



407 Non-addressable Reflective Beam Line-type Smoke Detector

INSTALLATION MANUAL

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1. INTRODUCTION

1.1. Overview

The 407 non-addressable reflective beam line-type smoke detector uses a transceiver, in conjunction with a reflector, to monitor obscuration across a space (such as building atria). It provides detection over linear distances ranges of 8 m to 100 m and lateral distances of 14.5 m.

Automatic compensation adjusts for lens contamination, alignment drift, ambient light conditions and transmitted beam ageing.

The 407 is ideal for use in buildings with high ceilings (such as atria) and long spaces (such as warehouses or shopping malls). Line-type smoke detectors may be used to replace point-type smoke detectors in applications where ceilings are much higher than the fire source, or where point detectors are difficult to install and service.



Fig. 1 – 407 line-type smoke detector transceiver and reflector

1.2. Features

- Long detection distance from 8 m to 100 m at up to 14.5 m width
- Single transceiver and separate reflector components
- Quiescent condition indicator
- Automatic compensation for lens contamination, alignment drift, ambient light conditions and transmitted beam ageing
- Self-diagnostics function monitors internal faults
- Separate Alarm and Fault relay outputs
- Easy to install and commission

1.3. Operating Principle

1.3.1. General

The optical beam sent by the transmitter is reflected back to a receiver across the monitored space. The receiver measures the intensity of the received beam. A firmware algorithm within the unit calculates the received signal attenuation, that may be caused by smoke particles absorbing or scattering the light and obscuring the beam path (see Fig. 2).

The algorithm monitors the rate of received signal attenuation to differentiate between obscuration caused by smoke and other causes, such as objects in the beam path.

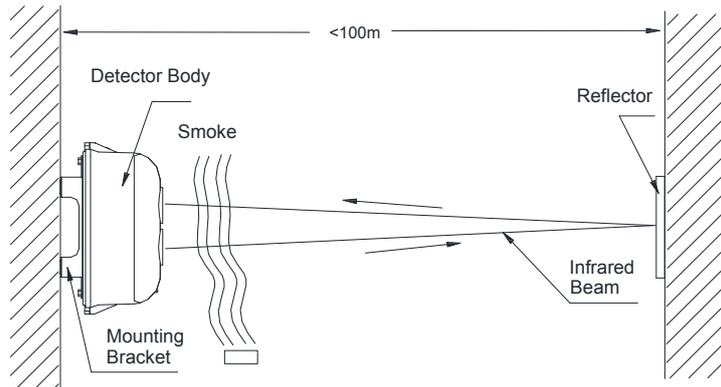


Fig. 2 – Operating principle

1.3.2. Automatic Light Compensation

Dust in the environment may obscure the lens and contaminate the reflector. In this event, the detector will automatically compensate the received signal to ensure normal operation. When the compensation limit is exceeded, the detector will release a Fault signal.

1.3.3. Transceiver Self-diagnosis

The detector checks the transmitter, receiver and amplifier circuits. In the event that these components fail, the detector will release a Fault signal.

1.3.4. Fault Conditions

The detector monitors the correct operation of the internal detection circuitry and the optical pathway.

If a failure of the internal detection circuitry is detected, then the device will release a fault signal to the control and indicating equipment. The fault signal will cause the yellow Fault LED and the Fault relay to operate.

If the optical path is interrupted for more than 10 s by an opaque object the yellow Fault LED and Fault relay will operate. If the optical path is not restored, within a further 30 s the red Fire Alarm LED and the Alarm relay will operate. The yellow Fault LED and Fault relay will turn off. When the optical path is restored, the fault signal will cancel automatically. If the detector has released an Alarm signal, then the detector must be reset to clear the Alarm signal.

1.4. Connection to Control and Indicating Equipment

There are two options available to connect 407 line-type smoke detectors to CIE.

1.4.1. Direct Connection Option

When connecting to non-addressable CIE, the 407 detectors can be connected directly to detection zone transmission path. The specific connection wiring will be introduced in the installation section.

