Joystick Evaluation Platform

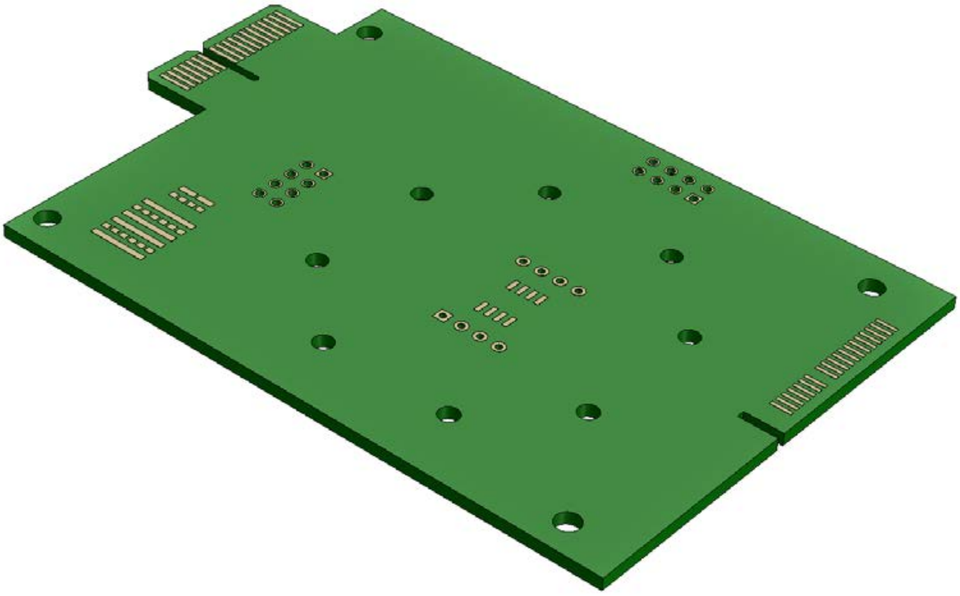
User Manual

HAL 3900

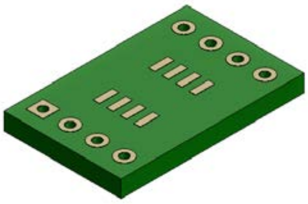
TDK-Micronas GmbH

Contents

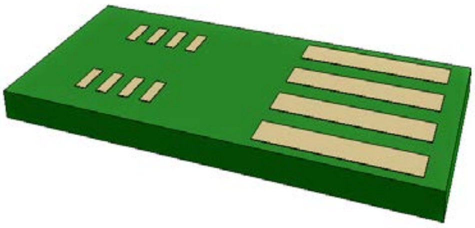
1 Component List



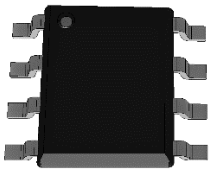
1 X JOYSTICK PCB



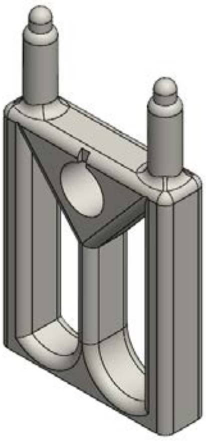
2 X RAISED PCB



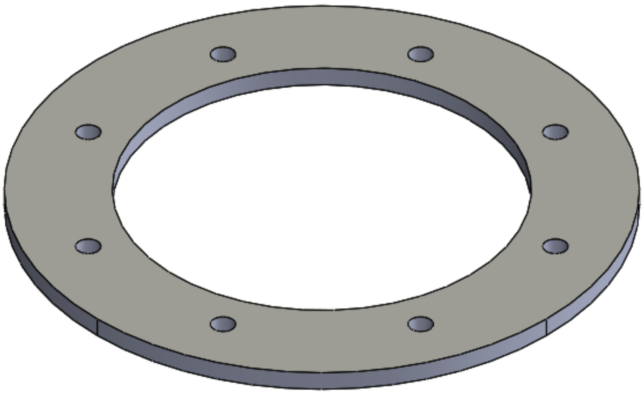
2 X SIDE PCB



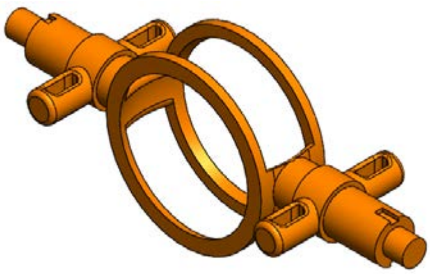
3 X HAL 3900



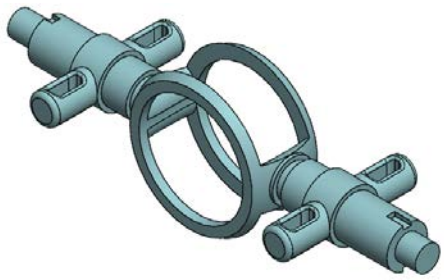
4 X HOLDER



1 X TOP PLANE

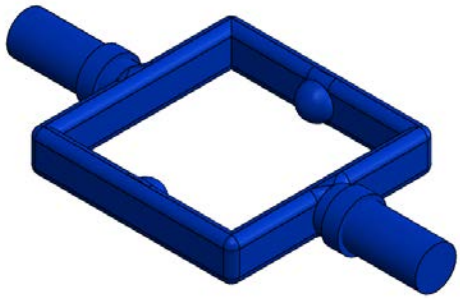


1 X LARGE REV. JOINT



1 X SMALL REV. JOINT

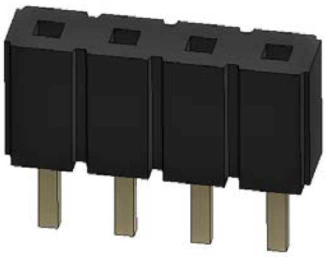
1 X REV. LEVER



1 X GIMBAL JOINT

1 X GIMBAL LEVER

2 X 4x10 mm MAGNET



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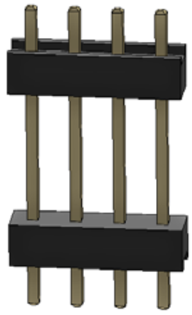

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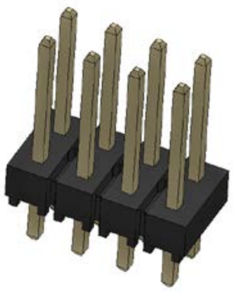

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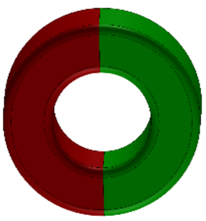


2X 2-POLE RINGMAGNET

8 X BRASS SCREWS

2 Introduction

2.1 Aim

The purpose of this project is to demonstrate the use of a Direct Angle Magnetic Sensor in a Joystick configuration. For this demonstration, the HAL 3900 is used. However, other sensors of TDK-Micronas product line can be configured and used in this application.

2.2 Specifications

The HAL 3900 is a 3D position sensor based on Hall-effect technology. The sensor includes an array of horizontal and vertical Hall plates based on TDK-Micronas' 3D HAL technology. The Hall plate signals are first measured by two/three separate A/D-converters (one for each channel), filtered and temperature compensated. A linearization block can be used optionally to reduce the overall system non-linearity error, due to mechanical misalignment, magnet imperfections, etc. Offset compensation by spinning current minimizes the errors due to supply voltage and temperature variations as well as external package stress. Stray-field compensation (according to ISO11452-8) is done automatically. Communication to the sensor is established via SPI interface.

2.3 Measurement Configuration

Three of the measurement configurations supported by the sensor are demonstrated by the Joystick Module as following:

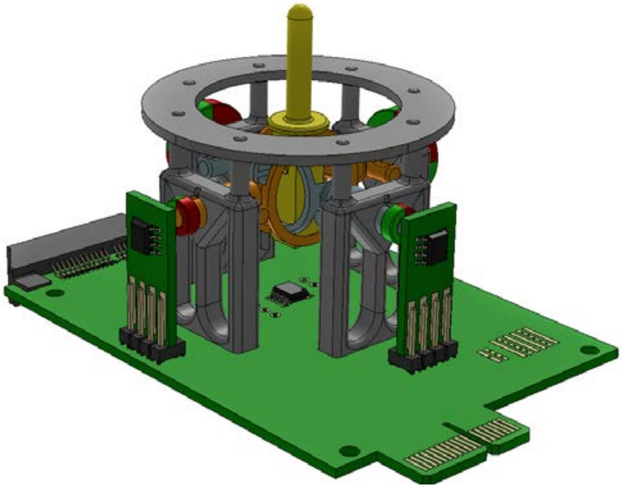
- ❖ 3D Position Detection – Joystick → The sensor is at the center of the joystick module and detects the positioning of a magnet inside the joystick lever.
- ❖ 3Z rotational measurement – Joystick → Two sensors are placed at the sides of the module at X and Y coordinates detecting the rotation of the 2pole magnets, which are fixed at the end of the revolving joints. The sensor is placed on the Side PCBs side marked "4 Pole 180 DEG" and is facing the magnet.
- ❖ XY rotational measurement – Joystick → Two sensors are placed at the sides of the module at X and Y coordinates detecting the rotation of the 2pole magnets, which are fixed at the end of the revolving joints. The sensor is placed on the Side PCBs side marked "2 Pole 360 DEG" and is facing the magnet.

