SafEye™ Xenon 800 Open Path Gas Detection System

Instruction Manual

In North America, to contact your nearest stocking location, dial toll-free 1-800-MSA-INST
To contact MSA International, dial 1-412-967-3354

This manual is available on the internet at www.msanet.com

Manufactured by

MSA NORTH AMERICA

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(L) Rev 2 **IMZ001-035** **10055711**

⚠ WARNING

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR USING OR SERVICING THE PRODUCT. Like any piece of complex equipment, this instrument will perform as designed only if it is used and serviced in accordance with the manufacturer's instructions. OTHERWISE, IT COULD FAIL TO PERFORM AS DESIGNED AND RESULT IN LOSS OF LIFE, SEVERE PERSONAL INJURY, AND/OR PROPERTY DAMAGE.

The warranties made by Mine Safety Appliances Company with respect to the product are voided if the product is not used and serviced in accordance with the instructions in this manual. Please protect yourself and others by following them. We encourage our customers to write or call regarding this equipment prior to use or for any additional information relative to use or repairs.

MSA Permanent Instrument Warranty

1. **Warranty-** Seller warrants that this product will be free from mechanical defect or faulty workmanship for a period of three years from date of shipment, provided it is maintained and used in accordance with Seller's instructions and/ or recommendations. The flash lamp is warranted for ten years from the date of shipment. The Seller shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than its own or authorized service personnel or if the warranty claim results from physical abuse or misuse of the product. No agent, employee or representative of the Seller has any authority to bind the Seller to any affirmation, representation or warranty concerning the goods sold under this contract. Seller makes no warranty concerning components or accessories not manufactured by the Seller, but will pass onto the Purchaser all warranties of manufacturers of such components. **THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, AND IS STRICTLY LIMITED TO THE TERMS HEREOF. SELLER SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.**
2. **Exclusive Remedy-** It is expressly agreed that Purchaser's sole and exclusive remedy for breach of the above warranty, for any tortious conduct of Seller, or for any other cause of action, shall be the repair and/ or replacement at Seller's option, of any equipment or parts thereof, which after examination by Seller is proven to be defective. Replacement equipment and/ or parts will be provided at no cost to Purchaser, F.O.B. Seller's Plant. Failure of Seller to successfully repair any nonconforming product shall not cause the remedy established hereby to fail of its essential purpose.
3. **Exclusion of Consequential Damage-** Purchaser specifically understands and agrees that under no circumstances will seller be liable to purchaser for economic, special, incidental or consequential damages or losses of any kind whatsoever, including but not limited to, loss of anticipated profits and any other loss caused by reason of non-operation of the goods. This exclusion is applicable to claims for breach of warranty, tortious conduct or any other cause of action against seller.

General Warnings

⚠ WARNING

1. The instruments described in this manual must be installed, operated, and maintained in strict accordance with its labels, cautions, warnings, instructions, and within the limitations stated.
2. Do not paint the SafEye system. If painting is done in an area where the unit is located, make sure paint is not deposited or placed on the lens of the unit. Such paint deposits on the lens interfere or block the radiation produced by the source unit or received by the detector unit; this can prevent the unit from detecting gas.
3. The only method to ensure proper overall operation of the SafEye System is to check the output by placing the filter (supplied in the alignment kit) in the IR beam at the detector. The resulting upscale reading is compared to the reading taken at initial alignment.

   Verification of SafEye System operation must be included as part of the routine inspection of the system.
4. The Source and Detector are sealed: Do not attempt to open (except for the wiring tray) and modify or adjust the units.
5. Alteration of the Source or Detector, beyond the scope of this manual or by anyone other than authorized service personnel, could cause the product to fail to perform as designed, and persons relying on this product for their safety could sustain severe personal injury or loss of life.
6. Locate,install, and operate the SafEye System in accordance to all applicable codes including, but not limited to, the National Fire Prevention Code and National Electric Code. Only qualified personnel familiar with operation and maintenance must work on the system.
7. Do not open the technical compartment for any reason while circuits are powered.
8. The detector is not field-repairable. Do not attempt to repair or adjust the unit as this will only cause the detector to function improperly. The bolts securing the connecting box to the main housing are not meant to be removed by the user.

9. The SafEye System detects the presence of most combustible gases by identifying the difference in the amount of infrared light energy absorbed during the presence of these gases. This monitor, however, does NOT detect the presence of hydrogen gas and must never be used to monitor for hydrogen gas.
10. Protect the SafEye System from extreme vibration, as this may adversely affect operation of the SafEye System.
11. The SafEye System is one option for providing gas detection. As there are certain limitations with this type of system, use in conjunction with point detectors may be required to provide optimum gas detection capability. Proper evaluation of the application is required to ensure a suitable level of gas detection is achieved.

Failure to follow the above can result in loss of life, serious personal injury and/or property damage.

Table of Contents

Chapter 1, Introduction

Introduction

The SafEye System IR open-path gas detector:

- uses an advanced Xenon Flash Source and integrated electronics package in low-profile stainless steel housings
- provides line-of-sight gas monitoring with:
  - high quality performance and
  - fast response
- detects ambient combustible gases over long path lengths in harsh environments where dust, fog, rain, snow or vibration can cause signal reduction
- can maintain operation with significant signal obscuration and misalignment due to its unique combination of:
  - triple optics
  - dual-spectrum reference sensor and
  - heated optics
- is manufactured in stainless steel with a heated optical window to improve performance in icy, snowy, and condensation conditions
- configurable functions are available through an RS 485 port used with SafEye System Host software and a standard PC. An intrinsically safe, handheld PDA is available as an option for convenient configuration in the field. (A non-I.S. PDA is also available as an option if it is possible to make the area non-hazardous during its use.) See SafEye Xenon 800 Series Diagnostic Kit Instruction Manual (P/N 10085905)

The enclosures are designed with:

- integral segregated rear terminal compartment that avoids sensor and electronic exposure to the surrounding environment
- internal intrinsically safe circuit for heating the optical window
- plug interface for IrDA connection to an approved I.S. PDA with combined approval.

Features

- Long Range Gas Detection
- Simultaneous detection of flammable gases per TABLE 1-10, "Typical Specifications"
- High Sensitivity and fast response to hydrocarbon gases
- Heated optics to improve performance in icy, snowy and condensation conditions
- Continuous operation in extreme / harsh environmental conditions
- Solar blind and immune to industrial environments
- Withstands extreme vibration conditions
- Interfaces with most commonly used control panels
- Standard 4-20 mA output and dry relay contacts
- RS-485 Output Modbus compatible for PC Communication
- Network for a maximum of 32 detectors
- Simple, one person installation, alignment, and calibration
- Programmable configuration via the handheld PDA
- Fast connection to I.S. approved handheld diagnostic/calibration PDA
- 3 mA "maintenance call"

Principle of Operation

The SafEye System detects gases by:

- using differential spectral absorption.

Definitions of Terms

Gas Concentration Measurement Terms used in this manual:

- LEL: The volume ratio of flammable gas or vapor in air below which an explosive atmosphere will not be formed.
- LEL.meter: Integral of the gas concentration along the optical path expressed in units of concentration, multiplied by the distance.

  NOTE: 100% LEL x 1 meter = 1 LEL.meter

Spectral Finger Print

- Each gas or vapor is detected at a wavelength selected according to its specific spectral absorption or "finger print".
- There are three IR sensors:
  - two signal and
  - one reference.
- The detection process involves two separate filters:
  - one transmitting radiation that is absorbed by a particular gas
  - one that is not sensitive to to that particular gas.

Optical Path

- The presence of hazardous airborne vapors, gases, or aerosols in a monitored area is detected when the defined substance crosses the optical path between the IR Source unit and the Detector.
- Gas or vapor present in the atmosphere causes absorption of the radiation pulse in the optical path between the IR Source and the Detector unit at some specific wavelengths.
  - This changes the signal intensity received by the Detector.
  - The system analyzes the defined open path at the spectral bands specific to the materials being monitored.
  - The Automatic Gain Control (AGC) compensates for environmental disturbances such as fog, rain, etc., through a constant comparison with its dual spectral beam.

Microprocessor Based

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

Gas Sensitivity

- The SafEye System uses wavelengths around the 3.4 micron spectral band to measure the flammability of hydrocarbon gas in air along the open path between the Source and Detector.
  - At this wavelength, all hydrocarbon materials have a strong absorption peak.

- This peak enables the Detector to achieve both Low sensitivity of 0-5 LEL.m and High sensitivity of 0-2 LEL.m, depending on the SafEye System configuration. However, since the desired detection information is flammability in air and the actual measurement is radiation absorption around the 3.4 micron spectral band, the Detector sensitivity is not the same for all gases or gas combinations.

- This difference in sensitivity is not important if the gas composition in the protected area is known. However, if the gas composition can vary substantially in a protected area, then the difference in sensitivity must be considered when determining the Detector calibration.

Gas and Mixture Selection and Setting

- At the 3.4 micron spectral band of the SafEye System, the least sensitive gas is Ethylene and the most sensitive gases are various mixtures of Methane with heavier alkanes where the Methane percentage is less than 90%. For pure Ethane, the sensitivity is close to the high sensitivity gases and for pure Propane it lies somewhere between the two extremes.
- The SafEye System can be ordered to detect ethylene or a choice of three other gases (hydrocarbons). The general hydrocarbon SafEye System has built-in gas calibration settings that can be changed by function set up.
- The calibration settings are designed for use in various applications:

  Gas 1: Methane
  Pure methane used in methane storage and piping applications

  Gas 2: Natural Gas
  92% Methane, 4% Propane and 4% Ethane
  Universal oil and gas production mixture to be used where Methane concentration in the mixture does not exceed 98%.

  It can also be used for pure Ethane applications.

  Gas 3: LPG (liquefied petroleum gas)
  60% Propane, 40% Butane;
  recommended for propane monitoring.

- Actual selections must be made by the user after consulting with experts regarding safety requirements.

Flash Source

- The Xenon Flash Source is designed to overcome false alarms.
- The SafEye System uses the latest generation of flash bulbs to provide more power and extended operation life.

Heated Optics

- The Xenon System includes heated optics for the Detector and Source.
- The heater increases the temperature of the optical surface by 5 to 8°F (3 to 5°C) above the ambient temperature to improve performance in icing, condensation and snow conditions.
- The default configuration causes the optics heater to automatically operate when temperature change requires it.
- The heated optics can also be configured to operate in one of the following modes:
  1) OFF (this is not an option for the Source)
  2) ON continuously
  3) ON when the temperature is below a setpoint.
     - When operated in mode 3, the user can define the setpoint. In this mode, the heater turns OFF when the temperature rises 15°C above the setpoint.
- See "Detector Configuration" later in this chapter.
- When operated in the mode 3, the user can define the start temperature below which the optics will be heated (default 20°C).
  - This temperature can be defined between 32 and 95°F (0 and 35°C).
  - Heating stops when the temperature reaches 27°F (15°C) above the start temperature.

Handheld Unit

- The intrinsically safe (I.S.)-approved handheld diagnostics unit is available to make installation and maintenance easier. This setup/diagnostic/ interrogation plug-in unit enables one-person installation and maintenance.
- The Handheld PDA can be used:
  1) for on-site function configuration and detector setup changes.
  2) during installation, to display all detector parameters and confirm successful installation.
  3) for Maintenance and Troubleshooting.
  4) for datalogging.
- For more details, refer to the Diagnostic Kit Instruction Manual (P/N 10085905).

