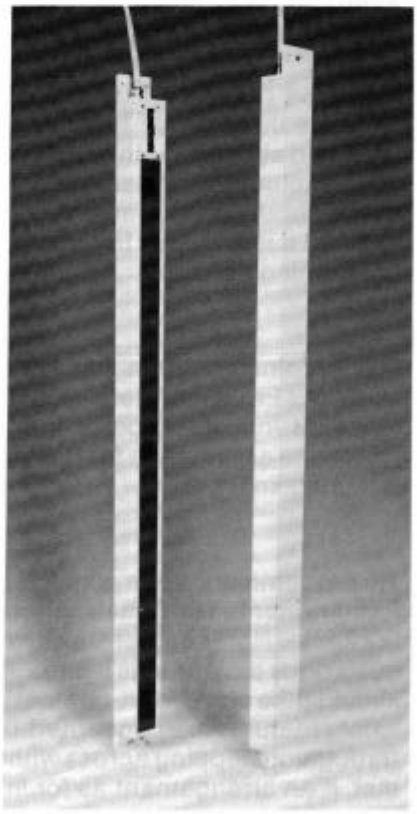
ELEKTRONIK FÜR DIE AUTOMATION

lumiflex®

ACCIDENT PREVENTION DEVICE

Type **ULZS-4/1** with single-path light grid **EL-3/400**

Safeguarding of hazard areas, especially accesses to industrial robot systems and transfer equipment.



LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

Contents

1. General

For the use of single-beam light beam switches to safeguard hazardous areas and accesses to industrial robot-equipped operating systems and transfer equipment, the regulatons of **ZH 1/597 „Sicherheitsregeln für berührungslos wirkende Schutzeinrichtungen an kraftbetriebenen Arbeitsmitteln"** (directive for use non-contact protective devices on power-driven devices), Section 5.5.1 are not considered sufficient, since a single light beam switch, located between 0,75 m and 0,9 m above floor level, may at any time be evaded by crawling through underneath it. Also an arrangement of two single-beam light beam switches at heights of 0,4 m resp. 0,9 m above floor level cannot be considered sufficiently safe, since light beam switches at these distances can also easily be evaded by crawling through between the light beams.

For above reasons it is considered necessary to provide an equipment of the above mentioned type three single-beam light beam switches with separate emitters and receivers, one arranged above the other, at heights of 0,3 m, 0,7 m and 1,1 m above floor level. Such arrangement excludes an evasion simply by crawling through underneath or through or by climbing over without auxiliary means. The light beam switches must be arranged in such a manner as to make it impossible to reach hazardous movements by reaching under, reaching through or reaching across.

This recommendation was set up in 1985 and publicized by the „Prüfstelle des Fachausschusses Eisen und Metall 3" of the competent „Berufsgenossenschaft für Handhabungsgeräte und Industrieroboter in Montagestraßen und Fertigungslinien" (Employers Liability insurance association for handling equipment and industrial robots in assembly and manufacturing lines).

