DOCUMENT CONTROL NUMBER /

MS302Ex, INFRA-RED FLAME DETECTOR

PRODUCT APPLICATION AND DESIGN INFORMATION

1. INTRODUCTION

The MS302Ex infra-red flame detector forms part of the M300 series of plug-in detectors for ceiling mounting. The detector is intended for two-wire operation on all control equipment currently manufactured by Thorn Security Limited.

The detector is certified intrinsically safe and may therefore be used in hazardous areas in conjunction with specified safety barriers, or without a barrier in safe areas.

2. OPERATING PRINCIPLE

2.1 OPTICAL CHARACTERISTICS

The MS302Ex is designed to detect the infra-red radiation produced by flaming fires involving carbonaceous materials.

Fig. 1(a) shows the spectrum of a typical fire of this type,

Fig. 1(b) the spectrum of the radiation of the sun and

Fig. 1(c), that of a tungsten filament lamp.

It can be seen that there is a large peak in the flame output at wavelengths in the region of 4.4µm. This peak is a characteristic of carbonaceous flames and results from the formation of carbon dioxide in the flame. It will be seen also that the radiation from the sun and from the filament lamp is relatively low in this region.

In order to exploit these spectral characteristics, the MS302Ex uses an optical filter which transmits infra-red between 4.2µm and 4.7µm [shown shaded in Fig. 1(a)]. This bandwidth allows high sensitivity to flames with low sensitivity to other interfering sources.

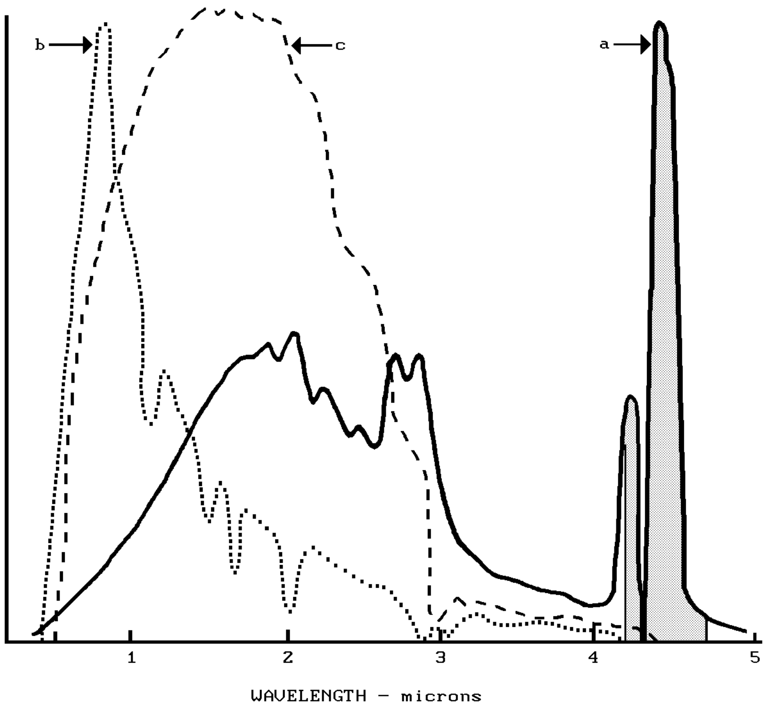

Fig. 1 Spectrums of a) Typical Carbonaceous Fire b) Solar Radiation at ground level c) Tungsten Filament Lamp

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2.2 FLICKER CHARACTERISTICS

It is observed that the radiation from a flame is not constant but varies with time. This flicker is present in all flames to a greater or lesser degree [including those resulting from high pressure gas jets] and can be used to give improved discrimination between flames and other sources of infra-red.

The MS302Ex responds to flicker frequencies in the range 1-10Hz which provides high sensitivity to almost all types of accidental fire.

2.3 CIRCUIT OPERATION

A simplified block schematic of the circuit is given in Fig.2.

