Linear smoke detector

Technical description
Planning
Installation
Commissioning
Technische Änderungen vorbehalten.
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1 Overview

1.1 Characteristics

- Switchable to conventional SynoLINE systems
- Microprocessor-controlled signal processing
- Suitable for surveillance ranges from 5 to 100m
- Operates according to the principle of light-attenuation by smoke
- Response behavior selectable in 3 sensitivity stages
- Automatic digital compensation of ambient influences
- High immunity to extraneous light
- Transmitter and receiver installed in the same housing
- Easy installation, adjustment and commissioning
- Two-wire installation
- Comprehensive accessories
- New diagnostic capabilities with fuzzy logic
- Efficient signal processing algorithms with application-specific characteristics
- Comprehensive EMC concept based on the latest technologies
  enables the detector to be installed in difficult environments
- Integrated multi-coincidence circuit
  suppresses extreme electrical and optical noise signals
1.2 Design

The BeamRex DLO1191 comprises:
- Base DLB1191A consisting of:
  - Terminal support with terminals

The base is required already at the time of installation. The base housing features six PG16 tapped cable inlets.
- Detector module DLA1191A consisting of:
  - Transmitter
  - Receiver
  - Lens
  - Electronics

The plug-in detector module is inserted just prior to commissioning.

The lens can be optimally aligned to the reflector by means of the adjustment set.

Reflectors
Different reflectors are available for different distances:
- 5 to 30m Reflector foil DLR1193 (10 x 10cm) 1 pc.
- 30 to 50m Reflector foil DLR1192 (20 x 20cm) 1 pc.
- 50 to 65m Reflector foil DLR1192 (20 x 20cm) 4 pcs.
- 20 to 100m Prism made of glass DLR1191 (cat’s eye) 1 pc. with built-in heating against condensation

Short distance filter
For shorter distances between 5 and 10 m an additional short distance filter is required:
- 5 to 8m DLF1191-AB
- 7 to 10 m DLF1191-AA
- Filter against external light influences DLF1191-AC

The detector is rarely influenced by external light. If, however, powerful external light causes interference, the filter DLF1191-AC can be used to eliminate this.

Accessories:
- Detector heater DLH1191 for DLO1191, against condensation of the lens

Auxiliary tools:
- Detector adjustment set DZL1191 consisting of:
  - Adjustment device
  - Test filter
  - Aiming device
1.3 Operating principle

The linear smoke detector operates on the basis of the extinction principle, i.e. the reduction in light intensity due to smoke is measured. The transmitter (IRED) emits a strongly focused infrared light bundle along the optical measuring section. Without smoke a large part of the beams attains the reflector and is sent back in the same direction toward the receiver. The arriving light produces an electrical signal on the photodiode of the receiver.

![Fig. 1 Linear smoke detector without smoke](image1)

If smoke penetrates the measuring section, part of the light beams is absorbed by the smoke particles while another part is scattered by the smoke particles, i.e. the light beams merely change direction. The remaining light reaches the reflector. The remaining light is then reflected and once again passes through the measuring section and is further attenuated. Thus only a small portion of the beam reaches the receiver and the signal ($S_{\text{smoke}}$) becomes smaller.

![Fig. 2 Measuring principle of the linear smoke detector with smoke](image2)

Extinction = Absorption + Scattering
## 2 Technical data

Normal ambient conditions, if nothing else is specified:
Temperature $T_a = 20^\circ C (293 K)$
Air pressure: $p = 1'000hPa (750 Torr)$

### 2.1 Conventional SynoLINE mode

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Unit</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage (quiescent)</td>
<td>$U_b$</td>
<td>V</td>
<td>18</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum permissible voltage</td>
<td>$U_{\text{max}}$</td>
<td>V</td>
<td></td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch-on current</td>
<td>$I_e$</td>
<td>mA</td>
<td>2.8</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Operating current (quiescent condition)</td>
<td>$I_b$</td>
<td>mA</td>
<td>1.5</td>
<td>2.8</td>
<td></td>
<td></td>
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<tr>
<td>Alarm voltage at $I_A = 1 \ldots 10mA$</td>
<td>$U_A$</td>
<td>V</td>
<td>5</td>
<td>11</td>
<td></td>
<td></td>
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<tr>
<td>Alarm current at $U_b = 24V$</td>
<td>$I_A$</td>
<td>mA</td>
<td>40</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reset voltage</td>
<td>$U_R$</td>
<td>V</td>
<td>2</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reset current</td>
<td>$I_R$</td>
<td>$\mu A$</td>
<td>5</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reset time ($U_R = 2V$)</td>
<td>$t_R$</td>
<td>s</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response indicator Voltage</td>
<td>$U_{ie}$</td>
<td>V</td>
<td>3</td>
<td>6</td>
<td></td>
<td>permanent</td>
</tr>
<tr>
<td>Response indicator Current</td>
<td>$I_{ie}$</td>
<td>mA</td>
<td></td>
<td>60</td>
<td>100</td>
<td>pulsed</td>
</tr>
<tr>
<td>Flashing frequency</td>
<td></td>
<td>Hz</td>
<td>1</td>
<td></td>
<td></td>
<td>$f \geq 0.5Hz$, Duty Cycle 50% depending on line module</td>
</tr>
<tr>
<td>Connection factor</td>
<td>KMK</td>
<td>–</td>
<td>25</td>
<td>–</td>
<td></td>
<td>maximum 1 detector per detection line</td>
</tr>
</tbody>
</table>
### 2.2 General data

