Manual

Radarsensor M30 Documentation

Document version: *2026-07-03 - 507913e1fb40783432f36d242d12f5e3d7fd7b68*

CONTENTS

CHAPTER

ONE

ABOUT THIS GUIDE

1.1 Validity

This guide provides extensive information about the IO-Link configuration of the following product:

Product description

Type: BRS S–M30S04–0301–LA2–000S04
Order code: BRS0002

Note

The configuration guide does not replace the user's guide. Read the appropriate user's guide and the other applicable documents completely before installing and operating the product.
About this Guide
This guide was created in English. Other language versions are translations of this guide.

1.2 Symbols and conventions

Individual action **instructions** are indicated by a preceding triangle.

► Instruction 1

Action sequences are numbered:

1. Instruction 1
2. Instruction 2

Numbers unless otherwise indicated are decimals (e.g. 23). Hexadecimal numbers are represented with a preceding 0x (e.g. 0x12AB).

Note

This block indicates general notes.

1.3 Technical terms and abbreviations used

AdSS
: Adjustable Switching Sensor

IODD
: IO-Device-Description

ISDU
: IO-Link-Parameter (Index Service Data Unit)

LSB
: Least Significant Bit

LSSC
: Legacy Smart Sensor Channel

MSB
: Most Significant Bit

PD
: Process data

RMS
: Root Mean Square

SSC
: Switching Signal Channel

SP
: Set Point

CHAPTER

TWO

QUICK START - INTRODUCTION

Welcome to the quick start for the Balluff Radar Sensor *BRS0002*.

This quick start walks you step by step through commissioning the sensor with the Balluff Condition Monitoring Toolkit (CMTK) or a Balluff IO-Link Master. It shows you how to adjust the most important parameters. The focus is deliberately on the practical workflow – in-depth background information is provided in the manual.

Safety

Before mounting, wiring and configuring, read the *Safety notes*.
This quick start does not replace the *manual*, it remains authoritative. You will find further information there.

Excursus – How does a radar sensor work?

Radar sensors determine distance by emitting electromagnetic waves and evaluating their echoes. The *BRS0002* uses FMCW (Frequency Modulated Continuous Wave).
In FMCW operation the sensor continuously changes its transmit frequency in rising and falling ramps (“chirps”). When the signal hits an object, the echo returns time-shifted. All reflected echoes form a spectrum. The peaks in this spectrum can be converted into a distance.

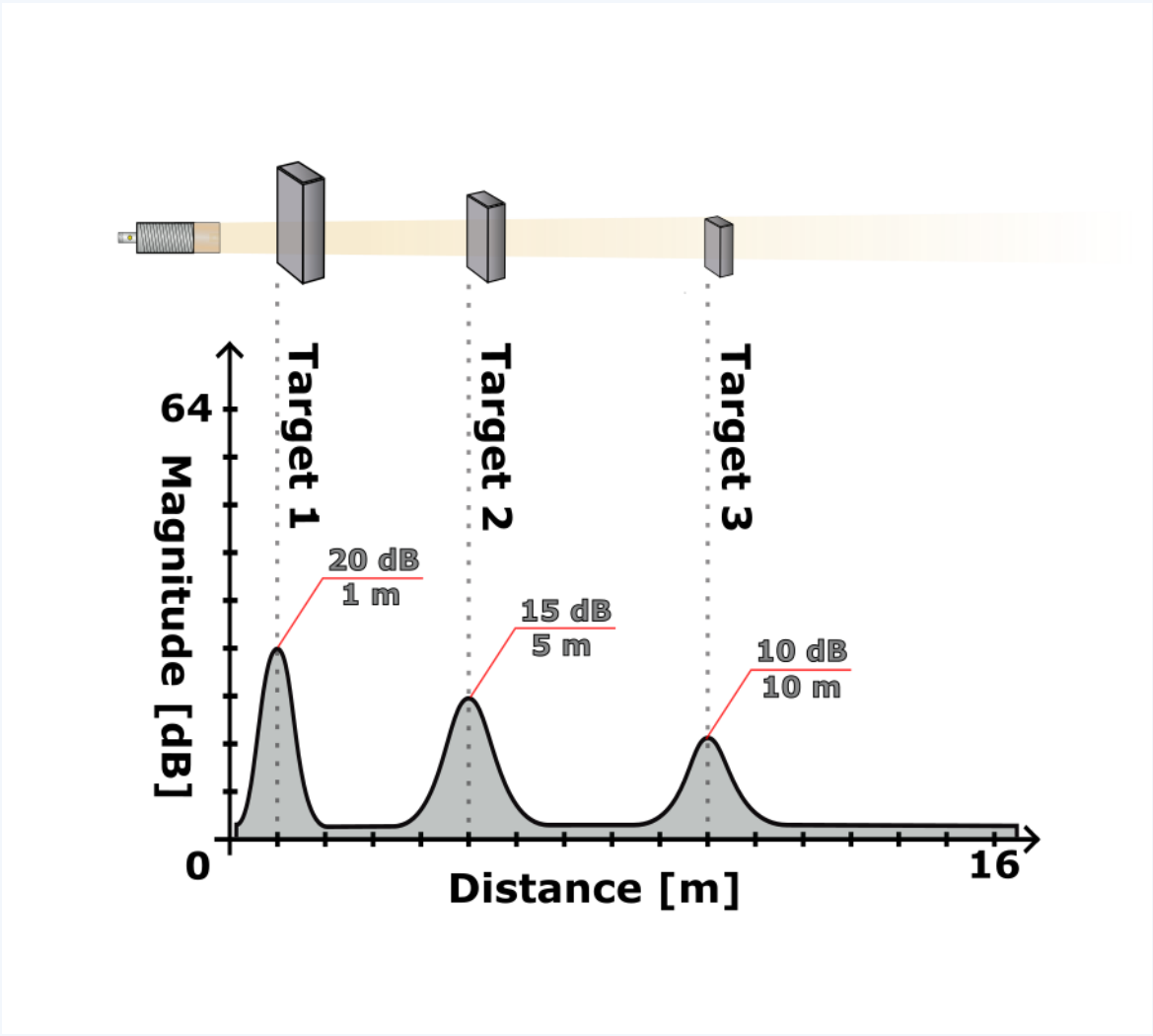


Fig. 1: Example spectrum

The magnitude of a peak describes the strength of the received echo. It is influenced by material properties (conductive / dielectric), size and orientation of the surface, surface texture (smooth vs. rough), distance (two-way attenuation), angle as well as shadowing or multi-path. Magnitude is relative – comparisons under identical conditions are more meaningful than individual values.
Materials: Metals reflect strongly. Dry non-conductive materials (e.g. some plastics, wood) allow part of the energy to pass; objects behind can be visible provided their echo is not masked. Moist or water-containing substances attenuate more strongly and reduce visibility of targets behind. *"Penetration"* means: An attenuated portion passes through – not fully *"see-through"*. More information on reflection properties is in the *Manual*.
Geometry: Frontally aligned, flat surfaces deliver strong peaks. Angled or strongly curved surfaces deflect energy away – the echo is weaker. Round or cylindrical shapes scatter; edges or corners can locally amplify. Each peak is the interplay of material, shape, angle and distance. Changes over time or differences between defined states provide the greatest information gain.

2.1 Prerequisites

- **Hardware:** Balluff Radar Sensor BRS0002
- **Cable:** Suitable M12 connection cable (4-pin for analog and digital output)
- **IO-Link Master:** This quick start uses an IO-Link Master and the CMTK. You can choose which one you want to use. Other IO-Link masters can also be used.

Factory settings and order

This quick start assumes the sensor is at factory settings and the sections are performed in the order shown. To set the sensor to factory settings at the beginning, follow the steps in the commissioning chapter.

Note on analog/digital output

The quick start demonstrates output configuration. The CMTK itself is only used for parameterization – for actual measurement or verification of a current/voltage value (analog) or switching level (digital) you must connect the sensor afterwards to appropriate evaluation or control technology (e.g. PLC, measuring device).

2.2 Using another IO-Link master

You can operate the sensor with any other IO-Link master. Configure parameters directly via ISDU indices or load the IODD. Relevant indices are listed in each section's parameter tables. Read your master's manual for the specific steps.

2.3 Glossary

Glossary

Table 1: Glossary

Term	Short description
CMTK	Balluff Condition Monitoring Toolkit; IO-Link master with web UI and apps.
IO-Link Master	Interface between sensor and controller; enables parameter and process data access.
IODD	Device description (parameter & process data structure).
ISDU (Index)	Addressed parameter in the IO-Link device.
Blob UI	Visualization app in the CMTK for raw and process data.
Magnitude (Reflection strength)	Relative strength of the reflected echo (dB).
Process data	Cyclically transmitted current measurement and status values.
Search window	Distance range within which a target is searched.
Target search mode	Strategy to select the target peak (e.g. strongest or nearest target).
Switching channel	Logical channel that switches based on distance or magnitude.
Radar Reflex Gate mode	Variant for near-range object detection using magnitude change at a reference distance.
Teach / Teaching	Automatic setting of switching points based on current measurement values.
Blind zone	Area close to the sensor where measurements are unreliable (increased error probability).
Peak	Peak in the frequency/distance spectrum that corresponds to a reflecting target.

Next section Step 1 – Connection & Commissioning

Connection & Commissioning

2.4 Connection & Commissioning

Chapter goal

Goal: Make the sensor visible in your Master and obtain first measurement values.

Prerequisite

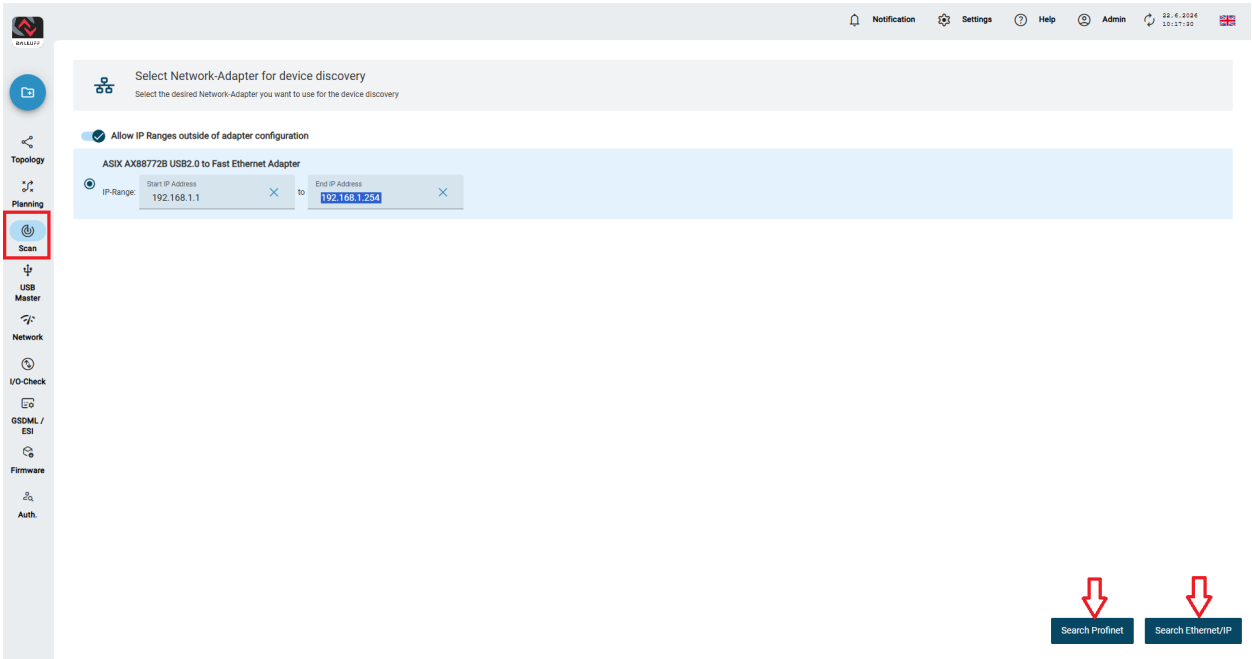
The CMTK must be set up according to its own manual (Network, access, basic function). These steps are not part of this guide. For IO-Link Masters this guide uses the Balluff Engineering Tool. If you are using this also first read its manual and the manual of your IO-Link Master before using this guide.

2.4.1 1. Mount and connect the sensor

Mount the sensor rigidly and aligned exactly towards the target to be measured. Even slight angle changes (e.g. holding the sensor in your hand) lead to fluctuating values.

BET & Balluff IO-Link Master

Connect the sensor with the IO-Link Master, power on the IO-Link Master and connect it to your PC. Make sure your PC and the IO-Link Master are in the same Network. Open the Balluff Engineering Tool and go to “Scan”



Select the Network Adapter which connects the IO-Link Master and your PC. After that press either `Scan Profinet` or `Scan Ethernet/IP` depending on your IO-Link Master. If everything worked, it should look like that:

Your Name, IP Address and Product ID may differ if you use a different IO-Link Master. Select your IO-Link Master. After that go to `Keep Port settings`. After some seconds your IO-Link Master should be added to your Balluff Engineering Tool.

CMTK

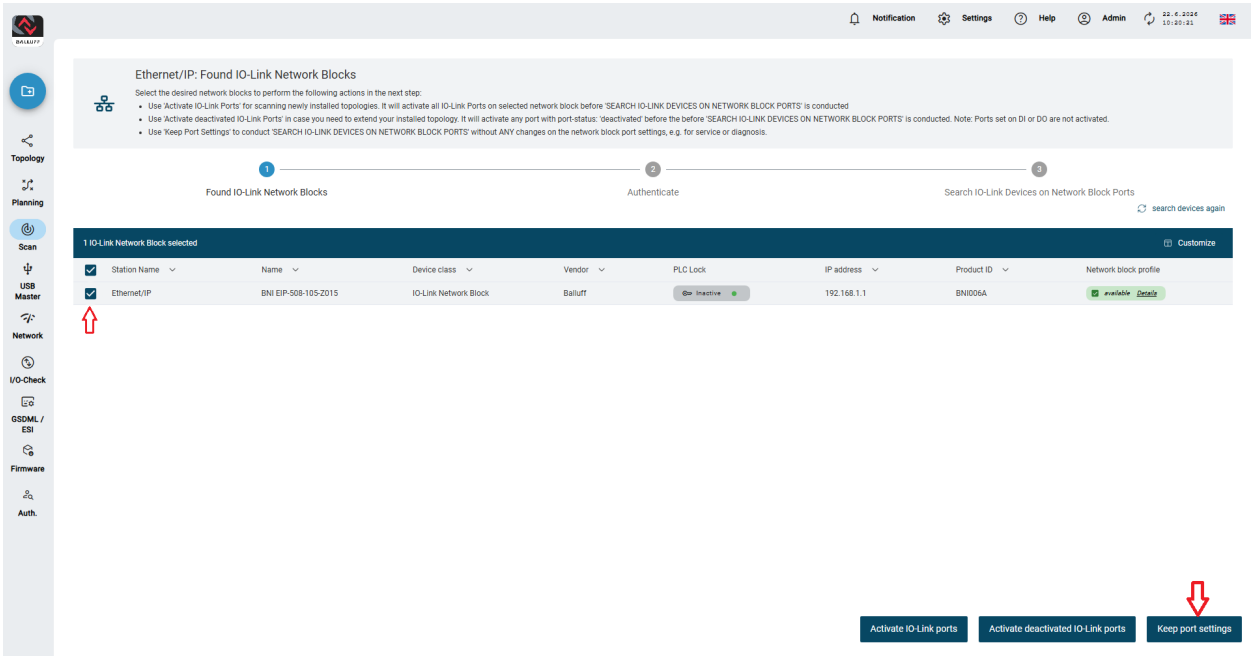
Connect the sensor via a suitable M12-to-M8 cable to an IO-Link Port of the CMTK. If the CMTK is powered, at least one green LED should light or blink (Sensor ready / IO-Link connection). The second LED can be off or yellow – both are fine.

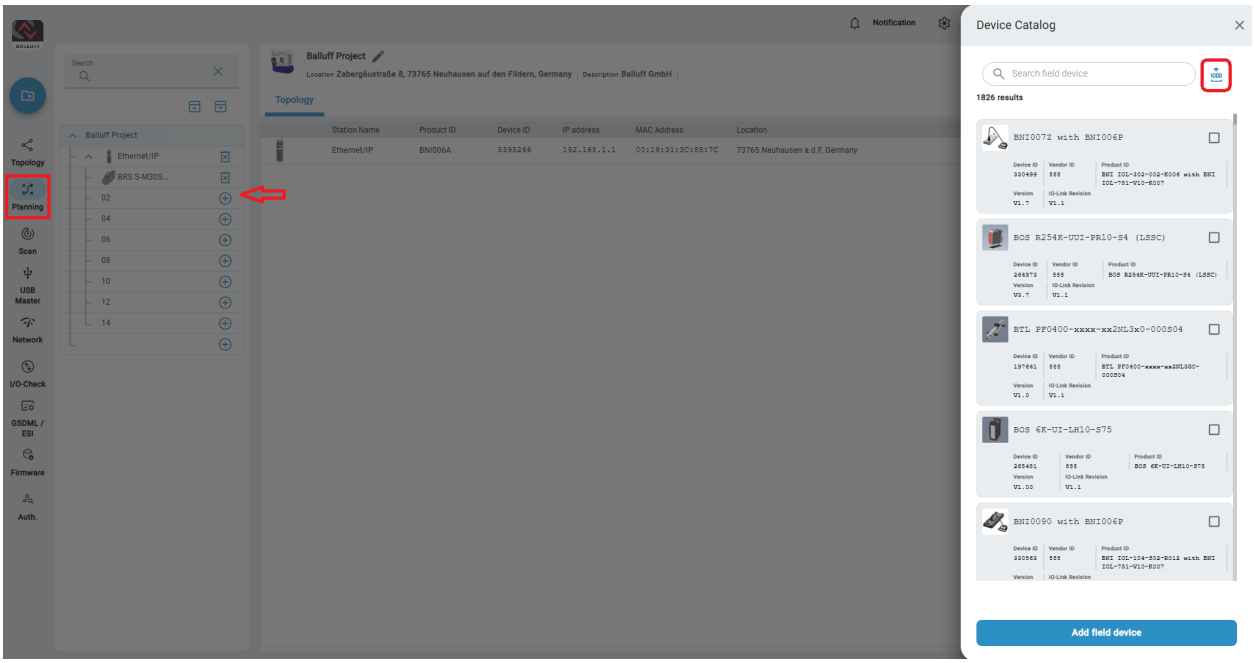
2.4.2 2. Upload IODD

BET & Balluff IO-Link Masters

Normally the Balluff Engineering Tool should recognize all Balluff Products and assign the right IODD. If that doesn’t work, you can upload the IODD by manually, like shown in the image:

First go to Scan and open the connections from your IO-Link Master. Select the Port your sensor is connected to. After that click on the IODD Icon and select your IODD.


Notification
Settings
Help
Admin
Topology
Planning
Scan
USB Master
Network
I/O-Check
GSDML / ESI
Firmware
Auth.
Ethernet/IP: Found IO-Link Network Blocks
Select the desired network blocks to perform the following actions in the next step:
Use 'Activate IO-Link Ports' for scanning newly installed topologies. It will activate all IO-Link Ports on selected network block before 'SEARCH IO-LINK DEVICES ON NETWORK BLOCK PORTS' is conducted
Use 'Activate deactivated IO-Link Ports' in case you need to extend your installed topology. It will activate any port with port-status: 'deactivated' before the before 'SEARCH IO-LINK DEVICES ON NETWORK BLOCK PORTS' is conducted. Note: Ports set on DI or DO are not activated.
Use 'Keep Port Settings' to conduct 'SEARCH IO-LINK DEVICES ON NETWORK BLOCK PORTS' without ANY changes on the network block port settings, e.g. for service or diagnosis.
1 Found IO-Link Network Blocks
2 Authenticate
3 Search IO-Link Devices on Network Block Ports
search devices again
1 IO-Link Network Block selected
Customize
Station Name
Name
Device class
Vendor
PLC Lock
IP address
Product ID
Network block profile
Ethernet/IP
BNI EIP-508-105-Z015
IO-Link Network Block
Balluff
Inactive
192.168.1.1
BNI006A
available
Details
Activate IO-Link ports
Activate deactivated IO-Link ports
Keep port settings

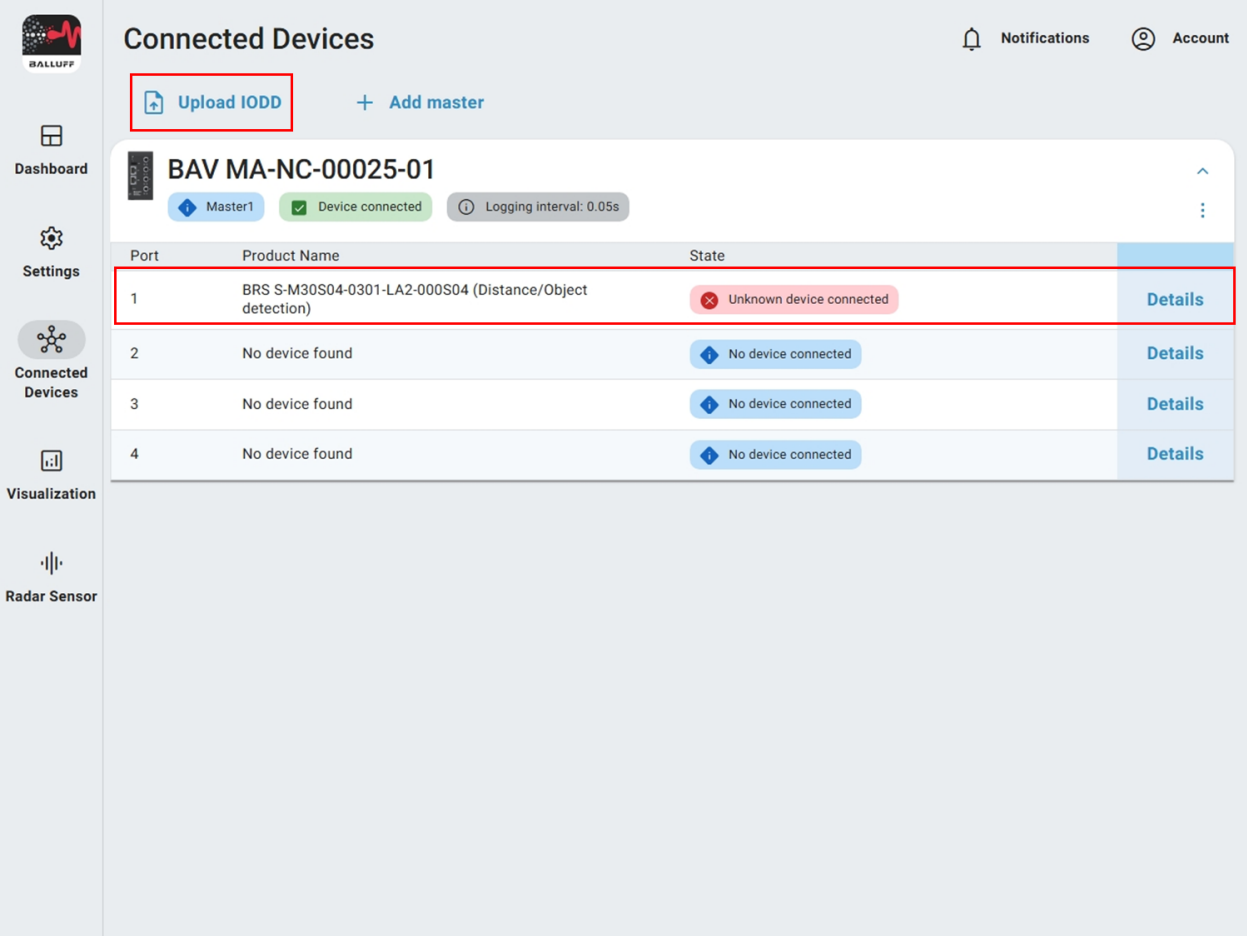

Notification
Balluff Project
Topology
Planning
Scan
USB Master
Network
I/O-Check
GSDML / ESI
Firmware
Auth.
Device Catalog
Search field device
1826 results
BNI0072 with BNI006P
BOS R254K-UUI-PR10-S4 (LSSC)
BTL PF0400-xxxx-xx2NL3x0-000S04
BOS 6K-UI-LH10-S75
BNI0090 with BNI006P
Add field device

CMTK

If the sensor appears with status `Unknown device connected`, the CMTK does not yet know the IODD. Download the correct IODD from the Balluff Update Platform. For the standard mode you need the variant `BRS S-M30 (Distance/Object detection)`. Import it via the `Upload IODD` button.

Tip

Unzip the ZIP file before uploading.



2.4.3 3. Reset sensor to factory settings

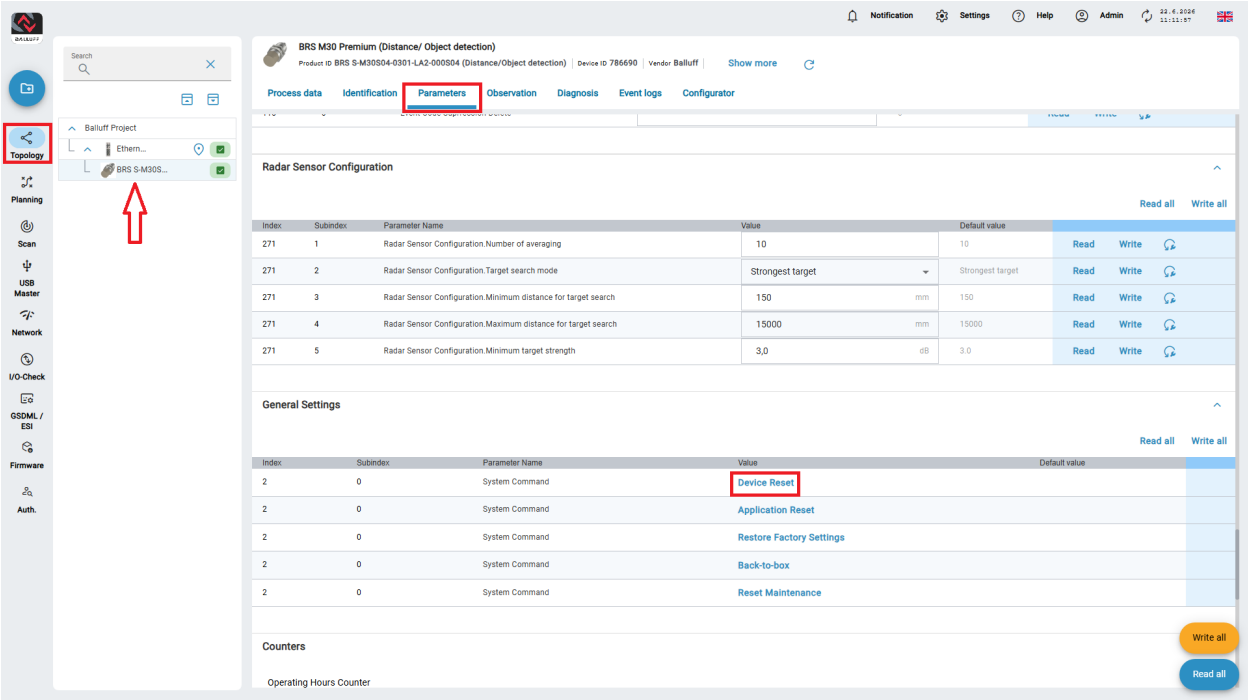
Set the sensor to factory settings to obtain a defined starting point.

WARNING

All sensor settings are reset and lost irreversibly.

BET & Balluff IO-Link Masters

To reset your sensor you need to click on your sensor, go to `Parameters`, search for `General Settings` and click on `Device Reset`.



CMTK

You can find parameters in the CMTK under `Parameters (IODD)` → `Parameters`. Select the sensor under `Connected devices` first.

Go to `General Settings` → `Restore Factory Settings`.

2.4.4 4. Interpret process data

BET & Balluff IO-Link Masters

The current process data of the sensor is shown in the process data view under `Process data` after you click on your sensor. For a start, the values `MDC1 (Target distance)` and `MDC2 (Target strength)` are especially relevant.

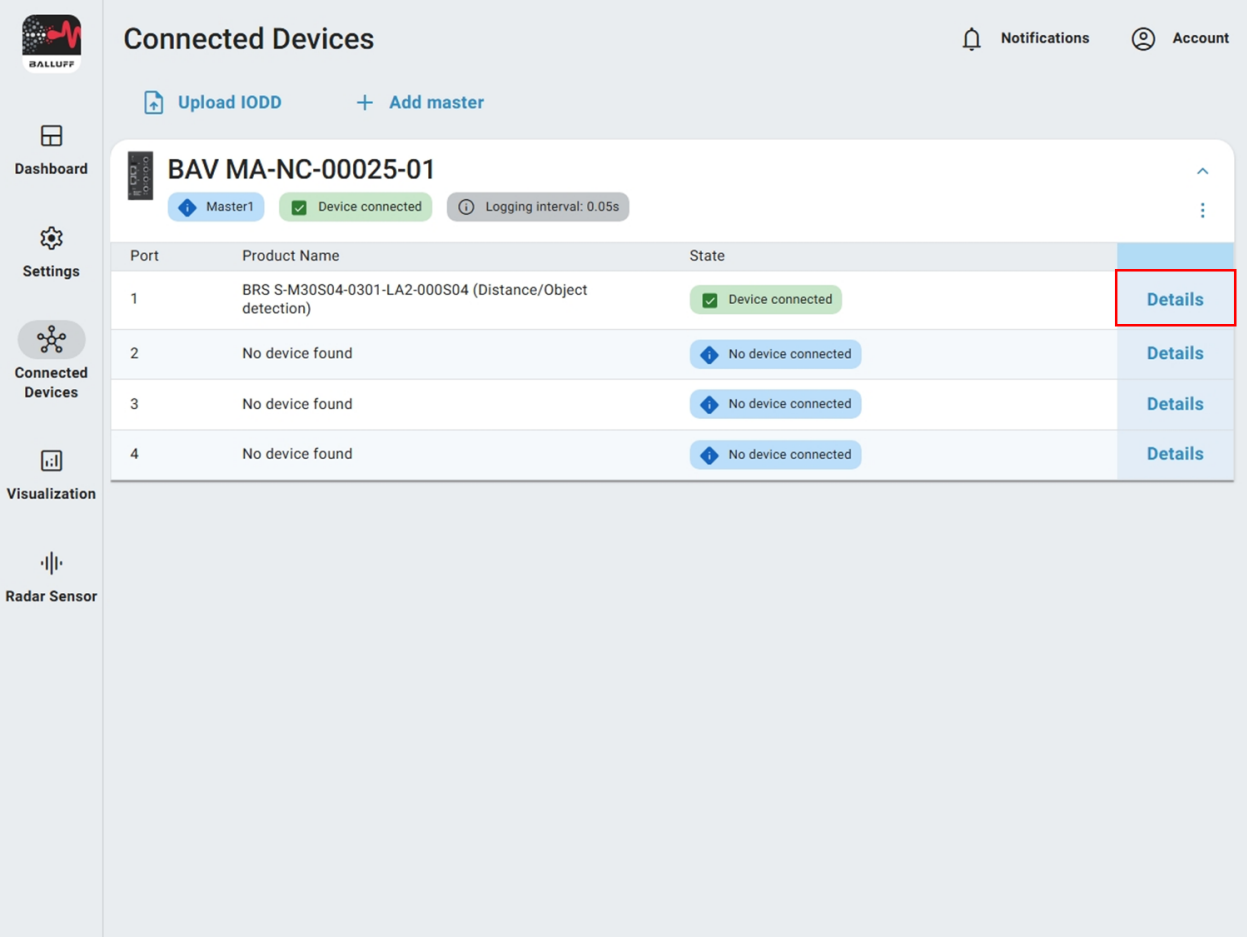
CMTK

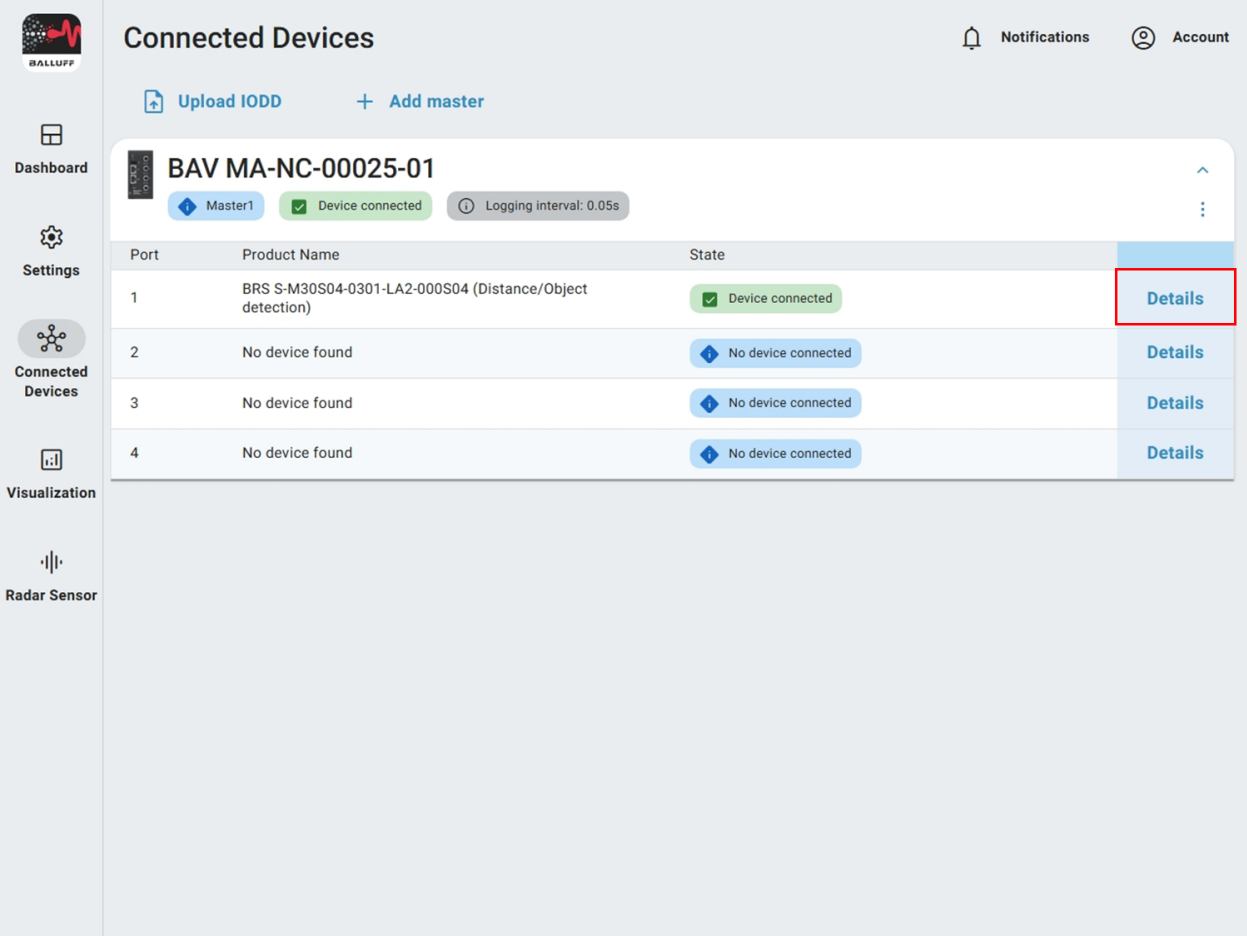
The current process data of the sensor is shown in the process data view under `Details`.

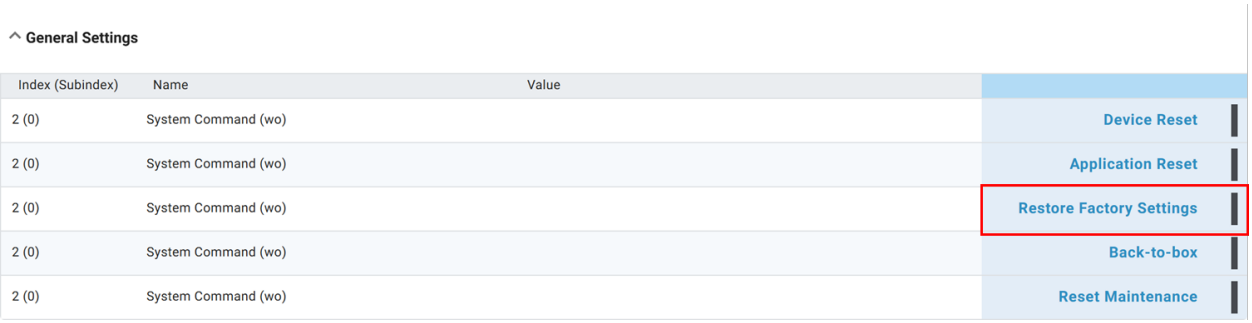
For a start, the values `MDC1 (Target distance)` and `MDC2 (Target strength)` are especially relevant.

