

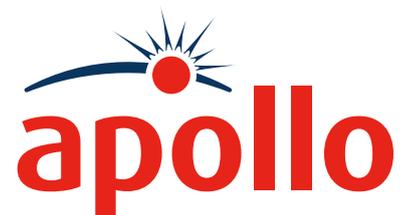
SAFETY INTEGRITY LEVEL MANUAL



SIL2

IEC 61508 and IEC 61511

XP95® and Discovery® SIL Approved Product Range



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General information

This manual should be read in conjunction with the corresponding documents listed on Page 38. The data sheets, Engineering Product Guides and Installation Guides published by Apollo provide the product technical description, technical data and relevant certification that forms an integral part of this manual. All of the Apollo publications are available from the website www.apollo-fire.co.uk

Mounting, installation, commissioning, operation, maintenance and disassembly of a device where necessary may only be done by suitably qualified and experienced personnel. They in turn must read and understand this manual.

The devices in the product ranges within this manual are developed, manufactured and tested in accordance with the relevant safety standards. They must only be used for the applications described in the device instructions and in the specified environmental conditions. They should only be connected to approved external devices.

Apollo Fire Detectors Ltd will be pleased to provide any additional information on the products, Safety Integrity Levels and Functional Safety upon request. Relevant certificates are available on the website www.apollo-fire.co.uk

Introduction

The purpose of this manual is to explain Safety Integrity Levels (SILs) and to provide Technical Data for the Apollo range of SIL approved devices.

Why do we need Safety Integrity Levels?



The morning of 11th November 2005 saw the largest detonation since World War 2 when the Buncefield Oil Depot at Hemel Hempstead in Hertfordshire was subject to a series of some twenty explosions which were measured at 2.4 on the Richter scale.

Industrial safety in pre-digital times was centred mainly around safe work practices, hazardous material control and protective 'armouring' of personnel and equipment. If any of these things failed the results were often catastrophic as the photo shows.

Today, nothing is more important than safety to many industries, not only to protect personnel and equipment but to reduce costs and minimise downtime. This means that reliability is a key component of safety, the more reliable the device, the safer the process.

What does Safety Integrity Level mean?

SIL, an acronym for Safety Integrity Level, is a system used to quantify and qualify the requirements for Safety Instrumented Systems (SIS). The International Electro-technical Commission (IEC) introduced the safety standards that follow to assist with quantifying the safety performance requirements for hazardous operations:

- **IEC 61508** - Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems.
- **IEC 61511** - Safety Instrumented Systems for the Process Industry Section.

These standards have been widely adopted in the Marine, Offshore and Industrial sectors including, Process Industries, Wind, Power, Rail and Nuclear industries.

What is SIL?

Basics

SIL describes the integrity of a safety related function. Management and technical measures are necessary to achieve a given integrity. A SIL is attributed to a safety function, which includes different function blocks such as sensors, logic systems and actuators.

A SIS consists of one or more safety related functions, each of which has a SIL requirement. A component, subsystem and system do not have SILs in their own right.

Systems have 'SIL limitation effect'. For example the function that follows - see Figure 1 - can only claim SIL2 because of the limitation of the sensor system.

- Sensor system : max SIL2
- Logic system (Logic solver): max SIL 3
- Output element: max SIL3

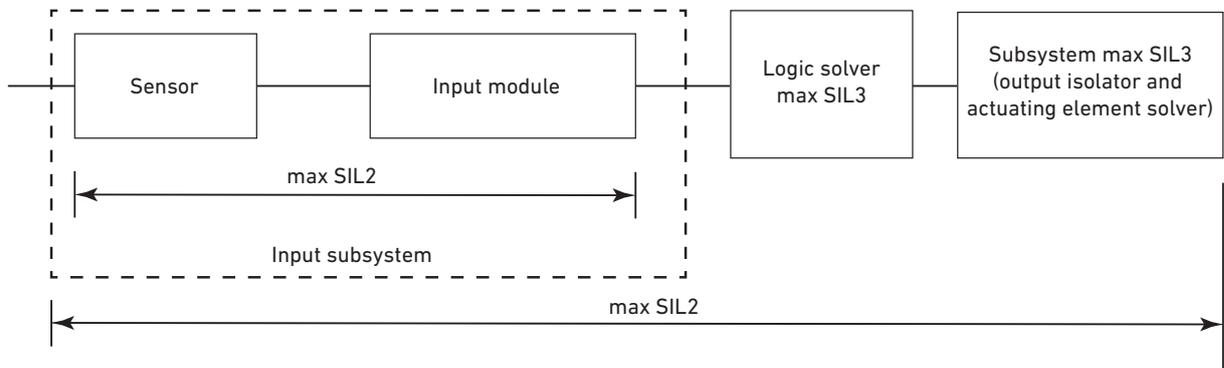


Figure 1: System structure

Within a system, components or subsystems can be combined (in parallel for example) in order to modify the SIL limitation - see Figure 2.

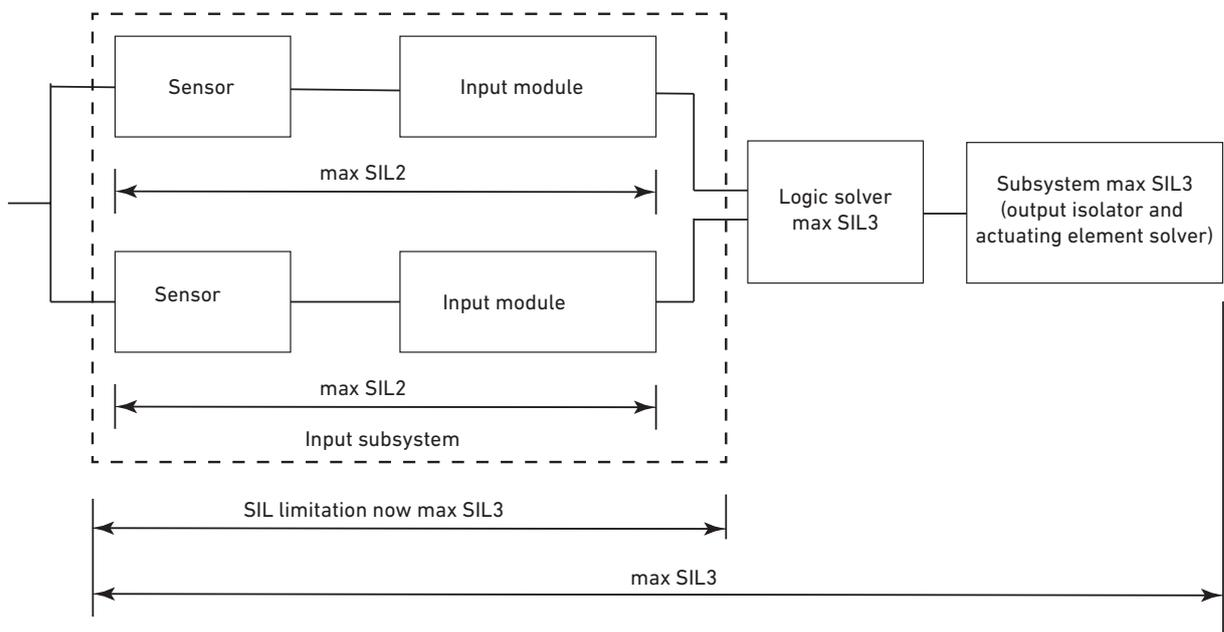


Figure 2: Example configuration for redundant sensor channels

Management requirements

It has been shown that the most important factor in the occurrence of accidents is a commitment from management to safety and the basic safety culture in the industry or individual company. Because of this, the standards IEC 61508 or IEC 61511 describe a life-cycle of the safety related function and its components and require management measures to be implemented.

How is the selected SIL achieved ?

