FlameGard® 5 UV/IR

Ultraviolet/Infrared
Flame Detector

Instruction Manual

Part No. **MAN5UVIR-EU**
Revision **0**

EC Declaration of Conformity

The manufacturer or his in the community established authorized representative

MSA AUER GmbH
Thiemannstraße 1
D-12059 Berlin

declares that the product :

MSA AUER **FlameGard 5 UV/IR**
FlameGard 5 UV/IR-H2

based on the EC-Type Examination Certificates :

SIRA 10 ATEX 1362

complies with the ATEX directive 94/9/EC, Annex III. Quality Assurance Notification complying with Annex IV of the ATEX Directive 94/9/EC has been issued by SIRA Certification Service , Notified Body number: 0518.

The product is in conformance with the directive 2004 / 108/ EC ,(EMC) :

EN 50130-4 : 2002 EN 61000 - 6 - 4 :2007

MSA AUER GmbH
Dr. Axel Schubert
R & D Instruments

Berlin , March 2011

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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 ingression into the housing. Mount detector using swivel mount or mounting bracket hardware.

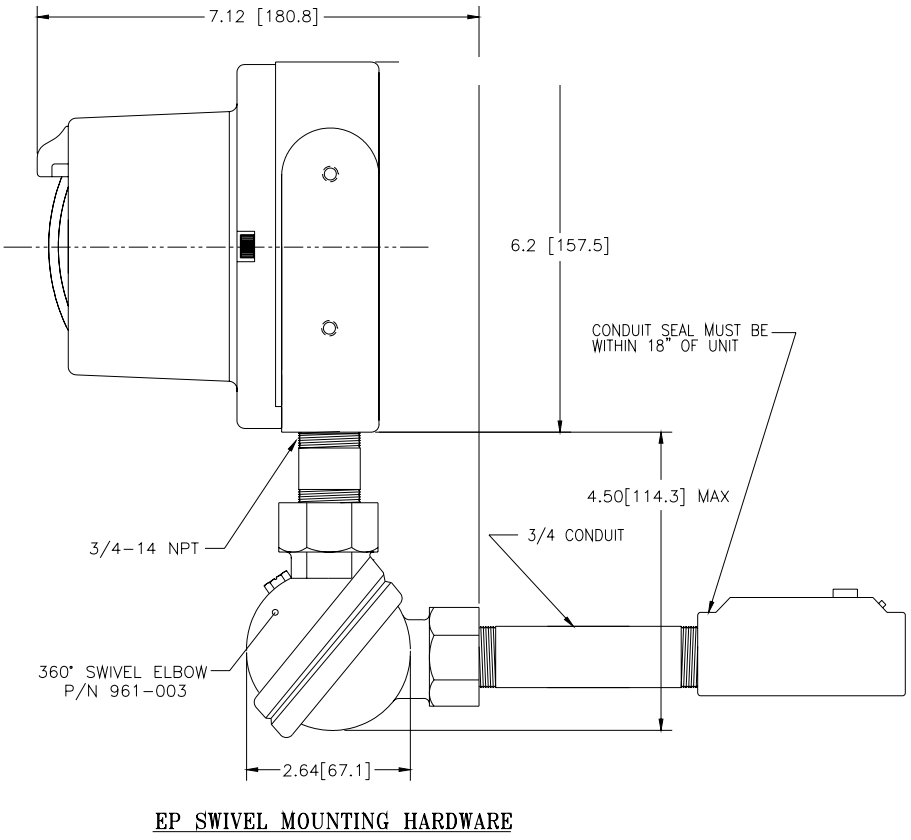

Fig. 1 Union Swivel Mounting Hardware

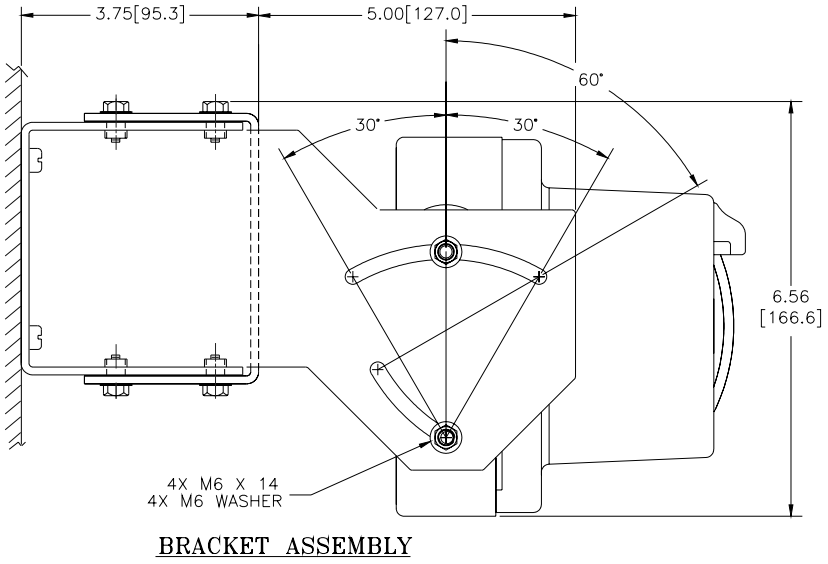

Fig. 2 Side View Bracket Assembly

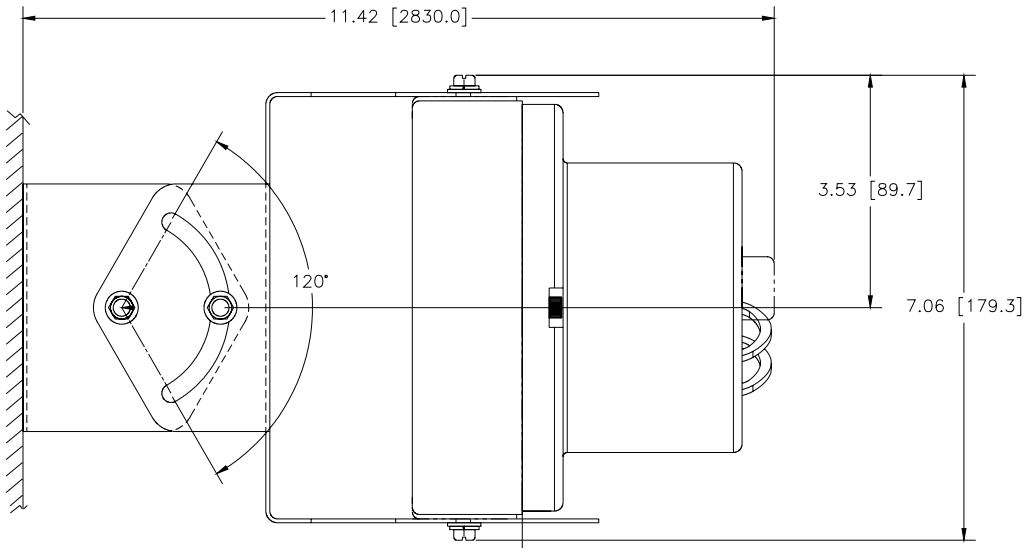

Fig. 3 Top View Bracket Assembly

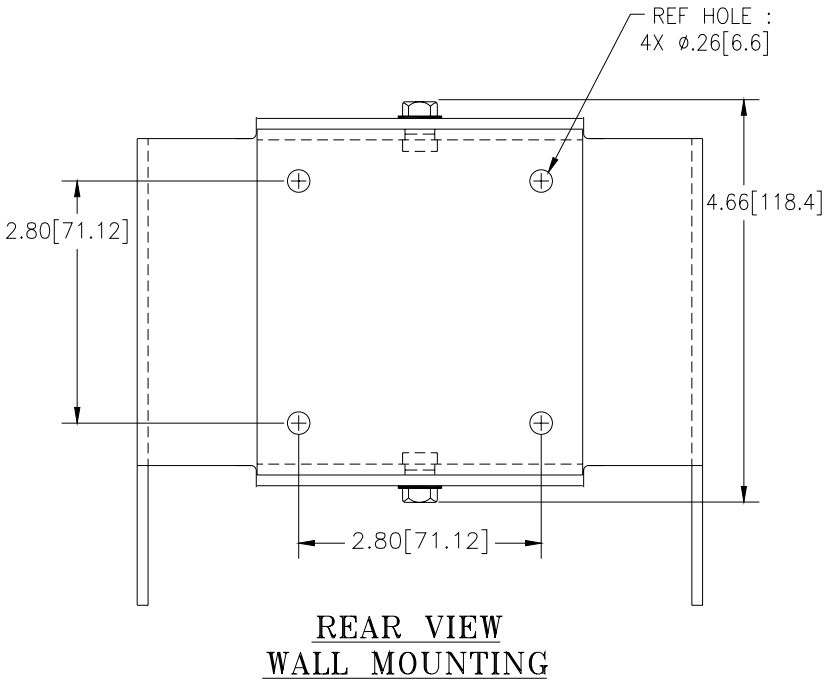

Fig. 4 Rear View Bracket Assembly

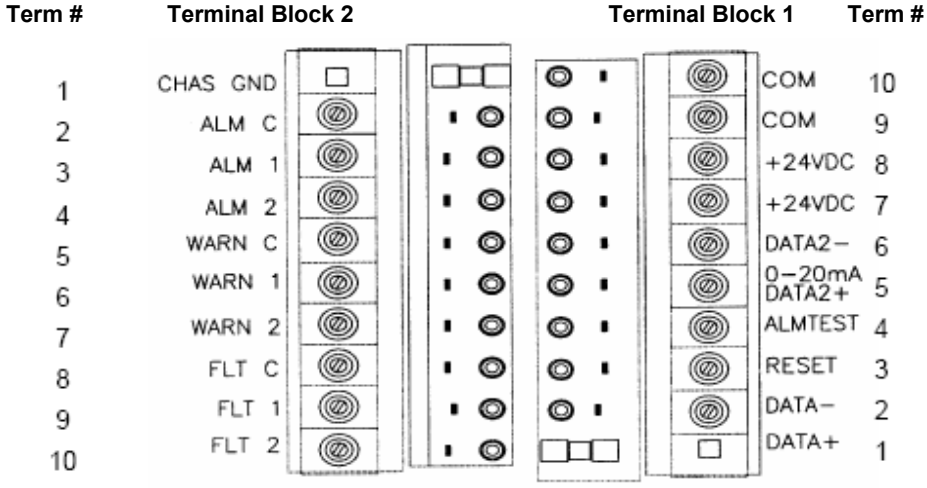

Fig. 5 Field Terminations

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.

MSA Contact Information

Address	Phone/Web/Email
Please, contact your local MSA representative (see last page).	

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

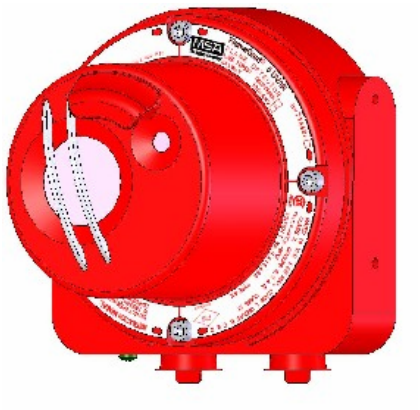

Fig. 6 FlameGard 5 UV/IR Flame Detector

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. (0.093m^2).

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 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.

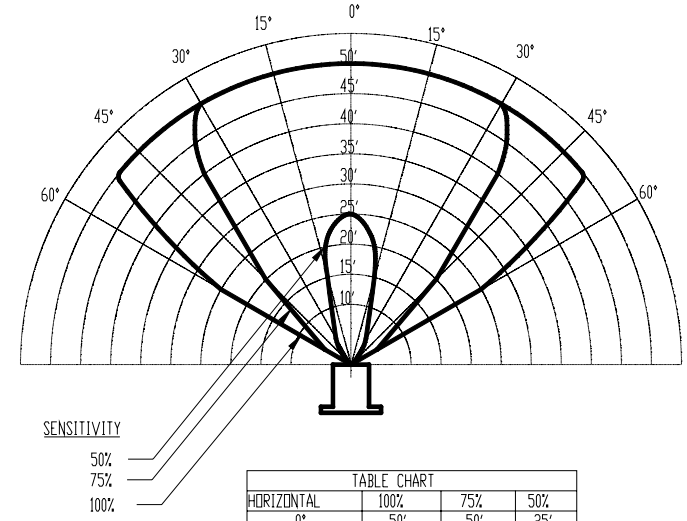

TABLE CHART			
HORIZONTAL	100%	75%	50%
0°	50'	50'	25'
+/-15°	50'	50'	15'
+/-30°	50'	50'	<5'
+/-45°	50'	20'	<5'
+/-60°	25'	<5'	<5'

