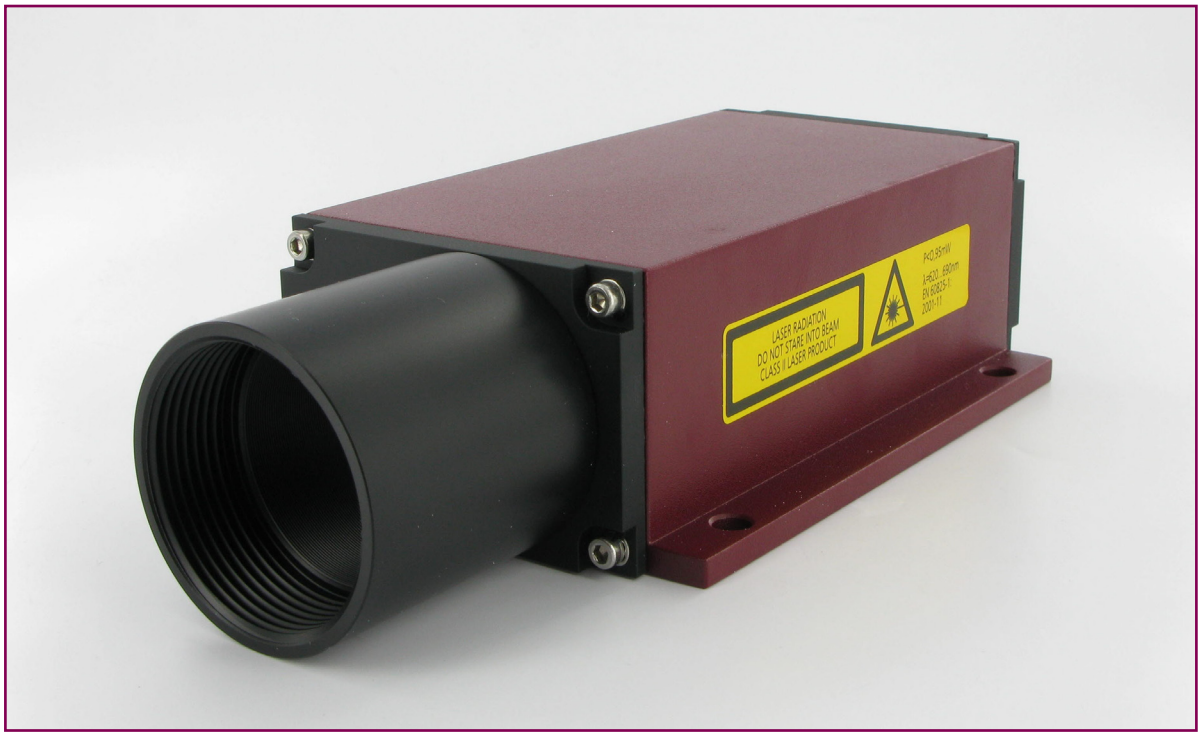
Sensor Partners

Laser Distance Meter SP LAM 53



User Manual

You are advised to carefully read this User Manual before powering on the SP LAM 53 laser distance measuring module for the first time.
This is necessary to ensure that you will be able to utilize all the capabilities and features which your new acquisition provides.
This technology is subject to continuously ongoing development.

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For highlighting purposes, the following pictograms, signs of reference and warning symbols are used throughout this Manual:

- • Enumeration
- ☞ Advice/Important/Important Note
- → Reference (to a passage of text or a Figure)

Warning symbols

Warning: Indicates potential health risks that may occur if symbols of this type are disregarded.

Caution: Warns of potential product damage.

Laser: Warns of potential exposure to emerging visible or invisible laser radiation.

Information: Provides a reference to important data or details.

1 General

The SP LAM 53 is an opto-electronic distance measuring module for industrial applications.
Equipped with a Profibus® DP interface, the SP LAM 53 can easily be integrated into any fieldbus-driven process controller.
The additional SSI interface provides another convenient option for controlled operation of the measuring module.
A compact and robust design shape combines with low power consumption, selectable switching outputs and the possibility to set specific application parameters to warrant flexibility in use.

You should not start using the SP LAM 53, unless you have read this User Manual and familiarized yourself with all safety notes contained in it. This is necessary to ensure that your opto-electronic distance measuring module can be used in the best possible way and damage will be prevented.

2 Safety Instructions

2.1 Basic Notes

These safety and operating instructions should be carefully read and followed during practical work with the SP LAM 53.

There is danger of laser radiation or electrical shock.
For necessary repair work, the SP LAM 53 may not be opened by anyone other than Manufacturer personnel. Unauthorized intervention into the inner product space will void any warranty claims.

Compliance with all specified operating conditions is necessary.
Failure to observe advisory notes or information contained in this Manual or non-conforming product usage may cause physical injury to the user or material damage to the SP LAM 53. Cable connectors must not be plugged or unplugged, as long as voltage is supplied. Remember to turn voltage supply off before you begin working on cable connections.

2.2 Laser Classification

The LAM51/52 is a class 2 laser product as stipulated in IEC825-1/DIN EN 60825-1:2001-11 and a class II product under FDA21 CFR. In the event of accidental, short-time laser exposure, the human eye is sufficiently protected by its own optico-facial winking reflex. This natural reflex may be impaired by medication, alcohol and drugs. Although the product can be operated without taking special safety precautions, one should refrain from directly looking into the laser beam. Do not direct the laser beam onto persons.

Caution:
There is class 2 laser radiation. Do not look into the beam!

2.3 Electric Supply

Use only 10 V to 30 V direct voltage for SP LAM 53 operation. Use only the specially designated connector terminal for voltage supply. Specified signal levels must not be exceeded, in order to guarantee correct data communication.

2.4 Important Operating Advice

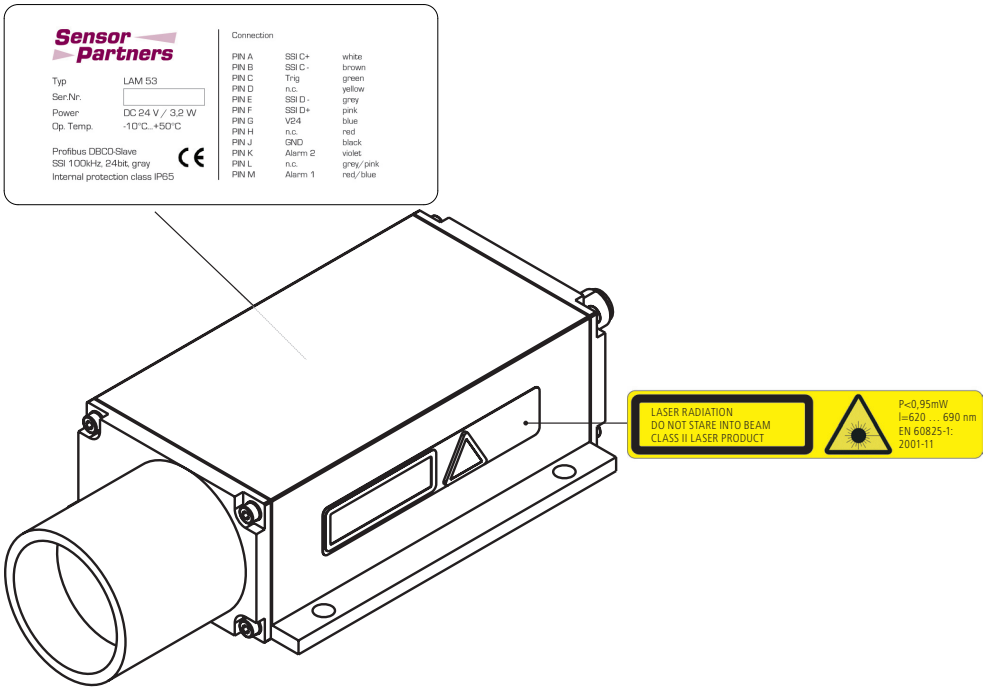
To make full use of the system's inherent performance capabilities and achieve a long service life, you should always follow these operating rules:

- Do not turn the SP LAM 53 on if there is fogging or soiling on its optical parts!
- Do not touch any of the module's optical parts with bare hands!
- Proceed with care when removing dust or contamination from optical surfaces!

