Original manual

Functional Safety
Type Approved

Absolute Encoder CD_582 PROFINET/PROFIsafe

- TR Encoder Profile
- OPTION: PNO Encoder Profile V4.2, Class S1/S2
- PNO Encoder Profile V4.2, Class 3/4
- PROFIsafe V2.4 / V2.6.1
- OPTION: Additional Interface

CDV582

CDS582 / CDH582

Pictures show similar items

DIN EN 61508:	**SIL CL2 / SIL CL3**
DIN EN ISO 13849:	**PL d / PL e**

_Safety instructions
_Installation
_Commissioning
_Configuration / Parameterization
_Troubleshooting / Diagnostic options

User Manual Interface

TR-ECE-BA-GB-0139 v16 / 12/09/2025

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First release	05/28/2019	00
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- Description of bit “0” chapter 5.3.4.1.2 edited - Diagnostic message/Meaning chapter 12.2 edited	11/21/2019	02
- Description of bit 1 and bit 2 in chap. 5.4.5.1 edited - Reference to example program “F_Dest_Add – Acyclic-Write-Request” - F_Dest_Add - address assignment for the slots 1/4/5/6	12/03/2019	03
Parameter added for the additionaly SSI interface	01/28/2020	04
Parameter added for the additionaly incremental interface	02/14/2020	05
Chapter: 3.6.2 "Cable length" for optional SSI interface added	04/08/2020	06
Cable specification for supply voltage edited, chapter: 3.3.1	04/16/2020	07
Note: Commissioning via ABB AC500-S	04/16/2020	08
Correction of the byte order in sub module Preset	06/16/2020	09
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1 General information

This interface-specific user manual contains the following topics:

- Safety instructions
- Installation
- Commissioning
- Configuration / Parameterization
- Troubleshooting and diagnostic options

Since it has a modular structure, this User Manual is supplementary to other documentations, 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 series according to the following keys for article numbers and types with ***PROFINET IO*** interface and ***PROFIsafe*** profile:

Article number

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

Position	Designation	Description
* 1	A C	Explosion protection enclosure (ATEX); Ex Absolute encoder, programmable
* 2	D	Redundant dual scanning unit
* 3	V H S	Solid shaft Hollow shaft Blind shaft
* 4	582	Outer diameter ∅ 58 mm, Generation 2
* 5	M S	Multi-turn Singleturn
* 6	-	Consecutive number

* = placeholder

Type key

See Revision Lists:
CD_582M +FS02: www.tr-electronic.de/f/TR-ECE-TI-D-0343
CD_582M +FS03: www.tr-electronic.de/f/TR-ECE-TI-D-0349

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

The following documentation therefore also applies:

- See the Chapter "Other Applicable Documents" in the Safety Manual www.tr-electronic.de/f/TR-ECE-BA-GB-0142
- Product data sheets https://www.tr-electronic.com/s/S020955

1.2 References

1.	IEC/PAS 62411	Real-time Ethernet PROFINET IO International Electrotechnical Commission
2.	IEC 62443	IT security for industrial automation systems
3.	IEC 61158	Digital data communications for measurement and control - Fieldbus for use in industrial control systems
4.	IEC 61784	Digital data communications for measurement and control - Fieldbus for use in industrial control systems - Profile sets for continuous and discrete manufacturing relative to fieldbus use in industrial control systems
5.	ISO/IEC 8802-3	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
6.	IEEE 802.1Q	IEEE Standard for Priority Tagging
7.	IEEE 1588-2002	IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems
8.	PROFIBUS Guideline	Profile Guidelines Part 1: Identification & Maintenance Functions. Order no. 3.502
9.	PROFINET Guideline	PROFIsafe – Environmental Requirements Order no.: 2.232
10.	PROFINET Guideline	Security Class 1 for PROFINET security Order no.: 7.312
11.	PROFINET Guideline	Design Guidelines, Order no.: 8.062
12.	PROFINET Guideline	Installation Guidelines Order no.: 8.072
13.	PROFINET Guideline	Commissioning Guidelines Order no.: 8.082
14.	PNO Specification	Encoder Profile, Version 4.2 Order no.: 3.162
15.	PNO Specification	PROFIdrive Profile, Version 4.2 Order no.: 3.172
16.	PNO Specification	Application Layer protocol for decentralized periphery and distributed automation Order no. 2.722

1.3 Abbreviations used / Terminology

0x	Hexadecimal representation
API	***A***pplication ***P***rocess ***I***dentifier
BMP	***B***ase-***M***ode-***P***arameter
CAT	Category: Cable classification also used for Ethernet
CL3, CL4	Denotes Encoder Profile Class 3 or 4
CRC	***C***ylic ***R***edundancy ***C***heck (redundancy check)
DAP	***D***evice ***A***ccess ***P***oint
DC_{avg}	***D***iagnostic ***C***overage Average diagnostic coverage
EU	***E***uropäische ***U***nion
EMC	***E***lectro***M***agnetic ***C***ompatibility
Engineering Tool	Planning, commissioning tool
F	generally means the Safety or Fail-safe
F-Device	Safety device for safety applications
Fault exclusion	Compromise between technical safety requirements and the theoretical possibility that an error occurs
F Host	Safety controller for security applications
FMEA	***F***ailure ***M***ode and ***E***ffects ***A***nalysis, methods used in reliability engineering to detect potential weaknesses
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.
GSD	***G***eneric ***S***tation ***D***escription (GSD file)
GSDML	***G***eneric ***S***tation ***D***escription (***M***arkup ***L***anguage)
I&M	***I***dentification & ***M***aintenance
IEC	International Electrotechnical Commission
IEEE	***I***nstitute of ***E***lectrical and ***E***lectronics ***E***ngineers
IOCS	IO Consumer Status: status indication by the Consumer of an IO data element (good, bad with fault location)
IOPS	IO Provider Status: status indication by the Provider of an IO data element (good, bad with fault location)
IP	***I***nternet ***P***rotocol
IRT	***I***sochronous ***R***eal-***T***ime Communication
ISO	***I***nternational ***S***tandard ***O***rganisation
MAC	***M***edia ***A***ccess Control, ***E***thernet ID
MRP	***M***edia ***R***edundancy ***P***rotocol
$MTTF_d$	***M***ean ***T***ime ***T***o ***F***ailure (dangerous)
NRT	***N***on-***R***eal-***T***ime Communication
Re-Integration (User Acknowl-edgment)	Switching from substitute values to process values
PAS	***P***ublicly ***A***vailable ***S***pecification

Passivation	In a fail-safe I/O with outputs, the F-system does not transmit the output values provided by the safety program in the process image to the fail-safe outputs in the event of a passivation but sends substitute values (e.g., 0) instead.
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.
PNO	***P***ROFIBUS ***N***utzer ***O***rganisation e.V.
PNU	***P***arameter ***Nu***mber
PROFIBUS	manufacturer independent, open field bus standard
PROFINET	PROFINET is the open Industrial Ethernet Standard of the PROFIBUS User Organization for automation.
RT	***R***eal-***T***ime Communication
SCS	***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 safeguard a dangerous process and reduce the risk of an accident. Process instruments are part of a Safety Instrumented System. They consist of the essential components of an entire safety-relevant process I/O unit: Sensor, fail-safe processing unit (controller) and actuator
Slot	Addressing a physical slot
Subslot	Addressing the data
SNMP	***S***imple ***N***etwork ***M***anagement ***P***rotocol
SRS	***S***ound ***R***etrieval ***S***ystem with control function with respect to PROFIsafe also referred to as F Host
STP	***S***hielded ***T***wisted ***P***air
TCP	***T***ransmission ***C***ontrol ***P***rotocol
UDP	***U***ser ***D***atagram ***P***rotocol
VDE	***V***erband ***d***er ***E***lektrotechnik, Elektronik und Informationstechnik (Association for Electrical, Electronic and Information Technologies e.V.)
Proof test	Recurrent test for detecting hidden dangerous failures in a safety-related system.
XML	E***X***tensible ***M***arkup ***L***anguage

1.4 Main features

- PROFINET IO interface with PROFIsafe protocol, for transfer of a safe position and velocity
- Fast process data channel via PROFINET IO, non-safety related
- Variant 1 only:
  Additional incremental or SIN/COS or SSI interface, non-safety related
- 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 disc with transmitted light and magnetic multi-turn scanning
    Channel 2, Test system:
    Magnetic single- and multi-turn scanning
  - Variant 2:
    Channel 1, Master system:
    Magnetic single- and multi-turn scanning
    Channel 2, Test system:
    Magnetic single- and multi-turn scanning
- One common drive shaft

Channel 1 Master System data and Channel 2 Test System data are separately provided in the non safety-related process data channel with normal PROFINET IO protocol (untested) and short cycle time.
In “legacy mode”, controllers with 16-bit registers transfer safety-oriented data using the *PROFIsafe V2.4 Basic Protocol (BP).* Other operating modes also use 32-bit position data and the safety-related data can be transmitted either with the *PROFIsafe V2.4 Basic Protocol (BP)* or with the *PROFIsafe V2.6.1 Expanded Protocol (XP).*

The inspection system is used for the internal safety check. “Safe data” obtained through two-channel data comparison are packed into the PROFIsafe protocol and transmitted to the controller via the PROFINET IO.

The optional incremental interface in Variant 1, or its alternative SIN/COS interface, are derived from the master system and are not evaluated with respect to safety.
Instead of the incremental interface, a synchronous-serial absolute-value interface (SSI) is available, which is also not evaluated with respect to safety.

1.5 Principle of the safety function

System safety is established as follows:

– 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 velocity in two channels and transfers the safe data in the PROFIsafe protocol via PROFINET IO.

– In the event of a failed channel comparison or other error detected through internal diagnostic mechanisms, the measuring system switches the PROFIsafe channel to error state.

– Initialization of the measuring system and execution of the preset adjustment function are appropriately safeguarded.

– The control additionally checks whether the obtained position data are within the position window expected by the control. Unexpected position data are, e.g., position jumps, tracking error deviations and incorrect direction of travel.

– In case errors are detected, the control introduces appropriate safety measures defined by the system manufacturer

– The system manufacturer ensures, through correct attachment of the measuring system, that the measuring system is always driven by the axis to be measured and is not overloaded.

– The system manufacturer performs a safeguarded test during commissioning and whenever a parameter has been changed.

2 Safety instructions

2.1 Definition of symbols and notes

⚠ DANGER	means that death or serious injury will occur if the user fails to take the respective precautionary measures.
⚠ 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 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 ensure the appropriate measures can be taken in the event of an error, the following applies:

If the measuring system detects an error and a safe position cannot be output, the PROFIsafe channel is automatically put into the fail-safe state. In this state, so-called “passivated data” are output via PROFIsafe. Also see Chapter 7.1.4 on Page 136.

Passivated data as seen by the measuring system:

PROFIsafe data channel:	All outputs are set to 0
PROFIsafe status:	Error bit 2^1 `Device_Fault` is set
PROFIsafe-CRC:	valid
TR Status1:	Safe State Bit 2^4 = 0

Upon receipt of passivated data, the F Host must put the system into a safe state. This error state can be terminated only by elimination of the error and subsequent re-integration!

This does not necessarily affect the process data channel that can be addressed via PROFINET IO. 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 in terms of a safety standard.

2.2.1 Mandatory safety checks / measures

Measures for commissioning, changes	Error response F Host
Application-dependent parameterization or definition of the necessary `iParameters`.	–
In the event of parameter changes, check whether the measure is taken as desired.	STOP

Check by F Host	Error response F Host
Cyclic check of the current safety-oriented data for consistency with the previous data.	STOP
Monitoring of non-safety-related and safety-related cyclic data.	Receipt of passivated data -> STOP
Timeout: Monitoring of the measuring system – response time. To check, e.g., for cable breakage, power failure, etc.	STOP

2.3 PROFINET Security Class 1

Available from firmware version 2.xx

The measuring system supports PROFINET security class 1 in accordance with the PROFINET guideline `Security Class 1 for PROFINET Security`, order no.: 7.312.

As in other areas of IT security, PROFINET security is also based on a multi-layered approach. PROFINET Security class 1 offers multi-layered protection against attacks aimed at manipulating device configuration or unauthorized access.

The following security measures are supported to protect the PROFINET network:

- Digital signature of PROFINET `General Station Description Files` (GSD files)
- Advanced `Simple Network Management Protocol` (SNMP) configurations
- `Discovery and Configuration Protocol` (DCP) in read-only mode

2.3.1 Digital signature of the GSD file

The digital signature ensures the integrity and authenticity of the GSDML device description file (XML-based). The GSDML device description file signed by TR Electronic is provided in the form of a GSDX container format. The container also contains other related files, such as images or text files, including the verified manufacturer signature.
When the GSDML device description file is used via an engineering tool, the signature is verified. If the signature is valid, the GSDML device description file is used; otherwise, it is rejected. This prevents manipulation of device descriptions and the introduction of malicious or faulty configurations.
To use the digital signature, the engineering tool must support and be able to read the GSDX container format.
For SIEMENS, this is only possible with TIA Portal V19 or higher with the appropriate updates.

2.3.2 SNMP configuration options

Basically, SNMP enables monitoring and diagnosis of the network topology. Security class 1 offers the option of completely deactivating SNMP access, allowing only read mode, or configuring read/write access using community string authentication. This allows better control of unwanted access to device information.
Starting with SIEMENS TIA Portal V19, SNMP is disabled by default. Changed SNMP settings only take effect after the hardware configuration has been loaded.

2.3.3 DCP write protection

DCP write protection is one of the most important functions of security class 1. It prevents unauthorized write access to the measurement system during ongoing IO data exchange.
When DCP write protection is activated, DCP only has read access to the device information of the measurement system. Changes to the basic settings of the measurement system are then no longer possible during operation.
Protection against takeover of the measurement system by attackers, unwanted interruption of communication relationships (ARs), unauthorized changing of the device name or IP address via PROFINET commissioning and diagnostic tools as soon as communication between the IO controller and the measurement system has been established.

If the IO controller also supports the write protection function for DCP, DCP write protection is enabled by default for the corresponding communication link starting with SIEMENS TIA Portal V19.

3 Installation / Preparation for Commissioning

3.1 Basic rules

⚠ WARNING

The safety function may be deactivated by wire-based disturbance sources!

- ➢ All safety-related communication devices must be certified to IEC 61010 or have a corresponding declaration of conformity.
- ➢ All PROFIsafe devices used on the bus must have a PROFINET certificate and a PROFIsafe certificate.
- ➢ All safety devices must also have a certificate from a “Notified Body” (e.g., TÜV, BIA, HSE, INRS, UL, etc.).
- ➢ The 24 V power supplies used must comply with the requirements of IEC 60364-4-41 SELV/PELV and be NEC Class 2 compliant for UL applications.
- ➢ Only use cables and connectors for which the manufacturer has issued a PROFINET manufacturer’s declaration.
- ➢ The shielding effect of cables must also be ensured after installation (bending radii/tensile strength!) 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 ensure good contact between the cable shield and the connector housing. Connect the cable shield to the connector housing over a large area.
- ➢ Compensating currents caused by differences in potential across the shield to the measuring system must be prevented.
- ➢ A shielded and stranded data cable must be used to ensure high electromagnetic interference stability of the system. The shield should be connected to protective ground in a well-conducting manner using large-scale shield clips, if possible on either end. The shielding should be grounded in the switch cabinet on one end 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. During installation, observe the applicable national safety and installation regulations for data and power cables.
- ➢ 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.
- ➢ Recommendation: Check the PROFINET network for sufficient bandwidth reserves (determination of network load) before starting serial operation.

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

To ensure safe and fault-free operation, the

- PROFINET Design Guidelines, PNO order no.: 8.062
- PROFINET Installation Guidelines, PNO order no.: 8.072
- PROFINET Commissioning Guidelines, PNO order no.: 8.082
- PROFIsafe “Environmental Requirements”, PNO order no.: 2.232
- and the standards and PNO documents referenced therein

must be observed!

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

3.2 PROFINET IO transmission technology, cable specification

The safety-related PROFIsafe communication and the PROFINETcommunication are transmitted over the shared network.

PROFINET supports linear, tree or star structures. The bus or linear structure used in the field buses is thus also available for Ethernet. This is particularly useful in plant wiring, as a combination of linear and branch lines is possible. The line topology is easily implemented as the measuring systems already have an integrated switch.

Only use cables and connectors for which the manufacturer has issued a PROFINET manufacturer’s declaration. The conduction type A/B/C, the mechanical and chemical properties, as well as the configuration of the PROFINET cable, are to be defined according to the automation task. The cables are designed for bit rates of up to 100 Mbit/s. Both cross-over and straight cables can be used as the measuring system supports the “auto crossover function”. The transmission velocity is automatically detected by the measuring system and does not have to be set by switches.

Bus addressing via switches as with PROFIBUS-DP is also not necessary as this is done automatically by the addressing options of the PROFINET controller, however, the PROFIsafe destination address “F_Dest_Add” must be set, see Page 23.

The cable length including the patch cable for copper cabling between two subscribers is designed for a distance of up to max. 100 m. This transmission link is defined as a PROFINET *end-to-end link*. Within an end-to-end link, the number of detachable connections is limited to six (male/female) connector pairs. If more than six connector pairs are required, the maximum permissible connection loss index (Channel Class-D values) must be maintained for the entire transmission link.

The IRT communication topology is configured in a connection table. Correct connection of ports 1 and 2 must be ensured.
This is not the case for RT communication, which can be freely wired.

3.3 Connection instructions

The pin assignment depends on the device version and is therefore noted on every connector as a pin assignment number. When the measuring system is delivered, a printed device-specific pin assignment form is enclosed.

Download
https://www.tr-electronic.com/service/downloads/pin-assignments.html

---

⚠ WARNING

NOTICE

The measuring system may be destroyed or damaged or its function be impaired by ingress of moisture!

- Connector plugs of the measuring system that are unused during storage and/or operation of the system have to be provided either with a mating connector or a protective cap. The IP degree of protection is to be selected according to requirements.
- Protective cap with O-ring:
  When re-closing, check that the O-ring is present and seated properly.
- For suitable protective caps, see the Chapter on Accessories in the Safety Manual.

3.3.1 Supply voltage

NOTICE

The internal electronics may be damaged by impermissible overvoltages and this damage go unnoticed!

- The power supply used must meet the requirements of
  – SELV/PELV (IEC 60364-4-41:2005)
  – and be designed according to NEC Class 2,
  see also Chapter “UL/CSA Approval” in the safety manual

Cable specification: min. 0.34 mm^2 (recommended 0.5 mm^2). Generally, the cable cross-section must be harmonized with the cable length. At use in particularly sensitive EMC environments, the use of a shielded cable is recommended.

3.3.2 Optional additional interfaces (Incremental, SSI)

Cable specification: min. 0.25 mm^2 and shielded.
To guarantee the signal quality and minimization of possible environmental influences, we urgently recommend to use a shielded twisted pair cable.

3.4 Setting the PROFIsafe source-/destination-address for address type 1 / 2

⚠ WARNING **NOTICE**	***The measuring system may be destroyed or damaged or its function be impaired by penetration of foreign bodies and ingress of moisture!*** ➢ Firmly close the access to the address switches with the screw plug after the settings have been made.

The setting options and selection of the address type depend on the firmware version of the measuring system:

- **1.xx:** Only address type 1 is supported and corresponds to the default setting.
- **2.xx**: Address types 1 and 2 are supported. The default setting here is also address type 1. To select address type 2, one of the two submodules `Acceleration + Position + Velocity` “BP” or “XP” must be selected, see chapter 5.3.4 on page 53. If address type 2 is set in the measuring system and other submodules are used, PROFINET diagnostic alarms are reported.

The PROFIsafe source address is used to assign the address for the F parameter `F_Source_Add`, and the PROFIsafe destination address is used to assign the address for the F parameter `F_Dest_Add`. The address range covers addresses from 1 to 65534.
The measuring system checks `F_Source_Add` and `F_Dest_Add` during the control system startup, depending on the selected address type. If the check fails, this is reported by a corresponding PROFINET diagnostic alarm.
The setting of the address type, the PROFIsafe source address, and the PROFIsafe destination address in the measuring system is only read at the moment of switch-on. Subsequent settings during operation are therefore not recognized.

3.4.1 Address type 1

If PROFIsafe address type 1 is preselected, the configured PROFIsafe destination address `F_Dest_Add` in the control system must correspond to the PROFIsafe destination address stored in the measurement system.

The following notes on the uniqueness of PROFIsafe addresses must be observed:

- The uniqueness of the PROFIsafe address is only ensured by the PROFIsafe destination address.
- The PROFIsafe destination address must be unique across the network and across CPUs
- The PROFIsafe destination address and PROFIsafe source address are included in the CRC of the safety program

For more information on this topic, see SIEMENS documentation
https://support.industry.siemens.com/cs/ww/de/view/109740240

The measuring system can be operated with up to four PROFISafe modules via slots 1, 4, 5, and 6; see also the chapter “Shared Device applications” on page 141.
However, for PROFIsafe address type 1, only one set PROFIsafe target address `F_Dest_Add` is used for verification. This can be set using the HEX rotary switches, the `TR TCI Device Tool`, or an acyclic write command.

Therefore, the following address assignments apply to the `F_Dest_Add` of slots 1, 4, 5, and 6:

HEX rotary switch measuring system: 0

- F_Dest_Add:
  - Slot 1 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 4 = set value + 1
  - Slot 5 = set value + 2
  - Slot 6 = set value + 3

HEX rotary switch measuring system: 1…255

- F_Dest_Add:
  - Slot 1 = value set via HEX rotary switch
  - Slot 4 = set value + 1
  - Slot 5 = set value + 2
  - Slot 6 = set value + 3

Settings for the PROFIsafe source address `F_Source_Add` are not checked in the measurement system.

3.4.1.1 Setting via HEX rotary switch

The PROFIsafe destination address `F_Dest_Add` can be set directly in the address range from 1 to 255 using the two HEX rotary switches on the device. For the location and switch assignment, see the pin assignment.

3.4.1.2 Setting via `TR TCI Device Tool`

TR Electronic's own `TR TCI Device Tool` program provides a simple way to set the PROFIsafe destination address `F_Dest_Add` in the measurement system. This program is a device tool with a TCI interface `Tool Calling Interface` that can be started directly from the engineering tool.
- Program download: www.tr-electronic.de/f/zip/TR-ECE-SW-MUL-0008
- Manual download: www.tr-electronic.de/f/TR-ECE-TI-DGB-0327

To write the value to the measurement system, the HEX rotary switches must be set to the value 0. With firmware version 2.xx, the measurement system can also be switched from address type 1 to address type 2 in the `TR TCI Device Tool`.

3.4.1.3 Setting via acyclic write command

- Firmware version 1.xx:
  The PROFIsafe destination address `F_Dest_Add` is set by an acyclic write request with the Async ID `0x2300`. As with the `TR TCI Device Tool`, the HEX rotary switches of the measuring system must be set to the value 0. A detailed description of the data block can be found in chapter 11.2.1.5 on page 169.

  TR Electronic provides a sample program for `SIEMENS TIA Portal V15.1` for this purpose:
  - Download, Sample program: www.tr-electronic.de/f/zip/TR-ECE-SW-MUL-0014
  - Download; Description: www.tr-electronic.de/f/TR-ECE-TI-DGB-0360

- Firmware version 2.xx:
  The PROFIsafe destination address `F_Dest_Add` is set by an acyclic write request with the Async ID `0x230A`. The HEX rotary switches of the measurement system do not necessarily have to be set to the value 0 for this. However, depending on the settings of the HEX rotary switches, the above-mentioned check values apply after restarting the measuring system.
  A detailed description of the data block can be found in chapter 11.2.1.6 on page 170.

3.4.2 Address type 2, firmware version 2.xx

If PROFIsafe address type 2 is preselected, the configured PROFIsafe source address `F_Source_Add` and PROFIsafe destination address `F_Dest_Add` must correspond to the addresses stored in the measurement system.

The following notes on the uniqueness of PROFIsafe addresses must be observed:

- The uniqueness of the PROFIsafe address is ensured by the combination of the PROFIsafe source address and the PROFIsafe destination address.
- The PROFIsafe destination address must be unique across the CPU and must differ from all PROFIsafe destination addresses of PROFIsafe address type 1 in the same network.
- The PROFIsafe source address used for the F peripherals of an F CPU must be unique across the entire network.
- PROFIsafe destination address and PROFIsafe source address are included in the CRC of the safety program

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For more information on this topic, see SIEMENS documentation
https://support.industry.siemens.com/cs/ww/de/view/109740240

The measuring system can be operated with up to four PROFISafe modules via slots 1, 4, 5, and 6; see also the chapter “Shared Device applications” on page 141.
For PROFIsafe address type 2, all PROFIsafe source addresses `F_Source_Add's` and PROFIsafe destination addresses `F_Dest_Add's` set in the measurement system are used for verification. These can be set using the `TR TCI Device Tool` or an acyclic write command. However, the settings of the HEX rotary switches must also be taken into account.

The following address assignments apply to `F_Dest_Add` and `F_Source_Add` for slots 1, 4, 5, and 6:

HEX rotary switch measuring system: 0

- F_Dest_Add:
  - Slot 1 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 4 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 5 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 6 = value set via `TR TCI Device Tool` or acyclic write command
- F_Source_Add:
  - Slot 1 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 4 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 5 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 6 = value set via `TR TCI Device Tool` or acyclic write command

HEX rotary switch measuring system: 1…255

- F_Dest_Add:
  - Slot 1 = set value via the hex switch
  - Slot 4 = set value via the hex switch
  - Slot 5 = set value via the hex switch
  - Slot 6 = set value via the hex switch
- F_Source_Add:
  - Slot 1 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 4 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 5 = value set via `TR TCI Device Tool` or acyclic write command
  - Slot 6 = value set via `TR TCI Device Tool` or acyclic write command

3.4.2.1 Setting via TR TCI Device Tool

The `TR TCI Device Tool` can be used for PROFIsafe address type 2, as is the case with PROFIsafe address type 1. To write the PROFIsafe destination address `F_Dest_Add` to the measurement system, the HEX rotary switches must also be set to the value 0 here. The PROFIsafe source address `F_Source_Add` can always be written regardless of the set HEX rotary switch values. In the `TR TCI Device Tool`, the measurement system can be changed from address type 2 to address type 1.

3.4.2.2 Setting via acyclic write command

The PROFIsafe destination address `F_Dest_Add` is set by an acyclic `Write Request` with the Async ID `0x230A`. The HEX rotary switches of the measurement system do not necessarily have to be set to the value 0 for this. However, depending on the settings of the HEX rotary switches, the above-mentioned check values apply after restarting the measuring system.
A detailed description of the data block can be found in chapter 11.2.1.6 on page 170.

3.5 Incremental interface / SIN/COS interface (optional)

In addition to the PROFINET IO interface for outputting the absolute position, the measuring system can be equipped with an additional incremental interface.

Adjustable parameter, see chapter 5.8.2 on page 121.

Alternatively, this interface can also be designed as a SIN/COS interface. This interface cannot be parameterized.

⚠ WARNING

This additional interface is not evaluated in relation to safety and may not be used for safety-related purposes!

- ➢ In motor control applications, the interface is generally used as position feedback.

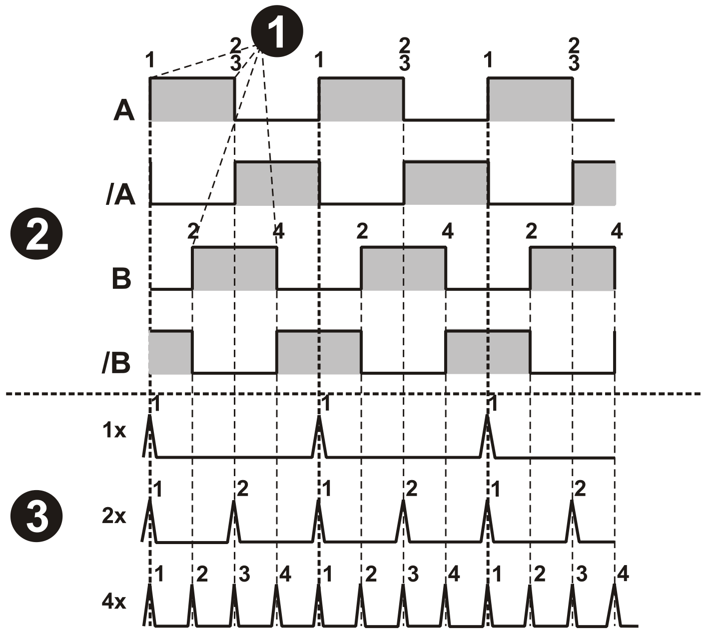
NOTICE

In the event of overvoltage, caused by a missing ground reference point, there is a danger of damage to the downstream electronic devices!

- If the ground reference point is completely missing, e.g., 0 V of the power supply are not connected, voltages equal to the supply voltage can occur at the outputs of this interface.
  - ➢ Ensure that a ground reference point is present at all times,
  - ➢ or the organization responsible for the system must provide appropriate protective measures for downstream electronic devices.

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

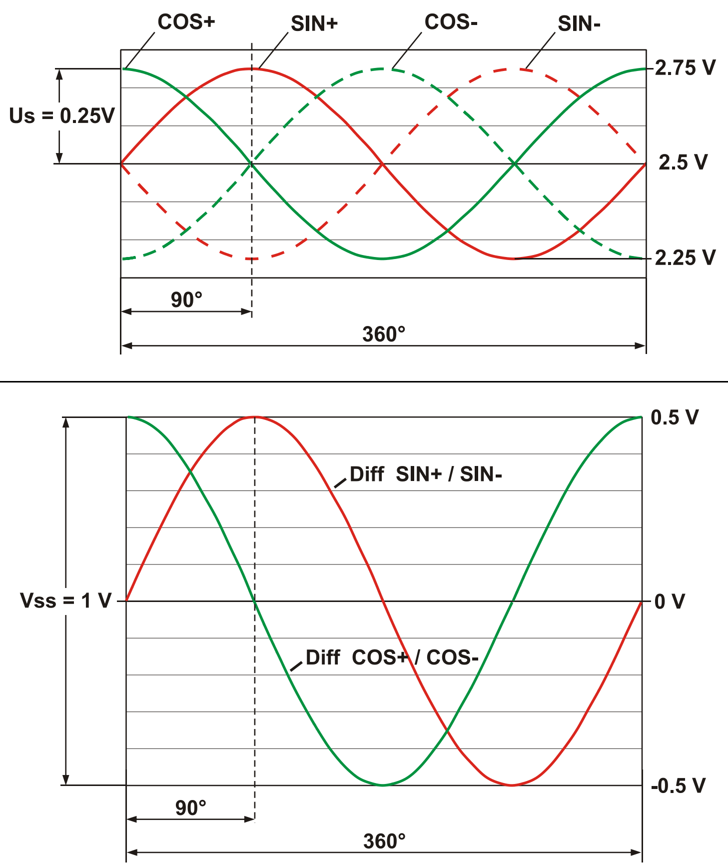
3.5.1 Signal characteristics



1: Edge evaluation
2: Measuring system with 1024 pulses/revol.
3: Counter evaluation

1x: 1024 counter pulses/rev.
2x: 2048 counter pulses/rev.
4x: 4096 counter pulses/rev.

Figure 1: Counter evaluation, incremental interface



Measurement of signals tending to 0 V

Differential measurement

Figure 2: Level definition, SIN/COS interface

3.5.2 HTL/TTL Level (optional)

Optionally, the incremental interface is also available with HTL and TTL levels. For technical reasons, the user using this version has to take the following general conditions into account: ambient temperature, cable length, cable capacitance, supply voltage, and output frequency.
In this case, the maximum output frequencies that can be reached via 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. The load quantity required varies strongly depending on the cable capacitance. It is this reloading of the cable capacitances that is responsible for the high power dissipation and heat, which result in the measuring system.

The following diagrams show, separated by TTL and HTL version, the different dependencies with respect to three different supply voltages.

TR's own hybrid cable (part number: 64-200-021) was used for the measurements.

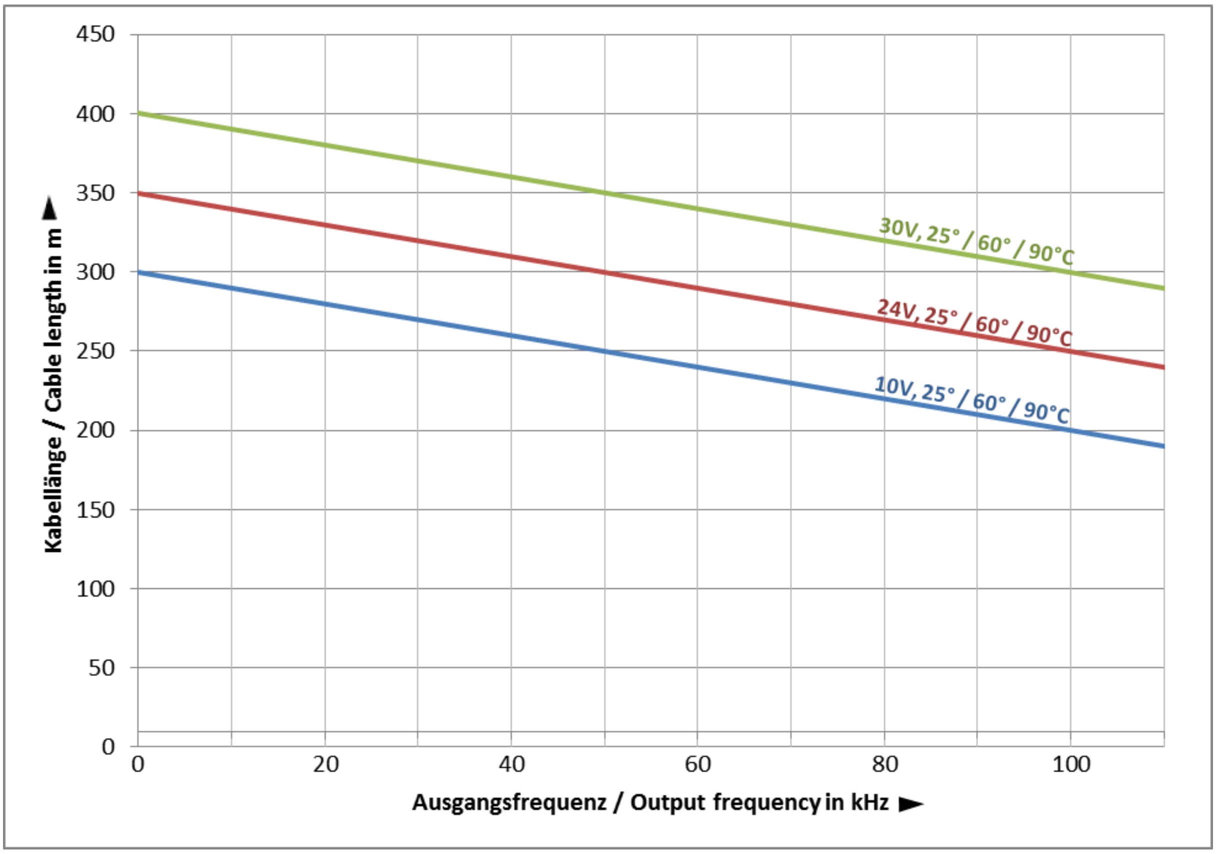


Figure 3: Cable lengths / limit frequencies, TTL version

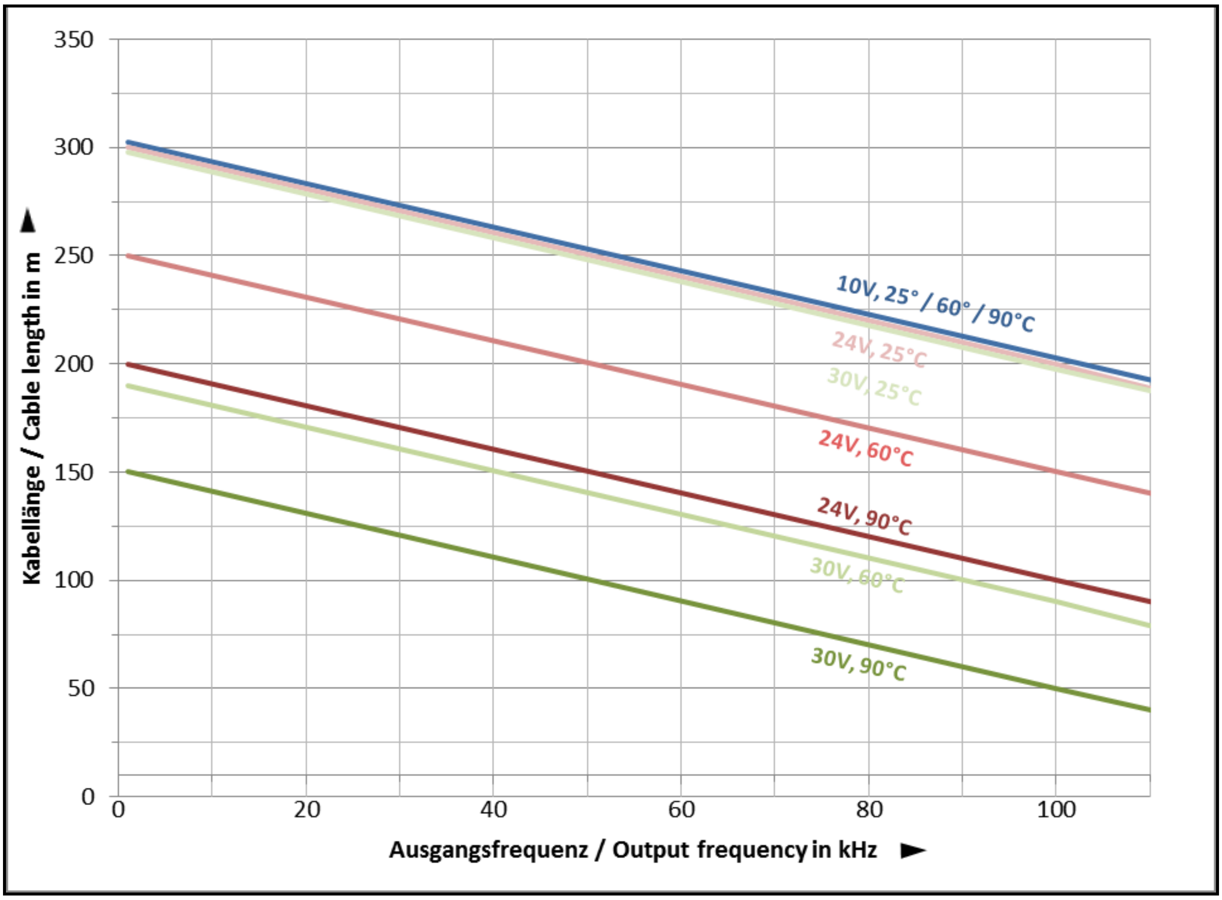


Figure 4: Cable lengths / limit frequencies, HTL version

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

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

3.6 SSI interface (optional)

Instead of the incremental interface, the measuring system can be optionally equipped with a synchronous serial absolute SSI interface in addition to the PROFINET IO interface.

