DOCUMENT CONTROL NUMBER /

FIRERAY 2000 OPTICAL BEAM SMOKE DETECTOR

PRODUCT APPLICATION AND SYSTEM DESIGN

LIST OF CONTENTS

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1. GENERAL

The FIRERAY 2000 Optical Beam Smoke Detector is an active infrared smoke detector. The system comprises a Transmitter, a Receiver, and a Control Box.

A modulated infrared beam from Transmitter to Receiver is analysed by the Control Box to determine whether smoke is present. A fire alarm signal is generated when the Control Box determines that smoke is causing partial obscuration of the infrared beam.

The system is designed for use in large open type interiors such as manufacturing plants, hangars and workshop areas, power stations, shopping malls where the installation and servicing of point-type detectors would prove difficult or impractical, or cable tunnels where access is only possible at either end.

The system can be used with any Tyco Conventional or Addressable Fire Controller.

2. SALIENT FEATURES

- Beam range 5 metres to 100 metres
- Area of coverage 1400 square metres
- Selectable sensitivity
- Self-check and automatic compensation
- Manual or automatic reset
- Suitable for use with both conventional and addressable controllers
- Fault/Fire interface to MINERVA controller
- Alarm relay may be latching or non latching
- Optional MINERVA loop-powered interface module (LPBD520)
- Low current consumption
- Robust metal construction
- Flexible system design options
- Designed to conform to BS5839 Part 5

3. CONTROLS AND INDICATORS

The Control Box has a fire indicator (red LED) on the front panel. No operator controls are fitted. Other presets and indicators are fitted inside the unit. The presets and status indicators are accessible when the front panel of the unit is opened. The presets and indicators mounted on the PCB give status indications as an aid to setting up and fault finding.

The Transmitter Unit has a range adjustment preset, (used when setting up) which is located beneath a removable grommet opposite the cable entry gland.

The Receiver Unit has no controls, indicators, or presets.

4. OPERATION

4.1 PRINCIPLES OF OPERATION

The Transmitter Unit emits a beam of infrared light which is pulse-modulated and collimated to produce a cone of illumination of approximately 3 metres radius at 100 metres range.

The Receiver Unit senses the transmitted beam amplifies it and feeds it to the Control Box.

The Control Box examines received the signal to determine if the received signal strength has changed from the calibrated alignment value. Any change in signal strength is analysed to check if it is above or below a certain reference level, and is present for a required time. If the conditions are met then the circuit responds by either adjusting the system gain or by signalling a fault or an alarm.

4.2 SMOKE DETECTION

When smoke is present in the beam, the signal received is reduced to a level determined by the density of the smoke. In the event of the smoke reducing the signal strength to a level between the specified alarm threshold and 93% obscuration for a period of between 5 to 10 seconds, the fire alarm output is activated.

Three alarm thresholds can be selected.

i) 25% - 1.23 dB
ii) 35% - 1.87 dB
iii) 50% - 3.01 dB

Note:

1) *The 25% threshold does not fully meet BS5839 requirements for stability over the full temperature range.*
2) *The 50% threshold is recommended for retro-reflective operation.*

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4.2.1 EXAMPLES OF THRESHOLD SETTINGS

If the threshold level for a conventional beam Tx to Rx, end-to-end was set at 25%. Then the threshold level for a retro-reflective beam set up for a comparable response would need to use the 35% setting.

Similarly, if the threshold level for a conventional beam Tx to Rx end-to-end was set at 35%. Then the threshold level for a retro-reflective beam set up for a comparable response would need to use the 50% setting.

4.3 AUTO RESET

The Auto-reset function automatically resets the receiver five seconds after a fault condition has been indicated if the fault is no longer present.

4.3.1 LINK SETTING FOR AUTO RESET

The fire alarm may be latching or non-latching:

i) For latching operation set the link marked 'ALARM' to closed.

ii) For non-latching operation set the link to open.

For MINERVA application use the latching setting and also refer to publication 08A-02-D26.

4.4 AUTOMATIC GAIN CONTROL (AGC)

Long term degradation of signal strength by component ageing or the accumulation of dirt on the optical surfaces will not generate an alarm because of compensation provided by the AGC circuit. The AGC circuit operates by comparing the received signal against a standard at predetermined time intervals. Differences of more than 7% are corrected by the automatic selection of gain stages. The AGC time is factory set to nominally 1.5 hours.

4.4.1 LINK SETTING FOR (AGC COMPENSATION)

There are two options available when the AGC runs out of compensation:

i) The Fireray will, when at the last stage of gain, signal a fault.
In the event of further signal loss reducing the signal to the alarm threshold, a Fire alarm will be signalled. (This is to conform to BS5839 part 5). For option (i) set the link marked 'COMP' to open.

ii) The Fireray will, when at the last stage of gain, signal a fault. This will inhibit the Fire alarm.
For option (ii) set the link marked 'COMP' to closed.

4.5 FAULT INDICATION

A fault condition is signalled if the signal level is reduced by more than 93% for a period in excess of 5 seconds. The reduction in signal level may be caused through power failure at the transmitter or mechanical blockage of the beam, or other malfunction.

5. DESIGN CONSIDERATIONS

5.1 GENERAL

The beam can detect the presence of black or white smoke. The beam range is between 5 metres to 100 metres.

The beam between the Transmitter (Tx) and Receiver (Rx) must be between **0.3m and 0.6m below and parallel to the ceiling** of the building in which the detectors are installed.

The transmitter and receiver must be mounted so that the beam emitted from the round glass area of the transmitter is in line-of-sight with the round glass area of the receiver.

Each pair of detectors must be mounted on a firm structural part of the building.

Note: Ensure that there is no source of infrared (heat) near the detectors such as a heater, an incandescent light bulb or direct sunlight.

The Control Box should be mounted at ground level, within 100 metres cable run of the receiver.

5.2 LOOP POWERED OPERATION

For details on loop powered operation and connections refer to publication 08A-02-D26.

5.3 RETRO-REFLECTIVE OPERATION

Where the beam path is less than 10 metres or access to the opposing wall is restricted or wiring to one of the heads is difficult, the Fireray 2000 should be configured for retro-reflective operation.

Note: For beam ranges of less than 10 metres, use a retro-reflective configuration to avoid receiver saturation.

For retro-reflective operation the two heads are mounted side by side as closely as possible and a reflector is mounted on the opposing wall. The number of reflectors required varies proportionally with the distance between heads and reflector.

