



GENERAL MONITORS

SAFETY MANUAL
Infrared Point Detectors
And Monitors for
Hydrocarbon Gas Applications



The information and technical data disclosed in this document may be used and disseminated only for the purposes and to the extent specifically authorized in writing by General Monitors.

Safety Manual

04-09

General Monitors reserves the right to change published specifications and designs without prior notice.

Part No.
Revision

MANIRSAFETY
A/04-09

This manual describes the safety related information for the installation, operation, configuration, and maintenance of the following field devices:

- IR2100 Infrared Point Detector
- IR400 Infrared Point Detector
- IR4000M Multi-Point Monitor
- IR4000S Single-Point Monitor

For complete information regarding performance, installation, operation, maintenance and specifications of the above products, please refer to the associated product manual.

General Monitors' mission is to benefit society by providing solutions through industry-leading safety products, services and systems that save lives and protect capital resources from the dangers of hazardous flames, gases and vapors.

The safety products you have purchased should be handled carefully and installed, calibrated, and maintained in accordance with the associated product instruction manual. Remember, these products are for your safety.



WARNING: TOXIC, COMBUSTIBLE, AND FLAMMABLE GASES AND VAPORS ARE VERY DANGEROUS. USE EXTREME CAUTION WHEN THESE HAZARDS ARE PRESENT.

INTRODUCTION

General Description – Point Detectors

The Model IR2100 and IR400 infrared (IR) point detectors are microprocessor-based combustible gas detectors that continuously monitor combustible gases in the lower explosive limit (LEL) range and provide a 4-20 mA analog output proportional to the 0 to 100% LEL gas concentration. Both products are regarded as Type B field devices per IEC 61508.

Both the IR2100 and IR400 are calibrated at the factory and need no routine field calibration other than periodic cleaning and integrity checks to insure proper operation. Both Point IR Detectors interface directly with the existing Safety Integrity Level (SIL) suitable TA102A trip amplifier and IR4000S Single-Point Monitor. In addition, the IR400 also interfaces with the SIL suitable IR4000M Multi-Point monitor.

The safety function of the IR2100 detector does not include:

- RS-485 Modbus communication

The safety function of the IR400 detector does not include:

- HART communication
- RS-485 Modbus communication

NOTE: Neither the Model IR2100 or Model IR400 detect hydrogen (H₂) gas.

General Description – Monitors

The Model IR4000S Single-Point Monitor and IR4000M Multi-Point Monitor provide 4-20 mA analog output or relay output for the IR point detectors. The IR4000S connects to the IR2100 or IR400 point IR gas detectors. The IR4000M connects up to eight IR400 point IR gas detectors. The IR4000M is not compatible with the IR2100. The monitors allow local calibration, user interface, and display detector gas concentration levels. Using the relay output option provides output for Alarm, Warn, and Fault conditions. Both the IR4000M and IR4000S monitors are housed in explosion-proof junction box enclosures that can be installed in hazardous locations. The monitors are regarded as Type B field devices per IEC 61508.

The IR4000S and IR4000M monitor menus allow the user to complete many operational tasks for the point detectors such as reset Alarm and Warn relays; zero, calibrate, or initiate a gas check; and select Alarm and Warn relay settings.

The safety function of the IR4000M monitor does not include:

- HART communication
- RS-485 Modbus communication to the control room

The safety function of the IR4000S monitor does not include:

- HART communication

HART and Modbus communication are typically used for field device setup, diagnostics, and troubleshooting. Observe requirements for interfacing in hazardous locations. HART and Modbus communication are non-interfering functions and do not interrupt the safety critical function of the detectors.

INSTALLATION

NOTE: Power should remain disconnected until all other wiring connections are made.

Detector Location Considerations

There are no standard rules for detector placement, since the optimum detector location varies with the application. The customer must evaluate conditions at the facility to make this determination. If practical, the Model IR2100 and Model IR400 IR point detectors should be easily accessible for occasional integrity checks.

The point detectors should be mounted horizontally so that dirt and dust does not build-up on the windows. Although both the IR2100 and IR400 are Radio Frequency Interference (RFI) resistant, the units should not be mounted close to radio transmitters, high magnetic or electrical fields, or in areas with similar interference.

Locate the IR2100 and IR400 where prevailing air currents contain the maximum concentration of gas. Also, locate the point detectors as near as possible to the likely source of a gas leak. Observe the temperature range of the field device and locate the unit away from concentrated sources of heat or light. Do not locate the IR2100 or IR400 in areas that exceed the maximum operating temperature of the unit, such as gas turbine exhaust. Mount the point detectors away from sources of excessive vibration.

No special or additional detector mounting, wiring, power, or tool requirements exist beyond the standard installation practices documented in the product instruction manuals for the IR2100 and IR400.

