TELEDYNE
GAS AND FLAME DETECTION
Everywhereyoulook™

# Safety Manual

# SPYGLASS

User manuals in other languages are available on Website https://teledynegasandflamedetection.com



All of the information that is provided in this document is accurate to the best of our knowledge.

As a result of continuous research and development, the specifications of this product may be changed without prior notice.

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# Table of contents

# Revisions History

| Version | Author | Date | Reason of Change | Approved |
|---|---|---|---|---|
| 1.0 | YM | 02/2023 | creation | |
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# 1 Introduction

## 1.1 General description

The Spyglass series of triple IR (IR3) and UV IR flame detectors are flame detectors that detect fires and explosions extremely fast allowing preventative action to be initiated rapidly and minimize the consequences.

The Spyglass IR3-HD models of the Spyglass series provide ultra-fast response, high performance, and reliable detection of all types of hydrocarbon fires (visible and non-visible). The Spyglass IR3-H2-HD models of the Spyglass series provide ultra-fast response, high performance, and reliable detection of Hydrogen fires. The detector (both variants) addresses slow growing fires as well as fast eruption of fire using improved triple IR (IR3) technology. It operates in all weather and light conditions with highest immunity to false alarms.

In addition, some of the detector's models in this series (called HD models) provide also high-definition (HD) video output of the monitored area with clear imaging of a fire event and of personnel at distances up to 100 ft (30m). This allows the rescue team to be aware of the exact situation before entering the hazardous area. The detector automatically records video of fire events (from 1 minute before the alarm and up to 3 minutes post-alarm). These features, along with the built-in event logger, provide additional means to study the cause and development of fire events.

The Spyglass family of flame detectors fulfils the requirements of IEC 61508 for a safety integrity level SIL 2. All detectors are regarded as Type B field devices per IEC 61508. The assessment report may be obtained from the manufacturer upon signing a non-disclosure agreement.

The Spyglass family Include:

| | |
|---|---|
| SG50-F-IR3-V-ASXX | IR3 flame detector with HD camera |
| SG50-F-IR3-H2-HD-ASXX | IR3 for H2 flame detector with HD camera |
| SG50-F-UV-IR-V-ASXX | UV-IR flame detector with HD camera |
| SG50-F-UV-IR-F-V-ASXX | UV-IR flame detector with HD camera |
| SG50-F-IR3-ASXX | IR3 flame detector |
| SG50-F-IR3-H2-ASXX | IR3 for H2 flame detector |
| SG50-F-UV-IR-ASXX | UV-IR flame detector |
| SG50-F-UV-IR-F-ASXX | UV-IR flame detector |

The following table lists the system versions to which this document refers (where MMM means any minor version value):

| Detector Model | System version |
|---|---|
| SG50-F-IR3-V | F101.01.00.MMM |
| SG50-F-IR3-H2-V | F140.01.00.MMM |
| SG50-F-UV-IR-V | F130.01.00.MMM |
| SG50-F-UV-IR-F-V | F170.01.00.MMM |
| SG50-F-IR3 | F120.01.00.MMM |
| SG50-F-IR3-H2 | F150.01.00.MMM |
| SG50-F-UV-IR | F110.01.00.MMM |
| SG50-F-UV-IR-F | F160.01.00.MMM |

# 2 Term

| | |
|---|---|
| SIL | Safety Integrity level |
| HFT | Hardware fault Tolerance |
| SFF | Safe Failure Fraction |
| $PDF_{avg}$ | Average Probability of Dangerous Failure on Demand |
| PFH | Probability of dangerous Failure per Hour |
| FMEDA | Failure Mode, Effects and Diagnostics Analysis |
| λsd | Rate of safe detected failure |
| λsu | Rate of safe undetected failure |
| λdd | Rate of dangerous detected failure |
| λdu | Rate of dangerous undetected failure |
| MTBF | Mean Time between Failure |

# 3 Safety functions

All family of Spyglass flame detectors have two mode of fire detections which are safety functions.

- SF01 Normal detection of flame
- SF02 Fast detection of flame

As the difference between these two safety functions are relatively small only the worst case is presented.

