Optical Scientific Inc.

# User's Guide
# OFS 2000-C
# Optical Flow Sensor

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## Revision Log

| Rev Date | Description of Changes |
|---|---|
| 11/29/2011 | Production Release |
| 04/11/2012 | Added explanation for second current loop full scale |
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OFS-2000 Certifications
UL 3101-1:1993
CSA C22.2 No. 1010.1:92
IEC 61010:1999

OSi is an ISO-9001 Registered Company

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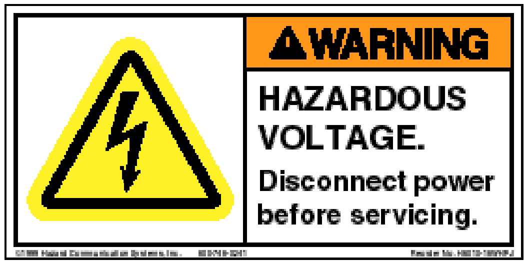
## Caveats

Only trained personnel are allowed to service this equipment.

The OFS shall only be used in a manner specified by the manufacturer.




This equipment contains hazardous voltages.

Disconnect AC power before servicing.

Optical Scientific, Inc. will not be held liable for any accident, injury to personnel, or damage to property incurred while operating or servicing this equipment. Implementation and enforcement of proper work safety procedures is solely the responsibility of the user, user employees or contracted personnel.

**!CAUTION!**
Read the entire User's Guide before proceeding with any installation or maintenance activity.

# 1 OFS -2000-C OVERVIEW

## 1.1 Theory of Operation

Scintillation is the variation of light caused by it's passage through pockets of air with different temperature and density. It's what makes the stars seem to twinkle in the night sky. OFS uses scintillation in air flow to determine velocity. Our proven measurement technology originally developed and patented for use in atmospheric visibility and turbulence detecting instruments, offers unequalled response and accuracy in air flow sensing.

The basic system consists of:

- Transmitter unit that emits an eye-safe red light beam
- Receiver unit containing 2 photodetectors and signal amplifiers
- Control unit that houses the DC power supply, DSP, control and user interface
- Temperature probe for temperature correction
- Heat Activator rod

Transmitter


Receiver

Activator Heater & RTD Temp Probe


Control Unit

**Figure 1-1 OFS Basic Components**

The LED in the transmitter emits a light beam which illuminates twin photodetectors in the receiver. The received signal is amplified and sent to the Digital Signal Processor (DSP) in the Control Unit. The results are shown on the front panel display and relayed to the customer either through a 4-20 mA current loop or through an RS-232 interface.

The system is designed to fit standard commercial/industrial installations and to easily interface with PC, PLC, DAS, CEM - almost any data collection device

OFS -2000-C Specifications

| | | |
|---|---|---|
| **Flow Performance** | | |
| Technique | Optical scintillation | |
| Velocity Range | 0.1 to 40 m/s velocity | |
| Path Distance | 0.3 to 4 meters (1 to 12 feet) | |
| Accuracy | 2% of reading | |
| Resolution | 0.1 m/s | |
| Averaging Time | User selectable: 3 sec to 600 sec | |
| Long Term Drift | <1% >6 months | |
| Media Temperature | No upper limit (for cold air applications an 'activator' may be required) | |
| Light Source | 670 nm red LED | |
| Beam Divergence | 5 degrees | |
| Optics | Quartz | |
| Purge | Purge fittings supplied (Nominal recommendation is 4 CFM per system) | Factory-supplied instrument – grade purged air with 1-2 CFM |
| **Maintenance** | | |
| Diagnostics | Continuous monitoring of sensor status including power supply voltage check, performance check, optics contamination, etc | |
| Indicators | TX Optical Unit - LEDs indicating power ON & correct operation<br>RX Optical Unit - LEDs indicating power ON & correct operation<br>Control Box - LEDs indicating correct operation | |
| **Operational Environment** | | |
| Ambient Temperature | -40 to 60 C | |
| Dust Intrusion | IP65 | |
| Moisture | 0-100% condensing with dry purge air supplied | |
| **Data Output** | Four 4-20 mA optical isolated outputs | |
| | Loop 1 – Velocity | Loop 3 – Temperature (optional) |
| | Loop 2 - Volume | Loop 4 – Pressure (optional) |
| | Two relays for fault and calibration check indications | |
| **Control/Data Interface** | RS-232 ASCII, DB9 exterior serial port. USB adapter included<br>Baud rate (9600 standard) 8 data bits, no parity, 1 stop bit<br>2 Data output string formats<br>Short with only velocity and P/F status<br>Long with all velocity and status data<br>Front panel backlit LED display | |
| **Power Requirements** | Fuse, Surge, & EMI protected | |
| | Transmitter Unit | Universal 100-240 VAC, 50/60 Hz, 12 VA |
| | Control Box | Universal 100-240 VAC, 50/60 Hz, 40 VA |
| | Activator Heater | 120 VAC, 50/60 Hz, 15A |
| **Physical Characteristics** | | |
| Weight | TX & RX Optical Units | 5 kg ea |
| | Control Box (NEMA-4), | 4.7 kg |
| | Flange Adapter (spool piece) (2) | 3 kg ea |
| Dimensions | TX & RX Optical Units | 15 x 15 x 14 cm ea |
| | Control Box (NEMA-4), | 34 x 28 x 17 cm |
| | Flanged Adapter (spool piece) | 9-in. dia. (150# 4" ANSI bolt pattern on user end)<br>6-inch (15 cm) long |
| Materials | TX & RX Optical Units | Aluminum with powder-coat paint |
| | Control Box | Aluminum with powder-coat paint (NEMA-4) |
| | Adapter | Aluminum with powder-coat paint |

## 1.2 Description of Units

The OFS -2000-C has five main elements:

- Transmitter (TX) Unit [1910-100]
- Receiver (RX) Unit [1910-200]
- Control Box [1910-302]
- Activator Heater [1910-850]
- Temperature Probe [1910-852]

The TX and RX Units use identical packaging to house the optical and electronic subsystems. All parts are made from powder-coated aluminum, and are weather tight. Both housings have holes for standard 1/2" electrical fittings for cable or conduit. 1/4" NPT fittings are provided for low-pressure air if internal pressurization is required.

