
Manual

LLD-150-PROF2

Version 3.6



CE

Dear User,

You are advised to carefully read this User Manual before powering on the LLD-150-PROF2 Laser distance measuring sensor 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.

Editorial deadline: July 2018

Firmware version: ≥ 7.05 and 8.06

Manual version: V 3.6

Note:

Proper care has been used in compiling this document. No liability will be accepted in the event of damage resulting from failure to comply with the information contained herein.

Revisions history

Manual Version	Date	Changes
3.6	25.07.2018	Max. Trigger voltage changed
3.5	29.06.2016	Ch. 8.1, Fig. 7, MTBF E19 added
3.4	16.03.2015	New design

Phone: +49 (0)381 / 44073-0 Fax: +49 (0)381 / 44073-20

I. Content

1	General.....	6
2	Safety Instructions	8
2.1	General Safety Instructions	8
2.2	Intended & Conforming Use	8
2.3	Nonconforming use.....	8
2.4	Laser Classification	9
2.5	Electric Supply	10
2.6	Important Operating Advice	10
3	Technical Data.....	11
4	Mounting	13
5	Electrical Connection	15
5.1	LLDRear-Side Cover Terminals.....	15
5.2	Assignment of Terminals.....	16
5.3	Profibus DP	16
5.4	RS232 Serial Interface	16
5.5	Programming Cable.....	17
5.6	Shield and Grounding.....	18
6	Limiting Values for Voltages	19
7	Start up	20
8	Parameters and Control via RS232	21
8.1	General.....	21
8.2	DT – distance tracking	24
8.3	DS – distance tracking (<7 m).....	24
8.4	DW – distance tracking with target board (10 Hz)	24
8.5	DX – distance tracking with target board (50 Hz)	25
8.6	DF – distance measurement with external trigger.....	25
8.7	DM – distance measurement	26
8.8	TP – internal temperature [°C]	26
8.9	SA – display/set average value [1..20]	26
8.10	SD – display/set display format [d/h/s]	26

8.11	ST – display/set measure time [0..25]	27
8.12	SF – display/set scale factor	28
8.13	SE – display/set error mode [0/1/2]	29
8.14	AC – display set ALARM center	29
8.15	AH – display/set ALARM hysteresis	30
8.16	AW – display/set ALARM width	30
8.17	HO – display/set Temperature for heating on	30
8.18	HF – display/set Temperature for heating off	31
8.19	TDx y – display/set trigger delay trigger level	31
8.20	BR – display/set baud rate [2400..38400]	31
8.21	AS – display/set autostart command	32
8.22	OF – display/set distance offset	32
8.23	SO – set current distance to offset	32
8.24	LO – Laser on	32
8.25	LF – laser off	32
8.26	PA – display settings	33
8.27	PR – reset settings	33
9	Interface Connection	34
9.1	Profibus DP	34
9.2	Serial Interface RS232	36
9.3	Output Format Ethernet and RS232	37
9.4	Digital Switching Output (Alarm)	38
9.5	Trigger Input	40
10	List of Commands	41
11	Error Codes RS232 and Profibus	42
12	GSD Data	43
13	Contact Assignment for Cable Connectors	45
14	EG Declaration of Conformity	46

II. List of Figures

Figure 1 : Measurement principle	6
Figure 2 : Warning Sign Laser Radiation Class 2	9
Figure 3 : Mounting drawing	13
Figure 4 : Offset against zero-edge	14
Figure 5 : LLD-150-PROF2 terminals	15
Figure 6 : Termination RS232	17
Figure 7 : LDMTool	21
Figure 15 : Digital switching output behavior	39
Figure 8 : GSD data and bitmap	44
Figure 9 : Contact assignment	45

III. List of Tables

Table 1 : Technical data	11
Table 2 : LLD-150-PROF2 terminals	15
Table 3 : Pin assignment power supply, alarm and trigger	16
Table 4 : Pin assignment Profibus DP	16
Table 5 : Pin assignment RS232	17
Table 6 : Pin assignment programming cable	18
Table 7 : Input voltages	19
Table 8 : Output voltages	19
Table 9 : Command list LLD-150-PROF2	23
Table 10 : Output format	26
Table 11 : Examples of scale factor	29
Table 12 : Meaning of SE	29
Table 13 : Meaning of Profibus DP modes	35
Table 14 : Profibus error codes	35
Table 15 : LLD-150-PROF2 command list	41
Table 16 : Error codes	42
Table 17 : Part numbers	47

1 General

The LLD-150-PROF2 are Laser sensors to measure distances from 0.1 m to more than 100 m with pinpoint accuracy.

A given target can be clearly identified with the help of a red Laser sighting point. In terms of operating reach, the LLD-150-PROF2 performs depending on the reflectance, morphology and qualities of the target to be measured.

The sensor works based on comparative phase measurement. It emits modulated Laser 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.

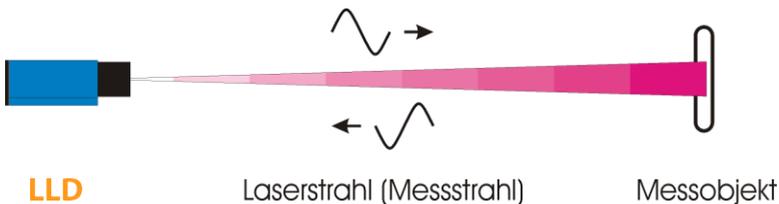


Figure 1 : Measurement principle

A distance measuring cycle can be triggered in three different ways:

- By sending a command from the PC or another equivalent control unit
- By making appropriate prior parameter settings for the auto start command and applying supply voltage
- By external triggering (in remote-trigger mode).

For a more detailed description of these three trigger options, you should consult chapter 8, Parameters and Control via RS232 of this User Manual.

Special performance features are:

- Provides high accuracy and great reach under extreme outdoor temperatures.
- Works in a wide range of operating voltages from 10 V= to 30 V= from an on-board vehicle supply point, an industrial direct voltage supply net or a DC power pack.
- Features consistently low power consumption of $<3.5 \text{ W}^1$ (without I_{Alarm})
- Up to 30 m reach for distance measurement, with potential for more than 100 m reach if additional reflectors² are mounted onto the target (depending on reflectance and environmental conditions).
- Visible Laser beam for easier sighting.
- Output and control via Profibus DP
- Measured values can be displayed in meters, decimeters, centimeters, feet and inches due to.
- Option for remote triggering of a measurement from an external trigger device.
- Large range of accessories available

¹ inactive internal heating for devices with internal heating (LLD-150-PROF2-h)

²e.g. 3M, foil white non glossy or foil for longer distances

2 Safety Instructions

2.1 General Safety Instructions

These safety and operating instructions should be carefully read and followed during practical work with the LLD-150-PROF2.



There is danger of Laser radiation or electrical shock. For necessary repair work, the LLD-150-PROF2 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 nonconforming product usage may cause physical injury to the user or material damage to the LLD-150-PROF2.

Cable connectors must not be plugged or unplugged under voltage. Remember to turn voltage supply off before you begin working on cable connections.