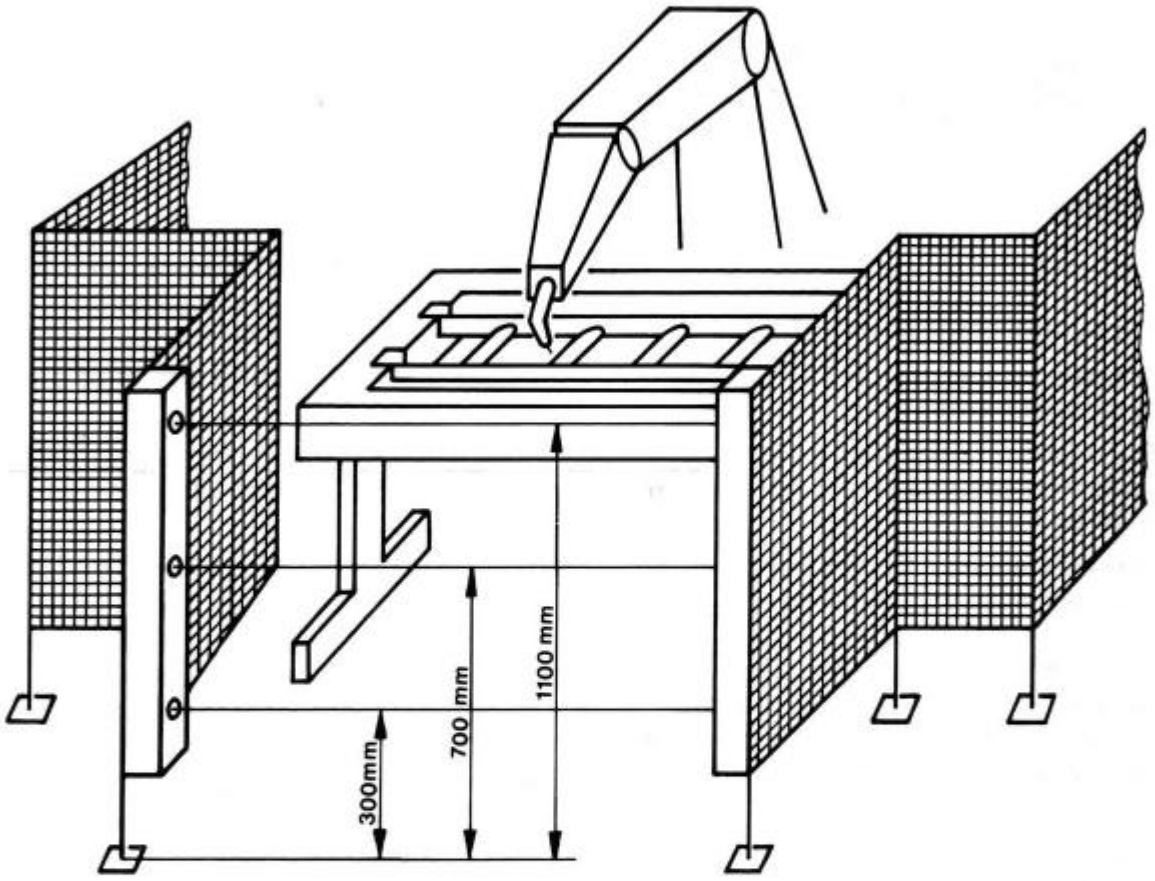
This recommendation was integrated in the **VDI Directive VDI 2853** of July 1987 **„Safety Requirements for Construction, Equipment and Operation of Industrial Robots".** Section 3.2.2.2.1 – Non-contact Devices (BWS) – reads: Non-contact protective devices must stop hazardous movements in time, if a penetration (walking in, reaching in) into the hazard area should take place. Non-contact protective devices must comply with ZH 1/597 as far as their safety features are concerned. If individual beams are used to safeguard accesses, stepping through or stepping across without auxiliary means must be prevented. This requirement is met, if an arrangement as for instance shown in Fig. 7 is chosen.

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

This figure (see **our** Fig. 1) calls for **three individual beams** at distances of 400 mm each, the first to be located 300 mm above floor level.

The accident prevention device ULZS-4/1 in connection with the single-path light grid EL-3/400 meets tis requirement – it is a rugged unit, built for industrial use, easy to mount and reliable. One single central unit ULZS-4/1 also makes possible double-sided access protections.

Fig. 1:



lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 5760 54 · Telex 5 213 058 · Telefax (089) 570 13 86

2. Safety, regulations, Approval

The unit is self-monitoring, that is, functional disorders which could impair the safety, are recognized and effect a shut-down instruction. If the user meets the requirements for operation, listed under Sect. 3 and complies with the directive of the DIN publication 2853 and those of the „Berufsgenossenschaft", he himself and third parties are adequately protected, provided the use of the unit complies with the „Law on the Savety of Devices (GSG)" of April 14, 1968.

The entire system represents a self-monitoring, non-contact protective device (BWS-S). It complies with the **„Safety Regulations for Non-contact Protective Devices on Power-driven Equipment" (ZH 1/597)** and with the **„Safety Regulations for Non-contact Protective Devices on Presses in Metal-working" (ZH 1/281).** The „Prüfstelle Fachausschuss Eisen und Metall III der Berufsgenossenschaft" has granted the test certificate.

The distance of 400 mm between the individual beams, required by the VDI Directive, has been realized by arranging the emitters and receivers in narrow, rail-type housings.

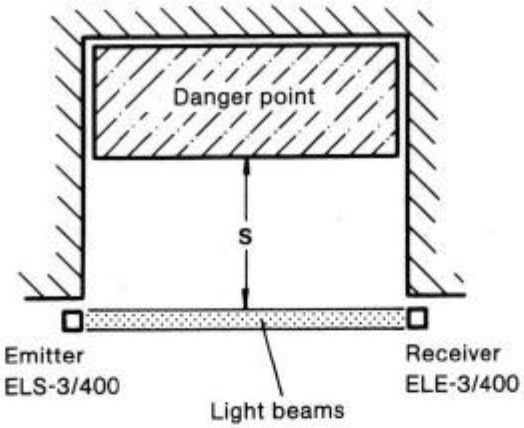
3. Operating conditions

The protective function can only be guaranted, if the following preconditions are satisfied:

