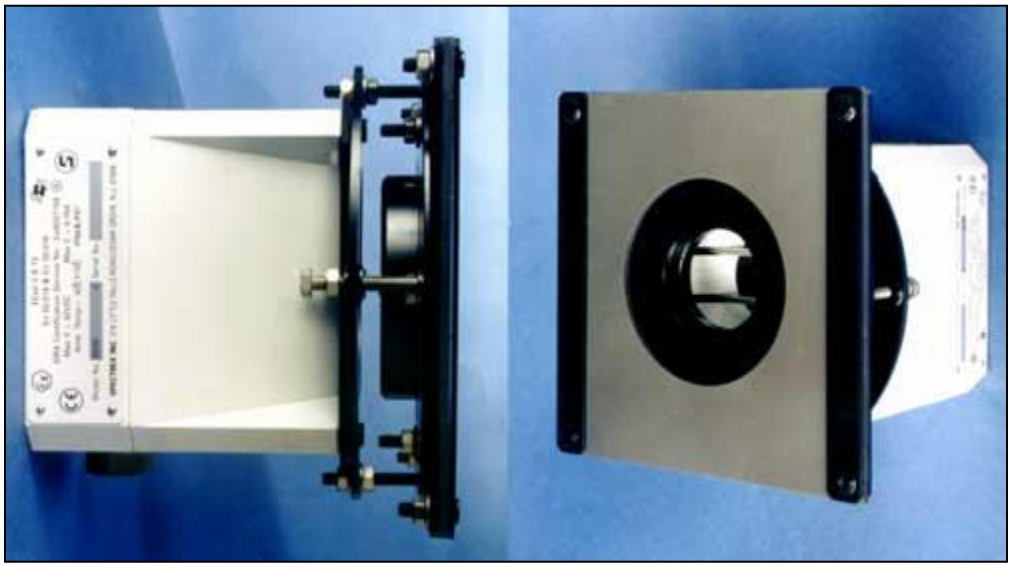
SafEye™

300 Series

Open-Path Gas Detection System

User Guide



Document Ref: TM794200, Rev Ae July 2021

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Warning: This manual should be read carefully by all individuals who have or will have responsibility for using, maintaining or servicing the product.

The detector is not field-repairable due to the meticulous alignment and calibration of the sensors and the respective circuits. Do not attempt to modify or repair the internal circuits or change their settings, as this will impair the system's performance and void the SPECTREX product warranty.

Warranty

SPECTREX agrees to extend to Purchaser/Distributor a warranty on the SPECTREX supplied components of the SharpEye products. SPECTREX warrants to Purchaser/Distributor that the products are free from defects in materials and workmanship for a period of three (3) years, commencing with the date of delivery to Purchaser/Distributor. SPECTREX expressly excludes damage incurred in transit from the factory or other damage due to abuse, misuse, improper installation, or lack of maintenance or "Act of God" which are above and beyond its control. SPECTREX will, upon receipt of any defective product, transportation prepaid, repair or replace it at its sole discretion if found to have been defective when shipped. Said repair or replacement is SPECTREX's sole liability under this warranty and SPECTREX's liability shall be limited to repair or replacement of the component found defective and shall not include any liability for consequential or other damages. The customer is responsible for all freight charges and taxes due on shipments both ways. This warranty is exclusive of all other warranties express or implied.

Release History

Rev	Date	Revision History	Prepared by	Approved by
Aa	August 2018	First Release	Michal Heller	Udi Tzuri
Ab	December 2018	Second Release	Michal Heller	Udi Tzuri
Ac	February 2019	Third Release	Michal Heller	Udi Tzuri
Ad	March 2019	Fourth Release	Michal Heller	Udi Tzuri
Ae	July 2021	Fifth Release	Michal Heller	Udi Tzuri

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1 Scope

1.1 Product Overview

The SafEye 300 Series is an IR open-path gas detector that detects ambient combustible gases at LEL*m concentrations over a path length from 2ft/0.6m up to 11.5ft/3.5m, even in harsh environments.
The shorter path lengths are usually associated with applications in ducts/air intakes to provide a fast response to ingress of flammable gases.

Due to its unique combination of triple optics and dual-spectrum reference sensor, the SafEye can maintain operation in up to 90% signal obscuration and ±2 degree of misalignment.

SafEye has a fast response detection time of no more than 2 seconds. This feature enables an adequate time to take appropriate safety measures.

This manual contains instructions on the installation, operation and maintenance of the product.

- To use the host software to change the required functions and for maintenance, refer to *Manual TM899050* for instructions.
- To use HART protocol to change the required functions and for maintenance, refer to *Manual TM899030*.

2 Technical Description

2.1 Features

- Operating distance from 2ft/0.6m up to 11.5ft/3.5m
- Simultaneous detection of C_1–C_8 flammable hydrocarbon gases
- High sensitivity and fast detection response
- Continuous operation in extreme and harsh environmental conditions
- Withstands extreme vibration conditions
- Interfaces with most commonly used control panels
- Standard 4–20mA and dry contact relay outputs
- RS-485 output for PC communications network for a maximum of 64 systems
- HART communication protocol
- Simple 1-person installation
- SIL-2 approval by TÜV
- Programmable configuration

2.2 Applications

The SafEye system may be used to monitor flammable gas concentration in air-intakes and duct installations found in various industries, such as:

- Petrochemical, chemical, and pharmaceutical production areas
- Refineries, oil platforms, pipelines, refueling stations, and fuel storage facilities
- Engine rooms
- Compressor and pumping stations
- Hazardous enclosures and test cells
- LNG-LPG systems
- Offshore Floating Production Storage and Shipping vessels (FPSO) and fixed oil rigs

2.3 Principle of Operation

The SafEye system detects gases through a dual spectral range monitoring, analyzing the absorption of radiation caused by gases in the atmosphere, and comparing it (ratio) to background atmospheric absorption.

2.3.1 Definitions of Terms

The following list defines gas concentrations measurement terms that are used in this manual:

LEL Lower Explosive Limit - The minimum concentration of a substance (gas/vapor) in air mixture that can be ignited. This mixture is different for every gas/vapor, measured in % of LEL.

LEL*m Integral of Concentration in LEL units (1 LEL = 100% LEL) and the operation distance, or path length, in meters (m).

2.3.2 Spectral Finger Print

Each hazardous material is detected at a specific wavelength selected according to its specific spectral absorption or "fingerprint." There are 3 IR sensors: 2 signals and 1 reference. The detection process involves 2 separate filters: 1 transmitting radiation that is absorbed by a particular gas and 1 that is not sensitive to it.

2.3.3 Optical Path

The presence of hazardous airborne vapors, gases, or aerosols in a monitored area is detected when the defined substance crosses/enters the optical path between the radiation source unit and the detector.

Hazardous gases/vapors present in the atmosphere cause absorption of the radiation pulse in the optical path between the radiating source and the detector unit at some specific wavelengths. This causes a change in the signal intensity received by the detector, which is translated into an output related to the detector's measuring scale.

The system analyzes the defined open path at the spectral bands specific to the materials being monitored.

2.3.4 Microprocessor Based

The incoming signals are analyzed by the built-in microprocessor. A sophisticated mathematical algorithm calculates between the various functions of the detected signal thresholds. Statistics, ratio algorithms, data communications, diagnostics, and other functions are performed.

2.3.5 Gas Sensitivity

The SafEye 300 series uses wavelengths around the 3.4µ spectral band to measure air flammability potential between the source and detector. At this wavelength, hydrocarbon-based gases have a strong absorption peak. The measuring scale in which gas concentration is detected can be selected using RS485 Winhost, or HART communication. The two measuring scale options are:

- 1 LEL.m
- 2.5 LEL.m.

2.3.6 Gas and Mixture Selection and Setting

Every SafEye has 4 built-in gas calibration settings that can be changed by function setup.

The calibration settings are designed for use in various applications:

Gas 1 Pure methane and is for use in methane storage and piping applications

Gas 2 92% methane, 4% propane, and 4% ethane (default). Universal oil and gas production mixture to be used in all cases where methane concentration in the mixture does not exceed 98%. It can also be used for pure ethane applications.

Gas 3 LPG – 60% propane and 40% butane.

Gas 4 99% methane and 1% propane and is for use in detecting methane mixture with heavier gases where the methane component can vary between 100% and 95%. It is also good for protecting areas where a leak can be either pure methane or pure propane.

The 4 internal gas calibrations cover most of the flammable gas detection applications. Actual selections should be made by the user in consultation with experts to provide for safety requirements. However, for special cases where none of the 4 calibrations are appropriate, SPECTREX, through local agents, can advise on how to calibrate a SafEye detector to any specific gas.

2.3.7 HART Protocol

The SafEye 300 uses the HART Protocol.

HART communications is a bi-directional industrial field communications protocol used to communicate between intelligent field instruments and host systems. HART is the global standard for smart instrumentation and the majority of smart field devices installed in plants worldwide are HART-enabled.

HART technology is easy to use and very reliable.

Through the HART connection, the SafEye is able to perform:

- Detector set-up
- Detector troubleshooting
- Detector health and status

For more details, refer to the *HART Manual TM899030*.

2.3.8 Modbus RS-485

A PC can be used for onsite function programming and setup changes to the detector using RS-485 Modbus-compatible output. This feature enables easy maintenance of local and remote diagnostic tools.

During installation, the personal computer with the preinstalled Winhost software, which could be downloaded from the product web page will display all the detector's parameters and confirm that the installation has been completed successfully. It is also required to perform the necessary zero calibration function.

For more details, refer to *Manual* TM899050.

2.4 Product Certification

The SafEye 300 Series is approved by the following certifications:

2.4.1 FM

The SafEye 300 series is approved per FM certification:

Class I, Div. I, Groups B, C, and D

Class II, Div. I, Groups E, F, and G

Type 6P, IP66/IP67

2.4.2 SIL-2

The SafEye 300 is TUV approved for SIL-2 requirements per IEC 61508.

According to SIL-2 requirements, the alert condition can be implemented by an alert signal via the 0–20mA current loop.

2.5 300 Series Model

The SafEye 300 is available in the following model.

Table 1: SafEye 300 IR type Model Information

Model	Distance		Detector*	Light Source*
	Ft	m		
301	2–11.5	0.6–3.5	OP-IL000DFAL	OPS-LI0DFAL

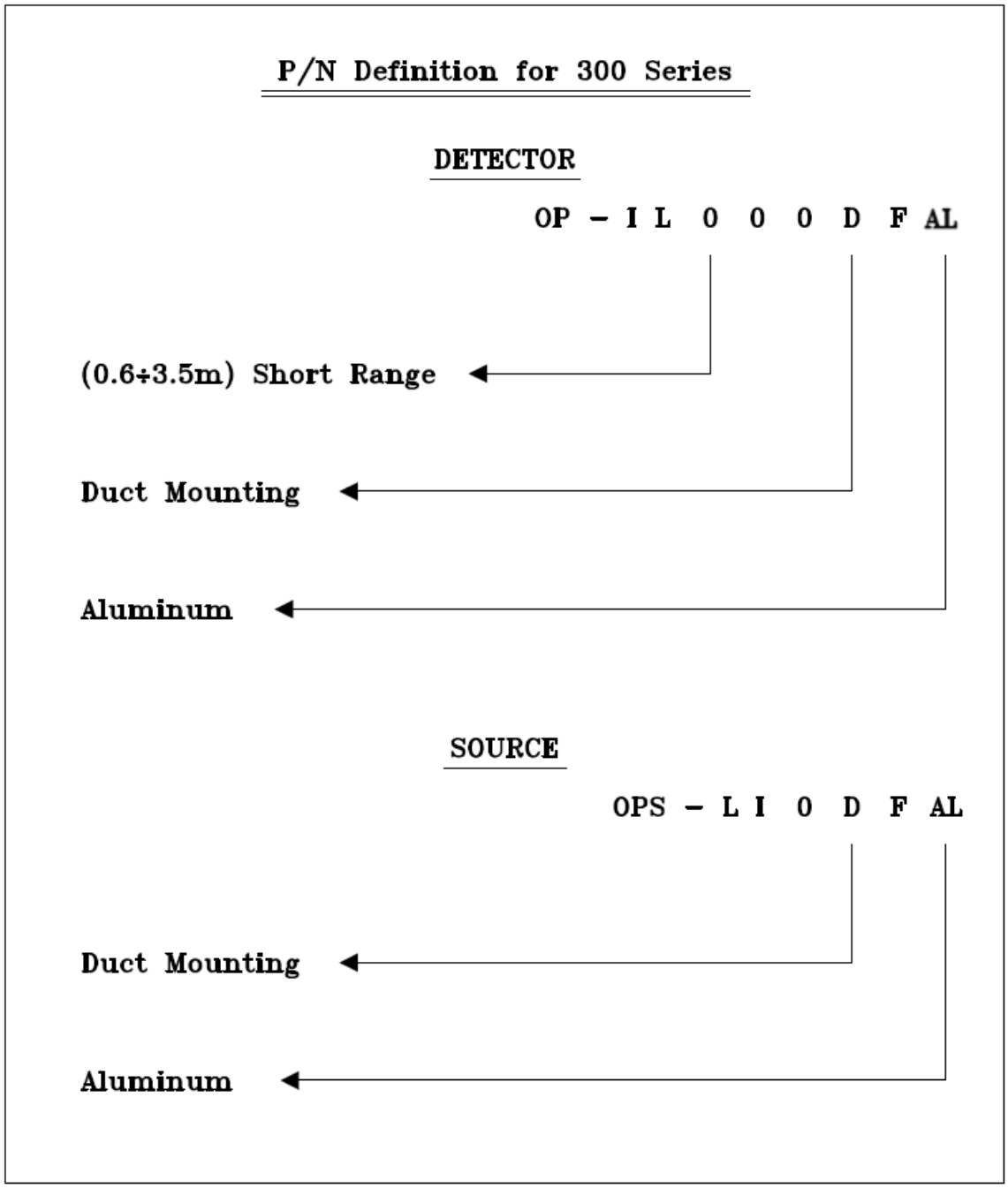


Figure 1: P/N Definition for the 300 Series

2.6 Description

The system comprises 2 main units: the light source and the detector. The SafEye 300 Series detects gases over an open path transmitted from the light source to the detector.

