Absolute Rotary Encoders

SIL3 / PLe

Family CD_75

www.tr-electronic.com

Rotary Encoders- Functional Safety - SIL3 / Ple

Functional safety up to SIL3 / Ple

Many applications in automation technology are subject to the highest safety requirements. By using SIL3/PLe-certified products you will achieve maximum safety in workplaces or environments that are shared by people and machines. Our absolute rotary encoders with SIL3 or PLe certification (safety rotary encoders) are available in sizes from 75 mm (hollow shaft or solid shaft). Standard interfaces such as Double SSI, PROFIsafe via PROFIBUS, PROFIsafe via PROFINET or openSAFETY via Powerlink or EtherCAT guarantee optimal safety and precision. The ATEX-compliant housing variant offers additional protection in explosive atmospheres. No separate modules are necessary for reliable position output, and there is no need to separately program a safety module - you couldn't get a simpler or more cost-effective solution.

Contents

Safety rotary encoders

CD_75 M

The double rotary encoder system with solid- or hollow shaft and multi-turn detection fulfill the requirement of EN 615081, EN 61508, EN ISO 13849 and the EN6206*. The use of certified individual components makes it easier for the system integrator to fulfill the safety requirements of the entire application, for example within the event technology, storage and logistic technology and wind energy.
The use of our SIL 3-certified safety absolute rotary encoder liberates the user from the obligation to prove functional safety for this positioning sensor separately.
With certified components the strict safety guidelines will be met. The double rotary encoders CD_75 M are available with hollow and solid shaft. They are approved for applications according to SIL 3 or PLe.
For local motor feedback, there is an optional rectangle or sine/cosine incremental output available. Different resolutions can be chosen (period/revolution).

*test regulations category 4/PL e according to EN ISO 13849-1, SIL CL3 according to EN 61800-5-2/EN 62061 and IEC 61508.

Safety rotary encoders

Possible application areas

_ crane technology
_ event and stage technology
_ drive technology
_ conveying systems and logistics
_ machinery and plant engineering
_ automation technology
_ wind energy plant

Cranes with overlapping work areas or with obstacles within the working area
Through measurement of rope positions and rotation angles, collisions can be avoided. Numerous travelling cranes on a common track – through safe measurement of each position, collision can be avoided.

Common work areas of men and machines –
Through safe position detection in the various areas of safety, safe work areas can be differentiated from each other.

Processes with minimal or maximum speed – Through safe speed sensing, it is assured that the drive never oversteps a maximum speed or that it safely achieves a required speed before starting a process.

Synchronous run monitoring[1] – An unsafe electrical axial synchronization can be made safe by using a certified SIL 3 / PLe rotary encoder with an externally attached safety system.

Shaft control[1] **–** Rotation through overload or a twist-off will be detected through a SIL 3 / PLe rotary encoder with an external safety system.

Advantage of certified components

The basic safety standard EN 61508[2] differentiates between measures to eliminate errors and measures to control errors. The measures to eliminate errors embrace the entire design and development process. These are required for the development of individual components and they serve to avoid systematic errors.
Important for error control are quantifiable characteristics of the considered components and of the complete system. The probability of a dangerous failure of the safety function has priority. The calculation results in the rated failure probability of all individual components for the entire safety chain. It is checked and documented how systematic errors can be avoided or controlled for certified components.
If non-certified components are chosen to be used solely based on their mathematical safety value, the responsibility is laid upon the person who undertook the construction.
The producer of components with certification makes a clear statement: "Yes, ideal for safety-oriented applications". As a user of certified components you can rely on this – after all, the certification according to SIL 3 or PLe has been given by independent specialists.

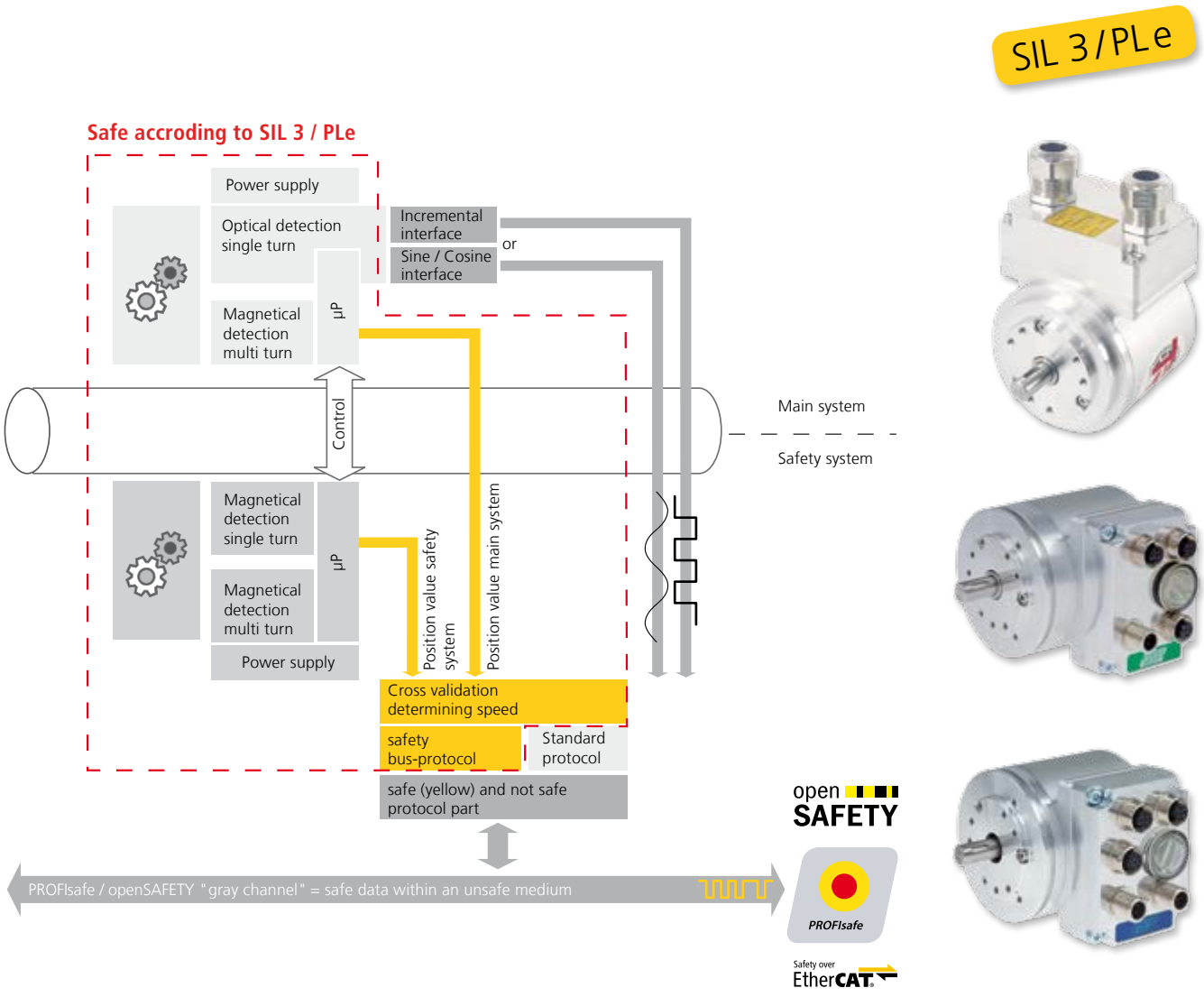
[1]on request [2]test regulations category 4 / PL e according to EN ISO 13849-1, SIL CL 3 according to EN 61800-5-2 / EN 62061 and IEC 61508.

