# Functional Safety
## Plant Safety and Personal Security

SIL3, PLe

PROFIsafe

## Certified according to SIL3 and PLe

# Accuracy and Reliability

The double encoder system with hollow shaft and multi turn detection fulfills the requirements of EN 61508 and is certified since 2008 according to SIL 3 und PL e.

To implement certified individual components makes it easier for the system integrator to fulfill the goal of safeness for the entire application, for example within the area of event technology and common storage and logistics.

**Available interfaces:**

- PROFIsafe via PROFIBUS (page 3 ff)
- 2 SSI with check sum (page 8 ff)



SSI
SSI

PROFIsafe

**SIL 3, PL e**

+ certified according to EN 61508 SIL3, EN ISO 13849 PLe
+ hollow shaft up to 20 mm with nut
+ resolution SSI: 13 bit x 4096 revolutions in system 1
  13 bit x 4096 revolutions in system 2
  PROFIsafe: 13 bit x 32.768 revolutions

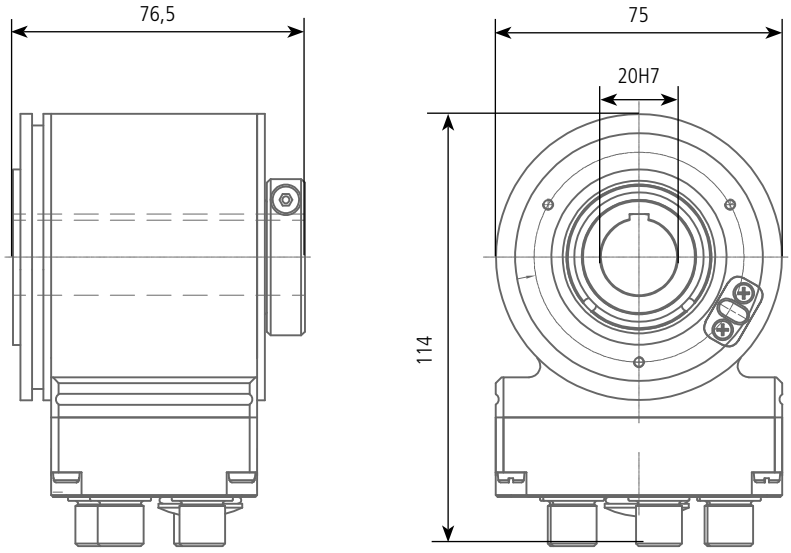
+ additional incremental signals (not safe), resolution factory-adjusted, selective square 5V 1024, 2048, 4096,8192, 16384, 32768 pulses/revolution or sine / cosine 1Vss 1024, 4096 periods / revolution

+ via PROFIsafe output on position and speed within the safe telegram

+ areas of use: drive technology, assembly systems, machine and plant manufacture, automation technology, wind engery, event technology, etc.

**SIL encoder with hollow shaft and PROFIBUS interface CDH 75 M PB - also available with SSI**

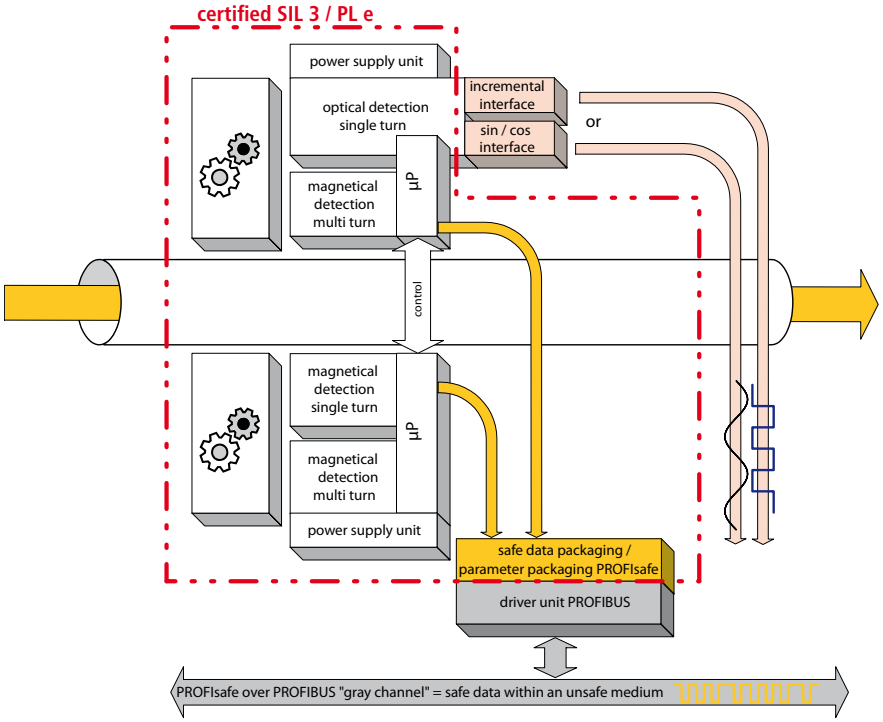
Maximum rotational speed 3000 /min




Please ask your project manager for detailed drawings.

