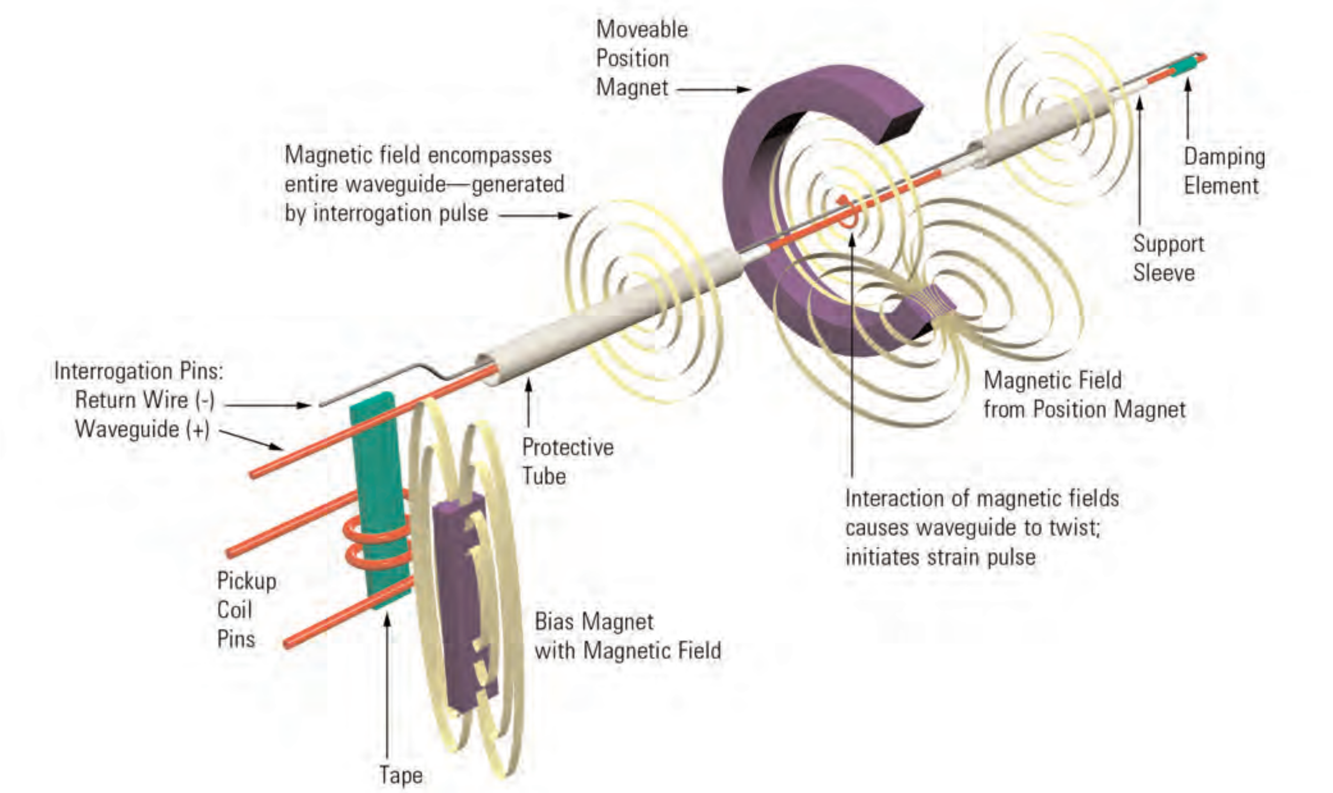
Temposonics®

Magnetostrictive Linear-Position Sensors

Understanding the influence of magnets and magnetic fields

551056 A

Technical Tip - Installation Guidelines



Circumferential magnet field

The magnet's role in realizing performance

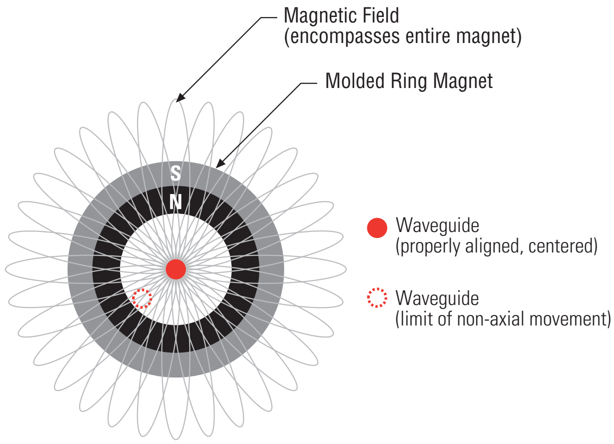
All magnetostrictive sensors should be considered a system of matched, interacting components consisting of magnets, electronics and sensing elements. The attributes of those components are selected and designed so that when acting in concert, the sensor provides the best possible performance for the purpose intended. That's why some magnets, including some MTS designed for other sensor models and any catalog magnet from an industrial supply house, do not work well with the sensor element and electronics.

It also follows that proper installation of the magnet is important for maintaining that best performance possible. Improper installation of the magnet can modify its performance which can have a significant effect on the output of the sensor. Some performance characteristics that can be affected by improper installation are linearity, signal stability, noise susceptibility and temperature range.

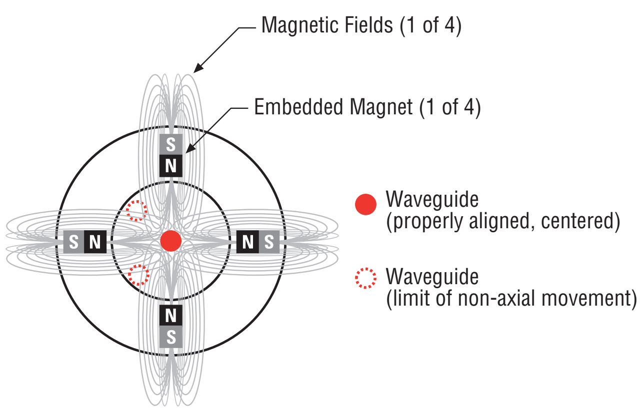
