801FEx/811FEx Intrinsically Safe Infra-red Flame Detector

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 a 5BEx IS base.

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

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

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 60079-0:2012+A11:2013 and EN/IEC 60079-11:2012 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 Ga (-20 °C ⩽ Ta ⩽ +70 °C)
  - Ex ia IIIB T135 °C Da (-20 °C ⩽ Ta ⩽ +70 °C)
- 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.

Detector Use

The detectors may only be used in conjunction with an EXI800 Interface Module and a Pepperl+Fuchs KFD0-CS-Ex1.54/KFD0-CS-Ex2.54 galvanic isolator.

Special Conditions of Safe Use

The apparatus has a polyester enclosure which constitutes a potential electrostatic hazard. The enclosure must be cleaned with a damp cloth and do not mount in a high velocity dust laden atmosphere.

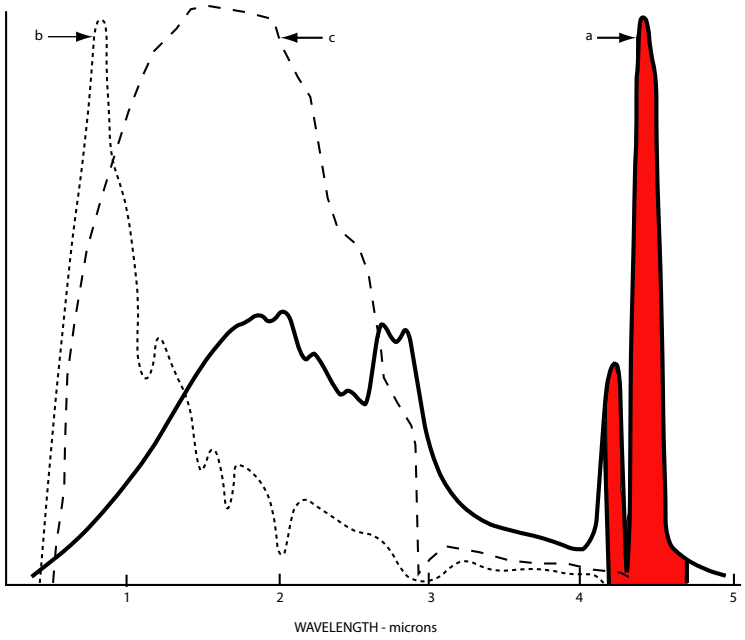

Fig. 1: Spectrums of:
a) Typical Carbonaceous Fire
b) Solar Radiation at Ground Level
c) Tungsten Filament Lamp

