

Operating instruction



Arc Detection System



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ARC DETECTION SYSTEM
LBW21

Installation Instructions
No. 531 766 Edition 12/2004

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1 Positioning the Sensors and Evaluation Unit in the Switchgear Panel

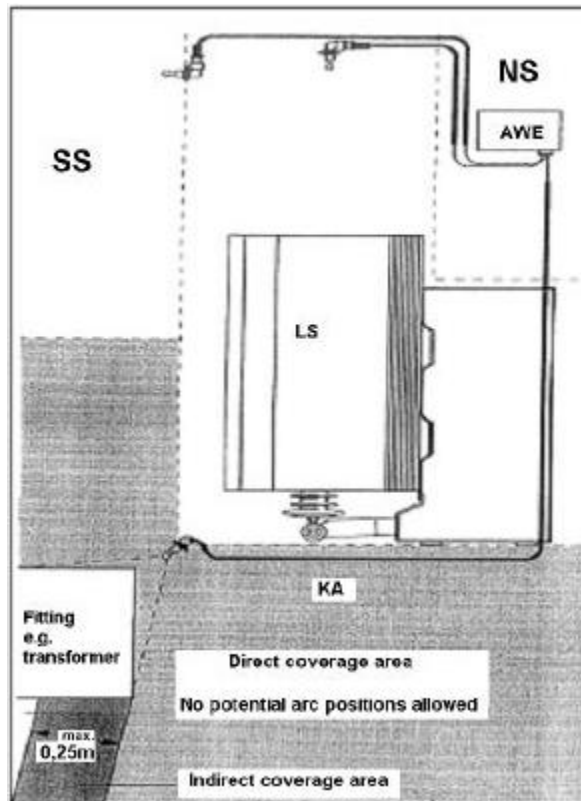
SS =
busbar

LS =
circuit-breaker

KA =
able connection

NS =
low-voltage cabinet

AWE =
Evaluation



A sensor is needed for each clad functional compartment (busbar, circuit-breaker, cable connection).

- In the ideal case the sensor must be so positioned that all potential arc positions are situated in the direct unrestricted coverage area (no casting of shadows). The maximum spacing between the sensor and arc position is 4 metres.

Preference should be given a position in the upper area of the functional compartment.

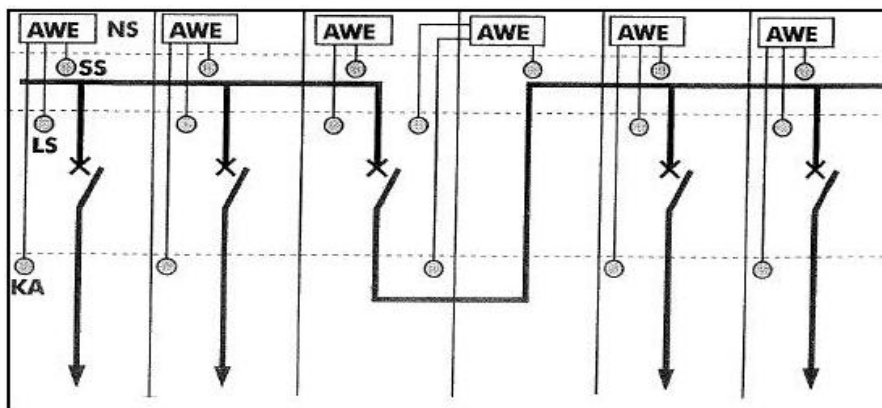
- If it is impossible to cover all potential arc positions in the direct coverage area, the indirect coverage area may also be used with restricted spacing between sensor and arc position.

The indirect coverage area is defined as follows (cf. Fig. 1). The indirect coverage may deviate by 0.25 m parallel to the boundary line of the direct coverage area. The maximum spacing (path travelled by the light) between sensor and arc position is then reduced to 2 metres.

The sensors are connected through connection cables the evaluation unit in the low-voltage cabinet of the panel.

Exception:
Switchboard with bus sectionaliser unit/busbar riser and selective disconnection of the left-hand or right-hand busbar section.

The Sensor for the left-hand busbar section in the sectionaliser panel is connected to the evaluation unit in the sectionaliser panel. The sensor for the right-hand busbar section in the sectionaliser panel is connected to the evaluation unit in the busbar riser. The sensors in the circuit-breaker compartment of the



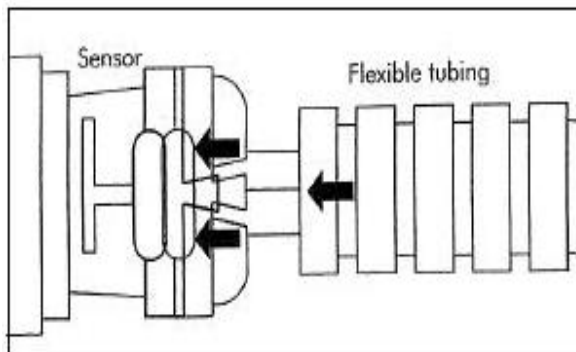
2
Switchboard with bus sectionaliser unit/busbar riser

2 Mounting the Sensors

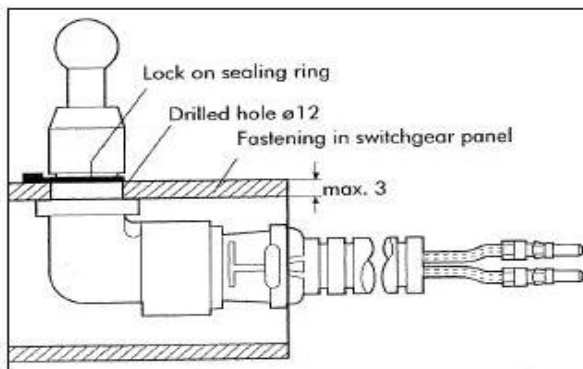
3
Slide flexible tubing
onto optical waveguide



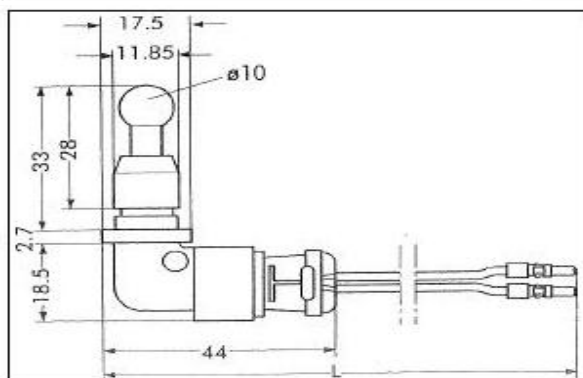
4
Engage flexible
tubing in sensor



5
Example: sensor
Installation in
an air-insulated
switchgear panel



6
Mounting
dimensions



Connect flexible tubing to sensor

(!) Install optical waveguides only with flexible tubing in the area of the switchgear panel outside the low-voltage cabinet.

