601PH/601PH-M HIGH PERFORMANCE OPTICAL SMOKE DETECTOR PRODUCT APPLICATION AND DESIGN INFORMATION

1. INTRODUCTION

The 601PH High Performance Optical Smoke Detector forms part of the Series 600 range of plug in detectors for ceiling mounting. The detector plugs into a 5B 5" Universal Base or 5BD 5" Conventional Continuity Base and is intended for two-wire operation with the majority of control equipment currently manufactured by the company The High Performance Optical detector is available in one sensitivity setting only.

The 601PH-M is the Marine version of the 601PH High Performance Optical Smoke Detector.

2. OPERATING PRINCIPLE

The 601PH operates by sensing the optical scatter from smoke particles generated in a fire. While the optical scatter detector can give good detection performance for the majority of fires, some fast burning fires produce little visible smoke and some produce very black smoke, neither of which are easily detected by the optical scatter detector. (Such fires are represented in EN 54 Part 7 by Wood Crib and Heptane type fires respectively). These fires do however, produce high heat outputs with an associated rise in air temperature.

The HPO detector has been designed to offer improved detection of such fires by detecting the rapid Rate-of-Rise of air temperature and under these conditions increasing the smoke detection sensitivity. This gives an earlier detection of such fires and a broader detection capability than a standard sensor.

The HPO detector has two sensing systems as follows:

- An optical chamber with associated electronics to measure the presence of smoke by light scatter.
- A thermistor bridge with its associated electronics to detect the presence of hot air currents.

2.1 SMOKE DETECTION

The 601PH detects visible particles produced in fires by using the light scattering properties of the particles. Fig. 1 shows the chamber schematic.

The optical system consists of an emitter and receiver, so arranged that their optical axes cross in the sampling volume. The emitter, produces a narrow beam of light which is prevented from reaching the sensor directly by the baffles. When smoke is present in the sampling volume, a proportion of the light is scattered, some of which reaches the receiver. For a given type of smoke, the light reaching the sensor is proportional to the smoke density. The amplified output from the sensor can be used to activate an alarm circuit at a predetermined threshold.

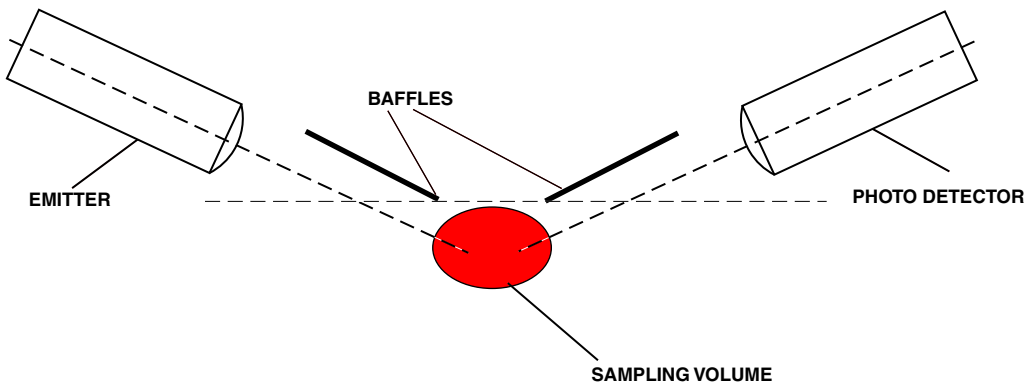

Fig. 1 Optical System Schematic

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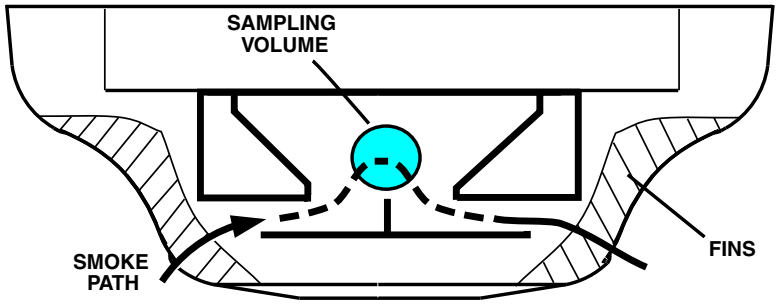

