Selection Guide for Encoders

This document guides you to find the right encoder for your application.
Very often the differences between two encoders seem to be marginal. With the help of this document you are in the position to find these differences quickly and easily enabling you to choose the right encoder product family.

What is the difference between ...?

**Incremental**
- Counts pulses from 1 to n
- Reference run (zero pulse) necessary to obtain position value
- The number of pulses defines the resolution

**Absolute**
- Measures the absolute position from 1 to n
- Every measuring step is defined by a unique (absolute) code pattern
- The number of steps defines the resolution

**Singleturn**
- Variant of an absolute encoder
- Measures the absolute position from 1 to n within one revolution

**Multiturn**
- Variant of an absolute encoder
- Measures the absolute position from 1 to n within one revolution
- In addition measures the number of revolutions

And between ...?

**Wire draw encoders**
- Measures lengths between A and B
- Consists of a rotary encoder and a wire draw mechanism
- The wire is mounted to the moving part
- The encoder is fixed

**Linear encoders**
- Measures lengths between A and B
- Consists of read head and scale
- The read head is mounted to the moving part
- The measuring element is fixed
What should be measured? Angle or distance?

The question seems to be easy. However, the correct answer is the basis used when entering the selection guide on the next two pages. There we distinguish between “rotary” and “linear”.

**Angle = rotary encoders (selection guide page 4)**

**Distance = linear encoders (selection guide page 5)**
## Rotary encoders

<table>
<thead>
<tr>
<th>Feature</th>
<th>Incremental encoders</th>
<th>Absolute encoders singleturn</th>
<th>Absolute encoders multiturn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should an absolute position always be measured?</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>How many absolute turns should be measured?</td>
<td>No absolute measurement</td>
<td>1</td>
<td>2 or more</td>
</tr>
<tr>
<td>Which Interface connection is required?</td>
<td>TTL/HTL</td>
<td>Open Collector</td>
<td>Parallel</td>
</tr>
<tr>
<td></td>
<td>SIN/COS 1 Vpp</td>
<td>SSI</td>
<td>PROFIBUS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CANopen</td>
<td>DeviceNet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EtherNet/IP</td>
<td>PROFINET</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EtherCAT</td>
<td></td>
</tr>
<tr>
<td>What is the maximum diameter available?</td>
<td>Up to 36 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 40 mm</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Up to 50 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 60 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 90 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What type of mounting shaft is required?</td>
<td>Face mount flange solid shaft</td>
<td>Square mount flange solid shaft</td>
<td>Servo flange solid shaft</td>
</tr>
<tr>
<td></td>
<td>Blind hollow shaft</td>
<td>Through hollow shaft</td>
<td></td>
</tr>
<tr>
<td>Should a measuring wheel be used to measure the position?</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Is a shaft diameter &gt; 16 mm required?</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>What resolution is required (pulses/ steps)?</td>
<td>Up to 2,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 8,192</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 8,192</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 32,768</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a solution enabling programming by the customer required (resolution, zero-pulse …)?</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

1) Programming by programming tool (SSI) or controller of the relevant bus interface.
# Linear encoders

<table>
<thead>
<tr>
<th>Maximum number of measuring cycles?</th>
<th>EcoLine</th>
<th>Compact</th>
<th>HighLine</th>
<th>KH53</th>
<th>KH53A</th>
<th>TTR70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 1,000,000</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infinite</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which type of distance measurement is required?</th>
<th>Absolute</th>
<th>Incremental</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTL/HTL</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Analog</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>HIPERFACE</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>SSI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROFIBUS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CANopen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DeviceNet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EtherNet/IP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROFINET</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EtherCAT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which interface connection is required?</th>
<th>TTL/HTL</th>
<th>Analog</th>
<th>HIPERFACE</th>
<th>SSI</th>
<th>PROFIBUS</th>
<th>CANopen</th>
<th>DeviceNet</th>
<th>EtherNet/IP</th>
<th>PROFINET</th>
<th>EtherCAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTL/HTL</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIPERFACE</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SSI</td>
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<tr>
<td>PROFIBUS</td>
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<tr>
<td>CANopen</td>
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<tr>
<td>DeviceNet</td>
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<td></td>
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<tr>
<td>EtherNet/IP</td>
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<tr>
<td>PROFINET</td>
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<td></td>
<td></td>
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<tr>
<td>EtherCAT</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is a continuous mounting surface available along the total measuring length?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How are the mounting tolerances?</th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What measuring length is required?</th>
<th>≤ 5 m</th>
<th>≤ 10 m</th>
<th>≤ 50 m</th>
<th>≤ 548 m</th>
<th>≤ 1,700 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 5 m</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 10 m</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 50 m</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 548 m</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>≤ 1,700 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What resolution is required?</th>
<th>≤ 0.1 mm</th>
<th>≤ 0.05 mm</th>
<th>≤ 1 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.1 mm</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 0.05 mm</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>≤ 1 µm</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How robust should the measuring system be?</th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which frame size can be used?</th>
<th>Small</th>
<th>Middle</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

