



FlameGuard® 5 UV/IR

Ultraviolet/Infrared
Flame Detector



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Instruction Manual

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Part No.
Revision

MAN5UVIR
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Quick Start Guide

Mount and Wire the Detector

Pay special attention to the conduit seal entry (Canadian Electrical Code Handbook Part 1, Section 18-154). Also, lithium based grease is applied to the O-ring seal between the back-plate and housing, as additional protection to avoid water ingress into the housing. Mount detector using swivel mount or mounting bracket hardware.

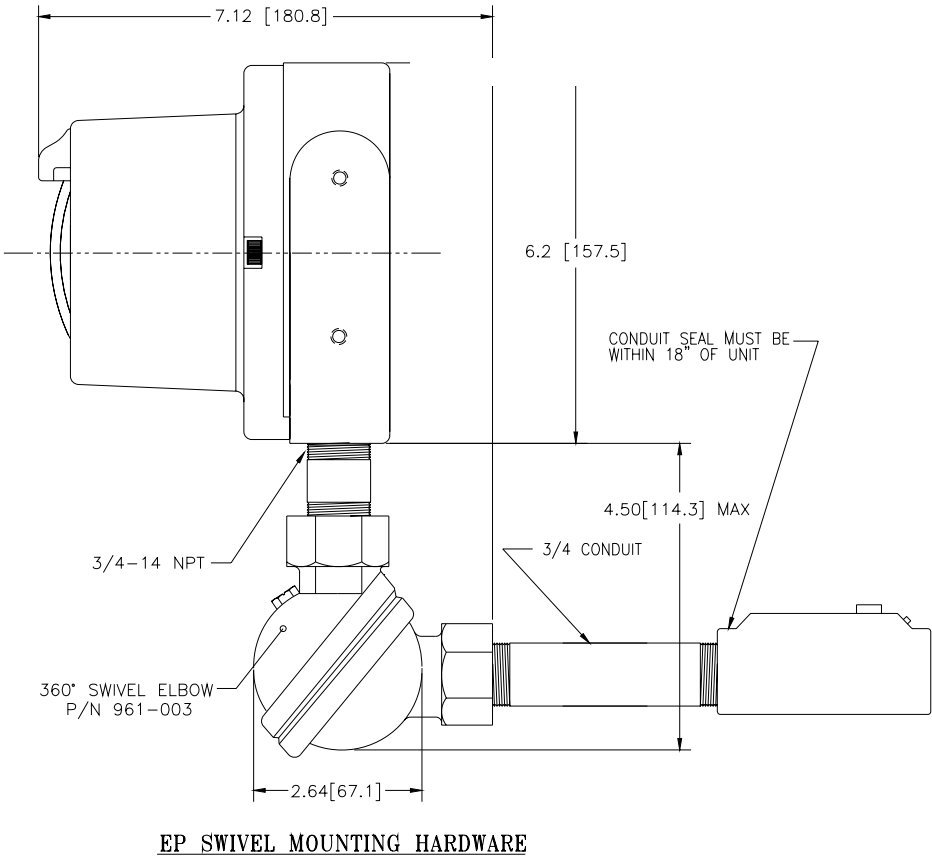


Figure 1: P/N 961-004 Union Swivel Mounting Hardware

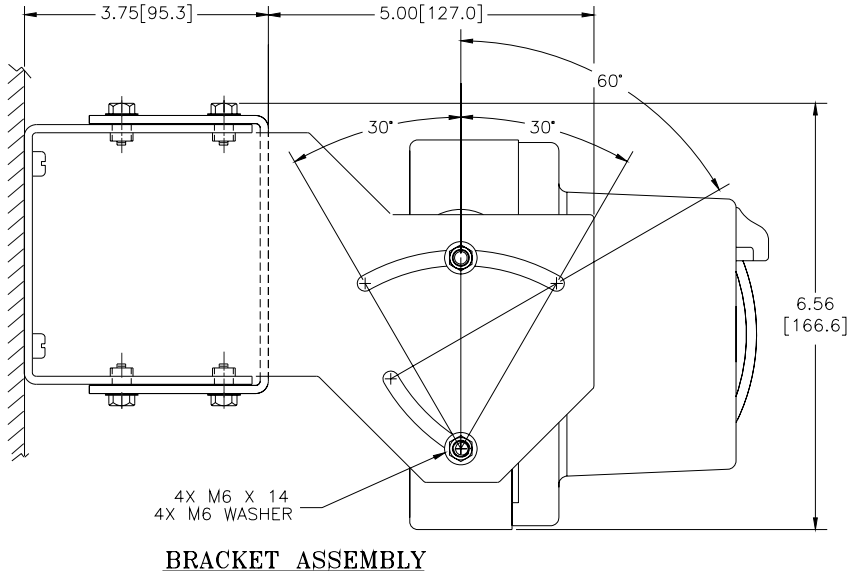


Figure 2: P/N 71172 Side View Bracket Assembly

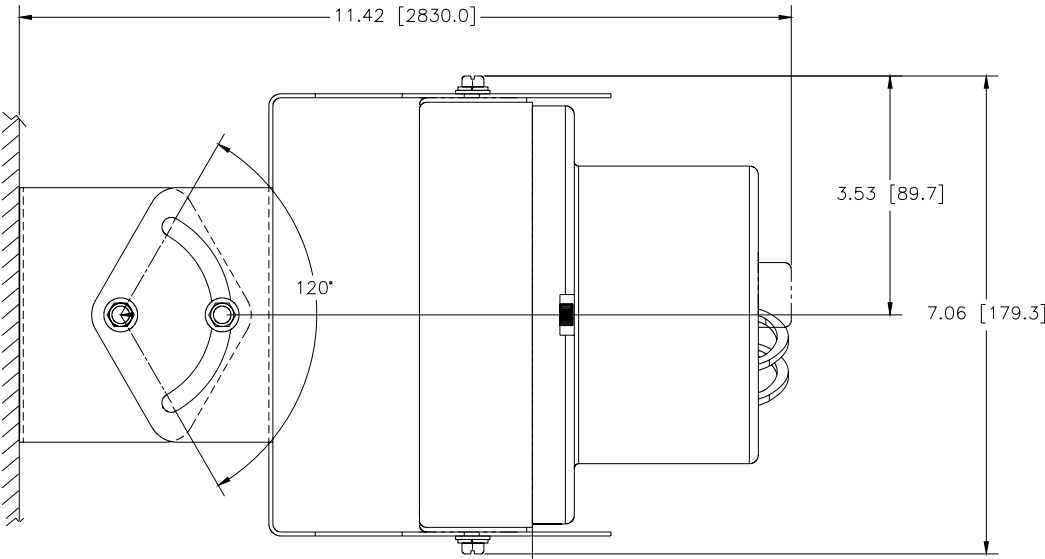


Figure 3: P/N 71172 Top View Bracket Assembly

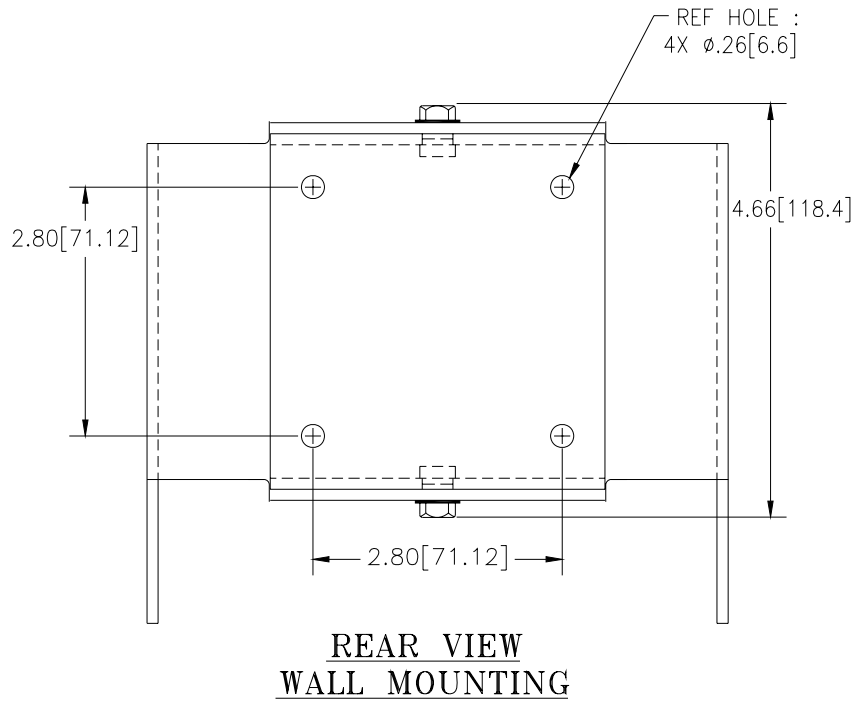


Figure 4: P/N 71172 Rear View Bracket Assembly

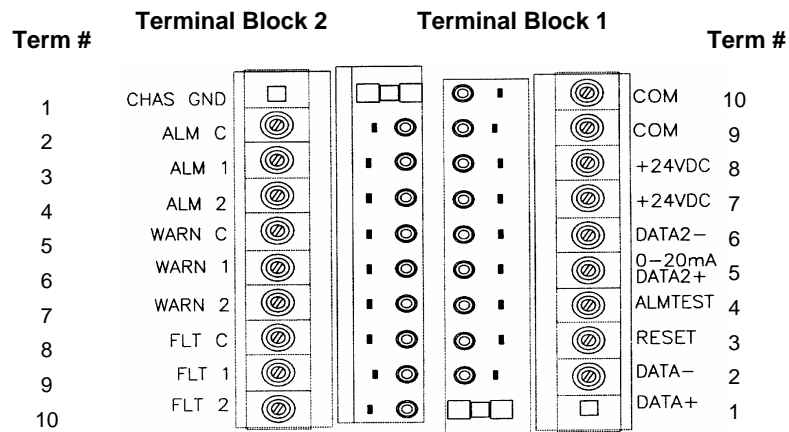


Figure 5: Field Terminations

Apply Power to the Detector

Two light emitting diodes (LEDs) are visible through the UV window (the larger window on UV/IR units). Immediately upon powering up the detector, both LEDs will start blinking alternately for 10 seconds. The unit will then enter the “Ready” mode. During the “Ready” mode, the green LED will flash off 1 second, every 10 seconds.

Test the Detector Using the FlameGard 5 UV/IR Test Lamp

Test the integrity of your system by using the FlameGard 5 UV/IR Test Lamp. The original configuration (i.e. sensitivity and relay options) can be changed by using the “Switch Selectable Options” (Table 11) and then changing the dipswitch settings located on the bottom of the power board (SW1).

The instrument is now ready to operate. Please consult the manual for more information on the instrument’s many features.

NOTE: If you have any problems in the set-up or testing of the detector, please refer to the “Troubleshooting Section”, or call the factory direct.

Worldwide service is available by contacting:

Address	Phone/Email
Mine Safety Appliances Co. 26776 Simpatica Circle Lake Forest, CA 92630	Toll Free: 1-800-MSA-INST E-mail: customer.service@msanet.com

1.0 Introduction

1.1 Protection for Life

MSA's 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.

This manual provides instruction for installing and operating the MSA FlameGard 5 UV/IR Flame Detector. While the FlameGard 5 UV/IR Flame Detector is easy to install and operate, this manual should be read in full and the information contained herein understood before attempting to place the system in service.

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



1.2 Special Warnings

Through engineering design, testing, manufacturing techniques, and rigid quality control, MSA supplies the finest flame detection systems available. The user must recognize his responsibility for maintaining the flame detection system in operational condition. Installation and maintenance must be carried out by suitably skilled and competent personnel only.

The FlameGard 5 UV/IR Flame Detectors contain components, which can be damaged by static electricity. Special care must be taken when wiring the system, to ensure that only the connection points are touched.

1.3 System Integrity Verification

Commissioning Safety Systems

Before power up, verify wiring, terminal connections and stability of mounting for all integral safety equipment including, but not limited to:

- Power supplies
- Control modules
- Field detection devices
- Signaling / output devices
- Accessories connected to field and signaling devices

After the initial application of power (and any factory specified warm-up period) to the safety system, verify that all signal outputs, to and from devices and modules, are within the

manufacturers' specifications. Initial testing should be performed per the manufacturers' recommendations and instructions.

Proper system operation should be verified by performing a full, functional test of all component devices of the safety system, ensuring that the proper levels of alarming occur. Fault/Malfunction circuit operation should be verified.

Periodic Testing of Field Devices

Periodic testing should be performed per the manufacturers' recommendations and instructions. Testing procedures should include, but not be limited to:

- Verify integrity of all optical surfaces and devices
- For flame detectors, use the appropriate test lamp

When testing produces results outside of the manufacturers' specifications, replacement of the suspect device(s) should be performed as necessary.

Periodic System Verification

The following system verifications should be performed at least annually:

Verify wiring, terminal connections and stability of mounting for all integral safety equipment including, but not limited to:

- Power supplies
- Control modules
- Field detection devices
- Signaling / output devices
- Accessories connected to field and signaling devices

Proper system operation should be verified by performing a full, functional test of all component devices of the detection system, ensuring that the proper levels of alarming occur. Fault/Malfunction circuit operation should be verified.

Maintenance intervals should be independently established through a documented procedure, including a maintenance log maintained by plant personnel or third party testing services.

2.0 Product Description

2.1 General Description

Fire is usually manifested in heat (IR), smoke, light (visible), and flame (UV). Flame is the gaseous region of a fire where vigorous combustion chain reactions take place. These reactions emit radiation covering the Infrared, Ultraviolet and the Visible Spectral Regions.

The MSA FlameGard 5 UV/IR Flame Detector is an ultraviolet/infrared (UV/IR) flame detector (Figure 6). It detects the ultraviolet and infrared spectral regions of flame to produce a system which is highly immune to false alarms caused by lightning, arc-welding, hot objects, and other sources of radiation.

The units may be used with MSA's controllers, or with other equipment, which accept the 4 to 20 mA output. They may also be interfaced directly with alarm/suppression devices or with switched input modules using integral relays. If HART is used with the above controllers, you must use the special 1.25 mA to 20 mA mode.

The FlameGard 5 UV/IR Flame Detector features include:

- Compact unitized design
- Continuous optical path monitoring (COPM)
- 4-20 mA, alarm relays, and Modbus RTU RS-485 standard (Dual Modbus optional) (HART optional)
- Wide field of view
- High false alarm immunity & visual indicators

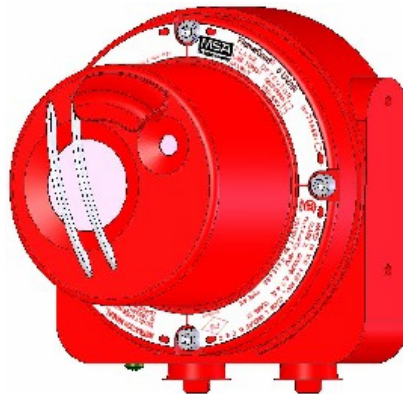


Figure 6: FlameGard 5 UV/IR Flame Detector

3.0 Installation



WARNING: Suitably skilled and competent personnel must carry out installation and maintenance.

3.1 Tools Required

- “T” Allen head wrench to remove detector head from its base (included).
- Flat head screwdriver maximum 3/16 in (5 mm) width for terminal block connections.
- Adjustable wrench for conduit, or cable gland connections.

3.2 Choosing Product Locations

Several variables are involved in selecting the locations to install detectors to ensure proper flame detection. There are no hard and fast rules defining the optimum location. Following are some general suggestions that should be considered in regard to particular conditions at the site where the unit(s) are being installed:

3.2.1 Detector Field of View

The FlameGard 5 UV/IR Flame Detector has a maximum cone of vision of 120°. This cone has its vertex at the center of the detector (Figure 7).