The infra-red radiation passing through the narrow-band filters falls on a pyroelectric sensor which responds to the flickering component of the radiation. The electrical signal produced is filtered, to remove frequencies outside the required flicker region, and amplified to drive the threshold detector.

The threshold detector and pulse analyser evaluate the amplitude and frequency characteristics of the flicker. If the flicker signal is above the preset threshold for three seconds, the output latch is triggered to light the internal LED alarm indicator. The increased current drawn from the line signals the alarm condition to the control unit.

All critical parts of the circuit are fed by an internal voltage regulator to make the sensitivity independent of supply over a wide range.

The facility for a remote LED indicator is available without the need for additional circuitry.

Two +ve terminals are provided to allow the monitoring of the circuit wiring through the detector.

3. MECHANICAL CONSTRUCTION

An exploded view of the detector is given in Fig. 3.

The major components of the detector are:

- Body assembly
- Printed circuit/sensor assembly
- Outer cover

3.1 BODY ASSEMBLY

The body assembly consists of a plastic moulding to which are secured the four detector contacts which align with the contacts in the M300 base. The moulding incorporates securing and polarising features to retain the detector in the base.

The inside surface of the moulding is metallised to provide shielding against RFI [Radio Frequency Interference] and EMI [Electro-Magnetic Interference]. The connections between the contacts and the PCB are made using feed-through capacitors.

3.2 PRINTED CIRCUIT/SENSOR ASSEMBLY

The greater part of the circuit is contained within a custom thick-film hybrid. This, together with the sensor, the LED alarm indicator and a small number of other components, are mounted on a single printed circuit board.

The printed circuit board is fitted inside the body assembly and secured to the feed-through capacitors. All external connections to the circuit are thereby provided with RFI filtering.