1.4.2. Indirect Connection Option

When connecting to addressable CIE or non-addressable CIE, the 407 detector can be connected to a single input module (Part number 621-007). The 621-007 input module provides a switchable DC 24 V supply to the 407 detector, and transfers Alarm signal from the 407 detector to the CIE.

The switchable DC 24 V supply voltage falls to 0 V when the CIE enters the Reset Condition, providing a simultaneous reset to the 407 line-type smoke detector.

2. INSTALLATION

2.1. Safety



ELECTRICAL HAZARD: Disconnect power from equipment prior to making any internal adjustments.



FRAGILE: Inspect the equipment prior to installation. Do not install the equipment if damage is apparent. If damaged, return to the supplier.



ELECTROSTATIC HAZARD: This is sensitive electronic equipment. Apply safe ant-static practices when handling this equipment.



GENERAL CAUTIONS: This equipment must be installed by a suitably qualified and technically competent person. A basic knowledge and training in the installation of fire detection and alarm systems is assumed. The system should be designed by a suitably qualified person with reference to local regulations and guidance from the fire officer where applicable. Service should only be performed by qualified personnel.

2.2. Tools and Equipment

Before commencing installation, ensure all equipment and tools to mount and connect the equipment are available, such as drills, mounting screws, cables and ladders.

Check that the following components are available.

- Transceiver.
- Four 2 x 1 reflectors.
- Mounting bracket.
- Six 6 mm wall plugs. (Six additional wall plugs are required if three additional reflectors are used).
- Six ST4 x 30 screws. (Six additional screws are required if three additional reflectors are used).
- Two M4 x 10 screws.
- Magnet test tool.
- Obscuration filter.
- 621-007 single input module with switched external DC 24 V supply (for indirect connection method).

2.3. Components

The 407 consists of a transceiver (incorporating the beam transmitter, receiver and laser light alignment tool), the transceiver mounting bracket, and four 2 x 1 reflectors.

2.4. Location Selection

2.4.1. General Criteria



Location selection, maximum height from the floor, and clearance distances from ceilings and walls may be set by local regulations. Where local regulations allow, adhere to the following requirements.

Select an installation location that satisfies the following criteria.

- Clean and dry.
- Not subject to direct sunlight.
- Away from a glass external wall.
- Where the beam path is not obscured by moving items.
- On a surface such that the direction of transmitted beam does not vary due to vibration or changes in temperature.

2.4.2. Ceiling Heights

For ceiling heights up to 40 m, mount the transceiver (25 ~ 600) mm below the ceiling or roof (see Fig. 3).

Where detectors cannot be installed (25 ~ 600) mm below the ceiling or roof (eg due to the construction of the structure or absence of suitable mounting points), install detectors more than 600 mm below the ceiling or roof and reduce the spacing between beams to a quarter of the mounting height of the beam above the floor.

For ceiling heights above 25 m, the sensitivity of the detectors should be set to compensate for expected increased smoke dilution caused by the likely spread of a smoke plume as a function of height from the fire source.

Where more than one line-type smoke detector is installed, the distance between beams should not exceed 14.5 m. The maximum distance from any wall to the nearest beam should not exceed 7.2 m.

It is generally the case that hot plumes have a spreading angle of $12^{\circ} \sim 30^{\circ}$. A reduced spacing of detectors accounts for the likely spread of a smoke plume as a function of height.

Where there is a risk that smoke may not rise to the ceiling or roof, additional detection may be provided at intermediate heights. The distance between detectors mounted at intermediate heights should be a quarter of the mounting height above the floor.

- Additional line-type smoke detectors are often installed in vertical spaces at lower levels, eg atria.
- Designers might also consider mounting detectors such that the beams traverse the space at an angle to the horizontal.
- Intermediate line-type detectors located in spaces with high ceilings will detect a fire where stratification may occur because the smoke plume has insufficient energy to rise to the ceiling, or where smoke dilution is significant at greater distances from the source of the fire.

