Technical definitions

Connection cables

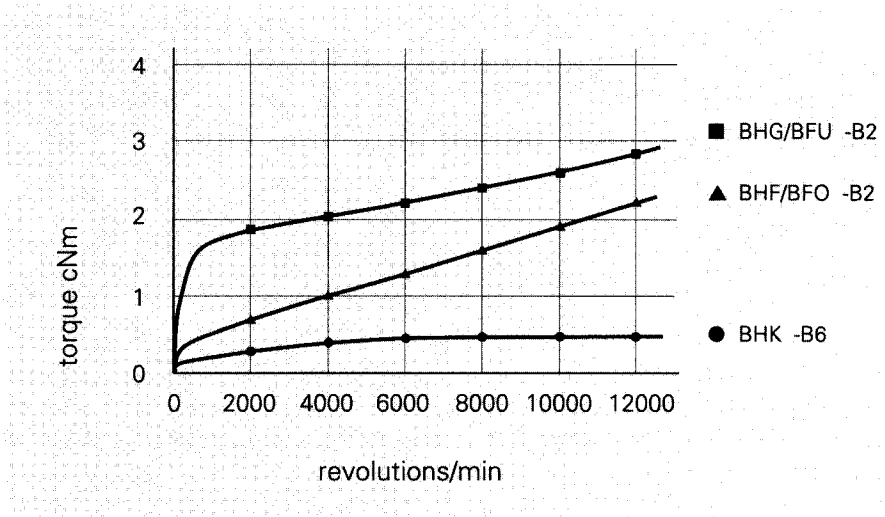
For shaft encoders, equipped with a connector base, the appropriate connector can be ordered as an accessory. For encoders with cable connection, the standard length of cable provided is 2 meters (1 meter for types BDK, BHK). The sheathing material for the incremental encoder is PUR, and for the absolute encoder PVC. The wire size is 0,14 mm. All encoders have a shielded cable. The cable screen is connected to the housing (BDK, BHK to the flange). The operating temperature range is -20 to +85 degrees centigrade. Cables with a PVC sheath should not be bent below a temperature of -5 degrees centigrade.

Maximum bending radius at 20 °C:

cable with a PUR sheath 12x cable ø
cable with a PVC sheath 15x cable ø

Torque

Because the encoder should not affect the load of the machine shaft, the torque is small. The torque depends on the size and the type of the bearing, grease, temperature, number of revolutions per minute and various other influences. The diagram shows a typical overview of various encoder torques as a function of revolutions per minute. The torque decreases with lower rpm, smaller shaft diameter and lower protection class.



Technical definitions

RPM

The max. mechanical rpm is 12'000 and should not be exceeded.

The max. electrical rpm is defined by the max. frequency of the internal electronics and the user interface.

Maximum error

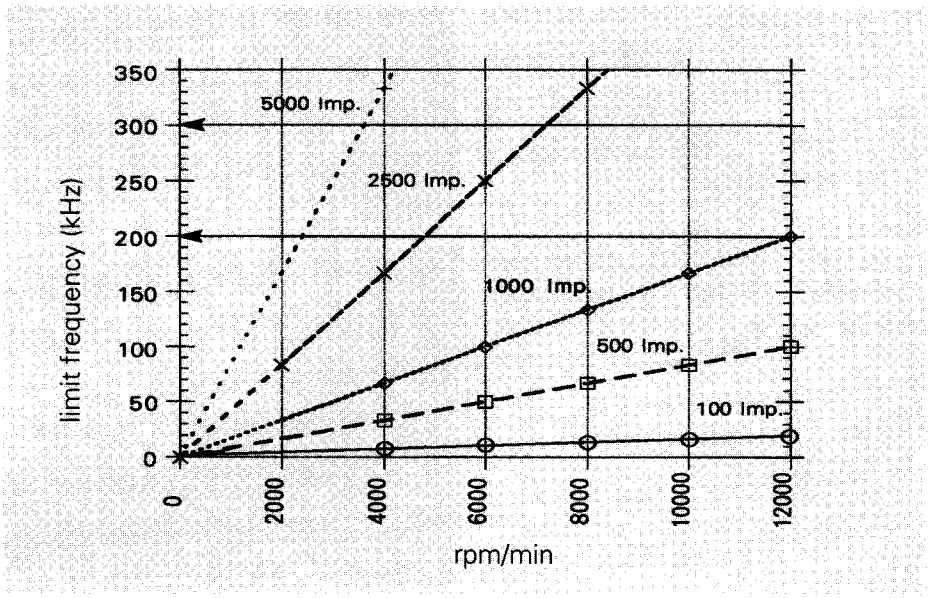
The maximum error of an absolute encoder is ±1/2 bit. This tight tolerance ensures that direction of rotation is always defined and that no step is lost.