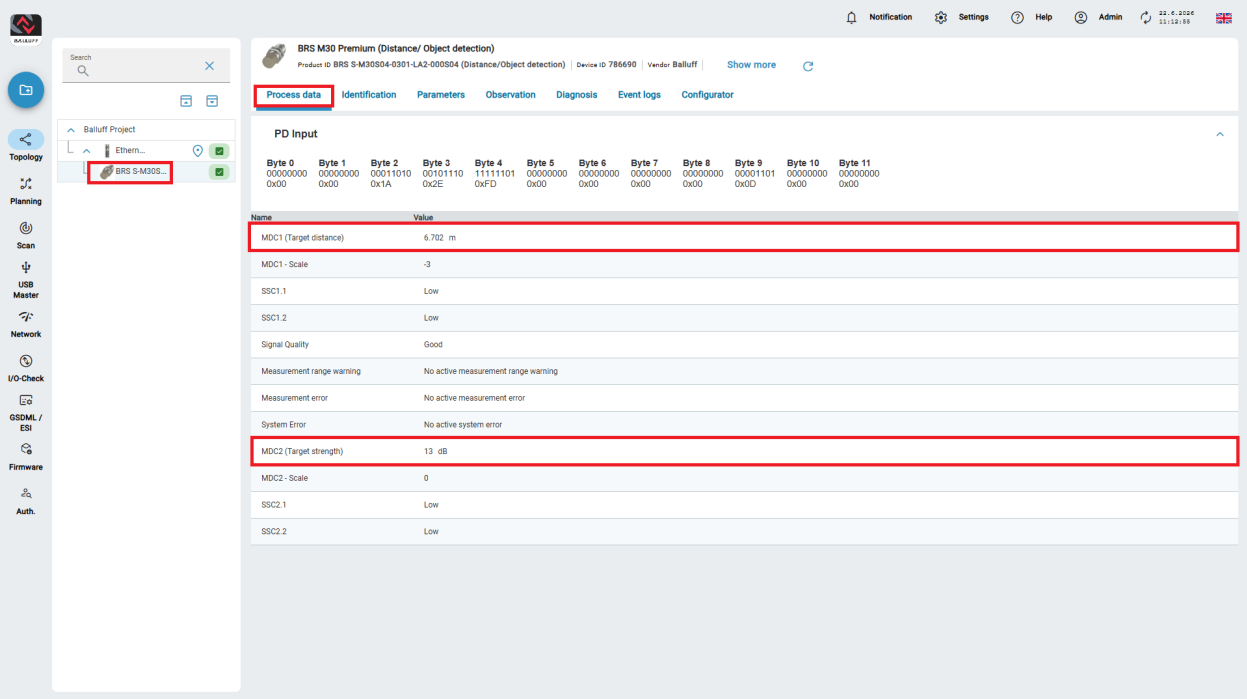
MDC1 (Target distance) – Distance

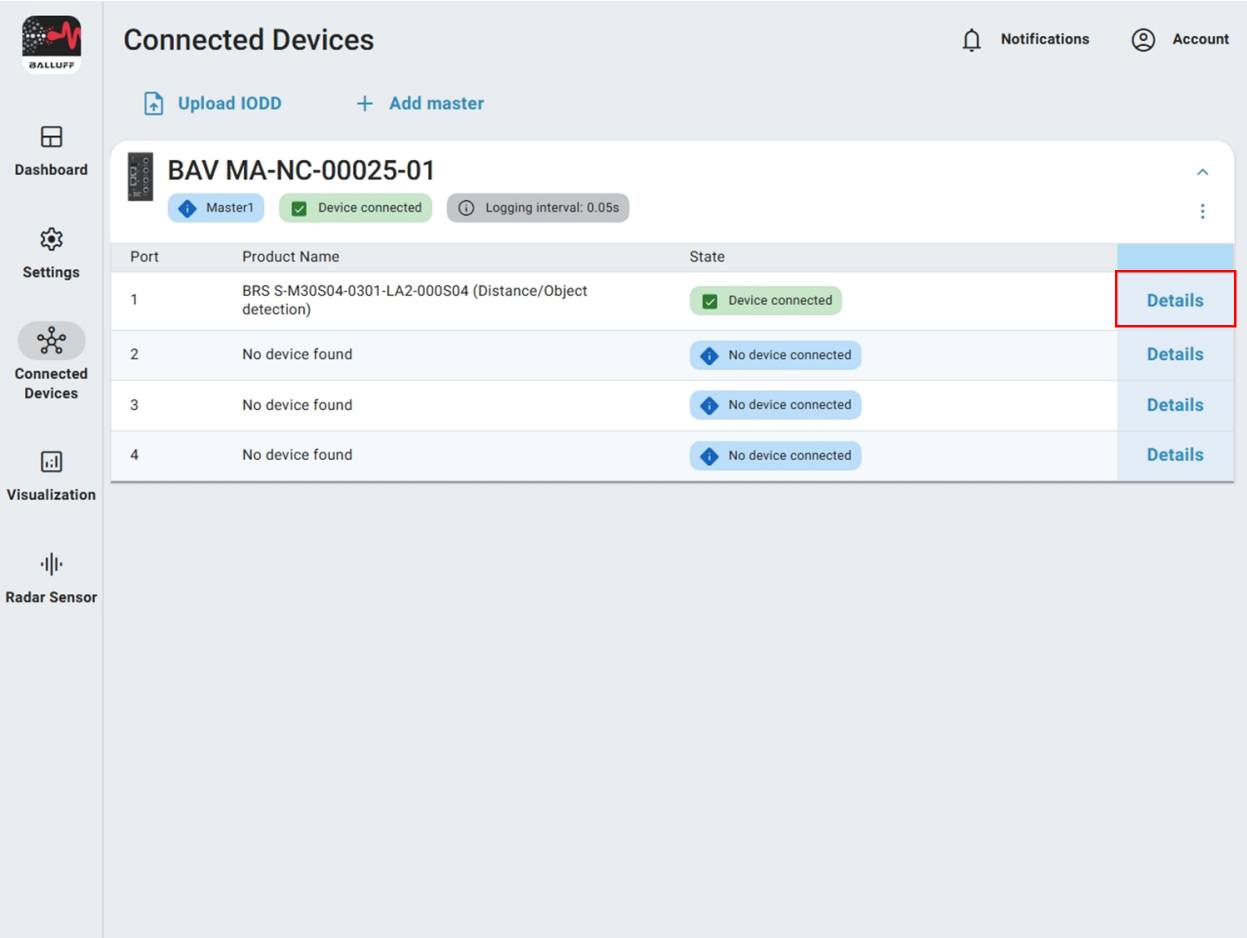
Distance is the measured range (in meters) to the currently selected target. The usable measurement range extends up to 15 m. Below approx. 300 mm the blind zone begins; accuracy drops significantly there. By default the sensor reports objects from about 150 mm however, measurement error can exceed ±10 mm there. For reliable results the target should be outside the blind zone.

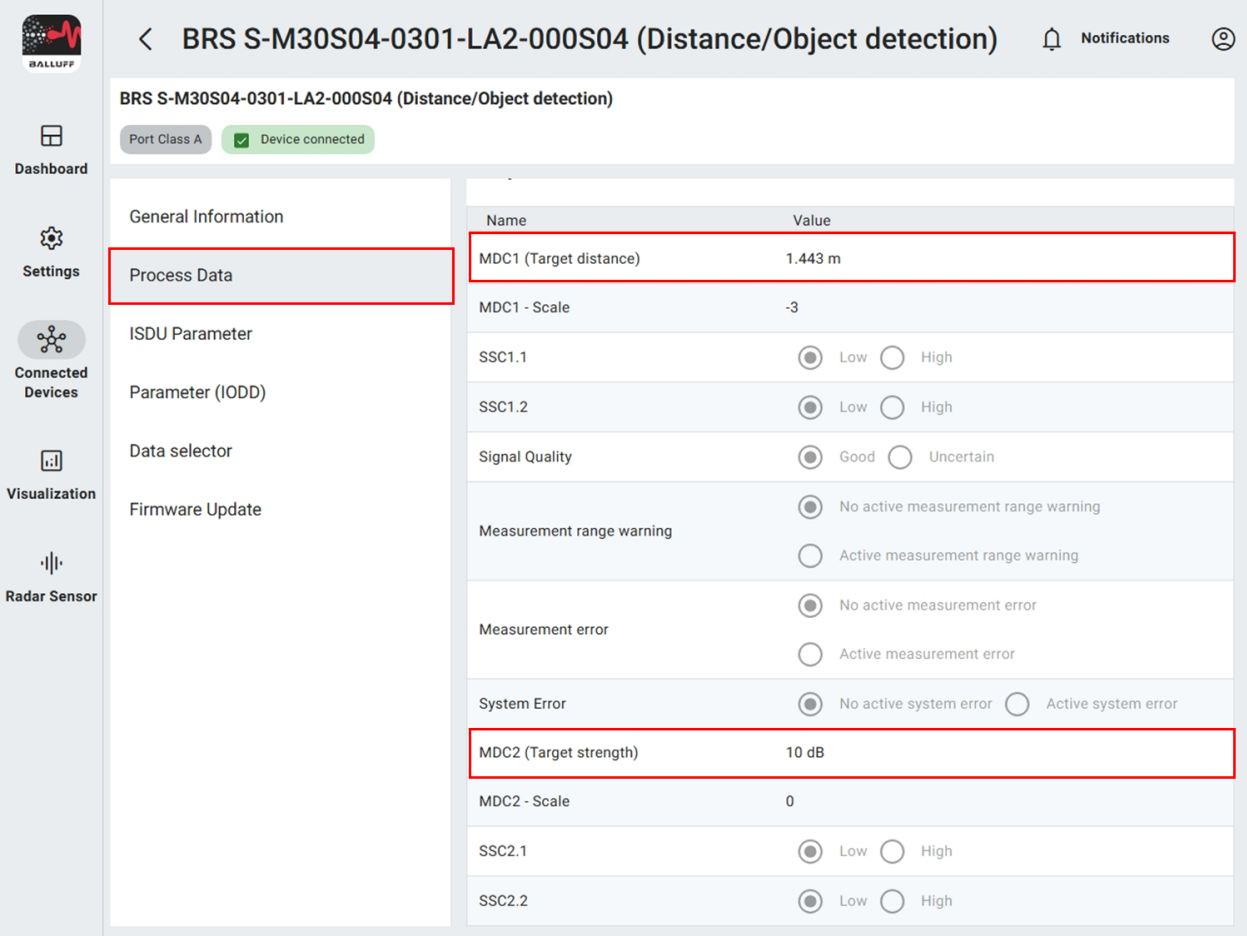

Connected Devices
Notifications
Account
Upload IODD
Add master
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
BAV MA-NC-00025-01
Master1
Device connected
Logging interval: 0.05s
Port
Product Name
State
1
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Device connected
Details
2
No device found
No device connected
Details
3
No device found
No device connected
Details
4
No device found
No device connected
Details


Connected Devices
Notifications
Account
Upload IODD
Add master
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
BAV MA-NC-00025-01
Master1
Device connected
Logging interval: 0.05s
Port
Product Name
State
1
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Device connected
Details
2
No device found
No device connected
Details
3
No device found
No device connected
Details
4
No device found
No device connected
Details

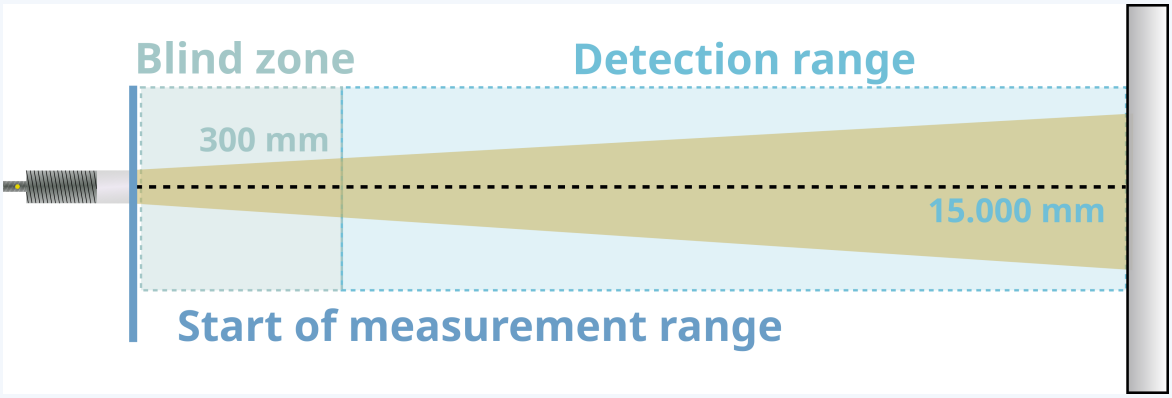

General Settings
Index (Subindex)
Name
Value
2 (0)
System Command (wo)
Device Reset
2 (0)
System Command (wo)
Application Reset
2 (0)
System Command (wo)
Restore Factory Settings
2 (0)
System Command (wo)
Back-to-box
2 (0)
System Command (wo)
Reset Maintenance


Notification
Settings
Help
Admin
BRS M30 Premium (Distance/ Object detection)
Show more
Process data
Identification
Parameters
Observation
Diagnosis
Event logs
Configurator
PD Input
Topology
Planning
Scan
USB Master
Network
I/O-Check
GSDML / ESI
Firmware
Auth.
Balluff Project
BRS S-M30S...
Name
Value
MDC1 (Target distance)
6.702 m
MDC1 - Scale
-3
SSC1.1
Low
SSC1.2
Low
Signal Quality
Good
Measurement range warning
No active measurement range warning
Measurement error
No active measurement error
System Error
No active system error
MDC2 (Target strength)
13 dB
MDC2 - Scale
0
SSC2.1
Low
SSC2.2
Low


Connected Devices
Notifications
Account
Upload IODD
Add master
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
BAV MA-NC-00025-01
Master1
Device connected
Logging interval: 0.05s
Port
Product Name
State
1
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Device connected
Details
2
No device found
No device connected
Details
3
No device found
No device connected
Details
4
No device found
No device connected
Details


BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Notifications
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Port Class A
Device connected
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
General Information
Process Data
ISDU Parameter
Parameter (IODD)
Data selector
Firmware Update
Name
Value
MDC1 (Target distance)
1.443 m
MDC1 - Scale
-3
SSC1.1
Low
High
SSC1.2
Low
High
Signal Quality
Good
Uncertain
Measurement range warning
No active measurement range warning
Active measurement range warning
Measurement error
No active measurement error
Active measurement error
System Error
No active system error
Active system error
MDC2 (Target strength)
10 dB
MDC2 - Scale
0
SSC2.1
Low
High
SSC2.2
Low
High

Detection range and blind zone



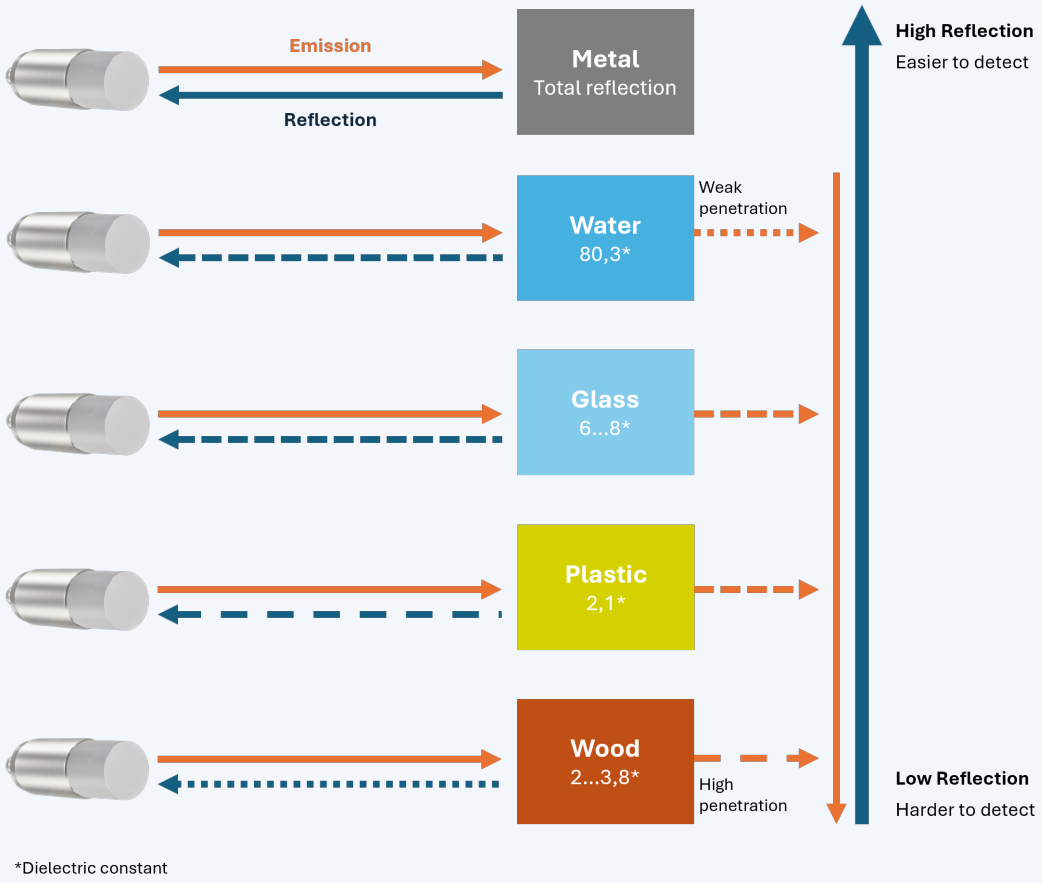
My distance value is wrong

Tips for optimization are in the *next chapter*.

MDC2 (Target strength) – Magnitude

Magnitude describes reflection strength at the computed distance. Different materials and surfaces (metal, plastic, angle, curvature) reflect differently. Matte or angled surfaces often yield lower values. The mounting angle has a strong influence. Therefore a clean mounting and alignment are crucial. Align the sensor so magnitude is as high as possible.

Reflectivity of materials



More information on reflectivity is in the *Excursus – How does a radar sensor work* and the *Manual*.

2.4.5 5. Visualize process data

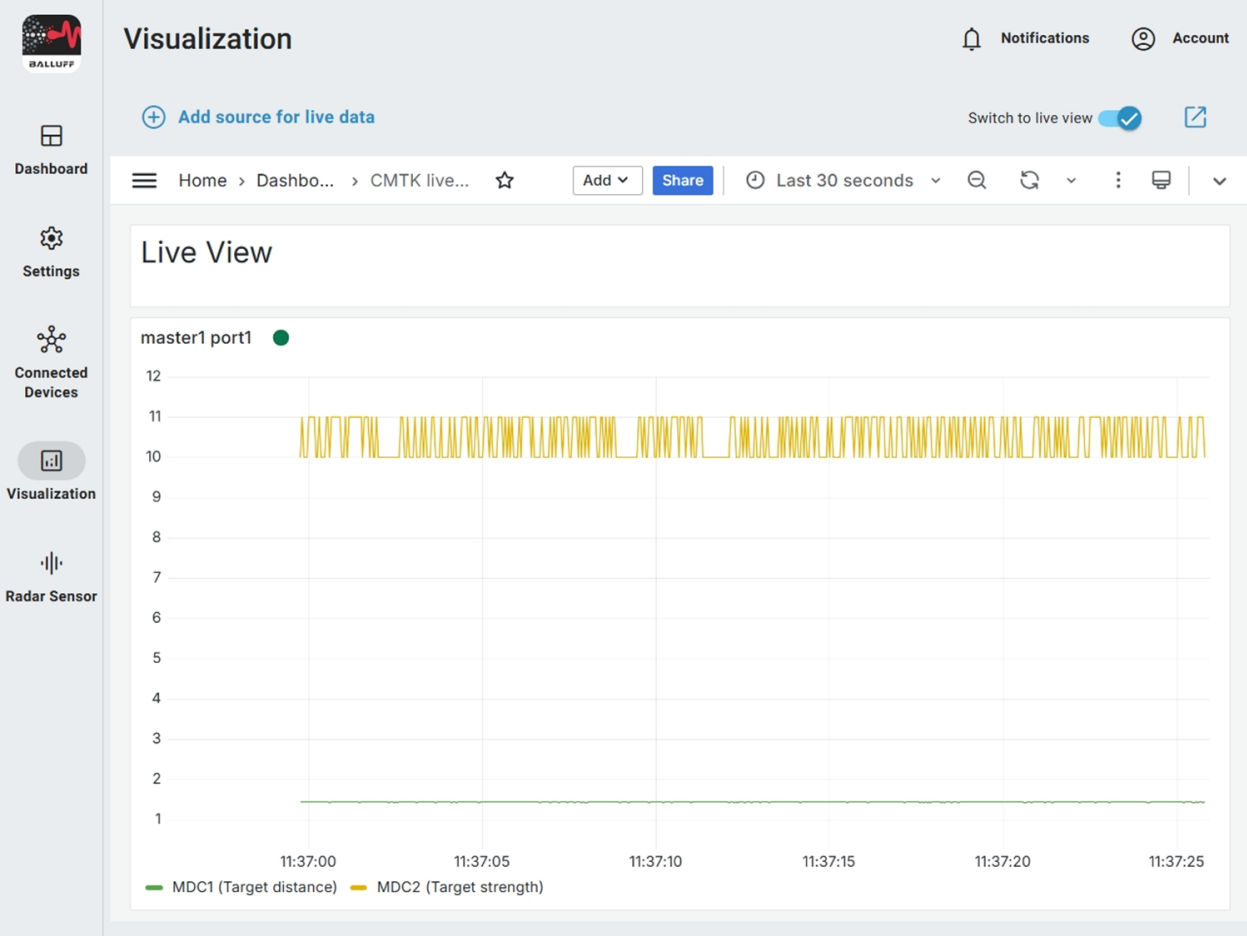
With the CMTK you can visualize the course of process data – recorded values and live data. This helps especially during alignment.

Tip

This only works on the CMTK. Details on visualization are in the CMTK Manual.

Next section Step 2 – Distance measurement – Understand & Optimize

Distance Measurement – Understand & Optimize


Visualization
Notifications
Account
Add source for live data
Switch to live view
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
Home › Dashbo... › CMTK live...
Add
Share
Last 30 seconds
Live View
master1 port1
12
11
10
9
8
7
6
5
4
3
2
1
11:37:00
11:37:05
11:37:10
11:37:15
11:37:20
11:37:25
MDC1 (Target distance)
MDC2 (Target strength)

2.5 Distance Measurement – Understand & Optimize

Chapter goal

Goal: Understand how distance measurement works and learn which parameters optimize it.

Prerequisite

For this chapter the `Radar Sensor Blob UI` app on the CMTK is helpful. It is available in the App Store (installation info in the manual).
The `Radar Sensor Blob UI` also exists as a plugin for the Balluff Engineering Tool (BET). Plugins are shipped with the BET. Using BET you can connect Balluff IO-Link masters via Ethernet or USB.
Optimization is possible without visualization – you will simply miss raw data insights.

2.5.1 How it works

Factory settings make the sensor determine the distance of the strongest target. Relevant parameters are listed below; their effect is described afterwards.

Parameter table

Table 2: Parameter table

Parameter (Section / Parameter name)	Index (Subindex)	Default

Lower limit measurement range
`Sensor Measurement Config`
`Measurement Range.Lower`
`1`
	514
	300 mm	

Upper limit measurement range
`Sensor Measurement Config`
`Measurement Range.Upper`
`2`
	514
	15000 mm	

Target search mode
`Radar Sensor Configuration`
`Target search mode`
`2`
	271
	Strongest target	

Minimum target search distance
`Radar Sensor Configuration`
`Minimum distance for target search`
`3`
	271
	150 mm	

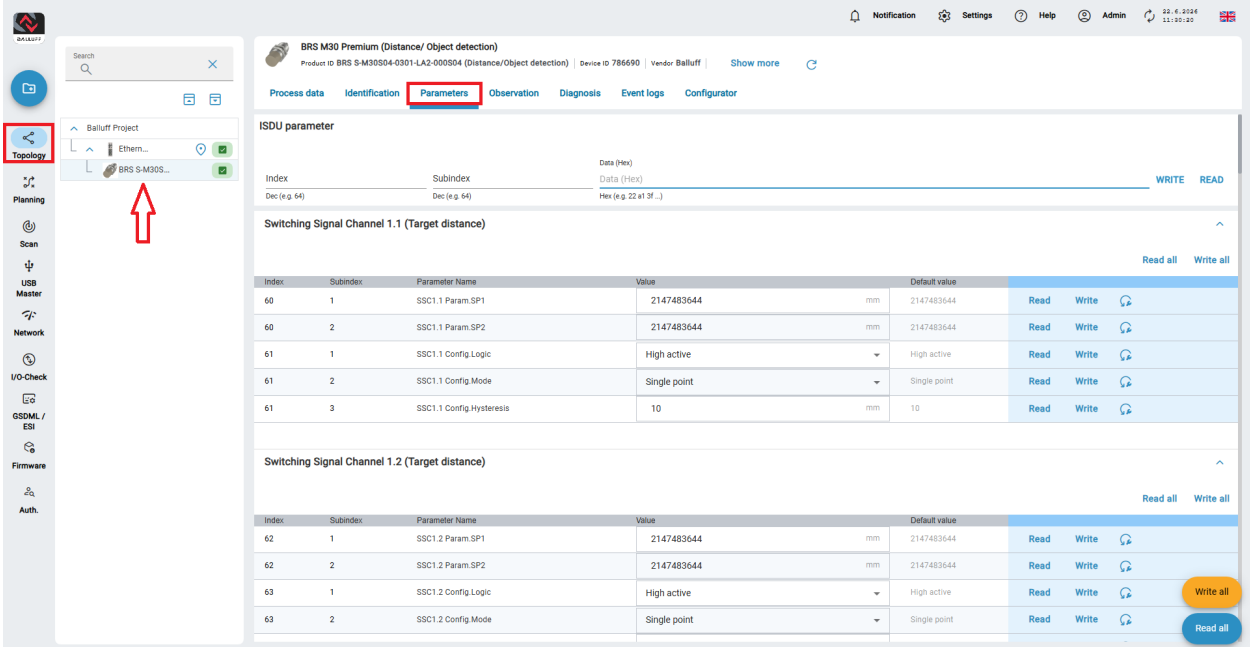
Maximum target search distance
`Radar Sensor Configuration`
`Maximum distance for target search`
`4`
	271
	15000 mm	

Minimum target strength
`Radar Sensor Configuration`
`Minimum target strength`
`5`
	271
	3 dB	

Averaging count
`Radar Sensor Configuration`
`Number of averaging`
`1`
	271
	10	

BET & Balluff IO-Link Master

You can find the parameters under `Parameters` after you select your sensor.



You can visualize the output of the sensor with a graph under `Configurator` after you select your Sensor.

Enable `Auto Update` or click on `Update` to update the graph manually.

CMTK

Find the parameters in the CMTK under `Parameters (IODD)` → `Parameters` after selecting the sensor under `Connected devices`.

You can ideally visualize their relationship with the `Radar Sensor Blob UI`. Open it under `Radar sensor`, refresh once with `Update` or enable `Auto Update`.

Magnitude

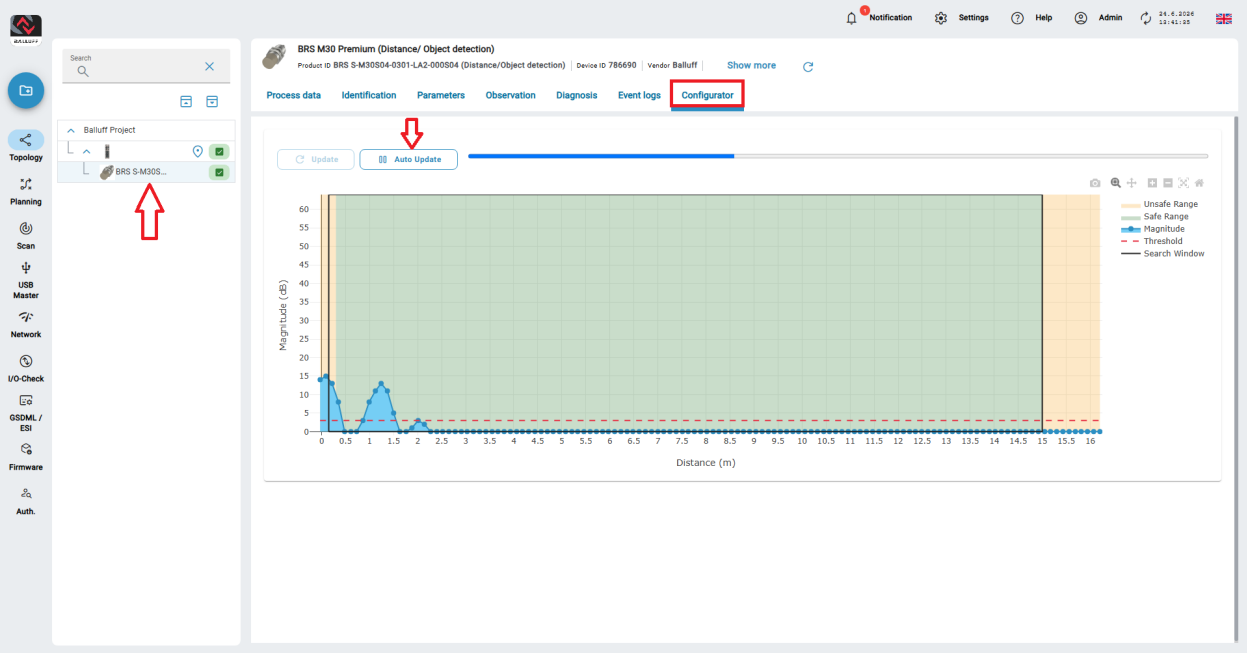
Magnitude (blue line) shows the reflection strength of an object at a certain distance. The higher the value, the stronger the reflection. See also *Commissioning*.

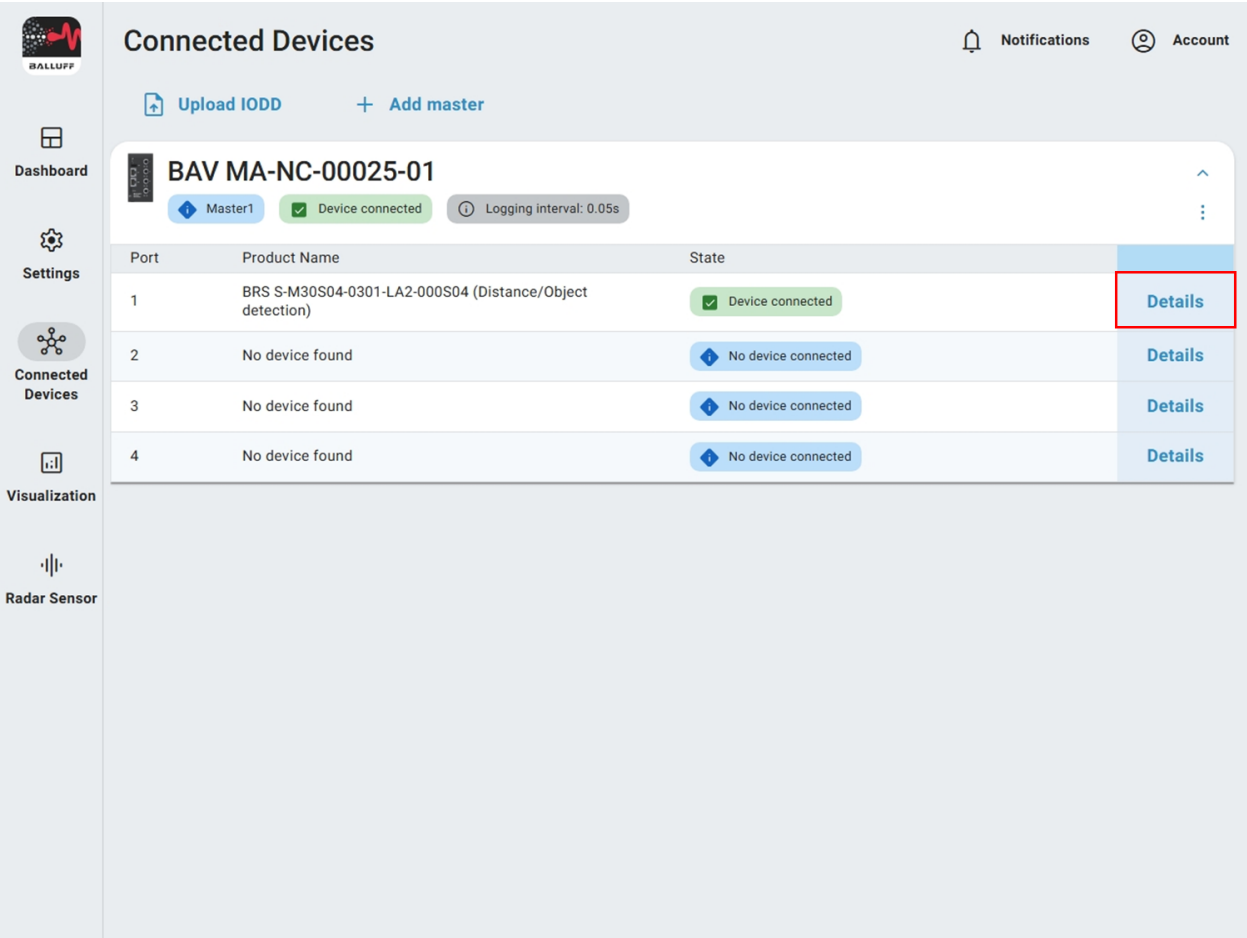
Target search mode, search window and minimum target strength

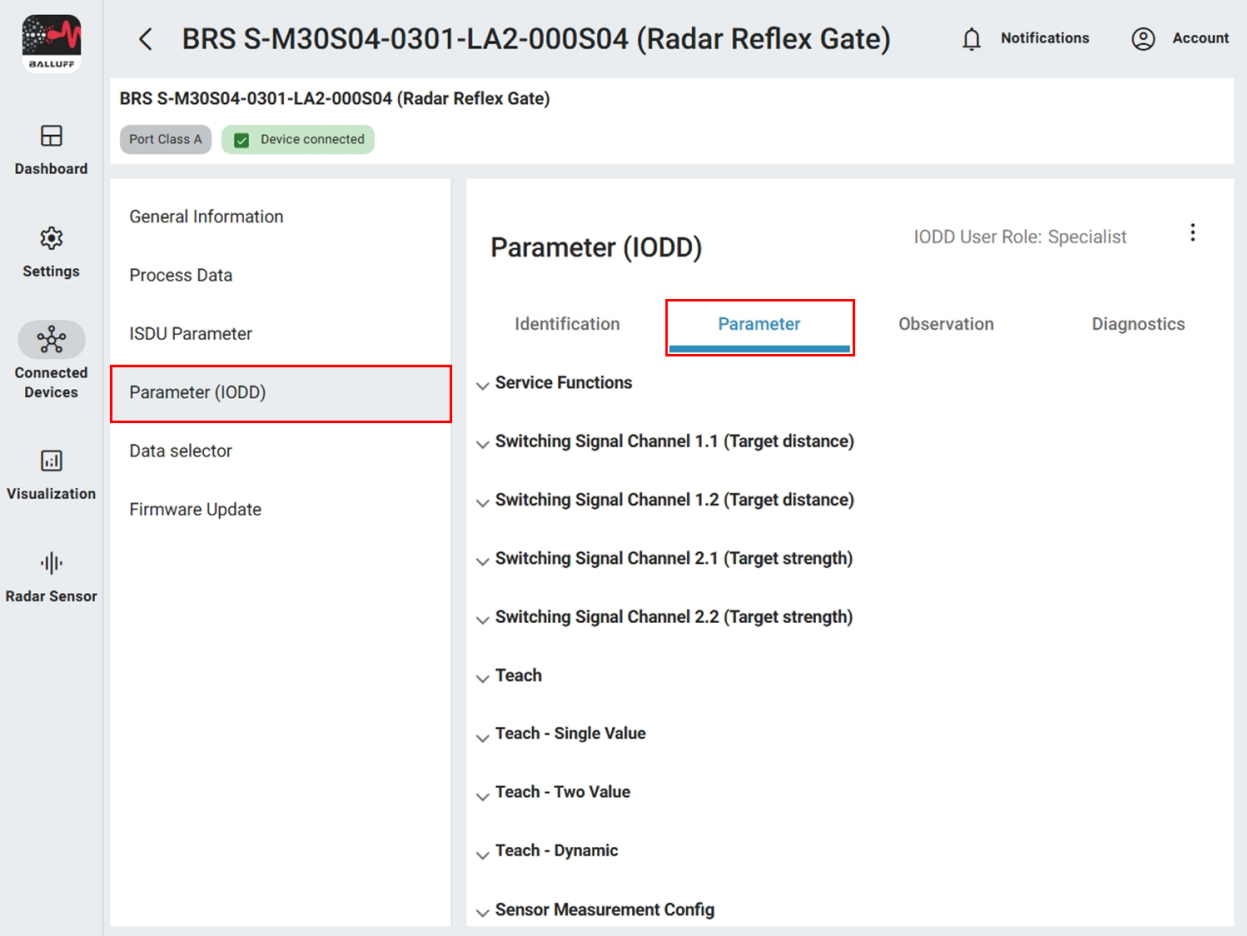
In the standard mode `Strongest target` the sensor selects the highest magnitude peak within the search window (min/max target search distance; black rectangle). A target must also lie above the threshold (dashed red line = minimum target strength).

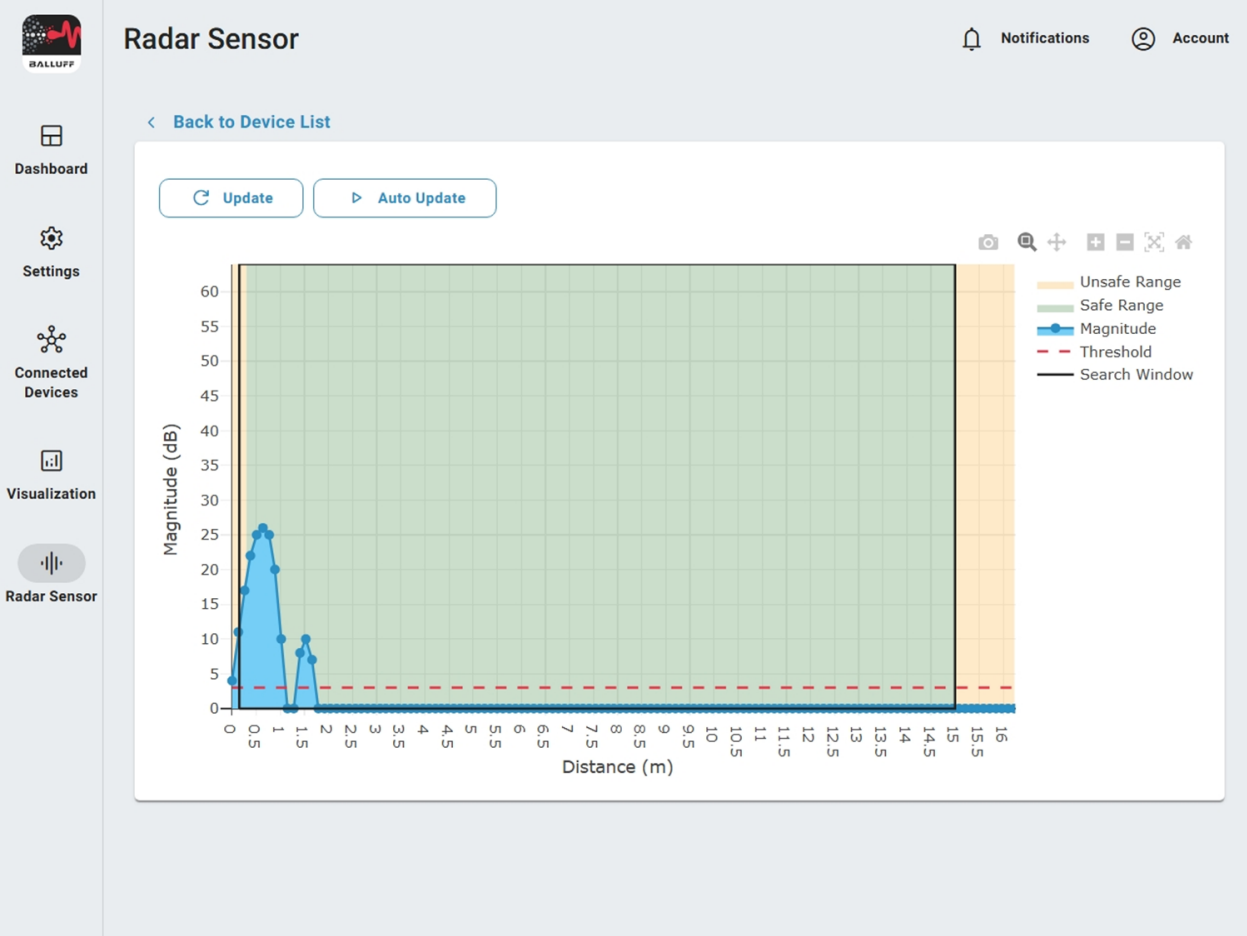
Important

The strongest value must be a pronounced peak (peak = central value with both neighbors smaller). The visualization shows rastered values. The computed value can lie slightly outside the search window although the peak visually still appears inside – in this case it is discarded.


Notification
Settings
Help
Admin
BRS M30 Premium (Distance/ Object detection)
Show more
Process data
Identification
Parameters
Observation
Diagnosis
Event logs
Configurator
Update
Auto Update
Balluff Project
Topology
Planning
Scan
USB Master
Network
I/O-Check
GSDML / ESI
Firmware
Auth.
Unsafe Range
Safe Range
Magnitude
Threshold
Search Window
Magnitude (dB)
Distance (m)


Connected Devices
Notifications
Account
Upload IODD
Add master
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
BAV MA-NC-00025-01
Master1
Device connected
Logging interval: 0.05s
Port
Product Name
State
1
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Device connected
Details
2
No device found
No device connected
Details
3
No device found
No device connected
Details
4
No device found
No device connected
Details


BRS S-M30S04-0301-LA2-000S04 (Radar Reflex Gate)
Notifications
Account
BRS S-M30S04-0301-LA2-000S04 (Radar Reflex Gate)
Port Class A
Device connected
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
General Information
Process Data
ISDU Parameter
Parameter (IODD)
Data selector
Firmware Update
Parameter (IODD)
IODD User Role: Specialist
Identification
Parameter
Observation
Diagnostics
Service Functions
Switching Signal Channel 1.1 (Target distance)
Switching Signal Channel 1.2 (Target distance)
Switching Signal Channel 2.1 (Target strength)
Switching Signal Channel 2.2 (Target strength)
Teach
Teach - Single Value
Teach - Two Value
Teach - Dynamic
Sensor Measurement Config


Radar Sensor
Notifications
Account
Back to Device List
Update
Auto Update
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
Unsafe Range
Safe Range
Magnitude
Threshold
Search Window
Magnitude (dB)
Distance (m)

Measurement range

The measurement range splits into a safe and an unsafe portion. In the near range, the sensor can detect objects, but accuracy drops significantly (> ±10 mm). The effective limit depends on application, environment and target reflection. Unsafe values are signaled via *LEDs* (yellow blinking) and via process data.

