Hays Cleveland
Division of UniControl Inc.

# SERIES A-08740-*0
# UNIVERSAL OPACITY MONITOR

# Table of Contents

# 1.0 INTRODUCTION

## 1.1 Description of Operation

The **Hays Cleveland Model A-08740 Universal Opacity Monitor** provides reliable, continuous measurement of the density of confined particulates such as dust or smoke. It is easy to calibrate and requires no routine maintenance other than occasionally cleaning the sight glass.
The basic system consists of an electronics unit and two breeching components. A light source directs a beam through the measured particulate, and a light sensor receives the beam, detects changes in opacity, and sends a proportional signal to the electronics unit. The wide-beam light source and narrow-view receiver make installation easy: alignment of the breeching units does not need to be precise. The electronics produces a digital readout of percent opacity and a 4-20 mA DC output signal suitable for recording, display, or indication. SPDT contacts are provided for a remote alarm (which can be purchased separately: **Hays Cleveland L-05500-00**). The operator can select manual or automatic alarm reset. **Modbus communications** for interface with a SCADA system (Supervisory Control and Data Acquisition system) or other controls is standard. A standard serial printer port is provided. The electronics unit is available in open-mount, surface-mount, and flush-mount formats. It can be installed in any dry, convenient area within 250 feet of the light source and receiver units. The standard model has a vacuum fluorescent display with three status LED's. There are four LED indicators on units equipped with **auxiliary functions** (described below).

The **Burner Cutoff Auxiliary Function** is a delayed de-energization timer that shuts the burner down if an alarm condition (opacity exceeding 20%) persists for 120 seconds. The timer can be manually reset only after reduction of opacity: it cannot be reset when opacity is above 20%. (This feature meets **the requirements of the New York City air pollution control code** for alarm and burner control functions). **Model A-08740 Opacity Monitors** equipped with the burner cutoff function have four LED indicators on the front of the electronics panel, marked **Clear**, **Smoke**, **Alarm**, and **Burner Off**. In addition, an audible alarm with adjustable trip point and delay is mounted on the front face of the electronics unit.

The **Overfire Air Timer Auxiliary Function** is a delayed de-energization timer that provides relay contacts for the control of smoke-reduction air in **coal-fired installations**. As soon as opacity exceeds the alarm trip point, the relay is energized. It remains energized as long as the alarm condition persists. After the alarm condition is corrected, the relay remains energized for an adjustable period up to five minutes. **Model A-08740 Opacity Monitors** equipped with the overfire air timer function have four LED indicators on the front of the electronics panel, marked **Clear**, **Smoke**, **Alarm**, and **Overfire Air**.

## 1.2 Specifications

**Power requirements:**120 V AC ± 10%, 50/60 Hz.
**Ambient temperature ranges:** 32–130F (0-54C) for electronics unit. 32–160F (0-70C) for light source and receiver units.
**Fuse:** One, @ 1 amp.
**Measurement range:** 0 to 100% opacity.
**Retransmit Output range:** 4–20 ma DC, 750 ohms maximum load. Directly proportional to measurement range, where 4 ma = 0% and 20 ma = 100%. **Output is grounded (not isolated.)**

**Resolution:** Digital meter reads 0–100% opacity with 1% resolution.
**Response time:** 1 second for 90% of actual change in opacity.
**Accuracy:** ±5% opacity under all specified operating conditions.
**Light source to receiver distance: minimum** 4 ft. (1.2 m.), to maximum 20 ft. (6.0 m.).
**Light source lamp life:** 1 year minimum.
**Spectral response of photocell:** 350–1100 nM.
**Cable length:** 250 ft. (76 m.) maximum.
**Indicators:**

- **Green:** "Clear" LED.
- **Yellow:** "Smoke" LED and flashing display.
- **Red:** "Alarm" LED and flashing display.

**Alarm timer:** adjustable 0-300 second delay.
**Alarm trip point:** adjustable 0-99% opacity.
**Alarm reset:** automatic. Field-convertible to manual.
**Alarm contacts:** isolated SPDT, 10 amp, 120 V AC resistive, failsafe.
**Purge Delay timer:** adjustable 1-600 second delay.
**NYC Burner Cutoff (optional):** fixed 20% trip point and fixed 2-minute (120-second) delay.
**NYC Burner Cutoff contacts:** isolated SPDT, 10 amp, 120 V AC resistive, failsafe.
**Overfire air timer (optional):** maintains contact closure after smoke abatement for a period adjustable from 1-300 seconds.
**Overfire air contacts:** isolated SPDT, 10 amp, 120 V AC resistive, failsafe.
**Housing for enclosed models:** NEMA 1.
**Relative Humidity:** 0-90%, non-condensing.
**Printer port:** RS232 serial port, DB9-M connector, 9600 baud, N81 (no parity, 8 data bits, 1 stop bit). Output format: 5 sequence #, blank space, 3 digit opacity, "%" symbol, carriage return, line feed. Output adjustable, generated every 0–60 minutes, where 0 = disabled.

Example: `01234 011% c/r l/f.`

**Shipping Weight:** varies with options.
Electronics units in enclosures are 7.5–8.5 lbs.
Open-mounted electronics units are 6.5–8.0 lbs.
Light source and receiver, combined, 9 lbs.
**Approvals:** NYC DEP. UL & CUL pending.
**Modbus Communication**: RTU. 9600 or 19200 Baud rate. N/8/1 (no parity, 8 databits, 1 stop bit).

SPECIFICATIONS ARE SUBJECT TO CHANGE.

**A - 0 8 7 4 0 - * 0 - A B**

*** = Current Model Designation**

## 1.3 Nomenclature

The basic catalog number for the **Hays Cleveland Model A-08740 Universal Opacity Monitor** is shown below. Replace suffixes **A** and **B** with selections from the table below.
The standard base unit includes light source and receiver units. The electronics unit has a vacuum fluorescent display with 3 LED's (standard: Clear, Smoke, and Alarm) or 4 LED's (if an auxiliary function is present). Standard features include: adjustable alarm trip point and delay, field-selectable auto/manual alarm reset, **a contact closure for a remote alarm** (customer-supplied or quoted separately with **Hays Cleveland L-05500-00**), retransmitted 4-20 ma DC output, a serial printer port (printer not included), and Modbus communication. The **Model A-08740 Universal Opacity Monitor** replaces **Model A-08711.**

**A: Auxiliary Application Functions**

0. None.
1. Burner Cutoff Timer with **audible alarm on front of electronics** and "Burner Off" LED. **NYC DEP approved.**
2. Overfire Air Timer with "Overfire Air" LED (for stoker applications).

**B: Housing**

0. Open-mounted
   (for OEM applications).
1. Surface-mount
   (for wall-mounting). NEMA 1.
2. Semi-flush mount
   (for panel-mounting). NEMA 1.

# 2.0 Installation

## 2.1 Mounting

**Mount** the electronics/display unit in a dry location where the ambient temperatures are within the specified temperature range, 32–130F (0-54C).

- Mount the unit away from excessive vibration.
- Do not mount in a wiring cabinet that has any power wiring in excess of 120 V AC.
- Mount the unit in such a manner that the wiring cable from the main electronics does not touch or approach any high magnetic source. If mounted near a high magnetic source, electronic interference may cause the display to read incorrectly.

Referring to Figure 2, mount the light source and receiver units directly opposite each other on the particulate passage. Select a position where a true, low-turbulence particulate sample is present, and where the sight glasses are safely and conveniently accessible for cleaning. For applications where soot on the sight glass might present a problem, apply purge air as shown in Figures 3 and 4.

The width of the passage must not exceed 20 feet (6 meters). The length of the wires to the control unit must not exceed 250 feet (76 meters).

**Left to Right: Light Source and Receiver units.**

## 2.2 Wiring

The following information on wiring is generally applicable to all models. Refer also to the **wiring diagrams** in this manual (**Figures 5 - 7**). Field wiring consists of **120 V AC control wirin**g, **DC signal wiring, and Modbus wiring**.

**120 V AC Control wiring** connecting the opacity monitor to the power source must be 14 AWG minimum, and must not be run in conduit with low voltage signal wiring. DC signal wiring and Modbus wiring may be run in the same conduit if practical.

**DC wiring** is at voltage levels of 24 V DC or less. Unless otherwise specified, all signals are 4-20 mA DC. Each signal requires a shielded 2-wire pair, 16 AWG minimum.

To wire the **light source** and **receiver**, loosen the screw at the lower edge of the rear panel on each unit and allow the back panel to swing open, giving access to the field wiring terminals. Refer to Figures 5-7 and wire the units exactly as shown. The wires may be no longer than 250 feet (76 meters).

