IP 67 module with sine/cosine encoder interface

High-precision measuring in the µm range directly at the Fieldbus Box

Direct connection of path and angle measuring devices with sine/cosine differential outputs.

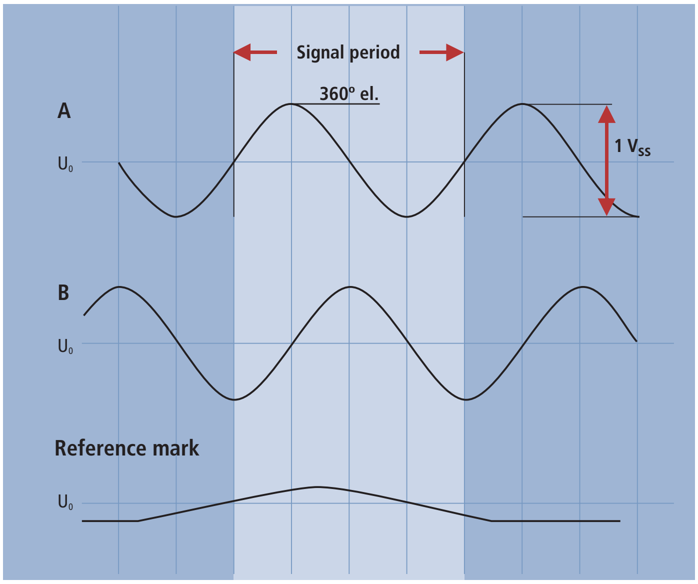
Faster, Better, Cheaper! Pretty much sums up the growing demands in automation technology. In many automation areas, "small revolutions" take place every day. IP 20 class fieldbus systems enclosed in control cabinets or small terminal boxes have been state of the art for some time. The next step for decentralization is the use of IP 67 modules which are directly installed at the machine or plant without additional protective enclosures. This offers tremendous advantages, particularly where space is tight or there are extreme ambient conditions.

Standard digital or analog type signals cover the majority of applications. However, like in IP 20 applications, users increasingly demand special signal types. There is less benefit to using distributed I/O if you cannot bring all your signals back to the controller over the fieldbus. The Fieldbus Box IP5209-Bxxx with sine/cosine interface is an example of a special function module allowing you to distribute all your signals over the bus.

Sine/cosine interface overview

This interface is used in many applications including shaft encoders or measuring probes. Compared with devices with digital square wave signals, the transfer frequency on the signal input lines is reduced significantly, while the resolution is unchanged. Instead of transfer rates in the MHz range, the transfer rate at a speed of 6000 rpm, for example, is only 100 kHz.
The sinusoidal signals A and B are offset by 90°, hence the name sine/cosine interface. Signal levels are typically 1 V_{SS}. Current variants such as 11 μA_{SS} are also available.

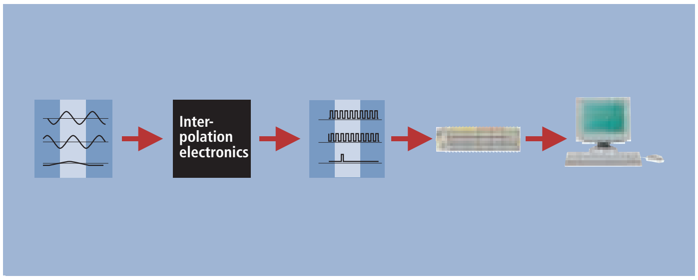
Apart from the sine/cosine output signals, the probes also provide a reference mark. For measuring probes, this mark is located, for example, just before the upper or lower end of the measuring range. Once the mark is reached or passed, a signal is generated that is evaluated and stored by the downstream electronics. So subsequent referencing in the control is possible.



Sine/cosine encoder signal

Data transfer to the control

The measuring sensor with sine/cosine output is usually connected via a sequential electronic system. The sampled signals are initially interpolated and converted into square wave signals. Subsequently, they are transferred via a Bus Terminal station with appropriate I/O terminal with incremental encoder input and via the fieldbus to the PLC.

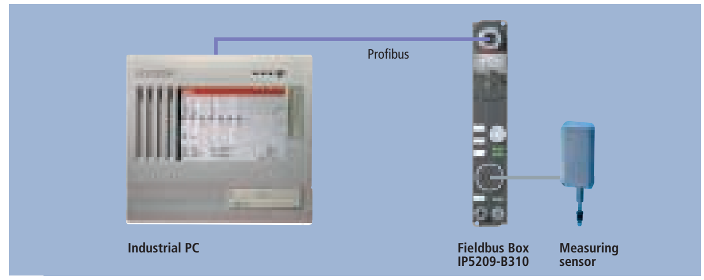


With the new Beckhoff module, there is no need any more for sequential electronics. In the Fieldbus Box IP5209-Bxxx, interpolation electronics and fieldbus connections are consolidated in a single device. The measuring probe is directly connected to the Fieldbus Box via an IP 67 impermeable, industrial M23 connector. All signals are transferred via this connector, which also supplies the required voltage for the sensor.

