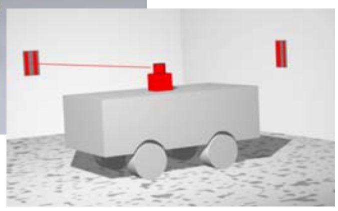

Laser Scanner

HG 43600YA

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1 General Annotations

This is the description of the Götting Laser Scanner HG 43600YA. The Laser Scanner allows a very variable way of guiding vehicles. Using reflecting marks, vehicles can be guided more or less autonomously depending only on the programming.

With additional sensors for obstacle detection (like ultrasonic or optical systems) it is possible to guide the vehicle around an obstacle on alternative routes. The accuracy of the position is sufficient enough for even meeting the high requirements for taking over loads automatically.

1.1 Intended use

ATTENTION! The Laser Scanner HG 43600YA may only be applied in industrial areas.

The Laser Scanner HG 43600YA has exclusively been designed for detecting reflecting marks (source: refer to section 2.4 starting on page 12) in its environment and output the position of the reflection marks for further processing through an interface.

In order to be able to guide and position a vehicle, it is necessary to construct a positioning system, which is able to control a vehicle based on the available positioning data. The Laser Scanner will then be part of this system.

1.2 Safety Information (Laser)

Figure 1 Laser Class 1

LASER CLASS 1

The optical output power of the laser is **not dangerous** for the eyes (in general: for human tissue). The optical output power of the laser is limited and eye-safe according to

- EN 60825-1
- VDE 0837 and
- IEC 825-1

The sensor therefore meets the requirements of the 'laser class 1'.

Using **invisible laser radiation** the sensor searches (scans) its environment for reflecting marks. In stand-by (motionless), the laser is turned off and will not be turned on before the sensor has reached a certain minimum speed of rotation.

1.3 Maintenance Instructions

In order to guarantee the undisturbed operation of the Laser Scanner, ensure that the Laser Scanner screen is clean. Only use very soft fabric, e. g. slightly damped microfibre cloth or pre-moistened lens cleaning wipes, to clean the transparent cover. Do not use paper tissues!

1.4 Special Advice regarding Positioning Accuracy

The accuracy of the position calculation depends on the accurate placement of the reflecting marks (reflectors). As long as a minimum of four marks with a distance of at least 15° between each other and a distance to the sensor of not more than 15 m are recorded, the repeating accuracy of the absolute positioning measurement will be **better than ±5 mm**. The difference between the absolute and the repeat accuracy results from possible mistakes during the reflector placement.

NOTE! The measurement of the coordinates and the positioning of the reflectors has to be carried out by experienced and specialised staff. Inaccuracy during this measurement will inevitably lead to inexact determination of the position and in the overall view to an incorrect navigation.

2 Mounting Instructions

2.1 Mounting

Three drill holes M5 are required for mounting the Laser Scanner (e.g. on the outer body of the vehicle).

NOTE! Underneath the whole area of the Laser Scanner, the body of the vehicle needs to be plane and tough in order to level the Laser Scanner after the mounting (also refer to section 2.1.2)!

ATTENTION! Maximum torque of mounting screws 5 Nm!

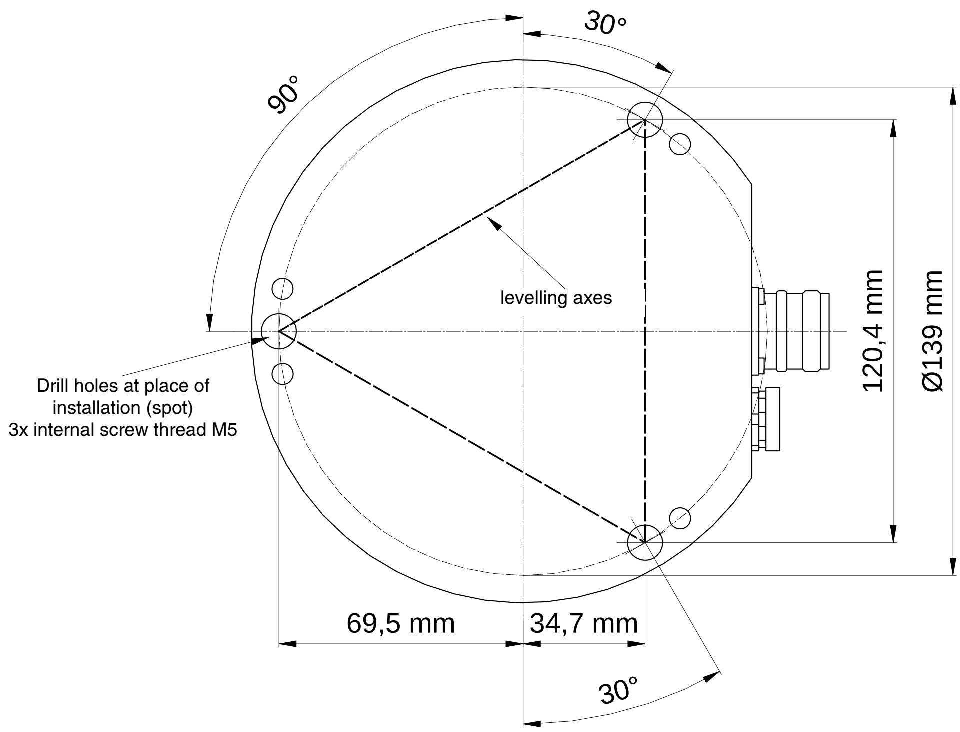


Figure 2 Position of the M5 drill holes for mounting

Mount the Laser Scanner in the drill holes using M5 screws. Refrain from tightening the screws, since there must remain a gap between the Laser Scanner and the place where it is mounted for the Laser Scanner to be levelled later on (also refer to Figure 5 on page 8).

2.1.1 Output Height of the Laser Beam

In order to be able to determine the correct height of the reflecting marks, it is essential to know the exact height at which the laser beam rotates. This height is exactly 125 mm above the bottom line of the Laser Scanner (refer to Figure 3).