2.4 Joystick Joint Types

The Joystick module is delivered with two different joint types. Revolving Joint and Gimbal Joint, the functionality of a Universal Joint is covered by the Revolving Joint assembly. Any of the provided joints can be assembled by the customer. The Demonstrating software provided (see section 4) supports all three assemblies.

Table 1: List of Joystick Module setups

No	Mechanical Setup	Sensor measuring configuration	COM Device			Magnets
			MSP(i)	MSP	Arduino	
1	Revolving Joint	3D Position Detection	✓	✓	✓	4 x 10 mm 2 P
		3Z rotational measurement	✓	✗	✗	
		XY rotational measurement	✓	✗	✗	2 P ring
2	Gimbal Joint	3D Position Detection	✓	✓	✓	4 x 10 mm 2 P
3	Universal Joint	3D Position Detection	✓	✓	✓	4 x 10 mm 2 P
		Sensor Programmable?	✓	✓	✗	



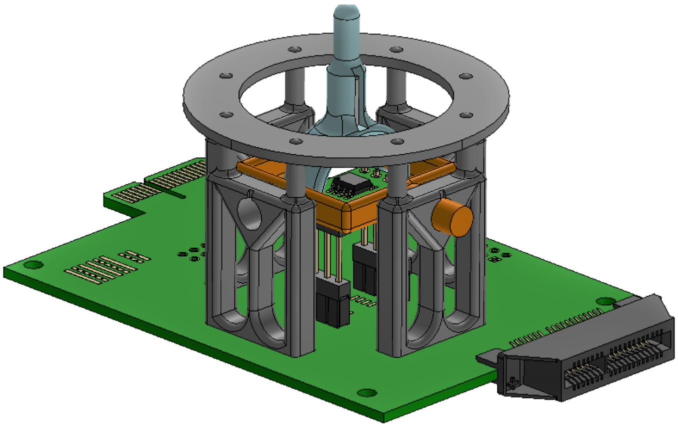


Figure 1: Revolving Joint

Figure 2:Gimbal Joint

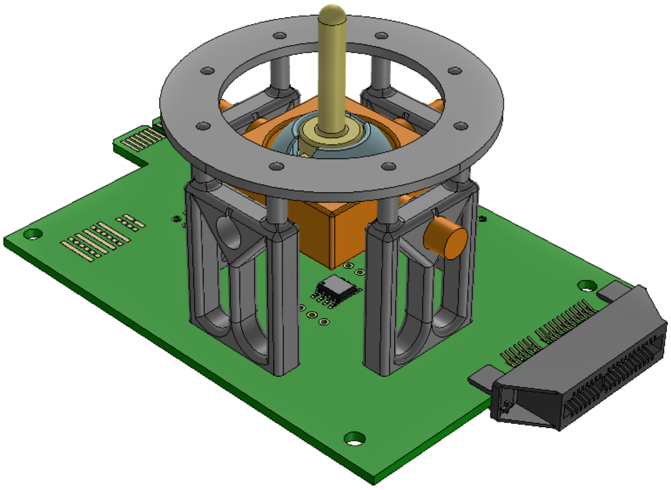


Figure 3: Universal Joint (not available)

2.5 Software

A LabVIEW™ based Evaluation software environment named "Joystick/Shift-by-wire Evaluation Platform" can be downloaded from service.micronas.com (registration required). "Joystick/Shift-by-wire Evaluation Platform" is providing the communication interface to the sensor as well as visualization of the Magnetic Field characteristics and Joystick position. The user is also given the opportunity to program the sensor when it is set to factory defaults. The installation includes the executable of the evaluation software, STL files loaded by the 3D Environment and EEPROM dump files used to program the sensor. More details found in section 4.

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3 Assembly Guide

3.1 Communication Device Notes:

3.1.1 TDK SPI Programmer V1.x

This is TDK's dedicated Programmer for SPI Sensors. It is the preferred communication device for this Evaluaton and can be used in all measurement configurations. Using the TDK SPI Programmer two different configurations can be handled on the same Joystick module (eg. 3D position and Rotational)

3.1.2 TDK Magnetic Sensor Programmer V1.x

This is the original TDK Magnetic Sensor Programmer, it can only be used in 3D Position Detection. In addition, the Joystick Module has the capapility to accommodate a biphase sensor and establish communication through the RJ25 or using the TDK micro edge card to Dsub-25 adapter board.
A Biphase Bridge is provided for Biphase communication setup (eg. HAL3930), a 0R 0603 resistor need to be connected between selected sensor and output in this mode. Further notes in Appendix 5.1.3.

3.1.3 Arduino

An arduino can be used for 3D Position Detection to communicate with the sensor, provided that the sensor is already programmed and calibrated. Further notes in Appendix 5.1.2.

Configuration for Arduino:

1. Solder both Arduino headers
2. Solder a 0603 0R Resistor at the Arduino PWR bridge, between S1/3 and/or S2/4 and desired voltage pad.
3. If you intend to use S2/4 please
4. Open Joystick_Module.ino (provided Arduino code) using the Arduino IDE and upload it to your Arduino.

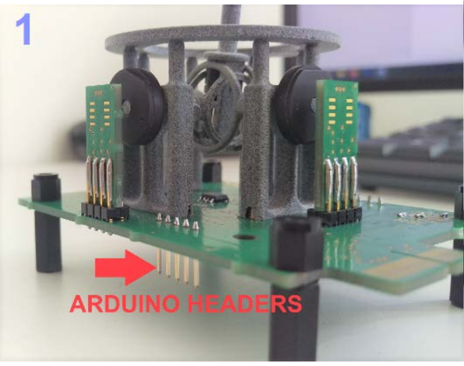


Figure 4:Arduino Config, Step 1

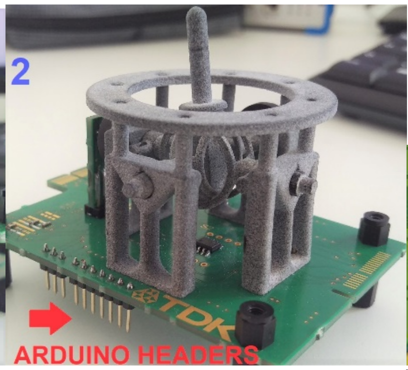


Figure 5:Arduino Config, Step 1

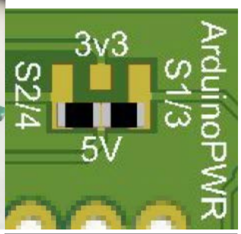


Figure 6:Arduino Config, Step 3

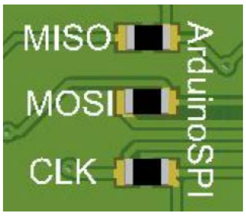


Figure 7:Arduino Config, Step 4

Note: × Connecting any other device when an Arduino is already present could cause damage

3.2 Revolving Joint

This setup can be used with three different measurement configurations of the sensor.

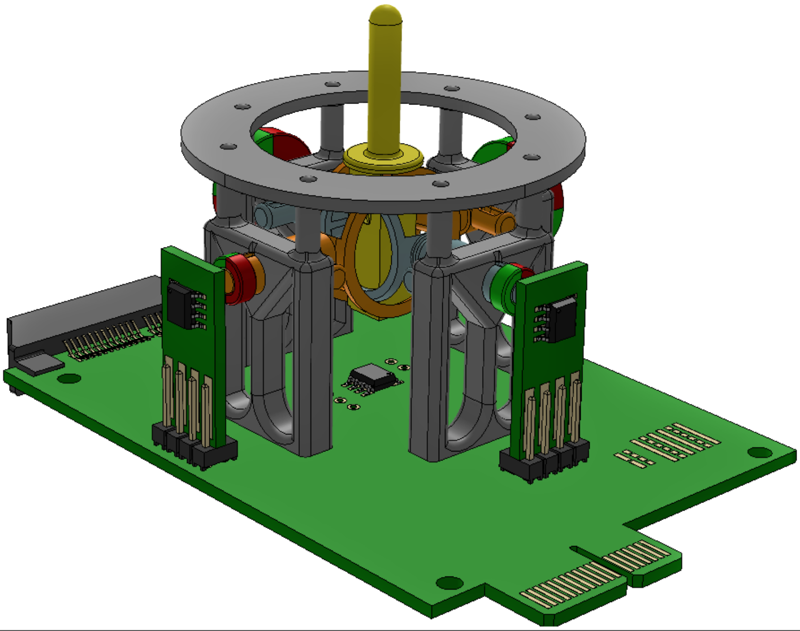


Figure 8: Revolving Joint complete

3.2.1 3D Position Detection

1. Solder the HAL 3900 on the Joystick PCB at S1
2. Fix one holder on the joystick PCB using the provided brass screws.
3. Place the large rev. joint through the holder
4. Secure it with a second holder at the opposite side.
5. Insert the small rev. joint through the large rev. joint
6. Use Brass Screws to fix the 3rd holder on the joystick PCB
7. Use Brass Screws to fix the 4rd holder on the joystick PCB
8. Insert a magnet in the slot of the rev. lever, make the magnet level with the bottom surface of the lever for an air gap of 10mm, adjust the airgap as needed. Airgap indicator at the edge of the lever, 2mm per notch.
9. Place the top plane.
10. Center both rev. joints and push the rev. lever trough the center slot until it locks.
11. Solder a 0R 0603 on CS Bridge between S1 and CS0.