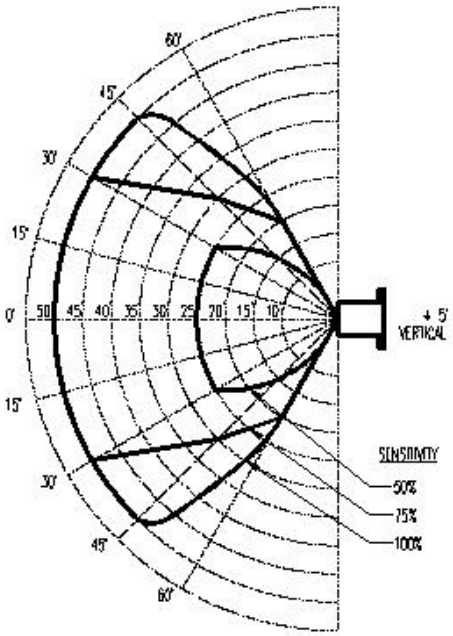

TABLE CHART			
VERTICAL	100%	75%	50%
0'	50'	50'	25'
+/-15'	50'	50'	25'
+/-30'	50'	50'	25'
+/-45'	50'	30'	<15'
+/-60'	20'	<15'	<5'

Fig. 7 FlameGard 5 UV/IR Detector Field of View

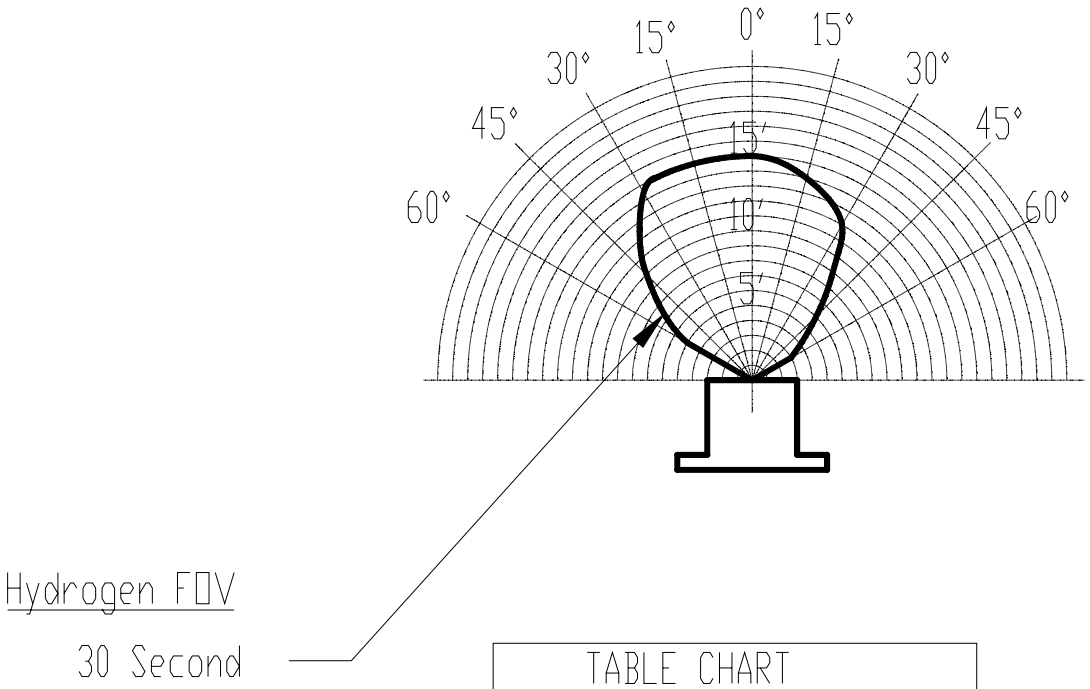

TABLE CHART	
ANGLE	30 SEC
+60°	3'
+30°	12'
0°	15'
-30°	15'
-60°	5'

Fig. 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 9, 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.

In the following drawings, the values without brackets are given in inches, those in brackets in mm.

