Original manual

Functional Safety
Type Approved

Absolute Encoder CD_-75
PROFIBUS-DP/PROFIsafe

Explosion Protection Enclosure
_ADV75
_ADH75
_ADV115

Protection Enclosure
_CDV115

CDH 75 M

(CDW 75 M)

CDV 75 M

DIN EN 61508: **SIL CL3**
DIN EN ISO 13849: **PL e**

_Safety instructions
_Device-specific specifications
_Installation/Commissioning
_Parameterization
_Cause of faults and remedies

User Manual
Interface

TR-ECE-BA-GB-0092-20 11/19/2020

TR-Electronic GmbH
D-78647 Trossingen
Eglishalde 6
Tel.: (0049) 07425/228-0
Fax: (0049) 07425/228-33
E-mail: info@tr-electronic.de
www.tr-electronic.de

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Author:	MÜJ

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1 General information

The present interface-specific User Manual addresses the following topics:

- Safety instructions
- Device-specific specifications
- Installation/Commissioning
- Parameterization
- Error causes and remedies

As the documentation is arranged in a modular structure, the User Manual is supplementary to other documentation, such as product data sheets, dimensional drawings, brochures, the Safety Manual, etc.

The User Manual may be included in the customer's specific delivery package or it may be requested separately.

1.1 Applicability

This User Manual applies exclusively to measuring system models according to the following type designation code with ***PROFIBUS-DP*** interface and ***PROFIsafe*** profile:

* 1	* 2	* 3	* 4	* 5	-	* 6	* 6	* 6	* 6	* 6

Position	Notation	Description
* 1	A C	Explosion protection enclosure (ATEX);  Absolute Encoder, programmable
* 2	D	redundant dual scanning unit
* 3	V H W	Solid shaft Hollow shaft Rope length transmitter (wire)
* 4	75 115	External diameter ∅ 75 mm External diameter ∅ 115 mm
* 5	M	Multi turn
* 6	-	Consecutive number

* = Wild cards

The products are labeled with affixed nameplates and are components of a system.

This means that, all in all, the following documentations are applicable:

- see chapter "Other applicable documents" in the Safety Manual www.tr-electronic.de/f/TR-ECE-BA-GB-0107
- Product data sheets: https://www.tr-electronic.com/s/S019556

1.2 Abbreviations and terms used

CDH	Absolute encoder with redundant dual scanning, hollow shaft design
CDV	Absolute encoder with redundant dual scanning, solid shaft design
CDV115	Series 75 measuring system installed in a 115 "Heavy Duty" protection enclosure
CD_	Absolute encoder with redundant dual scanning, all designs
CRC	***C***yclic ***R***edundancy ***C***heck
EU	***E***uropean ***U***nion
EMC	***E***lectro ***M***agnetic ***C***ompatibility
ESD	***E***lectro ***S***tatic ***D***ischarge
IEC	***I***nternational ***E***lectrotechnical ***C***ommission
VDE	Association for Electrical, Electronic & Information Technologies
Engineering tool	Projection and commissioning tool
F	Generally stands for the term safety or fail-safe
F-Device	Safety device for safety applications
F-Host	Safety control for safety applications
Fault exclusion	Compromise between the technical safety requirements and the theoretical possibility of an error occurring
FMEA	***F***ailure ***M***ode and ***E***ffects ***A***nalysis, reliability engineering methods, for finding potential weak points
Operator acknowl-edgment	Switching from substitute values to process data
Passivation	In the case of an F-Periphery with outputs, the F-System transmits substitute values (e.g. 0) to the fail-safe outputs during a passivation instead of the output values provided in the process image by the safety program.
DC_{avg}	***D***iagnostic ***C***overage Average diagnostic coverage
PFD_{av}	***Av***erage ***P***robability of ***F***ailure on ***D***emand Average probability of failure of a safety function with low demand
PFH	***P***robability of ***F***ailure per ***H***our Operating mode with high requirement rate or continuous demand. Probability of dangerous failure per hour.
$MTTF_d$	***M***ean ***T***ime ***T***o ***F***ailure (dangerous) Mean time until dangerous failure
SIL	***S***afety ***I***ntegrity ***L***evel: Four discrete levels (SIL1 to SIL4). The higher the SIL of a safety-related system, the lower the probability that the system cannot execute the required safety functions.

SIS	***S***afety ***I***nstrumented ***S***ystem: is used to protect a dangerous process and reduce the risk of an accident. Process instruments are a constituent of a Safety Instrumented System. This comprises the essential components of a complete safety-relevant process unit: Sensor, fail-safe processing unit (control) and actuator
Functional safety	Part of the overall system safety, which depends on the correct functioning of safety-related systems for risk reduction. Functional safety is ensured when each safety function is executed as specified.
SCS	***S***afety ***C***omputer ***S***ystem with control function, also referred to as F-Host in relation to PROFIsafe
Standard measuring-system	Definition: Safety-related measuring system, without explosion protection
0x	Hexadecimal representation

1.3 Main features

- PROFIBUS interface with PROFIsafe protocol, for transfer of a safe position and speed
- Quick process data channel via PROFIBUS, not safety-oriented
- Variant 1 only:
  Additional incremental or SIN/COS interface, not safety-oriented
- Two-channel scanning system, for generation of safe measured data through internal channel comparison
  - Variant 1:
    Channel 1, master system:
    optical Single-Turn scanning via code disk with transmitted light and magnetic Multi-Turn scanning
    Channel 2, inspection system:
    magnetic Single- and Multi-Turn scanning
  - Variant 2:
    Channel 1, master system:
    magnetic Single- and Multi-Turn scanning
    Channel 2, inspection system:
    magnetic Single- and Multi-Turn scanning
- A common drive shaft

The data of the master system are unevaluated in the non-safety-oriented process data channel with normal PROFIBUS protocol, but are made available with a short cycle time.

The inspection system serves for the internal safety check. The "safe data" obtained through two-channel data comparison are packed into the PROFIsafe protocol and also transmitted to the control via the PROFIBUS.

The incremental interface available in variant 1, or the optionally available SIN/COS interface, is derived from the master system and is not evaluated in relation to safety.

1.4 Principle of the safety function

System safety results when:

- Each of the two scanning channels is largely fail-safe thanks to individual diagnostic measures
- The measuring system internally compares the positions detected by both channels in two channels, also determines the speed in two channels and transfers the safe data to the PROFIBUS in the PROFIsafe protocol
- In the event of a failed channel comparison or other errors detected through internal diagnostic mechanisms, the measuring system switches the PROFIsafe channel into error state
- The measuring system initialization and execution of the preset adjustment function are appropriately verified
- The control additionally checks whether the obtained position data lie in the position window expected by the control. Unexpected position data are e.g. position jumps, tracking error deviations and incorrect direction of travel
- When errors are detected the control introduces appropriate safety measures defined by the system manufacturer
- The system manufacturer ensures, through correct mounting of the measuring system, that the measuring system is always driven by the axis for measurement and is not overloaded
- The system manufacturer performs a verified test during commissioning and in the event of any parameter modification

2 Safety instructions

2.1 Definition of symbols and notes

⚠ DANGER	means that death or serious injury will occur if the required precautions are not met.
⚠ WARNING	means that death or serious injury can occur if the required precautions are not met.
⚠ CAUTION	means that minor injuries can occur if the required precautions are not met.
NOTICE	means that damage to property can occur if the required precautions are not met.
	indicates important information or features and application tips for the product used.

2.2 Organizational measures

- This User Manual must always be kept ready-to-hand at the place of use of the measuring system.
- Prior to commencing work, personnel assigned to handle the measuring system must
  - have read and understood the Safety Manual, in particular chapter ***"Basic safety instructions"***,
  - as well as this User Manual, in particular chapter ***"Safety instructions"***.

This is particularly applicable for personnel who handle the measuring system only occasionally, e.g., when the measuring system is parameterized.

2.3 Safety functions of the fail-safe processing unit

The **F-Host**, to which the measuring system is connected, must perform the following safety checks.

To enable the correct measures to be taken in case of an error, the following applies:

If no safe position can be output due to an error detected by the measuring system, the PROFIsafe data channel is automatically put into fail-safe status. In this status so-called "passivated data" are output via PROFIsafe. Also see the chapter "Output of passivated data (substitute values) in case of error" on page 42.

Passivated data from the viewpoint of the measuring system are:

- PROFIsafe data channel: all outputs are set to 0
- PROFIsafe status: error bit 2^1 `Device_Fault` is set
- PROFIsafe-CRC: valid

Upon receipt of passivated data, the F-Host must put the system into a safe state. It is only possible to leave this error state by eliminating the error and then switching the supply voltage off and on again!

The process data channel addressable via PROFIBUS is not necessarily affected by this. If the internal diagnosis in the master channel does not detect an error, the process data are still output. However, these data are not safe for the purposes of a safety standard.

