801FEx/811FEx INTRINSICALLY SAFE INFRA-RED FLAME DETECTORS

PRODUCT APPLICATION AND DESIGN INFORMATION

1. INTRODUCTION

The 801FEx Intrinsically Safe Infra-Red Flame Detector forms part of the 800Ex Intrinsically Safe Series of MX Addressable Fire Detectors. The detector plugs into an MUBEx or 5BEx base.

The 811FEx is the Marine version of the 801FEx.

The detector is designed to transmit, to a remote MX/MX2/T2000 fire controller, a digital signal which represents the status of the flame detector.

2. INTRINSIC SAFETY

The detectors are for use in potentially explosive gas and dust atmospheres (zone 0 gas, zone 20 dust).

The detectors are designed to comply with EN/IEC 60079-0:2006, EN/IEC 60079-11:2007 and EN/IEC61241-11:2006 for Intrinsically Safe apparatus. They are certified:

ATEX code:	**Ex II 1 GD**
Certificate:	**Baseefa03ATEX0422X**
Gas/Dust code for ATEX and IECEx:	**Ex ia IIC T4** **Ex iaD 20 T135°C** **(-20°C ⩽ Ta ⩽ +70C)**
IECEx Certificate:	**IECEx BAS 07.0075X**

These detectors are designed and manufactured to protect against other hazards as defined in paragraph 1.2.7 of Annex II of the ATEX Directive 94/9/EC.

2.1 DETECTOR USE

The detectors may only be used in conjunction with an IF800Ex Interface Module and a Pepperl+Fuchs KFD0-CS-Ex1.54 galvanic isolator.

2.2 SPECIAL CONDITIONS OF SAFE USE

The apparatus has a plastic enclosure which constitutes a potential electrostatic hazard. The enclosure must be cleaned only with a damp cloth.

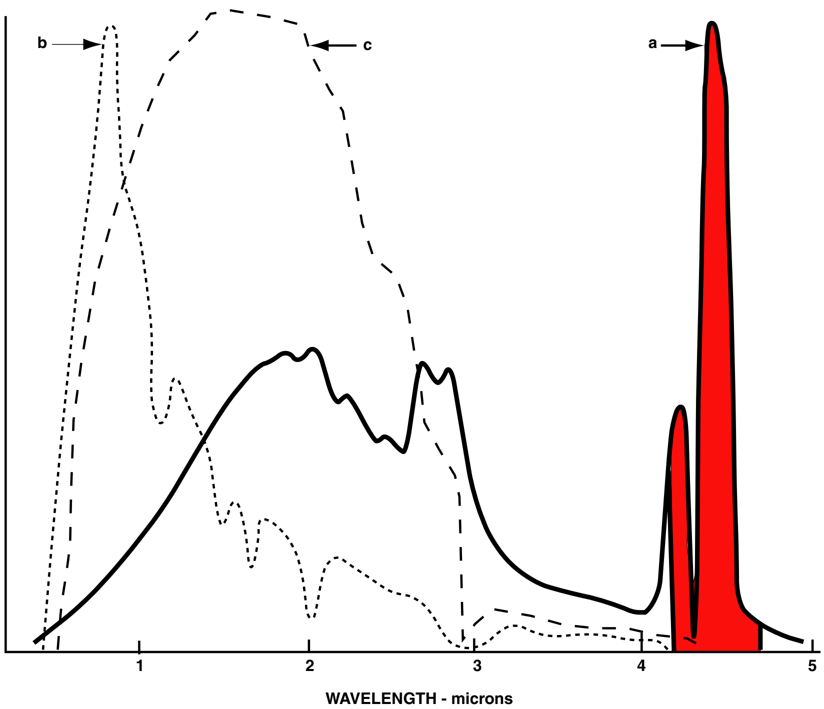

Fig. 1 Spectrums of: a) Typical Carbonaceous Fire b) Solar Radiation at Ground Level c) Tungsten Filament Lamp

