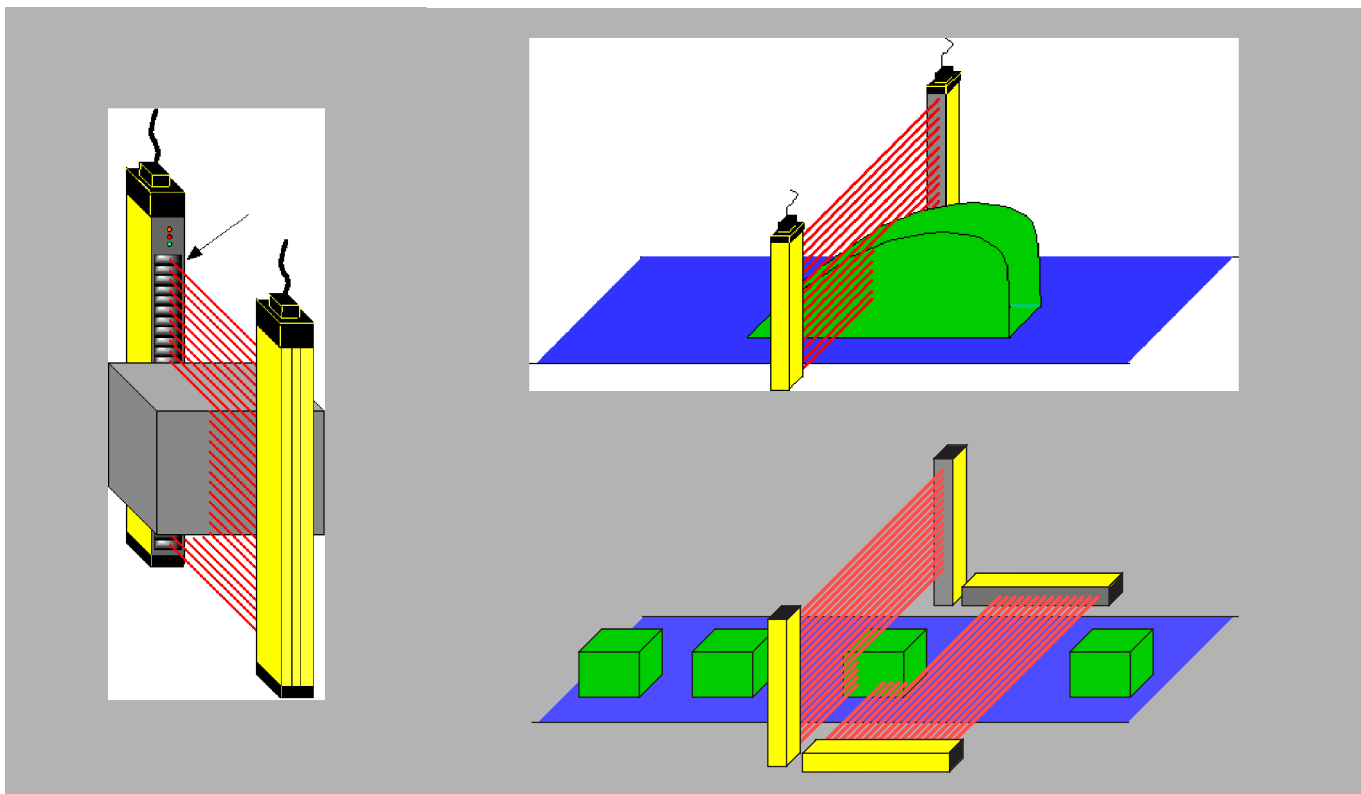


Scanning Light Curtain

MLVT



beam spacings 7,5 mm and 14 mm

scanning field up to 1,9 m x 20 m

constructional lengths in steps of 100 mm

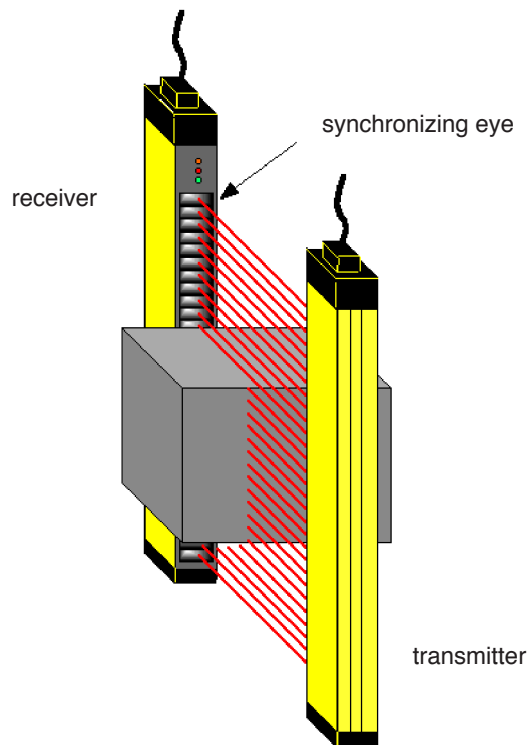
high speed scanning, reaction time from 1,2 ms, depending from constructional lengths

serial communications interface - SPS or IPC

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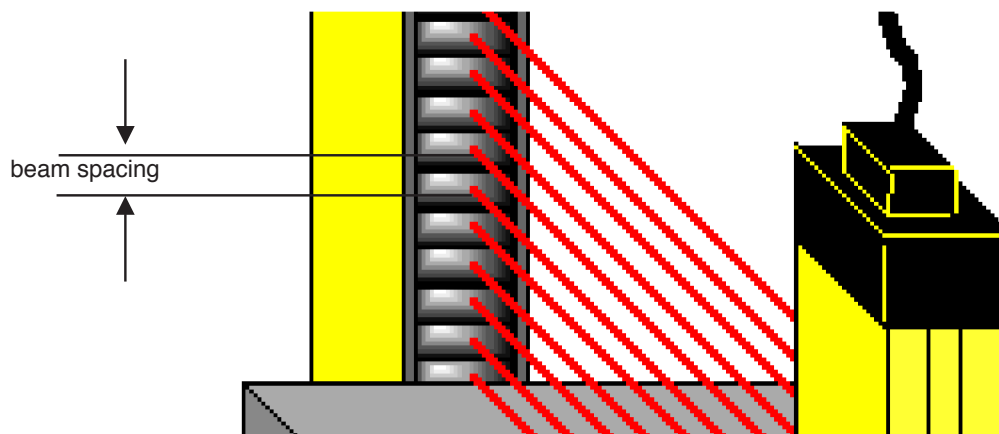
1. Function Principle

The transmitter generates infrared light beams that are permanently flashing at high speed. The parallel light beams (beam spacing 7,5mm or 14 mm) are evaluated in the receiver in synchronous action with the transmitter. This evaluation of the beams is carried out by photo diodes, in the following referred to as "elements" or "eyes". The receiver is optically synchronized to the transmitter by means of a so-called synchronizing eye, which is located within the scanning field on the plug end of the units (see drawing). This synchronizing eye must remain uncovered during the whole scanning procedure. The eyes are checked one after the other, whether all beams are free of whether they are interrupted by an obstacle. During this checking, a monitoring of the current status of all eyes is carried out. The obtained data are ready to be retrieved via the serial interface. The presence on any obstacle within the scanning field will activate both receiver outputs.



2. Areas of Application

The scanning light curtain MLVT scans and measures non-transparent objects that are placed within the scanning field. Due to the parallel scanning method, there is no geometric error of measurement like it occurs when, during the mensuration procedure, a camera is used for scanning. With a beam spacing (see below) of 7,5mm /14 mm and a scanning field height of up to 1,9m x 20m, this light curtain can be used very flexibly for various applications. The MLVT provides 5 different operating modes (numbers of covered eyes, first (topmost) covered eye, lowest (bottom) covered eye, first free eye, status of all eyes as reference bit pattern). The obtained data are produced via an RS 485 interface on demand or by permanent data output. A detailed description of the different operating modes is provided in section 5.



3. Features

3.1 Operational Data

The scanning light curtains MLVT are characterized by the following features:

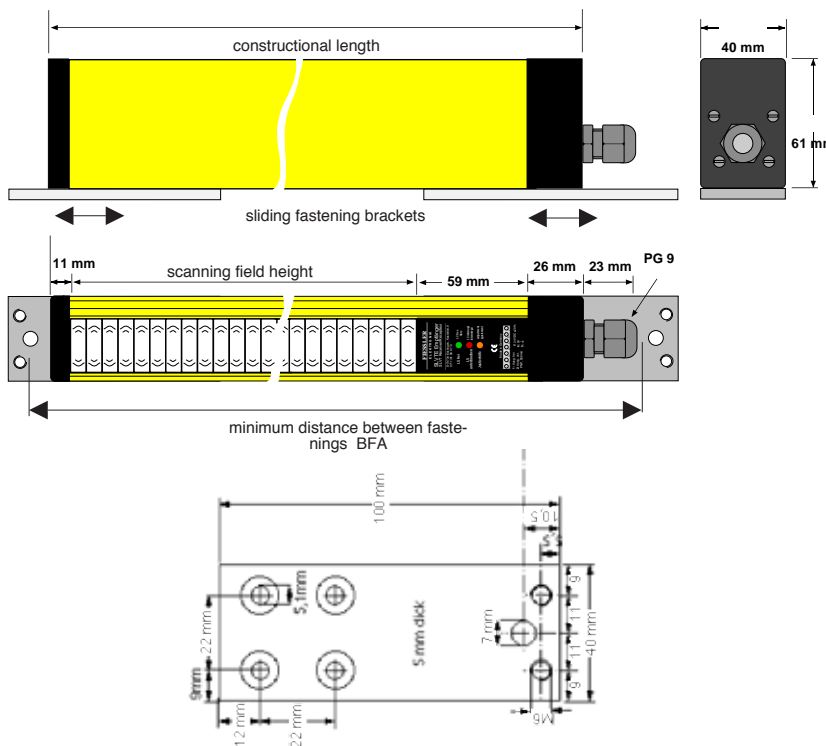
- beam spacing only 7,5mm (0,29 in.)
- short response times from 1,0ms up to 10,3ms, depending on their respective constructional lengths
- scanning field heights from 100 up to 1900 mm in steps of 100 mm available
- small guards/valves directly connectable to 2 short-circuit safe, non-equivalent semiconductor outputs PNP (connecting capacity 0,5A/24V)
- protective sytem IP 65
- 7m scanning range with beam spacing 7,5 mm
- 24m scanning range with beam spacing 14 mm
- serial interface (RS 485) for IPC or SPS, interface converter available as option

3.2 Physical Dimensions

MLVT housings (transmitter and receiver)

Aluminium profile, plastic coated RAL 1020 yellow, end pieces made from non-corrosive, spherically reinforced plastic (polyamide). Plexiglass light outlet and inlet, optionally available with solvet-resistant silicate glass windows.

