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A Comparison of the measured Magnetic Field Strength using Ampere-Turns (AT) and Millitesla (mT)

With the advent of the Reed Switch, developed by Bell Labs in the 1930s, it was convenient to measure its operate characteristics using the units of ampere turns. Since the Reed Switch is cylindrical it is easy to make the measurement of its closure, release and contact resistance using a coil with a given geometry, wire size and number of turns. It is easy to conventionalize this approach as long as other users, internal or external, find no problem using ampere-turns (AT) as their unit of measure.

However, a real problem arises when one finds that no convention has ever been adopted in the Reed Switches' long history; in fact, most manufacturers of Reed Switches have their own standard. Therefore, companies who purchase their Reed Switches for making Reed Relays, Reed Sensors or other reed products find they have to deal with an assortment of AT standards. No true standard is offered to customers who use Reed Relays, Reed Sensors, etc.

Users find themselves selecting reed products with no idea how to categorize or select them for their own applications. This results in much time lost and frustration in trying to select the proper product. Often times, many thousands of dollars may be lost through high production failures or production line shut down, before determining the correct Reed Switch sensitivity selection.

What we plan to present here is a standard that manufacturers of Reed Switches, manufacturers of reed products, and users of reed products can all use. We will present a simple way to bridge the approach of measuring the magnetic field strength of a Reed Switch from the Reed Switch manufacturer/reed product manufacturer to the reed user's application.

Before we present this approach, we need to review a few very important points that generally affect Reed Switch applications:

1. When a Reed Switch is initially measured, it is made with its given overall length. This length is established by the manufacturer to offer the users the most flexibility for short and long length design requirements. As one cuts the Reed Switch to a given size for a given application the AT for that switch will change. If now measured in the same coil to a given cut length, the AT will be different. If significant lead length is cut off the AT change can be dramatic. This occurs because the reed blades are ferromagnetic and the more magnetic material present the more efficient the magnetic field strength. Cutting away the magnetic material will reduce the magnetic field strength; thereby, reducing the magnetic sensitivity of the Reed Switch. Some companies for a given special requirement will supply the AT difference in their specification for a given cut length. However, if the user cannot measure his application in the standard test coil used by the Reed Switch supplier because his application does not 'fit' into it, which is most times the case, it becomes impossible to directly correlate between the two companies when using AT only.

2. Reed Switches that are not cut, but bent into a new configuration, will often undergo an AT change as well. Here, whenever the magnetic path is altered, the magnetic field strength may change depending upon the new given configuration.

3. When a Reed Switch is bent into a new configuration with or without cutting the lead length, the AT may be additionally altered by improperly bending the Reed Switch. All Reed Switches have some susceptibility to any stress placed on either end of its glass to metal seal. Some switches are more susceptible than others. In any case, a stress to the seal can alter the mechanical operation and thereby alter its AT. The Reed Switch gap generally averages less than 25 microns (0.001"). Any small mechanical change produced by either a torsional, rotational or linear force can give rise to an

AT or contact resistance change. The contact gap, contact design, blade overlap, lead material, lead material hardness, lead material length and thickness, seal strength, seal length, glass length and measurement approach, will all influence the AT of a Reed Switch.

Since the user in most cases can not measure his magnetic field requirements in AT, the easi-est way and more accepted way is to measure the requirement in Gauss or Millitesla (mT). Here 10 Gauss is equal to 1 mT making the in-terchange between the two units an easy task. More generally accepted outside the Reed Switch and reed product manufacturing arena is the use of Gauss and Tesla or Millitesla (mT).

Bridging Ampere-Turns (AT) to Millitesla (mT)

The rest of this discussion will be to bridge the gap between ampere-turns (AT) to Millitesla (mT). The lower the AT or mT rating of a Reed Switch the lower the magnetic field strength required to close the Reed Switch. To accomplish this bridge, we have chosen to use its internal KMS standard coils as our AT standard; and bridging to mT by using a standard AlNiCo 5 magnet with a given length and mT rating. We found the easiest way to make this bridging of units was to do the following:

1. First measure a group of Reed Switches in our standard KMS coil and record the operate AT.

2. Using a linear micrometer table, with a 120 mT AlNiCo 5 magnet measuring 4 mm by 19 mm in length, mounted at its axis origin, the magnetic field strength was measured (in mT) at regular mm intervals along the linear axis. See Figure 1. Here it is very important not to have any ferromagnetic material as part of the test setup or anywhere near the testing..

3. Using the same setup as in step two, we now measure the operate point in mm of the previously measured Reed Switches used in step one.

4. The mm distance of the closure points is now mapped with the mT field strength taken in step two

The graphs that follow were produced in exactly this above described manner. Keep in mind this data is taken for the full length, uncut Reed Switch. However, this data can be used for vari-ous cut lengths by using another graph, which presents the percent of change for a given cut length. This percentage change graph is shown for various AT switches and the percentage changes not covered can be extrapolated using the graph data.

Using the graphs in figure 5ff, we can directly convert to mT.