2.3.1 Mandatory safety checks / measures

Measures for commissioning, changes	F-Host error reaction
Application-dependent parameterization and definition of the necessary `iParameters`, see chapter "iParameters" on page 40.	–
In the event of parameter changes, check that the measure is executed as desired.	STOP

Check by F-Host	F-Host error reaction
Cyclical consistency check of the current safety-oriented data from the `TR-PROFIsafe` module in relation to the previous data.	STOP
Travel curve calculation and monitoring by means of cyclical data from the `TR-PROFIsafe` module.	STOP
Monitoring of cyclical data from the `TR-PROFIsafe` module, and the process data from the `TR-PROFIBUS` module.	Receipt of passivated data --> STOP
Timeout: Monitoring of the measuring system - response time. For checking e.g. cable breakage, power failure etc.	STOP

3 Technical Data

3.1 Safety

Startup time	Time between POWER-UP and safe position output
Overall system	≤ 5 s
PFH, "High demand" operating mode	7.88 * 10^{-10} 1/h
Scanning, double magnetic	2.30*10^{-9} 1/h
PFD_{av} (T_1 = 20 a)	6.71 * 10^{-5}
$MTTF_d$ high	98 a
Scanning, double magnetic	110 a
*** DC_{avg} high**	98 %
Scanning, double magnetic	98.87 %
Internal process safety time	Time between occurrence of an F-Error and alarm indication
Overall system	≤ 10 ms
Process safety angle	Angle between error occurrence and alarm indication
Via channel-internal self-diagnosis	± 100 °, in relation to the measuring system shaft, at 6000 min^{-1}
Through channel comparison	Parameterizable with iParameter `Window increments`
T_1, Proof Test	20 years

* The assessment occurred in accordance with Note 2 on Table 6 of EN ISO 13849-1

3.2 Electrical characteristics

3.2.1 General

Supply voltage	11…27 V DC acc. to IEC 60364-4-41, SELV/PELV
Feed	single feed input, but electrically separated internally by means of two power supplies
Reverse polarity protection	yes
Short-circuit protection	yes, by internal 2 A safety fuse
Overvoltage protection	yes, up to ≤ 36 V DC
Current consumption without load	< 150 mA at 24 V DC
Option HTL-Level, 11…27 VDC	increased current consumption, see page 25

3.2.2 Device-specific

Total resolution ..... ≤ 268 435 456 steps

Number of steps / revolution ..... ≤ 8192

Number of revolutions ..... ≤ 32768

Functional accuracy ..... 8192 steps, Single-Turn

Scanning, double magnetic ..... 256 steps, Single-Turn

Safety-related applicable accuracy

Scanning, optical/magnetic ..... 256 steps, Single-Turn

Scanning, double magnetic ..... 128 steps, Single-Turn

Safety principle ..... 2 redundant scanning units with internal triangulation

PROFIBUS-DP V0 interface ..... IEC 61158, IEC 61784

PROFIsafe profile ..... 3.192b according to IEC 61784-3-3

Additional functions ..... Preset

* Parameter

- Integration time Safe ..... 50 ms…500 ms
- Integration time Unsafe ..... 5 ms…500 ms
- Size of monitoring window ..... 50…4000 increments
- Idleness tolerance Preset ..... 1…5 increments/Integration time Safe
- Counting direction ..... forward, backward

Transmission ..... RS485, twisted and shielded copper cable with a single conductor pair (cable type A)

Output code ..... Binary

Addressing ..... 1 – 99, settable via rotary switch

Baud rate ..... 9.6 kbit/s…12 Mbit/s

* TR-specific functions ..... Speed output in increments/Integration time Safe

Incremental interface ..... Cable specification see page 21

Availability ..... Scanning system: optical/magnetic

Pulses / revolution ..... 1024, 2048, 3072, 4096, 5120 or 4096, 8192, 12288, 16384, 20480, via factory setting

A, /A, B, /B, TTL ..... RS422 (2-wire) according to EIA standard

A, /A, B, /B, HTL ..... optional 11…27 V DC, see page 25

Output frequency, TTL ..... ≤ 500 KHz

Output frequency, HTL ..... see page 25

SIN/COS interface, alternative ..... Cable specification see page 21

Availability ..... Scanning system: optical/magnetic

Number of periods ..... 4096 / revolution

SIN+, SIN–, COS+, COS– ..... 1 Vss ± 0.2 V at 100 Ω, differential

Short-circuit proof ..... yes

Cycle time

Not safety-oriented ..... 0.5 ms, output via TR-PROFIBUS module

Safety-oriented ..... 5 ms, output via TR-PROFIsafe module

Preset write cycles ..... ≥ 4 000 000

* parameterizable via PROFIBUS-DP

3.3 Max. possible step deviation (master system / inspection system)

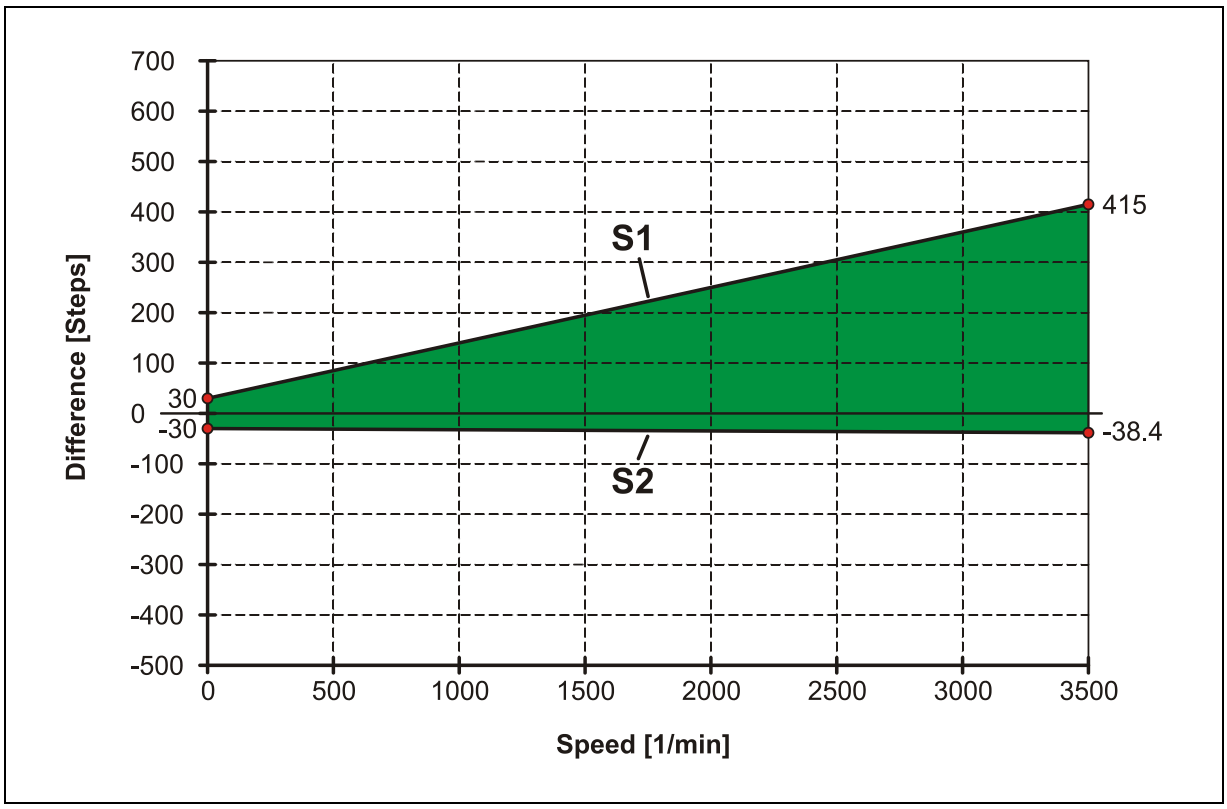


Figure 1: Dynamic view of the step deviation, counting direction rising (view onto flanging)

Figure 1 serves for the estimate of the possible step deviation. On the base of this estimate the parameter `Window increments` *can be adjusted, see chapter 5.6.2.3 on page 38.*

Function of the straight line S1:

S1 = 30 steps + (0.11 steps per revol. * actual speed [1/min])

Function of the straight line S2:

S2 = -30 steps + (-0.0024 steps per revol. * actual speed [1/min])

The max. possible step deviation results from the difference between S1 and S2

Example: Max. possible step deviation at 3500 1/min

S1 = 30 steps + (0.11 steps per revol. * 3500 1/min) = 415 steps
S2 = -30 steps + (-0.0024 steps per revol. * 3500 1/min) = -38.4 steps

Max. possible step deviation = 415 steps – (-38.4 steps) = **453.4 steps**

4 Installation / Preparation for Commissioning

4.1 Basic rules

⚠ WARNING ***Deactivation of the safety function through conducted interference sources!***

- All devices, standards and safety functions used on the bus must have a PROFIBUS certificate or a corresponding manufacturer's declaration.
- All safety devices must also have a certificate from a "Notified Body" (e.g. TÜV, BIA, HSE, INRS, UL, etc.).
- The 24V power supplies used must fulfil SELV/PELV according IEC 60364-4-41:2005.
- No stub lines.
- The shielding effect of cables must also be guaranteed after installation (bending radii!) and after connector changes. In cases of doubt, use more flexible cables with a higher current carrying capacity.
- Only use M12 connectors for connecting the measuring system, which guarantee good contact between the cable shield and connector housing. The cable shield must be connected to the connector housing over a large area.
- A 5-wire cable with a PE-conductor isolated from the N-conductor (so-called TN network) must be used for the drive/motor cabling. This will largely prevent equipotential bonding currents and the development of interference.
- A shielded and stranded data cable must be used to ensure high electromagnetic interference stability of the system. The shielding should be connected with low resistance to protective ground using large shield clips at **both ends**. The shielding should be grounded **in the switch cabinet only** if the machine ground is heavily contaminated with interference towards the switch cabinet ground.
- Equipotential bonding measures must be provided for the complete processing chain of the system.
- Power and signal cables must be laid separately.
- Observe the manufacturer's instructions for the installation of converters and for shielding power cables between frequency converter and motor.
- Ensure adequate dimensioning of the energy supply.

Upon completion of installation, a visual inspection with report should be carried out. Wherever possible, the quality of the network should be verified using a suitable bus analysis tool: no duplicate bus addresses, no reflections, no telegram repetitions etc.

To ensure safe and fault-free operation, the

- *PROFIBUS Planning Guideline, PNO Order no.: 8.012*
- *PROFIBUS Assembly Guideline, PNO Order no.: 8.022*
- *PROFIBUS Commissioning Guideline, PNO Order no.: 8.032*
- *PROFIsafe "Environmental Requirements", PNO Order no.: 2.232*
- *and the referenced Standards and PNO Documents contained in it must be observed!*

In particular the EMC directive in its valid version must be observed!

4.2 PROFIBUS transfer technology, cable specification

All devices are connected in a bus structure (line). Up to 32 clients (master or slaves) can be connected together in a segment.
The bus is terminated with an active bus termination at the beginning and end of each segment. For stable operation, it must be ensured that both bus terminations are always supplied with voltage. The bus termination must be provided externally via the connection plug.