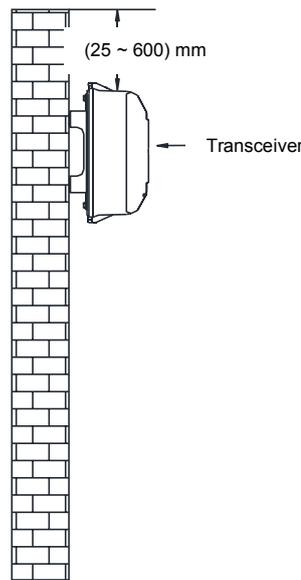


Fig. 3 – Transceiver mounting height

2.5. Transceiver and Reflector Orientation

The transceiver and the reflector must be mounted on the same horizontal plane and are parallel to each other. Some alignment adjustment is available, but if the received beam is reflected such that it is no longer parallel to the transmitted beam, then the performance of the detector will be negatively impacted.

Ensure the optical pathway is directly to and from the reflector, and is not received by the transceiver from other reflective surfaces.

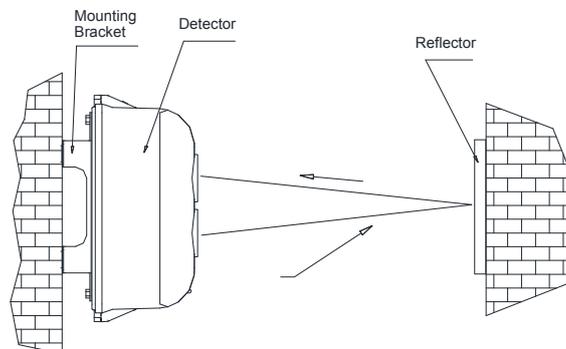


Fig. 4 – Transceiver and reflector orientation

2.6. Transceiver

2.6.1. Surface Mounting

Where cabling is embedded into the wall, the transceiver may be mounted directly on the wall surface. To install the transceiver complete the following steps.

- 1) Separate the transceiver cover from the body by removing the M4 screw located at top of the transceiver (see Fig. 1).
- 2) Align the base over the cable cavity and mark the positions of the two base mounting holes.
- 3) Drill two holes and install 6 mm wall plugs.
- 4) Push the conductors through the transceiver entry holes at the bottom of the base.
- 5) Screw the base to the bracket using the M4 x 10 screws and flat washers.



Fig. 5 – Transceiver base cable entry holes

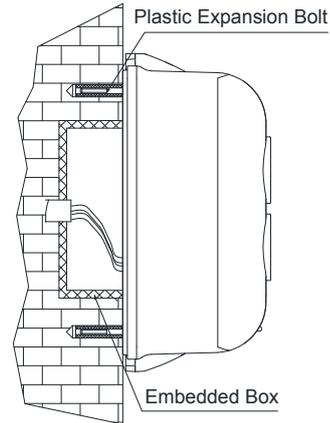


Fig. 6 – Surface mounted transceiver

2.6.2. Mounting Bracket

The mounting bracket is used where the cabling to the transceiver is installed on the surface of the wall. The mounting bracket provides space for the wiring to enter the rear of the transceiver base.

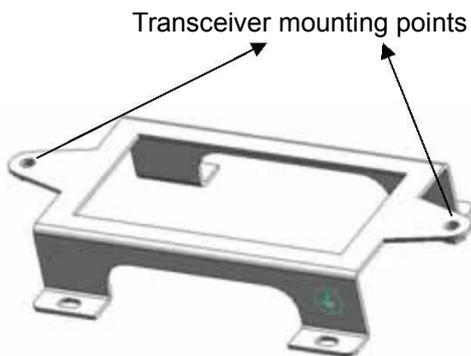


Fig. 7a – Mounting bracket

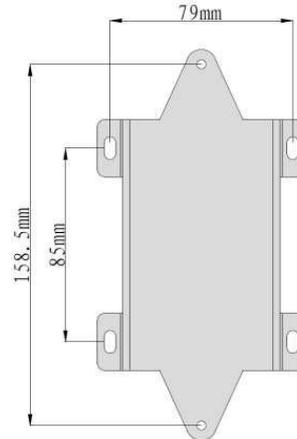


Fig. 7b – Mounting bracket drill template

To install the mounting bracket on the surface of the wall, complete the following steps.