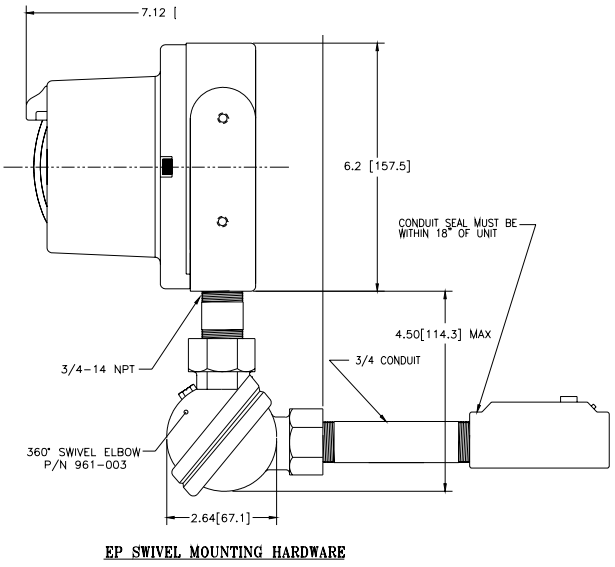

Fig. 9 Swivel Elbow Drawing

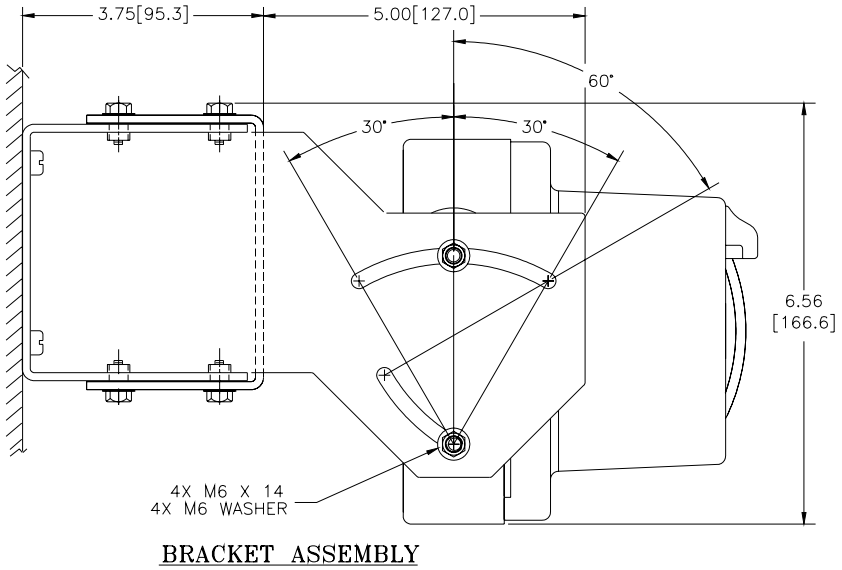

Fig. 10 Side View Mounting Bracket Drawing

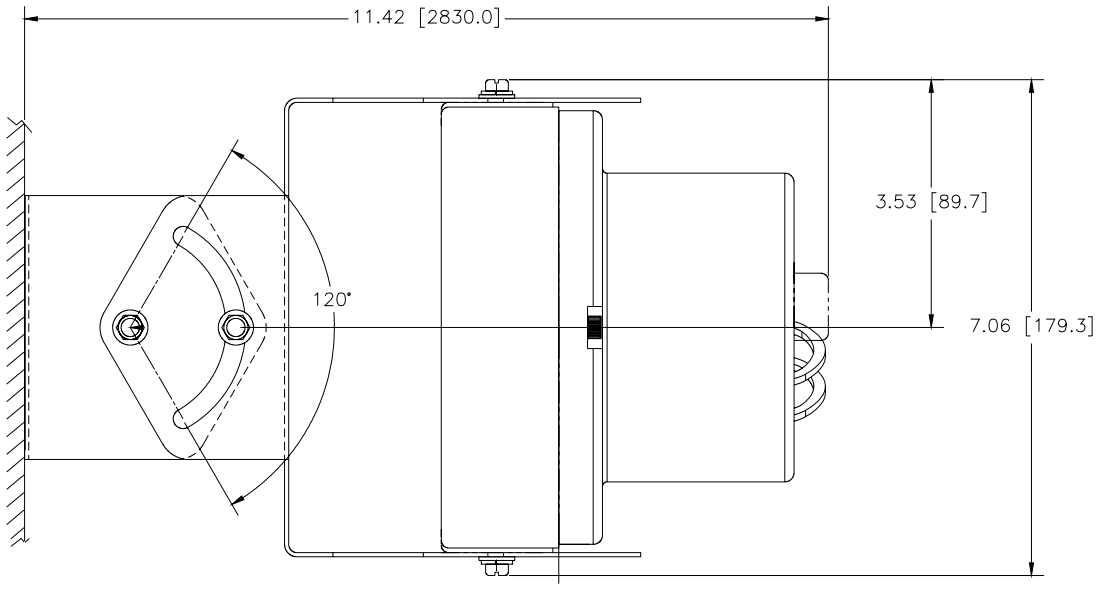

Fig. 11 Top View Mounting Bracket Drawing

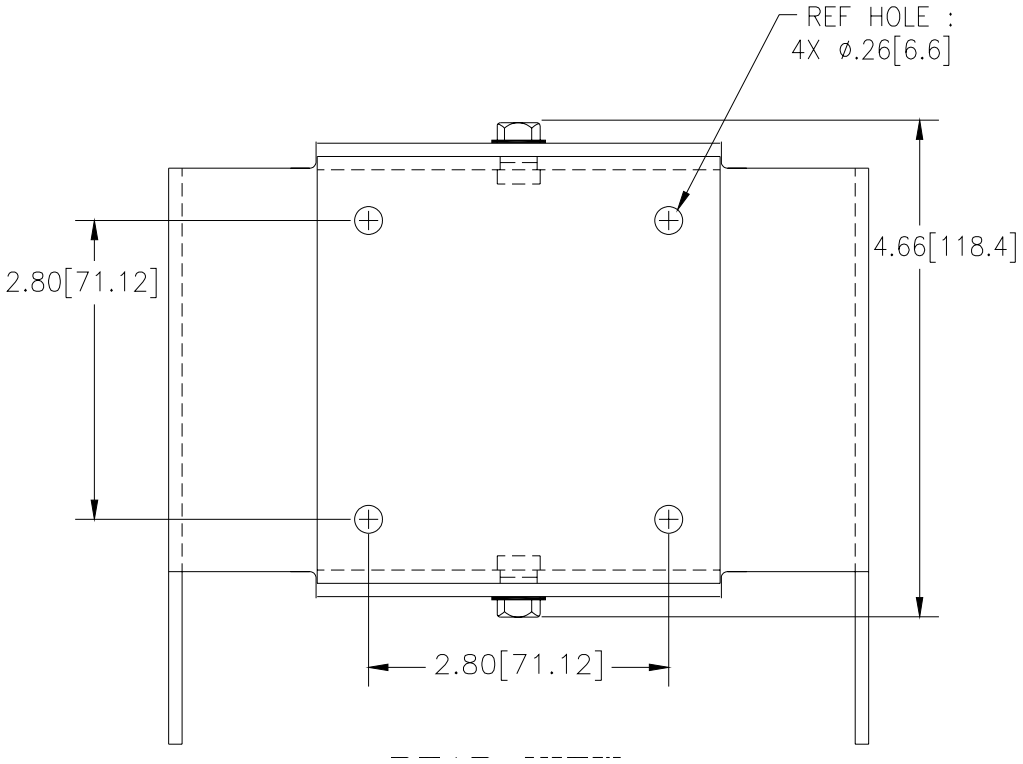

Fig. 12 Rear View Mounting Bracket Drawing

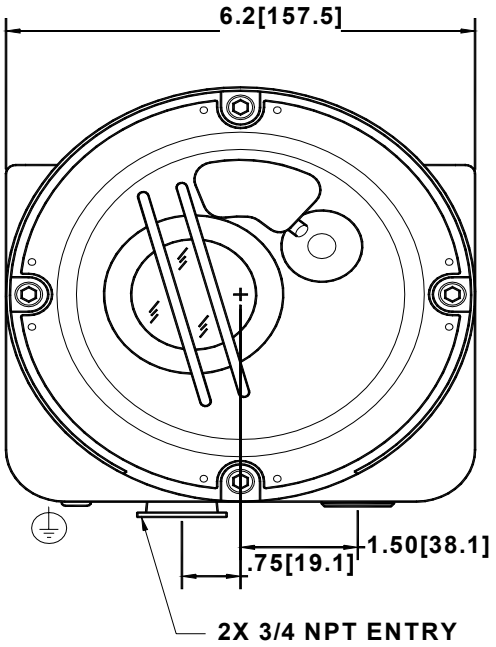

Fig. 13 FlameGard 5 UV/IR Outline Drawing

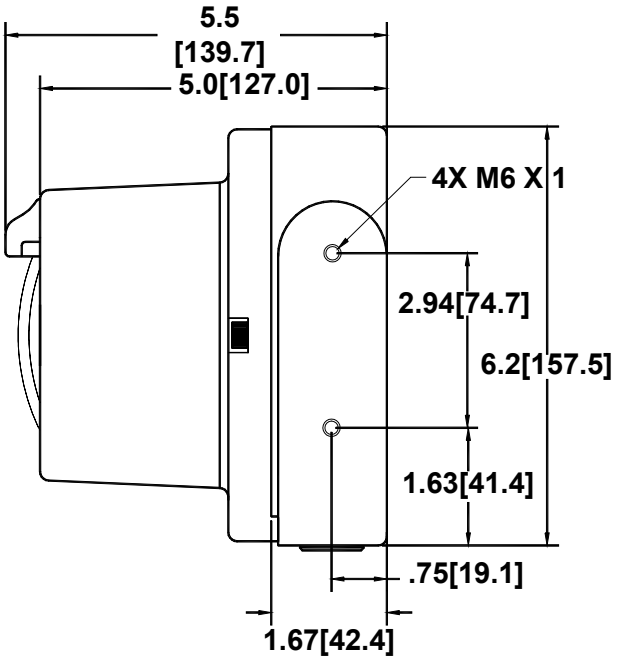

Fig. 14 FlameGard 5 UV/IR Outline Drawing