SIL and PL – two scales for safety

SIL The safety integrity level (SIL) is described in the international standard according to EN 61508. It serves to judge electrical/programmable systems relying on dependability of safety functions. The aimed-at level indicates which safety-related construction principals have to be satisfied to minimize the risk of malfunctions.

PL Within the standard EN ISO 13849-1 five categories are defined, called performance levels (PL). They build on one another, starting with a, b, c, d and e. The different levels help to classify safety-related performance. They are determined according to the average probability of a dangerous failure and the diagnostic coverage and in consideration of the structural design of a system (how many channels the system has, how independent they are from each other).
Our safety rotary encoders are certified according to PL "e", the highest performance level.

Safety rotary encoders



Rotary encoder, safe according to SIL 3 / PL e

Within the revolution in system one the shaft position is detected with an optical single-turn encoder. The revolutions are detected over mechanically attached satellites. This gives the absolute positioning value of measurement system one. For system two, the revolution position is transferred via magnetic central detection, and the revolutions are detected with magnetic equipped satellites. This gives the absolute positioning value of measurement system two. The CPUs give each other signs of life.

The optical detection gives out incremental signals. It can be switched between rectangle and sine/cosine outputs with various resolutions. For safety reasons, the resolutions of the measurement systems are not programmable.

Certification, PROFIBUS

SIL CL 3 according to IEC 61508 PL e according to EN ISO 13849-1

PROFIBUS/PROFIsafe: certification has been awarded to the PROFIBUS (PI certificate Z01522), the PROFIsafe conformance (PI certificate Z20031) as well as the fulfillment of the safety standards (TÜV Rheinland, 01/205/5015/10).

Certification, PROFINET

SIL CL 3 according to IEC 61508 PL e according to EN 61800-5-2

PROFINET/PROFIsafe: certification has been awarded to the PROFINET (PI certificate Z10472), the PROFIsafe conformance (PI-Zertifikat Z20068) as well as the fulfillment of the safety standards (TÜV Rheinland, 01/205/5221/12).

Certification, POWERLINK

SIL CL 3 to IEC 61508, PL e to EN 61800-5-2

POWERLINK/openSAFETY: certification has been awarded to the POWERLINK (PI certificate 1000022), the openSAFETY conformance (PI certificate 14000100) as well as the fulfillment of the safety standards (TÜV Rheinland, 01/205/5424.00/14).

Functional safety – plant safety and personal security

For a lot of applications in automation technology, there are high safety requirements. Dangerous plant conditions can be avoided by using SIL 3/PL e-certified rotary encoders. You don't have to independently prove the functional safety of these position sensors.

Current solution

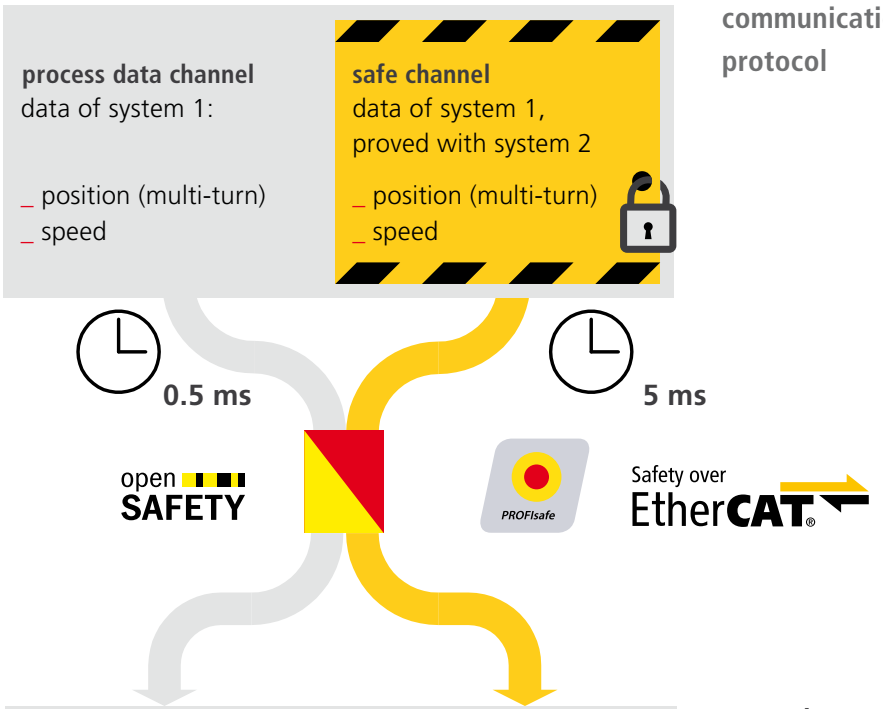
Until now, for applications with high safety requirements, absolute rotary encoders with additional incremental signals have been used. The incremental signals function as a control over the positioning values. With this method, there was a safety deficit when turning on the machine because there was only one absolute value available. If this value was wrong due to data loss or an adjustment value, it couldn't be detected.

Certified solution

The absolute rotary encoder CD_75 M captures the revolution information through a mechanical gear without a battery backed revolution counter. Development, technology and production of this device is certified through the *TÜV. They are used in plants and equipment requiring safety integrity level 3 (SIL 3: IEC 61508/EN 62061) or a performance level e (PL e: EN ISO 13849 -1). The CD_75 PROFIsafe additionally gives out safe speed values.