Adjustable parameter, see chapter 5.8.1 on page 118.

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

- The interface is typically used for control purposes when transferring absolute value data to a second non-safety related controller.

3.6.1 Signal characteristics

In power-down mode, Data+ and Clock+ are set to high. In the diagram below, this corresponds to the Time before point (1).

When the clock signal changes from High to Low (1) for the first time, the device-internal re-triggerable monoflop is set to monoflop time t_M.
The time t_M determines the lowest transmission frequency ($T = t_M / 2$). The upper limit frequency results from the sum of all signal propagation times and is additionally limited by the built-in filter circuits.

With each further falling clock edge, the active state of the monoflop is extended by the time t_M – this happens last at point (4).
Setting the monoflop (1) causes the bit-parallel data pending at the internal parallel-to-serial converter to be stored by an internally generated signal in an input latch of the shift register. This ensures that the data does not change during the transmission of an actual position value.

When the clock signal changes from Low to High (2) for the first time, the most significant device information bit (MSB) is applied to the serial data output. With each further rising edge, the next lower-order bit is pushed to the data output.
When the clock rate has ended, the data lines are kept at 0 V (low) for the duration of the monoflop time t_M (4). This also results in the minimum pause time t_p, which must be maintained between two consecutive clock sequences and is 2 * t_M.

The evaluation electronics read the data already at the first rising clock edge. Various factors result in a delay time t_V >100 ns, without cables. The measuring system data push to the output is thus delayed by the time t_V. Therefore, a “Pause-1” is read at time (2). This must be discarded or used for line break monitoring in conjunction with a “0” after the LSB data bit. The MSB data bit is read only at time (3). Therefore, the clock number must always be one higher (n+1) than the number of data bits to be transmitted.

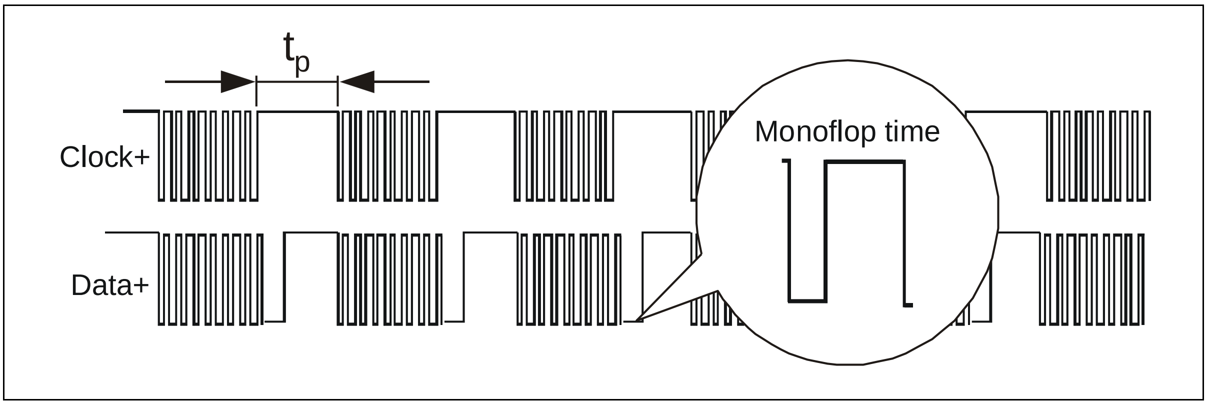


Figure 5: Typical SSI transmission sequences

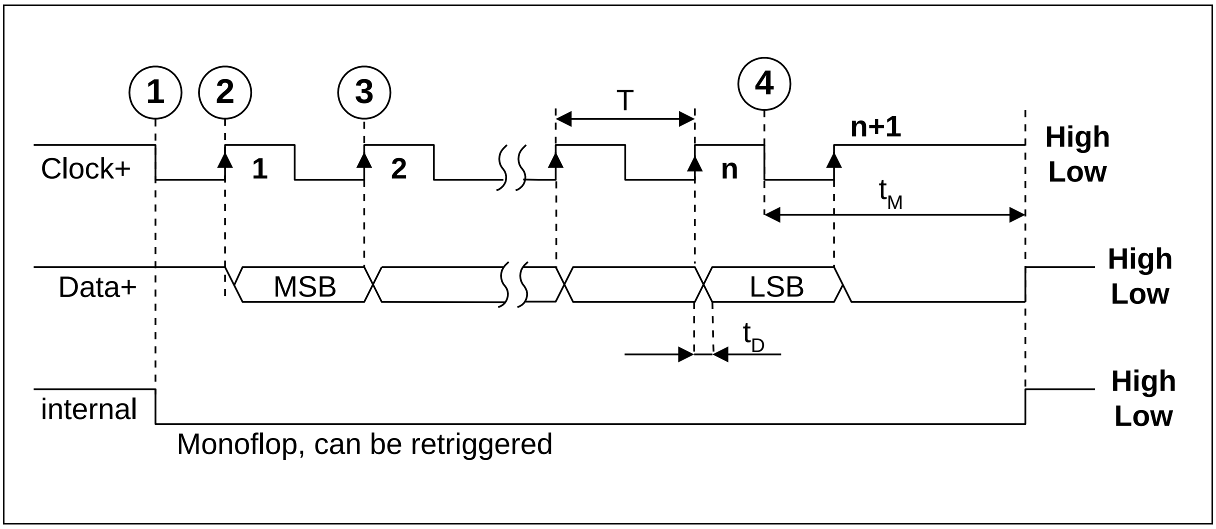


Figure 6: SSI transmission format

3.6.2 Cable length

The maximum cable length depends on the SSI clock frequency and cable quality.

TR's own hybrid cable (part number: 64-200-021) was used for the measurements.

SSI clock frequency [kHz]	2000	1000	500	250	125	125	125
Cable length [m]	approx. 12,5	approx. 25	approx. 50	approx. 100	approx. 150	approx. 200	approx. 250

Table 1: SSI clock frequency / Cable lengths

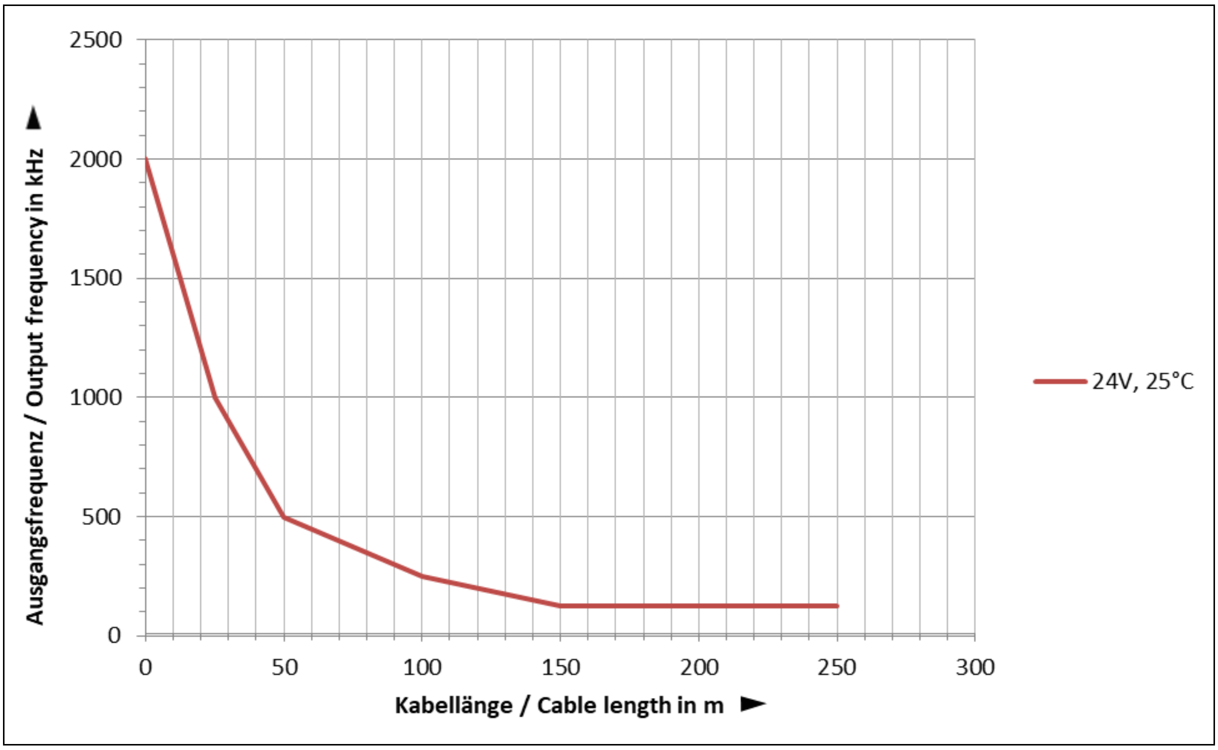


Figure 7: SSI clock frequency / Cable lengths

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

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

4 Commissioning

4.1 PROFINET IO

Important commissioning information can be found in the PROFINET Directive:

- PROFINET Commissioning Guidelines, Order No.: 8.082

This and more information on PROFINET or PROFIsafe is 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
e-mail: mailto:germany@profibus.com

4.1.1 Device classes

The following device classes are used in a PROFINET IO system:

- **IO controller**
  For example a PLC, which addresses the connected IO device.

- **IO device**
  Distributed field device (measuring system), which is assigned to one or more IO controllers and also transmits alarms in addition to the process and configuration data.

- **IO supervisor (Engineering Station)**
  A programming device or industrial PC, which has access to all process and parameter data in parallel with the IO controller.

4.1.2 Device description file (XML)

The GSDML file and the associated bitmap file are part of the measuring system.

Download
www.tr-electronic.de/f/TR-ECE-ID-MUL-0058

Important notes on the GSDML file versions can be found in the enclosed `README` file.

4.1.3 Device identification

Each PROFINET IO device has a device identification. It consists of a Vendor ID and a manufacturer-specific part, the Device ID. The Vendor ID is assigned by the PNO and for TR-Electronic has the value `0x0153`, while the Device ID has the value `0x0404`.
During start-up the configured device identification is checked and any configuration errors are detected.

4.1.4 PROFINET IO data exchange

PROFINET IO communication process:

The IO controller establishes, according to its parameterization, one or more application relationships with the IO devices. To do this it searches for the parameterized names of the IO devices in the network and assigns an IP address to the found devices. The ***DCP*** "Discovery and Control Program" service is used for this purpose. The IO controller then transmits the desired degree of expansion (module/submodule) and all parameters for the parameterized IO devices during the next start-up. The cyclical IO data, alarms, acyclical services and cross-connections are defined.

PROFINET IO allows the transmission velocity of the individual cyclical data to be set by way of a scaling factor. After parameterization the IO data are transmitted by the IO device in a fixed cycle after a one-time request by the IO controller. Cyclical data are not acknowledged. Alarms, on the other hand, must always be acknowledged. Acyclical data are also acknowledged.

To protect against parameterization errors, the expected and actual configuration are compared with regard to device type, order number and input and output data.

On successful start-up the IO devices start the data transmission automatically. The communication relationship in PROFINET IO always follows the provider-consumer model. During cyclical transmission of the measured value, the IO device is the provider of the data, and the IO controller (e.g. a PLC) is the consumer. The transmitted data are always given a status (good or bad).

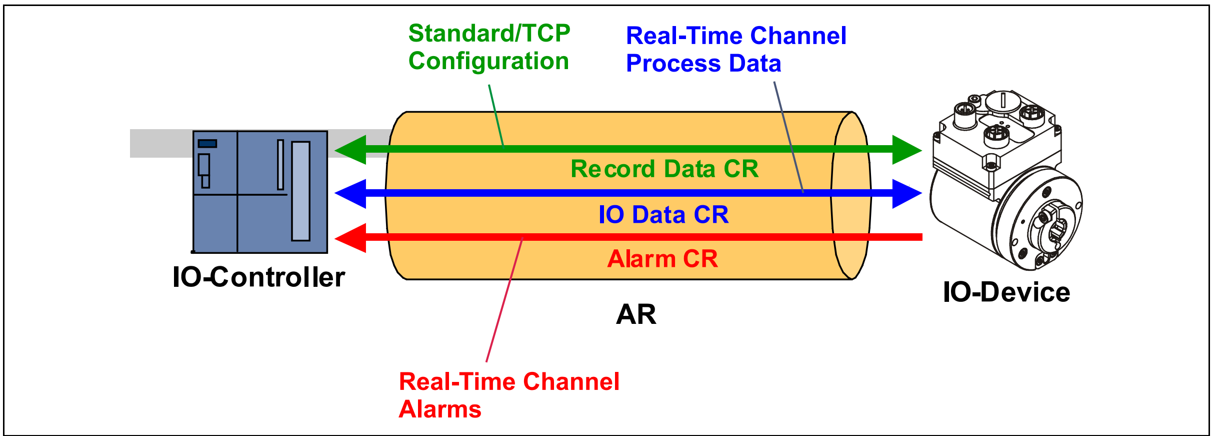


Figure 8: Device communication

AR:
Application relationship between IO controller and assigned IO devices.

CR:
Communication relationships for configuration, process data and alarms. One or more IO-CRs can be defined within an AR. Each IO-CR can consist of several slots and subslots.

4.1.5 Address assignment

Parameter	Default value	Description
MAC address	-	When the measuring system is delivered, its `MAC address` is stored by default. This is noted on the nameplate of the device, eg "00-03-12-04-00-60", and can not be changed.
Device type	TR Rotative Safety	The name for the device type assigned by TR-Electronic is `TR Rotative Safety` and can not be changed.
Device names	-	Before an IO device can be addressed by an IO controller, it must have a `device name`, so that an IP address can be assigned to the device. If necessary, the IO controller assigns IP addresses to the IO devices according to their device names during startup. The measuring system has no device name stored when delivered and after a reset. Only after the assignment of a device name with the engineering tool is the measuring system addressable for an IO controller, e.g. for the transmission of configuration data (e.g. the IP address) during start-up or for useful data exchange in cyclical operation. The name is assigned before commissioning via the engineering tool.
IP address	0.0.0.0	The measuring system has no IP address stored when delivered and after a reset. Default value: "0.0.0.0"
Subnet mask	0.0.0.0	The measuring system has no subnet mask stored when delivered and after a reset. Default value: "0.0.0.0"

Procedure for assignment of device name and address for an IO device

- Define device name, IP address and subnet mask. Depending on the configuration of the IO controller, this may be defined automatically.
- Device name is assigned to an IO device (MAC address)
  - Transfer device name to the device
- Upload configuration to the IO controller
- IO controller assigns the IP addresses to the device names during start-up. The assignment of the IP address can also be switched off. In this case the existing IP address in the IO device is used.

4.2 Bus status display

The measuring system is equipped with four bicolor LEDs:

LED1: Device status	(green, red)
LED2: Net Status	(green, red)
LED3: Data / Link PORT1	(green, yellow)
LED4: Data / Link PORT2	(green, yellow)

The position and assignment of the LEDs can be found in the accompanying pin assignment.
For measures to be taken in the event of a fault, see chapter “Troubleshooting and diagnostic options” on page 171.

4.3 Commissioning via SIEMENS SIMATIC S7

Download
Technical Information: www.tr-electronic.de/f/TR-ECE-TI-DGB-0340

4.4 Commissioning via ABB AC500-S

Download
Technical Information: www.tr-electronic.de/f/TR-ECE-TI-DGB-0366

5 Parameterization and configuration

Parameterization

Parameterization means providing a PROFINET IO device with certain information required for operation prior to commencing the cyclic exchange of process data. The measuring system requires e.g. data for resolution, counting direction etc..

The Engineering Tool generally provides an input mask for the PROFINET IO controller, which the user can use to enter or select the parameter data from a list. The structure of the input box is stored in the device master file. The number and type of parameters entered by the user depend on the choice of configuration.

Configuration

Configuration means specifying the length and type of process data and how these are to be treated. The Engineering Tool usually provides a graphic interface in which the configuration is entered automatically. All you need to do then is specify the desired I/O address for this configuration.

The measuring system requires, depending on the desired configuration, a different number of input and output words on PROFINET.

5.1 Modular structure

Unused configuration options can be hidden on the bus as not all configuration options of the measuring system can be used at all times.

For this purpose the measuring system is represented as a modular device in the interface of the configuration software of the PROFINET master.

The relevant configuration list is already pre-configured (`Safety (TR)`, `Channel 1 (TR)`) when inserting the measuring system into the master participant list. This is not mandatory and can be adjusted according to the wishes or even discarded. The aim and purpose of this configuration is to quickly and easily commission the measuring system with all necessary parameters for a safety-oriented application.

Each module or submodule requires a different number of inputs and outputs and has a set of parameter data, which can be set according to the application.

With the exception of the Legacy-Mode, the modules can be freely selected in all other configurations. This means that a configuration is not necessarily safety-related.

5.2 Configurable modules - overview/selection

The following brief descriptions of the modules are intended to help you decide which modules or submodules are needed for the configuration based on the application requirements.

Each module block listed below represents a self-contained configuration:

- Safety (TR); slots 1,4,5,6 + subslot 1 ....chap. 5.3, p44
- Channel 1 (TR); slot 2 + subslots 2,3,4,5, 6 ....chap. 5.4, p70
- Channel 2 (TR); slot 3 + subslots 2,3,4,5, 6 ....chap. 5.4, p70
- [1]Channel 1-2 (TR) Slot 3 + subslots 2, 3, 5, 6 ....chap. 5.5, p83
- [1]Channel 2-2 (TR) Slot 2 + subslots 2, 3, 5, 6 ....chap. 5.5, p83
- OPTION: Safety BP/XP (PNO); slots 1,4,5,6 + subslot 2 ....chap. 5.6, p84
- Channel 1 (PNO); slot 2 + subslot 2 ....chap. 5.7, p98
- Channel 2 (PNO); slot 3 + subslot 2 ....chap. 5.7, p98
- SSI (TR); slot 5 ....chap. 5.8, p118
- Incremental (TR); slot 5 ....chap. 5.8, p118
- Safety (Legacy) + 1XP; slots 1,4,5,6 + Channel 1 (Legacy); slot 2......chap. 5.9, p122

Therefore, there is a separate description block for each module block. The corresponding chapters and page numbers are given below before each module block.

In order not to lose orientation, it is recommended to work through a complete module and then return here, select the next module and directly select the corresponding description block.

If it is clear which module will be processed next, you can also jump directly from here to the corresponding chapter.

[1] available from firmware version 2.xx

5.2.1 TR Encoder Profile, safety-related (Safety (TR))

Description, see chapter 5.3 from page 44 to 69.

Module	Description	Slot	Page
Safety (TR)	PROFIsafe module for the TR Profile	1,4,5,6	44
Submodule	**Description**	**Subslot**	**Page**
Position (BP/XP)	PROFIsafe V2.4 (BP) or V2.6.1 (XP) submodule INPUT: 8 bit TR-Status2, 8 bit TR-Status1, 32 Bit safety position, 4 or 5 byte safety message block OUTPUT: 8 bit TR-Control2, 8 bit TR-Control1, 32 Bit safety Preset, 4 or 5 byte safety message block	1	44
Velocity (BP/XP)	PROFIsafe V2.4 (BP) or V2.6.1 (XP) submodule INPUT: 32 bit safety velocity, 4 or 5 byte safety message block OUTPUT: 4 or 5 byte safety message block	1	47
Position + Velocity (BP/XP)	PROFIsafe V2.4 (BP) or V2.6.1 (XP) submodule INPUT: 8 bit TR-Status2, 8 bit TR-Status1, 32 bit safety position, 32 bit safety velocity, 4 or 5 byte safety message block OUTPUT: 8 bit TR-Control2, 8 bit TR-Control1, 32 bit safety preset, 4 or 5 byte safety message block	1	50
[1]Acceleration + Position + Velocity (BP/XP)	PROFIsafe V2.4 (BP) or V2.6.1 (XP) submodule INPUT: 8 bit TR-Status2, 8 bit TR-Status1, 16 bit safety acceleration, 32 bit safety position, 32 bit safety velocity, 4 or 5 byte safety message block OUTPUT: 8 bit TR-Control2, 8 bit TR-Control1, 32 bit safety preset, 4 or 5 byte safety message block	1	53

Default setting:
Module `Safety (TR)` on slot 1
Submodule `Acceleration + Position + Velocity (XP)` on subslot 1

[1] available from firmware version 2.xx

5.2.2 TR Encoder Profile, non-safety related (Channel 1/2 (TR))

Description, see chapter 5.4 from page 70 to 82.

Module	Description	Slot	Page
Channel 1 (TR)	Channel 1 standard module for the TR profile	2	70
Channel 2 (TR)	Channel 2 standard module for the TR profile	3	70
Submodule	**Description**	**Subslot**	**Page**
Position	Channel 1 + 2 standard submodule INPUT: 32 bit position	2	71
Velocity	Channel 1 + 2 standard submodule INPUT: 32 bit velocity	3	75
Preset	Channel 1 + 2 standard submodule INPUT: 8 bit preset status OUTPUT: 8 bit preset control, 32 bit preset	4	78
Status	Channel 1 + 2 standard submodule INPUT: 8 bit sensor status	5	79
[1]Acceleration	Channel 1 + 2 standard submodule INPUT: 16 bit acceleration	6	80

Default setting:
Module `Channel 1 (TR)` on slot 2
Submodules `Position`, `Velocity, Preset, Status and Acceleration` on the subslots 2, 3, 4, 5 and 6

5.2.3 TR Encoder Profile, non-safety related (Channel 1-2/2-2 (TR))

Description, see chapter 5.5, page 83.

Module	Description	Slot	Page
[1]Channel 1-2 (TR)	Channel 1 standard module for the TR profile	3	83
[1]Channel 2-2 (TR)	Channel 2 standard module for the TR profile	2	83
Submodule	**Description**	**Subslot**	**Page**
Position	Channel 1 + 2 standard submodule INPUT: 32 bit position	2	71
Velocity	Channel 1 + 2 standard submodule INPUT: 32 bit velocity	3	75
Status	Channel 1 + 2 standard submodule INPUT: 8 bit sensor status	5	79
[1]Acceleration	Channel 1 + 2 standard submodule INPUT: 16 bit acceleration	6	80

1 available from firmware version 2.xx

5.2.4 OPTION: PNO Encoder Profile, safety-related (Safety BP/XP (PNO))

Description, see chapter 5.6 from page 84 to 97.

Module	Description	Slot	Page
Safety BP/XP (PNO)	PROFIsafe V2.4 (BP) or V2.6.1 (XP) module for the PNO Encoder Profile	1,4,5,6	84
Submodule	**Description**	**Subslot**	**Page**
Telegram 36 (BP/XP)	INPUT: 16 bit safety status (S_ZSW1_ENC), 16 bit safety speed (S_NIST16), 32 bit safety position OUTPUT: 16 bit safety control (S_STW1_ENC), 32 bit safety preset value (S_PRESET32)	2	85
Telegram 37 (BP/XP)	INPUT: 16 bit safety status (S_ZSW1_ENC), 32 bit safety position OUTPUT: 16 bit safety control (S_STW1_ENC), 32 bit safety preset value (S_PRESET32)	2	85

5.2.5 PNO Encoder Profile, non-safety related (Channel 1/2 (PNO))

Description, see chapter 5.7 from page 98 to 117.

Module	Description	Slot	Page
Channel 1 (PNO)	Channel 1 standard module for the PNO Encoder Profil	2	98
Channel 2 (PNO)	Channel 2 standard module for the PNO Encoder Profil	3	98
Submodule	**Description**	**Subslot**	**Page**
Telegram 81	Channel 1 + 2 standard submodule INPUT: 16 bit encoder status2 (ZSW2_ENC), 16 bit sensor status (G1_ZSW), 32 bit position1 (G1_XIST1), 32 bit position2 (G1_XIST2) OUTPUT: 16 bit control2 (STW2_ENC), 16 bit sensor control (G1_STW)	2	99
Telegram 82	Channel 1 + 2 standard submodule INPUT: 16 bit encoder status2 (ZSW2_ENC), 16 bit sensor status (G1_ZSW), 32 bit position1 (G1_XIST1), 32 bit position2 (G1_XIST2), 16 bit velocity (NIST_A) OUTPUT: 16 bit control2 (STW2_ENC), 16 bit sensor control (G1_STW)	2	99
Telegram 83	Channel 1 + 2 standard submodule INPUT: 16 bit encoder status2 (ZSW2_ENC), 16 bit sensor status (G1_ZSW), 32 bit position1 (G1_XIST1), 32 bit position2 (G1_XIST2), 32 bit velocity (NIST_B) OUTPUT: 16 bit control2 (STW2_ENC), 16 bit sensor control (G1_STW)	2	99
Telegram 84	Channel 1 + 2 standard submodule INPUT: 16 bit encoder status2 (ZSW2_ENC) 16 bit sensor status (G1_ZSW), 64 bit position3 (G1_XIST3), 32 bit position2 (G1_XIST2), 32 bit velocity (NIST_B) OUTPUT: 16 bit control2 (STW2_ENC), 16 bit sensor control (G1_STW)	2	99

5.2.6 OPTION: Additional Interface

Description, see chapter 5.8 from page 118 to 121.

Module	Description	Slot	Page
SSI (TR)	SSI module for the TR Profile	5	118

Module	Description	Slot	Page
Incremental (TR)	Incremental module for the TR Profile	5	121

5.2.7 Legacy (TR) Profile

Description, see chapter 5.9 from page 122 to 132.

Module	Description	Slot	Page
Safety (Legacy)	PROFIsafe V2.4 (Basic Protocol (BP)) module, compatible with CD_75_-EPN INPUT: 16 bit cams, 16 bit TR-status, 16 bit velocity, 16 bit multi-turn, 16 bit single-turn, 4 byte safety message block OUTPUT: 16 bit TR-control1, 16 bit TR-control2, 16 bit preset multi-turn, 16 bit preset single turn, 4 byte safety message block.	1,4,5,6	122
Safety (Legacy) XP	PROFIsafe V2.6.1 (Expanded Protocol (XP)) module, compatible with CD_75_-EPN INPUT: 16 bit cams, 16 bit TR-status, 16 bit velocity, 16 bit multi-turn, 16 bit single-turn, 5 byte safety message block OUTPUT: 16 bit TR-control1, 16 bit TR-control2, 16 bit preset multi-turn, 16 bit preset single-turn, 5 byte safety message block.	1,4,5,6	122
Channel 1 (Legacy)	Standard module, compatible with CD_75_-EPN INPUT: 16 bit cams, 16 bit velocity, 16 bit multi-turn, 16 bit single-turn	2	129

5.3 TR Encoder Profile, safety-related (Safety (TR))

Back to the module overview, page 39.

The F-status byte `Safe Status` or F-Control Byte `Safe Control` contained in the `F_MessageTrailer` (process data) is contained in all safety-instrumented submodules (Position (BP/XP), Velocity (BP/XP), Position + Velocity (BP/XP)) and Acceleration + Position + Velocity (BP/XP)) and is therefore described only once in Chapter 7.1 from Page 134.

5.3.1 Submodule position (BP/XP)

As the submodules `Acceleration + Position + Velocity (BP/XP)` contain the same process data and parameters as the Submodule `Position (BP/XP)` with respect to the position output, the exact breakdown is therefore described only once in Chapter "Submodule Acceleration + Position + Velocity (BP/XP)", as from page 53.

5.3.1.1 Structure of the cyclic process data

Basic Protocol (BP)

Structure of input words 1 to 3, IO device -> Master

IW 1		**IW 2**	**IW 3**	**Safe Status, 3-Byte-CRC (V2.4)**
IB1	**IB2**			
Stat. 2	Stat. 1	Position		F_MessageTrailer4Byte

Stat.: TR status

Structure of output words 1 to 3, Master -> IO device

OW 1		**OW 2**	**OW 3**	**Safe Control, 3-Byte-CRC (V2.4)**
OB1	**OB2**			
Cont. 2	Cont. 1	Preset		F_MessageTrailer4Byte

Cont.: TR control

Expanded Protocol (XP)

Structure of input words 1 to 3, IO device -> Master

IW 1		**IW 2**	**IW 3**	**Safe Status, 4-Byte-CRC (V2.6.1)**
IB1	**IB2**			
Stat. 2	Stat. 1	Position		F_MessageTrailer5Byte

Stat.: TR status

Structure of output words 1 to 3, Master -> IO device

OW 1		**OW 2**	**OW 3**	**Safe Control, 4-Byte-CRC (V2.6.1)**
OB1	**OB2**			
Cont. 2	Cont. 1	Preset		F_MessageTrailer5Byte

Cont.: TR control

5.3.1.2 Configurable submodule-related IParameters (F_iPar)

Application-specific device properties are defined with the iParameters of the safety-related submodule `Position (BP)` and `Position (XP)`. The secure transmission of iParameters requires a CRC calculation, see Chapter 7.2.9 on Page 138.

The iParameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- ➢ The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Byte	Parameter	Data type	Description		Page
0	Rotational direction	Bit	Bit 0	0: backward 1: `forward`	59
1-4	Measuring range	Unsigned32	No. of steps/revolution * No. of revolutions Default value: `536870912` Value range: 2-536870912		59
5-8	Revolutions numerator	Unsigned32	Number of steps per revolution numerator value Default value: `65536` Value range: 1-256000		59
9-12	Revolutions denominator	Unsigned32	Number of steps per revolution denominator value Default value: `1` Value range: 1-16384		59
13-14	Window increments	Unsigned16	Max. permissible position deviation in increments Default value: `1000` Value range: 50-4000		64

5.3.1.3 Configurable submodule-related F-parameters (F_Par)

Safety-related parameters are defined with the F-Parameters of the safety-related submodule `Position (BP)` and `Position (XP)`. The secure transmission of F-Parameters requires a CRC calculation, see Chapter 7.2.10 on Page 138.

The F-Parameter can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0002`.

DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Parameter	BP	XP	Description
F_Check_iPar	X	X	`NoCheck`: No check
F_SIL	X	X	SIL1, `SIL2`, SIL3, no SIL
F_CRC_Length	X	–	`3-Byte-CRC`
	–	X	`4-Byte-CRC`
F_CRC_Seed	–	X	`CRC-Seed32`
F_Passivation	–	X	`Device/Module`
F_Block_ID	X	X	`1: uses F_iPar_CRC`: requires F_iPar_CRC
F_Par_Version	X	X	`1: V2 mode`
F_Source_Add	X	X	`1`: Source address = 1 Range: 1-65534
F_Dest_Add	X	X	`1`: Destination address = 1 Range: 1-65534
F_WD_Time	X	X	`125 ms`: Watchdog time = 125 Range: 10-10000 ms
F_Par_CRC	X	–	`9296`: CRC of F-parameters = 9296 Range: 0-65535
	–	X	`35282`: CRC of F-parameters = 35282 Range: 0-65535
F_iPar_CRC	X	X	`3489011925`: CRC iParameter = 3489011925 Range: 0-4294967295

X: applicable
–: not applicable

Centralized and detailed description of the F-parameters, see Chapter 7.2 from Page 137.

5.3.2 Submodule Velocity (BP/XP)

As the submodules `Acceleration + Position + Velocity (BP/XP)` contain the same process data and parameters as the Submodule `Velocity (BP/XP)` with respect to the velocity output, the exact breakdown is therefore described only once in Chapter "Submodule Acceleration + Position + Velocity (BP/XP)", as from page 53.

5.3.2.1 Structure of the cyclic process data

Basic Protocol (BP)

Structure of input words 1 to 2, IO device -> Master

IW 1	IW 2	Safe Status, 3-Byte-CRC (V2.4)
Velocity		F_MessageTrailer4Byte

Structure of output data, master -> IO device

Safe Control, 3-Byte-CRC (V2.4)
F_MessageTrailer4Byte

Expanded Protocol (XP)

Structure of input words 1 to 2, IO device -> Master

IW 1	IW 2	Safe Status, 4-Byte-CRC (V2.6.1)
Velocity		F_MessageTrailer5Byte

Structure of output data, master -> IO device

Safe Control, 4-Byte-CRC (V2.6.1)
F_MessageTrailer5Byte

5.3.2.2 Configurable submodule-related IParameters (F_iPar)

Application-specific device properties are defined with the iParameters of the safety-related submodule `Velocity (BP)` and `Velocity (XP)`. The secure transmission of iParameters requires a CRC calculation, see Chapter 7.2.9 on Page 138.

The iParameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Byte	Parameter	Data type	Description		Page
0	Velocity format	Bit-Area	Bit 2-0	Unit 000: rev/sec * factor 001: `rev/min * factor` 010: rev/hour * factor 011: steps/integration time	62
	Velocity filter intensity		Bit 6-3	Filter intensity value Default value: `0` Value range: 0-10	62
	Velocity filter type		Bit 7	Filter Type `0: static` 1: dynamic	63
1-2	Velocity factor	Unsigned16	Selected unit * factor Default value: `1` Value range: 1-1000		63
3-4	Velocity integration time	Unsigned16	Integration time [ms] Default value: `100` Value range: 1-1000		63
5-6	Window increments	Unsigned16	Max. permissible position deviation in increments Default value: `1000` Value range: 50-4000		64
7	Rotational direction	Bit	Bit 0	Sign setting Velocity Output 0: backward 1: forward	62

5.3.2.3 Configurable submodule-related F-parameters (F_Par)

Safety-related parameters are defined with the F-Parameters of the safety-related submodule `Velocity (BP)` and `Velocity (XP)`. The secure transmission of F-Parameters requires a CRC calculation, see Chapter 7.2.10 on Page 138.

