

### 1.2 Related Documentation From Texas Instruments

This user's guide is available from the TI website under literature number [SLYU065](#). 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](#) 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. [Related Documentation From Texas Instruments](#) lists documentation related to the EVM. Click the links in [Related Documentation](#) for further information. The device name links to the product web folder on [www.ti.com](#). The literature number links to the document PDF.

**Table 1-3. Related Documentation**

DOCUMENT TITLE	DOCUMENT LITERATURE NUMBER
<a href="#">TMAG6180-Q1 data sheet</a>	<a href="#">SLYS037</a>
<a href="#">TMAG6181-Q1 data sheet</a>	<a href="#">SLYS048</a>
<a href="#">TI-SCB user's guide</a>	<a href="#">SLAU839</a>

## 2 Hardware

The EVM is an easy-to-use platform for evaluating the main features and performance of the TMAG6180-Q1 and TMAG6181-Q1. The EVM includes a graphical user interface (GUI) used to read data from the on-board [ADS8354](#), as well as view and save measurement results. Also included is a 3D-printed Rotate & Push module to test the common functions of angle measurement and push button with a single device.

The EVM is intended to provide basic functional evaluation of the devices. The layout is not intended to be a model for the target circuit, nor is the model laid out for electromagnetic compatibility (EMC) testing. The EVM is intended to interface with the [TI-SCB](#), but can be used as a standalone device if desired.

### 2.1 Features

- On-board 16 bit Analog to Digital converter
- Differential sine and cosine analog outputs
- 3D-printed Rotate & Push module
- Easy USB measurements using the TI - Sensor Control Board (TI-SCB)

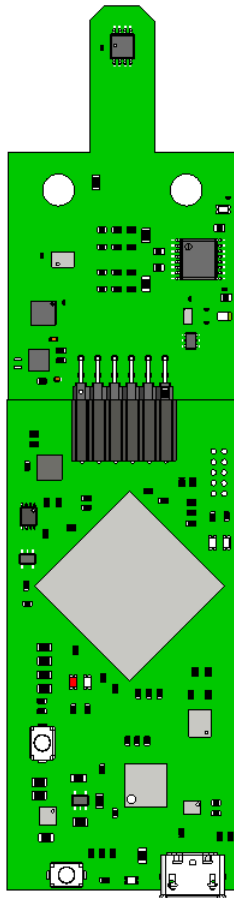
## 3 Operation

### 3.1 Quick Start Setup

1. Download and install the PAMB Windows® USB driver: <http://www.ti.com/lit/zip/sbac253>.
2. Attach the EVM to the Sensor Control Board (TI-SCB) (see [TMAG6180-6181EVM Connected to TI-SCB](#)).
  - a. **TI-SCB** must be ordered separately.
3. Apply a magnetic field to the sensor by doing one of the following:
  - a. Connect the Rotate & Push module by attaching to the EVM (see [Figure 3-10](#)).
  - b. Mount the EVM with the sensors aligned to the axis of rotation of a rotating magnet.
4. Connect the EVM to a PC using a USB cable.
  - a. Insert the micro USB cable into the TI-SCB Controller onboard USB receptacle J2.
  - b. Plug the other end of the USB cable into a PC.
5. Access the GUI from the following link in either a Firefox™ or Google Chrome™ browser:
  - a. TMAG6180-6181EVM GUI: <https://dev.ti.com/gallery/search/TMAG6180-6181>.
6. Select a device to test
  - a. Click plots icon to advance to main device interface.
  - b. EVM GUI defaults to TMAG6180.
7. Click *Collect Data*
8. Observe the outputs in the GUI. See [GUI Setup and Usage](#) for more information on GUI setup and operation.

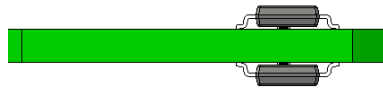
### 3.2 EVM Operation

To use the EVM with the TI-SCB, connect the EVM as shown in [TMAG6180-6181EVM Connected to TI-SCB](#).