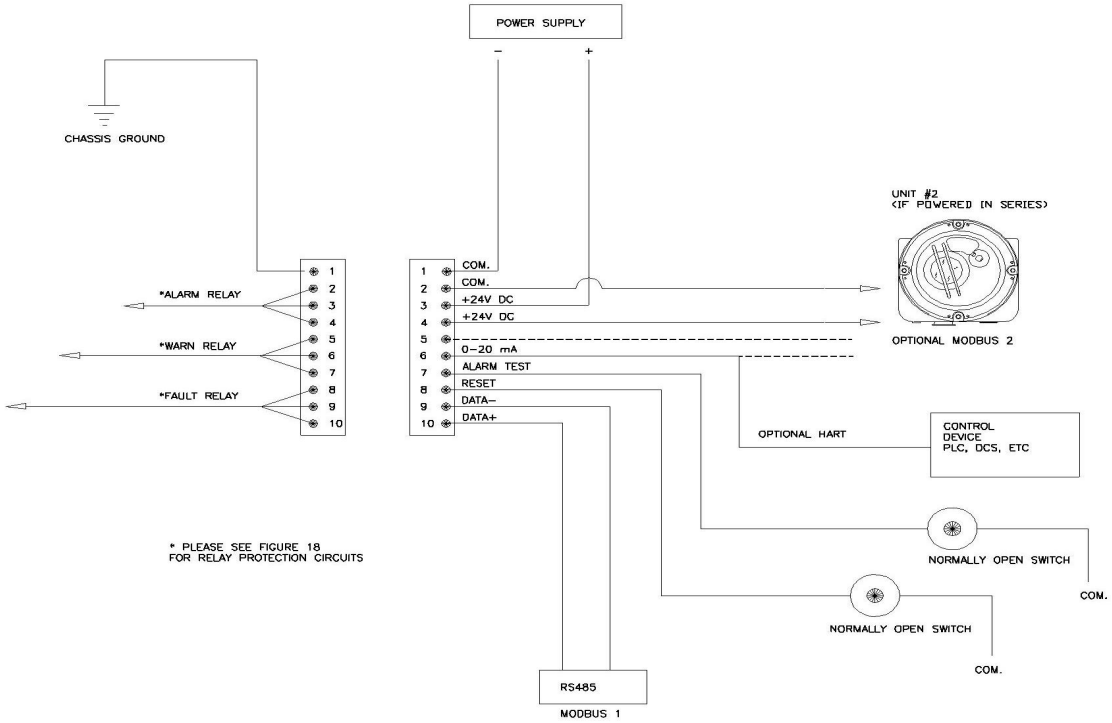

Fig. 15 FlameGard 5 UV/IR Field Terminations

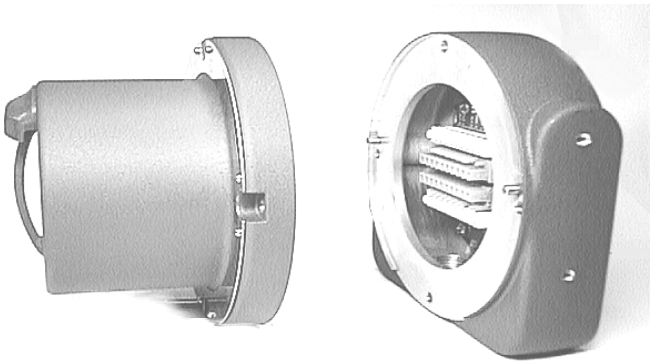

Fig. 16 Detector Housing and Base

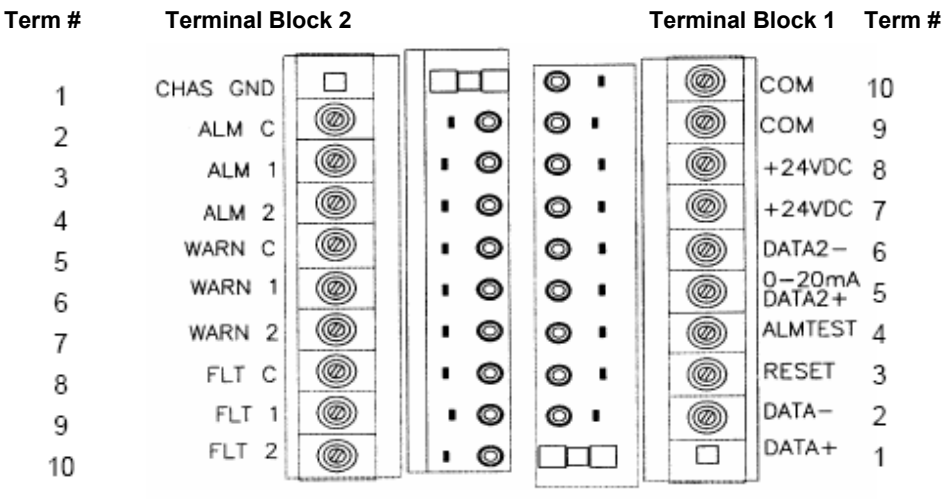

Fig. 17 Terminal Block Operation

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 (Fig. 17. The terminal block accepts 14 AWG to 22 AWG (2.1 to 0.3 mm^2) 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 Fig. 16 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).

