

# About XP95 I.S.

## XP95 Intrinsically Safe communications protocol

The standard XP95 communications protocol is designed to be very robust and to give the maximum flexibility to designers of loop driver circuits. The current and voltage levels used are chosen to be well above noise levels and to operate in adverse conditions with the minimum of errors. The maximum voltage and current levels used are, however, outside the limits of intrinsically safe (I.S.) systems and it has been necessary to apply lower limiting values for both current and voltage in the I.S. range.

The voltage limitation arises because of the need for safety barriers. The barriers used with Apollo I.S. detectors are rated at 28 volts, the highest rating that is commercially available. These are used to limit the voltage inside the hazardous area to a (practical) maximum of about 26 V dc. Although this is within the standard XP95 protocol specification, it is lower than that provided by most loop drivers.

The safety barrier is also responsible for the current limitation because the 28 V barriers have a series resistance of at least 300 ohms. This resistance results in unacceptable voltage drops if the normal 20 mA current pulses are used. It has therefore been necessary to reduce the amplitude of the current pulses to 10 mA.

The differences between the standard protocol and the intrinsically safe are summarised in Table 1.

**Table 1: Protocol variance data**

Parameter	XP95 standard	XP95 I.S.
dc input voltage	17 - 28 V	14 - 22 V
Pulse voltage peak to peak	5 - 9 V	5 - 9 V
dc + pulse voltage	37 V max	26.6 V max
Current pulse amplitude	18 - 22 mA	9 - 11 mA
Input voltage polarity	polarity insensitive	L1 positive L2 negative

## System design

The design of an intrinsically safe fire detection system should only be undertaken by engineers familiar with codes of practice for detection systems and hazardous area electrical systems. In the UK the relevant standards are BS5839-1 and BS EN 60079-14 respectively.

The fire detection performance of the XP95 I.S. range is the same as that of its standard counterparts. Performance information is given in the XP95 I.S. products data sheets.

The BASEEFA certification of the I.S. devices covers their characteristics as components of an intrinsically safe system and indicates that they can be used with a margin of safety in such systems. The precise way in which the system can be connected and configured is covered by an additional, 'system' certification. The System Diagram, Z20982, see Figure 5, details cable

parameters and permissible configurations of detectors, manual call points and safety barriers which are certified by BASEEFA. Any user wishing to install a system outside the parameters given on this system diagram cannot make use of the Apollo certification and should seek independent certification from a competent certification body.

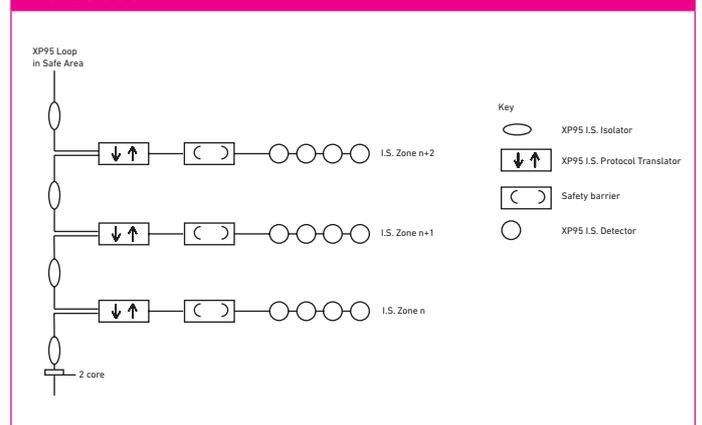
The BASEEFA system Certificate Number is Ex94C2444.

Any system installed within the parameters specified in Z20982 should be marked in accordance with BS EN 60079-25. The marking should include at least 'Apollo XP95 I.S. Fire Detection System, BASEEFA No Ex94C2444 SYST'.

In safe area (standard) applications it will be normal practice to connect the wiring as a loop, with both ends terminated at the control panel. In the event of an open-circuit fault it is then possible to drive both ends simultaneously. In a hazardous area it is not possible to use a loop configuration because the potential to feed power from each end of the loop would double the available energy in the hazardous area and contravene the energy limitations of the I.S. certification. All XP95 I.S. circuits must therefore be connected as spurs from the safe area loop or as radial connections from the control panel.