Range: 2 metres to 25 metres: 1 reflector

Range: 25 metres to 35 metres: 4 reflectors (to form a square)

Range: 35 metres to 45 metres: 6 reflectors (to form a rectangle)

When using reflectors the gain of the Transmitter must be set to full (max).

5.4 AREAS OF PROTECTION

The areas of protection for different roof styles are detailed in this section, for examples see Fig. 1 to Fig. 5.

It is possible for the beam to pass through holes in wall but the holes must be at least 20 cm diameter or the diameter of the beam at the point along the beam path.

5.4.1 BEAMS INSTALLED IN THE APEX OF A PITCHED OR NORTH LIGHT ROOF

Where beam detectors are installed in the apex of a pitched or north light roof, the width of the area protected by the beam, can be increased.

The beam width in flat areas is 14 metres and this dimension can be increased by 1% (14 centimetres) for each degree of slope from the horizontal, up to a maximum increase of 25% of slope (equating to 3.5 metres).

Note: This relaxation only applies to a beam mounted in the apex.

5.4.2 BEAMS INSTALLED UNDER A FLAT ROOF

For areas under a flat horizontal ceiling (less than 3.5 degrees from the horizontal) the maximum distance from any adjacent parallel wall or partition must not exceed 8 metres when measured perpendicular to the beam on the plan view.

In open areas the maximum permitted distance between parallel beam smoke detectors is 14 metres when measured perpendicular to the beam on the plan view.

5.5 CABLING

Receiver Unit - The cable supplied with the receiver unit is nominally one metre in length and unscreened, therefore it is usually necessary to use a conduit box to connect between the receiver unit cable and the cable to the Control Box. Mount the conduit box as close as practicably possible to the receiver unit so that the cable between conduit box and receiver is kept as short, to reduce the possibility of electomagnetic interference. Use screened cables and terminate the screen braid to the cable gland on the control box, refer to Fig. 17.
The maximum length of cable run between Rx unit and control box should not exceed 100 metres.

Transmitter Unit - As with the receiver unit, the the cable supplied with the transmitter unit is also nominally one metre in length, and unscreened therefore use a conduit box to connect between the transmitter unit cable and the incoming power supply cable. Position the the conduit box as close as practicable to the transmitter unit. Use screened cables and terminate the screen braid to the cable gland on the control box. or power supply casing if a separate supply is used, refer to Fig. 17.

The terminal blocks in the control box accept a maximum of $2.5mm^2$ cable.

The size for the cables from the detectors is $0.5mm^2$. Use fire resistant cable between the detectors and Control Box.

5.5.1 RECOMMENDED CABLES

MICC 'Pyro' type cable is recommended for all applications, as it provides excellent EMC performance, high strength and superb long term fire resistance, however, any good quality screened cable may be used. (Legislation and building/local regulations permitting).

The most important aspect in meeting the required EMC performance is the method of screen termination. Pigtails are not sufficient. Good quality metal glands should be used. The cable screens must be terminated at the gland and have a 360^o connection to it. Also metal junction boxes should be used where extensions are made to the supplied Tx and Rx cables.

The screens should be terminated at metal junction box glands, with the screen effectively passing through the metal box MICC 'Pyro' glands are suitable for use both with pyro cable and normal screened cable if the correct size is chosen. The screen of the cable should be folded back over the outer insulatiom of the cable and the gland olive should be a push fit over this.

Whenever possible, avoid bunching the system cabling with other factory/ building services wiring.

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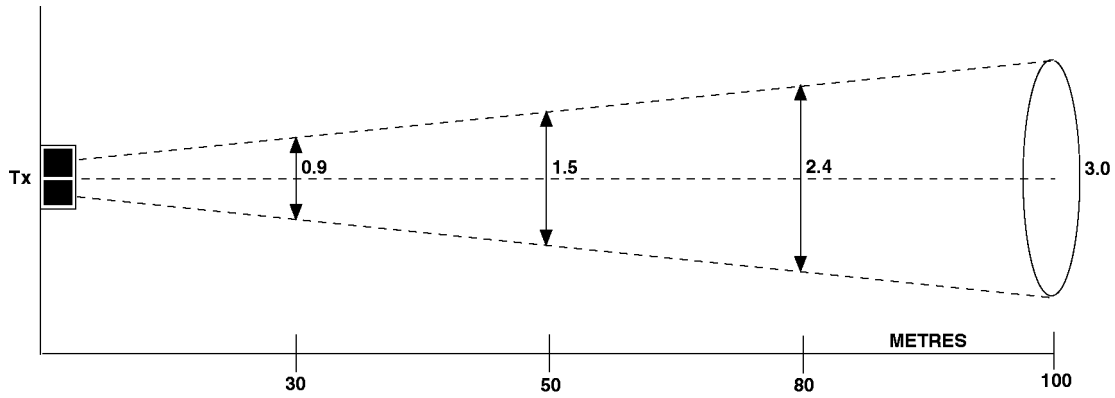

