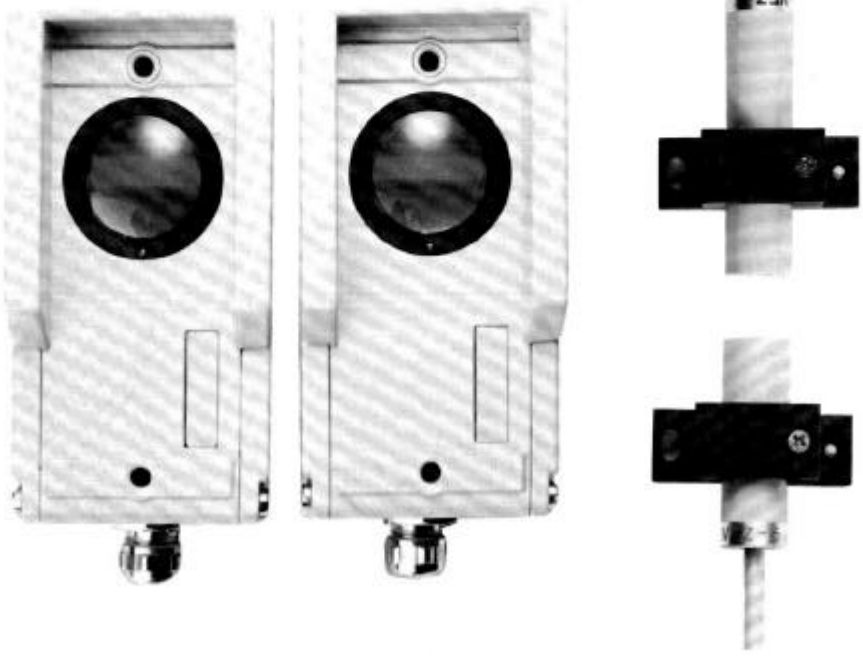
ELECTRONICS FOR AUTOMATION

ACCIDENT PREVENTION DEVICE

Type ULZS-4/1 in connection with individual light barriers **VLZ-5** and **VLW-30**



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Contents

1. General Comments

The accident prevention device ULZS-4/1 consists of a central control and switching module and of one to eight single-path light barriers type VLZ-5 or VLZ-30.

The entire system represents a non-contact self-monitoring protective device (BWS-S).
It complies with "Safety rules for non-contact protective devices on presses in metalworking industries" (ZH 1/281) as well as with the "Safety rules for non-contact protective devices on power-driven devices" (ZH 1/597).

Approvals:

Federal Republic of Germany: "Fachausschuss Eisen und Metall III"
The Netherlands: "Directoraat-Generaal van de Arbaid"
*approvals in other country in preparation.

In the design of the accident prevention device ULZS-4/1 the light barrier itself is purposely separated from the control and switching module; emphasis was put on keeping the physical dimensions of the light barrier to a minimum. This permits protection also in nearly inaccessible areas of a machine or device, where a larger housing could not be accommodated or where it would at least be disturbing. This applies in particular to the light barrier VLZ-5 – its range being considerably shorter and its physical dimensions being much smaller than those of the unit VLW-30 (also refer to Fig. 12).

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The following are the essential features of the protective device:

- Possibility to connect up to 8 individual light barriers to one single control and switching module to protect different areas in any desired location.
- No mutual influencing of light barriers.
- No blanking line required between transmitter and receiver.
- Immune to external interferences. Reliable cut-off where certain limits of these external interferences are exceeded.

2. Application

The accident prevention device ULZS-4/1 safeguards hazard areas on power-driven devices. A few examples from a multitude of possible applications:

- Automated stackers in storage and conveying technique
- Jigging machines in building materials industry
- Safeguarding of door and gate areas
- Safeguarding in the vicinity of industrial robots
- Applications in elevator technique
- Safeguarding on textile machinery
- Safeguarding of trimming presses
- Safeguarding of areas on automatic assembly machines in which manual operations are performed
- Guards preventing stepping behind hazardous areas – in connection with accident prevention light grid type ULG

3. Safety

The device is self-monitoring, that is, functional disorders that could impair the safety, are recognized and effect a cut-off instruction. If the user complies with the "operative conditions" listed under 4. and with the regulations issued by the "Industrial Injuries Insurance Institutes" (Berufsgenossenschaften), he himself and third parties are adequately protected, provided the device is used in accordance with the "Law on Safety of Equipment" (Gerätesicherheitsgesetz GSG) of June 14, 1968.

4. Operative conditions

The protective function is only provided where the following conditions are satisfied:

- The control of the power-driven device must be electrically influencable.
- The power-driven device must provide instantaneous and non-stepping interruption of the hazardous movement.
- The control of the power-driven device must be safe (self-monitoring). In case of a defect (or malfunction) within the control any further hazardous movement of the power-driven device must be excluded.

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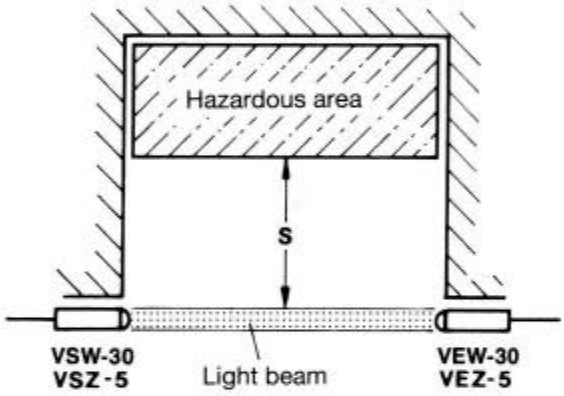
- Once the power-driven device has been switched on or after stoppage due to an interruption of the light beam, provision must be made that the hazardous movement can only be started by actuating a control switch (re-start interlock).
- The diameter of the effective light beam is 12 mm on the unit Type VLZ-5 and 30 mm on the unit Type VLW-30. The cut-off instruction is only carried out if the light beam is completely interrupted.
- The light barrier is to be arranged in such a manner that access to the hazard area is not possible without interrupting the light beam.
- Persons present within the hazard area but outside the light beam will not be recognized. Consequently it must be guaranteed that the power-driven device can only be operated if there are no persons present within the hazard area.
- The "Safe distance" between protective area and hazard area must be large enough to exclude that the hazard area can be reached before the hazardous movement is interrupted or terminated (see Fig. 1).