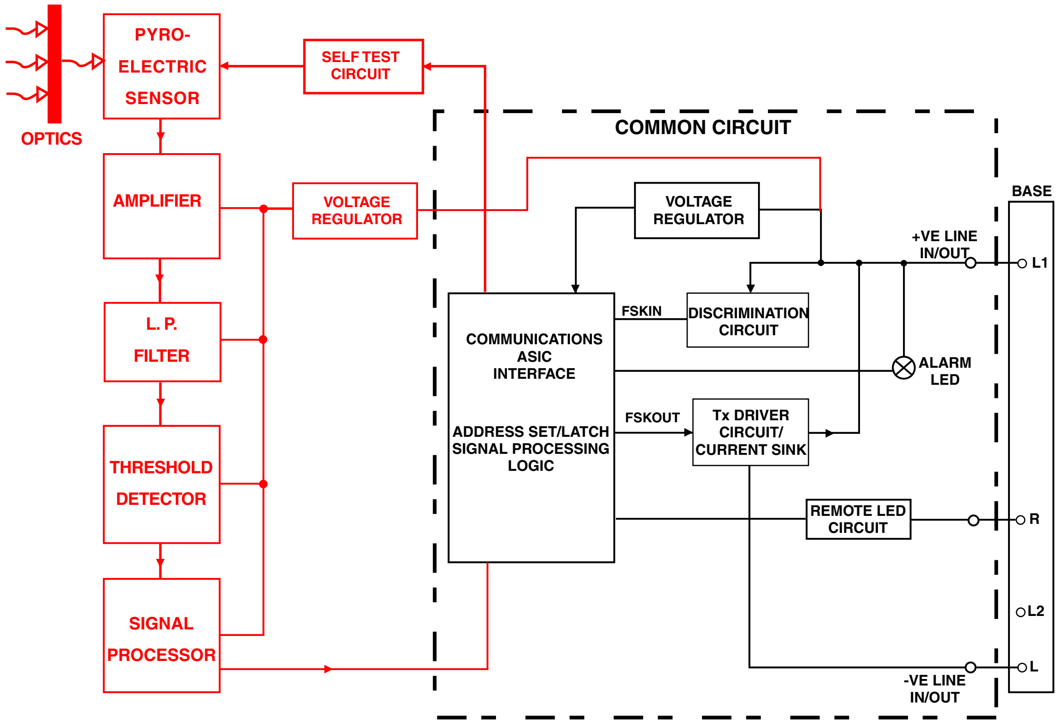

Fig. 2 Simplified Block Schematic of Detector

3. OPERATING PRINCIPLE

3.1 OPTICAL CHARACTERISTICS

The 801FEx 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 4.45µm. 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 801FEx uses an optical filter which transmits infra-red between 4.38µm and 4.56µm (shown shaded in fig. 1(a)). This bandwidth allows high sensitivity to flames with low sensitivity to other interfering sources.

3.2 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 801FEx responds to flicker frequencies in the range 1-10Hz which provides high sensitivity to almost all types of accidental fire.

3.3 CIRCUIT OPERATION

3.3.1 FLAME SENSOR

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 amplified and filtered, to remove frequencies outside the required flicker region.

The threshold detector and signal processor evaluate the amplitude and frequency characteristics of the flicker and pass the results to the signal processing logic in the common circuit.

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

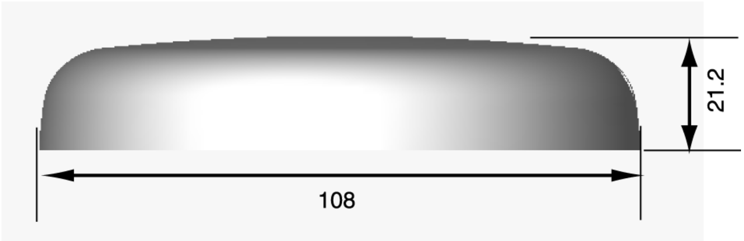

Fig. 3 Overall Dimensions of 801FEx Detector

3.4 COMMON CIRCUIT

Refer to Fig. 1.

