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**MR901 OPTICAL ANALOGUE ADDRESSABLE SMOKE DETECTOR**

**PRODUCT APPLICATION & DESIGN INFORMATION**

**1. INTRODUCTION**

The MR901 optical smoke detector forms part of the M900 Series Analogue Addressable fire detectors. The detector plugs into the M600/M900 Universal base to form an analogue addressable detector which transmits analogue signals representing the state of the detector chamber to a remote control equipment.

**2. OPERATING PRINCIPLE**

The MR901 operates by sensing the optical scatter from smoke particles generated in a fire.

**2.1 OPTICAL SYSTEM**

The MR901 detects visible particles produced in fires by using the light scattering properties of the particles. The detector uses the optical arrangement shown in Fig. 1.

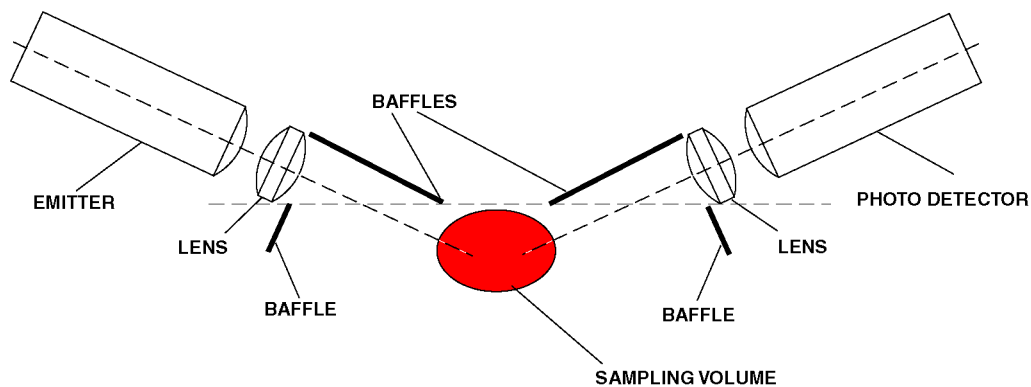
The optical system consists of an emitter and detector, with a lens in front of each, so arranged that their optical axes cross in the sampling volume. The emitter, with its lens, produces a narrow beam of light which is prevented from reaching the detector by the baffles. When smoke is present in the sampling volume a proportion of the light is scattered, some of which reaches the detector. For a given type of smoke, the light reaching the detector is proportional to the smoke density. The output from the detector is converted into an analogue electrical signal and transmitted to the Fire Controller.

**2.2 FEATURES OF MEASURING CHAMBER**

The MR901 uses a unique measuring system shown in Fig. 2. Unlike most other optical scatter detectors the MR901 does not use vertical chevrons to exclude ambient light, but uses concentric baffles. This approach gives a better signal to noise ratio. The chamber is the subject of a patent application.

Smoke incident on the detector is channelled into the detector by the cover fins and pass through the insect screen which will exclude most insects. Some of the smoke passes into the scatter volume before passing out the other side of the detector.

The emitter [see Fig. 1] is a GaAlAs solid state type operating in the near infra-red at 880nm, while the detector is a matched silicon photodiode. These devices together with their associated lenses are held in place by the labyrinth mouldings. The design of the labyrinth is such that the presence of small insects such as thrips should not cause false alarms.



**Fig. 1 Optical Chamber Schematic**

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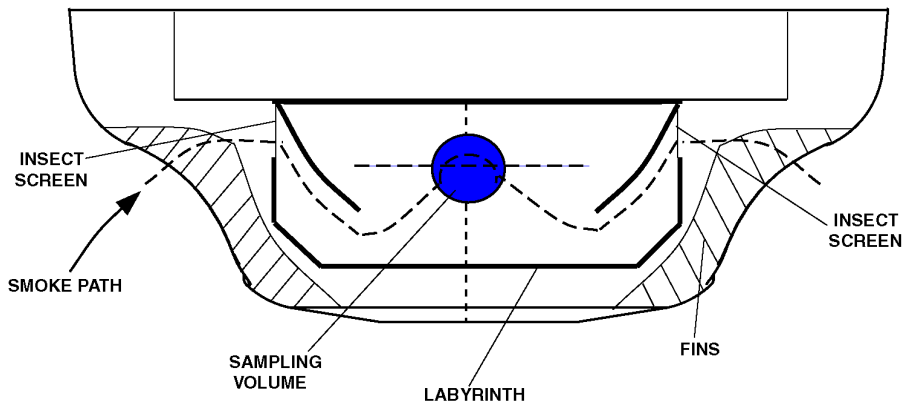