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Unit</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between detector and reflector</td>
<td>L</td>
<td>m</td>
<td>8</td>
<td>100</td>
<td>&lt;10m filter DLF1191-AA</td>
<td></td>
</tr>
<tr>
<td>Additional area (without approval)</td>
<td></td>
<td></td>
<td>5</td>
<td>8</td>
<td>Filter DLF1191-AB</td>
<td></td>
</tr>
<tr>
<td>Response sensitivity</td>
<td>D₁</td>
<td>%</td>
<td>65</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>reduced</td>
<td></td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>standard</td>
<td></td>
<td></td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>increased</td>
<td></td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensation (if beam is attenuated)</td>
<td>%</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensation speed</td>
<td>%/h</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-test interval</td>
<td>min.</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
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<tr>
<td>Alarm integration</td>
<td>s</td>
<td></td>
<td>6</td>
<td>16</td>
<td>Dependent on diagnosis</td>
<td></td>
</tr>
<tr>
<td>Fault activation</td>
<td>%</td>
<td></td>
<td>&gt;90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR transmitter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wavelength</td>
<td>nm</td>
<td></td>
<td>880</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse frequency</td>
<td>Hz</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse length</td>
<td>µs</td>
<td></td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electromagnetic compatibility</td>
<td>V/m</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>Tₐ</td>
<td>°C</td>
<td>-25</td>
<td>+60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>≤30°C</td>
<td></td>
<td>≤95% rel.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;30°C</td>
<td></td>
<td></td>
<td>≤29g/m³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tₐ</td>
<td>°C</td>
<td>-30</td>
<td>+75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colour: pure white</td>
<td></td>
<td></td>
<td>~RAL9010</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Detector heater DLR1191 / DLH1191**

| Supply voltage | U_H | V DC | 20 | 30 |
| Operating current | I_H | mA | 33 | 50 |
| Resistance | R | Ω | 600 | |

**Classification**

- Standards: BS 5839: Part 5
- CE conformity marking
- Application category: IEC 60721-3: 3K6
- Test category: IEC 60068-1: 25/060/42
- Protection category: IEC 60529: IP65

**Compatibility:**

- conventional SynoLINE

**Environmental compatibility:**

- Easy to overhaul
- Easy to uninstall and disassemble
- Plastic material identifiable through embossed code
3 Design and principle of operation

3.1 Detector

3.2 Structure of the infrared beam

The infrared beam emitted by the transmitter to the reflector is not a strictly parallel bundle of rays. It exhibits a certain degree of scattering which makes it conical in shape. The radiation energy decreases towards the outside, so that the beam can be divided into the three effective, core and scattered regions. The reflector possesses the characteristic to retransmit the received light.
The effective region corresponds to the ribbon connecting transmitter, reflector and receiver.

The core region contains sufficient radiation energy to operate the system.

The energy in the scattered region is not sufficient to ensure reliable operation of the system.

### 3.3 Alignment possibilities

The infrared beam can be adjusted by each $10^\circ$ in horizontal direction and each $5^\circ$ in vertical direction from the centre axis. When selecting the optimum mounting location bear in mind that this adjustment range can be fully used. Experience has shown that the detector and reflector should be arranged as parallel as possible especially with distances of $>50$m, as this makes adjustment simpler.

One rotation of the knurled screw moves the beam at $100$m approx. $1.15$m.
3.4 Refectors

Retroreflectors reflect the received light beam in parallel to the latter. For this reason the reflector does not have to be installed thereby mandatory right–angled to the infrared beam. Also vibrations and distortions of the reflector mounting wall do not cause any problems. Another advantage is that any extraneous light is also reflected in its own direction and consequently does not reach the receiver.

![Diagram of reflector and reflector foil]

Fig. 8 The reflector and reflector foil can be mounted inclined max. ±20° in all directions

**DLR1191 prism**

The retroreflecting prism has the shape of a pyramid whose lateral faces are formed by isosceles orthogonal triangles. Light beams entering through the base are completely reflected twice on the lateral faces and reflected back through the base.

The prism is installed in a housing that is identical to the one used for the detector base. The reflector is equipped with a reflector heater at the factory. If dew condensation is possible the heater should be connected to a 24V supply.

