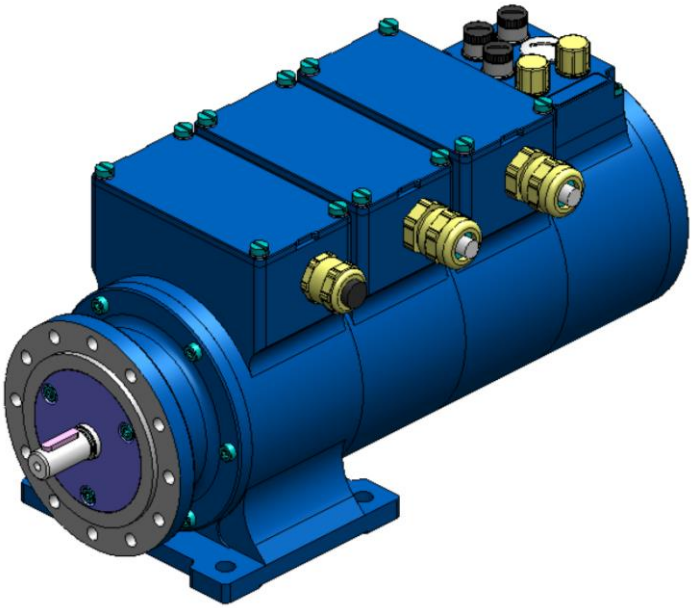
English

JOHANNES HÜBNER GIESSEN
ideas and solutions



Configuration manual U-ONE®-SAFETY-Compact

PROFIBUS-DP interface and PROFIsafe protocol

Read the configuration manual prior to assembly, starting installation and handling!
Keep for future reference

Translation of the original configuration manual SPB C
ID 74465

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Italic or **bold** font styles are used for the title of a document or are used for highlighting.

`Courier-New` font displays text, which is visible on the screen and software/software menu selections.

Content

1 General Information

These operating and assembly instructions contain the following topics:

- Basic safety instructions with declaration of the intended use
- Characteristics
- Parameterization
- Error causes and remedies

The operating and assembly instructions are supplementary to other documentation, such as product data sheets, dimension drawings, etc.

1.1 Applicability

These operating and assembly instructions apply exclusively for the following measuring system series with ***PROFIBUS-DP*** interface and ***PROFIsafe*** profile:

The products are labelled with affixed nameplates and are components of a system.
The following documentation therefore also applies:

- operator's operating instructions specific to the system,
- the "Operating and Assembly Instructions U-ONE Compact"
- and these operating and assembly instructions

1.2 Main Features

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

Due to its technology the optical system possesses greater accuracy; therefore it is used as master system. The data of the master system are unevaluated in the non-safety-oriented process data channel with normal PROFIBUS protocol, but are made available with a short cycle time.

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

1.2.1 Principle of the safety function

System safety results when:

– Each of the two scanning channels is largely fail-safe thanks to individual diagnostic measures.
– The measuring system internally compares the positions detected by both channels in two channels, also determines the speed in two channels and transfers the safe data to the PROFIBUS in the PROFIsafe protocol, **see “Black Channel” Abb. 3-2 on page 14**.
– In the event of a failed channel comparison or other errors detected through internal diagnostic mechanisms, the measuring system switches the PROFIsafe channel into error state.
– The measuring system initialization and execution of the preset adjustment function are appropriately verified.
– The control additionally checks whether the obtained position data lie in the position window expected by the control. Unexpected position data are e.g. position jumps, tracking error deviations and incorrect direction of travel.
– When errors are detected the control introduces appropriate safety measures defined by the system manufacturer.
– The system manufacturer ensures, through correct mounting of the measuring system, that the measuring system is always driven by the axis for measurement.
– The system manufacturer performs a verified test during commissioning and in the event of any parameter modification.

2 Basic safety instructions

2.1 Explanation of symbols and notes

Warnings are indicated by symbols in these operating and assembly instructions. The warnings are introduced by signal words that express the scope of the hazard.
The warnings must be strictly heeded; you must act prudently to prevent accidents, personal injury, and property damage.

DANGER!
Means that death or serious injury will occur if the required precautions are not met.

WARNING!
Means that death or serious injury can occur if the required precautions are not met.

CAUTION!
Means that minor injuries can occur if the required precautions are not met.

NOTICE!
Indicates a possibly dangerous situation that can result in material damage if it is not avoided.

NOTES!
Indicates important information or features and application tips for the product used.

NOTES!
Means that appropriate ESD-protective measures are to be considered according to EN 61340-5-1 supplementary sheet 1.

NOTES!
Do not use a hammer or similar tool when installing the device due to the risk of damage occurring to the bearings or coupling!

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.

NOTES!

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

If no safe position can be output due to an error detected by the measuring system, the PROFIsafe data channel is automatically put into fail-safe status. In this status so-called "passivated data" are output via PROFIsafe.

See chapter 6.1 "Output of passivated data (substitute values) in case of error" on page 54.

Passivated data outputs are:

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

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

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

2.2.1 Mandatory safety checks / measures

Measures for commissioning, changes	F-Host error reaction
Application-dependent parameterization and definition of the necessary `iParameters`, **see chapter 4.1 "iParameter" on page 30**.	–
In the event of parameter changes, check that the measure is executed as desired.	STOP

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

2.3 Warranty and liability

In principle the "General Terms and Conditions" of Johannes Hübner - Fabrik elektrischer Maschinen GmbH apply. These are available to the operator with the Order Confirmation or when the contract is concluded at the latest. Warranty and liability claims in the case of personal injury or damage to property are excluded if they result from one or more of the following causes:

- Non-intended use of the measuring system
- Improper assembly, installation, start-up and programming of the measuring system
- Work carried out incorrectly on the measuring system
- Operation of the measuring system with technical defects
- Mechanical or electrical modifications to the measuring systems undertaken autonomously
- Repairs carried out autonomously
- Third party interference and Acts of God
- Non-observance of these operating and assembly instructions
- Opening of the measuring system
- Deployment of non-qualified personnel

2.4 Organizational measures

- The operating and assembly instructions must always be kept ready-to-hand at the place of use of the measuring system.
- In addition to the operating and assembly instructions, generally valid legal and other binding regulations on accident prevention and environmental protection must be observed and communicated.
- The respective applicable national, local and system-specific provisions and requirements must be observed and communicated.
- The operator is obliged to inform personnel on special operating features and requirements.
- Prior to commencing work, personnel working with the measuring system must have read and understood the **chapter 2 "Basic safety instructions" on page 9**.
- The nameplate and any prohibition or instruction symbols applied on the measuring system must always be maintained in a legible state.
- Do not undertake any mechanical or electrical modifications to the measuring system, except for those expressly described in this operating and assembly instructions.
- Repairs may only be undertaken by the manufacturer or a center or person authorized by the manufacturer.

2.5 Personnel selection and qualification; basic obligations

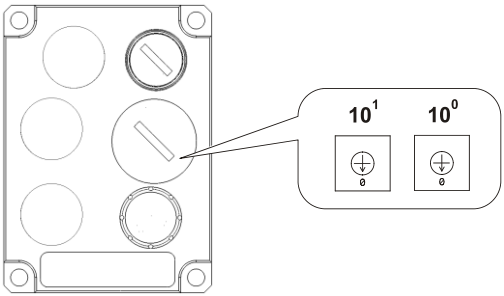
- All work on the measuring system must only be carried out by qualified personnel. Qualified personnel includes persons, who, through their training, experience and instruction, as well as their knowledge of the relevant standards, provisions, accident prevention regulations and operating conditions, have been authorized by the persons responsible for the system to carry out the required work and are able to recognize and avoid potential hazards. They are capable of identifying and avoiding potential hazards.
- The definition of “qualified personnel” also includes an understanding of the standards VDE 0105-100 and IEC 364 (source: e.g. Beuth Verlag GmbH, VDE-Verlag GmbH).
- The responsibility for assembly, installation, commissioning and operation must be clearly defined. The obligation exists to provide supervision for trainee personnel.

3 PROFIBUS / PROFIsafe – Commissioning

3.1 PROFIBUS

PROFIBUS is a continuous, open, digital communication system with a broad range of applications, particularly in manufacturing and process automation. PROFIBUS is suitable for fast, time-sensitive and complex communication tasks.

PROFIBUS communication is based on the international standards ICE 61158 and IEC 61784. The application and engineering aspects are defined in the PROFIBUS User Organization guidelines. These serve to fulfil the user requirements for a manufacturer-independent and open system where the communication between devices from different manufacturers is guaranteed without modifications of the devices.



Valid PROFIBUS-addresses: 1 – 99
10^0: Setting the 1st position
10^1: Setting the 10th position
The device will not start up with an invalid station address.
The set PROFIBUS address automatically gives the PROFIsafe destination, **see „F_Source_Add / F_Dest_Add“ on page 27.**

Important information in this regard can be found in the PROFIBUS Guidelines:

- PROFIBUS guideline: PROFIsafe – Environmental Requirements
  Order no.: 2.232
- PROFIBUS Assembly Guideline,
  Order no.: 8.022
- PROFIBUS Commissioning Guideline,
  Order no: 8.032

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

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D-76131 Karlsruhe	Fax:	+ 49 721 96 58 589
www.profibus.com	E-Mail:	germany@profibus.com
www.profisafe.net		

3.1.1 DP communication protocol

The measuring systems support the ***DP*** communication protocol, which is designed for quick data exchange in the field level. The basic functionality is defined by the performance level ***V0***. This includes cyclical data exchange as well as station and module specific diagnosis.

3.1.2 Device master file (GSD)

In order to achieve a simple plug-and-play configuration for PROFIBUS, the characteristic communication features for PROFIBUS devices were defined in the form of an electronic device data sheet (device master file, GSD file).

Using the defined file format, the configuration system can easily read in the device master data of the PROFIBUS measuring system and automatically take account of it in the bus system configuration.

The GSD file is a constituent of the measuring system and has the file name **HUEB0E3F.GSE**. The measuring system also has three bitmap files called **HUEB_BDE.bmp**, **HUEB_BDI.bmp** und **HUEB_BSF.bmp**, which it displays in normal mode, in diagnostic mode and in special operating states.

The files are on the Software and Support CD (siehe Kapitel „Zubehör“ in der Betriebs- und Montageanleitung). It is included in the scope of delivery.

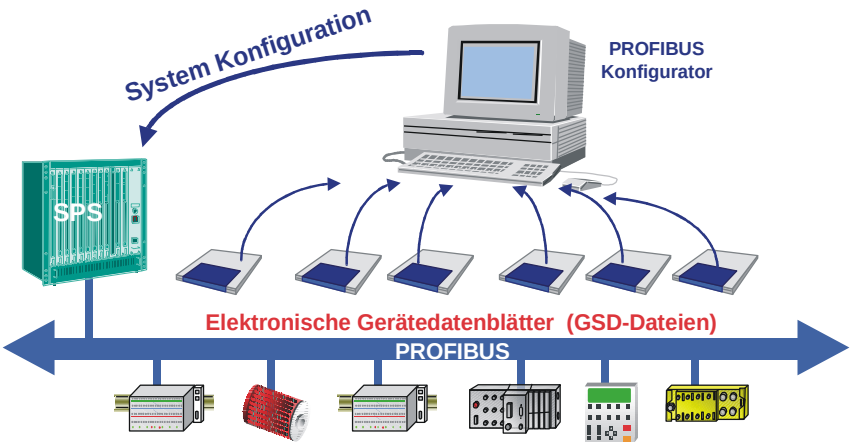


Abb. 3-1: GSD for the configuration

3.1.3 PNO ID number

Every PROFIBUS slave and every Class 1 master must have an ID number. This is already entered in the supplied GSD file.

It is required so that a master can identify the type of the connected device without significant protocol overhead. The master compares the ID numbers of the devices connected with the ID numbers of the configuration data specified in the configuration tool. The transfer of user data only starts once the correct device types have been connected with the correct station addresses on the bus. This achieves a high level of security against configuration errors.

The measuring system has the PNO ID number **0x0E3F** (hex). This number is reserved and is stored with the PNO.

3.2 PROFIsafe

PROFIsafe is the profile for the transfer of safety-oriented data via PROFIBUS and PROFINET and is internationally standardized in IEC 61784-3-3.

PROFIsafe is a functional extension of PROFIBUS-DP and was the first communication standard in accordance with safety standard IEC 61508, which permits standard and fail-safe communication on one and the same bus line. PROFIsafe devices therefore do not require any modifications to the existing hardware components, and can be integrated problem-free into existing systems.

These characteristics are implemented with the "Black-Channel" principle:

- No effect on standard bus protocols
- Independent of the respective transmission channel, whether copper cable, fiber-optic cable, backplane bus or wireless
- Neither the transmission rates nor the respective error detection play a role
- For PROFIsafe the transmission channels are only "Black Channels".

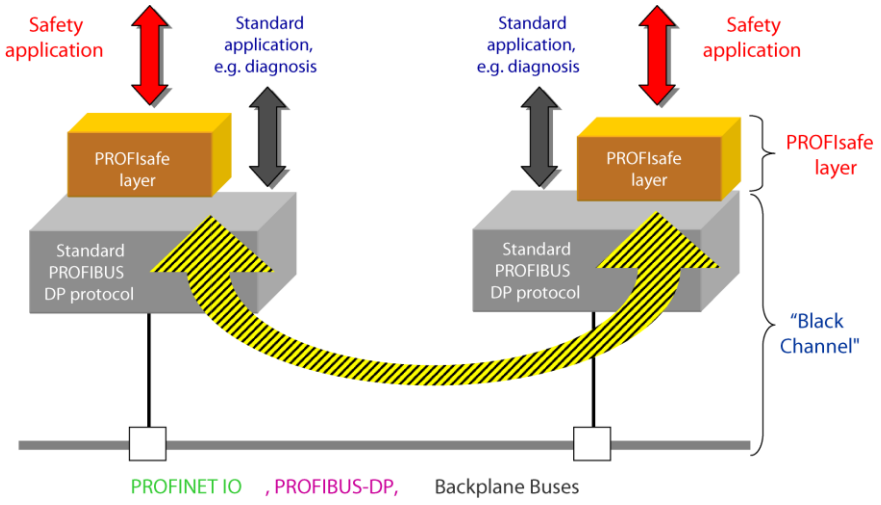


Abb. 3-2: „Black-Channel“ principle [source: PROFIsafe system description]

3.3 Measuring system ←→ PROFIBUS / PROFIsafe communication

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

- The position actual values of both measuring systems are compared for safe transmission. If the difference is less than the set monitoring window, the value is considered safe. The safe position actual value and the calculated safe speed value are transmitted via the PROFIsafe profile. The part of the control which performs the safety-oriented functions can then process these values.
- The position actual value and the calculated speed value of the first measuring system are directly transmitted in the unsafe process data channel. This channel is generally processed more frequently by the control. This allows normal automation processes to access the updated position value more frequently.