2.6.1 Light Source Unit

The light source unit emits IR radiation pulses in a collimated beam to the detector unit.

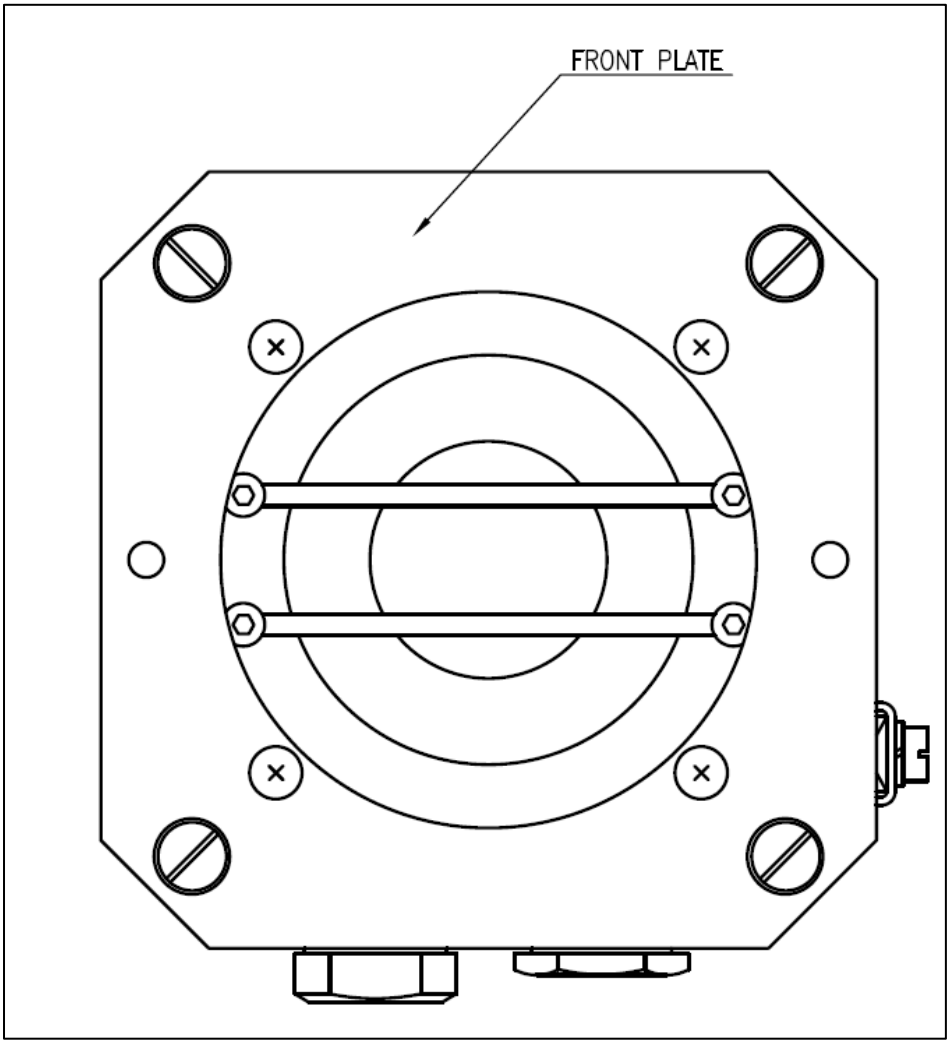


Figure 2: Light Source – Reflector Type

2.6.2 Detector Unit

The detector's sensors receive the transmitted pulsed radiation signals from the light source (see Figure 3). The detector uses sophisticated signal processing techniques for the detection of the targeted gas. The detector output signals can be sent to a standard control panel or to a central computer.

The 300 Series detector, model no. OP-IL000DFAL is available for short-range, duct mounted installation.

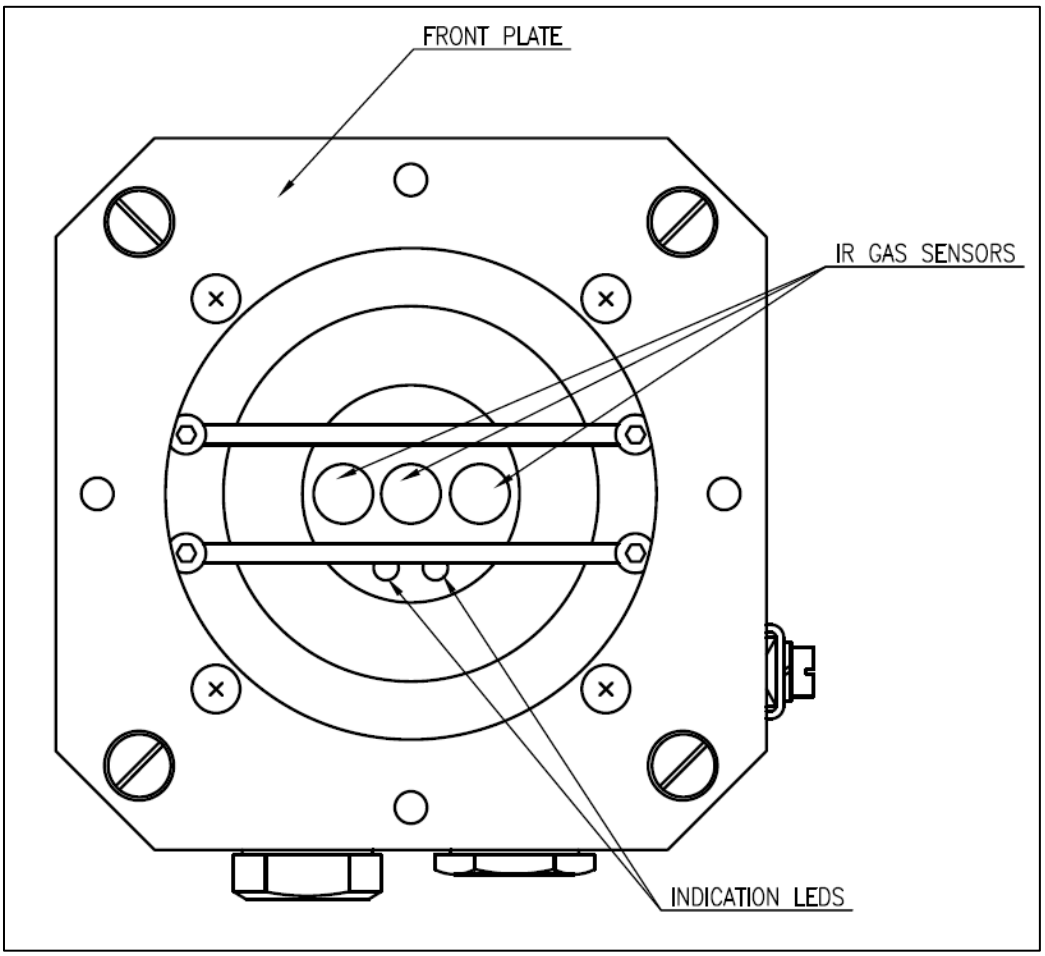


Figure 3: Detector

3 Operation Mode

The SafEye system has 3 operation modes: Normal, Alignment, and Zero Calibration.

3.1 Normal Mode

This mode is used for gas detection. The following status signals are possible (see Table 2 for visual indications):

Normal	The targeted gases have not been detected at warning / alarm levels
Warning	The targeted gases have been detected at warning levels
Alarm	The targeted gases have been detected at alarm levels

3.2 Fault Mode

There are 3 fault types:

- **Fault 1 (2mA Output)**
  Detection is no longer possible due to poor alignment, very low signal, or obscuration. This mode will occur after a delay of 60 sec. from the moment of the fault. This delay is important to eliminate momentary obscuration through the beam. The detector will automatically return to normal operation when the reason for fault is no longer present.
- **Low Voltage Fault (0mA Output)**
  In this case, **detection is disabled** due to low voltage being supplied to the detector. The detector returns to proper operation only when proper voltage level is restored.
- **Fault 2 (0mA Output)**
  In this case, the **detection is disabled** due to an electrical/software operational failure fault.

3.3 Alignment Mode

This mode is used during initial alignment and periodic maintenance. Please connect the device to Winhost/HART and refer to Table 10 on page 56 for signal verification parameters. There is a temporary standby mode to enable the option of switching from alignment mode to zero calibration mode (setting the baseline).

3.4 Setting the Baseline (Zero Calibration Mode) - 1mA Output

This mode zeros the base level from which the detector will read gas.

It should only be performed after verifying the installation parameters (refer to Table 10 on page 56) and when there are:

- No combustible gases present
- Clear paths between the light source and detector
- Clear weather conditions

Zero calibration must be performed after installation, re-alignment, and window cleaning, using RS485/HART to verify the installation parameters.

The Magnetic mode selector, supplied in the Commissioning Kit, can be used to zero the values, instead of clicking of the relevant button in RS485/HART communication.

3.5 Mode Selection

RS485/HART, For Mode A magnetic mode selector is used to change to alignment and calibration modes by placing the magnet on the side of the detector (Figure 16).

3.6 Visual Indicator LEDs

In most cases, when the detector is connected to the duct, the visual indicator LEDs are not applicable. If the front window is visible, the visual indicators are applicable. Otherwise, please refer to 4-20mA outputs, relays, RS485/HART statuses.

There are 2 indicators (LEDs) located in the detector's front window, referred to as the right and left LEDs. They display red, orange, and green lights that can be either "On" steady, flashing, or "Off."

Table 2: Status Indication

Status	Remarks	4–20mA Output
Normal		4mA
Warning		14mA
Alarm		19mA
Fault 1		2mA
Fault 2		0mA
Low Voltage		0mA
Alignment Mode	First receives the intensity compared to the last calibration: The intensity is min. 80% of the last calibration intensity	0mA
	80%–60%	0mA
	60% or less	0mA
	After 20 seconds the color represents the signal intensity	0mA
Standby mode		0mA
Calibration mode		0mA

Once the baseline has been set, the device will return to normal mode.

3.7 Output Signals

The SafEye system provides the following outputs:

- Standard 4–20mA port
- Three dry contact relays
- Optional RS-485 output for PC communications
- HART Communication

3.7.1 4–20mA Current Output

The 4–20mA is measured proportionally showing a continuous reading of the exact gas concentration (see Table 3).

The 4–20mA functions as the current source. The maximum permitted load resistance for the 4–20mA output is 600ohms. The minimum permitted load resistance is 100ohms.

Table 3: Standard 4–20mA Current for the Gas Channel

Current	Status and Description
0mA + 0.5mA	Fault 2 or low voltage
2mA ± 0.5mA	Fault 1
4mA ± 0.5mA	Zero reading - no gas detected
4–20mA	Continuous measuring of gas concentration at a range between 0 and 5 LEL*m or full scale
21mA	Concentration is over the range limit (more than full scale concentration).

3.7.2 Relays

The detector includes 3 relays:

- Fault relay
- Alarm relay
- Accessory relay

Fault relay contacts are normally energized closed and opened when in fault condition.

3.7.3 RS-485 Interface

The RS-485 input/output sends data information to a PC and receives data or control commands from the PC. The protocol is Modbus-compatible. Communication with the PC is operated through this interface is executed only when used with appropriate host software (available to download for free from the product page on the Spectrex website)

3.8 Terminals

Terminal outputs are described for the detector and the light source.

3.8.1 Detector Terminal

Terminal wiring: Figure 4 displays a schematic diagram of the terminals and Figure 5 shows their location.