Fig. 2 Measuring Chamber Showing Smoke Flow Path

2.2 FEATURES OF MEASURING CHAMBER

The 601PH uses a unique measuring system shown in Fig. 2. Unlike most other optical scatter detectors the 601PH does not use vertical chevrons to exclude ambient light, but uses concentric baffles. This approach gives a better signal to noise ratio and allows the detector to be used in its high sensitivity enhanced mode. The chamber is the subject of a patent application.

The emitter (see Fig. 1) is a GaAlAs solid state type operating in the near infra-red at 880nm, while the sensor is a matched silicon photodiode. These devices together with their associated lenses are held in place by the labyrinth mouldings. The design of the labyrinth is such that the presence of small insects such as thrips should not cause false alarms.

The sampling volume is enclosed within a measuring chamber. The optical design of the chamber provides a very low background signal and is the subject of a patent application.

2.3 THERMAL MEASURING SYSTEM

Refer to Fig. 3.

This is designed to detect the presence of horizontally moving hot air draughts moving across the ceiling which occur in a fast burning fire.

The measuring system consists of two fast responding negative temperature thermistors. A sensing thermistor is located above the labyrinth under the cover in the airstream and will detect any sudden changes in the air temperature or draughts of hot air moving across the ceiling. The second thermistor is located out of the airflow, but still within the smoke labyrinth and has a longer time constant and is used as a temperature reference to compare the sensing thermistor against. At a given temperature differential between the two thermistors, the comparator will switch and increase the gain of the amplifier, thereby increasing the sensitivity of the sensor. Fins located on the top of the labyrinth are designed to increase air turbulence and the efficiency of the sensing thermistor.

