Leuze

Translation of original operating instructions

FBPS 648i

Fail-safe bar code positioning system

The Sensor People

We reserve the right to make technical changes
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1 About this document

1.1 Used symbols and signal words

Tab. 1.1: Warning symbols and signal words

	Symbol indicating dangers to persons
	Symbol indicating dangers from harmful laser radiation
	Symbol indicating possible property damage
NOTE	Signal word for property damage Indicates dangers that may result in property damage if the measures for danger avoidance are not followed.
ATTENTION **LASER RADIATION**	Signal word for dangers from harmful laser radiation
CAUTION	Signal word for minor injuries Indicates dangers that may result in minor injury if the measures for danger avoidance are not followed.

Tab. 1.2: Other symbols

	Symbol for tips Text passages with this symbol provide you with further information.
	Symbol for action steps Text passages with this symbol instruct you to perform actions.
	Symbol for action results Text passages with this symbol describe the result of the preceding action.

Tab. 1.3: Terms and abbreviations

FBPS	Fail-safe bar code positioning system
BCB	Bar code tape with 30 mm or 40 mm grid
BP	PROFIsafe protocol version (Basic Protocol)
CFR	Code of Federal Regulations
CRC	Cyclic redundancy check PROFIsafe-specific check of the validity of values within a module
DAP	Device Access Point
DAT	Device Acknowledgement Time
EN	European standard
ERT	Error response time
F_WD_Time	PROFIsafe watchdog time
FE	Functional earth
GSDML	Device description file (Generic Station Description Markup Language)
LED	Light Emitting Diode

LSB	Least Significant Bit
MSB	Most Significant Bit
MVS	Type of control bar code
NEC	National Electric Code
OSHA	Occupational Safety and Health Administration
PELV	Protective Extra-Low Voltage
PN	PROFINET RT
PS	PROFIsafe
SIL	Safety Integrity Level
PLC	Programmable Logic Control Programmable Logic Control
SSI	Digital synchronous serial interface
TCI	Tool for calculating the checksum via the safety application parameters (Tool Calling Interface)
USB	Universal Serial Bus
UL	Underwriters Laboratories
WCDT	Maximum reaction time in an error-free case (worst case delay time)
XP	PROFIsafe protocol version (Expanded Protocol)

1.2 Scope of delivery

The FBPS package includes the following components:

- The FBPS device
- A safety notice/package insert

2 Safety

This sensor was developed, manufactured and tested in line with the applicable safety standards. It corresponds to the state of the art.

↳ Before using the FBPS, perform a risk assessment according to valid standards, for example, in accordance with:

- ISO / EN ISO 12100
- ISO / EN ISO 13849-1
- IEC / EN IEC 62061

The result of the risk assessment determines the required safety level of the safety sensor, see chapter 19.1 "Safety-relevant data".

↳ For mounting, operating and testing, observe this document as well as all applicable national and international standards, regulations, rules and directives.

↳ Observe the relevant and supplied documents, print them out and hand them out to the people concerned.

↳ Before working with the FBPS, fully read and observe the documents applicable to your work.

In particular, the following national and international legal regulations apply for the commissioning, technical inspections and work with safety sensors:

- Directive 2006/42/EC
- Directive 2014/35/EU
- Directive 2014/30/EU
- Directive 2009/104/EC
- OSHA 1919 Subpart O
- Safety regulations
- Accident-prevention regulations and safety rules
- Ordinance on Industrial Safety and Health and employment protection act
- Product Safety Law (ProdSG)

	NOTICE
	For safety-related information you may also contact local authorities (e.g., industrial inspectorate, employer's liability insurance association, labor inspectorate, occupational safety and health authority).

2.1 Intended use

The FBPS fail-safe bar code positioning system is an absolute measurement system for the safe, metric ACTUAL position detection of moving system parts (axes) in machine and system construction.

	⚠ CAUTION
	**Observe intended use!** The protection of personnel and the device cannot be guaranteed if the device is operated in a manner not complying with its intended use. ↳ Only operate the device in accordance with its intended use. ↳ Leuze electronic GmbH + Co. KG is not liable for damages caused by improper use. ↳ Read these operating instructions before commissioning the device. Knowledge of the operating instructions is an element of proper use.

Areas of application

The FBPS is designed for positioning in the following areas of application:

- Travel and lifting axes of high-bay storage devices
- Electrical monorail systems
- Repositioning units
- Gantry crane bridges and their trolleys

CAUTION

Use only approved bar code tapes!

The bar code tapes approved by Leuze and listed on the Leuze website **www.leuze.com** as accessories under the respective FBPS product are an essential part of the measurement system.

Bar code tapes not approved by Leuze are not allowed. The use of such bar code tapes is contrary to the intended use.

NOTICE

Comply with conditions and regulations!

- Observe the locally applicable legal regulations and the rules of the employer's liability insurance association.

2.2 Foreseeable misuse

Any use other than that defined under "Intended use" or which goes beyond that use is considered improper use.

In particular, use of the device is not permitted in the following cases:

- in rooms with explosive atmospheres
- for medical purposes

NOTICE

Do not modify or otherwise interfere with the device!

- Do not carry out modifications or otherwise interfere with the device. The device must not be tampered with and must not be changed in any way.
- The use of a bar code tape not approved by Leuze is equivalent to an intervention in or change to the device/measurement system.
- The device must not be opened. There are no user-serviceable parts inside.
- Repairs must only be performed by Leuze electronic GmbH + Co. KG.

2.3 Competent persons

Connecting, mounting, commissioning and adjustment of the FBPS must only be carried out by competent persons.

Prerequisites for competent persons:

- They have a suitable technical education.
- They know the rules and regulations for labor protection, safety at work and safety technology and can assess the safety of the system.
- They have been instructed by the responsible person on the mounting and operation of the system and of the FBPS.
- They keep their knowledge up to date through continuous further training.

Certified electricians

Electrical work and configurations with the webConfig tool on the FBPS must only be carried out by a certified electrician.

Due to their technical training, knowledge and experience as well as their familiarity with relevant standards and regulations, certified electricians are able to perform work on electrical systems and independently detect possible dangers.

In Germany, certified electricians must fulfill the requirements of accident-prevention regulations DGUV (German Social Accident Insurance) provision 3 (e.g. electrician foreman). In other countries, there are respective regulations that must be observed.

2.4 Disclaimer

Leuze electronic GmbH + Co. KG is not liable in the following cases:

- The FBPS is not used as intended.
- Safety notices are not adhered to.
- Reasonably foreseeable misuse is not taken into account.
- Mounting and electrical connection are not properly performed.
- The BCB approved by Leuze is not used.
- Changes (e.g., constructional) are made to the device.

2.5 Laser warning notices

⚠ ATTENTION	
	**LASER RADIATION – CLASS 1 LASER PRODUCT** The device satisfies the requirements of IEC 60825-1:2014 / EN 60825-1:2014+A11:2021 safety regulations for a product of **laser class 1** and complies with 21 CFR 1040.10 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019. ↳ Observe the applicable statutory and local laser protection regulations. ↳ The device must not be tampered with and must not be changed in any way. There are no user-serviceable parts inside the device. **CAUTION!** Opening the device may result in hazardous radiation exposure! Repairs must only be performed by Leuze electronic GmbH + Co. KG.

2.6 Cybersecurity

This chapter provides information on the secure operation of an FBPS 600i series safe bar code positioning system with regard to cybersecurity. Guarding against cybersecurity threats requires the operating company to have a comprehensive cybersecurity concept, which must be continuously reviewed and maintained. A suitable concept consists of organizational, technical, procedural, electronic and physical defense levels and takes into account appropriate measures for the different types of risk. The measures implemented in this product can only help guard against cybersecurity threats if the product is used as part of such a concept.

Physical access control

The operating company must ensure that physical access to the safe bar code positioning system is restricted to authorized persons.

Network segmentation

The safe bar code positioning system should only be operated in a network that is protected against unauthorized access. The operating company's network should therefore be segmented into different zones. Each environment has a subnet and internal communication is only permitted on the basis of a predefined network policy based on an approval list. Information on the correct zoning of industrial automation networks can be found, for example, in the IEC 62443 series of standards.

Activating access protection for the webConfig tool

When using the webConfig tool's web-based user interface, it should be protected against unauthorized access by means of a user role to prevent unintentional or accidental misuse. For further information, see see chapter 14.4 "Short description of the webConfig tool".

Network services

The device uses several network services for operation. Information on the factory default settings when using the device can be found in the following table.

Tab. 2.1: Standard device settings for the network services

Service/ Protocol	Physical connection	Port	Encrypted	Default status	Description
WebConfig tool	XF1, XF2, USB[1)]	80 / TCP	No	Deactivated	Used to diagnose or configure the device
PROFINET/ PROFIsafe	XF1, XF2	Various	No	Activated	Used for configuration and data exchange
DHCP server	USB[1)]	67 / UDP	No	Activated	Automatic IP configuration for USB-RNDIS
Telnet server	USB[1)]	23 / TCP	No	Activated	Used to diagnose or configure the device
Device Finder	XF1, XF2, USB[1)]	7000 / UDP	No	Activated	Used for device identification

[1)] The USB interface is a service interface and is not intended for permanent connections during operation.

3 Fast commissioning

	NOTICE
	The action steps described below provide an overview of installation and commissioning of an FBPS system. Included in the individual steps is a reference to the chapters with the corresponding detailed explanations.

Risk assessments in accordance with ISO / EN ISO 13849-1

The required performance level PL r in accordance with ISO / EN ISO 13849-1 or the required Safety Integrity Level SIL in accordance with IEC / EN IEC 62061 must be determined for the risk assessment of the system component.

European C-standards EN 528 "Rail dependent storage and retrieval equipment – Safety requirements for S/R machines" and EN 619 "Continuous handling equipment and systems" describe the dangers and risks typically present at stacker cranes and continuous conveyors.

Mounting the FBPS

- Mounting the FBPS at the specified reading distance to the bar code tape, see chapter 8 "Mounting".
- Connecting the FBPS to the supply voltage, see chapter 9 "Electrical connection".
- Connecting the PROFINET/PROFIsafe interface or SSI interface, see chapter 9.3 "PROFINET/ PROFIsafe cables" or see chapter 9.2 "SSI interface cable".

Selecting and mounting the bar code tape

- Standard tapes or customer-specific special tapes, see chapter 20.5 "Bar code tapes".
- Mounting the barcode tape along the track, see chapter 6.3 "Mounting the bar code tape".

Configuring the PROFINET/PROFIsafe parameters

The PROFINET/PROFIsafe parameters can be adjusted via the GSDML file's module structure, see chapter 12 "Commissioning – PROFINET/PROFIsafe".

Configuration of the SSI parameters

If required, the SSI parameters of the FBPS can also be adapted via the GSDML file's module structure, see chapter 12.4.8 "Module 6 – SSI interface".

Measures during commissioning

With respect to the safety functions of the overall system, the safe position detection of the FBPS must be validated in the context of the safety requirements of the system.

To do this, the FBPS is moved along the entire bar code tape.

Possible operating states and how they are signaled see chapter 11 "Operating states".

The signaling via the status LEDs see chapter 17.3 "Diagnosis via the LED indicators".

The validation of the safe position detection of the FBPS is satisfied if the FBPS can be moved along the entire track with BCB without external or internal error signaling.

Safety levels

In compliance with the stated requirements, the FBPS can be used for safe positioning systems up to the following safety levels:

ISO / EN ISO 13849-1: PL e / Cat. 4

IEC / EN 61508: SIL 3

IEC / EN IEC 62061: SIL 3

4 Components of the fail-safe positioning system

The FBPS fail-safe bar code positioning system is an absolute measurement system for the safe, metric ACTUAL position detection of moving system parts (axes) in machine and system construction.

The FBPS is developed in accordance with the following safety directives:

IEC / EN 61508: SIL 3

IEC / EN IEC 62061: SIL 3

ISO / EN ISO 13849-1: PL e / Cat. 4

The measurement system consists of two components that are separated from one another:

- A fail-safe bar code reader (FBPS) for calculating safe, absolute position values.
- A bar code tape (BCB) affixed along the transportation path with consecutively printed 1D bar codes that contain position information. The bar code tape establishes a metrological reference between the system and the FBPS.

4.1 The fail-safe bar code positioning system

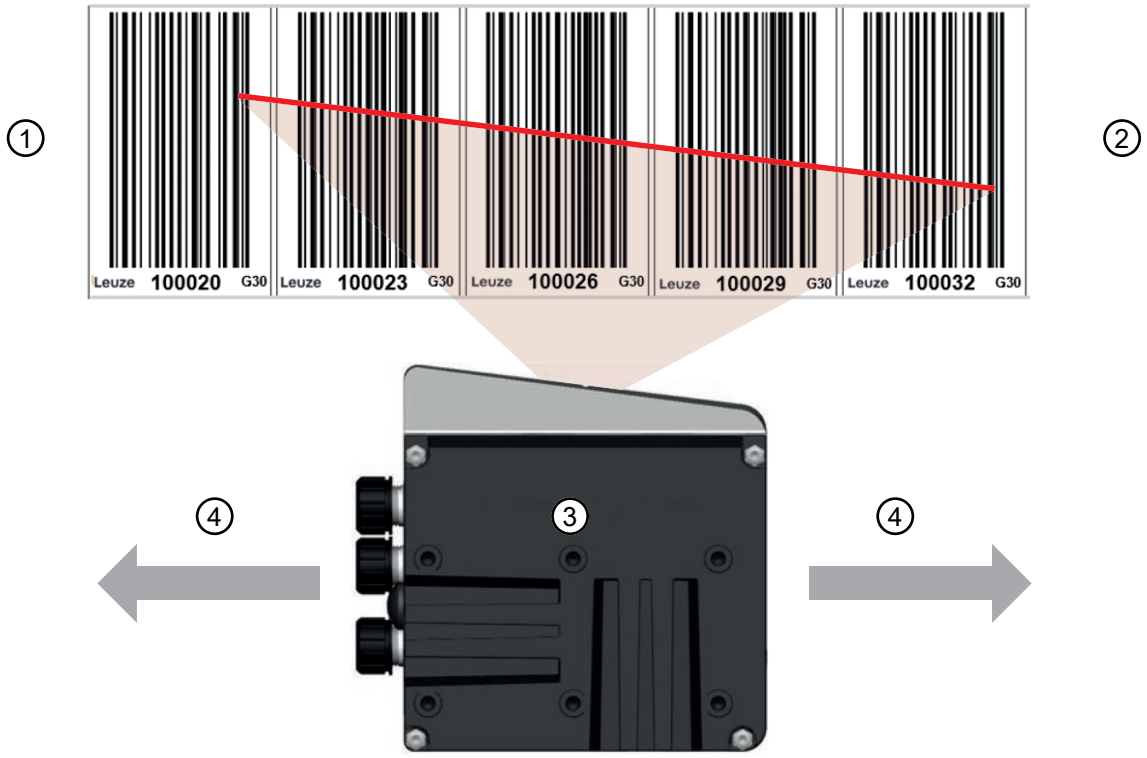
The FBPS uses a visible red laser scanning beam to determine the absolute metric position information consecutively stored on the BCB.

To do this, the FBPS is mounted at the specified distance parallel to the BCB.

The FBPS and the BCB move relative to one another.

For the function of the safe position evaluation, it plays no role whether the FBPS moves relative to the BCB or vice versa.

The bar code tape and the FBPS may be mounted independent of one another with a rotation of 180 degrees.



1 Bar code tape with consecutive positions
2 Linear red scanning beam
3 Bar code positioning system
4 Relative movement of the FBPS

Fig. 4.1: Relative-movement bar code positioning system – bar code tape

To calculate the safe position value, the scanning beam must detect at least one bar code. The readability of the bar code must be ensured.

If there is excessive soiling, damage or missing bar code information, no position value can be output. Signaling occurs according to the criteria of an external error, see chapter 11.6 "External errors".

Signaling via the status LEDs see chapter 17.3 "Diagnosis via the LED indicators".

The safe position value is provided via the FBPS's PROFINET/PROFIsafe interface.

A safety-related control with PROFIsafe input interface evaluates the position value.

At the same time, the position value is not securely provided in gray code via the PROFINET interface and the SSI interface.

The FBPS uses the detected bar codes to calculate the relative position with respect to the BCB with a reproducibility of just a few tenths of a millimeter, see chapter 19.3 "General specifications".

The relative movement (speed) of the FBPS with respect to the BCB can be up to 10 m/s.

The safe position value calculation of the FBPS is performed using a sliding arithmetic average calculation of 4 successive safe position values (integration depth).

Due to the arithmetic average calculation, the output safe position value is subject to a contouring error of just a few millimeters depending on the relative speed and integration depth.

At a standstill, the contouring error is 0 mm.

4.2 The bar code tape

The bar code tape (BCB) is a self-adhesive plastic tape on which bar codes are affixed consecutively and equidistantly.

The bar code tape is available in different models:

- Bar code tape BCB G30 ... in 30 mm grid, ascending by 3 digits (e.g. 000003, 000006, …)
- Bar code tape BCB G40 ... in 40 mm grid, ascending by 4 digits (e.g. 000004, 000008, …)

Fig. 4.2: Example BCB G30 bar code tape, beginning with position value 1000.20 m, ascending in increments of 3 cm

Lined up sequentially without interruption, the bar codes produce a digitized tape measure with a grid of 30 mm or 40 mm. The BCB is affixed along the measurement path (track).

NOTICE

Only one BCB type per system!

↳ In a given system, use either only BCB G30 … with 30 mm grid or only BCB G40 … with 40 mm grid.
If different BCB G30 … or BCB G40 … types are used in one system, the FBPS cannot ensure an exact position determination.

⚠ CAUTION

Use only qualified barcode tapes!

The bar code tape is part of the FBPS safe positioning system. Only the bar code tapes qualified by Leuze are approved, see chapter 20.5 "Bar code tapes".

The use of unqualified bar code tapes will result in a loss of the safety category of the FBPS and is not in accordance with the intended use.

4.3 Accuracy of the measurement system

NOTICE
The measurement system consists of two components: 1. A fail-safe bar code reader (FBPS) for calculating safe, absolute position values 2. A bar code tape (BCB) affixed along the transportation path The BCB establishes a metrological reference between the system and the FBPS.

The bar code tape is mounted/affixed in the system at the installation site.

Various factors influence the affixing of the bar code tape and make it necessary to differentiate between the accuracy and the reproducibility of the measurement system.

Accuracy of the measurement system

The following circumstances may result in deviations in the accuracy of the determined position values:

- The BCB has a production-related accuracy of ±1 mm/m.
- Depending on the force that is applied when affixing the BCB (strong tension), it can be stretched.
- With vertical curves, the BCB is splayed by making cuts, see chapter 6.3.4 "Mounting in curves". The absolute accuracy of the position may deviate up to ±30 mm if the FBPS can only detect a position code that is distant from the middle of the device.
- With horizontal curves, the FBPS detects the read bar code with an optical distortion that varies depending on the radius. The absolute accuracy of the position may deviate up to ±30 mm if the FBPS can only detect a position code that is distant from the middle of the device.
- Distortions in the accuracy arise as a result of the permitted cutting of the BCB at switches and expansion joints.
- The joining together of bar code tapes, e.g., if a bar code tape is delivered that is made up of several rolls.
- The general measurement value noise of the FBPS.

NOTICE
The stated factors affect the accuracy of the measurement system and cannot be qualitatively evaluated by the FBPS. It is not possible to specify an accuracy of the complete system consisting of FBPS and the bar code tape affixed by the user.

The reproducibility of the position values

Positions that are moved to repeatedly are typically stored in the control as target positions of a positioning process and determined by means of a "teach-in" or similar process. The repeatability for the repeated movement to the target positions is referred to as reproducibility or repeatability of the output position. It describes a possible measurement error of the output position values from the actual mechanical position of the axis.

The reproducibility applies at a standstill, with a response time (integration time) of 8 ms and constant ambient temperature. It is ±0.15 mm (1 sigma) and occurs in the form of measurement value noise.

4.3.1 Safe position

For a safety-rated measurement system, the safe position describes the maximum measurement value deviation of the output distance value to be expected in the event of an internal error that is not detected by the internal detection measures. The safe position is ±4 mm.

4.3.2 Speed

The safe speed value describes the speed relative to the bar code tape.

Tab. 4.1: Relative speed FBPS to BCB

Limit value	Value
Minimum detectable speed	≥ 4.0 mm/s
Maximum detectable speed	≤ 10.0 m/s
Typical reproducibility (1 sigma) at ≤ 50 mm/s	1 mm/s
Typical reproducibility (1 sigma) at ≥ 50 mm/s	10 mm/s

4.3.3 Dynamic measurement error

The dynamic measurement error defines the deviation between the actual distance and output distance at the data interface of the sensor during movement with speed V at a given time.

The dynamic measurement error is also referred to as contouring error.

At constant speed, the dynamic measurement error can be estimated as:

$E_d = V \cdot (T_a/2 + T_t)$

E_d: Dynamic measurement error [mm]

V: Speed [m/s]

T_a: Response time (integration time) [ms]

T_t: Dead time (internal dead time in the sensor, typically 1 ms) [ms]

Comments:

- The transmission time of the position data on the data interface from the sensor to the control is to be considered separately.
- For safety-rated systems in the context of the machinery directive, the time overhead for the data transmission from the sensor for the safe evaluation and the time overhead for the data comparison and the data evaluation in the safe evaluation are to be considered separately for an evaluation of the dynamic deviation of the actual position for a safety function.

5 Device description

The FBPS is available in the following device models and with the following options:

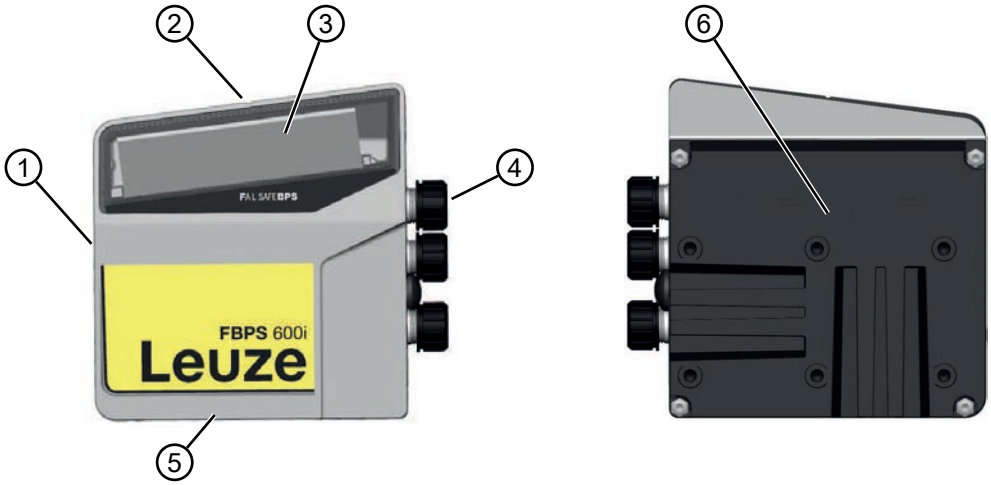
- Devices with PROFINET/PROFIsafe and standard SSI interface
- Devices with side plug outlet
- Devices with bottom plug outlet
- Devices with display
- Devices with heating

NOTICE
The order guide and type overview can be found under see chapter 20 "Order guide and accessories". A list with all available device types can be found on the Leuze website **www.leuze.com**.

NOTICE
Unless expressly noted in the document, all features described in the following are identical for all FBPS models. In addition, the general term "FBPS" is used in the document. In cases where the features of the individual device models differ, the document will refer directly to the respective designation of the model.

5.1 Devices with side plug outlet

The devices with side plug outlet can be recognized by the 3-digit number 100 in the type designation, e.g., FBPS 648i 07 SM **100**.

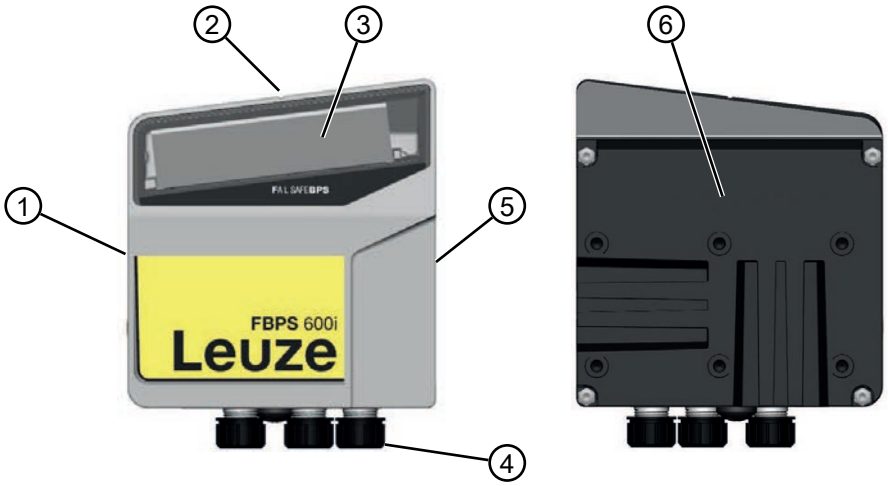


1 Control and display panel (display including control buttons optional)
2 Reference point for position value
3 Scanning beam exit window
4 M12 + USB device connections
5 Name plate
6 Device rear with M4 internal threads and alternative dovetail mounting

Fig. 5.1: Device with side plug outlet

5.2 Devices with bottom plug outlet

The devices with bottom plug outlet can be recognized by the 3-digit number 110 in the type designation, e.g., FBPS 648i 07 SM **110**.



1 Control and display panel (display including control buttons optional)
2 Reference point for position value
3 Scanning beam exit window
4 M12 + USB device connections
5 Name plate
6 Device rear with M4 internal threads and alternative dovetail mounting

Fig. 5.2: Device with bottom plug outlet

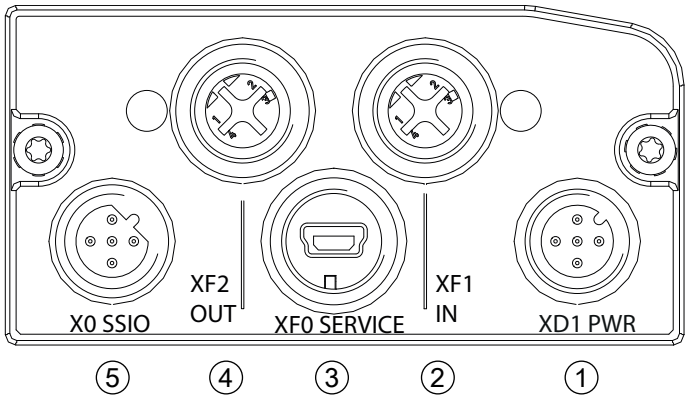
5.3 Connection technology

5.3.1 Device connection

The connection field is identical for the two models with plug outlet located on a different side.

FBPS 648i ... SM 100: Connection field outputting from the side, see chapter 5.1 "Devices with side plug outlet"

FBPS 648i ... SM 110: Connection panel outputting from the bottom, see chapter 5.2 "Devices with bottom plug outlet"



1	XD1 PWR	Supply voltage / switching input / switching output / functional earth
2	XF1 IN	PROFINET/PROFIsafe IN
3	XF0 SERVICE	USB connection for webConfig tool
4	XF2 OUT	PROFINET/PROFIsafe OUT
5	X0 SSI0	SSI

Fig. 5.3: Connection field

5.3.2 Connection XD1 PWR

The connection at socket XD1 PWR is made via a 5-pin M12 connector, A-coded.

