FLAMEVision

FV400 Series – Triple IR Flame Detectors

Product Application and Design Information Manual

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Contents

1 Introduction

This guide provides detailed information on the Design and Application of the FV400 Series of detectors. It covers all three flameproof variants: FV411f, FV412f and FV413f.

1.1 About this Guide

1.1.1 Who this Guide is For

This guide is aimed at suitably qualified engineers who are experienced in the principles of Fire Detection and Alarm System (FDAS) design.

It is assumed that they have prior knowledge of how to apply flame detectors in hazardous areas and are familiar with the appropriate standards and directives (ATEX, IEC Ex etc).

1.1.2 What this Guide Covers

This guide provides the necessary information to support the design of a fire detection system using the FV400 Series of detectors. This guide includes the technical information and relevant notes to design a FDAS using the FV400 detectors.

1.1.3 What this Guide does not Cover

This guide does not provide general information on the principles of fire alarm and control system design where this is covered by local regulations. These will typically cover cable specifications and detector siting restrictions, and it will be the responsibility of the designer to ensure these are followed.

Reference Document
Refer to the FV400 Series Fixing Instructions guide for information on installation, mounting, wiring, configuration and commissioning of the detectors.

1.2 Overview

The FV400 Series of detectors is a family of advanced, high technology triple IR flame detectors that provide reliable wide area flame detection of burning hydrocarbon fuels. They also offer excellent false alarm immunity.

For some variants of the detector, an in-built CCTV camera can transmit a “detector's eye view” of the protected area to a CCTV monitor. Superimposed onto the CCTV is the video overlay showing alarm and status information.

The FV400 Series of detectors has three flameproof variants as follows:

- FV411f - No camera
- FV412f - PAL camera
- FV413f - NTSC camera

The detectors have the following outputs to connect to the external monitoring equipment:

- 4-20 mA Current Loop
- MX Loop
- Video Output (FV412f and FV413f)
- MODBUS (RS485)
- Fire and Fault Relays
- Conventional Interface

The detectors have heaters to keep the detector windows clear of ice and mist.

The FV400 Series of detectors is highly configurable to provide versatile detectors for all applications. The most common options are set using DIP switches with more advanced options set using the FV Consys.

Reference Document
Refer to the FV400 Series Fixing Instructions guide for information on DIP Switches configuration.

The FV400 Series of detectors also include features designed to reduce maintenance, including remote configuration, internal diagnostic logs and built-in alarm and window cleanliness tests. A portable test tool, suitable for use in hazardous areas is available to operate the alarm and window test facilities remotely.

The detectors are housed in rugged stainless steel housing suitable for external use in harsh environments (See Fig. 1). The housing provides two 20 mm cable gland entries for wiring with terminal blocks for cable termination.

A stainless bracket is available to mount the detector. It provides flexible adjustment (in any direction) to easily position the detector such that the detector’s field of view covers the protected area.

1.3 Typical Features

1.3.1 Detection

- Fast and reliable, high sensitivity flame detection with high false alarm immunity, throughout a wide field of view.
- Operational range 65 m (0.1 m^2 heptane pan fire) on axis with wide field of view - 90° horizontal and 85° vertical field of view. (See Figs. 8 and 9)
- Consistent detection of different sizes of flames from a wide range of hydrocarbon fuels such as wood cellulose, alcohol to aviation fuel (JP4 and JP5).
- Simplifies alarm handling for remote control situations.
- Video output provides immediate visual identification of the alarm location (FV412f and FV413f).
- Excellent false alarm immunity. Proven to be immune to common radiation sources (continuous or modulated) such as halogen lamps, lightning, X-rays, sparks, corona, welding, heaters, etc.
- Unaffected by sunlight, completely solar blind.

1.3.2 Electrical Interfaces

The FV400 Series of detectors provide a range of integral interface options to leverage it's flexibility which are selectable by configuration as follows:

- Fire and Fault relays (NO or NC contacts)
- 4-20 mA (Source or Sink)
- MX Loop
- Conventional Interface
- Video output compatible with twisted pair balanced line (FV412f (PAL) and FV413f (NTSC))
- MODBUS (RS485) interface
- Configuration port (RS485)
- Remote Indicator for fire and fault events
- Remote Self-test and Reset switches

1.3.3 Functions

The FV400 detectors have the following functions:

- Window heater fitted on all variants to reduce window misting.
- Flexible configuration: Primary options on DIP switches such as alarm delay timings, fire/fault latching, etc.
- Advanced options set using the FV Consys such as field network parameters etc.
- Regular self-testing of critical electronic circuits.
- Optical Path Monitoring (OPM) that monitors the detector window cleanliness and hence reduces the frequency of maintenance visits.
- Remote control of delay, range and remote test via the MX Loop. (Options configured in FV Consys)
- Very low quiescent power consumption.
- Ease of installation.
- Connection for remote LED.
- Integral flame simulation for verification of detection and is activated by either using IR remote-control or using the wired Walk-Test input.
- Diagnostic logs: The detector keeps a log of all events, alarms etc. This information can be read remotely using the FV Consys and CTI400 for maintenance purposes.
- Hand-held Walk-Test tool available to initiate alarm and window tests and reset the detector on demand.
- Wired Walk-Test input available to initiate the alarm test.

1.3.4 Mechanical

- Rugged two part stainless steel 316L housing sealed to IP66 for use in harsh environments.
- The back box has two M20 gland entries for cables with terminal blocks for direct field wire termination.
- Optional mounting bracket in 316L stainless steel allows +/-45°horizontally, 0° to -45° vertically.
- Detector ATEX and IECEx certified ('Flameproof').

Fig. 1: FV400 Detector - General View

2 Flame Detection and False Alarm Immunity

2.1 Flame Detection Operation

The FV400 Series of detectors are designed to provide fast, reliable detection of fires from burning hydrocarbon fuels. The detectors analyse radiant energy at three different wavelengths (See Fig. 2). They offer all the advantages of triple IR flame detectors.

The detector uses a well proven, flame detection technique. This is based on monitoring for modulated infra-red radiation in the 4.5 μm waveband corresponding to CO_2 emissions.

2.1.1 Detection Range

The FV400 detector's range can detect on axis a fully developed 0.1 m^2 n-heptane or petrol (gasoline) pan fire at a range of:

- 65 m - Extended range
- 33 m - Normal range
- 15 m - Half range
- <6 m - Close range

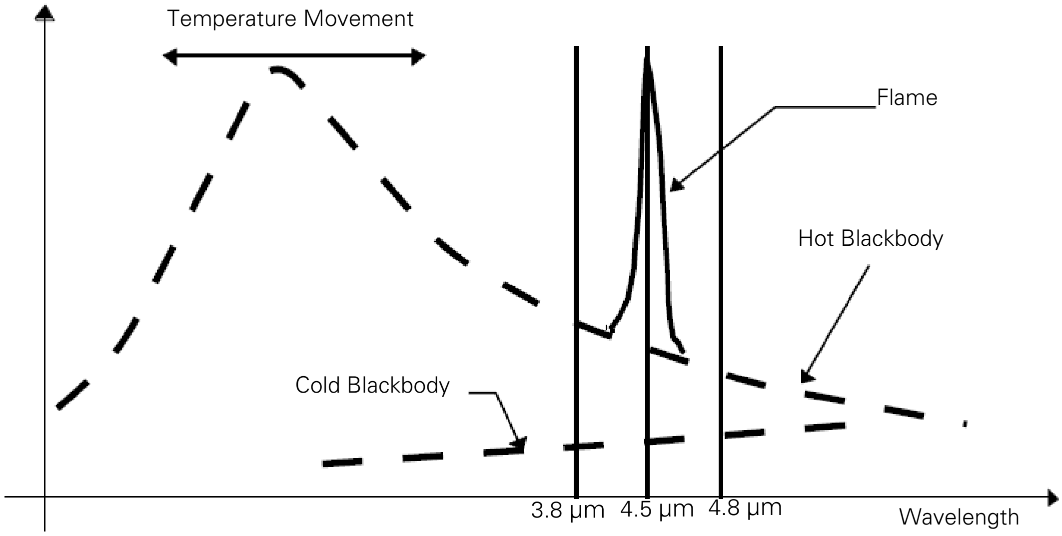

Fig. 2: Radiation from Objects

2.2 False Alarm Immunity

The FV400 detectors implement a well-proven concept for eliminating nuisance alarms from modulated blackbody sources.

The design incorporates a novel optical filter which enables a single electronic infra-red sensor to measure the radiated energy present in two separate wavebands placed on either side of the flame detection waveband, at 3.8 μm and 4.8 μm respectively (see Fig. 2).

The signal from this 'guard' channel is cross-correlated with the signal from the flame detection channel to provide an accurate prediction of the non-flame energy present in the flame detection waveband.

This prediction is independent of the temperature of the radiation source, allowing the FV400 detector to provide blackbody rejection over a wide range of source temperatures.

2.2.1 Detection of flame in the presence of Blackbody Radiation

The alarm threshold varies according to the amount of non-flame radiation received at the time (see Fig. 3). This mechanism minimises the possibility of a false alarm due to the presence of modulated blackbody sources of different temperatures and intensity.