Note: Both TX and RX units are supplied with integral "spool piece" flange adapters. These adapters provide isolation and are equipped with 1/8" NPT purge air fittings to keep the light path clear.

The Control Box houses the DSP processor, power supply, and interface components. The Box is connected to the RX Unit via a shielded cable (P/N 1910-217) supplied with the OFS. The Control Box meets NEMA-4 standards. It has 1/2" conduit holes for the user to make power and signal/communications connections. The user supplies power and communication cables. The use of 1/2-inch flex conduit is recommended to protect the wiring from the harsh industrial environment.

The Temperature Probe is used to monitor flow temperature.

The Activator Heater is used to excite scintillation where air flow is < 150°F [65.6°C]

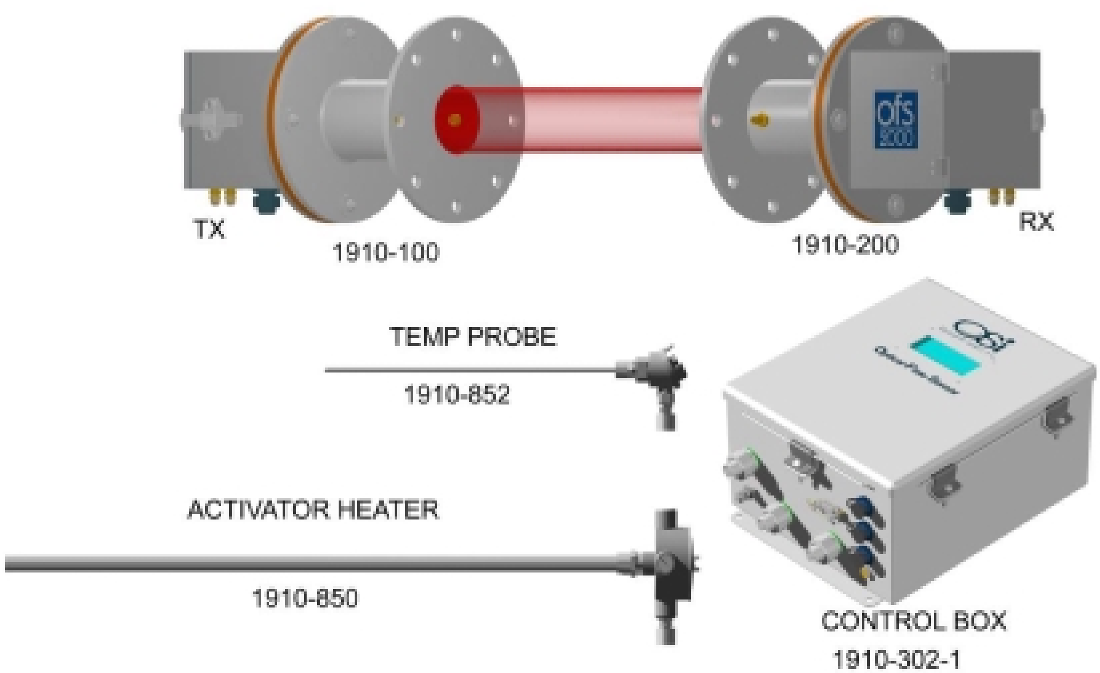



**Figure 1-2 OFS System Components**

## 1.3 Transmitter (TX) Unit

The TX Unit, P/N 1910-100, consists of two major parts, the housing and the flange adapter. Figure 1.3 illustrates the major components of the TX unit.

The OFS TX and RX units (with integral spool piece) are designed to mate to an ANSI 150 # 4" flange as is commonly used in commercial applications. The flange adapter (spool piece) is provided for this purpose. It also provides thermal isolation from the air flow to be measured and, when supplied with purge air, an air curtain to help keep the atmosphere in the mounting nozzles clear and the windows clean.

The transmitter housing contains the transmitter optical assembly and transmitter driver circuit board. The optical assembly is pre-aligned in the factory and needs no focusing, just aiming. The LED (transmitter optical module) aim is adjustable to ensure the eye-safe red light beam properly illuminates the detectors in the RX Unit.

The transmitter driver circuit board contains a universal (100 - 240 VAC) power supply, 1A, 250V, 3AG fuse, and modulation & drive circuitry for the light source.

Two indicator LEDs are provided on the PCB to indicate correct operation of the TX Unit:

- a red LED is ON when AC power is supplied.
- a green LED is ON when the transmitter red LED is operating with the proper modulation.