- Prevent exposure to shock impacts during transportation of the SP LAM 53!
- Prevent overheating of the SP LAM 53!
- Prevent major temperature variances during SP LAM 53 operation
- In accordance with IP65 internal protection standards, the SP LAM 53 is designed to be splashproof and dustproof.

Read these safety and operating instructions with due care and follow them in practical use.

2.5 Danger Signs & Specification Plates



3 Intended & Conforming Use

3.1 General Product Description

The SP LAM 53 is a laser distance measuring module to determine distances from 0.1 m to 30 m, using natural surfaces, or to measure distances up to 150 m with a target reflector. Providing a red laser sighting point, the SP LAM 53 allows you to unequivocally mark a particular target. Its effective operating range depends on the reflectance and surface qualities of the targets being sighted.
The module works based on comparative phase measurement. It emits modulated high-frequency light which is diffusely reflected back from the target with a certain shift in phase to be compared with a reference signal. From the amount of phase shift, a required distance can then be determined with millimeter accuracy.

A distance measurement cycle can be triggered:

- via the Profibus
- from an external trigger source (external trigger mode)
- via the SSI.

Special performance features are:

- Profibus interface
- Broad range of parameter setting options via Profibus
- SSI interface
- Two switching outputs, each with selectable parameter settings
- External trigger input, with selectable parameter settings
- Capable of operating at outdoor temperatures from +15°C to +30°C with ±2 mm accuracy
- Up to 30 m reach for distance measurement, with potential for 150 m reach if additional reflectors are mounted onto the target
- Visible laser beam for easier sightingl.

The SP LAM 53 measuring module is shipped in a rugged cardboard box with adequate padding for safe transportation.

3.2 Conforming Use

- Measurement of distances and output of measured data to the Profibus.
- Special measuring functions.
- Compliance with prescribed temperatures for operation and storage.
- Operation at correct voltage level.
- Application of specified signal levels to the appropriate data lines.

3.3 Nonconforming Use

- Do not operate the SP LAM 53 in any other way than described under “Intended & Conforming Use“ above and only in a proper working condition.
- Safety devices must not be defeated or otherwise rendered ineffective.
- Information and warning signs must not be removed.
- Repair work on the SP LAM 53 must not be carried out by anyone other than JENOPTIK personnel.
- Refrain from using the SP LAM 53 in an explosive environment.
- Measurement with the SP LAM 53 pointed at the sun or other strong light-sources may produce faulty results.
- Measurement of targets with poor surface reflectance in a strongly reflecting environment may also result in faulty measurement values.
- Measurement of strongly reflecting surfaces may deliver faulty results.
- Measurement performed through transparent optical media, for example, glass, optical filters, plexiglass, etc. may equally produce incorrect results.
- Rapidly changing measuring conditions are likely to falsify the result of measurement.

4 Product Description

4.1 Scope of Delivery

Description	Part number
SP LAM 53	012840-530-22
CD with Customer documentation	
Optional accessories	
Power chord, 2 m	012840-144-24
Power chord, 5 m	012840-145-24
Power chord, 10 m	012840-146-24
12-pole jack	28509
Profibus terminator, M12	94145
Profibus 5-pole jack	94136
Profibus 5-pin plug	94133
Profibus-in-out cable, 5m	012840-170-24
Profibus-in cable jack, 5m	012840-165-24
Profibus-in cable jack, 10m	012840-166-24
Profibus-out cable plug, 5m	012840-160-24
Profibus-out cable plug, 10m	012840-161-24
Screw cap for Profibus jack	95363
Screw cap for Profibus plug	95366
Set of Customer documentation (hardcopy)	

4.2 Technical Data

Measuring Performance	
Measuring principle	Comparative phase measurement
Measuring parameter	Distances
Measuring range [*1]	0.1 m ... 30 m for natural, diffusely reflecting surfaces, and up to 150 m with a target board
Measuring accuracy	± 2 mm for white surfaces, (+15 °C ... +30 °C) ± 3 mm for natural surfaces, (+15 °C ... +30 °C) ± 5 mm (-10 °C ...+50 °C)
Target surface	Of natural, diffusely reflecting type
Target board required	From 30 m to 150 m
Measured value resolution	0.1 mm
Reproducibility	≤ 0.5 mm
Measuring time	0.16 sec ... 6 sec on white target board (10 Hz mode) 20 msec on white target board (50 Hz mode)
Max. carrier motion speed	4 m p. sec in “DX” operating mode
[*1] conditional on target reflectance, ambient light influences and atmospheric conditions	

Laser	
Laser class	Laser class 2, ≤ 1 mW conforming to standard IEC 825-1 / EN 60825
Laser beam divergence	0.6 mrad
Wavelength	650 nm (red, visible)
Electric Power Requirements	
Supply voltage	10 V ... 30 V DC
Max. power consumption	3.2 W at 24 V
Interface	
Data interface	Profibus RS485 Ident. no. 0x09CB Profibus DP-V0 slave under IEC 61158 / IEC 61784 External termination resistor
Baud rate	9.6 / 19.2 / 93.75 / 187.5 / 500 kbaud 1.5 / 3 / 6 / 12 Mbaud Automatic baud rate detection
GSD file	LAM409CB.GSD PNO Profile Encoder Class 1/2 Configuration of measuring parameters Output of measured values and error messages Parameters and PB-address are stored in NVRAM
SSI interface	Transfer rate: 50 kHz ... 1 MHz, 200 µs break Signal input to signal output differential signal (RS422), 24bit, gray-encoded, Slave Electrical isolation to 500 V for signal input
Operation modes	Continuous measurement external triggering
Switching output	Two outputs with HIGH signal level VCC -2 V and LOW signal level < 2 V; max. load carrying capacity 0.5 A, short-circuit-proof; switching threshold and hysteresis selectable
Trigger input	One input with HIGH signal level > 11 V and LOW signal level < 6.5 V 2.5 mA input current at 24 V Trigger edge and delay selectable Trigger pulse of max. 24 V
Environment & Ambient Conditions	
Operating temperature	-10 °C ... +50 °C with automatic laser diode shut down on excession of temperature limits
Temperature measurement	Internal
Storage temperature	-20 °C ... +70 °C
Humidity	< 65%
Dimensions (L x W x H)	210 mm x 96 mm x 50 mm
Weight	770 g
Protection type	IP 65
EMC	EN 61000-6-2, EN 55011

4.3 Mechanical Mounting Conditions

The casing consists of a rugged, corrosion-resistant extruded aluminum profile with front-side and rear-side covers also in corrosion-resistant design. Four mounting holes are provided in the baseplate for mechanical attachment of the SP LAM 53. (→ Fig. 2 Dimensional drawing).