2.2 Intended & Conforming Use

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

2.3 Nonconforming use

- Do not operate the LLD-150-PROF2 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 LLD-150-PROF2 must not be carried out by anyone other than authorized personnel.

- Refrain from using the LLD-150-PROF2 without certified protection in an explosive environment
- Measurement with the LLD-150-PROF2 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 faulty measurements.
- Measurement of strongly reflecting surfaces may deliver faulty results.
- Measurement performed through transparent optical media, for example glass, optical filters, Plexiglas, etc. may equally produce incorrect results.
- Measurement on translucent objects (materials allow light to pass through, but are not transparency, e.g. polystyrene, wax, different plastics etc.) can give a too large measured value, since also light is reflected by deeper layers
- Rapidly changing measuring conditions are likely to falsify the result of measurement

2.4 Laser Classification

The LLD-150-PROF2 is a Class 2 laser product with a maximum output power of 1 mW as stipulated in EN60825-1:2007, Class 2.

Caution:

There is Class 2 Laser radiation. Do not stare into beam!



Figure 2 : Warning Sign Laser Radiation Class 2

The Laser power is limited to maximum 1 mW. The Laser radiation is visible. A short-term exposure (duration up to 0.25 s) is harmless to the eye.

Users are instructed by Laser warning sign (see Figure 2) to do not stare into the beam. They have to protect themselves by turn the head and/or closing the eyes and by avoid a long look into the beam.

Do not direct the Laser beam onto persons.

The sensor can use without any additional safety protection.

2.5 Electric Supply

Use only 10 V to 30 V DC (direct voltage) for LLD-150-PROF2 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.

2.6 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 module on if there is fogging or soiling on its optical parts
- Do not touch any of the module's parts with bare hands.
- Proceed with care when removing dust or contamination from optical surfaces!
- Prevent shock impacts during transport and use of the LLD-150-PROF2
- Prevent overheating of the LLD-150-PROF2.
- Prevent major temperature variances during LLD-150-PROF2 operation
- In accordance with IP65 internal protection standards, the LLD-150-PROF2 is designed to be splash proof and dustproof.
- Read these safety and operating instructions with due care and follow them in practical use.

3 Technical Data

Table 1 : Technical data

Measurement range ³	0.1 m up to 30 m with natural surfaces, depending on target reflectance or reflectors more than 100 m achievable ⁴
Measuring accuracy ⁵	±2 mm under defined measuring conditions ⁶ ±3 mm (+15 °C up to +30 °C) ±4 mm in DS mode <0.5 m (+15 °C ... 30 °C) ±5 mm (-10 °C up to +50 °C)
Resolution ⁷	0.1 mm, user scalable, standard 1 mm
Reproducibility	±0.5 mm
Measuring time	0.24 to 6 s setup or auto Mode DT 0.1 s (10 Hz) mode DW at white surface 20 ms (50 Hz) mode DX at white surface (only LLD-150-PROF2-50)
Target motion speed	≤4 m/s in DX-Mode (LLD-150-PROF2-HH only)
Acceleration	≤2.5 m/s ² in DX-Mode (LLD-150-PROF2-HH only)
Operating temperature	-10 °C up to +50 °C -40 °C up to +50 °C (LLD-150-PROF2-X-H only)
Storage temperature	-40 °C up to +70 °C
Supply voltage	10 V ... 30 V DC (protected against polarity reversal) ⁸
Power consumption	Depending on operation mode < 2.5 W in Standby < 3.5 W for distance tracking < 24 W with heating active (only with -H option)

³ dependent on target reflectance, stray light influences and atmospheric conditions

⁴ e.g. 3M, self adhesive foil white non glossy

⁵ statistic spread 95 %

⁶ for measurement at a planar white target surface in continues movement or still standing, +15 up to +30 °C

⁷ dependent on target reflectance, stray light influences and atmospheric conditions Please

⁸ use only 24V DC For devices with heating (LLD-150-PROF2-x-H) The heater is connected directly to the power supply.

Profibus interface	Profibus DP norm slave , auto detect up to 12 Mbit, ID Number 0x2079 (8313), 13 Byte IN, 1 Byte OUT
Data interface	RS232, baud rate 9600 (2400..38400), ASCII, Format 8N1 (fix), receive path is deactivated after connecting to the Profibus master!
Digital switching output	„high-side-switch“, programmable switching threshold and hysteresis, rated for max. load of 0.5 A, HIGH = UB - 2 V, LOW < 2 V
Trigger input ⁹	External trigger, trigger pulse 3 up to 20 V, pulse length ≥ 1 ms, start of measurement 5 ms + trigger delay, trigger slope and delay can be set (0 ms ... 9999 ms),
EMC	EN 61326-1
Shock resistance	10 g / 6 ms Persistence shock DIN ISO 9022-3-31-01-1
Laser Class	Laser class 2, under EN60825-1:2007, Class 2
Wave length	650 nm (red visible)
Laser divergence ¹⁰	0.6 mrad
Laser angle tolerance	Better than ± 1° to the ground plane
MTBF	30,000 h, 24/7, Operating temp. +25 °C
Connector	12-pol. M18-male socket, Binder Serie 423
Dimensions (LxWxH)	212 mm x 96 mm x 50 mm
Mounting	100 mm x 85 mm, 4 x M6 holes
Weight	approx. 850 g
Protection class	IP 65 (spatter water and dust protection)

⁹trigger function is not available for devices with internal heating (LLD-150-PROF2-X-H)

¹⁰ at 10 m distance the beam diameter is 6 mm, at a distance of 50 m it is 3 cm and at a distance of 100 m it is 6 cm

4 Mounting

The casing consists of a rugged, corrosion-resistant extruded aluminum profile with front-side and rear-side covers also of corrosion-resistant design. Four mounting holes are provided in the base plate for mounting the LLD-150-PROF2.

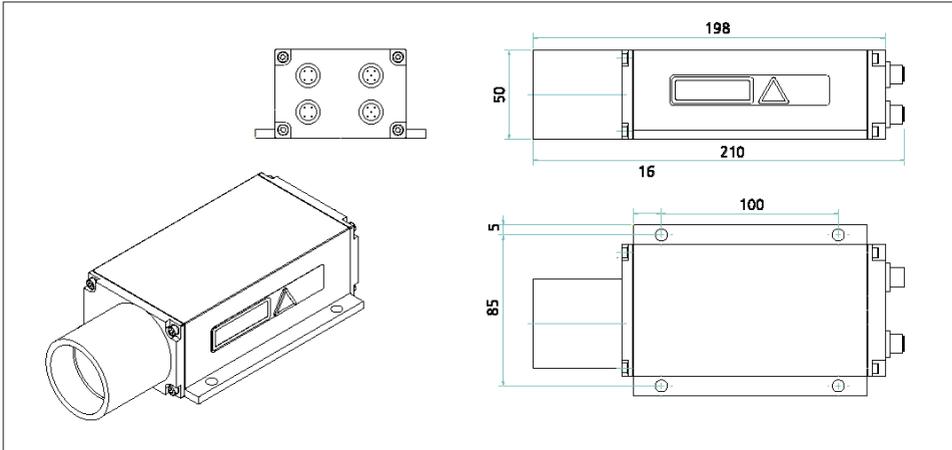


Figure 3 : Mounting drawing

To protect the range finder's optical surfaces from dust, physical contact and impacts, etc., a protection tube has been attached to the casing. Please note that measurement cannot be guaranteed to function correctly if the protection tube is removed incorrectly or by unqualified personnel!