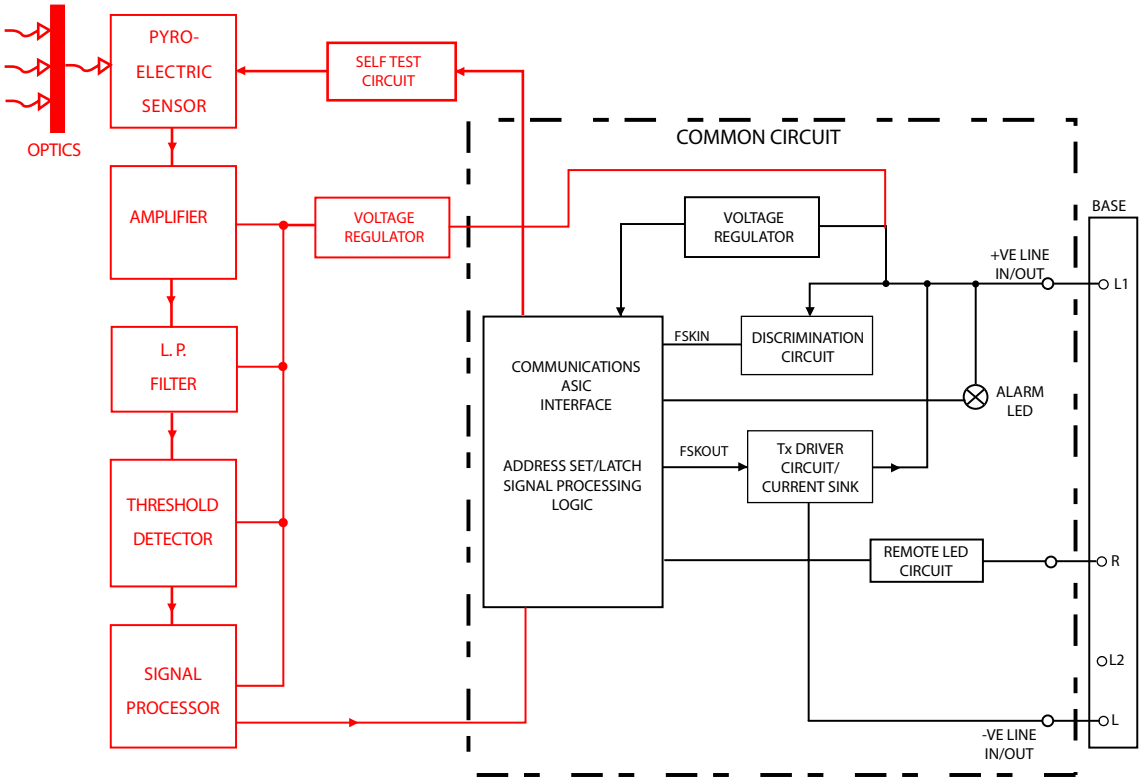

Fig. 2: Simplified Block Schematic Diagram of Detector

Operating Principle

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 4.45 µm. 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 4.38 µm and 4.56 µm (shown shaded in Fig. 1(a)). This bandwidth allows high sensitivity to flames with low sensitivity to other interfering sources.

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 1-10 Hz which provides high sensitivity to almost all types of accidental fire.

Circuit Operation

Flame Sensor

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

The infra-red radiation passing through the narrow-band filter 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.

Common Circuit

Refer to Fig. 2.

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.

Wiring

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

Approvals

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

Mechanical Construction

The major components of the detector are:

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

Body Assembly

The body assembly consists of a plastic moulding, secured with the four detector contacts, which align with contacts in the 5BEx base. The moulding incorporates securing features to retain the detector in the base.

The PCB assembly is fitted into the body and then soldered to the body contacts; the underside of the PCB is encapsulated.

Final Assembly

The assembly described in "Body Assembly" is, in effect, a complete detector. The outer cover is fitted with sapphire window, which is clipped onto the body assembly. The outer cover provides a further protection against external influences.

Technical Specifications

Mechanical

Parameter	Value
Overall Dimensions	See Fig. 3.
Materials: ■ Body, Cover and Closure	 FR3010 'BAYBLEND' flame retardant.
Weight: ■ Detector ■ Detector + Base	 110 g 174 g

Table 1: Mechanical Specifications

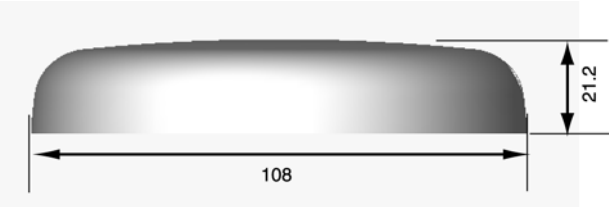

Fig. 3: Overall Dimensions of 801FEx Detector

Environmental

Parameter	Value
Operating Temperature	-20 °C to +70 °C
Storage Temperature	-40 °C to +80 °C
Relative Humidity - Operational	90% RH continuous (non-condensing) and up to 99% RH intermittent (non-condensing)
Relative Humidity - Storage	40% RH and <70% RH
■ Shock ■ Vibration ■ Impact ■ Corrosion	To EN54-10

Table 2: Environmental Specifications

Operating Temperature

The operating temperatures quoted exceed the ATEX Certification limits.