- The control of the power-driven device must be electrically controllable
- Te power-driven device must guarantee an immediate and continuous interruption of the hazardous movement
- The control of the power-driven device must be safe (self-monitoring). In case of a defect or disorder within the control any further hazardous movement of the power-driven device must be excluded.
- With reference to industrial robots, the provisions of the VDI Directive 2853, Section 3.1.2 – Controls – are to be observed
- After starting the power-driven device or after a shut-down due to interruption of one of the emitter-receiver lines it must be ensured, that the hazardous movement can only be initiated by means of a control station (re-start interlock). The control station of the re-start interlock must be placed in a location, where it cannot be reached from the hazardous area, this area however can be monitored from this location.
- Persons within the hazard area but outside the protective device are not recognized. Consequently it must be ensured, that the power-drive device can only be put into operation, if no persons are present within the hazard area. The start-up key of the safety device is located in the central unit; it may also be connected as external switch. The central unit as well as an external starting contact – if used – must be mounted in a location from which the hazard area can be monitored.
- Emitter/receiver assemblies are to be mounted in such a manner, that penetrating into the hazard area without interrupting emitter/receiver lines is made impossible.
- The savety distance between hazard area and protected field must be large enough to prevent in case of a penetration into the protected field, that the danger point can be reached before the hazardous movement is interrupted or has come to a stop (see Fig. 2).

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

Fig. 2:



The Safety distance is computed as follows:

$S = v \times (t1 + t2) + 850$ mm
S = Safety distance
v = gripping speed (1,6 m/sec.)
t1 = slow-down time of the power-driven device msec
t2 = reaction time of non-contact safety device (BWS-S) msec

4. Design, function

The protective devicel ULZS-4/1, designed to safeguard hazard areas in connection with the single-path light grid EL-3/400, is particularly well suited to safeguard accesses to industrial robot systems and transfer equipment; it consists of the following three items:

1. The central unit ULZS-4/1
2. Emitter assembly ELS-3/400
3. Receiver assembly ELE-3/400

The central unit consists primarily of power supply, oscillator, thyristor shift register, amplifier and two relays with guided contacts providing one holding current circuit and two working circuits to the outside.

One or two single-path light grids EL-3/400 consisting each of an emitter assembly and a receiver assembly can be connected to each central unit. Mutual optical interference is excluded, since only one emitter and the respective receiver is active at one and the same time. The light pulses of the emitters are transformed by the component receivers into electrical pulses. Incandescent light or modulated light of other frequencies is not processed. The number of single-path light grids that may be connected, is set and fixed by the manufacturer according to the buyer's specifications.

lumiflex
LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 1386

The output relays of the central unit are only energized, if all light paths are free. By means of the start-up key, located on the central unit, a start-up test run is initiated and the protective device is started. These start-instructions (self-wiping contact) can also be initiated – if required – externally by means of a potential–free closing contact (=„start", see Fig. 3, Terminal arrangement). For use on controls which do not possess their own re-start interlock feature, the ULZS-4/1 is equipped with an internal re–start interlock. The operating mode „with internal re-start interlock" is activated, if the switch S1 is open (for location of S1 refer to Fig. 3, Terminal arrangement). The re-start interlock prevents an automatic re-start of the power-driven device after a person or an object has passed through the protective field. The re-start interlock remains locked. The output relays of the central unit are de-energized until they are unlocked by a start-instruction from an external closing contact. (refer to „Re-starting" in Fig. 3, Terminal arrangement).

