SIEMENS

Cerberus Division

CERBERUS PYROTRONICS™
MODEL PB-1191
Linear Smoke Detection System

Siemens Building Technologies, Inc.

Siemens Building Technologies, Ltd.

P/N 315-095424-3

Overview

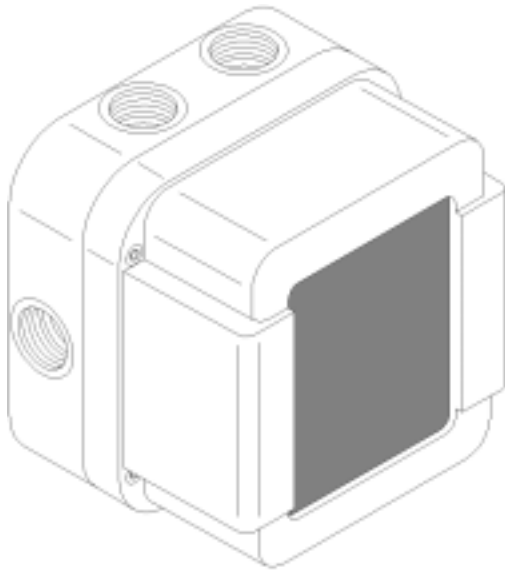


Figure 1
PBA-1191

Characteristics

- Microprocessor-controlled signal processing
- Suitable for surveillance ranges from 17 to 280 feet
- 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
- Automatic and comprehensive self-test design

Design

The PB-1191 linear smoke detector has the following components:

- Base PBB-1191 consisting of:
  – Terminal support with terminals

The base housing features six PG16 tapped cable inlets.

- Detector module PBA-1191 consisting of:
  – Transmitter
  – Receiver
  – Lens
  – Electronics

Insert the plug-in detector module just prior to alignment and commissioning. Align the lens to the reflector by setting the adjustment on the PBL-1191.

Reflectors

Different reflectors are available for different distances:

– 17ft to 99ft	Reflector foil PBR-1193 (I0 x 10cm) 1 pc.
– 99ft to 164ft	Reflector foil PBR-1192 (20 x 20cm) 1 pc.
– 164ft to 214ft	Reflector foil PBR-1192 (20 x 20cm) 4 pcs.
– 214ft to 262ft	Reflector foil PBR-1192 (20 x 20cm) 9 pcs.
– 66ft to 280ft	Prism made of glass PBR-1191 (cat's eye) 1 pc.

Short distance filter

For shorter distances between 17ft and 33ft, use an additional short distance filter as listed below:

– 17ft to 26ft	PBF-1191B
– 23ft to 33ft	PBF-1191A

Accessories:

- Detector heater PBH-1191 protects against condensation of the lens

Auxiliary tools:

- Detector adjustment set PBL-1191 consisting of:
  – Adjustment device
  – Test filter
  – Target device

Operating principle

The transmitter (IRLED) emits an invisible infrared (IR) pulse through the transmitter lens. The IR pulse crosses over the measuring section and reaches the reflector located opposite the detector. The reflector deflects the IR pulse back to the point of origin. The receiver lens directs the reflected IR pulse to a silicon photodiode. The resulting electrical signal is evaluated by the electronics.

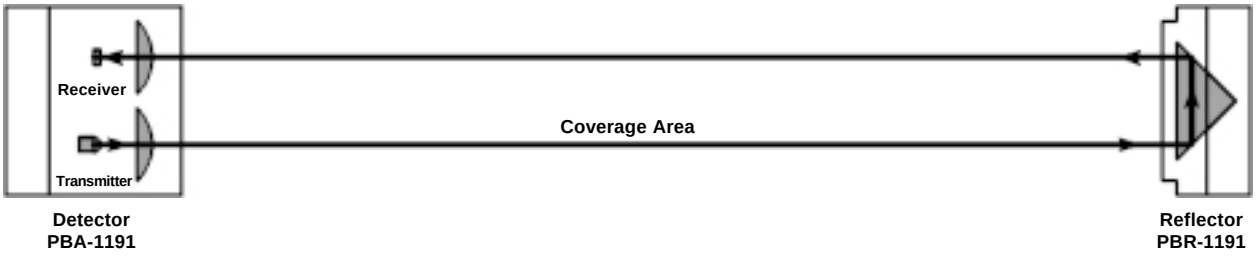


Figure 2
Linear smoke detector without smoke

If smoke penetrates the measuring section, part of the light beam is absorbed by the smoke particles while another part is scattered by the smoke particles; that is, 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_{smoke}) becomes smaller.

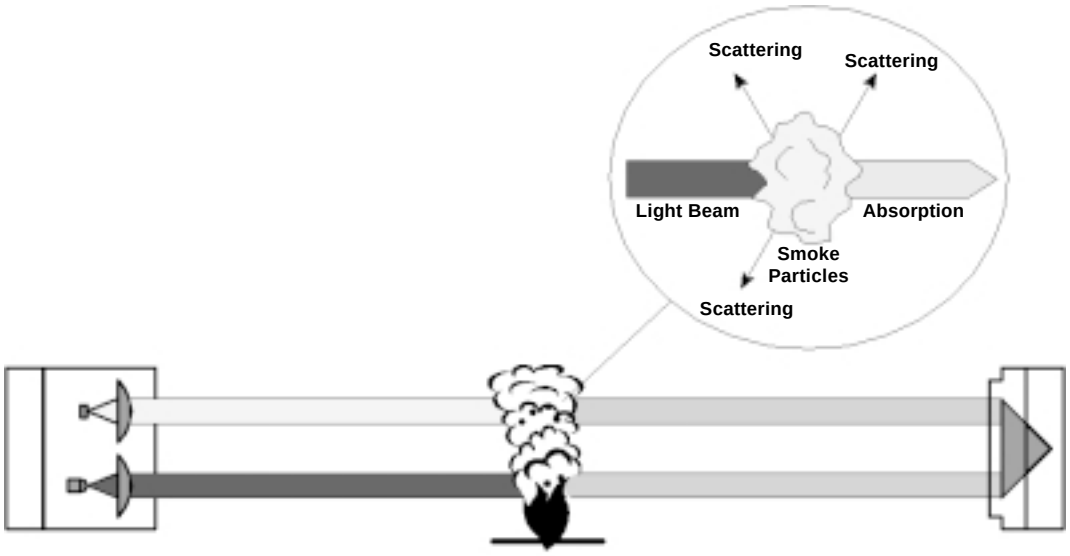


Figure 3
Measuring principle of the linear smoke detector with smoke
Attenuation = Absorption + Scattering

Technical Data

Parameters	Value					Conditions
	Symbol	Unit	min.	typ.	max.	
Operating voltage (quiescent)	U_b	V	18		28	
Maximum permissible voltage	U_{max}	V			30	
Switch-on current	I_e	mA			2.8	
Operating current (quiescent condition)	I_b	mA		1.5	2.8	
Alarm voltage at I_A = 1 ... 10mA	U_A	V	5		11	
Alarm current at U_b = 24V	I_A	mA	40		75	
Reset voltage	U_R	V	2		6	
Reset time (U_R = 2V)	t_R	s			2	
Distance between detector and reflector	L	FT	17	280		
Response sensitivity reduced standard increased	D_1	 % % %		 65 50 30		Attenuation of the beam (See TABLE on page 22.)
Compensation (if beam is attenuated)		%			50	
Compensation speed		%/h			4	
Self-test interval		min.		15		
Response indicator Voltage Current	 U_{ie} I_{ie}	 V mA	 3		 6 60	
Electromagnetic compatibility		V/m	50			1MHx...1GHz
Operating temperature	T_a	^{O}C	-25		+60	
Humidity ≤30^{O}C >30^{O}C					≤95% rel ≤29g/m^3	Transient condensation allowed
Storage temperature	T_l	^{O}C	-30		+75	
Detector heater (optional) Supply voltage Operating current	 U_H I_H	 V_{DC} mA	 20 33		 30 50	 Regulated DC

(maximum 1 detector per detection line)