The interface connector is located on the back cover. Interface cables with different length are available (standard 2 m, optionally 5 or 10 m).

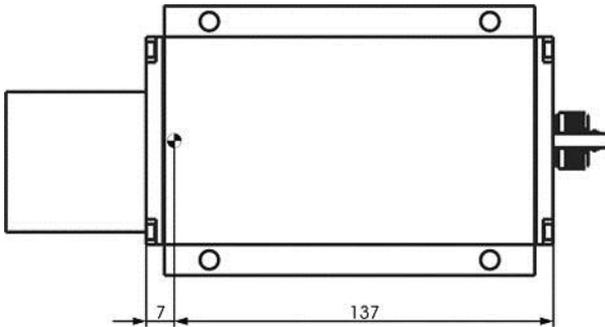


Figure 4 : Offset against zero-edge

The LLD-150-PROF2'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. It can be compensated with the help of parameter "OF" (see section 8.22 OF – display/set distance offset)

5 Electrical Connection

5.1 LDM Rear-Side Cover Terminals

Connector terminals are located on the rear-side cover of the device. The terminals consist of 4 buses for metal circular plug-in connectors (from Binder), or compatible connectors, sealed against the casing in compliance with IP 65 requirements. This connector type guarantees optimized screening and a high IP level.

The following connection plugs should be used:

Table 2 : LLD-150-PROF2

Quantity	Connector Type	Use
1	4-pin male cable connector (series 715 B from Binder)	Profibus DP Output
1	4-pin female cable connector *) (series 715 B from Binder)	Profibus DP Input
1	5-pin male cable connector (series 713 from Binder)	RS232
1	5-pin female cable connector (series 713 from Binder)	Power supply, trigger input and digital output

*) until Dec. 2006 4-pin male cable connector



Note: Various connectors and cables are available. Please ensure that **only shielded connectors and shielded cables** are used.

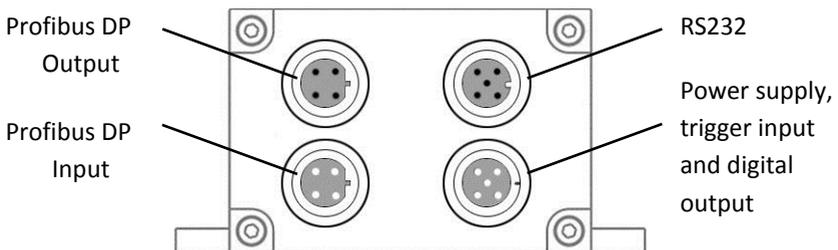


Figure 5 : LLD-150-PROF2 terminals

5.2 Assignment of Terminals

The required power supply is 10 to 30 V DC.

The trigger input allows for a distance measurement via an external signal in the form of a voltage impulse from 3 to 24 V (only DF mode, please see Chapter 8).

Table 3 : Pin assignment power supply, alarm and trigger

Pin	Description	Colour	Comment
1	VCC	brown	Power supply 10 to 30 V
2	ALARM	white	Digital Output (\geq VCC – 2 V)
3	GND	blue	Power supply 0 V
5	Trigger	gray	Trigger input 3 to 20 V (ground potential GND)

5.3 Profibus DP

The LLD-150-PROF2 has two terminals (input and output) for circular plug-in connectors (series 715 B for Profibus DP from Binder) conforming to the relevant standards.

Table 4 : Pin assignment Profibus DP

Pin	Description	Comment
1	+UB	Power supply for active terminal resistance
2	A	Profibus signal line A (green)
3	0 V	Power supply for active terminal resistance
4	B	Profibus signal line B (red)



Note: Only use connection plugs and Profibus cables that conform to the relevant standards. If the LLD-150-PROF2 is to be connected at the end of the bus, then a terminal resistance must be connected to the output terminal for the Profibus DP.

5.4 RS232 Serial Interface

The RS232 interface was originally designed as a PC interface only. It has now become the standard for serial data transfer for short distances. It is subject to interference when used for longer distances, in particular, in environments

with interfering high-frequency electromagnetic radiance. As a result, this interface should only be used for configuring the LLD-150-PROF2. Please configure using the programming cable and the LDMSTool program.

Following successful configuration, remove the programming cable and protect the terminal with a sealing plug.



Note: Please configure the LLD-150-PROF2 prior to connecting the Profibus. **The receiving line of the RS232 serial interface is deactivated after connecting to the Profibus master.**

Please observe the RS232 standard. The maximum extension of the RS232 lines is 15 m.

Table 5 : Pin assignment RS232

Pin	Description	Colour	Comment
1	RxD	brown	Receiving line
2	TxD	white	Transmit line
3	GND	blue	Ground potential

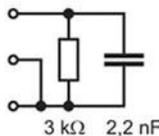


Note: Following successful programming, remove the RS232 cable and protect the RS232 cable connector with the enclosed sealing plug against entry of dirt. If the cable is to remain connected to the device, then a terminal resistance must be attached.

TxD Pin 2

RxD Pin 1

GND Pin 3



Ensure that no data line ends are left open, since they may be subject to interference (EMC).

A terminator circuit should be installed when the RS232 is unconnected.

Figure 6 : Termination RS232

This circuit must be provided by the customer (see diagram on the left).

5.5 Programming Cable

Connection to a PC requires the following cable with SUB-D 9 F connectors. The TxD and RxD signals of the LLD-150-PROF2 and the PC connection are crossed. The colours apply to the optional programming cable.

Table 6 : Pin assignment programming cable

Pin LLD PROF	Description	Colour	Pin SUB-D 9 F	Description
1	RxD	brown	3	TxD
2	TxD	white	2	RxD
3	GND	blue	5	GND

5.6 Shield and Grounding

Cable shields must be grounded with low resistance. Only high quality shielded cables should be used.

Carrier bases and control boxes should have equal potential. Potential differences could lead to electrical currents and may cause EMC problems (no correct measurement function or switching the gauge off or on is necessary).

If no potential equalization is possible, then mount the LLD-150-PROF2 isolated from the carrier base (use nylon screws and washers). Connect the screen with mass to the cable end. This way of assembly should also be used when installing the LLD-150-PROF2 inside vehicles.

6 Limiting Values for Voltages

Input voltages:

Table 7 : Input voltages

Terminal point	Voltage	Comment
VCC	+10 V ... +30 V	Pole-reversal-protected
TxD	± 13.2 V	Short-circuit-proof
RxD	± 25 V	Short-circuit-proof
TRIG ¹¹	± 25 V	Short-circuit-proof

Output voltages:

Table 8 : Output voltages

Terminal point	Voltage	Comment
TxD	± 5.4 V	± 5 V at 3 k Ω load
Alarm	$\geq VCC - 2$ V	Level depending on VCC

Limiting values of voltages, loads and logical levels comply with relevant RS232 and Profibus standards.

