# TMAG5170EVM

# User's Guide

![Texas Instruments logo]

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# TMAG5170 Evaluation Module

This user's guide describes the characteristics, operation, and use of the TMAG5170 evaluation module (EVM). This EVM is designed to evaluate the performance of the TMAG5170. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the TMAG5170EVM. This document includes a schematic, reference printed-circuit board (PCB) layouts, and a complete bill of materials (BOM).
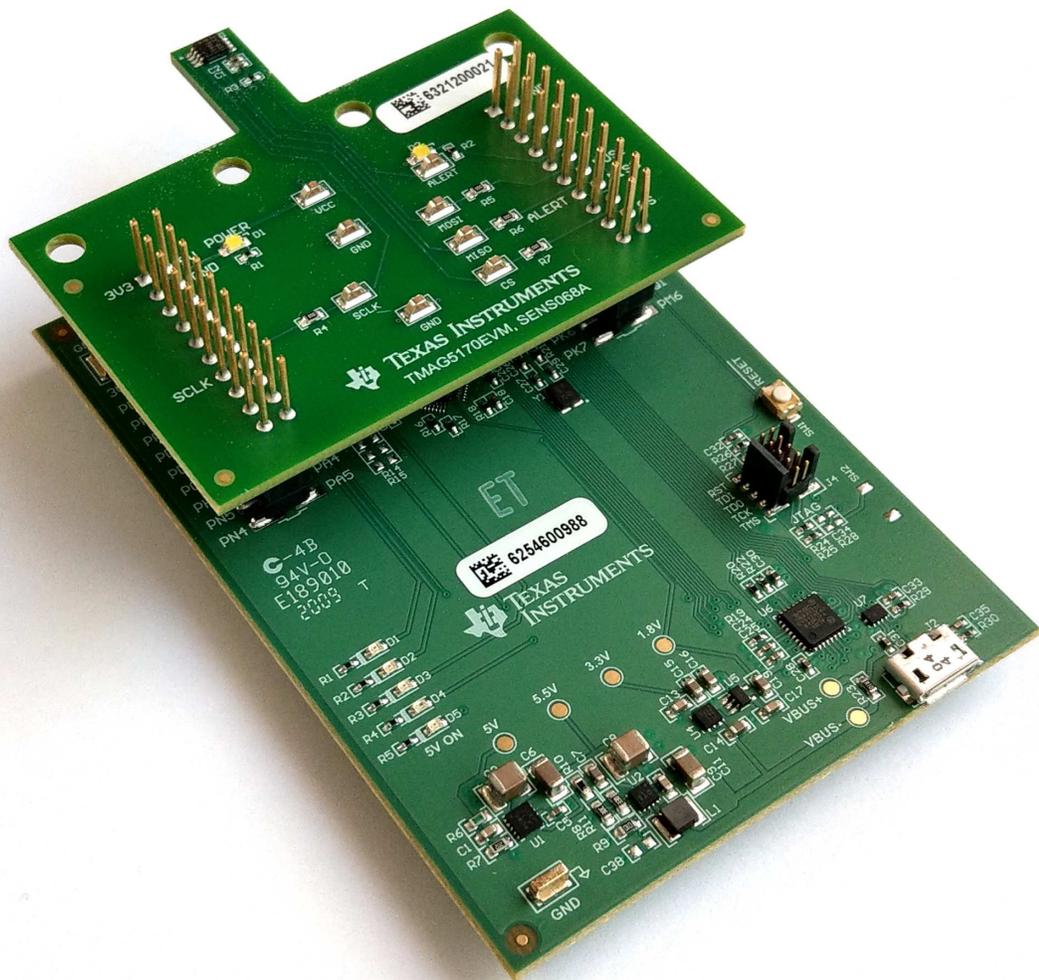
# 1    Trademarks

All trademarks are the property of their respective owners.

# 2    Overview

The TMAG5170 is a 3-axis linear Hall effect sensor. This device integrates 3 independent Hall sensors in X, Y, and Z axes. A precision analog signal-chain along with integrated 12-bit ADC digitizes the measured analog magnetic field values. The device can be configured further to select one of three magnetic field ranges that suits the magnet strength and component placements during system calibration.

**Table 1. TMAG5170 Device Summary**

| PRODUCT | SENSITIVITY RANGE OPTIONS |
|---|---|
| TMAG5170A1 | ±25 mT, ±50 mT, ±100 mT |

## 2.1    Kit Contents

Table 2 lists the contents of the EVM kit. Contact the nearest Texas Instruments Product Information Center if any component is missing.