A user-supplied AC power cable connects to the three position terminal block on the PCB. [See Section 3.7 AC Power Connections]

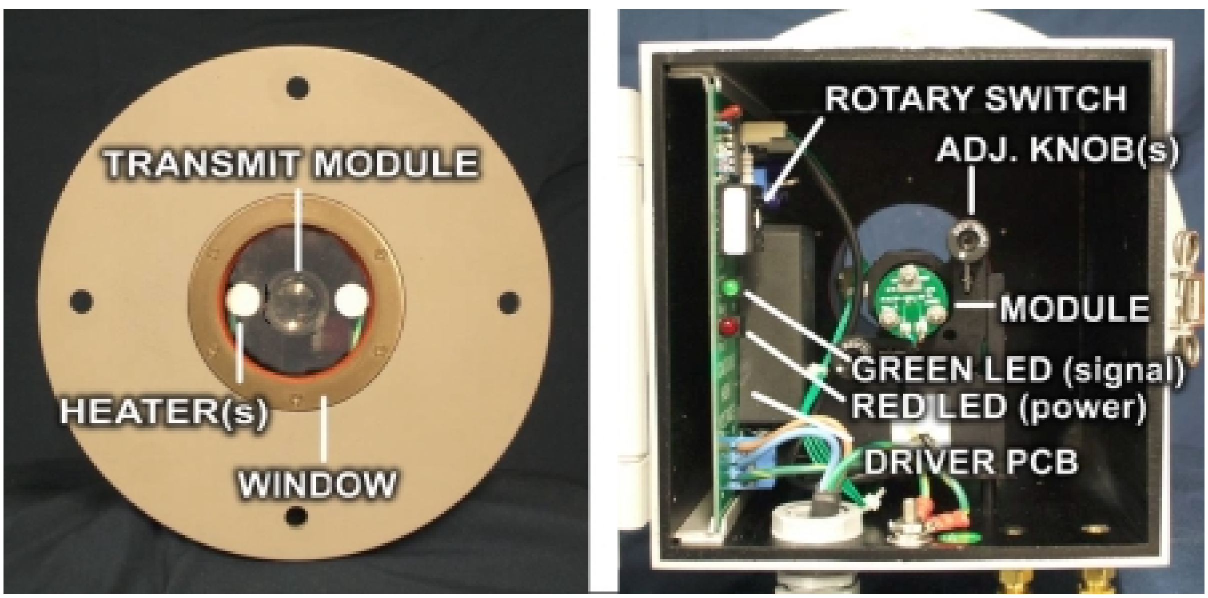



**Figure 1-3 OFS 2000-C Transmitter**

## 1.4 Receiver (RX) Unit

The RX Unit, P/N 1910-200-1, consists of two major parts, the housing and the flange adapter (spool piece). Figure 1.4 illustrates the major components of the RX unit.

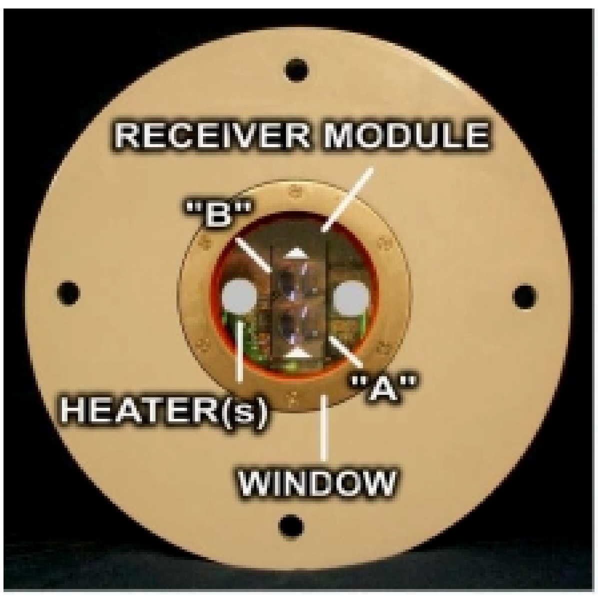
The OFS TX and RX units (with integral spool piece) are designed to mate to a 150#, 4" ANSI flange as is commonly used in commercial applications. The flange adapter (spool piece) is provided for this purpose. It also provides thermal isolation from the air flow to be measured and, when supplied with purge air, an air curtain to help keep the atmosphere in the mounting nozzles clear and the windows clean.

Mounting screws and gaskets are supplied for installing the Transmitter and flange adapter on the customer's flange. A silicone gasket is provided between the housing and the flange adapter to provide a weather-tight seal. A 9-inch diameter Kevlar gasket is provided for the user to place between the flange adapter and the user supplied mating flange. Complete sealing of the flange is critical for proper operation.

The housing contains the receiver optics and amplifier electronics subassemblies. The optics assembly is pre-aligned in the factory and needs no focusing in the field. The optical assembly is mounted on a circular PCB which is rotated to align the twin photodetectors with the direction of flow.

Two indicator LEDs are provided on the PCB to indicate correct operation of the TX Unit:

- A red LED is ON when AC power is supplied.
- A green LED is ON when infrared light is being received from the TX Unit.
  (Note: This LED is NOT an indicator of signal strength.
-