All cables used must conform with PROFIBUS specifications for the following copper data cable parameters:

Parameter	**Cable type A**
Wave impedance in Ω	135...165 at a frequency of 3...20 MHz
Operating capacitance (pF/m)	30
Loop resistance (Ω/km)	≤ 110
Wire diameter (mm)	> 0.64
Wire cross-section (mm²)	> 0.34
Shielding	Generally foil shielding with braided shield

The range is dependent on the transmission speed for cable type A:

Baud rate (kbits/s)	9.6	19.2	93.75	187.5	500	1500	12000
Range / segment	1200 m	1200 m	1200 m	1000 m	400 m	200 m	100 m

4.3 Connection

⚠ WARNING

NOTICE

Destruction, damage and malfunction of the measuring system in case of infiltration of damp!

- In case of storage as well as in the operation of the measuring system unused connecting plugs have to be provided either with a mating connector or with a protective cap. The IP protection class is to be selected according to the requirements.
- Protective cap with O-ring:
  In case of re-close of the protective cap the existence and the correct seat of the O-ring have to be checked.
- Corresponding protective caps see chapter accessories in the Safety Manual.

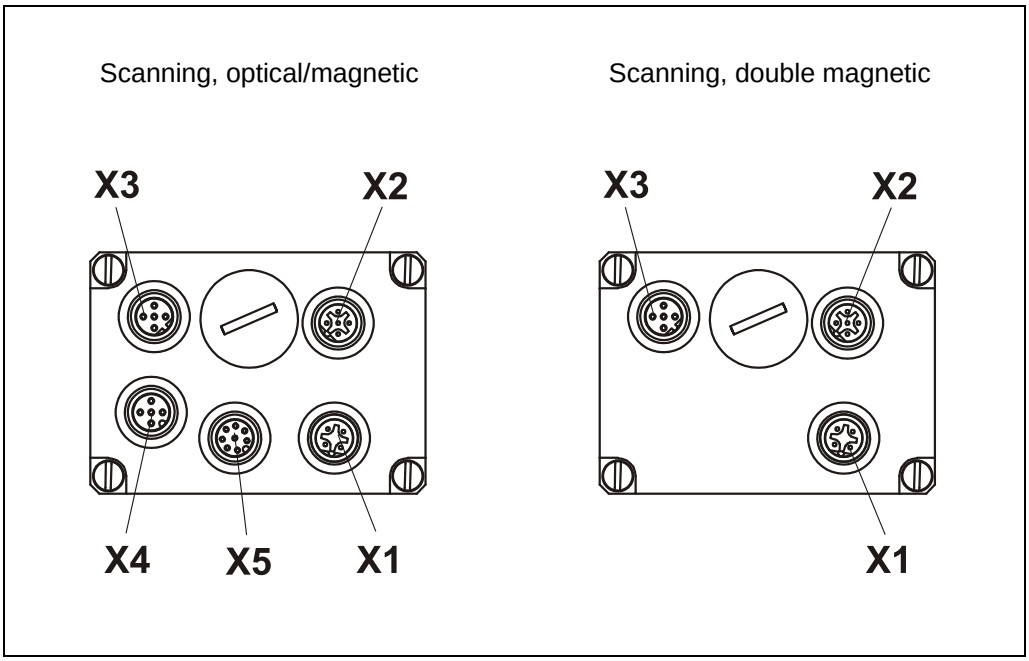


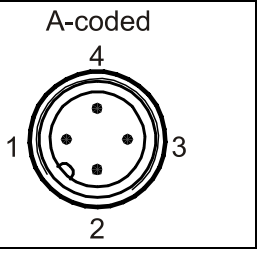
Figure 2: Connector assignment

4.3.1 Supply voltage

NOTICE

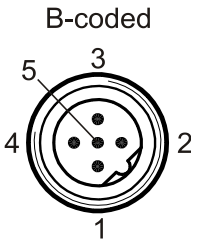
Danger of unnoticed damage to the internal electronics, due to unacceptable overvoltages!

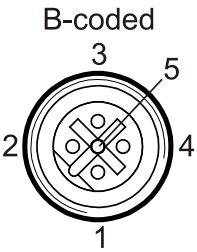
- If an overvoltage of >36 V DC is inadvertently applied, the measuring system must be checked in the factory. The measuring system is permanently switched off for safety reasons, if the overvoltage is applied for more than 200 ms.
  - ➢ The measuring system must be shut down immediately
  - ➢ When sending the measuring system to the factory, the reasons and circumstances relating to the overvoltage must be specified
  - ➢ The power supply used must meet the requirements of SELV/PELV (IEC 60364-4-41:2005)

X1	Signal	Description	Pin, M12x1, 4 pole
1	+ 24 V DC (11…27 V DC)	supply voltage	
2	n.c.	-	
3	0 V	GND	
4	n.c.	-	

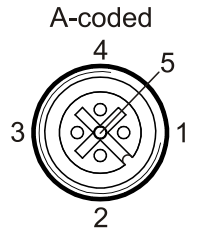
Cable specification: min. 0.34 mm² (recommended 0.5 mm²) and shielded.
General the cable cross section and the cable length must be well-matched.

4.3.2 PROFIBUS

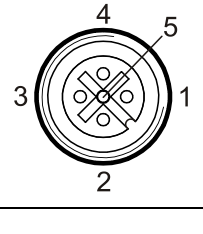
X2	Signal	Description	Pin, M12x1, 5 pole
1	n.c.	-	
2	PROFIBUS, Data A	PROFIBUS_IN, green	
3	n.c.	-	
4	PROFIBUS, Data B	PROFIBUS_IN, red	
5	n.c.	-	
Thread		Shielding	

X3	Signal	Description	Socket, M12x1, 5 pole
1	+5V	for termination	
2	PROFIBUS Data A	PROFIBUS_OUT, green	
3	GND	for termination	
4	PROFIBUS Data B	PROFIBUS_OUT, red	
5	n.c.	-	
Thread		Shielding	

4.3.3 Incremental interface / SIN/COS interface

X4	Signal	Description	Socket, M12x1, 5 pole
[1)] 1	Channel B +	5 V differential / 11…27 V DC	
[1)] 2	Channel B –	5 V differential / 11…27 V DC	
[1)] 3	Channel A +	5 V differential / 11…27 V DC	
[1)] 4	Channel A –	5 V differential / 11…27 V DC	
5	0 V, GND	Data reference potential	

Alternative with SIN/COS signals

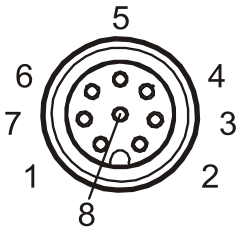
X4´	Signal	Description	Socket, M12x1, 5 pole
1	SIN +	1 Vss, differential	
2	SIN –	1 Vss, differential	
3	COS +	1 Vss, differential	
4	COS –	1 Vss, differential	
5	0 V, GND	Data reference potential	

Cable specification: min. 0.25 mm² and shielded.
To guarantee the signal quality and minimization of possible environmental influences it is recommended urgently to use a shielded twisted pair cable.

[1)] TTL/HTL – Level variant: see type plate

4.3.4 Optional external SSI safety channel

Not available at this time!

X5	Signal	Description	Socket, M12x1, 8 pole
1	–		
2	–		
3	–		
4	–		
5	–		
6	–		
7	–		
8	–		

4.4 Bus termination

If the measuring system is the last station in the PROFIBUS segment, the bus must be terminated via flange socket X3 in accordance with the PROFIBUS standard.

The bus termination can also be obtained from TR-Electronic, art. no.: 40803-40005 (M12 connector, B-coded, 220 Ω).

4.5 Bus addressing

⚠ WARNING

Destruction, damage and malfunction of the measuring system in case of infiltration of foreign substances and damp!

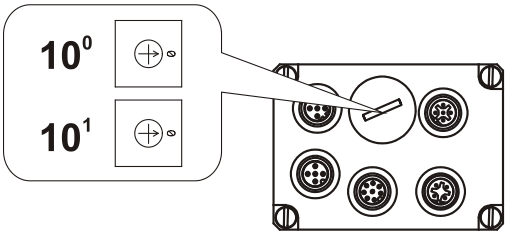
NOTICE

➢ The access to the address switches has to be locked after the settings with the screw plug. Tighten firmly!

Valid PROFIBUS addresses: 1 – 99
10^0: Setting the 1st position
10^1: Setting the 10th position

The device will not start up with an invalid station address.

The set PROFIBUS address automatically gives the PROFIsafe destination address, see chapter "F_Source_Add / F_Dest_Add" on page 37.



4.6 Incremental interface / SIN/COS interface

In addition to the PROFIBUS-DP interface for output of the absolute position, the measuring system in the standard version also has an incremental interface.

However, this can alternatively also be designed as a SIN/COS interface.

⚠ WARNING ***This additional interface is not evaluated in relation to safety and must not be used for safety-oriented purposes!***

- The measuring system checks the outputs of this interface for the feed-in of external voltages. In the event of voltages > 5.7 V, the measuring system is switched off for safety reasons. In this state the measuring system behaves as if it were not connected.
- The interface is generally used as position feedback for motor control applications.

NOTICE ***Danger of damage to subsequent electronics due to overvoltages caused by a missing ground reference point!***

- If the ground reference point is completely missing, e.g. 0 V of the power supply not connected, voltages equal to the supply voltage can occur at the outputs of this interface.
  - It must be guaranteed that a ground reference point is present at all times.
  - or corresponding protective measures by the system operator must be provided for subsequent electronics.

The signal characteristics of the two possible interfaces are shown below.