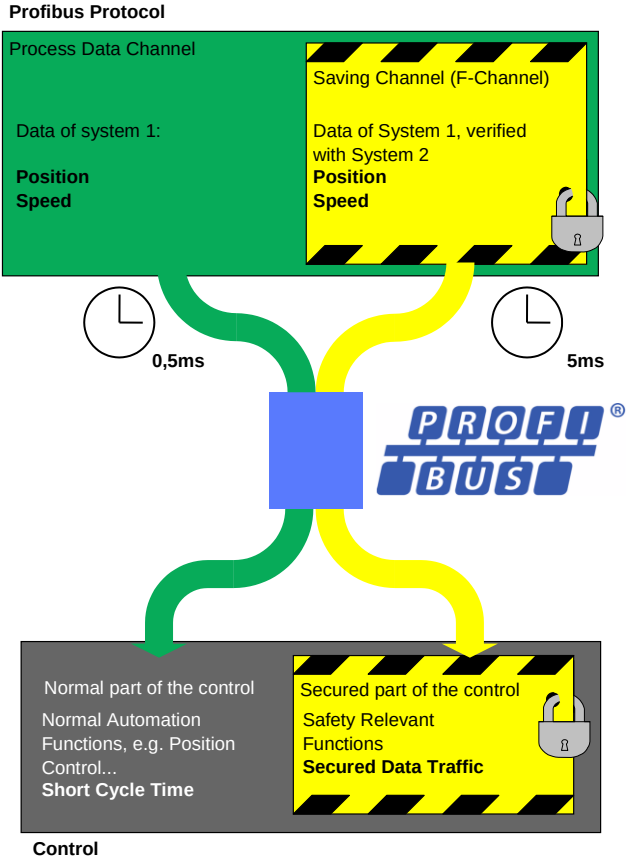


Abb. 3-3: Measuring system – PROFIsafe communication

3.4 Start-up on PROFIBUS

Before the measuring system can be included in the user data traffic (Data_Exchange), the master must first initialize the measuring system during start-up. The resulting data traffic between the master and the measuring system (slave) is divided into the parameterization, configuration and data transfer phases.
It is checked whether the planned nominal configuration agrees with the actual device configuration. The device type, the format and length information as well as the number of inputs and outputs must agree in this check. The user is thus reliably protected against data format errors.

If the check was successful, there is a switch to the DDLM_Data_Exchange mode. In this mode the measuring system transfers e.g. its actual position

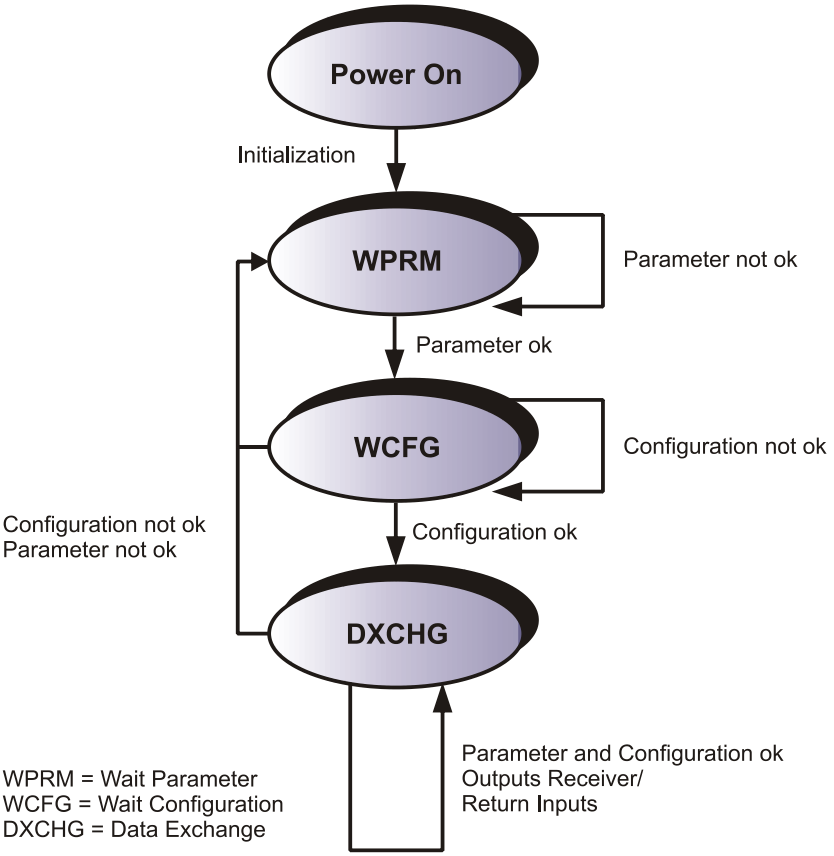


Abb. 3-4: DP slave initialization

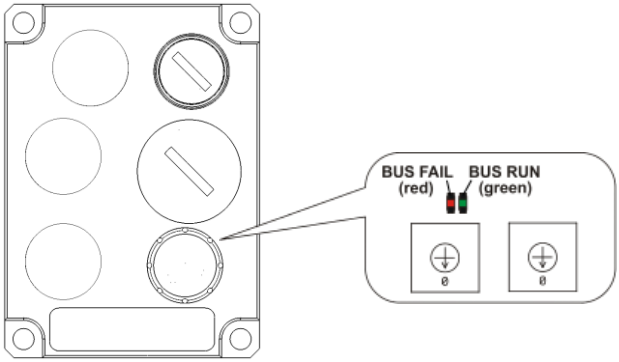
3.5 Bus status display

WARNING! NOTICE!

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

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

The measuring system has two LEDs in the connection cover. A red LED (bus fail) to display faults and a green LED (bus run) to display status information.
When the measuring system starts up, both LEDs flash briefly. The display then depends on the operating status of the measuring system.



LED, green		Bus Run
●	ON	Ready for operation
○	OFF	Supply absent, hardware error
◉	1 Hz	Incorrect parameterization of F_Parameters
◉	3x with 5 Hz	PROFIsafe communication running, master requesting Operator Acknowledgment

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

For appropriate measures in case of error,
see chapter 8 “Troubleshooting and Diagnosis Options” on page 61.

3.6 Configuration

Configuration means that the length and type of process data must be specified and how it is to be treated.
The measuring system uses a defined number of input and output words on the PROFIBUS, depending on the configuration. This structure information is already entered for both the safety-oriented and the non-safety-oriented data in the GSD file, and is described below.
The following definition applies:
Data flow for input data: F-Device → F-Host
Data flow for output data: F-Host → F-Device

3.6.1 Safety-oriented data, JHG-PROFIsafe module

The module uses five input words for the user data and four input bytes for the PROFIsafe parameter block.

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

The module uses four output words for the user data and four output bytes for the PROFIsafe parameter block.
The Safe-Control Register can only be accessed indirectly via the safety program from an F-Runtime Group.

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

3.6.2 Register structure of safety-oriented data

3.6.2.1 Input data

3.6.2.1.1 Cam register

Unsigned16

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

Bit	Beschreibung
2^{0}	**Speed overflow** The bit is set if the speed value is outside the range of -32768…+32767
2^{1}…2^{15}	Reserved

3.6.2.1.2 Status

Unsigned16

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

Bit	Beschreibung
2^{0}	**Preset_Status** The bit is set if the F-Host triggers a preset request via the variable `IPAR_EN` of the F-Periphery-DB or the bit `Preset_Request` in the `Control1` register. When the preset has been executed, the bit is automatically reset.
2^{1}…2^{14}	Reserved
2^{15}	**Error** The bit is set if a present request could not be executed due the excessive speed. The current speed must be in the range of the speed set under `Preset Standstill Tolerance`. The bit is reset after the host has cleared the variable `IPAR EN`, **also see from page 59**.

3.6.2.1.3 Speed

Integer16

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

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

Setting the direction of rotation = **forward**
– Looking at the flange connection, turn the shaft clockwise:
  → positive speed output

Setting the direction of rotation = **backward**

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

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

3.6.2.1.4 Multi-Turn / Single-Turn

Multi-Turn, Integer16

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

Single-Turn, Integer16

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

As only 16-bit registers have previously been possible on the control side, the position value must be calculated first. The number of revolutions is noted in the `Multi-Turn` register, and the current Single-Turn position is noted in steps in the `Single-Turn` register. Together with the measuring system resolution, max. number of steps per revolution according to type plate, the actual position can then be calculated

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

Steps per revolution: **8192** **≙ 13 Bit**
Number of revolution: **0…32767** **≙ 15 Bit**

The output position does not have a preceding sign.

3.6.2.1.5 Safe-Status

Unsigned8

Byte	X+10
Bit	7 – 0
Data	2^7 – 2^0

Bit	Beschreibung
2^0	**iPar_OK:** New iParameter values have been assigned to the F-Device. The bit is set when a preset request has been successfully completed via the F-Host (iPar_EN bit), **see chapter 7 "Preset Adjustment Function" on page 59**.

Bit	Beschreibung
2^1	**Device_Fault:** Error in F-Device or F-Module The bit is set if the value set for the `Window increments` under the iParameters has been exceeded and/or the internally calculated PROFIsafe telegram is defective. The measuring system is then put into fail-safe status and outputs its passivated data. It is only possible to leave this status by eliminating the error and turning the supply voltage OFF/ON.
2^2	**CE_CRC:** Checksum error in communication The bit is set if the F-Device detects an F-Communication error, such as e.g. an incorrect consecutive number (detected via a CRC2 error in V2 mode) or if the data integrity has been violated (CRC error). The F-Host must then count all defective messages within a defined time period T and assume a configured safe status in the event of exceeding the maximum permissible defective messages. This error can also be triggered by incorrect CRC values in the iParameters (F_iPar_CRC) or F-Parameters (F_Par_CRC) in the parameterization sequence. The measuring system reports a parameter error via the PROFIBUS standard diagnosis and does not start up.
2^3	**WD_timeout:** Watchdog-Timeout during communication The bit is set if the set watchdog time `F_WD_Time` in the F-Paramters is exceeded. A valid current safety telegram must arrive from the F-Host within this time, otherwise the measuring system will be set to fail-safe status and output its passivated data. It is only possible to leave this status be eliminating the error and turning the supply voltage OFF/ON. **Also see chapter 0"Standard value F** `Source Add` = 1, Standard value `F Dest Add` = 503, `F_Source_Add` ≠ `F_Dest_Add`. **" on page 27.**
2^4	**FV_activated:** Fail-safe values activated The bit is set when the measuring system is in fail-safe status and output its passivated data.
2^5	**Toggle_d:** Toggle bit The toggle bit is device-based and causes the incrementation of the virtual consecutive number in the F-Host. The toggle bit is used to synchronize the counters in the measuring system/F-Host for generation of the virtual consecutive number.
2^6	**cons_nr_R:** Virtual consecutive number has been reset The counter is reset if the F-Host detects an F-Communicator error (`CE_CRC`).
2^7	Reserved

NOTES!

Safe status can only be indirectly accessed from a F-Runtime Group via the safety program with the aid of variables of the F-Periphery-DB, **see chapter 6 "**Zugriff auf den sicherheitsgerichteten Datenkanal**" on page 53**.

3.6.2.2 Output data

3.6.2.2.1 Control1

Unsigned16

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

Bit	Beschreibung
2^{0}	**Preset_Request** The bit serves to control the preset adjustment function. When this function is executed, the measuring system is set to the position value stored in the `Preset Multi-Turn/Preset Single-Turn` registers. A precise sequence must be observed in order to execute the function, **see chapter 7 "Preset Adjustment Function" on page 59.**
$2^{1}…2^{15}$	Reserved

3.6.2.2.2 Control2

Reserved.

3.6.2.2.3 Preset Multi-Turn / Preset Single-Turn

Preset Multi-Turn, Integer16

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

Preset Single-Turn, Integer16

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

As only 16-bit registers have previously been possible on the control side, the preset value to be written must be calculated first. The desired preset value must be in the range of 0 to 268 435 455 (28 bit). Together with the measuring system resolution, max. number of steps per revolution according to type plate (8192), the corresponding values for `Preset Multi-Turn/Preset Single-Turn` can then be calculated:

Number of revolutions = desired preset value / steps per revolution

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

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

The result of this calculation is entered in the `Preset Single-Turn` register.
The preset value is set as new position when the preset adjustment function is executed, **see chapter 7 "Preset Adjustment Function" on page 59**.

3.6.2.2.4 Safe-Control

Unsigned8

Byte	X+8
Bit	7 – 0
Data	2^7 – 2^0

Bit	Beschreibung
2^0	**iPar_EN:** iParameter assignment unlocked The bit must be set indirectly via a variable of the F-Host in order to be able to execute the preset adjustment function, **see chapter 7 "Preset Adjustment Function" on page 59**.
2^1	**OA_Req:** Operator acknowledgment required The bit is set by the F-Host driver after detection and elimination of an error in the safety-oriented communication. The bit is also set if the measuring system/F-Host could not be synchronously integrated into the bus operation at start-up of the F-System. An operator acknowledgment is displayed via the green LED (3x with 5 Hz) in relation to the measuring system. In this case an operator acknowledgment of the function blocks contained in the safety program must be performed. In this way the counters contained in the F-Host and F-Device for the virtual consecutive numbers are synchronized. The measuring system is then reset from safe status, output of passivated data, to normal status, output of cyclical data.
2^2	**R_cons_nr:** Resetting of the counter for the virtual consecutive no. The bit is set when the F-Host detects an F-Communicator error, either via the status byte or itself.
2^3	Reserved
2^4	**activate_FV:** Aktiviere fehlersichere Werte Das Bit wird geräteintern über die Firmware gesetzt, wenn das Mess-System aufgrund eines Gerätefehlers, Fehlern in der sicherheitsgerichteten Kommunikation oder beim Anlauf des F-Systems keine fehlersicheren Daten mehr ausgeben kann. Das Mess-System gibt stattdessen seine passivierten Daten aus.
2^5	**activate_FV:** Activate fail-safe values The bit is set inside the device via the firmware if the measuring system can no longer output fail-safe data due to a device error, errors in the safety-oriented communication or at start-up of the F-system. The measuring system outputs its passivated data instead.
2^6-2^7	Reserved

NOTES!

The Safe-Control register can only be indirectly accessed from a F-Runtime Group via the safety program with the aid of variables of the F-Periphery-DB, **see chapter 6 "**Zugriff auf den sicherheitsgerichteten Datenkanal**" , on page 53**.

3.6.3 Process data, JHG-PROFIBUS module

The module uses four input words for pure user data, which are not safety-oriented.

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

3.6.4 Register structure of the process data

3.6.4.1 Input data

3.6.4.1.1 Cam register

Unsigned16

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

Bit	Beschreibung
2^0	**Speed overflow** The bit is set if the speed value is outside the range -32768…+32767.
2^1…2^{15}	Reserved

3.6.4.1.2 Speed

Integer16

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

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

Setting the direction of rotation = **forward**
Looking at the flange connection, turn the shaft clockwise:
→ positive speed output

Setting the direction of rotation = **backward**
Looking at the flange connection, turn the shaft clockwise:
→ negative speed output

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

3.6.4.1.3 Multi-Turn / Single-Turn

	Multi- Turn, Integer16		Single- Turn, Integer16	
Byte	**X+4**	**X+5**	**X+6**	**X+7**
Bit	15 – 8	7 – 0	15 – 8	7 – 0
Data	$2^{15} – 2^8$	$2^7 – 2^0$	$2^{15} – 2^8$	$2^7 – 2^0$

As only 16-bit registers have previously been possible on the control side, the position value must be calculated first. The number of revolutions is noted in the `Multi-Turn` register, and the current Single-Turn position is noted in steps in the `Single-Turn` register. Together with the measuring system resolution, max. number of steps per revolution according to type plate, the actual position can then be calculated:

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

Steps per revolution: **8192 ≙ 13 Bit**
Number of revolutions: **0…32767 ≙ 15 Bit**

The output position does not have a preceding sign.