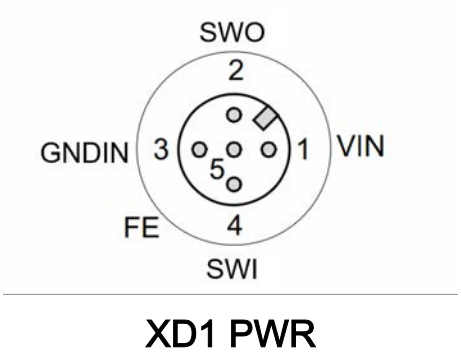


Fig. 5.4: Pin assignment for connection XD1 PWR

Tab. 5.1: XD1 PWR pin assignment

Pin	Connection designation	Function	Comment	Core color
1	VIN	Supply voltage positive pole	see chapter 9 "Electrical connection"	Brown
2	SWO	Digital switching output	Default: Invalid position value	White
3	GNDIN	Supply voltage negative pole	see chapter 9 "Electrical connection"	Blue
4	SWI	Digital switching input	Default: No function	Black
5	FE	Functional earth		Gray or green-yellow

NOTICE

The wire colors only apply if Leuze's original connection cables are used (see chapter 20.3 "Accessories – connection technology").

The functional earth is electrically connected to the FBPS housing and to the shields of the PROFINET/ PROFIsafe and SSI data line.

NOTICE

The functional earth (PIN 5) as well as the housing must not be used as PE ground connection of the system. The PE connection for grounding the system and the steel construction must be provided via a separate PE connection.

Connection cables for the supply voltage with and without shield in PUR sheathing: see chapter 20.3 "Accessories – connection technology".

5.3.3 XF1 IN and XF2 OUT connections

The connections to the XF1 IN and XF2 OUT sockets are made via a 4-pin M12 connector, D-coded.

Fig. 5.5: Pin assignment of XF1 IN and XF2 OUT connections

Tab. 5.2: XF1 IN and XF2 OUT pin assignment

Pin	Connection designation	Function
1	TD+	Transmit Data +
2	RD+	Receive Data +
3	TD-	Transmit Data -
4	RD-	Receive Data -
Thread	Functional earth*	FE

* The shielding is connected via the M12 connector thread.

5.3.4 USB connection for webConfig

The connection to socket XF0 SERVICE is performed using a USB connector, Mini Type B, USB version 2.0.

Fig. 5.6: Pin assignment for connection XF0 SERVICE

Tab. 5.3: XF0 SERVICE pin assignment

Pin	Connection designation
1	VB
2	D-
3	D+
4	ID
5	GND

USB interconnection cables: see chapter 20.3 "Accessories – connection technology"

5.3.5 X0 SSI0 connection

The X0 SSI0 socket is connected via a 5-pin M12 connector, B-coded.

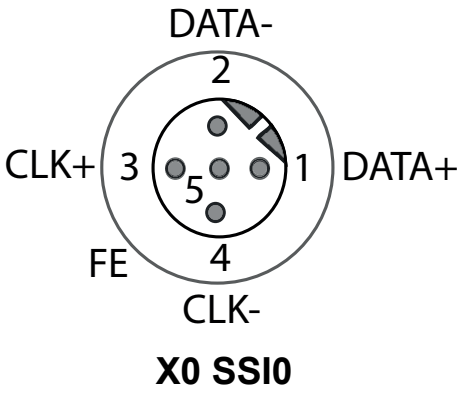


Fig. 5.7: Pin assignment of X0 SSI0 connection

Tab. 5.4: X0 SSI0 pin assignment

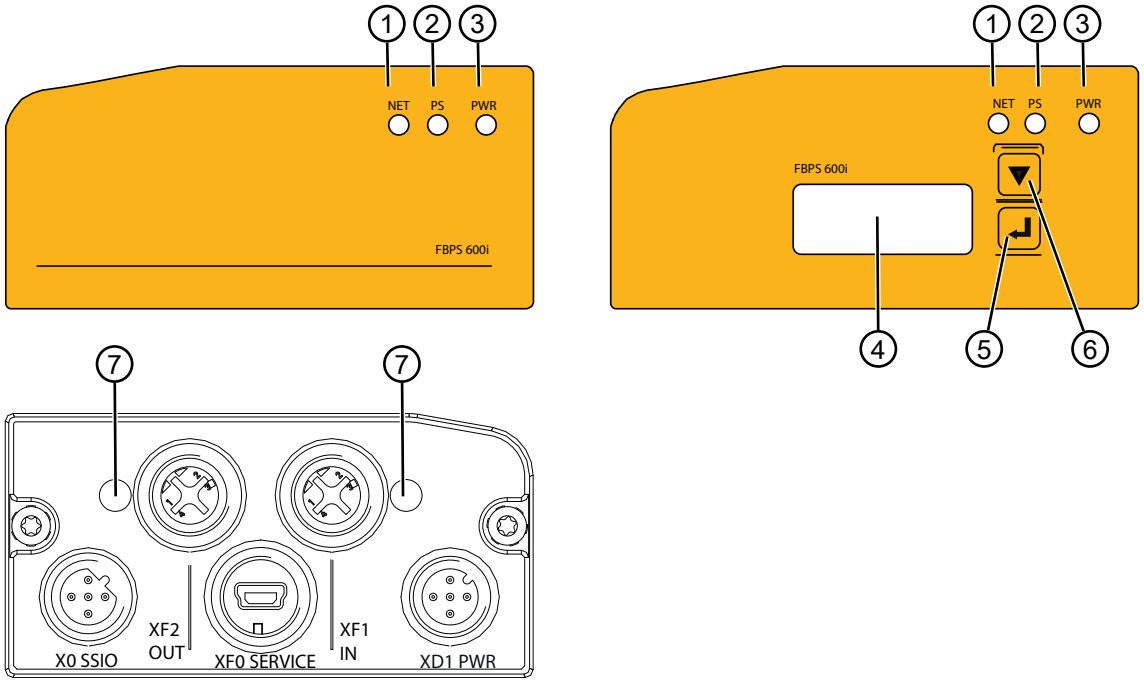
Pin	Connection designation	Function
1	SSI DATA+	Data +
2	SSI DATA-	Data -
3	CLK+	CLK +
4	CLK-	CLK -
5	Functional earth*	FE

* The functional earth is electrically connected to the FBPS 648i housing and above it to the shields of the PROFINET/PROFIsafe and SSI data line and to the FE of the XD1 PWR.

5.4 Display elements

1 Position of display elements

Fig. 5.8: Display elements of the FBPS



1	Status NET	Multicolor LED in the colors green, orange and red
2	PS status	Multicolor LED in the colors green, orange and red
3	Power status (PWR)	Multicolor LED in the colors green, orange and red
4	Display	
5	↵ button	Activates the static display or deactivates the flashing of the display
6	▼ button	Scrolls the various displays
7	Status link	Multicolor LED in the colors green and yellow

Fig. 5.9: Display elements on the sides of the FBPS

NOTICE

The display of the FBPS is optional and shows the status and information for the device. The FBPS cannot be configured via the display.

The two buttons can be used to toggle between various information, see chapter 5.4.1 "Display".

5.4.1 Display

Monochromatic, two-line display with background lighting. The lighting is activated at the touch of a button and switches off after approx. 10 minutes. The ↵ button can be used to scroll through the following information.

Tab. 5.5: Information in the display

1st line in the display	2nd line in the display	Comment
Version	Software V2.0.0 / HW 3	Software and hardware version
Position value	Position value	Position value with resolution of 0.1 mm
Quality	0%–100%	Reading quality
FBPS Info	System OK Warning / Error / Fatal Error	• System status messages • System ok: no messages • Warning • Error • Fatal Error
I/O status	SWO: (0 or 1) / SWI: (0 or 1)	Input/output status
Start up	Leuze electronic GmbH + Co. KG	Startup after PWR on
FBPS address	PROFINET station name IP address MAC address F-Dest: Address	
Reload firmware	0%–100%	

5.4.2 LED indicators

Tab. 5.6: PWR (power) status indicator LED

Status indicator	Meaning
Off	• No supply voltage at FBPS • Supply voltage too high (> 34 V DC) • The operating temperature is above or below the specified limit.
	“Power on”, the FBPS is initialized.
	Device ok, position codes are decoded.
	Service mode: Position codes are decoded. No data on the host interface.
	Wave function (synchronous with NET LED)
	External error, see chapter 11.6 "External errors"
	Internal error, see chapter 11.7 "Internal error"

Tab. 5.7: NET LED status indicators

Status indicators	Meaning
Off	• No supply voltage at FBPS • PROFINET/PROFIsafe communication not initialized or inactive • No connection attempt made by the control
	Connection to the PLC is established
	Connection to the PLC is error-free
	Wave function
	• Pending diagnosis alarm • Configuration error • Connection to the PLC interrupted
	• Internal error, see chapter 11.7 "Internal error" • Bus error, no communication with the host

Tab. 5.8: PS LED status indicators

Status indicators	Meaning
Off	No supply voltage at FBPS
	• 2 Hz: no PROFIsafe connection to the PLC • 0.5 Hz: Device in passive state or acknowledgement required
	PROFIsafe connection to the PLC is error-free
	N/A
	Wave function
	PROFIsafe configuration failed
	• Internal error, see chapter 11.7 "Internal error" • PROFIsafe communication error

Tab. 5.9: LINK/ACT LED status indicators

Status indicators	Meaning
Off	No supply voltage at FBPS
	Ethernet link active, no data transmission
	Ethernet link active, data transmission active. Green / orange, flashing

6 Bar code tape

The bar code tape (BCB) is a self-adhesive plastic tape on which 1D bar codes are affixed consecutively and equidistantly.

Each individual bar code represents an absolute dimension of 30 mm or 40 mm.

Fig. 6.1: G30 bar code tape, beginning with position value 1000.20 m, ascending in increments of 3 cm / 30 mm

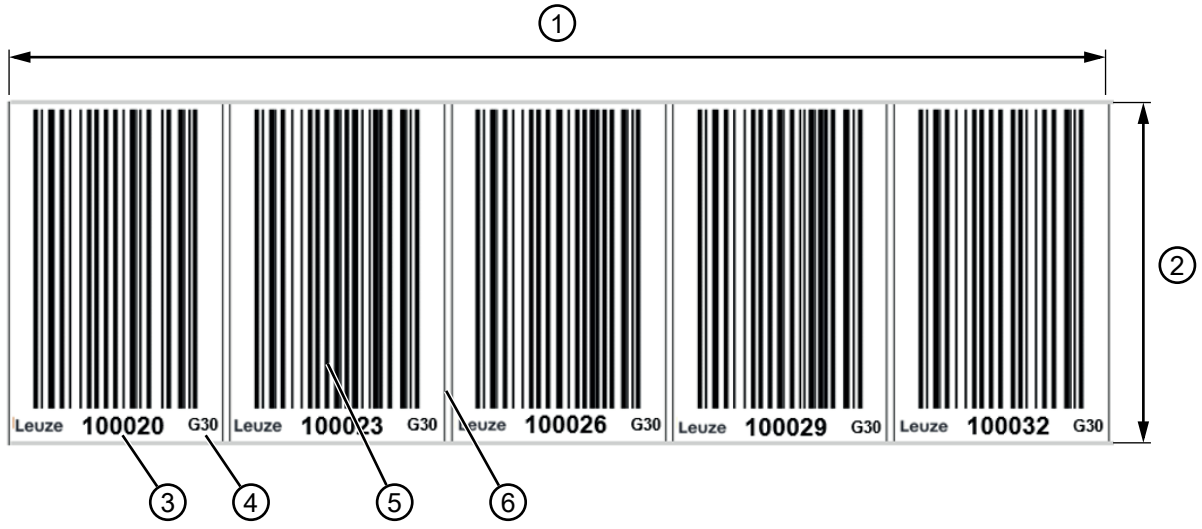
Lined up sequentially without interruption, the bar codes produce a digitized tape measure with a grid of 30 mm or 40 mm.

The BCB is affixed along the measurement path (track).

The BCB is part of the FBPS safe positioning system. Only the bar code tapes qualified by Leuze are approved.

NOTICE	
	The use of unqualified bar code tapes will result in a loss of the safety category of the FBPS and is not in accordance with the intended use.

6.1 Dimensions and content of the bar code tape



1 Length of the BCB
2 Height of the BCB
3 Position value in cm
4 G30/G40 = Designation of a bar code tape with 30 mm or 40 mm grid
5 1D bar code with sequential position values in a 30 mm or 40 mm grid
6 Cut mark for cutting the BCB

Fig. 6.2: Dimensions and content of the bar code tape

NOTICE

↳ When cutting the BCB at the designated cutting edge, see notes, see chapter 6.3.5 "Cutting the bar code tape".

6.2 Delivery of bar code tapes

BCBs are delivered as a roll, wound on a core. The maximum roll length is 300 m. BCBs longer than 300 m are divided into several rolls. Each roll is packed separately.

Fig. 6.3: Bar code tape roll

NOTICE

When using bar code tapes that are delivered on several rolls due to their length, make certain that they are joined together so that the value ranges of two rolls yield consecutive position values.

The position value from one bar code to the next always increases by the value 3 or value 4.

When joining the two tapes together, the width of the cut mark [2] should correspond to the width of the other cut marks.

1 Last bar code of the previous roll
2 Cut mark between the two tapes
3 First bar code of the next roll

Fig. 6.4: Joining BCB rolls together

NOTICE

TWIN bar code tapes are two tapes of identical length and tolerance that are delivered packed together, TWIN bar code tapes.

6.3 Mounting the bar code tape

6.3.1 Mounting instructions

NOTICE

BCB mounting

- When processing BCBs, observe the specified processing temperatures.
  When processing BCBs in cold storage facilities, the BCB must be affixed before cooling the storage facility.
  However, if it should be necessary to affix the BCB at temperatures outside of the specified processing temperature, ensure that the bonding surface as well as the BCB are at the processing temperature.
- Avoid dirt deposits on the BCB.
  If possible, affix the BCB vertically.
  If possible, affix the BCB below an overhead covering.
  The BCB must never be continuously cleaned by on-board cleaning devices such as brushes, rollers, sponges, etc. Permanent on-board cleaning devices polish the BCB and give it a glossy finish or damage it through mechanical abrasion. The reading quality deteriorates as a result and may even lead to the destruction of the BCB.
- After affixing the BCBs, make certain that there are no polished, high-gloss surfaces in the scanning beam (e.g., glossy metal at gaps between the individual BCBs), as the reading quality of the FBPS may be impaired.
  Affix the BCBs to a diffusely reflective support, e.g., a painted surface.
- Avoid sources of extraneous light and reflections on the BCB.
  Ensure that neither strong sources of extraneous light nor reflections of the support on which the BCB is affixed occur in the vicinity of the FBPS scanning beam.
- Affix the BCB over expansion joints up to a width of several millimeters.
  The BCB must not be interrupted at this location.
- Cover protruding screw heads with the BCB.
- Ensure that the BCB is affixed without tension.
  The BCB is a plastic tape that can be stretched by strong mechanical tension. Excessive mechanical stretching results in lengthening of the tape and distortion of the position values.

NOTICE

For the calculation of safe position values, it plays no role whether the BCB is affixed with the position values at the bottom or rotated 180 degrees with the position values at the top.

- If BCBs with different value ranges are positioned next to one another, observe the notes see chapter 6.3.5 "Cutting the bar code tape".

6.3.2 Reading quality of the bar code tape

NOTICE

Output of the reading quality

The bar code positioning system can diagnose the reading quality from the arrangement of the FBPS relative to the bar code tape.

- The reading quality shown in the display or webConfig is given in % values.
- In spite of optimum operating conditions, the reading quality may be slightly below 100 %. This does not indicate a defect of the FBPS or of the bar code tape.

NOTICE

The warning threshold preset ex works for a reading quality < 60 % as well as a switch-off threshold for a reading quality < 30 % corresponds to Leuze's experience in a typical application.

For applications that involve an intentional interruption of the bar code tape (switches, expansion gaps, vertical slopes/descents), the preset limit values can be adapted to the respective application.

The reading quality is dependent on several factors:

- Operation of the FBPS in the specified depth of field
- Number of bar codes in the transmitted beam
- Number of bar codes in the reading field
- Soiling of the bar code
- Traverse rate of the FBPS (number of bar code symbols within the time window)
- Ambient light incident on the bar code and on the optics (glass exit window) of the FBPS

The reading quality is affected, in particular, in the following cases:

- Switches, expansion gaps and other transition points at which the bar code tape is not affixed interruption-free.
- Vertical travel if at least three bar code symbols are not completely in the reading field of the sensor at any given point in time.
- Vertical curve in which the bar code tape was separated at the marked cut marks for adapting to the curve.

	NOTICE
	If the reading quality is influenced by the factors listed above, the reading quality can be reduced to as low as 0 %. ↳ This does not mean that the FBPS is defective, but rather that the reading quality characteristics are reduced to as low as 0 % in the given arrangement. ↳ If, at a reading quality of 0 %, a position value is output, it is correct and valid.

	NOTICE
	The values for the reading quality are shown in the optional display (*Quality*) and in the webConfig tool.

The evaluation of the reading quality provides the following information, e.g.:

- The reading quality is constantly bad: Soiling of the FBPS optics.
- The reading quality is always poor at certain position values: Soiling of the bar code tape.

6.3.3 Height offset of the affixed bar code tape

For a reading quality of 100%, at least 3 readable labels must be detected by the scanning beam.

↳ Make certain that the scanning beam always detects at least 3 labels during movement.

Excluded from this requirement are switches and expansion joints in which the bar code tape must be separated for design reasons, see chapter 6.3.5 "Cutting the bar code tape".

The FBPS then also delivers safe position values if only one readable label is detected by the scanning beam. The reading quality is less than 100% in this case, see chapter 6.3.2 "Reading quality of the bar code tape".

If the start and end of the scanning beam leaves the bar code tape, this does not represent any additional impairment to the reading quality.

The goal should, however, be that as many labels as possible be detected by the scanning beam at the appropriate reading distance.

A consistently good projection of the scanning beam on the bar code tape over the length of the track is dependent on the following factors:

- The height offset of the affixed bar code tape.
- The angular height of the scanning beam. The angular height results from the length of the scanning beam and, thus, the reading distance between the FBPS and the bar code tape*.
- The mechanical movement tolerances of the system part on which the FBPS is mounted.

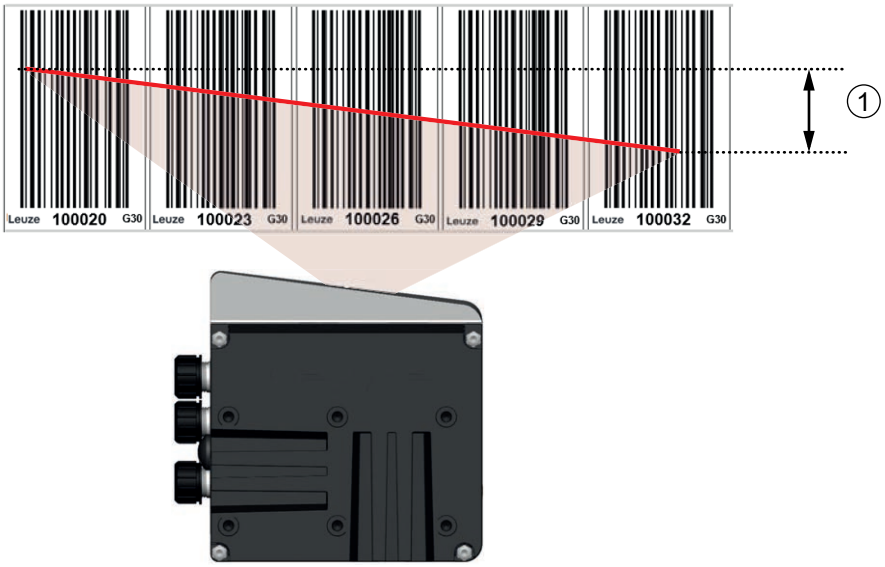
The following relationship applies:

The lower the tape height (e.g., < 25 mm) and the smaller the reading distance between FBPS and BCB (e.g., < 70 mm) are, the smaller the height offset of the affixed BCB is allowed to be.

NOTICE

* The scanning beam of the FBPS is longer than the boundary lines of the reading field width, see chapter 19.3 "General specifications". For position labels that are located outside of the reading field, the decodability is limited. Undecodable position labels are not used for position determination by the FBPS.

If the FBPS outputs position values, they are valid. If the reading quality is impaired to such an extent that a position can no longer be output, the FBPS signals an external error, see chapter 11.6 "External errors".



1 Angular height of the scanning beam

Fig. 6.5: Angular height of the scanning beam

The scanning beam exits the device at an angle of approx. 7 degrees. The angular height of the scanning beam is dependent on the reading distance, e. g,

- Reading distance 50 mm: angular height approx. 15 mm
- Reading distance 170 mm: angular height approx. 20 mm

1 Height offset downward
2 Height offset upward

Fig. 6.6: Height offset

NOTICE

↳ Affix the bar code tape along an optical reference edge so that the height offset [1] and [2] is as small as possible over the entire affixed edge.

Pay attention to the smallest travel tolerances of the system part on which the FBPS is mounted. Travel tolerances that produce another height offset may result in the scanning beam not being fully projected on the bar code tape. If the bar code can no longer be read, the FBPS responds with an external error, see chapter 11.6 "External errors".

Examples:

- Height of the bar code tape = 47 mm, angular height of the scanning beam = 15 m at a reading distance of 50 mm.
  A gluing tolerance of approx. 32 mm is present, including the travel tolerances.
- Height of the bar code tape = 20 mm, angular height of the scanning beam = 15 m at a reading distance of 50 mm.
  There is nearly no gluing tolerance present. For this case, the FBPS should be mounted with a reading distance that is as large as possible.

6.3.4 Mounting in curves

CAUTION

Check the safety requirements regarding accuracy!

The accuracy of the measurement system is subject to the conditions described in chapter 5.

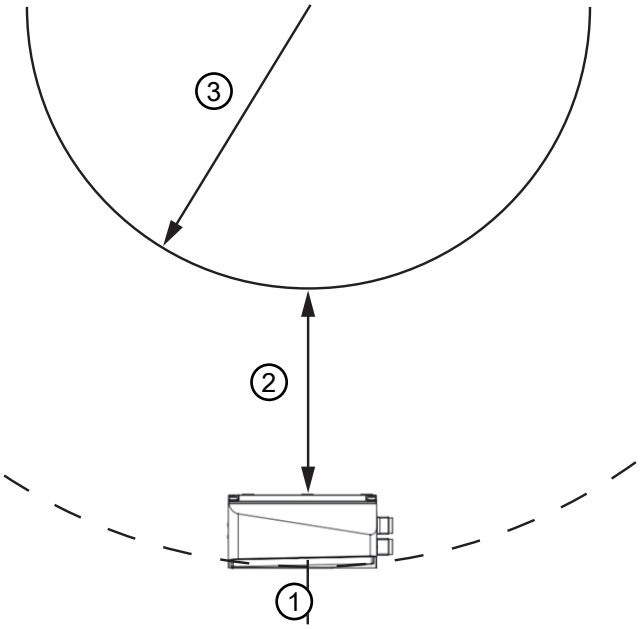
↳ If mounting the bar code in curves, have a competent person determine whether the accuracy is sufficient for the safety requirements of the system.

Horizontal radii

NOTICE

Limited accuracy and reproducibility!

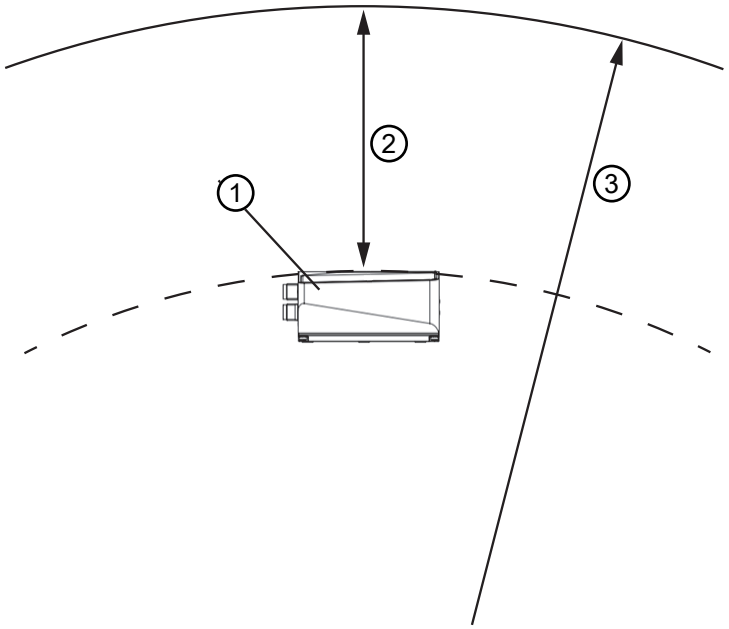
BCB mounting in curves reduces the accuracy of the FBPS, since the distance between two bar codes is no longer exactly 30 mm or 40 mm due to optical distortions.



1 FBPS
2 Reading distance
3 Radius of the bar code tape, R_{min} = 300 mm

Fig. 6.7: Mounting the bar code tape in horizontal curves, FBPS traveling on the outside of the curve

The FBPS can be used for position measurement in both the inside and the outside radii of horizontal curves. The radius must not be less than 300 mm.



1 FBPS
2 Reading distance
3 Radius of the bar code tape, R_{min} = 300 mm

Fig. 6.8: Mounting the bar code tape in horizontal curves, FBPS traveling on the inside of the curve

Vertical radii

The FBPS can be used for position measurement with vertical radii. It is irrelevant whether the curve runs upwards or downwards. The radius must not be less than 300 mm.

NOTICE	
	Limited absolute measurement accuracy and reproducibility! ↳ BCB mounting in curves decreases the absolute measurement accuracy of the FBPS, since the distance between two bar codes is no longer exactly 30 mm or 40 mm. ↳ In areas where the BCB is fanned out around curves, limitations of the reproducibility must be expected.

Fig. 6.9: Preparing the bar code tape for use in vertical curves

↳ Only partially cut the BCB at the cut mark.
With vertical curves, the BCB is splayed by making cuts when affixing.

↳ Affix the BCB along the curve like a fan.

↳ Ensure that the BCB is affixed without mechanical tension.

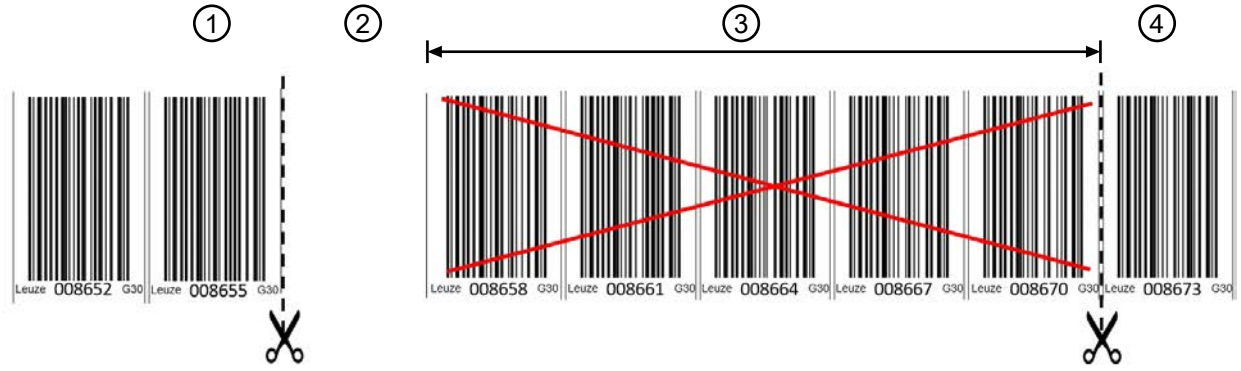
NOTICE

No glossy gaps in the bar code tape!

↳ Ensure that there are matt, bright surfaces behind the fanning in the BCB curves. Polished, reflective, and high-gloss surfaces in the scanning beam may impair the reading quality of the FBPS.

6.3.5 Cutting the bar code tape

The bar code tape can be cut and the section after the cut reused. The BCB can be cut after every position code at the corresponding cut mark.



1 Position code before cut point
2 Gap
3 Cut out the next 5 successive position codes
4 First position code after the gap

Fig. 6.10: Cutting the bar code tape

NOTICE

Please note:

The gap [2] must be at least 200 mm in size.

The position code before the gap [1] and the first position code after the gap [4] must not be struck by the scanning beam simultaneously.