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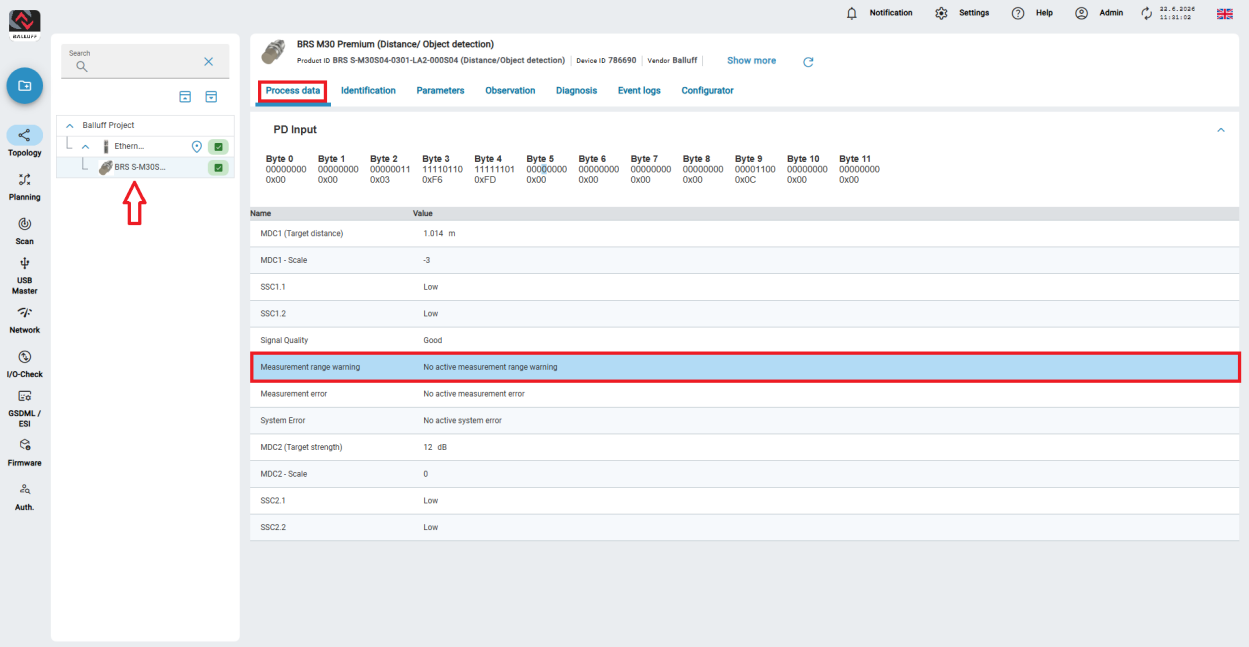

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2.5.2 Configuration

Optimize distance measurement

If multiple objects cause the wrong target to be chosen or values fluctuate strongly, you can adjust settings. The settings are under `Radar Sensor Configuration`. Typical workflow comprises four steps:

1. Configure search window

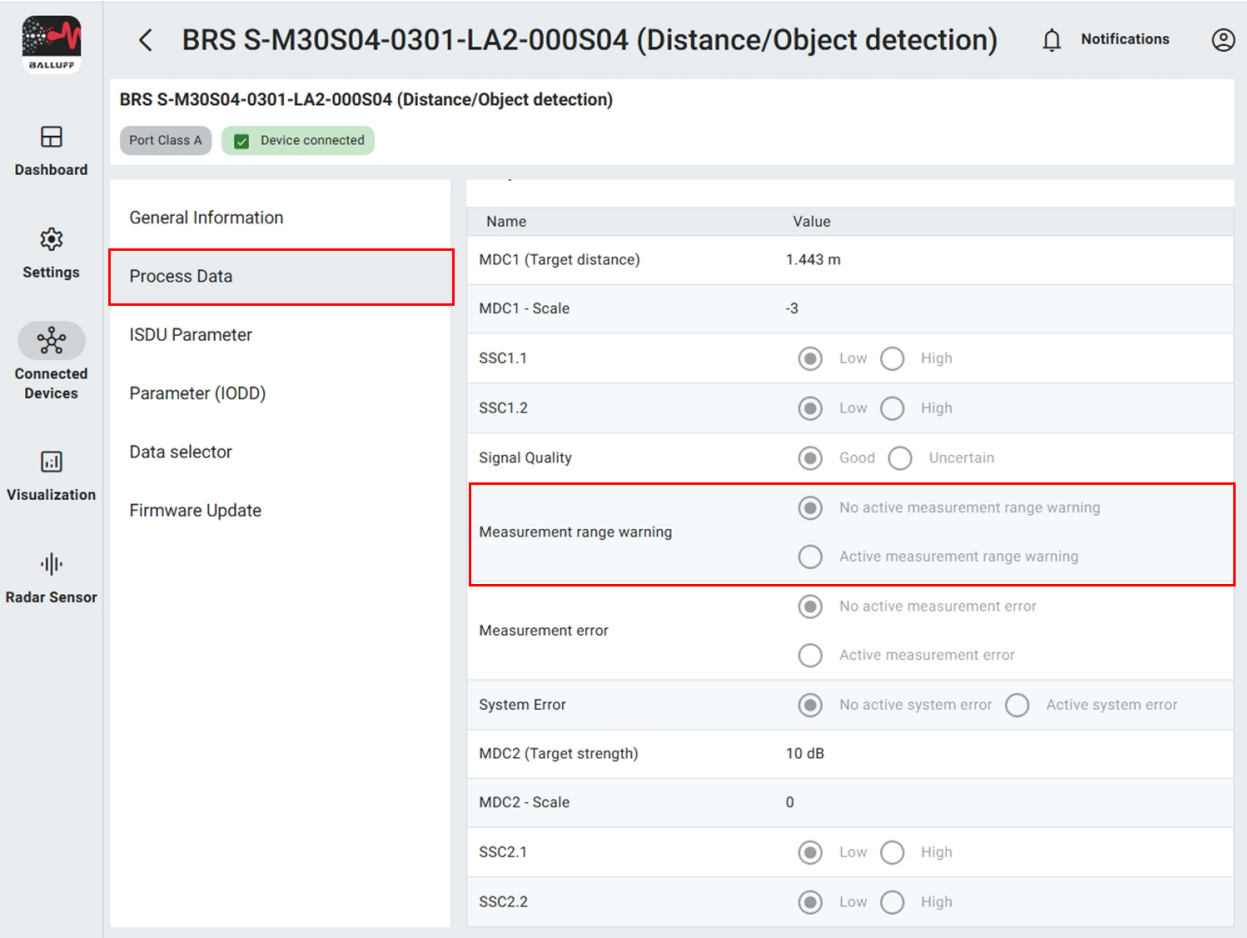
Set min and max target search distance so irrelevant targets are excluded (values in mm).

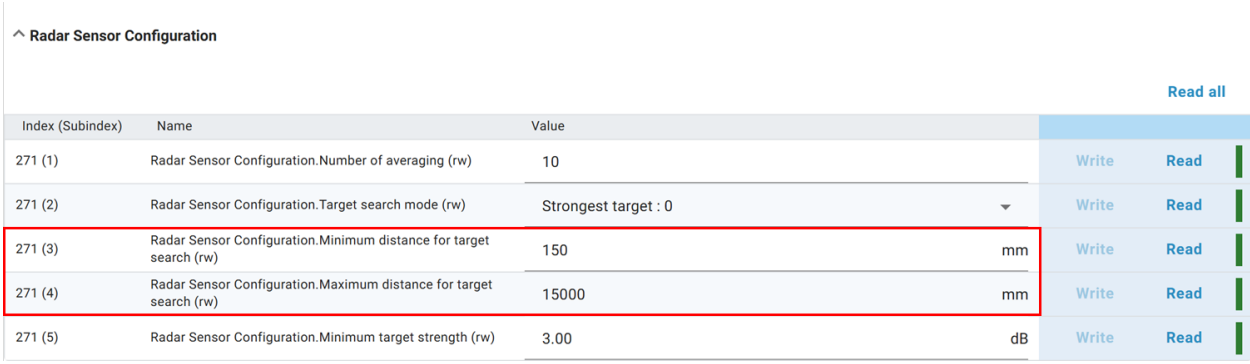
2. Configure target search mode

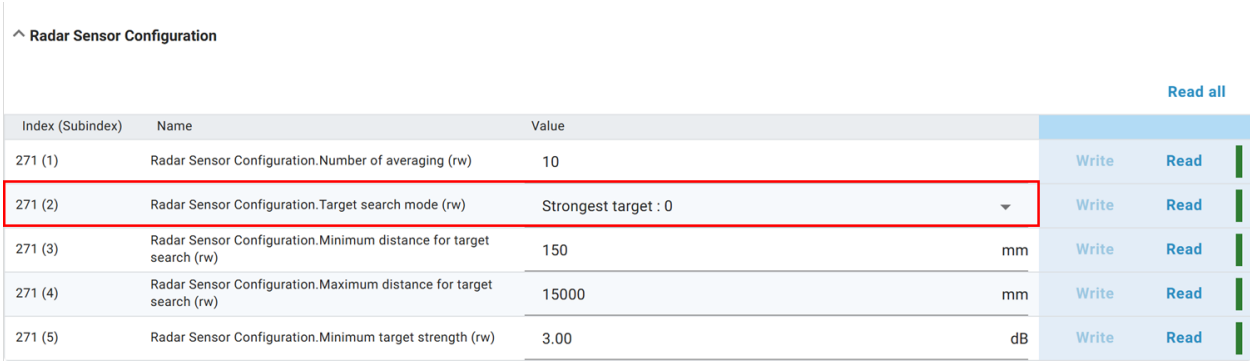
If the search window is insufficient, switch from `Strongest target` to `Nearest target` (first object above threshold).

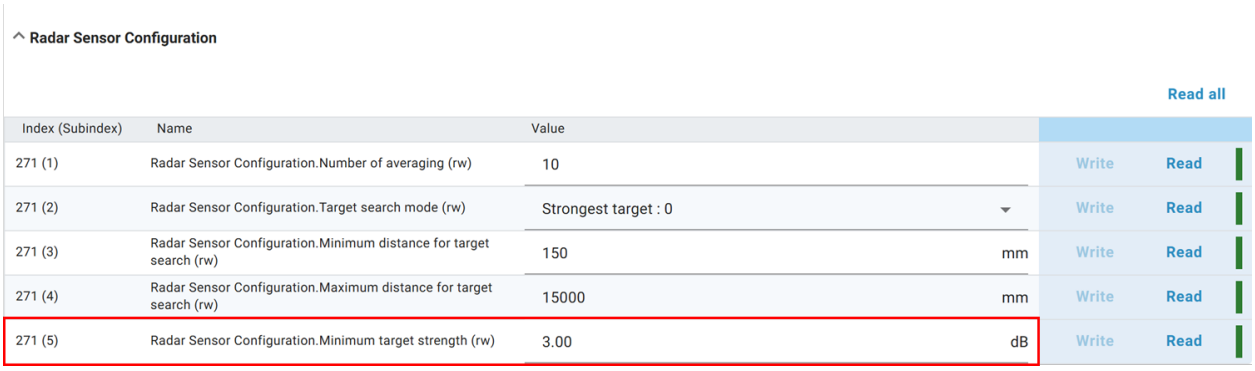
3. Configure minimum target strength

Increase or decrease minimum target strength to ignore weak targets or allow additional ones.


BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Notifications
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Port Class A
Device connected
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
General Information
Process Data
ISDU Parameter
Parameter (IODD)
Data selector
Firmware Update
Name
Value
MDC1 (Target distance)
1.443 m
MDC1 - Scale
-3
SSC1.1
Low
High
SSC1.2
Low
High
Signal Quality
Good
Uncertain
Measurement range warning
No active measurement range warning
Active measurement range warning
Measurement error
No active measurement error
Active measurement error
System Error
No active system error
Active system error
MDC2 (Target strength)
10 dB
MDC2 - Scale
0
SSC2.1
Low
High
SSC2.2
Low
High

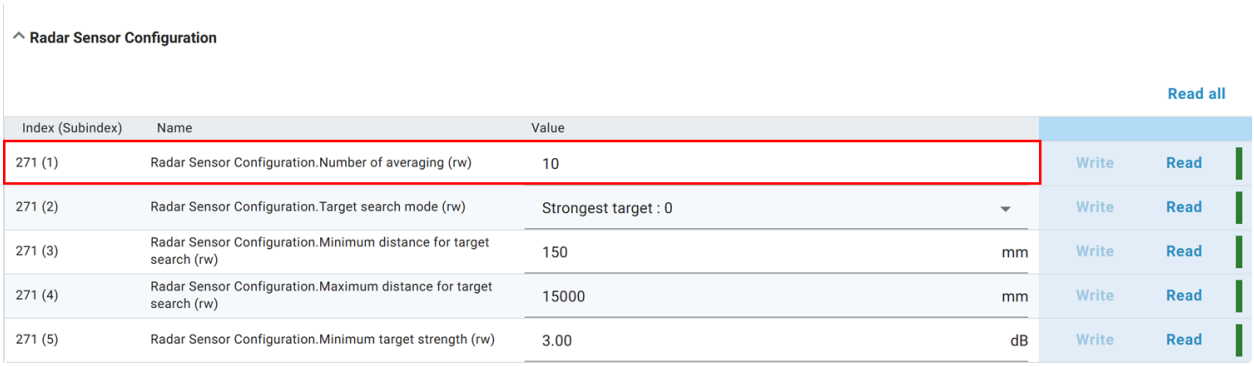

Radar Sensor Configuration
Read all
Index (Subindex)
Name
Value
271 (1)
Radar Sensor Configuration.Number of averaging (rw)
10
Write
Read
271 (2)
Radar Sensor Configuration.Target search mode (rw)
Strongest target : 0
Write
Read
271 (3)
Radar Sensor Configuration.Minimum distance for target search (rw)
150
mm
Write
Read
271 (4)
Radar Sensor Configuration.Maximum distance for target search (rw)
15000
mm
Write
Read
271 (5)
Radar Sensor Configuration.Minimum target strength (rw)
3.00
dB
Write
Read


Radar Sensor Configuration
Read all
Index (Subindex)
Name
Value
271 (1)
Radar Sensor Configuration.Number of averaging (rw)
10
Write
Read
271 (2)
Radar Sensor Configuration.Target search mode (rw)
Strongest target : 0
Write
Read
271 (3)
Radar Sensor Configuration.Minimum distance for target search (rw)
150
mm
Write
Read
271 (4)
Radar Sensor Configuration.Maximum distance for target search (rw)
15000
mm
Write
Read
271 (5)
Radar Sensor Configuration.Minimum target strength (rw)
3.00
dB
Write
Read



4. Configure averaging

Adjust averaging (moving average of last n measurements) – more smoothing vs. reaction speed.



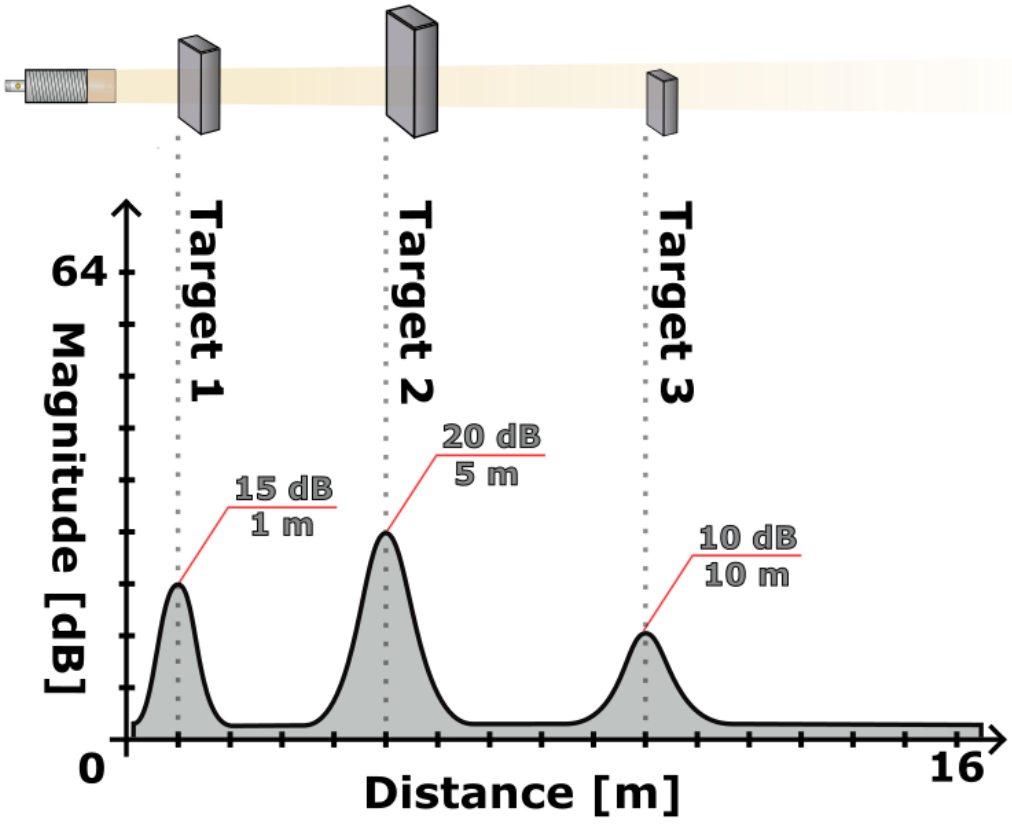
2.5.3 Configuration scenario examples

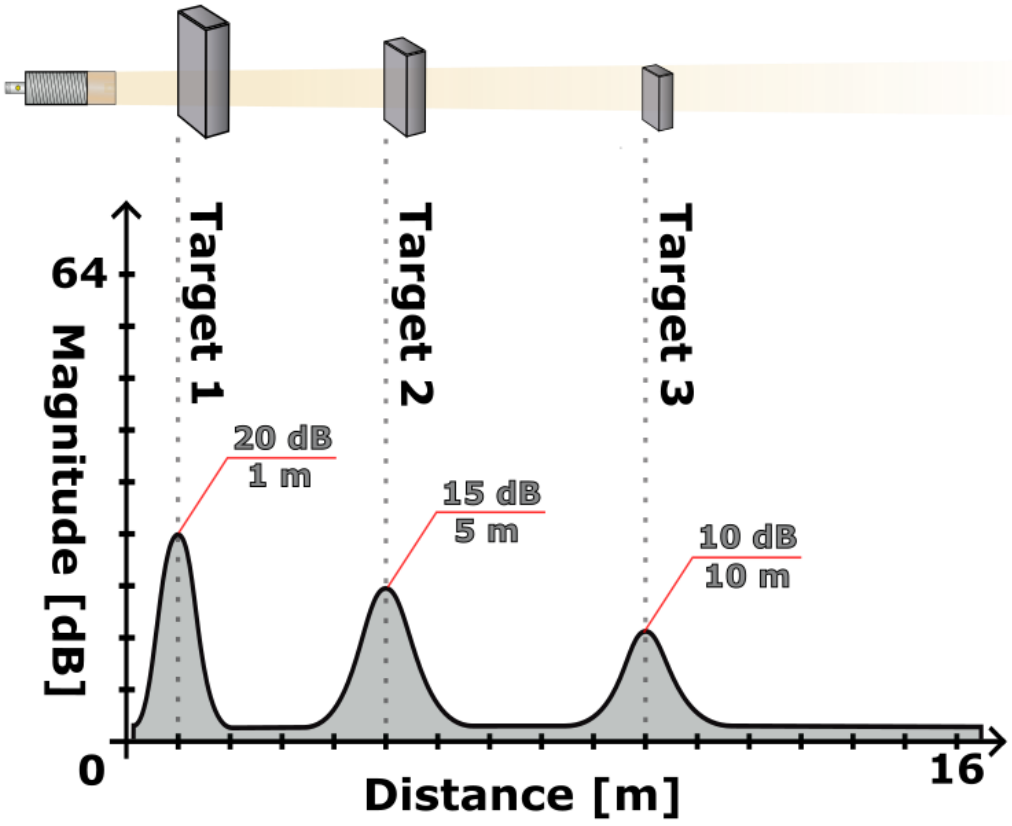
In each example minimal configuration changes show how the respective object can be detected. Deviations from the defaults are highlighted in **bold**.

Example 1

Table 3: Example 1

Object	Search window	Target search mode	Minimum target strength
1	300–15000 mm	**Nearest target**	3 dB
2	300–15000 mm	Strongest target	3 dB
3	**6000–15000 mm**	Strongest target	3 dB


Target 1
Target 2
Target 3
64
Magnitude [dB]
0
15 dB
1 m
20 dB
5 m
10 dB
10 m
16
Distance [m]


Target 1
Target 2
Target 3
64
Magnitude [dB]
0
20 dB
1 m
15 dB
5 m
10 dB
10 m
16
Distance [m]

Example 2

Table 4: Example 2

Object	Search window	Target search mode	Minimum target strength
1	300–15000 mm	Strongest target	3 dB
2	**2000–15000 mm**	Strongest target	3 dB
3	**6000–15000 mm**	Strongest target	3 dB

Example 3

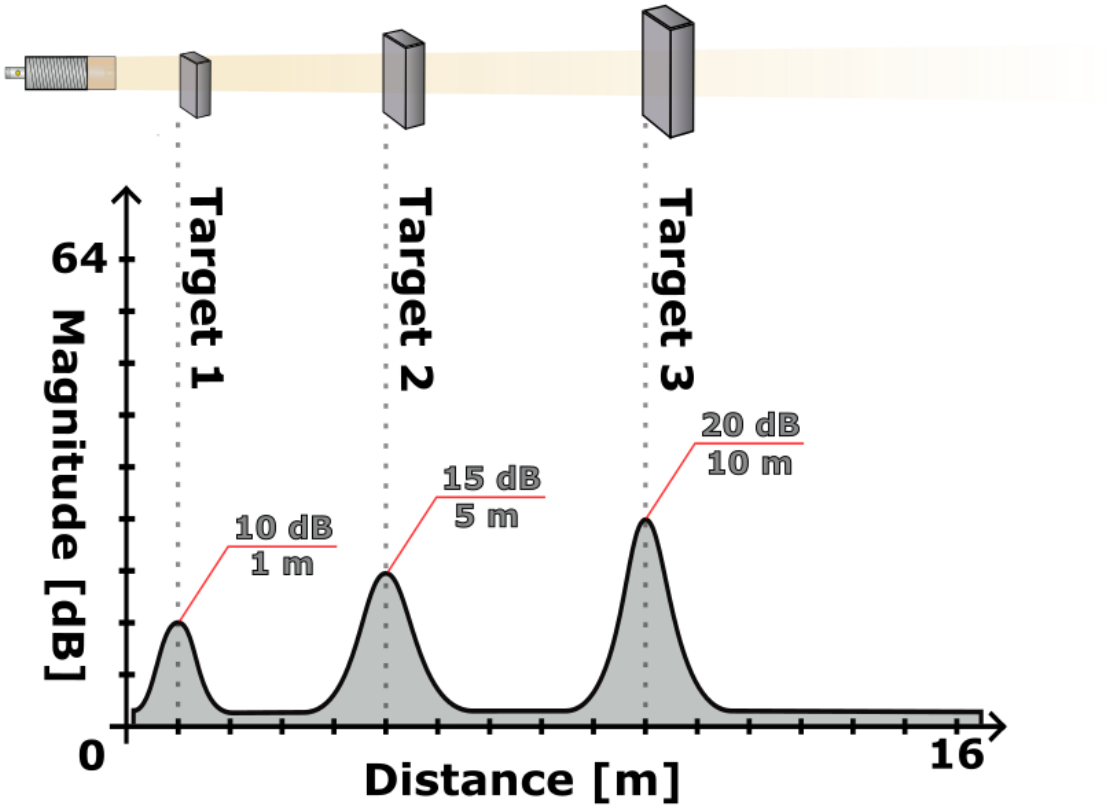


Table 5: Example 3

Object	Search window	Target search mode	Minimum target strength
1	300–15000 mm	**Nearest target**	3 dB
2	300–15000 mm	**Nearest target**	**12 dB**
3	300–15000 mm	Strongest target	3 dB

Example 4

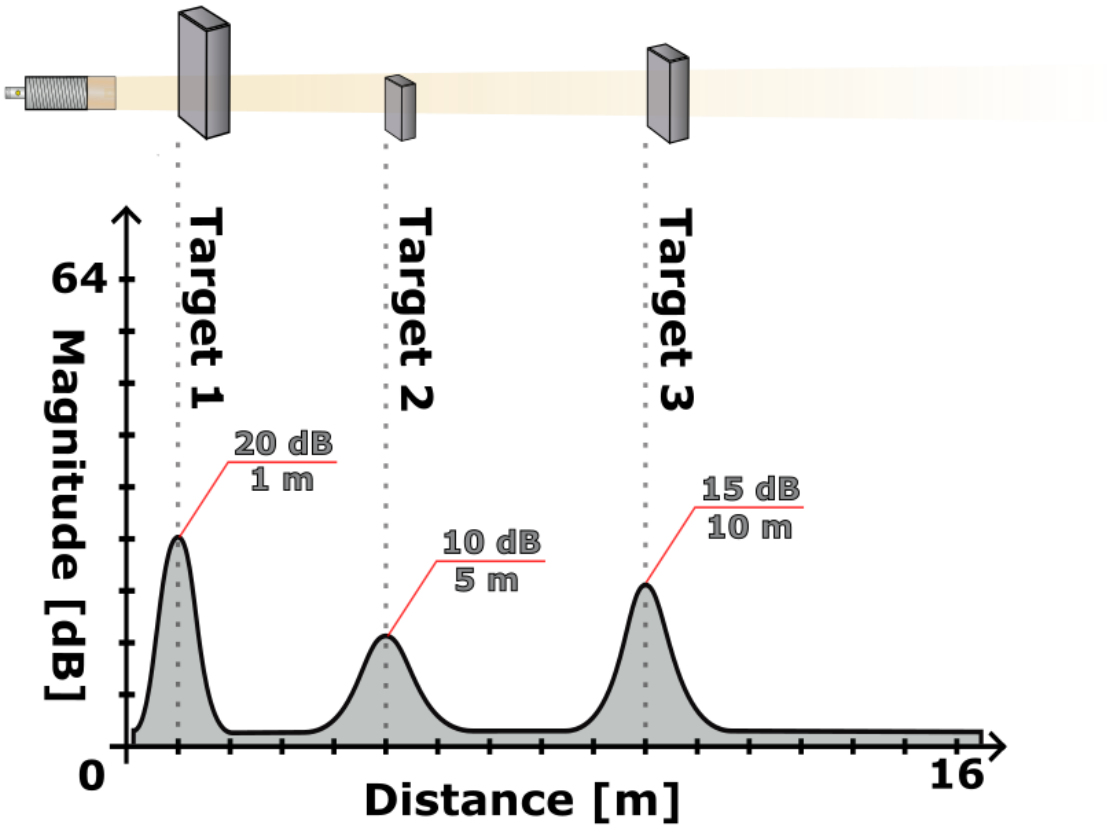


Table 6: Example 4

Object	Search window	Target search mode	Minimum target strength
1	300–15000 mm	Strongest target	3 dB
2	**2000–15000 mm**	**Nearest target**	3 dB
3	**2000–15000 mm**	Strongest target	**12 dB**

2.5.4 Configure measurement offset

If you mount the sensor further away (to bypass near-range inaccuracy) you can set a measurement offset.

Parameter table

Table 7: Parameter table

Parameter	

`Section`
`Parameter name`
`Subindex`
	Index
	Default

Measurement offset
`Sensor Measurement Config`
`Offset Distance`
`0`
	
	193
	0 mm

Preset distance
`Sensor Measurement Config`
`Preset Distance`
`0`
	
	194
	0 mm

Teach Preset (Command)
`Sensor Measurement Config`
`Standard Command`
`0`
	
	2
	Teach Preset

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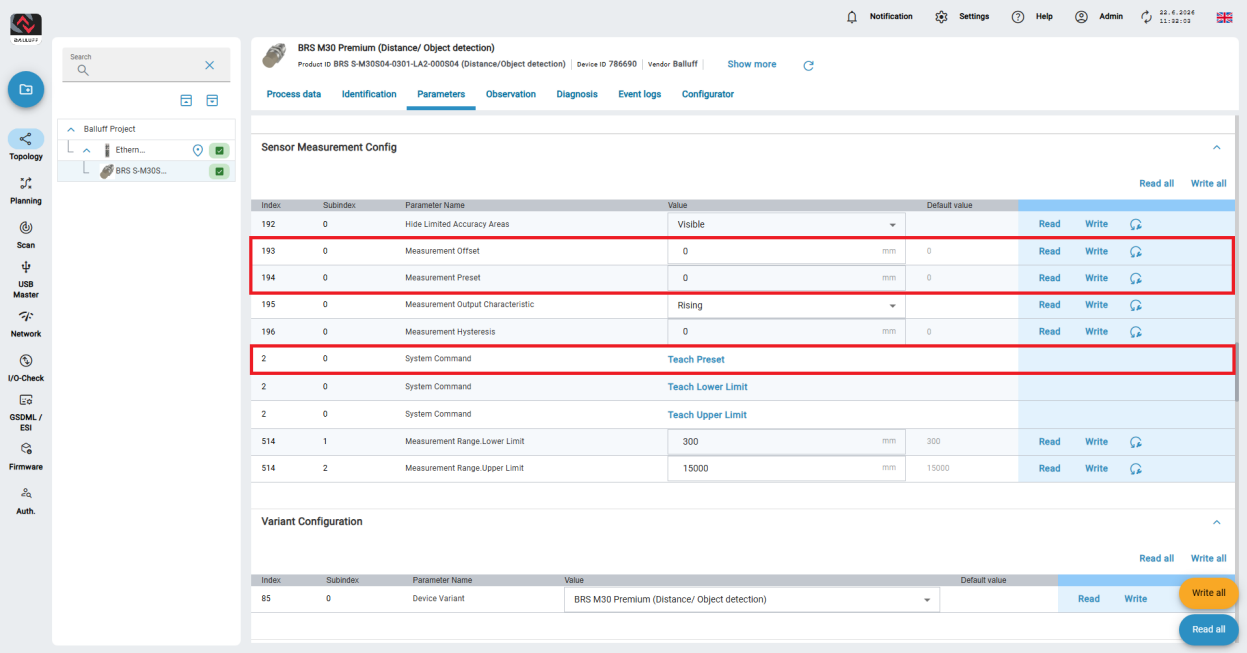
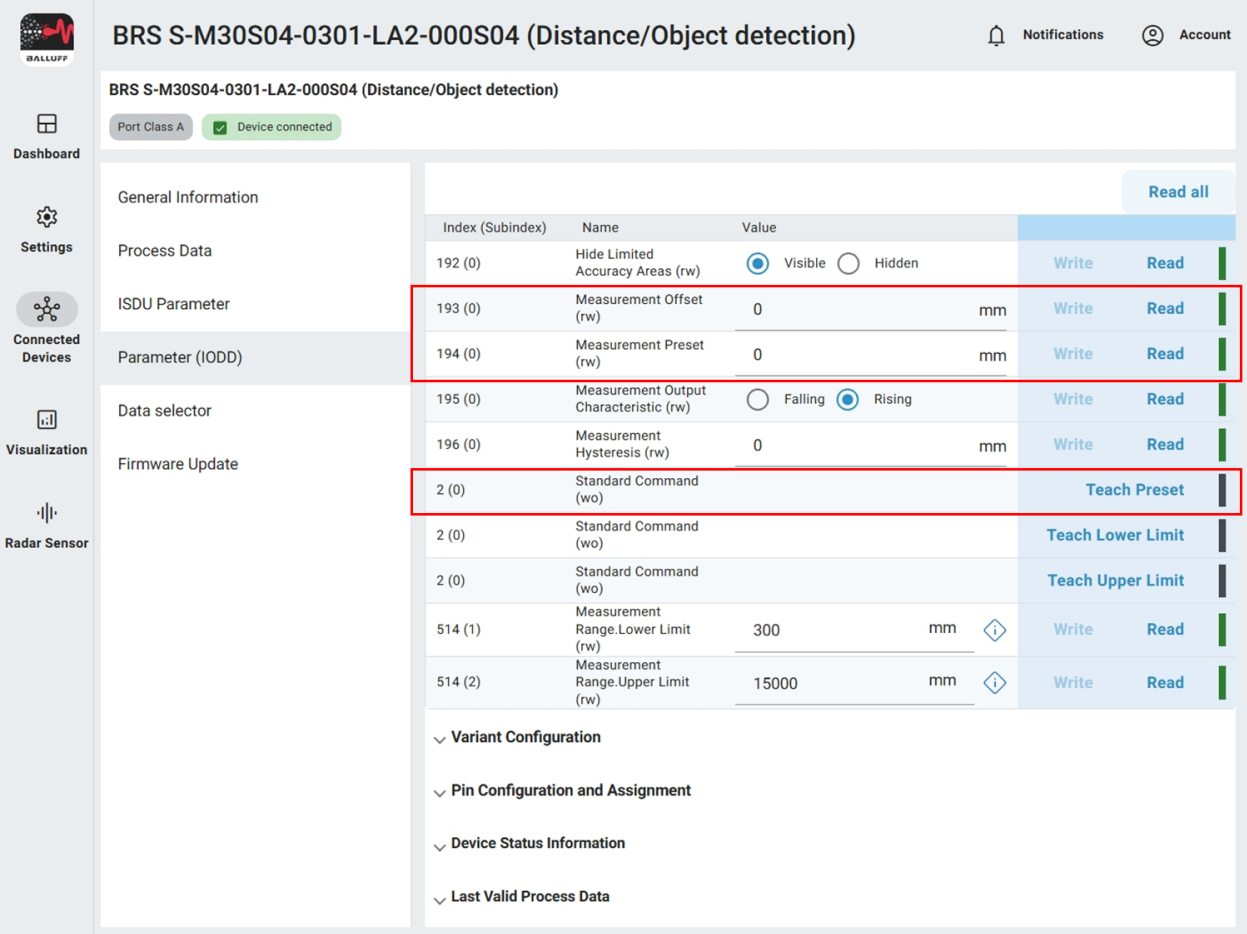
You can enter the offset manually (value is subtracted from measurement) or calculate it automatically.

Examples

Example 1: Measured value is currently 1.5 m but should be 1 m. Difference 500 mm. Enter 500 mm into `Measurement offset`.


Notification
Settings
Help
Admin
BRS M30 Premium (Distance/ Object detection)
Process data
Identification
Parameters
Observation
Diagnosis
Event logs
Configurator
Sensor Measurement Config
Read all
Write all
Index
Subindex
Parameter Name
Value
Default value
192 0 Hide Limited Accuracy Areas Visible
193 0 Measurement Offset 0 mm
194 0 Measurement Preset 0 mm
195 0 Measurement Output Characteristic Rising
196 0 Measurement Hysteresis 0 mm
2 0 System Command Teach Preset
2 0 System Command Teach Lower Limit
2 0 System Command Teach Upper Limit
514 1 Measurement Range.Lower Limit 300 mm
514 2 Measurement Range.Upper Limit 15000 mm
Read
Write
Variant Configuration
85 0 Device Variant BRS M30 Premium (Distance/ Object detection)
Topology
Planning
Scan
USB Master
Network
I/O-Check
GSDML / ESI
Firmware
Auth.


BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Notifications
Account
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Port Class A
Device connected
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
General Information
Process Data
ISDU Parameter
Parameter (IODD)
Data selector
Firmware Update
Read all
Index (Subindex)
Name
Value
192 (0) Hide Limited Accuracy Areas (rw) Visible Hidden
193 (0) Measurement Offset (rw) 0 mm
194 (0) Measurement Preset (rw) 0 mm
195 (0) Measurement Output Characteristic (rw) Falling Rising
196 (0) Measurement Hysteresis (rw) 0 mm
2 (0) Standard Command (wo) Teach Preset
2 (0) Standard Command (wo) Teach Lower Limit
2 (0) Standard Command (wo) Teach Upper Limit
514 (1) Measurement Range.Lower Limit (rw) 300 mm
514 (2) Measurement Range.Upper Limit (rw) 15000 mm
Write
Read
Variant Configuration
Pin Configuration and Assignment
Device Status Information
Last Valid Process Data

Example 2: Measured value is currently 1.5 m but should be 2 m. Difference −500 mm. Enter −500 mm into `Measurement offset`.

For automatic configuration place the object at a defined position (e.g. 2 m), enter that value (2000 mm) into `Preset distance` and execute `Teach Preset`. The offset is set so the measured value afterwards is 2000 mm.

Next section Step 3 – Analog output

Analog Output

2.6 Analog Output

Chapter goal

Goal: Output distance or magnitude via the analog output.

Prerequisite

The CMTK here is only for parameterization – for measuring or checking a current/voltage value or switching level you must connect the sensor to suitable evaluation or control equipment (e.g. PLC, measuring device).

2.6.1 How it works

The sensor can output the measured distance or magnitude via the analog output at Pin 2 as a voltage or current signal. The parameter tables below give an overview of the relevant settings.

Parameter table

Table 8: Parameter table

Parameter Section Parameter name Subindex	 **Index** **Default**
Lower limit measurement range Sensor Measurement Config Measurement Range.Lower 1	 514 300 mm
Upper limit measurement range Sensor Measurement Config Measurement Range.Upper 2	 514 15000 mm
Pin 2 mode Pin Configuration and Assignment Pin 2 Function.Pin Mode 2	 147 Inactive
Analog output signal source Pin Configuration and Assignment Pin 2 Analog Configuration.Signal Source 1	 149 Target Distance
Analog output type Pin Configuration and Assignment Pin 2 Analog Configuration.Type 3	 149 4-20 mA

Pin assignment

Fig. 2: IO-Link port (M12, A-coded, socket)

Table 9: Pin assignment

PIN	Function
1	24 V
2	Digital output / Analog output
3	0 V
4	IO-Link / Digital output

2.6.2 Configuration

1. Activate analog output

Set Pin-2 mode to `Analog Output`. You can find the pin configuration under `Pin Configuration and Assignment`. By default, the pin outputs distance as a current value (4–20 mA).

