DOCUMENT CONTROL NUMBER /

MR300 OPTICAL SMOKE DETECTOR RANGE

PRODUCT APPLICATION & DESIGN INFORMATION

1. INTRODUCTION

The MR300 range of optical smoke detectors forms part of the M300 series of plug-in detectors for ceiling mounting. The range is intended for two-wire operation on the majority of the control equipment currently manufactured by the company. Detectors having different smoke sensitivities are offered as is an intrinsically-safe type for use in hazardous atmospheres.

2. OPERATING PRINCIPLE

2.1 OPTICAL SYSTEM

Detectors in the MR300 range detect visible particles produced in fires by using the light scattering properties of the particles. All detectors in the range use the same optical system which is shown diagrammatically in Fig. 1.

The optical system consists of an emitter and sensor, with a lens in front of each, so arranged that their optical axes cross in the sampling volume. The emitter, with its lens, produces a narrow beam of light which is prevented from reaching the sensor by the baffles. When smoke is present in the sampling volume a proportion of the light is scattered, some of which reaches the sensor. For a given type of smoke, the light reaching the sensor is proportional to the smoke density. The output from the sensor can be used to activate an alarm circuit at a pre-determined threshold.

2.2 FEATURES OF MEASURING CHAMBER

In order to make a practical smoke detector which uses the type of optical system described above, great care is needed in the design of the housing. Both the optical components and the sampling volume must be protected from the environment but still allow smoke to enter freely into the sampling volume. The housing must also be designed in such a way that dust settling on its surfaces will not scatter so much light into the sensor that false alarms are generated.

The emitter is a Gallium Arsenide [GaAs] solid state type operating at a wavelength of 0.94µm; the sensor is a silicon photodiode. These devices with their associated lenses are held within the optical array which also provides the baffles of Fig.1. The design of this assembly is such that the presence of very small insects [e.g. thrips] will not cause false alarms.

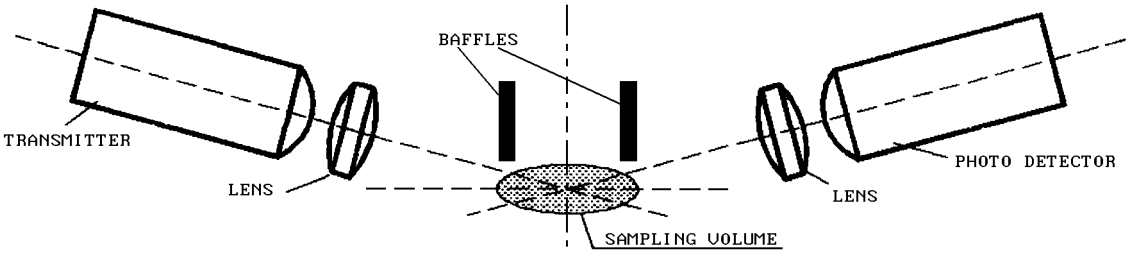

Fig. 1 M300 Detector Range, Optical System

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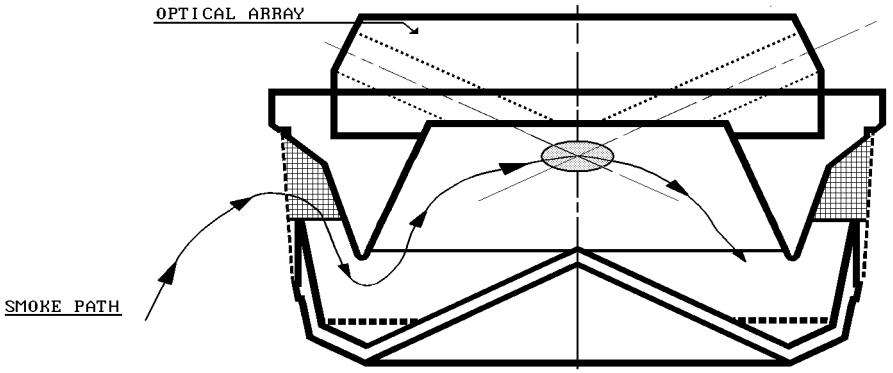

Fig. 2 Measuring Chamber Showing Smoke Flow Path

Detectors in the MR300 Range use the unique measuring chamber shown in Fig.2.

The Sampling Volume is enclosed within a measuring chamber formed by conical labyrinth mouldings. The optical design of the chamber provides a very low background signal in clean air conditions even when the chamber is contaminated by white dust. This high tolerance to dust is improved even further by an aerodynamic design which encourages dust settlement to occur on the less critical optical surfaces.