- 1) Mark the mounting bracket hole locations as shown in Fig. 7b.
- 2) Drill four holes and install 6 mm wall plugs.
- 3) Fix the mounting bracket to the wall using four ST4 x 30 screws.

To install the transceiver complete the following steps.

- 1) Separate the transceiver cover from the body by removing the M4 screw located at top of the transceiver (see Fig. 1).
- 2) Push the conductors through the transceiver entry holes at the bottom of the base.
- 3) Screw the base to the bracket using the M4 x 10 screws and flat washers.



Fig. 8 – Transceiver base cable entry holes

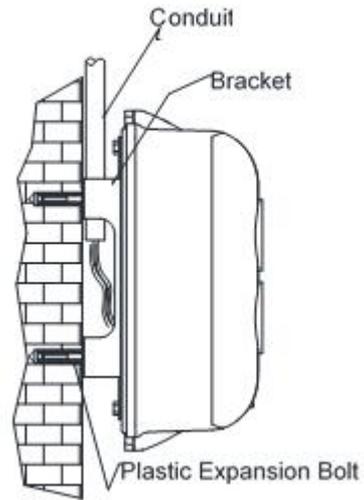


Fig. 9 – bracket mounted transceiver

2.7. Reflector

If the distance between the transceiver and the reflector is (8 ~ 40) m, one 2 x 1 reflector is required. If the distance between the transceiver and the reflector is (40 ~ 100) m, four reflectors are required (see Fig. 10).

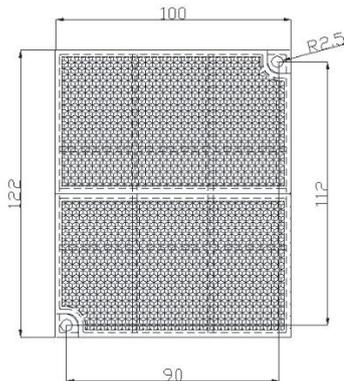


Fig. 10a – Single 2 x 1 reflector

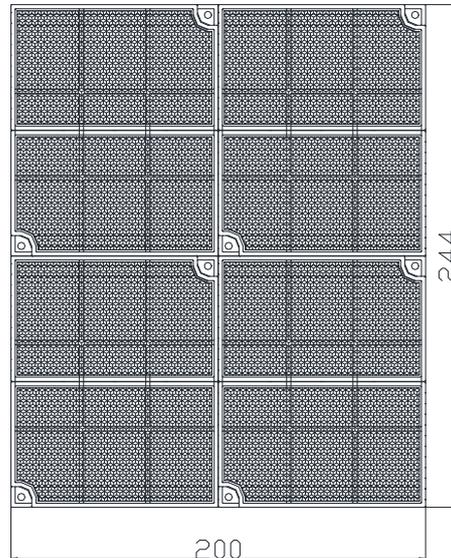


Fig. 10b – 4 x 2 reflector matrix

To install the reflector complete the following steps.

- 1) Drill two holes and install 6 mm wall plugs.
- 2) Fix the reflector to the wall using four ST4 x 30 screws.

2.8. Wiring

Wiring should be installed in accordance with National Standards and wiring regulations. The maximum cross section of cables compatible with the device is 1.5 mm².

Terminate power and signal wires to the terminals (see Fig. 11) as follows.

DC +24 V	D1
0 V	D2
Alarm output relay (N/O)	K11, K12
Fault output relay (N/O)	K21, K22



Fig. 11a – Wiring terminals



Fig. 11b – Wiring terminals

2.9. Direct Connection Option (for Non-addressable CIE)

The 407 line-type smoke detector can be connected directly to non-addressable control and indicating equipment detection zone transmission paths. Installers should refer to the relevant CIE installation instructions for power and signal connection requirements.

Power terminals (D1, D2) connect to external 24V DC power supply. Power connection is required to fall to 0 V to initiate a reset of the 407 detector.

Alarm output terminals (K11, K12) and a series 470 Ω resistor is connected across the detection zone transmission path conductors. When an alarm signal is released from the detector, the relay contacts will close.