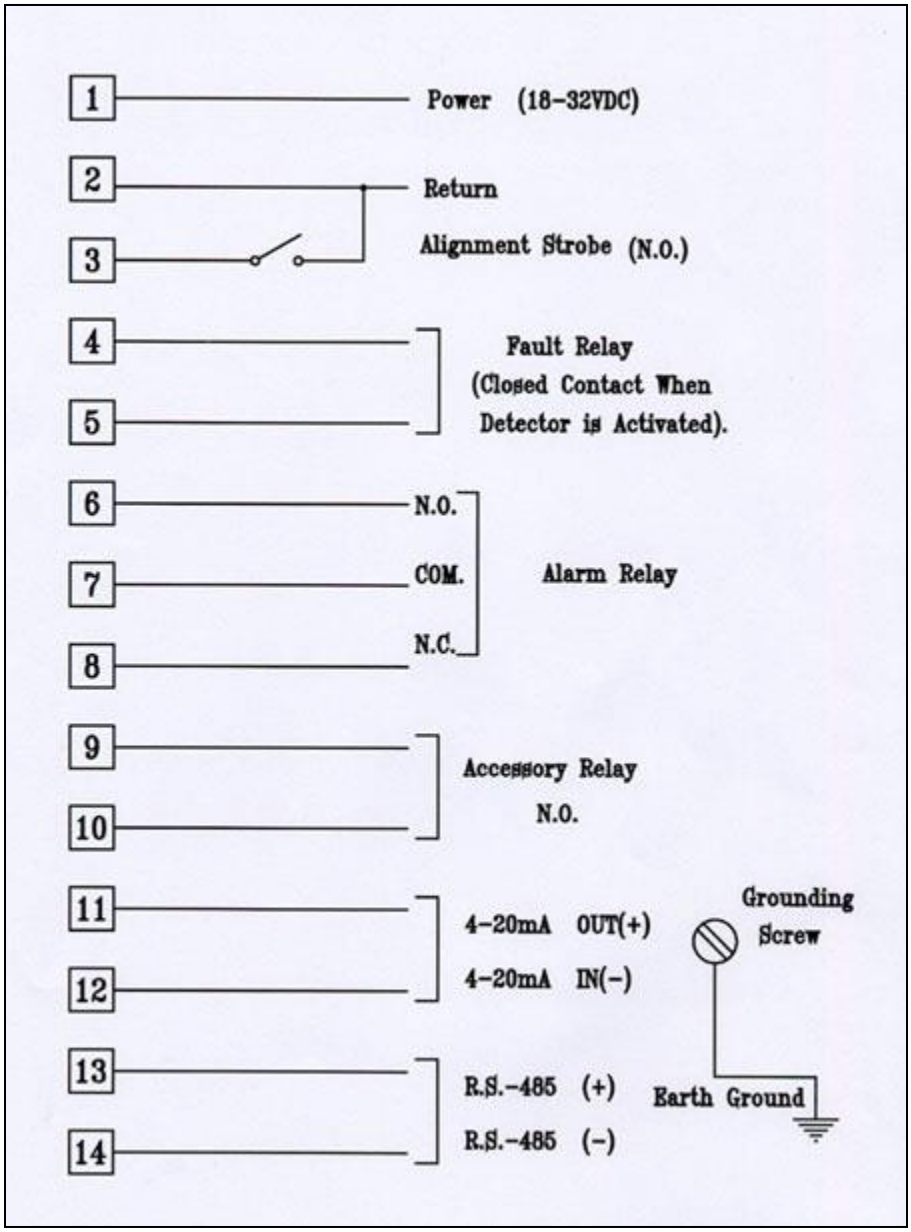
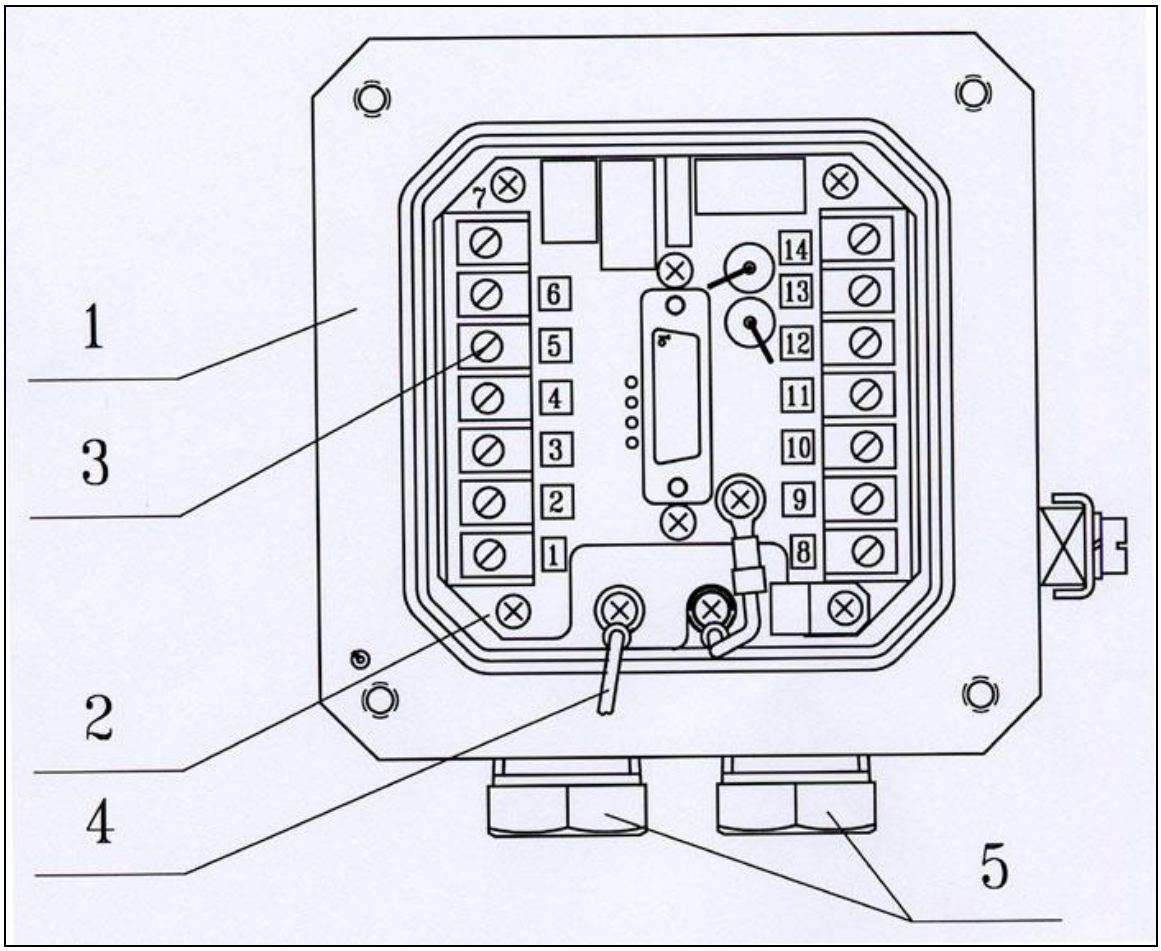


Figure 4: Detector Wiring Diagram



Description	
1	Detector Cover
2	Terminal Board
3	Terminal Screw
4	Securing Cable

Figure 5: Detector Terminal Board

3.8.2 Light Source Terminals

Figure 6 shows the terminals board and Table 4 describes their use.

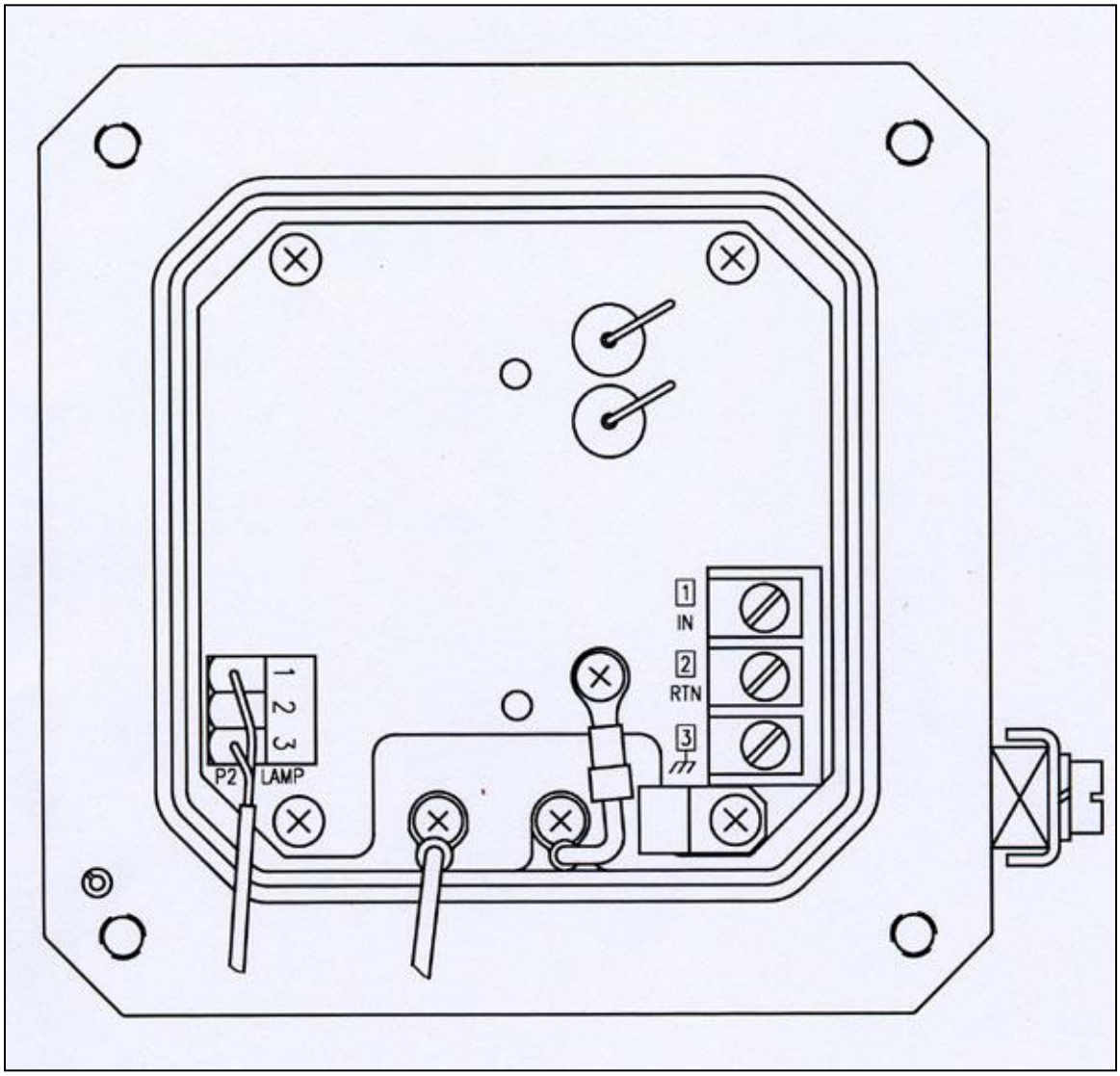


Figure 6: Light Source Terminal Board

Table 4: Light Source Terminals

Light Source Terminal Number	Description
1	VIN
2	RTN

3.9 System Setup

The SafEye 300 series is configured according to the default settings. See *Detector Default Setup* on page 31

It incorporates several functions that can be set by the customer using:

- **Host software**: Refer to *Manual TM899050* for programming instructions
- **HART Communication:** Refer to Manual

3.9.1.1 Selecting the Gas Type

There is no need for field calibration. The detector is factory calibrated to four basic gas types which can also be used to detect other gases based on cross-sensitivity. For more information about detection of other gas types, please contact your regional Spectrex representative.

Factory Calibrated Gas Types:

- Gas type 1: Methane
- Gas type 2: Mixture 92% methane 4%, ethane 4%, propane (default)
- Gas type 3: LPG - 60% propane, 40% butane
- Gas type 4: Mixture 99% methane, 1% propane

3.9.1.2 Measurement Scales

The SafEye 300 series has two selectable measurement scales: normal and high sensivity.

Table 5: Sensitivity Levels Options 301 SIL

Sensitivity	Full Scale	Warning Level	Alarm Level
Normal	2.5 LEL*m	1 LEL*m	1.5 LEL*m
High	1 LEL*m	0.4 LEL*m	0.6 LEL*m

When selecting a full scale value, the warning and alarm level will automatically change accordingly.

3.9.1.3 Background Adjustment

Background adjustment – use of constant monitoring of environmental conditions to make automatic adjustments.

Background adjustment enabled	Device adjustment is performed according to background
Background adjustment disabled	Device not adjusted due to change of background

3.9.1.4 Winhost Address Setup

The detector provides up to 247 addresses.

3.9.2 Detector Default Setup

Detector Default Setup	
	SafEye 301
RS485 Address	1
Gas type	2
Full scale sensitivity	2.5 LEL*m
BG zero calibration	Enabled
Accessory relay	Warning
Alarm latching	No

4 Technical Specifications

4.1 General Specifications

Detected Gases: Simultaneous detection of selected C_1–C_8 flammable gases

Table 6: Detection Distance Range

Model No.	**301**
Distance (ft)	2–11.5
Distance (m)	0.6–3.5
Response Time	Typically, 2 sec., max. 5 sec.