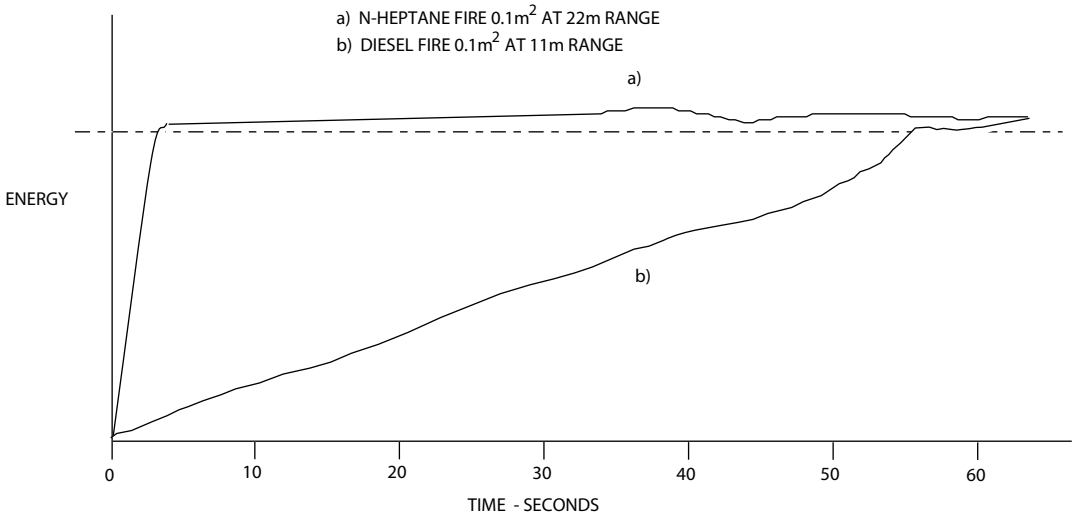

Fig. 4: Typical Response to Fires

Electromagnetic Compatibility

The detector complies with the following:

- Product family standard EN50130-4 in respect of:
  Conducted Disturbances
  Radiated Immunity
  Electrostatic Discharge
  Fast Transients
  Slow High Energy.
- EN 6100-6-3 for Emissions

Compatibility Standards

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

Electrical Characteristics

The following characteristics (Table 3) apply at 25 °C and nominal supply voltage of 22 V 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 3: Electrical Characteristics

Intrinsic Safety Rating

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

Table 4: Safety Rating

Performance Characteristics

Mode of Operation - Behaviour in Fire Tests

The operating principles of the detector has been described in "Operating Principle" on page 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. 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 6 seconds after ignition. Diesel, being less volatile, takes approximately 60 seconds to reach equilibrium burning state and an alarm is given approximately 55 seconds after ignition.

The time taken by the fire to reach equilibrium depends on the initial temperature of the fuel. If diesel is preheated to a temperature above its flash point, then it behaves the same as n-heptane at 25 °C.

The fire test data presented in Fig. 4 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.

Fire Test Data

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 of figures specified in "Other Liquid Hydrocarbons" on page 6 relates to a n-heptane fire in a 0.1 m^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.

