ST27 Series

Safety Laser Scanner

OPERATING INSTRUCTIONS

Applicable models	ST27-03S / ST27-03D / ST27-03P ST27-05S / ST27-05D / ST27-05P
Product category	Type 3 electro-sensitive protective equipment (ESPE / AOPDDR)
Safety rating	Type 3 (IEC 61496) · SIL 2 (IEC 61508) · Cat. 3 / PL d (ISO 13849)
Document version	V1.0
Document number	ST27-UM-EN-V1.0

READ BEFORE USE

This product is a safety component intended for the protection of persons. Before installing, configuring, commissioning or servicing it, read these instructions in full — in particular Chapter 2 "Safety Information" and Chapter 10 "Installation and Safety Distance".

Incorrect installation, configuration or safety-distance calculation will render the protective function ineffective and may result in serious injury or death.

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1 About These Instructions

1.1 Scope

These operating instructions apply to all models of the ST27 series safety laser scanner: ST27-03S, ST27-03D, ST27-03P, ST27-05S, ST27-05D and ST27-05P. They describe the function, technical data, installation, electrical interfaces, configuration, commissioning, maintenance and troubleshooting of the product.

These instructions do not replace the laws, regulations and machine-safety standards applicable in the country of use, nor the machine manufacturer's own operating procedures. When integrating this product into a machine or vehicle, the integrator remains responsible for carrying out a risk assessment in accordance with ISO 12100 and for verifying, in accordance with ISO 13849-1 / IEC 62061, that the overall safety function achieves the required safety level.

1.2 Target Audience

These instructions are addressed to:

- Machine and AGV designers and safety engineers — responsible for selection, safety-distance calculation and safety-function design;
- Electrical installers — responsible for mechanical mounting and wiring;
- Commissioning personnel — responsible for field configuration, parameter setting and functional verification;
- Operating and maintenance personnel — responsible for daily checks, cleaning and periodic inspection.

1.3 Symbols Used in This Document

Symbol	Meaning
DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury, or could render the protective function ineffective.
NOTICE	Indicates a practice which may result in equipment damage, malfunction or misconfiguration.
NOTE	Provides supplementary information that helps in understanding or optimising the use of the product.

1.4 Parameters Marked with an Asterisk (*)

Parameters marked with an asterisk (*) in the technical data tables are safety-related parameters. They are used directly in safety-distance calculation and safety-function assessment, and these values must be used when performing the risk assessment and safety-distance calculation. The asterisked parameters are: safety output (OSSD), response time, and extension distance ZR.

2 Safety Information

2.1 Intended Use

The ST27 series safety laser scanner is an active opto-electronic protective device responsive to diffuse reflection (AOPDDR). Using laser time-of-flight (TOF) ranging and rotational scanning, it detects persons or objects entering a pre-configured protective field within a single plane and issues a stop command to the machine control system via its OSSD safety outputs.

The product may be used for:

- Hazardous area protection — horizontal mounting, detecting persons entering the hazardous area of a machine;
- Hazardous point protection — detecting body parts approaching a specific hazardous point;
- Access protection — vertical mounting, detecting persons passing through an access route;
- Travel-path and anti-collision protection for AGVs, AMRs, forklifts and other mobile equipment;
- Zone monitoring and staged warning in intelligent warehousing and human-robot collaboration workstations.

2.2 Improper Use

DANGER — The following uses will render the protective function ineffective

Do not use outdoors or in environments subject to rain, snow, fog or condensing dust. The enclosure rating is IP65, but frost or misting on the optics window causes false or missed detection.

Do not use in explosive or flammable atmospheres — this product has no explosion-protection approval.

Do not use to detect transparent, translucent or specular objects (glass, acrylic, polished metal, mirrors); such objects may not be reliably detected.

Do not use as the sole protective measure on machines that cannot be stopped within the response time due to inertia, gravity or stored energy (e.g. presses without brakes, gravity-falling loads).

Do not modify or disassemble the product, and do not obstruct or bypass the optics window or the safety outputs in any way.

Do not use for safety functions requiring more than SIL 2 / PL d. If the risk assessment requires SIL 3 / PL e, this product alone does not satisfy the requirement.

2.3 Personnel Qualifications

Only appropriately qualified personnel may carry out the following activities:

Activity	Required qualification
Selection and safety-distance calculation	Safety engineer trained in machine safety and familiar with ISO 12100, ISO 13849-1, ISO 13855 and IEC 61496.
Mechanical installation	Trained mechanical fitter, with the mounting position and orientation confirmed by a safety engineer.
Electrical installation and wiring	Qualified electrical technician familiar with safety control circuits and the requirements of these instructions.
Configuration and commissioning	Commissioning personnel trained by the manufacturer or its authorised agent and familiar with the configuration software and field-definition rules.

Activity	Required qualification
Acceptance and periodic inspection	Authorised competent person; records must be retained.
Daily checks	Operators trained for the task, following the checklist in Chapter 13.

2.4 Laser Safety

The ST27 series uses a pulsed laser source with a wavelength of 905 nm ± 10 nm, classified as a Class 1 laser product in accordance with IEC 60825-1:2014.

> **NOTE — Class 1 laser**
>
> A Class 1 laser is safe for the eye under all reasonably foreseeable conditions of use, including prolonged direct viewing. Laser protective eyewear is not required.
>
> Nevertheless, do not view the emission window directly through telescopes, magnifiers or other optical aids.
>
> Do not open the housing. Opening it exposes the rotating assembly and the laser source, the laser classification is no longer guaranteed, and all safety approvals and the warranty are immediately void.

2.5 Responsibilities of the Integrator and the User

1. Carry out a risk assessment of the machine or vehicle in accordance with ISO 12100 and determine the required safety level (PLr / SIL).
2. Confirm that the safety rating of the ST27 (Type 3 / SIL 2 / Cat. 3 / PL d) meets the requirement of the risk assessment.
3. Calculate and set the safety distance correctly in accordance with ISO 13855, taking into account the response time, extension distance ZR and tolerance zone TZ given in these instructions.
4. Ensure the OSSD safety outputs are correctly integrated into the machine's safety control circuit, and that this circuit is rated at least PL d / SIL 2.
5. Ensure the protective field cannot be circumvented, stepped over or crawled under; add mechanical guarding or supplementary protective devices where necessary.
6. Perform the initial commissioning acceptance and record the results in accordance with Chapter 12.
7. Perform periodic inspections at the intervals specified in Chapter 13 and retain the records.
8. Train the operating and maintenance personnel.

2.6 Limitation of Liability

The manufacturer accepts no responsibility for the safety function of the product in any of the following cases: use other than as specified in these instructions; installation, configuration or inspection by unqualified personnel; failure to calculate the safety distance in accordance with ISO 13855, or an insufficient safety distance; unauthorised modification, disassembly or repair; failure to perform inspection and maintenance at the specified intervals; use of accessories or cables not supplied or approved by the manufacturer.