Fig. 2 Measuring Chamber Showing Smoke Flow Path

## 2.3 CIRCUIT OPERATION

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

The emitter is pulsed every 10s to reduce quiescent current. The optical pulse signal, as received by the photodetector, is amplified and fed to the synchronous detector. This detector is provided with a reference signal from the timer/oscillator and gives an output proportional to the photodetector signal which is stored on a 'memory' capacitor. The voltage on the capacitor is updated every 10s when the emitter pulses.

The signal voltage, together with a reference voltage, is fed to the electronic changeover switch S1.

The signal processing decodes the signals from the line and compares them with a detector address code. On receiving a correct address the logic circuit then switches S2 to supply voltage to the current sink, and S1 to the reference voltage for ident current pulse and then to the stored reference voltage output from the synchronous detector to give a condition current pulse. The logic circuit also controls the switched output and remote indicator output.

The currents drawn by the current sink are measured and processed at the control panel, where alarm and fault decisions are made.

The analogue output current flows through the internal LED indicator which lights every time the detector is polled. In alarm the LED is polled continuously and the LED appears permanently ON.

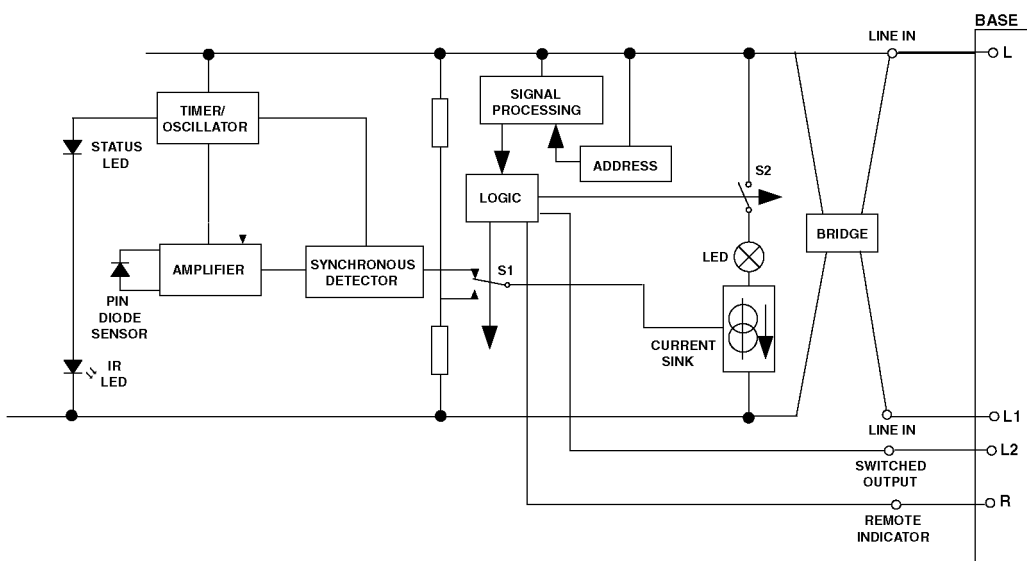


Fig. 3 Block Schematic of detector

## 2.4 WIRING

Loop cabling may be connected to base terminals L and L1 in any order as the detector bridge circuit makes it polarity insensitive.

A drive is provided for a remote indicator connected between loop positive and terminal R, therefore at a detector where a remote indicator is connected, the polarity of the loop must be known.

## 3. MECHANICAL CONSTRUCTION

The major components of the detector are:

- Body and Contacts
- Printed Circuit
- Labyrinth
- 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 four detector contacts which align with the contacts in the M600/M900 Universal base. The moulding incorporates securing features to retain the detector in the base.

The PCB is fastened to the body by four screws which screw into the four base contacts through holes in the body. These screws both hold the assembly together mechanically and provide electrical contact between the contacts and the PCB.

