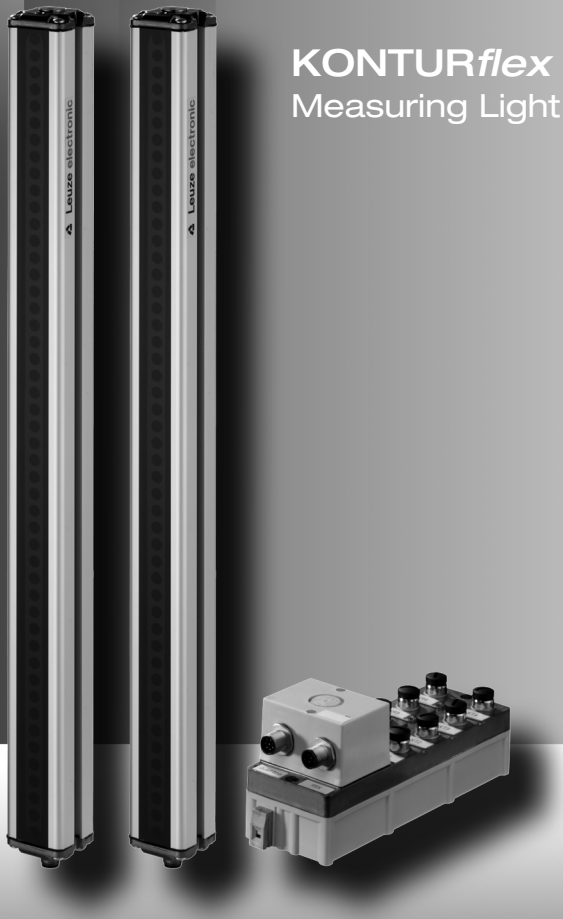
Leuze electronic

the sensor people

KONTUR*flex*

Measuring Light Curtain



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11/2011

1 General information

1.1 About this technical description

These operating instructions contain information regarding the proper and effective use of KONTUR*flex* light curtains. They are included in the delivery contents.

1.2 Explanation of symbols

The symbols used in this technical description are explained below.

Attention!

This symbol precedes text messages which must strictly be observed. Failure to comply with this information results in injuries to persons or damage to the equipment.

Notice!

This symbol indicates text passages containing important information.

1.3 Declaration of Conformity

The KONTUR*flex* measuring light curtain was developed and manufactured in accordance with applicable European standards and directives.

The manufacturer of the products, Leuze electronic GmbH & Co KG in D-73277 Owen, possesses a certified quality assurance system acc. to ISO 9001. The KONTUR*flex* measuring light curtain also satisfies the UL requirements (Underwriters Laboratory Inc.) for the USA and Canada.

2 Safety notices

2.1 Safety standards

The KONTUR*flex* measuring light curtain was developed, manufactured and tested in accordance with the applicable safety standards. It corresponds to the state of the art.

2.2 Approved purpose

Attention!

This product may only be used by qualified personnel and must only be used for the approved purpose. This sensor is not a safety sensor and is not to be used for the protection of persons.

The protection of personnel and the device cannot be guaranteed if the device is operated in a manner not complying with its intended use. Leuze electronic GmbH + Co. KG is not liable for damages caused by improper use. Knowledge of this manual is an element of proper use.

Light curtains of model KONTUR*flex* are designed as measuring and object-detecting, configurable, multi-sensor units.

In particular, unauthorized uses include:

- Rooms with explosive atmospheres
- Operation for medical purposes

Areas of application

The KONTUR*flex* light curtains are designed, in particular, for the following areas of application:

- object detection in painting and packaging systems
- overshoot, position and diameter detection in storage and materials-handling applications

2.3 Working safely

Attention!

Access to or changes on the device, except where expressly described in this operating manual, is not authorized.

Safety regulations

Observe the locally applicable legal regulations and the rules of the employer's liability insurance association.

Qualified personnel

Mounting, commissioning and maintenance of the device must only be carried out by qualified personnel.
Electrical work must be carried out by a certified electrician.

3 General description of the KONTUR*flex*

3.1 Introduction

The continuous optimization of manufacturing processes has led to a demand for increasingly faster and "more intelligent" sensors. The KONTUR*flex* measuring light curtain is a system which meets all current requirements in this field. The experiences gathered in the years since the introduction of the first generation of the KONTUR measuring light curtains have been implemented in this device.

With this measuring light curtain, lengths, widths, heights, contours or positions of parts located between the light beams can be specified. The acquired data are then transmitted via a serial interface to a connected controller. Up to four light strip pairs can be connected to, and simultaneously evaluated by, the QUATTRO control device.

a = Overall height
b = Transmitter
c = Measurement field width
d = Receiver
e = Measurement field length
f = Light strip pair 1
g = Light strip pairs 2 through 4
h = QUATTRO control device

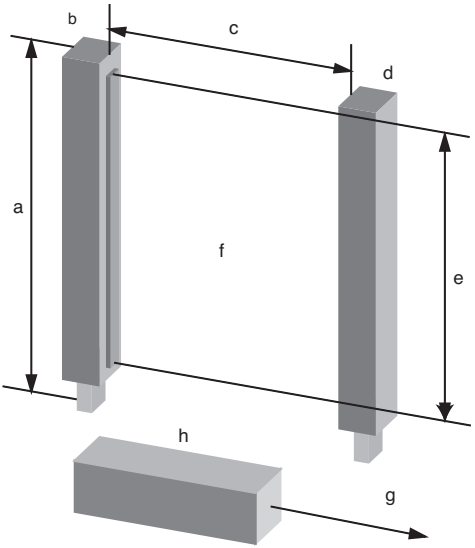


Figure 3.1: KONTUR*flex* measuring light curtain

3.2 Features of the KONTUR*flex*

- Contactless, measuring optical electronic system.
- Up to four light curtains of varying lengths and numbers of beams can be connected to one control device. The maximum number of beams is 512.
- The measurement result is independent of the surface and color of the measurement object.
- With the Windows software, the control device can be adapted to a wide range of tasks and applications.
- The alloy profiles of the light strips are designed for industrial use and have minimal space requirements.
- The high scanning rate of the control device provides rapid measurement value acquisition for fast events.
- Individual areas of the measurement field can be suppressed with the "blanking" function.

Attention!

The KONTURflex measuring light curtain must not be used as an active optoelectronic protective device for the protection of persons. The system does not have a safety category rating and must only be used for measurement purposes.

3.3 QUATTRO control device

The QUATTRO control device can control up to four light curtains and can be configured by means of software via an RS 232 interface with a PC program or directly by a PLC. The configuration can be stored in the QUATTRO in such a way that it is retained after the device is switched off. Should it be necessary, the RS 232 interface can be used to update the firmware.

The QUATTRO automatically detects the number of connected light strips and the associated number of beams. The light curtains can have varying numbers of beams and distances. The total number of beams must not, however, exceed 512.

The receiver strips must be connected to sockets KR1, KR2, KR3, KR4 for channels 1, 2, 3 and 4. The corresponding transmitter strips are connected to sockets KT1, KT2, KT3, KT4 (see chapter 10). If transmitter and receiver strips are reversed, a light curtain is detected but does not function.

If fewer than four light strip pairs are to be connected, the first channels must be used. The receiver and the corresponding transmitter strip must have the same beam spacing and same number of beams. If the numbers of beams differ, the wrong connected channel is detected and all subsequent channels are not detected by the QUATTRO. If the first channel is incorrectly connected, the QUATTRO control device indicates that no light curtains have been detected by flashing (approx. 3 Hz) the green LED.

If, on start-up, at least the first light curtain is detected, the QUATTRO switches to normal beam detection and analysis mode. If the stored configuration does not match that determined on start-up, the configuration is automatically adjusted with regard to the number of beams and number of light strips and then switches to normal beam detection and analysis

mode. In this case, the green LED flashes at approx. 1 Hz, indicating to the user that it may be necessary for the user to make other changes to the configuration.

3.4 Preprocessed measurement values

As specified by the configuration, the following beam analyses are performed by the QUATTRO in every cycle for all connected light strips: These analyses are performed internally in the control device and do not affect the connected controller.

3.4.1 Definition of terms

HU	Highest interrupted light beam
TU	Lowest interrupted light beam
HNU	Highest uninterrupted light beam
TNU	Lowest uninterrupted light beam
ZU	Number of all interrupted light beams
ZNU	Number of all uninterrupted light beams

HU_{Min}	Minimum highest interrupted light beam
TU_{Min}	Minimum lowest interrupted light beam
HNU_{Min}	Minimum highest uninterrupted light beam
TNU_{Min}	Minimum lowest uninterrupted light beam
ZU_{Min}	Minimum number of all interrupted light beams
HNU_{Min}	Minimum number of all uninterrupted light beams

HU_{Max}	Miaximum highest interrupted light beam
TU_{Max}	Maximum lowest interrupted light beam
HNU_{Max}	Maximum highest uninterrupted light beam
TNU_{Max}	Maximum lowest uninterrupted light beam
ZU_{Max}	Maximum number of all interrupted light beams
ZNU_{Max}	Maximum number of all uninterrupted light beams

The minimum values are values which, when the current value increases, retain the smaller value for an adjustable period of time. If the current value decreases, the minimum value also immediately decreases.

The maximum values are values which, when the current value decreases, retain the larger value for an adjustable period of time. If the current value increases, the maximum value also immediately increases.

With the minimum and maximum values, it is possible to detect small objects even with very long PLC cycle times.

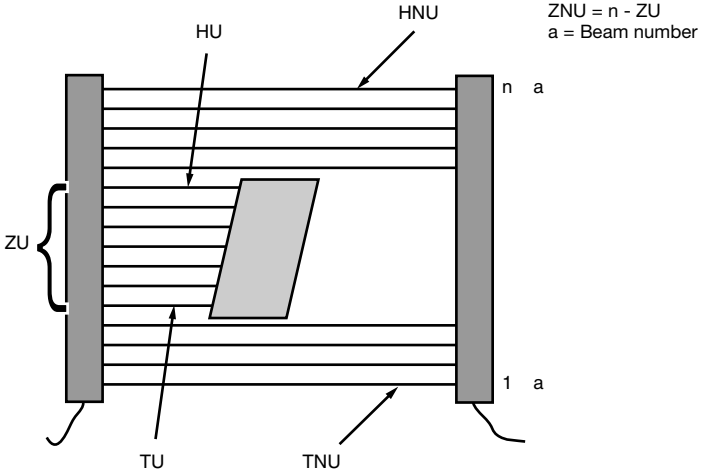


Figure 3.2: Access definition

3.4.2 Beam suppression (blanking)

No analysis is performed for blanked beams due to the fact that when blanking is used, the state of the blanked beam does not affect the analysis of subsequent beams. The beams are sequentially numbered from 1 to n starting at the light strip plug. Beam numbering is not changed as a result of blanking. When blanking is used, the sum of the number of interrupted beams (ZU) and the number of uninterrupted beams (ZNU) is not equal to the number of beams (see chapter 7.1).

3.4.3 Path functions

Three functions can be used for center control of a material path:

- center position
- path run too high
- path run too low

These functions are controlled via the respective interrupted light beams. By blanking at the top and bottom edges of the light strips, the point determined to be the center is not shifted.

For hole recognition, the number of beams and, thus, the size of the hole to be detected can be set. A hole is detected as such as soon as an edge is detected and the set minimum size is reached. If multiple holes are present in a path, the first hole from below is detected.

3.4.4 Message output

The message output (PNP output) in the QUATTRO control device can display the following results for a light strip:

- all beams uninterrupted
- all beams interrupted
- object in middle
- object too high
- object too low
- hole recognized
- toggle after each scan (state change after each pass)

3.5 Configuration

The KONTUR*flex* measuring light curtain and the QUATTRO control device can be configured with the aid of a Windows program via the RS 232 interface. The configuration data can be stored in non-volatile memory (EEPROM). A distinction is made between the configuration data for the complete device, for each light strip and for the interfaces.

Notice!

*The KONTUR*flexsoft *configuration software can be download from the Internet at http://www.leuze.de/downloads/los/08/konturflexsoft.zip*

3.5.1 Configuration of the complete device

The configuration of the complete device can be used to first define the event for the message output of the QUATTRO control device. This control output can be assigned to one of the connected light strips.

3.5.2 Configuration for a single light strip

Various parameters can be defined for the light strips.

- distance between receiver and transmitter (0.1 m – 4 m)
- integration time (number of passes)
- hold times of the min/max values
- smallest hole size for the recognition of a hole (i.e. the number of light beams that must be free in order to be recognized as a hole)
- tolerance in the middle/upper/lower range definitions (symmetrically around the mid point, the central area is defined by the number of beams)

Groups can then be defined for the output data. In this way it is possible to group together multiple beams. The beams can be processed as either OR or AND functions.