# Safety According to SIL3 / PLe

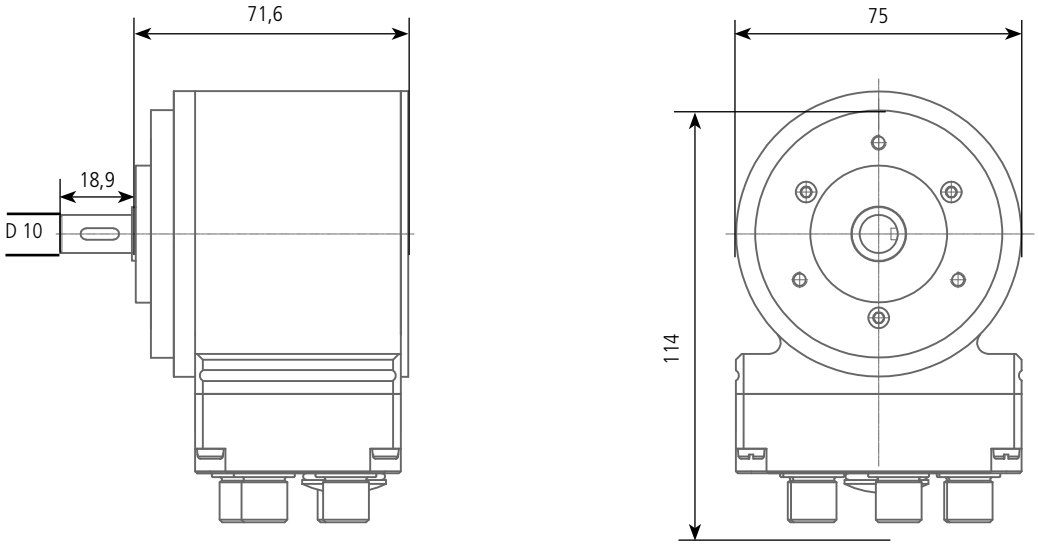
PROFIsafe over Profibus:






**SIL encoder with solid shaft and PROFIBUS interface CDV 75 M PB - also available with SSI**

Maximum rotational speed 6000 /min




Please ask your project manager for detailed drawings.

**TR-Electronic offers safety**

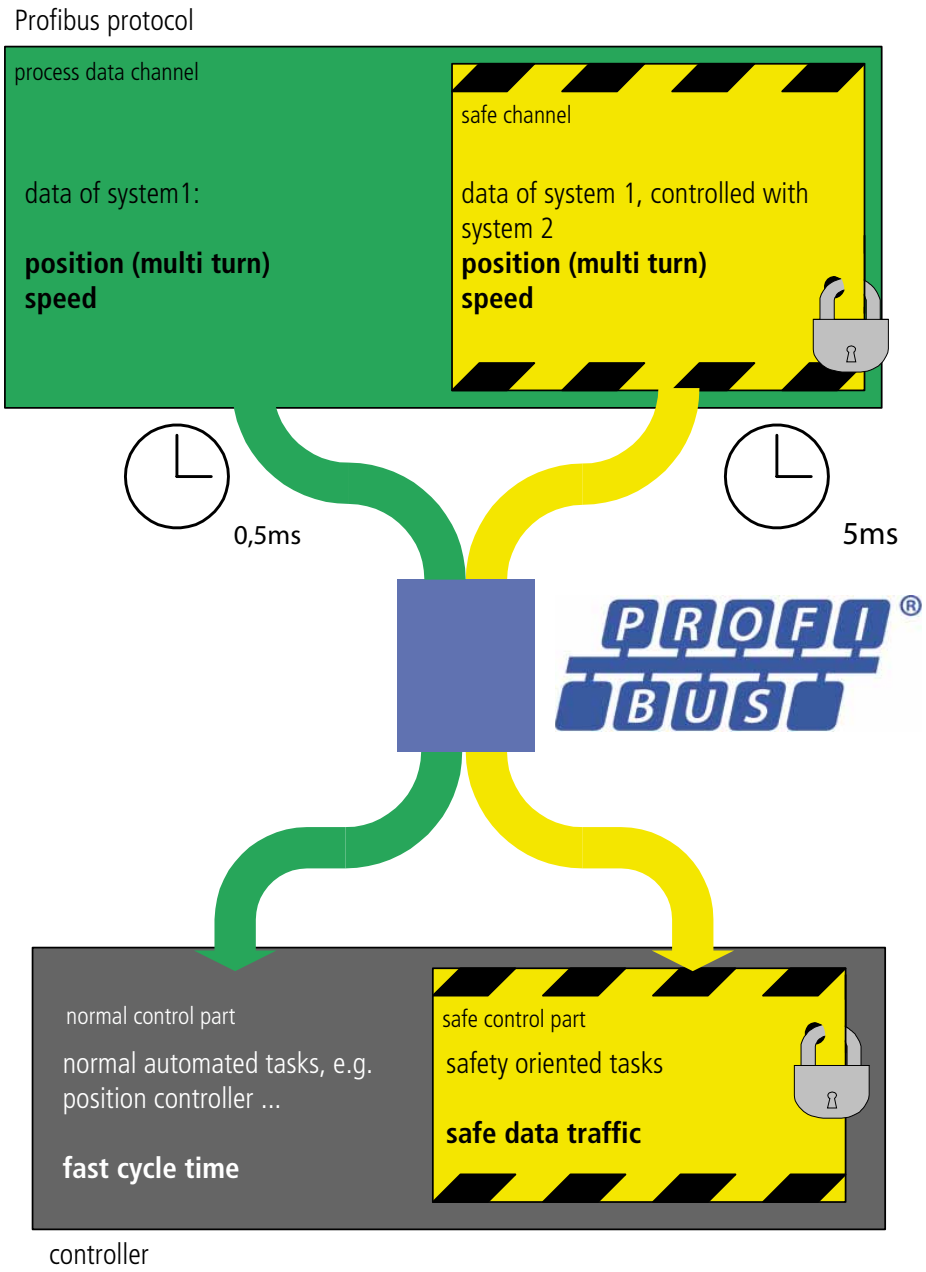
according to SIL3 - EN 61508 respectively PLe - EN ISO 13849