4.6.1 Signal characteristics

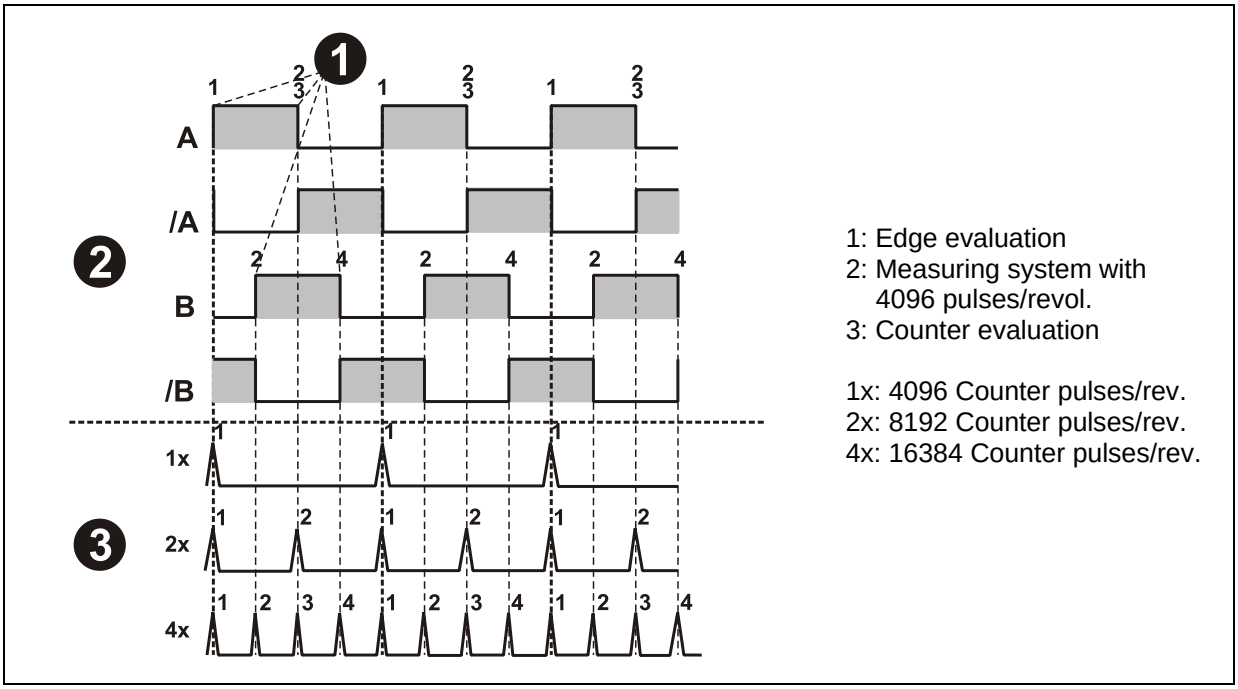


Figure 3: Counter evaluation, incremental interface

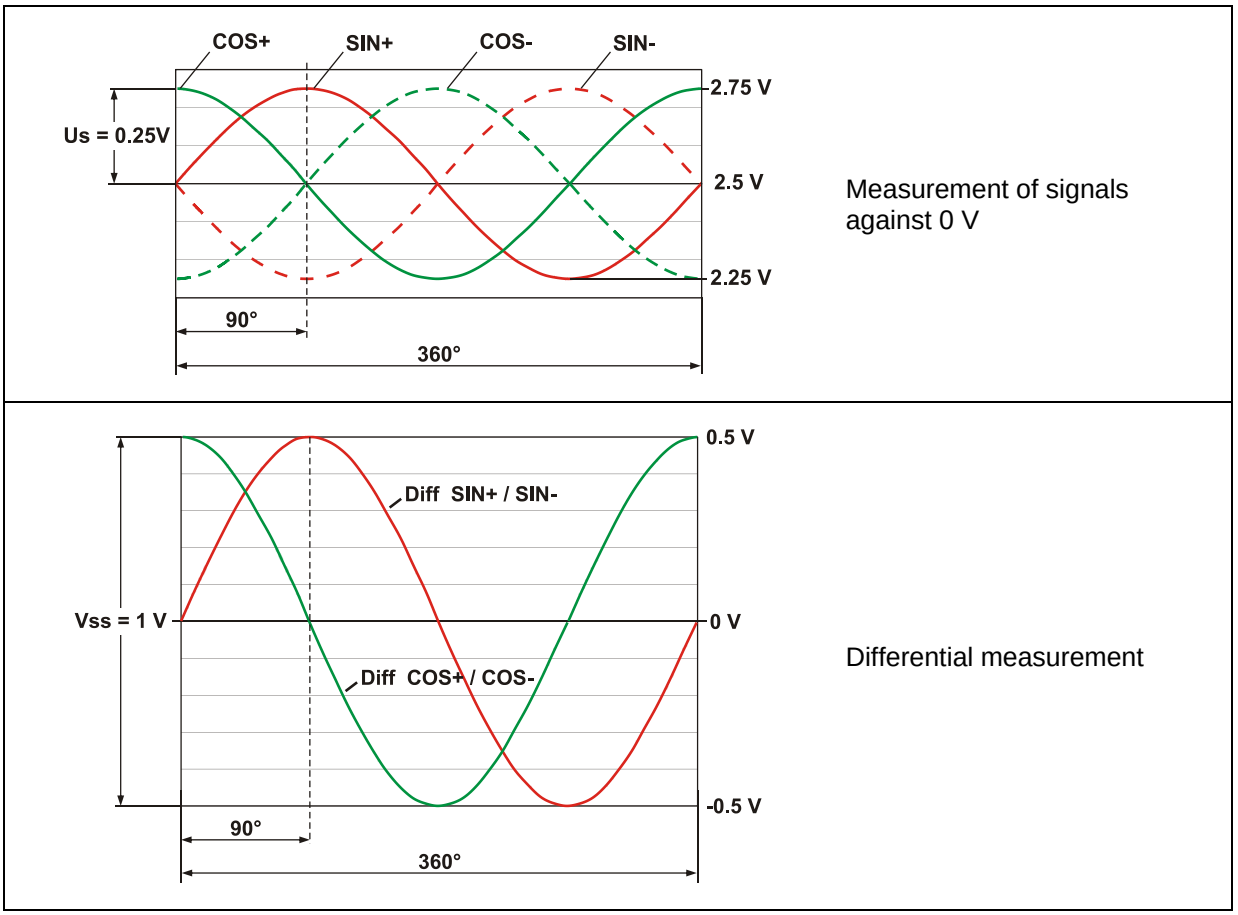


Figure 4: Level definition, SIN/COS interface

4.6.2 Option HTL-Level, 11…27 VDC

Optionally the incremental interface is available also with HTL levels. For technical reasons, the user must consider the following boundary conditions at this variant: Ambient temperature, cable length, cable capacitance, supply voltage and output frequency.
In this case the maximum reachable output frequencies about the incremental interface are a function of the cable capacitance, the supply voltage and the ambient temperature. Therefore, the use of this interface is reasonable only if the interface characteristics meet the technical requirements.

From the view of the measuring system, the transmission cable represents a capacitive load which must be reloaded with each impulse. In dependence of the cable capacitance, the load quantity necessary for it varies very strongly. Exactly this reloading of the cable capacitances is responsible for the high dissipation and heat, which result thereby in the measuring system.

Example: Cable with 75 pF/m, cable length = 100 m, half limiting frequency related to the rated voltage of 24 VDC: It results a twice as high current consumption of the measuring system.

By the arising heat the measuring system may be only operated with approx. 80% of the given working temperature.

The following diagram shows the different dependences with respect to three different supply voltages.

Fixed items are

- Capacity of the cable: 75 pF/m
- Ambient temperature: 25 °C

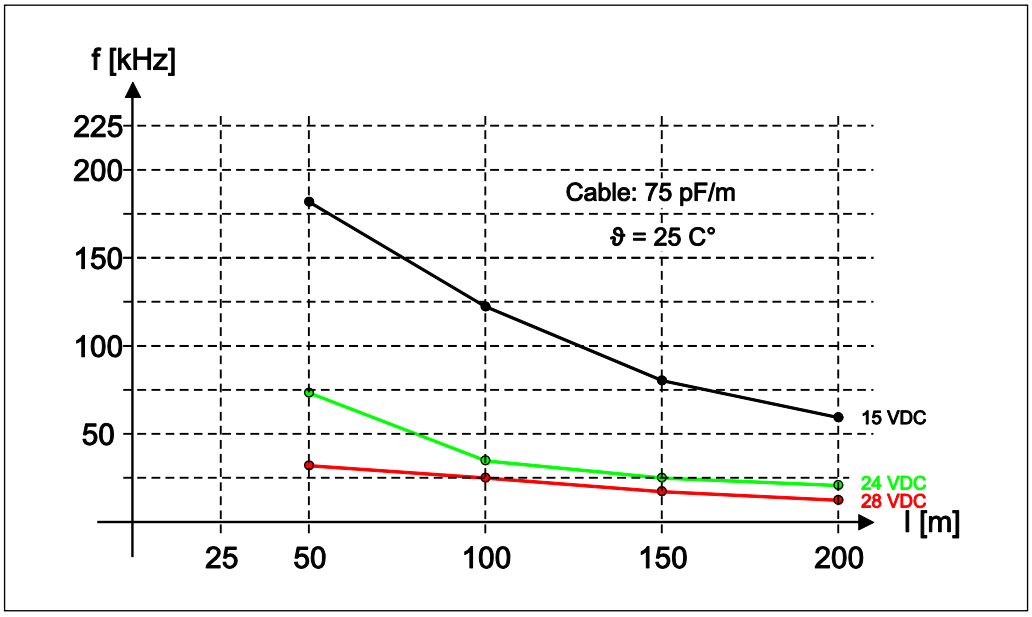


Figure 5: Cable lengths / Limiting frequencies

Other cable parameters, frequencies and ambient temperatures as well as bearing heat and temperature increase over the shaft and flange, can produce a considerably worse result in the practice.

Therefore, the fault-free function of the incremental interface with the application-dependent parameters has to be checked prior to the productive operation.