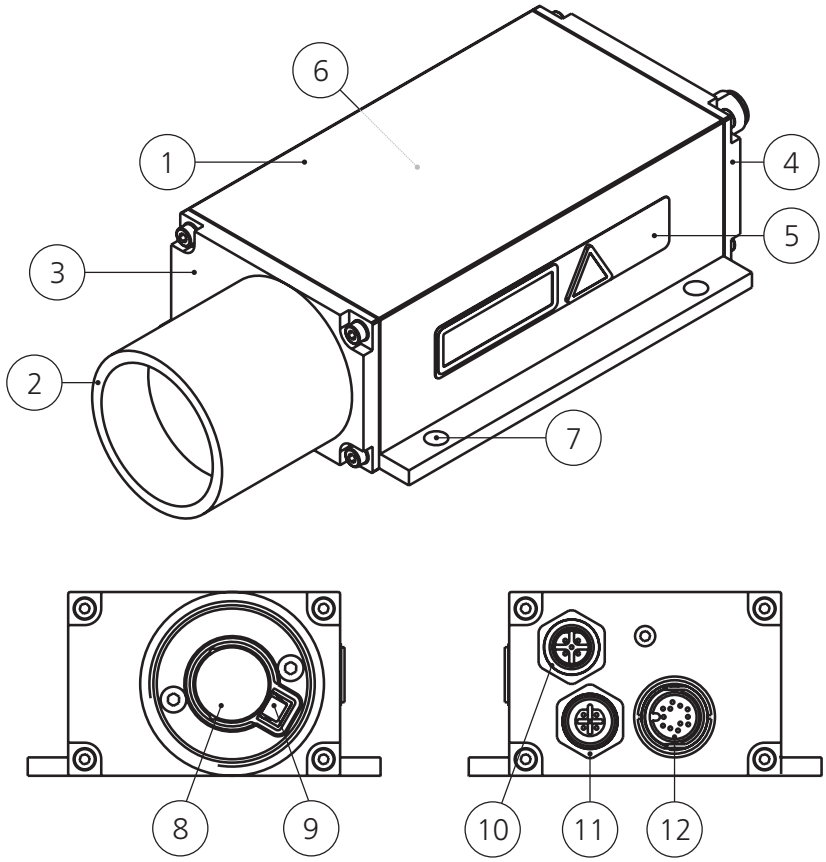


Fig. 1: SP LAM 53

Captions

1	Housing (extruded aluminum profile, powder-coated)	7	Mechanical mounting holes (4x, Ø = 6,6 mm)
2	Equalizer tube (anodized)	8	Receiver optics
3	Front cover (anodized)	9	Sender optics
4	Back cover (anodized)	10	Profibus-IN (M12)
5	Laser warning sign	11	Profibus-OUT (M12)
6	Specification plate	12	Power inlet

To protect the range finder's optical surfaces from dust, physical contact, mechanical impacts, etc., the casing has a special equalizer tube attached to it. Please note that measurement cannot be guaranteed to function correctly if the equalizer tube is removed by unqualified action!

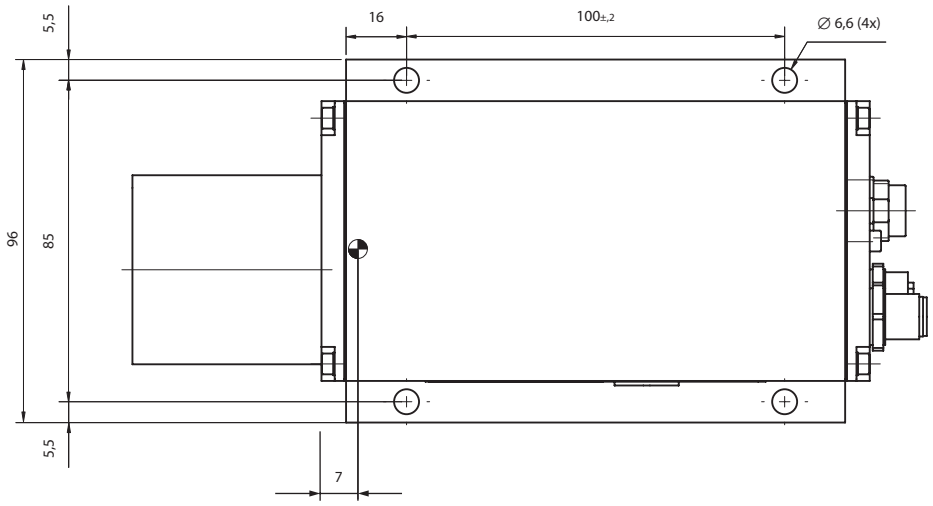


Figure 2 Offset against zero-edge (Dimensions in mm)

The SP LAM 53's zero-point is located 7 mm behind the outer surface of the front cover or 137 mm before the back cover outside face respectively. This zero-point has been introduced for constructional design reasons.

4.4 Connector Pin Assignments

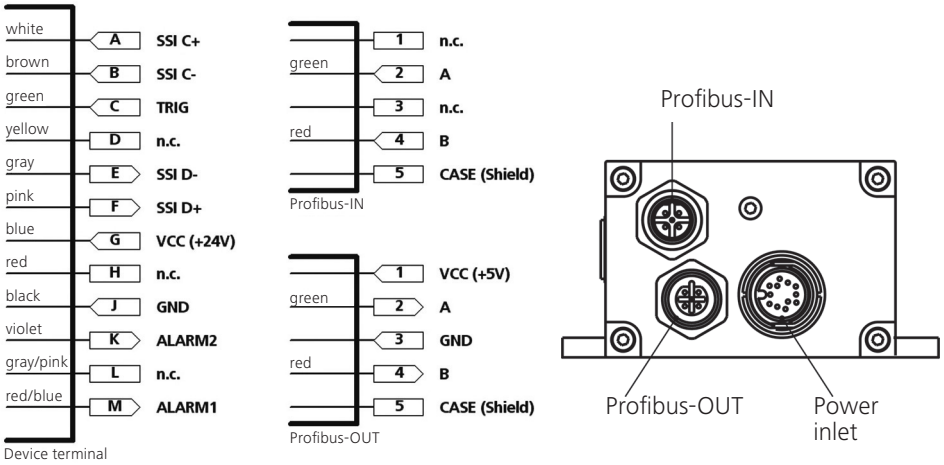


Fig. 3: Pinning diagram

For operation via Profibus, other Profibus participants may connect to the 5-pole jack (A-wire, B-wire). The Profibus may terminate or continue at the 5-pole connector. Some kind of termination device must always be provided at the end of the Profibus. Supply voltage for the bus terminator is available at Profibus-OUT.

4.5 Profibus Interface

4.5.1 ID Number

The SP LAM 53 has been registered with "PROFIBUS Nutzerorganisation e.V. (PROFIBUS User Organization, incorporated society) under ID number 09CB (HEX).

4.5.2 Interfacing Requirements

The SP LAM 53 is prepared for connection to any type of Profibus DP structure. The related Profibus DP Master must be capable of sending a parameterization telegram. The Master's own configuring tool (typically configuring software) must support representation of the parameters which are contained in the SP LAM 53 Master file (GSD file).

4.5.3 GSD File

The GSD file is named LAM409CB.GSD. It includes the two files "SP LAM 53.dib" and "SP LAM 53.bmp" which are necessary for representation of the SP LAM 53 in the configuring tool. For information regarding integration of these files, please consult the special documentation parts that relate to the configuring tool.

4.5.4 Slave Address

A Profibus address can be assigned, with due consideration of other participants in bus communications, to any number from 0 to 125.
The setting of an address can be achieved by triggering an SSA command via the Profibus. For details on how to change a previously set slave address via the configuring tool, you should consult the special tool documentation. In as-delivered state, the slave is set to the address "4".
A currently set slave address is permanently stored in the EEPROM. It is also preserved in the event of a power failure.
Where more than one slave (SP LAM 53) communicates via one Profibus, they must be connected in series and each of them must be assigned a different address.