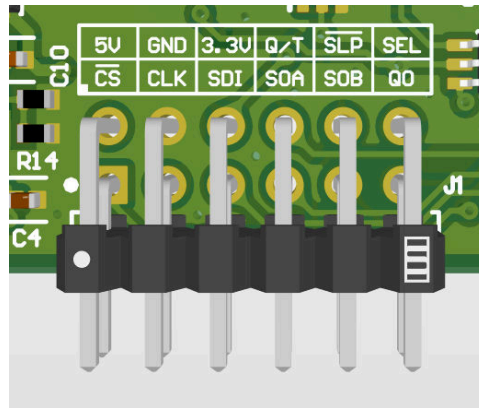
**Figure 3-1. TMAG6180-6181EVM Connected to TI-SCB**

The two sensors are mounted opposite from each other at the end of the sensor platform, with TMAG6180-Q1 mounted on the topside and TMAG6181-Q1 mounted on the bottom.



**Figure 3-2. Side Profile of EVM**

For use independent of the TI-SCB, a pin map of J1 has been provided on the top layer silk screen.

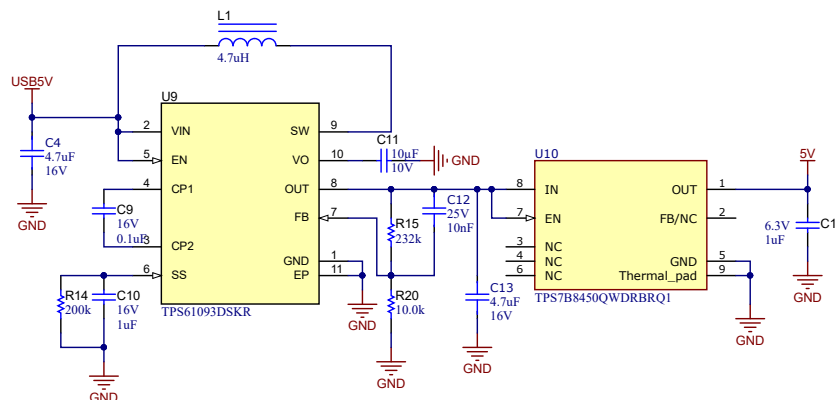


**Figure 3-3. J1 pin map**

Access to 5 V, GND, and 3.3 V are respectively available on pins 2, 4, and 6 of J1. The 5 V input from TI-SCB is provided over USB and is not used to directly power TMAG6180 or TMAG6181. U9 and U10 on TMAG6180-6181EVM accept this input and provide a low noise 5 V AVDD voltage for the ADS8354 (U4) and sensors.

**Low Noise 5V Supply**

TI-SCB 5V is powered via USB and is less ideal for use as an ADC supply. This block steps up to 12V and then drives 5V using an LDO for lower noise



**Figure 3-4. 5 V Supply Circuit**

Input to the ADS8354 is controlled using pin 12 (SEL) of J1. The SEL signal sets the output of multiplexor U3 and toggle output control of pin 8 on J1, which is shared between Q1 of TMAG6180 and TURNS on TMAG6181. Access to the SPI I/O pins of the ADS8354 are available on pins 1,3,5,7 and 9 of J1, also shown in J1 pin map.

For additional device testing, probe test pads are provided for COS\_P, COS\_N, SIN\_P, and SIN\_N of each device as shown in [Test Pad Locations](#).

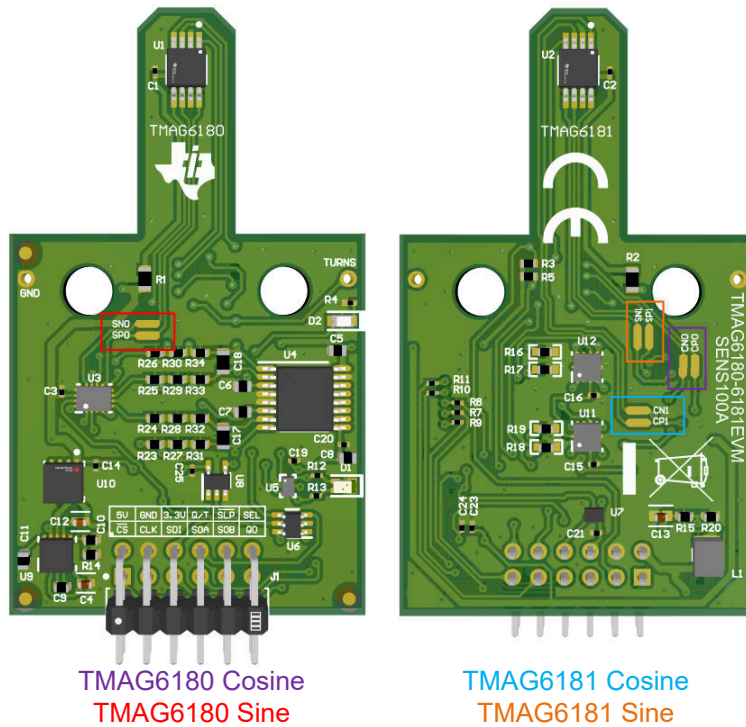


Figure 3-5. Test Pad Locations

The output of the selected device passes through an anti-aliasing filter with an optional active stage. In many cases, this filter is not necessary, but the active stage was included in the reference design for [ADS8354](#) and was used here for congruency.