If the recommendations in this document are followed, most systemic problems can be avoided. However, this document is only a set of guidelines. Some applications have unique influences that are not contemplated here. If your anticipated installation situation is not similar to one described herein, it is recommended that you contact MTS Applications for consultation and recommendations. In some cases, MTS will run tests on prototype installations to determine the impact, if any, on performance of the sensor.

Ring magnets

The standard and optional ring magnets are the best overall in performance and are more immune to errors in installation. This is due to the shape of the magnetic field.



Molded ferrite ring magnet

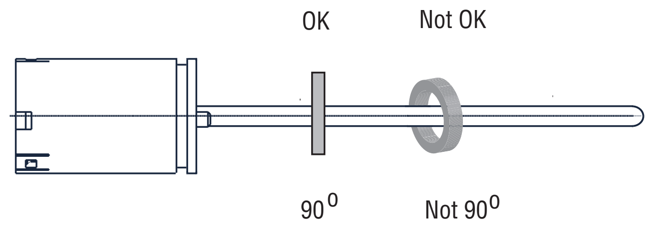


Bar magnets molded in plastic

Each ring magnet has north on the inside diameter and south on the outer diameter. Other configurations of the magnetic field, such as south inside and north outside or north-south along the axis of the sensor, will not work with the sensor. Magnets from other sources than MTS are not recommended for use with the sensor. Field strengths and shapes in MTS magnets recommended for use with specific sensors are designed to support the performance specifications of those sensors. Using non-MTS magnets may reduce the performance in many respects, including temperature range.

