CANopen

LE-200

User Manual

Laser Measuring Device LE-200 with CANopen - interface

- Safety notes
- Assembly
- Installation / Commissioning
- Parameter setting
- Causes of Faults and Remedies

- Software/Support CD: 490-01001
  - Soft-No.: 490-00408

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″ < > ″ indicates keys on your computer keyboard (such as <RETURN>).

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Revision History

i   *Note*
The cover of this document shows the current revision status and the corresponding date. Since each individual page has its own revision status and date in the footer, there may be different revision statuses within the document.

Documents that are in the appendix have their own revision history.

Document created: 24.07.2003

Revision	Date
Expansion of the function for the error output, object 2005 • Speed-check, configurable via TRWinProg	19.09.2003
- New Object: 2007, Resolution - Revision of the warning label in chapter "Intended purpose"	11.12.2003
- Modification of the Laser Standard DIN EN 60825-1 - Warning bit "Plausibility measured value" - Additional reflector foils, chap. Accessories - Max. measuring range 240 m	18.12.2007

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1 Safety

1.1 General risk potential

The Laser Measuring Device LE-200 CANopen cannot be operated independently, but is installed as part of an overall system usually consisting of several interacting components. For this reason, the laser measuring device is not equipped directly with a protective device.

Warning
The corresponding measures must be taken in order to avoid person and property damages!

However, in the event of an error via the error register "Object 1001h: Error Register", page 24 a generally occurred error is displayed by setting the bit 5. Via the "Object 1003h: Pre-defined Error Field", page 25 the error occurred generally is specified and the cause described in detail. Via the "Emergency Message", page 38 the Error Register/Error Field can be read. It is therefore essential to **integrate the error messages into your own safety system** via the evaluation software (e.g. a PLC).

All persons responsible for the assembly, start-up and operation of the device must

- be suitably qualified
- adhere strictly to this operating manual.

Your safety and the safety of your equipment depends on this!

1.2 Safety information

This operating manual contains information which must be observed in the interests of your own personal safety and that of your equipment. The safety hints are emphasized by a warning triangle and classified according to the degree of danger as follows:

Warning
means that failure to take the relevant safety precautions can lead to serious damage to property or injuries.

Note
refers to important information and features of the product, plus tips on its application.

1.2.1 Hints on installation

Since the Laser Measuring Device is normally used as part of a larger system, these hints are merely intended as a guide for integrating the device safely into its environment.

⚠ *Warning*

- During the operation of the Laser Measuring Device it isn't allowed to interrupt the laser beam. If it comes nevertheless to an interruption, at the restart of the automatic operation mode first the validity (plausibility) of the measured value has to be checked.

- Precautionary measures must be taken to allow an interrupted program to be properly resumed following a voltage drop or failure. Dangerous operating conditions must not be permitted to arise even for short periods. If necessary, an **"EMERGENCY STOP"** must be forced.

- EMERGENCY STOP devices according to EN 60204/IEC 204 (VDE 0113) must remain operational in all operating modes of the programmable controller. The release of the EMERGENCY STOP devices must not trigger an uncontrolled or undefined reactivation of the equipment.

- The safety and accident prevention regulations applicable to the specific application must be observed.

- In the case of permanently installed plants or systems without an all-pole mains switch and/or fuses, one of these devices must be installed accordingly and the equipment connected to a PE conductor.

- In the case of 24 V supplies, make sure the extra-low voltage is reliably disconnected. Only use power supply units manufactured to the standards IEC 364 - 4 - 41 / HD 384.04.41 (VDE 0100 Part 410).

- Fluctuations or deviations of the supply voltage from the nominal value must not exceed the tolerance limits stated in the specifications, otherwise operational failures and dangerous states in the electrical assemblies cannot be ruled out.

- Connecting and signal wires must be installed in such a way as to prevent the automation functions from being hampered by inductive and capacitive interference.

- The units of the automation system and their operating elements must be installed in such a way as to ensure adequate protection against accidental actuation.

- In order to prevent a wire or strand breakage on the signal side from causing undefined states in the programmable controller, suitable hardware and software safety precautions must be taken with regard to the I/O interface.

1.2.1.1 General interference suppression measures

- Lay the (shielded) connecting cable to the device at a sufficient distance or in a separate room from any power cables which are subject to interference. Otherwise the data transmission of the measured value can be interfered.

- To ensure reliable data transmission, use fully shielded cables and make sure they are well earthed. For differential data transfer (RS422, RS485 etc.), twisted-pair wires must be used in addition.

- Use a minimum cable cross-section of 0.22 mm^2 for data transfer purposes.

- Use a minimum earthing cable (machine base) cross-section of 10 mm^2 in order to avoid equipotential currents across the shield. Make sure the resistance of the earthing cable is much lower than that of the shield.

- Avoid crossing cables where possible. If unavoidable, only cross them at right-angles.

- Ensure continuous wiring of the shield and a large contact area on special shield clampings or cable screw glands, see Figure 1 point **(A)** and **(B)**.
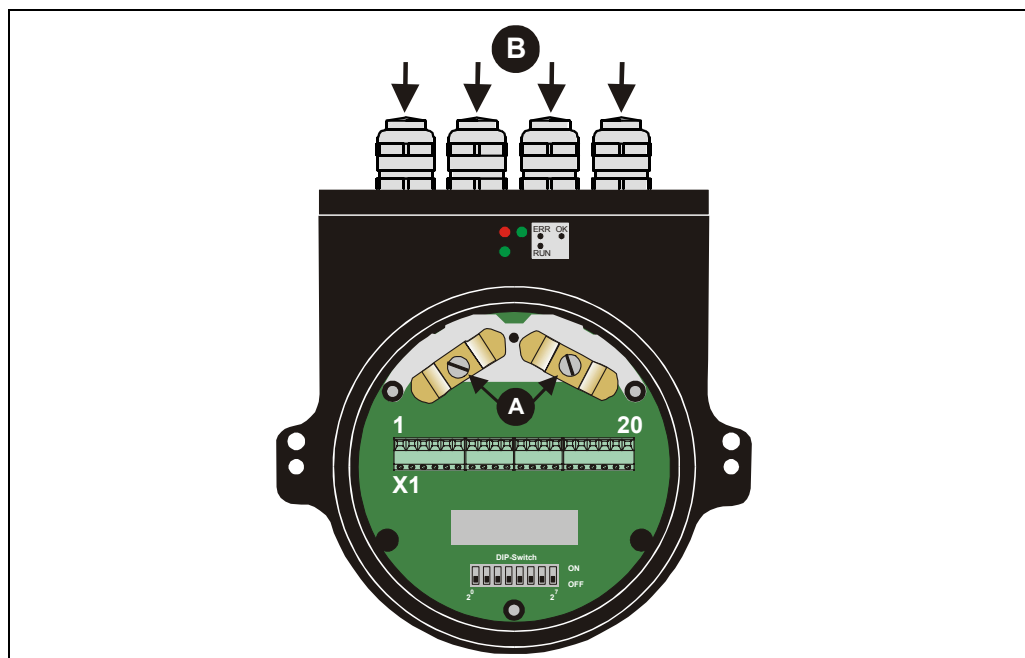
Figure 1: Connection cap with cable screw glands and shield clampings

Shield connection via cable screw glands:

1. Screw the cable screw gland into the housing.
2. Dismount the compression nut (1) and the terminal holder (2).
3. Push the compression nut (1) and the terminal holder (2) over the cable.
4. Strip the cable; push back the braiding around the terminal holder (2) such that the braiding goes over the inner O-ring (3) and does not lie over the cylindrical section or the torsional bars.
5. Insert the terminal holder (2) into the intermediate gland (4) such that the torsional bars fit into the intended lengthwise grooves in the intermediate gland (4).
6. Screw the compression nut (1) to the intermediate gland (4).

Element 1
Compression nut

Element 2
Terminal holder

Element 3
inner O-ring

Element 4
Intermediate gland

1.3 Intended purpose

The measuring system is used for recording linear movements and processing the measured data for a downstream control system with a CANopen Field Bus interface according to ISO/DIS 11898.

The laser measuring device with CANopen protocol supports the device profile for Encoder CiA Draft standard 406, version 2.0.

Particularly the measuring system is designed for the use of distance measurements for the detection of the position and positioning of:

- High-bay storage devices and lifting gears
- Crane systems
- Side-tracking skates and truck storage vehicles
- Transfer machines

Warning
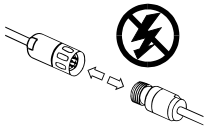
Switch off the voltage supply before carrying out wiring work or opening and closing electrical connections!
Short-circuits, voltage peaks, etc. can cause operating failures and uncontrolled operating states, as well as serious personal injuries and damage to property.

Check all electrical connections before switching on the system!
Incorrectly wired connections can cause operating failures, while wrong connections can lead to serious personal injuries and damage to property.
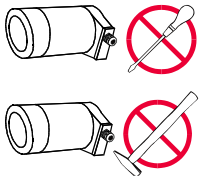
Mechanical or electrical modifications to the measuring systems ***are prohibited for safety reasons!***

In particular the following uses are forbidden
- operation in areas where interruption of the laser beam, e.g. by covering the laser lens opening, can lead to equipment damage or injury to personnel
- in environments, in which strong rain, snow, fog, steams or direct insolations etc. can influence the laser beam intensity negatively
- operation in rooms with explosive atmospheres
- operation for medical purposes

With use-purposes larger 125m measuring length, a special reflector must to be used! (see chapter "Accessories", page 45)

TRelectronic

⚠ *Warning*

Laser Light
Do not stare into the beam
Laser Class 2
P max = 1 mW, λ = 670 nm
DIN EN 60825-1: 2003-10
Complies with 21 CFR 1040.10 and
1040.11 except for deviations pursuant
to laser notice No. 50, July 2001

- In the case of Class 2 laser devices, the eye is not endangered if the exposure of the laser radiation is very short (up to 0.25 s) and accidental. For this reason, devices of this class can be used without additional protective measures, provided for the application it is not necessary to look into the laser beam deliberately for longer periods, i.e. 0.25 s, or to look repeatedly into the laser beam itself or the specular reflected beam.