A SIL assessed product presents some parameters that are specific. The SIL limitation created by a product is directly affected by these parameters:

- Hardware fault tolerance
- Safe failure fraction
- Architectural constraints
- Probability of failure on demand
 - PFD (Probability of Failure on Demand)
 - low demand mode
- PFH (Probability of dangerous Failure per Hour)
 - continuous mode
- Maintenance intervals.

All of these parameters have a numerical value which is combined with the corresponding value of the other components of the safety related function and then checked with the values of the target SIL in the relevant standard (IEC 61508 or IEC 61511).

Failure Mode And Effect

The different failures of a subsystem are calculated using Failure Mode, Effects and Diagnostics Analysis (FMEDA). The values of PFD_{avg} and Safe Failure Fraction are calculated and stated in the manufacturer's documentation.

Average Probability of Failure on Demand

The failure rate is the dangerous (detected and undetected) failure rate of a channel in a subsystem. For the PFD calculation in low demand mode (applicable to Apollo products) it is stated as the number of failures per year.

Target failure measure PFD_{avg} is the average probability of failure on demand of a safety function or subsystem. This is also called the average probability of failure on demand. The probability of a failure is time dependant. This means that a maximum SIL of a (sub)system cannot be found unless a test procedure is implemented.

The maximum SIL according to the failure probability requirements is then determined from the table in IEC 61508, Part 1 - the low demand figures. These are applicable to Apollo products and shown in Table 1 below:

Table 1 - Safety Integrity Levels: target failure measures for a safety function operating in the low demand mode of operation	
Safety Integrity Level	Low demand of operation (average probability of failure to perform its design function on demand)
4	$\geq 10^{-5}$ to $< 10^{-4}$
3	$\geq 10^{-4}$ to $< 10^{-3}$
2	$\geq 10^{-3}$ to $< 10^{-2}$
1	$\geq 10^{-2}$ to $< 10^{-1}$

The values in Table 1 are required for the whole safety function, this usually includes different systems or subsystems. The average probability of failure on demand of a safety function is determined by calculating and combining the average probability of failure on demand for all the subsystems, which together provide the safety function.

Safe Failure Fraction

The Safe Failure Fraction (SFF) is used to describe the ratio of all safe failures and dangerous detected failures against the total failure rate.

In accordance with IEC 61508 the SFF is defined as only relevant for the (sub) systems in a complete safety loop. The device under consideration is always part of a safety loop but is not regarded as a complete element or subsystem.

For calculating the SIL of a safety loop it is necessary to evaluate the SFF of elements, subsystems and the complete system, not just a single device.

SFF is divided into four categories as shown in Table 2. All SFF need to be in the same range, e.g. 90% - 99%.

Table 2 - Maximum allowable SIL for a safety function executed by a TYPE B safety related element or subsystem			
SFF	Hardware Fault Tolerance (HFT)		
	0	1	2
<60%	Not allowed	SIL1	SIL2
60% - 90%	SIL1	SIL2	SIL3
90% - 99%	SIL2	SIL3	SIL4
> 99%	SIL3	SIL4	SIL4

Apollo products generally fall into the Type B SFF category, which is defined as follows:

A subsystem shall be regarded as Type B, if for the components required to achieve the safety function:

- *the failure mode of at least one constituent component is not well defined; or*
- *the behaviour of the subsystem under fault conditions cannot be completely determined; or*
- *there is insufficient dependable failure data from field experience to support claims for rates of failure for detected and undetected dangerous failures.*

Simply put, it can be said that as long as programmable or highly integrated electronic components are used, a subsystem must be considered as Type B.

Mean Time to Failure

As a metric, Mean Time to Failure (MTTF) represents how long a product can reasonably be expected to perform in the field based on specific testing. It is important to note, however, that the mean time to failure metrics provided by companies regarding specific products or components may not have been collected by running one unit continuously until failure. Instead, MTTF data is often collected by running many units, even many thousands of units, for a specific number of hours.

Useful lifetime

A constant failure rate is assumed by the MTTF estimation which only applies if the lifetime of components is not exceeded. Once a component has exceeded its life expectancy the MTTF significantly increases over time. A components lifetime is dependant upon the environmental conditions it is subjected to during storage and operation.

According to IEC 61502 - 2 a useful lifetime, based on experience can be assumed. Typically the useful lifetime is approximately 10 years. If suitable, measures recommended by the Manufacturer can often extend useful lifetime.

Using expert knowledge Apollo has shown that the lifetime of an Apollo product can be higher if:

- there are no components with decreased lifetime in the safety path which can produce dangerous undetected failures, and,
- if the ambient temperature is significantly below 60°C.

Introduction

This section of the manual details the Apollo XP95 and Discovery SIL2 approved range of products and their associated technical data and other generic information.

General information

Configuration

The Apollo devices that are covered in this section of the manual are generally supplied pre-configured and only require connection to the loop. Discovery Heat Detectors, for example, have response modes with configured temperature settings that can be manually set according to the application which the detector will be used for, whilst response modes on Optical and Multisensor detectors are used to adjust their sensitivity to smoke.

Loop design

Loop calculations for devices, current and wiring should be done in conjunction with panel partners, as well as taking into consideration other standards or manuals.

With regards to SIL, a wrong installation in this respect might compromise SIL itself as it could prevent the execution of safety functions and depending upon the panel performance could lead to an undetected failure.

Provisions for short-circuit isolation

This should be taken into account for SIL as well as for EN54 and other standards. In respect of SIL, lack of short-circuit isolation within the loop could exponentially increase the beta factor (common cause failures).

Installation

When doing any installation or maintenance work, all aspects affecting the SIL of the loop must be taken into consideration. The safety function must be tested to make sure the predicted outputs are shown.

When a device is required to be replaced it is permissible to leave the loop powered up. However, action must be taken to ensure that the system cannot trigger an alarm as a consequence of a detected fault (device removed) and that the device can safely be removed from the system. Depending upon the Control and Indicating Equipment (CIE) this may mean placing the CIE into maintenance mode, disabling outputs such as sounder circuits or loop-powered sounders, or both, or any other acceptable method. For example:

- advise that maintenance is in progress
- exclude or disable actuation or outputs potentially triggered by a fault condition.
- override or disable any outputs potentially associated with the device.

The replacement device must be commissioned correctly by exercising and testing both its functional and SIL performance as it relates to the safety function.

XP95 and Discovery products

All XP95 and Discovery devices continuously self-monitor during normal operation and any faults are reported to the CIE. The CIE will detect all faults that are not internally sensed. Thus in order to meet the maintenance and proof test requirements the system should be proof tested and inspected in accordance with the CIE manufacturers instructions and the requirements of IEC 61508 - 2 for the required SIL level as well as local legislation and Codes of Practice.

All products have a fault tolerance of 0. All devices are capable of SIL2, provided that the total system is of the same or higher level and all correct installation and operating instructions are followed.

Discovery firmware

The firmware within Discovery devices related to the Functional Safety aspect of the product has no configurable parts. It is fully embedded firmware and cannot be changed, reprogrammed or adjusted in the field. It can only be reprogrammed by returning the entire unit to Apollo.

There is a small amount of configurable memory, however, this can only be accessed via the CIE or a dedicated programming device. This configuration data has NO influence on the functional safety of the device. In the detector it is used to adjust the sensitivity of the device to smoke or heat, or to turn on the flashing polling LED. In sounders it is used to select the alarm tone as dictated by different markets.

Compliance with Clause D2 of IEC 61508 - 3:

D.2.1 – Safety manual for hardware is provided.