**Table 2. Kit Contents**

| ITEM | QUANTITY |
|---|---|
| TMAG5170EVM | 1 |
| Rotate and push 3D print module | 1 |
| Handheld magnet | 1 |
| USB cable | 1 |

## 2.2    Related Documentation From Texas Instruments

This user's guide is available from the TI website under literature number SBAU350. 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. Table 3 lists documentation related to the EVM. Click the links in Table 3 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 3. Related Documentation**

| DOCUMENT TITLE | DOCUMENT LITERATURE NUMBER |
|---|---|
| TMAG5170-Q1 data sheet | SBAS934 |

## 3 Hardware

The EVM is an easy-to-use platform for evaluating the main features and performance of the TMAG5170. The EVM includes a graphical user interface (GUI) used to read and write registers, 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 it laid out for electromagnetic compatibility (EMC) testing. The EVM consists of 2 PCBs. The smaller PCB is referred to as the EVM, and has the TMAG5170 installed. The larger PCB is referred to as the PAMB Controller, and is used to interface the EVM with the GUI.

### 3.1 Features

- GUI support to read and write device registers, as well as view and save measurement results
- 3D print rotate and push module
- Detachable EVM for custom use cases
- Conveniently powered from a common micro-USB connector

## 4 Operation

### 4.1 Quick Start Setup

The following instructions describe how to set up and use the EVM.

Step 1. Download and install this driver: http://www.ti.com/lit/zip/sbac253

Step 2. Attach the EVM to the PAMB Controller as shown in Figure 1.

Step 3. Connect the EVM to a PC using a USB cable.

1. Insert the micro USB cable into the PAMB Controller onboard USB receptacle J2.
2. Plug the other end of the USB cable into a PC.

Step 4. Access the GUI from the below link in either Chrome or Firefox:

1. TMAG5170EVM GUI:
https://dev.ti.com/gallery/info/4910879/TMAG5170EVM_GUI/ver/1.0.0/

Step 5. Apply a magnetic field to the sensor by doing one of the following:

1. Wave the included handheld magnet around the sensor.
2. Use the Rotate & Push Module, by attaching it to the EVM as shown in Figure 9. For more details on how to use this module, see Section 4.2.2.

Step 6. Observe the outputs in the GUI. See Section 4.2.1.3 for more info on GUI setup and operation.

## *4.2 EVM Operation*

To use the EVM with the included PAMB Controller, connect the EVM as shown in Figure 1.
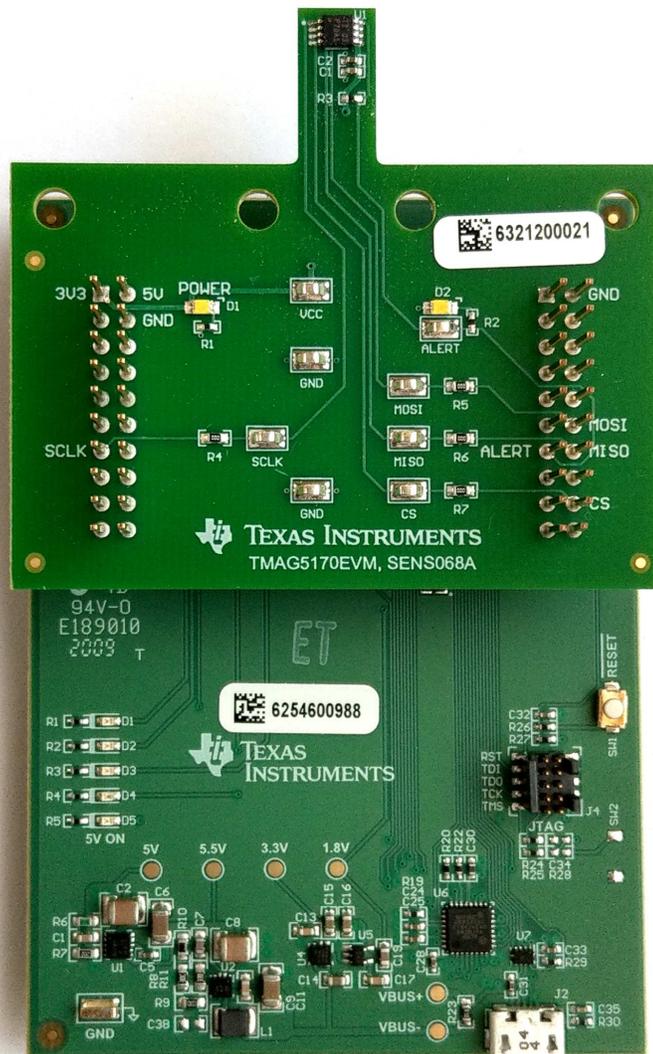


**Figure 1. EVM on PAMB Controller**

### 4.2.1    Setup

#### *4.2.1.1    Driver Installation*

Download and install this 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.