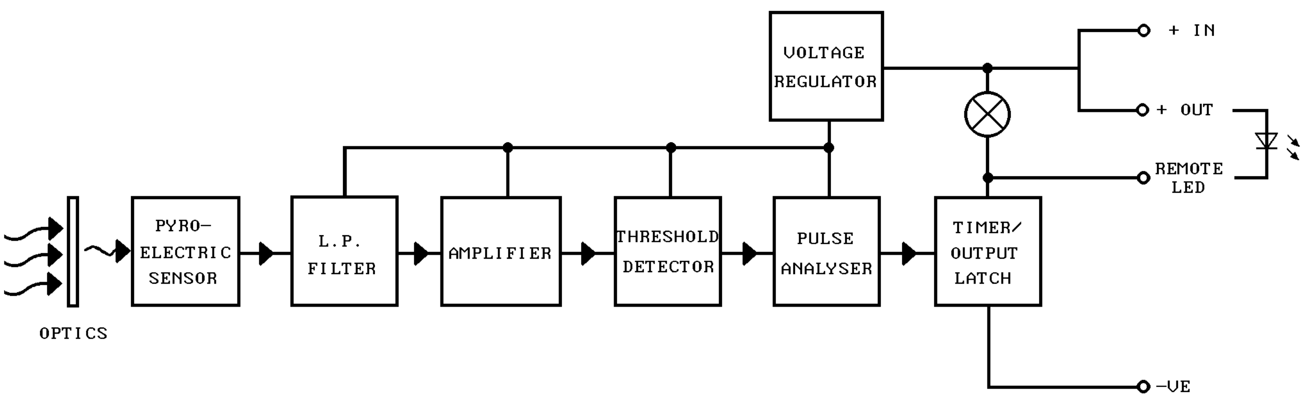

Fig. 2 Simplified Block Schematic Diagram

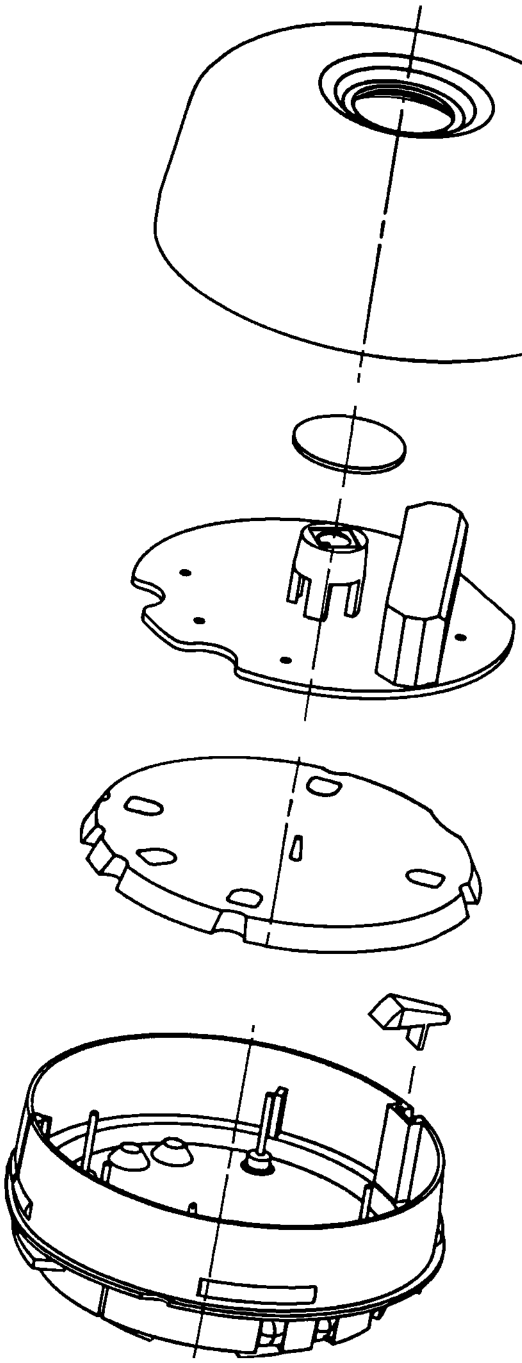

Fig. 3 General Assembly, Type MS302Ex Flame Detector

The body assembly is then filled with epoxy resin so that all critical components and conductors are encapsulated. Excellent protection against corrosion and mechanical shock is thus guaranteed.

3.3 FINAL ASSEMBLY

The assembly is completed by the outer cover which is a snap fit onto the body assembly. The inside surface of the cover is metallised to complete the RFI shielding. A sapphire window in the cover allows infra-red radiation to reach the sensor.

4. TECHNICAL SPECIFICATION

4.1 MECHANICAL

Dimensions

The overall dimensions are shown in Fig. 4 below.

Materials

Body & outer cover	"Bayblend" ABS/ Polycarbonate alloy Self coloured white. Flame retardant to UL94-V0.
Window	Synthetic sapphire.
Weight	174gm 275gm [including base].

4.2 ENVIRONMENTAL

Temperature

Operating	-10^{o}C to +60^{o}C
Storage	-30^{o}C to +80^{o}C

Note: Operation below 0^{o}C is not recommended unless steps are taken to eliminate condensation and hence ice formation on the detector.

Relative Humidity 95% [non-condensing]

Shock
Vibration
Impact
Corrosion

Satisfactory performance demonsrated using test methods detailed in EN54-5 [BS5445Part 5]

4.3 ELECTROMAGNETIC COMPATIBILITY

RFI To BS6667 Part 3, [10V/m @ 100kHz to 500MHz]