  > *The existence of the blinking reflex for the protection of the eyes may not be assumed. Therefore the eyes should be closed consciously, or the head should be turned away immediately!*

- The device must be installed in such a way that the exposure of persons to the laser beam can only happen accidentally.

- The laser beam may only extend as far as is necessary for the range measurement. The beam must be limited at the end of the useful range by a diffusely reflecting target area in such a way as to minimize the danger from direct or diffuse reflection. For this purpose, you should use the TR-Electronic reflecting foil supplied with the device.

- The area outside the operating range where the unshielded laser beam falls should be limited as far as possible and should remain out of bounds, particularly in the area above and below eye level.

- Observe the legal and local regulations applicable to the operation of laser units.

ℹ *Note*
The start-up, operating and programming instructions contained in this manual are mandatory.

1.4 Authorized operators

The start-up and operation of this device may only be performed by qualified personnel. For the purposes of this manual, the term "qualified personnel" refers to persons who are authorized to operate, earth and label equipment, systems and power circuits according to recognized safety standards.

1.5 Safety measures at the installation site

⚠ *Warning*

Do not perform any welding work once the device is connected and switched on!
Variations in potential can destroy the device or restrict its operation.

Do not touch plug contacts with your hands!
Static charges may destroy electronic components of the device.

Do not connect unused inputs (see pin assignment)!

Observe the voltage supply range:
Standard device: 18-27 V DC ($\pm$ 5 %)
Device with heating: 24 V DC ($\pm$ 5 %)

Clean lens opening of the laser and the reflecting foil regularly!
(see chapter "Maintenance", page 43)

i *Note*
Make sure that the environment of the installation site is protected against corrosive media (acids, etc.)

2 General Description

The laser measuring devices of the series LE are optical sensors, with which larger distances can be measured without contact and serviceable for controller. The measuring system consists of the real measuring device with laser light source, receiving optics, electronic evaluation and data interface as well as a reflector. The device sends out a modulated light beam which is reflected by the reflector. From the phase difference of the sent and received light beam the distance is measured 1000 times per second. Thus the LE is suitable also directly for the position feedback in controller loops.

According to the requirements the laser distance measuring devices of the series LE-200 CANopen are configured either directly over the CAN-bus or with the PC-programming software "TRWinProg".

Principle

Receiver signal
Transmitter signal
Reflecting foil

φ = Phase displacement
d = Distance
d = f(φ)

Measuring start
Measuring range
Measuring end
0,2m
125m
Display range max. 240m (Special Device)
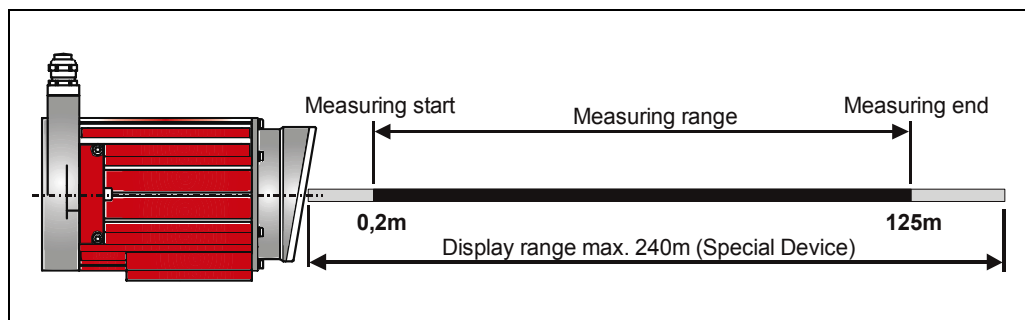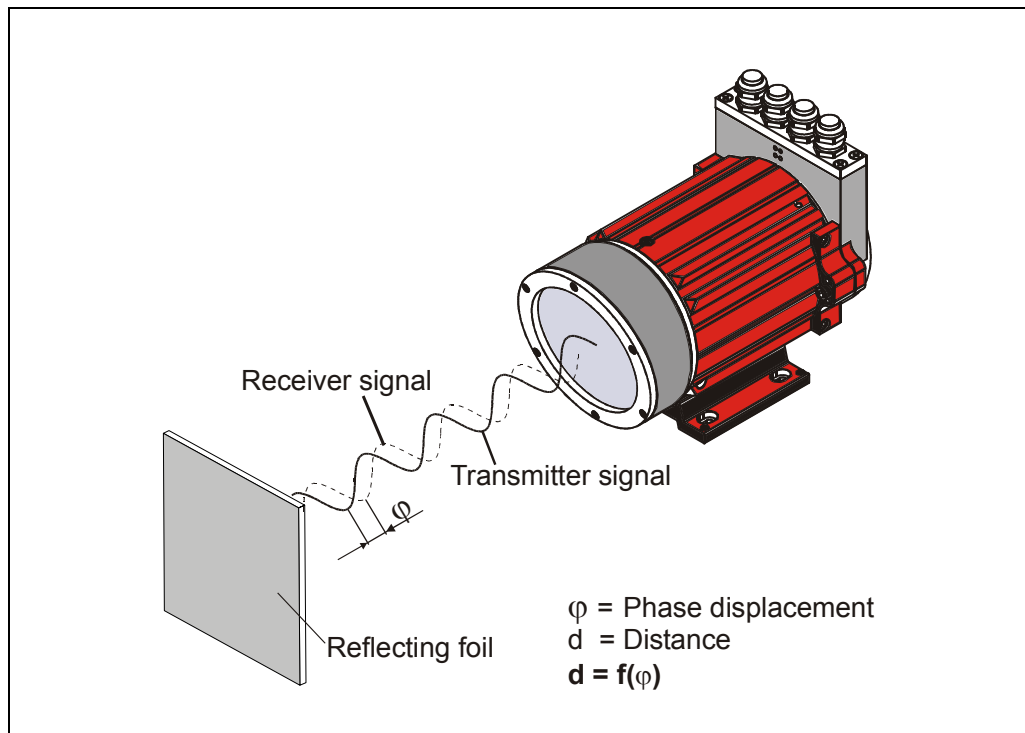
3 Transportation / Storage

Transport instructions

Do not drop the device or expose it to shocks or vibrations!
Device contains an optical system with glass elements.

Only use the original packaging!
The wrong packaging material can cause damage to the device during transportation.

Storage

Storage temperature : -20 to +75°C

Store in dry conditions.

4 Assembly instructions

The adjustment of the laser measuring device in the vertical plain is carried out via four studs (A) in the mounting plate. The adjustment in the horizontal plane can be made by four hexagon bolts (B). It has to be taken into account that the screw diameter is approx. 1-2 mm smaller than the through bore of the mounting plate. Exact dimensional properties are on the dimensional drawing in the rear part of the document.
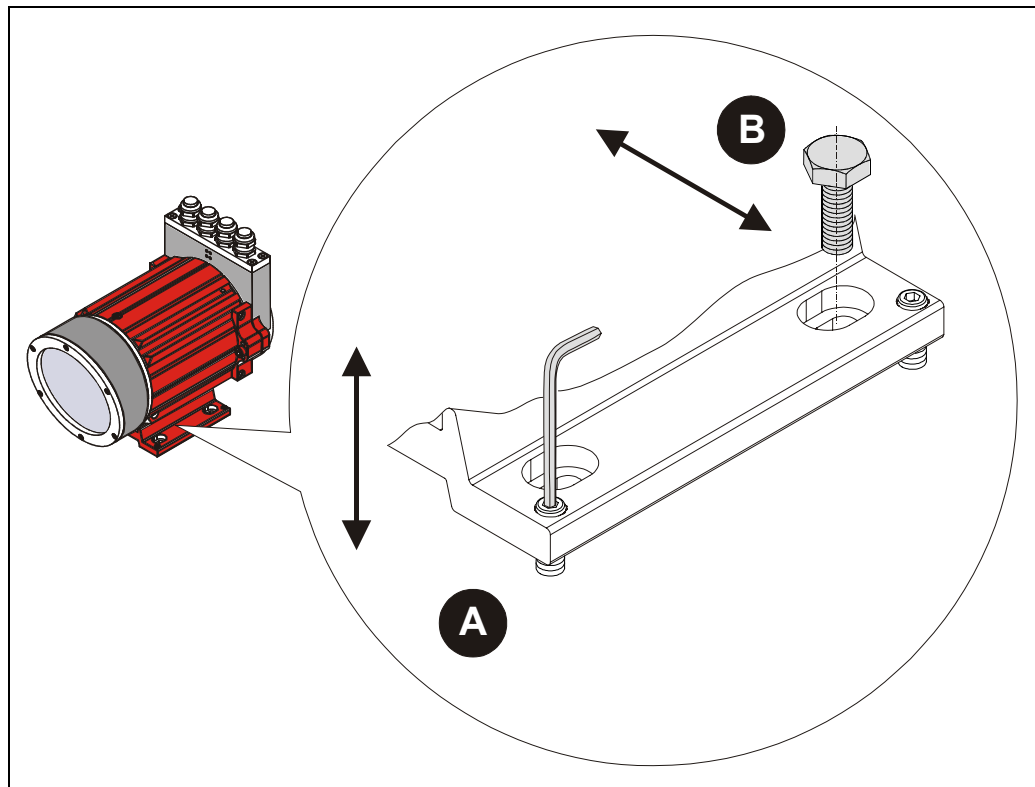
Figure 2: Mechanical adjustment possibilities

4.1 Aligning of the laser light spot to the reflector / foil inclination

The measuring device or reflector is attached to the moving object and the reflector/sensor to the fixed remote station in such a way that the reflector always remains within the visual field of the sensor. This can be done using the light spot of the laser diode, which is still clearly visible on the reflecting foil even at long distance. When aligning the laser measuring device, the user may need to take measures to ensure that it can be mechanically adjusted.