After the cut point, at least the first 5 position codes [3] must be cut out to avoid duplicate position values.

NOTICE

The FBPS detects no position code in the gap and signals an external error, see chapter 11.6 "External errors".

Expansion joints

The bar code tape is affixed over mechanical expansion joints up to 30 mm long. The part of the bar code tape that covers the expansion joint can be cut out.

NOTICE

Expansion joints that change in length due to, e.g., the effects of temperature, influence the absolute measurement reference between FBPS and the system. As a result, deviations in the absolute dimension may occur that correspond to the change in length of the expansion joint.

Bar code tapes with different value ranges in the scanning beam

see chapter 6.5 "MVS label control bar code"

6.4 Types of bar code tapes

6.4.1 Standard bar code tapes

Standard bar code tapes have the following features:

Tab. 6.1: Data for standard bar code tapes

Feature	Value
Grid dimension	30 mm (BCB G30 …) 40 mm (BCB G40 …)
Tape heights	47 mm 25 mm
Tape start value	000000, on the outside of the roll
Tape tolerance	±1 mm/m

NOTICE

A list of all available bar code tapes can be found online at **www.leuze.com**.

- On the website, enter the type designation, the part number or search term **FBPS** in the search window.
- Select one of the listed devices.
- The bar code tapes are listed in the *Accessories* tab of the respective device.

6.4.2 Special bar code tapes

Special tapes are customer-specific bar code tapes with the following features:

Tab. 6.2: Data for special bar code tapes

Feature	Value
Grid dimension	30 mm (BCB G30 …) 40 mm (BCB G40 …)
Tape height	Custom, between 20 mm and 140 mm in 1 mm increments
Tape length	Maximum 10000.02 m (BCBs longer than 300 m are divided into a corresponding number of rolls). Each roll is packed separately.
Tape start value	• Always divisible by 3 without remainder (grid dimension G30) Minimum value: 000000 cm • Always divisible by 4 without remainder (grid dimension G40) Minimum value: 000000 cm
Tape end value	• Always divisible by 3 without remainder (grid dimension G30) Maximum value: 999999 cm • Always divisible by 4 without remainder (grid dimension G40) Maximum value: 999996 cm
Tape tolerance	±1 mm/m

6.4.3 Repair bar code tapes

Repair bar code tapes are customer-specific bar code tapes with the following features:

Tab. 6.3: Data for repair bar code tapes

Feature	Value
Grid dimension	30 mm (BCB G30 …) 40 mm (BCB G40 …)
Tape heights	47 mm 25 mm
Tape length	G30 grid dimension: Maximum 4.98 m G40 grid dimension: Maximum 5.00 m
Tape start value	Custom in grid dimension G30/G40 Minimum value: 000000 cm
Tape end value	Custom in grid dimension G30/G40 Maximum value: 999999 cm (G30) / 999996 cm (G40)
Tape tolerance	±1 mm/m

6.4.4 Online repair bar code tapes

If the bar code tape is damaged, an online repair bar code tape can be downloaded from the Leuze website as a quick replacement.

On the website, enter the type designation, the part number or search term *FBPS* in the search window. Select one of the listed devices. The online repair bar code tape is the same file for all FBPS devices.

The online repair bar code tapes are listed under the term *Repair kit* in the *Download* tab of the respective device.

NOTICE

Do not use the online repair bar code tape on a permanent basis!

Self-printed bar code tapes (labels) must not remain permanently in the system. In the area in which the online repair bar code tapes are used, safe position detection may be limited due to poor print quality.

The optical and mechanical properties of the self-printed bar code tape do not correspond to those of the original bar code tape. Self-printed bar code tapes should not remain permanently in the system.

- Use the bar code tape created with the repair kit only temporarily.

Replacing a defective section of tape

- Determine the position values of the defective area.
- On the website, select the repair kit that contains the desired position value.
- Open the repair kit PDF and scroll to the desired position value.
- Print the corresponding value range.
- Affix the printed position values over the defective section of tape.

Printing position values

- Only print the pages with the position values that you need.
- Check the correct dimensions of the printed position values by measuring 30 mm or 40 mm between the two cut marks. It may be necessary to adjust the zoom factor of the printer.

Fig. 6.11: Example: Checking the dimension of 30 mm on the self-printed online repair bar code tape

- Cut out the necessary position values at the cut marks.
- Affix the printed and cut out position values over the defective bar code tape.
- Pay particular attention to the two transitions from the original bar code tape to the printed bar code tape and ensure that the position values increase sequentially by the value 3 or value 4.

Ordering originally manufactured repair bar code tapes: see chapter 20.5.3 "Repair bar code tapes"

6.4.5 TWIN bar code tapes

TWIN bar code tapes are two customer-specific bar code tapes that are identical with respect to both tape values and tape tolerances. Both tapes are delivered together in a single shrink wrap.

Tab. 6.4: Data for TWIN bar code tapes

Feature	Value
Grid dimension	30 mm (BCB G30 …) 40 mm (BCB G40 …)
Tape height	Custom, between 20 mm and 140 mm in 1 mm increments
Tape length	Maximum 10000.02 m per single tape
Tape start value	• Grid dimension G30: Always divisible by 3 without remainder Minimum value: 000000 cm • Grid dimension G40: Always divisible by 4 without remainder Minimum value: 000000 cm
Tape end value	• Grid dimension G30: Always divisible by 3 without remainder Maximum value: 999999 cm • Grid dimension G40: Always divisible by 4 without remainder Maximum value: 999996 cm

Fig. 6.12: TWIN bar code tape

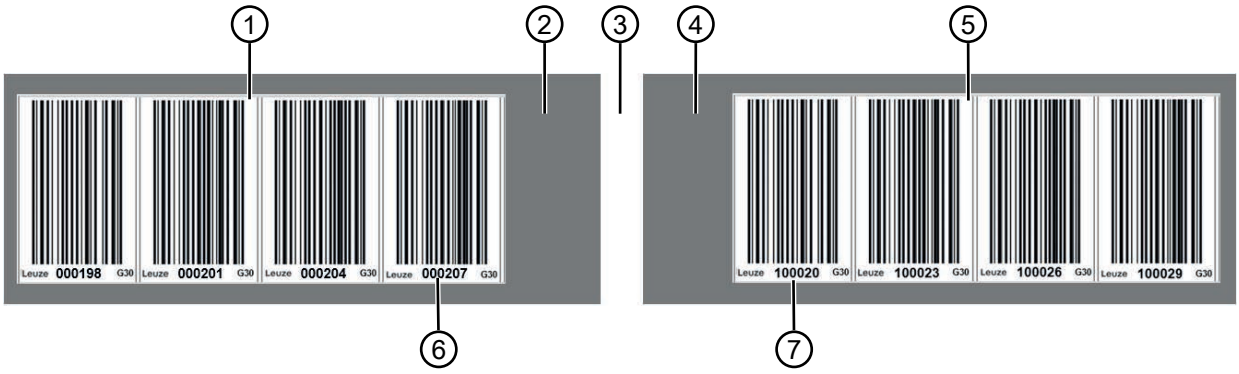
TWIN bar code tapes are labeled below and above the bar code.

Order guide: see chapter 20.5.4 "TWIN bar code tapes"

6.5 MVS label control bar code

Bar code tapes with different value ranges in the scanning beam

In applications such as electrical monorail systems, constellations occur in which bar code tapes with different value ranges are used, e.g., switch functions.



1 Bar code tape with value range 1
2 Area free of bar codes < 30 mm
3 Mechanical cut point / gap ≤ 15 mm
4 Area free of bar codes < 30 mm
5 Bar code tape with value range 2
6 Position value 1 at the cut point
7 Position value 2 at the cut point

Fig. 6.13: Example: G30 bar code tapes with different value ranges

If bar code tapes with different value ranges are used, the following requirements must be complied with. The requirements apply regardless of whether an MVS label is used for position control, see chapter 6.5.1 "MVS control label".

Tab. 6.5: Requirements for bar code tapes with different value ranges

Criterion	Position in the image	Value
Difference between the position values at the cut point	6 + 7	≥ 100 cm
Width of the areas at the cut point that are free of bar codes	2 + 4	< 30 mm (G30) < 40 mm (G40)
Width of the cut point	3	≤ 15 mm

CAUTION

System standstill due to safety control!

If the difference between the two position values at the cut point is less than 100 cm, the output value fluctuates between value range 1 and value range 2.

Due to the measurement value fluctuations that occur, the safety control for evaluating the safe position value as well as the position controller in this constellation may activate an error message that results in a system standstill.

↳ Make sure that the difference between the position values at the cut point is greater than 100 cm.

6.5.1 MVS control label

The MVS control bar code is a single label that is marked with “Leuze MVS G30” or ”Leuze MVS G40” on the label line.

Tab. 6.6: Data on the MVS control label

Feature	Value
Grid dimension/label width	G30 / 30 mm G40 / 40 mm
Label height	47 mm
Encoding	MVS (Measurement Value Switch)
Label color	Red
Packaging unit	10 pieces

Fig. 6.14: MVS control label

Application

An MVS label is used if two bar code tapes with different value ranges are detected together in the scanning beam, e.g., at switch transitions in electrical monorail systems.

If the preceding BCB (value range 1) as well as the subsequent BCB (value range 2) are detected in the scanning beam of the FBPS, the position output on the interfaces is controlled as follows.

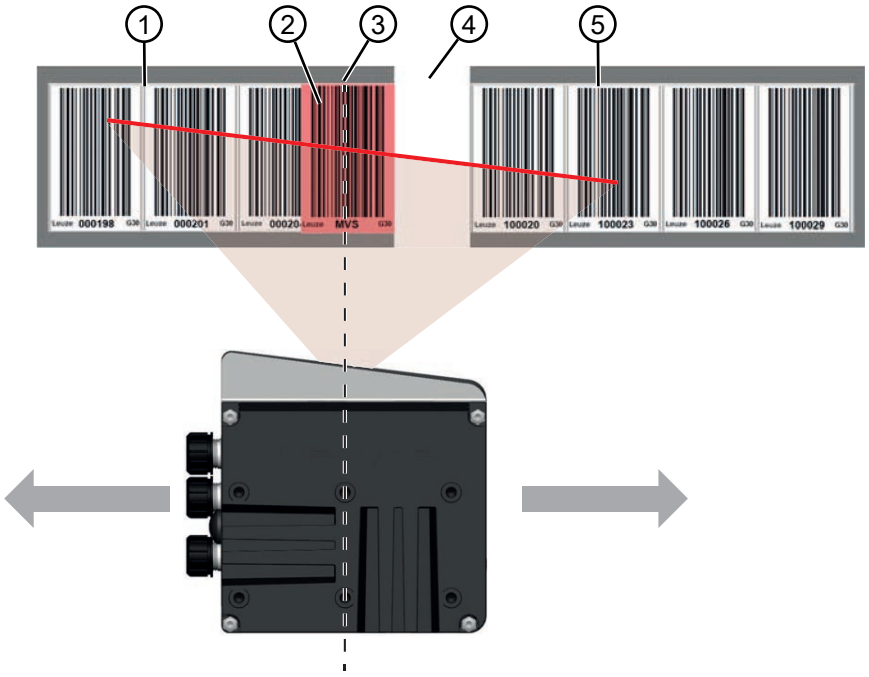
As soon as the FBPS is positioned opposite the center of the MVS label with its measurement reference point attached to the housingsee chapter 5.1 "Devices with side plug outlet" or see chapter 5.2 "Devices with bottom plug outlet"), a position changeover occurs between the two value ranges 1 and 2. The changeover always takes place at the same position, regardless of the FBPS’s direction of movement.

NOTICE
The behavior of the FBPS during position value changeover using the MVS label can be configured, see chapter 6.5.3 "Configuring MVS position value changeover".

NOTICE
Only one MVS label can be detected by the scanning beam at a time. If the scanning beam simultaneously detects two or more MVS control labels, an external error is signaled, see chapter 11.6 "External errors".

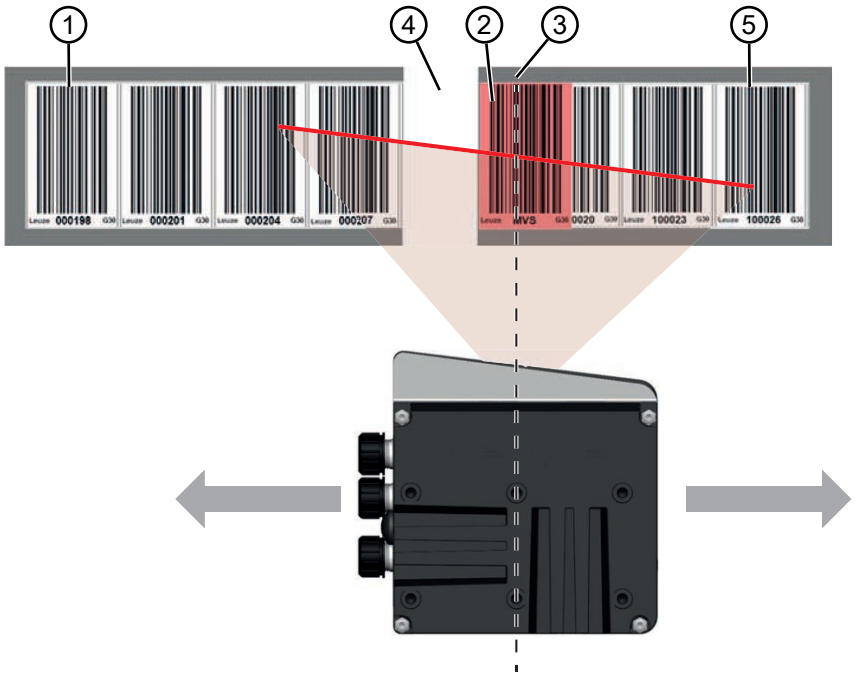
Affixing an MVS label

The MVS label can be affixed in value range 1 as well as in value range 2.



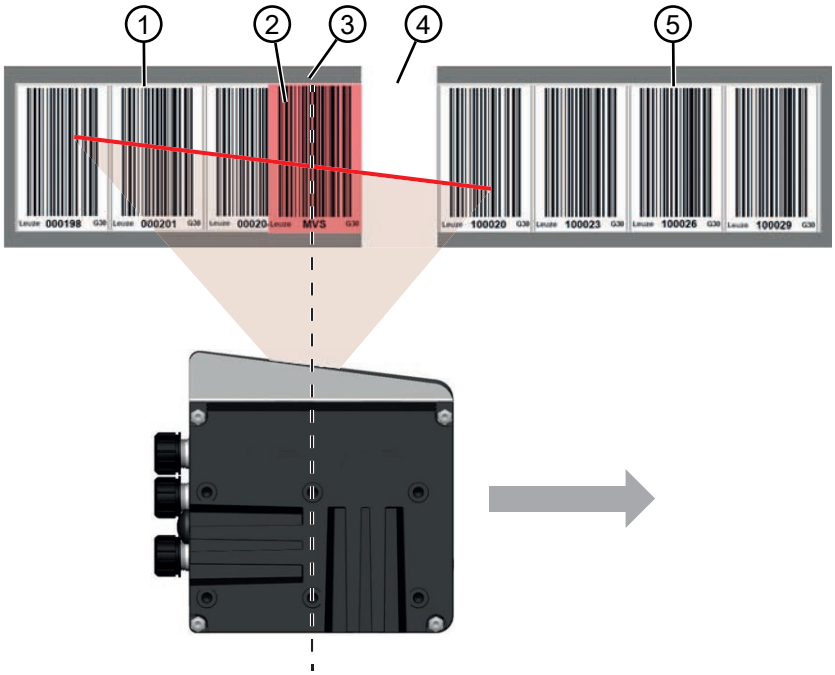
1 Bar code tape value range 1
2 MVS label
3 Middle of FBPS and middle of MVS label
4 Mechanical cut point/gap at switches, expansion joints, etc.
5 Bar code tape value range 2

Fig. 6.15: Value range 1 and 2 in the scanning beam, MVS label affixed in value range 1



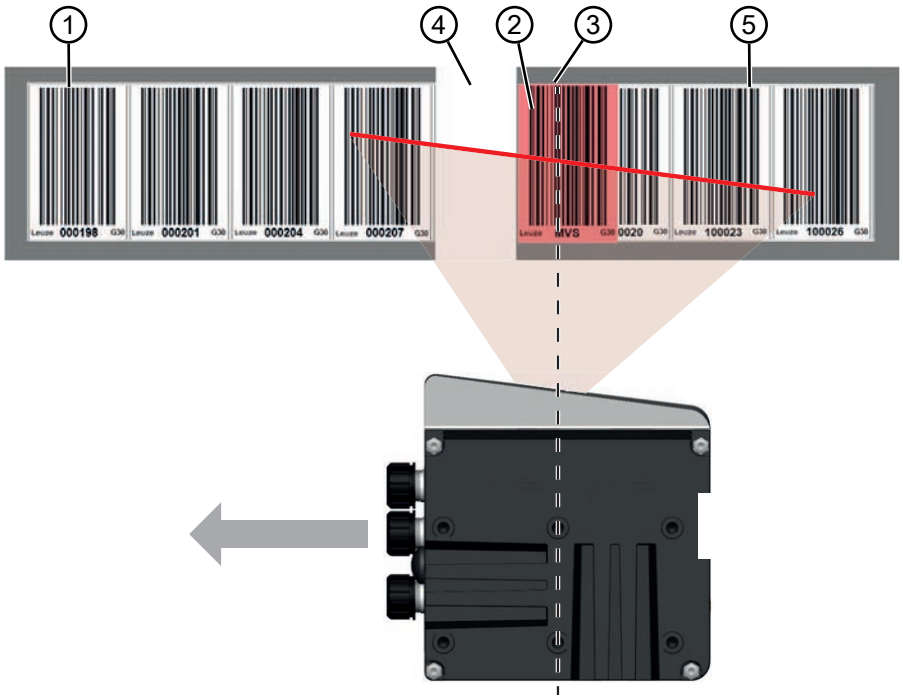
1 Bar code tape value range 1
2 MVS label
3 Middle of FBPS and middle of MVS label
4 Mechanical cut point/gap at switches, expansion joints, etc.
5 Bar code tape value range 2

Fig. 6.16: Value range 1 and 2 in the scanning beam, MVS label affixed in value range 2



1 Bar code tape value range 1
2 MVS label
3 Middle of FBPS and middle of MVS label
4 Mechanical cut point/gap at switches, expansion joints, etc.
5 Bar code tape value range 2

Fig. 6.17: Detection of only one value range in the scanning beam, MVS label affixed in value range 1



1 Bar code tape value range 1
2 MVS label
3 Middle of FBPS and middle of MVS label
4 Mechanical cut point/gap at switches, expansion joints, etc.
5 Bar code tape value range 2

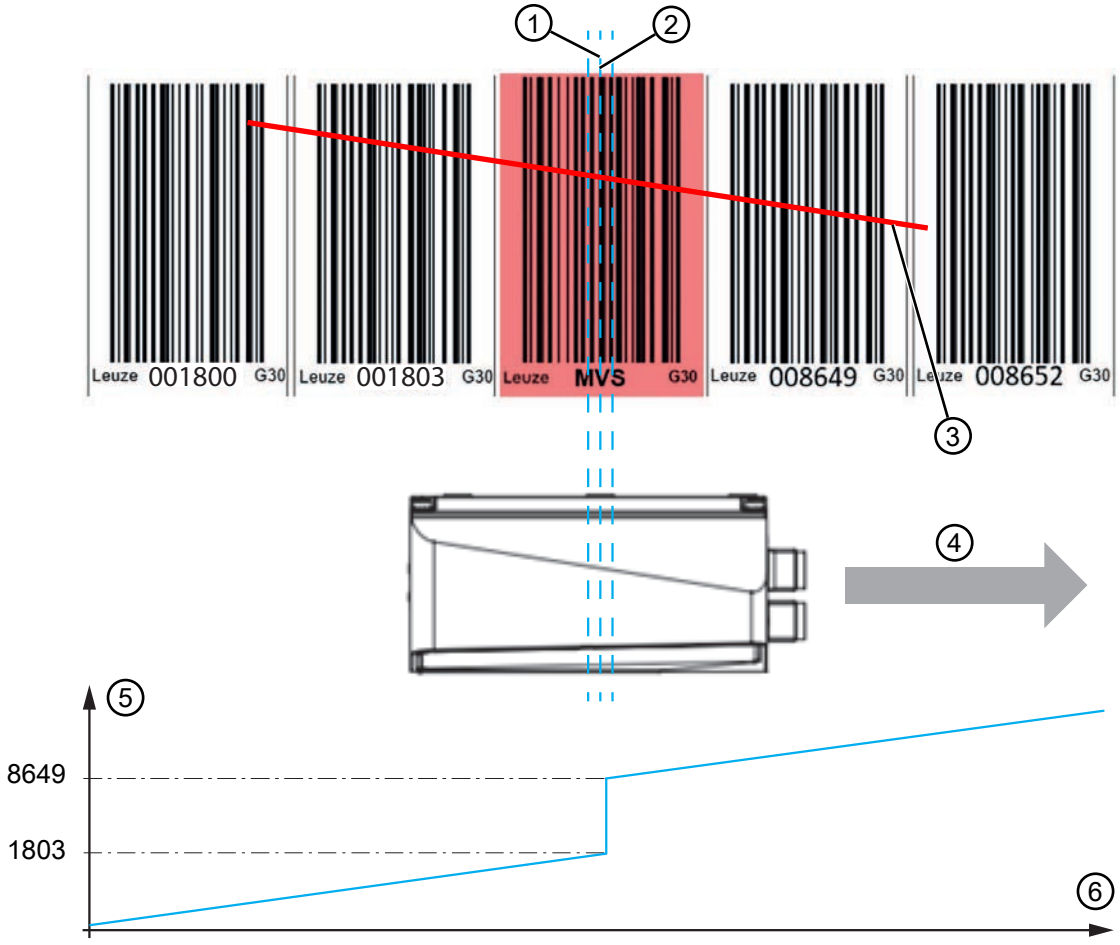
Fig. 6.18: Detection of only one value range in the scanning beam, MVS label affixed in value range 2

NOTICE
It is recommended that the MVS label be affixed flush with the cut point/gap, even if this results in the preceding label no longer being legible. The maximum size of a gap can be calculated from the reading distance and the resulting length of the scanning beam, Optical data. A position value can only be output if the FBPS can detect and read a complete position value label. The behavior of the FBPS during a position value changeover using the MVS label can be adapted to the application, see chapter 6.5.3 "Configuring MVS position value changeover".

NOTICE
Cut points, such as switches or expansion joints, require special consideration during commissioning, especially if this is associated with a change in the BCB value ranges. They must be checked according to the following criteria: If only the MVS label is detected within the scanning beam and no other complete position label, an external error is signaled in the following operating states: - after interruption of the scanning beam - after power off/on - after an operating mode change in the webConfig tool from service to process In this case, the FBPS must be moved to a position in which it can detect a complete position value label, e.g., by manually moving the vehicle. At the moment in which the first bar code of the subsequent value range is detected, the signaling of the external error is stopped and the FBPS again makes position values available at the interface.

6.5.2 Reversing the direction of travel

The MVS label is a control bar code for the direction-independent switching of the position values from one bar code tape to another in the middle of the control bar code label.



1	FBPS center + hysteresis ± 5 mm
2	Center of MVS control label
3	Scanning beam
4	Direction of movement
5	Position values
6	Measurements

Fig. 6.19: Changeover position with MVS control bar code

If the MVS label is passed over, the new tape value is always output relative to the center of the device or label. In this situation, the hysteresis of ±5 mm is irrelevant. If, however, the device is stopped within the hysteresis on the MVS label and the direction changed, the starting position values have an inaccuracy ±5 mm.

If, upon reaching the changeover position in the middle of the MVS label, the FBPS does not detect the new BCB section in the scanning beam, the position value of the first BCB section is still output after the middle of the MVS label for half of the label width.

6.5.3 Configuring MVS position value changeover

The behavior of the FBPS during a position value changeover using an MVS label can be adapted to the application via the safe PROFIsafe modules, see chapter 12.5 "PROFIsafe modules".

***MVS switching tolerance* parameter in default factory setting**

Value 1: Measurement value switching, maximum 15 mm (G30) / 20 mm (G40) tolerance

Example 1

The scanning beam of the FBPS simultaneously detects the MVS label as well as the position label from value range 1 **and** value range 2 (see chapter 6.5.1 "Value range 1 and 2 in the scanning beam, MVS label affixed in value range 1" / see chapter 6.5.1 "Value range 1 and 2 in the scanning beam, MVS label affixed in value range 2").

The position value changeover between value range 1 and value range 2 occurs at the moment in which the FBPS, with its measurement reference point, is opposite the middle of the MVS label.

Example 2

The scanning beam of the FBPS detects the MVS label and only position labels from value range 1 **or** value range 2 (see chapter 6.5.1 "Detection of only one value range in the scanning beam, MVS label affixed in value range 1" / see chapter 6.5.1 "Detection of only one value range in the scanning beam, MVS label affixed in value range 2").

With its measurement reference point, the FBPS outputs the position values according to the detected value range up to the end of the MVS label. This corresponds to an extended measurement data output of 15 mm (G30) / 20 mm (G40).

If the FBPS does not detect a new value range at the end of the MVS label, an external error is signaled.

***MVS switching tolerance* parameter without tolerance**

Value 0: Measurement value switching – no tolerance

Example 3

The scanning beam of the FBPS simultaneously detects the MVS label as well as the position label from value range 1 **and** value range 2 (see chapter 6.5.1 "Value range 1 and 2 in the scanning beam, MVS label affixed in value range 1" / see chapter 6.5.1 "Value range 1 and 2 in the scanning beam, MVS label affixed in value range 2").

The position value changeover between value range 1 and value range 2 occurs at the moment in which the FBPS, with its measurement reference point, is opposite the middle of the MVS label.

Example 4

The scanning beam of the FBPS detects the MVS label and only position labels from value range 1 **or** value range 2 (see chapter 6.5.1 "Detection of only one value range in the scanning beam, MVS label affixed in value range 1" / see chapter 6.5.1 "Detection of only one value range in the scanning beam, MVS label affixed in value range 2").

If the FBPS with its measurement reference point is opposite the middle of the MVS label and if the new value range (1 or 2) cannot be detected by the scanning beam in the subsequent movement, an external error is signaled, see chapter 11.6 "External errors".

The signaling via the status LEDs see chapter 17.3 "Diagnosis via the LED indicators".

6.6 Negative position values and position 0 (zero)

The position value 0 (zero) and negative position values can be transferred via the PROFINET/PROFIsafe interface. Only the position value 0 (zero) can be transferred via the non-safe SSI interface.