*German Association for Technical Inspection

Communication and preset



communication protocol

controls

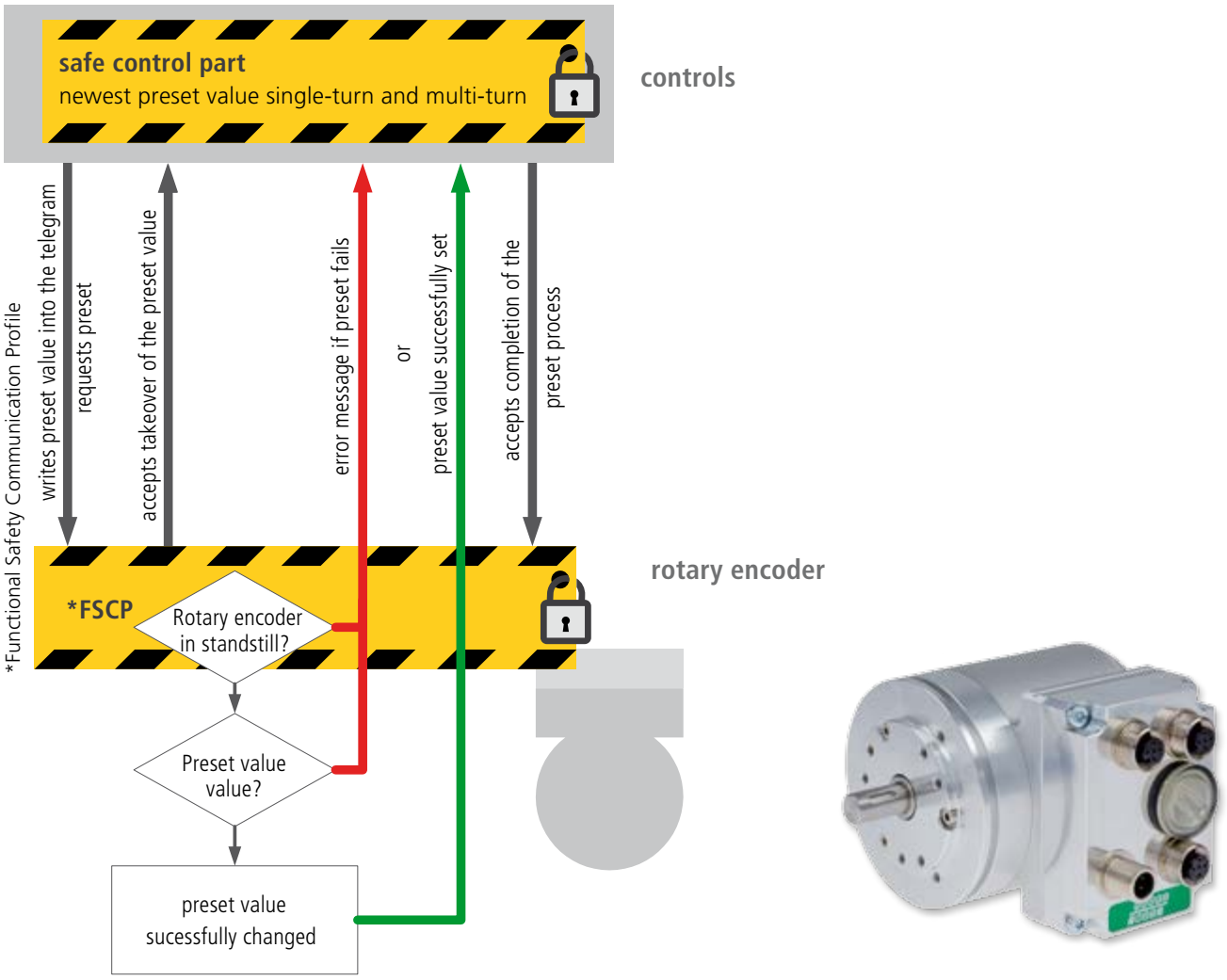
Communication with safety bus system

The actual values will be transferred via safety bus system. Within the safe protocol part the actual value and the speed will be transferred. These values are also available over not safe normal bus telegrams. Therefore, safe and normal control parts have access to it. Certified are the bus interface, the bus compliance, as well as the fulfilling of the safety standards.

The actual values for position and speed are transferred in two slots:

For safe transmission the actual position values of both rotary encoder systems are compared. If the difference is smaller than the adjusted control window, the rotary encoder value does count as safe. The safe actual position value and the derived safe speed value will be transferred over the secured telegram.
The part of the control taking on the safety-related tasks can process these values.

The actual position value and the calculated speed of the main rotary encoder are directly transferred within the unsecured process data channel. Usually, this channel is processed more often by the controller. Normal automation processes can access actual position values more often.