The size of the reflecting foil must be such that the light spot cannot be displaced from the reflector by vibrations. Since with an increasing distance the light spot gets larger and larger, the edge areas of the foil also have to be avoided.

The device comes with a reflecting foil measuring 20 x 20 [cm], but other sizes can be ordered on request.

i *Note*

Reflecting foils by other manufacturers should not be used under any circumstances, as all the information in the "Specifications" chapter refers to the foil already supplied with the device.

Procedure:

- **Figure 3: Detection of the surface reflectivity:**
  - At first attaching the reflector foil flatly and drive plant on minimal distance Laser – Foil.
  - Centering paper (C) in front of the laser optics so, that the laser beam can unhinderedly emerge by an approx. 2 cm hole. Now, the interfering signal (B) should get visible on the paper (C). To the better location of the interfering signal (B) the reflector foil can be moved also a little. Here it is valid: angle of incidence = angle of reflection

- **Figure 4: Transmitting away the surface reflectivity:**
  - Rotate the reflector foil in the Y- or in the Z-axis so, that the interference signal (B) always is outside the laser lens. Nevertheless keeping the inclination of the reflector foil as low as possible to minimize measuring errors caused by misalignments in the procedure movement. For example, if the light spot drifts on the reflector foil around, small differences arise as a result of the oblique position.
  - Fix reflector foil
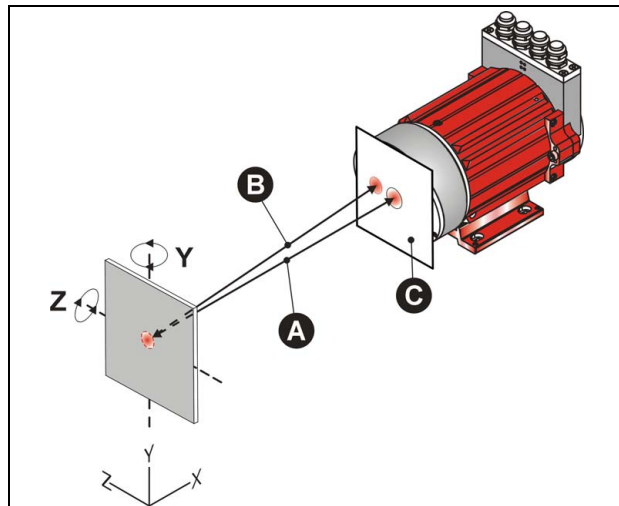
Figure 3: Detection of the surface reflectivity

(A)
real wanted signal, is always thrown back 180° independently of the reflector inclination

(B)
Surface reflectivity (interference signal)

(C)
Paper with an approx. 2 cm large hole in the center
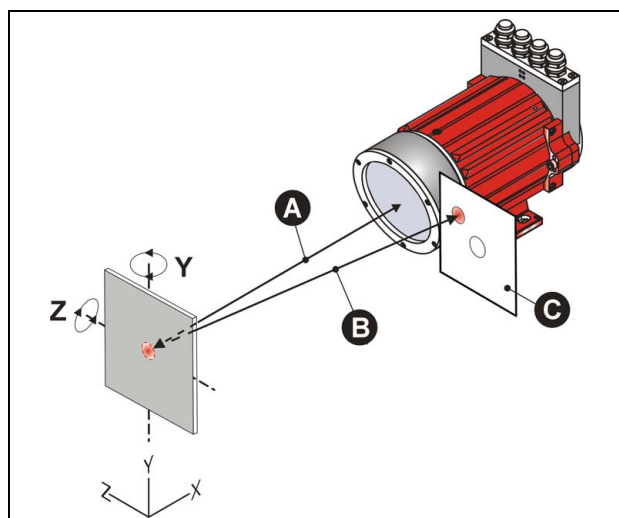
Figure 4: Transmitting away the surface reflectivity

4.2 Parallel operation of laser linear paths

It has to be taken care in the parallel operation of laser linear paths that a minimum distance of 1 m is kept. The reflector foil inclination must be made in such a way that the surface reflectivity (see arrows) points not into the other laser linear path.

The alignment is carried out as described in chapter 4 / 4.1.
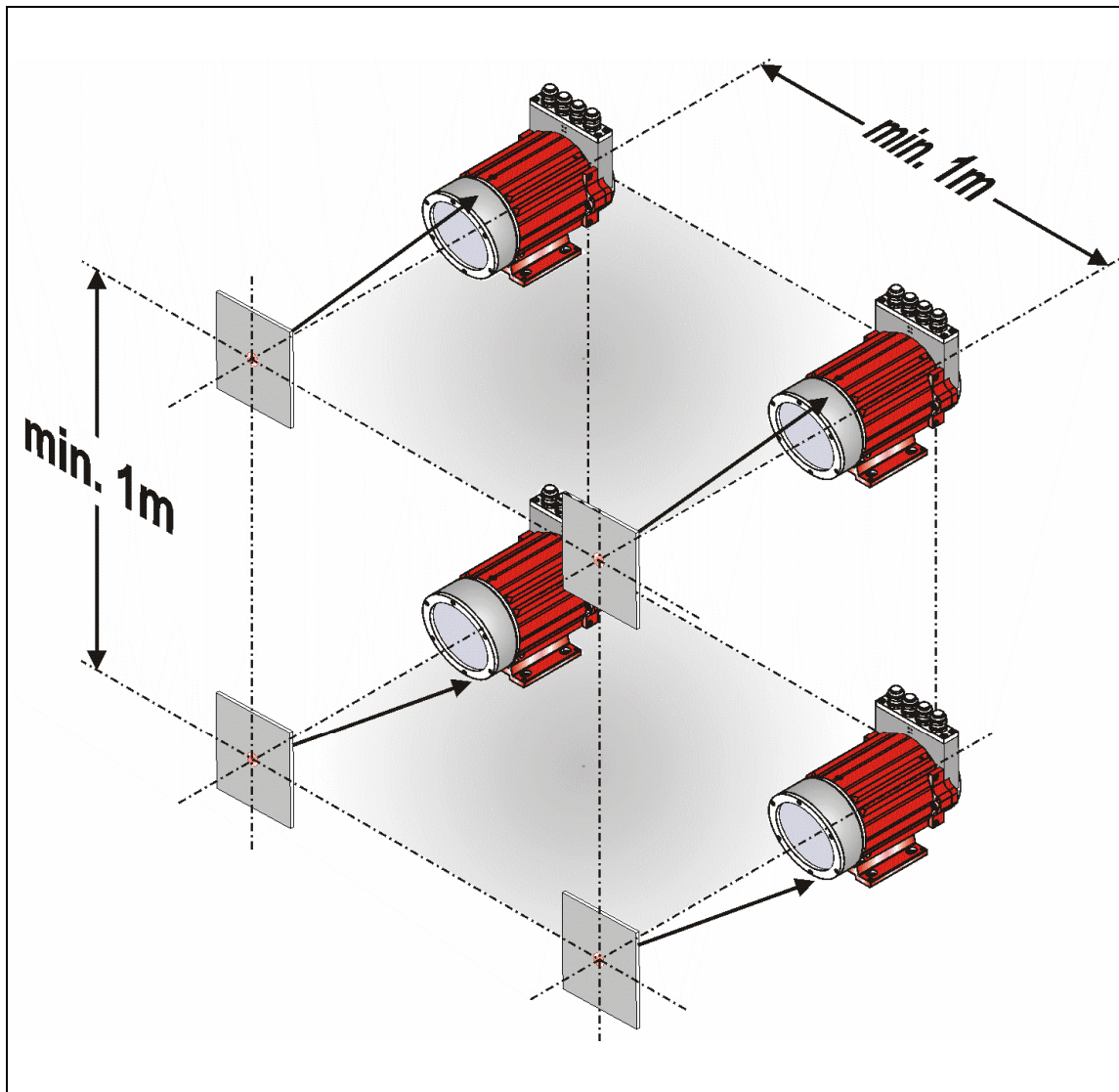
Figure 5: Minimum distance in parallel operation

5 Commissioning / Installation

5.1 Electrical connection

i *Note*
At the realization of the electrical connection the references in chapter 1.2.1, starting from page 7 must be considered.
CiA DR 303-1 conformal pin assignment see "TR-ELE-TI-DGB-0011"

In order to be able to carry out the connection, the connection cap must be removed from the laser first.
For this the screws **(A)** are loosened and the cap **(B)** is removed away from the laser.
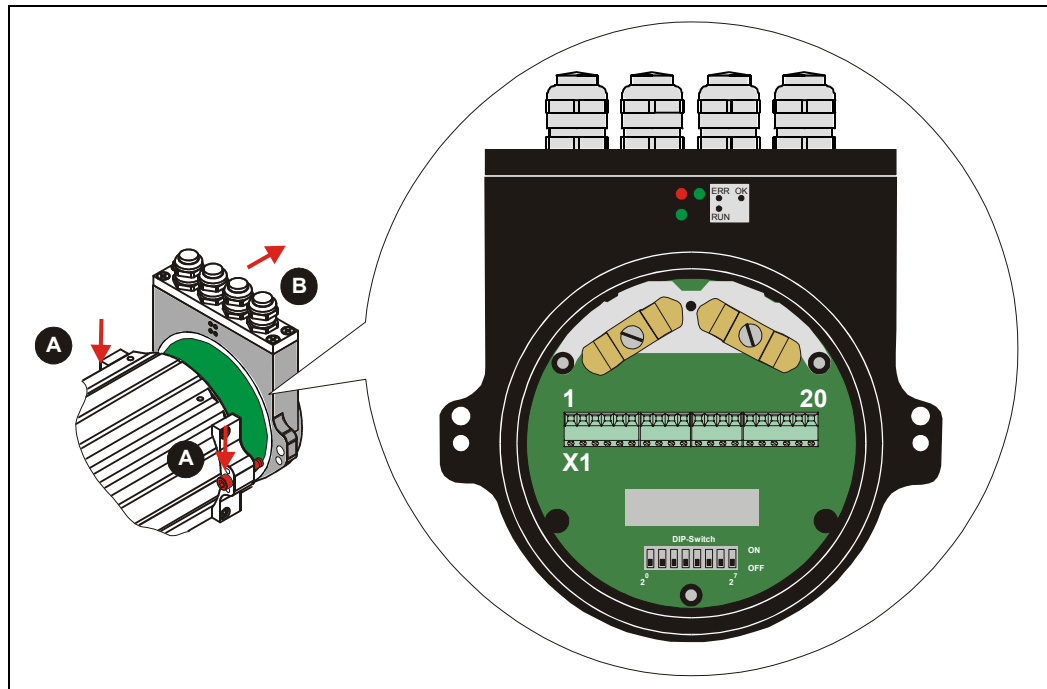
5.1.1 Supply voltage