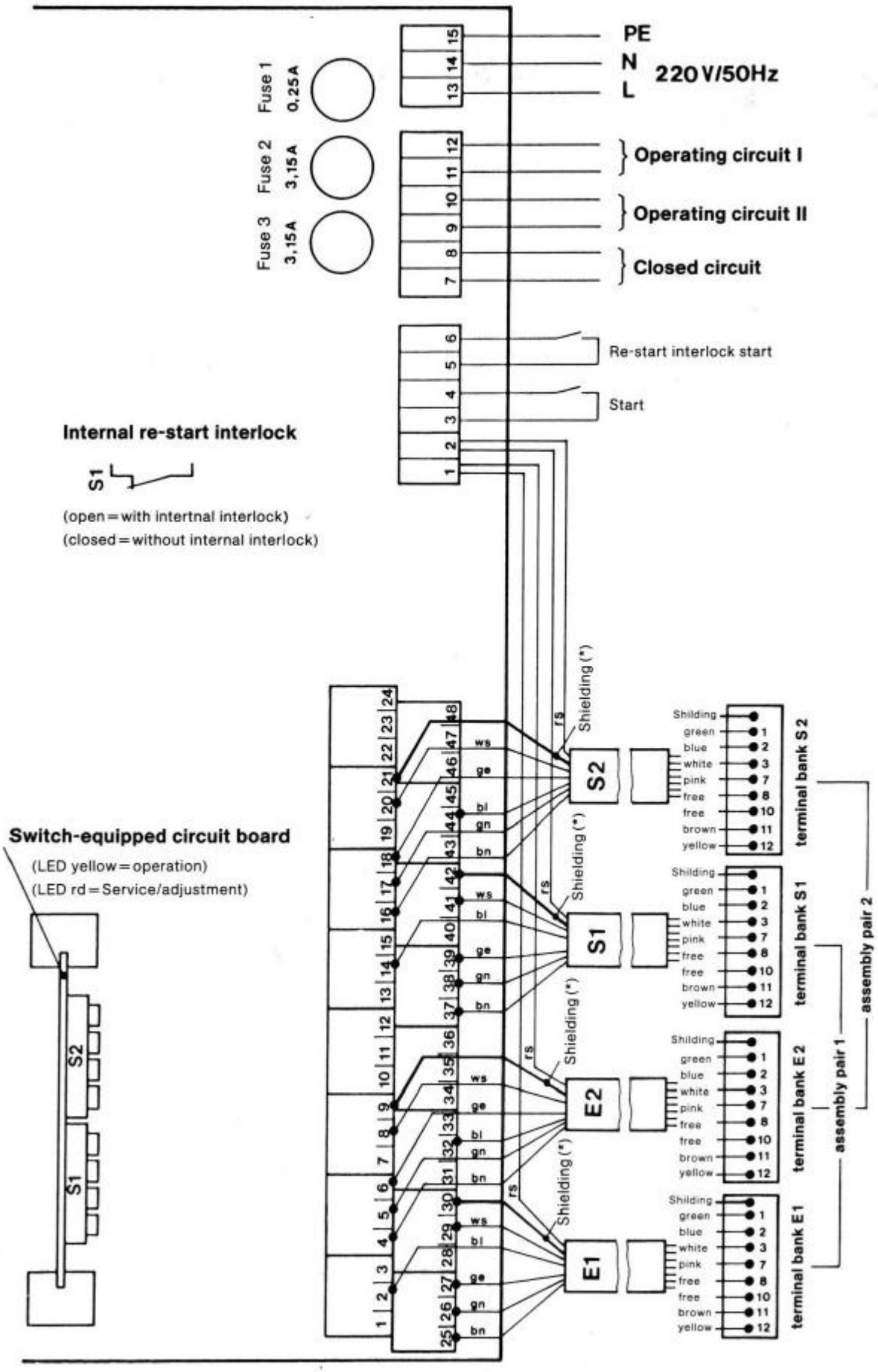
The pilot lamps in the cover of the central unit indicate the following modes of operation:

The yellow pilot lamps lights up, while the start-up key or the external starting contact is being actuated. Beyond that, it indicates insufficient light reception or an interruption of one or several emitter/receiver lines. It goes out, if the amount of light in all connected emitter/receiver lines is adequate.

The green and the red indicator lights indicate the switching status of the output relays within the central unit. Green lights up, if the output relays are energized (protected field free). Red lights up, if the output relays are de-energized (in case of penetration or in case the internal re-start interlock is not unlocked).

Lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

Fig. 3:
Cable arrangement



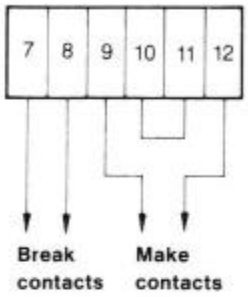
(*) lenght of exposed shilding not to exceed a maximum of 3 cm.

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 1386

5. Terminals

A minimum of two outputs must be connected to the downstream control of the power-driven device. To each of the two outputs an electromagnetic switching device is to be assigned. If the connected control requires one make and one break contact, then the two make contacts are to be wired in series (see Fig. 4). In case of inductive loads it is indispensable to provide spark quenching devices.

Fig. 4:



The interference suppressors must be connected in parallel to the inductivity. Connecting in parallel to the output contact is not permissible. For operating voltages from 110 – 220 V the use of Siemens MKC B 81921 0,25 uF 220 Ohm is recommended. For voltages from 24 – 48 V 2,2 uF 100 Ohm.