#### *4.2.1.2    Firmware*

The firmware comes preinstalled on the PAMB Controller. Firmware updates will be pushed through the GUI (requires previous driver to be installed). Downloaded offline GUIs may check for GUI/Firmware updates depending on the version.

#### 4.2.1.2.1 *Firmware Debug*

If the firmware gets corrupted or must be manually reinstalled for any reason, follow these steps to reinstall the firmware.

1. Configure the MCU on the PAMB Controller to be in Device Firmware Update (DFU) Mode.
   a. It is possible that the MCU has already entered DFU mode. If so, the GUI will notify you and try 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 PAMB Controller is powered on:
      • Through software:
        – Send the command 'bsl' on the PAMB's USB Serial (COM) port.
      • Though hardware (with the EVM removed):
        – Short the two test points near PK1 and PK2 of the header pins (shown in Figure 2) with a pair of tweezers (or wire) while pressing the RESET button.
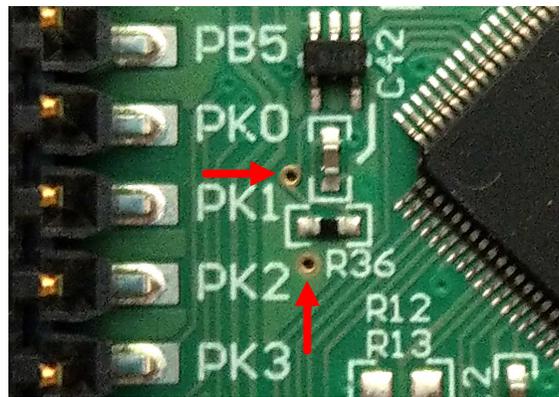


**Figure 2. Test Points Used to Enter DFU Mode Manually**

2. With the MCU in DFU mode, the firmware can now be uploaded through one of the following methods:
   • Through the GUI:
     – Plug in the PAMB Controller to a PC through the USB port and launch the GUI. DFU mode should be automatically detected, and the firmware will be uploaded automatically.
   • Through the USB Bootstrap Loader (BSL) scripter tool and batch file:
     – Download the firmware package and BSL scripter tool from the EVM page, or use the links below.
       • TMAG5170EVM: http://www.ti.com/lit/zip/sbac268
     – Unzip the fimware folder and run the .bat file.

#### 4.2.1.3 *GUI Setup and Usage*

Access the GUI from the below link in either Chrome or Firefox:
• TMAG5170EVM GUI: https://dev.ti.com/gallery/info/4910879/TMAG5170EVM_GUI/ver/1.0.0/

#### 4.2.1.3.1 *Initial Setup*

To set up the GUI the first time, follow the below instructions:

1. Make sure that the above mentioned driver was installed successfully to ensure that everything works properly and that the GUI can update the EVM firmware, if necessary.
2. With the EVM/PAMB Controller unit plugged to the PC, go to the GUI link provided above.
3. To launch the GUI from the web browser, click the **GUI Composer** application to open the *GUI Composer* window shown in Figure 3.
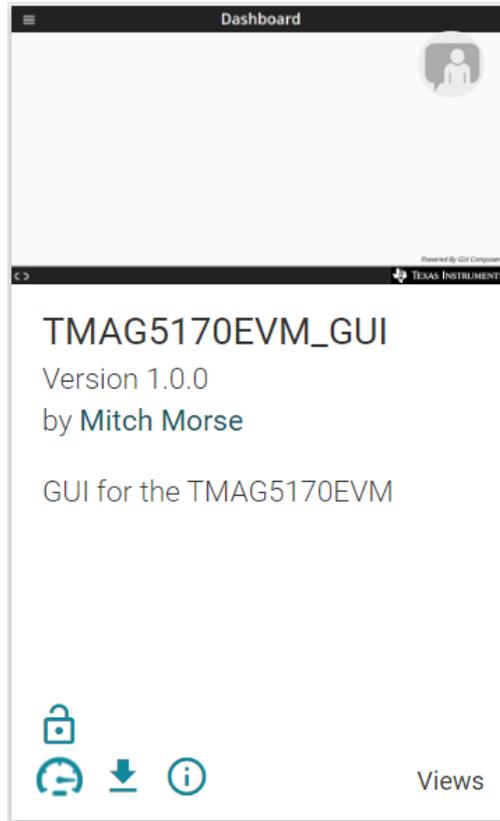
**Figure 3. GUI Composer Application Window**

    a. For first-time GUI Composer setup, follow the prompts to download the **TI Cloud Agent** and browser extension shown in Figure 4. These prompts will appear after you close the README.md dialog.