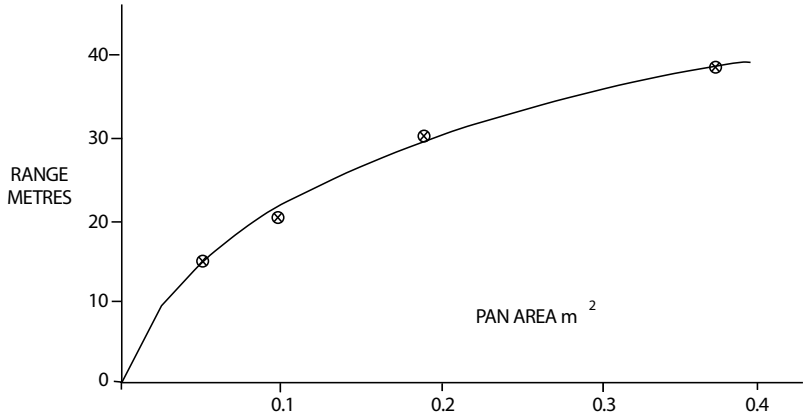

Fig. 5: Typical Detector Range vs Pan Area - n-heptane

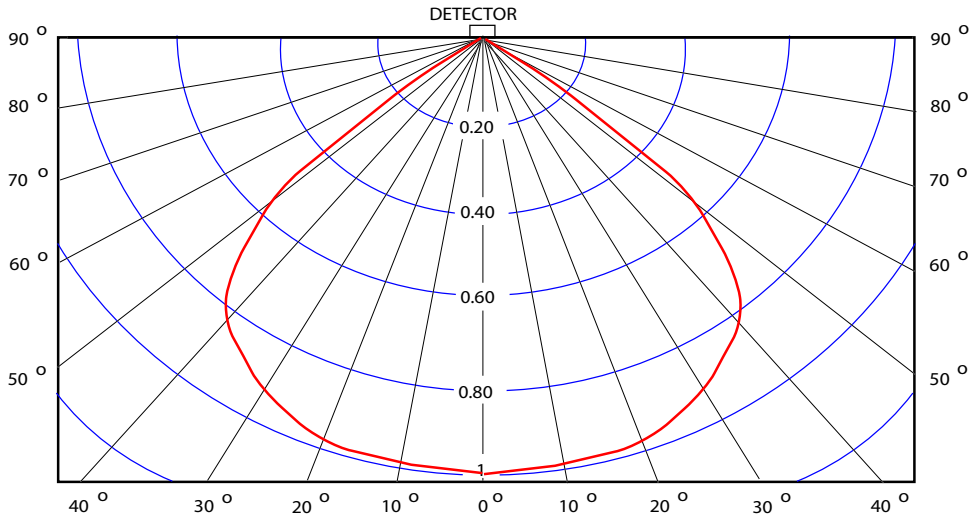

Fig. 6: Relative Range vs Angle of Incidence

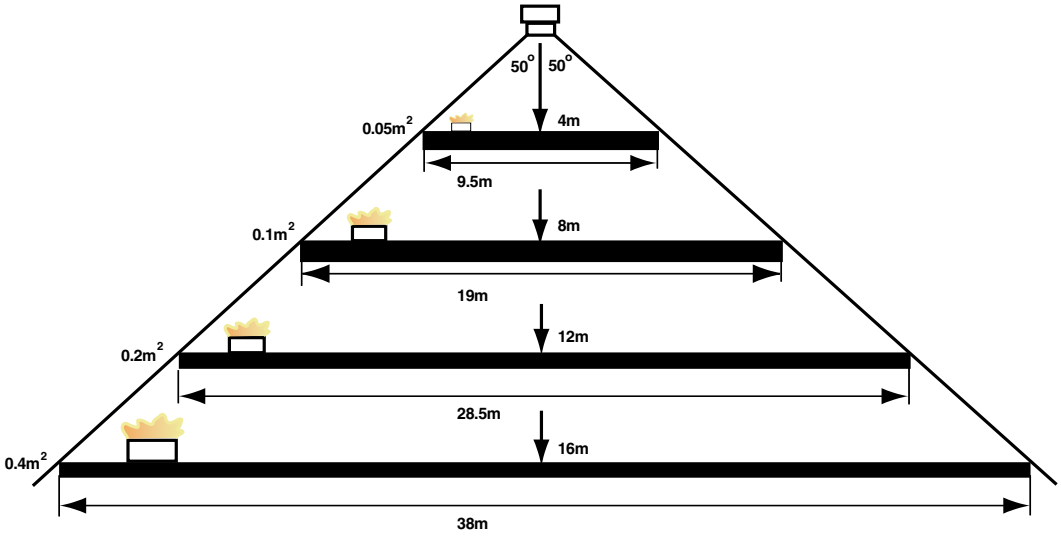

Fig. 7: Field of View

Other Liquid Hydrocarbons

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

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

Table 5: Fuel Burning Ranges

The typical detection range for other pan areas may be calculated using the square law relationship given in the "Fire Test Data" on page 5.

