

# Safety and Availability

## The small details make the difference – encoders in wind turbines

**Encoders for pitch and azimuth positioning or for speed measurement in wind turbines are exposed to a harsh working environment. In addition, high expectations are placed on the availability of the signals, as downtimes are expensive and replacement is time-consuming.**

There are many encoders on the market for positioning and rotary speed measurement. At first glance they all appear to be similar - or even the same - in their functionality and characteristics. However, as is often the case, the advantages they offer for particular customer applications and areas of operation lie in the details. Encoders from the Kübler company boast functionality and features that have been of great benefit to wind turbine manufacturers and system suppliers for many years.

Using a rugged encoder from the Sendix Absolute series, the angle of the rotor blade in the pitch drive is measured and adjusted via the pitch controller. Versions with additional incremental signals or sine/cosine signals can be used for speed regulation in the frequency inverter. If even greater safety is required, a resolver that is integrated in

the encoder housing can in addition send resolver signals to the frequency inverter, over and above the multiturn signals. These analogue signals are then utilised by the frequency inverter as rotational speed and direction data. The rugged resolver and the accurate encoder represent independent systems. This redundancy increases the availability and means that the blades can be taken out of the wind in the case of a malfunction. Multiturn encoders from Kübler feature very accurate optical scanning. In conjunction with their proven optical drive they have no need for a battery to store the number of revolutions. They thus provide absolute immunity against the influences of magnetic fields, caused for instance by electromagnetic brakes as are often employed in pitch drives.

### The application determines the version

Furthermore, Kübler offers singleturn and multiturn encoders, which are mounted either centrally in the rotor blade shaft or eccentrically with a pinion on the blade gear rim. The accessories necessary for installation – such as gearwheels, mounting brackets or protective covers – are pre-assembled and enable fast, safe installation everywhere, including out in the field. Spring-mounted installation systems ensure that the contact pressure of the gearwheel is not too great and that the loading of the encoder bearings cannot be exceeded. Encoders used for pitch and azimuth measurement can be reset to the zero position via a reset signal from the controller. For special cases, however, Kübler encoders also have a reset button in the cover. So, during mounting or servicing, the rotor blade reference can be manually set, even in the field. This is very helpful – not least when mounting the components in the restricted environment of the rotor hub. In order to meet the general requirements for components that are suitable for use offshore, Kübler offers its encoders with a sea-water resistant coating of the housing components.

In addition the encoders are tested to the IP67 protection level. They are thus more than able to cope with the damp, salty air they will encounter when used in offshore applications. They comply fully with the requirements for components used in a corrosive environment, such as, for example, with EN ISO 12944-2 Class C3. Here too Kübler goes one step further and tests its encoders according to the highest requirements of the standard IEC 68-2-11: over a time period of 672 hours in the salt-spray chamber. This test is specified by the automobile industry, although cars only have to withstand this test for a maximum of 120 hours. The combination of rugged design and interference-resistant electronics, which ensure reliability and availability, make the Kübler encoders ideally suited for use in offshore applications.



