User's Guide

Head-On Linear Displacement 3D Attachment

ABSTRACT

This document serves to accompany the design files for the linear head-on travel attachment that is compatible with the TMAG5273EVM and TMAG5170UEVM. These design files are provided as an example and may be used in a 3D printer to generate a demonstration of head-on linear displacement function, where fastening the screw portion of the attachment into the base portion of the attachment decreases the linear displacement between the attachment's magnet and the Hall sensor underneath it.

Design files described in this document can be downloaded from Head-On Linear Displacement Design Files.

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1 Introduction

The linear head-on travel attachment has two portions, each of which have different STL 3D print files. Nylon was selected for the material of the two portions of the attachment because it will not interfere with the magnetic field generated by the magnet and also bonds well when glued to the utilized magnet.

The first portion of the attachment is the screw, which has a thread with 3-mm pitch. The bottom base of the screw has an opening where a N52 grade cylindrical magnet is placed, thereby causing a magnetic field in the Z direction that can be sensed by the Hall position sensor. When the screw is fully unfastened at the top of the base (see Figure 1-1), the distance from the attachment to the top of the Hall position sensor's package is approximately 16.5 mm. The threading on the screw has a length of 12.7 mm. As a result, the linear displacement from when the screw is fully unscrewed at the top of the base to when it is fully screwed into the base is approximately 12.7 mm (see Figure 1-2). In addition, the distance from the top of the Hall sensor package to the magnet is approximately 3.8 mm when the screw is fully fastened. Figure 1-3 shows a cross-section view of the attachment when the screw is fully fastened into the base.

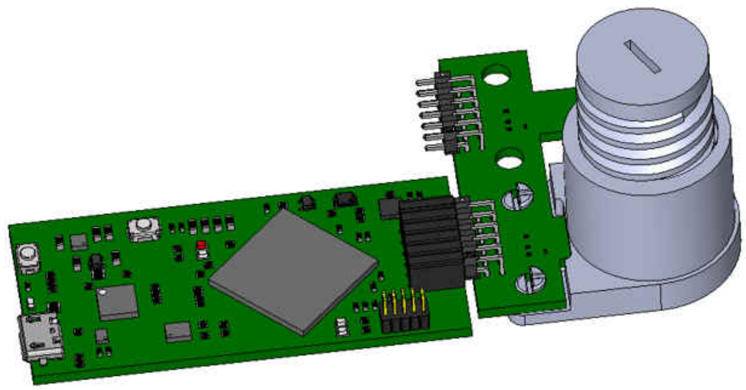

Figure 1-1. Linear Head-On Travel Attachment With Screw Fully Unfastened From Base