### 3.2 PRINTED CIRCUIT/OPTICAL ARRAY ASSEMBLY

All electronic components are fitted to the PCB including the Alarm LED, the IR emitter and the photo-diode. The floor of the labyrinth clips into three holes on the PCB, the upper and lower labyrinth parts clip onto the labyrinth floor.

### 3.3 TEST AND FINAL ASSEMBLY

The detectors are fully functionally tested and their sensitivities set in a smoke tunnel to ensure correct calibration. The sealing ring and labels are then fitted to complete the detector assembly.

## 4. TECHNICAL SPECIFICATION

### 4.1 MECHANICAL

#### Dimensions

The dimensions of the MR901 detector are shown in Fig. 5.

#### Materials

Body and cover: FR110 "BAYBLEND"  
Fire Resistant

#### Weight

detector: 0.112kg  
detector plus base: 0.190kg

### 4.2 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: }

### 4.3 ELECTROMAGNETIC COMPATIBILITY

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

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

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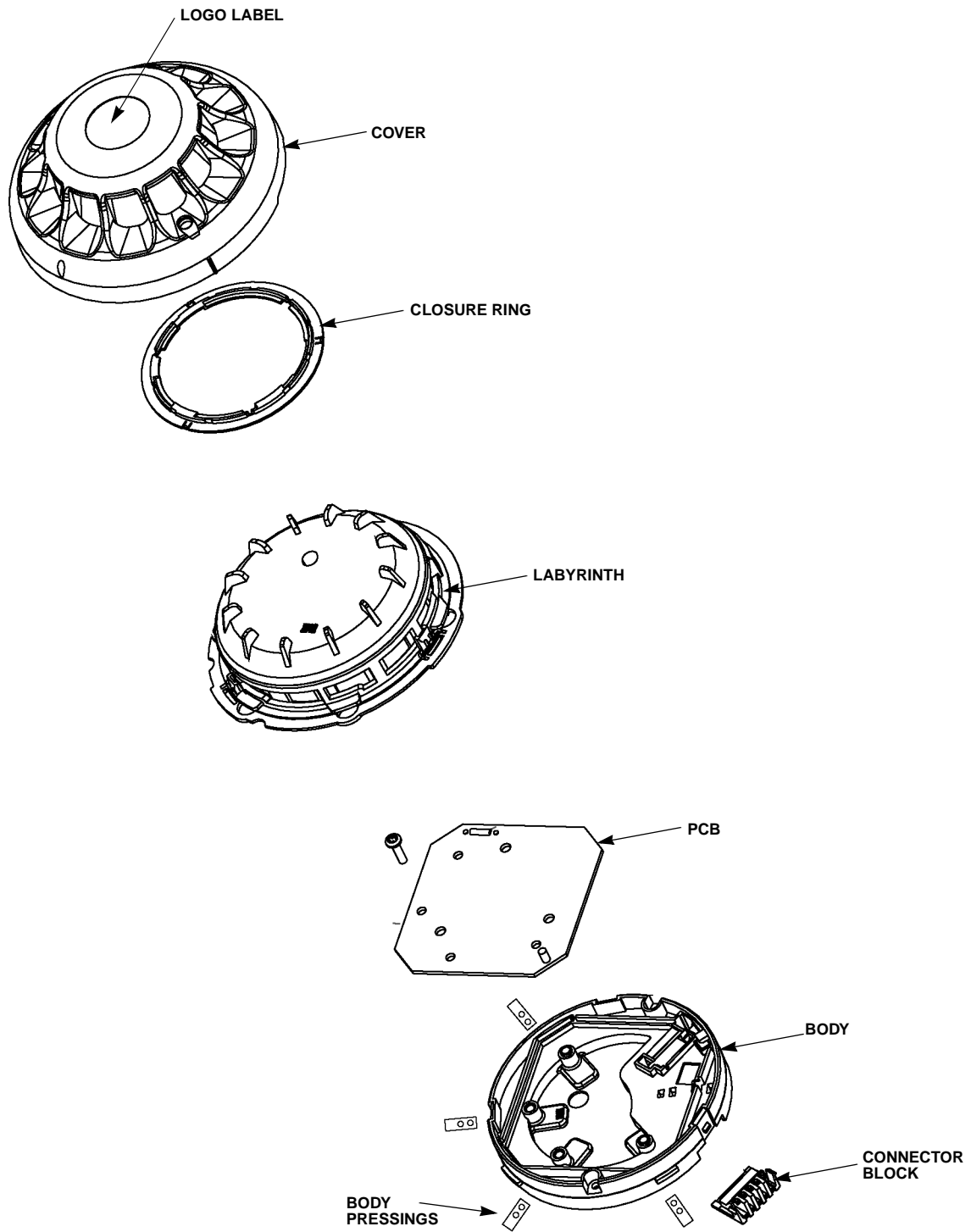
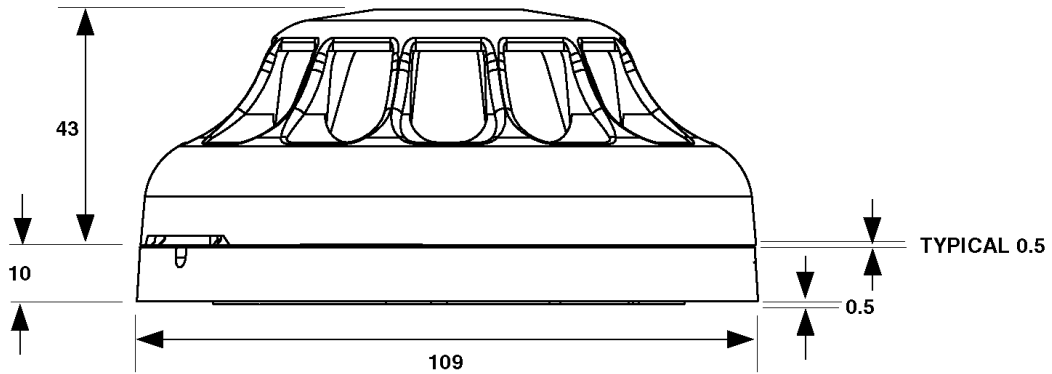