D2.2. – For software, the demonstration that the firmware is unchanged (due to embedded nature) and information to the integrator is available. [See Tables 3 to 28.](#)

D2.3 – Element configuration:

- a) Safety manual to document configuration of the software element, the software (firmware) and run-time - [Clause Satisfied.](#)
- b) Recommended configuration documented in safety manual and used in safety application - [See Tables 3 to 28.](#)
- c) All assumptions documented in safety manual - [See Tables 3 to 28.](#)

D2.4 The following may be included:

- a) Competence – minimum required with regards to software tools / etc. – [Not Applicable.](#)
- b) Reliance – systematic capability assumed.
- c) Installation instructions into an integrated system – [See device Tables.](#)
- d) Reason for release – [Not Applicable.](#)
- e) Outstanding Anomalies - [Not Applicable.](#)
- f) Backward Compatibility – [Compatible with systems using Apollo XP95 or Discovery protocols only.](#)
- g) Compatibility with other Systems – [Compatible with systems using](#)

Apollo XP95 or Discovery protocols only that support the device type. CIE that supports, recognizes and properly manages the diagnostic analogue value codes.

- h) Element Configuration – See device Tables.
- i) Change control – Not applicable at Integrator level.
- j) Requirements not met – Not Applicable.
- k) Design Safe State – Not Applicable.
- l) Interface constraints – Not Applicable.
- m) Security Measures against listed threats / vulnerabilities – Not Applicable.
- n) Configurable Elements – See above.

Intended use

When the devices are used in conjunction with a suitable CIE in a SIL application it is the responsibility of the CIE manufacturer and/or the installer to ensure that the entire system operates in compliance with Clause D.2 of IEC 61508 - 3.

The Apollo range of SIL approved products has been independently evaluated and certified to SIL2 with respect to their primary function, i.e. Detectors, Manual Call Points, Audio and Visual Indication etc. under IEC 61508 - Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems.

Apollo XP95 SIL2 approved product range

Product	Part No.	Description	Installation Guide	Datasheet No.
	55100-908	XP95 Manual Call Point with Isolator	39214-750	PP2468
	55100-940SIL	XP95 Intrinsically Safe Manual Call Point	39214-104 39214-411	PP1095, PP2479
	45681-286	Marine Isolating Base	39214-597	PP2479
	55000-440SIL	XP95 I.S. Heat Detector	39214-104	PP1095, PP2479
	55000-540SIL	XP95 I.S. Ionisation Smoke Detector	39214-104	PP1095, PP2479
	55000-640SIL	XP95 I.S. Optical Smoke Detector	39214-104	PP1095, PP2479
	55000-855APO	XP95 Protocol Translator (Single Channel)	-	PP2479
	55000-856APO	XP95 Protocol Translator (Dual Channel)		
	55000-770MAR	Marine DIN Rail Dual Isolator	39214-539	PP2479
	55000-773MAR	Marine DIN Rail Zone Monitor	39214-541	PP2479
	55000-775MAR	Marine Mini Switch Monitor	39214-599	PP2479
	55000-849SIL	SIL Output Unit with Isolator	39214-134	PP2093
	55000-847SIL	SIL Inpit/Output Unit with Isolator	39214-135	PP2092

Apollo Discovery SIL2 approved product range - cont'd

Product	Part No.	Description	Installation Guide	Datasheet No.
	58100-976MAR	Discovery Waterproof Manual Call Point with Isolator (Red)	39214-498	PP2479
	58100-971MAR	Discovery Marine Isolated Manual Call Point	39214-279	PP2194
	58100-908	Discovery SIL Isolated Call Point		PP2052
	58100-951	Waterproof Manual Call Point with Isolator (Red)	39214-475	PP2369
	45681-393SIL	Discovery Sounder Visual Indicator Base with Isolator	39214-434	PP2334
	45681-394MAR		39214-538	PP2479
	58000-400SIL	Discovery Heat Detector	39214-481	PP2052
	58000-400MAR	Discovery Marine Heat Detector		PP2194
	58000-600SIL	Discovery Optical Smoke Detector	39214-481	PP2052
	58000-600MAR	Discovery Marine Optical Smoke Detector		PP2194
	58000-700SIL	Discovery Multisensor Detector	39214-481	PP2052
	58000-700MAR	Discovery Marine Marine Multisensor Detector		PP2194
	58000-500SIL	Discovery Ionisation Smoke Detector	39214-481	PP2194
	58000-500MAR	Discovery Marine Ionisation Smoke Detector		
	55000-721MAR	Marine Negative Isolator	39214-597	PP2479

Table 3 XP95 MCP with Isolator

Device Reference		55100-908SIL		
Function Specification		XP95 MCP with Isolator		
Report Reference		Technis T616 Iss 2.0 & ESC E046_PU002 rev. 2 and E046_CT003 rev 2		
Safety Function		To report to the CIE an alarm condition when its element is activated.		
Software Configuration / Settings		N/A		
Software Version		34000-036 Issue 4		
Hardware Diagram Version		55100-908CD Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a push-button action i.e. Broken Switch / Component failure.	Internally sensed	Analogue Value Code 4
		Failure to provide a valid "Apollo" protocol output frame in response to a push-button action i.e. Communications Failure.	Not internally sensed	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure of Switch/CPU/R40 such that Switch status change CANNOT be detected AND Alarm state cannot be registered.	Not internally sensed	-
		Safe	Broken switch / mechanics generating unwanted Fire condition (Spurious output despite no call).	Internally sensed
Estimated Failure Rate		0.338 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0105 pmh		
Dangerous Detected Failures (λ_{DD})		0.14 pmh		
Safe Failures (λ_S)		92.83%		
Probability of Failure on Demand (PFD)		4.91E ⁻⁰⁵		
Safe Failure Fraction (SFF)		>94%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +70°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-11, EN 54-17, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 98.1g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/axis		
Impact		1.9J ± 0.1J, Hammer velocity 1.5 ± 0.13J, 1 Impact , 2 Positions		
IP Rating		IP21D		
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 4 Marine Isolating Base

Device Reference		45681-286MAR		
Function Specification		Marine Isolating Base		
Report Reference		ESC E046_PU002 rev. 2 and E046_CT009 rev 2		
Safety Function		To convert S/C on the Communication Loop into an O/C - thus recovering from a total system failure.		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		45681-284CD Issue 2		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to detect a short-circuit, and thus fail to remove power.	Not internally sensed	Detection of missing or corrupt communications to CIE will initiate a CIE fault condition.
	Dangerous Undetected	Failure to detect a short-circuit, and thus fail to remove power.	Not internally sensed	
	Safe	Loss of power.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.0816 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0026 pmh		
Dangerous Detected Failures (λ_{DD})		0.079 pmh		
Safe Failures (λ_S)		0.000 pmh		
Probability of Failure on Demand (PFD)		3.46E ⁻⁰⁴		
Safe Failure Fraction (SFF)		96.82%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-17, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 98.1g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/axis		
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹		
IP Rating		IP21D		
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 5 Marine DIN Rail Dual Isolator

Device Reference		55000-770MAR		
Function Specification		Marine DIN Rail Dual Isolator		
Report Reference		ESC E046_PU001 rev.2 and E046_CT008 rev 2		
Safety Function		To convert S/C on the Communication Loop into an O/C - thus recovering from a total system failure.		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		55000-802CD Issue 2		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to detect a short-circuit, and thus fail to remove power	Not internally sensed	Detection of missing or corrupt communications to CIE will initiate a CIE fault condition.
	Dangerous Undetected	Failure to detect a short-circuit, and thus fail to remove power	Not internally sensed	
	Safe	Loss of power.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.0816 pmh		
Dangerous Undetected Failures (λ_{DU})		0.015 pmh		
Dangerous Detected Failures (λ_{DD})		0.16 pmh		
Safe Failures (λ_S)		0.000 pmh		
Probability of Failure on Demand (PFD)		6.99E ⁻⁰⁴		
Safe Failure Fraction (SFF)		91.29%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-17, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 98g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/axis		
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹		
IP Rating		IP20		
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 6 Marine DIN Rail Zone Monitor Unit