3 Product Overview

3.1 Introduction

The ST27 series safety laser scanner is an "electronic safety officer" for industrial applications. Using millimetre-level laser ranging and 276° panoramic scanning, it builds a blind-spot-free protective net for AGVs, intelligent warehousing and human-robot collaboration, meeting the certification requirements of Type 3 (IEC 61496), SIL 2 (IEC 61508), Cat. 3 (ISO 13849) and PL d (ISO 13849).

The scanner continuously sweeps a 276° field of view in a single plane at 30 Hz with an angular resolution of 0.1°. When an object enters the user-configured protective field, the OSSD safety outputs switch from the ON state to the OFF state within the response time, triggering a machine stop or AGV braking.

3.2 Operating Principle

The product works on the laser time-of-flight (TOF) principle. An internal laser diode emits 905 nm laser pulses; the light is diffusely reflected by an object and part of the echo is captured by the receiver. By precisely measuring the time difference t between emission and reception, the distance D to the object is calculated as:

$$D = c \times t / 2$$

where c is the speed of light (approx. 3×10^8 m/s). The transmit and receive optics are mounted on a motor-driven rotating mirror assembly which sweeps the laser beam through the horizontal plane, producing a set of angle/distance polar data points across the 276° field of view — one contour frame.

The system compares each contour frame with the user-configured field boundaries: if a measured point falls inside the protective field, the field is judged to be infringed. To prevent single-point noise from causing nuisance trips, the decision uses a multi-frame confirmation strategy; the number of confirmation frames is linked to the response time.

Because ranging relies on diffuse reflection, detectability depends on the surface remission of the object. The scanning range of this product is specified at 1.8% remission (equivalent to black velvet, representing the most difficult clothing to detect) — the worst case in safety applications. Objects with higher remission are detected at greater distances.

3.3 Key Features

- New window-contamination indicator for easier maintenance — warns in advance when the optics window is dirty, avoiding unplanned downtime.
- Low power consumption extends equipment life and battery runtime — total consumption < 4 W (no load), with negligible impact on AGV battery endurance.
- High-precision measurement with angular resolution down to 0.1° for accurate recognition of the surroundings.
- Strong immunity to same-source optical interference — multiple units can operate simultaneously without mutual interference.
- Dual-mode protection architecture — freely switchable between PAA mode (protective field + two-stage warning) and PP mode (dual protective fields).
- Advanced field management — 64 vector field sets, 256 monitoring field sets, millisecond-level strategy switching (< 50 ms).
- Compact 80 × 80 × 79.5 mm housing weighing 405 g, easy to integrate into AGVs and equipment.

- Multiple interface options — PNP digital output, Ethernet, Profinet.

3.4 Typical Applications

Application	Description
AGV / AMR travel protection	Mounted at the front of the vehicle; the protective field size is switched dynamically with travel speed, giving staged protection — slow down at a distance, stop at close range.
Hazardous area protection	Mounted horizontally around a machine to detect persons entering the hazardous area and stop the machine.
Access protection	Mounted vertically at an access point to detect persons passing through.
Intelligent warehousing	Path protection and load-contour checking for stacker cranes and shuttles.
Human-robot collaboration	Two-stage warning provides flexible "slow on approach, stop on infringement" protection, reducing unnecessary stops.

4 Model Range and Ordering Information

4.1 Type Code

ST27 series type designations consist of three fields:

ST27 – 0X Y

Field	Value	Meaning
ST27	—	Product series: ST series 276° safety laser scanner.
0X	03	Protective field scanning range 3 m (@1.8% remission).
	05	Protective field scanning range 5 m (@1.8% remission).
Y	S	Standard: PNP digital output.
	D	Ethernet: PNP digital output + Ethernet.
	P	Profinet: Profinet communication.

4.2 Model Specification Table

The table below lists the parameters that differ between models. Safety rating, optical data, environmental data and dimensions are identical for all models; only the ranging capability and the communication interface differ.

Model	Output type	Scanning range (@1.8% remission)	Warning field range (@10% remission)	Measuring range (@70% remission)	Static input config.	Dynamic input config.	Contour detection	Max. static field sets	Max. monitoring field sets
ST27-03S	PNP	3 m	10 m	40 m	6 sets (12 pcs)	4 sets (8 pcs)	4 pcs	64	256
ST27-03D	PNP + Ethernet								
ST27-03P	Profinet								
ST27-05S	PNP	5 m	20 m	60 m					
ST27-05D	PNP + Ethernet								
ST27-05P	Profinet								

Certification body: TUV / Safenet.

> **WARNING — Scanning range and remission**
>
> The "scanning range" is a safety-related parameter specified at 1.8% remission, representing the worst case (deep black clothing). The safety-distance calculation must use this value (3 m or 5 m). Do not use the warning field range or the measuring range.
>
> The "warning field range" (@10% remission) is for the non-safety warning function only.

The "measuring range" (@70% remission) is the maximum range for contour measurement and navigation purposes and has no safety function.

4.3 Accessories

Items marked "default" are included with the scanner; other variants must be ordered separately.

Name	Model	Description
ST single-ended extension cable, 1 m	ST-BZM12-1M	Power cable (default)
ST single-ended extension cable, 2 m	ST-BZM12-2M	Power cable
ST double-ended extension cable, 2 m	M12-MSDX-2M	Double-ended extension cable
ST double-ended extension cable, 5 m	M12-MSDX-5M	Double-ended extension cable
M12 to RJ45 extension cable, 1 m	ST-RJ45YCX-1M	Network cable (default)
M12 to RJ45 extension cable, 2 m	ST-RJ45YCX-2M	Network cable
Mounting bracket	Contact us	L-shaped bracket, 116.0 × 93.0 × 90.0 mm

NOTE

The double-ended extension cables (M12-MSDX series) are optional and are used to extend the power/IO cable. When extension cables are used, check the voltage drop to ensure the voltage at the scanner remains within DC 24 V ± 20%.

5 Technical Data

5.1 Safety Data

Item	Value
Type	Type 3 (IEC 61496)
Safety integrity level	SIL 2 (IEC 61508)
Category	Cat. 3 (ISO 13849)
Performance level	PL d (ISO 13849)

5.2 Functional Data

Item	Value
*** Safety output (OSSD)**	PNP output (ON state: max. IOUT = 100 mA, VOUT ≥ VCC − 2 V; OFF state: IOUT < 1 mA, VOUT < 2 V), overcurrent protection, capacitive load ≤ 0.5 µF. ON when no object is in the protective field; OFF when an object is present or a fault occurs.
Auxiliary output	PNP output, max. IOUT = 100 mA, VOUT ≥ VCC − 2 V; OFF state: IOUT < 1 mA, VOUT < 2 V, overcurrent protection.
Laser source	Wavelength 905 nm, Class 1 laser product (IEC 60825-1:2014)
Scanning angle	276°
Angular resolution	0.1°
Distance deviation	±2 cm ①
Repeatability	±4 mm @ 1 sigma ②
*** Response time**	100 ms (configurable)
Object resolution	70 mm @ maximum radius of the protective field
Tolerance zone	65 mm (TZ = tolerance range of the safety laser scanner)
*** Extension distance ZR**	350 mm
Supply voltage	DC 24 V ± 20%
Power-up time	10 s (typical)
Scanning frequency	30 Hz
Power consumption	< 4 W (no load)
Dimensions	80 mm × 80 mm × 79.5 mm ③
Weight	405 g
Housing colour	Yellow