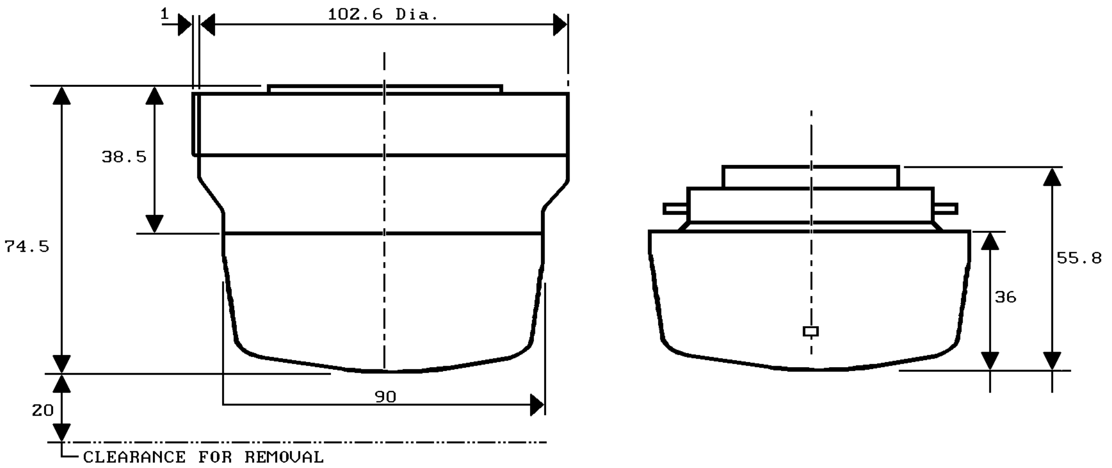

Fig. 4 Overall Dimensions

4.4 ELECTRICAL CHARACTERISTICS

Specified at 25C, 20V supply unless otherwise stated.

Characteristics	Min.	Typ.	Max.	Unit
Operating Voltage [d.c.]	15	20	24	V
Quiescent Current			100	µA
Switch-on-Surge	Limited by circuit duration <500µs			
Stabilisation Time			20	sec
Alarm Load/Equivalent Alarm Circuit	330ohms in series with 4V zener			
Alarm Current	5	20	50	mA
Holding Current	1			mA
Holding Voltage	2			volts
Remote LED drive	Alarm Current less 10 mA			
Reset Time			2	sec

4.5 INTRINSIC SAFETY

The MS302Ex complies with BS5501 part 7 [EN50 020 [1977] +A1 and BS5501 part 1 [EN50 014 [1977] +A1 - 4] for intrinsically safe apparatus, and is certified:

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and can be used in conjunction with specified safety barriers in a certified intrinsically safe system. [See System 601 Handbook].

The intrinsic safety certification specifies the following parameters:

Max input voltage	Vmax	28V
Max power input	Wmax	1W
Equivalent capacitance	Ceq	1.5nF
CERTIFICATE No.	Ex88B2168X	

5. PERFORMANCE CHARACTERISTICS

5.1 MODE OF OPERATION - BEHAVIOUR IN FIRE TESTS

The operating principles of the detector have been described in Para 2 and the information given below is intended to supplement this basic description.

It has already been noted that the detector analyses the signal flicker frequency and produces an alarm if the level is above a preset threshold for three seconds. It is worth stressing that if the signal is below this threshold the detector will not respond even after a long time.

The level of the signal received depends on the size of the flame and its distance from the detector. For liquid fuels the level is almost proportional to the surface area of the burning liquid. For any type of fire, the signal level varies inversely with the square of the distance.

Fire tests are normally carried out using liquid fuels, burning in pans of known area. The sensitivity of a detector is then expressed as the distance at which a particular fire size can be detected.

It is important to think in terms of distance rather than time because of the burning characteristics of different fuels. Fig. 5shows the typical response of two different fuels which ultimately produce the same signal level. The signal level given by petrol quickly reaches its maximum,