## 3.1 Safety functions interfaces

All the detectors include two safety interfaces- current output and relay outputs:

### 3.1.1 Current outputs

All IR3 and IR3-H2 model:

| Detector status | 0 – 20mA | State |
|---|---|---|
| Startup | 1±0.1 mA | Fail safe |
| Fault | 0-1.1 mA | Fail safe |
| BIT fault | 2±0.1 mA | Fail safe |
| Dirty Window | 3±0.2 mA | Fail safe |
| Normal | 4±0.2 mA | Normal |
| Pre Alarm | 16±0.3mA | Fail safe |
| Fire Alarm | 20±0.3 mA | Fail safe |

All UV-IR models:

| Detector status | 0 – 20mA | State |
|---|---|---|
| Startup | 1±0.1 mA | Fail safe |
| Fault | 0-1.1 mA | Fail safe |
| BIT fault | 2±0.1 mA | Fail safe |
| Dirty Window | 3±0.2 mA | Fail safe |
| Normal | 4±0.2 mA | Normal |
| IR radiation detection | 8±0.3 mA | Fail safe |
| UV radiation detection | 12±0.3 mA | Fail safe |
| Pre Alarm | 16±0.3 mA | Fail safe |
| Fire Alarm | 20±0.3 mA | Fail safe |

### 3.1.2 Relays output

All models:

| Detector status | output | state |
|---|---|---|
| Fault relay | Open | Fail safe |
| Fault relay | Close | normal |
| Alarm relay | Open | normal |
| Alarm relay | Close | Fail safe |
| Aux relay | Open | normal |
| Aux relay | Close | Fail safe |

The Auxiliary relay shall be configurated to act as an extra fire alarm relay and shall be connect to the Alarm relay in parallel by the user.

## 3.2 Functions that are not suitable to be used in safety loops

The safety function of the flame detector does not include:

- RS 485 Modbus communication
- Hart protocol communication
- HD camera and Ethernet communication (in HD models)

## 3.3 Function and parameter accessible by the user

All functions and parameters accessible by the user are defined in the user manuals, section 3 Configuration options.

All configuration changes must be done off line and be verified by the user via a proof test (e.g., with a flame simulator) power cycle and re-check of settings.

# 4 Installation

For full instructions please refer to the user manuals. In the end of the installation, perform an acceptance test by verifying that the current or relay outputs (whichever is used) do not report fault.

### ⚠ This section includes important information.

- To help obtain optimal performance, the detector should be aimed toward the centre of the hazard or area to be monitored and protected ("detection zone") and have, to the extent that is required, an unobstructed view of the protected area. Whenever possible, the detector face should be tilted (aimed) down at an angle to prevent the accumulation of dust and dirt.
- Do not start an installation until the performance target, system configuration, installation location and coverage considerations have been defined by the responsible person.

The installation must comply with national and local regulations and standards applicable to flame detectors (e.g., NFPA 72) and all local and common engineering practices. It is recommended to consult with the-authority having jurisdiction.

### ⚠ Warnings

- Do not open the detector, even when isolated, when flammable atmosphere present.
- The equipment may be used in hazardous areas with flammable gasses and vapors with apparatus groups IIC, IIB and IIA and with temperature classes T1, T2, T3, T4 and T5.
- The equipment is certified only if operated within the ambient temperature range listed in section 6.3. It should not be used in temperatures outside this range.
- Installation shall be carried out in accordance with the applicable code of practice by suitably trained personnel.
- Inspection and maintenance of this equipment shall be carried out by suitably trained personnel in accordance with the applicable code of practice.
- If the equipment is likely to come into contact with corrosive and/or other harsh substances, consult with the relevant technical persons to take suitable precautions to prevent the detector from being adversely affected, thus ensuring that the type of protection is not compromised.
- Harsh substances: For example, acidic liquids, gases, or solvents that may attack the windows, metals, seals, or polymeric materials.
- Suitable precautions: For example, regular checks as part of routine inspections or establishing from the material's data sheet that it is resistant to specific chemicals.

### ⚠ Specific conditions for use

- The equipment is not intended to be repaired by the user. Repair of this equipment shall be carried out in accordance with the Teledyne Gas and Flame Detection quality process.
- HW and SW updates, changes or modifications shall be done only by the manufacturer and after an approval to Teledyne Gas and Flame Detection.

Note: There are no special requirements for decommissioning of the detectors.

# 5 Maintenance

After powering up, the detector should work maintenance free. Regular checks should be in the form of a physical inspection and to periodically ensure the optical surfaces are clean (windows and reflective mirror). It is also recommended to perform a function test annually or in line with local requirements, whichever is the sooner.

Note: **All failures impacting functional safety shall be reported back to the manufacturer**.


WARNING

**The sensor module in the front half of the detector contains no serviceable components and should never be opened. The terminal compartment at the back is the only part of the housing that should be opened by the user. Any violation of these instructions will invalidate the warranty.**

## 5.1 Cleaning Procedure

To clean the detector:

**a)** Disconnect the power to the unit and disable/inhibit any extinguishing equipment that is connected to the unit.

**b)** Use water and detergent to clean the detector windows and underside of the reflector. Rinse with a soft cloth, cotton swab, or tissue.

Where dust, dirt or moisture accumulates on the window, first clean the window with a soft optical cloth and detergent, and then rinse with a clean soft cloth, cotton swab, or tissue. If contamination continues to be an issue consider using air shield.