Pin Configuration and Assignment

Read all

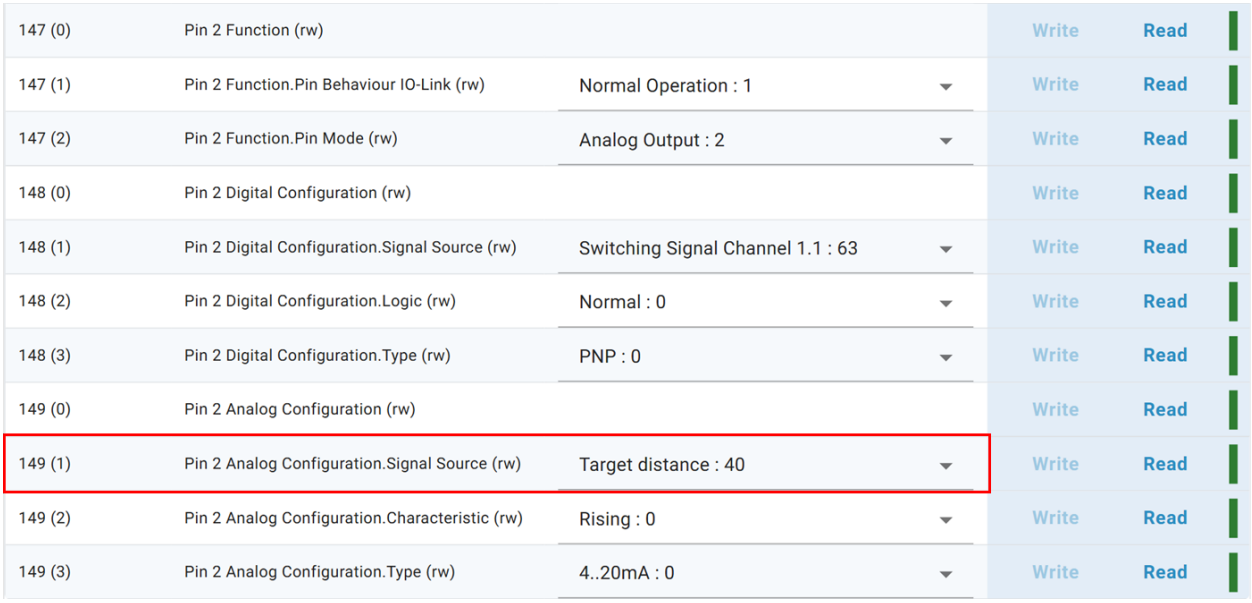
Index (Subindex)	Name	Value		
144 (0)	Pin 4 Function (rw)		Write	Read
144 (1)	Pin 4 Function.Pin Behaviour IO-Link (rw)	IO-Link : 0	Write	Read
144 (2)	Pin 4 Function.Pin Mode (rw)	Inactive : 0	Write	Read
145 (0)	Pin 4 Digital Configuration (rw)		Write	Read
145 (1)	Pin 4 Digital Configuration.Signal Source (rw)	Switching Signal Channel 1.1 : 63	Write	Read
145 (2)	Pin 4 Digital Configuration.Logic (rw)	Normal : 0	Write	Read
145 (3)	Pin 4 Digital Configuration.Type (rw)	Push-Pull : 2	Write	Read
147 (0)	Pin 2 Function (rw)		Write	Read
147 (1)	Pin 2 Function.Pin Behaviour IO-Link (rw)	Normal Operation : 1	Write	Read
147 (2)	Pin 2 Function.Pin Mode (rw)	Inactive : 0	Write	Read
148 (0)	Pin 2 Digital Configuration (rw)		Write	Read
148 (1)	Pin 2 Digital Configuration.Signal Source (rw)	Switching Signal Channel 1.1 : 63	Write	Read
148 (2)	Pin 2 Digital Configuration.Logic (rw)	Normal : 0	Write	Read
148 (3)	Pin 2 Digital Configuration.Type (rw)	PNP : 0	Write	Read
149 (0)	Pin 2 Analog Configuration (rw)		Write	Read
149 (1)	Pin 2 Analog Configuration.Signal Source (rw)	Target distance : 40	Write	Read
149 (2)	Pin 2 Analog Configuration.Characteristic (rw)	Rising : 0	Write	Read
149 (3)	Pin 2 Analog Configuration.Type (rw)	4..20mA : 0	Write	Read

2. Configure signal source

You can choose either distance (`Target Distance`) or magnitude (`Target Strength`) as signal source.

Info

Distance: Scaled based on the configured measurement range (see step 4). Factory setting: 300 mm to 15000 mm → for 4-20 mA this means 4 mA = 300 mm and 20 mA = 15000 mm.
Magnitude: Fixed range 0 dB to 64 dB → for 4-20 mA this means 4 mA = 0 dB and 20 mA = 64 dB.



3. Configure type

The analog output supports the following current and voltage signals:

- 4-20 mA
- 0-20 mA
- 1-5 V
- 0-10 V
- 2-10 V

Note

Current and voltage ranges are nominal. Error and status conditions can exceed upper or lower limits.

Table 10: Value Meaning

Value	Meaning
11 V / 22 mA	Sensor in error state
10.5 V / 20.5 mA	Measured value above measurement range
−0.5 V / −0.5 mA	Measured value below measurement range

147 (0)	Pin 2 Function (rw)		Write Read
147 (1)	Pin 2 Function.Pin Behaviour IO-Link (rw)	Normal Operation : 1	Write Read
147 (2)	Pin 2 Function.Pin Mode (rw)	Analog Output : 2	Write Read
148 (0)	Pin 2 Digital Configuration (rw)		Write Read
148 (1)	Pin 2 Digital Configuration.Signal Source (rw)	Switching Signal Channel 1.1 : 63	Write Read
148 (2)	Pin 2 Digital Configuration.Logic (rw)	Normal : 0	Write Read
148 (3)	Pin 2 Digital Configuration.Type (rw)	PNP : 0	Write Read
149 (0)	Pin 2 Analog Configuration (rw)		Write Read
149 (1)	Pin 2 Analog Configuration.Signal Source (rw)	Target distance : 40	Write Read
149 (2)	Pin 2 Analog Configuration.Characteristic (rw)	Rising : 0	Write Read
149 (3)	Pin 2 Analog Configuration.Type (rw)	4..20mA : 0	Write Read

4. Configure measurement range

The measurement range defines scaling (lower / upper limit) for distance. Configuration under `Sensor Measurement Config`.

Sensor Measurement Config

Read all

Index (Subindex)	Name	Value	
192 (0)	Hide Limited Accuracy Areas (rw)	(•) Visible ( ) Hidden	Write Read
193 (0)	Measurement Offset (rw)	0 mm	Write Read
194 (0)	Measurement Preset (rw)	0 mm	Write Read
195 (0)	Measurement Output Characteristic (rw)	( ) Falling (•) Rising	Write Read
196 (0)	Measurement Hysteresis (rw)	0 mm	Write Read
2 (0)	System Command (wo)		Teach Preset
2 (0)	System Command (wo)		Teach Lower Limit
2 (0)	System Command (wo)		Teach Upper Limit
514 (1)	Measurement Range.Lower Limit (rw)	621 mm	Write Read
514 (2)	Measurement Range.Upper Limit (rw)	15000 mm	Write Read

WARNING

The measurement range also defines the safe measurement range. Values outside the safe range are indicated by a yellow blinking LED.

2.6.3 Convert analog values

Conversion

Current

Calculation of output current or back-calculation to distance:

$$I_{\text{out}} = I_{\text{min}} + \frac{x - x_{\text{min}}}{x_{\text{max}} - x_{\text{min}}} \cdot (I_{\text{max}} - I_{\text{min}})$$

$$x = x_{\text{min}} + (x_{\text{max}} - x_{\text{min}}) \cdot \frac{I_{\text{out}} - I_{\text{min}}}{I_{\text{max}} - I_{\text{min}}}$$

- I_{out}: output current
- I_{min}: lower current limit (e.g. 4 mA)
- I_{max}: upper current limit (e.g. 20 mA)
- x: measurement value (distance mm or magnitude dB)
- x_{min}: lower measurement range limit
- x_{max}: upper measurement range limit

Tip

For distance the measurement range is configurable. Factory settings: **300 mm** to **15000 mm**. For magnitude the range is fixed at **0 dB** to **64 dB**.

Example: For a measurement of 800 mm in the range 300–1300 mm:

$$I_{\text{out}} = 4\,\text{mA} + \frac{800\,\text{mm} - 300\,\text{mm}}{1300\,\text{mm} - 300\,\text{mm}} \cdot (20\,\text{mA} - 4\,\text{mA}) = 4\,\text{mA} + 0.5 \cdot 16\,\text{mA} = 12\,\text{mA}$$

$$x = 300\,\text{mm} + (1300\,\text{mm} - 300\,\text{mm}) \cdot \frac{12\,\text{mA} - 4\,\text{mA}}{20\,\text{mA} - 4\,\text{mA}} = 300\,\text{mm} + 1000\,\text{mm} \cdot 0.5 = 800\,\text{mm}$$

Voltage

Analog voltage:

$$U_{\text{out}} = U_{\text{min}} + \frac{x - x_{\text{min}}}{x_{\text{max}} - x_{\text{min}}} \cdot (U_{\text{max}} - U_{\text{min}})$$

$$x = x_{\text{min}} + (x_{\text{max}} - x_{\text{min}}) \cdot \frac{U_{\text{out}} - U_{\text{min}}}{U_{\text{max}} - U_{\text{min}}}$$

- U_{out}: output voltage
- U_{min}: lower voltage limit (depends on type)
- U_{max}: upper voltage limit
- x: measurement value (distance mm or magnitude dB)
- x_{min}: lower measurement range limit
- x_{max}: upper measurement range limit

Next section Step 4 – Object detection

Object Detection

2.7 Object Detection

Chapter goal

Goal: Detect an object in the measurement range and output it via IO-Link.

Four switching channels are available for object detection: two switch on distance, two on magnitude. Channel parameters are summarized below.

Key Terms

Table 11: Key Terms

Term	Description
Switching Point	Numeric threshold
Switching Channel	Logical unit that evaluates a measurement and drives an output
Hysteresis	A buffer around a switching point (mm or dB) that prevents rapid toggling from small measurement noise
Teach / Teaching	Sensor command that stores the current measured value as a switching point
Magnitude	Reflection strength in dB; depends on material, angle and distance

2.7.1 How it works

Object detection continuously compares a measured value with a defined switching point and triggers a switching signal when the measurement exceeds the threshold or falls below it.

There are four switching channels: two for distance, two for magnitude. The sensor compares the current measured value with these switching values and changes its state according to the selected mode (`Single Point`, `Two Point`, `Window Mode`). Detailed configuration and parameter tables follow in the next section.

Parameter table – Switching Signal Channel 1.1 (Distance)

Table 12: Parameter table – Switching Signal Channel 1.1 (Distance)

Parameter (Section / Parameter name)	Index (Subindex)	Default
Switching point 1 — `Switching Signal Channel 1.1` — `SC1.1 Param.SP1`	60 — 1	2147483644 mm — (Disabled)
Switching point 2 — `Switching Signal Channel 1.1` — `SC1.1 Param.SP2`	60 — 2	2147483644 mm — (Disabled)
Logic — `Switching Signal Channel 1.1` — `SSC1.1 Config.Logic`	61 — 1	High active
Mode — `Switching Signal Channel 1.1` — `SSC1.1 Config.Mode`	61 — 2	Single point
Hysteresis — `Switching Signal Channel 1.1` — `SSC1.1 Config.Hysteresis`	61 — 3	10 mm

Parameter table – Switching Signal Channel 1.2 (Distance)

Table 13: Parameter table – Switching Signal Channel 1.2 (Distance)

Parameter (Section / Parameter name)	Index (Subindex)	Default
Switching point 1 — `Switching Signal Channel 1.2` — `SC1.2 Param.SP1`	62 — 1	2147483644 mm — (Disabled)
Switching point 2 — `Switching Signal Channel 1.2` — `SC1.2 Param.SP2`	62 — 2	2147483644 mm — (Disabled)
Logic — `Switching Signal Channel 1.2` — `SSC1.2 Config.Logic`	63 — 1	High active
Mode — `Switching Signal Channel 1.2` — `SSC1.2 Config.Mode`	63 — 2	Single point
Hysteresis — `Switching Signal Channel 1.2` — `SSC1.2 Config.Hysteresis`	63 — 3	10 mm

Parameter table – Switching Signal Channel 2.1 (Magnitude)

Table 14: Parameter table – Switching Signal Channel 2.1 (Magnitude)

Parameter (Section / Parameter name)	Index (Subindex)	Default
Switching point 1 — `Switching Signal Channel 2.1` — `SC2.1 Param.SP1`	16396 — 1	2147483644 dB — (Disabled)
Switching point 2 — `Switching Signal Channel 2.1` — `SC2.1 Param.SP2`	16396 — 2	2147483644 dB — (Disabled)
Logic — `Switching Signal Channel 2.1` — `SSC2.1 Config.Logic`	16397 — 1	High active
Mode — `Switching Signal Channel 2.1` — `SSC2.1 Config.Mode`	16397 — 2	Single point
Hysteresis — `Switching Signal Channel 2.1` — `SSC2.1 Config.Hysteresis`	16397 — 3	10 dB

Parameter table – Switching Signal Channel 2.2 (Magnitude)

Table 15: Parameter table – Switching Signal Channel 2.2 (Magnitude)

Parameter (Section / Parameter name)	Index (Subindex)	Default
Switching point 1 — `Switching Signal Channel 2.2` — `SC2.2 Param.SP1`	16398 — 1	2147483644 dB — (Disabled)
Switching point 2 — `Switching Signal Channel 2.2` — `SC2.2 Param.SP2`	16398 — 2	2147483644 dB — (Disabled)
Logic — `Switching Signal Channel 2.2` — `SSC2.2 Config.Logic`	16399 — 1	High active
Mode — `Switching Signal Channel 2.2` — `SSC2.2 Config.Mode`	16399 — 2	Single point
Hysteresis — `Switching Signal Channel 2.2` — `SSC2.2 Config.Hysteresis`	16399 — 3	10 dB

Note

All four switching channels are configured identically. The only difference is the input value (distance or magnitude). Examples refer to `Switching Signal Channel 1.1`.

2.7.2 Configuration

1. Configure switching mode

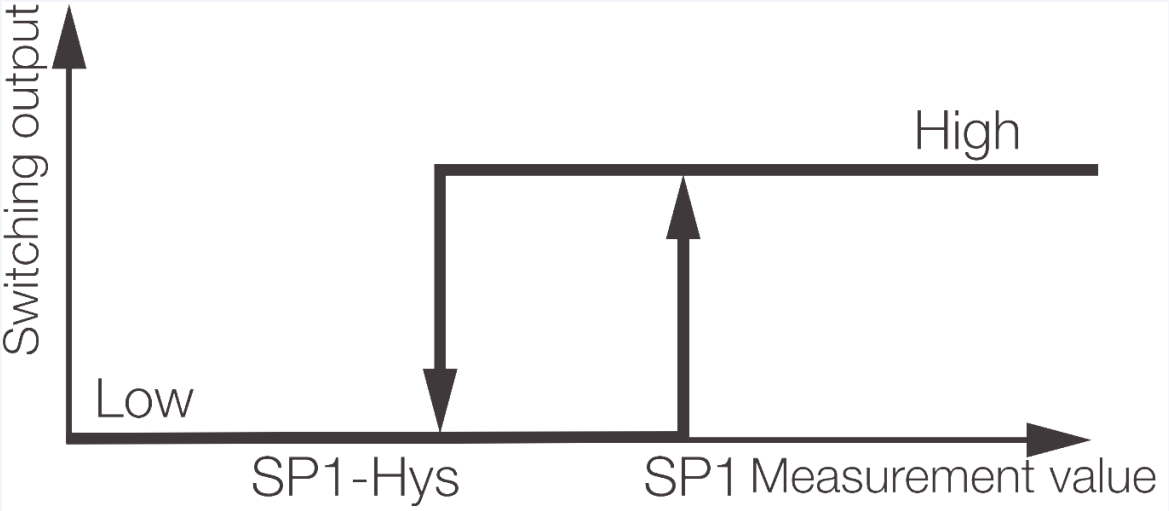
Choose a switching mode (three options):

Details on how the modes work can be expanded here.

Index (Subindex)	Name	Value			
62 (1)	SSC1.2 Param.SP1 (rw)	2147483644	mm	Write	Read
62 (2)	SSC1.2 Param.SP2 (rw)	2147483644	mm	Write	Read
63 (1)	SSC1.2 Config.Logic (rw)	High active : 0		Write	Read
63 (2)	SSC1.2 Config.Mode (rw)	Single point : 1		Write	Read
63 (3)	SSC1.2 Config.Hysteresis (rw)	10	mm	Write	Read

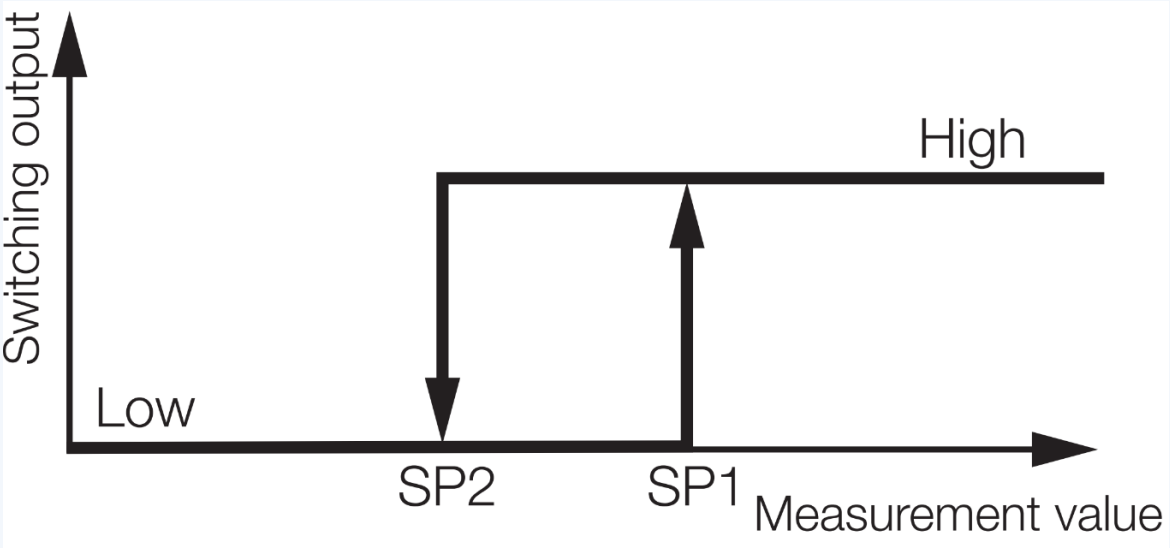
Single Point

`Single Point` uses only `SP1` and optionally hysteresis. The channel becomes active when the measurement is greater than or equal to `SP1` and only returns to inactive when the measurement falls below `SP1` minus the configured hysteresis.
Example: `SP1 = 1000 mm, Hysteresis = 10 mm` → ON at ≥ 1000 mm, OFF at < 990 mm.



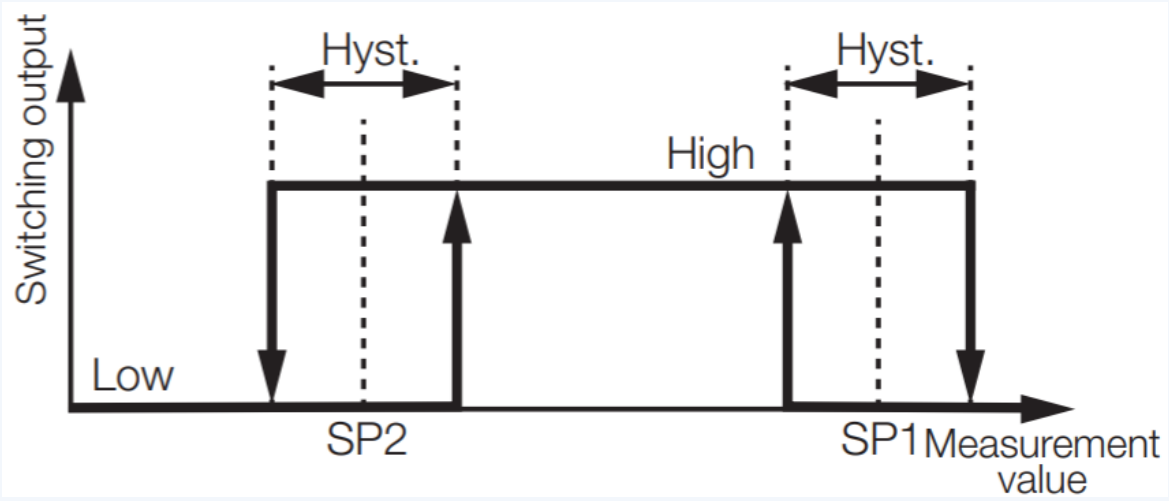
Two Point

`Two Point` uses `SP1` and `SP2` and does not use hysteresis. The channel turns ON when the measurement ≥ `SP1` and turns OFF when the measurement < `SP2`.
Example: `SP1 = 1200 mm, SP2 = 1100 mm` → ON at ≥ 1200 mm, OFF at < 1100 mm.



Window Mode

`Window Mode` is active only when the measurement lies between `SP1` and `SP2`. Hysteresis is applied to both edges (50% split of the configured hysteresis value).
Example: `SP1 = 800 mm, SP2 = 1200 mm, Hysteresis = 40 mm` → nominal active window 800–1200 mm. A change beyond ±20 mm at an edge is required to flip the state.



2. Configure hysteresis

Hysteresis is effective only in `Single Point` and `Window Mode`. A value of 0 disables it. `Two Point` mode does not use hysteresis.

What is Hysteresis and why do I need it?

Hysteresis is a dead band around a switching point that ignores small fluctuations in the measured value so the output does not chatter. Without hysteresis, measurement noise around the threshold can cause rapid ON/OFF toggling that stresses relays, creates false events and complicates down-

Index (Subindex)	Name	Value			
62 (1)	SSC1.2 Param.SP1 (rw)	2147483644	mm	Write	Read
62 (2)	SSC1.2 Param.SP2 (rw)	2147483644	mm	Write	Read
63 (1)	SSC1.2 Config.Logic (rw)	High active : 0		Write	Read
63 (2)	SSC1.2 Config.Mode (rw)	Single point : 1		Write	Read
63 (3)	SSC1.2 Config.Hysteresis (rw)	10	mm	Write	Read

stream logic. Example: with `SP1 = 1000 mm` and `Hysteresis = 10 mm`, measurements between 995 mm and 1005 mm will not flip the output. A sustained change beyond 10 mm is required. Practical guidance: distance channels commonly use 5–20 mm hysteresis. Magnitude channels typically need smaller hysteresis (for example 2–5 dB). Setting hysteresis to 0 disables it.

Note

Default: 10 mm / 10 dB. For magnitude channels (2.1 / 2.2) a smaller hysteresis is usually required.

3. Configure switching points

Important

Switching points are not identical to switching channels. A channel uses one or two switching points depending on mode.

You can configure a channel's switching points manually or teach them via the `Teach function`.

Manual: Enter values in SP1 / SP2. Value 2147483644 disables the channel. Unused points do not need resetting.

Index (Subindex)	Name	Value			
62 (1)	SSC1.2 Param.SP1 (rw)	2147483644	mm	Write	Read
62 (2)	SSC1.2 Param.SP2 (rw)	2147483644	mm	Write	Read
63 (1)	SSC1.2 Config.Logic (rw)	High active : 0		Write	Read
63 (2)	SSC1.2 Config.Mode (rw)	Single point : 1		Write	Read
63 (3)	SSC1.2 Config.Hysteresis (rw)	10	mm	Write	Read

"Teach" captures the sensor's current measurement and stores it as a switching point. There are three teach modes: `Single Value`, `Two Value`, `Dynamic`. Only `Single Value` is covered here. Information on the other modes is in the *IO-Link configuration guide*.

Note

`Two Value Teach` is not identical to `Two Point`. All switching modes work with all teach modes.

Parameter table – Single Point Teach

Table 16: Parameter table – Single Point Teach

Parameter
`Section`
`Parameter name`
`Subindex`
	Index
	Default	

Select switching channel
`Teach`
`Teach Select`
`1`
	60
	SSC1.1	

Teach channel 1 switching point 1
`Teach - Single Value`
`Teach SP1`
	System command	0x41

Teach channel 2 switching point 2
`Teach - Single Value`
`Teach SP2`
	System command	0x42

Status
`Teach - Single Value`
`Teach Result.State`
`1`
	59	

Table 17: Possible values for Teach Select

Channel	**Description**	**Value for *Teach Select***
SSC1.1	Switching Signal Channel 1.1 (Distance)	1
SSC1.2	Switching Signal - Channel 1.2 (Distance)	2
SSC2.1	Switching Signal Channel 2.1 (Magnitude)	11
SSC2.2	Switching Signal Channel 2.2 (Magnitude)	22

First select the channel to teach. `Teach SP1` / `Teach SP2` sets the current value for SP1 or SP2, respectively.

Use `Teach Result` to check status. An error occurs e.g. if no target is detected.

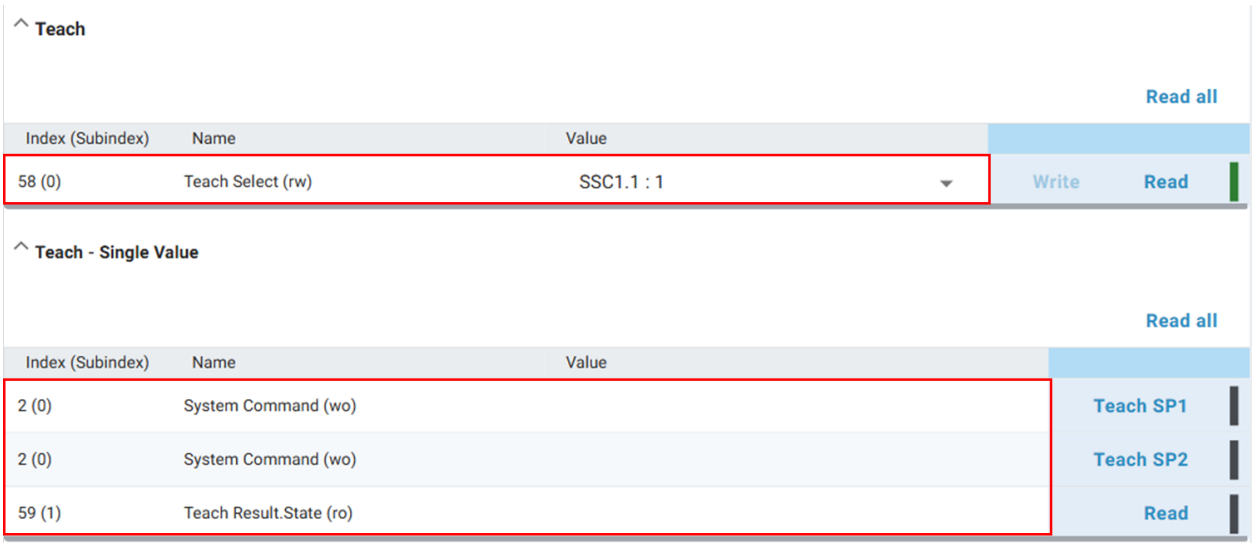
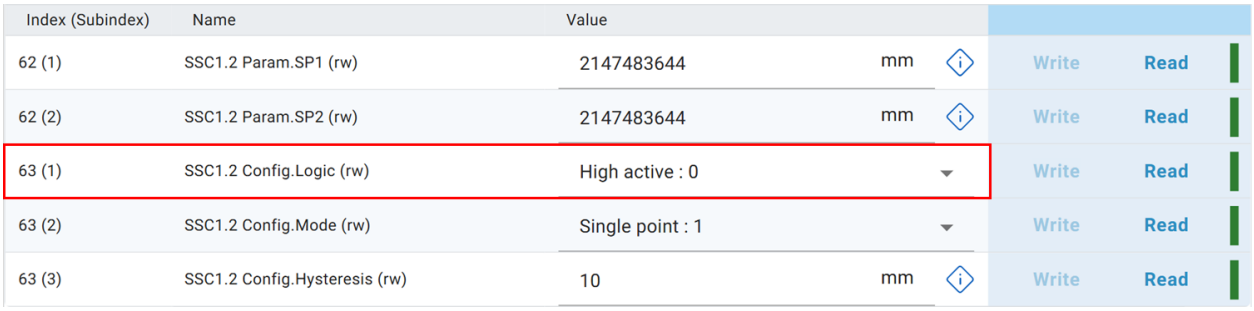


Table 18: Teach Result codes

Value	Meaning
0	Idle
1	Switching point 1 taught successfully
2	Switching point 2 taught successfully
7	Error during teaching

4. Invert switching behavior

With the parameter `Logic` you invert behavior (`High active` / `Low active`).



My switching behavior in the near range is not reliable

Below 500 mm distance and magnitude values can fluctuate. For the near range use the *Radar Reflex Gate mode*.

Next section Step 5 – Output detected object via a digital output

Digital Output

2.8 Digital Output

Chapter goal

Goal: Output a detected object via a digital output.

Prerequisite

The configuration and monitoring tool (CMTK) is used here only for parameterization. It displays the state of pins 2 and 4 but cannot record or further process them.

2.8.1 How it works

The sensor can output two switching channels via digital outputs. These share pins with analog output and IO-Link – you must decide on usage.

Parameters are summarized in the following table.

Use of IO-Link pin

The IO-Link pin automatically detects an IO-Link master, activates IO-Link and disables the digital output. This behavior cannot be overridden.

Parameter table

Table 19: Parameter table

Parameter Section Parameter name Subindex	 **Index** **Default**
Pin 4 mode Pin Configuration and Assignment Pin 4 Function.Pin Mode 2	 144 Inactive
Pin 4 signal source Pin Configuration and Assignment Pin 4 Digital Configuration.Signal Source 1	 145 Switching Signal Channel 1.1
Pin 2 mode Pin Configuration and Assignment Pin 2 Function.Pin Mode 2	 147 Inactive
Pin 2 signal source Pin Configuration and Assignment Pin 2 Digital Configuration.Signal Source 1	 148 Switching Signal Channel 1.1
Pin 2 type Pin Configuration and Assignment Pin 2 Digital Configuration.Type 3	 148 PNP

Pin assignment

Fig. 3: IO-Link port (M12, A-coded, socket)

Table 20: Pin assignment

PIN	Function
1	24 V
2	Digital output / Analog output
3	0 V
4	IO-Link / Digital output

2.8.2 Configuration

1. Configure object detection

First set up *object detection* – alternatively you can output certain system states.

Possible output signals

Table 21: Possible output signals

Description	Name	Value
Switching channel 1.1	Switching Signal Channel 1.1	63
Switching channel 1.2	Switching Signal Channel 1.2	64
Switching channel 2.1	Switching Signal Channel 2.1	371
Switching channel 2.2	Switching Signal Channel 2.2	372
Supply voltage warning - under-voltage	Primary supply voltage under-run	23
Supply voltage warning - over-voltage	Primary supply voltage over-run	24
Error state - No object in detection range	MDC Measurement Error	43
Measurement range warning	MDC Out of Measurement Range Warning	44
System error	System Error	47
Temperature alarm	Device Temperature Alarm Status	78

2. Configure pin mode and signal source

Set pin mode to `Digital Output` and choose the desired switching channel as signal source. The pin configuration settings are under `Pin Configuration and Assignment`.

3. Configure switching type

Pin 4 supports only `Push-Pull`. Pin 2 supports `PNP`, `NPN` or `Push-Pull`.

Note on Pin 4

Pin 4 is used for IO-Link communication by default. If the sensor is connected to an IO-Link master or similar devices, the device automatically detects the connection, activates IO-Link communication, and disables the digital output functionality on Pin 4.
This behavior cannot be overridden.

Pin Configuration and Assignment

Read all

Index (Subindex)	Name	Value		
144 (0)	Pin 4 Function (rw)		Write	Read
144 (1)	Pin 4 Function.Pin Behaviour IO-Link (rw)	IO-Link : 0	Write	Read
144 (2)	Pin 4 Function.Pin Mode (rw)	Inactive : 0	Write	Read
145 (0)	Pin 4 Digital Configuration (rw)		Write	Read
145 (1)	Pin 4 Digital Configuration.Signal Source (rw)	Switching Signal Channel 1.1 : 63	Write	Read
145 (2)	Pin 4 Digital Configuration.Logic (rw)	Normal : 0	Write	Read
145 (3)	Pin 4 Digital Configuration.Type (rw)	Push-Pull : 2	Write	Read
147 (0)	Pin 2 Function (rw)		Write	Read
147 (1)	Pin 2 Function.Pin Behaviour IO-Link (rw)	Normal Operation : 1	Write	Read
147 (2)	Pin 2 Function.Pin Mode (rw)	Inactive : 0	Write	Read
148 (0)	Pin 2 Digital Configuration (rw)		Write	Read
148 (1)	Pin 2 Digital Configuration.Signal Source (rw)	Switching Signal Channel 1.1 : 63	Write	Read
148 (2)	Pin 2 Digital Configuration.Logic (rw)	Normal : 0	Write	Read
148 (3)	Pin 2 Digital Configuration.Type (rw)	PNP : 0	Write	Read
149 (0)	Pin 2 Analog Configuration (rw)		Write	Read
149 (1)	Pin 2 Analog Configuration.Signal Source (rw)	Target distance : 40	Write	Read
149 (2)	Pin 2 Analog Configuration.Characteristic (rw)	Rising : 0	Write	Read
149 (3)	Pin 2 Analog Configuration.Type (rw)	4..20mA : 0	Write	Read

Pin Configuration and Assignment

Read all

Index (Subindex)	Name	Value		
144 (0)	Pin 4 Function (rw)		Write	Read
144 (1)	Pin 4 Function.Pin Behaviour IO-Link (rw)	IO-Link : 0	Write	Read
144 (2)	Pin 4 Function.Pin Mode (rw)	Inactive : 0	Write	Read
145 (0)	Pin 4 Digital Configuration (rw)		Write	Read
145 (1)	Pin 4 Digital Configuration.Signal Source (rw)	Switching Signal Channel 1.1 : 63	Write	Read
145 (2)	Pin 4 Digital Configuration.Logic (rw)	Normal : 0	Write	Read
145 (3)	Pin 4 Digital Configuration.Type (rw)	Push-Pull : 2	Write	Read
147 (0)	Pin 2 Function (rw)		Write	Read
147 (1)	Pin 2 Function.Pin Behaviour IO-Link (rw)	Normal Operation : 1	Write	Read
147 (2)	Pin 2 Function.Pin Mode (rw)	Inactive : 0	Write	Read
148 (0)	Pin 2 Digital Configuration (rw)		Write	Read
148 (1)	Pin 2 Digital Configuration.Signal Source (rw)	Switching Signal Channel 1.1 : 63	Write	Read
148 (2)	Pin 2 Digital Configuration.Logic (rw)	Normal : 0	Write	Read
148 (3)	Pin 2 Digital Configuration.Type (rw)	PNP : 0	Write	Read
149 (0)	Pin 2 Analog Configuration (rw)		Write	Read
149 (1)	Pin 2 Analog Configuration.Signal Source (rw)	Target distance : 40	Write	Read
149 (2)	Pin 2 Analog Configuration.Characteristic (rw)	Rising : 0	Write	Read
149 (3)	Pin 2 Analog Configuration.Type (rw)	4..20mA : 0	Write	Read

As a result, Pin 4 cannot be used as a digital output while an active IO-Link connection is present. The pin is exclusively reserved for communication in this case.
For testing or using the digital output function of Pin 4, the IO-Link connection must be inactive or not established. Alternatively, use Pin 2, which can be configured as a digital output independently of IO-Link communication.

Switching types

PNP: The output supplies +24 V when active. The load or PLC input is connected between the output and 0 V.
NPN: The output switches to 0 V when active. The load or PLC input is connected between +24 V and the output.
Push-Pull: The output actively drives the signal both high (+24 V) and low (0 V). It can therefore be used with many PNP- or NPN-compatible inputs, depending on the wiring and input specification.

Next section Step 6 – Radar Reflex Gate mode – Near-range object detection

Radar Reflex Gate Mode

2.9 Radar Reflex Gate Mode

Chapter goal

Goal: Understand the Radar Reflex Gate mode and configure it correctly for near-range object detection.

Prerequisite

Basic commissioning and IO-Link connection are completed (see *Connection & Commissioning*).
The CMTK is used for parameterization.

Besides distance measurement the sensor offers the `Radar Reflex Gate mode`. It is optimized for near-range object detection and uses a different algorithm.

2.9.1 How it works

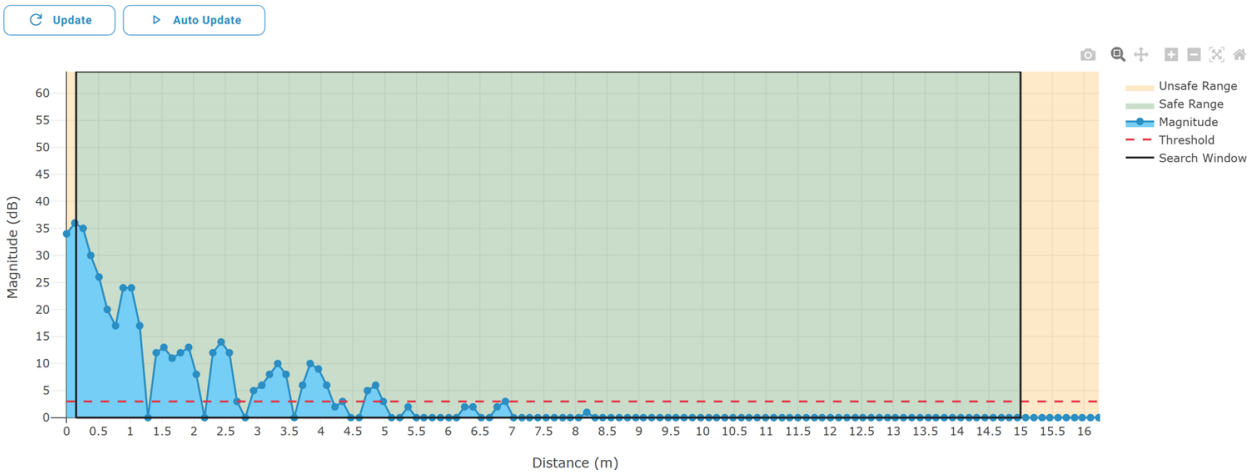
The mode uses differences in reflection strength between materials. Instead of continuously determining distance, the sensor observes magnitude at a reference distance (reflector). A strong reflector (e.g. a metal plate) produces a high peak. If an object intrudes between sensor and reflector, magnitude changes – usually decreases, sometimes increases (material / geometry).

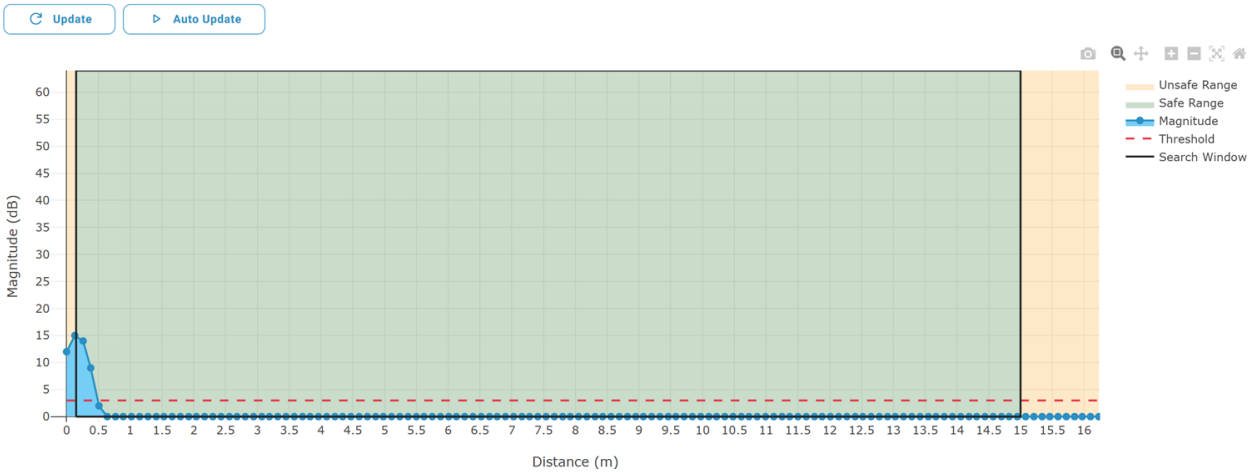
You can visualize the principle in the `Radar Sensor UI`.