Pin 7   0V, GND

Pin 8   Standard: 18 – 27 V DC
Device with heating: 24 V DC (±5%)

5.1.2 CANopen

Pin 15   GNDI (reference potential CAN_L / CAN_H)

Pin 16   Shield (internal RC-element onto case)

Pin 17   CAN_H

Pin 18   CAN_H

Pin 19   CAN_L

Pin 20   CAN_L
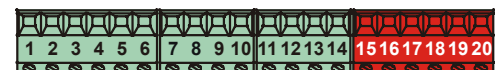
5.1.2.1 Bus termination

For the communication a defined no-signal level must be guaranteed on the CAN bus. To this both line ends have to be terminated with terminating resistors.
In the laser measuring device is not provided an add-on connection of the terminating resistor. Therefore, if the laser measuring device is the last slave in the CAN bus line, the termination must be made manually with a terminating resistor of 121 ohms between the CAN_H and CAN_L lines.

5.1.2.2 Identifier (Node-ID)

The identifier (laser address) 1 – 64 is adjusted via the DIL-switches 1-6:
DIL-1 = ID 2^0, DIL-6 = ID 2^5

The Node-ID is the adjusted hardware number by the DIL-switches 1-6 + 1.
That means:
all 6 switches off = 0, Node-ID = 1

(see also "Object 100Bh: Node-ID", page 27)

Note:
The adjusted address may be assigned only once in the CANopen bus.
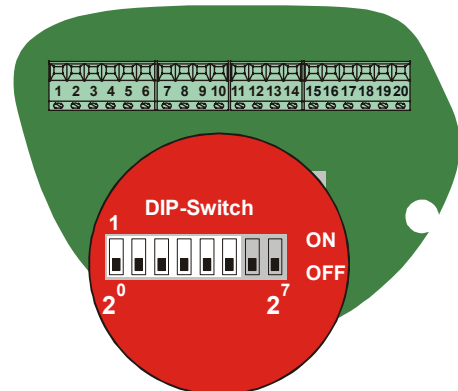
5.1.2.3 Baud rate

The baud rate is adjusted via the DIL-switches 7-8:

DIP-7	DIP-8	Baud rate
OFF	OFF	20 kbps
ON	OFF	125 kbps
OFF	ON	500 kbps
ON	ON	1000 kbps
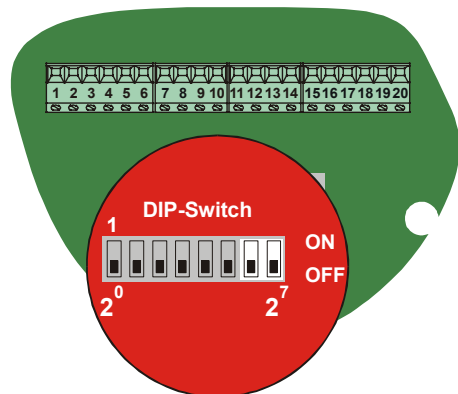
5.1.2.4 Length of the bus line

The max. bus line length is dependent on the adjusted baud rate:

Baud rate	Line length [m]
20 kbps	up to 2500
125 kbps	up to 500
500 kbps	up to 100
1000 kbps	up to 25

5.1.3 Switching input / Switching output

The programming of the switching input /switching output is carried out either directly via the bus, or via the PC software "TRWinProg".

Functions of the switching input:
- Preset
- Switch off laser diode
- Failure quit

Functions of the switching output:
- Temperature- ,
- Intensity- ,
- Hardware-Fail-Output or
- every fail
- Speed-check
- Plausibility measured value
- Switching output position

Pin 1 GND, reference potential pin 2

Pin 2 Switching output

Pin 3 Switching input

5.1.4 RS485 - programming interface

The RS485 programming interface was developed mainly only as service interface for the technician.
Primarily therefore the programming possibilities via the CANopen should be used.
Via the PC software "TRWinProg" and a PC adapter the connection to the laser measuring device is established. More informations see page 20 or in the TRWinProg software manual.

Pin 9 RS485–

Pin 10 RS485+

5.1.5 Switching on the supply voltage

After the connection, baud rate and Node-ID-setting has been carried out, the supply voltage can be switched on.

After power on and finishing the initialization, the laser goes to the Pre-operational state and waits for command. If the laser detects an internal error, an emergency message with the error code will be transmitted (see chapter "Emergency Message", page 38).

5.1.6 Wiring examples

* Shield connection, see chapter 1.2.1.1 page 8.
CiA DR 303-1 conformal pin assignment see "TR-ELE-TI-DGB-0011"

CANopen connection
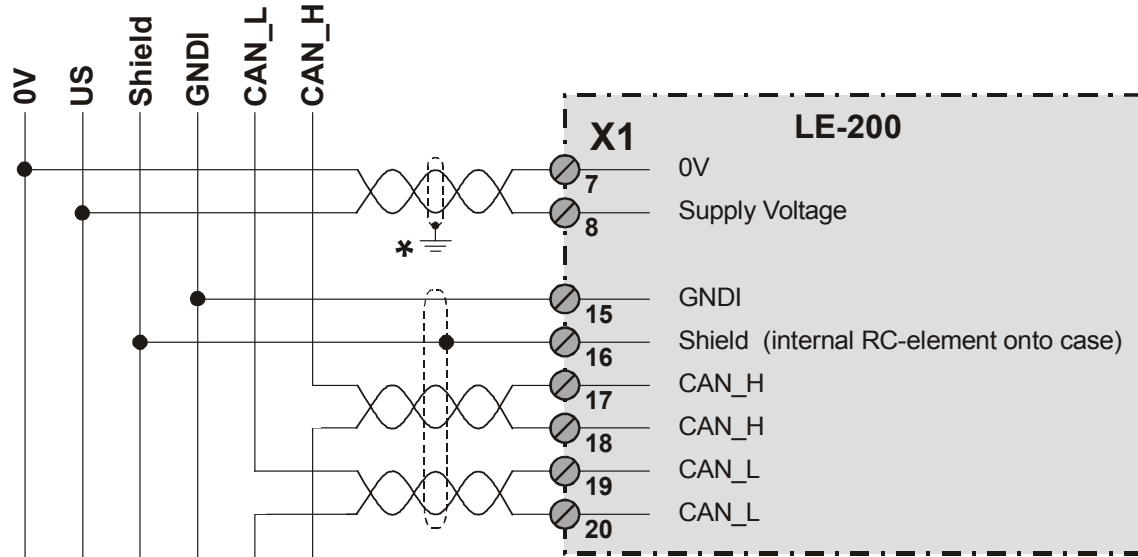
RS485-connection with parameter setting via "TRWinProg"
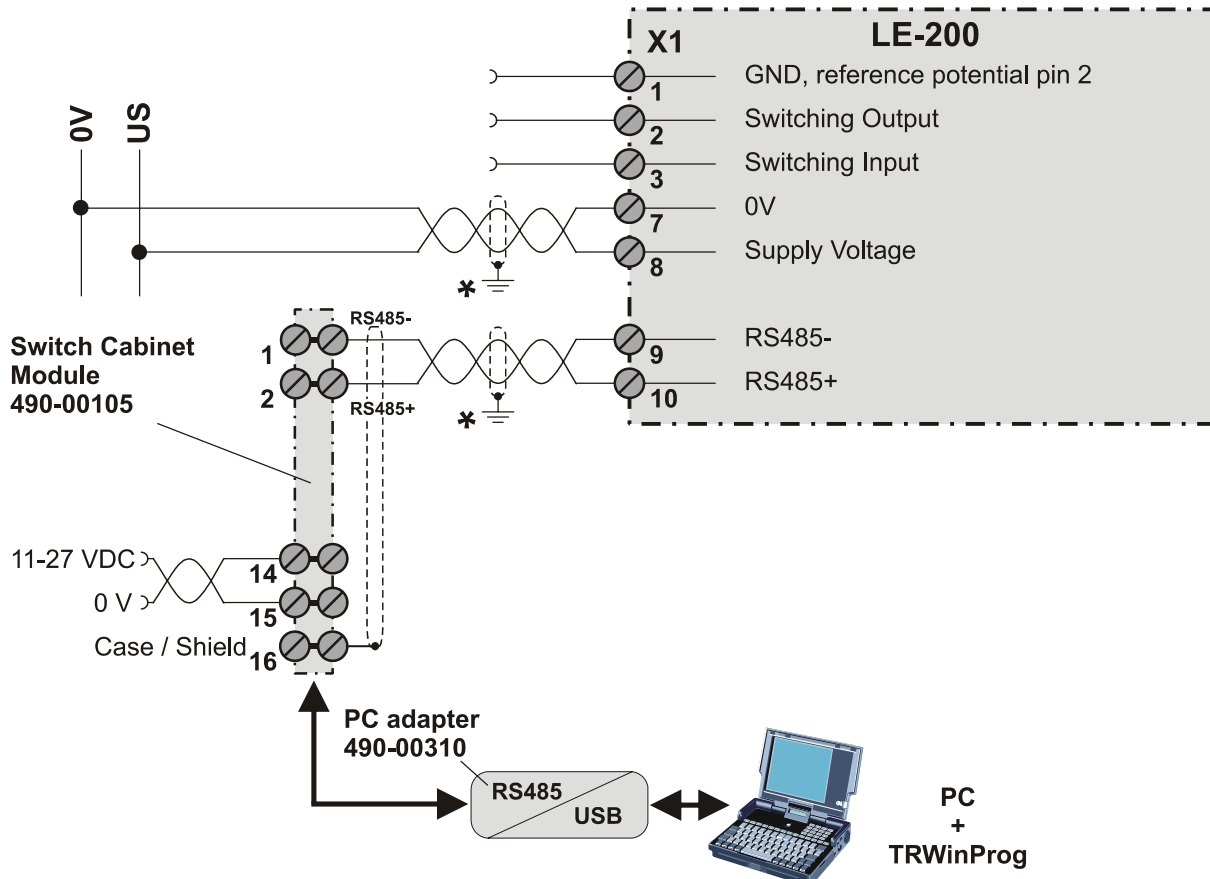
5.2 CANopen interface