*On demand*
**A**

**Analog interface**
Standard analog interface: As required from 4 to 20 mA, or 0 to 10 V output signal.

**B**

**Baud rate**
Gives the signal rate and hence the speed of serial data transfer in bits per second.

**Bend radius**
In cabling terms, the bend radius relates to the smallest curve radius a cable may have when installed, without the cable properties being altered. The bend radius is given in relation to the cable diameter.

**Bus system**
A system for transferring data between multiple devices over a common cable. A bus system makes it possible to control all sensors and actuators centrally. Additional information such as process data, service data and diagnostics data can also be exchanged.

Well known examples are:
DeviceNet, PROFIBUS, CANopen, PROFINET, EtherNet/IP, EtherCAT.
Additional information on bus systems can be found in this glossary under the CANopen, DeviceNet, EtherCAT, EtherNet/IP, PROFIBUS and PROFINET entries.

**C**

**CANopen**

CANopen: is a communication protocol based on CAN.
User organization: CiA (CAN in Automation)
More detailed information about this technology is available at www.can-cia.org

**Channel**
Signal path upon which a signal is output.

**Code disc**
See “Output frequency, maximum” on page 10

**Code type**
Unique encoding of the measured values according to a defined scheme at the encoder output. In practice, different codes are used for different electrical interfaces, e.g. SSI interface with Gray code.

**Cycle**
See “Service life” on page 11

**D**

**DeviceNet**

DeviceNet is a CAN based communication protocol.
User organization: ODVA
More detailed information about this technology is available at www.odva.com

**Differential evaluation**
Evaluation of signals produced by a circuit which produces a signal and its invert. The 1/0 level, or sine/cosine signals are transferred in the form of voltage differences between two cables. In this way, the signal used (the difference) remains uncorrupted as interference normally affects both cables equally.

**Drag chain use suitability**
Drag chain use suitability is the ability of cabling to be used in moving applications. PUR cabling is suitable for drag chain use, but PVC cabling is of limited suitability or completely unsuitable. In the case of PUR cabling, the number of bend cycles is generally greater and the bend radius smaller than with PVC cabling.

**Drum circumference**
The resolution in mm of a wire draw encoder can be determined using the circumference of the drum and the resolution of the rotary encoder (e.g. 12 bits per revolution).
**EMC**

Electromagnetic compatibility (EMC) means that technical equipment should not be affected by electromagnetic interference. This is achieved both by limiting sources of interference in devices and by devices being designed to be sufficiently resistant to interference. EMC is regulated by EU Directives and Standards.

**Enclosure rating**

The enclosure rating indicates the degree of protection of a machine or sensor against contact and penetration by impurities and water. The enclosure ratings begin with the letters IP, followed by the first digit, which indicates the degree of protection provided against touch and particles. The second digit describes the protection against penetration by water.

**Encoders**

Encoders are sensors for monitoring position, angle and speed. Essentially, encoders can be categorized as rotary or linear. Rotary encoders are sub-divided into incremental and absolute encoders. Linear encoders are further sub-divided into wire draw encoders and non-contact linear encoders.

**Encoders, absolute**

Absolute encoders generate information relating to position, angle and rotation counts in type-specific angle steps. For this, a unique code pattern is assigned to each angle step. The number of code patterns available per revolution determines the resolution. Each code pattern forms a unique reference, and is therefore absolute position information. There is therefore no need for a reference run after switching on. A singleturn encoder measures the absolute position within a revolution. A multiturn encoder not only provides the position within a revolution but also the number of revolutions.

**Encoders, incremental**

Incremental encoders generate information related to position, angle and number of rotations. The number of lines per revolution determines the number of impulses that the encoder transmits to the control unit for each revolution. The current position can be determined by the control unit counting these impulses from a reference point. When the machine is switched on, a reference run to the reference point is required to determine the actual position of the encoder.

**Error limit**

The error limit is the largest positive or negative deviation of any angle position (absolute) or of a measured angle (incremental) from the true value.