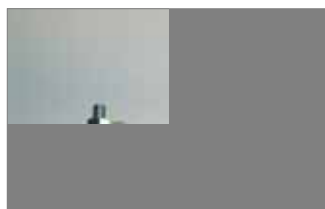
The required scanning field heights can be looked up in table in section 3.3.



| scanning field height (mm) | constructional length (mm) | Minimum ndstance between fastenings BFA (mm) |
|----------------------------|----------------------------|--|
| 100 | 196 | 226 |
| 200 | 296 | 336 |
| 300 | 396 | 436 |
| 400 | 496 | 536 |
| 500 | 596 | 636 |
| 600 | 696 | 736 |
| 700 | 796 | 836 |
| 800 | 896 | 936 |
| 900 | 996 | 1036 |
| 1000 | 1096 | 1136 |
| 1100 | 1196 | 1236 |
| 1200 | 1296 | 1336 |
| 1300 | 1396 | 1436 |
| 1400 | 1496 | 1536 |
| 1500 | 1596 | 1636 |
| 1600 | 1696 | 1736 |
| 1700 | 1796 | 1836 |
| 1800 | 1896 | 1936 |
| 1900 | 1996 | 2036 |

Insulating Brackets

Insulating plastic layers and rings provided as additional insets to be mounted at the receiver brackets. These enhance the electromagnetic compatibility of the MLVT when it is used in an area where electromagnetic interferences may occur.



3.3 Scanning Area dimensions, Resolution, Order Codes

| scanning field height (mm) | constr. length (mm) | resolution 14 mm | | | resolution 30 mm | | |
|----------------------------|---------------------|----------------------|---|---|------------------------|---|---|
| | | order code range 7 m | * response time of switching outputs ("worst Case") in ms | ** availability of obtained data ("worst Case") in ms | order codes range 24 m | * response time of switching outputs (worst Case) in ms | ** availability of obtained data (worst Case) in ms |
| 100 | 196 | MLVT100 / 13 | 1,2 | 2,4 | MLVT100 / 7 | 0,9 | 2,0 |
| 200 | 296 | MLVT200 / 26 | 1,7 | 3,4 | MLVT200 / 14 | 1,2 | 2,4 |
| 300 | 396 | MLVT300 / 39 | 2,2 | 4,4 | MLVT300 / 21 | 1,5 | 3,0 |
| 400 | 496 | MLVT400 / 52 | 2,7 | 5,4 | MLVT400 / 28 | 1,8 | 3,6 |
| 500 | 596 | MLVT500 / 65 | 3,2 | 6,4 | MLVT500 / 35 | 2,0 | 4,0 |
| 600 | 696 | MLVT600 / 78 | 3,7 | 7,4 | MLVT600 / 42 | 2,3 | 4,6 |
| 700 | 796 | MLVT700 / 91 | 4,2 | 8,4 | MLVT700 / 49 | 2,5 | 5,0 |
| 800 | 896 | MLVT800 / 104 | 4,7 | 9,4 | MLVT800 / 56 | 2,9 | 5,8 |
| 900 | 996 | MLVT900 / 117 | 5,2 | 10,4 | MLVT900 / 63 | 3,1 | 6,2 |
| 1000 | 1096 | MLVT1000 / 130 | 5,7 | 11,4 | MLVT1000 / 70 | 3,4 | 6,8 |
| 1100 | 1196 | MLVT1100 / 143 | 6,2 | 12,4 | MLVT1100 / 77 | 3,7 | 7,4 |
| 1200 | 1296 | MLVT1200 / 156 | 6,8 | 13,6 | MLVT1200 / 84 | 3,9 | 7,8 |
| 1300 | 1396 | MLVT1300 / 169 | 7,3 | 14,6 | MLVT1300 / 91 | 4,2 | 8,4 |
| 1400 | 1496 | MLVT1400 / 182 | 7,8 | 15,6 | MLVT1400 / 98 | 4,5 | 9,0 |
| 1500 | 1596 | MLVT1500 / 195 | 8,3 | 16,6 | MLVT1500 / 105 | 4,8 | 9,6 |
| 1600 | 1696 | MLVT1600 / 208 | 8,8 | 17,6 | MLVT1600 / 112 | 5,0 | 10,0 |
| 1700 | 1796 | MLVT1700 / 221 | 9,3 | 18,6 | MLVT1700 / 119 | 5,3 | 10,6 |
| 1800 | 1896 | MLVT1800 / 234 | 9,8 | 19,6 | MLVT1800 / 126 | 5,3 | 11,2 |
| 1900 | 1996 | MLVT1900 / 247 | 10,3 | 20,6 | MLVT1900 / 133 | 5,9 | 11,8 |

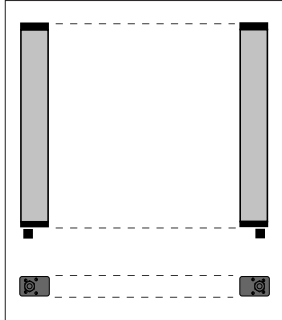
* maximum capture and response time = minimum sojourn time of the object in the scanning field until reaction of light curtain outputs.

** maximum response time from alteration of scanning field until data output

4. Commissioning

4.3 Mounting of transmitter and receiver

When installing the transmitter and receiver of the MLVT, it must be ensured that the connectors of both devices are located at the same side. Transmitter and receiver must be installed with **parallel** faces.

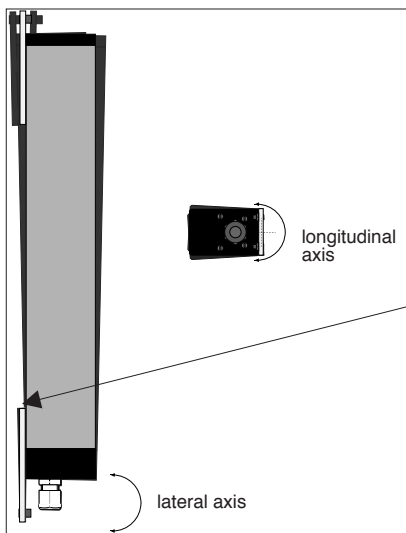


installation with parallel faces

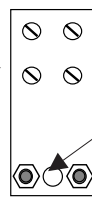
Important: In order to ensure an error-free operation, both the transmitter and the receiver devices must be attached to stable, distortion-free and face-parallel constructions. Install the fastening brackets in a way that the adjusting screws remain easily accessible.



Make sure that the shape of the housing profile is not distorted. Otherwise a perfect optical adjustment will not be possible. Adjust one fastening bracket whilst the adjusting screws on the other fastening bracket are loose. The synchronizing eye must remain free in all cases.



Swivelling along the longitudinal and lateral axis



drill hole \varnothing 7 mm for attachment of light curtain

adjustment screws with counter nuts for swivelling along longitudinal and lateral axis

Attachment and adjustment

The supplied fastening brackets serve for the attachment and the adjustment of the light barrier. Together with the shifting tenon blocks, the brackets enable a multi-functional attachment.

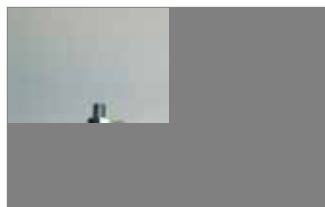
To swivel along the longitudinal axis, turn the respective adjusting screw on one of the fastening brackets whilst both screws on the other fastening bracket are loose. To swivel along the lateral axis, turn both screws of one fastening bracket at the same time whilst both screws on the other fastening bracket are loose.

Rubber-metal connection

In the event of intense vibrations, please use rubber-metal connections which can be obtained as optional accessories.

Insulating layers

Insulating plastic layers and rings provided as additional insets to be mounted at the receiver brackets. These enhance the electromagnetic compatibility of the MLVT when it is used in an area where electromagnetic interferences may occur.

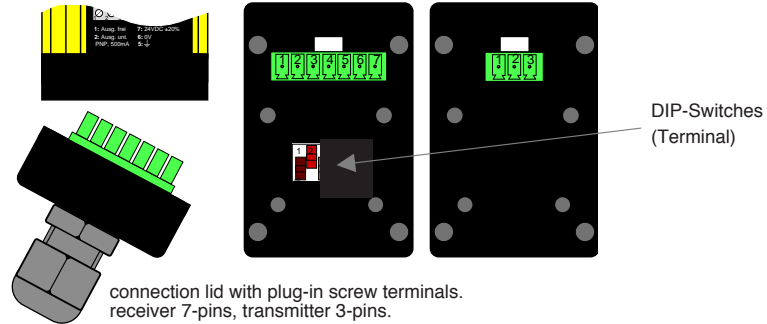


4. Commissioning

4.2 Connectors

The product standard of the series MLVT includes an extra flat plug-in connector that is located in the connection lid. Its cover may be removed without cutting the connection cable plug. The housing itself remains tightly closed. As option, several standard connection plugs are available.

The transmitter is connected via one 3-pin cable and the receiver via one 7-pin cable.



