

E²T QUASAR Flare Monitors

M8100PM-EXP • M8100FM-EXP • M8100SM-EXP



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1 General

1.1 Information about the user manual

This manual provides important information that can be used as a work of reference for installing, operating, maintaining, aligning, and/or troubleshooting your LumaSense Instrument. It is important that you carefully read the information contained in this manual and follow all safety procedures before you install or operate the system. To avoid handling errors, keep this manual in a location where it will be readily accessible.

1.1.1 Legend



Note: Indicates tips and useful information in this manual. All notes should be read to effectively operate the instrument.



Caution: Denotes information critical to avoiding instrument damage or a severe impact to processing. **When this symbol is found on the instrument it indicates a potential hazard. Consult the documentation before proceeding with any actions.**



Warning: Denotes information critical to avoiding personal injury, such as when an electrical hazard is present. **When this symbol is found on the instrument it indicates a potential hazard. Consult the documentation before proceeding with any actions).**



Protective Earth Ground connection.



Caution Must be Followed: reference supplied documents.



Electric Shock Hazard: disconnect service before opening.



Voltage Alternating current (VAC).



Voltage Direct Current (VDC).

1.2 Safety

This manual provides important information on safely installing and operating your LumaSense Instrument. Several sections of this manual provide safety warnings to avert danger. These safety warnings are specified with a warning symbol. You must read and understand the contents of this manual before operating the instrument even if you have used similar instruments or have already been trained by the manufacturer.

It is also important to continually pay attention to all labels and markings on the instrument and to keep the labels and markings in a permanent readable condition.

See **Chapter 10 Safety Assurances and Precautions**, for more information.

1.2.1 Explosion Proof Housing

The housing is designed to meet the explosion-proof requirements of the National Fire Protection Association (NFPA) Article 500 for hazardous locations. This Instrument holds both CSA International and European (ATEX) certifications.

To ensure safe operating conditions, it is recommended that you review the certification and area classifications that pertain to this system:

Reference

- **Appendix B, Area Classification/Protection Concepts**
- **Appendix C, Declaration of Conformity/Certificate**



Warning: Service personnel shall be qualified to install and service electrical equipment designed for areas classified as hazardous. At no time should the cover be removed unless power is switched off first. When it is necessary to service the instrument with the power applied, ensure proper safe environmental conditions exist and that such maintenance is authorized and pursuant to safe conditions. See **Chapter 10, Safety Assurances and Precautions**, for more information.

1.3 Limit of Liability and Warranty

All general information and notes for handling, maintenance and cleaning of this instrument are offered according to the best of our knowledge and experience.

LumaSense Technologies is not liable for any damages that arise from the use of any examples or processes mentioned in this manual or in case the content of this document should be incomplete or incorrect. LumaSense Technologies reserves the right to revise this document and to make changes from time to time in the content hereof without obligation to notify any person or persons of such revisions or changes.

All instruments from LumaSense Technologies have a regionally effective warranty period. This warranty covers manufacturing defects and faults which arise during operation, only if they are the result of defects caused by LumaSense Technologies.

See **Appendix D: Statement of Limited Warranty, New Instruments**, for more information.

1.4 Unpacking and Inspection

Before unpacking the instrument, locate the packing invoice on the outside of the carton. The invoice lists every item that was included in your shipment. Each LumaSense E²T QUASAR M8100-EXP instrument is configured to customer specifications. It is recommended that you confirm that the instrument's configuration meets expectation by carefully reviewing the packing slip details.

When unpacking and inspecting your system, you need to do the following:

- Check all materials in the container against the enclosed packing list.
- LumaSense Technologies cannot be responsible for shortages against the packing list unless a claim is immediately filed with the carrier. Final claim and negotiations with the carrier must be completed by the customer.
- Carefully unpack and inspect all components for visible damage.
- Save all packing materials, including the carrier's identification codes, until you have inspected all components and find that there is no obvious or hidden damage.
- Before shipment, each instrument is assembled, calibrated, and tested at the LumaSense Factory. If you note any damage or suspect damage, immediately contact the carrier and LumaSense Technologies, Inc.

Once you have determined the unit you received is the unit you ordered and it is in acceptable condition, it is recommended that you spend a few minutes acquainting yourself with the design and functions of the QUASAR M8100-EXP.

Be sure to reference **Chapter 10, Safety Assurances and Precautions**, before you begin installation.

1.5 Service Request, Repair, or Support

Contact LumaSense Technologies Technical Support in case of a malfunction or service request. Provide clearly stated details of the problem as well as the instrument model number and serial number. Upon receipt of this information, Technical Support will attempt to locate the fault and, if possible, solve the problem over the telephone.

If Technical Support concludes that the instrument must be returned to LumaSense Technologies for repair, they will issue a Return Material Authorization (RMA) number.

Return the instrument upon receipt of the RMA number, transportation prepaid. Clearly indicate the assigned RMA number on the shipping package exterior. Refer to **Section 1.6, Shipments to LumaSense for Repair**, for shipping instructions.

Technical Support can be contacted by telephone or email:

Santa Clara, California (U.S., Mexico, and Canada)

- Telephone (408) 727-1600 or 1-800-631-0176
- Email support@lumasenseinc.com

Frankfurt, Germany

- Telephone: +49 (0) 69 97373 0
- Email: eusupport@lumasenseinc.com

For customers requiring language assistance, please contact your local office or representative to facilitate support and repair.

1.6 Shipments to LumaSense for Repair

All RMA shipments of LumaSense Technologies instruments are to be prepaid and insured by way of preferred carrier. For overseas customers, ship units air-freight, priority one.

The instrument must be shipped in the original packing container or its equivalent. LumaSense Technologies is not responsible for freight damage to instruments that are improperly packed.

Clearly indicate the assigned RMA number on the shipping package exterior. If no RMA is indicated, shipment will not be accepted.

Send RMA Shipments to your nearest technical service center:

Customers in **North America**
should send RMA Shipments to:

Santa Clara, California

LumaSense Technologies, Inc.
3301 Leonard Court
Santa Clara, CA 95054 USA
Telephone: +1 408 727 1600
+1 800 631 0176

Email: support@lumasenseinc.com

All other customers should
send RMA Shipments to:

Frankfurt, Germany

LumaSense Technologies GmbH
Kleyerstr. 90
60326 Frankfurt
Germany
Telephone: +49 (0)69-97373 0

Email: eusupport@lumasenseinc.com

1.7 Disposal / Decommissioning

Inoperable QUASAR M8100-EXP instruments must be disposed of in compliance with local regulations for electro or electronic material.

2 Introduction

2.1 System Overview

The Quasar 8100-EXP Pilot Monitor (PM), Flare Monitor (FM), and Smoke Monitor (SM) are unique monitoring and detection instruments designed for continuous duty monitoring of Pilot Flame, Flaring and Smoke on Flares.

The heart of the LumaSense E²T QUASAR M8100-EXP Flare Monitoring System is the non-contact infrared Electro-Optical package, which can be removed from the explosion proof housing for repairs or replacement, while leaving all wiring and alignment of the system intact (see Figure 1).

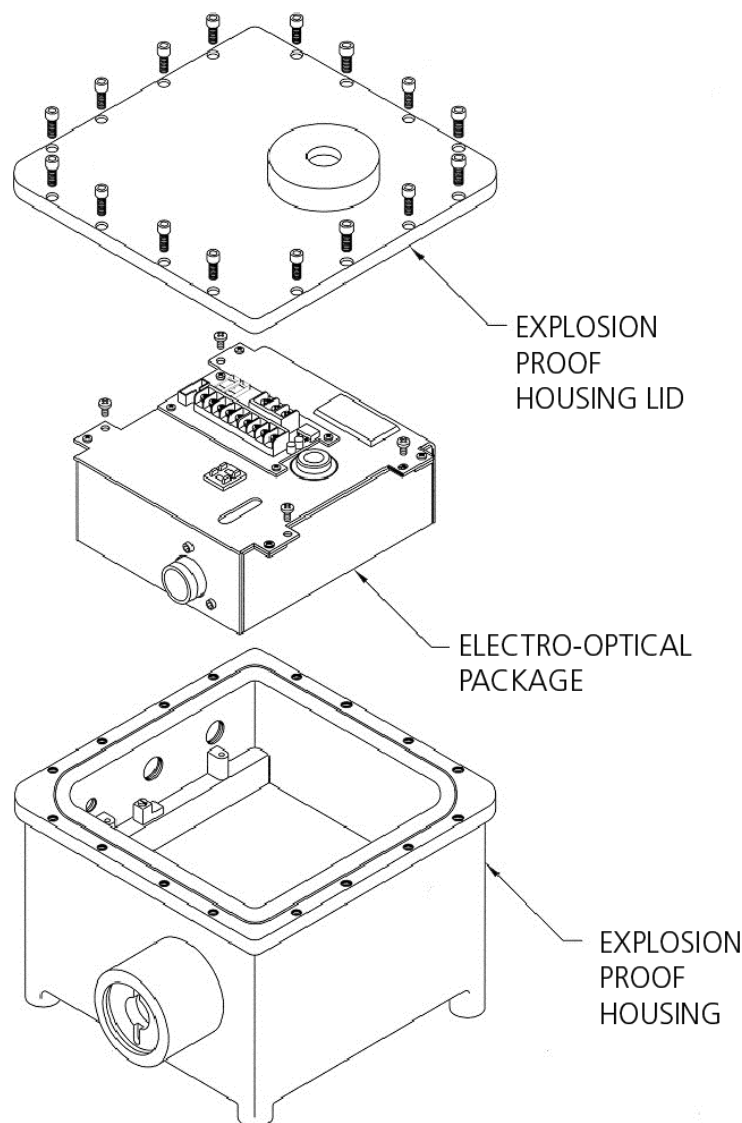


Figure 1: M8100 Housing and Electro-Optical Package

A sight-through optical system and selection of various optical resolutions (fields of view) enable the QUASAR M8100-EXP to be positioned as far as 1/4 mile (400 m) from the stack being monitored. Alignment on the target is accomplished using exceptional sight-through optics and the M-3 Heavy Duty Swivel Mount.



Figure 2: Quasar M8100-EXP

The electronics allow for target movement, varying luminosity and a range of climate conditions. The alarm contact closure delay can be adjusted for a specific location or application, eliminating false alarms due to intermittent flames, wind, and/or transitory high smoke levels. A single internally heated detector assures long-term stability and drift-free operation. The system is complete with internal cooling base, air purge tube and swivel mount. An optional adjustable pedestal stand allows for easy mounting.

2.2 System Features

Features of the QUASAR M8100-EXP Flare Monitoring System are as follows:

- Explosion-proof housing.
- 4 ... 20 mA output.
- The Quasar 8100-EXP PM & FM provide a switched 4mA (Flame) or 20mA (No Flame) switched mA output.
- The Quasar 8100-EXP SM provides a mA span determined by the flame size of the target flaring event. (Note: every span will be different for different flare applications)
- On-board ALARM set point with normally open N.O. and normally closed N.C. relay outputs. This Alarm Setpoint is delayed in the PM/FM from 2 seconds to 2 minutes. The SM system has no delay.
- Climatic compensation adjustments.
- An Electro-Optical package that is easy to remove from the explosion-proof housing, minimizing downtime and increasing reliability (see Figure 1).
- An internal heater and water/air cooler cavity for ambient temperature compensation.
- High quality sight-through optics.
- Local status indication lights.

2.3 Principle of Operation

All objects above absolute zero emit infrared energy. The amount of energy emitted is proportional to the body's temperature. The QUASAR M8100-EXP collects this energy by means of a focusing optical system concentrating the energy from a body onto a sensitive infrared detector. Specialized amplification circuitry converts the signal received by the detector into a DC level to activate relay and mA outputs for monitoring. The M8100-EXP utilizes amplitude correction circuitry which, when initially set, will automatically correct for diminishing radiation amplitude due to varying and/or adverse weather conditions.

2.3.1 Alarm Set Point

PM/FM - If the instrument detects a loss of signal fault, an adjustable delay timing circuit starts a countdown to activate a "loss of signal" alarm. This delay circuit allows for loss of signal due to wind or adverse conditions for a time period of two seconds to two minutes. This allows the monitor to reacquire the flame before an alarm signal is sent, limiting false alarms due to weather conditions. The alarm provides status by LED and Relay contacts.

SM - The alarm set point has no delay and activates in real time.

2.3.2 Relay Contacts

Denoted by their non-energized states, Normal Open (N.O.) and Normal Closed (N.C.) contacts are common to a single Relay Common (Com), also known as "single pole double throw" contacts.

4-20mA Outputs

- **PM & FM:** 4 or 20mA circuit outputs 4mA or 20mA depending on a preset signal level. Standard output provides 4mA with a flame present, 20mA without a flame present. This is a switched output.
- **SM:** mA circuit outputs a signal proportional to the relative amount of smoke detected.

2.4 Signal Path

Infrared (IR) energy is focused onto the detector through a rotating chopper wheel. The chopper wheel provides the ability to stabilize and improve noise rejection. IR filters are employed for the FM, PM, and SM models. By virtue of these select, application-specific IR filters, the desired IR energy is allowed to pass and be amplified by the detector. Filters are located on the chopper wheel for the SM and are located on the detector for the FM and PM.

The rotating chopper wheel creates a pulsing (on/off) signal, which is then selectively amplified by the detector. The detector's amplified signal is conditioned by chopper synchronized, automatic amplitude control and stabilization circuits. This allows for compensation for diminishing IR radiation due to climate conditions and is accomplished without operator intervention.

After the signal is conditioned, it is further filtered and provides the input to subsequent; relay driver, time delay and 4 ... 20mA output control circuits.

2.4.1 SM: Smoke Monitor's Dual Wavelength (2 color)

Unique to the QUASAR M8100SM-EXP is the use of 2 filters at separate wavelengths or colors. These filters located on the chopper wheel, allow the electronics to selectively amplify the IR energy of interest over the background IR energy, thus allowing the Smoke Monitor to distinguish particulate (smoke) from the background flame that is present.

2.4.2 PM: Pilot Monitor's Flame Sensitive Wavelength

The QUASAR M8100PM-EXP uses a single select filter allowing the electronics to amplify the IR energy of interests over the background IR energy. This allows the Pilot Monitor to achieve high sensitivity and dynamic range.

2.4.3 FM: Flare Monitor's Flame Sensitive Wavelength

The QUASAR M8100FM-EXP uses a single select filter allowing the electronics to amplify the IR energy of interests over the background IR energy. This allows the Flare Monitor to achieve high sensitivity and dynamic range.

2.5 Quick Installation Procedure

This quick installation procedure may be used as a checklist if you are familiar with the equipment. For complete instruction and safety precautions, refer to the appropriate sections of this manual:

- **Appendix E: Engineering Drawing 613-816, Service Connections**
- **Chapter 3, Mechanical Installation**
- **Chapter 4, Electrical Installation**
- **Chapter 10, Safety Assurances and Precautions**



Warning: Service personnel shall be qualified to install and service electrical equipment designed for areas classified as hazardous. At no time should the cover be removed unless power is switched off first. When it is necessary to service the instrument with the power applied, ensure proper safe environmental conditions exist and that such maintenance is authorized and pursuant to safe conditions. See **Chapter 10, Safety Assurances and Precautions**, for more information.