3.7 Parameterization

Parameterization means providing a PROFIBUS-DP slave with certain information required for operation prior to commencing the cyclic exchange of process data. The measuring system requires e.g. data for the integration time, counting direction etc.

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

DANGER!

NOTICE!

Danger of death, serious physical injury and/or damage to property due to malfunction, caused by incorrect parameterization!

The system manufacturer must ensure correct functioning by carrying out a protected test run during commissioning and after each parameter change.

3.7.1 F-Parameters (F_Par)

The F-Parameters contain information for adapting the PROFIsafe layer to defined applications and checking the parameterization using an independent separate method. The F-Parameters supported by the measuring system are listed below.

Byte-Order = Big Endian

Byte	Parameter	Typ	Beschreibung		Seite
X+0	F_Check_SeqNr	Bit	Bit 0 = 0: no check		26
	-	Bit	Bit 1 = 0: not used		–
	F_SIL	Bit range	Bit 3-2	00: SIL1 01: SIL2 10: SIL3 [default] 11: no SIL	26
	F_CRC_Length	Bit-Bereich	Bit 5-4	00: 3-Byte-CRC	26
X+1	F_Block_ID	Bit-Bereich	Bit 5-3	001: 1	26
	F_Par_Version	Bit-Bereich	Bit 7-6	01: V2-Mode	27
X+2	F_Source_Add	Unsigned16	Source address, Default = 1 Range: 1-65534		27
X+4	F_Dest_Add	Unsigned16	Destination address, Default = 503 Range: 1-65534		27
X+6	F_WD_Time	Unsigned16	Watchdog time, Default = 125 Range: 125-10000		27
X+8	F_iPar_CRC	Unsigned32	CRC of iParameters, Default = 1132081116 Range: 0-4294967295		27
X+12	F_Par_CRC	Unsigned16	CRC of F-Parameters, Default = 46906 Range: 0-65535		28

3.7.1.1 F_Check_SeqNr

The parameter defines whether the sequence number will be included in the consistency check (CRC2 calculation) of the F-User Data telegram. The parameter is set to "NoCheck" and cannot be changed. This means that only fail-safe DP standard slaves are supported, which behave accordingly.

3.7.1.2 F_SIL

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

3.7.1.3 F_CRC_Length

Depending on the length of the F input/output data (12 or 123 bytes) and the SIL level, a CRC of 2, 3 or 4 bytes is required. In order to check the data, this parameter transmits the expected length of the CRC2 signature in the safety protocol to the F-Component during start-up. The measuring system supports the CRC length of 3 bytes. This value is predefined and cannot be changed.

3.7.1.4 F_Block_ID

This parameter specifies whether a CRC should also be formed using the device-specific safety parameters "F_iPar". As the measuring system supports device-specific safety parameters such as e.g. "Integration time Safe", this parameter is preconfigured with the value "1 = generate F_iPar_CRC" and cannot be changed.

3.7.1.5 F_Par_Version

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

3.7.1.6 F_Source_Add / F_Dest_Add

The parameter `F_Source_Add` defines a unique source address within a PROFIsafe cluster.
The parameter `F_Dest_Add` defines a unique destination address within a PROFIsafe cluster.
The device-specific part of the F-Devices compares the value with the in-situ address switch or an assigned F-Address, to check the authenticity of the connection.
The PROFIsafe destination address must correspond to the PROFIBUS address + 500, set by the address switches implemented in the measuring system,(**also see chapter** Fehler! Verweisquelle konnte nicht gefunden werden. **“Fehler! Verweisquelle konnte nicht gefunden werden.” in the USC42 manual).**
Standard value `F_Source_Add` = 1, Standard value `F_Dest_Add` = 503,
`F_Source_Add` ≠ `F_Dest_Add`.

3.7.1.7 F_WD_Time

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

3.7.1.8 F_iPar_CRC

This parameter represents the checksum value (CRC3), which is calculated from all iParameters of the device-specific part of the measuring system and ensures safe transmission of the iParameters. The calculation occurs in a program called "JHG_iParameter" provided by Johannes Hübner Giessen. The checksum value calculated there must then be manually entered in the F-Host engineering tool, **also see chapter 4 “Parameter Definition/CRC Calculation“ on page 30**.
The measuring system also generates a checksum itself from the iParameters transferred by the F-Host. This checksum is compared with the checksum transferred by the F-Host in the measuring system. If both `F_iPar_CRC` are identical, the measuring system is put into data exchange mode at start-up, otherwise it does not start up.
To calculate the `F_iPar_CRC`, the 32-bit CRC polynomial 0x04C11DB7 is used in both the measuring system and in the `JHG_iParameter` program.
Standard value = 1132081116, valid for all iParameters with default setting.

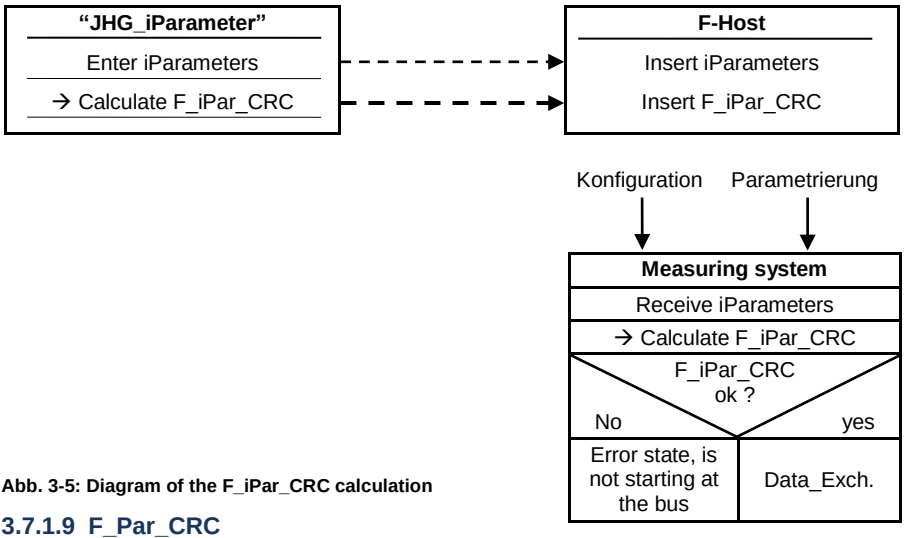


Abb. 3-5: Diagram of the F_iPar_CRC calculation

3.7.1.9 F_Par_CRC

This parameter represents the checksum value (CRC1), which is calculated from all F-Parameters of the measuring system and ensures safe transmission of the F-Parameters. The calculation occurs externally in the F-Host engineering tool and must then be entered here under this parameter, or is generated automatically.
The CRC1 checksum value is also the start value for the cyclical CRC2 calculation.
The 16-bit CRC polynomial 0x4EAB is used to calculate the `F_Par_CRC`.
Standard value = 46906, valid for all F-Parameters with default setting.

3.7.2 iParameters (F_iPar)

Application-dependent device characteristics are defined with the iParameters. A CRC calculation is necessary for safe transmission of the iParameters,
see chapter 4.1 on page 30.
The iParameters supported by the measuring system are listed below.

Byte-Order = Big Endian

Byte	Parameter	Typ	Beschreibung	Seite
X+0	Integration time Safe	Unsigned16	Default = 2 Range: 1-10	29
X+2	Integration time Unsafe	Unsigned16	Default = 20 Range: 1-100	29
X+4	Window increments	Unsigned16	Default = 1000 Range: 50-4000	29
X+6	Idleness tolerance Preset	Unsigned8	Default = 1 Range: 1-5	29
X+7	Direction	Bit	0: Decreasing counting direction 1: Increasing counting direction [default]29	29

3.7.2.1 Integration time Safe

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

3.7.2.2 Integration time Unsafe

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

3.7.2.3 Window increments

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

3.7.2.4 Idleness tolerance Preset

This parameter defines the maximum permissible speed in `increments` per `Integration time Safe` for performance of the preset function. The permissible speed is dependent on the bus behavior and the system speed, and must be determined by the system operator first. The value range extends from 1 increment per `Integration time Safe` to 5 increments per `Integration time Safe`.
Standard value = 1 increment per standard value `Integration time Safe`.

3.7.2.5 Direction

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

Forward = Counting direction increasing
Backward = Counting direction decreasing

Standard value = Forward

4 Parameter Definition/CRC Calculation

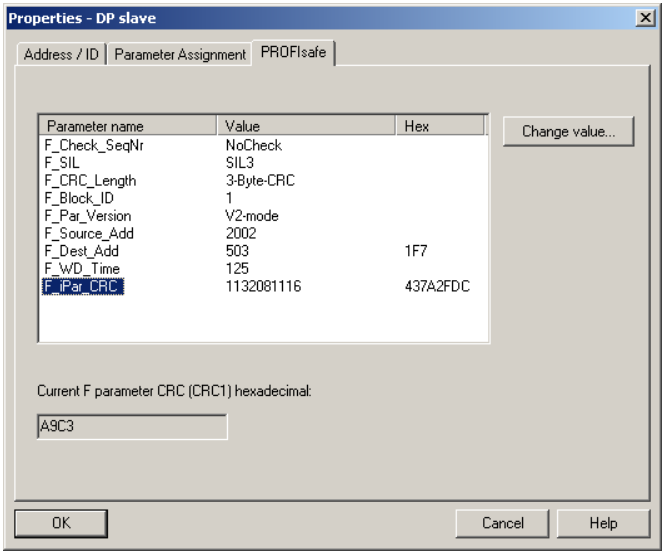
It is best to define the known parameters before configuration in the F-Host, so that they can be taken into account during configuration.

The procedure, in conjunction with the SIEMENS configuration software `SIMATIC Manager` and the optional package `S7 Distributed Safety`, is described below.

The `JHG_iParameter` software required for the CRC calculation is a constituent of the Software and Support CD (siehe Kapitel „Zubehör“ in der Betriebs- und Montageanleitung).

4.1 iParameter

The iParameters are preconfigured with meaningful values in the default setting and should only be changed if expressly required by the automation task. A CRC calculation is necessary for safe transmission of the individually set iParameters. This must be performed when changing the predefined iParameters via the JHG program "JHG_iParameter". The calculated checksum corresponds to the F-Parameter `F_iPar_CRC`. This must be entered in the field with the same name in the `Properties – DP slave` window when configuring the measuring system with the hardware configurator, **also see chapter 5.3.1 “Setting the iParameters“ on page 45**.

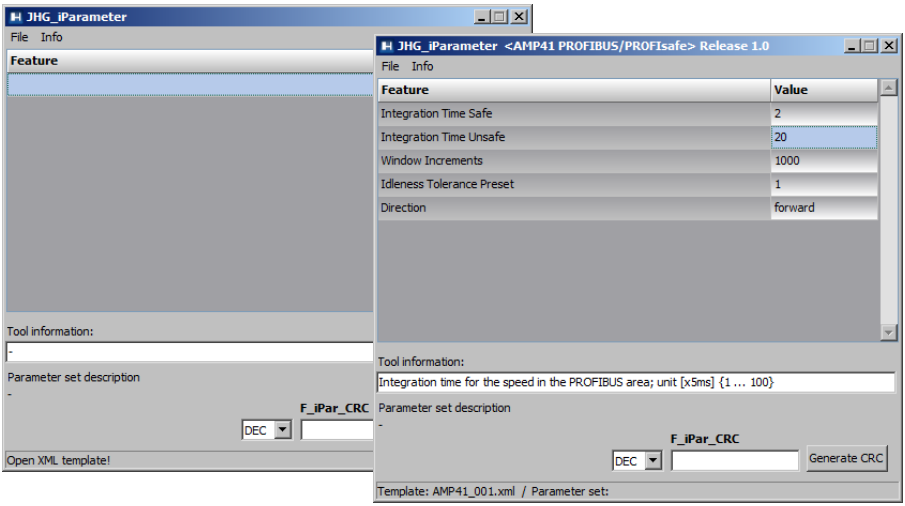


4.1.1 CRC calculation across the iParameters

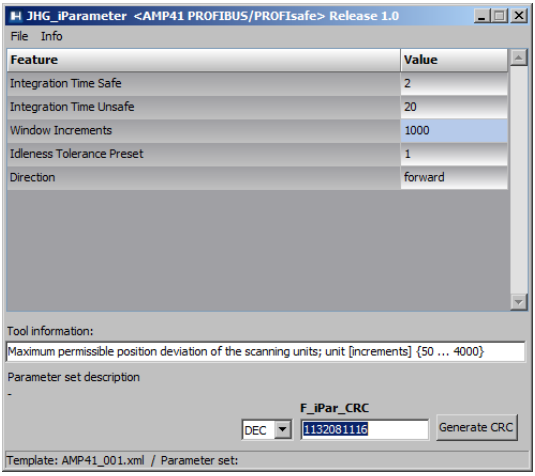
The predefined standard values are used for the following example of a CRC calculation. These can be loaded in the `JHG_iParameter` program using an XML template file. If different values are required, the standard values can be overwritten by double-clicking on the relevant entry. The modified parameters can be saved as a complete parameter set or opened again as a template.

→ Install `JHG_iParameter` by means of the setup file “JHG_iParameter_setup.exe”.

→ Start `JHG_iParameter` by means of the start file "JHG_iParameter.exe", then open the template file provided with the measuring system with the menu `File` → `Open XML template` (as example here: AMP41_001.xml).



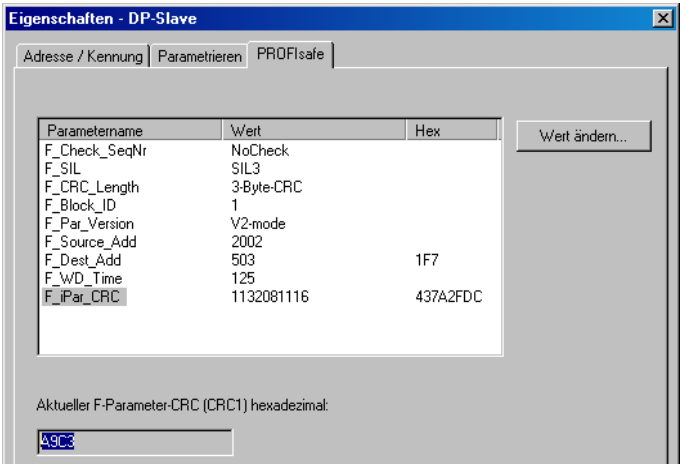
Modify the relevant parameters if necessary, then click on the `Generate CRC` switch for the `F_iPar_CRC` calculation.