5 Commissioning

5.1 PROFIBUS

Important information for the commissioning can be found in the PROFIBUS Guideline:

- PROFIBUS Commissioning Guideline, Order No.: 8.032

These and further information on PROFIBUS or PROFIsafe are available from the offices of the PROFIBUS User Organization:

PROFIBUS Nutzerorganisation e.V.,
Haid-und-Neu-Str. 7,
D-76131 Karlsruhe,
www.profibus.com/
www.profisafe.net/
Tel.: ++ 49 (0) 721 / 96 58 590
Fax: ++ 49 (0) 721 / 96 58 589
Email: mailto:germany@profibus.com

5.1.1 DP communication protocol

The measuring systems support the ***DP*** communication protocol and the performance level ***V0***, which is defined the basic functionality.

5.1.2 Device master file (GSD)

The GSD file and the corresponding bitmap files are a constituent of the measuring system.

Download

- www.tr-electronic.de/f/TR-ECE-ID-MUL-0016

5.1.3 PNO ID number

The measuring system has the PNO ID number 0x0CE3 (hex).

5.2 Start-up on PROFIBUS

If the parameterization- and configuration-phase during the start-up was successful, there is a switch to the DDLM_Data_Exchange mode (user data traffic). In this mode the measuring system transfers e.g. its actual position.

5.3 Bus status display

⚠ WARNING

Destruction, damage and malfunction of the measuring system in case of infiltration of foreign substances and damp!

NOTICE

➢ The access to the LEDs has to be locked after the settings with the screw plug. Tighten firmly!

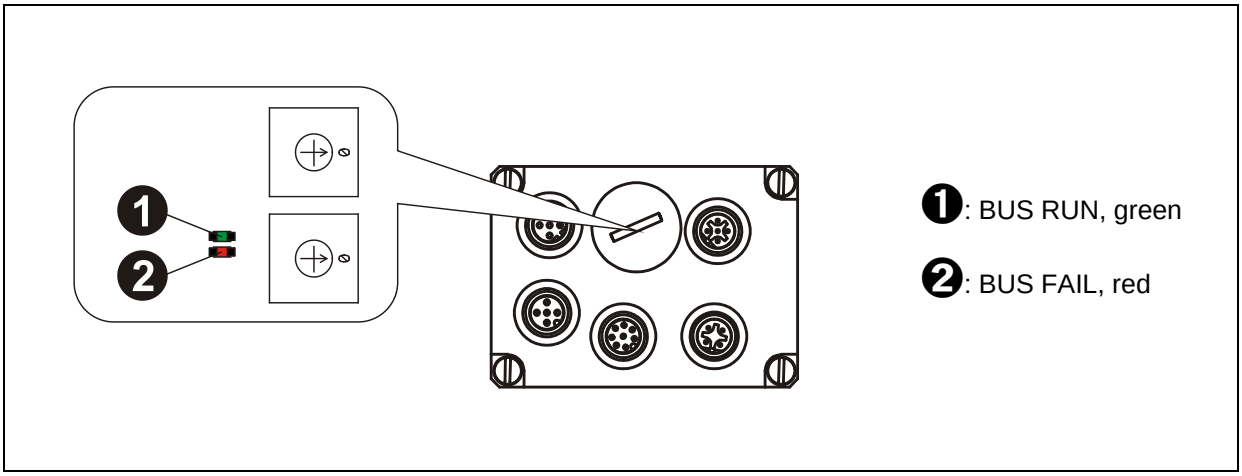


Figure 6: Bus status display

● = ON
○ = OFF
◉ = 1 Hz
◉ = 3x with 5 Hz

LED	*Bus Run*
●	Ready for operation
○	Supply absent, hardware error
◉	Incorrect parameterization of F_Parameters
◉	PROFIsafe communication running, master requesting operator acknowledgment

LED	*Bus Fail*
○	No error, bus in cycle
◉	Measuring system not addressed by the master, no cyclical data exchange
●	Internal error, Bit 1 set in PROFIsafe status byte

For appropriate measures in case of error, see chapter "Troubleshooting and Diagnosis Options", page 45.

5.4 Commissioning using the SIEMENS SIMATIC S7 control

Download

- Technical Information: www.tr-electronic.de/f/TR-ECE-TI-DGB-0244

5.5 Configuration

The following definition applies:
Data flow for input data: F-Device --> F-Host
Data flow for output data: F-Host --> F-Device

5.5.1 Safety-oriented data, TR-PROFIsafe module

Structure of the input data

Byte	Bit	Input data	
X+0	2^8-2^{15}	Cams	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	TR-Status	Unsigned16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Speed	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Actual value, Multi-Turn, 15 bit	Integer16
X+7	2^0-2^7		
X+8	2^8-2^{15}	Actual value, Single-Turn, 13 bit	Integer16
X+9	2^0-2^7		
X+10	2^0-2^7	Safe status	Unsigned8
X+11	2^{16}-2^{23}	CRC2	3 Bytes
X+12	2^8-2^{15}		
X+13	2^0-2^7		

Structure of the output data

byte	Bit	Output data	
X+0	2^8-2^{15}	TR-Control1	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	TR-Control2	Unsigned16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Preset, Multi-Turn	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Preset, Single-Turn	Integer16
X+7	2^0-2^7		
X+8	2^0-2^7	Safe Control	Unsigned8
X+9	2^{16}-2^{23}	CRC2	3 Bytes
X+10	2^8-2^{15}		
X+11	2^0-2^7		

5.5.1.1 Input data

5.5.1.1.1 Cams

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	2^{15} – 2^{8}	2^{7} – 2^{0}

Bit	Description
2^{0}	Speed overflow The bit is set if the speed value is outside the range of –32768…+32767.
2^{1}…2^{15}	reserved

5.5.1.1.2 TR-Status

Unsigned16

Byte	X+2	X+3
Bit	15 – 8	7 – 0
Data	2^{15} – 2^{8}	2^{7} – 2^{0}

Bit	Description
2^{0}	Preset_Status The bit is set if the F-Host triggers a preset request. When the preset has been executed, the bit is automatically reset, also see page 43.
2^{1}…2^{14}	reserved
2^{15}	Error The bit is set if a preset request could not be executed due to excessive speed. The current speed must be in the range of the speed set under `Preset Standstill Tolerance`. The bit is reset after the host has cleared the variable associated to the control bit 2^{0} `iPar_EN`, also see page 43.

5.5.1.1.3 Speed

Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The speed is output as a two's complement value with preceding sign.

Setting the direction of rotation = forward

– Looking at the flange connection, turn the shaft clockwise:
--> positive speed output

Setting the direction of rotation = backward

– Looking at the flange connection, turn the shaft clockwise:
--> negative speed output

If the measured speed exceeds the display range of
–32768…+32767, this results in an overflow, which is reported in the cams register via bit 2^{0}. At the time of the overflow the speed stops at the respective +/- maximum value, until the speed is once again in the display range. In this case the message in the cams register is also cleared.
The speed is specified in `increments` per `Integration time Safe`.

5.5.1.1.4 Multi turn / Single turn

Multi-Turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

Single-Turn, Integer16

Byte	X+8	X+9
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The number of revolutions is noted in the `Multi-Turn` register, and the current Single-Turn position is noted in steps in the `Single-Turn` register. Together with the measuring system resolution, max. number of steps per revolution according to type plate, the actual position can then be calculated:

Position in steps = (steps per revolution * number of revolutions) + Single-Turn position

Steps per revolution: 8192 ≙ 13 bit

Number of revolutions: 0…32767 ≙ 15 bit

The output position does not have a preceding sign.

5.5.1.1.5 Safe status

Unsigned8

Byte	X+10
Bit	7 – 0
Data	2^7 – 2^0

Bit	Description
2^0	**iPar_OK:** New iParameter values have been assigned to the F-Device
2^1	**Device_Fault:** Error in F-Device or F-Module
2^2	**CE_CRC:** Checksum error in communication
2^3	**WD_timeout:** Watchdog timeout during communication
2^4	**FV_activated:** Fail-safe values activated
2^5	**Toggle_d:** Toggle bit
2^6	**cons_nr_R:** Virtual consecutive number has been reset
2^7	reserved

Safe status can only be indirectly accessed from the safety program with the aid of variables, see chapter "Access to the safety-oriented data channel" on page 42.

A detailed description of the status bits can be taken from the PNO document "PROFIsafe – Profile for Safety Technology on PROFIBUS DP and PROFINET IO", Order No.: 3.192b.

5.5.1.2 Output data

5.5.1.2.1 TR-Control1

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

Bit	Description
2^{0}	Preset_Request The bit serves to control the preset adjustment function. When this function is executed, the measuring system is set to the position value stored in the `Preset Multi-Turn`/`Preset Single-Turn` registers. A precise sequence must be observed in order to execute the function, see chapter "Preset Adjustment Function" on page 43.
$2^{1}…2^{15}$	reserved

5.5.1.2.2 TR-Control2

Reserved.

5.5.1.2.3 Preset multi turn / Preset single turn

Preset Multi-Turn, Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

Preset single turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The desired preset value must be in the range of 0 to 268 435 455 (28 bit). Together with the measuring system resolution, max. number of steps per revolution according to type plate (8192), the corresponding values for `Preset Multi-Turn`/`Preset Single-Turn` can then be calculated:

Number of revolutions = desired preset value / steps per revolution

The integer part from this division gives the number of revolutions and must be entered in the `Preset Multi-Turn` register.

Single-Turn-Position = desired preset value – (steps per revolution * no. of revolutions)

The result of this calculation is entered in the `Preset Single-Turn` register.

The preset value is set as new position when the preset adjustment function is executed, see chapter "Preset Adjustment Function" on page 43.

5.5.1.2.4 Safe-Control

Unsigned8

Byte	X+8
Bit	7 – 0
Data	2^7 – 2^0

Bit	Description
2^0	**iPar_EN:** iParameter assignment unlocked
2^1	**OA_Req:** Operator acknowledgment required
2^2	**R_cons_nr:** Resetting of the counter for the virtual consecutive no.
2^3	reserved
2^4	**activate_FV:** Activate fail-safe values
2^5	**Toggle_h:** Toggle bit
2^6-2^7	reserved

The Safe-Control register can only be indirectly accessed from the safety program with the aid of variables, see chapter "Access to the safety-oriented data channel" on page 42.