The indicated pulse tolerance of the encoder is specified on the product data pages.

Switching frequency

With the following formula the maximum rpm is calculated as a function of the number of pulses. The maximum rpm however must be lower than the allowable mechanical value.

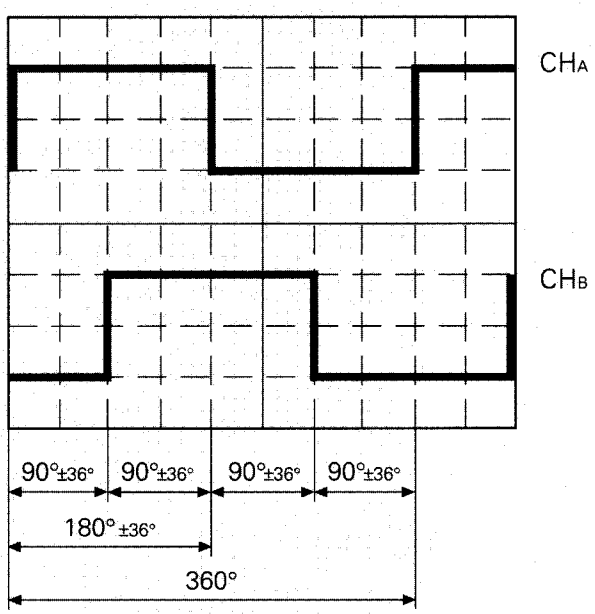
$$f_{max.} = \frac{\text{rpm x number of pulses}}{60}$$



Technical definitions

Pulse tolerances

The tolerance of the pulse/periode ratio is ±10 %. Values outside this range are specially marked on the product. This tight tolerance is also valid between the two channels CH_A and CH_B, which are 90 degrees out of phase. Therefore the sense of rotation can be clearly defined and a quadruplication of the signal can be attained.



Couplings

The most suitable flexible coupling can be chosen from the data of a servo drive system. Resolution, acceleration and the desired positional precision must be considered. The lag angle can be judged from the torque stiffness. This torque might be considerable, if high dynamic drive systems are used. The inertia moment is specified on the product data pages.

Measuring step

In the case of incremental encoders, the time between the positive edges of CH_A and CH_B is evaluated as measuring step. In this way, it is possible to achieve measuring step resolutions four times greater than the pulse rate used. This signal multiplication must be effected by means of external sequence electronics.

Protection class

Protection class is defined according to DIN VDE 0470 (EN 60529, IEC 529) standards. The protection class specified is valid for the installed encoder. There is a separate protection class for the housing and for the shaft. The protection class of the housing depends on the connector base and the type of connector used.

Technical definitions

Shock and vibration

All encoders are tested according to the following standards:

shock test **IEC 68-2- 27**
50 g, 11 ms, half sine

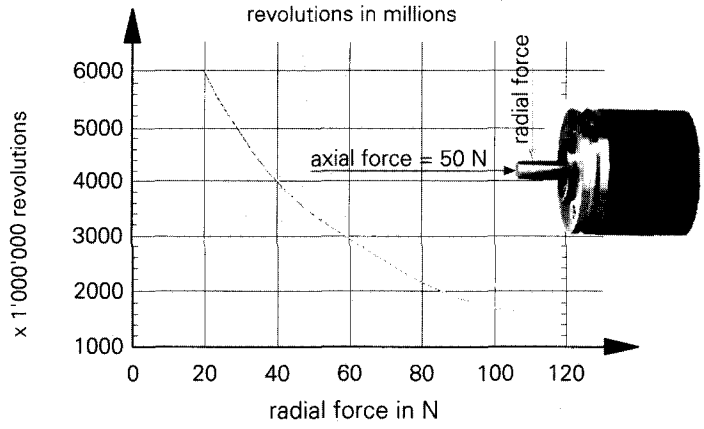
vibration test **IEC 68-2-6**
10 g, 100...200 Hz sine

Shaft loading

During operation encoders are exposed to various influences. Even if load and number of revolutions are known, other influences like temperature, humidity, vibration and greasing must be considered.

The expected lifetime can only be predicted. Due to many influences and depending on the operational environment, the lifetime may fluctuate from less than 10^6 revolutions under heavy load conditions to over 10^9 revolutions under optimal conditions.

The diagram shows a typical graph for a modified nominal lifetime in millions of revolutions (Lna) according to ISO 281, with 4000 revolutions/min^{-1}, 20 °C and variable radial shaft load.