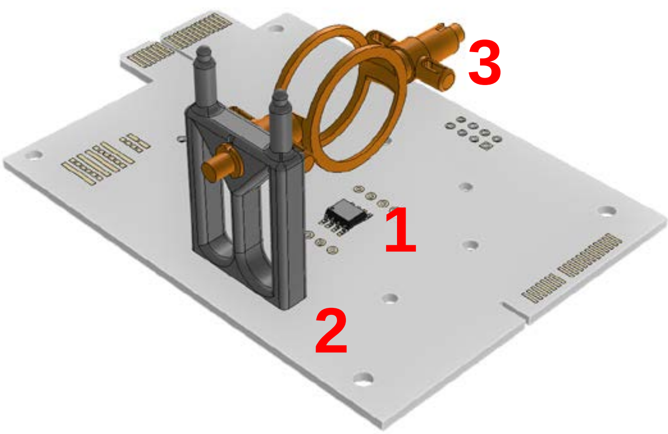


Figure 9: Revolving 3D position step 1/ 2/ 3

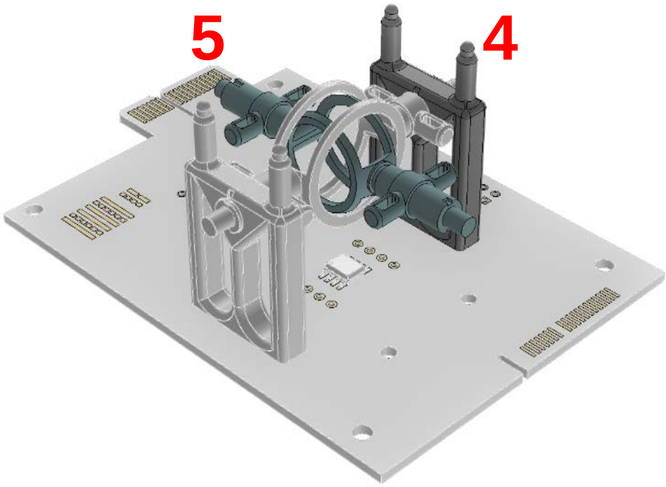


Figure 10: Revolving 3D position step 4/ 5

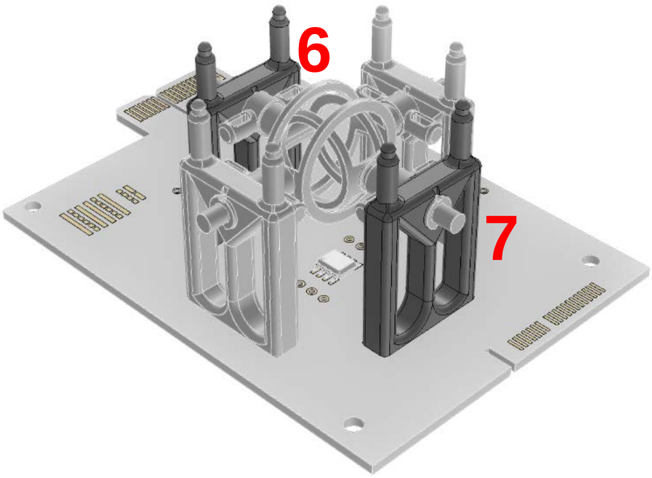


Figure 11: Revolving 3D position step 6/ 7

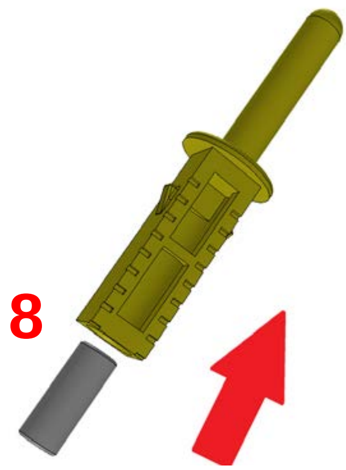


Figure 12: Revolving 3D position step 8

Figure 13: Revolving Lever airgap indicator

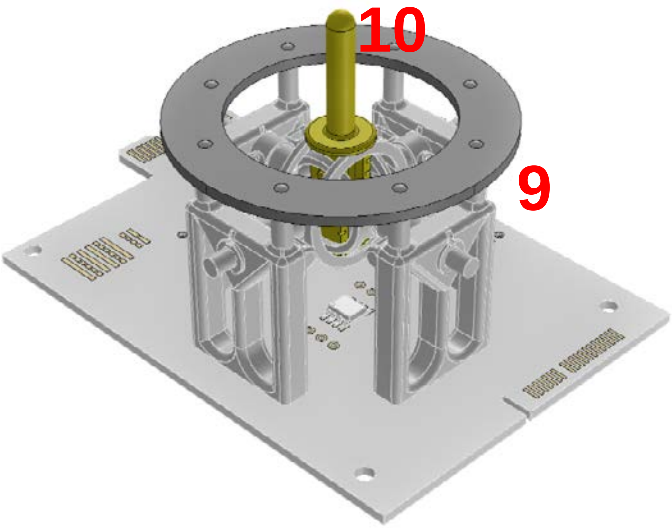


Figure 14: Revolving 3D position step 9/ 10

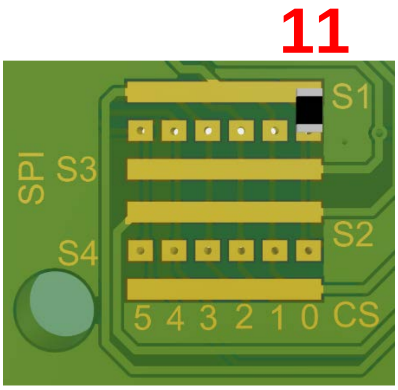


Figure 15: Revolving 3D position step 11

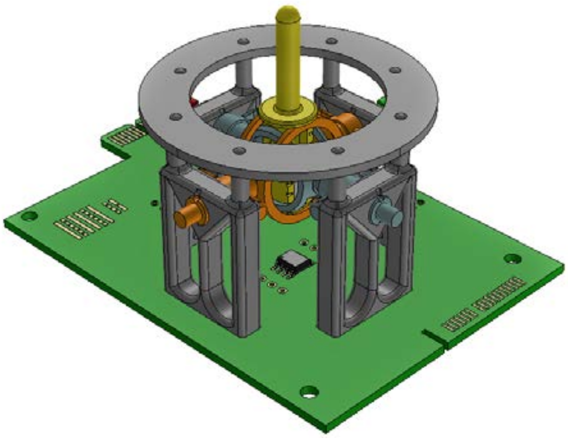


Figure 16: Revolving 3D position complete

3.2.2 Rotational Position Detection

Note: The rotation of the joints is important, the two pole magnet ring fit only on one of the sides of each joint

1. Fix one holder on the joystick PCB using the provided brass screws.
2. Place the large rev. joint through the holder
3. Secure it with a second holder at the opposite side.
4. Insert the small rev. joint through the large rev. joint and repeat steps 2 & 3.
5. Place the top plane.
6. Center both rev. joints and push the rev. lever trough the center slot until it locks.
7. Solder a 0R 0603 on CS Bridge between S3 and CS2
8. Solder a 0R 0603 resistor on CS Bridge between S4 and CS3