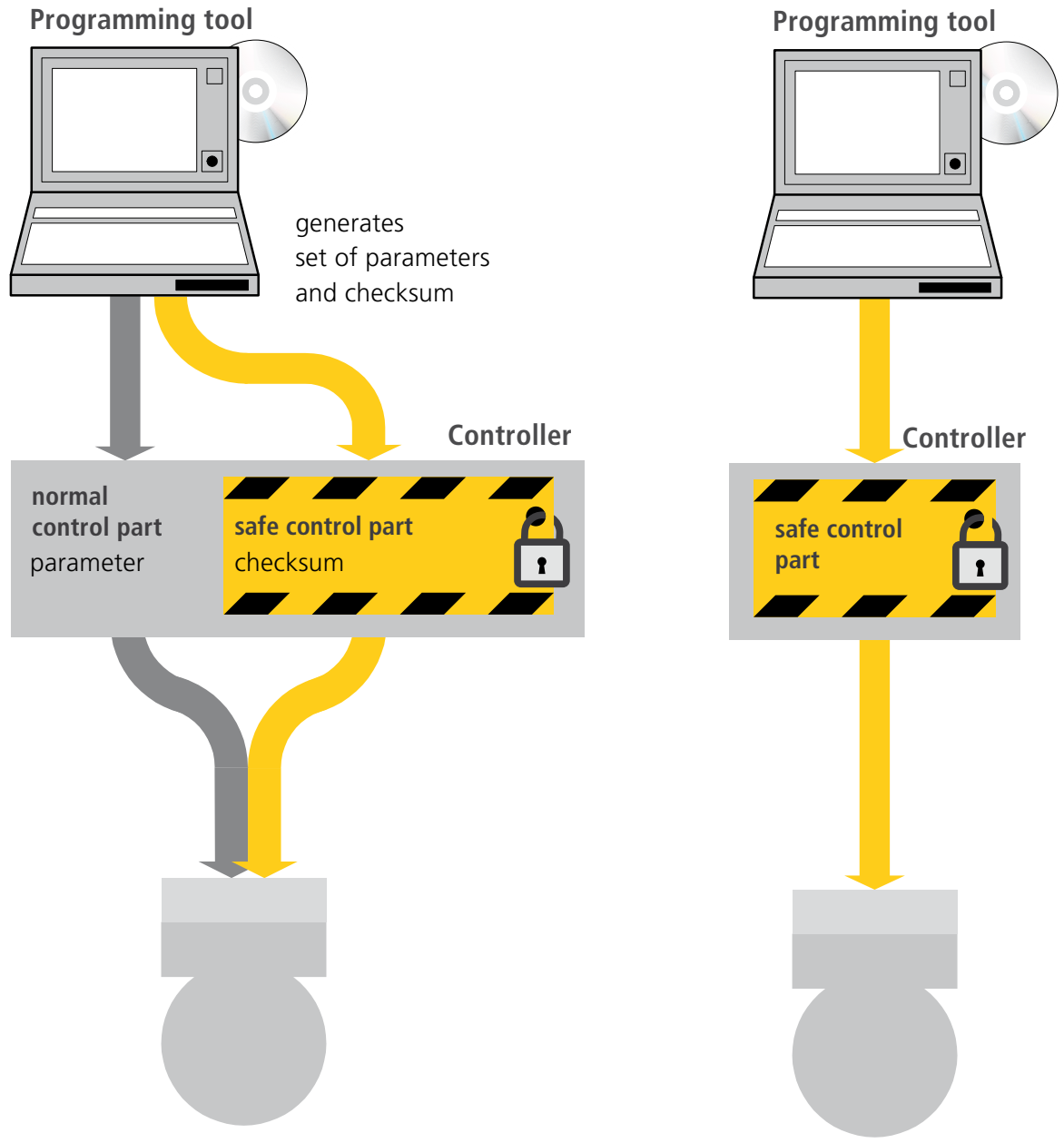


Preset via safety bus system

By setting a preset value, the actual issued value of the rotary encoder can be placed arbitrarily at a value within the maximum measurement range. With this, the shown position can be placed electronically at a machine referencing position. The offset value will be saved within the rotary encoder.
Setting a preset value is a safety-relevant process. An jump of the actual value, for example using a controller, can lead to an uncontrolled movement of the machine.
Therefore, setting a preset value can only be done when the relevant machine part is still. The preset is already locked within the rotary encoder and can only be activated via a special part within the safe protocol part.

Even if all preconditions of the controller are fulfilled, the preset will only be executed when the rotary encoder shaft stands still. Further measures have to be taken into account. The controller can start the preset process only when the related drives are secured against running.
It is recommended to lock the preset process from the controller through further safety measures (for example key switches, password prompts, etc).

Parameterization via safety bus system



Parameterization

Parameters are transferred over the bus each time the machine starts up. This set of parameters will be saved over a checksum:

Reading value difference
Permissible difference between the rotary encoder values of system 1 and system 2.

Standstill tolerance
To trigger a preset process, the rotary encoder must be still. Depending on the drive, it is necessary to specify its tolerance range.

Direction of rotation
Positive count direction clockwise/counterclockwise.

Integration time
Time base of the speed calculation. Long integration times enable high resolution measurements at a low rotary speed. A short integration time shows speed changes faster: well suited for high rotation speeds and great dynamics. Information is a multiple of the cycle time of the rotary encoder system: For process data channel (unsecured) 5 … 500 ms, for safe channel 50 … 500 ms.

Integrated safety – CD_75M

For numerous industrial applications such as presses, cranes and robots, it is important to exactly capture the movement exactly in position and speed. These movements always have the potential to be accompanied by a hazard. Therefore, working stations, positions and speed are always controlled. In general, controls like this require a higher standard of technology. The relevant functions are interpreted as safety functions with necessary SIL / PL. For positioning sensors, the following methods of secured data are possible.

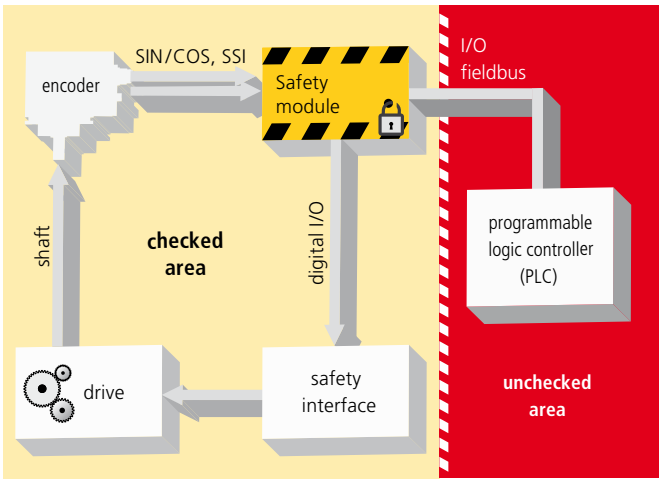
Secured Speed Data
Secured speed data is needed to allow access to a usually dangerous area where tasks such as maintenance or start-up work have to be done.
The CD_75M delivers safe position information which is used in a controller to realize secured maximum speed (SLS: Safely Limited Speed).

Safe Position
A safety function needs reliable position information when different safety requirements must be determined in different areas. With this information, for example, a “Safe Direction – SDI” can be realized, or other safety parameters in relation to the position can be determined.
The CD_75M sends the safe position information directly over a appropriate safety protocol within the safety control.

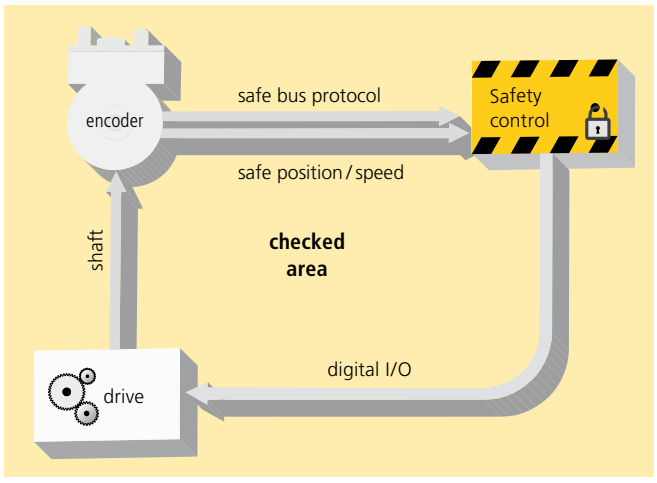
Application examples
_safety standstill
_safety position detection (monitoring the danger area)