Host Software

Host software is available for use with a computer to configure and monitor SafEye System functions. This allows:

1) on-site function configuration and detector setup changes.
2) the display of all detector parameters and confirmation of successful installation.
3) Maintenance and Troubleshooting
4) for datalogging.

- For additional information, see Appendix C

Modbus RS-485

- For remote setup and more advanced communications, the SafEye System has an RS-485 Modbus-compatible output that provides data communication from a network (up to 32 detectors) to a host computer or universal controller for central monitoring.
- This feature provides both local and remote diagnostic tools for ease of maintenance.

Tilt Mount

The stainless steel tilt mount design:

- enables installation in areas with limited space constraints
- maintains alignment even with constant vibration
- 'X' and 'Y' axis adjustments provide quick and easy alignment for installation and maintenance procedures.

Models and Types

The SafEye System is available in two versions for the detection of different gas groups:

- Model 801, 802 and 803 units are used for the methane, ethane mixtures of most offshore and onshore applications
- Model 821, 822 and 823 units use a different optical bandpass filter that is sensitive to ethylene.

Table 1-1. Model Installation Distances

MODEL NO.	MIN. INSTALLATION DISTANCE	MAX. INSTALLATION DISTANCE
801	13 ft (4 m)	65 ft (20 m)
802	50 ft (15 m)	230 ft (70 m)
803	165 ft (50 m)	394 ft (120 m)
821	13 ft (4 m)	65 ft (20 m)
822	50 ft (15 m)	230 ft (70 m)
823	165 ft (50 m)	394 ft (120 m)

Description

The SafEye System:

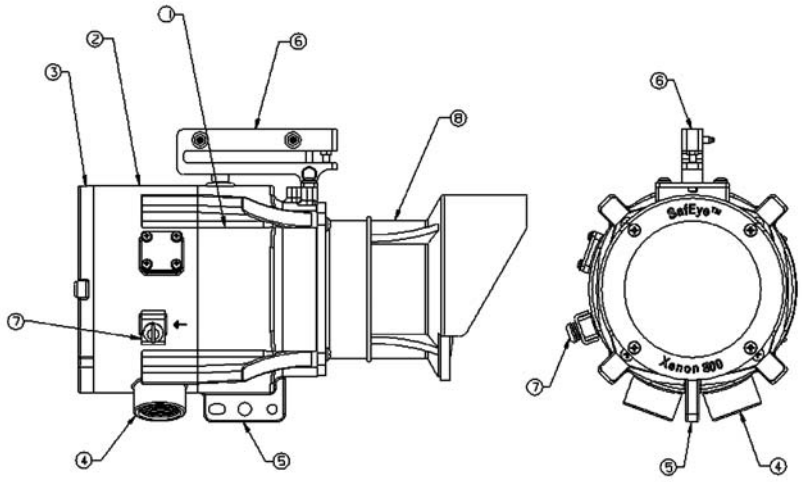
- has two main units:
  1) The Flash Infrared Source (Transmitter)
  2) The Infrared Detector (Receiver)
- detects gases over an open path between the Flash Source and the Detector.

Flash Source Unit (FIGURE 1-1)

The Flash Source:

- emits powerful IR radiation pulses (two pulses per second)
- has a coated silicon lens that:
  - collimates the IR beam for maximum intensity
  - blocks all UV and visible light

- is heated to improve performance in icing, condensation and snow conditions.



1	Main Housing	5	Holding Plate
2	Junction Box	6	Telescope Site
3	Back Cover	8	Earth Terminal
4	Cable Inlet	9	Front Window / Lens Section

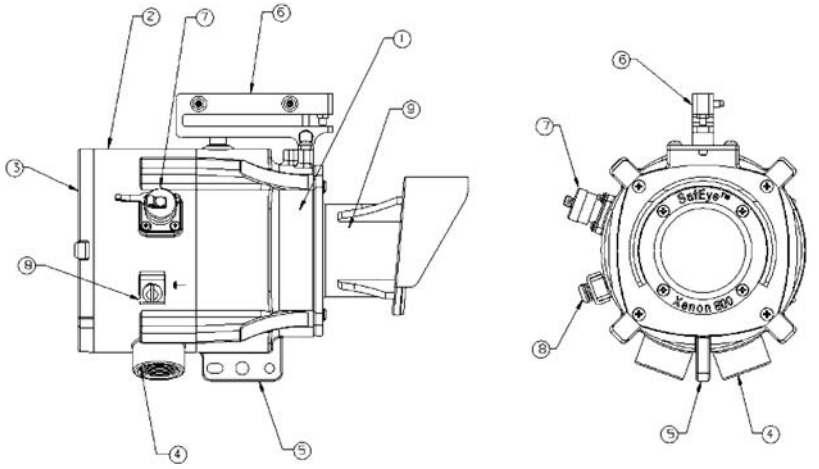
Figure 1-1. Flash Source

Detector Unit (FIGURE 1-2)

- The Detector receives the transmitted pulsed radiation signals from the Flash Source.
- The signals are then amplified, fed to an A/D converter, and on to the microprocessor.
- The internal microprocessor continually compensates for any loss of signal amplitude that may occur even during severe weather conditions.
- Outputs are then generated and sent to the interface section where they may be sent remotely to a standard control panel or central PC.
- The detector front window is heated to improve performance in icing, condensation and snow conditions.

Table 1-2. Three Detector Types

DETECTOR TYPE	RANGE
1) Short range	13 to 65 ft (4 to 20 m)
2) Mid-range	50 to 230 ft (15 to 70 m)
3) Long range	165 to 394 ft (50 to120 m)



1 Main Housing
2 Terminal Compartment
3 Back Cover
4 Cable Inlet`
5 Holding Plate
6 Telescope Site
7 Hand-held Fast Connection
8 Earth Terminal
9 Front Window / Window Section

Figure 1-2. Detector

Operating Modes

The SafEye System has four operating modes:

1) **Normal**
2) **Maintenance Call**
3) **Fault**
4) **Zero Calibration**.

Normal Mode

Gas detection is active with the following states possible:

- Normal (measured gas signal is less than 1 LEL.m).
  - Alarm relay is de-energized
  - Fault relay is energized
  - Discrete 4-20 mA, if configured, = 4.0 mA
  - Continuous 4-20 mA, if configured, = (4.0 mA to 7.2 mA) Detector
  - RS485 Status = NNN.
- Warning (measured gas signal is 1 LEL.m but less than 3 LEL.m)
  - Alarm relay is de-energized
  - Fault relay is energized
  - Discrete 4-20 mA, if configured, = 14 mA
  - Continuous 4-20 mA, if configured, = (7.2 mA – 13.6 mA)
  - RS485 Status = WWN.
- Alarm (measure gas signal is 3 LEL.m or more.)
  - Alarm relay is energized
  - Fault relay is energized
  - Discrete 4-20 mA, if configured, = 19 mA
  - Continuous 4-20 mA, if configured, = (13.6 mA to 21 mA)
  - RS485 Status = AAN, LAN, or JAN.

Maintenance Call Mode

Gas detection is active, but maintenance is required due to:

- dirty optics
- low source output
- misalignment or
- one of the detector parameters is at a limiting value.
  - In this mode, the outputs continue to operate as described above only when the sensed gas value reaches or is in excess of the warning level.

- If the sensed gas value is below the warning level, the following output states are maintained.
  - Alarm relay is de-energized
  - Fault relay is energized
  - Discrete 4-20 mA = 3 mA
  - Continuous 4-20 mA = 3 mA
  - RS485 Status = OMN, RMN, or BMN.

Fault Mode

There are two fault types:

- Fault 1:
  The system is still operational, but gas detection is not possible as a result of very low signal (normally due to poor alignment or a continuous obscuration of the beam). It is also possible that one or more detector channels or the source output may be nonfunctional.

  This fault is asserted following a 60-second delay from the onset to avoid nuisance faults. If signal levels can be restored, either by re-alignment or by removing the obscuration, the fault self-clears.

  During this type of fault, the following output levels are maintained:
  - Alarm relay is de-energized
  - Fault relay is de-energized
  - Discrete 4-20 mA = 2 mA
  - Continuous 4-20 mA = 2 mA
  - RS485 Status = OON, RON, KON, PON, ION, YON, or CON.
- Fault 2:
  The detection system is not operational and gas detection is not possible due to failure of the:
  - microprocessor/memory
  - detector power systems or
  - external input power levels.

If the external input power levels are not within the specified range, correcting the input level restores proper operation to the detector and the fault self-clears.

During this type of fault, the following output levels are maintained:
- Alarm relay is de-energized
- Fault relay is de-energized
- Discrete 4-20 mA = 0 mA
- Continuous 4-20 mA = 0 mA
- RS485 Status = OON, RON, KON, PON, ION, YON, or CON.

Zero Calibration Mode (1 mA output)

- The Detector is put in Zero Calibration mode by "hitting" the ALIGN key three times via the host computer or an optional handheld PDA.
- This mode:
  - adjusts the zero level from which the Detector reads gas
  - It must only be performed when the following occurs:
    - no combustible gases present
    - clear path between Flash Source and Detector
    - clear weather conditions
- Zero calibration must be done after installation, physical re-alignment or cleaning the Source or Detector optical window.

Output Signals

The SafEye System provides the following outputs according to the wiring options:

- Standard 4-20 mA analog signal
- Relays with dry contacts
- RS-485 output.

Refer to TABLE 1-3 for possible output configuration choices between relays, 4-20 mA, and RS485.

Table 1-3. SafEye System Wiring Options

OPTION	WIRING
1	Power, Alarm Relay, RS-485, 4-20 mA, RS-485 RTN (default)
2	Power, Alarm Relay, Fault Relay, 4-20 mA

NOTE: The wiring option is factory-set and not customer-changeable.

- If the Output Wiring Option needs to be changed, the Detector unit must be returned to the factory.

Table 1-4. Continuous 4-20 mA Current Output (default)

OUTPUT CURRENT	STATUS AND DESCRIPTION
0 mA	Fault 2 or Low Voltage (Critical)
1 mA	Zero Calibration in progress
2 mA	Fault 1 (Non Critical)
3 mA	"Maintenance Call"
4 mA	Zero - No gas present
4-20 mA	Continuous measuring of gas concentration between zero and full scale
21 mA	The gas concentration is greater than full scale

Table 1-5. Discrete 4-20 mA Current Output (optional)

OUTPUT CURRENT	STATUS AND DESCRIPTION	ALARM LEVEL (LEL.M) (0-5 LEL.m)	(0-2 LEL.m)
0 mA	Fault 2 or Low Voltage		
1 mA	Zero Calibration (in progress)		
2 mA	Fault 1		
3 mA	"Maintenance Call"		
4 mA	Standby		
14 mA	Warning	1	0.4
19 mA	Alarm	3	1.2
21 mA	Gas concentration is greater than full scale		

4-20 mA Current Output

- The galvanically isolated 4-20 mA output can provide detector status by one of the following user-reselectable methods:

  1) Default -
  A continuously variable current proportional to the gas concentration (see TABLE 1-4).

  2) Optional - (see TABLE 1-5)
  A discrete current value corresponding to the:
     - detector mode
     - gas warning signal
     - or alarm signal.