1. Installation Sight Assessment
 - a. Verify the location is within the instrument's design capabilities and that the field of view will yield acceptable performance. Refer to **Chapter 3, Mechanical Installation**, for more information.
 - b. Confirm the instrument's input power and signal output configuration is as expected.
2. Mechanical - ensure the correct air requirements are met:
 - a. View port purge
 - b. Vortex cooler (if required)
3. Focus the instrument on the target (adjust the lens).
4. Electrical - (Reference: **Section 10.2, Electrical Service Protection**):
 - a. Connect the instrument power:
 - i. The power service type is marked on the Terminal Output PC Board; verify that it corresponds to the service type being installed.
 - ii. Separate the power wires from the signal wires by routing through separate conduit ports.
 - iii. Connect the service power to TB1 on the Terminal Output PC Board.

Note: Secure power input lines together after connection to the Terminal block to prevent an accidental hazardous live condition in the unlikely event that a terminal screw becomes loose. Sleeve or tie wrapping is acceptable.

- b. Connect the instrument loops and alarm outputs:
 - i. Connect the lines as needed for Normal Open (N.O.) or Normal Closed (N.C.) relay to the corresponding locations on TB2.
 - ii. Connect the mA lines to the corresponding (MA-) and (MA+) outputs on TB2. Cable shield, if present, is NOT recommended to be connected to the instrument.
- 5. Proceed to the following chapters to complete the start-up checklist:
 - a. **Chapter 5: Pilot Monitor (PM)**
 - b. **Chapter 6: Flare Monitor (FM)**
 - c. **Chapter 7: Smoke Monitor (SM)**

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3 Mechanical Installation

3.1 Getting Started

Each LumaSense E²T QUASAR M8100-EXP instrument is configured as per customer's request. The packing slip order number matches that of the instrument's serial number. It is recommended to confirm that the instrument's configuration meets expectation, by reviewing packing slip details.

Once you have determined the unit you received is the unit you ordered and it is in acceptable condition, the unit is ready for installation. It would be a good idea to spend a few minutes "getting to know" your QUASAR M8100-EXP.

Reference: **Chapter 10 Safety Assurances and Precautions.**

3.2 Sight Assessment

Care must be taken during installation to ensure that the sun will not be seen through the optical sight path in any season or time of day. This requires that the instrument be located on a true north-south axis $\pm 45^\circ$. In the northern hemisphere, the monitor preferably should be looking toward true north, while in the southern hemisphere it should be aimed toward true south. Contact LumaSense for exceptions to these standard installation parameters.

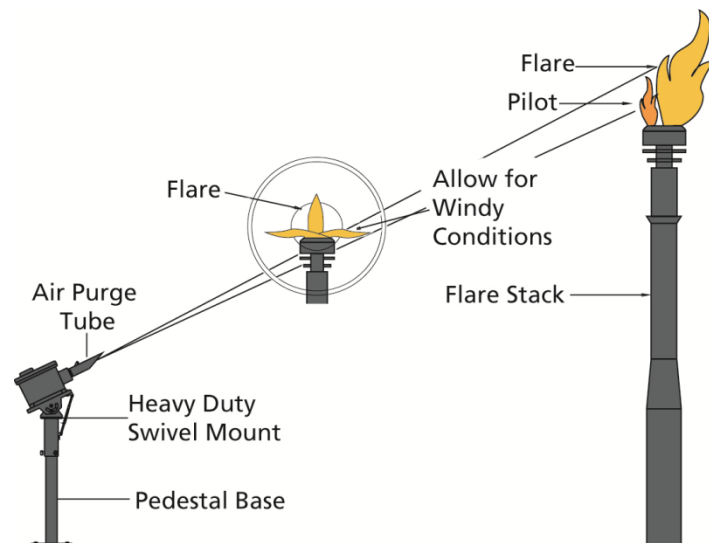


Figure 3: Field of View Concept

3.2.1 Pilot Monitor (PM) Sighting

Recommended installation distance should be equal to the height of the flare stack from the base of the flare stack. The maximum vertical angle for sighting the monitor is 45° above horizontal. (See **Appendix E Engineering Drawing 613-228**) Targeting should include the Pilot flames and have a spot size of 1.5x to 2x the flare diameter.

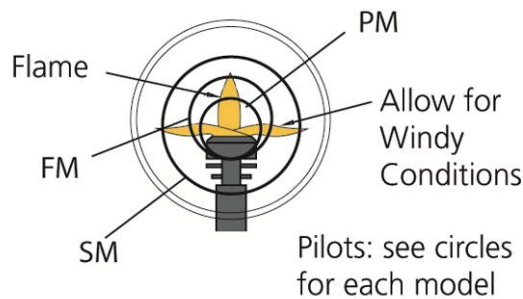


Figure 4: Field of View Concept

3.2.2 Flare Monitor (FM) Sighting

Recommended installation distance should be equal to the height of the flare stack from the base of the flare stack. The maximum vertical angle for sighting the monitor is 45 ° above horizontal. (See **Appendix E Engineering Drawing 613-228**)

Targeting should be just above the pilot flames, so that they are not included in the measurement, or if this is not possible, then the gain should be reduced until the pilot flames are not detected. The spot size of the system should be 3x to 4x the flare tip diameter.

3.2.3 Smoke Monitor (SM) Sighting

Recommended installation distance from the base of the stack is at least 1 to 2 times the stack height. The maximum vertical angle for sighting the monitor is 45 ° above horizontal. The field of view must be at least 4 to 5 times the stack top diameter when no wind is present.

3.2.4 Mounting Options

For easy mounting, alignment, and focusing on the target, a swivel mount with locking and adjusting capability is provided (LumaSense's M-3 Heavy Duty Swivel Mount). The M-3 Heavy Duty Swivel Mount can be secured on a pedestal base model M-8 using a telescoping steel pipe with a bolt down plate to secure the M-8 to a foundation. (See Figure 5) As an alternative, the M-3 Heavy Duty Swivel Mount can be installed on a client supplied 2-inch schedule 40 pipe mount.

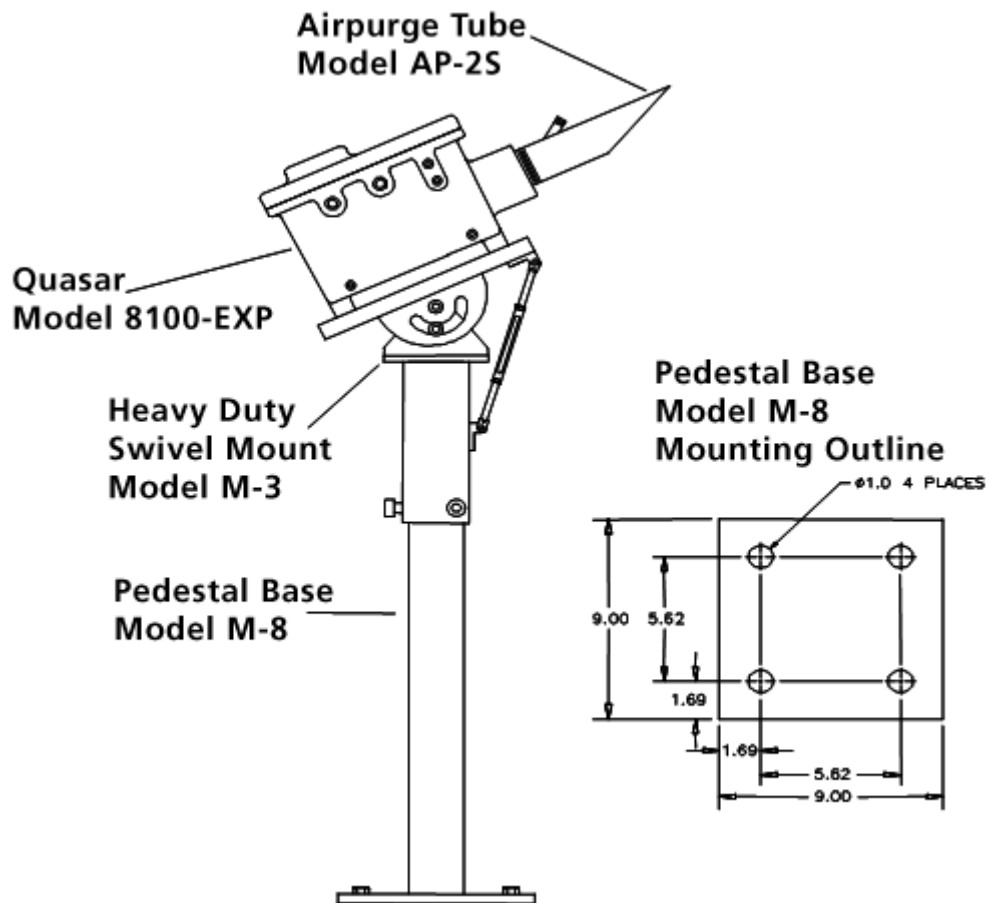


Figure 5: Pedestal Mounting Concept

3.3 Ambient Temperature Limits

The ambient operating temperature limits of the QUASAR M8100-EXP are -40 °F (-40 °C) to 120 °F (50 °C). When the internal temperature drops below 40 °F (4 °C), an internal electric heater activates to keep the internal temperature at or above 40 °F (4 °C). If the ambient temperature is expected to be below -40 °F (-40 °C), additional heating or protection for the instrument is required. If the ambient temperature is expected to be above 120 °F (50 °C), water or Vortex Air cooling is required.

3.4 Cooling Requirements

If ambient temperatures in excess of 120 °F (50 °C) are anticipated during the operation of the QUASAR M8100-EXP, cooling will be required by one of the following two methods:

3.4.1 Water Cooling

Provide cooling water at 60 °F (15 °C) maximum from a filtered source with a flow rate capable of sustaining at least 10 gallons per hour (37.8 L/h) to the cooling cavity built into the underside of the explosion-proof enclosure. This method allows operation in ambient temperatures up to 200 °F (93 °C). If the available cooling water temperature is above 60 °F (15 °C), then trial-and-error testing will have to be performed to empirically set the appropriate flow rate. The flow rate must be adequate to ensure that the electronics inside the explosion-proof enclosure do not rise above 120 °F (50 °C).



Note: The cooling cavity is isolated from internal surface of explosion-proof enclosure. See **Appendix E Engineering Drawing 613-816, Service Connections.**

3.4.2 Vortex Air Cooling

Connect a V208-15-H Vortex Air cooler to the cooling cavity built into the underside of the explosion-proof enclosure. Provide filtered, dry, compressed air from a minimum 90 psig source with a sustained flow rate capability of at least 10 SCFM to the vortex air cooler. This will result in a temperature reduction up to 27 °F (3 °C) lower than the supply air. It is not necessary to over cool the instrument. Instead, reduce the enclosure temperature to its specified operating limits by adjusting the upstream pressure to the Vortex Cooler. If over cooling does occur, the heater built into the system will activate and keep the electronics within limits.



Note: The cooling cavity is isolated from internal surface of explosion-proof enclosure. See **Appendix E Engineering Drawing 613-816, Service Connections.**

3.5 Viewport Air Purge Requirements

A source of sustained dry instrument air with a flow rate through a regulator or needle valve capable of sustaining 1 SCFM flow rate from a 20 psig or greater supply is required to keep the lens clean.

3.6 Target Size and Focusing Range

The target size of the QUASAR M8100-EXP is a function of the distance from the lens to the object under observation and the optical resolution set at the factory. The target area is a circle reticle as viewed through the QUASAR M8100-EXP's sight-through optics. The diameter of the detection area (Target Size) is represented by the reticle circle and is calculated using the formula:

$$\text{Target Size} = \frac{D}{R}$$

Where D = the distance from the lens to the target.

R = the appropriate value from the following table

The resolution of the optics is application-specific and determined at time of order.

Resolution
37.5
60
75
150
300

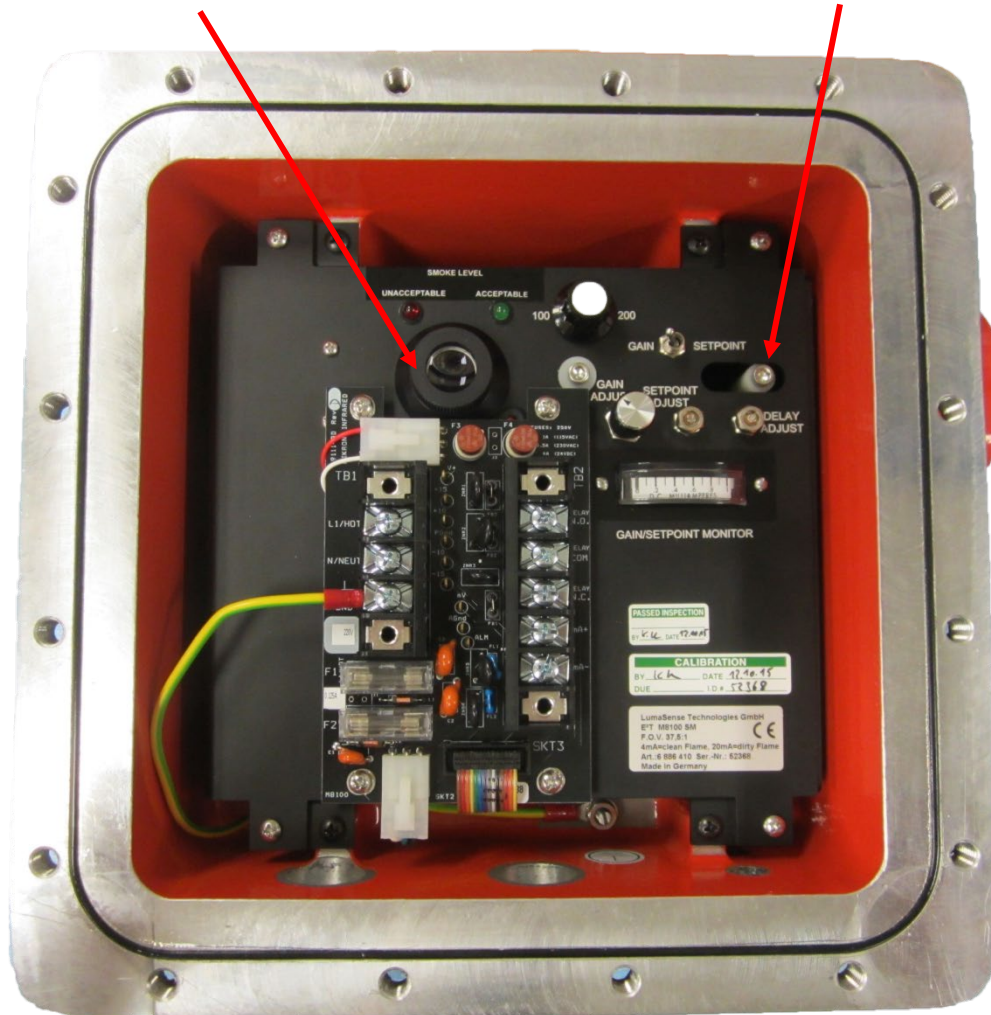
3.7 Focusing on the Target (Adjust Lens)

The objective lens locking and focusing screw and the eyepiece are both located on the top of the infrared electro-optical package inside the explosion-proof enclosure (see Figure 6).

To focus, first rotate the eyepiece lens (Figure 6, item 1) in or out until the reticle is clear and sharp. Next, slowly loosen the lens locking and focusing screw (see Figure 6, item 2). Move the objective lens (see Figure 6, item 3) in or out with the focusing screw until the target is clear and sharp. Tighten the screw; the focus is now set.