It is then possible to make various adjustments to the light strips in order to suppress the light beams (deactivate/blank).

3.5.3 Configuration for the interfaces

- baud-rate setting
- slave address
- operating mode:
  automatic or triggered scanning
- autosend configuration:
  the data set to be transmitted can be grouped together freely
- pause time following reception of a Modbus command which must pass before a response is transmitted

3.6 The Modbus interface

The QUATTRO RSX control device is equipped with an RS 485 interface for the PLC. With the QUATTRO RSX, the RS 485 interface is electrically insulated by means of an optical coupler. The device uses the Modbus-compatible LUMINET protocol for communicating with the PLC (see Appendix B) and functions as a slave both with point-to-point connection as well as on the bus.

3.7 The PROFIBUS DP interface

The QUATTRO DP control device has a Profibus-DP interface as interface to the PLC and can be connected as a slave to the PLC.

The control device recognizes the baud rate of the master and adjusts to it. All baud rates from 9.6 kBaud to 12 MBaud are supported.

3.7.1 General behavior of QUATTRO DP

The QUATTRO control device is a freely configurable or parameterizable modular PROFIBUS-DP slave. All relevant parameters can be written and read via a special mechanism (see below), even during cyclic data traffic. As a result, it is possible for a PLC program to react independently to various requirements from the process by changing parameters. It is also possible to write a driver for general applications that adapts to different applications in various projects.

The PROFIBUS address can be adjusted using 2 hex switches S7 (lower nibble), S8 (upper nibble) under the connector cover or by means of the configuration program in the range of 0…126 (0…0x7E). If an address has been set to > 126 by means of the hex switch, the address from the configuration stored in the EEPROM will be used.

It is not possible to change the address via the PROFIBUS.

After switching on, the QUATTRO DP works in the same way as the QUATTRO RSX using the parameters (configuration) saved in the EEPROM. Only after successful transition of the PROFIBUS into cyclic data traffic does the system begin to operate using the parameters selected via the PROFIBUS parameterization.

If using masters which permit the setting of a configuration, the QUATTRO DP parameterization created with the configuration program has no effect on operation on the PROFIBUS as this parameterization is always overwritten by the PROFIBUS parameterization.

When using masters which can only function using a default configuration, the desired data set configuration must be set with the configuration program and saved in the EEPROM. The remaining parameters are adopted from the PROFIBUS parameterization for this master as well.

Aside from configuring the data set, the configuration program can only be used for visualization, checking the PROFIBUS parameterization and possibly for setting the PROFIBUS address.

For test purposes, the configuration program can also be used to change parameters in a QUATTRO DP control device in cyclic data traffic. However, only those parameters which do not cause a change to the length or arrangement of the cyclically exchanged data set may be changed.

The green LED of the QUATTRO DP serves as an error and status indicator.

- brief flash during start-up, then off: OK
- flashing slowly (~5Hz): no light strips connected, or connected incorrectly
- flashing (~1Hz): number or length of light strips has changed since the last time the device was switched on
- flashing long on/short off (~1Hz): PROFIBUS status waiting for parameterization
- flashing short on/long off (~1Hz): PROFIBUS status waiting for configuration
- on continuously: device defective

Attention!

When operating the QUATTRO-DP, be aware that the system may behave abnormally if, in a multi-meter system, DP masters of class 1 and class 2 simultaneously try to access the slave with parameterization/configuration data (this is very unlikely to occur) or if other PROFIBUS level 2 based masters are involved.

3.7.2 Diagnostic data

For static diagnostics, the QUATTRO supplies a user diagnostic datablock consisting of 40 bytes of manufacturer-specific diagnostic data.

Diagnostic data:

Meaning:	Diagnostic byte no.:
Diagnostic header	7
Error number conf/param	8
Status strip 1	9
Status strip 2	10
Status strip 3	11
Status strip 4	12
Number of beams strip 1	13, 14

Table 3.1: Definition and location of the diagnostic data

Number of beams strip 2	15, 16
Number of beams strip 3	17, 18
Number of beams strip 4	19, 20
Status of complete device	21, 22
Serial number	23…42
HW version	43, 44
SW version	45, 46

Table 3.1: Definition and location of the diagnostic data

To make error diagnostics easier for project planning, an error number is output in the diagnostics.

If it is a parameterization error (bit 6 in station status 1 is set), the error number specified in the parameterization table is output to simplify localization of the error. Zero means that the length is incorrect.

If it is a configuration error (bit 2 in station status 1 is set), the number of the faulty configuration byte (beginning with 1) is displayed as an error number. Zero means that the length is incorrect.

3.7.3 Parameterization

All parameters relevant for operating the QUATTRO control device are selected via the PROFIBUS parameterization. The QUATTRO checks each parameter for its validity. The parameterization is accepted only if all parameters are assigned with valid values.

All parameters with their value ranges are described in the GSD file so that the parameterization can be performed simply with a PROFIBUS planning tool. The GSD file assigns default values to all parameters (see table below).

Attention!

The number of beams for all light strips must always be adapted to the actually connected strips.

Before parameterizing, the GSD file must be copied or loaded into the respective GSD directory.

In the data set configuration, note that the PROFIBUS configuration must match the respective parameterization. See also the examples of parameterization and configuration using Siemens S7 and SIMATIC Manager. Note here, that there are two different configurations, depending on the master. If the master permits the definition of a PROFIBUS configuration during project planning, the parameterization described above is followed exactly. If the master uses Get_Config in order to set the correct configuration, the QUATTRO delivers a default configuration. This means that, instead of the data set configuration from the parameterization, the configuration from the EEPROM of the QUATTRO is used. However, this only applies to the data set configuration; all other parameter must still be set with the project planning tool. The default configuration of the QUATTRO must be set by the user with the QUATTRO configuration program and, therefore, does not correspond to the default configuration from the GSD file.

If the master is to reliably detect very short beam interruptions at slow PLC cycle times and fast PROFIBUS cycle times by means of the individual beam data, it may be necessary to set the data update rate to a value greater than 2* (PLC cycle time + PROFIBUS cycle time). Beam interruptions are then saved from one data update to the next by "rounding" the beam data.

If it is intended in this case to use evaluation data in addition to the individual beam data, the respective minimum and maximum values must be used in order to detect everything. For this purpose, the hold time must be set to a value greater than the data update rate.

Meaning	Value range	Length (bytes)	Parameter byte number	Error no.	Default (acc. to. GSD)
Data update rate	1. Update after each scan 2…255 Update after n scans >1 beam data rounding to data update	1	9	1	1
Configuration Message output	PNP-output configuration: Bit 0: active if all beams uninterrupted Bit 1: active if all beams interrupted Bit 2: active if path run in middle Bit 3: active if path run too high Bit 4: active if path run too low Bit 5: active if hole recognized Bit 6: free Bit 8, 9 channel number (0-3), PNP output is assigned to this channel Bit 15 = 0 output is active low Bit 15 = 1 output is active high Bit 14 = toggle with every scan	2	10, 11	2	0x0001 active at channel 1 all beams uninterrupted, output is active low

Table 3.2: PROFIBUS configuration

Meaning	Value range	Length (bytes)	Parameter byte number	Error no.	Default (acc. to. GSD)

Configuration data set	Bit0…Bit4: coded as number
	0: end of data set
	1: individual beam data, 8 beams per byte
	2: TU
	3: HU
	4: ZU
	5: TNU
	6: HNU
	7: ZNU
	8: TU_{Min}
	9: HU_{Min}
	10: ZU_{Min}
	11: TNU_{Min}
	12: HNU_{Min}
	13: ZNU_{Min}
	14: TU_{Max}
	15: HU_{Max}
	16: ZU_{Max}
	17: TNU_{Max}
	18: HNU_{Max}
	19: ZNU_{Max}
	20: status word
	Bit5…Bit7: #light strip,
	000=base device
	001=1. light beam, etc.
		30	12…41	3	0x22 TU K1
					0x23 HU K1
					0x34 Stat. K1
					0x00
					…
					0x00

Number of beams strip 1	8 – 512 must be in agreement with HW, is verified	2	42, 43	4	16, must always be changed according to hardware during project planning
Number of beams strip 2		2	44, 45	5	0
Number of beams strip 3		2	46, 47	6	0
Number of beams strip 4		2	48, 49	7	0

Table 3.2: PROFIBUS configuration

Meaning	Value range	Length (bytes)	Parameter byte number	Error no.	Default (acc. to. GSD)
Resolution strip 1	5, 10, 20, 40 (mm)	1	50	8	5mm
Resolution strip 2		1	51	9	5mm
Resolution strip 3		1	52	10	5mm
Resolution strip 4		1	53	11	5mm
Range strip 1	Value 0: 5…30cm 1: 20…100cm 2: 50…150cm 3: 100…250cm 4: 200…350cm 5: 300…400cm	1	54	12	4: 20…100cm
Range strip 2		1	55	13	4: 20…100cm
Range strip 3		1	56	14	4: 20…100cm
Range strip 4		1	57	15	4: 20…100cm
Scan mode (integration) strip 1	1-63	1	58	16	1
Scan mode (integration) strip 2		1	59	17	Scan mode (integration) strip 2
Scan mode (integration) strip 3		1	60	18	1
Scan mode (integration) strip 4		1	61	19	1
Group counter strip 1	Bit0…Bit6 Group counter (1…127) Bit7 = 0 AND link Bit7 = 1 OR link	1	62	20	1, AND
Group counter strip 2		1	63	21	1, AND
Group counter strip 3		1	64	22	1, AND

Table 3.2: PROFIBUS configuration

Meaning	Value range	Length (bytes)	Parameter byte number	Error no.	Default (acc. to. GSD)
Group counter strip 4		1	65	23	1, AND
Min./max. hold time strip 1	1…255 Scans	1	66	24	10
Min./max. hold time strip 2		1	67	25	10
Min./max. hold time strip 3		1	68	26	10
Min./max. hold time strip 4		1	69	27	10
Hole size strip 1	1…255	1	70	28	1
Hole size strip 2		1	71	29	1
Hole size strip 3		1	72	30	1
Hole size strip 4		1	73	31	1
Center tolerance strip 1	1…255	1	74	32	1
Center tolerance strip 2		1	75	33	1
Center tolerance strip 3		1	76	34	1
Center tolerance strip 4		1	77	35	1
Blanking pattern strip 1…4	Blanking pattern 1 bit per beam, 1 for blanked LSB from first byte is first beam of strip 1. Blanking pattern for next strip starts with LSB in first free byte	64	78…141	36	no blanking 0x00 … 0x00

Table 3.2: PROFIBUS configuration

3.7.4 Configuration

The PROFIBUS configuration describes the format and the number of data in cyclic data traffic. The QUATTRO DP control device is a modular slave, for which the data set for the cyclic data traffic can be assembled as required.

The QUATTRO DP uses the parameterization to determine what the data set must look like and only permits the exactly matching configuration or the default configuration.

For the default configuration, the data set stored in the EEPROM is used.

A data set can be assembled from a maximum of 30 of the data items listed above in any order. The first end marker determines the length of the data set.

The following identifiers are used for user data exchange in the PROFIBUS configuration data in the sequence specified by the parameterization or default configuration.

The first identifier must always be the identifier for writing/reading parameters (see below). Identifier 0xb2(178) (3 byte input/output length, consistency all bytes).

The individual beam data are transmitted as bits with max. 64 bytes (Bit0 of first byte is beam 1, 1 for uninterrupted beams and 0 for interrupted beams). A special identifier with code 0x40(64) and length specification 0x80 – 0xbf for 1-64 is required for the individual beam data of each strip depending on the number of beams (length byte, consistency byte).

The evaluation data TU – ZNU_{Max} and status base device are words (2 byte values): An identifier code 0xd0(208) is used for each word in the configuration data (1 word, input, length word, consistency word).

Status for channel 1 to 4 are bytes. An identifier code 0x90(144) is used for each byte in the configuration data (1 byte, input, length byte, consistency byte).

3.7.5 Cyclic data traffic

Depending on parameterization, three to maximum 217 bytes input data and three bytes output data are exchanged in cyclic data traffic.

3.7.6 Reading and writing parameters (during cyclic data traffic)

The first three bytes of input and output data are reserved for reading and writing parameters during cyclic data traffic.