Fig. 1 Beam Divergence

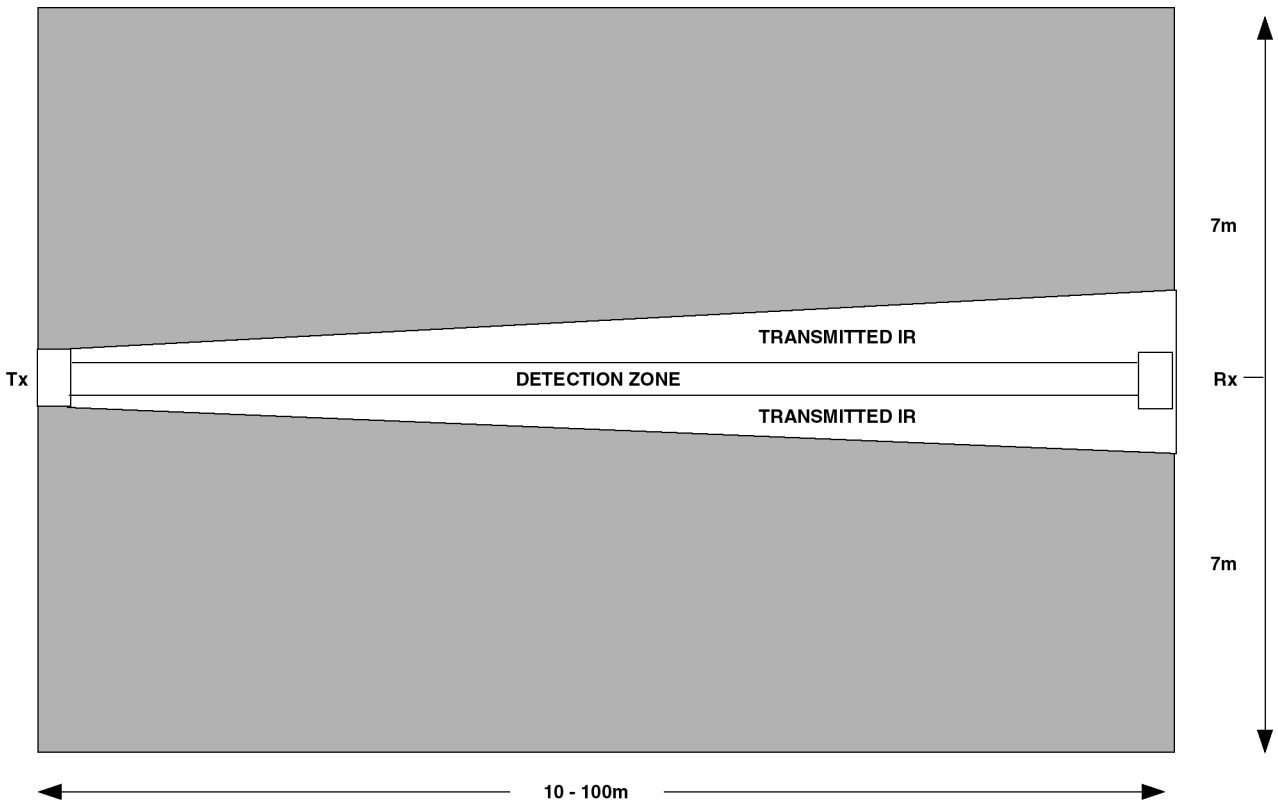

Fig. 2 Area of Protection

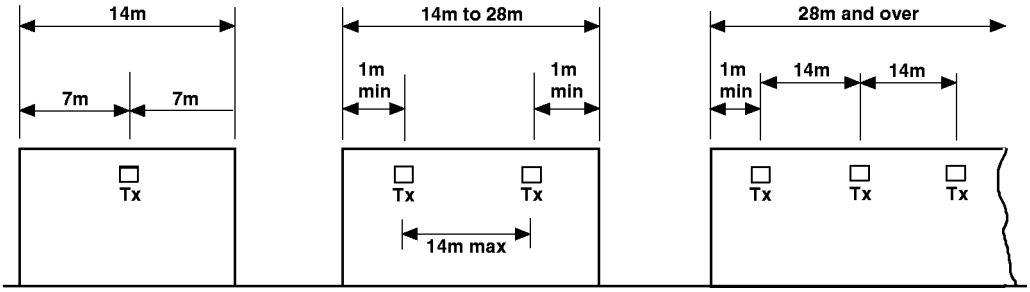

Fig. 3 Flat Roofs

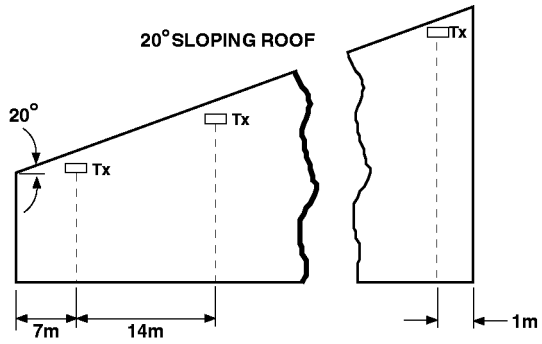