(1) Eyepiece Lens with Reticle

(2) Focus Adjust and Lens Locking Screw



(3) Objective Lens

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4 Electrical Installation

4.1 Electrical Installation Guidelines

Be sure to reference **Appendix E Engineering Drawing 613-816, Service Connections** during this procedure.

4.1.1 Conduit/Connections

Power and signal wires are fed through the 3/4 inch NPT conduit holes in the side of the housing. All wires exiting the enclosure must run through properly installed explosion-proof packing gland fittings to maintain the explosion-proof rating. Only a qualified service person should perform operations on this instrument.



Warning: The seal fittings must be located NO GREATER than 18 inches (457mm) from the instrument enclosure to maintain the explosion proof rating.



For II 2 G, EEx d IIB T4 applications, this seal must be directly at the enclosure entry.

LumaSense does not provide the explosion-proof packing gland fittings required for installations since client standards vary as to the brand or type of explosion-proof packing gland fittings required for installations. Additionally, states and countries have different standards, making it very difficult for LumaSense to stock the proper fittings.

Flexible conduit of sufficient length must be used from the housing explosion-proof packing gland fittings to the hard conduit or junction box to enable movement of the unit on the pedestal.

All power and signal connections are made on the Terminal Output board mounted on the infrared electro-optical package inside the explosion-proof enclosure. Power is connected to terminal block TB1. Output signals are connected to terminal block TB2.

See **Chapter 10.2, Electrical Service Protection**, for more information.

4.1.2 Over-Current Protection/Service Switch

It is necessary to incorporate an external over-current protection device appropriate to the instrument's service and to include a disconnect switch located near the instrument. The service disconnect should be clearly marked as pertaining to this instrument.

4.2 Power Connections

Connect the input power as described in this chapter. Confirm service type and check that the instrument service markings correspond to expectations. When wiring, follow local code regulations. Secure power input conductors together after connection to terminal block to prevent an accidental hazardous live condition in the event a terminal screw becomes loose. Sleeve or tie wrapping is acceptable. Check to ensure power is not accidentally connected to the low voltage I/O terminal block TB2.

4.2.1 Service Markings

Input Power service (i.e. 120VAC, 220VAC, 24VDC) and Fusing type are factory set and marked on the Terminal Output PCB (See Figure 7).

4.2.2 Protective Ground Connection



Connect the protective Earth conductor to the terminal lug located inside the housing as indicated by the symbol.

4.2.3 Cover Attachment



Warning: At no time should the cover be removed unless power is switched off first. When it is necessary to service the instrument with the power applied, ensure that proper safe environmental conditions exist and that such maintenance is authorized and pursuant to safe conditions.

Reference **Chapter 10, Safety Assurances and Precautions**, during this procedure.

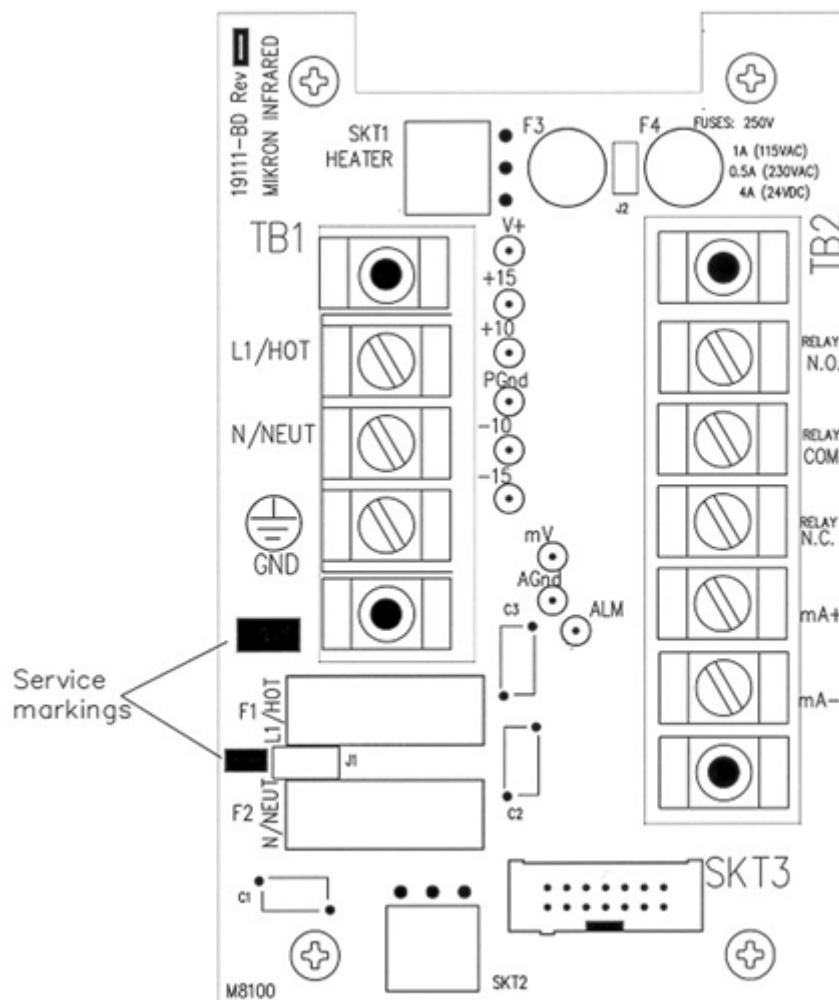


Figure 6: Terminal Output PCB Service Markings

4.2.4 Powering with 115 Volts AC~



Note: Voltage/fusing are factory set. Use a wire gauge appropriate to service installation. See **Appendix A for Power and Fuse Requirements** and **Appendix E Engineering Drawing 613-816, Service Connections**.

To connect 115 VAC to Terminal TB1:

- AC Hot to terminal labeled L1/HOT
- AC Neutral to terminal labeled N/NEUT
- AC Ground to Safety Ground stud.

4.2.5 Powering with 220/230 Volts AC~



Note: Voltage/fusing are factory set. Use a wire gauge appropriate to service installation. See **Appendix A for Power and Fuse Requirements** and **Appendix E Engineering Drawing 613-816, Service Connections**.

North American Connection, as follows to TB1:

- AC Hot1 to terminal labeled L1/HOT
- AC Hot2 to terminal labeled N/NEUT
- AC Ground to Safety Ground stud

European Connection, as follows to TB1:

- AC L1 to terminal labeled L1/HOT
- AC N to terminal labeled N/NEUT
- AC Ground to Safety Ground stud

4.2.6 Powering with 24 Volts DC



Note: Voltage/fusing are factory set. Use a wire gauge appropriate to service installation. See **Appendix A for Power and Fuse Requirements** and **Appendix E Engineering Drawing 613-816, Service Connections**.

To connect 24VDC to Terminal TB1:

- +24 V DC to terminal labeled 24 V DC
- 24 V Return to terminal labeled RTN
- Ground to Safety Ground stud

4.3 Fusing

4.3.1 Mains

Two fuses, F1 and F2, are each mounted within fuse holders on the Terminal Output PC Board, located directly under TB1.

- F1 is used for all power configurations.
- F2 is used only in 220 / 230 V AC applications.



Note: The factory installed F2 bypass jumper J1, is hardwired for 110 V AC and 24 V DC systems. Refer to **Appendix A for Power and Fuse requirements**.

4.3.2 Heater

Two fuses, F3 and F4, are each mounted within fuse holders on the Terminal Output PC Board located near the Heater connector SKT1.

- F3 is used for all power configurations.
- F4 is used only in 220 / 230 V AC applications.



Note: The factory installed F2 bypass jumper J2, is hardwired for 110 V AC and 24 V DC systems. Refer to **Appendix A for power and fuse requirements** and **Appendix E, drawing 613-816, Service Connections**.

4.4 Connection for mA Output

The mA current loop is a self-powered output for recorders or controllers requiring current loop feedback. The QUASAR M8100-EXP supplies its own 4 ... 20mA current to a load. The 4 ... 20mA output is isolated from the Power ground. Loads up to a maximum of 400 ohms may be connected in SERIES. Once connected, voltage measured between mA outputs and Chassis GND (common mode) should not to exceed 20 V DC.

A shield is recommended, however do not connect the shield to the instrument's GND, connect it only to the Chassis GND.



Caution: Refer to **Chapter 10, Safety Assurances and Precautions** before connecting the 4 ... 20mA loop to the terminal.

Connect the mA lines to the corresponding (MA-) and (MA+) outputs on TB2.

- Positive mA to mA+
- Negative mA to mA-

4.5 Connecting the Set Point Relay

The set point relay provides a dry contact closure with a normally open and normally closed output. The relay is rated 1 amp resistive to 120 V AC max.

Connect the relay to terminal TB2 as follows:

- Relay COMMON to COM
- Relay NORMALLY OPEN to N.O.
- Relay NORMALLY CLOSED to N.C.

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5 Operating the M8100PM-EXP

This section covers the start-up procedures for operating the flare stack Pilot Monitor after the unit has been installed in accordance with **Chapters 3** and **Chapter 4**. To provide insight into the logic behind the procedure, some background on the field operation of the instrument is provided.

The Pilot (flame) Monitor is designed to continuously monitor the presence of a pilot flame under varied environmental and changing weather conditions. It reports the presence of a flame via a 4 mA or 20mA current output; low current signal when Flame is detected, and high level current (alarm) when No Flame is detected.

Setup of the Pilot Monitor is best performed during adverse weather conditions (cloudy/windy) so that the adjustments will produce the highest dynamic range. This is achieved by setting the highest gain without putting the instrument into a self-oscillation condition. The delay setting is optimized under windy conditions so that false alarms are minimized.

Two possible adjustments enable the operator to optimize instrument performance based on the environmental and weather conditions of the given installation. The instrument will 'see through' maximum obstruction when utilizing both of these gains at their highest settings possible.

- The System Gain compensates for smaller target at longer ranges.
- The Climate Compensation set point compensates for adverse weather conditions.

Field experience has proven that dense fog, heavy snow, and severe sandstorms absorb infrared energy, so closer placement of the instrument may be necessary if setup cannot accommodate these conditions.



Note: Refer to Figure 8: Instrument Aiming Concepts and Figure 9: Opto-Electronics Module for the following start-up procedure.

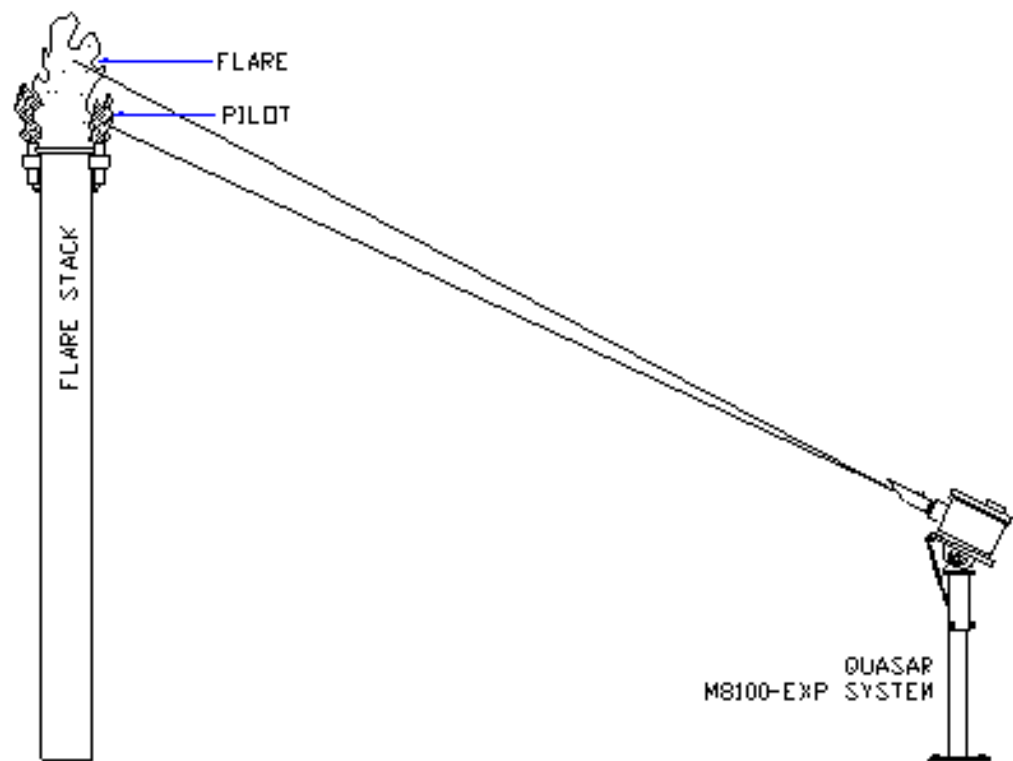


Figure 7: Instrument Aiming Concept

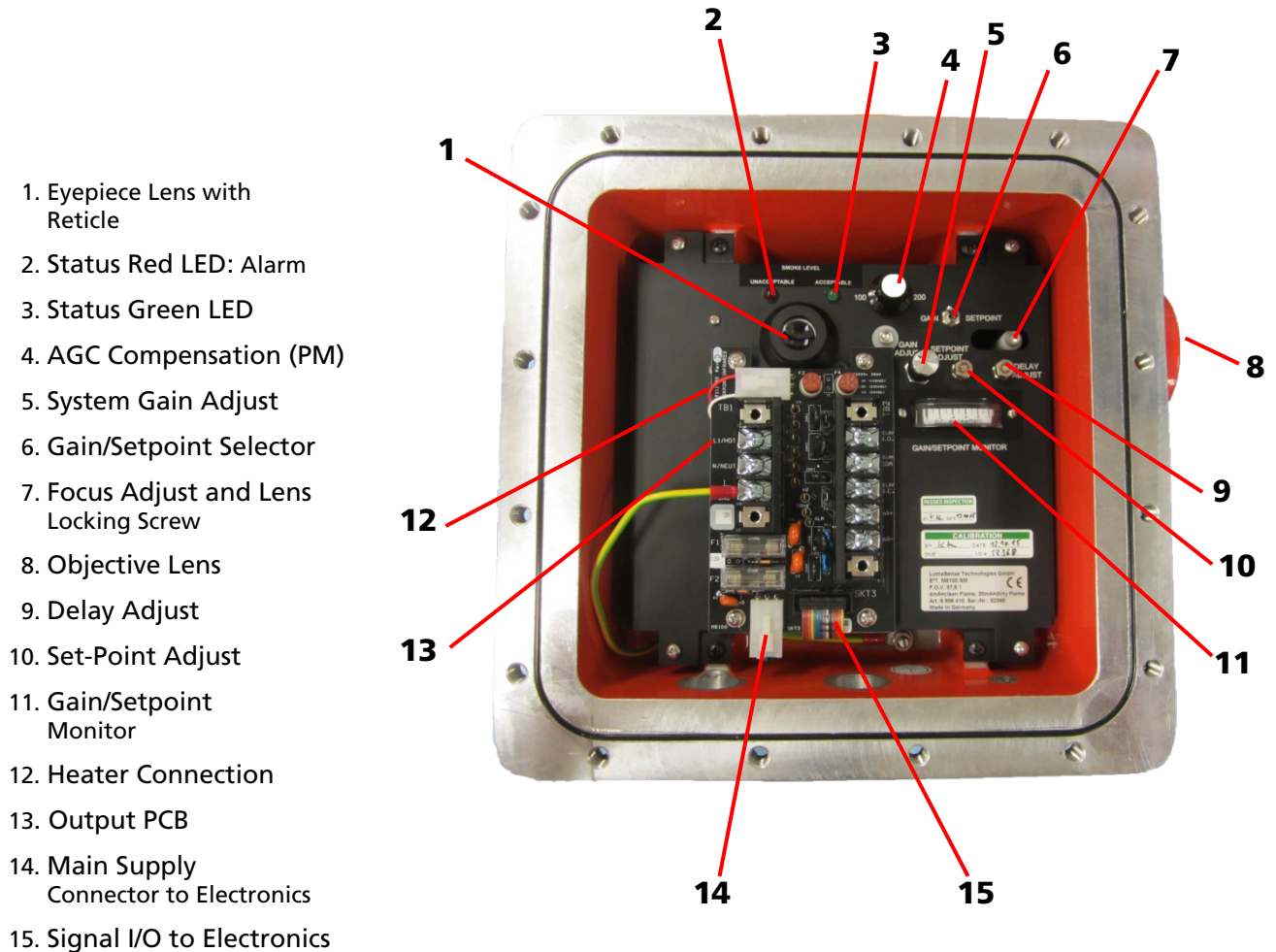


Figure 8: Opto-Electronics Module

5.1 Start-Up Operation Checklist, Pilot Monitor (PM)



Warning: At no time should the cover be removed unless the power is switch-off first. When it is necessary to service the instrument with the power applied, ensure that proper safe environmental conditions exist and that such maintenance is authorized and pursuant to safe conditions.