3.2.2 Optical Sensitivity Range

The distance at which the detector responds to a flame is a function of the intensity of that flame. The maximum distance is 50 ft. (15.2m) for a heptane fire with a surface area of 1 sq. ft. (0.093m²).

3.2.3 Environmental Factors

Mounting should be as free from shock and vibration as possible and convenient for visual inspection and cleaning.

Detectors mounted in dirty atmospheric conditions will require frequent inspection, cleaning, and sensitivity checking. Make sure the field-of-view of the detector is not obstructed by the cover or nearby objects.

Observe the ambient temperature range for the specific model (Section 10.3.4). For outdoor installations or other areas exposed to intense, direct solar radiation, the detector may reach temperatures well above specifications. For these installations, a shade or cover may be required to keep the detector temperature within specifications.

Avoid conditions that would allow ice build-up on the optical detector windows. Complete icing over of the detector window(s) can result in fault conditions. Mount away from sources of electrical noise where possible. A constant UV source detected by the unit will cause the detector to go into FAULT after 9 – 10 minutes of exposure. The source must be removed or the detector must be repositioned. (UV detectors can pick-up arc welding up to 2–3 miles

FlameGard 5 UV/IR Detector

away). Users should be aware that any UV detector may be triggered by other sources of EMI, for instance X-rays, sunlight, reflected sunlight, Gamma rays, lightning, arc welding, industrial lighting, fluorescent lighting, etc., and due regard should be paid to the possible presence of such radiation.

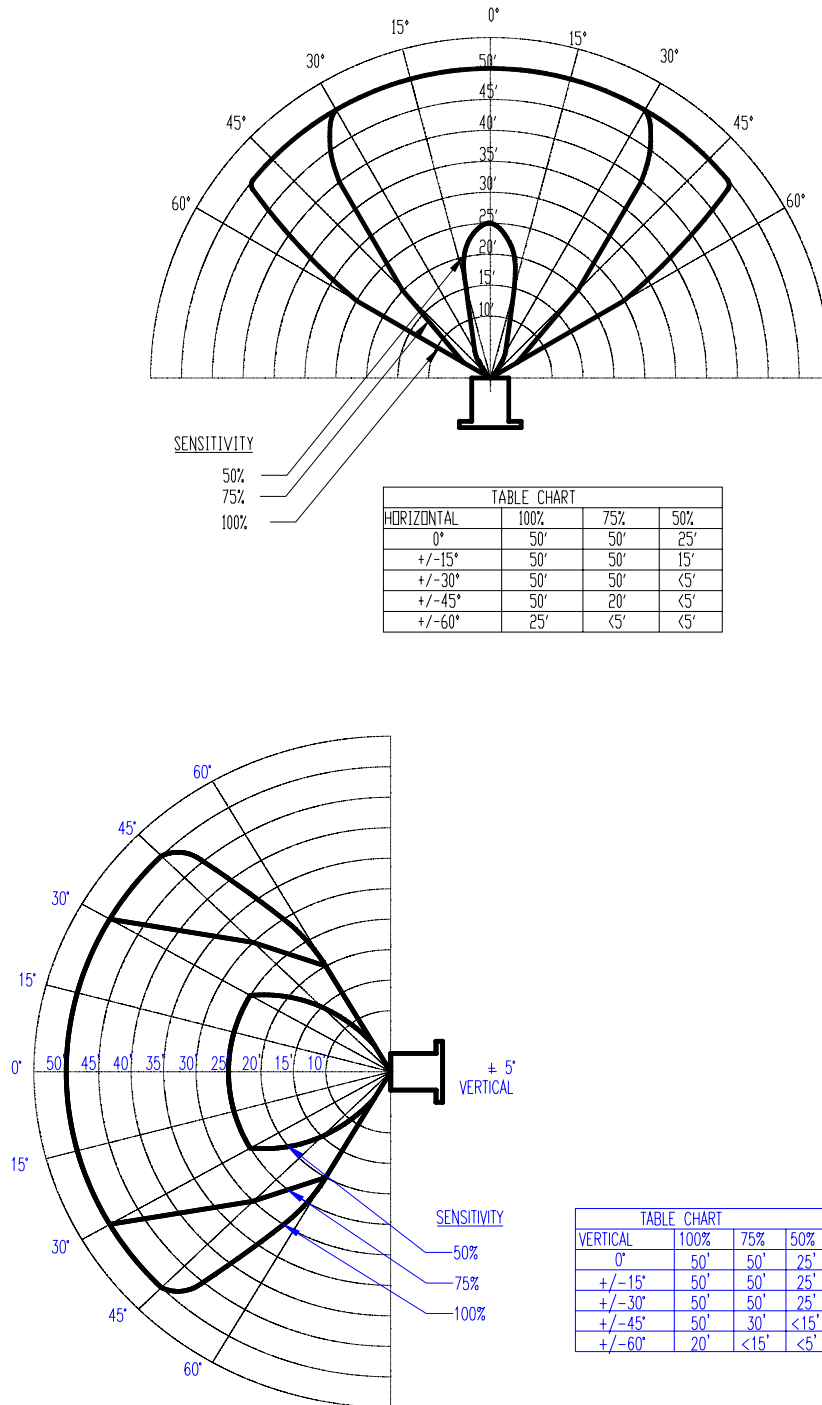


Figure 7: FlameGard 5 UV/IR Detector Field of View

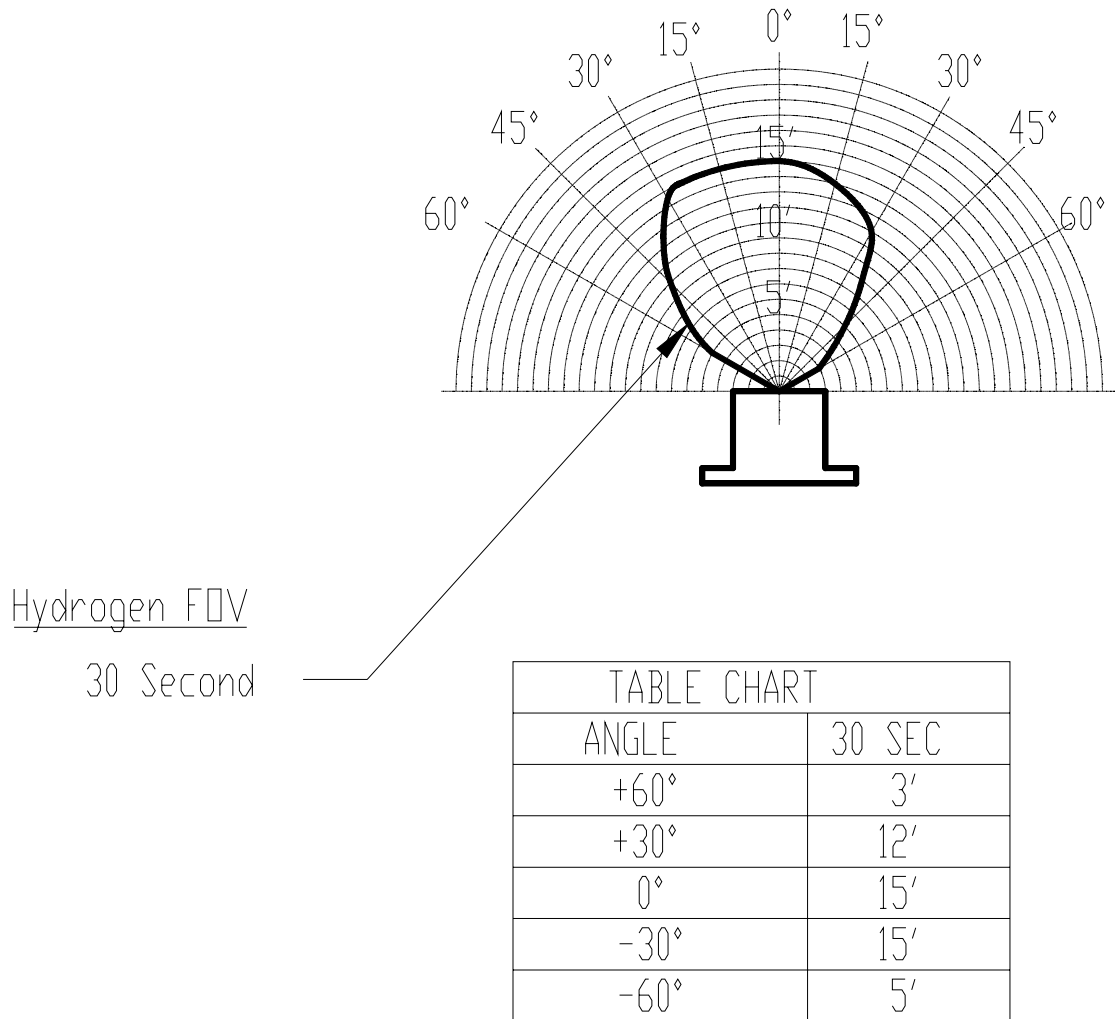


Figure 8: FlameGard 5 UV/IR Hydrogen Flame Detector Field of View

NOTE: Response Times and Field of View data have been derived by testing the FlameGard 5 UV/IR Flame Detector with a flame from a round 6 inch diameter burner. The hydrogen gas was supplied from a high pressure tank via a reducing regulator, set to 12 psi. This produces a flame 6 inches in height. The FlameGard 5 UV/IR-Hydrogen Detector can be tested by the FlameGard 5 UV/IR Test Lamp as far as 40 feet. These are typical values and different results may occur depending on the variation of each fire.

NOTE: The FlameGard 5 UV/IR-Hydrogen Detector is not FM approved.

3.3 Mounting and Wiring



WARNING: The conduit entries should be sealed per the Canadian Electrical Code Handbook (Part 1, Section 18-154) or NEC 500-3d. An additional benefit of conduit seals is the prevention of water entering the housing through the conduit entry.



WARNING: Unused cable entry holes must be sealed with an approved stopping plug. Red caps supplied by MSA are for dust protection only and must not be left on the unit when installed.

The FlameGard 5 UV/IR Flame Detectors should be mounted pointing downward so that dust/moisture will not accumulate on the optical window(s). The detector(s) should be mounted in locations which will inhibit people or objects from obscuring the detector's cone of vision.

Detectors should be mounted such that the conduit or cable gland entries are pointed downward. See above warning for conduit entries. For cable glands and stopping plugs, the threads should be sealed with Castrol EP and boots fitted over the cable gland to prevent water ingress at the cable-to-gland junction. Mounting hardware should be used as shown in Figure 10, and Figure 11. The overall dimensions of the detector and mounting hardware are shown in Figures 13 and 14.

NOTE: MSA does not recommend the use of cable shoes or crimps on any junction box or housing wiring terminals. Poor crimping can cause a bad connection when the unit experiences temperature variations.