     This option can be set with host PC software or Handheld PDA.

- The 4-20 mA output is configured as a current sink (default) but can be configured as a current source by the addition of a wire link (see Appendix B).

- The maximum loop resistance for the 4-20 mA output is 600 ohms.

Relays

- The Detector has the following relays, depending on wiring option:
  - Fault relay
  - Alarm relay
- The Alarm relay is normally de-energized and contacts are normally-open.
- When in the Alarm condition, the appropriate relay is energized and relay contacts closed.
- The normal position for the Fault relay is:
  - energized with the contact closed and
  - in the Fault condition, the contact is open.
- All the relays have dry contacts.

RS-485 Interface

- The Modbus compatible RS-485 input/output:
  - sends complete data information to a PC and
  - receives data or control commands from the PC.
- For communication with a PC through the RS485 interface, use the SafEye System host software.

System Set up

Detector Configuration

The SafEye System incorporates several functions that can be configured by the customer using:

- SafEye System PC host software (see Appendix C).
- Handheld unit (option).

Connection of the Handheld unit or PC to the Detector allows the user to make configuration changes.

(See Chapter 1, "Detector Default Setup" for default settings.)

Table 1-6. Two Full Scales are Available

SENSITIVITY	FULL SCALE	WARNING LEVEL	ALARM LEVEL
Low (default)	5 LEL.m	1 LEL.m	3 LEL.m
High	2 LEL.m	0.4 LEL.m	1.20 LEL.m

When choosing full scale, the warning and alarm level automatically change to the values in this table.

Table 1-7. Automatic Background Zero Calibration

ENABLE	Zero calibration is performed according to background
DISABLE	The detectors are not updated due to change of background

Table 1-8. Other Functions

FUNCTION	DEFAULT	OPTION
Alarm Latching	No latching of alarm relay*	Alarm relay is latched. Latched alarms may be reset via momentary power disconnection or by setting the detector to the Alignment mode (via PDA or Winhost by pressing the ALIGN button one time, or by the RS485 command)
4-20 mA output	Continuous reading of 4-20 mA output proportional to gas concentration (see TABLE 1-4)	Discrete reading of 4-20 mA output according to detector status (see TABLE 1-5)
Beam Block During Alarm	No latching of alarm indication during beam block	Alarm outputs are latched when Detector goes to beam block mode from alarm condition. Latched alarms can only be reset after the Detector returns to normal mode
*NOTE: In accordance with ANSI/ISA-12.13.04-2007, the Alarm relay shall be connected to an auxiliary system which accomplishes the same purpose as latching, if not already latched.		

Address Setup

The Detector provides up to 247 addresses that can be used for the RS-485 communication link.

Heated Optics Operation

The heated optics for the Detector can be configured in one of the following modes:

Mode1: Not operated

Mode 2: Operated continuously

- Operated with temperature change **(default)**.

  When operated with temperature change:

  - The user can define the temperature below which heating of the optics will start.
  - The default start temperature is 20°C, but this can be set to operate between 0 and 35°C in 5°C increments.
  - The Detector window stops heating when the temperature is 15°C above the defined start temperature.
  - This feature is only available in the Detector.

Detector Default Set up

Detector functions can be configured at the customer facility by using an optional Handheld unit or Host software on a PC. TABLE 1-9 shows the default set up.

Table 1-9. Detector Default Set Up

GAS TYPE	2
FULL SCALE SENSITIVITY	5 LEL.m
BACKGROUND ZERO CALIBRATION	Disabled
ACCESSORY RELAY	Not available
ALARM LATCHING	No
4 to 20 mA	Continuous
BEAM BLOCK DURING ALARM	No latch
OPTICS HEATER MODE	AUTO
HEATER TURNS ON	20°C

Table 1-10. Typical Specifications

DETECTED GASES	Methane, Natural Gas (92% Methane + 4% Ethane + 4% Propane), LPG (60% Propane + 40% Butane), and Ethylene		
DETECTION RANGE	**MODEL NO.**	**MINIMUM INSTALLATION DISTANCE**	**MAXIMUM INSTALLATION DISTANCE**
short	801	13 ft (4 m)	65 ft (20 m)
medium	802	50 ft (15 m)	230 ft (70 m)
long	803	165 ft (50 m)	394 ft (120 m)
short	821	13 ft (4 m)	65 ft (20 m)
medium	822	50 ft (15 m)	230 ft (70 m)
long	823	165 ft (50 m)	394 ft (120 m)
ACCURACY	±5% of measuring range or ±10% of measured value		
RESPONSE TIME	<5 seconds		
SPECTRAL RESPONSE	3.0 - 4.0		
SENSITIVITY RANGE	0-5 LEL.m or 0-2 LEL.m		
FIELD OF VIEW	Line of Sight		
ALIGNMENT TOLERANCE	±0.4°		
LONG TERM DRIFT	0.02 LEL.m per month		
TEMPERATURE RANGE	-40°C (-40°F) to 55°C (+131°F)		
MINIMUM INTEGRAL PATH CONCENTRATION RESOLUTION	0.01 LEL.m		
IMMUNITY TO FALSE ALARM	Does not produce false alarm. Is not influenced by Solar Radiation, Hydrocarbon Flames and other external IR Radiation Sources.		
CONDITIONS THAT MAY IMPAIR RELIABILITY	window contaminants misalignment lack of routine maintenance		

Table 1-11. Electrical Specifications

OPERATING VOLTAGE	18-32 VDC (24 VDC nominal)			
MAXIMUM POWER CONSUMPTION		**WITHOUT HEATED OPTICS**		**WITH HEATED OPTICS**
	DETECTOR	100 mA		200 mA
	SOURCE	220 mA		300 mA
ELECTRICAL INPUT PROTECTION	The input circuit is protected against reversed voltage polarity, voltage transients, surges and spikes			
ELECTRICAL INTERFACE	See Appendix B for wiring/terminal details for each option			
	OPTION 1	Power, Alarm Relay, RS 485, 4-20 mA, RS-485 RTN		
	OPTION 2	Power, Alarm, and Fault Relays, 4-20 mA		
ELECTRICAL OUTPUTS	4-20 mA Current Output (isolated current sink default)			
	This can be configured as source - see Appendix B.			
	The maximum permitted load resistance is 600 ohms			
4-20 mA OUTPUT OPTIONS	Continuous output default (TABLE 1-4)			
	Discrete output (TABLE 1-5)			
NETWORK COMMUNICATION	Detector equipped with RS 485-communication link that can be used in installations with computerized controllers. Communication is compatible with the Modbus protocol			
	Enables continuous communication between a single standard Modbus controller (Master device) and a serial Network of up to 32 detectors			
	Enables connection between different types of detectors or Modbus devices connected to the same Network			
RELAY OUTPUT	**RELAY**	**TYPE**	**CONTACTS NORMAL STATE**	**MAXIMUM RATINGS**
	Alarm	SPST	NO	5 A at 30 VDC or 250 VAC
	Fault	SPST	NC	5 A at 30 VDC or 250 VAC
	Alarm relay - normally de-energized with normally open contacts. When in alarm condition - relay contact is closed			
	Fault relay normally-energized with contact normally-closed. When in fault condition, the relay contact is open			

Table 1-12. Mechanical Specifications

ENCLOSURE		Detector, Source & tilt mount are Stainless Steel 316
INGRESS PROTECTION		IP 66\X7
ELECTRONIC MODULES		Conformally coated
CABLE ENTRIES		2 x M25 or 2 x 3/4" 14NPT (specified when ordering)
DIMENSIONS	**DETECTOR**	9.7 x 6 x 6.1 inches (246 x 152 x 155 mm)
	SOURCE	11 x 5.6 x 6.1 inches (279 x 142 x 155 mm)
	TILT MOUNT	4.7 x 4.7 x 5.5 inches (120 x 120 x 140 mm)
WEIGHT	**DETECTOR**	12.8 lbs. (5.8 kg)
	SOURCE	14.3 lbs. (6.5 kg)
	TILT MOUNT	4.2 lbs. (1.9 kg)

Table 1-13. Environmental Specifications

The SafEye System is designed to withstand harsh environmental conditions. The Source and Detector units compensate for adverse conditions while maintaining accuracy.

OPERATING TEMPERATURE RANGE	-40°C to +55°C (-40°F to +131°F)
STORAGE TEMPERATURE RANGE	-40°C to +65°C (-40°F to +149°F)
HUMIDITY	Relative humidity of up to 95%
SALT	Complies with NEMA 250 Type 4X
FOG/MIST	90% attenuation per FM 6325, ANSI/ISA - 12.13.04, EN50241
VIBRATION	FM 6325

Chapter 2,
Installation - Mounting and Wiring

General Considerations

Personnel

Installation must be done by suitably qualified personnel, familiar with the local codes and practices, trained for gas detection maintenance. Wiring must only be performed or supervised by someone with knowledge of electronics and, in particular, wiring installation.

Tools Required

The SafEye System requires the following tools:

- SafEye System Commissioning Kit (P/N 10081519)
- Set of screwdrivers
- Set of hexagon socket wrenches (supplied with commissioning kit)
- Diagnostic Kit with Intrinsically Safe PDA (P/N 10080217) or Diagnostic Kit with General Purpose PDA (P/N 10080213) or host computer connected via RS-485
- Multimeter.

Site Requirements

The SafEye System installation site must take the following into account:

- If the gas being monitored is heavier or lighter than air
- The site must provide the Detector with a direct view to the Source
- The mounting point for each item must be secure and stable with minimal vibrations
- Equipment must be mounted in a position where it is guarded from physical impact
- If the system is installed in an indoor environment, the Automatic Background Zero Calibration must be set to DISABLED (see Chapter 1, TABLE 1-7).

Source and Detector

- Select a Detector appropriate for the length of open path to be monitored.

- The open path between the Source, the Detector, and the immediate surroundings must be kept clear of obstructions that might:
  - hinder the free movement of air in the protected area or
  - block the infrared beam.
- Be especially aware of beam blockages that can occur over time; for example, do not place the Source and Detector where grass or shrubs could grow in front of the beam.

Guidance Tips for Gas Detector Locations

To provide the best detection coverage, locate the detector:

- Below potential leak sources for heavier-than-air gases
- Above potential leak sources for lighter-than-air gases
- Near leak sources along the expected leak trajectory, taking into account prevailing wind directions
- Between leak source and potential ignition sources

Preparations for Installation

Installation must comply with local, national and international regulations and norms for electrical devices installed in hazardous areas. Detectors can be mounted with general-purpose common tools and equipment.

- In addition to this manual, the System includes the following:
  - Detector unit
  - Source unit
  - Two Tilt Mount Bases
    - One for the Detector
    - One for the Flash Source.
- The Commissioning Kit (P/N 10081519) includes a:
  - Function Check Filter
  - Telescope Kit used during detector installation.
    - The telescope is removed after installation.

  NOTE: Only one set of these items is needed for several detectors since they can be used for all other detector installations at the site.

1. Verify that all equipment on the Purchase Order was received.
2. Record the ATO (Assemble to Order) Code Number of all equipment (found on the Connecting Box label).
3. Prior to installation, visually inspect all equipment and ensure it is not damaged.
4. Ensure that all components required for installation are available before installation.
5. If installation cannot be completed in a single session, secure and seal each Source, Detector, and their cable entries.
6. Use color-coded conductors or suitable wire markings or labels.
7. Use wires of 0.5 mm^2 to 3.5 mm^2 (12 to 20 AWG) for site wiring.
8. Base the selection of wire gauge on the number of detectors used on the same line and the distance from the control unit. (See Appendix A.)

