Application Notes for Incremental Rotary Encoders

Incremental rotary encoders emit pulses as the shaft is rotated, and the number of pulses is used to calculate angular position. The resolution (Z) of an incremental encoder is the number of pulses per revolution. The signal frequency is used to determine the angular speed (ω) and the change in position for a given period of time is used to calculate the angular acceleration (α).

Rotational direction monitoring with incremental rotary encoders

In order to determine the direction of rotation of a movement, the scanning principle is used on both channel A and channel B. The direction of rotation can be determined by evaluating the two signals, which are phase-shifted by 90 degrees.

In the first figure below (I cw), channel A precedes channel B. This indicates clockwise rotation. II ccw shows counter-clockwise rotation. The direction of rotation is determined by viewing the encoder shaft head-on.

Depending on the type of incremental rotary encoder, channel A or channel B is the leading channel. For more information, refer to the encoder data sheet.

Zero signal

Determining the frequency of the pulses is the job of the controller, PLC or tachometer. The zero signal is a pulse that occurs once per revolution at a fixed point and is transmitted using a third channel (often called channel 0 or Z). The zero signal is usually used as a reference signal for positioning.

The diagram below illustrates the output of a 3-channel incremental rotary encoder.

Note: catalog refers to zero channel signal as “Z” channel. This position signal can also be referred to as “0” channel or encoder marker pulse.

Inverted channels

Inverted signals are transmitted in addition to channels A, B and Z to improve signal quality. Inverted signals are a standard feature in RS-422 interfaces and are optional on push-pull outputs.

Pulse multiplication

Pulse multiplication is used to increase the number of measuring steps or to reduce the output frequency of an incremental rotary encoder. The signals of an incremental rotary encoder can be doubled or quadrupled by linking channels A and B.

For example, an application may need 20,000 measuring steps for each revolution at a speed of 3000 RPM. If the control unit (PLC, counter or tachometer) provides the option to quadruple the signal, then an inexpensive rotary encoder with 5000 pulses can be used. In addition, the output frequency of the incremental rotary encoder is reduced.

- Without quadruple multiplication: 1 MHz (this frequency is too high for most control units)
- With quadruple multiplication: 250 kHz

Doubling of signals