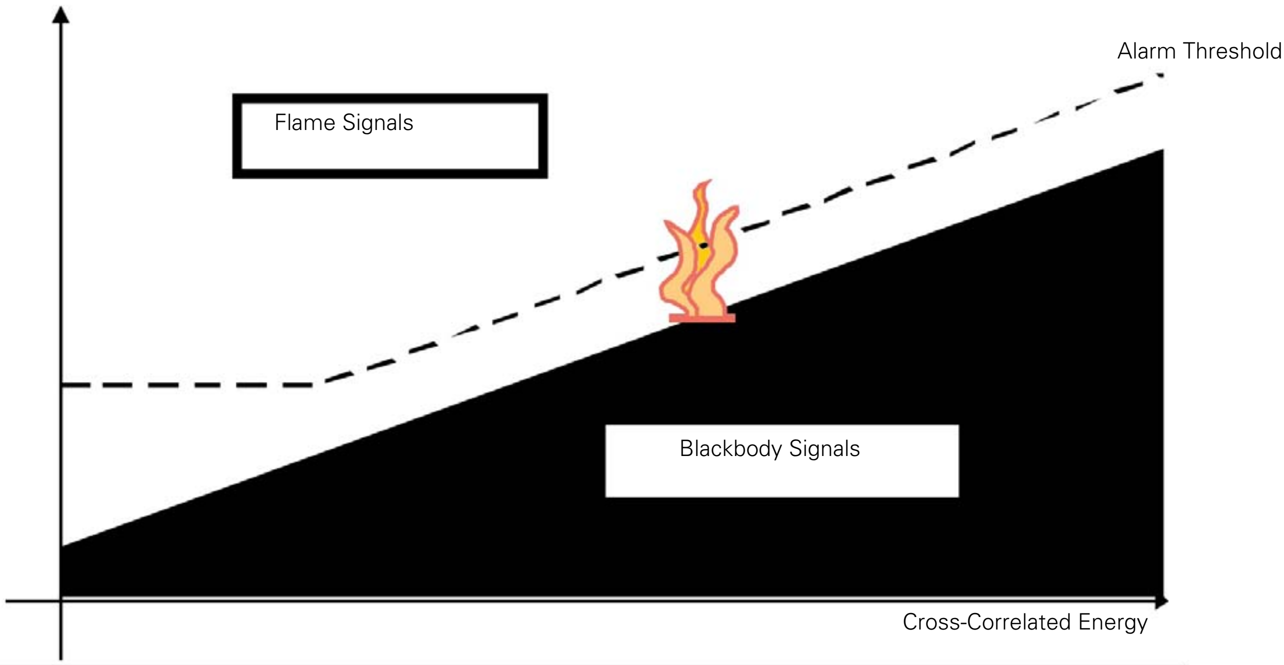

Fig. 3: Signal Processing

2.2.2 Immunity to Solar Radiation

Modulated radiation from direct or reflected sunlight, as well as modulated radiation from strong sources of artificial lighting can produce an unwanted response from triple IR flame detectors. To counter this possibility, the FV400 detectors look for the flame in a very narrow waveband where most of the sun radiation is absorbed by CO_2 gases in the atmosphere.

The sun can heat the optical components of the detector and to prevent secondary re-radiation effects, an additional long wave IR filter is provided on the flame detection channel.

3 Application

3.1 General

The FV400 Series of detectors are intended for the protection of high-risk areas where combustion produces carbon dioxide, such as:

- Flammable liquids, including petroleum products, alcohol and glycol, etc.
- Flammable gases, including methane
- Paper, wood and packing materials
- Coal
- Plastics

These substances ignite readily and burn rapidly, producing flame, often accompanied by large volumes of dense smoke.

Detecting Fires from Non-carbon Materials

The detectors are not designed to respond to flames emanating from fuels which do not contain carbon, for example, hydrogen, ammonia and metals.

Hence, they should not be used for such risks without satisfactory fire testing.

The FV400 detectors, by virtue of their construction and rejection of spurious radiation, are suitable for use indoors and outdoors in a wide range of applications.

3.1.1 Choice of Mounting Position

The mounting position should be chosen so that the field of view of the detector covers the area to be protected. The location must be suitable to mount a detector considering access for servicing and maintenance. The following principles appended to the original system requirements should be followed.

- The detector must be positioned such that a clear line of sight is provided to all parts of the risk area.
- The detectors must be mounted onto a rigid and stable surface to limit the risk of vibration.
- The detector should not be installed where it may be subjected to mechanical or thermal stresses or where it may be attacked by existing or foreseeable aggressive substances.
- Roof trusses, pipework, supporting columns and similar structures in front of the detector can cause significant shadowing and should be avoided.
- If the area immediately below the detector needs to be supervised, then the angle between the detector and the horizontal plane may need to be greater than 45° (see Fig. 9).
- The detector should not be sited in a position where it will be continuously subjected to water drenching.
- In outdoor installations, in areas of high solar radiation, some form of sunshade like the weather hood (See Fig. 13) is recommended to prevent excess heating of the detector.
- The detector should not be sited in a position in which it will be subjected to severe icing.

  Where icing or water condensation can occur, it is recommended that the window heater is enabled.
- The detector must be mounted on a stable structure that is readily and safely accessible for maintenance staff.
- Preferably, the detector should be mounted such that the face is tilted downwards to prevent water collection and lessen the settlement of particle deposits on the window.

Detector Mounting

Avoid mounting detectors:

- In enclosed locations where they will be exposed to concentrated chemical vapours or where the chemical vapour can condense on the detector as it may be severely damaged.

  OR
- Where they are subjected to high levels of vibration.

3.1.2 Use in Hazardous Atmospheres

The FV400 detectors are certified 'Flameproof' to the ATEX and IECEx directives.

They are classified as suitable for Zone 1 and 2 areas over an ambient temperature range of -40°C to +80°C for temperature class T4/T135 gasses and dust or -40°C to +70°C for the FV412f/FV413f. For the FV411f -40°C to +75°C for temperature classification T5/T100°C gases and dust.

CAUTION

Cable glands and stopping plugs must be certified to the required safety standards. Detectors must be earthed to the required safety standards.

4 Functional Characteristics

The electrical, mechanical, environmental characteristics and the performance of the FV400 Series of detectors must be taken into account while designing a system which uses these detectors. The following section provides this information together with guidance on the detector siting.

As standard, the FV400 detector is supplied with the following interfaces (See Fig. 4) to enable it to be connected to a wide range of monitoring equipment to leverage it’s flexibility.

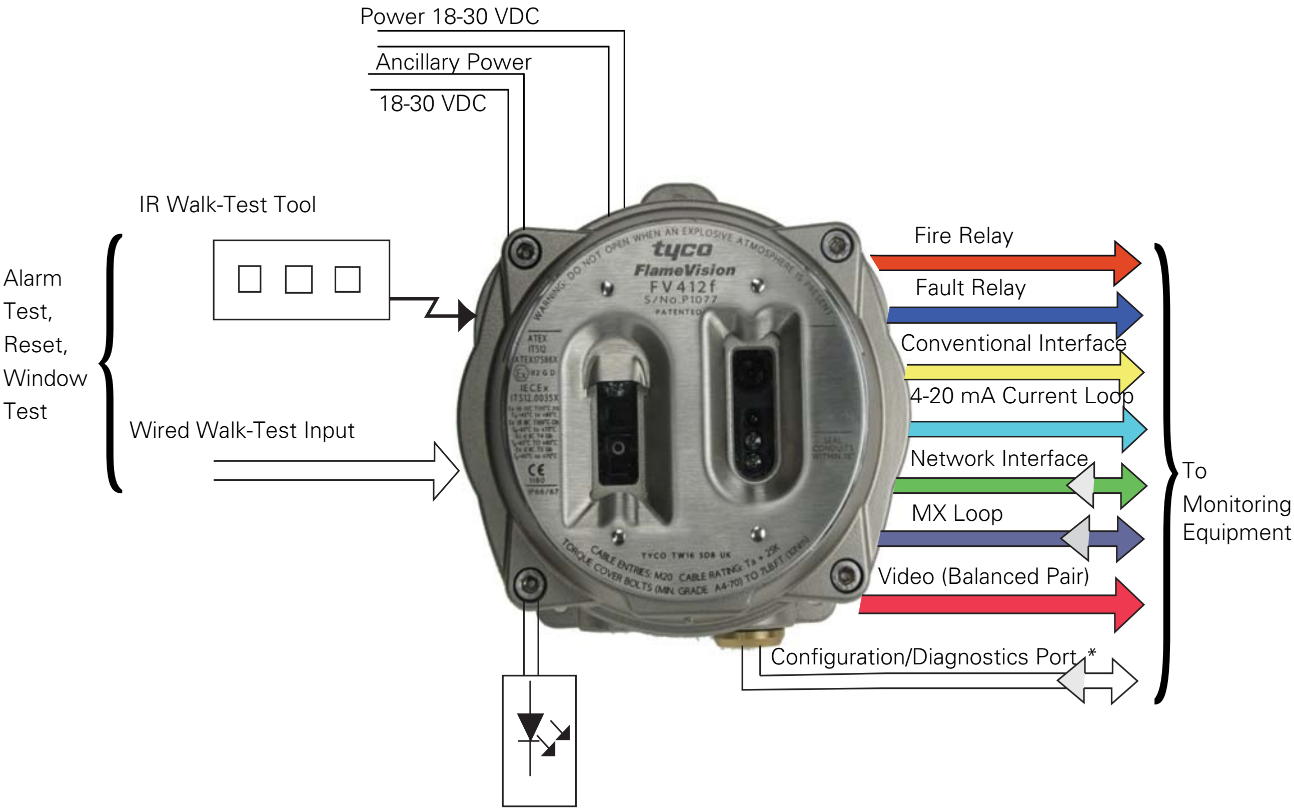

Fig. 4: FV400 Detector - Interfaces
**It is recommended to provide connections for this port to enable remote configuration and diagnostics.*

Interface Configuration

The interfaces are selected by configuration. Table 1 shows the combinations of interfaces that can be used together:

Interface Mode	4-20 mA Current Loop	Relay	MODBUS	MX Loop	Conventional
4 - 20 mA Current Loop and Relay (Default)	✓	✓	✓	×	×
Conventional	×	×	×	×	✓
4-20 mA	✓	×	✓	×	×
MX Loop	×	×	×	✓	×

Table 1: Interface Modes
The interface modes are as selected by DIP switches or FV Consys.*
**For information on DIP Switches Configuration, refer to the FV400 Series Fixing Instructions guide.*

4.1 Electrical Characteristics

Information

The characteristics depend upon the interface mode and the type of options that have been enabled. It is important that the detector is correctly powered for the options selected.

4.1.1 General

The following section lists the Electrical characteristics of the FV400 Series of detectors.

Power Supplies

The FV400 detectors contain two power supply inputs.

- The main power supply that operates the detector and the selected interface can be either a D.C power supply (18 - 30 V), an MX Loop or a Conventional Interface.

  With the main power supply alone, the window cleanliness is tested using a low power IR LED system. A built-in Self-test is performed on the electronics and the pyro sensors.
- An ancillary power supply that operates the window heater, alarm test lamp, RS485 interface and camera/video options.

  With an ancillary power supply connected, the built-in alarm test uses a lamp to test the pyro sensors with IR radiation. These tests are infrequently conducted and take negligible current for the ancillary power supply.

The main and ancillary supplies can be combined if there is a single power supply that can power the entire detector. When the MX Loop or Conventional Interface is used, the ancillary power supply must be a separate D.C supply.

The total power consumption of the detector from both supplies must not exceed the maximum rating to comply with the ATEX/IEC Ex-limits.