The design of the measuring chamber is patented in the UK under the number GB 2170597 and in the USA under the number US 4728801.

2.3 CIRCUIT OPERATIONS

A simplified block schematic of the detector is given in Fig.3.

2.3.1 GENERAL

The GaAs emitter is pulsed every 10s in order to reduce its power consumption. The pulse signal, as received by the silicon photodiode, is fed to a high-gain amplifier. If smoke is present, the pulse signal received varies in proportion to the smoke density. The output of the amplifier is thus proportional to the smoke density.

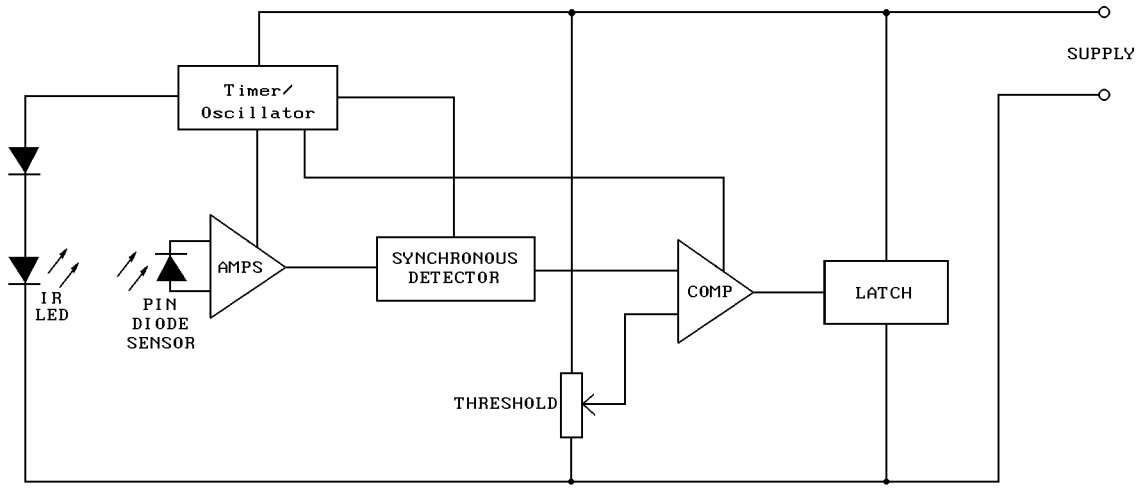

Fig. 3 Schematic Diagram of Detector

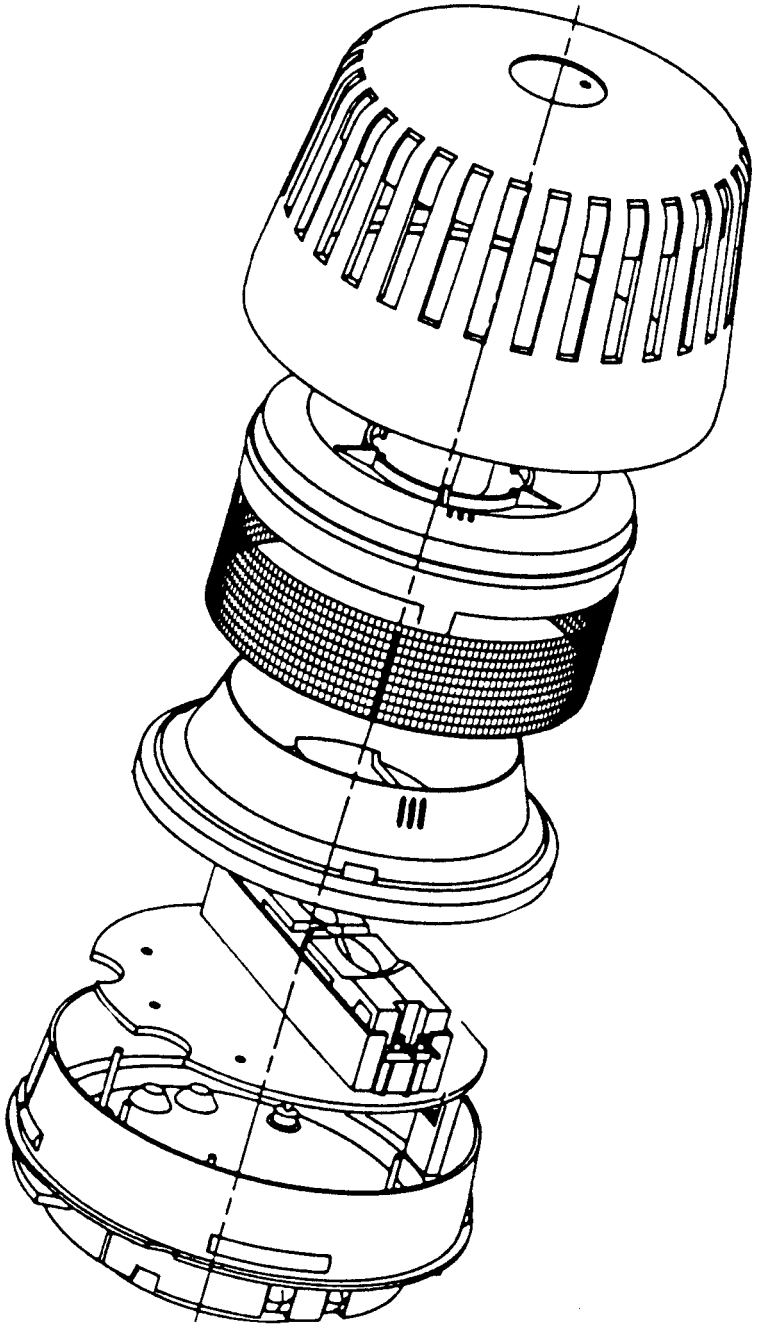

Fig. 4 Exploded View of the MR300 Type Detector

The amplifier output is fed to a pulse height discriminator which compares the signal with a preset threshold level. Sophisticated synchronous detection techniques are used to eliminate virtually all the effects of noise and spurious transients.

If the signal amplitude exceeds the threshold level then the emitter pulse period is reduced to two seconds. The pulse period remains at two seconds if the signal is above threshold. When the counter has counted three consecutive pulses above the threshold, the output stage is latched into the alarm condition. If, however, the amplitude of the second or third pulse is below threshold, then the pulse period reverts to 10 seconds and the counter resets. The switching of the output stage lights the integral alarm indicator [LED] and provides drive for an external [remote] LED indicator.

2.3.2 INTRINSICALLY-SAFE VERSION

The operation of the MR301Ex detector is the same as that of the standard MR300 range detector. Circuits are modified, however, to ensure that safety is maintained under normal conditions and with up to two zone circuit faults.