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.

Design of System

General

Using the information given in "Operating Principle" on page 2 to "Technical Specifications" on page 3, 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 in the following section.

Use of Fire Test Data

It has been explained in the "Technical Specifications" on page 3 that the sensitivity of the detector is specified in terms of its response to well-defined test fires. Tests are carried out using a 0.1 m^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, for example, 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 2 m^2. Using the data for n-heptane fires and extrapolating to an area of 2 m^2, the 801FEx should respond at a distance of about 120 m.

If the spillage is of a less volatile material (for example, 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.

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 "Other Liquid Hydrocarbons" on page 6.

NOTICE: Installation Guidance

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.

The detectors should not be installed directly below or in close proximity to watermist nozzles/sprinkler heads or where they will be directly affected by water when a release takes place.

NOTICE: Hot Vibrating Body

Engines (and other hot vibrating bodies) can cause false alarms. This happens when the rising column of hot air above the engine has a wave motion from the vibration. This is interpreted by the detector as the flickering of a flame, which could cause a false alarm.

To prevent this the detector should not be mounted above the engine. You should mount the detector so it points diagonally at the engine on a suitable bracket. Alternatively, mount the detector to a vertical wall pointing sideways at the engine.

Detector Address

The loop address of the detector is held in the internal E2PROM which is programmed either from the controller, or by the 801AP MX Service Tool/ 850EMT Engineering Management Tool.

NOTICE: Programming Detector

The detector must be programmed in the Safe Area when using the 801AP MX Service Tool/ 850EMT Engineering Management Tool.

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.

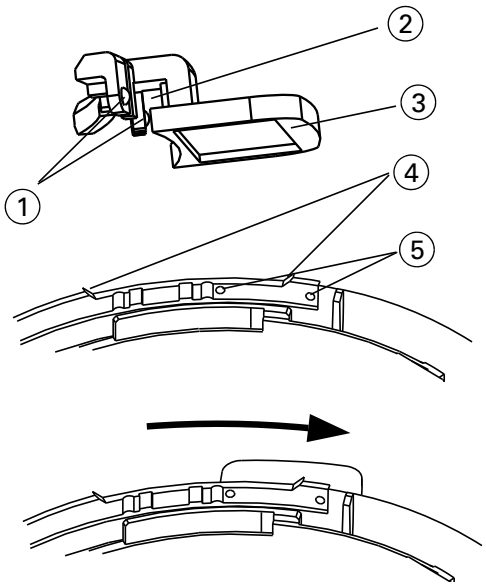

Fig. 8: Fitting Address Flag
1– Retaining pimples
2– 'U'shaped channel
3– 'D'shaped part
4– Mounting recess
5– Retaining depressions

Configuration

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

CPD Information

CE

0832

Tyco Safety Products
Dunhams Lane
Letchworth SG6 1BE
UK

07

0832-CPD-0503

EN 54-10: 2002 + A1: 2005

MX Intrinsically Safe Addressable Class 2 point type flame detector for use in fire detection and alarm systems in buildings.

801FEx
811FEx (Marine)

Application & Design 17A-02-FEx
Installation Instructions 17A-03-5BEx
Service Instructions 17A-04-S

Order Information

Item	Order Code
801FEx Infra-red Flame Detector	516.800.066
811FEx Infra-red Flame Detector (Marine)	516.800.067
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

Table 6: Order Codes