Here a metal plate is mounted in the immediate vicinity (~10 cm). The distance display does not need to show exactly 10 cm – in this mode exact distance is secondary. When, for example, a hand is placed between the sensor and the reflector, the peak drops (e.g. from ~40 dB to ~20 dB).

Info

Magnitude is given in dB (logarithmic). A difference of −3 dB corresponds roughly to halving the power.


Update
Auto Update
Unsafe Range
Safe Range
Magnitude
Threshold
Search Window
Magnitude (dB)
Distance (m)


Update
Auto Update
Unsafe Range
Safe Range
Magnitude
Threshold
Search Window
Magnitude (dB)
Distance (m)

Note

Process data remains structurally unchanged. Distance is updated only roughly every 10 seconds and serves merely for orientation of peak position. Magnitude shows exclusively the value at reflector distance.

Parameter table

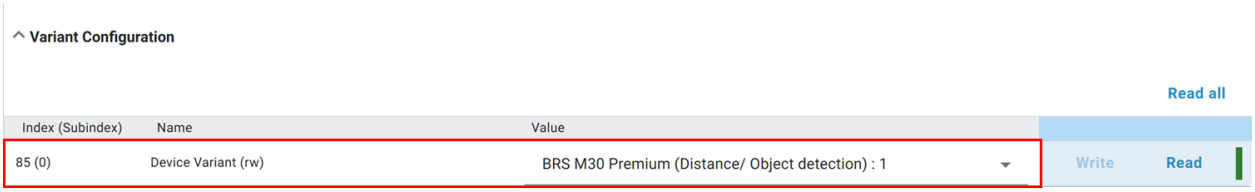
Table 22: Parameter table

Parameter Section Parameter name	Index (Subindex)	Default
Set reflector distance Sensor Measurement Config Set reflector distance 0	320	
Read reflector distance Sensor Measurement Config Read reflector distance 0	321 350 mm	

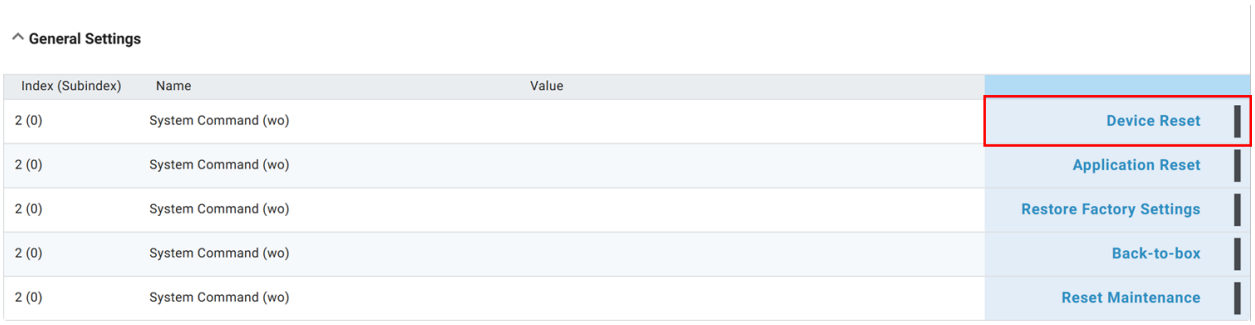
2.9.2 Configuration

1. Change variant

Activate the mode via variant configuration under `Variant Configuration`.

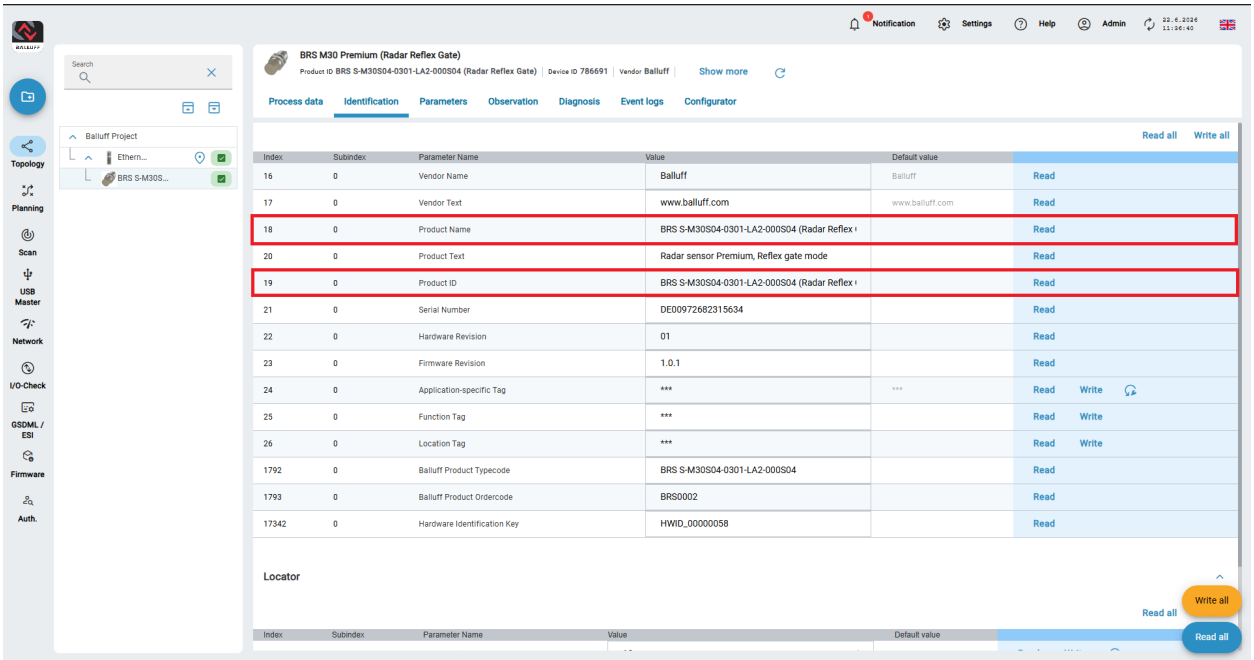


The setting becomes effective only after a restart (disconnect the connector or perform a device reset (`Device Reset`) under `General Settings`).



After restart, the sensor reports the variant `Radar Reflex Gate`. If the IODD is missing you must upload it (see *Commissioning*).

BET & Balluff IO-Link Master



CMTK

2. Teach reflector

You find the reflector settings under `Radar Sensor Configuration`. Enter the measured or process-data derived distance under `Set reflector distance`. The sensor searches around this value for the strongest peak and sets it as reference. Verify with `Read reflector distance`.

Tip

The mode is usable without reflector if the target itself reflects strongly. Then teach the object directly and evaluate changes of magnitude.

3. Configure switching channel

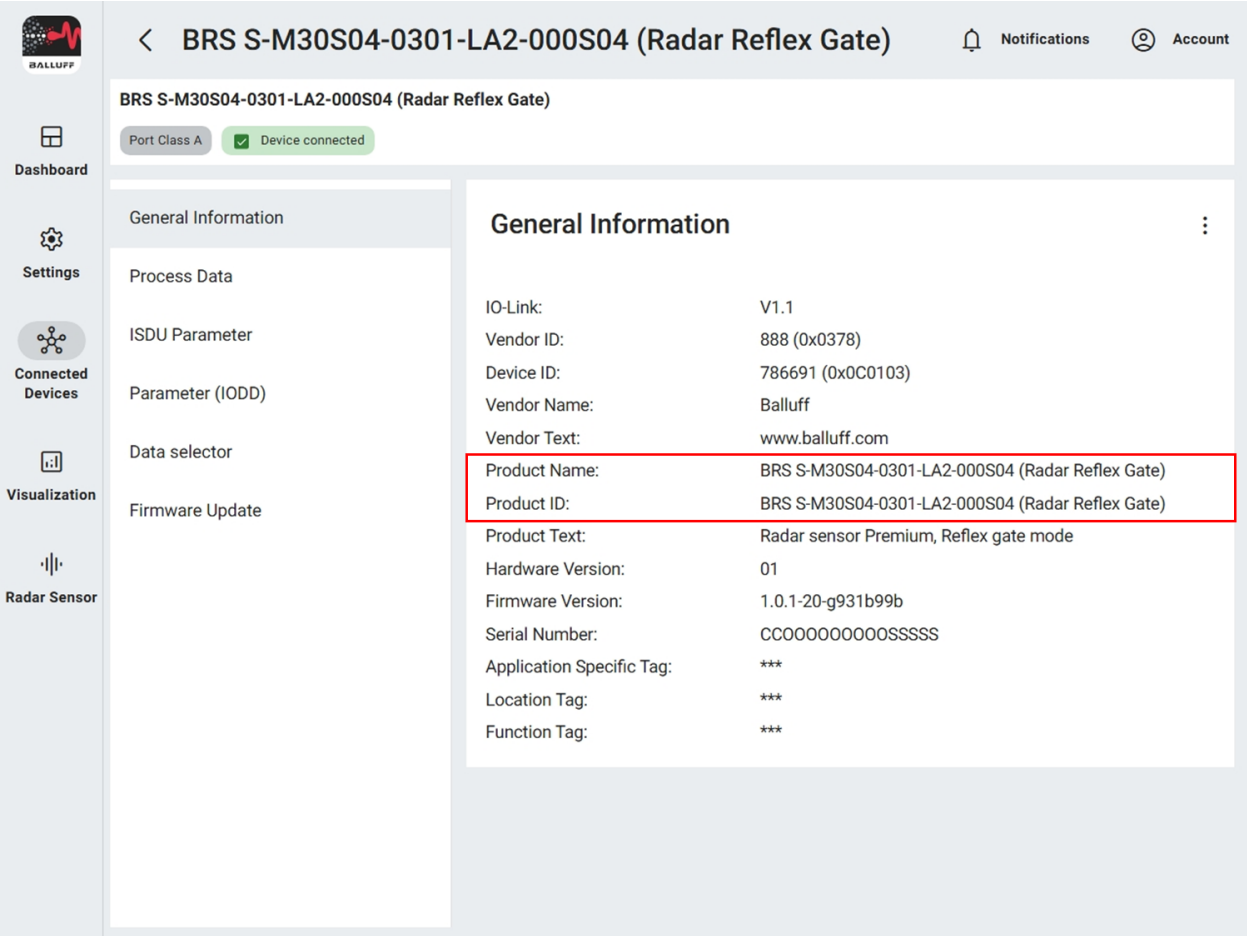
Configure a *switching channel*. Only variants 2.1 or 2.2 (magnitude) make sense. Hysteresis should typically be less than 10 dB.

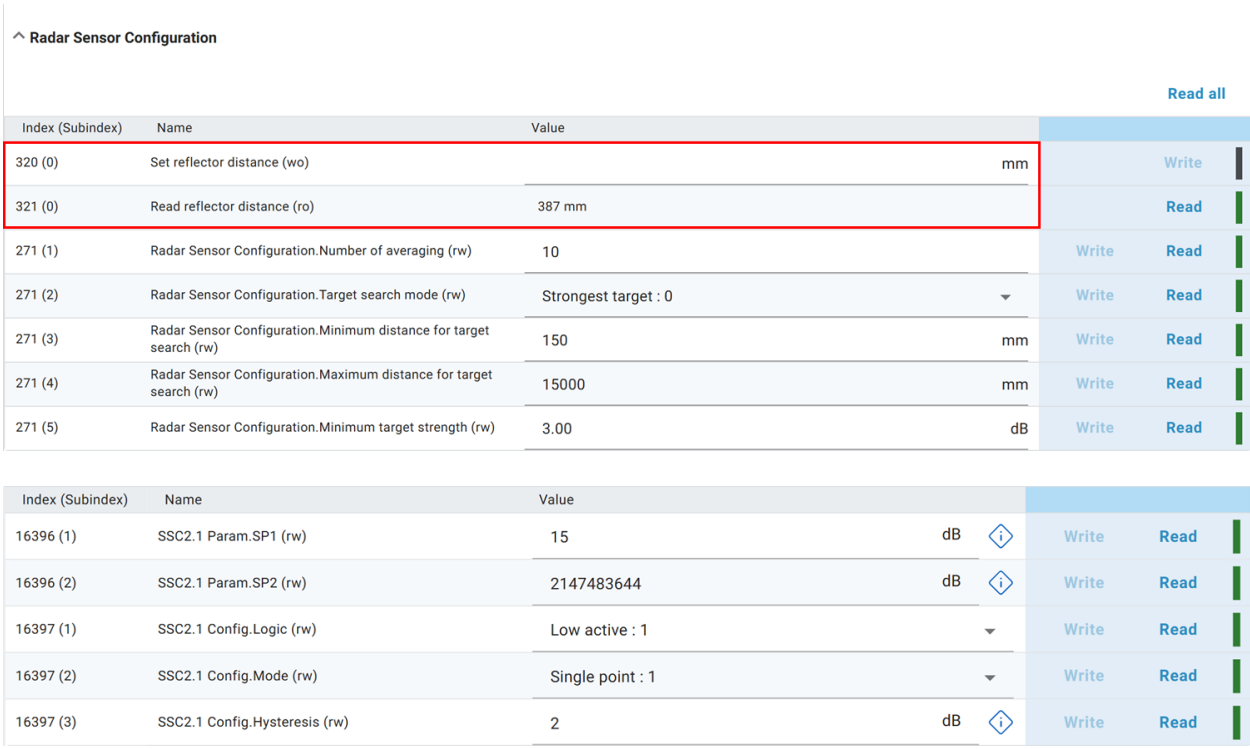
In most cases an object is considered detected when magnitude is lower than the reflector/reference magnitude. You can therefore invert switching logic. A possible configuration is shown below.

Optionally route the switching channel to a *Digital Output*.

Tip

The temporal course of magnitude can provide additional information, e.g. edge profiles of passing objects or material differences. For analysis, output magnitude on the *Analog Output* (1 kHz update) and record it.


BRS S-M30S04-0301-LA2-000S04 (Radar Reflex Gate)
Notifications
Account
BRS S-M30S04-0301-LA2-000S04 (Radar Reflex Gate)
Port Class A
Device connected
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
General Information
Process Data
ISDU Parameter
Parameter (IODD)
Data selector
Firmware Update
General Information
IO-Link: V1.1
Vendor ID: 888 (0x0378)
Device ID: 786691 (0x0C0103)
Vendor Name: Balluff
Vendor Text: www.balluff.com
Product Name: BRS S-M30S04-0301-LA2-000S04 (Radar Reflex Gate)
Product ID: BRS S-M30S04-0301-LA2-000S04 (Radar Reflex Gate)
Product Text: Radar sensor Premium, Reflex gate mode
Hardware Version: 01
Firmware Version: 1.0.1-20-g931b99b
Serial Number: CCOOOOOOOOSSSSS
Application Specific Tag: ***
Location Tag: ***
Function Tag: ***


Radar Sensor Configuration
Read all
Index (Subindex) Name Value
320 (0) Set reflector distance (wo) mm Write
321 (0) Read reflector distance (ro) 387 mm Read
271 (1) Radar Sensor Configuration.Number of averaging (rw) 10 Write Read
271 (2) Radar Sensor Configuration.Target search mode (rw) Strongest target : 0 Write Read
271 (3) Radar Sensor Configuration.Minimum distance for target search (rw) 150 mm Write Read
271 (4) Radar Sensor Configuration.Maximum distance for target search (rw) 15000 mm Write Read
271 (5) Radar Sensor Configuration.Minimum target strength (rw) 3.00 dB Write Read
Index (Subindex) Name Value
16396 (1) SSC2.1 Param.SP1 (rw) 15 dB Write Read
16396 (2) SSC2.1 Param.SP2 (rw) 2147483644 dB Write Read
16397 (1) SSC2.1 Config.Logic (rw) Low active : 1 Write Read
16397 (2) SSC2.1 Config.Mode (rw) Single point : 1 Write Read
16397 (3) SSC2.1 Config.Hysteresis (rw) 2 dB Write Read

CHAPTER

THREE

MANUAL

This section provides the full, structured user manual for the radar sensor. It focuses on safe installation, commissioning, operation, troubleshooting, and key technical data. Use it when you need comprehensive, step-by-step guidance beyond the quick-start topics.

Main topics

- *Safety instructions*: mandatory safety and handling
- *Scope of delivery, transport and storage*
- *Product description*: device overview and features
- *Installation*: mounting, wiring, and environment notes
- *Commissioning*: first startup and verification
- *Faults, repair and disposal*
- *Technical data*: ratings, interfaces, and dimensions

Related sections

- Quick-start guides for common tasks: *Quick Start - Introduction*
- IO-Link parameters, profiles, and commands: *IO-Link*

3.1 Safety notes

3.1.1 Intended Use

The radar sensor BRS 30 is a sensor for object detection and distance measurement. It is intended to be installed in a machine or system and is designed for industrial use.

Important Notes:

- The BRS 30 may only be operated in approved countries (see information sheet on conformity and approval) and in accordance with national laws.
- Proper function is only guaranteed if the device is used in accordance with the manual, all relevant documents, and the technical specifications. Use only original Balluff accessories.

Cybersecurity:

- The sensor must be used in a secure environment. The operator or manufacturer of the machine is responsible for ensuring the machine is cybersecure. This also includes a cybersecurity risk analysis.
- It is important to plan and implement security measures based on this risk analysis.

- The operator or manufacturer must ensure that all persons working with the device have received cybersecurity training.

Important

Only for use in the secondary of a Class 2 source of supply.

3.1.2 Reasonably Foreseeable Misuse

Uses not listed in the description of intended use are prohibited. Such prohibited uses will void any warranty and liability claims against the manufacturer. Technical or electrical modifications to the product are also not permitted, except for updates.

The device must not be used:

- in safety-critical applications where the safety of persons depends on the function of the device.
- in potentially explosive atmospheres.
- in outdoor use
- in direct contact with food.
- by private consumers.

3.1.3 General Safety Instructions

Installation and commissioning

Installation and commissioning of the device must only be performed by trained specialists. Only the components and replacement parts approved by *Balluff GmbH* in the device data sheet and/or the device operating manual may be used. *Balluff GmbH* accepts no liability for damages resulting from improper use or unauthorized manipulation.

Planning the system

Before you commission the device, please carefully read the device data sheet, the device operating manual and the technical documentation for the device (hereafter referred to as “documentation”), where it exists. The respective, current documentation associated with the device is available from www.balluff.com. During installation and operation of the device, please observe all safety aspects provided in the documentation.

Failure to comply in part or in whole may result in harm to life, the body or health and in property damage. Adhere to the specifications for the operating voltage according to the documentation and observe the details provided in the documentation for the intended use of the device. The device may only be used with an approved power supply.

Using the system

Observe the voltages specified in the documentation. Incorrect voltages may lead to excessive heat and cause a fire. Incorrect connection of the device may cause machine malfunctions! Make certain that power is switched off and that the device is grounded during installation and maintenance work.

Operation and testing

The system owner and user are responsible for adhering to locally applicable safety regulations. In the event of device defects and malfunctions, it is to be taken out of operation and safeguarded against unauthorized use

Electromagnetic Radiation
When handled properly, this device poses no hazard at a distance of 20 cm or more. At a distance of less than 20 cm, heating of exposed body parts in the field (e.g., fingers) is possible.

Nevertheless, Balluff recommends that people with pacemakers and pregnant women do not stay in the immediate vicinity of the device.
Do not operate the device near medical equipment or, without prior approval, near military installations, airports, or radio astronomy facilities.

3.1.4 Cybersecure Environment

To ensure cybersecurity, you must protect components, networks, and systems from unauthorized access and ensure data integrity.

Recommended Measures:

- Take organizational and technical measures for network-capable devices and software.
- Implement an information security management system (ISMS) to manage all information security measures.

Cybersecurity Resources:

- BSI Recommendations for ICS Operators
- CISA Best Practices for Industrial Control Systems
- NIST SP 800-82 Guide to Industrial Control Systems (ICS) Security

We recommend using a network secured according to the state of the art.
The sensors are intended for use at **Purdue Level 0 "Field Level / Sensors"**.

Note on Purdue Level 0: Purdue Level 0 refers to the lowest level of the Purdue reference architecture for industrial automation systems. This level includes the physical sensors and actuators directly connected to the production environment. Devices at this level are responsible for real-time data acquisition and processing.
Access to the devices from outside should only be possible for known and trusted devices and authorized users.

According to IO-Link Standard V 1.1.4, the sensor does not have authentication mechanisms.
Changing the settings/parameters of the sensor is possible for all actors who have access to the IO-Link interface.
Use the device only on an IO-Link network module that is sufficiently protected against access and operated in a secure network.
Ensure that only authorized users have access to the IO-Link network module and the secure network.

According to IO-Link Standard V 1.1.4, the sensor does not have mechanisms to protect against physical manipulation or reading of memory contents in the event of physical access.
The sensor and its interfaces must be protected against physical access by appropriate measures, such as access monitoring to the machine and barriers.

According to IO-Link Standard V 1.1.4, the sensor does not have mechanisms to protect data integrity.
Data is transmitted unencrypted from the device via the IO-Link protocol to the IO-Link network module. Eavesdropping, influencing, or interfering is possible if the network is not sufficiently protected.
The sensor and its interfaces must be protected against physical access by appropriate measures, such as access monitoring to the machine and barriers.
The sensor should only be operated on an IO-Link network module that is sufficiently protected against access.

According to the IO-Link Standard, this IO-Link device does not have an independent logging mechanism.
However, the device has mechanisms for reporting events (events) that may also be suitable for analyzing cybersecurity events.
We recommend using the device on an IO-Link network module with event logging, where the event log can be read out from the IO-Link network module via a suitable protocol.

3.2 Scope of delivery, transport and storage

3.2.1 Scope of delivery

- Radar sensor
- 2 x M30 nuts for clamp mounting
- Mounting instructions

Other accessories are not included in the scope of delivery and must be ordered separately.

Note

Recommended accessories can be found at **www.balluff.com** on the product page.

3.2.2 Transport

► Transport the product in its original packaging to the place of use.

3.2.3 Storage Conditions

► Store the product in its original packaging.
► Observe the *environmental conditions*.

3.3 Product description

3.3.1 Construction

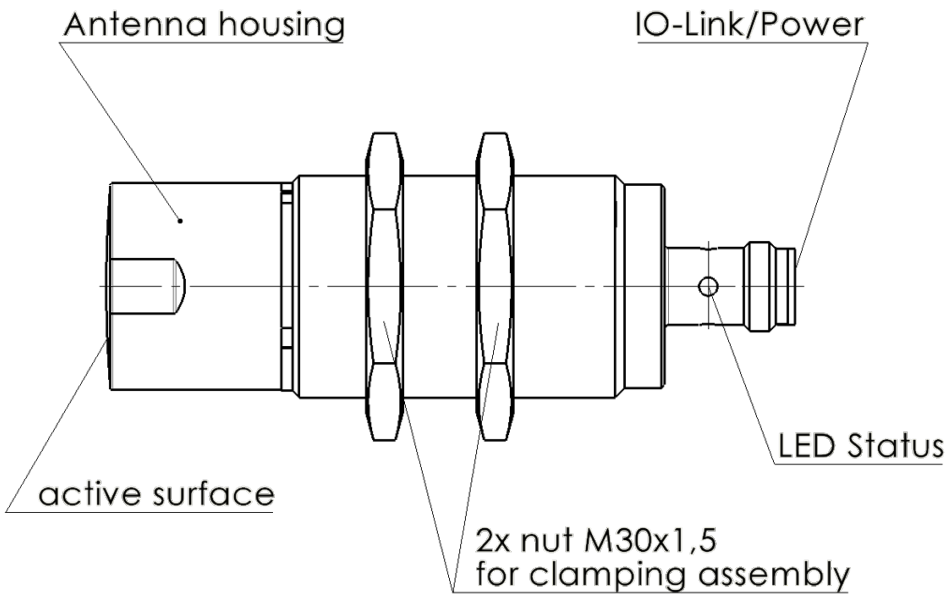


Fig. 1: Mechanical labeling of the sensor

3.3.2 Function

The radar sensor *BRS S–M30S04–0301–LA2–000S04* is optimized for measurements in industrial close-range applications and offers a range for object detection of up to 15 m. Its robust, cylindrical M30 housing has proven itself in many industrial sectors.

Interfaces and Parameterization:

- **IO-Link:** Standardized interface according to IO-Link specification. Allows parameterization of the measurement mode and foreground/background suppression, as well as other parameters.
- **Analog:** Additional interface for versatile applications.

Operating principle: The sensor operates using the frequency-modulated continuous wave method (FMCW) in the 122-123 GHz ISM band. It emits a continuous radar signal whose frequency is varied. This enables the sensor to reliably detect the distance to static and moving objects.

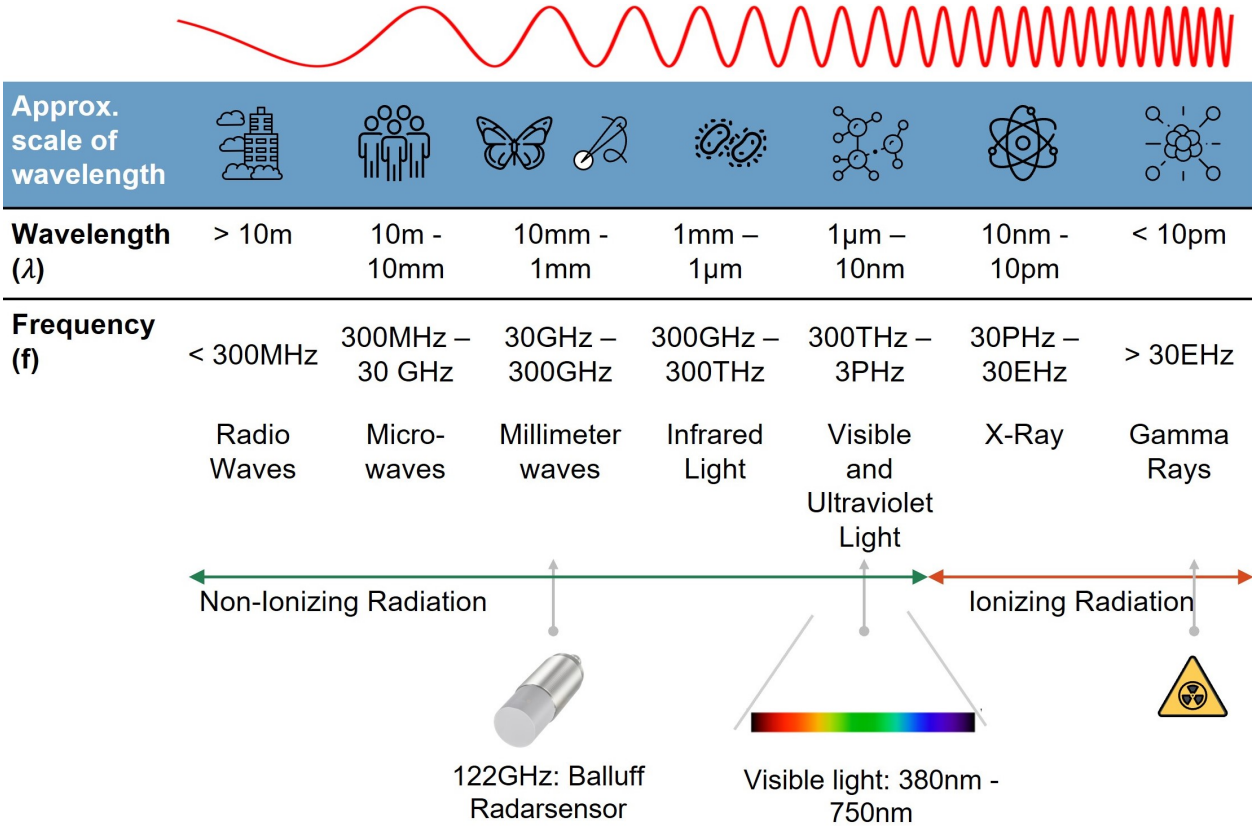


Fig. 2: Position of a 122 GHz radar sensor in the electromagnetic spectrum

Performance features:

- **High resolution:** Up to 1 mm.
- **High measurement rate:** Up to 1 kHz enables the detection of more than 100,000 objects per hour.
- **Low blind zone:** Only 300 mm (depending on the target object and environmental conditions).

Typical applications:

- Distance measurement (e.g., diameter of a film roll).
- High-speed close-range object detection (e.g., bottles in filling lines).

- Detection of objects with challenging surfaces (e.g., tires).

Advantages:

- Measurement of distance and close-range object detection.
- Reliable and precise measurements in fast applications.
- Resistant to dust, dirt, moisture, direct light, or darkness.
- IO-Link interface for service and process data as well as parameterization.
- Washdown-capable thanks to IP69K.
- Increased EMC resistance.
- Proven M30 housing design.
- Flexible mounting.

3.3.3 Display Elements

LED 1 (Operating State and Communication)

Table 1: LED 1 (Operating State and Communication)

Name	Signal	Meaning
Failure	Red, static	General error
Communication The device is ready.	Green, alternating with LED off in a ratio of 10:1, 1 s period	IO-Link communication is active.
Ready	Green, static	The device is ready.
Firmware Update The LED indicates update activity.	Magenta, alternating with LED off in a ratio of 9:1, 1 s period	Firmware update is in progress.

LED 2 (Indication/Warning/Teach/Device Discovery)

Table 2: LED 2 (Indication/Warning/Teach/Device Discovery)

Name	Signal	Meaning
Locator	Blue, double blink (2×100 ms on, 100 ms pause), then 600 ms off – 1 s cycle	The function Locator can be activated via a system command to find the device again.
Maintenance required	Blue, static	Perform a factory reset
Short Circuit Pin 2 / Pin 4	Red, flashing, 3 Hz	Short circuit at pin 2 or pin 4
Teach-in	Red, static	The device is currently in teach-in mode.
Overload	Orange, flashing, 3 Hz	Overload on pin 2 / pin 4 has been detected.
Bad Signal Quality	Orange, flashing, 1 Hz	Poor signal quality, the signal quality is below the configured warning threshold.
Out of Specification	Yellow, flashing, 3 Hz	The device is operated outside of specifications. The measurement value is unknown due to an error or outside of the measurement range.
Function Display	Yellow, static	Switching point is active.

3.3.4 Laser printing

3.4 Installation and connection

3.4.1 Preparation for installation

Prepare installation site:

- Clean the area and check the environment for sources of interference.
- Choose a suitable position for the sensor that ensures optimal coverage.
- Select the installation site so that a sufficient distance to workplaces where people are present is maintained (see *Safety notes*).
- Securely fasten the mounting bracket at the desired position.
- Plan the safe and tidy routing of cables.

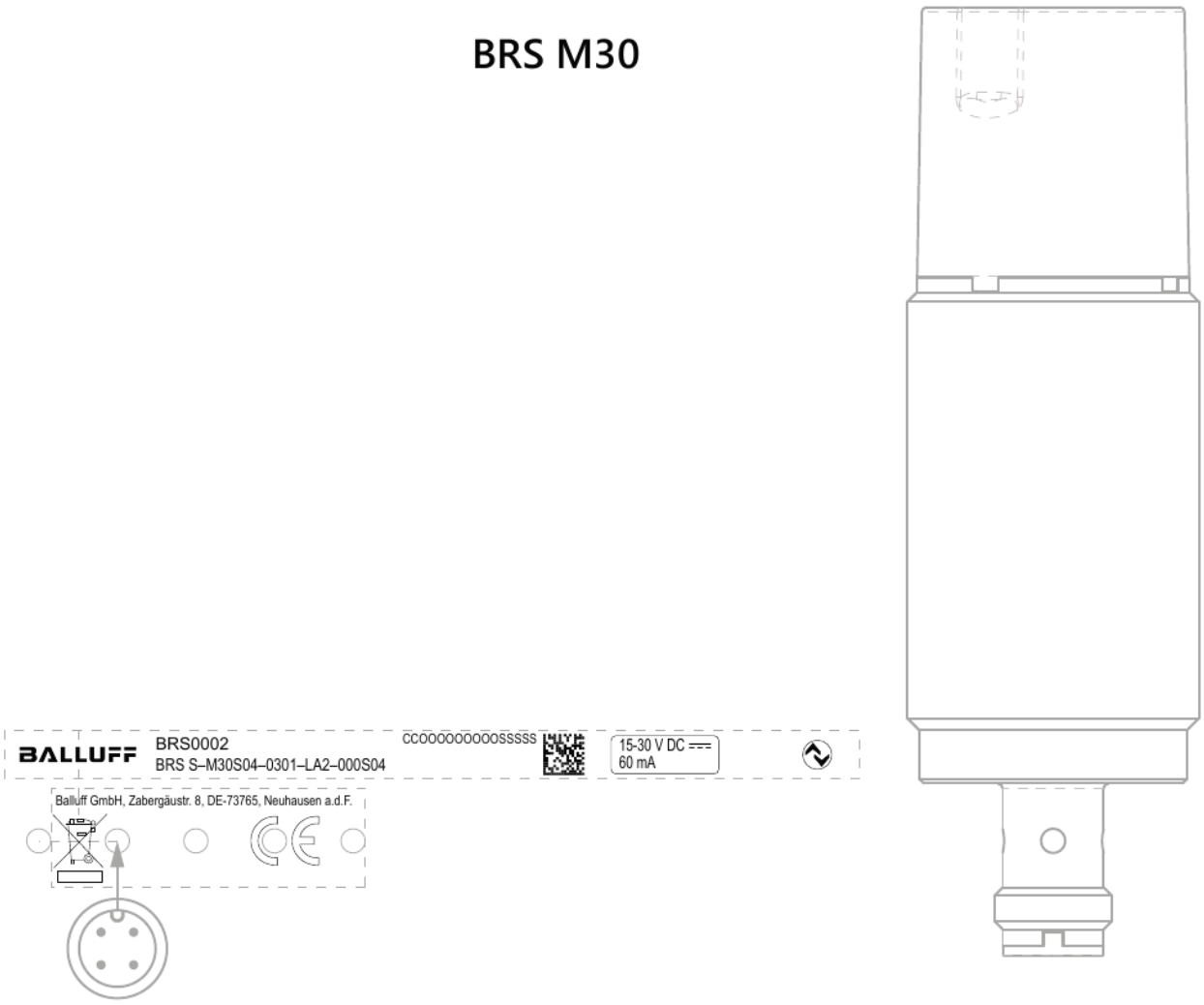


Fig. 3: Product outline and nameplate layout for the BRS M30 sensor

3.4.2 Installation and Safety Instructions

Safety Notice

High-frequency electromagnetic waves
The antenna of the radar sensor emits high-frequency electromagnetic waves. To avoid health hazards, additional measures should be taken.

- Position the antenna so that a safety distance of at least 20 cm between the antenna and workplaces is ensured.
- Ensure that people do not stay in the immediate vicinity of the antenna for extended periods.

Effect of radiation on humans
The radiation of the wavelength emitted by the radar sensor has no known effects on the human body, apart from heat absorption in the range of a few tenths of a degree. The radiation of the radar sensor is comparable to, for example, smartphones and Wi-Fi routers, which operate insimilar frequency range. However, the transmission power of the radar sensor is much lower.

3.4.3 Dimensions

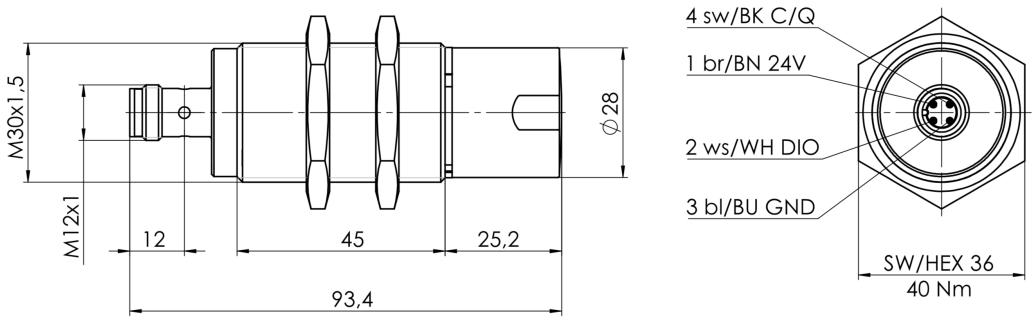


Fig. 4: Dimensions of the sensor

3.4.4 Mounting the Sensor

- Attach the sensor to the bracket and align it so that there are no foreign objects in the detection area.
- Note the blind zone of approx. 300 mm (depending on the target object and environmental conditions), in which no accurate object detection can take place. Objects in this zone can cause false reflections.
- Thin materials with low absorption, such as plastic or glass, can be placed and penetrated in the blind zone, e.g., to protect the sensor against mechanical influences. This must be tested individually.
- The maximum tightening torque of the clamping nuts when fastening the sensor is **40 Nm**.

3.4.5 Aligning the Sensor

The direction of emission of the radar wave is crucial for reflection on an object. In the factory setting, the radar sensor detects the nearest object. Parameterization options can be used to specify which object should be referenced preferentially. The radar wave propagates perpendicular to the radar lens surface. The beam angle of the radar lobe is +/-5°. The sensor provides the best measurement result when the marking on the cap points upwards (indicating the orientation of the radar chip).

Fig. 5: Product picture BRS M30

Safety Notice

If the sensor is operated outdoors (without shielding above), the orientation must not exceed 0° elevation.

Note

- For optimal performance in stationary applications, good alignment and mounting are required.
- Temperature fluctuations affect signal quality. It is recommended to acclimatize the powered sensor in the operating environment for about 15 minutes before use.

Reference objects with planar surfaces reflect the signal most strongly when the radar wave strikes at a right angle. For inclined surfaces, the angle of inclination must be less than the beam angle of the sensor to avoid false reflections.

For reference objects with **curved surfaces**, such as cylindrical objects, align the radar sensor centrally to the reflection object. The radar signal is scattered in various directions. Although distances to such objects can be measured, the signal strength is lower than for planar surfaces.