4.5.5 Bus Termination

For SP LAM 53 operation, the bus must be fitted with an external terminator. 5 V supply voltage for bus termination can be drawn from the Profibus-OUT. This voltage is electrically isolated from actual operating voltage supply (VCC) and provides 100 mA current load capacity.
The terminating resistor is available as an accessory item.

4.5.6 Baud Rate

The SP LAM 53 is prepared to automatically detect any of the following baud rates: 9.6 / 19.2 / 93.75 / 187.5 / 500 kbaud and 1.5 / 3 / 6 / 12 Mbaud, respectively.

4.5.7 Segment Length

The maximum segment length between Profibus participants depends on the selected baud rate. The following segment length requirements must be met:

Baud rate [baud]	Segment length [m]
9.6 k – 93.75 k	1200
187.5 k	1000
500 k	400
1.5 M	200
3 M – 12 M	100

For cabling in accordance with these segmenting limits, you are stongly recommended to use cable of type A. This cable type provides the following performance features:

Surge impedance	135 ... 165 W
Capacitance per unit length	≤ 30 pf/m
Loop impedance	≤ 110 W/km
Wire diameter	> 0.64 mm
Wire cross-section	> 0.34 mm²

4.5.8 Wiring Diagram

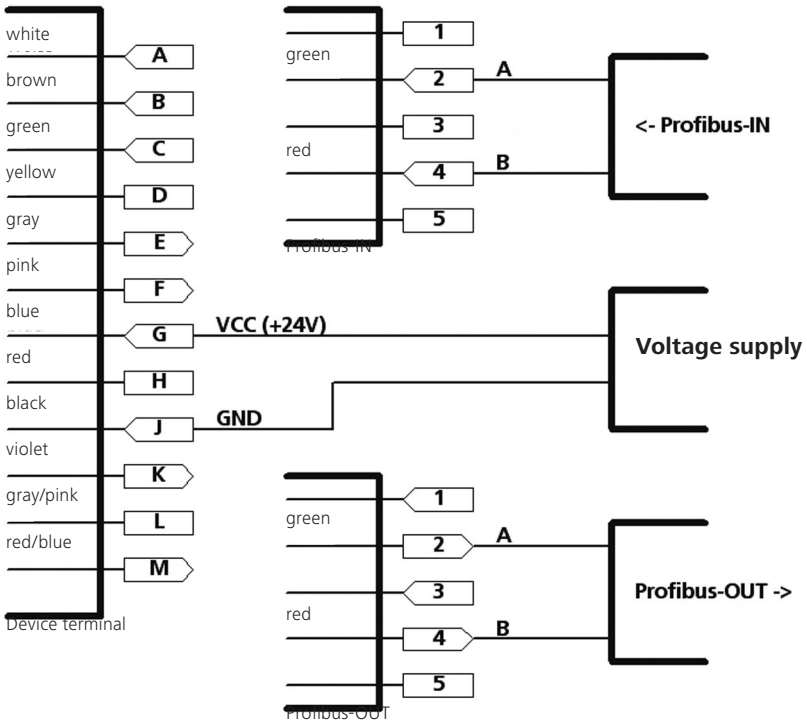


Fig. 4: Minimum wiring configuration of Profibus interface

4.6 SSI Interface

Parameter settings for SSI interface operation can be made via the Profibus.
Default state set on initial product delivery: DT Mode.

The SP LAM 53 has a SSI data interface (SSI = synchronous serial interface).
At the request of a SSI clock generator, the SP LAM 53 triggers a distance measurement cycle, sending the data bit by bit to a controller for processing in the same order as it arrives at the shift register. This process occurs in the measuring mode that was most recently stored in the SP LAM 53. A desired measuring mode can be selected via the Profibus.
Transfer rates from 50 kHz to 1 MHz are available for selection. Selections should always take into account the actual cable length.
The SSI interface works independently of the Profibus interface. It provides a data length of 24 bits and uses Gray code.
The pause interval between two bit sequences is 200 µsec.
All interface inputs are electrically isolated. They provide an isolation strength of 500 V.
To guarantee undisturbed data transmission, screened twisted-pair cables have to be used.
This requirement is met by the cable type which you can find quoted in the optional accessories section above (→ Scope of Delivery).
The following table shows selectable clock rates with corresponding cable lengths that must not be exceeded:

Clock rate [kHz]	Cable length [m]
< 500	< 25
< 400	< 50
< 300	< 100
< 200	< 200
< 100	< 400

For SSI interface operation, the wiring diagram is as follows:

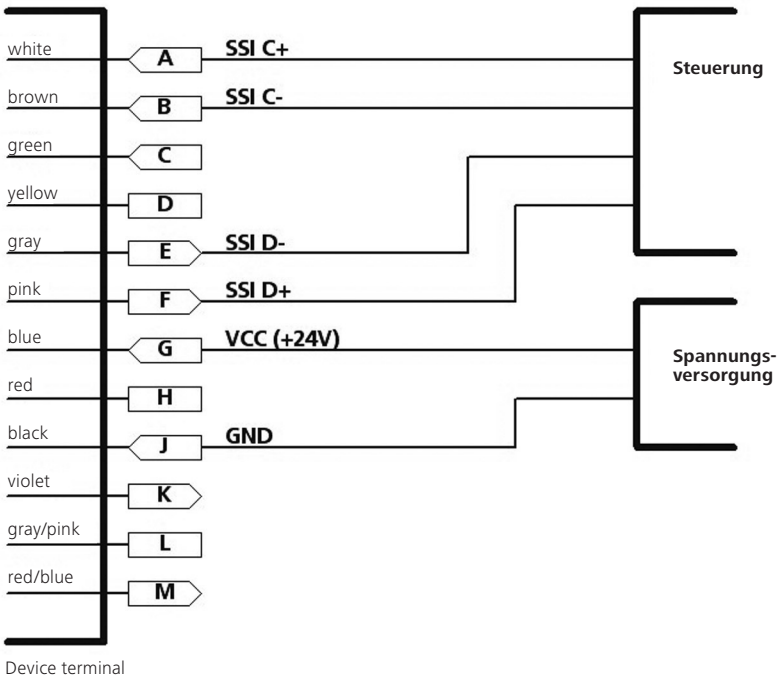


Fig. 5: Wiring for SSI interface operation

4.7 Alarm Outputs

Parameter settings for alarm outputs can be made via Profibus. This function is only available with the Profibus in active state.

Each of the two alarm outputs allows a given object or state to be monitored for positive or negative excession of its limit values. This is achieved with the help of a user-definable distance threshold value (AC). Which way the particular alarm output will switch depends on the mathematical sign of its hysteresis.

Rule:

Positive hysteresis: With increasing distance, the output switches from LOW to HIGH, as soon as AC + AH/2 is exceeded, with decreasing distance, it switches from HIGH to LOW, as soon the distance value falls below AC – AH/2.

Negative hysteresis: With increasing distance, the output switches from HIGH to LOW, as soon as AC + |AH/2| is exceeded, with decreasing distance, it switches from LOW to HIGH, as soon the distance value falls below AC – |AH/2|.

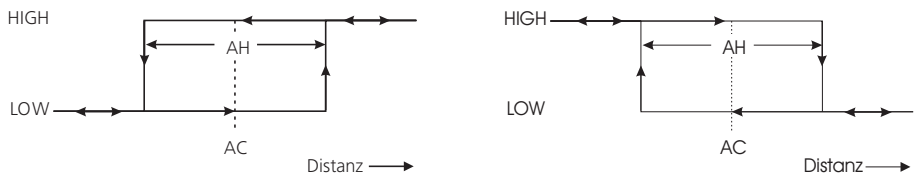


Fig. 6: Digital switching output behaviour for positive and negative hysteresis.

LOW corresponds to a voltage level < 2 V.

HIGH corresponds to a voltage level of VCC - 2 V.