Parameter	Value
FV411f - variant without camera	
Maximum Power	7 W
FV412f / FV413f - variants with camera	
Maximum Power	10 W

Table 2: General Electrical Characteristics

4.1.2 Fire and Fault Relay Outputs

The FV400 detectors have two independent volt-free relays to signal fire and fault conditions. These are also available in the 4-20 mA operating mode. The alarm relay coil is monitored for correct operation.

Parameter	Value
Main supply voltage	18 V - 30 V
Quiescent current (Main supply)	8 mA at 24 V
Alarm current (Main supply)	20 mA at 24 V
Ancillary supply voltage	18 V - 30 V
Ancillary current- No camera or video system idle, window heater off	15 mA at 24 V
Ancillary current- Camera active, window heater off	85 mA at 24 V (2 W Typical)
Ancillary current- No camera with video system idle, window heater active	245 mA at 24 V (5.9 W Typical)
Ancillary current- Camera active, window heater active	320 mA at 24 V (7.9 W Typical)
Fault relay	Normally closed or normally open selectable
Alarm relay	Normally closed or normally open selectable
Contact rating	2 A at 30 VDC

Table 3: Relay contact outputs -Electrical Characteristics

4.1.3 4-20 mA Current Loop

The FV400 detectors provide an industry standard 4-20 mA interface. The Header links may be fitted to the terminal PCB to minimise wiring for the selected mode.

The interface can be used in either sink or source modes.

Reference Document

For further information on routing links, refer to the wiring diagrams in the FV400 Series Fixing Instructions guide.

The FV400 detector outputs the appropriate currents to signal normal, fire or fault status. The detector supports several sets of current bands, selected by configuration to provide a flexible interface.

Some states can report a separate window fault and pre-alarm. A setting is available that is compatible with the S241f+ detectors.

With the main power supply alone, the window cleanliness (OPM) is tested using a low power IR LED system. A built-in self-test is performed on the electronics and the pyro sensors.

A separate ancillary power supply must be connected if the window heater and the camera or alarm test lamp are required.

The 4-20 mA Current Loop can be used alone or combined with the relay and MODBUS interfaces.

Parameter	Value
Main supply voltage	18 V - 30 V
Quiescent current (Main supply)	1.5 mA at 24 V
Alarm current (Main supply)	6 mA at 24 V
Maximum current monitor resistor	150 R (Source/Sink)

Table 4: General Electrical Characteristics
See Table 3 for ancillary power supply currents.

4-20 mA Normal Mode

Parameter Status	Value	
	Nominal	Range
General fault	1.5 mA	1.0 to 3.0 mA
Normal	4.5 mA	3.5 to 5.5 mA
Alarm	17 mA	15 to 19 mA

Table 5: 4-20 mA Normal Mode-Electrical Characteristics
This mode is equivalent to S241f+ discrete mode bands.

4-20 mA Enhanced Bands

The 4-20 mA interface supports 3 different sets of current bands which are selected by configuration.

Parameter Status	Value	
	Nominal	Range
General fault	0 mA	0.0 to 0.8 mA
Window dirty	2 mA	1 to 3 mA
Normal	4.5 mA	3.5 to 5.5 mA
Pre-alarm	11.5 mA	10 to 13 mA
Alarm	17 mA	15 to 19 mA

Table 6: 4-20 mA Enhanced Bands-Electrical Characteristics

4-20 mA Variable Mode

Parameter Status	Value	
	Nominal	Range
General fault	0 mA	0.0 to 0.8 mA
Window dirty	2 mA	1 to 3 mA
Normal	4.5 mA	3.5 to 5.5 mA
Flame sensing	5.7 to 17 mA	5.7 to 17 mA
Alarm	17 mA	17 to 20 mA

Table 7: 4-20 mA Variable Electrical Characteristics
This mode is equivalent to S241+ variable mode current bands.
The Alarm LED turns on when the current value is approximately 17 mA.

4.1.4 MX Loop Interface

The FV400 detectors connect to the MX range of addressable fire control panels via the MX Loop interface. The FV400 detectors connect directly to the MX Loop and the main power is provided from the loop.

A separate ancillary power supply must be connected if the window heater and the camera or alarm test lamp are required.

Parameter	Value
Supply voltage	MX Loop
Supply current	Quiescent mode: 1.5 mA Alarm Current: 5.5 mA

Table 8: MX Loop Interface Values
See Table 3 for ancillary power supply currents.

The detector reports the following conditions to the panel:

- Normal
- Fault
- Window Fault
- Pre-Alarm
- Alarm

The detectors must be configured with an address using an MX programming tool. The range and delay options can either be set locally in the detector or remotely from the panel using MX Consys.

The FV400 detectors can be used as direct replacements for the S271f+ detectors without re-configuring the panel.

With the main (loop) power supply alone, the window cleanliness (OPM) is tested using a low power IR LED system. A built-in self-test is performed on the electronics and the pyro sensors.

4.1.5 MODBUS Network Interface

The FV400 detectors connect to the MODBUS protocol via an RS485 connection.

MODBUS Network Interface

The MODBUS interface is available in the 4-20 mA Current Loop modes (See Table 2 for details on power requirements). The ancillary power is required to operate the RS485 interface.

MODBUS Communication Parameters

Parameter	Value
Baud Rate	9,600 or 19,200 selectable
Maximum number of units	32
Protocol	To MODBUS Application Protocol Specification V1.1
Mode	RTU

Table 9: MODBUS Communication parameters Electrical Characteristics

MODBUS Line Termination

The MODBUS network should be terminated at each end of the cable. The resistor value should be chosen to match the impedance of the cable. This is typically 120 R for the twisted pair cables and 100 R for CAT5 cables.

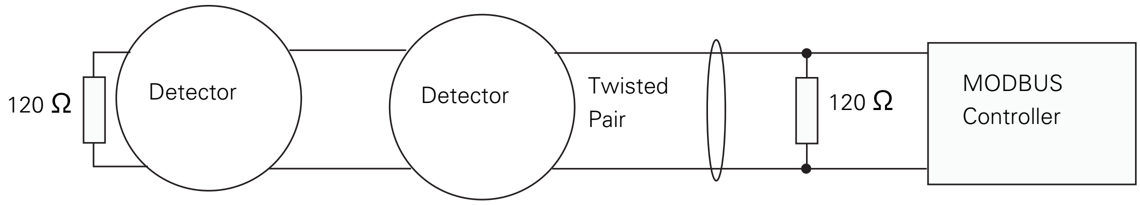

Fig. 5: Line Termination

4.1.6 Conventional Interface

The FV400 detectors have a two wire conventional interface designed to operate on any typical conventional fire detection control equipment providing a regulated 20 VDC current monitoring loop.

The detectors can also be used on a PLC that provides an analogue input to monitor the current through the detector.

In this mode, the detectors are typically powered from a 24V supply via a 330 Ω resistor in series.

Compatibility

The compatibility should be assessed using the information as provided in Table 10. It is recommended that the evaluation tests are carried out prior to siting and installation.

The alarm condition is signalled by a large increase in the detector's current supply. Resetting from the alarm state is achieved by removing the supply voltage for a minimum period of 2 sec.

The FV400 detectors support the fault transmission system used on the S231f+ detectors. The zone EOL resistor should be wired to the EOL terminal of the last FV400 detector on the circuit.

If a fault needs to be reported by any of the detectors, it will be signalled to the end detector and the EOL will be disconnected to report the fault to the panel. The FV400 detectors can be used as substitutes or with a combination of S231f+ devices.

With the main (loop) power supply alone, the window cleanliness (OPM) is tested using a low power IR LED system. A built-in self-test is performed on the electronics and the pyro sensors.

Parameter	Value
Supply Voltage	18 V - 30 V
Quiescent current	750 uA
Alarm current	33 mA from a 24 V supply via a 330 Ω resistor in series

Table 10: Conventional Interface Values

Due to the low operating current in conventional interface mode, the camera, alarm test lamp, WT300, RS485 and Video interfaces are not supported.

The Window Heater may be used by providing a separate ancillary supply.

The window cleanliness (OPM) is tested using a low power IR LED system. A built-in self-test is performed on the electronics and the pyro sensors.

Test Tool
In the conventional interface mode, the detector needs to be tested using T210+ test source.

4.1.7 Window Heater

The FV400 detectors have a heater to warm the sensing window and prevent misting. The heater is enabled on the DIP switches. When enabled, the heater will turn off when the detector temperature rises above +40 °C.

Window Heater
The window heater is supplied from the ancillary power input.

Parameter	Value
Window Heater current (Ancillary power supply)	230 mA at 24 V
Heater current: 5.5 W ÷ Supply Voltage	

Table 11: Window Heater Current

4.1.8 Walk-Test Input

The Walk-Test Input provides a means to activate the alarm test and window test (OPM) functions or to reset the detector. The required operation is selected by connecting the appropriate resistor value (See Fig. 6) between the Walk-Test Input and 0 V using a momentary switch. The switch should be opened once the function has been activated. (See Walk-Test Input Wiring diagram in the FV400 Series Fixing Instructions guide).

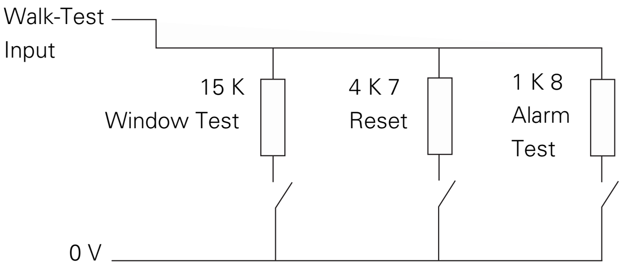

Fig. 6: Walk -Test Input

Walk-Test
Where FV400 detectors are installed in dust risk environments the wired Walk-Test input should be used, as the WT300 Test tool is not approved for such areas.

4.1.9 Remote LED

An external LED indicator can be connected to the detector. The output follows the indications of the alarm LED and provides pulsed indications for fault conditions and a steady-state indication if the detector is in alarm.

The connections are as shown in Fig. 7.