It is recommended, for the highest system integrity, that each I.S. circuit be restricted to a single zone and that the connection from the safe area loop to the I.S. spur be protected on each side by XP95 isolators. The DIN-Rail dual isolator (55000-802) is particularly suited to this application. This configuration, shown in Figure 1 will conform fully with the requirements of BS5839-1 and with the European Guidelines DD CEN/TS 54-14 since a single wiring fault will result in the loss of only one zone of detection.

**Figure 1: Schematic wiring diagram of XP95 I.S. circuit to BS5839**



In certain circumstances it may be possible for the simpler configuration, shown in Figure 2 to be used. This arrangement may include single or dual-channel translators, housed, together with the critical wiring, in a robust mechanical housing such as the Apollo DIN-Rail enclosures part no. 29600-239 (1 x I.S. circuit) or part no. 29600-240 (up to 5 x I.S. circuits). For further advice, please contact the Technical Sales department at Apollo.

XP95 Protocol Translator

In order to enable the use of standard control and indicating equipment in intrinsically safe systems, Apollo has developed a device to 'translate' voltage levels from any loop driver operating within the XP95 limits to levels compatible with the I.S. requirements. The translator also 'boosts' the current pulses returned by the I.S. detectors from 10 mA to 20 mA, thereby ensuring compatibility with standard loop driver thresholds. For more information regarding the XP95 Protocol Translator refer to PP5034.

Figure 2: Schematic wiring diagram of XP95 I.S. circuit using a dual channel protocol translator

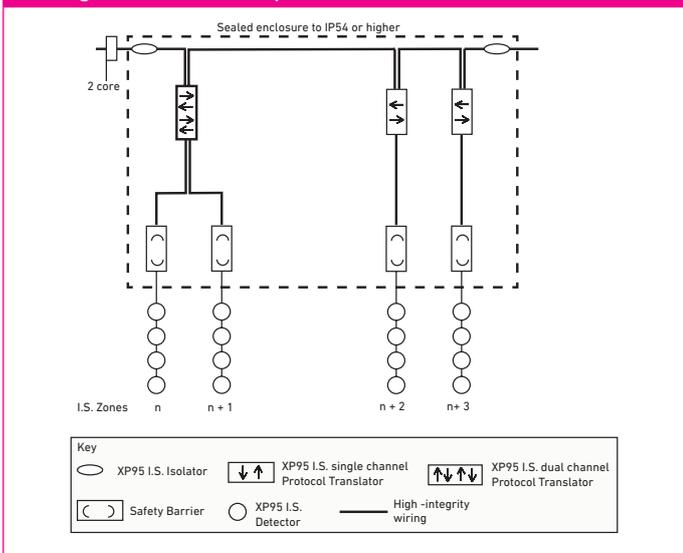
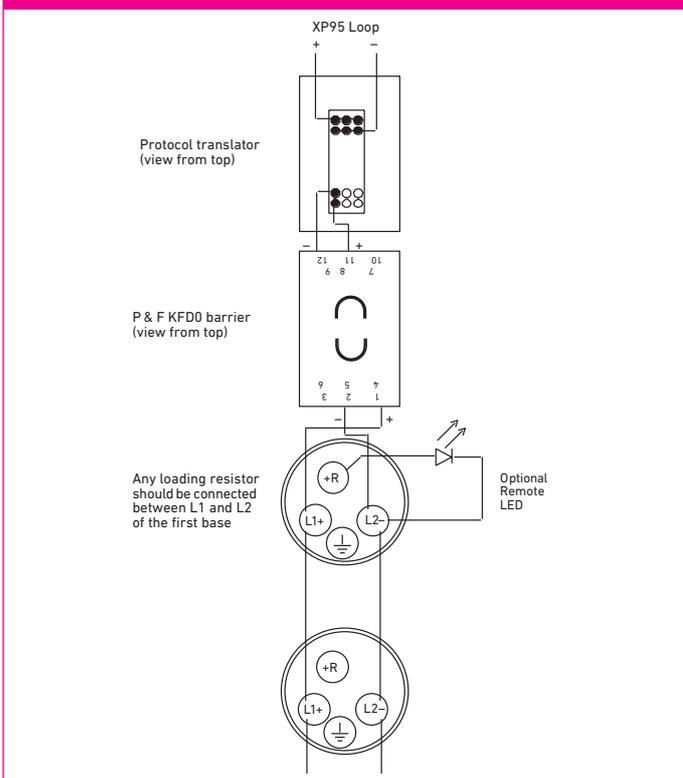


Figure 3: Detail of wiring diagram for XP95 I.S. Zone



Types of safety barriers

The certified system configurations allow for three types of safety barrier, each of which has its own advantages and disadvantages. A brief outline of their characteristics is given below.