3.4.6 Electrical Connection

PIN	Function
1	L+ (VS)
21)	I/Q
3	L– (0V)
4	C/Q

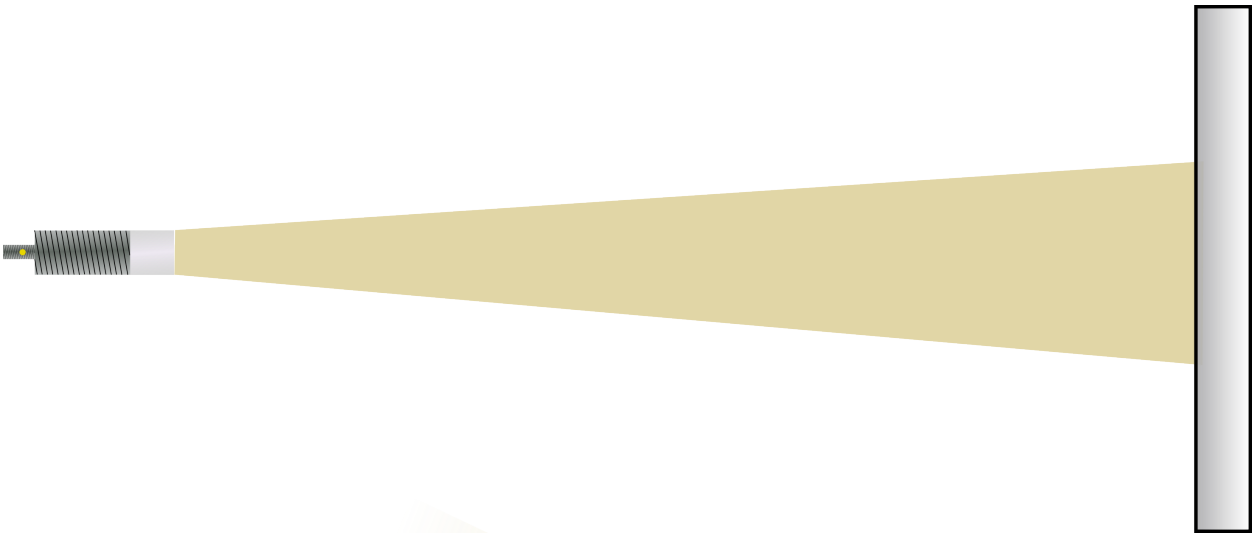


Fig. 6: Planar target – Propagation of radar waves (schematic)

Fig. 7: Tilted planar target – Propagation of radar waves (schematic)

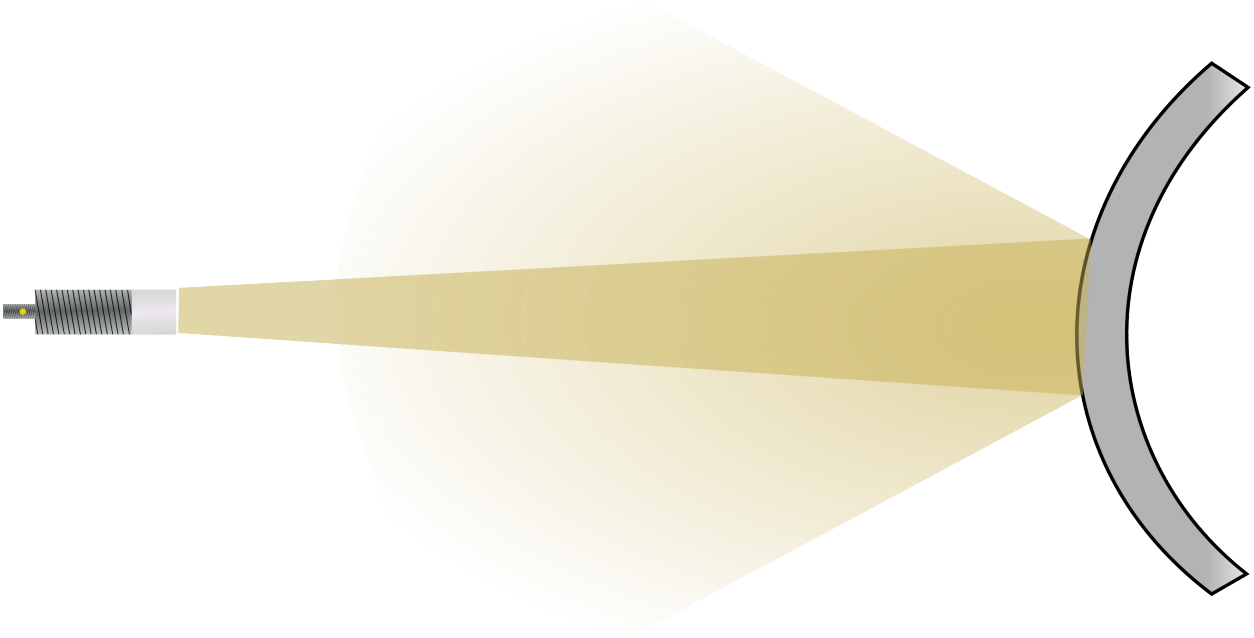


Fig. 8: Target with curved surface – Propagation of radar waves (schematic)

Fig. 9: IO-Link port (M12, A-coded, socket)

Note 1)

Pin 2 is a configurable digital output on which various signals or functions can be output.

Connect the data cable to the IO-Link master (connection cable and accessories see www.balluff.com on the product page).

3.4.7 Shielding and Cable Routing

Both unshielded and shielded cables can be used to connect the devices. In systems with strong electromagnetic interference, the use of shielded cables is recommended. Route cables with strain relief. Additionally, grounding the radar sensor can minimize the influence of electromagnetic interference.

3.5 Startup and operation

DANGER

Uncontrolled system movements
During commissioning, and if the radar sensor is part of a control system whose parameters have not yet been set, the system may perform uncontrolled movements. This can endanger people and cause property damage.

- People must stay away from hazardous areas of the system.
- Commissioning only by trained personnel.
- Observe the safety instructions of the system or machine manufacturer.

1. Check connectors for secure fit and correct polarity. Replace damaged connectors.
2. Switch on the system.

3.5.1 Electrical connection

The supply voltage is 15…30 VDC.

For further details, see the *IO-Link configuration manual*.

3.5.2 Operation notes

WARNING

High-frequency electromagnetic waves
The antenna of the radar sensor emits high-frequency electromagnetic waves. To avoid health hazards, additional measures must be taken.

- Position the antenna so that a safety distance of at least 20 cm between the antenna and workplaces is ensured.
- Ensure that people do not stay in the immediate vicinity of the antenna for extended periods.

Note

If pin 2 is used as a switching output, the maximum current limitation must be observed (see Technical Data).

3.5.3 Sensor detection ranges

Blind zone:

- No object detection takes place in the blind zone. This area should be kept clear for reliable measurements.
- Objects in the blind zone can cause false reflections and incorrect distance values.
- Thin materials with low absorption, such as plastic or glass, can be placed and penetrated in the blind zone, e.g., to protect the sensor against mechanical influences. This must be tested individually.
- In **radar reflex-gate mode**, depending on the object properties, it is possible to detect objects within the blind zone.

Detection range:

- Objects are detected if their radar cross-section is sufficient for radar reflections and the alignment is suitable.
- The maximum range is achieved under the conditions specified in the data sheet.
- Measurements outside the detection range have not been tested. Use outside the detection range is at your own risk.

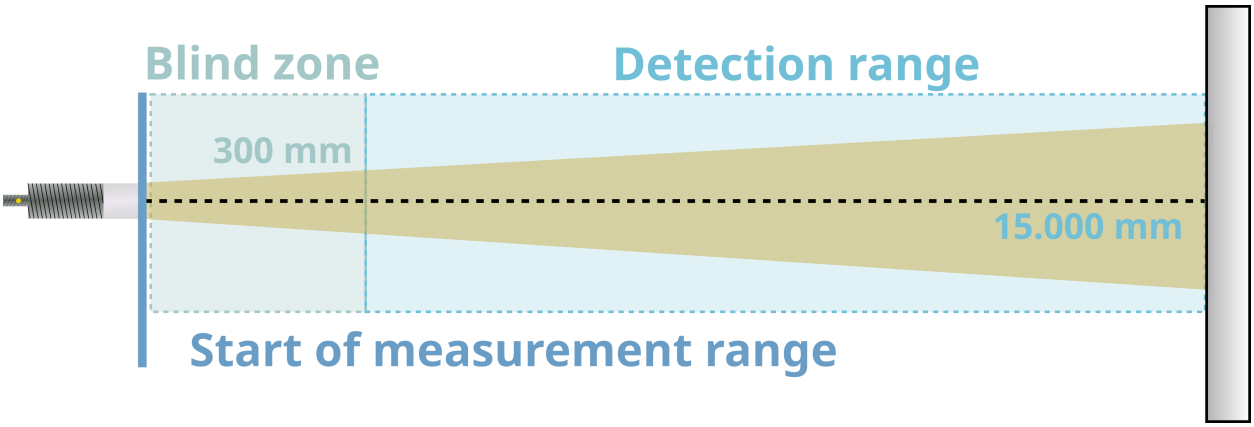


Fig. 10: Sensor detection ranges

The following standardized target objects are used for radar sensor calibration:

Table 3: Standardized target objects

Target object	Width/Diameter [m]	Depth [m]	Radar cross-section [m²]	Reflection strength [dB]
Large radar corner reflector (metal)	0.212	0.150	84.82	19.29
Medium radar corner reflector (metal)	0.071	0.050	1.05	0.20
Small radar corner reflector (metal)	0.047	0.033	0.20	-7.02
Metal sphere	0.120	—	0.01	-19.47

3.5.4 Reflectivity and typical radar cross-sections

Microwaves behave similarly to light due to their small wavelength and show effects such as diffraction, total reflection, mirroring, and interference. These effects are crucial for understanding the properties of radar sensors. An emitted wave is diffusely scattered at an object, with part of the wave being reflected back to the sensor. The strength of this reflection depends on the nature and material of the object.

The radar cross-section indicates how much of the radar signal is reflected by an object back towards the source. It depends on the size, shape, and material of the object. Larger objects with a smooth surface are easier to detect because they have a higher radar cross-section.

A human target has a lower radar cross-section compared to a metal object and is therefore a less effective radar target.

Material dependence

Radar waves propagate unhindered in a vacuum. When they hit an object, the signal changes depending on the nature of the object. Depending on the material, radar waves are completely or partially absorbed or reflected. They can also penetrate various substances.

In summary, absorbing materials are less suitable as radar targets. Although they create a reflection due to the "material jump," most of the radar wave energy is absorbed.

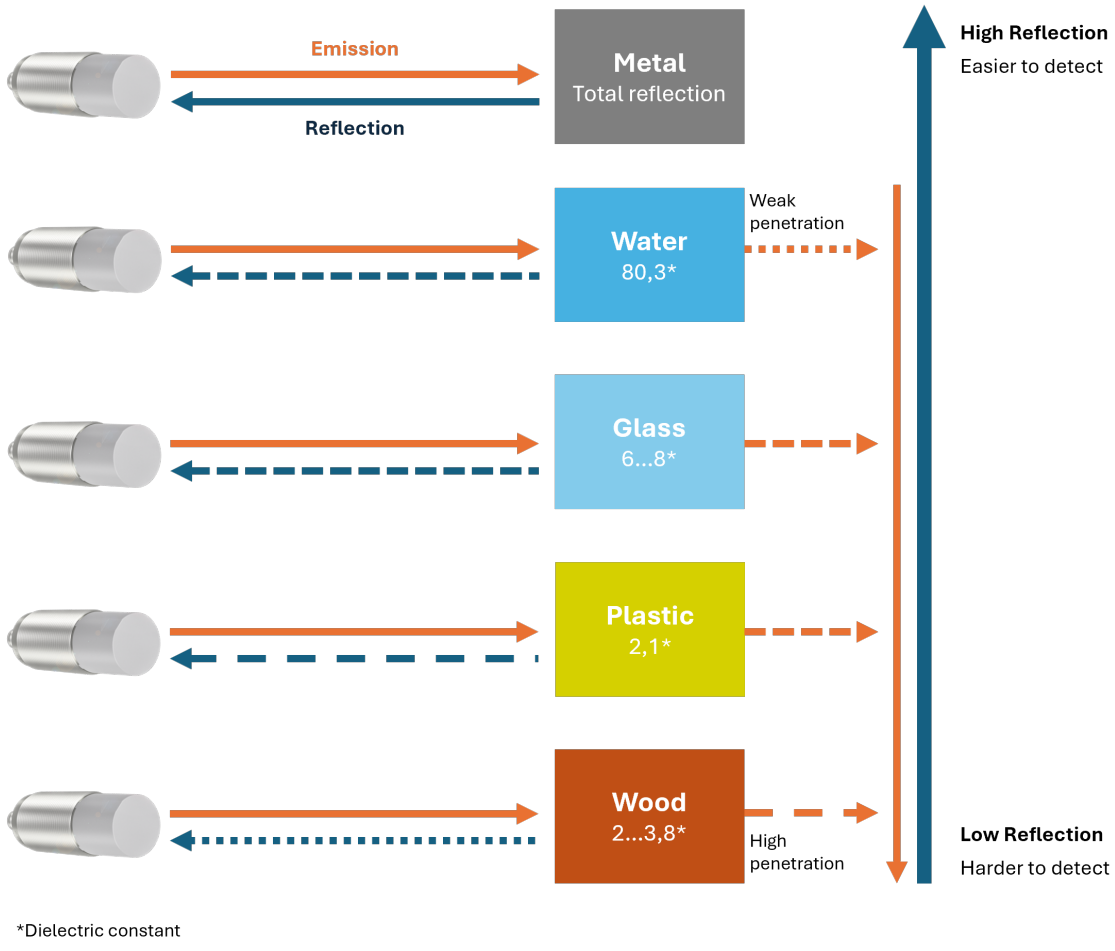


Fig. 11: Typical radar reflectivity of common materials (metal, water, glass, plastic, wood).

The dielectric constant plays an important role in radar sensors, as it influences the propagation of electromagnetic waves in the material. The dielectric constant is the ratio of the electric field strength in a vacuum to the field strength in the material.

Here are some relevant points:

Material selection

Materials with a high dielectric constant can improve the efficiency of radar sensors by optimizing waveguiding and signal strength.

Signal processing

The dielectric constant influences the reflection and absorption of radar waves, which is crucial for the accuracy and range of the sensors.

Dielectrics (non-conductive materials)

- With $\epsilon_r > 1$, e.g., plastics, glass, paper, ceramics
  - Reflectivity depends on ϵ_r
  - Partial transmission, partial absorption
- With $\epsilon_r >> 1$, e.g., plastics, glass, paper, ceramics
  - Materials with high absorption (e.g., water) can completely absorb radar waves
- With $\epsilon_r \approx 1$, e.g., air, vacuum
  - No attenuation, completely transparent to radar waves

Table with the properties of various materials regarding absorption, reflection, and penetration of radar waves:

Table 4: Material properties: absorption, reflection, penetration

Material	Absorption	Reflection	Penetration of Radiation
Metal	None	Total reflection with direct incidence; refraction and partial reflection possible with oblique incidence	None
Wood	Medium to strong (depending on moisture content)	Low	Low
Water	Very strong	Partial or total reflection possible (depending on angle of incidence)	None, due to absorption
Foams	Low	Low	Very low
Plastics	Low to high (depending on thickness and type of plastic)	Low to high (depending on thickness and type of plastic)	Low to high (depending on thickness and type of plastic)
Glass	Low to high (depending on thickness of glass)	Low to high (depending on thickness of glass)	Low to high (depending on thickness of glass)
Clothing	Medium to strong (depending on moisture content)	Low	Low
Rain	Low	Low	Very good
Humans	Medium	Medium	Low
Ice	Very high	Partial or total reflection possible (depending on angle of incidence)	None, due to absorption

3.5.5 Detection range of the radar sensor

3.5.6 Cleaning

The radar sensor can be cleaned with a high-pressure cleaner. During cleaning, the radar sensor may not reliably detect a target.

The front cap of the radar sensor can be cleaned with a soft cloth if necessary.

3.5.7 Maintenance

The product is maintenance-free.

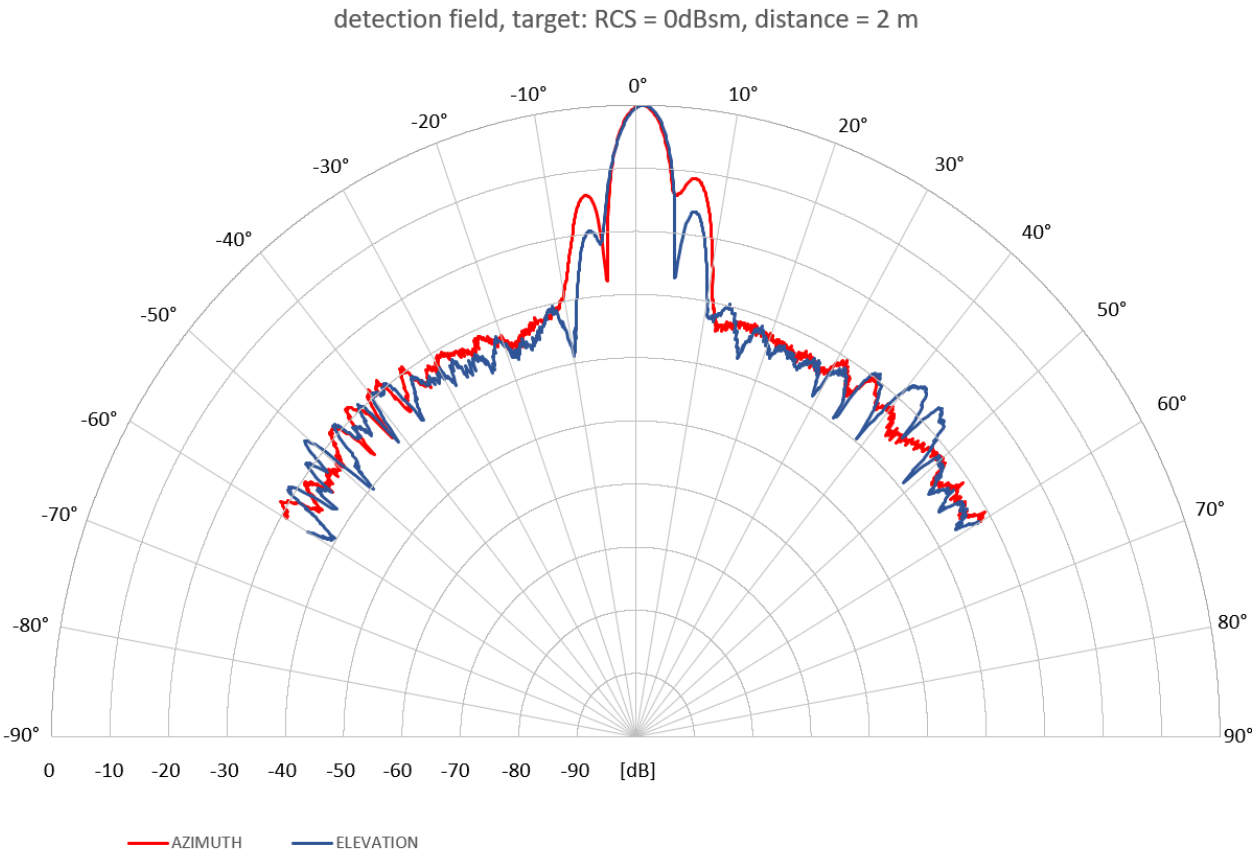


Fig. 12: Detection range of the radar sensor

3.6 Faults, repair and disposal

3.6.1 Troubleshooting

Note

Further information can be found at www.balluff.com on the product page.

If the sensor does not function as expected, first check for environmental disturbances. If there are no environmental disturbances, check the device connections for errors. In case of a malfunction, use the following checklist to see if you can resolve the sensor's problem.

Table 5: Troubleshooting

Fault	Cause	Remedy
LEDs do not light up	The power supply is switched off.	Check if there is a reason for the shutdown (e.g., installation or maintenance work). Switch on the power supply if necessary.
	The connector is not connected to the sensor.	Connect the connector to the sensor and hand-tighten the coupling nut.
	Wiring error in the distributor or control cabinet.	Carefully check the wiring and correct any errors. Pay attention to the pin assignment.
	The cable to the sensor is damaged.	Replace the damaged cable.
Target object is not detected	There may be a disturbing object near the sensor (environmental disturbance).	Remove the disturbing object. Try to avoid metal objects in the immediate vicinity of the sensor.
	The material of the target object has too low reflection properties.	Check if the **radar reflex-gate mode** can be used. This works independently of the reflection properties of the target object.
	The radar cross-section of the target object is too small.	Check if the **radar reflex-gate mode** can be used. This works independently of the reflection properties of the target object.
	Individual target objects are not resolved separately.	Increase the distance between the target objects.

Note

If none of the hints in the checklist are successful, you can contact the Balluff technical customer service.
To simplify assignment, the type designation and firmware version of the sensor are required.

3.6.2 Repair

- Repairs to the product may only be carried out by Balluff.
- If the product is defective, contact our technical customer service.

3.6.3 Disposal

- Follow national regulations for disposal.

Note

Further information can be found at www.balluff.com on the product page.

3.7 Technical Data

3.7.1 Ambient conditions

Characteristic	Value
Ambient temperature	−25 … +70 °C
Storage temperature	−25 … +70 °C
Degree of protection according to IEC 60529 (with connection cable screwed in)	IP69K
Altitude	≤ 2,000 m (above sea level)
Relative humidity	≤ 85 %, non-condensing
Pollution	Pollution degree 2
Vibration/Shock	EN 60068-2-27
EMC	country-specific

3.7.2 Detection/Measurement Range

Table 6: Detection/Measurement Range

Characteristic	Value
Measuring length[1]	300 … 15,000 mm
Blind zone	0 … 300 mm

[1] Measurements are also possible in the range below 300 mm, but accuracy and object detection cannot be guaranteed in this range.

3.7.3 Electrical data

Electrical characteristic	Value
Operating voltage VS	15…30 V DC
Nominal voltage	24 V DC
Current consumption at 24 V	60 mA

3.7.4 Radar-Specific data

Radar characteristic	Value
Radar Technology	FMCW
Frequency Range	122 – 123 GHz
Max. Transmit Power EIRP	< 20 dBm EIRP
Antenna Polarization	Circular

Note

Radio characteristics (radiated power, antenna gain, etc.) are country-specific due to different national regulations and depend on the device variant. Country-specific details on conformity and approval can be found in the enclosed information or at www.balluff.com on the product page.

3.7.5 Electrical Connection

- Connection IO-Link/Power
- M12 built-in connector, 4-pin, A-coded

See *Electrical Connection*

3.7.6 Output/Interface

Interface (Pin 4)

- IO-Link Revision 1.1 (COM 3)

Digital output (Pin 2)

Output voltage VLow / VHigh	0 V / VS – 0.3 V
Output current (limited)	≤ 60 mA

Error and Out-of-Range Thresholds

To support diagnostic and monitoring functions, the following internal thresholds are defined for the analog interface:

Voltage thresholds

Error condition	11.0 V
Out-of-range high	10.5 V
Out-of-range low	–0.5 V

Current thresholds

Error condition	22.0 mA
Out-of-range high	21 mA
Out-of-range low	-1 mA

These values are used internally to detect abnormal signal conditions and trigger appropriate device status changes. They are not configurable and are defined as fixed constants in the firmware.

3.7.7 Mechanical Data

Housing material	Stainless steel (1.4404)
Cap material	PEEK
Dimensions	M30 x 1.5
Mounting part	Nut M30 x 1.5
Weight	60 g

3.7.8 Approvals and Markings

CE

With the CE mark, we confirm that our products comply with the requirements of the current EU directive.

Note

For more information on directives, approvals, and standards, see www.balluff.com on the product page.

CHAPTER

FOUR

IO-LINK

This section provides comprehensive documentation of the radar sensor's IO-Link interface, including communication parameters, data functions, and device-specific profiles. Use this section for detailed configuration, parameter access, and integration with IO-Link master systems.

Main topics

- *IO-Link basics*: general concepts and device access
- *Communication parameters*: IO-Link specification and settings
- *Measurement Profiles*: available measurement modes and configurations
- *Process Data Profiles*: process data input/output structures
- *System Commands*: device commands via IO-Link
- *ISDU – Identification Data*: device identification parameters
- *Events*: event codes and diagnostics

Function categories

- Primary Functions: device identification, locator, switching profiles, measurement modes, signal quality
- Secondary Functions: operating hours, boot cycles, voltage/current monitoring, internal temperature
- System Functions: analog output, device status, diagnosis, reset commands, variant/pin configuration, LED meanings, process data info, profile characteristics, parameter manager, firmware update

Related sections

- Quick-start guides for common tasks: *Quick Start - Introduction*
- User manual with installation and commissioning: *Manual*

4.1 IO-Link basics

4.1.1 General

IO-Link integrates conventional and intelligent sensors and actuators in automation systems and is intended as a communication standard below classic field buses. Fieldbus-independent transfer uses communication systems that are already available (field buses or Ethernet-based systems).

IO-Link devices, such as sensors and actuators, are connected to the controlling system using a point-to-point connection via a gateway, the IO-Link master. The IO-Link devices are connected using commercially available unshielded standard sensor cables.

Communication is based on a standard UART protocol with a 24-V pulse modulation in half-duplex operation. This allows classic three-conductor physics.

4.1.2 Advantages of IO-Link

IO-Link offers the following advantages:

- Uniform and simple wiring of different devices
- Device parameters can be changed by the controlling system
- Remote query of diagnostic information is possible
- Centralized data management of device parameters is possible

The manufacturer-independent IO-Link standard transmits not only pure process data but also all relevant parameter and diagnostic data from the process level via a simple standard cable. Communication is based on a standard UART protocol with 24 V pulse modulation. A separate power supply is not necessary. The BRS IO-Link device uses three-wire technology and operates at a transmission rate of 230400 bit/s (COM3). The amount of process data is 32 bytes per direction.

4.1.3 Protocol

With IO-Link communication, permanently defined frames are cyclically exchanged between the IO-Link master and the IO-Link device. In this protocol, both process and required data, such as parameters or on demand data, is transferred. The size and the type of the frame and the cycle time used result from the combination of master and device features. (see communication properties in section *Communication parameters*).

4.1.4 Cycle Time

The cycle time used (master cycle time) results from the minimum possible cycle time of the IO-Link device (min cycle time, see chapter *Communication parameters*) and the minimum possible cycle time of the IO-Link master. When selecting the IO-Link master, please note that the larger value determines the cycle time used.

4.1.5 Communication parameters

In order to be able to establish a stable communication connection between master and device, the master requests some important communication parameters from the device at the start of communication. Settings for communication in *Preoperate* and *Operate* modes are influenced by the parameters and the device is clearly identified.

Communication parameters are described in the chapter *Communication parameters*.

4.1.6 Process Data Flow

The data transfer is based on the general profile specification (IO-Link Common Profile 1.0, see *Example of a PDinput data flow* for example).

The highest value byte (MSB, designated as *Byte 0*) is transferred first and can be found in the PLC under the lowest storage address. The lowest value byte (LSB) is transferred last and has the highest byte number (designated in *Example of a PDinput data flow* as *Byte 4*).

For word-based data types (> 8 bit) this means that the byte at the lowest address is the highest value byte, while the highest address contains the lowest value byte.

The description of the data flow structure in IODD uses bit offsets. Offset 0 means the least significant bit of the last byte.

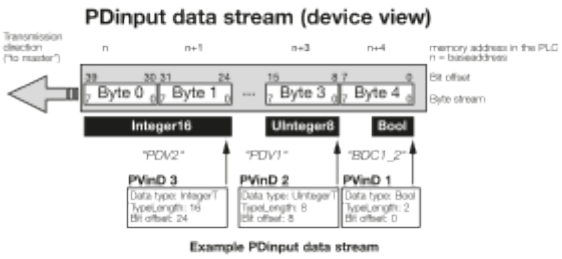


Fig. 1: Example of a PDinput data flow

Process data variables (in *Example of a PDinput data flow* PDV1, PDV2) are aligned to the byte limits in most cases.

Binary information (BDC) is transferred in the lowest value byte in most cases.

4.1.7 Process data objects

The process data flow is made up of various process data objects, which are not only shown in the process data flow, but are also used for the internal exchange of information between functions.

For example, *PdObjects* can be used to monitor threshold values in the device and trigger a warning if a limit is exceeded, or to provide status information such as the switching state directly in the process data.

Therefore, a unique object ID is assigned to this individual information, which can be used at different places.

Process data objects are described in the function chapters under *Process Data*.

4.1.8 Device Status

The *Device Status* indicates the current status of the device or of the directly connected peripherals. This functionality is part of the IO-Link specification.

The following states are output by the device:

- *Device is operating properly* (device is functioning error-free) This status indicates that no serious error has occurred in the device and the device can be operated without restrictions.
- *Maintenance-Required* Although the process data is valid, internal diagnosis functions show that the device or the operational environment of the device should be serviced.
- *Out-of-Specification* Although the process data is valid, internal diagnosis functions show that the device is operating outside of its specification. This can affect both the measurement application itself as well as the environmental conditions.
- *Functional Check* Process data is temporarily invalid while a deliberate intervention is performed on the device. For example, parameterization processes or teach-in.
- *Failure* The device or the connected peripherals have a severe error. The device cannot perform its intended function!

For further information, see section *Device Status and Detailed Device Status*.

The creation of the *Device Status* is always based on the output of diagnosis messages. A *Device Status* is output for every diagnosis message (event). Each of these can be found in the event overview list (see section *Events* or in the description of the functions).

4.1.9 Block Parameterization

Block parameterization refers to a special process in which multiple parameters are parameterized in one process. It is started with a start command and concluded with an end command.

Because the check of the data is not performed until the parameterization is concluded, pieces of data that are dependent on one another can also be set without problem.

The System Commands 0x01…0x06 are also part of the Parameter Manager (see *System Commands*).

The functionality and processes are described in the IO-Link specification.

4.1.10 Data Storage

Data Storage refers to a special process for being able to store the parameterization data of a device on the master. The master controls the process between uploads (if data is intentionally changed) or downloads (if, e.g., an incorrectly parameterized device is connected). The system comprising master and device thereby ensures that a device can be exchanged without the need for an active re-parameterization.

> **Note**
>
> The settings regarding *Data Storage* are to be performed on the IO-Link master gateway (refer to the information in the corresponding documentation).

Operation is dependent on the used IO-Link master and is explained in the corresponding description.

> **Note**
>
> All parameters that are stored for parameter management in the IO-Link master are marked appropriately in *ISDU – Identification Data*.

4.1.11 Variant Handling

A device can contain several different IO-Link devices. These device variants differ in the basic functionality, the IO-Link communication settings (length of the process data, communication speed) or in the IO-Link communication model or data model (e.g., support of other ISDU parameters or IO-Link profiles).

A variant can be selected via an ISDU access (see function *Variant Configuration*). Note here, that changes do not take effect until after a communication restart (e.g., through *Device Reset* (see *Reset Commands*)).

All device variants can also be selected via the so-called *Compatibility Mode*. In this case, the port configuration on the master is used to switch the device to the target variant, which is then used permanently by the device.

4.1.12 Reset Commands

The device offers various reset functions. A corresponding command is executed via a *system command*.

The behavior and the values that are reset in a given case can be found in the ISDU overview (see section *ISDU – Identification Data* and in the individual function descriptions).

The *Reset Commands* are described in the corresponding chapter.

4.1.13 Device Functions and Master Gateway

The functions of the device are described in detail in the subsequent sections. Refer to the guide of the IO-Link master for information on the implementation of the process, parameter and diagnostic data via the master gateway.

4.2 Communication parameters

In the following table the basic IO-Link specification.

Table 1: Communication Parameters

Specification	IO-Link Description	Value
Transmission rate	COM	COM3 (230.4 kBaud)
Minimum cycle time of device	min cycle time	0×0A (10 ms)
Frame specification:– Amount of Preoperate on demand data required – Amount of Operate on demand data required - ISDU	M-sequence capability:– Number of On-demand Data in Preoperate – Number of On-demand Data in Operate - ISDU supported	0×1B 2 bytes 2 bytes Supported
IO-Link protocol version	Revision ID	0×11 (Version 1.1)
Amount of process data from the device to themaster	ProcessDataIn	0×CB (12 bytes)
Amount of process data from the master to the device	ProcessDataOut	0×00 (0 Bit)
Manufacturer ID	Vendor ID	0×378
Device identification	Device ID	0x0C0102 0x0C0103

4.2.1 Communication parameters – Device variants

The following device variants can be selected (also see chapter *Variant Configuration*):

Table 2: Communication parameters – Device variants

Variant name	Device identification	Transmission rate	Minimum cycle time of device	Frame specification	IO-Link protocol version	Qty. of process datafr the device to the master	Qty. of process datafrom the master to the device
						from the device to the master	from the master to the device
BRS M30 Premium (Distance/ Object detection)	0x0C0102 (786690)	COM3(230.4 kBaud)	0x0A(10 ms)	0x1B(2 bytes / 2 bytes / supported)	0x11(Version 1.1)	0xCB(12 bytes)	0x00(0 Bit)
BRS M30 Premium (Radar Reflex Gate)	0x0C0103 (786691)	COM3(230.4 kBaud)	0x0A(10 ms)	0x1B(2 bytes / 2 bytes / supported)	0x11(Version 1.1)	0xCB(12 bytes)	0x00(0 Bit)

4.3 Process Data Profiles

4.3.1 PDInput

4.4 System Commands

The device supports various commands that can be accessed via *System Commands*. This function is defined in the IO-Link specification and is implemented accordingly. (see section *Reset Commands*)

Table 3: System Commands

Command Value	Device Action
Basic commands	
0x00 (0)	Reserved
0x01 (1)	ParamUploadStart – Starts parameter upload.
0x02 (2)	ParamUploadEnd – Ends parameter upload.

continues o

Table 3 – continued from previous page

Command Value	Device Action
0x03 (3)	ParamDownloadStart – Starts parameter download.
0x04 (4)	ParamDownloadEnd – Ends parameter download.
0x05 (5)	ParamDownloadStore – Finishes parameter setting and starts data storage.
0x06 (6)	ParamBreak – Cancels all Param commands.
Switching Channel Teach	
0x40 (64)	Teach Apply – Calculates the switching point for SP1, SP2.
0x41 (65)	Teach SP – Determines teach point 1 for the setpoint and calculates the switching
0x41 (65)	Teach SP1 – Determines teach point 1 for setpoint 1 and calculates the switching
0x42 (66)	Teach SP2 – Determines teach point 1 for setpoint 2 and calculates the switching
0x43 (67)	Teach SP TP1 – Determines teach point 1 for the setpoint 1.
0x44 (68)	Teach SP TP2 – Determines teach point 2 for the setpoint 1.
0x45 (69)	Teach SP2 TP1 – Determines teach point 1 for setpoint 2.
0x46 (70)	Teach SP2 TP2 – Determines teach point 2 for setpoint 2.
0x47 (71)	Teach SP1 Start – Starts dynamic teach-in for setpoint 1.
0x48 (72)	Teach SP1 Stop – Stops dynamic teach-in for the setpoint and calculates the swit
0x49 (73)	Teach SP2 Start – Starts dynamic teach-in for setpoint 2.
0x4A (74)	Teach SP2 Stop – Stops dynamic teach-in for setpoint 2 and calculates the switch
0x4E (78)	Teach Reset – Teach-in interrupted, setpoints reset to defaults.
0x4F (79)	Teach Cancel – Teach-in process is interrupted.
Locator	
0x7E (126)	Start Locator
0x7F (127)	Stop Locator
General Settings	
0x80 (128)	Device Reset – Warm start; parameters unchanged. (see *System Commands*)
0x81 (129)	Application Reset (see *System Commands*)
0x82 (130)	Restore Factory Settings (see *System Commands*)
0x83 (131)	Back-to-Box Reset (see *System Commands*)
0xA5 (165)	Maintenance Reset (see *System Commands*)
Balluff Measurement Sensor Profile	
0xE0 (224)	Teach Preset – Sets current measurement value to Measurement Preset.
0xE1 (225)	Teach Lower Limit – Sets lower end of measurement range.
0xE2 (226)	Teach Upper Limit – Sets upper end of measurement range.

4.5 ISDU – Identification Data

Table 4: Identification ISDUs

Name	Index	Subinde	Access	Length	Data Type	Data Storage	Default
Vendor Name	0x0010 (16)	0	R	7 bytes	STRING	n/a	“Balluff”
Vendor Text	0x0011 (17)	0	R	15 bytes	STRING	n/a	“www.balluff.com”
Serial Number	0x0015 (21)	0	R	16 bytes	STRING	n/a	
Hardware Revision	0x0016 (22)	0	R	2 bytes	STRING	n/a	
Firmware Revision	0x0017 (23)	0	R	≤ 10 bytes	STRING	n/a	
Application Specific Tag	0x0018 (24)	0	R/W	≤ 32 bytes	STRING	Yes	“***”
Function Tag	0x0019 (25)	0	R/W	≤ 32 bytes	STRING	Yes	“***”
Location Tag	0x001A (26)	0	R/W	≤ 32 bytes	STRING	Yes	“***”
Product Type Code	0x0700 (1792)	0	R	≤ 64 bytes	STRING	n/a	BRS S-M30S04-0301-LA2-000S04
Product Order Code	0x0701 (1793)	0	R	7 bytes	STRING	n/a	BRS0002
Locator Timeout	0x00FE (254)	0	R/W	2 bytes	UINT16	Yes	10

4.5.1 Variant: Distance/Object Detection

Table 5: Variant: Distance/Object Detection

Name	Index	Subinde	Access	Length	Data Type	Default
Product Name	0x0012 (18)	0	R	55	STRING	BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Product ID	0x0013 (19)	0	R	55	STRING	BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Product Text	0x0014 (20)	0	R	63	STRING	Radar sensor Premium, Object Detection & Distance Measurement

4.5.2 Variant: Radar Reflex Gate

Table 6: Variant: Radar Reflex Gate

Name	Index	Subinde	Ac-cess	Length	Data Type	Default
Product Name	0x0012 (18)	0	R	51	STRING	BRS S-M30S04-0301-LA2-000S04 (Radar Reflex Gate)
Product ID	0x0013 (19)	0	R	51	STRING	BRS S-M30S04-0301-LA2-000S04 (Radar Reflex Gate)
Product Text	0x0014 (20)	0	R	43	STRING	Radar sensor Premium, Reflex gate mode

4.6 Events

Event Code	Event Type	Event – Description – Remedy
Process Data Profile Selection		
0x1850 (6224)	Notification	Process data profile selection cannot be used – default value is use
0x1851 (6225)	Notification	Process Data Update Timeout – For information purposes only. A P
0x1852 (6226)	Warning	Multiple Process Data Update Timeout – For information purposes
Device Temperature		
0x4000 (16384)	Error	Temperature Fault – Overload – The device is operated outside of th
0x4210 (16912)	Warning	Device Temperature Overrun – Clear Heat Of Source – Risk of devic
0x4220 (16928)	Warning	Device Temperature Underrun – Insulate Device – Risk of device da
0x8D10 (36112)	Warning	Customer-defined upper warning for device temperature. The upper
0x8D20 (36128)	Warning	Customer-defined lower warning for device temperature. The lower
Signal Quality		
0x8CFF (36095)	Warning	Low signal quality level
Balluff Measurement Sensor Profile		
0x8D00 (36096)	Warning	The measurement value is below the measurement range. Accuracy
0x8D01 (36097)	Warning	The measurement value is above the measurement range. Accuracy
0x8D02 (36098)	Warning	The measurement value is below the detection range; no measurem
0x8D03 (36099)	Warning	The measurement value is above the detection range; no measurem
0x8D04 (36100)	Warning	No measurement value can be determined. ► Check application.
0x8D05 (36101)	Warning	Measurement error / redundancy check failed. ► Check application.
Electrical monitoring		

Table 7

Event Code	Event Type	Event – Description – Remedy
0x5110 (20752)	Warning	Primary supply voltage exceeded. ► Check for deviations in the sup
0x5111 (20753)	Warning	Primary supply voltage below minimum value. ► Check for deviatio
0x8D0B (36107)	Warning	Overload or short circuit at pin 2. ► Check wiring.
0x8D0D (36109)	Warning	Incorrect load/cable breakage, analog current output pin 2. ► Check
0x8D15 (36117)	Warning	Overload at pin 2. ► Check wiring.
Parameter manager		
0x8D24 (36132)	Notification	An error occurred during the EEPROM write – for information only.
0x8D25 (36133)	Error	Parameters not consistent – basic settings are used, service require
0x8D26 (36134)	Warning	User data was reset to the default settings. ► Check settings and a
Switching profiles		
0x8DC0 (36288)	Notification	Teach-in Timeout – The current teach-in process took too long and

4.7 Primary Functions

This section covers the primary functions of the radar sensor.

Use this section to access the core device capabilities and profiles used in most applications. The topics below are ordered as in the navigation and link directly to detailed guides.

Topics

- *Identification*: device identity, vendor and product information
- *Locator*: make the device signal itself for locating
- *Radar frontend*: core measurement algorithm and process data
- *Switching Profiles*: smart sensor profile switching channels
- *Measurement Profiles*: measurement ranges and output semantics
- *Signal Quality*: quality metric, thresholds, and events

4.7.1 Identification

The identification data is used for the identification and management of the IO-Link devices.

ISDU

Application Specific Tag

With the *Application Specific Tag* parameter, a string (maximum 32 bytes) can be written to the device. This value typically describes the application in which the product is used.

Function Tag

With the *Function Tag* parameter, a string (maximum 32 bytes) can be written to the device. This value typically describes the function of the product in the application area.

Location Tag

With the *Location Tag* parameter, a string (maximum 32 bytes) can be written to the device. This value typically describes the location of the product in the application area.