4.3 Pin configuration

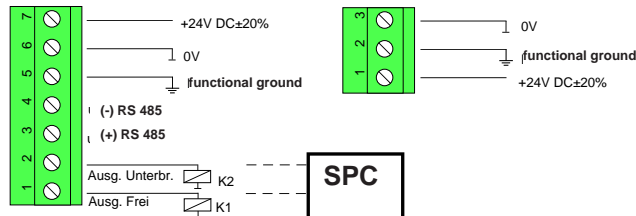
The connection is carried out according to the following diagram. The non-equivalent PNP-ports are short-circuit-safe and can be connected independently from each other.

The switching capacity of 0,5A/24V permits the direct connection of small guards, relays or SPC.

If the scanning field is free, the PNP port "free" (connection 1) is conducting and the PNP port "interrupted" (connection 2) is not conducting.

If the scanning field is interrupted, the PNP port "interrupted" is conducting and the PNP port "free" is not conducting.

Serial port RS485: 2-core cable simplex connection. Connection 3 is B (+), connection 4 is A (-).



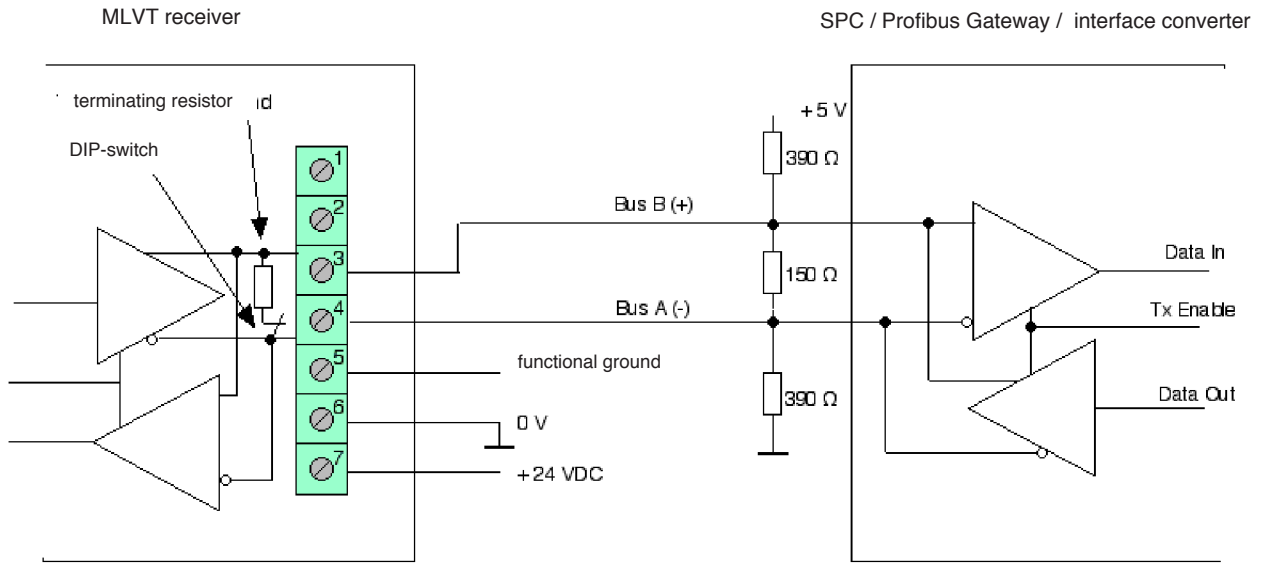
Caution!

Ports 3 and 4 are no fail-safe outputs.

4.4.1 MLVT as single system

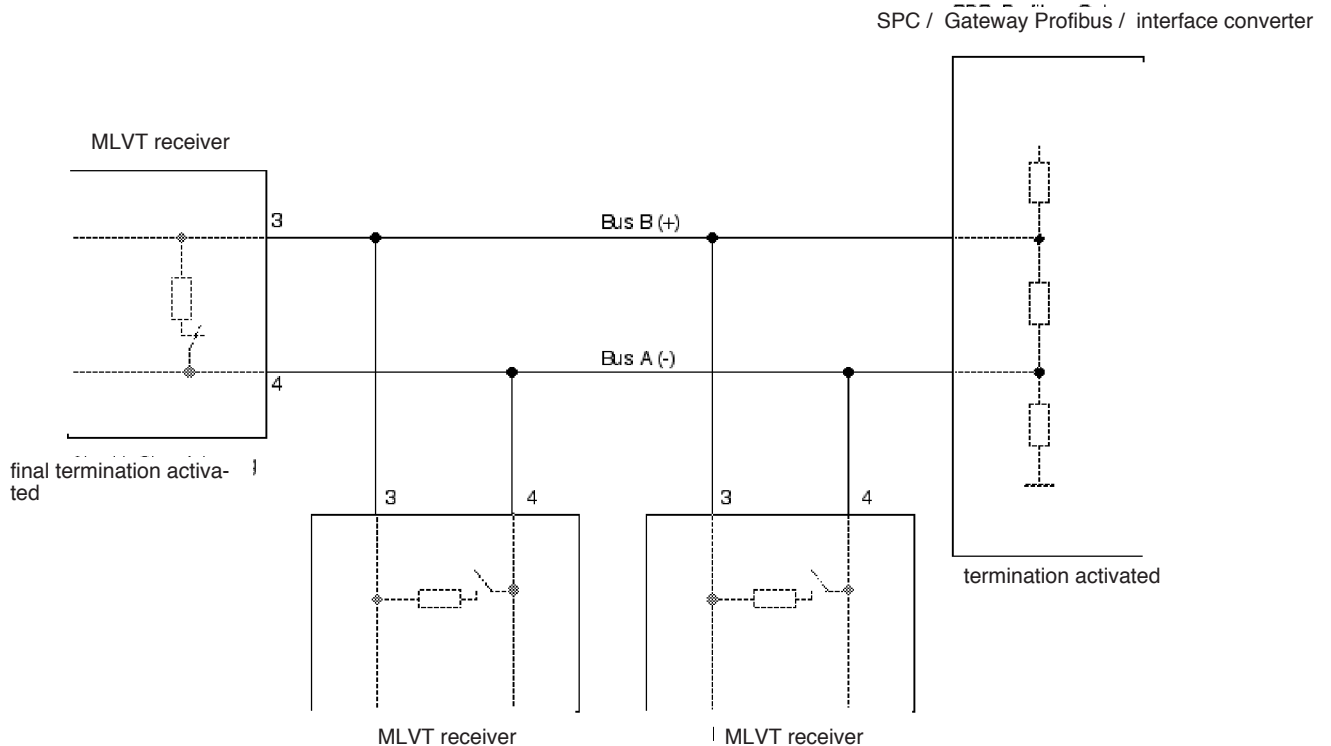
Our connection example shows one MLVT receiver connected either to an SPC, or to a profibus gateway, or to an interface converter. A termination (see section 8.1.3) is urgently required when using the RS485 connection. The MLVT (receiver) therefore disposes of a terminating resistor (150 Ohms) which can be activated by the corresponding setting of a DIP-switch (see section 4.2).

At the other side of the MLVT, where the SPC, the "Profibus Gateway" or the interface converter are connected, there is another terminating network that can be hooked up. If not, an external network (see below) must be elaborated.



4.4.2 Several MLVTs in a network

Another example shows several MLVTs connected to an SPC, to a Gateway profibus, or to an interface converter. In this case, a termination is required only for the physically first and last device.



4. Commissioning

4.5 Function Test

For the initial commissioning it is sufficient to provide a voltage of 24V DC +/-20% for both transmitter and receiver.

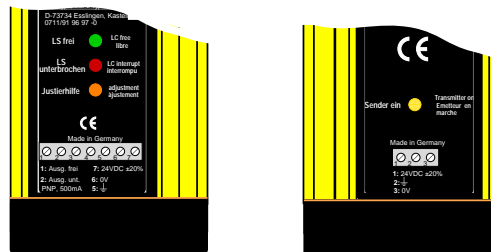
If the adjustment procedure has been carried out correctly (see section 4.1), the green LED at the receiver and the orange-coloured LCD at the transmitter light up if the scanning field is free.

In case of slight de-adjustment of both devices, the orange-coloured LED at the receiver will light up additionally (adjustment LED). In order to dispose of a certain light reserve, (the presence of dirt on the plexiglass windows may lead to a certain weakening of the scanning signal) it is in any case imperative to adjust the devices in a way that the orange LED at the receiver will extinguish and only the green LED lights up.

If the adjustment of the devices is carried out correctly, only the green LED on the receiver will light up if the scanning field is free.

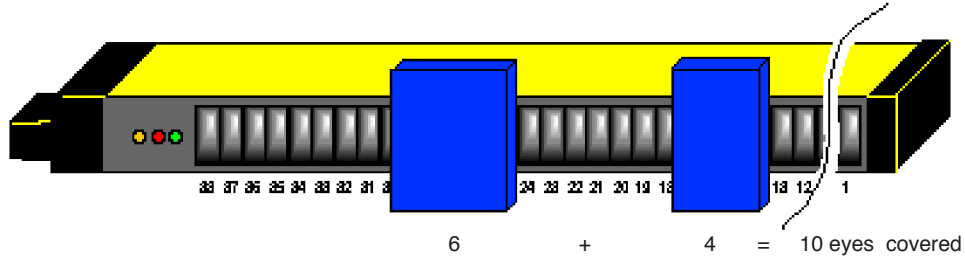
If the scanning field is interrupted, the orange-coloured LED will light up together with the red LED.

If the orange-coloured LED and the red LED of the receiver device are lit, even if the scanning field is free, check if the adjustment of both devices is carried out correctly (see section 4.1).