Each parameter change requires a new `F_iPar_CRC` calculation, which must then be taken into account in the projection. If a safety program is already present, it must be re-generated. For further information on the use of `JHG_iParameter`, refer to the help file with the menu `Info` → `Help`.

4.2 F-Parameters

The F-Parameters are already preconfigured with meaningful values in the default setting and should only be changed if expressly required by the automation task. A CRC which is automatically calculated by the `SIMATIC Manager` is necessary for safe transmission of the individually set F-Parameters. This checksum corresponds to the F-Parameter `F_Par_CRC`, which is displayed as a hexadecimal value in the `Properties – DP slave` window under the heading `Current F parameter CRC (CRC1)` when configuring the measuring system with the hardware configurator: The value `A9C3` entered in the example below is valid for the default setting shown here, **also see chapter 5.3.2 "Setting the F-Parameters" on page 46**.



4.2.1 Non-settable F-Parameters

The F-Parameters specified below are either managed by the measuring system or by the F-Host, and therefore cannot be manually changed:

- F_Check_SeqNr: NoCheck
- F_CRC_Length: 3-Byte-CRC
- F_Block_ID: 1
- F_Par_Version: V2-mode
- F_Source_Add: 2002 (example value, is predefined by the F-Host)

4.2.2 Settable F-Parameters

It is assumed that the following parameters are configured with their standard values:

- F_SIL: SIL3
- F_Dest_Add: 503 (corresponds to the set PROFIBUS address +500)
- F_WD_Time: 125
- F_iPar_CRC: 1132081116 (calculation by means of JHG tool JHG_iParameter)

Each parameter change gives a new `F_Par_CRC` value, which is displayed as shown above. If a safety program is already present, it must be re-generated.

5 Safety Creation – Configuration Example

This chapter describes the procedure for creating the safety program using the SIEMENS SIMATIC Manager configuration software and the S7 Distributed Safety optional package.

The safety program is created with the FBD/LAD Editor in STEP 7. The fail-safe FBs and FCs are programmed in the F-FBD or F-LAD programming language, while the fail-safe DBs are created in the F-DB programming language. The Distributed Safety F-Library supplied by SIEMENS provides the user with fail-safe application modules, which can be used in the safety program.

When generating the safety program, safety checks are performed automatically and additional fail-safe blocks are integrated for error detection and error reaction. This ensures that failures and errors are detected and corresponding reactions are triggered, which keep the F-System in safe status or put it into a safe status.

A standard user program can run in the F-CPU in addition to the safety program. The co-existence of standard and safety program in the F-CPU is possible, as the safety-oriented data of the safety program are protected against undesirable influence by data of the standard user program.

Data exchange between safety and standard user program in the F-CPU is possible by means of flags and through access to the process image of the inputs and outputs.

Access protection

Access to the F-System S7 Distributed Safety is protected by two passwords, the password for the F-CPU and the password for the safety program. A differentiation is made between offline and online password for the safety program:

- The offline password is part of the safety program in the offline project on the programming device.
- The online password is part of the safety program in the F-CPU.

5.1 Prerequisites

WARNING!

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

The safety program must be created in conjunction with the system documentation provided by SIEMENS for the software and hardware.

Extensive documentation on "Configuring and Programming" a safe control is provided by SIEMENS in its manual ***S7 Distributed Safety - Configuring and Programming***, document order number: ***A5E00109537-04***. This documentation is a constituent of the optional package `S7 Distributed Safety`.

The following descriptions relate to the pure procedure and do not take account of the instructions from the SIEMENS manual.

It is therefore essential to observe and comply with the information and instructions provided in the SIEMENS manual, particularly the safety instructions and warnings.

The configuration shown should be taken as an example. The user is required to check and adapt the usability of the configuration for his own application. This also includes the selection of suitable safety-oriented hardware components and the necessary software prerequisites.

Software components used for the `S7 Distributed Safety` configuration example:

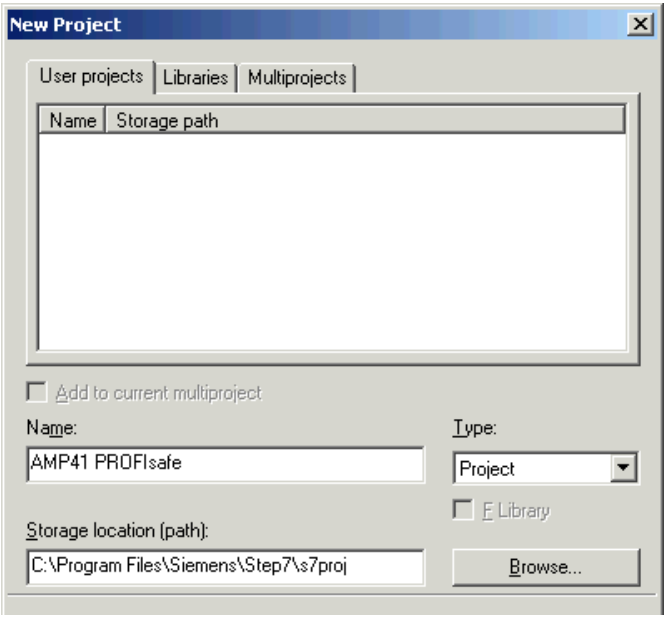
- STEP 7 V5.5 + SP2
- S7 Distributed Safety Programming V5.4 + SP5
- S7 F ConfigurationPack V5.5 + SP9

Hardware components in the SIMATIC 300 series used for the `S7 Distributed Safety` configuration example:

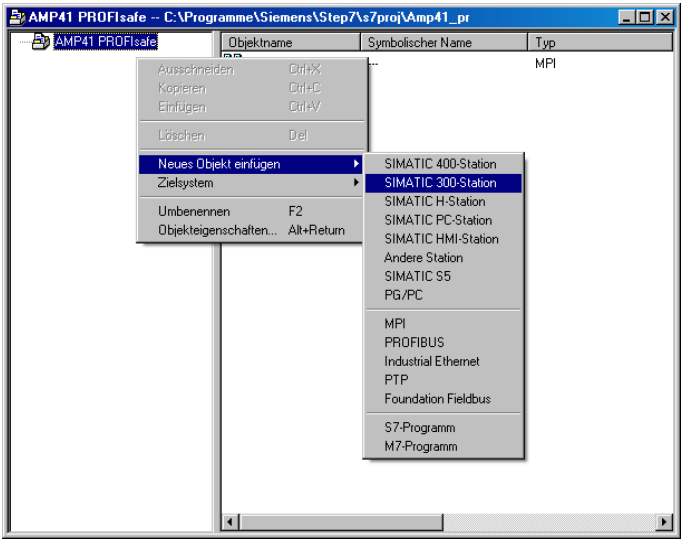
- Rail
- Power supply "PS307 2A" (307-1BA00-0AA0)
- F-CPU unit "CPU317F-2 PN/DP" (317-2FK13-0AB0)
- Digital output module "SM 326F DO 10xDC24V/2A" (326-2BF01-0AB0),
  is not actively used in the following safety program and is intended for customer-specific outputs, e.g. to show the variable states of the F-Periphery-Block:
  PASS_OUT, QBAD, ACK_REQ, IPAR_OK etc.
- Digital input module "SM 326F DI 24xDC24V" (326-1BK01-0AB0),
  is used for the operator acknowledgment.

5.2 Hardware configuration

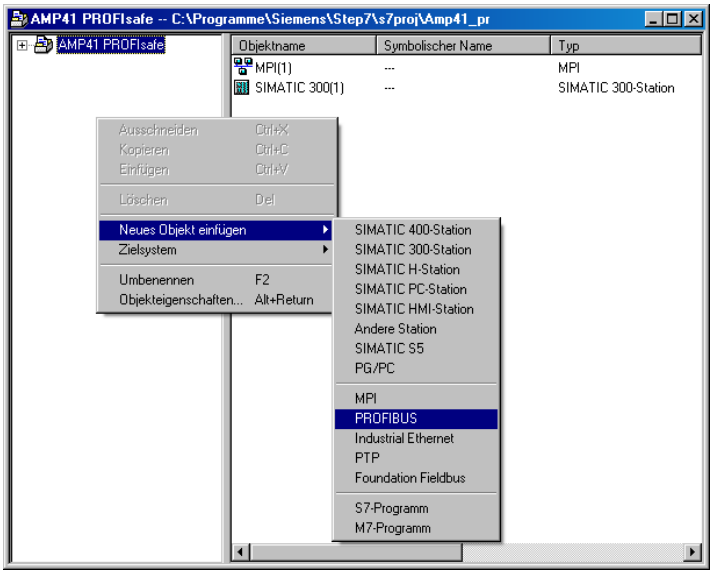
→ Start `SIMATIC Manager` and create a new project



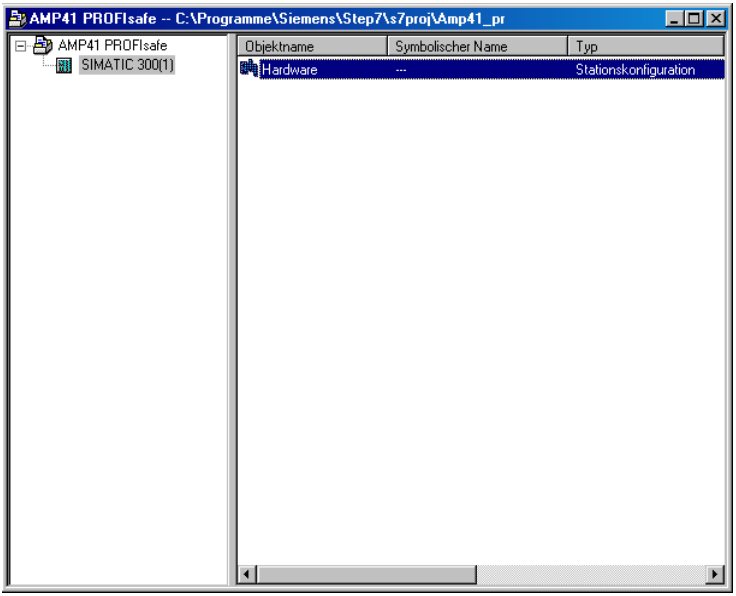
→ Using the right mouse button, insert the `SIMATIC 300 Station` as a new object in the project window



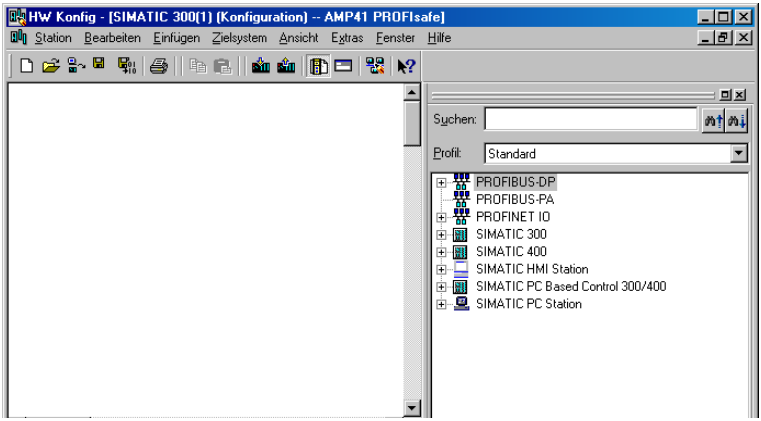
→ Insert a `PROFIBUS` as a new object in the same way. An `Industrial Ethernet` must also be inserted at this point if necessary.



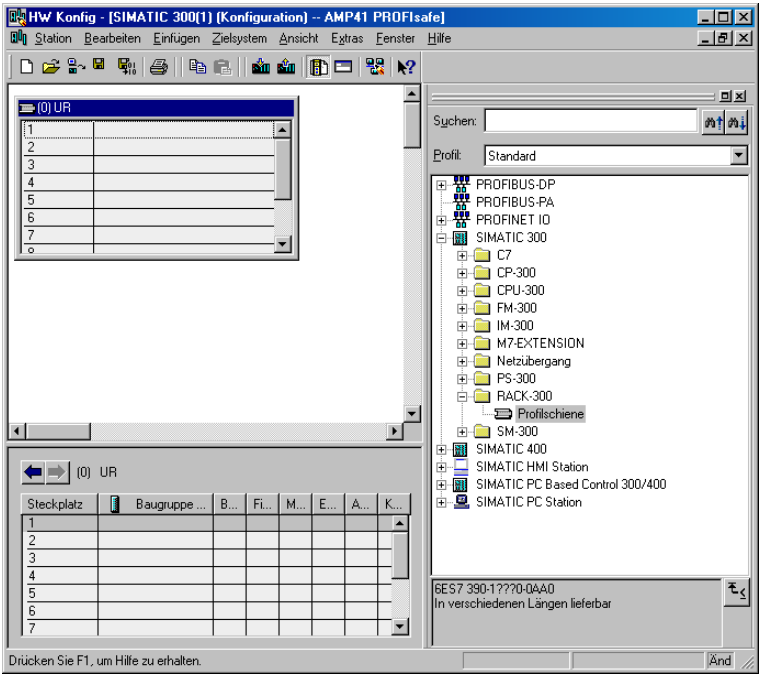
→ Double-click on `Hardware` to start the hardware configurator `HW Config`



→ If the hardware catalog is not shown on the right, it can be displayed with the `View` → `Catalog` menu



→ Drag a `rail` into the project window to take the hardware components

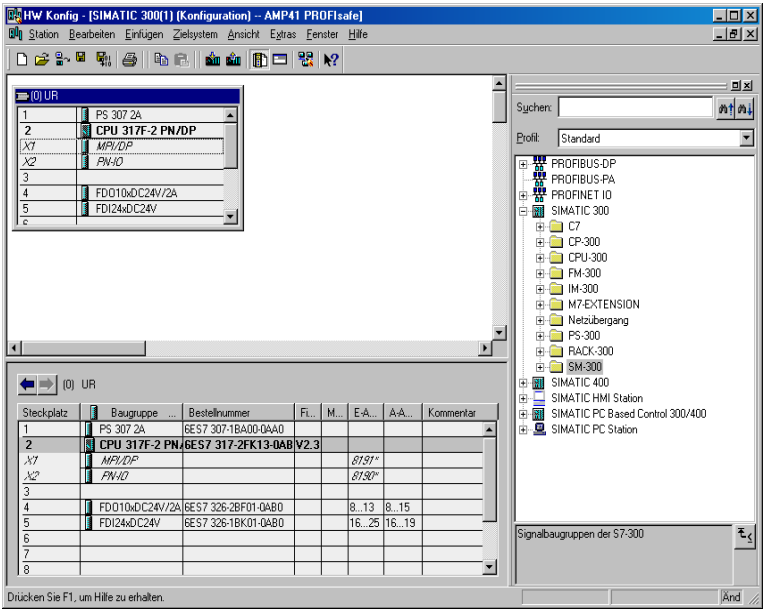


→ Drag the power supply `PS 307 2A` in the catalog to position 1 of the rack with `SIMATIC 300` → `PS-300` → `PS 307 2A`

→ Drag CPU `317F-2 PN/DP` in the catalog to position 2 of the rack with `SIMATIC 300` → `CPU-300` → `CPU 317F-2 PN/DP` → `6ES7 317-2FK13-0AB0` → `V2.3`. Also specify the characteristics of the `Ethernet interface` here if necessary.