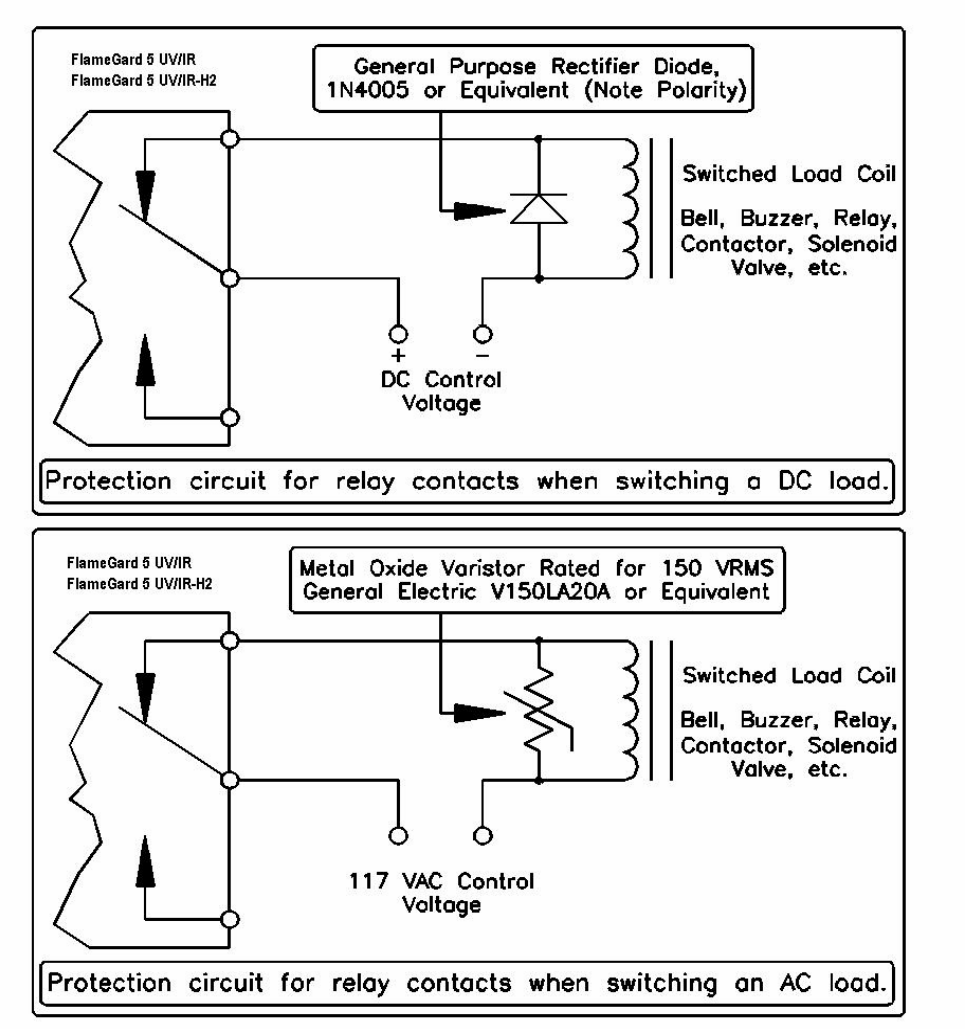

Fig. 18 Protection Circuits for Relay Contacts

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.

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 MODBUS documentation 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 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

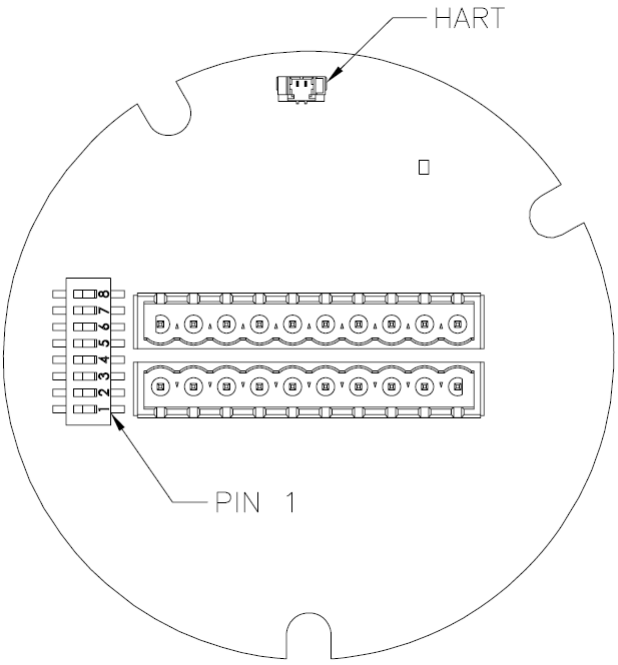

Fig. 19 DIP switch Location

5.0 Modbus Serial Communications

See Modbus Specifications for detailed information on Modbus RTU protocol.

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	Numeric value	0 - 9	**Index**

Address (hex)	Parameter	Function	Data Type	Data range	Access
		Logged Event			
47	Warn Seconds Time Hi	Seconds Time Hi for warning event log entries	Numeric value	0 – 65535	**Warn**
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 for fault event log	Numeric value	0 – 65535	**Fault**

Address (hex)	Parameter	Function	Data Type	Data range	Access
	Seconds time Hi	entries			
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 12: 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.

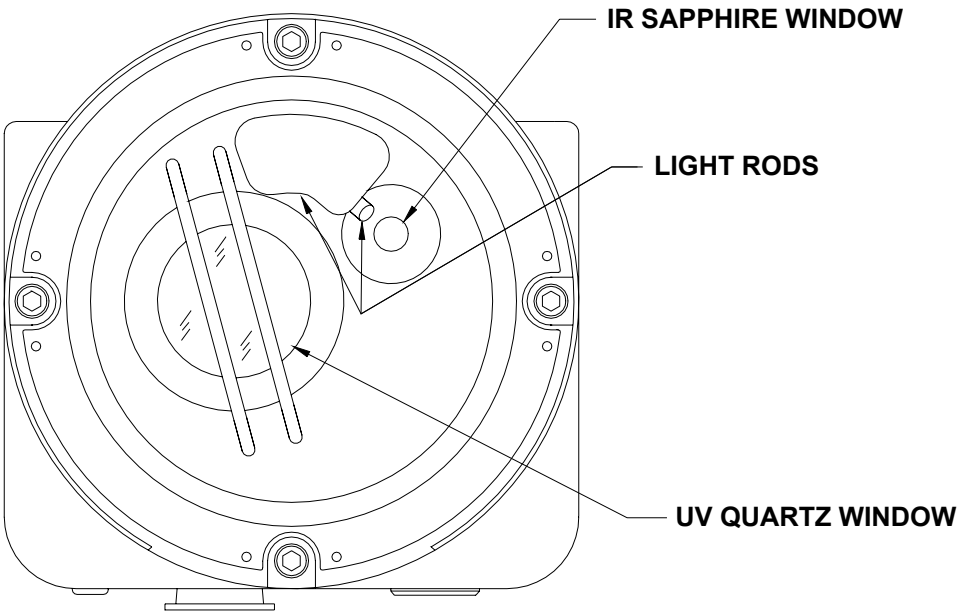

Fig. 20 UV and IR Windows

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 test lamp checks with a fully charged unit. Stand within 20 feet [6 m] (FlameGard 5 UV/IR), 40 feet [12 m] (FlameGard 5 UV/IR Hydrogen) of the unit to be tested and aim the FlameGard 5 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 is 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 will shut 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 13: Troubleshooting Table

9.0 Customer Support

9.1 MSA Office

Table 14: MSA Contact Information

Address	Phone/Web/Email
Please, contact your local MSA representative (see last page).	