Spectral Response: 3.0–4.0µm

Table 7: Sensitivity Range

Sensitivity	**301**
Standard	0–2.5 LEL*m
High	0–1 LEL*m

Field of view: Line of Sight

Alignment tolerance: ± 2°

Drift: Long term ± 5% of full scale

Temperature range: -40°F/-40°C – +185°F/+85°C

Immunity to false alarms: Does not produce false alarms due to hydrocarbon flames and IR radiation sources

4.2 Electrical Specifications

- **Operating Voltage**: 18–32 VDC

  Power Consumption

  Detector 200 mA at 24 VDC (250 mA peak)

  Source 250 mA at 24 VDC (450 mA peak)

- **Electrical input protection**:
  The input circuit is protected against voltage-reversed polarity, voltage transients, surges, and spikes according to MIL-STD-1275A.
- **Electrical Interface** (see Figure 5).
- **Electrical outputs.**

4.2.1 4–20mA Current Output

The 4–20mA is a source configuration. The maximum permitted load resistance is 600ohm.

4.2.2 Communication

Communication with the SafEye 300 series can be via RS485 or HART protocol.

4.2.2.1 RS485

The detector is equipped with an RS 485-communication link that can be used in installations with computerized controllers.

Communication is compatible with the Modbus protocol through RS485 communication. It enables continuous communication between a single standard Modbus controller (master device) and a serial network of up to 247 detectors.

4.2.2.2 HART

The HART protocol is a digital communications signal at low level on top of the 0-20mA.

This is a bi-directional field communications protocol used to communication between intelligent field instruments and the host system.

Through the HART protocol, the detector can:

- Display setup
- Reconfigure setup
- Display detector status and definition
- Perform detector diagnostics
- Troubleshoot

4.2.3 Relay Output

The detector includes the following three relays.

Table 8: Dry Contact Relays

Relay	Type	Normal	Maximum Ratings
Alarm*	SPST	N.O.	2A at 30VDC
Accessory*	SPST	N.O.	2A at 30VDC
Fault**	SPST	N.C.	2A at 30VDC

* Alarm and accessory relays are normally de-energized open. When in the Alarm or Warning status, the appropriate relay is closed.

** Fault relay is normally energized closed and the contact will be closed. When it is in Fault status, the relay is opened.

4.2.4 HART Protocol

The HART protocol is a digital communications signal at low level on top of the 0–20mA.

This is a bi-directional field communications protocol used to communicate between intelligent field instruments and the host system.

Through the HART protocol the detector can:

- Display setup
- Reconfigure setup
- Display detector status and definition
- Perform detector diagnostics
- Troubleshoot

4.3 Mechanical Specifications

Enclosure:	Anodized aluminum with less than 1% magnesium with an epoxy enamel finish	
Approvals:	FM	Class I Div. 1 Groups B, C, and D Class II Div. 1 Groups E, F, and G
	SIL-2	Per IEC61508 (TÜV)
Electrical Connection:	2x3/4" - 14NPT conduits	
Water and Dust-Tight:	IP66 and IP67 NEMA 250 Type 6p	
Weight and Dimensions	See Table 9	

Table 9: Detector/Source Weight and Dimensions

Detector/source type and application	Al. enclosure		Dimensions	
	Lb	Kg	Inch	mm
Detector	8.1	3.7	5.2x5.2x4.7	132x132x120
Source	8.5	3.9	5.2x5.2x4.7	132x132x120

4.4 Environmental Specifications

- **High Temperature:**
  Designed to meet MIL-STD-810C, Method 501.1, Procedure II.

  Operating temperature: +185ºF/+85ºC

  Storage temperature: +185ºF/+85ºC

- **Low Temperature:**
  Designed to meet MIL-STD-810C, Method 502.1, Procedure I.

  Operating temperature: -40ºF/-40ºC

  Storage temperature: -40ºF/-40ºC

- **Humidity:**
  Designed to meet MIL-STD-810C, Method 507.1, Procedure IV.
  Relative humidity of up to 95% for the operational temperature range.
- **Salt and Fog:**
  Designed to meet MIL-STD-810C, Method 509.1, Procedure I.
  Exposure to a 5% salt solution for 48 hours.
- **Water and Dust**:
  Designed to meet IP66 and IP67 per EN60529

  Dust: Totally protected against dust.

  Liquids: Protected against immersion between 15cm and 1m in depth.
  Protected against all water jets from all directions.

- **Shock and Vibration:**
  Vibration: Designed to meet MIL-STD-810C, Method 514.2, Procedure VIII.

  Mechanical Shock: Designed to meet MIL-STD-810C, Method 516.1, Procedure I.

- **Electromagnetic Compatibility (EMC):**
  This product is designed to meet EMC directive 89/336/EC.

Radiated Emission	EN61000-6-3
Conducted Emission	EN61000-6-3
Radiated Immunity	EN61000-4-3
Conducted Immunity	EN61000-4-6
ESD	EN61000-4-2
Burst	EN61000-4-4
Surge	EN61000-4-5

5 Installation Instructions

The detector and light source units can be installed and maintained with the use of general-purpose common tools and equipment.

5.1 General Considerations

5.1.1 Required Tools

The detector can be installed using general-purpose common tools and equipment. An open wrench is required for installation of the duct mount and detector and alignment.

5.1.2 Site Requirements

When selecting a site location and position for the SafEye system, the following points must be considered:

- The individual site requirements
- The detector should have a direct view of the source
- The mounting point for each item should be secure and stable with minimal vibrations
- Equipment should be either mounted in a position where it cannot be knocked out of alignment, or it is guarded from physical impact

5.1.3 The Source and Detector

The open path between the source and detector and the immediate surroundings should be kept clear of obscuration that might hinder the free movement of air in the protected area or block the infrared beam.

5.1.4 Guidance Tips for Gas Detector Locations

The following are some tips for selecting gas detector locations, in order to provide the best detection coverage:

- For heavier-than-air gases: below potential leak sources.
- For lighter-than-air gases: above potential leak sources.
- Along the expected leak trajectory: near leak sources, considering prevailing wind directions.

5.2 Needed for Installation

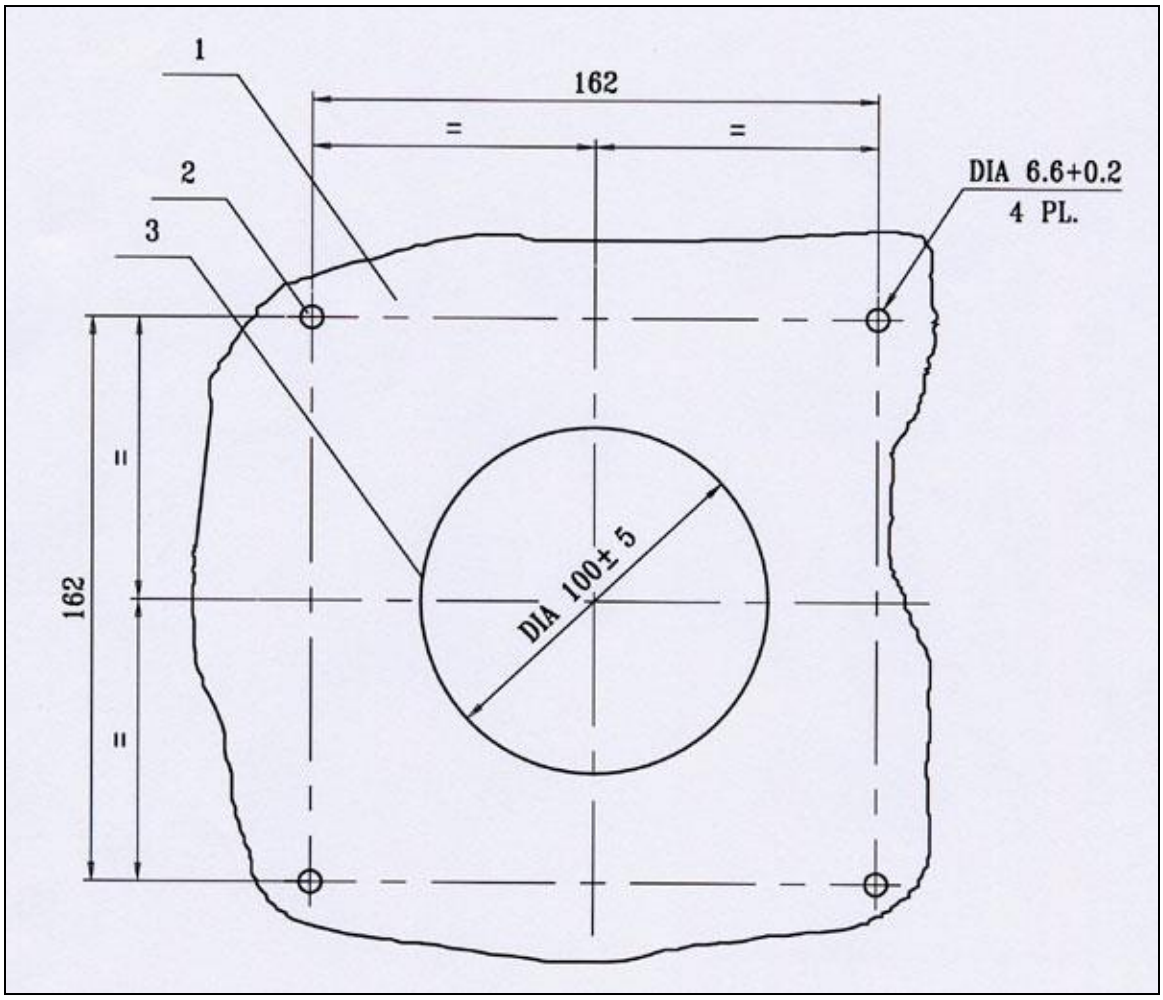
- Detector unit
- Source unit

- Two duct mounts – 1 for the detector and 1 for the light source.
- RS485 Communication harness – 794079
- PC/laptop with Windows 10
- Commissioning kit 794247-5:
    - The commissioning kit includes an alignment toll and check filter. The kit is used for installation and maintenance and then removed. The kit can be used for all other SafEye installations on the site. Therefore, only 1 set is required for several detectors.

5.2.1 Duct Installation: Surface Preparation

The duct mount should be installed on both sides of the air duct. The location of the central point of each duct opening on both sides (3) should be at the same distance from the surface edge. This will ensure that the optical axis will be parallel to the air duct.

Figure 7 shows surface drilling dimensions. Prepare the duct opening (3) and the screw holes (2).



Description	
1	Air duct installation surface
2	Duct mount screw securing hole
3	Opening for detector/light source

Figure 7: Drilling Layout Dimensions for Duct Installation

5.2.2 Duct Mount Installation

The following instructions are applicable for both the light source unit and the detector unit.

1) Unscrew the detector plate holding screws, Figure 8, item A.

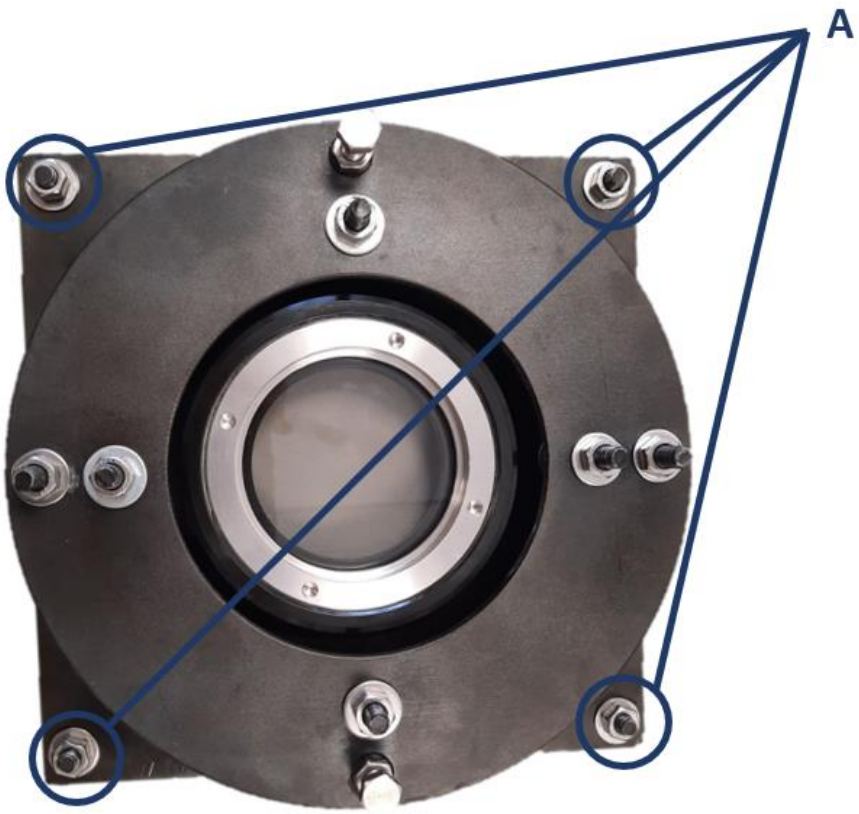


Figure 8: Duct Mount

2) Remove the detector plates, Figure 9, item A.