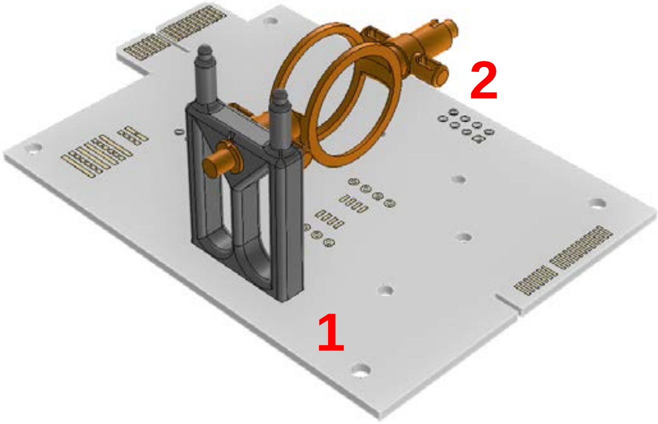


Figure 17: Revolving Rotational step 1

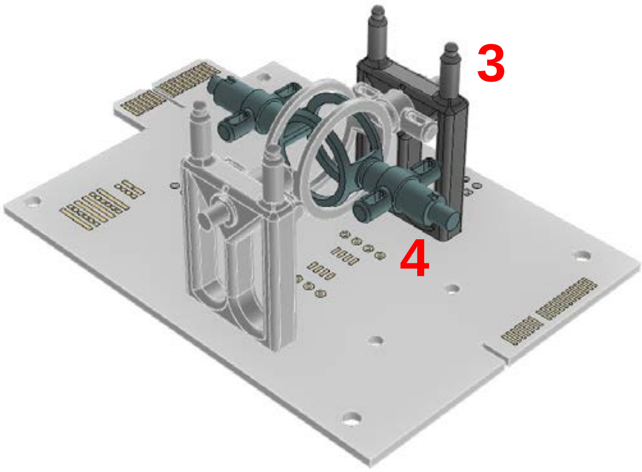


Figure 18: Revolving Rotational step 2

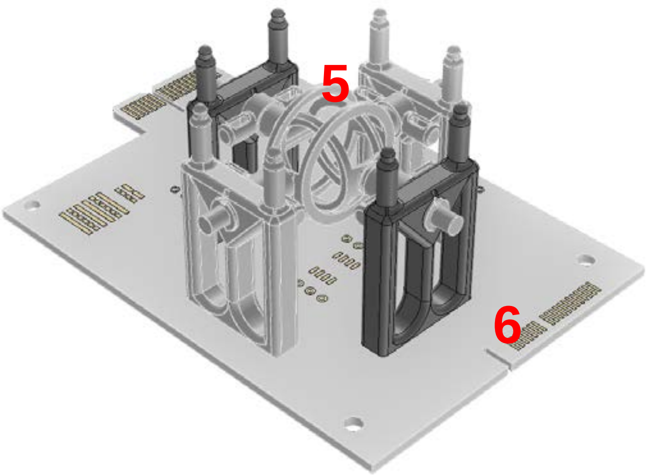


Figure 19: Revolving Rotational step 4

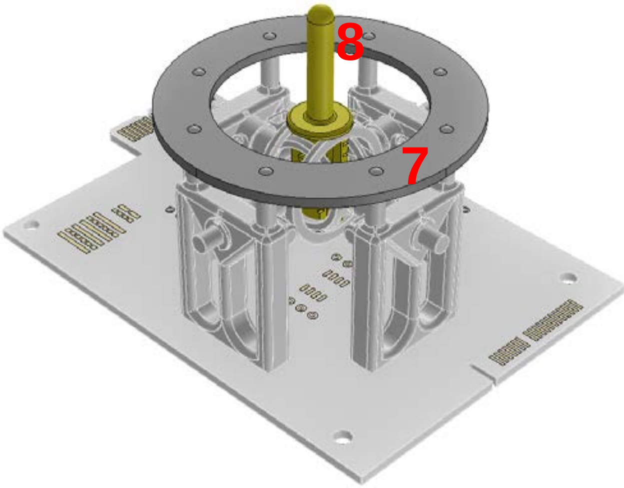


Figure 20: Revolving Rotational step 4

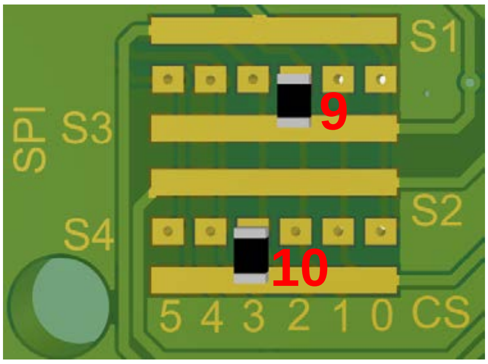


Figure 21: Revolving Rotational step 5

Note: 1. Do not solder a sensor at the face of the side PCB that is unused, if a sensor is already present, remove it.

2. The Position of the HAL 3900 on the "2-pole 360 DEG" side of the side PCB is lower than the "4-pole 180 DEG" side.

3.2.2.1 3Z rotational measurement

1. Fix the two 2-pole magnets at the sides of the joint (close to S3 and S4 connectors).
2. Solder the 2x4 Header at the edge of the two side PCBs
3. Solder the HAL 3900s on the two side PCB's at the face indicating "4-pole 180 DEG".
4. Solder the Side PCBs to the Joystick PCB at S3 and S4 with the sensor facing the Joystick module.

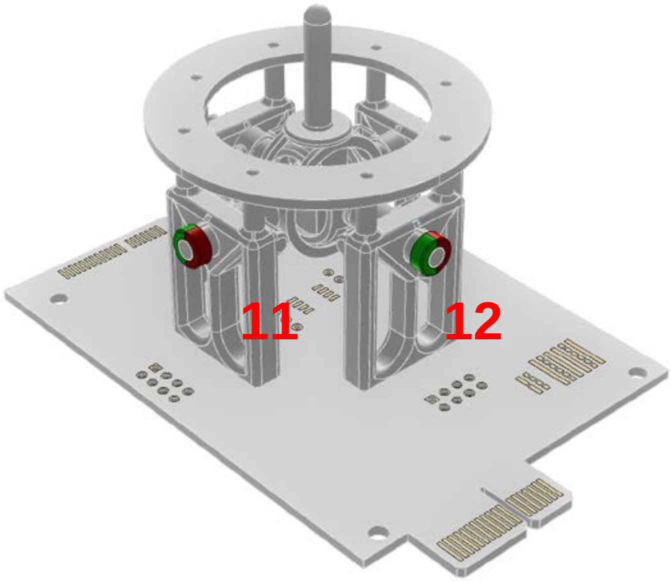


Figure 22: 2 pole magnets

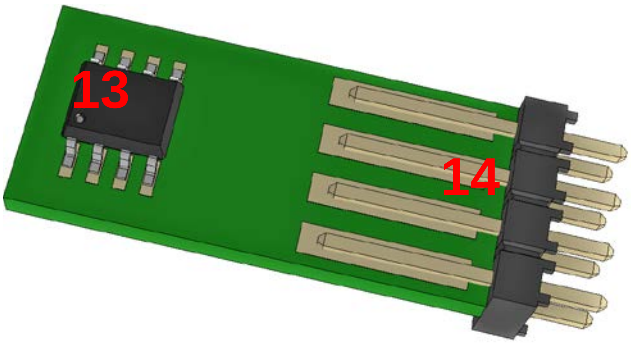


Figure 23: 3Z side PCB assembly ("4-pole 180 DEG" face)

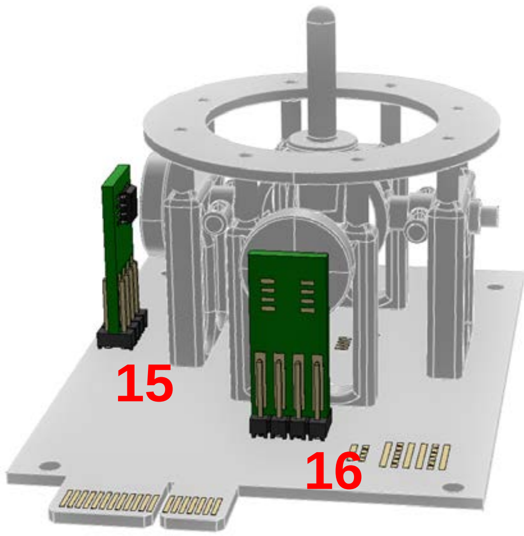


Figure 24: 3Z side PCB installation

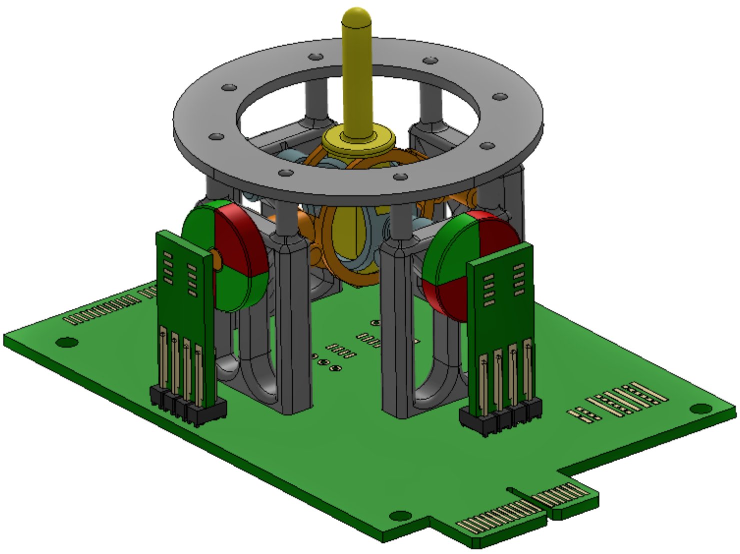


Figure 25: 3Z complete

3.2.2.2 XY rotational measurement

1. Fix the two 2-pole magnets at the sides of the joint (close to S3 and S4 connectors).
2. Solder the 2x4 Header at the edge of the two side PCBs
3. Solder the HAL 3900s on the two side PCB's at the face indicating "2-pole 360 DEG".
4. Solder the Side PCBs to the Joystick PCB at S3 and S4 with the sensor facing the Joystick module.

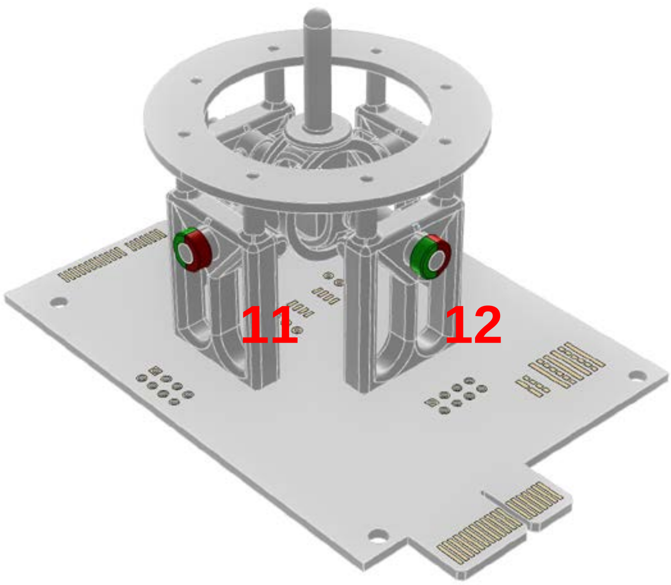


Figure 26: 2 pole magnets

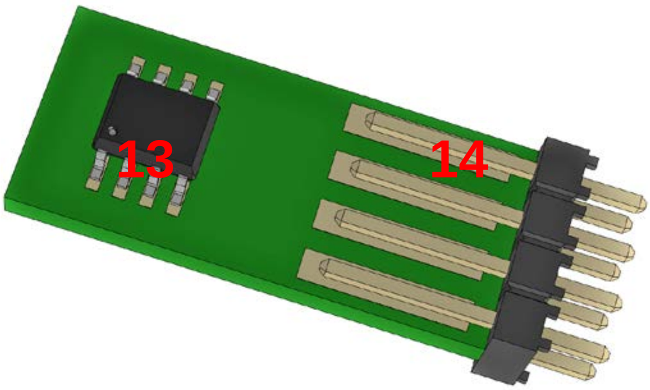


Figure 27: XY side PCB assembly ("2-pole 360 DEG" face)