The optical waveguides must not be shortened function as regards light decoupling cannot be guaranteed.

Inserting the optical waveguide in the flexible tubing is facilitated when the two optical waveguide plugs are staggered by approx. 2 cm.

(!) Optical waveguides must not be tensioned.

Slide back clamping device on the angular holder of the sensor, slide on flexible tubing and engage lamping device above flexible tubing.

Mounting in the switchgear panel

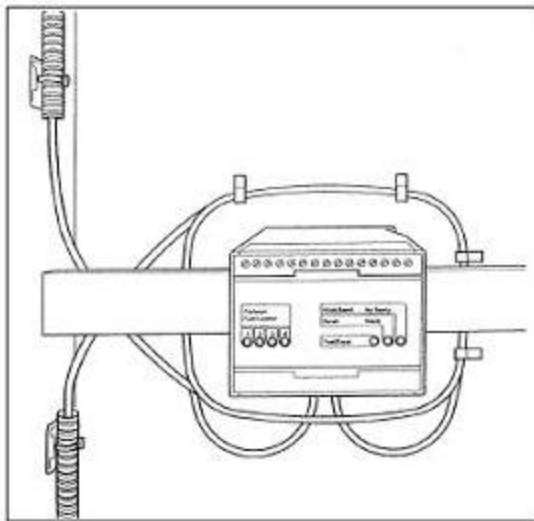
The outside surface of the sensors must be clean and not covered.

Sensors and optical waveguide cable (the end too) must not come into contact with spirits of wine and lubricants.

Optical waveguide lengths:

- L = 1.5 m
- L = 3 m
- L = 5 m
- L = 10 m

3 Laying Optical Waveguide



7
Laying optical waveguide in the low-voltage cabinet

Fix optical waveguide with flexible tubing within an air-insulated switchgear panel using cable binders and self-adherent plates (29 x 29).

Fix optical waveguide with flexible tubing into the low-voltage cabinet. At suitable points fix flexible tubing by means of self-adherent plates and cable binders. Fix further optical waveguide without flexible tubing.

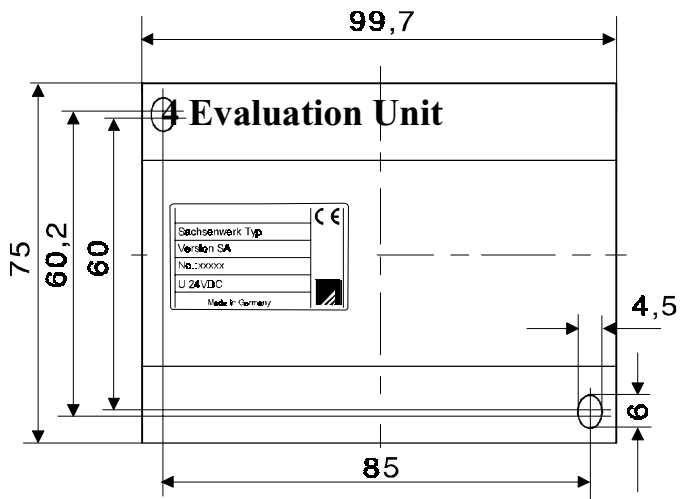
Roll up slurps lengths of waveguide with a minimum diameter of 130 mm and make bundles using insulating tape.

The ends of optical waveguides must be marked with a plate.

(!) Careful handling is necessary on laying optical waveguides:

- do not pull optical waveguides over edges.
- do not kink or shorten optical waveguides.
- the minimum bending radius on laying optical waveguides is 35 mm.
- do not expose waveguide plugs to tension.
- prevent pressure points through cable binders.

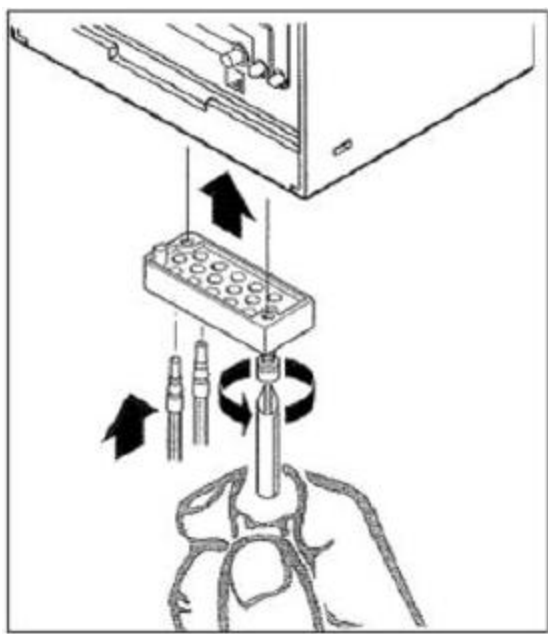
Lay connection cable (from sensor to evaluation unit) in the longitudinal and transverse posts, on cladding partitions, or similar parts, fix it in place by means of self-adherent plates (29 x 29) and cable binders.



8
Mounting dimensions of evaluation unit

Fitting in low-voltage cabinet for snap action on top hat rail in compliance with DIN 46277 and DIN EN 50022 or fitting through two drilled holes in compliance with DIN 46121 and DIN 43660.

It is recommended to equip each switchgear panel laying of the optical waveguides.

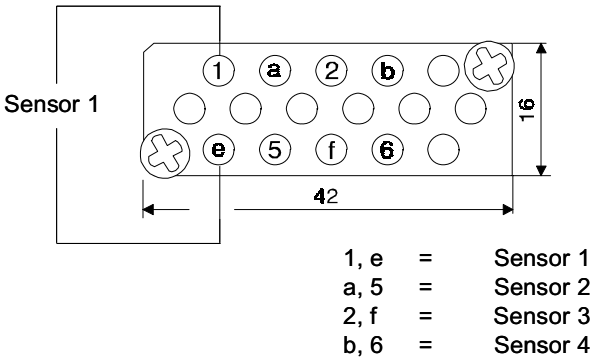


Position the evaluation unit in the low-voltage cabinet in such manner that enough space remains for connection of the optical waveguides on the underside.