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.

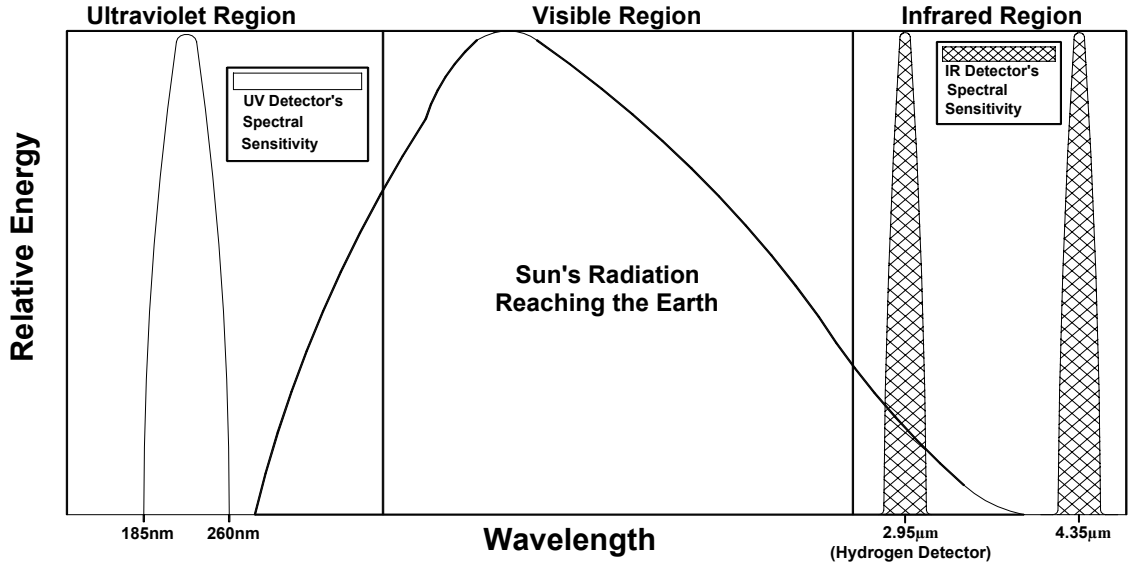

Fig. 21 Spectral Response of UV and IR Detectors

(See Sections 3.0 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)	Ex d IIC T5 Gb Ex t IIIC T100°C Db Ta = -40°C to +85°C
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)
Minimum Detector Response Times:	FlameGard 5 UV/IR Flame Detector < 500 ms
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:	*North American Approved Applications:* SPDT, 8A, @ 250 VAC, or 8A @ 30 VDC resistive max. *European Union (EU) Approved Applications:* 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 K C_X= 5 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 Accessories

10.4.1 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.

10.4.2 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.

10.5 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.

11.0 Marking, Certificates and Approvals

11.1 ATEX

Manufacturer	:	Mine Safety Appliances Company 1000 Cranberry Woods Drive Cranberry Township, PA 16066 United States of America
Product	:	**FlameGard 5 UV/IR**
Type of protection	:	EN 60079-0:2006 EN 60079-31:2009 EN 60079-1:2007 IEC 60079-0:2007 Edition 5
Measuring function for explosion protection	:	None
Marking	:	 II 2 G D Ex d IIC T5 Gb Ex t IIIC T100°C Db IP66/67 Ta = -40°C to +85°C
Options:		
EC-Type Examination Certificate	:	Sira 10ATEX1362
Quality Assurance Notification	:	????
Year of Manufacture	:	see label
Serial No.	:	see label
Special Conditions for safe use		None
EMC Conformance (**2004 / 108 / EC**)	:	EN 50130-4 , EN 61000 - 6 - 4

11.2 IECEx

Manufacturer	:	Mine Safety Appliances Company 1000 Cranberry Woods Drive Cranberry Township, PA 16066 United States of America
Product	:	**FlameGard 5 UV/IR, FlameGard 5 UV/IR-H2**
Type of protection	:	EN 60079-0:2006 EN 60079-31:2009 EN 60079-1:2007 IEC 60079-0:2007
Measuring function for explosion protection	:	None
	:	
Marking	:	Ex d IIC T5 Gb Ex t IIIC T100°C Db IP66/67 Ta = -40°C to +85°C
Options:		
EC-Type Examination Certificate	:	IECEx SIR 10.0190
Quality Assurance Notification	:	0518
Year of Manufacture	:	see label
Serial No.	:	see label
Special Conditions for safe use		None

Quality Assurance Notification	:	0158
Year of Manufacture	:	see label
Serial No.	:	see label

11.3 SIL Parameters

The FLAMEGARD UV/IR has gone through rigorous reliability and functional safety assessments, which have resulted in the flame detector 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 40ºC and an environmental factor equivalent to Ground Fixed. It is assumed that the flame detectors will be installed in a Safety Instrumented System (SIS) operating in a Low Demand environment per IEC 61508. The following table lists the Safety Integrity Level (SIL) parameters for both the non-HART and HART versions.

Field Device	Relay Output	4 – 20mA Output
MTBF (Years)	20	20
λ_{DD} (Fails per hour)	2.63E-6	2.61E-6
λ_{DU} (Fails per hour)	3.15E-9	2.65E-8
Safe Failure Fraction (SFF)	95 %	99,6 %
Safety Integrity Level (SIL)*	2	3
Diagnostic Test Interval	1 second (critical) 2 minutes (COPM)	
Typical Response Time	<3 seconds	
Average Probability of Failure on Demand PFD_{avg}1oo1**	3.51E-5	3.91E-5