![Diagram of DLR1191 reflector and reflection principle]

**DLR1192, DLR1193 reflector foil**

This foil consists of microprismatic elements that are formed by transparent, synthetic resin sealed to a plastic substrate. In principle, the reflector foil has the same effect (function) as the prism.

3.5 Compatibility

<table>
<thead>
<tr>
<th></th>
<th>Conventional SynoLINE600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control unit</td>
<td>FC330C, FC330A, FC500C</td>
</tr>
</tbody>
</table>
3.6 Description of block diagram

The transmitter 1 transmits the light pulses to the reflector 2. This transmits the light pulses back to the receiver 3. The light pulses are proportional to the signal current, which is amplified in the preamplifier 4 and fed to the customer-specific integrated circuit (ASIC) 5. The microprocessor (µP) 6 synchronizes the receiver pulses with the transmitter pulses so that no external pulse is evaluated.

The sensor-specific functions are contained in the ASIC. It is used to filter signals, process signals using fuzzy algorithms, amplify signals and for the entire sequence control which is synchronized with the µP.

The µP communicates with the control unit via the line interface 7 via terminals 8 and the two-wire bus line. The detector receives commands which activate the type of operating mode, diagnostic stages etc. via the data interface which is integrated in the line interface. The detector transmits response signals, the results of diagnostic polling and status signals back to the control unit.

With the help of the isolation function, sections which malfunction are “isolated”, so that in the event of a short circuit, the entire bus line does not break down. Upon short circuit, two “electronic switches” (FET) open automatically and isolate the line in the area where the malfunction has occurred until the short circuit has been eliminated.

The internal response indicator (AI) 9 and the external response indicator 10 provide indication of alarm and are activated by the control unit.

The 6 DIP switches 11 allow parameterization of the detector (see section 6.1).

The REED contact 12 serves to initialize the detector during commissioning (see section 6.4).

A detector heating device, which prevents condensation of the lenses, can be connected to detector heating terminal 13.

The DZL1191 adjustment device can be connected via connector 14. The purpose and function of the adjustment device is explained in section 6.3 (electronic alignment).

Fig. 10 Block diagram
3.7 General detector functions

3.7.1 Alarm algorithms

Compensation value
The compensation value (NFW) is the reference variable for the actual measurement signal. All thresholds, diagnostic functions and self-checking are based on the current compensation value.

The first compensation value (NFW) is set at the time of initialization. It is subsequently updated approx. every 60 minutes to compensate a slow drift of the measurement signal. This drift can be caused, for example, by contamination of the detector optics.

The maximum compensation is 50% of the total signal of 100%.

Response threshold
The response threshold corresponds to a danger level.
An alarm algorithm is activated when the response threshold drops.
According to the sensitivity setting, the response threshold is higher or lower.
**Smoothing**

The measuring signal is measured with a 6Hz clock. The raw data are processed with so-called "smoothing filters" for subsequent evaluation. In this way extreme peak values caused by signal interference are "smoothed".

An alarm is triggered based on the smoothed signals.
Three “smoothing filters” A, B and C are used. They are characterized by the time it takes to reach response threshold 3 of the corresponding sensitivity setting.

If the smoothed signal reaches response threshold 3, the alarms in the alarm counter are added up. Upon reaching the given value, danger level 3, i.e. an alarm is activated.

According to the diagnosis made, other alarm parameters are automatically selected:

- **Diagnosis “Fire or slowly-developing fire”** \( \Rightarrow \) alarm activation after \( \leq 6s \) (smoothing A + 20 alarm counts)
- **Diagnosis “Noise or repeated interruption”** \( \Rightarrow \) alarm activation after \( \leq 16s \) (smoothing C + 20 alarm counts)
- **Diagnosis “Test filter”** \( \Rightarrow \) alarm activation after \( \leq 10s \) (smoothing A + 40 alarm counts)

Smoothing filter B filters out reflections.

Reflecting or shining surfaces, which are too near at the path of the beam, can impair the detector.

**Smoothing B > actual compensation value x 1.5 = reflection**
Application diagnoses

The detector has an automatic diagnosis evaluation facility based on complex fuzzy algorithms. The raw data are treated by 4 different filters. Each filter assesses a special characteristic of the signal: Gradient, noise, asymmetry, jump.

Filter

Typical events and results for the 4 filters:

**Fire**

<table>
<thead>
<tr>
<th>Raw data</th>
<th>Gradient indicator</th>
</tr>
</thead>
</table>

**Thermal turbulence**

<table>
<thead>
<tr>
<th>Raw data</th>
<th>Noise indicator</th>
</tr>
</thead>
</table>

**Repeated interruptions**

<table>
<thead>
<tr>
<th>Raw data</th>
<th>Asymmetry indicator</th>
</tr>
</thead>
</table>

**Test filter**

<table>
<thead>
<tr>
<th>Raw data</th>
<th>Jump indicator</th>
</tr>
</thead>
</table>
3.7.2 Fuzzy Logic

The different «filtered» and smoothed signals are combined with fuzzy logic. A diagnosis is prepared automatically and on-line.