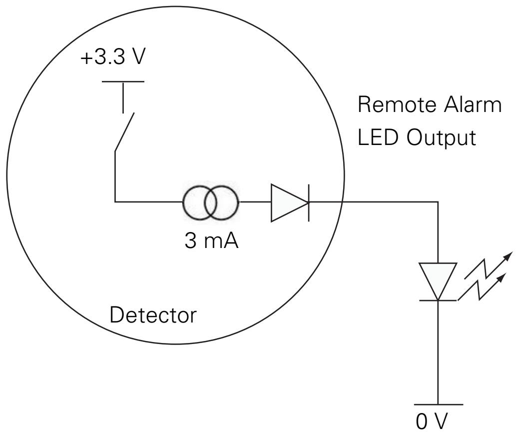

Fig. 7: Remote LED Wiring Diagram
The maximum current available is 3 mA.
The voltage drop across the LED must be < 3 V.

External LED Output
The external LED output should be used for visual indication only. It should not be used for signalling alarms to other equipment.

4.1.10 Video Output

The FV400 detectors provide a video output from the optional internal camera for connection to CCTV systems. It is available in either PAL or NTSC format (FV412f and FV413f). The detector superimposes an overlay with status information on top of the picture to notify alarms and faults.

The video output is a balanced signal suitable to drive twisted pair cable. The cable should be terminated in a balun to provide the connection to the video system.

The video output operates from -30 °C to +70 °C and the video camera from -10 °C to +50 °C. The detector controls the video output to prevent damage if the temperature goes outside the range (see Table 13).

Video Output

Parameter	Value
Output impedance	100 Ω into 100 Ω twisted pair
Receiving end	Active balun NV - 652 W (603.015.027)

Table 12: Video Output Electrical Characteristics
If the RS485 interface option is used, a 24 V supply is required for the active balun and isolated from detector supply.
Balun earth should not be connected.

From (° C)	To (° C)	Text Overlay	Video Camera	Video Output
+70	+80	OFF	OFF	No video signal
+50	+70	ON	OFF	Overlay with blue background
-10	+50	ON	ON	Camera or blue background with overlay
-40	-30	OFF	OFF	No video signal

Table 13: Temperature Range Video Output Characteristics
The detector monitors the internal temperature to decide when to switch the video output mode. The temperatures in shown as above are external temperatures and vary depending on the environmental conditions and if the window heater is enabled.

4.2 Performance Characteristics

4.2.1 General

A large number of fire tests have been carried during the development phase of the FV400 variants of the detector to determine their response limits. The results of these tests are summarised below.

The FV400 detector's range can detect on axis a fully developed 0.1 m^2 n-heptane or petrol (gasoline) pan fire at a range of:

- 65 m - Extended range
- 33 m - Normal range
- 15 m - Half range
- <6 m - Close range

Fire-Test Data

The FV400 Series of detectors have been assessed to BS EN 54 Part 10 : 2002 and classified as a Class 1 flame detector on the extended range and Half range settings. The FV400 detectors are certified as Class 3 on the Half range setting.

Other Liquid Hydrocarbons

Typical ranges achieved with other fuels burning on 0.1m^2 pans, relative to that for n-heptane, are as follows:

Hydrocarbons	Ranges
Alcohol (Ethanol, Meths)	100%: Test performed using meths in a 0.25 m^2 pan.
Petrol	95%
Paraffin, Kerosene, JP4	70%: Test performed using paraffin.
Diesel fuel	52%

Table 14: Liquid Hydrocarbons

Table 14: Liquid Hydrocarbons (cont.)

The detection range is also a function of pan area. Field trials using n-heptane fires indicate that the detection range increases by approximately 20% when the pan area is doubled.

Gas Flames

The FV400 detectors will not detect a hydrogen fire as it does not contain carbon. The FV400 detectors will detect gas fires from inflammable gases containing carbon and hydrogen providing its flame produces flame modulation in the 1 to 15 Hz range. Fires burning a premixed air/gas mixture may be difficult to detect as they may produce little modulation.

Tests show that an FV400 detector set to the extended range will typically detect a 0.8 m high and 0.2 sqm area methane/natural gas flame (venting from an 8 mm diameter gas vent at 0.5Bar (7.5lbs/sq in) as below:

Range	30 m	40 m	50 m
Time to Respond	3 sec	6 sec	15 sec

Table 15: Range vs Time to Respond

Directional Sensitivity

The sensitivity of the FV400 detector is at a maximum on the detector axis. The variation of range with angle of incidence is shown in Figs. 8 and 9 for open air tests using 0.1 m^2 pan fires with the detector operating at Normal range.

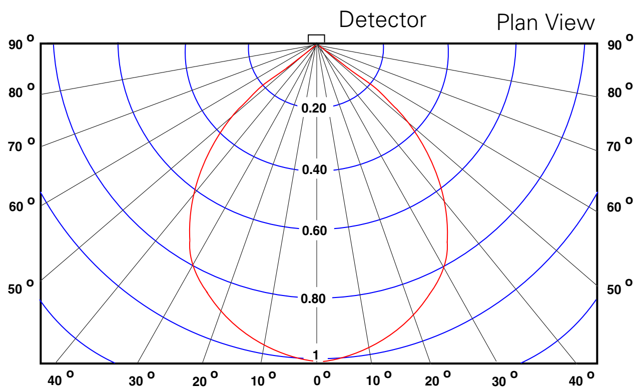

Fig. 8: Pan Fires - Relative Range vs Angle of Incidence. - Horizontal Plane

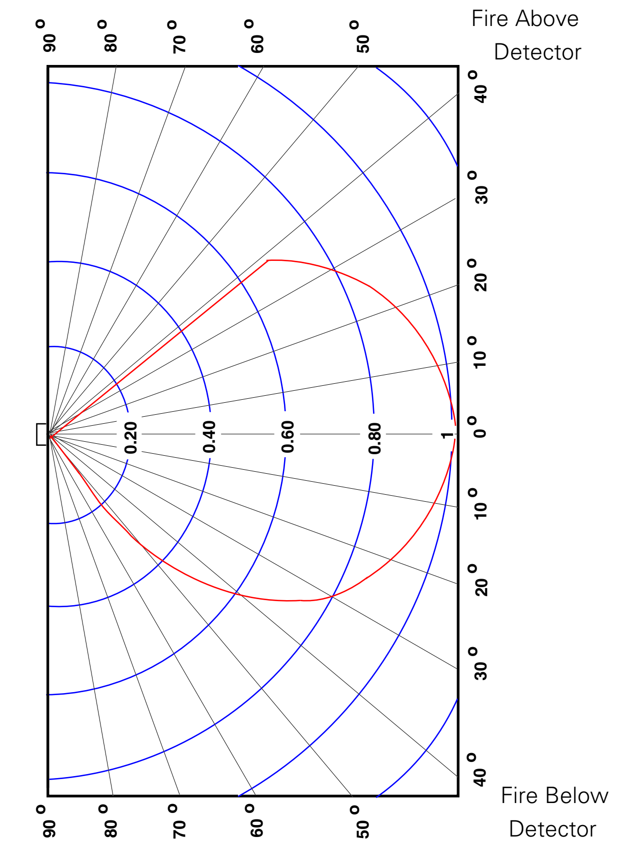

Fig. 9: Relative Range vs Angle of Incidence.- Vertical Plane Note: The field of view looking upwards is restricted to 38° due to the window test reflector.

4.2.2 False Alarm Immunity

The FV400 detectors have been subjected to the following stimuli which might be considered potential sources of false alarms. Unless otherwise specified, tests were performed at a minimum distance between source and detector of 3 m. The detectors were set to maximum sensitivity (Extended range). Steady state sources were modulated at regular and random frequencies in the range 0 - 10Hz.

A sun shade is available for use in tropical climates where intense sunlight may occur it also provides protection from rain falling on the window.

False Alarm Source	Distance (m)
Sunlight	No response
Sunlight with rain	No response
100 W tungsten filament lamp	>3 m
Fluorescent lamp (bank of 4 x 32 W circular lamps)	>3 m
125 W mercury vapour lamp	>3 m
1 KW radiant electric fire element	>3 m
2 KW fan heater	>3 m
Halogen torch	>3 m
Car headlights (60 W halogen)	>3 m
Lighted cigarette	>3 m
Grinding metal	>3 m
Electric arc welding (2.5 mm rod)	>3 m
Photographic quartz lamp (1000 W)	>3 m
Photographic electronic flash unit [a]	>3 m

Table 16: False Alarm Immunity vs Distance

a – Minolta Maxim/ Program Flash 5400HS - operates in both single and multi-flash modes.

4.3 Design of the System

4.3.1 General

Using the information given in the preceding sections, it is possible to design a flame detection system having a predictable performance. Guidelines on the application of the above data and on siting of detectors are given in the following paragraphs.

Determining the number of detectors

It will be clear that the number of detectors required for a particular risk will depend on the area to be monitored and the fire size at which detection is required.

There are as yet no agreed ‘rules’ for the application of flame detectors and the overall system sensitivity must, therefore be agreed between the installer and the end user.

Once decided, the system designer can determine the area covered by each detector using a scaled plot based on Figs. 8 and 9 and the fire test data. This plot is best drawn to the same scale as the site plan so that direct superposition can be used to determine detector coverage.

In carrying out the design, certain factors should be kept in mind:

- Mounting the detectors on the perimeter of the area and pointing into the area will give the best coverage for area rather than spot protection.
- As the FV400 detectors are line of sight detectors any object within the detector's field of view will cause a 'shadow' in the protected area. Even small objects close to the detector can cause large shadows.
- The detectors are passive devices and will not react with one another. They may therefore be positioned with their fields of view overlapping.
- If the FV400 detectors are installed in dust risk environments then the Walk-Test wired input should be used. The WT300 is not approved for dust risk environments.
- The RS485 Configuration port from the FV400 detector is wired back to a central point to support remote configuration and diagnostics.
- The configuration port can be wired as a bus connecting up to 16 detectors.
- The configuration port requires an RS485 to PC interface (RS232 or USB) that can communicate at up to 38,400 baud with direction controlled by the RTS line.

4.4 General Construction

The detector is of robust construction to allow its use in harsh environments.

The detector comprises a two-part stainless steel 'spigot-type' enclosure. Both halves of the enclosure are guided together by an alignment pin. The Top Case of the enclosure contains the detector optical and electronic sub-assemblies. Connectors on the rear of the Top Case mate with headers in the rear section to provide electrical connection to the field wiring.

The rear section of the detector is provided with two M20 gland entry holes at the bottom of the detector. Two 13-way terminal blocks are provided for termination of the field wiring.

The rear section has a dedicated earthing point on the side of the casting (Fig. 11) to connect an earth bonding wire from the nearest safety earthing point to the enclosure. Also, a tagging loop (see item 1 in Fig. 10) is provided on the side of the rear enclosure to attach a suitable label to identify the detector on site.