5.1.1 Getting Started

1. Remove the top cover and sixteen M8 x 1.25 socket head screws.
2. Ensure that the sight path is clear.
3. Ensure that the optics are properly focused on the target (See Sections 3.2, 3.6, and 3.7).
4. Verify that the proper power and signal connections have been made as per **Chapter 4, Electrical Installation**.



Caution: Ensure that safe conditions exist before applying power to the instrument. Allow at least 30 minutes of warm-up time before proceeding.

5.1.2 Initial Control Settings

(Item numbers refer to and Figure 9: Opto-Electronics Module)

1. Adjust all Pots to full counterclockwise (Items: 5, 9, 10).
2. Set Climatic Compensation Selector Switch (Item 4) at 100X.
3. Move the Gain/Setpoint Switch (Item 6) to Setpoint position.
4. Verify the Setpoint Adjust Pot (Item 10) is set for 0.6 on analog meter (Item 11).
5. Move the Gain/Setpoint Switch (Item 6) to Gain position after step 4 is accomplished.



Note: When first powered up, the instrument will show a Green LED on even when no signal is present on meter. This occurs while the Delay circuit is charging and will switch to Red LED (flame lost status) on, in approximately 2 seconds with the Delay pot adjusted fully counterclockwise.

5.1.3 Delay Setting

The Delay setting postpones the Alarm condition once the set-point value is exceeded. This can prevent false alarms from varying conditions or wind.

- Once the instrument is aimed at the pilot flame and the Three-Way Switch is set to 100X, adjust the Delay Pot (item 9) to achieve the desired delay response.
- To verify settings, simply block the sight path by covering the Objective lens (item 8) and time the delay for the red LED to turn on.



Note: Full clockwise for maximum delay (approximately 2.0 minutes).
Full counterclockwise for minimum delay (approximately 2 seconds).

5.1.4 System Gain/Climate Compensation

Optimize these two gain settings by performing the following (See Figure 9, Opto-Electronics module):

- For System Gain, adjust item 5
- For Climate Compensation, switch item 4

The purpose is to maximize the System Gain without observing excessive oscillation (noise) on the analog meter.

5.1.5 Oscillation on the Analog Meter

Some minor fluctuations on the analog meter are acceptable as long as they do not exceed +/- .5 meter units.

Red/Green LED Indicators:

When the analog meter reading falls below the setpoint (0.6 on meter), the red LED "Flame Out Alarm" will light after the delay has timed out. The green LED will go out.

5.1.6 Noise Amplification

Once setup adjustments have been completed, confirm that the flame signal, and not the noise, is being amplified. Check for noise application.

To check for Noise Amplification:

1. Completely cover the objective lens.
2. Ensure that the red LED activates with the anticipated delay time. If the red LED fails to activate or there is repeated green-red-green-red "chatter," then too much noise is being amplified. In such cases, the following steps should be taken:
 - a. Keep the delay set at the present value and adjust the System Gain (Figure 9, item 5) counterclockwise no more than two complete turns, just until the "chatter" stops. Be sure to keep track of the number of turns. If the chatter stops, proceed to step b. if chatter doesn't stop, proceed to step c.
 - b. Verify that the analog meter remains above .9 while aiming at the flame. The procedure is now successfully completed (Proceed to Section 5.1.7 Relay Contacts).
 - c. Return the System Gain to its original setting.
 - d. Reduce the Climate Compensation by selecting the next lower setting on the Switch. (i.e. 200x to 150x, 150x to 100x).
 - i. Check for noise amplification. If noise amplification has stopped, go to step 3.
 - ii. If noise continues, return the Climate Compensation switch to its original setting and proceed to step 5.
3. Verify that the analog meter remains above .9 while aiming at the flame.
4. Verify that the analog meter remains at or below .35 when the objective lens is covered. If this cannot be accomplished, then:
 - a. Manually adjust the gain no more than two complete turns to achieve acceptable meter readings.
 - b. Verify that noise amplification has not returned. If the noise has returned, proceed to step 5.
 - c. If noise has not returned, the procedure is completed. (Proceed to Section 5.1.7 Relay Contacts).
5. Reduce the delay time and repeat the above procedure.
 - a. If noise amplification continues, repeat the setup adjustment procedures starting at **Section 5.1.4 System Gain/Climate Compensation**.
 - b. If problems persist, contact the factory for further technical assistance. (Refer to **Section 1.5** for details).

5.1.7 Relay Contacts

Check the relay contacts at the instrument's Terminal Output board. N.O. and N.C. contacts are both available simultaneously. Verify that the desired polarity is obtained during an alarm condition.



Note: Make note of the contact position when the instrument power is interrupted or shut-off. The relay is energized when the green LED is lit. It is not energized during an alarm or power loss.

5.1.8 Delay Adjust

The Delay Adjust (Figure 9, Item 9) can be configured from 2 seconds (completely counterclockwise) to approximately 2 minutes (completely clockwise). The Delay Pot postpones the Alarm condition once the set-point value is exceeded. This can prevent false alarms from temporary loss of signal due to wind.

5.1.9 Milliamp Output (+mA / -mA)

Check the milliamp output signal at the instrument's Terminal Output board. The signal should be approximately 4mA when the flame is present and the analog meter reads full-scale. The signal should read approximately 20mA when flame is lost, with analog meter under .35 of scale.

Milliamp checks must be accomplished with a Milliamp meter placed in series with the control room loop or parallel across the mA+ and mA- terminals when no other connections are on the terminals.

1. Replace the top cover and the sixteen M8 x 1.25 socket head screws, torque to 30in/lbs.
2. Supply positive air flow and pressure to the air connections.
3. Verify that the temperature of the LumaSense E²T QUASAR M8100-EXP housing will not exceed 120 °F (50 °C). If cooling is required, refer to Chapter 3, Mechanical Installation.

6 Operating the M8100FM-EXP

This section covers the start-up procedures for operating the flare stack Flare Monitor after the unit has been installed in accordance with **Chapters 3** and **Chapter 4**. To provide insight into the logic behind the procedure, some background on the field operation of the instrument is provided.

The Flare Monitor is designed to continuously monitor flared gases from remote locations up to ¼ mile (400 m) away in nearly any climate condition while ignoring Pilot Flames. This makes it ideal for confirming compliance with government-set flaring time limits.

Field experience has proven that dense fog, heavy snow, and severe sandstorms absorb infrared energy, so closer placement of the instrument may be necessary if setup cannot accommodate these conditions.



Note: Refer to Figure 10: Instrument Aiming Concepts and Figure 11: Opto-Electronics Module for the following start-up procedure.

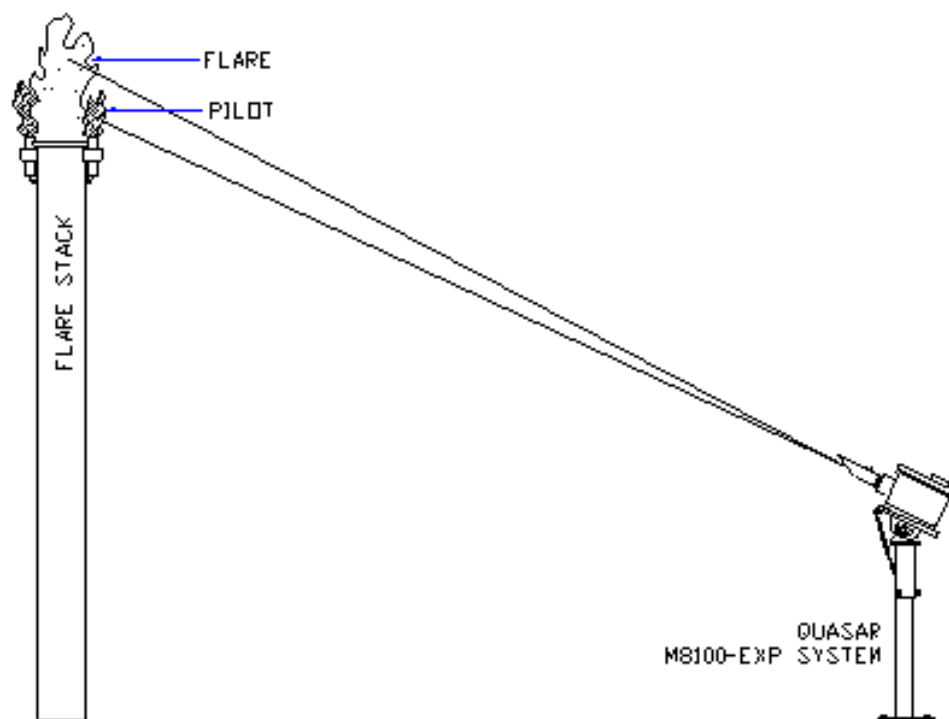


Figure 9: Instrument Aiming Concept

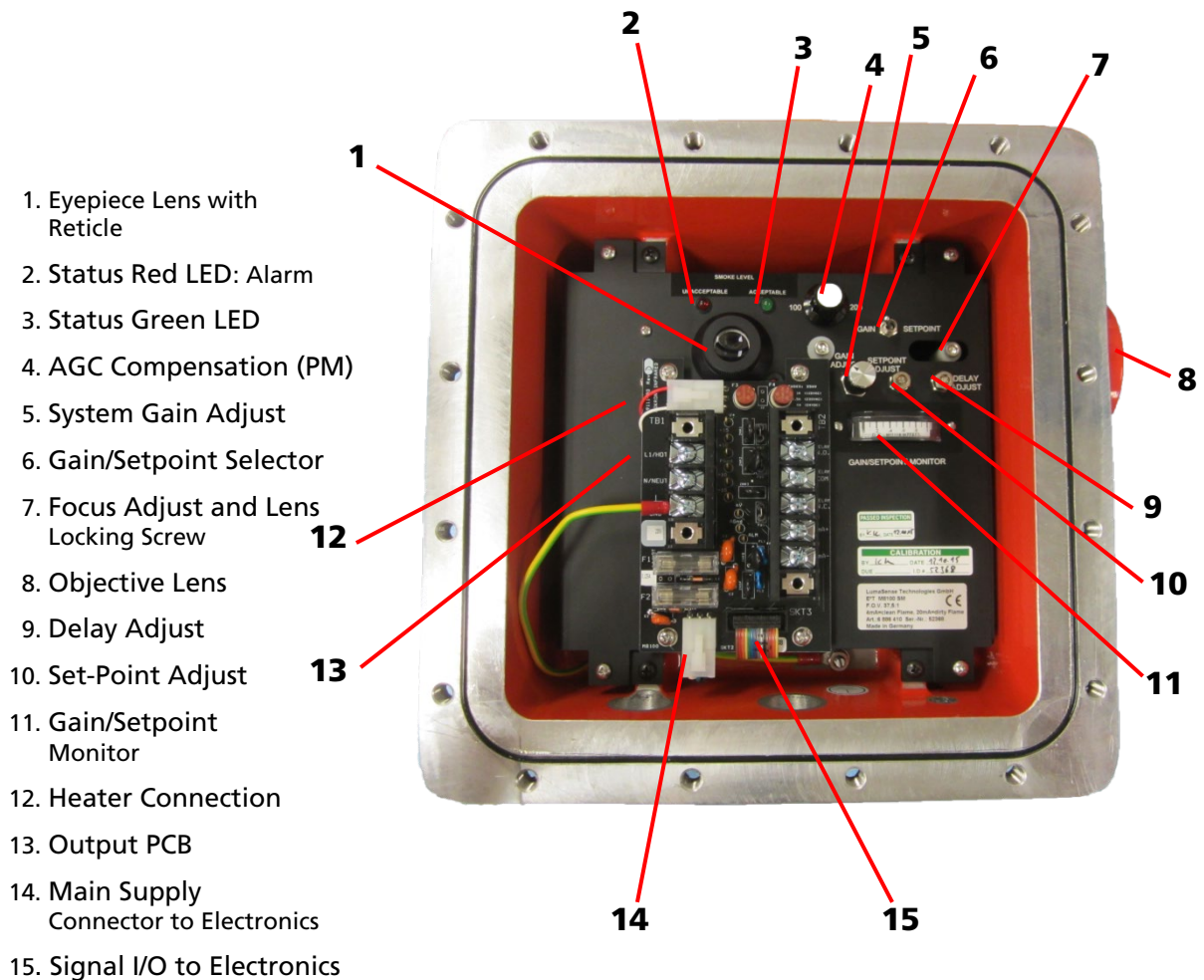


Figure 10: Opto-Electronics Module

6.1 Start-Up Operation Checklist, Flare Monitor (FM)



Warning: At no time should the cover be removed unless the power is switch-off first. When it is necessary to service the instrument with the power applied, ensure that proper safe environmental conditions exist and that such maintenance is authorized and pursuant to safe conditions.

6.1.1 Getting Started

1. Remove the top cover and sixteen M8 x 1.25 socket head screws.
2. Ensure that the sight path is clear.
3. Ensure that the optics are properly focused on the target (See Sections 3.2, 3.6, and 3.7).
4. Verify that the proper power and signal connections have been made as per **Chapter 4, Electrical Installation**.



Caution: Ensure that safe conditions exist before applying power to the instrument. Allow at least 30 minutes of warm-up time before proceeding.

6.1.2 Initial Control Settings

(Item numbers refer to and Figure 11: Opto-Electronics Module)

1. Adjust all Pots to full counterclockwise (Items: 5, 9, 10).
2. Set the Climatic Compensation Selector Switch (Item 4) at 100X.
3. Move the Gain/Setpoint Switch (Item 6) to Setpoint position.
4. Verify the Setpoint Adjust Pot (Item 10) is set for 0.6 on analog meter (Item 11).
5. Move the Gain/Setpoint Switch (Item 6) to Gain position after step 4 is accomplished.



Note: When first powered up, the instrument will show a Green LED on even when no signal is present on meter. This occurs while the Delay circuit is charging and will switch to Red LED (flame lost status) on, in approximately 2 seconds with the Delay pot adjusted fully counterclockwise.

