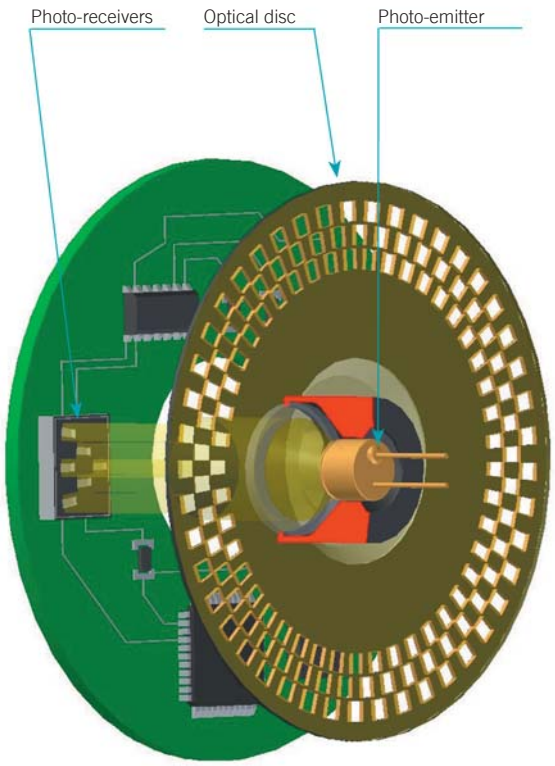
INCREMENTAL ENCODERS

GENERAL DESCRIPTION

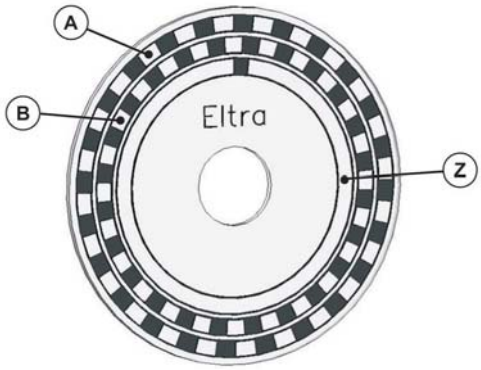
WORKING PRINCIPLE

An encoder is a rotary transducer that converts an angular movement into a series of electrical digital pulses. If associated to racks or endless screws, these generated pulses can be used to control angular or linear movements. During rotation, electrical signals can be elaborated by numerical controls (CNC), programmable logic controls (PLC), control systems, etc. Main applications of these transducers are: machinery, robots, motor feedback, measure and control devices. In Eltra encoders the angular movement transduction is based on the photoelectric scanning principle. The reading system is based on the rotation of a radial graduated disk formed by opaque windows and transparent ones alternated. The system is perpendicularly illuminated by an infrared light source. The light projects the disk image on the receivers surface which are covered by a grating called collimator having the same disk steps. The receivers trasduce the occurring light variations caused by the disk shifting and convert them into their corresponding electrical variations. Electrical signals, raised to generate squared pulses without any interference, must be electronically processed. The reading system is always carried out in differential modality, that is comparing different signals nearly identical but out of phase of 180 electrical degrees. That in order to increase quality and stability of output signals. The reading is performed comparing the difference between the two channels, to remove the noise known as “common mode”, because signals are overlapped in equal way on each wave.



INCREMENTAL ENCODER

The incremental encoder usually gives two types of squared waves out of phase of 90 electrical degrees. They are usually called channel A and B. The first channel gives information about the rotation speed while the second, basing on the state sequence produced by the two signals, provides the direction of rotation. A further signal, called Z or zero channel, is also available. It gives the absolute zero position of the encoder shaft. This signal is a squared pulse with phase and width centered on A channel.