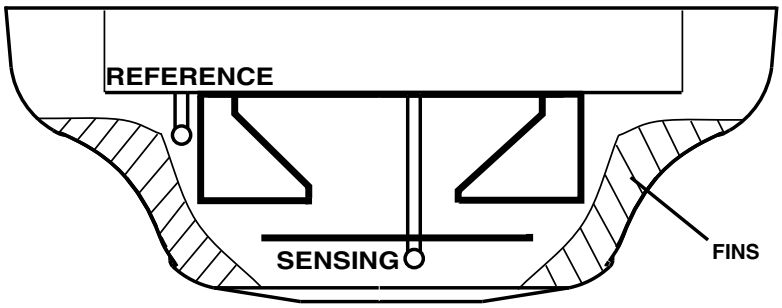

Fig. 3 Thermal Measuring System

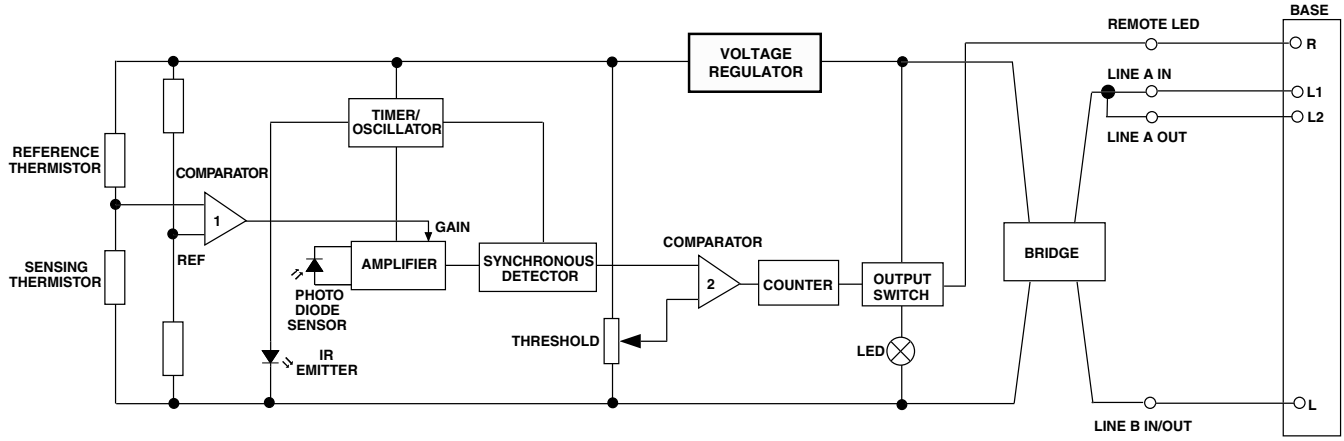

Fig. 4 Block Schematic of Detector

2.4 CIRCUIT OPERATIONS

A simplified block schematic of the detector is given in Fig. 4.

The emitter is subjected to a pulse stream only every 10s in order to reduce the quiescent current. The pulse signal received by the photodiode is fed to a high-gain amplifier. If smoke is present, the pulse signal received varies in proportion to the smoke density.

The amplifier output is fed via an integrator, the output of which is compared to a preset threshold level. Sophisticated synchronous detection techniques are used to reduce the effects of noise and spurious transients.

The gain of the front end amplifier is controlled by the thermistor bridge circuit. When the temperature differential between the two thermistors exceeds a certain value, the amplifier gain increases. Under these conditions the High Performance Optical detector is more sensitive to the presence of smoke and is said to be in 'Enhanced Mode'.

When the detector is in the 'Enhanced Mode', the detector will only alarm if a smoke signal is present. The presence of rising temperature alone cannot cause an alarm.

If the signal amplitude exceeds a threshold level, then the emitter samples the smoke every two seconds. The sample period remains at two seconds if the signal is above the threshold. When the counter has counted three consecutive pulses above the threshold, the output stage is latched into the alarm condition. If however, the amplitude of the second or third pulse is below the threshold, then the pulse period reverts to 10 seconds and the counter resets. The switching of the output stage lights the alarm LED and provides drive for an remote LED indicator.

The critical front end of the circuit is run off a 9.5V regulator to make it independent of supply voltage.

2.5 WIRING

The detector circuit requires a positive and negative supply and these are wired to terminals L1 and L on the base (see Fig. 4). The bridge circuit in the detector makes the detector polarity insensitive. Base terminal L1 is connected to base terminal L2 when the detector is fitted to provide continuity monitoring through the detector. Base terminals L2 and L provide outputs to the next detector or EOL device.

A drive is provided for a remote indicator connected between supply +ve and terminal R, therefore, at a detector where a remote indicator is connected, the polarity of the supply must be known.

3. MECHANICAL CONSTRUCTION

The major components of the detector are:

- Body Assembly
- Printed Circuit
- Optical Chamber
- Optical Chamber Cover
- Thermistor
- Light Pipe
- Outer Cover

3.1 ASSEMBLY

The body assembly consists of a plastic moulding which has four embedded detector contacts aligning with contacts in the 5B or 5BD base. The moulding incorporates securing features to retain the detector in the base.

The PCB with the optical chamber is clipped to the body by four spring contacts. These contacts act as a mechanical fixture during assembly and provide electrical contact between the contacts and the PCB.

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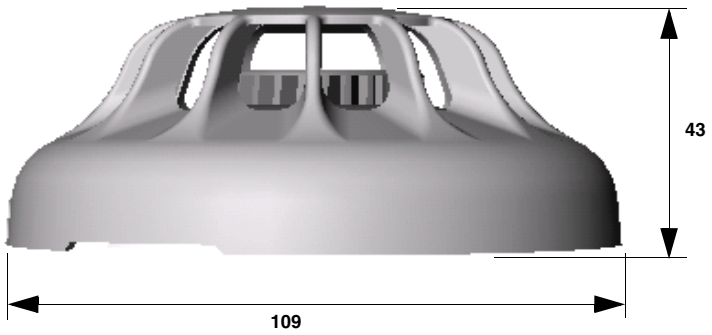

Fig. 5 Overall Dimensions of 601PH

The chamber cover is clipped to the body over the optical chamber ensuring the sensing thermistor protrudes through the chamber cover. The light pipe is slotted into the chamber cover. Finally, the outer cover is clipped to the body.