Fig. 4 Sloping Roofs

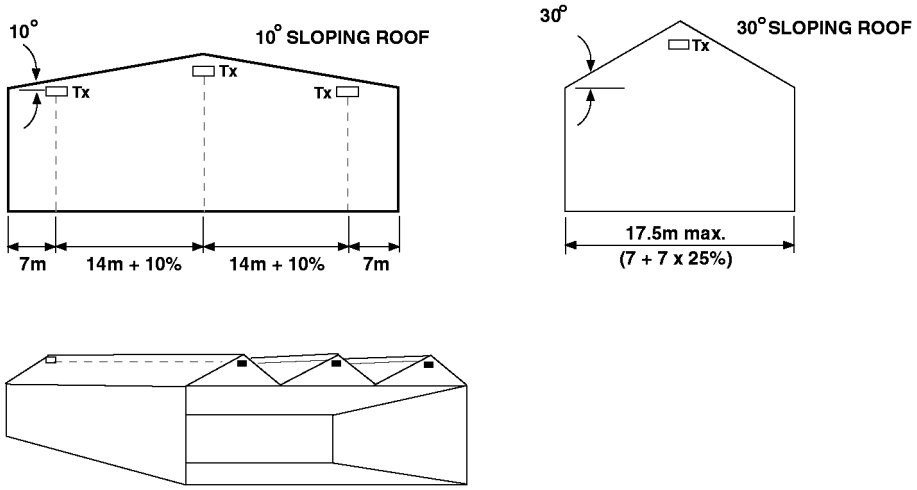

Fig. 5 Pitched and North Light Roofs

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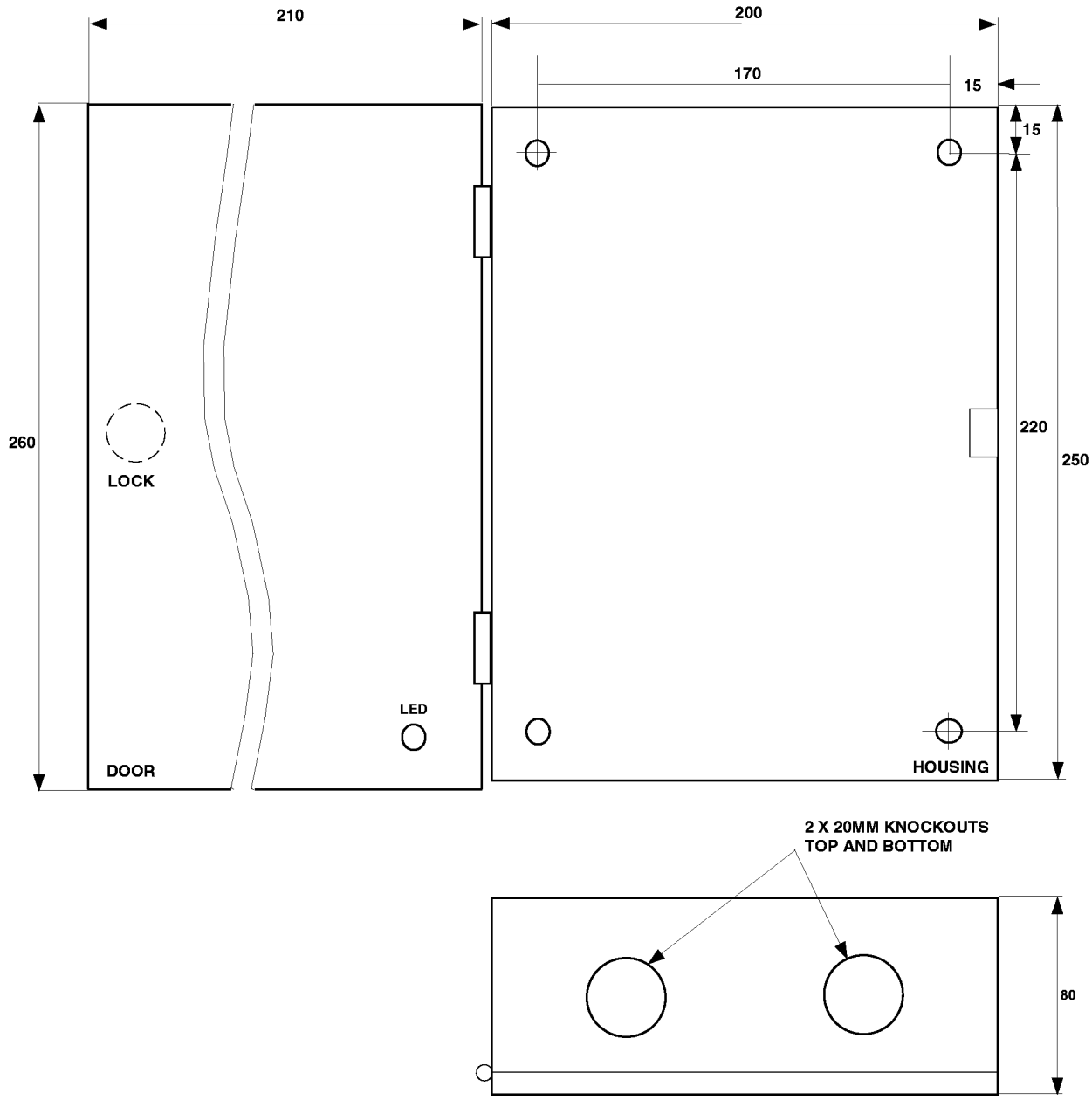