Principle of the fuzzy logic

- **Signal**
- **Noise**
- **Gradient**
- **Jumps**
- **Asymmetry**

**Regulating**

- **Beam interruption**
- **Condensation**
- **EMI**
- **Test filter**

**Fuzzification**

**Defuzzification**

**Modification of alarm criteria**

**Diagnosis/misapplication warning**
3.7.3 Possible diagnosis results

1. Fire
The detector registered a signal which corresponded to a normal fire with the necessary extinction and activated an alarm.

If this turns out to be a false alarm, then most probably an aerosol was present in the room which simulated the development of a genuine fire and caused the necessary extinction.

Possible remedy: – Less sensitive setting

2. Slowly developing fire
The detector registered a signal which corresponded to a slowly developing fire and upon sufficient extinction activated an alarm.

In the event of a false alarm the diagnosis could point to possible condensation.

Possible remedy: – Install detector heating
– Less sensitive setting

3. Thermal turbulence / electromagnetic interference (EMI)
Thermal turbulence points to powerful air circulation. This is mainly caused by air heaters, baking ovens, furnaces etc.

Thermal turbulence and/or powerful electromagnetic interference generate “noise” which is filtered out by the algorithms. However, if it exceeds a certain strength and duration, it can still lead to detector impairment.

Possible remedy: – Remove detectors from such an environment.

4. Repeated interruption
Repeated interruption of the beam is caused by moving objects, such as cranes, ladders, decorations etc. or also by powerful electromagnetic interference which has an effect on the detector.

Normally, in time this leads to fault signals being activated, but also results in unwanted alarms.

Possible remedy: – Such applications must be avoided

5. Test filter
If the test filter is held in the infrared beam, it causes a sudden decrease in signal strength without however, reaching zero.

This characteristic causes the detector to activate an alarm after approx. 10s.
4 Planning

4.1 General project engineering principles

The linear smoke detector DLO1191 is due to its detection principle and its large monitoring surface for certain applications an attractive detector.

*If local national regulations exist concerning application, have this priority!*

4.2 Operating conditions

- The distance between DLO1191 and reflector must be between 5m and 100m.
- There must be a permanent, clear line of vision between detector and reflector.
- The monitoring IR beam may not be interrupted by moving articles, e.g. overhead cranes, ladders, transportable articles, spiders’ webs etc.
- Turbidity of visibility caused by operations-related dust, steam or smoke development can impair the system.
- The mounting place of the detector must be statically absolutely stable, since the allowable deviation of the monitoring beam amounts to max 0,43° (see section 3.2).
- Concrete and brick walls mostly fulfill these characteristics.
- Pure wood and steel constructions are usually unsuitable, there temperature and humidity variations, wind or snow pressure influence such constructions.
- The monitoring beam must have free view at least 30cm on all sides, so that no unwanted reflections develop.
- Frontal incidence of sunlight, light from halogen lamps, etc. on the DLO1191 should be avoided if possible (to high temperature).
- For the service staff the detector must be at any time well accessible.
- Cleaning and adjusting works are badly executable on ladders. Suitable equipment for this purpose includes fixed catwalks, platforms, “Skyworker” etc.
- The alarm activation of the DLO is based on the light attenuation caused by smoke (extinction). The accumulation of smoke in a fire is adequately dense usually only in the "smoke plume", in order to produce sufficient extinction for alarm activation.
- For this reason always mount the DLO1191 in the vicinity of the ceiling (see Fig. 21 for distances). It must not be too close to or too far from the ceiling.
- For very high rooms we recommend to arrange additional DLO1191 on different levels (see section 4.6.3) and/or additionally to install flame detectors.

*If careful attention is not given to these points, the linear smoke detector system cannot function correctly and sometimes later leads to insoluble problems with unwanted activation of fault and alarm signals.*
4.3 Fields of application

4.3.1 Examples of suitable fields of application

Basically whenever point type smoke detectors do not offer the best solution and where linear smoke detectors comply with the operating conditions in section 4.2 and thus have as regards application, installation and price.