2.10. Indirect Connection Option

The 407 line-type smoke detector can be connected indirectly to control and indicating equipment using the 621-007 single input module to provide switched power to, and signal connections from the 407 line-type smoke detector. Installers should refer to the relevant CIE installation instructions for power and signal connection requirements.

An external DC 24 V supply is switched by the module to provide power to the detector. When the CIE enters the Reset Condition, the voltage falls to 0 V and the 407 line-type smoke detector resets.

Alarm output terminals (K11, K12) are connected to the 621-007 input terminals. When an alarm signal is released from the detector, the relay contacts will close.

The 621-007 single input module is installed and configured to the CIE in accordance with the installation instructions (document number 32-0021). When connected to non-addressable CIE, the address setting DIP switches on the module are not used.

3. PRE-COMMISSIONING

Prior to commissioning, undertake the following pre-commissioning checks.

- 1) Check the wiring for continuity. Short- or open-circuit indications must be rectified before connecting to CIE. All cable testing must be carried out with a multi-meter, not a meg-ohm meter when devices are connected. Induced voltages greater than DC 1 V indicates possible cable problems or bad earth connection and must be rectified before device connection.
- 2) Ensure all connections are made.
- 3) Check that end-of-line devices are fitted.
- 4) Check that the correct number of reflectors are installed for the monitoring distance.
- 5) Ensure both the transceiver and reflector(s) are securely mounted, oriented in the correct axis, and clear of obstructions.
- 6) Check the configuration settings are correct for the monitoring distance and sensitivity requirements.

4. COMMISSIONING

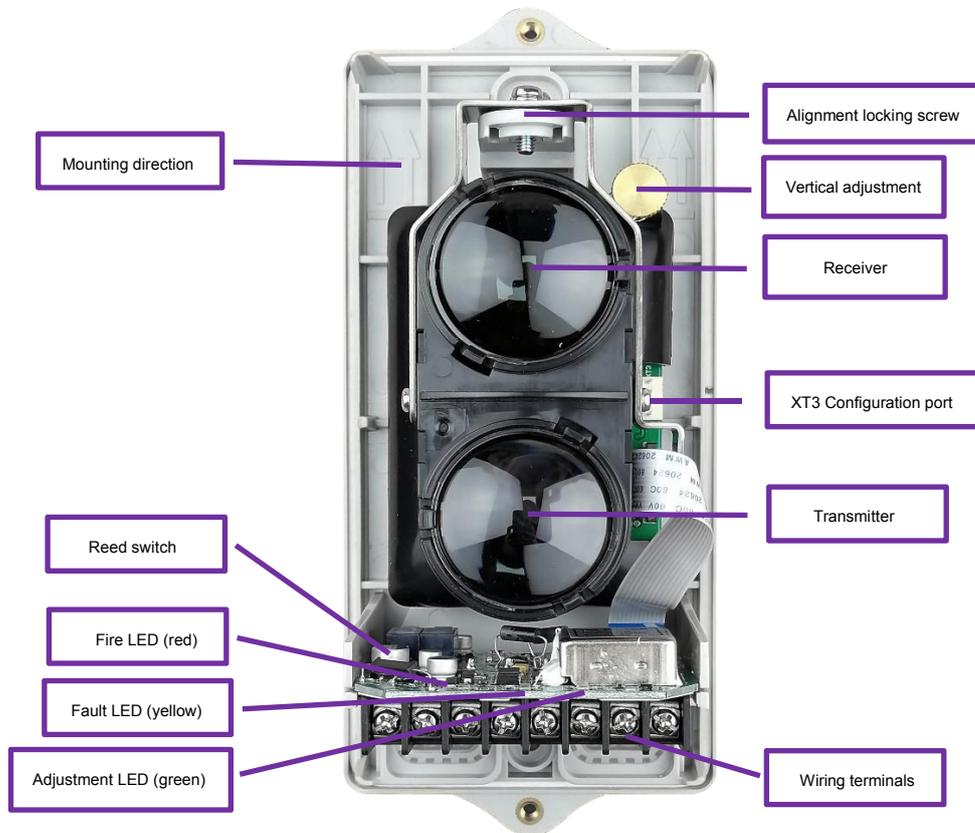


Fig. 14 – Transceiver with cover removed

4.1. Detector Beam Alignment

4.1.1. General

To align the detector beam, undertake the following actions.