Device Reference		55000-773MAR		
Function Specification		Marine DIN Rail Zone Monitor Unit		
Report Reference		ESC E046_PU001 rev.2 and E046_CT008 rev 2		
Safety Function		To control and monitor a zone of conventional detectors and report any alarms from that zone to the CIE.		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		55000-812CD Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to detect alarm condition via Zone Power and Monitoring Circuit.	Internally sensed	Detection of open or short circuit on alarm device zonal wiring, sends analogue (4) fault signal to CIE.
		Failure to report alarm condition to CIE via Comms. ASIC and Addressing.	Not internally sensed	Detection of missing or corrupt communications to CIE will initiate a CIE fault condition.
	Dangerous Undetected	Failure to report alarm condition to CIE via Comms. ASIC and Addressing.	Not internally sensed	
		Failure to report alarm condition to CIE via Comms. ASIC and Addressing.	Not internally sensed	
	Safe	Spurious alarm reported to CIE.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.15 pmh		
Dangerous Undetected Failures (λ_{DU})		0.013 pmh		
Dangerous Detected Failures (λ_{DD})		0.096 pmh		
Safe Failures (λ_S)		0.041 pmh		
Probability of Failure on Demand (PFD)		$6.0E^{-05}$		
Safe Failure Fraction (SFF)		91.6%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-17, EN 54-18, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 98.1g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/axis		
Impact		0.5J ± 0.04J, 3 Impacts per accessible point		
IP Rating		IP20		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 7 Marine Mini Switch Monitor				
Device Reference		55000-775MAR		
Function Specification		Marine Mini Switch Monitor		
Report Reference		ESC E046_PU001 rev. 2 and E046_CT008 rev 2		
Safety Function		To monitor a set of single pole volt free switch contacts and report the switch status to the CIE. This product is used for monitoring alarm devices.		
Software Configuration / Settings		N/A		
Software Version		34000-072 Issue 5		
Hardware Diagram Version		55000-760CD Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to detect alarm condition via Microcontroller (Block 2) / External Resistance Measurement.	Internally sensed	Detection of open or short circuit on alarm device zonal wiring, sends analogue (4) fault signal to CIE.
		Failure to report alarm condition to CIE via Comms.	Not internally sensed	Detection of missing or corrupt communications to CIE will initiate a CIE fault condition.
	Dangerous Undetected	Failure to detect alarm condition via Microcontroller (Block 2) / External Resistance Measurement.	Not internally sensed	
		Failure to report alarm condition to CIE via Comms.	Not internally sensed	
	Safe	Spurious alarm reported to CIE.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.0876 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0026 pmh		
Dangerous Detected Failures (λ_{DD})		0.085 pmh		
Safe Failures (λ_S)		0.0 pmh		
Probability of Failure on Demand (PFD)		1.4E ⁻⁰⁵		
Safe Failure Fraction (SFF)		97%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-17, EN 54-18, BS5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 98.1g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		0.5J ± 0.04J, 3 Impacts per accessible point		
IP Rating		IP20		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 8 XP95 I.S. Heat Detector

Device Reference		55000-440APO			
Function Specification		XP95 I.S. Heat Detector			
Report Reference		Technis T595 Iss 2.0 & ESC E046_PU002 rev. 2 and A191_CT002 - (2.0)			
Safety Function		To detect a fire by sensing heat and report this fire to the CIE. Product is Intrinsically Safe to specified standards.			
Software Configuration / Settings		N/A			
Software Version		N/A			
Hardware Diagram Version		55000-440 Issue 4A			
Hardware Configuration / Settings		N/A			
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e.	Internally sensed	Analogue Value Code <10	
		Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e. Communications Failure.	Not internally sensed	CIE sees loss of or incorrect communications.	
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e.	Not internally sensed		
		Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e. Communications Failure.	Not internally sensed		
	Safe	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e. Communications Failure.	Internally sensed	Analogue Value 64 – unwanted Fire condition.	
Estimated Failure Rate		0.1612 pmh			
Dangerous Undetected Failures (λ DU)		0.0005 pmh			
Dangerous Detected Failures (λ DD)		0.1383 pmh			
Safe Failures (λ S)		0.007 pmh			
Probability of Failure on Demand (PFD)		5.51E ⁻⁰⁶			
Safe Failure Fraction (SFF)		>91%			
Hardware Fault Tolerance (HFT)		0			
Classification (Type A or Type B)		Type B			
Demand (Low Demand or High Demand)		Low demand			
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.			
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice. Also, as determined by the requirements of IEC 60079-0 and IEC 60079-11.			
Average Lifetime of Device		10 Years			
Temperature Range		-20°C / +70°C, -20°C / +45°C (T5), -20°C / +60°C (T4) EN 54-5 Performance - Class A			
		Typical Application Temp °C	Maximum Application Temp °C	Min Static Response Temp °C	Max Static Response Temp °C
		25	50	54	70
Systematic Safety Integrity Level		SIL2			
General Notes and Applicable Regulations		EN 54-5, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice & IEC 60079-0.			
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice & IEC 60079-0.			
Usage Constraints					
RH%		95%			
Shock		Half Sine, 6ms pulse, 98g , 6 directions , 3 pulses/direction			
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/axis			
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹			
IP Rating		IP54			
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH			

Table 9 XP95 I.S. Ionisation Smoke Detector

Device Reference		55000-540APO		
Function Specification		XP95 I.S. Ionisation Smoke Detector		
Report Reference		Technis T595 Iss 2.0 & ESC E046_PU002 rev. 2 and A191_CT002 - (2.0)		
Safety Function		To detect a fire by sensing heat and report this fire to the CIE. Product is Intrinsically Safe to specified standards.		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		55000-540 Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e.	Internally sensed	Analogue Value Code <10
		Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e. Communications Failure	Not internally sensed	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e.	Not internally sensed	
		Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e. Communications Failure.	Not internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value >64 – unwanted Fire condition.
Estimated Failure Rate		0.1598 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0005 pmh		
Dangerous Detected Failures (λ_{DD})		0.1417 pmh		
Safe Failures (λ_S)		0.0005 pmh		
Probability of Failure on Demand (PFD)		5.59E ⁻⁰⁶		
Safe Failure Fraction (SFF)		>91%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice. Also, as determined by the requirements of IEC 60079-0 and IEC 60079-11.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-7, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 108g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹		
IP Rating		IP44		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 10 XP95 I.S. Optical Smoke Detector

Device Reference		55000-640APO		
Function Specification		XP95 I.S. Optical Smoke Detector		
Report Reference		Technis T595 Iss 2.0 & ESC E046_PU002 rev. 2 and A191_CT002 - (2.0)		
Safety Function		To detect a fire by sensing heat and report this fire to the CIE. Product is Intrinsically Safe to specified standards.		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		55000-640 Issue 4		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e.	Internally sensed	Analogue Value Code <10
		Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e.	Not internally sensed	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e. Communications Failure.	Not internally sensed	
		Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition i.e. Communications Failure.	Not internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value >64 – unwanted Fire condition.
Estimated Failure Rate		0.2177 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0023 pmh		
Dangerous Detected Failures (λ_{DD})		0.1810 pmh		
Safe Failures (λ_S)		0.011 pmh		
Probability of Failure on Demand (PFD)		1.4E ⁻⁰⁵		
Safe Failure Fraction (SFF)		>92%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice. Also, as determined by the requirements of IEC 60079-0 and IEC 60079-11.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-7, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice & IEC 60079-0.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 108g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹		
IP Rating		IP44		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 11 XP95 Protocol Translator (Single Channel)