Each alarm output is short-circuit proof and rated for a maximum current load of 0.5 A.
Parameter settings for alarm outputs can be made with the Profibus master, using the Encoder profile with Class 1 functionality.

The following parameters may be configured (refer to GSD File):

ExtUserPrmData = 29 "Switching point output 1 (31-16)" for AC alarm output 1
ExtUserPrmData = 30 "Switching point output 1 (15-0)" for AC alarm output 1
ExtUserPrmData = 31 "Switching point output 2 (31-16)" for AC alarm output 2
ExtUserPrmData = 32 "Switching point output 2 (15-0)" for AC alarm output 2
ExtUserPrmData = 33 "Hysteresis output 1 (31-16)" for AH alarm hysteresis 1
ExtUserPrmData = 34 "Hysteresis output 1 (15-0)" for AH alarm hysteresis 1
ExtUserPrmData = 35 "Hysteresis output 2 (31-16)" for AH alarm hysteresis 2
ExtUserPrmData = 36 "Hysteresis output 2 (15-0)" for AH alarm hysteresis 2

Further switching functionalities, for example, monitoring for specified operating ranges may be accomplished by combining the two alarm outputs.

The wiring diagram for utilization of alarm outputs is as follows:

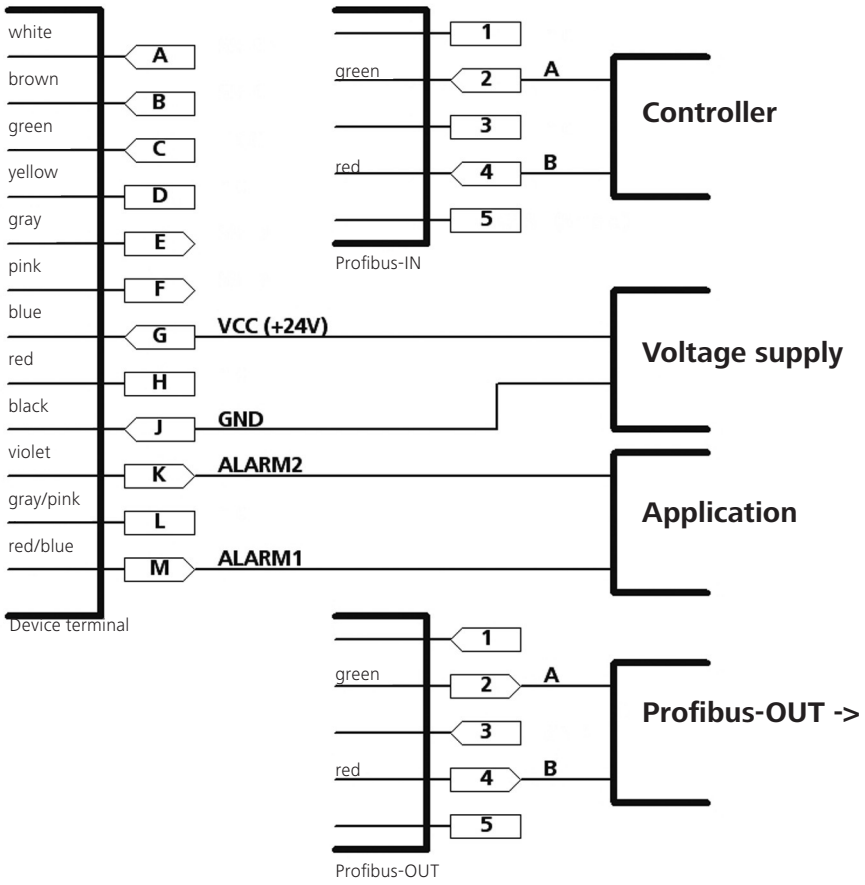


Fig. 7: Wiring for alarm outputs

4.8 Trigger Input

Parameter settings for the trigger input can be made using Profibus tools. This function is only enabled with the Profibus in active state.
The trigger input allows a distance measurement cycle to be triggered by an external signal that is applied as a voltage pulse.
Available setting options are the delay time (Trigger Delay) until measurement actually starts and the pulse edge to be selected for triggering (Trigger Level). Trigger mode (0 ... Off, 1 ... On) must be turned on.
Parameter settings for Trigger Input can be made with the help of the Profibus Master, using the Encoder profile and Class 2 encoder functionality.
The following parameters are available for configuration (refer to GSD File):

ExtUserPrmData = 20	"Trigger Mode"	for trigger mode
ExtUserPrmData = 21	"Trigger Level"	for trigger level
ExtUserPrmData = 25	"Trigger Delay (31-16)"	for trigger delay
ExtUserPrmData = 26	"Trigger Delay (15-0)"	for trigger delay

For detection of a clock edge, the following voltage signals are required:

24 V	> HIGH	> 11 V
0 V	< LOW	< 6.5 V

Wiring connections for working with the trigger input are as follows:

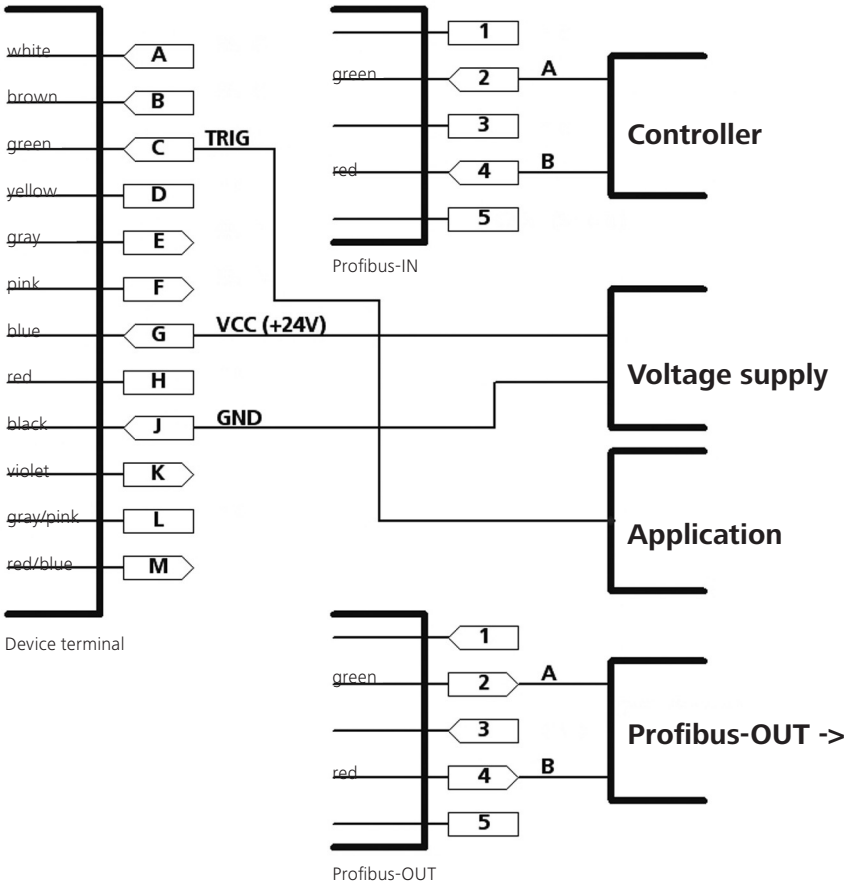


Fig. 8: Wiring of trigger input

5 Start-Up

The table below proposes a sample procedure that may be followed for SP LAM 53 start-up. It does not purport to provide complete information or exhausting details on all possible applications. For this description, it is assumed that the user will match cabling to his/her specific requirements.