6. Mounting instructions

The optical axis of the three emitters in the emitter assemblies and of the three receivers within the receiver assemblies are adjusted by the manufacturer so as to be in one plane, in parallel and at right angles. This facilitates mounting the units even in case of larger distances up to 25 m without any difficulties. Beyond that, the precise adjustment is further facilitated by specially designed flanges; thus, a maximum operating reserve is guaranteed. An indicating diode in receiver and emitter assembly is also provided to further facilitate mounting and adjustment.

The central control unit is mounted by means of the wall mounting angle provided. Please refer to the „Outline drawing" in Fig. 5 for the location of the mounting holes. Please note, when mounting the central unit, that – for reasons of safety and reliability – the connecting cables to emitter assembly resp. receiver assembly do not exceed the maximum specified lenghts (see Section „Technical Data").

For perfect function and adequate operational safety it is indispensable to adjust the axis of receiver and emitter lines with respect to each other as precisely as possible. The low divergency of emitter and receiver optics result in a very narrow bundle of light rays. The precise adjustment within the assemblies – which is made by the manufacturer, as mentioned earlier – considerably simplifies correct mounting, putting into operation and precise adjustment.

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

First mount one of the assemblies and attach it by means of the two mounting screws through the slots in the mounting flanges on upper and lower end of the assemblies (also refer to Fig. 6, Section „Outline drawing"). The altogether four set screws (two each on top and bottom) shall constitute the actual supporting plane. Thus, the assemblies are, in fact, resting on these four supporting points.

Then fasten the other assembly on the opposite side at the same height. Here again, the four screws, turned out equally far, are to provide the supporting place.

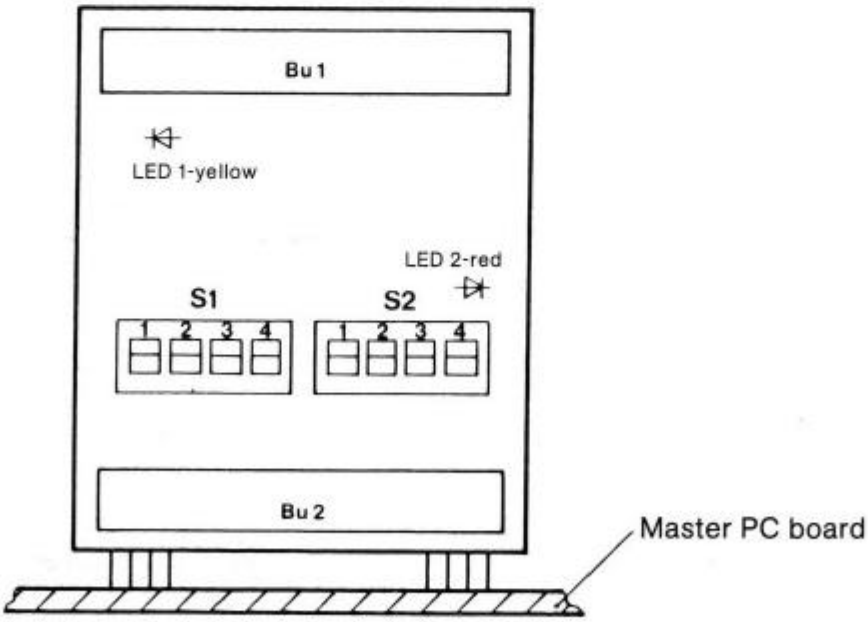
Connect emitter assembly and receiver assembly to the central unit as shown in Fig. 3. When preparing the connecting cables, please note, that the exposed lenghts of the shielding on these cables are as short as possible, at any rate no longer than 3 cm.

7. Commissioning

After mounting and after completing the electrical connections, check, if supply voltage and line voltage at the at the place of use correspond with the specifications on the type plate of the units.

The switch-equipped PC board is to be plugged into the master PC board in plugging direction „Service" (see Fig. 7).

Fig. 7:
Switched-equipped PC board in plugging direction „Service":

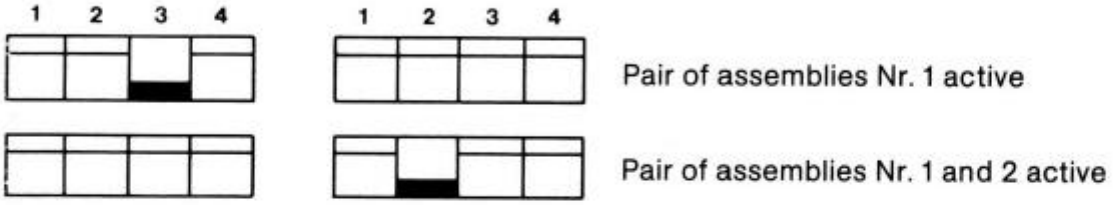


Emitter and receiver are provided with red LED's. They operate in parallel and deliver a summation indication of adequate light reception of all connected pairs of assemblies.