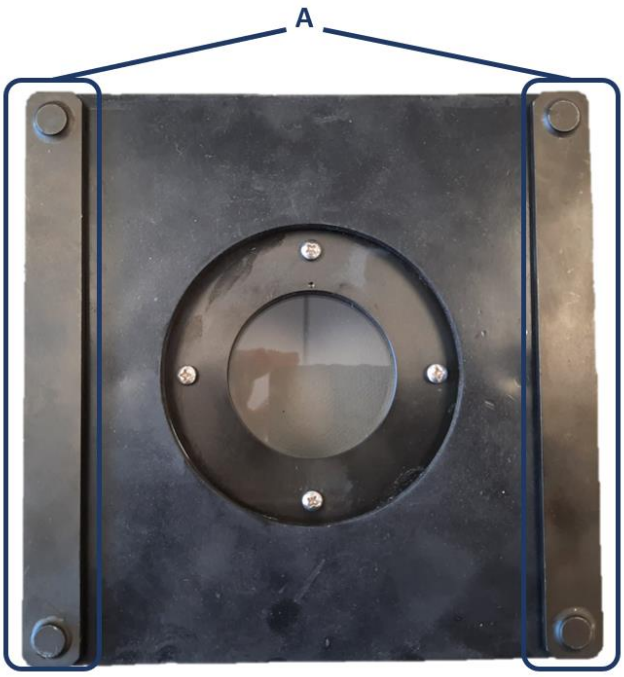


Figure 9: Duct Mount – rear view

3) Insert the detector plate screws into the screw holes, item A, Figure 10 as prepared in section 5.2.1 on page 40

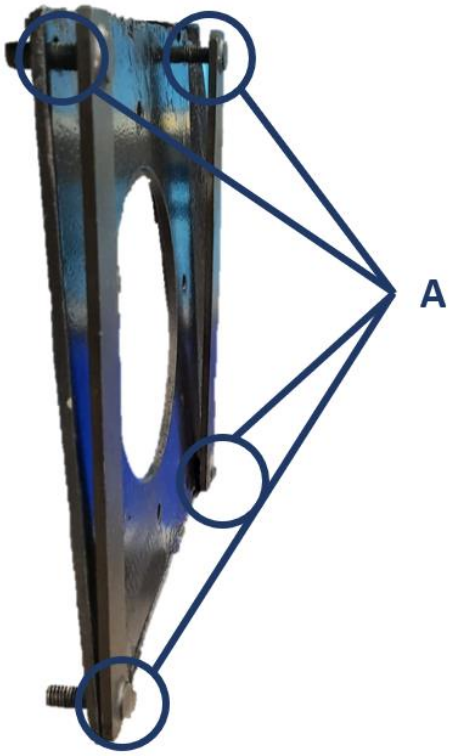


Figure 10: Inserting detector plate screws

4) Place the duct mount front plate on the screws that have been threaded through the drilled screw holes as indicated in **Error! R eference source not found.**.

   Note: Ensure the duct mount is positioned correctly, using the affixed label.

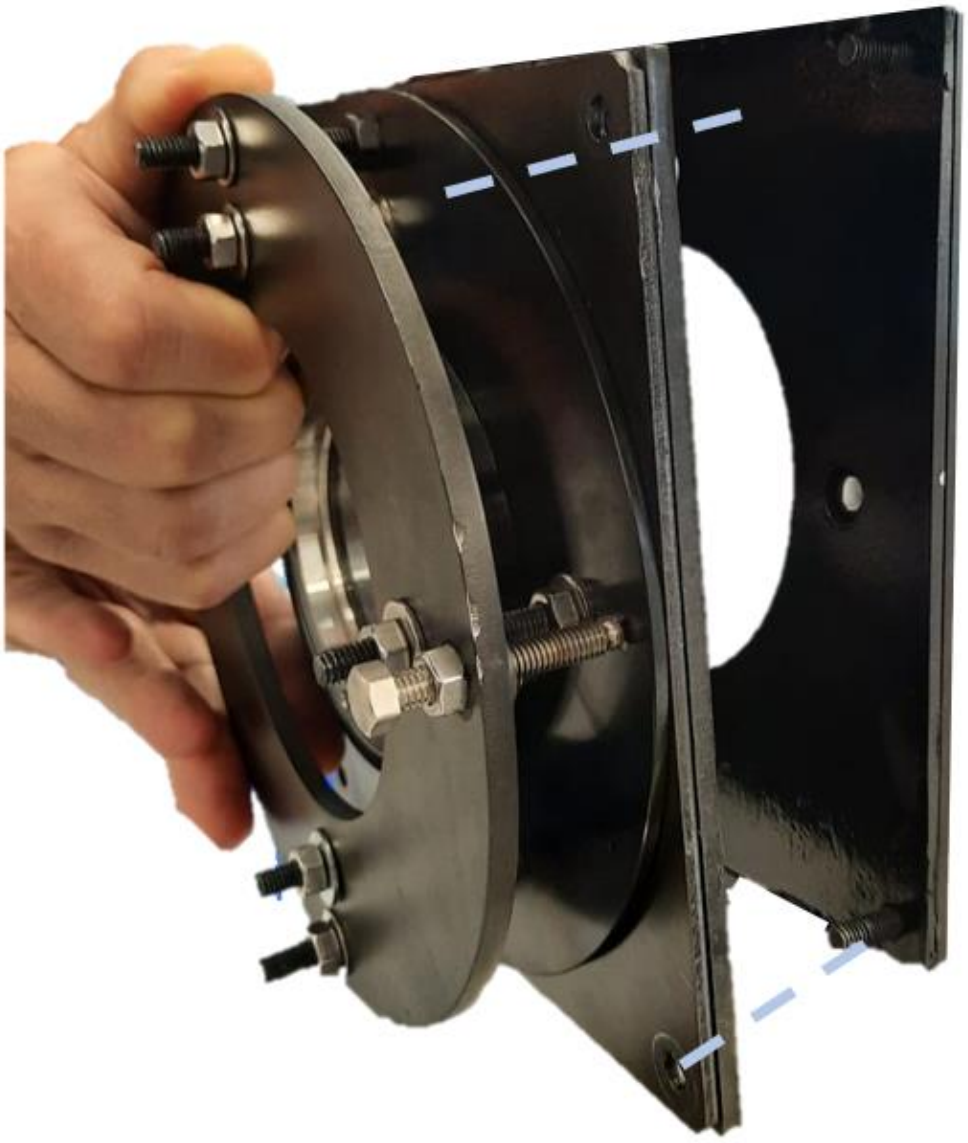


Figure 11: Attaching the duct mount plate

5) Attach washers and nuts to the four detector plate screws, item A, Figure 12 and tighten.

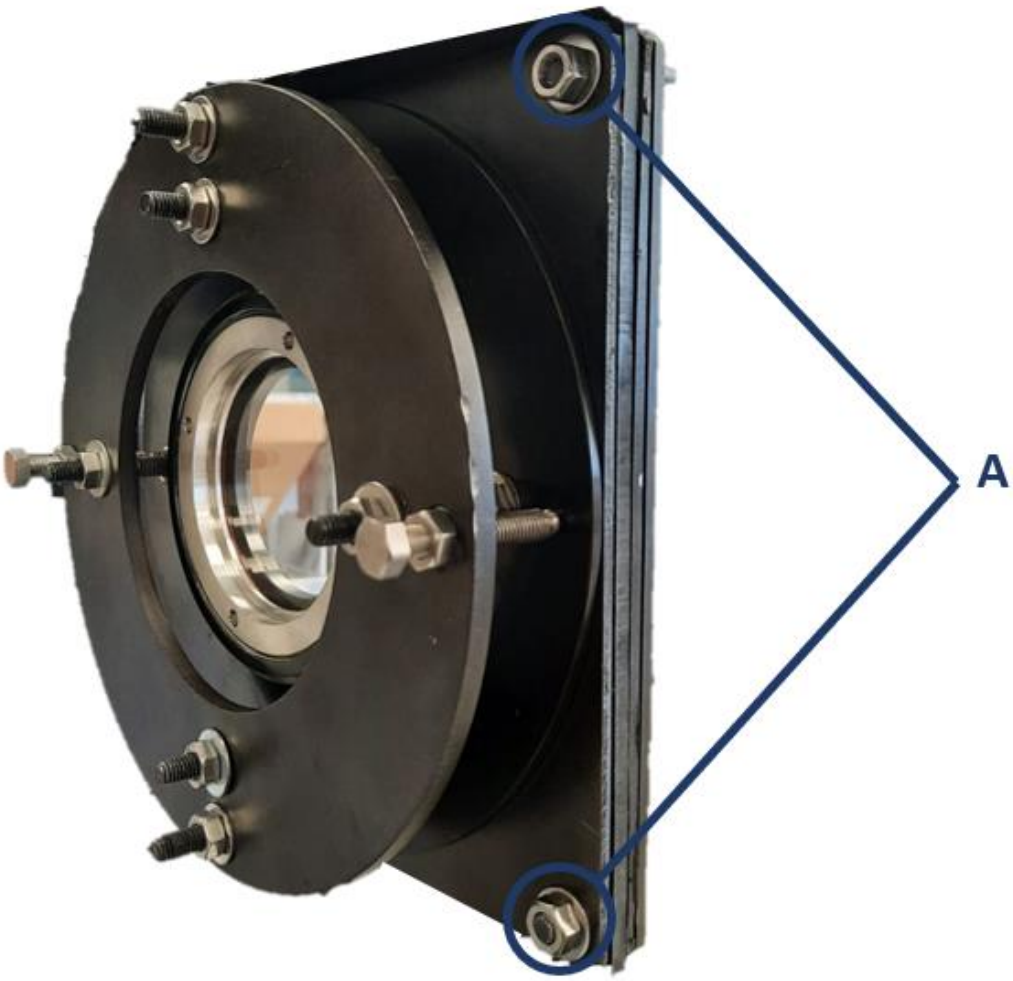


Figure 12: Tightening the detector plate screws

5.2.3 Duct Mount Alignment

The following instructions are applicable for both the light source unit and the detector unit and require the alignment tool, included in the commissioning kit, Figure 13.

Attaching the alignment tool to the duct mount simulates the position in which the device will be attached to the duct mount once the alignment step is complete and the alignment tool removed.

Figure 13: Alignment tool

1) Connect the alignment tool plate, item A, Figure 14, to the duct mount plate, item B, Figure 14 by connecting and tightening the four holding screws, item A, Figure 15

Figure 14: Connecting the alignment tool

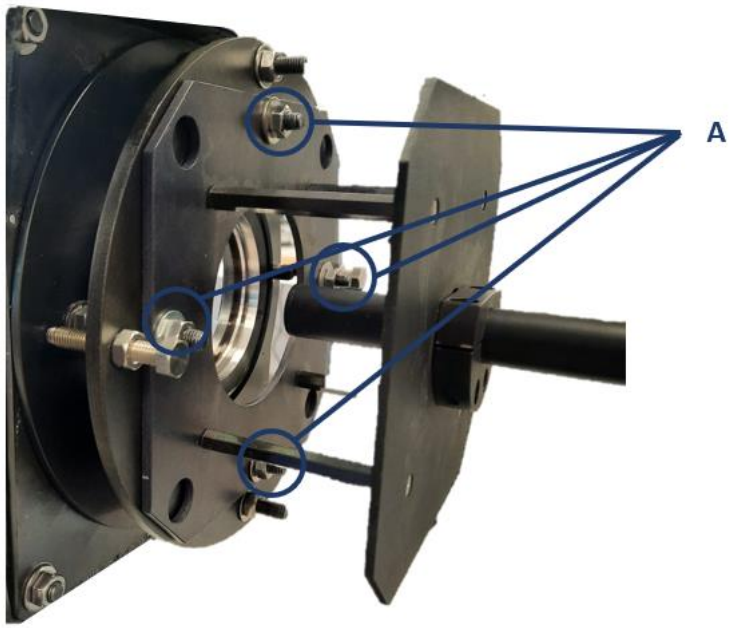


Figure 15: Affixing the alignment tool

2) Look at the aim view, item C, Figure 14 and use the vertical, item A Figure 16, and horizontal, item B Figure 16, nuts to adjust the detector plate angle until you see a cross in the middle of the aim view, as shown in Figure 17.