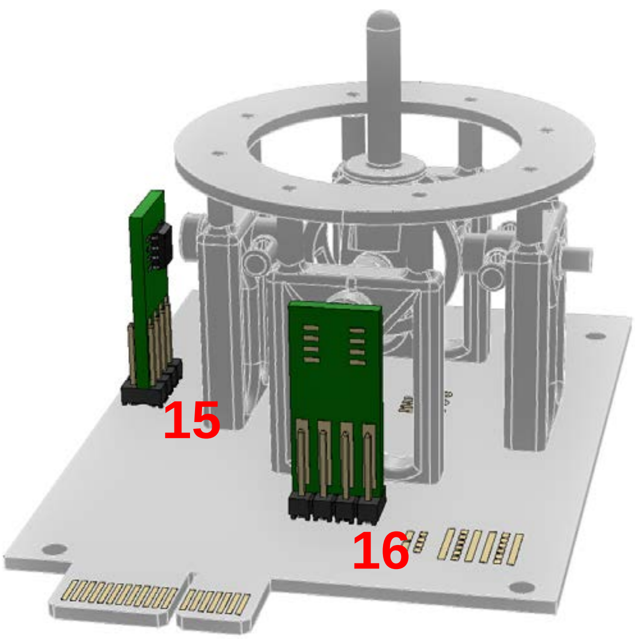


Figure 28: XY side PCBs installation

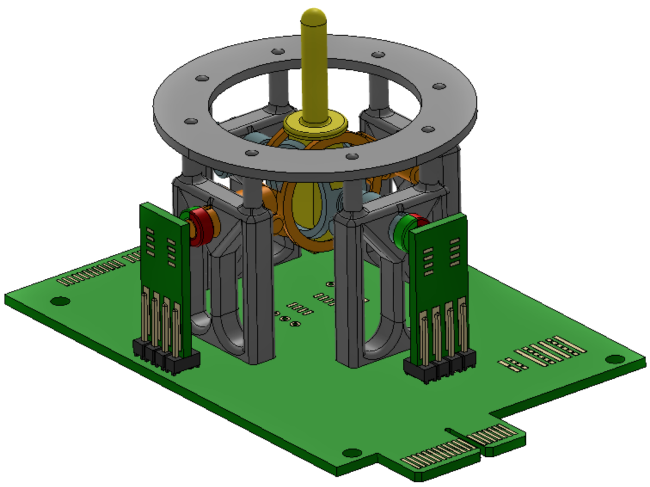


Figure 29: XY complete

3.3 Gimbal Joint

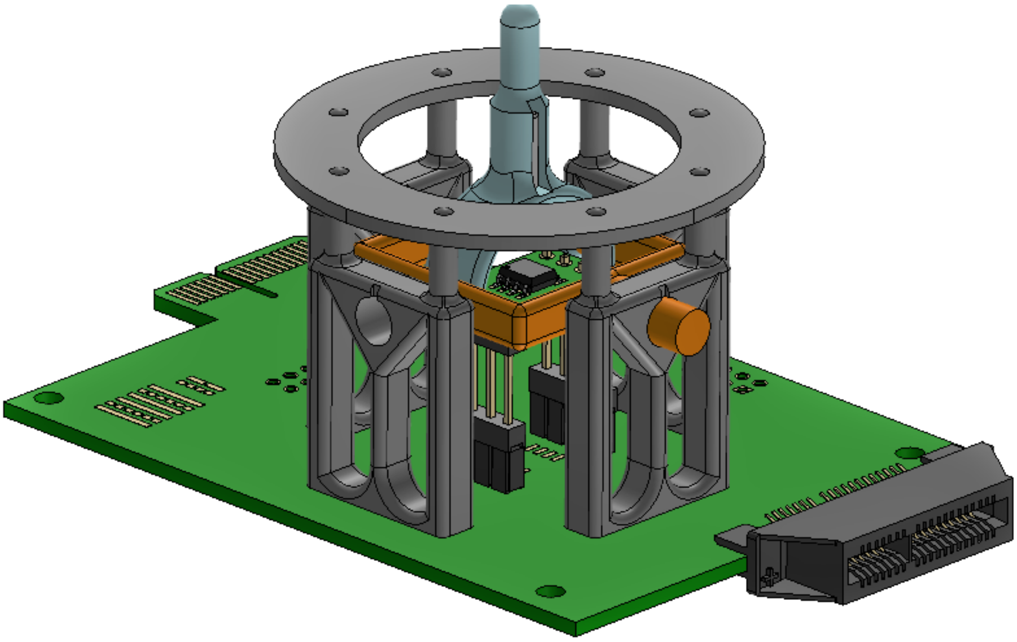


Figure 30: Gimbal Joint Complete

1. Solder the female header sockets at position S2
2. Solder the HAL3900 and raised headers on the raised PCB
3. Insert the raised PCB on the Joystick Module PCB at S2
4. Fix one holder on the joystick PCB using the provided brass screws.
5. Place the gimbal joint through the holder
6. Secure it with a second holder at the opposite side.
7. Screw the remaining holders
8. Insert a magnet in the slot of the gimbal stick until it is level with the bottom surface of the slot.
9. Push the gimbal lever onto the joint until it locks.
10. Place the top plane.
11. Solder a 0R 0603 on CS Bridge between S2 and CS1.