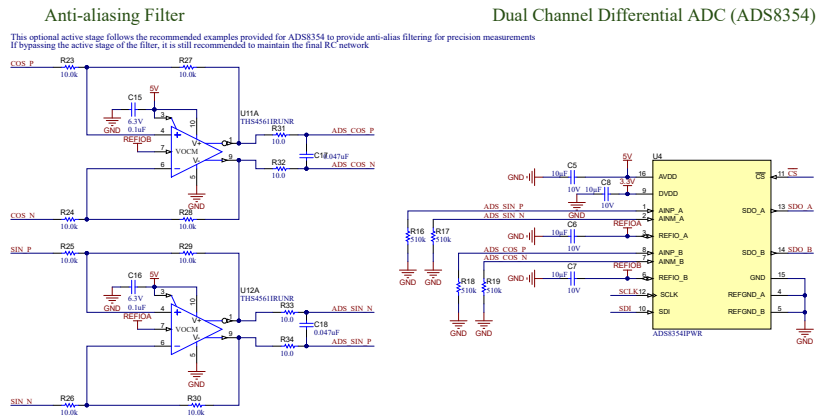


Figure 3-6. ADS8354 with Anti-Aliasing Filter

Full details of the hardware schematic are available in [Schematics](#).

### 3.2.1 Software Setup

#### 3.2.1.1 Driver Installation

Download and install the PAMB Windows USB driver: <http://www.ti.com/lit/zip/sbac253>. This is a one-time step per computer. Unzip the folder and run the .exe file with administrator privileges.

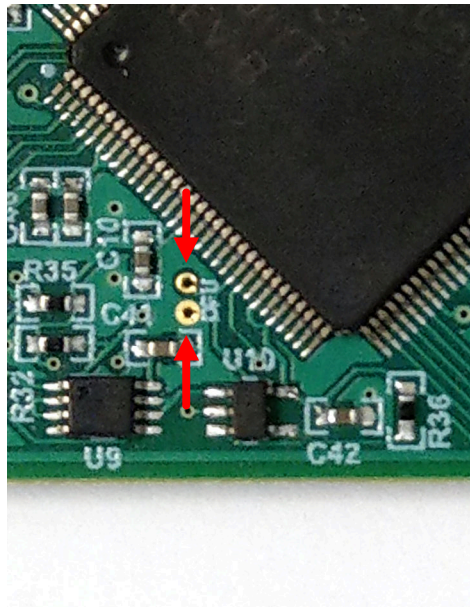
### 3.2.1.2 Firmware

The GUI can load firmware onto the TI-SCB as described in [Section 3.2.1](#). Firmware updates are pushed through the GUI (requires driver installation). Downloaded offline GUIs can check for GUI/Firmware updates depending on the version.

#### 3.2.1.2.1 Firmware Debug

If the firmware becomes corrupted or requires manual reinstallation for any reason, follow these steps to restore the firmware. This is demonstrated in the [TMAG5170 EVM Quick Start Video](#):

1. Configure the MCU on the TI-SCB Controller to Device Firmware Update (DFU) Mode.
  - a. The MCU entering DFU mode is possible. If so, then the GUI sends a notification and tries to update the firmware to the latest version after the GUI is connected to the PC.
  - b. DFU mode can be entered manually through one of the following methods while the TI-SCB Controller is powered on:
    - Through software:
      - Send the command 'bsl' on the TI-SCB's USB Serial (COM) port.
    - Through the hardware:
      - Make sure TI-SCB is connected to the PC through a USB
      - Short the two test points near PK1 and PK2 of the header pins (see [Test Points Used to Enter DFU Mode Manually](#)) with a pair of tweezers (or wire) while pressing the RESET button.