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 1386

This means, that the pairs of assemblies are to be switched-on and adjusted – by means of the encoding switches – in sequence (see Fig. 8). The red LEDs indicate the light reception of that pair of assemblies which is active at that particular moment. They light up, if the light reception is unsufficient or if there is an object present in the path of the light beams.

Fig. 8:
Setting of encoding switches on PC board in plugging direction „Service".



8. Adjustment

Pair Nr. 1:

- Set encoding (see Fig. 8).
- Connect supply voltage to unit. The red LED on the switch-equipped PC board lights up.
- Actuate and release the start-up key on the central unit ULZS-4/1. In case, the coarse adjustment is already satisfactory, the red indicating diodes in receiver and emitter assembly go out, – also in assembly Nr. 2, if so equipped.
- If the coarse adjustment is not in order, the red diodes in emitter and receiver assembly of pair 1 – and in assemblies of pair 2, if so equipped – will remain lit.
- Fine adjustment is made by turning the four set screws in receiver and emitter assembly. After unscrewing the already tightened mounting screws slightly, the assemblies may be tilted. To find the exact switching point by means of the indicating diodes in receiver and emitter assembly, tilt the assemblies slightly until the desired result is obtained. In this fashion first the optimum position of the emitter, then that of the receiver is determined. After finishing the fine adjustment tighten the mounting screws; this will pull the assemblies tightly up against the supporting plane, created by the set screws und thus fix the assemblies in their final position.

Pair Nr. 2:

- Set encoding switch (see Fig. 8)
- Continue as for pair Nr. 1

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

After completion of adjusting the one resp. the two pairs of assemblies reverse the switch-equipped PC board and plug it in, so that the yellow LED lights up – and no longer the red LED.

After renewed actuation of the start-up key on the central unit ULZS-4/1 the red LEDs in the assembly, resp. in the two pairs of assemblies will go out.

Now only the green LED in the cover of the central unit is lit. Where the integrated re-start interlock is used, it must be unlocked, so that only this green indicating LED lights up, provided the unit is properly mounted.

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

9. Technical Data:

9.1 Central unit ULZS-4/1

Supply voltage:	220 V + 10 % −15 % 50–60 Hz other voltages upon special request
Power consumption:	approx. 15 VA
Fuse:	0,25 A med.slow
Connections:	By means of PG screw coupling
Output:	2 relays with guided contacts 2 operating circuits, fused with 3,15 A ff and one closed circuit; Relays contacts self–monitoring.
Switching voltage max:	250 V AC
Switching current max:	220 V AC 6 A 110 V DC 0,45 A 60 V DC 0,75 A 24 V DC 6 A
Reaction time:	25 msec
Re-start interlock:	integrated; unlocking externally by potential-free contact
Control station:	Start key in housing of central unit or external contact for remote start.
Remote start:	at the same time test resp. control possibility; external contact
Protection:	IP 65
Environment temperature:	−20 C to +55 C
Housing:	APM, colour similar to RAL 7024
Cable inlet:	PG 7, PG 9
Dimensions:	see „Outline drawing"
Weight:	1,7 kg

9.2 Single-path impulse light grid EL-3/400

Nominal reach:	30 m
Operating reach:	25 m

9.2.1 Emitter assembly: ELS-3/400

Connecting cable:	LiYCY-öw 6x0,5, shielded, max. lenght 30 m, connected by means of PG screw joints with separate terminal compartment
Light source:	GaAs diode with approx 100 000 hour service life
Type of light:	infrared, pulse
Wave lenght:	950 nm
Optical system:	d = 30 mm
Beam divergency:	±2 °
Protection:	IP 67
Environment temperature:	−20 °C bis +70 °C
Housing:	Al
Dimensions:	see „Outline drawing", Fig. 6

9.2.2 Receiver assembly ELE-3/400

Connection cable:	LiYCY-öw 6x0,5, shielded, max. lenght 15 m, connected by means of PG screw joints with separate terminal compartment
Receiving element:	Si Photo-element with downstream pre-amplifier
Extraneous light:	safe up to 50 000 Lux

For further technical details see 9.2.1, emitter assembly.