Conventional Standard versus Integrated Safety

Conventional Standard



Integrated Safety with CD_75M



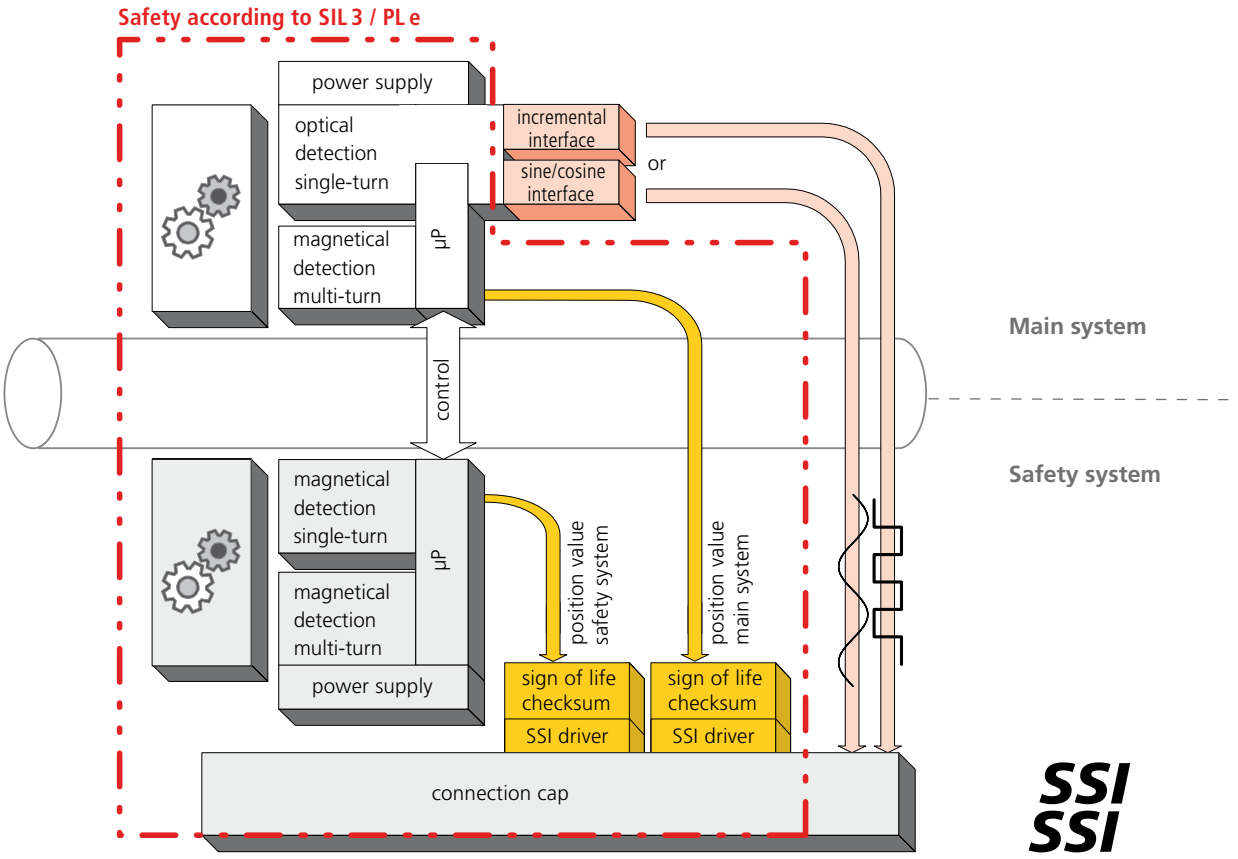
Conventional Standard

The tests of the signals are done in a safety module. Depending on the features of the rotary encoder, the safety module can identify the safe speed or single/multi-turn position. The safety module decides based on the parameters of limited values and functions whether the status of the machine is safe and the drive keeps running or whether it has to stop. The safety function is solely restricted to this part of the plant. If real positioning and speed values requested (e.g. controller), a second rotary encoder is needed. Both, the controller as well as the safety module, have to be correctly programmed and parameterized.
For individual plant parts, this technology can be retrofitted. The rotary encoders used don't have to be certified. They only have to fulfill the requirements of the producer of the safety modules.

Integrated Safety with CD_75M

The measurement values of safe speed and safe single/multi-turn position are determined within the certified rotary encoder. They are transmitted over a safe bus system to an safety-oriented module. Therefore, the safe sensor values are available for each controller of the entire machine or plant. This enables intelligent safety conditions where humans and machines share the work environment without mechanical safety devices. Work areas can be divided into different zones with adjusted safety requirements.
Position and speed values are available for either safety applications over a secured channel or for normal automation functions over an unsecured channel. Therefore, a rotary encoder for position feedback is unnecessary. Due to the integration of the PLC a safe operation with a large range of functions can be guaranteed.

Safety according to SIL 3 / PL e with 2 × SSI



The determined position values will be enhanced with status information and checksum. These position values will be distributed on separate SSI interfaces. It is the task of the sequential electronics to determine the accuracy of the measurement values by comparing both values. Hereby, additional information provided within the SSI telegram is helpful. The SSI telegram also transfers an error bit of the other system; therefore it is possible to determine that you have to look for an error within the rotary encoder (the other system reports the error) or in the cable (the other system reports no error).

Both systems transfer the actual position value in an enhanced SSI telegram.

Error bit

The error bit of both systems is shown in both SSI channels. Therefore, if there is a malfunction in one of the SSI channels the error can be transferred into the other channel without issue. Hence, the diagnosis of both systems can be determined even when only one channel is operational.

Checksum

An 8 bit CRC checksum will be calculated from all user data within the SSI telegram and will then be put into the SSI telegram. Secured data: MT and ST data, error bits, sign of life counter. Hamming distance = 3: two incorrect data bits will safely be recognized.

Sign of life counter

The sign of life counter will be incremented with each detection process of the rotary encoder system. The incremented sign of life counter makes sure, up to the latest telegram, that the latest transferred data comes out of a new position detection.

If SSI requests happen faster than the internal detection (500 µs master channel, 500 µs safety channel), the position data and the sign of life counter remain unchanged.