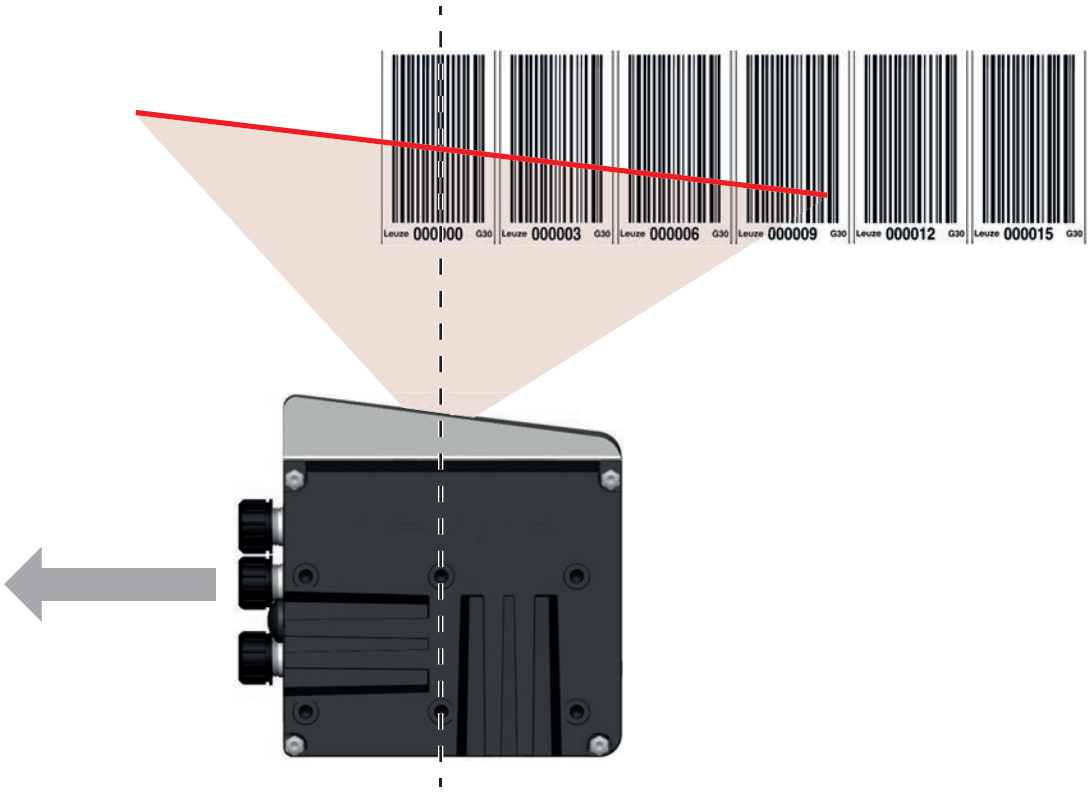


Fig. 6.20: Negative position values

	NOTICE
	If the FBPS is to the left of the position label 0, the FBPS signals the value 0 (zero) on the SSI interface. Negative position values and position value 0 can be avoided by means of a corresponding position offset.

6.7 Qualification of the safety function after affixing the bar code tape

	NOTICE
	Check the safety function of the entire positioning system! Correct mounting/affixing of the bar code tape is decisive for the safety function of the entire FBPS positioning system. With respect to the safety functions of the overall system, the safe position detection of the FBPS must be qualified in the context of the safety requirements of the system. ↳ Move the FBPS along the bar code tape installed in the system. Possible operating states and how they are signaled are described in chapter 10. Signaling via the status LEDs: see chapter 17.3 "Diagnosis via the LED indicators". ⇨ The safety function of the safe positioning system comprising FBPS and bar code tape is satisfied if the FBPS can be moved along the entire bar code tape without external or internal error signaling.

7 Applications

To minimize risk at automatically moving system parts, such as stacker cranes or transverse transfer cars, control-related safety devices in combination with sensor system in safe or – alternatively – with redundant, diverse technologies, are used.

For the risk assessment, the necessary performance level PL r according to ISO / EN ISO13849-1 or the necessary Safety Integrity Level SIL according to IEC / EN IEC 62061 must be determined.

Both are internationally recognized standards.

European C-standards EN 528 "Rail dependent storage and retrieval equipment – Safety requirements for S/R machines" and EN 619 "Continuous handling equipment and systems" describe the dangers and risks typically present at stacker cranes and continuous conveyors.

The applications presented below provide no details on safety-relevant implementations but instead only serve the fundamental understanding of the use of an FBPS.

7.1 High-bay storage devices

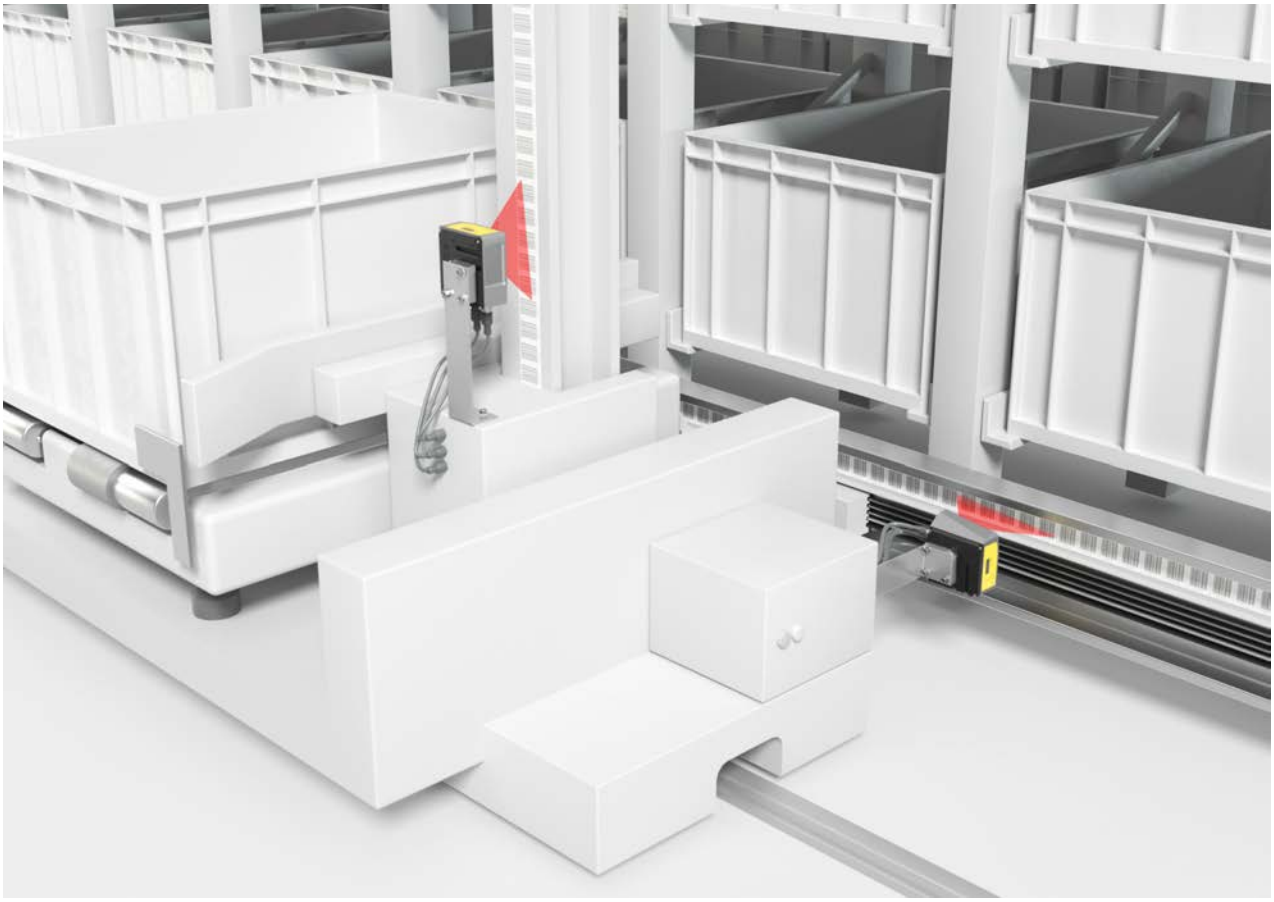


Fig. 7.1: High-bay storage device

- Safe position detection for the x and y-axis
- Precise positioning with a reproducibility of ± 0.15 mm (1 Sigma)
- Safe position detection up to a max. speed of 10 m/s

7.2 Electrical monorail systems

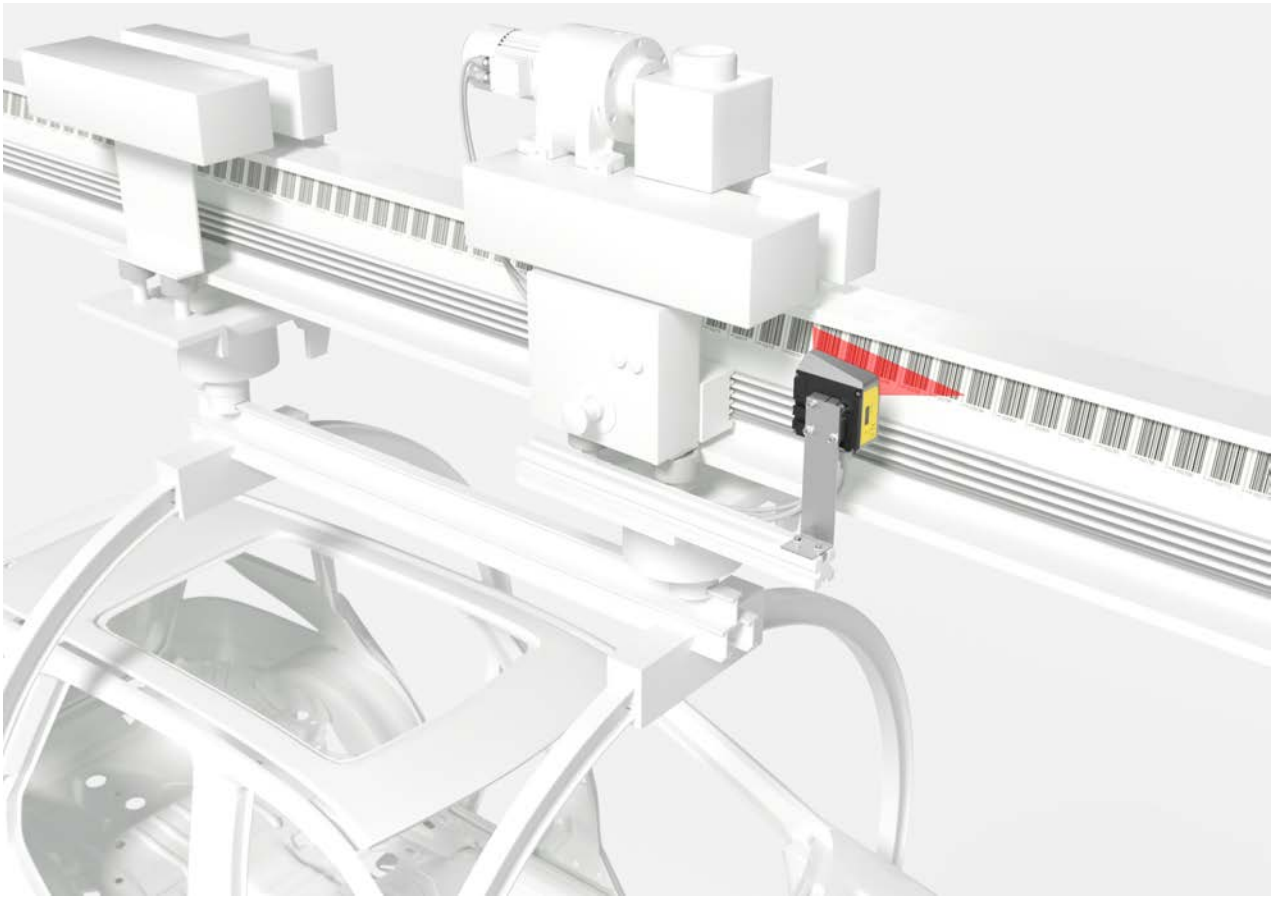


Fig. 7.2: Electrical monorail system

- The working range/depth of field of the FBPS of 50 – 170 mm allows for flexible mounting positions at varying distances.
- Control bar code for the safe position value changeover in the case of switch applications in which different tape values occur.
- Safe position values up to a maximum length of 10000 meters.

7.3 Gantry cranes

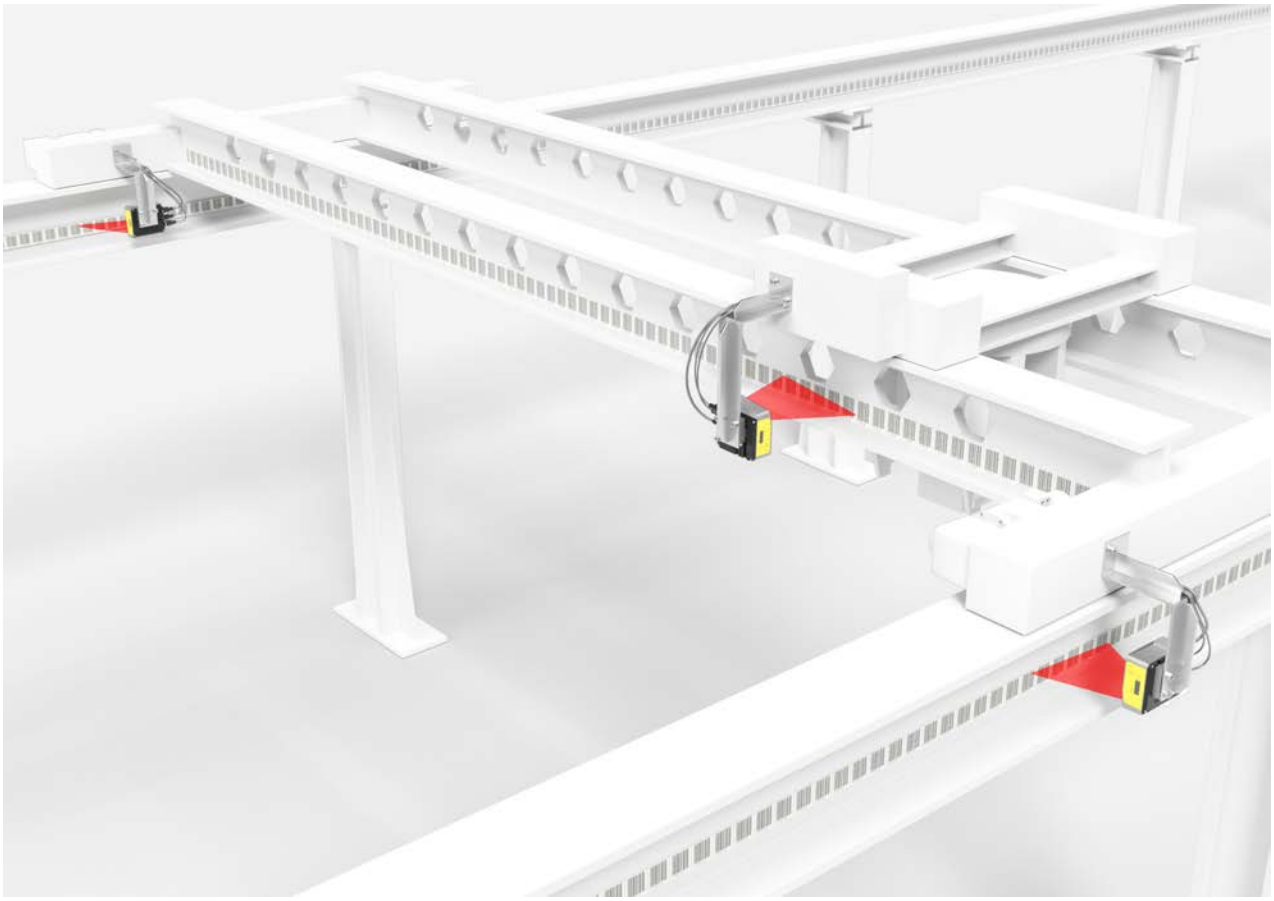


Fig. 7.3: Gantry crane

- Scratch- and smudge-proof, UV-resistant bar code tapes
- Synchronous positioning with TWIN bar code tapes on both longitudinal beams
- Mounting devices for fast, precise mounting

8 Mounting

8.1 Mounting instructions

NOTICE

Select the mounting location

- Make certain that the required environmental conditions (air humidity, temperature) are maintained, Environmental data.
- Make sure that the distance between FBPS and bar code tape lies in the working range of the reading field curve over the entire track, Optical data.
  The working range is at a reading distance from 50 mm to 170 mm.
  With an uninterrupted bar code tape, the scanning beam of the FBPS must detect at least three bar codes.
- Mount the FBPS so that no interruptions of the scanning beam occur during operation.
- Make certain that the exit window does not become soiled, e.g., by leaking liquids, permanent dust exposure, abrasion from cardboard packaging or residues from packaging material.
- Protect the exit window of the FBPS against rain and direct sunlight with a cover installed on-site. Alternatively, the FBPS can be installed in a protective housing.
- Mounting the FBPS in a protective housing:
  When installing the FBPS in a protective housing, ensure that the scanning beam can exit the protective housing without obstruction and without having to pass through another glass cover.
- At operating temperatures below –5°C, an FBPS with integrated heating must be used.
  If the operating temperature is below –25°C and the device is moved constantly and without interruption, additionally attach e.g. a protective housing to the device so that it is protected against the airflow.
- Mounting the FBPS with integrated heating:
  Mount the FBPS in a way which provides maximum thermal isolation, e.g., using rubber-bonded metal.
  Mount the FBPS so that it is protected from airflow, e.g., in a protective housing.

NOTICE

For parallel mounting, maintain the minimum distance!

- Maintain the minimum distance of 300 mm if you mount two FBPS next to or above one another.

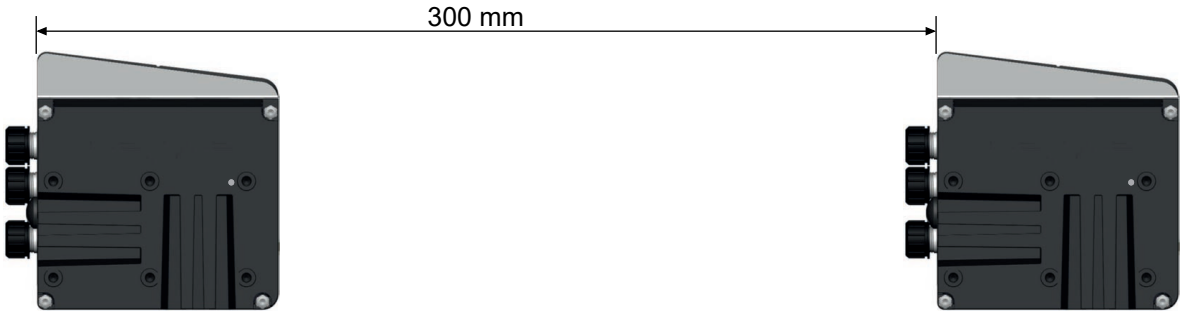
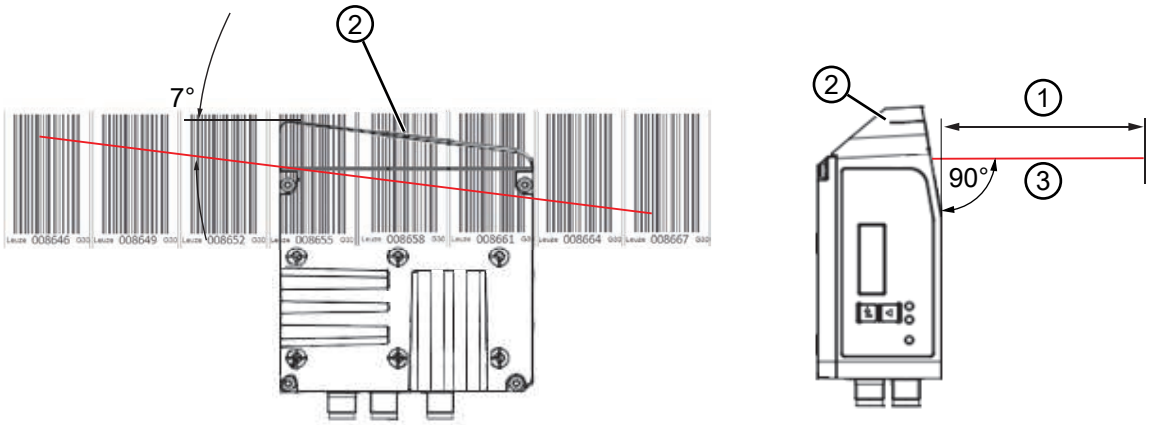


Fig. 8.1: Minimum distance for parallel mounting

8.2 Orientation of the FBPS to the bar code tape



1 Reading distance
2 Measurement reference point of the FBPS
3 Scanning beam

Fig. 8.2: Beam exit

Upon exit from the housing, the scanning beam is at an angle of 7° (2).

The angle of radiation of the scanning beam to the front is 90° relative to the rear side of the housing (3).

The specified reading distance is to be maintained (1).

8.3 Mounting the FBPS

The FBPS can be mounted in the following ways:

- Mounting using four M4 mounting threads on the rear of the device
- Mounting using a mounting device on the M4 mounting threads on the rear of the device
- Mounting using a mounting device on the fastening grooves

8.3.1 Mounting with M4 fastening screws

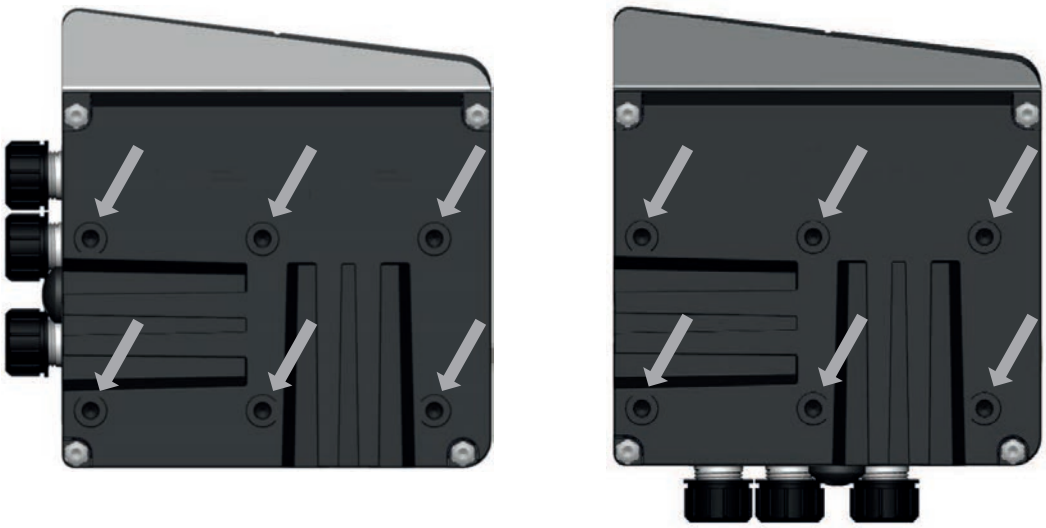


Fig. 8.3: Six M4x5 threaded holes on the rear side of the device

Located on the rear side of the device are six M4x5 threaded holes, arranged in two squares (42 mm x 42 mm).

- Mount the FBPS on the system with four M4 fastening screws.
  Secure the fastening screws against loosening with a snap ring, lock washer or other means.
  Tightening torque of the fastening screws: 1 Nm … max. 2 Nm
  Thread depth: min. 3.5 mm

The mounting parts (screws, snap rings, lock washers, etc.) are not included in delivery.

8.3.2 Mounting with the BT 300 W mounting bracket

Mounting of the FBPS with a BT 300 W mounting bracket is intended for base mounting.

For ordering information: see chapter 20.4 "Accessories – mounting systems"

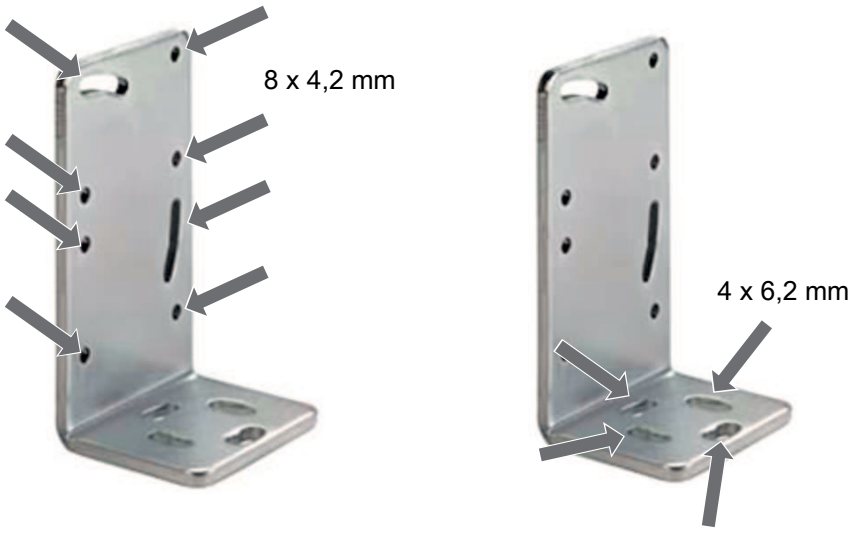


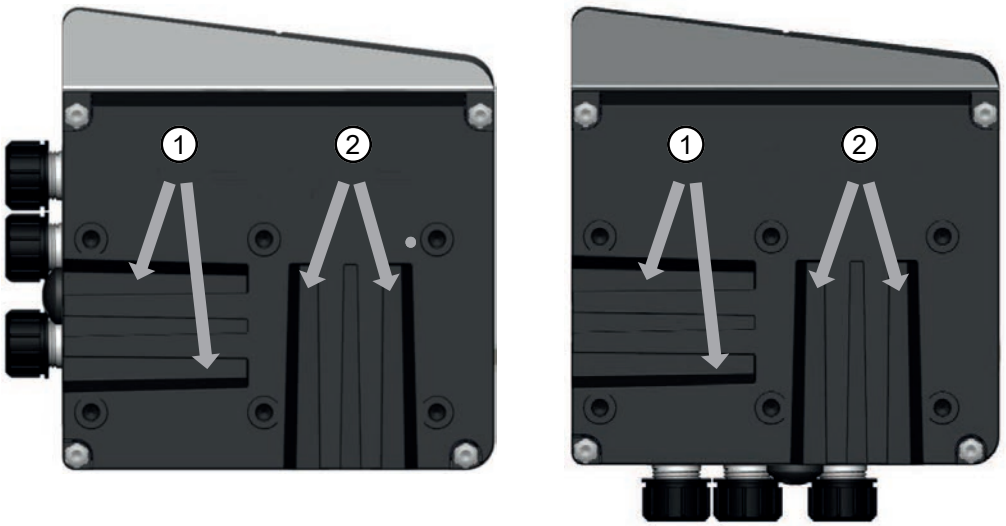
Fig. 8.4: BT 300 W mounting bracket

The FBPS is screwed to the long side of the mounting bracket with four M4 fastening screws. Base mounting requires at least two M6 fastening screws on the short side of the mounting bracket.

- Mount the FBPS on the mounting bracket with four M4 fastening screws (included with delivery) in square or rectangular arrangement.
  Secure the fastening screws against loosening with a spring washer (included with delivery).
  Tightening torque of the fastening screws: 1 Nm … max. 2 Nm
  Thread depth: min. 3.5 mm
- Mount the BT 0300 W mounting bracket on the system side with at least two M6 fastening screws (not included in delivery).
  Secure the fastening screws against loosening with a spring washer.
- Position the device so that the exit window of the FBPS is parallel to the bar code tape. If necessary, turn the mounting bracket using the 6.2 mm slotted holes on the short side.

8.3.3 Mounting with the BTU 0300M-W mounting device (quick-change system)

Dovetail fastening grooves are located on the rear side of the FBPS for mounting the FBPS to a BTU 0300M-W quick-change system.

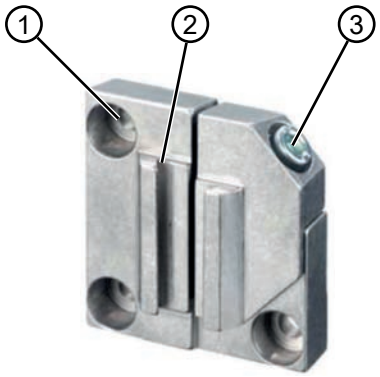


1 Guide the FBPS into the dovetail fastening grooves of the BTU 0300M-W from the side
2 Guide the FBPS into the dovetail fastening grooves of the BTU 0300M-W from above

Fig. 8.5: Dovetail fastening grooves on the rear side of the device

Mounting the FBPS with a BTU 0300M-W mounting device is intended for vertical mounting.

For order guide: see chapter 20.4 "Accessories – mounting systems"



1 Ø 6.6 mm through holes for mounting the mounting device on the system
2 Clamping jaws
3 M6 screw for clamping the FBPS to the dovetail

Fig. 8.6: BTU 0300M-W mounting devices

Fig. 8.7: Mounting with BTU 0300M-W

- Use the through holes to mount the BTU 0300M-W on the system side with three M6 fastening screws (not included in delivery contents).
- Mount the FBPS with the dovetail fastening grooves on the clamping jaws of the BTU 0300M-W. Push the FBPS to the limit stop.
- Secure the FBPS in the dovetail grooves with the M6 clamping screw.
  Tightening torque for the clamping screw: 8 Nm … max. 11 Nm

	NOTICE
	- If the device needs to be replaced, push the new FBPS with the dovetail grooves to the limit stop again.