Sensor/ring magnet concentricity

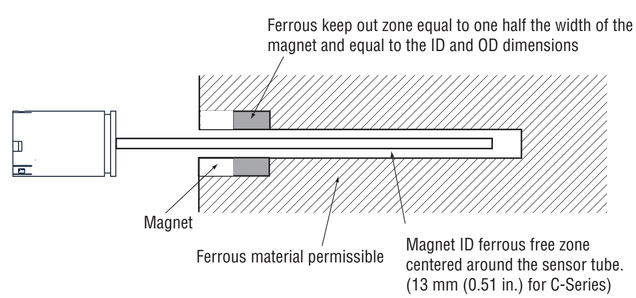
The sensor tube can be anywhere inside the inner diameter of the ring and provide strong signals. Moving the sensor tube from one side of the inner diameter to the opposite side of the inner diameter has little effect on the indicated position, within the performance specs of the sensor, due to the field strength and shape throughout the inside diameter. However, the magnet should always be orthogonal with the sensor's tube axis and as close as possible to the center of the inside diameter.



Keep ring magnet's plane orthogonal to the sensor tube waveguide

When the ring magnet is installed, surrounding application structures and the material used to make them can have a positive or negative effect on the symmetry of the field. Field symmetry is engineered into MTS magnets along the travel axis and the orthogonal axes. Disrupting that symmetry can cause intermittent or permanent shifts in indicated position. By installing the magnet in ferromagnetic materials such as mild steel incorrectly, the field can be disrupted changing the symmetry.

When installing ring magnets in ferrous materials, MTS recommends that non-ferrous materials such as brass, aluminum, plastic, or air be used in the indicated keep out areas around the ring magnet. Snap or retaining rings used to keep the magnet in place should be non-ferrous if possible, but it's not mandatory because the amount of ferrous material is small and the shunting effect is usually small.



Ferrous materials 'keep out' area

Installing the magnet directly into ferromagnetic materials that encroach into the keep out areas can cause shifts in indicated position, reduced temperature range, and noise susceptibility.

Residual magnetism in application structures

In rare instances in some installations, even though the keep out areas have been observed, the symptoms of position shifts, reduced linearity, reduced temperature range and noise can be induced by residual magnetism in the structural materials. Residual magnetism can be created by cold working or machining of the structure. For example, a cylinder rod that picks up magnetism from machining can change the magnetic characteristics of the magnet. This can even happen with some stainless steels. The magnet's design field may be reduced or become asymmetric, causing the reduced performance symptoms.

Degaussing the structure can reduce or eliminate the problem. Degaussing coils, commonly used to degauss CRT screens such as televisions, can be passed over the structure to reduce the magnetism. A degaussing coil is simply a ring coil and a core that has AC, usually at line voltage, passing through it. When passed over a magnetic part, the AC induced field reduces the alignment of the magnetic domains in the material, reducing the magnetism.

If it appears that the installation structure is magnetic, a gauss meter and probe can be used to check levels. Generally, the keep-out areas should not have a permeability of greater than 1.05 or fields from other sources greater than 5 gauss (0.5 milliTesla). If fields greater than this are found, take steps to remove the fields via degaussing techniques, increasing ferrous material gaps, or materials substitutions.