No.	Working step
1	Unpack SP LAM 53 and inspect for visible damage
2	Connect and firmly screw on Profibus terminals
3	Connect and firmly screw on device terminals in power-off state
4	Turn voltage supply on
5	Trigger distance measurement (laser comes on and Profibus or SSI launches measurement)
6	Sight a given target using the visible laser spot
7	Lock the SP LAM 53 in position
8	Perform final visual inspection

6 SP LAM 53 Operation

6.1 Measuring Modes

The various measuring modes are distinguished by the algorithms they use for calculation.
The SP LAM 53 relies on the phase comparison method for normal operation.
In order to obtain a precise measured value, the user should perform an appropriate number of single distance shots at different frequencies of a fixed number. For DW mode and DX mode, the number of frequencies and/or the number of single distance shots is limited, which allows for higher measurement frequencies. On the other hand, this also places tighter demands on the quality of operating conditions, for example, targets should be strongly reflecting. The resulting limitations should be taken into account by the user in practical work.

In DT mode or DM mode, the user may define his/her own limits for the maximum time which measurement is to last, by setting appropriate measuring time values in Measuring Time.

6.1.1 DM: Single Distance Measurement

In DM mode, a single distance shot is triggered. A desired measuring time can be set in the Master's configuring tool, using the Encoder profile and Class 2 encoder functionality.

6.1.2 DT: Distance Tracking

DT mode can be chosen for distance measurement of different kinds of surfaces (varying reflectance). This may cause longer measuring times in the case of poor reflectance or sudden jumps in distance. The minimum measuring time is 160 msec, the maximum time is 6 sec. On expiry of six seconds, measurement will be aborted with an error message. A desired Measuring Time can be set in the Master's configuring tool, using the Encoder profile and Class 2 encoder functionality.

6.1.3 DW: Distance Tracking With White Target (10 Hz)

DW mode uses a steady measuring rate of 10 Hz. A white target board is a necessary prerequisite for measured values to be stable. There must be no sharp jumps in distance above a value of 16 cm within the area being measured.

6.1.4 DX: Distance Tracking With Cooperative Target (50 Hz)

DX mode uses a steady measuring rate of 50 Hz.
It is primarily intended for applications where there is uniform carrier motion up to a rate of 4 m p. sec. The high measuring rate of 50 Hz is achieved by involving previously measured values in calculation of a currently measured value. Distance jumps greater than 16 cm should be avoided.
A white target board is a necessary prerequisite for stable distance readings.

6.1.5 DF: Distance Measurement with External Trigger

In DF mode, measurement begins on arrival of an external trigger pulse.
This trigger pulse releases a single distance shot.
Desired settings for the Measuring Time, the trigger edge ("Trigger Level") and the delay in triggering ("Trigger Delay") can be made in the Master's configuring tool, using the Encoder profile and Class 2 encoder functionality. Trigger mode must be active.

6.2 Parameters

Settings can be made for each parameter in the Master configuration tool, using the Encoder profile and Class 2 encoder functionality. For a description, you should refer to the special configuring tool documentation.
The configuring tool of the Master uses the GSD file as input to create parameters for the slave. It must have sent these parameters at least once to the slave before the slave will be able to work in cyclical data exchange mode. The slave has been programmed with enough tolerance to allow operation with only its seven byte standard PB parameters (i.e. without any profile-adapted user parameters).
Where the Master is unable to send user parameters, the EEPROM's previously stored parameters will be used. This may make sense in SSI encoder applications without involvement of a Profibus. In such cases, the SP LAM 53 must be parameterized once, using the Profibus. The selected parameter settings must then be saved, the Profibus disabled again and the SSI interface terminal be activated.

6.2.1 Class 2 Function

Selects slave type according to Encoder profile.

6.2.2 Extended Diagnostics

Transmits more than six standard diagnostic bytes (16 bytes as Class 1 Slave, 61 bytes as Class 2 Slave).

6.2.3 Scale Factor

Scale factor (SF) multiplies a calculated distance value with a factor that can be selected within the range from – 10.00000 to + 10.00000 to allow changes in resolution setting or output of results in a unit of measure other than the metric system. Up to five positions after decimal point can be processed.
To make settings for profibus system operation, SF needs to be multiplied with 100,000. The resulting number must then be converted into a 32-bit hexadecimal number. In profibus setup mode, a mathematically obtained number can be entered at bytes (Octet) 55 ... 58 of the table of parameter setup data.

SF	Resolution	Long integer	Byte 55		Byte 56		Byte 57		Byte 58	
10	0.1 mm	1,000,000	0	0	0	F	4	2	4	0
1	1 mm	100,000	0	0	0	1	8	6	A	0
-1	1 mm	- 100,000	F	F	F	E	7	9	6	0
-10	0.1 mm	- 1,000,000	F	F	F	0	B	D	C	0

SF	Resolution	Long integer	Byte 55		Byte 56		Byte 57		Byte 58	
0.3937	1 inch	39,370	0	0	0	0	9	9	C	A
3.28084	0.01 feet	328,084	0	0	0	5	0	1	9	4
1.0936	0.01 yard	109,360	0	0	0	1	A	B	3	0

6.2.4 Trigger Mode

Trigger Mode enables (1) or disables (0) external triggering.

6.2.5 Trigger Level

Trigger Level defines if measurement will start on a rising (0) or a falling (1) pulse edge.

6.2.6 Trigger Delay

Trigger Delay sets the time from the arrival of a trigger pulse to the actual beginning of measurement. It may correspond to any value between 0 and 9999 msec.

6.2.7 Error Reaction

Error Reaction defines how the alarm outputs will react if a measurement cycle is found to have been unsuccessful.
Different setting options are available in order to cause error messages to trigger different kinds of response as appropriate for a particular environment in which the SP LAM 53 operates. Possible settings are 0, 1 and 2 with the following assigned effects upon occurrence of an error message

Error reaction	Alarm outputs
0	Preserves latest valid measurement state
1	Positive alarm hysteresis = LOW, negative alarm hysteresis = HIGH
2	Positive alarm hysteresis = HIGH, negative alarm hysteresis = LOW

6.2.8 Measuring Time

Measuring Time is active in DM and DT measuring mode. As a general rule, it may be assumed that the poorer the surface quality of a targeted object the more time will be required by the SP LAM 53 to determine that target's distance with specified accuracy. For example, if error message E15 is output because of poor reflectance and too small a measuring time value, the setting for measuring must be increased.
The available range for measuring time variation is 0 to 25.
Note:
The greater the value which is selected for measuring time the longer the time which will be available for measurement and the smaller the frequency at which measurement will be performed.
"0" value setting is an exception. In this case, the SP LAM 53 will use its internal

criteria for evaluation.
In addition, by varying the Measuring time, one may also configure the measuring frequency. This may prove helpful where data volumes have to be restricted. The following provides an approximated measuring time equation:

$$\text{Measuring time} \;\gg\; \text{Measuring time} \times 240\ \text{ms} \quad (> 0)$$

Because different factors may result in frequency shifts, this equation can only be given in an approximated relationship.

6.2.9 Display Offset

On selection of Display Offset, a desired amount of offset may be applied to the measured value (for correction).

6.2.10 Switching Point Output 1 or 2

Switching Point Output 1 or 2 corresponds to the trigger threshold of alarm output 1 or 2 respectively.
The trigger threshold behaviour is user-definable. For settings of this kind, a switching hysteresis parameter is provided (refer to section 6.2.11).

6.2.11 Hysteresis Output 1 or 2

Hysteresis Output 1 or 2 corresponds to the switching hysteresis of alarm output 1 and 2 respectively.
Your settings for switching hysteresis define:

- how a switching output will respond to the positive or negative excession of a trigger threshold, depending on the mathematical sign of a hysteresis value
- what range will be covered by the switching output, depending on the amount of hysteresis.