3. MECHANICAL CONSTRUCTION

The major components of the detector are:

- Body Assembly
- Printed Circuit/Optical Array Assembly
- Labyrinth and Insect Screen
- Outer Cover

An exploded view of the detector is given in Fig. 4.

3.1 BODY ASSEMBLY

The body assembly consists of a plastic moulding to which are secured the four detector contacts which align with 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 EMI [Electro-Magnetic Interference]; the connections between the contacts and the PCB are made using feed-through capacitors.

3.2 PRINTED CIRCUIT/OPTICAL ARRAY ASSEMBLY

All electronic components, including the LED alarm indicator, are mounted on a single printed circuit board. The Optical Array Assembly is also mounted on the PCB. The combined assembly is fitted inside the body and connected to the feed-through capacitors. All external connections to the circuit are thereby provided with EMI filtering. The Body Assembly is then filled with epoxy to provide mechanical strength and to protect circuit components against corrosive atmospheres.

3.3 FINAL ASSEMBLY

The two labyrinth mouldings are fitted on the encapsulated body and the smoke entry area is sealed by a wire mesh to keep out larger insects. The labyrinth is retained by the outer cover which is a snap fit on the body.

4. TECHNICAL SPECIFICATION

4.1 GENERAL

Several detector variations are offered within the MR300 Range. The technical specifications of these are very similar and the details given below are applicable to all unless otherwise stated.

4.2 MECHANICAL

Dimensions

The dimensions of the MR300 detector are shown in Fig. 5.

Materials

Body and cover:	"BAYBLEND" ABS /Polycarbonate alloy Thermo-plastic, self-colour white.