# Communication with PROFIsafe

The actual value for position and speed are transferred into two slots:

- For safe transfer, the actual values of both encoder systems will be compared. If the difference is smaller than the preset controlling window, the encoder value will count as safe. The saved positioning value and out of it the calculated speed value is transferred over the PROFIsafe part. The part of the controller that takes on the safety tasks can process the values.
- The actual positioning value and the calculated speed value of the first rotary encoder will be transferred directly in the non-secured processing channel. Generally, the controller works more frequent on this channel. Normal automated processes can be retrieved more often the actual positioning values.



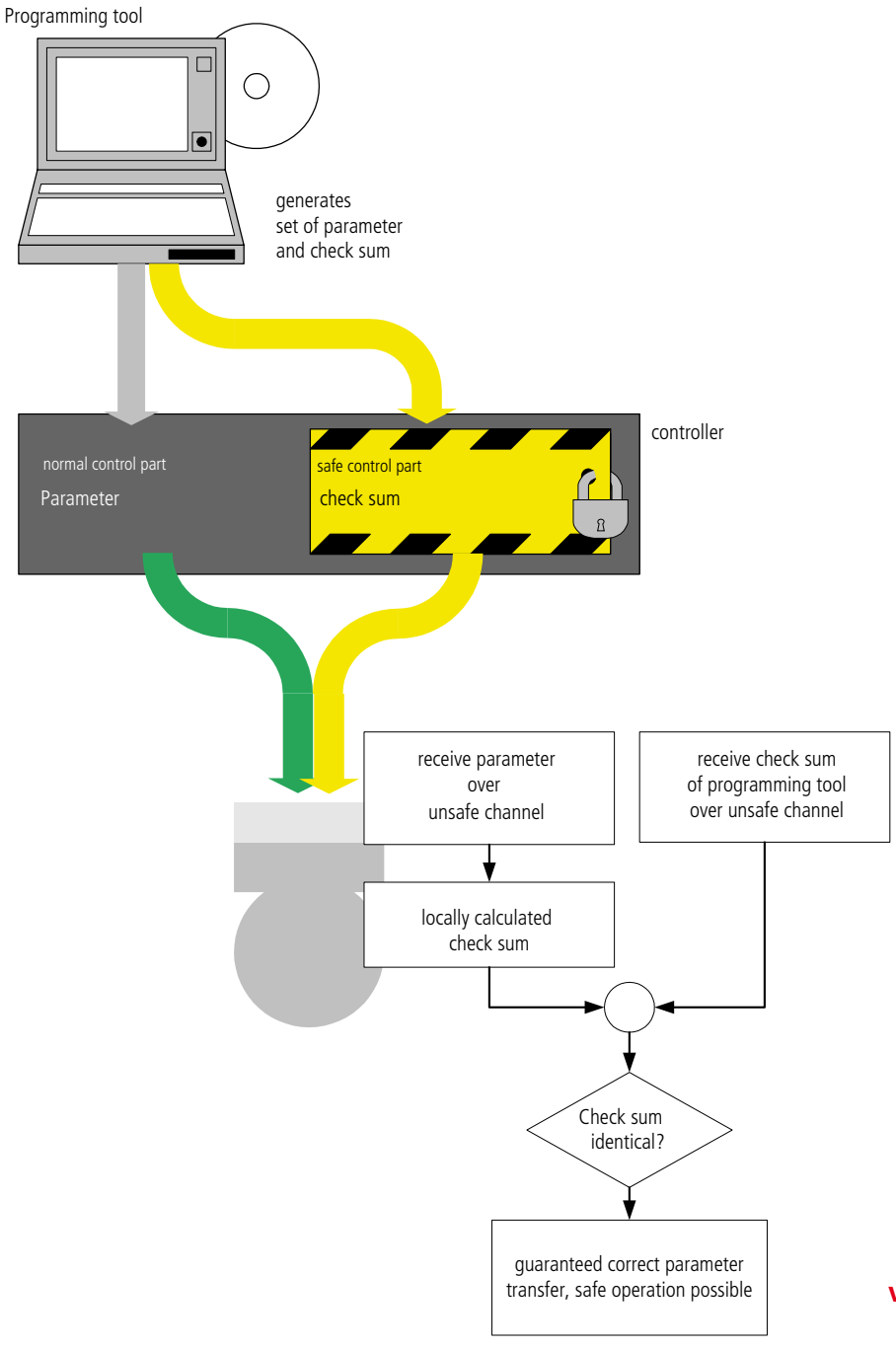


# Parametrizing over PROFIsafe

With every start of the machine, the parameters are transferred over the bus into the rotary encoder. The set of parameters are saved over a check sum.