The CAN-Bus-Interface is defined by the international norm ISO/DIS 11898 and specifies the two lowest layers of the ISO/DIS CAN Reference Model.

The CAN-BUS-Interface with the BUS-Driver PCA82C251 is galvanic isolated of the laser electronic and becomes the power over internal DC/DC-converter. There is no external power supply necessary for the CAN-BUS-Driver.

The conversion of the laser information to the CAN message format (CAN 2.0A) is done by the CAN-controller SJA1000. The function of the CAN-controller is controlled by a watchdog .

The CANopen Communication Profile (CIA standard DS 301) is a subset of CAN Application Layer (CAL) and describes, how the services are used by devices. The CANopen Profile allows the definition of device profiles for decentralized I/O.

The laser with CANopen-protocol support the Device Profile for Encoder (CIA Draft Standard Proposal 406, Version 2.0). The encoders support the extended functions in Class C2 .

The communication functionality and objects, which are used in the laser profile, are described in a EDS-File (Electronic Data Sheet).
When using a CANopen Configuration Tool (e.g.:CANSETTER), the user can read the objects of the laser (SDOs) and program the functionality.

The selection of transmission rate and node number is done by hardware (switches).

5.2.1 Bus status

At the connection cap the laser has 3 LEDs, which display the bus status of the laser:

LEDs Off	Laser is not on-line - Device may not be powered	
RUN, green	On-line, with connections in the established state - Device is allocated to a master	

RUN,
green flashing
	Recoverable fault
	   - e.g. I/O-connections are in the time-out state
	     (Node-Guarding active)	

ERR, red	- Turn off system, after that turn on system - Replace laser device	
ERR, red flashing	- Off-Line	
OK, green	Laser hardware ok	
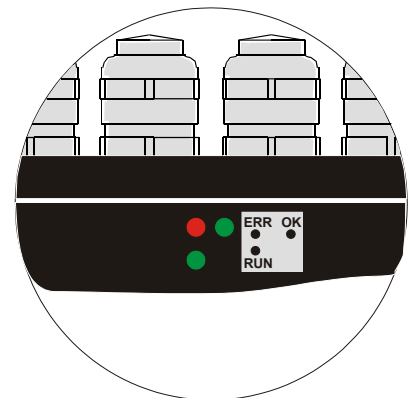
5.2.2 EDS-file

The EDS-file (electronic data sheet) contains all informations about the laser specific parameters and operating modes of the laser measuring device. The EDS-file is needed by the CANopen network configuration tool to be able to configure or to take into operation the laser measuring device duly.

The EDS-file has the file name **"LE200.EDS"**

The file is on the Software/Support CD:
Order number: 490-01001, Soft-No.: 490-00408.

5.2.3 The communication profile

Two process data objects (PDO) are implemented in the device. One is used for asynchronous transmission and the other one for the cyclic transmission functions.

The output position value is transmitted in binary code:

COB-ID	Output Position Value			
11 Bit	Byte 0	Byte 1	Byte 2	Byte 3
	2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

5.2.3.1 1st Transmit Process Data Object (asynchronous)

This PDO transmit the position value of the laser in an asynchronous way. The cyclic timer is stored in index 6200h.

Index	Sub-Index	Comment	Default Value
1800h	0	number of supported entries	3
	1	COB-ID used by PDO 1	180h + Node-ID
	2	transmission type	254
	3	inhibit time	0
1A00h	0	number of mapped objects	1
	1	Position value	60040020h

5.2.3.2 2nd Transmit Process Data Object (synchronous)

This PDO transmit the position value of the laser in a cyclic way (on request). Request by remote frame and/or sync telegrams.

Index	Sub-Index	Comment	Default Value
1802h	0	number of supported entries	3
	1	COB-ID used by PDO 2	280 + Node-ID
	2	transmission type	1
	3	inhibit time	0
1A02h	0	number of mapped objects	1
	1	Position value	60040020h

5.2.4 Communication specific standard objects

Following table gives an overview on the supported indices in the communication profile area:

Index (h)	Object	Name	Type	Attr.
1000	VAR	device type	Unsigned32	const
1001	VAR	error register	Unsigned8	ro
1002	VAR	manufacturer status register	Unsigned32	ro
1003	ARRAY	pre-defined error field	Unsigned32	ro
1004	ARRAY	Number of PDOs supported	Unsigned32	ro
1005	VAR	COB-ID SYNC-message	Unsigned32	rw
1008	VAR	device name	Vis-String	const
1009	VAR	hardware version	Vis-String	const
100A	VAR	software version	Vis-String	const
100B	VAR	Node-ID	Unsigned32	ro
100C	VAR	guard time	Unsigned16	rw
100D	VAR	life time factor	Unsigned8	rw
100E	VAR	COB-ID guarding protocol	Unsigned32	ro
1010	VAR	store parameters	Unsigned32	rw

5.2.4.1 Object 1000h: Device Type

Contains information about the device type. The object at index 1000h describes the type of device and its functionality. It is composed of a 16 bit field which describes the device profile that is used (Device Profile Number 406 = 196h) and a second 16 bit field which gives information on the type of device.

Structure of parameter

Unsigned32, const

Device Type			
Device Profile Number		Encoder Type	
Byte 0	Byte 1	Byte 2	Byte 3
196h		2^7 to 2^0	2^{15} to 2^8

Encoder type

Code	Definition
08	Laser measuring device

5.2.4.2 Object 1001h: Error Register

This object contains the error register for the device. If an alarm bit is set (object 6503), bit 5 is set in the error register.

Unsigned8, Read

Bit	Meaning
0	0
1	0
2	0
3	0
4	0
5	device profile specific
6	0
7	0

5.2.4.3 Object 1002h: Manufacturer Status Register

This object is not used by the laser, by read access the value is always "0".

Printed in the Federal Republic of Germany

5.2.4.4 Object 1003h: Pre-defined Error Field

This object contains an occurred laser error and indicates the error via the Emergency object.

Index	Sub-Index	Comment	Type
1003h	0	number of errors / clear error code	Unsigned8
	1	standard error field	Unsigned32

Sub-index 0: The entry in sub-index 0 contains the number of occurred errors and registers it in sub-index 1.

After elimination of the error the error code can be cleared about a write access on sub-index 0.

Sub-index 1: The error field consists of an 8 bit error code.

Unsigned32, Read

Standard Error Field			
Byte 0	Byte 1	Byte 2	Byte 3
error code	0	0	0
2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0	-	-	-

Description of the error code

No error Byte 0 = 0x00	Corresponds to the normal condition
Intensity Bit 0 in byte 0	The bit is set, if an intensity value of smaller 8% is present, or the laser beam is interrupted and leads to the error value output.
Temperature Bit 1 in byte 0	The bit is set, if the device temperature is outside of the range from 0 - 50 °C. A low range deviation has still no influence on the measurement and is therefore to be regarded as a warning.
Hardware Bit 2 in byte 0	The bit is set, if an internal hardware error were noticed and leads to the error value output.
Laser diode switched off Bit 3 in byte 0	The bit is set, if the laser diode was switched off over the bus, or the switching input. Serves only for information purposes.
Intensity warning Bit 4 in byte 0	The bit is set, if an intensity value of smaller 12% were determined and means that the measuring system optics, or the reflecting foil is to be cleaned. However, the device operates error-freely furthermore.
Overspeed warning Bit 5 in byte 0	The bit is set if the speed, adjusted in the PC program TRWinProg, is exceeded. About the default setting the speed-check is switched off. A configurability over the bus is not possible.
Plausibility warning Bit 6 in byte 0	The bit is set if the plausibility of the measured value cannot be guaranteed. E.g. this is the case at a position jump if a second reflection foil is held into the laser beam.

5.2.4.5 Object 1004h: Number of PDOs supported

This object contains information about the maximum number of PDOs supported by the laser.

Index	Sub-Index	Comment	Type
1004h	0	number of PDOs supported	Unsigned32
	1	number of synchronous PDOs	Unsigned32
	2	number of asynchronous PDOs	Unsigned32

Sub-index 0 describes the overall number of PDOs supported (synchronous / asynchronous).
Sub-index 1 describes the number of synchronous PDOs supported by the laser.
Sub-index 2 describes the number of asynchronous PDOs supported by the laser.

Unsigned32, Read

Number of PDOs			
Byte 0	Byte 1	Byte 2	Byte 3
Transmitted PDOs		Received PDOs	

Sub-index 0: Transmitted PDOs = 2, Received PDOs = 0
Sub-index 1: Transmitted PDOs = 1, Received PDOs = 0
Sub-index 2: Transmitted PDOs = 1, Received PDOs = 0

5.2.4.6 Object 1005h: COB-ID SYNC message

This object defines the COB-ID of the ynchronization object (SYNC). Further, it defines whether the device processes the SYNC or whether the device generates the SYNC.