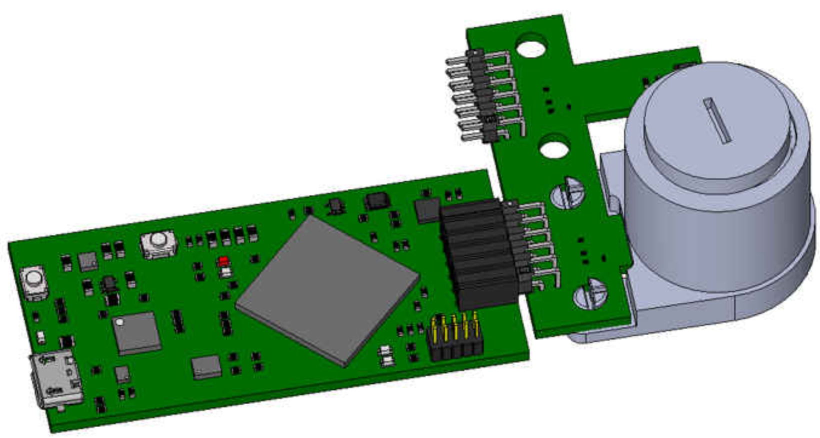

Figure 1-2. Linear Head-On Travel Attachment With Screw Fully Fastened into Base

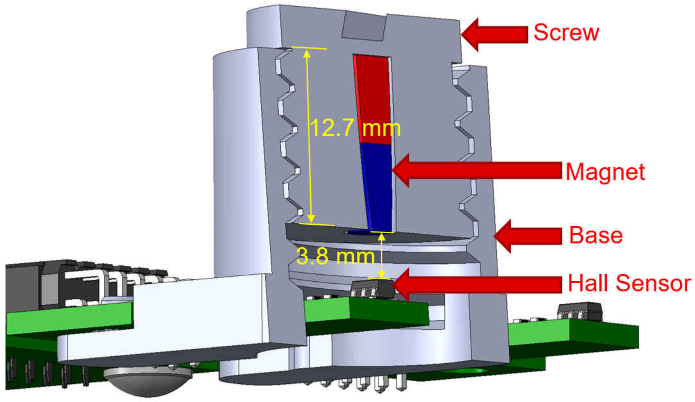

Figure 1-3. Cross-section of Linear Head-On Travel Attachment With Screw Fully Fastened into Base

The second portion of the attachment is the base. The screw part of the attachment gets fastened into the top portion of the base, which is directly above the Hall position sensor. The screw can be rotated by hand or by using a flat head screwdriver on the slot at the top of the screw. Turning the screw clockwise when it is within the base causes the magnet to decrease its distance with respect to the Hall sensor, thereby increasing the magnetic flux density sensed by the Hall position sensor. To decrease the magnetic flux density seen by the sensor, the screw should be rotated counterclockwise to increase the distance from the Hall position sensor to the magnet embedded within the screw. Using the sensed magnetic flux density and information on the characteristics of the magnet, the linear distance from the magnet to Hall sensor can be calculated. Refer to the *Head-on Linear Displacement* application brief for more information.

2 Assembly Guide

Table 2-1. Linear Head-On Travel Attachment Table of Materials

ITEM	DESCRIPTION	QUANTITY
Screw portion of attachment	Printed from Screw.STL file	1
Base portion of attachment	Printed from Base.STL	1
Cylinder Magnet	1/8” diameter, ½” thickness, N52 grade, axial magnetization from K&J magnetics	1
TMAG5273EVM or TMAG5170UEVM		1
Sensor Controller Board (SCB)	Control board that comes with TMAG5170UEVM and TMAG5273EVM	
8333-20G	Super Glue	0.02 ounces