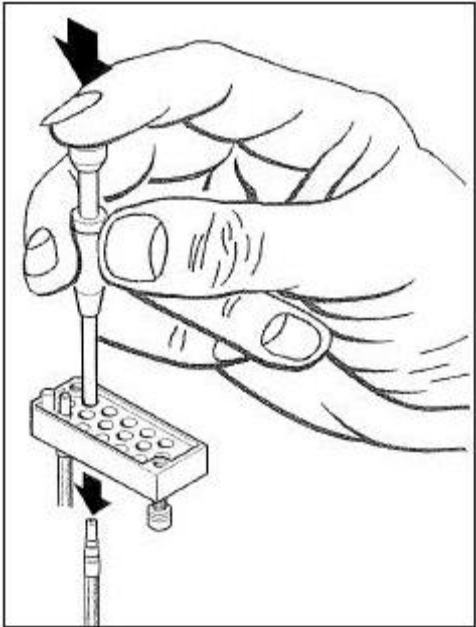
The plug-in adapter to accept the optical waveguides is situated on the underside of the evaluation unit. The optical waveguides of the sensors may be inserted in the plug-in adapter when screwed on or screwed off.

9
Connection of optical waveguides

If a termination is not connected with the sensor, an optical waveguide bridge must be connected instead.



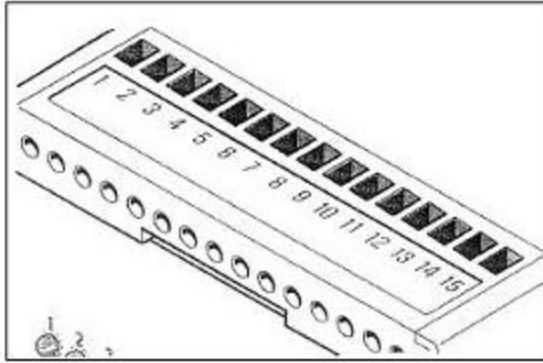
10
Contacts in the plug-in adapter



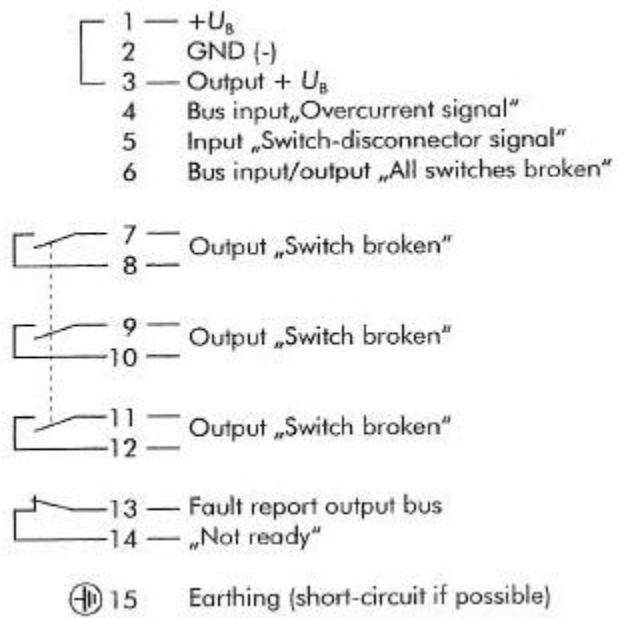
If optical waveguides shall be pushed out, the plug-in adapter must be screwed off and the optical waveguides must be removed with an ejection tool.

11
Push out connections of the optical waveguides

5 Terminal Connections



12
Terminal Strip



6 Technical Data

Admissible ambient temperatures

Service temperature:
-25 to +70°C

Storage temperature:
-40 to +85°C

Mounting position:

Perpendicular $\pm 30^\circ$

Weight:

330 g

Service data

Rated supply voltage:
 $U_B = 24 \text{ V DC (+10\% - 30\%)}$

Because of the safety of operation it is recommended to fuse the rated supply voltage of all evaluation units of a switchboard with a separate mcb. In case of use of voltage transformers for matching the rated supply voltage (cf. section 8) the mcb must be connected before the voltage transformer.

Power consumption:
 $I_B = 25 \text{ mA (max. 45 mA)}$

Power consumption on tripping:
Max. 150 mA (<1s)

Bus input “Overcurrent signal”, Terminal 4; output + U_B through terminal 3

An overcurrent signal supplied by the switchgear is internally in the evaluation unit AND-linked with a possible signal “Arc detected” to ensure unambiguous detection of the arc.

The overcurrent signal may be trapped off the overcurrent protective relay (floating contact) in the switchgear.

The overcurrent signal must be a fast contact in order to detect even weak-current arcs.

The fast contact must respond within 75 ms so that disconnection of the arc takes place and remains effective as long as the overcurrent is applied. To ensure disconnection in less than 100 ms (provided the switch time is 35 ms) in the event of high-current arcs, the fast contact must respond within 40 ms. To ensure that the overcurrent signal is applied to each evaluation unit, a ring connection is required through all installed evaluation units (terminal 4) of a switchgear.

Input voltage:
 $U_E = U_B$

Power consumption :
 $I_E = 1 \text{ mA (24 V)}$

If the danger of strong interfering light sources in the switchgear (e.g. arcing through welding work of photographic flash guns) may be precluded, the overcurrent signal may be dispensed with. Terminals 3 and 4 must then be jumpered.

Input “Switch-disconnector signal”, terminal 5; output + U_B through terminal 3

To prevent false detections on monitoring a functional compartment with switch-disconnector, an auxiliary contact (wiper or delayed break contact) must be connected to the appropriate evaluation unit (terminal 3/5). Once the auxiliary contact is closed, response of the release relay due to an arc is suppressed for 30 ms.

The auxiliary contact must close at least $> 1 \text{ ms}$ to 200 ms before opening of the main current path for at least 1 ms.

Input voltage:
 $U_E = U_B$
Power consumption :
 $I_E = 1 \text{ mA (24 V)}$

Bus input/output “All switches broken”, terminal 6

A combined input/output
In its function as input this connection is used for the internal activation “Switches broken” by means of an external signal of an adjacent evaluation unit.

Input voltage:
 $U_E \geq 12 \text{ V, max. } U_B$
Input current :
 $I_E \leq 1 \text{ mA}$

In its function as output this connection is used for the external activation of the output “Switches broken” of other evaluation units.

Synchronous with the internal outputs “Switches broken” the output is effective.

Output voltage:
 $U_A = U_B - (2 \dots 10\text{V})$
(dependent on load)

Output current:
 $I_A \text{ max. } 100 \text{ mA}$

To ensure that all the controlled switching devices in a switchgear are disconnected on detection of an arc in one functional chamber, a ring cable is necessary though all evaluation units (terminal 6) of a switchgear.

A common ground potential (GND) is an additional condition for all evaluation units.

Exception:
Switchgear with sectionaliser/busbar riser and selective disconnection of the left-hand or right-hand busbar section.
Release of the evaluation unit on arc detection may be effective only for the relevant busbar section. A connection of terminal 6 is not allowed beyond the busbar sectionaliser.