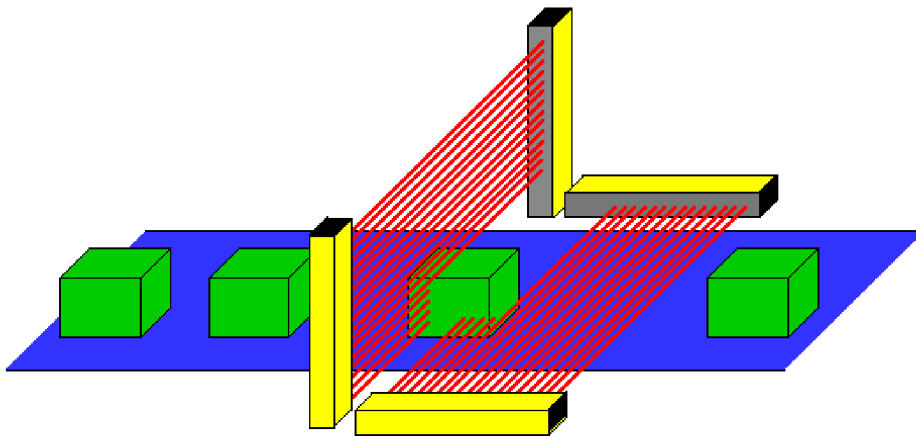


5.1 operating mode „number of covered eyes“

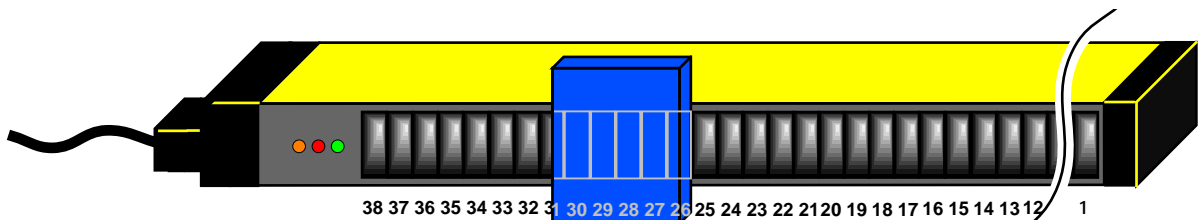
All covered receiver elements (=eyes) are counted and added, regardless of the number of objects placed into the scanning field or their positions within the field. Our example shows two objects placed in the scanning field, covering a total of 10 eyes.



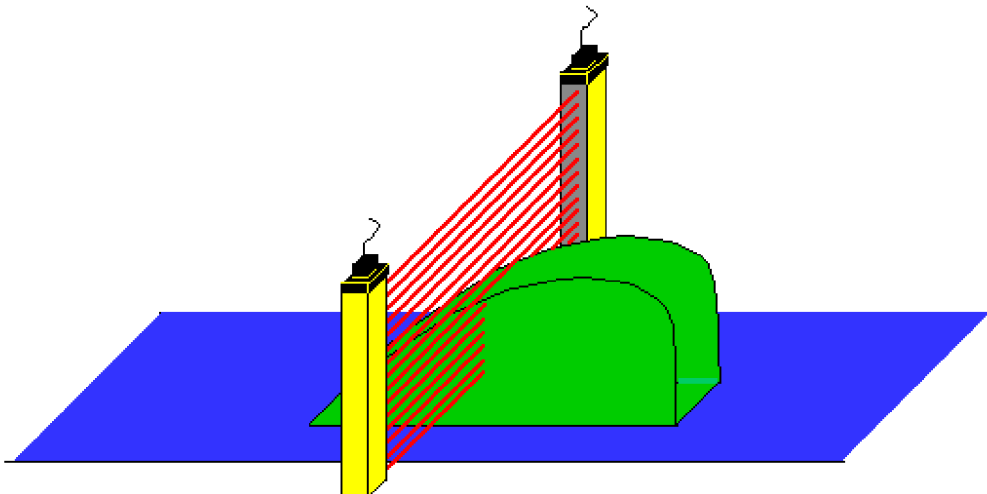
Select this operating mode for e.g. the mensuration of the dimensions of an object. Combined to a second MLVT, even two-dimensional measurements are possible.



5.2 operating mode „topmost eye covered“



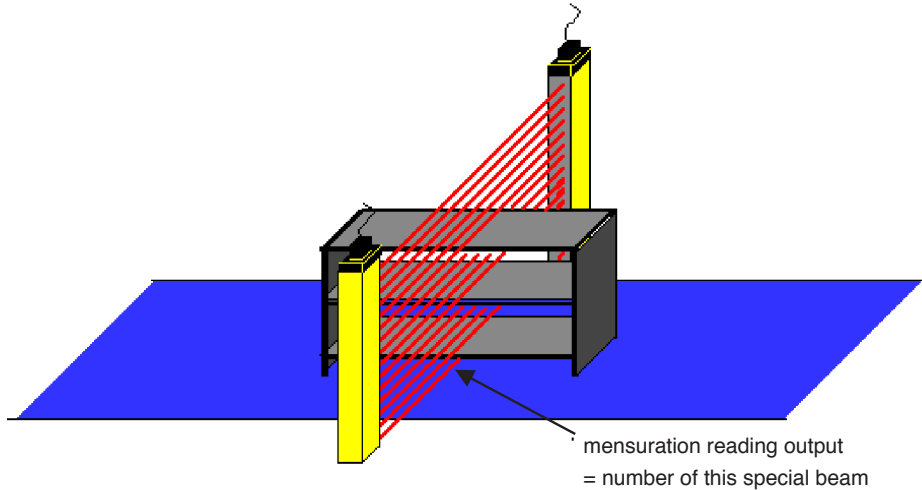
This mode displays only the position of the topmost covered eye. (the highest of all numbers of the covered eyes). The numbering of the eyes starts at the end of the unit that has no plug. The example shows: obtained mensuration reading: 30.



This mode is selected for special applications during levelling or contour scans.

5.3 operating mode „lowest (bottom) covered eye“

This mode displays only the position of the lowest covered eye. (smallest of all numbers of the covered eyes).

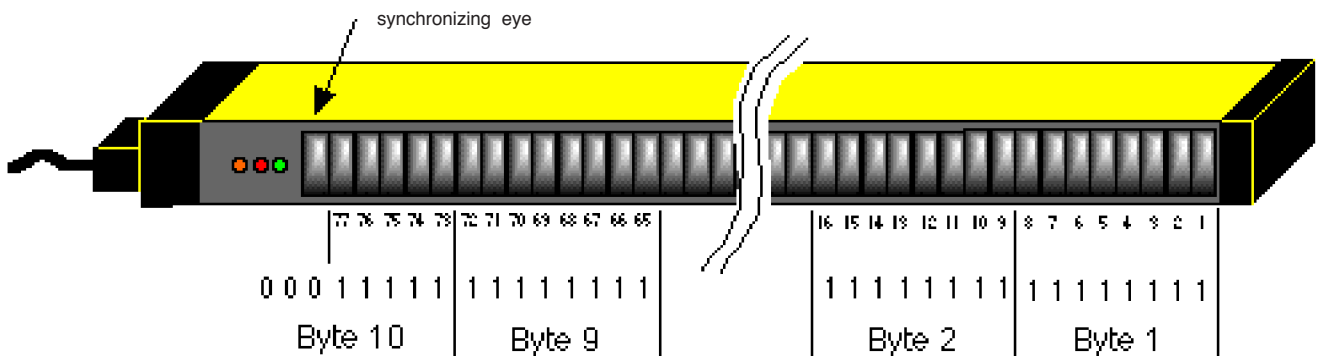


5.4 operating mode „status of all eyes as reference bit pattern“

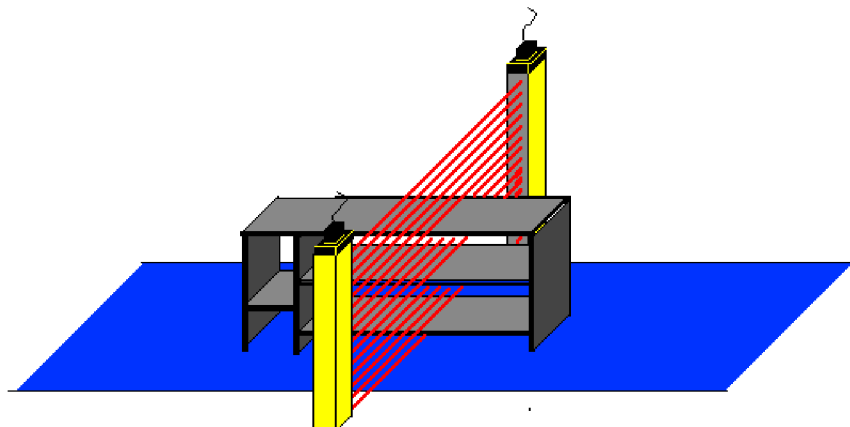
This mode displays the conditions of all eyes along with their respective positions. Depending on the length of the light barrier, more than one byte can be obtained as a result. One after the other, the obtained results are transmitted byte per byte as bit patterns. One free eye signifies: binary "1", a covered eye is a binary "0".

The first byte displays the position of the lowest (first) 8 eyes. The lowest bit position in the byte corresponds to the first eye. The second byte represents the positions of the next 8 eyes, i.e. eyes number 9 through 16, and so on. If, for the representation of the last eyes, no complete byte is needed, the remaining bits are addressed as "0".

Example: MLVT receiver 600/78

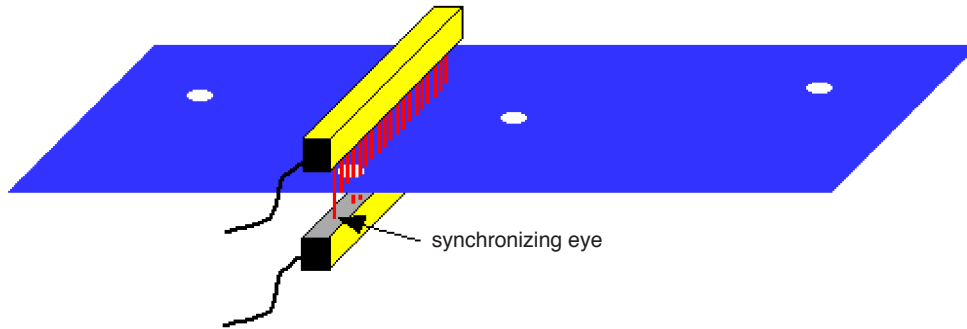


As a practicable application, the scanning of a grid-shaped object is possible.