¹¹Trigger function is not available for devices with internal heating (LLD-150-PROF2-x-H)

7 Start up

Ensure that all cable ends are protected against short circuit prior to turning on the power supply!

Connect cable terminals as required for the particular operating mode. A pole-reversal protection is included so as to prevent the destruction of electronic components.

Connection to the Profibus master should only take place following start up!



Note: Please turn on the LLD-150-PROF2 prior to connecting the Profibus. **The receiving line of the RS232 serial interface is deactivated after connecting to the Profibus master.**

Turning on the LLD-150-PROF2 requires a **PC with a corresponding COM1 data interface**, an **optional programming cable** and a terminal programme. We recommend the use of the following programme: **LDMTOOL (Version 4.5 or higher)**.

When turning on the LLD-150-PROF2, it must be properly installed at the designated operation site, aimed at the target, and kept in a stable position. Targets to be measured (e.g. machine or system components) should preferably have a light and homogeneous surface. Several optional reflex foils are available.



Caution: Do not use any retro reflectors!

Alignment of the LLD-150-PROF2 is facilitated by a visible laser beam¹² that can easily be turned on from a PC.

Operating voltage supply occurs via the power supply terminal (see Chapter 5).

¹² Depending on ambient light and target conditions

8 Parameters and Control via RS232

8.1 General

It is easy to configure the LLD-150-PROF2 by using a PC, as it provides a wide range of operating functions. Configuration should take place prior to connecting to the Profibus.



Caution: If the LLD-150-PROF2 has been configured via the Profibus DP Master, then the PC interface (RS232) can no longer be used to enter commands. However, the LDMTTool programme can be used for display distance values.

By selecting the ID[Enter] command, you may call up the menu with the available set-up commands.

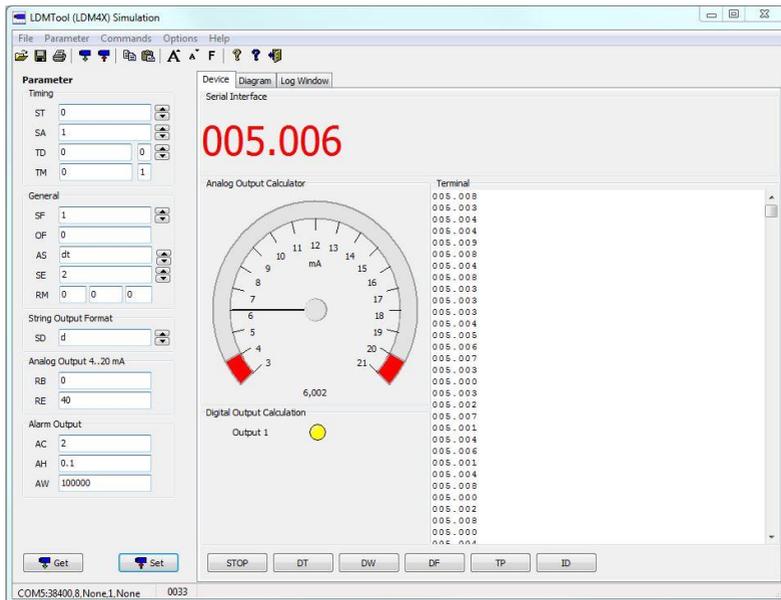


Figure 7 : LDMTTool

Prior to commencing measurements, desired parameter settings can be entered via a smart selection procedure, so as to adapt the LLD-150-PROF2 in an optimal manner to specific environments and measuring tasks.

Such settings will be stored when turning off the LLD-150-PROF2.

They can only be changed by entering new values or by reinstalling the standard parameter settings.

Command entries are not case-sensitive. This means that small and capital lettering can be used for commands.

Any command must be terminated by a hexadecimal 0Dh (carriage return) character.

Where decimal digits are to be entered, they must be separated by period (2Eh).

For command parameter entries, one must distinguish between parameter settings and parameter queries.

Querying is achieved with a command in simple format, e.g. (for alarm center parameters):

AC[Enter]

For parameter setting, a new value must be added after the command with no delimitation sign in between, for example:

AC20.8[Enter]

In the given example, the alarm center will be set to 20.8.



Note: The LLD-150-PROF2 are not equipped with an analogue current output. Therefore the configuration commands for the analogue output cannot be used for the LLD-150-PROF2. However, they do ensure compatibility with the LLD-150-PROF2 (without Profibus DP).

The following is a short overview of the commands:

Table 9 : Command list LLD-150-PROF2

Command	Description
DT	Start distance tracking
DS	Start distance tracking (< 7 m)
DW	Start distance tracking on white target at 10 Hz
DX	Start distance tracking on white target at 50 Hz
DF¹³	Start remote triggered single distance measurement
DM	Start single distance measurement
TP	Queries inner temperature
SA	Queries/sets floating average value(1...20)
SD	Queries/set output format (dez/hex/sig)
ST	Queries/set time to measure(0...25)
SF	Queries/set scale factor
SE	Queries/set Error Mode (0, 1, 2)
AC	Queries/set alarm center
AH	Queries/set alarm hysteresis
AW	Queries/set alarm width
HO¹⁴	Queries/set temperature for heating on
HF¹⁴	Queries/set temperature for heating off
TD	Queries/set trigger delay and level
BR	Queries/set baud rate
AS	Queries/set auto start
OF	Queries/set offset
SO	Sets current distance as offset
LO	Turns Laser on
LF	Turns Laser off
PA	Displays all parameter values
PR	Resets all parameters to standard values (don't use)

¹³ Trigger function is not available for devices with internal heating (LLD-150-PROF2-X-H)

¹⁴ Only for devices with internal heating (LLD-150-PROF2-X-H)

8.2 DT – distance tracking

Input parameter SA, SD, SE, SF, ST, OF

Output RS232/RS232, digital switching output, analog output

DT mode can be chosen for distance measurement of different kinds of surfaces (varying reflectance). In this type of distance tracking mode, the LLD-150-PROF2 uses internal algorithms to continuously evaluate the quality of the Laser radiation signal that is coming back. This may cause longer measuring times in the case of poor reflectance or sudden jumps in distance.

The minimum time to measure is 240 ms, the maximum time is 6 s. If the measuring signal fails to reach a specified quality within six seconds, an error message is output.

The time to measure may also be limited by setting the ST parameter to a desired value. ESC stops the measurement.

8.3 DS – distance tracking (<7 m)

Input parameter SA, SD, SE, SF, ST, OF

Output RS232/RS422, digital switching output, analog output

Operation in DS mode makes sense where different types of surfaces have to be measured at close range up to 7 m. Compared to DT measuring mode, it allows a higher measurement rate. Within the range from 0.1 m to 0.5 m, measuring accuracy is restricted (± 4 mm). Measuring time (time to measure) can be limited via ST parameter settings.

ESC stops the measurement.

8.4 DW – distance tracking with target board (10 Hz)

Input parameter SA, SD, SE, SF, OF

Output RS232/RS422, digital switching output, analog output

DW mode performs at a steady measuring rate of 10 Hz. As a necessary precondition for measured values to be stable, a white target board must be placed at the selected object. There must be no sudden jumps in distance greater than 16 cm within the measuring field!