Output byte 1:	Bit 0…6 consecutive number of the write/read command 0 – 127 – 0 Bit 7 = 1 for writing, 0 for reading
Output byte 2:	Write/read number, see Appendix B1.2 sub-unit
Output byte 3:	Data byte
Input byte 1:	Bit 0…6 consecutive number of last processed write/read command Bit 7 = 1 if error, 0 if command executed correctly
Input byte 2:	Write/read number as received
Input byte 3:	Data byte as written or read

Data flow for reading a parameter:

Output byte 1:	The PROFIBUS master increments the current consecutive number by 1 and deletes the write/read bit
Output byte 2:	Desired write/read number
Output byte 3:	Data byte not required. Wait for input byte 1 with identical consecutive number Test error bit
Input byte 3:	Read out data byte, if error: error code

Data flow for writing a parameter:

Output byte 1:	The PROFIBUS master increments the current consecutive number by 1 and sets the write/read bit
Output byte 2:	Desired write/read number
Output byte 3:	Parameter value Wait for input byte 1 with identical consecutive number Test error bit
Input byte 3:	Written data byte, if error: error code

As soon as the slave detects a new consecutive number, the command is executed and the requested data byte with the same number is returned as input byte.

If the parameter number is not known or if the written value is incorrect, the QUATTRO returns an error code.

Error	Error code
Parameter number unknown	0x02
Invalid data	0x03

Table 3.3: Error code

Parameter	Write/read no.
No function	0
Data update rate	1
Message output high byte	2
Message output low byte	3
Range strip 1	4
Range strip 2	5
Range strip 3	6
Range strip 4	7
Scan mode (integration) strip 1	8
Scan mode (integration) strip 2	9
Scan mode (integration) strip 3	10
Scan mode (integration) strip 4	11
Group counter strip 1	12
Group counter strip 2	13
Group counter strip 3	14
Group counter strip 4	15
Min./max. hold time strip 1	16
Min./max. hold time strip 2	17
Min./max. hold time strip 3	18
Min./max. hold time strip 4	19
Hole size strip 1	20
Hole size strip 2	21
Hole size strip 3	22
Hole size strip 4	23
Center tolerance strip 1	24
Center tolerance strip 2	25
Center tolerance strip 3	26
Center tolerance strip 4	27
Number of beams, strip 1, high byte	28
Number of beams, strip 1, low byte	29
Number of beams, strip 2, high byte	30
Number of beams, strip 2, low byte	31
Number of beams, strip 3, high byte	32
Number of beams, strip 3, low byte	33

Table 3.4: Parameter definition

Parameter	Write/read no.
Number of beams, strip 4, high byte	34
Number of beams, strip 4, low byte	35
Resolution, strip 1 (read only)	36
Resolution, strip 2 (read only)	37
Resolution, strip 3 (read only)	38
Resolution, strip 4 (read only)	39
Configuration of data set (read only)	40…70
Blanking model, strips 1…4, 64 bytes	71…134

Table 3.4: Parameter definition

For value ranges of parameters, see section "Parameterization".

3.7.7 PROFIBUS and Modbus

A QUATTRO DP control device for PROFIBUS can be configured or operated in exactly the same way as the QUATTRO RSX for Modbus via the RS 232 interface with the Modbus protocol. Simultaneous use of both interfaces is also possible. However, the autosend mode at the RS 232 interface is not available with the QUATTRO DP control device.

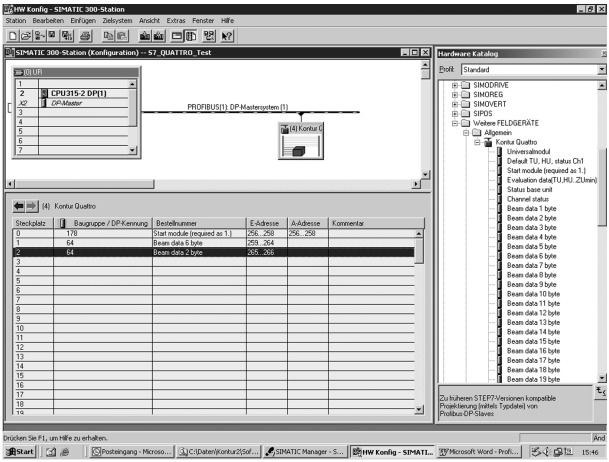
Notice!

After configuring via the RS 232 interface, the QUATTRO control device must be switched off and then back on before the system can be addressed via the PROFIBUS

3.7.8 Parameterizing and configuring with Simatic Manager S7

After starting KONTUR QUATTRO, under … Additional FIELD systems, select General and link to PROFIBUS by means of drag and drop.

The configuration can be performed by simply combining the provided modules. This means that the modules can be used multiple times, as in the example shown below (here, beam data 6 byte [1st row] and beam data 2 byte [2nd row]). As an alternative to this, it is also possible to configure the system by repeatedly using the universal module (manual entry of all configuration data, identifiers etc.).



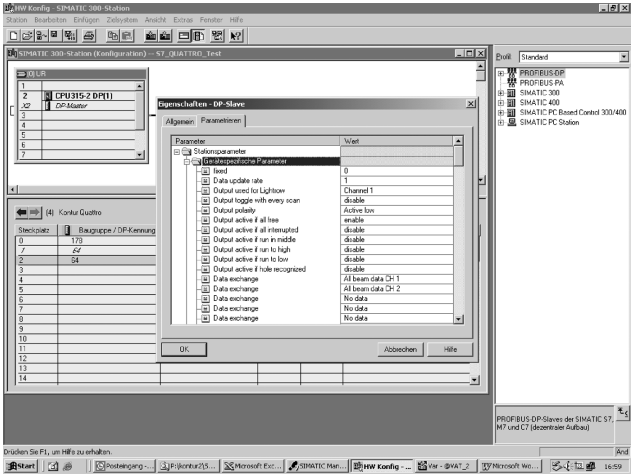
The following modules are available:

Universal module:	Using this, all possible configurations can be implemented, but all values must be entered manually.
Default TU, HU, Status Ch1:	Standard module if only HU, TU and Status are placed on a single row. Can only be used once.
Start module:	Must absolutely be placed on the first line (DP identifier 178); may only be omitted for the default module.
Evaluation data:	For configuration of the HU and TU parameters, etc. For each HU and TU etc., use the "Evaluation data" module.
Status base unit:	Status of complete device
Channel status:	Shows channel status.
Beam data x byte:	Configuration of individual beam data depending on number of beams (1 byte for every 8 beams)

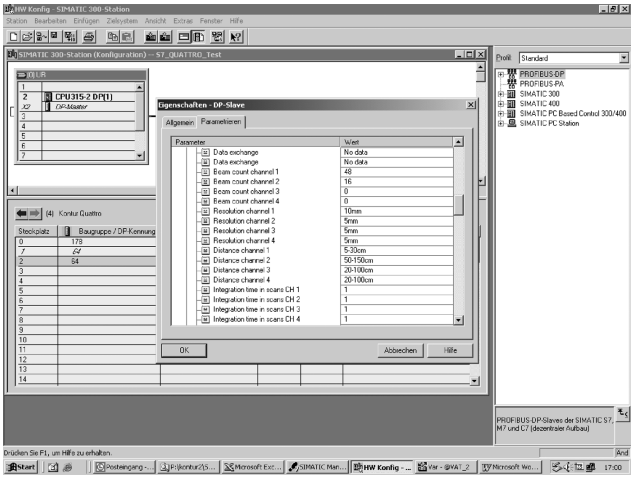
Simply place the data configuration modules (universal module, evaluation data, status base unit, channel status, beam data x byte) in the configuration table according to the parameterization, i.e. in the same order.

Parameterizing:

E.g. 2 rows (48 beams and 16 beams) with individual beam evaluation as shown below:

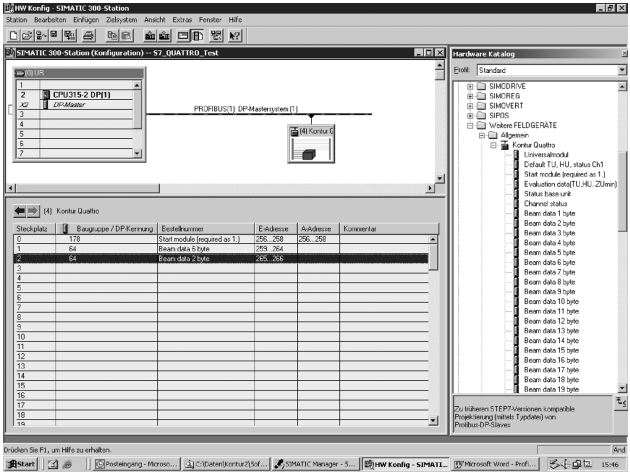


In "Data exchange" here, select "All beam data CH1" or "All beam data CH2".
(For other data, select e.g. HU or TU as appropriate).



In "Beam count channel 1, 2, 3, 4", enter the number of beams in each case.
Other settings, such as range, resolution etc., according to requirements.

Configuring:



In the example shown, the Start Module must be entered on the first line.

The individual beam data modules (in the example, for 6 bytes and 2 bytes, depending on the number of beams) are placed on the following lines.

Parameterization	Configuration	Comment
	Start module	
Data exchange: TU, HU …	Evaluation data	To be inserted once for each parameterized variable
Data exchange: status base unit	Status base unit	
Data exchange: status channel x	Channel status	
Data exchange: all beam data CH x	Beam data x byte	
Example:		The sequence of the parameters is immaterial; it need only be same for the parameterization and the configuration.
	Start module	
TU channel 1	Evaluation data	
All beam data Ch1	Beam data 4 bytes	i.e. 32 beams
HU channel 2	Evaluation data	
Status channel 1	Channel status	

Table 3.5: Parameterization with Simatic Manager S7

Notice!

For many older PLC CPUs, it is normal that only 2 or 4 bytes are consistently transmitted (affects e.g. online immediate diagnostics [monitoring of variables]). In such a case, please make use of the system function SFC14, together with the DB data building block (see also the Siemens programming handbook). This makes it possible to consistently transmit data up to 64 bytes.

Parameterizing blanking:

Using blanking patterns, it is possible to suppress, or blank, individual beams. Each of these 64 blanking patterns represents one byte or 8 beams. The first blanking pattern belongs to the beams 1 to 8, the second blanking pattern to the beams 9 to 16 and so on. The beams are counted continuously, i.e. if, for example, the first strip pair has 16 beams and the second strip pair has 32 beams, then the beam numbers of the second strip pair are 17 to 48.

The least significant bit is equivalent to the beam with the lowest beam number, i.e. for the first blanking pattern the first beam, for the second blanking pattern the ninth beam and so on. For each beam which is to be suppressed, the corresponding bit is to be set to 1.

Example:

Beams 1, 3 and 4 are blanked:

1st byte:

Bit	0	0	0	0	1	1	0	1
Beam no.	8.	7.	6.	5.	4.	3.	2.	1.

Byte 00001101 is equivalent to decimal value 13, which is to be entered in the first blanking pattern in the example (default 0 [no blanking]).

The second and following blanking patterns are all to be set to 0 or left in the default setting.

3.8 RS 485 terminator

Switch S5 is located under the terminal cover. The terminating resistors can be switched on or off by means of the two dip switches DIP 4 (RS 485 A) and DIP 3 (RS 485 B). If the QUATTRO is the last or only device connected to the PROFIBUS or Modbus, the terminating resistors must be switched on. Both switches must be pushed to the right position.

If both switches are in the left position, the terminating resistors are switched off.

Upon shipment from the factory, the two dip switches DIP 1 and DIP 2 for the terminating resistors are in the ON position (right position).

3.9 Parameterizing and configuration

The configuration interface is an RS 232 interface and functions in the same way as the PLC interface, according to the LUMINET protocol with the same registers. Therefore, it can be used not only to configure with the PC program, but also as an interface to a control computer (e.g. PC or microcontroller). As only a point-to-point connection is possible in this case, the slave address in the protocol is ignored.

4 The transmitter and receiver light strips

The transmitter and receiver strips of the KONTUR*flex* measuring light curtain are available with beam spacings of 5mm, 10mm, 20mm and 40mm. The resulting resolutions are thus 10mm, 15mm, 25mm and 45mm.

The light strips are available in lengths from 80mm to 3,200mm. In order to be able to provide all necessary lengths, the light strips are available in increments of 80mm.

The appropriate light strips and corresponding order numbers for your application can be found in the table in Appendix A.

The light strips are housed in an alloy profile with 40mm x 40mm cross section. T-grooves, for which special fastening elements were developed, are located on both sides of the profile.

The connection is located on the bottom of the light strips and is implemented with a standardized M12 plug. The numbering of the light beams begins on the plug side with light beam 1.

On the receiver strip, the state "no beams interrupted" is indicated by a green LED; the state **"at least one beam interrupted"** is indicated by a red LED. This display is controlled by the QUATTRO control device. Thus, the blanking function is also taken into consideration.

When configuring the light strips, the distance between the transmitter and receiver light strips must be set. The spacing can be set in 6 steps between 30cm and 400cm. To prevent over-illuminating the objects being measured by using excessing lighting, the spacing should be set as exactly as possible.

4.1 Time overhead and cycle time

The QUATTRO processes all light strips quasi-parallel to one another with a time overhead of ts = 50µs per beam.