| | |
|---|---|
| Difference window | Permissible variation between the rotary encoder value system 1 and system 2 |
| Rotational direction (planned) | Positive clockwise / counterclockwise direction |
| Integration time | Time base of the speed calculation. Long integration times enable high resolution measurements with low number of revolutions. A small integration time shows faster speed changes, ideal for high number of revolutions and big dynamic. Factor of the cycle times (rotary encoder systems). For process data channel (unsafe) 5 ... 500 ms, for safe channels 50 ... 500 ms |
| Stationary test window | To release a preset action (see page 7), the rotary encoder has to stand still. Depending on the mechanics / drive it may be necessary to quote a range of tolerance. |





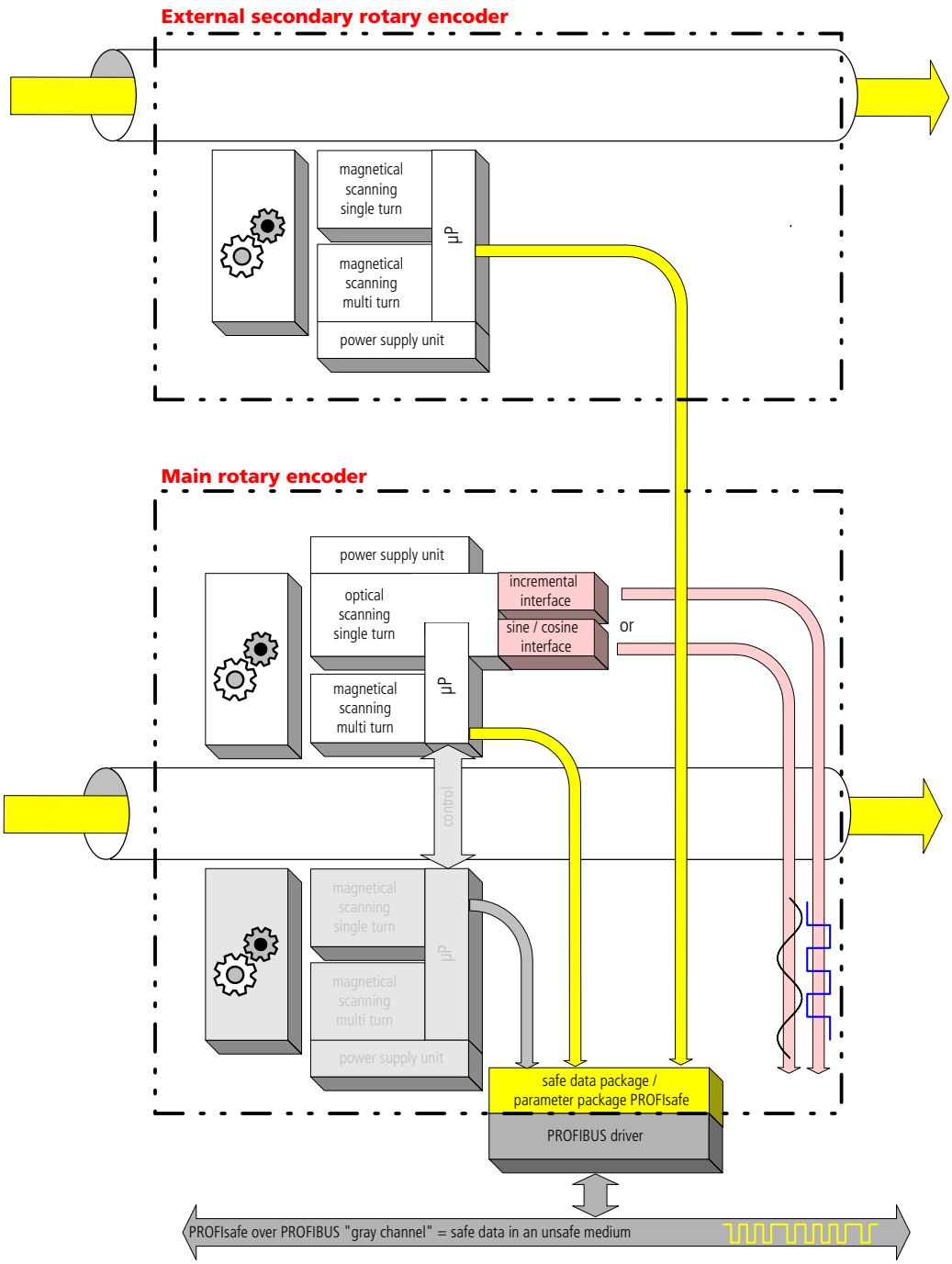
# Import of External Secondary Rotary Encoder