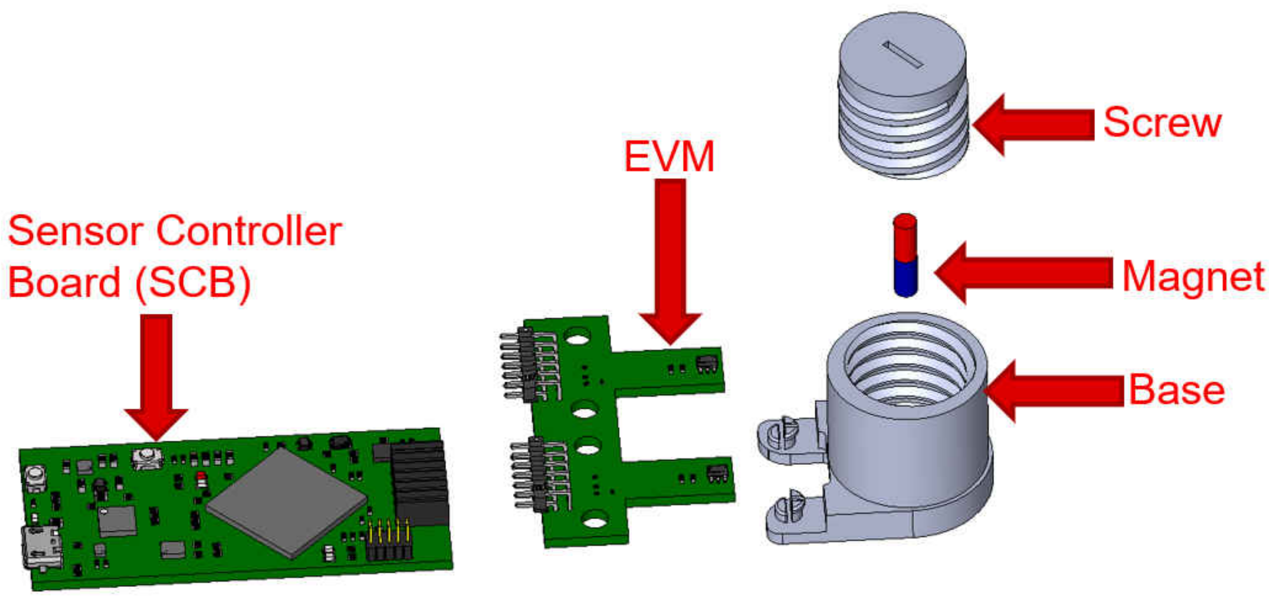

Figure 2-1. Linear Head-On Travel Attachment Exploded View

Step 1 – Identify the North and South Pole Faces of the Cylinder Magnet

Unipolar Hall position sensors require that the appropriate magnetic pole is applied near the top of the Hall position sensor. Applying the incorrect magnetic pole to a unipolar sensor results in an output that does not respond to the magnet’s movement. As an example, if the output of a Hall switch only responds to when a south pole of a magnet is applied near the top of the package, the output will not switch if the north pole of the magnet is brought near the top of the Hall switch’s package.

For compatibility with unipolar Hall position sensors, the user must determine the north and south poles of the magnet before the magnet is placed in the screw attachment. To determine the north and south poles of the magnet, a second magnet with known north and south poles can be applied to the attachment’s magnet. If the known south pole of the second magnet is attracted to a face of the attachment magnet, that face is the north pole of the attachment magnet. In contrast, if the known south pole of the second magnet is repulsed from a face of the attachment magnet, that face is the south pole of the attachment magnet.

Step 2 – Print the Screw Portion of the Attachment (Screw.STL)

The screw contains the cavity where the magnet will eventually be placed. Figure 2-2 and Figure 2-3 show the side and bottom view of the screw attachment. To use this attachment with other magnets, the diameter and length of the cavity can be altered by modifying the screw 3D print file.

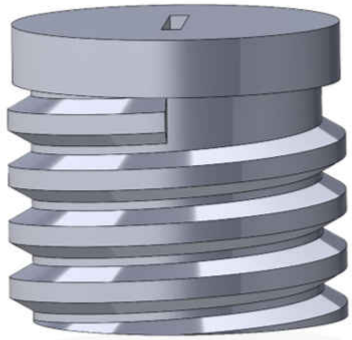

Figure 2-2. Side View of Screw

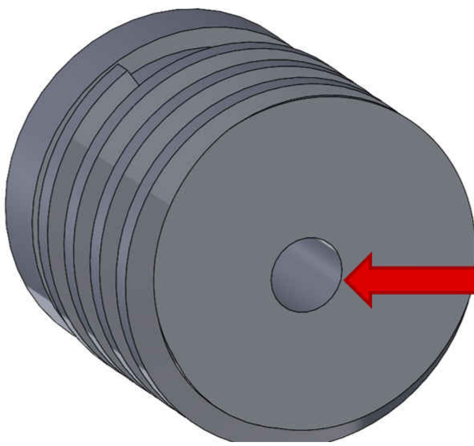

Figure 2-3. Bottom View of Screw

Step 3 – Glue the Magnet into the Screw

For compatibility with south-responding unipolar Hall sensors, the south pole of the magnet must be placed above the package of the Hall sensor. This is done by inserting the north pole of the magnet, as determined from Step 1, into the cavity of the screw attachment. To ensure the magnet is secured, add glue to the north face of the magnet before inserting it into the cavity. Figure 2-4 shows the orientation of the magnet before it is inserted into the screw's cavity.