Item	Value
Ambient temperature	Operating: −10 °C to 50 °C (window free of frost and misting) Storage: −40 °C to 70 °C
Ambient humidity	Operating: 35% RH to 95% RH Storage: 35% RH to 95% RH
Enclosure rating	IP65
Ambient light immunity (incandescent)	3000 Lux
Vibration resistance	Frequency 10 Hz to 55 Hz, amplitude 0.35 ± 0.05 mm, 20 cycles in each of the X, Y and Z axes; 5M1 (IEC 60721-3-5) sinusoidal: 1.5 mm, 2 to 9 Hz
Shock resistance	Acceleration 10, pulse duration 16 ms, 1000 ± 10 shocks in each of the X, Y and Z axes; 5M1 (IEC 60721-3-5) 50 m/s², 11 ms
Electromagnetic compatibility (EMC)	EN 61326-1:2013 EN 61000-4-2:2009 EN 61000-4-3:2006+A1:2008+A2:2010 EN 61000-4-4:2004+A1:2010 EN 61000-4-6:2014 EN 61000-4-8:2010

5.3 Notes to the Technical Data

① Distance deviation

The measuring error across materials of differing remission is held within ±2 cm (typical). Factory test method: three specimens (black velvet, white paper, retro-reflective tape) are placed at different angles and at the same distance (59 cm) on the automated final-inspection fixture; the median value for each material deviates from the true distance by no more than ±2 cm, and the maximum difference between the three materials is within 2 cm.

② Repeatability

Statistically determined with 10% black velvet at a distance of 600 mm.

③ Dimensions

As given in the dimensional drawing: base 80 × 80 mm, overall height 79.5 mm.

5.4 Supplementary Notes

1. The response time is configurable. The configured value must be used in the safety-distance calculation and recorded in the acceptance record.
2. The extension distance ZR compensates for the measuring error caused by reflection. If a retro-reflector is located near the protective device (distance between the retro-reflector and the protective field ≤ 6 m), the extension distance must be taken into account: ZR = 350 mm.
3. The OSSDs are paired outputs. OSSD1.A and OSSD1.B form one OSSD pair; OSSD2.A and OSSD2.B form a second pair. "OSSD(s)" refers to one or two pairs (selectable by pin configuration).

5.5 Applied Standards

Standard	Subject
IEC 61496-1:2020	Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests (Type 3 ESPE)
IEC 61496-3:2019	Safety of machinery — ESPE — Part 3: Particular requirements for active opto-electronic protective devices responsive to diffuse reflection (Type 3 AOPDDR)
UL 61496-1:2021	Electro-sensitive protective equipment — General requirements and tests
IEC 61508-1 to 7:2020	Functional safety of electrical/electronic/programmable electronic safety-related systems (SIL 2)
IEC 62061	Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems
ISO 13855	Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body
IEC 61326-1	Electrical equipment for measurement, control and laboratory use — EMC requirements
EN 61326-1:2013	EMC requirements
EN 61000-4-2:2009	Electrostatic discharge immunity
EN 61000-4-3:2006+A1:2008+A2:2010	Radiated radio-frequency electromagnetic field immunity
EN 61000-4-4:2004+A1:2010	Electrical fast transient / burst immunity
EN 61000-4-6:2014	Immunity to conducted disturbances induced by radio-frequency fields
EN 61000-4-8:2010	Power-frequency magnetic field immunity
IEC 60825-1:2014	Safety of laser products — Equipment classification and requirements (Class 1)

5.6 Regarding the Certificates

IMPORTANT — Model designations on the certificates

The EMC type-approval and laser-class test certificates for this product are held by the original manufacturer. If you sell the product under the ST27 series designation, you must confirm that the type designations listed on the certificates include ST27-03S, ST27-03D, ST27-03P, ST27-05S, ST27-05D and ST27-05P.

If the certificates list only the original manufacturer's type designations, apply to the issuing body for an OEM model addition (multiple listing) and obtain a formal certificate listing the ST27 designations before release.

Under no circumstances may the type designations, numbers, certificate holder or any other content of a certificate be altered.

6 Design and Dimensions

6.1 Product Design

The product consists of a rotating scanner head, an optics window, the main housing, an indicator panel and the cable interfaces.

Component	Description
Rotating scanner head	The yellow rotating part on top, containing the rotating mirror assembly, which turns at 30 Hz during operation. Never touch or obstruct it while running.
Optics window	The annular transparent window below the scanner head, through which the laser is emitted and received. Must be kept clean — see Section 13.1.
Angle scale	The angle scale printed on top of the scanner head, used during installation to confirm the scan start angle and the field-of-view orientation.
Main housing	Yellow engineering-plastic housing — the standard colour for safety components.
Indicator panel	Eight LED indicators on the front panel — see Chapter 7.
Cable interfaces	Two 0.3 m pre-assembled cables exit the side of the housing — see Chapter 8.
Mounting holes	Mounting holes at the four corners of the housing for fixing to the equipment or to the bracket.

6.2 Dimensions

Unit: mm

Item	Dimension
Base, length × width	80 × 80 mm
Overall height	79.5 mm
Weight	405 g
Housing colour	Yellow

NOTE — Height of the scan plane

The scan plane lies at the centre height of the optics window. The detection height H used for installation must be the actual height of the scan plane above the floor, not the height of the underside of the housing. For this offset, refer to the dimensional drawing or request it from the manufacturer.

6.3 Bracket Dimensions

The ST scanner mounting bracket is an L-shaped sheet-metal bracket. Unit: mm

Item	Dimension
Length	116.0 mm
Width	93.0 mm

Item	Dimension
Height	90.0 mm

Both the base plate and the upright of the bracket have slotted holes, allowing the fore-and-aft position and the pitch angle of the scanner to be adjusted within a limited range to align the scan plane on site.

7 Indicators and Status Display

7.1 Indicator Layout

The front panel carries eight LED indicators arranged in two rows:

POWER	**OSSD1**	**OSSD2**	**ALARM**
CLEAN	**MOTOR**	**LASER**	**OTHER**

7.2 Indicator Functions

Indicator	Function	Description
POWER	Power status	Indicates DC 24 V supply and device operating status. Self-test and start-up take approx. 10 s after power-on.
OSSD1	Safety output 1 status	Indicates the state of the first OSSD pair (OSSD1.A / OSSD1.B). ON when the protective field is clear; OFF when an object is present or a fault occurs.
OSSD2	Safety output 2 status	Indicates the state of the second OSSD pair (OSSD2.A / OSSD2.B). Used only in PP dual-protective-field mode.
ALARM	Warning output status	Indicates infringement of a warning field. In PAA mode this corresponds to the ALARM1 / ALARM2 two-stage warning.
CLEAN	Window contamination	Optics window contamination warning. Lit or flashing means the window requires cleaning — see Section 13.1.
MOTOR	Motor status	Indicates the status of the rotating scanner motor. A fault indicates abnormal speed or motor failure.
LASER	Laser status	Indicates the status of the laser emission and reception path. A fault indicates an optical-path or light-source failure.
OTHER	Other faults	Indicates internal faults outside the above categories (self-test failure, configuration error, internal communication error, etc.).