## 5.2 Proof test using flame simulator

Proof tests shall be undertaken to reveal all dangerous fault which are undetected by diagnostic test.

Proof test procedure:

1. Bypass the safety PLC or take other appropriate action to avoid a false trip (i.e inhibit alarm)
2. Aim the flame simulator to the detector and operate it (or apply a real fire) at the appropriate distance in order to verify that:
    a. Configuration 4 to 20 mA: the analog output current is within the range 20±0.3 mA if the detector is configured with no alarm delay, or if an alarm delay is configured the analog output current is within the range 16±0.3 mA during the "early alarm" delay period and then within the range 20±0.3 mA.
    b. Configuration relay: The ALARM and AUXILIARY relays are closed.
3. Restore the loop to full operation.
4. Remove the bypass from the safety PLC or otherwise restore normal operation.
5. The test results shall be recorded.

This test will detect about 30% of possible dangerous undetected failures when using 4-20mA current output and about 70% of possible dangerous undetected failures when using relay output.

# 6 Specifications

For full specification refer to the user manuals.

## 6.1 Electrical Specifications

- Operating Voltage: 24 VDC nominal (18-32 VDC)
- Current Consumption HD models
    - Standby180mA
    - Maximum300mA all systems in operation (including window heater)
- Current Consumption none HD models
    - Standby120mA

  Maximum180mA all systems in operation (including window heater}

## 6.2 Outputs

- Relays: Volt-free contacts rated 2A at 30 VDC
    - Alarm: Normally open
    - Auxiliary: Normally open
    - Fault[1]: Closed when energized
- 0-20mA (stepped) current output: 3 wire and 4 wire configurations (sink and source).
- HART® 7.

  Tri-color LED indication
- Modbus RTU compatible Protocol on RS-485
- Digital Video: IP network IEEE 802.3 10Base-t (on HD models)

## 6.3 Environmental Specifications

- Temperature Range:
    - Operating-67°F to + 167°F (-55°C to +75°C)2
    - Storage -67°F to + 185°F (-55°C to +85°C)
- Humidity: up to 99%, non-condensing
- Ingress Protection: IP66 & IP68 (2m, 24hr); NEMA 4X & 6P
- The assumed life time: 10 years

# 7 Certifications

The Spyglass series of flame detectors are certified to FM us, FMc, IECEx, ATEX, EN54-10 and Inmetro. For detailed certification data refer to the user manuals.

The Spyglass series of flame detectors are considered type B devices per IEC61508, and are SIL 2 certified.

[1] The FAULT relay will normally be energized and the contact will be closed during normal operation of the detector. The contact will be open at fault condition or low voltage.
[2] In the first hour of operation the ambient temperature must be -40°C (-49°F) or above.

# 8 Conditions for safe operation

1. The Spyglass flame detectors family are installed per the manufacturer's instructions.
2. The ambient temperature is in the range -40°C to +75°C when the detector is turned on, and may be in the range -55°C to +75°C after one hour of continuous operation. The listed failure rates are valid for operating stress conditions typical of an industrial field environment with temperatures in this range and an average temperature over a long period of time of up to 40°C. For higher average temperatures, the failure rates should be multiplied with an experience-based factor of e.g., 1.5 for 50°C, 2.5 for 60°C and 4.5 for 75°C.
3. All configuration changes must be done off-line and be verified by the user via a proof test (e.g. with flame simulator) power cycle and recheck of setting.
4. The worst-case fault detection and reaction time (diagnostic test rate/interval) is 60 minutes for IR3 models and 120 minutes for UV-IR models.
5. In high demand mode, the ratio of the diagnostic test interval to the demand rate equals or exceeds 100.
6. In low demand mode of operation, the sum of diagnostic test interval and the time to perform the repair of a detected failure is less than the MTTR used in the calculation to determine the achieved safety integrity for the safety function.
7. The Mean Time To Restoration (MTTR) is considered to be 24 hours.
8. The HART protocol is only used for setup, calibration, and diagnostics purposes, not during normal operation.
9. When using the current output configuration, the 4-20mA output signal is fed to a SIL 2 compliant analogue input board of the safety PLC.
10. When using the current output configuration, the application program in the safety logic solver is configured to detect alarm ranges and automatically trip on these failures; therefore, these failures have been classified as safe failures.
11. The FAULT relay will normally be energized and the contact will be closed during normal operation of the detector. The contact will be open at fault condition or low voltage.
12. ALARM and AUXILIARY relay are normally open.
13. When using the relay output configuration, the fault relay outputs are permanently monitored and part of the safety function.
14. When using the relay output configuration, the AUX relay must be set to operate at alarm level. The Alarm and AUX relay outputs must be connected in parallel.
15. When using the relay output configuration, the relay contacts (alarm, AUX and fault) are protected with a fuse rated at 0.6 of the nominal specified relay contact current.
16. To allow identification of any fault event one of the fault outputs of the detector should be monitored once every 20 seconds or at a faster rate.