<table>
<thead>
<tr>
<th>Use</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings with ceilings of historical interest</td>
<td>Point type detectors on the ceiling unwanted</td>
</tr>
<tr>
<td></td>
<td>Installation on the ceiling not possible</td>
</tr>
<tr>
<td>Atria (Malls), detection at different levels</td>
<td>Point type detectors due to height inaccessible and detection of smoldering fire is impossible</td>
</tr>
<tr>
<td>Large and high halls</td>
<td>Lower capital investment</td>
</tr>
<tr>
<td>Churches</td>
<td>No impairment of the ceiling by installation and point type detectors</td>
</tr>
<tr>
<td>Long corridors, cable and energy ducts with &gt;3m room height</td>
<td>Lower capital investment</td>
</tr>
<tr>
<td>Aircraft hangars with sturdy building construction and flame detectors alone are insufficient</td>
<td>Lower capital investment</td>
</tr>
<tr>
<td>Sawtooth roofs, where point type detectors must be lower suspended</td>
<td>Lower capital investment</td>
</tr>
</tbody>
</table>

4.3.2 Examples of unsuitable fields of application

<table>
<thead>
<tr>
<th>Use</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings of wooden or steel construction, without statically stable mounting surfaces</td>
<td>Insufficient building static, too large beam deviation caused by changing environmental influences</td>
</tr>
<tr>
<td>Low rooms or halls with crane tracks</td>
<td>Beam interruptions by moving persons or objects</td>
</tr>
<tr>
<td>Production rooms, garages with diesel engine vehicles</td>
<td>False alarms through accumulation of smoke, dust, steam etc.</td>
</tr>
</tbody>
</table>
4.4 Monitoring areas with flat ceilings

Min. gap between two parallel beams determined by distance DLO11.. and reflector (section 4.9)

Distance from ceiling min. 30cm, max. 60cm for rooms <10m high (section 4.10)

Max. width of monitored area determined by height of room (section 4.11)

Fig. 11 Detector layout in areas with flat ceilings

4.5 Monitoring areas with sloping ceilings

To be defined as «sloping», a ceiling must have an angle of inclination of at least 11° which corresponds to 20cm/m. With gable roofs which have a slope of >0.5, always arrange a monitoring beam in the gable area.

Example:
Calculation of the slope n

\[ n = \frac{a}{b} = \frac{4m}{10m} = 0.4 \]

4.5.1 Additional DLO1191’s on the slope of the ceiling

The number of DLO1191’s required results from the maximum permissible monitoring width shown in section 4.11

Fig. 12 Arrangement with 3 monitoring beams on a sloping ceiling
**Fig. 13** If the ceiling slopes only slightly (N < 0.5), the monitoring beam in the gable is unnecessary.

When the sides of the roof are unequal, the unit must be displaced from the centre towards the less steep side.

**Fig. 14** Positioning underneath unequal sloping ceilings

With sloping ceilings the smoke is channelled into the gable, i.e. there is an increased smoke concentration in this area. Therefore, the monitoring width per DLO1191 can be increased according to section 4.11.
4.6 Monitoring areas with joist constructions

Note that the term «joists» also covers such structures as air conditioning ducts which are mounted up to 0.15m below the ceiling.

In principle linear smoke detectors must be placed in the inter-joist area. Due to economic reasons this is not possible, layout underneath joist constructions is also permissible according to 4.6.1

4.6.1 Layout underneath joist construction

The linear smoke detector can be mounted below the joists, if:
- the joist height is less than 20% of the total height of the room
- if the width of the inter-joist area is ≤50% of the maximum broad of surveillance
- or if the inter-joist area is ≤200m²

When calculating the width of the monitored area that only the distance up to the joist construction counts as the height of the room h.

![Diagram of detector layout underneath joist construction](image)

h: Height for determining max. width of monitored area

Fig. 15 Detector layout underneath joist construction

4.6.2 Layout within the joist area

When the joist construction is more than 20% of the total height of the room, than the joists must be considered as room dividers and each section must be individually monitored.

![Diagram of detector layout within joist construction](image)

Min. gap between two parallel beams determined by distance

Fig. 16 Detector layout within joist construction
4.6.3 Detection of smouldering fire in high rooms

In order that smouldering fires or smaller fires with weak thermal current can be detected even in high rooms, a second or a third IR beam must be arranged at the assumed height of the spread of smoke of a smouldering fire. This application can be useful for rooms >6m in height.

Fig. 17 Detection of smouldering fires in high rooms on different levels

Examples:

<table>
<thead>
<tr>
<th>Room height (highest level)</th>
<th>lowest level</th>
<th>intermediate level</th>
</tr>
</thead>
<tbody>
<tr>
<td>6m</td>
<td>3 – 4m</td>
<td>–</td>
</tr>
<tr>
<td>12m</td>
<td>6 – 7m</td>
<td>–</td>
</tr>
<tr>
<td>20m</td>
<td>6 – 7m</td>
<td>~12m</td>
</tr>
</tbody>
</table>

4.7 Guideline for distances between DLO1191 and reflector

<table>
<thead>
<tr>
<th>Distance DLO1191 → reflector</th>
<th>Types and number of reflectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 – 10m</td>
<td>Short distance filter + 1 DLR1193</td>
</tr>
<tr>
<td>10 – 30m</td>
<td>1 DLR1193</td>
</tr>
<tr>
<td>30 – 50m</td>
<td>1 DLR1192</td>
</tr>
<tr>
<td>50 – 65m</td>
<td>4 DLR1192</td>
</tr>
<tr>
<td>20 – 100m</td>
<td>1 DLR1191</td>
</tr>
</tbody>
</table>

If a number of reflectors are used they must be arranged close together and in the form of a square. Distances are approximate, i.e. they depend on detector and reflector tolerances and can easily vary by a few metres. The important thing is that sufficient signal strength is achieved.
4.8 Panes of glass

4.8.1 Penetration of panes of glass

With the reflector principle, the penetration of panes of glass is subject to certain restrictions.