On request, we can calculate an estimated service life for a defined installation.

Safety concept

Products and EC conformity

The encoders and resolvers described in this documentation conform to EC norms and carry the CE mark. In attaining EC conformity and observing our full responsibility towards our customers, our products and associated documentation have been reviewed to cover the following aspects:

Sales documentation (DOC)

The following is included in this documentation:

- Safety concept
- Instructions relevant to safety
- Technical fundamentals
- Delivery program
- Product-specific data

The sales documentation is available in German, English and French.

Mounting instruction (MAL)

Mounting instructions are enclosed with each sensor. They contain:

- Safety relevant instructions
- Product identification
- Type of connection and important technical data

Mounting instructions are provided with each sensor in 3 languages (German, English, French)

Risk analysis

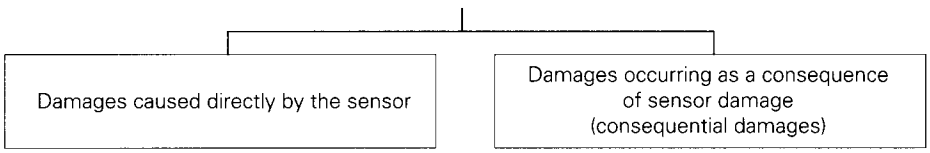
In order to determine the hazard associated with the application of our products, a wide variety of damage scenarios have been constructed.
The conclusions derived from these scenarios constitute the basis for the safety concept.

Damage scenarios

For developing the damage scenarios, four items have been precisely analyzed:

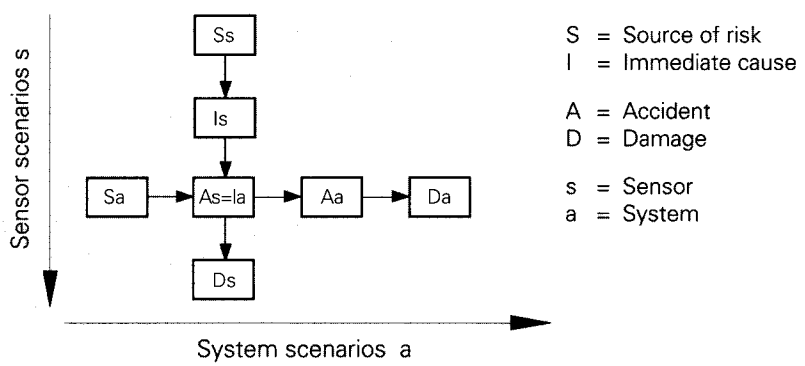
Source of risk → **Immediate cause** → **Accident** → **Damage**

Damage cases can be subdivided into two categories



The graphic illustrates the fact that sensor damage can result in consequential damages to the system as well as damage induced by the system.

In correspondence with the application, the consequential damages may be of extreme severity (for instance, loss of life, total system failure, environmental pollution, etc.). Hence, the system designer must consider possible damage scenarios for all phases of system life and implement appropriate measures.



Safety concept

Concept

The safety concept defines the technical, instructive and legal measures that will ensure a high degree of safety for the user (system manufacturer, operator and user) when handling our sensors. This safety concept also serves as a basis for the declaration of EC conformity and CE marking of products.

Safety objective and risk limitation

The damage scenarios listed in the risk analysis have undergone assessment. The following criteria have been taken as the basis for initiating and implementing measures:

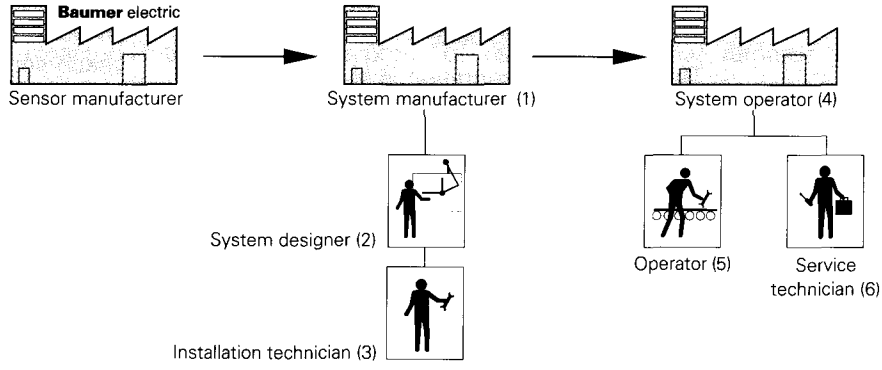
- *Damage involving severe, fatal consequences and complete failure* must in all cases be prevented by means of technical or instructive measures.