A detailed description of the control bits can be taken from the PNO document "PROFIsafe – Profile for Safety Technology on PROFIBUS DP and PROFINET IO", Order No.: 3.192b.

5.5.2 Not safety-oriented Process data, TR-PROFIBUS module

Structure of the input data

Byte	Bit	Input data	
X+0	2^8-2^{15}	Cams	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	Speed	Integer16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Actual value, Multi-Turn, 15 bit	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Actual value, Single-Turn, 13 bit	Integer16
X+7	2^0-2^7		

5.5.2.1 Input data

5.5.2.1.1 Cams

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	2^{15} – 2^8	2^7 – 2^0

Bit	Description
2^0	Speed overflow The bit is set if the speed value is outside the range of –32768…+32767.
2^1…2^{15}	reserved

5.5.2.1.2 Speed

Integer16

Byte	X+2	X+3
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The speed is output as a two's complement value with preceding sign.

Setting the direction of rotation = forward

– Looking at the flange connection, turn the shaft clockwise:
--> positive speed output

Setting the direction of rotation = backward

– Looking at the flange connection, turn the shaft clockwise:
--> negative speed output

If the measured speed exceeds the display range of
–32768…+32767, this results in an overflow, which is reported in the cams register via bit 2^{0}. At the time of the overflow the speed stops at the respective +/- maximum value, until the speed is once again in the display range. In this case the message in the cams register is also cleared.
The speed is specified in `increments` per `Integration time Unsafe`.

5.5.2.1.3 Multi turn / Single turn

Multi-Turn, Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

Single-Turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

The number of revolutions is noted in the `Multi-Turn` register, and the current Single-Turn position is noted in steps in the `Single-Turn` register. Together with the measuring system resolution, max. number of steps per revolution according to type plate, the actual position can then be calculated:

Position in steps = (steps per revolution * number of revolutions) + Single-Turn position

Steps per revolution: 8192 ≙ 13 bit

Number of revolutions: 0…32767 ≙ 15 bit

The output position does not have a preceding sign.

5.6 Parameterization

Normally the configuration program provides an input box for the PROFIBUS-DP master with which the user can enter parameter data or select from a list. The structure of the input box is stored in the device master file.

⚠ DANGER

- **Danger of death, serious physical injury and/or damage to property due to malfunction, caused by incorrect parameterization!**
  - ➢ The system manufacturer must ensure correct functioning by carrying out a protected test run during commissioning and after each parameter change.

NOTICE

5.6.1 F-Parameters (F_Par)

The F-Parameters supported by the measuring system are listed below.

Byte order = Big Endian

Byte	Parameter	Type	Description		Page
X+0	F_Check_SeqNr	Bit	Bit 0 = 0: No check		36
	-	Bit	Bit 1 = 0: not used		-
	F_SIL	Bit range	Bit 3-2	00: SIL1 01: SIL2 10: SIL3 [default] 11: no SIL	37
	F_CRC_Length	Bit range	Bit 5-4	00: 3-Byte-CRC	37
X+1	F_Block_ID	Bit range	bit 5-3	001: 1	37
	F_Par_Version	Bit range	Bit 7-6	01: V2-Mode	37
X+2	F_Source_Add	Unsigned16	Source address, Default = 1 Range: 1-65534		37
X+4	F_Dest_Add	Unsigned16	Destination address, Default = 503 Range: 1-65534		37
X+6	F_WD_Time	Unsigned16	Watchdog time, Default = 125 Range: 125-10000		37
X+8	F_iPar_CRC	Unsigned32	CRC of i-Parameters, Default = 1132081116 Range: 0-4294967295		37
X+12	F_Par_CRC	Unsigned16	CRC of F-Parameters, Default = 46906 Range: 0-65535		37

5.6.1.1 F_Check_SeqNr

The parameter is set to "NoCheck" and cannot be changed. This means that only fail-safe DP standard slaves are supported, which behave accordingly.

5.6.1.2 F_SIL

F_SIL specifies the SIL which the user expects from the respective F-Device. This is compared with the locally saved manufacturer's specification. The measuring system support the safety classes no SIL and SIL1 to SIL3, SIL3 = standard value.

5.6.1.3 F_CRC_Length

The measuring system supports the CRC length of 3 bytes. This value is predefined and cannot be changed.

5.6.1.4 F_Block_ID

As the measuring system supports device-specific safety parameters such as e.g. "Integration time Safe", this parameter is preconfigured with the value "1 = generate F_iPar_CRC" and cannot be changed.

5.6.1.5 F_Par_Version

The parameter identifies the PROFIsafe version "V2-Mode" implemented in the measuring system. This value is predefined and cannot be changed.

5.6.1.6 F_Source_Add / F_Dest_Add

The parameter `F_Source_Add` defines a unique source address within a PROFIsafe cluster. The parameter `F_Dest_Add` defines a unique destination address within a PROFIsafe cluster.
The device-specific part of the F-Devices compares the value with the in-situ address switch or an assigned F-Address, to check the authenticity of the connection.
The PROFIsafe destination address must correspond to the PROFIBUS address + 500, set by the address switches implemented in the measuring system, also see page 22. Valid addresses: 501…599.
Standard value `F_Source_Add` = 1, Standard value `F_Dest_Add` = 503, `F_Source_Add` ≠ `F_Dest_Add`.

5.6.1.7 F_WD_Time

This parameter defines the monitoring time [ms] in the measuring system. A valid current safety telegram must arrive from the F-Host within this time, otherwise the measuring system will be set to safe status.
The predefined value is 125 ms.
The watchdog time must generally be set at a level where telegram runtimes are tolerated by the communication, but it must also allow quick execution of the error reaction function in case of error.

5.6.1.8 F_iPar_CRC

This parameter represents the checksum value (CRC3), which is calculated from all iParameters of the device-specific part of the measuring system and ensures safe transmission of the iParameters. The calculation occurs in a program called "TR_iParameter" provided by TR-Electronic. The checksum value calculated there must then be manually entered in the F-Host engineering tool, also see chapter "Parameter Definition / CRC Calculation" on page 40.

5.6.1.9 F_Par_CRC

This parameter represents the checksum value (CRC1), which is calculated from all F-Parameters of the measuring system and ensures safe transmission of the F-Parameters. The calculation occurs externally in the F-Host engineering tool and must then be entered here under this parameter, or is generated automatically.

5.6.2 iParameters (F_iPar)

Application-dependent device characteristics are defined with the iParameters. A CRC calculation is necessary for safe transmission of the iParameters, see chapter "iParameters" on page 40.
The iParameters supported by the measuring system are listed below.

Byte order = Big Endian

Byte	Parameter	Type	Description	Page
X+0	Integration time Safe	Unsigned16	Default = 2 Range: 1-10	38
X+2	Integration time Unsafe	Unsigned16	Default = 20 Range: 1-100	38
X+4	Window increments	Unsigned16	Default = 1000 Range: 50-4000	38
X+6	Idleness tolerance Preset	Unsigned8	Default = 1 Range: 1-5	39
X+7	Direction	Bit	0: Decreasing counting direction 1: Increasing counting direction [default]	39

5.6.2.1 Integration time Safe

This parameter is used to calculate the safe speed, which is output via the cyclical data of the PROFIsafe module. High integration times enable high-resolution measurements at low speeds. Low integration times show speed changes more quickly and are suitable for high speeds and high dynamics. The time basis is predefined to 50 ms. 50…500 ms can thus be set using the value range of 1…10. Standard value = 100 ms.

5.6.2.2 Integration time Unsafe

This parameter is used to calculate the unsafe speed, which is output via the process data of the PROFIBUS module. High integration times enable high-resolution measurements at low speeds. Low integration times show speed changes more quickly and are suitable for high speeds and high dynamics. The time basis is predefined to 5 ms. 5…500 ms can thus be set using the value range of 1…100.
Standard value = 100 ms.

5.6.2.3 Window increments

This parameter defines the maximum permissible position deviation in increments of the master / slave scanning units integrated into the measuring system. The permissible tolerance window is basically dependent on the maximum speed occurring in the system and must first be determined by the system operator. Higher speeds require a larger tolerance window. The value range extends from 50…4000 increments. Standard value = 1000 increments.

The larger the window increments, the larger the angle until an error will be recognized.

5.6.2.4 Idleness tolerance Preset

This parameter defines the maximum permissible speed in `increments` per `Integration time Safe` for performance of the preset function, see page 43. The permissible speed is dependent on the bus behavior and the system speed, and must be determined by the system operator first. The value range extends from 1 increment per `Integration time Safe` to 5 increments per `Integration time Safe`. That means that the shaft of the measuring system must be nearly at rest, so that the preset function can be executed.
Standard value = 1 increment per standard value `Integration time Safe`.

5.6.2.5 Direction

This parameter defines the current counting direction of the position value looking at the flange connection, turning the shaft clockwise.

Forward = Counting direction increasing
Backward = Counting direction decreasing

Standard value = Forward.

6 Parameter Definition / CRC Calculation

It is best to define the known parameters before configuration in the F-Host, so that they can be taken into account during configuration.

The TR_iParameter software required for the CRC calculation can be downloaded from: www.tr-electronic.com/service/downloads/software.html

6.1 iParameters

The iParameters are preconfigured with meaningful values in the default setting and should only be changed if expressly required by the automation task. A CRC calculation is necessary for safe transmission of the individually set iParameters. This must be performed when changing the predefined iParameters via the TR program "TR_iParameter". The calculated checksum as decimal value corresponds to the F-Parameter F_iPar_CRC. This must be entered in the field with the same name in the F-Host when configuring the measuring system.

Procedure - CRC-calculation

- Start TR_iParameter by means of the start file "TR_iParameter.exe", then open the template file provided with the measuring system with the menu Datei --> Vorlage öffnen...