→ Drag digital output module `SM 326F DO 10xDC24V/2A` in the catalog to position 4 of the rack with
`SIMATIC 300` → `SM-300` → `DO-300` → `SM 326F DO 10xDC24V/2A`
(6ES7 326-2BF01-0AB0)

→ Drag digital input module `SM 326F DI 24xDC24V` in the catalog to position 5 of the rack with
`SIMATIC 300` → `SM-300` → `DI-300` → `SM 326F DI 24xDC24V`
(6ES7 326-1BK01-0AB0)

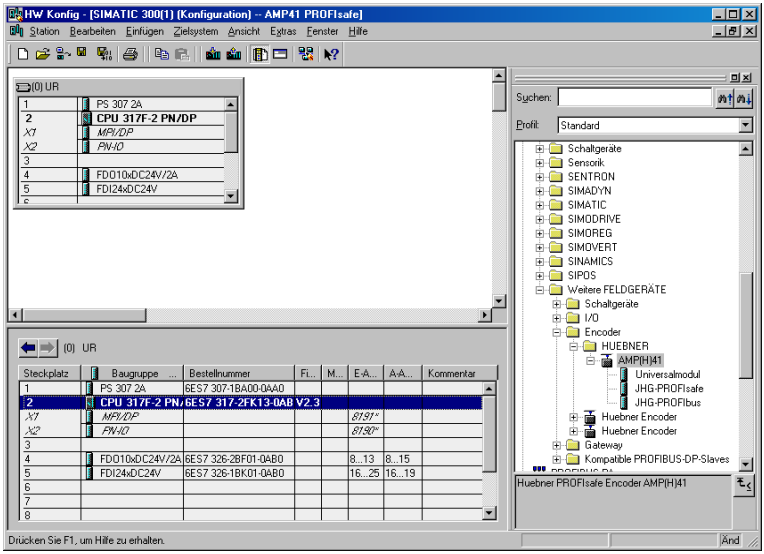


The hardware components to be included in the rack are now complete.

The GSD file `HUEB0E3F.GSE` belonging to the measuring system must be installed in the next step. This is copied into the installation directory of the `SIMATIC Manager`: …`\S7DATA\GSD`. The bitmap file `HUEB_BDE.bmp` belonging to the measuring system is copied into the following folder: …`\S7DATA\NSBMP`. You should note that the directory structure can vary.

→ Install GSD file `HUEB0E3F.GSE` in the stored directory with menu `Options` → `Install GSD File`….

The measuring system now appears in the catalog as a new item:
`PROFIBUS DP` → `Additional Field Devices` → `Encoder` → `HUEBNER` → `AMP(H)41`



The individual configuration options are shown under this item:

JHG-PROFIsafe, see page 18
JHG-PROFIbus, see page 24

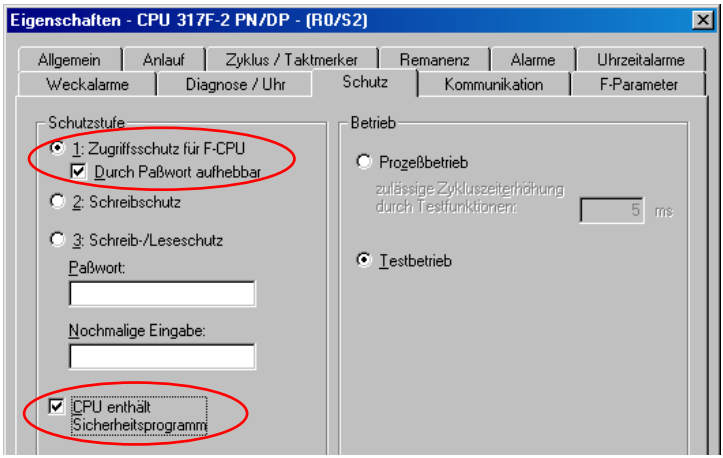
NOTES!

The item Universal module is erroneously provided automatically by some systems, but must not be used!

5.2.1 Defining the properties of the hardware configuration

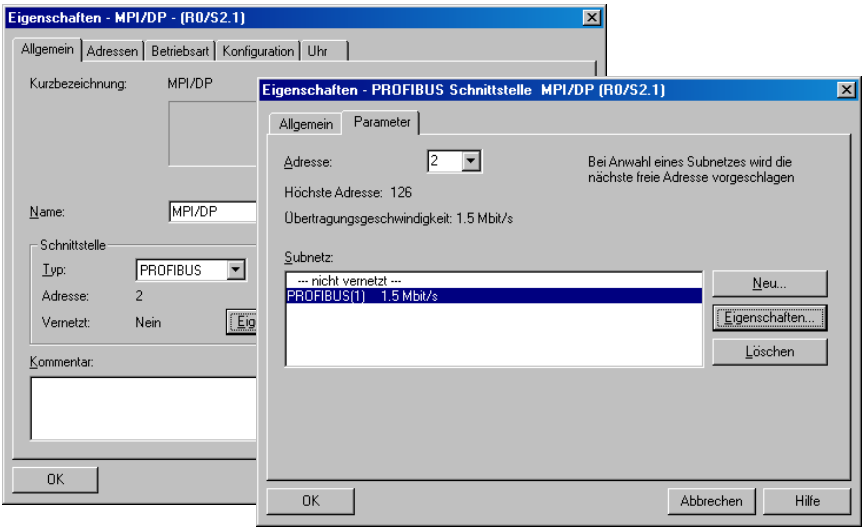
Die Objekteigenschaften der einzelnen Hardware-Komponenten werden mit Klick über die rechte Maustaste auf die entsprechende Position im Baugruppenträger oder Steckplatz festgelegt:

→ Für die CPU muss im Register `Schutz` die `Schutzstufe 1` und ein `Paßwort` projektiert werden. Das Feld `Betrieb` ist für den Sicherheitsbetrieb nicht relevant.

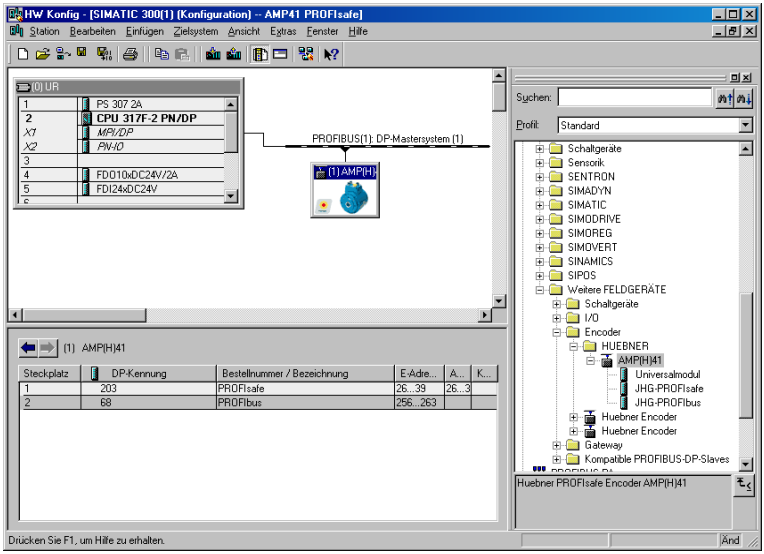


→ For the CPU, in the sub-item `MPI/DP`, `General` → register, select `PROFIBUS` type in the `Interface` field.

→ In the Properties window of `PROFIBUS interface MPI/DP`, configure the transmission rate `1.5 Mbps`

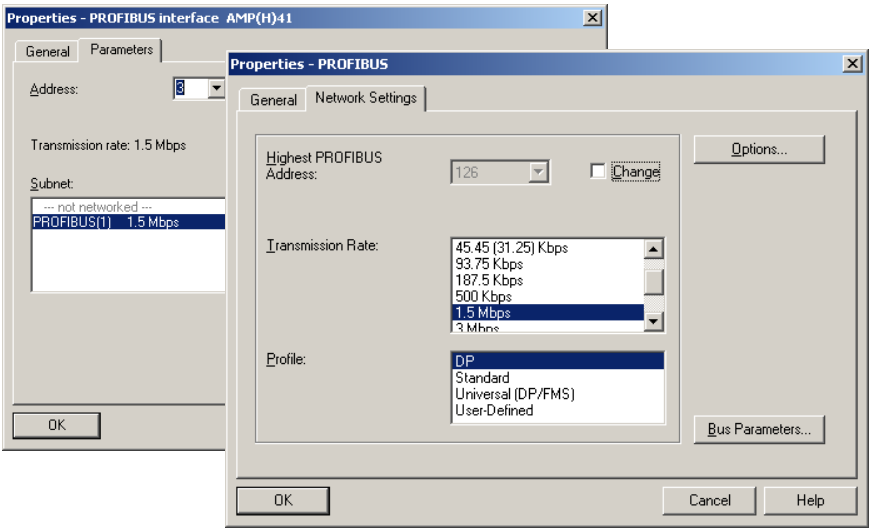


→ Connect the AMP(H)41 measuring system from the catalog to the DP master system, to the bus line now available, using Drag&Drop.

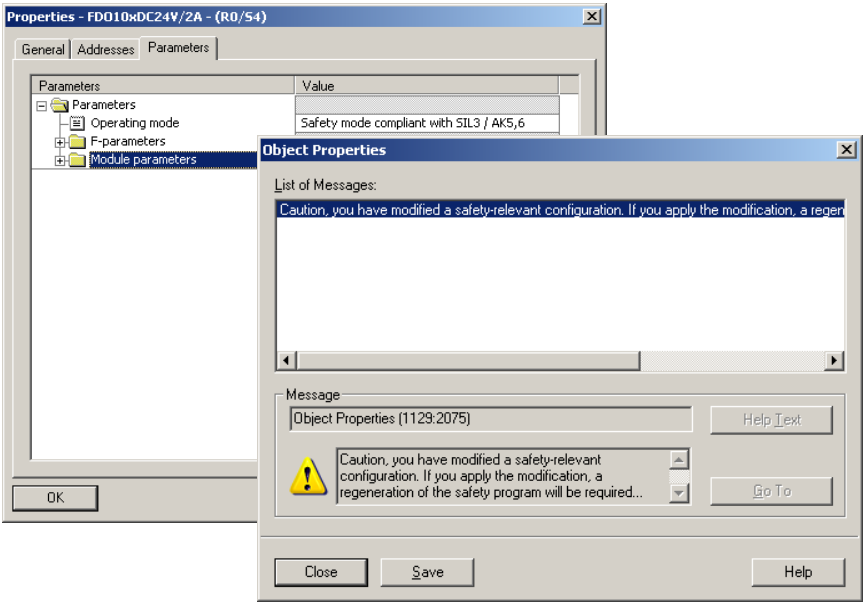


→ With connection of the measuring system to the master system, in the Properties window of PROFIBUS interface AMP(H)41, in the Parameters register, you can now configure the desired Address.

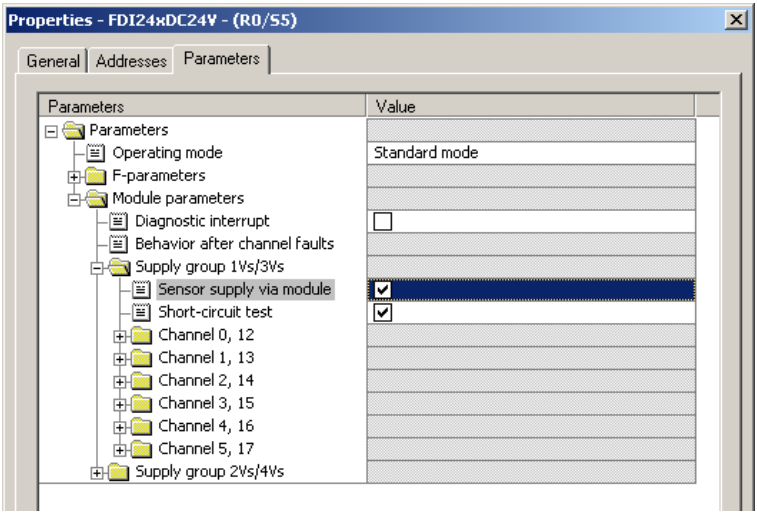
→ With the switch `Properties…` → Register `Network Settings` select the desired transmission rate (`1.5 Mbps`) and enter `DP` for the `Profile`.



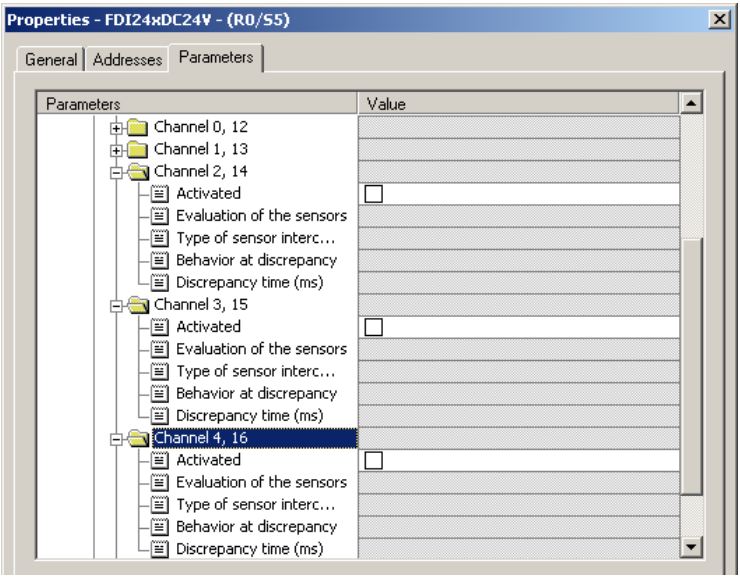
→ For the digital output module, in the `Parameters` register configure `Operating mode` → `Safety mode compliant with SIL3/AK5,6` and confirm the following window with `Close`



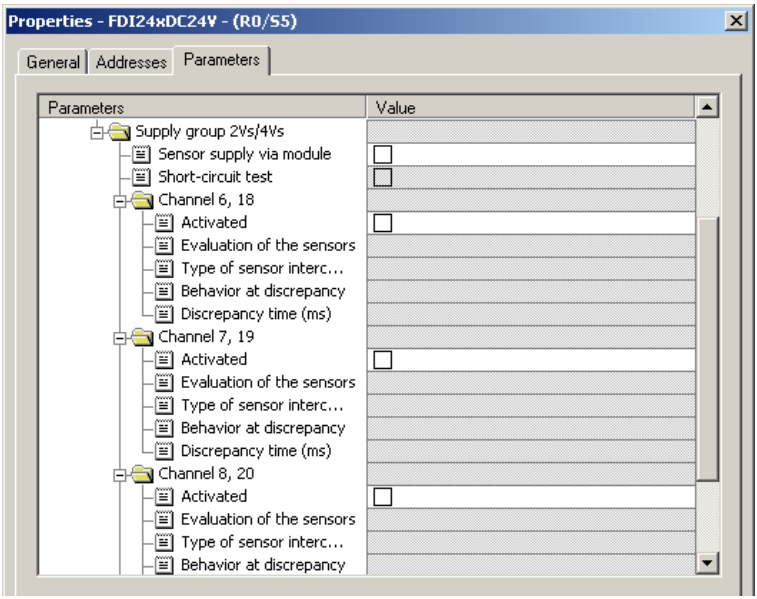
→ For the digital input module, in the `Parameters` register in folder structure `Parameters` → `Module parameters` → `Supply group 1Vs/3Vs`, put a tick in the items `Sensor supply via module` and `Short-circuit test`