Design and Principle of Operation

Detector

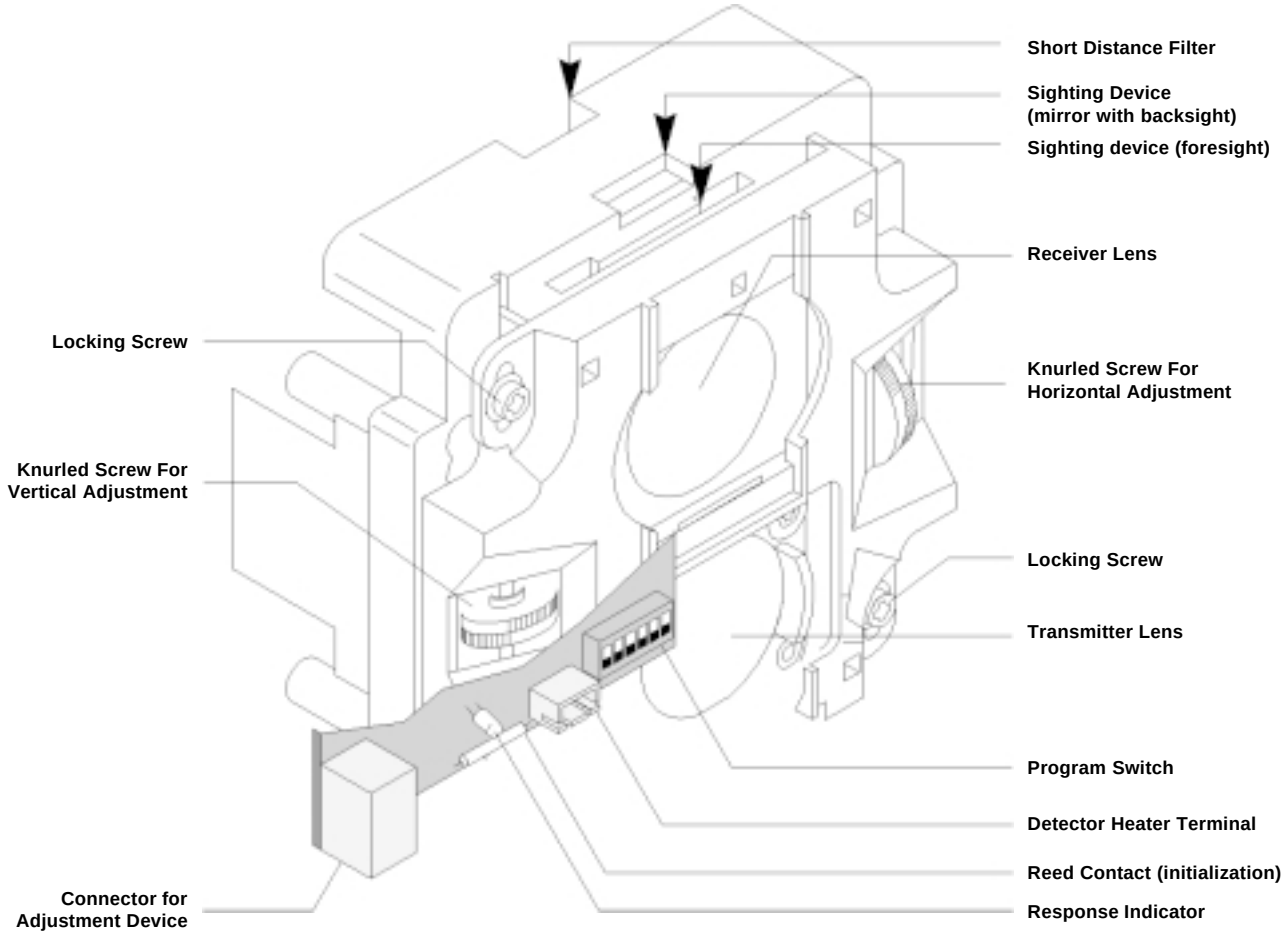


Figure 4
The Detector

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 as you move towards the outside edges of the beam and can be divided into the three regions:

- effective
- core
- scattered

The reflector retransmits the received light.

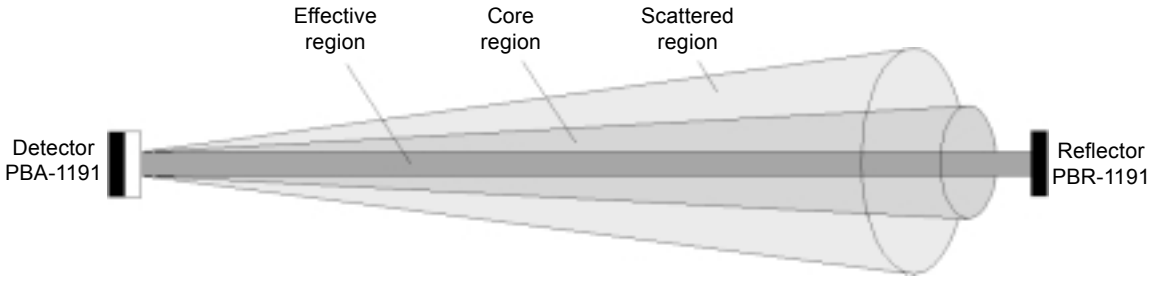


Figure 5
Structure of the infrared beam

- 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.

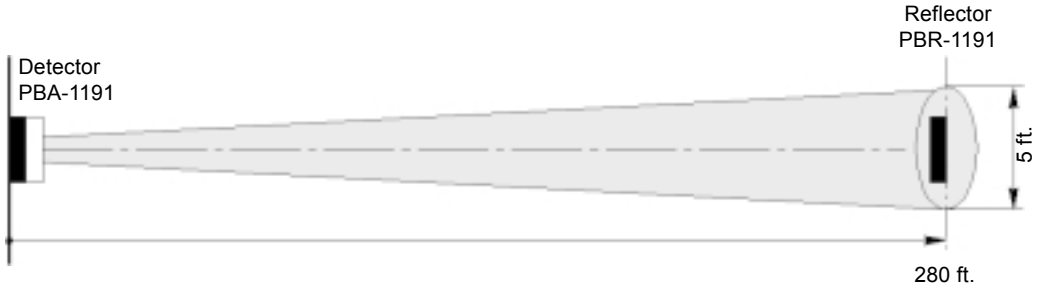


Figure 6
Diameter of the core region

Alignment Possibilitites

The infrared beam can be adjusted by 10° increments horizontally and in 5° increments vertically from the center axis. When selecting the optimum mounting location, remember 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 >162.5 feet, as this makes adjustment simpler.

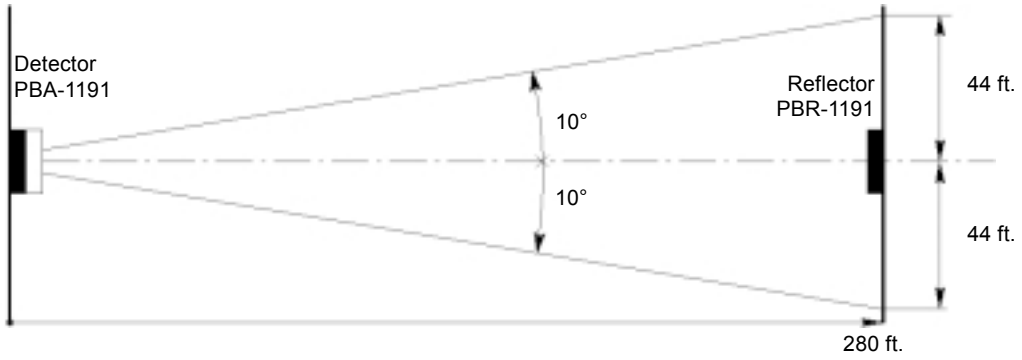


Figure 7
Horizontal adjustment range of the optical system - max. 10° each side of the axis

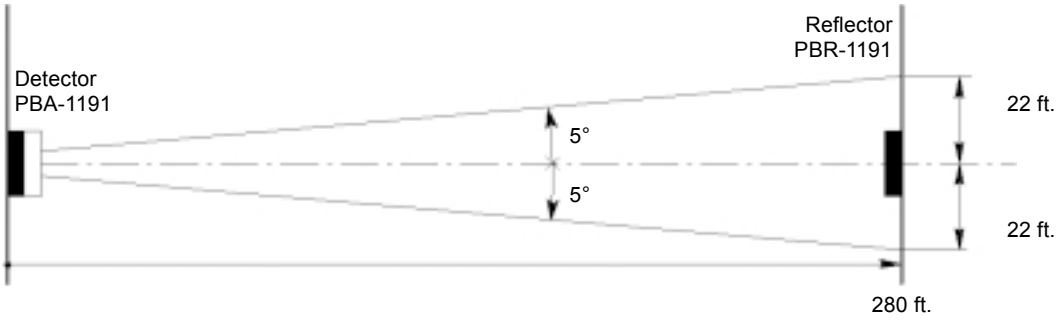


Figure 8
Vertical adjustment range of the optical system - max. 5° above and below the axis

Note: One rotation of the knurled screw moves the beam at 280 ft. approximately 3 ¾ ft.