If, for example, four light strips are connected, the time overhead per beam, based on one light strip, is:

tl = 4 * ts = 4 * 50µs = 200µs.

The cycle time for a light strip can be calculated using:

cycle time = (number of beams + 3) * ts * number of light strips

ts –> time overhead per beam

Number of beams	Number of strips	Beam spacing time (µs)	Constant (µs)	Cycle time for one light strip (µs)
32	1	50	150	1750
	2	100	300	3500
	3	150	450	5250

Table 4.1: Cycle time when connecting one or more identical-length light strips

Number of beams	Number of strips	Beam spacing time (µs)	Constant (µs)	Cycle time for one light strip (µs)
	4	200	600	7000
n	1	50	150	n * 50 + 150
	2	100	300	n * 100 + 300
	3	150	450	n * 150 + 450
	4	200	600	n * 200 + 600

Table 4.1: Cycle time when connecting one or more identical-length light strips

The cycle time for a light strip must not be less than 1 ms. When connecting only one light strip, a cycle time less than 1 ms is obtained for beam numbers less than 17 if ts = 50 µs. Therefore, the beam spacing time ts is increased in this case until the cycle time is ~1 ms.

Example:

1 light strip with 16 connected beams

The beam time is exactly set in the QUATTRO to 100 ms and calculated using the following formula, rounding off to the nearest integer:

cyc = 10 000 / (16 + 3) = 526

The beam spacing time is thus

ts = 526 * 100 ns = 52.6 µs

The exact cycle time is then

(16 + 3) * 52.6 µs = 999.4 µs

Even if only one light strip is connected, the cycle time is never less than 1 ms.

The maximum integration time per light strip is calculated and output during configuration. By making a manual adjustment, a multiple of this integration time can also be specified. In this way, events can be matched to PLC cycle times.

5 Programming and configuring

The KONTUR*flex* measuring light curtain can be configured using the included "KONTURflexsoft" configuration software or directly via a connected controller. The RS 232 interface in the control device is provided for programming purposes.

5.1 "KONTURflexsoft" configuration software

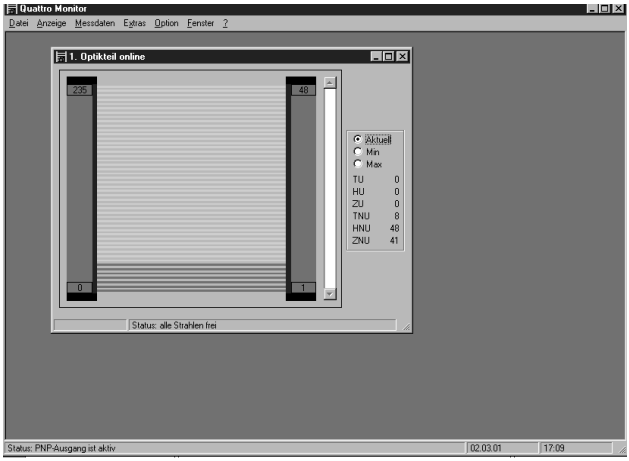


Figure 5.1: KONTURflexsoft configuration software

The configuration software functions under operating systems such as Windows® 95/98/2000/NT or XP. For a description of the software, please refer to separate documentation of the Help texts included in the software.

The KONTURflexsoft packet can be download from the Internet at http://www.leuze.de/downloads/los/08/konturflexsoft.zip

5.2 Configuring via a controller

The registers of the QUATTRO control device are divided into three blocks in accordance with the LUMINET protocol. Some of these can be written to and read from, while some can only be written to or read from. When reading, command code 03 can be used to read individual registers or several in sequence. If a given register is not present, 0 is returned. If the first register is not present, an error code is returned (see Appendix B). When writing multiple registers with command code 0x10, value 0 must be stored in the registers which are not present in the data set. If this is not the case, an error code is returned.

Base unit:

(see also Appendix B)

This block contains all registers which are relevant to the complete device.

The register "Current Password" has no meaning to the user. It is used only during production.

Sub-unit:

(see also Appendix B)

This block contains all registers for the light strips.

The four light strip pairs are addressed indirectly. This means that before it is possible to access the register set of a given light strip pair, channel number (0…3) must be set in the base unit in register 212 sub-unit Index.

Com-unit:

(see also Appendix B)

This block contains all registers which are relevant to communication.

6 Operating modes

The QUATTRO control device can, in principal, be operated in four different ways:

- autosend mode
- triggered scanning
- free reading and writing of all registers
- fixed configuration without communication to the PLC

6.1 Autosend mode

Attention!

Not compatible with the ModBus definition

The autosend mode is designed to transmit a freely definable datablock from the QUATTRO control device to the PLC as fast as possible with little overhead.

The QUATTRO transmits the autosend datablock using a fixed time reference. The time reference is based on the scan duration of the longest connected light strip. It can be increased manually to a multiple of this time reference.

Once the autosend mode has been started, it can be terminated only via the configuration interface.

The datablock can have two different formats:

1. Freely definable format:

   Byte 1: number of user-data bytes
   Byte 2: user-data byte
   .
   .
   .
   Byte n+1: 8-bit checksum for all user-data bytes and the number of user-data bytes

   It is possible to connect multiple PLCs which only receive data to a QUATTRO control device. However, no additional active devices may be connected to the bus. This format functions with the smallest overhead, but requires interface programming specially adapted for this task for the PLC.

2. The data format is defined as for the Modbus (see Appendix B)
   It is transmitted as though in response to a standard read request (0x03). It is possible to connect multiple PLCs which only receive data to a QUATTRO control device. However, no additional active devices may be connected to the bus. Specially adapted interface programming is required for the PLC in this case as well.

Because the QUATTRO cannot be reconfigured directly from the PLC once the autosend mode is started, this mode should only be used when it is required for speed reasons. Triggered scanning offers a much more flexible option.

If the autosend mode is to be used for the reasons mentioned above, there are various configuration options available:

1. If the autosend configuration is to be changed infrequently, it can be created with the configuration program and stored with all settings in the QUATTRO EEPROM. Changes to the configuration can then only be made via the configuration interface (configuration program).
2. If it should be possible to change the autosend configuration directly through the PLC without using the configuration program, Register 74 (autosend transfer type) in the com-unit is to be set to 0 in the configuration stored in the EEPROM. In this way, the PLC can at least be used following power-up to change the configuration. The PLC must then start autosend following each power-up by setting the desired auto-transfer type and the following control word 2.

6.2 Triggered scanning

Triggered scanning functions with the same freely configurable datablock as the autosend mode. Transmission of the datablock is, however, compatible with the Modbus protocol. This means that the datablock is requested by the PLC to the Autosend datablock register with a standard Modbus read command 03. The size of the requested datablock can be smaller than that defined in the configuration.

There are two modes available for triggered scanning:

1. The requested datablock is transmitted immediately following the request. This means that the data are read out asynchronously to the scan and are not associated with a given scan. The PNP output or the status register in toggle mode can be used by the PLC to synchronize the data request for a given channel.
2. Upon request of a datablock, the system waits for the conclusion of the active scan of the longest connected light strip and, after the scan has completed, transmits the datablock. The data transmission is, thus, synchronous and the data are all associated with the same scan. If the PLC is fast enough and the data transmission rate is high enough, this method can be used to analyze each scan.

6.3 Free reading and writing of all registers

By directly accessing all data, each individual register can, if necessary, be read out or written to. This can take place in addition to triggered scanning. The direct access is asynchronous. Synchronization is, however, possible here as well using the method described above via the PNP output or status.

6.4 Fixed configuration without communication to the PLC

For an application which only requires switchable information from the PNP output, a communication connection to the PLC is not necessary for a fixed configuration (stored in the EEPROM).

7 The data format

7.1 Composition of the data

The data for autosend or triggered scanning can be composed of all evaluation data, states and beam data. These data can be organized in any order. The configuration software can be used to select and structure all data.

The evaluation data TU, HU, ZU, TNU, HNU, ZNU, TU_{Min}, HU_{Min}, ZU_{Min}, TNU_{Min}, HNU_{Min}, ZNU_{Min}, TU_{Max}, HU_{Max}, ZU_{Max}, TNU_{Max}, HNU_{Max}, ZNU_{Max} are each 16-bit words. As per the Modbus protocol, the higher-value byte is transmitted first.

The status word of the complete device is a 16-bit word (see Appendix B 1.1). The higher-value byte is transmitted first.

The status values for the individual light strips are byte values (see Appendix B 1.2). The beam data are transmitted with either 1 bit for each beam or, for a beam group, in bytes beginning with bit 0.

The bit is set to 1 for an uninterrupted beam. Bits that are not occupied remain undefined. If beams are blanked out, they are be transmitted as uninterrupted beams, i.e. with a bit that is set to 1.

The number of required bytes can be calculated using the following formula, rounding off to the nearest integer:

number of bytes = ((number of beams + group counter –1) / group counter + 7) / 8

All evaluation data are transmitted without gaps in a telegram in the order specified in the autosend configuration. The length is checked during configuration and is limited to maximum 240 bytes.

7.2 Data transmission

Data are always transmitted in hexadecimal format!

Variable	Data type	Comment
Evaluation data (HU, TU, etc.)	16-bit words	Higher-value byte is transmitted first
QUATTRO status	16-bit words	Higher-value byte is transmitted first
Light strip status	Byte	
Beam data	8 beams to a byte	With an uninterrupted beam, bit is set to 1 If interrupted, bit is set to 0 [lowest-value bit corresponds to first beam] First transmitted byte for beams 1…8 Second transmitted byte for beams 2…16 …

Table 7.1: Definition of the output format

a) Autosend fast:

Structure: xx y1 …. yn cc

xx: Number of transmitted user-data bytes (e.g. only HU is transmitted -> One 16-bit word -> 2 bytes, i.e. xx, that is to say 02)

y1…yn: User data

cc: 8 bit check sum, using xx, y1. … yn (cc=(xx,y1…yn) mod 2^8)

Interrupted beams	Beam data, binary	Beam data, hexadecimal	Data sent from Quattro
1.	11111110 (1st byte)	FE FF FF FF	04 FE FF FF FF FF
2.	11111101 (1st byte)	FD FF FF FF	04 FD FF FF FF FE
14. + 15.	10011111 (2nd byte)	FF 9F FF FF	04 FF 9F FF FF A0

Table 7.2: Example for autosend fast mode: K10-320, individual beam data, (32 beams)

b) Autosend in MODBus format:

see c)

c) Triggered scanning:

The data are transmitted according to a standard MODBUS read command:

Structure: xx cc of nn crc_L crc_M

xx: Slave address (corresponds to the setting of the HEX switch)

cc: Read command, here x 03

of: Register address + offset (see chapter B.1.3 "Com-unit – communication data (address offset 0x4000)")

nn: Number of transmitted user-data bytes

crc_L: Lowest-value byte of the 16-bit CRC word

crc_M: Highest-value byte of the 16-bit CRC word

The CRC word is calculated in accordance with chapter 7.3 and by way of (xx cc of nn).

Example (K10-320, individual beam data): 01 03 4085 04 CRC_L CRC_M

Answer from QUATTRO:

Structure:	xx cc nn yy crc_L crc_M
xx:	Slave address (corresponds to the setting of the HEX switch)
cc:	Read command, here x 03
nn:	Number of transmitted user-data bytes
yy:	User data
crc_L:	Lowest-value byte of the 16-bit CRC word
crc_M:	Highest-value byte of the 16-bit CRC word

The CRC word is calculated in accordance with chapter 7.3.

Example (K10-320, individual beam data): 01 03 04 FF9FFFFF CRC_L CRC_M

7.3 CRC calculation for RTU Modbus protocol

The CRC calculation is performed using all bytes of the telegram to be transmitted, including the slave address. The CRC word is appended to the end of the telegram.

Attention!