ESC stops the measurement.

8.5 DX – distance tracking with target board (50 Hz)

Input parameter	SA, SD, SE, SF, OF
Output	RS232/RS422, digital switching output, analog output

DX mode performs at a steady measuring rate of 50 Hz (only LLD-150-PROF2-50). As a necessary precondition for measured values to be stable, a white target board must be placed at the selected object.

This measurement mode is intended in the first place for objects performing homogeneous motion up to 4m/s. For higher rates of measurement, preceding measured values will be included in the process to calculate a currently measured value. There must be no sudden jumps in distance greater than 16 cm within the measuring field!



Caution: To prevent transmission problems, please use 9600 baud as the minimal baud rate for DX Mode!

8.6 DF – distance measurement with external trigger¹⁵

Input parameter	SD, SE, SF, ST, OF, TD, ST, SA, RM
Output	RS232/RS232, digital switching output, analog output

DF mode allows a measurement that is triggered by an external trigger pulse.

Initially, after selecting this mode, the operator does not receive any response. As soon as the trigger pulse has been detected, the LLD-150-PROF2 will send data and switches to digital and/or analog output.

Settings for trigger delay (delay) and trigger slope can be defined via parameter TD (see 8.19 TDx y – display/set trigger delay trigger level).

With ST=1 the maximum trigger frequency should not exceed 3.5 Hz.

¹⁵Trigger function is not available for devices with internal heating (LLD-150-PROF2-x-H)

8.7 DM – distance measurement

Input parameter SD, SE, SF, ST, OF

Output RS232/RS232, digital switching output, analog output

DM mode triggers a single measurement (single shot)

8.8 TP – internal temperature [°C]

TP queries the value of the inner LLD temperature.

Note: In tracking mode, the inner temperature may exceed the surrounding temperature level by as much as 10 K.

8.9 SA – display/set average value [1..20]

SA allows you to calculate a floating average value from 1 to 20 measured values. Calculation is based on this formula:

$$\text{Average value: } \bar{x} = \frac{x_1 + x_2 + x_3 + \dots + x_{n(20)}}{n}$$

Standard setting is 1 (no average).

8.10 SD – display/set display format [d/h/s]

SD selects the output format of measured value data. There are three modes available:

Table 10 : Output format

Parameter	Output	Format
d	decimal	xxx.xxx<CR><LF> x=0...9
h	hexadecimal	<SPACE>xxxxxx<CR><LF> x=0...F
s	decimal with signal quality	xxx.xxx<SPACE>yyyyyy<CR><LF> x=0...9; y=0...9

SD affects all commands that output a distance value.

An output value is calculated from a given measured distance value (in mm), multiplied by the scale factor SF.

Negative distance values are output in two's complement notation.

The value for the signal quality varies between 0 and 1024. 0 means a bad signal quality while 1024 indicates a very good signal quality.

Examples:

Distance = 4,996 m, SF1

dec: 004.996<CR><LF>

hex: <SPACE>001384<CR><LF>

(= 4996 mm × SF1)

dec+sig: 004.996_000005<CR><LF>

(bad signal quality)

dec+sig: 004.996_000985<CR><LF>

(good signal quality)

Distance = 4,996 m, SF10

dec: 049.960<CR><LF>

hex: _00C328<CR><LF>

(= 49960 = 4996 mm × SF10)

dec+sig: 049.960_000005<CR><LF>

Error case

dec/hex: E15<CR><LF>

(see 11 Error Codes RS232 and Profibus)

8.11 ST – display/set measure time [0..25]

Measuring time is directly conditional on the selected measuring mode. As a general rule, one may say: the poorer the reflectance of the surface of a particular target, the more time the LLD-150-PROF2 will require to determine the distance with specified accuracy. For example, if error message E15 is output because of poor reflectance and insufficient time to measure, this latter setting must be increased.

The available value range for measuring time is 0 to 25. Basically, the greater the time setting is the more time will be available for measurement and the lower the resulting measuring rate.

An exception there from is zero-value. In this case, the LLD-150-PROF2 automatically picks the smallest possible time value for measurement!

LLD-150-PROF2 comes factory-set with $ST = 0$.

ST is effective in the DT, DF and DM mode of operation.

The measuring time setting option can also be used to modify the measuring rate, for example, in order to restrict the data volume or for synchronization purposes. Measuring time can only be set as an approximate value, because the underlying principle of measurement is subject to certain variances that cannot be accounted for:

DT measuring mode \rightarrow measuring time = $ST \times 240$ ms (except $ST = 0$)

DS measuring mode \rightarrow measuring time = $ST \times 150$ ms (except $ST = 0$)

Example:

The target distance is 25 m, but the target's reflectance is not ideal. With a measuring time setting of ST 2, E15 will be output following measurement. The user must increase the time ($ST > 2$) or set auto ($ST = 0$) to measure in this case!



One should work in DW or DX measuring mode where stable measuring times are required.

8.12 SF – display/set scale factor

SF multiplies a calculated distance value with a user-selectable factor for changes in resolution or outputs in a different unit of measure. The scale factor may also be negative. Standard setting is 1.

The scale factor influence the output of measurement results, Offset (OF), Alarm Centre (AC), Alarm Hysteresis (AH), Range Begin (RB) and Range End (RE)!

Table 11 : Examples of scale factor

Scale factor	Resolution	Output	Output Unit
SF1	1 mm	012.345	m
SF10	0.1 mm	123.450	dm
SF1.0936	0.01 yard	013.500	yard
SF3.28084	0.01 feet	040.501	feet
SF0.3937	1 inch	004.860	100 inch
SF-1	1 mm	-12.345	m



Note: Following a change in the scale factor, the settings for digital and/or analog output and offset must be matched accordingly!

8.13 SE – display/set error mode [0/1/2]

SE (error mode) allows you to configure the behavior of the digital switching output (alarm) and/or the analog output following an error message (E15, E16, E17). Depending on the particular LLD-150-PROF2 application environment, error messages have to be handled in different ways.

Available setting options are 0, 1 and 2 with the following effects in the case of an error:

Table 12 : Meaning of SE

SE	Digital switching output (Alarm)	Analog output (4 -20 mA)
0	ALARM of latest valid measurement	Outputs current of last valid measurement
1	Positive alarm hysteresis = LOW Negative alarm hysteresis = HIGH	RE >RB: Current =3 mA RE <RB: Current =21 mA
2	Positive alarm hysteresis = HIGH Negative alarm hysteresis = LOW	RE >RB: Current =21 mA RE <RB: Current =3 mA

8.14 AC – display set ALARM center

AC sets the beginning of the distance range, for which the switching output will be turned active. The length of this active range can be set using the AW parameter.

AC must be selected in keeping with the currently set SF scale factor (see **9.4 Digital Switching Output (Alarm)**).

8.15 AH – display/set ALARM hysteresis

AH allows you to make parameter settings for the switching hysteresis at the beginning and the end point of the active range of the switching output.