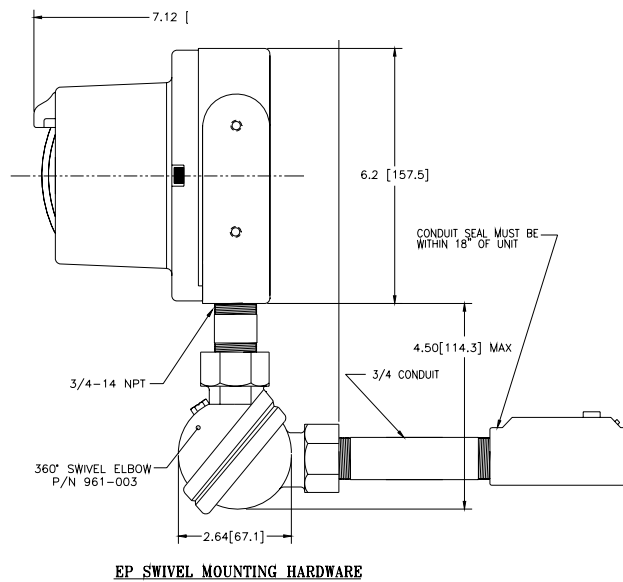


Figure 9: P/N 961-004 Swivel Elbow Drawing

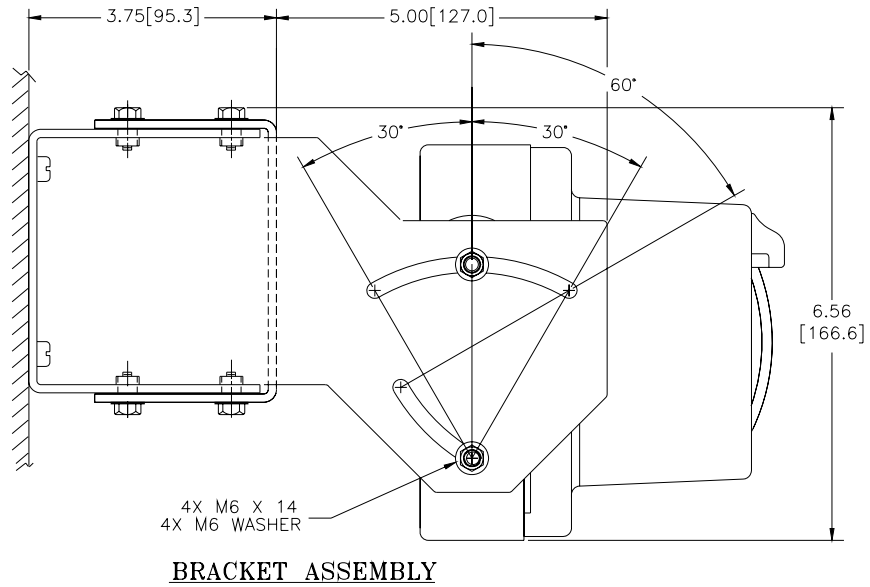


Figure 10: P/N 71072 Side View Mounting Bracket Drawing

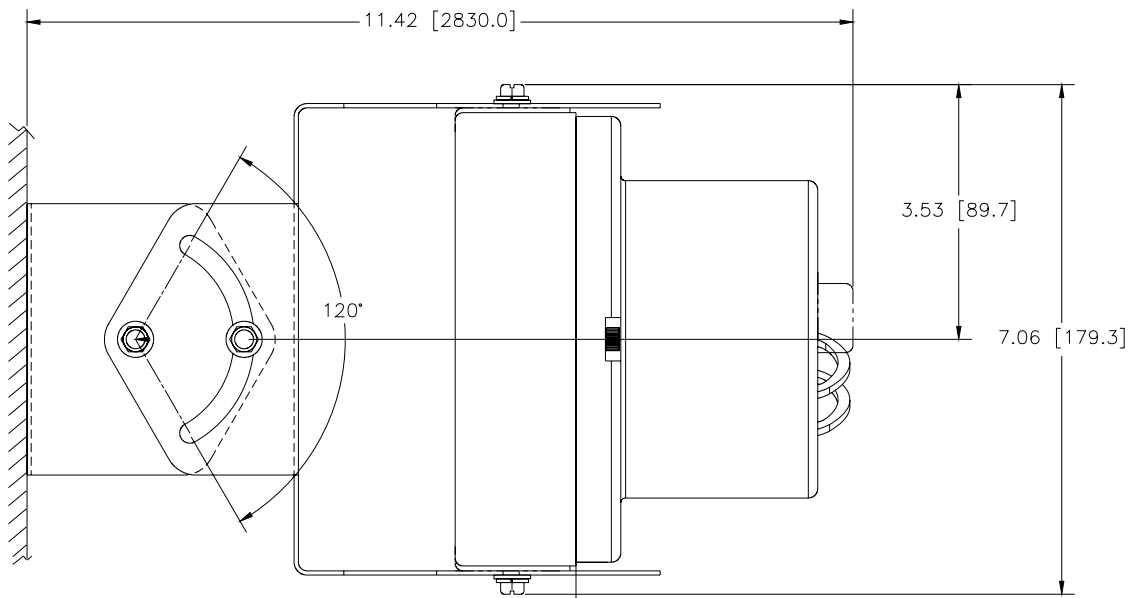


Figure 11: P/N 71072 Top View Mounting Bracket Drawing

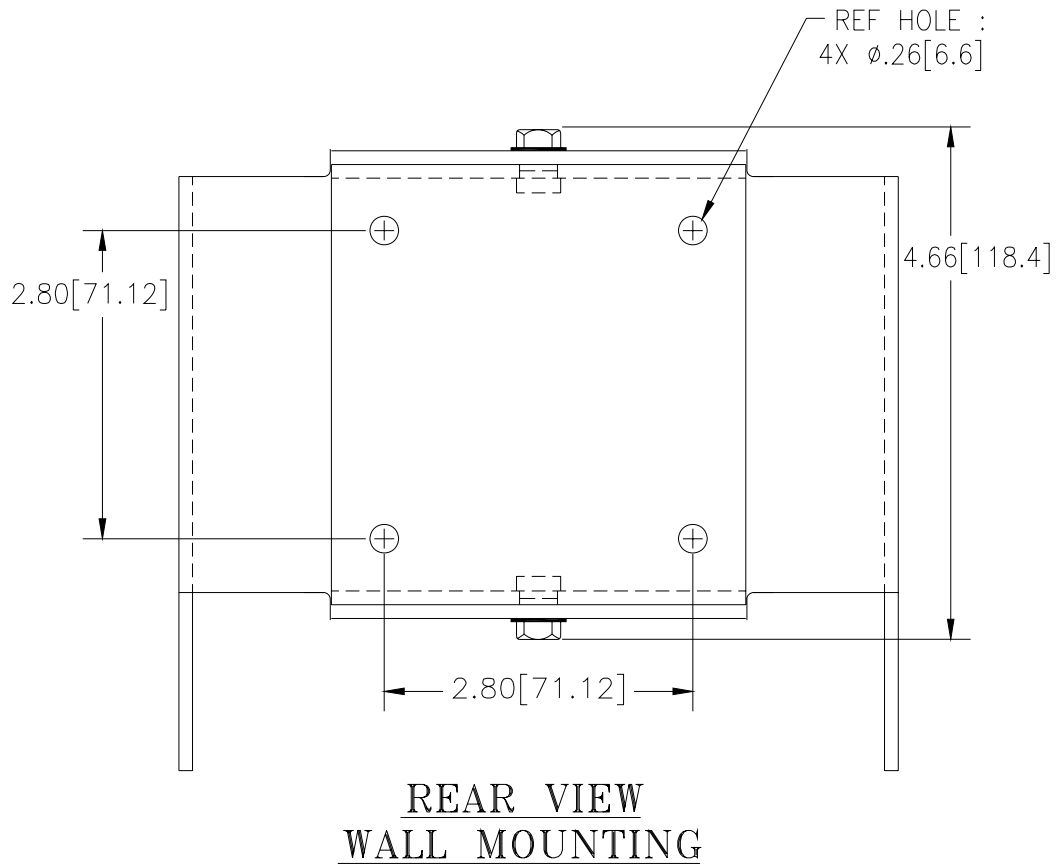


Figure 12: P/N 71072 Rear View Mounting Bracket Drawing

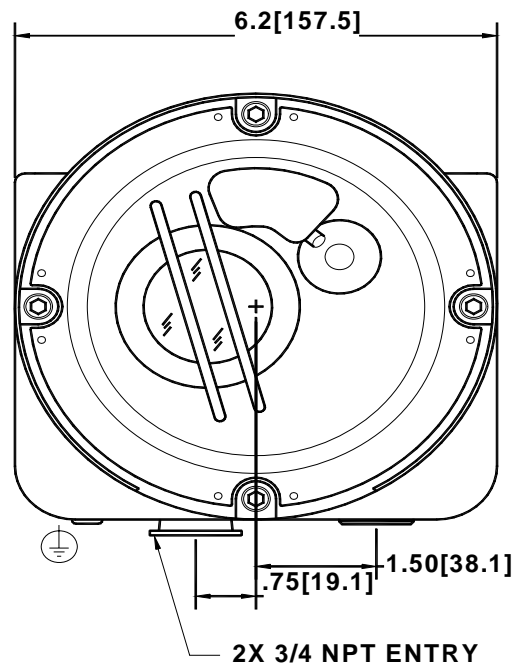


Figure 13: FlameGard 5 UV/IR Outline Drawing

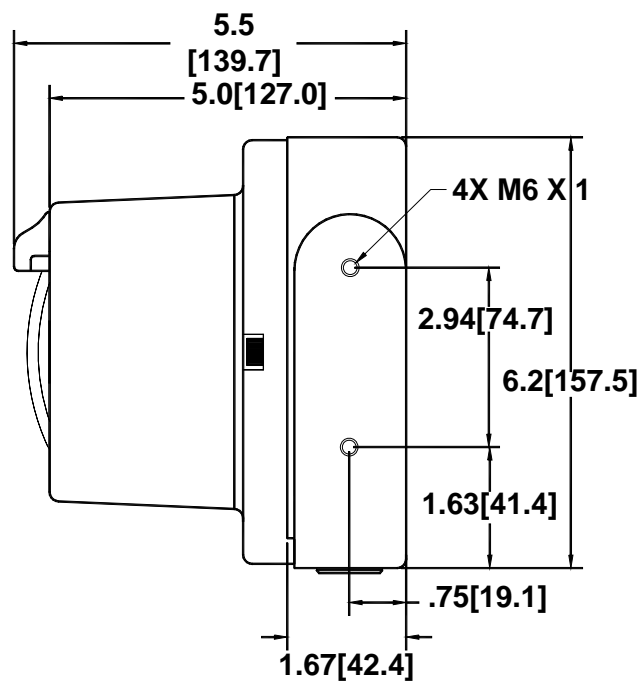


Figure 14: FlameGard 5 UV/IR Outline Drawing

FlameGard 5 UV/IR Detector

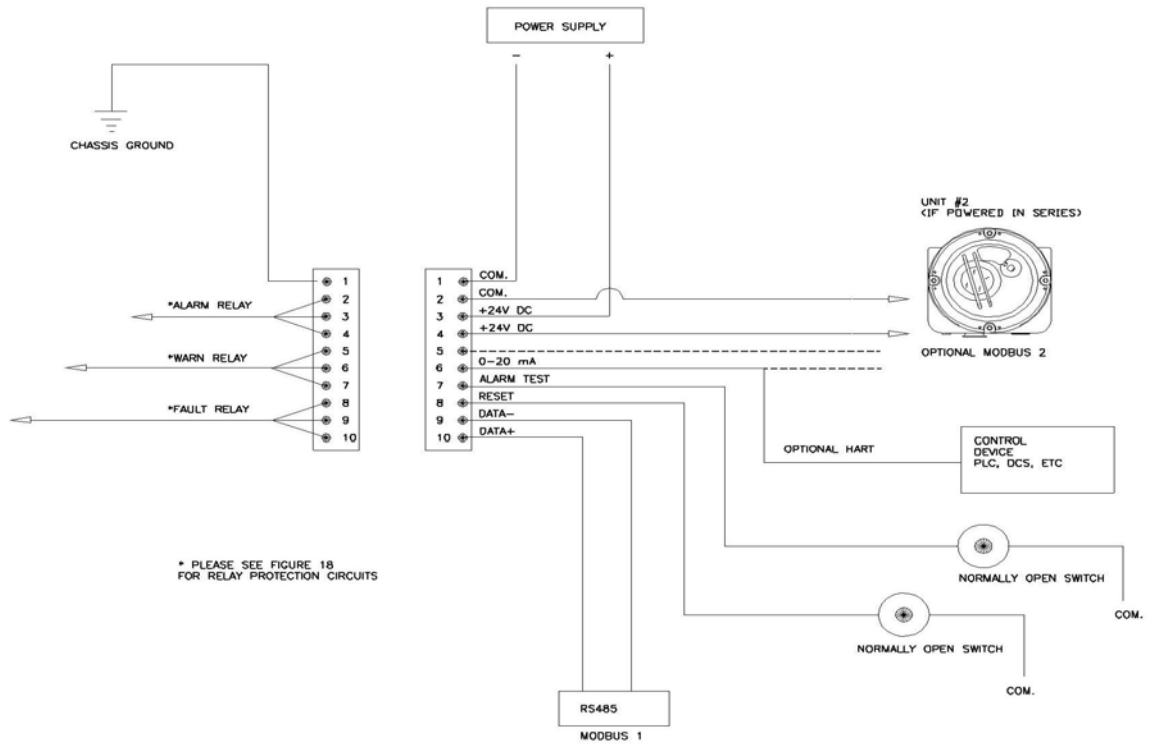


Figure 15: FlameGard 5 UV/IR Field Terminations

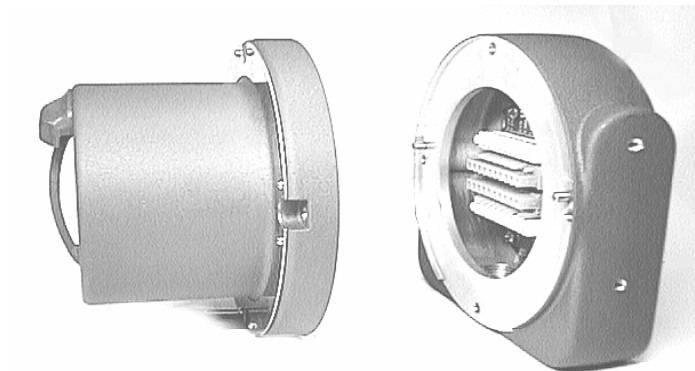


Figure 16: Detector Housing and Base

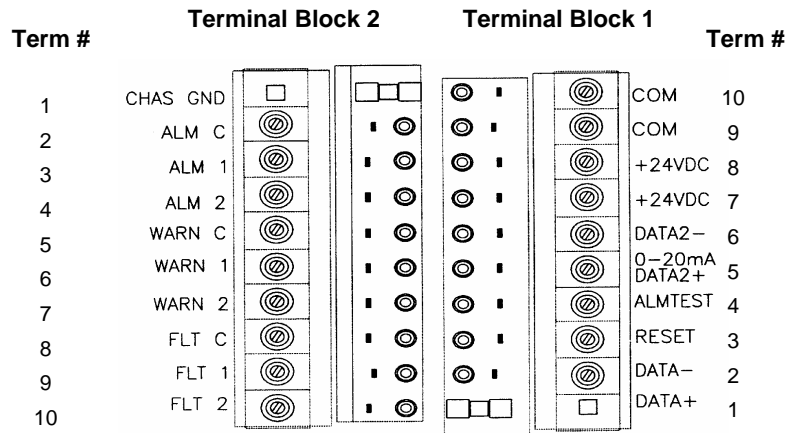


Figure 17: Terminal Block Operation

The optional HART signal will be on pin TB1- 5

3.3.1 Terminal Connections

All wire connections are made through the base entries to the terminal block (Figure 17). The terminal block accepts 14 AWG to 22 AWG (2.1 to 0.3 mm²) stranded or solid core wire. Each wire should be stripped to .25 in (.64 cm). To connect the wire to the terminal block, insert the conductor into the connection space as shown in Figure 7 and tighten the corresponding screw terminal. There are twenty terminal connections. The following pages contain descriptions and specifications for each connection.



WARNING: Relay contacts must be protected against transient and over-voltage conditions (Figure 18).

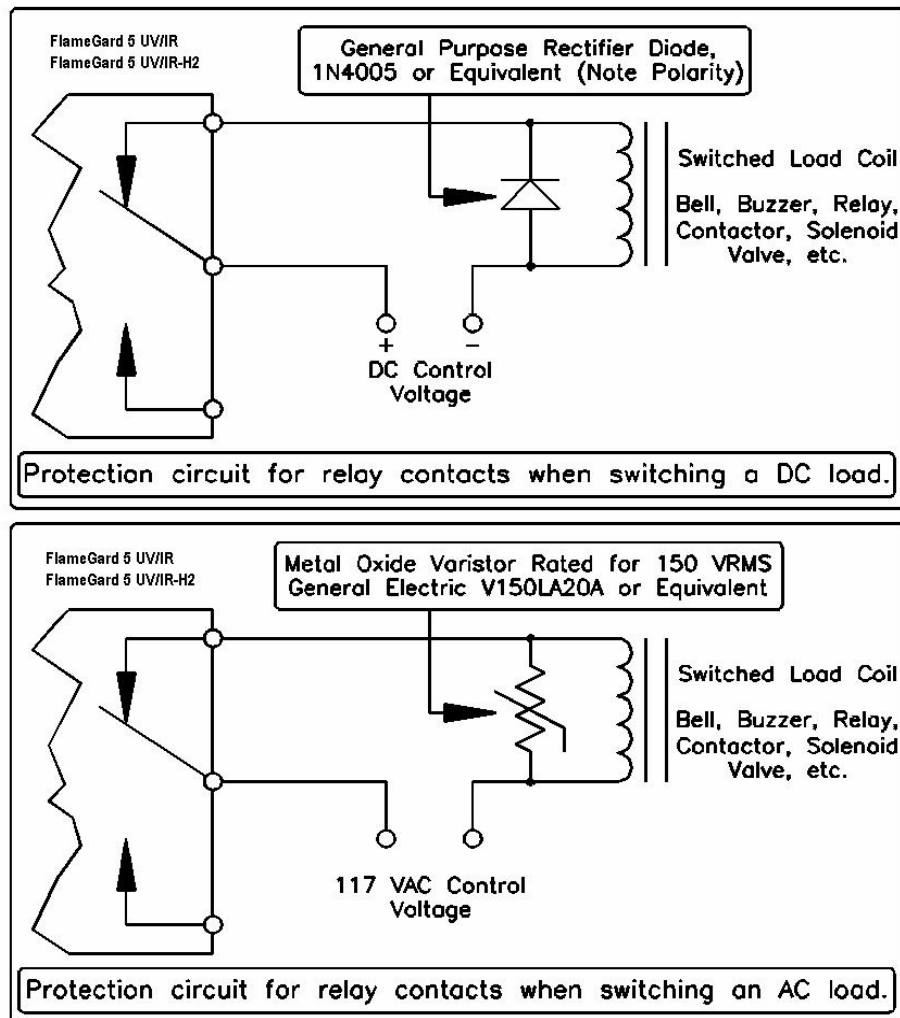


Figure 18: Protection Circuits for Relay Contacts

3.3.2 Terminal Block TB2 – Alarm Relay Connections

TB2 Position	Alarm Relays	Relay Contact (De-Energized)	Relay Contact (Energized)
2	C	Common	Common
3	1	Normally Closed	Normally Open
4	2	Normally Open	Normally Closed

Table 1: TB2 Alarm Relay Connections

These connections are for the SPDT ALARM relay. The ALARM output is time delayed for 2, 4, 8 or 10 seconds. This time delay can be set by Modbus, HART, or by Dipswitch. The ALARM output can be normally energized or normally de-energized, latching or non-latching, and these options can be set by Modbus, HART, or by Dipswitch (Section 4.4). For all relay connections see Figure 18.

North American Approved Applications: The ALARM relay contact ratings are 8A @ 250 VAC and 8A @ 30 VDC resistive max.

European Union (EU) Approved Applications: The ALARM relay contact ratings are 8A, 30 V RMS/42.4 V peak or 8A @ 30 VDC resistive max.

3.3.3 Terminal Block TB-2 Warning Relay Connections

TB2 Position	Warn Relays	Relay Contacts (De-Energized)	Relay Contacts (Energized)
5	C	Common	Common
6	1	Normally Closed	Normally Open
7	2	Normally Open	Normally Closed

Table 2: TB2 Warning Relay Connections

These connections are for the SPDT WARN relay. The WARN output is immediate on the FlameGard 5 UV/IR Flame Detector. The WARN output can be normally energized or normally de-energized, latching or non-latching, and these options are also set via Modbus, HART, or by Dipswitch (Section 4.4).