5.5 operating mode „first free eye“

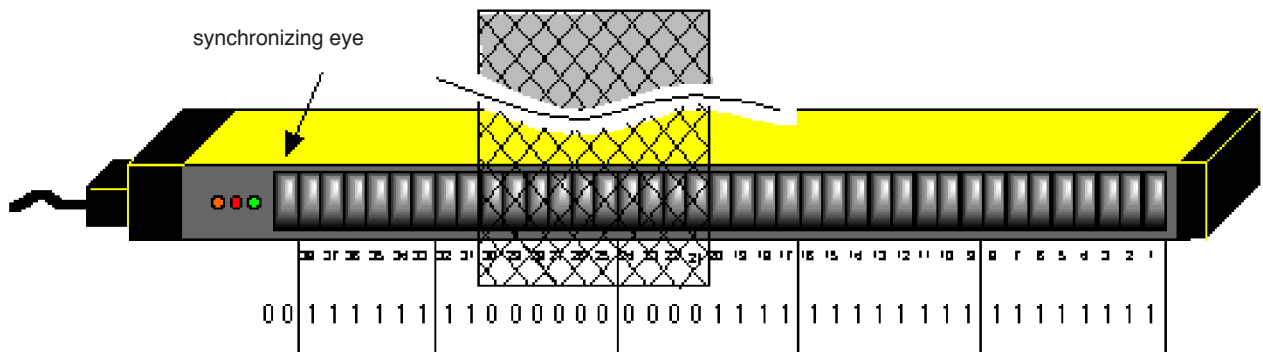
This operating mode monitors the position of the first free eye. The measurement starts at the end of the unit that has no electrical connector. The example shows the utilization of the MLVT as hole detecting device. During this application it must be observed that the synchronizing eye (the one closest to the plug) must remain free at all times.



5.6 Example for readings output

The following example shows an MLVT 300 light barrier with an object placed into the scanning field. The following measurement readings are obtained:

| | |
|-----------------------------|---|
| covered number of eyes | = 10d (d = decimal code) |
| topmost covered eye | = 30d |
| lowest covered eye | = 21d |
| first free (=uncovered) eye | = 1d |
| all eyes | = 00111111b (b = binary code), 11000000b, 00001111b, 11111111b, 11111111b |

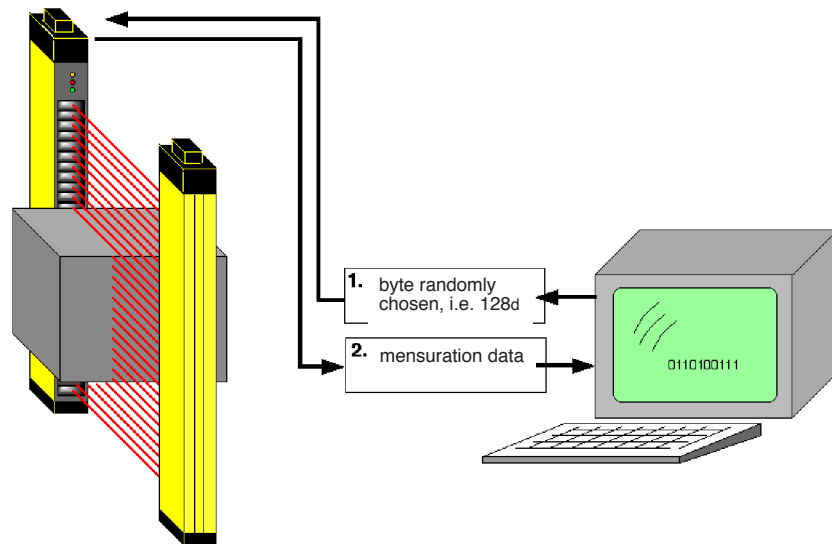


6. Different ways of Data Output (Communication)

The MLVT produces the obtained mensuration readings via a serial interface (RS 485). As option, these light curtains can be connected via an external converter to a serial RS 232 interface, or to a profibus-DP fieldbus. The user may choose from different operating and scanning modes, e.g. permanent output (polling mode) or data output via PC or SPC using one byte as requisition byte. For these modes, there is no need for a special protocol to be elaborated. The transmission parameters are: 9600, N, 8, 1 (Baud, No Parity, Data bits, Stop bit).

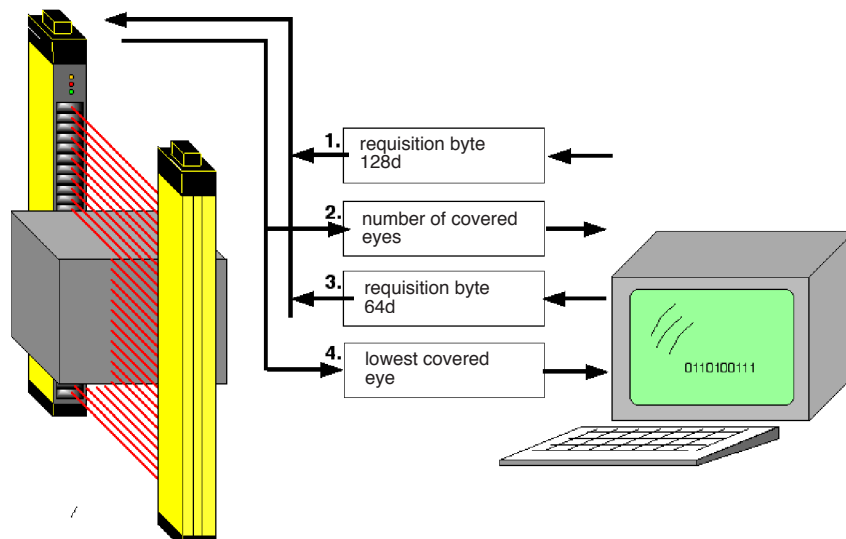
6.1 Determined data output by using random requisition byte

If there is no fixed value (byte) for the data transfer, this operating mode provides a special possibility for data output using a randomly chosen requisition byte. Our example shows the operating mode "number of covered eyes".



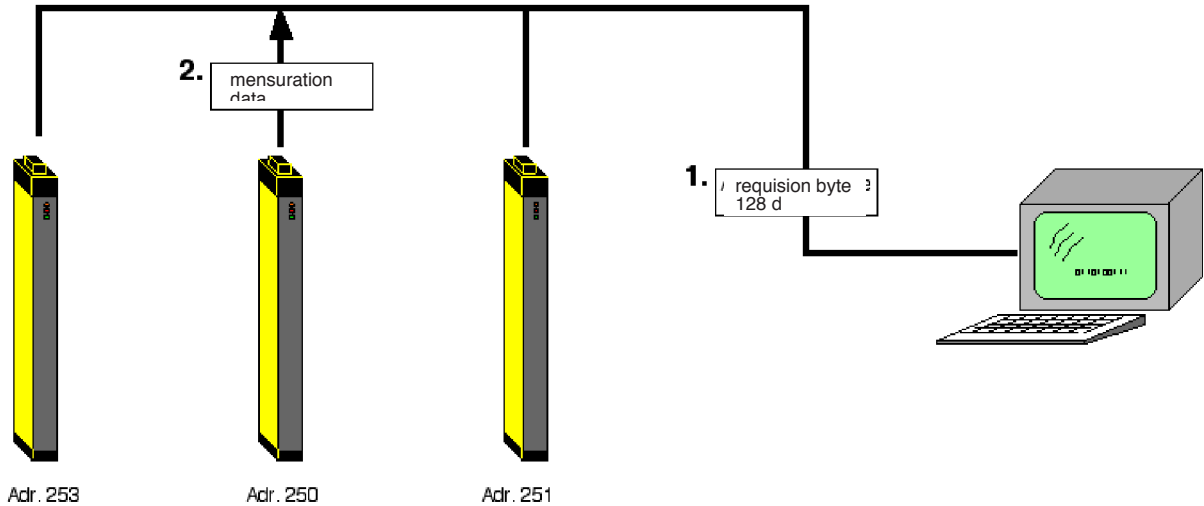
6.2 data output on demand according to individual requisition bytes

If different mensuration procedures are carried out by the MLVT, this mode provides the possibility to display the obtained data of the various mensurations according to their individual requisition bytes.



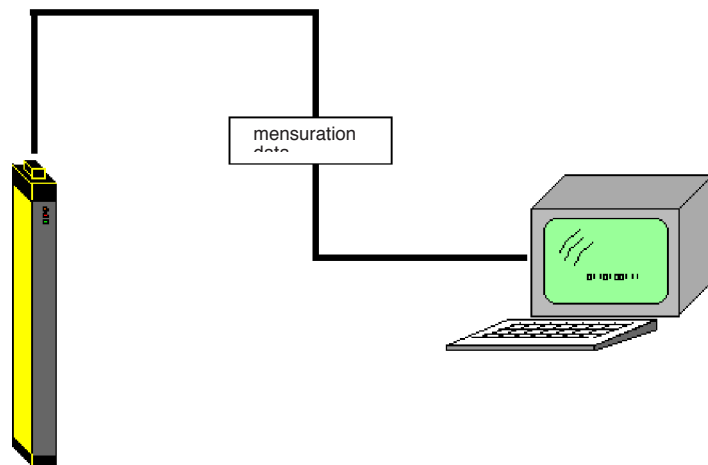
6.3 Determined data output by using pre-defined requisition byte

The RS485 interface is laid out as a bi-directional bus-system for up to 32 extensions. The user may apply up to 6 different addresses in order to directly actuate the MLVT units. Here, however, the operating mode "Status of all elements as reference bit pattern" is not available.



6.4 Permanent data output (polling)

This operating mode enables permanent data output without the use of any requisition byte. Here, however, the operating mode "Status of all elements as reference bit pattern" is not available.