**Figure 4. TI Cloud Agent**

4. Optionally, the GUI can be downloaded for offline use by clicking the ⤓ icon in the *GUI Composer* window shown in Figure 3.

#### 4.2.1.3.2 *GUI Operation*

To operate the GUI, follow these steps:

1. Connect to and launch the GUI as described in Section 4.2.1.3.1.

2. With the EVM connected to the GUI, after closing the README.md file page the text near the bottom-left hand corner of the GUI should read *Hardware Connected* as in Figure 5.

COM7:115200    Hardware Connected.

**Figure 5. Hardware Connected**

    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**, as shown in Figure 6.

File    Options    Tools
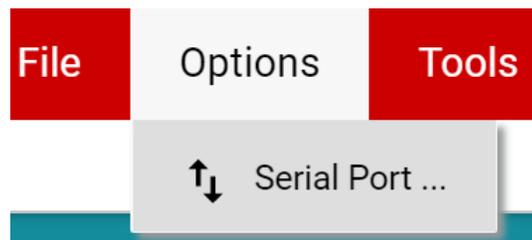↑↓ Serial Port ...

**Figure 6. Change Serial Port**

    b. If the hardware still does not connect, make sure you are using the correct GUI/EVM combination.

3. Click the **Registers** icon shown in Figure 7 (also available on the left side menu) to view the register map, and change device settings, and enable automatic register read. For questions about a register or register bit field, select the ❓ icon. For more questions about registers, check the data sheet.

Registers

Low level register read and write operations

**Figure 7. Registers Page Icon**

4. To view and save graphical data from the results registers, click on the **Plots** icon shown in Figure 8 (also available on the left side menu).

Plots

Plots for device outputs

**Figure 8. Plots Page Icon**

### 4.2.2    Rotate and Push Demo

To use the rotate and push demo:

1.  Attach the Rotate & Push Module to the EVM as shown in Figure 9.



**Figure 9. Rotate & Push Module on EVM**

2.  In the GUI register page:
    a.  Make sure that the DEVICE_CONFIG → OPERATING_MODE says *(TRIGGER_MODE Active)*.
    b.  Make sure that SYSTEM_CONFIG → TRIGGER_MODE is set to the default value.
    c.  Under the SENSOR_CONFIG register:
        i.   Make sure both the x and y channels are enabled (MAG_CH_EN).
        ii.  Set X_RANGE and Y_RANGE to ±100mT for A1 versions, and ±133mT for A2 versions.
        iii. Optional: Set ANGLE_EN to X-Y angle calculation.
    d.  At the top of the register map, set *Auto Read* to *As fast as possible.*
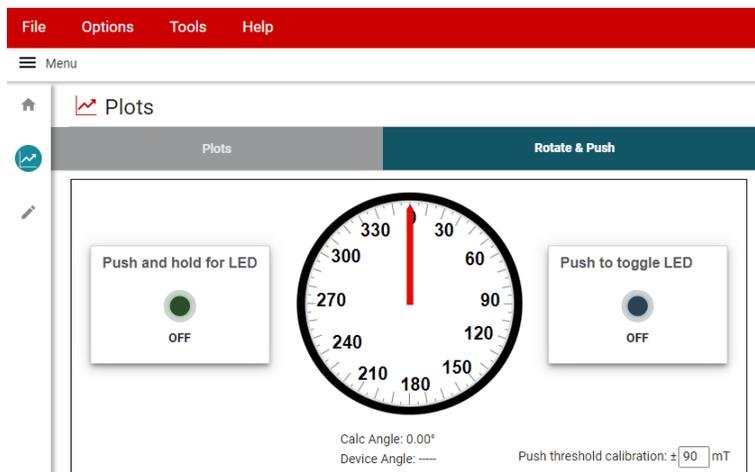3.  Go to the *Rotate & Push* tab inside the plots page, as shown in Figure 10.