**Figure 3-7. Test Points Used to Enter DFU Mode Manually**

- c. LEDs D1 and D2 are off if successful.
2. With the MCU in DFU mode, upload the firmware through the GUI:
  - Open the *File* menu and select *Program Device*.
  - The firmware update initiates.
  - After the GUI re-initializes, the TI-SCB automatically connects.

If the firmware programming was unsuccessful, then TI recommends to repeat the above steps with a different USB port connection on the machine.

#### 3.2.1.3 GUI Setup and Usage

Access the GUI from the following link in either a Firefox or Google Chrome browser:

- TMAG6180-6181EVM GUI: <https://dev.ti.com/gallery/search/TMAG6180-6181>



### 3.2.1.3.1 Initial Setup

To set up the GUI the first time, follow these steps:

1. Make sure that the above mentioned driver was installed successfully to verify that everything works properly and that the GUI can update the EVM firmware, if necessary.
2. With the EVM/TI-SCB Controller unit plugged to the PC, go to the GUI link: <https://dev.ti.com/gallery/search/TMAG6180-6181>.
3. To launch the GUI from the web browser, click the *GUI Composer* application to open the *GUI Composer* window (see [GUI Composer Application Window](#)).



**Figure 3-8. GUI Composer Application Window**

- a. For first-time GUI Composer setup, follow the prompts to download the *TI Cloud Agent* and browser extension (see [TI Cloud Agent](#)). These prompts appear after you close the README.md dialog.


#### TI Cloud Agent Installation

Hardware interaction requires additional one time set up. Please perform the actions listed below and try your operation again.(What's this?)

- Step 1: **INSTALL** browser extension
- Step 2: **DOWNLOAD** and install the TI Cloud Agent Application
- Help. I already did this

**FINISH**

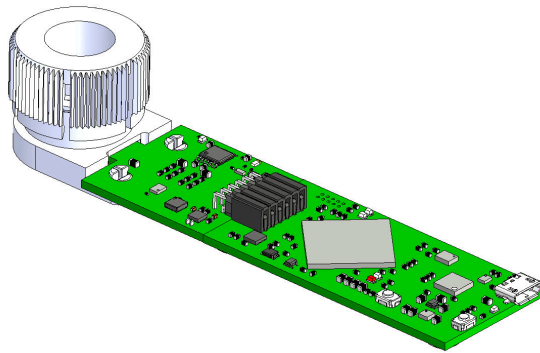
**Figure 3-9. TI Cloud Agent**

4. Optionally, click the  icon in the *GUI Composer* window to download the GUI for offline use (see [GUI Composer Application Window](#)).

### 3.2.1.3.2 GUI Operation

To operate the GUI, follow these steps:

1. Connect the EVM to TI-SCB and mount the Roate & Push Module.



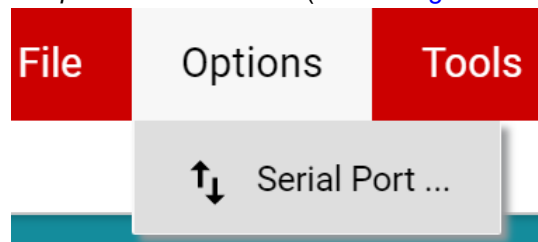
**Figure 3-10. T MAG6180-6181EVM with Magnet Knob Attachment**

2. Connect to and launch the GUI as described in [Initial Setup](#).
3. With the EVM connected to the GUI, close the README.md file page. The text near the bottom-left hand corner of the GUI reads *Hardware Connected* (see [Hardware Connected Indicator](#)).



**Figure 3-11. Hardware Connected Indicator**

- a. If *Hardware Connected* does not show in the bottom-left hand corner of the GUI, check different hardware COM ports under *Options* → *Serial Port* (see [Change Serial Port](#)).



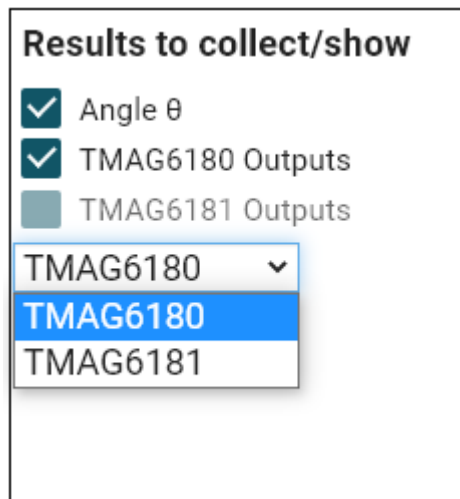
**Figure 3-12. Change Serial Port**

- b. If the hardware still does not connect, make sure you are using the correct GUI/EVM combination.
4. Click on the Plots icon to setup the EVM for measurements.