9 Electrical connection

CAUTION

- Before connecting the device, be sure that the supply voltage agrees with the value printed on the name plate.
- Only allow competent persons to perform the electrical connection.
- Ensure that the functional earth (FE) is connected correctly. Fault-free operation is only guaranteed if the functional earth is connected properly.
- If faults cannot be rectified, take the device out of operation. Protect the device from accidentally being started.

CAUTION

UL applications!

For UL applications, use is only permitted in Class 2 circuits in accordance with the NEC (National Electric Code).

NOTICE

Protective Extra Low Voltage (PELV)!

The device is designed in accordance with protection class III for supply with PELV (Protective Extra-Low Voltage).

9.1 Supply voltage cable

NOTICE

For all connections (connection cable, interconnection cable, etc.), use only the cables listed in the accessories , see chapter 20 "Order guide and accessories".

Cables for the supply voltage: see chapter 20.3 "Accessories – connection technology"

9.2 SSI interface cable

Requirement for the SSI cable

The SSI cable must satisfy the following requirements:

- Clock lines and data lines are routed under a common shield. Or alternatively
- Clock lines and data lines are each shielded separately. In this case, the two shields can be conductively enclosed by another common shield.

The cable variant must meet the following requirements:

- The two clock lines of the SSI connection must be a twisted pair.
- The two data lines of an SSI connection must be a twisted pair.
- The shield must be connected to functional earth at both ends.

NOTICE

- Install SSI cables that carry data separately and not parallel to the power supply cables of motors/frequency inverters or other power-carrying cables.
- Avoid crossing these cables.
- Protect the cables from mechanical damage, especially against crushing.
- When laying cables in the switch cabinet, make certain that the SSI data line is laid to just before its clamping point in the switch cabinet under the shielded sheathing.

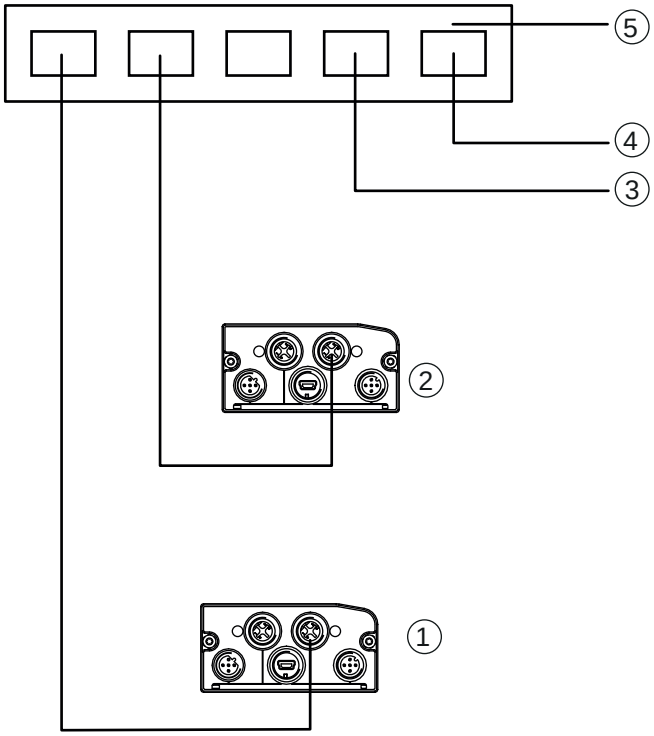
9.3 PROFINET/PROFIsafe cables

NOTICE
For PROFINET/PROFIsafe wiring, please note! ↳ Use the preassembled cables from Leuze (see chapter 20.3 "Accessories – connection technology") or the recommended connectors/sockets. ↳ Always use a CAT 5 Ethernet cable for the wiring. ↳ For the conversion of the connection technology from M12 to RJ45, use the KDS ET M12 / RJ 45 W - 4P adapter (see chapter 20.3 "Accessories – connection technology"). Standard network cables can be plugged into the adapter. ↳ If no standard network cables are used (e.g. due to lacking IP… degree of protection), you can use the KB ET - … - SA user-configurable cable on the BPS; (see chapter 20.3 "Accessories – connection technology"). ↳ The individual BPS devices in a linear topology are connected with the KB ET - … - SSA cable (see chapter 20.3 "Accessories – connection technology").

9.4 PROFINET/PROFIsafe topologies

9.4.1 Star topology

The FBPS can be operated as a stand-alone device in a PROFINET/PROFIsafe star topology with an individual device name (for PROFINET and PROFIsafe). The control must communicate this device name to the participant during the device naming.

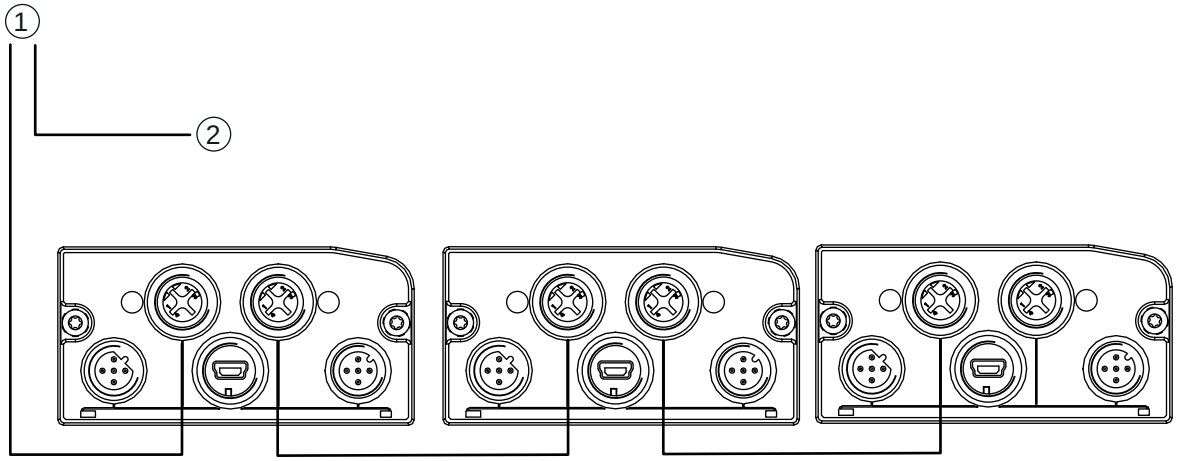


1 FBPS with M12 connectors
2 FBPS with M12 connectors
3 other network participants
4 PC/control host interface
5 Router / switch

Fig. 9.1: PROFINET/PROFIsafe in star topology

9.4.2 Linear topology

The integrated switch functionality of the FBPS offers the possibility to network multiple FBPS devices. In addition to the classic "star topology", a "linear topology" is thus also possible. The wiring of the network in a linear topology is simple and economical since the network connection is looped through from one participant to the next. The maximum length of a segment (connection from one participant to the next) is limited to 100 m.



1 Host interface - PC/control
2 other network participants

Fig. 9.2: PROFINET/PROFIsafe in line topology

9.5 Cable lengths and shielding

Observe the maximum cable lengths and the shielding types:

Connection	Interface	Max. cable length	Shielding
FBPS host	PROFINET/ PROFIsafe	100 m	Shielding absolutely necessary
Network from the first FBPS to the last FBPS	PROFINET/ PROFIsafe	Max. segment length: 100 m for 100Base-TX twisted pair (min. CAT 5)	Shielding absolutely necessary
FBPS service	USB	3 m	Shielding absolutely necessary acc. to USB specifications
FBPS power supply unit	-	30 m	Not necessary
Switching input	-	10 m	Not necessary
Switching output	-	10 m	Not necessary
FBPS-SSI	SSI	Depending on the data rate 80 kBit/s: 500 m 100 kBit/s: 400 m 200 kBit/s: 200 m 300 kBit/s: 100 m 400 kBit/s: 50 m 500 kBit/s: 25 m 600 kBit/s: 18 m 800 kBit/s: 15 m	Shielding and wires must be twisted in pairs

10 Device replacement

The FBPS can be replaced if necessary.

NOTICE
Only allow competent persons to replace the device, see chapter 2.3 "Competent persons".

10.1 Transfer PROFINET/PROFIsafe parameters

CAUTION
Transfer the parameter set to the new device! The parameter set of the previous FBPS is transferred to the replacement device via the connected control. Please note the following: ↳ Only ever replace individual devices. ↳ When connecting the PROFINET cables, make sure that the cable is connected to the original XF1 IN or XF2 OUT socket. In the event of a mix-up, the control will not detect the neighbors. ↳ The F address is automatically derived from the PROFINET name. It must therefore be checked that the correct device has been addressed.

Do not mount and commission the new FBPS until clear information about the parameters of the previous FBPS is available.

10.2 Mounting the new device

Mount the new FBPS in the same way as the previous device.

↳ Observe the mounting instructions, see chapter 8 "Mounting"

↳ Pay attention to the specifications for the tightening torques of the fastening screws.

10.3 Connecting the new device

If the wiring is undamaged, it can be reused for the new device.

If the wiring needs to be replaced, observe the notices, see chapter 5.3 "Connection technology".

CAUTION
Risk of mixing up the PROFINET/PROFIsafe connections! ↳ Before unscrewing the two connection cables, clearly mark which of the connection cables was assigned to the XF1 IN connection and which was assigned to the XF2 OUT connection. As both connection cables have a D-coded M12 connector plug, there is a risk of mixing them up. ↳ Connect the connection cables to the same connections on the replacement FBPS.

10.4 Qualification of the safety function after replacement

With respect to the overall system's safety function, the safe position detection and optionally the safe speed must be qualified in the context of the system's safety requirements after replacing an FBPS.

↳ Move the replaced FBPS along the entire bar code tape.
Possible operating states and how they are signaled: see chapter 11 "Operating states".
Signaling via the status LEDs: see chapter 17.3 "Diagnosis via the LED indicators".

⇨ The safety function of the overall system is satisfied if the new FBPS can be moved along the entire bar code tape without external or internal error signaling.

	NOTICE
	Do not release the system for operation until the renewed qualification has been completed error-free.

11 Operating states

11.1 Power off

XF1 IN and XF2 OUT

The channels are high-impedance, which is equivalent to a cable interruption.

X0 SSI0

The channel is high-impedance, which is equivalent to a cable interruption.

11.2 Signaling during startup

The ramp-up time is the time between "Power on" and the safe measured value output at the PROFINET/ PROFIsafe interfaces or the SSI interface. At "power on", the ambient temperature and the internal temperature of the FBPS determine the boot time.

Tab. 11.1: Boot time as a function of ambient temperature

Ambient temperature	Boot time
-5 °C … +60 °C	10 s + PN/PS connection setup by PLC
-35 °C	Approx. 30 min

Tab. 11.2: Signaling during startup

Component	Signal/activity
PWR status LED	Flashes green
NET status LED	Deactivated
PS status LED	Flashes green
Laser diode	Deactivated
LINK status LED	Deactivated

11.3 Signaling after "power on" without errors

Tab. 11.3: Signaling after "power on" without errors

Component	Signal/activity
PWR status LED	Lights up green
NET status LED	Lights up green
PS status LED	Lights up green
Laser diode	Is activated
LINK status LED	Flashes green/yellow

11.4 Signaling in the event of excessive or insufficient temperature during operation

Devices without heating

Operating temperature of FBPS without device heating: -5°C … +60°C

Signaling of a temperature error

At an ambient temperature lower than -10°C and higher than +65°C, the FBPS signals an internal error.

Devices with heating

Operating temperature of FBPS with device heating: -35°C … +60°C

Signaling of a temperature error

At an ambient temperature lower than -38°C and higher than +65°C, the FBPS signals an internal error.

NOTICE
In the case of insufficient temperature, the warm-up phase is allowed to elapse after power-on. If the operating temperature range is reached during the warm-up phase, the device starts up automatically. If the temperature of the device remains too low after the warm-up phase, the FBPS signals an internal error. Whether or not the system can be restarted is determined by the unit that performs the evaluation or by the safety concept of the system.

Tab. 11.4: Signaling in the event of excessive or insufficient temperature

Component	Signal/activity
PWR status LED	Lights up green
NET status LED	Flashes red
PS status LED	Lights up green
Laser diode	Is active
LINK status LED	Flashes green/yellow

NOTICE
Any pending temperature errors will trigger a diagnostic alarm via the PROFINET/PROFIsafe interface.

Restarting following an internal error

In the event of an internal error, the FBPS is not automatically restarted. Restarting can only be unlocked on the FBPS by means of power off/on. If the internal error remains, unlocking is not possible.

NOTICE
Whether or not the system can be restarted automatically following an internal error is determined by the unit that performs the evaluation or by the safety concept of the system.

11.5 Signaling in the event of overvoltage and undervoltage during operation

The FBPS monitors the supply voltage for the following error thresholds:

- Overvoltage:
  - 30 V DC – 30.9 V DC: Warning
  - 31 V DC – 34 V DC: Error
  - more than approx. 34 V DC, the device is switched off
- Undervoltage:
  - 18 V DC – 17.1 V DC: Warning
  - less than approx. 17 V DC: Error

11.5.1 Signaling in the event of overvoltage

In the case of voltages > approx. 34 V DC, the FBPS is internally disconnected from the supply voltage.

Tab. 11.5: Signaling in the event of overvoltage > 34 V DC

Component	Signal/activity
PWR status LED	Off
NET status LED	Off
PS status LED	Off
Laser diode	Off
LINK status LED	Off

11.5.2 Signaling in the event of undervoltage

With a voltage of < approx. 15 V DC, the state of the FBPS corresponds to the de-energized state.

Tab. 11.6: Signaling in the event of undervoltage < 15 V DC

Component	Signal/activity
PWR status LED	Off
NET status LED	Off
PS status LED	Off
Laser diode	Off
LINK status LED	Off

If the supply voltage is within the supply voltage range of 24 V DC ±25% again after overvoltage (> 34 V DC) or undervoltage (< approx. 8.5 V DC), the FBPS starts up again automatically, see chapter 11.2 "Signaling during startup".

NOTICE

Whether or not the system can be restarted automatically is determined by the unit that performs the evaluation or by the safety concept of the system.

For voltages between approx. 8.5 V DC … 15 V DC, the FBPS signals an internal error.

11.6 External errors

11.6.1 Causes of external errors

- No bar code tape with position information in the scanning beam
  - No position label present or readable.
  - After power off/on or after a light beam interruption, there is only an MVS label in the scanning beam.
  - Following the webConfig operating mode change from **service** to **process**, there is an MVS label without subsequent position label in the scanning beam.
- Position values of the bar code tape are not readable due to:
  - Soiling
  - Damaged bar code tape
  - Bar code tape interruptions (gaps) at switches or expansion joints are too large
  - Bar code tape outside of the reading distance
  - Bar code tape not readable due to reading distance at horizontal inner and outer radii
  - Bar code tape with incorrect grid dimension (G40 instead of G30)
    In the event of this error, the device is not restarted automatically.
    The error must be acknowledged after replacing the incorrect tape by power off/on on the FBPS, see chapter 11.6.3 "Restarting following an external error".
- Stop / start of the position measurement via the switching input (configurable option), Configuring general, non-safety parameters
- Error threshold for excessive or insufficient temperature reached, Environmental data
- Maximum permissible speed of 10 m/s exceeded

11.6.2 Signaling in the event of an external error

Tab. 11.7: Signaling in the event of an external error

Component	Signal/activity
PWR status LED	Flashes red
Laser diode	Is activated

11.6.3 Restarting following an external error

	NOTICE
	As soon as the external error is no longer present, the FBPS automatically restarts. Whether or not the system can be restarted automatically following an external error is determined by the unit that performs the evaluation or by the system's safety concept. An exception to automatic restart is the detection of an incorrect bar code tape (e.g. G40 instead of G30), see chapter 11.6.1 "Causes of external errors". ↳ After replacing the tape, the error must be acknowledged by means of Power on/off on the FBPS.

11.7 Internal error

Causes of internal errors

- Internal hardware or software error
- Excessive or insufficient temperature
- Undervoltage between approx. 8.5 V DC … 15 V DC

Signaling in the event of an internal error

Tab. 11.8: Signaling in the event of an internal error

Component	Signal/activity
PWR status LED	Lights up red
NET status LED	Lights up red
PS status LED	Lights up red
Laser diode	Is deactivated
LINK status LED	Flashes green/yellow

Restarting following an internal error

In the event of an internal error, the FBPS is not automatically restarted. Restarting can only be unlocked on the FBPS by means of power off/on. If the internal error remains, unlocking is not possible.

NOTICE

Whether or not the system can be restarted automatically following an internal error is determined by the unit that performs the evaluation or by the safety concept of the system.

11.8 Position value 0 (zero)

The position value 0 (zero) is output on the process interface (PROFINET, PROFIsafe and SSI).

11.9 Negative position values

A negative position value is only output on the PROFINET/PROFIsafe interface. The data output on the SSI channel is blocked.

Causes and measures in the event of negative position values

Tab. 11.9: Causes and measures in the event of negative position values

Cause	Measure
The FBPS is located outside the middle of the bar code label with the value 000000 in such a way that a negative position value occurs.	The output value is configured to a value ≥ zero by means of a corresponding offset, see chapter 12.4.8 "Module 6 – SSI interface".
Adding a position offset results in output of a negative position value.	The error state must be rectified by correcting the position offset, see chapter 12.4.8 "Module 6 – SSI interface".

11.10 Multiple clocking out of the same position value

The output time of the position value on the FBPS is 2 ms for the SSI channel.

The clock frequency of the SSI master in combination with short clock breaks and excessively short monoflop times (see chapter 13.4 "Monoflop time") between the individual clock bursts results in the same position value being clocked out multiple times until the next update (intervals of 2 ms).

	NOTICE
	During the plausibility check of two successive position values in the control, several identical position values may thus be clocked out in succession.

11.11 Error bit in the SSI protocol

The error bit is set upon detection of an external error, see chapter 11.6 "External errors".

The FBPS remains functional.

Gray coded

For error bit = 1 (set), the position value of the gray coding is set to 0. The binary error bit is appended to the gray-coded 0 value.

Binary coded

For error bit = 1 (set), the position value of the binary coding of all position data bits is set to 1. The error bit is appended to the position value.

	NOTICE
	As soon as the external error is no longer present, the FBPS automatically restarts; the error bit is reset to the value 0 (zero). Whether or not the system can be restarted following an external error is determined by the unit that performs the evaluation or by the safety concept of the system.

11.12 Behavior of the FBPS in operation with the webConfig tool

The FBPS can activate the webConfig tool's web-based user interface via the XF1/XF2 connection or via the USB connection. This connection must first be activated via the PROFINET module 8 – Security control.

The webConfig tool is activated by entering the IP address (Controls and indicators) in an Internet browser.

In the webConfig tool, both the *process* and *service* operating modes are available.

The operating modes affect the behavior of the process interfaces.

Process operating mode

The *process* operating mode is active by default and is set after the FBPS starts up.

The operating mode has no additional effects on the process interfaces.

Service operating mode

The *service* operating mode has the following effects:

The FBPS signals an external error. No valid position value is output at the process interfaces.

The signals of the digital switching inputs/outputs are deactivated.

	NOTICE
	When switching from the *service* operating mode to the *process* operating mode in the webConfig tool, the FBPS automatically restarts. Whether or not the system can be restarted after activating the *process* operating mode is determined by the competent person or by the safety concept of the system.

12 Commissioning – PROFINET/PROFIsafe

12.1 Overview

The FBPS 648i safe bar code positioning system is designed as a modular field device and is a PROFIsafe device that communicates cyclically with the assigned PROFIsafe control.

The device can be operated as a single device (standalone) with individual device name in a PROFINET-IO/PROFIsafe star or tree topology. This device name must be communicated to the participant by the control system when the device is named).

NOTICE	
	Safe PROFIsafe communication is required for safe position and speed detection. Optionally, the non-safe position or speed values can be transferred via PROFINET or the SSI channel.

Performance characteristics

The device has the following performance characteristics:

- A GSDML file is available for the device description
- The device family is certified as a PROFINET-IO device according to V2.43
- The device family is certified as a PROFINET-IO device according to V2.62
- PROFINET-IO with real-time (RT) communication
- Integrated 2-port IRT switch
- Standard Fast Ethernet (100 Mbit/s) connection (M12 technology)
- Auto-crossover and auto-negotiation
- Cyclical data exchange
- Detection of topology errors
- 4-pin, M12 connectors with D-coding are used for the electrical connection.
- Identification & maintenance functions (I&M) IM0 – IM4
- The IP address, the PROFIsafe address or the name assignment is set using, e.g., the Siemens TIA development environment or comparable tools
- The separate TCI Device Tool calculates a checksum via the FBPS security application parameters.
- PROFIsafe address 1
- PROFINET cycle time: minimum 2 ms (MinDeviceInterval=64)
- PROFIsafe cycle time: minimum 8 ms
- Function range acc. to Conformance Class B
- Network class III, security level 1
- Media Redundancy Protocol (MRP) – Client

Communication

Communication and integration take place via the GSDML file (see chapter 12.2 "GSDML file").

The modules of the GSDML file are used to configure non-safe (PROFINET + SSI) and safe (PROFIsafe) device functionality.

On delivery, the device is assigned the following network address:

- IP address: 192.168.60.101
- Subnet mask: 255.255.255.0

Electrical connection

The device features multiple M12 connectors/sockets for the electrical connection of the supply voltage, the interface and the switching inputs and outputs (see chapter 9 "Electrical connection").

12.2 GSDML file

The functionality of the FBPS 648i via the PROFINET interface is defined with parameters and input/output data that are specified in the GSDML file modules (PROFINET project modules).

A user-specific configuration tool is used during PLC program creation to integrate the required modules and configure them appropriately for their respective use.

	NOTICE
	**Observe when configuring PROFINET devices!** ↳ **Always** perform the basic configuration using the GSDML file (GSDML=Generic Station Description Markup Language). ↳ Download the appropriate GSDML file from the Internet: **www.leuze.com**. ↳ In process operation, the input/output data of the respective, activated GSDML modules are exchanged with the control. ↳ If you switch the device to the *Service* operating mode via the webConfig tool, the device is disconnected from the PROFINET.

12.3 Integrating in a PROFIsafe network

12.3.1 Network topology

FBPS 648i PROFIsafe devices can be integrated in the following network topologies:

- Star
- Line
- Ring

12.3.2 Addressing

The following information is needed for the FBPS 648i PROFIsafe to exchange data with other devices in the network:

- PROFINET name
- Unique IP address
- Subnet mask
- If applicable, the IP address of the router.

You can assign the data to the FBPS 648i PROFIsafe in the following ways:

- Configuration software for a PROFINET network
- PROFINET control

12.3.3 Configuring the PROFINET control

Proceed as follows to configure the PROFINET control:

↳ Load the GSDML file in the control configuration software.

↳ Select the desired device in the hardware catalog, e.g., use the search function and enter *FBPS 648i* or *Leuze*.

↳ Add the device to the project and connect the device to the control.

↳ Select the PROFINET or the safe PROFIsafe configuration modules according to the process image.

↳ Assign a unique PROFINET device name.

↳ Set the PROFIsafe parameters.

↳ Create the iPar_CRC using the TCI tool.

Tab. 12.1: PROFIsafe parameters

Parameter	Meaning	Setting
F_SIL	Safety integration level of the safe positioning system	SIL1 – SIL3
F_CRC_Length	Informs the F-CPU of the expected length of the CRC key in the security telegram.	4-byte CRC (cannot be changed)
F_Block_ID		1 (not changeable)
F_Par_Version	PROFIsafe operating mode	1 (not changeable)
F_Source_Add	Unique address of the safe control	1 … 65534
F_Dest_Add	Unique address of the safe positioning system	1 … 65534 Special syntax required, see chapter 12.8 "Addressing the FBPS 648i"
F_Par_CRC_WithoutAdresses		’0’ (not changeable)
F_Passivation		Device/Module (not changeable)
F_CRC_Seed		CRC-Seed24/32
F_WD_Time	Watchdog time for the cyclical service. The watchdog time should be long enough that small delays in the communication are tolerated. The watchdog time affects the response time of the total system and is therefore relevant to safety.	50 ms … 10000 ms, depending on the application
F_iPar_CRC	CRC via the individual device parameters (i-parameters)	Creation via the TCI tool
F_Par_CRC	Automatically generated CRC	Not changeable

12.4 PROFINET project modules

12.4.1 Overview of the modules

The following table provides an overview of the **non-safe** modules used in the device profile.

Tab. 12.2: Overview of PROFINET configuration modules

Module	Description	Number of parameters	Input data	Output data
see chapter 12.4.2 "DAP"	FBPS profile	2	0	0
see chapter 12.4.3 "M1"	Position value	1	1	0
see chapter 12.4.4 "M2"	Status and control	0	8	1
see chapter 12.4.5 "M3"	Speed	1	1	0
see chapter 12.4.6 "M4"	Velocity status	0	3	0
see chapter 12.4.7 "M5"	Reading quality	3	1	0
see chapter 12.4.8 "M6"	SSI interface	5	0	0
see chapter 12.4.9 "M7"	Device status	0	1	2
see chapter 12.4.10 "M8"	Security control	1	0	1

12.4.2 DAP module

Module ID: Profinet_DAP_001

Contains general and device-related parameters, but no input data and no output data.

Tab. 12.3: DAP module parameters

Parameter	Address	Data type	Value range	Default	Description
Profile	0	Unsigned8	1	1	Defines the used device profile. Currently, only the FBPS profile is stored. Thus, no selection is possible. 1: FBPS profile
Logging filter	1.0	Bit Area	0 … 3	3	Changes the logging filter: 0: FBPS logging not active 1: FBPS logging filter info 2: FBPS logging filter warning 3: FBPS logging filter error

12.4.3 Module 1 – Position value

Module ID: 1001

Submodule ID: 1

Permitted slots: 2 ... 9

Module for outputting the current 32-bit position value in the selected resolution.

Tab. 12.4: Parameters for module 1

Parameter	Address	Data type	Value range	Default	Description
Resolution of the position value	0.0	Bit Area	0 … 2	1	Changes the position resolution of the non-safe position value. 0: 0.1 mm 1: 1 mm 2: 10 mm

Tab. 12.5: Module 1 input data

Input data	Address	Data type	Value range	Default	Description
Position	0	Integer32	-2,000,000,000 … +2,000,000,000	0	Signed position value

12.4.4 Module 2 – Position value status and control

Module ID: 1002

Submodule ID: 1

Permitted slots: 2 ... 9

This module signals various status information of the FBPS.

Tab. 12.6: Module 2 input data

Input data	Address	Data type	Value range	Default	Description
Position value valid	0.0	Bit	0 … 1	0	Signals that a valid non-safe position value can be determined. 0: Position value invalid 1: Position value valid
Control bar code decoded	0.1	Bit	0 … 1	0	Signals a decoded control bar code in the scanning beam. 0: No control bar code decoded 1: Control bar code decoded
Warning threshold for read quality reached	0.2	Bit	0 … 1	0	Signals that the ascertained reading quality has dropped below the configured warning threshold. 0: OK 1: Reading quality below the warning threshold
Error threshold for read quality reached	0.3	Bit	0 … 1	0	Signals that the ascertained reading quality has dropped below the configured error threshold. 0: OK 1: Reading quality below the error threshold
Reserved	0.4	Bit	-	-	Reserved
Ascending tape direction	0.5	Bit	0 … 1	0	The alignment between the FBPS and the bar code tape results in an ascending reading direction. 0: Not ascending 1: Ascending
Descending tape direction	0.6	Bit	0 … 1	0	The alignment between the FBPS and the bar code tape results in a descending reading direction. 0: Not descending 1: Descending
Measurement active	0.7	Bit	0 … 1	0	Signals an inactive measurement. 0: Measurement not active 1: Measurement active

Tab. 12.7: Module 2 output data

Output data	Address	Data type	Value range	Init value	Description
Measurement stop / start	0.0	Bit	0 … 1	0	With this bit, the measurement can be stopped and restarted. If the measurement is stopped, the scanning beam is deactivated. If the measurement is restarted, measurement values are available again after a few milliseconds. 0: Measurement active 1: Stop measurement

12.4.5 Module 3 – Speed

Module ID: 1003

Submodule ID: 1

Permitted slots: 2 ... 9

This module is used to output the current non-safe speed in the selected resolution.