The WARN relay contact ratings are 8A @ 250 VAC and 8A @ 24 VDC.



CAUTION: Inductive loads (bells, buzzers, relays, etc.) on dry relay contacts must be clamped down as shown in Figure 18. Unclamped inductive loads can generate voltage spikes in excess of 1000 Volts. Spikes of this magnitude may cause false alarms and contact damage.

North American Approved Applications: The WARN relay contact ratings are 8A @ 250 VAC and 8A @ 30 VDC resistive max.

European Union (EU) Approved Applications: The WARN relay contact ratings are 8A, 30 V RMS/42.4 V peak or 8A @ 30 VDC resistive max.

3.3.4 Fault Relay

These connections are for the SPDT FAULT relay. The FAULT output configuration is normally energized and non-latching. This is the standard configuration and it cannot be changed. The FAULT circuit will be activated during the time-out function, a low power or loss of power condition, and during a failed COPM check. During these conditions the FAULT relays will de-energize and the analog output signal will drop to 0 mA (2 mA for COPM faults) for the duration of the FAULT.

TB2 Position	Fault Relays	Relay Contacts (De-Energized)	Relay Contacts (Energized)
8	C	C	C
9	1	Normally Closed	Normally Open
10	2	Normally Open	Normally Closed

Table 3: Fault Relay Connections

North American Approved Applications: The FAULT relay contact ratings are 8A @ 250 VAC and 8A @ 30 VDC.

European Union (EU) Approved Applications: The FAULT relay contact ratings are 8A, 30 V RMS/42.4 V peak or 8A @ 30 VDC resistive max.

3.3.5 Alarm Reset Terminal

The RESET, when activated, returns a latched ALARM and/or WARN output that is no longer valid, to its original state. For this RESET function, place one contact of a normally open momentary switch to TB1 Terminal 3 and the other contact to DC COM (the detector's common). To activate, just press and release the switch.

TB1 Position	Relays
3	RESET
4	TEST
5	0-20 mA

Table 4: Alarm Reset Terminal Connections

By connecting one contact of a normally open, momentary switch, to TB1 Terminal 4 and the other contact to TB1 Terminals 9 and 10 (DC COM), the user can test the alarm outputs of the flame detector by activating this switch for two to ten seconds depending on the alarm time delay setting. The Alarm Test will activate the WARN and ALARM relay outputs as well as the appropriate analog output. The flame detector will remain in this state until the switch is released. Note: This function is also available via Modbus and HART.

NOTE: The latching WARN and/or ALARM will have to be RESET manually. The Alarm Test feature **cannot** be daisy chained between two or more FlameGard 5 UV/IR Flame Detectors.

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3.3.6 Analog Output

The 0 to 20 mA output is a current signal that corresponds to the following signals:

Condition	Current Modbus	HART (Normal)	HART (Special)
START UP:	0 to 0.2 mA	3.5 ± 0.1 mA	1.25 ± 0.1 mA
FAULT:	0 to 0.2 mA	3.5 ± 0.1 mA	1.25 ± 0.1 mA
COPM Fault:	2.0 ± 0.1 mA	3.5 ± 0.1 mA	2.0 ± 0.1 mA
Ready:	4.05 ± 0.05 mA	4.05 ± 0.05 mA	4.05 ± 0.05 mA
IR:	8.0 ± 0.1 mA	8.0 ± 0.1 mA	8.0 ± 0.1 mA
UV:	12.0 ± 0.1 mA	12.0 ± 0.1 mA	12.0 ± 0.1 mA
WARN:	16.0 ± 0.1 mA	16.0 ± 0.1 mA	16.0 ± 0.1 mA
ALARM:	20.0 ± 0.1 mA	20.0 ± 0.1 mA	20.0 ± 0.1 mA

When HART is selected, the output current changes to comply with the HART Foundation requirements. The HART Foundation does not specify current below 3.5 mA. In normal HART mode, the actual current does not go below 3.5 mA. Modbus reports the analog output as if HART was not there, meaning it reports 2.0 mA for COPM. This allows users to use a constant Modbus program. The digital HART reports the actual current. When the alarm or warning relays are latched, the highest output current is also latched. The output current will return to 4.0 mA after the relay reset is activated via Modbus, HART, or remote switch.

The HART special mode allows the current to go down to 1.25 mA. The HART will still function.

NOTE: The maximum analog output load is 600 Ohms, including wiring.

3.3.7 Cable Requirements

For interfacing with 250 Ohm input impedance devices, the following maximum cable lengths apply (maximum 50-Ohm loop):

Cable AWG	Run Feet	Cable mm ²	Run Meters
14	9000	2.50	2750
16	5800	1.50	1770
18	3800	1.00	1160
20	2400	0.75	730
22	1700	0.50	520

Table 5: Maximum Cable Requirements

3.3.8 Power

The supply voltage range is 20 to 36 VDC at the detector (low voltage is detected at approximately 18.5 VDC).

TB1 Position	Connection
7	+24 VDC
8	+24 VDC
9	COM
10	COM

Table 6: Power Connections

The following maximum cable lengths apply for a +24 VDC supply (maximum 20 Ohm loop):

Cable AWG	Run Meters	Cable mm ²	Run Feet
14	1370	2.5	4500
16	715	1.5	2340
18	470	1.00	1540
20	300	0.75	970
22	205	0.50	670

Table 7: Maximum Cable Lengths for +24 VDC Supply

3.3.9 Modbus Interface

The Modbus interface is used to either query the unit’s status or to configure the unit. See Section 5.0 for detailed information on Modbus RTU Protocol.

TB1 Position	Connection
1	DATA +
2	DATA -

Table 8: Connections for the Modbus Interface

NOTE: If Dual Modbus output is ordered, then the 0-20 mA and HART output is not available and the wiring terminals for the second Modbus channels are as follows:

TB1 Position	Connection
5	DATA2 +
6	DATA2 -

Table 9: Connections for the Second Modbus Interface

3.3.10 Chassis Ground

This connection is available for use in wiring that requires a connection to chassis ground. It is recommended the chassis be grounded at all times.

TB2 Position	Connection
1	CHAS GND

Table 10: Chassis Ground Connection

3.3.11 Connection to Fire Cards/Panels

For detectors wired together for monitoring via standard fire cards, MSA will factory-fit EOL and alarm resistors. If this special option is required, please specify at time of order and provide the following information:

- Specify one or two resistors (i.e. alarm only, or alarm resistor and EOL).
- Specify value of resistors.

NOTE: Contact MSA or an authorized representative for further details.

European Union (EU) Approved Applications: Interconnecting cables must have an overall screen or screen and armor. Note that the terms ‘screen’ and ‘shield’ are equivalent for the purpose of this manual. The cable armor must be terminated in a suitable cable gland at the detector to ensure a positive electrical connection.

3.3.12 Cable Termination in the Non-Hazardous Area

- The cable **armor** must be connected to **safety earth** in the safe area.
- The cable **screen** (drain wire) must be connected to an **instrument earth** in the safe area.
- The power supply **OV return** must be connected to an **instrument earth** in the safe area.
- The interconnecting cables should be segregated from power and other noisy cables. Avoid proximity to cables associated with radio transmitters, welders, switch mode power supplies, inverters, battery chargers, ignition systems, generators, switch gear, arc lights and other high frequency or high power switching process equipment. In general, maintain separation of at least 1m between instrument and other cables. Greater separations are required where long parallel cable runs are unavoidable. Avoid running instrument cable trenches close to lightning conductor earthing pits.
- Complete all cable insulation testing before connecting the cable at either end.



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

4.0 Operation

4.1 Checklist

Prior to starting the system verify the following:

- Inhibit any external devices, such as automatic extinguishing fire suppression systems or others, which you do not want activated.
- Verify that the DIP-switch settings are set for the desired configuration.
- Verify that the unit is properly mounted. Ensure the conduit/cable gland entries are pointed downward.
- Verify the field of view for each detector covers the area intended for flame detection.
- Verify that the wiring is correct.
- Verify that the power supply is connected properly. The detector is powered by +24 VDC (20 to 36 VDC voltage range). The detector will output a low voltage fault at 18.5 VDC or below.

4.2 Start Up

To start up the system, apply power to the flame detectors. Each detector will begin its self-test start up sequence. For the first 10 seconds, the unit will output 0 mA, the fault relay stays de-energized, and the green and red LED will flash alternately. Each is on for about 300 ms. After this 10-second period, the unit will output 4 mA, the fault relay will energize, the red LED will turn off, and the green LED will turn on constant and briefly flash off every 10 seconds. The dual Modbus version does not have a current output.

4.3 System Test

To test the system, use the FlameGard 5 UV/IR Test Lamp (Section 7.3).

4.4 User Selectable Options/Factory Defaults

All settings on the FlameGard 5 UV/IR Flame Detector are done via a DIP switch on the Power/Relay Board or via Modbus or HART which will override the dipswitch settings. To set these options, remove the detector head from the base assembly and locate the DIP switch (Figure 19). On the DIP switch, ON/CLOSED means the switch is pushed in on the side labeled ON or CLOSED (opposite the OPEN side). OFF/OPEN means the switch is pushed in on the side with the number corresponding to the switch position or the side labeled OPEN. Refer to Table 11 for the switch assignments. The settings for the WARN and ALARM outputs have been covered in Section 3.3. The time delay specifies the amount of time a WARN condition persists before an ALARM condition will occur. If the HART option is ordered the current you

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desire must be selected (1.25 mA or 3.5 mA). Factory default is 3.5 mA to 20 mA. HART current is only HART or Modbus selectable, not DIP switch selectable.

Option	Off	On
1. 100% Sens – 1 sqft @ 50 ft	1&2	
2. 75% Sens – 1 sqft @ 35 ft	2	1
3. 50% Sens – 1 sqft @ 25 ft	1	2
4. 2 Second ALARM Time Delay	3	4
5. 4 Second ALARM Time Delay	3&4	
6. 8 Second ALARM Time Delay	4	3
7. 10 Second ALARM Time Delay		3&4
8. ALARM non-latching	5	
9. ALARM latching		5
10. WARN non-latching	6	
11. WARN latching		6
12. ALARM normally energized		7
13. ALARM normally de-energized	7	
14. WARN normally energized		8
15. WARN normally de-energized	8	

Table 11: DIP Switch Options

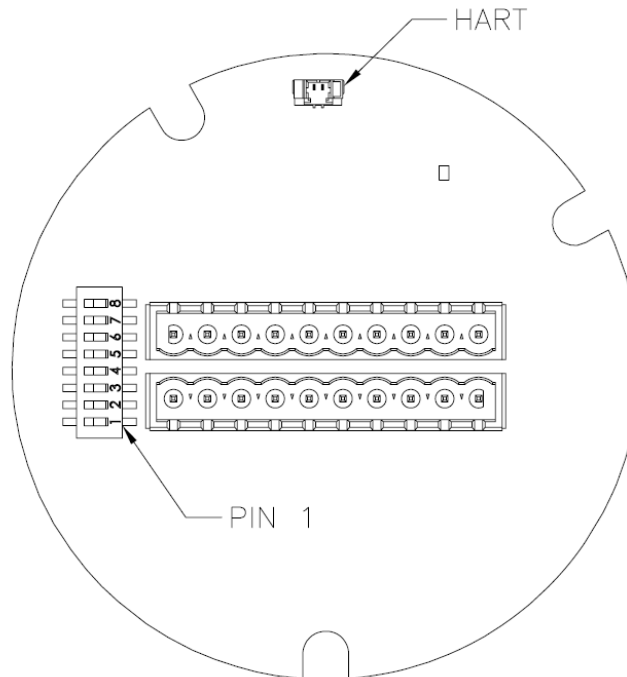


Figure 19: DIP switch Location

5.0 Modbus Interface

Standard FlameGard 5 UV/IR Flame Detectors include a single Modbus that is referenced as Comm 1. A dual Modbus feature is optional, which includes two independent communications channels referenced as Comm 1 and Comm 2.

NOTE: If the dual Comm option is ordered, the analog output & HART will not be available.

5.1 Baud Rate

The Baud Rate is a selectable setting via the Modbus communications interface. The selectable baud rates are 19.2K, 9600, 4800, or 2400 bits per second.

5.2 Data Format

The Data Format is a selectable setting via the Modbus communications interface. The selectable data formats are as follows:

Data Bits	Parity	Stop Bit	Format
8	None	1	8-N-1
8	Even	1	8-E-1
8	Odd	1	8-O-1
8	None	2	8-N-2

Table 12: Data Format

5.3 Modbus Read Status Protocol (Query/Response)

5.3.1 Modbus Read Query Message

Byte	Modbus	Range	Referenced to FlameGard 5 UV/IR Flame
1 st	Slave Address	1-247 *	FlameGard 5 UV/IR Flame (X = 0 or 1 Model Type)
2 nd	Function Code	03	Read Holding Registers
3 rd	Starting Address Hi**	00	Not Used by FlameGard 5 UV/IR Flame Detector
4 th	Starting Address Lo**	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Commands
5 th	No. of Registers Hi	00	Not Used by FlameGard 5 UV/IR Flame Detector
6 th	No. of Registers Lo	01	No. of 16 Bit Registers
7 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

Table 13: Modbus Query Messages

NOTE*: Address 0 is reserved for broadcast mode and will not be supported at this time.

NOTE:** Start Address can be a maximum of 247 Address Locations (0000-0x00F7)

5.3.2 Modbus Read Response Message

Byte	Modbus	Range	Referenced to FlameGard 5 UV/IR, FlameGard 5 UV/IR1
1 st	Slave Address	1-247* (Decimal)	FlameGard 5 UV/IR Flame Detector ID (Address)
2 nd	Function Code	03 or 04	Read Holding Registers
3 rd	Byte Count	02 – FF (Hex)	No. of Data Bytes
4 th	Data Hi	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Hi Byte Status Data
5 th	Data Lo	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Lo Byte Status Data
6 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
7 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

Table 14: Modbus Read Response Messages

NOTE: Address 0 is reserved for broadcast mode and will not be supported at this time.

5.4 Modbus Write Command Protocol (Query/Response)

5.4.1 Modbus Write Query Message

Byte	Modbus	Range	Referenced to FlameGard 5 UV/IR Flame Detector
1 st	Slave Address	1-247* (Decimal)	FlameGard 5 UV/IR Flame Detector (Address)
2 nd	Function Code	06	Preset Single Register
3 rd	Register Address Hi**	00	Not used by FlameGard 5 UV/IR Flame Detector
4 th	Register Address Lo**	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Commands
5 th	Preset Data Hi	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Hi Byte Command Data
6 th	Preset Data Lo	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Lo Byte Command Data
7 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

Table 15: Modbus Write Query Message

NOTE*: Address 0 is reserved for broadcast mode and will not be supported at this time.

NOTE**: Start Address can be a maximum of 247 Address Locations (0000-0x00F7).

5.4.2 Modbus Write Response Message

Byte	Modbus	Range	Referenced to FlameGard 5 UV/IR Flame Detector
1 st	Slave Address	1-247* (Decimal)	FlameGard 5 UV/IR Flame Detector ID (Address)
2 nd	Function Code	06	Preset Single Register
3 rd	Register Address Hi**	00	Not used by FlameGard 5 UV/IR Flame Detector
4 th	Register Address Lo**	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Commands
5 th	Preset Data Hi	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Hi Byte Command Data
6 th	Preset Data Lo	00-FF (Hex)	FlameGard 5 UV/IR Flame Detector Lo Byte Command Data
7 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
8 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

Table 16: Modbus Write Response Message

NOTE*: Address 0 is reserved for broadcast mode and is not supported at this time.