Fig. 1



Safe distance = minimum distance between light beam and borderline of hazardous area.

The Safe distance is calculated as follows:

$S = vx(tl+t2) + Z$

S = Safe distance (mm)
v = grasping velocity (1,6 m/s)
t1 = slowing-down time of the power-driven device (msec)
t2 = reaction time of BWS-S (contactless protective device) (msec)
Z = excess value (mm)

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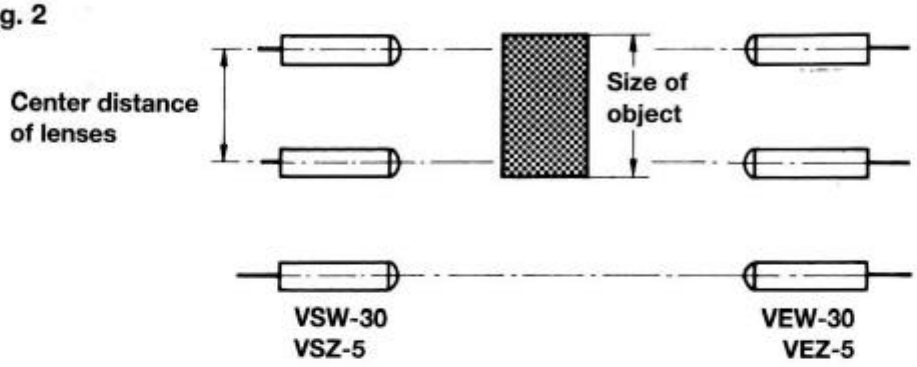
The slowing-down time of the power-driven device is to be established under practical conditions in multiple measurements. The response time of the accident prevention device ULZS-4/1 is 25 msec. Where a BWS-S is used on a power-driven device, the distance to the hazardous area must be at least 100 mm. Where only one single beam is to be used to safeguard a hazardous area, an excess value of Z = 850 mm is to be taken into account in order to avoid possible injuries to hands. If a "light grid" is constructed by using multiple beams, then the minimum size of the object which will trip the cut-off instruction is calculated as follows:

Size of object = center distance of lenses + 12 mm for VLZ-5, + 30 mm for VLW-30 (see Fig.2).

Fig. 2



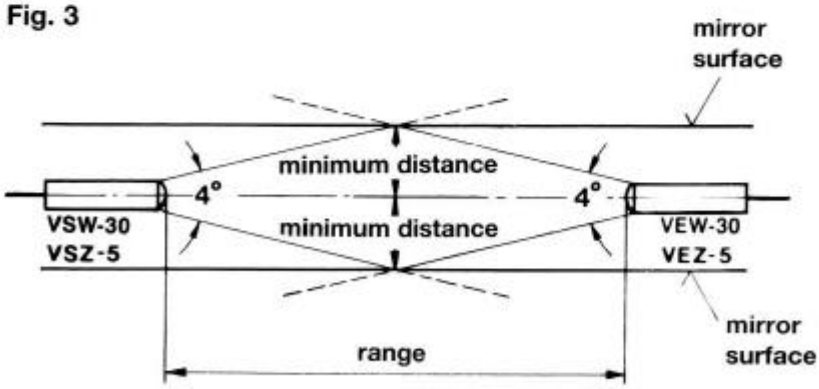
"Size of object" is defined as the smallest object which can be recognized by the protective area of the non-contact protective device and which will trip the cut-off instruction under all actual operating conditions.

If this object size does not correspond with the size of the parts of the human body to the protected, the appropriate excess value Z has to be added to the Safe Distance S [refer to regulations for non-contact protective devices on power-driven devices (ZH 1/597)].

- Mirror surfaces within the transmitting and receiving lobe may lead to reflection and consequently to non-recognition of the object. A minimum distance between mirror-surfaced objects and the optical axis must therefore be maintained (see Fig. 3). The following table lists the minimum distance-to-range relation to be maintained.

Range	Minimum distance
2 m	84 mm
3 m	126 mm
4 m	168 mm
5 m	210 mm
6 m	252 mm
7 m	294 mm
8 m	336 mm
9 m	378 mm
10 m	420 mm

Fig. 3



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5. Function description

5.1 Design

In essence, the central control and switching module consists of power supply, oscillator, thyristor shift register, amplifier, relay triggering and output circuit consisting of two relays with guided contacts, which provide one closed circuit and two operating circuits.

5.2 Function

The connected transmitter elements (VSZ-5 / VSW-30) generate sequential infrared light pulses. At any given time only one transmitter and the respective receiver (VEZ-5 / VEW-30) is active. Mutual optical interference of the individual light barriers is thus excluded. The associated receivers transform these light pulses into electrical pulses; they are amplified by the amplifier. Incandescent light or modulated light with other frequencies is not utilized. The number of the individual light barriers connected to the circuit is set by the manufacturer at the control module according to the specifications of the order.

The output relays will pick up only if all light paths of the connected light barriers are free. Actuation of the start-key provided on the control module activates a start-up test and starts the accident prevention device. If needed, this start-up instruction (short wiping pulse) can also be given externally by means of a floating make-contact (= "remote start" see Fig. 4.). The ULZS-4/1 is provided with an integrated re-start interlock to permit its connection to controls which do not incorporate a re-start interlock. The mode of operation "with internal re-start interlock" is activated where S1 (for location of S1 refer to Fig. 4) is open. This re-start interlock prevents an automatic re-start of the power-driven device after re-starting the accident prevention device or upon penetration of objects into the protected area and their subsequent withdrawal. The re-start interlock remains interlocked (the output relays have dropped out) until it is unlocked by a start-up instruction (short wiping pulse of an external make-contact) [also see "WA START" (Re-start Interlock Start) in Fig. 4].

The indicator lights in the control and switching module indicate the following operating conditions:

The yellow indicator light lights up while the start key or the external start instruction is actuated. Moreover it signalizes insufficient light reception or a penetration into one or several light barriers. It goes out as soon as the amount of light received by all connected light barriers is adequate.