8 Electrical Interfaces and Wiring

8.1 Interface Overview

Two pre-assembled cables exit the side of the housing:

Interface	Connector	Cable length	Purpose
Power / input-output interface	M12, 17-pin male	0.3 m	Supply, OSSD safety outputs, auxiliary outputs, field-switching inputs.
Network interface	M12, 4-pin female	0.3 m	Ethernet / Profinet communication and configuration (D and P variants only).

Both pre-assembled cables are connected to the equipment via extension cables:

Extension cable	Specification	Description
Power / single-ended extension cable	M12 17-pin male → 2 × GB1.25-8Y, cable Ø6.8 mm, standard length 1 m	M12 17-pin male at one end, two GB1.25-8Y terminals at the other. 1 m version (ST-BZM12-1M) supplied by default.
Double-ended extension cable (optional)	M12 male → M12 female, 2 m / 5 m	Used to extend the power/IO line.
Network extension cable	M12 4-pin male → RJ45, 4-core industrial network cable, Ø5 mm, standard length 1 m	1 m version (ST-RJ45YCX-1M) supplied by default.

8.2 Power / IO Interface Pin Assignment

The power / input-output interface is an M12 17-pin male connector with a 0.3 m cable. The complete pin assignment and core-colour table is given in the wiring diagram supplied with the product; contact us if you require an electronic copy.

DANGER — Wire only to the official pin assignment

Never guess the pin assignment or determine it by trial and error.

Mis-wiring the OSSD safety outputs renders the protective function completely ineffective, and this failure is invisible in appearance and in normal operation — the indicators light, the fields test normally, but the machine will not stop when a hazard occurs.

Before wiring, work from the wiring diagram supplied with the product and verify it against the actual cable core colours.

8.3 Network Interface Pin Assignment

M12, 4-pin female, D-coded (industrial Ethernet standard).

The other end of the network extension cable is a standard RJ45 connector, which can be plugged directly into a switch, an AGV controller or a commissioning PC.

8.4 OSSD Safety Outputs

The OSSDs (Output Signal Switching Devices) are the safety outputs of the product. Their electrical characteristics are:

Item	Value
Output type	PNP (active high)
ON state	Max. IOUT = 100 mA, VOUT ≥ VCC − 2 V
OFF state	IOUT < 1 mA, VOUT < 2 V
Protection	Overcurrent protection
Capacitive load	≤ 0.5 µF
Output logic	ON when the protective field is clear; OFF when an object is present or the device is faulty.
Paired outputs	OSSD1.A + OSSD1.B form one pair; OSSD2.A + OSSD2.B form a second pair.

WARNING — OSSD wiring requirements

Both signals of an OSSD pair must be connected to two independent channels of a safety controller or safety relay to achieve dual-channel redundancy. Never use only one of the two, and never connect the two in parallel.

The safety control circuit receiving the OSSD signals must be rated at least PL d / SIL 2; otherwise the overall safety function is downgraded to the rating of that circuit.

The OSSD outputs contain periodic test pulses (OFF test pulses) used to detect a welded output channel. The connected safety controller must tolerate these test pulses, otherwise nuisance trips will occur. Obtain the test-pulse width and period from the manufacturer.

Never use an OSSD to drive loads other than contactor coils rated for the purpose, and never feed an OSSD into a standard PLC input for a safety purpose.

8.5 Auxiliary and Warning Outputs

The auxiliary output is a PNP output with the same electrical characteristics as the OSSDs (max. IOUT = 100 mA, VOUT ≥ VCC − 2 V; OFF state: IOUT < 1 mA, VOUT < 2 V, overcurrent protection).

DANGER — The auxiliary output is not a safety output

The auxiliary output and the warning outputs (ALARM1 / ALARM2) have no safety function and are not safety-related outputs.

Never use the auxiliary output or the warning outputs for any safety function. They may only be used for non-safety purposes such as status indication, warning signalling and AGV speed reduction.

Only the OSSDs are safety outputs.

8.6 Field-Switching Inputs

The product provides static and dynamic inputs for switching between field sets during operation:

Input type	Quantity	Description
Static input configuration	6 sets (12 pcs)	Selects a static field set via the level combination of the static inputs. Suitable for fixed workstations where fields change with the process step.

Input type	Quantity	Description
Dynamic input configuration	4 sets (8 pcs)	Switches field sets dynamically. Suitable for AGVs that change protective field size with travel speed.
Contour detection settings	4 pcs	Configuration channels for the reference-contour detection function.

For the pin assignment, level requirements and combination-encoding rules of these inputs, refer to the wiring diagram supplied with the product (see Section 8.2).

WARNING — Safety requirements for field switching

The switching signals must come from a reliable source that genuinely reflects the actual operating state (e.g. a safe encoder or a safety PLC). An incorrect switching signal can select a small protective field while travelling at high speed, leaving the safety distance insufficient.

Every field set that can be selected must have its own safety-distance calculation and its own acceptance test.

Strategy switching has a switching delay (< 50 ms) which must be included in the total response time.

8.7 Cable Specifications

Cable	Diameter	Description
Power/IO pre-assembled cable (device)	—	M12 17-pin male, length 0.3 m
Network pre-assembled cable (device)	—	M12 4-pin female, length 0.3 m
Power / single-ended extension cable	Ø6.8 mm	M12 17-pin male → 2 × GB1.25-8Y, standard length 1 m
Network extension cable	Ø5 mm	4-core industrial network cable, M12 4-pin male → RJ45, standard length 1 m

- Route all cables separately from power cables (inverter outputs, motor cables), with a recommended separation of ≥ 200 mm, to avoid electromagnetic interference.
- Secure the cables properly to avoid repeated flexing and breakage on a moving AGV; observe the bending radius specified for the cable.
- Extension-cable connectors must be fully tightened, otherwise the IP65 rating is not achieved.
- When long cables are used, check the voltage drop to ensure the voltage at the scanner remains within DC 24 V ± 20%.

9 Protective Fields and Operating Modes

9.1 Field Concepts

Term	Definition
Protective field	The safety-related field. When an object enters it, the OSSDs switch to OFF immediately and the machine stops. The maximum radius is 3 m (ST27-03x) or 5 m (ST27-05x), specified at 1.8% remission.
Warning field	A non-safety field. When an object enters it, only the warning output (ALARM) is triggered; the OSSDs are not affected. Used for early warning or AGV speed reduction. Maximum radius 10 m (03 models) or 20 m (05 models), specified at 10% remission.
Field of view	The angular range the scanner can sweep: 276°. The remaining 84° is a blind zone and must face a direction that requires no protection (e.g. the vehicle interior or a wall).
Contour	The reference contour. Used to monitor a fixed background (wall, floor) for changes; it can detect that the protective field has been removed or that the scanner has been displaced.

9.2 Dual-Mode Protection Architecture

The product offers an industry-leading dual protection mechanism: PAA mode (protective field + two-stage warning) and PP mode (dual protective fields). The protection logic can be freely switched to suit AGV navigation, human-robot collaboration and other applications, supporting customised safety solutions under ISO 13849.