Reflectors

Retroreflectors reflect the received light beam in parallel to the latter. For this reason the retroreflector does not have to be installed parallel to the detector. 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.

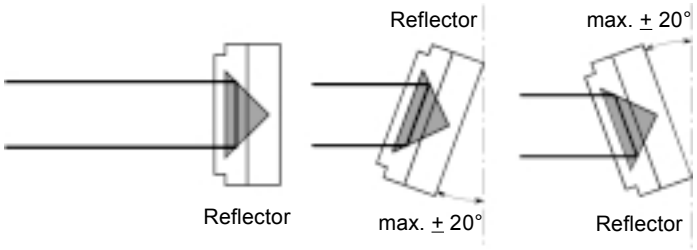


Figure 9
The reflector can be mounted inclined a maximum of ± 20° in all directions

PBR-1191 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. If condensation is possible, connect the heater to a 24V supply.

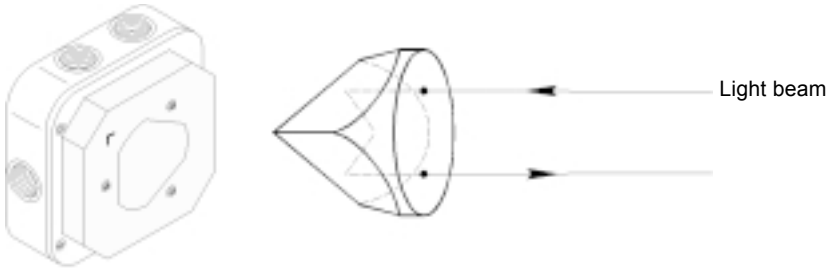


Figure 10
PBR-1191 reflector and reflection principle

PBR-1192, PBR-1193 reflector

This reflector consists of microprismatic elements that are formed by transparent, synthetic resin sealed to a plastic substrate.

Compatibility

COMPATIBLE EQUIPMENT	
System	**Zone Module**
System - 3	ZB-35
MXL	CZM-4
MXL-IQ	CZM-4
PXL	PCM-1 PZE-4B
SXL-EX	SZE-4X

Planning

Fundamentals of planning

The linear smoke detector PBA-1191 is ideal for certain applications. Use it to supplement or replace point-type smoke detectors. Refer to the Fields of Use table for suitable applications.

FIELDS OF USE	
Very Suitable:	**Suitable:**
Large and high halls Aircraft hangars Cable and energy ducts Churches Buildings with artwork ceilings of historical interest Rooms with complex ceiling sructures Rooms with strong air currents Heavy soiling of point detectors (textile and wood processing) Monitoring at different levels Expensive installation and maintenance of point detectors, for example: -- in sawtooth roofs -- very high rooms -- where point detectors would have to be suspended at a lower level	Underground garages >9ft high (min) Computer rooms Under floor Above ceiling Corridors Inner courtyards (malls) Open-plan offices Cross zone releasing appliances In combination with flame detectors

Operating conditions

The distance between the PBA-1191 and the reflector must be between 17 ft and 280 ft.

- There must be a permanent line of vision between the PBA-1191 and the reflector. Care should be taken to ensure that the IR beam is not interrupted by moving objects such as overhead cranes, etc., which can lead to trouble signals.
- If point detectors cannot be used because of the interfering effects of smoke, steam, or dust, note that the PBA-1191 will only solve the problem in certain cases.
- Avoid frontal incidence of sunlight, light from halogen lamps, etc. on the PBA-1191.
- Always mount the PBA-1191 in the vicinity of the ceiling (See Figure 11 for distances). The detector placement must not be too close to or too far from the ceiling.
- The PBA-1191 is also suitable for very high rooms. As a supplementary measure, install additional PBA-1191s at different levels and/or use additional flame detectors.

Monitoring areas with flat ceilings

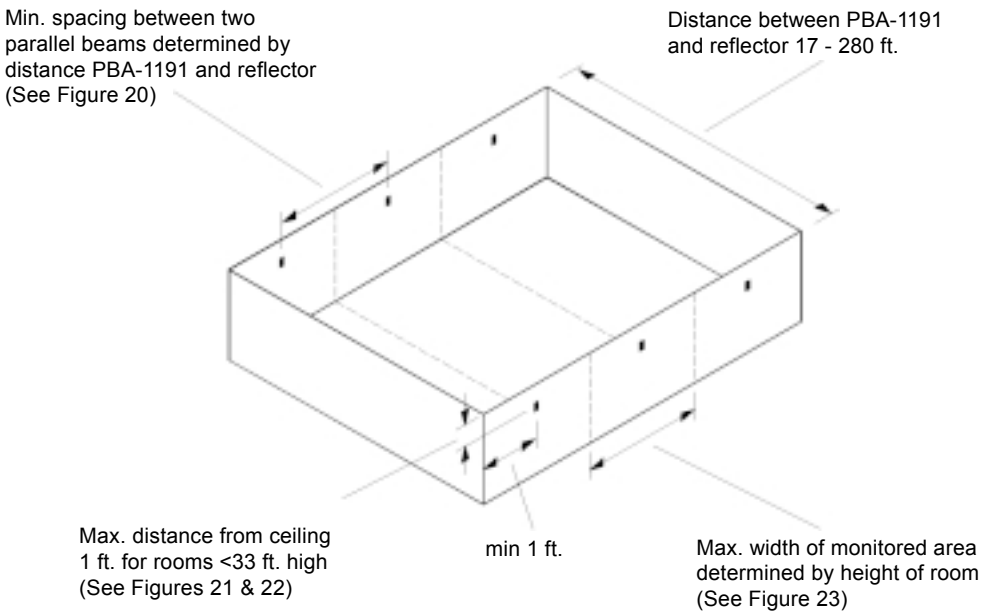


Figure 11
Detector layout in areas with flat ceilings

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 ≥7.0 inch/yard. With gable roofs which have a slope of ≥0.5, always arrange a monitoring beam in the gable area.

Additional PBA-1191s on the slope of the ceiling

The number of PBA-1191s required results from the maximum permissible monitoring width shown in Figure 23.

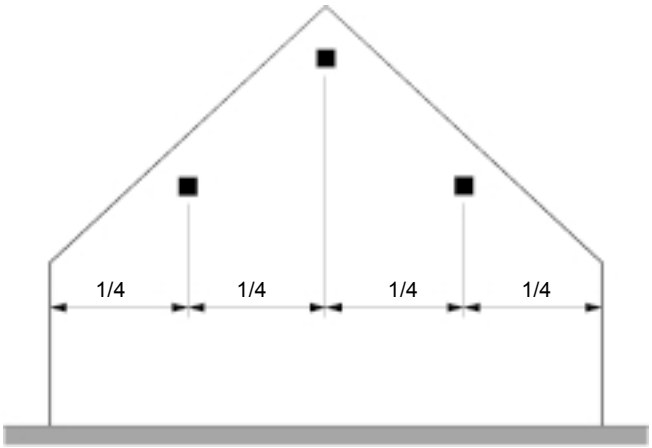


Figure 12
Arrangement with 3 monitoring beams on a sloping ceiling

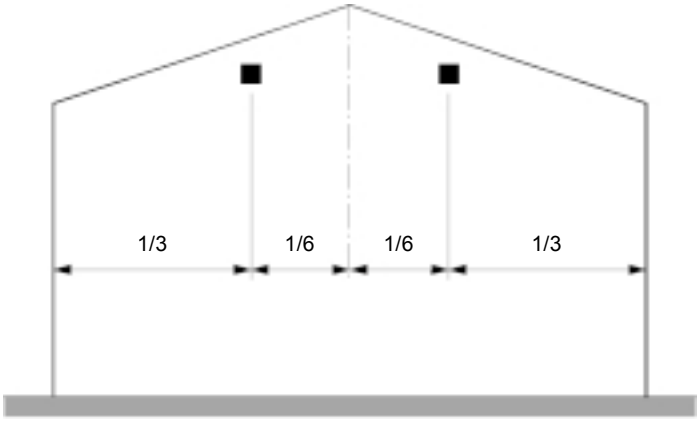


Figure 13
If the ceiling slopes only slightly (N <0.5), the monitoring beam in the gable is unnecessary