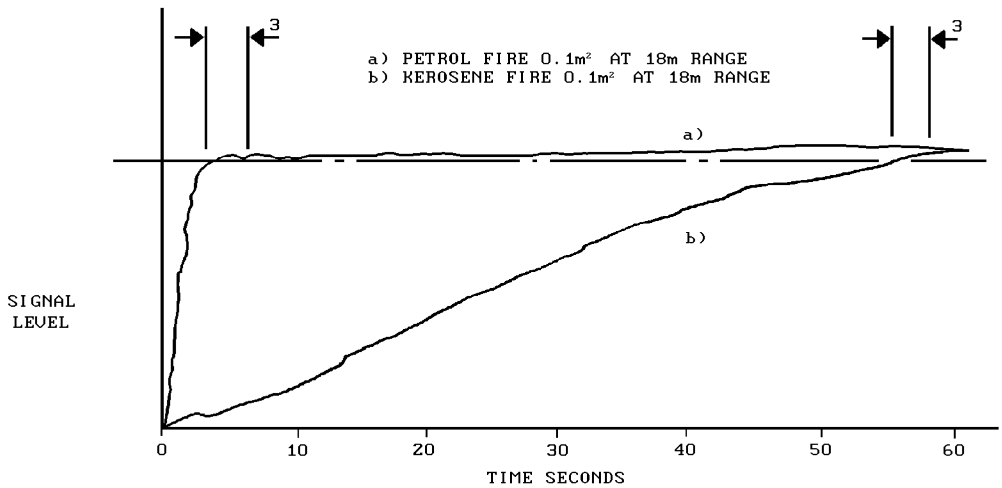

Fig. 5 Typical Response to Fires

and produces an alarm in approximately six [6] seconds after ignition. Kerosene, being less volatile, takes approximately sixty [60] seconds to reach equilibrium burning state and an alarm is given approximately fifty-five [55] seconds after ignition.

The time taken by the fire to reach equilibrium depends on the initial temperature of the fuel. If kerosene is pre-heated to a temperature above its flash point, then it behaves the same as petrol at 25^{o}C.

The test data presented below refers to fires which have reached their equilibrium condition. The range specified is that obtained with the detector axis horizontal and with the fire on the detector axis.

5.2 FIRE TEST DATA

5.2.1 PETROL

The most convenient fuel for fire tests is petrol [gasoline] since it is readily available and quickly reaches its equilibrium burning rate.

The graph in Fig. 7shows the typical detection ranges as a function of pan area for petrol fires. It will be seen that this curve is approximately a square law; that is to say that to obtain detection at twice the distance the pan area must be multiplied by four.

5.2.2 OTHER LIQUID HYDROCARBONS

Ranges achieved with other fuels burning in 0.1m2 pans are as follows:

n-heptane	26m
Kerosene	26m
Alcohol[I.M.S.]	22m
Diesel oil	22m
Ethylene glycol	26m

The typical detection range for other pan areas may be calculated using the square law relationship give in Para 5.2.1.

5.3 DIRECTIONAL SENSITIVITY

The sensitivity of the MS302Ex is at a maximum on the detector axis. The variation of range with angle of incidence is shown in Fig. 8.

6. DESIGN OF SYSTEM

6.1 GENERAL

Using the information given in Paras 2 to 5, it is possible to design a flame detection system having a predictable performance. Guidance on the application of the above data and on siting of detectors is given on the following page.