1. Panes of glass must be absolutely smooth, clear and firmly installed.

2. Panes of glass must never be positioned at a right angle to the optical axis, in which the pane of glass has the effect of a mirror and can reflect the beam back to the receiver (angle of incidence = angle of reflection).

3. As much as possible penetrate only one pane of glass. Maximum 2 panes of 5mm glass may be penetrated.

4. Each pane of glass reduces the distance by 20m.

5. The detection is certain, if the signal decreases to <2 when the reflector is covered (see section 6.3 electronic alignment).

![Diagram](image)

Fig. 18 With the penetration of panes of glass, check the angle in relation to the optical axis
4.8.2 Application example

Fig. 19 Application example for the penetration of panes of glass

4.8.3 Reflectors mounted on glass walls

If reflectors are mounted on glass walls, there is a danger that the glass and not the reflector will reflect the beam. This situation may only occur after commissioning if the glass wall moves slightly. However, it does not occur if the beam strikes a glass wall at an angle greater or less than 90°.

Recommendation: In such cases hit the beam in a light angle of 5° – 10° to the reflector, in order that such reflections which cause interference can be avoided.
4.9 Minimum distances between two pairs of detectors

The monitoring beam must not be mounted closer than 30cm to the ceiling, walls, installations and stored material.

In order to prevent the mutual interference of two or more DLO1191 detectors where there is an increasing distance between DLO1191 and reflector, maintain an ever-increasing transverse distance between DLO1191 and reflector:

![Distance DLO11.. and reflector](image)

Fig. 20 Min. distance between two parallel IR beams

4.10 Beam spacing from the ceiling

In order that the IR beam can detect the smoke, it is normally mounted immediately beneath the cushion of warm air. The higher the room, the further away the DLO1191 and the reflector should be mounted from the ceiling.

![Distance from IR beam ⇒ ceiling](image)

- The steeper the gable roof, the greater the distance must be between the IR beam in the gable and the ridge.
4.11 Maximum monitoring width

The monitoring width can be increased with increasing room height.

Fig. 22 Monitoring width dependent on the room height

If the monitoring beam is set at a low level in order to detect smouldering fire, then instead of room height the distance between floor and detector applies. However, to cover increased risks a narrower monitoring width can be chosen.

4.12 Measures for dividing long distances

DLO1191s can negatively influence each other if mounted face-to-face. In such an arrangement a sufficiently large plate must be mounted between the reflectors.

4.13 Measures against condensation

If the DLO1191 or the reflector is mounted on cool outside walls, in rooms in which high humidity and rapid increase in temperature (e.g. sunshine on non-insulated roof) are to be expected, the detector heating unit DLH1191 must be used to prevent. Condensation of the front cover cause trouble or false alarms. For this application and for short distances, use the reflector DLR1191 with built-in heating.
4.14 Installation locations

When installation locations are rigid and vibration-free even a large temperature fluctuation (e.g. between day and night) has only slight influence on steel girders and therefore does not greatly alter the structure of a building. However, if the installation location is not rigid, the closely bundled infrared beam can quickly wander from the receiver and so cause an alarm or trouble signal. Unstable installation locations include:

- the walls of rooms constructed of steel which expand and contract due to the temperature coefficient of steel
- masonry walls on which a steel roof has been constructed

In such cases the DLO1191 must be mounted on the rigid structural element, meanwhile the reflector can be mounted on the instable wall.

Fig. 23  Deflection of the IR beam caused by heat on the steel roof

The linear expansion of steel:

\[ l \text{ (mm)} \times \Delta T \text{ (°C)} \times \text{linear coefficient of expansion (0.000012)} = \text{mm} \]

**Example:**

\[ 80,000 \times 30 \times 0.000012 = 28.8\text{mm} \]

Fig. 24  Possible solution by mounting of the DLO1191 on the stable surface and mounting of the reflector on the instable wall
4.15 Accessibility

The DLO1191 must always be easily accessible also in high halls for commissioning and servicing. Suitable equipment for this purpose includes fixed ladders, catwalks, etc. or safe mobile equipment such as stacker trucks, sky-workers etc.