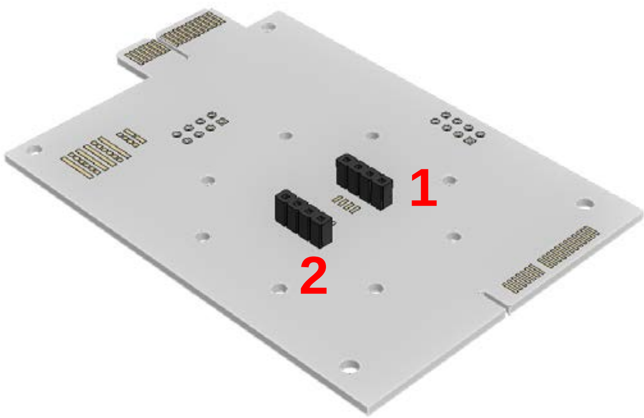


Figure 31: Gimbal Step 1

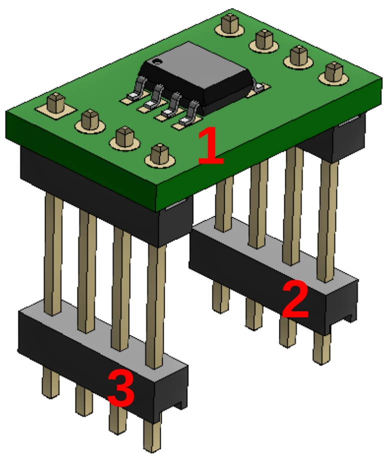


Figure 32: Gimbal Step 2 - Raised PCB assembly

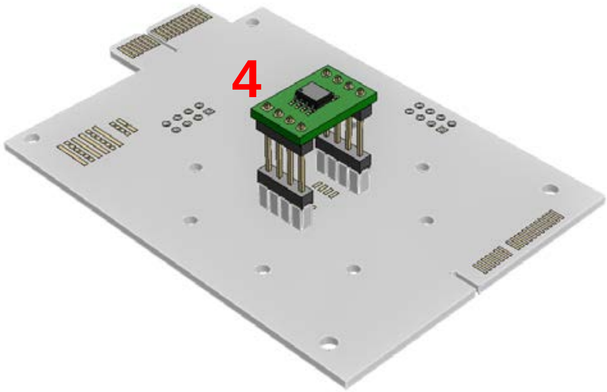


Figure 33: Gimbal Step 3

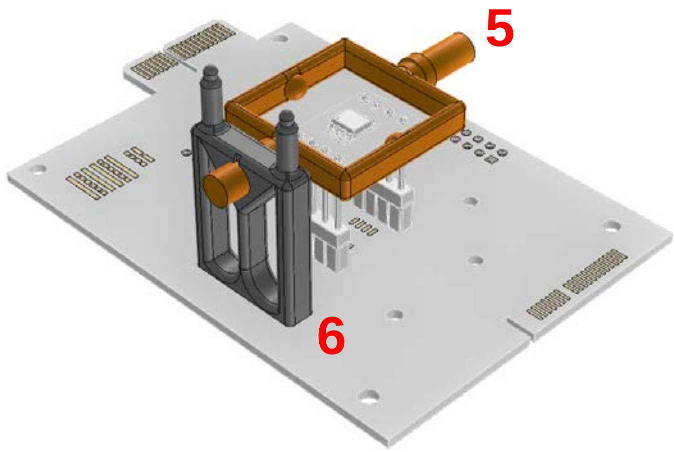


Figure 34: Gimbal Step 4

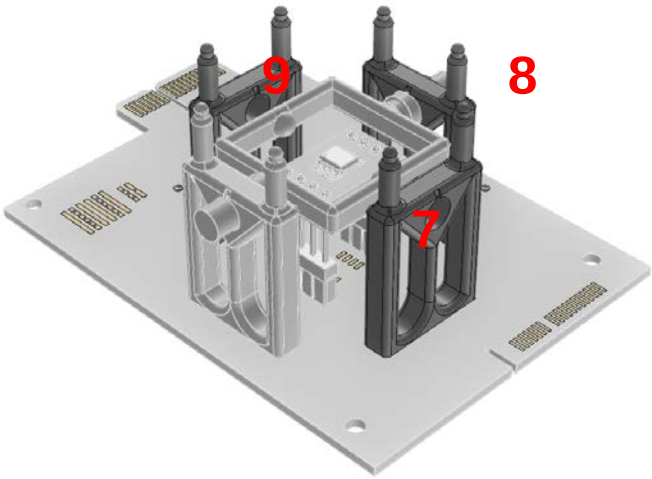


Figure 35: Gimbal Step 5

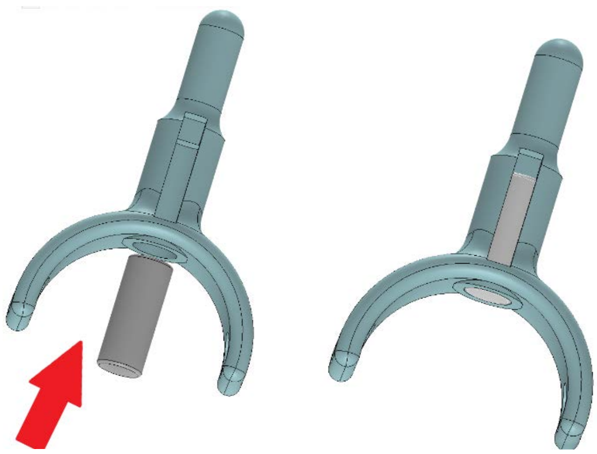


Figure 36: Gimbal Step 6 - magnet installation and position

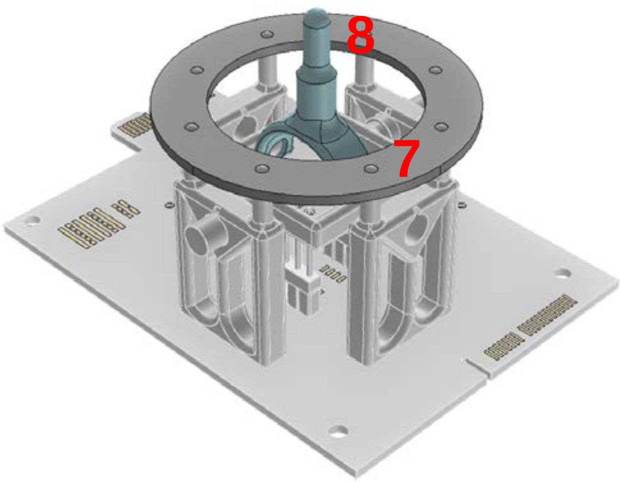


Figure 37: Gimbal Step 6

4 Software

The Joystick Module is delivered with a Labview based Visualization Environment. The software allows for communication to the sensor, representation of Magnetic Field components and 3D modeling of the Joystick position. Three different communication devices can be used with this software, the Micronas preferred TDK SPI Programmer, TDK Magnetic Sensor Programmer V1.x or an Arduino[1].

Note: 1. See Arduino Assembly Guide 3.1.3

4.1 Sensor Configuration

4.1.1 Configuration Note

The sensor delivered is set to the factory default values. Therefore for proper operation a programming sequence needs to take place. For simplicity a programming process is described at step 4 of paragraph 4.2. By executing this steps the sensor used will be programmed using saved EEPROM dump files from pre calibrated joystick modules. Following this process, will ensure immediate access to the Joystick Evaluation Environment with no further programming needed. However due to mechanical variations of the assembled module the output of the sensor can be inaccurate.
In case the movement of the joystick is inverted relative to the visualization environment the magnet attached to the joystick module can be reversed.

4.1.2 Sensor Calibration using HAL 3900 Programming Environment

In case further accuracy is desired, the sensor will need to be calibrated using a TDK SPI Programmer or the TDK-MSP and the HAL 3900 Programming environment.

Two Point Calibration

1. Connect the Joystick Module using the TDK SPI Programmer or the TDK-MSP.
2. Run the HAL 3900 Programming Environment.
3. The TDK SPI Programmer will be automatically detected (for the MSP select the used Com- Port.)
4. Set the SPI frequency to 1MHz.
5. Press VSUP ON.
6. Press Calibration Tool and select two-point calibration.
7. Select Data Channel 1.
8. Bring the Joystick lever to position 1 as shown in Figure 38 and press Calibration Point 1
9. Move the lever by approx. 1 cm and press Calibralibration Point 2.
10. Note if Angle Out 2 is higher or lower than Angle out 1 and set increasing or decreasing angle out accordingly.
11. Bring the Joystick lever to position 2 and press Calibration Point 2.
12. Press Calculate and then Write & Store.
13. Select Data Channel 2.
14. Repeat steps 8-12 for position 3 and 4 of Figure 38.
15. Press Exit .
16. Press VSUP OFF.
17. Press STOP.

Note: For further information refer to HAL 3900 Programming Environment and User Manual documents.

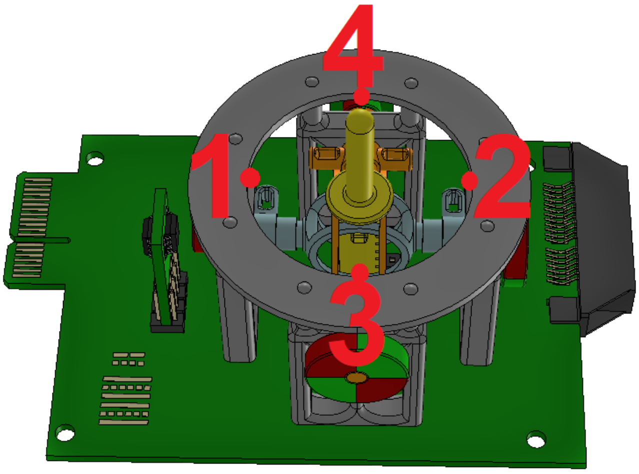
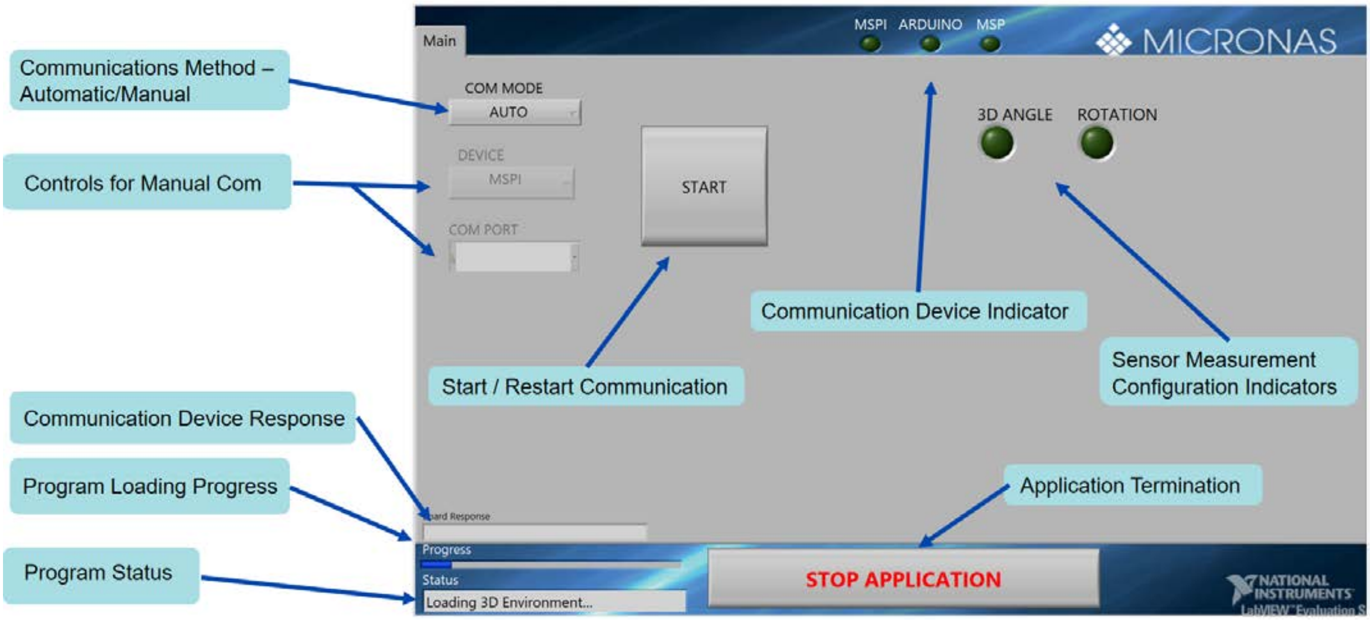