Single Channel 28 V/300 Ω Barrier

This is the most basic type of barrier and therefore the lowest in cost. Being passive devices, they also impose the minimum of restrictions on the operation of the fire detectors. Thus, single channel barriers are available either as positive or negative polarity where the polarity refers to the polarity of the applied voltage relative to earth. The significance of this is that one side of the barrier must be connected to a high-integrity (safety) earth. Although this earth connection has no effect on the operation of the XP95 I.S. devices and is not needed for their correct operation, it may not be acceptable to the operation of the control and indicating equipment. This is particularly true if the control equipment incorporates earth-leakage monitoring and even without this feature the earthing of the loop may cause unwanted cross-talk between loops.

If the earth connection is not acceptable then the ac or isolating barriers should be used.

Star-connected ac Barrier

ac barriers are also passive devices and must still be connected to a high-integrity safety earth. However, they are designed to allow either positive or negative voltages with respect to earth and under normal conditions provide a connection to earth via a reverse-biased diode, rather than directly.

The disadvantage of this type of barrier is that the end-to-end resistance is nominally 1200 Ohms compared with the 300 Ohms of the single channel type. This high resistance results in an extra voltage drop in the circuit.

This type of barrier is not recommended for general use.

Galvanically Isolated Barrier

Galvanically isolated barriers (also known as transformer isolated barriers) differ from conventional shunt zener barriers in that they provide electrical isolation between the input (safe area) and the output (hazardous area). This is achieved by the use of a dc converter on the input side which is connected to the hazardous area through a voltage- and power-limiting resistor/zener combination similar to a conventional barrier.

The galvanic isolation technique means that the circuit does not need a high integrity (safety) earth and that the intrinsically safe circuit is fully floating. Earth leakage problems for control and indicating equipment are therefore eliminated if this type of interface is used.

**Note:** Although the circuit does not require a high-integrity earth, it is permissible to earth either priority of the hazardous area circuit if required by other system considerations.

Although galvanically isolated barriers are widely used with conventional fire detectors the pulse response of standard products has been too slow to allow their use in analogue addressable systems. Apollo has worked closely with Pepperl + Fuchs in the development of a special galvanically isolated barrier which freely transmits the XP95 protocol pulses without introducing severe voltage drops.

This interface is available as single or dual channel versions and is recommended for any application in which direct earth connections are not acceptable. The Pepperl + Fuchs type numbers are KFD0-CS-Ex1.54 (Apollo part no. 29600-098) and KFD0-CS-Ex2.54 (available from Pepperl + Fuchs) for the single and dual channel devices respectively. Both versions are BASEEFA certified under Certificate Number BAS00ATEX7087. (The KFD0- types have replaced the earlier KHD0- types.)

The galvanically isolated barrier is a two-wire device which does not need an external power supply. Current drawn from the XP95 loop by the barrier itself is less than 2mA when loaded as specified by the manufacturer. The housing is a DIN-Rail mounting, identical to that used for the protocol translator.

**Maximum loading of an I.S. circuit**

Because of the finite resistance of the safety barrier, there will be a limit to the current drain which can be tolerated before the voltages on the circuit fall outside the specified limits for XP95 I.S. devices. Two components of the current drain must be considered, namely the standing current of the devices by themselves and the maximum drain caused by alarm LEDs being illuminated. The standing current of the devices can be calculated by taking the sum of the individual device currents on the circuit, as given in the section 'Technical data' for each product.

The maximum number of LEDs that can be illuminated simultaneously should ideally be limited by the panel software.