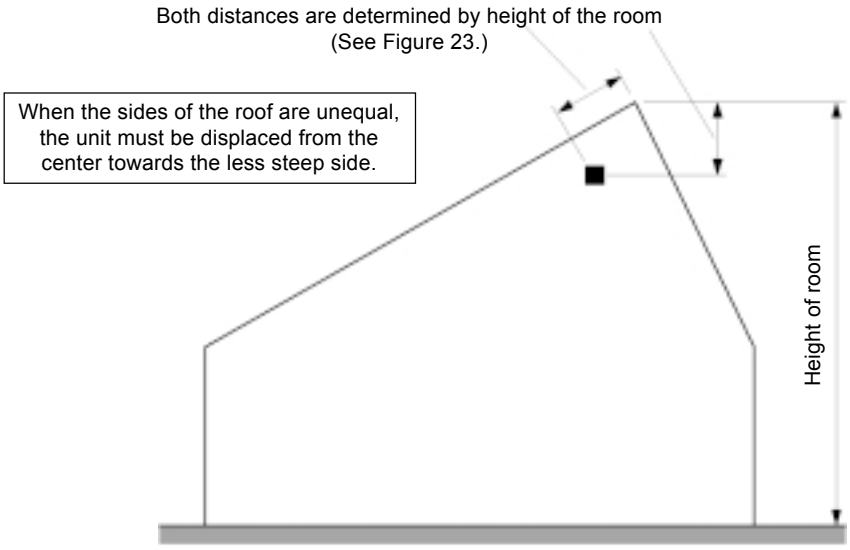


Figure 14
Positioning underneath unequal sloping ceilings

With sloping ceilings the smoke is channeled into the gable, resulting in an increased smoke concentration in this area. Therefore, the monitoring width for each PBA-1191 can be increased according to Figure 23.

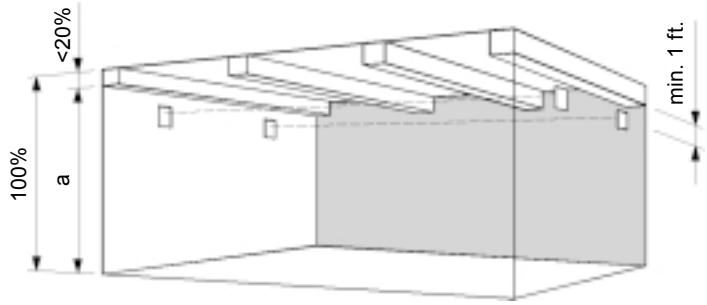
Monitoring areas with beam constructions

Note that the term ***beams,*** also covers such structures as air conditioning ducts which are mounted up to 0.5 ft below the ceiling.

Layout underneath beam construction

If the beam construction is *less than 20%* of the total height of the room, the units of the linear smoke detector can be mounted below the beams as indicated in Figure 15.

Note: When calculating the width of the monitored area, only the distance up to the beam construction counts as the height of the room.



a: Height for determining max. width of monitored area

Figure 15
Detector layout underneath beam construction

Layout within the beam area

When the beam construction is *more than 20%* of the total height of the room, then the beams can be considered as room dividers and each section must be individually monitored.

Note: When distance exceeds maximum monitored area, mount more than one linear smoke detector per section.

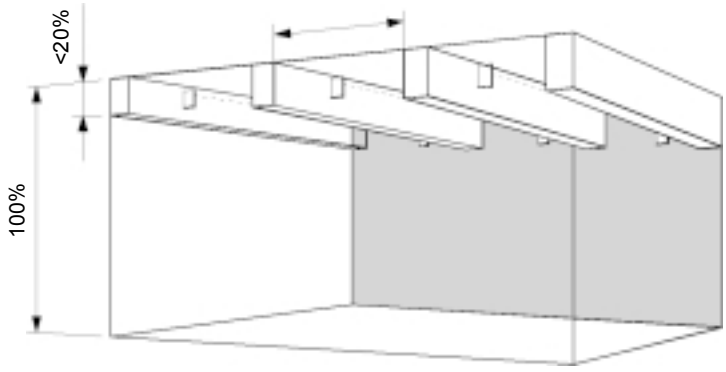


Figure 16
Detector layout within beam construction

Detection of smoldering fire in high rooms

In order to detect smoldering fires with weak thermal current even in high rooms, the second IR beam must be arranged at the assumed height of the spread of smoke of a smoldering fire.

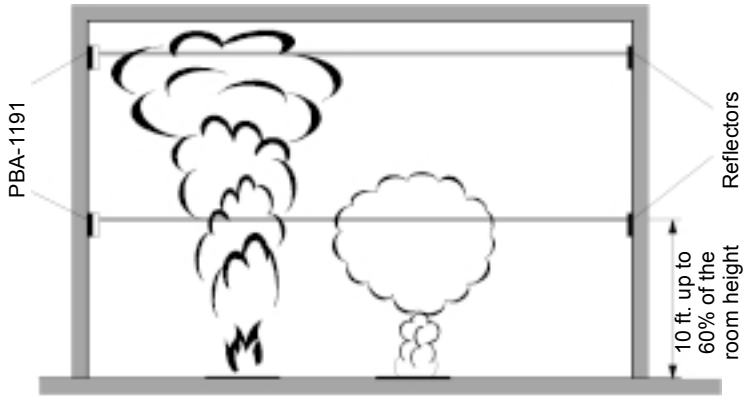


Figure 17
Detection of smoldering fires in high rooms with two linear smoke detectors

Guideline for distances between PBA-1191 and reflector

Distance PB reflector	Types and number of reflectors	
17 — 33 ft	Short distance filter +	1 PBR-1193
33 — 99 ft		1 PBR-1193
99 — 164 ft		1 PBR-1192
164 — 214 ft		4 PBR-1192
214 — 262 ft		9 PBR-1192
66 — 280 ft		1 PBR-1191

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

Penetration of panes of glass

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

- Panes of glass must be absolutely smooth, clear and firmly installed.
- Panes of glass must never be positioned at an 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).
- No more than 2 panes of 3/16 inch glass may be penetrated.
- Each pane of glass reduces the distance by 66 feet.

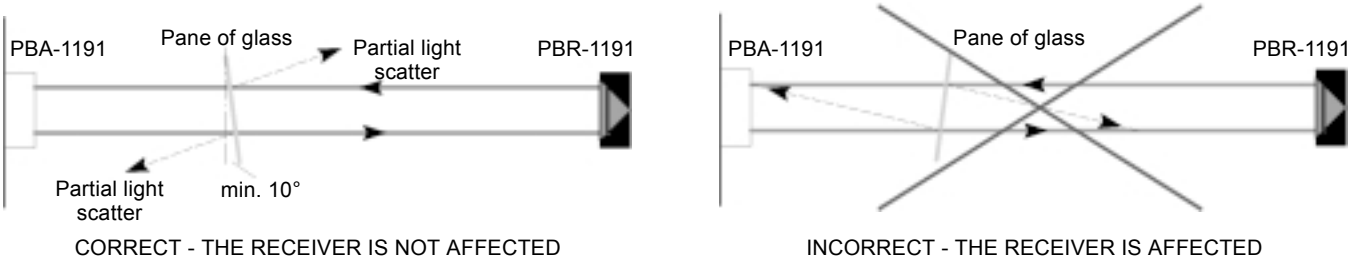


Figure 18
With the penetration of panes of glass, check the angle in relation to the optical axis