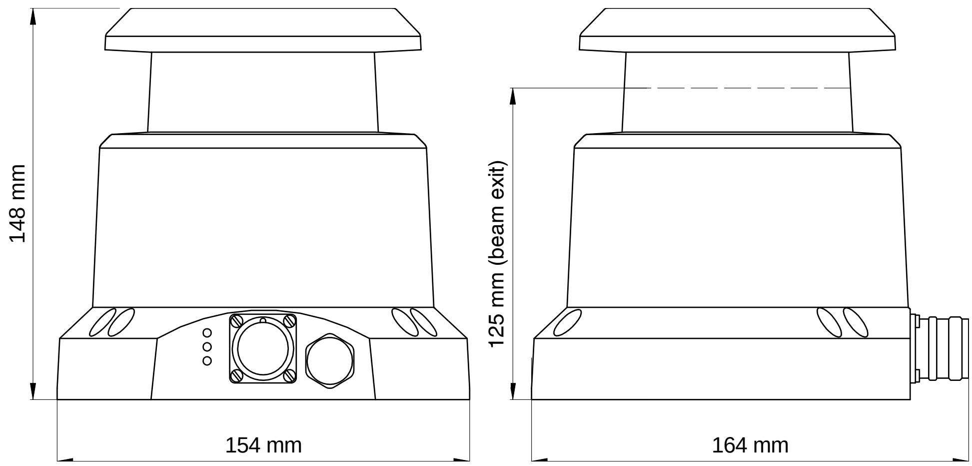


Figure 3 Casing dimensions / Output height of the laser beam

2.1.2 Levelling the Laser Scanner

Following the mounting of the Laser Scanner it needs to be levelled in order to assure that the laser beam rotates on the correct level. For this purpose it is essential that the Laser Scanner is supplied with power and that the interface is read out.

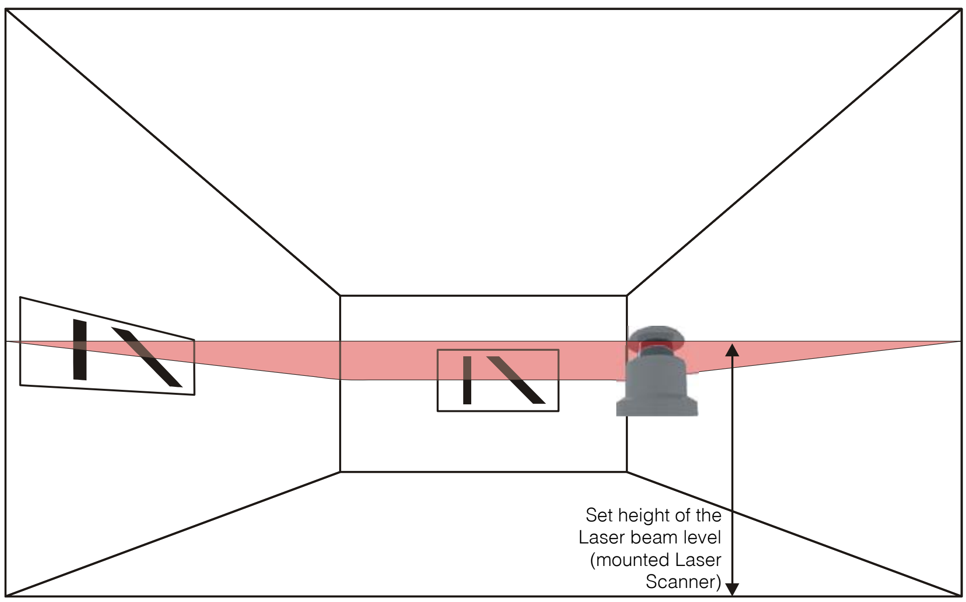


Figure 4 Levelling the laser beam by using two levelling marks

For tightening and levelling the laser scanner casing has four M5 threads and three drill holes for M5 screws.

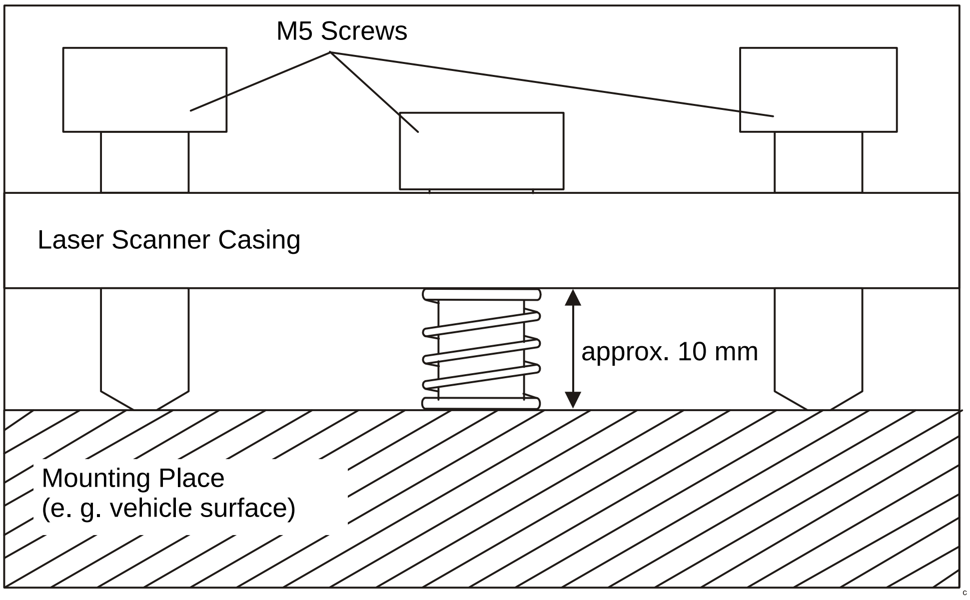


Figure 5 Mounting of the Laser Scanner

Levelling the sensor is done by the three-point adjuster of the casing. The edges of an imaginary triangle of which the M5 screws are the corners form the levelling axes.