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**EtherCAT**

EtherCAT is an Ethernet based fieldbus.
User organization: EtherCAT Technology Group
More detailed information about this technology is available at www.ethercat.org

**EtherNet/IP**

EtherNet/IP is an Ethernet based fieldbus.
User organization: ODVA
More detailed information about this technology is available at www.odva.com

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**Fieldbus**

Bus system in the process area for direct connection of sensors and actuators that have their own intelligence. Data in digital form is transferred between sensors, actuators and control devices via a fieldbus. This transfer must be as rapid as possible, i.e. close to real time. For this, a fixed minimum and maximum response time must be guaranteed.

**Flange**

Part of the encoder for fixing to the customer installation interface. There are various mechanical versions, for example:

Left: Face mount flange; Right: Servo flange.

Left: Blind hollow shaft; Right: Through hollow shaft.
Gray code
Constant code that is also used with the SSI interface. When the position value changes from one value to the next, only one data bit changes. This ensures reliable data transfer.

Gray excess code
If a suitable section for encoder resolution is extracted from the middle of the complete Gray code, this results in the “Gray Excess Code” (capped Gray code). The use of this Gray excess code allows only a single data bit to be altered even when the encoder crosses zero, although the number of steps is not $2^n$ where $n$ is a whole number.

Halogen-free (wiring technique)
Cables and wiring are said to be halogen-free if the materials used do not contain salt forming chlorine, fluorine, bromine or iodine. The insulation and sheath materials of these cables consist of polymers based on pure hydrocarbons. When such materials are burned, no corrosive or toxic gases are produced, but only water vapor and carbon dioxide.

HIPERFACE®
High Performance Interface (HIPERFACE®) is a hybrid interface developed by SICK that can transfer analog speed values and digital position values. Electrical compatibility is guaranteed by the use of HIPERFACE® as the obligatory interface for all physical parameters.

The advantages of HIPERFACE® are that only one interface is required on the drive electronics for all applications, only one type of signal cabling is needed between the drive electronics and the signal encoder and manual configuration of the speed sensor is not necessary.

HIPERFACE® DSL
The High Performance Interface DSL is a pure Digital Servo Link interface developed by SICK that provides new servo drive system architecture for HIPERFACE® with a completely new range of options as it is not hybrid (analog/digital), but is completely digital.

Thanks to the innovative and interference-free HIPERFACE DSL® protocol, rugged and reliable communication can be achieved using just two wires that are integrated into the motor cable. In addition, the digital protocol requires a minimum of connection cables between the frequency inverter and the motor feedback system.

The absence of motor feedback connections achieves significant cost savings and distinctly increased performance.

HTL push-pull
High Voltage Transistor Logic functions with a voltage supply in the range 10 and 30 V DC, with 24 V DC being the most usual. “Low” is defined as an output of between 0 V and 3 V and “high” as between $V_{CC}$ and $V_{CC} - 3.5$ V.

Interface, electrical
Connection point between two devices or systems. The devices or systems on either side of an interface are connected to each other by interface cabling over which data, addresses and control signals are exchanged. The term interface embraces the complete functional, electrical and constructive conditions that make up the point of contact between the devices or systems. Depending on the type of data transfer, a distinction must be made between parallel (e.g. Centronics, IEEE 488) and serial interfaces (e.g. RS-422, RS-423, RS-485) that are designed for differing transfer speeds and distances.

Inverted signal
Reciprocal signal for the suppression of interference impulses when using differential sampling.

Jitter
From the English verb “to jitter”: flicker, tremble; time variation of the output signal resulting from constantly present tolerances.
**Linear encoders**

A linear encoder is for frictionless length measurement and determining positions. A read head samples a code pattern or the magnetic field of a magnetic scale and outputs the appropriate electric signal.

**Principle of operation**

**Linearity**

The accuracy of wire draw encoders is described by the linearity. This indicates the maximum deviation for the measurement of a defined measurement distance or rotation. In contrast to repeatability, this relates to the measuring range covered and not to the positioning point.

The data sheet values for wire draw encoders refer to the particular measuring range.

**Measurement range**

The range within which a rotary or linear encoder can produce a valid measurement signal.

**Material resistance, PUR**

Flexible silicone and halogen-free cabling with PUR outer sheath: The oil and fire resistance requirements of VDE 0472 are fulfilled. Can be used in drag chain applications with a minimum bend radius. This cabling is most suitable for flexible use in robot technology, for machine tools, as well as for machining production.