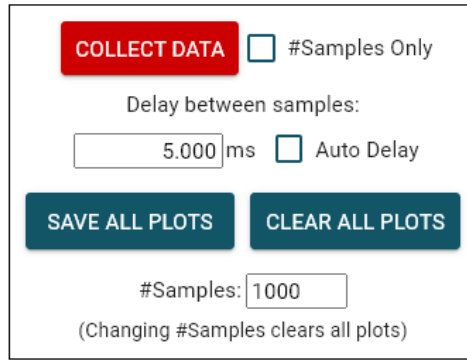
**Figure 3-13. Plots Page Icon**

5. Select the Sensor to test using the drop-down menu shown in the figure below:



**Figure 3-14. Device Select Drop-Down**

6. Click *Collect Data* to initiate data capture.



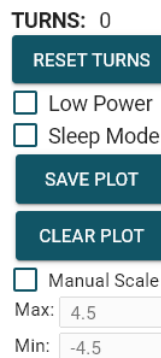
**Figure 3-15. Data Collection Settings**

- a. *Delay between samples* sets the sample rate.
  - b. *#Samples* sets the plot record length.
  - c. *#Samples Only* stops collecting after the specified samples are captured, and disabling this checkbox causes data to stream continuously.
7. Observe the status indicators relative to the device being tested:
- a. TMAG6180-Q1: Q0 and Q1 indicates the quadrant of rotation for the magnetic source. The quadrant of rotation is also indicated by LEDs mounted on the EVM.



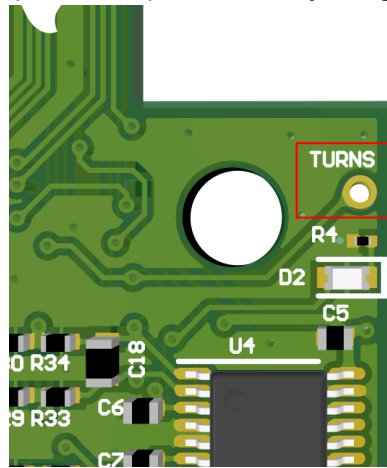
**Figure 3-16. TMAG6180 Quadrature Output Indicators**

- b. TMAG6181-Q1: Turns count increments and decrements by 0.25 as each quadrant change occurs. The PWM output is captured and converted for position tracking.



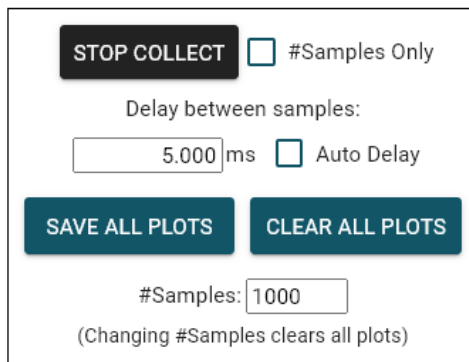
**Figure 3-17. TMAG6181 Turns Indicator**

- i. Additionally, the PWM output can be probed directly using the Turns test point.



**Figure 3-18. TURNS Test Point Location**

- 8. Click *Stop Collect* to stop data capture.