**Figure 10. Rotate & Push GUI Page**

4.  If the push button LEDs are not triggering at every angle or trigger when they are not supposed to, calibrate the module by doing the following:

    a.  With the settings set to run the demo, slowly rotate the module 360° and use the plots page to record the absolute value of the minimum and maximum magnetic field measurements (in mT) for both the X and Y channels.

    b.  Adjust the *Push threshold calibration* value found in the *Rotate & Push* tab to be about 3-5mT larger than the maximum value recorded above.

### 4.2.3    Direct EVM Serial Communication

If desired, the EVM can be communicated with directly without the use of the GUI through the USB serial (COM) port. Simply send the desired command string over the serial port and recieve the results. This is useful for interfacing the EVM with custom setups/scripts/GUIs. To read and write registers, follow the below format:

- Read register format: rreg ADR
    - Where ADR is the address in hex, and rreg is always lower case
    - Register addresses can be in upper or lower case, and do not need to be led by '0x'. 0 padding register addresses is also optional. For example, to read register address 0xA, some valid commands include:
        - rreg a
        - rreg 0A
        - rreg 0x0A
            - When '0x' is used, the 'x' must be lower case.
    - For the above example, the EVM would return the results in JSON format

        {"acknowledge":"rreg 0x0A"}

        {"register":{"address":10,:"value":65488}}

        {"evm_state":"idle"}

- Write register format: wreg ADR VAL
    - where ADR and VAL are in hex, and wreg is always lower case
    - Register addresses and values can be in upper or lower case, and do not need to be led by '0x'. 0 padding register addresses and values is also optional. For example, to write register address 0x1 with the value 0x01c0, some valid commands include:
        - wreg 1 1c0
        - wreg 01 0x1c0
        - wreg 0x01 0x01C0
            - When '0x' is used, the 'x' must be lower case.
    - For the above example, the EVM would return the results in JSON format:

        {"acknowledge":"wreg 0x01 0x01C0"}

        {"console":"Writing 0x1c0 to SENSOR_CONFIG register"}

        {"evm_state":"idle"}

## 5    Circuitry

This section summarizes the EVM subsystems and their components.

### 5.1    Hall Effect IC

This section describes the main TMAG5170 device and supporting components.

U1 is the main TMAG7170 3D Hall effect device. C1 and C2 are bypass capacitors that are placed near the sensor to help mitigate power supply noise and provide current quickly to the device when needed. LED D1 with current limiting resistor R4 are used to indicate when the EVM is powered on.

The device pins can be monitored directly through the test points TP1 – TP8. Note that there is one extra test point on GND for convenience.

### 5.2    Digital Circuitry

This section describes the digital circuitry around the device.

J1 and J2 are the main header pins that connect the digital and power pins to the PAMB Controller. R4-R7 are 0-$\Omega$ resistors in series with the main digital IO pins. These resistors can be removed to disconnect the digital pins from the header pins. Optionally, these resistor spaces can be used to provide inline filtering on the digital lines.

R3 is used as a pullup resistor for the ALERT pin, which is routed to J2. LED D2 with current limiting resistor R2 are used to indicate when the ALERT has triggered.

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

> **NOTE:**    Board layouts are not to scale. These figures are intended to show how the board is laid out. The figures are not intended to be used for manufacturing EVM PCBs.