Fig. 25 Difficult and dangerous work using a ladder

Fig. 26 Precise and safe work using a permanent platform
5 Installation

5.1 Mounting

- Surface mounting directly on the wall (minimum clearance to ceiling and other obstacles at least 30 cm)

Fig. 27 Installation of the DLO1191

Fig. 28 Installation of the DLR1191 reflector
5.2  Wiring

The detector is installed with a twisted 2-wire line from base to base. Ring and stub lines are admissible.

The DLB1191 base contains a terminal block with 6 terminals for connecting the detector to the line and for connecting the external response indicator.

5.2.1  Special filter

For distances $\leq$10m insert the corresponding short distance filter (7–10m DLF1191-AA, 5–8m DLF1191-AB).

In the event of influence from external light, insert the corresponding filter (DLF1191-AC) (not possible, if short distance filter is inserted).

Fig. 29  Insertion of special filter

5.2.2  Detector heater

In the event of danger of condensation the installation of the detector heater is recommended (Note: Supply voltage 24V necessary).

A terminal block is supplied together with the detector heater for connecting the detector heater and is latched in the base opposite the terminal block.

Fig. 30  Connection of the detector heater
5.3 Conventional SynoLINE mode

In conventional SynoLINE mode only one detector may be connected to a detector line.
Connection factor $KMK = 25$

5.4 Connection

Connection diagram conventional SynoLINE

![Connection diagram](image)

 purge (option) 24V

Fig. 31 Connection diagram for conventional SynoLINE
6 Commissioning

6.1 Settings

- Remove the detector cover
- Set the DIP switches

With the conventional SynoLINE the DIP-Switch [S4] must be set to ON.

The detector has 3 sensitivity settings («Reduced», «Standard», «Increased»). The response threshold is set with DIP switch [S1], [S2].

The transmitter intensity (strong, weak) can be set with DIP switch [S3].

The DIP switch [S3] which governs the transmitter intensity is set to «strong» by default. If the signal amplitude is too high (display on the adjustment unit: Range = 13, signal > 50), the transmitter can be set to «weak». If the measurement section is ≤10m, a supplementary filter must be installed.

<table>
<thead>
<tr>
<th>Function</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced sensitivity</td>
<td>OFF</td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard sensitivity</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased sensitivity</td>
<td>ON</td>
<td></td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weak transmitter signal</td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strong transmitter signal</td>
<td></td>
<td></td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional SynoLINE system</td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reserve</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>«S6 ON» Alarm at beam interruption (&lt; 60s)</td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>«S6 OFF» Fault at beam interruption (&lt; 30s)</td>
<td></td>
<td></td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Operating conditions according to BS 5839: Part 5

Fig. 32 Settings
6.2 Mechanical adjustment

- Install the alignment device on the detector.
  The mirror with backsight and the foresight must be firmly mounted to be free from play!

- Unfasten the locking screw.

- Align the detector lens to the reflector.
  The detector lens can be adjusted with the knurled screws.
  Rough adjustment via backsight and foresight so that the target (reflector) and the foresight opening are aligned with the reticule. Attaching a pocket torch to the reflector side or illuminating the reflector with a spotlight simplifies the rough adjustment procedure.

- Switch on the detection line.

- Connect the adjustment unit to the detector.
  **Attention:** At first use insert a new battery!
  Switch the adjustment unit to «ON» and «AUTO-RANGE». The correct range will be measured automatically.
  When the mechanical adjustment is correct, a signal > 2 should be available on the adjustment unit. This signal changes strongly when the knurled screw is turned.

- Remove the aiming device.

---

**Fig. 33** Mount the aiming device and align the detector to the reflector
6.3 Electronic alignment

- Switch to «AUTO-RANGE».
- With the knurled screws fine-adjust the detector lens to the maximum signal (adjustment set display switched to «RANGE»). The knurled screws should be turned slowly in order to avoid large signal jumps. When the maximum value is obtained (must be between min. 4 and max. 13), switch to «FIX-RANGE» and adjust to the maximum value «SIGNAL». Caution! If the signal value is >60, switch back to «AUTO-RANGE» in order to adjust the range, and then readjust to the maximum value «SIGNAL».
- The «RANGE» and «SIGNAL» indication on the adjustment device should both be attain a maximum value. If «Range» is 13 and «Signal» ≥60, the transmitter signal (switch S3) must be set to weak.
- Engage the locking screws.
- Switch the adjustment set to «FIX-RANGE».

**Cover the reflector.**
With a dark cover interrupt the IR beam: the signal should decrease to <2. If this is not the case the detector has not been aligned correctly to the reflector but to reflecting obstacles in the environment of the measurement section. Repeat the adjustment procedure!
- Disconnect the adjustment set from the detector.
- Reinstall the detector cover.

---

Fig. 34 Adjustment set
6.4 Initialization

- To initialize the detector, a reed relay located near the internal response indicator (A) is activated with a magnet. The initialization is signalled with a flashing response indicator.