3.2 PRINTED CIRCUIT/OPTICAL ARRAY ASSEMBLY

All electronic components are fitted to the PCB including the Alarm LED, the IR emitter, the photo-diode and the thermistors.

3.3 TEST AND FINAL ASSEMBLY

The detectors are fully functionally tested and their sensitivities set in a smoke tunnel to ensure correct calibration. The sealing ring and labels are then fitted to complete detector assembly.

4. TECHNICAL SPECIFICATION

4.1 MECHANICAL

Dimensions

The dimensions of the 601PH detector are shown in Fig. 5.

Materials

Body and cover:	FR110 'BAYBLEND' Fire Resistant

Weight

Detector:	0.093kg
Detector + MUB base:	0.143kg

4.2 ENVIRONMENTAL

Operating Temperature:	-20°C to +70°C (please see note below).
Storage Temperature:	-25°C to +80°C

Note:

1) Operation below 0°C is not recommended unless steps are taken to eliminate condensation and hence ice formation on the detector.

Relative Humidity:	95% non-condensing
Shock:) Vibration:) Impact:) Corrosion:)	To EN54-7

4.3 ELECTROMAGNETIC COMPATIBILITY

The detector complies with the following:

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

EN61000-6-3 for Emissions

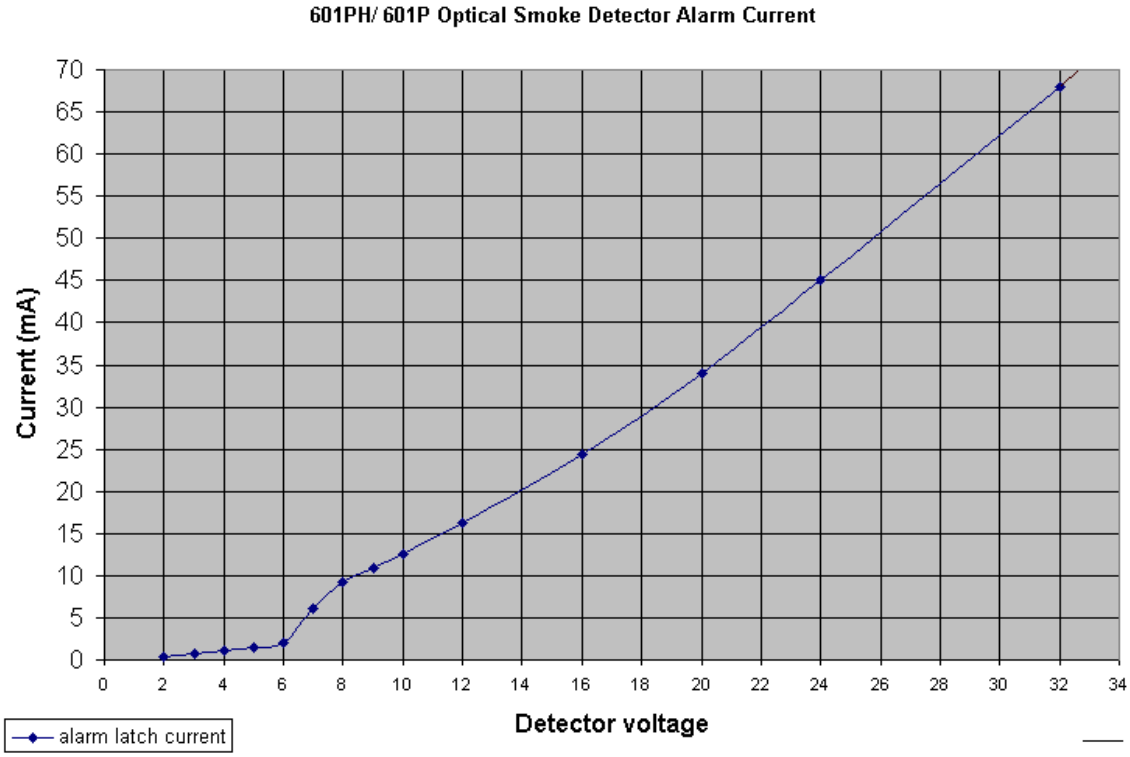

Fig. 6 Alarm Load Presented to the Controller

4.4 ELECTRICAL CHARACTERISTICS

The alarm load presented to the controller is shown in Fig. 6.

The following characteristics shown in Table 1 are taken at 25°C with a supply voltage of 24V unless otherwise specified.

Characteristics	Min.	Typ.	Max.	Unit
Operating Voltage (d.c.)	10.5	24	33	V
Average Quiescent Current	62	65	70	µA
Switch-on-Surge	120	140	160	µA
Stabilisation Time		30		sec
Alarm Current	See Fig. 6			mA
Holding Voltage			2	V
Holding Current			0.4	mA
Reset Time		2		sec
Remote LED drive	Remote LED via 1k			

Table. 1 Electrical Characteristics

4.5 PERFORMANCE CHARACTERISTICS

The fundamental parameter used to define the sensitivity of an optical smoke detector is the level of smoke which will just produce an alarm under 'ideal' conditions. This parameter, known as the response threshold value, is normally measured in a smoke tunnel and is defined in terms of the obscuration produced by the smoke over a one metre path. The response threshold value is normally given in dB/m, (or % per m).