The green indicator light and the red indicator light indicator indicate the switching status of the output relays. The green indicator lights up if the output relays have pulled up (protective area is clear). The red indicator lights up if the output relays are de-energized (due to penetration or due to re-start interlock not having been unlocked).

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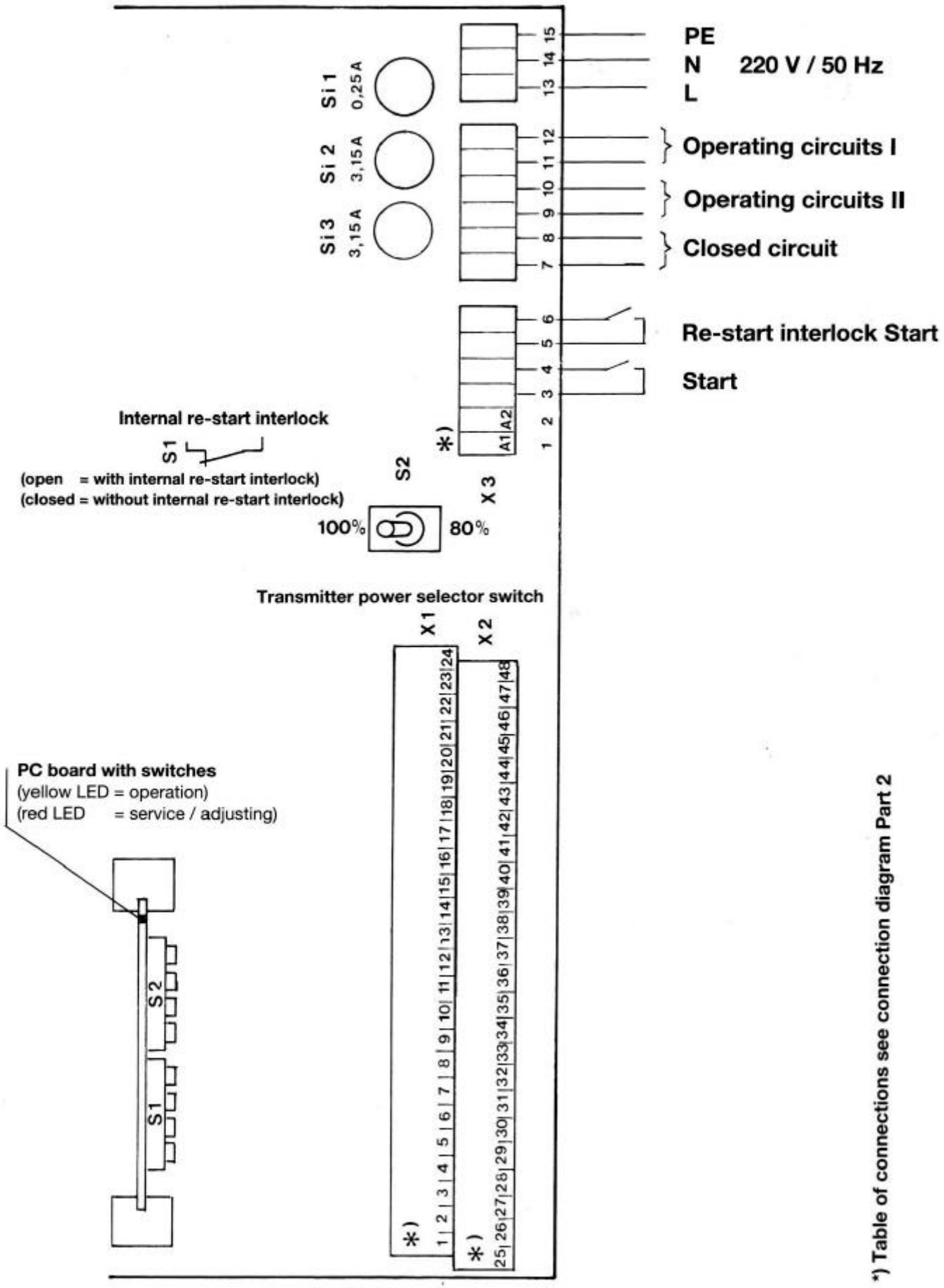
Fig. 4 Connection diagram Part 1



*) Table of connections see connection diagram Part 2

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Fig. 4 Connection diagram Part 2

To connect individual light barriers VLZ-5 use the following table of connections:

Transmitter VSZ-5		Receiver VEW-5	
brown 37 green 38 white 39	1st transmitter	white 25 green 26 black 27	1st transmitter
brown 13 green 14 white 15	2nd transmitter	white 1 green 2 black 3	2nd receiver
brown 40 green 41 white 42	3rd transmitter	white 28 green 29 black 30	3rd receiver
brown 16 green 17 white 18	4th transmitter	white 4 green 5 black 6	4th receiver
brown 43 green 44 white 45	5th transmitter	white 31 green 32 black 33	5th receiver
brown 19 green 20 white 21	6th transmitter	white 7 green 8 black 9	6th receiver
brown 46 green 47 white 48	7th transmitter	white 34 green 35 black 36	7th receiver
brown 22 green 23 white 24	8th transmitter	white 10 green 11 black 12	8th receiver

Terminals 1 – 24 bank X1
Terminals 25 – 48 bank X2
Terminals A1, A2 bank X3

To connect the individual light barrier VLW-30 use the following table of connections:

Transmitter VSW-5		Receiver VEW-30	
brown 37 green 38 black 39 white A1	1st transmitter	white 25 green 26 black 27	1st receiver
brown 13 green 14 black 15 white A1	2nd transmitter	white 1 green 2 black 3	2nd receiver
brown 40 green 41 black 42 white A1	3rd transmitter	white 28 green 29 black 30	3rd receiver
brown 16 green 17 black 18 white A1	4th transmitter	white 4 green 5 black 6	4th receiver
brown 43 green 44 black 45 white A2	5th transmitter	white 31 green 32 black 33	5th receiver
brown 19 green 20 black 21 white A2	6th transmitter	white 7 green 8 black 9	6th receiver
brown 46 green 47 black 48 white A2	7th transmitter	white 34 green 35 black 36	7th receiver
brown 22 green 23 black 24 white A2	8th transmitter	white 10 green 11 black 12	8th receiver