**Figure 3-19. Stop Data Collection**

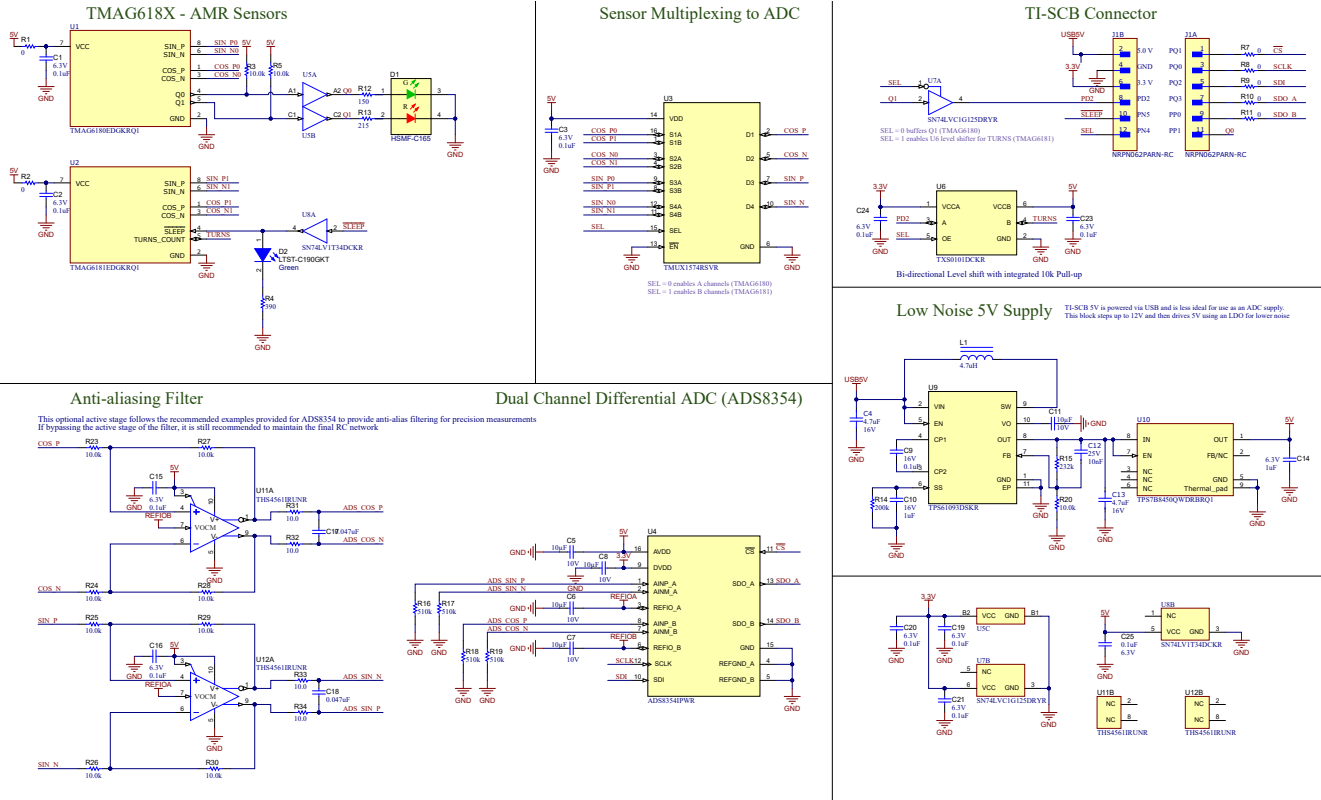
- 9. Click *Save Plot* or *Save all Plots* to store captured data locally.



**Figure 3-20. Save Button**

## 4 Schematics, PCB Layout, and Bill of Materials

### 4.1 Schematics



## 4.2 PCB Layout

Top View through Bottom Layer show the PCB layers of the EVM.