# 9 Failure rate and safety metrics according to IEC 61508

The following FMEDA results were calculated by the $1_H$ approach according to 7.4.4.2 of IEC 61508-2 with Hardware Fault Tolerance (HFT) = 0.

An average probability of failure demand ($PFD_{AVG}$)calculations performed for a single Spyglass flame detector. A mission time of 10 years has been assumed, a mean time to restoration of 24 hours and a Site Safety Index (SSI) of 2.

The $PFD_{AVG}$ value is listed in the tables for different proof test intervals considers the assumed proof test coverage.

## 9.1 Current Output

| | IR3<br>IR3-H2 | IR3-HD<br>IR3-H3-HD | UV-IR<br>UV-IR-F | UV-IR-HD<br>UV-IR-F-HD |
|---|---|---|---|---|
| Safe Detected - $\lambda_{SD}$ (FIT) | 13 | 19 | 0 | 0 |
| Safe Undetected - $\lambda_{SU}$ (FIT) | 353 | 407 | 293 | 353 |
| Dangerous Detected λDD (FIT) | 593 | 583 | 611 | 619 |
| Dangerous detected - λDD (FIT) | 520 | 502 | 537 | 538 |
| Annunciation detected - λAD (FIT) | 73 | 81 | 74 | 81 |
| Dangerous Undetected - λDU (FIT) | 78 | 69 | 81 | 77 |
| No effect (FIT) | 2905 | 3973 | 2889 | 4004 |
| Annunciation undetected (FIT) | 28 | 25 | 28 | 25 |
| Total Failure Rate (FIT) | 1037 | 1078 | 985 | 1049 |
| SFF | 92% | 93% | 91% | 92% |
| $PFD_{AVG}$ ($T_{Proof}$ = 1 Year) | 2.53E-03 | 1.98E-03 | 2.47E-03 | 2.38E-03 |
| $PFD_{AVG}$ ($T_{Proof}$ = 2 Year) | 2.65E-03 | 2.12E-03 | 2.62E-03 | 2.52E-03 |
| $PFD_{AVG}$ ($T_{Proof}$ = 5 Year) | 2.98E-03 | 2.50E-03 | 3.01E-03 | 2.88E-03 |
| SIL AC | SIL 2 | SIL 2 | SIL 2 | SIL 2 |
| Systematic Capability (SC) | SIL 2 | SIL 2 | SIL 2 | SIL 2 |
| MTBF (Year) | 29 | 22 | 29 | 22 |

## 9.2 Relay Output

| | IR3<br>IR3-H2 | IR3-HD<br>IR3-H3-HD | UV-IR<br>UV-IR-F | UV-IR-HD<br>UV-IR-F-HD |
|---|---|---|---|---|
| Safe Detected - $\lambda_{SD}$ (FIT) | 13 | 19 | 0 | 0 |
| Safe Undetected - $\lambda_{SU}$ (FIT) | 602 | 651 | 542 | 593 |
| Dangerous Detected - $\lambda_{DD}$ (FIT) | 528 | 527 | 545 | 563 |
| Dangerous detected - $\lambda_{DD}$ (FIT) | 524 | 520 | 541 | 556 |
| Annunciation detected - $\lambda_{AD}$ (FIT) | 4 | 7 | 4 | 7 |
| Dangerous Undetected - $\lambda_{DU}$ (FIT) | 106 | 99 | 108 | 106 |
| No effect (FIT) | 2524 | 3586 | 2510 | 3622 |
| Annunciation undetected (FIT) | 197 | 194 | 197 | 194 |
| Total Failure Rate (FIT) | 1249 | 1296 | 1195 | 1262 |
| SFF | 91% | 92% | 90% | 91% |
| $PFD_{AVG}$ ($T_{Proof}$ = 1 Year) | 1.82E-03 | 1.50E-03 | 1.72E-03 | 1.69E-03 |
| $PFD_{AVG}$ ($T_{Proof}$ = 2 Year) | 2.20E-03 | 1.89E-03 | 2.13E-03 | 2.09E-03 |
| $PFD_{AVG}$ ($T_{Proof}$ = 5 Year) | 3.25E-03 | 2.94E-03 | 3.25E-03 | 3.19E-03 |
| SIL AC | SIL 2 | SIL 2 | SIL 2 | SIL 2 |
| Systematic Capability (SC) | SIL 2 | SIL 2 | SIL 2 | SIL 2 |
| MTBF (Year) | 29 | 22 | 29 | 22 |

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