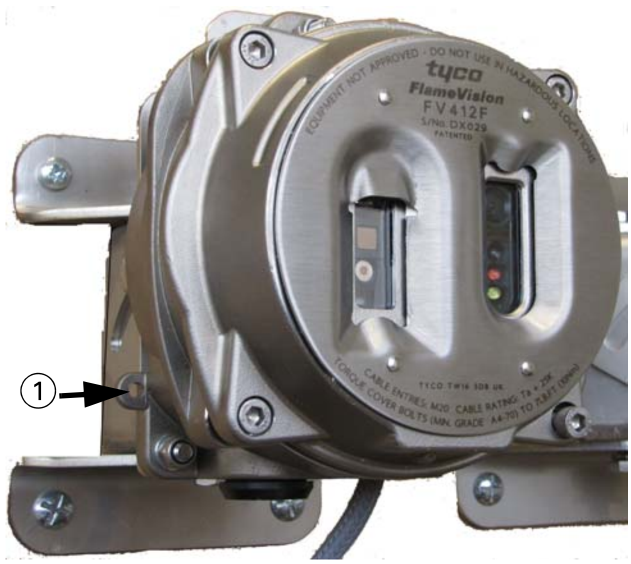

Fig. 10: FV400 Detector - General View
1 – Tagging Loop Connection Point

A lanyard enables the two halves of the enclosure to remain attached when opening the detector during maintenance work.

Fig. 11: FV400 Detector - Earthing Point
1 – Screw
2 – Split Washer
3 – Square Washer

The Top Case of the enclosure is attached to the rear section by four captive bolts. An O-ring seal provided between the front and rear sections ensure protection to IP66.

The Top Case of the enclosure is fitted with a window guard plate to protect the two detector windows. A locally formed section of this plate acts as a mirror for the Optical Path Monitoring test. This plate also contains the mandatory markings required by the Flameproof and Explosion Proof Regulatory standards (ATEX and IECEx).

The detector may be fitted directly to a suitable surface or to an adjustable mounting bracket.

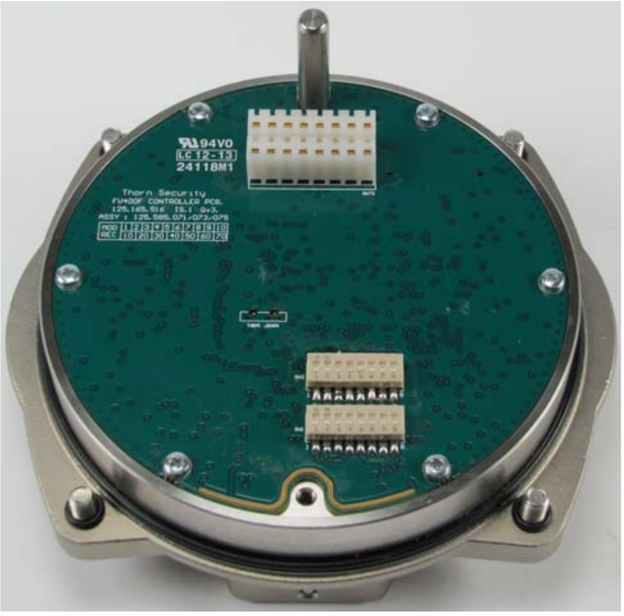

Fig. 12: FV400 Detector - Top Section

An optional weather hood is available for use where protection against extreme environmental conditions such as hot sun or heavy downpour is needed (Fig. 13).

Fig. 13: FV400 Detector With Weather Hood Fitted

Ionisation Radiation

The FV400 detector, like other triple IR detectors, is insensitive to X-rays and gamma radiation as used in non-destructive testing.

The detector will operate normally and will not false alarm when exposed to this type of radiation. However, long-term exposure to high radiation levels may lead to permanent damage.

Corrosion

The use of a sealed stainless steel 316L enclosure allows the FV400 detector to withstand the effects of most corrosive substances and gas. In particular, it meets the requirements for sulphur dioxide (SO_2) conditioning in EN 54-10 and exposure to salt mist concentration as specified in LRS, DNV and GL test specifications for approval of equipment for marine use.

Discolouration of outer surfaces

Over time, the outer surfaces of the detector may discolour and give an appearance of being ‘rusty’.

This discolouration is caused by the oxidation of contaminants collected on the surface of the enclosure, especially areas with a textured finish.

It only affects the surface of the material and does not reduce the thickness or affect the mechanical properties of the enclosure in any way.

4.4.1 Mechanical Characteristics

The mechanical characteristics of the FV400 variants of the detector are:

Dimensions

Parameter	Value
Height	156 mm
Width	155 mm
Depth	99 mm
Weight	3.96 kg
Gland Entries	Standard M20 gland tapped holes (two)
Mounting bracket weight	1.54 kg

Table 17: Dimensions

Materials

Parameter	Value
Enclosure	Stainless steel 316L, ANC4BF-CLC to BS 3146: Part 2
Detection window	Sapphire
Camera window	Toughened glass
Guard/label plate	Stainless steel 316S16 to BS 1449: Part 2
Mounting bracket	Stainless steel 316S16 to BS 1449: Part 2
Screws etc. exposed to the elements	Stainless steel 316 A4
Electronic modules	Fibreglass substrate

Table 18: Materials

IP Rating

Parameter	Value
Enclosure protection	IP66

Table 19: IP Rating Values
Cable gland entries must be suitably sealed to achieve the required IP rating

4.5 Environmental Characteristics

The design and construction of the FV400 variants of the detector are such that they may be used over a wide range of environmental conditions.

4.5.1 Temperature and Humidity

Parameter	Value
FV411f - variant without camera	
Operating temperature range	-40°C to +80°C
Storage temperature range	-40°C to +80°C
FV412f / FV413f - variants with camera	
Operating temperature range with camera on	-10°C to +50°C
Operating temperature range with camera off	-40°C to +80°C
Storage temperature range	-20°C to +70°C
All variants	
Relative Humidity	Up to 99% (non-condensing)

Table 20: Temperature and Humidity

The detector will turn the camera off whilst the temperature falls outside this range; however, the fire detection capability is still present when the video is switched off.

4.5.2 Vibration and Shock

The FV400 detectors have been designed and tested for vibration and shock and comply with the following requirements:

- EN 54-10, European standard for point flame detectors.
- Lloyd's Register of Shipping (LRS) Test Specification Number 1 (2002).
- Germanisher Lloyd, Test Requirements for Electrical / Electronic Equipment and Systems 2012
- Electrical, Electronic Equipment, Computers and Peripherals (April 2001).

4.5.3 Electromagnetic Compatibility

The FV400 Series of detectors comply with the following requirements:

- European Union EMC Directive 2004/108/EC.
- EN 50130-4, the European product family standard for components of fire and security systems.
- EN61000-6-3: Radiated emissions
- VdS 2504 1996-12 (01)
- LRS Test Specification Number 1 (2002)
- DNV Certification Notes No 2.4 (April 2001), Class A
- Germanisher Lloyd, Test Requirements for Electrical / Electronic Equipment and Systems 2012

4.6 Approvals, Compliance with Standards

4.6.1 FlameProof Certification

The flameproof variants of the FV400 Series of detectors are certified to the ATEX and IECEx directives.

The detectors are designed to comply with BS EN60079-0: 2009, IEC 60079-0: 2011, BS EN60079-1:2007, IEC 60079-1:2007, BS EN61241-0:2006, BS EN61241-1:2004, IEC61241-0: 2004, IEC61241-1: 2004

They are certified:

- ATEX code: Ex II 2 G D
- Certificate: ITS12ATEX17586X
- IECEx/Cenelec code for FV411f:
  - Ex d IIC T4 Gb Ta -40°C to +80°C
  - Ex d IIC T5 Gb Ta -40°C to +75°C
  - Ex tb IIIC T135°C Db Ta -40°C to +80°C
  - Ex tb IIIC T100°C Db Ta -40°C to +75°C
- IECEx/Cenelec code for FV412f / FV413f:

- Ex d IIC T4 Gb Ta -40°C to +80°C
- Ex d IIC T5 Gb Ta -40°C to +70°C
- Ex tb IIIC T135°C Db Ta -40°C to +80°C
- Ex tb IIIC T100°C Db Ta -40°C to +70°C

- Certificate:IECExITS12.0035X

These detectors are designed and manufactured to protect against other hazards as defined in paragraph 1.2.7 of Annex I1 of the ATEX directive 94/9/EC.

4.6.2 EN54 Approval

The FV400 variants of the detector have been approved to BS EN 54 Part 10:2002 + A1:2005.

The FV400 Series of detectors is classified as Class 1 on the Extended and Normal range settings. The FV400 detector is certified as Class 3 on the Half range setting. (The close range setting cannot be classified within EN54.)

4.6.3 Construction Products Regulation

The FV400 Series of detectors comply with and are manufactured to the requirements of the Construction Products Regulation. The detectors carry the CE and CPR marks.

CPR Information

CE 0786
Thorn Security Ltd Dunhams Lane Letchworth SG6 1BE UK 13 0786-CPR-21221
EN54-10:2002+A1:2005 FV411f Class 1 IR point flame detector for use in fire detection and alarm systems FV412f Class 1 IR point flame detector for use in fire detection and alarm systems FV413f Class 1 IR point flame detector for use in fire detection and alarm systems
Documentation: FV400 Fixing Instructions: 120.515.124_FV-D-400-F

4.6.4 Marking

All the markings required by the various approval bodies are on the front plate with the exception of:

- The Year of Manufacture/Construction which is stated on a label affixed to the rear of the front case assembly.
- The ‘WEEE’ mark, EN54-10 approval and CPR approval which are on a label affixed internally.

5 Operation

5.1 Flame Detection Operation

The FV400 Series of detectors has a range of integral interface options and various indicators to report alarms and faults.

Their functionality including the operation of the automated OPM and alarm test features are as described below.

5.2 Indicators

The FV400 detectors have a red LED for reporting alarms and a fault LED for reporting faults. Both LEDs are located in the camera window as shown in Fig. 14. The alarm LED turns on to report an alarm. The fault LED flashes to report hardware faults or an OPM 'dirty window' fault.