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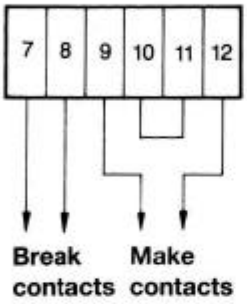
6. Terminals

A minimum of two outputs must be connected to the subsequent control of the power-driven device. An electricromagnetic contact mechanism is to be assigned to each of these two outputs. Where the control connected to the unit requires one make contact and one break contact, both make contacts are to be wired in series (see Fig. 5). In case of inductive loads, spark suppressing equipment is absolutely necessary. This equipment must be wired in parallel to the inductance. Wiring in parallel to the output contact is not permitted. For operating voltages between 100 and 220 V for example Siemens MKC B 81921, 0,25 µF 220 Ohm may be used, for voltages between 24 and 48 V 2,2 µF 100 Ohm.

Fig. 5



6.1 Start-up testing

After the power-driven device is switched on, a start-up test must be automatically initiated before the first hazardous movement. This start-up test can be tripped either by actuating the start-key at the ULZS-4/1 or externally by the control of the power-driven device.

Fig. 6 shows a circuit diagram for connecting the ULZS-4/1 with external start-up test and re-start interlock. After switching-on the mains voltage and after every penetration of the protective field the key T has to be actuated. The internal re-start interlock is not active (S1 is closed).

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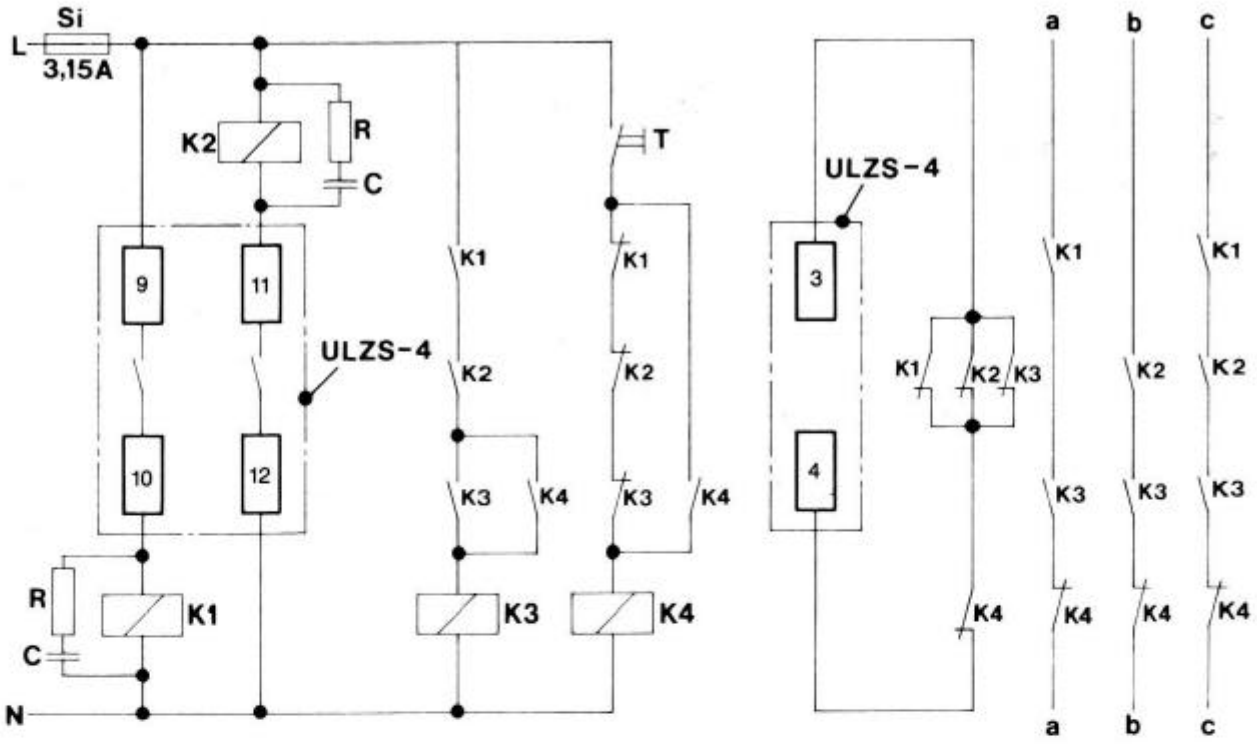
Fig. 6



Terminal ULZS-4/1

K1 ... K4: Relays resp. magnetic switch with guided contacts

RC-unit: Spark suppressing equipment, obligatory

T: Control switch, for example pushbutton; for starting, the start-key is to be used.

a and b: Insert in the safe control of a power-driven device to interrupt the dangerous movement. For safety reasons both contact banks (a and b) must be inserted separately in the control (two-channel control).

c: In exceptional cases, where the control of the power-driven device is provided with one channel only, the contact bank c may be used.

7. Mounting instructions

7.1 General comments

The accident prevention device is to be installed and connected according to "Operative conditions" and "Terminals". Moreover, the safety regulations for non-contact safety devices on power-driven devices ZH 1/597 resp. the safety regulations for non-contact safety devices on presses in metal-working industries ZH 1/281 are strictly to be observed.

7.2 Mounting the control and switching module

Use the mounting frame provided with the control and switching module to mount the unit. Refer to Fig. 11 for position of mounting holes. When mounting the unit please note that in order to ensure reliability of operation, the connecting cables between control module and transmitter elements must not exceed the specified maximum lengths (see Technical Data).