- Modify the relevant parameters if necessary, then click on the CRC bilden switch for the F_iPar_CRC calculation. The result is displayed in the field F_iPar_CRC as decimal value.

Each parameter change requires a new F_iPar_CRC calculation, which must then be taken into account in the projection.

6.2 F-Parameters

The F-Parameters are already preconfigured with meaningful values in the default setting and should only be changed if expressly required by the automation task. A CRC which is usually automatically calculated by the Engineering tool is necessary for safe transmission of the individually set F-Parameters. This checksum corresponds to the F-Parameter F_Par_CRC.

Each parameter change, including F_iPar_CRC, also gives a new F_Par_CRC value.

7 Integration of the measuring system into the safety program

This chapter describes the necessary steps for the integration of the measuring system into the safety program and is not related to a certain control unit. The exact process is control specific and must be taken from the system documentation of the control unit manufacturer.

7.1 Prerequisites

⚠ WARNING ***Danger of deactivation of the fail-safe function through incorrect configuration of the safety program!***

- The safety program must be created in conjunction with the system documentation provided by the control unit manufacturer.
- It is essential to observe and comply with the information and instructions provided in the system documentation, particularly the safety instructions and warnings.

7.2 Hardware configuration

- Create a new project
- Perform the general hardware configuration (CPU, Voltage supply)
- Provide a digital input module, in order to be able to carry out the operator acknowledgment
- Install the GSD file belonging to the measuring system
- Defining the properties of the hardware configuration
  - Access protection via password allocation
  - PROFIBUS (Address, Transmission rate, Profile)
  - I/O modules (Operating mode, F-Parameter, Diagnosis, Arrangements for the operator acknowledgment)

7.3 Parameterization

- Parameterize device specific `iParameter` in the module `TR-PROFIbus`, also see starting from page 38 and 40
- Define PROFIsafe specific `F-Parameter` in the module `TR-PROFIsafe`, also see starting from page 36 and 40
- Save and if necessary compile hardware configuration

7.4 Generating the safety program

- Define the program structure, access protection via password allocation
- Create modules for the program call, Diagnosis, Data, Program, Functions, Periphery, System etc., can partly performed also automatically
- Edit modules for the program call, operator acknowledgment of the safety-oriented periphery
- Define program sequence
- Define cycle time for the program call of the safety program
- Generate safety program
- Load safety program into the control unit
- Perform a complete functional test of the safety program according to the automation task
- Perform an acceptance test of the safety system by an independent expert

7.5 Access to the safety-oriented data channel

The safety-oriented data channel in the `TR-PROFIsafe` module of the measuring system may only be accessed from the safety program. A direct access is not permitted.
For this reason the registers `Safe-Control` and `Safe-Status` can be accessed only indirectly about variables. The range of the variables and the way how the variables can be addressed is control dependent. This information must be taken from the system documentation provided by the control unit manufacturer.

The variables must be accessed in the following cases:

- during operator acknowledgment of the measuring system after communication errors or after the start-up phase, is indicated via the status LED see page 27
- during execution of the preset adjustment function
- when analyzing whether passivated or cyclical data are output
- if the cyclical data of the `TR-PROFIsafe` module are to be passivated depending on defined states of the safety program

7.5.1 Output of passivated data (substitute values) in case of error

The safety function requires that for passivation in the safety-oriented channel in the `TR-PROFIsafe` module, the substitute values (0) are used in the following cases instead of the cyclically output values. Dependent on the control, this condition is indicated over an appropriate variable.

- at start-up of the safety-oriented system
- in the case of errors in the safety-oriented communication between control unit and measuring system via the PROFIsafe protocol
- if the value set for the `Window increments` under the `iParameters` is exceeded and/or the internally calculated PROFIsafe telegram is defective
- if the permissible ambient temperature range, as defined under the corresponding article number, is fallen below or exceeded
- if the measuring system is supplied with >36 V DC for longer than 200 ms
- if the measuring system is disconnected in RUN mode, the F-Host is reconfigured and the measuring system is then reconnected
- Scanning system, double magnetic: if the electrically permissible speed has been exceeded which is defined in the safety manual. Since up to this limit value a fault-free operation is guaranteed, the real output of safe data is performed therefore only explicitly above the given limit value

8 Preset Adjustment Function

⚠ WARNING

NOTICE

- **Danger of death, serious physical injury and/or damage to property due to uncontrolled start-up of the drive system during execution of the preset adjustment function!**
  - ➢ Execute preset function only in the standstill, see chapter “Idleness tolerance Preset” on page 39
  - ➢ The relevant drive systems must be locked to prevent automatic start-up
  - ➢ It is advisable to protect the preset triggering via the F-Host by means of additional protective measures, such as e.g. key-operated switch, password etc.
  - ➢ The operational sequence described below is to be kept mandatorily. In particular the status bits are to be evaluated by the F-host, in order to check the successful and/or incorrect execution.
  - ➢ The new position must be checked after execution of the preset function

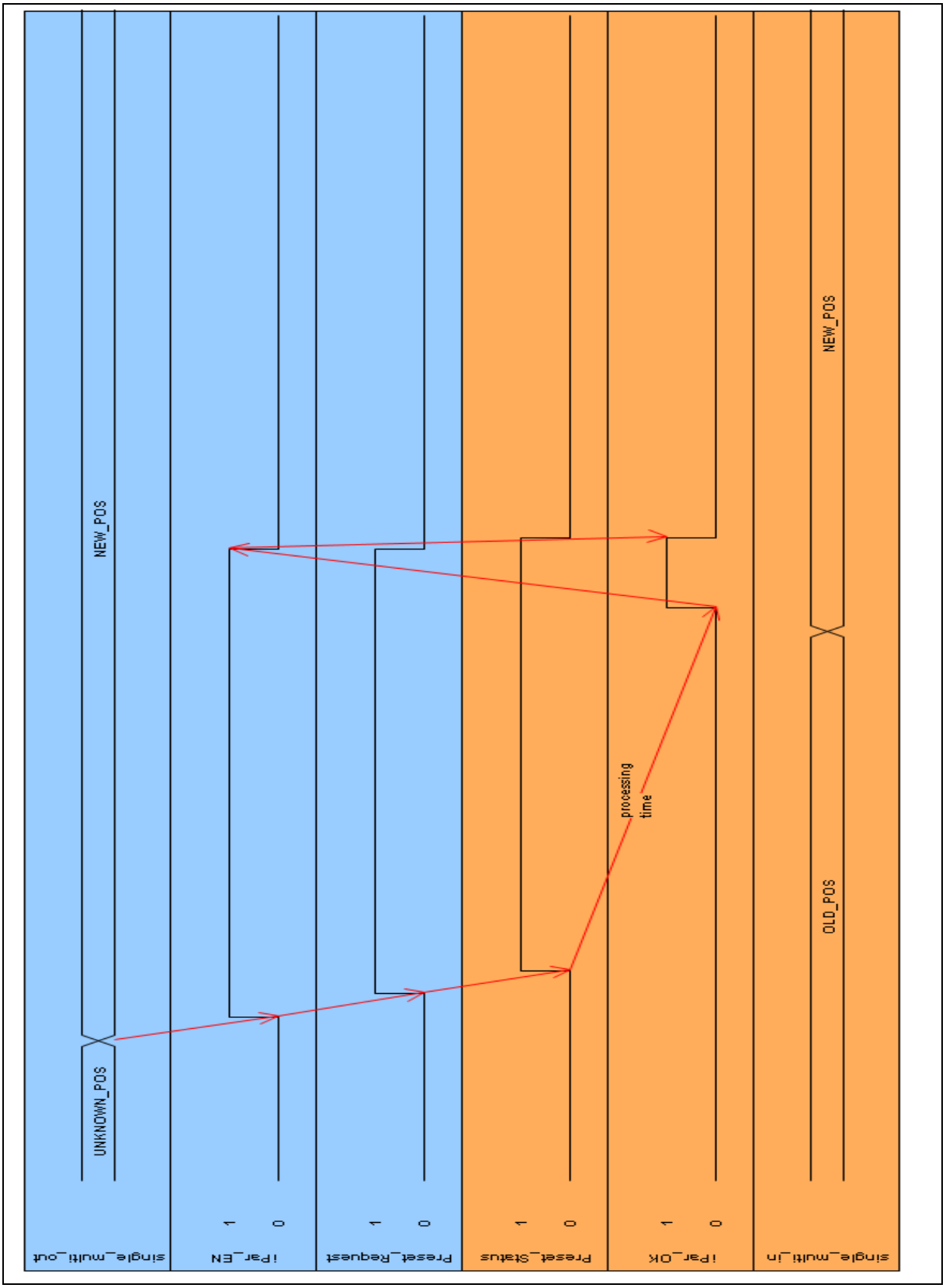
The preset adjustment function is used to set the currently output position value to any position value within the measuring range. The displayed position can thus be set to a machine reference position purely electronically.

8.1 Procedure

- ➢ Prerequisite: The measuring system is in cyclical data exchange.
- ➢ Write the `Preset Multi-Turn` and `Preset Single-Turn` registers in the output data of the `TR-PROFIsafe` module with the desired preset value.
- ➢ The F-Host must set the variable associated to the control bit 2^0 `iPar_EN` to 1. With the rising edge, the measuring system is now switched ready to receive.
- ➢ With the rising edge of Bit 2^0 `Preset_Request` in the `TR-Control1` register, the preset value is accepted. The receipt of the preset value is acknowledged in the `TR-Status` register by setting Bit 2^0 `Preset_Status`.
- ➢ After receipt of the preset value, the measuring system checks that all prerequisites for execution of the preset adjustment function are fulfilled. If so, the preset value is written as the new position value. In case of error, the execution is rejected and an error message is output via the `TR-Status` register by setting Bit 2^{15} `Error`.
- ➢ After execution of the preset adjustment function, the measuring system sets the variable associated to the status bit 2^0 `iPar_OK` to 1 and thus indicates to the F-Host that the preset execution is complete.
- ➢ The F-Host must now reset the variable associated to the control bit 2^0 `iPar_EN` to 0. The variable associated to the status bit 2^0 `iPar_OK` and Bit 2^0 `Preset_Status` in the `TR-Status` register are thus also reset with the falling edge. Bit 2^0 `Preset_Request` in the `TR-Control1` register must be reset manually again.
- ➢ Finally, the F-Host must check that the new position corresponds to the new nominal position.