**Material resistance, PVC**

Pure PVC cables, suitable for medium mechanical strain in packaging machines as well as for assembly and production lines: good resistance to acids and alkalis and hence ideal for use in the foods and drinks industries. Resistance to wear as well as oil and chemical resistance is limited.

**Measurement step**

There is a differentiation here between the measurement step for absolute and incremental measurement systems.

**Incremental measurement systems:**

In this case, the measurement step represents the period of the output signal. Here, the number of periods is the same as the number of lines per revolution on the measurement scale, or a multiple thereof.

**Absolute measurement systems:**

In this case the measurement step is the smallest possible angular movement of the rotor that will produce a change in the output signal.

**Measurement step deviation**

The measurement step deviation indicates the maximum measurement deviation from measurement step to measurement step. For this, measured values are taken at one or more adjacent positions in the test range and their maximum deviation from the desired value determined.

**Multiturn (MT)**

A version of an absolute encoder that in addition to the angular position of the shaft (singleturn) can also definitively determine and output the number of shaft rotations (multiturn).
NPN Open Collector

The NPN Open Collector is an interface based on an output circuit with an NPN transistor. An open collector is the unconnected collector connection of an NPN transistor, whose emitter is connected to earth and whose collector is connected to the output.

NPN output

NPN output is an interface based on an output circuit with NPN transistor.

Offset

The difference between the actual physical value and the preset value is described as the offset. This can be both a position offset for position measurement, as well as a voltage offset.

Position: Offset value
                   2000
Actual value 1000  Preset value 3000

Output frequency, maximum

The maximum encoder output signal frequency, for which the correct sequence of the code values is assured is called the maximum output frequency.

The formula used is as follows:
\[ f = \frac{n \times Z}{60 \text{ s}} \]

Z = Number of encoder lines; n = Revolutions per min; f = Output frequency.

PNP output

The PNP output is an interface based on an output circuit with a PNP transistor.

Preset

For absolute encoders, a preset value can be allocated to the actual physical position value. In the case of an allocation via the set wire, this equates to the value 0. For programmable absolute encoders, the preset value can be any value within the measuring range.

PROFIBUS

PROFIBUS is a fieldbus for industrial communications.
User organization: PNO (PROFIBUS Nutzerorganisation e.V.)
More detailed information about this technology is available at www.profibus.com

PROFINET (Process Field Network)

PROFINET is an Ethernet based fieldbus.
User organization: PNO (PROFIBUS Nutzerorganisation e.V.)
More detailed information about this technology is available at www.profibus.com

R

Reference signal

See “Zero pulse” on page 13

Repetition accuracy

See “Reproducibility” on page 10

Reproducibility

Reproducibility, repetition accuracy or repeatability is defined as the maximum distribution from at least five consecutive measurements, carried out under identical conditions.
Resolution
The resolution is expressed as the number of impulses per revolution or path units.

<table>
<thead>
<tr>
<th>Encoder type</th>
<th>Resolution definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary, incremental</td>
<td>Resolution as number of impulses</td>
</tr>
<tr>
<td>Rotary, absolute, single-turn</td>
<td>Resolution as number of steps per revolution</td>
</tr>
<tr>
<td>Rotary, absolute, multi-turn</td>
<td>The total resolution consists of the number of steps per revolution and the number of revolutions</td>
</tr>
<tr>
<td>Linear encoders</td>
<td>Resolution in mm</td>
</tr>
<tr>
<td></td>
<td>Special for cable pull:</td>
</tr>
<tr>
<td></td>
<td>Circumference of cable drum</td>
</tr>
<tr>
<td></td>
<td>Resolution for one revolution of the encoder</td>
</tr>
</tbody>
</table>

If, for example a rotary incremental encoder has a resolution of 12 bits, this means the number of impulses is 4096.
The formula for calculation is: Number of impulses = \(2^x\), where \(x\) is the resolution in bits.

Rotation direction, clockwise (cw)
Rotation to the right, when viewing the shaft.

Rotation direction, counterclockwise (ccw)
Rotation to the left, when viewing the shaft.

Sampling frequency
The frequency with which the signal periods of a sensor system are measured per second.
For incremental measuring systems, the speed is limited by the maximum sampling frequency.

Sampling, magnetical
Position, angle and speed determination for rotary or linear encoders using permanent magnets and appropriate evaluation units to determine the magnetic field. Encoders with magnetic sampling are usually of lower resolution than optical ones.