- 1) Remove the reflector protective cover.
- 2) Separate the transceiver cover from the body by removing the M4 screws located at top and bottom of the transceiver (see Fig. 1).
- 3) Ensure there is clear line-of-sight between the transceiver and reflector.
- 4) Ensure the transceiver is steady on its mounting bracket during alignment.
- 5) Connect power to the transceiver and enable it to stabilize for 2 min.
- 6) Place the magnetic tool alongside the reed switch. The green Adjustment LED will flash or be on steady.
- 7) Remove the magnetic tool.

4.1.2. Manual Alignment

In alignment mode, a flashing Alignment LED indicates the reflected light beam is weak (the slower the flash, the weaker the received light beam). To improve the received light beam strength, complete the following steps.

- 1) Carefully remove the transceiver lens protective cover.
- 2) Adjust the adjustment screw and the locking screw so that the Adjustment LED is on continuously.
- 3) Tighten the locking screw.

4.1.3. Automatic Alignment

- 1) Replace the transceiver cover. The Adjustment LED will remain on.
- 2) Place the magnetic tool alongside \textcircled{M} (marking the location of the reed switch) until the Fault LED

illuminates continuously.

- 3) Immediately remove the magnet. Automatic alignment will commence. The following indications will be displayed after 10 s.

Indication	Explanation
Adjustment LED off. Fault LED on continuously.	Received light signal is acceptable.
Adjustment LED on continuously. Fault LED off.	Received light signal is weak.

- 4) After 10 s, the following indications will be displayed.

Indication	Explanation
Adjustment LED off. Fault LED off. Fire LED flashes	Received light signal is acceptable for the detector to enter the Quiescent condition.
Fire, Fault, Adjustment LED flash sequentially.	Automatic adjustment has failed. The detector cannot enter the Quiescent condition. Repeat the manual alignment steps.

4.2. Alarm Signal Test

To check the operation of the Alarm signal, undertake the following actions.

- 1) Ensure the detector is in the Quiescent condition for at least 20 s.
- 2) Place the translucent portion of the obscuration filter over the half of the transceiver lens for 30 s (see Fig. 15). Check that the red Alarm LED is on and the Alarm relay latches closed (terminals K11 and K12).
- 3) Remove the obscuration filter from the transceiver lens.
- 4) Reset the detector by removing power for ≥ 2 s.

4.3. Fault Signal Test

To check the operation of the Fault signal, undertake the following actions.

- 1) Place the opaque portion of the obscuration filter over the half of the transceiver lens (see Fig. 15). Check that the yellow Fault LED is on and the Fault relay latches open (terminals K21 and K22) within 10 s.
- 2) Remove the obscuration filter from the transceiver lens within 15 s. Check that the yellow Fault LED is off and Fault relay returns to its quiescent position.
- 3) Place the opaque portion of the obscuration filter over the half of the transceiver lens for 30 s. Check that the red Alarm LED is on and the Alarm relay latches closed (terminals K12 and K12).
- 4) Remove the obscuration filter from the transceiver lens.
- 5) Reset the detector by removing power for at least 2 s.

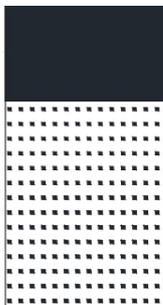


Fig. 15a – Obscuration filter

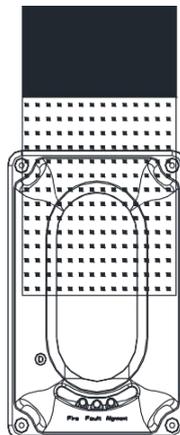


Fig. 15b – Alarm test

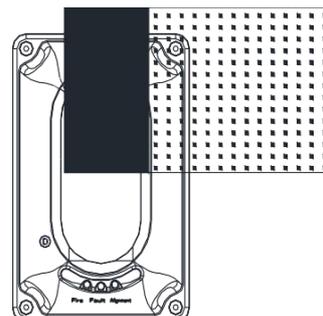


Fig. 15a – Fault test

5. TROUBLE SHOOTING GUIDE

Table 2 provides a guide to faults with the detector or during commissioning.