In order to offer a wide range of application options, the Fieldbus Box series is designed for all common bus systems. The IP5209-B310 variant has a Profibus slave interface. After the system start-up, i.e. after the Industrial PC with integrated Profibus master connection and the associated software has been started, the current counter value of the measuring probe is available via the Profibus. The Fieldbus Box evaluates the sine/cosine signals of the probe and adds these quasi-incremental impulses to the internal 32 bit counter. This makes the system independent from the higher-level controller or the fieldbus. The counter value can be absolutely converted to a physical sensor position.

Evaluation/scaling of the measuring signals

The signals are evaluated in terms of zero crossing and through interpolation within the oscillation. Zero crossing evaluation achieves a resolution of measuring probe period/4. Example: for a measuring probe with a signal period of 2 µm, the resolution is 0.5 µm.



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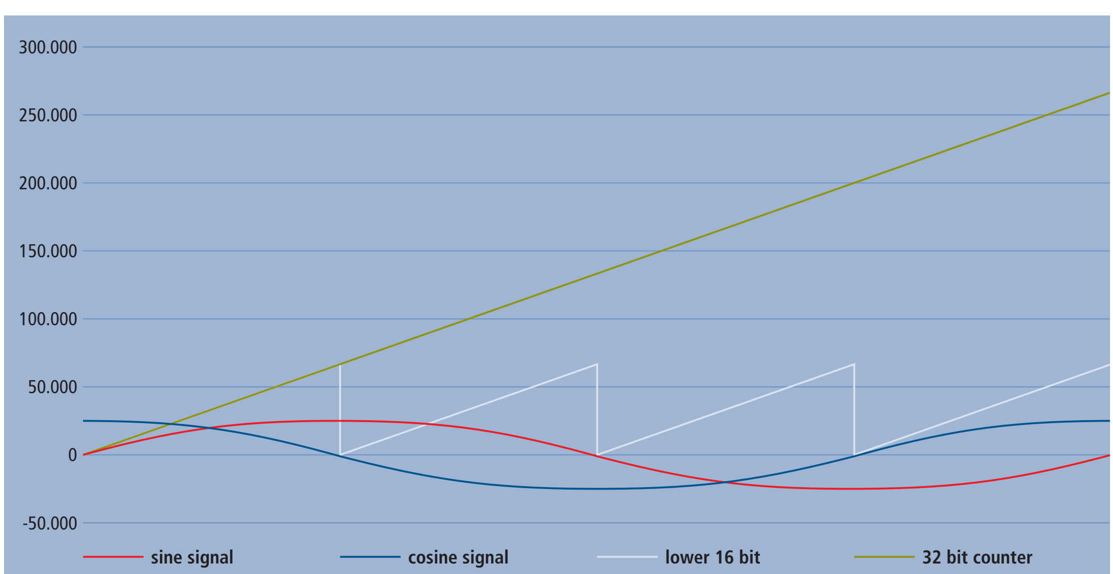
The interpolation within the oscillation provides the complete image of a period to 11 bits, i.e. 2048 steps! Theoretically, the system could therefore measure with an accuracy of approximately 1 nm (2 µm/2048). In reality, this is limited by the system accuracy of the measuring sensor and the configuration of the overall system.

The scaling or adaptation of the values to the "real" world can therefore be carried out very quickly through right-shifting or division by 2. In our example, the measuring probe with a signal period of 2 µm and a total measuring path of 12 mm would therefore result in a total figure of 12 mm/2 µm * 2048 = 12,288,000.

The trend is clear – the machines are becoming more compact, physical size and costs are becoming increasingly important. The availability of various special functions for IP 67 Fieldbus Box applications enables cost-efficient optimization.

The signal is represented in a 32 bit value. The zero crossings are summed up in the upper 16 bit value, whilst the interpolation values are stored in the lower 16 bit value (from bit 7 = direct).

Upper 16 bits			Lower 16 bits									
31…18	17	16	15	14	13	12	11	10	9	8	7	6…0
Period counter	Zero crossings		Resolution within a quarter period									invalid
	2048 steps within a period											



Mapping of the signal to the counter value