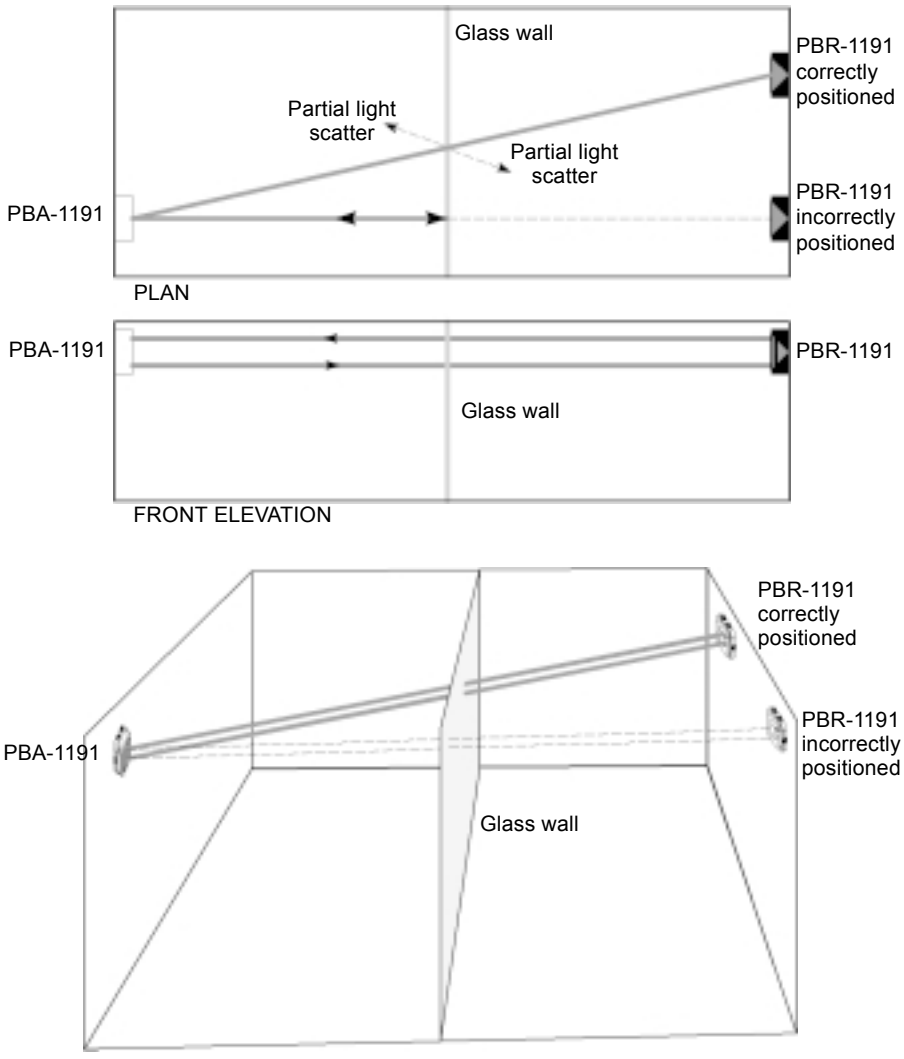


Figure 19
Application example for the penetration of pages of glass

Minimum distances between two pairs of detectors

The monitoring beam must not be mounted closer than 1 ft. to the ceiling, walls, installations, and stored material.

In order to prevent the mutual interference of two or more PBA-1191 detectors where there is an increasing distance between PBA-1191 and reflector, maintain an ever-increasing transverse distance between PBA-1191 and reflector.

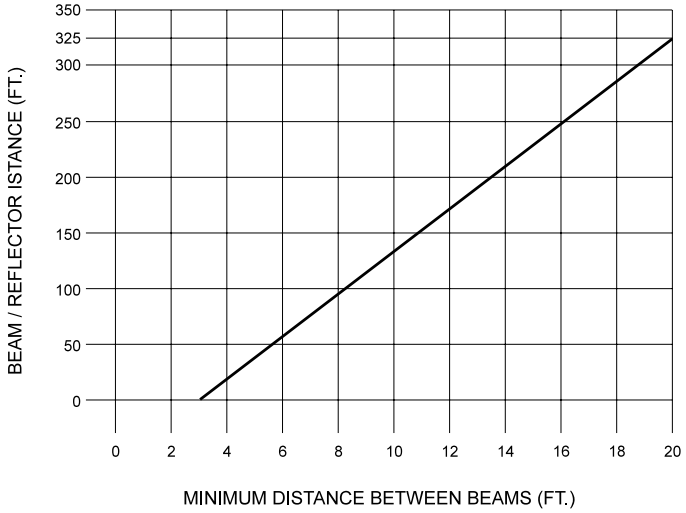


Figure 20
Minimum distance between two parallel IR beams

Beam spacing from the ceiling

In order for the IR beam to detect the smoke, it is normally mounted immediately beneath the cushion of warm air. The higher the room, the further away the PBA-1191 and the reflector should be mounted from the ceiling.

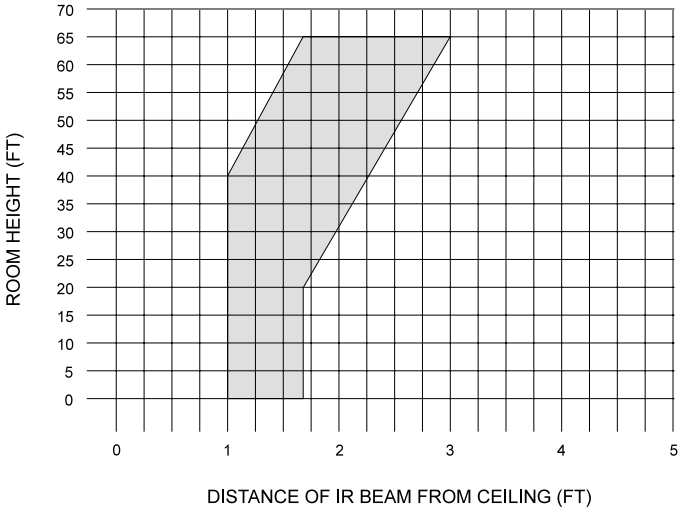


Figure 21
Distance from IR beam ⇒ flat ceiling (N < 0,2)

NOTE: The steeper the gable roof, the greater the distance must be between the IR beam in the gable and the ridge.

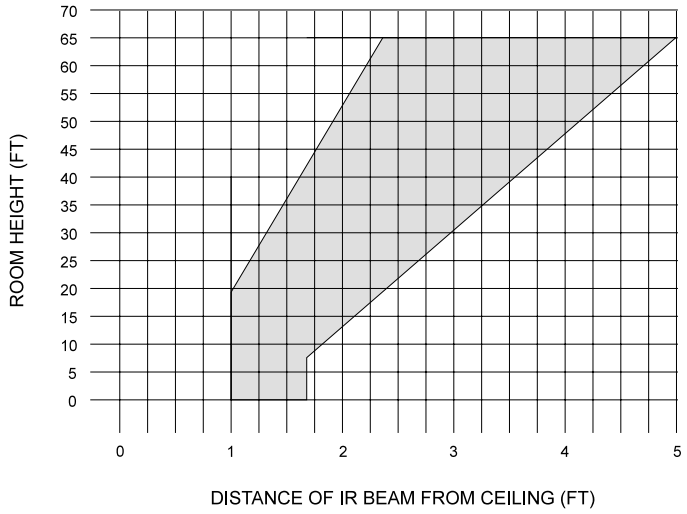


Figure 22
Distance from IR beam ⇒ sloping ceiling (N > 0,2)

Maximum monitoring width

The monitoring width can be increased with increasing room height.