AH must be selected so it is properly matched to the currently valid scale factor (SF).

The mathematical sign of AH can be used to set an active state logic level:

Positive sign (“+”): active range is HIGH-active.

Negative sign (“-“): active range is LOW-active.

No sign setting means positively-signed (see **9.4 Digital Switching Output (Alarm)**).

8.16 AW – display/set ALARM width

AW sets the length of the active range, beginning at AC.

AW settings must be made in agreement with the currently valid SF scale factor.

AW is always equal or greater than “0” (zero).

AW is always equal or greater than |AH| (the amount of AH).

Standard setting is 100000 – means off.

8.17 HO – display/set Temperature for heating on¹⁶

HO displays/sets the temperature value at which the internal heating is switched on. The values can be varied between -40°C and 70°C.

Standard setting is 3°C.

¹⁶Only for devices with internal heating (LLD-150-PROF2-x-H)

8.18 HF – display/set Temperature for heating off¹⁶

HF displays/sets the temperature value at which the internal heating is switched off. The values can be varied between -40°C and 70°C. Standard setting is 12°C.

8.19 TDx y – display/set trigger delay trigger level¹⁷

TD is only intended for the configuration of the remote trigger input (see 8.6 DF – distance measurement with external trigger).

TD consists of two sub parameters, of the actual delay value, i.e. the delay time, and the trigger level.

Trigger delay corresponds to the time from arrival of the trigger signal to the starting point of a measurement. It may be set to any value between 0 and 9999 ms. With the help of the trigger level one may define if measurement is to begin on a rising or a falling pulse slope.

Trigger delay and trigger level must be separated by space (20h) in the entry line. Standard setting: 0 0.

x Delay time between trigger signal and start of measurement, delay can be set from 0 to 9999 ms.

y 0 for HIGH → LOW-slope
 1 for LOW → HIGH-slope

Example:

```
TD1000_0[Enter]
```

In the given example, the delay has been set to 1000 ms and the trigger slope to "rising" (LOW-to-HIGH transition)

8.20 BR – display/set baud rate [2400..38400]

Available baud rate settings are: 2400, 4800, 9600, 19200, 38400. Faulty entries will be rounded to the nearest baud rate. A fixed data format of eight

¹⁷Trigger function is not available for devices with internal heating (LLD-150-PROF2-X-H)

data bits, with no parity and one stop bit is used. Standard setting is 9600 baud.

8.21 AS – display/set autostart command

AS (auto start) defines which function will be carried out when power becomes available to the LLD-150-PROF2.

Possible entries are those delivering a measured value on the output side, an ID command or the command for turning the Laser on (LO).

For example, if ASDT has been parameterized, the LLD-150-PROF2 will begin with distance tracking on turning on power.

8.22 OF – display/set distance offset

With the help of OF (offset) the user may define a zero-point for his/her application. For details on the position of the module's zero-point, refer to section 4.

OF must be selected so it is properly matched to the currently valid scale factor setting (SF).

OF may also take on negative values. Standard setting: 0

8.23 SO – set current distance to offset

SO performs a distance measurement and saves the measured reading as an offset value with inverted mathematical sign (OF).

8.24 LO – Laser on

LO turns the Laser on. This function can be used for orientation or functional testing of the LLD-150-PROF2. After the command LO it's necessary to send LF! Don't use LO because this. Please use instead of LO the command DT to turn the Laser on.

8.25 LF – laser off

LF turns the Laser off.

8.26 PA – display settings

PA lists all parameters in a table.

8.27 PR – reset settings

PR resets all parameters (except baud rate). After this a new configuration of the LLD-150-PROF2 is necessary

```

average value[SA].....1
display format[SD].....d
measure time[ST].....0
scale factor[SF].....1
error mode[SE].....1
ALARM center[AC].....1000
ALARM hysteresis[AH].....0.1
ALARM width[AW].....100000
distance of Iout=4mA [RB].....1000
distance of Iout=20mA [RE].....2000
remove measurement [RM].....0 0 0
trigger delay, trigger level[TD]..0 0
trigger mode, trigger level[TM]...0 1
baud rate[BR].....9600
autostart command[AS].....ID
distance offset[OF].....0

```



Use instead of PR the "Set Standard" command from Windows program LDMTool.

9 Interface Connection

9.1 Profibus DP

General

The LLD-150-PROF2 is operated as a standard Profibus slave. It becomes operational with master 13 byte entry data: 2x 8 bit error information, 16 bit measurement value counter, 32 bit time stamp, 32 bit distance and 8 bit internal temperature are available.

One byte of output data is used for control. It is possible to switch between various measurement modes. In addition, the internal equipment temperature can be measured and the laser can be turned off.

Bus rates of up to 12 Mbaud (autodetect) are supported. The slave address is provided via the bus. **The slave address will be set via Profibus** (e.g. Siemens PG other master with SET_SLAVE_ADD_REQ).

Connection takes place via circular plug-in connectors that are in compliance with relevant standards. If only one Profibus is used, then a terminal resistance should be attached to the other Profibus.

Configuration of measuring time, scaling, etc., takes place via the serial interface (see Chapter 8).

Parameter Setting

The LLD-150-PROF2 is configured as a standard Profibus slave. The standard mode transfers binary data from the Profibus. In the ASCII mode, the ASCII values are transferred in the way they are transferred from the LLD-150-PROF2 (only for special applications).



Note: Please ensure that the parameter setting of the LLD-150-PROF2 is correct. The parameter baud rate (BR9600) and output format (SDh) must be set via the serial RS232 interface of the LLD-150-PROF2 by using a PC and the LDMTTool programme, or alternatively a terminal program, prior to connection to the Profibus Master!

Table 13 : Meaning of Profibus DP modes

Modes	Profibus IN	Profibus Configuration	Profibus Configuration Bytes
Standard	8 bit Error Counter	13 byte IN	156 32 0 (0x9C 0x20 0)
	8 bit Error Code	1 byte OUT	
	16 bit Counter		
	32 bit Time Stamp		
ASCII	32 bit Distance ¹⁸		223 0 0 (0xDF 0 0)
	8 bit Temperature ¹⁹		
	16 bit Counter	32 byte IN	
	32 bit Time Stamp	0 byte OUT	
	8 bit Number of Character n		
	n byte ASCII Character		

Profibus IN, Explanation of Error Codes

Table 14 : Profibus error codes

Code	Description
0 (0x00)	<u>Received valid measurement value</u> ; Error Counter and Code are set to zero
15 (0x0F)	Reflexes too weak, use target board ²⁰ or distance from LDM (front edge) is out of range
16 (0x10)	Reflexes too strong, use target board
17 (0x11)	Too much constant light (e.g. sun)
23 (0x17)	Temperature below - 10 °C
24 (0x18)	Temperature above + 50 °C
61 (0x3D)	Faulty command
255 (0xFF)	Invalid string from LDM 4x P (e.g. hexadecimal output has not been set)

Profibus IN, Explanation of Additional Binary Values

Error Counter Number of errors after last valid measurement value

Counter Increased for each new valid measurement value

¹⁸ Scaling depends on LLD-150-PROF2 parameter settings

¹⁹ Displays the internal temperature in °C, if the control byte has been set on the TP mode, activation HI/LO slope bit 6