Certification Instructions

Do not open when flammable atmosphere is present. The cable entry point may exceed 70°C; suitable precautions must be taken when selecting the cable.

1. The equipment may be used with flammable gases and vapors with apparatus groups IIA, IIB and IIC T6 in the ambient temperature range of -40°C to + 55°C.
2. Installation shall be carried out by suitably-trained personnel in accordance with the applicable code of practice (e.g., EN 60079- 14:1997).
3. Inspection and maintenance of this equipment shall be carried out by suitably-trained personnel in accordance with the applicable code of practice (e.g., EN 60079-17).
4. Repair of this equipment shall be carried out by suitably-trained personnel in accordance with the applicable code of practice (e.g., EN 600079-19).
5. The certification of this equipment relies upon the following materials used in its construction:
   - Enclosure: 316L Stainless Steel
   - Window: Sapphire Glass
   - Cemented Joints: EPOCAP 25137
   - Seals: Buna-n and EPDM
6. If the equipment is likely to come into contact with aggressive substances, it is the user's responsibility to take suitable precautions to prevent it from being adversely affected, ensuring that the protection provided by the equipment is not compromised.
   - Aggressive substances (e.g., acidic liquids or gases that may attack metals or solvents that may effect polymeric materials).
   - Suitable precautions [e.g., regular checks as part of routine inspections and establishing from the Material's Safety Data Sheets (MSDS) that it is resistant to specific chemicals].
7. The t90 response time of the SafEye System and the controller shall be added together and not exceed 10 seconds.

Conduit Installation

- Install with the cable entries pointing downward to prevent water from entering the Detector or Source enclosure.
- Install conduit elbows in the cable entries and use flexible conduit at end connecting to the Detector or Source. This will allow the maximum range of motion for the Detector and Source during physical alignment. Use fittings and conduit suitable for the area classification.
- When pulling cables through conduits, ensure they are not tangled or stressed.
    - Extend cables about 30 cm. (12 in) beyond the Source and Detector location to accommodate wiring termination after installation.
- After cables are pulled through conduits, perform a continuity and grounding test on each conductor.

Detector and Source Mounting

The Detector and Source must be mounted with a Tilt Mount Kit. The Tilt Mount enables the detector to be rotated up to 45º in all directions.

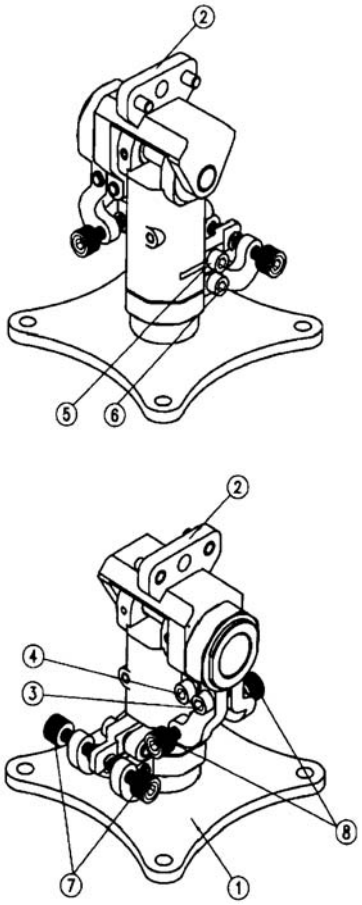
Tilt Mount Kit (P/N 799640)

The Tilt Mount kit consists of one:

- Tilt Mount assembly
- 5/16" - 18UNC x 3/4" screw
- 5/16" spring washer.

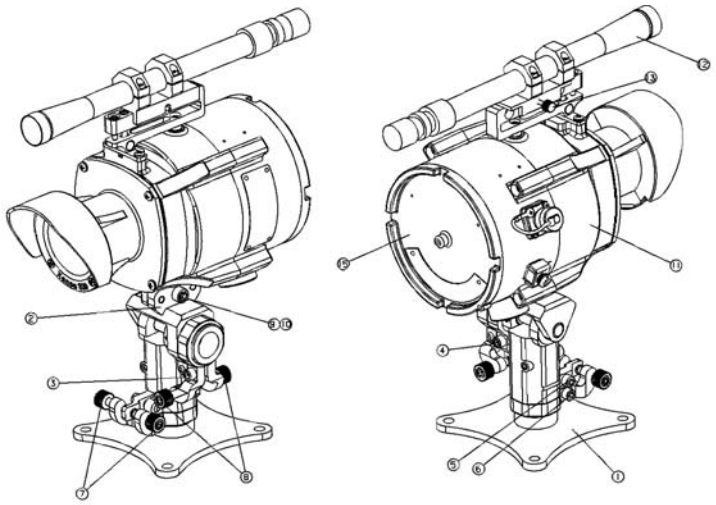
Detector and Source Installation

(FIGURES 2-1 and 2-2)



1 Tilt Mount Holding Plate
2 Detector/Source Holding Plate
3 Vertical Coarse Alignment Tightening Screw
4 Vertical Fine Alignment Tightening Screw
5 Horizontal Fine Alignment Tightening Screw
6 Horizontal Coarse Alignment Tightening Screw
7 Horizontal Fine Alignment Screw
8 Vertical Fine Alignment Screw

Figure 2-1. Tilt Mount



1 Tilt Mount Holding Plate
2 Detector/Source Holding Plate
3 Vertical Coarse Alignment Tightening Screw
4 Vertical Fine Alignment Locking Screw
5 Horizontal Fine Alignment Locking Screw
6 Horizontal Coarse Alignment Locking Screw
7 Horizontal Fine Alignment Screw
8 Vertical Fine Alignment Screw
9 Detector Tightening Screw
10 Detector Tightening Washer
11 Detector
12 Telescope
13 Telescope Tightening Bolt
15 Detector Back Cover

Figure 2-2. Detector and Tilt Mount Assembly

1 Place Tilt Mount holding plate (item 1) in designated location and secure it with four fasteners through four 8.5-mm diameter holes.

NOTE: Skip this step if the Tilt Mount is already installed.

NOTE: Detector removal for maintenance does not require Tilt Mount removal.

2 With its cable entries pointing downward, place the Detector on the detector holding plate of the Tilt Mount (item 2).

3. Secure the detector with a 5/16"-18UNC x 3/4" screw and No. 5/16" spring washer (9,10) to the Tilt Mount. Use ¼" Hex Key for 5/16" screw (item 9).

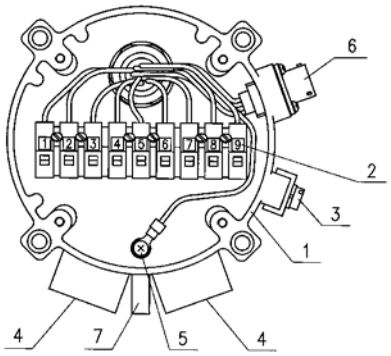
4. Repeat steps 1 through 3 to install the Source.

Detector Terminal Wiring

The Detector has two wiring options for the rear, segregated terminal section, with Terminals labeled 1-9.

Table 2-1. Detector Terminal Wiring

WIRING OPTION	TERMINAL NUMBER 1	2	3 & 4	5	6	7	8	9
1	24 VDC	0 VDC	Alarm Relay Contacts	RS485+	RS485-	4-20 mA	4-20 mA	(RS485 RTN)
2	24 VDC	0 VDC	Alarm Relay Contacts	Fault Relay Contacts		4-20 mA	4-20 mA	Not Used



1 Housing
2 Terminal Board
3 Earth Terminal
4 Cable Entry
5 Internal Earth Connection
6 Connection to Handheld Unit
7 Detector Holding Plate
8 Detector Telescope Site

Figure 2-3. Detector with Cover Removed

NOTE: All relays have dry contacts.

See Appendix B for details on the 4-20 mA output and RS485 for network communication.

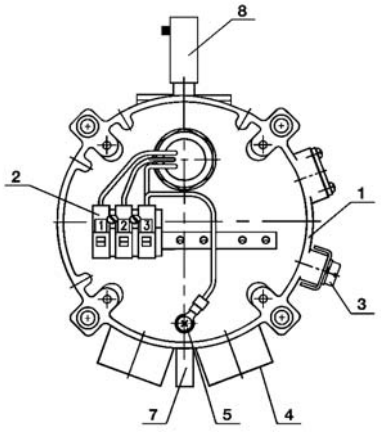
⚠ CAUTION

Correct voltage must be applied to the detector. Failure to use correct voltage may result in instrument damage.

Detector Wiring

(FIGURE 2-3)

1. Unscrew the Detector rear cover (FIGURE 2-2, item 14).
2. Remove the protective plug in the Detector cable entry.
3. Connect to the M25 x 1.5 or 3/4" x 14NPT connection with a conduit elbow and flexible conduit suitable for the area classification. Pull the wires through the cable gland or conduit into the Detector terminal section (FIGURE 2-3, item 4).
4. Connect the wires to the required terminals (FIGURE 2-3, item 2) corresponding to the wiring diagram. See Chapter 2, "Detector Terminal Wiring" and Appendix B.
5. Connect the grounding wire to the ground screw on the outside of the Detector (FIGURE 2-3, item 3).
   - The Detector must be connected to Earth Ground.
6. Check all wires for secure mechanical connection and press them neatly against the terminals to prevent them from interfering while replacing the rear cover (FIGURE 2-2, item 15).
7. Replace the Detector rear cover (FIGURE 2-2, item 15).



1 Housing	5 Internal Earth Connection
2 Terminal Board	6 Connection to Handheld Unit
3 Earth Terminal	7 Detector Holding Plate
4 Cable Entry	8 Detector Telescope Site

Figure 2-4. Flash Source Wiring

Flash Source Wiring

The Flash Source segregated terminal section has three terminals:

- Terminal 1 - 24 VDC
- Terminal 2 - 0 VDC
- Terminal 3 - not used.

⚠ CAUTION

Correct voltage must be applied to the source. Failure to use correct voltage may result in instrument damage.

Wiring

(FIGURES 2-2 and 2-4)

1. Unscrew the Source back cover (FIGURE 2-2, item 15) to reveal the chamber.
2. Remove the protective plug in the Source cable entry.
   - Connect to the M25 x 1.5 or 3/4" x 14NPT connection with a conduit elbow and flexible conduit suitable for the area classification. Pull the wires through the cable gland or conduit into the Source terminal section (FIGURE 2-3, item 4).
3. Pull the wires through the cable gland or conduit into the Source terminal section inlet (FIGURE 2-4, item 4).
4. Connect the wires to the required terminals (FIGURE 2-4 item 2).
   - See "Detector Terminal Wiring".
5. Connect the ground wire to the ground screw outside the detector (FIGURE 2-4, item 3).
   - The source must be well grounded to earth ground.
6. Check wires for secure mechanical connection and press them neatly against the terminal to prevent them from interfering while closing the cover (FIGURE 2-2, item 15).
7. Replace the Source rear cover (FIGURE 2-2, item 15).

⚠ CAUTION

Installation is not complete until the Chapter 3, "Alignment" procedure is performed. Accurate alignment is essential for proper operation of the SafEye System.