Product Type Code

The Balluff type code is stored permanently in the device.

Product Order Code

The Balluff order code is stored permanently in the device.

System Commands

For an overview of all System Commands, see section *System Commands*.

Variant Dependence

The functionality is available in all variants.

4.7.2 Locator

With the *Locator* function, an IO-Link device can be found again by starting signaling on the LED of the device using a system command. Signaling can be stopped with another system command.

The functionality corresponds to the specification in the IO-Link Common Profile – *Locator* function class.

ISDU

Locator Timeout

The *Locator Timeout* parameter sets the duration of the Locator signal that is displayed via LEDs. The value is specified in minutes. The value range from 1 to 30 minutes is allowed. The parameter is reset by *Application Reset* and *Factory Reset* (also see section Reset Commands).

Table 8: Locator Timeout Parameter

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Locator timeout	0x00FE (254)	0	R/W	1 byte	UINT8	Yes	10

System Commands

Table 9: Locator System Commands

Command Value	Device Action
0x7E (126)	Start Locator
0x7F (127)	Stop

4.7.3 Radar frontend

Description

This device utilizes a Frequency Modulated Continuous Wave (FMCW) radar. An FMCW radar operates by emitting a continuous radio frequency signal whose frequency increases or decreases linearly over a set period, forming what is known as a "chirp." When this signal encounters an object, part of it is reflected back to the radar sensor. Because the reflected signal travels a longer path, it arrives with a time delay compared to the transmitted signal, resulting in a frequency difference known as the beat frequency.

The radar frontend captures both the transmitted and received signals and mixes them to generate the beat frequency signal. This signal contains information about the distance to the reflecting object. The device samples the beat frequency signal and processes it using a Fast Fourier Transform (FFT), which converts the signal from the time domain to the frequency domain. In the resulting FFT spectrum, each peak represents a potential target at a specific range.

Depending on the configuration, the processing algorithm searches for the strongest peak or the closest peak in the FFT magnitude spectrum. The position of the peak in the frequency spectrum is used to calculate the range to the target, based on the known properties of the chirp signal and the radar's configuration. The amplitude of the peak provides a measure of the signal strength, which can be interpreted as the reflectivity or size of the target.

The Radar Frontend outputs two main values: the calculated range of the target and the corresponding signal strength.

Mathematics/Algorithm

The processing of the output of the Radar Frontend HW involves the following steps:

- **Distance/Object detection variant**

1. **Signal processing**: The radar frontend samples the analog signals using an ADC. After derivation and windowing the sampled data, an FFT is performed to convert the signals to the frequency domain. The magnitude spectrum is then calculated from the FFT output for further analysis.
2. **Peak Search**: The algorithm searches within Minimum distance for target search and Maximum distance for target search for the most significant peak or the first peak in the magnitude spectrum, which is bigger than the Minimum target strength.
3. **Distance Calculation**: The frequency position of the detected peak is used to calculate the distance to the target, based on the radar's chirp parameters.
4. **Moving Window Averaging**: The calculated distance values may be averaged over a moving window to smooth out measurement noise and improve stability. (see Number of averaging)
5. **Output of Measurement Value**: The final, processed measurement value (distance and signal strength) output is provided.

- **Radar reflex gate variant**

1. **Signal processing**: The radar frontend samples the analog signals using an ADC. After derivation a DFT is calculated for one specified frequency which corresponds to the Reflector distance. The result of the calculation is the signal strength at this distance.
2. **Output of Measurement Value**: The signal strength is converted to dB and provided to the output.

Process Data

The process data items listed in here are used only internally to provide data to the measurement frontend.

Table 10: Process Data Objects

Object ID	Name	Description
0x0025 (37)	Transducer Value High Resolution	Distance output
0x0175 (373)	Transducer Value High Resolution 2	Target Strength output

ISDU

Table 11: Radar Sensor Configuration ISDUs

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Radar Sensor Configuration	0x010F (271)	0	R/W	9 bytes		n/a	0x00
Number of averaging		1	R/W	2 bytes	UINT16	Yes	10
Target search mode		2	R/W	1 byte	UINT8 (ENUM)	Yes	0
Minimum distance for target search		3	R/W	2 bytes	UINT16	Yes	150
Maximum distance for target search		4	R/W	2 bytes	UINT16	Yes	15000
Minimum target strength		5	R/W	2 bytes	UINT16	Yes	300
Radar Reflex Gate variant only							
Set reflector distance	0x0140 (320)	0	W	2 bytes	UINT16	Yes	
Get reflector distance	0x0141 (321)	0	R	2 bytes	UINT16		500

Number of averaging

The distance output is calculated by averaging the last N measurements.

Target search mode

Table 12: Target search mode

Value	Description
0x00	Strongest Target
0x01	Closest Target

Minimum distance for target search

The distance (in mm) at which the search for a peak starts.

Maximum distance for target search

The distance (in mm) at which the search for a peak stops.

Minimum target strength

The strength (in dB) that a peak must have to be considered a peak.

Set reflector distance

Only used in Radar Reflex Gate variant. Sets the Distance to the Radar Reflector. Automatically adjusts the distance to a close peak if present.

Read reflector distance

Only used in Radar Reflex Gate variant. Reads back the set (and adjusted) Distance to the Radar Reflector

Variant Dependence

Object Detection and Distance Measurement variant

In Object detection and Distance Measurement variant the sensor can detect one object and provides the Distance and Target Strength of the object in every 1 ms.

The detection depends on the Radar Sensor Configuration parameters Minimum distance, Maximum distance, Minimum target strength and Target search mode as well as on the Measurement Configuration Measurement range. The following figure summarizes these configuration options.

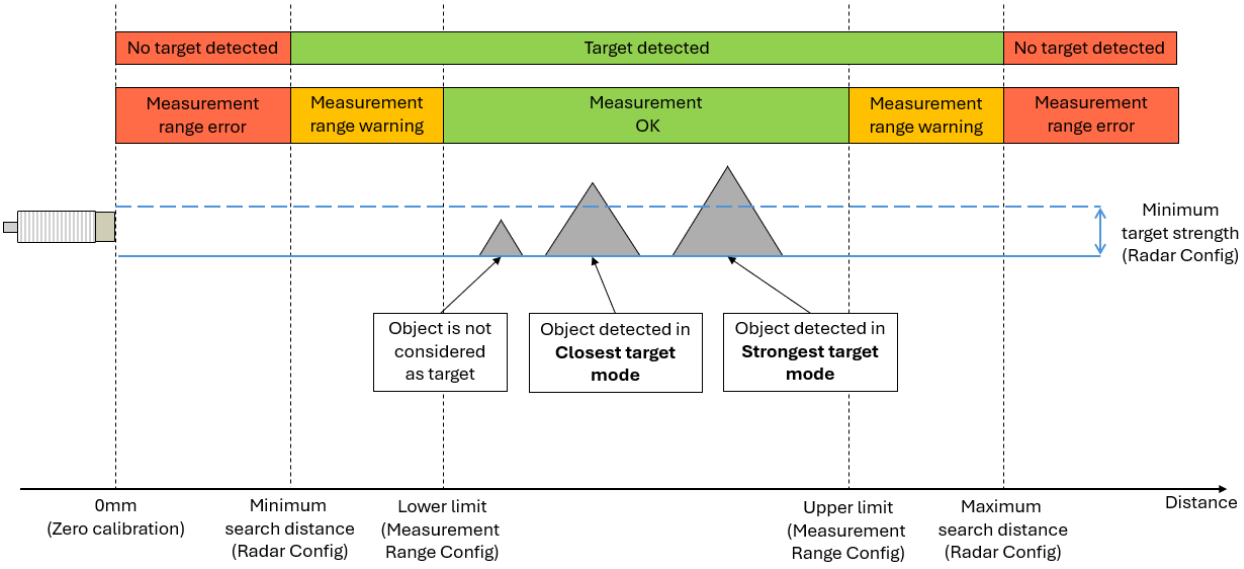


Fig. 2: Distance measurement

Radar Reflex Gate variant

In Radar Reflex Gate variant the sensor is placed in front of a fixed reflector or background plate and the objects are appearing between the sensor and the reflector. The objects can block or reduce reflected signal from the reflector, thus the Target Strength of the reflector correlates if an object is present or not.

The distance of the reflector is configured by Set reflector distance so the Target Strength output corresponds to the magnitude of the signal at this distance. The Target Strength output is updated every 1ms.

Similarly to in Object detection and Distance measurement variant, the Distance output is provided but the update rate is 10ms. The Distance output calculation uses the same configuration parameters as in the other variant. The Distance output will show the distance of the object, or the reflector.

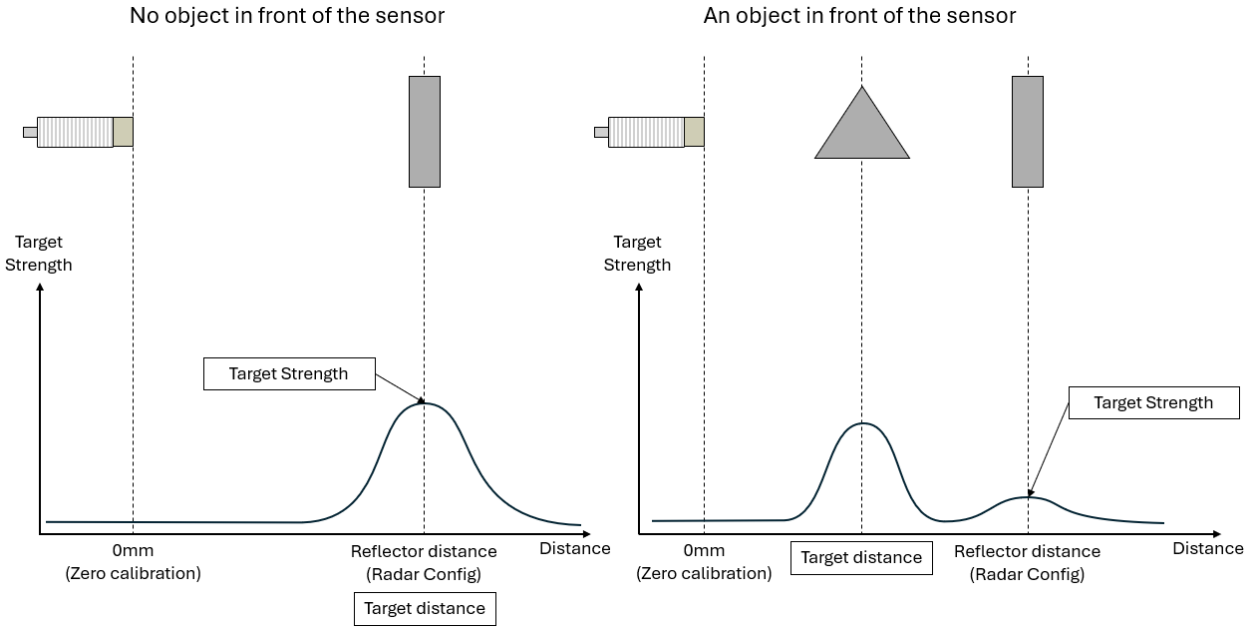


Fig. 3: Radar Reflex Gate

The ISDUs Set reflector distance and Read reflector distance are only available in Radar Reflex Gate variant.

4.7.4 Switching Profiles

The sensor implements SSP 4.2.2 profile according to the IO-Link specification 'IO-Link Profile Smart Sensors 2nd Ed' Version 1.2 from January 2024. In this profile there are two switching channels (SSCx.1 and SSCx.2) per measurement channel.

Description

Sensor Principle / Evaluation Logic

The sensor performs measurement value acquisition as a continuous signal that is evaluated for switching signal generation. The measurement value is only evaluated if it is within this valid measurement range. If the measurement value is outside of this range, the switching channel output switches to low.

Switching points are defined by means of setpoints that can be determined using various teach processes. Alternatively, the setpoints can also be set directly via ISDUs, but under observation of the same requirements and rules as define for the teach processes.

The setpoint setting can also be used to deactivate the switching point evaluation. This is performed with the *Setpoint not teached* setting:

Table 13: Setpoint not teached

Status	Value
Setpoint not teached (32 bit)	2,147,483,644 (`0x7FFFFFFC`)

Overview of Switching Signal Channels

- Two switching channels are available per measurement channel.
- Two switching points (setpoints) per switching channel.
- Adjustable hysteresis.
- Multiple switching modes are possible: *Single-Point Mode*, *Two-Point Mode* and *Window Mode*.
- The following teach commands are available for both setpoint 1 and setpoint 2: *Single Value Teach*, *Two Value Teach* and *Dynamic Teach*

Switchpoint Logic

With switching logic *High Active*, the switching output switches to high if the current measurement value is greater than the set (taught) setpoint. With *Low Active* this logic is inverted.

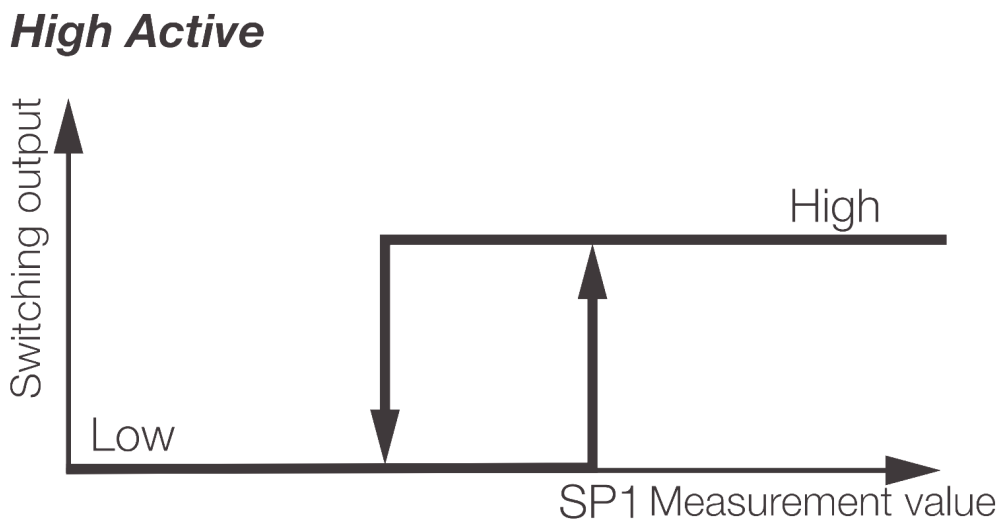


Fig. 4: Switchpoint logic High Active

Single Point Mode

In Single Point Mode, only one switching point (setpoint) is defined.

Switching behavior:

- Measurement value ≥ switching point: output active
- Measurement value ≤ switching point minus a defined hysteresis: output inactive

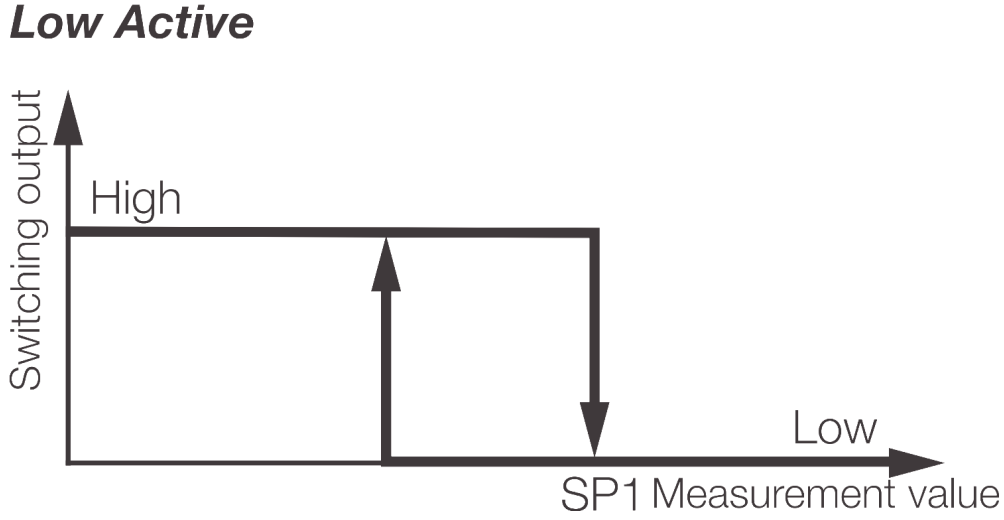


Fig. 5: Switchpoint logic Low Active

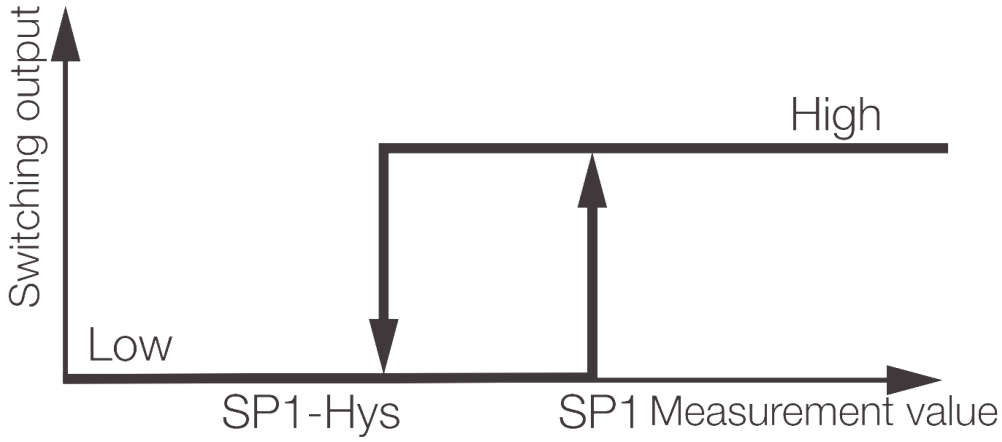


Fig. 6: Single-Point Mode

Two Point Mode

In Two Point Mode, two switching points (setpoint) are defined.

Switching behavior:

- Measurement value ≥ switching point 1: output active
- Measurement value ≤ switching point 2 output inactive

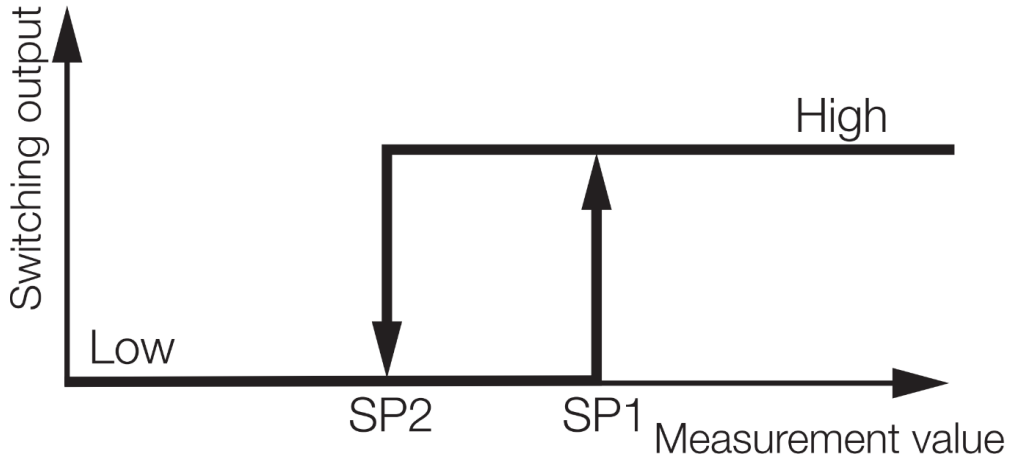


Fig. 7: Two-Point Mode

Teach Process

For a successful teach-in as well to directly set a setpoint, the following conditions must be met:

- The setpoint that is to be taught must be in the validity range of the measurement value signal.

Additionally in Two-Point Mode:

- The distance between the setpoints must be greater than or equal to the minimum hysteresis.

Note

Due to the requirements listed above, it may be necessary to vary the order of the setpoints for a successful teach-in.

An active teach process in indicated by illumination of the red LED. If the red LED flashes, the currently pending measurement value is outside of the validity range (IO-Link process) or a manual teach was not possible.

Single Value Teach

With *Single-Value Teach*, the switching point (setpoint) is defined via a teach point. Moreover, this is a static process, i.e., the measurement value is constant during the teach phase. The teach process is performed independently for each switching point in Two-Point Mode.

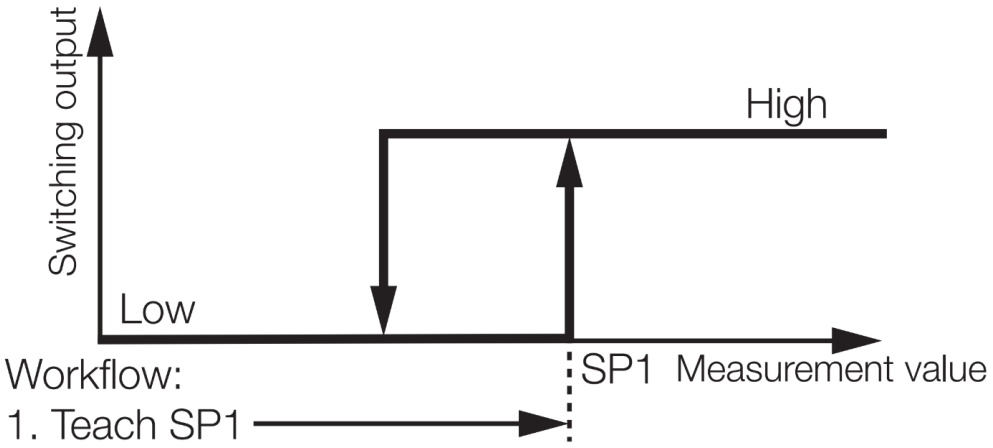


Fig. 8: Single Value Teach in Single Point Mode

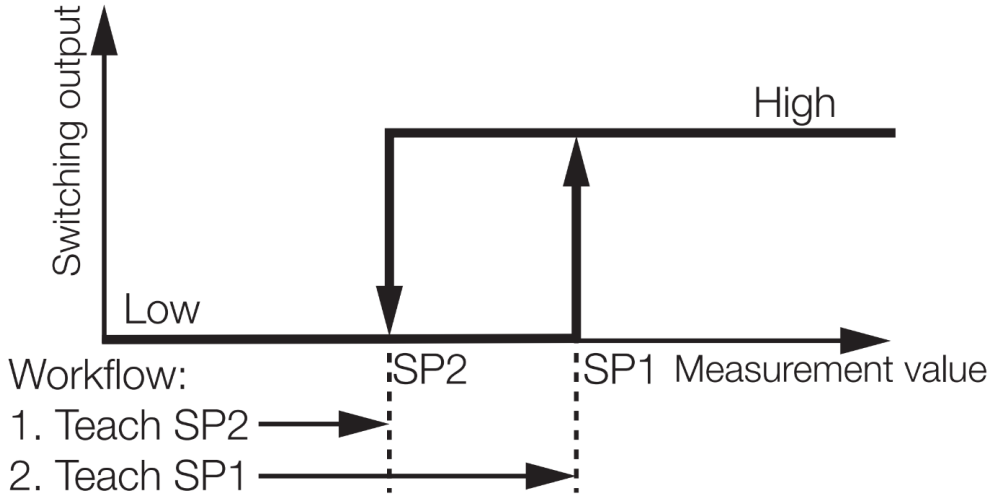


Fig. 9: Single Value Teach in Two Point Mode

Two Value Teach

With *Two-Value Teach*, the switching point (setpoint) is defined via two teach points. The average value of the two teach points defines the setpoint. This is a static process as well, i.e., each teach point is defined statically. The teach process can be performed independently for each switching point in Two-Point Mode or Window Mode. The teach process is concluded with the Apply command; this is only possible if each of the two teach points has been taught. Alternatively, the teach process can be interrupted with a Cancel command. All incomplete teach point pairs are thereby lost.

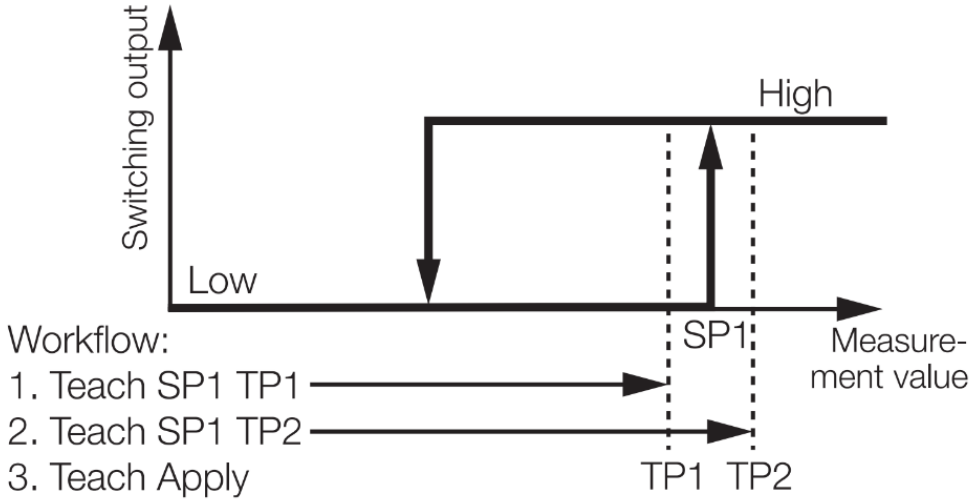


Fig. 10: Two Value Teach in Single Point Mode

Dynamic Teach

With this process, no static teach points are recorded, unlike with the previous methods; rather, multiple measurement values are recorded over a defined period of time. Measurement value acquisition is started with the *Dynamic Teach SP1 Start* system command and ended with *Dynamic Teach SP1 Stop*. If all recorded measurement values were in the valid detection range, the switching point calculation is started. For this purpose, the minimum and maximum values are determined. The average value of these two extrema is used to form the new switching point (setpoint). The maximum acquisition time is 5 minutes. After 5 minutes without a Stop command, the event 0x8DC0 *Teach Timeout* is set.

Process Data

Object ID	Name	Description	Direction
0x003F (63)	SSC 1.1	Switching Signal Channel 1.1	Input
0x0040 (64)	SSC 1.2	Switching Signal Channel 1.2	Input
0x0173 (371)	SSC 2.1	Switching Signal Channel 2.1	Input
0x0174 (372)	SSC 2.2	Switching Signal Channel 2.2	Input

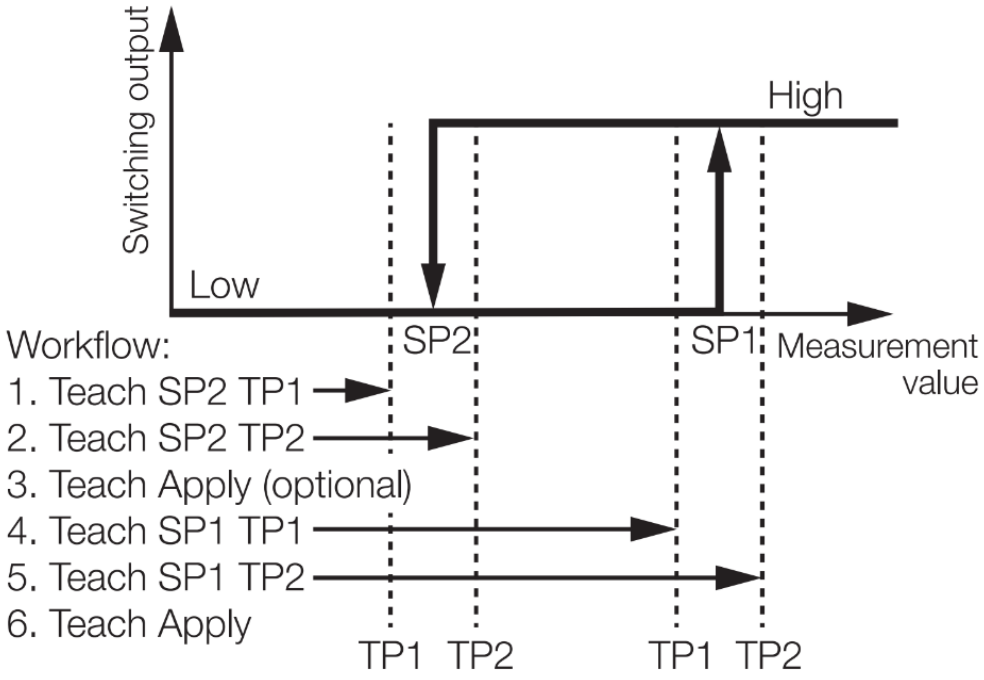


Fig. 11: Two Value Teach in Two Point Mode

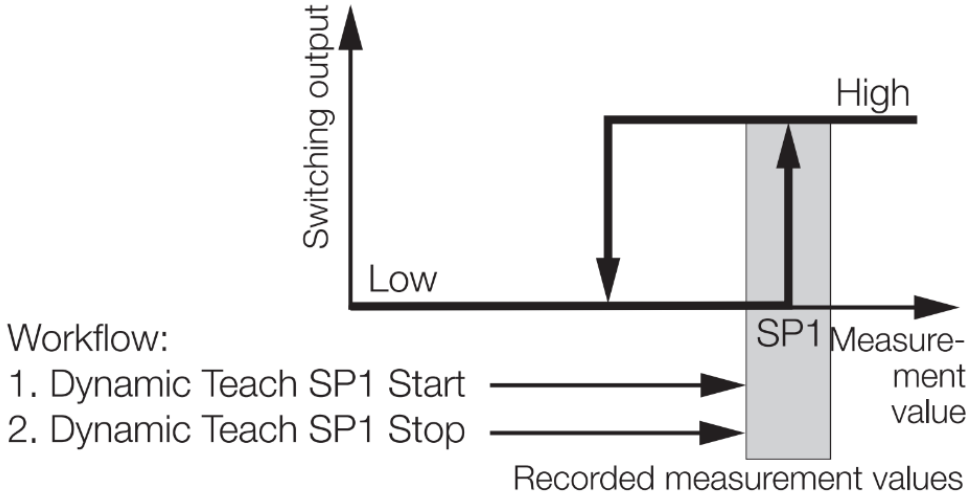


Fig. 12: Dynamic Teach in Single Point Mode

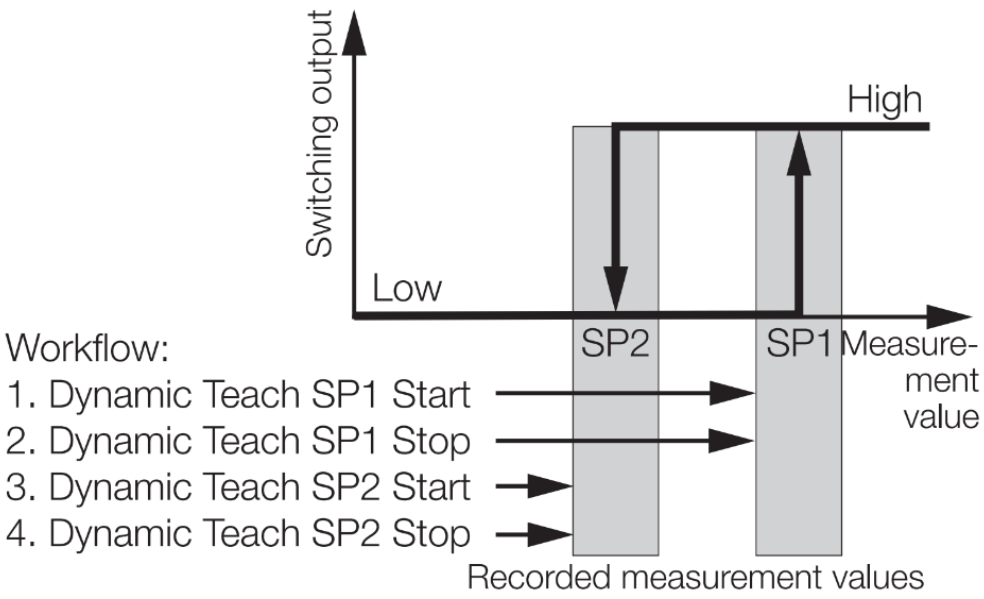


Fig. 13: Dynamic Teach in Two Point Mode

ISDU

Teach in Select

With the help of this parameter, the switching channel that is to be taught is selected.

Teach in Result

Outputs the current status of the currently active or of the last teach-in process:

SSC Parameter

This parameter represents the currently configured switching points for each switching channel (setpoint 1 and setpoint 2). The switching point 1 (setpoint 1) is active in all switching modes and can be taught. Switching point 2 (setpoint 2) is only active in Two-Point or Window Mode and is otherwise deactivated.

It is possible to deactivate a switching channel (SSC) by assigning the value 0x7FFFFFFC (*Setpoint not teached*) to one of the active setpoints.

SSC Configuration

This parameter is used to configure the SSC. It is possible to set the switching logic, switching mode as well as the hysteresis.

If the switching mode is changed, the setting of the setpoint parameter can be adjusted:

- If changing from Two-Point or Window Mode to Single-Point Mode, setpoint 2 is set to *0x7FFFFFFC* and thereby deactivated. In this state or in this setting, the setting of setpoint 2 cannot take on any other value.
- If changing from Single-Point Mode to Two-Point oder Window Mode, setpoint 2 is again activated and set to the value of setpoint 1 minus the minimum hysteresis and, in the subsequent process, can be taught to a different value.

System Commands

Command Value	Device Action
0x40 (64)	Teach Apply – Calculates the switching point for SP1, SP2.
0x41 (65)	Teach SP – Determines teach point 1 for the setpoint and calculates the switching point.
0x41 (65)	Teach SP1 – Determines teach point 1 for setpoint 1 and calculates the switching point.
0x42 (66)	Teach SP2 – Determines teach point 1 for setpoint 2 and calculates the switching point.
0x43 (67)	Teach SP TP1 – Determines teach point 1 for the setpoint 1.
0x44 (68)	Teach SP TP2 – Determines teach point 2 for the setpoint 1.
0x45 (69)	Teach SP2 TP1 – Determines teach point 1 for setpoint 2.
0x46 (70)	Teach SP2 TP2 – Determines teach point 2 for setpoint 2.
0x47 (71)	Teach SP1 Start – Starts dynamic teach-in for setpoint 1
0x48 (72)	Teach SP1 Stop – Stops dynamic teach-in for the setpoint and calculates the switching point.
0x49 (73)	Teach SP2 Start – Starts dynamic teach-in for setpoint 2
0x4A (74)	Teach SP2 Stop – Stops dynamic teach-in for setpoint 2 and calculates the switching point.
0x4E (78)	Teach Reset – The teach-in process is interrupted, the setpoints are reset to the default settings.
0x4F (79)	Teach Cancel – The teach-in process is interrupted.

For an overview of all System Commands, see section *System Commands*.

Events

Event Code	Event Type	Event – Description - Remedy	Device Status
0x8DC0 (36288)	Notification	*Dynamic Teach-in Timeout* – The current teach-in process took too long and was interrupted. ► The teach-in process must be completed within 5 minutes.	0 – Device is operating properly.

4.7.5 Measurement Profiles

Description

The sensor realizes the measuring Smart Sensor Profile Ed. 2 according to profile SSP 4.2.2. The profile defines four different ranges in which a measurement value (*Measurement Value*) can be output:

- The measurement range (*Measurement Range*)
- Detection range (*Detection Range*)
- Out of Range

- No Measurement Data

The evaluation is realized based on the value “Transducer Value High Resolution” (PDObjectID 0x0025) as the distance output provided by the Radar Frontend, see *Radar frontend*.

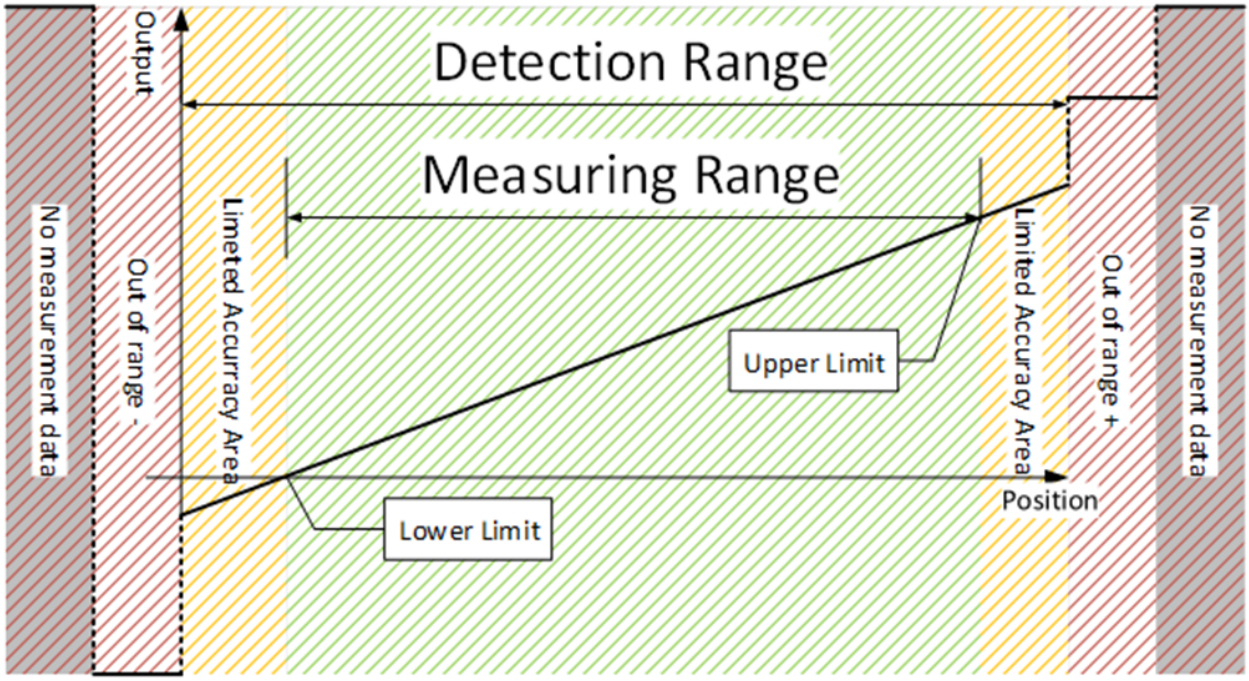


Fig. 14: Ranges for which a measurement value is output

Measurement Range

Within the measurement range, all values specified in the data sheet related to measurement accuracy are satisfied. Information on the size of the measurement range can be found in parameter *MDC Descriptor*, which contains the lower measurement limit (*Lower Limit*) and upper measurement limit (*Upper Limit*).

Detection Range

Outside of the measurement range, a measurement value output in the non-linear areas (*Limited Accuracy Areas*) is still possible, though the accuracy cannot be ensured for these areas. Limited accuracy is indicated via the *Measurement Warning* bit in the process data.

Out of Range

Outside of the detection range, the sensor can determine whether the measurement value is below or above the detection range. A meaningful measurement value is not possible in these areas. Instead, a replacement value is output:

Table 14: Out of Range

Status	Value
Out of Range Minus	−2,147,483,640 (`0x80000008`)
Out of Range Plus	2,147,483,640 (`0x7FFFFFF8`)

In addition to the replacement value, the *Measurement Error* bit is set.

No Measurement Data

If no measurement value can be determined, the replacement value *No Measurement Data* is output:

Table 15: No Measurement Data

Status	Value
No Measurement Data	2,147,483,644 (`0x7FFFFFFC`)

In addition to the replacement value, the *Measurement Error* bit is set.

This state is set if no target can be detected within the measurement range. See more details in *Radar frontend*.