²⁰ E.g. 3M, white non-glossy foil

Time Stamp Set for each new valid measurement value (ms)

Profibus OUT, Explanation of Control Byte

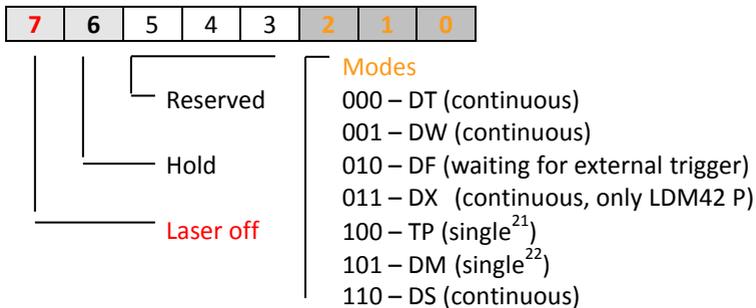
The control byte sets the **Measuring Mode** via **Bit 0 to 2**. For a description of the various **Modes**, please see Chapter 8.

Bit 3 to 5 are reserved and can be set to 0.

If **Bit 6** has been set to 1, then the actual measuring value is kept. If Bit 6 is set from 0 to 1, the 1/0 slope is also activated. This slope will provide a new measurement for the DM single measurement mode and TP temperature measurement. For all other modes, Bit 6 generally remains set at 0.

To turn off the **Laser** and switch the LLD-150-PROF2 to **standby operation**, **Bit 7** should be set at 1. The remaining bits have no meaning.

If all bits are set at 0, then the LLD-150-PROF2 will operate in the DT mode (Distance Tracking, continuous measurement).



9.2 Serial Interface RS232

Initially, RS232 communication interfaces purely functioned as PC communication ports. They have become the established standard tool for serial data transmission over short cable lengths. With greater transmission lengths, the interface is highly susceptible to interferences, notably, in the vicinity of strong electromagnetic noise emitters.

Therefore, it should only be used for LLD-150-PROF2 configuration.

²¹ New temperature measurement (second and subsequent) at Bit 6 Hold (1/0 slope)

²² New distance measurement (second and subsequent) at Bit 6 Hold (1/0 slope)

The commands of the serial interface are described in chapter 8 starting page 21. The data output format is determined by parameter SD (display format), see page 26.

9.3 Output Format Ethernet and RS232

The output format on the serial interface is selected by the command SD. There are three modes available:

Parameter	Output	Format
d	decimal	xxx.xxx<CR><LF> x=0...9
h	hexadecimal	<SPACE>xxxxxx<CR><LF> x=0...F
s	Decimal with signal quality	xxx.xxx<SPACE>yyyyyy<CR><LF> x=0...9; y=0...9

SD affects all commands that output a distance value.

An output value is calculated from a given measured distance value (in mm), multiplied by the scale factor SF.

Negative distance values are output in two's complement notation.

The value for the signal quality varies between 0 and 1024. 0 means a bad signal quality while 1024 indicates a very good signal quality.

Examples:

Distance = 4,996 m, SF1

```
dec:    004.996<CR><LF>
hex:    <SPACE>001384<CR><LF>
        (= 4996 mm × SF1)
dec+sig: 004.996_000005<CR><LF>
        (bad signal quality)
dec+sig: 004.996_000985<CR><LF>
        (good signal quality)
```

Distance = 4,996 m, SF10

```
dec:    049.960<CR><LF>
hex:    _00C328<CR><LF>
        (= 49960 = 4996 mm × SF10)
```

dec+sig: 049.960_000005<CR><LF>

Error case

dec/hex: E15<CR><LF>

(see page 42, chapter 11, Error Codes RS232 and Profibus)

9.4 Digital Switching Output (Alarm)

With the help of a user-selectable distance threshold, the switching output can be set to monitor objects or conditions for positive or negative overstep.

For example, using the digital switching output, an object which was selected for measurement can be monitored for excision of a threshold value. To do this, parameter settings for a measurement window are required. Settings for this window can be made via the three parameters: Alarm Center (AC), Alarm Hysteresis (AH) and Alarm Width. The range which will be subject to monitoring begins at AC and ends at AC+AW. Switching transitions can be set via parameter AH.

The logic state of the switching output follows from the mathematical sign of AH.

In the case of a positive AH, the output switches

- with increasing distance:

- from LOW to HIGH if the distance is greater than $(AC \pm AH/2)$
- from HIGH to LOW if the distance is greater than $(AC+AW+AH/2)$

- with decreasing distance:

- from LOW to HIGH if the distance is smaller than $(AC +AW-AH/2)$
- from HIGH to LOW the distance is smaller than $(AC-AH/2)$

In the case of a negative AH, the output switching pattern will be inverse.

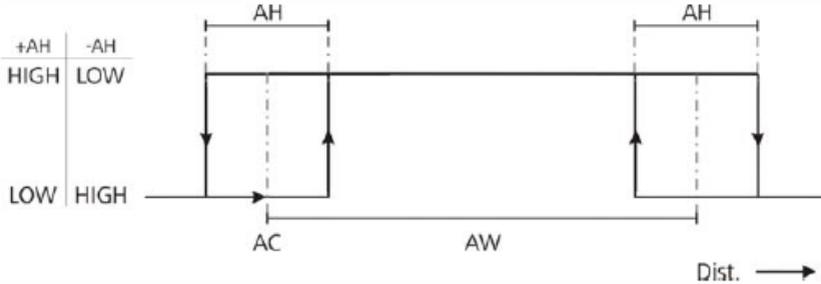


Figure 8 : Digital switching output behavior with positive and negative hysteresis

Example:

A moving object is assumed to be monitored within a window of 10 m to 11 m with a hysteresis of 0.2 m.

AC10
AH0.2
AW1

Distance (m) increases →										
	9.8	9.9	10.0	10.1	10.2	...	11.0	11.1	11.2	11.3
+AH	L	L	L	H	H	H	H	L	L	L
-AH	H	H	H	L	L	L	L	H	H	H

Distance (m) decreases →										
	11,3	11,2	11,1	11,0	10,9	10,8	...	10,0	9,9	9,8
+AH	L	L	L	L	H	H	H	H	H	L
-AH	H	H	H	H	L	L	L	L	L	H

L = LOW, H = HIGH

How the switching output is to behave on occurrence of an error message (E15, E16, E17, E18) can be defined by making suitable settings under "SE" (see 8.13, SE – display/set error mode [0/1/2])

9.5 Trigger Input²³

The trigger input is intended for triggering a distance measurement with an external signal that is applied as a voltage pulse between 3 V and 20 V. This input is used only in trigger mode DF (DF – distance measurement with external trigger)!

It is for the user to specify a desired delay time and a pulse slope to be selected for synchronization (see 8.19, TDx y – display/set trigger delay trigger level). The distance measurement will always be started with a delay of 5 ms in addition with the programmed trigger delay time.

Having done this, the LLD-150-PROF2 has to be switched to trigger mode (see 8.6, DF – distance measurement with external trigger).