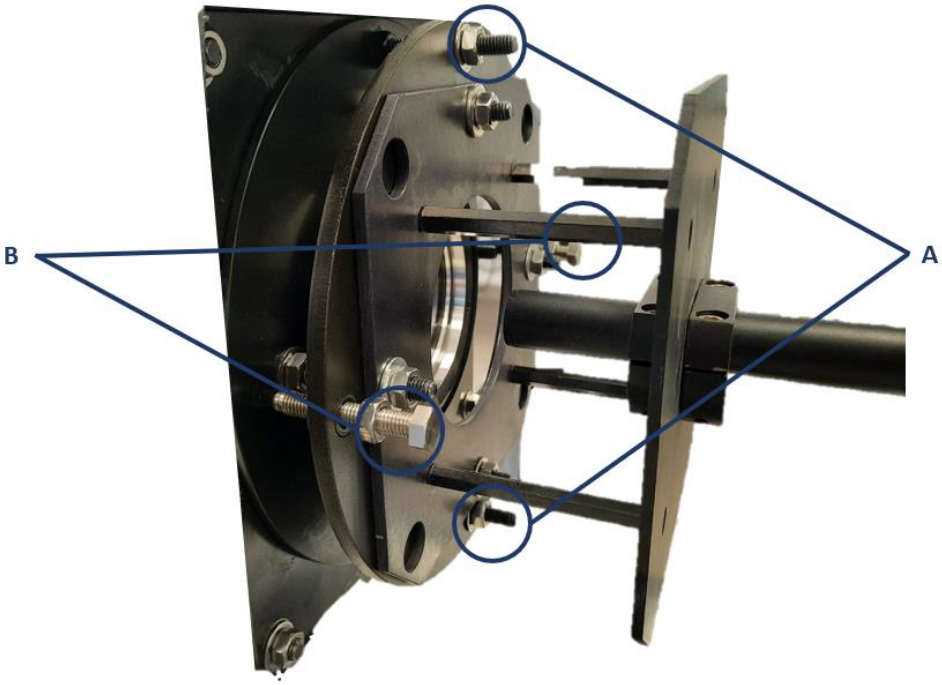


Figure 16: Adjusting the detector plate

Figure 17: Aligning the alignment tool

3) After aligning the alignment tool, remove the alignment tool and affix the device in its place, using the same nuts used to affix the alignment tool.

5.2.4 Conduit/Cable Installation

- To avoid water condensation in the detector, it should be installed with the conduits/electrical entries facing downward.
- Use flexible conduits for the last portion connecting to the detector.
- When pulling the cables through the conduits, ensure that they are not tangled or stressed. Extend the cables about 12”/30cm beyond the detector location to accommodate wiring after installation.
- After the conductor cables have been pulled through the conduits, perform a continuity test.

5.2.5 Harness Connection

➢ **To prepare the harness connection (see Figure 18):**

1 Remove the 4 threaded plugs (13) from detector front.

2 Release the 4 socket-head screws (14) that secure the detector housing (1) to its back cover (2) using no. 5 hex key for M6 screw.

3 Hold the housing during the removal of the screws.

4 Pull the detector housing from its cover.
The cover remains attached to the detector swivel mount. The housing slides under the cover and remains attached to it by a securing cable (8). Do not let the cover simply drop but rather support it until it hangs.
The terminal board (12) inside the detector cover is now revealed.

5 Remove the protective plug (6) mounted on the detector conduit inlet.

6 Pull the wires through the detector cover (2) and secure them firmly to the cover using the cable-tie (16) attached to it.
Use a 3/4”-14NPT explosion-proof conduit/electrical entry connection to assemble the conduit/cable to the detector.

7 Connect the wires to the required terminals (12) according to the wiring diagram (see Appendix B).

8 Connect a grounding cable to the ground terminal (7) outside the detector cover (2). The detector must be well grounded to earth ground for proper operation.

9 Verify the wiring. Improper wiring may damage the detector.

10 Check the wires for secure mechanical connections and press them neatly against the terminal board (12) to prevent them from interfering while closing the detector housing.

11 Dress all wires so they will not interfere with the closure of the unit.

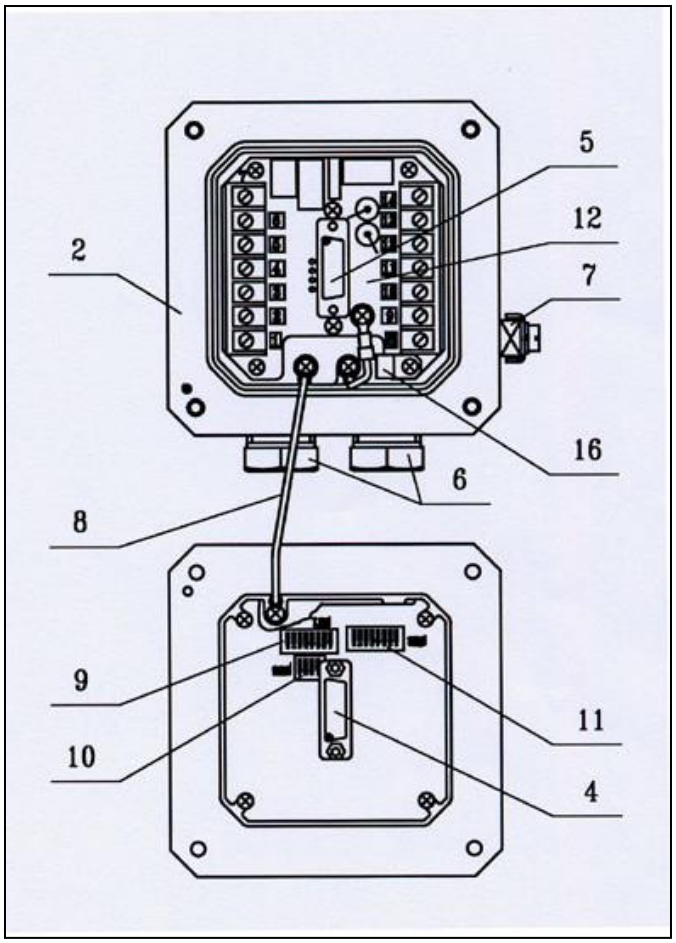
12 Seal the conduit inlet and outlet.

13 Align the 2 connector guide pins in the housing section with the correct openings in the housing section.

14 Carefully slide the housing section onto the floating holes in the female D connector.

15 Using the long handled hex key, tighten the 4M6 1.0Px50 screws (14).

16 Insert the 4 threaded plugs (13).



Description			
1	Housing	9	SW1
2	Cover	10	SW3
3	Screw hole	11	SW2
4	Female D connector	12	Terminal board
5	Male D connector	13	Threaded plug
6	Conduit inlet plug	14	Socket head screw (M6x1.0Px50)
7	Ground terminal screw	15	Screw pan head (No. 4-40UNC-2Ax3/8”)
8	Securing cable	16	Cable tie

Figure 18: Detector with Cover (removed)

5.2.6 Detector Terminal Wiring

The detector contains a terminal board consisting of two parts.

5.2.6.1 Power Supply:

The input power is supplied to Terminal 1. The return is connected to Terminal 2.

Note: Ensure that the detector unit receives a minimum of 18VDC and does not exceed 32VDC.

5.2.6.2 Fault Relay:

The fault relay is normally open. The SPST relay is at Terminals 4 and 5. The contacts are normally energized closed when the detector is in normal operation.

5.2.6.3 Alarm Relay:

The Alarm Relay is SPDT relay. Terminals 6 and 7 are normally open and the contacts are closed when the detector is in the alarm status. Terminals 7 and 8 are normally closed and the contacts are open when the detector is in the alarm status.

5.2.6.4 Accessory Relay:

The Accessory output is normally open SPST relay. Its contacts are at Terminals 9 and 10. It can be defined per user requirements (see Appendix B).

Note: To protect the dry contacts from voltage surges when connected to reactive loads (electric motors, sirens, etc.), connect an appropriate varistor over these contacts.

5.2.6.5 4–20mA Output

Terminals 11 and 12 are used for 4–20mA current output as specified in *4–20mA Current Output* on page 26 (see Appendix B).

5.2.6.6 RS-485 Output

Terminal 13 and 14 are used for the communications network (see Appendix B).

5.3 Light Source Wiring

5.3.1 Power Supply

Input power is supplied to Terminal 1.

The return is connected to Terminal 2 (see Figure 19).

Note: Ensure that the light source unit will receive a minimum of 18VDC and does not exceed 32VDC.

Pre-wiring requirements and wiring requirements are identical to the appropriate requirements for the detector, as described in Appendix A.

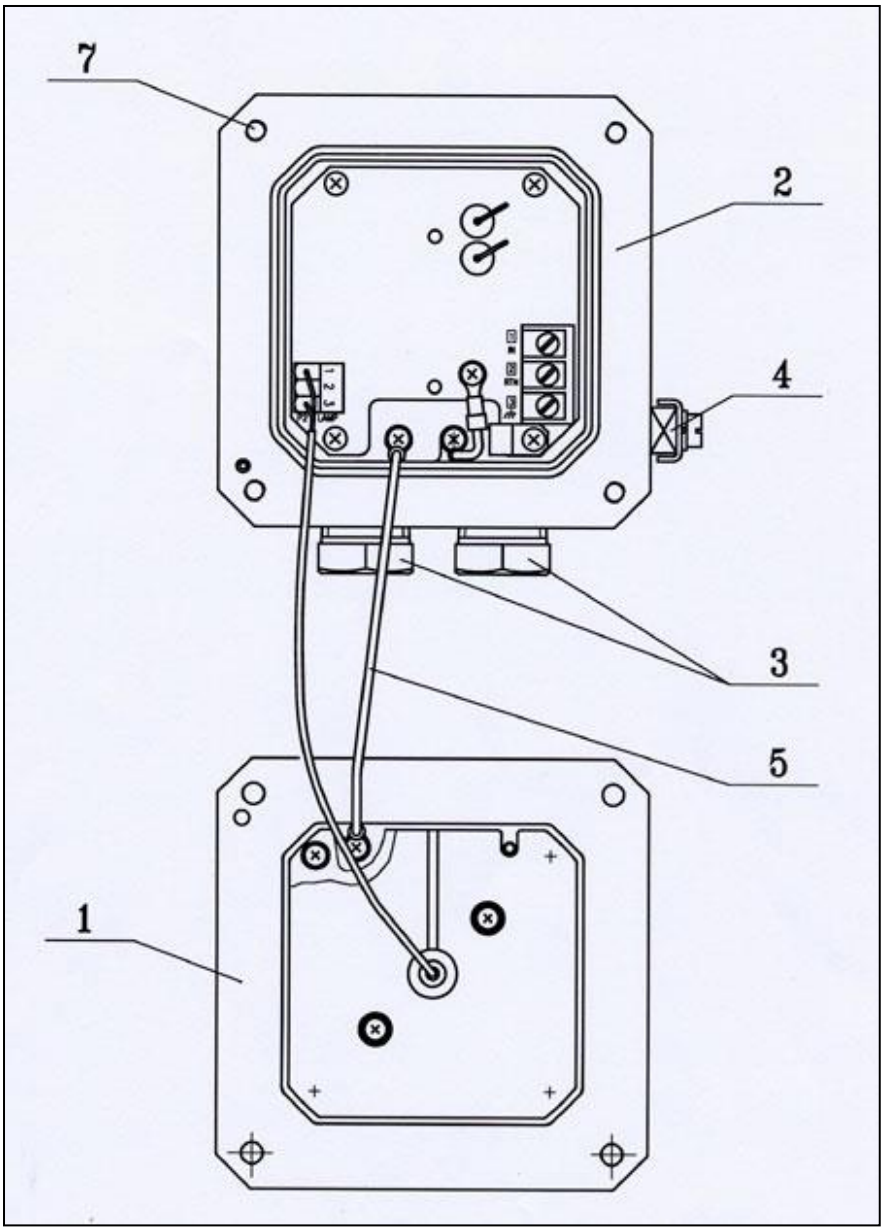
5.3.2 Harness Connection

The instructions for this are identical to the detector (see Figure 18). Refer to *Harness Connection* on page 49.

5.3.3 Terminal Wiring

The light source contains a terminal board (see Table 4). The light source consists of 2 wires only. The positive supply power is connected to Terminal 1 and the common return is connected to Terminal 2.

Connect the grounding cable to the ground terminal (Figure 19, Item 4) outside the light source cover (Figure 19, Item 2). The source must be well grounded to earth ground for proper operation.



Description			
1	Housing	5	Grounding wire
2	Cover	6	Securing cable
3	Conduit/cable inlet plugs	7	Screw hole
4	Ground terminal screw	8	

Figure 19: Light Source - Open View

6 Operating Instructions

6.1 SafEye Operation

Once the system is positioned, it will monitor for possible specified gases, automatically sending signals to a standard control panel or a PC.

This chapter describes the alignment, calibration, and operation of the detector.

Note: Accurate alignment is essential for proper operation of the SafEye system.

6.2 Powering on the System

Note: Prior to any operation or maintenance, follow the *Safety Precautions* on page 55.

- **To power up the system:**

1. Make sure that the source and detector are connected to the power.
2. Make sure that the 4–20mA meter is connected to the detector.
3. Power up the system 18–32VDC.
4. After 60 seconds, the left LED lights at green, the current meter will indicate 4mA.

If it is the first operation after installation, the LED may indicate any status. Zero calibration should be performed after powering the system (see *Safety Precautions* on page 55).

6.3 Safety Precautions

After powering-up, the detector requires minimal attention in order to function properly, but the following should be noted:

- Follow the instructions in the manual and refer to the drawings and specifications issued by the manufacturer.
- Do not open the detector housing while power is supplied.
- Do not touch internal parts other than the 2 functional switches. Interference with internal circuits may impair detector performance and will invalidate manufacturer's warranty.
- Disconnect external devices, such as automatic extinguishing systems, before carrying out any maintenance tasks.