- *Damage with slight consequences* must be avoided by instructive measures if we observe or estimate them to occur occasionally or frequently.

User roles

The safety concept assumes that only trained and authorized persons select, install, operate, and maintain sensors for application in a system.

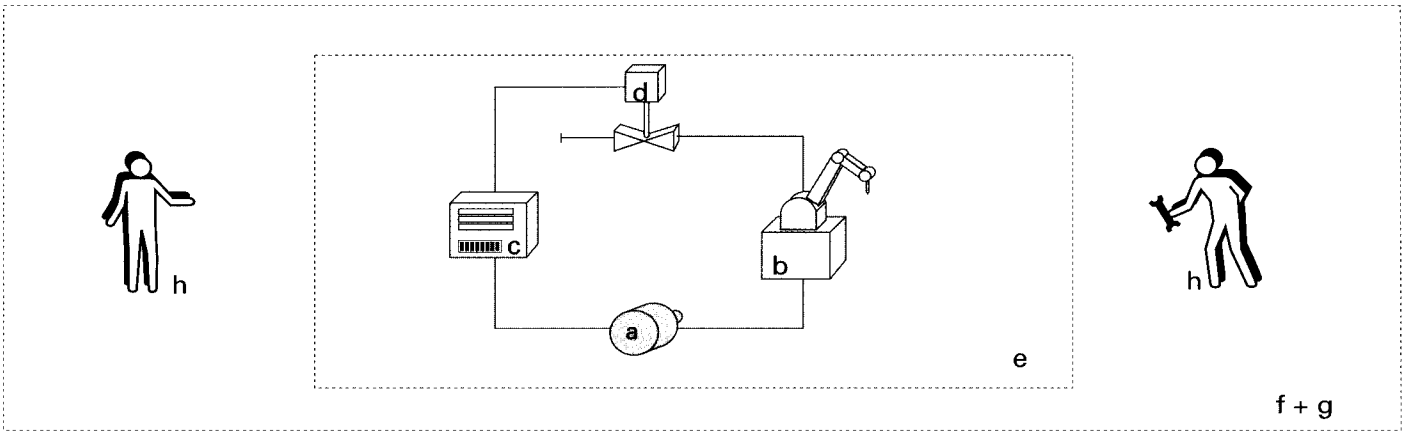
Baumer electric provides for six user roles:



User roles	Tasks
System manufacturer (1)	ensures the proper use of sensors; compiles the customer documentation for the system; notifies Baumer electric in the event of deficiencies.
System designer (2)	is familiar with and observes the relevant accident prevention regulations; examines suitability, plans application; instructs and supervises upon initial commissioning.
Installation technician (3)	properly connects the sensors to the system and checks for their correct operation.
System operator (4)	implements the accident prevention regulations. They ensure the proper use of the system, notifies the system manufacturer or Baumer electric in the event of operating or safety defects, and after useful life ensures appropriate disposal in accordance with statutory provisions.
Operator (5)	is able to operate the system; knows and follows the operating instructions for the system; only operates the system as long as any protection facilities are in working order; does not conduct any repair work relating to the sensor.
Service technician (6)	is familiar with the technical specifications for the sensor and relevant accident prevention regulations. They ensure that operational limits, correct maintenance and operation of the system, including built-in sensors are observed.

These six user roles provide a clear definition of responsibilities between Baumer electric, system manufacturer and system operator. They demonstrate the user abilities and experience necessary for the safe and efficient performance of tasks.

Risk areas and fields of responsibility



Risk areas		Fields of responsibility
a	Sensor	Sensor manufacturer (Baumer electric)
b	Other system parts	Suppliers of the respective components
c	Sensor supply voltage, indicating instrument and system control	
d	Control and actuating devices in the system	
e	Selection and assembly of all components	System manufacturer
f	Application of the system and its components in conformance with specifications	System operator
g	Buildings	
h	Users and third parties	

Risks of use

In pre-installation inspection, during the course of startup, maintenance, and removal of opened PLS units with limit switches (Section 6), there is an electric shock hazard if the live parts are touched. Before shipment, Baumer electric check every unit for proper insulation between live parts and enclosures. PLS units may only be connected or disconnected after the power supply has been switched off!

Misuse

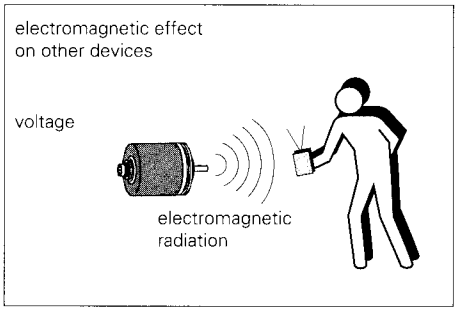
If angle and position sensors are used outside the specified operating limits, i.e. where misuse is foreseeable, there is a hazard that the sensor will fail in operation and serious consequential injury to persons and damage to the system or the materials to be processed, as well as to the environment, will occur.