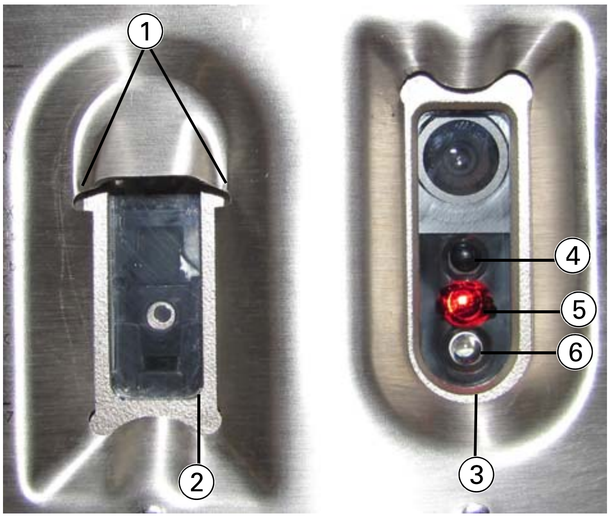

Fig. 14: LED Location
1– Window Test Lamp Under Reflector
2– Sapphire Window
3– Reinforced Glass Window
4– Walk-Test Tool IR Receiver
5– Alarm LED (Red)
6– Fault LED (Yellow)

Fault LED Indicators

The fault LED flashes in different patterns to indicate the detector statuses as follows:

5.2.1 Power Up and Initialization

On power up, the detector performs a complete self-test during which the alarm (red) and fault (yellow) LEDs will flash briefly. If a fault is detected, the fault LED flashes in periodic intervals (see Fig. 15).

Additionally, the remote indicator (if fitted) flashes briefly on power up and shows the same fault indication as appears on the fault LED.

Conventional Interface

In the Conventional Interface mode, the LEDs do not flash during power up to minimise power consumption.

5.2.2 Alarm and Pre-Alarm Indication

The alarm (red) LED illuminates when the detector is in alarm. It remains in the illuminated state until the reason for the alarm has cleared (non-latching mode) when it will turn off. In latching mode, the detector will need to be reset to clear the alarm.

The alarm (red) LED remains off when the detector enters the pre-alarm state.

5.2.3 Alarm Signalling

The FV400 detector has a number of external interfaces. An alarm condition is signalled on all of these interfaces as follows:

Indicator	Description
Conventional Interface	Increase in current drawn from supply,
4-20 mA Current Loop	Current drawn on the loop will be 17.0 mA.
Relay Interface	Alarm relay will close.
MX Loop	Returned values will be 190 bits.
MODBUS	A status register is available so that a MODBUS controller can request the alarm and fault status from the detector. The detector also supports commands to perform OPM and alarm tests, reset latched alarms and faults.
Video	A flashing alarm message will be super-imposed on the middle of the CCTV image.

Table 21: Alarm Signal Indicators

Each interface will remain activated until the reason for the alarm has cleared (non-latching mode) when it will turn off. In latching mode the detector will need to be reset, see below.

5.2.4 Pre-Alarm Signalling

The detector enters a pre-alarm state when it detects a source within the field of view that has not yet reached the alarm threshold. The source may be worthy of investigation.

A pre-alarm condition is signalled on some interfaces as follows:

Indicator	Description
Alarm Relay	No change, the alarm relay will remain open.
4-20 mA Current Loop	The current (source or sink) becomes 11.5 mA.
MX Loop	Returned value of 153 bits.
MODBUS	The pre-alarm bit is set in the status register and is available at the next read of the unit.
Video	No change.

Table 22: Pre-Alarm Signal Indicators

The pre-alarm condition will escalate into a full alarm if the source is determined to be a fire or it will clear if the source is removed.

5.2.5 Fault and OPM Indication

The fault (yellow) LED will flash, when a hardware fault has been detected. It will continue flashing until the reason for the fault has cleared (non-latching mode). In the latching mode, the detector will need to be reset.

If the regular OPM test determines that the window is dirty, then the fault (yellow) LED will flash. If the window is found to be completely obscured, it is classified as a hardware fault and the fault LED will flash using the fault pattern. The diagrammatic representation of the fault LED pulsing patterns are as shown in Fig. 15.

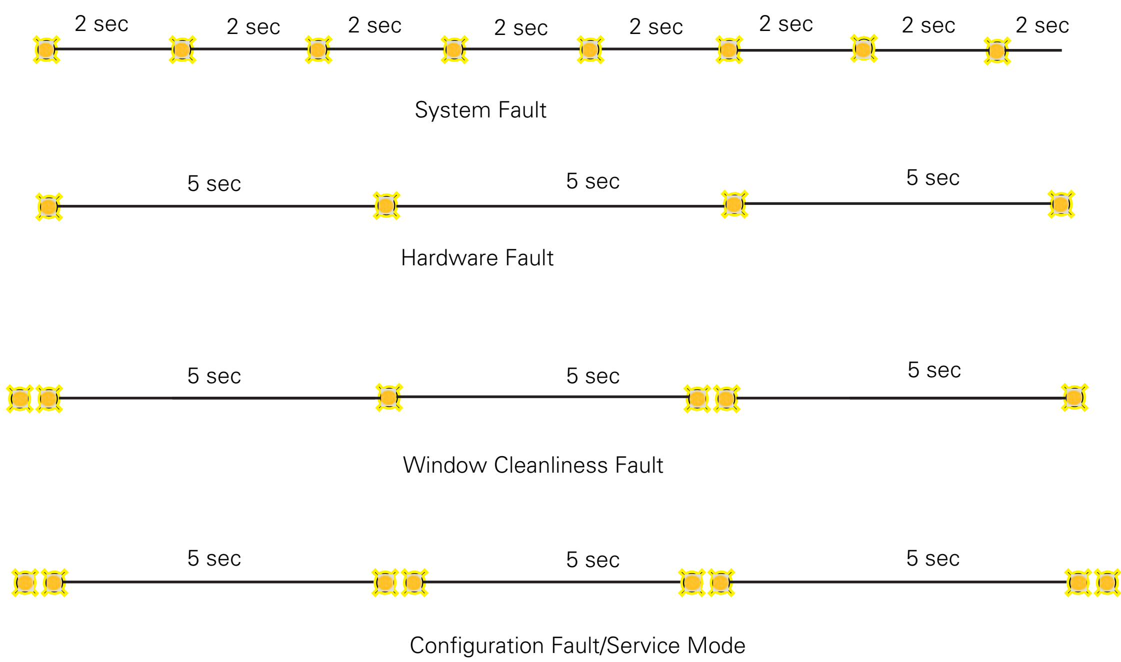

Fig. 15: Fault LED Pulsing Patterns

5.2.6 Configuration Fault Indication

A configuration fault will be reported if:

- An error is detected in the configuration downloaded from the FV Consys.
- The window heater is enabled and the ancillary supply is disabled.

5.2.7 Service Mode Indication

When the RS485 port is connected to a PC, the detector can be placed in Service Mode for configuration or diagnostics. When it is in this mode, the alarm (red) LED and the fault (yellow) LED will flash together once every 5 sec.

Service Mode
In Service Mode the detector is disabled and will not detect a fire.

5.2.8 Fault and OPM Signalling

The FV400 detector has a number of external interfaces. A fault condition is signalled on these interfaces as follows:

Indicator	Description
Fault Relay	The fault relay will open. (Hardware, window and OPM faults)
4-20 mA Current Loop	The current (source or sink) become 0 mA for hardware and window faults or 2 mA for OPM faults.
MX Loop	The returned value becomes less than or equal to 10 for hardware faults and between 11 and 51 for window dirty (OPM) faults.
MODBUS	The appropriate fault bit will be set in the status register and is available at the next read of the unit. Hardware faults, window obscured and window dirty are identified separately.
Video	A fault banner will be super-imposed on the CCTV image with an information field to specify the fault type.

Table 23: Fault and OPM Signal Indicators

Modes
Each output will remain activated until the reason for the fault has cleared (non-latching mode) when it will return to normal status. In latching mode the detector will also need to be reset.

5.2.9 Alarm Confirmation (Delay to Alarm)

The FV400 detector continuously processes the sensor signal to identify a potential alarm event. If an event is detected, the FV400 confirms it as an alarm by checking that the event is still present over a longer period.

The FV400 provides three confirmation windows which are configurable via the DIP switches. In each confirmation window, the alarm condition is checked every second and if the event is present for the required duration, an alarm is reported on all the active interfaces. This introduces a delay to alarm reporting.

The available windows are:

- 3 sec in a 5 sec window
- 6 sec in an 8 sec window
- 12 sec in a 14 sec window.

For example, an alarm is reported in the first window where an event occurs for 3 sec within any 5 sec window. The minimum response time to a fire is 3 sec.

Note
In the continuous 4-20 mA variable mode, there is no alarm confirmation, as the output is directly generated from the pyro sensor outputs. Appropriate alarm confirmation should be provided in the host system.

Reference Document
For additional information on DIP Switches and Delay Settings, refer to the FV400 Series Fixing Instructions guide.

The selected confirmation window also defines the alarm clearing time in non-latching mode. An alarm is cleared after a number of reports which show that no alarm is present. The default setting requires that 10 reports (10 sec) are required. Thus, a detector remains in alarm for at least 10 sec.

5.2.10 Resetting Alarm and Fault Conditions

In the latching mode, alarms and faults, will continue to be indicated and signalled, even if the event that caused the alarm generation has been cleared. The detector can be reset by activating the wired input, using the MODBUS network or remotely using the Walk-Test trigger tool.

During the reset, the indicators and outputs will be turned off but if the alarm or fault is still present the condition will be re-established. The detector will perform re-tests if necessary, such as an OPM test, to determine if faults have cleared.

The detector may be reset by reducing the supply and voltage to less than 2 V for greater than 2 sec.

Self-Monitoring

The FV400 detector continuously monitors the hardware for correct functionality. If any unexpected conditions are detected, then a fault will be reported and logged.

Window Cleanliness Test/Optical Path Monitoring (OPM)

The FV400 detector can check the cleanliness of the window used by the pyro sensors. The detector briefly flashes an IR LED which shines onto a mirror that reflects the energy back through the window onto an IR receiver. The detector analyses the reflected signal to assess if the window is dirty.

The OPM test can be initiated manually using the Walk-Test trigger tool, the Walk-Test wired input or from the field network interface. When the OPM test is activated manually, a single test is performed and the result reported on the indicators and outputs. If the window is considered to be dirty or obscured then an OPM fault is reported. The fault will be cleared when the window is cleaned and the test re-run to give a clean result. Requests for a manual OPM test will be ignored if the detector is in alarm, pre-alarm or performing an alarm test.