Device Reference		55000-855APO		
Function Specification		XP95 Protocol Translator (Single)		
Report Reference		Technis T663 Iss 1.1 & ESC E046_PU002 rev. 2 and E046_CT007 rev 2		
Safety Function		To convert XP95 communications to the safe levels required in the hazardous areas.		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		55000-855 Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to accurately transpose a valid "Apollo" protocol output to an input, if the attached fire detector goes into alarm then this alarm will not be transmitted to the network.	Not internally sensed	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to accurately transpose a valid "Apollo" protocol output to an input, if the attached fire detector goes into alarm then this alarm will not be transmitted to the network (100% Diagnostic).	Not internally sensed	CIE sees loss of or incorrect communications.
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.0766 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0463 (100% Diagnostic) pmh		
Dangerous Detected Failures (λ_{DD})		0.0463 pmh		
Safe Failures (λ_S)		0.001 pmh		
Probability of Failure on Demand (PFD)		1.4E ⁻⁰⁵		
Safe Failure Fraction (SFF)		>92%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice. Also, as determined by the requirements of IEC 60079-0 and IEC 60079-11.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN54-18, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice & IEC 60079-0.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice & IEC 60079-0.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 98.1g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		0.5J ± 0.04J, 3 Impacts per accessible point		
IP Rating		IP20		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 12 XP95 Protocol Translator (Dual Channel)

Device Reference	55000-856APO			
Function Specification	XP95 Protocol Translator (Dual)			
Report Reference	Technis T663 Iss 1.1 & ESC E046_PU002 rev. 2 and E046_CT007 rev 2			
Safety Function	To convert XP95 communications to the safe levels required in the hazardous areas.			
Software Configuration / Settings	N/A			
Software Version	N/A			
Hardware Diagram Version	55000-855 Issue 3			
Hardware Configuration / Settings	N/A			
Failure Mode(s)	Dangerous Detected	Failure to accurately transpose a valid "Apollo" protocol output to an input, if the attached fire detector goes into alarm then this alarm will not be transmitted to the network.	Not internally sensed	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to accurately transpose a valid "Apollo" protocol output to an input, if the attached fire detector goes into alarm then this alarm will not be transmitted to the network (100% diagnostic).	Not internally sensed	CIE sees loss of or incorrect communications.
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate	0.0766 pmh			
Dangerous Undetected Failures (λ_{DU})	0.0463 (100% Diagnostic) pmh			
Dangerous Detected Failures (λ_{DD})	0.0463 pmh			
Safe Failures (λ_S)	0.001 pmh			
Probability of Failure on Demand (PFD)	1.4E ⁻⁰⁵			
Safe Failure Fraction (SFF)	>92%			
Hardware Fault Tolerance (HFT)	0			
Classification (Type A or Type B)	Type B			
Demand (Low Demand or High Demand)	Low demand			
Proof Testing Procedure	Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.			
Installation	To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice. Also, as determined by the requirements of IEC 60079-0 and IEC 60079-11.			
Average Lifetime of Device	10 Years			
Temperature Range	-20°C / +60°C			
Systematic Safety Integrity Level	SIL2			
General Notes and Applicable Regulations	EN54-18, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice & IEC 60079-0.			
Testing Requirements	Regular Maintenance as defined by BS 5839 or local codes of practice & IEC 60079-0.			
Usage Constraints				
RH%	95%			
Shock	Half Sine, 6ms pulse, 98.1g , 6 directions , 3 pulses/direction			
Vibration	10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis			
Impact	0.5J ± 0.04J, 3 Impacts per accessible point			
IP Rating	IP20			
S0 ²	21days @ 25±5 ppm, 25±2°C, 93±3% RH			

Table 13 Discovery Sounder Visual Indicator Base with Isolator

Device Reference	45681-393SIL			
Function Specification	Discovery Sounder Visual Indicator Base with Isolator			
Report Reference	Technis T618 Iss 3.0 and ESC E046_PU001 rev. 2 and E046_CT004 rev 2			
Safety Function	To Sound / Illuminate in response to a valid protocol transmission from the CIE.			
Software Configuration / Settings	N/A			
Software Version	34000-071			
Hardware Diagram Version	45681-393CD Issue 5			
Hardware Configuration / Settings	Tone and Volume adjustment via magnetic wand			
Failure Mode(s)	Dangerous Detected	Failure to sound or illuminate in response to a valid 'Apollo' protocol output from host system The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the Sounder / Beacon	Analogue Value Code <10
	Dangerous Undetected	Failure to sound or illuminate in response to a valid 'Apollo' protocol output from host system, which cannot be internally sensed, and thus signal cannot be sent to the CIE to warn of the Fault.	Not Internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Not Internally sensed	Unwanted sound or Light output.
Estimated Failure Rate	0.4824 pmh			
Dangerous Undetected Failures (λ_{DU})	0.0114 mph			
Dangerous Detected Failures (λ_{DD})	0.4717 pmh			
Safe Failures (λ_S)	0.001 pmh			
Probability of Failure on Demand (PFD)	1.93E ⁻⁰⁴			
Safe Failure Fraction (SFF)	>95%			
Hardware Fault Tolerance (HFT)	0			
Classification (Type A or Type B)	Type B			
Demand (Low Demand or High Demand)	Low demand			
Proof Testing Procedure	Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.			
Installation	To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.			
Average Lifetime of Device	10 Years			
Temperature Range	-20°C / +60°C			
Systematic Safety Integrity Level	SIL2			
General Notes and Applicable Regulations	EN54-3, EN54-17, BS5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.			
Testing Requirements	Regular Maintenance as defined by BS 5839 or local codes of practice.			
Usage Constraints				
RH%	95%			
Shock	Half Sine, 6ms pulse, 162g , 6 directions , 3 pulses/direction			
Vibration	10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 20 sweep cycle/ axis			
Impact	0.5J ± 0.04J, 3 Impacts per accessible point			
IP Rating	IP21D			
S0 ²	21 days @ 25±5 ppm, 25±2°C, 93±3% RH			

Table 14 Discovery Sounder Visual Indicator Base with Isolator

Device Reference	45681-394MAR			
Function Specification	Discovery Sounder Visual Indicator Base with Isolator			
Report Reference	Technis T618 Iss 3.0 & ESC E046_PU001 rev. 2 and E046_CT004 rev 2			
Safety Function	To Sound / Illuminate in response to a valid protocol transmission from the CIE			
Software Configuration / Settings	N/A			
Software Version	34000-071			
Hardware Diagram Version	45681-393CD Issue 5			
Hardware Configuration / Settings	Tone and Volume adjustment via magnetic wand			
Failure Mode(s)	Dangerous Detected	Failure to sound or illuminate in response to a valid 'Apollo' protocol output from host system The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the Sounder / Beacon	Analogue Value Code <10
	Dangerous Undetected	Failure to sound or illuminate in response to a valid 'Apollo' protocol output from host system, which cannot be internally sensed, and thus signal cannot be sent to the CIE to warn of the Fault.	Not Internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Not Internally sensed	Unwanted sound or Light output.
Estimated Failure Rate	0.4824 pmh			
Dangerous Undetected Failures (λ_{DU})	0.0114 pmh			
Dangerous Detected Failures (λ_{DD})	0.4717 pmh			
Safe Failures (λ_S)	0.001 pmh			
Probability of Failure on Demand (PFD)	1.93E ⁻⁰⁴			
Safe Failure Fraction (SFF)	>95%			
Hardware Fault Tolerance (HFT)	0			
Classification (Type A or Type B)	Type B			
Demand (Low Demand or High Demand)	Low demand			
Proof Testing Procedure	Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.			
Installation	To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.			
Average Lifetime of Device	10 Years			
Temperature Range	-20°C / +60°C			
Systematic Safety Integrity Level	SIL2			
General Notes and Applicable Regulations	EN54-3, EN54-17, BS5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.			
Testing Requirements	Regular Maintenance as defined by BS 5839 or local codes of practice.			
Usage Constraints				
RH%	95%			
Shock	Half Sine, 6ms pulse, 162g , 6 directions , 3 pulses/direction			
Vibration	10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 20 sweep cycle/ axis			
Impact	0.5J ± 0.04J, 3 Impacts per accessible point			
IP Rating	IP21D			
S0 ²	21days @ 25±5 ppm, 25±2°C, 93±3% RH			