Because the LED load is often the limiting factor in determining the voltage drop, the later versions of the XP95 I.S. detectors are fitted with high efficiency LEDs. This has allowed a reduction from 2 mA to 1 mA in the LED current. It is important when fitting remote LEDs that high efficiency types are used.

Table 2 shows the maximum device standing current which can be supported for varying numbers of LEDs illuminated.

**Table 2: Maximum loading 28 V/300 Ω single channel barrier**

Max. No of LEDs illuminated	Max. (Total) device load (mA)
0	8.0
1	7.0
2	6.0
3	5.0
4	4.0
5	3.0

**Remote LED connection**

A drive point is provided on each of the XP95 I.S. detectors for a remote LED indicator. For connection details see Figure 3. The indicator must be a standard high-efficiency red LED and does not require a series limiting resistor since current is limited within the detector to approximately 1 mA. The remote LED cannot, as in the standard XP95 range, be controlled independently from the integral LED since it is effectively connected in series with the integral LED. The benefit of this configuration is that illumination of the remote LED does not increase the current drawn from the loop.

The system certification allows for the use of any LED indicator having a surface area between 20 mm<sup>2</sup> and 10 cm<sup>2</sup> which covers all commonly used case styles from T1 (3 mm) upwards but would exclude some miniature and surface mounted types. Additional requirements of the certification are that the LED and its terminations must be afforded a degree of protection of at least IP20 and must be segregated from other circuits and conductors as defined in BS EN 60079-14.

The Apollo MiniDisc Remote Indicator (53832-070) is suitable.

**Approved safety barriers**

The system certification includes a generic specification for barriers, two additional, individually approved barriers and two transformer isolated current repeaters (galvanic barriers).

The generic specification is:

Any shunt zener diode safety barrier certified by BASEEFA or any EEC approved certification body to

E Ex ia IIC

Having the following or lower output parameters:

U<sub>z</sub> = 28 V

I max:out = 93.3 mA

W max: out = 0.67 W

In any safety barrier used the output current must be limited by a resistor 'R' such that

$$I \text{ max: out} = \frac{U_z}{R}$$

A number of single-channel barriers meet this specification and examples are given below:

The two individually approved barriers are:

1. Pepperl & Fuchs Z978

Star connected shunt zener diode safety barrier, 28V/600V, dual channel. BASEEFA Certificate No. Ex 93C2412, BAS01ATEX7005.

2. Measurement Technology Ltd. MTL 778

Star connected shunt zener diode safety barrier, 28V/600V. BASEEFA Certificate No. Ex 832452, BAS01ATEX7202.

**Safety earth**

Single channel and star connected ac safety barriers must be connected to a high integrity earth by at least one and preferably two copper cables, each of cross sectional area of four mm<sup>2</sup> or greater. The connection must be such that the impedance from the connection point to the main power system earth is less than one ohm.

Intrinsically safe circuits in the hazardous area should be insulated from earth and must be capable of withstanding a 500V RMS ac test voltage for at least one minute. When using armoured or copper sheathed cables, the armour or sheath is normally isolated from the safe area busbar.

**Wiring and cable types**

It is not permitted to connect more than one circuit in the hazardous area to any one safety barrier and that circuit may not be connected to any other electrical circuit.

Both separate and twin cables may be used. A pair contained in a type 'A' or 'B' multicore cable (as defined in clause 12.2.2 of BS EN 60079-14) may also be used, provided that the peak voltage of any circuit contained within the multicore does not exceed 60 V.

The capacitance and either the inductance or the inductance to resistance (L/R) ratio of the hazardous area cables must not exceed the parameters specified in Table 4. The reason for this is that energy can be stored in a cable and it is necessary to use cable in which energy stored is insufficient to ignite an explosive atmosphere.

To calculate the total capacitance or inductance for the length of cables in the hazardous area, refer to Table 3, which gives typical per kilometre capacitance and inductance for commonly used cables. (*Note: All XP95 I.S. devices have zero equivalent capacitance and inductance*).