Button or bar magnet mounting

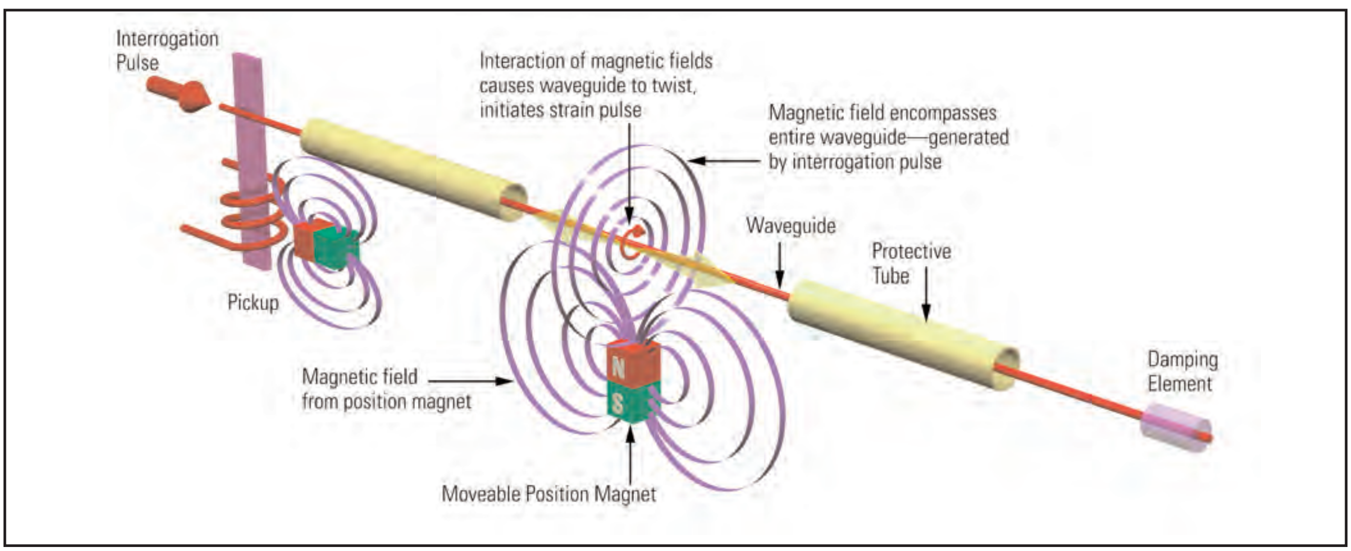
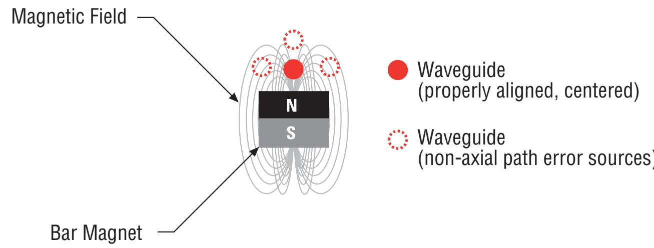


Figure 6 Single sided magnet field

In some installations, a ring magnet won't fit. So, MTS offers bar or button magnets to activate the sensor from one side of the sensor shaft rather than completely around the sensor shaft as in a ring magnet.

Button, bar or segment magnets have additional considerations for installation.



Bar or button magnet aligment consideration for error control

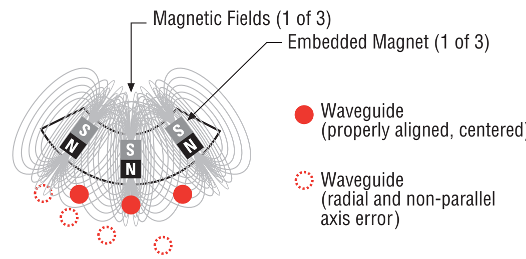
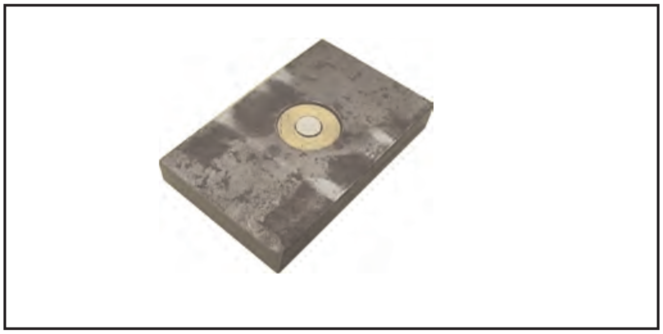


Figure 6 Custom curved magnet alignment considerations for error control

The distance of the magnet from the sensor shaft is critical. All MTS button or bar magnets have an optimal stand-off distance specified with an allowable range on either side of that distance for specified sensors. It's at this optimal distance that the sensor signals are at their optimum for the electronics and sensor element. Any closer than that permissible range and the sensor can saturate. Any further away than the permissible range and the sensor will experience reduced signal strength until at some distance the magnet strength is insufficient to generate a signal.