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7.3 Mounting the single beam light barriers

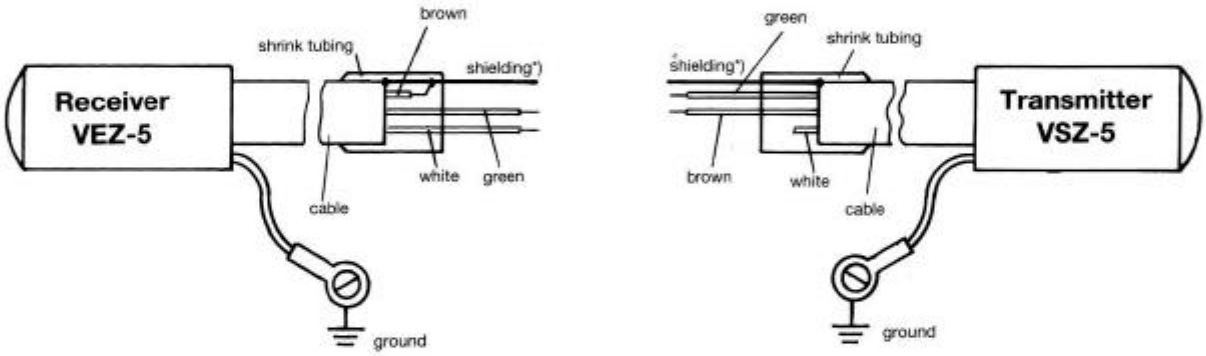
To mount the individual light barriers VLZ-5, the use of mounting elements, available as accessory items, is recommended (see Fig. 12).
In order to guarantee optimum shielding, the shielding of each VLZ-5 light barrier element is to be conductively connected to ground (refer to Fig. 7). When routing the light barrier cables, a minimum distance of 5 cm between light barrier cables and power cables is to be maintained.
To ensure faultless function with adequate reliability of operation, it is absolutely necessary to adjust the optical axis of transmitter and receiver elements to each other as accurately as possible. The small divergence of transmitter and receiver optics results in a very narrow beam. Careless mounting makes adjustment of the light barriers considerably more difficult. In case there are mirror surfaces along the light path of the light barriers, it is important to maintain the minimum distance mentioned in Section 4 (also see Fig. 3).
Connect the individual photoelectric light barriers to the central unit in sequence, beginning with number 1 (see Terminals, Fig. 4).

7.4 To shorten connecting wires

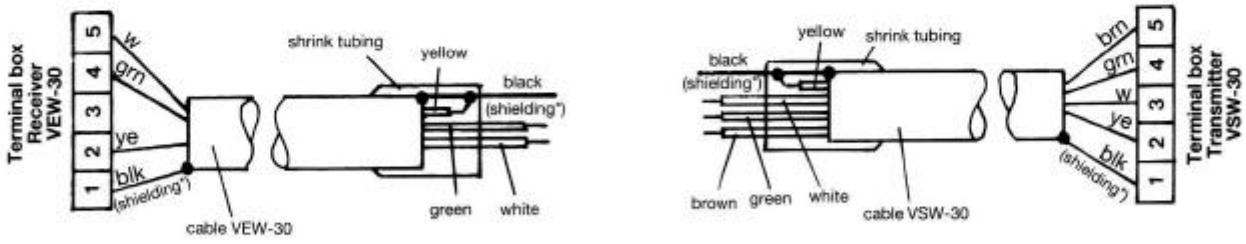
After shortening the connecting wires prepare cable ends according to Fig. 7.

Fig. 7

Light barrier VLZ-5



Light barrier VLW-30



*) length of shielding 30 mm max.

7.5 Extension of connecting cables

If the access to the light barrier cables after installation should turn out to be difficult, the use of a terminal box in the vicinity of the light barriers is recommended to improve serviceability. If a defect on one of the light barriers should occur, the respective light barrier can then be replaced without difficulty. Care should be taken, however, to avoid exceeding the specified maximum permissible cable lengths as specified (refer to 10. Technical data)
It is important to use a metal-type terminal box for this purpose. The following figure shows the wiring of such a terminal box.

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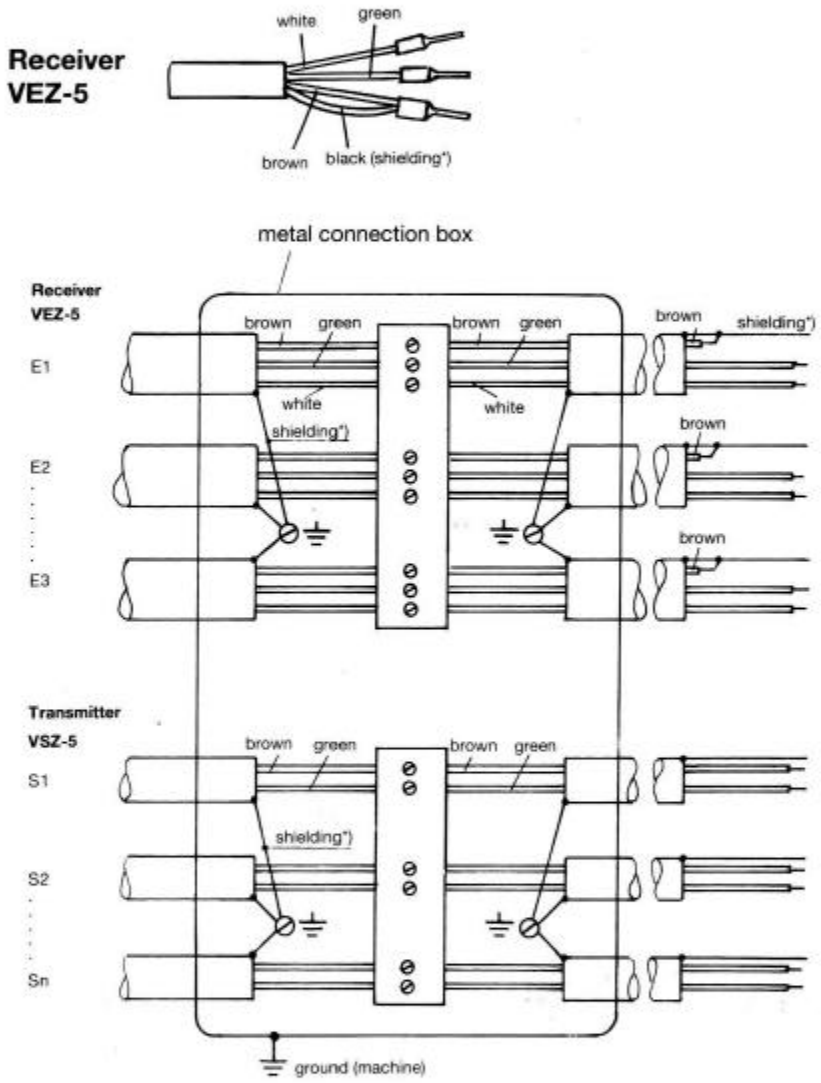
Fig. 8 Terminal box for extension of light barrier cables

Cut black lead (shielding) at multi-core cable end sleeve, remove insulation and attach crimp connector. Connect wires according to Fig. 8.