**Installation**

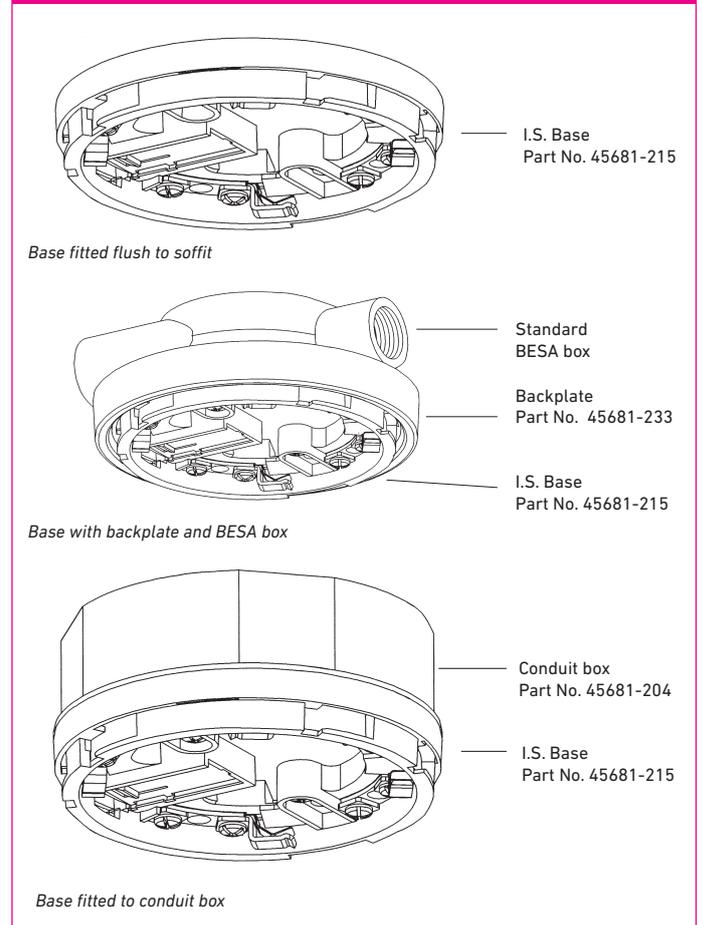
It is important that the XP95 I.S. detectors are installed in such a way that all terminals and connections are protected to at least IP20 when the detector is in the base. Special care must be taken with the rear of the mounting base where live metal parts (rivets) may be accessible. Flush mounting of the base on a flat surface will provide the required degree of protection.

If the base is mounted on a conduit box (e.g. BESA box or similar) whose diameter is less than 85 mm then the base should be fitted with a XP95 Backplate (Apollo part number 45681-233). Use of the backplate will prevent access to the metal parts and will also protect the rear of the base from water ingress. The conduit box available from Apollo, part no. 45681-204, is also acceptable for mounting I.S. bases. Apollo also supply a range of deckhead mounting boxes.

Figure 4 shows permissible methods of installing intrinsically safe detector bases.

*Note: The earth terminal in the base is provided for convenience where continuity of a cable sheath or similar is required. It is not necessary for the correct operation of the detector nor is it provided as a termination point for a safety earth.*

**Figure 4: Permissible methods of mounting I.S. detector bases**



**Table 3: Examples of electrical characteristics of cables commonly used in fire protection systems**

Cable type	Core	Size mm <sup>2</sup>	Conductor resistance Ohm/km/core	Inductance mH/km	Capacitance µF/km		Sheath resistance Ohm/km
					Core to core	Core to sheath	
MICC Pyrotenax light duty	2	1.5	12.1	0.534	0.19	0.21	2.77
MICC Pyrotenax heavy duty	2	1.5	12.1	0.643	0.13	0.17	1.58
Pirelli FP200	all	1.5	12.1	-	0.08	0.15	-
PVC sheathed and insulated to BS 6004	all	1.5	12.1	0.77	0.09	-	-

**Table 4: Limits for energy stored in cables**

Group	Capacitance µF	Inductance mH	L/R ratio µH/Ohm
IIC	0.083	4.2	55
IIB	0.65	12.6	165
IIA	2.15	33.6	440

## Servicing

Servicing of I.S. fire detectors may be carried out only by a BASEEFA authorised body. In practical terms this means that Apollo XP95 I.S. fire detectors may be serviced only by Apollo at its factory. Servicing of the fire protection system should be carried out as recommended by the code of practice BS 5839-1 or other local regulations in force. For more information on servicing Apollo detectors, please refer to the care, service and maintenance guide, PP2055.