An example of using this approach with the in-cluded graphs is the following:

1. Your application requires you to use our KSK-1A85 Reed Switch, and you need to use only its cut length of 30 mm.

2. You plan to have the Reed Switch close 15 mm away from the magnet you have chosen.

3. You are capable of measuring your magnetic field strength at this distance with a standard gaussmeter, and find you have a 2.2 mT field 15 mm from your magnet.

4. You next look at figure 7. where the AT and mT graphs presents the comparison you need for the KSK-1A85. But since you are cutting the Reed Switch to 30 mm you need to determine the percent increase expected. For a 20 AT Reed Switch being cut to 30 mm the percent increase is approximately 30% or 6 AT change (see Figure 3). This brings the AT of the switch up to 26 AT. Now, looking at Figure 3 you see 26 AT corresponds to about 1.7 mT.

5. Here the original 20 AT switch will close well under the field of 2.2 mT giving you plenty of margin. In this way, depending upon your tolerances, you can directly select the AT range you require.

Please be aware, that a Hall probe only measures the field strength at a certain point. Whereas a Reed Switch absorbs the magnetic field lines of its entire length. Therefore this approach can only be used for a rough approximation but, will enable your engineers to make a preselection of the Reed Switch easily, quickly and cost effectively for your application. Following this, we would be able to help you with the precision adjustment.

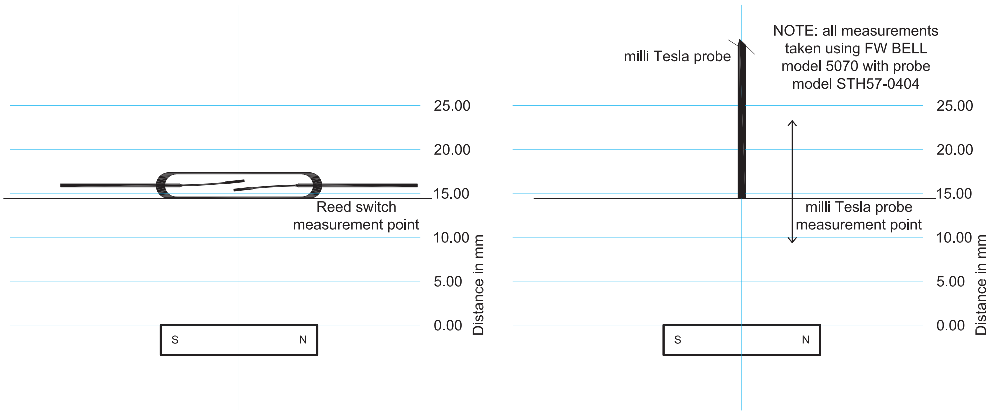

Fig. #1 Presentation of the equipment and test layout in which the magnetic data was taken using a linear micrometer.

The following graphs show the AT change for various cut lengths of Reed Switches.

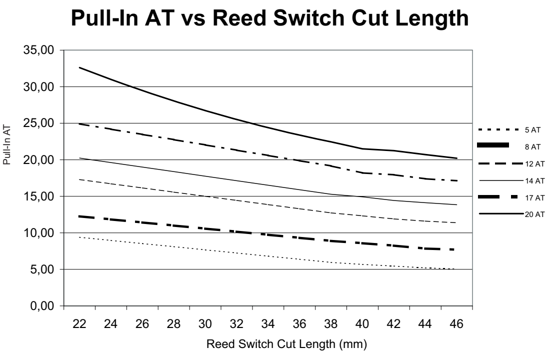

Fig. #2 Presentation of the operate AT change for various cut lengths for a given operate AT.

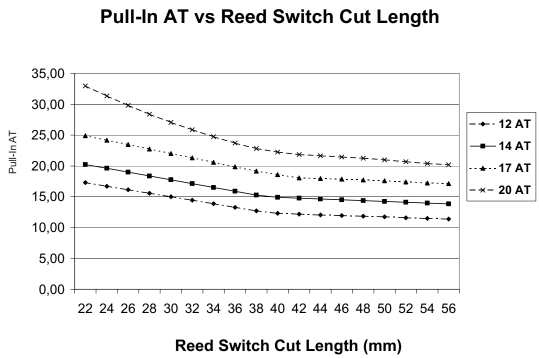

Fig. #3 Presentation of the operate AT change for various cut lengths for a given operate AT.

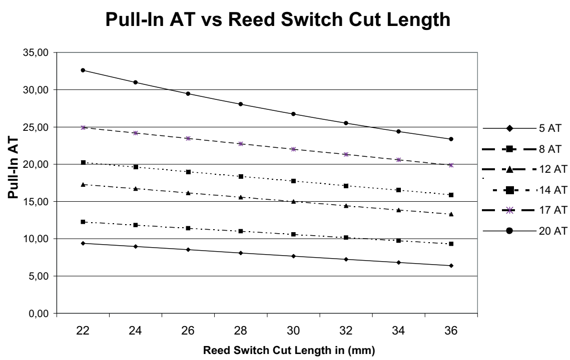

Fig. #4 Presentation of the operate AT change for various cut lengths for a given operate AT.

We have also supplied graphs showing the AT operate point versus mm distance so that a gaussmeter is not necessary. Just using these enclosed graphs will allow you to make the correct selection assuming you are using a similar magnet as was used in our data selection.