6.1.3 Delay Setting

The Delay setting postpones the Alarm condition once the set-point value is exceeded. This can prevent false alarms from varying conditions or wind.

- Once the instrument is aimed at the pilot flame and the Three-Way Switch is set to 100X, adjust the Delay Pot (item 9) to achieve the desired delay response.
- To verify settings, simply block the sight path by covering the Objective lens (item 8) and wait for the red LED to turn on.



Note: Full clockwise for maximum delay (approximately 2.0 minutes).
Full counterclockwise for minimum delay (approximately 2 seconds)..

6.1.4 System Gain/Climate Compensation

Optimize these two gain settings by performing the following
(See Figure 11, Opto-Electronics module):

- For System Gain, adjust item 5
- For Climate Compensation, switch item 4

The purpose is to maximize the System Gain without observing excessive oscillation (noise) on the analog meter.

6.1.5 Oscillation on the Analog Meter

Some minor fluctuations on the analog meter are acceptable as long as they do not exceed +/- .5 meter units.

Red/Green LED Indicators:

When the analog meter reading falls below the setpoint (0.6 on meter), the red LED "Flame Out Alarm" will light after the delay has timed out. The green LED will go out.

6.1.6 Flare Monitor (FM)

Ensure that the Pilot flame is not in the instrument's field of view. If this is not possible, then the System Gain may have to be set lower (counterclockwise) so that the instrument does not 'see'

the Pilot flame when the Flare is not present. Complete the procedure below and be sure to refer to **Section 6.2, Considerations: Flare Monitor (FM)** at the end of this procedure.

1. Set the Climate Compensation to 100x.
2. Aim the instrument at the target flame (See Figure 10).
3. Adjust the System Gain clockwise until the analog meter remains above 0.95. The green LED (Flame Detect status) should turn on.
4. Completely cover the Objective Lens. Verify that the meter remains below .35.
5. If steps 2 through 4 above are completed satisfactorily, proceed to "Noise Amplification" below, if not proceed to step 6.
6. Set the Climate Compensation to the next higher setting (150x or 200x).
7. Adjust the System Gain so that the analog meter remains between 0.95 and 1.0.
8. Completely cover the Objective Lens. Verify that the analog meter remains below .35.
9. If step 5 through 8 above are completed satisfactorily, proceed to "Noise Amplification" below, if not proceed to step 10.
10. If a .35 to .95 range cannot be reached and Climate compensation is at maximum 200x, then repeat setup procedure starting at "Initial Control Settings." If problem persists, contact the factory for further assistance.

6.1.7 Noise Amplification

Once setup adjustments have been completed, confirm that the flame signal, and not the noise, is being amplified. Check for noise application.

To check for Noise Amplification:

1. Completely cover the objective lens.
2. Ensure that the red LED activates with the anticipated delay time. If the red LED fails to activate or there is repeated green-red-green-red "chatter," then too much noise is being amplified. In such cases, the following steps should be taken:
 - a. Keep the Delay set at the present value and adjust the System Gain (Figure 11, item 4) counterclockwise no more than two complete turns, just until the "chatter" stops. Be sure to keep track of the number of turns. If the chatter stops, proceed to step b. If chatter doesn't stop, proceed to step c.
 - b. Verify that the analog meter remains above .9 while aiming at the flame. The procedure is now successfully completed (Proceed to Section 6.1.8, Relay Contacts).
 - c. Return the System Gain to its original setting.
 - d. Reduce Climate Compensation by selecting the next lower setting on the Switch. (i.e. 200x to 150x, 150x to 100x).
 - i. Check for noise amplification. If noise amplification has stopped, go to step 4.
 - ii. If noise continues, return the Climate Compensation switch to its original setting and proceed to step 5.
3. Verify that the analog meter remains above .9 while aiming at the flame.
4. Verify that the analog meter remains at or below .35 when the objective lens is covered. If this cannot be accomplished, then:
 - a. Manually adjust the gain no more than two complete turns to achieve acceptable meter readings.

- b. Verify that noise amplification has not returned. If the noise has returned, proceed to step 5.
 - c. If noise has not returned, the procedure is completed. (Proceed to 6.1.8, Relay Contacts.)
5. Reduce the delay time and repeat the above procedure.
 - a. If noise amplification continues, repeat the setup adjustment procedures starting at **Section 6.1.4, System Gain/Climate Compensation.**
 - b. If problems persist, contact the factory for further technical assistance. (Refer to **Section 1.5** for more information).

6.1.8 Relay Contacts

Check the relay contacts at the instrument's Terminal Output board. N.O. and N.C. contacts are both available simultaneously. Verify that the desired polarity is obtained during an alarm condition.



Note: Make note of the contact position when the instrument power is interrupted or shut-off. The relay is energized when the green LED is lit. It is not energized during an alarm or power loss.

6.1.9 Delay Adjust

The Delay Adjust (Item 9) can be configured from 2 seconds (completely counterclockwise) to approximately 2 minutes (completely clockwise). The Delay Pot postpones the Alarm condition once the set-point value is exceeded. This can prevent false alarms from temporary loss of signal due to wind.

6.1.10 Milliamp Output (+mA / -mA)

Check the milliamp output signal at the instrument's Terminal Output board. The signal should be approximately 4mA when the flame is present and the analog meter reads full-scale. The signal should read approximately 20mA when flame is lost, with analog meter under .35 of scale.

Milliamp checks must be accomplished with a Milliamp meter placed in series with the control room loop or parallel across the mA+ and mA- terminals when no other connections are on the terminals.

1. Replace the top cover and the sixteen M8 x 1.25 socket head screws, torque to 30in/lbs.
2. Supply positive air flow and pressure to the air connections.
3. Verify that the temperature of the QUASAR M8100-EXP housing will not exceed 120 ° F (50 °C). If cooling is required, refer to **Chapter 3, Mechanical Installation.**

6.2 Considerations for the Flare Monitor (FM)

In the case where it is not possible to eliminate the Pilot flame completely from the instrument's field of view, it is necessary to verify that a "Flame-out" alarm will occur as expected. It is recommended that you complete the following procedure to confirm proper operation. Be sure to complete the start-up checklist procedure first. Refer to **Section 6.1** of this Chapter.

1. Ensure that the Pilot flame is present and that the Flare is in the condition where the operator wishes to see an Alarm from the instrument.

2. Verify that the instrument's red "Flame-out" alarm LED is on and that the green LED is off. If this is not the case, go to step 3 below.
3. Adjust the System Gain no more than 2 turns counter-clockwise so that the analog meter reads .35. Once adjusted, the red "Flame Out Alarm" LED should light after the expected delay. If this does not occur, proceed to step 5 below.
4. Verify that the analog meter reads at least .8 when the Flare is present. The procedure is complete. (Do not proceed to step 5.)
5. Adjust the set-point pot (Figure 11, Item 10) to be above the unacceptable condition observed in step 4 by .2 divisions on the meter.
 - a. Move the Gain/Setpoint Switch (Item 6) to the Setpoint position.
 - b. Adjust the setpoint as required; verify the Alarm LED lights.
 - c. Return the Gain/Setpoint switch to the Gain position.
 - d. Return to step 4 above.

7 Operating the M8100SM-EXP

This section covers the start-up procedures for operating the flare stack Smoke Monitor after the unit has been installed in accordance with **Chapters 3 and Chapter 4**. To provide insight into the logic behind the procedure, some background on the field operation of the instrument is provided.

The LumaSense E²T QUASAR M8100SM-EXP Smoke Monitor is designed to monitor the smoke (particulate) content in a flare flame. It reports the smoke level via a proportional current signal, higher as smoke level increases and a lower current for cleaner burning flames. Instrument setup is affected by several factors including; distance to stack, size of normal flame, color of normal flame, and type of gas used for the burners.

The goal during QUASAR M8100SM-EXP setup is to set the desired range for the installation and define the maximum acceptable smoke level directly from the flare stack being monitored. This is necessary since the instrument provides relative smoke (particulate) level information rather than an absolute quantification.

Setup of the Smoke Monitor is most easily performed under the flare stack's normal operating conditions that is, conditions which give the highest instrument output prior to an actual upset. These conditions are usually evident by emission of an intermittent primary blue and faint light orange flame (from pilots, not flared gas) and are used to set mid-scale readings of 0.5 volts on the analog meter corresponding approximately to 12 mA current output. From this benchmark, cleaner flames will go downscale and carbon (higher particulate) flames will go upscale.

Two possible adjustments enable the operator to custom set the desired mid-scale reading corresponding to each flare stack's normal operating conditions.

- The system gain precisely adjusts to a pre-upset (normal) condition.
- The climatic compensation switch for adverse weather conditions.

The following steps are based on the ability to set the Smoke Monitor to 12mA (0.5 on the analog meter) while operating the flare stack under nominal conditions.



Note: Refer to Figure 12: Instrument Aiming Concepts and Figure 13: Opto-Electronics Module for the following start-up procedure.

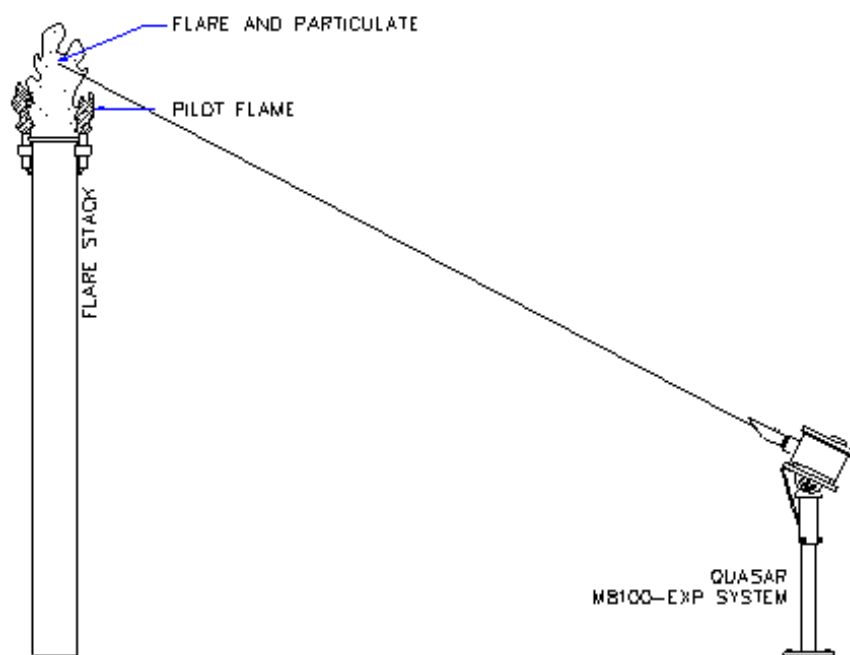


Figure 11: Instrument Aiming Concept

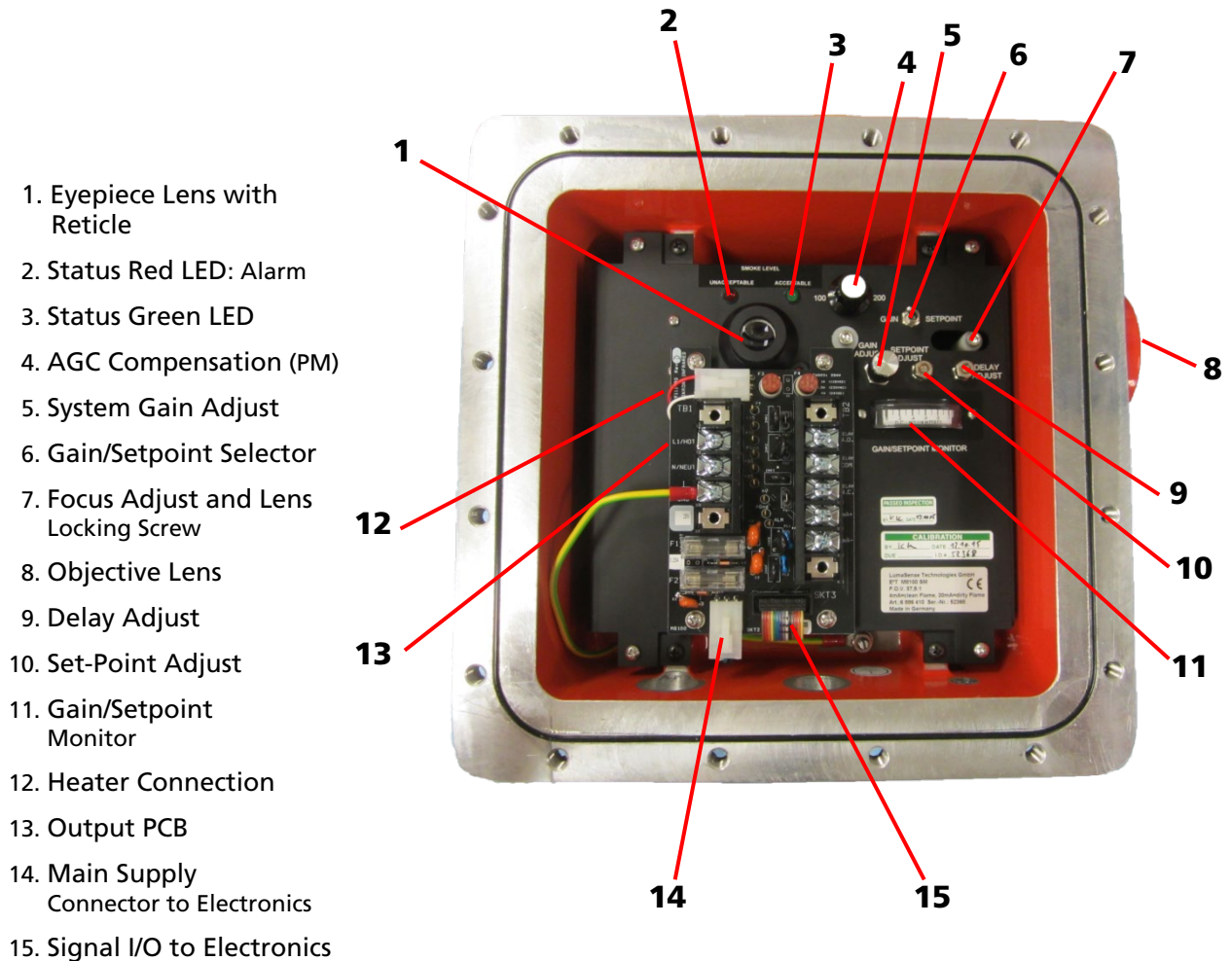


Figure 12: Opto-Electronics Module

7.1 Start-Up Operation Checklist, Smoke Monitor (SM)



Warning: At no time should the cover be removed unless the power is switch-off first. When it is necessary to service the instrument with the power applied, ensure that proper safe environmental conditions exist and that such maintenance is authorized and pursuant to safe conditions.

7.1.1 Getting Started

1. Remove the top cover and sixteen M8 x 1.25 socket head screws.
2. Ensure that the sight path is clear.
3. Ensure that the optics are properly focused on the target (See Sections 3.2, 3.6, and 3.7).
4. Verify that the proper power and signal connections have been made as per **Chapter 4, Electrical Installation**.



Caution: Ensure that safe conditions exist before applying power to the instrument. Allow at least 30 minutes of warm-up time before proceeding.