Weight

Detector:	0.2kg
Detector plus base:	0.3kg

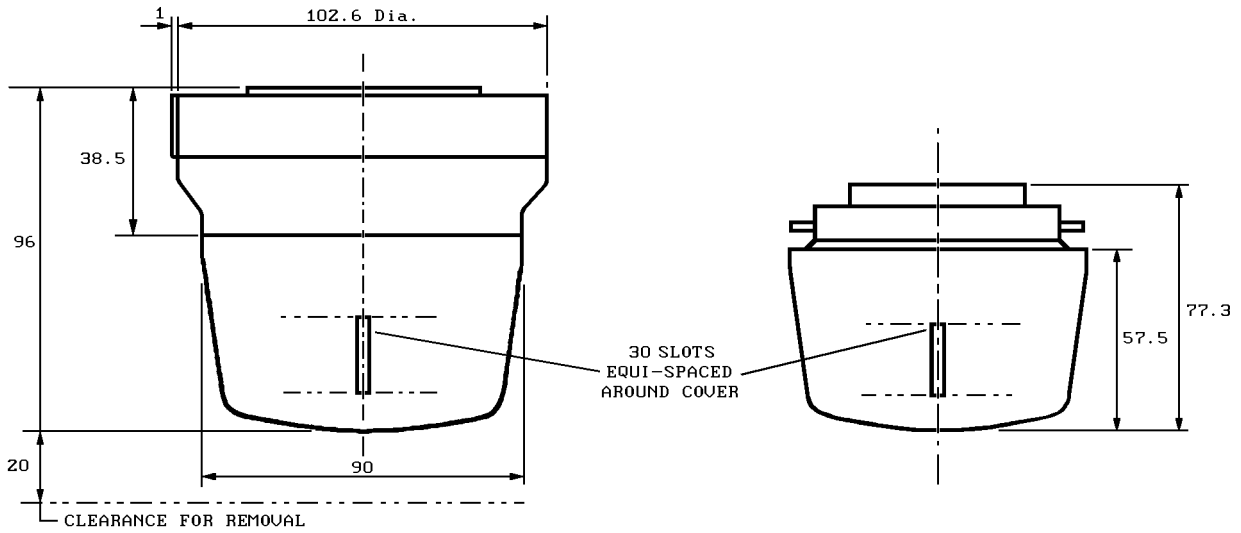

Fig. 5 Overall Dimensions of the MR300 Detector

Environmental

Operating Temperature: -20°C to +70°C
but see note below.
Storage Temperature: -25°C to +80°C

Note: Operation below 0°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: } To BS 5445:Pt 7
Impact: [EN54-7]
Corrosion:
EMC: Equals or exceeds the requirements of BS EN 50081-1 and BS EN 50082-1.

4.3 ELECTRICAL

Characteristics

The following characteristics shown in Table 1 are taken at 25°C with an operating voltage of 20V unless otherwise specified. The alarm load presented to the controller by the detector is shown in Fig. 6 overleaf.

Characteristics	Min.	Typ.	Max.	Unit
Operating Voltage [d.c.]	15	20	24	V
Quiescent Current			100	µA
Switch-on-Surge		100		µA
Stabilisation Time			30	sec
Alarm Current	5	25	60	mA
Alarm Current [Ex types]	5	20	50	mA
Holding Current	1		6	mA
Holding Voltage	2		8	V
Reset Time			2	sec
Remote LED drive	Alarm Current less 10 mA			

Table. 1 Electrical Characteristics

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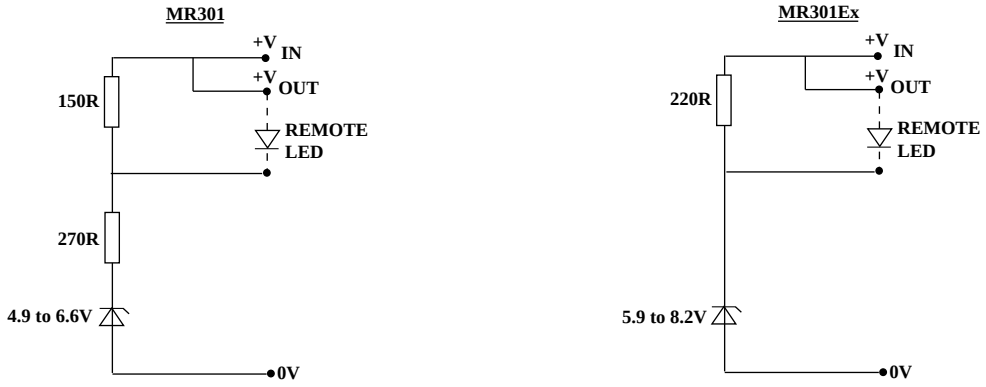

Fig. 6 Alarm Loads

4.4 INTRINSIC SAFETY

The MR301Ex, detector is designed to comply with BS 5501 Pt 7 [EN 50 020] for intrinsically safe apparatus. It is designed to be certified:

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and to be used in conjunction with a shunt diode safety barrier in a certified intrinsically-safe system.