Fig. 35  Initialization with the magnet

During the initialization the working range of the electronics («RANGE»), the compensation value, all smoothing algorithms and diagnostics, and the status are set to an initial value. All required thresholds are calculated. At the same time a self-test is performed.

- Initialization with the magnet.
  - Place the magnet directly behind the response indicator (AI) in order to activate the Reed relay (Attention! Black point = magnet).
  
  **As soon as the response indicator flashes, the compensation value is formed (approx. 30 sec.). During this time the measurement should not be interfered with: No manipulations on the detector and no interruption of the IR beam.**

  When the initialization is completed, the AI turns off. If any procedural error has been made, a new initialization can be started at any time with the magnet.

- Test alarm with test filter.
  - Place the test filter immediately in front of the detector and cover the entire measurement window. When an alarm is triggered, the response indicator flashes after approx. 10 seconds (conventional).

- The commissioning is now completed.
7 Faults / overhaul

7.1 Fault

If the detector is removed a fault is triggered (detection line interruption).
- Too powerful a signal: «RANGE» 13, Signal ≥60: Set switch S3 to weak.
- Too weak a signal: «RANGE» 4, Signal ≤50: Set switch S3 to strong or enlarge the reflector dimension.

7.1.1 Interruption to beam

An interruption to the beam can be evaluated as an alarm or a fault depending on the S6 Dip-switch setting.

If it is evaluated as a fault, this function can be correctly tested by covering the reflector with non-reflective material. When covering the reflector, depending on the material used, reflections of up to approx. 10m can still cause an alarm by the material reflecting a weakened signal to the receiver.

Interruptions of the beam by moving objects are to be avoided. These can lead to inadvertent alarms or disturbances.

7.2 Reflection

If a specular surface comes too close to the measurement section or near the detector, a reflection can occur. Reflections can lead to an amplified signal.

This can cause unwanted faults (coventional).

7.3 Checklist for trouble-shooting

- Is the building structure stable?
- Is the detector solidly mounted and are all screws tightened?
- Is the correct type of reflector installed?
- Are the Dip switches S1 – S6 set correctly?
- Is the correct voltage connected to the detector
- Are the range and signal really adjusted to the absolute maximum?
- Does the signal fall to 0 if the reflector is covered?
- Was the detector initialized after adjustment with cover mounted?
- Is the beam sometimes interrupted by obstacles (crane, decorations, spiders’ webs etc.)
- Is the beam sometimes subject to mist, steam or dust?
- Is there danger of condensation?
- Does the sun or another powerful light source impinge on the detector direct?
- Do radiators have an influence on the beam (thermal turbulence)?
7.4 Functional check / overhaul

The detector self-test subjects the DLO1191 automatically to an extensive electronic functional check. Nevertheless it is necessary to physically check the functions on site in regular intervals by triggering the detector with a suitable test filter (usually once per year). Detectors that do not respond or which are mechanically damaged must be replaced.

If an information or fault signal is transmitted during operation, the status bits in the EEPROM of the detector can be read out with the service computer. A preliminary diagnosis on the cause can be established based on this information.

All detector hoods and reflectors should be cleaned regularly with a soft piece of cloth which is either dry or soaked with Plexiklar, or a mild soap solution, depending on the environmental conditions and severity of contamination at the installation site. Do not use any solvents or steam jets.
## Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AlgoLogic</td>
<td>Protected trade-mark (Algorithm + Logic)</td>
</tr>
<tr>
<td>Algorithm</td>
<td>Special calculation method in the detector processor for optimizing the smoke sensitivity, noise immunity, and operational reliability</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
<tr>
<td>DIP switch</td>
<td>Microswitch</td>
</tr>
<tr>
<td>DLO1191</td>
<td>Linear smoke detector</td>
</tr>
<tr>
<td>EEPROM</td>
<td>Electrically Erasable and Programmable Read Only Memory</td>
</tr>
<tr>
<td>EMC</td>
<td>Electro Magnetic Compatibility</td>
</tr>
<tr>
<td>EMI</td>
<td>Electro Magnetic Influence</td>
</tr>
<tr>
<td>FET</td>
<td>Field Effect Transistor</td>
</tr>
<tr>
<td>Fuzzy logic</td>
<td>Imprecise logic</td>
</tr>
<tr>
<td>IR</td>
<td>Infrared</td>
</tr>
<tr>
<td>IRED</td>
<td>Infra-Red Emitting Diode</td>
</tr>
<tr>
<td>KMK</td>
<td>Load factor for conventional elements</td>
</tr>
<tr>
<td>NFW</td>
<td>Compensation value (reference variable)</td>
</tr>
<tr>
<td>µp</td>
<td>Microprocessor</td>
</tr>
<tr>
<td>Range</td>
<td>Working range of the electronics</td>
</tr>
</tbody>
</table>