7. Programming

By using the different programming possibilities, the user may choose from 5 different modes of mensuration data coverage (operating modes) and 4 output modes, which will remain stored even after a power failure. Usually, the programming of the MLVT units is carried out during their manufacturing process according to the customer's directions. Programming, however, may be altered by the customer anytime.

7.1 Preparation

Any re-programming can be carried out by using a PC, with a serial terminal software and an interface converter (RS 232 <-> RS 485), which enables a data link between the COM-Port of the PC and the RS 485 output of the MLVT.

Re-programming can also be carried out anytime via an IPC, an SPC etc.

Depending on the data output mode carried out previously, the light curtain can be programmed either during operation (mode: "data output on requisition") or after having carried out a re-start procedure (during operating mode "permanent data output").

7.2 Short description of re-programming

First of all, the MLVT requires the entry of the password as a 4-digit byte sequence (109d,108d,118d,116d). This can be carried out during the regular operation of the MLVT. However, if the light curtain has been previously set on "permanent data output" mode, " this can only be achieved after a voltage reset (short interruption of the power supply of the MLVT).

The time period between entering the bytes, i.e. until entering the first byte, must never exceed 2,5 seconds. To terminate the programming, look up the terminating byte in the center column of the table shown below and enter it into the MLVT. If the entry procedure is carried out faulty or if the maximum allowable time period of 2,5 s is exceeded, the light curtain will automatically return to the previously programmed data output mode. Then the programming procedure must be repeated.

| Output possibilities of mensuration data | The following 4 bytes are transmitted to the MLVT, the fifth byte (closing byte) taken from the data in this column defines the data output mode and terminates the re-programming procedure. 109,108,118,116, ... | | | | | requisition byte for mensuration data output |
|--|--|--|--|-----------------------------------|---|--|
| | total number of covered eyes (decimal value) | topmost covered eye (decimal value) | lowest (bottom) covered eye (decimal value) | first free eye (decimal value) | status of all free eyes as bit pattern(decimal value) | |
| defined mensuration output by randomly chosen requisition byte | 128 | 32 | 64 | 50 | 96 | any byte (any character) |
| mensuration data output : according to the requisition byte | 16 | - | - | - | - | 128 |
| | - | 16 | - | - | - | 32 |
| | - | - | 16 | - | - | 64 |
| | - | - | - | 16 | - | 50 |
| | - | - | - | - | 16 | 96 |
| determined mensuration output by pre-defined requisition byte (address byte) | 12 | 17 | 22 | 51 | - | 248 |
| | 13 | 18 | 23 | 52 | - | 249 |
| | 4 | 36 | 68 | 53 | - | 250 |
| | 133 | 37 | 69 | 54 | - | 251 |
| | 6 | 38 | 70 | 55 | - | 252 |
| | 7 | 39 | 71 | 56 | - | 253 |
| permanent data output without requisition byte | 8 | 40 | 72 | 57 | - | - |

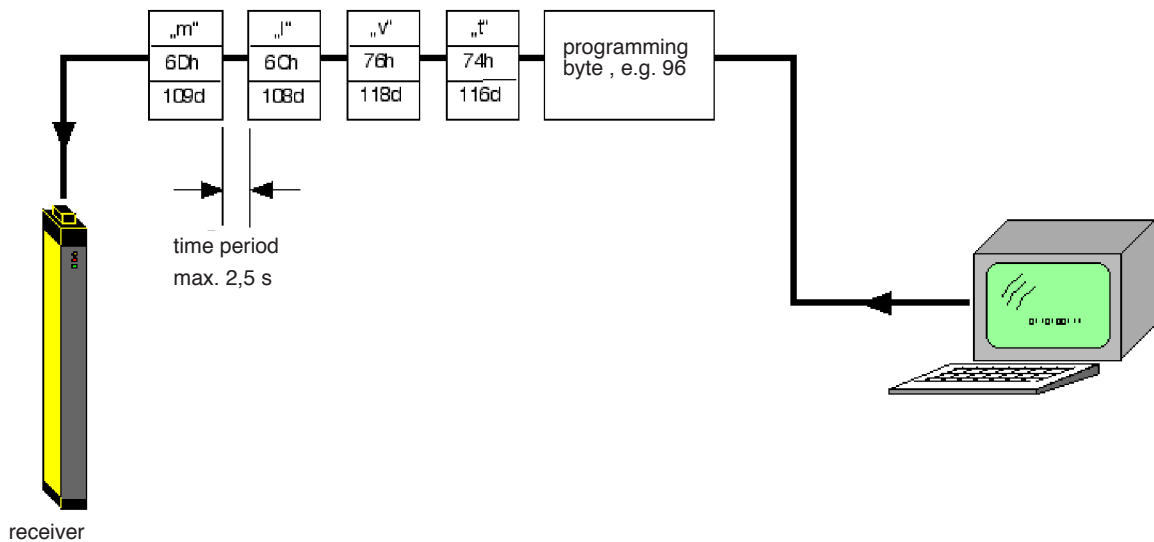
7.3 Detailed description: re-programming

Basic requirement is the presence of a communication link (as described in chapter 4.1). The MLVT program is pre-set on the mensuration data output mode "topmost covered eye, permanent data output". The RS 485 interface at the light curtain is laid out as a two-wire system, i.e. data input and data output (half-duplex) are carried out through the same line. Therefore, a re-programming during operation (under permanent data output) is not possible.

If a re-programming is needed, this can only be achieved after a voltage reset (short interruption of the power supply of the MLVT). After that, the interface will turn to "data input" for about 2,5 s. The re-programming byte sequence can be looked up in the center column of the tables shown in the following.

If, during the entry procedure the allowable time period of 2,5 s (before and between the bytes) is exceeded, or if a wrong byte is used, the light curtain will automatically return to the previously programmed data output mode. Then the programming procedure must be repeated.

If programming has been completed correctly, the mensuration data can be retrieved immediately by entering the corresponding requisition byte (see right column of the table), i.e. during permanent data output, the obtained mensuration data will be displayed continuously. Our example shows the MLVT programmed to a determined data output (status of all eyes as reference bit pattern) by a requisition byte randomly chosen.



7.3.1 determined data output by any requisition byte

This output mode requires a pre-selection of the mensuration data to be displayed and its programming. The left column of the table below provides a selection of possible mensuration data output possibilities. Every output pattern is related to a special byte sequence (center column). **One** of these sequences is selected and transmitted to the MLVT for programming it. After that, the mensuration data can be retrieved by entering any non-defined (randomly chosen) byte as requisition byte.

| available mensuration data output possibilities | required byte sequence for programming the desired operating mode into the MLVT (decimal values) | requisition byte for mensuration data retrieval |
|---|--|---|
| status of all eyes as reference bit pattern | 109 108 118 116 96 | |
| lowest (bottom) covered eye | 109 108 118 116 64 | |
| topmost covered eye | 109 108 118 116 32 | any byte |
| total number of covered eyes | 109 108 118 116 128 | |
| first free eye | 109 108 118 116 50 | |

7.3.2 Data output depending on requisition byte

This operating mode permits the retrieval of the four mensuration data by using the corresponding requisition byte. For this purpose, the byte sequence shown in the center column of the table mentioned below is transmitted to the MLVT. Afterwards, the mensuration data can be obtained by using their corresponding requisition byte (see right column).

| available mensuration data output possibilities | required byte sequence for programming the desired operating mode into the MLVT (decimal values) | requisition byte for mensuration data retrieval (decimal values) |
|---|---|---|
| status of all eyes as reference bit pattern | | 96 |
| lowest (bottom) covered eye | | 64 |
| topmost covered eye | 109 108 118 116 16 | 32 |
| total number of covered eyes | | 128 |
| first free eye | | 50 |

7.3.3 Permanent data output

This operating mode permits the permanent retrieval of the mensuration data without using any requisition byte. However, here the operating mode "status of all eyes as reference bit pattern" is not possible.

If a re-programming of the MLVT during selected operating mode "permanent data output" is needed, this can only be achieved after a voltage reset (short interruption of the power supply of the MLVT). In this case, the allowable time period of 2,5 s between the programming of the first 4 characters (bytes) must not exceed 2,5s.

If, during the entry procedure, the allowable time period of 2,5 s between the first 4 characters (bytes) for the programming is exceeded, or if a wrong byte is used, the light curtain will remain in the previously programmed data output mode and will return into operational readiness.

| available mensuration data output possibilities | required byte sequence for programming the desired operating mode into the MLVT (decimal values) | permanent data output without using any requisition byte |
|---|---|--|
| total number of covered eyes | 109 108 118 116 8 | - |
| topmost covered eye | 109 108 118 116 40 | - |
| lowest (bottom) covered eye | 109 108 118 116 72 | - |
| first free eye | 109 108 118 116 57 | - |
| status of all eyes as reference bit pattern | not available | - |

7.3.4 Determined data output by pre-defined requisition byte (address byte)

This operating mode is applied if the MLVT is operated in connection to a bus system with several extensions. Using this operating mode it must be made sure that every single MLVT at the same bus is programmed to a different address in order to avoid data collision! Due to this fact, only one single light curtain must be connected to the PC (IPC, SPC etc.) during the programming procedure for defining mensuration data output. The following table provides the available mensuration data output possibilities and their according byte sequences that are transferred to the MLVT.

After that, the light curtain can be addressed with the corresponding address, and data can be obtained.