Output “Switch broken”, terminals 7 / 8 / 9 / 10 and 11 / 12

Relay output (three make contacts)

Contact making:

250 – 500 ms

Switching capacity:
max. 1250 VA/ 150W

Max. making power at 24 VDC:
168 W

Switching voltage:
max. 380 V/AC
max. 220 V/DC

Current load:
at 250 VAC: 5 A (cos φ = 1)
at 30 VDC: 5 A

Minimum response time:
5 ms

Minimum response time:

- direct drive of max. 3 switching devices or
- remoted reports or
- remote tripping the upstream incoming feeder switch.

The incoming feeder panel of a switchgear panel may be protected with LBW21 only if the upstream incoming feeder switch is integrated in the protection concept.

Fault report output bus “Not ready”, terminal 13 / 14

The report “System defect” is activated once a defect report, e.g. the breakage of an optical waveguide is detected.

A parallel circuit of the defect report outputs of all evaluation units of a switchgear is recommended so that the defect report is reduced to a single report for an entire switchgear installation

Relay output (one break contact)

Switching capacity:
max. 1250 VA / 150 W

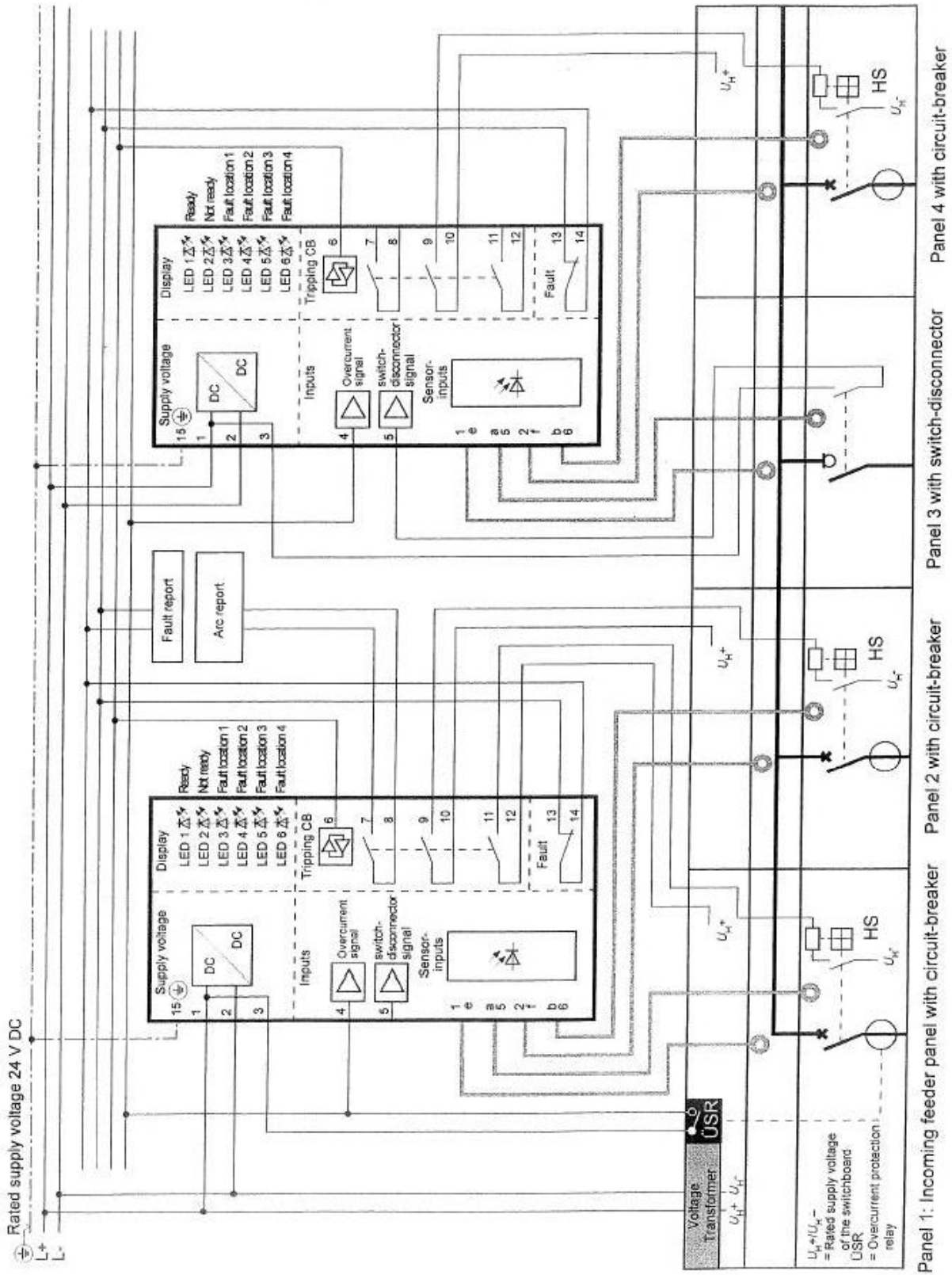
max. making power at 24 VDC :
168 W

Switching voltage:
max. 380 V/AC
max. 220 V/DC

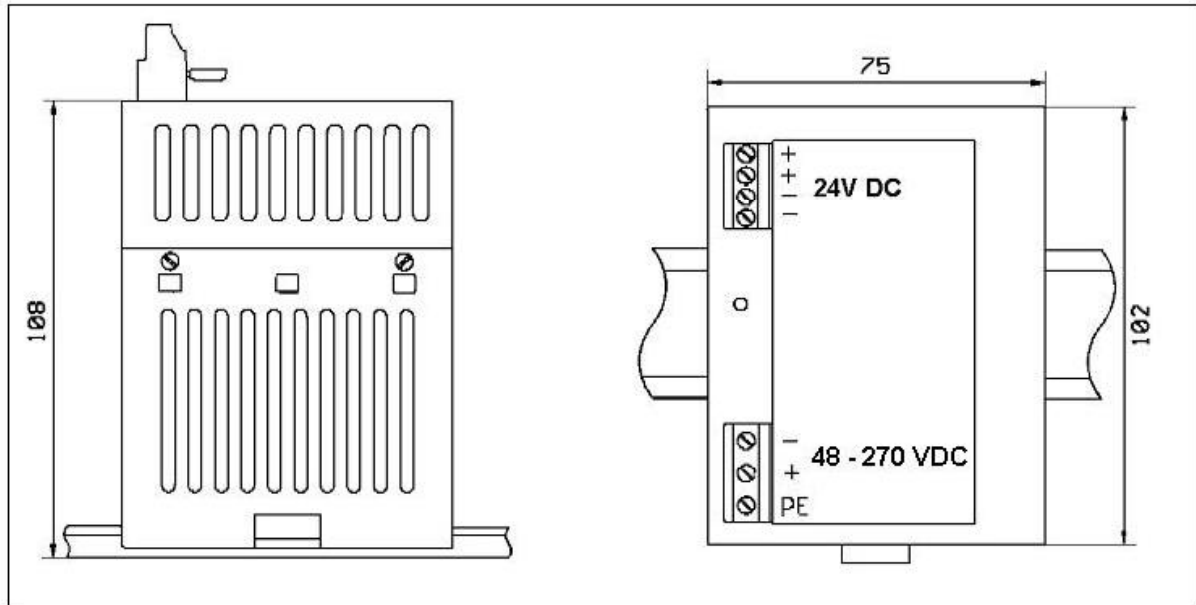
Current load:
at 250 V AC: 5 A (cos φ = 1)
at 30 V DC: 5 A