→ The settings for channels `0,12` and `1,13` remain unchanged.
For channels `2,14` / `3,15` / `4,16` and `5,17`, the tick must be removed under `Activated`



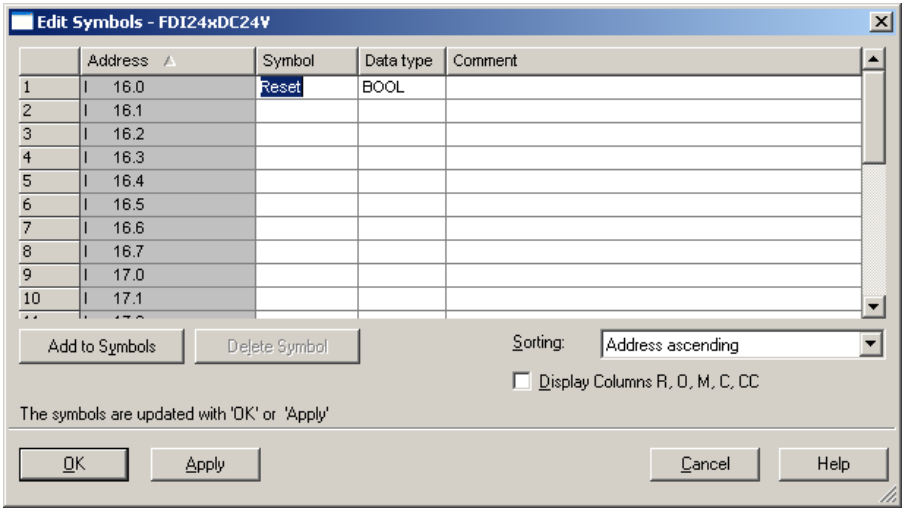
→ In the sub-folder `Supply group 2Vs/4Vs`, for all channels `6,18` / `7,19` / `8,20` / `9,21` / `10,22` and `11,23` the tick must also be removed under `Activated`



For the operator acknowledgment of the F-Periphery, a RESET symbol is required for the digital input `I 16.0`.

→ To do this, click with the right mouse button on the item `FDI24xDC24V` in the rack or slot and select `Edit Symbols`…. In the `Symbol` column enter the symbol name `Reset`, the data type `BOOL` will then be applied automatically.

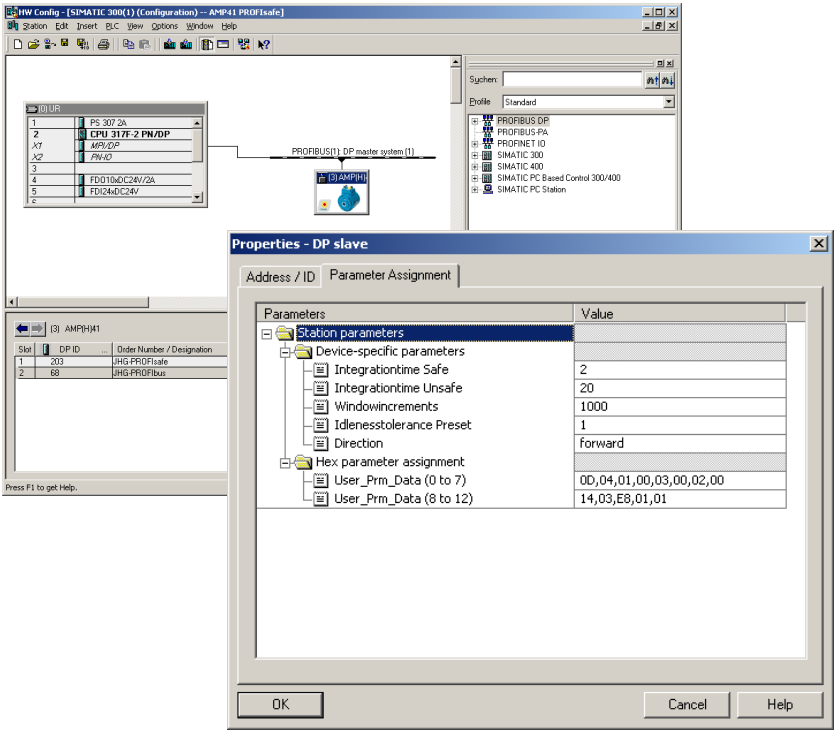
→ Press `OK` to update.



5.3 Parameterization

5.3.1 Setting the iParameters

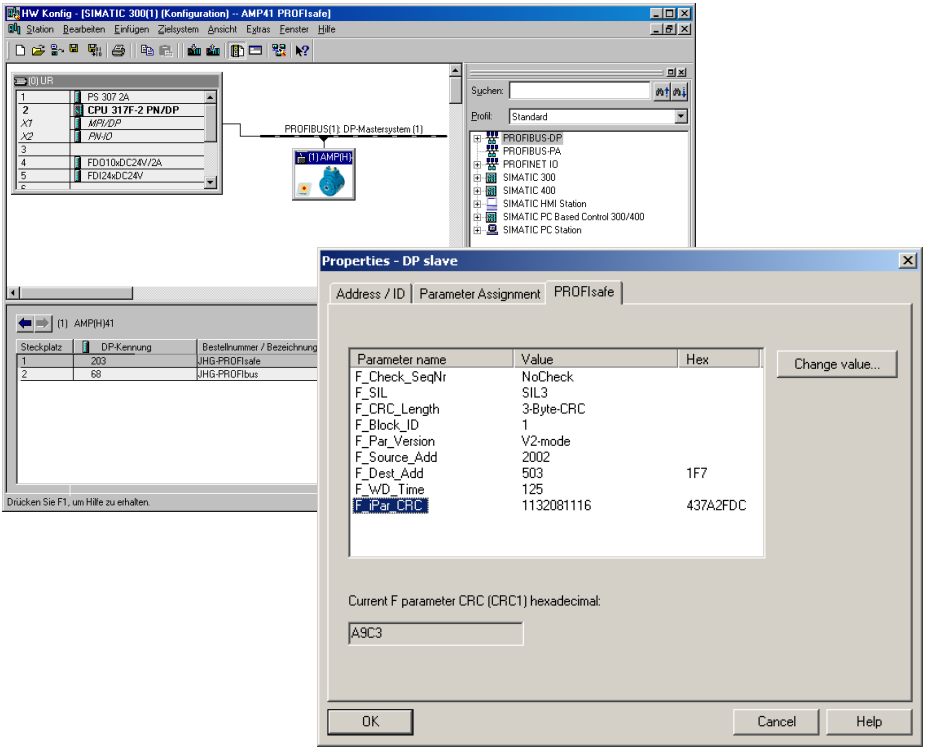
→ The iParameters can be set by selecting the `Symbol` for the measuring system → Double click on the slot item `JHG-PROFIbus` → Select the `Parameter Assignment` register



If different parameter values are required, as shown above, a `F_iPar_CRC` calculation must occur for this new parameter data set, **see chapter 4 5.3.1 "Parameter Definition/CRC Calculation" on page 30.** The calculated value must then be entered in the parameter data set for the F-Parameters under `F_iPar_CRC`, **see chapter 5.3.2 "Setting the F-Parameters" on page 46**.

5.3.2 Setting the F-Parameters

→ The F-Parameters can be set by selecting the `Symbol` for the measuring system
→ Double-click on the slot item `JHG-PROFIsafe` → Select the `PROFIsafe` register



The parameter value for the parameter `F_iPar_CRC` results from the set parameter data set for the iParameters and the calculated CRC value **see chapter 5.3.1 "Setting the iParameters" on page 45**.

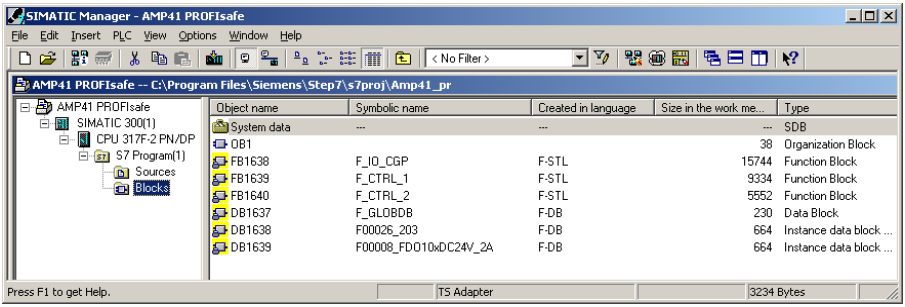
The hardware projection is now complete. To enable automatic generation of the safety program, the hardware configuration must now be compiled via the menu `Station` → `Save and Compile`.

The `HW Config` can now be closed.

5.4 Creating the missing (F-)blocks

The blocks that have already been automatically created can be viewed in the project folder of the SIMATIC Manager under:
AMP41 PROFIsafe → SIMATIC 300(1) → CPU 317F-2 PN/DP → S7-Programm(1) → Bausteine.

All fail-safe blocks are shown with a yellow background to distinguish them from blocks of the standard user program.



5.4.1 Program structure

The safety program is accessed by calling up the F-CALL from the standard user program.
The F-CALL is called up directly e.g. in the cyclic interrupt OB OB 35.
Cyclic interrupt OBs have the advantage that they interrupt the cyclic program processing in OB 1 of the standard user program at fixed time intervals, i.e. in a cyclic interrupt OB the safety program is called up and processed at fixed time intervals.
After the safety program has been processed, the standard user program is further processed.

5.4.2 F-Runtime Group

Zur besseren Handhabung besteht das Sicherheitsprogramm aus einer „F-Ablaufgruppe“. Die F-Ablaufgruppe ist ein logisches Konstrukt aus mehreren zusammengehörigen F-Bausteinen, welches intern vom F-System gebildet wird.

To facilitate handling, the safety program consists of an "F-Runtime Group". The F-Runtime Group is a logic construct consisting of a number of related F-Blocks, which is formed internally by the F-System.

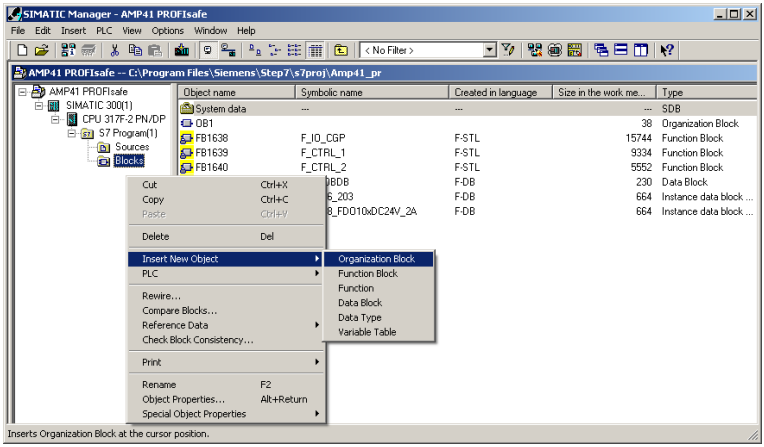
The F-Runtime Group comprises:

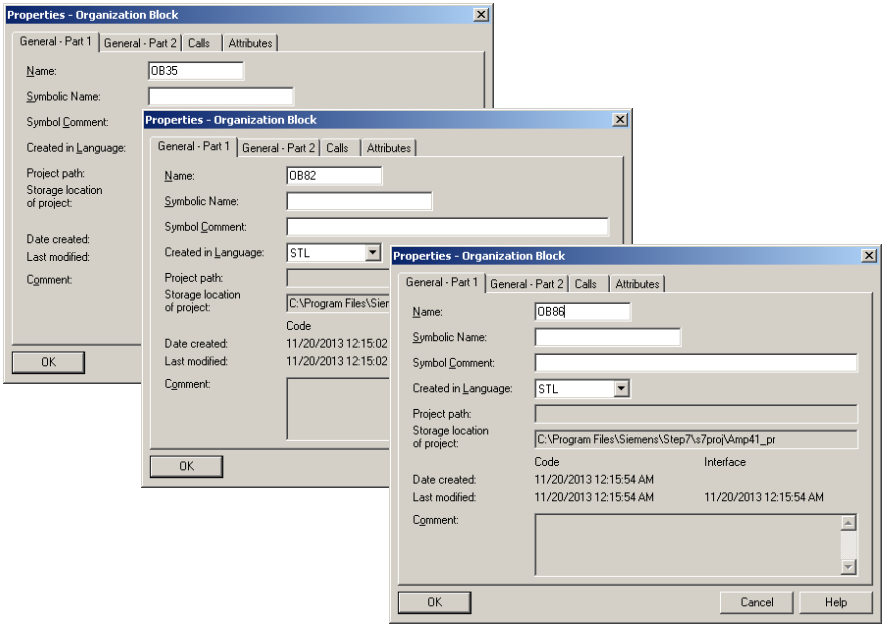
- one F-Call block F-CALL, "FC1"
- one F-Program block, to which the F-CALL is assigned, "FC2"
- further F-FBs
- several F-DBs
- F-Periphery-DBs
- F-System blocks F-SBs
- automatically generated F-Blocks

5.4.3 Generating the Object Blocks (OBs)

The necessary Organization Blocks OB35 and OB82 to OB86 are created below.