7.1.2 Initial Control Settings

(Item numbers refer to Figure 13)

1. Adjust all Pots to full counterclockwise (Items 5, 9, 10).
2. Set the Climatic Compensation Selector Switch (Item 4) at 200X.
3. Move the Gain/Setpoint Switch (Item 6) to the Setpoint position.
4. Verify the Setpoint Adjust Pot (Item 10) is set for 0.7 on analog meter (Item 11).
5. Set the Gain/Setpoint Switch (Item 6) to Gain position after step 4 is accomplished.



Note: When powered up, the instrument will show a Green LED on even when no signal is present.

7.1.3 System Gain/Climate Compensation

A normal operating condition is defined as the condition in which the flame will be operating nominally where any more intense orange flame or smoke would indicate an upset condition. System gain is set under this nominal condition such that the instrument reads mid-scale.

While operating the Flame Stack during normal conditions, aim the instrument at the flame on the top of the stack (Figure 12). Adjust the System Gain Pot (item 5) for a peak reading of approximately 0.5 (mid-scale) on the analog meter. Place your hand over the Objective lens. The analog meter should drop to slightly above zero.



Note: If the Flame 'normal' operating conditions are not achievable for this adjustment, refer to the Flame Description Note at the end of this procedure.

7.1.4 Set-point

The System Gain setup (section 7.1.3) established a reference point of .5 on the analog meter for normal operational conditions. If .5 is the acceptable condition, the operator must determine the reference point on the meter where an unacceptable condition is present, thus triggering an alarm condition.

The Set point adjustment sets the reference point for this alarm condition. A typical setting of 0.7 on the meter was set in step 4 of **Section 7.1.2**, if this is acceptable, then nothing needs to be done. If this is not acceptable, then repeat steps 3 thru 5 ONLY to adjust to desired level.

7.1.5 Relay Contacts

The Instrument can provide to the control room a separate 'loss of signal' alarm through relay dry contacts which indicates a smoke condition.

Check the relay contacts at the instrument's Terminal Output board TB2. Relay N.O. and Relay N.C. contacts are available simultaneously. Verify that the desired polarity is observed during an alarm condition. Note the Relay contact position when the instrument power is interrupted or shut-off.

7.1.6 Delay Adjust

The Delay setting postpones the Alarm condition once the set-point value is exceeded. This can prevent false alarms from the occasional, very short smoky bursts.

The Delay Adjust (Item 9) can be configured from 2 seconds (completely counterclockwise) to approximately 2 minutes (completely clockwise).

7.1.7 Milliamp Output (+mA / -mA)

The milliamp output to the control room is a constant real time (not delayed) monitor. Once System Gain is setup, the operator will have approximately an 8mA (12mA to 20mA) span indicating normal flame condition to maximum upset condition.

Check the milliamp output signal at the instrument's Terminal Output board (+mA, -mA). The signal should be approximately 12mA when the analog meter is at mid-scale (0.5 volts). Milliamp checks must be accomplished with a Milliamp meter placed in series with the control room loop or parallel across the mA+ and mA- terminals when no other connections are on the terminals.

7.1.8 Final Steps

1. Replace the top cover and the sixteen M8 x 1.25 socket head screws, torque to 30in/lbs.
2. Supply positive air flow and pressure to the air connections.
3. Verify that the temperature of the QUASAR M8100-EXP housing will not exceed 120 °F (50 °C). If cooling is required, refer to **Chapter 3, Mechanical Installation**.

7.2 Considerations for the Smoke Monitor

If you are unable to observe a normal operation or experience maximum upset conditions during installation, the infrared monitor's nominal setting can be set with the industry-wide nominal values corresponding to flame color (See Figure 14).

For example, if you only had a blue flame, but normal operating conditions specify blue flame with occasional faint orange (from pilot only); you could set the M8100SM-EXP Smoke Monitor to 0.3 on the analog meter (10mA output). The meter and mA values should then be checked when true normal operating procedures prevail to ensure 0.5 and 12mA readings are observed.

From normal operating conditions to worst case scenario (12 to 20mA), you will have approximately an 8mA spread available to monitor the flare condition. Should your normal operating condition permit continuous orange flaring with some observable carbon particulate, the estimated values in Figure 14 do not apply. Adjust as outlined above.

MOST PREVALANT WORLD-WIDE STANDARD FLARE STACK VALUES

OBSERVABLE DESCRIPTION	METER READING VALUE	mA OUTPUT VALUE
(best seen at night)		

PILOT FLAME ONLY

Blue pilots only	0.2	6mA
Blue plume	0.3	10mA
Prevailing blue flame with occasional faint orange	0.5	12mA
Intermittent light orange flame with puffs of light smoke	0.6-0.7	13-14mA

FLARING GAS

Continuous orange with smoke	0.7-0.81	14-17mA
Intense orange w/heavy smoke	0.80-1.0+	18-20mA

Figure 13: Flare Stack Values



Note: The values presented above are for reference only. Actual values may differ due to the wide variety of installations possible with this instrument.

8 Troubleshooting

8.1 Problem Isolation Checkout Procedure

This is an outline of what to do if the LumaSense E²T QUASAR M8100-EXP is not performing correctly after initial installation. Follow the procedures below to determine the problem. Do not hesitate to contact the factory for assistance. (Refer to **Section 1.5** for more information.)



Warning: At no time should the cover be removed unless the power is switch-off first. When it is necessary to service the instrument with the power applied, ensure that proper safe environmental conditions exists and that such maintenance is authorized and pursuant to safe conditions.

8.1.1 Sight Path and Optical Alignment

Ensure that the QUASAR M8100-EXP is aligned properly by looking into the eyepiece. The circular reticle in the center of the field of view should be sighted at the target. Look for any blockage in the sight path that would reduce the energy received by the QUASAR M8100-EXP.

Without a clear optical path, the infrared energy from a target cannot reach the detector. If the lens becomes smeared, smudged, or otherwise dirty, excessive attenuation of the signal may occur.

The internal optics seldom becomes dirty with normal use. Rarely will cleaning of the internal optics be necessary.

8.1.2 Power Input

Look for status LED operation; if the electronics are powered properly, one of the LEDs will be lit.

Verify that the input power is connected properly and that the ratings correspond to the instrument's rating.

See **Chapter 3, Electronic Installation**, for details on connections and rating.

8.1.3 Power Fuse

If the Power input has been checked and neither LED is on, then there is a possibility of a blown Fuse(s). This can easily be checked by inspection. Fuses marked F1 and F2 (if equipped) are located on the Output PCB just under TB1. Inspect and check for an open condition.

8.1.4 Instrument Loops

Check that the mA signal is being transmitted through the loop to the control room display. To verify the signal from the instrument, disconnect the mA control room loop wires from TB2 and check the instrument's output using a standard mA meter.

8.1.5 Stopped Chopper Wheel

The signal reaching the detector is chopped by a rotating wheel driven by a precision current motor. A forceful jolt, such as dropping the instrument or banging it, could cause the wheel to stop. This problem can be identified by the absence of the motor's characteristic whining sounds as it rotates. The output may produce a non-rising low reading even when looking at high levels. Inspect the wheel and motor for physical damage. If power is applied and the wheel will not rotate, check to see if the wheel is hanging up on any obstruction.



Caution: DO NOT attempt to bend the wheel or motor bracket. Instead, loosen the bracket mounting screws and re-adjust it slightly until free movement is obtained.

8.1.6 Broken Wire Harness



Caution: The disassembly of the Electro-Optical Package will result in the voiding of the Limited Warranty.

If the instrument appears to be working correctly but the recording or control attachments are not receiving the proper signals, the problem may be due to a broken wire in the interconnecting cables. Using field mA and mV calibrators or an ohm meter, check for continuity of all wiring.

1. Chassis Lower
2. Front End PCB
3. Power Supply PCB
4. MOVs
5. Lens Screw
6. Chassis Upper
7. Chassis Assembly Screw
8. Mounting Assembly Screw
9. Mains Fuse (s)
10. Heater Fuse (s)

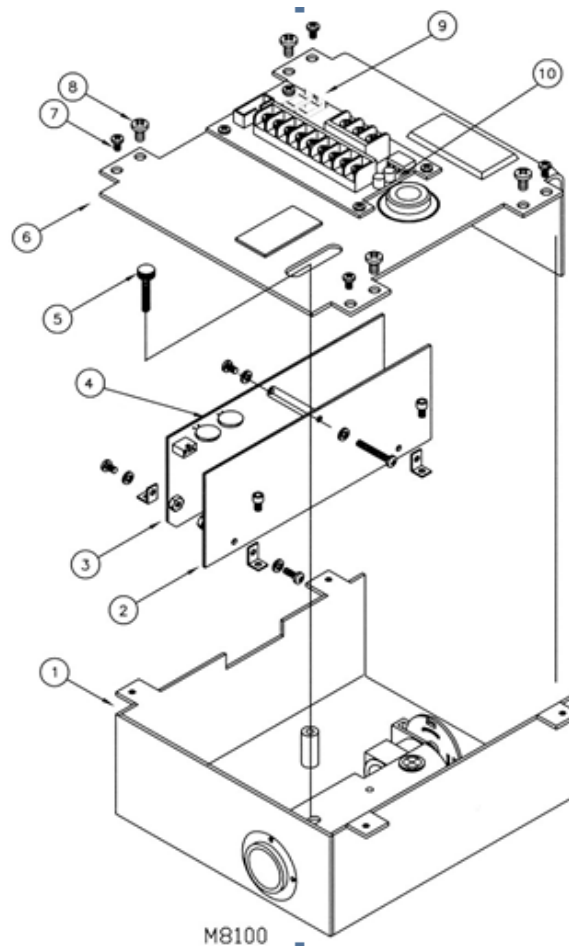


Figure 14: Electronics Assembly

8.1.7 Component Failure

Every QUASAR M8100-EXP is thermally cycled between 40 °F (4 °C) and 120 °F (50 °C) for a minimum of 48 hours during the pre-calibration procedure. Each detector is independently burned in until a stable output is achieved. Inspection and quality control procedures assure the highest standard of component reliability. However, electronic components do fail occasionally and may cause your instrument to function improperly.

Changing components in the field may require your unit to be re-calibrated by the factory. Other than fuses, replacement of PC board components is strongly discouraged and may compound the problem and void the system's warranty.

In applications where the operation of the system is critical, it is recommended that you purchase an additional Electro-Optical package as a backup for the in-service system.

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9 Maintenance

9.1 General Maintenance

Refer to **Chapter 10, Safety Assurances and Precautions**, when performing the following procedures.



Warning: At no time should the cover be removed unless the power is switch-off first. When it is necessary to service the instrument with the power applied, ensure that proper safe environmental conditions exist and that such maintenance is authorized and pursuant to safe conditions.

Some internal electronic repairs may be performed on the LumaSense E²T QUASAR M8100-EXP without requiring re-calibration to the factory standards, but many components are matched and temperature compensated and cannot be replaced in the field without factory re-calibration.

Repairs that can be performed without affecting instrument performance are:

- Replacement of MOV components on the power supply and Terminal Output boards.
- Repairs to the Output terminal board, heater assemblies, interconnecting cables, connectors, eyepiece and lens.

9.1.1 Chopper Motor Repair

The primary failure mode of the chopper motor is bearing failure. It can be identified by listening for an excessive whining noise as it runs. Replacement is recommended and must be performed at the factory.

Troubleshooting guides are included and our staff will provide assistance via FAX, phone or e-mail.

Any damage to the instrument affecting the optical alignment or critical electronic components usually requires the instrument to be returned to the factory for repair.

It is recommended that a spare or back up unit be procured with the acquisition of your original equipment if the QUASAR M8100-EXP is to be used in a critical control installation.

Only the Optical Electronics Package is required as a spare unit.

9.2 Cleaning the Optics

The front window in the explosion-proof housing should be cleaned monthly. After removing the air purge tube, use facial tissue dipped in rubbing alcohol (isopropyl 70%) to clean the window.

The optical system of the QUASAR M8100-EXP consists of a lens, an eyepiece and a specially coated front surface mirror mounted on a special insert. The optics of the QUASAR M8100-EXP are located within the electro-optical package and will remain clean under normal conditions, provided the enclosure remains sealed at all times with o-rings in place. LumaSense does not recommend cleaning optics other than the objective lens. A complete cleaning requires disassembly of the optical train.

To clean the objective lens, remove the electro-optical package from the explosion-proof enclosure. Use facial tissue dipped in rubbing alcohol (Isopropyl 70%). If it is especially dirty, use a lens cleaning solution. Press softly or the lens may become loose or dislodged. Blow off lint, and then replace the electro-optical package in the explosion-proof housing.

10 Safety Assurances and Precautions

10.1 Hazardous Environment Safety

The LumaSense E²T QUASAR M8100-EXP enclosure is designed to hold an explosion inside the housing and release the hot gases slowly enough to allow them to cool sufficiently to not ignite the explosive gases outside the housing. It is important to take care of the mating surfaces between the housing and its lid. Also be sure to torque the lid bolts to specification.

Factory inspections, assembly and test procedures are strictly followed to ensure the highest quality, integrity, and functionality of the Explosion Proof Housing. Use care during reassembly to maintain gasket and surface integrity. Deep scratches or gouges could allow gases to be released at excessively high temperatures during an explosion.

- When servicing the instrument, ensure that the main power is disconnected or switched off. Allow the instrument 20 minutes to cool down prior to opening.
- When connecting electrical wiring to the circuit board, ensure that the wires are properly secured to prevent accidental shorting or a hazardous live condition in the event screws loosen.
- Check and secure the safety ground connections just prior to lid closure.
- When attaching the utility conduit, ensure that at least five threads are engaged and that appropriate seal fittings and practices are followed in accordance to explosion-proof practices.
- When replacing the top cover, the sixteen M8 x 1.25 socket head screws must be torqued to specification (50in-lbs, 5.5n-m).
- Ensure that the surface temperature of the explosion-proof housing does not exceed 120 °F (50 °C). Cooling may be required.
- Take note of all Hazardous Classifications. Refer to **Appendix B, Area Classifications and Protection Concepts**, for details.

10.2 Electrical Service Protection

10.2.1 Over-Current Protection / Service Switch

It is necessary to incorporate an external over-current protection device appropriate to the instrument's service and to include a disconnect switch located near the instrument. The service disconnect should be clearly marked as pertaining to this instrument.

10.2.2 Over-Voltage Protection

Maximum applied voltage must not exceed the following limits:

- 260~ Terminal Block 1 (TB1) between terminals or any terminal and GND.
- 120~ Terminal Block 2 (TB2) terminals 2, 3, and 4 between terminals or any terminal and GND.
- 20VDC Terminal Block 2 (TB2) terminal 1 and 2 between terminals or any terminal and GND.

10.2.3 Transient Protection

Transients must not exceed 2.5kV between any terminal or any terminal and GND. The electronics provide some protection against transient as per EN61326-1 EMC Immunity. However, if higher transients are expected, it is recommend that transient protection devices be included as part of service installation.

10.2.4 Wiring

Confirm service type and check that service markings correspond to expectations. When wiring, follow the local code regulations. Secure the power input lines together after connection to the terminal block to prevent an accidental hazardous live condition in the event that a terminal screw becomes loose. Sleeve or tie wrapping is acceptable. Check to ensure that the power is not accidentally connected to the low voltage I/O terminal block TB2.

See Chapter 4, Electrical Installation, for power service installation details.

10.2.5 Protective Ground Connection



Connect the protective Earth conductor as instructed in **Chapter 4, Electrical Installation**. The Earth Ground connection is located on the inside surface of housing denoted by the symbol shown left.