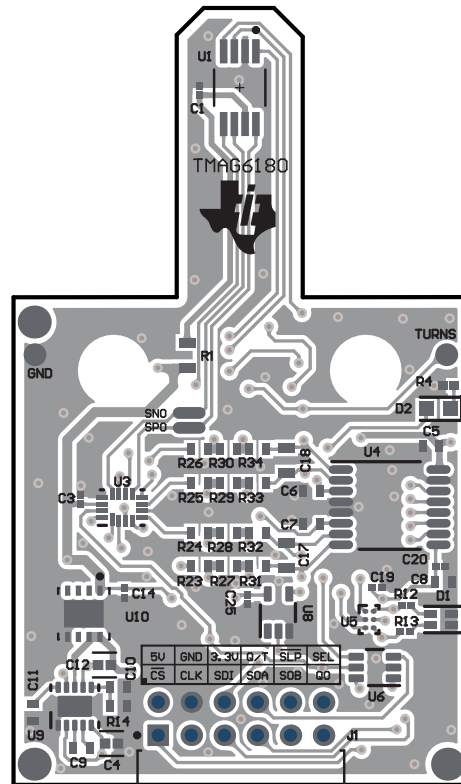


Figure 4-1. Top View

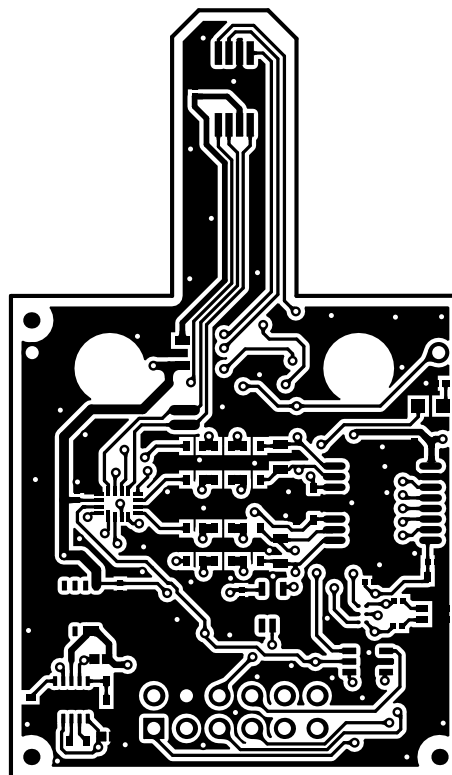


Figure 4-2. Top Layer

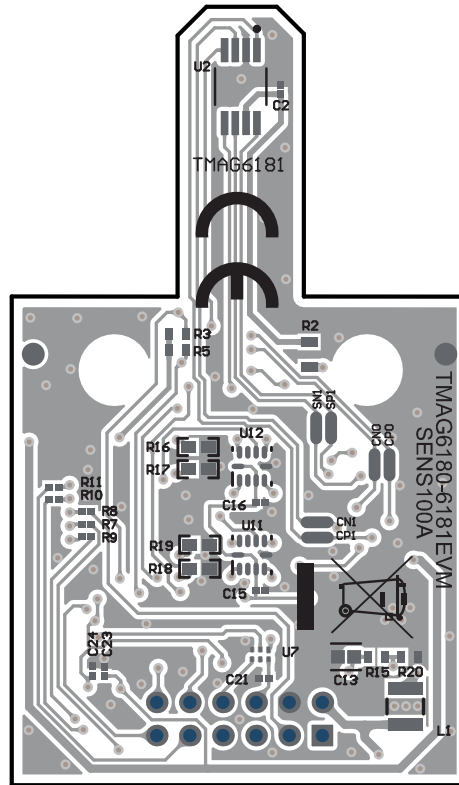


Figure 4-3. Bottom View

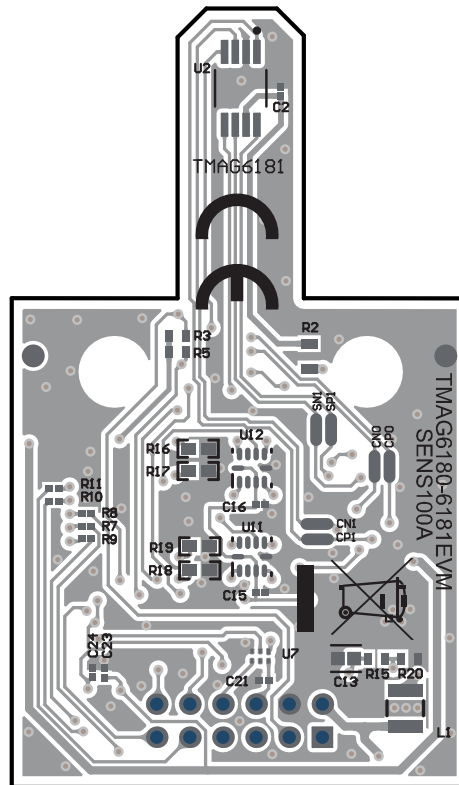


Figure 4-4. Bottom Layer



### 4.3 Bill of Materials

Bill of Materials provides the parts list for the EVM.