### 6.1    Schematics

Figure 11 and Figure 12 show the schematic of the EVM. Figure 11 shows the circuitry for the EVM. Figure 12 shows the mechanical components included with the EVM.
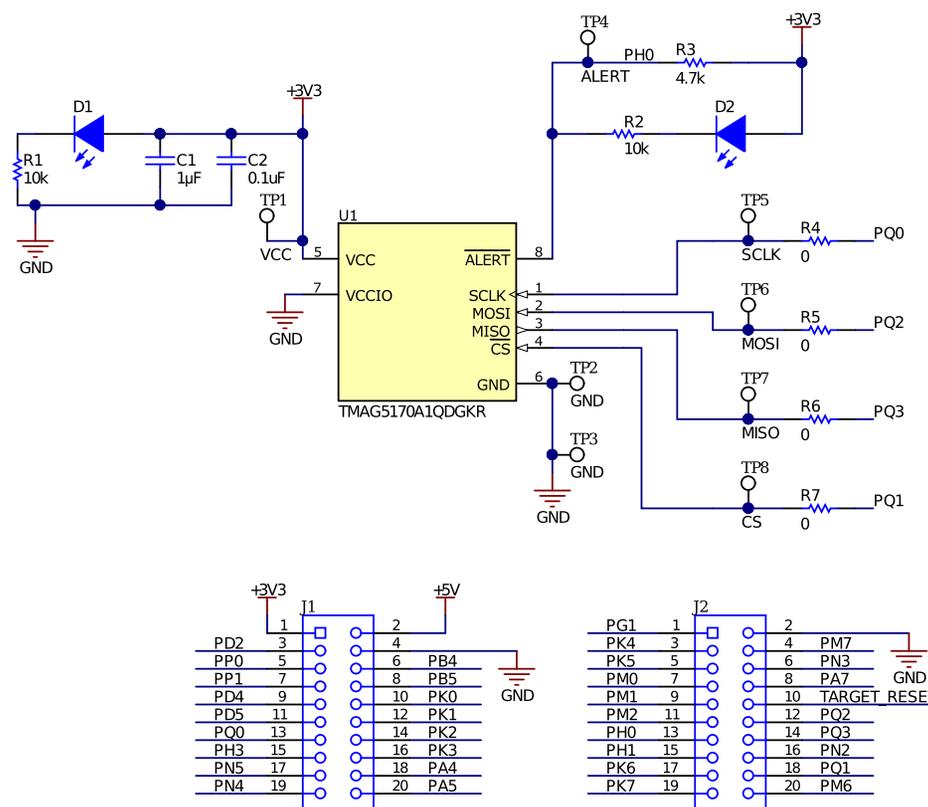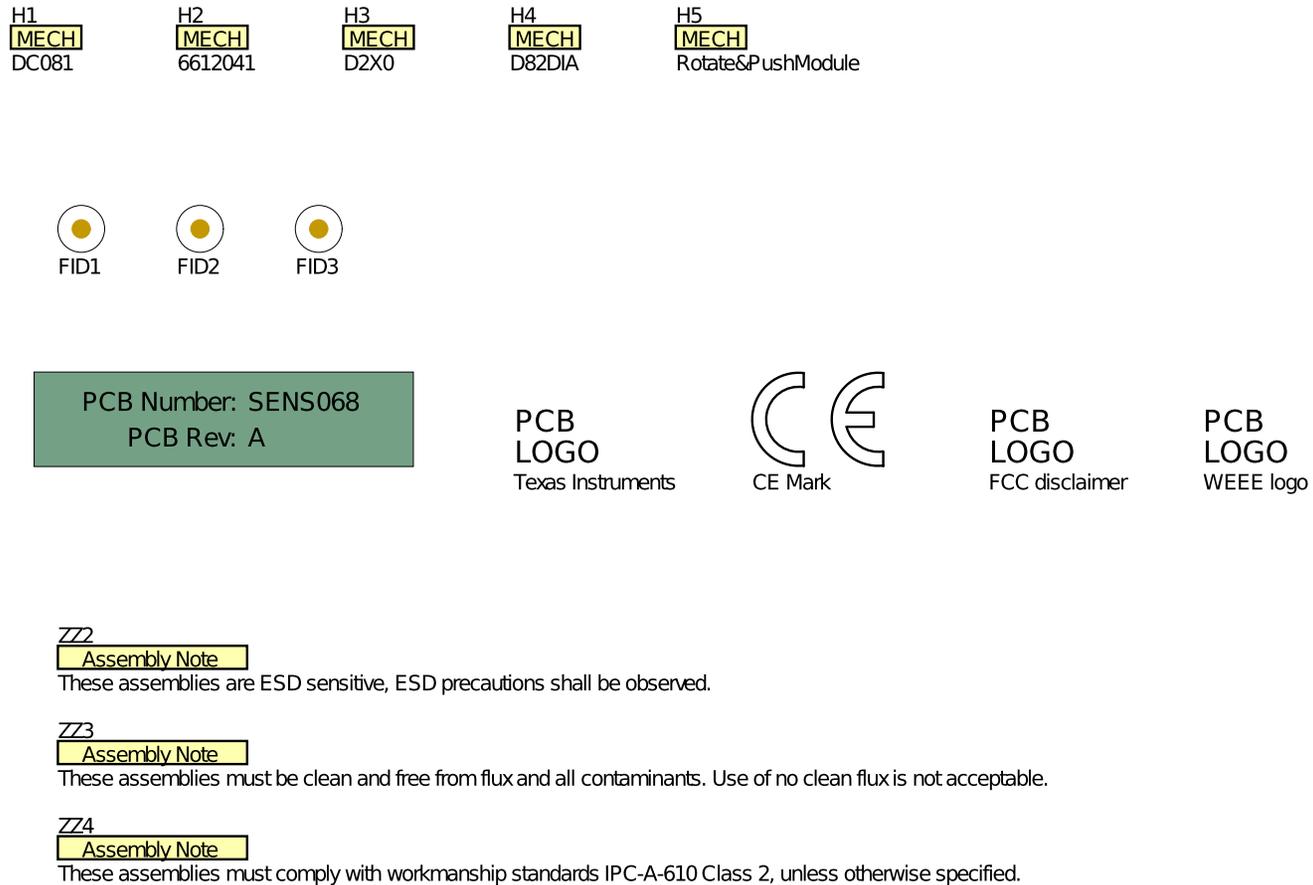