Contrary to the arrangement of words otherwise typical for the Modbus, the CRC word with the lower-value byte is transmitted first.

```
*****************************************************************
* DESCRIPTION:      CALCULATES CRC16 FOR
*                   MODBUS RTU PROTOCOL,
*                   USING PRELOADED ARRAYS AND
*                   GENERATOR POLYNOM
*                   A001 hex (X**15 + X**13 + 1)

*****************************************************************
unsigned word CalculateCRC16 (char *buf, int len)


{
int i;
unsigned word crc = 0xFFFF;                    /* local CRC initialized */
i = 0;                                         /* init index */
while (i < len)
crc = (crc >> 8) ^ Crc16Mb [(crc ^ buf [i++]) & 0x00FF];
return crc;
}
```

```
/* CRC16 - Modbus RTU Protocol - lookup table for polynom A001hex */const unsigned word Crc16Mb [] =
{  0x0000, 0xC0C1, 0xC181, 0x0140, 0xC301, 0x03C0, 0x0280, 0xC241, 0xC601, 0x06C0,
0x0780, 0xC741, 0x0500, 0xC5C1, 0xC481, 0x0440, 0xCC01, 0x0CC0, 0x0D80, 0xCD41,
0x0F00, 0xCFC1, 0xCE81, 0x0E40, 0x0A00, 0xCAC1, 0xCB81, 0x0B40, 0xC901, 0x09C0,
0x0880, 0xC841, 0xD801, 0x18C0, 0x1980, 0xD941, 0x1B00, 0xDBC1, 0xDA81, 0x1A40,
0x1E00, 0xDEC1, 0xDF81, 0x1F40, 0xDD01, 0x1DC0, 0x1C80, 0xDC41, 0x1400, 0xD4C1,
0xD581, 0x1540, 0xD701, 0x17C0, 0x1680, 0xD641, 0xD201, 0x12C0, 0x1380, 0xD341,
0x1100, 0xD1C1, 0xD081, 0x1040, 0xF001, 0x30C0, 0x3180, 0xF141, 0x3300, 0xF3C1,
0xF281, 0x3240, 0x3600, 0xF6C1, 0xF781, 0x3740, 0xF501, 0x35C0, 0x3480, 0xF441,
0x3C00, 0xFCC1, 0xFD81, 0x3D40, 0xFF01, 0x3FC0, 0x3E80, 0xFE41, 0xFA01, 0x3AC0,
0x3B80, 0xFB41, 0x3900, 0xF9C1, 0xF881, 0x3840, 0x2800, 0xE8C1, 0xE981, 0x2940,
0xEB01, 0x2BC0, 0x2A80, 0xEA41, 0xEE01, 0x2EC0, 0x2F80, 0xEF41, 0x2D00, 0xEDC1,
0xEC81, 0x2C40, 0xE401, 0x24C0, 0x2580, 0xE541, 0x2700, 0xE7C1, 0xE681, 0x2640,
0x2200, 0xE2C1, 0xE381, 0x2340, 0xE101, 0x21C0, 0x2080, 0xE041, 0xA001, 0x60C0,
0x6180, 0xA141, 0x6300, 0xA3C1, 0xA281, 0x6240, 0x6600, 0xA6C1, 0xA781, 0x6740,
0xA501, 0x65C0, 0x6480, 0xA441, 0x6C00, 0xACC1, 0xAD81, 0x6D40, 0xAF01, 0x6FC0,
0x6E80, 0xAE41, 0xAA01, 0x6AC0, 0x6B80, 0xAB41, 0x6900, 0xA9C1, 0xA881, 0x6840,
0x7800, 0xB8C1, 0xB981, 0x7940, 0xBB01, 0x7BC0, 0x7A80, 0xBA41, 0xBE01, 0x7EC0,
0x7F80, 0xBF41, 0x7D00, 0xBDC1, 0xBC81, 0x7C40, 0xB401, 0x74C0, 0x7580, 0xB541,
0x7700, 0xB7C1, 0xB681, 0x7640, 0x7200, 0xB2C1, 0xB381, 0x7340, 0xB101, 0x71C0,
0x7080, 0xB041, 0x5000, 0x90C1, 0x9181, 0x5140, 0x9301, 0x53C0, 0x5280, 0x9241,
0x9601, 0x56C0, 0x5780, 0x9741, 0x5500, 0x95C1, 0x9481, 0x5440, 0x9C01, 0x5CC0,
0x5D80, 0x9D41, 0x5F00, 0x9FC1, 0x9E81, 0x5E40, 0x5A00, 0x9AC1, 0x9B81, 0x5B40,
0x9901, 0x59C0, 0x5880, 0x9841, 0x8801, 0x48C0, 0x4980, 0x8941, 0x4B00, 0x8BC1,
0x8A81, 0x4A40, 0x4E00, 0x8EC1, 0x8F81, 0x4F40, 0x8D01, 0x4DC0, 0x4C80, 0x8C41,
0x4400, 0x84C1, 0x8581, 0x4540, 0x8701, 0x47C0, 0x4680, 0x8641, 0x8201, 0x42C0,
0x4380, 0x8341, 0x4100, 0x81C1, 0x8081, 0x4040  };
```

7.4 Data transmission via RS 232 interface

In addition to use for configuration, the RS 232 interface can also be used for data exchange purposes.

Configuration is carried out via the QUATTRO SW. This means that the autosend, autosend in Modbus format or triggered scanning operating modes are also available. When using the RS 232 interface for data transmission, observe the following:

- 1 stop bit, no parity bit
- In triggered scanning mode, the baud rate is set to 38.4 kBaud
- In autosend mode, the baud rate corresponds to that specified in the configuration

8 Firmware update

The user can update the QUATTRO control device with new firmware. This can be accomplished in two different ways. The QUATTRO configuration data should be backed up with the configuration program before updating the firmware. An update is only necessary if Leuze electronic has made a new firmware version available.

1. With the configuration program, started by calling up the menu item Extras/Flasher. This method requires that the new Kontur2.s firmware file be located in the same directory as the QUATTRO.exe configuration program.
   The configuration program first starts the boot loader in the QUATTRO and then the Hexload.exe program with the appropriate parameters on the PC. Upon successful completion of programming, the QUATTRO is started with the new firmware. For this purpose, it is necessary to switch the control device off and then back on again.
   During programming (red LED illuminated), in no case may the power supply be switched off or the interface cable disconnected. Should this however occur, the firmware can only be loaded manually.
2. The manual firmware update should only be used if the QUATTRO cannot, for some reason (see above), communicate with the configuration program. The Hexload.exe program must be started on the PC and the Kontur2.s firmware loaded with File/Load. The boot loader must now be started on the QUATTRO. This is done with the aid of DIP switch S5, located under the terminal cover of the QUATTRO.
   When the supply voltage is switched on, first push dip switch DIP 2 to the right (programming) (the red LED illuminates, programming voltage is switched on), then push the lower dip switch DIP 1 one step to the right (green LED illuminates, reset is active) and then back to the left (green LED extinguishes, start bootloader). The Hexload.exe PC program now communicates with the QUATTRO boot loader and should display the following message:

Range(s)	F4000 –FFFFF
Application	Kontur 2 QUATTRO
CPU	MC20
BTL S/W Version	BTL V2.32

   If this message does not appear, check the interface connection (baud rate 38400).

   If everything is OK, the QUATTRO can be reprogrammed using Target/Clear and Target/Program.

   Once programming has been completed, switch DIP 2 must be pushed back to the left. The QUATTRO can then be switched to the normal operating mode with Target/Start program or by switching on and off.

9 Limits for detecting objects

To ensure that objects are detected and the data analyzed, the following conditions must be fulfilled.

- Minimum object size for stationary objects.
- Under what boundary conditions is pure detection of moving objects possible?
- How many data bytes can be transmitted?
- Is the cycle time of the PLC sufficient?

With the KONTURflexsoft software, the points mentioned above can be simulated using the Tools/Simulation menu without any need to connect additional hardware.

9.1 Minimum object size for stationary objects

The minimum object size of a stationary object is determined by the height *H = beam spacing + 5mm in the beam plane.*

Vertical to the beam plane, the object must have a length of at least *L = 10mm*.

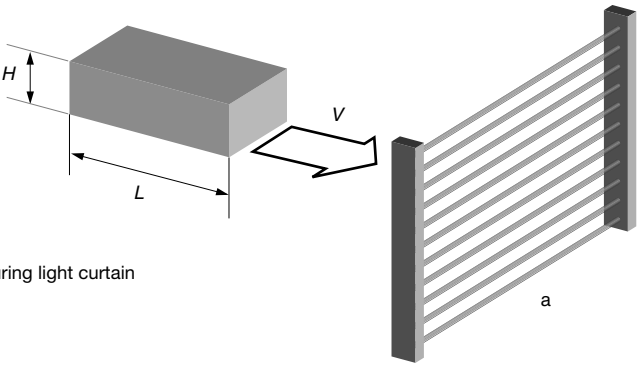
9.2 Boundary conditions for pure detection of moving objects

For a moving object, the cycle time of the light strip must be shorter than the period of time that the object to be detected is located in the beam plane. In the following equation, it is assumed that the object moves vertically relative to the beam plane.

v_{max} = (L –10mm) / tz
or
L_{min} = v * tz + 10mm

tz cycle time of the given light strip
v object speed
L length of the object in the direction of movement

The prerequisite is that the gap between two successive objects be greater than the length (minimum length).



a = KONTUR*flex* measuring light curtain
H = height
L = length
v = speed

Figure 9.1: Object detection

9.3 How many data bytes can be transmitted?

Numerous factors play a role in the data transmission time. The shortest transmission time is achieved in autosend mode (fast). Note here that in autosend mode, data are transmitted at an adjustable multiple of the cycle time of the strip with the most beams.

The number of bytes B which can be transmitted can, in principle, be calculated using the equation

B_{max} = tzl / (11 / baud + 0.5ms) - 1

tzl cycle time of the light strip with the most beams

Baud used baud rate; 11 is the number of bits per byte

0.5ms internal calculation time for preparing the data

9.4 Is the cycle time of the PLC sufficient?

The cycle time of the PLC must be < tzl*2 in order for the PLC to reliably detect each object.

If the data transmission rate is the limiting factor, the minimum/maximum values of the data to be evaluated and a multiple of the light-strip cycle time can be used for the data transmission cycle.

The hold time for the minimum/maximum values must be set so that it is greater than the data transmission cycle time.

tdü > (a-1) * tz

tdü data transmission cycle time

an adjustable factor

tz cycle time of the given light strip

If the PLC cycle time is the limiting factor, the minimum/maximum values can be used.

The hold time for the minimum/maximum values must be set so that it is greater than the PLC cycle time.

tsps > (a-1) * tz

tsps PLC-cycle time

an adjustable factor

tz cycle time of the given light strip

Notice!

When using the minimum/maximum values, it must be ensured that the pause or distance between two objects is sufficiently large.

Notice!

The user can use the configuration program on the PC together with the configuration data to calculate the maximum speed or the minimum length and the data transmission time.

Notice!

In order to be independent of PLC cycle times, a parameter can be set in the configuration software of the KONTURflex. While the parameter is switched on, all beam data from interrupted beams are stored until requested by the connected controller.

10 Connections and switches

The connections and switches on the QUATTRO control device are depicted in the illustrations shown below.

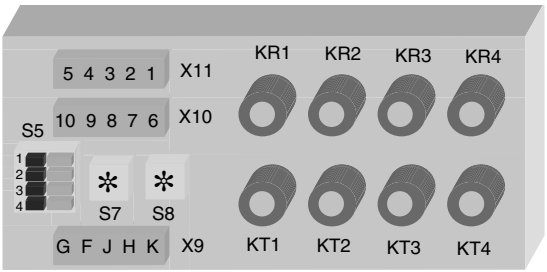


Figure 10.1: QUATTRO control device

Plug X9 (gray):

The voltage supply of the control device is connected at plug X9.

The PNP switching output of the device can be connected at PIN J.

PIN G	+24V
PIN F	GND
PIN J	PNP OUT
PIN H	free
PIN K	free

Plug X10 (black):

The configuration software can be connected to the PC via an RS 232 connection at plug X10.

PIN 6	free	
PIN 7	free	
PIN 8	GND	(-> pin 5 on the 9-pin Sub-D plug on the PC)
PIN 9	RS 232 transmitter	(-> pin 2 on the 9-pin Sub-D plug on the PC)
PIN 10	RS 232 receiver	(-> pin 3 on the 9-pin Sub-D plug on the PC)

Plug X11 (green):

A control (PLC, PC, …) can be connected to plug X11. The RS 485 connection can be looped through.

The PROFIBUS link for the PROFIBUS-DP can be realized by means of these connections.

PIN 1	RS 485 A (-)
PIN 2	RS 485 B (+)
PIN 3	Shield
PIN 4	RS 485 B (+)
PIN 5	RS 485 A (-)

S7, S8 decade switches – slave address

The slave address of the control device can be set with the two decade switches S7 and S8.

S7: lower-value nibble of the slave address

S8: higher-value nibble of the slave address

S5 DIP switch – terminating resistors of the RS 485

The terminating resistors for the RS 485 connection must be switched on or off depending on the type of connection. As soon as the QUATTRO control device is the last or only user on the bus, the resistors must be switched on.

DIP 4	RS 485; A	On	right
DIP 3	RS 485; B	On	right

Firmware update

The programming voltage for a possible firmware update can be increased by means of dip switch DIP 2.

DIP 2:

Programming	switch in right position
Normal operation	switch in left position

Resetting the control device

In case of failure, the QUATTRO control device can be reset manually with dip switch DIP 1.

DIP 1:

Reset	right switch position
Operation	left switch position

Receiver-optics strips

The receiver-optics strips can be connected to the sockets labeled KR1 through KR4. Ready-made cables are available in various lengths as accessories (see Appendix A).