Table 15 Discovery Heat Detector

Device Reference		58000-400SIL			
Function Specification		Discovery Heat Detector			
Report Reference		Technis T594 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT001 rev 2			
Safety Function		To detect a fire by sensing heat and report this fire to the CIE.			
Software Configuration / Settings		Sensitivity (adjustment via protocol)			
Software Version		34000-064, 34100-001, 34100-002			
Hardware Diagram Version		58000-400CD			
Hardware Configuration / Settings		N/A			
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the detector	Analogue Value Code <10	
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.	
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed		
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE, which prevents a valid alarm being enunciated.	Not Internally sensed		
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value 64 – unwanted Fire condition.	
Estimated Failure Rate		0.1561 pmh			
Dangerous Undetected Failures (λ .DU)		0.005 pmh			
Dangerous Detected Failures (λ .DD)		0.1441 pmh			
Safe Failures (λ .S)		0.0007 pmh			
Probability of Failure on Demand (PFD)		5.64E ⁻⁰⁶			
Safe Failure Fraction (SFF)		94.90%			
Hardware Fault Tolerance (HFT)		0			
Classification (Type A or Type B)		Type B			
Demand (Low Demand or High Demand)		Low demand			
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.			
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.			
Average Lifetime of Device		10 Years			
Temperature Range		-40°C / +70°C, EN54-5 Performance - Class A2			
		Typical Application Temp °C	Maximum Application Temp °C	Min Static Response Temp °C	Max Static Response Temp °C
		25	50	54	70
Systematic Safety Integrity Level		SIL2			
General Notes and Applicable Regulations		EN54-5, BS5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.			
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.			
Usage Constraints					
RH%		95%			
Shock		Half Sine, 6ms pulse, 97.9g , 6 directions , 3 pulses/direction			
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis			
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹			
IP Rating		IP54			
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH			

Table 16 Discovery Ionisation Smoke Detector

Device Reference	58000-500SIL			
Function Specification	Discovery Ionisation Smoke Detector			
Report Reference	Technis T594 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT001 rev 2			
Safety Function	To detect a fire by sensing smoke and report this fire to the CIE.			
Software Configuration / Settings	Sensitivity (adjustment via protocol)			
Software Version	34000-062, 34100-001, 34100-002			
Hardware Diagram Version	58000-500CD			
Hardware Configuration / Settings	N/A			
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the detector	Analogue Value Code <10
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed	
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE, which prevents a valid alarm being enunciated.	Not Internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value >64 – unwanted Fire condition.
Estimated Failure Rate	0.1643 pmh			
Dangerous Undetected Failures (λ_{DU})	0.0005 pmh			
Dangerous Detected Failures (λ_{DD})	0.1638 pmh			
Safe Failures (λ_S)	0.0005 pmh			
Probability of Failure on Demand (PFD)	$6.08E^{-06}$			
Safe Failure Fraction (SFF)	91.5%			
Hardware Fault Tolerance (HFT)	0			
Classification (Type A or Type B)	Type B			
Demand (Low Demand or High Demand)	Low demand			
Proof Testing Procedure	Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.			
Installation	To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.			
Average Lifetime of Device	10 Years			
Temperature Range	-30°C / +70°C			
Systematic Safety Integrity Level	SIL2			
General Notes and Applicable Regulations	EN54-7, BS5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.			
Testing Requirements	Regular Maintenance as defined by BS 5839 or local codes of practice.			
Usage Constraints				
RH%	95%			
Shock	Half Sine, 6ms pulse, 97.9g , 6 directions , 3 pulses/direction			
Vibration	10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis			
Impact	1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹			
IP Rating	IP44			
S0 ²	21days @ 25±5 ppm, 25±2°C, 93±3% RH			

Table 17 Discovery Optical Smoke Detector

Device Reference		58000-600SIL		
Function Specification		Discovery Optical Smoke Detector		
Report Reference		Technis T594 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT001 rev 2		
Safety Function		To detect a fire by sensing smoke and report this fire to the CIE.		
Software Configuration / Settings		Sensitivity (adjustment via protocol)		
Software Version		34000-062, 34100-001, 34100-002		
Hardware Diagram Version		58000-600CD		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the detector	Analogue Value Code <10
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed	
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE, which prevents a valid alarm being enunciated.	Not internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value >64 – unwanted Fire condition.
Estimated Failure Rate		0.1968 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0005 pmh		
Dangerous Detected Failures (λ_{DD})		0.1897 pmh		
Safe Failures (λ_S)		6600 pmh		
Probability of Failure on Demand (PFD)		6.71E ⁻⁰⁶		
Safe Failure Fraction (SFF)		91.8%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-40°C / +70°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-7, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 97.9g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹		
IP Rating		IP44		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 18 Discovery Multisensor Smoke Detector

Device Reference		58000-700SIL		
Function Specification		Discovery Multisensor Smoke Detector		
Report Reference		Technis T594 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT001 rev 2		
Safety Function		To detect a fire by sensing smoke or heat (or both) and report this fire to the CIE.		
Software Configuration / Settings		Sensitivity (adjustment via protocol)		
Software Version		34000-063, 34100-001, 34100-002		
Hardware Diagram Version		58000-700CD		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the detector	Analogue Value Code <10
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed	
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE, which prevents a valid alarm being enunciated.	Not Internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value >64 – unwanted Fire condition.
		Smoke	Heat	
Estimated Failure Rate		0.1539 pmh	0.208 pmh	
Dangerous Undetected Failures (λ_{DU})		0.0005 pmh	0.0005 pmh	
Dangerous Detected Failures (λ_{DD})		0.1450 pmh	0.2007 pmh	
Safe Failures (λ_S)		0.0084 pmh	0.0068 pmh	
Probability of Failure on Demand (PFD)		$6.96E^{-06}$	$5.62E^{-06}$	
Safe Failure Fraction (SFF)		>91.8%	>94.6%	
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-40°C / +70°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-7, EN 54-5, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 97.9g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹		
IP Rating		IP44		
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 19 Waterproof Manual Call Point with Isolator (Red)

Device Reference		58100-951		
Function Specification		Waterproof Manual Call Point with Isolator (Red)		
Report Reference		Technis T616 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT006 rev 2		
Safety Function		To report to the CIE an alarm condition when its element is activated.		
Software Configuration / Settings		N/A		
Software Version		34000-036 Issue 4		
Hardware Diagram Version		55100-908CD Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a push-button action i.e. Broken Switch / Component failure.	Internally sensed by the MCP	Analogue Value Code 4
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure of Switch/CPU/R40 such that Switch status change CANNOT be detected AND Alarm state cannot be registered.	Not internally sensed	
	Safe	Broken switch / mechanics generating unwanted Fire condition (Spurious output despite no call).	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.338 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0105 pmh		
Dangerous Detected Failures (λ_{DD})		0.14 pmh		
Safe Failures (λ_S)		92.83%		
Probability of Failure on Demand (PFD)		4.91E ⁻⁰⁵		
Safe Failure Fraction (SFF)		>94%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-11, EN 54-17, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 96.4g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, Hammer velocity 1.5 ± 0.13J, 1 Impact , 2 Positions		
IP Rating		IP67		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 20 Discovery SIL Isolated Call Point