**Figure 11. TMAG5170EVM Schematic**

H1
MECH
DC081

H2
MECH
6612041

H3
MECH
D2X0

H4
MECH
D82DIA

H5
MECH
Rotate&PushModule

FID1

FID2

FID3

PCB Number: SENS068
PCB Rev: A

PCB
LOGO
Texas Instruments

CE Mark

PCB
LOGO
FCC disclaimer

PCB
LOGO
WEEE logo

ZZ2
Assembly Note
These assemblies are ESD sensitive, ESD precautions shall be observed.

ZZ3
Assembly Note
These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

ZZ4
Assembly Note
These assemblies must comply with workmanship standards IPC-A-610 Class 2, unless otherwise specified.

**Figure 12. Hardware Schematic**

## 6.2 PCB Layout
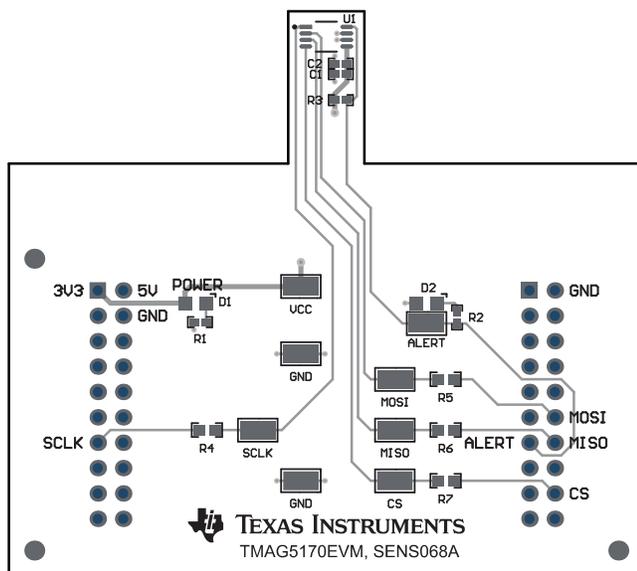
**Figure 13. Top View**
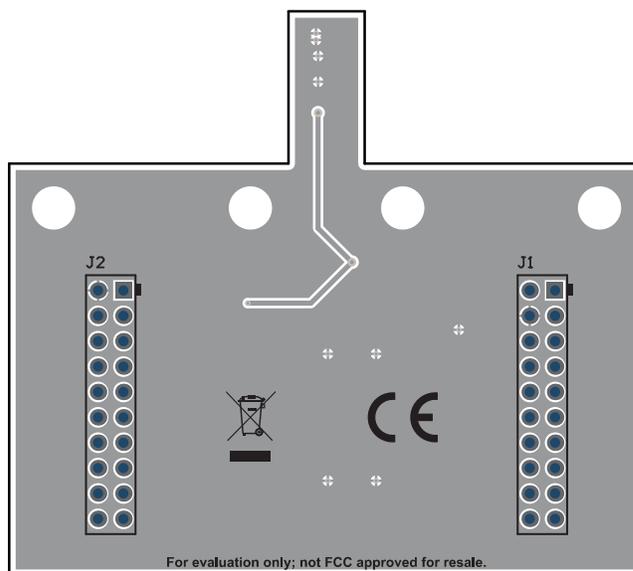