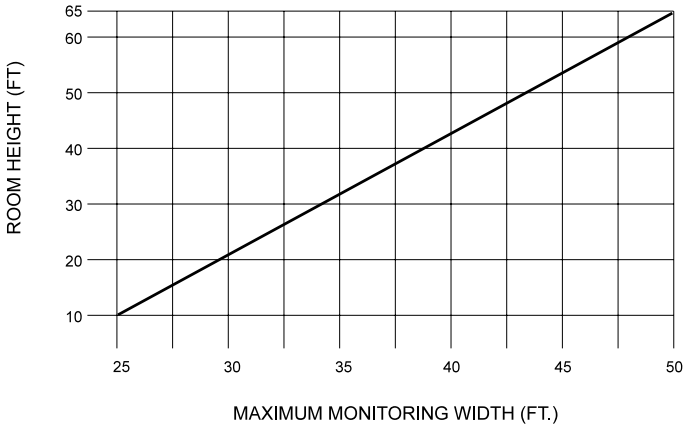


Figure 23
Monitoring width dependent on the room height

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

Measures against condensation

If the PBA-1191 or the reflector is mounted on cool outside walls or in rooms in which there is high humidity and a rapid increase in temperature (e.g. sunshine on a non-insulated roof), use the detector heating unit PBH-1191. If condensation on the front cover causes troubles or false alarms, or for short distances, use the reflector PBR-1191 with built-in heating.

Installation locations

When installation locations are rigid and vibration-free, large temperature fluctuations (e.g., between day and night) have only a slight influence on steel girders and do not greatly affect the building structure. However, if the installation location is not rigid, the closely bundled infrared beam can drift from the receiver and 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 upon which a steel roof has been constructed
- non-bonded wooden beam construction

In the cases listed above the PBA-1191 must be mounted on the rigid structural element, while the reflector can be mounted on the unstable wall.

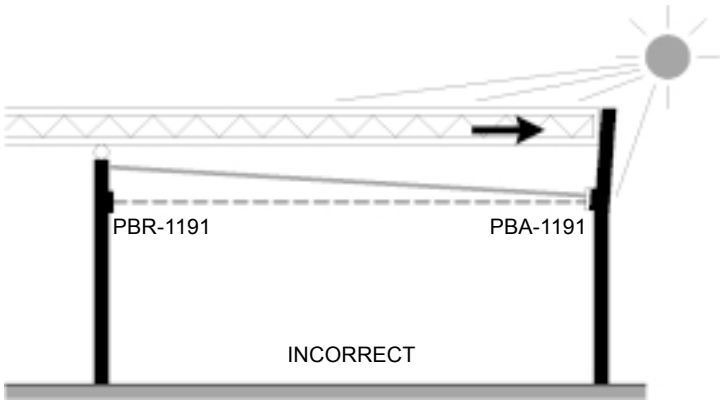


Figure 24
Deflection of the IR beam caused by heat on the steel roof

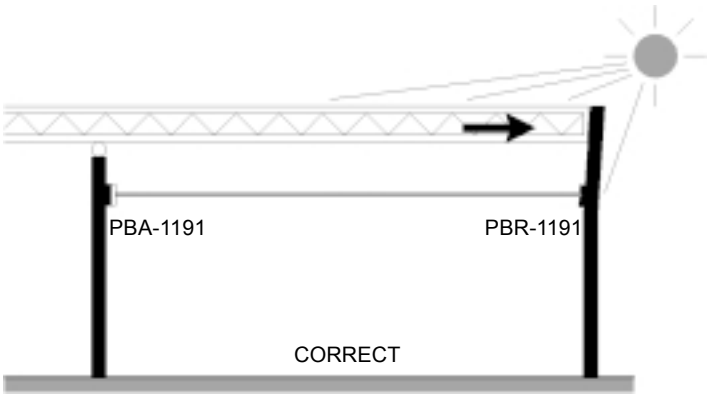


Figure 25
Possible solution: mounting the PB-1191 on the stable surface and mounting the reflector on the unstable wall

Accessibility

The PB-1191 must always be easily accessible 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.

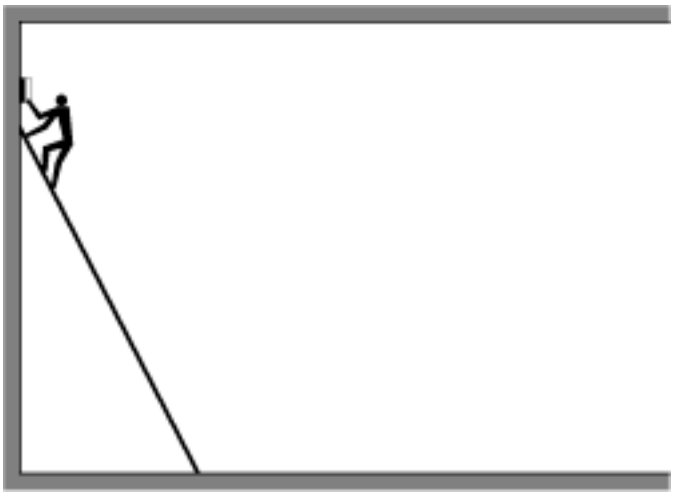


Figure 26
Difficult and dangerous work using a ladder

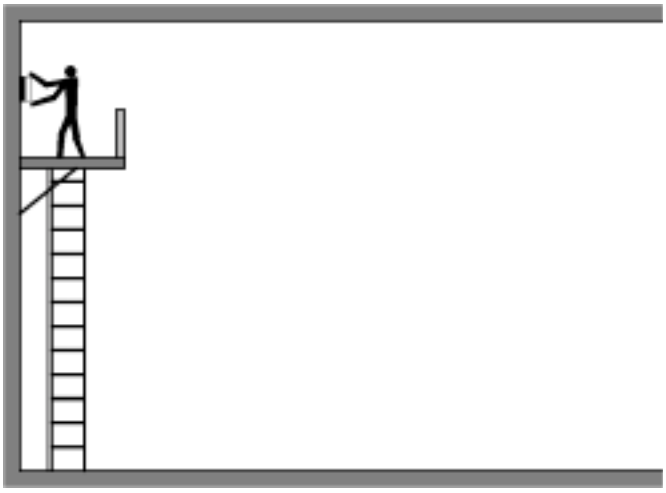


Figure 27
Precise and safe work using a permanent plafform

Installation

Mounting

Surface mounting directly on the wall (minimum clearance to ceiling and other obstacles at least 1 ft)

