

## **Rugged Length and Angle Measurement**

*Encoders, draw wire systems and magnetic measuring systems for harsh industrial environments.*

Length and angle measurement have to take place close to the action, which means that they must be able to withstand exacting environmental conditions and mechanical loads. In this article we will explain in more detail the application-oriented factors, to which the user must pay particular attention.

### Encoders:

When it comes to encoders, important selection criteria for the user include such technical characteristics as the degree of protection (IP value), temperature range, shock and vibration resistance as well as shaft load capacity. However these alone do not afford sufficient security that the encoder will enjoy a long service life under the given application conditions.

Let us take, for example, the case of encoders being used outdoors. They must offer IP67 protection as well as withstand temperatures down to -40°C. But is this sufficient? In many instances encoders used outdoors are subjected to direct solar radiation. This results in heating and cooling cycles that occur at regular intervals, causing a possible build-up of condensation inside the encoder housing. This can be prevented by using a very sturdy, compact die-cast housing, with multiple seals between the encoder flange and the housing, as is the case with Kübler Sendix encoders. The variable wall-thicknesses avoid any weak spots. So, for example, if screws are being used (maybe for fixing the connector flange) these will engage solid material and no through drilling is necessary, which might subsequently give rise to weak spots. The very compact design of the encoder keeps air spaces to a minimum, thus drastically reducing possible effects of condensation.

If the encoders are to be subjected additionally to high-pressure water or steam jets, as often occurs when construction machinery is being cleaned, then an even higher level of protection IP69k is necessary. This is available in the form of magnetic encoders from the Sendix range. It is also important to bear in mind that not only the encoder itself but also the relevant connectors, whether plug connectors or cables, must also be able to withstand the required conditions.

Alongside the environmental conditions, it is also important to take into consideration the mechanical loads. Thus an encoder that is being used on a drive or in machine-building should offer shock resistance of at least 1000 m/s<sup>2</sup> and vibration resistance of at least 100 m/s<sup>2</sup>. With heavy industrial applications a level of shock resistance of 2500 m/s<sup>2</sup> is to be recommended and where extreme loads are likely to be encountered, as is the case with certain construction machinery, then even 5000 m/s<sup>2</sup> may be required.

The deciding factor when it comes to the service life of the encoder is the quality of the bearing assembly. Here the maximum radial and axial load capacities provide an indication of the strength of the bearings – in this instance values of 80N radial shaft load capacity and 40N axial shaft load capacity are to be recommended. This is however not the sole indication of quality. The bearing design itself also determines, which installation conditions the encoder can withstand. Kübler offers its so-called "Safety-Lock<sup>™</sup>" bearing design for the Sendix encoder series. This bearing design incorporates two mechanically-interlocked bearings that have the maximum possible distance between them. This ensures stability with vibrations and affords a ruggedness that tolerates installation errors, thus drastically reducing premature damage to the encoder. This also considerably minimizes machine downtime and repairs, which sometimes only manifest themselves years later in the field.

In certain specific applications it is the technology employed that plays a decisive role. For example, in applications that are subject to the influence of strong magnetic fields, as occurs for instance with drives with magnetic brakes, then it is necessary to ensure that a technology is employed that is 100% resistant to these magnetic fields. This poses a particularly high technical hurdle for multiturn encoders in applications involving geared motors, as in this type of application it is very common to find a large diameter through hollow-shaft being used. This was one of the main reasons why the Sendix multiturn encoder with 100% optical technology was originally developed. This required the development of a geared multiturn stage - the first mechanical multiturn stage with a through hollow shaft up to 15 mm in a standard 58 mm housing format. Kübler benefited here from their many years experience with gears from the field of electromechanical micro counters. The innovative gear design with its special materials, a first stage with double bearing layer and specially developed gear teeth all ensure a long service life, even when running continuously at high temperatures and speeds up to 9000 rpm.

### Draw wire encoders:

At the core of a draw wire encoder is a drum mounted on bearings, onto which a wire is wound. The winding takes place via a spring-loaded device. An encoder counts the number of revolutions. If the circumference of the roll is known, the length can be calculated. Draw wires transform linear movements into rotary movements. These movements are measured by encoders.

The primary quality characteristics here, alongside those of the encoder itself, are the winding mechanics, the stability of the draw wire mechanics housing as well as of course the wire itself and how it is fixed. Significant technical features include the linearity, the maximum acceleration that the mechanics can withstand, as well as the service life expressed as the number of possible cycles – here it is important to note whether one is talking about true complete cycles, in other words where the wire is drawn out and fed back in over the whole wire length.

With its new generation of draw wire encoders Kübler has placed special emphasis on rugged design. Depending on the model the measuring length ranges from 0.25 up to 40 meters. The systems have a linearity of up to 0.05% and can be supplied on request together with the corresponding calibration certificate.

Winding takes place via a dynamic spring mechanism using a constant force spring, which allows for a high traverse speed of up to 10m/s and high acceleration of up to 140 m/s<sup>2</sup> - or optionally even up to 255 m/s<sup>2</sup>. The system is thus ideally suited to dynamic applications and still achieves a long service life of around 2 million complete cycles.

The construction is particularly robust and unaffected by environmental influences thanks to its titanium-anodised aluminium housing. The wire is made from stainless-steel with a diameter of 0.5mm and is thus exceptionally hard-wearing. Furthermore a diamond-polished ceramic guide ensures a wire exit that is free from wear. The wire is fixed by means of either a wire clip with swivel or with an M4 screw fixing. IP67 protection is available as an option, as is a special HART-COATE coating. Fixing is simple and quick, using just two screws. Thanks to the flexible housing technology, a choice of versions is available to meet a variety of mounting requirements.

### Linear Measuring Systems:

So-called linear magnetic measuring systems (Limes) are available as an alternative to the draw wire systems. This type of system consists of a sensing head and a magnetic band. The system allows resolutions of up to 0.005 mm and measuring lengths of up to 90 meters to be achieved. As the system works on a non-contact principle and as the sensor electronics are fully encapsulated, it offers a particularly high level of ruggedness and resistance to the environment. In contrast to standard devices that have a plastic housing, the Limes system from Kübler uses a tough die-cast housing, which also offers in addition excellent shielding of the electronics. Used in conjunction with rugged magnetic bands with their stainless-steel covering, the resulting linear measuring system stays sealed even in harsh industrial environments and offers security against failures in the field.

### The selection

..... of the right measuring system is no easy task and requires a good knowledge of the products being used. We therefore recommend that you do not rely only on a few technical characteristics shown in a data sheet. Instead it is better to ask for a detailed explanation of the devices and the applications, for which they have been developed.

Fig 1: Cover picture - Encoders, draw wire systems and magnetic measuring systems for harsh industrial environments.

Fig 2: The versatile Sendix encoder family – with tough bearing assembly and housing technology.

Fig 3: Draw wire encoders for demanding applications, for measuring lengths from 0.25 m up to 40 m.

Fig 4: Limes – magnetic linear measuring systems for up to 90m measuring length.