While no damage results if the wires are connected to the wrong unit, or if the polarity of any of the wires is reversed, the unit will not function. **Connecting 120 V AC to any light source or receiver may result in serious damage.** If the light source does not come on when 120 V AC is applied, remove the power immediately and recheck the field wiring.

The voltage on the light source wires is approximately 4–10 V DC. If these wires are shorted to each other, the light source power supply will shut down. Shielded wire must be used on the receiver, and the shield must not be shorted to ground. A grounded shield may result in erratic operation or a shorted 4–20 ma output.

**RS-485 Modbus wiring:** a plus terminal is provided for the plus signal, a minus terminal for the minus signal, and a shield (shd) for shield wire**.** Generally, Belden 9841™ shielded cable or equivalent is suggested for RS-485 communications.

**Wiring Tips**

- **Wire** with extreme caution!
- All wiring must conform to the **National Electrical Code** and to local code regulations. Verify all electrical ratings on equipment.
- Connecting **high** voltage to the **low** voltage circuits will damage the circuitry!
- Mount the **display** unit in such a manner that the wiring cable from the main electronics does not touch or approach any **high magnetic source**. If mounted near a high magnetic source, electronic interference may cause the display to read incorrectly.

# 3.0 Operation & Maintenance

## 3.1 Displays and Indicators

### 3.1.1 Continuous Display Screen

When power is applied to the unit, the continuous display screen lights. It provides a continuous display of particulate density from 000% Opacity (no particulates detected) to 100% Opacity (particulates are dense enough to block all light), in 1% increments. The display window indicates the parameters and messages shown in **Figures 8-11** in this manual.

### 3.1.2 Indicator LED Lights and Status Messages

The green LED lights and the “Clear” message appears on the first line of the display to indicate that opacity is below alarm trip point. As soon as the trip point is exceeded, the green LED and “Clear” message go out and the yellow LED and blinking “Smoke” message come on. On the second line of the display, the alarm delay timer countdown appears. The red LED and blinking “Alarm” display are activated if the excessive opacity persists after the alarm delay period expires. If automatic alarm reset mode is selected, the Clear message and green LED wilI resume after the smoke has cleared to the point that the monitor detects an opacity percentage less than the alarm trip point. If manual alarm reset mode is selected, press the reset button to reset the alarm in all Standard and Overfire Air Timer models. See **Figures 9 and 11**.

For NYC models equipped with the 2-minute shutdown and alarm options, reset both the main and NYC alarms by first pressing the reset button, and then pressing the “Dec” key to reset the NYC alarm, and the “Inc” key to reset the main alarm. If the main alarm is in automatic reset mode, it will be necessary to reset only the NYC alarm. See **Figure 10**.

### 3.1.3 Output Functions

A 4 to 20 ma signal corresponding to 0 to 100% opacity provides for remote recording, control, or indication. SPDT alarm contacts are provided for remote alarm or control. The alarm relay is normally energized for failsafe operation. Refer to lines 11a through 11c on Figures 9, 10, and 11 for calibration of the retransmitted output. Note that the output can be varied from the low (4 ma DC) and high (20 ma DC) values by ±.5 ma DC.

## 3.2 Field Configuration on Continuous Display Screen

The scrolling display permits you to view and change parameters. Press the “Enter” button repeatedly to scroll through the parameters, which appear on the bottom line of the display. With a parameter visible, press the “Inc” button to increase its value. Press the “Dec” button to decrease its value. The new value becomes effective immediately: pressing “Enter” again brings up the next parameter. After 10 seconds of inactivity, the display reverts to the default screen except during calibration mode. Following an alarm event, press the “Reset” button to clear the

"Alarm" message and restore the "Clear" message to the display if the unit is a Standard or Overfire Air Timer model configured (on the p.c. board) for manual alarm reset. If the unit is configured for automatic alarm reset, the "Clear" message will replace the "Alarm" message automatically as soon as the excessive opacity is cleared. For NYC models equipped with the 2-minute shutdown and alarm options, reset both the main and NYC alarms by first pressing the reset button, and then pressing the "Dec" key to reset the NYC alarm, and the "Inc" key to reset the main alarm. If the main alarm is in automatic reset mode, it will still be necessary to reset the NYC alarm.

The scrolling display includes the parameters and messages shown on **Figures 8 through 11**.

## 3.3 Calibration on Continuous Display Screen

**A summarized version of the calibration information below is located in Figures 9 through 11.**

**AUTO CALIBRATION MODE** To calibrate the light source and receiver units, press the "Enter" button until the "Enter Cal Menu?" message appears. While holding down the "Inc" button, press the "Dec" button simultaneously to display the "Calibrate Opacity" screen. While holding down the "Inc" button, press the "Dec" button simultaneously to display the "Auto-Cal Purge" screen and initiate the purge countdown from the purge delay value (which is already configured: see 3.2 above, and line 5 in Figures 9, 10, or 11). Following the countdown, the "Calibrate Phase-1" message is displayed, along with a countdown from 04 to 00, and the light source lamp goes out. Following the countdown, the "Calibrate Phase-2" message appears and the light source lamp comes on and varies in intensity as it adjusts to the diameter of the stack. While the adjustment is in progress, a countdown from "40" displays on the screen, but calibration may be complete before it reaches "00". At the end of the calibration process, either the default screen display or a calibration error screen appears. "Cal Err #1" means that the receiver has not detected enough light from the light source. "Cal Err #2" means that the receiver has detected too much light from the light source. In either case, the process conditions responsible for the error message must be corrected, and then the calibration process must be repeated until successful.

To calibrate the retransmitted 4-20 mA DC signal, connect a 4-20 mA meter to the retransmit terminals, and then follow the steps above until the "Calibrate Opacity" screen appears. Next, press "Enter" to display the "Calibrate Retrans" message. While holding down the "Inc" button, press the "Dec" button simultaneously to display the "Set Retrans Low" screen. Observing the meter reading, use the "Inc" and "Dec" keys to correct the value. The output can be varied from 4 mA by ±0.5 mA DC. When satisfied, press the "Enter" key again and the "Set Retrans High" message is displayed. Observing the meter reading, use the "Inc" and "Dec" keys to correct the value. The output can be varied from 20 mA by ±0.5 mA DC.

**MANUAL CALIBRATION MODE** To calibrate the light source and receiver units, press the "Enter" button until the "Enter Cal Menu?" message appears. While holding down the "Inc" button, press the "Dec" button simultaneously to display the "Stack Clear?" screen. Check the stack, and press "Enter" to confirm that it is clear. The "Calibrate

Phase-1" message is displayed, along with a countdown from 04 to 00, and the light source lamp goes out. Following the countdown, the "Calibrate Phase-2" message appears and the light source lamp comes on and varies in intensity as it adjusts to the diameter of the stack. While the adjustment is in progress, a countdown from "40" displays on the screen, but calibration may be complete before it reaches "00". At the end of the calibration process, either the default screen display or a calibration error screen appears. "Cal Err #1" means that the receiver has not detected enough light from the light source. "Cal Err #2" means that the receiver has detected too much light from the light source. In either case, the process conditions responsible for the error message must be corrected, and then the calibration process must be repeated until successful.

To calibrate the retransmitted 4-20 mA DC signal, connect a 4-20 mA meter to the retransmit terminals, and then follow the steps above until the "Calibrate Opacity" screen appears. Next, press "Enter" to display the "Calibrate Retrans" message. While holding down the "Inc" button, press the "Dec" button simultaneously to display the "Set Retrans Low" screen. Observing the meter reading, use the "Inc" and "Dec" keys to correct the value. The output can be varied from 4 mA by ±0.5 mA DC. When satisfied, press the "Enter" key again and the "Set Retrans High" message is displayed. Observing the meter reading, use the "Inc" and "Dec" keys to correct the value. The output can be varied from 20 mA by ±0.5 mA DC.

## 3.4 Other Adjustments on Continuous Display Screen

| | |
|---|---|
| **MODBUS ADDR** | Set the Modbus address from 001– 247, using the "Inc" key to increase the value or the "Dec" key to decrease the value. |
| **BAUD RATE** | Select a baud rate of 9600 or 19200, using the "Inc" or the "Dec" key to toggle between these values. |
| **PRINT INTERVAL** | Select a print interval value between 0 and 60 minutes to regulate printed report frequency. A print inverval of "0" disables the printer output. |

# 4.0 Miscellaneous

## 4.1 Retransmission of Process Variable

Refer to the overall wiring diagrams (**Figures 5-7**). The terminals for the retransmission of the process variable are located on the printed circuit board. They are marked “4-20 ma.”

## 4.2 Modbus Communications

Refer to the overall wiring diagrams (**Figures 5-7**). Terminals for Modbus communication are located on the lower left of the printed circuit board. They are marked “RS-485 +, -, SHD.” These terminals provide information with Modbus protocol using RS-485.

The Modbus address assignments are shown in **Figure 12**.