Transmitter-optics strips

The transmitter-optics strips can be connected to the sockets labeled KT1 through KT4. Ready-made cables are available in various lengths as accessories (see Appendix A).

When connecting, note that one cable is required for the transmitter light strip and one is required for the receiver light strip.

The light curtain will not be destroyed if the connection cables are reversed. The light strips will not, however, function property if the connections are reversed.

10.1 General connection hints

Shielding of the M12 connection cables

Attention!

We strongly recommend using the CB-M12-... cables listed in the Accessories section. Observe when using other cables:

The connection cables between the QUATTRO control device and the respective transmitter or receiver bars must absolutely be shielded cables. The shield must lay flat on ***both*** *M12 connectors on the connector housing.*

10.2 QUATTRO-RSX/M12 control device

The QUATTRO control device can also be supplied in a special version with **two** standard plug-type connectors. For this purpose, one 8-pin and one 5-pin M12 connector are built into the housing.

These plugs can be used to realize the voltage supply as well as the communication to a control via RS 485.

The order number of the control device is: 670003

Assignment of the 8-pin plug-type connector:

8-pin plug Pin	Function	Core color for standard M12 cable	QUATTRO X 9 connection Pin
1	+ 24VDC	white	G
2	Earth	brown	
3	GND	green	F
4	PNP output	yellow	J
			QUATTRO X 11 Connection
5	Free		
6	RS 485 (B+)	pink	4
7	RS 485 (A-)	blue	5
8	Earth	red	

Table 10.1: Assignment of the 8-pin M12-connector for voltage supply / RS 485

The RS 232 interface to a computer is realized by means of a 5-pin built-in plug.

5-pin plug Pin	Function	Core color for standard M12 cable	QUATTRO X 10 connection Pin
1	RxD	brown	10
2	TxD	white	9
3	GND	blue	8
4	Free		
5	Free		

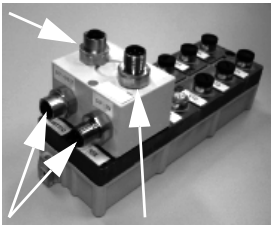
Table 10.2: Assignment of the 5-pin M12 connector for the RS 232 interface

10.3 QUATTRO-DP/M12 control device

The QUATTRO control device can also be supplied in a special version with **four** standard M12 plug-type connectors.

These four plugs can be used to realize the voltage supply as well as the communication to a control via RS 232 or the PROFIBUS.

M12.5 - RS 232



M12 - PROFIBUS connection M12.4 - Power supply unit

Figure 10.2: QUATTRO-DP/M12 control device

The order number of the control device is: 50111868

10.3.1 Voltage supply

The voltage supply is realized via a 4-pin, A-coded M12-connector.

4-pin connector (A-coded) Pin	Function	Core color for standard M12 cable	QUATTRO X 9 connection Pin
1	+24VDC	brown	G
2	NC	white	
3	GND	blue	F
4	PNP out	black	J

Table 10.3: Assignment of the 4-pin M12-connector for voltage supply

10.3.2 RS 232

Connection to a computer for purposes of diagnostics and configuration via RS 232 is realized via a 5-pin, A-coded socket.

5-pin socket (A-coded) Pin	Function	Core color for standard M12 cable	QUATTRO X 10 connection Pin
1	NC	brown	
2	TxD	white	9
3	GND	blue	8
4	RxD	black	10
5	NC		

Table 10.4: Assignment of the 5-pin M12 socket for the RS 232 interface

10.3.3 Connecting to the PROFIBUS network

The connection to the PROFIBUS network is realized via B-coded connectors/sockets according to standards. If the PROFIBUS is not connected to other devices via DP-Out, the terminating resistors must be activated, see "S5 DIP switch – terminating resistors of the RS 485" on page 43.

DP-IN:

5-pin connector (B-coded) Pin	Function	Core color for PROFIBUS M12 cable	QUATTRO X 11 connection Pin
1	NC		
2	RS 485 A(-)	green	1
3	NC		
4	RS 485 B(+)	red	2
5	shield		3

Table 10.5: Assignment of the 5-pin M12 connector DP-IN

DP-OUT:

5-pin socket (B-coded) Pin	Function	Core color for PROFIBUS M12 cable	QUATTRO X 11 connection Pin
1	NC		
2	RS 485 A(-)	green	5
3	NC		
4	RS 485 B(+)	red	4
5	shield		3

Table 10.6: Assignment of the 5-pin M12 connector DP-IN

10.4 QUATTRO-DP/KV control device

This version is identical in design to QUATTRO-DP, however with integrated screwed cable glands for 2x 6.9 … 9.5mm (PROFIBUS) and 1x 5 … 8mm (voltage supply)

11 Dimensioned drawings

Dimensioned drawing using the example of a light strip with a beam spacing of 10mm.

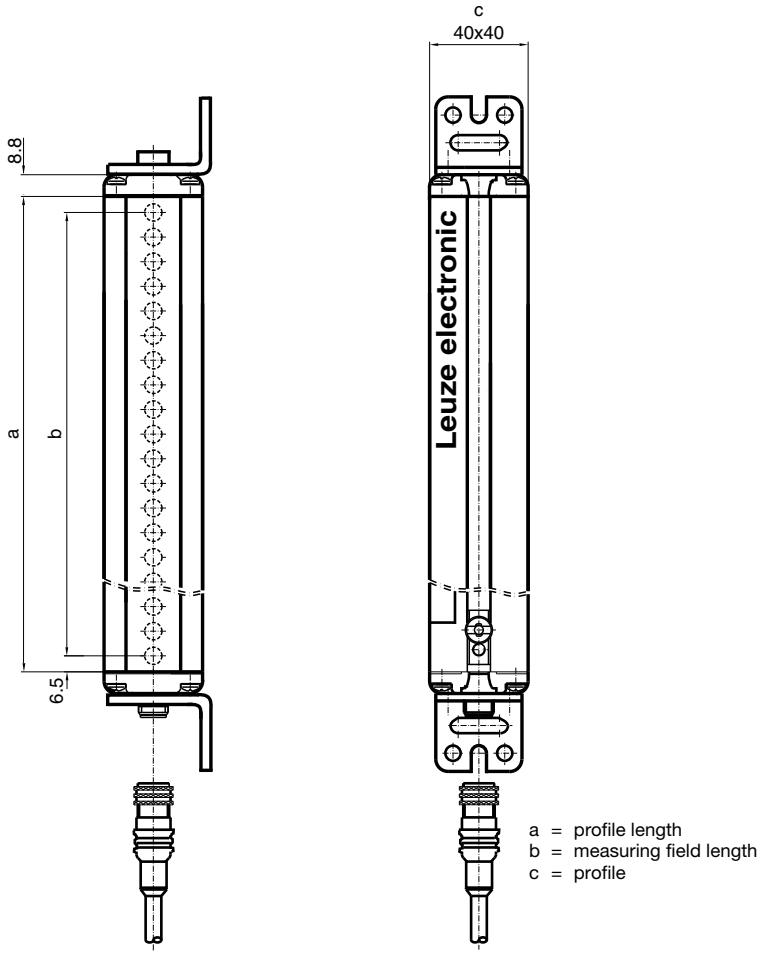


Figure 11.1: Dimensioned drawing of light strips

The measurement field length of the light strips is equal to the profile length "a" minus 3mm. The total length can be found in the type designation (see Appendix A).

Dimensioned drawing of bracket:

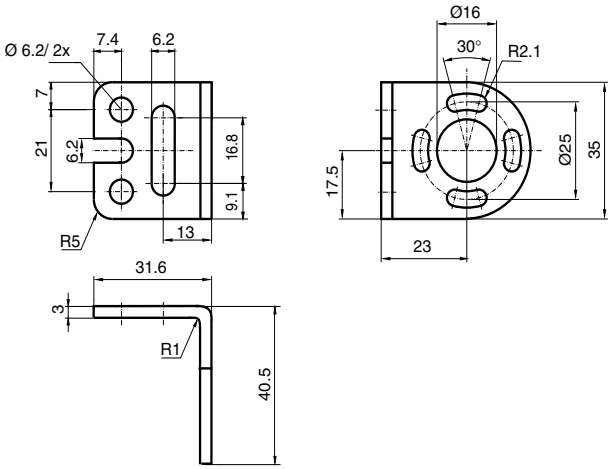


Figure 11.2: Dimensioned drawing of standard bracket

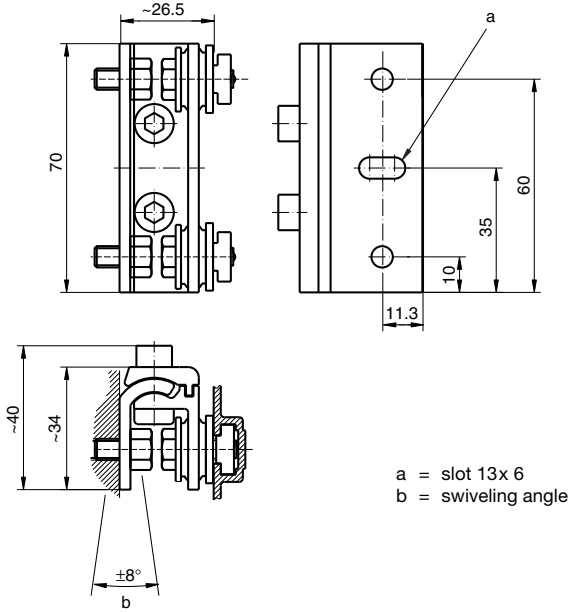


Figure 11.3: Swiveling bracket with vibration damper

Dimensioned drawing of QUATTRO control device:

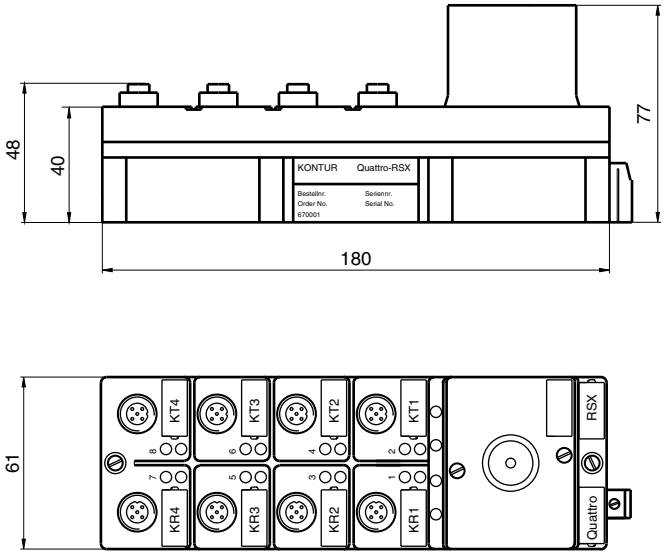


Figure 11.4: Dimensioned drawing of QUATTRO control device:

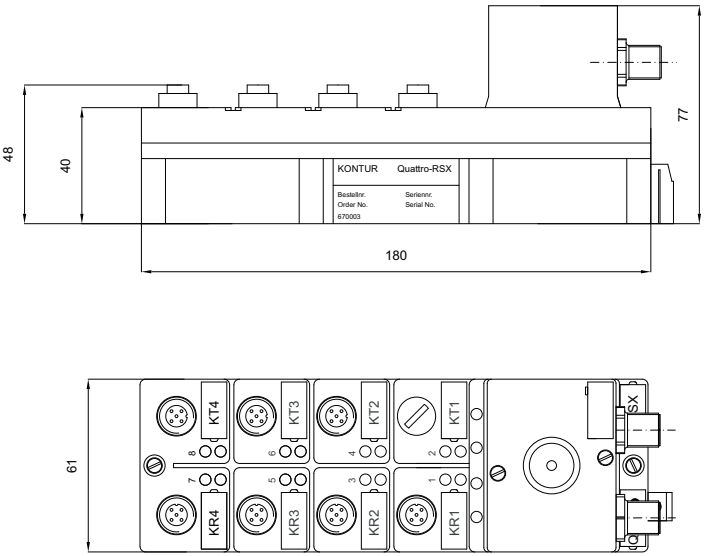


Figure 11.5: Dimensioned drawing of the QUATTRO-RSX/M12 control device

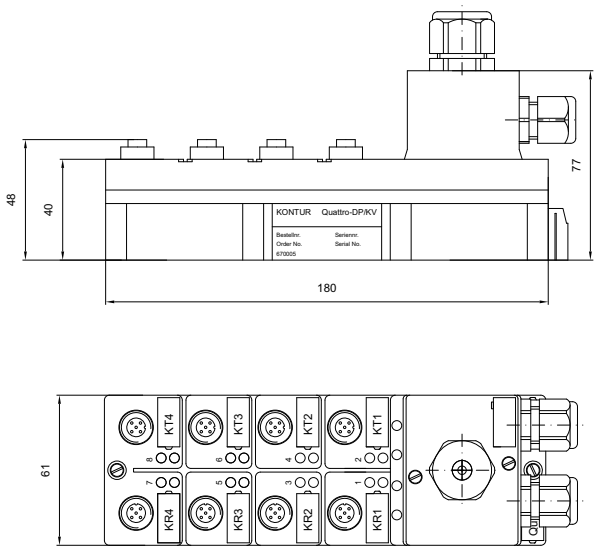


Figure 11.6: Dimensioned drawing of QUATTRO DP/KV control device:

Notice!