Electrical and performance details are generally the same as for the MR301 detector. The following additional information is applicable to the MR301Ex detector:

Maximum Voltage [for safety]:	28V
Maximum Power Input:	0.58W
Equivalent Inductance:	0
Equivalent Capacitance:	1.5nF

4.5 PERFORMANCE CHARACTERISTICS

The fundamental parameter used to define the sensitivity of an optical smoke detector is the level of smoke which will just produce an alarm under 'ideal' conditions. This parameter, known as the response threshold value, is normally measured in a smoke tunnel and is defined in terms of the obscuration produced by the smoke over a one metre path. The response threshold value is normally designated "m" and is given in dB/metre, [or % per metre].

Interpretation of response threshold value is somewhat complicated by the fact that the measurement is given in terms of obscuration, whereas the detector works by scattering from the smoke particles. The response threshold [m] value will therefore depend on the colour of the smoke. Black smoke give less scattering than light smokes for given values of obscuration as shown in Fig. 7.

Sensitivities are invariably specified for 'grey' smokes as produced by typical smouldering fires. Values for the MR300 range are given in Table 2.

The MR301 is suitable for the majority of applications and the high and low sensitivity types should only be used for very clean and very dirty [smoky] environments respectively.

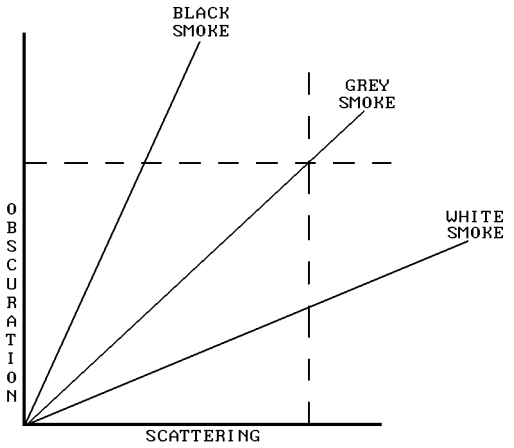

Fig. 7 Graph, Obscuration v Scattering

DETECTOR TYPE	RESPONSE THRESHOLD		IDENTIFICATION COLOUR
	dB/m	%/m	
MR301H	0.12	2.7	RED
MR301	0.15	3.4	WHITE
MR301Ex	0.15	3.4	WHITE
MF301I	0.27	6.0	BLUE

Table. 2 Detector Sensitivity

4.6 RESPONSE TO FIRE TESTS

The response of an optical scatter detector to a particular "real" fire will depend, to a large extent, on the colour of the smoke produced in the fire. In order to evaluate the response under realistic conditions, detectors are subjected to test fires which cover a range of fire types. These tests are defined in BS 5445: Pt.9 [EN54 Pt.9] which also defines the way in which detector sensitivity is classified. Three classes are used; A, B and C, where A is the highest sensitivity. If the detector does not respond, or responds inadequately to a test fire, it is not classified,i.e. [N].

Typical results for the MR301 are given in Table 3.

DESIGNATION	TYPE	CLASSIFICATION
TF1	open cellulosic [wood - flaming]	N
TF2	smouldering pyrolysis [wood]	A
TF3	glowing smouldering cotton]	A
TF4	open plastics polyurethane foam	C
TF5	liquid [n-heptane]	C
TF6	liquid [methylated spirit]	N

Table. 3 Response to Fire Tests

It will be noted that the MR301 is not classified for the open [flaming] wood fire TF1. This test fire is typical of the fast-burning fire which produces mainly invisible particles and which, by definition, cannot be detected optically.

5. ORDERING INFORMATION

MR301H High Sensitivity:	516-021-004
MR301 Normal Sensitivity:	516-021-002
MR301Ex Normal Sensitivity Intrinsically-Safe:	516-021-003
MR301L Low Sensitivity:	516-021-001

6. RELATED PUBLICATIONS

01A-02-D2	M300 SERIES DETECTOR BASE AND ACCESSORIES, PRODUCT APPLICATION & DESIGN INFORMATION,
01A-02-I1	M300 SERIES DETECTOR BASE AND ACCESSORIES, INSTALLATION INSTRUCTIONS
01A-02-C1	M300 SERIES DETECTOR BASE AND ACCESSORIES, COMMISSIONING INSTRUCTIONS
01A-02-S1	M300 SERIES DETECTORS AND BASE, SERVICE & MAINTENANCE

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19th February 1996

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