9.2.1 PAA Mode (Protective Field + Two-Stage Warning)

In PAA mode the scanner monitors three fields simultaneously, providing one OSSD pair and two warning outputs:

Field	Output	Typical use
Field 1 (innermost)	OSSD	Protective field. On infringement the OSSDs switch OFF and the machine stops / the AGV brakes.
Field 2 (middle)	ALARM1	First warning stage. The AGV slows to low speed.
Field 3 (outermost)	ALARM2	Second warning stage. The AGV slows to medium speed or an audible/visual warning is issued.

PAA mode suits AGV travel protection and human-robot collaboration: the staged "slow down at a distance, stop at close range" strategy substantially reduces unnecessary emergency stops while maintaining safety, improving throughput and equipment life.

9.2.2 PP Mode (Dual Protective Fields)

In PP mode the scanner monitors two independent protective fields, providing two independent OSSD pairs:

Field	Output	Typical use
Protective field 1	OSSD1	First hazardous area, triggering a stop independently.
Protective field 2	OSSD2	Second hazardous area, triggering a stop independently.

PP mode suits applications where two independent hazards must be controlled separately — for example one

scanner protecting two adjacent machines, or an AGV whose travel direction and fork direction are protected separately.

> **WARNING — Mode selection**
>
> PAA mode and PP mode cannot be enabled at the same time. After changing the operating mode, the safety-distance calculation and the acceptance test must be repeated for all fields.

9.3 Advanced Field Management

- 64 vector field sets: pre-stored templates of various shapes (sector / polygon / dynamic contour) that can be recalled per application.
- Scenario-based case configuration: field sets are bound to specific monitoring cases, building a staged protection scheme with up to 256 monitoring field sets.
- Millisecond-level strategy switching: protection strategies are loaded dynamically on a trigger condition, with a switching delay of < 50 ms.

Capability	Specification
Vector field library	64 sets
Max. configurable static field sets	64
Max. configurable monitoring field sets	256
Static input configuration	6 sets (12 pcs)
Dynamic input configuration	4 sets (8 pcs)
Contour detection settings	4 pcs
Strategy switching delay	< 50 ms
Field shapes	Sector / polygon / dynamic contour

9.4 Field Sets and Monitoring Cases

A field set is a collection of fields (protective field + warning fields) that are active at the same time. A monitoring case is the mapping "input condition → field set": when a specific input condition is satisfied (e.g. the AGV is in a particular speed band, or the process is at a particular step), the corresponding field set is activated.

Observe the following principles when configuring monitoring cases:

1. Enumerate every possible operating state and ensure that exactly one monitoring case is active in each.
2. Calculate the safety distance separately for every monitoring case and confirm that the protective field size for that case satisfies the result.
3. Define a default case: if the input conditions are invalid or contradictory, the system must fall back to the most conservative case (largest protective field), or drive the OSSDs to the OFF state.
4. During acceptance, test the switching and triggering of every monitoring case individually.

10 Installation and Safety Distance

10.1 Checks Before Installation

1. The risk assessment of the machine/vehicle (ISO 12100) is complete and the required performance level is PLr ≤ PL d, SIL ≤ 2.
2. The object resolution of 70 mm has been confirmed as adequate (leg detection typically requires ≤ 70 mm).
3. The stopping time of the machine / braking distance of the AGV is known for the safety-distance calculation.
4. The mounting position does not allow the protective field to be circumvented, stepped over or crawled under.
5. The site meets the requirements: −10 °C to 50 °C, 35% to 95% RH, no frost or misting, ambient light ≤ 3000 Lux.

10.2 Mounting Position and Orientation

- The 84° outside the 276° field of view is a blind zone. Mount the scanner so the blind zone faces a direction that requires no protection (vehicle interior, wall, machine body).
- The scan plane must be parallel to the intended detection plane. For horizontal mounting the scan plane must be parallel to the floor; tilt causes the protective field to rise at its far edge or to strike the floor.
- Use the angle scale on the scanner head to confirm the scan start angle and the field-of-view orientation during installation.
- The mounting surface must be sufficiently rigid to prevent vibration from shifting the scan plane.
- Leave sufficient clearance around the scanner so that the housing, bracket or vehicle structure does not intrude into the field of view and cause permanent obstruction.
- Avoid positions where the scanner is likely to be struck, covered by goods or stepped on.

10.3 Mounting Height

For horizontal mounting in hazardous area protection, the height H of the scan plane above the floor must satisfy:

Constraint	Explanation
H ≥ 15 × (d − 50)	d is the object resolution (70 mm), so H ≥ 15 × (70 − 50) = 300 mm. Below this height a person may pass beneath the scan plane undetected (crawling approach).
H ≤ 1000 mm	Above 1000 mm a person may crawl beneath the scan plane undetected.
Recommended value	Typically 150 to 300 mm (AGV) or 300 to 400 mm (stationary hazardous area protection), to be determined by the risk assessment.

WARNING — Supplementary measures for low mounting

Where the scan plane is lower than 300 mm (common on AGVs), other measures (vehicle skirts, mechanical guarding, additional sensors) must prevent persons from being run over beneath the scan plane, or the risk assessment must demonstrate that the residual risk is acceptable.

10.4 Safety Distance Calculation

DANGER — The safety-distance calculation is the integrator's responsibility

The formulae in this section are based on ISO 13855 and are provided as guidance only.

The actual safety distance must be calculated and verified by a qualified safety engineer for the specific application, based on a complete risk assessment and the standards applicable in the country of use, and must be verified by measurement on site.

An insufficient safety distance allows a person to reach the hazardous area before the machine has stopped, causing serious injury or death.

10.4.1 Stationary — Horizontal Protective Field (Hazardous Area Protection)

For a person approaching a horizontal protective field on foot, the safety distance S is:

$$S = K \times T + C + ZR + TZ$$

Symbol	Meaning and value
S	Safety distance (mm) — the minimum horizontal distance from the boundary of the hazardous area to the outer edge of the protective field.
K	Approach speed of the human body; for horizontal approach K = 1600 mm/s (ISO 13855).
T	Total response time (s), $T = t_1 + t_2$. t_1 = scanner response time (100 ms, configurable — the actual configured value must be used); t_2 = machine stopping time (supplied by the machine manufacturer, including the reaction of the safety controller and the actuators). If field switching is used, the strategy switching delay (< 50 ms) must also be included.
C	Additional distance (mm) compensating for the reach of the body before detection: $C = 1200 - 0.4 \times H$, with $C \geq 850$ mm. H is the height of the scan plane above the floor (mm).
ZR	Extension distance (mm) compensating for the measuring error caused by reflection. For this product ZR = 350 mm. Must be included when a retro-reflector is within 6 m of the protective field.
TZ	Tolerance zone (mm) — the tolerance range of the safety laser scanner. For this product TZ = 65 mm.

Worked example (to illustrate the formula only — do not apply directly)

Given: scan plane height H = 300 mm, scanner response time t_1 = 100 ms, machine stopping time t_2 = 200 ms, retro-reflective labels present within 6 m.