**Table 4-1. Bill of Materials**

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
IPCB1	1		Printed Circuit Board		SENS100	Any
C1, C2, C3, C15, C16, C19, C20, C21, C23, C24, C25	11	0.1uF	CAP, CERM, 0.1 uF, 6.3 V, +/- 10%, X5R, 0201	0201	GRM033R60J104KE19D	MuRata
C4, C13	2	4.7µF	0402 4.7 uF 16 V ±20% Tolerance X5R Surface Mount Multilayer Ceramic Capacitor	0402	0402YD475MAT2A	KYOCERA AVX
C5, C6, C7, C8, C11	5	10uF	CAP, CERM, 10 µF, 10 V, +/- 20%, X5R, 0402	0402	0402ZD106MAT2A	AVX
C9	1	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 20%, X5R, 0402	0402	885012105016	Würth Elektronik
C10	1	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X5R, 0402	0402	EMK105BJ105KVHF	Taiyo Yuden
C12	1	10 nF	10000 pF ±10% 25 V Ceramic Capacitor X5R 0402 (1005 Metric)	0402	04023D103KAT2A	KYOCERA AVX
C14	1	1uF	CAP, CERM, 1 uF, 6.3 V, +/- 20%, X5R, 0201	0201	GRM033R60J105MEA2D	MuRata
C17, C18	2	0.047uF	CAP, CERM, 0.047 uF, 50 V, +/- 10%, X5R, 0603	0603	C1608X5R1H473K080AA	TDK
D1	1	Rg	LED, Rg, SMD	1.6x0.8mm	HSMF-C165	Avago
D2	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
J1	1			HDR12	NRPN062PARN-RC	Sullins Connector Solutions
L1	1	4.7uH	Inductor, Film, 4.7 uH, 1.6 A, 0.2 ohm, AEC-Q200 Grade 0, SMD	2.5x2mm	TFM252012ALMA4R7MTAA	TDK
R1, R2	2	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R3, R5, R20	3	10.0k	RES, 10.0 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1002X	Panasonic
R4	1	390	RES, 390, 1%, 0.05 W, 0201	0201	RC0201FR-07390RL	Yageo America
R7, R8, R9, R10, R11	5	0	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale
R12	1	150	RES, 150, 5%, 0.05 W, 0201	0201	RC0201JR-07150RL	Yageo America
R13	1	215	RES, 215, 1%, 0.05 W, 0201	0201	RC0201FR-07215RL	Yageo America
R14	1	200k	RES, 200 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF2003X	Panasonic
R15	1	232k	RES, 232 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402232KFKED	Vishay-Dale
R16, R17, R18, R19	4	510k	RES, 510 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402510KJNED	Vishay-Dale
R23, R24, R25, R26, R27, R28, R29, R30	8	10.0k	RES, 10.0 k, .1%, .0625 W, 0402	0402	RT0402BRD0710KL	Yageo America
R31, R32, R33, R34	4	10.0	RES, 10.0, 1%, 0.063 W, 0402	0402	RK73H1ETTP10R0F	KOA Speer
U1	1		Hall Effect Magnetic Sensor VSSOP8	VSSOP8	TMAG6180EDGKRQ1	Texas Instruments
U2	1		Hall Effect Magnetic Sensor VSSOP8	VSSOP8	TMAG6181EDGKRQ1	Texas Instruments

**Table 4-1. Bill of Materials (continued)**

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
U3	1		Low-capacitance, 2:1 (SPDT) 4-channel, powered-off protection switch with 1.8 V logic, RSV0016A (UQFN-16)	RSV0016A	TMUX1574RSVR	Texas Instruments
U4	1		SAR ADC, Dual, 700 kSPS, 16 Bit, Simultaneous Sampling, PW0016A (TSSOP-16)	PW0016A	ADS8354IPWR	Texas Instruments
U5	1		Dual Buffer Gate, YZP0006ADAD, LARGE T&R	YZP0006ADA D	SN74LVC2G34YZPR	Texas Instruments
U6	1		1-Bit Bidirectional Voltage-Level Shifter for Open-Drain and Push-Pull Application, DCK0006A (SOT-SC70-6)	DCK0006A	TXS0101DCKR	Texas Instruments
U7	1		Single Bus Buffer Gate With 3-State Outputs, DRY0006A (USON-6)	DRY0006A	SN74LVC1G125DRYR	Texas Instruments
U8	1		Single Power Supply BUFFER Logic Level Shifter (no enable), DCK0005A (SOT-SC70-5)	DCK0005A	SN74LV1T34DCKR	Texas Instruments
U9	1		Low Input, 20 V/1.1A Step-Up DC/DC Converter with Integrated Power Diode and Input/Output Isolation, DSK0010A (WSON-10)	DSK0010A	TPS61093DSKR	Texas Instruments
U10	1		Linear Voltage Regulator IC Positive Fixed 1 Output 150 mA 8-SON (3x3)	VSON8	TPS7B8450QWDRBRQ1	Texas Instruments
U11, U12	2		Low Power, High Supply Range, 70 MHz, Fully Differential Amplifier, RUN0010A (WQFN-10)	RUN0010A	THS4561IRUNR	Texas Instruments

## 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.
  - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductor products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
  - 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/llds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/llds/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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

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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ンスツルメンツ株式会社

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/llds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page)

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#### 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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