Communications between the controller and detector uses the Frequency Shift Keying (FSK) method.

The ‘Discrimination Circuit’ filters the FSK signal from the +ve line voltage and converts it to a digital square wave input for the ‘Communications ASIC’.

The ‘Communications ASIC’ decodes the signal and when its own address is decoded, the analogue inputs received from the flame sensing elements are converted to corresponding digital values. These digital values are then passed to the ‘Tx Driver Circuit/Current Sink’ which applies them to the +ve line for transmission to the controller.

3.5 WIRING

Loop cabling is connected to base terminals L (-ve) and L1 (+ve).

4. APPROVALS

The 801FEx/811FEx meet all the requirements of EN 54 : Part 10 as a Class 2 flame detector.

5. MECHANICAL CONSTRUCTION

The major components of the detector are:

- Body Assembly
- Printed Circuit
- Outer Cover
- Saphire window

5.1 BODY ASSEMBLY

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

The PCB is fitted into the base tray and then the outer cover with saphire window is clipped onto the onto the base, securing features securing the PCB.

5.2 FINAL ASSEMBLY

The assembly described in Section 4.1 is, in effect, a complete detector but the remaining components provide further protection against external influences.

The PCB is soldered to the body, the underside of the PCB is then encapsulated

6. TECHNICAL SPECIFICATION

6.1 MECHANICAL

Dimensions

The overall dimensions are shown in Fig. 3.

Materials

Body, cover, and closure:	FR110 ‘BAYBLEND’ flame retardant.

Weight

Detector:	110g
Detector + Base:	174g

6.2 ENVIRONMENTAL

Operating Temperature:	-20^{o}C to +70^{o}C - but see note below.
Storage Temperature:	-40^{o}C to +80^{o}C

Note: The operating temperatures quoted exceed the ATEX Certification limits.

Relative Humidity

Operational:	90% RH continuous (non-condensing) and up to 99% RH intermittent (non-condensing)
Storage:	>40% RH and <70% RH

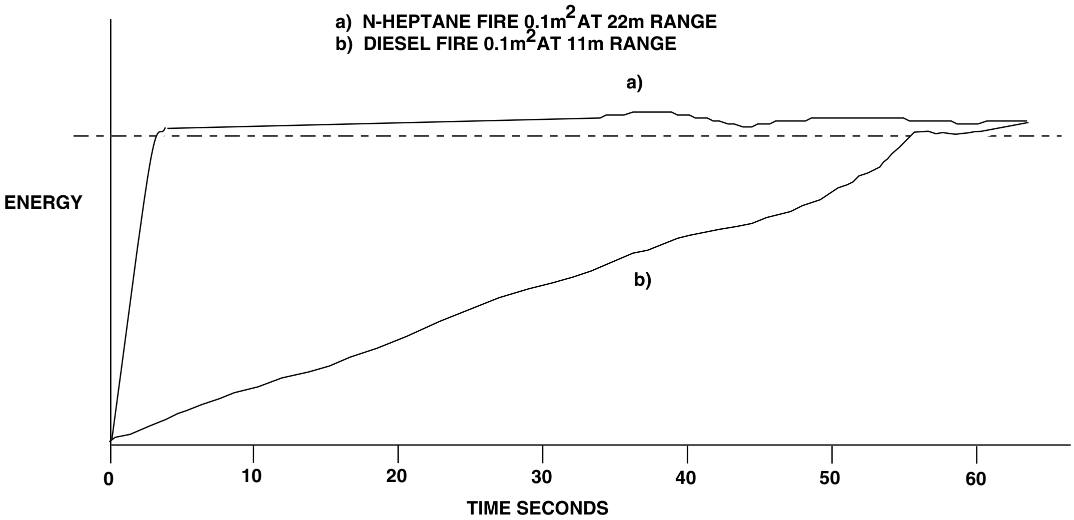

Fig. 4 Typical Response to Fires

Shock:
Vibration:
Impact:
Corrosion:
} To EN54 Part 10

6.3 ELECTROMAGNETIC COMPATIBILITY

The detector complies with the following:

Product family standard EN50130-4 in respect of Conducted Disturbances, Radiated Immunity, Electrostatic Discharge, Fast Transients and Slow High Energy

EN50081-1 for Emissions

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

6.4 ELECTRICAL CHARACTERISTICS

The following characteristics (Table 1) apply at 25^{o}C and nominal supply voltage of 22V unless otherwise specified.

Characteristic	Min.	Typ.	Max.	Unit
Loop Voltage	20	-	24	V
Quiescent Current	-	300	350	μA
Alarm Current	-	3	3.3	mA

Table 1: Electrical Characteristics

Intrinsic Safety Rating:

Maximum Voltage for safety (U_i):	28V
Maximum Current for Safety (I_i):	93mA
Maximum Power Input (P_i):	650mW
Equivalent Inductance (L_i):	0
Equivalent Capacitance (C_i):	0

7. PERFORMANCE CHARACTERISTICS

7.1 MODE OF OPERATION-BEHAVIOUR IN FIRE TESTS

The operating principles of the detector have been described in Section 3 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. 4 shows the typical response of two different fuels which ultimately produce the same signal level. The signal level given by n-heptane quickly reaches its maximum approximately six (6) seconds after ignition. Diesel, 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 diesel is pre-heated to a temperature above its flash point, then it behaves the same as n-heptane at 25^{o}C.

The fire test data presented in Section 6.2 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.

7.2 FIRE TEST DATA

7.2.1 N-HEPTANE

The most convenient fuel for fire tests is n-heptane since it is readily available and quickly reaches its equilibrium burning rate. The range figures specified in Section 5.2.2 relate to a n-heptane fire in a 0.1m^2 pan on the main axis of the detector field of view.

The graph in Fig. 5 shows the typical detection ranges as a function of pan area for n-heptane 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.