## Approvals

XP95 I.S. detectors have been approved by LPCB to EN54 and the XP95 I.S. Manual Call Point, Part No 55100-940, is LPCB approved to EN54-11. These products have also been approved for marine use by the following bodies:

- American Bureau of Shipping
- Bureau Veritas
- DNV GL
- Lloyds Register of Shipping
- China Classification Society
- Korean Register of Shipping

Details of approvals held are available on request.

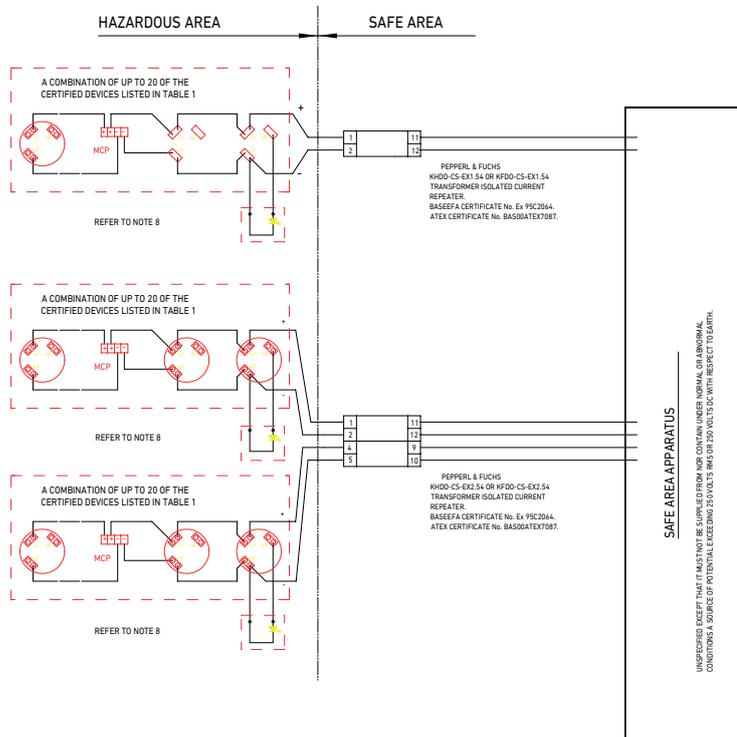
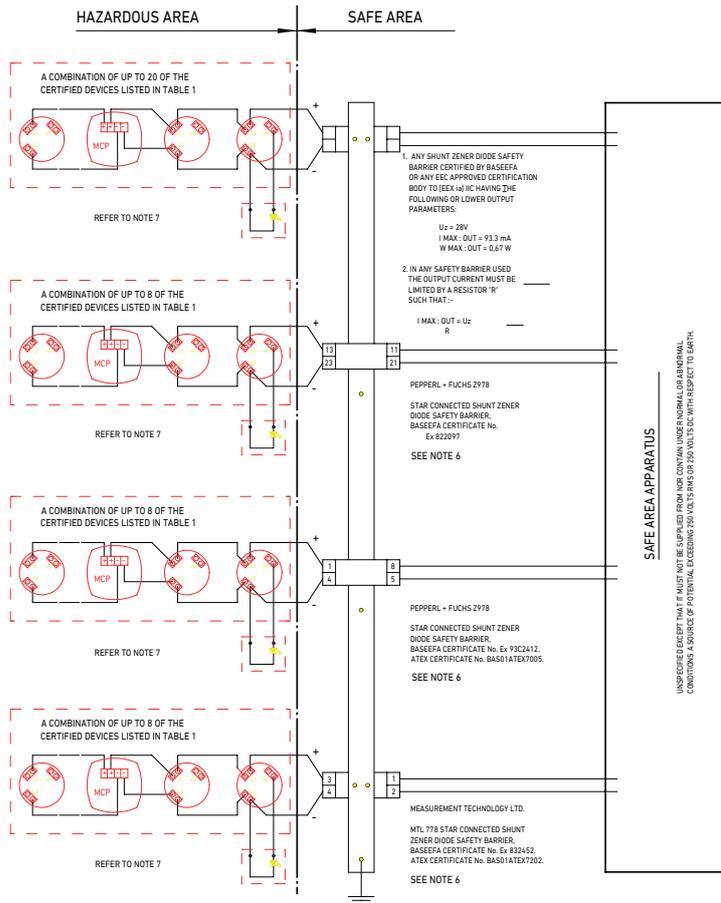
The product certification technical files for the XP95 I.S. range are held by BASEEFA in accordance with the requirements of the ATEX Directive 2014/34/EU. All detectors and manual call points are  marked.