Device Reference		58100-908		
Function Specification		Discovery SIL Isolated Call Point		
Report Reference		Technis T616 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT003 rev 2		
Safety Function		To report to the CIE an alarm condition when its element is activated.		
Software Configuration / Settings		N/A		
Software Version		34000-036 Issue 4		
Hardware Diagram Version		55100-908CD Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a push-button action i.e. Broken Switch / Component failure.	Internally sensed by the MCP	Analogue Value Code 4
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure of Switch/CPU/R40 such that Switch status change CANNOT be detected AND Alarm state cannot be registered.	Not internally sensed	
	Safe	Broken switch / mechanics generating unwanted Fire condition (Spurious output despite no call).	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.338 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0105 pmh		
Dangerous Detected Failures (λ_{DD})		0.14 pmh		
Safe Failures (λ_S)		92.83%		
Probability of Failure on Demand (PFD)		4.91E ⁻⁰⁵		
Safe Failure Fraction (SFF)		>94%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-11, EN 54-17, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 96.4g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, Hammer velocity 1.5 ± 0.13J, 1 Impact , 2 Positions		
IP Rating		IP24		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 21 Marine Isolated Call Point

Device Reference		58100-971MAR		
Function Specification		Marine Isolated Call Point		
Report Reference		Technis T616 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT003 rev 2		
Safety Function		To report to the CIE an alarm condition when its element is activated.		
Software Configuration / Settings		N/A		
Software Version		34000-036 Issue 4		
Hardware Diagram Version		55100-908CD Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a push-button action i.e. Broken Switch / Component failure..	Internally sensed by the MCP	Analogue Value Code 4
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure of Switch/CPU/R40 such that Switch status change CANNOT be detected AND Alarm state cannot be registered.	Not internally sensed	
	Safe	Broken switch / mechanics generating unwanted Fire condition (Spurious output despite no call).	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.338 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0105 pmh		
Dangerous Detected Failures (λ_{DD})		0.14 pmh		
Safe Failures (λ_S)		92.83%		
Probability of Failure on Demand (PFD)		4.91E ⁻⁰⁵		
Safe Failure Fraction (SFF)		>94%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-11, EN 54-17, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 96.4g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, Hammer velocity 1.5 ± 0.13J, 1 Impact , 2 Positions		
IP Rating		IP67		
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 22 Waterproof Manual Call Point with Isolator (Red)

Device Reference		58100-976MAR		
Function Specification		Waterproof Manual Call Point with Isolator (Red).		
Report Reference		Technis T616 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT006 rev 2		
Safety Function		To report to the CIE an alarm condition when its element is activated.		
Software Configuration / Settings		N/A		
Software Version		34000-036 Issue 4		
Hardware Diagram Version		55100-908CD Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a push-button action i.e. Broken Switch / Component failure.	Internally sensed by the MCP	Analogue Value Code 4
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure of Switch/CPU/R40 such that Switch status change CANNOT be detected AND Alarm state cannot be registered.	Not internally sensed	
	Safe	Broken switch / mechanics generating unwanted Fire condition (Spurious output despite no call).	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.338 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0105 pmh		
Dangerous Detected Failures (λ_{DD})		0.14 pmh		
Safe Failures (λ_S)		92.83%		
Probability of Failure on Demand (PFD)		4.91E ⁻⁰⁵		
Safe Failure Fraction (SFF)		>94%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable , or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-11, EN 54-17, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 96.4g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, Hammer velocity 1.5 ± 0.13J, 1 Impact , 2 Positions		
IP Rating		IP67		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 23 Marine Negative Isolator				
Device Reference		55000-721MAR		
Function Specification		Marine Negative Isolator		
Report Reference		ESC E046_PU002 rev. 2 and E046_CT009 rev 2		
Safety Function		To convert S/C on the Communication Loop into an O/C - thus recovering from a total system failure.		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		55000-720CD Issue 3		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to detect a short-circuit, and thus fail to remove power	Not internally sensed	Detection of missing or corrupt communications to CIE will initiate a CIE fault condition.
	Dangerous Undetected	Failure to detect a short-circuit, and thus fail to remove power	Not internally sensed	
	Safe	Loss of power.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.0816 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0026 pmh		
Dangerous Detected Failures (λ_{DD})		0.079 pmh		
Safe Failures (λ_S)		0.0 pmh		
Probability of Failure on Demand (PFD)		3.46E ⁻⁰⁴		
Safe Failure Fraction (SFF)		96.82%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable , or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +60°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-17, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 63g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, Hammer velocity 1.5 ± 0.13J, 1 Impact , 2 Positions		
IP Rating		IP21D		
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 24 Discovery Marine Heat Detector

Device Reference		58000-400MAR			
Function Specification		Discovery Marine Heat Detector			
Report Reference		Technis T594 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT001 rev 2			
Safety Function		To detect a fire by sensing heat and report this fire to the CIE.			
Software Configuration / Settings		Sensitivity (adjustment via protocol)			
Software Version		34000-064, 34100-001, 34100-002			
Hardware Diagram Version		58000-400CD			
Hardware Configuration / Settings		N/A			
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the detector	Analogue Value Code <10	
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.	
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed		
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE, which prevents a valid alarm being enunciated.	Not Internally sensed		
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value 64 – unwanted Fire condition.	
Estimated Failure Rate		0.1561 pmh			
Dangerous Undetected Failures (λ .DU)		0.005 pmh			
Dangerous Detected Failures (λ .DD)		0.1441 pmh			
Safe Failures (λ .S)		0.0007 pmh			
Probability of Failure on Demand (PFD)		5.64E ⁻⁰⁶			
Safe Failure Fraction (SFF)		94.90%			
Hardware Fault Tolerance (HFT)		0			
Classification (Type A or Type B)		Type B			
Demand (Low Demand or High Demand)		Low demand			
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.			
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.			
Average Lifetime of Device		10 Years			
Temperature Range		-40°C / +70°C, EN54-5 Performance - Class A2			
		Typical Application Temp °C	Maximum Application Temp °C	Min Static Response Temp °C	Max Static Response Temp °C
		25	50	54	70
Systematic Safety Integrity Level		SIL2			
General Notes and Applicable Regulations		EN54-5, BS5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.			
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.			
Usage Constraints					
RH%		95%			
Shock		Half Sine, 6ms pulse, 97.9g , 6 directions , 3 pulses/direction			
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis			
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹			
IP Rating		IP54			
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH			

Table 25 Discovery Marine Optical Smoke Detector

Device Reference		58000-600MAR		
Function Specification		Discovery Marine Optical Smoke Detector		
Report Reference		Technis T594 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT001 rev 2		
Safety Function		To detect a fire by sensing smoke and report this fire to the CIE.		
Software Configuration / Settings		Sensitivity (adjustment via protocol)		
Software Version		34000-062, 34100-001, 34100-002		
Hardware Diagram Version		58000-600CD		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the detector	Analogue Value Code <10
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed	
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE is detected by the CIE, which prevents a valid alarm being enunciated.	Not Internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
Estimated Failure Rate		0.1968 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0005 pmh		
Dangerous Detected Failures (λ_{DD})		0.1897 pmh		
Safe Failures (λ_S)		0.0066 pmh		
Probability of Failure on Demand (PFD)		6.71E ⁻⁰⁶		
Safe Failure Fraction (SFF)		91.8%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-40°C / +70°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-7, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 97.9g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹		
IP Rating		IP44		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 26 Discovery Marine Multisensor Smoke Detector