Minimum response time:
3 ms

7 Connection Example



8 Voltage Transformer for Rated Supply Voltage



13
Voltage transformer for rated supply voltage, dimensions

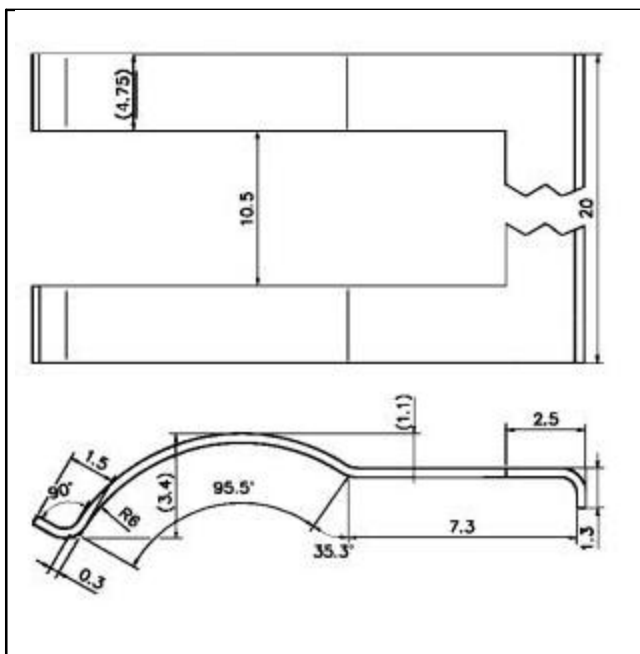
If the design supply voltage deviates from 24 VDC, voltage transformers with electrical isolation are supplied.

Input voltage ranges:
48 to 270 VDC

Output voltage:
24 VDC, 1.5A

Mounting in the low-voltage cabinet by snap action on top hat rail.

Dimension:
75 x 108 x 102 mm



14
Retaining clamp for quick mounting of sensor head

9 LBW21 Components

Item No.	Designation
AS300	Evaluation Unit
	Sensor with permanently connected optical waveguides
AS301	Optical waveguide, length 1.5m
AS302	Optical waveguide, length 3m
AS303	Optical waveguide, length 5m
AS304	Optical waveguide, length 10m
AS305	Optical waveguide bridge $L = 150 \pm 2$
AS307	Flexible tubing for waveguide (sold by metre)
AS308	Retaining clamp for quick mounting of sensor head
AS299	Voltage transformer for 48 VDC and 270 VDC
AS306	Ejection tool for optical waveguide

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1 Commissioning

Before commissioning a Medium Voltage Switchgear with an installed Intelligent Light Information System (LBW21), the complete system must be checked.

Test of the complete system during commissioning

- Test LBW21 with the Test/Reset button (Section 3.2). Thereby check the LED indicators and the fault report outpost.
- Test of release:
 - Bridge input terminals 3 and 4 of overcurrent signal. (The bridge is already wired if LBW21 is operated without overcurrent criterion.)
 - Flash at least one sensor of each evaluation unit. Distance to sensor < 0.3 m

(!) LBW21 breaks all connected switching devices.

Recommended flash light device: Metz Mecablitz 45CL4 (manual operation mode, full light capacity). If such a flash light device is not available, another flash light with following characteristic data may be used:

- guide number min. 45 at 21-DIN film
 - shutter time min. 1/300 s
 - operation angel for illumination approx. 62° x 42°
 - colour temperature approx. 5600 K
- Remove bridge at input terminals 3 and 4 which has been wired for the test of release.

After commissioning the LBW21 is free of maintenance

2 LBW21 in Service

The Arc Detection System (LBW21) consists of sensors, an evaluation unit and a power supply.

The LBW21 is installed by panel (one evaluation unit per switchgear panel) or inter-panel (one evaluation unit for max. five switchgear panels). The arrangement depends on the number of function compartments which must be monitored in a switchgear panel.

The LBW21 must be fitted in switchgear and control gear in such manner that arcs are definitely detected in the shortest possible time. In this manner high sensitivity is achieved.

By means of a green LED "Ready" the LBW21 indicates its readiness for operation.

In service the LBW21 continuously monitors the function compartments concerned for light emissions.

The digital electronics of the evaluation unit and the optical waveguides operate on the light optical principle and cannot therefore be influenced by electromagnetism.

Irrespective of other light sources the evaluation unit analyses the sensor signals, indicates the location of arcing and generates separately the reports "Arc detected" – "System defective".

Through the generation of internal test signals the optical sensors for the detection of an arc are continuously tested.

The test signals produce a light signal which is transmitted to the sensor head through the optical waveguide. Through the diffusion in the sensor head the signal is fed.

Into the second optical waveguide and returned to the evaluation unit.

If faults are detected in the optical signal path (e.g. line interruption) or also in the electrical signal path (receiver, amplifier), the fault is displayed by means of the LED "Not ready" on the front panel, the report "Not ready" is reported by bus and the appropriate sensor channel for evaluation is deactivated.

The self-monitoring of the sensor Path is performed in a 200 msec. cycle.

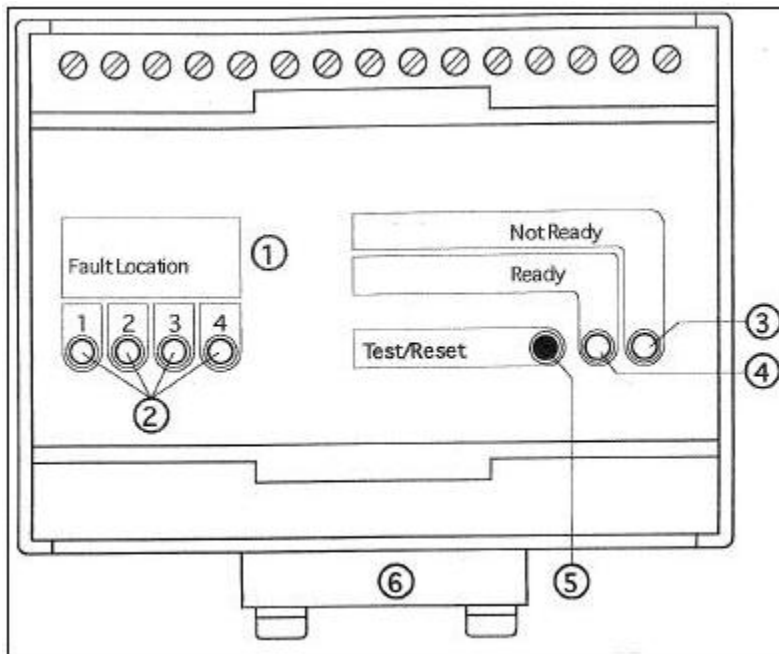
If one evaluation unit fails the rest of The system remains fully operational.