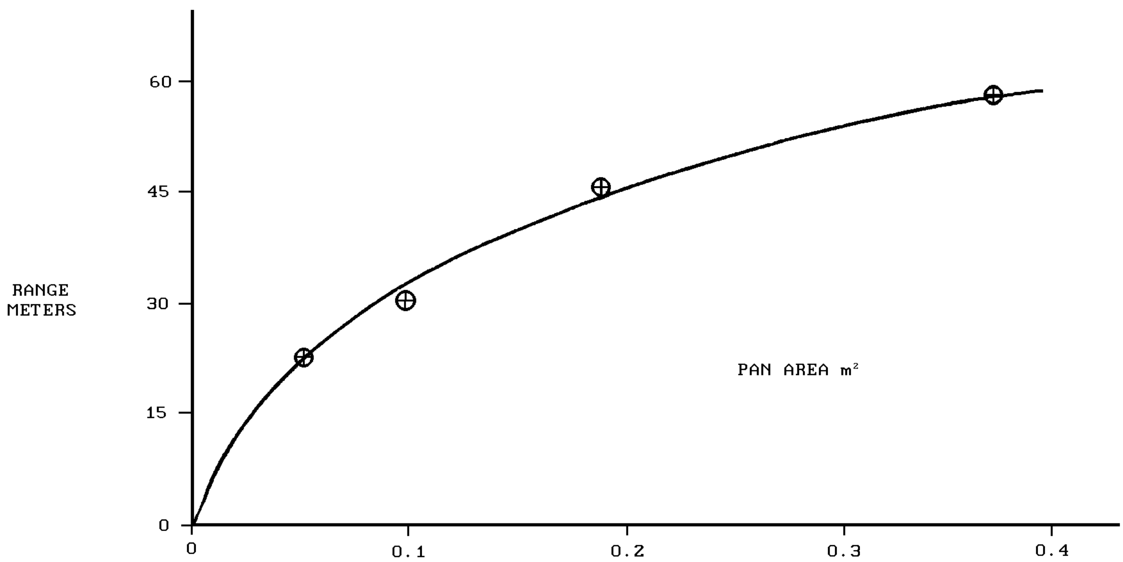

Fig. 6 Typical Detection Range vs Pan Area - Petrol

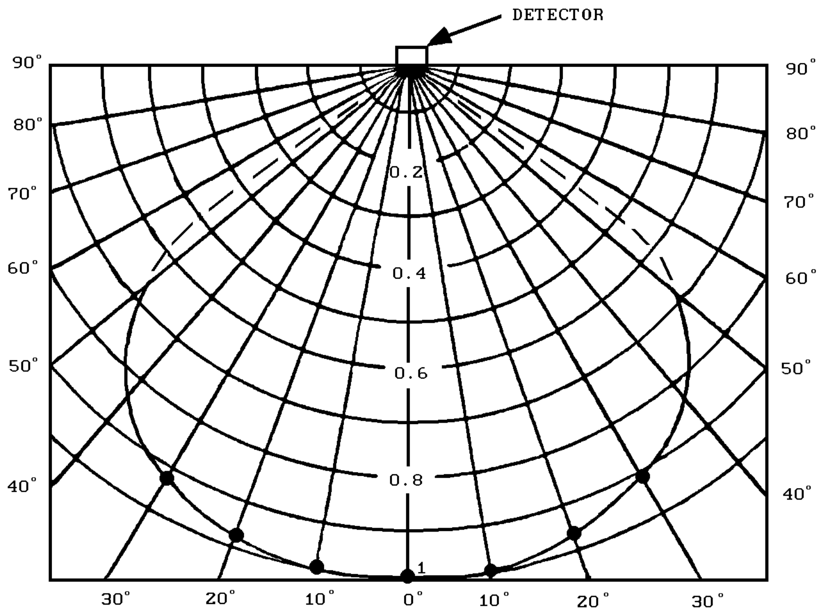

Fig. 7 Relative Range vs Angle of Incidence

6.2 USE OF FIRE TEST DATA

It has been explained in Para 5 that the sensitivity of the detector is specified in terms of its response to well-defined test fires. Tests are carried out using a $0.1m^2$ pan. Sensitivity to other pan areas is calculated from the square law relationship. That is to obtain detection at twice the distance, the pan area must be multiplied by four.

Accidental fires are rarely of a well-defined size. It is still possible however to calculate the response to a ‘real’ fire using the fire test data.

For example, a spillage fire involving a highly volatile liquid [e.g. petrol] will spread quickly from the point of ignition to cover the complete surface of the pool. Such a spillage would normally cover approximately $2m^2$. Using the data for petrol fires and extrapolating to an area of $2m^2$, the MS302Ex should respond at a distance of about 120m within ten [10] seconds. It WILL NOT respond in less than three [3] seconds, even at short range.

If the spillage is of a less volatile material [e.g. kerosene], the spread of the flame from the ignition point will be much slower. The detector will then respond in a time dependent on the distance from the fire.