During normal operations, the quality of positioning value in the CD_75M PROFIsafe will be saved by the second rotary encoder system.
Alternatively you can use the CD_75M SSI.
Than, the actual values of both mechanical separated systems are compared with each other.

This enables
- synchronized speed control
- shaft control
- gear control

Permissible mechanical variation between the two systems can be considered over the difference window.



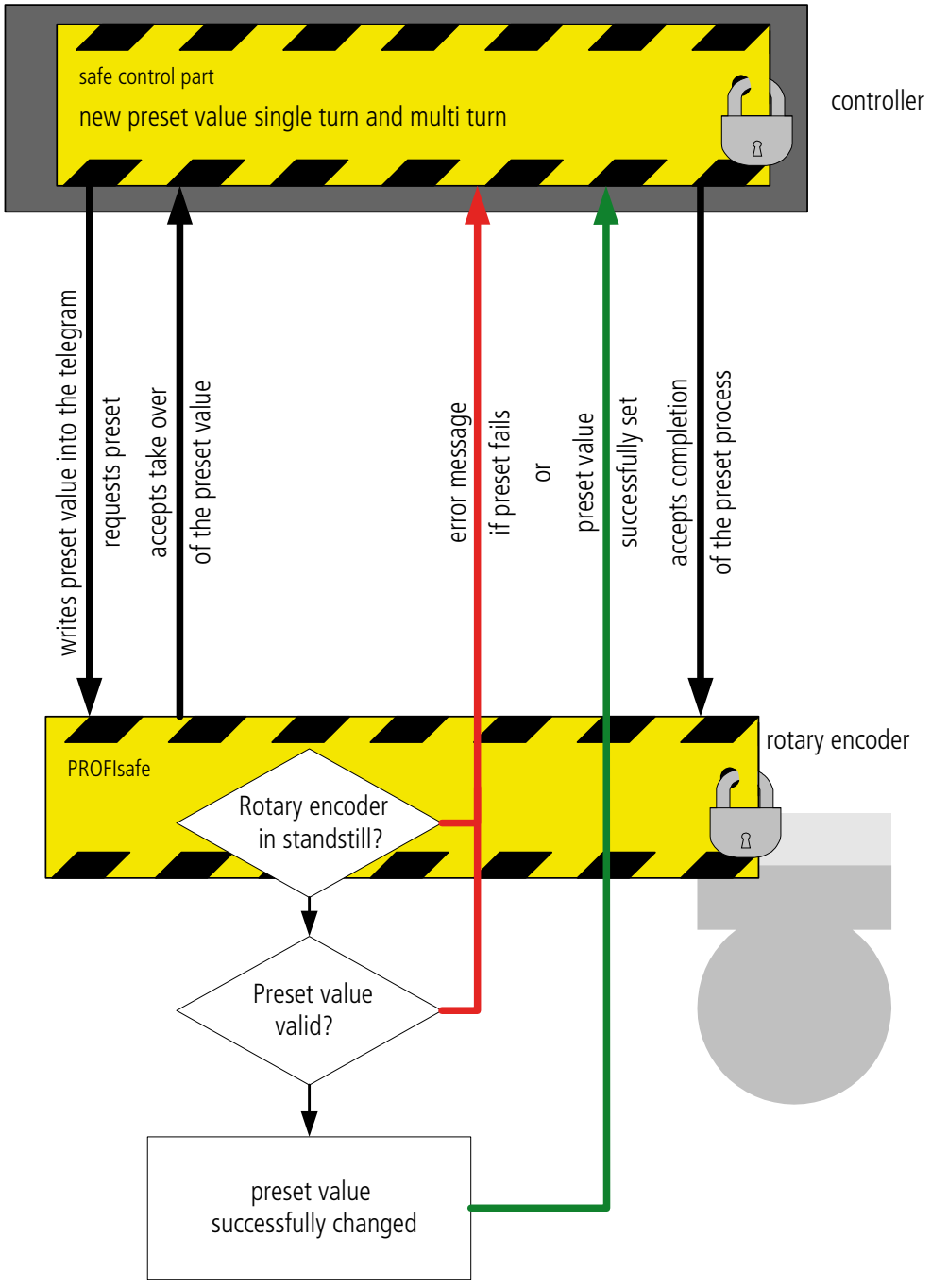


# Preset over PROFIsafe

By setting a preset value, the actual encoder value can put arbitrarily within the maximum measurement range. Therefore, you can solely electronically reference the displayed position. The encoder will store the offset value.
Setting a preset value is a critical process. The occurring difference of the actual value can lead to uncontrolled machine movements by using a controller. Therefore, you are only allowed to do a preset when the applied part of the machine is in standstill.