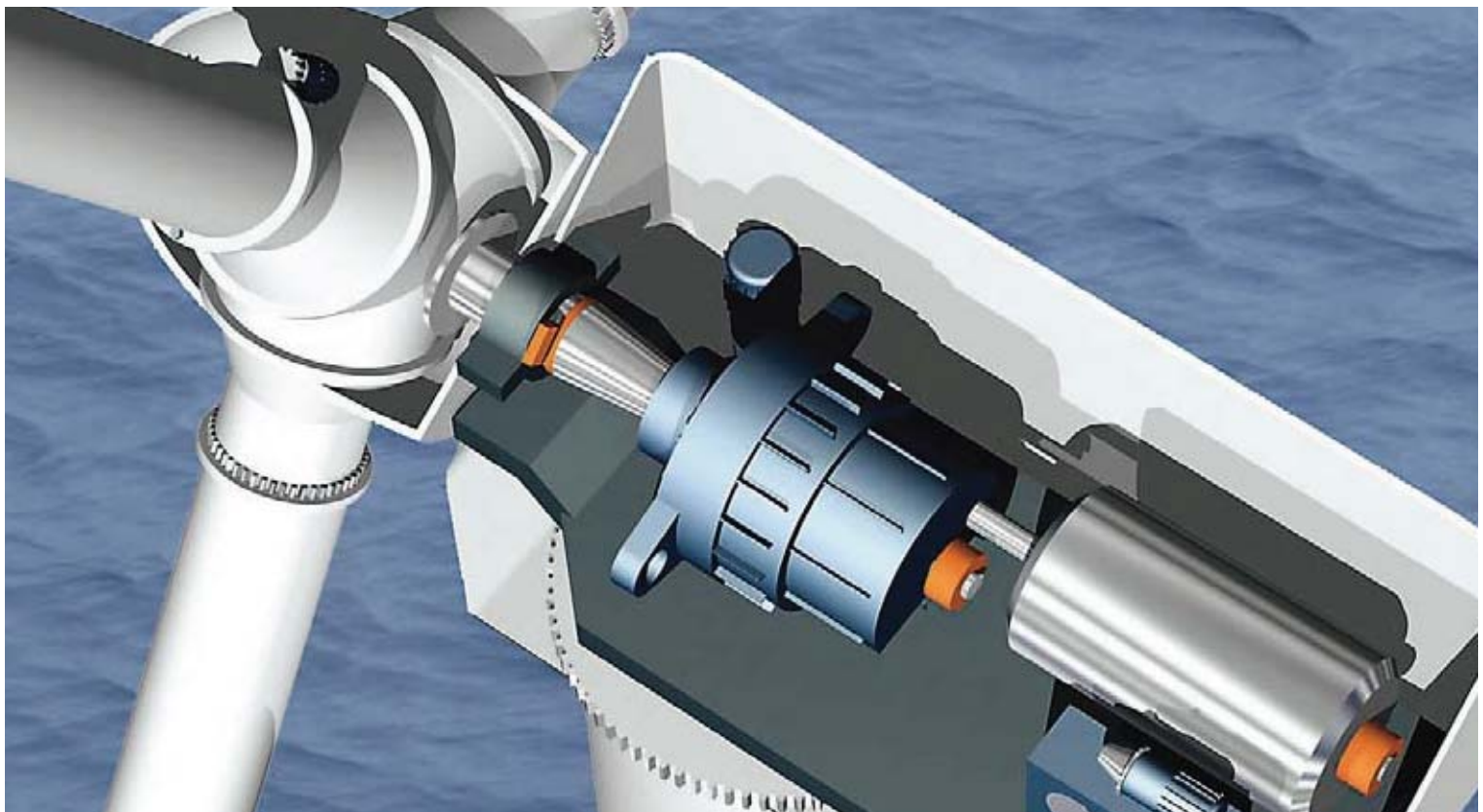
## Braving heat and cold

In contrast to applications in factories and assembly shops, encoders that are installed in wind turbines are operated in a wide range of temperatures. Depending on the location, daytime and night-time temperatures - and also summer and winter temperatures - can vary wildly. However, after a shutdown, the system must be able to be started up again safely and the signals must always be available. For such extreme conditions Kübler offers a working temperature range from  $-40^{\circ}\text{C}$  up to  $+90^{\circ}\text{C}$ , so the position monitoring or speed measurement neither 'freezes up' nor 'overheats'. High-temperature versions of the encoders can function in environments, where the temperature is up to  $105^{\circ}\text{C}$ . This can play a decisive role in applications in slip ring housings or in particularly hot wind turbine locations. The speed measurement at the generator is an important measured variable for the entire control loop of the turbine. Here accurate, high-resolution encoders are necessary for dynamic rotational speed control, supplying the controller with speed information in real time. The harsh operating conditions on the generator B-side are no problem for Kübler incremental encoders. Shaft currents and the associated damage they do to bearings are avoided by using isolating inserts. A wide diverse variety of accessories and stator couplings enable easy installation without impairing the measuring accuracy. Even a large amount of generator shaft expansion poses no problem here. In collaboration with its customers, the manufacturer defines special product tests, such as for example the Highly Accelerated Life Test (HALT). Here encoders are placed in a chamber and subjected to extremes of temperature, as well as to quick changes of temperature. At the same time they are accelerated in three dimensions.



## Speed of rotor hub and generator

The speed information from the encoders is brought together in the controller, evaluated and then sent from there to the turbine's control loop. In wind turbines supplementary, redundant monitoring of the speed is frequently desired. Mostly it is the slow rotor speed that is evaluated and – for wind turbines with gears – the fast speed at the generator. For this purpose Kübler offers tachometer/frequency meters for monitoring the difference between the speed of the rotor hub



and that of the generator; the meters offer safe relay contacts to break the safety chain. This means that additional safety can be offered if there is a deviation in the two speeds, or in the case of over-speed. Hour meters display the exact amount of hours during which the plan has produced current on the grid. Thanks to the electromechanical hour meters the information is available at all times, even if there is no supply voltage at all. Both the speed and the number of hours run can be viewed and monitored by the operator in the tower base – independently of the controller – without having to connect his laptop to the controller.

Wind turbines are being erected in more and more locations. Alongside the wind farms that have been planned globally in the seas, mountainous regions and other high areas are now being developed. Even if the logistics and grid connections in these locations are difficult, the advantages are obvious. The lack of population and the high wind speeds are attractive determining factors. These pose new challenges to the manufacturers of the turbines and components. Kübler encoders can be used at altitudes up to more than 3,000 meters above sea-level. The lower atmospheric pressure, as well as the quick changes in temperature, do not cause any problems, either for the electronics or for the rugged housing components.

The bottom line of all this is that although rotary encoders represent only a very small part of the total wind turbine, it cannot be denied that they carry significant responsibility for the safety, availability and performance of the whole turbine.

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