Appendix A: Specifications and Parameter Settings

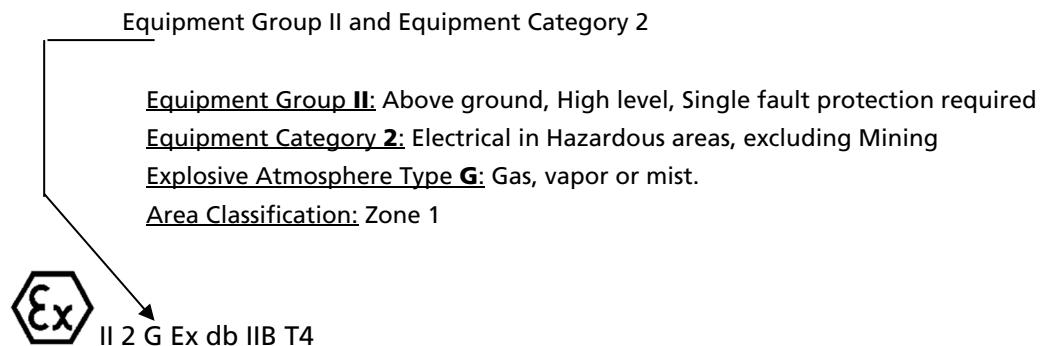
Temperature Range	Designed for Flares/Pilots of any intensity
Working Distance	0 ... 1320 ft. (0 ... 400m)
Response Time	100 mSeconds
Outputs	Red and Green status lights, mA and set point relay contacts
Relay Contacts	120 V AC 0.5A , 24 V DC 1A , Resistive
Sensitivity Adjustment	0 ... 1 V DC
Focusing Range	20 in. (51cm) to infinity
Sighting	Visual aiming
Target Size (Field of View)	S (dia. of circle) = D (Distance)/37.5, 60, 75, 150, or 300
Power Ratings	115 ~ ± 5%, 50 / 60 Hz (standard) 220 ~ ± 5%, 50 / 60 Hz (optional) 24 V $\overline{\text{---}}$ + / - 20%, (optional) 115 Watts
Fusing	ELECTRONICS: 115 ~ .250A, 'T' Time-Lag 5x20 Little fuse type 218.250 220 ~ .125A, 'T' Time-Lag 5x20 Little fuse type 218.125 24 V $\overline{\text{---}}$ 1A, 'T' Time-Lag 5x20 Little fuse type 218.001 6 882 480 Fuse, 1 A (24 V DC), (P/N 15825-1000) 6 882 490 Fuse, 4 A (24 V DC), (P/N 19154-4) 6 882 500 Fuse, 1 A (115 V AC), (P/N 19154-1) 6 882 510 Fuse, 1/4 A (115 V AC), (P/N 19534-0250) 6 882 520 Fuse, 0.5 A (230 V AC), (P/N 19154-0.5) 6 882 530 Fuse, 125 mA (230 V AC), (P/N 19534-0125) HEATER : 115 ~ 1A, Fast TR5, Wickman 370 ... 1100 220 ~ .5A, Fast TR5, Wickman 370 ... 0500 24 V $\overline{\text{---}}$ 4A, Fast TR5, Wickman 370 ... 1400
Ambient Temperature Limits	A. -40 to 140 °F (-40 to 60 °C) with no cooling and using internal heater. B. If the equipment is used at the ambient temperature above +60 °C, before turning on the equipment, the cooling system shall be verified that the ambient temperature does not rise above +60 °C.

Hazard Classification (See Appendix B, Area Classifications / Protection Concepts.)	Explosion Proof, prevent flame propagation CSA/US Class 1, Division 1, Groups C and D Class 1, Division 2, Groups A through D Temp code – T4A Enclosure Type – 4X CENELEC/ATEX approved Zone 1 Type : Ex db IIB T4
Threads	Electrical service: ¾ inch NPT conduit cooling base service: ¼ inch NPT
Mounting	M-3 mounting fixture –height adjustable pedestal with 360 ° swivel –70 ° to +70 ° vertical
Torque Spec, Lid Bolts	50in-lbs, + / -5; 5.5N-m
Air	View port purge 20psig min., 1 SCFM
Cooling (For ambient environments over 120F)	WATER: 10 gph (37.8 lph) AIR: Vortex, V208-15H, 10SCFM minimum Reference manufacturer data for pressure specs.
Weight/Dimensions	48 Pounds (22 Kg) / 5 x 12.5 x 8.5 in (127 x 318 x 217 mm)
Varying Flame Luminescence	The LumaSense E ² T QUASAR M8100-EXP automatically compensates for low and varying target emissivity (luminescence) and minimizes the effects of attenuation by intervening media, such as rain, snow and fog.

Appendix B: Area Classification/Protection Concepts

Label Markings

European Markings and Classification for the M8100-EXP



European Community **Explosion** protection standard and environment:

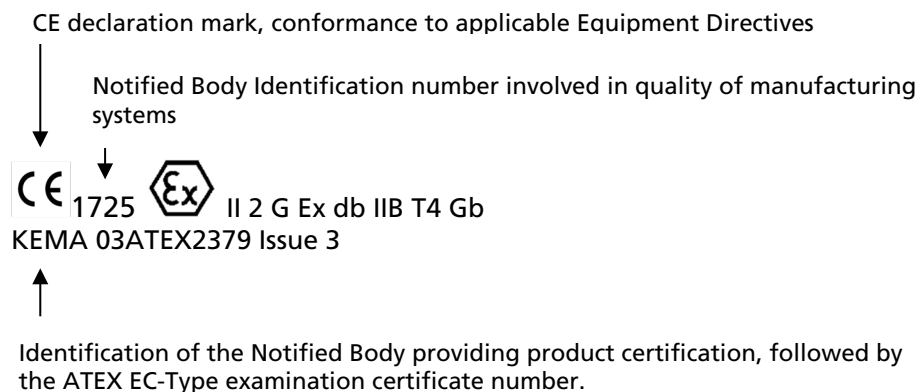
Ex d "Flameproof Enclosure" Protection Type, CENELEC standard: EN 50018, 2002; by method of containing the explosion, prevents flame propagation in the event of a failure

IIB: Explosion Proof Gas Grouping based on type testing

Temperature code T4: maximum surface temperature will not exceed 135 °C (275 °F) Pertinent when considering gas ignition temperatures that may come in contact.

CENELEC : European Committee Norms for Standardization ELECtrical Equipment

CE Declaration and Notified Body Markings:



CSA Markings and Classification for the QUASAR M8100-EXP.

US = Tested to UL standards for NRTL acceptance.



Contains the explosion, prevents flame propagation

Class 1, Division 1, Groups C and D; T4A

Class 1, Division 2, Groups A,B,C&D; T4A

Enclosure Type 4x

Defined by Article 500 NEC; Class, Division and Gas Groups:

Location Classification I (**Class 1**): flammable gases or vapors

Hazard probability Division 1 (I): Intermittent or High probability of explosive atmosphere present during normal **Div 1** operation

Division 2 (**Div2**): abnormal conditions, low probability during operation

Gas/Vapor Groups: A through D

T4A:

Temperature code: maximum surface temperature will not exceed 2488 °F (1208 °C).

Enclosure Type 4X:

Indoor/Outdoor type; Protection from: corrosion, windblown dust and rain, splashing water, hose directed water, external formation of ice.

Where a given location is classified as hazardous, it should not be difficult to determine in which of the three classes it belongs. Common sense and good judgment must prevail in classifying an area that is likely to become hazardous and in determining those portions of the premises to be classed Division 1 or Division 2.

Protection Concepts, Article 500

Sections 500-5, 500-6, and 500-7 recognize three classes of hazardous (classified) locations having varying degrees of hazard, and each class is subdivided into two divisions. The requirements for Division 1 of each class are more stringent than those for Division 2.

The hazards of the three classes are defined as follows:

- Class I, flammable gases or vapors;
- Class II, combustible dust;
- Class III, combustible fibers or filings.

500-5. Class I Locations. Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Class I locations shall include those specified in (a) and (b) below.

(a) Class I, Division 1. A Class I, Division 1 location is a location: (1) in which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions; or (2) in which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) in which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

(FPN): This classification usually includes locations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another; interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used; locations containing open tanks or vats of volatile flammable liquids; drying rooms or compartments for the evaporation of flammable solvents; locations containing fat and oil extraction equipment using volatile flammable solvents; portions of cleaning and dyeing plants where flammable liquids are used; gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; the interiors of refrigerators and freezers in which volatile flammable materials are stored in open, lightly stoppered, or easily ruptured containers; and all other locations where ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

(b) Class I, Division 2. A Class I, Division 2 location is a location: (1) in which volatile flammable liquids or flammable gases are handled, processed or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or (2) in which ignitable concentrations of gases or vapors are normally pre-vented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operation of the ventilating equipment; or (3) that is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

(FPN No. 1): This classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used but which, in the judgment of the authority having jurisdiction, would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location.

(FPN No. 2): Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases. Locations used for the storage of flammable liquids or of liquefied or compressed gases in sealed containers would not normally be considered hazardous unless subject to other hazardous conditions also.

Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier shall be classed as a Division 2 location if the outside of the conduit and enclosures is an unclassified location.

500-6. Class II Locations. Class II locations are those that are hazardous because of the presence of combustible dust. Class II locations shall include those specified in (a) and (b) below.

(a) Class II, Division 1. A Class II, Division 1 location is a location: (1) in which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures; or (2) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes; or (3) in which combustible dusts of an electrically conductive nature may be present in hazardous quantities.

(FPN): Combustible dusts which are electrically nonconductive include dusts produced in the handling and processing of grain and grain products, pulverized sugar and cocoa, dried egg and milk powders, pulverized spices, starch and pastes, potato and wood flour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Electrically conductive dusts are dusts with a resistivity less than 105 ohm-centimeter. Dusts containing magnesium or aluminum are particularly hazardous and the use of extreme precaution will be necessary to avoid ignition and explosion.

(b) Class II, Division 2. A Class II, Division 2 location is a location where combustible dust is not normally in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment and where combustible dust accumulations on, in, or in the vicinity of the electrical equipment may be sufficient to interfere with the safe dissipation of heat from electrical equipment or may be ignitable by abnormal operation or failure of electrical equipment.

(FPN No.1): The quantity of combustible dust that may be pre-sent and the adequacy of dust removal systems are factors that merit consideration in determining the classification and may result in an unclassified area.

(FPN No. 2): Where products such as seed are handled in a manner which produces low quantities of dust, the amount of dust deposited may not warrant classification.

500-7. Class III Locations. Class III locations are those that are hazardous because of the presence of easily ignitable fibers or filings, but in which such fibers or filings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures. Class III locations shall include those specified in (a) and (b) below.

(a) Class III, Division 1. A Class III, Division 1 location is a location in which easily ignitable fibers or materials producing combustible filings are handled, manufactured, or used.

(FPN No. 1): Such locations usually include some parts of rayon, cotton, and other textile mills; combustible fiber manufacturing and processing plants; cotton gins and cotton-seed mills; flax-processing plants; clothing manufacturing plants; woodworking plants; and establishments and industries involving similar hazardous processes or conditions.

(FPN No. 2): Easily ignitable fibers and filings include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior, and other materials of similar nature.

(b) Class III, Division 2. A Class III, Division 2 location is a location in which easily ignitable fibers are stored or handled.

Appendix C: Declaration of Conformity/ Certificate

 CSA INTERNATIONAL	
Certificate of Compliance	
Certificate: 1127148	Master Contract: 251718
Project: 2518482	Date Issued: April 24, 2012
Issued to: Lumasense Technologies GmbH Kleyerstrasse 90 Frankfurt, Main, 60326 Germany Attention: Dirk Fabian	
<i>The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.</i>	
	
<i>Jelena Dzeletovic</i> Issued by: Jelena Dzeletovic	
PRODUCTS	
CLASS 4868 01 - TEMPERATURE-INDICATING AND REGULATING EQUIPMENT - For Hazardous Locations	
CLASS 4868 81 - TEMPERATURE-INDICATING AND REGULATING EQUIPMENT - For Use in Hazardous Locations - Certified to US Standards	
Class I, Division 1, Groups C and D; Class I, Division 2, Groups A, B, C and D; Temperature Code T4A: Model 8100-EXP, Non-Contact Infrared Pyrometer; Enclosure Type 4X Supply Rated 120 Vac/1A, 240 Vac/0.5A, 50/60 Hz; or 24 Vdc/4A Output: 4-20 mA or mV/°C	
APPLICABLE REQUIREMENTS	
C22.2 No. 0-10 - General Requirements - Canadian Electrical Code Part II.	
C22.2 No. 0.4-2004 (R2009) - Bonding and Grounding of Electrical Equipment (Protective Grounding).	
C22.2 No. 0.5-M1982(R2008) - Threaded Conduit Entries	
DQD 507 Rev. 2009-09-01	
Page: 1	



Certificate: 1127148

Master Contract: 251718

Project: 2518482

Date Issued: April 24, 2012

C22.2 No.24-M1993(R2008) - Temperature Indicating and Regulating Equipment

C22.2 No.30-M1986 (R2007)- Explosion-Proof Enclosures for Use in Class I Hazardous Locations.

C22.2 No.213-M1987(R2008) - Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations.

UL 873, Twelfth Edition - Temperature Indicating and Regulating Equipment

UL 1203, Fourth Edition - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations

UL 1604, Third Edition - Electrical Equipment for Use in Class I and Class II, Division 2 and Class III Hazardous (Classified) Locations

ATEX KEMA Dekra Certificate

Please contact the factory for a copy of the document.

Appendix D: Statement of Limited Warranty, New Instruments

LumaSense Technologies, Inc., hereby warrants said instruments for a period of twelve (12) months from date of shipment from our facility, unless otherwise specified. Further, LumaSense Technologies, Inc., warrants the temperature measurement instrument(s), components, subassemblies, described herein, shall be free from material defects and/or workmanship, provided the instrument is used in the prescribed manner under normal and established conditions as set forth in this manual and has not been subject to abuse. Further this warranty shall be declared null and void if this unit was modified or altered.

During operation of the instrument in the aforementioned warranty period, should a defect be detected that causes the temperature measurement instrument(s) to fail, the customer shall contact LumaSense to obtain a return authorization number prior to returning the unit to the facility. Failure to display the proper RMA (return material authorization) number on the outside of the container, as well as on all internal return documents, could result in the unit being returned to the customer in a non-repaired state and additionally incur return shipping and freight charges.

The customer's/end user's sole and exclusive remedy in the event of a perceived or real defect is herein and expressly limited to the correction of said defect(s), at LumaSense Technologies, Inc.'s, election and expense. There shall be no obligation on the part of LumaSense Technologies, Inc., to repair or replace items, components, and subassemblies, which by their nature and use are deemed expendable.

No further representation, or affirmation of fact, including, but not limited to, statements regarding capacity, suitability for use, or performance of, said equipment shall be or be deemed, to infer or be implied to be a warranty or representation by LumaSense Technologies, Inc. No representative of LumaSense Technologies, Inc., has real or vested authority to change or modify this governing agreement.