The preset value is already locked in the encoder and can solely be activated over a special bit in the safe protocol part. Even if the controller does fulfil all pre-conditions, the preset is only executed when the encoder shaft does not move.
Further measures have to be considered when programming a controller. The controller may only start the preset process when the associated drives are locked to run. It is recommended to lock the preset process through further safety regulations within the controller (e.g. key button, login,…).

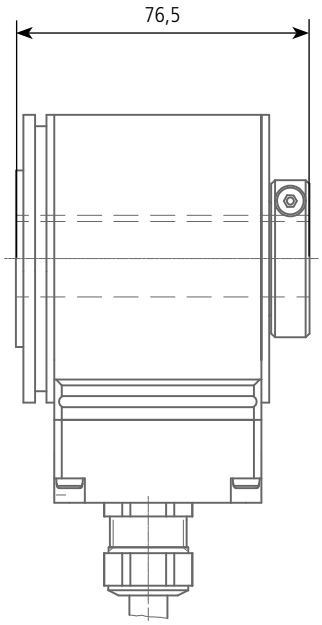


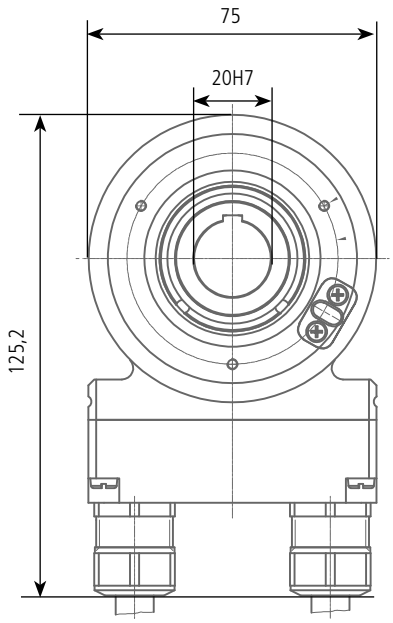


# CD_75 M 2SSI

## SIL encoder with hollow shaft and SSI interface CDH 75 M SSI - also available with PROFIBUS

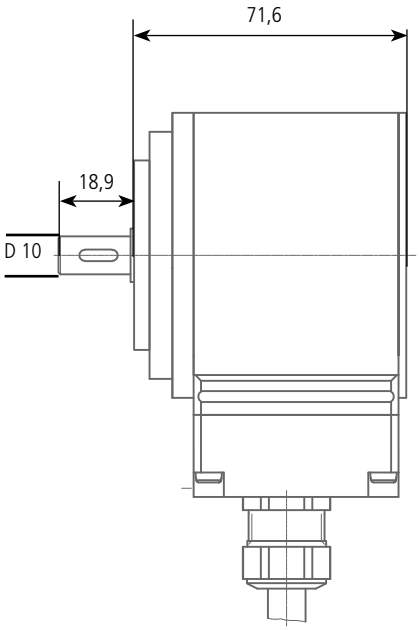
Maximum rotational speed 3000 /min

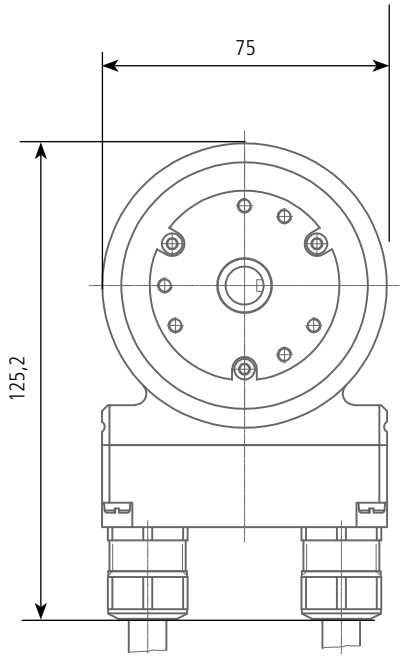



## SIL encoder with solid shaft and SSI interface CDV 75 M SSI - also available with PROFIBUS

Maximum rotational speed 6000 /min

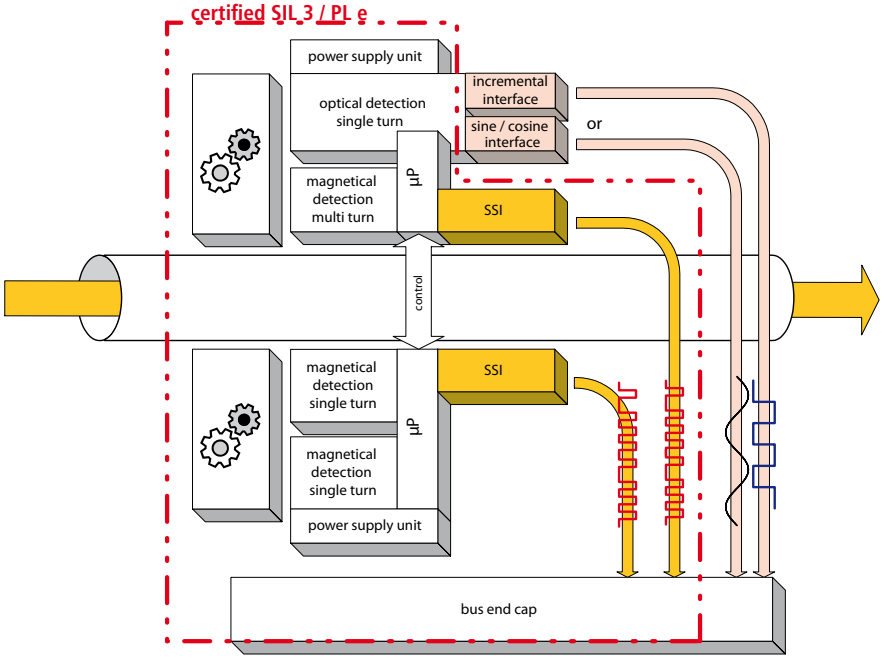



Please ask your project manager for detailed drawings.

# Safety according SIL3 / PLe

SSI:






## SSI telegram (identical for primary and secondary system)

| bit 0..11 | bit 12..24 | bit 25 | bit 26 | bit 27..31 | bit 32..39 |
|---|---|---|---|---|---|
| measurement value multi turn part | measurement value single turn part | own error bit | error bit of the other system | sign of life counter | check sum CRC |
| 12 bit | 13 bit | 1 bit | 1 bit | 5 bit | 8 bit |

Both systems transfer the positioning value to another SSI telegram.

### Error bit

In the SSI channels of both encoder systems, the error bit will be shown. If there is a fall out, you can transfer the error without any problems through the other channel. Therefore, you can even in an one-channel operation (havarie operation) realize a diagnose of both systems.

### Life of sign counter

The life of sign counter will be incremented each time in the process of scanning. An incremented life of sign counter dated to the last telegram does assure that the actual transferred data of the positioning scanning is also the latest.

Are the SSI requests faster than the internal scanning, (250µs with the master channel, 500µs with the safety channel) the data of the position and the life of sign counter has not changed yet.