Unsigned32, Read/Write
MSB   LSB

31	30	29	28-11	10-0
1	0	0	0	00 1000 0000

Bit 31 = 1 , Device processes SYNC message
Bit 31 = 0 , Device does not generate SYNC message

Bit 30 = 0
Bit 29 = 0 , 11 bit ID (CAN 2.0A)
Bit 28 -11 = 0
Bit 10 – 0 = 11 bit SYNC-COB-IDENTIFIER, default value = 080h

If a SYNC-telegram with the identifier, defined in this object (080H), and data length = 0 has been received by the device, the position value of the laser is transmitted by the 2nd Transmit PDO (object 1802).
The default value 80 H in byte 0 (bit 0 -7) can be overwritten by another value ($\neq$ 0). The new adjusted value is stored permanently about "Object 1010h: Store Parameters", page 28.

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5.2.4.7 Object 1008h: Manufacturer Device Name

Contains the manufacturer device name (visible string) "LE200".

5.2.4.8 Object 1009h: Manufacturer Hardware Version

Contains the manufacturer hardware version (visible string).

5.2.4.9 Object 100Ah: Manufacturer Software Version

Contains the manufacturer software version (visible string).
See also object 6507.

5.2.4.10 Object 100Bh: Node-ID

This object contains the Node-ID (device address).

The value is selected by 6 hardware switches and cannot be changed using SDO services.

Unsigned32, Read

Node_ID			
Byte 0	Byte 1	Byte 2	Byte 3
Node-ID	reserved	reserved	reserved

Value range: 1 – 64.

The Node-ID is the selected hardware number by switches + 1. That means:

> all 6 switches off = 0, Node-ID = 1
> switch bit 5 = on = 32, Node-ID = 33

5.2.4.11 Object 100Ch: Guard-Time

The objects of index 100CH and 100DH include the guard time in milli-seconds and the life time factor. The life time factor multiplied with the guard time gives the live time for the node guarding protocol.

Unsigned16, Read/Write

Guard-Time	
Byte 0	Byte 1
2^7 to 2^0	2^{15} to 2^8

5.2.4.12 Object 100Dh: Life Time Factor

The life time factor multiplied with the guard time gives the life time for the node guarding protocol. If the result is "0", no node guarding is supported.

Unsigned8, Read/Write

Life Time Factor
Byte 0
2^7 to 2^0

5.2.4.13 Object 100Eh: Node Guarding Identifier

The identifier is used for the node guarding and the life guarding procedure.

Unsigned32, Read

MSB
LSB

31	30	29	28-11	10-0
reserved		0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	11 bit identifier

Bit 10 – 0 = 11 bit identifier, value = 700h + Node-ID

5.2.4.14 Object 1010h: Store Parameters

This object supports the saving of parameters in non volatile memory (EEPROM).

Index	Sub-Index	Comment	Type
1010h	0	largest supported sub-index	Unsigned8
	1	save all parameters	Unsigned32

Sub-index0: The entry in sub-index 0 contains the largest sub-index which is supported. Value = 1.

Sub-index1: By read access the device provides information about its saving possibility.

Unsigned32, Read/Write

MSB   LSB

bits	31-2	1	0
value	= 0	0	1

By read access the device provides information about its saving possibility.

Bit 0 = 1, the device saves parameters only on command. That means, if parameters have been changed by the user and no "Store Parameter Command" has been executed, at the next power on, the parameters will have there old values.

By write access the device stores the parameters to the non volatile memory.
In order to avoid storage of parameters by mistake, storage is only executed when a specific signature is written to the object. The signature is "save".

Unsigned32

Signature   MSB   LSB

e	v	a	s
65h	76h	61h	73h

On reception of the correct signature, the device stores the parameters. If the storing failed, the device responds with abort domain transfer, error class 6 , error code 6 (hardware fault). See also "Object 6503h - Alarms", page 35.

If a wrong signature is written, the device refuses to store and responds with abort domain transfer, error class 8, error code 0.

6 Configuration / Parameter setting via the CANopen master

The configuration of the laser occurs alternatively via the configuration software of the CANopen – master or via the TRWinProg-software. With a download of the control parameters the parameters, which were configured via the TRWinProg-software, will be overwritten by the control.
In this instruction only the configuration via the CANopen – master is described. The PC program TRWinProg is described in an instruction of its own.

6.1 Standardized encoder profile area

Each encoder shares the dictionary entries from 6000h to 65FFh. These entries are common to encoders. Additionally the laser measuring device uses the entries from 2000 to 2006h.
NOTE that all indices shown in the "Index" column are hexadecimal.

The overview of all laser entries are shown below:

Index	Object	Name	Data Length	Attr.
Parameters				
2000	VAR	Clear Preset	Unsigned8	rw
2001	VAR	Output value in case of an error	Unsigned8	rw
2002	VAR	Error value **(not supported)**	Unsigned32	rw
2003	VAR	Function external input	Unsigned8	rw
2004	VAR	Automatic error acknowledgement	Unsigned8	rw
2005	VAR	Function error output	Unsigned8	rw
2006	VAR	Switching functions	Unsigned8	rw
2007	VAR	Resolution	Unsigned8	rw
6000	VAR	Operating parameters	Unsigned16	rw
6003	VAR	Preset value	Unsigned32	rw
6004	VAR	Position value	Unsigned32	ro
6005	REC	Measuring step	Unsigned32	ro
6200	VAR	Cyclic-Timer	Unsigned16	rw
Diagnostics				
6500	VAR	Operating status	Unsigned16	r
6501	VAR	Measuring step	Unsigned32	ro
6503	VAR	Alarms	Unsigned16	r
6504	VAR	Supported alarms	Unsigned16	r
6505	VAR	Warnings	Unsigned16	r
6506	VAR	Supported Warnings	Unsigned16	r
6507	VAR	Software version	Unsigned32	r
6508	VAR	Operating time	Unsigned32	r
6509	VAR	Offset value	Signed32	r
650A	VAR	Manufacturer offset value	Signed32	r
650B	VAR	Serial number	Unsigned32	r

On the following pages each single object is explained in detail.

6.1.1 Object 2000 – Clear Preset

Via this object, the zero-point correction calculated in "Object 6003h - Preset value", page 33 is deleted. The correction arises from the difference of the desired preset value to the physical laser position. That means, after deletion of the zero-point correction the laser outputs his "real" physical position.

Unsigned8, Read/Write

0	Clear Preset
1	No clearing

6.1.2 Object 2001 – Output value in case of an error

Determines, which data value is to be transmitted in the case of an error. The data value is output, if the laser can output no more measurement. This is given e.g., if a beam interruption is present.

Unsigned8, Read/Write

0	*Null (default)*	The position is set to "0"
1	0xFF	All 24 bits are set to '1' (0xFFFFFF or -1)
2	last valid value	Output of the last valid position

6.1.3 Object 2003 – Function external input

Determines, whether the switching input is to be used as
- Preset input
- Switch-off Laser-Diode (LD) or
- Failure reset – input

With connection of the switching input as Preset-input the laser is adjusted on the predefined position value in "Object 6003h - Preset value", page 33. With connection the switching input as LD-input the laser diode is switched off for the extension of the life time. If in the PC-program "TRWinProg" in the basic parameters the switching-off of the laser diode is carried out automatically, the LD-switching input does not have a function.

Unsigned8, Read/Write

0	*disabled (default)*	Function switched off, following parameters without meaning
1	Preset function	External switching input is determined as Preset input. Software execution see chapter "Object 2006 - Switching functions", page 32.
2	LD switching input	External switching input is used for switching-off of the laser diode. Software switching-off see chapter "Object 2006 - Switching functions", page 32.
3	Error acknowledgement	External switching input is used as error acknowledgement. Software acknowledgement see chapter "Object 1003h: Pre-defined Error Field", page 25.

6.1.4 Object 2004 – Automatic error acknowledgement

Determines, whether occurring error reports should be cleared automatically after eliminating the trouble.

Unsigned8, Read/Write

0	*not automatically (default)*	An occurring error report can be cleared via "Object 1003h: Pre-defined Error Field", page 25 or via "Object 2003 – Function external input", page 31.
1	automatically	An occurring error report is cleared automatically after remedying of the error.

6.1.5 Object 2005 – Function error output

Determines, the function of the error output (external switching output). Definition of the error see "Description of the error code", page 25.

Unsigned8, Read/Write

0	*disabled (default)*
1	Temperature
2	Intensity
3	Hardware
4	all errors
5	Speed-check
6	Plausibility measured value

6.1.6 Object 2006 - Switching functions

Unsigned8, Read/Write

Switch off laser diode Bit 0 = 1	By setting this bit the laser diode (LD) is switched off for the extension of the life time. If in "Object 2003 – Function external input", page 31 = "LD-switching input" is preselected, or in the PC-program "TRWinProg" in the basic parameters the switching-off of the laser diode is carried out automatically, this function is ineffective.
Switch on laser diode Bit 1 = 1	By setting this bit the laser diode is switched on. This function is ineffective if: see "Switch off laser diode" above.
Execute Preset Bit 2 = 1	By setting this bit the laser is adjusted to the value deposited in "Object 6003h - Preset value", page 33.

A read access returns the status of the laser diode:

0	Laser diode is switched off
1	Laser diode is switched on

6.1.7 Object 2007 - Resolution

Definition of the measuring system resolution. Options:

0	Centimeter
1	**Millimeter (default)**
2	1/10 millimeter
3	1/100 millimeter
4	Inch
5	1/10 Inch
6	Free resolution (in 1/100 mm), valid values are 1 - 65535, **default = 100**

With selection "Free resolution" the entered value of the object "Object 6005h – Measuring step" is used.

