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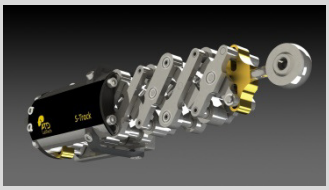

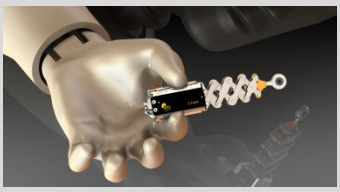

Linear Position Sensor für High Accelerations:

Conductive Plastic Potentiometers in Crash Testing

Even as the trend in linear and rotational measuring technologies is headed towards non-contacting principles, potentiometer-based sensors are still largely unrivaled for many applications. Their positive characteristics are keeping these sensors ever popular and this is unlikely to change much. After all, comparable measuring speeds, linearity values, resolutions, hysteresis values, and temperature ranges would otherwise entail significantly higher costs and efforts. Now, the versatile "pots" are once again proving their strengths in an application involving crash test dummies. A linear potentiometer, made of conductive plastic and customized to the application, is playing a key role.

Crash test dummies (officially called "Anthropomorphic Test Devices", or short: ATDs) are life-size mannequins used to simulate the effects of traffic accidents on the human body. To this end, they are equipped with a large number of sensors in order to measure the stresses endured during crash testing as realistically as possible. With the S-Track, ATD-LabTech has now developed a new sensor unit that is especially well-suited for installation in chest or abdomen. It promises to deliver significantly more relevant measuring results than the telescoping infrared or pulley solutions commonly used today. The new sensor ‘s dimensions, center of gravity, and weight are identical to those of the existing systems, permitting an

easy exchange without the need to modify the dummy ‘s physical characteristics. Calibration is also easy, using the tools already on hand.

Scissoring instead of Telescoping

The patented measuring principle relies on a high-precision, low-friction stainless steel scissors mechanism, which retracts during the impact phase of the test. During impact, the stroke ‘s movement is transferred at a reduction ratio of i=4.5, in an absolute and linear manner, to a potentiometric sensor element housed in the relatively small base enclosure of the sensor unit.

” Novotechnik offered us precisely the right solution, “ says Gerhard Pfeifer, managing partner at ATD-Lab Tech, obviously pleased. ” In light of the high speeds and our high linearity requirements of 0.25%, other sensors were not an option for this application. “ With a travel speed of 10m/s over a distance of 90mm, the measuring element is exposed to acceleration and breaking forces of up to 500g during the tests. Thanks to their operating principle (see Technology Box), conductive plastic potentiometers are ideally suited for this.

High Measuring Rates – Not a Problem

Since the test takes only approximately 150ms, the sensors need to provide as many measurements as possible during this short time span. ” This is where the potentiometer also convinces, “ explains Pfeifer. Because only the high measurement frequency of 20kHz can provide a sufficient amount of measurement data for highly realistic results. ” Besides the fact that laser sensors are much too large for our application, their cutoff frequencies of approx. 3.5kHz would also make them significantly slower. The latter also applies to most Hall sensors, for instance, “ Pfeifer continues. Thanks to the analog measuring principle, potentiometric sensors can be scanned as often as the interpretive electronics allow.

This application benefits from yet other ” classic “ potentiometer properties. For example, linearization of the measurement signal by way of electronics or calculations is not necessary. The S-Track can provide absolute linear position sensing at sheer endless resolutions. The scissors sensor with its 2D or 3D adapter can be utilized not only in the thoracic cavity, but also for abdominal measurements. Additionally, the purely potentiometric measuring principle requires less input current and operates at voltages as low as 0.1V.

Application-specific and Ready to Install

An “off the shelf” conductive plastic potentiometer was definitely not an option for this application. However, Novotechnik ‘s vast portfolio of products comprised a suitable solution that could be modified for integration into the scissors sensor. “Novotechnik provided us with excellent support right from the start, even though we were not talking large numbers of units,” Pfeifer states pleased.

A conductive plastic potentiometer essentially consists of 3 components: the resistive element, the wiper, and a moving mechanism for the wiper. In this particular case, the moving mechanism is connected to the scissors mechanism. It moves the wiper, thus changing its position on the resistive element. The picked up voltage potential is a linear function of its actual position . It is therefore distance proportional, and with the S-Track it is immediately processed further in the form of an analog signal. The basis for this application-specific potentiometer solution is the linear resistive element called PTX 0025, which Novotechnik manufactures in the desired length. The carrier material is high-quality FR4 (FR = Flame Retardant). To achieve linearization, the resistive track undergoes laser treatment after the silk screen processes. In principle, this makes linearity values of 0.05% or better a possibility.

Of course, another important factor that determines a potentiometer ‘s reliability is the wiper picking up the measuring signal. For this reason,

ATD-LabTech receives the wiper element in a form that it is ready to mount from Ostfildern. In German, the wiper is called a "Schleifer" (literally "grinder".) "It would actually be better to refer to this component as the slider," says Pfeifer with a smile. "With a life expectancy of more than 100 million strokes, mechanical wear and tear are of minor importance, not only with our S-Track but also in regards to many other applications." Translational resistive elements, such as the one used in the application described, should always be considered, when space restrictions do not permit the use of a linear positioner with a housing. Among many others, they are commonly used in actuating drives and positioners. Since conductive plastic potentiometers for linear and rotary sensing are offered in countless designs, these fast, precise and low-cost sensors can be used nearly anywhere: in mobile electronics as well as in industrial machinery, factory automation and in the field of measurement and analytics technology in particular.

Technology Box: Conductive Plastic Potentiometer – Principle of Operation and Wiring

A conductive plastic potentiometer essentially consists of 3 components: the resistive element, the wiper, and the mechanism moving the wiper. Thus, its position on the resistive element changes. The picked up voltage potential is a linear function of the actual stroke. It is proportional to distance or angle, and in many cases it can immediately be processed further as an analog signal. In order to actually achieve the data sheet values for linearity, resolution, life expectancy, etc., conductive plastic potentiometers need to be set up as voltage dividers without wiper loads. To this end, the wiper voltage, for instance, is picked up with an operational amplifier, wired as a unity gain buffer. As a result, the contact resistance at the wiper becomes irrelevant. What's more, with the potentiometric measuring technology, temperature fluctuations or moisture have practically no impact on the measuring result. Modern industrial grade potentiometers are of low noise, the life time can exceed 100 mio.

movements making them a great choice for almost any application in position sensing.

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