Fig. 4 MR901 Optical Smoke Detector - General Assembly



**Fig. 5 MR901 - Overall Dimensions**

**4.4 ELECTRICAL CHARACTERISTICS**

The following characteristics [Table 1] apply at 25°C and with supply voltage of 24V unless otherwise specified.

Characteristic	Min.	Typ.	Max.	Unit
Loop Voltage	18	24	32	V
Quiescent Current	150	240	300	µA
Ident Current	8.5	9.0	9.5	mA
Average Condition Current	7.8	8.8	9.8	mA

**Table. 1 Electrical Characteristics**

**4.5 PERFORMANCE CHARACTERISTICS**

The MR901 detector, with the M900 Base, forms an analogue addressable detector which transmits signals representing the detector analogue current levels to a remote control unit. The control unit evaluates these signals against pre-determined criteria and decides when an alarm condition has occurred. The information given below therefore relates to the performance of the MR901 as a transducer only, since the system alarm response is determined by the control unit.

**4.5.1 RESPONSE TO SMOKE**

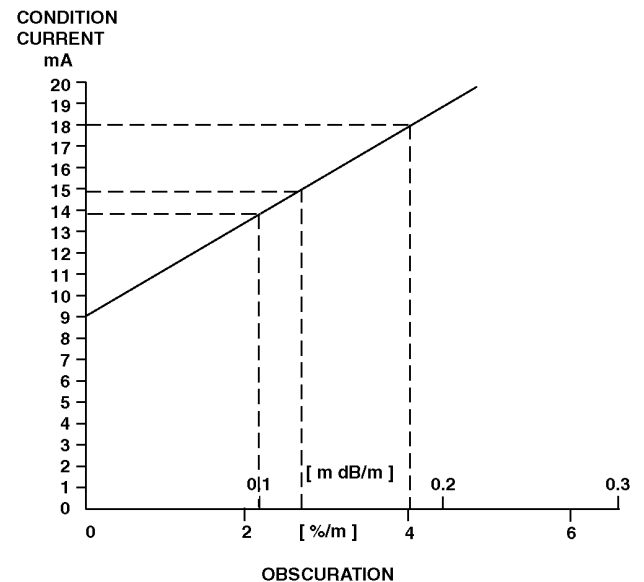
The response of an optical smoke detector is normally measured with reference to the obscuration produced by smoke. Obscuration is measured in percent per metre, or in dB per metre. The latter unit is used in BS 5445 Pt 7 and is designated 'm'.