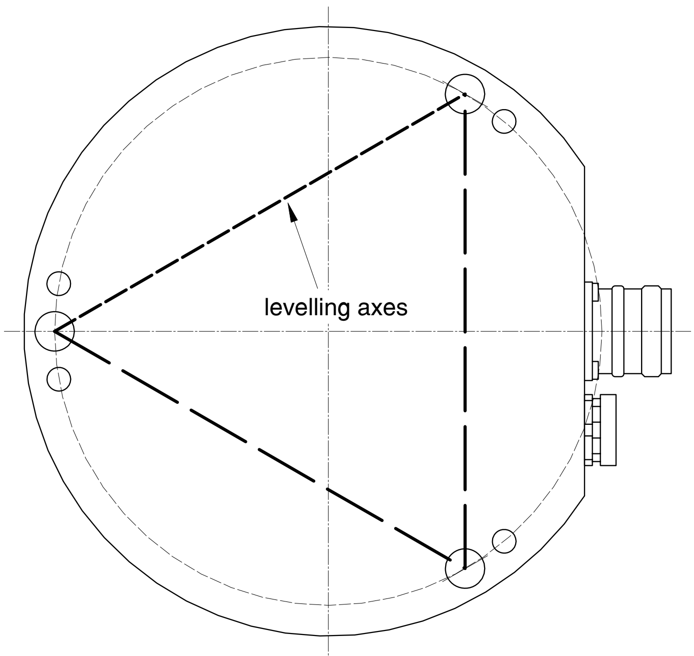


Figure 6 Levelling the Laser Scanner using the M5 screws

If an M5 screw is tightened, the sensor's axis leans towards the direction of this screw (over the levelling axis being located on the opposite side of the screw).

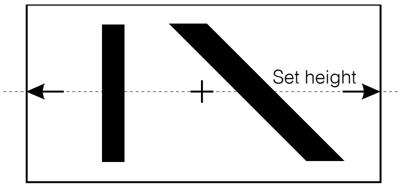


Figure 7 Levelling mark including indication of the set height (for setup)

To level the Laser Scanner to its set height it is necessary to have two levelling marks. Mounting them is a lot easier if they are provided with according markings of the desired height.

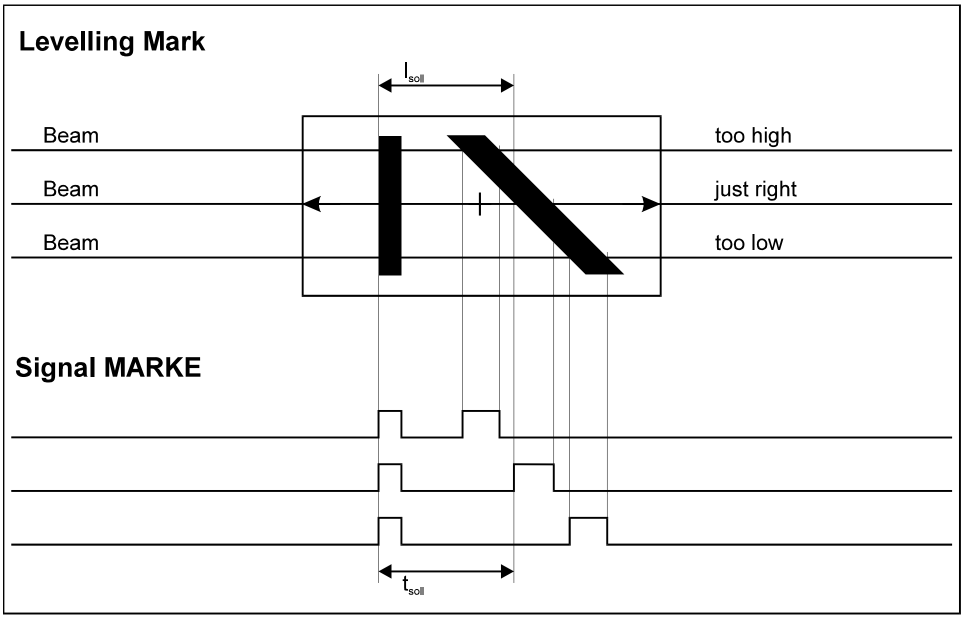


Figure 8 Comparison of three possible levels of the laser beam during levelling (shown is one of the two marks)

Use the service program LST (see chapter 3.1 on page 22) to analyze the scanner readings of the levelling mark.

2.2 Electrical Interface

2.2.1 Pin Assignment of M23-Socket on the Equipment

Subsequent to the following explanations you will find a table with the connector pin assignment.

Explanations

INDEX	Pulse of a duration of 5 µs, which is emitted once per revolution (also refer to Figure 9 on page 11).
Track A (steps)	Output rotary encoders channel A.
Track B (steps)	Output rotary encoders channel B. Track B has a phase shift of -90° compared to track A.
MARKE	0utput is only set to high level for the period of time in which the laser beam hits a reflecting mark.

IRQ — Each time an INDEX pulse or a slope is set in MARKE a pulse with a duration of 5 μs is generated in this output.

Enable Motor — This input must have a level of +24 V to enable the laser scanner motor. Otherwise the motor is switched off.

PC_RxD, PC_TxD — Serial RS 232-interface to PC (for service purpose)

Pin	Color	Name	I/O	Description
1				
2				
3				
4				
5				
6	red	+Ub	I	Supply Sensor +24V
7				
8	red-blue	OC_RxD		Receiving Line Guidance Computer (RS 232)
9				
10	yellow	OC_TxD		Transmitting Line Guidance Computer (RS 232)
11				
12	grey-pink	PC_RxD		Receiving line Service interface (RS 232)
13				
14	pink	PC_TxD		Transmitting line Service interface (RS 232)
15				
16				
17	blue	Activate Motor	I	Must be +24 V to enable motor
18				
19	black	GND	I	Supply Sensor Ground

Table 1 Pin assignment

2.2.2 Output Signals Time Diagrams

The most important signals are explained in the following diagram.