- T = 0.1 + 0.2 = 0.3 s
- K × T = 1600 × 0.3 = 480 mm
- C = 1200 − 0.4 × 300 = 1080 mm (≥ 850 mm, so 1080 mm is used)
- ZR = 350 mm; TZ = 65 mm
- S = 480 + 1080 + 350 + 65 = 1975 mm

The outer edge of the protective field must therefore be at least 1975 mm from the boundary of the hazardous area. Since the protective field radius of the ST27-03x is 3 m, this example is satisfied; if the required S exceeds the protective field radius of the model, use an ST27-05x or reduce the machine stopping time.

10.4.2 Stationary — Vertical Protective Field (Access Protection)

For a person passing through a vertical protective field:

$$S = K \times T + C + ZR + TZ$$

where K = 1600 mm/s. The additional distance C depends on the object resolution d; for access protection with d = 70 mm, C is typically 850 mm (body passage). The actual value must be determined in accordance with ISO 13855 and the risk assessment.

10.4.3 Mobile — AGV / AMR Travel Protection

The length of the protective field in the direction of travel, SL, is estimated as:

$$SL = v \times (t_1 + t_2) + SB + ZR + TZ + L$$

Symbol	Meaning and value
SL	Minimum length of the protective field in the direction of travel (mm).
v	Maximum travel speed of the AGV while this field set is active (mm/s).
t_1	Scanner response time (s), 100 ms (configurable — use the actual configured value). If dynamic field switching is used, include the switching delay (< 50 ms).
t_2	Reaction time of the AGV control system (s), from receipt of the OSSD signal to the brakes beginning to act.
SB	Braking distance (mm), measured at maximum speed, maximum load and worst floor conditions, with a margin for brake wear.
ZR	Extension distance, 350 mm. Retro-reflective labels and high-visibility vests are extremely common in warehouses, so this must normally be included.
TZ	Tolerance zone, 65 mm.
L	Distance from the scanner mounting position to the foremost point of the vehicle (mm). If the scanner is set back from the front, this distance must be compensated.

WARNING — Additional requirements for AGV applications

SL must be calculated and accepted separately for every speed band / field set.

The width of the protective field must cover the full width of the vehicle and allow for the swept envelope when cornering, including any overhanging load.

The braking distance SB must be measured, not calculated theoretically, and must be measured under the worst conditions (fully laden, maximum speed, most slippery floor).

The braking distance must be re-measured periodically — brake wear increases SB and can make a previously adequate protective field insufficient.

10.5 Reflectors and Background

Retro-reflectors (reflective labels, reflective tape, high-visibility vests, mirrored metal, polished floors) cause measurement errors and give rise to the extension distance.

- When a retro-reflector is within 6 m of the protective field, the extension distance ZR = 350 mm must be included in the safety distance.
- Remove retro-reflectors near the protective field and directly behind it wherever possible; where they cannot be removed, cover them or replace them with matt surfaces.

- The background behind the protective field should be a diffuse, matt surface to avoid specular reflection causing a "tunnel effect" or spurious measurement points.
- Reflective markers used for AGV navigation should be placed outside the scanner field of view, or more than 6 m from the protective field.

10.6 Multiple Scanners — Mutual Interference

The product has strong immunity to same-source optical interference and multiple units can operate simultaneously without interfering with one another. Even so, observe the following for best performance:

- Avoid mounting two scanners with their scan planes facing each other at the same height.
- If face-to-face mounting is unavoidable, offset the scan planes vertically (≥ 100 mm recommended) or angle the optical axes apart.
- Avoid placing the optics window of one scanner at the centre of another scanner's field of view.
- In aisles where AGVs pass each other frequently, stagger the scanner mounting heights.

10.7 Mechanical Installation Procedure

1. Disconnect the power supply.
2. Fix the L-shaped bracket to the mounting surface, leaving the fasteners slightly loose for adjustment.
3. Fix the scanner to the bracket through the housing mounting holes, ensuring the 276° field of view faces the area to be protected and the 84° blind zone faces the area that requires no protection.
4. Using a spirit level (or a laser alignment tool), adjust the level of the scan plane and the height H to meet the requirements of Section 10.3.
5. Using the angle scale on the scanner head, confirm that the scan start angle matches the actual mounting orientation.
6. Confirm that no housing, bracket, cable or vehicle structure causes permanent obstruction within the field of view.
7. Tighten all fasteners and secure them against loosening (thread-locking compound or lock washers) — this is particularly important in the vibrating environment of an AGV.
8. Record the final mounting height H, orientation and angular offset in the acceptance record.

11 Electrical Installation and Configuration

11.1 Wiring Precautions

- Disconnect all power before wiring and take measures to prevent inadvertent re-energisation (lock-out / tag-out).
- The supply must be a SELV / PELV safety extra-low voltage supply in accordance with IEC 60204-1, DC 24 V ± 20%.
- The supply must hold up under the worst operating conditions — in AGV applications, the voltage dip when the drive motors start can easily take the scanner outside its supply range and cause a reset.
- The two OSSD signals must be connected to two independent channels of the safety controller.
- Route all signal cables separately from power cables, with a separation of ≥ 200 mm.
- Earth the cable shield at one point on the equipment side to avoid earth loops.
- Tighten the connectors fully to maintain IP65.
- After wiring, verify every connection point — in particular, the OSSDs and the auxiliary outputs must not be interchanged.

11.2 Initial Power-Up

1. Confirm the wiring is correct, with no short circuits and correct polarity.
2. Switch on the DC 24 V supply.
3. Confirm the POWER indicator lights and the device begins its self-test, typically 10 s.
4. The OSSDs remain OFF during the self-test — this is normal.
5. After the self-test, with no object in the protective field, the OSSDs must switch ON and the OSSD indicators must light.
6. If the OSSDs do not switch ON, check for objects in the protective field, check the optics window is clean, and check for fault indications (see Chapter 14).

11.3 Configuration Software

Item	Value
Configuration software	The configuration software, its installer, the default IP address and the communication parameters are available from us on request.
Connection	Via the M12 4-pin network interface and the RJ45 extension cable to a PC (D and P variants). For the configuration method of the S variant, consult the manufacturer.

11.4 Configuration Procedure

1. Connect the scanner to the PC with the network extension cable and set the PC IP address to the same subnet as the scanner.
2. Start the configuration software, scan for and connect to the device, and verify the model and firmware version.
3. Select the operating mode: PAA (protective field + two-stage warning) or PP (dual protective fields).

4. Draw the fields: determine the protective field size from the calculation in Section 10.4, using a sector, polygon or dynamic contour.
5. Configure the field sets and monitoring cases, establishing the "input condition → field set" mapping, and define the default (most conservative) case.
6. Set the response time — a longer response time gives better interference immunity but a larger safety distance, and it must match the safety-distance calculation.
7. Configure the OSSD pin assignment (one or two pairs).
8. Download the configuration to the device and wait for it to restart and complete its self-test.
9. Read the configuration back and check it item by item against the design documentation.
10. Export the configuration report and checksum and file them with the device records.