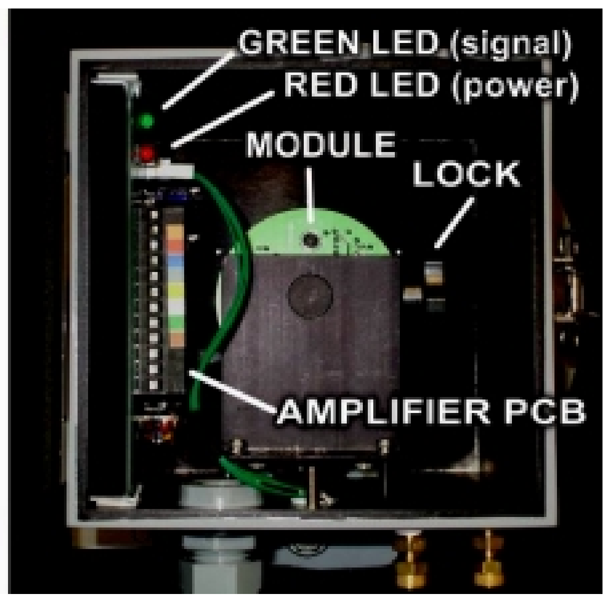




**Figure 1-4 OFS Receiver**

## 1.5 Control Box

1910-302 Control Box is housed in an enclosure that meets NEMA-4 standards The Control Box may be hard-wired using either cables or flexible conduit at the customer's discretion.

**A** AC Power connection J1

**B** Power Supply
The OFS contains a universal input DC power supply that operates with input voltages from 100 to 240 VAC, 50/60 Hz. This allows the unit to operate with all line voltages world-wide.

**C** Control/Interface Board
Central point for all of the OFS interconnections.

- DC Power distribution for internal components and OFS Receiver
- TB1 connections for the Control Box to the RX Unit. [F]
- TB2 connections for the fault relays, and optional Calibration [E]
- TB3 connections for 4-20 mA current loops.[D]
- J2, J3, J4 DSP data interconnects
- J5 DB9 Serial Data I/O (connects to enclosure bottom [J5])
- J6 connections for enclosure cover display [L]
- J7 Remote display connector (connects to enclosure bottom [J7])
- J8 Factory test connector
- J9 Air Temperature connects to enclosure bottom [J9]
- J10 Heater Current Sensor connects to enclosure bottom [J10]
- U6 Pressure Sensor connects to filter fitting "Pressure Port" at enclosure bottom

**D** TB3 4-20mA Current Loop Outputs [see Section

**E** TB2 Fault Relay & External Cal Check [ see Section

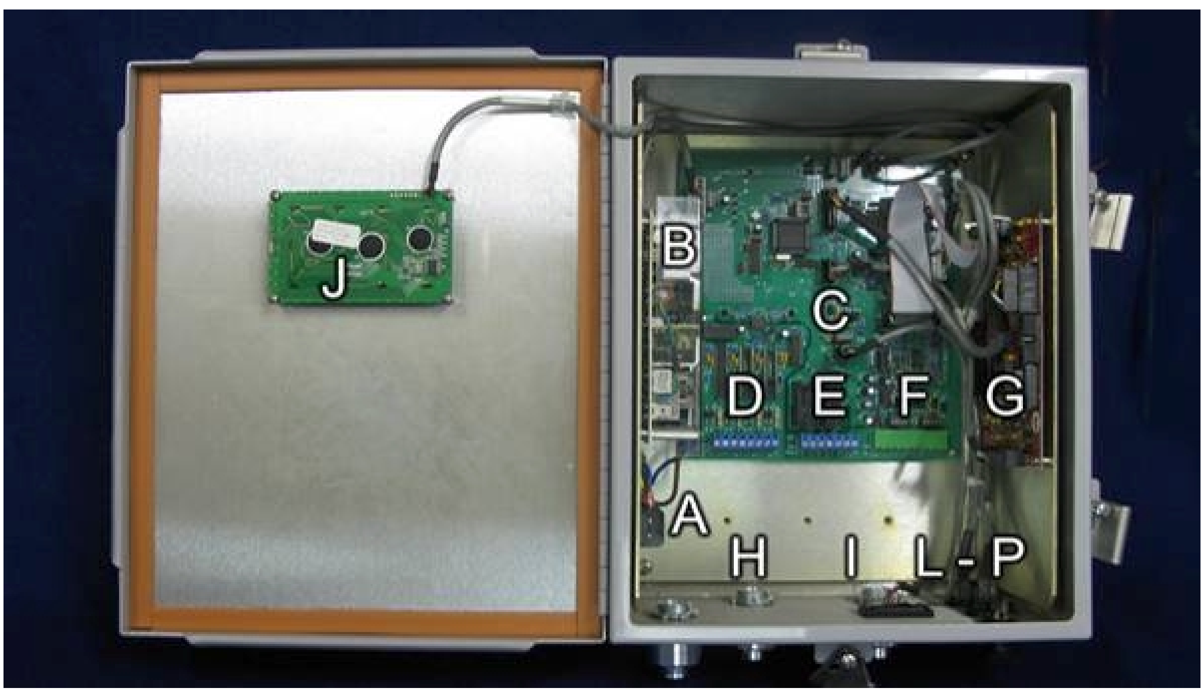



**Figure 1-5 OFS Control Box**

**F** TB1 Receiver Power and Signal I/O

**G** Digital Signal Processor (DSP)
This board is a state-of-the-art digital processor used to convert the optical data from the RX Unit into flow measurements. This data is transmitted to the microcontroller to be integrated into the information data stream.