### Check sum

Over the reference data in the SSI telegram, an 8 bit CRC check sum will be calculated and than inserted into the SSI telegram.

Secured data: MT and ST data, error bits, life of sign counter.

Hamming distance = 3: tow error data bits will be surely recognized.

## Data sheet extract

# CD_ 75 M PROFIsafe

### Electrical features

| | |
|---|---|
| Power supply | 11 ... 28 V DC |
| Power input witout demand | < 150 mA, at 24 V DC |
| Total resolution | 28 bit |
| Steps / revolution | 8.192 |
| Number of revolutions | 32.768 |
| Safety<br>- Safety Integrity Level (SIL): 3<br>according to DIN EN 61508; VDE 0803<br>- Performance Level (PL): e<br>according to DIN EN ISO 13849 | 2 redundant scanning systems with internal cross comparison. Adjustable difference window. Safety system optional external attached. |

### Mechanical features hollow shaft

| | |
|---|---|
| Permissible rotational speed | ≤ 3.000 $min^{-1}$ |
| Shaft loading (shaft end) | dead weight |
| Bearing life time | ≥ 3,9 * $10^{10}$ revolutions at |
| Number of rotations | ≤ 1.500 $min^{-1}$ |
| Operating temperature | ≤ 60 °C |
| Permissable angular acceleration | ≤ $10^4$ $rad/s^2$ |
| Mass | 1 kg |

### Mechanical features solid shaft

| | |
|---|---|
| Permissable rotational speed | ≤ 6.000 $min^{-1}$ |
| Shaft loading (shaft end) | ≤ 50 N axial, ≤ 90 N radial |
| Bearing life time | ≥ 3,9 * $10^{10}$ revolutions at |
| Number of rotations | ≤ 3.000 $min^{-1}$ |
| Operating temperature | ≤ 60 °C |
| Permissable angular acceleration | ≤ $10^4$ $rad/s^2$ |
| Mass | 1 kg |

### Environmental conditions

| | |
|---|---|
| Vibration | DIN EN 60068-2-6: 1996 |
| Shock | DIN EN 60068-2-27: 1995 |
| Interference resistance | DIN EN 50082-2, DIN EN 61000 |
| | DIN EN 61000-4-2 |
| | DIN EN 61000-4-3 |
| | DIN EN 61000-4-4 |
| | DIN EN 61000-4-6 |
| Emitted interference | DIN EN 50081-1, DIN EN 55022 |
| | class B, industrial area |
| Interference field | <30 MHz; 30 ...1.000 MHz |
| Working temperature | 0 °C ... +60 °C |
| | optional -20 °C ... +70 °C |
| Storage temperature | -30 °C ... +80 °C, dry |
| Relative humidity<br>DIN EN 600068-3-4: 2002 | 98 %, no condensation |
| Protection class DIN EN 60529: 1991 | IP 65 solid shaft,<br>IP 54 hollow shaft |