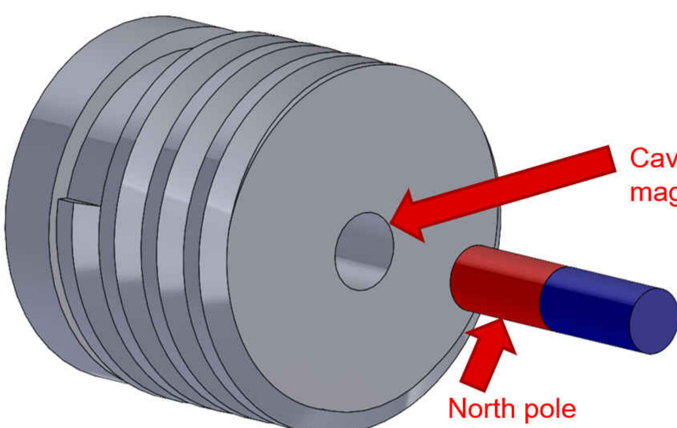

Figure 2-4. Orientation of Magnet With Respect to Screw

After the magnet is inserted into the cavity, push the magnet down the cavity so that only a minimum amount of the magnet sticks out of the attachment, as shown in Figure 2-5. How far the magnet is actually pushed within the cavity determines the maximum magnetic flux density reading seen in the system when the screw is fully fastened in the base (see Figure 1-2). The more the magnet is pressed within the cavity, the smaller the displacement from the actual magnet to the sensor and the smaller the maximum magnetic flux density seen in the system.

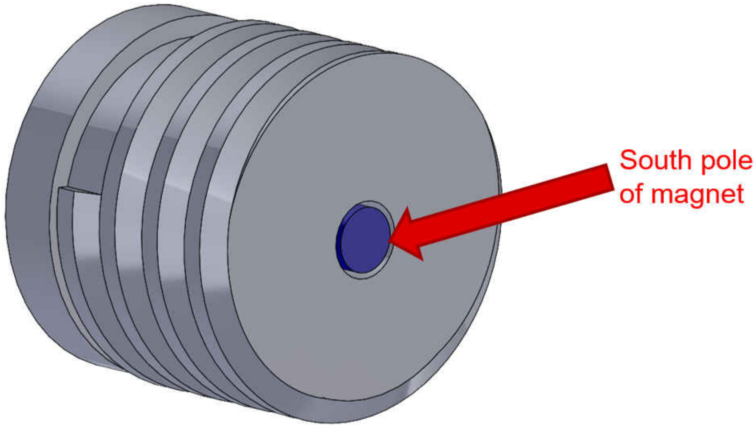

Figure 2-5. Fully-Embedded Magnet in the Screw

Leave the screw attachment unbothered until the glue fully cures after the prescribed dry time has elapsed.

Step 4 – Print the Base Portion of the Attachment (Base.STL)

The screw part of the attachment gets fastened into the top portion of the base. Figure 2-6 shows the base part of the attachment.

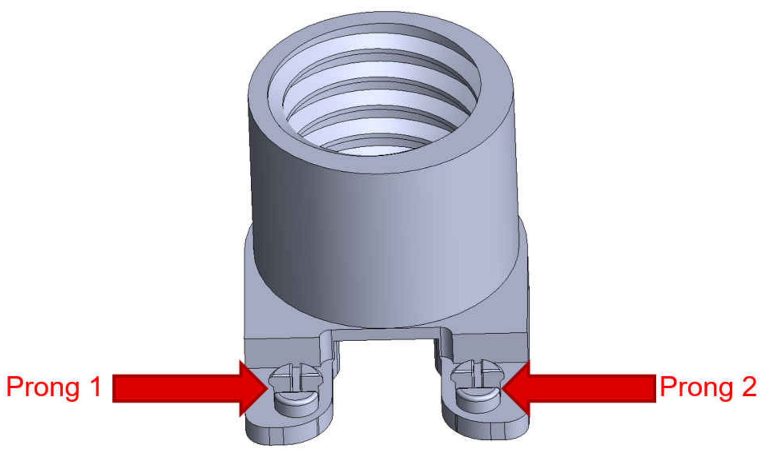

Figure 2-6. Base of Attachment

3 Connecting to an EVM

The two prongs in Figure 2-6 are inserted into two matching holes of an EVM, thereby enabling the attachment to be physically secured onto an EVM. The prongs are inserted from underneath the EVM's PCB until they snap into the two holes on the EVM's PCB. In Figure 3-1, the attachment is connected to the TMAG5273A2 portion of the TMAG5273EVM. The attachment could also connect to the TMAG5273A1 portion of the EVM, however, by inserting the attachment into the two holes on the left of the EVM. When properly connected to an EVM, the Hall position sensor can be viewed through the top hole of the attachment (see Figure 3-1). After connecting the base to the EVM, the Sensor Controller Board is then connected to the EVM.