## 4.3 Troubleshooting (Diagnostic LED’s)

### 6.31 Diagnostic LED’s

LED’s are provided for onboard diagnostic of the I/O (Input/Output). The Relay Status and “Processor Running” LED’s are identified in **Figure 1**.

The “Processor Running” LED indicates the state of the microprocessor by blinking at different rates as shown in **Figure 13**.

### 6.32 Checksum Error

When the microprocessor values do not match the values stored in memory, “Checksum Error” is displayed. All logic functions stop. To correct the Checksum Error, turn the power off and then back on. If this procedure doesn’t rectify the error, reenter all control parameters. If the problem persists, contact the sales office where you purchased the unit.

# 5.0 Customer Service Information

## 5.1 Contacts

### Hays Cleveland Sales Office

1903 South Congress Avenue

Boynton Beach FL 33426

Telephone: 561.734.9400

Fax: 561.734.8060

email: **salescombustion@unicontrolinc.com**

### Hays Cleveland Customer Service Department

1111 Brookpark Road

Cleveland OH 44109

Telephone: 216.398.4414

Fax: 216.398.8556

email: **customerservice@unicontrolinc.com**

### Visit us on the WEB!

**http://www.hayscleveland.com**

## 5.2 Repairs

Damaged or defective units may be returned to the factory for repair. However, factory authorization must be obtained before shipping whether warranty or non-warranty service is required, and all units must be shipped prepaid.
A letter of transmittal that includes the following information should accompany the returned instrument:

1. Location, type of service, and length of time in service of the unit.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the unit.
4. Indicate whether warranty or non-warranty service is requested.
5. Attach Purchase Order for all out-of-warranty repairs.

6. Complete shipping instructions for the return of the repaired instrument.

7. Original purchase order number and date of purchase.

8. Return Goods Authorization number provided by the factory when you called.

Clearly label the shipping container:

**RETURN FOR REPAIR**

**Model _____**

**RG # _____**


Ship prepaid to:

**HAYS CLEVELAND**

**1111 Brookpark Road**

**Cleveland OH 44109-5869**

**216-398-4414**

Please follow this procedure. It expedites handling of the returned item, and avoids unnecessary additional charges for inspection and testing to determine the problem before repairing it.

## 5.3 Service

A **Maintenance and Service Contract** can ensure trouble-free, economical operation of **Hays Cleveland** equipment for many years. One-time onsite service by a factory-trained service engineer can also be provided as needed. Contact Hays Cleveland for information on these service options.

## 5.4 Standard Terms and Conditions of Sale

**TERMS OF SALE**: 1% discount if paid in ten (10) days, net amount due and payable in thirty (30) days.

**AGREEMENT OF SALE**: Acceptance by Seller of any order placed for goods whether submitted on Buyer's purchase order form or on seller's Sales Order Acknowledgment form, shall be subject to Seller's Standard Terms and Conditions of Sale and is conditioned upon the Buyer's acceptance of these Standard Terms and Conditions.

**TERMS OF CONTRACT**: Any terms or conditions of the buyer's order which are inconsistent with these terms and conditions shall not be binding on the Seller and shall not be considered applicable to the sale or shipment of goods or materials. Unless buyer shall notify Seller in writing to the contrary within ten (10) days after the mailing of the Sales Contract by Seller, acceptance of the terms and conditions hereof by Buyer shall be indicated and, in the absence of such notification, the sale and shipment by Seller of the goods and materials covered hereby shall be conclusively deemed to be subject to the terms and conditions hereof.

**PRICES**: All prices and specifications and applicable discounts are subject to change without notice. Sales contracts which call for delivery in the future will be billed at prices in effect at the time of shipment. Shipping weights shown are approximate and subject to change without notice.

**SHIPMENT AND PAYMENTS**: All prices contained on the Sales Contract are F.O.B. factory in Cleveland, Ohio. No freight is allowed on any shipments. Shipments and deliveries shall at all times be subject to the approval of Seller's Credit Department, and at any time seller may require payment in advance or satisfactory security or guarantee that invoices will be promptly paid when due. If buyer fails to comply with any terms of payment, seller, in addition to its other rights and remedies, but not in limitation thereof, reserves the right to withhold further deliveries or terminate the Agreement, and any unpaid amount thereon shall become due immediately. Terms of payment shall be as set forth on the Sales Contract.

**DELAYS AND DEFAULTS**: Delays or defaults in delivery by Seller of the goods and materials covered by the Sales Contract shall be excused so far as the same is caused by fire, strikes, accident, governmental regulation, or any delays unavoidable or beyond reasonable control of Seller. In no event shall Seller be liable for any consequential, special, or contingent damages on account of any default or delay in delivery.

**NON-CANCELLATION**: Orders are not subject to suspension, reduction, or cancellation, except on terms that will indemnify Seller against loss.

**SPECIFICATIONS**: Seller relies on specifications and other data furnished by the Buyer, an architect, contractor, or consulting engineer in all phases of the work covered by the Sales Contract. Seller shall be responsible to check quantities only. Alterations to or changes in specifications, approval of samples, changes in delivery instructions and all other instructions must be submitted in writing to Seller.

In the event Seller performs design or engineering work at the request of Buyer, an architect, contractor, consulting engineer, or representative in any phase of the work covered by the Sales Contract, Seller shall not be responsible for any damages claimed by Buyer as a result of alleged errors or defects in such design or engineering work.

**WARRANTY AND LIMITATION OF LIABILITY**: Seller warrants that the goods supplied by it have been manufactured in accordance with its standard manufacturing practices and conform to the contract or catalog description set forth in the order. Seller further warrants that the goods supplied by it are fit for the ordinary purpose or purposes specified in its catalog for which such goods are used when installed in accordance with Seller's recommended installation procedures. Except as stated herein, Seller makes no express warranty with respect to goods supplied by it and Seller makes no warranty that the goods are fit for any particular purpose.

When the use of materials not manufactured by Seller is suggested by Seller's recommended installation procedures or otherwise, Seller makes no express warranty with respect to such materials nor that such materials are merchantable or fit for any particular purpose.

Seller will, at its sole option, credit, repair or replace, any goods supplied by it which its examination shall disclose to its satisfaction are defective in workmanship or material and are returned to it within one year from the date of shipment and any claim not made within this period shall conclusively be deemed waived by Buyer. Credit, repair or replacement will be preconditioned upon examination of the goods by Seller, and, if requested by Seller, return of the goods to Seller at its direction and expense. No goods are to be returned to Seller without its written consent. Seller shall not be liable for any expense incurred by Buyer in order to remedy any defect in its goods. Seller shall not be liable for any consequential, special, or contingent damage or expense, arising directly or indirectly from any defect in its goods or from the use of any defective goods. The remedies set forth herein shall constitute the exclusive remedies available to Buyer and are in lieu of all other remedies.

**CLAIMS**: Claims for shortage of goods or for mistakes or errors in billing must be presented within forty-five (45) days from the date of shipment of goods and must state the packing slip number and container number applicable to the claim. Any claim not so presented will be conclusively deemed waived.

**TAXES**: Any federal taxes or other government charges on the sale, shipment, or installation of the goods or equipment covered by the Sales Contract shall be added to the price and paid by Buyer, or, in lieu thereof, the Buyer shall furnish the Seller with tax-exemption certificates acceptable to the taxing authority. The procedure also applies to duty and other similar charges on export sales. Seller is not responsible for sales and/or use tax in any state other than Ohio. The purchase made under this Sales Contract must be exempt or paid directly by Buyer. If Seller is required to pay any such tax, there shall be added to the prices quoted herein all such state and local taxes. Buyer agrees to reimburse and save Seller harmless from all such state and local taxes, including interest and penalties thereon, which may at any time be payable to any state or local government unit with respect to the sale of any goods or materials covered by the Sales Contract.

**CORRECTIONS**: Typographical or clerical errors contained in the Sales Contract, including prices, are subject to correction by the Seller.

**FAIR LABOR STANDARDS**: All goods covered by the Sales Contract have been produced in conformity with all applicable provisions of the Fair Labor Standards Act of 1938 as amended.

**RENEGOTIATION**: Unless advised by Buyer in writing, Seller assumes that Buyer's order and the Sales Contract are not renegotiable under the Renegotiation Act of 1951.

**APPLICABLE LAW**: All questions arising out of the Sales Contract, which shall be deemed an Ohio contract, shall be governed by the laws of the state of Ohio.

**EXCLUSIVE TERMS**: The Sales Contract shall constitute the complete contract between the parties, and no one has authority to depart from the terms and conditions set forth therein, nor to make any representations or arrangements other than those printed thereon whether in the execution or in the performance of the Sales Contract, unless the same are written on the face of the Sales Contract or are given in writing with it or in pursuance of it, and are fully approved in writing by an officer or authorized employee of the Seller.