Unfortunately, there is no fixed relationship between optical scattering and obscuration, the ratio between them being dependent on the type of smoke. For convenience, 'grey' smoke is normally used but white and black smokes give more or less scattered light respectively for a given obscuration level.

The condition current of the MR901 is a linear function of obscuration for a given type of smoke. For grey smoke the current is given by:

**CONDITION CURRENT (Ic) = 8.8 + 50 x 'm' mA**

This is shown graphically in Fig. 6.



**Fig. 6 Condition Current vs Smoke Density [Grey Smoke]**

Normal Alarm threshold = 0.12 dB/m or 2.7%/m typical, which corresponds to an alarm threshold of 14.8mA.

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Panel Setting	Nominal No Smoke $I_{CON}$	Panel Threshold	Nominal Alarm Lift mA	Nominal Smoke Sensitivity (Grey Smoke)	
				%/m	dB/m
High	8.8	13.6	4.8	2.2	0.10
Normal	8.8	14.8	6.0	2.7	0.12
Low	8.8	18.0	9.2	4.1	0.18

Table. 2

## 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. However other factors such as the detector smoke entry characteristics, the development of the fire and the thermal lift produced by the fire are also important. 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 : Pts 7 and 9 [EN54 Pts 7 and 9] and include mandatory fire tests, which are:

- TF2 smouldering pyrolysis
- TF3 glowing smouldering (cotton)
- TF4 open plastics (polyurethane foam)
- TF5 liquid (n-heptane)

Fire tests have shown that the MR901 passes the above tests with the Minerva Analogue Addressable Controller configured to MR901 Normal or High sensitivity settings.

## 4.7 CHOICE OF ALARM THRESHOLD

The Minerva Analogue Addressable Controllers have three sensitivity settings for the MR901 [see Table 2].

For the vast majority of installations, the MR901 should be configured to normal sensitivity. High sensitivity should only be used in installations where very early fire detection is required and where the environment is benign and clean, eg computer suites. Low sensitivity should only be used where delayed detection is acceptable or desirable or possibly where an installation is prone to false alarms.

## 4.8 APPROVALS

At LPCB, the MR901 has been subjected to extensive electrical, environmental and fire tests to EN54 Pts 7 and 9 and the detector is LPCB approved for use on MR901 Normal and High sensitivity controller settings.

CAUTION:

ONLY DETECTOR SENSITIVITY MR901 'HIGH' AND MR901 'NORMAL' SET IN THE CONTROLLER BY CONSYS HAVE BEEN ASSESSED AND APPROVED BY LPCB.

## 5. 'SMARTCARD' AND ADDRESS LABEL CARRIER

Refer to Figs 7 and 8. The address information for the detector is stored in an EPROM on a separate smartcard with an associated label carrier which is used to identify the address and zone of the detector. The smartcards and label carriers are supplied as shown in Fig. 7 and are ordered separately from the detector. The smartcard is pre-programmed with the address of the detector via 'CONSYS' version 9.1 or later. The smartcard and label carrier are then detached from the sprue and fitted to the bottom of the detector [Fig. 8]. When the detector is fitted to the base and turned until fully located the smartcard and label carrier are then transferred to the base. If the detector is removed from the base, the smartcard and label carrier remain with the base.