Tab. 12.8: Module 3 parameters

Parameter	Address	Data type	Value range	Default	Description
Speed value resolution	0.0	Bit Area	0 … 3	1	Changes the position resolution of the non-safe speed value. 0: 0.1 mm/s (only even-numbered output with factor 10x) 1: 1 mm/s 2: 10 mm/s 3: 100 mm/s

Tab. 12.9: Module 3 input data

Input data	Address	Data type	Value range	Default	Description
Speed value not safe	0	Integer16	-32,768 … +32,767	0	Signed speed value With a resolution of 0.1 mm/s, this can be used for a system speed of up to 3 m/s.

12.4.6 Module 4 – Speed status

Module ID: 1004

Submodule ID: 1

Permitted slots: 2 ... 9

This module supplies various speed measurement status information to the PROFINET master.

Tab. 12.10: Module 4 input data

Input data	Address	Data type	Value range	Default	Description
Speed value valid	0.0	Bit	0 … 1	0	Signals that a valid or invalid speed value can be determined. 0: Speed value invalid 1: Speed value valid
Movement status	0.1	Bit	0 … 1	0	Signals whether a movement is currently detected. 0: No movement detected 1: Movement detected
Direction of movement	0.2	Bit	0 … 1	0	If the *Movement status* bit is set, this status indicates the direction of movement. 0: Positive direction 1: Negative direction

12.4.7 Module 5 – Reading quality

Module ID: 1005

Submodule ID: 1

Permitted slots: 2 ... 9

This module enables the FBPS reading quality to be transferred and the parameters for the warning threshold, error threshold and smoothing of the reading quality to be configured.

Tab. 12.11: Parameters for module 5

Parameter	Address	Data type	Value range	Default	Description
Warning threshold reading quality	0	Unsigned8	30 … 90	60	Below this threshold for reading quality in units of [%], the FBPS generates a warning event.
Error threshold reading quality	1	Unsigned8	10 … 70	30	Below this threshold for reading quality in units of [%], the FPS generates an error event.
Reading quality smoothing	2	Unsigned8	0 … 100	5	Sensitivity towards changes in reading quality. The higher this value is, the less of an effect a change has on the reading quality.

Tab. 12.12: Module 5 input data

Input data	Address	Data type	Value range	Default	Description
Reading quality	0	Unsigned8	0 … 100	0	Reading quality in percent [%]

12.4.8 Module 6 – SSI interface

Module ID: 1006

Submodule ID: 1

Permitted slots: 2 ... 9

This module provides parameters for configuring the **non-safe** SSI interface of the FBPS.

Tab. 12.13: Module 6 parameters

Parameter	Address	Data type	Value range	Default	Description
SSI position value coding	0.0	Bit	0 … 1	1	This parameter defines the coding of the SSI position value. 0: Binary coded 1: Gray coded
SSI position value resolution	0.1	Bit Area	0 … 2	1	Resolution of the SSI position value Depending on the selected resolution and the number of data bits, a maximum position value can be transferred, see chapter 13.3 "Maximum position value which can be represented". 0: 0.01 mm 1: 0.1 mm 2: 1 mm

Parameter	Address	Data type	Value range	Default	Description
Number of data bits - position value	0.3	Bit Area	0 … 3	0	Defines the number of data bits for the position value (without error bit). 0: 24 bit 1: 25 bit 2: 26 bit 3: 27 bit
Error bit	0.6	Bit	0 … 1	1	Defines whether an error bit is appended to the SSI position value. 0: Position value without error bit 1: Position value with appended error bit
Master clock	0.7	Bit	0 … 1	0	Depending on the selected master frequency, the FBPS signals the end of an SSI data transmission with the appropriate monoflop time. 0: 80 kHz – 800 kHz (20 µs monoflop time) 1: 50 kHz – 79 kHz (30 µs monoflop time)

12.4.9 Module 7 – Device status

Module ID: 1060

Submodule ID: 1

Permitted slots: 2 ... 9

This module contains the device status as well as some device control bits.

Tab. 12.14: Module 7 input data

Input data	Address	Data type	Value range	Default	Description
Device status	0	Unsigned8	0 … 129	0	This byte represents the device status. 0: Undefined PROFINET Init value 1: Device initialization 15: Device is ready 128: Device error 129: Device warning

Tab. 12.15: Module 7 output data

Output data	Address	Data type	Value range	Default	Description
Delete event memory	0.0	Bit	0 … 1	0	This bit can be used to delete the event memory for warnings and errors. 0 > 1: Delete event buffer
Reset system / restart	0.6	Bit	0 … 1	0	This bit can be used to trigger a system reset and restart. 0 > 1: Reset device

12.4.10 Module 8 – Security control

Module ID: 1065

Submodule ID: 1

Permitted slots: 2 ... 9

This module is used to activate an Ethernet-based web server, such as the webConfig configuration tool. On delivery, access to the webConfig tool is deactivated both via PROFINET and via the separate USB service interface.

Tab. 12.16: Module 8 parameters

Parameter	Address	Data type	Value range	Default	Description
Web server activation	0.0	Bit	0 … 1	0	This bit allows the integrated web server to be permanently activated or deactivated or to only allow activation via the output data. 0: Deactivated Allow activation via output data 1: Activated Always available

Tab. 12.17: Module 8 output data

Output data	Address	Data type	Value range	Default	Description
Activate web server	0.0	Bit	0 … 1	0	This bit can be used to activate the web server until the next restart. 0 > 1: Activate web server

12.5 PROFIsafe modules

The FBPS offers various safe PROFIsafe modules. Only one of the PROFIsafe modules can be added to the project.

PROFIsafe modules 50 and 51 as well as 52 and 53 are identical in content. The modules are available for the new XP version (Expanded Protocol) and the older BP version (Basic Protocol).

12.5.1 Overview of the modules

The following table provides an overview of the **safe** modules used in the device profile.

Tab. 12.18: Overview of PROFIsafe modules

Module	Description	Number of parameters	Input data	Output data
see chapter 12.5.2 "M50"	Safe position value (XP)	7	3	0
see chapter 12.5.3 "M51"	Safe position value (BP)	7	3	0
see chapter 12.5.4 "M52"	Safe position value + safe speed (XP)	9	5	0
see chapter 12.5.5 "M53"	Safe position value + safe speed (BP)	9	5	0

12.5.2 Module 50 – Safe position value (XP)

Module ID: 1050

Submodule ID: 1

Permitted slots: 1

This module contains the configuration and input data for 32-bit **safe** position values with the current PROFIsafe XP (Expanded Protocol).

Tab. 12.19: Parameters for module 50

Parameter	Address	Data type	Value range	Default	Description
Safe data layout ID	0	Unsigned32	1050	1050	This parameter is used internally and does not allow any selection.
Error reaction time	4.0	Bit Area	0 … 5	0	Allows the FBPS error response time to be adapted to the application. 0: 10 ms 1: 20 ms 2: 50 ms 3: 100 ms 4: 200 ms 5: 400 ms
PROFIsafe position value resolution	4.4	Bit Area	0 … 2	1	Changes the resolution of the PROFIsafe position input data. 0: 0.1 mm 1: 1.0 mm 2: 10 mm
Counting direction	4.6	Bit	0 … 1	0	Counting direction for the position calculation and sign for the speed calculation. This parameter affects all interfaces (incl. SSI). 0: Positive 1: Negative
MVS label switching tolerance	4.7	Bit	0 … 1	1	Tape switching with MVS label 0: without tolerance 1: up to 15 mm (G30) or 20 mm (G40) tolerance
Tape selection BCB G30 … BCB G40 …	5.0	Bit	0 … 1	0	Tape selection 0: only 3 cm coded bar code tapes (BCB G30 …) 1: only 4 cm coded bar code tapes (BCB G40 …)
Position offset	6	Integer32	-10,000,000 … +10,000,000	0	Output position = measured position + offset Offset resolution is 1 mm The offset affects all interfaces (incl. SSI).

NOTICE

For safe functionality, the *tape selection* parameter **must** be set according to the bar code tape grid used.

Tab. 12.20: Module 50 input data

Input data	Address	Data type	Value range	Default	Description
Position value valid	0.0	Bit	0 … 1	0	Status bit for signaling the validity of the safe position value. 0: Safe position value invalid 1: Safe position value valid
Control bar code de-coded	0.1	Bit	0 … 1	0	The status bit indicates the decoding of an MVS label. 0: no MVS label decoded in the scanning beam 1: MVS label decoded in the scanning beam
Safe posi-tion value	1	Inte-ger32	-2,147,483,648 … +2,147,483,647	0	Signed 32-bit integer safe position value. Maximum values result from resolution, band value and offset.

NOTICE

If no valid safe position value can currently be determined, the safe input bit *Position value* valid is set to 0. At the same time, the safe position value is zeroed. This case is regarded as a permissible temporary operating state and has no effect on the safe module's PROFIsafe status.

NOTICE

For safety-compliant operation of FBPS 648i, it is essential to evaluate the safe *position value valid* bit in the currently used PROFIsafe module's input data in the PLC program. The PLC program must react to this and, if necessary, ensure safe operation without the safe position value.

12.5.3 Module 51 – Safe position value (BP)

Module ID: 1051

Submodule ID: 1

Permitted slots: 1

This module contains the configuration and input data for 32-bit **safe** position values with the current PROFIsafe BP (basic protocol).

Tab. 12.21: Parameters for module 51

Parameter	Address	Data type	Value range	Default	Description
Safe data lay-out ID	0	Un-signed32	1051	1051	This parameter is used internally and does not allow any selection.
Error reaction time	4.0	Bit Area	0 … 5	0	Allows the FBPS error response time to be adapted to the application. 0: 10 ms 1: 20 ms 2: 50 ms 3: 100 ms 4: 200 ms 5: 400 ms

Parameter	Address	Data type	Value range	Default	Description
PROFIsafe position value resolution	4.4	Bit Area	0 … 2	1	Changes the resolution of the PROFIsafe position input data. 0: 0.1 mm 1: 1.0 mm 2: 10 mm
Counting direction	4.6	Bit	0 … 1	0	Counting direction for the position calculation and sign for the speed calculation. This parameter affects all interfaces (incl. SSI). 0: Positive 1: Negative
MVS label switching tolerance	4.7	Bit	0 … 1	1	Tape switching with MVS label 0: without tolerance 1: up to 15 mm (G30) or 20 mm (G40) tolerance
Tape selection BCB G30 … BCB G40 …	5.0	Bit	0 … 1	0	Tape selection 0: only 3 cm coded bar code tapes (BCB G30 …) 1: only 4 cm coded bar code tapes (BCB G40 …)
Position offset	6	Integer32	-10,000,000 … +10,000,000	0	Output position = measured position + offset Offset resolution is 1 mm The offset affects all interfaces (incl. SSI).

NOTICE

For safe functionality, the *tape selection* parameter **must** be set according to the bar code tape grid used.

Tab. 12.22: Module 51 input data

Input data	Address	Data type	Value range	Default	Description
Position value valid	0.0	Bit	0 … 1	0	Status bit for signaling the validity of the safe position value. 0: Safe position value invalid 1: Safe position value valid
Control bar code decoded	0.1	Bit	0 … 1	0	The status bit indicates the decoding of an MVS label. 0: no MVS label decoded in the scanning beam 1: MVS label decoded in the scanning beam
Safe position value	1	Integer32	-2,147,483,648 … +2,147,483,647	0	Signed 32-bit integer safe position value. Maximum values result from resolution, band value and offset.

NOTICE

If no valid safe position value can currently be determined, the safe input bit *Position value* valid is set to 0. At the same time, the safe position value is zeroed. This case is regarded as a permissible temporary operating state and has no effect on the safe module's PROFIsafe status.

NOTICE

For safety-compliant operation of FBPS 648i, it is essential to evaluate the safe *position value valid* bit in the currently used PROFIsafe module's input data in the PLC program. The PLC program must react to this and, if necessary, ensure safe operation without the safe position value.

12.5.4 Module 52 – Safe position value and safe speed (XP)

Module ID: 1052

Submodule ID: 1

Permitted slots: 1

This module contains the configuration and input data for 32-bit **safe** position values and 16-bit **safe** speed values with the current PROFIsafe XP (Expanded Protocol).

Tab. 12.23: Parameters for module 52

Parameter	Address	Data type	Value range	Default	Description
Safe data layout ID	0	Unsigned32	1052	1052	This parameter is used internally and does not allow any selection.
Error reaction time	4.0	Bit Area	0 … 5	0	Allows the FBPS error response time to be adapted to the application. 0: 10 ms 1: 20 ms 2: 50 ms 3: 100 ms 4: 200 ms 5: 400 ms
PROFIsafe position value resolution	4.4	Bit Area	0 … 2	1	Changes the resolution of the PROFIsafe position input data. 0: 0.1 mm 1: 1.0 mm 2: 10 mm
Counting direction	4.6	Bit	0 … 1	0	Counting direction for the position calculation and sign for the speed calculation. This parameter affects all interfaces (incl. SSI). 0: Positive 1: Negative
MVS label switching tolerance	4.7	Bit	0 … 1	1	Tape switching with MVS label 0: without tolerance 1: up to 15 mm (G30) or 20 mm (G40) tolerance

Parameter	Address	Data type	Value range	Default	Description
Tape selection BCB G30 … BCB G40 …	5.0	Bit	0 … 1	0	Tape selection 0: only 3 cm coded bar code tapes (BCB G30 …) 1: only 4 cm coded bar code tapes (BCB G40 …)
PROFIsafe speed value resolution	5.1 … 5.2	Bit Area	0 … 3	1	Changes the resolution of the PROFIsafe speed input data. 0: 0.1 mm/s (only even-numbered output with factor 10x) 1: 1 mm/s 2: 10 mm/s 3: 100 mm/s
Speed value averaging	5.3 … 5.5	Bit Area	0 … 5	2	All calculated speeds are averaged over the specified time. 0: No averaging 1: 2 ms 2: 4 ms 3: 8 ms 4: 16 ms 5: 32 ms
Position offset	6	Inte-ger32	-10,000,000 … +10,000,000	0	Output position = measured position + offset Offset resolution is 1 mm The offset affects all interfaces (incl. SSI).

NOTICE

For safe functionality, the *tape selection* parameter **must** be set according to the bar code tape grid used.

Tab. 12.24: Module 52 input data

Input data	Address	Data type	Value range	Default	Description
Position value valid	0.0	Bit	0 … 1	0	Status bit for signaling the validity of the safe position value. 0: Safe position value invalid 1: Safe position value valid
Control bar code de-coded	0.1	Bit	0 … 1	0	The status bit indicates the decoding of an MVS label. 0: no MVS label decoded in the scanning beam 1: MVS label decoded in the scanning beam
Speed value valid	0.2	Bit	0 … 1	0	Status bit for signaling the validity of the safe speed value. 0: Safe speed value invalid 1: Safe speed value valid

Input data	Address	Data type	Value range	Default	Description
Safe speed value	1	Integer16	-32,768 … +32,767	0	Signed 16-bit integer safe speed value in the selected resolution. With a resolution of 0.1 mm/s, this can be used for a system speed of up to 3 m/s.
Safe position value	3	Integer32	-2,147,483,648 … +2,147,483,647	0	Signed 32-bit integer safe position value. Maximum values result from resolution, band value and offset.

NOTICE

If no valid safe position value or speed value can currently be determined, the safe input bits *Position value valid* and *Speed value valid* are set to 0. At the same time, the safe position value and the speed value are zeroed. This case is regarded as a permissible temporary operating state and has no effect on the safe module's PROFIsafe status.

NOTICE

For safety-compliant operation of FBPS 648i, it is essential to evaluate the safe *Position value valid* and *Speed value valid* bits in the currently used PROFIsafe module's input data in the PLC program. The PLC program must react to this and, if necessary, ensure safe operation without the safe position and speed values.

12.5.5 Module 53 – Safe position value and safe speed (BP)

Module ID: 1053

Submodule ID: 1

Permitted slots: 1

This module contains the configuration and input data for 32-bit **safe** position values and 16-bit **safe** speed values with the current PROFIsafe BP (basic protocol).

Tab. 12.25: Parameters for module 53

Parameter	Address	Data type	Value range	Default	Description
Safe data layout ID	0	Unsigned32	1053	1053	This parameter is used internally and does not allow any selection.
Error reaction time	4.0	Bit Area	0 … 5	0	Allows the FBPS error response time to be adapted to the application. 0: 10 ms 1: 20 ms 2: 50 ms 3: 100 ms 4: 200 ms 5: 400 ms
PROFIsafe position value resolution	4.4	Bit Area	0 … 2	1	Changes the resolution of the PROFIsafe position input data. 0: 0.1 mm 1: 1.0 mm 2: 10 mm

Parameter	Address	Data type	Value range	Default	Description
Counting direction	4.6	Bit	0 … 1	0	Counting direction for the position calculation and sign for the speed calculation. This parameter affects all interfaces (incl. SSI). 0: Positive 1: Negative
MVS label switching tolerance	4.7	Bit	0 … 1	1	Tape switching with MVS label 0: without tolerance 1: up to 15 mm (G30) or 20 mm (G40) tolerance
Tape selection BCB G30 … BCB G40 …	5.0	Bit	0 … 1	0	Tape selection 0: only 3 cm coded bar code tapes (BCB G30 …) 1: only 4 cm coded bar code tapes (BCB G40 …)
PROFIsafe speed value resolution	5.1 … 5.2	Bit Area	0 … 3	1	Changes the resolution of the PROFIsafe speed input data. 0: 0.1 mm/s (only even-numbered output with factor 10x) 1: 1 mm/s 2: 10 mm/s 3: 100 mm/s
Speed value averaging	5.3 … 5.5	Bit Area	0 … 5	2	All calculated speeds are averaged over the specified time. 0: No averaging 1: 2 ms 2: 4 ms 3: 8 ms 4: 16 ms 5: 32 ms
Offset	6	Integer32	-10,000,000 … +10,000,000	0	Output position = measured position + offset Offset resolution is 1 mm The offset affects all interfaces (incl. SSI).

NOTICE

For safe functionality, the *tape selection* parameter **must** be set according to the bar code tape grid used.

Tab. 12.26: Module 53 input data

Input data	Address	Data type	Value range	Default	Description
Position value valid	0.0	Bit	0 … 1	0	Status bit for signaling the validity of the safe position value. 0: Safe position value invalid 1: Safe position value valid

Input data	Address	Data type	Value range	Default	Description
MVS control bar code decoded	0.1	Bit	0 … 1	0	The status bit indicates the decoding of an MVS label. 0: no MVS label decoded in the scanning beam 1: MVS label decoded in the scanning beam
Speed value valid	0.2	Bit	0 … 1	0	Status bit for signaling the validity of the safe speed value. 0: Safe speed value invalid 1: Safe speed value valid
Safe speed value	1	Integer16	-32,768 … +32,767	0	Signed 16-bit integer safe speed value in the selected resolution. With a resolution of 0.1 mm/s, this can be used for a system speed of up to 3 m/s.
Safe position value	3	Integer32	-2,147,483,648 … +2,147,483,647	0	Signed 32-bit integer safe position value. Maximum values result from resolution, band value and offset.

NOTICE

If no valid safe position value or speed value can currently be determined, the safe input bits *Position value valid* and *Speed value valid* are set to 0. At the same time, the safe position value and the speed value are zeroed. This case is regarded as a permissible temporary operating state and has no effect on the safe module's PROFIsafe status.

NOTICE

For safety-compliant operation of FBPS 648i, it is essential to evaluate the safe *Position value valid* and *Speed value valid* bits in the currently used PROFIsafe module's input data in the PLC program. The PLC program must react to this and, if necessary, ensure safe operation without the safe position and speed values.

12.6 PROFINET diagnosis alarms

The sensor can make alarms available for diagnostic purposes.

- If the FBPS detects an error, it passes this on to the I/O controller as an alarm.
- The signaling of an alarm takes place as acyclic communication.
- Alarm-specific texts can be read out and/or displayed on the I/O controller.

Tab. 12.27: PROFINET diagnosis alarms

Error type	Severity	Alarm text	Measures
2	Maintenance required	Undervoltage	Check whether the FBPS is operated according to the permissible environmental conditions. The device is still in operation and provides **valid** position values.
2	Demanded / Fatal	Undervoltage	Check whether the FBPS is operated according to the permissible environmental conditions. The device is **no** longer in operation and is not providing **any** position values.
3	Maintenance required	Overvoltage	Check whether the FBPS is being operated in accordance with the permissible connection conditions. The device is still in operation and provides **valid** position values.

Error type	Severity	Alarm text	Measures
3	Demanded / Fatal	Overvoltage	Check whether the FBPS is being operated in accordance with the permissible connection conditions. The device is **no** longer in operation and is not providing **any** position values.
258	Demanded / Fatal	Temperature error	Check whether the FBPS is being operated in accordance with the permissible ambient temperature. The device is **no** longer in operation and is not providing **any** position values.
259	Maintenance required	Temperature problem	Check whether the FBPS is being operated in accordance with the permissible ambient temperature. The device is still in operation and provides **valid** position values.

NOTICE

The specification differs depending on the device used (with/without heating).

12.7 PROFIsafe diagnosis alarms

The sensor can make alarms available for diagnostic purposes.

- If the FBPS detects an error, it passes this on to the I/O controller as an alarm.
- The signaling of an alarm takes place as acyclic communication.
- Alarm-specific texts can be read out and/or displayed on the I/O controller.

Tab. 12.28: PROFIsafe diagnosis alarms

Hex	Number	Diagnostic information	Measures
0x0040	64	Non-identical secure target address (F_Dest_Add)	
0x0041	65	Safe target destination address not valid (F_Dest_Add)	Check whether the PROFINET name contains a valid F-Dest address.
0x0043	67	Safe watchdog time is 0 ms (F_WD_Time, F_WD_Time_2)	Check the configured watchdog time and adjust if necessary.
0x0045	69	Parameter *F_CRC_Length* does not match the generated values	
0x0046	70	F parameter set version incorrect	
0x0047	71	Data inconsistent in the received F parameter block (CRC1 error)	
0x0048	72	Device-specific or unspecified diagnostic information. The configuration of the PROFIsafe parameters (F-Par) or the safe application parameters associated with the PROFIsafe module has failed.	Check that the GSDML used matches the device firmware.
0x004B	75	Inconsistent iParameters (iParCRC error)	Check configuration of the safe module and recalculate CRC with TCI Device Tool.
0x004C	76	F_Block_ID not supported	
0x004D	77	Transmission error: Data inconsistent (CRC2 error)	
0x004E	78	Transmission error: Timeout (F_WD_Time or F_WD_Time_2 elapsed)	

12.8 Addressing the FBPS 648i

On the FBPS 648i, a separate address must be assigned for communication with the control for both safe and non-safe communication. This is the PROFINET name for non-safe communication as well as the PROFIsafe address for safe communication.

In the event of a device exchange, the (safe and non-safe) addresses configured in the project should be automatically transferred to the new device.

The following condition must be met:

A special address syntax is required with which the FBPS can derive the PROFIsafe address from the PROFINET device name.

	NOTICE
	As the F address is automatically derived from the PROFINET name, it must be checked after a device exchange that the correct device has been addressed.

12.8.1 Address syntax for the FBPS 648i (F_Dest_Add)

A PROFINET device name may contain a maximum of 240 characters, consisting of lower case letters, numbers, hyphens and dots. The 240 characters contain the safe and non-safe communication addresses.

The FBPS PROFINET device name is defined as follows:

****.fdstxxxxxd****

**	Placeholder for the non-safe address part with a maximum total of 229 characters
.fdst	Unchangeable identifier for the FBPS, followed by the safe address (F address) in the next 5 digits(**xxxxx**).
xxxxx	(to be determined by the project planner) Safe address, consisting of a maximum of 5 digits. Leading zeros do not have to be written.
d	(unchangeable identifier)

12.9 TCI Device Tool for safe parameters

The TCI Device Tool calculates a checksum via the FBPS security application parameters.

This CRC is required in the PROFIsafe engineering tool (e.g. Siemens TIA Portal) and in some of the data sent to the PLC. The CRC calculation is not standardized. Each device manufacturer must therefore provide its own CRC algorithm in the device and in a corresponding PC/device tool.

With the so-called Tool Calling Interface (TCI), the PNO offers a standardized interface for transferring safe device parameters to the PC/device tool.

The CRC calculated from the safe parameters must be manually transferred to the TIA portal. The retransfer is also carried out manually. Only the data from the project planning tool is transferred to the TCI Device Tool.

The figure shows the input screen of the TCI Device Tool for the CRC calculation for the safe parameter.

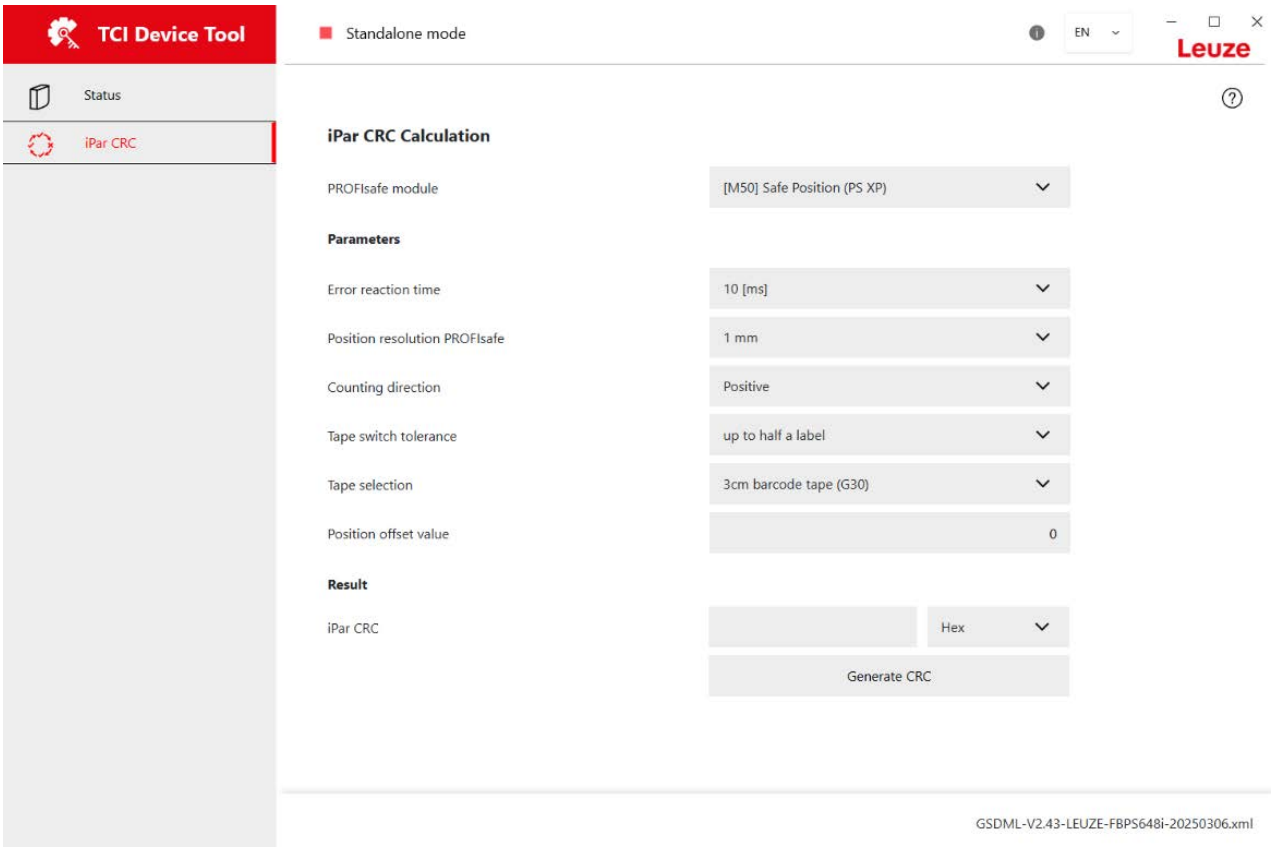


Fig. 12.1: TCI Device Tool

13 SSI interface description

The Synchronous Serial Interface (SSI) is an interface for absolute value encoders (position measuring systems). It is used to receive absolute information about the position via serial data transmission.