Fig. 6 Control Box - Overall and Fixing Dimensions

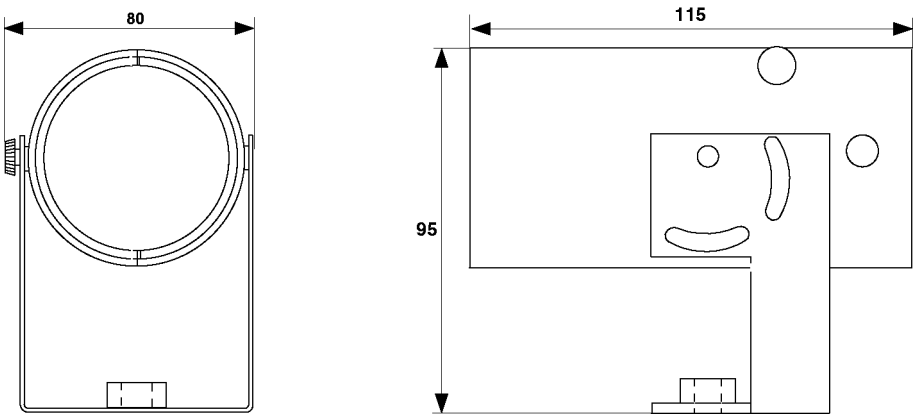

Fig. 7 Transmitter and Receiver Unit - Overall Dimensions

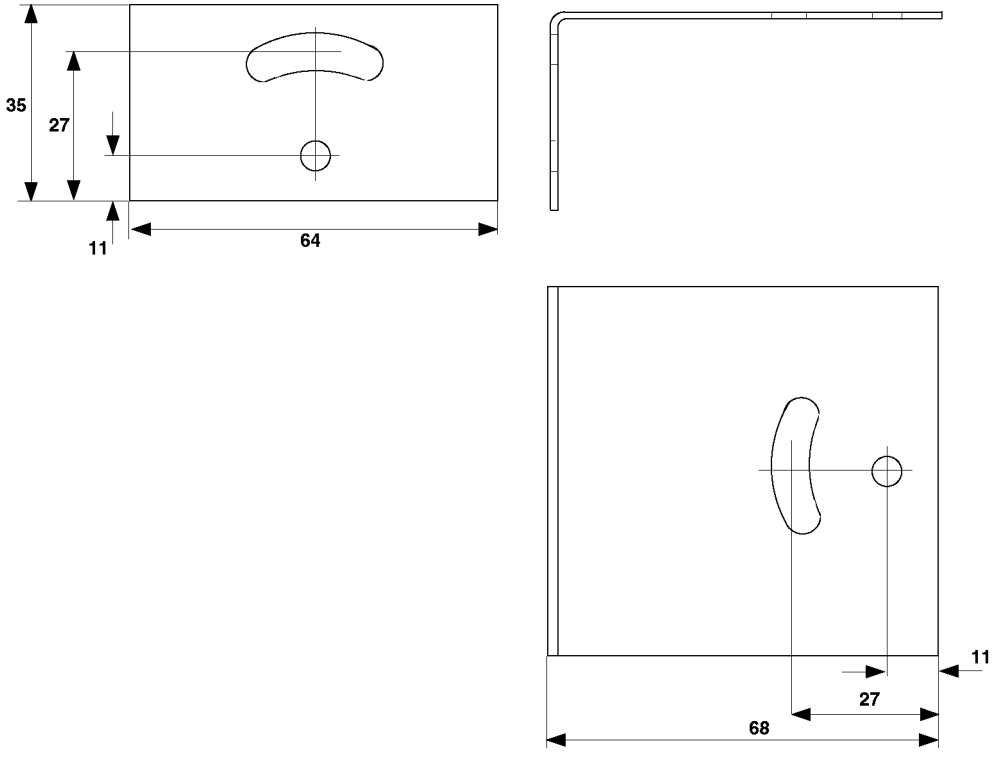

Fig. 8 Transmitter/Receiver - Mounting Bracket

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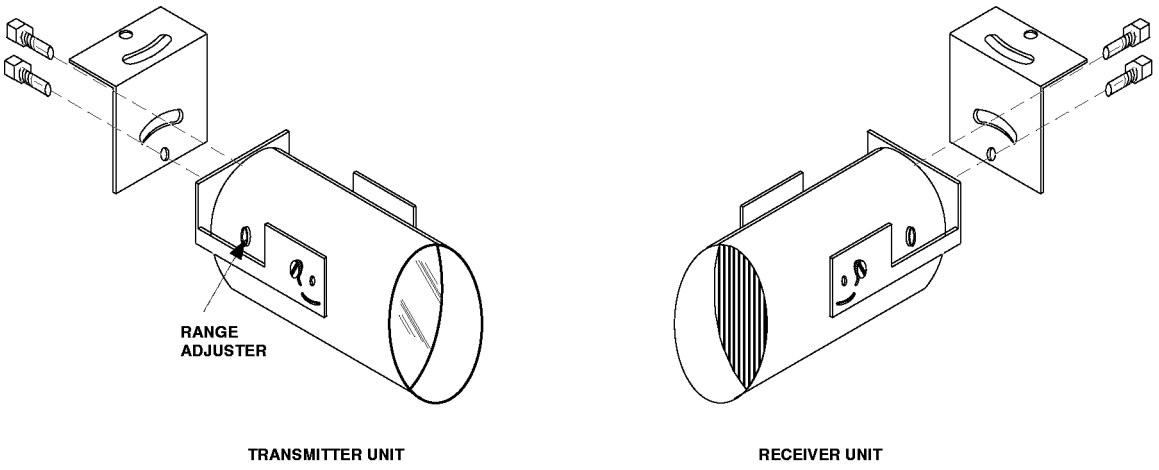

Fig. 9 Ceiling Mounting

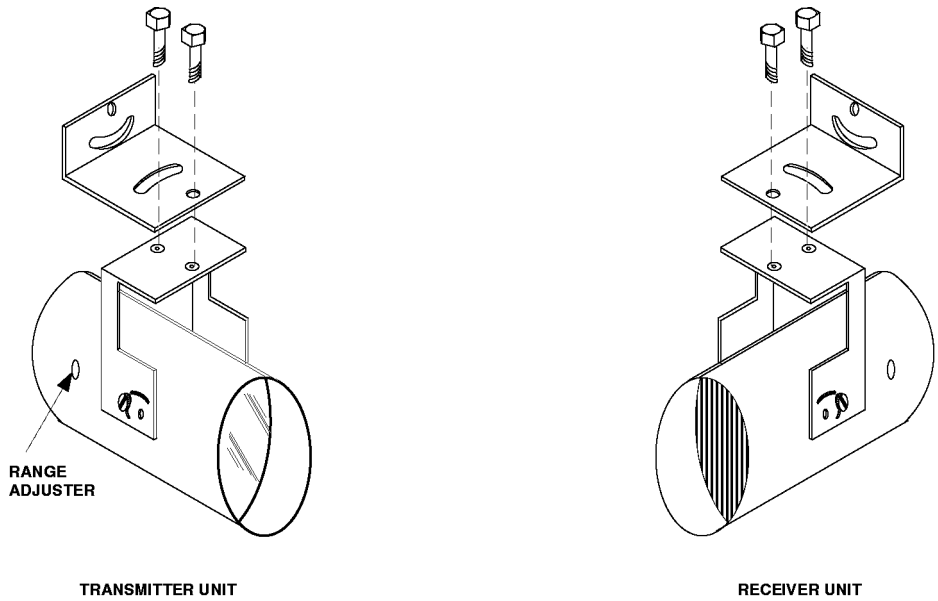

Fig. 10 Wall Mounting

5.6 POWER SUPPLIES

The optical beam smoke detector can be powered from either a 12 volt or 24 volt dc supply.

The Receiver unit derives its power from the Control Box.

The Transmitter unit may be powered from either the Control Box or from a separate 12 volt or 24 volt dc supply.

If the optical beam smoke detector is being used with a MINERVA addressable fire controller the power supply can be derived the loop via a LPBD520 module.

If the optical beam smoke detector is being used with a conventional fire controller the power is drawn from a suitable 12 volt or 24 volt dc power supply unit.

5.7 ALIGNMENT AND TESTING

The detectors need to be aligned so that they work correctly. An Alignment Aid (Fig. 12) which consists of a small box with a light mounted on it, is used during commissioning to facilitate optimum beam alignment.

Supplied inside the Control Box is an acetate Test Card with black markings on it. The markings pattern provides partial obscuration of the beam when testing the FIRE and FAULT functions.