In the event of a voltage failure (rated supply voltage 24 VDC) the LBW21 remains in operation for further 200 msec.



1
LBW21

Evaluation unit



2 Evaluation unit

(1) Fault location

1 to 4 are function compartments of the switchgear panel, which are shown in the binding LBW21 diagram placed in the information pigeon hole of the switchgear panel in question.

(2) Red LED:

The four sensor LED's are used to display arcing and sensor module defects. An LED is continuously illuminated when the evaluation unit for the relevant channel detects an arc. On the display or arcing the remote report takes place as group report "Arc detection".

(3) Yellow LED:

Remote report as group report "System defective". When the yellow LED lights up, the green LED is extinguished.

(4) Green LED:

The system is in proper condition. The system is serviceable.

(5) Test/Reset button:

Press the Test/Reset button. When the Test/Reset button is released all display LED's light up for 3 seconds. Afterwards a test process is initiated, during which the optical waveguide cables to the sensor head are tested with two threshold values.

When the threshold values are adhered to

all the LED's are extinguished and the green LED is illuminated. At the same time the fault report output "Not ready" is closed for 3 seconds.

When the threshold values are not adhered to

The yellow LED "Not ready" (system fault) is illuminated continuously and the relevant sensor LED, in whose sensor branch the fault is located, is illuminated for 3 seconds. At the

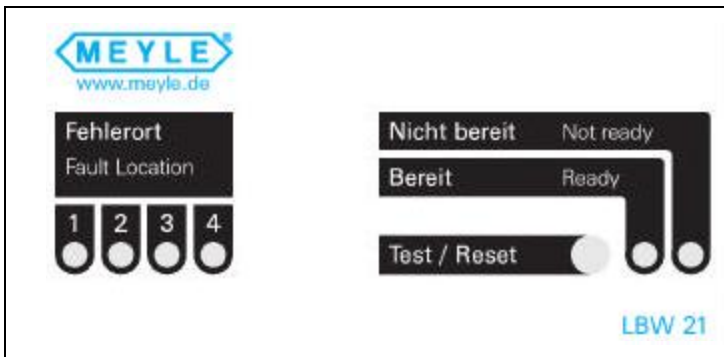
same time the fault report output "Not ready" is closed permanently. In this case consult the manufacturers.

When an arc is detected

the relevant sensor LED may be reset by means of the Test/Reset button.

(6) Plug-in adapter for four pairs of sensors.

3 Displays, Reports and Contact Reactions



3
Display

3.1 Fault detection by cyclic Selfmonitoring

Display/Report

- The LED for “Not ready” is permanently illuminated.
- Fault report output is permanently closed

Function

Fault in a sensor circuit or in the evaluation unit.

Necessary action

- Press the Test/Reset button to ascertain whether or not a sensor circuit fault is concerned.
- Check the sensor connected to the sensor circuit concerned for correct fitting and laying on the optical waveguide. If the fault is not rectified, the sensor concerned must be replaced in the medium-term.

If there is no sensor circuit fault, exchange the evaluation unit.

3.2 Fault detection by manual actuation of the Test/Reset button

Test of the LED's and the fault report output:

Display/Report

- All display LED's are illuminated for 3 seconds.
- Afterwards all LED's are extinguished for 3 seconds and the fault report output is closed for 3 seconds.

Function

The evaluation unit is not serviceable for approx 6 seconds (test run) for the detection of arcs. After 6 seconds the green LED “Ready” is illuminated when all sensor circuits and the evaluation unit are in order.

3.2.1

If, after the 6 seconds test run (cf. item 3.2), the warning threshold has not been reached in a sensor circuit:

Display/Report

- The LED of the sensor circuit concerned (fault location) is illuminated for 3 seconds.

- The LED for “Not ready” is illuminated for 3 seconds.
 - The fault report output is closed for 3 seconds
- On expiry of the 3 seconds the system is set to the status “Ready”

Function

During the 9 seconds (test run) the evaluation unit is not ready for detecting arcs.

Necessary action

Check the sensor connected to the sensor circuit concerned for correct fitting and laying of the optical waveguide. If the fault is not rectified in the sensor concerned must be replaced in the medium-term.

3.2.2

If, after the 6 Seconds test run (cf. item 3.2) the alarm threshold has not been reached in a sensor circuit:

Display/Report

- The LED of the defective sensor circuit is illuminated for 3 seconds.
- The LED for “Not ready” is illuminated permanently.
- The fault report output is closed permanently.

Function

During the 9 seconds (test run) the evaluation unit is not ready for detecting arcs. The defective sensor circuit is disconnected for detection. After the test run the remaining sensor circuits are fully serviceable.

Necessary action

Check the sensor connected to the sensor circuit concerned for correct fitting and laying of the optical waveguide. If the fault is not rectified, the sensor concerned must be replaced soon.

3.3.

Detection of an arc

Arc detected (light excitation and applying an overcurrent signal to LBW21)

Display/Report

- The display “Fault Location” is illuminated permanently.
- The LED for “Ready” is illuminated permanently.
- All output relays “Switch broken” are enabled for at least 250 msec (max 500 msec).

Function

The LBW21 system is fully serviceable

Necessary action

The switchgear section is concerned is disconnected. Inspect the switchgear, record damage, initiate disposal and repair. Check LBW21 system of the panel concerned and replace in the event of damage.

Resetting

Resetting the display “Fault Location” by means of the Test/Reset button.