6.4 Signal Verification

Perform signal verification using Winhost software or HART handheld unit using the limitation values detailed in Table 10.

Channel	Installation Distance		
	Min (0.6m)	**Med (2m)**	**Max (3.5m)**
Reference	2.5V Gain 0	1V Gain 1	1.5V Gain 2
Signal 1	2.5V Gain 0	1V Gain 1	1.5V Gain 2
Signal 2	2.5V Gain 0	1V Gain 1	1.5V Gain 2
Ratio 1	0.6-2	0.6-2	0.6-2
Ratio 2	0.6-2	0.6-2	0.6-2
NQRat 1	0.95 – 1.05		
NQRat 2	0.95 – 1.05		
LEL	0 LEL x m		
Temp.	Up to 25° C beyond ambient temp.		
Voltage	32VDC > V > 18VDC		

Table 10: Signal verification limitation values

6.5 Setting the Baseline (Zero Calibration)

Please refer to section 3.4 on page 24 for setting the baseline conditions.

6.6 Validating the Installation

Use the check filter, included in the commissioning kit, to verify that the SafEye 300 Series has been properly installed.

Caution: Automatic activation or any external device that should not be activated during the calibration check should be disconnected.

➢ **To perform a check of the unit:**

1 Position the check filter in front of the SafEye 300 Series detector.

2 The check filter window must be placed in between the base plate and the alignment plate, centered over the viewing window of the detector.

7 Maintenance Instructions

7.1 General Maintenance

The SafEye system requires only simple periodic maintenance to provide satisfactory service and achieve maximum performance. The detector and source units can be maintained with the use of common tools and equipment.

Note: The maintenance can be performed through RS-485. For more details, refer to *Manual TM899050*.

7.2 Periodic Maintenance

The source and detector viewing windows should be kept as clean as possible. The frequency of cleaning operations depends on the existing environmental conditions and the applications used.

- **To perform periodic maintenance:**

1. Perform alignment procedures each time that the source or the detector unit are opened or moved for any reason.
2. The signal verification check corroborates the proper alignment. This check should be performed every 6–12 months. The signal should be checked according to threshold levels (see *Signal Verification* on page 62).
3. Perform a functional check every 6 months (see
4. *Validating the Installation* on page 56).
5. Perform the alignment procedure only if the signals are below threshold value (see *Signal Verification*, page *62*).
6. Set the baseline (see *Signal Verification*

Perform signal verification using Winhost software or HART handheld unit using the limitation values detailed in Table 10.

Channel	Installation Distance		
	Min (0.6m)	**Med (2m)**	**Max (3.5m)**
Reference	2.5V Gain 0	1V Gain 1	1.5V Gain 2
Signal 1	2.5V Gain 0	1V Gain 1	1.5V Gain 2

Signal 2	2.5V Gain 0	1V Gain 1	1.5V Gain 2
Ratio 1	0.6-2	0.6-2	0.6-2
Ratio 2	0.6-2	0.6-2	0.6-2
NQRat 1	0.95 – 1.05		
NQRat 2	0.95 – 1.05		
LEL	0 LEL x m		
Temp.	Up to 25° C beyond ambient temp.		
Voltage	32VDC > V > 18VDC		

Table 10: Signal verification limitation values

7 Setting the Baseline (Zero Calibration on page 56) every time the detector or source is realigned, or the windows are cleaned.

7.2.1 Routine Optical Surface Cleaning

The optical surfaces concerned are the source and detector viewing windows.

➢ **To clean the optical window:**

1 Turn off the power to the SafEye detector and source.

1 Where dust or dirt has accumulated on the optical surface, clean the surface with a small, soft-bristle brush.

2 If needed, rinse the glass surface with clean water and dry with a clean and soft cloth.

3 Turn on power to the SafEye detector and source.

4 Perform signal verification (see *Signal Verification* on page 62).

5 Set the baseline (see *Signal Verification*

6 Perform signal verification using Winhost software or HART handheld unit using the limitation values detailed in Table 10.

Channel	Installation Distance		
	Min (0.6m)	**Med (2m)**	**Max (3.5m)**
Reference	2.5V Gain 0	1V Gain 1	1.5V Gain 2
Signal 1	2.5V Gain 0	1V Gain 1	1.5V Gain 2
Signal 2	2.5V Gain 0	1V Gain 1	1.5V Gain 2
Ratio 1	0.6-2	0.6-2	0.6-2
Ratio 2	0.6-2	0.6-2	0.6-2
NQRat 1	0.95 – 1.05		
NQRat 2	0.95 – 1.05		
LEL	0 LEL x m		
Temp.	Up to 25° C beyond ambient temp.		
Voltage	32VDC > V > 18VDC		

Table 10: Signal verification limitation values

7 Setting the Baseline (Zero Calibration on page 56).

8 Perform functional check (see

9 *Validating the Installation* on page 56).

7.2.2 Signal Verification

The Signal Intensity Check determines if there is a misalignment or if the light source signal is wearing over a period of time. Clean the optical surfaces prior to performing this check (see *Routine Optical Surface Cleaning* on page 61).

Perform signal verification according to the instructions in section 6.4 on page 56.

7.2.3 Function Check of Unit

The SafEye system has been calibrated at the factory per the user's specific gas or vapor detection requirements. This procedure validates the functional operation. The functional check must be done periodically. Refer to

Validating the Installation on page 56 for instructions.

Caution: Automatic activation, or any external device that should not be activated during the calibration check, should be disconnected.

7.2.4 Maintenance Records

Record every maintenance operation performed on the source and/or detector in a maintenance logbook. The logs should include but not be restricted to the following:

- The information identifying the measurement units.
- The date of installation and contractor.
- Entries for every maintenance operation performed to include at least the description of the operation, date, and personnel ID.
- Signal intensity records with SIC results.
- Calibration check (CC) results.

If the unit(s) is (are) sent to the authorized supplier, a copy of the maintenance records must accompany the unit concerned.

8 Troubleshooting

Problem	Cause	Solution
LEDs are off and fault is indicated at 0mA level	Power is not supplied to the detector	Supply power to the detector
Both LEDs are on at yellow and fault is indicated at 0mA level	Fault 2	Bring the detector unit for service
Both LEDs are flashing at yellow and fault is indicated at 0mA level	Low voltage is supplied to the detector	Check the voltage level supplied to the detector
One LED is on at yellow and 4–20mA indication level is 2mA	Dirt has accumulated on the detector window or on the light source window	Clean the optical windows (see *Routine Optical Surface Cleaning* on page 61)
	One unit at least has been moved or tilted	Perform realignment (see *Operating Instructions* on page 55)
	Power is not supplied to the light source	Supply power to the light source
	The optical open path beam is blocked	Remove the obstruction
	One unit at least has been moved or tilted	Perform realignment (see *Operating Instructions* on page 55)
	Electrical problem at the light source	Perform SIC in order to measure signal intensity Bring the light source to a technician for service if it is not flashing

Appendix A: Wire Selection Tables

A.1 General Instructions for Electrical Wiring

- **mA output or relay wiring**: Refer to Table 11 to determine the required wire gauge for general wiring and to calculate the permitted voltage fall with respect to loads current, wire gauge, and length of wires.
- **Power supply wires**: Refer to Table 12 to select wire gauge. DO NOT connect any circuit or load to detector supply inputs.

Table 11: Maximum DC Resistance at 68°F for Copper Wire

AWG #	mm^2	Ohm/100ft	Ohm/100m
26	0.12–0.15	4.32	14.15
24	0.16–0.24	3.42	11.22
22	0.30–0.38	1.71	5.60
20	0.51–0.61	1.07	3.50
18	0.81–0.96	0.67	2.20
16	1.22–1.43	0.43	1.40
14	1.94–2.28	0.27	0.88
12	3.09–3.40	0.17	0.55
10	4.56–6.64	0.11	0.35

- Select "number of detectors" connected in 1 circuit.
- Select "wiring length" per your installation requirements.
- Refer to "power supply range" for voltage extreme applied.

Table 12: Wiring Length in Feet/Meters

No. of Detectors	Recommended Wire Diameter					Power Supply Range (VDC)
24	18	16	14	-	-	22–32
20	18	16	14	-	-	22–32
16	20	18	16	14	-	22–32
12	20	18	16	14	-	20–32
8	20	18	16	14	-	20–32
4 and less	20	18	16	16	14	20–32
Feet	164	328	492	656	820	
Meters	50	100	150	200	250	
	Max. length from power supply to last detector					