**LIMITATION FOR SUITS**: Any controversy or claim arising out of or relating to this Sales Contract or the breach thereof, must be commenced within one (1) year after the cause of action accrued.

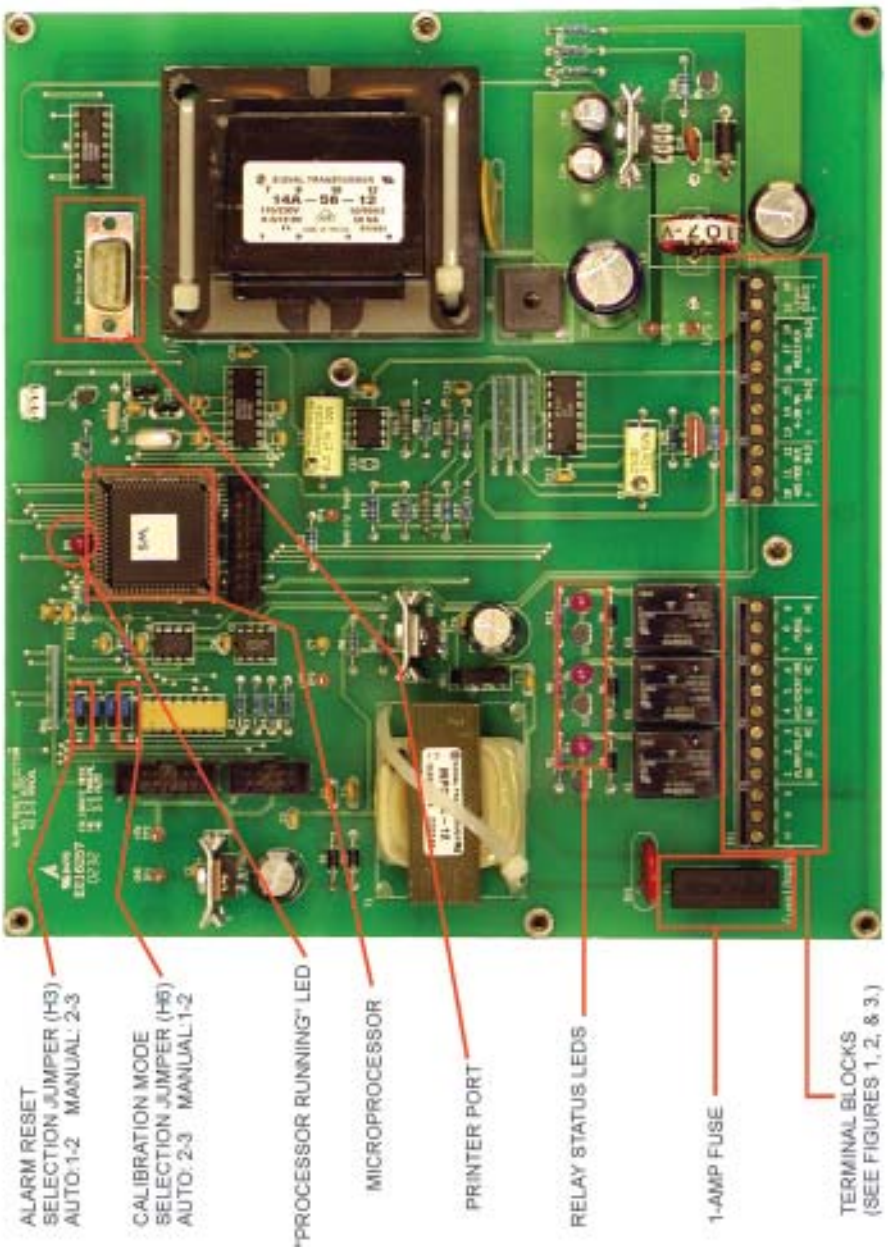



**Figure 1: Printed Circuit Board Assembly for A08740 Universal Opacity Monitor.**

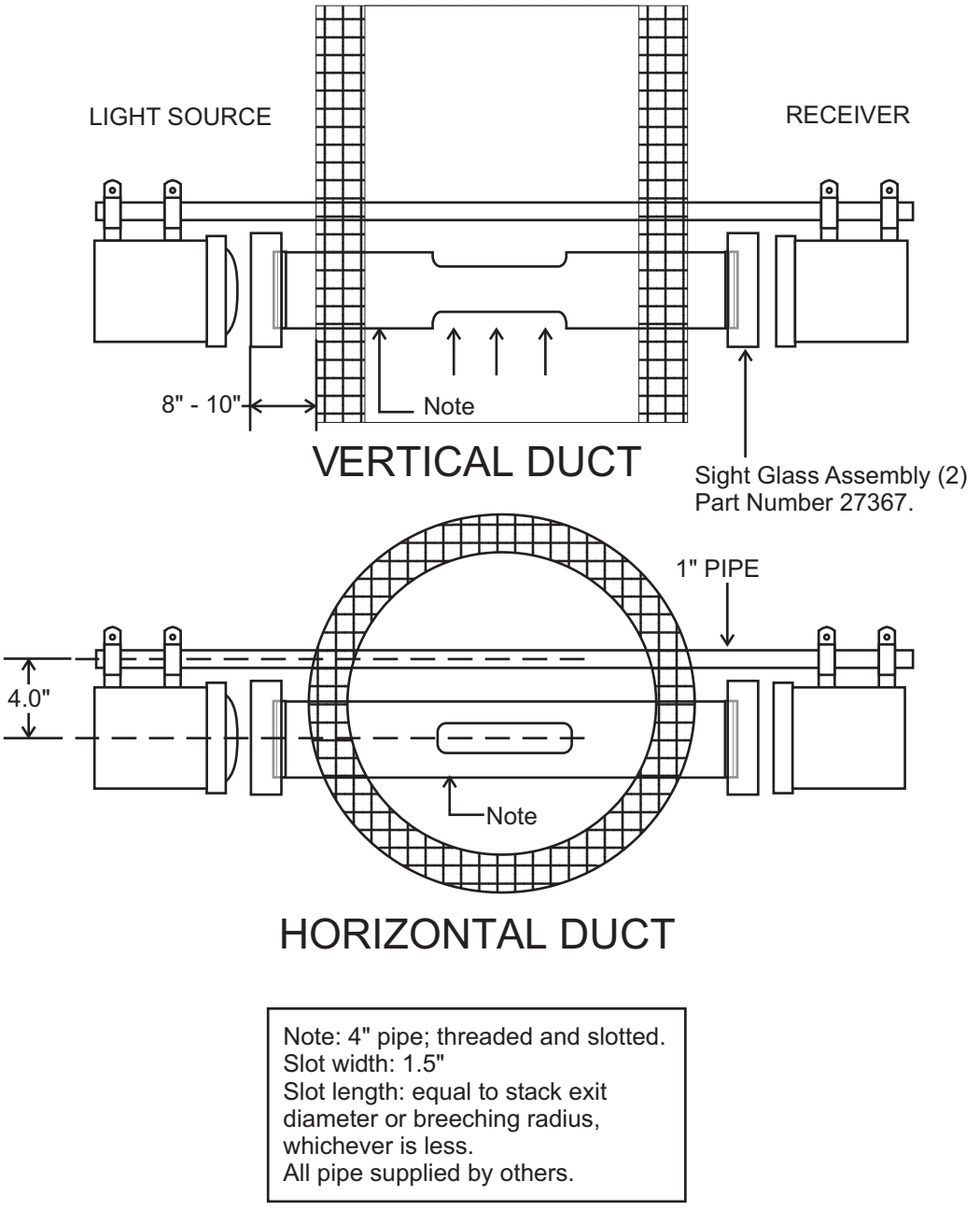