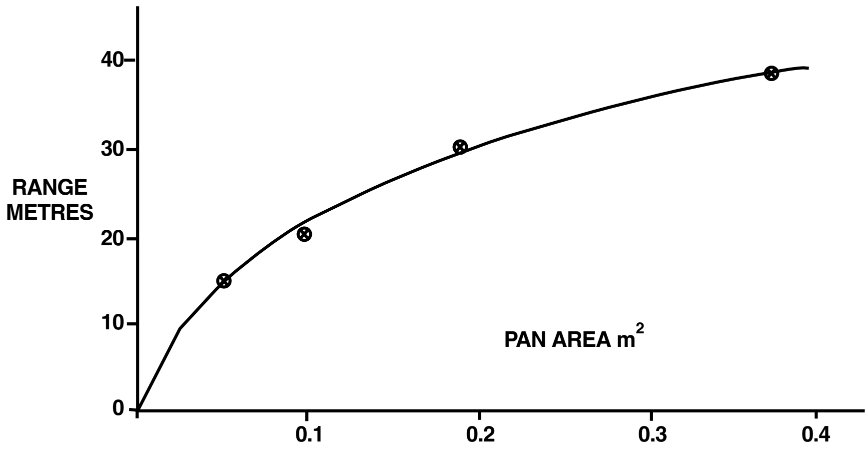

Fig. 5 Typical Detector Range vs Pan Area - n-heptane

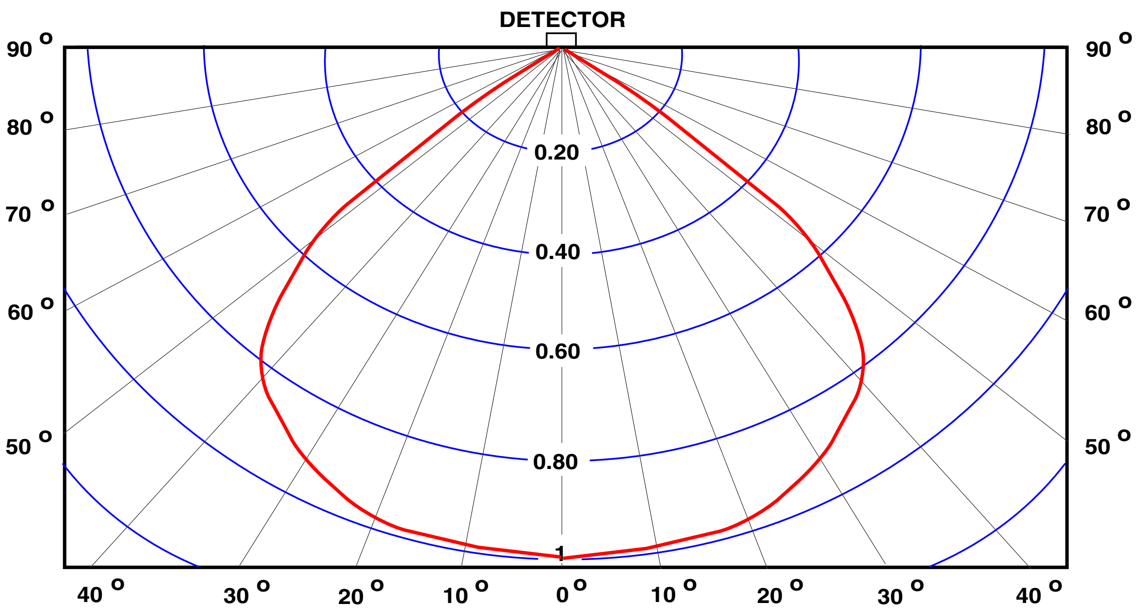

Fig. 6 Relative Range vs Angle of Incidence

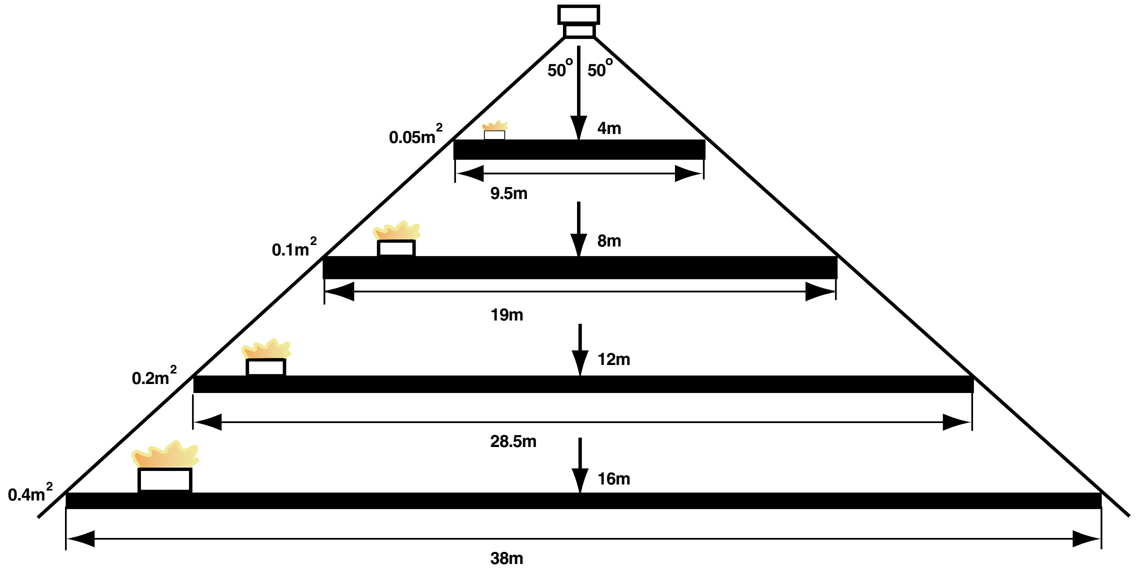

Fig. 7 Field of View

7.2.2 OTHER LIQUID HYDROCARBONS

Ranges achieved with other fuels burning in 0.1m^2 pans are as follows:

Kerosene	15.5m
Alcohol (I.M.S.)	13m
Diesel oil	13m
Ethylene glycol	15.5m

The typical detection range for other pan areas may be calculated using the square law relationship give in Para 6.2.1.

7.2.3 DIRECTIONAL SENSITIVITY

The sensitivity of the 801FEx is at a maximum on the detector axis. The variation of range with angle of incidence is shown in Fig. 6.

8. DESIGN OF SYSTEM

8.1 GENERAL

Using the information given in Sections 3 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.

8.2 USE OF FIRE TEST DATA

It has been explained in Section 6 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, eg, n-heptane: 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 n-heptane fires and extrapolating to an area of 2m^2, the 801FEx should respond at a distance of about 120m.

If the spillage is of a less volatile material (eg, diesel), 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.

8.3 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. 5 shows the effective sensitivity for n-heptane fires when used in this configuration. Sensitivity to other fuels can be determined from the data given in Section 6.2.2.

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.

9. DETECTOR ADDRESS

The loop address of the detector is held in internal E^2PROM which is programmed either from the controller, or by the 801AP MX Service Tool.

Note: The detector must be programmed in the Safe Area when using the MX Service Tool.

10. ADDRESS FLAG

Refer to Fig. 8. The address flag is used to identify the address and zone of the detector. The address flags are supplied in one of two packs (address 1 - 127 or 128 - 255, with a different colour for each loop) and are ordered separately from the detector. The address flag is fitted to the bottom of the detector. When the detector is fitted to the base and turned until fully located, the address flag is then transferred to the base. If the detector is removed from the base, the address flag remains with the base.

11. CONFIGURATION

The detector may be configured as Immediate (interrupt) or Verified (5 second delay).

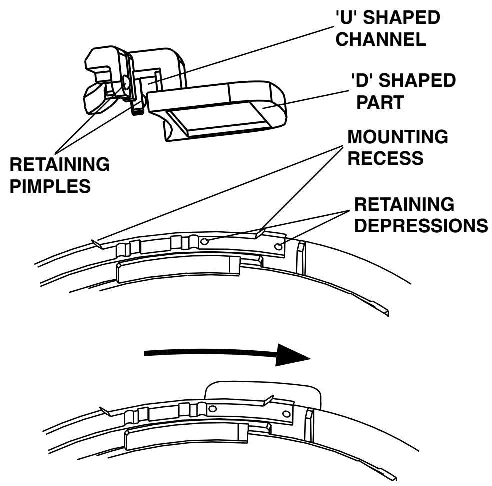

Fig. 8 Fitting Address Flag

12. ORDERING INFORMATION

801FEx Infra-red Flame Detector:	516.800.066
811FEx Infra-red Flame Detector (Marine):	516.800.067
MUBEx Base for use with Ex Detectors:	517.050.610
5BEx 5" Universal Base:	517.050.023
Address Flag Labels - Loop A (White):	516.800.931
Address Flag Labels - Loop B (Yellow):	516.800.932
Address Flag Labels - Loop C (Purple):	516.800.933
Address Flag Labels - Loop D (Green):	516.800.934
Address Flag Labels - Loop E (Grey)	516.800.935
Address Flag Labels - Loop F (Blue)	516.800.936
Address Flag Labels - Loop G (Orange)	516.800.937
Address Flag Labels - Loop H (Red)	516.800.938

JM/ds

4th September 2008