The F-Parameter can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0002`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- ➢ The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Parameter	BP	XP	Description
F_Check_iPar	X	X	`NoCheck`: No check
F_SIL	X	X	SIL1, `SIL2`, SIL3, no SIL
F_CRC_Length	X	–	`3-Byte-CRC`
	–	X	`4-Byte-CRC`
F_CRC_Seed	–	X	`CRC-Seed32`
F_Passivation	–	X	`Device/Module`
F_Block_ID	X	X	`1: uses F_iPar_CRC`: requires F_iPar_CRC
F_Par_Version	X	X	`1: V2 mode`
F_Source_Add	X	X	`1`: Source address = 1 Range: 1-65534
F_Dest_Add	X	X	`1`: Destination address = 1 Range: 1-65534
F_WD_Time	X	X	`125 ms`: Watchdog time = 125 Range: 10-10000 ms
F_Par_CRC	X	–	`24611`: CRC of F-parameters = 24611 Range: 0-65535
	–	X	`52641`: CRC of F-parameters = 52641 Range: 0-65535
F_iPar_CRC	X	X	`3398001874`: CRC iParameter = 3398001874 Range: 0-4294967295

X: applicable
–: not applicable

Centralized and detailed description of the F-parameters, see Chapter 7.2 from Page 137.

5.3.3 Submodule Position + Velocity (BP/XP)

Since the `Acceleration + Position + Velocity (BP/XP)` submodules contain the same process data and parameters as the `Position + Velocity (BP/XP)` submodules with regard to position output and velocity output, the exact breakdown is described centrally in the chapter “Submodule Acceleration + Position + Velocity (BP/XP)”, as from page 53.

5.3.3.1 Structure of the cyclic process data

Basic Protocol (BP)

Structure of input words 1 to 5, IO device -> Master

IW 1		**IW 2**	**IW 3**	**IW 4**	**IW 5**	**Safe Status, 3-Byte-CRC (V2.4)**
IB1	**IB2**					
Stat. 2	Stat. 1	Position		Velocity		F_MessageTrailer4Byte

Stat.: TR status

Structure of output words 1 to 3, Master -> IO device

OW 1		**OW 2**	**OW 3**	**Safe Control, 3-Byte-CRC (V2.4)**
OB1	**OB2**			
Cont. 2	Cont. 1	Preset		F_MessageTrailer4Byte

Cont.: TR control

Expanded Protocol (XP)

Structure of input words 1 to 5, IO device -> Master

IW 1		**IW 2**	**IW 3**	**IW 4**	**IW 5**	**Safe Status, 4-Byte-CRC (V2.6.1)**
IB1	**IB2**					
Stat. 2	Stat. 1	Position		Velocity		F_MessageTrailer5Byte

Stat.: TR status

Structure of output words 1 to 3, Master -> IO device

OW 1		**OW 2**	**OW 3**	**Safe Control, 4-Byte-CRC (V2.6.1)**
OB1	**OB2**			
Cont. 2	Cont. 1	Preset		F_MessageTrailer5Byte

Cont.: TR control

5.3.3.1.1 Configurable submodule-related iParameter (F_iPar)

The iParameters of the safety-related submodules `Position + Velocity (BP)` and `Position + Velocity (XP)` are used to define application-dependent device properties. A CRC calculation is required for secure transmission of the iParameters; see section 7.2.9 on page 138.

The iParameters can be set using an input mask in the project planning tool in accordance with the table below and are automatically sent by the controller to the measuring system during startup via the Record Data object with index `0x0001`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- ➢ The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Byte	Parameter	Data type	Description		Page
0	Rotational direction	Bit	Bit 0	0: backward 1: `forward`	59
1-4	Measuring range	Unsigned32	No. of steps/revolution * No. of revolutions Default value: `536870912` Value range: 2-536870912		59
5-8	Revolutions numerator	Unsigned32	Number of steps per revolution numerator value Default value: `65536` Value range: 1-256000		59
9-12	Revolutions denominator	Unsigned32	Number of steps per revolution denominator value Default value: `1` Value range: 1-16384		59
13	Velocity format	Bit-Area	Bit 2-0	Unit 000: rev/sec * factor 001: `rev/min * factor` 010: rev/hour * factor 011: steps/integration time	62
	Velocity filter intensity		Bit 6-3	Filter intensity value Default value: `0` Value range: 0-10	62
	Velocity filter type		Bit 7	Filter Type `0: static` 1: dynamic	63
14-15	Velocity factor	Unsigned16	Selected unit * factor Default value: `1` Value range: 1-1000		63
16-17	Velocity integration time	Unsigned16	Integration time [ms] Default value: `100` Value range: 1-1000		63
18-19	Window increments	Unsigned16	Max. permissible position deviation in increments Default value: `1000` Value range: 50-4000		64

5.3.3.1.2 Configurable submodule-related F-parameters (F_Par)

Safety-related parameters are defined with the F-Parameters of the safety-related submodule `Position + Velocity (BP)` and `Position + Velocity (XP)`. The secure transmission of F-Parameters requires a CRC calculation, see Chapter 7.2.10 on Page 138.

The F-Parameter can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0002`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Parameter	BP	XP	Description
F_Check_iPar	X	X	`NoCheck`: No check
F_SIL	X	X	SIL1, `SIL2`, SIL3, no SIL
F_CRC_Length	X	–	`3-Byte-CRC`
	–	X	`4-Byte-CRC`
F_CRC_Seed	–	X	`CRC-Seed32`
F_Passivation	–	X	`Device/Module`
F_Block_ID	X	X	`1: uses F_iPar_CRC`: requires F_iPar_CRC
F_Par_Version	X	X	`1: V2 mode`
F_Source_Add	X	X	`1`: Source address = 1 Range: 1-65534
F_Dest_Add	X	X	`1`: Destination address = 1 Range: 1-65534
F_WD_Time	X	X	`125 ms`: Watchdog time = 125 Range: 10-10000 ms
F_Par_CRC	X	–	`4590`: CRC of F-parameters = 4590 Range: 0-65535
	–	X	`48236`: CRC of F-parameters = 48236 Range: 0-65535
F_iPar_CRC	X	X	`3008999609`: CRC iParameter = 3008999609 Range: 0-4294967295

X: applicable
–: not applicable

Centralized and detailed description of the F-parameters,
see Chapter 7.2 from Page 137.

5.3.4 Submodule Acceleration + Position + Velocity (BP/XP)

Available from firmware version 2.xx

5.3.4.1 Structure of cyclic process data

Basic Protocol (BP)

Structure of the inputs words 1 up to 6, IO-Device -> Master

IW 1		IW 2	IW 3	IW 4	IW 5	IW 6	Safe Status, 3-Byte-CRC (V2.4)
IB1	IB2						
Stat. 2	Stat. 1	Acceleration	Position		Velocity		F_MessageTrailer4Byte

Stat.: TR-Status

Structure of the output words 1 up to 3, Master -> IO-Device

OW 1		OW 2	OW 3	Safe Control, 3-Byte-CRC (V2.4)
OB1	OB2			
Cont. 2	Cont. 1	Preset		F_MessageTrailer4Byte

Cont.: TR-Control

Expanded Protocol (XP)

Structure of the input words 1 up to 6, IO-Device -> Master

IW 1		IW 2	IW 3	IW 4	IW 5	IW 6	Safe Status, 4-Byte-CRC (V2.6.1)
IB1	IB2						
Stat. 2	Stat. 1	Acceleration	Position		Velocity		F_MessageTrailer5Byte

Stat.: TR-Status

Structure of the output words 1 up to 3, Master -> IO-Device

OW 1		OW 2	OW 3	Safe Control, 4-Byte-CRC (V2.6.1)
OB1	OB2			
Cont. 2	Cont. 1	Preset		F_MessageTrailer5Byte

Cont.: TR-Control

5.3.4.1.1 Input TR Status1 (Stat. 1)

⚠ WARNING

NOTICE

If the drive system starts uncontrolled and the `Safe State` bit 2^4 fails to be evaluated, there is the danger of death, serious physical injury and/or damage to property!

- ➢ The output actual values are only valid if the `Safe State` bit 2^4 = 1.

Input byte 2, Unsigned8

Bit	Description
0	`Velocity Error` Bit = 1, if the velocity value is outside the range –2147483648…+2147483647. The bit is automatically reset when the velocity value is within the permissible range.
1	`Acceleration Error` Bit = 1 if the acceleration value is outside the range of –32768…+32767. The bit is automatically reset when the acceleration value is back within the permissible range.
2	`Preset OK` Bit = 1, if a preset request was executed successfully.
3	`Preset Error` Bit = 1, if a preset request was not executed because of an error. The bits can be reset using the `Preset Request` and `Preset Preparation` preset control bits; see also Chapter 5.3.4.1.6 on Page 56.
4	`Safe State` Bit = 0, - in the initialization phase or, rather, if initialization was unsuccessful - if a preset request is initiated using the `Preset Preparation` control bit - if the measuring system is in safe state Bit = 1, - if initialization was completed successfully - if the `Preset Request` and `Preset Preparation` preset control bits were reset
5	`Preset Active` Bit = 1, if execution of the preset function is triggered via the `Preset Request` control bit. After the preset function has been executed, the bit is reset automatically; see also page 131.
6	reserved
7	`Scaling Error` Bit = 1, if the measuring system was run in de-energized state. As it is impossible to verify whether a zero transition has been generated in this case, the issued position must first be verified with the desired mechanical position before the application is started. After positive verification, the bit can be cleared by executing the preset adjustment function, see Chapter 5.3.4 on Page 53.

5.3.4.1.2 Input TR Status2 (Stat. 2)

Input byte 1, Unsigned8

Bit	Description
0	`Error Ack Request` Bit = 1 if the measuring system is in the safe state and is waiting for an error acknowledgment. This bit is control-dependent and can only be acknowledged by means of a re-integration of the measuring system.
1	`Preset Locked` Bit = 1, if a preset is already being executed in another safety-related submodule of a shared device application. In order to avoid inconsistencies, this submodule will not be able to run a preset until the preset operation has been completed in the other application.
2…7	reserved

5.3.4.1.3 Input Acceleration

The `Acceleration` register outputs the current ***scaled*** safety-related acceleration of the measurement system as a signed 16-bit two's complement value. Default setting: (`U/sec²`), see “Acceleration format” parameter on page 64.

Structure of the input data, IO device -> master

Integer16

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

5.3.4.1.4 Input Position

The current ***scaled*** absolute actual safety-related position of the measuring system is output unsigned as a right-justified 32-bit binary value via the `Position` register.

Structure of input data, IO device -> master

Integer32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.3.4.1.5 Input Velocity

The current ***scaled*** safety-related velocity of the measuring system is output as a signed 32-bit two’s complement value via the `Velocity` register. Default setting: `Rev/min`, see parameter “Velocity format” on Page 62.

Structure of input data, IO device -> master

Integer32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.3.4.1.6 Output TR-Control1 (Cont. 1)

Output byte 2, Unsigned8

Bit	Description
0	`Preset Preparation` This bit serves to prepare the preset adjustment function. The actual preset function can only be set using the `Preset Request` control bit if this bit is set. This function can only be executed when the corresponding sequence is exactly followed; see Chapter "Preset adjustment function" on Page 67.
1	`Preset Request` This bit serves to control the preset adjustment function. When this function is executed, the measuring system is set to the actual position value stored in the `Output Preset` register. This function can only be executed when the corresponding sequence is exactly followed; see Chapter "Preset adjustment function" on Page 67.
2…7	reserved

5.3.4.1.7 Output TR-Control2 (Cont. 2)

Output byte 1, Unsigned8

Bit	Description
0…7	reserved

5.3.4.1.8 Output Preset

The zero point of the measuring system can be adapted to the mechanical zero point via the `Preset` register. The desired preset value must be in the range of 0 to (measuring range in steps – 1), otherwise the preset adjustment function will not be executed and in `TR-Status1`, Bit 3 `Preset Error` is set to = 1.
The preset value is set as new position when the preset adjustment function is executed; see Chapter 5.3.4 on Page 53.

Structure of output data, master -> IO device

Integer32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.3.4.2 Configurable submodule-related iParameters (F_iPar)

Application-specific device properties are defined with the iParameters of the safety-related submodule `Acceleration + Position + Velocity (BP)` and `Acceleration + Position + Velocity (XP)`. The secure transmission of iParameters requires a CRC calculation, see Chapter 7.2.9 on Page 138.

The iParameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Byte	Parameter	Data type	Description		Page
25	PROFIsafe Address type	Unsigned8	PPOFIsafe address type 81 = `Address type 1` 82 = Address type 2		58
0	Rotational direction	Bit	Bit 0	0: backward 1: `forward`	59
1-4	Measuring range	Unsigned32	No. of steps/revolution * No. of revolutions Default value: `536870912` Value range: 2-536870912		59
5-8	Revolutions numerator	Unsigned32	Number of steps per revolution numerator value Default value: `65536` Value range: 1-256000		59
9-12	Revolutions denominator	Unsigned32	Number of steps/revolution denominator value Default value: `1` Value range: 1-16384		59
13	Velocity format	Bit-Area	Bit 2-0	Unit 000: rev/sec * factor 001: `rev/min * factor` 010: rev/hour * factor 011: steps/integration time	62
	Velocity filter intensity		Bit 6-3	Filter intensity value Default value: `0` Value range: 0-10	62
	Velocity filter type		Bit 7	Filter Type `0: static` 1: dynamic	63
14-15	Velocity factor	Unsigned16	Selected unit * factor Default value: `1` Value range: 1-1000		63

Continued on the following page

Continuation

Byte	Parameter	Data type	Description		Page
16-17	Velocity integration time	Unsigned16	Integration time [ms] Default value: `100` Value range: 1-1000		63
18-19	Window increments	Unsigned16	Max. permissible position deviation in increments Default value: `1000` Value range: 50-4000		64
20	Acceleration format	Bit-Bereich	Bit 2-0	Unit 000: $rev/sec^2 * factor$ 010: steps/(integration time)^2	64
21-22	Acceleration factor	Unsigned16	Selected unit * factor Default value: `1` Value range: 1-1000		65
23-24	Acceleration integration time	Unsigned16	Integration time [ms] Default value: `100` Value range: 50-1000		65

5.3.4.2.1 PROFIsafe Address type

A detailed description of the address types can be found in Chapter 3.4 starting on page 23.

Selection	Value	Description	Default
1	81	Preselection: PROFIsafe Address type 1	X
2	82	Preselection: PROFIsafe Address type 2	

5.3.4.2.2 Rotational direction

WARNING

NOTICE

Danger of death, severe personal injury and/or material damage due to a jump in the absolute value when the code sequence is changed!

- The internal calculation algorithm results in different absolute positions for the counting direction settings `backward` and `forward`. Therefore, after changing the rotational direction, verify the correct function by a protected test run first. Under certain circumstances, the output position must be adjusted via the preset function.

Selection	Value	Description	Default
backward	0	Measuring system – position descending clockwise (looking at shaft, flange connection)	
forward	1	Measuring system – position ascending clockwise (looking at shaft, flange connection)	X

5.3.4.2.3 Scaling parameter

WARNING

NOTICE

Risk of physical injury and material damage due to shifting of the zero point when the measuring system is switched on again after positioning in de-energized state!

If the scaling parameter settings listed below deviate from the default settings, the zero point of the multi-turn measuring system may be lost if more than the permissible revolutions are performed in the de-energized state!

- SIL2 – measuring system: Make sure that positioning operations in de-energized state take place within 3200 revolutions on a multiturn measuring system.
- SIL3 – measuring system: Make sure that positioning operations in de-energized state take place within 320 revolutions on a multiturn measuring system.
- If this cannot be ensured, the issued position must first be verified with the desired mechanical position before the application can be started.
  If the permissible revolutions have been exceeded, this fact is indicated by a PROFINET diagnostic alarm of error type 8211_{dec} when the measuring system restarts. This fact is displayed in `TR-Status1`, Bit 7 `Scaling Error` = 1 via the cyclic process input data. After positive verification, the PROFINET diagnostic alarm bit and the `Scaling Error` bit can be cleared by executing the preset adjustment function, see Chapter 5.3.4 on Page 53.

The physical resolution of the measuring system can be changed using the scaling parameters. The measuring system supports the gear function for rotary axes.

This means that the ***number of steps per revolution*** and the quotient of `Revolutions numerator / Revolutions denominator` can be a decimal number.

The output actual position value is offset by a zero-point correction, the set counting direction and the entered gearbox parameter.

MEASURING RANGE

Defines the total number of steps of the measuring system, before the measuring system starts at 0 again.

Lower limit	2 steps
Upper limit	536 870 912 steps (30 bits)
Default	**536870912**

The actual upper limit value to be entered for the `measuring range` in steps depends on the measuring system design and can be calculated using the formula below. As the value "0" is already counted as a step, the end value = measuring range in steps - 1.

Measuring range = steps per revolution * number of revolutions

For the purposes of calculation, the parameters ***Steps/Revolution*** and ***Number of Revolutions*** can be taken from the measuring system nameplate.

REVOLUTIONS NUMERATOR / REVOLUTIONS DENOMINATOR

These two parameters together define the ***number of revolutions***, before the measuring system starts at 0 again.

As decimal numbers are not always finite (such as 3.4), but may have an infinite number of digits after the decimal point (such as 3.43535355358774...) the number of revolutions is entered as a fraction.

Numerator lower limit	1
Numerator upper limit	256000
Default numerator	**65536**

Denominator lower limit	1
Denominator upper limit	16384
Denominator default	**1**

Formula for gearbox calculation:

$$\text{Measuring range in steps} = \text{number of steps per revolution} * \frac{\text{Number of numerator revolutions}}{\text{Number of denominator revolutions}}$$

If it is not possible to enter parameter data in the permitted ranges of numerator and denominator, the attempt must be made to reduce these accordingly. If this is not possible, it may only be possible to represent the relevant decimal number approximately. The resulting minor inaccuracy accumulates for real round axis applications (infinite applications with motion in one direction).
A solution is e.g. to perform adjustment after each revolution or to adapt the mechanics or gear ratio accordingly.

The parameter **Number of steps per revolution** may also be a decimal number, however the `measuring range` may not. The result of the above formula must be rounded up or down. The resulting error is distributed over the total number of revolutions programmed and is therefore negligible.

Preferably for linear axes (forward and backward motion):

The parameter `Revolutions denominator` can be programmed as a fixed value of “1” for linear axes. The parameter `Revolutions numerator` is programmed slightly higher than the required number of revolutions. This ensures that the measuring system does not generate an actual value jump (zero transition) if the travel is slightly exceeded. For the sake of simplicity, the full revolution range of the measuring system can also be programmed.

The following example serves to illustrate the approach.

Given:

Measuring system with 4096 steps/rev. and max. 4096 revolutions

Resolution 1/100 mm

Make sure that the measuring system is programmed in its full resolution and measuring range (4096x4096):
Measuring range in steps = 16777216,
Revolutions numerator = 4096
Denominator revolutions = 1
Set the mechanics to be measured to the left stop position

Set measuring system to "0" by adjustment

Set the mechanics to be measured to the end position

Measure the mechanical distance covered in mm

Read off the actual position of the measuring system on the connected control

Assumption:

Distance covered = 2000 mm

Measuring system actual position after 2000 mm = 607682 steps

Consequently:

Number of revolutions covered = 607682 steps / 4096 steps/rev.
= **148.3598633 revolutions**

Number of mm/revolution = 2000 mm/148.3598633 revs. = **13.48073499 mm/rev.**

For a resolution of 1/100 mm, this equates to **1348.073499 steps/revolution**

required programming:

Number of numerator revolutions = ***4096***
Number of denominator revolutions = ***1***

$$\text{Measuring range in steps} = \text{number of steps per revolution} * \frac{\text{Number of numerator revolutions}}{\text{Number of denominator revolutions}}$$

$$= 1348.073499\ \text{steps / rev.} * \frac{4096\ \text{numerator revolutions}}{1\ \text{denominator revolution}}$$

= ***5521709 steps*** *(rounded)*

5.3.4.2.4 Velocity format

Indicates the resolution at which the velocity is calculated and output.

The velocity is output signed, as a two's complement:

- Counting direction setting = forward
  - Output positive, with clockwise rotation (looking at flange connection)
- Counting direction setting = backward
  - Output negative, with clockwise rotation (looking at flange connection)

If the velocity value range (-2147483648…+2147483647) is exceeded or not reached, the limit values (0x7FFF FFFF or 0x8000 0000) are output and `TR status1` Bit 2^0 `Velocity Error` is set to 1.

Selection	Value	Velocity output	Default
rev/sec * factor [1)]	0	Output in [rev./second], multiplied by the factor set under the *`Velocity factor`* parameter, see Page 63	
rev/min * factor [1)]	1	Output in [rev./minute], multiplied by the factor set under the `Velocity factor` parameter, see page 63	X
rev/hour * factor [1)]	2	Output in [rev./hour], multiplied by the factor set under the `Velocity factor` parameter, see page 63	
steps/integration time	3	Output in [steps/ms] Resolution : scaled steps/rev.	

[1)] For the selection 0-2 the scaling has no influence on the calculation of the velocity.

5.3.4.2.5 Velocity filter intensity

Using the `Velocity filter intensity` parameter, the output velocity can be averaged. The parameter serves to setup a lowpass filter working on the measuring system's actual velocity value. Higher intensity values allow stronger filtering yielding to lower cut-off frequencies. High acceleration motion profiles require lower filter intensities. Refer to the following described parameter `Velocity filter type`, for a dynamic filter engagement according to the current motion status.

Data type	Bit-Area
Lower limit	0
Upper limit	10
Default	**0**

0: no filtering

1: weak filtering, high cut-off frequency

. . .

10: strong filtering, low cut-off frequency

5.3.4.2.6 Velocity filter type

See also parameter `Velocity filter intensity` on page 62.

Selection	Value	Description	Default
static	0	The lowpass filter characteristic is applied on the actual velocity value regardless of the drive's current motion and acceleration status, respectively.	X
dynamic	1	The lowpass filter characteristic is deactivated as soon as the measuring system detects a significant acceleration in the velocity signal. The lowpass filter will be reactivated as soon as a uniform motion is detected from the measuring system.	

5.3.4.2.7 Velocity factor

Indicates the factor value for the `Velocity format` parameter, see page 62

Lower limit	1
Upper limit	1000
Default	**1**

5.3.4.2.8 Velocity integration time

Indicates the integration time in [ms] for the *`Velocity format`* parameter, see page 62.

Generally, the parameter serves to calculate the velocity, which is output via the cyclic process data. Long integration times allow high-resolution measurements at low speeds. Low integration times show velocity changes more quickly and are suitable for high velocitys and high dynamics.

Lower limit	1 ms
Upper limit	1000 ms
Default	**100 ms**

Example for the unit "steps/integration time

Given: - Programmed resolution = 8192 steps per revolution
- Speed = 4800 revolutions per minute
- Integration time t_i = 50 ms = 0.05 s

Wanted: - Output value in steps/integration time

$$\text{Number of steps / s} = \frac{8192 \text{ steps} * 4800 \cancel{\text{rev.}}}{\cancel{\text{Rev.}} * 60 \text{ s}} = \frac{655360 \text{ steps}}{1 \text{ s}}$$

$$\text{Number of steps/t} = \frac{655360 \text{ steps}}{1 \text{ s}} * 0.05 \text{ s} = 32768 \text{ steps}$$

Steps/integration time = <u>32768 steps / 50 ms</u>

The integration time with the units rev/sec, rev/min and rev/hour (see chapter: 5.3.4.2.4) has no influence on the amount of the velocity. These units always indicate the real revolutions of the shaft. The integration time has here only an effect on the resolution and the dynamics.

5.3.4.2.9 Window increments

This parameter defines the maximum permissible position deviation in increments of the master / slave scanning systems integrated in 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. Values are within a range of 50…4000 increments. Standard value = 1000 increments.

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

The position deviation in increments is always based on the non-scaled resolution of 13 bits = 8192 steps/revolution.

5.3.4.2.10 Acceleration format

Specifies the resolution at which acceleration is calculated and output.

The acceleration is output as a two's complement with a sign:

- Counting direction setting = forward
  - Output positive, during acceleration in the ↻ direction or deceleration in the ↺ direction (Viewing direction toward flange connection)
- Counting direction setting = backward
  - Output negative, during acceleration in the ↻ direction or deceleration in the ↺ direction (Viewing direction toward flange connection)

If the acceleration value range (-32768…+32767) is exceeded or not reached, the limit values (0x7FFF or 0x8000) are output and bit 2^1 `Acceleration Error` is set to 1 in `TR-Status1`.

Selection	Value	Acceleration output	Default
rev/sec^2 * factor [1)]	0	Output in [revolution/second^2], multiplied by the factor set under the `Acceleration factor` parameter, see page 65	X
steps/(integration time)^2	2	Output in [steps/ms^2] Resolution: scaled steps/revolution	

[1)] For selection 0, the scaling has no influence on the calculation of acceleration.

5.3.4.2.11 Acceleration factor

Specifies the factor value for the `Acceleration format` parameter, see page 64.

Lower limit	1
Upper limit	1000
Default	**1**

5.3.4.2.12 Acceleration integration time

Specifies the integration time in [ms] for the `Acceleration format` parameter, see page 64

The parameter is generally used to calculate the acceleration, which is output via the cyclic process data. High integration times enable high-resolution measurements with slow speed changes (low dynamics). Low integration times display acceleration changes more quickly and are well suited for fast speed changes (high dynamics).

Lower limit	50 ms
Upper limit	1000 ms
Default	**100 ms**

Example for the unit "Steps / (Integration time)²"

Given: - Programmed resolution = 8192 steps per revolution
- Integration time t_i = 100 ms = 0.1 s
- Measuring system accelerates from 1000 rpm (v1) to 1200 rpm (v2) in 100 ms.

Wanted: - Output of acceleration in Steps / (Integration time)^2

Change of speed, (∆v):

$\Delta v = v2 - v1 = 1200\ 1/\text{min} - 1000\ 1/\text{min} = 200\ 1/\text{min}$

Acceleration (a):

$$a_{rev/s^2} = \Delta v / \Delta t = \frac{200\ \text{rev}}{60\ \text{s} * 0.1\ \text{s}} = 33.33\ \text{rev/s}^2$$

$$a_{steps/(integration\ time)^2} = \frac{33.33\ \cancel{\text{rev}} * 8192\ \text{steps}}{\text{s}^2\ \cancel{\text{rev}} * (\text{integration time})^2} = \frac{273066.6666\ \text{steps}}{(10 * \text{integration time})^2}$$

$$= \frac{273066.6666\ \text{steps}}{100 * (\text{integration time})^2} = \frac{2730.666666\ \text{steps}}{(\text{integration time})^2}$$

$a_{steps/(integration\ time)^2} \approx$ **<u>2731 steps / (100 ms)²</u>**

This means that the speed increases by approximately 2731 steps/100 ms in the integration interval of 0.1 s. The unit `Steps/(Integration time)`^{2} expresses how much the speed changes per integration time, measured in steps.

5.3.4.3 Configurable submodule-related F-parameters (F_Par)

Safety-related parameters are defined with the F-Parameters of the safety-related submodule `Acceleration + Position + Velocity (BP)` and `Acceleration + Position + Velocity (XP)`. The secure transmission of F-Parameters requires a CRC calculation, see Chapter 7.2.10 on Page 138.

The F-Parameter can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0002`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Parameter	BP	XP	Description
F_Check_iPar	X	X	`NoCheck`: No check
F_SIL	X	X	SIL1, `SIL2`, SIL3, no SIL
F_CRC_Length	X	–	`3-Byte-CRC`
	–	X	`4-Byte-CRC`
F_CRC_Seed	–	X	`CRC-Seed32`
F_Passivation	–	X	`Device/Module`
F_Block_ID	X	X	`1: uses F_iPar_CRC`: requires F_iPar_CRC
F_Par_Version	X	X	`1: V2 mode`
F_Source_Add	X	X	`1`: Source address = 1 Range: 1-65534
F_Dest_Add	X	X	`1`: Destination address = 1 Range: 1-65534
F_WD_Time	X	X	`125 ms`: Watchdog time = 125 Range: 10-10000 ms
F_Par_CRC	X	–	`54507`: CRC of F-parameters = 54507 Range: 0-65535
	–	X	`31081`: CRC of F-parameters = 31081 Range: 0-65535
F_iPar_CRC	X	X	`4183745132`: CRC iParameter = 4183745132 Range: 0-4294967295

X: applicable
–: not applicable

Centralized and detailed description of the F-parameters, see Chapter 7.2 from Page 137.

5.3.5 Preset adjustment function

WARNING

NOTICE

Risk of death, serious physical injury and/or damage to property if the drive system starts uncontrolled while executing the Preset Adjustment function!

- The relevant drive systems must be locked to prevent automatic start-up
- We recommend to protect triggering of the preset adjustment function via the F Host by taking additional safety measures, such as key-operated switch, password, etc.
- It is absolutely necessary to follow the operational sequence described below, particularly to evaluate the status bits by means of the F Host, in order to check whether the preset adjustment function has been executed successfully or unsuccessfully
- The new position must be checked after execution of the preset function

The preset adjustment function is used to set the currently output actual position value to any actual position value within the scaled measuring range. This allows setting the displayed position to a machine reference position electronically.

5.3.5.1 Procedure

- Requirement: The measuring system is in cyclical data exchange mode.
- Set the `Preset` register in the output data of the safety-related submodule to the desired preset value.
- Set the control bits `Preset Preparation` and `Preset Request` to 0.
- Set the `Preset Preparation` control bit to 1. In response, the `Safe State` status bit is set to 0, whereupon the F Host must transfer the system to the safe state. The output actual position value is not safe any longer!
- The preset value is applied with a rising edge of the `Preset Request` control bit. Receipt of the preset value is acknowledged by setting (= 1) the `Preset Active` status bit. Once execution of the preset function has been completed, the `Preset Active` status bit is reset to 0.
- After receipt of the preset value, the measuring system checks whether all prerequisites for execution of the preset adjustment function are fulfilled. If yes, the preset value is written as the new actual position value. If no, execution is rejected and an error message is output by setting the `Preset Error` status bit.
- After successful execution of the preset adjustment function, the measuring system sets the `Preset OK` status bit to 1, thus signaling to the F Host that execution of the preset adjustment function has been completed.
- Reset the `Preset Request` control bit to 0.
- Reset the `Preset Preparation` control bit to 0. In response, the `Safe State` status bit is set to 1 again.
- Finally, the F Host must check that the new position corresponds to the new command position.

5.3.5.2 Timing – diagram

Blue area:	Output signals F Host-> measuring system
Orange area:	Input signals measuring system-> F Host

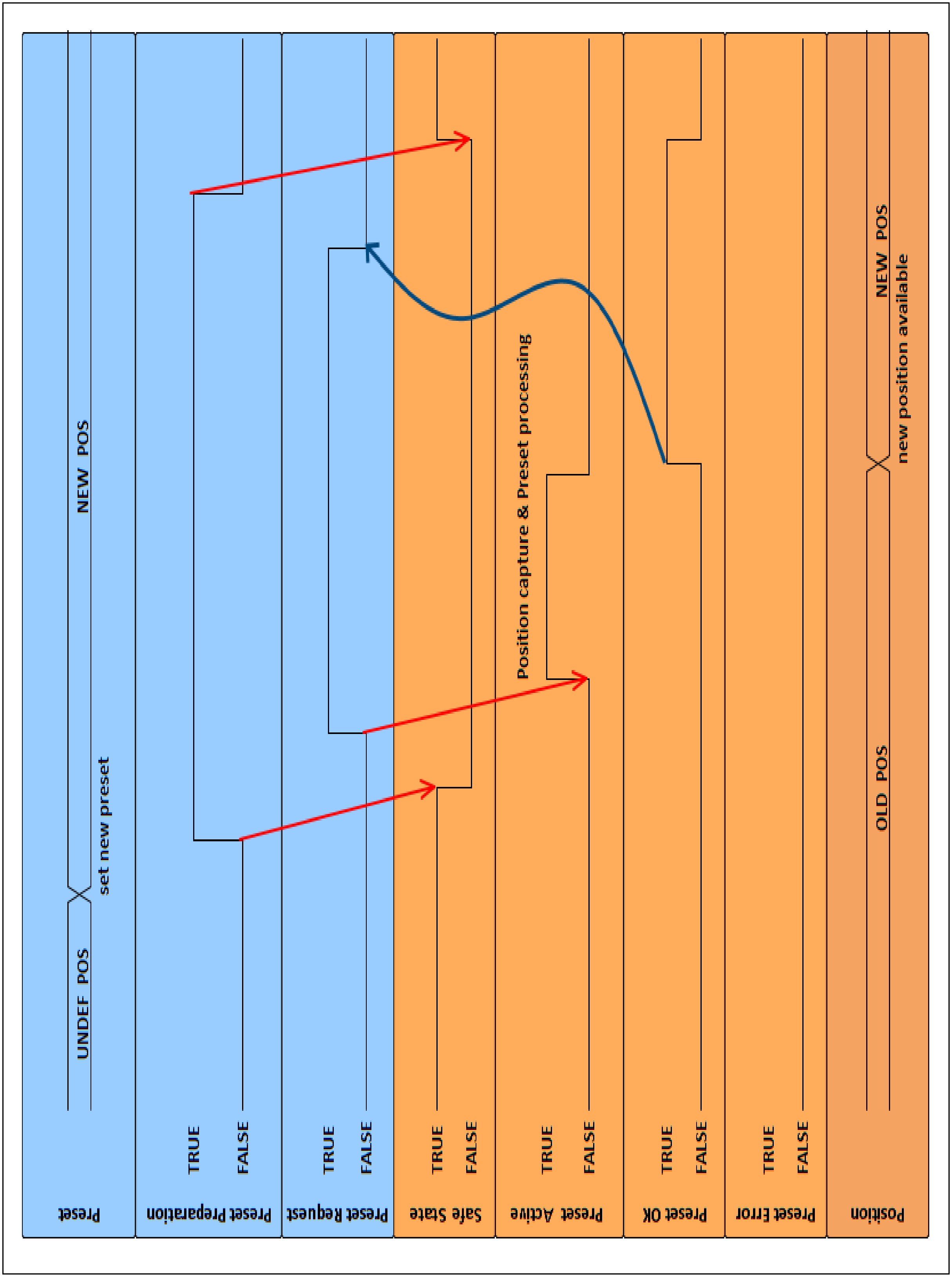


Figure 9: Preset Timing Diagram

5.3.5.3 Calculating the delay for a moving axis

If the preset adjustment function is executed while the axis is in motion, processing and run-times in the control system and the speed of the measuring system play a major role for the delay between preset execution and actually setting the value. The faster the axis moves, the greater the delay, measured in revolutions.
The delay can also be expressed in steps when using the programmed `Number of steps per revolution`.

The following example explains these facts in more detail.

Given:
- Programmed resolution = 8192 steps per revolution
- Speed: n = 3000 revolutions per minute
- Processing time in the controller: $t_{Control}$ = 100 ms (application-specific)
- Transmission time via the PROFINETnetwork: $t_{PROFINET}$ = 2 ms (application-specific)
- Processing time in the measuring system: $t_{measuring\ system} \leq 10$ ms

Wanted:
- Delay in revolutions and steps

The static delay time t_{static} [ms] results from the addition of processing times and PROFINET transmission time:

$t_{static} = t_{control} + t_{PROFINET} + t_{measuring\ system}$ = 100 ms + 2 ms + 10 ms = **<u>112 ms</u>**

The dynamic delay in revolutions $V_{dynamic}$ results from the static delay time multiplied by the speed:

$$V_{dynamic} = t_{static} * n \quad = \quad \frac{0.112\ \cancel{s} * 3000\ rev.}{60\ \cancel{s}} = \underline{\mathbf{5.6\ rev.}}$$

The steps taken result from:

$$V_{dynamic} * Resolution \quad = \quad \frac{5.6\ \cancel{Rev.} * 8192\ steps}{\cancel{Rev.}} = \underline{\mathbf{45875\ steps}}$$

5.4 TR Encoder Profile, non-safety related (Channel 1/2 (TR))

Back to the module overview, page 39.

The following description also applies to modules `Channel 1-2 (TR)` and `Channel 2-2 (TR)` intended for use in shared device applications. For more information, see page 83.

5.4.1 Configurable module-related parameters

The Parameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

Byte	Parameter	Data type	Description		Page
0	Option 1	Unsigned16	reserved		-
2-5	Option 2	Unsigned32	reserved		-
6	Coupled channel	Bit	Bit 0	0: `off` 1: on	70

5.4.1.1 Coupled channel

Use the setting `Coupled channel = on` to specify whether the non-safety-related channel `Channel 1 (TR)` or `Channel 2 (TR)` should be linked to the safety-related `Safety (TR)` channel. The position, velocity and the acceleration settings are used by the safety-oriented channel `Safety (TR)` and the current settings in the channel `Channel 1 (TR)` or `Channel 2 (TR)` are ignored.