Optical Detection (E)
Magnetic detection (M)

Products	CDV75M	CDV75MM	CDH75M
			
Detection	Optical Detection (E)	Magnetic detection (M)	Optical Detection (E)
Single / Multi	(M) Multi	(M) Multi	(M) Multi
Supply	11...27 VDC	11...27 VDC	11...27 VDC
Full Resolution	28 bit	28 bit	28 bit
Steps per Turn	8192	8192	8192
Nuber of turns	32768	32768	32768
Properties	fast optical main detection	dewfall proof	fast optical main detection
Shaft diameters available	10mm with keyway	10mm with keyway	20mm with keyway
Connectors	connectors radial, cable glands radial (SSI)	connectors radial, cable glands radial (SSI)	connectors radial, cable glands radial (SSI)
Protection Class	IP 54	IP 65	IP 54
ATEX-Zone			
Interface	SSI, PROFINET, PROFIBUS, ETHERNET POWERLINK, EtherCAT	SSI, PROFINET, PROFIBUS, ETHERNET POWERLINK, EtherCAT	SSI, PROFINET, PROFIBUS, ETHERNET POWERLINK, EtherCAT
Option, additional interfaces (on request)	INC	INC	INC
Weblink	www.tr-electronic.com/s/S007271	www.tr-electronic.com/s/S007271	www.tr-electronic.com/s/S007272
QR-Code			

Can't find the right variant? Please contact us (info@tr-electronic.de)

Optical Detection (E)

Products	ADV75M	ADH75M	ADV88M
			
Detection	Optical Detection (E)	Optical Detection (E)	Optical Detection (E)
Single / Multi	(M) Multi	(M) Multi	(M) Multi
Supply	11...27 VDC	11...27 VDC	11...27 VDC
Full Resolution	28 bit	28 bit	28 bit
Steps per Turn	8192	8192	8192
Nuber of turns	32768	32768	32768
Properties	fast optical main detection	fast optical main detection	fast optical main detection
Shaft diameters available	10mm with keyway	20mm with keyway	10mm with keyway
Connectors	connectors radial, cable glands radial (SSI)	connectors radial, cable glands radial (SSI)	cable gland axial
Protection Class	IP 54	IP 54	IP 65
ATEX-Zone	Zone 2/22	Zone 2/22	Zone 1/21
Interface	SSI, PROFINET, PROFIBUS, ETHERNET POWERLINK, EtherCAT	SSI, PROFINET, PROFIBUS, ETHERNET POWERLINK, EtherCAT	SSI, ETHERNET POWERLINK, EtherCAT
Option, additional interfaces (on request)	INC	INC	INC
Weblink	www.tr-electronic.com/s/S007273	www.tr-electronic.com/s/S007274	
QR-Code			

Suggested Products

Order code	Steps per Turn	Turns	Shaft / Flange	Connector Position	Connector Type	Remark
CDV75M-SSI (D) Double detection, Solid shaft, SSI						
CDV75M-00001	8192	4096	10Keyway/19,5 ZB50	2 x cable gland		TTL Incr -20...70C°C
CDV75M-PB (D) Double detection, Solid shaft, Profibus						
CDV75M-00008	8192	32768	10Keyway/19,5 ZB50/D75 9XM4	Connector radial	5 x M12	SIN/COS -20°...70°C
CDV75M-PN (D) Double detection, Solid shaft, Profinet						
CDV75M-00012	8192	32768	10Keyway/19,5 ZB50/D75 9XM4	Connector radial	4 x M12	TTL Incr -20°...70°C
CDV75M-00014	8192	32768	10Keyway/19,5 ZB50/D75 9XM4	Connector radial	4 x M12	
CDV75M-00018	8192	32768	10Keyway/19,5 ZB36	Connector radial	4 x M12	TTL Incr -20°...70°C IP65
CDV75M-00026	8192	32768	10Keyway/19,5 ZB50/D75 9XM4	Connector radial	4 x M12	seawater-resistant
CDV75M-EPL (D) Double detection, Solid shaft, Powerlink						
CDV75M-00021	8192	32768	10Keyway/19,5 ZB36	Connector radial	4 x M12	
CDH75M-SSI (D) Double detection, Hollow shaft, SSI						
CDH75M-00001	8192	4096	20H7/Keyway Slot for pin D4	2 x cable gland		TTL Incr -20...70C°C 2x KV
CDH75M-00024	8192	4096	14H7/Keyway Slot for pin D4	2 x cable gland		
CDH75M-PB (D) Double detection, Hollow shaft, Profibus						
CDH75M-00008	8192	32768	20H7/Keyway Slot for pin D4	Connector radial	5 x M12	TTL Incr -20°...70°C
CDH75M-PN (D) Double detection, Hollow shaft, Profinet						
CDH75M-00013	8192	32768	20H7/Keyway Slot for pin D4	Connector radial	4 x M12	TTL Incr -20°...70°C
CDH75M-00019	8192	32768	20H7/Keyway Slot for pin D4	Connector radial	4 x M12	seawater-resistant

For further product information simply enter the order number in the search field at www.tr-electronic.de.

We will help you to select the most suitable products from the complete TR range. Please contact us (info@tr-electronic.de).

Suggested Products

Order code	Steps per Turn	Turns	Shaft / Flange	Connector Position	Connector Type	Remark
CDH75M-EPL (D) Double detection, Hollow shaft, Powerlink						
CDH75M-00026	8192	32768	20H7/Keyway Slot for pin D4	Connector radial	4 x M12	
ATEX ADV75M-PB (D) Double detection, Solid shaft, Profibus						
ADV75M-00001	8192	32768	10Keyway/19,5 ZB50/D75 9XM4	Connector radial	5 x M12	II 3G Ex nAc IIC T6X II 3D Ex tc IIIC T65°C IP64 X
ATEX ADV75M-PN (D) Double detection, Solid shaft, Profinet						
ADV75M-00002	8192	32768	10Keyway/19,5 ZB50/D75 9XM4	Connector radial	4 x M12	II 3G Ex nAc IIC T6X II 3D Ex tc IIIC T65°C IP64 X
ATEX ADH75M-PB (D) Double detection, Hollow shaft, Profibus						
ADH75M-00001	8192	32768	20H7/Keyway Slot for pin D4	Connector radial	5 x M12	II 3G Ex nAc IIC T6X II 3D Ex tc IIIC T65°C IP64 X
ATEX ADH75M-PN (D) Double detection, Hollow shaft, Profinet						
ADH75M-00002	8192	32768	20H7/Keyway Slot for pin D4	Connector radial	4 x M12	II 3G Ex nAc IIC T6X II 3D Ex tc IIIC T65°C IP64 X

Further product information

1. Enter order code into …

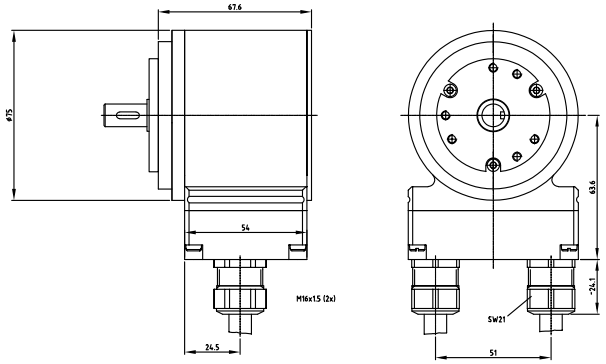
2. Searchfield (top right) on www.tr-electronic.com

3. Choose desired information

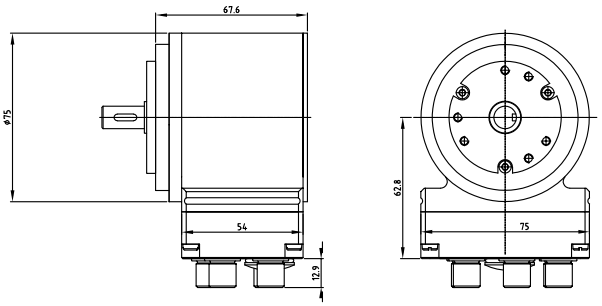
We will help you to select the most suitable products from the complete TR range. Please contact us (info@tr-electronic.de).