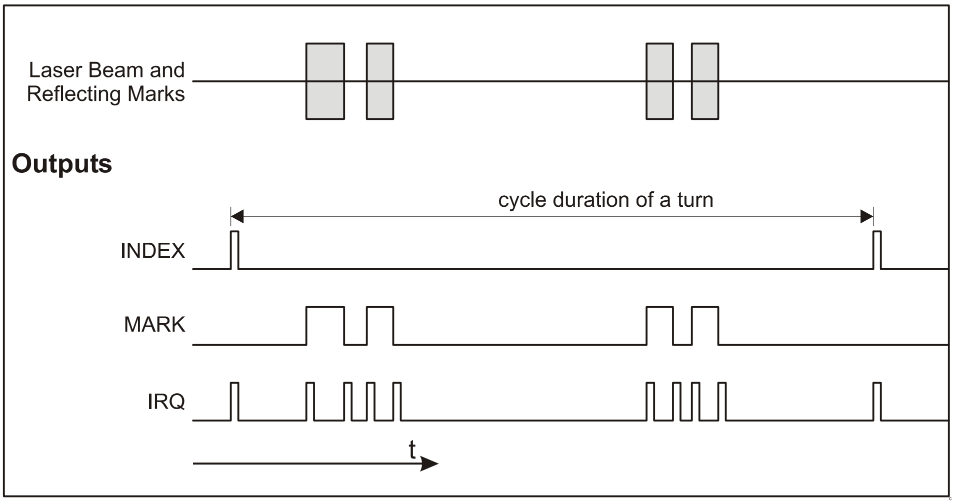
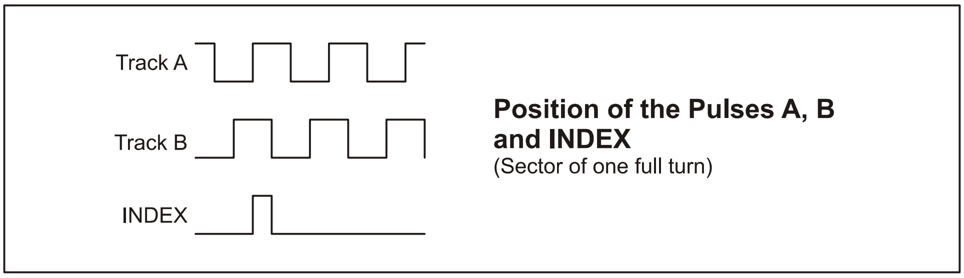


Figure 9 Time diagram 1: Logical levels of the output signals INDEX, MARKE, NULL and IRQ for two groups of reflecting marks during one full turn (over the time)



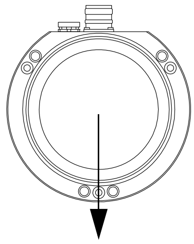


Figure 10 Time diagram 2: Position of the track pulses / position of the INDEX pulse

2.3 Signification of LEDs on the Equipment

LED-Display	
● Red	Supply voltage applied, device switched- on
● Yellow	- Continuous light: heating switched- on - Flashing: temperature < 10^{o}, motor shut off
● Green	Flashes at each index-pulse rsp. every 200 ms at the latest

Table 2 Signification of LEDs

2.4 Reflecting Tags

In order to use the Laser Scanner according to its intended purpose, reflecting marks are essential. They may be self produced, according to the signals needed. Important is a good contrast between mark and background and highly reflecting beacons.

NOTE! While determining the size of the reflecting marks, please note, that the height of the laser beam may vary depending on the load of the vehicle and on the bumpiness of the ground!

The Laser Scanner has been tested with reflective marks made from the material **FD 1403** by the company Reflexite. This self-adhesive material is available on rolls in different widths:

- 25 mm x 45,7 m
- 50 mm x 45,7 m

For further information please refer to the Reflexite homepage at http://www.reflexite.eu/.