NOTE:** Start Address can be a maximum of 247 Address Locations (0000-0x00F7).

5.4.3 Function Codes Supported

Function Code 03 or 04 (Read Holding Registers) is used to read status from the slave unit. Function Code 06 (Preset Single Register) is used to write a command to the slave unit.

5.5 Exception Responses and Exception Codes

In a normal exchange, the master device sends a query to the FlameGard 5 UV/IR Flame Detector. The FlameGard 5 UV/IR Flame Detector receives the query and returns a normal response to the master. If a normal communications error occurs, there are 4 possible responses from the FlameGard 5 UV/IR Flame Detector:

1. If the FlameGard 5 UV/IR Flame Detector does not recognize the query due to a communications error, then no response is returned from the FlameGard 5 UV/IR Flame Detector and the master device will eventually process a timeout condition for the query.
2. If the FlameGard 5 UV/IR Flame Detector receives the query, but detects a communication error (CRC, etc.), then no response is returned from the FlameGard 5 UV/IR Flame Detector and the master device will eventually process a timeout condition for the query.

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- An exception code is returned when the FlameGard 5 UV/IR Flame Detector receives the query without a communications error, but cannot process it due to reading or writing to a non-existent or illegal Function Code, Illegal Command Starting Address or Register Address, or Illegal Data Value. The exception response message has two fields that differentiate it from a normal response. See the next section for more information.

5.5.1 Exception Responses

Byte	Modbus	Range	Referenced to FlameGard 5 UV/IR Flame Detector
1 st	Slave Address	1-247* (Decimal)	FlameGard 5 UV/IR Flame Detector ID (Address)
2 nd	Function Code	83 or 86 (Hex)	MSB is set with Function Code
3 rd	Exception Code	01 - 06 (Hex)	Appropriate Exception Code (See below)
4 th	CRC Lo	00-FF (Hex)	CRC Lo Byte
5 th	CRC Hi	00-FF (Hex)	CRC Hi Byte

Table 17: Exception responses

5.5.1.1 Exception Code Field

In a normal response, the FlameGard 5 UV/IR Flame Detector returns data and status in the data field, requested in the query from the master. In an exception response, the FlameGard 5 UV/IR Flame Detector returns an exception code in the data field, which describes the condition that caused the exception. Below is a list of exception codes that are supported by the FlameGard 5 UV/IR Flame Detector:

Code	Name	Description
01	Illegal Function	The function code received in the query is not an allowable action for the FlameGard 5 UV/IR Flame Detector.
02	Illegal Data Address	The data address received in the query is not an allowable address for the FlameGard 5 UV/IR Flame Detector.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the FlameGard 5 UV/IR Flame Detector.
04	Slave Device Failure	An unrecoverable error occurred while the FlameGard 5 UV/IR Flame Detector was attempting to perform the requested action.
05	Acknowledge	The FlameGard 5 UV/IR Flame Detector has accepted the request and is processing it, but a long duration of time will be required. This response is returned to prevent a timeout error from occurring in the master.
06	Device Busy	The FlameGard 5 UV/IR Flame Detector is engaged in processing a long-duration program command. The master should retransmit the message later when the slave is free.

Table 18: Exception Code Field

5.6 Command Register Locations

5.6.1 Operational Mode Commands

See section number listed below and reference Section 5.7 for details of each register.

NOTE: The FlameGard 5 UV/IR Flame Detector has Modbus error reporting. The optional dual Modbus has error reporting for each channel. It can also provide simultaneous block mode.

R - indicates Read Only Access

R/W - indicates Read/Write Access

Parameter	Function	Type	Scale	Access	REG Addr	Master I/O Addr
Analog	0-20 mA Current Output	Value	16-Bit	R	0000	40001
Mode	Indicates Fire Status Mode	Value	(0-11)	R	0001	40002
Status/Error	Indicates Error	Bit	16-Bit	R	0002	40003
UV/IR Only	Indicates Detection of UV Only	Bit	2-Bit	R	0003	40004
Model Type	Identifies the FlameGard 5 UV/IR Flame Detector	Decimal	310X	R	0004	40005
Software Rev	Indicates the Software Revision	ASCII	2-Char	R	0005	40006
COPM Fault	UV/IR COPM Fault	Bit	2-Bit	R	0006	40007
Override	Override Dipswitch Settings	Bit	1-Bit	R/W	0007	40008
Options	Indicates Unit Options	Bit	8-Bit	R/W	0008	40009
Comm 1 Address	Unit Address	Decimal Hex	(1-247) (01-F7)	R/W	0009	40010
Not Used					000A	40011
Comm 1 Baud Rate	Baud Rate (2400, 4800, 9600,19.2K)	Value	(0-3)	R/W	000B	40012
Comm 1 Data Format	Data Format (8N-1, 8E-1, 8O-1, 8N-2)	Value	(0 - 3)	R/W	000C	40013
UV Sig Count	Indicates No. of UV Signal Pulses within 500 ms	Value	16-Bit	R	000D	40014
IR Sig Count	Indicates No. of IR Signal Pulses within 500 ms	Value	16-Bit	R	000E	40015
UV Fault Total	Indicates Total No. of UV COPM Faults	Value	16-Bit	R	000F	40016
IR Fault Total	Indicates Total No. of IR COPM Faults	Value	16-Bit	R	0010	40017
Remote Reset	Remotely Resets the Alarm & Warn Relays	Bit	1-Bit	R/W	0011	40018

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Parameter	Function	Type	Scale	Access	REG Addr	Master I/O Addr
Remote Alarm Test	Remotely Activates Alarm Test	Bit	1-Bit	R/W	0012	40019
Clear COPM Faults	Clears UV/IR COPM Fault Counters	Bit	1-Bit	R/W	0013	40020
	NOT Used				0014	40021
Serial Number	Serial Number Upper	Value	16 bit	R	0015	40022
Serial Number	Serial Number Lower	Value	16 bit	R	0016	40023
	NOT Used				0017-1C	40024-40029
Optional HART	HART Enable	Bit	1 bit	R/W	001D	40030
All "1" or "0"	HART Test 0 off 1, 2	Bit	2 Bit	R/W	001E	40031
	Not Used				001F	40032
Comm 1 Register errors	Total # of Register Errors	Value	16-Bit	R	0020	40033
Comm 1 Bus Activity Rate %	Bus Activity Rate in % Of this Addressed Node vs. Other Addressed Nodes	Decimal Hex	(0-100%) (0-64)	R	0021	40034
Comm 1 Function Code Errors	Total # of Function Code Errors	Value	16-Bit	R	0022	40035
Comm 1 Starting Address Errors	Total # of Starting Addresses Errors	Value	16-Bit	R	0023	40036
Comm 1 Total Receive Errors	Total # of Comm 1 Receive Errors	Value	16-Bit	R	0024	40037
Comm 1 RXD CRC Errors	Total # of RXD CRC Errors	Value	16-Bit	R	0025	40038
Comm 1 RXD CRC Errors	Total # of RXD CRC Errors	Value	16-Bit	R	0026	40039
Comm 1 Overrun Errors	Total # of Overrun Errors	Value	16-Bit	R	0027	40040

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Parameter	Function	Type	Scale	Access	REG Addr	Master I/O Addr
Comm 1 Parity Errors	Total # of Parity Errors	Value	16-Bit	R	0028	40041
Comm 1 Framing Errors	Total # of Framing Errors	Value	16-Bit	R	0029	40042
Comm 1 UART errors	Total # of UART errors	Value	16 Bit		002A	40043
Comm 1 Total Receive Errors	Total # of Comm 1 Receive Errors	Value	16-Bit	R	002B	40044
Comm 1 Clear UART	Clear UART errors	Bit	1-Bit	R/W	002C	40045
Comm1 Clear Stats	Clear Comm Stats	Bit	1-Bit	R/W	002D	40046
HART Current Range	3.5 ma to 20 ma 1.25 ma to 20 ma	Bit	1-Bit	R/W	002E	40047
Comm 2 Address	Unit Address	Decimal Hex	(1-247) (01-F7)	R/W	002F	40048
Comm 2 Baud Rate	Indicates present Baud Rate (2400, 4800, 9600, 19.2K)	Value	(0-3)	R/W	0030	40049
Comm 2 Data Format	Indicates present Data Format (8N-1, 8E-1, 8O-1, 8N-2)	Value	(0-3)	R/W	0031	40050
	Not Used				0032	40051
Input Voltage	Indicates the 24 volts	Value	16-Bit	R	0033	40052
Voltage at the alarm input	Indicates alarm test input voltage	Value	16-Bit	R	0034	40053
Voltage at the Reset input	Indicates reset input voltage	Value	16-Bit	R	0035	40054
The position of the dip switch	Dip Switch Data	Bits	16-Bit	R	0036	40055
	Not used				0037 003F	40056 40064

Parameter	Function	Type	Scale	Access	REG Addr	Master I/O Addr
EVENT LOGGING	Event logging See Section 6.0	Value			0040 0067	40065 40104
USER INFO	User Information	Value	16-Bit	R/W	0068 0077	40105 40120
Comm 2 Register errors	Total # of Register Errors	Value	16-Bit	R	0078	40121
Comm 2 Bus Activity Rate %	Bus Activity Rate in % Of this Addressed Node vs. Other Addressed Nodes	Decimal Hex	16-Bit	R	0079	40122
Comm 2 Function Code Errors	Total # of Function Code Errors	Value	16-Bit	R	007A	40123
Comm 2 Starting Address Errors	Total # of Starting Addresses Errors	Value	16-Bit	R	007B	40124
Comm 2 Total Receive Errors	Total # of Comm 2 Receive Errors	Value	16-Bit	R	007C	40125
Comm 2 RXD CRC Errors	Total # of RXD CRC Errors	Value	16-Bit	R	007D	40126
Comm 2 RXD CRC Errors	Total # of RXD CRC Errors	Value	16-Bit	R	007E	40127
Comm 2 Overrun Errors	Total # of Overrun Errors	Value	16-Bit	R	007F	40128
Comm 2 Parity Errors	Total # of Parity Errors	Value	16-Bit	R	0080	40129
Comm 2 Framing Errors	Total # of Framing Errors	Value	16-Bit	R	0081	40130
Comm 2 UART errors	Total # of UART errors	Value	16-Bit	R	0082	40131
	Not Used				0083	40132
Comm 2 Clear UART	Clear UART errors	Bit	1-Bit	R/W	0084	40133
Comm2 Clear Stats	Clear Comm Stats	Bit	1-Bit	R/W	0085	40134

Table 19: Operational Mode Commands

5.7 FlameGard 5 UV/IR Operational Mode Command Register Details

5.7.1 Analog (00H)

A read returns a value which is proportional to the 0-20 mA output current. The current is based on a 16-bit value. The master scaling is 0-65535 decimal, which corresponds to the FlameGard 5 UV/IR Flame Detector scaling which is 0-20 mA.

5.7.2 Mode (01H)

A read returns the fire status mode of the FlameGard 5 UV/IR Flame Detector.

Mode	Decimal Value
Power-up Delay	1
Warn Non-latching Only	2
Warn & Alarm Non-Latching	3
Warn Latching Only	4
Alarm Latching Only	5
Warn & Alarm Latching	6
Ready State (No Fire)	7
UV Only Fire	8
IR Only Fire	9
Alarm Test	10
COPM Fault Detected	11

Table 20: Fire Status Mode

5.7.3 Status/Error (02H)

A read returns the errors that are occurring, which are indicated by bit position.

Byte	Function Bit	Position	Hex
High	Reset Line Shorted	8	0x8000
	UV 10 Minute	7	0x4000
	Not Used	6	0x2000
	Not Used	5	0x1000
	Output Current Fault	4	0x0800
	Not Used	3	0x0400
	Not Used	2	0x0200
	Not Used	1	0x0100
Low	Flash Checksum	8	0x0080
	EEPROM Checksum	7	0x0040
	RAM Test	6	0x0020
	Low Line Voltage Check	5	0x0010
	UV COPM	4	0x0008
	IR COPM	3	0x0004
	Not Used	2	0x0002
	Internal Voltage	1	0x0001

Table 21: Status/Error

5.7.4 Faults

Reset Line Shorted: The Detector sees a continuous short. Check TB1-3.

UV 10 Minute: The UV detector sees a constant source of UV. Check for welding, arcing, very bright lights or other sources of UV.

Output Current Fault: There is an error in the current output circuit. Return for service.

Flash Checksum: The main program memory is not functioning properly. Return for service.

EEPROM Checksum: There are two sources of EEPROM error. One is recoverable, the other must be sent back to the factory. The recoverable error can be reset by turning the power on and off. The user then must check all the FlameGard 5 UV/IR Flame Detector options; Latch/Non-latch, Energized/De-energized, Baud rate etc.

RAM Test: The memory is not functioning. Return for service.

Low Line Voltage Check: The input voltage is low. Check the input voltage with a meter or via HART or Modbus.

UV COPM: The UV window needs to be cleaned.

IR COPM: The IR window needs to be cleaned.

Internal Voltage: The FlameGard 5 UV/IR Flame Detector monitors various internal voltages. Return for service.

5.7.5 UV/IR Only (03H)

A read indicates the detection of UV Only or IR only when using the FlameGard 5 UV/IR Flame Detector.

UV Only Detected = 01 (Lo Data Byte)

IR Only Detected = 02 (Lo Data Byte)

The High Data Byte is Not Used.

5.7.6 Model Type (04H)

A read returns the Decimal Value 3100, which identifies each particular type of unit by model number.

Model	Configuration	HART ID	Modbus ID
FlameGard 5 UV/IR	Standard UV/IR	NA	3100 0x0C1C
FlameGard 5 UV/IR	Standard UV/IR	0x90	3103 0x0C1F
FlameGard 5 UV/IR	Long Range	0x90	3106 0x0C22
FlameGard 5 UV/IR	Hydrogen	0x90	3105 0x0C21

Table 22: Model Type

5.7.7 Software Revision (05H)

A read returns the software revision of the FlameGard 5 UV/IR Flame Detector in 2 ASCII characters. (REV "A" appears as a blank and the letter A).

5.7.8 COPM Fault (06H)

A read returns the type of Continuous Optical Path Monitoring (COPM) Fault which is an UV COPM Fault or an IR COPM Fault, or both. The UV COPM and/or the IR COPM Faults indicate that the UV and/or IR windows are dirty and need to be cleaned, or that there is a hardware problem with the UV and/or IR detection circuitry.

UV COPM Fault = 01 (Lo Data Byte)

IR COPM Fault = 02 (Lo Data Byte)

The High Data Byte is Not Used.

5.7.9 EEPROM Override (07H)

A read indicates the status of the EEPROM Override bit. A write command changes the state of the EEPROM Override bit. When the EEPROM Override bit is enabled, the options for the Detector Sensitivity, Relay Delay, Relay Latching/Non-Latching and Relay Energized/Non-Energized features are now controlled by the data stored in the EEPROM and are no longer controlled by the 8-position DIP switch located on the bottom of the Power/Relay Board. When the EEPROM Override bit is disabled the options are under the control of the 8-position DIP switch. The EEPROM Override bit is located in the LSB of the Low Data Byte and the High Data Byte is not used.

Function	Bit (LSB)	Access
Enable	1	Read/Write
Disable	0	Read/Write

Table 23: EEPROM Override

NOTE: By grounding the ALARM TEST input during power-up cycle (approximately 10 seconds), the FlameGard 5 UV/IR Flame Detector will disable the EEPROM Override and set the Bit = 0, thus enabling the 8-position DIP switch.

5.7.10 Options (08H)

A read returns the status of the settings for the Detector Sensitivity, Relay Delay, Relay Latching/Non-Latching and Relay Energized/Non-Energized features either from the Options Dipswitch or the EEPROM depending on the setting of the EEPROM Override bit listed above. A write command changes the settings for the EEPROM only when the EEPROM Override bit is set.

