DIST Linear Non-Contact Position Sensors Used in Applications Requiring Redundancy

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LRT Sensors designs and manufactures a standard series of non-contact linear sensors using our patented DIST (**D**istributed **I**mpedance **S**ensor **T**echnology) technology. This know-how is also applicable to rotary, gap sensing and liquid level applications on a custom basis. LRT's sensors compare favorably to traditional technologies such as LVDT's and magnetostrictive sensors from a cost, accuracy and resolution perspective and are impervious to harsh environments such as high temperature (225° C), high magnetic fields, high shock and vibration and high radiation. They are used in a wide variety of applications in the aircraft, medical, recreation, farm and construction equipment industries. DIST sensors are easily adapted to replace existing LVDT's and magnetostrictive sensors and can readily be incorporated internally into hydraulic and pneumatic cylinders. The sensors have no wear parts and can therefore deliver long trouble-free service. This paper discusses methods, using the DIST sensor, to provide double and triple redundancy in critical applications.

The DIST sensor, in a manner similar to inductive sensors, follows the fundamental laws of physics concerning changing electromagnetic fields. In a perfect vacuum an electromagnetic wave will travel forever at the speed of light in a straight line with no energy loss. However, if the electromagnetic wave encounters any material, the energy and the direction of the electromagnetic wave will be changed. The amount of the change can, in theory, be calculated by a set of equations called Maxwell's equations which is beyond the scope of this paper. A position sensor determines the change in the wave and from that we can calculate the presence and position of material in the wave's path. So, if something moves into the path of the electromagnetic wave, the wave will be distorted in a predictable manner. If we measure this distortion it is possible to determine the motion and or position of the material in the wave's path, i.e. a position sensor.

Redundancy

In many applications it is sometimes desirable to deploy multiple sensors making identical measurements of the same motion. In a dual redundant system (two sensors), when both sensors produce the same result the data are assumed to be accurate. If the two sensors disagree, then the data from both sensors are suspect and must be disregarded.

With a triple redundant system (three sensors), when at least two of the sensors agree, the system can continue operation based on the values of the two sensors in agreement and the value from the third sensor is ignored. With LVDT's and magnetostrictive sensors, redundant systems can be deployed only by installing two or three separate sensors and then mechanically coupling each of them to the same movable object. This linkage introduces errors due to differences in alignment, backlash (lost motion) and other imperfect attributes of the mechanical coupling. By comparison, the DIST sensor has the ability to make a true double or triple redundant measurement without any need for separate linkages and only a small increase in the physical size of the sensor.

For a double redundant system the nonconductive shaft of the sensor can be extended and a second coil wound on this extension, as show in Figure 1 below.

Figure 1

At first glance this appears to double the length of the sensor but that is not true. The conductive tube that covers the initial sensor has to have an extra space equal to the length of the sensor into which it is withdrawn when the coil is uncovered. This is shown below in Figure 2 with the conductive tube at full extension.

Figure 2

When we have two sensors on the same rod, the single conductive tube serves two functions. As the conductive tube uncovers coil #1 it simultaneously covers coil #2. If space is at a premium the electronics package for coil #2 could be combined with the electronics of coil #1 by using a hollow nonconductive rod and running a shielded wire through the rod. Thus a redundant system requires no additional space, but more importantly both coils are measuring the same moving surface with no requirement for mechanical alignment or attachments.

The DIST technology can easily be extended to a triple redundant system by adding a third coil. This coil is wound on a larger diameter hollow non conductive tube that fits over the moving conductive surface. The outer coil will also resonate (albeit at a different frequency) in response to the conductive surface moving on its INNER surface. This is all shown in Figure 3 which has an exploded view showing the three coils and the conductive rod which is the actual measurement point.

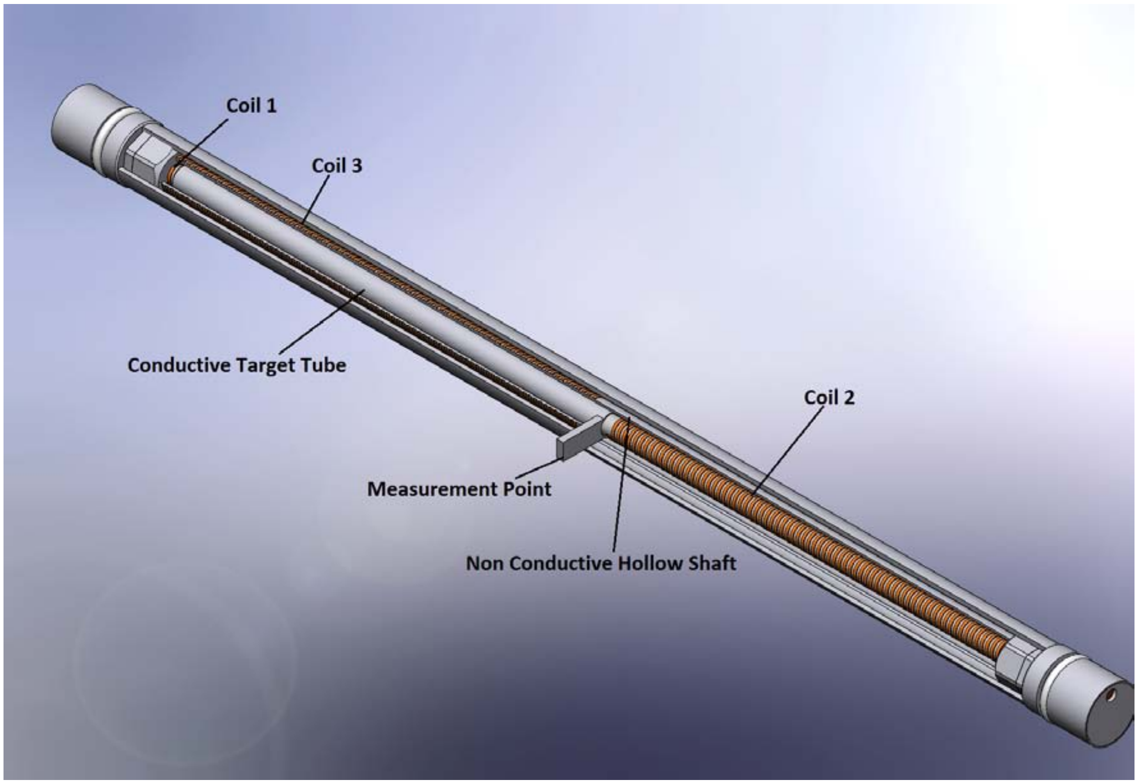

Figure 3

We now have three separate measurements on the SAME moving surface (the conductive rod). All three coils can be calibrated at the same time. There is some penalty in size for having the third coil, in that the diameter of the total package has increased, although the length (which is usually the more important parameter) remains unchanged.

In summary, the DIST sensor is a simple, economical and compact device that can make accurate and reliable linear measurements in almost any environment with only a single wire for power and signal. It has few components with no wear parts and is extremely robust and reliable. However, in some critical applications redundancy may still be desirable. The DIST sensor's ability to perform a true double or triple redundant measurement with only a slight expansion of its physical size is both practical and elegant.

It is currently available in custom configurations for OEM users and is also available off-the-shelf in standard configurations.