Here, however, the operating mode "Status of all elements as reference bit pattern" is not available.

| available mensuration data output possibilities | required byte sequence for programming the MLVT to the desired operating mode (decimal values) | requisition byte (byte address) for mensuration data retrieval |
|---|--|--|
| total number of covered eyes | 109 108 118 116 12 | 248 |
| topmost covered eye | 109 108 118 116 17 | |
| lowest (bottom) covered eye | 109 108 118 116 22 | |
| first free eye | 109 108 118 116 51 | |
| total number of covered eyes | 109 108 118 116 13 | 249 |
| topmost covered eye | 109 108 118 116 18 | |
| lowest (bottom) covered eye | 109 108 118 116 23 | |
| first free eye | 109 108 118 116 52 | |
| total number of covered eyes | 109 108 118 116 4 | 250 |
| topmost covered eye | 109 108 118 116 36 | |
| lowest (bottom) covered eye | 109 108 118 116 68 | |
| first free eye | 109 108 118 116 53 | |
| total number of covered eyes | 109 108 118 116 133 | 251 |
| topmost covered eye | 109 108 118 116 37 | |
| lowest (bottom) covered eye | 109 108 118 116 69 | |
| first free eye | 109 108 118 116 54 | |
| total number of covered eyes | 109 108 118 116 6 | 252 |
| topmost covered eye | 109 108 118 116 38 | |
| lowest (bottom) covered eye | 109 108 118 116 70 | |
| first free eye | 109 108 118 116 55 | |
| total number of covered eyes | 109 108 118 116 7 | 253 |
| topmost covered eye | 109 108 118 116 39 | |
| lowest (bottom) covered eye | 109 108 118 116 71 | |
| first free eye | 109 108 118 116 56 | |

8.1 RS 485

8.1.1 Interface

The MLVT disposes of an RS 485 interface that enables an operation of the light barrier as a single system or within a bi-directional bus system with up to 32 extensions (6 MLVT units) in half duplex mode.

The serial data are transmitted in the form of voltage difference without ground relation via an inverted line (designated as "A" or "-") and a non-inverted line (designated as "B" or "+"). Between the two RS 485 outputs, an output level of +/- 2V is provided for the transmitter. On the receiver, levels of +/- 200mV are still detected as valid signal. Due to the symmetrical transfer procedure, combined with a twisted pair cable, reliable linkages covering distances of up to 500 metres at high transmission speed are possible.

8.1.2 Bus system

As more than one transmitter are connected to one common line, only one data transmitter is activated at a time. This must be made sure by using a protocol. All other transmitters must remain inactive, this is realized by applying high-ohmic resistances. Single-line input bus systems always permit only half-duplex traffic, i.e. only one extension is allowed to transmit data. Only if the transmission procedure is completed, other extensions may resume transmitting.

For data retrieval, 6 addresses are provided (248,249,250,251,252,253) for the MLVT. In order to avoid any unwanted data collision, it must be made sure that every single address is assigned to only one MLVT only once, i.e. that no output data value will correspond to that value.

The RS 485-standard defines only the electrical specifications, but not the transfer protocol. The MLVT uses the widely circulated RS232 interface protocol with the parameters 9600, N, 8, 1.

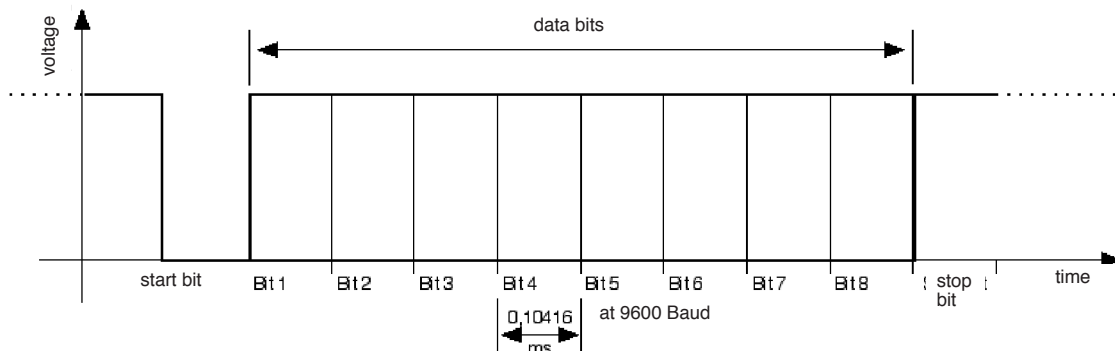
8.1.3 Termination

The 2-cored RS 485 bus systems require the termination of the connection by using a terminating network which ensures a defined state of rest during the high-ohmic phases of the bus operation. A terminating resistor (150 Ohms) will provide a sufficient termination for the RS 485 drivers. The cables should be laid out according to this resistor characteristics, i.e. they should have an impedance of 150 Ohms or higher.

The MLVT (receiver) disposes of a DIP-switch (switch 1 set to ON) at the connector end. By using this switch, the termination at 150 Ohms can be carried out.

8.2 RS 232 Protocol

The following diagram shows the progress of the signal for a data transfer at 9600 baud, 8 data bits, no parity bit, 1 stop bit.



For the RS 232 protocol, only two states (low and high) apply. During the rest position, the line is high. The transmission start is indicated by the declining curve at the start bit. Then follow 8 data bits. The end of every transmission is indicated by a stop bit (always high). After each stop bit, the next start bit may follow immediately. At a transmission rate of 9600 baud, every single bit will take 0,104166666ms, a complete data package will therefore need 1,04166666ms.

9. Cleaning

In order to ensure an error-free operation of the MLVT (both receiver and transmitter), it is necessary to keep the front windows clean at all times. If both the orange-coloured LED and the green LED at the receiver light up at the same time, even if the light curtain is perfectly adjusted and the scanning field is free, this might be a sign for possible dirty front windows. For cleaning of the front windows we suggest the use of a mild cleanser. The plexiglass is impervious to diluted acids and alkaline solutions and provides limited chemical resistance against organic solvents.

10. Specification

| Characteristic data | MLVTS... / MLVTE... | |
|--------------------------------|--|---|
| scanning field height | 100 mm ... 1900 mm (according to number of beams) | |
| scanning field lengths (range) | 0,1... 7 m, at a resolution of 14 mm 0,1... 24 m, at a resolution of 30 mm | |
| construction lengths | 196 mm ... 1996 mm (according to number of beams) | |
| definition | smallest resolution 7,5 mm | |
| number of beams | 7... 247 beams | |
| reaction time/response time | max. detection and reaction time = Minimum sojourn time of the object in the scanning field until response of outputs. see table on page 5 | |
| Mechanical data | | |
| Housing design | aluminium profile, eloxal coated or yellow plastic coated RAL 1020, end pieces made of non-corrosive, spherically reinforced plastic (polyamide). Plexiglass light outlet and inlet, optional with solvent-resistant silicate glass. | |
| attachment | shifting fastening brackets on rear side of housing. | |
| weight | transmitter: 0,45 kg to 4,5 kg depending on construction length receiver: 0,5 kg to 5,0 kg depending on construction length | |
| Operating data | | |
| protection category | IP 65 | |
| protection class | III | |
| Operating ambient temperature | -10 to 55 °C | |
| Storage temperature | -25 to 70 °C | |
| Electrical data | Sender MLVTS | Empfänger MLVTE |
| power supply | 24 V DC ±20 % | 24 V DC ±20%, |
| current draw | max. 200 mA | max. 200 mA (no load) |
| outputs (receiver) | - | output FREE and output Interrupted : failsafe PNP-outputs, max. 0,5 A, RS-485 (+) and (-) |
| electric connection | integrated connector plug with PG9 as strain relief, alternatively conventional connector plug | integrated connector plug with PG9 as strain relief, alternatively conventional connector plug |
| connecting cable | 3-cored, max. 0,75 mm ² | 5-cored, max. 0,5 mm ² |