Alternatively, the detector can be configured to perform the OPM test automatically at regular intervals by setting a DIP switch (OPM Man/Auto). The default is automatic OPM testing. The time interval can be adjusted using the PC configuration tool. The default OPM test interval is every 20 minutes. The first OPM test will be made 20 minutes (or the configured time) after power-up. The regular OPM test will be delayed if the detector is in alarm, pre-alarm or performing an alarm test. A manual OPM test can be initiated at any time when the detector is in automatic OPM mode and will produce an immediate test result reported on the indicators and outputs as described above.

If the automatic OPM test detects the dirty condition (5-50%) for 20 successive tests then an OPM fault is reported. If the window is considered to be obscured (<5%) then the OPM test interval reduces to 5 minutes and if the window remains obscured for 5 further tests then an OPM fault is reported. The obscured condition is thus detected and reported much faster. Either fault will be cleared when the window is cleaned and the test re-run to give a clean result. The test can be activated manually after cleaning rather than waiting for the next timed automatic test.

Alarm Test (Walk-Test)

WARNING

The Detector outputs will be activated during a Walk-Test. Disconnect all extinguishing systems or external devices that should not be activated during a test.

The FV400 detector has a built in alarm test facility. A lamp is flashed in a pattern to simulate a flame. The IR output from the lamps reflects off the mirror and onto the pyro sensors.

The lamp signal is then processed and compared with the signal levels from an external source that produces an alarm.

The alarm self-test may also be initiated from the wired Walk-Test input, the remote IR Walk-Test tool unit or the field network interface.

This result is then reported as an alarm on the LED and signalled on all the external interfaces. Thus, the ability of the detector to detect a fire is tested.

Video Display

The FV400 detector can overlay alarm and fault information onto the camera picture (CCTV output). The overlay is normally enabled but can be disabled by configuration (if no camera is fitted then the video interface is not fitted either).

If an alarm is detected, an alarm message is superimposed over the camera image.

Faults are individually identified on the display as shown in Fig. 21.

6 Maintenance

6.1 General

The FV400 Series of detectors contain no replaceable or adjustable components within the housing, which should not be opened once installed and commissioned.

Routine maintenance is, therefore, limited to cleaning and testing the detectors.

6.1.1 Routine Inspection

At regular intervals of not more than 3 months, the detectors should be visually inspected to confirm that no physical damage has occurred and that the alignment of the detectors has not been disturbed. The detector windows should be checked to confirm that they are not blocked and that no physical obstructions have been placed between the detector and the protected area.

Any excessive deposits of dirt, oil etc. should be removed from the detector housing.

In addition, at intervals of not more than 1 year, an alarm test should be performed to confirm correct operation.

Inspection Frequency

The inspection frequency specified above should be considered as a minimum requirement to be applied in the average environment. The inspection frequency should be increased for dirtier environments or those which present a higher risk of physical damage.

For flameproof detectors, the following periodic checks must be made:

- The O-ring on the body of the detector should be inspected for damage, wear and tear, corrosion and replaced if necessary to ensure that the detector is properly sealed.
- As required by EN60079-17 Electrical installations, inspection and maintenance: In dust environments the O-ring must be inspected every 3 years and replaced if worn. The O-ring should be replaced on or before the third inspection.
- Spigot joints should be separated and the faces examined for possible defects resulting from corrosion, erosion or other causes.
- Check that all stopping plugs and bolts are in position and tight.
- No attempt should be made to replace or repair windows except by replacement of the complete assembly.

Detector Cleaning

The detectors have a window cleanliness test facility. The window test can either operate automatically at regular intervals or it can be activated at any time manually by using the Walk-Test Tool, the Walk-Test Input or by initiating a network command.

The detector reports a window fault if the test determines that the windows are dirty. After cleaning, reset the detector to re-run the test and the fault will clear. If the window is blocked, a fault will be indicated which can be cleared by cleaning the window and resetting the detector to re-run the test.

6.1.2 Fault Finding

If the detector reports a fault, then the indicators along with the 4-20 mA, video or network interfaces can be used to diagnose the cause. For further details, refer to sections 5 “Operation” and “Appendix-B” for information on video overlay messages.

The most likely fault is a dirty or blocked window. To clear the fault, clean the window and manually activate the window test using the Walk-Test Input or the Walk-Test Tool. When the window test has finished the fault should be cleared.

The configuration faults can be rectified on- site by correcting the DIP switch settings on the detector or updating the downloaded configuration.

However, system and hardware faults cannot be rectified on site, so the detector needs to be replaced.

6.1.3 Walk-Test and Window Test (OPM)

Refer to “Window Cleanliness Test/Optical Path Monitoring (OPM)” and “Alarm Test (Walk-Test)” on page 24) for information on performing the respective tests.

6.1.4 WT300 Walk-Test Tool

The WT300 Walk-Test is a portable, hand-held and battery powered tool that can be used in hazardous areas to activate the alarm test, window test and reset the FV400 detectors. The WT300 is a remote control; it is not a test torch.

It uses IR signals to communicate with the detector to activate commands and has a range of 6 m. This means that the Walk-Test Tool can activate tests on the FV400 detectors from the ground without needing poles or any other means to reach the detector.

6.2 Ordering Information

Components	**Ordering Numbers**
FV411f - without camera	516.300.411
FV412f - with PAL camera	516.300.412
FV413f - with NTSC camera	516.300.413
FLAMEVision MB300 Mounting Bracket	517.300.001
FLAMEVision WH300 Weather Hood	517.300.002
FLAMEVision MK300 Field Spares Kit	517.300.006
FLAMEVisionWT300 Walk-Test Controller	517.300.021
FLAMEVision CTI400 Configuration Tool Kit	517.300.024
NV – 652W Active video balun	603.015.027
ADAM4520 RS485/RS422 to RS232 Converter	557.180.151

Table 24: Ordering Information

7 Appendix-A

7.1 MODBUS Interface

7.1.1 Introduction

The FV400 Series of detectors can connect to a MODBUS network as a slave device conforming to V1.1 protocol specification. The detector provides a bank of 16 bit registers to provide comprehensive information on the status of the detector.

A status register is available so that a MODBUS controller can request the alarm and fault status from the detector. Full location information is available for an alarm. The detector also supports commands to perform OPM and alarm tests, reset latched alarms and faults and to control masking.

7.1.2 References

MODBUS Application Protocol Specification V1.1can be downloaded from www.MODBUS.org.

MODBUS over serial line specification and implementation guide V1.0 can be downloaded from www.MODBUS.org.

7.1.3 Electrical Interface

The FV400 detector's MODBUS interface operates on a 2-Wire serial bus in accordance with EIA/TIA-485 standard.

Installation

The MODBUS serial bus must be fitted with termination resistors at each end. See section 4.1.5 "MODBUS Network Interface" for additional details. While installing on an existing bus check that the correct resistors have been fitted.

7.1.4 MODBUS Serial Line Parameters

The FV400 detectors meet the Basic Implementation Class for a Slave device. These options are summarised in Table 25.

Parameters	Basic	Default Value	FV400 Configurations
Node Addressing	Configurable Address from 1 to 247		1 to 247
Register Address Offset			0 to 0xFFFF
Broadcast	Accept broadcast, (target address 0)		Yes (non-configurable)
Baud Rate	9600 (19200 recommended)	19200	19200, 9600
Parity	EVEN	EVEN	EVEN, ODD, NONE
Mode	RTU	RTU	RTU Only
Electrical Interface	RS-485 2W-cabling	RS-485 2W-cabling	
Connector Type	Screw Terminal		

Table 25: MODBUS Serial Line Parameters

The MODBUS parameters are configured on the Network tab of the FV Consys configuration tool.

When MODBUS is enabled or disabled or if the network parameters are changed, then the detector should be powered down and up or restarted from the configuration tool to activate the new settings.

The MODBUS protocol starts running 30 sec after powering up the detector.

7.1.5 Supported MODBUS Function Codes

The FV400 detectors support the following MODBUS Function Codes:

Code	Function
03	Read Holding Registers
04	Read Input Registers
06	Write Single Registers
16	Write Multiple Registers

Table 26: Supported MODBUS Function Codes

7.1.6 Registers

The FV400 detector has one block of 16 bit registers used for MODBUS access organised as follows:

Offset	Register	Data	Read/Write (R/W)
00	Commands	See 7.1.6	R/W
01	Reserved		
02	Reserved		
03	Reserved		
04	Reserved		
05	Reserved		
06	Reserved		
07	Reserved		
08	Overall Status	See 7.1.7	R
09	4-20 mA Current Loop	4-20mA level x 1000 for example, Alarm=17mA,Value=17000	R

Table 27: FV400 Detector Registers

The base address for the register block is set in the PC configuration tool. The default is 00.

7.1.7 Detector Command Register

The command register allows the PLC to activate functions within the detector.

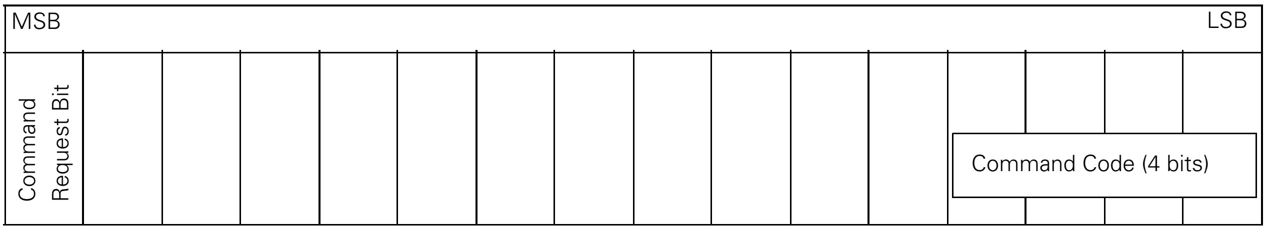

Fig. 16: FV400 Detectors - Command Register

Command Codes:

- Initiate alarm test
- Initiate manual OPM test
- Reset latched alarm or faults

7.1.8 Detector Overall Status Register

The FV400 detector's status register is a collection of flags that report the current state of the detector.