EXCEPTION - If an attempt to change the EEPROM Options is made while the EEPROM Override bit is not set, then the unit shall return an Exception Code 01 (Illegal Function).

These functions are indicated on the Low Data Byte and the High Data Byte is not used.

Function	Bit Position	Conditions				Access
Warn Energized	8 (MSB)	1 = Energized 0 = Non-Energized				Read/Write
Alarm Energized	7	1 = Energized 0 = Non-Energized				Read/Write
Warn Latched	6	1 = Latched 0 = Non-Latched				Read/Write
Alarm Latched	5	1 = Latched 0 = Non-Latched				Read/Write
		10	8	4	2	Time Delay in Seconds
Alarm Time Delay 2	4	1	0	0	1	Read/Write
Alarm Time Delay 1	3	1	1	0	0	Read/Write
		100	75	50		% Sensitivity
Sensitivity 2	2	0	0	1		Read/Write
Sensitivity 1	1 (LSB)	0	1	0		Read/Write

Table 24: Setting Options

5.7.11 Comm 1 Address (09H)

A read returns the Comm 1 address of the FlameGard 5 UV/IR Flame Detector. A write changes the address to the requested address. The range of the address is 1 to 247 (01 to F7 Hex). After the address has been changed to the slave unit, the Modbus communications will cease because the address has changed; therefore the master will have to change its query address to the slave's new address in order to restart the communications.

EXCEPTION - If an illegal data value is entered (must be between 1, 0x00F7), then the Exception Code 03 (Illegal Data Value) is returned.

NOTE: By grounding the RESET input during power-up cycle (approximately 10 seconds), the FlameGard 5 UV/IR Flame Detector Address will default to 1.

5.7.12 Comm 1 Baud Rate (0BH)

A read returns the Comm 1 baud rate of the FlameGard 5 UV/IR Flame Detector. A write changes the baud rate to the requested baud rate. After the baud rate has been changed to the addressed unit, the Modbus communications will cease because the baud rate has changed; therefore the master will have to change its baud rate to the slave's new baud rate in order to restart the communications.

Baud Rate	Low Data Byte	Access
19.2K	03	Read/Write
9600	02	Read/Write
4800	01	Read/Write
2400	00	Read/Write

Table 25: Comm 1 Baud Rate

This function is indicated on the Low Data Byte (the High Data Byte is not used).

EXCEPTION - If an illegal data value is entered which is not listed above, then the Exception Code 03 (Illegal Data Value) is returned.

NOTE: By grounding the RESET input during power-up cycle (approximately 10 seconds), the FlameGard 5 UV/IR Baud Rate will default to 19.2K.

5.7.13 Comm 1 Data Format (0CH)

A read returns the Comm 1 data format of the FlameGard 5 UV/IR Flame Detector. A write changes the data format to the requested data format. After the data format has been changed to the addressed unit, the Modbus communications may cease or start producing Comm errors because the data format has changed; therefore the master will have to change its data format to the slave's new data format in order to restart or provide proper communications.

Data	Parity	Stop	Format	Low Data Byte	Access
8	None	1	8-N-1	00	Read/Write
8	Even	1	8-E-1	01	Read/Write
8	Odd	1	8-O-1	02	Read/Write
8	None	2	8-N-2	03	Read/Write

Table 26: Comm 1 Data Format

This function is indicated on the Low Data Byte and the High Data Byte is not used.

EXCEPTION - If an illegal data value is entered which is not listed above, then the Exception Code 03 (Illegal Data Value) is returned.

NOTE: By grounding the RESET input during power-up cycle (approximately 10 seconds), the FlameGard 5 UV/IR Data Format will default to 8-N-1.

5.7.14 UV Signal Count (0DH)

A read indicates the number of UV Signal Counts that have occurred within 500 ms, which is the time duration that is required to detect a fire in the UV spectrum.

5.7.15 IR Signal Count (0EH)

A read indicates the number of IR Signal Counts that have occurred within 500 ms which is the time duration that is required to detect a fire in the IR spectrum.

5.7.16 UV Fault Total (0FH)

A read indicates the total number of UV COPM Faults for an indefinite period of time until the Clear COPM Fault command is activated. The maximum count is 65535 and then the counter will rollover to zero and begin counting again.

5.7.17 IR Fault Total (10H)

A read indicates total number of IR COPM Faults for an indefinite period of time until the Clear COPM Fault command is activated. The maximum count is 65535 and then the counter rolls back to zero and begins counting again.

5.7.18 Remote Reset (11H)

Writing a 1 to the bit activates the Remote Reset function that resets the Alarm and Warn Relays. The function is active momentarily and resets automatically after being used.

Function	Bit (LSB)	Access
Enable	1	Read/Write
Disable	0	Read/Write

Table 27: Remote Reset

EXCEPTION - If an illegal data value is entered which is not listed above, then the Exception Code 03 (Illegal Data Value) is returned.

5.7.19 Remote Alarm Test (12H)

Writing a 1 to the bit activates the Remote Alarm Test function, which activates the Warn and Alarm relay and causes the Analog current to show warn then alarm. Once the Alarm Test is complete, the Remote Alarm Test function should be disabled by writing a zero to the Remote Alarm Test and then resetting the Alarm and Warn relays by writing a one to the Remote Reset (referenced above).

Function	Bit (LSB)	Access
Enable	1	Read/Write
Disable	0	Read/Write

Table 28: Remote Alarm Test

EXCEPTION - If an illegal data value is entered which is not listed above, then the Exception Code 03 (Illegal Data Value) is returned.

5.7.20 Clear COPM Faults (13H)

Writing a 1 to the bit activates the Clear COPM Faults function that resets both the UV and IR COPM faults. The function is active momentarily and resets automatically after being used.

Function	Bit (LSB)	Access
Enable	1	Read/Write
Disable	0	Read/Write

Table 29: Clear COPM Faults Function

EXCEPTION - If an illegal data value is entered which is not listed above, then the Exception Code 03 (Illegal Data Value) is returned.

5.7.21 Serial Number (15/16H)

The serial number is a 32-bit word but the value is only 23 bits long. The upper bits are always zero. This is done to keep the same serial number as the HART serial number. Address 0x16 contains the lower part of the number and address 0x15 contains the upper part.

5.7.22 HART Enable (1D)

This command enables or disables HART. A “0” is HART disabled. A “1” is HART Enabled. This is an option that must be ordered. If HART is not installed, an exception will be returned.

5.7.23 HART Test (1E)

This command is used to test the HART output. It produces constant zeros or constant ones on the HART output. This is only available if the HART option was purchased.

Code	Results
0	Normal
1	Constant ones
2	Constant zeros

5.7.24 Not Used (1F)

5.7.25 Comm 1 Total Illegal number of registers Errors (20H)

A read indicates the total illegal number of registers errors on the Modbus. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.26 Comm 1 Bus Activity Rate % (21H)

A read indicates the Comm 1 Bus Activity Rate in percent of this Slave's addressed node versus other addressed nodes. Range of this value is in hex (0-64), which translates to decimal (0-100%).

5.7.27 Comm 1 Function Code Errors (22H)

A read indicates the number of Comm Function Code Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.28 Comm 1 Starting Address Errors (23H)

A read indicates the number of Comm 1 Starting Address Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.29 Comm 1 Total Receive Errors (24H)

A read indicates the total Modbus Comm 1 Only Receive Errors that occurred in the slave device. These are address, function, etc. type of errors. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.30 RXD CRC Errors Hi (25h)

A read indicates the number of RXD CRC Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.31 RXD CRC Errors Lo (Same as Hi) (26h)

NOTE: Since the FlameGard 5 UV/IR Flame Detector has a 16 bit CRC, the Hi and Lo CRC errors are now reported in the same 16 bit word. A read from either the old high Hi or Lo CRC address will return the same count.

5.7.32 Comm 1 Overrun Errors (27H)

A read indicates the number of Comm 1 Overrun Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

NOTE: An overrun error occurs when the next received byte of data tries to overwrite an existing received data byte, which has not been processed. Therefore, the next received byte of data is lost. This can be controlled by implementing the proper DCS or PLC Error Handling Timing Setting (ex. Reply Timeout Setting, Delay Time, and Number of Retries) and proper Baud Rate Setting.

5.7.33 Comm 1 Parity Errors (28H)

A read indicates the number of Comm 1 Only Parity Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.34 Comm 1 Framing Errors (29H)

A read indicates the number of Comm 1 Framing Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.35 Comm 1 Total UART Receive Errors (2AH)

A read indicates the total Modbus Comm 1 Receive Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again. The total errors are an accumulation of the individual Comm errors such as Overrun, CRC, Parity and Framing errors.

5.7.36 Comm 1 Total Receive Errors (2BH)

A read indicates the total Modbus Comm 1 Only Receive Errors that occurred in the slave device. These are address, function, etc type of errors. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.37 Clear Comm 1 UART Errors (2CH)

Writing a 0 to the bit activates the Clear Comm 1 Errors function, which resets all of the Modbus UART Comm Error counters to zero. The function is active momentarily and will reset automatically after being used.

5.7.38 Clear Comm 1 Modbus Errors (2DH)

Writing a 0 to the bit activates the Clear Comm 1 Errors function, which resets all of the Modbus Comm Error counters to zero. The function is active momentarily and resets automatically after being used.

5.7.39 HART Current (2E)

Normally in HART mode the low current does not go below 3.5 mA. In order for the current to distinguish between COPM Fault and Fault there is a HART setting that allows the current to go as low as 1.25 mA. A read returns “1” or “0”.

Condition	Normal HART Current	HART Expanded Scale	Units
Run	4 ,8, 12,16, 20	4 ,8, 12,16, 20	mA
COPM Fault	3.5	2.0	mA
Fault	3.5	1.25	mA

5.7.40 Comm 2 Address (2FH)

A read returns the Comm 2 address of the FlameGard 5 UV/IR Flame Detector. A write changes the address to the requested address. The range of the address is 1 to 247 (01 to F7 Hex). After the address has been changed to the slave unit, the Modbus communications will cease because the address has changed. Therefore, the master will have to change its query address to the slave's new address in order to restart communications.

EXCEPTION - If an illegal data value is entered which is not listed above, then the Exception Code 03 (Illegal Data Value) is returned.

NOTE: By grounding the RESET input during power-up cycle (approximately 10 seconds), the FlameGard 5 UV/IR Flame Detector Address defaults to 2.

5.7.41 Comm 2 Baud Rate (30H)

A read returns the Comm 2 baud rate of the FlameGard 5 UV/IR Flame Detector. A write changes the baud rate to the requested baud rate. After the baud rate has been changed to the addressed unit, the Modbus communications ceases because the baud rate has changed. Therefore, the master will have to change its baud rate to the slave's new baud rate in order to restart communications.

Baud Rate	Low Data Byte	Access
19.2K	03	Read/Write
9600	02	Read/Write
4800	01	Read/Write
2400	00	Read/Write

Table 30: Comm 2 Baud Rate

This function is indicated on the Low Data Byte (the High Data Byte is not used).

EXCEPTION - If an illegal data value is entered which is not listed above, then the Exception Code 03 (Illegal Data Value) is returned.

NOTE: By grounding the RESET input during power-up cycle (approximately 10 seconds), the FlameGard 5 UV/IR Flame Detector Baud Rate will default to 19.2K.

5.7.42 Comm 2 Data Format (31H)

A read returns the Comm 2 data format of the FlameGard 5 UV/IR Flame Detector. A write changes the data format to the requested data format. After the data format has been changed to the addressed unit, the Modbus communications may cease or start producing Comm errors because the data format has changed. Therefore, the master will have to change its data format to the slave's new data format in order to restart or provide proper communications.

Data	Parity	Stop	Format	Low Data Byte	Access
8	None	1	8-N-1	00	Read/Write
8	Even	1	8-E-1	01	Read/Write
8	Odd	1	8-O-1	02	Read/Write
8	None	2	8-N-2	03	Read/Write

Table 31: Comm 2 Data Format

This function is indicated on the Low Data Byte (the High Data Byte is not used).

EXCEPTION - If an illegal data value is entered which is not listed above, then the Exception Code 03 (Illegal Data Value) is returned.

NOTE: By grounding the RESET input during power-up cycle (approximately 10 seconds), the FlameGard 5 UV/IR Flame Detector Data Format will default to 8-N-1.

5.7.43 Not Used (32H)

5.7.44 Input Voltage (33H)

A read returns the input voltage. This allows the user to remotely read the actual input voltage via Modbus. If the measured voltage is below the required 20 volts measures should be taken or low line faults may occur.

5.7.45 Alarm Test Voltage (34H)

This is useful if the Alarm test button is located a long distance from the FlameGard 5 UV/IR Flame Detector or the ground is not a good ground. A read returns the Alarm input voltage. If the voltage is below 3.5 volts, the Alarm test is activated.

5.7.46 Reset Relays Voltage (35H)

This is useful if the Reset test button is located a long distance from the FlameGard 5 UV/IR Flame Detector or the ground is not a good ground. A read returns the Reset input voltage. If the voltage is below 3.5 volts, the Reset is activated.

5.7.47 Dip Switch Settings (36H)

A read returns a digital copy of the dip switch. This is useful to check the FlameGard 5 UV/IR Flame Detector configuration.

5.7.48 Not Used (37 – 3FH)

5.7.49 See Event Logging - Section 6.0 (40H – 67H)

5.7.50 User Information (68h to 77h)

There is a section in memory that allows the user to store information. This is useful if the physical location or other user identification is required. The only restriction on the information is it must be Modbus compatible. Only one word can be written per command. There are a total of 16 words for the user.

NOTE: The following information only applies if the dual Modbus configuration was purchased.

5.7.51 Comm 2 Total Illegal Number of Registers Errors (78H)

A read indicates the total illegal number of registers errors on the Modbus. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.52 Comm 2 Bus Activity Rate % (79H)

A read indicates the Comm 2 Bus Activity Rate in percent of this slave's addressed node versus other addressed nodes. Range of this value is in hex (0-64), which translates to decimal (0-100%).

5.7.53 Comm 2 Function Code Errors (7AH)

A read indicates the number of Comm 2 Function Code Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.54 Comm 2 Starting Address Errors (7BH)

A read indicates the number of Comm 2 Starting Address Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.55 Comm 2 Total Receive Errors (7CH)

A read indicates the total Modbus Comm 2 Only Receive Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.56 RXD CRC Errors Hi (7DH)

A read indicates the number of RXD CRC Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.57 RXD CRC Errors Lo (Same as Hi) (7EH)

NOTE: Hi and Lo CRC errors are reported in the same word. A read from either Hi or Lo will return the same count.

5.7.58 Comm 2 Overrun Errors (7FH)

A read indicates the number of Comm 2 Only Overrun Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

NOTE: An overrun error occurs when the next received byte of data tries to overwrite an existing received data byte, which has not been processed. Therefore, the next received byte of data is lost. This can be controlled by implementing the proper DCS or PLC Error Handling Timing Setting (ex. Reply Timeout Setting, Delay Time, and Number of Retries) and proper Baud Rate Setting.

5.7.59 Comm 2 Parity Errors (80H)

A read indicates the number of Comm 2 Parity Flag Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.60 Comm 2 Framing Errors (81H)

A read indicates the number of Comm 2 Framing Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.61 Comm 2 Total UART Receive Errors (82H)

A read indicates the total Modbus Comm 2 UART Receive Errors that occurred in the slave device. The maximum count is 65535 and then the counter rolls over to zero and begins counting again.

5.7.62 Not Used (83H)

5.7.63 Clear Comm 2 UART Errors (84H)

Writing a 0 to the bit activates the Clear Comm 2 UART Errors function, which resets all of the Modbus UART Error counters to zero. The function is active momentarily and will reset automatically after being used.