The dimensioned drawing from figure 11.5 also applies for the QUATTRO DP/M12 control device with one exception: the connectors on the top of the housing protrude 13mm above the housing edge, resulting in a total height of 90mm instead of 77mm for the QUATTRO DP/M12.

12 Technical Data

12.1 Specifications of the KONTURflex measuring light curtain

Meas. field length with 5 mm grid	80 mm - 2560 mm in increments of 80 mm
Meas. field length with 10/20 mm	160 … 3200 mm
Resolution	10 mm, 15 mm, 25 mm
Width of field measured	max. 4 m
Beam spacing	5 mm, 10 mm, 20 mm
Max. number of beams (total)	512
Time overhead per beam	50 µs
Light source (transmitter)	IR LEDs, exempt group (acc. to EN 62471)
Transmitter wavelength	880 nm
Measurement field display	LEDs in the receiver
Supply voltage	from the KONTUR*flex*-QUATTRO (12 VDC)
Connection	M12 plug connector
Connection cable	5-pole, shielded, 20 m max.
Housing	continuous-cast Al
Covering plate	PMAA dark gray
Protection class	IP 65
VDE safety class	III
Standards applied	IEC 60947-5-2, UL 508
Ambient temperature	0 … 55 °C
Ground	40 mm x 40 mm
Attachment	lateral sliding block or face-mounted corner bracket

12.2 Specifications of the QUATTRO control device

Supply voltage	24 VDC ±20 %
Safeguarding	1 AT (current consumption: 100 mA + approx. 150 mA per pair of light curtains)
Connectable light curtains	4 with up to max. 512 beams
Connection (light curtain)	M12 plug connector
Interface	RS 485 or PROFIBUS-DP (optical coupler)
Configuration interface	RS 232
Switching output	1 bit (optical coupler, event can be configured)
Connection (interfaces and supply voltage)	pluggable screw terminals
Operating modes	automatic and triggered scanning
Housing	plastic (fieldbus housing)
Protection class	IP 65
Certifications	UL 508 [1)]
Ambient temperature	0 … 55 °C
Dimensions	W = 60 mm, L = 180 mm, H = 40 mm (w/o plug)

1) With regard to power supply and wiring, observe the safety and installation instructions

A Appendix A

Order numbers and light-strip lengths for the KONTUR*flex* measuring light curtain.

A.1 KONTURflex optics with 5mm beam spacing

Order no.	Short designation	Type / feature	Measurement field length A [mm]
	K5-80	**Light curtain**	
671008	KT5-80	Transmitter	80
670008	KR5-80	Receiver	80
	K5-160	**Light curtain**	
671016	KT5-160	Transmitter	160
670016	KR5-160	Receiver	160
	K5-240	**Light curtain**	
671024	KT5-240	Transmitter	240
670024	KR5-240	Receiver	240
	K5-320	**Light curtain**	
671032	KT5-320	Transmitter	320
670032	KR5-320	Receiver	320
	K5-400	**Light curtain**	
671040	KT5-400	Transmitter	400
670040	KR5-400	Receiver	400
	K5-480	**Light curtain**	
671048	KT5-480	Transmitter	480
670048	KR5-480	Receiver	480
	K5-560	**Light curtain**	
671056	KT5-560	Transmitter	560
670056	KR5-560	Receiver	560
	K5-640	**Light curtain**	
671064	KT5-640	Transmitter	640
670064	KR5-640	Receiver	640
	K5-720	**Light curtain**	
671072	KT5-720	Transmitter	720
670072	KR5-720	Receiver	720
	K5-800	**Light curtain**	
671080	KT5-800	Transmitter	800
670080	KR5-800	Receiver	800

Order no.	Short designation	Type / feature	Measurement field length A [mm]
	K5-960	**Light curtain**	
671096	KT5-960	Transmitter	960
670096	KR5-960	Receiver	960
	K5-1120	**Light curtain**	
671112	KT5-1120	Transmitter	1120
670112	KR5-1120	Receiver	1120
	K5-1280	**Light curtain**	
671128	KT5-1280	Transmitter	1280
670128	KR5-1280	Receiver	1280
	K5-1440	**Light curtain**	
671144	KT5-1440	Transmitter	1440
670144	KR5-1440	Receiver	1440
	K5-1600	**Light curtain**	
671160	KT5-1600	Transmitter	1600
670160	KR5-1600	Receiver	1600
	K5-1760	**Light curtain**	
671176	KT5-1760	Transmitter	1760
670176	KR5-1760	Receiver	1760
	K5-1920	**Light curtain**	
671192	KT5-1920	Transmitter	1920
670192	KR5-1920	Receiver	1920
	K5-2080	**Light curtain**	
671208	KT5-2080	Transmitter	2080
670208	KR5-2080	Receiver	2080
	K5-2240	**Light curtain**	
671224	KT5-2240	Transmitter	2240
670224	KT5-2240	Receiver	2240
	K5-2400	**Light curtain**	
671240	KT5-2400	Transmitter	2400
670240	KR5-2400	Receiver	2400
	K5-2560	**Light curtain**	
671256	KT5-2560	Transmitter	2560
670256	KR5-2560	Receiver	2560

A.2 KONTURflex optics with 10mm beam spacing

Order no.	Short designation	Type / feature	Measurement field length A [mm]
	K10-160	**Light curtain**	
673016	KT10-160	Transmitter	160
672016	KR10-160	Receiver	160
	K10-320	**Light curtain**	
673032	KT10-320	Transmitter	320
672032	KR10-320	Receiver	320
	K10-480	**Light curtain**	
673048	KT10-480	Transmitter	480
672048	KR10-480	Receiver	480
	K10-640	**Light curtain**	
673064	KT10-640	Transmitter	640
672064	KR10-640	Receiver	640
	K10-800	**Light curtain**	
673080	KT10-800	Transmitter	800
672080	KR10-800	Receiver	800
	K10-960	**Light curtain**	
673096	KT10-960	Transmitter	960
672096	KR10-960	Receiver	960
	K10-1120	**Light curtain**	
673112	KT10-1120	Transmitter	1120
672112	KR10-1120	Receiver	1120
	K10-1280	**Light curtain**	
673128	KT10-1280	Transmitter	1280
672128	KR10-1280	Receiver	1280
	K10-1440	**Light curtain**	
673144	KT10-1440	Transmitter	1440
672144	KR10-1440	Receiver	1440
	K10-1600	**Light curtain**	
673160	KT10-1600	Transmitter	1600
672160	KR10-1600	Receiver	1600
	K10-1760	**Light curtain**	
673176	KT10-1760	Transmitter	1760
672176	KR10-1760	Receiver	1760

Order no.	Short designation	Type / feature	Measurement field length A [mm]
	K10-1920	**Light curtain**	
673192	KT10-1920	Transmitter	1920
672192	KR10-1920	Receiver	1920
	K10-2080	**Light curtain**	
673208	KR10-2080	Transmitter	2080
672208	KR10-2080	Receiver	2080
	K10-2240	**Light curtain**	
673224	KT10-2240	Transmitter	2240
672224	KR10-2240	Receiver	2240
	K10-2400	**Light curtain**	
673240	KT10-2400	Transmitter	2400
672240	KR10-2400	Receiver	2400
	KT10-2560	**Light curtain**	
673256	KT10-2560	Transmitter	2560
672256	KR10-2560	Receiver	2560
	KT10-2720	**Light curtain**	
673272	KT10-2720	Transmitter	2720
672272	KR10-2720	Receiver	2720
	K10-2880	**Light curtain**	
673288	KT10-2880	Transmitter	2880
672288	KR10-2880	Receiver	2880
	K10-3040	**Light curtain**	
673304	KT10-3040	Transmitter	3040
672304	KR10-3040	Receiver	3040
	K10-3200	**Light curtain**	
673320	KT10-3200	Transmitter	3200
672320	KR10-3200	Receiver	3200

A.3 KONTURflex optics with 20mm beam spacing

Order no.	Short designation	Type / feature	Measurement field length A [mm]
	K20-160	**Light curtain**	
675016	KT20-160	Transmitter	160
674016	KR20-160	Receiver	160
	K20-320	**Light curtain**	
675032	KT20-320	Transmitter	320
674032	KR20-320	Receiver	320
	K20-480	**Light curtain**	
675048	KT20-480	Transmitter	480
674048	KR20-480	Receiver	480
	K20-640	**Light curtain**	
675064	KT20-640	Transmitter	640
674064	KR20-640	Receiver	640
	K20-800	**Light curtain**	
675080	KT20-800	Transmitter	800
674080	KR20-800	Receiver	800
	K20-960	**Light curtain**	
675096	KT20-960	Transmitter	960
674096	KR20-960	Receiver	960
	K20-1120	**Light curtain**	
675112	KT20-1120	Transmitter	1120
674112	KR20-1120	Receiver	1120
	K20-1280	**Light curtain**	
675128	KT20-1280	Transmitter	1280
674128	KR20-1280	Receiver	1280
	K20-1440	**Light curtain**	
675144	KT20-1440	Transmitter	1440
674144	KR20-1440	Receiver	1440
	K20-1600	**Light curtain**	
675160	KT20-1600	Transmitter	1600
674160	KR20-1600	Receiver	1600
	K20-1760	**Light curtain**	
675176	KT20-1760	Transmitter	1760
674176	KR20-1760	Receiver	1760

Order no.	Short designation	Type / feature	Measurement field length A [mm]
	K20-1920	**Light curtain**	
675192	KT20-1920	Transmitter	1920
674192	KR20-1920	Receiver	1920
	K20-2080	**Light curtain**	
675208	KT20-2080	Transmitter	2080
674208	KR20-2080	Receiver	2080
	K20-2240	**Light curtain**	
675224	KT20-2240	Transmitter	2240
674224	KR20-2240	Receiver	2240
	K20-2400	**Light curtain**	
675240	KT20-2400	Transmitter	2400
674240	KR20-2400	Receiver	2400
	KT20-2560	**Light curtain**	
675256	KT20-2560	Transmitter	2560
674256	KR20-2560	Receiver	2560
	K20-2720	**Light curtain**	
675272	KT20-2720	Transmitter	2720
674272	KR20-2720	Receiver	2720
	K20-2880	**Light curtain**	
675288	KT20-2880	Transmitter	2880
674288	KR20-2880	Receiver	2880
	K20-3040	**Light curtain**	
675304	KT20-3040	Transmitter	3040
674304	KR20-3040	Receiver	3040
	K20-3200	**Light curtain**	
675320	KT20-3200	Transmitter	3200
674320	KR20-3200	Receiver	3200

A.4 QUATTRO control devices

Order no.	Short designation	Type / feature
670001	QUATTRO-RSX	Control device for KONTUR*flex* with RS 485 interface
670003	QUATTRO-RSX/M12	Control device for KONTUR*flex* with RS 485 interface and standard M12-plug-type connector
670002	QUATTRO-DP	Control device for KONTUR*flex* with PROFIBUS-DP interface
670005	QUATTRO-DP/KV	Control device for KONTUR*flex* with PROFIBUS-DP interface and screwed cable glands
50111868	QUATTRO-DP/M12	Control device for KONTURflex with PROFIBUS-DP interface and standard M12-plug-type connector
670004	QUATTRO-CANopen	Control device for KONTURflex with CANopen interface

A.5 Connection cable between QUATTRO and light strips

Order no.	Short designation	Type / feature
678031	CB-M12-1000S-5GF/GM	QUATTRO-KT/KR connection cable, length 1 m, shielded
678033	CB-M12-2500S-5GF/GM	QUATTRO-KT/KR connection cable, length 2.5 m, shielded
678035	CB-M12-5000S-5GF/GM	QUATTRO-KT/KR connection cable, length 5 m, shielded
678040	CB-M12-10000S-5GF/GM	QUATTRO-KT/KR connection cable, length 10 m, shielded
678045	CB-M12-15000S-5GF/GM	QUATTRO-KT/KR connection cable, length 15 m, shielded
678032	CB-M12-20000S-5GF/GM	QUATTRO-KT/KR connection cable, length 20 m, shielded

A.6 Connection cable to the external control

The QUATTRO control device is connected to the control environment either via the internal X9, X10 and X11 connectors or via the M12 connector that extends out of the device.