List of Displays

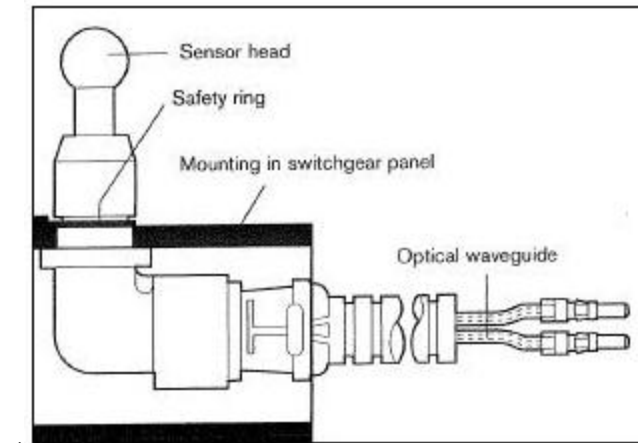
Event	1-4 (red LED)	Display Ready (green LED)	Not ready* (yellow LED)	Reaction	
				Tripping CB	Fault report
System without power supply	○	○	○		X
System ready	○	●	○		
Arc	● rel. LED	●	○	X	
Test/Reset button: all LEDs light for 3 secs	●	●	●		X
Cyclic test: sensor circuit fault or other internal faults	● rel. LED	○	●		X
Equipment defect	○	○	●		X

*All “Not Ready” states are reported through relay contacts.

4 Sensor in the Switchgear Panel

Sensor

The sensor is a ball-shaped head with two optical waveguides coupled to it. Its design as “diffused ball” allows feeding light into the optical waveguides with uniform sensitivity irrespective of the angle of incidence of the light. The head is mounted on a bracket with a clamping device for a flexible plastic protective tube, into which the optical waveguide is inserted and is protected against mechanical damage.



4 Sensor in an air-insulated switchgear panel

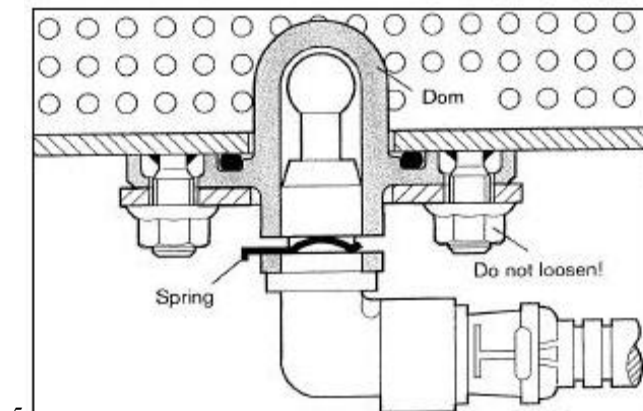
The “dual optical waveguide technology” is also used for selfmonitoring of the sensor circuit: light is fed into an optical waveguide, passed through the “diffused ball” to the other optical waveguide and conducted to the evaluation unit.

Dome

The transparent dome (fitted only in gas-insulated switchgear) is used as

- window into the function compartments of a switchgear panel
- acceptance and fastening piece for the sensor.
- sealing element, which allows the replacement of sensors without opening the gas chamber.

Consequently the fastening screws must not be loosened.



5 Sensor with dome in a gas-insulated switchgear panel

Cleaning

Sensors and optical waveguide cables (including the ends) must not be brought into contact with spirits (ethanol) and the SF₆ multi-purpose lubricant MS.

The dome must not come into contact with spirits (ethanol). Clean all parts with water only (moist duster) if necessary.

5 Plug-in Adapter (Connections for Sensors)

The sockets are connected in accordance with the LBW21 diagram (in the information pigeon hole of each switchgear panel). The maximum tensile load on the sensor is 5 N.

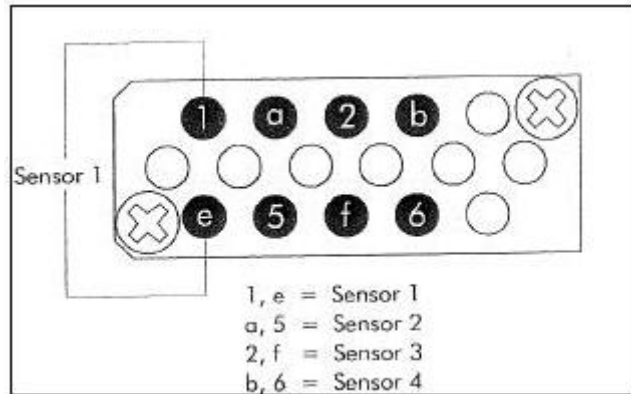
The optical waveguides must not be shortened or kinked and the radius of bend must be larger than 35 mm.

The excessive length of the optical waveguides must be rolled up in the low-voltage cabinet or in the cable ducts and fixed in bundles with Velcro strips. Note that the minimum diameter must be 130 mm. The ends of the optical waveguides are marked with a plate.

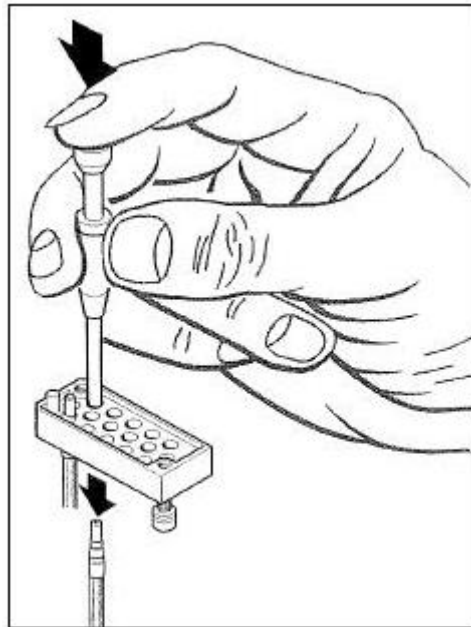
The plug-in adapter to accept the optical waveguides is arranged on the lower side of the evaluation unit. The optical waveguides of the sensors may be inserted in the plug-in adapter when it is screwed on or not.

If the connection of optical waveguides shall be removed, the plug-in adapter must be screwed off and the sensors removed with an ejection tool.