5.7.64 Clear Comm 2 Modbus Errors (85H)

Writing a 0 to the bit activates the Clear Comm 2 Modbus Errors function, which resets all of the Modbus Error counters to zero. The function is active momentarily and will reset automatically after being used.

6.0 Event Logging

6.1.1 Faults

- Whenever the fault word changes, the time will be recorded.
- The time of the fault will be saved.
- The quantity of faults will be saved in a counter.
- When the fault is removed, it is not saved and the counter is not incremented.
- A fault event is logged for every 30 seconds recorded.
- There are a total of 10 event time stamps stored.

6.1.2 Warning

At the time the fire level reaches the Warning level, the time is recorded. Each time this happens a counter is incremented and saved. The end of the event is after the fire has gone away and the latching state has been reset. There are a total of 10 event time stamps stored.

6.1.3 Alarm

At the time the fire level reaches the Alarm level, the time is recorded. Each time this happens a counter is incremented and saved. The end of the event is after the fire has gone away and the latching state has been reset. There are a total of 10 event time stamps stored.

6.1.4 Maintenance

At the time an alarm test occurs, the time is saved in the maintenance event log. Each successful test increments and saves the maintenance counters. There are a total of 10 event time stamps stored.

6.1.5 Setting Clock

Please see the table below.

Address (hex)	Parameter	Function	Data Type	Data range	Access
40	Seconds Time Hi	Seconds Time Hi	Numeric value	0 – 65535	Timer Sec
41	Seconds Time Low	Seconds Time	Numeric value	0 – 65535	Timer Sec
42	Real Time Clock Year, Month	Read/Set year and month of RTC	2 Numeric Values	0-99 year, 1 – 12 month	Timer Struct
43	Real Time Clock Day, Hour	Read/Set day and hour of RTC	2 Numeric Values	1 – 31 day, 0 – 23 hour	
44	Real Time Clock Minute, Second	Read/Set minutes and seconds of RTC	2 Numeric Values	0 – 59 minute, 0 – 59 second	Timer Struct
46	Event Index	Event index of Logged Event	Numeric value	0 - 9	Index
47	Warn	Seconds Time Hi for warning event	Numeric value	0 – 65535	Warn

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Address (hex)	Parameter	Function	Data Type	Data range	Access
	Seconds Time Hi	log entries			
48	Seconds Time Low	Seconds Time Low for warning event log entries	Numeric value	0 – 65535	Warn
49	Structure time Hi	Hi byte – year, low byte – month for warning event log entries	Numeric value	0 – 65535	Warn
4A	Structure time Mid	Hi byte – day, low byte – hour warning event log entries	Numeric value	0 – 65535	Warn
4B	Structure time Low	Hi byte – min, low byte – sec for warning event log entries	Numeric value	0 – 65535	Warn
4C	Reserved	Reserved	Numeric value	0	
4D	Reserved	Reserved	Numeric value	0	
4E	Warn Event Count	Warning Event Count	Numeric value	0 – 65535	Warn
4F	Alarm Seconds Time Hi	Seconds Time Hi for alarm event log entries	Numeric value	0 – 65535	Alarm
50	Seconds Time Low	Seconds Time Low for alarm event log entries	Numeric value	0 – 65535	Alarm
51	Structure time Hi	Hi byte – year, low byte – month for alarm event log entries	Numeric value	0 – 65535	Alarm
52	Structure time Mid	Hi byte – day, low byte – hour alarm event log entries	Numeric value	0 – 65535	Alarm
54	Reserved	Reserved	Numeric value	0	
55	Reserved	Reserved	Numeric value	0	
56	Alarm Event Count	Alarm Event Count	Numeric value	0 – 65535	Alarm
57	Fault Seconds time Hi	Seconds Time Hi for fault event log entries	Numeric value	0 – 65535	Fault

Address (hex)	Parameter	Function	Data Type	Data range	Access
58	Seconds time Low	Seconds Time Low for fault event log entries	Numeric value	0 – 65535	Fault
59	Structure time Hi	Hi byte – year, low byte – month for fault event log entries	Numeric value	0 – 65535	Fault
5A	Structure time Mid	Hi byte – day, low byte – hour alarm event log entries	Numeric value	0 – 65535	Fault
5B	Structure time Low	Hi byte – min, low byte – sec for fault event log entries	Numeric value	0 – 65535	Fault
5C	Fault code	Fault code. Same code as register 2	Numeric value	0 – 65535	Fault
5D	Reserved	Reserved	Numeric value	0	
5E	Fault Event Count	Fault Event Count	Numeric value	0 – 65535	Fault
5F	Maintenance Seconds time Hi	Seconds Time Hi for event log entries	Numeric value	0 – 65535	Maintenance
60	Seconds time Low	Seconds Time Low for event log entries	Numeric value	0 – 65535	Maintenance
61	Structure time Hi	Hi byte – year, low byte – month for event log entries	Numeric value	0 – 65535	Maintenance
62	Structure time Mid	Hi byte – day, low byte – hour event log entries	Numeric value	0 – 65535	Maintenance
64	Maintenance code	Cal check	Numeric value	0	Maintenance
65	Reserved	Reserved	Numeric value	0	
66	Maintenance Count	Maintenance Count	Numeric value	0 – 65535	Maintenance
67	Reset Event Counters	Reset Event Counters	Numeric value	1	Reset

Table 32: Event Logging Registry Table

7.0 Maintenance

7.1 General Maintenance

Once correctly installed, the unit requires very little maintenance other than regular sensitivity checks and cleaning of the lenses. MSA recommends that a schedule be established and followed.



WARNING: Disconnect or inhibit external devices, such as automatic extinguishing or fire suppression systems before performing any maintenance.

NOTE: The removal of particulate matter and any film buildup on the windows and light rods is necessary to ensure proper sensitivity of the system. It is recommended that the window and light rods be cleaned at least every 30 days or more often if the detector is located in a particularly dirty environment.

During routine maintenance of the equipment, if the base plate is removed, the flame path should be replenished with grease compound.

European Union (EU) Approved Applications: The following grease compound is recommended for use: High Vacuum Grease (or equivalent), as a jointing compound on flameproof electrical enclosures. This is available from MSA Ireland.

The viton o-ring gasket should also be lubricated with Castrol EP or High Vacuum grease should it become dry.

The removal of dust and film build-up on the windows is necessary to ensure proper sensitivity of the system. Windows may be cleaned periodically, to avoid a COPM fault being triggered by build-up, dirt or debris.

7.2 Cleaning the Lenses/Light Rods

NOTE: DO NOT USE A COMMERCIAL GLASS CLEANER OTHER THAN "INDUSTRIAL STRENGTH WINDEX[®] with Ammonia D". The lenses are not glass. The UV lens material is quartz and the IR lens material is sapphire. The cleaning solution should be "Industrial Strength Windex[®] with Ammonia D".

A clean, soft, lint-free cloth, tissue or cotton swab should be used to apply the cleaning solution. Do not touch the lenses or light rods with fingers.

1. Wet the window with the cleaning solution.
2. Rub with a dry, unsoiled cloth until the window is clean.
3. Let the window dry completely.
4. Repeat steps 1, 2 and 3 for the light rods (Figure 20). Take care only to clean the non-coated (non - aluminum) areas of the light rods.

NOTE: The removal of particulate matter and any film buildup on the lenses and light rods is necessary to ensure proper sensitivity of the system. It is recommended that the window and light rods be cleaned at least every 30 days or more often if the detector is located in a particularly dirty environment.

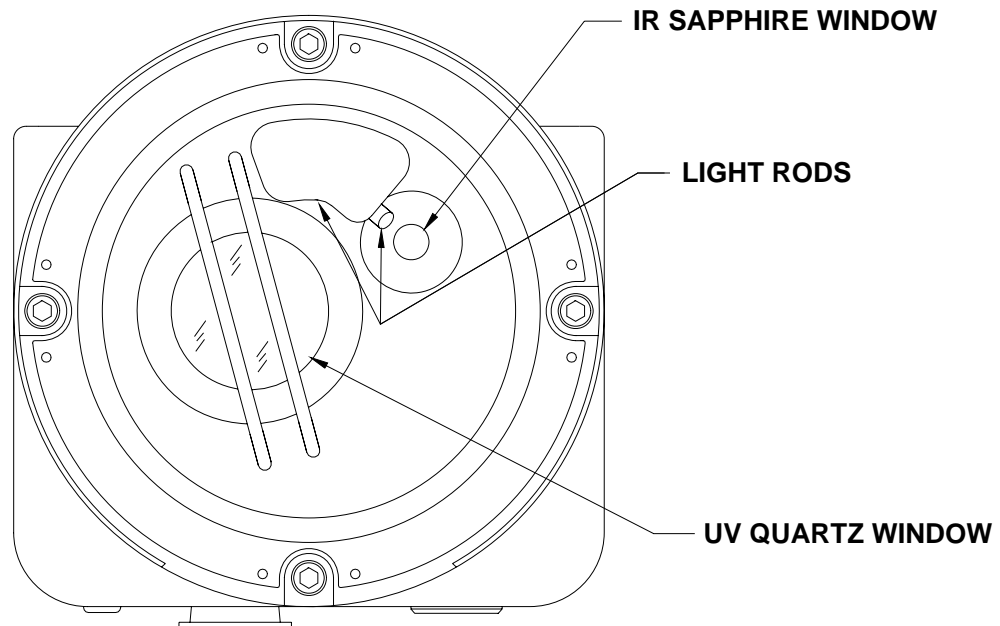


Figure 20: UV and IR Windows

7.3 Sensitivity Check

To verify that each detector is functioning correctly, a FlameGard 5 UV/IR Test Lamp and/or the ALARM TEST function should be used.

7.3.1 Alarm Test

The FlameGard 5 UV/IR Flame Detector has a built-in Alarm Test feature. By connecting one contact of a SPST momentary switch to TB1 position 4 and the other contact to DC COM TB1, position 9 or 10 (Section 3.3.1), the user can test the alarm outputs of the flame detector by activating this switch for two to ten seconds depending on the Alarm Time Delay Setting.

If the flame detector detects these sources, it will immediately go into WARN and then into the time delayed ALARM. After two to ten seconds the flame detector will reset the non-latching WARN and/or ALARM. A latching WARN and/or ALARM will remain latched until manually reset. If the flame detector does not respond to the sources, it will output a FAULT condition and will retest every ten seconds, as in the COPM FAULT case.

7.3.2 FlameGard 5 UV/IR Test Lamp

The MSA FlameGard 5 UV/IR Test Lamp is a battery operated, rechargeable test source specifically designed to test MSA UV/IR flame detectors.



It consists of a high-energy broadband radiation source, which emits sufficient energy in both the Ultraviolet and Infrared spectra to activate UV and/or IR detectors. To simulate a fire, the test lamp automatically flashes at the proper rate for different models. See the test lamp instruction manual.

The FlameGard 5 UV/IR Test Lamp, rated explosion-proof, is CSA certified for use in Class I, Groups C and D areas.

The test lamp operates on internal batteries which, when fully charged, operate continuously for 30 minutes. An internal circuit will prevent operation when the batteries are low.

7.3.3 FlameGard 5 UV/IR Test Lamp Operating Instructions

It is always important to start a series of FlameGard 5 UV/IR Test Lamp checks with a fully charged unit. Stand within 20 feet (FlameGard 5 UV/IR), 40 feet (FlameGard 5 UV/IR-Hydrogen) of the unit to be tested and aim the FlameGard 5 UV/IR Test Lamp squarely into the detector face. Shaking the lamp from side to side or up and down will increase the simulation of flame flicker, and improve the response of the flame detector to the lamp.

If the system is operating normally, the detector will go into a WARN condition after a few flashes of the test lamp. If the lamp remains ON for the time-delayed period of the DIP switch setting, the detector will go into ALARM.

To conserve charge, do not operate the test lamp longer than necessary to test each detector. When the battery level drops below the level required to maintain the proper intensity of the lamp, an internal low voltage circuit shuts the lamp off until the batteries have been recharged.

7.3.4 FlameGard 5 UV/IR Test Lamp Recharging Instructions

Insert the charging plug into the receptacle. Complete recharging takes less than 2 hours. A schedule of testing should be established and followed.



WARNING: Replace the knurled plug after charging is complete. Charging must be carried out in a non-hazardous area. The charging receptacle is located inside the housing adjacent to the ON button. To gain access, it is necessary to unscrew

the knurled plug from the body of the unit. The plug is secured to the ON button by a safety strap to keep it from being lost. It is recommended that the FlameGard 5 UV/IR Test Lamp be kept on charge when not in use to prevent excessive battery discharge. The batteries may be charged an average of 500 times and the battery pack is replaceable.

Additional information can be found in the FlameGard 5 Test Lamp operating manual.

7.4 Storage

MSA Flame Detectors should be stored in a clean, dry area and within the temperature and humidity ranges quoted in the Appendix, under Environmental Specifications.

When prolonged storage is anticipated, detectors should be sealed together with a desiccant into plastic bags and double wrapped for protection. They should not be subjected to shock or vibration as this may cause damage. Ideally, the detectors should remain packed in the molds as shipped by MSA. Insert red dust caps into vacant cable entry holes.

8.0 Troubleshooting

8.1 Troubleshooting



CAUTION: Component level repair must be undertaken either by MSA personnel or by competent authorized service engineers. SMT PCB repair shall only be performed at an MSA facility.

8.1.1 Introduction

Included in this section is a troubleshooting table. The information included is designed to cope with the more common faults, which occur during commissioning and operation and which are repairable by a competent operator. Should the various actions suggested in the table fail to restore normal operation, the unit should be returned to MSA for repair. A complete written description of the problem should be included.

Be sure to inhibit or disconnect external alarm wiring before making any check that might send the unit into alarm.

NOTE: On no account should repair of the electronic circuit be undertaken by anyone other than MSA personnel or authorized representative. Failure to comply with this requirement will invalidate the warranty.

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
No output signal and green LED in UV window is off.	No DC Power to the Unit	Be sure the +24 VDC is applied with the correct polarity.
No output signal and green LED in UV window is rapidly blinking.	Low voltage FAULT (voltage at unit less than +18 VDC).	Be sure that the unit is powered with at least +20 VDC under load.
2 mA signal and green LED in UV window is slowly blinking.	COPM FAULT, dirty or obscured optical path (UV or IR window)	Clean UV and IR window and associated source light rods.
Constant 12 mA signal with no known radiation to detector.	Background UV radiation at detector.	Cover UV portion of FlameGard 5 UV/IR Flame Detector for ten seconds to determine if there is background UV. If there is, remove UV radiation source or change FlameGard 5 UV/IR Flame Detector location.

Table 33: Troubleshooting Table

9.0 Customer Support

9.1 MSA Office

Address	Phone/Web/Email
UNITED STATES	
Mine Safety Appliances Co. 26776 Simpatica Circle Lake Forest, CA 92630	Toll Free: 1-800-MSA-INST Email: customer.service@msanet.com

Table 34: MSA Locations

9.2 Other Sources of Help

MSA provides extensive documentation, white papers, and product literature for the company's complete line of safety products, many of which can be used in combination with the FlameGard 5 UV/IR Flame Detector. Many of these documents are available online at the MSA website at <http://www.msanet.com>.

10.0 Appendix

10.1 Warranty

MSA warrants the FlameGard 5 UV/IR Flame Detector to be free from defects in workmanship or material under normal use and service within two years from the date of shipment.

MSA will repair or replace without charge any such equipment found to be defective during the warranty period. Full determination of the nature of, and responsibility for, defective or damaged equipment will be made by MSA personnel.

Defective or damaged equipment must be shipped to MSA plant or representative from which the original shipment was made. In all cases this warranty is limited to the cost of the equipment supplied by MSA. The customer will assume all liability for the misuse of this equipment by its employees or other personnel.