NOTE: The Model IR2100 and Model IR400 are both factory calibrated and need no routine calibration. However, if the point detectors are to be installed at altitudes greater than 1000 ft (300 m), a recalibration must be conducted onsite.

NOTE: If the IR400 is being used with a +24 VDC power supply and an industrial analog to digital (A/D) converter, then the negative supply (Common) of all three devices must be connected. This will insure readings between the applied gas concentration and the 4-20 mA analog output are proportional.



WARNING: Under NO circumstances should equipment be connected or disconnected when under power. This is contrary to hazardous area regulations and may also lead to serious damage to the equipment. Equipment damaged in this manner is not covered under warranty.

Monitor Location Considerations

Although both the IR4000M and IR4000S are RFI resistant, the units should not be mounted close to radio transmitters, high magnetic or electrical fields, or in areas with similar interference.

Observe the temperature range of the IR4000M and IR4000S and locate the units away from concentrated sources of heat or light. Do not locate the IR4000M and IR4000S in areas that exceed the maximum operating temperature of the unit, such as gas turbine exhaust. Mount the field devices away from sources of excessive vibration.

No special or additional mounting, wiring, power, or tool requirements exist beyond the standard installation practices documented in the product instruction manuals for the IR4000M and IR4000S.

OPERATION AND CONFIGURATION

For complete operation and configuration information for the IR2100, IR400, IR4000M, and IR4000S, refer to the specific instruction manual for each of these field devices.

Before connecting a unit, check to make sure power is turned off. Before power-up, check all wiring connections. Upon power-up, a 60 minute temperature stabilization time is required before gas checking or calibration on the IR2100 and IR400. For point detector installations at altitudes greater than 1000 feet (300m), an onsite calibration is required.

Each IR2100 and IR400 is calibrated at the factory and needs no routine field calibration, however, the detectors will need occasional zeroing as well as gas check tests and calibration after initial installation to ensure proper operation. Before zeroing or calibration, always check that the optics path is clear and the windows are clean. These are the most important operations to ensure that the point detectors measure accurately.

The IR2100 and IR400 are smart sensors performing internal diagnostics on critical faults every second. The IR2100 responds with 0 mA or 2 mA at the analog output upon detection of a fault. The IR400 responds with 0 mA, 1.25 mA, 2 mA, or 3.5 mA at the analog output, depending on the configuration.

The IR4000M and IR4000S are monitors / display units and do not require gas checks or calibrations. The monitors allow local gas checks, zeroing, and calibration of the IR2100 and IR400 detectors when necessary.

MAINTENANCE

For complete maintenance information refer to the individual product instruction manuals for the IR2100, IR400, IR4000M, and IR4000S.

The Model IR2100 and Model IR400 are calibrated at the factory and are fail-to-safe; once each unit is correctly installed and calibrated upon start-up, the point detector requires little maintenance other than periodic cleaning, gas checks, zeroing and recalibration to ensure system integrity. Integrity checks can be performed using General Monitors' Gas Check Kit for the IR2100 (P/N 31468) or IR400 (P/N 32548).

Before zeroing or calibration, always check that the optical path is clear and the windows are clean. These are the most important operations to ensure that the IR2100 and IR400 are measuring accurately. A maintenance cycle of 90 days is recommended for the IR2100 and IR400.

The IR4000M and IR4000S are monitors / display units and do not require gas checks or calibrations. The monitors allow local gas checks, zeroing, and calibration of the IR2100 and IR400 detectors when necessary. See the Maintenance section of the IR4000M and IR4000S Instruction Manuals for complete information.

NOTE: Entering Gas Check, Zeroing, or Calibration mode sends a 1.5 mA output signal that disables the IR4000M and IR4000S Warning and Alarm relay circuits.



WARNING: Disconnect or inhibit external devices such as Trip Amplifiers, Programmable Logic Controllers (PLC), or Distributed Control Systems (DCS) before performing any maintenance.

SPECIFICATIONS

Table 1 and Table 2 list specifications for the IR2100, IR400, IR4000M, and IR4000S. For a complete list of specifications, refer to the instruction manual of each respective model.

	IR400	IR2100	IR4000M	IR4000S
Instruction Manual P/N	MANIR400	MANIR2100	MANIR4000M	MANIR4000S
Temp. Range				
Operating:	-40°F to 167°F (-40°C to +75°C)	-40°F to 167°F (-40°C to +75°C)	-40°F to 167°F (-40°C to +75°C)	-40°F to 167°F (-40°C to +75°C)
Storage:	-58°F to 185°F (-50°C to +85°C)	-58°F to 167°F (-50°C to +75°C)	-58°F to 185°F (-50°C to +85°C)	-58°F to 185°F (-50°C to +85°C)
Humidity Range:	5 to 100% RH non-condensing	5 to 100% RH non-condensing	5 to 100% RH non-condensing	5 to 100% RH non-condensing
Input Power:				
Absolute min:	20V	20V	20V	20V
Nominal:	24V	24V	24V	24V
Absolute max:	36V	36V	36V	36V