Figure 38: Calibration Points

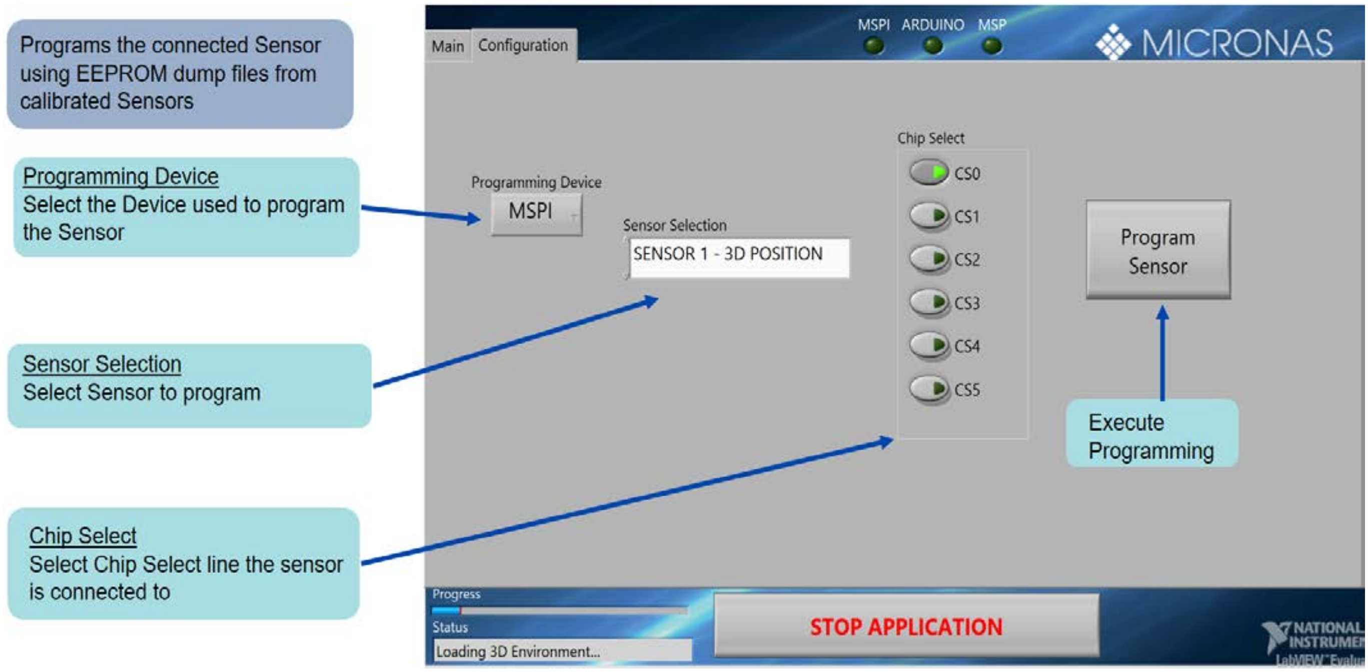
4.2 Evaluation Software Instructions

1. Extract the file Joystick_Module_Environment.zip on your Computer.
2. Connect the preferred Communication Device to the Computer USB port and the Joystick Module PCB.
3. Run Joystick_Module_Environment.exe.
4. If the Sensor is used for the first time (or the sensor is not programmed via HAL 3900 PE)
    a. Navigate to the Configuration Tab
    b. Select the programming device you are using TDK SPI Programmer or MSP
    c. Select the Sensor to be programmed
    d. Click the appropriate chip select setting
    e. Press Program Sensor, a message appears showing the status of the process.
5. Navigate to the Main tab
6. Make Sure the Com Mode is set to Auto and press Start.
7. Once communication to the sensor is established you are redirected to the Magnetic Field Tab
8. When the 3D environment is loaded, the Joystick Tab is available and the progress bar stops flashing.
9. Press Stop Application to Terminate the program