A.6.1 QUATTRO-RSX, QUATTRO-DP, QUATTRO-DP/KV and QUATTRO-CANopen

These control devices can only be connected via the internal X9, X10, and X11 screw/plug-type connections. Standard cables with wire leads are to be used here.

Order no.	Short designation	Type / feature
678100	K-CB-SUBP-3000	RS 232/QUATTRO, 3m diagnosis cable

A.6.2 QUATTRO-RSX/M12

Connection cable for voltage supply and RS 485 communication:

Order no.	Short designation	Type / feature
50104591	K-D M12A-8P-2m-PUR	Supply plus RS 485-communication, 2m
50104590	K-D M12A-8P-5m-PUR	Supply plus RS 485-communication, 5m

Other cable lengths on request.

A.6.3 QUATTRO-DP/M12

Order no.	Short designation	Type / feature
50104555	K-D M12A-5P-2m-PVC	Voltage supply, 2m
50104180	KB PB-5000-BA	PROFIBUS connection DP-IN, 5m, open cable end
50104187	KB PB-5000-SA	PROFIBUS connection DP-OUT, 5m, open cable end
50104098	KB PB-5000-SBA	PROFIBUS connection DP, connector socket
50106881	KB ROD4 plus-5000	Diagnosis cable RS 232/QUATTRO-M12, 5m

Other cable lengths on request.

A.7 Accessories and mounting brackets

Order no.	Short designation	Type / feature
345899	BT-K2	Bracket for KONTUR*flex* [1)]
560120	BT-S	Standard fastening bracket set (2 pieces, inc. screws)
560300	BT-SSD	Bracket, swiveling with vibration damping
425720	BT-NC	Sliding block [1)]

1) 2 brackets are included in delivery contents of the transmitter and of the receiver.

B Appendix B

Units see table.

The registers and functions used for data transmission with the LUMINET protocol are listed and described in this appendix.

B.1 Function codes

Type	R/O, ROM	manufacturer-configured or device-specific data	Stored on EEPROM or Flash-EPROM
	R/W, ROM	user-configured data	
	W/O, ROM	passwords	
	R/O, RAM	device-status data	
	R/W, RAM	control data	

	R/O - Read Only	R/W - Read/Write	W/O-Write Only

Rules:

Configuration: xxx — represents data which are, as a rule, written to the device only once

Status: yyy — represents data which are read out of the device during runtime

B.1.1 Base unit – global device data (address offset 0X0000)

Reg. adr. hex.	Variable	Max. length [Reg.]	Value range	Type: R/O, R/W, ROM, RAM	PW Level	Factory setting, comment
0X0000	Type identifier	1	0x32: KONTUR	R/O, ROM	0	Set by manufacturer
0X0009	Serial number	10	20 numerical characters (ASCII)	R/O, ROM	1	-"-
0X0014	Date of manufacture	4	8 alphanumerical characters; order: year 4, month 2, day 2 characters	R/O, ROM	1	-"-
0X0018	HW version	1	MSByte main version, LSByte subversion	R/O, ROM	1	-"-
0X0019	SW version	1	MSByte main version, LSByte subversion	R/O, ROM	0	-"-
0X00B2	Current password	8	Manufacturer password	W/O, RAM	0	-
0X00BD	Device control word	1	Action dependent on value: MSByte: Type; with Kontur, type always 0 LSByte: value; 1: All configuration data are stored in the EEPROM and are retained when switched off 2: Base unit configuration data are stored in the EEPROM 3: New-start as on power-up	R/W, RAM	0	-
0X00C1	Configuration: message outputs	2	PNP-output configuration: Bit 0: active if all beams uninterrupted Bit 1: active if all beams interrupted Bit 2: active if path run in middle Bit 3: active if path run too high Bit 4: active if path run too low Bit 5: active if hole recognized Bit 6: free Bit 8, 9: channel number (0 … 3), the PNP output is assigned to his channel Bit 15 = 0 output is active low Bit 15 = 1 output is active high Bit 14 = toggle with every scan	R/W, ROM	0	Active high if at least one beam interrupted with channel 0

Reg. adr. hex.	Variable	Max. length [Reg.]	Value range	Type: R/O, R/W, ROM, RAM	PW Level	Factory setting, comment
0X00C4	Status: complete device	1	Bit 0: error: set on every error Bit 1: PNP output active Bit 2: no light strip found Bit 4: light strip 0, wrong number of beams (number of beams does not match entry in EEPROM) Bit 5: light strip 1, incorrect number of beams Bit 6: light strip 2, incorrect number of beams Bit 7: light strip 3, incorrect number of beams Bit 12: error in EEPROM for configuration of light strip 0 Bit 13: error in EEPROM for configuration of light strip 1 Bit 14: error in EEPROM for configuration of light strip 2 Bit 15: error in EEPROM for configuration of light strip 3 All states with the exception of bit 1 are determined on power-up.	R/O, RAM	0	-
0X00D4	Sub-unit Index (e.g. light strip 0, 1…)	1	0 … n depending on the device; to read or write sub-unit registers, the sub-unit Index (0 … 3 for channels 1 … 4) must first be entered here	R/W, RAM	0	-
0X00D5	Com-unit Index (communication chan. KK)	1	0 … n depending on the device; always 0 for Kontur	R/W, RAM	0	-

B.1.2 Sub-unit – specific device data (address offset 0x2000)

(first select the appropriate sub-unit in the base unit)

Reg. adr. hex.	Variable	Max. length [Reg.]	Value range	Type: R/O, R/W, ROM, RAM	PW Level	Factory setting, comment
0X000C	Number of beams / segments	1	1 … 512 (determined on up-power)	R/O, ROM	0	-
0X000D	Resolution [1 mm or 1/100 degree]	1	5, 10, 20, 40	R/W, ROM	0	5 mm
0X000E	Range	1	Value 0: 5 … 30 cm 1: 20 … 100 cm 2: 50 … 150 cm 3: 100 … 250 cm 4: 200 … 350 cm 5: 300 … 400 cm	R/W, ROM	0	300 … 400 mm
0X0013	Scan mode	1	Bit 0 … 5: number of passes for integration (1 … 63)	R/W, ROM	0	1
0X0018	Configuration: subdevices - behavior	4	0: Bit 0…6 group counters (1 … 127), Bit 15=0 group with AND, Bit 15=1 group with OR 1: Bit 0 … 7 min/max hold time (number of passes 1 … 255) 2: Bit 0 … 7 hole size (1 … 255) 3: Bit 0 … 7 center tolerance (1 … 255)	R/W, ROM	0	1 10 1 2
0X002C	Status: sub device	1	Bit 0: all beams uninterrupted Bit 1: all beams interrupted Bit 2: path run in middle Bit 3: path run too high Bit 4: path run too low Bit 5: hole recognized Bit 7: light strip is present	R/O, RAM	0	-
0X0034	Measuring field	40	Blanking pattern, 1 bit per beam, 1 for blanked (maximum 64 bytes, LSB of first byte is first beam)	R/W, ROM	0	no blanking
0X014F	Status: TU	1	Lowest interrupted beam	R/O, RAM	0	-
0X0150	Status: HU	1	Highest interrupted beam	R/O, RAM	0	-
0X0151	Status: ZU	1	Number of interrupted beams	R/O, RAM	0	-

Reg. adr. hex.	Variable	Max. length [Reg.]	Value range	Type: R/O, R/W, ROM, RAM	PW Level	Factory setting, comment
0X0152	Status: TNU	1	Lowest uninterrupted beam	R/O, RAM	0	-
0X0153	Status: HNU	1	Highest uninterrupted beam	R/O, RAM	0	-
0X0154	Status: ZNU	1	Number of uninterrupted beams	R/O, RAM	0	-
0X0155	Status: TU_{Min}	1	Lowest interrupted beam	R/O, RAM	0	-
0X0156	Status: HU_{Min}	1	Highest interrupted beam	R/O, RAM	0	-
0X0157	Status: ZU_{Min}	1	Number of interrupted beams	R/O, RAM	0	-
0X0158	Status: TNU_{Min}	1	Lowest uninterrupted beam	R/O, RAM	0	-
0X0159	Status: HNU_{Min}	1	Highest uninterrupted beam	R/O, RAM	0	-
0X015A	Status: ZNU_{Min}	1	Number of uninterrupted beams	R/O, RAM	0	-
0X015B	Status: TU_{Max}	1	Lowest interrupted beam	R/O, RAM	0	-
0X015C	Status: HU_{Max}	1	Highest interrupted beam	R/O, RAM	0	-
0X015D	Status: ZU_{Max}	1	Number of interrupted beams	R/O, RAM	0	-
0X015E	Status: TNU_{Max}	1	Lowest uninterrupted beam	R/O, RAM	0	-
0X015F	Status: HNU_{Max}	1	Highest uninterrupted beam	R/O, RAM	0	-
0X0160	Status: ZNU_{Max}	1	Number of uninterrupted beams	R/O, RAM	0	-
0X0161	Status: current beam data	64	1 bit per light axis, 0=occupied, 1=free (LSB of first byte is beam 1)	R/O, RAM	0	-
0X01A1	Control register	1	1: Store configuration data of the sub-unit in EEPROM	R/W, RAM	0	-

B.1.3 Com-unit – communication data (address offset 0x4000)

Reg. adr. hex.	Variable	Max. length [Reg.]	Value range	Type: R/O, R/W, ROM, RAM	PW Level	Factory setting, comment
0X0000	Interface type (remote interface)	1	0: RS 485 Modbus 1: PROFIBUS-DP	R/O, ROM	0	-
0X0002	Format to be set for master determined automatically for slave	1	Bit 0 … 7: data rate 12: 4.8 kBaud 13: 9.6 kBaud 14: 19.2 kBaud 15: 38.4 kBaud 16: 57.6 kBaud Bit 8, 9: # stop bits 1: 2 stop bits 3: 1 stop bit Bit 10, 11: parity bits 0: none 1: odd 2: even (without parity, 2 stop bits; with parity, 1 stop bit)	R/O, ROM	0	-
0X0004	SW- configurable station address	1	1 … 240	R/W, ROM	0	1
0X0008	Pause time for answer	1	0 … 65535 time in 0.1 ms	R/W, ROM	0	0

Reg. adr. hex.	Variable	Max. length [Reg.]	Value range	Type: R/O, R/W, ROM, RAM	PW Level	Factory setting, comment
0X004A	Configuration: AutoSend transfer type	1	LSByte: 0: No autosend 1: Autosend with data format number of bytes, user data bytes and 8-bit checksum (automatic scanning) 3: Autosend with data format as with Modbus 4: Triggered scanning with trigger with data format as with Modbus Bit 7 = 1: data connected until transmitted MSByte: Without trigger: Autosend rate in scans of the longest light strip (1-255) With trigger: 0: Data transmission is initiated by the trigger signal 1: Data transmission is initiated by the trigger signal upon conclusion of a complete scan of the longest light strip	R/W, ROM	0	Autosend with data format as with Modbus Autosend-rate 1

Reg. adr. hex.	Variable	Max. length [Reg.]	Value range	Type: R/O, R/W, ROM, RAM	PW Level	Factory setting, comment
0X004B	Configuration: AutoSend data	30	H‘0000‘: end of the valid configuration Bit 0 … 7: coded as number 1: individual beam data, 8 beams per byte 2: TU 3: HU 4: ZU 5: TNU 6: HNU 7: ZNU 8: TU_{Min} 9: HU_{Min} 10: ZU_{Min} 11: TNU_{Min} 12: HNU_{Min} 13: ZNU_{Min} 14: TU_{Max} 15: HU_{Max} 16: ZU_{Max} 17: TNU_{Max} 18: HNU_{Max} 19: ZNU_{Max} 20: status word Bit 8 … 11: #data source, 000=base device	R/W, ROM	0	TU (1) HU (1) ZU (1) TNU (1) HNU (1) ZNU (1) status word (1)

Reg. adr. hex.	Variable	Max. length [Reg.]	Value range	Type: R/O, R/W, ROM, RAM	PW Level	Factory setting, comment
0X007E	AutoSend byte format	1	Bit 0 … 7: data rate 12: 4.8 kBaud 13: 9.6 kBaud 14: 19.2 kBaud 15: 38.4 kBaud 16: 57.6 kBaud Bit 8, 9: # stop bits 1: 2 stop bits 3: 1 stop bit Bit 10, 11: parity bits 0: none 1: odd 2: even (without parity, 2 stop bits; with parity, 1 stop bit)	R/W, ROM	0	38.4 kBaud no parity 2 stop bits
0X0084	Control word	1	1: Store ComUnit configuration in EEPROM 2: Start autosend (only if without trigger) 4: Conclude configuration 5: Configuration with autosend baud rate	W/O	0	-
0X0085	Autosend datablock read register	1	The autosend data block is read out (1 … 240 bytes)	R/O	0	-