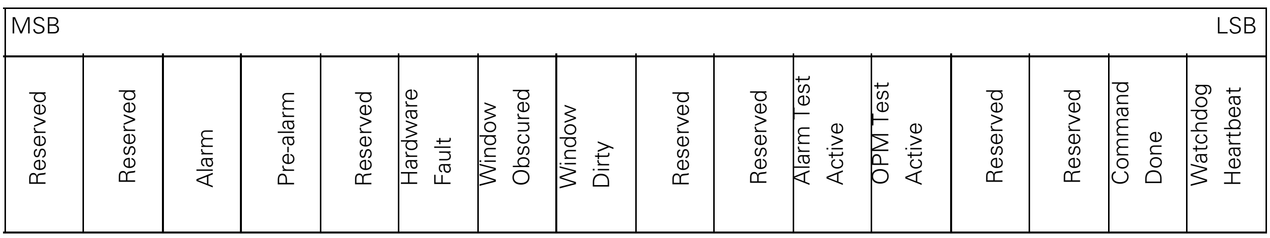

Fig. 17: FV400 Detectors - Overall Status Register

The Watchdog Heartbeat toggles from 0 to 1 or from 1 to 0 every 16 sec.

7.1.9 Command Transfer from PLC to FV400 Detector

- The PLC will examine the Command Done bit in the FV400 detector's overall status register and wait until it is cleared by the FV400 detector.
- The PLC will set the Command Code in the Command Register.
- The PLC will set the Command Request bit in the Command Register.
- The FV400 detector detects the change in Command Request bit and will action the command code.
- When completed, the FV400 detector sets the Command Done in the Overall Status register.
- The PLC will detect that the Command Done bit has been set showing that the command has been completed.
- The PLC will clear the Command Request bit in the Command Register.
- The FV400 detector detects the change in Command Request bit and clears the Command Done bit.

8 Appendix-B

8.1 Video Text Overlay

8.1.1 Video Text Overlay

The FV400 Series of detectors can be supplied with a built in colour video camera which looks out over the same field of view as seen by the flame sensors. The camera provides a balanced output video signal on twisted pair connections suitable to feed into a CCTV system. (An active balun may be required to connect to some systems.)

The detector superimposes a text overlay (12 lines of 24 characters) onto the live video output to provide identity and status information. The content of the overlay changes depending on the state of the detector and is described below.

The following describes the overlay configured in standard mode. The fields are shown enclosed in ‘< >’.

Identity and Location Information

Each detector can be configured with a user defined text string up to 24 characters long. This is normally used to identify the detector and its location. This information is programmed using the FV Consys configuration tool. The identity and location will be displayed on the overlay if an event occurs but can be permanently shown if required.

In addition to the upper (ABC…) and lower (abc…) case alphabet and numbers (0123…), the following characters may be used in the identity and location string:

! ” # % & ’ ( ) * + , - . / : ; < = > ? [ ] _ | ~with '{' displayed as '((' and '}' as '))'

Characters that cannot be displayed on the overlay will be shown as a “?”.

8.1.2 Quiescent State

In the quiescent, normal, operation, the text overlay displays the basic identity, location and status information. The default layout of the overlay is shown in Fig. 18.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	F	l	a	m	e	V	i	s	I	o	n					*Log Counter*								
2	*Location and Identity Field*																							
3	*D*																							
4	*R*																							
5	*O*																							
6	*W*																							
7																								
8																								
9																								
10																								
11																								
12																								

Fig. 18: Quiescent State Overlay

The top of the overlay gives the basic identity and location information, with option flags down the left-hand edge. The displayed fields can be turned on or off using the PC configuration tool.

Overlay Field	Contents	Description
Name	`FLAMEVision`	Name of detector range, permanently displayed.
Location & Identity	User data	A user defined location and identity message up to 24 characters. Set by the configuration tool.

Table 28: Fault and OPM Signal Indicators

The top left-hand corner of the overlay gives the status information about configurable options and the delay settings as follows:

Overlay Field	**Contents**	**Description**
D	`S / M / L`	Detector delay setting represented as: S - Short / M - Medium / L - Long
R	`C / H / N / E`	This field shows the selected Detector range setting: C - Close / H - Half / N - Normal / E - Extended
O	`M / A`	Shows the mode of the OPM test: M - Manual / A - Automatic
W	`- / W`	Shows the window heater status: - OFF / W - ON

Table 29: Fault and OPM Signal Indicators

8.1.3 Alarm State

If the detector enters the alarm state, then the overlay will change to report the event with a flashing `"!!ALARM!!"` message in the centre of the overlay.

The log counter will be displayed to show where the event is recorded in the detectors internal log.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	F	l	a	m	e	V	i	s	i	o	n					***Log Counter***								
2	***Location and Identity Field***																							
3	***D***																							
4	***R***																							
5	***O***																							
6	***W***																							
7																								
8																								
9								!	!	**A**	**L**	**A**	**R**	**M**	!	!								
10																								
11																								
12																								

Fig. 19: Alarm State Overlay

8.1.4 Window (OPM) Test and Alarm Test

The OPM test and alarm test (AT) have their own sections of the text overlay to report status.

The OPM MODE (O) field shows the current OPM operating mode, automatic or manual.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	F	l	a	m	e	V	i	s	i	o	N					***Log Counter***								
2	***Location and Identity Field***																							
3	***D***				***Serial Number Field***																			
4	***R***				***OPM Condition Field***																			
5	***O***																							
6	***W***																							
7																								
8																								
9																								
10																								
11					***OPM/AT Progress Field***																			
12																								

Fig. 20: OPM and Alarm Test Overlay

The top of the text overlay gives the basic identity and location information which is displayed as described for the quiescent state above. The log counter will be displayed when an event occurs to show where it is held it is recorded in the internal log.

The OPM/AT operation field displays alternating messages to show progress and how the test was initiated. This field can also give a prompt when a regular alarm test is due; this is triggered by a timer set by configuration. The following messages are displayed:

Message Field	**Description**
`MANUAL OPM TEST / IN PROGRESS`	An OPM test is in progress; initiated manually using the Walk-Test Tool, wired input or network.
`AUTO OPM TEST / IN PROGRESS`	An OPM test is in progress; initiated automatically at the configured regular time interval.
`ALARM TEST / IN PROGRESS`	An alarm test is in progress; initiated manually using the Walk-Test Tool, wired input or network.
`WALK TEST DUE`	A reminder that the regular alarm test should be performed. This is a configurable option.

Table 30: OPM Messages

If the OPM test determines that the window is clean then the overlay returns to the quiescent condition. However, if the OPM test fails then the Serial Number and a message describing the problem are displayed on two lines of the overlay.

OPM Condition Messages	**Description and How to fix it**
`DIRTY`	The sensing window is dirty and must be cleaned soon.
`BLOCKED`	The sensing window is completely blocked and must be cleaned immediately.

Table 31: OPM Condition Messages

8.1.5 Hardware Fault State

If a hardware fault is found in the detector then it will be reported by a message displayed in the middle section of the text overlay. This is in addition to the fault being indicated on the fault LED and signalled on the outputs as described in Sections 5.2.5 “Fault and OPM Indication” and 5.2.7 “Service Mode Indication”.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	F	l	a	m	e	V	i	s	i	o	n					***Log Counter***								
2	***Location and Identity Field***																							
3	***D***				***Serial Number Field***																			
4	***R***				***Fault Field #1***																			
5	***O***				***Fault Field #2***																			
6	***W***				***OPM Condition Field***																			
7																								
8																								
9																								
10																								
11																								
12																								

Fig. 21: Hardware Fault Overlay

The top of the fault state overlay gives the basic identity and location information which is displayed as described for the quiescent state. The log counter will be displayed when an event occurs to show where it is recorded in the internal log.

The next line displays the device serial number. This is the serial number as etched on the front plate of the detector and is entered during manufacture, it cannot be changed. This is followed by one or two lines describing the fault.

The status messages indicate:

Message Field	Contents	Description
Log Counter	`Counter`	Used to index the internal event log.
Serial Number	`"Ser. No. nnnn/YY"`	Shows front plate serial number and year from internal memory.
Faults	"Wiring Fault" / "Detector Fault"	Simple report of detected fault(s) - Faults shall be put in either category. More details may be displayed in development mode.
OPM Condition	See Table 30: "OPM Messages"	See 8.1.4 "Window (OPM) Test and Alarm Test".

Table 32: Fault and OPM Signal Indicators
Other fields shall be the same as in the Quiescent state.

8.1.6 Other Messages

There are a few messages that can appear towards the bottom of the quiescent mode text overlay to report other states of the detector.

An FV400 detector's banner message appears briefly for a few sec and then clears. Additionally, another message appears if the detector is in the service mode (see Fig. 22).

If the temperature is between +55°C and +70°C or between -10°C and -30°C, then the camera switches off. A message will be displayed on the video overlay, with a blue background, reporting the condition. The detector will also report if the camera signal is lost.

The FV400 detector will turn off the video section if the temperature goes above +70°C or below -30°C.

If the video is active then, the log counter will be displayed when an event occurs to show where it is recorded in the internal log.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	F	l	a	m	e	V	i	s	i	o	n					***Log Counter***								
2	***Location and Identity Field***																							
3	***D***																							
4	***R***																							
5	***O***																							
6	***W***																							
7																								
8																								
9																								
10									***Banner Field***															
11					***Service Field***																			
12		***Camera State Field***																						

Fig. 22: Power Up and Other Messages Overlay
The Log Counter is not visible for the initial Power Up screens (Banner and Service Fields).

Fig. 22 shows position of the other message fields on the text overlay.

The status messages indicate as follows:

Status Message	Contents	Description
Banner	`Blank` / `FV400 Series` / `Service Mode`	Displayed while the detector is powering up.
Service	`Detection Disabled`/`Blank`	Displayed while the detector is in service mode for configuration or diagnostics. In normal operation this field is blank.

Camera State	`CAMERA FAULT`/
	`CAMERA OFF/TOO HOT`
	`CAMERA OFF/TOO COLD`
		The following messages will be displayed on a blue background as the camera signal is not available:
		■ `CAMERA FAULT` - The camera signal has been lost.
		■ `CAMERA OFF`: `TOO HOT` - The camera temperature is too hot and it has been turned OFF.
		■ `CAMERA OFF`: `TOO COLD` - The camera temperature is too cold and it has been turned OFF.

Table 33: Other Messages
Other fields shall be the same as in the Quiescent state.

Further information about Tyco can be found on the Internet at www.tycoemea.com

Company stamp

120.515.123_FV-D-400-A, doc. version 3, 5. May 2015. Subject to change without notice.