Main Tab

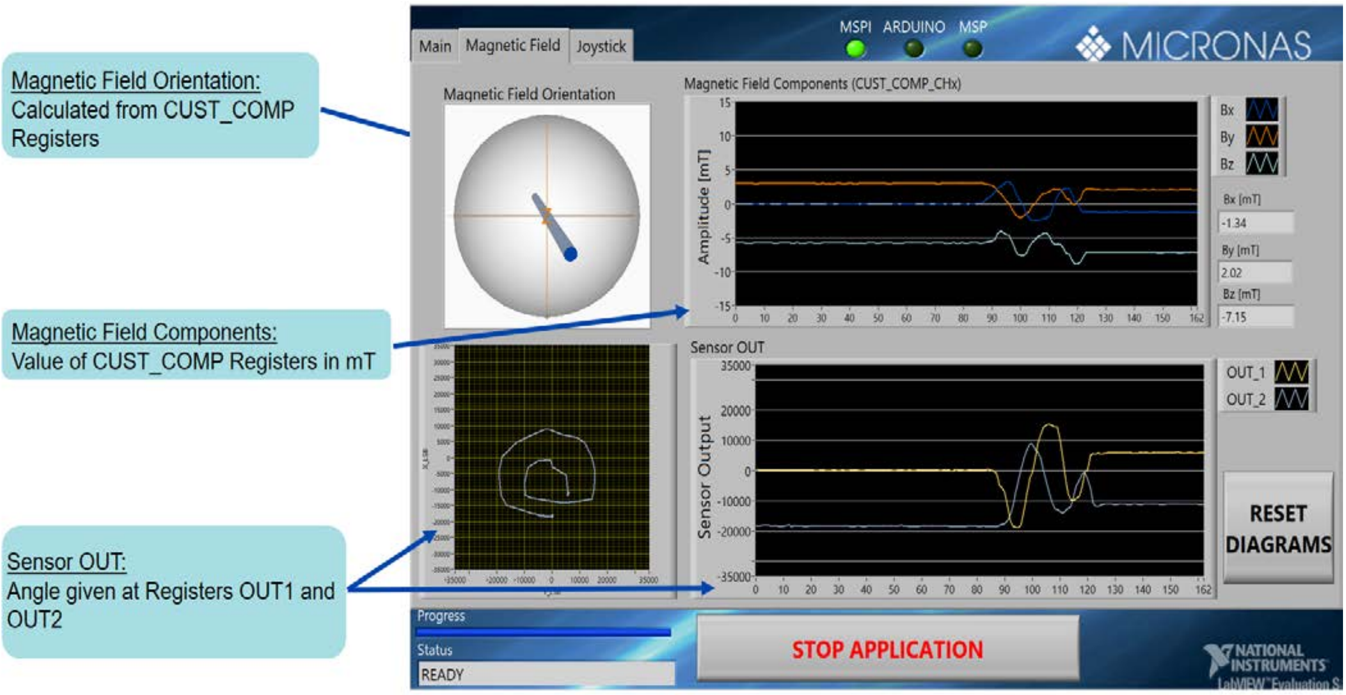


Configuration Tab

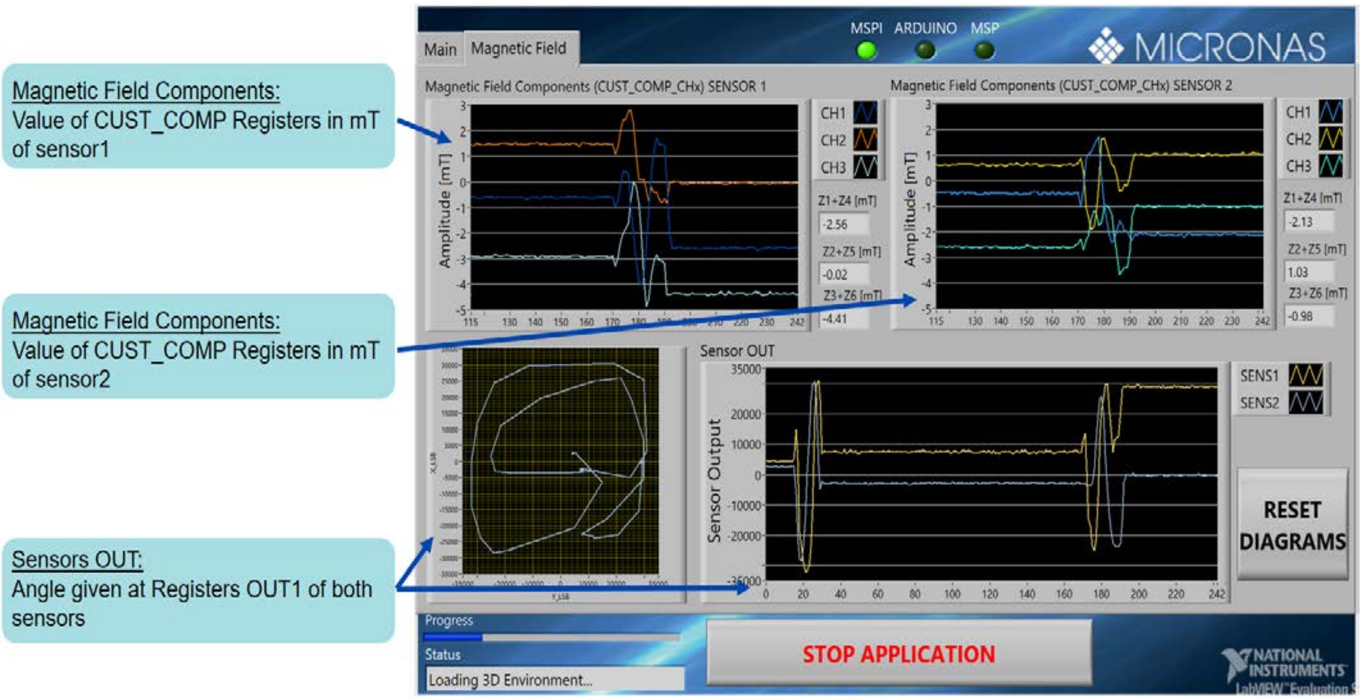


4.3 Visualisation

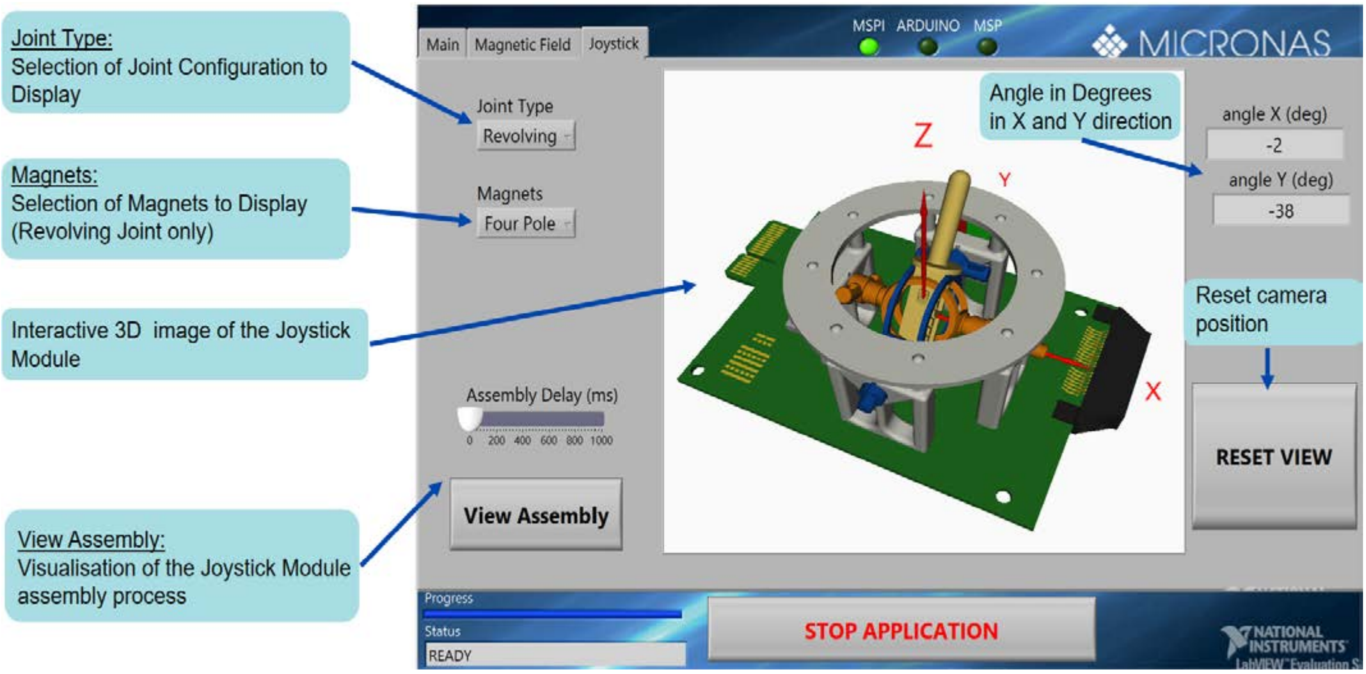
4.3.1 Magnetic Field Tab (3D Position Detection)



4.3.2 Magnetic Field Tab (180º or 360º Angular Measurement)



4.3.3 Joystick Tab



5 Appendices

5.1 Appendix 1: Soldering Bridges

5.1.1 Chip Select

The Joystick module PCB supports six different chip select lines which translates to six different sensors can communicate through the Joystick PCBs. The increased number of chip selects allows for more than one PCB's to be connected in tandem with a compatible communication device. This idea is illustrated in Figure 39.

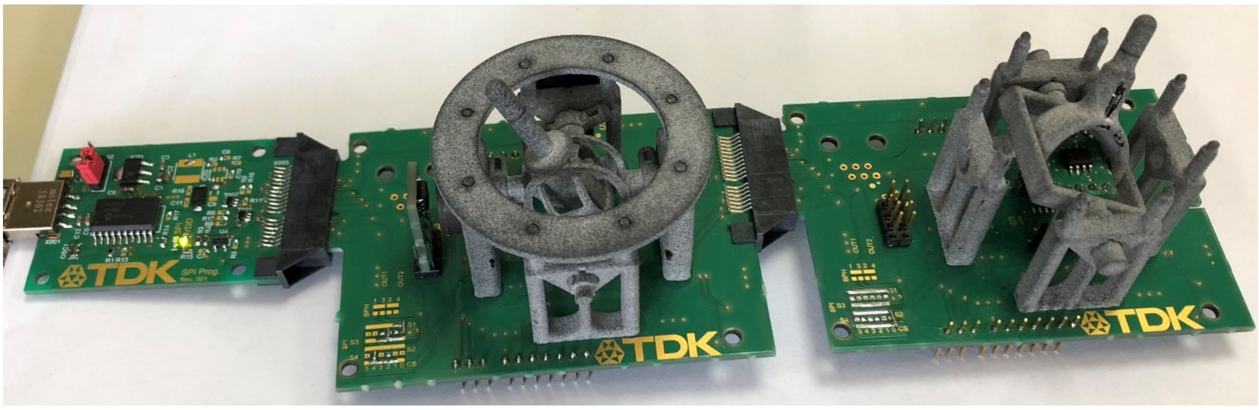


Figure 39: MSP(I) connected to two joystick modules

To achive that, the Joystick Module PCB is equipped with soldering bridges as shown on the schematic in Figure 40. CS_SENSx stands for the chip select signal attached to the sensor. A 0603 0R resistor can be soldered between the CS_SENS of any sensor to any chip select CS .

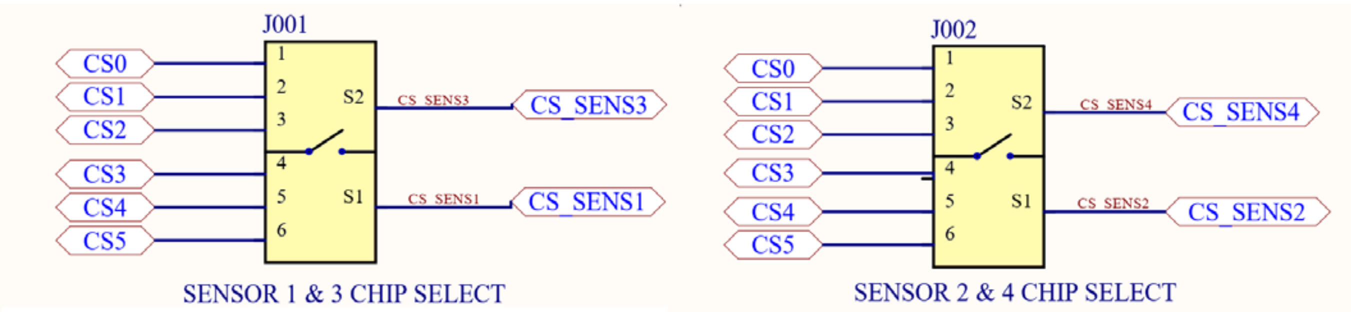


Figure 40: Chip select Bridges

5.1.2 Arduino Power Select

The Joystick Module PCB has two unique power supply lines VDD1 and VDD2 the reason behind this design is the compatibility with biphase communication. As a result Sensors 1 & 3 are powered by VDD1 and Sensors 2 & 4 are powered by VDD2. When a TDK MSP or TDK SPI Programmer is used the power supply

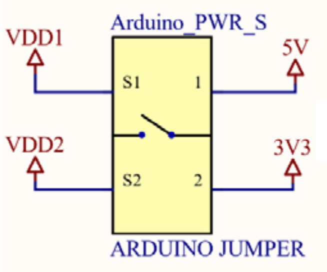


Figure 41: Arduino Power Bridge

of any sensor is managed, despite which VDD line it is connected to. By default the Ardunino 5v and 3v pins are floating, to connect any of the pins to a power supply line (VDDx) to the Arduino a 0603 0R resistor should be soldered on the Arduino power bridge between the desired voltage level and VDDx. The schematic is shown in Figure 40.

5.1.3 Biphase Communication

The Joystick Module Evaluation Environment is build using the SPI protocol only. However the PCB had been designed to support biphase communication. To use a sensor over biphase protocol, communication is established through the edge card connector or soldering an RJ25 connector at the available slot. Furthermore a biphase bridge, shown in Figure 40, provides selection as to which sensor is connected to the output. Sensors 1 & 3 can be connected to OUT1 and sensors 2 & 4 can be connected to OUT2. The connection is established by soldering a 0603 0R resistor between OUT_SENSx and OUTx. Note each OUTx line supports only one sensor, therefore the maximum allowed number of sensors to be used at once is two.

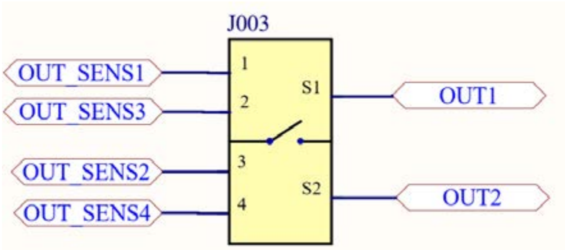


Figure 42: Biphase solder bridge

5.2 Joystick Module Schematic