Interpretation of response threshold value is somewhat complicated by the fact that the measurement is given in terms of obscuration, whereas the detector works by scattering from the smoke particles. The response threshold (m) value will therefore, depend on the colour of the smoke. Black smokes give less scattering than light smokes for given values of obscuration as shown in Fig. 7.

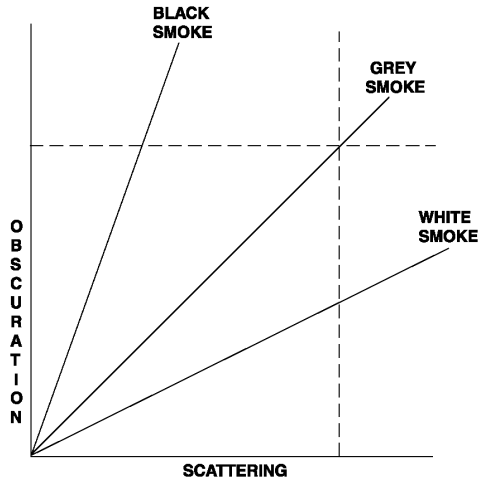

Fig. 7 Response Threshold vs Smoke Colour

Sensitivities are invariably specified for 'grey' smokes as produced by typical smouldering fires. Values for the 601PH are given below.

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4.5.1 RESPONSE TO RATE OF CHANGE OF TEMPERATURE

The detector will not be enhanced by slow rates of change of temperature, or by cold air draughts moving across the ceiling creating negative rates of change of temperature. The detector is designed to detect sudden horizontal draughts of hot air produced by fast burning fires. The enhancement switching point has been set to allow the detection of TF1 type fires.

Normal response threshold = 0.12 dB/m, 2.7%/m typical.

Enhanced mode threshold = 0.05 dB/m, 1.1%/m typical.

4.6 RESPONSE TO FIRE TESTS

The response of an optical scatter detector to a fire will depend to a large extent on the colour of the smoke produced in the fire. However, other factors such as the detector smoke entry characteristics, the development of the fire and the thermal lift produced by the fire are important. In order to evaluate the response under realistic conditions, detectors are subjected to test fires which cover a range of fire types. These tests are defined in EN54 Pt 7. The 601PH passes the following Fire Tests:

TF1	open cellulosic (wood-flaming)
TF2	smouldering pyrolysis
TF3	glowing smouldering (cotton)
TF4	open plastics (polyurethane foam)
TF5	liquid (n-heptane)

Table 2: Response to Fire Tests

Note: TF2 to TF5 are mandatory test fires required to meet EN54 Pt 7.