**Figure 2: Mounting the Breeching Units (A08740 Universal Opacity Monitor).**

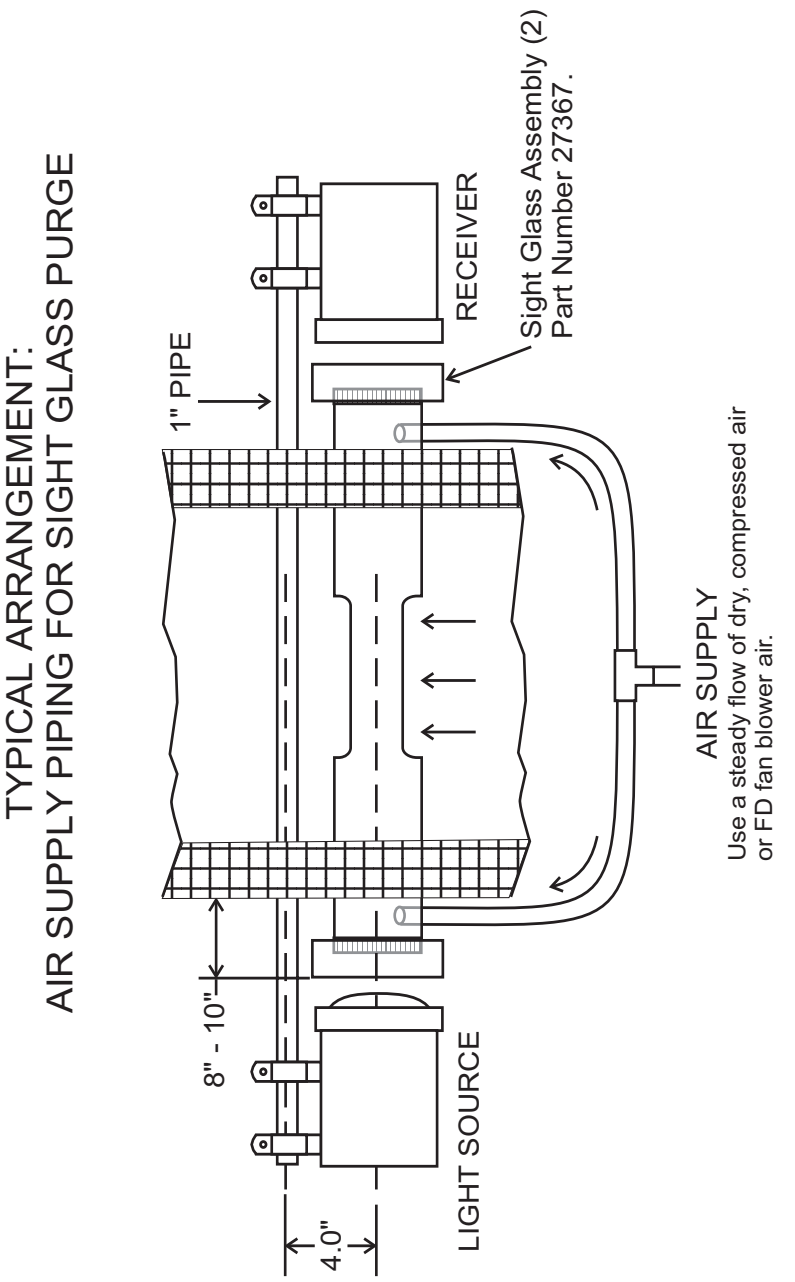



**Figure 3: Typical Air Supply Arrangement for Sight Glass Purge (A08740 Universal Opacity Monitor).**

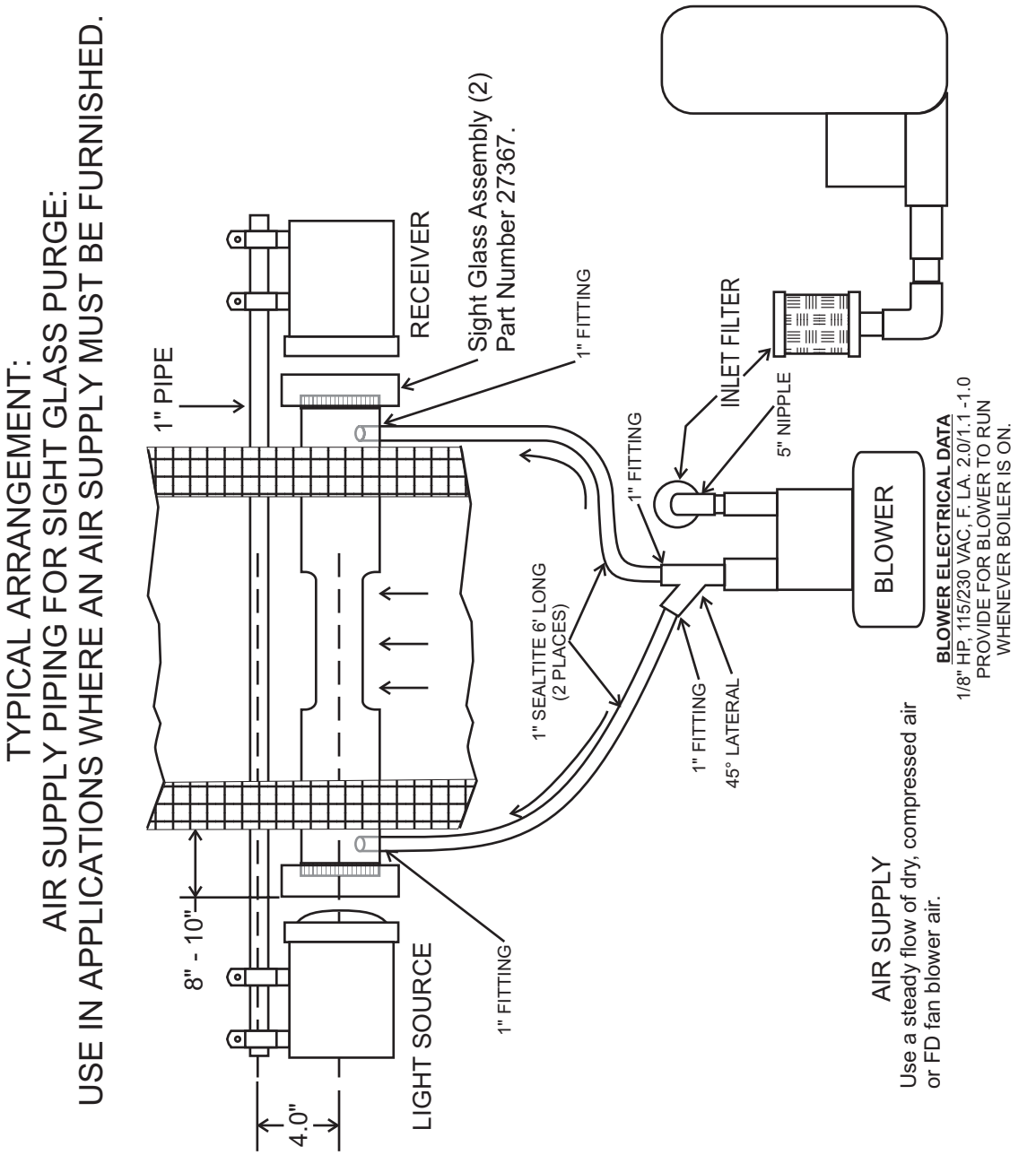
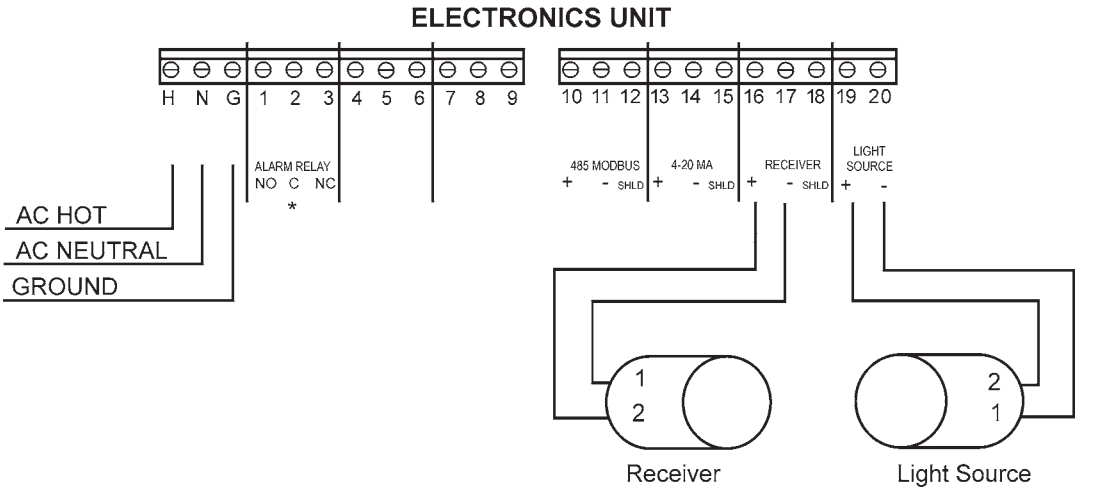