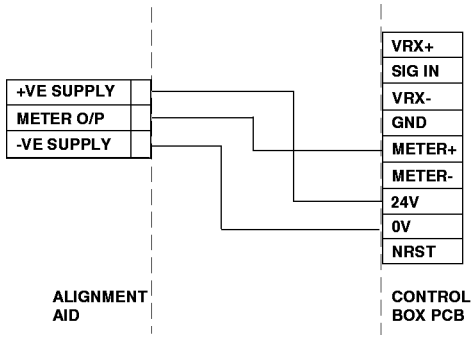

Fig. 11 Connections to Alignment Aid

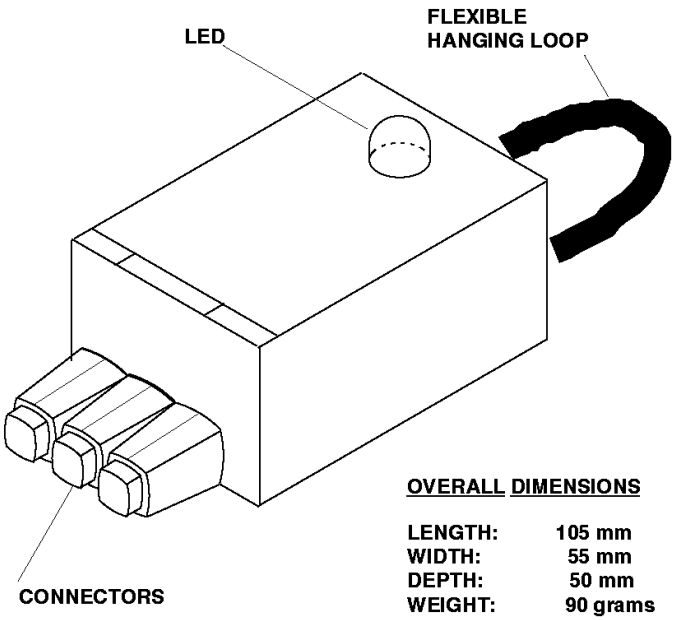

Fig. 12 Alignment Aid

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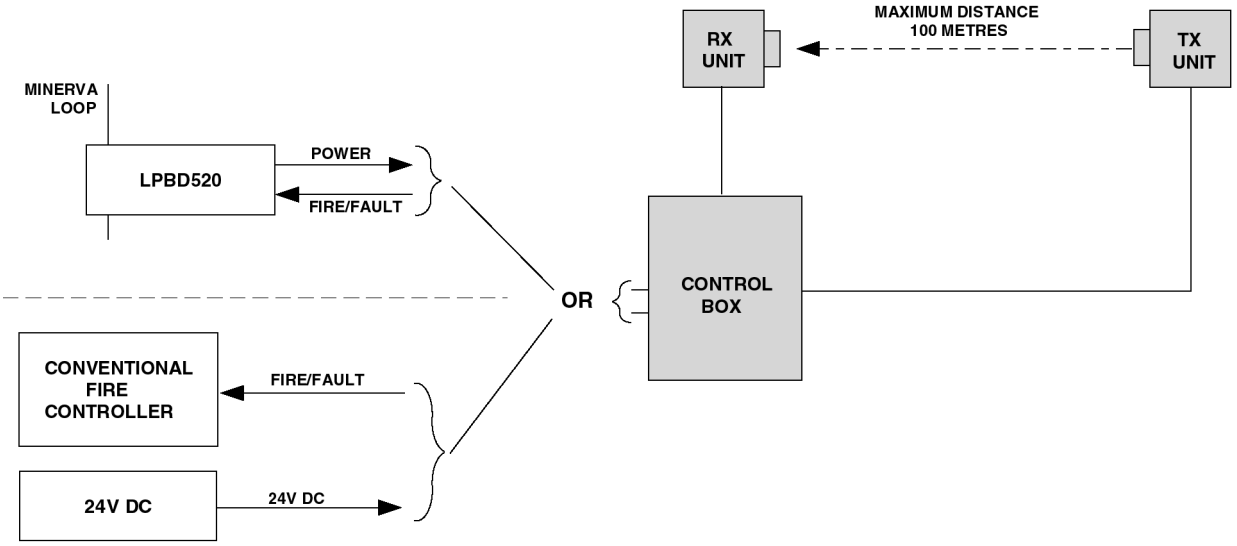
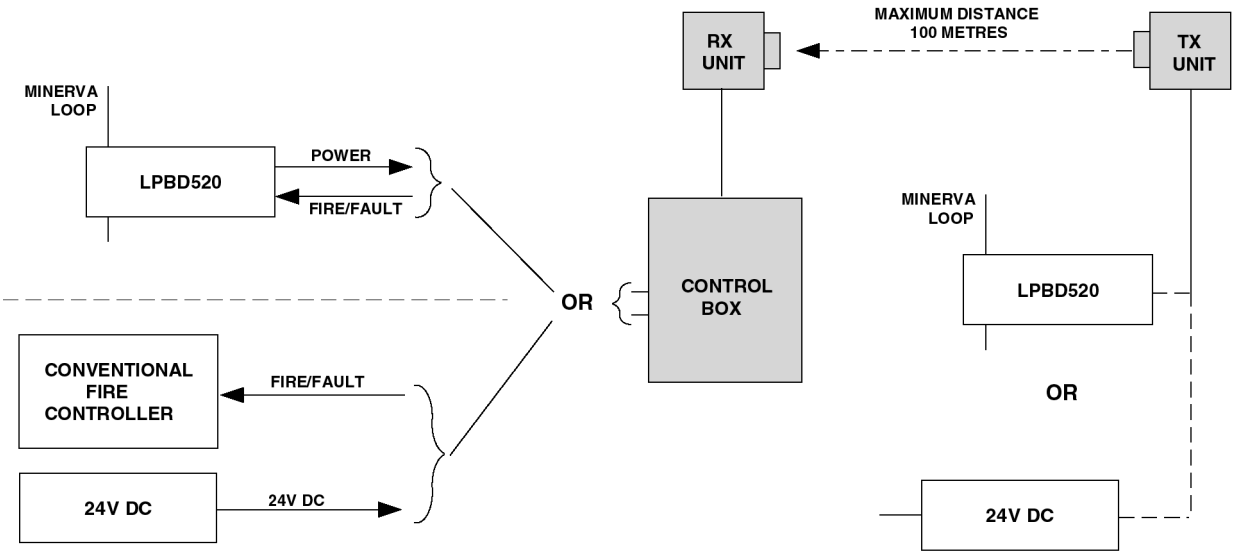


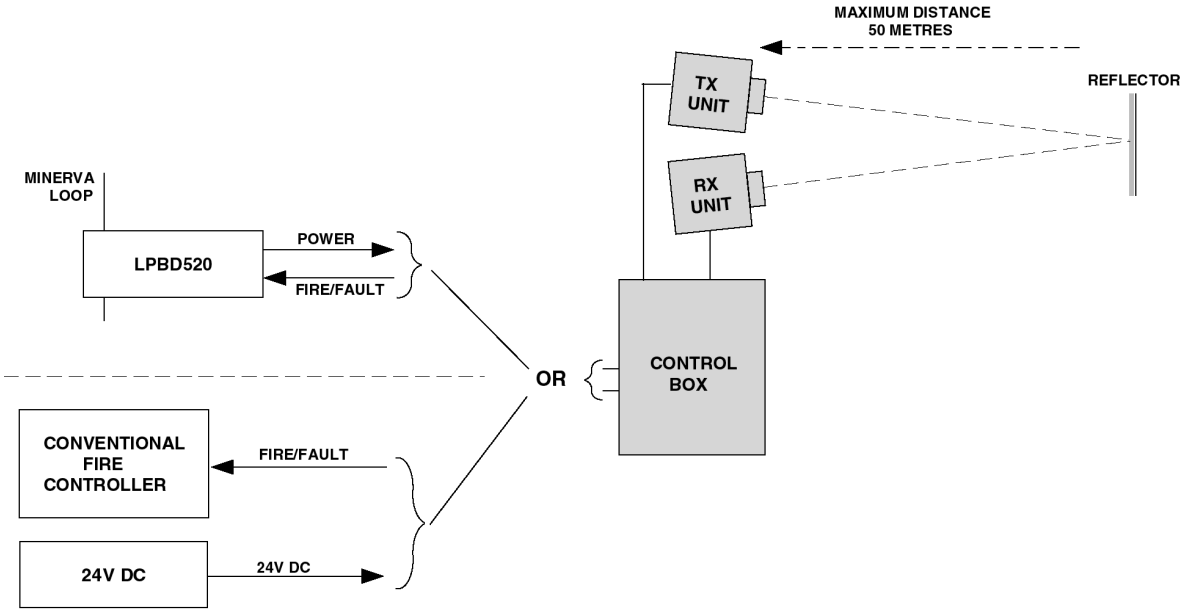
NOTE: WHEN USING A CONVENTIONAL FIRE CONTROLLER A SEPARATE 24 VOLT DC POWER SUPPLY MUST BE USED.
WHEN USING AN ADDRESSABLE FIRE CONTROLLER THE LPBD520 CAN BE USED TO POWER THE BEAM UNITS FROM THE LOOP.