The following table shows switching output behaviour depending on the mathematical sign of hysteresis:

	Trigger threshold positively exceeded	Trigger threshold negatively exceeded
Positive hysteresis	HIGH	LOW
Negative hysteresis	LOW	HIGH

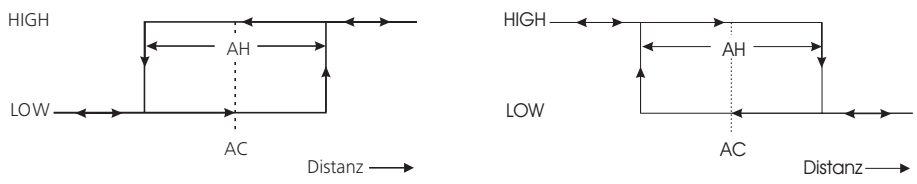


Fig. 10: Behaviour of digital switching output for positive and negative hysteresis

6.2.12 Diagnostic Interval

Diagnostic Interval allows you to define how often diagnostic reports are to be output. A diagnostic report includes information about (but not limited to) the inner device temperature. For generation of diagnostic data, a running distance measurement will be interrupted!
The available setting range for Diagnostic Interval is from 0 to 10000. The time scale is 100 msec. If Diagnostic Interval is set to "0", diagnostic data will only be output if there was an error.
Consequently, a setting of "10000" for Diagnostic Interval will correspond to an interval of 1000 sec.

6.2.13 Average

Average allows a floating mean value to be calculated from one to twenty measured single values.
Calculation is based on this formula:

$$\text{Mean value } x = \frac{x_1 + x_2 + x_3 + \ldots + x_n \ (20)}{n}$$

6.2.14 Factory Settings

Slave Address	1
Measuring Mode	DT
Scaling Function	0
Trigger Mode	0
Trigger Level	0
Trigger Delay	0
Error Reaction	0
Measuring Time	0
Display Offset	0
Switching Point Output 1	10000
Switching Point Output 2	20000
Hysteresis Output 1	100
Hysteresis Output 2	100
Diagnostic Interval	10
Average	1

7 Profibus Interface

7.1 General Information

The Profibus Interface for SP LAM 53 operation control is identical with the Standard DP V0 Profibus (with peripherals decentralized) where V0 designates the version. Telegrams are byte-oriented. A byte is also referred to as an Octet in Standard Profibus terminology. From a user's point of view, the following types of telegrams are required to accomplish communication:

- cyclical data exchange telegrams (DataEx)
- diagnostic telegrams
- parameter setup telegrams

The various Profibus slaves of identical or similar functionality are described in profiles. These make it easier for users to work with PB slaves from different manufacturers, which provide identical functionality.

For operation of the SP LAM 53 in Profibus mode, the encoder profile of the Profibus (order no. 3062 of PNO) is supported. The SP LAM 53 works as a linear encoder in this case. Within the available encoder profile capabilities, the SP LAM 53 can work as a class1 or class2 encoder (recommended). All versions are accomplished via a GSD file. In addition to specific profile data, the SP LAM 53 provides specific device settings. These concern laser control and diagnosing aspects.

Profile	Class	Functionality
Encoder	class 1	- only input - simple diagnosis - minimal parameter setup options
	class 2	- input and output (Preset) - extended diagnosis - extended parameter setup otions
SP LAM 53	class 1	- see encoder profile
	class 2	- additional vendor-specific diagnosis and parameter setups

7.2 Slave Address Setting

Slave address 4 is factory-set.
Changes can be made via the Profibus Master.
A desired address can be assigned using the SSA (Set Slave Address) signal.

7.3 Selection of Operating Mode

DT measuring mode is factory-set.
Changes can be implemented in parameter setup mode,
using bits 5 ... 7 of parameter setup byte 26.

0 = 000 = DF

1 = 001 = DT

2 = 010 = DW

3 = 011 = DX

4 = 100 = DM

Where modified data are to be written onto the EEPROM, bit 4 of parameter setup byte 26 must be set to '1'.

7.4 Configuration Data

For input and output data, the following configurations are available:

mandatory

class 1	D1 hex	2 words input consistency
class 2	F1 hex	2 words of input data, 2 words of output data for preset value, consistency

optional

class 1	D0 hex	not implemented in SP LAM 53
class 2	F0 hex	not implemented in SP LAM 53

7.5 Cyclical Data Exchange – Input (Slave -> Master)

The SP LAM 53 outputs position data which are mathematically signed. The SF (scale factor) parameter can be used to invert a given mathematical sign. Resolution is also defined via SF.

Octets in a telegram are arranged in a Profibus-compliant manner (big endian), i.e. the MSB always comes first and the LSB is always the last one.

Octet	Bit	Type	Output
1…4		signed 32	position data from encoder

7.6 Cyclical Data Exchange – Output (Master -> Slave)

The most significant bit in a preset value (bit 32) defines the validity of that preset.

Octet	Bit	Type	Output
1 … 4		signed 32	preset-value standard mode: MSB = 0 (bit 31) preset mode : MSB = 1 (bit 31)

The “Preset“ value is available for setting a current output value to a desired value. This is achieved with the help of an internal offset M_{offset}. By setting of bit 31, this offset value can be changed.
The following assignments are valid:

M_{DataEx} value transported to the Profibus in cyclical data exchange mode
M_{Laser} reading determined by the laser
M_{offset} intern calculated offset value
M_{Preset} value transferred with “Preset“ function

- Cyclical calculation of: $M_{DataEx} = M_{Laser} + M_{offset}$
- The value for M_{offset} is not permanently stored in the SP LAM 53, i.e. it will be lost on turning power off. The offset value can also be stored as a parameter in Octet 32 ... 35.
- If bit 31 of M_{Preset} is set, M_{Offset} will be calculated in such a manner that the following equation is met:

  $M_{Preset} = M_{Laser} + M_{offset}$.

  The new offset value can be read in the diagnostic data as Octet 30 ... 33.

7.7 Parameter data

The following minimum parameter setups apply to class 1 devices:

Octet	Bit	Type	Output	
1		byte	station status	(profibus default)
2		byte	wd_fact_1 (watch dog)	(profibus default)
3		byte	wd_fact_2	(profibus default)
4		byte	min_tsdr	(profibus default)
5 ... 6		word	word ident number	(profibus default)
7		byte	group ident	(profibus default)
8		byte	spc3 spec	(profibus default)
9	0	bool	unused	
	1	bool	class 2 functionality on/off	
	2	bool	commissioning diagnostic on/off	
	3	bool	commissioning diagnostic on/off	
	4	bool	reserved for future use	
	5	bool	reserved for future use	
	6	bool	reserved for manufacturer	
	7	bool	reserved for manufacturer	

The following additional parameters apply to class 2 devices:

Octet	Bit	Type	Output
10 … 13		unsigned 32	unused – linear encoder (Measuring units per revolution)
14 … 17		unsigned 32	linear encoder (Measuring range in ..)
18 … 25		byte(s)	unused – (reserved for future use)
26	0	bool	unused
	1	bool	trigger level 0 = H →L 1 = L → H (TDnn x)
	2 ... 3	2 bit number	error reaction 0 … 2 (SEnn)
	4	bool	0= non action 1= write on EEPROM (store all parameters)
	5 ... 7	3 bit number	measure mode (0 = DF, 1 = DT, 2 = DW, 3 = DX, 4 = DM)
27		byte	measure time [STnn] 0 ... 25
28 ... 31		signed 32	trigger delay [TDnn] 0 ... 9999
32 ... 35		signed 32	display offset [OFnnnn]
36 ... 39		signed 32	output1 switch limit 0 ... 5000000 [ACnn]
40 ... 53		signed 32	output2 switch limit 0 ... 5000000 [ACnn]
44 ... 47		signed 32	output1 switch hysterese –5000000 ... 5000000 [AHnn]
48 ... 51		signed 32	output2 switch hysterese –5000000 ... 5000000 [AHnn]
52 ... 53		word	diag update time in 0.1 sec
54		byte	average time [SAnn] 1 ... 20
55 ... 58		signed 32	scale factor [SFnn] n*0.00001 (1.0 = 100000)

Since the SP LAM 53 is a linear encoder that measures absolute distances, the four parameters “code sequence”, ”scaling function control“, ”Measuring units per revolution“ and ”Measuring range in measuring units“ will be ignored.