Figure 5: XP95 I.S. System drawing

DEVICE	TYPE	CERTIFICATE No.
OPTICAL SMOKE MONITOR	55000-640	Ex 94C2406 BAS02ATEX1289
ION CHAMBER SMOKE MONITOR	55000-540	Ex 94C2406 BAS02ATEX1289
HEAT MONITOR	55000-440	Ex 94C2406 BAS02ATEX1289
MANUAL CALL POINT	55000-940 TO 945 INCL. 55000-960 TO 967 INCL. 55000-970 TO 973 INCL.	Ex 94C2443 BAS02ATEX1290

GROUP	CAPACITANCE $\mu$ F	INDUCTANCE mH	L/R RATIO	
			OR	$\mu$ H/ohm
IIC	0.083	4.2		55
IIB	0.65	12.6		165
IIA	2.15	33.6		440

- NOTE 1. EACH BARRIER FED CIRCUIT MUST BE A SEPARATE CIRCUIT & MUST NOT BE INTERCONNECTED WITH ANY OTHER ELECTRICAL CIRCUIT.
- NOTE 2. THE ELECTRICAL CIRCUIT IN THE HAZARDOUS AREA MUST BE CAPABLE OF WITHSTANDING AN a.c. TEST VOLTAGE OF 500 VOLTS RMS TO EARTH OR FRAME OF THE APPARATUS FOR ONE MINUTE.
- NOTE 3. THE INSTALLATION MUST COMPLY WITH NATIONAL INSTALLATION REQUIREMENTS (e.g. IN THE UK BS EN6079-14).
- NOTE 4. THE CAPACITANCE & EITHER THE INDUCTANCE OR THE INDUCTANCE TO RESISTANCE (L/R) RATIO OF THE HAZARDOUS AREA CABLES MUST NOT EXCEED THE PARAMETERS SPECIFIED IN TABLE 2.
- NOTE 5. THE CABLE MAY BE SEPARATE CABLES OR A TWIN PAIR OR A PAIR CONTAINED IN A TYPE 'A' OR A TYPE 'B' MULTICORE CABLE (AS DEFINED IN CLAUSE 5.3 OF BS5501-9:1982, EN50039) PROVIDED THAT THE PEAK VOLTAGE OF ANY CIRCUIT CONTAINED WITHIN THE MULTICORE DOES NOT EXCEED 60 VOLTS.
- NOTE 6. SPECIAL CONDITIONS MAY APPLY WHEN USING a.c. BARRIERS. CONSULT APOLLO FOR FURTHER INFORMATION.
- NOTE 7. AN EXTERNAL LIGHT EMITTING DIODE (LED) MAY BE FITTED TO TERMINALS L2 AND N2 OF A FIRE MONITOR. THE SURFACE AREA OF THE LED MUST LIE BETWEEN 20mm AND 10cm. THE LED AND ITS TERMINATIONS MUST BE AFFORDED A DEGREE OF PROTECTION OF AT LEAST IP20, AND MUST BE SEGREGATED FROM OTHER CIRCUITS AND CONDUCTORS AS DEFINED IN CLAUSE 5 OF EN50020:2002



NOTE 8. IF REQUIRED A LOADING RESISTOR OF NOT LESS THAN 3K $\Omega$ , 0.5W AND HAVING A SURFACE AREA BETWEEN 20mm AND 10cm, MAY BE CONNECTED BETWEEN L1 & L2 OF ANY SINGLE MOUNTING BASE OR BETWEEN UNUSED + AND - TERMINALS OF ANY SINGLE MANUAL CALL POINT.