**H** 1/2" Conduit fitting for User's Analog I/O wiring

**I** 1/2" Conduit fitting for receiver interconnect cabling

**J** Control unit information display

**K** Ground Lug – User must connect to Earth ground.

**L** J5 DB9 RS-232 serial interface connector [connects to J5 header on Control Interface PCB]

**M** J7 Remote display connector [connects to J7 header on Control Interface PCB]

**N** J9 Air Temp. sensor connector [connects to J9 header on Control Interface PCB]

**O** J10 Heater current sensor connector [connects to J10 header on Control Interface PCB]

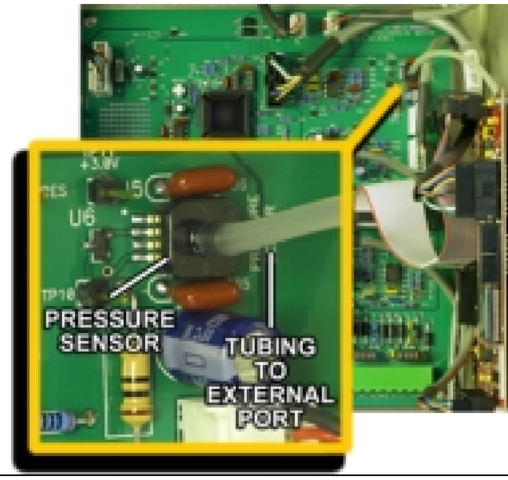
**P** Filter fitting for air pressure sensor [connects to U6 pressure sensor on Control Interface PCB]


**Figure 1-6 OFS Control Box**


**Figure 1-7 Control Display**

The Control Box Display is a back lit LCD type and shows:

- Velocity
- Volumetric Flow
- Temperature of flow media
- Atmospheric pressure
- Signal correlation
- A Channel & B Channel voltages

| | |
|---|---|
| The Pressure Sensor is located on the Control/Interface board. It is a state-of-the-art, monolithic, signal conditioned, silicon piezo-resistive pressure sensor. It connects to a filter fitting at the bottom of the control enclosure. See Figure XXXX Section XXXX<br><br>This sensor provides an accurate, high level analog output signal that is proportional to applied pressure. The pressure range is rated 2.2 - 16.7 PSI.<br><br>The pressure sensor output is integrated into the data stream and passed on to the DSP along with information from the Temperature Sensor. |  |
| | **Figure 1-8 Pressure Sensor** |

## 1.6 Temperature Probe

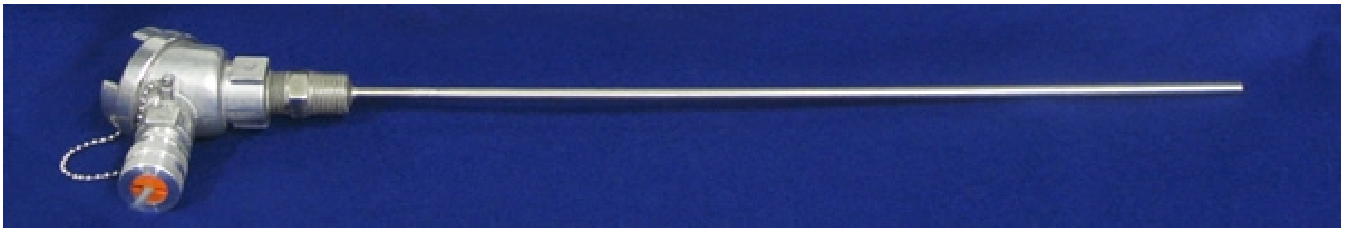


**Figure 1-9 Temperature Probe**

The Temperature Probe [1910-852] is an RTD type. The probe itself is 1/4" diameter 18" long, stainless steel, with an aluminum connector head. It screws into a 1/2" NPT port and is provided with a cable which plugs into the J3 connector at the bottom of the Control Box. The operational range for OFS 2000-C is -40° to +932°F [-40° to +500°C].

## 1.7 Activator Heater

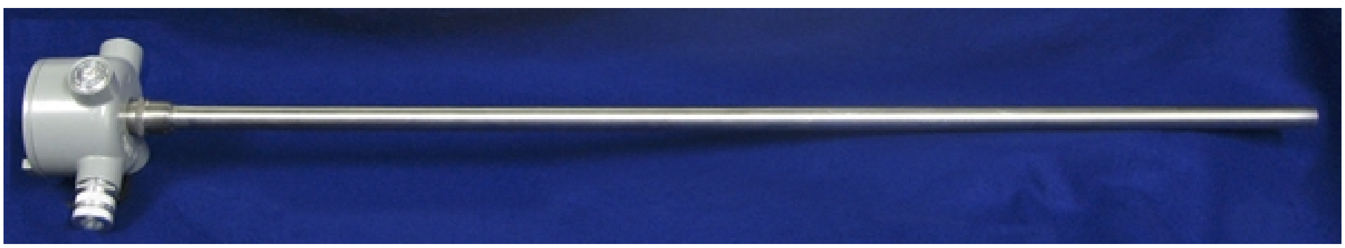


**Figure 1-10 Activator Heater**

The Activator Heater [1910-850] is rated at 1500W @ 120V. It is recommended that a dedicated branch circuit controlled with a 15A breaker be provided. The heater element is 3/4" in diameter 36" long with an INCONEL™ sheath and threaded to fit a 3/4" NPT port. The active portion of the heating element begins 12" from the base and extends the remaining 24" to the end of the rod. The connector head is Class I, Div. 1 & 2, Groups C,D rated. The heater element is equipped with a K-type thermocouple. For OFS 2000-C application a current-sensing circuit is used. The connecting cable (provided) plugs into the J4 connector at the bottom of the Control Box.