Chapter 3,
Installation - Alignment and Operation

SafEye System Operation

Once the system is installed, it will monitor for specified gases, automatically sending signals to a standard control panel or a PC. This chapter describes the alignment, calibration and operation.

⚠ CAUTION

Accurate Alignment is essential for proper operation of the SafEye System.

Alignment

Introduction

- Alignment must only be performed using the Telescope from the Commissioning Kit (P/N 10081519).
- The alignment procedure requires that:
  - The Source is first aligned to the Detector
  - Then, the Detector is aligned to the Source.
- Perform the alignment procedure in two stages:
  - Coarse alignment
  - Then, fine alignment.
- The Telescope includes a Periscope that consists of:
  - A prism and
  - An ocular vertically located to the Telescope assembly.
    - This allows the user to look through the telescope perpendicularly to the alignment when access from the rear of the unit is impossible.
    - For installations where rear access is possible, the Periscope is not necessary and can be removed by releasing the Periscope Fastening Screw.

IMPORTANT NOTES:

1. Prior to Telescope Installation, verify that the Telescope and its Sight Mounting are free from dirt to ensure proper alignment corresponding to the factory calibration.

2. To achieve optimum alignment, do not attempt to change the factory calibration of the Telescope or its mounting.

Alignment Procedure

(See FIGURES 2-1 and 2-2.)

1. Ensure that the Detector and the Flash Source are installed properly. Installation instructions are described in Chapter 2.
2. Install the Telescope Assembly (item 12) on the Telescope Site Mounting of the Source.
3. Secure the Telescope with the knurled thumb screw (item 13).
4. Flash Source Coarse Alignment:
   - Use a ¼" hexagon socket screwdriver for all alignment screws.

   a. Loosen screws 5 and 6.

   b. Approximately aim the Source horizontally toward the Detector.

   c. Tighten screw 6.

   d. Loosen screws 3 and 4.

   e. Approximately aim the Source vertically toward the Detector.

   f. Tighten screw 3.
5. Install the Telescope Assembly (item 12) on the Detector Telescope Site Mounting (FIGURE 2-2).
6. Secure the Telescope with the knurled thumb screw (item 13) and repeat the coarse alignment (given in step 4) for the Detector.
7. Install the Telescope Assembly (item 12) on the Telescope Site Mounting of the Source (FIGURE 2-2).
8. Secure the Telescope with the knurled thumb screw (item 13).
9. Flash Source Fine Alignment:
   a. Aim the Source at the Detector and align the horizontal axis using adjustment screws (item 7).
   b. Aim the telescope cross hair at the upper edge of the Detector telescope site mounting.
   c. Tighten screw (item 5).
   d. Aim the Source to the Detector and align the vertical axis using adjustment screw (item 8).
   e. Tighten screw (item 4).

f. Ensure the telescope cross hair is pointing at the top of the Detector telescope site mounting.

10. Install the Telescope Assembly (item 12) on the Detector Telescope Site Mounting (FIGURE 2-2).

11. Secure the Telescope with the knurled thumb screw (item 13) and repeat the fine alignment (given in step 9) for the Detector.

Powering the System

⚠ CAUTION

Prior to performing any operation or maintenance procedure, perform the Chapter 3, "Safety Precautions".

1. Ensure that the Source and Detector are properly connected to a suitable power supply.
2. Ensure that the 4-20 mA output and/or relay contacts are properly connected to the detector.
3. Power up the system (18-32 VDC).
   - After 60 seconds, the output current indicates 4 mA.

NOTE: After powering up the system, perform the Chapter 3, "Zero Calibration" procedure .

Safety Precautions

After power-up:

1. Follow the instructions in this Manual.
2. Refer to the drawings and specifications issued by the manufacturer.
3. Do not open the detector housing while power is supplied to the SafEye System itself or any of the relays.
4. Disconnect external devices, such as automatic extinguishing systems before carrying out any maintenance task.

Zero Calibration

- Refer to the Host software instructions in Appendix C or to the Diagnostic Kit instruction manual for the following procedure.

  NOTE: 'Zero calibration' may also be referred to as 'electronic alignment'.

- Zero calibration must be done after:
  - Installation
  - Realignment
  - Window cleaning
  - Any change in Detector or Source position.
- Precise alignment must be performed prior to the zero calibration procedure.
- Perform calibration in good weather conditions and with insignificant gas concentrations in the surrounding area.

1. Switch from Normal to Alignment mode indication.
2. Switch from Alignment to Standby mode.
3. Switch from Standby to Zero Calibration mode.
   - The 4-20mA output will now be 1mA.
4. Wait up to 60 seconds until it switches to Normal mode.
   - The Detector reading is now set to normal.
   - The 4-20 mA output will now indicate 4 mA.

Functional Check of Unit

- The SafEye System is factory-calibrated for the user's specific gas or vapor detection requirements.
- The following procedure validates the system functional operation.
- The Functional Check Filter is:
  - A convenient operational check used to confirm that the response has not changed from previous readings.
  - Not necessary for calibration; nor does it equate to a particular gas quantity.

⚠ CAUTION

Disconnect or inhibit any external device from the SafEye System that must not be activated during the calibration check.

NOTES:

- Prior to starting the functional check:
  - Verify that the power to the SafEye System Source and Detector is ON
  - Verify that the output signal is stable
  - Record the reading.

1. Position the Functional Check Filter in front of the Detector so that filter window is centered over the optical window of the Detector.
2. Wait 20 seconds; then, read the output signal.
3. Determine the difference between the reading taken with and without the Functional Check Filter.
   - This difference is the signal variance.
4. Record the signal variance in the Maintenance Logbook.
5. If the variance has changed by more than 30% when compared to the previous check (see Maintenance Logbook), repeat the alignment (see Chapter 3, "Alignment").

Monitoring SafEye System Status

The SafEye System is designed to give the user reliable gas detection with diagnostic features and reduced false alarms. If the SafEye System encounters some degree of misalignment and/or obscuration, the algorithms analyze the path to deliver unambiguous gas readings. This maximizes run time of the system and keeps false alarms to a minimum.

Under normal conditions, the system status will indicate NNN (see Appendix C for status codes) on the handheld diagnostic unit (PDA) and 4 mA or higher on the current output signal. The system status can be continuously monitored if the unit is equipped with the RS485 communication link.

If the infrared signal beam (path) becomes fully obscured and/or misaligned such that the instrument can no longer function properly, an obscuration/misalignment fault will be set and the outputs (handheld diagnostic unit, RS485 link and current signal) will also indicate a fault condition. If the path is neither normal nor fully obscured/misaligned but, becomes obscured and/or misaligned to some degree, the system will continue to run. In this mode, the system status may indicate _BN (status code ending in BN). The _BN status will clear and return to NNN within one hour provided the cause is removed. If after one hour, the cause is still present, the system will remain in _BN status.

⚠ WARNING

- **While in _BN status, the system may not alert users of gas levels at the 3 LELm Alarm level or the 1 LELm Warning level. It may not alert users until a gas level of 4 LELm is reached. Check the system status frequently with the PDA or monitor it continuously with the RS485 link to verify that the unit is not in _BN status.**
- **If immediate notification of loss of the 3 LELm Alarm and 1 LELm Warning functions is required, the system must be equipped with the RS485 link to allow continuous monitoring of the system status.**
- **If the system goes into _BN status, investigate the cause and correct the condition as described below.**

Failure to follow this warning can result in ignition of combustible gases, causing loss of life, serious personal injury, and/or property damage.

During _BN status, since there is some degree of obscuration and/or misalignment, the system may not be able to distinguish gas levels below 4 LELm. During such a condition, the current output may read 4 mA for gas levels below 4 LELm. The system status can be monitored via the RS485 communication link or checked manually with the PDA. Use a system equipped with the RS485 link for applications requiring immediate notification of a change to _BN status. The RS485 link provides the maximum diagnostic information. See Appendices B & C for information on RS485 link, status codes and current output readings. It is recommended that user install the SafEye System in an area that minimizes conditions that may produce path obscurations.

If the system goes into _BN status, investigate the cause and remove any obscurations. Perform a physical alignment and/or a zero calibration to return the unit to NNN status.

Chapter 4, Maintenance

General Maintenance

The SafEye System requires only simple periodic maintenance to provide satisfactory service and maximum performance. The Detector and Source units can be maintained with common tools and equipment. Record the periodic test results in a Maintenance Logbook.

⚠ CAUTION

Disconnect or inhibit any external device from the SafEye System that must not be activated during the calibration check.

Periodic Maintenance

- Periodically clean the optical surfaces.
- Cleaning frequency depends on the application and environmental conditions in which the SafEye System is used.
- Proper maintenance allows the SafEye System to retain maximum performance and reliability.
- Keep surfaces of the Source and Detector optical windows as clean as possible.
- Periodically perform a visual check of the system to prevent potential obscuration.
- Alignment procedures must be performed each time the Source or Detector is opened or moved for any reason.
- The Signal Verification Check:
    - Measures the intensity of the IR Flash Source to determine if the Source and Detector are misaligned or the Flash Source output is decreasing
    - Perform every 6-12 months.
        - Check signals against:
            - Limits given in TABLE 4-1
            - Previous signals recorded in the Maintenance Logbook.
- Perform the Functional Check every 6 months (See Chapter 3, "Functional Check of Unit").

- Perform the Alignment procedure only if the signals are outside the limits specified in TABLE 4-1.
- Perform the Chapter 3, "Zero Calibration" procedure each time the:
  - Detector and/or Source are realigned or
  - Optical windows are cleaned.

Routine Optical Surface Cleaning

The SafEye System is an optical device, and its Source and Detector windows must be kept as clean as possible.

Optical Window Cleaning

1. Turn OFF power to the Detector.
2. With a small, soft-bristle brush, clean the surfaces where dust or dirt has accumulated.
3. With water and a mild non-abrasive detergent, thoroughly wash the surfaces.
4. With clean water, thoroughly rinse the optical surface,ensuring no residue is left behind.
5. With a clean dry soft cloth, dry the optical surface.
6. In the Maintenance Logbook, enter the date and the name of person and company who performed the maintenance service.
7. Turn ON power to the detector.
8. Perform the "Signal Verification" procedure.
9. Perform the "Zero Calibration" procedure.
10. Perform the "Functional Check of Unit" procedure.

Signal Verification

- The signal verification check:
  - Determines if the SafEye System open path gas detection system is operating correctly
  - Checks the alignment and cleanliness of the optical window
  - Checks if there is a problem in Source or Detector.
- Use the SafEye System Host PC software or the Handheld Unit to perform the signal verification.
- For signal verification, use the PDA or PC Host Software to read the SafEye System parameters under normal operation with no gas present. Compare to TABLE 4-1 to ensure proper operation.

TABLE 4-1 shows typical ranges for various signals created by the detector. If the signal is in the "Maint. Limit" range, corrective action is needed; this may consist of:

- physical re-alignment of the source and detector
- re-zeroing the detector
- cleaning the source and detector windows
- various combinations of the above corrective actions.

NOTE: Signal amplitudes are typically between the levels specified in TABLE 4-1. For best operation, seek the highest signal amplitudes and the best match possible between the three signals.

TABLE 4-1 ratio values are clean air ratios. If NQratios vary significantly from 1.00 in clean air:

- detector-to-source alignment may have changed
- re-zero the detector.