**Figure 4: Typical Air Supply Arrangement for Sight Glass Purge with Blower (A08740 Universal Opacity Monitor).**

## BASIC FIELD WIRING (NO AUXILIARY MODULES) FOR A-08740 UNIVERSAL OPACITY MONITOR

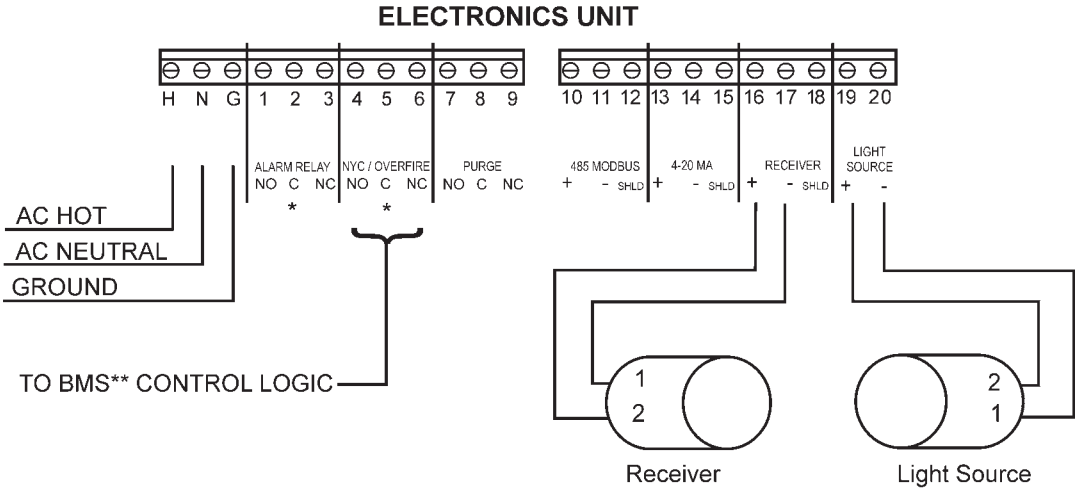



The light source and receiver operate at less than 24 VDC.
Light source wiring: two 14 AWG stranded wires.
Light receiver wiring: one shielded 16 AWG pair.
Wiring/cable length must not exceed 250 ft. (76 m.).
Install with a minimum of 3 feet (1m.) of flexible conduit at both the light source and receiver.

*NOTE: RELAY IS FAILSAFE:
ON POWER UP, RELAY IS ENERGIZED.
THE CONTACTS CHANGE STATE FROM **NO** TO **NC** AND **NC** TO **NO**.
**BMS = Burner Management System.

**Figure 5: Field Wiring for Universal Opacity Monitor, basic model (no auxiliary modules).**

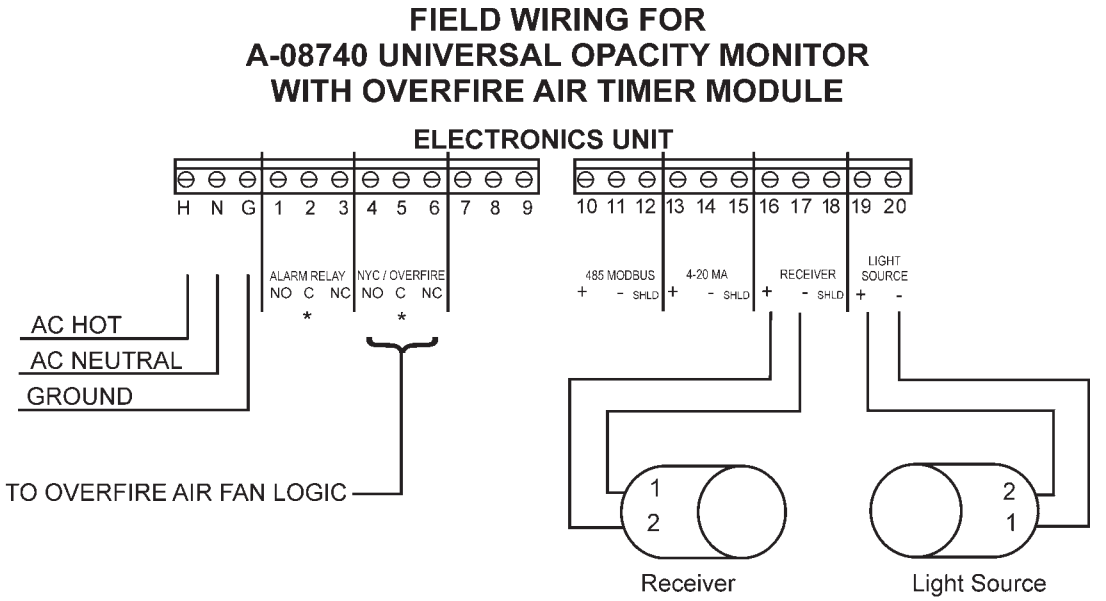
# FIELD WIRING FOR A-08740 UNIVERSAL OPACITY MONITOR WITH NYC BURNER SHUTDOWN MODULE




The light source and receiver operate at less than 24 VDC.
Light source wiring: two 14 AWG stranded wires.
Light receiver wiring: one shielded 16 AWG pair.
Wiring/cable length must not exceed 250 ft. (76 m.).
Install with a minimum of 3 feet (1m.) of flexible conduit at both the light source and receiver.

*NOTE: RELAYS ARE FAILSAFE:
ON POWER UP, RELAY IS ENERGIZED.
THE CONTACTS CHANGE STATE FROM **NO** TO **NC** AND **NC** TO **NO**.
**BMS = Burner Management System.

**Figure 6: Field Wiring for Universal Opacity Monitor Equipped with NYC Burner Cutoff Module.**




The light source and receiver operate at less than 24 VDC.
Light source wiring: two 14 AWG stranded wires.
Light receiver wiring: one shielded 16 AWG pair.
Wiring/cable length must not exceed 250 ft. (76 m.).
Install with a minimum of 3 feet (1m.) of flexible conduit at both the light source and receiver.

*NOTE: RELAYS ARE FAILSAFE:
ON POWER UP, RELAY IS ENERGIZED.
THE CONTACTS CHANGE STATE FROM **NO** TO **NC** AND **NC** TO **NO**.

**Figure 7: Field Wiring for Universal Opacity Monitor Equipped with Overfire Air Timer Module for Stoker Applications.**

| Display | Name | Function |
|---|---|---|
| Opacity | Opacity | Displays opacity level as 000-100%. |
| Cal% | Calibration | Unit is in opacity calibration mode. |
| Clear | Clear | Opacity is within permissable limits. |
| Smoke | Smoke | Flashes when opacity has exceeded the trip point. |
| Alarm | Alarm | Flashes when opacity has exceeded the trip point for longer than the delay period. |
| / | Micro-flipper | Indicates that microprocessor is running. |
| Delay: | Delay | Adjustable period during which process exceeds trip point before monitor goes to alarm condition. |
| Cutoff: | Cutoff | 120-second period during which process exceeds trip point before monitor goes to alarm condition |
| *NYC Cutoff: | NYC Cutoff | Displayed when monitor goes to alarm condition after 120-second period in which process exceeds trip point. NYC models only. |
| *Ovrfir | Overfire | Displayed as monitor initiates adjustable period after smoke is cleared during which contacts used to run overfire air blower are closed. |

* = Optional Features

**Figure 8: Summary of Continuous Display Screen. (Also see detailed tables on next nine pages.)**

| **Scrolling Display Screen: press "Enter" key to scroll through the following screens which display status messages and permit adjustment of parameters.** | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **1a** | **Default Screen** | Line 1: **OPACITY = XXX% / CLEAR**<br>Line 2: blank when line 1 reads "Clear". | Displays on Line 1 in operating mode when opacity is below the alarm trip point. Microprocessor flipper (/) spins. When "Clear" appears on line 1, there is no line 2 display. |
| **1b** | **Default Screen** | Line 1: **OPACITY = XXX% / SMOKE**<br>Line 2: timer countdown appears (see **screen 4** below). | **"Smoke" Blinks** on Line 1 in operating mode **immediately** when opacity exceeds the alarm trip point. |
| **1c** | **Default Screen** | Line 1: **OPACITY = XXX% / ALARM**<br>Line2: "**Delay = T/O**" (T/O = timed out.) | **"Alarm" Blinks** on Line 1 in operating mode when opacity exceeds the alarm trip point and the adjustable time delay has expired. |
| **2** | **Model** | Displays the model number of the **standard** opacity monitor and current software version: **87400 V___** | Models are factory-configured. If reconfiguration in the field is necessary, unplug the unit and reset the jumpers. Plug the unit in again. **Reconfiguration may require devices that are not available in the field.** |
| **3** | **Alarm Trip** | Displays the alarm trip point (opacity level at which alarm mode activates). | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 0-99% opacity. |
| **4** | **Delay Time** | In alarm mode, displays the delay period before the blinking "alarm" message replaces the continous "smoke" message. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 1-300 seconds. |
| **5** | **Purge Dly Time** | Displays the purge delay timer setting **only when monitor is set up in AUTO CAL mode.** Determines the time allowed for purging of the system. When the delay period expires the calibration cycle commences. | Adjust while the unit is powered and in AUTO CAL mode. Press "Inc" or "Dec" key to adjust the setting. Set from 1-600 seconds. |