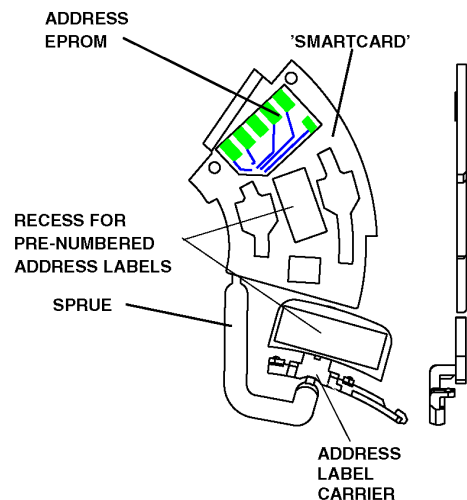
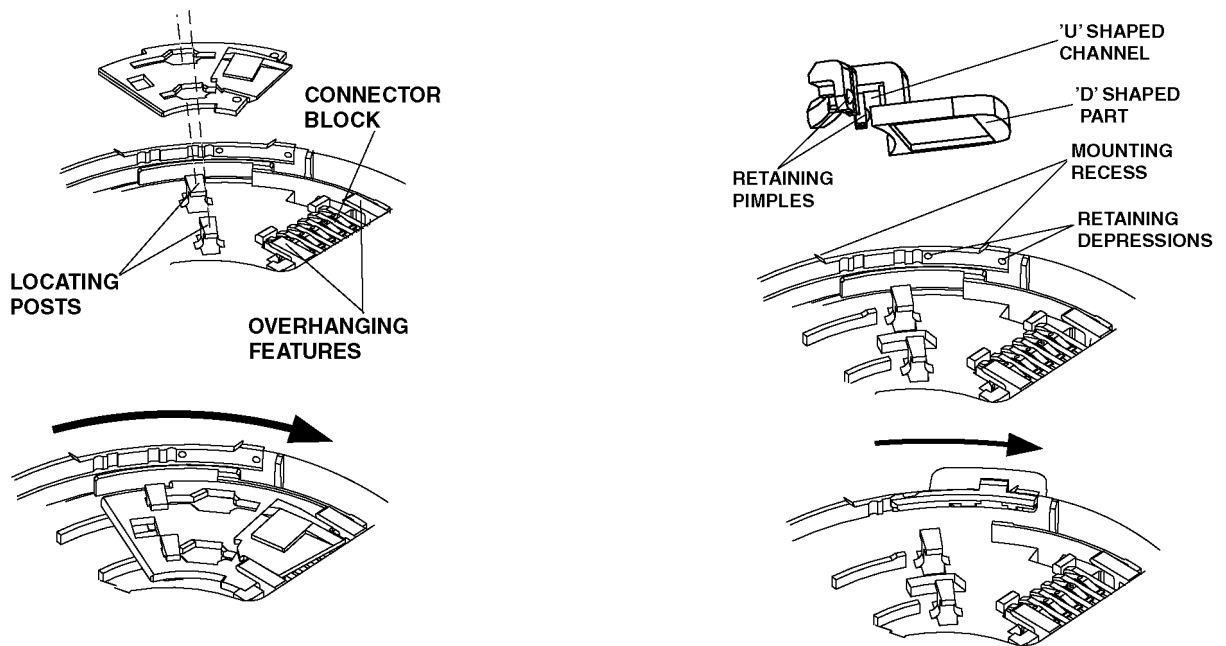


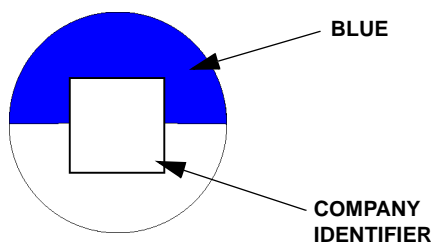
Fig. 7 Smartcard and Address Label Carrier



**Fig. 8 Fitting Smartcard and Address Label Carrier to detector**

## 6. DETECTOR IDENTIFICATION

The detector is identified by the logo label colouring as shown in Fig. 9.



**Fig. 9 Detector Identification**

## 7. ORDERING INFORMATION

MR901 detector:	516-057-001
M600/M900 Universal Detector Base:	517-050-001
Address and Label Carrier:	517-051-002

## 8. RELATED PUBLICATIONS

01B-03-D2 M600/M900 UNIVERSAL BASE AND ACCESSORIES - PRODUCT APPLICATION & DESIGN INFORMATION

01B-03-I1M600/M900 UNIVERSAL DETECTOR BASE - INSTALLATION INSTRUCTIONS

01B-03-C1M600/M900 UNIVERSAL DETECTOR BASE - COMMISSIONING INSTRUCTIONS

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16th April 1999