→ The Organization Blocks are inserted with the right mouse button in the project window `Insert New Object` → `Organization Block`
The programming language is `STL` for all Organization Blocks

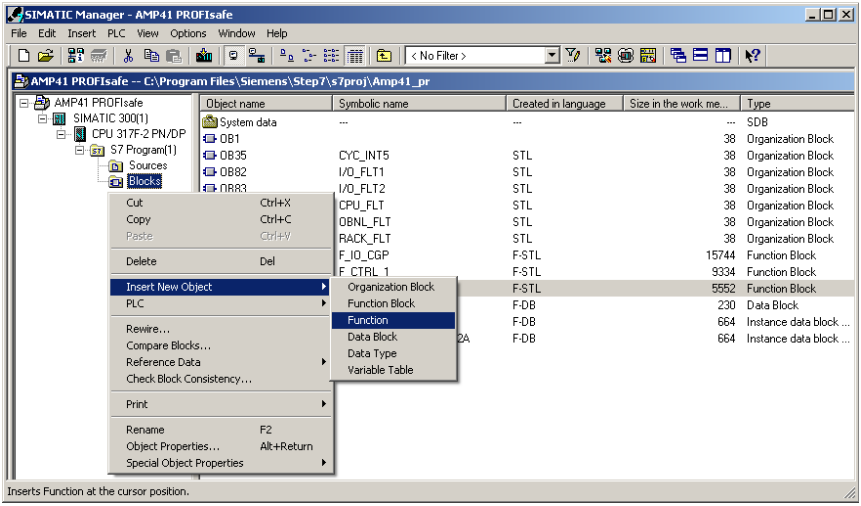


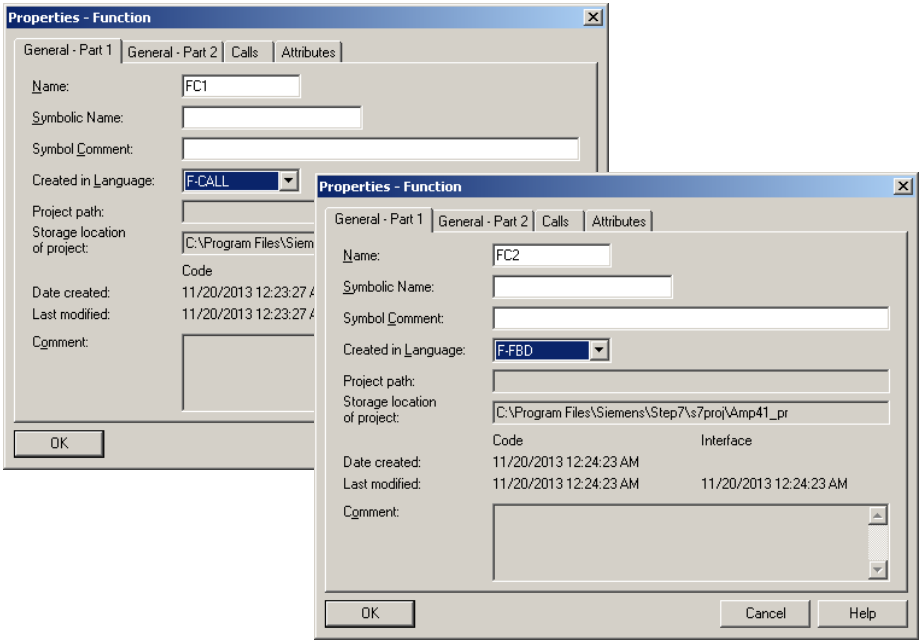


5.4.4 Generating the functions (F-FCs)

The necessary functions FC1 and FC2 are created below.

→ The functions are inserted with the right mouse button in the project window `Insert New Object → Function`
The programming language for FC1 is `F-CALL`, for FC2 `F-FBD`

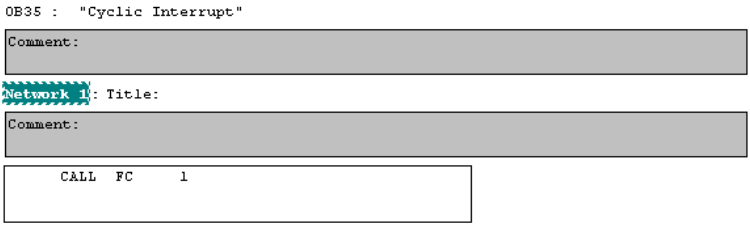




5.4.5 Programming the F-Blocks

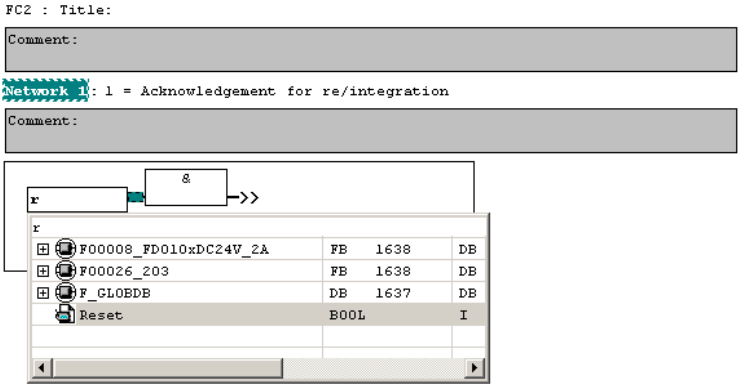
The programming and modifications for blocks `OB35`, `FC1` and `FC2` are carried out below.

→ The safety program is called up in `OB35` by double-clicking on the object name `OB35` in the project window. The instruction `CALL FC1` must be entered in the open `LAD/STL/FBD` program window. Finally save the item and close the window again.

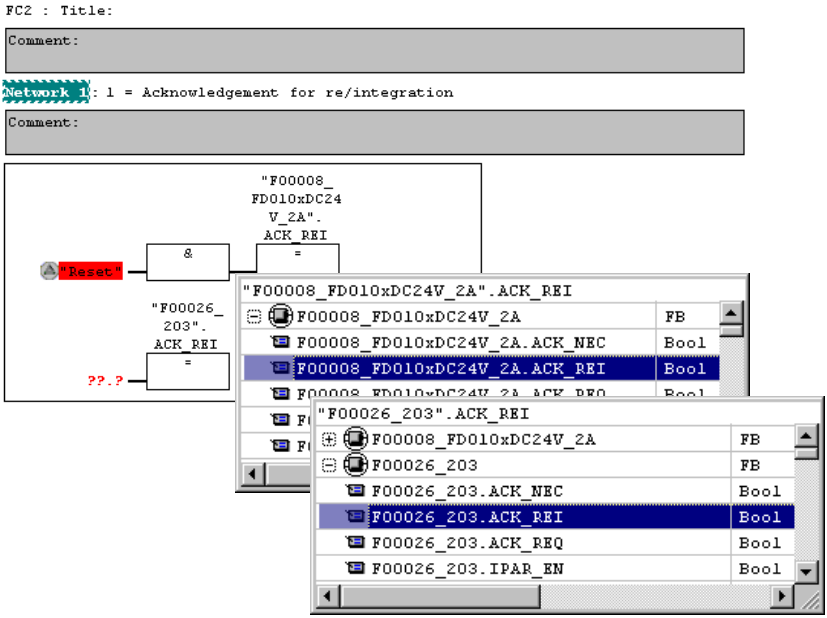


For the operator acknowledgment of the F-Periphery after the elimination of errors, the variable `ACK_REI` of the F-Periphery-DB must be interconnected to the digital input `I 16.0 RESET` of the digital input module. The function `FC2` must be programmed accordingly for this purpose.

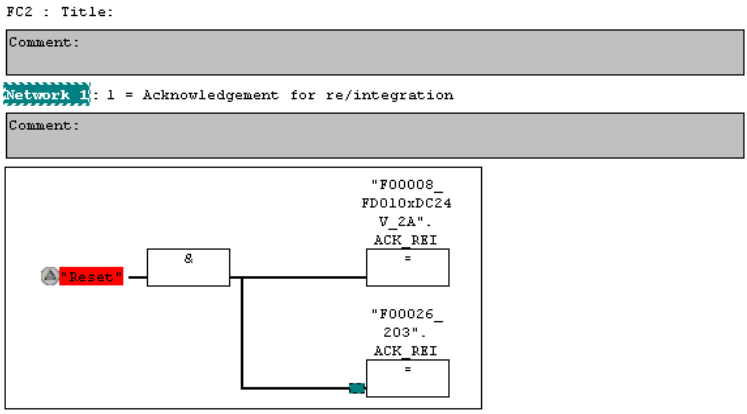
→ An `And Box` is inserted from the tool bar, one input is deleted and the `Reset` symbol is assigned to the second input.



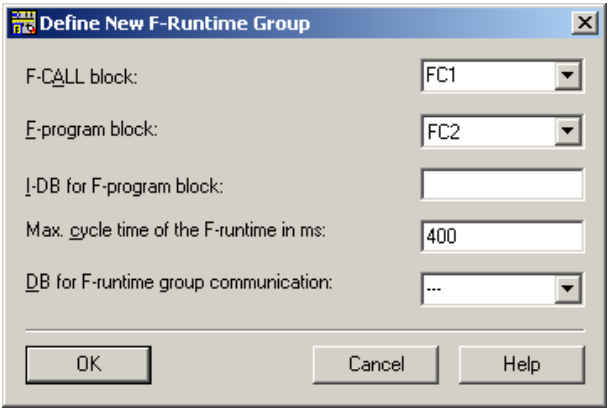
→ Two `Assignments` are inserted from the tool bar, the variable `"F00008..."."ACK_REI` is assigned to one assignment, and the variable `"F00026..."."ACK_REI` to the other.



→ Finally, the `Assignment` not yet interconnected is interconnected to the output of the `And Box` by a `Branch`. Save the programming and close the window.



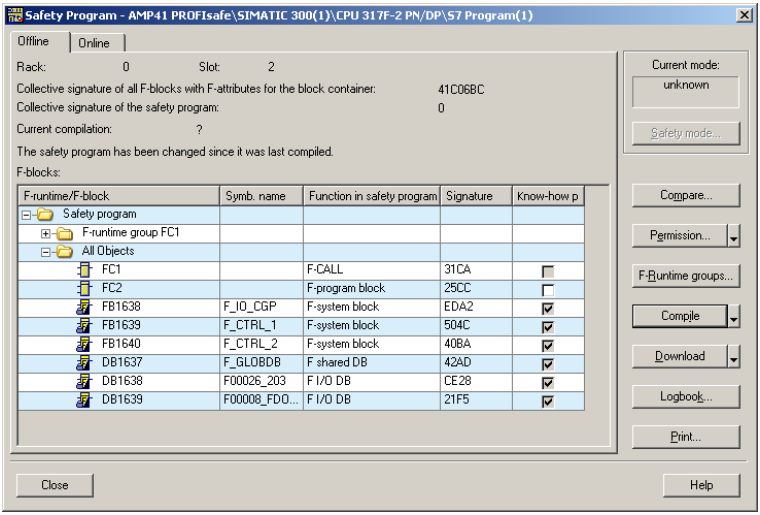
→ The Runtime Group is defined with the function `FC1`. In the field `Max. cycle time of the F-runtime in ms:` enter the value `400` and confirm with `OK`. Also confirm the next window `Edit F-Runtime Groups` with `OK`.



The programming and modifications are now complete.

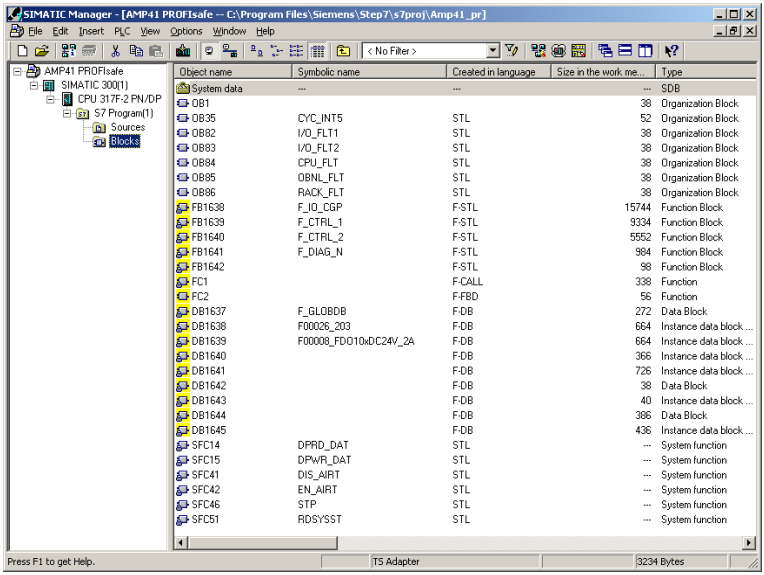
5.5 Generating the safety program

→ To generate the safety program, in `SIMATIC Manager`, `Options` → `Edit safety program` menu, open the `Safety Program` dialog. The safety program is compiled and generated with the `Compile` switch.



If compilation is successful 0 warnings are displayed, and the windows can then be closed.

All necessary blocks are now displayed in the project window:



5.6 Loading the safety program

When the safety program has been generated, it can be loaded into the F-CPU. It is advisable to transfer the complete safety program to the F-CPU in STOP operating status. This guarantees that a consistent safety program is loaded. The program is loaded with the menu `Options` → `Edit safety program` → `Download` switch.

5.7 Testing the safety program

After generating the safety program, a complete functional test must be carried out according to the automation task.
After modifications to an already completely function-tested safety program, it is sufficient to test the modifications.

6 Zugriff auf den sicherheitsgerichteten Datenkanal

The safety-oriented data channel in the `JHG-PROFIsafe` module is accessed via the process image, as with a standard periphery. However, direct access is not permitted. The safety-oriented data channel of the measuring system may only be accessed from the generated F-Runtime Group.
The actual communication between F-CPU (process image) and measuring system for updating the process image occurs concealed in the background, by means of the PROFIsafe protocol.
The measuring system uses a larger area in the process image in the `JHG-PROFIsafe` module, due to the PROFIsafe protocol, than would be necessary for the measuring system function. The `F-Parameter-block` contained in the process image is not included in the user data. When accessing the process image in the safety program, only access to the pure user data is permitted!

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

The safety function requires that for passivation in the safety-oriented channel in the JHG-PROFIsafe module, the substitute values (0) are used in the following cases instead of the cyclically output values. This status is indicated via the F-Periphery-DB with PASS_OUT = 1, see below.

- at start-up of the F-System
- in the case of errors in the safety-oriented communication between F-CPU and measuring system via the PROFIsafe protocol
- if the value set for the Window increments under the iParameters is exceeded and/or the internally calculated PROFIsafe telegram is defective
- if the permissible operating temperature range, as defined under the corresponding article number, is fallen below or exceeded
- if the measuring system is supplied with >36 V DC for longer than 200 ms
- if the measuring system is disconnected in RUN mode, the F-Host is reconfigured and the measuring system is then reconnected

6.2 F-Periphery-DB

For each F-Periphery, measuring system and digital output module, an F-Periphery-DB is automatically generated during compilation in HW Config. With reference to the generated safety program, **see chapter 5 “Safety Creation – Configuration Example“ on page 33**, this is block DB1638 for the measuring system and DB1639 for the digital output module. The F-Periphery-DB contains variables which can be analyzed in the safety program and can or must be written. An exception is the variable DIAG, which may only be analyzed in the standard user program. Modification of the initial/current values of the variables directly in the F-Periphery-DB is not possible, as the F-Periphery-DB is know-how-protected.

The variables of the measuring system F-Periphery-DB must be accessed in the following cases:

- during operator acknowledgment of the measuring system after communication errors or after the start-up phase
- during execution of the preset adjustment function
- when analyzing whether passivated or cyclical data are output
- if the cyclical data of the JHG-PROFIsafe module are to be passivated depending on defined states of the safety program, e.g. group passivation

6.2.1 Measuring system F-Periphery-DB “DB1638” – Overview of variables

Variable	Data Type	Function	Access
PASS_ON	BOOL	1 = Passivation of the cyclical data of the JHG-PROFIsafe module via the safety program	Read/Write Default value: 0
ACK_NEC	BOOL	1 = Operator acknowledgment in the event of F-I/O faults	Read/Write Default value: 1
ACK_REI	BOOL	1 = Operator acknowledgment after communication errors or after the start-up phase	Read/Write Default value: 0
IPAR_EN	BOOL	Variable for execution of the preset adjustment function	Read/Write Default value: 0
PASS_OUT	BOOL	Passivation output	Read
QBAD	BOOL	1 = Substitute values are output	Read
ACK_REQ	BOOL	1 = Acknowledgement request for the operator acknowledgment	Read
IPAR_OK	BOOL	1 = Execution of preset adjustment function successfully completed	Read
DIAG	BYTE	Service information, only possible in the standard program	Read
QBAD_I_xx	BOOL	1 = Substitute values are output in input channel	Read
QBAD_O_xx	BOOL	1 = Substitute values are output in output channel	Read

6.2.1.1 PASS_ON

With the variable PASS_ON = 1 a passivation of the safety-oriented data of the JHG-PROFIsafe module can be activated, e.g. depending on defined states in the safety program. The passivation is not performed directly in the measuring system, instead the status of these variables is registered by the F-Host and the passivation is only activated by means of the safety program data. Cyclical data are still output by the measuring system!
If a passivation is performed with PASS_ON = 1, the preset adjustment function is switched off.