WARNING — Configuration changes

Any configuration change (field size, response time, mode, monitoring case) affects the safety function. After any change, the full acceptance test in Chapter 12 must be repeated.

The configuration file and its checksum must be archived and placed under change control. At each periodic inspection, read the device configuration back and compare it with the archived file to confirm it has not been altered without authorisation.

12 Commissioning and Acceptance

12.1 When Acceptance Is Required

A full acceptance check must be performed: after initial installation and commissioning; after any configuration change; after replacement or repair of the device; after any change of mounting position or orientation; after any change to the machine stopping time or AGV braking distance; and after any anomaly found during periodic inspection.

12.2 Acceptance Checklist

No.	Check	Result	Remarks
1	Device model matches the order; type label intact and legible.	□Pass □Fail	
2	Mounting position and orientation correct; 84° blind zone faces an area requiring no protection.	□Pass □Fail	
3	Scan plane level (or at the designed tilt); height H = _____ mm, complying with Section 10.3.	□Pass □Fail	
4	No permanent obstruction (housing, bracket, cable, vehicle structure) within the field of view.	□Pass □Fail	
5	Optics window clean, free of scratches and misting.	□Pass □Fail	
6	Fasteners tightened and secured against loosening.	□Pass □Fail	
7	Supply voltage measured _____ V, within DC 24 V ± 20% (including worst-case conditions).	□Pass □Fail	
8	Both OSSD channels connected to two independent channels of the safety controller.	□Pass □Fail	
9	Safety control circuit rated ≥ PL d / SIL 2.	□Pass □Fail	
10	Safety controller tolerates the OSSD test pulses without nuisance trips.	□Pass □Fail	
11	Auxiliary / warning outputs are not used for any safety function.	□Pass □Fail	
12	Configuration read back and identical to the design documentation; checksum _____.	□Pass □Fail	
13	Configured response time _____ ms, matching the value used in the safety-distance calculation.	□Pass □Fail	
14	Machine stopping time / AGV braking distance measured _____, matching the value used in the calculation.	□Pass □Fail	
15	Safety-distance calculation on file, S = _____ mm; the actual field boundary meets the requirement.	□Pass □Fail	
16	Tested along the protective field boundary with a 70 mm test piece; the OSSDs switch OFF reliably at every point.	□Pass □Fail	
17	Tested in all directions (near, far, left, right, boundary); no detection blind spots.	□Pass □Fail	

No.	Check	Result	Remarks
18	Switching and triggering of every monitoring case / field set tested individually.	□Pass □Fail	
19	On invalid or contradictory switching inputs, the system falls back to the most conservative case or the OSSDs switch OFF.	□Pass □Fail	
20	Covering the optics window puts the device into a fault state and the OSSDs switch OFF.	□Pass □Fail	
21	Disconnecting the scanner supply switches the OSSDs OFF and stops the machine.	□Pass □Fail	
22	The protective field cannot be circumvented, stepped over or crawled under.	□Pass □Fail	
23	Retro-reflectors within 6 m identified; ZR = 350 mm included in the safety distance.	□Pass □Fail	
24	No mutual interference where several scanners coexist (observed for ≥ 30 min).	□Pass □Fail	
25	After a restart the device returns automatically to the correct configuration and normal operation.	□Pass □Fail	
26	Operating and maintenance personnel have been trained.	□Pass □Fail	
27	These instructions and the configuration report are filed and available on site.	□Pass □Fail	

Inspector	Qualification / cert. no.	Date	Signature
Approved by			

12.3 Interruption Test Method

Use a standard opaque test piece 70 mm in diameter and at least 300 mm long (matt black surface, simulating the worst-case remission):

1. Perform the test with the machine stopped (or the AGV stationary) to ensure the safety of the tester.
2. Insert the test piece vertically into the scan plane along the protective field boundary at a speed no greater than 1.6 m/s.
3. Select at least three test points each at the near edge, far edge, left boundary, right boundary and centre of the protective field.
4. At each test point, confirm that the OSSDs switch OFF, the OSSD indicators extinguish and the machine stops.
5. After withdrawing the test piece, confirm that the OSSDs return to ON (if configured for automatic restart) or require a manual reset (if configured for manual restart).
6. Record all test points and results.

13 Maintenance and Periodic Inspection

13.1 Cleaning the Optics Window

Contamination of the optics window is the most common cause of faults in a safety laser scanner. Dust, grease or scratches on the window significantly reduce the detection range, especially for low-remission (1.8%) dark objects — exactly the worst case on which the safety distance is based.

> **WARNING — CLEAN indicator**
>
> A lit or flashing CLEAN indicator means the window is contaminated to the point of affecting detection performance and must be cleaned immediately. Never continue operating by masking or ignoring this warning.

Cleaning procedure

1. Stop the machine or AGV and disconnect the scanner supply; wait until the scanner head has stopped rotating.
2. First blow off loose dust and particles with clean compressed air (oil-free, water-free) — wiping directly would drag hard particles across the window and scratch it.
3. Wipe gently in a circular direction with a clean, soft, lint-free cloth (lens cloth) moistened with a little neutral detergent or isopropyl alcohol.
4. Dry with a dry lint-free cloth and confirm no streaks or residue remain.
5. Restore power and confirm that the CLEAN indicator has gone out and the OSSDs operate normally.

- Never use organic solvents (acetone, toluene, petrol) or strongly acidic or alkaline cleaners — they attack the window material.
- Never use rough cloths, paper towels, brushes or abrasives.
- Never clean with a high-pressure water jet — IP65 does not mean resistance to high-pressure jets.
- If the window is scratched, cracked or permanently hazed, the complete device must be replaced; it must not remain in use.

13.2 Inspection Intervals

Interval	Performed by	Content
Every shift / daily	Operator	Visually check that the optics window is clean; confirm the POWER and OSSD indicators are in the normal state; confirm there is no CLEAN / MOTOR / LASER / OTHER fault indication; confirm the scanner shows no impact damage or displacement.
Weekly	Operator	Perform a simple interruption test with the test piece (at least three points on the protective field boundary) and confirm the OSSDs switch OFF reliably.
Monthly	Maintenance personnel	Check the fasteners for looseness; check the cables for abrasion and the connectors for looseness; clean the optics window; check for new obstructions or retro-reflectors within the field of view.
Every six months	Maintenance personnel	Measure the machine stopping time / AGV braking distance and compare with the value used in the safety-distance calculation; if it has changed, the safety distance must be recalculated.

Interval	Performed by	Content
Annually	Authorised competent person	Perform the full acceptance check in Section 12.2; read back and verify the device configuration and checksum; review whether the risk assessment and safety-distance calculation are still valid; retain the inspection record.
After any change	Authorised competent person	Perform the full acceptance check in Section 12.2.

NOTE — Retention of records

All inspection records should be retained for at least three years after the device is taken out of service, or longer where required by the regulations of the country of use. These records are essential evidence in accident investigation and compliance audits.

13.3 Serviceability

- The product is maintenance-free and contains no user-replaceable parts.
- Never open the housing. Opening it immediately and irrecoverably voids all safety approvals, the laser classification and the warranty.
- In the event of a fault, the complete device must be replaced or returned to the factory; it must not be repaired on site.
- After replacing a device, the configuration must be reloaded and the full acceptance check in Chapter 12 performed.