It is imperative to use a metal-type terminal box for the extension of the cables.



***) maximum length of shielding and wires 30 mm.**

Attention:
Transmitter wires and receiver wires must not be routed in a commmon cable

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8. Putting into service

After mounting and connecting the individual light barriers check to see if supply voltage and line voltage at the place of use agree with the specification on the type plate. Since the control and switching module is provided with only one indicator light (yellow) which signalizes a sum indication of adequate light reception of all photoelectric barriers, the photoelectric light barriers must be switched on – using the encoder switch – and adjusted, one after the other. To this end, the PC board carrying the switches is to be inserted in such fashion that the red indicator LED2 lights up (see Fig. 9).

Fig. 9
PC board with switches inserted in direction "Service". The red indicator LEd lights up.

For setting of encoder switches refer to Fig. 9

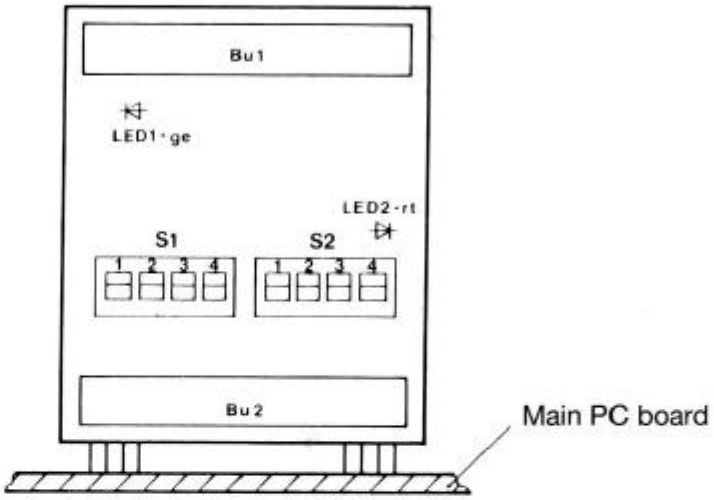
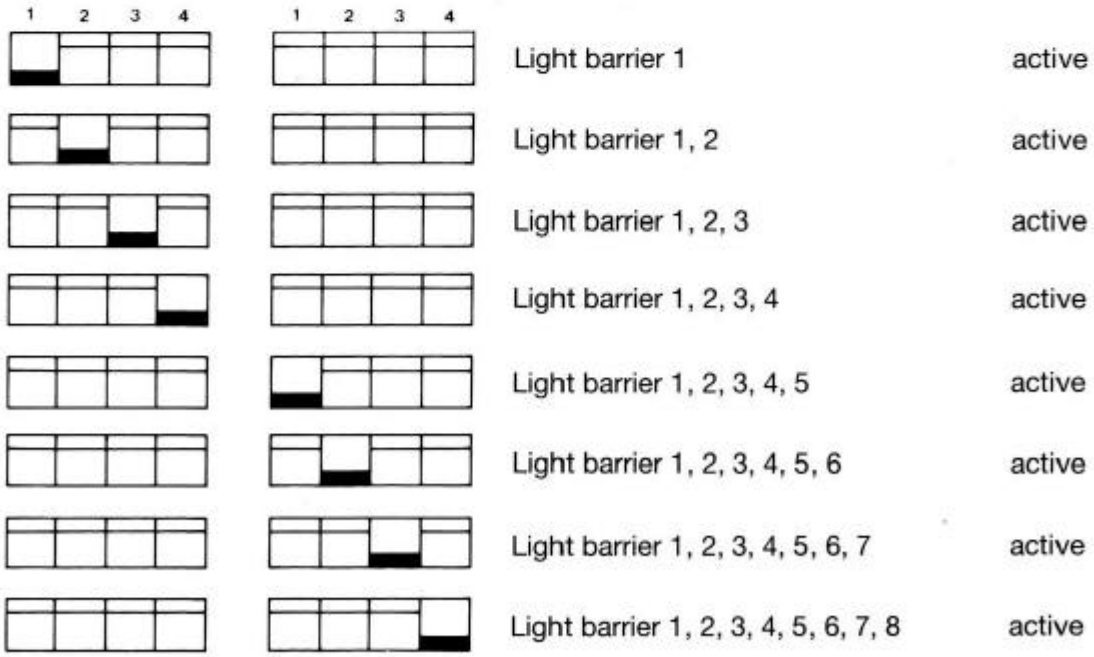


Fig. 10
Setting of encoder switches on PC board of the control and switching module, inserted in direction "Service"



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9. Adjustment

1st light barrier

- set encoder switch (light barrier 1 is active)
- press start key and release
- set transmitter power selector switch to 100% (refer to Fig. 4)
- adjust transmitter and receiver alternately until the yellow indicator light goes out
- set transmitter power selector switch to 80%
- optimize adjustment
- re-set transmitter power selector switch to 100%

2nd light barrier

- set encoder switch (light barriers 1 and 2 are active)
- continue as for the first light barier.

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8th light barrier

- set encoder switch (light barriers 1, 2, 3, 4, 5, 6, 7 and 8 are active)
- continue as for the first light barrier.

After completion of ajustment of all light barriers remove PC board with switches, turn around and re-insert so that the yellow LED lights up. The accident prevention device is now operative.