6.1.8 Object 6000h - Operating parameters

The operating parameters contain the functions for code sequence.

Structure of parameter
Unsigned16, Read/Write

Bit	Function	Bit = 0	Bit = 1
0	Code Sequence	increasing	decreasing
1	reserved		
3 - 11	reserved		
12-15	Manufacturer specific functions		

Code sequence:

The code sequence defines whether increasing or decreasing position values are output.

0 (default)	With increasing distance to the laser, values increasing
1	With increasing distance to the laser, values decreasing

6.1.9 Object 6003h - Preset value

The Preset function can be used to adjust the laser to any position value within a range of 0 … to measuring length in increments.
The output position value is set to the parameter "Preset value" when writing to this object. The call of "Object 1010h: Store Parameters", page 28 isn't necessary.

Structure of parameter
Unsigned32, Read/Write

Preset value			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

6.1.10 Object 6004h - Position value

The object 6004h "Position value" defines the output position value for the communication objects 1800h and 1802h.

Structure of parameter
Unsigned32, Read

Position value			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

6.1.11 Object 6005h – Measuring step

If in object "Object 2007 - Resolution" the selection "Free resolution" was carried out, via the measuring step the resolution of the measuring system is defined.

Index	Sub-Index	Comment	Type
6005h	0	number of entries	Unsigned8
	1	measuring step	Unsigned32

Unsigned32, Read

Measuring step			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}
Input value in 1/100 mm		0	0

Input value in 1/100 mm
1 mm e.g. corresponds to the input value of 100. That means, that the laser output 1 step / mm.
Default value: 100, maximum value: 65535

6.1.12 Object 6200h – Cyclic timer

Defines the parameter "Cyclic timer". A Cyclic transmission of the position value is set, when the cyclic timer is programmed > 0. Values between 1 ms and 65535 ms can be selected.

e.g.:   1 ms   =   1 h
         256 ms = 100 h

This value isn't saved in the device permanently and is lost with switching off the supply voltage. With each restart the cyclic timer is $\neq 0$ and must always be rewritten therefore.

When the laser is started with the NODE START command and the value of the cyclic timer is > 0, the 1st transmit PDO (object 1800h) transmit the laser position.

6.1.13 Laser diagnostics

6.1.13.1 Object 6500h - Operating status

This object contains the operating status of the laser. It gives information on laser internal programmed parameters.
(see also "Object 6000h - Operating parameters", page 33)

Structure of parameter
Unsigned16, Read

Bit	Function	Bit = 0	Bit = 1
0	Code Sequence	increasing	decreasing
1	reserved		
3 - 11	reserved		
12 - 15	Manufacturer specific functions		

0 = With increasing distance to the laser, values increasing
1 = With increasing distance to the laser, values decreasing

6.1.13.2 Object 6501h – Measuring step

The object 6501h indicates the adjusted resolution of the measuring system in 1/100 mm.
(see also "Object 6005h – Measuring step", page 34)

Structure of parameter
Unsigned32, Read

Measuring step			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}
adjusted resolution in 1/100 mm		0	0

6.1.13.3 Object 6503h - Alarms

Additionally to the "emergency message", object 6503h provides further alarm messages. An alarm is set if a malfunction in the laser could lead to incorrect position value. If an alarm occurs, the according bit is set to logical high until the alarm is cleared and the laser is able to provide an accurate position value.

Structure of parameter
Unsigned16, Read

Alarms								Byte 1
Byte 0								Byte 1
error code								Reserved for further use
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	-

Description of the error code

No error Byte 0 = 0x00	Corresponds to the normal condition
Intensity Bit 0 in byte 0	The bit is set, if an intensity value of smaller 8% is present, or the laser beam is interrupted and leads to the error value output.
Temperature Bit 1 in byte 0	The bit is set, if the device temperature is outside of the range from 0 - 50 °C. A low range deviation has still no influence on the measurement and is therefore to be regarded as a warning.
Hardware Bit 2 in byte 0	The bit is set, if an internal hardware error were noticed and leads to the error value output.
Laser diode switched off Bit 3 in byte 0	The bit is set, if the laser diode was switched off over the bus, or the switching input. Serves only for information purposes.
Intensity warning Bit 4 in byte 0	The bit is set, if an intensity value of smaller 12% were determined and means that the measuring system optics, or the reflecting foil is to be cleaned. However, the device operates error-freely furthermore.
Overspeed warning Bit 5 in byte 0	The bit is set if the speed, adjusted in the PC program TRWinProg, is exceeded. About the default setting the speed-check is switched off. A configurability over the bus is not possible.
Plausibility warning Bit 6 in byte 0	The bit is set if the plausibility of the measured value cannot be guaranteed. E.g. this is the case at a position jump if a second reflection foil is held into the laser beam.

6.1.13.4 Object 6504h - Supported alarms

Object 6504h contains the information on supported alarms by the laser.

Structure of parameter
Unsigned16, Read

Bit	Function	Bit = 0	Bit = 1
0	Intensity	No	Yes
1	Temperature	No	Yes
2	Hardware	No	Yes
3	Laser diode switched off	No	Yes
4	Intensity warning	No	Yes
5 - 13	Reserved for further use		
14 - 15	Manufacturer specific functions		

6.1.13.5 Object 6505h - Warnings

This object is not supported.
By read access the value is always "0" .

6.1.13.6 Object 6506h - Supported warnings

This object is not supported.
By read access the value is always "0" .

6.1.13.7 Object 6507h – Software version

This object contains the software version which is implemented in the laser. It is combined to a revision number and an index. The version-no. is indicated in ASCII code.

e.g.:
Version:	2.12				
Binary:	0011 0010	0010 1110	0011 0001	0011 0010	
Hex:	32	2E	31	32	

Structure of parameter
Unsigned32, Read

Software version			
Byte 0	Byte 1	Byte 2	Byte 3
2^7 to 2^0	2^{15} to 2^8	2^7 to 2^0	2^{15} to 2^8

6.1.13.8 Object 6508h - Operating time

The operating time function indicates the operation hours of the *activated laser diode*.

6.1.13.9 Object 6509h - Offset value

This object contains the offset value calculated by the preset function. The offset value is stored and can be read from the laser.

6.1.13.10 Object 650Ah - Manufacturer offset value

This object is not supported.
By read access the offset value is "0".

6.1.13.11 Object 650Bh - Serial number

This object contains the serial number of the laser device (4 byte).

7 Emergency Message

Emergency messages are triggered by the occurrence of a device internal malfunction and are transmitted from the concerned application device to the other devices with highest priority.

Emergency Message							
Byte	0	1	2	3	4	5	6	7
content	Emergency Error Code		Error register (object 1001H)	0	0	0	0	0

COB-Identifier = 080h + Node-ID

If the laser detects an internal error, an emergency message will be transmitted with the error code of "Object 1003h: Pre-defined Error Field", page 25 and the error register object 1001H. Additionally to the emergency object the according bit in "Object 6503h - Alarms", page 35 is set.

If the error disappears, the laser transmits an emergency message with error code "0" (reset error / no error) and error register "0". To this it is prerequisite that the error acknowledgment was set to "automatically" (see "Object 2004 – Automatic error acknowledgement", page 32).

8 Transmitting of the laser position value

Before the laser position can be transferred the laser has to be started with the Node Start command.

Node Start Protocol

COB-Identifier = 0	
Byte 0	Byte 1
1	Node-ID

Node Start command with the Node-ID of the laser (slave) starts only this device.

Node Start command with **Node-ID = 0** starts all slaves connected to the bus.

After the Node Start command the laser transmit the position value one time with the COB-ID of object 1800h.

Now the laser position value can be transmitted in different ways:

Asynchronous Transmission

The 1st transmit PDO (object 1800h) transmit the position value of the laser. The cyclic time is defined by the value of the cyclic timer (object 6200H). This transmission starts automatically after the Node Start command and the value of the cyclic timer is > 0.

The default value of the COB-ID is 180h + Node-ID.

Cyclic Transmission

The 2nd transmit PDO (object 1802) transmit the position value of the laser on request (remote / sync).
The laser receives a remote frame with the COB-ID (default value 280h + Node-ID)

The laser receives a sync telegram with the COB-ID (default value 080h) defined in object 1005h. All slaves with the this SYNC-COB-ID will transmit the position value.

To stop the transmission of the laser position the laser has to be stopped with the Node Stop command.

Node Stop Protocol

COB-Identifier = 0	
Byte 0	Byte 1
2	Node-ID

Node Stop command with the Node-ID of the laser (slave) stop only this device.

Node Stop command with **Node-ID = 0** stop all slaves connected to the bus.

8.1 Read/Write Service Data Object

The transfer of the Service Data Object (SDO) is done by the CMS "Multiplexed Domain" protocol (CIA DS202/2).

8.1.1 Read SDO:

(Initiate "Domain Upload")

Request Protocol format:

COB-Identifier = 600h + Node-ID

Byte	0	1	2	3	4	5	6	7
Read SDOs								
content	Code	Index		Sub-index	Data 0	Data 1	Data 2	Data 3
	40h	low	high	byte	0	0	0	0

The Read SDO telegram has to be send to the slave.

The slave answers with the following telegram:

Response Protocol format:

COB-Identifier = 580h + Node-ID

Byte	0	1	2	3	4	5	6	7
Read SDOs								
content	Code	Index		Sub-index	Data 0	Data 1	Data 2	Data 3
	4xh	low	high	byte	data	data	data	data

Format byte 0:

MSB   LSB

7	6	5	4	3	2	1	0
0	1	0	0	n		1	1

n = number of data bytes (bytes 4-7) that does not contain data.

If only 1 data byte (Data 0) contains data the value of byte 0 is "4FH".

If byte 0 = 80h the transfer has been aborted.