Table 2 – Troubleshooting conditions

Condition	Description	Actions
Cannot enter Alignment Mode	Commissioning cannot commence until the detector enters the Alignment mode. Alignment mode is initiated when the reed switch is activated by the magnetic tool.	Check that the magnetic tool retains its magnetic property and can activate the reed switch.
Fault signal cannot be cleared	Fault signals are generated when the received signal from the reflector is too low or the signal is distorted by ambient light. When the automatic compensation reaches its limit, the Fault LED and Fault relay will be constantly active.	Check that the beam path is clear of obstructions. Check that the reflector is clean. Check the beam alignment. Check that the ambient light conditions have not changed significantly.
Alarm signal cannot be cleared	Alarm signals are released when the obscuration level exceeds the alarm threshold or when the beam is obscured for more than 20 s.	Check the beam alignment to ensure the receiver is receiving the reflected signal.
Alarm signal released intermittently	Intermittent Alarm signals may be released when the local environment is not stable	Check that the detector is securely mounted on a stable surface. Check the beam alignment. Check for stray sources of electromagnetic interference. Check that the transceiver is shielded from direct sunlight.

6. SERVICE

Service intervals may be set by local regulations.

6.1. Inspections

Conduct the following inspections every 6 months.

- 1) Inspect detectors for any condition that is likely to adversely affect their operation, such as excessive deposition of dust or coating of paint.
- 2) Inspect the area around the detector to ensure there is no interference to the beam.

Every 12 months, disable the detector at the control and indicating equipment, then clean the transceiver lens and reflector with a damp cloth.

6.2. Tests

Following cleaning of the transceiver lens and reflector, conduct the following tests every 12 months:

- 1) Test the release of the Alarm signal using the obscuration filter (see 4.2).
- 2) Test the release of the Fault signal using the obscuration filter (see 4.3)

7. SPECIFICATIONS

7.1. Technical Data

Power	
	407-001
Operating voltage	DC (20 ~ 28) V
Commissioning current	≤ 20 mA @ DC 28 V
Quiescent current	≤ 12 mA @ DC 28 V
Quiescent condition	
Quiescent condition indication	Flashing red LED
Alarm	
Obscuration sensitivity level	(1.3 ± 0.3) dB/m
Alarm current (max)	22 mA @ DC 28 V
Alarm indicator	Red LEDs
Alarm N/O relay	2.0 A @ DC 28 V
Reset time	15 s
Fault	
Fault indicator	Yellow LED
Fault N/O relay	2.0 A @ DC 28 V
Environmental	
Operating temperature	(-10 ~ +50)°C
Operating humidity	(0 ~ 95)% RH, non-condensing
Storage temperature	(-25 ~ +80)°C
Storage humidity	(0 ~ 98)% RH, non-condensing
Miscellaneous	
Detection distance ^a	(8 ~ 100) m
Detection width	14.5 m
Beam adjustment angle	±6°
Transmitted beam path angle	±0.5° directional
Alignment indicator (during commissioning)	Green LED; yellow LED
Dimensions (h x w x d)	(206 x 95 x 95) mm
Weight (with base)	405 g
Ingress protection rating	IP-20 IP-66 ^b

^a 2 x 2 reflector matrix required for detection distance > 40 m.

^b Prepared with glue-seal treatment.

For current technical data, refer to the 407 non-addressable reflective beam line-type smoke detector datasheet. Document number 31-0106.

7.2. Ordering Information

Model	Description
407-001	Non-addressable reflective beam line-type smoke detector
407-002	Line-type smoke detector reflector
621-007	Module, single input, switched external DC 24 V

8. SPARE PARTS

The following spare parts are available for the 407 non-addressable reflective beam line-type smoke detector.

Description	Part Number
Reflector	407-002

Website

For more information, including product datasheets and other support material, please view our website at www.numens.com.



Contact Us

For sales and specific enquiries, please contact our sales office by telephone or email. Enquiries can also be submitted through our website.

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