Fig. 13 Detector Cabling - Single LPBD or Conventional Configuration



NOTE: WHEN USING A CONVENTIONAL FIRE CONTROLLER A SEPARATE 24 VOLT DC POWER SUPPLY MUST BE USED.
WHEN USING AN ADDRESSABLE FIRE CONTROLLER THE LPBD520 CAN BE USED TO POWER THE BEAM UNITS FROM THE LOOP.

Fig. 14 Detector Cabling - Two LPBD520s on the Same Loop or Two Different Loops or Conventional Configuration using Two Separate 24V Power Supplies



NOTE: WHEN USING A CONVENTIONAL FIRE CONTROLLER A SEPARATE 24 VOLT DC POWER SUPPLY MUST BE USED.
WHEN USING AN ADDRESSABLE FIRE CONTROLLER THE LPBD520 CAN BE USED TO POWER THE BEAM UNITS FROM THE LOOP.

Fig. 15 Detector Cabling - Retro-reflective or Conventional Configuration

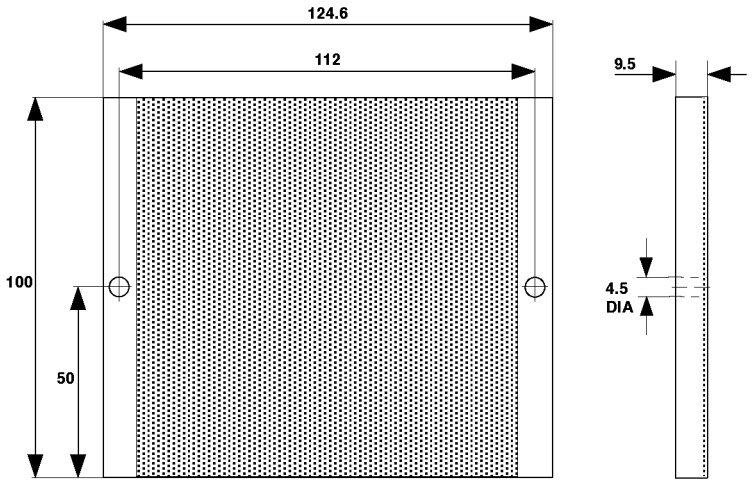


Fig. 16 Reflector - TKS 100x100

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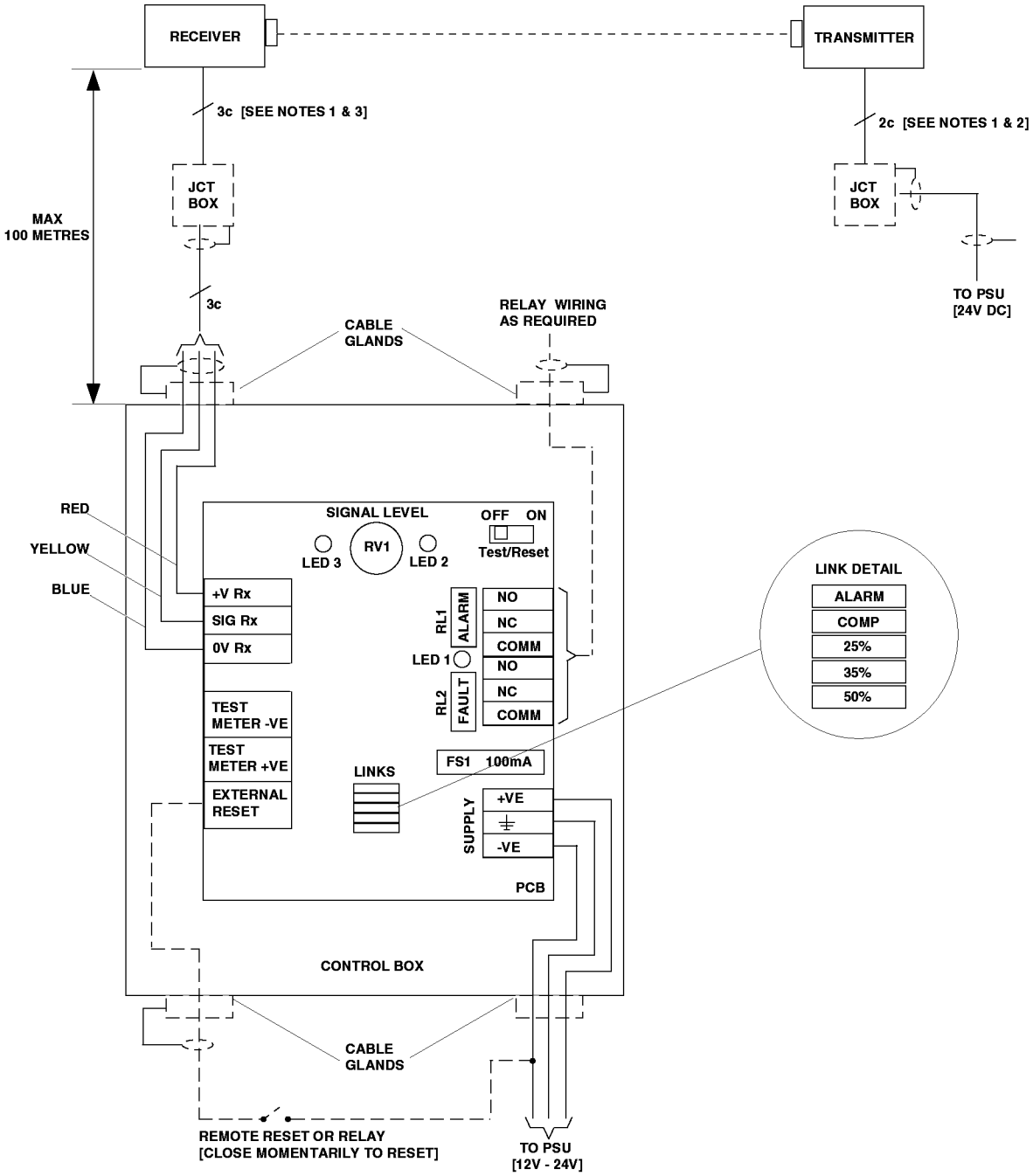