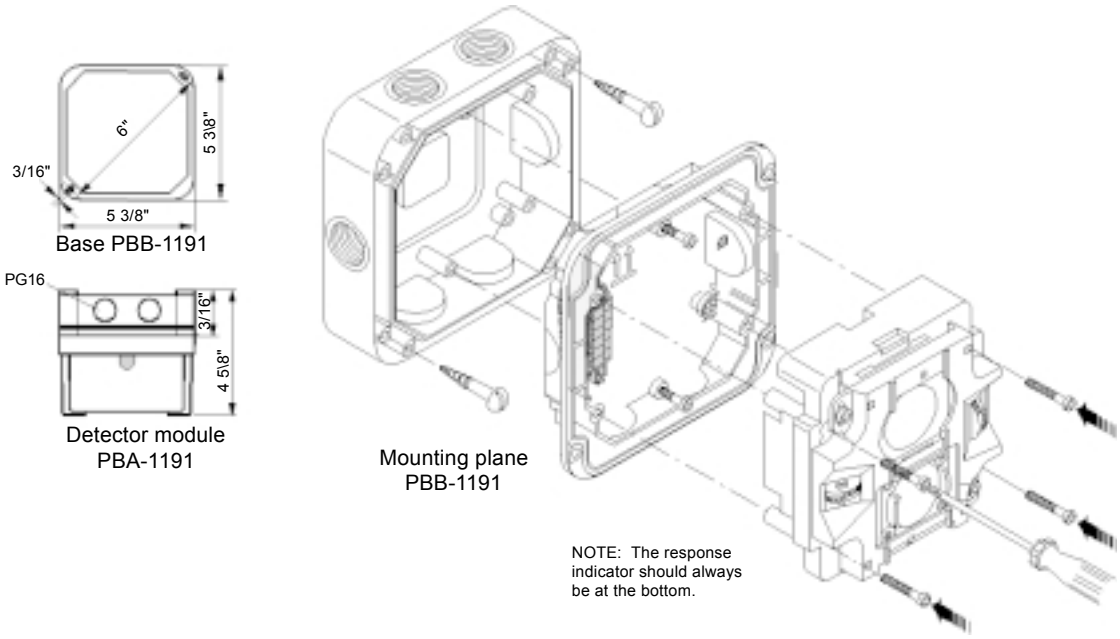


Figure 28
Installation of the PBA-1191

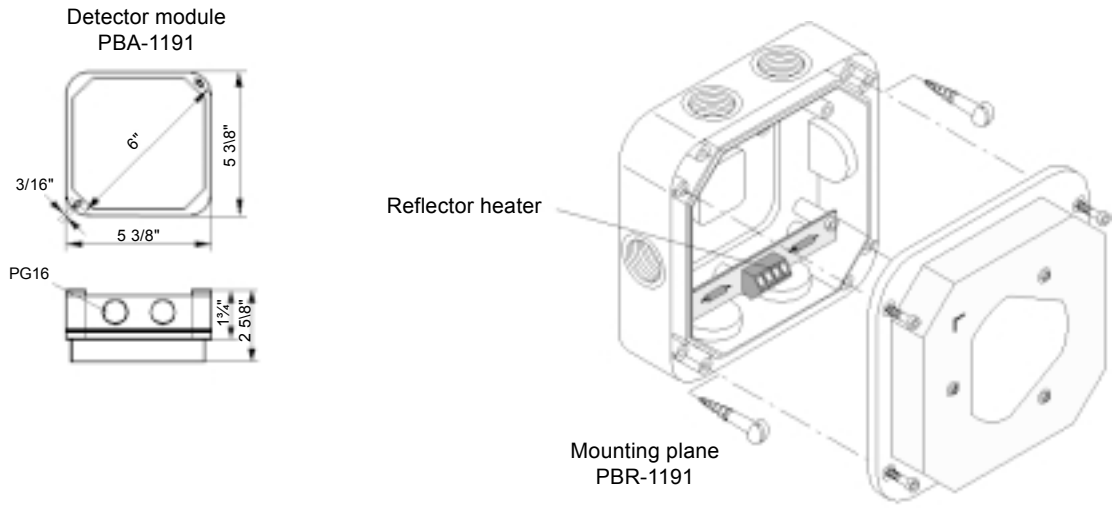


Figure 29
Installation of the PBR-1191 Reflector

Wiring

The detector is installed with a twisted 2-wire line from base to base.

The PBB-1191 base contains one terminal block with 6 terminals for connecting the detector to the line and for connecting the external response indicator. The terminal block incorporates a slide switch jumper which places the end of line device in the circuit for initial continuity check. When the detector is first installed, this jumper is automatically disengaged and remains that way.

Caution: Slide switch must be intact and engaged or trouble conitions will not be annunciated.

The opposite terminal block is supplied for the detector heater.

Short distance filter

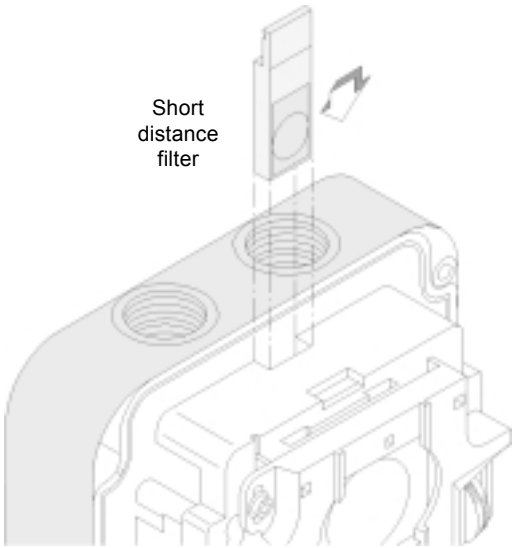


Figure 30
Insert short distance filter for distances ≤ 33 feet

Detector heater

In the event of danger of condensation, the installation of the detector heater is recommended

NOTE: Supply voltage 24V is necessary.

The opposite terminal block is supplied together with the detector heater and is used for connecting the detector heater.

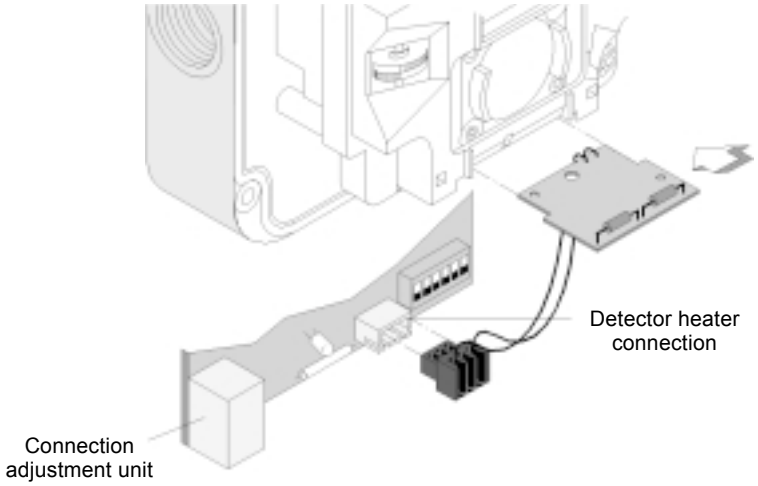
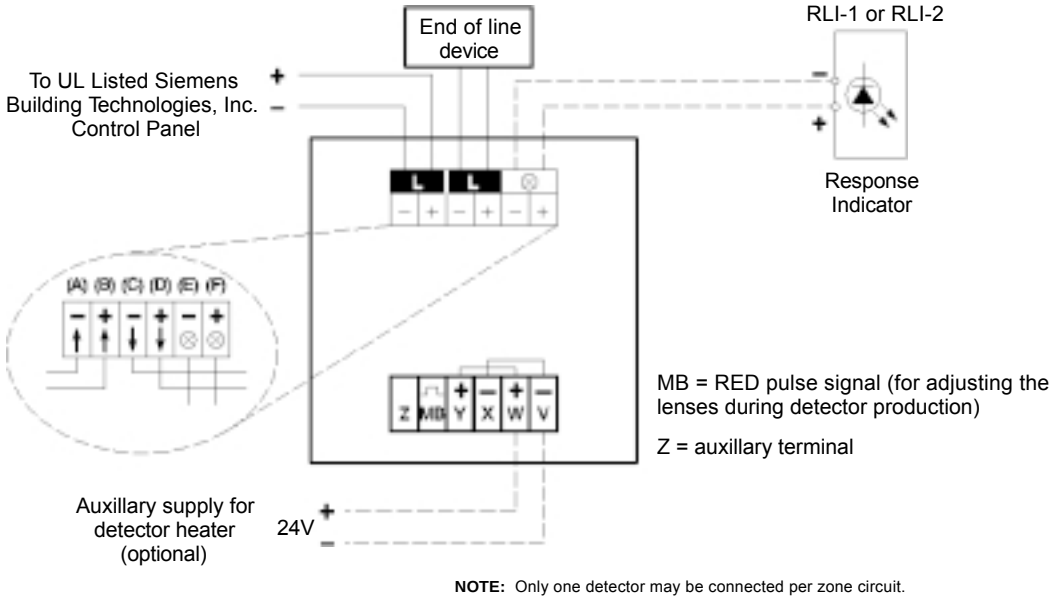


Figure 31
Connection of the dector heater

Connection



NOTE: Only one detector may be connected per zone circuit.

Figure 32
Connection diagram

Commissioning

Settings

- Remove the detector cover.
- Set the DIP switches.

The detector has 3 sensitivity settings - REDUCED, STANDARD, and INCREASED.
Set the response threshold with DIPswitch S1 and S2.

The transmitter intensity (strong, weak) is set with DIPswitch S3.

The S3 DIPswitch, 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 ≤ 33 ft., a supplementary filter must be installed.

Function	S1	S2	S3	S4	S5	S6
Reduced Sensitivity (65%) (See TABLE below.)	off	on				
Standard Sensitivity (50%) (See TABLE below.)	on	on				
Increased Sensitivity (30%) (See TABLE below.)	on	off				
Weak Transmitter Signal			on			
Strong Transmitter Signal			off			
Conventional				on		
Reserved						
S6 OFF Fault at beam interruption (<30s or >60s)						off

Beam Distance	Allowable Sensitivity Setting
17 ft. to 33 ft.	Increased only
33 ft. to 98 ft.	Standard only
98 ft. to 164 ft.	Standard and Reduced
164 ft. to 280 ft.	Reduced only

Figure 33
Settings

Preliminary adjustment

- Install the alignment device on the detector. The mirror and the front sight must be installed without play!
- Unfasten the locking screw.
- Align the detector lens to the reflector. The detector lens can be adjusted with the knurled screws. Check by using the mirror and front sight - the target center and the apex of the sight must be within the circle.
- Apply zone power.
- Connect the adjustment unit to the detector. **Note:** Install a new battery. Switch the adjustment unit to **ON** and **AUTO-RANGE**. The correct range is measured automatically.