The 601PH is designed to respond to the mandatory tests TF2 to TF5 as required by EN54 Pt 7. The 601PH gives an earlier response to TF5 fires than the MR601 due to its thermal circuit detecting the heat generated by this test of fire and the 601PH being 'enhanced'. For the same reason the 601PH will detect test fire TF1 (open wood cellulosic flaming fire) which is not normally detected by optical smoke detectors - demonstrating the detectors broader detection capability.

The 601PH does not respond to TF6 liquid (methylated spirit) which although having a rapidly rising temperature, does not generate any optical scattering. This shows that the High Performance Optical detector will not respond to hot air draughts without the presence of smoke.

5. INSTALLATION RECOMMENDATIONS

It is not recommended that the 601PH be installed in areas where it is likely to be regularly enhanced, since in this condition the detector is extra sensitive and there is a possibility of unwanted alarms from low ambient smoke levels.

The 601PH is designed to become enhanced by detecting a rapid temperature rise (>10°C) in air moving horizontally across the ceiling. Siting sensors in positions where air is being blown through the detector should therefore, be particularly avoided, eg, close to ceiling ducts or ceiling mounted industrial heaters; or areas of forced ventilation, such as ducts and under floor voids of computer suites.

Also, not recommended are areas open to the outdoors, such as cargo handling bays, or areas where the detector may become contaminated.

The 601PH is not recommended for use in applications where a heater jacket is required.

The 601PH is primarily aimed at benign environments.

6. DETECTOR IDENTIFICATION

The detector is identified by the logo label, as shown in Fig. 8.

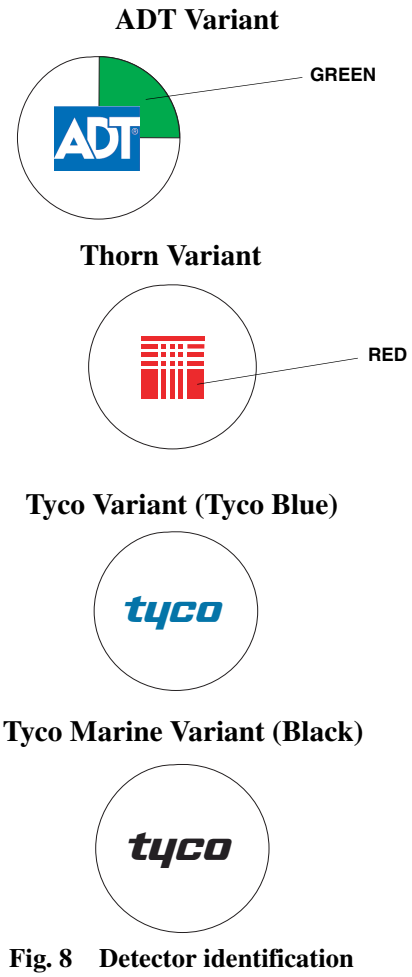

Fig. 8 Detector identification

7. CPD INFORMATION

CE

0832

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0832-CPD-0247

EN 54-7: 2000 + A1: 2002

Point type smoke detector (high performance optical) for use in fire detection and alarm systems in buildings

601PH
601PH-M (Marine)
601PH (VdS)

Application & Design	01C-02-D2
Installation Instructions	01C-02-I1
Service Instructions	01C-02-S1

8. ORDERING INFORMATION

601PH High Performance Optical Smoke Detector:	516.600.002.A/T/Y
601PH-M High Performance Optical Smoke Detector (Marine):	516.600.202
5B 5" Universal Base:	517.050.017
5BD 5" Conventional Continuity Base:	517.050.600

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5th May 2010

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