All warranties are contingent upon proper use in the application for which the product was intended and does not cover products which have been modified or repaired without MSA approval, or which have been subjected to neglect, accident, improper installation or application, or on which the original identification marks have been removed or altered.

EXCEPT FOR THE EXPRESS WARRANTY STATED ABOVE, MSA DISCLAIMS ALL WARRANTIES WITH REGARD TO THE PRODUCTS SOLD, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS AND THE EXPRESS WARRANTIES STATED HEREIN ARE IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF MSA FOR DAMAGES INCLUDING, BUT NOT LIMITED TO, CONSEQUENTIAL DAMAGES ARISING OUT OF, OR IN CONNECTION WITH, THE PERFORMANCE OF THE PRODUCT.

10.2 Principle of Operation

10.2.1 FlameGard 5 UV/IR Flame Detector

The FlameGard 5 UV/IR Flame Detector is a discriminating UV/IR Detector, which makes use of an ultraviolet radiation sensitive phototube in addition to an infrared detector. This combination provides a flame detector which is highly immune to false alarms.

The UV portion of the detector, as described in the previous section, is combined with an infrared detector, which responds to changes in the intensity of infrared radiation. By sensing very specific wavelengths in both the UV and IR spectra (Figure 21) and then processing these signals with a microcomputer, a very high degree of discrimination is achieved.

Incorporated in the IR circuitry is a flicker discrimination circuit. This permits the detector to ignore steady IR sources such as hot objects. The inherent flickering of a flame provides the necessary modulation to activate the IR circuit.

Since a flame is a copious source of both ultraviolet and infrared radiation, discrimination is provided when both UV and IR emissions are detected. If only UV is detected, as in the case of arc welding, no alarm is given. If only IR is detected, such as a large modulating hot object, no alarm is given. However, if both conditions are met in the correct combination and intensity, as determined by an algorithm in the microcomputer, a fire is identified and the alarm outputs are activated.

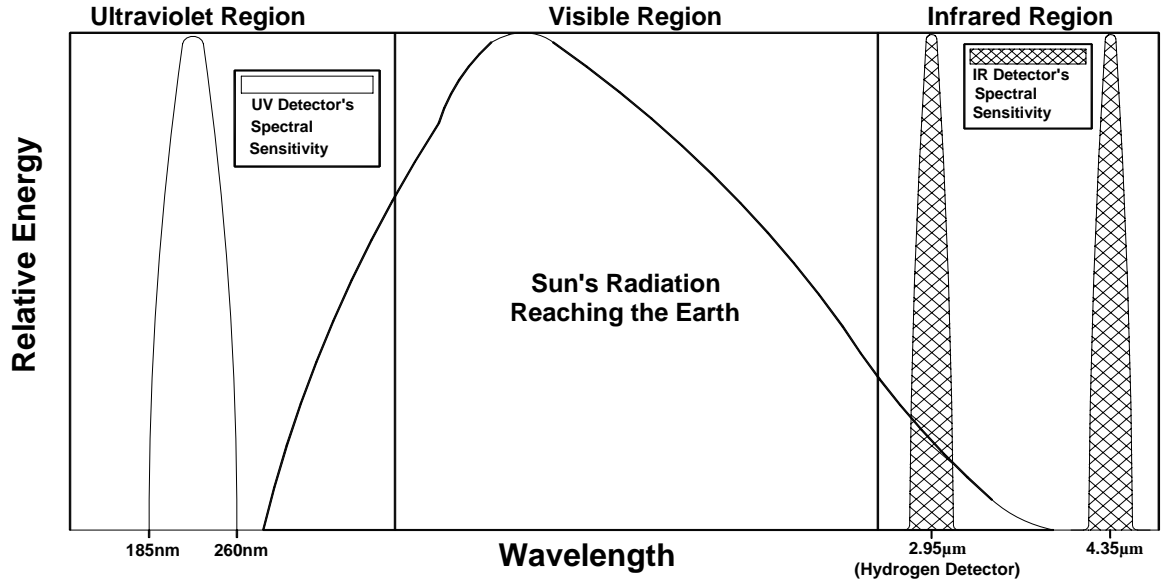


Figure 21: Spectral Response of UV and IR Detectors

(See Sections 3.0 and 5.2 for more information on detector outputs.)

10.2.2 COPM Circuitry

A self-testing feature called Continuous Optical Path Monitoring (COPM) checks the optical path, the detector(s), and the related electronic circuitry once every minute. If foreign material impairs the optical path of the UV detector or the infrared detector for two consecutive checks, the unit will indicate FAULT. The optical FAULT outputs are a 2.0 mA signal, de-energizing of the FAULT relay, and RS-485 output signal (Section 3.3.1). After a COPM FAULT, a COPM check is performed every 12 seconds until the fault condition is removed. Then the COPM check will resume a once per minute check.



WARNING: Dirty or partially blocked windows can significantly reduce the detector's field of view and detection distance.

NOTE: Since the optical path is checked once per minute and it requires two check failures to produce a FAULT, it may take up to two minutes for the unit to detect an obstruction.

10.2.3 Alarm Test

The FlameGard 5 UV/IR Flame Detector has a built-in Alarm Test feature. By connecting one contact of a SPDT momentary switch to TB1 position 4 and the other contact to DC COM TB1, position 9 and 10 (Section 3.3.1), the user can test the alarm outputs of the flame detector by activating this switch for one to eight seconds depending on the Alarm Time Delay Setting.

If the flame detector detects these sources, it will immediately go into WARN and then into the time delayed ALARM. After one to eight seconds the flame detector will reset the non-latching WARN and/or ALARM. A latching WARN and/or ALARM will remain latched until manually reset. If the flame detector does not respond to the sources, it will output a FAULT condition and will retest every ten seconds, as in the COPM FAULT case.

10.2.4 Visual Indicators

Two light emitting diodes (LEDs) are visible through the UV window (the larger window). LEDs are provided for a visual indication that corresponds with the detectors outputs. The following blinking sequence indicates the operation condition:

- Timeout (10 seconds when the unit is first powered) - Green and red LEDs blinking alternately
- Ready - Green LED that flashes off 1 second, every 5 seconds
- WARNING - Slow blinking red LED with green LED on steady
- ALARM - Fast blinking red LED with green LED on steady
- COPM FAULT - Slow blinking green LED
- Low Voltage FAULT/Shorted Reset Switch - Fast blinking green LED

10.3 Specifications

10.3.1 System Specifications

Application:	FlameGard 5 UV/IR Flame Detection FlameGard 5 UV/IR-Hydrogen Flame Detection
Detector Location: (FlameGard 5 UV/IR/FlameGard 5 UV/IR-Hydrogen)	Class I, Division 1 & 2, Groups B, C & D; Class II, Division 1 & 2, Groups E, F & G; Class III Ex d, IIC, T5
Waterproof:	Type 4x, IP66/IP67
UV Detector Pass Band:	185 to 260 nanometers
IR Detector center wavelength:	4.35 microns, 2.7-3.2 microns for Hydrogen
Typical Alarm Activation Response Times:	FlameGard 5 UV/IR Flame Detector < 3 sec. for heptane fire when detector is on axis to fire source and the distance of the detector to the fire is 15 -50ft FlameGard 5 UV/IR-Hydrogen < 3s @ 15 ft. (4.6m) FlameGard 5 UV/IR Flame Detector < 500 ms
Minimum Detector Response Times:	
Zeta Value:	Zeta = -0.001(The margin of error in the range measurement is estimated at ± 5 feet due to wind conditions and flame turbulence)
Field of View	FlameGard 5 UV/IR 120° maximum conical FlameGard 5 UV/IR-Hydrogen 120° maximum conical

NOTE: Response Times and Field of View data have been derived by testing the FlameGard 5 UV/IR Flame Detectors with a 1 square foot heptane fire. One cup of heptane on top of a one-inch layer of water was ignited for each test. These are typical values and different results may occur depending on the variation of each fire.

10.3.2 Mechanical Specifications

Enclosure Material:	Aluminum (AL) A-356 or Stainless Steel (SS): Natural 316
Color:	Aluminum Red
Finish:	Aluminum: Chemical Film per MIL-C-5541, Epoxy Powder Coated
Height:	6.0 in (15.2 cm)
Width:	6.0 in (15.2 cm)
Depth:	5.5 in (14.0 cm)
Weight:	5 lbs (2.3 kg) AL 16 lbs (7.3 kg) SS
Cable Entry:	2 x 25 mm ISO or 2 x PG 13.5 or 2 x 20 mm ISO or 2 x ¾" NPT. Each unit has an Ex d approved stopping plug installed, plus a Red Dust cap. Dust caps must be replaced by Ex d IIC approved cable glands and must not be left on the unit when powered up.
Cable Requirements:	Screened or screened and armored to BS5308 Part 2, Type 2 or equivalent. Note that terms "Screen" and "Shield" are used interchangeably.

10.3.3 Electrical Specifications

European Union (EU) Approved Applications: PSU noise and ripple voltage 1.0Vpp max. The customer supplied PSU must comply with IEC 61010-1, limiting current to 8A under Fault conditions, in order to comply with CE Marking requirements.

Nominal supply voltage:	24 VDC
Supply voltage range:	20 to 36 VDC
Maximum supply current:	400 mA during COPM only
Typical current:	80 to 150 mA Depends on relays ETC
Maximum output signal load:	600 Ohms
Output signal range:	0 to 20 mA *
FAULT signal:	0 to 0.2 mA *
COPM fault signal:	2.0 ± 0.2 mA *
Ready signal:	4.0 ± 0.2 mA
IR only signal:	8.0 ± 0.2 mA
UV only signal:	12.0 ± 0.2 mA
WARN signal:	16.0 ± 0.2 mA
ALARM signal:	20.0 ± 0.2 mA
Relay Contact Ratings:	<i>North American Approved Applications:</i> SPDT, 8A, @ 250 VAC, or 8A @ 30 VDC resistive max. <i>European Union (EU) Approved Applications:</i> SPDT, 8A 30V RMS/42.4V Peak, 8A @ 30 VDC, resistive max.
RS-485 Output:	Modbus RTU 128 units in series max. (247 units with repeaters) Baud Rate: 2400, 4800, 9600 or 19200 BPS Optional: Dual Modbus RTU Communications available (See Section 3.3 Terminal Connections, for Alarm Output Connections)
HART:	Fully HART Foundation compliant. See separate HART manual for use of HART
HART Impedance:	$R_x = _50\text{ K}$ $C_x = 5\text{ nF}$
AMS Aware:	Certified by AMS
RFI/EMI Protection:	Complies with EN 50130-4, EN 61000-6-4
Status Indicator:	Two LEDs indicate status, fault and alarm conditions

* Normal non-HART version. See analog output Section 3.3.6 for other currents.

10.3.4 Environmental Specifications

Operating temperature range:	-40°F to 185°F (-40°C to 85°C)
Storage temperature range:	-40°F to 185°F (-40°C to 85°C)
Humidity range:	0 to 100% RH non-condensing

10.4 Approvals

CSA, FM, ATEX, HART Registered, SIL 3 suitable and AMSAware. The FlameGard 5 UV/IR-Hydrogen flame detector is not FM approved.

10.5 Accessories

10.5.1 Mounting Swivel/Union

A mounting swivel and union are available to connect ¾" conduit into the base of the FlameGard 5 UV/IR Flame Detector. The swivel design allows for optical alignment adjustments for the flame detectors when using rigid conduit.

NOTE: Swivel is not approved for ATEX requirements.

10.5.2 Mounting Bracket

A mounting bracket is available to mount the FlameGard 5 UV/IR Flame Detector to a wall, pole, etc. The mounting bracket design allows for optical alignment adjustments for the flame detectors when installed to a fixed installation.

10.6 Storage

The flame detectors should be stored in a clean, dry area and within the temperature and humidity ranges mentioned in Section 10.3.4.

FlameGard 5 UV/IR Detector

10.7 Final Assembly

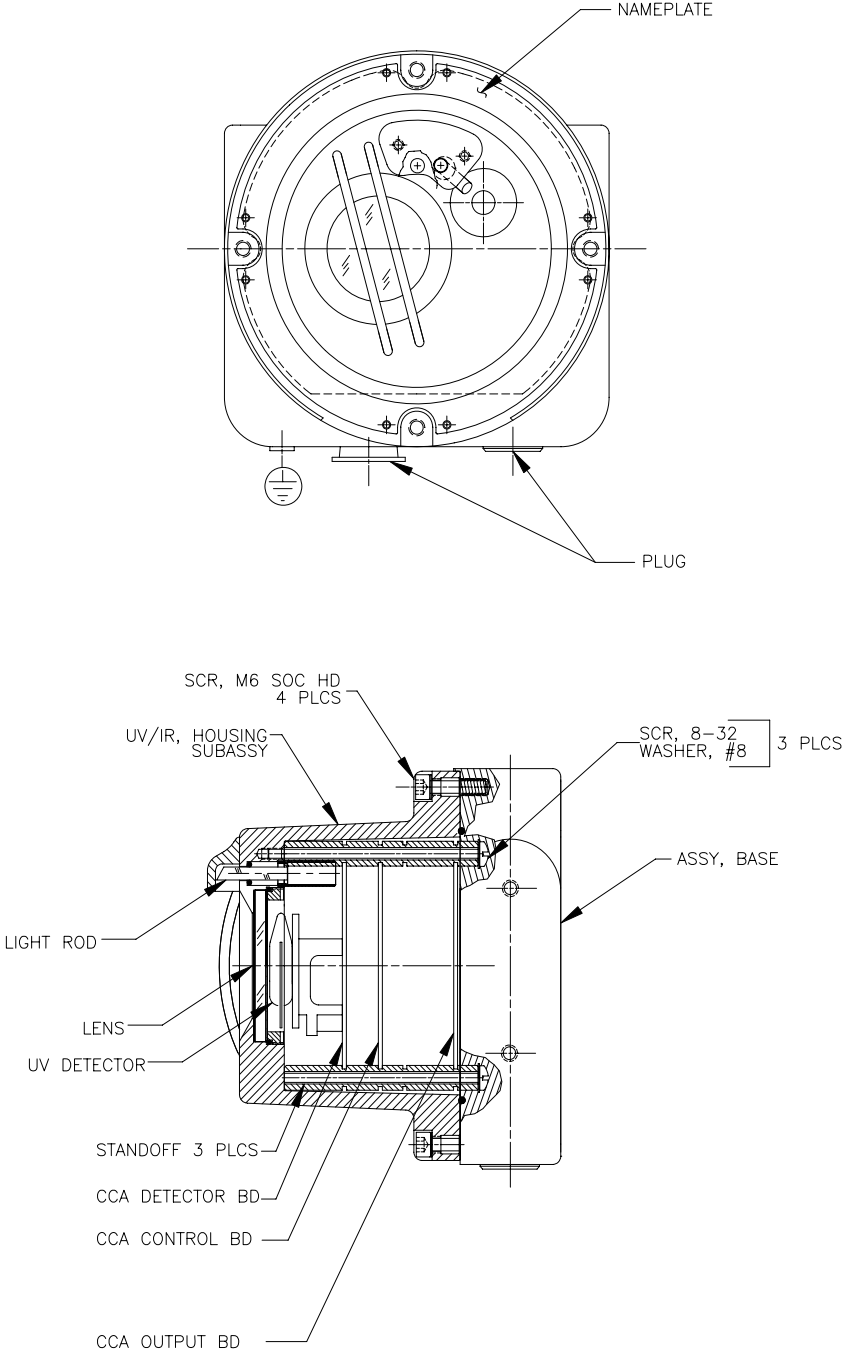


Figure 7: P/N 71450 FlameGard 5 UV/IR Flame Detector, Final Assembly