**Figure 9: Scrolling Display Screens for Standard Models A-08740-*0-0X**

| Continuation of Scrolling Display Screen for Opacity Models A-08740-*0-0X | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **6** | **Modbus Addr** | Displays the modbus address. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 001 to 247. |
| **7** | **Baud Rate** | Displays the baud rate. | Adjust while the unit is powered. Toggle between 9600 and 19200, using "Inc" or "Dec" key to adjust the setting. |
| **8** | **Print Interval** | Displays the print interval. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 00 to 60. |
| **9** | **Enter Cal Menu?** | Promps user to return to default screen or begin calibration procedure. | Press "Inc" and "Dec" keys simultaneously to display "Calibrate Opacity" screen. Press "Enter" to return to default screen. |
| **10a** | **Calibrate Opacity** | Promps user to begin calibration of light source and receiver units or to advance to "Calibrate Retrans?" screen, line 11 below. | Press "Inc" and "Dec" keys simultaneously to access calibration mode of the light source and receiver units. Press "Enter" key to display "**Calibrate Retrans**" screen. |
| **10-b1** | **Stack Clear?** | Displays **only when monitor is set up in MANUAL CAL mode.** Prompts the operator to check the stack before calibration commences. | Press "Enter" to confirm that the stack is clear. |
| **10-b2** | **Auto-Cal Purge** | Displays **only when monitor is set up in AUTO CAL mode.** Counts down from value set in line 5 above. Automatically advances to next screen when purge is completed. | Observe countdown from purge delay value to 00. |
| **10c** | **Calibrate Phase-1** | First phase of calibration: light source lamp is off. | Observe countdown from 04 to 00. |
| **10d** | **Calibrate Phase-2** | Second phase of calibration: light source lamp is on. | Observe countdown from 40 to 00. |

| Continuation of Scrolling Display Screen for Opacity Models A-08740-*0-0X | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **11a** | **Calibrate Retrans?** | Promps user to begin calibration of the 4-20 ma DC retransmitted output or return to the default screen. | Press "Enter" to return to default screen. To proceed with calibration, connect a 4-20 ma meter to the retransmit terminals. Press "Inc" and "Dec" keys simultaneously to display "Set Retrans Low" screen. |
| **11b** | **Set Retrans Low** | Promps user to calibrate the low end of the retransmitted output: 4 ma DC. | Observe meter reading, and adjust as necessary by pressing "INC" and "DEC" keys until the meter reading is correct. The output can be varied from 4 ma DC by ±0.5 mA DC. |
| **11c** | **Set Retrans High** | Promps user to calibrate the high end of the retransmitted output: 20 ma DC. | Observe meter reading, and adjust as necessary by pressing "INC" and "DEC" keys until the meter reading is correct. The output can be varied from 20 ma DC by ±0.5 mA DC. |
| **12** | **Cal Err #1** | This message displays in calibration mode if the receiver does not detect sufficient light. | Resolve process conditions and recalibrate. |
| **13** | **Cal Err #2** | This message displays in calibration mode if the receiver detects too much light. | Resolve process conditions and recalibrate. |

| Scrolling Display Screen: press ""Enter"" key to scroll through the following screens which display status messages and permit adjustment of parameters. | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **1a** | **Default Screen** | Line 1: **OPACITY = XXX% / CLEAR**<br>Line 2: blank when line 1 reads "Clear". | Displays on Line 1 in operating mode when opacity is below the alarm trip point. Microprocessor flipper (/) spins. When "Clear" appears on line 1, there is no line 2 display. |
| **1b** | **Default Screen** | Line 1: **OPACITY = XXX% / SMOKE**<br>Line 2: timer countdown appears (see **screen 4** below). | **"Smoke" Blinks** on Line 1 in operating mode **immediately** when opacity exceeds the alarm trip point. |
| **1c** | **Default Screen** | Line 1: **OPACITY = XXX% / ALARM**<br>Line2: "**Delay = T/O**" (T/O = timed out.) | **"Alarm" Blinks** on Line 1 in operating mode when opacity exceeds the alarm trip point and the adjustable time delay has expired. |
| **2** | **Model** | Displays the model number of the **standard** opacity monitor and current software version: **87401 V___** | Models are factory-configured. If reconfiguration in the field is necessary, unplug the unit and reset the jumpers. Plug the unit in again. **Reconfiguration may require devices that are not available in the field.** |
| **3** | **Alarm Trip** | Displays the alarm trip point (opacity level at which alarm mode activates.) | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 0-99% opacity. |
| **4** | **Delay Time** | In alarm mode, displays the delay period before the blinking ""alarm"" message replaces the continous ""smoke"" message. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 1-300 seconds. |
| **5** | **Purge Dly Time** | Displays the purge delay timer setting **only when monitor is set up in AUTO CAL mode.** Determines the time allowed for purging of the system. When the delay period expires the calibration cycle commences. | Adjust while the unit is powered and in AUTO CAL mode. Press "Inc" or "Dec" key to adjust the setting. Set from 1-600 seconds. |

**Figure 10: Scrolling Display Screens for Standard Models A-08740-*0-1X with NYC burner cutoff functions.**

| Continuation of Scrolling Display Screen for Opacity Models A-08740-1X | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **6** | **Modbus Addr** | Displays the modbus address. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 001 to 247. |
| **7** | **Baud Rate** | Displays the baud rate. | Adjust while the unit is powered. Toggle between 9600 and 19200, using "Inc" or "Dec" key to adjust the setting. |
| **8** | **Print Interval** | Displays the print interval. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 00 to 60. |
| **9** | **Enter Cal Menu?** | Promps user to return to default screen or begin calibration procedure. | Press "Inc" and "Dec" keys simultaneously to display "Calibrate Opacity" screen. Press "Enter" to return to default screen. |
| **10a** | **Calibrate Opacity** | Promps user to begin calibration of light source and receiver units or to advance to "Calibrate Retrans?" screen, line 11 below. | Press "Inc" and "Dec" keys simultaneously to access calibration mode of the light source and receiver units. Press "Enter" key to display "Calibrate Retrans" screen. |
| **10-b1** | **Stack Clear?** | Displays **only when monitor is set up in MANUAL CAL mode.** Prompts the operator to check the stack before calibration commences. | Press "Enter" to confirm that the stack is clear. |
| **10-b2** | **Auto-Cal Purge** | Displays **only when monitor is set up in AUTO CAL mode.** Counts down from value set in line 5 above. Automatically advances to next screen when purge is completed. | Observe countdown from purge delay value to 00. |
| **10c** | **Calibrate Phase-1** | First phase of calibration: light source lamp is off. | Observe countdown from 04 to 00. |
| **10d** | **Calibrate Phase-2** | Second phase of calibration: light source lamp is on. | Observe countdown form 40 to 00. |

| Continuation of Scrolling Display Screen for Opacity Models A-08740-1X | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **11a** | **Calibrate Retrans?** | Promps user to begin calibration of the 4-20 ma DC retransmitted output or return to the default screen. | Press "Enter" to return to default screen. To proceed with calibration, connect a 4-20 ma meter to the retransmit terminals. Press "Inc" and "Dec" keys simultaneously to display "Set Retrans Low" screen. |
| **11b** | **Set Retrans Low** | Promps user to calibrate the low end of the retransmitted output: 4 ma DC. | Observe meter reading, and adjust as necessary by pressing "INC" and "DEC" keys until the meter reading is correct. The output can be varied from 4 ma DC by ±0.5 mA DC. |
| **11c** | **Set Retrans High** | Promps user to calibrate the high end of the retransmitted output: 20 ma DC. | Observe meter reading, and adjust as necessary by pressing "INC" and "DEC" keys until the meter reading is correct. The output can be varied from 20 ma DC by ±0.5 mA DC. |
| **12** | **Cal Err #1** | This message displays in calibration mode if the receiver does not detect sufficient light. | Resolve process conditions and recalibrate. |
| **13** | **Cal Err #2** | This message displays in calibration mode if the receiver detects too much light. | Resolve process conditions and recalibrate |

| **Scrolling Display Screen: press ""Enter"" key to scroll through the following screens which display status messages and permit adjustment of parameters.** | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **1a** | **Default Screen** | Line 1: **OPACITY = XXX% / CLEAR**<br>Line 2: blank when line 1 reads "Clear". | Displays on Line 1 in operating mode when opacity is below the alarm trip point. Microprocessor flipper (/) spins. When "Clear" appears on line 1, there is no line 2 display. |
| **1b** | **Default Screen** | Line 1: **OPACITY = XXX% / SMOKE**<br>Line 2: timer countdown appears (see **screen 4** below). | **"Smoke" Blinks** on Line 1 in operating mode **immediately** when opacity exceeds the alarm trip point. |
| **1c** | **Default Screen** | Line 1: **OPACITY = XXX% / ALARM**<br>Line2: "**Delay = T/O**" (T/O = timed out.) | **"Alarm" Blinks** on Line 1 in operating mode when opacity exceeds the alarm trip point and the adjustable time delay has expired. |
| **2** | **Model** | Displays the model number of the **standard** opacity monitor and current software version: **87402 V___** | Models are factory-configured. If reconfiguration in the field is necessary, unplug the unit and reset the jumpers. Plug the unit in again. **Reconfiguration may require devices that are not available in the field.** |
| **3** | **Alarm Trip** | Displays the alarm trip point (opacity level at which alarm mode activates.) | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 0-99% opacity. |
| **4** | **Delay Time** | In alarm mode, displays the delay period before the blinking "alarm" message replaces the continous "smoke" message. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 1-300 seconds. |
| **5** | **Purge Dly Time** | Displays the purge delay timer setting **only when monitor is set up in AUTO CAL mode.** Determines the time allowed for purging of the system. When the delay period expires the calibration cycle commences. | Adjust while the unit is powered and in AUTO CAL mode. Press "Inc" or "Dec" key to adjust the setting. Set from 1-600 seconds. |