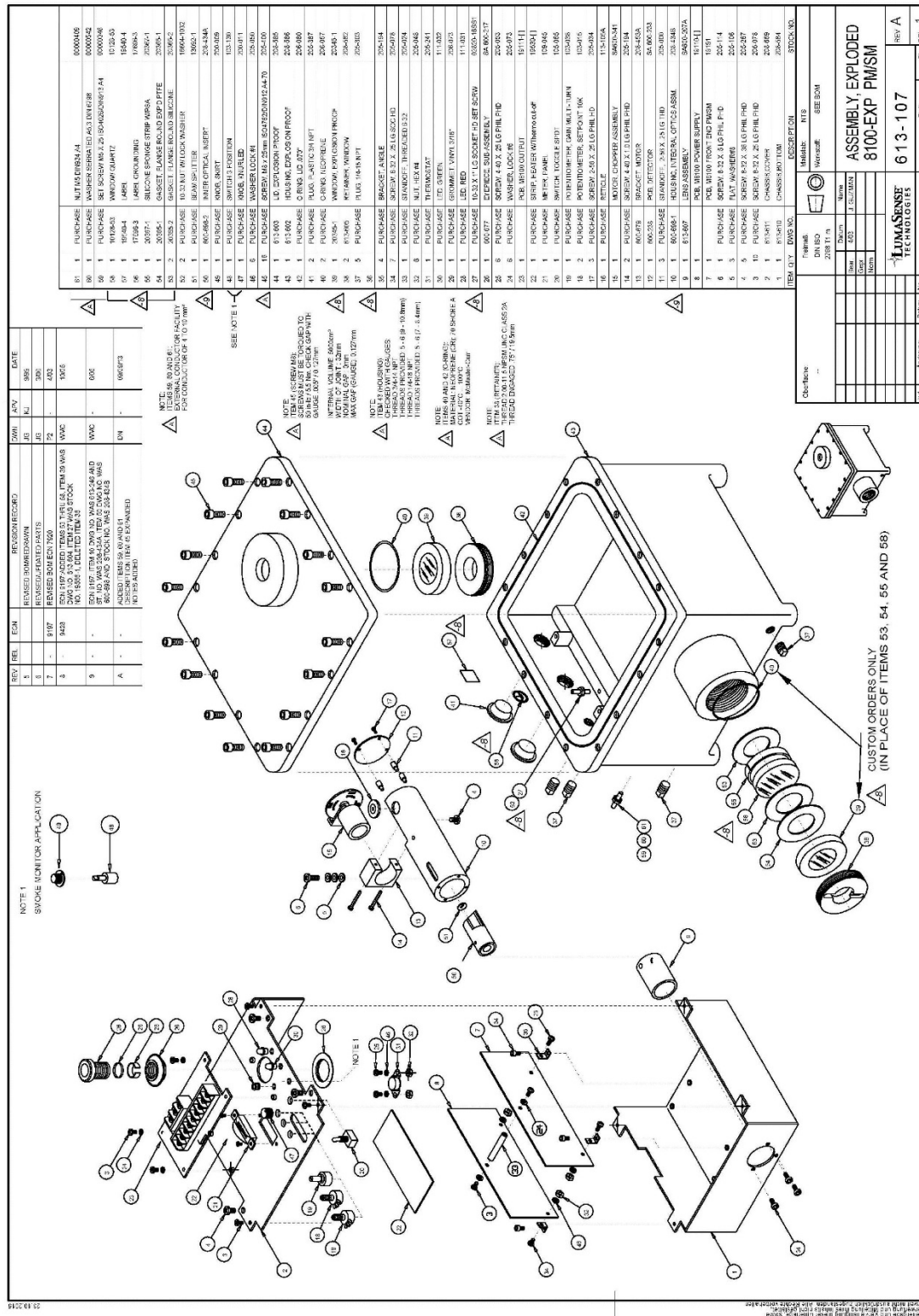
Except as specified and provided in the declaration and agreement, there are NO OTHER WARRANTIES, express or implied, including, but not limited to, any implied warranty, or merchantability, or fitness for a specific application or purpose. IN NO EVENT, shall LumaSense Technologies, Inc., be subject to, or be held liable for, loss of real or implied, materials, cash receipts/entries, benefits, and damages, (direct, indirect, special, consequential), or other similar related or non-related damages, that may arise out of any breach of this governing warranty or otherwise.

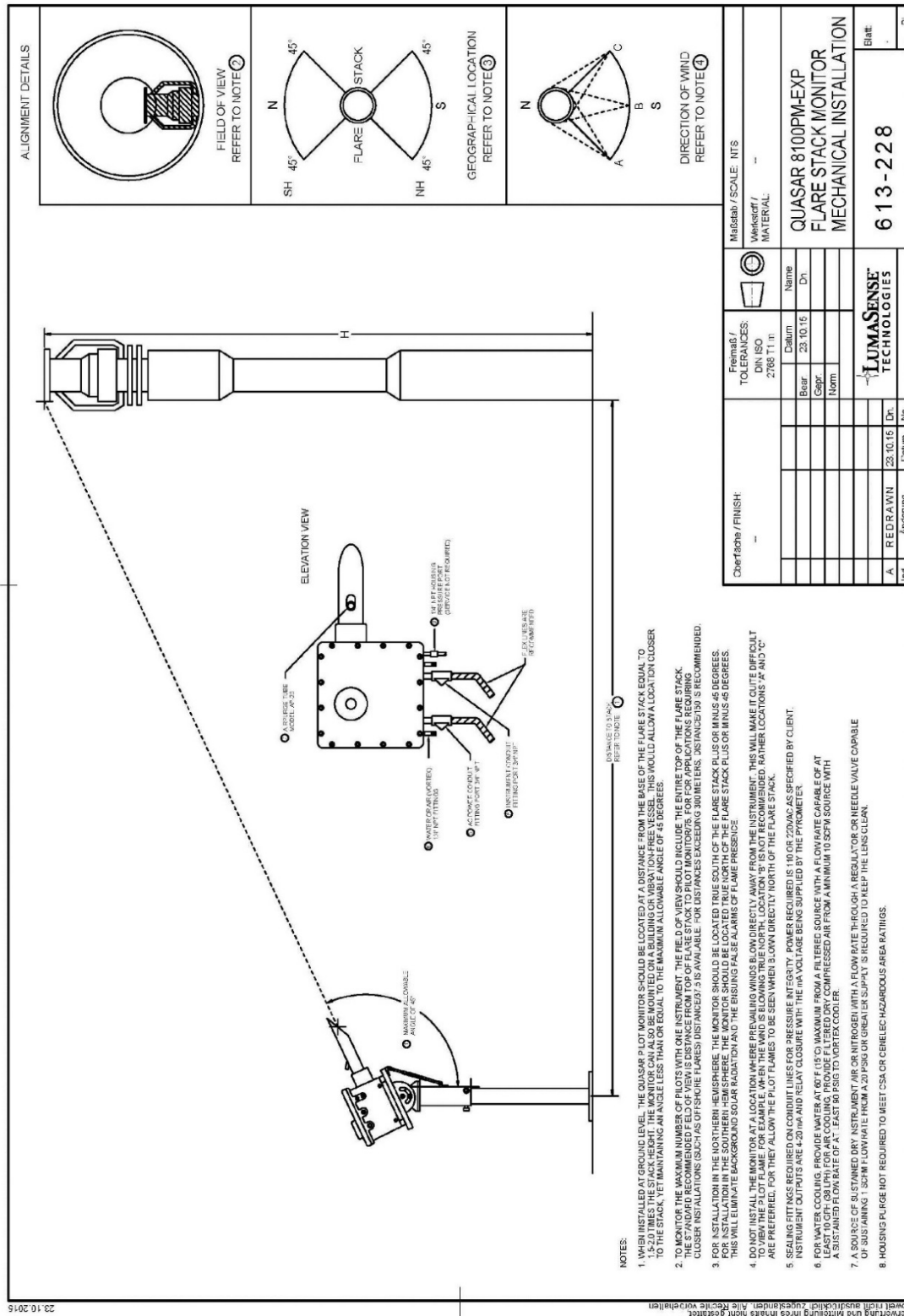
LumaSense Technologies, Inc.
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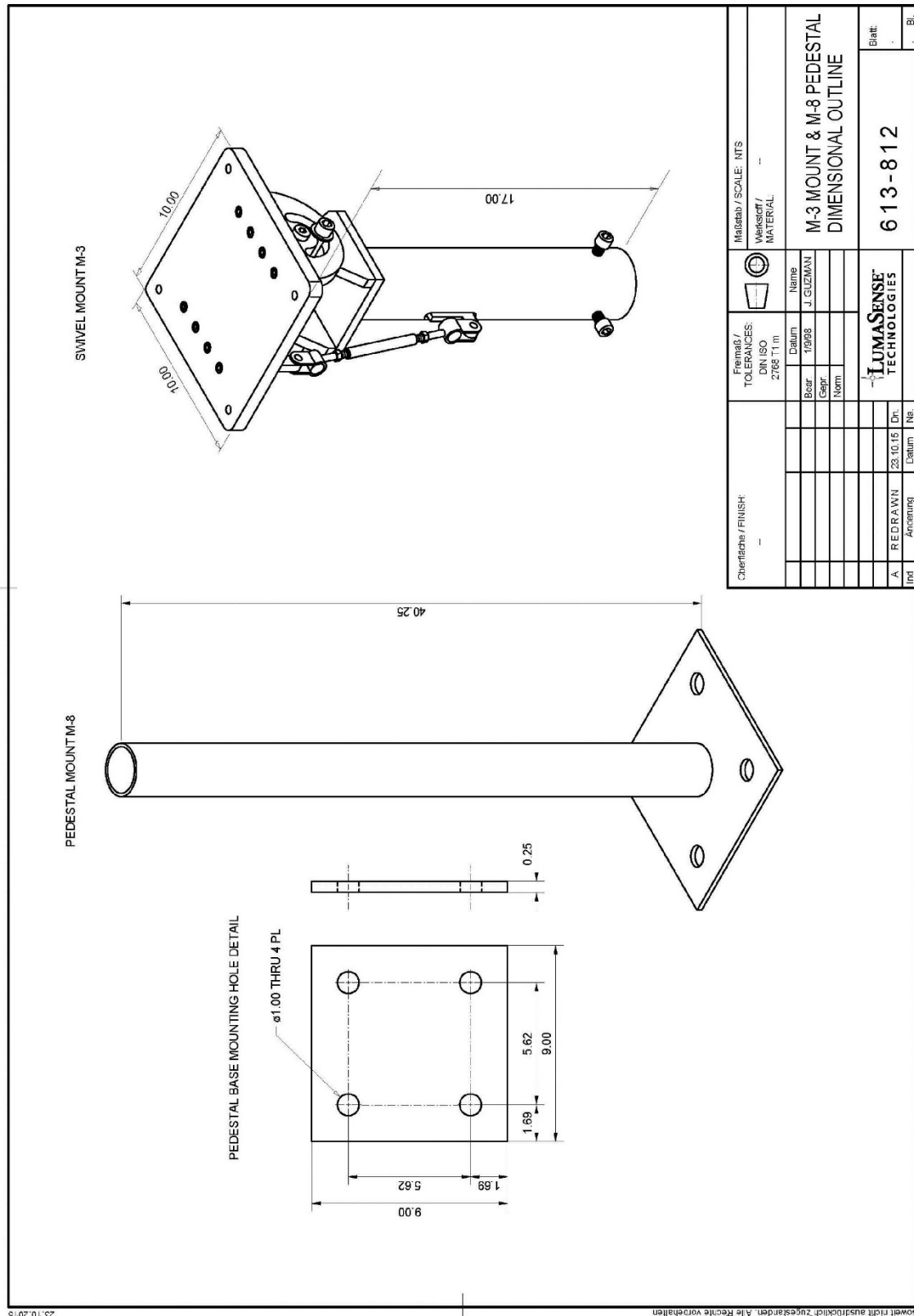
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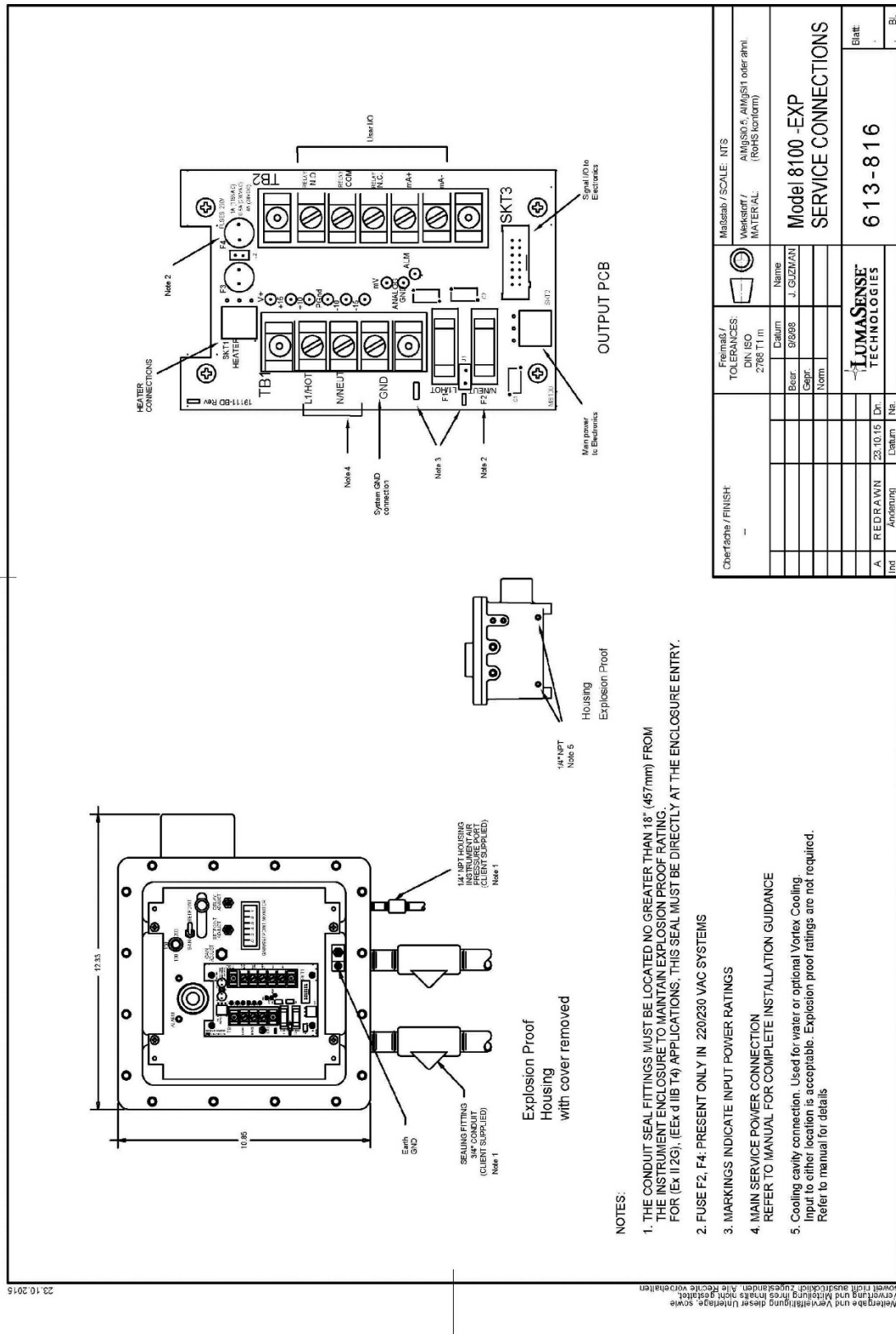
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