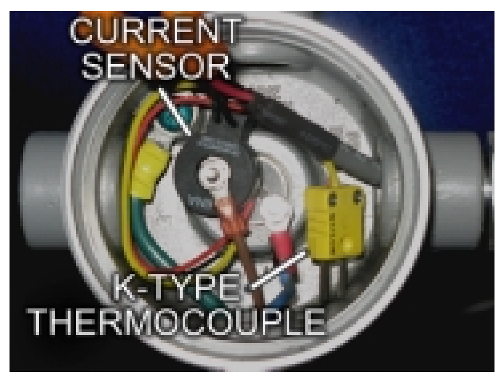



**Figure 1-11 Heater Current Sensor**

**!CAUTION!**

Heater can reach temperatures of over 14000°F [7760°C] when unregulated. Do not operate without proper control.

# 2 Pre – Installation

## 2.1 OFS Placement

One of the major concerns with installing a flow sensor is proper placement and alignment. Alignment will be addressed in the next section.

Since air flow has the characteristics of a fluid, the best location for any flow sensor is always at the place where the flow profile is well developed and consistent. A certain amount of leading and trailing distance (usually defined in "pipe diameters") from bends or flow disturbances in the pipe or stack is necessary for stabilization. Most types of flow sensors need very long straight distances. Because the OFS light beam passes through the entire flow cross-section, it can tolerate much shorter linear length, where other instruments may require ten times the distance.

Usually linear lengths more than two times the pipe diameter leading (upstream of the OFS) and one times the pipe diameter trailing are good enough for OFS to make a representative flow measurement. In some cases, OFS 2000-C units have been installed right at the elbow of a pipe and still provided satisfactory measurements. Consult OSI if you have any placement concerns.

Application requirements may require differing arrangements from the standard stack or duct. The shape, diameter, or cross section must also be taken into consideration. In some cases two OFS systems have been used in an "X" configuration to measure a large stack. In others, they have been mounted diagonally to measure across a rectangular duct corner-to-corner. The OFS will measure at any distance from 0.15 to 10 meters. Other distances are possible. Again consult OSI if you have questions regarding proper placement.

**Note:** In cases like these, it is advisable to mount the units so that the light beam is aligned along the axis of the upstream bend. This ensures that any stratification in the developed flow pattern will pass through the light beam and not slip by on either side.

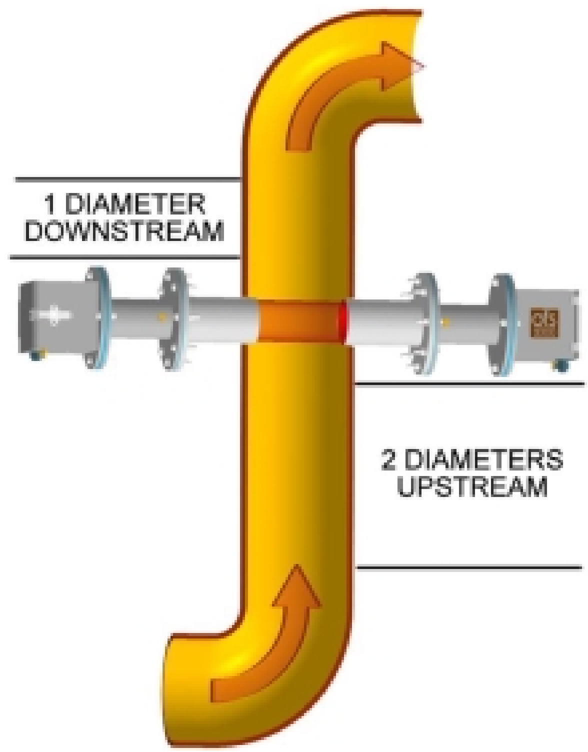



**Figure 2-1 OFS Placement**

The Transmitter should be placed on the inside curve of the upstream bend

Consideration must also be given to the proper placement of the Temperature Probe and Activator Heater as described in the following section.

## 2.2 OFS 2000-C Sensor Placement

In addition to the general placement considerations described in the previous section, proper allowance must be made for the location of the Temperature Probe [1910-852] and Activator Heater [1910-850].

These are placed upstream of the light beam axis as shown in the figure below. The heater and temperature probe are aligned on the centerline and installed on the receiver side of the duct. The heater should be mounted 8" upstream from the TX/RX light beam axis, and the temperature probe should be mounted 24 " upstream from the heater. A certain amount of shifting may be allowed for as not all sites are ideal, but the critical parameter is the 8" centerline distance between the heater and the light path. This should be adhered to at minimum.

The following figure shows a typical installation in a horizontal duct.