Appendix B: Wiring Option Configurations

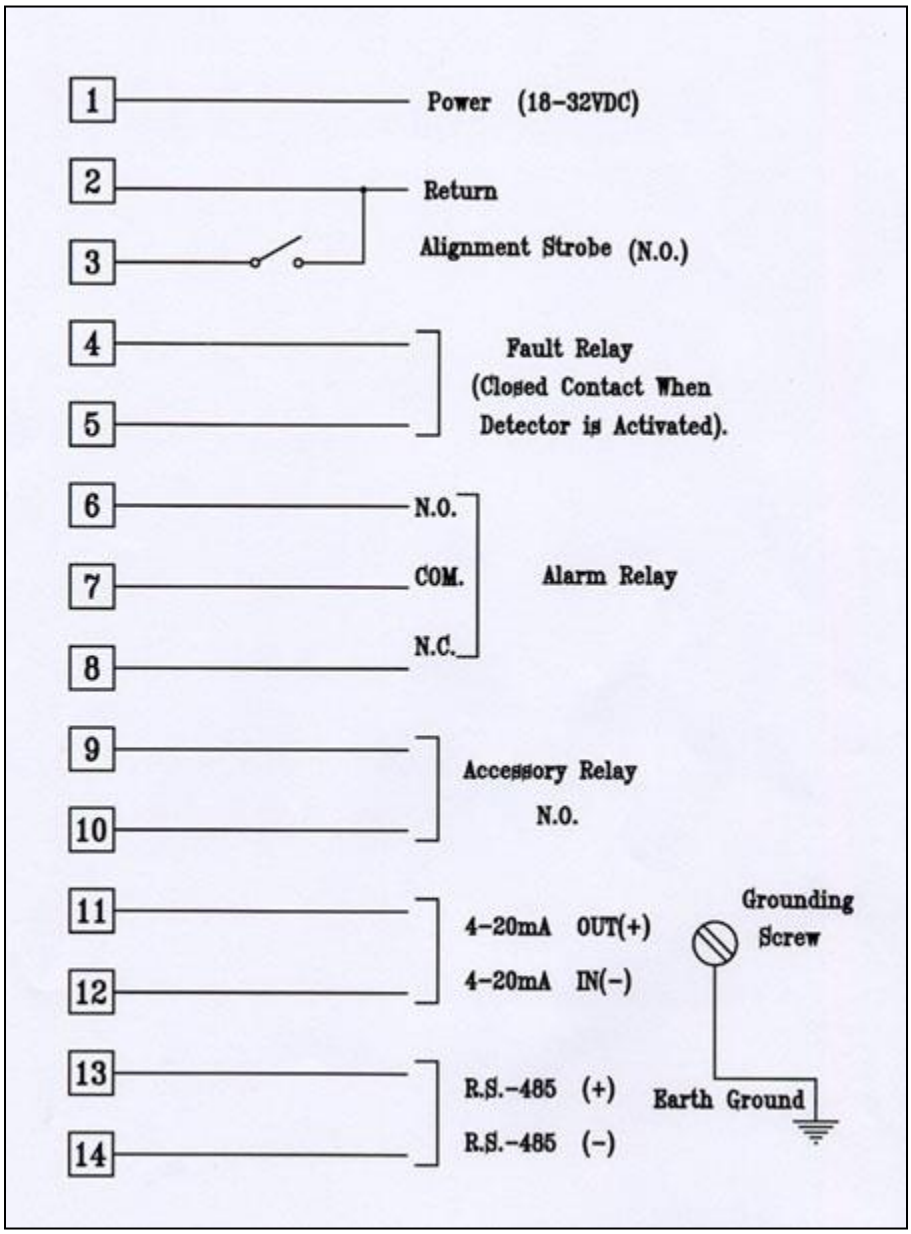


Figure 20: Detector Wiring Diagram

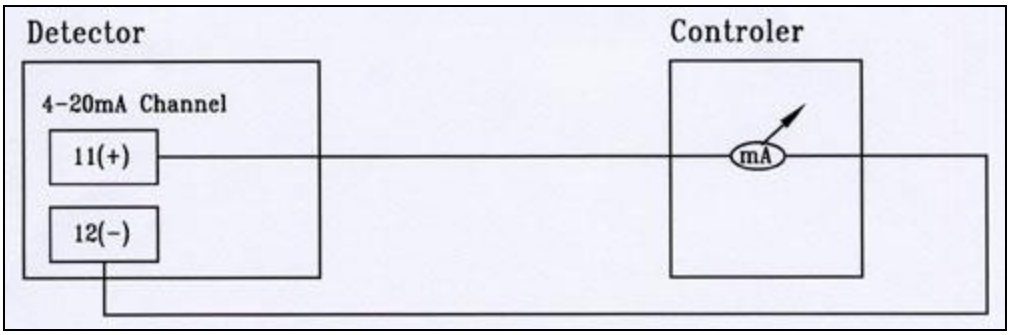


Figure 21: 4–20mA Source Output

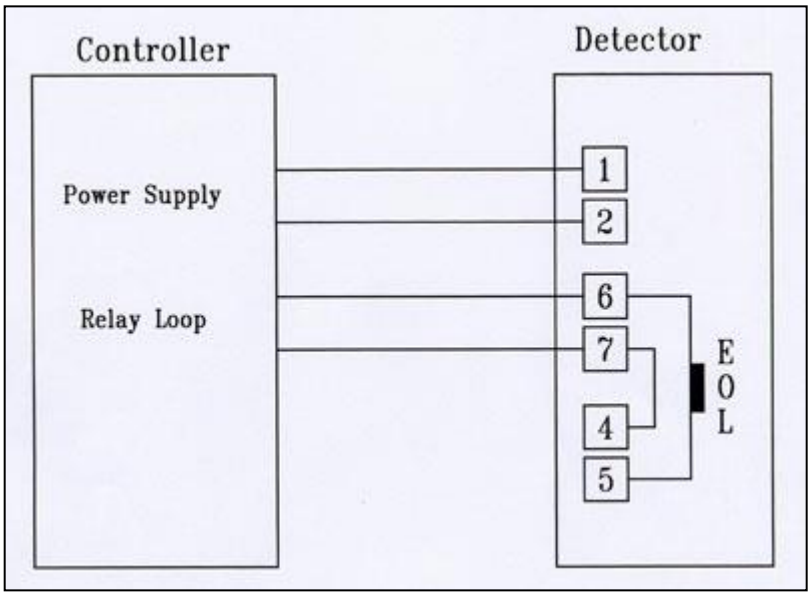


Figure 22: Typical 4 Wire Controller

A.2 RS-485 Communications Network

By using the RS-485 network capability of the SafEye detector and additional software, it is possible to connect up to 32 detectors in an addressable system with 4 wires only (2 for power and 2 for communication). Using repeaters, the number of detectors can be much larger (32 detectors for each repeater): up to 64 on the same 4 wires. When using the RS-485 network, it is possible to read each detector status (Fault, Warning, and Alarm).

For more details, consult the factory.

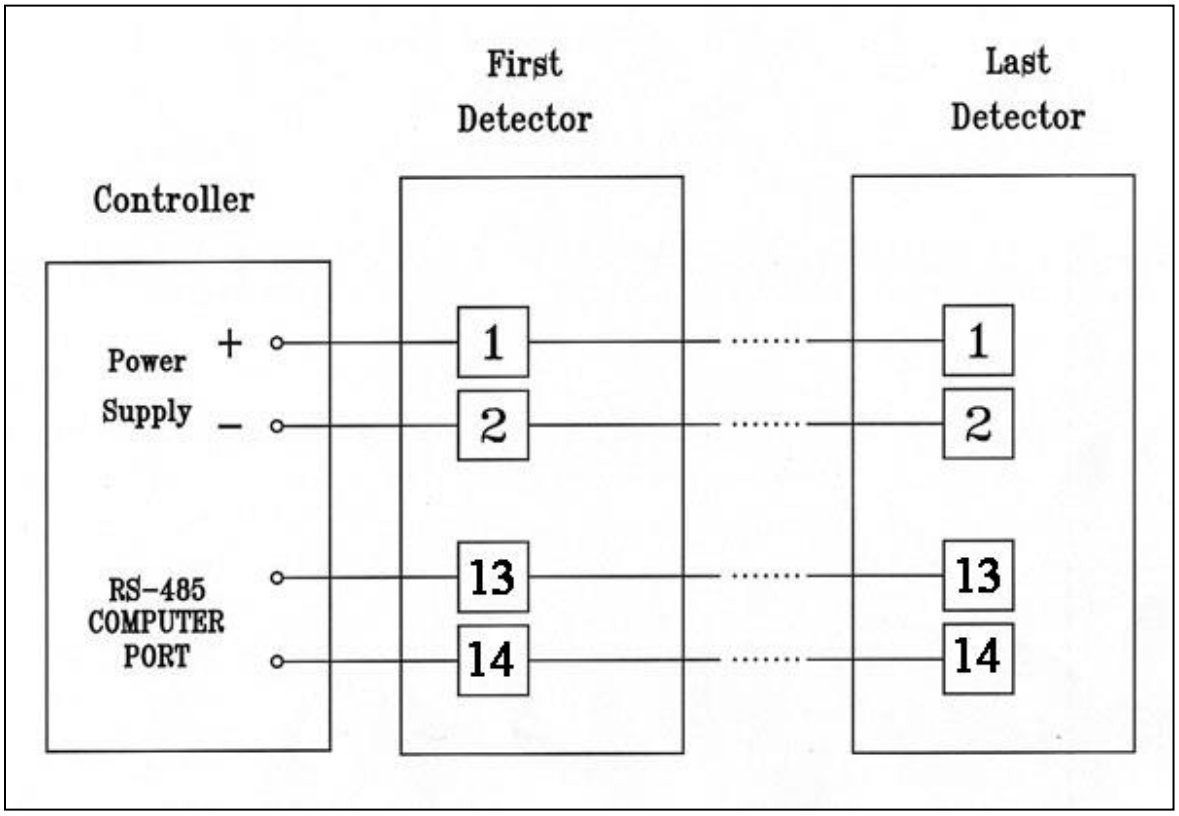
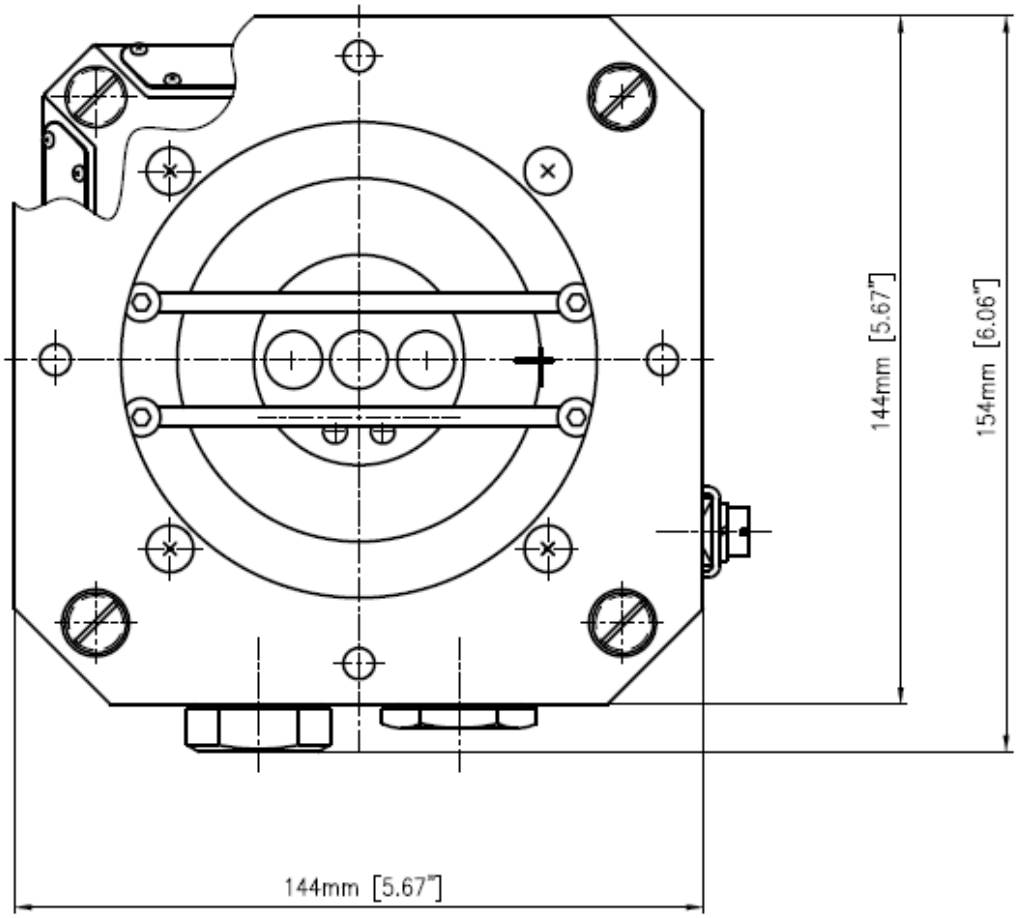
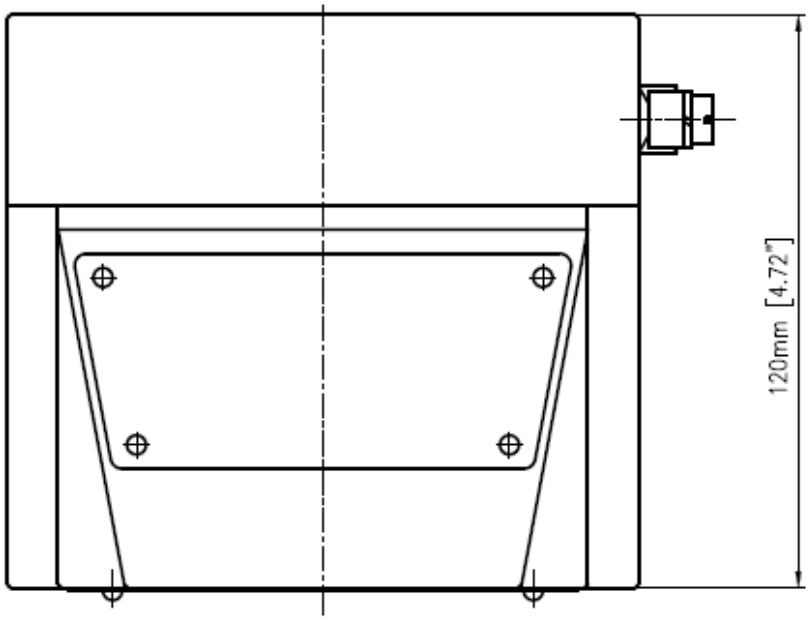


Figure 23: RS-485 Networking

Appendix C: Outline Drawings


144mm [5.67"]
154mm [6.06"]
144mm [5.67"]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Appendix D: Special Conditions to Comply with SIL-2 Requirements

This appendix details the special conditions to comply with the requirements of EN 61508 for SIL-2. The SafEye 300 can be used in low or high demand mode applications. See *IEC 61508.4*, Chapter 3.5.12.

A.3 Safety Relevant Parameters

Perform the following functional check of the detector every 6 months:

(See *Periodic Maintenance* on page 59 and

Validating the Installation on page 56*)*.

- HFT: 0.
- PFD: 3 x 10^{-4} (3% of SIL-2).
- PFH: 1.4 x 10^{-7} (14% of SIL-2) for 4–20mA signal current application. Relays, alarm relays, and accessory relays must be configured as the second alarm relay. The contacts of both alarm relays must be connected in series.
- SFF: Fulfils the conditions of EN61508 for SIL-2.

A.4 Guidelines for Configuration, Installation, Operation, and Maintenance

Alarm conditions complying with SIL-2 can be implemented in 1 of 2 ways: Using 2 alarm relays and using the fault relay.

A.4.1 Conditions for Safe Operation

- The SafEye 300 should consist only of the approved hardware and software modules.
- The 24C power supply must comply with the conditions for "safe low voltage" according to EN60950 (PELV/SELV).
- After installation and configuration, the setup parameters must be verified and the function of the SafEye 300 (gas detection, the 4–20mA interface function, and relay functions) must be checked completely.

A.4.2 Alarm Operation Using the 4–20mA Signal Current

- The connected controller has to monitor the 4–20mA signal current for valid values (see *Output Signals* on page 26).

Mode	Normal	Warning	Alarm
Continuous current with low sensitivity (Full Scale: 5 LEL*m)	4 mA (0 LEL*m)	7.2 mA (1 LEL*m)	13.6 mA (3 LEL*m)
Continuous current with high sensitivity (Full Scale: 2 LEL*m	4 mA (0 LEL*m)	7.2 mA (0.4 LEL*m)	12 mA (1 LEL*m)
Discrete current	4 mA	14 mA	19 mA

- The connected controller has to monitor the 4–20mA signal current for values below 4mA and above 20mA.

A.4.3 Alarm Operation Using Relay Outputs

- **Low Demand**: Only 1 alarm relay is needed
- **High Demand**: The accessory relay has to be configured as the second alarm relay. The contacts of both alarm relays have to be connected in series.
- The fault relay error message has to be monitored by the connected controller.
- The relay contacts must be protected with a fuse rated at 0.6 of the nominal specified relay contact current.

A.5 Miscellaneous

- The complete functional performance of the gas detector has to be verified every 6 months (gas detection, fault detection, performance of the 4–20mA signal current and the relays), gas alarms On and Off.
- The HART and RS-485 interface may not be used for the transmission of safety-related data.

Technical Support

For technical assistance or support, contact:

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Shakopee, MN 55379 ,
USA

Phone: +1 (973) 239 8398

Email: spectrex.csc.rmtna@emerson.com

Website: www.spectrex.net