8.1.2 Write SDO:

(Initiate "Domain Download")

Request Protocol format:

COB-Identifier = 600h + Node-ID

Write SDOs							
Byte	0	1	2	3	4	5	6	7
content	Code	Index		Sub-index	Data 0	Data 1	Data 2	Data 3
	2xh	low	high	byte	0	0	0	0

Format byte 0:

MSB　　　　　　　　　　　　　　　　　　LSB

7	6	5	4	3	2	1	0
0	0	1	0	n		1	1

n = number of data bytes (bytes 4-7) that does not contain data.

If only 1 data byte (Data 0) contains data the value of byte 0 is "2FH".

The Write SDO telegram has to be send to the slave.

The slave answers with the following telegram:

Response Protocol format:

COB-Identifier = 580h + Node-ID

Read SDOs							
Byte	0	1	2	3	4	5	6	7
content	Code	Index		Sub-index	Data 0	Data 1	Data 2	Data 3
	60h	low	high	byte	0	0	0	0

If byte 0 = 80h the transfer has been aborted.

9 Causes of Faults and Remedies

The error causes are determined in "Object 1003h: Pre-defined Error Field", page 25. Depending on setting the error messages must be acknowledged for resetting the error code (see chapter "Object 1003h: Pre-defined Error Field", page 25 / "Object 2003 – Function external input", page 31 and "Object 2004 – Automatic error acknowledgement", page 32).

Error code	Cause	Remedy
Bit 0 Intensity error	The device checks the intensity of the received laser signal continuously, it was detected a below-minimum intensity.	1. Clean measuring system optics 2. Clean reflecting foil 3. Rule out an interruption of the laser beam If the possibility of soiling or interruption of the laser signal can be ruled out, the device must be replaced.
Bit 1 Device temperature	The temperature has exceeded or fallen short of the range of 0 - 50°C at the housing of the device	Appropriate measures must be taken to prevent the device from overheating or undercooling.
Bit 2 Hardware error	The device has detected an internal hardware error.	If the error occurs repeated, the device must be replaced.
Bit 3 Laser diode switched off	The bit is set, if the laser diode was switched off over the bus, or the switching input.	Serves only for information purposes.
Bit 4 Intensity warning	The device determined an intensity of < 12%.	This message is only a warning and means that the measuring system optics, or the reflecting foil is to be cleaned. However, the device operates error-freely furthermore.
Bit 5 Speed-check warning	The speed level adjusted over the PC program TRWinProg was exceeded.	This message is a warning and means that possibly corresponding measures must be taken, so that no system components will be damaged.
Bit 6 Plausibility warning	The plausibility of the measured value couldn't be guaranteed any more.	This message is a warning and means that possibly corresponding measures must be taken, so that no system components will be damaged.

10 Maintenance

10.1 General Maintenance Information

The Laser Measuring Device does not, in general, require maintenance by the operator.

i *Note*
If the lens opening of the laser or the reflecting foil become dirty, clean with a soft cloth.

Do not use an aggressive cleaning material such as thinner or acetone !

10.2 Repair, Maintenance

Repairs to the devices must only be carried out by the manufacturer.

Contact your TR-Electronic GmbH distributor or service organization should repairs be required. The addresses are listed on the last page of this description.

11 Appendix

11.1 Specifications

i *Note*

The electric characteristics have validity, only after an operating time of approximate 30 minutes.

11.1.1 Electrical ratings

Measuring principle:	Phase delay time measurement
Range (measurement on reflecting foil):	0,2 – 125 m standard, 170m, 195m, 240m (special devices)
* Resolution:	selectable, physical resolution 0,7 mm

Linearization

up to 12m (standard):	absolute linearity error ±3 mm
complete measuring length:	absolute linearity error ±5 mm

Operating voltage

Standard device:	18-27 V DC ($\pm$ 5%)
Device with heating:	24 V DC ($\pm$ 5%)

Power consumption (no-load):	< 6 watts
Power consumption with heating:	< 60 watts
Opto-transmitter:	Laser diode (red light)
Wavelength λ:	670 nm
Max. laser power:	$P \leq 1$ mW
Laser protection class:	2 according to DIN EN 60 825-1: 2003-10
Lifetime:	50 000 h
Measured value output / refresh cycle:	1000 values / s
Integration time:	1 ms
Reproducibility:	$\pm$ 2 mm
Programming via RS485:	PC IBM compatible (TRWinProg) / CANopen
CANopen Interface:	CAN Bus Interface according to ISO/DIS 11898
Data protocol:	CAN 2.0 A, CANopen Device Profile for Encoder CiA DS-406 V2.0
Output code:	Binary
Baud rate (via switches):	- 20 kbps, line length up to 2500 m
	- 125 kbps, line length up to 500 m
	- 500 kbps, line length up to 100 m
	- 1000 kbps, line length up to 25 m
Special features:	Configuration of the following parameters via the CAN-Bus: Preset value, Clear Preset, Output value in case of an error, Function ext. input, Automatic error acknowledgement, Function error output, Switching functions, Operating parameters, Position value, Measuring step, Cyclic transmitting of the position values

* Switching input / Switching output

Levels switching input:	1-level > +8V, 0-level < +2V, up to ±35V, 5 kOhm
Levels switching output:	1-level > US-2V, 0-level < 1 V, up to 100mA

* programmable parameter

11.1.2 Environmental conditions

EMC: .... EN 61000-4-2 (IEC-801-2) /
EN 61000-4-4 (IEC-801-4)

Operating temperature range: .... 0-50°C
     Device with heating: .... -30 to +50°C

Thermal drift: .... 1 ppm / °C, related to the max. measuring
length of 125 m, 170 m, 195 m or 240 m

Storage temperature range: .... -20 to +75°C

Relative air humidity: .... 98 % (no moisture condensation)

* Degree of protection: .... IP 65 (DIN 40 050)

Vibration (50-2000 Hz Sinusoidal) DIN IEC 68-2-6: ..... ≤ 50 m/s^2 (5g)

Shock (11ms) DIN IEC 68-2-27: .... ≤ 300 m/s^2 (30g)

* The protection class is valid for the device with screwed-together cable glands.

11.2 Accessories

Article-No.:	Description
490-00105	TR-PT-15/2: switch cabinet module for PC adapter connection
490-00310	Device: PC adapter (RS485 <--> USB)
490-01001	Soft-No.: 490-00416 "TRWinProg" PC-software with user manual German and English
	Soft-No.: 490-00408 EDS-Files
Reflecting foils for measurements up to 125m	
49-500-020	200 x 200 mm, package contents
49-500-038	200 x 300 mm
49-500-031	749 x 914 mm
Other sizes upon request. In addition, the foils can be sticked-on side-by-side up to the desired size.	
Fresnel Reflecting foils for measurements > 125m	
49-500-032	554 x 480 mm, package contents
49-500-034	554 x 480 mm, predrilled
49-500-036	720 x 693 mm
49-500-037	1108 x 960 mm
49-500-039	200 x 200 mm, for measurements approx. up to 130m

11.3 References

| 1 | : | ISO 11898: Road Vehicles Interchange of Digital Information - Controller Area Network (CAN) for high-speed Communication, November 1993 |

| 2 | : | Robert Bosch GmbH, CAN Specification 2.0 Part A and B, September 1991 |

| 3 | : | CiA DS-201 V1.1, CAN in the OSI Reference Model, February 1996 |

| 4 | : | CiA DS-202-1 V1.1, CMS Service Specification, February 1996 |

| 5 | : | CiA DS-202-2 V1.1, CMS Protocol Specification, February 1996 |

| 6 | : | CiA DS-202-3 V1.1, CMS Encoding Rules, February 1996 |

| 7 | : | CiA DS-203-1 V1.1, NMT Service Specification, February 1996 |

| 8 | : | CiA DS-203-2 V1.1, NMT Protocol Specification, February 1996 |

| 9 | : | CiA DS-204-1 V1.1, DBT Service Specification, February 1996 |

| 10 | : | CiA DS-204-2 V1.1, DBT Protocol Specification, February 1996 |

| 11 | : | CiA DS-205-1 V1.1, LMT Service Specification, February 1996 |

| 12 | : | CiA DS-205-2 V1.1, LMT Protocol Specification, February 1996 |

| 13 | : | CiA DS-206 V1.1, Recommended Layer Naming Conventions, February 1996 |

| 14 | : | CiA DS-207 V1.1, Application Layer Naming Conventions, February 1996 |

| 15 | : | CiA DS-301 V3.0, CANopen Communication Profile based on CAL, October 1996 |

| 16 | : | CiA DS-406 V2.0, CANopen Profile for Encoder, May 1998 |

11.4 Definitions and Abbreviations

CAL

CAN Application Layer. The application layer for CAN-based networks as specified by CiA in Draft Standard 201 ... 207.

CAN

Controller Area Network. Data link layer protocol for serial communication as specified in ISO 11898.

CiA

CAN in Automation international manufacturer and user organisation e.V.: non-profit association for Controller Area Network (CAN).

CMS

CAN-based Message Specification. One of the service elements of the application layer in the CAN Reference Model.

COB

Communication Object. (CAN Message) A unit of transportation in a CAN Network. Data must be sent across a Network inside a COB.

COB-ID COB-Identifier. Identifies a COB uniquely in a Network. The identifier determines the priority of that COB in the MAC sub-layer too.

DBT

Distributor. One of the service elements of the application in the CAN Reference Model. It is the responsibility of the DBT to distribute COB-ID´s to the COB´s that are used by CMS.

LMT

Layer Management. One of the service elements of the application in the CAN Reference Model. It serves to configure parameters of each layer in the CAN Reference Model.

NMT

Network Management. One of the service elements of the application in the CAN Reference Model. It performs initialisation, configuration and error handling in a CAN network.

PDO

Process Data Object. Object for data exchange between several devices.

SDO

Service Data Object. Peer to peer communication with access to the Object Dictionary of a device.

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