Table 4-1. Signal Value Ranges with Maintenance Limits

SIGNAL NAME	MIN. DISTANCE	MED. DISTANCE	MAX. DISTANCE	MAINT. LIMITS
Reference, Signal 1 Signal 2	1.5V@Gain 0 to 1V@ Gain 1	3V@Gain 1 to 1V@Gain 2	1V@ Gain 2 to 1V@ Gain 3	>2.5V@ Gain 0 or <2.5V @ Gain 4
Ratio1 Ratio2	.75 to 1.35	.75 to 1.35	.75 to 1.35	>2.0 or <0.5
NQratio1 NQratio2	.95 to 1.05	.95 to 1.05	.95 to 1.05	>1.05 or <0.95
Detector Temp.	5 to 15° above ambient	5 to 15° above ambient	5 to 15° above ambient	25° above ambient
Input Voltage	18V to 32V	18V to 32V	18V to 32V	Voltage outside of the 18V to 32V range
Ref/Noise: Signal1/Noise Signal2/Noise	>125 (short & medium det.); >25 (long range det.)	>125 (short & medium det.); >25 (long range det.)	>125 (short & medium det.); >25 (long range det.)	<100 short & medium det.); <20 (long range det.)

Chapter 5, Troubleshooting

Table 5-1. Troubleshooting Guidelines

PROBLEM	CAUSE	SOLUTION
R, S1 and S2 are outside specified limits	Poor physical alignment	Perform physical alignment and zero calibration
	Dirt on the window	Clean the window
	Source IR output low	Replace the light source
	Detector fault	Replace/repair detector
NQRat1 and NQRat2 are below the permitted limit	Gas in the path between the Source and Detector	Make sure path is clean and weather conditions are good
NQRat1 and NQRat2 are outside specified limits	Poor physical alignment	Perform physical alignment and zero calibration
R/N, S1/N, S2/N are outside specified limits	Poor physical alignment	Perform physical alignment and zero calibration
	Dirt on the window	Clean the window
	Source IR output low	Replace the light source
	Detector fault	Replace/repair detector
Temperature more than 25°C above the ambient temperature	Electronic problem	Replace/repair detector
Ratio1 and Ratio2 are outside specified limits	Poor physical alignment	Perform physical alignment and zero calibration
	Dirt on the window	Clean the window
	Detector fault	Replace/repair detector
Voltage less than 16 VDC; The detector at "V" fault	Low supply voltage	Check the power supply and installation
RS485 Communications loss	Use of PDA will cause temporary interruption of RS485 comm link	Don’t use RS485 comms during PDA use

Chapter 6,
General Certification Information

COUNTRY	APPROVAL AGENCY	PROTECTION TECHNIQUE(S)	HAZARDOUS LOCATION	INGRESS PROTECTION	TEMP. RANGE AND RATING
USA and Canada	FM Approvals	Explosionproof Intrinsic Safety	Class I, Division 1, Groups A, B, C, D	Nema 4X IP66/X7	-40 to 55°C; T6
		Nonincendive	Class I, Division 2, Groups A, B, C, D		
		Flameproof Increased Safety, Intrinsic Safety	Class I, Zone 1, Group IIC, IIB, IIA		
		Type nA d	Class I, Zone 2, Group IIC, IIB, IIA		
Europe, Australia		Flameproof, Increased Safety, Intrinsic Safety	Class I, Zone 1, Group IIC, IIB, IIA	IP66/X7	-40 to 55°C; T6
		Type nA d	Class I, Zone 2, Group IIC, IIB, IIA		

Marking , Certificates and Approvals according to the Directive 94/9/EC (ATEX) .

Manufacturer: Mine Safety Appliances Company
1000 Cranberry Woods Drive
Cranberry Township, PA 16066 USA

Product: SafEye™ Xenon 800

Type of protection: EN 60079-0, EN 60079-1, EN 60079-7,
EN 60079-11, EN 60079-15

Performance: EN 50241-1, EN 50241-2

Gas: Measuring range : 0-2 LEL·m, 0-5 LEL·m

Ethylene CP
LPG (60% Propane + 40% Butane)
Methane
Natural Gas (92% Methane + 4% Ethane + 4% Propane)

Marking: Detector:  II 2(2) G Ex d e ib[ib] IIC T6
II 3(2) G Ex nA d ib[ib] IIC T6
-40°C ≤ Ta ≤ +55°C

Source :  II 2 G Ex d e ib IIC T6
II 3 G Ex nA d IIC T6
-40°C ≤ Ta ≤ +55°C

EC-Type Examination Certificate:

FM 07 ATEX 0019 X and FM 07 ATEX 0020 X

Quality Assurance Notification: 0080

Year of Manufacture: see Label

Serial Number: see Label

EMC Conformance according to the Directive 89/336/EC

EN 50 270 Type 2 EN 61 000 - 6 – 3

LVD Conformance according to the Directive 73/23/EC

EN 61010-1

SPECIAL CONDITIONS FOR SAFE USE

1. Upon installation of the SafEye Xenon 800, the label shall be permanently marked to show the type of explosion protection used for the installation.

Declaration of Conformity

MANUFACTURED BY: Mine Safety Appliances Company
1000 Cranberry Woods Drive
Cranberry Township, PA 16066 USA

The manufacturer or the European Authorized Representative

MSA AUER GmbH , Thiemannstraße 1 , D-12059 Berlin

declares that the product : **SafEye Xenon 800**

based on the EC-Type Examination Certificates :

FM 07 ATEX 0019 X and FM 07 ATEX 0020 X

complies with the ATEX directive 94/9/EC, Annex III. Quality Assurance Notification complying with Annex IV of the ATEX Directive 94/9/EC has been issued by INERIS of France , Notified Body number: 0080 .

The product is in conformance with the EMC directive 89/336/EC, changed by Directive 91/263/EC, 92/31/EC, 93/68/EC, with the following harmonized norms or normative documentation:

EN 50270 Type 2 EN 61 000 - 6 - 3

We further declare that the product complies with the provisions of LVD Directive 73/23/EC as amended by Directives 93/68/EC, with the following harmonized norms or normative documentation:

EN 61010-1

MSA AUER GmbH
Dr. Axel Schubert
R & D Instruments

Berlin , June 2007

Marking , Certificates and Approvals according to the Directive 94/9/EC (ATEX) .

Manufacturer:	Mine Safety Appliances Company 1000 Cranberry Woods Drive Cranberry Township, PA 16066 USA
Product:	IR Module
Type of protection:	EN 60079-0, EN 60079-11, EN 60079-15
Marking:	 II 2G Ex ib IIC T4 -40°C ≤ Ta ≤ +70°C
Battery Type:	Energizer No. E92 or Duracell MN2400

EC-Type Examination Certificate:

FM 07 ATEX 0021 X

Quality Assurance Notification: 0080

Year of Manufacture: see Label

Serial Number: see Label

EMC Conformance according to the Directive 89/336/EC

EN 61000-6-2 and EN 61000-6-3

.

MSA

Declaration of Conformity

MANUFACTURED BY: Mine Safety Appliances Company
1000 Cranberry Woods Drive
Cranberry Township, PA 16066 USA

The manufacturer or the European Authorized Representative

MSA AUER GmbH , Thiemannstraße 1 , D-12059 Berlin

declares that the product : **IR Module**

based on the EC-Type Examination Certificate : FM 07 ATEX 0021

complies with the ATEX directive 94/9/EC, Annex III. Quality Assurance Notification complying with Annex IV of the ATEX Directive 94/9/EC has been issued by INERIS of France , Notified Body number: 0080 .

The product is in conformance with the EMC directive 89/336/EC, changed by Directive 91/263/EC, 92/31/EC, 93/68/EC, with the following harmonized norms or normative documentation:

EN 61 000 - 6- 2 and EN 61 000 - 6 - 3

MSA AUER GmbH
Dr. Axel Schubert
R & D Instruments

Berlin , June 2007

Appendix A,
Wire Selection Tables

General Instructions for Electrical Wiring

1. See TABLE A-1 to determine the required wire gauge for general wiring, such as relay wiring.
2. See TABLE A-2 to select the wire gauge for power supply wires.
3. Calculate the permitted voltage drop with respect to load current, wire gauge and length of wires.
   - The wire gauge selected must be able to supply the Flash Source peak current and still maintain the required voltage at the Source terminals.
4. When the Source and Detector are connected to the same supply voltage, ensure the supply voltage at the Detector terminals is maintained above the minimum specified.

NOTE: DO NOT connect any circuit or load to Detector supply inputs.

Table A-1. Maximum DC Resistance of Copper Wire at 20°C (68°F)

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

Table A-2. Wire Gauge

1. Select "number of detectors" connected in one circuit.
2. Select "wire length" for installation requirements.
3. Refer to "power supply range" for supply voltage limits.
4. DO NOT connect any circuit or load to the voltage limits.

NUMBER OF DETECTORS	MM² (A W G)					POWER SUPPLY RANGE (VDC)
24	1.0 (18)	1.5 (16)	2.5 (14)			22-32
20	1.0 (18)	1.5 (16)	2.5 (14)			22-32
16	0.5 (20)	1.0 (18)	1.5 (16)	2.5 (14)		22-32
12	0.5 (20)	1.0 (18)	1.5 (16)	2.5 (14)		22-32
8	0.5 (20)	1.0 (18)	1.5 (16)	2.5 (14)		22-32
4	0.5 (20)	1.0 (18)	1.5 (16)	1.5 (16)	2.5 (14)	18-32
	50 (164)	100 (328)	150 (492)	200 (656)	250 (820)	
	Wire length in meters (feet)					

Appendix B, Wiring Options

Table B-1. Wiring Options

WIRING OPTION	TERMINAL NUMBER 1	2	3 & 4	5	6	7	8	9
1	24 VDC	0 VDC	Alarm Relay Contacts	RS485+	RS485-	4-20 mA	4-20 mA	(RS485 RTN)
2	24 VDC	0 VDC	Alarm Relay Contacts	Fault Relay Contacts		4-20 mA	4-20 mA	Not Used

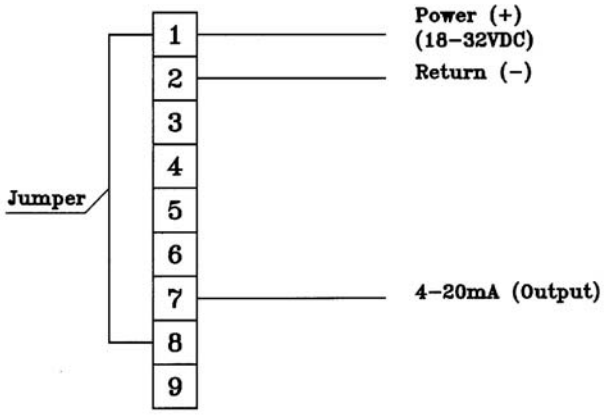


Figure B-1. 4-20 mA, Three-wire Connection (Non-isolated Current Source)

NOTES:

- The Detectors have an isolated 4-20 mA current output.
- Pins 7 and 8 are the output (emitter) and input (collector), respectively, for the isolated transistor output.
- To operate as non-isolated 4-20 mA current source, connect Terminal 8 to Terminal 1. Ensure that power is supplied from a Class 2 source.
    - The 4-20 mA output is then between Terminal 7 and Terminal 2.