Table 1 – Environmental/Electrical Specifications

Mode	IR400 (600 ohms max)	IR2100 (600 ohms max)	IR4000M (500 ohms max)	IR4000S (see IR400)
Startup Mode and Critical Fault for non-HART unit	0 mA	0 mA	Refer to levels for the IR400.	Refer to levels for the point IR detector connected to the monitor (either IR2100 or IR400).
Startup Mode and Critical Fault for HART unit	1.25 mA*	N/A		
Zero, Calibration and Gas Check Mode	1.5 mA*	1.5 mA		
Dirty Optics	2 mA*	2 mA		
0 – 100 % LEL	4 – 20 mA	4 – 20 mA		
Over Range	20.1 – 21.7mA	20 – 22 mA		

Table 2 – Analog Output Specifications

* IR400 and IR4000M: For HART units, the analog output minimum level can be configured at 3.5 mA or as stated above, depending on user selection.

CERTIFICATIONS and FAILURE RATE DATA

The IR2100, IR400, IR4000M, and IR4000S have gone through rigorous reliability and functional safety assessments, which have culminated in each of these field devices being certified to IEC 61508 Parts 1, 2, and 3, by FM Approvals. The reliability assessment is a failure rate prediction that assumes an average temperature of 40°C and an environmental factor equivalent to Ground Fixed. It is assumed that the field devices will be installed in a Safety Instrumented System (SIS) operating in a Low Demand environment per IEC 61508. The tables below list the SIL parameters for these field devices.

Parameter	IR2100	IR400
FM Certificate	3034949-IR2100	3034949-IR400
Product Life (Years)	30	25
λ_{DD} (Fails per hour)	9.83E-7	2.25E-6
λ_{DU} (Fails per hour)	1.00E-7	2.64E-8
Safe Failure Fraction (SFF)	97%	>99%
(Safety Integrity Level) SIL*	2	3
Diagnostic Test Interval	1 sec (critical faults)	1 sec (critical faults), 30 minutes (memory and non-critical faults)
Accuracy @ 25°C***	±3% FS for ≤ 50% FS, ±5% FS for > 50% FS	±3% FS for ≤ 50% FS, ±5% FS for > 50% FS
Response Time (with 100% LEL methane applied)	T50 ≤ 7 sec T60 ≤ 8 sec T90 ≤ 10 sec	T50 ≤ 7 sec T60 ≤ 8 sec T90 ≤ 10 sec
Average Probability of Failure on Demand PFD _{avg} 1oo1**	1.1E-4	3.75E-5

Table 3 – SIL Parameters for Detectors

* Hardware Fault Tolerance (HFT) = 0

** PFD_{avg} 1oo1 assumes a 4 hour repair time and 90 day proof test interval.

*** Accuracy is not affected by humidity as long as no condensation accumulates on the windows.

Parameter	IR4000M Relay Output	IR4000M Analog Output	IR4000S Relay Output	IR4000S Analog Output
FM Certificate	3034949- IR4000M	3034949- IR4000M	3034949- IR4000S	3034949- IR4000S
Product Life (Years)	20	20	25	25
λ_{DD} (Fails per hour)	1.85E-06	1.63E-06	1.30E-06	1.08E-06
λ_{DU} (Fails per hour)	2.71E-07	3.29E-08	2.67E-07	2.87E-08
Safe Failure Fraction (SFF)	94%	98%	94%	98%
(Safety Integrity Level) SIL*	2	2	2	2
Diagnostic Test Interval	1 sec (critical faults, 1-4 detectors) ~2 sec (critical faults, 5-8 detectors) 30 minutes (memory and non-critical faults, any number of detectors)		1 sec (critical faults) 30 minutes (memory and non-critical faults)	
Response Time	<0.125 sec per detector		0.1 sec	
Average Probability of Failure on Demand $PFD_{avg1001}^{**}$	3E-4	4.3E-5	3E-4	3.6E-5

Table 4 – SIL Parameters for Monitors

* Hardware Fault Tolerance (HFT) = 0

** $PFD_{avg1001}$ assumes a 4 hour repair time and 90 day proof test interval.

Agency Approvals

The IR2100, IR400, IR4000M, and IR4000S have the following approvals:

IR400	IR2100	IR4000M and IR4000S
CSA	CSA	CSA
FM Approvals	FM Approvals	FM Approvals
ATEX	ATEX	ATEX
Approved for Russia Pending	Approved for Russia	Approved for Russia Pending
IECEX	Kazakhstan	IECEX
IEC 61508 per FM Approvals	IEC 61508 per FM Approvals	IEC 61508 per FM Approvals
	BV	

Table 5 – Approvals