Process Data

Object ID	Name	Description	Direction
0x0028 (40)	Measurement Value (Distance)	Distance measurement value.	Input
0x002A (42)	Measurement Scale (Distance)	The scaling as the exponent of a power of ten	Input
0x002B (43)	Measurement Error	Measurement value outside of the detection range or no measurement value	Input
0x002C (44)	Measurement Warning	Measurement value outside of the measurement range	Input
0x0171 (369)	Measurement Value (Target Strength)	Target Strength value.	Input
0x0172 (370)	Measurement Scale (Target Strength)	The scaling as the exponent of a power of ten	Input

Measurement Value

The current measurement value as signed, 32-bit number. In case of an error, a substitute value is output (see Out of Range and No Measurement Data).

Measurement Scale

The scaling value is a signed, 8-bit number. The scaling indicates the exponents of a power of ten of the measurement value relative to the base unit meter in case of Distance, and dB in case of Target Strength. This value is used to interpret the unit of the output value.

Note

Measurement Value [unit] of output value = SI unit × 10Measurement Scale

Measurement Error

Indicates if the measurement value is outside of the detection range or if no measurement value can be determined.

Measurement Warning

Indicates if the measurement value is outside of the measurement range.

Process Data Profiles

PDin

ISDU and Reset Behavior

MDC Descriptor

The MDC Descriptor contains information about the current value range of the measurement value (*Measurement Value*) within the limits of the measurement range (*Measurement Range*), about the unit and the scaling of the measurement value. The values for the lower measurement limit (*Lower Limit*) and upper measurement limit (*Upper Limit*) specify the value range.

The *Scale* parameter in the MDC Descriptor is a signed 8 bit number. The scaling indicates the exponents of a power of ten of the measurement value relative to the base unit. The basic unit is coded by the parameter *Unit Code* in the MDC Descriptor. The possible unit values of the sensor include:

Unit	Value
Meter	1010
Decibel	1383

On delivery, the lower measurement value limit has its origin at value 300. If an offset is set, the value of the lower measurement value limit changes according to the *Measurement Offset*.

Hide Limited Accuracy Areas

Measurement values are still displayed outside the measuring range. These do not conform to the limits specified in the data sheet. The output of the non-linear area (Limited Accuracy Areas) can be configured. If the output is deactivated (Hidden), the sensor outputs either *Out Of Range Plus* or *Out Of Range Minus* if the measurement range is exited.

Value	Meaning
0x00 (0)	Visible
0xFF (255)	Hidden

Measurement Offset

The *Measurement Offset* is subtracted from the current measurement value. This parameter can be reset using *Application Reset* and *Factory Reset*.

Measurement Preset

Measurement Preset can be used to calculate a *Measurement Offset*. *Measurement Preset* specifies a target value that should be achieved after a *Teach Preset* by the current measurement value. Following a successful *Teach Preset*, the current measurement value has the same value as *Measurement Preset*.

This parameter can be reset using *Application Reset* and *Factory Reset*.

Measurement Output Characteristics

The *Measurement Output Characteristics* parameter defines the output characteristic, which can be rising or falling. This setting affects the offset setting. It is possible that the offset setting needs to be performed again after this setting is changed.

This parameter can be reset using *Application Reset* and *Factory Reset*.

Value	Meaning
0x00 (0)	Falling
0xFF (255)	Rising

Measurement Hysteresis

The hysteresis of the measurement value can be set with parameter *Measurement Hysteresis*. This parameter is used to dampen unstable measurement values. This parameter can be reset using *Application Reset* and *Factory Reset*.

Measurement Range

With *Measurement Range*, the measurement range can be changed by teaching with the *Teach Lower Limit* and *Teach Upper Limit* System Commands or by overwriting the parameter.

This parameter *Measurement Range* can be reset using *Application Reset* and *Factory Reset*.

System Commands

Command Value	Device Action
0xE0 (224)	*Teach Preset* – Sets the current measurement value to the value of Measurement Preset.
0xE1 (225)	*Teach Lower Limit* – Sets the lower end of the measurement range.
0xE2 (226)	*Teach Upper Limit* – Sets the upper end of the measurement range.

For an overview of all System Commands, see section *System Commands*.

Events

Event Code	Event Type	Event – Description – Remedy	Device Status
0x8D00 (36096)	Warning	The measurement value is below the measurement range. Accuracy cannot be guaranteed.	2 – Out of Specification
0x8D01 (36097)	Warning	The measurement value is above the measurement range. Accuracy cannot be guaranteed.	2 – Out of Specification
0x8D02 (36098)	Warning	The measurement value is below the detection range; no measurement value can be determined. ► Check application.	2 – Out of Specification
0x8D03 (36099)	Warning	The measurement value is above the detection range; no measurement value can be determined. ► Check application.	2 – Out of Specification
0x8D04 (36100)	Warning	No measurement value can be determined. ► Check application.	2 – Out of Specification
0x8D05 (36101)	Warning	Measurement error/redundancy check failed. ► Check application.	2 – Out of Specification

4.7.6 Signal Quality

Description

The signal quality is specified in percent steps as a value between 0 and 100%. If the signal quality cannot be provided, a substitute value of 0xFF (255) is output. The threshold value for the monitoring function can be set and is used to define two states of the signal quality. The signal quality is considered to be good at or above the threshold value; the signal quality is considered to be bad below the threshold value. A state change from good to bad signal quality triggers the *Low Signal Quality Level* IO-Link event.

The output of the current signal quality can provide support both when setting up as well as during predictive maintenance. When setting up, the location, the orientation and the environmental conditions can be adapted to achieve a satisfactory signal quality level. If the signal quality is checked regularly, a deterioration of the performance can be preventatively combated.

In addition, the monitoring of the signal quality offers an immediate response in the event of a critical failure. This reaction is triggered if the signal quality drops below the adjustable threshold value and gives the all clear if a satisfactory signal quality level is once again achieved.

The signal status is indicated by LED (see section *LED Meaning*).

The function can be deactivated by setting the threshold value to zero.

Mathematics/Algorithm

The signal quality value is based on the *Target Strength* signal. If the *Target Strength* is below a defined lower threshold (3dB), the signal quality is set to 0%. If the *Target Strength* is above an upper threshold (20dB), the signal quality is set to 100%. For values in between, the function linearly maps the *Target Strength* to a percentage between 0% and 100%.

Process Data

Object ID	Name	Description	Direction
0x0021 (33)	Signal Quality Bad	Output of the current signal quality evaluation; TRUE means a signal quality below the threshold value, FALSE means a signal quality equal to or above the threshold value.	Input

Also see section *Process Data Profiles*.

ISDU

Low Signal Quality Threshold

The threshold value for low signal quality can be set in order to monitor the current signal quality. It is displayed as a value between 0 and 100 in percent. If the current signal quality value drops below the signal quality threshold value, the *Low Signal Quality Level* warning is output.

The function can be deactivated by setting the threshold value to zero.

Current Signal Quality

The current signal quality is displayed as a value between 0 and 100 in percent. If no valid signal quality is available, the value is set to 255.

Signal Quality Bad

The status of the signal quality is displayed as a Boolean value. If the value is TRUE, the signal quality is below the threshold value; if the value is FALSE, the signal quality is equal to or greater than the threshold value.

System Commands

Command Value	Device Action
0x81 (129)	*Application Reset* – Sets the threshold value with ISDU index 0xCE Low Signal Quality Threshold to default 0. The feature is thereby deactivated and the evaluation of index 0xCF subindex 2 always results in FALSE.
0x82 (130)	*Restore Factory Settings* – Sets the threshold value with ISDU index 0xCE Low Signal Quality Threshold to default 0. The feature is thereby deactivated and the evaluation of index 0xCF subin dex 2 always results in FALSE.

For an overview of all System Commands, see section *System Commands*.

Events

Event Code	Event Type	Event – Description – Remedy	Device Status
0x8CFF (36095)	Warning	Low signal quality level	2 – Out-of Specification

Variant Dependence

The functionality is available only in Distance/ Object detection variant.

4.8 Secondary Functions

This section covers the secondary device functions.

Secondary functions provide diagnostic and monitoring capabilities for device health, uptime, and operating conditions. Use these features for predictive maintenance and system monitoring.

Topics

- *Operating Hours Counter*: track device runtime and usage
- *Boot Cycle Counter*: monitor device restart frequency
- *Voltage and Current Monitoring*: power supply diagnostics
- *Internal Temperature*: device temperature monitoring and thermal events

4.8.1 Operating Hours Counter

Description

The operating hours counter can record the operating hours of a device accurately to the second. There are a total of three operating hours counters. In addition to an operating hours counter for the operating hours since the start of the device, there is a total operating hours counter and a customer-specific operating hours counter that can be reset. The storage interval is configurable and the operating hours are not stored once 1000000 storage cycles have been reached.

Algorithm

While the counter is incremented every second, the storage interval doubles after each save operation. Starting with a save operation after 1 minute, then after 2 minutes, then after 4 minutes, then after 8 minutes, up to a maximum storage rate of 12 minutes.

The output of the operating hours can serve as a time control for the service interval as well as for preventative maintenance. Schedules for regular service can be tied to the operating hour values. Moreover, a high value of the total operating hours is indicative of intensive use of a device and possible deterioration of the performance. The risk of failure can be countered preventively through replacement.

Process Data

Object ID	Name	Description	Direc-tion
0x001B (27)	Current Operating Hours	Output of the current operating hours counter	Input
0x001C (28)	Total Operating Hours	Output of the total operating hours counter	Input
0x001D (29)	Custom Operating Hours	Output of a user-defined operating hours counter	Input

Also see section Process Data Profiles.

ISDU

Note

The maximum number of storage cycles is 1000000 and, with a switch-on and switch-off every 12 minutes (with static counter), this means a service life of over ~22,8 years (1.000.000 × 12 min). If switched on and off more frequently or in the case of dynamic storage, the maximum storage time is reduced depending on the application.

Current Operating Hours

This parameter saves the value of the operating hours since the last commissioning in seconds.

Total Operating Hours

This parameter saves the value of the operating hours since the first commissioning in seconds.

Custom Operating Hours

This parameter saves the value of the operating hours since the last reset in seconds.

Operating Hours Saving Mode

The current storage behavior can be set.

Valu	Mear ing	Description
0x00 (0)	Dy-namic	The first save operation is performed 1 minute after switching on; the storage interval then doubles after every save operation. This is limited to a storage interval of 12 minutes. The intervals are 1, 2, 4, 8, 12 minutes.
0x01 (1)	Static	Operating hours counters are stored every 12 minutes.

System Commands

Command Value	Device Action
0x81 (129)	*Application Reset* – Resets Custom Operating Hours to the default value.
0x82 (130)	*Restore Factory Settings* – Resets Custom Operating Hours and Operating Hours Saving Mode to the default value.
0xA5 (165)	*Maintenance Reset* – Resets Custom Operating Hours to the default value.

For an overview of all System Commands, see section *System Commands*.

4.8.2 Boot Cycle Counter

Description

After each start, the current Boot Cycle Counter is read from the non-volatile memory, incremented by 1 and rewritten. In addition, a second Boot Cycle Counter is implemented that can be reset.

The output of the current boot cycle can serve as a control for the service interval as well as for preventative maintenance. Schedules for regular maintenance can be tied to the values of the Boot Cycle Counter.

ISDU

Table 16: ISDU – Boot Cycle Counter

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Boot Cycle Counter	0x0058 (88)	0	R	8 bytes		n/a	
Boot Cycle Counter	0x0058 (88)	1	R	4 bytes	UINT32	n/a	–
Custom Boot Cycle Counter	0x0058 (88)	2	R	4 bytes	UINT32	n/a	–

Note

The maximum number of storage cycles is 1000000 and, with switch-on and switch-off every 12 minutes, this means a service life of over 1.000.000 × 12 min = ~22,8 years.

Boot Cycle Counter

This parameter saves the value of the current boot cycle, which is incremented on each start.

Custom Boot Cycle Counter

This parameter saves the value of the current, user-defined counter, which is incremented on each start and can be reset via the *Maintenance Reset* system command.

System Commands

Command Value	Device Action
0x81 (129)	*Application Reset* – Resets the Custom Boot Cycle Counter with ISDU-index 0x58 subindex 2 to the default value 0.
0x82 (130)	*Restore Factory Settings* – Resets the Custom Boot Cycle Counter with ISDU-index 0x58 subindex 2 to the default value 0.
0xA5 (165)	*Maintenance Reset* – Resets the Custom Boot Cycle Counter with ISDU-index 0x58 subindex 2 to the default value 0.

For an overview of all System Commands, see section *System Commands*.

4.8.3 Voltage and Current Monitoring

Description

The voltage and current module sends messages about over-current, short-circuit, wire breakage, over-voltage and under-voltage. Over-voltage and under-voltage detection starts a timer. If the timer has expired and the voltage level has not returned to the normal operating voltage threshold, the module sends out the messages.

The messages include device status, IO-Link events, process data and LED signaling.

Mathematics/Algorithm

In SIO mode the threshold for undervoltage is 17V and for overvoltage is 32V.

If the device is in IO-Link mode, undervoltage occurs at 17V
and overvoltage occurs at 32V.

Process Data

Object ID	Name	Description	Direction
0x0017 (23)	Undervoltage	TRUE = the voltage level is below the threshold value.	Input
0x0018 (24)	Overvoltage	TRUE = the voltage level is above the threshold value.	Input

Also see section Process Data Profiles

ISDU

With the parameter *Voltage Monitoring Detection Time Duration* is possible to change the time between the detection of over/under voltage and the reporting of the event. (This parameter is used to eliminate unstable (transition) state as a filter)

Voltage Monitoring Detection Time Duration

This parameter is used to define how long the under-voltage or over-voltage must be present before it is displayed. The unit is given in milliseconds. The values must be in the range between 10 and 1000. The default value is 10 milliseconds.

System Commands

Command Value	Device Action
0x81 (129)	*Application Reset* – Resets the Voltage Monitoring Detection Time Duration with ISDU-index 0x2200 to the default value 10.
0x82 (130)	*Restore Factory Settings* – Resets the Voltage Monitoring Detection Time Duration with ISDU-index 0x2200 to the default value 10.

For an overview of all System Commands, see section *System Commands*.

Events

Event Code	Event Type	Event – Description – Remedy	Device Status
0x5110 (20752)	Warning	Primary supply voltage exceeded ► Check for deviations in the supply.	2 – Out-of-Specification
0x5111 (20753)	Warning	Primary supply voltage below minimum value ► Check for deviations in the supply.	2 – Out-of-Specification
0x8D0B (36107)	Warning	Overload or short circuit at pin 2 ► Check wiring.	2 – Out-of-Specification
0x8D0D (36109)	Warning	Incorrect load/cable breakage, analog current output pin 2 ► Check wiring or connected devices.	2 – Out-of-Specification
0x8D15 (36117)	Warning	Overload at pin 2 ► Check wiring.	2 – Out-of-Specification

4.8.4 Internal Temperature

Description

The device has internal temperature monitoring. This records the device temperature as well as the maximum and minimum values since production and since the last time the device was restarted.

An upper and a lower threshold value can be defined for the device temperature module. If the threshold is exceeded or if device limit values are exceeded or undercut, the device triggers IO-Link events.

Note

The internal device temperature is measured in the device and is therefore higher than the ambient temperature. The level of this increased temperature depends on the ambient temperature, the ventilation of the device and the device settings.

Process Data

Object ID	Name	Description	Direction
0x004E (78)	Temperature Status Customer Limits	Temperature status – Warning related to the configured customer limits [Index 0x0053]. Set when out of limits.	Input
0x004F (79)	Temperature Status Device Limits	Temperature status – Warning related to the device limits. Set when out of limits.	Input
0x0050 (80)	Device Temperature	Current device temperature in °C.	Input

ISDU

Internal Temperature

Internal Temperature contains information about the device temperature (current value in °C), the minimum or maximum device temperature since the last time the device was switched on/reset (in °C) and minimum or maximum device temperature during the lifetime of the device (in °C).

Internal Temperature Alarm Configuration

Setting for the lower threshold value (in °C) for the device temperature warning (0x8D20) and upper threshold value (in °C) for the device temperature warning (0x8D10).

Events

Event Code	Event Type	Event – Description – Remedy	Device Status
0x4000 (16384)	Error	*Temperature Fault – Overload* – The device is operated outside of the device-specific temperature limits. Risk of device damage.	4 – Failure
0x4210 (16912)	Warning	*Device Temperature Overrun – Clear Heat Of Source* – Risk of device damage. The device is too hot. ► Remove heat source, provide the device with heat insulation if necessary.	2 – Out-of-Specification
0x4220 (16928)	Warning	*Device Temperature Underrun – Insulate Device* – Risk of device damage. The device is too cold. ► Insulate the device.	2 – Out-of-Specification
0x8D10 (36112)	Warning	Customer-defined upper warning for device temperature. The upper threshold value for the temperature warning has been exceeded.	0 – Device is operating properly.
0x8D20 (36128)	Warning	Customer-defined lower warning for device temperature – The lower threshold value for the temperature warning has been dropped below.	0 – Device is operating properly.

4.9 System Functions

This section covers the system functions and configuration options.

System functions control device behavior, hardware interfaces, configuration management, and firmware updates. Use this section for advanced device setup, I/O configuration, and system-level operations.

Topics

- *Analog Output*: configure analog output signal and mapping
- *Device Status and Detailed Device Status*: status information and diagnostics
- *Diagnosis Suppression*: suppress specific diagnostic events
- *Reset Commands*: device reset and restore operations
- *Variant Configuration*: select device operating variant
- *Pin Configuration Assignment*: configure physical pin functions
- *LED Meaning*: LED indicator states and meanings
- *Process Data Info and Configuration*: process data structure setup
- *Profile Characteristic*: profile identification and capabilities
- *Parameter Manager*: parameter backup and restore
- *Blob Firmware Update*: firmware update procedure

4.9.1 Analog Output

Description

The Sensor implements an Analog Output on Pin 2 that can be configured if needed. The Output can either use a Analog Voltage or Current Signal.

ISDU

Activate Analog Output

To Activate the Analog Output *Pin 2 Function* has to be set to *Analog Output* (`0x02`).

Signal Sources

Either *Target Distance* or the *Target Strength* can be selected as the Signal Source.

Target Distance

The Output Range of the Target Distance is scaled between the configured upper and lower limits of the *Meassurement Range*. If there is an active *Meassurement Range Warning* or *Meassurment Error* the corresponding Voltage or Current Value will be used.

Target Strength

The Target Strength will always be scaled between *0dB* and *64dB*. No *Meassurement Range Warning* or *Meassurment Error* will be output.

Characteristic

Type

> **WARNING**
>
> The voltage and current settins listed above (e.g., 4…20mA, 0…10V) only represent the nominal signal ranges of the configured meassurement range, not the absolute maximum or minimum values that may occur. Actual output may exceed these ranges in error or out-of-range conditions.

Meassurement Range

The Meassurement Range configures the *Upper* und *Lower Limit* of the Analog Output for the *Target Distance* as the *Signal Source*. If the *Lower Limit* is set the *Target Distance* in the *Process Data* will get an *Offset*. This can be compensated by setting the *Meassurement Offset*.

4.9.2 Device Status and Detailed Device Status

Description

The *Device Status* feature provides information about the current device status.

Each *Device Status* is combined with a corresponding diagnostic message (see chapter *Events*).

It is also possible to actively read out current pending events of the device.

Process Data

Object ID	Name	Description	Direction
0x0021 (47)	System Error	This bit is set (TRUE) if there is an error in the device. This information is linked to the device status (4-Failure), which can be triggered by different device functions or diagnostic messages. The bit is reset as soon as the error status is no longer displayed (FALSE).	Input

Also see section Process Data Profiles.

ISDU

Device Status

The parameters are accessed via subindex 0.

The output values are to be interpreted as follows:

Valu	Status	Description
0	Device is operating properly	Device working correctly.
1	Maintenance Required	Although the process data is valid, internal diagnoses show that the device will soon lose its ability to function properly. Maintenance is necessary.
2	Out-of-Specification	Although the process data is valid, internal diagnoses show that the device is operating outside of its specified measurement range or environmental conditions. The installation must be checked for unintentional malfunctions.
3	Functional Check	Process data is temporarily invalid due to intentional changes to the device, e.g., parameterization or teaching-in.
4	Failure	Process data is invalid due to a malfunction of the device or its peripheral devices. The device is not able to perform its intended function. Re-configuration (resetting to factory settings) can help. Otherwise, Balluff service must be contacted or the device replaced.

Detailed Device Status

Detailed Device Status indicates the currently pending diagnosis messages (error, warning). For an event overview, see chapter *Events*.

It can be used to perform a more detailed error analysis or to find the corresponding error source in the event of an unexpected device status.

The length of the list varies dynamically depending on the number of entries. Each entry in the list consists of the *EventQualifier* and the *EventCode* and has a data length of 3 bytes. The total list can be queried via subindex 0, individual entires with the corresponding subindex. Each of the entries in the lists can only be called while the event is pending.

Subindex	Object name	Data Type	Comment
1	Error_Warning_1	3 bytes	See comment note below.
2	Error_Warning_2	3 bytes	See comment note below.
3	Error_Warning_3	3 bytes	See comment note below.
4	Error_Warning_4	3 bytes	See comment note below.
...			
n	Error_Warning_n	3 bytes	See comment note below.

Comment

All bytes:
- `0x00` (0): no error/warning
- Byte 1: EventQualifier
- Byte 2, 3: EventCode

4.9.3 Diagnosis Suppression

Description

Diagnosis suppression is used to suppress diagnosis messages from the device. There are two possibilities here:

- Diagnosis suppression level that permits a general suppression of messages of a certain level (message, warning, error).
- Event-code suppression of up to 5 events as a list or via teach-in.

ISDU

Diagnosis Level Configuration

This parameter offers the possibility to select an output level for events.

This index is part of the data management and is stored in non-volatile memory.

Value	Diagnosis Level	Descriptions
0	All events	All diagnosis messages are reported (default setting).
1	Warnings and errors	All warnings and errors are reported – messages are suppressed.
2	Error	Only events of type error are reported.
3	No events	All diagnosis messages from the device are suppressed.

Events

For an event overview, see chapter see chapter *Events*.

Event Code Suppression

This parameter indicates the currently suppressed event messages. The individual messages can be accessed via subindex 0 or a specific subindex. This index is part of the data storage and is stored in non-volatile memory.

Value 0x0000 (0) is the default value and is interpreted as free.

Each event message is structured as follows:

Byte1 (MSB)	Byte0 (LSB)
Event Code High Byte	Event Code Low Byte

Event Code Suppression Teach-in/Delete

To add an event to the list of suppressed events, the event code is inserted in subindex 0 in *Event Code Suppression Teach-In*. It is added to the next free place in the table.

If the event code is deleted with *Event Code Suppression Delete*, it is removed from the list.

4.9.4 Reset Commands

Description

The device supports various reset commands for resetting the set parameters to default values. Each of these commands is accessed by means of *System Commands*.

This function is defined in the IO-Link specification and is implemented according to version 1.1.4

ISDU

System Commands

Command Value	Device Action
0x80 (128)	*Device Reset* – Device Reset means a warm start of the device. During this process, the microcontrollers are restarted and all initializations performed again without any change made to the parameter values.
0x81 (129)	*Application Reset* – This reset is performed using IO-Link specification version 1.1.4 • Resets all parameters and device settings to default values (with the exception of the identification and tagging parameters) • No reset of the configuration of the device variant • No communication stop or restart
0x82 (130)	*Restore Factory Settings* – This reset is performed using IO-Link specification version 1.1.4 • Reset all parameters and device settings to default settings (including identification and tagging parameters) • Reset the configuration of the device variants to the default variant • Communication stop and restart possible.
0x83 (131)	*Back-to-Box Reset* – This reset is performed using IO-Link specification version 1.1.4 • Reset all parameters and device settings to default settings (including identification and tagging parameters) • Reset the configuration of the device variants to the default variant • Communication stop until the next restart.
0xA5 (165)	*Maintenance Reset* – Resets all resettable maintenance and service life parameters for the user so that the next maintenance cycle can begin.

For an overview of all System Commands, see section *System Commands*.

4.9.5 Variant Configuration

Description

The device variant can be changed either via ISDU with this parameter or by using the IO-Link compatibility mode. If this parameter is written, the device variant is not changed immediately but instead after the device is restarted. If the device variant is changed via the IO-Link compatibility mode, the change in this parameter is visible immediately.

This parameter is not changed by a reset.

Hint

After a variant changeover, an inconsistent configuration may occur because there is no automatic changeover of parameters.
It is therefore recommended that the setup be done in the following order:

1. Variant setting
2. Activate the variant with a **device restart**.
3. Check parameters and set valid parameters if necessary or use Data Storage (see section *Data Storage*).

The variant dependent functional differences are described in the *Radar frontend* section.

ISDU

Device Variant

This parameter indicates which variant is currently set.

The following device variants are available:

Value	Description	Device Id
0x01 (1)	Distance/ Object detection	`0x0C0102` (786690)
0x02 (2)	Radar Reflex Gate	`0x0C0103` (786691)

4.9.6 Pin Configuration Assignment

Description

Several internal digital and analog signals are available that can be output at the pins of the device. Pin 4 and pin 2 can be configured with the following functions:

Pin 4

- Digital Output

Pin 2

- Digital Output
- Analog Output

ISDU

[1] The settings in the *digital configuration* are only used if the pin was configured as a digital output or digital input.

[2] The settings in the *analog configuration* are only used if the pin was configured as an analog output.

Behavior IO-Link

With *Behavior IO-Link*, the behavior of the pins during active IO-Link communication can be determined. The pin can either continue to perform its function or become inactive.

Pin 4

Value	Name	Description
0x00 (0)	IO-Link	This is the communication pin. It cannot execute any other function during an active IO-Link connection.

Pin 2

Value	Name	Description
0x00 (0)	Inactive	The pin has no function and is high-impedance.
0x01 (1)	Normal Operation	The pin retains its function.

Mode

The function of the pin can be selected with *Mode*.

Pin 4

Value	Name	Description
0x00 (0)	Inactive	The pin has no function and is high-impedance.
0x01 (1)	Digital Output	The pin works as a digital output.

Pin 2

Value	Name	Description
0x00 (0)	Inactive	The pin has no function and is high-impedance.
0x01 (1)	Digital Output	The pin works as a digital output.
0x02 (2)	Analog Output	The pin works as an analog output.

Signal Source

With *Signal Source*, the internal signal source for the pin can be selected. Various signal sources are available that can be output or read on a pin.

Digital

Value	Name	Description
0x0000 (0)	Nothing	No Signal Source
0x0017 (23)	Primary supply voltage under-run	Power supply voltage is under its limit.
0x0018 (24)	Primary supply voltage over-run	Power supply voltage is over its limit.
0x002B (43)	MDC Measurement Error	No valid Target found.
0x002C (44)	MDC Out of Measurement Range Warning	Target out of the configured measurement range.
0x002F (47)	System Error	A System Error is active.
0x003F (63)	Switching Signal Channel 1.1	The state of Switching Signal Channel 1.1.
0x0040 (64)	Switching Signal Channel 1.2	The state of Switching Signal Channel 1.2.
0x0173 (371)	Switching Signal Channel 2.1	The state of Switching Signal Channel 2.1.
0x0174 (372)	Switching Signal Channel 2.2	The state of Switching Signal Channel 2.2.
0x004E (78)	Device Temperature Alarm Status	The Device Temperature Alarm is active.

Analog

Value	Name	Description
0x0028 (40)	Target distance	The current Target distance.
0x0171 (369)	Target strength	The current Target strength.

Logic

With *Logic*, the input/output can be configured as inverted or normal.

Value	Name	Description
0x00 (0)	Normal	Non-inverting logic
0x01 (1)	Inverted	Inverted logic

Characteristic

With *Characteristic*, a rising or falling characteristic of the analog output can be configured.

Value	Name	Description
`0x00` (0)	Rising	Rising input value = Rising output value
`0x01` (1)	Falling	Rising input value = Falling output value

Type

The output can be configured with *Type*.

Digital

Value	Name	Description
`0x00` (0)	PNP	PNP output
`0x01` (1)	NPN	NPN output
`0x02` (2)	Push-Pull	Push-Pull output

Analog

Value	Name	Description
`0x00` (0)	4…20mA	Analog current output 4 to 20mA
`0x01` (1)	0…20mA	Analog current output 0 to 20mA
`0x02` (2)	1…5V	Analog voltage output 1 to 5V
`0x03` (3)	0…10V	Analog voltage output 0 to 10V
`0x04` (4)	2…10V	Analog voltage output 2 to 10V

WARNING

The voltage and current settins listed above (e.g., 4…20mA, 0…10V) only represent the nominal signal ranges of the configured meassurement range, not the absolute maximum or minimum values that may occur. Actual output may exceed these ranges in error or out-of-range conditions. More information about the analog output configuration can be found in the *Analog Output* section.

4.9.7 LED Meaning

Description

Only the signal with the highest priority is displayed. The signals are listed in descending priority.

LED 1 (Operating State and Communication)

Table 17: LED 1 (Operating State and Communication)

Name	Signal	Meaning
Failure	Red, static	General error
Communication The device is ready.	Green, alternating with LED off in a ratio of 10:1, 1 s period	IO-Link communication is active.
Ready	Green, static	The device is ready.
Firmware Update The LED indicates update activity.	Magenta, alternating with LED off in a ratio of 9:1, 1 s period	Firmware update is in progress.

LED 2 (Indication/Warning/Teach/Device Discovery)

Table 18: LED 2 (Indication/Warning/Teach/Device Discovery)

Name	Signal	Meaning
Locator	Blue, double blink (2×100 ms on, 100 ms pause), then 600 ms off – 1 s cycle	The function Locator can be activated via a system command to find the device again.
Maintenance required	Blue, static	Perform a factory reset
Short Circuit Pin 2 / Pin 4	Red, flashing, 3 Hz	Short circuit at pin 2 or pin 4
Teach-in	Red, static	The device is currently in teach-in mode.
Overload	Orange, flashing, 3 Hz	Overload on pin 2 / pin 4 has been detected.
Bad Signal Quality	Orange, flashing, 1 Hz	Poor signal quality, the signal quality is below the configured warning threshold.
Out of Specification	Yellow, flashing, 3 Hz	The device is operated outside of specifications. The measurement value is unknown due to an error or outside of the measurement range.
Function Display	Yellow, static	Switching point is active.

4.9.8 Process Data Info and Configuration

Description

Process data information and configuration offers various possibilities related to process data:

- Selection of a process dataset specified by the device
- Information about the structure of the input and output data
- Information about the last valid value for input and output data

As a diagnosis function, monitoring of the updates of certain process values is available. If these are not updated in the specified time, the device sends corresponding diagnosis messages.

Invalid Process Data

Input data (from the device to the master) is only marked as invalid if the device has the *Failure* device status.

> **Info**
>
> In the case of individual pieces of faulty data, the data is not marked as invalid but is instead replaced by substitution values or error codes. This is to be taken into account during the evaluation.

ISDU

PD Profile Selection

There is only one PD Profile

PD Description

This parameter is used to specify the structure of the currently selected process data profile for input and output data. The individual process data variables are described.

The total list is accessible via subindex 0, a single entry is possible using a specific subindex. Subindex 1 corresponds to the *least significant* (or the element most recently transferred in the process data stream). When reading out the entire list, this element is transferred first.

The length of the list is dependent on which process data profile is selected. A single element has a length of 3 bytes.

Last Valid Process Data

This parameter indicates the most recently valid input or output data of the device. The first transferred byte in the process data (MSB) is transferred first. This is an exact representation. Access occurs via subindex 0.

Events

PD Update Timeout

With special process data values, the device automatically checks whether the values are updated in the time period specified by the device. If an update timeout is triggered as a result, this is output via the following diagnosis messages:

PD Profile Selection after Change of Variant

If the variant of the device is changed, the currently set profile is retained.

In the case that the corresponding PD profile is not valid for this variant, the default profile for the corresponding variant is selected.

Variant Dependence

There is no variant dependency in PD-Profiles. All variants use the same PD-profile.

PD Invalid

PD Inputs Invalid:

Input data (device-to-master) is marked as invalid if the *device status* (see section *Device Status and Detailed Device Status* of the device is *Failure*. In all other states, replacement values for the data are output for which the content cannot be output correctly).

4.9.9 Profile Characteristic

Description

Profile Characteristic is a readable parameter that provides information about which IO-Link profiles are supported. It is used mainly to allow profile function modules of the control unit to detect which profile or functions on the device are available.

This parameter is defined in the IO-Link specification.

ISDU

The parameter can be read via subindex 0 and consists of multiple profile indices and function classes (each 16-bit values).

If a profile ID is specified, this means that all included function classes are supported. If only sub-functions are supported, these are output explicitly as an individual function class.

This device supports the following profiles:

The following function classes are supported:

All individual functions are described in this guide. For more exact descriptions of the profiles, refer to the corresponding profile specifications (see www.io-link.com).

Variant Dependence

There is no variant dependency of profile characteristics

4.9.10 Parameter Manager

Description

The parameter manager is responsible for the saving of parameters in the permanent memory of the device. On startup, all stored parameters are read from permanent memory; if parameters are changed, the data is stored within the permanent memory by the parameter manager.

All data is protected with a CRC32 checksum. In the event of damaged memory, the parameter manager outputs the *Parameters not consistent* event.

If this error only affects parameters which can be restored, the memory is repaired directly by the device. In this case all set data is reset to the default settings and the device signals this state via a warning.

Acknowledge warning

Data can be very easily restored via the IO-Link parameter server (see *Data Storage*).

System Commands

Events

4.9.11 Blob Firmware Update

Description

The *BLOB Firmware Update* feature offers the option of importing firmware updates for the IO-Link device itself. Version 1.1 of the BLOB FW update profile specified by the IO-Link consortium for all manufacturers is used for this purpose.

So-called IOLFW packages containing the necessary binaries and metadata are available via the Balluff Update Platform. These packages can be downloaded to the device using *BLOB FW update*-capable tools or controllers.

Info

Changes to the device firmware should only be carried out by trained specialist personnel and during specially designated maintenance periods. Before recommissioning, it must be ensured that the device parameters are correct and that the device is working properly.

Info

The sensor will signalize the update process by blinking in a specific pattern described within *LED Meaning*

ISDU / System Commands

There are a number of defined ISDUs and system commands to control the feature, but these are not explained further here. Necessary sequences are stored in BLOB-FW update-capable tools and do not have to be used explicitly.

Password protection disabled

During the update, the tool will **not** request a password that must be entered.

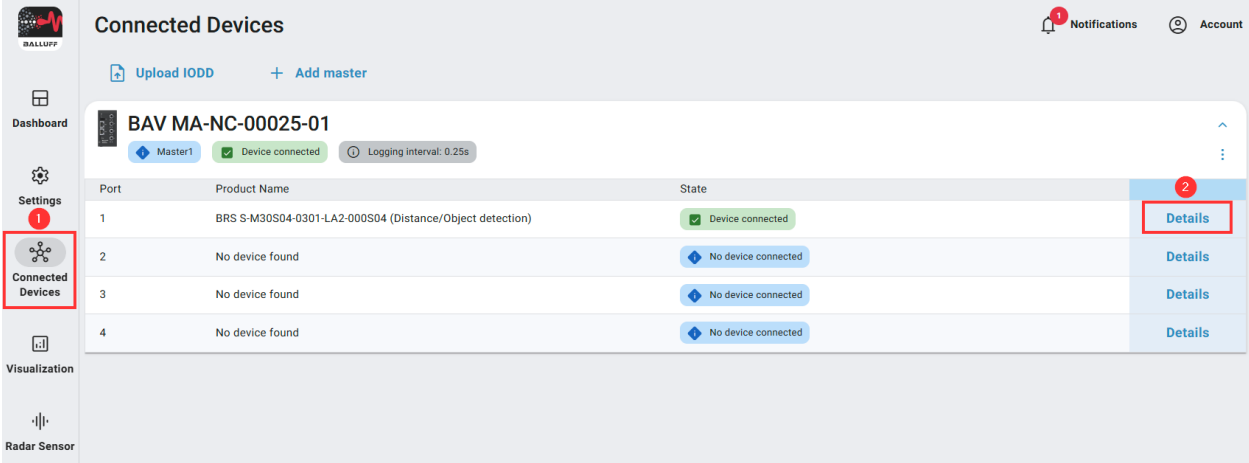
Balluff Engineering Tool (BET)

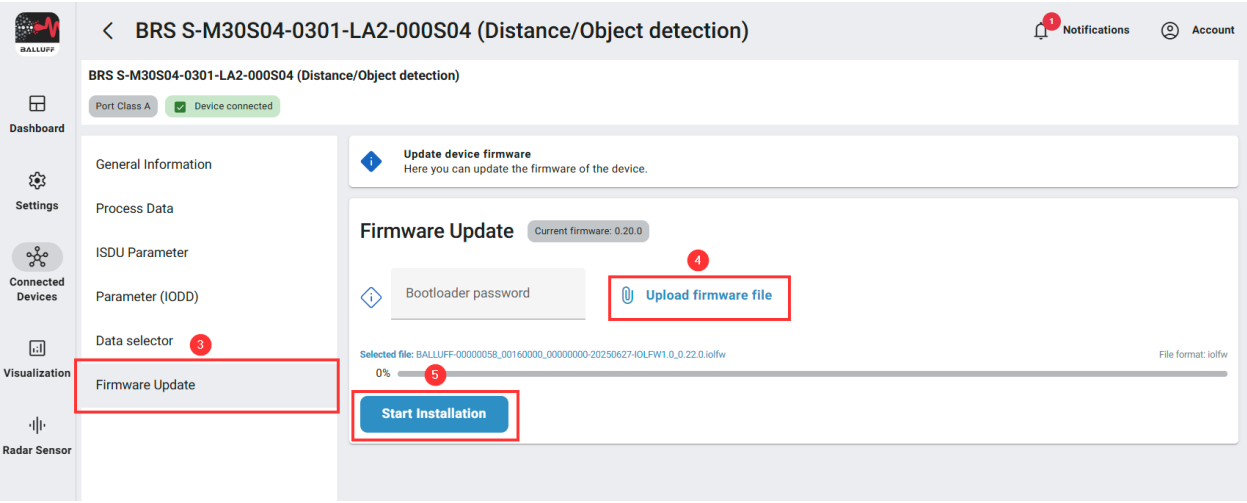
We recommend using the Balluff Engineering Tool for the system. A very simple integration of the Balluff Update Platform and the update mechanisms is implemented there. Documentation for the update via BET can be found here

Condition Monitoring Toolkit (CMTK)

The update process can be started from the device details page.

1. Click on “Connected Devices” on the left hand side
2. Click on “Details” of the sensor you would like to update
3. Select “ Firmware Update”
4. Select and upload an *.iolfw* update file via the “Upload firmware file” button
5. After an successfull upload start the installation on the sensor by clicking the “Start installation” button


Connected Devices
Notifications
Account
Upload IODD
Add master
Dashboard
Settings
1
Connected Devices
Visualization
Radar Sensor
BAV MA-NC-00025-01
Master1
Device connected
Logging interval: 0.25s
Port
Product Name
State
2
1
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Device connected
Details
2
No device found
No device connected
Details
3
No device found
No device connected
Details
4
No device found
No device connected
Details


BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Notifications
Account
BRS S-M30S04-0301-LA2-000S04 (Distance/Object detection)
Port Class A
Device connected
Dashboard
Settings
Connected Devices
Visualization
Radar Sensor
General Information
Process Data
ISDU Parameter
Parameter (IODD)
Data selector
3
Firmware Update
Update device firmware
Here you can update the firmware of the device.
Firmware Update
Current firmware: 0.20.0
4
Bootloader password
Upload firmware file
Selected file: BALLUFF-00000058_00160000_00000000-20250627-IOLFW1.0_0.22.0.iolfw
File format: iolfw
0%
5
Start Installation

Info

If the update fails, please repeat step 5 or contact the Balluff support.

Headquarters and Technical Service Hubs

www.balluff.com/go/contact

Headquarters and Technical Service Hub Region EMEA	**Technical Service Hub Region APAC**	**Technical Service Hub Region Americas**
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