Dimensional Drawings

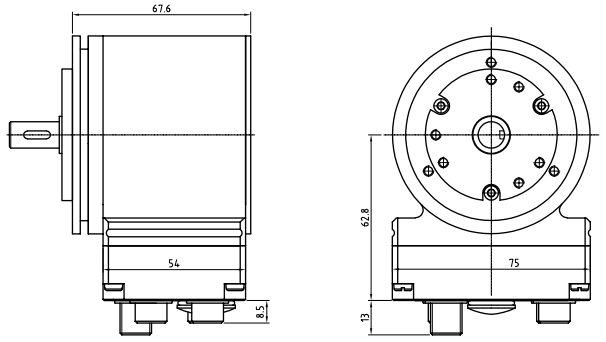
CDV75-SSI
Absolute-Encoder CDV75M - SSI



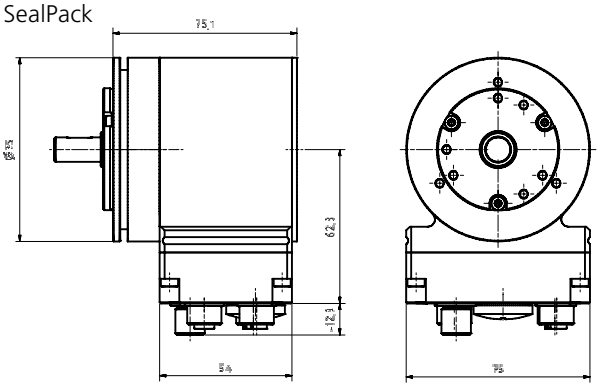
CDV75-PB
Absolute-Encoder CDV75M - PB



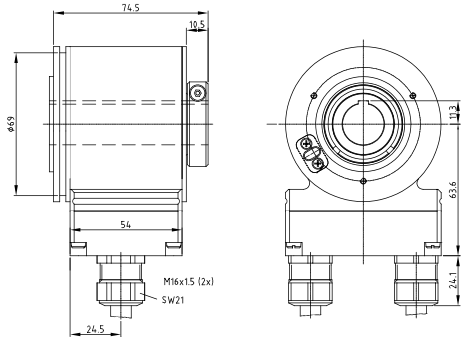
CDV75-PN / EPL
Absolute-Encoder CDV75M - PROFINET / PROFIsafe , - Powerlink / openSAFETY



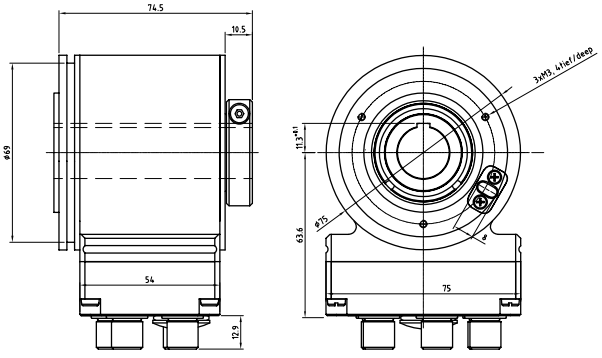
CDV75-PN
Absolute-Encoder CDV75M PROFINET / PROFIsafe+FS SealPack



CDH75-SSI
Absolute-Encoder CDH75M - SSI



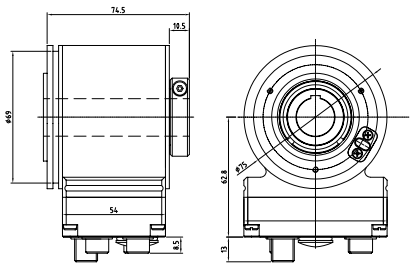
CDH75-PB
Absolute-Encoder CDH75M - PB



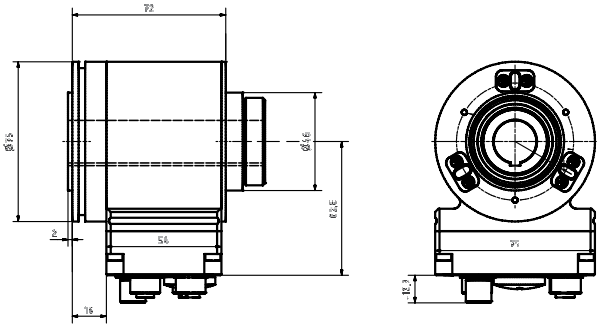
Illustrations are schematic diagrams. Binding dimension drawings and CAD data for specific order numbers at www.tr-electronic.com or on request.

Dimensional Drawings

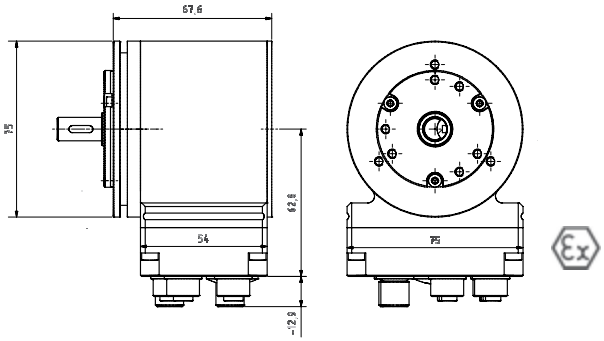
CDH75-PN / EPL
Absolute-Encoder CDH75M - PROFINET / PROFIsafe , - Powerlink / openSAFETY



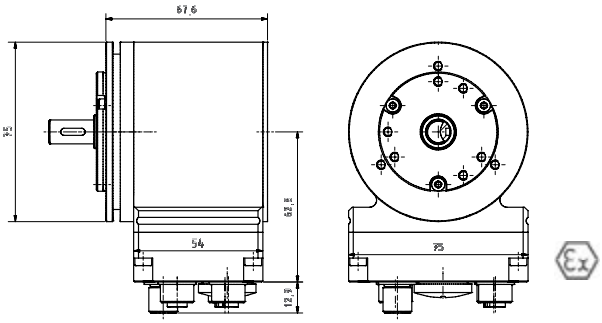
CDH75-PN
Absolute-Encoder CDH75M PROFINET / PROFIsafe+FS SealPack