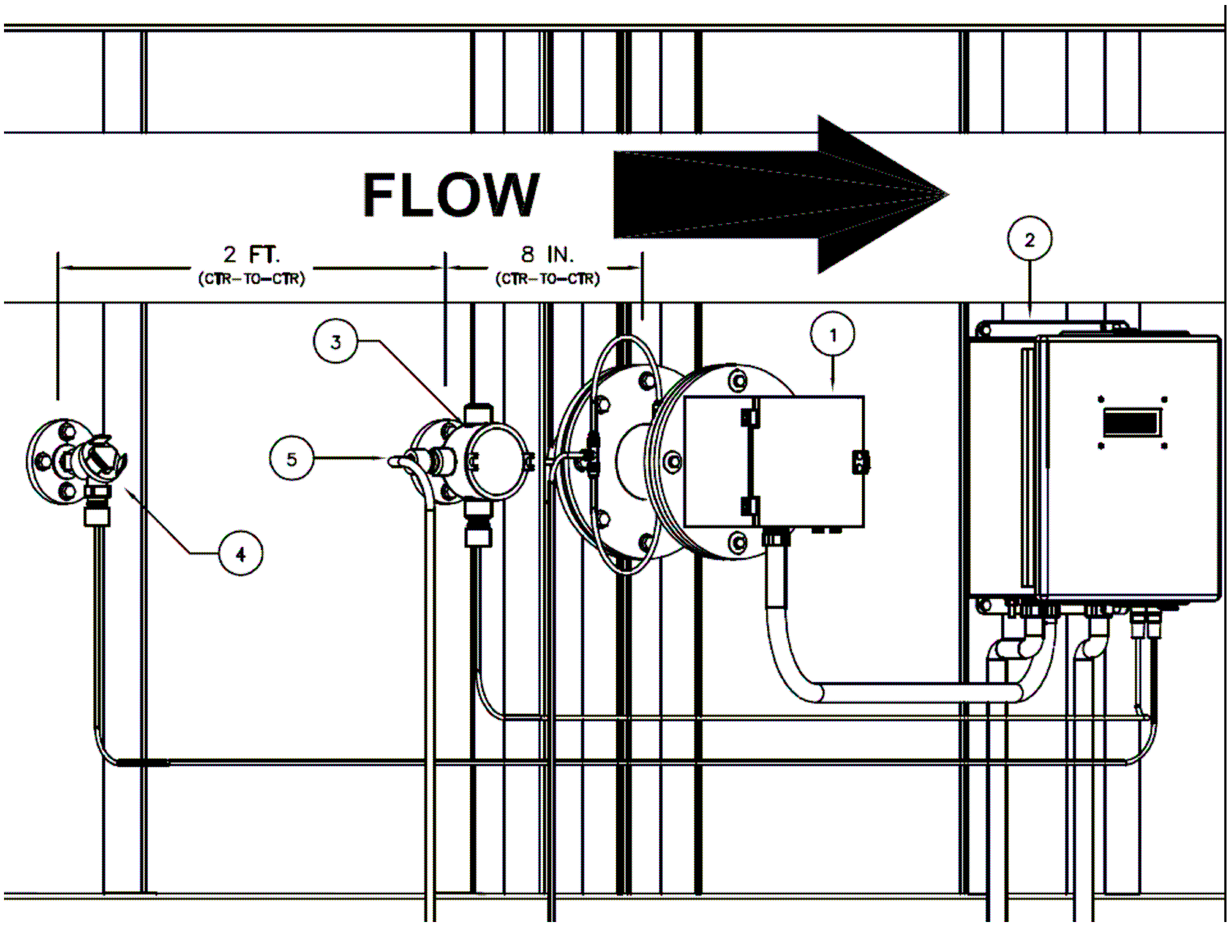



**Figure 2-2 Typical Sensor Placement**

**Component Description**

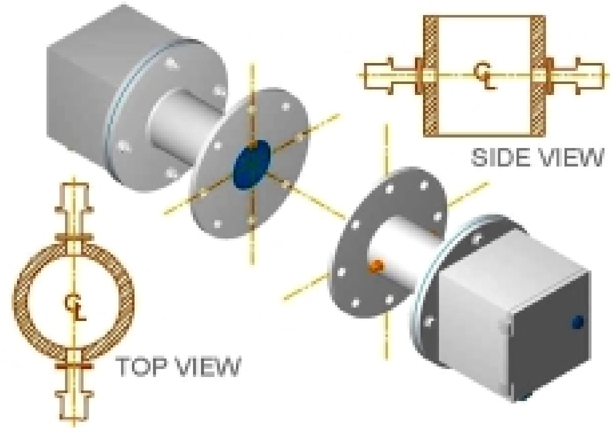
| | | |
|---|---|---|
| | Transmitter (not shown) | Mounted on opposite side and centered on common axis with receiver |
| 1 | Receiver Unit [1910-200] | Centered on axis with transmitter (see Flange Alignment Section) |
| 2 | Control Unit [1910-302-1] | Contains DSP/Sensor and Customer Interfaces, Display |
| 3 | Activator Heater [1910-850] | Mounts in 3/4" NPT fitting at least 8" upstream on center with RX |
| 4 | Temp Probe [1910-852] | Mounts in 1/2" NPT fitting at least 24" upstream from heater |
| 5 | Heater AC Supply | Dedicated AC Line |

## 2.3 Flange Alignment Guidelines

The OFS 2000-C is designed to function in difficult industrial environments and will operate satisfactorily in adverse conditions. It can operate over a broad range of media opacity with little or no change in accuracy. However, these advantages can be completely negated if the transmitter and receiver cannot be aligned properly – meaning that the receiver cannot "see" the light beam from the transmitter sufficiently well for proper response.

The first step to getting the most out of your sensor is making sure the mounting flanges are aligned properly. The OFS 2000-C is designed to mount to common ANSI 150# 4" pipe flanges. These flanges must be installed:

- diametrically opposite each other
- on a level horizontal plane
- squarely aligned on the same axis

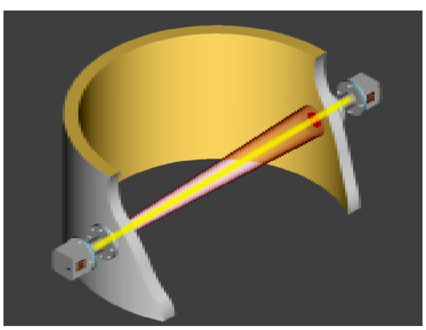



Proper care in mounting the flanges to the stack will pay off many times over.

There is no need to measure and know the path length for an OFS meter, which is required (for example) when mounting an opacity meter. Therefore, in this regard, mounting an OFS is simpler.