Data communication of the SSI interface is based on differential transmission as is used for RS 422 interfaces.

The SSI interface requires one pair of cables for the clock and a second pair of cables for the data.

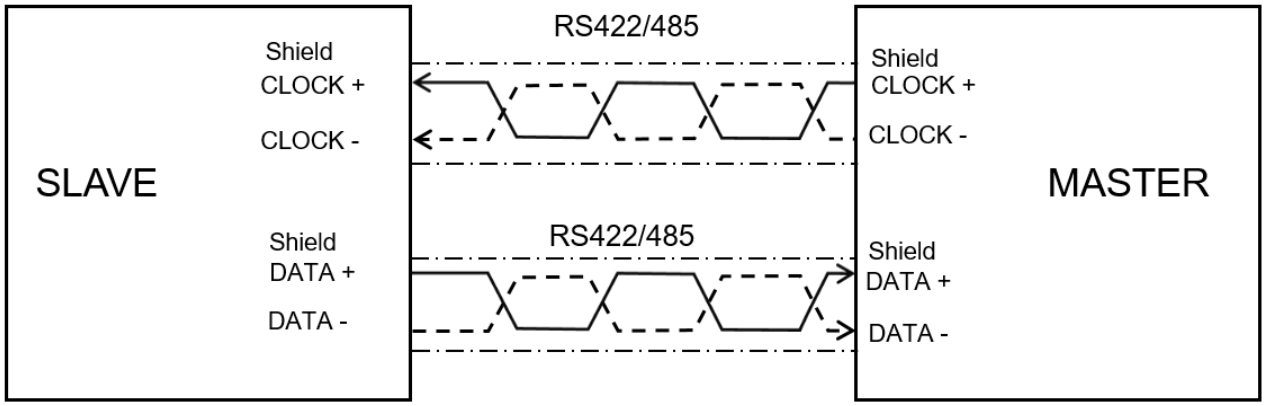


Fig. 13.1: Data transmission via RS 422

In the sensor (slave), a shift register is permanently loaded with the current position data.

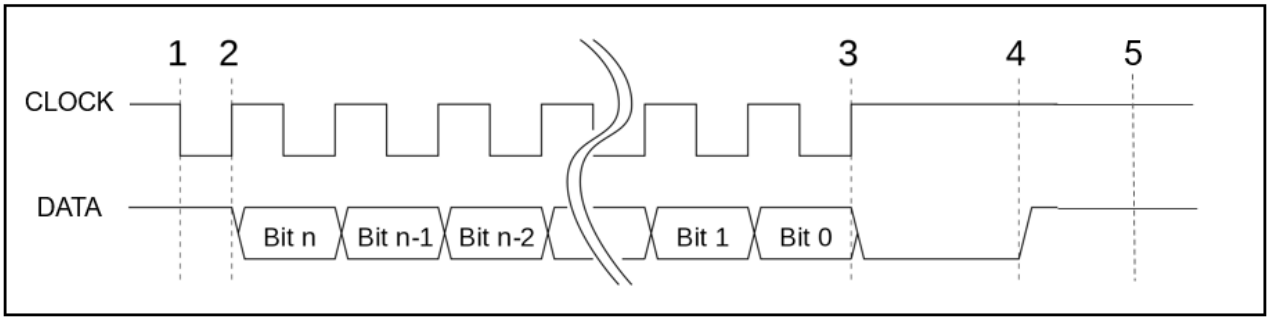
If a data value is to be transmitted by the sensor, the control (master) outputs a clock burst on the clock line.

The first falling edge of the clock burst stores the position value in the shift register of the sensor for the duration of the transmission. On every successive rising edge, a data bit is output.

The cycle is stopped when the least significant bit is received.

In the subsequent monoflop time, the shift register of the sensor loads a new data value.

At the end of the monoflop time, the new position value can be transmitted to the master by sending another clock burst.



1 Position value is stored in the shift register of the sensor.
2 Output of the first data bit
3 All data bits are transferred, the monoflop time starts.
4 The monoflop bit returns its base state, a new transmission (clock burst) can be started.
5 Clock break = idle state

Fig. 13.2: Data transmission

Clock frequency as a function of cable length

The SSI interface's data rate depends on the cable length. The permissible data rate per cable length must not be exceeded.

NOTICE
The maximum data rate (clock frequency) of the FBPS is 800 kHz.

13.1 SSI channel

The FBPS provides a non-safe position value of the interface with an update time of 2 ms, see chapter 5.3.1 "Device connection".

13.2 Internal wiring of the SSI interfaces

The internal wiring of the SSI interfaces is of significance for the following signaling types:

Signaling of an internal error

The SSI driver is deactivated. The data and clock cables are connected via the pull-up/pull-down resistor network, see chapter 11.7 "Internal error".

Signaling during the FBPS boot time

The SSI driver is deactivated. The data and clock lines are connected via the pull up / pull down resistor network, see chapter 11.2 "Signaling during startup".

13.3 Maximum position value which can be represented

The maximum displayable position value is limited by the number of data bits in relation to the resolution. An incorrectly selected position range of the BCB can lead to an overflow of the position value in relation to the configured resolution.

Example:

- Number of data bits: 24
- Resolution: 0.1 mm

If a position range of the bar code tape greater than 1677 m is used, an overflow of the SSI position value will occur.

Tab. 13.1: Maximum position value which can be represented

SSI configuration	Maximum position value which can be represented	Possible position overflow
24 bits; resolution 0.01 mm	167 m	X
24 bits; resolution 0.1 mm	1677 m	X
24 bits; resolution 1 mm	16777 m → BCB is limited to 10000 m	
25 bits; resolution 0.01 mm	335 m	X
25 bits; resolution 0.1 mm	3355 m	X
25 bits; resolution 1 mm	33554 m → BCB is limited to 10000 m	
26 bits; resolution 0.01 mm	671 m	X
26 bits; resolution 0.1 mm	6710 m	X
26 bits; resolution 1 mm	67108 m → BCB is limited to 10000 m	
27 bits; resolution 0.01 mm	1342 m	X
27 bits; resolution 0.1 mm	13421 m → BCB is limited to 10000 m	
27 bits; resolution 1 mm	134217 m → BCB is limited to 10000 m	

Reaction of the FBPS to position value overflow

A position value overflow is handled according to the criteria of an external error, see chapter 11.6 "External errors".

13.4 Monoflop time

Clock frequencies 80 – 800 kHz (standard)

If the defined monoflop time of ≤ 20 µs is not met and the subsequent clock burst is started before the 20 µs has elapsed, the same position value is clocked out again.

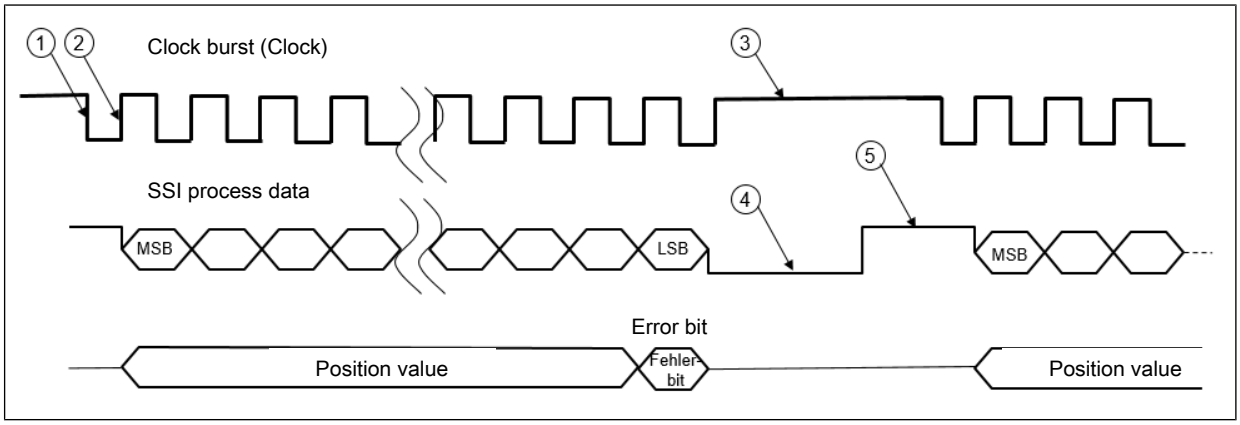
Clock frequencies: 50 – 79 kHz

If the defined monoflop time of ≤ 30 µs is not met and the subsequent clock burst is started before the 30 µs has elapsed, the same position value is clocked out again.

13.5 SSI protocol

The FBPS provides the following SSI protocol:

Data stream



1 The first falling edge of the clock burst stores the position value for the duration of the transmission in the shift register of the sensor.

2 On every successive rising clock edge, a data bit of the sensor is output, starting with the MSB of the position value.

3 The control/master ends the clocking out when the least significant bit is received. In the default setting, the LSB is the error bit.

4 At the end of the monoflop time, the shift register of the sensor loads a new data value.
The monoflop time is dependent on the set clock frequency.

5 At the end of the monoflop, the data line switches to the high level. Transmission begins again with the first falling edge of the clock burst.

Fig. 13.3: SSI protocol without CRC checksum

Example of a position calculation for X0 SSI0 (position value is gray coded)

24-bit gray coded position (standard resolution 0.1 mm)

+ 1 error bit

Raw position (24-bit Gray coded)

0111 0011 0100 1110 0110 0000 bin

MSB LSB

7556704dec Gray coded corresponds to 6130623dec binary coded.

Raw position with appended error bit (standard)

0 1110 0110 1001 1100 1100 0000 bin (24-bit position + 1 error bit)

MSB LSB The LSB is the error bit.

SSI output bit stream for X0 SSI0 (position value gray coded)*

01110011010011100110000000 bin (24-bit position + 1 error bit)

Position value Gray Error bit

* only the position value is transmitted Gray coded. The error bit remains in the binary representation.

Example of a position calculation for X0 SSI0 (position value is binary coded)

24-bit binary coded position (standard resolution 0.1 mm)

+ 1 error bit

Raw position (24-bit binary coded)

0101 1101 1000 1011 1011 1111 bin (6130623dec binary coded)

MSB LSB

Raw position with appended error bit (standard)

0 1011 1011 0001 0111 0111 1110 bin (24-bit position + 1 error bit)

MSB LSB The LSB is the error bit.

SSI output bit stream for X0 SSI0 (position value binary coded)

01011101100010111011111110 bin (24-bit position + 1 error bit)

Position value Binary Error bit

14 Starting up the device – webConfig tool

With the Leuze webConfig tool, a web-technology based, graphical user interface is available for configuring the FBPS.

The webConfig tool can be run on any Internet-ready PC. The webConfig tool uses HTTP as communication protocol and the client-side restriction to standard technologies (HTML, JavaScript and AJAX) that are supported by modern browsers.

On delivery, access to the webConfig tool is deactivated both via PROFINET and via the separate USB service interface. Activation is only possible via PROFINET module 8, see chapter 12.4.10 "Module 8 – Security control".

NOTICE

Because configuration of the safe positioning system is performed via the PROFINET-IO controller, the module overview shown in the webConfig tool is, in this case, used only for displaying and checking the configured parameters.

In service mode, it is possible to change the safety-relevant parameters of the FBPS. However, these are overwritten by the configured modules of the PLC during process operation.

NOTICE

The webConfig tool is offered in the following languages:

German, English, French, Italian, Spanish, Korean, Chinese, Portuguese

NOTICE

The webConfig tool is completely contained in the firmware of the FBPS.

The pages and functions of the webConfig tool may appear and be displayed differently depending on the firmware version.

14.1 System requirements

NOTICE

- Regularly update the operating system and the Internet browser.
- Install the current Windows Service Packs.

Tab. 14.1: webConfig system requirements

Monitor	Min. resolution: 1280 x 800 pixels
Internet browser	Recommended is a current version of Mozilla Firefox Google Chrome Microsoft Edge Note: Other Internet browsers are possible but have not been tested with the current device firmware.

Clear browser history

The cache of the Internet browser is to be cleared if different device types or devices with different firmware were connected to the webConfig tool.

- Delete cookies and temporary Internet and website data from browser history before starting the webConfig tool.

14.2 Install USB driver

NOTICE

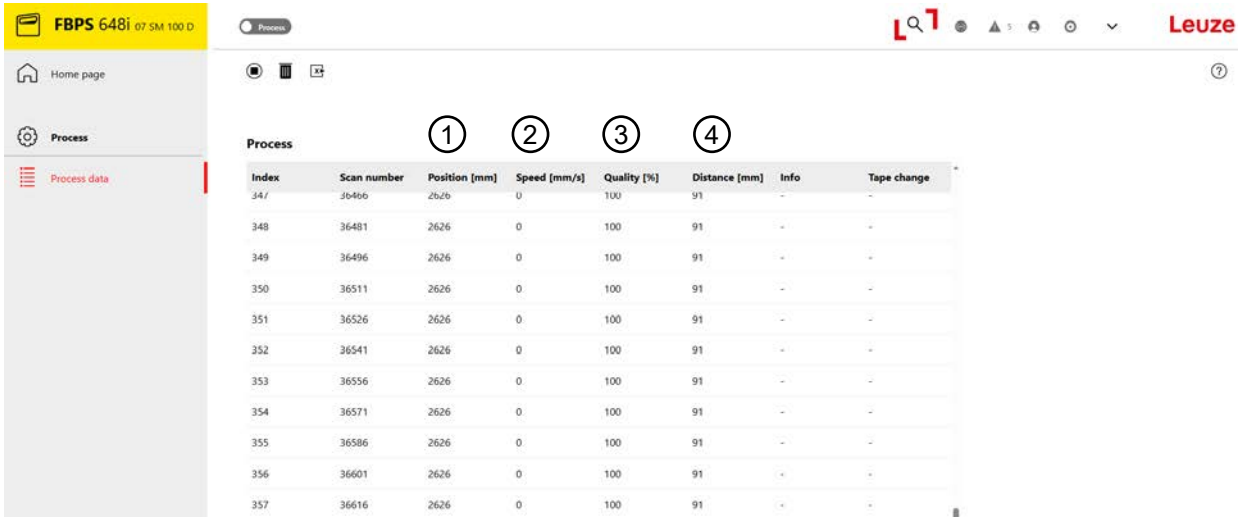
If a USB driver for the webConfig tool is already installed on your computer, the USB driver does not need to be installed again.

- Start your PC with administrator privileges and log on.
- Download the program from the Internet:
  www.leuze.com > Products > Measuring Sensors > Bar Code Positioning Systems > FBPS 600i > (Name of the FBPS) > Tab **Downloads > Software/driver**.
- Start the setup program and follow the instructions.

14.3 Start webConfig tool

Prerequisite: The Leuze USB driver for the webConfig tool is installed on the PC.

- Connect the supply voltage to the FBPS.
- Connect the SERVICE USB interface of the FBPS to the PC.
  The connection to the SERVICE USB interface of the FBPS is established via the PC-side USB interface.
  Use a standard USB cable with one Type A connector and one Mini-B type plug.
- Start the webConfig tool using your PC's Internet browser with IP address **192.168.61.100**
  This is the default Leuze service address for communication with bar code positioning systems.
- ⇨ The webConfig start page appears on your PC.



1 Current position value
2 Current speed
3 Current reading quality
4 Reading distance to the bar code tape

Fig. 14.1: The start page of the webConfig tool

NOTICE

On delivery, access to the webConfig tool is deactivated both via PROFINET and via the separate USB service interface. Activation is only possible via PROFINET module 8, see chapter 12.4.10 "Module 8 – Security control".

The webConfig tool is started in the *process* operating mode after startup.

14.4 Short description of the webConfig tool

The menus and dialog boxes of the webConfig tool are intuitive to operate and provide texts and tool tips. The start page of the webConfig tool displays the current process information.

14.4.1 Switching operating mode

You can use the webConfig tool to switch between the following operating modes:

Process

- The device is connected to the control or to the PC.
- Process communication with the control is active and safe position values are provided via the interfaces.
- The switching inputs/outputs are activated.
- The configuration cannot be changed.

Service

- The *Service* operating mode enables read and write access to all registers.
- The process communication to the control is interrupted and no safe position values are provided via the interfaces.
- The switching inputs/outputs are deactivated.
- The configuration can be changed.
- The FBPS signals an external error, see chapter 11.6 "External errors".

NOTICE

In general, parameters, especially safe parameters, should not be changed via the webConfig tool, but via the configured modules in the safe control. With respect to the safety functions of the overall system, the safe position detection must be qualified in the context of the system's safety requirements again.

↳ To do this, move the FBPS along the entire bar code tape.

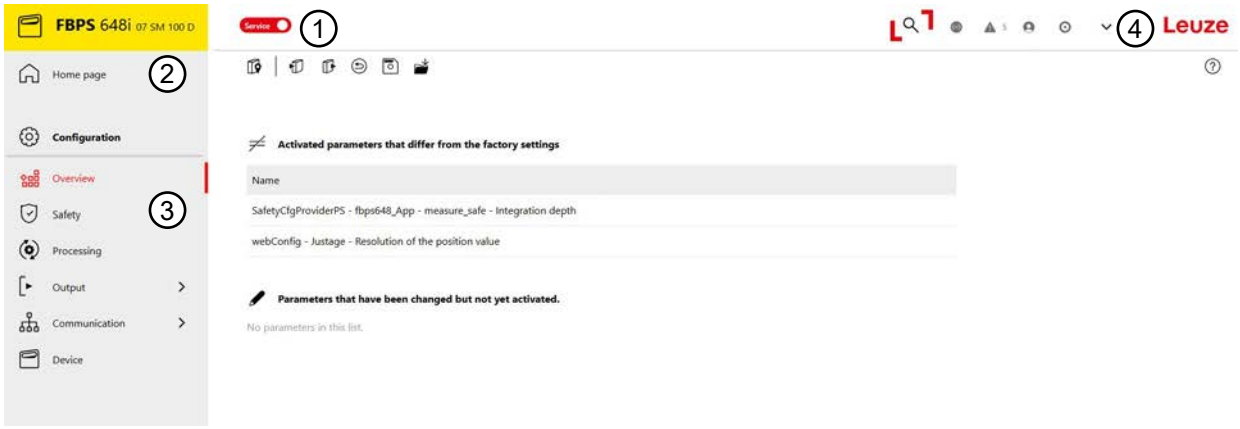
⇨ Possible operating states and how they are signaled, see chapter 11 "Operating states", Signaling via the status LEDs see chapter 17.3 "Diagnosis via the LED indicators".

⇨ The safety function of the overall system is satisfied if the FBPS can be moved along the entire bar code tape without external or internal error signaling.

NOTICE

Do not release the system for operation until the renewed qualification has been completed error-free.

Located in the top left of every page of the webConfig tool is a software switch for changing the operating mode (Process – Service).



1 Switching between the *process* and *service* operating modes
2 Menu structure
3 Toolbar configuration
4 Language switching

Fig. 14.2: webConfig tool – Overview

14.4.2 Menu structure

The [Home page] button displays the webConfig tool's menu structure.

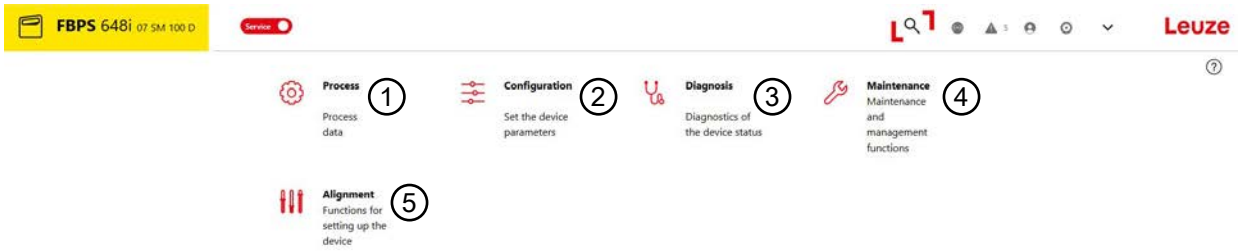


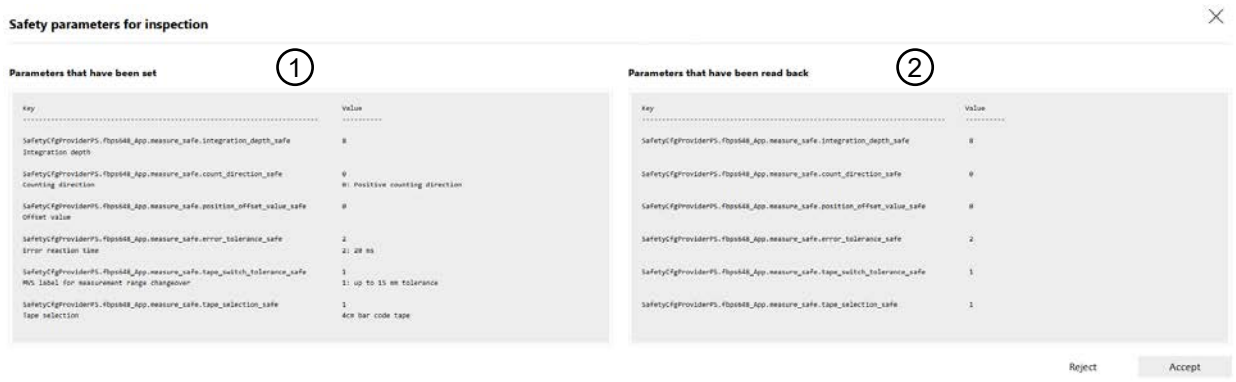
Fig. 14.3: webConfig tool – Menu structure

1. **PROCESS**
   - Information on the current result
2. **CONFIGURATION**
   - Overview of changed parameters to the delivery status
   - Safety parameters
   - Process quality
   - Data output – webConfig for the adjustment function
   - Communication: Service USB and PROFINET interface
   - Device: Display settings
3. **DIAGNOSIS**
   - Event logging of info, warnings and errors
4. **MAINTENANCE**
   - User management
   - Backup/Restore
   - Firmware update
   - System clock
   - Settings
5. **ALIGNMENT**
   - Measurement values
   - Reading quality

Validation of the safety parameters that have been read back

If safe parameters are set via webConfig, these must be read back for validation and the change confirmed.

↳ Compare in detail the set parameters with those that were read back.



1 Set safety parameters
2 Safety parameters that have been read back

Fig. 14.4: Validating parameters

Confirmation of the safety parameters

Fig. 14.5: Confirming safety parameters

Accept: The parameters are activated in the FBPS.

Refuse: The changed parameters are not activated.

	NOTICE
	The safe parameters set here only apply in *Service* operating mode. After switching to *Process* operating mode, the safe parameters from the safe program of the connected control are overwritten on the FBPS.

15 Validating the safety function

The safe positioning system consists of two spatially separated components:

- the bar code tape (BCB)
- the read head for the determination of the safe position (FBPS)

In the system, the two components are combined to form a safe positioning system.

During commissioning, the safe position of the positioning system must be validated in the position ranges in which a safety function is planned by means of the safety concept.

↳ Make sure that the read head (FBPS) and the bar code tape (BCB) are installed in accordance with the specifications described in the operating instructions.

↳ Perform a reference movement.

The determined safe position of the FBPS is dependent on the mounting of the FBPS with respect to the BCB and on the attachment of the BCB.

The determined safe position data of the FBPS is transmitted to the safe control by traveling over the entire traversing path. The FBPS must signal neither external nor internal errors.

Part of the commissioning process is to check the plausibility and to validate these safe position values with the expected values in the safe control.

If accelerations are derived from the safe position values or safe speeds in the safe control, the system planner is responsible for validating the correct, safety-relevant behavior (use of suitable safety functions) and commissioning.

The reference movement validates the output of safe position values e.g. in the case of:

- Expansion joints
- Switches
- Paths with rising and falling gradients
- Damages and deliberate interruptions of the BCB
- Possible partial electromagnetic coupling with the FBPS

The safety function of the positioning system must be validated and logged by a safety officer.

16 Care, maintenance and disposal

Cleaning the device

If there is dust on the device:

- Clean the device with a soft cloth; use a cleaning agent (commercially available glass cleaner) if necessary.

NOTICE
Do not use aggressive cleaning agents! - Do not use aggressive cleaning agents such as thinner or acetone for cleaning the device.

Clean the bar code tape

- Clean the bar code tape as necessary with a mild cleaning agent such as commercial cleaning detergent.
- Do not use cleaning agents with abrasive properties or solvents (e.g. acetone). When cleaning, take care not to scratch the surface of the tape.

NOTICE
Do not use abrasive cleaning aids! Cleaning devices that constantly travel along and press against the bar code tape such as sponges or brushes are not permitted. Over time, this type of cleaning will give the bar code tape a high-gloss finish, rendering it unreadable.

NOTICE
Follow the instructions when using a repair tape: Repair bar code tapes and see chapter 6.4.4 "Online repair bar code tapes".

Servicing

NOTICE
Safety sensors must be replaced after the specified mission time T_M, see chapter 19.1 "Safety-relevant data". Always exchange entire safety sensors. Carry out the replacement as described, see chapter 10 "Device replacement".

Disposing

NOTICE
For disposal observe the applicable national regulations regarding electronic components.

17 Diagnosis and troubleshooting

17.1 System restart

NOTICE
The FBPS signals various system and error messages via the process interface, the display elements and the webConfig tool. ↳ In this regard, it is essential that you carefully read chapter 12 Operating states of the FBPS and how they are signaled, see chapter 11 "Operating states". All restart concepts of the FBPS for all operation and system states are described there. ↳ When defining the system-side safety concept, note that the FBPS does not have a restart interlock following the rectification of errors.

The elimination of the cause of an error does not necessarily need to occur through the active intervention of a person.

Examples:

1. Direct sunlight on the bar code tape or on the optics of the FBPS can trigger an external error due to the resulting reduction in reading quality. This is automatically rectified as soon as the sunlight is no longer present.
2. If, following an overvoltage or undervoltage diagnosed by the FBPS, the supply voltage is again in the specified range, the FBPS automatically starts up. If startup occurs error-free, the FBPS begins to operate.

Whether or not the system can be restarted automatically after an error signal sent by the FBPS has been rectified, is determined by the unit that performs the evaluation or by the safety concept of the system.

NOTICE
When switching from the *service* operating mode to the *process* operating mode, the FBPS automatically restarts.

17.2 What to do in case of failure?

After switching on the FBPS, the display elements assist in checking that everything is functioning correctly and in identifying errors or malfunctions.

In the case of an error, the LEDs indicate possible error sources by means of various display colors and different flashing frequencies. Using this information, it is possible to determine the cause of an error and take measures for error rectification.

The *FBPS Info* info line in the optional display shows which error category is present: Info and/or Warning and/or Error. If an error occurs, it will be indicated in the PLC's event memory and diagnostic function.

If the error state of the FBPS cannot be rectified:

↳ Switch off the system and leave it switched off.
The safety functions monitored through the use of the FBPS can no longer be ensured.

↳ Contact the responsible Leuze subsidiary or Leuze service, see chapter 18 "Service and support".