**Figure 15. Bottom View**
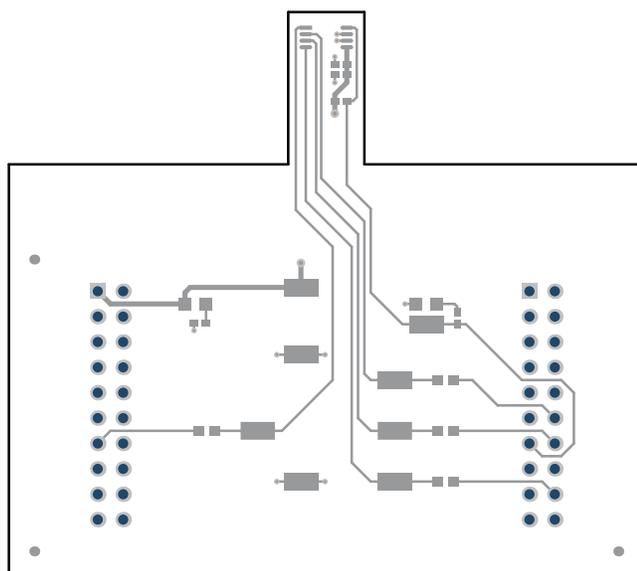


**Figure 14. Top Layer**
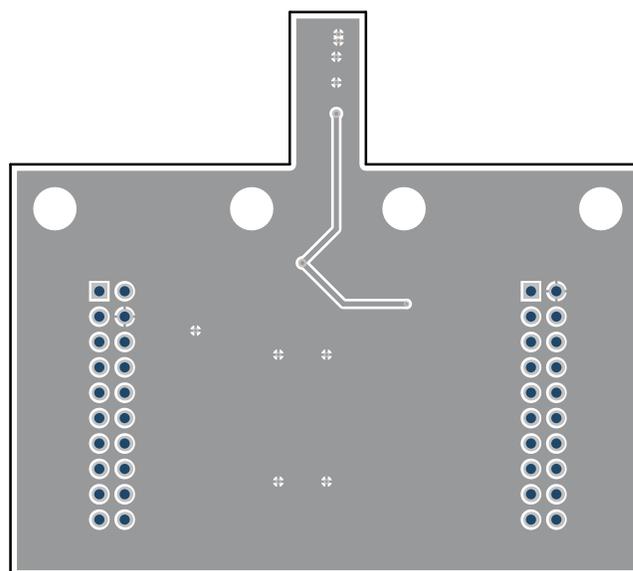


**Figure 16. Bottom Layer**

## 6.3 Bill of Materials

Table 4 provides the parts list for the EVM.

### Table 4. Bill of Materials

| Designator | Quantity | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| !PCB | 1 | | Printed Circuit Board | | SENS068 | Any |
| C1 | 1 | 1uF | CAP, CERM, 1 μF, 16 V,+/- 20%, X5R, 0402 | 0402 | CL05A105MO5NNNC | Samsung Electro-Mechanics |
| C2 | 1 | 0.1uF | CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, 0402 | 0402 | GRM155R71H104ME14D | MuRata |
| D1, D2 | 2 | White | LED, White, SMD | 0805 | VAOL-S8WR4 | Visual Communications Company, LLC |
| H1 | 1 | | PAMB Controller | | DC081 | Texas Instruments |
| H2 | 1 | | Kitting Item: 3025010-03; Cable, USB A MALE to Micro B MALE 3'; CDDS 6612041 | | 6612041 | Qualtek |
| H3 | 1 | | Kitting Item: D2X0, 1/8" dia. x 1" thick, N42 magnet | | D2X0 | K&J Magnetics |
| H4 | 1 | | Kitting Item: D82DIA, 1/2" dia. x 1/8" thick, N42 diametric magnet | | D82DIA | K&J Magnetics |
| H5 | 1 | | Kitting Item: Plastic module to test rotate and push setup | | Rotate&PushModule | Stratasys |
| J1, J2 | 2 | | Receptacle, 2.54mm, 10x2, Gold, TH | Receptacle, 2.54mm, 10x2, TH | SSQ-110-03-G-D | Samtec |
| R1, R2 | 2 | 10k | RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402 | 0402 | CRCW040210K0JNED | Vishay-Dale |
| R3 | 1 | 4.7k | RES, 4.7 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402 | 0402 | CRCW04024K70JNED | Vishay-Dale |
| R4, R5, R6, R7 | 4 | 0 | RES, 0, 5%, 0.125 W, 0603 | 0603 | MCT06030Z0000ZP500 | Vishay/Beyschlag |
| TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8 | 8 | | Test Point, Miniature, SMT | Testpoint_Keystone_Miniature | 5015 | Keystone |
| U1 | 1 | | 3-Axis Linear Hall Effect Sensor With SPI Interface | VSSOP8 | TMAG5170A1QDGKR | Texas Instruments |