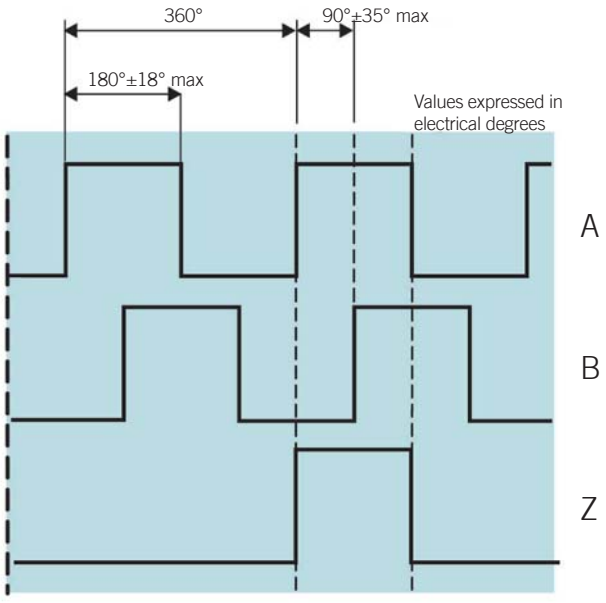


The incremental encoder accuracy depends on mechanical and electrical factors. These errors could be: grating division, disk eccentricity, bearings eccentricity, electronic reading and optical inaccuracy. The measurement unit to define encoder accuracy is the electrical degree. It determinates the division of the impulse generated by the encoder: 360 electrical degrees correspond to the mechanical rotation of the shaft which is necessary to carry out a complete cycle. To know how many mechanical degrees correspond to 360 electrical degrees the following formula has to be applied:

electrical 360°= mechanical 360°
nr. pulses / turn

The encoder division error is given from the maximum shifting shown in the electrical degrees of two consecutive edges. This error exists in any encoder and is due to the above mentioned factors.
On Eltra encoders pulse error is ±18° e max. on full operating range, which corresponds to a ±10% from nominal value.
Regarding the 90 electrical degrees phase relation between the two channels, it differs in ±35 electrical degrees max which corresponds to ±10% respect to signal period.

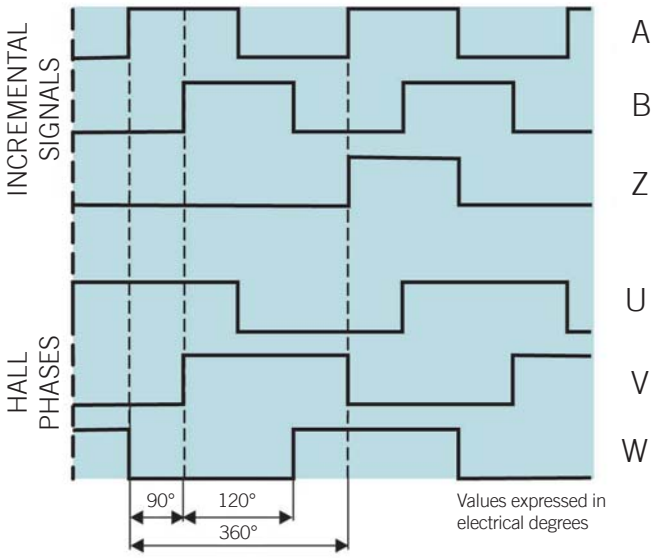
CLOCKWISE ROTATION DIRECTION



Graphic representation of A, B and Z incremental signals.

INCREMENTAL ENCODER WITH INTEGRATED COMMUTATION PHASES (HALL PHASES)

In addition to the above mentioned encoders, there are other encoders that integrate additional electrical output signals. These are incremental encoders with integrated commutation signals, used as motor feedback. These additional signals simulate the Hall phases that are usually present in brushless motors and are generally realized by magnetic sensors. In Eltra encoders these commutation signals are optically generated and presented as three squared waves, shifted by 120 electrical degrees. These signals will be used by the driver that controls the motor in order to generate correct voltage phases to determine right rotation. These commutation pulses can be repeated many times within one mechanical turn because they directly depend on the pole number in the related motor. So we have commutation phases for motors of 4, 6 or more poles.



Graphic representation of A, B and Z incremental signals with U, V and W Hall phases.