* Hardware Fault Tolerance (HFT) = 0

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

Approvals

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

12.0 Final Assembly

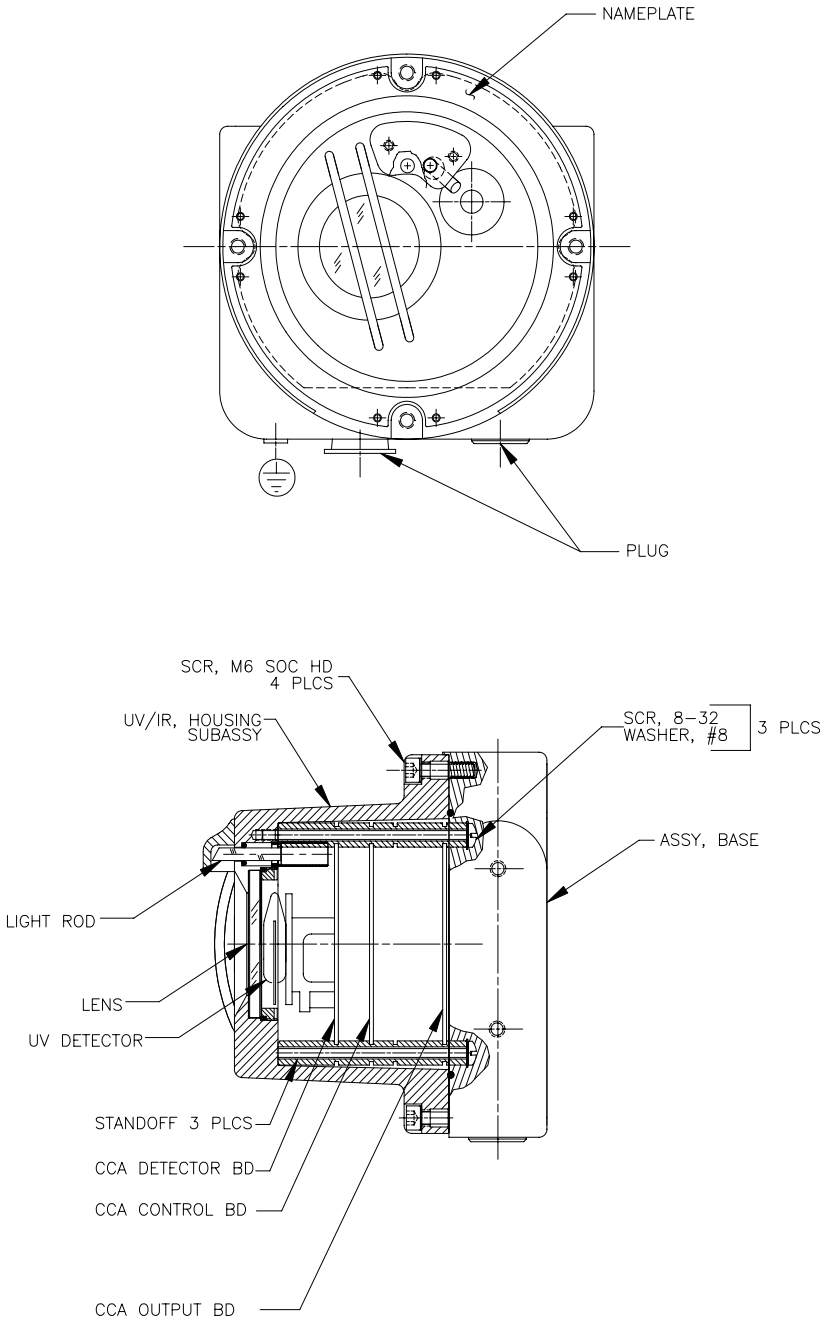

Fig. 22 FlameGard 5 UV/IR Flame Detector, Final Assembly

MSA in Europe

[www.msa-europe.com & www.msa-gasdetection.com]

Northern Europe

Netherlands
MSA Nederland
Kernweg 20
1627 LH Hoorn
Phone +31 [229] 25 03 03
Fax +31 [229] 21 13 40
info@msaned.nl

Belgium
MSA Belgium
Duwijckstraat 17
2500 Lier
Phone +32 [3] 491 91 50
Fax +32 [3] 491 91 51
msabelgium@msa.be

Great Britain
MSA Britain
Lochard House
Linnet Way
Strathclyde Business Park
BELLSHILL ML4 3RA
Scotland
Phone +44 [16 98] 57 33 57
Fax +44 [16 98] 74 0141
info@msabritain.co.uk

Sweden
MSA NORDIC
Kopparbergsgatan 29
214 44 Malmö
Phone +46 [40] 699 07 70
Fax +46 [40] 699 07 77
info@msanordic.se

MSA SORDIN
Rörläggarvägen 8
33153 Värnamo
Phone +46 [370] 69 35 50
Fax +46 [370] 69 35 55
info@sordin.se

Southern Europe

France
MSA GALLET
Zone Industrielle Sud
01400 Châtillon sur
Chalaronne
Phone +33 [474] 55 01 55
Fax +33 [474] 55 47 99
message@msa-gallet.fr

Italy
MSA Italiana
Via Po 13/17
20089 Rozzano [MI]
Phone +39 [02] 89 217 1
Fax +39 [02] 82 59 228
info-italy@
msa-europe.com

Spain
MSA Española
Narcís Monturiol, 7
Pol. Ind. del Sudoeste
08960 Sant-Just Desvern
[Barcelona]
Phone +34 [93] 372 51 62
Fax +34 [93] 372 66 57
info@msa.es

Eastern Europe

Poland
MSA Safety Poland
ul. Wschodnia 5A
05-090 Raszyn k/Warszawy
Phone +48 [22] 711 50 33
Fax +48 [22] 711 50 19
eer@msa-europe.com

Czech Republic
MSA Safety Czech
Pikartská 1337/7
716 07 Ostrava-Radvanice
Phone +420 [59] 6 232222
Fax +420 [59] 6 232675
info@msa-auer.cz

Hungary
MSA Safety Hungaria
Francia út 10
1143 Budapest
Phone +36 [1] 251 34 88
Fax +36 [1] 251 46 51
info@msa.hu

Romania
MSA Safety Romania
Str. Virgil Madgearu, Nr. 5
Ap. 2, Sector 1
014135 Bucuresti
Phone +40 [21] 232 62 45
Fax +40 [21] 232 87 23
office@msanet.ro

Russia
MSA Safety Russia
Pokhodny Proezd, 14
125373 Moscow
Phone +7 [495] 921 1370/74
Fax +7 [495] 921 1368
msa-moscow@
msa-europe.com

Central Europe

Germany
MSA AUER
Thiemannstrasse 1
12059 Berlin
Phone +49 [30] 68 86 0
Fax +49 [30] 68 86 15 17
info@auer.de

Austria
MSA AUER Austria
Kaplanstrasse 8
3430 Tulln
Phone +43 [22 72] 63 360
Fax +43 [22 72] 63 360 20
info@msa-auer.at

Switzerland
MSA Schweiz
Eichweg 6
8154 Oberglatt
Phone +41 [43] 255 89 00
Fax +41 [43] 255 99 90
info@msa.ch

European
International Sales
[Africa, Asia, Australia, Latin America, Middle East]

MSA EUROPE
Thiemannstrasse 1
12059 Berlin
Phone +49 [30] 68 86 55 5
Fax +49 [30] 68 86 15 17
contact@msa-europe.com

MSA
The Safety Company