The graph shows typical signal loss as the sensor to magnet distance is changed for a system that was designed to have a magnet stand-off distance of 6.8 mm from the sensor tube centerline.
If a button magnet is needed, follow the installation recommenda-

tions for those magnets in the specification for the sensor of interest. For example, a C-Series sensor requires a stack of two button magnets to get sufficient strength. Also, the area surrounding the magnet diameter must be non-magnetic, non-ferrous material.



Button magnets embedded in ferrous steel with non-ferrous spacer between magnet OD and the steel with a radius equal to 3 times the radius of the magnet

within ferrous metal structures. the area surrounding the tube defined by the inner diameter of the ring magnet that is recommended for use with the sensor should not have any ferrous material along its entire length. At no time during operation should any ferrous material come between the sensor tube and the inner diameter of the sensor.

In bar or button magnet installation, any ferrous material should not come closer to the sensor tube than an area defined by the recommended distance of the magnet surface to the sensor tube along its entire length and diameter. typically about 13 mm from the tube's centerline around the sensor would provide sufficient protection against field shunting in most applications.

For sensors that have embeddable heads, such as the C-Series, the sensor's head housing can be recessed entirely in metallic structures, ferrous or non-ferrous. Non-ferrous materials are also permissable, except that they offer no EMI/ESD advantages. the only consideration is that the area defined by the tube ferrous material keeping our rules in this section applies to where the tube enters the housing also.