Device Reference		58000-700MAR		
Function Specification		Discovery Marine Multisensor Smoke Detector		
Report Reference		Technis T594 Iss 2.0 & ESC E046_PU001 rev. 2 and E046_CT001 rev 2		
Safety Function		To detect a fire by sensing smoke or heat (or both) and report this fire to the CIE.		
Software Configuration / Settings		Sensitivity (adjustment via protocol)		
Software Version		34000-063, 34100-001, 34100-002		
Hardware Diagram Version		58000-700CD		
Hardware Configuration / Settings		58000-700CD		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the detector	Analogue Value Code <10
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed	
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE, which prevents a valid alarm being enunciated.	Not Internally sensed	
	Safe	Spurious code leading to a false "alarm" condition despite the detector not going into alarm.	Internally sensed	Analogue Value 64 – unwanted Fire condition.
		Smoke	Heat	
Estimated Failure Rate		0.1539 pmh	0.208 pmh	
Dangerous Undetected Failures (λ_{DU})		0.0005 pmh	0.0005 pmh	
Dangerous Detected Failures (λ_{DD})		0.1450 pmh	0.2007 pmh	
Safe Failures (λ_S)		0.0084 pmh	0.0068 pmh	
Probability of Failure on Demand (PFD)		$6.96E^{-06}$	$5.62E^{-06}$	
Safe Failure Fraction (SFF)		>91.8%	>94.6%	
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-40°C / +70°C		
Systematic Safety Integrity Level		SIL2		
General Notes and Applicable Regulations		EN 54-7, EN 54-5, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 98.1g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/ axis		
Impact		1.9J ± 0.1J, 1 Impact @ 1.5 ± 0.13m s ⁻¹		
IP Rating		IP44		
S0 ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 27 SIL Output Unit

Device Reference		55000-849SIL		
Function Specification		SIL Output Unit		
Report Reference		Technis Report No T617 Issue 2.0 & ESC A191_CT005 (2.0)		
Safety Function		To activate Relay upon command from CIE		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		55000-848		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the unit.	Analogue Value Code <10
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed	
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE, which prevents a valid alarm being enunciated.	Not Internally sensed	
	Safe	Spurious code leading to a false relay activation despite not being command sent by CIE	Not Internally sensed	Unwanted Relay activation.
Estimated Failure Rate		0.341 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0244 pmh		
Dangerous Detected Failures (λ_{DD})		0.13 pmh		
Safe Failures (λ_S)		1.9 E-2		
Probability of Failure on Demand (PFD)		1.10E-04		
Safe Failure Fraction (SFF)		92.83%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +70°C		
Systematic Safety Integrity Level		SIL2 (Two devices used in a Duplex configuration)		
General Notes and Applicable Regulations		EN 54-17, EN 54-18, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 97.9g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/axis		
Impact		0.5±0.04J, 3 impacts / point		
IP Rating		IP44		
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Table 28 SIL Input/Output Unit

Device Reference		55000-847SIL		
Function Specification		SIL Input/Output Unit		
Report Reference		Technis Report No T617 Issue 2.0 & ESC A191_CT005 (2.0)		
Safety Function		To detect switch state changes on I/P and report this to the CIE., activate Relay upon command from CIE		
Software Configuration / Settings		N/A		
Software Version		N/A		
Hardware Diagram Version		55000-846		
Hardware Configuration / Settings		N/A		
Failure Mode(s)	Dangerous Detected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition. The fault is detected internally and a signal is sent to warn of the fault.	Internally sensed by the unit.	Analogue Value Code <10
		Communications failure, which is detected by the CIE, which prevents a valid alarm being enunciated.	Internally sensed by the CIE panel	CIE sees loss of or incorrect communications.
	Dangerous Undetected	Failure to provide a valid "Apollo" protocol output frame in response to a valid fire condition, which cannot be sensed by the CIE panel.	Not Internally sensed	
		Communications failure, which would prevent an alarm being sent, however the fault is not detected by the CIE, which prevents a valid alarm being enunciated.	Not Internally sensed	
	Safe	Spurious code leading to a false "alarm" condition or relay activation despite the I/P not being triggered or command sent by CIE	Not Internally sensed	Incorrect I/P bit state or unwanted Relay activation.
Estimated Failure Rate		0.341 pmh		
Dangerous Undetected Failures (λ_{DU})		0.0326 pmh		
Dangerous Detected Failures (λ_{DD})		0.12 pmh		
Safe Failures (λ_S)		1.9 E-2		
Probability of Failure on Demand (PFD)		1.46E-04		
Safe Failure Fraction (SFF)		90.44%		
Hardware Fault Tolerance (HFT)		0		
Classification (Type A or Type B)		Type B		
Demand (Low Demand or High Demand)		Low demand		
Proof Testing Procedure		Actuate (simulate the actuation of the device) and check the CIE responds as intended/ designed.		
Installation		To be installed as per manufacturer's instructions, BS 5839-1 where applicable, or according to local legislation and code of practice.		
Average Lifetime of Device		10 Years		
Temperature Range		-20°C / +70°C		
Systematic Safety Integrity Level		SIL2 (Two devices used in a Duplex configuration)		
General Notes and Applicable Regulations		EN 54-17, EN 54-18, BS 5839-1, Regular Maintenance as defined by BS 5839 or local codes of practice.		
Testing Requirements		Regular Maintenance as defined by BS 5839 or local codes of practice.		
Usage Constraints				
RH%		95%		
Shock		Half Sine, 6ms pulse, 97.9g , 6 directions , 3 pulses/direction		
Vibration		10 – 150Hz, 5m s ⁻² Acceleration amplitude, 3 axis, 1 octave/min sweep, 1 sweep cycle/axis		
Impact		0.5±0.04J, 3 impacts / point		
IP Rating		IP44		
SO ²		21days @ 25±5 ppm, 25±2°C, 93±3% RH		

Related Standards and Directives

Related Standards

- ISO 9001: Quality Management System - Requirements.
- ISO 14001: Environmental Management System.
- IEC 60079-0: Explosive Atmospheres - Equipment - General Requirements.
- IEC 60079-11: Explosive Atmospheres - Part 11 - Equipment protection by intrinsic safety "I".
- BS 5839-1: Fire detection and fire alarm systems for buildings - Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises.
- EN 54-3: Fire detection and fire alarm systems - Fire alarm devices - Sounders.
- EN 54-5: Fire detection and fire alarm systems - Point detectors- Heat detectors.
- EN 54-7: Fire detection and fire alarm systems - Point detectors using scattered light, transmitted light or ionisation - Smoke detectors.
- EN 54-11: Fire detection and fire alarm systems - Manual call points.
- EN 54-17: Fire detection and fire alarm systems - Short circuit isolators.
- EN 54-18: Fire detection and fire alarm systems - Input/output devices.

Device specific standards and directives

- IEC 61508-1: Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1 - General requirements.
- IEC 61508-2: Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2 - Electrical/electronic/programmable electronic safety-related systems.
- IEC 61508-3: Functional safety of electrical/electronic/programmable electronic safety-related industry - Part 3 - Software requirements.

System specific standards and directives

- IEC 61511-1: Part 1 - Framework, definitions, system, hardware and applications programming requirements.
- IEC 61511-2: Part 2 - Guidelines in the application of IEC 61511-1.
- IEC 61511-3: Part 3 - Guidance for the determination of the required safety integrity level.

Abbreviations

CIE	Control and Indicating Equipment
°C	Degrees Celsius
EN	European Standard
FMEDA	Failure Mode, Effects and Diagnostics Analysis
g	gram(s)
HFT	Hardware Fault Tolerance
IEC	International Electrotechnical Commission
IP	Ingress Protection
I.S.	Intrinsically Safe
J	Joule
LED	Light Emitting Diode
MCP	Manual Call Point
ms	millisecond
MTTF	Mean Time To Failure
PFD	Probability of Failure on Demand
PFD _{avg}	Average Probability of Failure on Demand
PFH	Probability of Dangerous Failures per Hour
pmh	per million hours
ppm	parts per million
RH	Relative Humidity
SFF	Safe Failure Fraction
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System



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