11.1 Conversion tables

| decimal (X10) | hexadecimal (X16) | binary code X2 | ASCII code | decimal (X10) | hexadecimal (X16) | binary code X2 | ASCII code |
|---------------|-------------------|----------------|------------|---------------|-------------------|----------------|------------|
| 000 | 00 | 0000 0000 | NULL | 064 | 40 | 0100 0000 | @ |
| 001 | 01 | 0000 0001 | ! | 065 | 41 | 0100 0001 | A |
| 002 | 02 | 0000 0010 | " | 066 | 42 | 0100 0010 | B |
| 003 | 03 | 0000 0011 | # | 067 | 43 | 0100 0011 | C |
| 004 | 04 | 0000 0100 | \$ | 068 | 44 | 0100 0100 | D |
| 005 | 05 | 0000 0101 | % | 069 | 45 | 0100 0101 | E |
| 006 | 06 | 0000 0110 | & | 070 | 46 | 0100 0110 | F |
| 007 | 07 | 0000 0111 | ' | 071 | 47 | 0100 0111 | G |
| 008 | 08 | 0000 1000 | (| 072 | 48 | 0100 1000 | H |
| 009 | 09 | 0000 1001 |) | 073 | 49 | 0100 1001 | I |
| 010 | 0A | 0000 1010 | * | 074 | 4A | 0100 1010 | J |
| 011 | 0B | 0000 1011 | + | 075 | 4B | 0100 1011 | K |
| 012 | 0C | 0000 1100 | , | 076 | 4C | 0100 1100 | L |
| 013 | 0D | 0000 1101 | - | 077 | 4D | 0100 1101 | M |
| 014 | 0E | 0000 1110 | . | 078 | 4E | 0100 1110 | N |
| 015 | 0F | 0000 1111 | / | 079 | 4F | 0100 1111 | O |
| 016 | 10 | 0001 0000 | 0 | 080 | 50 | 0101 0000 | P |
| 017 | 11 | 0001 0001 | 1 | 081 | 51 | 0101 0001 | Q |
| 018 | 12 | 0001 0010 | 2 | 082 | 52 | 0101 0010 | R |
| 019 | 13 | 0001 0011 | 3 | 083 | 53 | 0101 0011 | S |
| 020 | 14 | 0001 0100 | 4 | 084 | 54 | 0101 0100 | T |
| 021 | 15 | 0001 0101 | 5 | 085 | 55 | 0101 0101 | U |
| 022 | 16 | 0001 0110 | 6 | 086 | 56 | 0101 0110 | V |
| 023 | 17 | 0001 0111 | 7 | 087 | 57 | 0101 0111 | W |
| 024 | 18 | 0001 1000 | 8 | 088 | 58 | 0101 1000 | X |
| 025 | 19 | 0001 1001 | 9 | 089 | 59 | 0101 1001 | Y |
| 026 | 1A | 0001 1010 | : | 090 | 5A | 0101 1010 | Z |
| 027 | 1B | 0001 1011 | ; | 091 | 5B | 0101 1011 | [|
| 028 | 1C | 0001 1100 | < | 092 | 5C | 0101 1100 | \ |
| 029 | 1D | 0001 1101 | = | 093 | 5D | 0101 1101 |] |
| 030 | 1E | 0001 1110 | > | 094 | 5E | 0101 1110 | ^ |
| 031 | 1E | 0001 1111 | ? | 095 | 5F | 0101 1111 | _ |
| 032 | 20 | 0010 0000 | Leer | 096 | 60 | 0110 0000 | ' |
| 033 | 21 | 0010 0001 | ! | 097 | 61 | 0110 0001 | a |
| 034 | 22 | 0010 0010 | " | 098 | 62 | 0110 0010 | b |
| 0335 | 23 | 0010 0011 | # | 099 | 63 | 0110 0011 | c |
| 036 | 24 | 0010 0100 | \$ | 100 | 64 | 0110 0100 | d |
| 037 | 25 | 0010 0101 | % | 101 | 65 | 0110 0101 | e |
| 038 | 26 | 0010 0110 | & | 102 | 66 | 0110 0110 | f |
| 039 | 27 | 0010 0111 | ' | 103 | 67 | 0110 0111 | g |
| 040 | 28 | 0010 1000 | (| 104 | 68 | 0110 1000 | h |
| 041 | 29 | 0010 1001 |) | 105 | 69 | 0110 1001 | i |
| 042 | 2A | 0010 1010 | * | 106 | 6A | 0110 1010 | j |
| 043 | 2B | 0010 1011 | + | 107 | 6B | 0110 1011 | k |
| 044 | 2C | 0010 1100 | , | 108 | 6C | 0110 1100 | l |
| 045 | 2D | 0010 1101 | - | 109 | 6D | 0110 1101 | m |
| 046 | 2E | 0010 1110 | . | 110 | 6E | 0110 1110 | n |
| 047 | 2F | 0010 1111 | / | 111 | 6F | 0110 1111 | o |
| 048 | 30 | 0011 0000 | 0 | 112 | 70 | 0111 0000 | p |
| 049 | 31 | 0011 0001 | 1 | 113 | 71 | 0111 0001 | q |
| 050 | 32 | 0011 0010 | 2 | 114 | 72 | 0111 0010 | r |
| 051 | 33 | 0011 0011 | 3 | 115 | 73 | 0111 0011 | s |
| 052 | 34 | 0011 0100 | 4 | 116 | 74 | 0111 0100 | t |
| 053 | 35 | 0011 0101 | 5 | 117 | 75 | 0111 0101 | u |
| 054 | 36 | 0011 0110 | 6 | 118 | 76 | 0111 0110 | v |
| 055 | 37 | 0011 0111 | 7 | 119 | 77 | 0111 0111 | w |
| 056 | 38 | 0011 1000 | 8 | 120 | 78 | 0111 1000 | x |
| 057 | 39 | 0011 1001 | 9 | 121 | 79 | 0111 1001 | y |
| 058 | 3A | 0011 1010 | : | 122 | 7A | 0111 1010 | z |
| 059 | 3B | 0011 1011 | ; | 123 | 7B | 0111 1011 | { |
| 060 | 3C | 0011 1100 | < | 124 | 7C | 0111 1100 | |
| 061 | 3D | 0011 1101 | = | 125 | 7D | 0111 1101 | } |
| 062 | 3E | 0011 1100 | > | 126 | 7E | 0111 1110 | ~ |
| 063 | 3F | 0011 1111 | ? | 127 | 7F | 0111 1111 | \x7f |

11. Appendix

| decimal (X10) | hexadecimal (X16) | binary code X2 | ASCII code | decimal (X10) | hexadecimal (X16) | binary code X2 | ASCII code |
|---------------|-------------------|----------------|------------|---------------|-------------------|----------------|------------|
| 128 | 80 | 1000 0000 | Ç | 192 | C0 | 1100 0000 | À |
| 129 | 81 | 1000 0001 | ü | 193 | C1 | 1100 0001 | Á |
| 130 | 82 | 1000 0010 | é | 194 | C2 | 1100 0010 | Â |
| 131 | 83 | 1000 0011 | â | 195 | C3 | 1100 0011 | Ã |
| 133 | 85 | 1000 0101 | à | 197 | C5 | 1100 0101 | Ä |
| 134 | 86 | 1000 0110 | â | 198 | C6 | 1100 0110 | Æ |
| 135 | 87 | 1000 0111 | ç | 199 | C7 | 1100 0111 | Ç |
| 136 | 88 | 1000 1000 | ê | 200 | C8 | 1100 1000 | + |
| 137 | 89 | 1000 1001 | ë | 201 | C9 | 1100 1001 | É |
| 138 | 8A | 1000 1010 | è | 202 | CA | 1100 1010 | Ê |
| 139 | 8B | 1000 1011 | ï | 203 | CB | 1100 1011 | Ë |
| 140 | 8C | 1000 1100 | î | 204 | CC | 1100 1100 | Ì |
| 141 | 8D | 1000 1101 | ì | 205 | CD | 1100 1101 | Í |
| 142 | 8E | 1000 1110 | Å | 206 | CE | 1100 1110 | Î |
| 143 | 8F | 1000 1111 | Å | 207 | CF | 1100 1111 | Ï |
| 144 | 90 | 1001 0000 | É | 208 | D0 | 1101 0000 | _ |
| 145 | 91 | 1001 0001 | æ | 209 | D1 | 1101 0001 | Ñ |
| 146 | 92 | 1001 0010 | Æ | 210 | D2 | 1101 0010 | Ò |
| 147 | 93 | 1001 0011 | ô | 211 | D3 | 1101 0011 | Ó |
| 148 | 94 | 1001 0100 | ö | 212 | D4 | 1101 0100 | Ô |
| 149 | 95 | 1001 0101 | ò | 213 | D5 | 1101 0101 | Õ |
| 150 | 96 | 1001 0110 | û | 214 | D6 | 1101 0110 | Ö |
| 151 | 97 | 1001 0111 | ù | 215 | D7 | 1101 0111 | _ |
| 152 | 98 | 1001 1000 | ÿ | 216 | D8 | 1101 1000 | Ø |
| 153 | 99 | 1001 1001 | Ö | 217 | D9 | 1101 1001 | Ù |
| 154 | 9A | 1001 1010 | Û | 218 | DA | 1101 1010 | Ú |
| 155 | 9B | 1001 1011 | | 219 | DB | 1101 1011 | Û |
| 156 | 9C | 1001 1100 | | 220 | DC | 1101 1100 | Ü |
| 157 | 9D | 1001 1101 | ¥ | 221 | DD | 1101 1101 | _ |
| 158 | 9E | 1001 1110 | \xfe | 222 | DE | 1101 1110 | _ |
| 159 | 9F | 1001 1111 | \xd9 | 223 | DF | 1101 1111 | ß |
| 160 | A0 | 1010 0000 | á | 224 | E0 | 1110 0000 | à |
| 161 | A1 | 1010 0001 | í | 225 | E1 | 1110 0001 | á |
| 162 | A2 | 1010 0010 | ç | 226 | E2 | 1110 0010 | â |
| 163 | A3 | 1010 0011 | £ | 227 | E3 | 1110 0011 | ã |
| 164 | A4 | 1010 0100 | ¤ | 228 | E4 | 1110 0100 | ä |
| 165 | A5 | 1010 0101 | ¥ | 229 | E5 | 1110 0101 | å |
| 166 | A6 | 1010 0110 | _ | 230 | E6 | 1110 0110 | æ |
| 167 | A7 | 1010 0111 | § | 231 | E7 | 1110 0111 | ç |
| 168 | A8 | 1010 1000 | " | 232 | E8 | 1110 1000 | è |
| 169 | A9 | 1010 1001 | © | 233 | E9 | 1110 1001 | é |
| 170 | AA | 1010 1010 | ª | 234 | EA | 1110 1010 | ê |
| 171 | AB | 1010 1011 | « | 235 | EB | 1110 1011 | ë |
| 172 | AC | 1010 1100 | ¬ | 236 | EC | 1110 1100 | ì |
| 173 | AD | 1010 1101 | \x7f | 237 | ED | 1110 1101 | _ |
| 174 | AE | 1010 1110 | ® | 238 | EE | 1110 1110 | - |
| 175 | AF | 1010 1111 | - | 239 | EF | 1110 1111 | ï |
| 176 | B0 | 1011 0000 | ° | 240 | F0 | 1111 0000 | _ |
| 177 | B1 | 1011 0001 | ± | 241 | F1 | 1111 0001 | ñ |
| 178 | B2 | 1011 0010 | _ | 242 | F2 | 1111 0010 | ò |
| 179 | B3 | 1011 0011 | _ | 243 | F3 | 1111 0011 | ó |
| 180 | B4 | 1011 0100 | ' | 244 | F4 | 1111 0100 | ô |
| 181 | B5 | 1011 0101 | µ | 245 | F5 | 1111 0101 | õ |
| 182 | B6 | 1011 0110 | ¶ | 246 | F6 | 1111 0110 | ö |
| 183 | B7 | 1011 0111 | · | 247 | F7 | 1111 0111 | ÷ |
| 184 | B8 | 1011 1000 | , | 248 | F8 | 1111 1000 | ø |
| 185 | B9 | 1011 1001 | _ | 249 | F9 | 1111 1001 | ù |
| 186 | BA | 1011 1010 | ° | 250 | FA | 1111 1010 | ú |
| 187 | BB | 1011 1011 | » | 251 | FB | 1111 1011 | û |
| 188 | BC | 1011 1100 | _ | 252 | FC | 1111 1100 | ü |
| 189 | BD | 1011 1101 | _ | 253 | FD | 1111 1101 | _ |
| 190 | BE | 1011 1110 | _ | 254 | FE | 1111 1110 | _ |
| 191 | BF | 1011 1111 | ¿ | 255 | FF | 1111 1111 | ÿ |