The preset function can only be performed in the safety-related `Safety (TR)` channel, but the preset function in the non-safety-related `Channel 1 (TR)` or `Channel 2 (TR)` channel is disabled.

5.4.2 Submodule Position

5.4.2.1 Structure of the cyclic process data

The current ***scaled*** absolute actual position of the measuring system is output unsigned as a right-justified 32-bit binary value via the submodule `Position`.

Structure of input data, IO device -> master

Unsigned32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.4.2.2 Configurable submodule-related parameters

The Parameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

Byte	Parameter	Data type	Description		Page
0	Rotational direction	Bit	Bit 0	0: backward 1: `forward`	71
1-4	Measuring range	Unsigned32	No. of steps/revolution * No. of revolutions Default value: `536870912` Value range: 2-536870912		72
5-8	Revolutions numerator	Unsigned32	Number of steps per revolution numerator value Default value: `65536` Value range: 1-256000		72
9-12	Revolutions denominator	Unsigned32	Number of steps per revolution denominator value Default value: `1` Value range: 1-16384		72

5.4.2.2.1 Rotational direction

⚠ WARNING

NOTICE

Danger of death, severe personal injury and/or material damage due to a jump in the absolute value when the code sequence is changed!

- ➢ The internal calculation algorithm results in different absolute positions for the counting direction settings `backward` and `forward`. Therefore, after changing the rotational direction, verify the correct function by a protected test run first. Under certain circumstances, the output position must be adjusted via the preset function.

Selection	Value	Description	Default
backward	0	Measuring system – position descending clockwise (looking at shaft, flange connection)	
forward	1	Measuring system – position ascending clockwise (looking at shaft, flange connection)	X

5.4.2.2.2 Scaling parameter

⚠ WARNING

NOTICE

Risk of physical injury and material damage due to shifting of the zero point when the measuring system is switched on again after positioning in de-energized state!

The zero point of the multiturn measuring system may be lost if more than 32767 revolutions are executed in de-energized state!

- Make sure that positioning operations in de-energized state take place within 32767 revolutions on a multiturn measuring system.
- If this cannot be ensured, the issued position must first be verified with the desired mechanical position before the application can be started.

The physical resolution of the measuring system can be changed using the scaling parameters. The measuring system supports the gear function for rotary axes.

This means that the ***number of steps per revolution*** and the quotient of `Revolutions numerator / Revolutions denominator` can be a decimal number.

The output actual position value is offset by a zero-point correction, the set counting direction and the entered gearbox parameter.

MEASURING RANGE

Defines the total number of steps of the measuring system, before the measuring system starts at 0 again.

Lower limit	2 steps
Upper limit	536 870 912 steps (30 bits)
Default	**536870912**

The actual upper limit value to be entered for the `measuring range` in steps depends on the measuring system design and can be calculated using the formula below. As the value "0" is already counted as a step, the end value = measuring range in steps - 1.

Measuring range = steps per revolution * number of revolutions

For the purposes of calculation, the parameters ***Steps/Revolution*** and ***Number of Revolutions*** can be taken from the measuring system nameplate.

REVOLUTIONS NUMERATOR / REVOLUTIONS DENOMINATOR

These two parameters together define the ***number of revolutions***, before the measuring system starts at 0 again.

As decimal numbers are not always finite (such as 3.4), but may have an infinite number of digits after the decimal point (such as 3.43535355358774...) the number of revolutions is entered as a fraction.

Numerator lower limit	1
Numerator upper limit	256000
Default numerator	65536

Denominator lower limit	1
Denominator upper limit	16384
Denominator default	**1**

Formula for gearbox calculation:

$$\text{Measuring range in steps} = \text{number of steps per revolution} * \frac{\text{Number of numerator revolutions}}{\text{Number of denominator revolutions}}$$

If it is not possible to enter parameter data in the permitted ranges of numerator and denominator, the attempt must be made to reduce these accordingly. If this is not possible, it may only be possible to represent the relevant decimal number approximately. The resulting minor inaccuracy accumulates for real round axis applications (infinite applications with motion in one direction).
A solution is e.g. to perform adjustment after each revolution or to adapt the mechanics or gear ratio accordingly.

The parameter **Number of steps per revolution** may also be a decimal number, however the `measuring range` may not. The result of the above formula must be rounded up or down. The resulting error is distributed over the total number of revolutions programmed and is therefore negligible.

Preferably for linear axes (forward and backward motion):

The parameter `Revolutions denominator` can be programmed as a fixed value of “1” for linear axes. The parameter `Revolutions numerator` is programmed slightly higher than the required number of revolutions. This ensures that the measuring system does not generate an actual value jump (zero transition) if the travel is slightly exceeded. For the sake of simplicity, the full revolution range of the measuring system can also be programmed.

The following example serves to illustrate the approach.

Given:

Measuring system with 4096 steps/rev. and max. 4096 revolutions

Resolution 1/100 mm

Make sure that the measuring system is programmed in its full resolution and measuring range (4096x4096):
Measuring range in steps = 16777216,
Revolutions numerator = 4096
Denominator revolutions = 1
Set the mechanics to be measured to the left stop position

Set measuring system to "0" by adjustment

Set the mechanics to be measured to the end position

Measure the mechanical distance covered in mm

Read off the actual position of the measuring system on the connected control

Assumption:

Distance covered = 2000 mm

Measuring system actual position after 2000 mm = 607682 steps

Consequently:

Number of revolutions covered = 607682 steps / 4096 steps/rev.
= **148.3598633 revolutions**

Number of mm/revolution = 2000 mm/148.3598633 revs. = **13.48073499 mm/rev.**

For a resolution of 1/100 mm, this equates to **1348.073499 steps/revolution**

required programming:

Number of numerator revolutions = ***4096***
Number of denominator revolutions = ***1***

$$\text{Measuring range in steps} = \text{number of steps per revolution} * \frac{\text{Number of numerator revolutions}}{\text{Number of denominator revolutions}}$$

$$= 1348.073499 \text{ steps / rev. } * \frac{4096 \text{ numerator revolutions}}{1 \text{ denominator revolution}}$$

= ***5521709 steps*** *(rounded)*

5.4.3 Submodule velocity

5.4.3.1 Structure of the cyclic process data

The current ***scaled*** velocity of the measuring system is output as a signed 32-bit two's complement value via the `Velocity` submodule.

Structure of input data, IO device -> master

Integer32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.4.3.2 Configurable submodule-related parameters

The Parameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

Byte	Parameter	Data type	Description		Page
0	Velocity format	Bit-Area	Bit 2-0	Unit 000: rev/sec * factor 001: `rev/min * factor` 010: rev/hour * factor 011: steps/integration time	76
	Velocity filter intensity		Bit 6-3	Filter intensity value Default value: `0` Value range: 0-10	76
	Velocity filter type		Bit 7	Filter Type `0: static` 1: dynamic	77
1-2	Velocity factor	Unsigned16	Selected unit * factor Default value: `1` Value range: 1-1000		77
3-4	Velocity integration time	Unsigned16	Integration time [ms] Default value: `100` Value range: 1-1000		77

5.4.3.2.1 Velocity format

Indicates the resolution at which the velocity is calculated and output.

The velocity is output signed, as a two's complement:

- Counting direction setting = forward
  - Output positive, with clockwise rotation (looking at flange connection)
- Counting direction setting = backward
  - Output negative, with clockwise rotation (looking at flange connection)

If the velocity value range (-2147483648…+2147483647) is exceeded or not reached, the limit values (0x7FFF FFFF or 0x8000 0000) are output.

Selection	Value	Velocity output	Default
rev/sec * factor	0	Output in [rev./second], multiplied by the factor set under the `Velocity factor` parameter, see Page 77	
rev/min * factor	1	Output in [rev./minute], multiplied by the factor set under the `Velocity factor` parameter, see page 77	X
rev/hour * factor	2	Output in [rev./hour], multiplied by the factor set under the `Velocity factor` parameter, see page 77	
steps/integration time	3	Output in [steps/ms] Resolution : scaled steps/rev.	

5.4.3.2.2 Velocity filter intensity

Using the `Velocity filter intensity` parameter, the output velocity can be averaged. The parameter serves to setup a lowpass filter working on the measuring system’s actual velocity value. Higher intensity values allow stronger filtering yielding to lower cut-off frequencies. High acceleration motion profiles require lower filter intensities. Refer to the following described parameter `Velocity filter type`, for a dynamic filter engagement according to the current motion status.

Data type	Bit-Area
Lower limit	0
Upper limit	10
Default	**0**

0: no filtering

1: weak filtering, high cut-off frequency

. . .

10: strong filtering, low cut-off frequency

5.4.3.2.3 Velocity filter type

See also parameter `Velocity filter intensity` on page 76.

Selection	Value	Description	Default
static	0	The lowpass filter characteristic is applied on the actual velocity value regardless of the drive's current motion and acceleration status, respectively.	X
dynamic	1	The lowpass filter characteristic is deactivated as soon as the measuring system detects a significant acceleration in the velocity signal. The lowpass filter will be reactivated as soon as a uniform motion is detected from the measuring system.	

5.4.3.2.4 Velocity factor

Indicates the factor value for the `Velocity format` parameter, see page 76

Lower limit	1
Upper limit	1000
Default	**1**

5.4.3.2.5 Velocity integration time

Indicates the integration time in [ms] for the *`Velocity format`* parameter, see page 76

Generally, the parameter serves to calculate the velocity, which is output via the cyclic process data. Long integration times allow high-resolution measurements at low speeds. Low integration times show velocity changes more quickly and are suitable for high velocitys and high dynamics.

Lower limit	1 ms
Upper limit	1000 ms
Default	**100 ms**

Example

Given:

- Programmed resolution = 8192 steps per revolution
- Speed = 4800 revolutions per minute
- Integration time t_i = 50 ms = 0.05 s

Wanted:

- Output value in steps/integration time

$$\text{Number of steps / s} = \frac{8192 \text{ steps} * 4800 \cancel{\text{rev.}}}{\cancel{\text{Rev.}} * 60 \text{ s}} = \frac{655360 \text{ steps}}{1 \text{ s}}$$

$$\text{Number of steps/t} = \frac{655360 \text{ steps}}{1 \text{ s}} * 0.05 \text{ s} = 32768 \text{ steps}$$

Steps/integration time = <u>32768 steps / 50 ms</u>

5.4.4 Submodule Preset (adjustment function)

WARNING

NOTICE

Danger of physical injury and material damage due to an actual value jump during execution of the adjustment function!

- The adjustment function should only be executed when the measuring system is stationary, or the resulting actual value jump must be permitted by both the program and the application!

5.4.4.1 Structure of the cyclic process data

With the submodule `Preset`, a 32-bit adjustment value can be transmitted and set as new actual position value via the cyclic I/O output data. The adjustment value must be within the programmed measuring range –1. If an invalid adjustment value is transmitted, the adjustment is not accepted and error code 0x80 is indicated in the status byte. The error code in the status byte is deleted again with control byte = 0x00.

The adjustment value is set with a rising edge 0->1 of bit 2^0 (0x01) in the control byte. Execution of the adjustment is acknowledged in the status byte by setting bit 2^0 (0x01). By resetting bit 2^0 (0x00) in the control byte, bit 2^0 (0x00) in the status byte is also reset automatically.

Structure of output data, master -> IO device

Unsigned8 / Unsigned32

Byte	X+0	X+1	X+2	X+3	X+4
Bit	39-32	31-24	23-16	15-8	7-0
Data	$2^7 – 2^0$	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^8$	$2^7 – 2^0$
Function	Control byte (2^0)	32-bit adjustment value (binary)			

Lower limit, adjustment value	0
Upper limit, admustment value	Programmed total measuring range in steps – 1

Structure of input data, IO device -> master

Unsigned8

Byte	X+0
Bit	7-0
Data	$2^7 – 2^0$
Function	Status byte (2^0)

Value	Function
0x00	Normal operation, no error
0x01	Adjustment was executed
0x80	Error, adjustment could not be executed

5.4.5 Submodule status

5.4.5.1 Structure of the cyclic process data

Structure of input data, IO device -> master
Unsigned8

Byte	X+0
Bit	7-0
Data	$2^7 – 2^0$
Function	Sensor status

Bit	Function
0	Velocity overflow 0: no velocity overflow 1: velocity overflow present
1	Output of the original position 0: own channel A [1)] or B [1)] in error state 1: Output of the original position, either -> via channel 1 (master system) or -> via channel 2 (test system), depending on the mapping of the sub-module configuration
2	Output of the substitute position 0: no output of the substitute position 1: Output of the substitute position, either -> via channel 2 (test system) in case of error constellation A or -> via channel 1 (master system) in case of error constellation B The substitute position must be configured accordingly, see chap. 5.4.5.2: Bit 0=`on`
3	Legacy mode 0: Measuring system is not operated in the Legacy mode 1: Measuring system is operated in the Legacy mode

1)
A : Channel 1 (master system)
B : Channel 2 (test system)

5.4.5.2 Configurable submodule-related parameters

The Parameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

Byte	Parameter	Data type	Description	
0	Substitute position	Bit	Bit 0	Output of the substitute position if the own channel is in error state 0: `off` 1: on

5.4.6 Submodule Acceleration

Available from firmware version 2.xx

5.4.6.1 Structure of cyclic process data

The `Acceleration` submodule outputs the current ***scaled*** acceleration of the measurement system as a signed 16-bit two's complement value.

Structure of the input data, IO device -> Master

Integer16

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

5.4.6.2 Configurable submodule-related parameters

The parameters can be set using an input mask in the project planning tool in accordance with the table below and are automatically sent by the controller to the measuring system during startup via the record data object with index `0x0001`.

Byte	Parameter	Data type	Description		Page
0	Acceleration format	Bit area	Bit 2-0	Unit 000: `rev/sec`^{2} `* factor` 010: steps/(integration time)^{2}	81
1-2	Acceleration factor	Unsigned16	Selected unit * factor Default value: `1` Value range: 1-1000		81
3-4	Acceleration Integration time	Unsigned16	Integration time [ms] Default value: `100` Value range: 50-1000		82

5.4.6.2.1 Acceleration format

Specifies the resolution at which acceleration is calculated and output.

The acceleration is output as a two's complement with a sign:

- Counting direction setting = forward
  - Output positive, during acceleration in the ↻ direction or deceleration in the ↺ direction (Viewing direction toward flange connection)
- Counting direction setting = backward
  - Output negative, during acceleration in the ↻ direction or deceleration in the ↺ direction (Viewing direction toward flange connection)

If the acceleration value range (-32768…+32767) is exceeded or not reached, the limit values (0x7FFF or 0x8000) are output.

Selection	Value	Acceleration output	Default
rev/sec^2 * factor	0	Output in [rev/second^2], multiplied by the factor set under the `Acceleration factor` parameter, see below	X
steps/(integration time)^2	2	Output in [steps/ms^2] Resolution: scaled steps/revolution	

5.4.6.2.2 Acceleration factor

Specifies the factor value for the `Acceleration format` parameter, see above.

Lower limit	1
Upper limit	1000
Default	**1**

5.4.6.2.3 Acceleration integration time

Specifies the integration time in [ms] for the *Acceleration format* parameter, see page 81.

The parameter is generally used to calculate the acceleration, which is output via the cyclic process data. High integration times enable high-resolution measurements with slow speed changes (low dynamics). Low integration times display acceleration changes more quickly and are well suited for fast speed changes (high dynamics).

Lower limit	50 ms
Upper limit	1000 ms
Default	**100 ms**

Example for the unit "Steps / (Integration time)²"

Given: - Programmed resolution = 8192 steps per revolution
- Integration time t_i = 100 ms = 0.1 s
- Measuring system accelerates from 1000 rpm (v1) to 1200 rpm (v2) in 100 ms

Wanted: - Output of acceleration in steps / (integration time)^2

Change of speed, (Δv):

$\Delta v = v2 - v1 = 1200\ 1/\text{min} - 1000\ 1/\text{min} = 200\ 1/\text{min}$

Acceleration (a):

$$a_{rev/s^2} = \Delta v / \Delta t = \frac{200\ \text{rev}}{60\ \text{s} * 0.1\ \text{s}} = 33.33\ \text{rev/s}^2$$

$$a_{steps/(integration\ time)^2} = \frac{33.33\ \cancel{\text{rev}} * 8192\ \text{steps}}{\text{s}^2\ \cancel{\text{rev}} * (\text{integration time})^2} = \frac{273066.6666\ \text{steps}}{(10 * \text{integration time})^2}$$

$$= \frac{273066.6666\ \text{steps}}{100 * (\text{integration time})^2} = \frac{2730.666666\ \text{steps}}{(\text{integration time})^2}$$

$a_{steps/(integration\ time)^2} \approx$ **2731 steps / (100 ms)²**

This means that the speed increases by approximately 2731 steps/100 ms in the integration interval of 0.1 s. The unit `steps/(integration time)`^{2} indicates how much the speed changes per integration time, measured in steps.

5.5 TR Encoder Profile, non-safety related (Channel 1-2/2-2 (TR))

Back to the module overview, page 39.

Available from firmware version 2.xx

Some automation tasks in **Shared Device Applications** require non-safety-related process data such as position, speed, acceleration, and status information to be available on two different IO controllers.

With the previous modules `Channel 1 (TR)` on slot 2, which corresponds to the master system, and `Channel 2 (TR)` on slot 3, which corresponds to the slave system, it was only possible to make the **master system and the slave system** available to two different IO controllers. Due to the **optical scanning unit in the master system** and the **magnetic scanning unit in the slave system**, there were inevitably differences in the process data output, despite the same parameter settings. This situation is undesirable for some automation tasks.

For this reason, two new modules, `Channel 1-2 (TR)` on slot 3, corresponding to the master system, and `Channel 2-2 (TR)` on slot 2, corresponding to the slave system, have been integrated. These modules are copies of the previous ones. Due to the different slot assignment, it is now possible to distribute either **both master systems** or **both slave systems** to two different IO controllers.

Due to the fact that both master systems and both slave systems have their own parameter data set, care must be taken to ensure that the parameter settings are exactly the same in each case. This is the only way to ensure that both systems output the same process data.

With the exception of the `Preset` submodule, all other submodules are available and the range of parameters is identical to the previous `Channel 1 (TR)` and `Channel 2 (TR)` modules. The `Preset` submodule was deliberately omitted from the newly introduced `Channel 1-2 (TR)` and `Channel 2-2 (TR)` modules in order to avoid inconsistencies when setting the position value via two different IO controllers.

For reasons of clarity, the submodules are not described again below. Instead, reference is made to the existing description of the previous modules `Channel 1 (TR)` and `Channel 2 (TR)`.

Module description, see chapter “TR Encoder Profile, non-safety related (Channel 1/2 (TR))” as from page 70.

5.6 OPTION: PNO Encoder Profile, safety-related (Safety BP/XP (PNO))

Back to the module overview, page 39.

With this configuration, as with a non-safety-related communication, the measuring system supports the `PNO Encoder Profile` (Profile-ID 0x3D00) defined by the PROFIBUS User Organization according to Version 4.2. Two additional encoder classes have been defined for safety-related PROFIsafe communication:

- Encoder Class S1:
  Standard safety-related measuring system with safe position data and preset functionality. The isochronous mode is not supported.

- Encoder Class S2:
  Standard safety-related measuring system (Class S1) with additional safe velocity data. The isochronous mode is not supported either.

The F-status byte `Safe Status` or F-Control Byte `Safe Control` contained in the `F_MessageTrailer` (process data) is contained in all safety-related submodules (Telegram 36 (BP/XP) and Telegram 37 (BP / XP)) and is described only once in Chapter 7.1 from Page 134.

5.6.1 Structure of the cyclic process data

For the configuration of the cyclic data exchange, a series of safety-related (F) standard signals is available for the PROFIsafe communication:

Signal no.	Meaning	Name	Length in bits	Format
96	F actual position value	S_XIST32	Integer32	Page 86
97	F actual speed value	S_NIST16	Integer16	Page 86
98	Encoder F control word 1	S_STW1_ENC	Unsigned16	Page 86
99	Encoder F status word 1	S_ZSW1_ENC	Unsigned16	Page 87
PNU 62000	F Preset value	S_PRESET32	Integer32	Page 87

5.6.1.1 Standard Telegram 36 (BP/XP)

Basic Protocol (BP)

Structure of input words 1 to 4, IO device -> Master

IW 1	IW 2	IW 3	IW 4	Safe Status, 3-Byte-CRC (V2.4)
S_ZSW1_ENC	S_NIST16	S_XIST32		F_MessageTrailer4Byte

Structure of output words 1 to 3, Master -> IO device

OW 1	OW 2	OW 3	Safe Control, 3-Byte-CRC (V2.4)
S_STW1_ENC	S_PRESET32		F_MessageTrailer4Byte

Expanded Protocol (XP)

Structure of input words 1 to 4, IO device -> Master

IW 1	IW 2	IW 3	IW 4	Safe Status, 4-Byte-CRC (V2.6.1)
S_ZSW1_ENC	S_NIST16	S_XIST32		F_MessageTrailer5Byte

Structure of output words 1 to 3, Master -> IO device

OW 1	OW 2	OW 3	Safe Control, 4-Byte-CRC (V2.6.1)
S_STW1_ENC	S_PRESET32		F_MessageTrailer5Byte

5.6.1.2 Standard Telegram 37 (BP/XP)

Basic Protocol (BP)

Structure of input words 1 to 3, IO device -> Master

IW 1	IW 2	IW 3	Safe Status, 3-Byte-CRC (V2.4)
S_ZSW1_ENC	S_XIST32		F_MessageTrailer4Byte

Structure of output words 1 to 3, Master -> IO device

OW 1	OW 2	OW 3	Safe Control, 3-Byte-CRC (V2.4)
S_STW1_ENC	S_PRESET32		F_MessageTrailer4Byte

Expanded Protocol (XP)

Structure of input words 1 to 3, IO device -> Master

IW 1	IW 2	IW 3	Safe Status, 4-Byte-CRC (V2.6.1)
S_ZSW1_ENC	S_XIST32		F_MessageTrailer5Byte

Structure of output words 1 to 3, Master -> IO device

OW 1	OW 2	OW 3	Safe Control, 4-Byte-CRC (V2.6.1)
S_STW1_ENC	S_PRESET32		F_MessageTrailer5Byte

5.6.1.3 Format Signal 96: F actual position value (S_XIST32)

The safety-related actual position value is transmitted via signal S_XIST32 if no error occurred and the measuring system can supply a safe actual position value. The scaling of the safety-related position is independent of the scaling settings of the non-safety-related position and is set independently via the iParameter, see Chapter 5.6.3 on Page 90. The axis type and the scaling settings can be read out via the safety-related operating status PNU 65100.
The F status word S_ZSW1_ENC, bit 2^0 SP_VALID = 1 indicates that the safety-related position data in S_XIST32 is valid.

S_XIST32, Integer32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.6.1.4 Format Signal 97: F actual speed value (S_NIST16)

The safety-related velocity value is transmitted via the signal S_XIST16 if no error occurred and the measuring system can supply a safe velocity value. The normalization of the safety-related velocity is independent of the normalization settings of the non-safety-related velocity and is performed independently via the iParameter Velocity value normalization, see Chapter 5.6.3 on Page 90.
The F status word S_ZSW1_ENC, bit 2^1 SS_VALID = 1 indicates that the safety-related velocity value in S_NIST16 is valid.

S_NIST16, Integer16

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

5.6.1.5 Format Signal 98: Encoder F control word 1 (S_STW1_ENC)

The F-control word S_STW1_ENC controls the safety-related measuring system functions:

Unsigned16

Bit	Function
0	Activation of preset function 0: Preset function is disabled 1: Preset function is enabled With a rising edge 0-> 1 in bit 2^6 Preset triggering, the current value in signal S_PRESET32 is adopted as the new actual position value in signal S_XIST32. By resetting this bit to 1-> 0, the preset function is reset and prepared for a new triggering. Following the procedure prescribed in Chapter 5.6.5 on Page 95 is mandatory.
1-5	reserved
6	Preset triggering See description under Bit 2^0 Preset activation.
7-15	reserved

5.6.1.6 Format Signal 99: Encoder F status word 1 (S_ZSW1_ENC)

The F-status word `S_ZSW1_ENC` indicates the safety-related measuring system function states:

Unsigned16

Bit	Function
0	Validity, safety-related actual position value in signal `S_XIST32` (SP_VALID) 0: Safety-related position is not valid 1: Safety-related position is valid
1	Validity, safety-related velocity value in signal `S_NIST16` (SS_VALID) 0: Safety-related velocity value is not valid 1: Safety-related velocity value is valid
2	Acknowledgment, activation of preset function 0: not activated via control word `S_STW1_ENC` bit 2^0 1: Activated via control word `S_STW1_ENC` bit 2^0
3-4	reserved
5	Preset error 0: no preset error exists 1: An error occurred while executing the preset function. The state transition from `SP2` to `SP3` could not be completed, see Chapter 5.6.5 on Page 95. Evaluate the diagnostic data for more details. This error does not result in an internal event (Bit 7).
6	Acknowledgment, preset triggering, preset value set The current value in signal `S_PRESET32` was adopted as the new actual position value in signal `S_XIST32`.
7	Internal event
8-15	reserved

5.6.1.7 Format Signal PNU 62000: F Preset value (S_PRESET32)

Signal `S_PRESET32` is used to transmit the safety-related preset value via the cyclic output data. The preset function is controlled via the F-control word `S_STW1_ENC`, see Chapter 5.6.1.5 on Page 86. The resolution of the F-preset value in signal `S_PRESET32` corresponds to the scaling settings for the F actual position value in signal `S_XIST32`, see Chapter 5.6.3.4 on Page 91.

S_PRESET32, Integer32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.6.2 Parameter access and initialization (safety-related)

Figure 10 shows the database of safety-related parameters and the access mechanism or initialization of the parameter data.

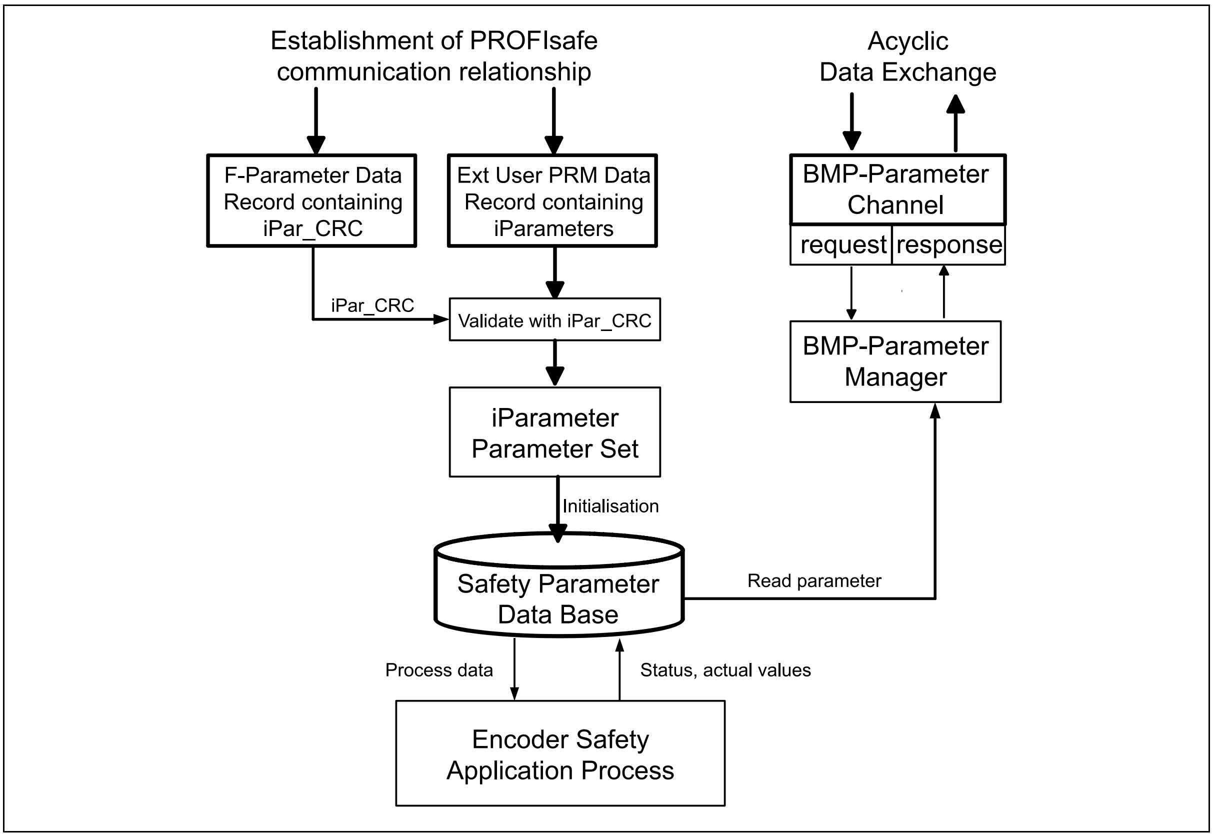


Figure 10: Parameter access and initialization (safety-related)

The iParameters (individual safety parameters) and the F-parameters (PROFIsafe parameter set) are set using a configuration tool and sent by the safety-related control (F Host) to the measuring system during startup.

To ensure the secure transmission of iParameters, the F-parameter data block contains the F-parameter `F_iPar_CRC`. The parameter contains the checksum value (CRC) from all iParameters of the device-specific part of the measuring system and ensures the secure transmission of iParameters. To further ensure the secure transmission of F-Parameters, the F-parameter data block contains the F-parameter `F_Par_CRC`. The parameter contains the checksum value (CRC) from all F-Parameters of the measuring system and ensures the secure transmission of F-Parameters.

The measuring system also generates a checksum from the iParameters transmitted by the F Host. This checksum is compared in the measuring system with the checksum provided by the F Host. If both `F_iPar_CRC` are identical, the measuring system switches to the cyclic data exchange during startup, otherwise the measuring system will not start up.

The checksum value pre-programmed into the parameters `F_iPar_CRC` and `F_Par_CRC` applies to the current standard setting of all parameters and can be used as such during plant configuration. Every change under a data block requires a new calculation of the respective checksum value `F_iPar_CRC` or `F_Par_CRC`. A change of the iParameters therefore requires a new calculation of the checksum value for the F-parameter `F_Par_CRC`.

The checksum calculation of the iParameters (`F_iPar_CRC`) requires the CRC calculation program `TCI Device Tool`:

– Program download: www.tr-electronic.de/f/zip/TR-ECE-SW-MUL-0008
– Manual download: www.tr-electronic.de/f/TR-ECE-TI-DGB-0327

This program is a Device Tool with TCI interface (Tool Calling Interface) and can be started from within the Engineering Tool. The network address of the measuring system to be configured is also provided. The Device Tool enables parameterization and calculates the iPar_CRC checksum. The checksum can either be displayed in hexadecimal or decimal form; it can be copy/pasted into the input field `F_iPar_CRC` in the configuration part of the Engineering Tool.
The program can also be operated in stand-alone mode if the engineering tool does not support a TCI interface. To do this, simply install the program under a WINDOWS operating system, load the appropriate GSDML device description file, set the iParameter accordingly, and calculate the iPar_CRC checksum from it.

The F_Par_CRC checksum calculation usually takes place within the Engineering Tool itself and requires no additional software.

As with the non-safety-related application, the parameter can also be accessed after the startup phase via the acyclic data traffic (**B**ase **M**ode **P**arameter channel). **However, for safety reasons, the parameter is read-only**.

5.6.3 Configurable module-related iParameters (F_iPar)

Application-specific device properties are defined with the iParameters of the safety-related modules `Safety BP (PNO)` and `Safety XP (PNO)`. The secure transmission of iParameters requires a CRC calculation, see Chapter 5.6.2 on Page 88.

The iParameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0xBF00`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Byte	Parameter	Data type	Description		Page
0	Code sequence	Unsigned8	Bit 0	Counting direction 0: `CW` 1: CCW	91
	Preset affects XIST32		Bit 2	Preset control for signal `S_XIST32` 0: enable 1: `disable`	91
	Scaling function		Bit 3	Enable scaling 0: `disable` 1: enable	91
1-4	Scaling: Measuring units per revolution	Unsigned32	Number of steps per revolution Default value: `8192` Value range: 2-8192		92
5-8	Scaling: Total measuring range	Unsigned32	No. of steps/revolution * No. of revolutions Default value: `536870912` Value range: 2-536870912		92
9	Velocity value normalization	Unsigned8	Velocity output unit 0: Steps/sec 1: Steps/100 ms 2: Steps/10 ms 3: `Revolutions per minute` Class S2: Telegram 36 (BP/XP)		93

5.6.3.1 Code sequence

⚠ WARNING

NOTICE

Danger of death, severe personal injury and/or material damage due to a jump in the absolute value when the code sequence is changed!

- The internal calculation algorithm results in different absolute positions for the counting direction settings `CW` and `CCW`. Therefore, after changing the rotational direction, verify the correct function by a protected test run first. Under certain circumstances, the output position must be adjusted via the preset function.

Selection	Value	Description	Default
CW	0	Measuring system – position ascending clockwise (looking at shaft, flange connection)	X
CCW	1	Measuring system – position descending clockwise (looking at shaft, flange connection)	

5.6.3.2 Preset affects XIST32

Selection	Value	Description	Default
enable	0	The preset adjustment function, see Page 95, is applied to the position output in `S_XIST32`.	
disable	1	The preset function has no effect on the position output in `S_XIST32`.	X

5.6.3.3 Scaling function control

Selection	Value	Description	Default
disable	0	Scaling function control switched off	X
enable	1	The scaling function control with the parameters `Scaling: Measuring units per revolution` and `Scaling: Total measuring range` is applied.	

5.6.3.4 Scaling parameter

The physical resolution of the measuring system can be changed if the scaling function control enabled. The actual position value output is binary decoded and is calculated with a zero point correction and the counting direction set. In this configuration, the measuring system does not support decimal numbers or revolution speeds deviating from powers of 2 (gear function).

5.6.3.4.1 Scaling: Measuring units per revolution

Defines how many steps the measuring system outputs during one revolution of the measuring system shaft.

Data type	Unsigned32
Lower limit	2 steps/revolution
Upper limit	8192 steps per revolution
Default	**8192**

5.6.3.4.2 Scaling: Total measuring range

Defines the total number of steps (measuring range in steps) of the measuring system, before the measuring system starts at 0 again.

Data type	Unsigned32
Lower limit	2 steps
Upper limit	536 870 912 steps
Default	**536 870 912**

The actual upper limit value to be entered for the measuring range in steps depends on the measuring system design and can be calculated using the formula below. As the value "0" is already counted as a step, the end value = measuring range in steps - 1.

Measuring range in steps = steps per revolution * number of revolutions

For the purposes of calculation, the parameters ***Steps/Revolution*** and ***Number of Revolutions*** can be taken from the measuring system nameplate.

*When entering parameter data, ensure that the parameters **“Measuring range in steps”** and **“Number of steps per revolution”** are selected such that the quotient of the two parameters is a power of 2.*

5.6.3.5 Velocity value normalization

Selection	Value	Description	Default
Steps/sec	0	The speed in signal `S_NIST16` is output in `steps per second`.	
Steps/100 msec	1	The speed in signal `S_NIST16` is output in `steps per 100 ms`.	
Steps/10 msec	2	The speed in signal `S_NIST16` is output in `steps per 10 ms`.	
Revolutions per minute	3	The speed in signal `S_NIST16` is output in `revolutions per minute`.	X

5.6.3.6 Window increments (internal, not visible)

This parameter defines the maximum permissible position deviation in increments of the master / slave scanning systems integrated in the measuring system. The permissible tolerance window is internally set to 1000 increments and can not be changed. The position deviation in increments is always based on the non-scaled resolution of 13 bits = 8192 steps/revolution.

5.6.4 Configurable submodule-related F-parameters (F_Par)

The safety-related parameters are defined with the F-Parameters of the safety-related submodules `Telegram 36 (BP/XP)` and `Telegram 37 (BP/XP)`. The secure transmission of F-Parameters requires a CRC calculation, see Chapter 5.6.2 on Page 88.