10. Technical data

10.1 Central control and switching module ULZS-4/1

Supply voltage:	220 V + 10% –15% 50–60 Hz other voltages on special order
Freedom from interference:	In compliance with IEC publication 255-4 and 255.5
Power consumption:	approx. 15VA
Fuses:	0,25A mt
Connection:	PG, see conecting diagram Fig. 4
Output:	2 relays with guided contacts. 2 operation circuits, fused with 3.15 A FF and one closed circuit Self-regulating relay contacts
Breaking voltage max.:	250 V AC
Current max.:	220 V AC 6A 110 V DC 0,45 A 60 V DC 0,75 A 24 V DC 6 A
Pick-up time (after penetration):	25 msec
Pick-up time (after release):	20 msec
Duration of wiping pulse for safety test:	$\geq$ 50 msec
Protection:	IP 65
Environment temperature:	0–55°C
Housing:	ABS, colour similar to RAL 7024
Cable inlet:	PG 9, PG 7
Dimensions:	see diagrammatic view Fig. 10
Weight:	1,7 kg

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10.2 Single-path light barrier VLZ-5/VLW-30

Range of operation:	VLZ-5: 10 m; VLW-30: 30 m

10.2.1 Transmitter VSZ-5

Supply voltage:	24 V, modulated
Connecting cable:	2x0,14 shielded, max. length = 6 m
Light source:	Ga-As Diode, service life approx. 100 000 hrs.
Type of light:	Infra-red, modulated
Wave length:	950 nm
Lens:	VSZ-5: D = 12 mm
Beam angle:	±2°
Protection:	IP 65
Environment temperature:	–20°C to +70°C
Housing:	Aluminum, anodized
Colour of housing:	RAL 1021 cadmium-yellow
Dimensions:	see Fig. 11

10.2.2 Receiver VEZ-5

Supply voltage:	12 V DC
Connecting cable:	3x0,14, shielded, max. length = 15 m
Receiving element:	Si photo-element with subsequent preamplifier
Stray light:	Safe up to 50 000 lux

Further technical data see: transmitter VSZ-5.

10.2.3 Transmitter VSW-30

Technical data like Transmitter VSZ-5, however:

Connecting cable:	3x0,25, shielded, max. length 30 m
Lens:	D = 30 mm

10.2.4 Receiver VEW-30

Technical data like Receiver VEZ-5, however:

Connecting cable:	4x0,25, shielded, max. length 15 m
Lens:	D = 30 mm

11. Data to be supplied with order

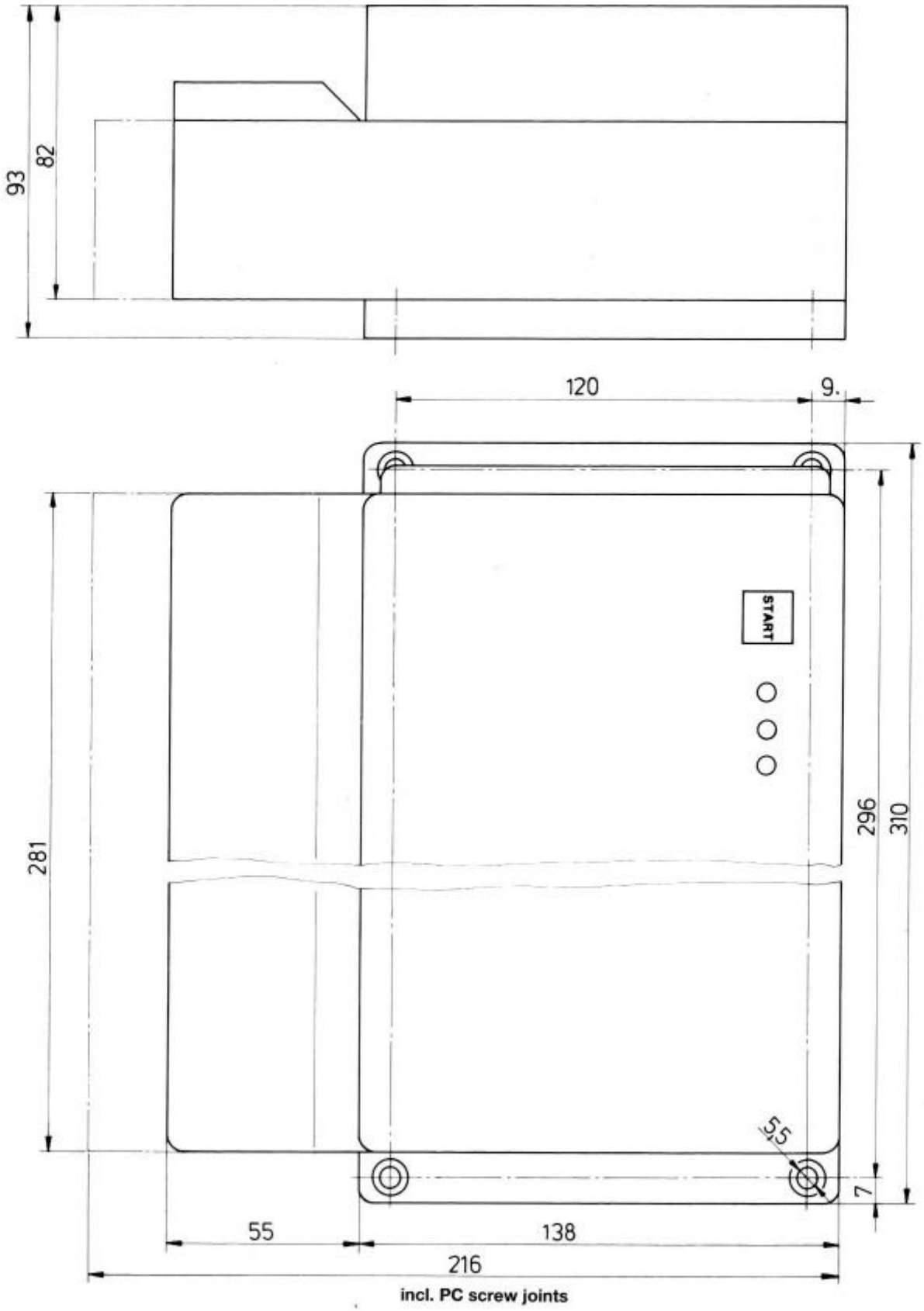
- Supply voltage
- number and type of individual light barriers
- cable lengths (observe max. allowable length)
- range of transmission

12. Accessories

- Bracket for VLZ-5 (see Fig. 12).