7.8 Diagnostic data

Class 2 functionality	Commissioning diagnostic	Diagnostic information
-	0	6 byte standard diagnosis
0	1	16 byte class 1 diagnosis
1	1	61 byte class 2 diagnosis

Octet	Bit	Type	Output	
1		byte	diag state 1	(profibus default)
2		byte	diag state 2	(profibus default)
3		byte	diag state 3	(profibus default)
4		byte	master address	(profibus default)
5 ... 6		word	ident number	(profibus default)
			class 1 diagnostic	
7		byte	group ident	(profibus default)
8		byte	spc3 spec	(profibus default)
9	0	bool	unused	
	1	bool	class 2 functionality on/off	
	2	bool	commissioning diagnostic on/off	
	3	bool	unused	
	4	bool	reserved for future use	
	5	bool	reserved for future use	
	6	bool	reserved for manufacturer	
	7	bool	reserved for manufacturer (operation status: parameter byte 9)	
10		byte	encoder type (=7 absolute linear encoder)	
11 ... 14		unsigned 32	single turn resolution => 100000nm = 0.1mm	
15 ... 16		unsigned 16	no. of distinguishable revolutions – unused (=0)	
			class 2 diagnostic	
17	0	bool	E98 – timeout SIO	
	1	bool	E99 – unknown error	
18 ... 19	0	bool	E15 – reflex signal too weak, use target boardn	
	1	bool	E16 – reflex signal too strong, use target board	
	2	bool	E17 – steady light (e.g. insolation)	
	3	bool	E18 – only in DX-mode (50 Hz): variance between measured and precalculated value too great	
	4	bool	E23 – temperature below –10 °C	

Octet	Bit	Type	Output
	5	bool	E24 – temperature above +60 °C
	6	bool	E31 – wrong EEPROM checksum, hardware errorr
	7	bool	E51 – failure to set avalanche voltage of laser diode; cause: stray light or hardware error
	8	bool	E52 – laser current too strong / defective laser
	9	bool	E53 – failure to set one or more parameters in EEPROM (consequence: division by 0)
	10	bool	E54 – hardware error (PLL)
	11	bool	E55 – hardware error
	12	bool	E61 – selected parameter is illegal; invalid command was triggered
	13	bool	E62 – 1. hardware error 2. false value for interface communications (SIO parity error)
	14	bool	E63 – SIO overflow
	15	bool	E64 – SIO framing error
20 ... 21		word	warnings – unused (=0)
22 ... 23		word	warnings – unused (=0)
24 ... 25		word	profile version (z.B. 1.1 = 0110 hex)
26 ... 27		word	software version (z.b. 1.11 = 0111 hex)
28 ... 31		unsigned 32	operating time (of laser), in units of 0.1 hour
32 ... 35		signed 32	offset value (also refer to Output Data)
36 ... 39		signed 32	manufacture offset – unused (=0)
40 ... 53		unsigned 32	unsigned 32 measuring units per revolution – unused (=0)
44 ... 47		unsigned 32	unsigned 32 measuring range – unused (=0)
48 ... 57		10 byte	10 byte serial number
58 ... 59		word	word reserved for future use
60		signed byte	laser temperature in °C
61		byte	reserved - unused

Since the SP LAM 53 is a linear encoder that measures absolute distances, the four parameters “code sequence”, ”scaling function control“, ”Measuring units per revolution“ and ”Measuring range in measuring units“ will be ignored

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8 Preventive Care & Maintenance

Please note:

- To remove dust from optical glass surfaces (of transmitter or receiver optics), you may use a pneumatic brush. Do not use solvent-containing cleaners to wipe optical surfaces down. You are advised to contact the Manufacturer if there is contamination of a more obstinate nature.
- Refrain from the use of solvents for cleaning work.
- You are prohibited from opening the SP LAM 53.
- Do not release any screws of the SP LAM 53.

In the event of necessary repair work, you are requested to carefully pack the SP LAM 53 away, indicate its particular operating environment (applications, communication & wiring details, environmental conditions) and send it back to your local distributor (or to us at the following address):

Sensor Partners BV
James Wattlaan 15
5151 DP Drunen
Holland

Phone: +31 (0) 416-378239
Web: www.sensor.nl
E-Mail: info@sensor.nl

9 Malfunction & Error Reports

9.1 Malfunction

Error situation	Cause	Action for removal
No data coming via Profibus	Faulty Profibus configuration	Check Profibus configuration
Device error (Ext. diagnosis)	Hardware problems	Reship SP LAM 53 for repair, contact technical support

9.2 Errror Report Outputs via Profibus

Code	Cause	Action for removal
E15	Excessively poor reflexes	Use target board, observe minimum requirement on measuring distance (> 0.1 m)
E16	Excessively strong reflexes	Use target board, do mot measure against reflecting surfaces
E17	Too much steady light (e.g. sun)	Mount SP LAM 53 in such a position that excessive incidence of steady light is prevented, extend glare protection tube, provide additional light-shielding, e.g. protective cap
E18	Only in DX mode: too much difference between measured and pre-calculated value	Check path from distance meter to target being measured for obstacles
E23	Temperature below –10°C	Provide ambient temperature > -10°C
E24	Temperature above +60°C	Provide ambient temperature < +60°C
E31	Faulty EEPROM checksum, hardware error	Service required if fault occurs repeatedly → Reship SP LAM 53 for repair
E51	Failure to set avalanche voltage 1. straylight 2. hardware error	1. Check target reflectance and ambient light (steady light), make sure that neither target not entry opening of SP LAM 53 is exposed to light from reflecting surfaces, projectors or sun) 2. Service required → reship for repair
E52	Laser current too high / laser defective	Reship SP LAM 53 for repair Contact technical support
E53	Hardwarefehler	Reship SP LAM 53 for repair Contact technical support
E54	Hardware error	Reship SP LAM 53 for repair Contact technical support
E55	Hardware error	Reship SP LAM 53 for repair Contact technical support
E61	Hardware error	Service required if occurring repeatedly → Reship SP LAM 53 for repair
E62	Hardware error	Check RS232 settings; if fault persists, reship SP LAM 53 for repair, contact technical support

Code	Cause	Action for removal
E63	SIO overflow	Check time of emitted signals in application software, integrate delay on transmission if necessary
E64	SIO framing error	Reship SP LAM 53 for repair Contact technical support

10 EC - Declaration of Conformity

Code	Cause	Action for removal
E98	Hardware error	Reship SP LAM 53 for repair Contact technical support

11 Abbreviation listing

DF	Distance Measurement with External Trigger
DM	Single Distance Measurement
DT	Distance Tracking
DW	Distance Tracking With White Target (10 Hz)
DX	Distance Tracking With Cooperative Target (50 Hz)
GSD-Datei	Devica Data Base File
ID number	SP LAM 53 registration number at “Profibus Nutzerorganisation e.V.“
LSB	Least Significant Bit
MSB	Most Significant Bit
SSI	Synchronous Serial Interface

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