The F-Parameter can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0002`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Parameter	BP	XP	Description
F_Check_iPar	X	X	`NoCheck`: No check
F_SIL	X	X	SIL1, `SIL2`, SIL3, no SIL
F_CRC_Length	X	–	`3-Byte-CRC`
	–	X	`4-Byte-CRC`
F_CRC_Seed	–	X	`CRC-Seed32`
F_Passivation	–	X	`Device/Module`
F_Block_ID	X	X	`1: uses F_iPar_CRC`: requires F_iPar_CRC
F_Par_Version	X	X	`1: V2 mode`
F_Source_Add	X	X	`1`: Source address = 1 Range: 1-65534
F_Dest_Add	X	X	`1`: Destination address = 1 Range: 1-255
F_WD_Time	X	X	`125 ms`: Watchdog time = 125 Range: 10-10000 ms
F_Par_CRC	X	–	`12275`: CRC of F-parameters = 12275 Range: 0-65535
	–	X	`33393`: CRC of F-parameters = 33393 Range: 0-65535
F_iPar_CRC	X	X	`1132081116`: CRC iParameter = 1132081116 Range: 0-4294967295

X: applicable
–: not applicable

Centralized and detailed description of the F-parameters, see Chapter 7.2 from Page 137.

5.6.5 Preset adjustment function

⚠ WARNING NOTICE	***Risk of death, serious physical injury and/or damage to property if the drive system starts uncontrolled while executing the Preset Adjustment function!*** ➢ The relevant drive systems must be locked to prevent automatic start-up ➢ We recommend to protect triggering of the preset adjustment function via the F Host by taking additional safety measures, such as key-operated switch, password, etc. ➢ It is absolutely necessary to follow the operational sequence described below, particularly to evaluate the status bits by means of the F Host, in order to check whether the preset adjustment function has been executed successfully or unsuccessfully ➢ The new position must be checked after execution of the preset function

The preset adjustment function is used to set the currently output actual position value to any actual position value within the scaled measuring range. This allows to electronically set the displayed position to a machine reference position.

5.6.5.1 Procedure

- Requirement: The measuring system is in cyclical data exchange mode.
- Ensure that the parameter `Preset affects S_XIST32` is set to `enable`, and that the acknowledgment bits 2^2 `Activation of preset function` and 2^6 `Preset triggering` in the status word `S_ZSW1_ENC` are cleared (**SP1**, Figure 11).
- Set the register `S_PRESET32` in the output data of safety telegram `36 (BP/XP)` or `37 (BP/XP)` to the desired preset value.
- In the control word `S_STW1_ENC`, set bit 2^0 `Activation of preset function` to 1. The activation is acknowledged in the status word `S_ZSW1_ENC` by setting bit 2^2 (**SP2**, Figure 11).
- The preset value is applied when the edge of bit 2^6 `Preset triggering` rises in the control word `S_STW1_ENC`. The measuring system then checks whether all prerequisites for execution of the preset adjustment function are fulfilled. If yes, the preset value is written as a new actual position value and acknowledged in the status word `S_ZSW1_ENC` by setting bit 2^6 `Acknowledgment, Preset triggering` (**SP3**, Figure 11). If no, execution is rejected and an error message is output via the status word `S_ZSW1_ENC` by setting bit 2^5 `Preset error`.
- After editing the preset adjustment function, bit 2^6 `Preset triggering` must be reset to 0 in the control word `S_STW1_ENC`. Bit 2^6 `Acknowledgment, Preset triggering` is then automatically reset to 0 in the status word `S_ZSW1_ENC`, indicating that the preset execution has been completed (**SP4**, Figure 11).
- To execute a new preset control cycle, bit 2^0 `Activation of preset function` must be reset to 0 in the control word `S_STW1_ENC`. Bit 2^2 `Acknowledgment, Activation of preset function` is then automatically reset to 0 in the status word `S_ZSW1_ENC` (**SP1**, Figure 11).
- Finally, the F Host must check that the new position corresponds to the new command position.

5.6.5.2 Preset finite state machine / control cycle

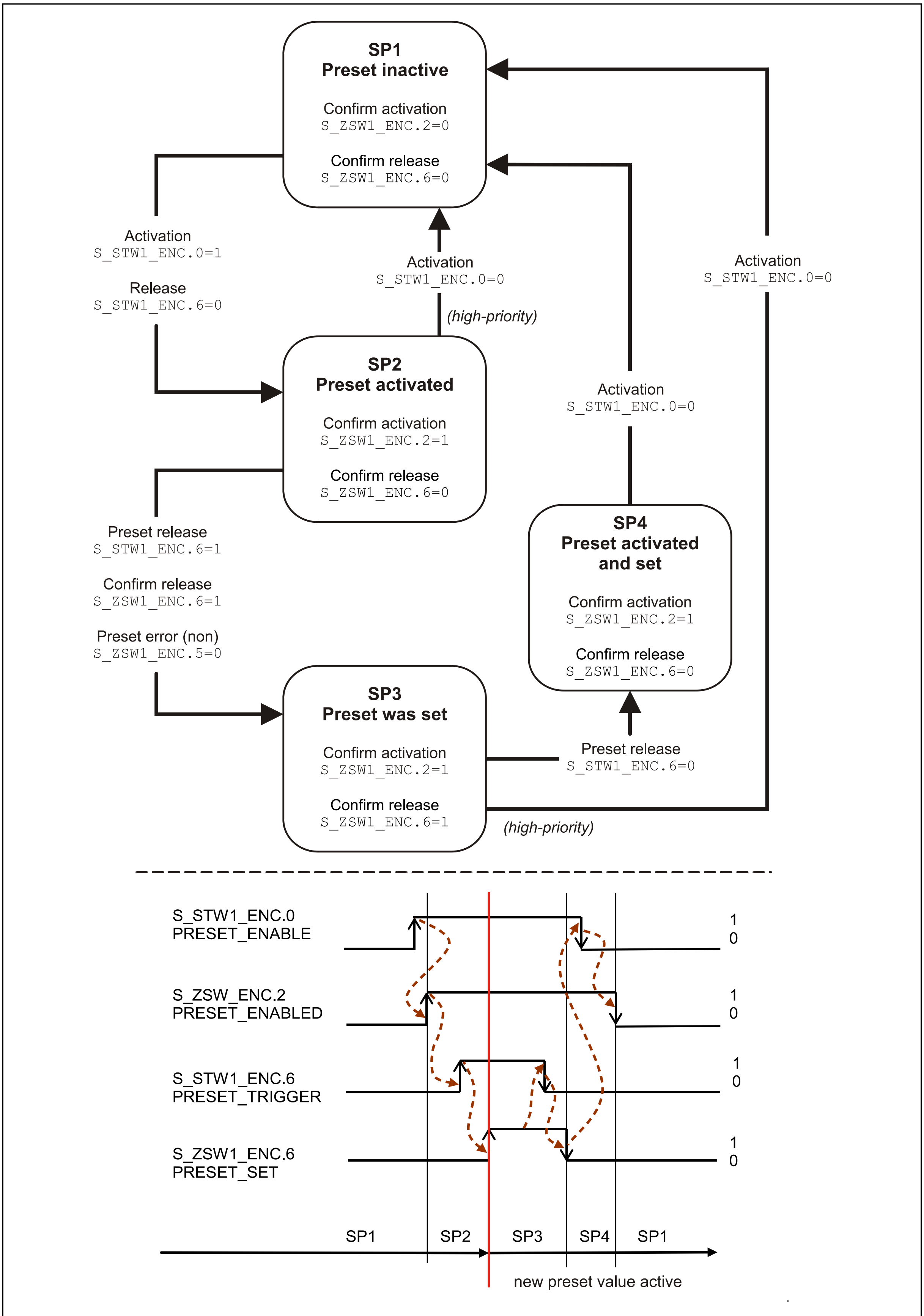


Figure 11: Preset finite state machine / control cycle

5.6.6 Diagnosis

The diagnosis for the safety-related application process is almost the same as for the non-safety-related application process, see Chapter "Warnings, errors, diagnosis" from Page 116. Both application processes initiate their own diagnostic alarm, each using their own alarm channel.
Errors or warnings, whose cause affects both application processes, are therefore reported once via the non-safety-related alarm channel and once via the safety-related alarm channel.
The measuring system always transmits diagnostic information as a channel-related diagnosis to the F Host.

Up to four application relationships can be established if the measuring system operates in the "shared device mode". For each of these application relationships, a separate alarm channel is supported for each F Host in this case, see also Chapter "Shared Device applications" on Page 141.

A number of diagnostic mechanisms are available for monitoring the measuring system functions. The following table shows an overview of the various options:

Function	**Reference**
Acyclic diagnosis parameters – `PNU 65100`, Subindex 2 "Error"	Chapter 11.1.2.6, Page 165
Channel-related control via the alarm channel	Chapter 5.7.5.2, Page 117
Evaluation of status bits in the F status word 1 `S_ZSW1_ENC`	Chapter 5.6.1.6, Page 87
LED display	Chapter 4.2, Page 37 Chapter 12.1, Page 171

5.7 PNO Encoder Profile, non-safety related (Channel 1/2 (PNO))

Back to the module overview, page 39.

With this configuration the measuring system supports the `PNO Encoder Profile` (Profile-ID 0x3D00) defined by the PROFIBUS User Organization according to Version 4.2. The measuring system only supports Applications Classes 3 and 4 defined there:

- Application Class 3:
  Measuring systems with access to basic parameters and limited parameterization of the measuring system functionality. Isochronous mode is supported.
  Area of application: simple motion control applications

- Application Class 4:
  Measuring systems with access to basic parameters and additional scaling and preset function. Isochronous mode is supported.
  Area of application: extended motion control applications

The Encoder Profile is normally based on the `PROFIdrive Profile` specified for drives. Many concepts and functionalities have therefore also been transferred to the Encoder Profile. The measuring system only supports the mandatory PROFIdrive-related parameters (9xx / 600xx).

5.7.1 Structure of the cyclic process data

A series of standard signals are available for the configuration of the cyclic data exchange, according to the PROFIdrive drive profile:

Signal no.	Meaning	Name	Length in bits	Format
6	Velocity value A	NIST_A	Integer16	Page 100
8	Velocity value B	NIST_B	Integer32	Page 100
9	Control word, Sensor 1	G1_STW	Unsigned16	Page 100
10	Status word, Sensor 1	G1_ZSW	Unsigned16	Page 101
11	Position value 1, Sensor 1	G1_XIST1	Unsigned32	Page 102
12	Position value 2, Sensor 1	G1_XIST2	Unsigned32	Page 102
39	Position value 3, Sensor 1	G1_XIST3	Unsigned64	Page 102
80	Control word 2, Encoder	STW2_ENC	Unsigned16	Page 103
81	Status word 2, Encoder	ZSW2_ENC	Unsigned16	Page 103

5.7.1.1 Standard Telegram 81

Structure of input words 1 to 6, IO device -> Master

IW 1	IW 2	IW 3	IW 4	IW 5	IW 6
ZSW2_ENC	G1_ZSW	G1_XIST1		G1_XIST2	

Structure of output words 1 to 2, Master -> IO device

OW 1	OW 2
STW2_ENC	G1_STW

5.7.1.2 Standard Telegram 82

Structure of input words 1 to 7, IO device -> Master

IW 1	IW 2	IW 3	IW 4	IW 5	IW 6	IW 7
ZSW2_ENC	G1_ZSW	G1_XIST1		G1_XIST2		NIST_A

Structure of output words 1 to 2, Master -> IO device

OW 1	OW 2
STW2_ENC	G1_STW

5.7.1.3 Standard Telegram 83

Structure of input words 1 to 8, IO device -> Master

IW 1	IW 2	IW 3	IW 4	IW 5	IW 6	IW 7	IW 8
ZSW2_ENC	G1_ZSW	G1_XIST1		G1_XIST2		NIST_B	

Structure of output words 1 to 2, Master -> IO device

OW 1	OW 2
STW2_ENC	G1_STW

5.7.1.4 Standard Telegram 84

Structure of input words 1 to 10, IO device -> Master

IW 1	IW 2	IW 3	IW 4	IW 5	IW 6	IW 7	IW 8	IW 9	EW 10
ZSW2_ENC	G1_ZSW	G1_XIST3				G1_XIST2		NIST_B	

Structure of output words 1 to 2, Master -> IO device

OW 1	OW 2
STW2_ENC	G1_STW

5.7.1.5 Format Signal 6 / 8: Actual speed value A / B (NIST_A / B)

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

Code sequence set to = CW
Looking at the flange connection, turn the shaft clockwise:
--> positive velocity output

Code sequence set to = CCW
Looking at the flange connection, turn the shaft clockwise:
--> negative velocity output

The unit is set via the parameter `Velocity value normalization` (PNU 60001), see Page 113. The default setting is `Revolutions per minute`.

NIST_A, Integer16

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

NIST_B, Integer32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.7.1.6 Format Signal 9: Control word, Sensor 1 (G1_STW)

The control word `G1_STW` controls the basic measuring system functions:

Unsigned16

Bit	Function	CL3	CL4
0-10	reserved	-	-
11	Preset mode Defines whether the measuring system's actual position value is set to the preset value or if it should be offset by this value. 0: Position value is set to the preset value (absolute) 1: Position value is offset by the preset value (relative = offset)	no	yes
12	Execute preset according to preset mode The preset value is set with a rising edge 0->1. The exact procedure is described in the Chapter "Preset function" on Page 116. In the default setting signal `G1_XIST1` remains unaffected, see parameter `Preset affects XIST1` on Page 110.	no	yes
13	Cyclically request absolute position 0: No querying of absolute position 1: Absolute position is cyclically transmitted via the signal `G1_XIST2`	yes	yes

Continued on next page

Continued

Bit	Function	CL3	CL4
14	Measuring system - park mode activation 0: Normal mode 1: Monitoring and position output of the measuring system are deactivated, and the measuring system also does not output any further error messages. The measuring system is inactive on the bus, but the sign-of-life function is active. This function is required e.g. in order to replace the measuring system, without having to change the drive configuration.	yes	yes
15	Measuring system - error acknowledgement 1: Error code in signal `G1_XIST2` is deleted (if deletable). Signal `G1_ZSW` Bit 15 indicates that an error acknowledgement is required.	yes	yes

5.7.1.7 Format Signal 10: Status word, Sensor 1 (G1_ZSW)

Status word `G1_ZSW` displays the measuring system status, acknowledgements and error messages for the basic measuring system functions:

Unsigned16

Bit	Function	CL3	CL4
0-10	reserved	-	-
11	Measuring system - error acknowledgement in process 0: No error acknowledgement triggered 1: Error acknowledgement triggered via signal `G1_STW` Bit 15	yes	yes
12	Preset function is executed 0: Preset function was not requested 1: Preset function was requested via signal `G1_STW` Bit 12	no	yes
13	Cyclic output of absolute position via `G1_XIST2` was requested 0: Querying of absolute position not requested 1: Querying of absolute position was requested via signal `G1_STW` Bit 13	yes	yes
14	Measuring system - park mode is active 0: Park mode inactive 1: Park mode was activated via signal `G1_STW` Bit 14	yes	yes
15	Measuring system - error present 0: No error present 1: Measuring system error or position error present. The relevant error code is output via signal `G1_XIST2`, see Chapter “5.7.5.1“ on Page 117. The acknowledgement or error deletion is made via signal `G1_STW` Bit 15.	yes	yes

5.7.1.8 Format Signal 11: Position value 1, Sensor 1 (G1_XIST1)

Via signal `G1_XIST1` the current ***incremental actual position*** of the measuring system is output unsigned as a right-justified 32-bit binary value. After switching on the supply voltage, the signal `G1_XIST1` is initially assigned the absolute value. Depending on the code sequence, this value is only incremented or decremented. An overflow is always generated after 32 bits: 0xFFFFFFFF -> 0x00000000. In the default setting, the preset function has no influence on the position output, see parameter `Preset affects XIST1` on Page 110. Depending on the setting of the parameter `Encoder Class 4 functionality`, other parameter settings can also directly affect the position output.

G1_XIST1, Unsigned32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.7.1.9 Format Signal 12: Position value 2, Sensor 1 (G1_XIST2)

Via signal `G1_XIST2` the current ***scaled absolute actual position*** of the measuring system is output unsigned as a right-justified 32-bit binary value. However, the corresponding bits must be set in the control words:
`G1_STW`: Bit 13 = 1, `STW2_ENC`: Bit 10 = 1

The preset function has a direct influence on the position output. Depending on the setting of the parameter `Encoder Class 4 functionality`, other parameter settings can also directly affect the position output.

If a measuring system error is present (`G1_ZSW`, Bit 15 = 1), instead of the position a 16-bit error code is transmitted in data bits 2^0 to 2^{15}, see Page 117.
The measuring system remains in the error state until the cause of the error has been eliminated and the error state has been acknowledged with the control word `G1_STW` Bit 15 = 0->1 edge.

G1_XIST2, Unsigned32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.7.1.10 Format Signal 39: Position value 3, Sensor 1 (G1_XIST3)

Via signal `G1_XIST3` the current ***scaled absolute actual position*** of the measuring system is output unsigned as a right-justified 64-bit binary value. However, only 32-bit is supported at present, Bits 2^{32} to 2^{63} are therefore set to 0. The preset function has a direct influence on the position output. For parameter settings to be effective, Class 4 functionality must be enabled under the parameter `Encoder Class 4 functionality`, see Page 109.

G1_XIST3, Unsigned64

Byte	X+0	X+1	X+2	X+3	X+4	X+5	X+6	X+7
Bit	63-56	55-48	47-40	39-32	31-24	23-16	15-8	7-0
Data	$2^{63} – 2^{56}$	$2^{55} – 2^{48}$	$2^{47} – 2^{40}$	$2^{39} – 2^{32}$	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

5.7.1.11 Format Signal 80: Control word 2, Encoder (STW2_ENC)

Control word STW2_ENC controls the PLC control mechanism and transmits the control-related sign-of-life to the measuring system:

Unsigned16

Bit	Function	CL3	CL4
0-9	reserved	-	-
10	Control by PLC (no support in compatibility mode) 0: cyclic I/O data of measuring system are not valid, except for sign-of-life function -> No position data are output via the signal G1_XIST2 -> Control word G1_STW is disabled 1: Control via the interface, cyclic I/O data of measuring system are valid -> Position data can be output via the signal G1_XIST2 -> Control word G1_STW is enabled	yes	yes
11	reserved	-	-
12-15	Control - sign of life Required in synchronous applications. The control increments the 4-bit counter in each cycle of the control application. Valid values are 1 to 15, the value 0 means error. You can set how many errors on the part of the control are tolerated by the measuring system via the parameter Tolerated sign-of-life faults in V3.1 compatibility mode, see page 111.	yes	yes

5.7.1.12 Format Signal 81: Status word 2, Encoder (ZSW2_ENC)

Status word ZSW2_ENC displays the PLC control mechanism and transmits the slave-related sign-of-life to the control. Bit 3 and Bit 7 indicate a general error or a general warning. Parameter PNU 65001 can be used to output a detailed error message or warning message.

Unsigned16

Bit	Function	CL3	CL4
0-2	reserved	-	-
3	Error present, see Chapter “Error (PNU 65001.02)“ on Page 151 0: no error occurred 1: General error occurred. Will be reset automatically if the error no longer exists.	yes	yes
4-6	reserved	-	-
7	Warning present, see Chapter “Warnings (PNU 65001.04)“ on Page 151 0: No Warning occurred 1: Warning occurred. Will be reset automatically if the cause for the warning no longer exists.	yes	yes
8	reserved	-	-

Continued on next page

Continued

Bit	Function	CL3	CL4
9	Control by PLC requested 0: No control by the PLC, the cyclic I/O data of the measuring system are invalid, except for the sign of life. 1: Control requested, the automation system is prompted to assume control, the data are valid.	yes	yes
10-11	reserved	-	-
12-15	Measuring system - sign of life Required in synchronous applications. The measuring system increments the 4-bit counter in each data cycle. Valid values are 1 to 15, the value 0 means error.	yes	yes

5.7.2 Parameter access and initialization

Figure 12 shows the parameter database of the measurement system and the mechanism by which the parameter database obtains its parameter data in the startup or initialization phase.

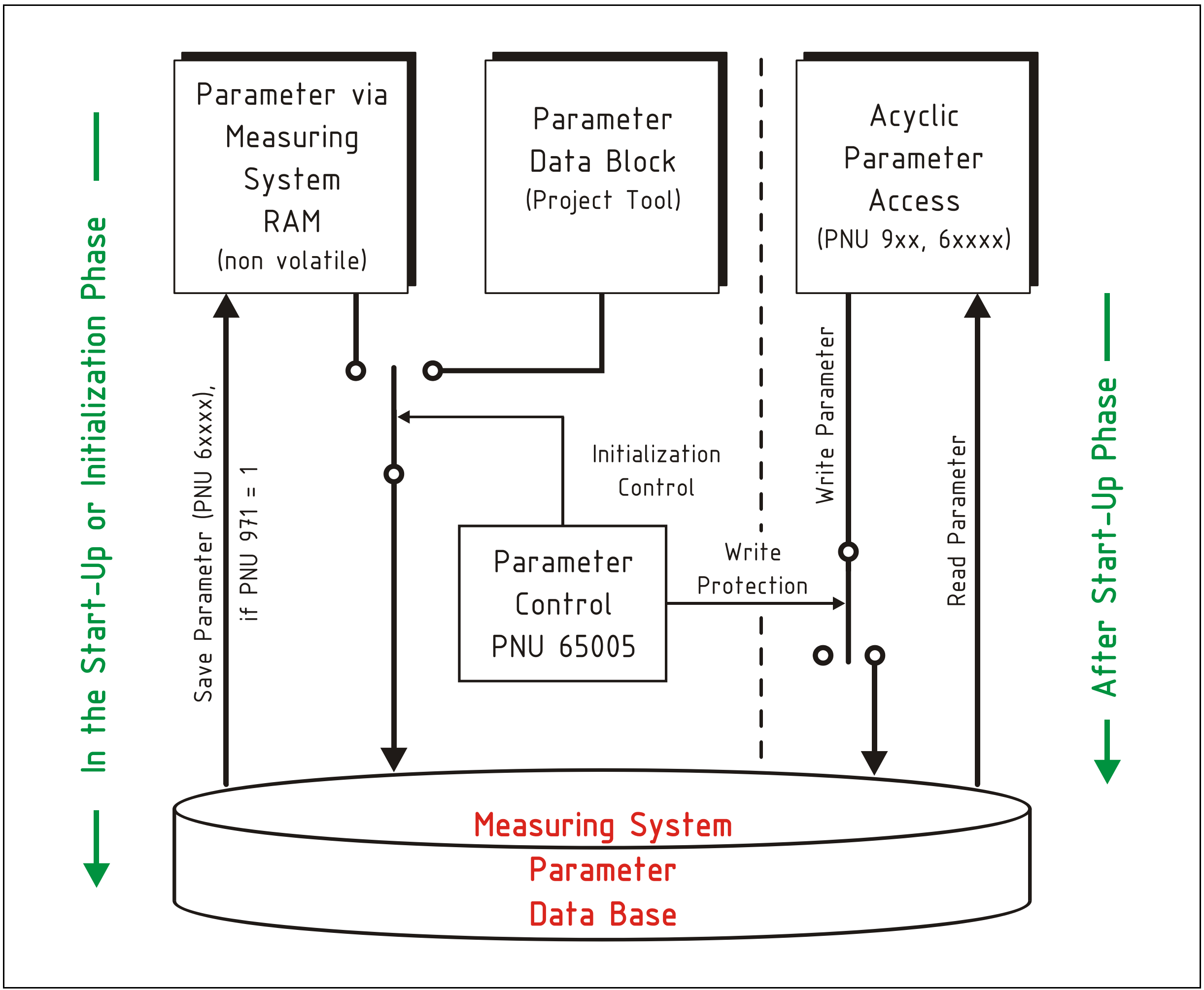


Figure 12: Parameter access and initialization (simplified functional representation)

In the default setting, the measuring system uses a configuration tool to obtain its parameters from the parameter data block, see Chapter “Configurable module-related parameters” from Page 106. Parameter changes therefore always require a restart of the measuring system to become effective.

However, if parameters must be changed during operation, parameters can also be accessed after the startup phase via an acyclic read/write request, see Chapter “Acyclic parameter access” on Page 145. However, changed parameters are not saved permanently and must be saved to the non-volatile RAM area of the measuring system via parameter `PNU 971` = 1, see Page 158.
To ensure that the measuring system receives the changed parameters from the non-volatile RAM area at the next restart, the parameter initialization must be switched over to the non-volatile RAM using the `PNU 65005` initialisation controller, see Page 108.

Access to the `PNU 65005` initialization controller is possible both via the parameter data block (if enabled) and anacyclic parameter access, and is therefore always adjustable, irrespective of the initialization setting.

5.7.3 Configurable module-related parameters

The parameters of the modules `Channel 1 (PNO)` and `Channel 2 (PNO)` can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0xBF00`.

Byte	Parameter	Data type	Description		Page
0-1	Parameter initialization (PNU 65005_0-1)	Bit range	Bit 0-1	Parameter initialization controller `0: PRM Data Block` 1: RAM Data *Class 3 and 4*	108
	Parameter Write protection (PNU 65005_2-4)		Bit 2-4	Parameter access control `0: Write all` 1: Read-only *Class 3 and 4*	108
	Write protection (PNU 65005_5) Parameter Control (PNU 65005) + Save parameter (PNU 971)		Bit 5	Access control to parameters PNU 65005 and PNU 971 `0: Write all` 1: Read-only *Class 3 and 4*	108
	Write protection (PNU 65005_6) for Parameter Reset (PNU 972)		Bit 6	Access control to parameters PNU 972 `0: Write all` 1: Read-only *Class 3 and 4*	108
2	Rotational direction	Unsigned8	Bit 0	Counting direction 0: `CW` 1: CCW *Class 4*	109
	Encoder Class 4 functionality		Bit 1	Enable Class 4 functionality 0: disable 1: `enable` *Class 4*	109
	Preset affects XIST1		Bit 2	Preset affects for signal G1_XIST1 0: enable 1: `disable` *Class 4*	110
	Scaling function		Bit 3	Enable scaling 0: `disable` 1: enable *Class 4*	110
	Alarm channel control		Bit 4	Enable via alarm channel control 0: `disable` 1: enable (only in compatibility mode)	110
	Compatibility mode V3.1		Bit 5	Compatibility with Encoder Profile V3.1 0: enable 1: `disable` *Class 3 and 4*	111

Continued on next page

Continued

<table>
<tr><th>Byte</th><th>Parameter</th><th>Data type</th><th colspan="2">Description</th><th>Page</th></tr>
<tr><td>3-6</td><td>Scaling: Measuring units per revolution</td><td>Unsigned32</td><td colspan="2">Number of steps per revolution
Default value: 8192
Value range: 2-8192
Class 4</td><td>111</td></tr>
<tr><td>7-10</td><td>Scaling: Total measuring range</td><td>Unsigned32</td><td colspan="2">No. of steps/revolution * No. of revolutions
Default value: 536870912
Value range: 4-536870912
Class 4</td><td>111</td></tr>
<tr><td>11</td><td>Tolerated sign-of-life errors</td><td>Unsigned8</td><td colspan="2">Max. tolerated errors of control
Default value: 1
Value range: 0-255
(only in compatibility mode)</td><td>112</td></tr>
<tr><td>12</td><td>Normalization of speed</td><td>Unsigned8</td><td colspan="2">Velocity output unit
0: Steps/sec
1: Steps/100 msec
2: Steps/10 msec
3: Revolutions per minute
4: N2/N4 normalized
Class 4</td><td>113</td></tr>
<tr><td rowspan="2">13</td><td>Velocity filter intensity</td><td rowspan="2">Bit-Area</td><td>Bit 0-3</td><td>Filter intensity value
Default value: 0
Value range: 0-10</td><td>113</td></tr>
<tr><td>Velocity filter type</td><td>Bit 4</td><td>Filter Type
0: static
1: dynamic</td><td>114</td></tr>
<tr><td>14-17</td><td>Velocity reference value N2/N4 (PNU 60000)</td><td>Float32</td><td colspan="2">Sets the velocity value for 100%
Default value: 3000 rev./min
Class 4</td><td>114</td></tr>
<tr><td>18-21</td><td>Preset value (PNU 65000)</td><td>Integer32</td><td colspan="2">Sets the actual position value for the preset function
Default value: 0
Class 4</td><td>115</td></tr>
</table>

5.7.3.1 Parameter initialization (PNU 65005_0-1)

Alternatively, this parameter can also be set during operation via an acyclic parameter access to parameter control `PNU 65005` Bits 0-1, see Page 154.

Selection	Value	Description	Default
PRM Data Block	0	The measuring system is initialized during startup with the parameters from the parameter data block of the measuring system. The settings are adopted in accordance with Chapter “Configurable module-related parameters” on Page 106.	X
RAM Data	1	The measuring system is initialized during startup with the parameters from the non-volatile RAM area of the measuring system.	

5.7.3.2 Parameter Write protection (PNU 65005_2-4)

Alternatively, this parameter can also be set during operation via an acyclic parameter access to parameter control `PNU 65005` Bits 2-4, see Page 154.

Selection	Value	Description	Default
Write all	0	Write access to all parameters which can be configured via an acyclic parameter exchange (PNU 9xx, 6x xxx).	X
Read-only	1	Parameters PNU 9xx and 6x xxx are read only.	

5.7.3.3 Write protection PNU 65005_5 (control) / PNU 971 (save)

Alternatively, this parameter can also be set during operation via an acyclic parameter access to parameter control `PNU 65005` Bit 5, see Page 154.

Selection	Value	Description	Default
Write all	0	Write access to parameters PNU 65005 and PNU 971	X
Read-only	1	Parameters PNU 65005 and PNU 971 (save parameters) are read only	

5.7.3.4 Write protection (PNU 65005_6), Param. Reset (PNU 972)

Alternatively, this parameter can also be set during operation via an acyclic parameter access to parameter control `PNU 65005` Bit 6, see Page 154.

Selection	Value	Description	Default
Write all	0	Write access to parameter PNU 972 (device RESET)	X
Read-only	1	Parameter PNU 972 is read only	

5.7.3.5 Code sequence

⚠ WARNING **NOTICE**	***Danger of death, severe personal injury and/or material damage due to a jump in the absolute value when the code sequence is changed!*** ➢ The internal calculation algorithm results in different absolute positions for the counting direction settings `CW` and `CCW`. Therefore, after changing the rotational direction, verify the correct function by a protected test run first. Under certain circumstances, the output position must be adjusted via the preset function.

Alternatively, this parameter can also be set during operation via an acyclic parameter access to function control `PNU 65004` Bit 0, see Page 153.

Selection	Value	Description	Default
CW	0	Measuring system – position ascending clockwise (looking at shaft, flange connection)	X
CCW	1	Measuring system – position descending clockwise (looking at shaft, flange connection)	

5.7.3.6 Encoder Class 4 functionality

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the function control `PNU 65004` Bit 1, see Page 153.

Selection	Value	Description	Default
disable	0	The parameters and functions `Scaling function control`, `Preset` and `Code sequence` are generally disabled.	
enable	1	The parameters and functions `Scaling function control`, `Preset` and `Code sequence` are generally enabled. The settings have a direct influence on the position output in `G1_XIST1`, `G1_XIST2` (if enabled via control word `G1_STW`, bit 13) and `G1_XIST3`. The preset function is also only effective in `G1_XIST1`, if the parameter `Preset affects XIST1` is set to `enable`.	X

5.7.3.7 Preset affects XIST1

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the function control `PNU 65004` Bit 2, see Page 153.

Selection	Value	Description	Default
enable	0	The preset function, see Page 116, is applied to the position output in `G1_XIST1`, if the parameter `Encoder Class 4 functionality` is set to `enable`.	
disable	1	The preset function has no effect on the position output in `G1_XIST1`.	X

5.7.3.8 Scaling function control

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the function control `PNU 65004` Bit 3, see Page 153.

Selection	Value	Description	Default
disable	0	Scaling function control switched off	X
enable	1	The scaling function control with the parameters `Scaling: Measuring units per revolution` and `Scaling: Total measuring range` is applied if the parameter `Encoder Class 4 functionality` is set to `enable`.	

5.7.3.9 Alarm channel control (V3.1)

Also see Chapter “Diagnostic alarm”on Page 117.

This parameter is only supported in compatibility mode V3.1. In standard mode V4.2, the profile-specific control via the alarm channel is always active.

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the function control `PNU 65004` Bit 4, see Page 153.

Selection	Value	Description	Default
disable	0	The profile-specific diagnosis is switched off if the parameter `V3.1 compatibility mode` is set to `enable`. Only the communication-specific alarms are sent via the alarm channel.	X
enable	1	The profile-specific diagnosis is turned on if the parameter `V3.1 compatibility mode` is set to `enable`. The measuring-system-specific alarm channel is transmitted as a **channel-related control**. This means that the data volume to be transferred can be limited in synchronous mode.	

5.7.3.10 Compatibility mode V3.1

Also see Chapter “Diagnostic alarm”on Page 117.

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the function control `PNU 65004` Bit 5, see Page 153.

Selection	Value	Description	Default
enable	0	Compatible with Encoder Profile V3.1 Only communication-specific or channel-specific alarms can be transmitted	
disable	1	Not downwards compatible	X

Function	Compatibility mode enabled (0) = V3.1	Compatibility mode disabled (1) = V4.2
Control by PLC (`STW2_ENC`, bit 10)	Is ignored, the control word `G1_STW` and the set values are always valid. Control requested (`ZSW2_ENC`, Bit 9) is not supported and is set to 0.	is supported
Parameter `Tolerated sign-of-life faults`	is supported	Is not supported. One sign-of-life error is tolerated. However, you can use `PNU 925` to set the number of tolerated errors.
Parameter `Alarm channel control`	is supported	is not supported; the profile-specific control via the alarm channel is always active.
Profile version PNU 965	31 (V3.1)	42 (V4.2)

5.7.3.11 Scaling parameter

You can change the physical resolution of the measuring system, if the scaling parameters are enabled (`Encoder Class 4 functionality` = `enable` and `Scaling function control` = `enable`). The actual position value output is binary decoded and offset with a zero point correction and the set counting direction. In this configuration, the measuring system does not support decimal numbers. Therefore, the total resolution must be an integer and a multiple of the parameter `Measuring units per revolution`.

5.7.3.11.1 Scaling: Measuring units per revolution

Defines how many steps the measuring system outputs during one revolution of the measuring system shaft.

Data type	Unsigned32
Lower limit	2 steps/revolution
Upper limit	8192 steps per revolution
Default	**8192**

5.7.3.11.2 Scaling: Total measuring range

Defines the total number of steps (measuring range in steps) of the measuring system, before the measuring system starts at 0 again.

Data type	Unsigned32
Lower limit	4 steps
Upper limit	536 870 912 steps
Default	**536 870 912**

The actual upper limit value to be entered for the measuring range in steps depends on the measuring system design and can be calculated using the formula below. As the value "0" is already counted as a step, the end value = measuring range in steps - 1.

Measuring range in steps = steps per revolution * number of revolutions

For the purposes of calculation, the parameters ***Steps/Revolution*** and ***Number of Revolutions*** can be taken from the measuring system nameplate.

*When entering parameter data, ensure that the parameters **“Measuring range in steps”** and **“Number of steps per revolution”** are selected such that the result is not a decimal number.*

5.7.3.12 Tolerated sign-of-life faults (V3.1)

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the master sign-of-life error function `PNU 925`, see Page 157.

The max. number of permissible errors of the master sign-of-life counter is defined with this parameter. The parameter `Compatibility mode V3.1` must be set to `enable` for this purpose. If the max. number of permissible errors is exceeded, the error code `0x0F02` is transmitted instead of the position via signal `G1_XIST2`.

Data type	Unsigned8
Lower limit	0
Upper limit	255
Default	**1**

5.7.3.13 Velocity value normalization (PNU 60001)

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the velocity normalization function `PNU 60001`, see Page 156.

Selection	Value	Description	Default
Steps/sec	0	The velocity in the signals `NIST_A` and `NIST_B` is output in `steps per second`.	
Steps/100 msec	1	The velocity in the signals `NIST_A` and `NIST_B` is output in `steps per 100 ms`.	
Steps/10 msec	2	The velocity in the signals `NIST_A` and `NIST_B` is output in `steps per 10 ms`.	
Revolutions per minute	3	The velocity in the signals `NIST_A` and `NIST_B` is output in `revolutions per minute`.	X
N2/N4 normalized	4	The velocity in the signals `NIST_A` and `NIST_B` is output according to the N2/N4 standard as set in the PROFIdrive drive profile. The velocity value in the signals `NIST_A` and `NIST_B` is a percentage of the parmeter `velocity reference value N2/N4`.	

5.7.3.14 Velocity filter intensity

Using the `Velocity filter intensity` parameter, the output velocity can be averaged in the `NIST_A` and `NIST_B` signals. The parameter serves to setup a lowpass filter working on the measuring system's actual velocity value. Higher intensity values allow stronger filtering yielding to lower cut-off frequencies. High acceleration motion profiles require lower filter intensities. Refer to the following described parameter `Velocity filter type`, for a dynamic filter engagement according to the current motion status.