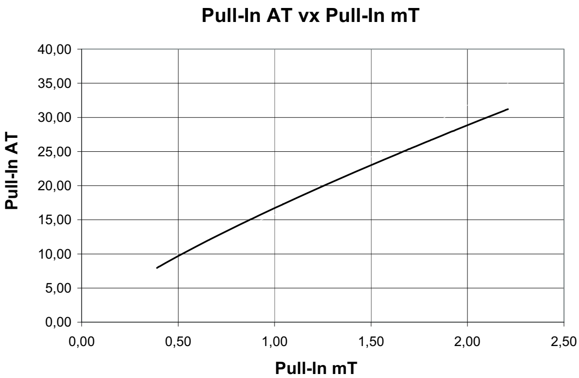

Fig. #5 The Pull-In AT is presented with its corre-sponding mT Pull-In level.

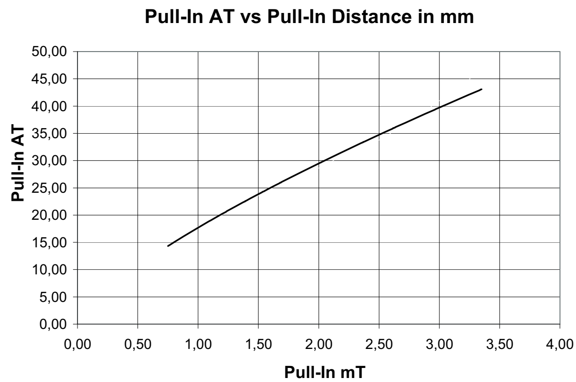

Fig. #7 The Pull-In AT is presented with its corresponding mT Pull-In level.

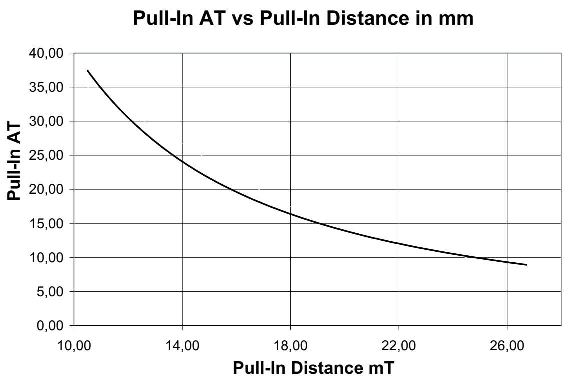

Fig. #6 The Pull-In AT is presented with its corresponding Pull-In distance from the magnet, and is measured in mm.

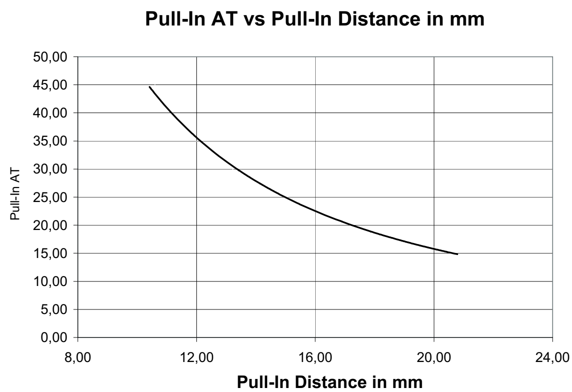

Fig. #8 The Pull-In AT is presented with its corresponding Pull-In distance from the magnet, and is measured in mm.

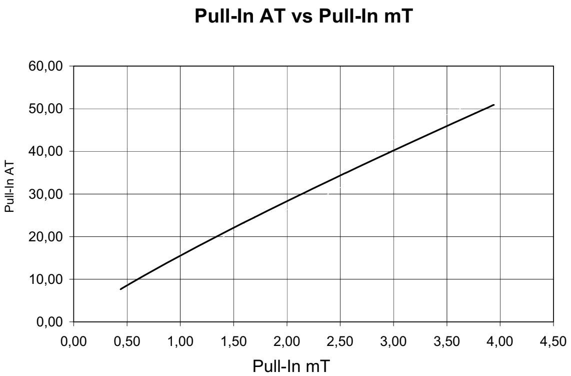

Fig. #9 The Pull-In AT is presented with its corresponding mT Pull-In level .

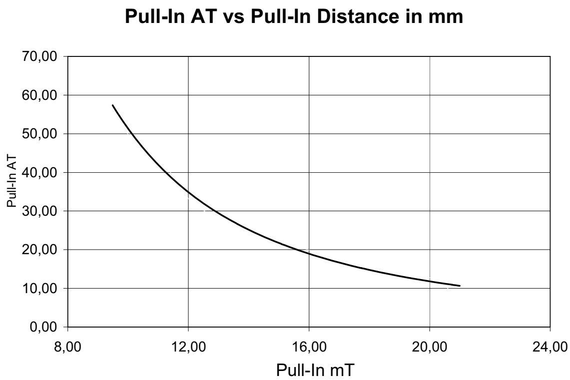

Fig #10 The Pull-In AT is presented with its corresponding Pull-In distance from the magnet, and is measured in mm.