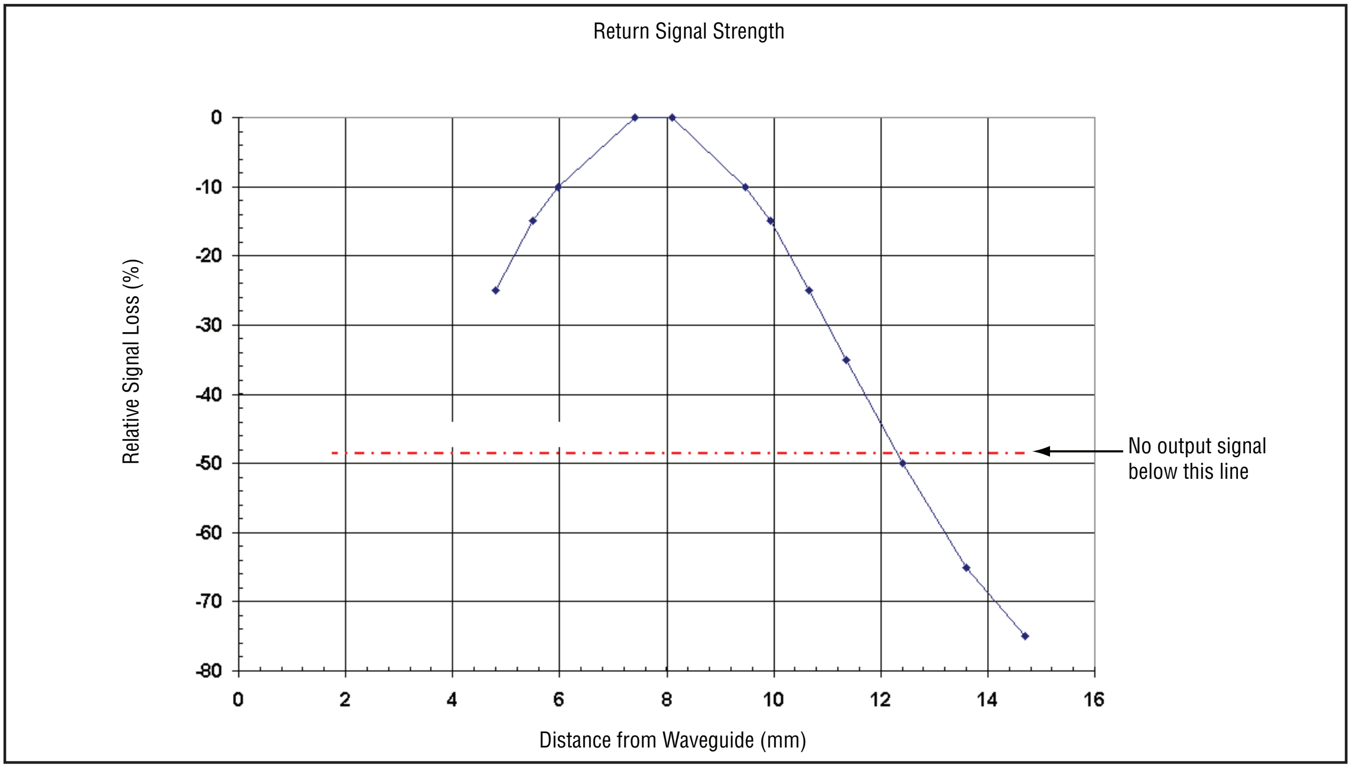


Figure 7 Temposonics C-Series - special considerations

Application materials and their effect on field shunting

Routinely, ferrous materials can be close to the sensor. However, each type of sensor is housed differently. for example, those sensors with enclosed metallic heads and those with extruded housings along their length govern to access of ferrous materials by virtue of their designs. but sensors that are designed for embedding, such as the C-Series, and most rod type sensors require that certain rules be followed for keeping surrounding ferrous structures of the application from interfering with the sensor's operation. The sensor's tube, also called the waveguide tube, can be housed

The sensor tube, also called waveguide, can be housed within metal structures also. But there are some applications rules.

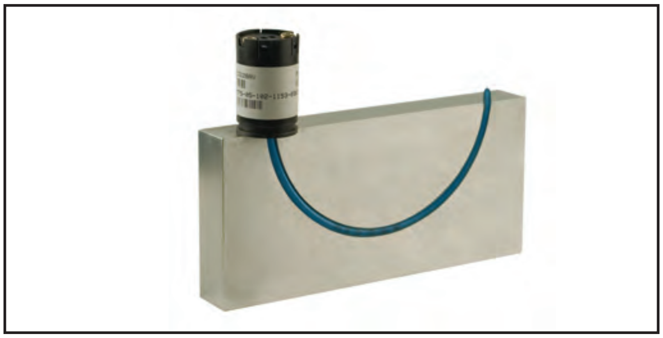
The area surrounding the sensor tube defined by the ring magnet's ID should not have any ferrous material present. No ferrous material should come between the sensor tube and the magnet ID.

In bar or button magnet installations, the ferrous material should not come closer to the sensor tube than 13 mm anywhere around the tube and no ferrous material should come between the sensor tube and the magnet's north surface.

Curved sensor installations

Any curved waveguide installation needs special attention during application evaluation due to the potential issues associated with an attenuated return signal level resulting from curving the waveguide and, just as importantly, correct selection of the magnet and installation of that magnet.

There are limits to the amount of curving that the sensor can tolerate and still have a viable output. The graph shows the amount of signal loss at a given radius of bend. For example, about 60% of the signal is lost with a bend radius of about 25 mm. MTS recommends never going below that. However, since the magnet choice and its proper installation is also critical to a robust installation, the higher an installation can be on that graph, the higher or stronger the signal and the more robust the system will be. MTS recommends a bend radius of 50 mm or more to give a signal strength of 60% or better. The material that the waveguide path is machined into is also important. It must not shield or shunt the magnetic lines of force. Also, the material must not be magnetized. Sometimes machining can create residual magnetism in the material that will shunt the magnetic field. Lastly, as the temperature range broadens, a stronger signal makes a more robust, reliable system over the temperature range.