Data type	Bit-Area
Lower limit	0
Upper limit	10
Default	**0**

0: no filtering

1: weak filtering, high cut-off frequency

. . .

10: strong filtering, low cut-off frequency

5.7.3.15 Velocity filter type

See also parameter `Velocity filter intensity` on page 113.

Selection	Value	Description	Default
static	0	The lowpass filter characteristic is applied on the actual velocity value regardless of the drive's current motion and acceleration status, respectively.	X
dynamic	1	The lowpass filter characteristic is deactivated as soon as the measuring system detects a significant acceleration in the velocity signal. The lowpass filter will be reactivated as soon as a uniform motion is detected from the measuring system.	

5.7.3.16 Velocity reference value N2/N4 (PNU 60000)

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the velocity reference value function `PNU 60000`, see Page 156.

If the `Velocity value normalization` parameter is set to `N2/N4 normalized (4)`, the velocity value output in the `NIST_A` and `NIST_B` signals is a percentage of the specified velocity reference value.
The entry is made in [Rev./min], the default setting is 3000 rev./min = 100%.

Data type	Float32
Limits	application-specific
Default	**3000 rpm**

Specifications for the N2/N4 normalization:

- Signal `NIST_A` corresponds to Scaling N2
- Signal `NIST_B` corresponds to Scaling N4
- 0 % = 0x0
- N2: 100% of the velocity reference value = 0x4000 (2^{14}), resolution: 2^{-14} * 100%
- N4: 100% of the velocity reference value = 0x4000 0000 (2^{30}), resolution: 2^{-30} * 100%
- Value range: -200% up to +200%
- MSB = 1: negative sign
- MSB = 0: positive sign

5.7.3.17 Preset value (PNU 65000)

Alternatively, this parameter can also be set during operation via an acyclic parameter access to the parameter number `PNU 65000`, see Page 149.

The zero point of the measuring system can be adapted to the mechanical zero point via the `preset value` parameter and is set either as an absolute value or as a relative value, in relation to the position output, during execution of the preset function, see Chapter “Preset function” on Page 116.

The transmitted value is interpreted differently, depending on the preset mode set:

Preset mode = absolute
- Transmitted value is interpreted as an Unsigned32 type

Preset mode = relative
- Transmitted value is interpreted as an Integer32 type in two's complement form

Data type	Integer32
Lower limit	-2^{31} (relative), 0 (absolute)
Upper limit	$+2^{31}-1$ (relative), 2^{31} (absolute)
Default	**0**

5.7.4 Preset function

WARNING

NOTICE

Danger of physical injury and damage to property due to an actual value jump during execution of the preset adjustment function!

- The preset adjustment function should only be executed when the measuring system is stationary, or the resulting actual value jump must be permitted by both the program and the application!

The measuring system can be adjusted to any actual position value in the value range of 0 to (measuring range in steps – 1) using this function. If an invalid preset value outside the measuring range is transmitted, the bit 7 `Warning present` is set in signal 81 `ZSW2_ENC` and the preset execution is rejected. In order to delete the warning, a valid preset value must be transmitted.

The preset function is controlled via bits 11 `Preset mode` and 12 `Execute preset` in the control word `G1_STW` (Chapter 5.7.1.6 on Page 100) and acknowledged via bit 12 `Preset function is executed` in status word `G1_ZSW` (Chapter 5.7.1.7 on Page 101).
In the default setting the `preset value` parameter has a value of 0. This value can be changed via acyclic data exchange using `PNU 65000`, see Chapter “Acyclic parameter access” from Page 145.

Preset mode = absolute, current preset value e.g. = 0:

Set bit 11 and 12 in control word `G1_STW` to 0. The current actual position value 12 is set to the value 0 with a rising edge 0->1 of bit 12 in control word `G1_STW`.
The preset execution is acknowledged in the status word `G1_ZSW` by setting bit 12. In order to conclude the preset execution, bit 12 must be reset again in the control word `G1_STW`. Bit 12 is then also automatically reset in the status word `G1_ZSW`.
The internally calculated offset value can be read via acyclic data exchange using `PNU 65001.08`, see Chapter “Acyclic parameter access” from Page 145.

Preset mode = relative, current preset value e.g. = 1000, current position e.g. = 4000:

Set bit 11 to 1 and bit 12 to 0 in the control word `G1_STW`. The current actual position value 4000 is set to the value 5000 with a rising edge 0->1 of bit 12 in control word `G1_STW`.
The process then continues as described above.

5.7.5 Warnings, errors, diagnosis

A number of diagnostic mechanisms are available for monitoring the measuring system functions. The following table shows an overview of the various options.

The measuring system errors are divided into faults and warnings:

- An error is reported if a malfunction in the measuring system leads to an incorrect position output
- A warning indicates that one or more internal measuring system parameters have been exceeded. Unlike error messages, warnings do not lead to an incorrect position output.

Function	Reference
Acyclic diagnosis parameters – `PNU 65001`, Subindex 2 “Error”	Chapter 11.1.1.2.3, Page 151
Channel-related control via the alarm channel	Chapter 5.7.5.2, Page 117
Evaluation of status bits in status word Sensor 1 `G1_ZSW`	Chapter 5.7.1.7, Page 101
Evaluation of status bits in status word 2, Encoder `ZSW2_ENC`	Chapter 5.7.1.12, Page 103
Error codes in signal `G1_XIST2`	Chapter 5.7.5.1, Page 117
LED display	Chapter 4.2, Page 37 / Chapter 12.1, Page 171

5.7.5.1 Error codes in signal G1_XIST2

If a measuring system error is present (`G1_ZSW`, Bit 15 = 1), instead of the position a 16-bit error code is transmitted in data bits 2^0 to 2^{15}, see also Chapter “Format Signal 12: Position value 2, Sensor 1 (G1_XIST2)” on Page 102.

The measuring system remains in the error state until the cause of the error has been eliminated and the error state has been acknowledged with the control word `G1_STW` Bit 15 = 0->1 edge.

If the error cannot be acknowledged, an attempt can be made to execute a device RESET via PNU 972. If the error still cannot be deleted after this measure, the measuring system must be replaced.

Error code	Meaning	Description
0x0001	Sensor group error	Error during processing of the sensor signal, which leads to an incorrect position output in the signals `G1_XIST1` to `G1_XIST3`. Troubleshooting see Chapter “Troubleshooting and diagnostic options” on Page 145.
0x0F01	Command is not supported	The performed command is not supported by the measuring system. Troubleshooting by execution of the cyclic data without the corresponding command.
0x0F02	Failure of the controller sign-of-life	The number of permissible failures of the master sign-of-life has been exceeded. Troubleshooting see Chapter “Troubleshooting and diagnostic options” on Page 145.

5.7.5.2 Diagnostic alarm

Depending on the setting, channel-specific, communication-specific and manufacturer-specific alarms are supported by the measuring system. In standard mode V4.2, the profile-specific control via the alarm channel is always active; it can be switched on or off in compatibility mode V3.1, see Chapter 5.7.3.9 Page 110.

5.8 OPTION: Additional interface

Back to the module overview, page 39.

5.8.1 SSI (TR), synchronous serial

Optionally, the measuring system can be equipped with a synchronous serial absolute SSI interface in addition to the PROFINET IO interface. The `SSI (TR)` module must be installed into slot 5.

MSB LSB

Position	Status	Sign of life	Checksum
max. 8…29 bits	max. 0…2 bits	max. 0…5 bits	max. 0…8 bits

5.8.1.1 Configurable submodule-related parameters

The Parameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

Byte	Parameter	Data type	Description		Page
0	Source	Bit-Area	Bit 3-0	Selection of the channel 0000: `Channel 1` 0001: Channel 2	119
	Coding		Bit 7-4	SSI output code 0000: `binary code` 0001: gray code	119
1	Data bits	Bit-Area	Bit 5-0	Number of SSI data bits (8…29) 00 1000: 8 00 1001: 9 . . . 01 1101: `29`	119
2	Mono time	Bit-Area	Bit 3-0	Selection of the SSI monoflop time t_M 0000: 15 µsec 0001: `20 µsec` 0010: 35 µsec 0011: 50 µsec 0100: 500 µsec	119
	Status bits		Bit 7-4	Number of the status bits 0000: `0` 0001: 1 0010: 2	119
3	Sign of Life bits	Bit-Area	Bit 3-0	Number of the sign of life bits 0000: `0` 0001: 1 0010: 2 0011: 3 0100: 4 0101: 5	120
	Checksum		Bit 6-4	000: `without` 001: Parity even 010: Parity odd 011: CRC8	120

5.8.1.1.1 Source

Selection	Value	Description	Default
Channel 1	0	SSI output: Actual position from the master system	X
Channel 2	1	SSI output: Actual position from the test system	

5.8.1.1.2 Coding

Selection	Value	Description	Default
binary code	0	SSI output binary coded	X
gray code	1	SSI output gray coded	

5.8.1.1.3 Data bits

The parameter `Data bits` define the number of reserved bits for the ouput of the measuring system position. Similarly, the parameter `Data bits` also specifies the number of SSI clocks required up to the LSB bit of the data. Special bits such as status bits, sign of Life bits or the checksum are not contained in it and will be output in this order after the data bits.

Lower limit	8
Upper limit	29
Default	**29**

5.8.1.1.4 Mono time

Selection	Value	Description	Default
15 µsec	0	SSI monoflop time = 15 µs	
20 µsec	1	SSI monoflop time = 20 µs	X
35 µsec	2	SSI monoflop time = 35 µs	
50 µsec	3	SSI monoflop time = 50 µs	
500 µsec	4	SSI monoflop time = 500 µs	

5.8.1.1.5 Status bits

The parameter `Status bits` define the number of reserved bits for the status output.

Value	Description	Default
0	No output of status bits	X
1	Output of one status bit 0: No error 1: Error in the master system or test system; depending on the source	
2	Output of two status bits MSB bit = 0: No error MSB bit = 1: Error in the master system LSB bit = 0: No error LSB bit = 1: Error in the test system	

5.8.1.1.6 Sign of Life bits

The parameter `Sign of Life bits` define the number of reserved bits for the sign of life output.

The sign of life counter is incremented in dependence of the scanning procedures and is inserted into the SSI telegram. The control of this incrementing event by the control guarantees that the newly transferred position value comes from a current scanning procedure.

Value	Description	Default
0	no output of sign of life bits	X
1	1 bit sign of life (toggle bit)	
2	2 bit sign of life	
3	3 bit sign of life	
4	4 bit sign of life	
5	5 bit sign of life	

5.8.1.1.7 Checksum

In general, the checksum is calculated via all user data (position, status and sign of life) in the SSI telegram and is always inserted into the SSI telegram at the last position (LSB).

An incorrect CRC checksum is not a reference to a measuring system error, but to a communication problem. A cause for it can be an EMC interference signal. Communication problems at SSI interfaces can also occur by too long cable lengths or to high SSI sampling rates.

Selection	Value	Description	Default
without	0	no output of a checksum	X
Parity even	1	The parity represents the checksum of the bits in the SSI data word. If the SSI data word contains an odd number of "1", this bit = "1" and supplements the checksum to even parity.	
Parity odd	2	The parity represents the checksum of the bits in the SSI data word. If the SSI data word contains an even number of "1", this bit = "1" and supplements the checksum to odd parity.	
CRC8	3	8 bit CRC checksum Polynom: $X^8 + X^5 + X^4 + 1$ (Maxim/Dallas) Start value: 0xFF Min. Hamming distance: 4	

5.8.2 Incremental (TR)

Optionally, the measuring system can be equipped with an incremental interface in addition to the PROFINET IO interface. The `Incremental (TR)` module must be installed into slot 5.

5.8.2.1 Configurable submodule-related parameters

The Parameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

Byte	Parameter	Data type	Description		Page
0	pulses/rev.	Bit-Area	Bit 4-0	Number of pulses 00000: 1024 00001: 2048 00010: 3072 00011: 4096 00100: 5120	121

5.8.2.1.1 Pulses/Rev.

Selection	Value	Description	Default
1024	0	The number of pulses is set to 1024	X
2048	1	The number of pulses is set to 2048	
3072	2	The number of pulses is set to 3072	
4096	3	The number of pulses is set to 4096	
5120	4	The number of pulses is set to 5120	

5.9 Legacy (TR) Profile

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Compatibility demands that the `Safety (Legacy)` and `Channel 1 (Legacy)` respectively `Safety (Legacy) XP` and `Channel 1 (Legacy)` modules are only operated in pairs when operated in “Legacy mode”.
Process data and parameter scope are predefined, which is why no further submodules are possible.
If the SIEMENS SIMATIC Manager is used for commissioning, the GSDML version V2.3 must be used.

The F-status byte `Safe Status` or F-Control Byte `Safe Control` contained in the `F_MessageTrailer` (process data) is contained in all safety-related `Legacy` modules and is described only once in Chapter 7.1 from Page 134.

5.9.1 Safety (Legacy) + XP, safety-related

5.9.1.1 Structure of the cyclic process data

Basic Protocol (BP)

Structure of input words 1 to 5, IO device -> Master

IW 1	IW 2	IW 3	IW 4	IW 5	Safe Status, 3-Byte-CRC (V2.4)
Cams	TR status	Velocity	Multi-Turn	Single-Turn	F_MessageTrailer4Byte

Structure of output words 1 to 4, Master -> IO device

OW 1	OW 2	OW 3	OW 4	Safe Control, 3-Byte-CRC (V2.4)
TR-Control1	TR-Control2 (reserved)	Preset Multi-Turn	Preset Single-Turn	F_MessageTrailer4Byte

[1] Expanded Protocol (XP)

Structure of input words 1 to 5, IO device -> Master

IW 1	IW 2	IW 3	IW 4	IW 5	Safe Status, 4-Byte-CRC (V2.6.1)
Cams	TR status	Velocity	Multi-Turn	Single-Turn	F_MessageTrailer5Byte

Structure of output words 1 to 4, Master -> IO device

OW 1	OW 2	OW 3	OW 4	Safe Control, 4-Byte-CRC (V2.6.1)
TR-Control1	TR-Control2 (reserved)	Preset Multi-Turn	Preset Single-Turn	F_MessageTrailer5Byte

[1] available from firmware version 2.xx

5.9.1.1.1 Input Cams

Unsigned16

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

5.9.1.1.2 Input TR status

Unsigned16

Bit	Description
2^0	Preset_Status The bit is set if the F Host triggers a preset request. After the preset function has been executed, the bit is reset automatically; see also page 131.
2^1…2^8	reserved
2^9	Preset Locked Bit = 1, if a preset is already being executed in another safety-related module of a shared device application. In order to avoid inconsistencies, this module will not be able to run a preset until the preset operation has been completed in the other application.
2^{10}…2^{14}	reserved
2^{15}	Error The bit is set, if a preset request could not be executed because the velocity was excessively high. The current velocity must be within the range of the velocity set under `Idleness tolerance preset`. The bit is reset after the F Host has cleared the variable associated with control bit 2^0 `iPar_EN`, see also page 131.

5.9.1.1.3 Input Velocity

Integer16

Bit	Description
2^0…2^{15}	The velocity is output as a two's complement value with preceding sign. Rotational direction setting = forward Looking at the flange connection, turn the shaft clockwise: --> positive velocity output Rotational direction setting = backward Looking at the flange connection, turn the shaft clockwise: --> negative velocity output If the measured velocity exceeds the display range of –32768…+32767, there will be an overflow that is reported in the cam register via bit 2^0. At the time of overflow, the velocity stops at the respective +/- maximum value until the velocity has returned to within the display range. In this case, the message in the cam register is cleared as well. The velocity is specified in `Increments` per `Integration time safety`.

5.9.1.1.4 Input Multi-Turn / Single-Turn

Integer16

Bit	Register	Description
$2^0 \ldots 2^{15}$	Multi-Turn	Number of revolutions, 0…32767 ≙ 15 Bit

Integer16

Bit	Register	Description
$2^0 \ldots 2^{15}$	Single-Turn	Steps per revolution, 8192 ≙ 13 Bit

The number of revolutions is recorded in the `Multi-Turn` register while the current single-turn position is recorded in steps in the `Single-Turn` register. On this basis, the actual position can be calculated along with the resolution of the measuring system, the max. number of steps per revolutions as specified on the nameplate:

Position in steps = (steps per revolution * number of revolutions) + single-turn position

The output position is unsigned.

5.9.1.1.5 Output TR-Control1

Unsigned16

Bit	Description
2^0	Preset Request This bit serves to control the preset adjustment function. When this function is executed, the measuring system is set to the actual position value stored in the `Preset Multi-Turn`/`Preset Single-Turn` registers. This function can only be executed when the corresponding sequence is exactly followed; see Chapter “Preset adjustment function“ on Page 131.
$2^1 \ldots 2^{15}$	reserved

5.9.1.1.6 Output Preset Multi-Turn / Preset Single-Turn

Integer16

Bit	Register	Description
$2^0 \ldots 2^{15}$	Preset Multi-Turn	Preset-Wert, Multi-Turn - share

Integer16

Bit	Register	Description
$2^0 \ldots 2^{15}$	Preset Single-Turn	Preset value, Single-Turn – share

The desired preset value must be in the range of 0 to 268 435 455 (28 bits). On this basis, the corresponding values for `Preset Multi-Turn/Preset Single-Turn` can be calculated along with the resolution of the measuring system, the max. number of steps per revolution as specified on the nameplate (8192):

Number of revolutions = desired preset value / steps per revolution

The integer content from this division results in 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 must be 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 131.

5.9.1.2 Configurable module-related iParameters (F_iPar)

Application-specific device properties are defined with the iParameters of the safety-related modules `Safety (Legacy)` and `Safety (Legacy) XP`. The secure transmission of iParameters requires a CRC calculation, see Chapter 7.2.9 on Page 138.

The iParameters can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0001`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

- The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Byte	Parameter	Data type	Description	Page
0	Integration time safety	Unsigned16	Default value: `2` Value range: 1-10	126
2	Integration time standard	Unsigned16	Default value: `20` Value range: 1-100	126
4	Window Increments	Unsigned16	Default value: `1000` Value range: 50-4000	127
6	Idleness tolerance preset	Unsigned8	Default value: `1` Value range: 1-5	127
7	Rotational direction	Bit	0: backward 1: `forward`	127

5.9.1.2.1 Integration time safety

This parameter is used to calculate the safe velocity that is output via the cyclic data of the Safety module. Long integration times allow high-resolution measurements at low speeds. Low integration times show velocity changes more quickly and are suitable for high velocitys and high dynamics. The time basis is set to a fixed value of to 50 ms. The value range of 1...10 can therefore be used to set 50...500 ms. Standard value = 100 ms.

5.9.1.2.2 Integration time standard

This parameter is used to calculate the unsafe velocity that is output via the process data of the NON Safety module. Long integration times allow high-resolution measurements at low speeds. Low integration times show velocity changes more quickly and are suitable for high velocitys and high dynamics. The time basis is set to a fixed value of to 5 ms. The value range of 1...100 can therefore be used to set 5...500 ms. Standard value = 100 ms.

5.9.1.2.3 Window increments

This parameter defines the maximum permissible position deviation in increments of the master / slave scanning systems integrated in 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. Values are within a range of 50…4000 increments. Standard value = 1000 increments.

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

5.9.1.2.4 Idleness tolerance preset

This parameter defines the maximum permissible velocity in `increments` per `Integration time safety` for executing the preset function, see page 131. The permissible velocity is dependent on the bus behavior and the system velocity, and must first be determined by the system operator. Values are within a range from 1 increment per `Integration time safety` to 5 increments per `Integration time safety`. That means that the shaft of the measuring system must be nearly at rest to ensure that the preset function can be executed.
Standard value = 1 increment per standard value `Integration time safety`.

5.9.1.2.5 Rotational direction

⚠ WARNING

NOTICE

Danger of death, severe personal injury and/or material damage due to a jump in the absolute value when the code sequence is changed!

- The internal calculation algorithm results in different absolute positions for the counting direction settings `forward` and `backward`. Therefore, after changing the rotational direction, verify the correct function by a protected test run first. Under certain circumstances, the output position must be adjusted via the preset function.

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

Forward code sequence = ascending counting direction
Backward code sequence = descending counting direction

Default value = Forward code sequence.

5.9.1.3 Configurable module-related F-parameters (F_Par)

Safety-related parameters are defined with the F-Parameters of the safety-related module `Safety (Legacy)`. The secure transmission of F-Parameters requires a CRC calculation, see Chapter 7.2.10 on Page 138.

The F-Parameter can be set according to the following table via an input box in the configuration tool and are automatically sent by the control to the measuring system during start-up via the record data object with index `0x0002`.

⚠ DANGER

NOTICE

Malfunctions which are caused by improper parameterization result in the danger of death, serious physical injury and/or damage to property!

➢ The system manufacturer must ensure proper functioning by carrying out a protected test run during commissioning and whenever parameters have been changed.

Parameter	BP	XP	Description
F_Check_iPar	X	X	`NoCheck`: No check
F_SIL	X	X	SIL1, `SIL2`, SIL3, no SIL
F_CRC_Length	X	–	`3-Byte-CRC`
	–	X	`4-Byte-CRC`
F_CRC_Seed	–	X	`CRC-Seed32`
F_Passivation	–	X	`Device/Module`
F_Block_ID	X	X	`1: uses F_iPar_CRC`: requires F_iPar_CRC
F_Par_Version	X	X	`1: V2 mode`
F_Source_Add	X	X	`1`: Source address = 1 Range: 1-65534
F_Dest_Add	X	X	`1`: Destination address = 1 Range: 1-65534
F_WD_Time	X	X	`125 ms`: Watchdog time = 125 Range: 10-10000 ms
F_Par_CRC	X	–	`12275`: CRC of F-parameters = 12275 Range: 0-65535
	–	X	`33393`: CRC of F-parameters = 33393 Range: 0-65535
F_iPar_CRC	X	X	`1132081116`: CRC iParameter = 1132081116 Range: 0-4294967295

X: applicable
–: not applicable

Centralized and detailed description of the F-parameters, see Chapter 7.2 from Page 137.

5.9.2 Channel 1 (Legacy), non-safety related

5.9.2.1 Structure of the cyclic process data

Structure of input words 1 to 4, IO device -> Master

IW 1	IW 2	IW 3	IW 4
Cams	Velocity	Multi-Turn	Single-Turn

5.9.2.1.1 Input Cams

Unsigned16

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

5.9.2.1.2 Input Velocity

Integer16

Bit	Description
$2^0…2^{15}$	The velocity is output as a two's complement value with preceding sign. Rotational direction setting = forward Looking at the flange connection, turn the shaft clockwise: --> positive velocity output Rotational direction setting = backward Looking at the flange connection, turn the shaft clockwise: --> negative velocity output If the measured velocity exceeds the display range of –32768…+32767, there will be an overflow that is reported in the cam register via bit 2^0. At the time of overflow, the velocity stops at the respective +/- maximum value until the velocity has returned to within the display range. In this case, the message in the cam register is cleared as well. The velocity is specified in `Increments` per `Integration time standard`.

5.9.2.1.3 Input Multi-Turn / Single-Turn

Integer16

Bit	Register	Description
$2^{0}\ldots2^{15}$	Multi-Turn	Number of revolutions, 0…32767 ≙ 15 Bit

Integer16

Bit	Register	Description
$2^{0}\ldots2^{15}$	Single-Turn	Steps per revolution, 8192 ≙ 13 Bit

The number of revolutions is recorded in the `Multi-Turn` register while the current single-turn position is recorded in steps in the `Single-Turn` register. On this basis, the actual position can be calculated along with the resolution of the measuring system, the max. number of steps per revolutions as specified on the nameplate:

Position in steps = (steps per revolution * number of revolutions) + single-turn position

The output position is unsigned.

5.9.3 Preset adjustment function

⚠ WARNING

NOTICE

Risk of death, serious physical injury and/or damage to property if the drive system starts uncontrolled while executing the Preset Adjustment function!

- Execute the preset function only at standstill, see chapter Idleness tolerance preset“ on Page 127
- The relevant drive systems must be locked to prevent automatic start-up
- We recommend to protect triggering of the preset adjustment function via the F Host by taking additional safety measures, such as key-operated switch, password, etc.
- It is absolutely necessary to follow the operational sequence described below, particularly to evaluate the status bits by means of the F Host, in order to check whether the preset adjustment function has been executed successfully or unsuccessfully
- The new position must be checked after execution of the preset function

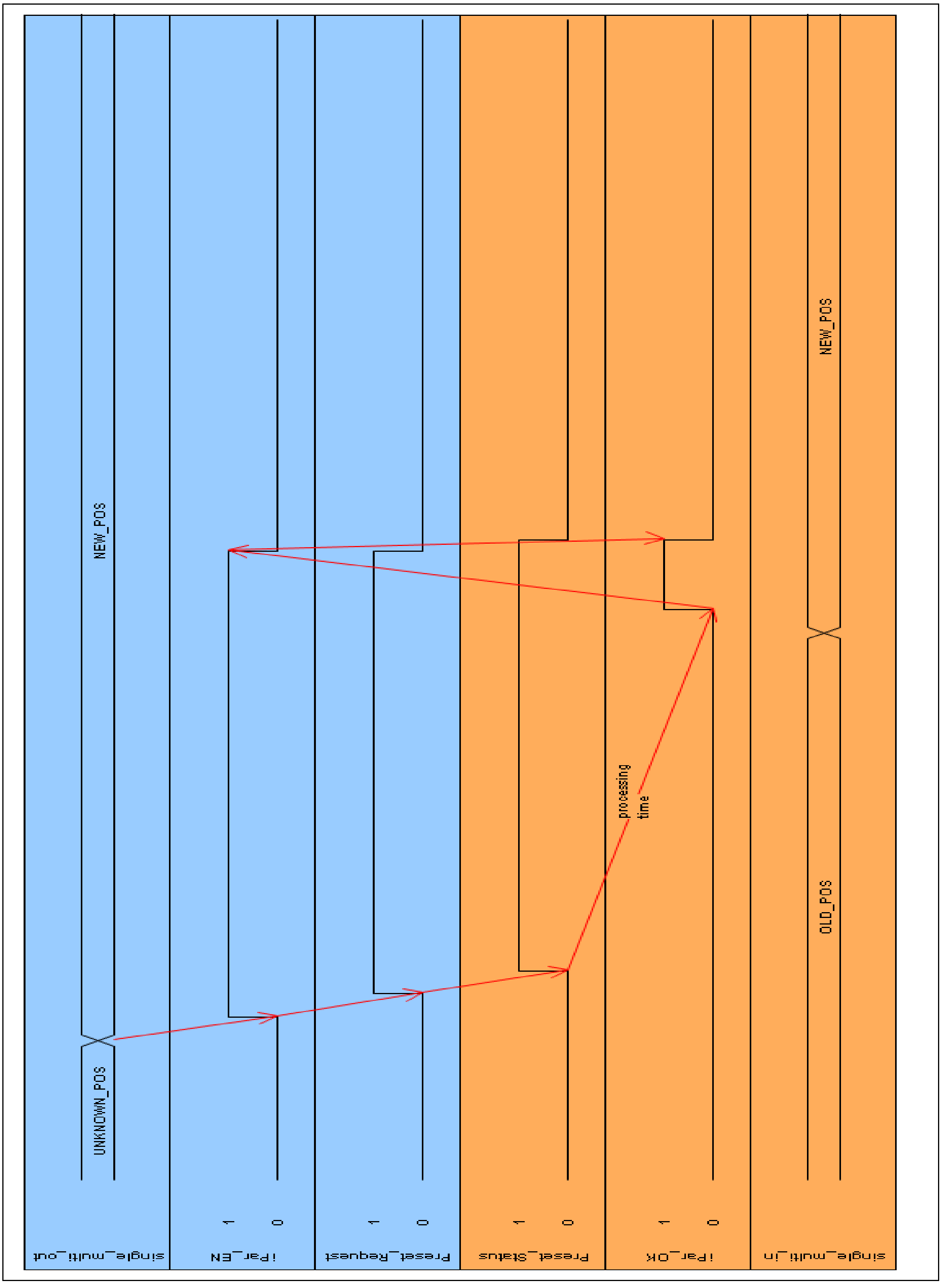
The preset adjustment function is used to set the currently output actual position value to any actual position value within the scaled measuring range. This allows to electronically set the displayed position to a machine reference position.

5.9.3.1 Procedure

- Requirement: The measuring system is in cyclical data exchange mode.
- Write the desired preset value into the registers `Preset Multi-Turn` and `Preset Single-Turn` of the output data.
- The F Host must set the variable associated with control bit 2^0 `iPar_EN` to 1. As the edge rises, the measuring system is switched to ready-to-receive.
- The preset value is applied when the edge of bit 2^0 `Preset Request` rises in the register `TR-Control1`. Receipt of the preset value is acknowledged in the `TR Status` register by setting the `Preset_Status` bit 2^0.
- After receipt of the preset value, the measuring system checks whether all prerequisites for execution of the preset adjustment function are fulfilled. If yes, the preset value is written as the new actual position value. If no, execution is rejected and an error message is output via the `TR Status` register by setting the `Error` bit 2^{15}.
- After processing the preset adjustment function, the measuring system sets the variable associated with `iPar_OK` status bit 2^0 to 1, thus signaling to the F Host that execution of the preset adjustment function has been completed.
- The F Host must then reset the variable associated with the `iPar_EN` control bit 2^0 to 0. A falling edge means that the variable associated with the `iPar_OK` status bit 2^0 and the `Preset_Status` bit 2^0 are reset in the `TR Status` register. The `Preset Request` bit 2^0 in the `TR-Control1` register must be reset manually.
- Finally, the F Host must check that the new position corresponds to the new command position.

5.9.3.2 Timing diagram

Blue area: Output signals F Host-> measuring system
Orange area: Input signals measuring system-> F Host



6 Resetting the device parameters

⚠ WARNING

NOTICE

The measuring system may be destroyed or damaged or its function be impaired by penetration of foreign bodies and ingress of moisture!

- Firmly close the access to the address switches with the screw plug after the settings have been made.

Use the two HEX rotary switches SW1 and SW2 for resetting the device parameters. The position and assignment of the HEX rotary switches can be found in the accompanying pin assignment.

Procedure:

1. Unscrew the screw plug
2. Switch SW1 / SW2 = 0
3. Wait 3 s
4. Switch SW2 = 5 / SW1 = 2, corresponds to 0x52 = “R” (RESET)
5. Wait 3 s, green NET status LED flashes at 2 Hz
6. Switch SW1 / SW2 = 0
7. [1]Resetting the stored device parameters
8. Restart the measuring system by switching the POWER OFF/ON cycle to apply the settings.
9. The process is complete, and the screw plug can be screwed back in again

[1] Resetting the stored device parameters:
- Device name = ' '
- IP parameters: Address = 0.0.0.0, Mask = 0.0.0.0, Router = 0.0.0.0
- I&M functions I&M1 up to 3 = ' ', I&M4 = '0'
- PROFIsafe address type = 1, PROFIsafe source address and destination address = 0
- PNO Encoder Profile values are cleared, no values remain
- TR Encoder Profile Parameters + Second Interface (safety-related/non-safety-related) = default values

7 F_MessageTrailer/F-Parameter - informative

7.1 Safe Status / Safe Control

7.1.1 Safe Status (BP/XP)

Unsigned8

Bit	Function	BP	XP
0	iPar_OK New iParameter values have been assigned to the F-Device	X	X
1	Device_Fault Error in F-Device or F-Module	X	X
	ChF_Ack_Req F-Device channel error present, acknowledgment via `ChF_Ack` bit 2^6 in Safe Control Byte required	-	X
2	CE_CRC Checksum error in communication	X	X
3	WD_timeout Watchdog Timeout in communication	X	X
4	FV_activated Fail-safe values activated	X	X
5	Toggle_d Toggle-Bit	X	X
6	cons_nr_R Virtual sequential number was reset	X	X
7	reserved	X	X

A more detailed description of the status bits can be found in the PNO document “PROFIsafe – Profile for Safety Technology on PROFIBUS DP and PROFINET IO”, Order No.: 3.192b.

7.1.2 Safe Control (BP/XP)

Unsigned8

Bit	Function	BP	XP
0	iPar_EN iParameter assignment unlocked	X	X
1	OA_Req Operator confirmation request required (re-integration)	X	X
2	R_cons_nr Reset the virtual serial number counter	X	X
3	reserved	X	-
	Use_TO2 The second watchdog F_WD_Time_2 is used	-	X
4	activate_FV Activate fail-safe values	X	X
5	Toggle_h Toggle-Bit	X	X
6	reserved	X	-
	ChF_Ack Operator confirmation request required after channel error handled	-	X
7	reserved	X	-
	Loop check Reserved for loop-back verification (“1”)	-	X

A more detailed description of the control bits can be found in the PNO document “PROFIsafe – Profile for Safety Technology on PROFIBUS DP and PROFINET IO”, Order No.: 3.192b.

7.1.3 Access mechanism

The safety-related data channel (F_MessageTrailer) may only be accessed from the safety program; direct access is not permitted.
Therefore, the registers `Safe Control` and `Safe Status` can only be accessed indirectly via variables. The scope of the variables and how the variables are addressed are control-dependent; please refer to the system documentation supplied by the manufacturer of the controller.

These variables must be accessed in the following cases:

- when the measuring system is re-integrated after communication errors or after the start-up phase; the variables are displayed via the status LEDs; see enclosed pin assignment
- when executing the preset adjustment function
- when evaluating, whether the data output are passivated data or cyclic data
- if the cyclic data of the safety-related (sub-) module is to be passivated based on certain states of the safety program

7.1.4 Output of passivated data (substitute values) in case of an error

In the event the safety-related channel is passivated, the safety function requires that, in the cases listed below, substitute values (0) be used instead of cyclically output values. This status is control-based reported by a corresponding variable:

- when the safety-related system is started
- in the event of errors in the safety-related communication between controller and measuring system, via the PROFIsafe protocol
- if the `Window Increments` value set under `iParameters` has been exceeded and/or the internally calculated PROFIsafe telegram is faulty
- if the ambient temperature, as defined under the corresponding article number, falls below or exceeds the permissible value range very much
- if there are hardware related errors in the measuring system

7.2 F-parameter (F_Par) – description

7.2.1 F_Check_iPar

The parameter is unchangeably set to `NoCheck`. This means that the iParameter checksum value is not evaluated.

7.2.2 F_SIL

F_SIL specifies the SIL (safety class) the user expects from the respective F-device. It is compared with the manufacturer's locally stored information. The measuring system supports the safety classes "no", "SIL" and "SIL1" to "SIL3".

7.2.3 F_CRC_Length

The measuring system supports the CRC length of 3 bytes (PROFIsafe V2.4) or 4 bytes (PROFIsafe V2.6.1). This value is preset and cannot be changed.

7.2.4 F_CRC_Seed / F_Passivation

The F-parameters `F_CRC_Seed` and `F_Passivation` allow the configuration according to PROFIsafe Version V2.4 or V2.6.1. The F-parameter combination is not adjustable but is specified by selecting a safety-related (sub-) module. If these two parameters are not available, the safety-related data is transmitted with the PROFIsafe `Basic Protocol (BP) V2.4`, otherwise with the PROFIsafe`Expanded Protocol (XP) V2.6.1`. The default setting for the parameter `F_CRC_Seed` = `CRC-Seed32` and for the parameter `F_Passivation` = `Device/Module`.

7.2.5 F_Block_ID

As the measuring system supports device-specific safety parameters such as "Integration time safety", this parameter is preset to the unchangeable value "1 = F_iPar_CRC".

7.2.6 F_Par_Version

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

7.2.7 F_Source_Add / F_Dest_Add

The parameter `F_Source_Add` defines the PROFIsafe source address and the parameter `F_Dest_Add` defines the PROFIsafe destination address. The setting options can be found in chapter 3.4 on page 23.

Default value `F_Source_Add` = 1
Default value `F_Dest_Add` = 1
Default setting for PROFIsafe address type = 1. Change the address type as described in the chapter "PROFIsafe Address type" on page 58.

7.2.8 F_WD_Time

This parameter determines 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 is set into the safe state.
The default value is 125 ms.
Generally, the watchdog time must be selected high enough so that telegram running times are tolerated by the communication, but low enough so that the fault reaction function can be executed fast enough in case of an error.