6.3 DETERMINING THE NUMBER OF DETECTORS

The number of detectors required for a particular risk will depend on the area involved and the fire size at which detection is required. Large areas or small fires require large numbers of detectors.

As there are no agreed ‘rules’ for the application of flame detectors, the overall system sensitivity must be agreed between the designer and the end user. When agreement has been reached the system designer can determine the area to be covered by each detector using the fire test data.

The detector is designed primarily for ceiling mounting with its axis vertically downwards. When used in this way it will cover a circular area at ground level, the diameters of the circle being proportional to the height. Under these conditions the effective sensitivity is that which is achieved at the edge of this circular area taking into account the slant range and the angle of incidence.

Fig. 8 shows the effective sensitivity for petrol fires when used in this configuration. Sensitivity to other fuels can be determined from the data given in Para 5.2.

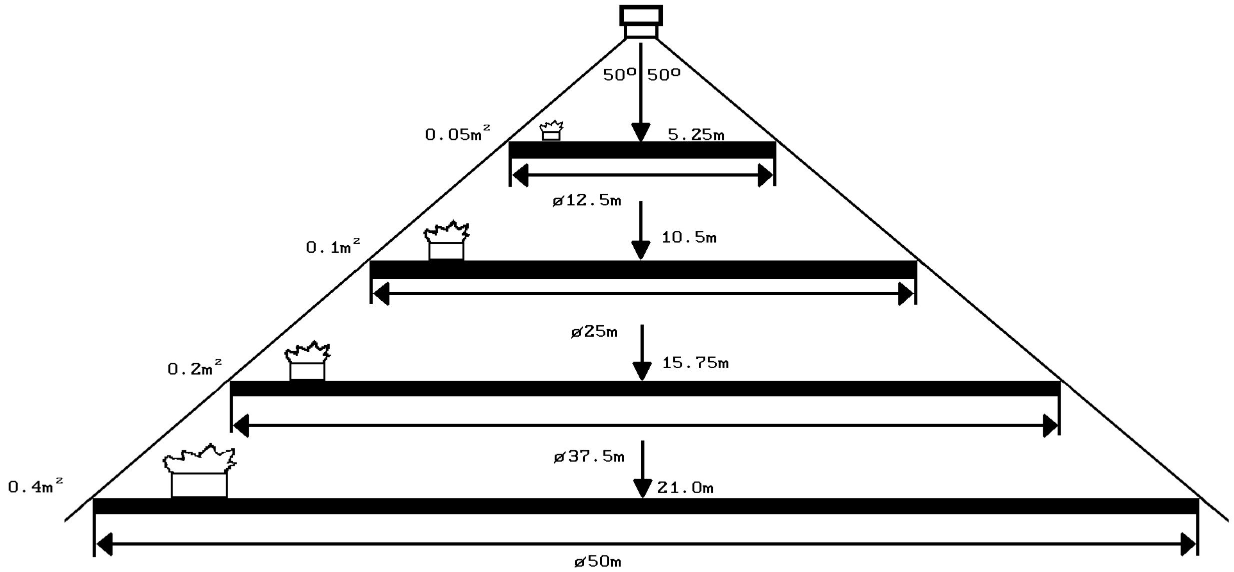

Fig. 8 Field of View

Note: Any object within the detector's field of view will cause a 'shadow' in the protected area. Small objects close to the detector can cause large shadows.

7. ORDERING INFORMATION

MS302Ex infra-red flame detector: 516-022-001

8. RELATED PUBLICATIONS

01A-02-D2 DESIGN INFORMATION, M300 SERIES DETECTOR BASE AND ACCESSORIES.

01A-02-I1 INSTALLATION, M300 SERIES BASE AND ACCESSORIES.

01A-02-C1 COMMISSIONING, M300 SERIES BASE AND ACCESSORIES.

01A-02-1 MAINTENANCE & SERVICE, M300 SERIES DETECTORS AND BASE.

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