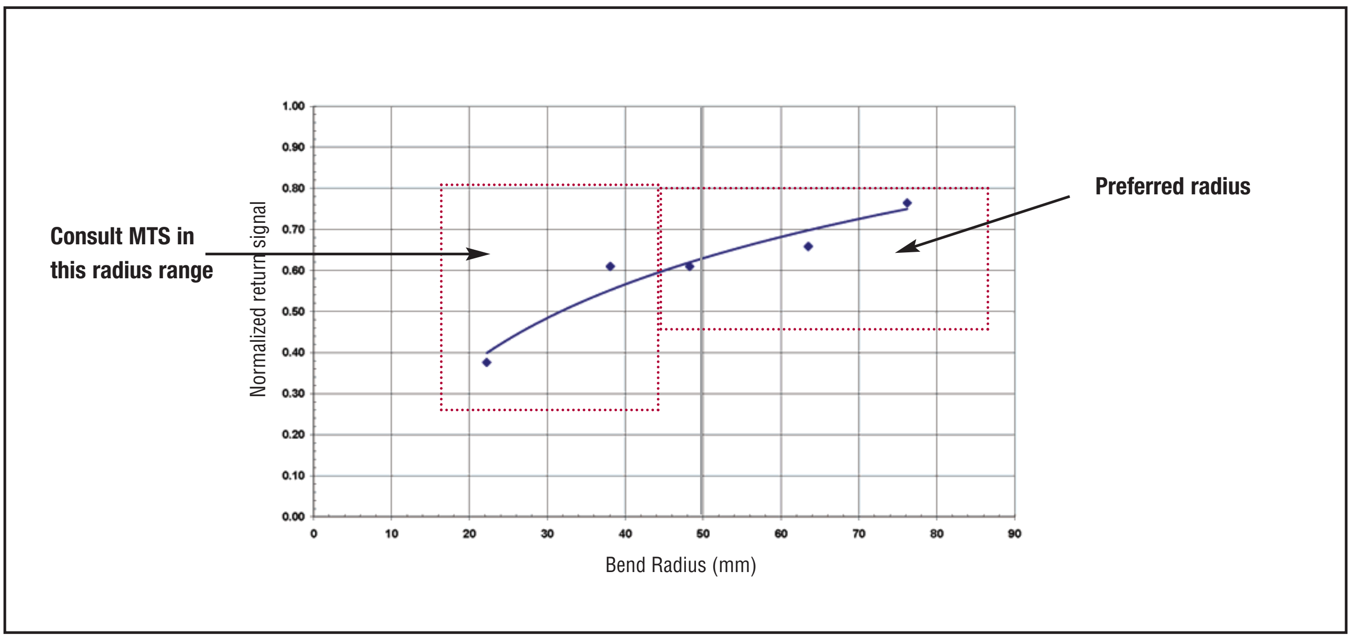


Curved sensors can be employed with application care

Most curved sensor applications need some form of bar or button magnet coming at the sensor waveguide from one side because a ring magnet won't fit the application. It’s important to note that with button or bar magnets, magnetic north must be facing toward and orthogonal to the waveguide. Reversing the magnet will shift the signal in time and reduce the temperature range. In addition, keeping the magnet travel skew from the sensor’s installed path is now critical.

Along the curve of the sensor, the magnet must maintain a specified standoff height. Plus the magnet path must be parallel to the sensor shaft. Any deviation in standoff height or path parallelism as the magnet passes along the sensor's path will, at minimum, produce a position error or reduce the effective temperature range, and, in the worst case, reduce the signal level to the point where the signal is lost completely, and introduce instability.

Installation design of a button or bar magnet is also critical. If a button magnet is selected, a stack of two is needed to get enough signal strength. also, the area surrounding the magnet diameter must be non-magnetic, non-ferrous material.



Sensor path curved to 180 degrees at indicated radius

In the photo, an additional radius area equal to the diameter of the magnet is filled with a non-ferrous spacer, in this case brass. This keep out area rule of thumb must be considered in designing the magnet installation. The area underneath the magnet can normally be ferrous material. In fact, sometimes it's better to have that area ferrous to focus the field. If there is a problem that appears to be related to magnet installation, MTS can run tests to determine the cause if we have a means to simulate the installation or have actual installation parts to run a simulated installation test.

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