7.2.9 F_iPar_CRC

This parameter represents the checksum value (CRC3) calculated from all iParameters of the device-specific part of the measuring system and ensures the secure transmission of iParameters. This value is calculated by the program `TR_iParameter` provided by TR-Electronic, see below. The checksum value determined must then be manually entered in the Engineering Tool of the F Host.

7.2.10 F_Par_CRC

This parameter represents the checksum value (CRC1) calculated from all F-Parameters of the measuring system and ensures the secure transmission of F-Parameters. This value is externally calculated in the F Host Engineering Tool and must be entered into this parameter, or it is automatically generated.

7.2.11 iPar_CRC checksums – calculation

The checksum calculation of the iParameters (`F_iPar_CRC`) requires the CRC calculation program `TCI Device Tool`:

– Program download: www.tr-electronic.de/f/zip/TR-ECE-SW-MUL-0008
– Manual download: www.tr-electronic.de/f/TR-ECE-TI-DGB-0327

This program is a Device Tool with TCI interface (Tool Calling Interface) and can be started from within the Engineering Tool. The network address of the measuring system to be configured is also provided. The Device Tool enables parameterization and calculates the iPar_CRC checksum. The checksum can either be displayed in hexadecimal or decimal form; it can be copy/pasted into the input field `F_iPar_CRC` in the configuration part of the Engineering Tool.
The program can also be operated in stand-alone mode if the engineering tool does not support a TCI interface. To do this, simply install the program under a WINDOWS operating system, load the appropriate GSDML device description file, set the iParameter accordingly, and calculate the iPar_CRC checksum from it.

The F_Par_CRC checksum calculation usually takes place within the Engineering Tool itself and requires no additional software.

8 Media Redundancy (MRP) / Fast Start-Up (FSU)

The measuring system supports the `Media Redundancy Protocol` (MRP) according to IEC 62439 as well as the `Fast Start-Up` (FSU) function for optimized system start-up.
However, only one of the two functions can be used at the same time. When configuring the system, you must therefore decide which of the two functions should be used.

8.1 MRP

To increase the availability, industrial communication networks are designed with redundant physical connection paths between the network nodes.
The Media Redundancy Protocol ensures a loop-free network topology and detection of communication interruptions.

The system and machine availability is significantly increased by the redundant network structure, as the failure of individual devices has no effect on the communication.
Maintenance and repair work no longer require a system shutdown and can be performed during operation.

The measuring system is integrated into the ring topology as an MRP client and is monitored by the MRP manager.

Installation guidelines

- All ring nodes must support MRP and have the MRP protocol activated.
- Connections in the ring must be connected via the configured ring ports.
- The maximum number of ring nodes is 50. Otherwise reconfiguration times > 200 ms can result.
- All devices connected within the ring topology must be members of the same redundancy domain. A device cannot belong to several redundancy domains.
- All devices in the ring must be set to “MRP Client”, “MRP Manager (Auto)/Client” or “Automatic Redundancy Detection”. At least one device in the ring must have the setting "MRP Manager (Auto)/Client" or "Automatic Redundancy Detection".
- All partner ports within the ring must have the same settings.

Also see SIEMENS Entry ID: *109739614*.

8.2 FSU

Fast Start-Up (FSU) is an optimized system start-up, which enables much quicker access to data exchange from the second start-up. This is done by permanently storing many parameters, so that they do not need to be re-transmitted during start-up.

In order to achieve optimized start-up times, the Auto-Negotiation and Auto-Cross-Over functions must be deactivatable at the relevant switch of the network node. To enable a connection however, a crossover cable or a switch with port wiring is required for crossing the connections.

See also *PROFINET Design Guidelines, PNO order no.: 8.062.*

9 System redundancy S2

Available from firmware version 2.xx

The PROFINET system redundancy standard distinguishes between four possible redundancy configurations:

- S1: One interface module, one connection, complete failure in the event of module failure.
- **S2: One interface module, two connections, uninterrupted switchover in the event of a connection failure.**
- R1: Two interface modules, two networks, uninterrupted switchover in the event of a connection or module failure.
- R2: Two interface modules, four application relationships, failure only in the event of complete failure of both controllers or modules.

The measuring system supports the “S2” system redundancy standard, which is often used when high availability of the control level is crucial, but the device level itself does not require a duplicate physical connection, or this should be avoided for cost reasons.

System redundancy S2 focuses primarily on the redundancy of the IO controllers. The system therefore has a primary controller and a backup controller, which run identical application programs and continuously synchronize their data.
In contrast to higher redundancy levels such as R1 or R2, the PROFINET device (measuring system) with S2 redundancy has only a single physical PROFINET connection (Network Access Point - NAP).
Although the measuring system has only one physical connection, it can establish two logical communication relationships on this one connection: one to the primary controller and the other to the backup controller.
In normal operation, the measuring system actively communicates with the primary controller via its communication relationship. The backup controller is in standby mode and maintains its communication relationship with the measuring system.
If the primary controller fails, e.g., due to a hardware defect, power failure, or switchover to the STOP state, the backup controller immediately takes over the control function. Communication with the measuring system then continues seamlessly via the previously passive communication relationship of the backup controller. The process continues without interruption or with minimal interruption.

With system redundancy S2, care must be taken to ensure that the IO controllers also support the system redundancy function S2.

If the SIEMENS automation system is used, a **S7-1500 H system** is required to implement system redundancy.

PROFINET redundancy functions,
see *SIEMENS article ID: 109756450*

Application example with SINAMICS or SIMATIC S7,
see *SIEMENS article ID: 109926733*

10 Shared Device applications

Multiple IO controllers are often used in larger or widely distributed plants. Without the “Shared Device function”, each I/O module of an IO device (measuring system) would be assigned to the same IO controller. This function enables the process data of the measuring system to be distributed to several IO controllers without having to establish a time-consuming controller-2-controller communication.

The Shared Device function integrated into the measuring system makes it possible to **configure max. four safety-related modules with the same** `Module Ident Number` and to distribute these to four different IO controllers (F Hosts). Each module is assigned to its own slot. In this context, the address assignments of the slots must be considered, see chapter “Setting the PROFIsafe source-/destination-address for address type 1 / 2” on page 23.

For shared device applications, the slots 1/4/5/6 are provided. Here, it must be ensured that only the same module types, either TR-related or PNO-related modules, with the same adjusted `iParameters` are configured.

If the optional additional interface has already been configured on slot 5, only slots 1 and 4 are available for shared device applications.

Decisive for the calculation of `F_iPar_CRC` are the `iParameters` of the controller starting first. `F_iPar_CRC` is calculated for this controller, which is then expected during startup for all other configured modules. Provided it is identical, the measuring system will start, otherwise a diagnostic alarm with error type 0072d is output, see Chapter “PROFINET Diagnose-Alarm” on Page 173.

Since with TR-Channel – as with PNO-Channel – modules, channels 1 and 2 are supported on different slots, these modules can be assigned to different controllers as well.

Within a single application relationship (`AR`), one or more communication relationships (`CR`) can be defined. Each communication relationship can in turn consist of several slots or subslots, see the following configuration example (TR mode):

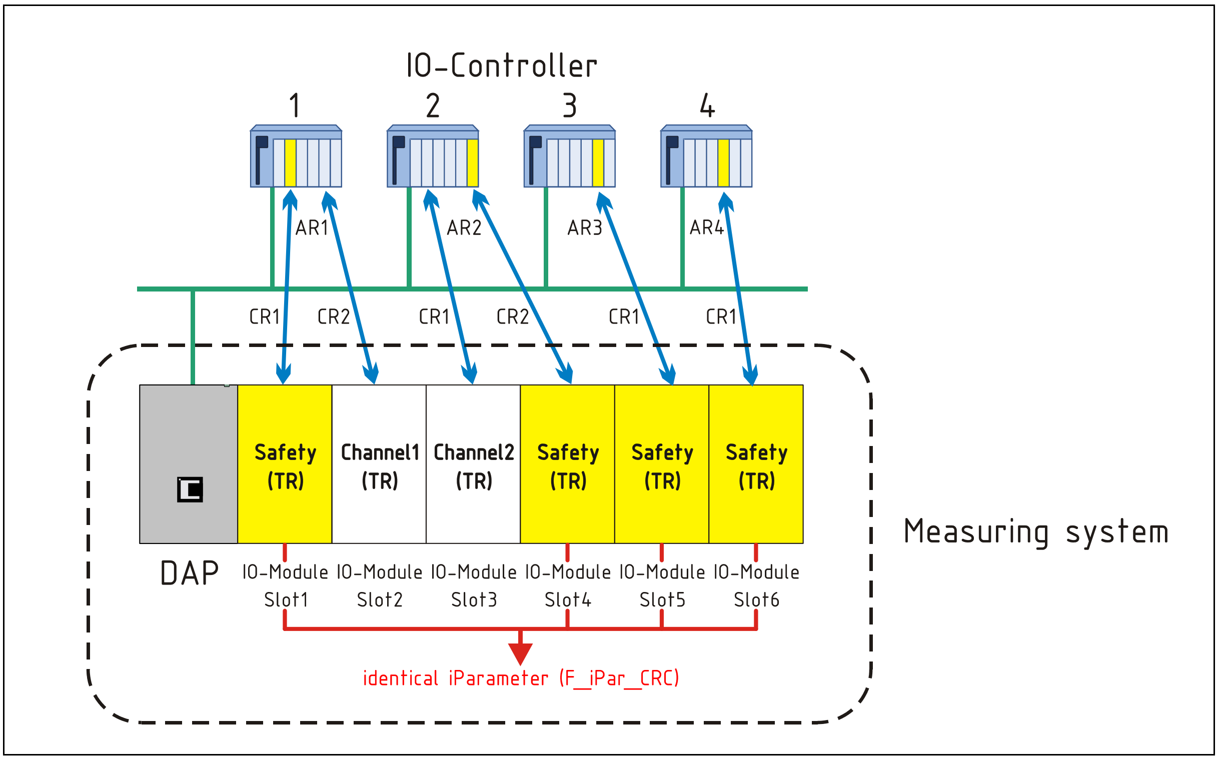


Figure 13: Shared Device (master/slave - system), configuration example 1

The modules `Channel 1 (TR)` and [1] `Channel 1-2 (TR)` or `Channel 2 (TR)` and [1] `Channel 2-2 (TR)` have a special feature, as the modules are copies of each other. Since the two master channels (1/1-2) and the two slave channels (2/2-2) must be plugged into different slots, exactly the same master value or slave value can be made available on two different controllers.

To do this, the same parameters must be set for both systems, the master system and the slave system. Unlike safety-related modules, which automatically calculate the `F_iPar_CRC` and then compare it with the `iParameters` set to the same value, this must be done manually for non-safety-related modules. Unequal parameter settings do not prevent the measuring system from starting up.

Due to the optical scanning unit in the master system and the magnetic scanning unit in the slave system, there will inevitably be differences in the values output. If this is not an issue for the application, the master and slave systems can of course be distributed across two different controllers; see configuration example 1 in Figure 13.

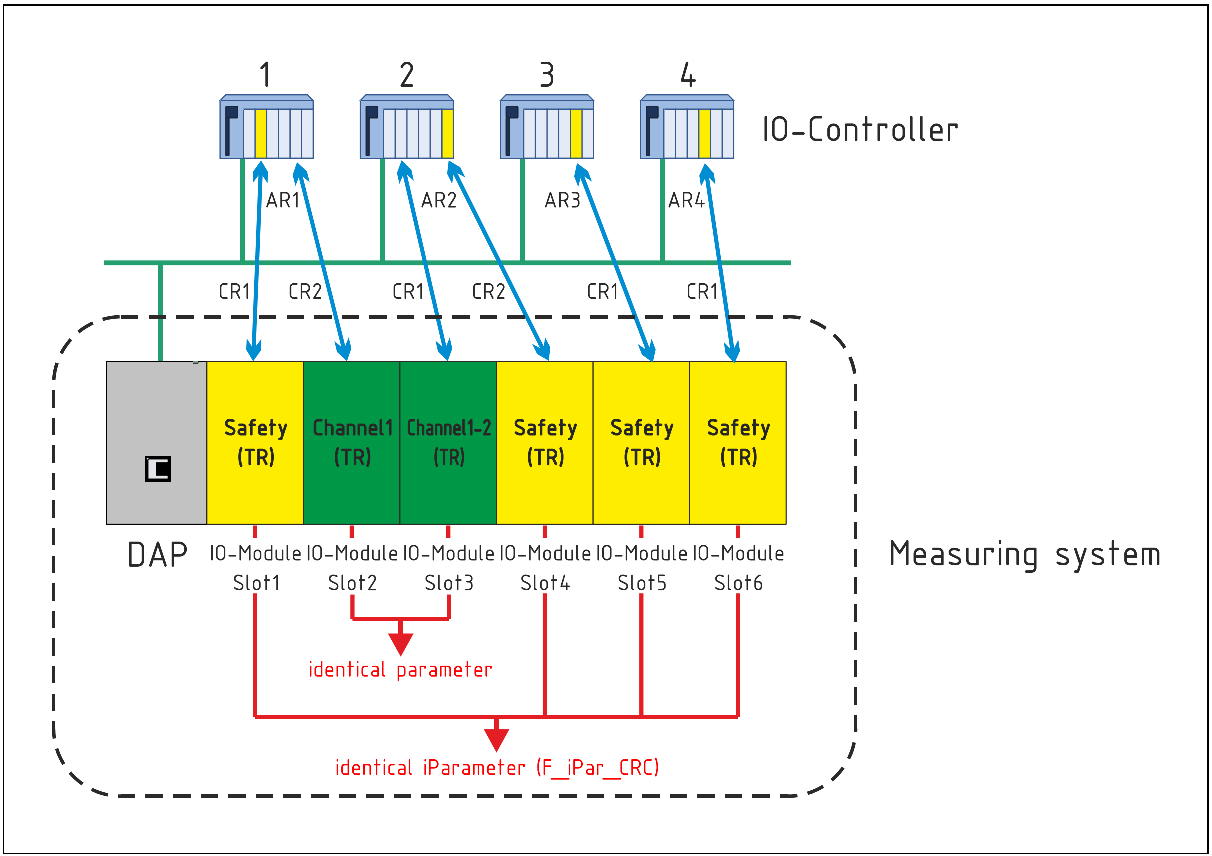


Figure 14: Shared Device (master/slave - system), configuration example 2

[1] available from firmware version 2.xx

Modules available for Shared Device applications:

Safety-related

Module name	Allowed slots	Max. number of configurations
Safety (TR)	1, 4, 5, 6	4, 1 per slot
Safety (PNO)	1, 4, 5, 6	4, 1 per slot

Non-safety related

Module name	Allowed slots	Max. number of configurations
Channel 1 (TR)	2	1, 1 per slot
Channel 2 (TR)	3	1, 1 per slot
[1]Channel 1-2 (TR)	3	1, 1 per Slot
[1]Channel 2-2 (TR)	2	1, 1 per Slot
Channel 1 (PNO)	2	1, 1 per slot
Channel 2 (PNO)	3	1, 1 per slot

Possible or useful module groupings – examples:

TR-Safety; channel 1/2 are not mandatory

Module name	Allowed slots	Max. number of configurations
Safety (TR)	1, 4, 5, 6	4, 1 per slot
Channel 1 (TR or PNO)	2	1, 1 per slot
Channel 2 (TR or PNO)	3	1, 1 per slot

or

Module name	Allowed slots	Max. number of configurations
Safety (TR)	1, 4, 5, 6	4, 1 per Slot
Channel 1 (TR)	2	1, 1 per Slot
[1]Channel 1-2 (TR)	3	1, 1 per Slot

or

Module name	Allowed slots	Max. number of configurations
Safety (TR)	1, 4, 5, 6	4, 1 per Slot
Channel 2 (TR)	3	1, 1 per Slot
[1]Channel 2-2 (TR)	2	1, 1 per Slot

[1] available from firmware version 2.xx

PNO-Safety; channel 1/2 are not mandatory

Module name	**Allowed slots**	**Max. number of configurations**
Safety (PNO)	1, 4, 5, 6	4, 1 per slot
Channel 1 (TR or PNO)	2	1, 1 per slot
Channel 2 (TR or PNO)	3	1, 1 per slot

or

Module name	**Allowed slots**	**Max. number of configurations**
Safety (PNO)	1, 4, 5, 6	4, 1 per Slot
[1]Channel 1-2 (TR)	3	1, 1 per Slot
[1]Channel 2-2 (TR)	2	1, 1 per Slot

TR/PNO-Channel; also single channel possible

Module name	**Allowed slots**	**Max. number of configurations**
Channel 1 (TR or PNO)	2	1, 1 per slot
Channel 2 (TR or PNO)	3	1, 1 per slot

or

Module name	**Allowed slots**	**Max. number of configurations**
[1]Channel 1-2 (TR)	3	1, 1 per Slot
[1]Channel 2-2 (TR)	2	1, 1 per Slot

: OPTION

[1] available from firmware version 2.xx

11 Acyclic parameter access

Acyclic parameter access is not required for commissioning and is a standard implementation of the PROFIdrive drive profile. It is only required if parameters must be written or read during operation. Since the procedure is relatively complicated, use is usually managed by so-called `Technology Objects`. The following information is therefore intended more for programming personnel.

11.1 PNO Profile

11.1.1 Non-safety related (Channel 1/2 (PNO))

The measuring system parameters in the parameter number range 9xx, 600xx (PROFIdrive-specific parameter) and 650xx (encoder-profile-specific parameter) are written and read via the acyclic Data Exchange Service using the standardized data exchange format “Base Mode Parameter Access - Local”. Implementation was in accordance with the PROFIdrive drive profile.

The parameters are accessed using the client-server principle via the record data object with index 0xB02E.

In the record data request the IO controller specifies which parameter is to be read or written, and in the record data response the IO device transmits the read data, or confirms the write command.

The record data request is triggered via a write command by means of the system function block SFB 53 "WRREC" (write record) provided by SIEMENS. The record data response must be requested separately via a read command by means of the system function block SFB 52 "RDREC" (read record).
The exact mode of operation of the system function blocks can be taken e.g. from the SIEMENS description *“6ES7810-4CA08-8AW1, System Software for S7-300/400 System and Standard Functions Volume 1/2”.*

Declaration of input parameters SFB52 / SFB53:

IN parameter	Type	Description
REQ	BOOL	REQ = 1: Perform data record transmission
ID	DWORD	Logical address of DP slave/PROFINET IO component (unit or module diagnostic address according to configuration)
INDEX	INT	0xB02E, valid for all 9xx und 6xxxx parameters
MLEN	INT	Maximum length of the data record information to be read in bytes or maximum length of the data record to be transmitted in bytes for a write command.
RECORD (IN/OUT)	ANY	The actual record data request or record data response must be specified here, see following tables Table 2: Record Data Request and Table 3: Record Data Response

Only one command can be processed at a time

The initiative always comes from the IO controller

Only one parameter can be processed in a command

Data format of the record data request:

<table>
<tr><th>Byte</th><th>Name</th><th colspan="2">Meaning</th></tr>
<tr><td>0</td><td>Request reference</td><td colspan="2">Unique identification for each request or response query. Valid values: 0x01 to 0xFF</td></tr>
<tr><td>1</td><td>Request ID</td><td colspan="2">0x01 Read parameter / 0x02 Write parameter</td></tr>
<tr><td>2</td><td>Axis</td><td colspan="2">always 0x00</td></tr>
<tr><td>3</td><td>Number of parameters</td><td colspan="2">always 0x01</td></tr>
<tr><td>4</td><td>Attribute</td><td colspan="2">always 0x10</td></tr>
<tr><td>5</td><td>Number of elements</td><td colspan="2">always 0x00</td></tr>
<tr><td>6</td><td>Parameter number</td><td colspan="2">High Byte</td></tr>
<tr><td>7</td><td>Parameter number</td><td colspan="2">Low Byte</td></tr>
<tr><td>8</td><td>Subindex</td><td colspan="2">High Byte</td></tr>
<tr><td>9</td><td>Subindex</td><td colspan="2">Low Byte</td></tr>
<tr><td>10</td><td>Format</td><td>Data type:
0x41 Byte
0x42 Wort
0x43 Double Word</td><td rowspan="3">Only for write access</td></tr>
<tr><td>11</td><td>Number of values</td><td>Number of following values</td></tr>
<tr><td>12-...</td><td>Values</td><td></td></tr>
</table>

Table 2: Record Data Request

Data format of the record data response:

<table>
<tr><th>Byte</th><th>Name</th><th colspan="2">Meaning</th></tr>
<tr><td>0</td><td>Request reference</td><td colspan="2">Mirrored identification from request</td></tr>
<tr><td>1</td><td>Response ID</td><td colspan="2">0x01 Parameter read successfully
0x81 Parameter not read successfully
0x02 Parameter written successfully
0x82 Parameter not written successfully</td></tr>
<tr><td>2</td><td>Axis</td><td colspan="2">Always 0x00</td></tr>
<tr><td>3</td><td>Number of parameters</td><td colspan="2">Always 0x01</td></tr>
<tr><td>4</td><td>Format</td><td>0x41 Byte
0x42 Wort
0x43 Double Word
0x44 Error</td><td rowspan="3">Not present if write access is successful:

In case of error
Format = 0x44
Number of values = 1
Value = Error number according to PROFIdrive drive profile</td></tr>
<tr><td>5</td><td>Number of values</td><td>Number of following values</td></tr>
<tr><td>6-...</td><td>Values /Error information</td><td>Parameter value, error number</td></tr>
</table>

Table 3: Record Data Response

Example: Write decimal preset value 1000 via PNU 65000

Byte	Value	Meaning
0	0x01	Request reference
1	0x02	Request ID (write parameter)
2	0x00	Axis
3	0x01	Number of parameters
4	0x10	Attribute
5	0x00	Number of elements
6	0xFD	PNU (High Byte)
7	0xE8	PNU (Low Byte)
8	0x00	Subindex (High Byte)
9	0x00	Subindex (Low Byte)
10	0x43	Format (Double Word)
11	0x01	Number of values
12	0x00	Value (MSB)
13	0x00	Value
14	0x03	Value
15	0xE8	Value (LSB)

Table 4: Record Data Request, write preset value 1000

Byte	Value	Meaning
0	0x01	Request reference, mirrored
1	0x02	Response ID (parameter written successfully)
2	0x00	Axis, mirrored
3	0x01	Number of parameters, mirrored

Table 5: Record Data Response to write preset value 1000

Example: read back written decimal preset value 1000 via PNU 65000

Byte	Value	Meaning
0	0x02	Request reference
1	0x01	Request ID (read parameter)
2	0x00	Axis
3	0x01	Number of parameters
4	0x10	Attribute
5	0x00	Number of elements
6	0xFD	PNU (High Byte)
7	0xE8	PNU (Low Byte)
8	0x00	Subindex (High Byte)
9	0x00	Subindex (Low Byte)

Table 6: Record Data Request, read back preset value

Byte	Value	Meaning
0	0x02	Request reference, mirrored
1	0x01	Response ID (parameter read successfully)
2	0x00	Axis, mirrored
3	0x01	Number of parameters, mirrored
4	0x04	Format (Integer32)
5	0x01	Number of values
6	0x00	Value (MSB)
7	0x00	Value
8	0x03	Value
9	0xE8	Value (LSB)

Table 7: Record Data Response to read back preset value

11.1.1.1 Preset value 32-bit (PNU 65000)

The zero point of the measuring system can be adapted to the mechanical zero point via this parameter and is set either as an absolute value or as a relative value, in relation to the position output, during execution of the preset function, see Chapter “Preset function” on Page 116. A sample procedure for adjusting the value is shown in Chapter 11 from Page 145.

The transmitted value is interpreted differently, depending on the preset mode set:

Preset mode = absolute
- Transmitted value is interpreted as an Unsigned32 type
  The preset function is not executed for negative values!

Preset mode = relative
- Transmitted value is interpreted as an Integer32 type in two's complement form

PNU	65000
Meaning	Preset value
Data type	Integer32
Access	read/write
Activation	with write access
Storage	PNU 971
Default value	0

Integer32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

11.1.1.2 Operating status (PNU 65001)

The parameter structure can only be read and contains all status information for the measuring system.

PNU	65001
Meaning	Encoder Operating Status
Data type	Array[n] Unsigned32
Access	read

Subindex	Meaning	Page
0	Block Header	150
1	Operating status	150
2	Error	151
3	Supported errors	151

Continued on next page

Continued

Subindex	Meaning	Page
4	Warnings	151
5	Warnings supported	152
6	Encoder Profile Version	152
7	Operating time **(is not supported)**	-
8	Offset value	152
9	Scaling: Measuring units per revolution	152
10	Scaling: Total measuring range	153
11	Velocity value normalization	153
12	Velocity reference value N2/N4	153
13-18	64-bit parameters **(are not supported)**	-

11.1.1.2.1 Block Header (PNU 65001.00)

The block header in Subindex 0 contains the parameter structure version.

Bits	Meaning	
0-7	0x02 (LSB)	Versions no. 0x0102
8-15	0x01 (MSB)	
16-23	0x12	Number of indices = 18
24-31	0x00, reserved	

11.1.1.2.2 Operating status (PNU 65001.01)

The operating status in Subindex 1 contains the parameter settings made for the bit-coded parameters in chapter “Configurable module-related parameters”, see from page 106.

Bits	Meaning
0	Rotational direction
1	Encoder Class 4 functionality
2	Preset affects XIST1
3	Scaling function control
4	Alarm channel control
5	Compatibility mode V3.1
6	Encoder type, see also Chapter 11.1.1.3 on Page 153 0: Shaft encoder, resolution in steps per revolution 1: Linear encoder, resolution in nm per step
7 - 31	reserved

11.1.1.2.3 Error (PNU 65001.02)

The parameter in Subindex 2 displays the current measuring system errors. When an error occurs, the corresponding bit is set. The measuring system remains in the error state until the cause of the error has been eliminated and the error state has been acknowledged with the control word `G1_STW` Bit 15 = 0->1 edge.

In case of a scaling error, check if the parameter `Total measuring range` is an integer and a multiple of the parameter `Measuring units per revolution`, see also chapter 5.7.3.11 as from page 111.
If the error cannot be acknowledged, an attempt can be made to execute a device RESET via PNU 972. If the error still cannot be deleted after this measure, the measuring system must be replaced.

Bits	Definition	= 0	=1
0	Position error	no	yes
1 - 5	Not supported	Always 0	-
6	Scaling error	no	yes
7 - 10	Not supported	Always 0	-
11	Sign-of-life faults	no	yes
12 - 24	Not supported	Always 0	-
25 - 31	reserved		

11.1.1.2.4 Supported errors (PNU 65001.03)

The parameter in Subindex 3 displays the errors supported by the measuring system.

Bits	Definition	= 0	=1
0	Position error	-	Supported
1 - 5	-	Not supported	-
6	Scaling error	-	Supported
7 - 10	-	Not supported	-
11	Sign-of-life faults	-	Supported
12 - 24	-	Not supported	-
25 - 31	reserved		

11.1.1.2.5 Warnings (PNU 65001.04)

The parameter in Subindex 4 displays the current measuring system warnings.

Bits	Definition	= 0	=1
0 - 13	-	Always 0	-
14	Preset value out of range The transmitted preset value is not executed and must be overwritten by a valid value.	no	yes
15	Command not supported	no	yes
16 - 24	-	Always 0	-
25 - 31	reserved		

11.1.1.2.6 Supported warnings (PNU 65001.05)

The parameter in Subindex 5 displays the warnings supported by the measuring system.

Bits	Definition	= 0	=1
0 - 13	-	Not supported	-
14	Preset value out of range	-	Supported
15	Command not supported	-	Supported
16 - 24	-	Not supported	-
25 - 31	reserved		

11.1.1.2.7 Encoder Profile Version (PNU 65001.06)

The parameter in Subindex 6 contains the profile version implemented in the measuring system.

Bits	Definition	
0 - 7	0x02 (LSB)	Versions no. 0x0402
8 - 15	0x04 (MSB)	
16 - 31	0x0000, reserved	

11.1.1.2.8 Offset value 32-bit (PNU 65001.08)

The offset value in Subindex 8 is calculated internally during execution of the preset function and offsets the actual position value by the calculated value. Each time the preset function is executed, the re-calculated value is specified as a scaled value according to the set resolution.

Integer32, complement on two

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

11.1.1.2.9 Measuring units per revolution (PNU 65001.09)

The parameter in Subindex 9 contains the set `number of steps/revolution`, see Chapter “Scaling parameter”on page 111.

Unsigned32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

11.1.1.2.10 Total measuring range (PNU 65001.10)

The parameter in Subindex 10 contains the set `Measuring range in steps`, see Chapter "Scaling parameter"on page 111.

Unsigned32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

11.1.1.2.11 Velocity value normalization (PNU 65001.11)

The parameter in Subindex 11 contains the set `unit` for the output velocity, see Chapter "Velocity value normalization (PNU 60001)" on Page 113.

Unit	**Value**
Steps/sec	0
Steps/100 msec	1
Steps/10 msec	2
Revolutions per minute	3
N2/N4 normalized	4

11.1.1.2.12 Velocity ref value N2/N4 (PNU 65001.12)

The parameter in Subindex 12 contains the set normalized reference value for the output velocity, see Chapter "Velocity reference value N2/N4 (PNU 60000)" on Page 114.

Float32

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

11.1.1.3 Function control (PNU 65004)

Using the function control, measuring system-related functions can be independently enabled or disabled, the code sequence can be set, and the encoder type can be read out.

PNU	**65004**
Meaning	Function control
Data type	Unsigned32
Access	read/write
Activation	PNU 972
Storage	PNU 971

Bits	Definition
0	`Code sequence`, see Chapter 5.7.3.5 on Page 109 0: CW 1: CCW
1	`Encoder Class 4 functionality`, see Chapter 5.7.3.6 on Page 109 0: disabled 1: enabled
2	`Preset affects XIST1`, see Chapter 5.7.3.7 on Page 110) 0: enable 1: disabled
3	`Scaling function control`, see Chapter 5.7.3.8 on Page 110 0: disabled 1: enabled
4	`Alarm channel control`, see Chapter 5.7.3.9 on Page 110 0: disabled 1: enabled
5	`Compatibility mode V3.1`, see Chapter 5.7.3.10 on Page 111 0: enable 1: disabled
6	`Encoder type`, see also Chapter 11.1.1.2.2 on Page 150 0: Shaft encoder, resolution in steps per revolution 1: Linear encoder, resolution in nm per step
7 - 31	reserved

11.1.1.4 Parameter control (PNU 65005)

Use parameter control to set the parameter initialization in the startup phase and the read-only settings for the parameters

- PNU 6xxxx and PNU 9xx (encoder-specific and PROFIdrive-specific)
- PNU 65005 (parameter control) and PNU 971 (storage)
- PNU 972 (RESET, Activation)

see also Chapter 5.7.2 on Page 105.

PNU	65005
Meaning	Parameter control
Data type	Unsigned16
Access	read/write
Activation	PNU 972
Storage	PNU 971

Bits	Definition
0-1	`Parameter initialization`, see Chapter 5.7.3.1 on Page 108 0: PRM Data Block 1: RAM Data
2-4	`Parameter write protection`, see Chapter 5.7.3.2 on Page 108 0: write all 1: read-only
5	`Write protection on PNU 65005 and PNU 971`, see Chapter 5.7.3.3 on Page 108 0: write all 1: read-only
6	`Write protection on PNU 972`, see Chapter 5.7.3.4 on Page 108 0: write all 1: read-only
7 - 16	reserved

11.1.1.5 Scaling: Measuring units per revolution (PNU 65006)

This parameter sets the resolution of the measuring system in [steps per revolution], see also Chapter 5.7.3.11 on Page 111.

PNU	65006
Meaning	Resolution in steps per revolution
Data type	Unsigned32
Access	read/write
Activation	PNU 972
Storage	PNU 971

11.1.1.6 Scaling: Total measuring range (PNU 65007)

This parameter defines the total number of steps over the entire measuring range of the measuring system, see also Chapter 5.7.3.11 on Page 111.

PNU	65007
Meaning	Total measuring range in steps
Data type	Unsigned32
Access	read/write
Activation	PNU 972
Storage	PNU 971

11.1.1.7 PROFIdrive-related parameters (PNU 600xx, 9xx)

11.1.1.7.1 Velocity reference value N2/N4 (PNU 60000)

The velocity value output in the `NIST_A` and `NIST_B` signals is a percentage of the specified velocity reference value, see also Chapter 5.7.3.13 and 5.7.3.16 on Page 114.

PNU	60000
Meaning	Velocity reference value according to N2 / N4 standardization
Data type	Float32
Unit	Revolution per minute
Default value	3000 (100 %)
Access	read/write
Activation	PNU 972
Storage	PNU 971

11.1.1.7.2 Velocity value normalization (PNU 60001)

This parameter sets the `unit` for the output velocity, see also Chapters 5.7.3.13 and 5.7.3.16 on Page 114.

PNU	60001
Meaning	Unit of velocity
Data type	Unsigned16
Access	read/write
Activation	PNU 972
Storage	PNU 971

Value	Unit
0	Steps/sec
1	Steps/100 msec
2	Steps/10 msec
3	Revolutions per minute
4	N2/N4 normalized

11.1.1.7.3 Telegram selection (PNU 922)

Use this parameter to read out the preselected telegram (81-84), see Chapter 5.7.1 on Page 98.

PNU	922
Meaning	Telegram selection
Data type	Unsigned16
Access	read

Value	Definition
81	Standard Telegram 81
82	Standard Telegram 82
83	Standard Telegram 83
84	Standard Telegram 84

11.1.1.7.4 Tolerated master sign-of-life faults (PNU 925)

The max. number of permissible errors of the master sign-of-life counter is defined with this parameter, see also Chapter 5.7.3.12 on Page 112.

PNU	925
Meaning	Tolerated master sign-of-life faults
Data type	Unsigned16
Access	read/write
Activation	with write access

11.1.1.7.5 Device identification (PNU 964)

This parameter contains all information needed to identify the PROFINET measuring system in the network.

PNU	964
Meaning	Device identification
Data type	Array [n] Unsigned16
Access	read

Subindex	Meaning
0	Manufacturer Vendor Code: 0x0153 (TR-Electronic GmbH)
1	Device type: 0x0404
2	Current Software Version: 101 (decimal) = Version 1.0.1 (example)
3	Firmware Date (Year): YYYY (decimal)
4	Firmware date: (Day/Month): ddmm (decimal)

11.1.1.7.6 Profile identification (PNU 965)

This parameter contains the encoder profile identification number that identifies the profile (0x3D) and the profile version (3.1 / 4.2).

PNU	965
Meaning	Profile identification
Data type	OctetString 2 (Unsigned16)
Access	read

	Profile no.	Profile version
Byte	1	2
Data	61 (0x3D)	31 (0x1F) / 42 (0x2A)

11.1.1.7.7 Parameter storage (permanent) (PNU 971)

Use this parameter to save the currently set parameter values in the non-volatile memory (RAM Data). After saving, the parameter value of PNU 971 is automatically reset to 0.

The parameter control PNU 65005 must be set accordingly for the stored parameters to be loaded from the non-volatile memory at the next startup of the measuring system, see Chapter 11.1.1.4 on Page 154.

PNU	971
Meaning	Saving the parameters to the non-volatile memory
Data type	Unsigned16
Access	read/write
Activation	with write access
Default value	0x0000
Permitted values	0x0001: save current parameter values to non-volatile memory

11.1.1.7.8 Device RESET / parameter activation (PNU 972)

⚠ WARNING

NOTICE

Danger of physical injury and material damage due to uncontrolled movements of the drive system when executing the RESET function!

- The measuring system immediately stops communicating when a RESET command is received; this can result in uncontrolled system conditions.
  Therefore, the application must be transferred to a safe state before the RESET command is executed. The write protection for this parameter prevents unwanted access, see Chapter 11.1.1.4 on Page 154.

Use this parameter to force a device RESET, e.g. during the commissioning phase, when all parameters have been set and the measuring system has to be reinitialized or after elimination of errors to delete an error message.

Procedure
-> Send the transfer value = 2 to PNU 972 -> measuring system acknowledges the write request
-> Send the transfer value = 1 to PNU 972 -> measuring system executes the device RESET

After re-establishment of the connection, read back PNU 972:
-> PNU 972 = 0: Device RESET was successfully executed
-> PNU 972 = 2: Device RESET write request has been lost, repeat the procedure
-> PNU 972 = 20: Illegal transfer value was written

However, the transfer value 100 must be sent to PNU 972, if a parameter is to be activated without a device RESET.