²³Trigger function is not available for devices with internal heating (LLD-150-PROF2-x-H)

10 List of Commands

Table 15 : LLD-150-PROF command list

Command	Description
DT	Starts distance tracking
DS	Starts distance tracking (< 7 m)
DW	Starts distance tracking on white target at 10 Hz
DX	Starts distance tracking on white target at 50 Hz (only LDM42P)
DF	Starts remote-triggered single distance measurement (single shot)
DM	Starts single distance measurement (single shot)
TP	Queries inner temperature
SA	Queries / sets floating average value (1...20)
SD	Queries / sets output format (dec/hex/sig)
ST	Queries / sets time to measure (0...25)
SF	Queries / sets scale factor
SE	Queries / sets error mode (0, 1, 2)
AC	Queries / sets alarm center
AH	Queries / sets alarm hysteresis
AW	Queries / sets alarm with
HO²⁴	Queries / sets temperature for heating on
HF²³	Queries / sets temperature for heating off
TD	Queries / sets trigger delay and level
BR	Queries / sets baud rate
AS	Queries / sets auto start
OF	Queries / sets offset
SO	Sets current distance as offset
LO	Turns Laser on (do not use, please use DT)
LF	Turns Laser off
PA	Displays all parameter values
PR	Resets all parameters to standard values (don't use)

²⁴Only for devices with internal heating (LLD-150-PROF2-H)

11 Error Codes RS232 and Profibus

Table 16 : Error codes

Code	Description	Action
E15	Reflexes are too weak, or distance from LDM (front edge) to target is less than 0.1 m	Use white target board ²⁵ or increase distance to target
E16	Reflexes are too strong	Use white target board or filter
E17	Too much steady light (e.g. sun) or reflexes are too strong	Use aperture or filter or white target board
E18	DX mode (only LDM42P): reflexes too weak, or distance from LDM (front edge) to target is less than 0.1 m	Use white target board or increase distance to target
E19	DX mode (only LDM42P): Motion speed > 10 m/s	Reduce motion speed
E23	Inner temperature below – 10°C	Heating necessary
E24	Inner temperature above + 60°C	Cooling necessary
E31	EEPROM checksum error	Necessary to repair
E51	Failed to set avalanche voltage	Necessary to repair
E52	Excessively high Laser current / Laser defect	Necessary to repair
E53	Division by 0	SF must be unequal of zero or necessary to repair
E54	Hardware error, PLL range	Necessary to repair
E55	Other hardware error	Necessary to repair
E61	Invalid command	Correct input
E62	Wrong parameter, wrong command	Check data transmission
E63	SIO overflow	Check data transmission
E64	SIO framing error	Check data transmission

²⁵ e.g. 3M, foil matte white

12 GSD Data

```

;=====
; Profibus Device ASTECH Unigate for LDM4xA and LDM4xP
; Model : LDM 4x Series
; Description : LDM 4x Series with Profibus-DP
; Language : English
; Date : 6 September 2005
; Author : ASTECH GmbH
;=====

#Profibus_DP

GSD_Revision          = 1

; Device identification
Vendor_Name           = "ASTECH"
Model_Name            = "LDM4xP"
Revision              = "V2.0"
Ident_Number          = 0x2079
Protocol_Ident        = 0
Station_Type          = 0
FMS_supp              = 0
Hardware_Release      = "Revision D"
Software_Release      = "V2.0"

; Supported baudrates
9.6_supp              = 1
19.2_supp             = 1
93.75_supp            = 1
187.5_supp           = 1
500_supp              = 1
1.5M_supp            = 1
3M_supp              = 1
6M_supp              = 1
12M_supp             = 1

; Maximum responder time for supported baudrates
MaxTsdR_9.6          = 60
MaxTsdR_19.2         = 60
MaxTsdR_93.75        = 60
MaxTsdR_187.5        = 60
MaxTsdR_500          = 100
MaxTsdR_1.5M         = 150
MaxTsdR_3M           = 250
MaxTsdR_6M           = 450
MaxTsdR_12M          = 800

; Supported hardware features
Redundancy            = 0           ; not supported
Repeater_Ctrl_Sig     = 0           ; not supported
24V_Pins              = 0           ; not connected
Implementation_Type    = "SPC3"

```

```

Bitmap_Device      = "LDM4xP_"

; Supported DP features
Freeze_Mode_supp  = 1
Sync_Mode_supp    = 1
Auto_Baud_supp    = 1
Set_Slave_Add_supp = 1

; Maximum polling frequency
Min_Slave_Intervall = 1      ; 100 us

; Maximum supported sizes
Modular_Station    = 1      ; modular
Max_Module         = 1
Max_Input_Len      = 244
Max_Output_Len     = 244
Max_Data_Len       = 432
Modul_Offset       = 0

Fail_Safe          = 0      ; state CLEAR not accepted
Slave_Family       = 9
Max_Diag_Data_Len = 8

; Definition of modules
Module = "Standard: 1/1/2/4/4/1 Byte" 0x9C,0x20
EndModule
Module = "-----" 0x00,0x00
EndModule
Module = "ASCII: 2/4/1/25 Byte" 0xDF,0x00,0x00
EndModule

;=====

```

Bitmap LDM4xP_N.bmp

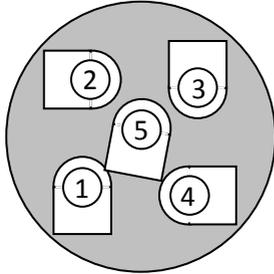


Figure 9 : GSD data and bitmap

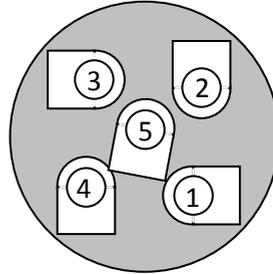
13 Contact Assignment for Cable Connectors

Numbers are displayed **when looking at the terminal side.**

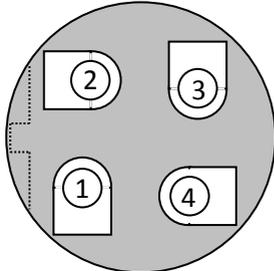
RS232
5-pin male cable connector



Power supply and Trigger
5-pin female cable connector



Profibus Output
4-pin male cable connector
(B code)



Profibus Input
4-pin female cable connector
(B code)

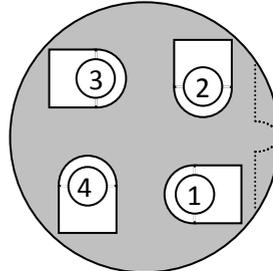


Figure 10 : Contact assignment

14 EG Declaration of Conformity

In accordance with the

Directive of Electromagnetic Compatibility 2004/108/EG

The company WayCon Positionsmesstechnik GmbH in Mehlbeerenstr. 4, 82024 Taufkirchen / Germany herewith declare, represented by the signatory, that the following designated product

Laser Distance Measurement Sensor

LLD-150-PROF2

agrees with the following harmonized standard:

IEC 61326-1

Electromagnetic interference and electromagnetic compatibility (EMC)

***including radio interference**