Foreseeable misuse may encompass:

- Incorrect electrical connection
- Electrical overloading due to unpermissible operating voltage, short-circuit or excessive load current
- Mechanical overloading with sensor damage
- Impact on the shaft
- Aggressive environment (corrosion of sensor components)
- Inadmissible electromagnetic exposure
- Use of sensors as safety components without redundancy

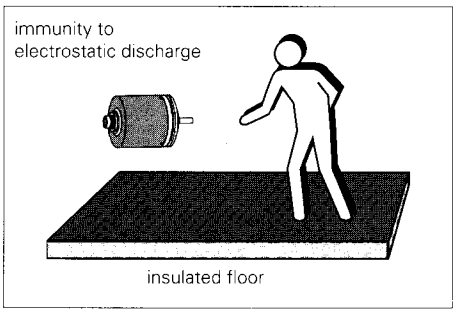
The technical information provided in this introduction together with the details on the product-specific data sheets constitute an integral part of this safety concept and must be observed when using the sensors.

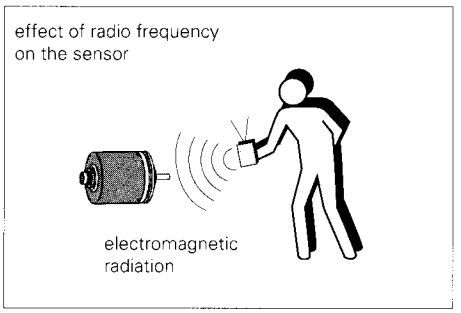
Electromagnetic compatibility

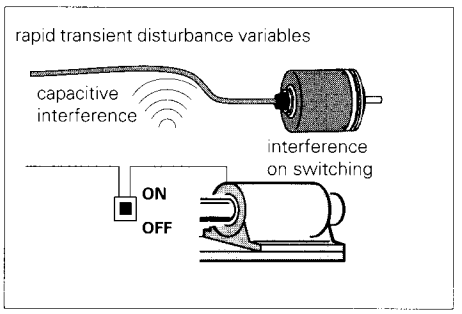


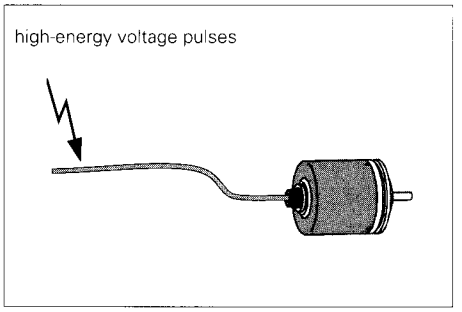
Electromagnetic emission

Electromagnetic emissions from Baumer electric angle and position sensors are all below the limit values as specified by the Standards EN 55011 and EN 50081-2.









Electromagnetic immunity

Baumer electric sensors have been tested to:

IEC 801-2

Immunity to electrostatic discharge (ESD), air and contact discharge

8 and 4 kV for earthed installation

ENV 50141

Immunity to alternating radio-frequency fields (RF) from 0,15 to 1000 MHz, 80% amplitude-modulated with modulation frequency of 1 kHz:

Immunity up to 10 V

In the case of Types BDK and BHK immunity is only 3 volts.

IEC 801-4

Immunity to rapid transient disturbance variables (burst); injection via coupling probe (burst frequency 5 kHz).

Behaviour category	A	B
Immune up to	1,5 kV	4 kV

IEC 255-5

Voltage pulses with rise/fall time: 1,2 / 50 µs

Peak value: 1 kV

Source impedance: 500 Ω

Immune with behaviour category B

All sensors are immune up to the values required in EN 50082-2; the following restrictions and extensions apply:

1. Baumer electric rotary and position sensors, in respect of burst immunity (IEC 801-4), generally comply with behaviour category A up to a value of 1.5 kV, i.e. the sensors evidence no interference up to this value.

Standard EN 50082-2 only requires behaviour category B, i.e. the sensors may evidence transient interference, but must return automatically to the same state and may not be damaged by the interference pulses.

2. Encoders are generally operated on stabilized operating voltage. Voltage pulses, as described in IEC 801-5, have not been observed in secondary circuits.

The encoders are immune to voltage pulses according to IEC 255-5.