13. Dimensions

Fig. 11 Housing



incl. PC screw joints

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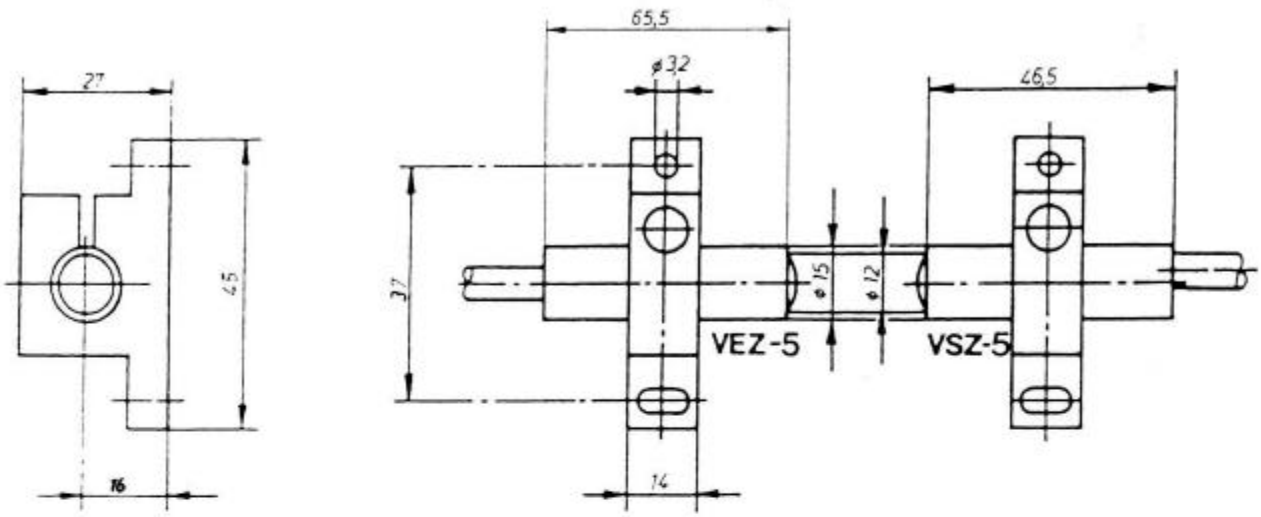
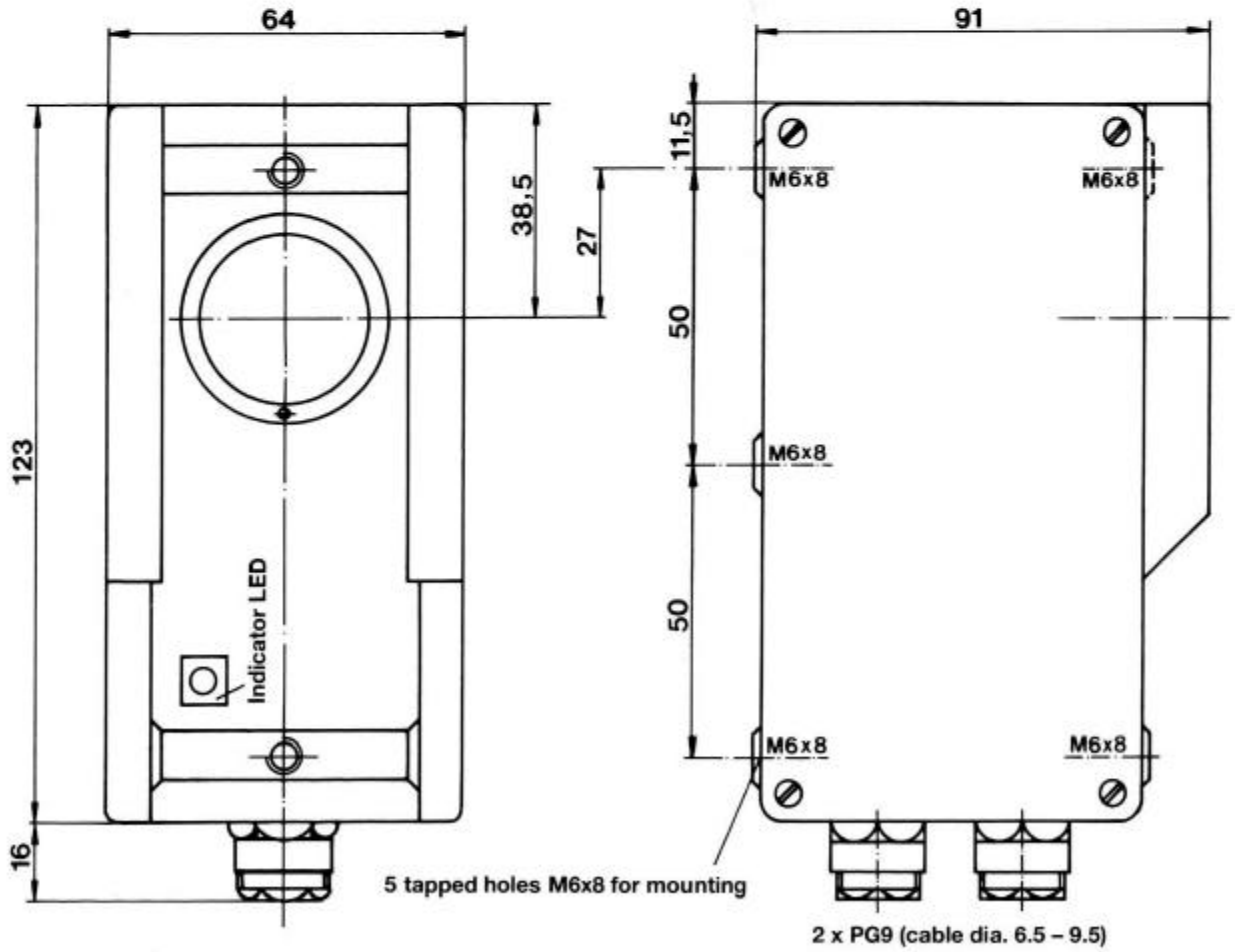
Fig. 12

Light barrier VLZ-5 with mounting element



Light barrier VLW-30



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