Item No.	Part
AS306	Ejection tool for optical waveguides

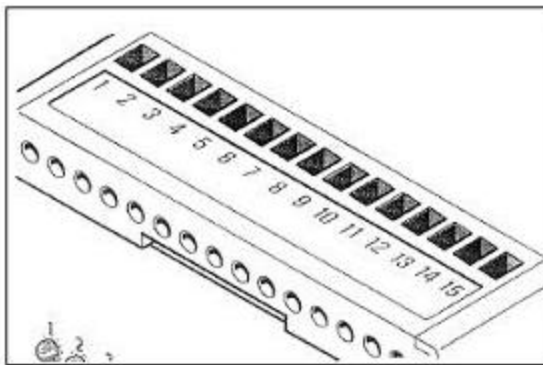


6
Contacts in the plug-in adapter

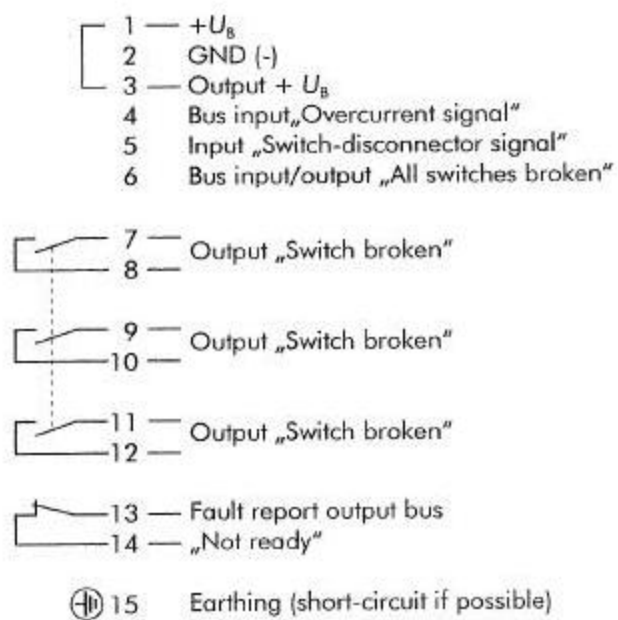


7
Pushing out connections of optical waveguides

6 Terminal Connections



8
Terminal strip



7 Technical Data

Arc detection

The arc is detected in a period of approx. 6 msec. (minimum excitation time) for high current density arcs, up to 250 msec. (maximum excitation time) for very low current arcs.

Type tests

The type tests are performed in compliance with DIN VDE 0435, part 303

Service conditions

Suitable for normal service conditions in compliance with IEC Publication 60694. Temperature class: "minus 25 indoor".

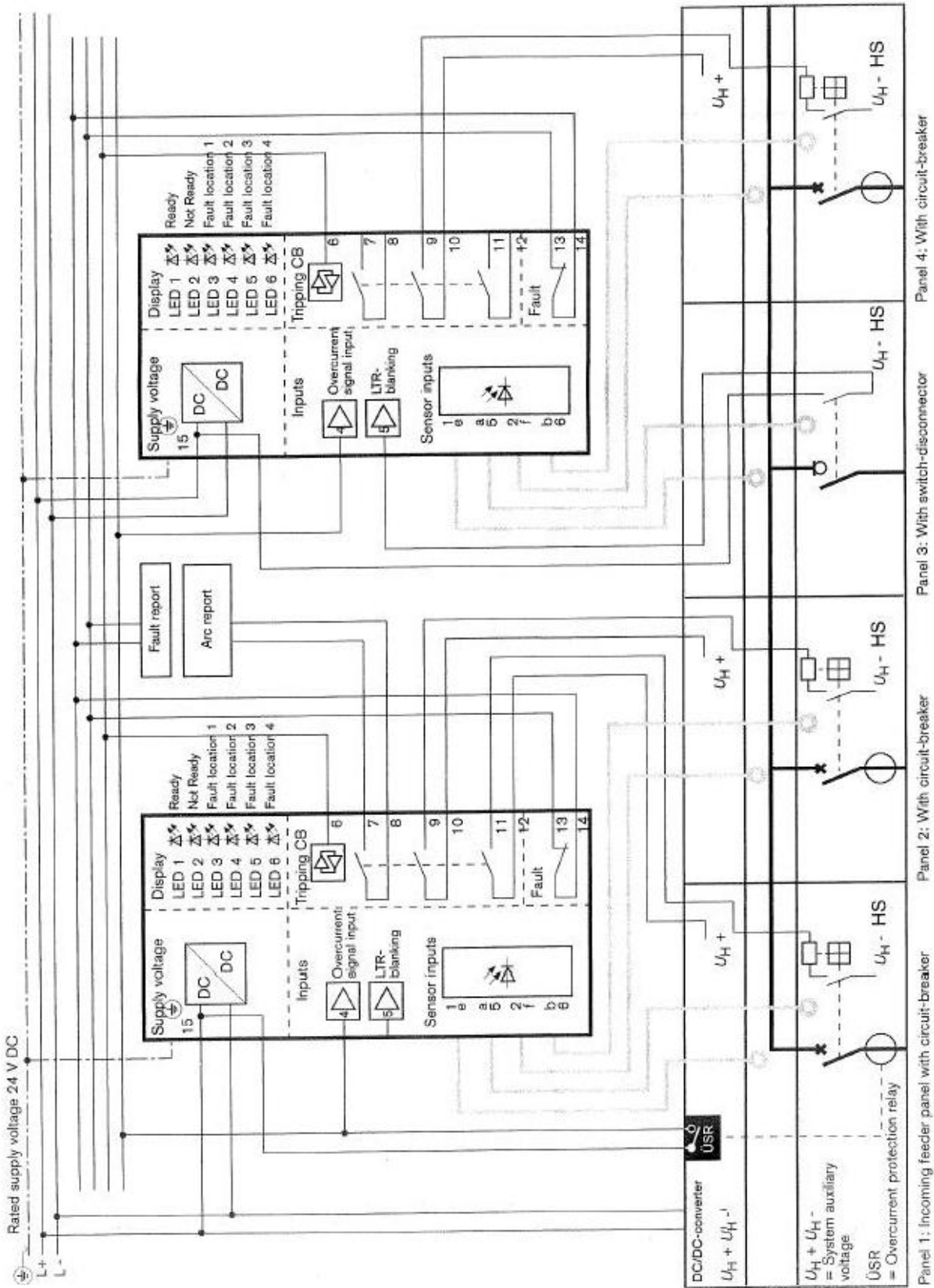
Service data

Rated supply voltage:
24 VDC (+10% / -30%)
Max. power consumption: < 4W

Switching capacity of relay outputs:
Current load
at 30 VDC: 5 A
at 250 VAC (cos φ = 1): 5 A

Max. making power
at 24 VDC: 168 W

8 Connection Example



Motors and Drives from 5 Watt to 1000 kW

- Servomotors
- Gears
- Geared motors
- Servo inverter
- Frequency inverter



Encoder and Length Measuring Systems

- Incremental Encoder
- Absolute Encoder
- (single-/multiturn)
- Profibus Encoder
- CAN-Bus Encoder
- Interbus Encoder
- Length Measuring Systems
- Heavy Duty Encoder
- Hollow Shaft Encoder with inside diameter 6–60 mm



Counting and Controlling

- Totalizing Counters
- Preset Counters
- Position Indicators
- Timers/Time Relays
- Tachometers
- Pneumatic Timers
- Process Controllers



Sensors for all Applications

- Opto-electronic sensors
- Contrast scanners
- Colour sensors
- Distance sensors
- Safety light curtain
- Light grid
- Laser scanner
- Safety switches
- Proximity switches





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