PNU	**972**
Meaning	Device RESET / Parameter activation
Data type	Unsigned16
Access	read/write
Activation	with write access
Default value	0x0000
Permitted values	0x0002: Prepare devcice RESET 0x0001: Execute device RESET 0x0064: Activate parameter

11.1.1.7.9 B M P Access – Identification (PNU 974)

This parameter contains information about the Base-Mode-Parameter access points. Also see Chapter 11 on Page 145.

PNU	**974**
Meaning	**B**ase-**M**ode-**P**arameter-Access – Identification
Data type	Array [n] Unsigned16
Access	read

Subindex	**Meaning**	
0	Max. block length:	0x00F0 = 240 bytes
1	Multiparameter access:	0x0001 = no multiparameter access
2	Max. latency:	0x0000 = unspecified

11.1.1.7.10 Encoder object identification (PNU 975)

This parameter contains the encoder object identification and is identified according to `PROFIdrive Profile` by the type class: `0x0005 = Encoder`. Sub-Class 1 contains the encoder classes supported by the measuring system.

PNU	975
Meaning	Encoder object identification
Data type	Array [n] Unsigned16
Access	read

Subindex	Meaning
0	Manufacturer Vendor Code: 0x0153 (TR-Electronic GmbH)
1	Device type: 0x0404
2	Current Software Version: 101 (decimal) = Version 1.0.1 (example)
3	Firmware Date (Year): YYYY (decimal)
4	Firmware date: (Day/Month): ddmm (decimal)
5	Type class: 0x0005 (Encoder)
6	Sub-Class 1: 0xC000 (Encoder class 3/4)
7	Drive object ID: 1

11.1.1.7.11 Sensor Format (PNU 979)

This parameter contains information about the encoder type, set resolution, shift factor and type of position output.

PNU	979
Meaning	Sensor format
Data type	Array [n] Unsigned32
Access	read

Subindex	Meaning
0	Header: 0x0000 5112 Bits 0-3: Version of parameter structure (LSB) = 2 Bits 4-7: Version of parameter structure (MSB) = 1, corresponds to Version 4 Bits 8-11: Number of active sensor interfaces = 1 (G1) Bits 12-15: Number of assigned subindexes = 5 (G1) Bits 16-31: reserved

Continued on next page

Continued

1	Encoder type: 0xC000 0002 Bit 0 = 0: Shaft encoder Bit 1 = 1: G1_XIST1 is loaded with the absolute value after supply is ON Bit 2 = 0: Only 32-bit position data available Bit 3-28: reserved Bit 29 = 0: Data in PNU 979 G1 substructure are static Bit 30 = 1: Data validity in PNU 979 G1 substructure is static Bit 31 = 1: Data in PNU 979 G1 substructure are valid
2	Resolution: 0x0000 2000 (Default value, see Chapter 5.7.3.11.1 on Page 111) 0x2000 = 8192 steps per revolution
3	Shift factor for `G1_XIST1`: 0x0000 0000 0: no shift factor set
4	Shift factor for absolute value in `G1_XIST2`: 0x0000 0000 0: no shift factor set
5	Revolutions: 0x00010000 = 65536
6-30	reserved

11.1.1.7.12 Parameter list (PNU 980)

This parameter contains all parameter numbers supported by the measuring system. The parameter numbers are written into the subindexes in ascending order. The value 0 in a subindex marks the end of a parameter list.

PNU	980
Meaning	List of all implemented parameters
Data type	Array [n] Unsigned16
Access	read

Subindex	Meaning
0	0x039A: Telegram selection (PNU 922), ...see Page 157
1	0x039D: Tolerated master sign-of-life faults (PNU 925),...............see Page 157
2	0x03C4: Device identification (PNU 964), ...see Page 157
3	0x03C5: Profile identification (PNU 965), ...see Page 158
4	0x03CB: Parameter storage (permanent) (PNU 971), ...see Page 158
5	0x03CC: Device RESET / parameter activation (PNU 972), ...see Page 158
6	0x03CE: B M P Access – Identification (PNU 974), ...see Page 159
7	0x03CF: Encoder object identification (PNU 975), ...see Page 159
8	0x03D3: Sensor Format (PNU 979),...see Page 160
9	0xEA60: Velocity reference value N2/N4 (PNU 60000),................see Page 156
10	0xEA61: Velocity value normalization (PNU 60001),.....................see Page 156
11	0xFDE8: Preset value 32-bit (PNU 65000),..................................see Page 149
12	0xFDE9: Operating status (PNU 65001), ...see Page 149
13	0xFDEC: Function control (PNU 65004),.......................................see Page 153
14	0xFDED: Parameter control (PNU 65005),....................................see Page 154
15	0xFDEE: Scaling: Measuring units per revolution (PNU 65006), ..see Page 155
16	0xFDEF: Scaling: Total measuring range (PNU 65007),................see Page 155
17	0x0000: End of parameter list

11.1.2 Safety-related (Safety BP/XP (PNO))

⚠ WARNING ***This parameter access is not evaluated in relation to safety and may not be used for safety-related purposes!***

- This data may only be used informally as the acyclic data traffic is basically not a safety-related transmission mechanism according to `Base-Mode-Parameter-Access – Local`.

As with the non-safety-related application, the parameter can also be accessed after the startup phase via the acyclic data traffic (**B**ase **M**ode **P**arameter channel). **However, for safety reasons, the parameter is read-only**. The access mechanism is described in Chapter 11 from page 145 to 148.

11.1.2.1 Safety telegram no. (PNU 60022)

This parameter contains the configured safety-related PROFIdrive telegram number. The value 0xFFFF is output if an error prevented the safety-related configuration.

PNU	**60022**
Meaning	Safety telegram number
Data type	Unsigned16
Access	read
Value range	36, 37, 0xFFFF

11.1.2.2 Safety velocity value normalization (PNU 60023)

This parameter contains the set normalization type for the safety-related velocity output in signal `S_NIST16`. The velocity output is part of the Standard Telegram 36 (BP) and 36 (XP). The setting is made as described in Chapter 5.6.3.5 on page 93.

PNU	**60023**
Meaning	Safe speed value normalization
Data type	Unsigned16
Access	read
Value range	0: Steps(s), 1: Steps/100 ms, 2: Steps/10 ms, 3: Revolutions per minute

11.1.2.3 Safety setpoint telegram (PNU 60024)

Use this parameter to acyclically read out the entire current safety-related process output data. As the process output data of the standard telegrams 36 (BP/XP) and 37 (BP/XP) do not differ, signal number 98 (Encoder F control word 1, `S_STW1_ENC`) and PNU 62000 (F preset value, `S_PRESET32`) are read back.

PNU	60024
Meaning	Safety setpoint value telegram
Data type	OctetString[n]
Access	read
Value range	S_STW1_ENC: Unsigned16 + S_PRESET32: Integer32

11.1.2.4 Safety setpoint telegram (PNU 60025)

Use this parameter to acyclically read out the entire current safety-related process input data. Depending on the configured standard telegram 36 (BP/XP) / 37 (BP/XP), signal numbers 96 (F actual position value, `S_XIST32`), 97 (F actual speed value, `S_NIST16`) and 99 (Encoder F status word 1, `S_ZSW1_ENC`) are read back.

PNU	60025
Meaning	Safety actual value telegram
Data type	OctetString[n]
Access	read
Value range	S_ZSW1_ENC: Unsigned16 + S_NIST16: Integer16 + S_XIST32: Integer32

11.1.2.5 Safety preset value S_PRESET32 (PNU 62000)

This parameter contains the safety-related preset value transmitted via the cyclic output data `S_PRESET32`, see Chapter 5.6.1.7 on Page 87.

PNU	62000
Meaning	Safety preset value 32 bit
Data type	Integer32
Access	read

11.1.2.6 Safety operating status (PNU 65100)

This parameter structure contains all safety-related status information for the measuring system. The block header version of the following subindexes corresponds to Version V2.1.

PNU	65100
Meaning	Encoder safety operating status
Data type	Array[n] Unsigned32
Access	read

Subindex	Meaning	Page
0	Block Header	165
1	Operating status	166
2	Error	151
3	Supported errors	151
4	Warnings **(are not supported)**	151
5	Warnings supported	152
6	Encoder Profile Version	152
7	Operating time **(is not supported)**	-
8	Offset value	166
9	Scaling: Measuring units per revolution	91
10	Scaling: Total measuring range	91
11	Velocity value normalization	93

11.1.2.6.1 Block Header (PNU 65100.00)

The block header in Subindex 0 contains the parameter structure version.

Bits	Meaning	
0 - 7	0x01 (LSB)	Version no. 0x0201
8 -15	0x02 (MSB)	
16 - 23	0x12	Number of indices = 18
24 - 31	reserved	

11.1.2.6.2 Operating status (PNU 65100.01)

The operating status in Subindex 1 contains the parameter settings made for the bit-coded parameters in chapter “Configurable module-related iParameters (F_iPar)”, see from page 90.

Bits	Definition
0	Rotational direction
1	reserved
2	Preset affects S_XIST32
3	Scaling function control
4	reserved
5	reserved
6	Encoder type 0: Shaft encoder, resolution in steps per revolution 1: Linear encoder, resolution in nm per step
7 - 31	reserved

11.1.2.6.3 Offset value 32-bit (PNU 65100.08)

The offset value in Subindex 8 is calculated internally during execution of the Preset Adjustment function and offsets the actual position value by the calculated value. Each time the Preset Adjustment function is executed, the re-calculated value is permanently stored and specified as a scaled value according to the set resolution.

Integer32, complement on two

Byte	X+0	X+1	X+2	X+3
Bit	31-24	23-16	15-8	7-0
Data	$2^{31} – 2^{24}$	$2^{23} – 2^{16}$	$2^{15} – 2^{8}$	$2^{7} – 2^{0}$

11.2 TR Profile

The acyclic data exchange service can also be used to write or read **manufacturer-specific parameters (extended operating data).**

The parameters are accessed via the Record Data Object with the corresponding index for the respective write or read parameter. The index corresponds to the “Async ID” specified under the corresponding parameter.

A write command is executed using the SFB 53 “WRREC” (write record) system function block provided by SIEMENS, and a read command is executed using the SFB 52 “RDREC” (read record) system function block.
The exact functionality of the system function blocks can be found, for example, in the SIEMENS description *“6ES7810-4CA08-8AW1, System and Standard Functions for S7-300/400 Volume 1/2.”*

Declaration of input parameters SFB52 / SFB53:

IN parameters	Type	Description
REQ	BOOL	REQ = 1: Execute data record transfer
ID	DWORD	Logical address of the DP slave/PROFINET IO component (Assembly or module diagnostic address according to project planning)
INDEX	INT	Async ID of the corresponding parameter
MLEN	INT	Maximum length of the data record information to be read in bytes or maximum length of the data record to be transferred in bytes for a write request.
RECORD (IN/OUT)	ANY	Write or read data, according to parameter Async ID

Data format of the read/write record data, e.g., 4-byte value:

Byte	Significance
0	Parameter value (MSB)
1	Parameter value
2	Parameter value
3	Parameter value (LSB)
...	...

Table 8: Record data

11.2.1 Extended operating data

- Available from firmware version 2.xx
- Exception Async ID 0x2300: available under firmware version 1.xx

11.2.1.1 Temperature

The current temperature of the internal master system is output as a signed 32-bit two's complement value via the Async ID of the `Temperature` parameter.

Async ID	0x2307
Data format	Integer32, two's complement
Access	read only
Unit	°C

11.2.1.2 Operating hours in motion

The Async ID of the parameter `Operating hours in motion` indicates the current time of the measuring system when the measuring system was powered and the shaft was in motion.

Async ID	0x2320
Data format	Unsigned32
Access	read only
Unit	0.1 hours

11.2.1.3 Total number of revolutions

The Async ID of the parameter `Total number of revolutions` outputs the currently measured number of revolutions of the measuring system shaft. The direction of rotation is irrelevant here.

Async ID	0x2321
Data format	Unsigned64
Access	read only
Unit	Number of measured revolutions of the shaft

11.2.1.4 Simulation – Fault- safe state

During the setup phase or for testing purposes, the measuring system can be put into a fail-safe state by writing the value 0x2C. In this case, the measuring system behaves exactly as if a safety-related error had occurred, and passivated data is output: `TR-Status1`, bit 2^4 `Safe State` = "0".
Only by writing the value 00h can the measuring system be returned to operating mode; other values will result in an error. Once this step has been completed, bit 2^0 `Error Ack Request` in `TR-Status2` is set to "1." As with a real error, the measuring system must then be re-integrated; see also the chapter "F_MessageTrailer/F-Parameter - informative" starting on page 134.
However, the measuring system can also be restarted by switching the supply voltage OFF/ON.

Async ID	0x2220
Data format	1 byte
Access	write / read
OFF	0x00
ON	0x2C
Default	**0**

11.2.1.5 Setting the F_Dest_Add (Address type 1, Firmware version 1.xx)

Alternatively, the PROFIsafe target address `F_Dest_Add` in the measuring system can be stored under address type 1 using the Async ID of this parameter group if, for example, the TR Electronic sample program for the `SIEMENS TIA Portal V15.1` cannot be used for compatibility reasons. See also section 3.4 starting on page 23.

Async ID	0x2300
Access	read
Data format	4 byte
2 bytes	Read back the value written via the write request for `F_Dest_Add` (Big-Endian)
2 bytes	Read back the value set for `F_Dest_Add` via the HEX rotary switch (Big-Endian)
Access	write
Data format	2 byte
2 bytes	Required value for `F_Dest_Add` (Big-Endian)

11.2.1.6 Setting the address type, F_Source_Add and F_Dest_Add

The Async ID of this parameter group is primarily intended to enable the PROFIsafe source address F_Source_Add to be stored in the measuring system under address type 2 if TR Electronic's own TR TCI Device Tool program cannot be used for compatibility reasons; see also section 3.4 on page 23.

Async ID	0x230A
Data format	17 bytes
Access	write / read
1 byte	Address type: 0x51 = type 1, 0x52 = type 2
2 bytes	F_Source_Add, address for slot 1 (Big-Endian)
2 bytes	F_Source_Add, address for slot 4 (Big-Endian)
2 bytes	F_Source_Add, address for slot 5 (Big-Endian)
2 bytes	F_Source_Add, address for slot 6 (Big-Endian)
2 bytes	F_Dest_Add, address for slot 1 (Big-Endian)
2 bytes	F_Dest_Add, address for slot 4 (Big-Endian)
2 bytes	F_Dest_Add, address for slot 5 (Big-Endian)
2 bytes	F_Dest_Add, address for slot 6 (Big-Endian)

12 Troubleshooting and diagnostic options

12.1 Optical displays

The position and assignment of the LEDs can be found in the accompanying pin assignment.

12.1.1 Device status, Bicolor LED

green	Cause	Solution
OFF	Voltage supply absent or too low	- Check power supply, wiring - Is the voltage supply in the permissible range?
	Connector incorrectly wired or screwed down	Check wiring and connector position
	Hardware error, measuring system defective	Replace measuring system
Repeating 3x 2.5 Hz	- Measuring system could not synchronize with the F Host in the start-up phase and requests a re-integration (user acknowledgment) - An error has been detected in the safety-related communication or a parameterization error has been detected, which has been eliminated	Re-integration of the designated variable is required via the safety program. See also bit 1 `OA_Req` in the `SafeControl` byte on Page 135.
Flashing (ON:1000 ms, OFF:200 ms)	- With an active safety-related connection, only “0x00” data are sent by the IO controller, but no safety-related data exchange takes place.	Design the safety-related modules in such a way that the safety-related data are used in the IO controller.
ON	Normal mode, measuring system in data exchange	-

red	Cause	Solution
ON	**A safety-relevant error was detected, the measuring system was put into fail-safe state and outputs its passivated data:**	**To restart the measuring system after passivation, eliminate the error first and then switch the supply voltage OFF/ON.**
	- Error in safety-related communication	- Try to localize the error using diagnostic variables (depending on the control) - Check that the set value for the `F_WD_Time` parameter is appropriate for the automation task; see Chapter “F_WD_Time” on Page 138 - Check whether the PROFINET connection between F-CPU and measuring system is faulty

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red	Cause	Solution
ON	Diagnostic alarm Error type "F:..." is present. (see chapter 12.2)	Solution of the respective error at "PROFINET Diagnose-Alarm" (see chapter 12.2)
Repeating 3x 2.5 Hz	Diagnostic alarm Error type W1, W2, F:16384$_d$ or F:0064$_d$ to F:0079$_d$ is present. (see chapter 12.2)	Solution of the respective error at "PROFINET Diagnose-Alarm" (see chapter 12.2)
	- Parameterization error	- Check value range of scaling parameters - PNO configuration: The parameters "Measuring range in steps" and "Number of steps per revolution" must be selected so that the quotient of both parameters is a power of two. - PNO configuration: Check mechanism of the master sign-of-life - PNO configuration: Check setting of the parameter `Tolerated sign-of-life faults`

12.1.2 Net-Status, Bicolor LED

green	Cause	Solution
OFF	Voltage supply absent or too low	- Check power supply, wiring - Is the voltage supply in the permissible range?
	Connector incorrectly wired or screwed down	Check wiring and connector position
	Hardware error, measuring system defective	Replace measuring system
ON	Normal mode, measuring system in data exchange	-

red	Cause	Solution
ON	- No connection to the IO controller - No data exchange	- Check bus connection - IO controller available and online? - Check device name, IP address and subnet mask.

12.2 PROFINET Diagnose-Alarm

PROFINET supports an integrated diagnostic concept, which enables efficient error detection and elimination. When an error occurs, the defective IO device generates a diagnostic alarm on the IO controller. This alarm calls up a corresponding program routine in the controller program, in order to react to the error.
Alternatively, the diagnostic information can also be manually acyclically read out directly from the IO device via record index 0xE00C and displayed on an IO supervisor.

Alarms belong to the acyclic frames which are transmitted via the cyclic RT channel. They are also identified by `Ether type = 0x8892`.

Errors and warnings are transmitted by the measuring system to the IO controller in the form of a so-called `Alarm Notification Request` (alarm message).

The exact structure of the `Alarm Notification Request` can be found e.g. in the PROFINET specification *Application Layer protocol for decentralized periphery and distributed automation, order no.: 2.722*.

Errors (F) and warnings (W) are reported in the same way, but with different types error types.

For warnings, two warning levels are distinguished:
- W1 = warnings with need for action
- W2 = warnings considered advises

Error type	Diagnostic message / Meaning	Solution
W2:0002 d	**Undervoltage** The supply voltage is below the tolerance limit.	- The supply voltage range specified for this article number must be maintained.
W2:0003 d	**Overvoltage** The supply voltage is above the tolerance limit.	- The supply voltage range specified for this article number must be maintained.
W2:0005 d	**Overtemperature** The output stage is overloaded and gets too hot.	- The ambient temperature range specified for this article number must be maintained.
W2:0016 d	**Parameter error** The module has detected a parameter assignment error.	- Check measuring system configuration; at least one module must be configured. - Check value range of scaling parameters.
F:0064 d	**Mismatch of safety destination address (F_Dest_Add)** A different F-destination address was detected in the PROFIsafe communication.	- Check the parameterization of the PROFIsafe communication and the address setting of the measuring system.
F:0065 d	**Safety destination address not valid (F_Dest_Add)**	- Check the parameterization of the PROFIsafe communication.
F:0066 d	**Safety source address not valid (F_Source_Add)**	- Check the parameterization of the PROFIsafe communication.

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Error type	Diagnostic message / Meaning	Solution
F:0067 d	**Safety watchdog time value is 0 ms (F_WD_Time)**	- Valid monitoring times: 10…10000 ms, see Chapter 7.2.8 on Page 138.
F:0068 d	**Parameter F_SIL exceeds SIL from special device application**	- The set value (SIL1, SIL2, SIL3, NoSIL) must correspond to the value of the device application, see Chapter 7.2.2 on Page 137.
F:0069 d	**Parameter F_CRC_Length does not match the generated values**	- This parameter is not adjustable and can only be preselected by selecting the corresponding safety-related submodule: (BP) = 3-Byte-CRC (XP) = 4-Byte-CRC
F:0070 d	**Version of F parameter set incorrect**	- The requested version does not match the implemented version. The measuring system cannot be operated with this application (incompatible), see Chapter 7.2.6 on Page 137.
F:0071 d	**Data inconsistent in received F-Parameter block (CRC1 error)**	- The checksum value calculated for the set safety-related F-parameters (F_Par_CRC) is incorrect. see Chapter 7.2.10 and 7.2.11 on Page 138.
F:0072 d	**Device-specific or unspecified diagnosis information, see manual** Different iParameter settings were detected for the shared device modules.	- The iParameter settings of all configured modules must be identical, see Chapter 10 on Page 141.
F:0073 d	**Save iParameter watchdog time exceeded**	- Check the parameterization of the iPar server.
F:0074 d	**Restore iParameter watchdog time exceeded**	- Check the parameterization of the iPar server.
F:0075 d	**Inconsistent iParameters (IParCRC error)**	- The checksum value calculated for the set safety-related iParameters (F_iPar_CRC) is incorrect, see Chapter 7.2.9 and 7.2.11 on Page 138.
F:0076 d	**F_Block_ID not supported**	- Check the parameterization of the PROFIsafe communication.
F:0077 d	**Transmission error: data inconsistent (CRC2 error)**	- Try to localize the error using diagnostic variables (depending on the control). - Check whether the PROFINET connection between F-CPU and measuring system is faulty.

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Error type	Diagnostic message / Meaning	Solution
F:0078 d	**Transmission error: timeout (F_WD_Time or F_WD_Time_2 elapsed)**	- Verify that the value set for this parameter is appropriate for the automation task; see Chapter 7.2.8 on Page 138.
F:0079 d	**Acknowledge needed to enable the channel(s)**	- A user acknowledgment is required.
F:0096 d	**Safety parameterization**	- The safety parameters cannot be set in the current system state. A system restart is required.
F:0097 d	**Invalid address type**	- The parameterized address and the Profisafe address type stored in the device are different. Check the settings, see pages 23, 58, and 137
F:0098 d	**Invalid F_iPar_CRC for shared device**	- The `F_iPar_CRC` for the shared device safety subslots are different. Ensure that the iParameters of all modules are set to the same value.
F:8192 d	**Processor unit – CPU** Error of the processor-internal hardware diagnostics.	- A system restart is required.
F:8193 d	**Processor unit - cross communication** Error of the inter processor communication between the two sampling channels	- A user acknowledgment is required. - Contact Product Support if the problems persist after a system restart.
F:8194 d	**Processor unit - sensor communication** Error of the data transmission between sensor and fieldbus interface.	- A user acknowledgment is required. - Contact Product Support if the problems persist after a system restart.
F:8195 d	**Sequence - cross data comparison** The device is in fail-safe state.	- Check whether the set value for the Window increments parameter is suitable for the automation task. See chapter "Window increments" on pages 64 and 127. - Contact Product Support if the problems persist after a system restart.
F:8196 d	**ST sampling unit - channel 1** The device is in fail-safe state.	- Contact Product Support if the problems persist after a system restart.
F:8197 d	**MT sampling unit - channel 1** The device is in fail-safe state.	- Contact Product Support if the problems persist after a system restart.

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Error type	Diagnostic message / Meaning	Solution
F:8198 d	**ST sampling unit - channel 2** The device is in fail-safe state.	- Contact Product Support if the problems persist after a system restart.
F:8199 d	**MT sampling unit - channel 2** The device is in fail-safe state.	- Contact Product Support if the problems persist after a system restart.
W2:8200 d	**ST sampling unit – LED** The light source's control of the optical sampling unit is outside the normal range.	- Contact Product Support if the problems persist after a system restart.
W1:8201 d	**Hardware - service life** The service life interval has expired.	- The manufacturer must proof test the device.
F:8202 d	**Sequence - preset adjustment** The preset adjustment is faulty.	- The adjustment procedure must be repeated.
F:8203 d	**Process – configuration** Error during initialization of the application's configuration data from configuration memory.	- Contact Product Support.
F:8204 d	**Processor unit – memory** The internal hardware diagnostics has detected a internal memory fault.	- A system restart is required. - Contact Product Support if the problems persist after a system restart.
W1:8205 d	**Sequence - parameter check** The device parameterization is faulty.	- Check all device configuration parameters -> transfer correct parameters.
F:8206 d	**Processor unit - program sequence** The device is in fail-safe state.	- A system restart is required.
F:8207 d	**MT sampling unit - gear unit** The device is in fail-safe state.	- Contact Product Support if the problems persist after a system restart.
W2:8208 d	**Sequence - remote channel**	- The remote channel overwrites the current process data value of the measurement channel.
W2:8209 d	**Power supply unit – undervoltage** The internal hardware diagnostics has detected an undervoltage in the internal power supply unit.	- Contact Product Support if problems persist.
W2:8210 d	**Power supply unit – overvoltage** The internal hardware diagnostics has detected an overvoltage in the internal power supply unit.	- Contact Product Support if problems persist.

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Error type	Diagnostic message / Meaning	Solution
W1:8211 d	**Sequence – scaling** The internal hardware diagnostics has detected a shaft movement out of range in switched off state.	- Verify the correctness of the transmitted process data. A preset adjustment must be performed in order to acknowlege the error.
F:8212 d	**Sequence - FSCP communication** The device is in fail-safe state.	- A system restart is required.
F:8213 d	**Processor unit – reset** Error of the processor-internal hardware diagnostics.	- A system restart is required.
F:8214 d	**Processor unit - remote channel** The device is in fail-safe state.	- A system restart or an error acknowledgement is required.
F:8217 d	**Process data – Velocity**	- The maximum permissible velocity has been exceeded. Reduce velocity to a permissible value.
F:16384 d	**Interface – fieldbus** The hardware diagnostics of the fieldbus interface has detected an internal error.	- A system restart is required.
F:37120 d	**Position erro**	- Error in the position measuring system. A system restart is required.
F:37126 d	**Commissioning: invalid scaling**	- The scaling values are not within the valid range. Adjust the scaling values to valid values.
F:37131 d	**Master life sign error**	- A synchronization loss has been detected. Automatic resynchronization will take place. If problems persist, check the cable connections and eliminate possible sources of interference.
F:37134 d	**Preset value outside the permissible range**	- Adjust preset value to a valid value
F:37135 d	**Command not supported**	- Check the executed command for correctness.

12.3 Return of Submodul Alarm

A so-called "Return-of-Submodule-Alarm" is indicated by the measuring system, if

- that measuring system can deliver valid data again for a defined input element, without having to perform a re-parameterization, or
- an output element can process the received data again.

The status for the measuring system (submodule) IOPS/IOCS changes from `BAD` to `GOOD` in this case.

12.4 Integration of organization blocks (OBs)

The user has access to a number of so-called "organization blocks" if the SIEMENS automation system SIMATIC S7 is used.
Organization blocks form the interface between the operating system of the CPU and the user program. OBs allow for the selective execution of program parts, e.g. when errors occur or when process alarms occur.
Organization blocks are processed according to the priority assigned to them.

In the event of an error, the controller CPU generally goes into *`STOP`* mode if the corresponding OB has not been included. This is not always desirable and can be prevented by including the corresponding OB. The OB does not have to be programmed explicitly for this purpose. The OB must be programmed accordingly only if a special error response is required.
OBs are called if the position of the measuring system is accessed during a failure.

For more information on organization blocks, see the SIEMENS documentation
6ES7810-4CA08-8AW1, "System Software for S7-300/400 System and Standard Functions Volume 1/2".

12.4.1 Diagnostic alarm OB (OB 82)

This OB is generally triggered when the measuring system transmits a diagnostic alarm to the controller, see Chapter "PROFINET Diagnostic alarm" on Pages 117 and 173.

12.5 Data status

The transmitted data are generally provided with a status during cyclic real-time communication. Each subslot has its own status information: `IOPS/IOCS`. This status information indicates whether the data are valid = `GOOD` (1) or invalid = `BAD` (0).

During parameterization and at start-up the output data may temporarily change to `BAD`. If the data change back to `GOOD` status, a “Return-Of-Submodule-Alarm” is transmitted.

The status is not set to `BAD` in the case of a diagnostic alarm.

Example: Input data IO device --> IO controller

VLAN	Ether type	Frame ID	Data	IOPS	...	IOPS	...		Cycle	Data status	Transfer status	CRC
4	0x8892	2	1..	1		1			2	1	1	4

Example: Output data IO controller --> IO device

VLAN	Ether type	Frame ID	IOCS	IOCS	...	Data	IOPS ...	Data ...IOPS.	Cycle	Data status	Transfer status	CRC
4	0x8892	2	1..	1		1 ...		1..	2	1	1	4

12.6 Information & Maintenance

12.6.1 I&M0 – I&M5

The measuring system supports the following I&M functions (**I&M RECORDS**):

- I&M0, Record Index = 0xAFF0
- I&M1, Record Index = 0xAFF1
- I&M2, Record Index = 0xAFF2
- I&M3, Record Index = 0xAFF3
- I&M4, Record Index = 0xAFF4
- [1]I&M5, Record Index = 0xAFF5

according to PROFIBUS*PROFINETProfile Guidelines Part 1, order no. 3.502.*

I&M functions specify how the device-specific data, according to a type plate, must be uniformly stored in the IO device.

The I&M record can be addressed via an acyclic read or write command and must be sent with the corresponding record index to Module 1 / Submodule 1 of the measuring system.

I&M0, Record Index = 0xAFF0 (read only):

Contents		Number of Bytes (60)
Block Header	Block Type = 0x0020 (I&M0)	2
	Block Length	2
	Block Version, High-Byte	1
	Block Version, Low-Byte	1
Manufacturer ID		2
Order no.		20
Serial No.		16
Hardware Revision		2
Software Revision		4
Revision Status		2
Profile ID		2
Profile-specific type		2
I&M Version		2
I&M Support		2

[1] available from firmware version 2.xx

I&M1, Record Index = 0xAFF1 (write/read):

Contents		Number of Bytes (60)
Block Header	Block Type = 0x0021 (I&M1)	2
	Block Length	2
	Block Version, High-Byte	1
	Block Version, Low-Byte	1
IM_Tag_Funktion (VisibleString) Unique identifier for the function/task		32
IM_Tag_Position (VisibleString) Unique identifier for the location		22

I&M2, Record Index = 0xAFF2 (write/read):

Contents		Number of Bytes (22)
Block Header	Block Type = 0x0022 (I&M2)	2
	Block Length	2
	Block Version, High-Byte	1
	Block Version, Low-Byte	1
IM_Datum (VisibleString) Date/time of installation or commissioning: Format: YYYY-MM-DD´T´HH:MM (ISO 8601)		16

I&M3, Record Index = 0xAFF3 (write/read):

Contents		Number of Bytes (60)
Block Header	Block Type = 0x0023 (I&M3)	2
	Block Length	2
	Block Version, High-Byte	1
	Block Version, Low-Byte	1
IM_Kommentar (VisibleString) Additional information or comments		54

I&M4, Record Index = 0xAFF4 (write/read):

Contents		Number of Bytes (60)
Block Header	Block Type = 0x0024 (I&M4)	2
	Block Length	2
	Block Version, High-Byte	1
	Block Version, Low-Byte	1
IM_Signatur (VisibleString) Signature		54

[1] The following I&M5 record refers to the `Enhanced Real-Time Ethernet Controller` from SIEMENS implemented in the measuring system.

I&M5, Record Index = 0xAFF5 (read only):

Contents I&M5		**Number of Bytes**
Block Header I&M5	Block Type = 0x0025 (I&M5)	2
	Block Length = 162 (+4)	2
	Block Version = 0x0100	2
Number of entries = 0x0001 (one I&M5Data block follows)		2
Contents I&M5Data		**Number of Bytes**
Block Header I&M5Data	Block Type = 0x0034 (I&M5Data)	2
	Block Length = 154	2
	Block Version = 0x0100	2
Comment field:	ERTEC 200P Communication Module	64
Order-No.:	6ES7 195-3BE00-0YA1	64
Manufacturer-ID:	Siemens AG (0x002A)	2
Serial-No.:		16
Hardware Revision:	2	2
Software Revision:	V5.20	4

Table 9: Sample data from the PROFINET communication processor “ERTEC 200P” from SIEMENS

[1] available from firmware version 2.xx

12.7 Asset Management Record (AMR)

Available from firmware version 2.xx

The measuring system supports `Asset Management Functions` in accordance with IEC 61158-6-10.

A machine, such as a complete machine tool, usually consists of various subsystems with different automation components. The components are not always part of the PROFINET system and therefore cannot be addressed directly via PROFINET.

The asset management functions offer a complementary concept for obtaining information (e.g., firmware or hardware versions and driver versions) from locally connected devices that are outside the PROFINET address range.

The PROFINET asset management function therefore normally only provides identification data for these non-PROFINET components. Submodules, on the other hand, continue to use the I&M functions.
Although all components of the measuring system are fully addressable via PROFINET, the asset management function was nevertheless implemented for compatibility reasons. Some applications expect this function as a matter of principle and would otherwise generate an error.
When reading out the function, the measuring system returns the so-called `Full Information` in accordance with block type `0x0036`. Understandably, the measuring system does not provide any additional data here that is not already defined in the I&M functions.

Asset management is also based on the I&M functions, but works with a standardized data set, the `Asset Management Record` (AMR) with `Index 0xF880`.

If the asset management record is to be read and received in a superimposed IO controller, then the data record must be requested from the measuring system in the IO controller, e.g., using the SIEMENS system function block SFB 52 `RDREC` (read data record) and `Index 0xF880`.

SIEMENS provides a documented application example with corresponding function blocks on this topic: https://support.industry.siemens.com/cs/ww/de/view/109748894

12.8 Behavior of the measuring system process data outputs

State	Safety-related data	Non-safety related data
IOPS = BAD	Data are set to 0	Data are set to 0
Connection abort	Data are set to 0	Values retain the last value before the abort
Supply ON	Values are initialized to 0	Values are initialized to 0

13 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	**Note**	**Reference**	**yes**
This User Manual was read and understood	–	Document no.: TR-ECE-BA-GB-0139	☐
Verify that the measuring system can be used for the present automation task based on 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 17 • Product data sheets www.tr-electronic.com/s/S021065	☐
Supply voltage	• The power supply unit used must meet the requirements of	• Chapter Supply voltage, Page 22	☐
Proper PROFINET installation	• Compliance with the valid international standards or PROFIBUS User Organization guidelines specified for PROFINET / PROFIsafe	• Chapter Installation / Preparation for Commissioning, from Page 20 • Chapter Commissioning, Page 34	☐
After commissioning and parameter changes – System test – Validation (Settings – Axis)	• During commissioning and whenever parameters have been changed – all relevant safety functions involved must be checked – if several (similar) axes are used, make sure that the settings have been made for the desired axis	• Chapter 3.4, Page 23 • Chapter Address assignment, Page 36 • Chapter PNO profile parameteriza-tion, from page 88 • Chapter Preset adjustment function (PNO profile), Page 95 • Chapter Parameterization TR-profile, from Page 45 • Chapter Preset adjustment function (TR profile), Page 67 • Chapter Legacy-profile parameterization, from Page 126. • Chapter Preset adjustment function (legacy profile), Page 131	☐

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Sub-item	Note	Reference	yes
Preset adjustment function	• In Legacy mode, the preset adjustment function may only be executed when the axis concerned is at standstill • Ensured the preset adjustment function can not be triggered unintentionally • After execution of the preset adjustment function, the new position must be checked before restarting	• Chapter Preset adjustment function (PNO profile), Page 95 • Chapter Preset adjustment function (TR profile), Page 67 • Chapter Preset adjustment function (legacy profile), Page 131	☐
Device replacement	• Ensure that the new device corresponds to the replaced device • All affected safety functions must be checked	• Safety Manual (checklist part 1 of 2) • Chapter PNO profile parameterization, from page 88 • Chapter Parameterization TR-profile, from Page 45 • Chapter Legacy-profile parameterization, from Page 126.	☐

14 Appendix

14.1 TÜV certificate

Download
CD_582M +FS02: www.tr-electronic.de/f/TR-ECE-TI-DGB-0344
CD_582M +FS03: www.tr-electronic.de/f/TR-ECE-TI-DGB-0350

14.2 PROFINET IO certificate

Download
www.tr-electronic.de/f/TR-ECE-TI-GB-0336

14.3 PROFIsafe certificate

Download
www.tr-electronic.de/f/TR-ECE-TI-GB-0337

14.4 EU Declaration of Conformity

Download
CD_582M +FS02: www.tr-electronic.de/f/TR-ECE-KE-DGB-0354
CD_582M +FS03: www.tr-electronic.de/f/TR-ECE-KE-DGB-0358