  When the mechanical adjustment is correct, a signal >2 shows on the adjustment unit. This signal changes in large increments when the knurled screw is turned.
- Remove the aiming device.

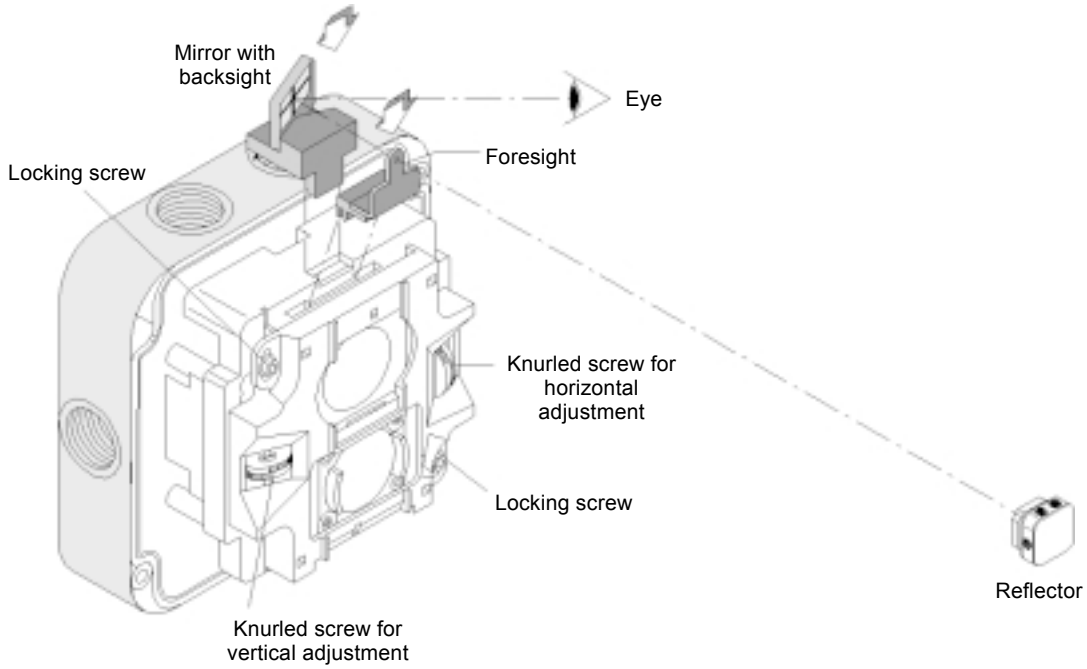


Figure 34
Mounting the aiming device and aligning the detector to the reflector

Final Adjustment

- Set the switch on the adjustment unit to AUTO-RANGE.
- Using the knurled screws, fine-adjust the detector lens to display the maximum level in the RANGE display.
  Note: The knurled screws should be turned slowly in order to avoid large signal jumps.
- When the maximum value is obtained, (it must be between min. 4 and max. 13) set the switch to FIX-RANGE. The range level is now programmed into the detector to set the internal amplifiers.
- Adjust the knurled screws to display the maximum level in the SIGNAL display.

  Caution: If the signal value can be adjusted to >60, the range level was not adjusted to its maximum. Switch back to AUTO-RANGE and readjust to the maximum range level. Then repeat the signal level adjustment.

  The RANGE and SIGNAL levels on the adjustment unit should both be set to the maximum.
- Engage the locking screws.
- Switch the adjustment unit to FIX-RANGE.

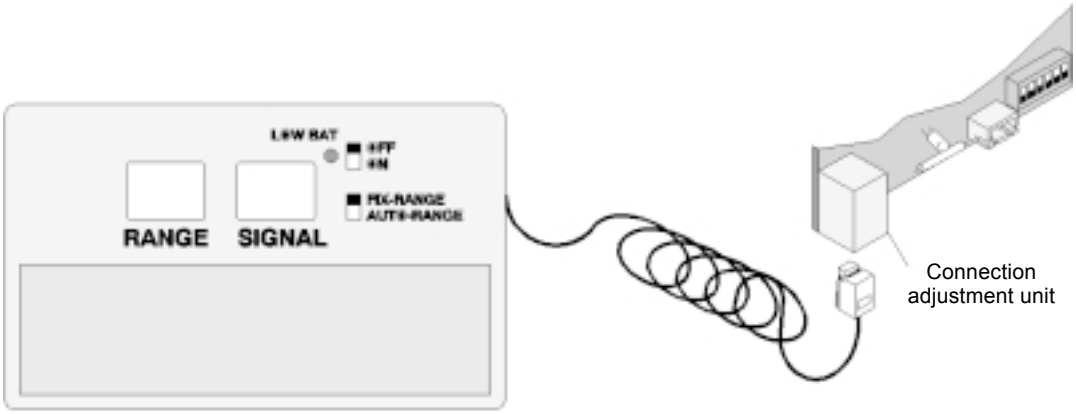


Figure 35
Front plate of the adjustment unit

- Cover the reflector.

  Completely cover the reflector with a dark cover. The signal should decrease to <2. If this is not the case, the detector has not been aligned to the reflector but to a reflecting obstacle in the environment of the measurement section. Repeat the adjustment procedure.
- Disconnect the adjustment unit from the detector.
- Reinstall the detector cover.

Initialization

To initialize the detector, activate a reed relay located near the internal response indicator with the supplied magnet. A flashing response indicator signals initialization.

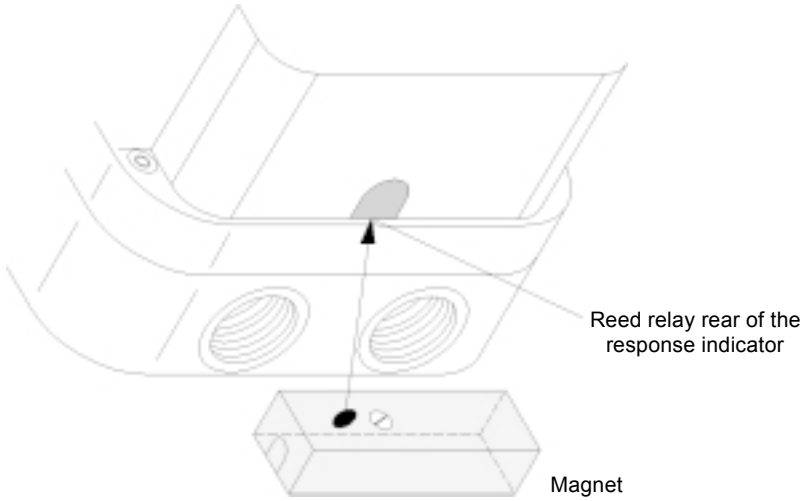


Figure 36
Initialization with the magnet

During the initialization, the working range of the electronics (RANGE), the compensation value, all smoothing algorithms and diagnostics, and the staus 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 to activate the Reed relay (Black or red point = magnet).

  As soon as the response indicator flashes, the compensation value is formed (approximately 30 sec.). Do not interfere with the measurement during this time.

  When the initialization is completed, the response indicator 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 turns on after approximately 10 seconds.

- The commissioning is now completed.

Troubles / Overhaul

Trouble

Removing the detector triggers a trouble condition (zone line interruption). Blocking the IR Beam also triggers a trouble condition (in approximately 1 minute).

Reflection

If a reflective surface comes too close to the coverage area or near the detector, a reflection can occur.

As a result, the measured value increases significantly above the compensation value and remains at that level. The system reports a trouble to the control unit.

Functional check/ overhaul

The detector self-test automatically subjects the PBA-1191 to an extensive electronic functional check. Nevertheless it is necessary to physically check the functions on site at 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.

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

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