**Figure 11: Scrolling Display Screens for Standard Models A-08740-*0-2X with overfire air timer functions.**

| Continuation of Scrolling Display Screen for Opacity Monitor Models A-08740-2X | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **6** | **Modbus Addr** | Displays the modbus address. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 001 to 247. |
| **7** | **Baud Rate** | Displays the baud rate. | Adjust while the unit is powered. Toggle between 9600 and 19200, using "Inc" or "Dec" key to adjust the setting. |
| **8** | **Print Interval** | Displays the print interval. | Adjust while the unit is powered. Press "Inc" or "Dec" key to adjust the setting. Set from 00 to 60. |
| **9** | **Enter Cal Menu?** | Promps user to return to default screen or begin calibration procedure. | Press "Inc" and "Dec" keys simultaneously to display "Calibrate Opacity" screen. Press "Enter" to return to default screen. |
| **10a** | **Calibrate Opacity** | Promps user to begin calibration of light source and receiver units or to advance to "Calibrate Retrans?" screen, line 11 below. | Press "Inc" and "Dec" keys simultaneously to access calibration mode of the light source and receiver units. Press "Enter" key to display "Calibrate Retrans" screen. |
| **10-b1** | **Stack Clear?** | Displays **only when monitor is set up in MANUAL CAL mode.** Prompts the operator to check the stack before calibration commences. | Press "Enter" to confirm that the stack is clear. |
| **10-b2** | **Auto-Cal Purge** | Displays **only when monitor is set up in AUTO CAL mode.** Counts down from value set in line 5 above. Automatically advances to next screen when purge is completed. | Observe countdown from purge delay value to 00. |
| **10c** | **Calibrate Phase-1** | First phase of calibration: light source lamp is off. | Observe countdown from 04 to 00. |
| **10d** | **Calibrate Phase-2** | Second phase of calibration: light source lamp is on. | Observe countdown from 40 to 00. |

| Continuation of Scrolling Display Screen for Opacity Models A-08740-*0-2X | | | |
|---|---|---|---|
| **Screen** | | **Function** | **Adjustment Procedure** |
| **11a** | **Calibrate Retrans?** | Promps user to begin calibration of the 4-20 ma DC retransmitted output or return to the default screen. | Press "Enter" to return to default screen. To proceed with calibration, connect a 4-20 ma meter to the retransmit terminals. Press "Inc" and "Dec" keys simultaneously to display "Set Retrans Low" screen. |
| **11b** | **Set Retrans Low** | Promps user to calibrate the low end of the retransmitted output: 4 ma DC. | Observe meter reading, and adjust as necessary by pressing "INC" and "DEC" keys until the meter reading is correct. The output can be varied from 4 ma DC by ±0.5 mA DC. |
| **11c** | **Set Retrans High** | Promps user to calibrate the high end of the retransmitted output: 20 ma DC. | Observe meter reading, and adjust as necessary by pressing "INC" and "DEC" keys until the meter reading is correct. The output can be varied from 20 ma DC by ±0.5 mA DC. |
| **12** | **Cal Err #1** | This message displays in calibration mode if the receiver does not detect sufficient light. | Resolve process conditions and recalibrate. |
| **13** | **Cal Err #2** | This message displays in calibration mode if the receiver detects too much light. | Resolve process conditions and recalibrate. |

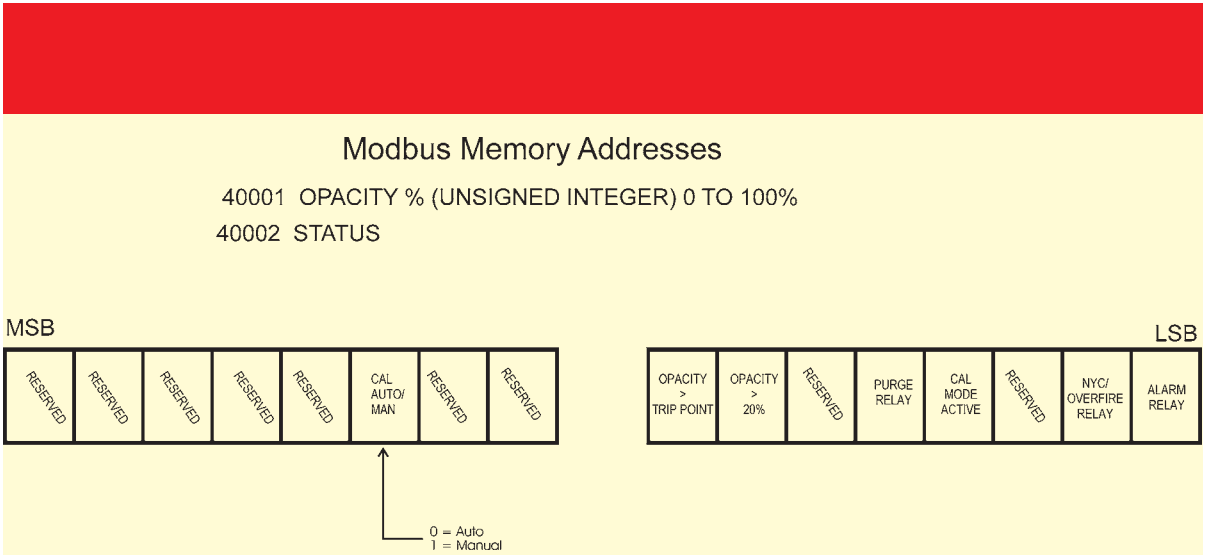



**Figure 12: Modbus Memory Addresses**

| ON/OFF TIMING | STATUS/FAULT |
|---|---|
| 1 SECOND | MICROPROCESSOR IS FUNCTIONING PROPERLY. |
| 0.1 SECOND | BROWN OUT: RESET VOLTAGE HAS DROPPED BELOW THE PROPER LEVEL.* |
| 0.05 SECOND | WATCH DOG TIMER RESET: AN ERROR HAS OCCURRED IN THE MICROPROCESSOR.* |

*Turning the power off and then back on may clear up this fault. If it does not, contact Hays Cleveland.

**Figure 13: "Processor Running" LED**

# TROUBLESHOOTING

| Component | Symptom | Possible Problem |
|---|---|---|
| **Control Unit** | Alarm or Opacity section of the control unit is not operating properly. | Main Pc. Board is faulty: replace. |
| | | One of the alarm or opacity controls is faulty: %, Set 100%, Delay, or Trip Point Control. |
| | The 4-20 ma output is not operating properly. | 4-20 ma field wiring is faulty. |
| | | Main Pc. Board is faulty: replace. |
| **Display Assembly** | The control unit can be calibrated by monitoring the 4-20 ma output, but not by watching the "per cent Opacity" display. | Display assembly is faulty: replace. |
| | Some of the number segments on the "per cent Opacity" display do not go on or off properly. | |
| **Light Source Assembly** | Lamp does not light but 4-10 V DC is present at the lamp terminals. | Lamp is burned out: replace. |
| | Lamp does not light and no voltage is present at Terminals 1 and 2, but voltage is present at the control unit terminals 19 and 20. | The interconnecting wire is open. |
| | Lamp does not light, and no voltage is present at Terminals 19 and 20. | Light source fuse is blown: replace. |
| | | Main fuse is blown: replace. |
| | | Light source transformer is faulty: replace. |
| | | Main p.c. board is faulty: replace. |
| **Receiver Assembly** | Light source is operating properly but unit will not calibrate. | Receiver assembly is faulty: replace. |
| | | Main p.c. board assembly is faulty: replace. |
| | | Interconnecting wiring is open. |

**Figure 14: Troubleshooting**