13.4 Service Life

Item	Value
Functional safety data (TM / PFHd / MTTFd / DC)	Available on request, for the machine-level PL / SIL calculation.

NOTE

In accordance with ISO 13849-1, the mission time of a safety component is typically 20 years, after which it must be replaced whether or not it still appears to function.

14 Troubleshooting

14.1 Symptoms and Remedies

Symptom	Possible cause	Remedy
POWER indicator does not light	No supply; broken cable; loose connector; reversed polarity.	Measure the voltage at the scanner and confirm it is within DC 24 V ± 20%; check the cable and connectors; verify the polarity.
OSSDs remain OFF after power-up	Object in the protective field; still within the 10 s self-test; a fault is present; configured for manual restart and not yet reset.	Clear the protective field; wait for the self-test to finish; check the CLEAN / MOTOR / LASER / OTHER indicators; perform a manual reset.
CLEAN indicator lit	Optics window contaminated.	Clean the window as described in Section 13.1.
MOTOR indicator abnormal	Rotational speed abnormal or motor fault; scanner head obstructed.	Switch off and check whether the scanner head is obstructed or fouled; if the fault persists, return the device for repair.
LASER indicator abnormal	Light source or receive path fault; window severely contaminated or scratched.	Clean the window first; if the fault persists, return the device for repair.
OTHER indicator abnormal	Internal self-test failure; configuration error; internal communication error.	Read back and verify the configuration; download it again; if the fault persists, return the device for repair.
Detection range noticeably reduced	Window contaminated; target remission lower than specified; ambient light above 3000 Lux; window misting.	Clean the window; confirm the target remission; improve the ambient light; confirm the operating temperature and humidity to avoid misting.
Intermittent nuisance trips	Intermittent obstruction in the field of view (flapping material, steam, dust); spurious points from retro-reflectors; safety controller does not tolerate the OSSD test pulses; momentary supply dips.	Investigate intermittent obstructions; remove or mask retro-reflectors; confirm the controller tolerates the test pulses; measure the supply voltage under worst-case conditions.
Cannot connect the configuration software	IP address not on the same subnet; faulty cable or connector; the S variant has no network interface.	Check the IP settings; test with a different cable; confirm whether the model has a network interface.
Several scanners interfere with each other	Scan planes face each other or meet at the same height.	Offset the mounting heights (≥ 100 mm) or angle the optical axes apart.

14.2 Repair and Technical Support

Before contacting technical support, please have the following ready to speed up handling: model and serial number; firmware version; the symptom and the indicator states; how often it occurs and under what conditions; the configuration file and checksum; photographs or video from site; a description of the installation environment (temperature, humidity, ambient light, presence of retro-reflectors).

Item	Value
Technical support telephone	_____
Technical support e-mail	_____
Return address	_____
Warranty period	_____

DANGER — A faulty device must not remain in use

Under no circumstances may a safety laser scanner showing a fault indication continue to be used for the protection of persons.

Never "restore" operation by bridging the OSSDs, masking the fault or bypassing the safety circuit.

Until the device has been repaired and has passed the acceptance check in Chapter 12, other measures (shutdown, isolation, manual supervision) must be taken to ensure the safety of persons.

15 Transport, Storage and Disposal

15.1 Transport and Storage

Item	Requirement
Storage temperature	−40 °C to 70 °C
Storage humidity	35% RH to 95% RH
Packaging	Transport in the original packaging or equivalent shock-absorbing packaging; the optics window must be protected.
Stacking	Do not place heavy loads on the device; housing deformation would displace the optical system.
Environment	Store in a dry place, free of corrosive gases and strong vibration.
After cold storage	After removal from a cold environment, allow the device to reach the ambient temperature of the operating environment before switching on, to avoid condensation on the window.

15.2 Disposal

- The product must be taken out of service and replaced once it reaches its mission time (TM), even if it still appears to work normally.
- Dispose of the product as electronic waste (WEEE) in accordance with local regulations; do not discard with household waste.
- The housing is engineering plastic and the interior contains electronic components and a laser diode; hand the device to an authorised recycling organisation.
- Decommissioned devices should be clearly marked or physically destroyed to prevent them being mistaken for serviceable units and returned to protective duty.

16 Appendices

Appendix A Glossary

Abbreviation	Full term	Meaning
AOPDDR	Active Opto-electronic Protective Device responsive to Diffuse Reflection	The device category of this product.
ESPE	Electro-Sensitive Protective Equipment	The equipment class defined in IEC 61496.
OSSD	Output Signal Switching Device	The safety output.
PL	Performance Level	Performance level as defined in ISO 13849.
PLr	Required Performance Level	The performance level required by the risk assessment.
SIL	Safety Integrity Level	Safety integrity level as defined in IEC 61508.
PFHd	Probability of Dangerous Failure per Hour	Used in the quantitative safety calculation.
MTTFd	Mean Time To Dangerous Failure	Used in the ISO 13849-1 calculation.
DC	Diagnostic Coverage	The proportion of dangerous failures detected by diagnostics.
TM	Mission Time	The service life of a safety component.
TOF	Time of Flight	The ranging principle used by this product.
ZR	Extension distance	Supplement for the measuring error caused by reflection.
TZ	Tolerance Zone	The ranging tolerance range.
PAA	Protection + Alarm + Alarm	Protective field plus two-stage warning mode.
PP	Protection + Protection	Dual protective field mode.
Field set	—	A group of fields active at the same time.
Monitoring case	—	The mapping "input condition → field set".

Appendix B Safety Distance Calculation Record

No.	Item	Value	Source / basis
1	Monitoring case / field set number		
2	Application type (horizontal / vertical / AGV)		

No.	Item	Value	Source / basis
3	Approach speed K or travel speed v		ISO 13855 / measured
4	Scanner response time t_1 (ms)		Configured value
5	Strategy switching delay (ms)		< 50 ms
6	Machine stopping time / AGV reaction time t_2 (ms)		Measured
7	Braking distance SB (mm) (AGV)		Measured (full load, max. speed)
8	Scan plane height H (mm)		Measured
9	Additional distance C (mm)		C = 1200 − 0.4H, ≥ 850
10	Extension distance ZR (mm)	350	Section 5.2
11	Tolerance zone TZ (mm)	65	Section 5.2
12	Scanner to front of vehicle L (mm)		Measured
13	Calculated safety distance S / SL (mm)		Formula in Section 10.4
14	Protective field size actually configured (mm)		Configured value
15	Conclusion (actual ≥ calculated?)	□Yes □No	
16	Calculated by / date		
17	Approved by / date		

Appendix C Revision History

Version	Date	Changes	Prepared by
V1.0		First release.	

Disclaimer

The technical data in these instructions is based on the product documentation supplied by the manufacturer. The manufacturer reserves the right to modify the product and these instructions without prior notice.

These instructions do not replace the applicable laws, regulations and standards, nor the machine manufacturer's operating procedures, nor the risk assessment and safety validation that the integrator must carry out.