8.2 Timing Diagram

blue area: Output signals F-Host -> Measuring system
orange area: Input signals Measuring system -> F-Host



9 Troubleshooting and Diagnosis Options

9.1 Optical displays

For assignment and position of the status LEDs see chapter "Bus status display" on page 27.

9.1.1 LED, green

Green LED	*Cause*	*Remedy*
Off	Power supply absent	Check power supply, wiring
	Hardware error, measuring system defective	Replace measuring system
3x 5 Hz repeating	– Measuring system could not synchronize with the F-Host in the start-up phase and requests an operator acknowledgment – An error in the safety-oriented communication or a parameterization error was detected, and has been eliminated	For the operator acknowledgment of the measuring system an acknowledgment about the safety program at the corresponding variable is required
1 Hz	F-Parameterization defective, e.g. incorrectly set PROFIsafe destination address `F_Dest_Add`	– Check PROFIBUS address set with the hardware switch. The address set here gives the necessary PROFIsafe destination address + 500, see chapter "Bus addressing" on page 22 – Synchronize required safety class `F_SIL` of system and measuring system, see chapter "F_SIL" on page 37
on	Measuring system ready for operation	–

9.1.2 LED, red

Red LED	*Cause*	*Remedy*
Off	No error, connection established with PROFIBUS master	–
1 Hz	– No connection to PROFIBUS master – PROFIBUS address incorrectly set – Incorrectly configured `F_iPar_CRC` value	– The PROFIBUS address set with the hardware switch must match the projected PROFIBUS address – The checksum calculated for the defined iParameter set is incorrect, or was not included in the projection, see chapter "Parameter Definition / CRC Calculation" on page 40
on	**A safety-relevant error was detected, the measuring system was put into fail-safe status and is outputting its passivated data:**	**In order to restart the measuring system after a passivation the error must generally be eliminated first of all and then the supply voltage switched OFF/ON.**
	– Error in the safety-oriented communication	– Try to localize the error with the aid of diagnosis variables (dependent on the control unit) – Check that the set value for the `F_WD_Time` parameter is suitable for the automation task, see chapter "F_WD_Time" on page 37 – Check whether the PROFIBUS connection between F-CPU and measuring system is faulty
	– The set value for the `Window increments` parameter was exceeded	– Check that the set value for the `Window increments` parameter is suitable for the automation task, see chapter "Window increments" on page 38
	– The permissible ambient temperature range, as defined under the corresponding article number, was fallen below or exceeded	– Suitable measures must be taken to ensure that the permissible ambient temperature range can be observed at all times
	– The measuring system was supplied with >36 V DC for longer than 200 ms	– The measuring system must be shut down immediately and checked in the factory. When sending the measuring system to the factory, the reasons and circumstances relating to the overvoltage must be specified
	– The measuring system was disconnected in RUN mode, the F-Host reconfigured and the measuring system then reconnected	– The configuration must only be transferred to the measuring system in STOP status in the start-up phase
	– The internally calculated PROFIsafe telegram is defective	– Power supply OFF/ON. If the error persists after this measure, the measuring system must be replaced
	– The PROFIBUS address set with the hardware switch was set to "0"	– Valid PROFIBUS addresses: 1 – 99
	– Scanning system, double magnetic: the electrically permitted speed which is defined in the safety manual was exceeded	– Bring speed into the permissible range. Error-acknowledgement about power supply OFF/ON.

9.2 Use of the PROFIBUS diagnosis

The generation or reading of diagnosis reports between the master and slave takes place automatically and does not need to be programmed by the user.

In addition to the standard diagnosis information, the measuring system provides an extended diagnosis report with module status information.

9.2.1 Standard diagnosis

The DP standard diagnosis is structured as follows. The perspective is always as viewed from the master to the slave.

	Byte no.	***Meaning***	
standard diagnosis	Byte 1	Station status 1	General part
	Byte 2	Station status 2	
	Byte 3	Station status 3	
	byte 4	Master address	
	byte 5	Manufacturer's identifier HI byte	
	byte 6	Manufacturer's identifier LO byte	
Extended ...	byte 7	Length (in bytes) of the extended diagnosis including this byte	Device-specific extensions
	Byte 8 to Byte 241 (max)	Further device-specific diagnosis	

9.2.1.1 Station status 1

standard diagnosis byte 1	Bit 7	Master_Lock	Slave has been parameterized from another master (bit is set by the master)
	Bit 6	Parameter_Fault	The parameter telegram last sent has been rejected by the slave
	Bit 5	Invalid_Slave_Response	Is set by the master, if the slave does not respond
	Bit 4	Not_Supported	Slave does not support the requested functions.
	Bit 3	Ext_Diag	Bit = 1 means an extended diagnosis report from the slave is waiting
	Bit 2	Slave_Cfg_Chk_Fault	The configuration identifier(s) sent from the master has (have) been rejected by the slave
	Bit 1	Station_Not_Ready	Slave is not ready to exchange cyclical data
	Bit 0	Station_Non_Existent	The slave has been configured, but is not available on the bus

9.2.1.2 Station status 2

standard diagnosis byte 2	Bit 7	Deactivated	Slave was removed from the poll list from the master
	Bit 6	Reserved	
	Bit 5	Sync_Mode	Is set by the slave after receipt of the SYNC command
	Bit 4	Freeze_Mode	Is set by the slave after receipt of the FREEZE command
	Bit 3	WD_On	The response monitoring of the slave is activated
	Bit 2	Slave_Status	Always set for slaves
	Bit 1	Stat_Diag	Static diagnosis
	Bit 0	Prm_Req	The slave sets this bit if it has to be reparameterized and reconfigured.

9.2.1.3 Station status 3

standard diagnosis byte 3	Bit 7	Ext_Diag_Overflow	Overflow for extended diagnosis
	Bit 6-0	Reserved	

9.2.1.4 Master address

Standard diagnosis byte 4

The slave enters the station address of the master into this byte, after the master has sent a valid parameterization telegram. To ensure correct function on the PROFIBUS it is imperative that, in the case of simultaneous access of several masters, their configuration and parameterization information exactly matches.

9.2.1.5 Manufacturer's identifier

Standard diagnosis byte 5 + 6

The slave enters the manufacturer's ID number into the bytes. This is unique for each device type and is reserved and stored by the PNO. The ID number of the measuring system is 0x0CE3.

9.2.1.6 Length (in bytes) of the extended diagnosis

Standard diagnosis byte 7

If additional diagnosis information is available, the slave enters the number of bytes (including this one) at this point, which still follows in addition to the standard diagnosis.

9.2.2 Extended diagnosis

In addition to the DP standard diagnosis report the measuring system provides an extended diagnosis report which contains the module status:

Status block

Byte 7	Byte 8	Byte 9	Byte 10	Byte 11
Header	Status type	Slot no.	Status-ID	Module status
0x09	0x82	0x__	0x00	0x00 or 0x03

- **Header:**
  - Number of bytes in addition to standard diagnosis, including Byte 7
- **Status type:**
  - Status block with module status
- **Slot no.:**
  - Specification of slot no., which is defective
- **Status-ID:**
  - No further differentiation
- **Module status:**
  - 0x00 = valid data from this module
  - 0x03 = invalid data, missing module
    Is reported by the measuring system if a CRC error is present in the F-Parameters or iParameters

Bytes 12 to 15 are intended for service purposes

10 Checklist, part 2 of 2

We recommend that you print out and work through the checklist for commissioning, replacing the measuring system and when changing the parameterization of a previously accepted system and store it as part of the overall system documentation.

Documentation reason	Date	Edited	Checked

Sub-item	To note	Can be found under	yes
Present user manual has been read and understood	–	Document no.: TR-ECE-BA-GB-0092	☐
Check that the measuring system can be used for the present automation task on the basis of the specified safety requirements	• Safety functions of the fail-safe processing unit • Compliance with all technical data	• Chapter Safety functions of the fail-safe processing unit, Page 13 • Chapter Technical Data, Page 14	☐
Requirement for the power supply	• The power supply used must meet the requirements of SELV/PELV (IEC 60364-4-41:2005)	• Chapter Supply voltage, Page 20	☐
Correct PROFIBUS installation	• Observance of the international standards valid for PROFIBUS / PROFIsafe or the directives specified by the PROFIBUS User Organization	• Chapter Installation / Preparation for Commissioning, Page 17 • Chapter Commissioning, Page 26	☐
System test after commissioning and parameter changes	• During commissioning and after each parameter change all affected safety functions must be checked	• Chapter Parameterization, Page 36	☐
Preset Adjustment Function	• The preset adjustment function may only be executed when the affected axis is stationary • It must be ensured that the preset adjustment function cannot be inadvertently triggered • After execution of the preset adjustment function the new position must be checked before restarting	• Chapter Preset Adjustment Function, Page 43	☐
Device replacement	• It must be ensured that the new device corresponds to the replaced device • All affected safety functions must be checked	• Safety Manual (checklist part 1 of 2) • Chapter Parameterization, Page 36	☐

11 Appendix

11.1 TÜV certificate

Download
- www.tr-electronic.de/f/TR-ECE-TI-DGB-0297

11.2 PROFIBUS certificate

Download
- www.tr-electronic.de/f/TR-ECE-TI-D-0178

11.3 PROFIsafe certificate

Download
- www.tr-electronic.de/f/TR-ECE-TI-D-0179

11.4 EU Declaration of Conformity

Download
- www.tr-electronic.de/f/TR-ECE-KE-DGB-0337

11.5 Drawings

see subsequent pages

Download
- www.tr-electronic.de/f/04-CDV75M-M0003
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