2.5 Reflecting Tag Codes

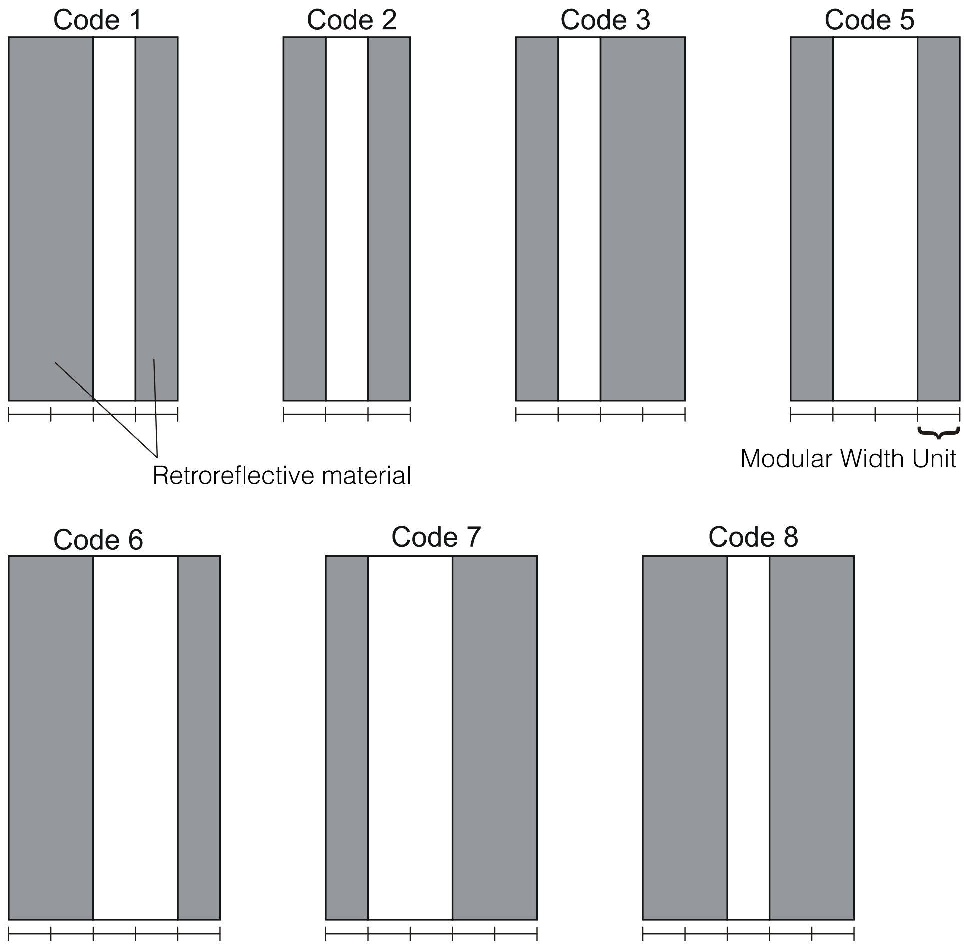


Figure 11 Predefined reflecting tag codes

The total width of the retroreflective surface as well as the width of the gap between retroreflective surfaces may be selected arbitrarily. Only the width - proportion between retroreflective stripes and gaps (the modular width units) on each tag has to be observed.

2.6 Interface to the Guidance Computer

2.6.1 Communication Parameters

Die Kommunikation wird über eine RS232 Schnittstelle unter Verwendung der Signale TxD, RxD und Signalmasse durchgeführt.

Die Kommunikationsparameter lauten: Baudrate einstellbar, 8 Datenbits, keine Parität, 1 Stopbit

2.6.2 Telegram Structure

STX	Length	Content	Check sum	ETX
Start of Text (0x02)	Length of „Content“ (binary number of characters of data-block	Data block (binary)	8 bit check sum	End of Text (0x03)

Table 3 Telegram Structure

The check-sum is is calculated by combining the data contained in the data-block using a XOR-operation.

2.6.2.1 „Content“

Abbreviations used in the following description:

AGV = Automated Guided Vehicle

GC = Guidance Computer of the AGV

The „Content“ - part of the telegram has the following make-up:

Type See chapter 2.6.2.2	**Data** See chapter 2.6.2.2.1 ff.

Table 4 Structure of the „Content“ - part of the telegram

2.6.2.2 Telegram types

Type	Description	Direction	Trigger - Event
I	Index	Sensor -> OC	Occurrence of Index - Pulse (once every 360° turn of sensor head at 0° position)
1	Tag of type 1	Sensor -> OC	Detection of this type of tag
2	Tag of type 2	Sensor -> OC	Detection of this type of tag
3	Tag of type 3	Sensor -> OC	Detection of this type of tag
4	Tag of type 4	Sensor -> OC	Detection of this type of tag

Table 5 Telegram types (part 1 of 2)

Type	Description	Direction	Trigger - Event
5	Tag of type 5	Sensor -> OC	Detection of this type of tag
6	Tag of type 6	Sensor -> OC	Detection of this type of tag
7	Tag of type 7	Sensor -> OC	Detection of this type of tag
8	Tag of type 8	Sensor -> OC	Detection of this type of tag
C	Configuration	OC <-> Sensor	Request by AGV, Answered by Sensor
S	Status	OC <-> Sensor	Request by AGV, Answered by Sensor
W	Write New Parameters	OC <-> Sensor	Request by AGV, Answered by Sensor
R	Read Current Parameters	OC <-> Sensor	Request by AGV, Answered by Sensor
M	switch motor of laser head on/off	OC -> Sensor	Request by AGV

Table 5 Telegram types (part 2 of 2)

2.6.2.2.1 „Index“ - Telegram „I“

This telegram does not contain any additional data and indicates the 0□ position of the sensor head at each 360° turn.

2.6.2.2.2 Tag telegrams „1“ to „8“

Data:

Position	Description	Data Type	Unit
0	high byte laser-angle at tag detection	unsigned short	1
1	low byte laser angle at tag detection		
2	high byte width of tag	unsigned short	1
3	low byte width of tag		

Table 6 Make-up of „tag“ - telegrams

2.6.2.2.3 „Configuration“ - Telegram „C“

- OC -> Sensor: Requesting configuration data, contains no data
- Sensor -> OC: Answering Request by sending configuration data

Data:

Position	Description	Data Type	Unit
0	High Byte software version	unsigned short	1
1	Low Byte software version		

Table 7 Make -up of „configuration“ telegram „C“

2.6.2.2.4 „Status“ - Telegram „S“

- OC -> Sensor: Requesting status information, contains no data
- Sensor -> OC: Answering Request by sending status data

Data:

Position	Bedeutung	Datentyp	Einheit
0	high byte measured increments per rotation	unsigned short	angular increments / rotation
1	low byte measured increments per rotation		
2	High Byte „Status“ (see Table 9)	unsigned short	1
3	Low Byte „Status“ (see Table 9)		
4	Temperature	char	° Celsius

Table 8 Make-up of „status“ telegram „S“

Explanation of „Status“ parameter (Position 2 and 3) in telegram „S“ (Table 8):

Bit	Description
0	1 = sensor reached preset rotation rate
1	1 = temperature is too low, preset rotation rate can not be reached
2	1 = heater is active
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Table 9 Explanation of possible status messages in telegram „S“

2.6.2.2.5 „Write“ - Telegram „W“

- OC -> Sensor: command to sensor update using this new set of parameters

Data:

Position	Description	Data Type	Unit
0	high byte rotation rate laser head	unsigned short	U/s * 10
1	low byte rotation rate laser head		
2	high byte increments per rotation (see Table 11 on page 18)	unsigned short	increment value (see Table 11 on page 18)
3	low byte increments per rotation (see Table 11 on page 18)		
4	high byte „settings“ (see Table 12 on page 19)	unsigned short	1
5	low byte „settings“ (see Table 12 on page 19)		
6	high byte gap - offset	unsigned short	increments
7	low byte gap - offset		
8	high byte equality - tolerance	unsigned short	increments
9	low byte equality - tolerance		
10	high byte minimum tag - width	unsigned short	increments
11	low byte minimum tag- width		
12	high byte maximum tag - width	unsigned short	increments
13	low byte maximum tag- width		
14	high byte parameter 1 (not used)	unsigned short	1
15	low byte parameter 1 (not used)		
16	high byte parameter 2 (not used)	unsigned short	1
17	low byte parameter 2 (not used)		
18	high byte parameter 3 (not used)	unsigned short	1
19	low byte parameter 3 (not used)		
20	high byte parameter 4 (not used)	unsigned short	1
21	low byte parameter 4 (not used)		

Table 10 Make-up of „write“ telegram „W“ from GC to sensor (part 1 of 2)

Position	Description	Data Type	Unit
22	high byte parameter 5 (not used)	unsigned short	1
23	low byte parameter 5 (not used)		
24	high byte parameter 6 (not used)	unsigned short	1
25	low byte parameter 6 (not used)		
26	high byte parameter 7 (not used)	unsigned short	1
27	low byte parameter 7 (not used)		
28	high byte parameter 8 (not used)	unsigned short	1
29	low byte parameter 8 (not used)		
30	high byte parameter 9 (not used)	unsigned short	1
31	low byte parameter 9 (not used)		
32	high byte parameter 10 (not used)	unsigned short	1
33	low byte parameter 10 (not used)		

Table 10 Make-up of „write“ telegram „W“ from GC to sensor (part 2 of 2)

Explanation of some parameters:

Please see also the section Filter - Parameter for the Tag - Decoding Functionality on page 23.

„Rotation rate laser head",„(Position 0 and 1) Example: Value 60 equals 6 rotations / second

„Increments per Rotation“ (Position 2 and 3):

Setting	Selected Resolution
0	8192 increments / rotation
1	16384 increments / rotation
2	24576 increments / rotation
3	32768 increments / rotation
4	40960 increments / rotation
5	65536 increments / rotation

Table 11 Explanation of „Increments per rotation“ in telegram „W“

"Settings" (Position 4 and 5):

Bit	Description
0	1 = enable heater activation (heater is switched on/off by internal thermostat)
1	1 = enable motor activation using serial interface (motor is switched on/off using telegram „M“)
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Table 12 Explanation of „Settings“ (position 4 and 5) in telegram „W“

- Sensor -> GC: acknowledgment *results of attempt to update using new set of parameter*

Data:

Position	Description	Data Type	Unit
0	answer - code (see Table 14 on page 20)	unsigned char	1

Table 13 makeup of „write“ telegram „W“ from sensor to GC

Explanation of *answer-code* (Position 0):

Code	Description
0	error during updating
0xFF	parameters correctly received and saved

Table 14 Explanation of „Increments per rotation“ in telegram „W“

2.6.2.2.6 „Read“ - Telegram „R“

- GC -> Sensor: Requesting current set of parameters, no data
- Sensor -> GC: answering request by sending currently saved set of parameters to GC, data structure same as explained in chapter 2.6.2.2.5 „Write“ - Telegram „W“ on page 17

2.6.2.2.7 „Motor“ - Telegram „M“

- GC -> Sensor: command to switch motor on/off

Daten:

Position	Description	Data Type	Unit
0	command - code (see Table 16)	unsigned char	1

Table 15 Make-up of „Motor“ telegram „M“

Explanation of „command-code“ (Position 0) in telegram „M“ (Table 15):

Code	Description
0	motor off
0xFF	motor on

Table 16 Explanation of „command - code“ in telegram „M“

2.6.3 Examples

2.6.3.1 Example 1: Telegram „Index“

Position	Data (Hex)	Explanation
0	0x02	STX
1	0x01	length
2	0x49	telegram type „I“ for „Index“
3	0x49	Check sum
4	0x03	ETX

Table 17 Example 1: telegram „Index“

2.6.3.2 Example 2: Telegram „Tag of type 2“

- laser-angle at tag detection: 7996 (hex) = 31126 (decimal) increments
- tag width: 75 (hex) = 117 (decimal) increments

Position	Daten (Hex)	Bedeutung
0	0x02	STX
1	0x05	length
2	0x32	telegram type „tag of type 2“ (ASCII „2“)
3	0x79	high byte laser angle at tag detection
4	0x96	low byte laser angle at tag detection
5	0x00	high byte width of tag
6	0x75	low byte width of tag
7	0xA8	check sum (see below)
8	0x03	ETX

Table 18 Example 2: telegram „Tag of type 2“

Explanation on calculation of the check - sum:

0x32 XOR 0x79 XOR 0x96 XOR 0x00 XOR 0x75 = 0xA8

3 Software

3.1 LST Service programme

This software is for diagnosis and paramterization of the Laser Scanner

System requirements

- Microsoft Windows version 95 and higher
- A free serial RS 232 interface

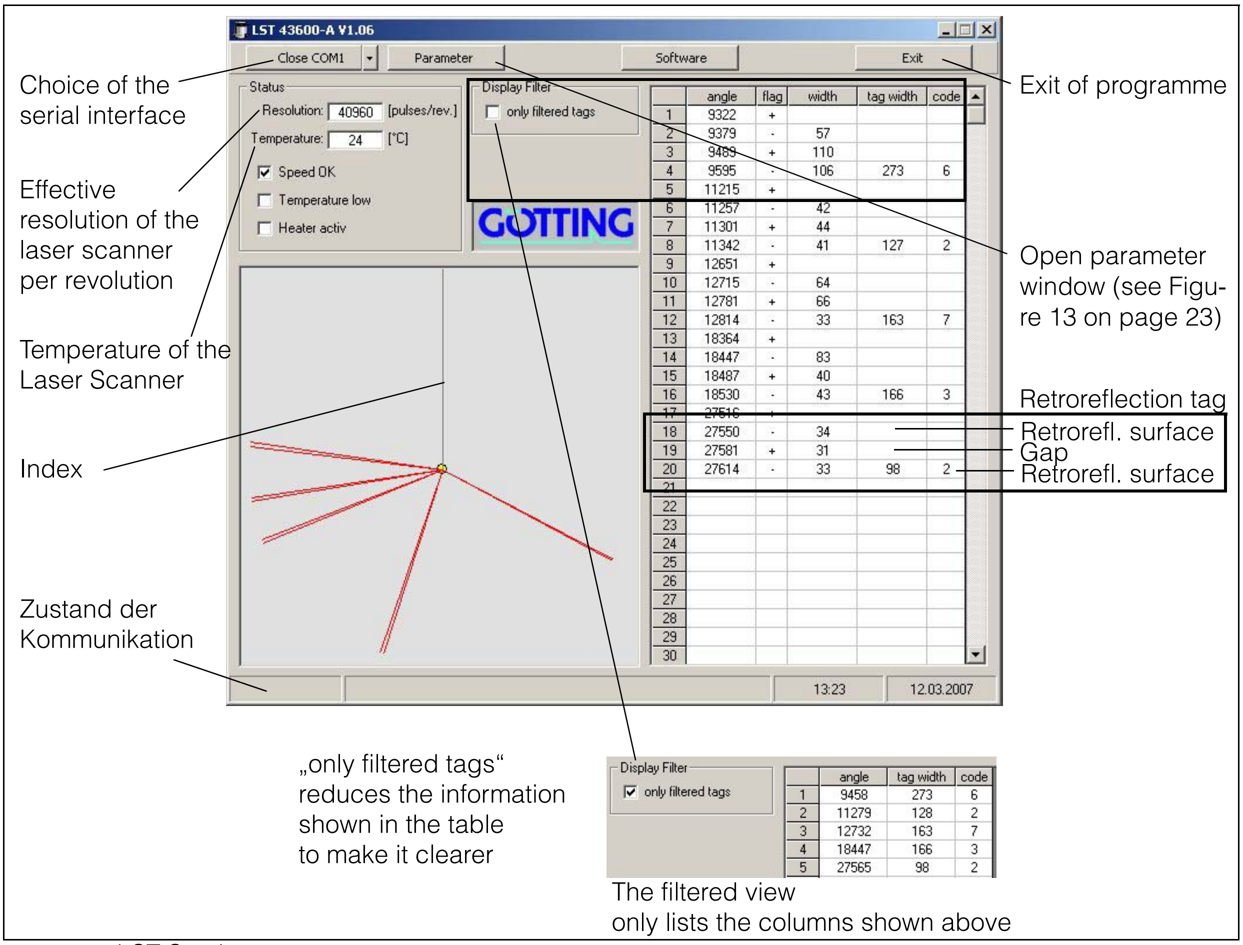


Figure 12 LST Service programme

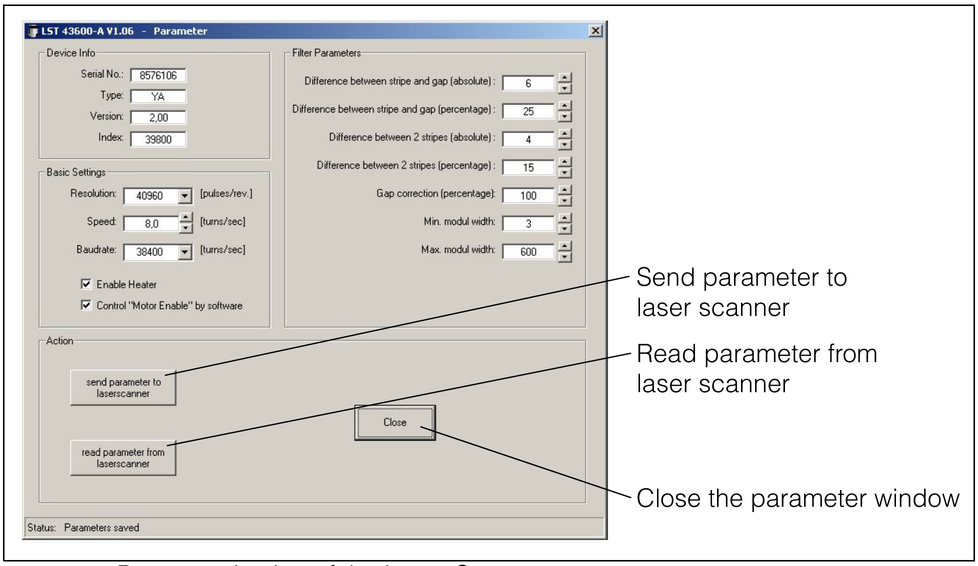


Figure 13 Parameterization of the Laser Scanner

`Serial No.` read only - preset by manufacturer

`Type` hardware version of laser scanner

`Index` read only - device type index preset by manufacturer

`Version` firmware version

`Resolution` angular resolution of the laser scanner
possible settings are: 8192, 16384, 24576, 32768, 40960 and 65536 increments / rotation

`Speed` rotation speed of laser scanner head
possible values are: 6.0 to 18.0 rotations / second

`baudrate` transmission speed RS-232 at guidance computer interface
possible settings are 9600, 19200, 38400, 57600, 115200 bit / second

`Enable Heater` enable or disable heater operation (heater is controlled by thermostat)

`control motor enable by software`
enable or disable the possibility to switch the motor on/off using the serial interface to the guidance computer

Filter - Parameter for the Tag - Decoding Functionality

difference between stripe and gap [absolute]
Maximum allowable difference between the width of the first retroreflective stripe of a tag and the gap between retroreflective stripes on that tag in absolute increments.

difference between stripe and gap [percentage]
Maximum allowable difference between the width of the first retroreflective stripe of a tag and the gap between retroreflective stripes on that tag as a percentage.

difference between 2 stripes [absolute]
Maximum allowable difference between the width of the first retroreflective stripe and the second retroreflective stripe of one tag in absolute increments.

difference between 2 stripes [percentage]
Maximum allowable difference between the width of the first retroreflective stripe and the second retroreflective stripe of one tag as a percentage.