RS-485 Communication Network

- By using the RS-485 network capability of the SafEye System and additional software, it is possible to connect up to 32 detectors in an addressable network.
- When using the RS-485 network, it is possible to read detector status (FAULT, WARNING, and ALARM).
- For RS-485 wiring, see FIGURE B-2. To ensure good RS485 communications, also daisy-chain the RS485 return connection (pin 9) to the controller.

For Modbus programming information, consult MSA at 1800-MSA-INST or go to www.msanet.com and search on ‘SafEye’.

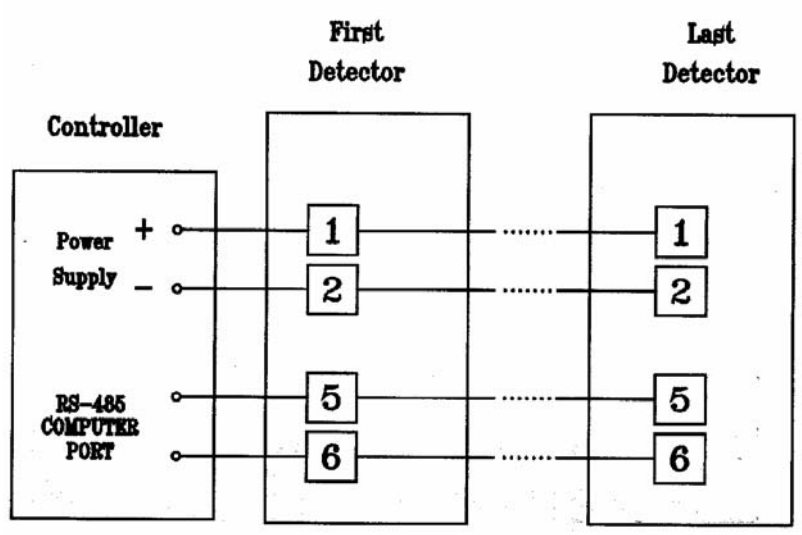


Figure B-2. RS-485 Wiring

Appendix C,
SafEye System 700/800 WinHost Software

Introduction

The SafEye System 700/800 WinHost Software:

- Is designed to be used on a personal computer (PC)
    - Software is loaded on a PC, which is connected to the Detector via the RS-485 output.
- Allows complete configuration of user-selectable options
- Allows user to view System performance
- Enables the required electronic alignment (Zeroing) of the Detector.

Requirements

- A personal computer running Windows 95 (or higher) Operating Software
- An RS 232 port on the PC
- A user-supplied RS485/RS232 converter
- 100 Mb of free disc space on the PC.

Loading the Software

Load the software from the CD provided.

It is suggested that the:

- Program files be loaded onto a suitable folder on the hard drive
- Start-up icon be placed on the desktop.

Connecting the Computer to the System

Attach the special cable between the data port of the Detector and the RS 232 port of the PC before initiating the SafEye System WinHost software.

Starting the Program

1. Click on (select) the SafEye System icon.
    - The Communication Setup screen appears (FIGURE C-1).
    - Typically, the port will be "Com 1" (FIGURE C-1).
2. To select Com 1 (If it is not selected), click on Com 1, then on OK

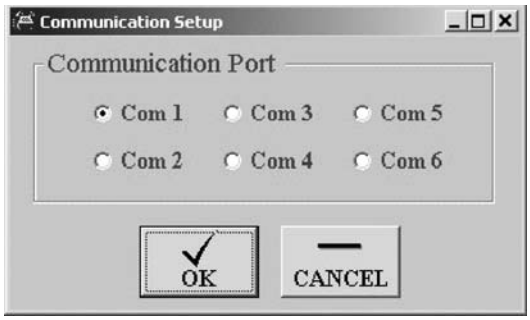


Figure C-1. Communications Setup

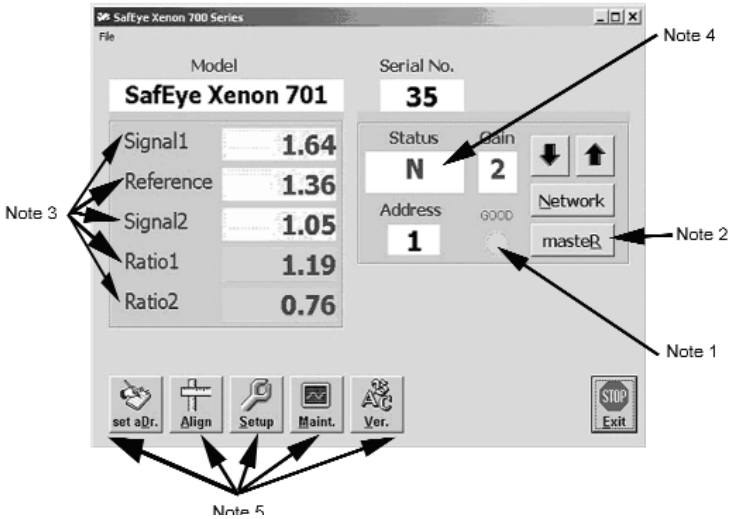


Figure C-2. Main Screen (see TABLE C-1)

Explanation of Screens and Functions

The Main Screen

- The main screen (FIGURE C-3) appears after the "Starting the Program" procedure is completed.
- There may be a wait of up to 10 seconds while the PC establishes communication and acquires readings.

Table C-1. Main Screen (see FIGURE C-2)

NOTE 1	Communication status must be green and indicate "good"
	If using Windows XP, it may be necessary to press the F12 key to establish communication with the system
NOTE 2	The Master button allows the software to find a Detector and establish communications
	The software is designed to always seek out address 1 by default
	Do not change this default unless the Detector is part of a Modbus System
	If the address is known, the up and down arrows can be used to scroll to it
	If the Detector is part of a Modbus system, its address may be a number other than 1; if this occurs, no values display until the user clicks on the Master button. The data and correct address then displays
NOTE 3	Signals Channels indicate how the system is functioning
	Signal 1, Signal 2, Ratio 1, Ratio 2, and Reference Signals must be within the limits shown in TABLE 4-1
NOTE 4	Status Indicator provides information on how the system is functioning
	A detailed list of Status Indicators is shown in TABLE C-2
	Refer to Chapter 3, "Monitoring SafEye System Status" for more information on status indicator codes
NOTE 5	Function buttons access other screens to facilitate configuration an diagnostics

Table C-2. Status Indicator Codes

STATUS	DESCRIPTION	4-20 mA	ALARM RELAY	FAULT RELAY
U U U	Power up	0 mA	Off	Off
S S U	Power up delay	0 mA	Off	Off
G G G	Gas calibration	1 mA	Off	Off
+ + + Or X X X	Alignment	1 mA	Off	Off
D D D	Disconnection	Unknown	Off	Unknown
P P P	Parameters fault	0 mA	Off	Off
V V V	Low voltage fault	0 mA	Off	Off
P R N	Alignment fault	0 mA	Off	Off
F F F	Noise fault	0 mA	Off	Off
N N N	Normal		Off	On
O M N	Maintenance call for low signal	3 mA	Off	On
R M N	Maintenance call for low ratio	3 mA	Off	On
B M N	Maintenance call in block detect	3 mA	Off	On

B	B	N	Block (partial obscuration) detect	4 mA	Off	On
b	B	N	Lot of wetting in short time (slowly gas detection)	4 mA	Off	On
M	B	N	Misalignment	4 mA	Off	On
Z	B	N	Reference LEL (detection relations as a result of rising reference)	4 mA	Off	On
E	B	N	Difference LEL between channels (high rise of reference)	4 mA	Off	On
T	N	N	Pre-alarm (alarm delay)	4 mA	Off	On
W	W	N	Warning	14 mA	Off	On
A	A	N	Alarm	19 mA	On	On
L	A	N	Alarm latch	19 mA	On	On
J	A	N	Disturbance while alarm	19 mA	Off	On
O	O	N	Obscuration	2 mA	Off	Off
H	O	N	Fast obscuration	4 mA	Off	On
R	O	N	Signal obscuration	2 mA	Off	Off
K	O	N	Absorption (low signal)	2 mA	Off	Off
P	O	N	Q0 fault	2 mA	Off	Off
I	O	N	Signal saturation	2 mA	Off	Off
Y	O	N	Obscuration delay	2 mA	Off	On
C	O	N	Obscuration C (report fault and no detect gas)	2 mA	Off	Off
T	B	N	Delay before reading at B Mode			
S	S	Y	Standby after alignment before zero calibration for 20 seconds			
Z	N	N		4 mA	Off	On
M	N	N	Misalignment	4 mA	Off	On

The Set Address Button

- When the SET ADDRESS button is selected, the New Address screen appears (FIGURE C-3).

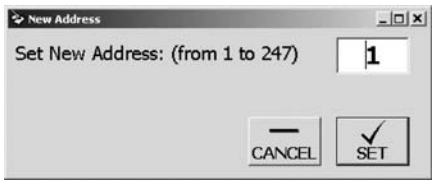


Figure C-3. New Address Screen

- If using the Detector as part of a Modbus system:
  - Set the Detector address by typing in a new address and selecting the SET button.
- If the Detector is *not* part of a Modbus system:
  - It is advisable to keep the address set at address 1 (default).

Electronic Alignment /Zero Calibration Screen and Procedure

1. Press the ALIGN button to start the electronic alignment procedure after window cleaning or Optical alignment with the telescope kit.
   - The status now changes to "XXX" (FIGURE C-4).

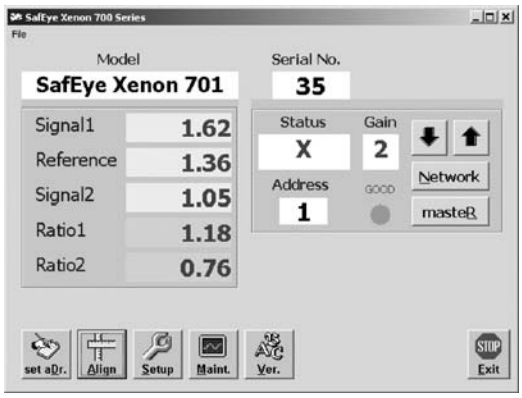


Figure C-4. Pressing ALIGN Button Changes Status

2. After approximately 10 seconds, press the ALIGN button again.
   - The status changes to "SSY".

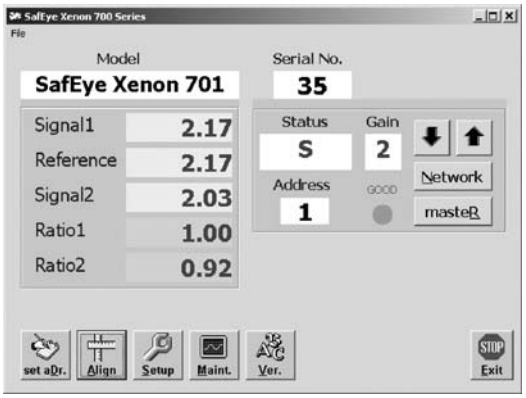


Figure C-5. Screen After Pressing ALIGN Button Again

3. After 10 seconds, press the ALIGN button again.
   - The status changes to "GGG".

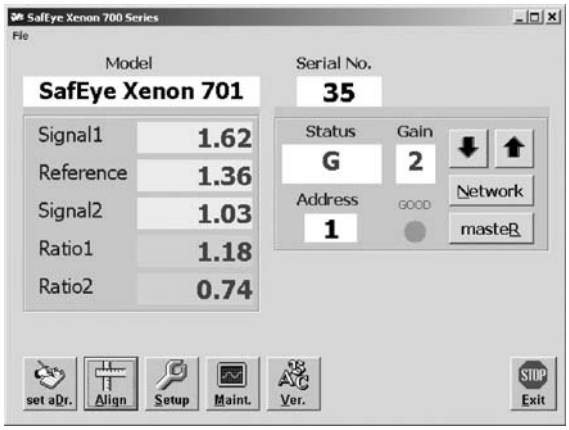


Figure C-6. Screen After Pressing ALIGN Button a Third Time

   - Do not press the ALIGN button when this Status is displayed.
   - When the Detector completes the automatic zero function, the status returns to "NNN" (normal).