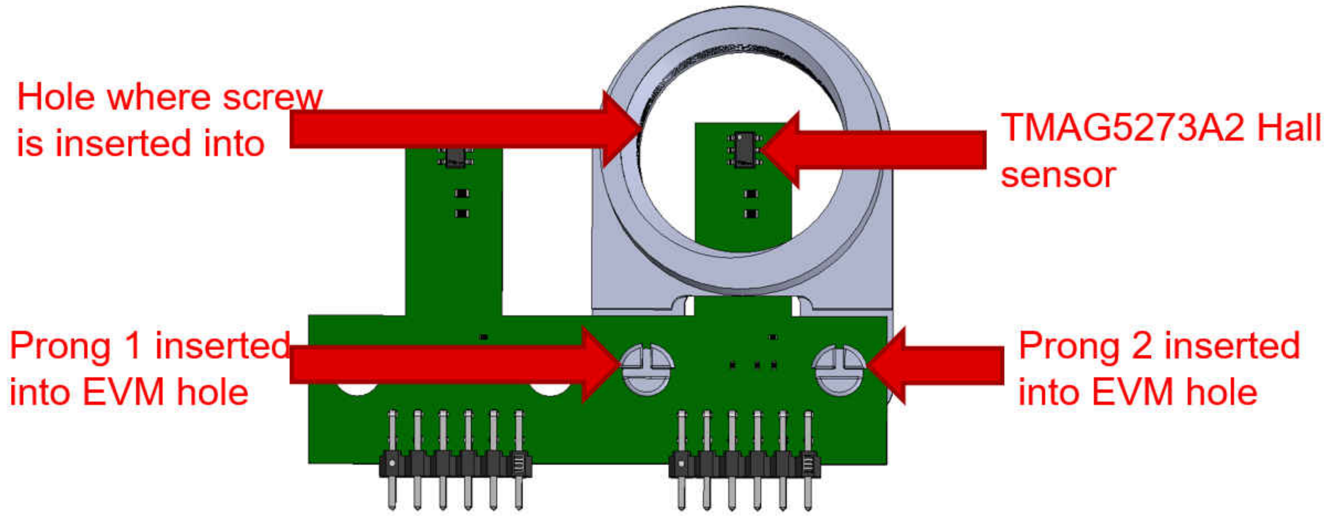

Figure 3-1. Top View of EVM Connection to Base of Attachment

The top hole of the attachment is where the screw is inserted. To fasten the screw into the base, the screw is turned clockwise, which decreases the distance between the magnet and the Hall position sensor. Figure 1-2 shows an image of the screw fully fastened into the base. To unfasten the screw, the screw is turned counter-clockwise until it is fully unfastened (see Figure 1-1).

4 Magnetic Flux Density Results

Figure 4-1 shows the X, Y, and Z magnetic flux densities measured by the TMAG5273 when the screw is fully unfastened like it is in Figure 1-1. Figure 4-2 shows a similar plot when the screw is fully fastened like it is in Figure 1-2. As shown in the plots, the Z-axis is the most affected by the linear displacement of the magnet. If the magnet was perfectly aligned so that it is centered with respect to the Hall elements within the device, the X and Y readings would go down to zero. Due to tolerances in the attachment and location of the Hall element within the device, however, the magnet is not centered with respect to the Hall element in this case, thereby resulting in small readings on the X and Y axes.