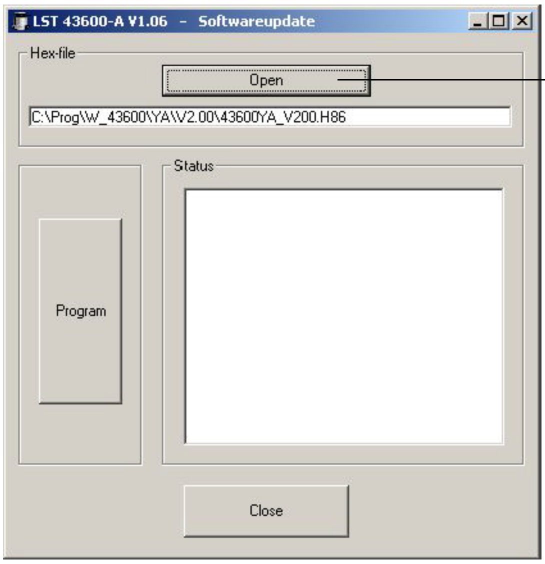
gap correction [percentage]
correction of the gap - width as a percentage.

difference between 2 stripes [percentage]
Maximum allowable difference between the width of the first retroreflective stripe and the second retroreflective stripe of one tag as a percentage.

min. module width
minimum allowable width of an individual retroreflective stripe in increments, so it will be included in further measurements / tag decoding at all

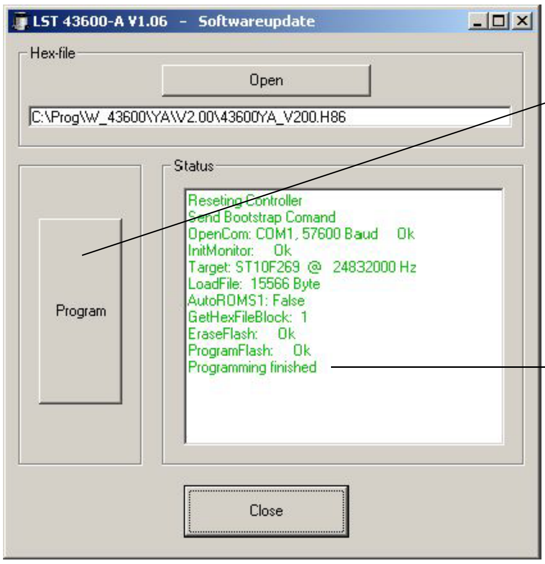
max. module width
maximum allowable width of an individual retroreflective stripe in increments, so it will be included in further measurements / tag decoding at all

3.2 Software Update



Step 1:
select hex file

Figure 14 Software update step 1



Step 2:
Start program update

If program update is successful, this text should be displayed.
If an error occurs during te update, the text changes to red color

Figure 15 Software update step 2

4 Technical Data

Technical Data	
Current Supply Sensor	+18 to +30 VDC Current consumption: - typ. 240 mA at 24 Volt and 6 revolutions / sec. - typ. 550 mA at 24 Volt and 18 revolutions /sec.
Current Supply Heating	+18 to +30 VDC Current consumption: typ. 1,2 A at 24 Volt
Outputs: INDEX, MARKE, track A, track B, IRQ	Output voltage: + 24 Volt Output current: max. 50 mA per output
Service interface	RS 232
Environmental conditions	Temperature: - +10 to +50 ^{o}C without heating - -25 to +50 ^{o}C with heating max. 80 % air humidity, not condensing
Type of protection	IP 67
Laser power	1 mW, not dangerous for the eyes, Laser class 1 (at a distance of less than 300 mm to the laser scanner laser class 1M will be applied), automatical switch-off at standstill
Read area	1 to 30 meters
Reading rate	6 to 18 measurements per second (programmable)
Intercept range	360^{o}
Angular resolution	8192, 16384, 24576, 32768, 40960 or 65536 increments per revolution (programmable)
Ambient light	< 10000 Lux
Dimensions	- Ø 153 mm - height 150 mm
Weight	2.3 kg

Table 19 Technical Data of the Laser Scanner

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8 Handbook Specifications

At the time this manual was printed, the following symbols and marks were used in all Götting KG documentations:

- For security advices, the following symbols stand for different degrees of danger and importance:

  NOTE!

  ATTENTION!

  WARNING!

- Further information or advices are indicated as follows:

  TIP!

- Program texts and variables are indicated through the use of the `Script Courier`.
- Whenever the pressing of letter keys is required for program entries, the required Letter Keys are indicated as such (for any programs of Götting KG small and capital letters are equally valid).
- Sections, drawings and tables are subsequential numbers throughout the complete document. In addition, each documents includes a list of contents showing the page numbers following the front. If a document exceeds 10 pages, it also has a drawings list and a list of tables on the last few pages. If required, in case a document is correspondingly long and complex, a index is added in the back.
- Each document shows a small table including meta information, such as deveopler, author, revision and date of issue, on the front page. The information regarding revision and date of issue are also included in the bottom line on each page of the document. This way it is possible to clear identify the source document for each bit of information.
- Online version (PDF) and printed handbook are always generated from the same source. Due to the consequent use of Adobe FrameMaker for these documentations, it is possible to use the cross hints and content entries (including page numbers of the index) of the PDF file for automatical transfer to the corresponding content.

9 Copyright and Terms of Liability

9.1 Copyright

9.2 Exclusion of Liability

Any information given is to be understood as system description only, but is not to be taken as guaranteed features. Any values are reference values. The product characteristics are only valid if the systems are used according to the description.

This instruction manual has been drawn up to the best of our knowledge. Installation, setup and operation of the device will be on the customer's own risk. Liability for consequential defects is excluded. We reserve the right for changes encouraging technical improvements. We also reserve the right to change the contents of this manual without having to give notice to any third party.

9.3 Trade Marks and Company Names

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