Setup Screen

When SETUP button is selected, the following screen appears.

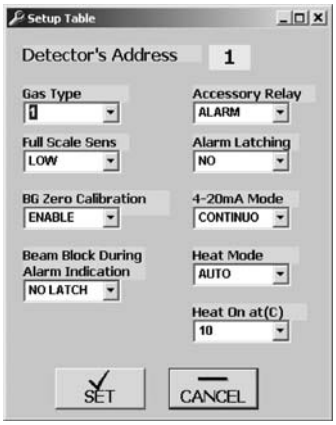


Figure C-7. Setup Screen

Selecting a Parameter Value

To select a value for any parameter:

1. Select each parameter pull-down menu and select the desired value; ensure that this value is highlighted in the parameter's window.
2. Once all selections are made, select the SET button.
    - The new settings will download to the Detector.

NOTE: Before changing any parameter, see TABLES 1-6 through 1-9 for information on how the system function will be affected.

Maintenance Screen

- When MAINT button is selected, the Maintenance screen appears.
    - This screen provides additional information on unit performance.

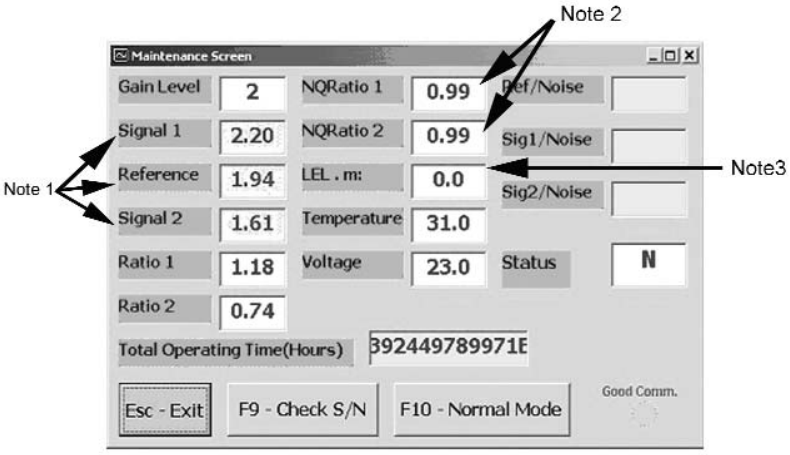


Figure C-8. Maintenance Screen (see TABLE C-3)

Table C-3. Maintenance Screen (see FIGURE C-8)

NOTE 1	Reference, Signal 1, and Signal 2 voltages are after electronic gain and may be higher than those on the Main screen.
NOTE 2	See TABLE 4-1 for valid ranges.
NOTE 3	LEL meter reading is a real-time reading.

- To check the signal to noise ratios, select the CHECK button or press F9.
  - The following screen appears (it may take up to 20 seconds for the values to display).

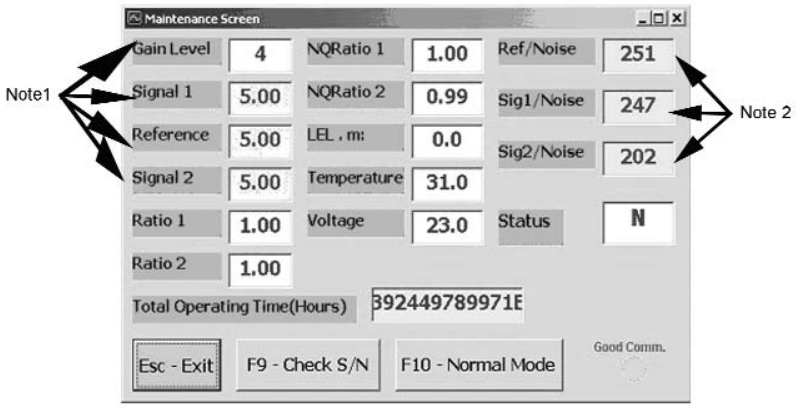


Figure C-9. Checking Signal-to-Noise-Ratio

NOTE 1	When in the signal-to-noise test mode, the gain automatically increases to Gain Level 4 and the signal levels also increase. The minimum signal in Gain Level 4 is 2.5 volts.
NOTE 2	See TABLE 4-1 for valid signal-to-noise ratios.

- To exit the Signal-to-Noise mode, select the NORMAL MODE button or F10.
- To return to the Main Screen select the EXIT button.

Software Version

- By selecting the VER button, the Detector software version is displayed (FIGURE C-10).

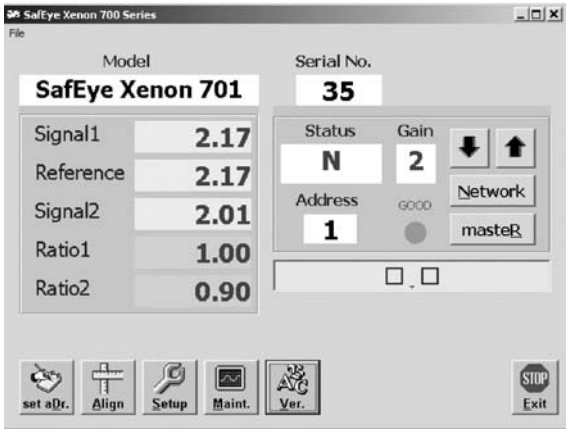


Figure C-10. Software Version

Data Logging

- Data logging allows the user to collect data on many of the performance values at predetermined, user selected, intervals.
- Selecting the FILE pop-up menu on the Main screen, enables the user to select from three options
  - Start Log
  - View Log
  - Exit.

Starting a New Log

1. Select START LOG.
   - The FIGURE C-12 screen appears.

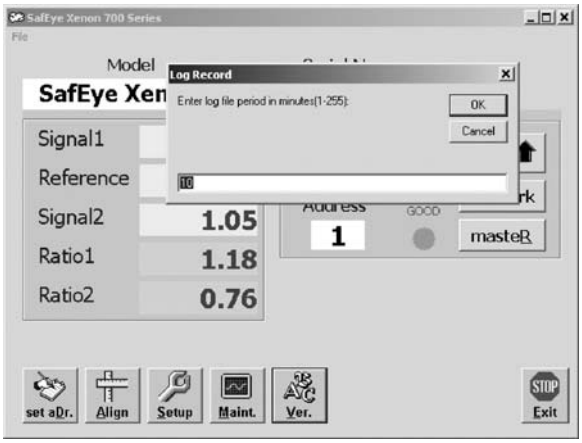
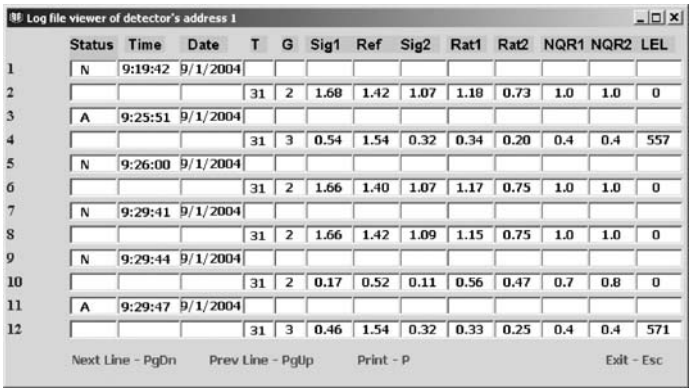


Figure C-11. Starting a New Log

2. Enter the desired log file period and select OK.
   - Logging begins and data is recorded at the interval selected.
   - If an event (Alarm warning) occurs, the event is logged, even if it is not at the selected interval.

Viewing a Log

1. Select VIEW LOG,
   - The FIGURE C-12 screen appears.



	Status	Time	Date	T	G	Sig1	Ref	Sig2	Rat1	Rat2	NQR1	NQR2	LEL
1	N	9:19:42	9/1/2004										
2				31	2	1.68	1.42	1.07	1.18	0.73	1.0	1.0	0
3	A	9:25:51	9/1/2004										
4				31	3	0.54	1.54	0.32	0.34	0.20	0.4	0.4	557
5	N	9:26:00	9/1/2004										
6				31	2	1.66	1.40	1.07	1.17	0.75	1.0	1.0	0
7	N	9:29:41	9/1/2004										
8				31	2	1.66	1.42	1.09	1.15	0.75	1.0	1.0	0
9	N	9:29:44	9/1/2004										
10				31	2	0.17	0.52	0.11	0.56	0.47	0.7	0.8	0
11	A	9:29:47	9/1/2004										
12				31	3	0.46	1.54	0.32	0.33	0.25	0.4	0.4	571

Figure C-12. Viewing a Log

Network Screen

The Network Screen provides an overview of an RS 485 Modbus network, if used,

- To view the overview, select the NETWORK button on the Main Screen.
    - The FIGURE C-13 screen appears.

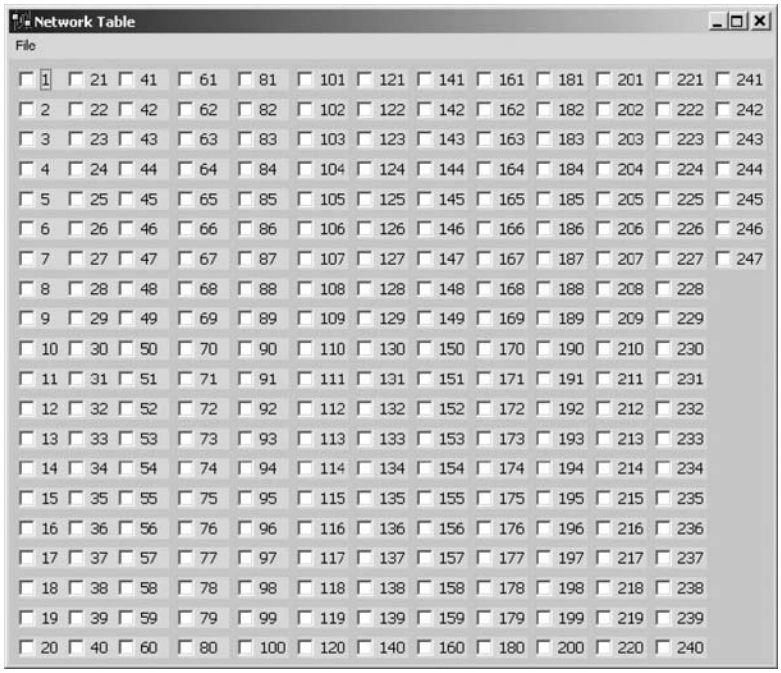


Figure C-13. Network Screen