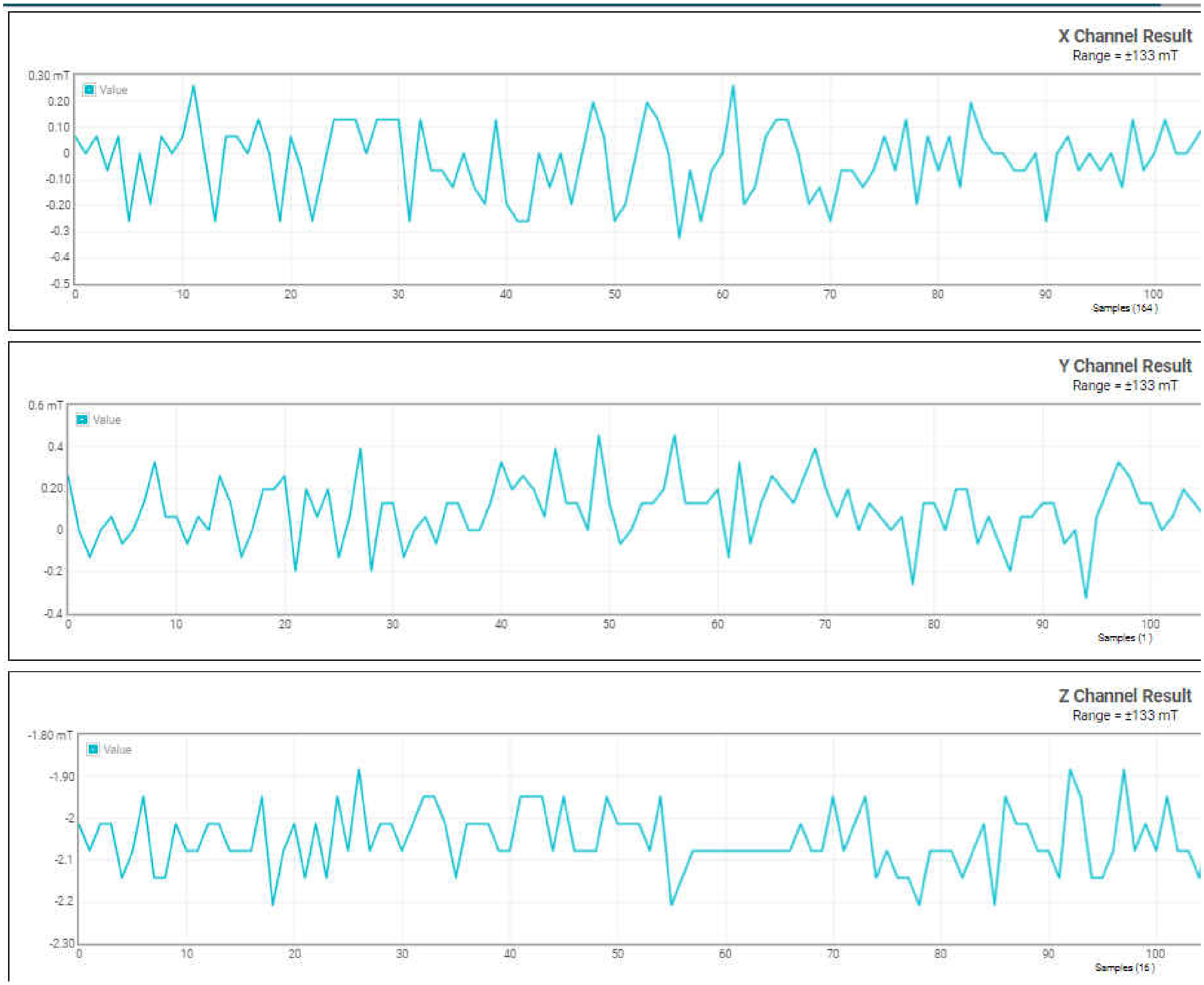

Figure 4-1. Magnetic Flux Density Results When Screw is Fully Unfastened From Base

For these results, the magnet was placed so that the south pole of the magnet is near the top of the device package. The TMAG5273 readings are negative because the TMAG5273 defines a negative field as when the south pole of the magnet is applied near the top of its package. For devices like the TMAG5170 that define a positive field as when the south pole of the magnet is applied near its top, the sign of the results shown in Figure 4-1 and Figure 4-2 would be positive instead of negative.

Figure 4-2. Magnetic Flux Density Results when Screw is Fully Fastened into Base