NOTE 1: BOTH THE TRANSMITTER [TX] AND RECEIVER [RX] UNIT ARE SUPPLIED WITH 1 METRE [NOMINAL] OF FACTORY CONNECTED 4-CORE CABLE [UNSCREENED].
THE TX UNIT USES ONLY THE RED [+VE] AND BLUE [-VE].
THE RX UNIT USES THE RED [+VE], YELLOW [SIGNAL], AND BLUE [-VE].
ENSURE THAT THE CABLE LENGTH BETWEEN TX AND RX UNITS AND THEIR RESPECTIVE JUNCTION BOXES IS KEPT AS SHORT AS PRACTICABLE.

NOTE 2: FOR TRANSMITTER POWER USE A COMMON OR INDEPENDENT POWER SUPPLY, DEPENDING ON THE INSTALLATION AND THE LOCATION.

NOTE 3: THE MAXIMUM CABLE RUN BETWEEN THE RECEIVER UNIT AND THE CONTROL BOX IS 100 METRES.

Fig. 17 Cable Connections

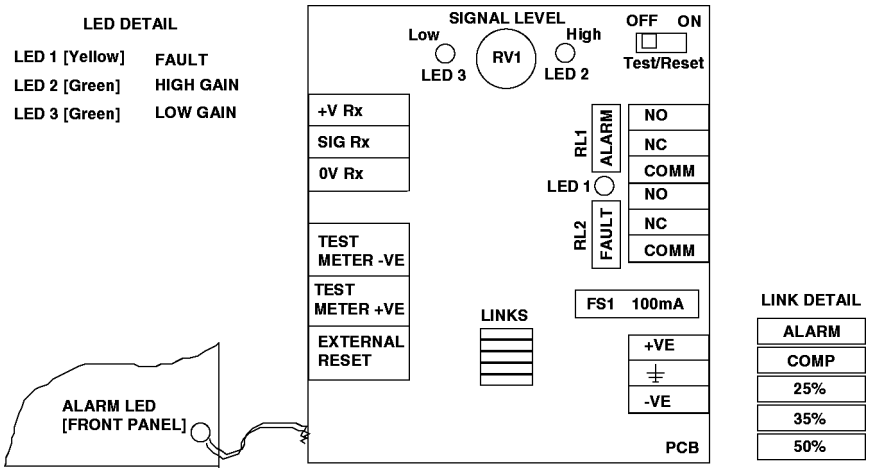

Fig. 18 PCB Layout

5.8 SETTING PCB LINKS

Set the links on the PCB to the positions required. See Table 1 below:

OPTION REQUIRED	LINK POSITION				
	ALARM	COMP	25%	35%	50%
ALARM Non-latching	OPEN	-	-	-	-
ALARM Latching	CLOSED	-	-	-	-
COMP - AGC compensation to signal FAULT and ALARM	OPEN	-	-	-	-
COMP - AGC compensation to signal FAULT and inhibit ALARM	CLOSED	-	-	-	-
25% Obscuration threshold	-	-	CLOSED	OPEN	OPEN
35% Obscuration threshold	-	-	OPEN	CLOSED	OPEN
50% Obscuration threshold	-	-	OPEN	OPEN	CLOSED

Table 1: Link Settings

6. CONSTRUCTION

The Control Box is pressed sheet steel and finished in white.

The Detector Heads are cast in Zinc alloy and also finished in white to match the Control Box.

The detector brackets are steel, finished in white.

7. TECHNICAL SPECIFICATION

OVERALL DIMENSIONS

Control box

Height:	260
Width:	210
Depth:	80
Weight:	2.25kg

Transmitter/Receiver Unit heads

Height:	95
Width:	80
Depth:	115
Weight (with brackets):	0.4kg

Colour: All units finished in white to RAL9010

Environmental:

Storage temperature:	-20^{o}C to +55^{o}C
Operating temperature:	-20^{o}C to +55^{o}C
Humidity:	up to 95% (non condensing)
Enclosure IP rating:	IP54

Electrical Charactristics:

Supply voltage: +11.5V to 28V dc

Current drawn:

Control Box, Receiver and Transmitter:

Quiescent current:	less than 13mA
Alarm current:	less than 20mA

Control Box and Receiver only:

Quiescent current:	less than 13mA
Alarm current:	less than 20mA

Transmitter only:

Quiescent current:	less than 13mA
Alarm current:	less than 20mA
Optical wavelength:	880nm

Electromagnetic Compatibility:

EMC	Equals or exceeds the requirements of: BS EN 50081-1 : 1992 BS EN 50082-1 : 1992

Note: The above standards fulfil the requirements of the European Directive for EMC (89/336/EEC).

Tolerance to Beam Misalignment:

Transmitter:	± 0.5^{o}
Receiver:	± 0.5^{o}

(Reflector TKS 100 x 100 Temp Range -20^{o}C to +60^{o}C)

8. ORDERING INFORMATION

Fireray 2000 complete:	516-015-006A
Fireray 2000 complete:	516-015-006T
LPBD520:	557-180-217
Retro-Reflector (TKS 100 x 100):	516-015-007
Alignment Aid:	516-015-008

9. ASSOCIATED PUBLICATIONS

15A-02-D1 'MINERVA' RANGE OF ANALOGUE ADDRESSABLE CONTROLLERS - PRODUCT APPLICATION AND SYSTEM DESIGN

20A-02-D1 T880 FIRE CONTROLLERS - PRODUCT APPLICATION AND SYSTEM DESIGN

20A-02-D1 T881 FIRE CONTROLLERS - PRODUCT APPLICATION AND SYSTEM DESIGN

08A-02-D26 LPBD520 LOOP POWERED BEAM DETECTOR INTERFACE MODULE - PRODUCT APPLICATION AND SYSTEM DESIGN

CB/jm 12th January 2001