17.3 Diagnosis via the LED indicators

Tab. 17.1: PWR (power) status indicator LED

Status indicator	Possible cause	Measures
Off	• No supply voltage • Supply voltage too high (> 34 V DC) • Operating temperature exceeded or not met	• Check supply voltage • Check operating temperature
	Power on, the FBPS is initialized	• Observe the warmup time, see chapter 19.4 "Startup and warmup times" • Send the FBPS in for repair if the status does not change
	The FBPS is operating error-free	-
	Wave function (synchronous with NET LED)	-
	Service mode active	Activate process mode
	External error, see chapter 11.6 "External errors"	Rectify causes, see chapter 11.6 "External errors"
	Internal error, see chapter 11.7 "Internal error"	• Send the FBPS in for repair if startup does not occur after power off/on • Check supply voltage

Tab. 17.2: NET LED status indicators

Status indicator	Possible cause	Measures
Off	• No supply voltage • Supply voltage too high (> 34 V DC) • Operating temperature exceeded or not met • No connection attempt made by the control	• Check supply voltage • Check operating temperature
	Connection to the PLC is established	• Observe the warmup time, see chapter 19.4 "Startup and warmup times" • Send the FBPS in for repair if the status does not change
	Connection to the PLC is error-free	-
	Wave function (synchronous with LED PWR)	-
	• Configuration error • Connection to the PLC interrupted • Topology error detected	Check diagnosis alarm and connection to the PLC
	Internal error, see chapter 11.7 "Internal error"	• Send the FBPS in for repair if startup does not occur after power off/on • Send FBPS in for repair

Tab. 17.3: PS LED status indicators

Status indicator	Possible cause	Measures
Off	• No supply voltage • Supply voltage too high (> 34 V DC) • Operating temperature exceeded or not met	• Check supply voltage • Check operating temperature
	• 2 Hz: no PROFIsafe connection to the PLC • 0.5 Hz: Device in passive state or acknowledgement required	• Observe the warmup time, see chapter 19.4 "Startup and warmup times" • Check PLC connection
	The FBPS is operating error-free	-
	Wave function	-
	PROFIsafe configuration failed	Check configuration
	• Internal error, see chapter 11.7 "Internal error"	• Send the FBPS in for repair if startup does not occur after power off/on

18 Service and support

Service hotline

You can find the contact information for the hotline in your country on our website **www.leuze.com** under **Contact & Support**.

Repair service and returns

Defective devices are repaired in our service centers competently and quickly. We offer you an extensive service packet to keep any system downtimes to a minimum. Our service center requires the following information:

- Your customer number
- Product description or part description
- Serial number or batch number
- Reason for requesting support together with a description

Please register the merchandise concerned. Simply register return of the merchandise on our website **www.leuze.com** under **Contact & Support > Repair Service & Returns**.

To ensure quick and easy processing of your request, we will send you a returns order with the returns address in digital form.

19 Technical data

19.1 Safety-relevant data

Tab. 19.1: Safety-relevant data

SIL in accordance with IEC / EN IEC 62061	SIL 3
SIL in accordance with EN 61508	SIL 3
Performance Level (PL) in accordance with ISO / EN ISO 13849-1	PL e
Category in accordance with ISO / EN ISO 13849-1	Cat. 4
Probability of dangerous failure per hour (PFH_d)	< 9.5 x 10^{-9} 1/h
Mission time (T_M)	20 years (ISO / EN ISO 13849-1)
$MTTF_d$ (without device heating)	52 years
$MTTF_d$ (with device heating)	44 years
DC avg	> 99.3 %
Error reaction time (ERT)	Adjustable (10 / 20 / 50 /100 / 200 / 400 ms) Standard: 10 ms
Accuracy	see chapter 4.3 "Accuracy of the measurement system"
Reproducibility	±0.15 mm (1 sigma) with a response time (integration time) of 8 ms see chapter 4.3 "Accuracy of the measurement system"
Safe position	±4 mm, see chapter 4.3.1 "Safe position"
Maximum speed with respect to the BCB	10 m/s

19.2 Certifications, conformity

Tab. 19.2: Certifications, conformity

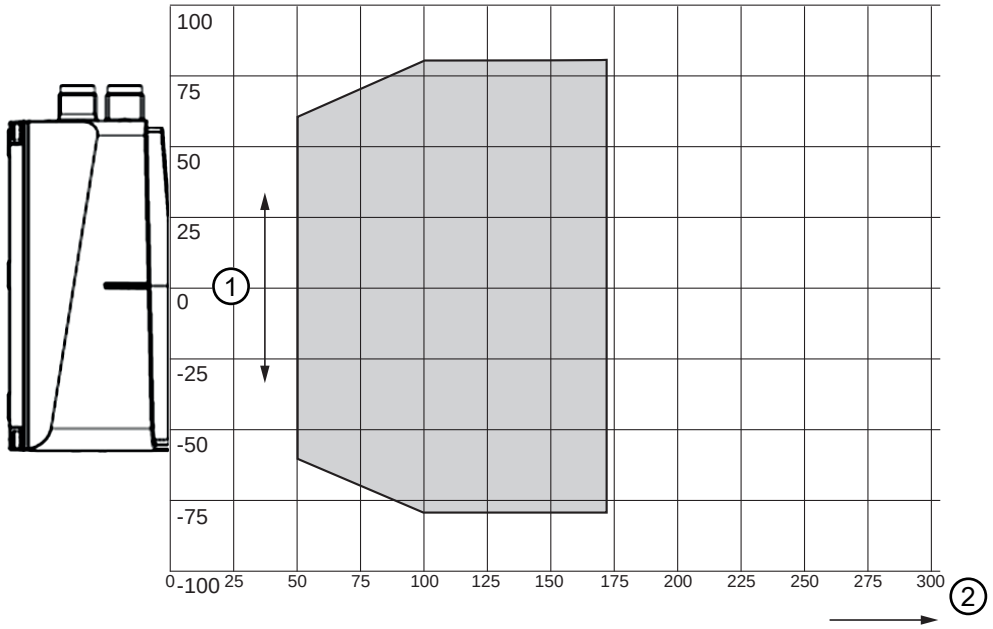
Certifications	
UL	UL 62368-1
CSA	CAN/CSA C22.2 No. 62368-1-14
NRTL	c TÜV NRTL US
TÜV	TÜV Süd
CE conformity	
CE	CE
Degree of protection	IP65
Protection class	III

19.3 General specifications

Tab. 19.3: Optical data

Light source	Laser diode
Wavelength	655 nm
Impulse duration	< 150 µs
Maximum output power	1.8 mW

Ambient light sensitivity	30000 lx (on the bar code tape)
Life expectancy laser diode	250,000 h (typ. at +25 °C)
Beam deflection	Via rotating polygon wheel
Exit window	Glass
Laser class	1 acc. to IEC 60825-1:2014 / EN 60825-1:2014+A11:2021
Working range	50 mm … 170 mm Reading distance 50 mm: reading field 120 mm Reading distance from 100 mm: reading field width 160 mm



1 Reading field width [mm]
2 Reading distance [mm]

Fig. 19.1: Reading field curve FBPS 600i

Tab. 19.4: Measurement data

Reproducibility (1 sigma)	±0.15 mm, see chapter 4.3 "Accuracy of the measurement system" Valid for an uninterrupted, contiguously affixed bar code tape
Response time (integration time)	8 ms
Output time	2 ms
Dynamic measurement error	see chapter 4.3.3 "Dynamic measurement error"
Measurement range	0 … 10,000,000 mm Dependent on the value range of the bar code tape and on the selected resolution for the interfaces
Maximum detectable speed	10 m/s
Minimum detectable speed	4 mm/s
Maximum acceleration	±100 m/s²

Tab. 19.5: PROFIsafe response times

	Minimum	Maximum
Maximum reaction time in the error-free case (WCDT)	-	11 ms + ERT [ms] + PROFINET cycle time [ms]
PROFIsafe processing and data output (DAT)	-	23 ms + PROFINET cycle time [ms]
PROFIsafe watchdog time (F_WD_Time)	50 ms	10000 ms

Tab. 19.6: Electrical data

Supply voltage U_B	24 V DC ±25 % PELV, Class 2 / SELV
Switching input Switching output	SWI: Digital switching input (default: “No function”) SWO: Digital switching output (default: “Invalid position value”) Maximum load = 60 mA
Power consumption without device heating	Max. 8.5 W
Current consumption without device heating at 18 V DC	Max. 400 mA
Current consumption without device heating at 24 V DC	Max. 350 mA
Power consumption with device heating	max. 24 W
Current consumption with device heating at 18 V DC	1100 mA
Current consumption with device heating at 24 V DC	1000 mA

Tab. 19.7: Interfaces

Interface type	PROFINET-RT with integrated switch for IN and OUT Protocols: • PROFINET RT • PROFIsafe • SSI
Service interface	Mini-B type USB 2.0 socket

Tab. 19.8: Connections

XD1 PWR	M12 connector, 5-pin, A-coded
XF1 IN	M12 connector, 4-pin, D-coded
XF2 OUT	M12 connector, 4-pin, D-coded
X0 SSI0	M12 connector, 5-pin, B-coded
XF0 SERVICE	USB 2.0 Mini B connector

Tab. 19.9: Mechanical data

Housing	Diecast aluminum
Connections	4 x M12 (PWR; SSI0; PN IN; PN OUT) 1 x USB 2.0 Mini-B type socket

Degree of protection	IP65 acc. to DIN EN 60529
Weight without packaging	Approx. 540 g

Tab. 19.10: Operation and display

LEDs	5 LEDs (1 x PWR; 1 x NET; 1 x PS; 2 x LINK)
Display (version FBPS 6xxi … D)	Monochromatic graphical display, 128 x 32 pixel with LED background lighting
Keyboard (version FBPS 6xxi … D)	2 membrane keyboards

Tab. 19.11: Environmental data

Ambient temperature (operation)	
Devices without device heating	-5 °C … +60 °C
Devices with device heating	-35 °C … +60 °C
Ambient temperature (storage)	
Devices without/with device heating	-35 °C … +70 °C
Air humidity	Max. 90% rel. humidity, non-condensing
Operating altitude	Max. 3500 meters above sea level

19.4 Startup and warmup times

Tab. 19.12: Startup and warmup times

Warmup time for low-temperature use	At -35°C, approx. 30 minutes after power-on
Boot time between power-on and safe measurement value output at PROFIsafe	The boot time is dependent on the ambient temperature and the inside temperature at the time of power-on. -5°C to +60°C: Boot time 10 s + PN/PS connection setup by PLC -35°C: boot time approx. 30 minutes

19.5 Bar code tape

Bar code tape adhesive strength

Tab. 19.13: Bar code tape adhesive strength

Adhesive strength (average values)	• on steel: 22 N / 20 mm • on polypropylene: 20 N / 20 mm

Print data

Tab. 19.14: Print data

Bar code	Code 128 character set C, 6 digits (increasing in increments of 3 or 4)
Length tolerance of the bar code tape	±1 mm/m
Module	0.33 mm (G30) / 0.44 mm (G40)
Ratio	1:2:3:4
Contrast	≥ 95 %

Environmental data

Tab. 19.15: Environmental data

Recommended processing temperature	+10°C up to +25°C
Processing temperature	0°C … +45°C
Ambient temperature	-40°C to +120°C
Curing	Final curing after 72 hours The FBPS can detect the position immediately after the BCB is affixed.
Weathering resistance	• UV light resistance based on ISO 4892-2 method A • Humidity
Chemical resistance In its affixed state, the bar code tape is resistant to chemicals at its front surface (i.e. the side of the bar code that is read). The rear side is not resistant to chemicals.	• Distilled water: 24 h / 21°C • Diesel oil: 6 h / 21°C • White spirit: 1 h / 21°C • Heptane: 1 h / 21°C • Cold cleaner: 6 h / 21°C • Antifreeze: 24 h / 21°C • Isopropyl alcohol (IPA 70% / 99.9%): wipe-resistant • Solvents (e.g. acetone): no resistance • Ethylene glycol: no resistance
Behavior in fire	Not self-extinguishing, does not drip
Mounting surface	Grease-free, dry, clean, smooth

Bar code tape variants

Information about the bar code tapes:

- Standard tapes
- Special tapes
- Twin tapes
- Repair tapes

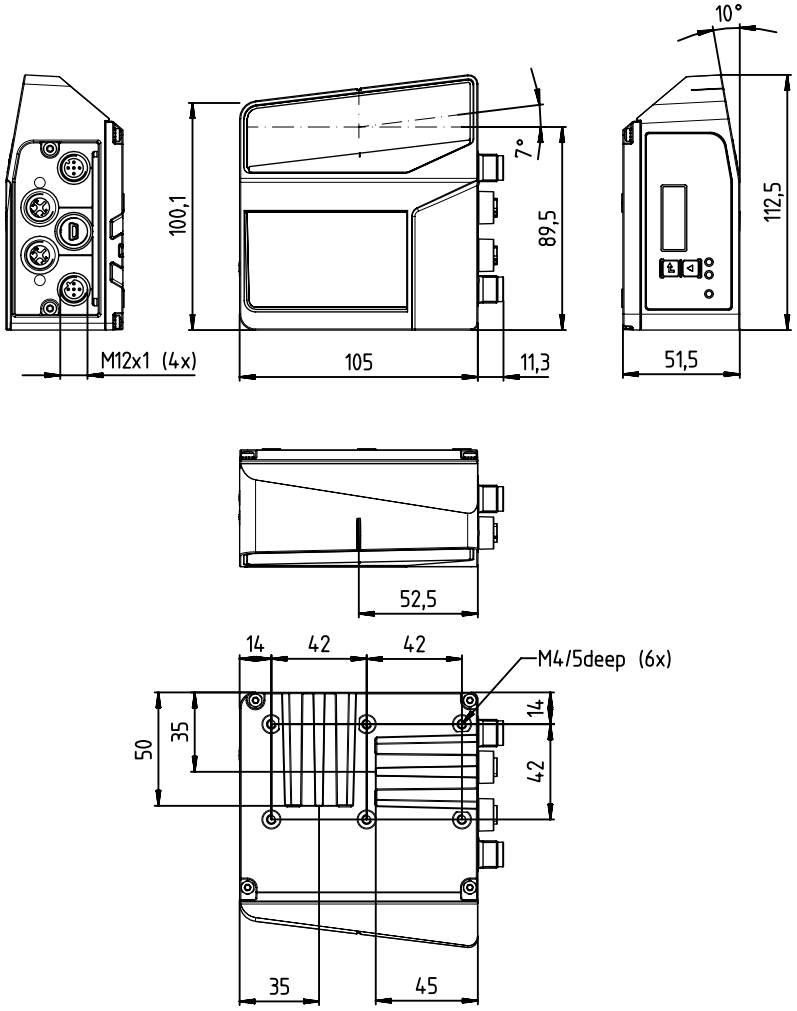
see chapter 6.4 "Types of bar code tapes"

Information on the MVS control bar code see chapter 6.5 "MVS label control bar code".

19.6 Dimensioned drawings

19.6.1 FBPS 648i … SM 100 … dimensioned drawings (side plug outlet)

Dimensions (H x W x D)	112.5 mm x 116.3 mm x 51.5 mm

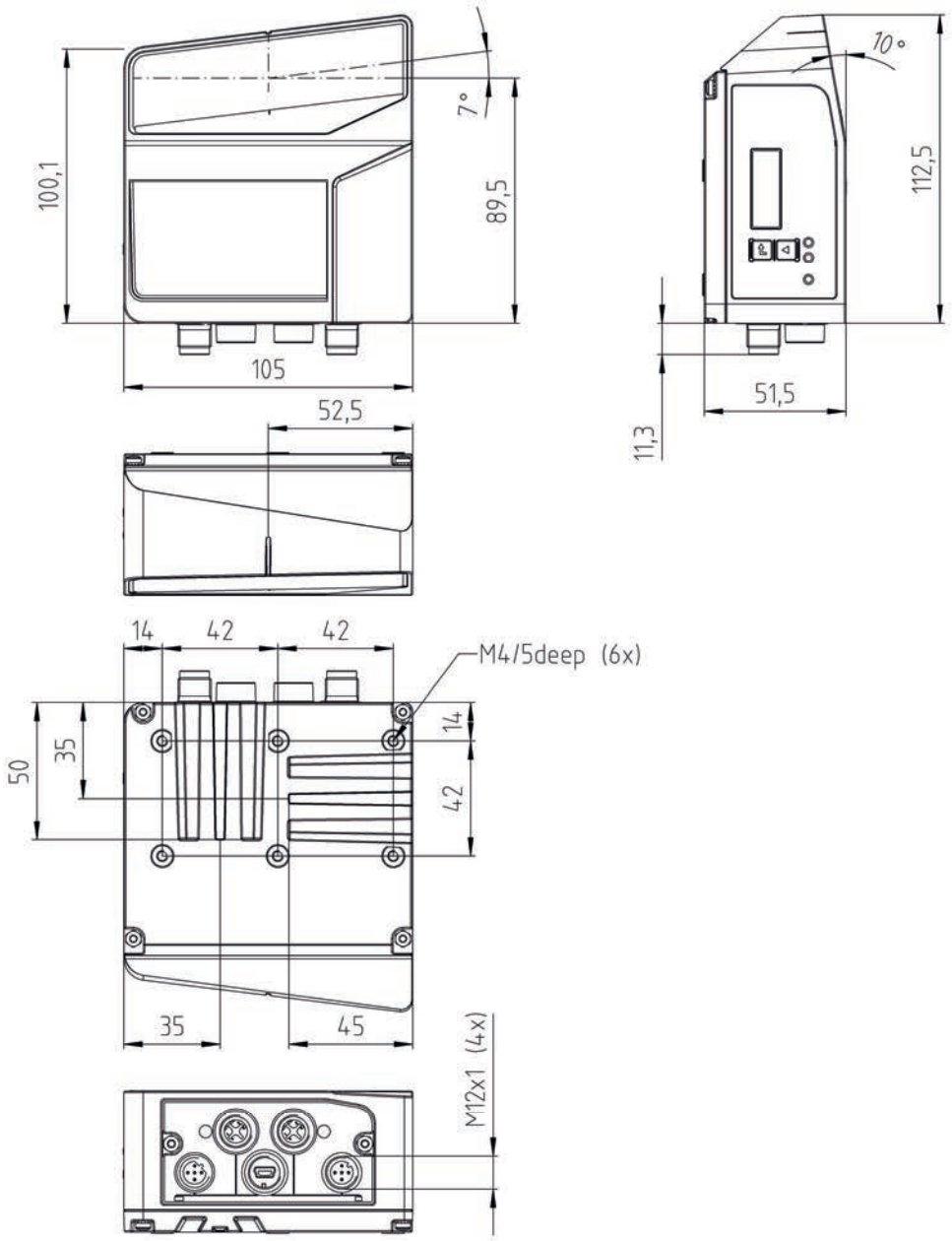


All dimensions in mm

Fig. 19.2: Dimensioned drawing of FBPS 648i with side connector

19.6.2 FBPS 648i … SM 110 … dimensioned drawings (bottom plug outlet)

Dimensions (H x W x D)	123.8 mm x 105.0 mm x 51.5 mm



All dimensions in mm

Fig. 19.3: Dimensioned drawing of FBPS 648i, bottom connector

20 Order guide and accessories

20.1 Part number code

FBPS 6xxi SM 1x0 x

Example: FBPS 648i 07 SM 110

FBPS	Fail-safe bar code positioning system
6	Series: FBPS 600i
xx	Interface: 07: 2-channel standard SSI 17: 2-channel SSI with CRC 48: PROFINET/PROFIsafe with SSI interface
i	i: Integrated fieldbus technology
S	Scanning principle: S: Line scanner
M	Optics: M: Medium distance (medium density)
1x0	Plug outlet: 100: side 110: bottom
x	Options: -: Device without additional options D: Display H: Heating

NOTICE

A list with all available device types can be found on the Leuze website **www.leuze.com**.

20.2 Type overview

Tab. 20.1: Type overview FBPS 648i

Part no.	Part designation	Description
50140960	FBPS 648i 07 SM 100	PROFINET/PROFIsafe and standard SSI, side plug outlet
50140961	FBPS 648i 07 SM 100 D	PROFINET/PROFIsafe and standard SSI, side plug outlet, display
50140962	FBPS 648i 07 SM 100 H	PROFINET/PROFIsafe and standard SSI, side plug outlet, heating
50140963	FBPS 648i 07 SM 110	PROFINET/PROFIsafe and standard SSI, bottom plug outlet
50140964	FBPS 648i 07 SM 110 D	PROFINET/PROFIsafe and standard SSI, bottom plug outlet, display
50140965	FBPS 648i 07 SM 110 H	PROFINET/PROFIsafe and standard SSI, bottom plug outlet, heating

20.3 Accessories – connection technology

Tab. 20.2: Power connection cables

Part no.	Part designation	Description
M12 socket (5-pin, A-coded), PUR, axial connector, open cable end, UL		
50133839	KD U-M12-5A-P1-20	PWR connection cable, length 2 m, unshielded
50133840	KD U-M12-5A-P1-30	PWR connection cable, length 3 m, unshielded
50133841	KD U-M12-5A-P1-50	PWR connection cable, length 5 m, unshielded
50132534	KD U-M12-5A-P1-100	PWR connection cable, length 10 m, unshielded
50133859	KD S-M12-5A-P1-20	PWR connection cable, length 2 m, shielded
50133860	KD S-M12-5A-P1-50	PWR connection cable, length 5 m, shielded
50133861	KD S-M12-5A-P1-100	PWR connection cable, length 10 m, shielded

Tab. 20.3: SSI connection cables

Part no.	Part designation	Description
M12 socket (5-pin, B-coded), PUR, axial connector, open cable end, shielded		
50104172	KB SSI/IBS-2000-BA	SSI connection cable, length 2 m
50104171	KB SSI/IBS-5000-BA	SSI connection cable, length 5 m
50104170	KB SSI/IBS-10000-BA	SSI connection cable, length 10 m
50104169	KB SSI/IBS-15000-BA	SSI connection cable, length 15 m
50108446	KB SSI/IBS-30000-BA	SSI connection cable, length 30 m

Tab. 20.4: Ethernet connection cables (to open end)

Part no.	Part designation	Description
M12 plug (4-pin, D-coded), axial connector, open cable end, shielded, UL		
50135073	KS ET-M12-4A-P7-020	Ethernet connection cable, length 2 m
50135074	KS ET-M12-4A-P7-050	Ethernet connection cable, length 5 m
50135075	KS ET-M12-4A-P7-100	Ethernet connection cable, length 10 m
50135076	KS ET-M12-4A-P7-150	Ethernet connection cable, length 15 m
50135077	KS ET-M12-4A-P7-300	Ethernet connection cable, length 30 m

Tab. 20.5: Ethernet interconnection cables (to RJ45)

Part no.	Part designation	Description
M12 connector (4-pin, D-coded), axial connector, to RJ-45 connector, shielded, UL		
50135080	KSS ET-M12-4A-RJ45-A-P7-020	Ethernet interconnection cable, length 2 m
50135081	KSS ET-M12-4A-RJ45-A-P7-050	Ethernet interconnection cable, length 5 m
50135082	KSS ET-M12-4A-RJ45-A-P7-100	Ethernet interconnection cable, length 10 m
50135083	KSS ET-M12-4A-RJ45-A-P7-150	Ethernet interconnection cable, length 15 m
50135084	KSS ET-M12-4A-RJ45-A-P7-300	Ethernet interconnection cable, length 30 m

Tab. 20.6: USB interconnection cable

Part no.	Part designation	Description
USB service line, type 1 connector and type Mini-B connector, axial connector		
50117011	KB USB A – USB MiniB	USB interconnection cable for webConfig tool, length 1.5 m

NOTICE

A list of all available accessories can be found on the Internet at **www.leuze.com**.

- On the website, enter the type designation, the part number or search term "FBPS" in the search window.
- Select one of the listed devices.
- ⇨ The connection technology is listed in the Accessories tab of the respective device.

20.4 Accessories – mounting systems

Tab. 20.7: Mounting systems

Part no.	Type designation	Description
50124941	BTU 0300M-W	Mounting device / quick-change system
50121433	BT 300 W	Mounting bracket

20.5 Bar code tapes

20.5.1 Standard bar code tapes

Leuze offers a wide selection of standardized bar code tapes.

Tab. 20.8: Data for standard bar code tapes

Feature	Value
Grid dimensions	30 mm (BCB G30 …) 40 mm (BCB G40 …)
Height	47 mm 25 mm
Length	5 m 10 m, 20 m … in 10 m increments up to 150 m 200 m
Length graduation	10 m
Tape start value	0

- Standard bar code tapes are printed below the bar code with the corresponding position value.
- The bar code tapes are wound and delivered on a core.

All available standard tapes are listed on the Leuze website under the currently selected FBPS in the *Accessories* tab.

20.5.2 Special bar code tapes

Special tapes are produced according to customer specifications.

Tab. 20.9: Data for special bar code tapes

Feature	Value
Grid dimensions	30 mm (BCB G30 …) 40 mm (BCB G40 …)
Height	20 mm – 140 mm in millimeter increments
Length	Configurable, maximum 10,000.02 m
Tape start value	Configurable
Tape end value	Configurable, maximum tape end value at 9,999.99 m

- Special bar code tapes are printed below the bar code with the corresponding position value.
- Special bar code tapes over 300 m in length are wound and delivered on multiple rolls.

NOTICE
On the Leuze website **www.leuze.com** under - **Products > Measuring sensors > Bar code positioning systems > FBPS** – *Accessories* tab and alternatively under - **Products > Accessories > Bar code tapes > Product selector** an entry wizard is available for all types of special, repair and TWIN bar code tapes. The entry wizard provides support when entering the individual pieces of tape data and creates a query or order form with the correct part number and type designation.

20.5.3 Repair bar code tapes

Repair bar code tapes are produced according to customer specifications.

Tab. 20.10: Data for repair bar code tapes

Feature	Value
Grid dimensions	30 mm (BCB G30 …) 40 mm (BCB G40 …)
Height	47 mm 25 mm
Length	Configurable, maximum 5 m
Tape start value	Configurable
Tape end value	Configurable

- Repair bar code tapes longer than 5 m must be ordered as special tapes.
- Repair bar code tapes are printed below the bar code with the corresponding position value.
- Repair bar code tapes are usually delivered wound on a roll.

NOTICE
On the Leuze website **www.leuze.com** under - **Products > Measuring sensors > Bar code positioning systems > FBPS** – *Accessories* tab and alternatively under - **Products > Accessories > Bar code tapes > Product selector** an entry wizard is available for all types of special, repair and TWIN bar code tapes. The entry wizard provides support when entering the individual pieces of tape data and creates a query or order form with the correct part number and type designation.

20.5.4 TWIN bar code tapes

TWIN bar code tapes are special bar code tapes and are manufactured according to customer specifications.

Tab. 20.11: Data for TWIN bar code tapes

Feature	Value
Grid dimensions	30 mm (BCB G30 …) 40 mm (BCB G40 …)
Height	20 mm – 140 mm in millimeter increments
Length	Configurable, maximum 10,000.02 m
Tape start value	Configurable
Tape end value	Configurable, maximum tape end value at 9,999.99 m

- Two identical tapes are delivered in one package. The tape values as well as the tape tolerances are identical on both tapes. The tapes are printed with the position value in plain text below and above the bar code.
- Twin bar code tapes over 300 m in length are wound and delivered on multiple rolls.

	NOTICE
	On the Leuze website **www.leuze.com** under - **Products > Measuring sensors > Bar code positioning systems > FBPS** – *Accessories* tab and alternatively under - **Products > Accessories > Bar code tapes > Product selector** an entry wizard is available for all types of special, repair and TWIN bar code tapes. The entry wizard provides support when entering the individual pieces of tape data and creates a query or order form with the correct part number and type designation.

20.5.5 MVS control label

Tab. 20.12: MVS control label

Part no.	Type designation	Description
50106476	BCB G30 H47 MVS	MVS control label, packaging unit 10 pieces
50106478	BCB G40 H47 MVS	MVS control label, packaging unit 10 pieces

21 EC Declaration of Conformity

The fail-safe bar code positioning systems of the FBPS 600i series have been developed and manufactured in accordance with the applicable European standards and directives.

	NOTICE
	You can download the EC Declaration of Conformity from the Leuze website. ↳ Call up the Leuze website: *www.leuze.com*. ↳ Enter the type designation or part number of the device as the search term. The article number can be found on the name plate of the device under the entry “Part. No.”. ↳ The documents can be found on the product page for the device under the *Downloads* tab.