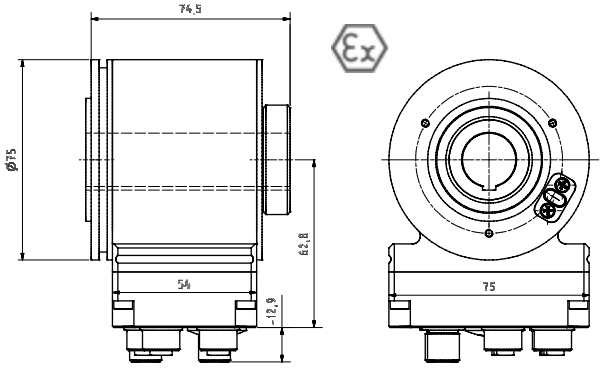
ADV75-PB
ATEX Zone 2/22 Absolute-Encoder ADV75M - PB



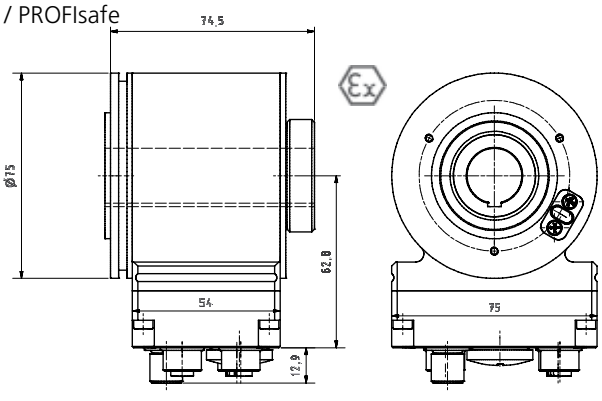
ADV75-PN
ATEX Zone 2/22 Absolute-Encoder ADV75M - PROFINET / PROFIsafe



ADH75-PB
ATEX Absolute-Encoder ADH75M - PB



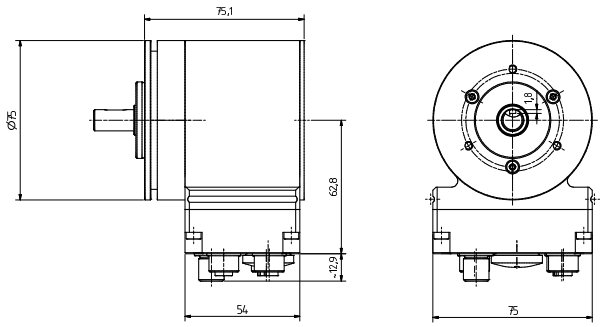
ADH75-PN
ATEX Zone 2/22 Absolute-Encoder ADH75M - PROFINET / PROFIsafe



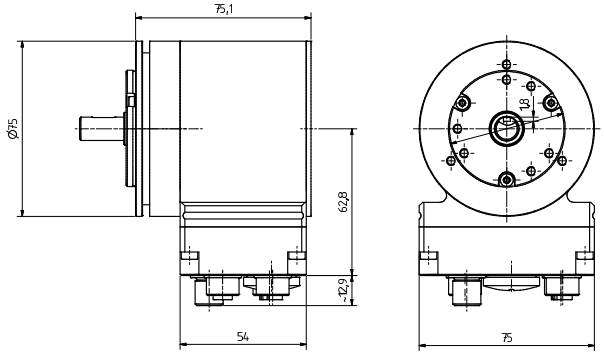
Illustrations are schematic diagrams. Binding dimension drawings and CAD data for specific order numbers at www.tr-electronic.com or on request.

Dimensional Drawings

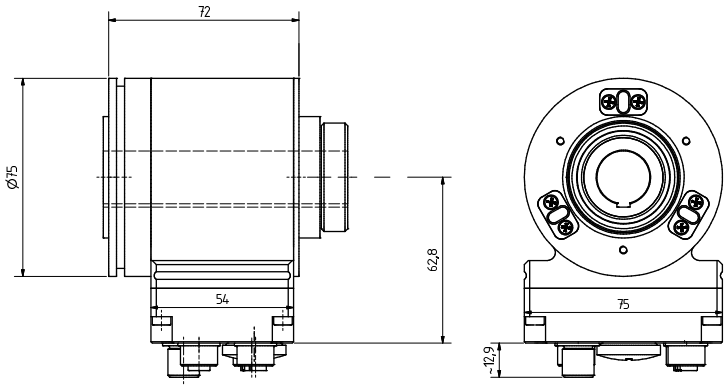
Seal Pack
Sample CDV75



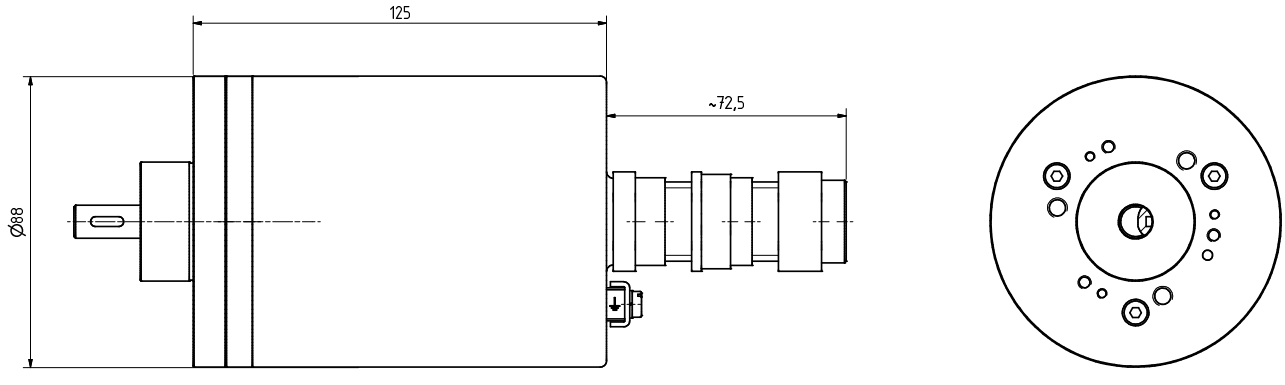
Stainless Steel
Sample CDV75



Seawaterresistant aluminum
Sample CDH75



ADV88
ATEX Zone 1/21



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