6.2.1.2 ACK_NEC

The official application of this variable would be an operator acknowledgment for the measuring system after F-I/O faults. However, for the measuring system no process is defined, for which this procedure is permissible. For safety reasons these faults must be removed first and then the supply voltage must be switched OFF/ON, **also see chapter 8 “Troubleshooting and Diagnosis Options“ on page 61**.

6.2.1.3 ACK_REI

If a communication error is detected by the F-System for the measuring system, a passivation of the measuring system is performed.
For the operator acknowledgment of the measuring system after the elimination of errors a positive edge of variable ACK_REI of the F-Periphery-DB is required, which is linked to the input of the digital input module → I 16.0, symbol name: "RESET".

An operator acknowledgment is required:

- after communication errors
- after the start-up phase

An acknowledgment is only possible if the variable ACK_REQ = 1.
An operator acknowledgment must be provided for each F-Periphery in the safety program via the variable ACK_REI. This requirement has already been taken into account for the measuring system and digital output module.

6.2.1.4 IPAR_EN

The variable IPAR_EN is used to execute the preset adjustment function. The process sequence for execution of this function is described **in chapter 7 "Preset Adjustment Function" on page 59.**
A precise description of when the variables must be set/reset during a re-parameterization of fail-safe DP standard slaves/IO standard devices can be found in the *PROFIsafe Specification* from *V1.20*, or the documentation on the fail-safe *DP Standard Slave/IO Standard Device*.

NOTES!

No passivation of the measuring system is triggered by IPAR_EN = 1!
With reference to the preset execution, the warning notice contained in the **chapter 7 "Preset Adjustment Function" on page 59** must be observed!

6.2.1.5 PASS_OUT/QBAD/QBAD_I_xx/QBAD_O_xx

The variables PASS_OUT = 1 and QBAD = 1 indicate that a passivation of the measuring system is present.
The F-System sets PASS_OUT, QBAD, QBAD_I_xx and QBAD_O_xx = 1, while the measuring system outputs substitute values (0) instead of cyclical values.
If a passivation is performed via the variable PASS_ON = 1, only QBAD, QBAD_I_xx and QBAD_O_xx = 1 are set. However PASS_OUT does not change its value for a passivation via PASS_ON = 1. PASS_OUT can therefore be used for the group passivation of further F-Peripheries.

6.2.1.6 ACK_REQ

If a communication error is detected by the F-System for the measuring system, a passivation of the measuring system is performed. ACK_REQ = 1 indicates that an operator acknowledgment for the measuring system is required.
The F-System sets the variable ACK_REQ = 1 as soon as the error has been eliminated and an operator acknowledgment is possible. After the acknowledgment the variable ACK_REQ is reset to 0 by the F-System.

6.2.1.7 IPAR_OK

The variable `IPAR_OK` is used to indicate successful execution of the preset adjustment function. The process sequence for execution of this function is described
in chapter 7 "Preset Adjustment Function" on page 59.
A precise description of how the variable can be analyzed in the event of a re-parameterization of fail-safe DP standard slaves/IO standard devices can be found in the *PROFIsafe Specification* from *V1.20*, or the documentation on the fail-safe *DP Standard Slave/IO Standard Device*.

6.2.1.8 DIAG

The `DIAG` variable provides non-fail-safe information of 1 byte on errors that have occurred, for service purposes. Access to this variable in the safety program is not permitted!
The coding and use of this variable can be found in the SIEMENS manual
S7 Distributed Safety - Configuring and Programming, document order number:
A5E00109537-04.

6.3 Access to variables of the F-Perhiphery-DB

For each F-Periphery, measuring system and digital output module, an `F-Periphery-DB` is generated automatically during compilation in `HW Config` and a symbolic name is entered in the symbol table at the same time.
The symbolic name is formed from the fixed prefix "F", the initial address of the F-Periphery and the name entered for the F-Periphery in `HW Config` in the `Object Properties`, max. 17 characters.
Variables of the F-Periphery-DB of an F-Periphery may only be accessed from an F-Runtime Group and only from the F-Runtime Group from which the channels of this F-Periphery are accessed, when access is available.
The variables of the F-Periphery-DB can be accessed by specifying the symbolic name of the F-Periphery-DB and the name of the variable: "fully qualified DB access".
It must be ensured in `SIMATIC Manager`, that in the `FBD/LAD Editor` in the menu `Options` → `Customize` in the `General` register the option "Report cross-accesses as error" is not activated. Otherwise access to variables of the F-Periphery-DB will not be possible.

6.4 Passivation and Operator acknowledgment of the measuring system

6.4.1 After start-up of the F-System

After a start-up of the F-System, the communication between F-CPU and measuring system via the PROFIsafe protocol must first be established. A passivation of the measuring system occurs during this time.

During use of the substitute values (0), the variables `QBAD`, `PASS_OUT`, `QBAD_I_xx` and `QBAD_O_xx` = 1. The operator acknowledgment of the measuring system, i.e. the output of cyclical data at the fail-safe outputs, automatically occurs, from the viewpoint of the F-Host, independently of the setting at the `ACK_NEC` variable, at the earliest from the 2nd cycle of the F-Runtime Group after start-up of the F-System. Depending on the cycle time of the F-Runtime Group and the PROFIBUS-DP, the operator acknowledgment can only occur after a few cycles of the F-Runtime Group.If the establishment of communication between F-CPU and measuring system takes longer than the monitoring time set in `HW Config` in the `Object Properties` for the F-Periphery, no automatic operator acknowledgment occurs. In this case a positive edge of variable `ACK_REI` of the F-Periphery-DB is required, which is linked to the input of the digital input module → I 16.0, symbol name: "RESET".

6.4.2 After communication errors

If the F-System detects an error in the safety-oriented communication between the F-CPU and measuring system via the PROFIsafe protocol, a passivation of the measuring system occurs.

During use of the substitute values (0), the variables `QBAD`, `PASS_OUT`, `QBAD_I_xx` and `QBAD_O_xx` = 1.

The operator acknowledgment of the measuring system, i.e. the output of cyclical data at the fail-safe outputs, only occurs if:

- no further communication errors are present, and the F-System has set the variable `ACK_REQ` = 1
- an operator acknowledgment with positive edge of variable `ACK_REI` of the F-Periphery-DB has occurred, which is linked to the input of the digital input module → I 16.0, symbol name: "RESET" .

7 Preset Adjustment Function

WARNING!

NOTICE!

Danger of death, serious physical injury and/or damage to property due to uncontrolled start-up of the drive system during execution of the preset adjustment function!

The relevant drive systems must be locked to prevent automatic start-up.
It is advisable to protect the preset triggering via the F-Host by means of additional protective measures, such as e.g. key-operated switch, password etc.
The new position must be checked after execution of the preset function.

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

The execution of the preset adjustment function is a critical process, as the resulting actual value jump, e.g. when using a controller, could cause uncontrolled machine movements. The preset adjustment function may therefore only be executed when the relevant system part is at a safe standstill.
After completion of the preset process, you must check that the position output by the measuring system matches the position transmitted to the measuring system.

The preset adjustment function is already locked in the measuring system and can only be activated via the variable `IPAR_EN` in the F-Periphery-DB `DB1638`. Even if all preconditions are fulfilled from the viewpoint of the F-Host, the preset adjustment function is only executed when the shaft of the measuring system is stationary. However, a certain edge jitter, e.g. caused by machine vibrations, is permitted within a certain tolerance window. This tolerance window can be set with the iParameter `Idleness tolerance Preset`, **see chapter 3.7.2.4 “Idleness tolerance Preset“ on page 29**.

7.1 Procedure

→ Prerequisite: The measuring system is in cyclical data exchange.

→ Write the `Preset Multi-Turn` and `Preset Single-Turn` registers in the output data of the `JHG-PROFIsafe` module with the desired preset value.

→ The F-Host must set the variable `IPAR_EN` in the F-Periphery-DB to 1. With the rising edge, the measuring system is now switched ready to receive.

→ With the rising edge of Bit 2^0 `Preset_Request` in the `Control1` register, the preset value is accepted. The receipt of the preset value is acknowledged in the `Status` register by setting Bit 2^0 `Preset_Status`.

→ After receipt of the preset value, the measuring system checks that all prerequisites for execution of the preset adjustment function are fulfilled. If so, the preset value is written as the new position value. In case of error, the execution is rejected and an error message is output via the `Status` register by setting Bit 2^{15} `Error`.

→ After successful execution of the preset adjustment function, the measuring system sets the variable `iPar_OK` = 1 in the F-Periphery-DB and thus indicates to the F-Host that the preset execution is complete.

→ The F-Host must now reset the variable `IPAR_EN` in the F-Periphery-DB to 0. The variable `iPar_OK` and Bit 2^0 `Preset_Status` in the `Status` register are thus also reset with the falling edge. Bit 2^0 `Preset_Request` in the `Control1` register must be reset manually again.

→ Finally, the F-Host must check that the new position corresponds to the new nominal position.

8 Troubleshooting and Diagnosis Options

8.1 Optical displays

For assignment and position of the status LEDs **see chapter 3.5 "Bus status display" on page 17**.

8.1.1 LED, green

Green LED	Cause	Remedy
OFF	Power supply absent	Check power supply, wiring
	Hardware error, measuring system defective	Replace measuring system
3x 5 Hz repeating	– Measuring system could not synchronize with the F-Host in the start-up phase and requests an operator acknowledgment. – An error in the safety-oriented communication or a parameterization error was detected, and has been eliminated.	For the operation acknowledgment of the measuring system a positive edge of variable `ACK_REI` of the F-Periphery-DB is required, **see chapter 6.4 "Passivation and Operator acknowledgment of the measuring system" on page 58**.
1 Hz	F-Parameterization defective, e.g. incorrectly set PROFIsafe destination address `F_Dest_Add`	– Check PROFIBUS address set with the hardware switch. The address set here gives the necessary PROFIsafe destination address + 500, (see chapter "Bus-adressing" in the USC42 manual). – Synchronize required safety class `F_SIL` of system and measuring system, **see chapter 3.7.1.2 "F_SIL" on page 26.**
ON	Measuring system ready for operation, connection established with PROFIBUS master	–

8.1.2 LED, red

Red LED	Cause	Remedy
OFF	No error	**–**
1 Hz	– No connection to PROFIBUS master – PROFIBUS address incorrectly set – Incorrectly configured `F_iPar_CRC`-value.	– The PROFIBUS address set with the hardware switch must match the projected PROFIBUS address – The checksum calculated for the defined iParameter set is incorrect, or was not included in the projection, see **chapter 4 "Parameter Definition/CRC Calculation" on page 30**.
on	**A safety-relevant error was detected, the measuring system was put into fail-safe status and is outputting its passivated data:**	**In order to restart the measuring system after a passivation the error must generally be eliminated first of all and then the supply voltage switched OFF/ON.**
	Error in the safety-oriented communication	– Try to localize the error with the aid of `DIAG` variable, **see chapter 6.2.1.8 "**DIAG**" on page 57**. –
	The set value for the `window increments` parameter was exceeded.	Check that the set value for the `Window increments` parameter is suitable for the automatic task, **see chapter 3.7.2.3 "Window increments" on page 29.**
	The permissible operating temperature range, as defined under the corresponding article number, was fallen below or exceeded.	Suitable measures must be taken to ensure that the permissible operating temperature range can be observed at all times.
	The measuring system was supplied with >36 V DC for longer than 200 ms.	The Measuring system must be shut down immediately and checked in the factory. When sending the measuring system to the factory, the reasons and circumstances relating to the overvoltage must be specified.
	The measuring system was disconnected in RUN mode, the F-Host reconfigured and the measuring system then reconnected.	The configuration must only be transferred to the measuring system in STOP status in the start-up phase.
	The internally calculated PROFIsafe telegram is defective.	Power supply OFF/ON. If the error persists after this measure, the measuring system must be replaced.
	The PROFIBUS address set with the hardware switch was set to "0".	Valid PROFIBUS addresses: 1 – 99

8.2 Use of the PROFIBUS diagnosis

In a PROFIBUS system, the PROFIBUS masters provide the so-called host system, e.g. a PLC-CPU, with process data. If there is no slave on the bus or it is no longer accessible, or the slave reports a fault itself, the master must notify the host system of the fault in one form or another. There are several possibilities here, whose evaluation is solely decided by the application in the host system.

Generally a host system is not stopped by the failure of just one component on the bus, but must react to the failure in an appropriate way in accordance with the safety regulations. Normally the master firstly provides the host system with a summary diagnosis, which the host system reads cyclically from the master, and through which the user is informed of the state of the individual clients on the bus. If a client is reported defective in the summary diagnosis, the host can request further data from the master (slave diagnosis), which then allows a detailed evaluation of the reasons for the fault. The reports obtained in this way can be generated from the master if the affected slave fails to respond to the master's requests, or they may come directly from the slave if it reports a fault itself. The generation or reading of a diagnosis report between the master and slave takes place automatically and does not need to be programmed by the user.

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

8.2.1 Standard diagnosis

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

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

8.2.1.1 Station status 1

Standard diagnosis byte 1

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

8.2.1.2 Station status 2

Standard diagnosis byte 2

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

8.2.1.3 Station status 3

Standard diagnosis byte 3

Bit 7	Ext_Diag_Overflow	Overflow for extended diagnosis
Bit 6-0	Reserved	

8.2.1.4 Master address

Standard diagnosis byte 4

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

8.2.1.5 Manufacturer's identifier

Standard diagnosis byte 5 + 6

The slave enters the manufacturer's ID number into the bytes. This is unique for each device type and is reserved and stored by the PNO. The ID number of the measuring system is 0x0E3F.

8.2.1.6 Length (in bytes) of the extended diagnosis

Standard diagnosis byte 7

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

8.2.2 Extended diagnosis

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

Status-Block

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

Header:
Number of bytes in addition to standard diagnosis, including byte 7

Status type:
Status block with module status

Slot no.:
Specification of slot no., which is defective

Status-ID:
No further differentiation

Module status:

– 0x00 = valid data from this module.
– 0x03 = invalid data, missing module
Is reported by the measuring system if a CRC error is present in the F-Parameters or iPa-rameters.

NOTES!

Bytes 12 to 15 are intended for service purposes.