Sampling, optical
Position, angle and speed determination for rotary or linear encoders using LEDs, code patterns and photo-diodes.
The line marks (for incremental encoders) or codes (for absolute encoders) are inscribed as digital patterns on a glass, metal or plastic disc and are sampled by a light source (light emitting diode) and photo-diodes.
Encoders with optical sampling are usually of higher resolution than magnetic ones.

Scaling
For programmable encoders, the encoder actual value is multiplied by a scaling factor. This means that the resolution can be adapted to the application in question.

Service life
For rotary encoders, the service life of the bearings represents the overall service life of the encoder expressed in revolutions.
For wire draw encoders, the service life is expressed as the total number of cycles. A cycle is defined as one withdrawal and rewind movement (load cycle).
The service life depends on the type of load. This is influenced by factors such as the environment, the installation location, the measuring range in use, the travel speed and acceleration. If the value of one or more of these influencing factors is in the high range, the service life may be reduced proportionally.
Shaft
The component of a rotary encoder that transfers the rotation movement and torque from the application to the sensor unit of the encoder.

Shaft coupling
A shaft coupling is for the indirect connection of two shafts to balance radial, axial or angular offset.

Shaft load capacity, axial
The axial shaft load capability describes the load capacity along the axis of the encoder shaft.

Shaft load capacity, radial
The radial shaft load capability describes the load capacity about the radius along the encoder shaft. For this, the point of action must be applied to the end of the shaft.

Shielding
The shielding of equipment or connecting cables is the design-dependent protection of equipment against radiated electromagnetic interference. Sensitivity to radiated electromagnetic interference, as well as the intensity of radiated electromagnetic interference, must be reduced by full shielding so that the encoder can be used properly. This should be extensive and all around.

Silicone-free (connections)
Silicone-free connections must be used in certain industrial fields, such as paint shops. The reason for this is that silicones can reduce the effectiveness of or disrupt adhesive or other joints.

Sine-Cosine interfaces
Unlike conventional pulse signals, sine-cosine signals are emitted in sine-wave form. These signals can be output at a higher resolution, as there is also an option to sample the signals using an analog-digital converter. For this reason also, encoders with sine-cosine interfaces are preferred for demanding servo applications for which a high level of accuracy is required. In addition to the signals, a zero set can also be emitted, from which the absolute position can be calculated.

Sine-Cosine interfaces
A version of an absolute encoder that can definitively determine and output the angle position within a single revolution.

SSI
A synchronous serial interface is a standardized interface originally developed by Max Stegman GmbH (now SICK) for serial data transfer that makes it possible to transmit absolute positions. The advantage of this type of transfer is that, as well as the time of the recording of the position, the speed of the data transfer can be controlled by the PLC. This guarantees safe transfer.

Starting torque
The torque required to move a shaft from the rest position in the rotation direction.

Stator coupling
The stator coupling compensates for both the radial and axial shaft movements of the drive element as well as installation tolerances without significantly affecting the accuracy of hollow shaft encoders. The stator coupling absorbs the torque derived from the bearing friction during angular acceleration.
Surrounding field strength
The surrounding field strength describes the maximum permitted influence of external magnetic fields. These external influences must be within the permitted limits to guarantee interference-free functioning of magnetic (linear) encoders.

Thermal expansion coefficient
This describes the behavior of a material in relation to changes of its dimensions as influenced by changes in temperature.

TTL RS-422
In a transistor-transistor logic (TTL), both the logical status and the amplification are done by transistors, hence the name. The TTL output is supplied with either a fixed 5 V voltage or a variable voltage of between 10 and 32 V. For this the low range is defined as the ≤ 0.4 V and the high range as ≥ 2.4 V.

Wire draw encoder
Wire draw encoders are position sensors that function according to the cable extension principle. The sensor system consists of a wire draw mechanism and a rotary encoder. The core component of a wire draw encoder is a drum around which a wire is wound in a single layer. Winding is achieved by means of a spring. The resolution of the wire draw encoder can be determined from the relationship between the circumference of the drum and the resolution of the rotary encoder.

Zero pulse
A signal (e.g. Channel Z) to determine the zero point of an incremental encoder, that is output once during a rotation of the encoder shaft. The zero pulse is normally used for the reference run of a machine.

Zero pulse width, electrical
Width of the zero pulse (= length of the high signal) in relation to an impulse period.
**Zero pulse width, mechanical**

Width of the zero pulse (= length of the high signal, occasionally of the low signal as well) in relation to a mechanical rotation of the shaft.
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