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

10. Data to be supplied with order

In order to enable us to fill your order to your satisfaction, the following data are important:

1. Supply voltage
2. Number of pairs of emitter and receiver assemblies to be connected to the central unit (specify „one" or „two")
3. Approximate reach (distance between emitter and receiver assembly)
4. Specification of order numbers:

Accident protection device ULZS-4/1	Order Number 52 39 02
Emitter assembly ELS-3/400	Order Number 52 44 10
Receiver assembly ELE-3/400	Order Number 52 44 20

Important:

The connecting cable between emitter assembly on the one hand and receiver assembly on the other hand and the central unit ULZS-4/1 (LiYCY-öw 6 x 0,5 shielded) is not part of the contract; it can, however, be supplied, if the order so specifies. Please observe the limitation on maximum lenghts. Please also note, that the exposed ends of the shielding must in no case exceed a maximum lenght of 3 cm. This is of particular importance for the reliability of operation (also refer to „Cable arrangement", Fig. 3).

If we are to provide the connecting cables, please specify their desired lenght.

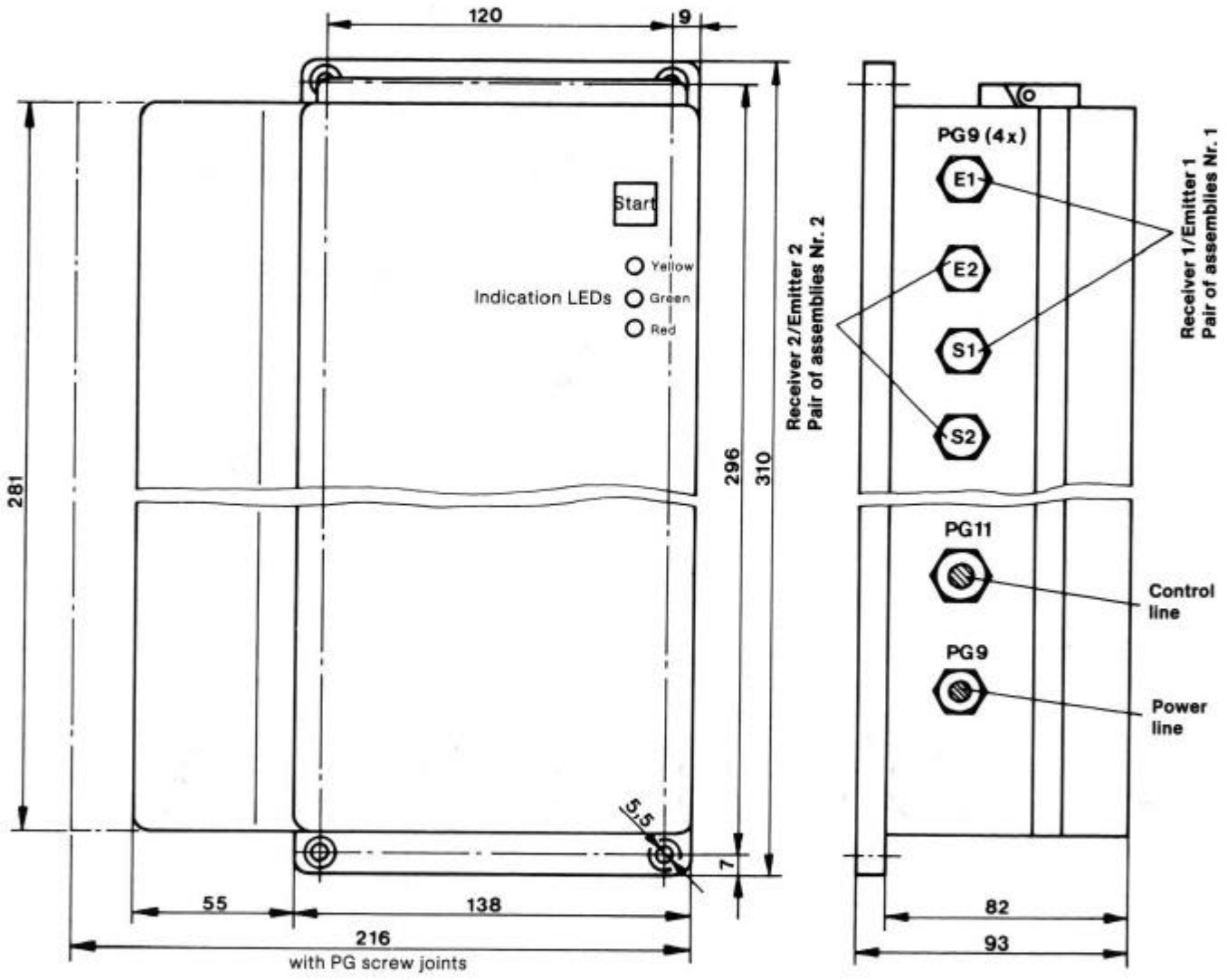
Order number of the connecting cable 18 40 60

lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 1386

11. Outline drawing:

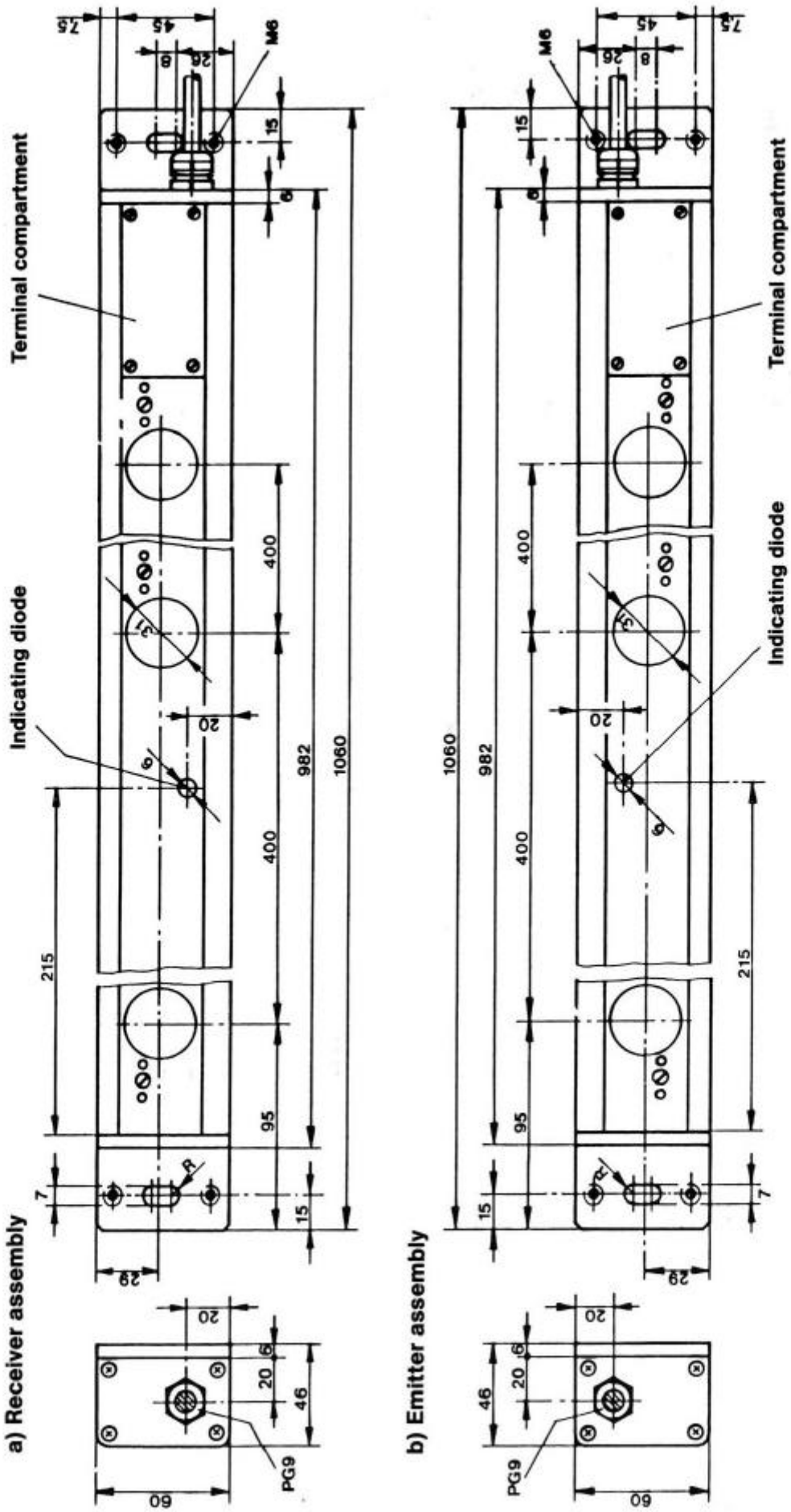
Fig. 5:

Outline drawing for: Central unit ULZS-4/1



lumiflex® LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 13 86

Fig. 6:



LUMIFLEX GMBH & CO. KG ELEKTRONIK · Landsberger Straße 191 · 8000 München 21 · Telefon (089) 57 60 54 · Telex 5 213 058 · Telefax (089) 570 1386