+ PROFIBUS-DP interface with PROFIsafe protocol
+ model with hollow shaft, max. 20mm or solid shaft
+ functional safety according to
  DIN EN 61508; VDE 0803: SIL 3
  DIN EN ISO 13849: PL e
+ 13 bit total capacity, 32.768 revolutions
+ SINE/COSINE signal respectively incremental signal for returning to position

### Data in a secured channel

| | |
|---|---|
| Position (multi turn) | |
| Speed | |
| Programmable parameter | integration time (50 .. 500 ms) |
| | difference window |
| | rotational direction (planned) |
| Cycle times | 5 ms |

### Data in a process data channel

| | |
|---|---|
| Position (multi turn) | |
| Speed | |
| Programmable parameter | integration time (5 .. 500 ms) |
| | rotational direction (planned) |
| Cycle times | 0,5 ms |

| | |
|---|---|
| Incremental signal optional | |
| Sine/Cosine, 1 Vss | 1024 or 4096 periods |
| or | |
| Quader, 5 V | 1024, 2048, 4096, 8192, 16384 or 32768 impulse |

# CD_ 75 M 2SSI

SSI
SSI



## Electrical features

| | |
|---|---|
| Power supply | 11 ... 28 V DC |
| Power input without demand | < 150 mA, at 24 V DC |
| Total resolution | 25 bit |
| Steps / revolution | 8.192 |
| Number of revolutions | 4.096 |
| Safety | is assured in combination with a controller, certified according to SIL3, and specified controlling conditions from TR-Electronic |
| - Safety Integritiy Level (SIL): 3 according to DIN EN 61508; VDE 0803 | |
| - Performance Level (PL): e according to DIN EN ISO 13849 | |
| - PFH, total system | < 10 * 10 $^{-9}$ 1/h |

+ two redundant SSI interfaces
+ model with hollow shaft, max. 20 mm or solid shaft
+ proven for the use in combination with the SIL 3 safety functions
+ functional safety according to DIN EN 61508; VDE 0803: SIL 3 DIN EN ISO 13849: PL e
+ master system: 13 bit resolution, 4.096 revolutions, SINE / COSINE signal respectively incremental signal for returning to position
+ safety system: 13 bit resolution, 4.096 revolutions

## Mechanical features hollow shaft

| | |
|---|---|
| Permissible rotational speed | ≤ 3.000 min$^{-1}$ |
| Shaft loading (shaft end) | own weight |
| Bearing life time | ≥ 3,9 * 10$^{10}$ revolutions at |
| Number of rotations | ≤ 1.500 min$^{-1}$ |
| Operating temperature | ≤ 60 °C |
| Permissable angular acceleration | ≤ 10$^{4}$ rad/s$^{2}$ |
| Mass | 1 kg |

## Mechanical features solid shaft

| | |
|---|---|
| Permissible rotational speed | ≤ 6.000 min$^{-1}$ |
| Shaft loading (shaft end) | ≤ 50 N axial, ≤ 90 N radial |
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## Environmental conditions

| | |
|---|---|
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| Shock | DIN EN 60068-2-27: 1995 |
| Interference resistance | DIN EN 50082-2, DIN EN 61000 |
| | DIN EN 61000-4-2 |
| | DIN EN 61000-4-3 |
| | DIN EN 61000-4-4 |
| | DIN EN 61000-4-6 |
| Emitted interference | DIN EN 50081-1, DIN EN 55022 |
| | class B, industrial area |
| Interference field | <30 MHz; 30 ...1.000 MHz |
| Working temperature | 0 °C ... +60 °C |
| | optional -20 °C ... +70 °C |
| Storage temperature | -30 °C ... +80 °C, trocken |
| Relative humidity DIN EN 600068-3-4: 2002 | 98 %, no condensation |
| Protectino class DIN EN 60529: 1991 | IP 65 solid shaft, IP 54 hollow shaft |

## Master system

| | |
|---|---|
| Accuracy | 13 bit, single turn |
| SSI interfaces, Hamming distance 3 | TR specific protocol with functional information and CRC |
| Incremental signal optional | resolution factory-adjusted |
| Sine/Cosine, 1 Vss | 1024 or 4096 periods |
| or | |
| Quader, 5 V | 1024, 2048, 4096, 8192, 16384 or 32768 impulse |
| Cycle time | ≥ 250 µs |

## Safety system

| | |
|---|---|
| Accuracy | 8 bit, single turn |
| SSI interface Hamming distance 3 | TR specific protocol with functional information and CRC |
| Cycle time | ≥ 250 µs |



**TR-Electronic GmbH**
Eglishalde 6
D-78647 Trossingen

Tel. +49 (0)7425 / 228-0
Fax +49 (0)7425 / 228-33
info@tr-electronic.de

**www.tr-electronic.de**