Alignment need not be micrometrically precise, but it must be done so that the axis of the transmitter and the receiver are aligned on the same centerline. The method of determining placement and alignment of the mounting flanges is the responsibility of the customer personnel or contracted service technicians.

Careful "eyeball" reference should suffice, but use of spirit levels, laser pointers, and other such alignment tools is recommended. Sensible precautions and attention to detail should be all that is required to complete the job properly.



We recommend that the user study OSI brochure "OFS Placement Advantage"

A typical basic installation is shown here at right. The OFS Transmitter and Receiver are supplied with flange adapters to mate to the customer's mounting flange. The customer's flange is typically cemented or welded in place. The inner end may be flush with the wall, or protrude depending on customer needs. [See Section 2.4 Flange Pipe Extension for details.]

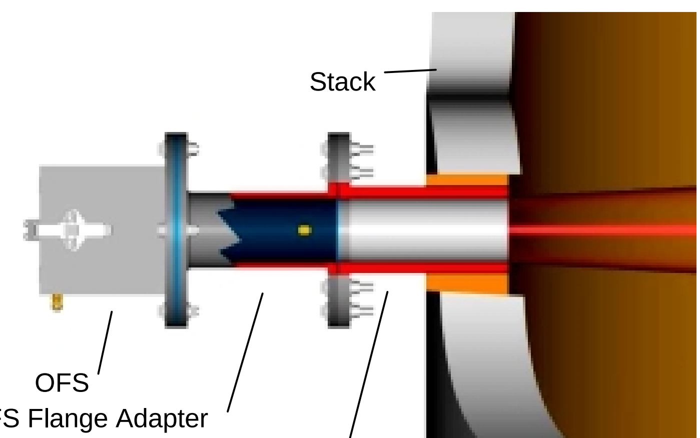
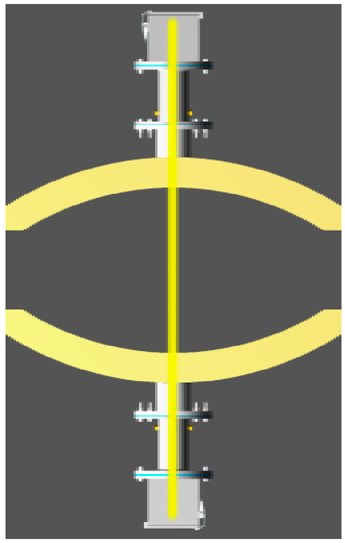


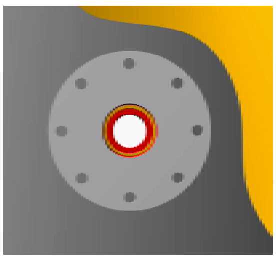

**Figure 2-3 Flange Installation (cutaway)**

## 2.4 Flange Mounting Examples

**Proper**
**Flange Alignment**

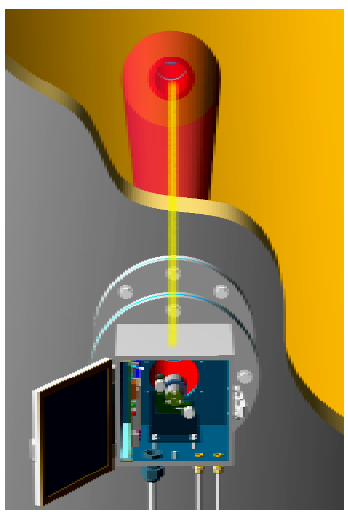
OFS Transmitter and Receiver are aligned on the same axis. The flanges and openings will have a straight view of each other.





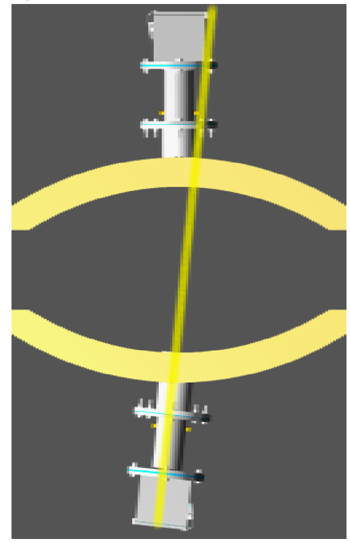
With proper care in mounting the flanges, the transmitted light beam will fall squarely on the receiver opening on the opposite side. The transmitter will require minor adjustment (aiming) for peak efficiency.

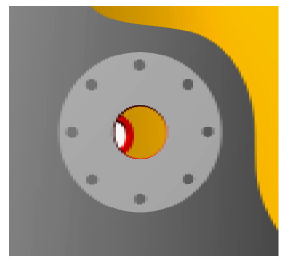
See Section 6.2 Transmitter Setup for further details.



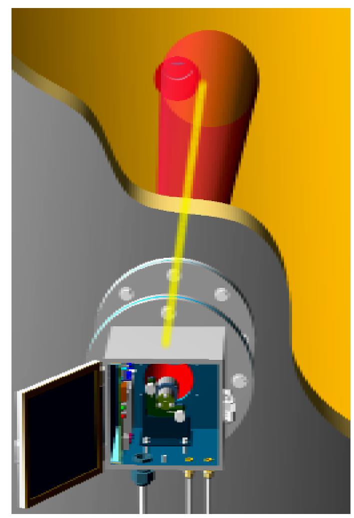
**Improper**
**Flange Alignment**

One (or both) flanges installed crookedly, the Transmitter and Receiver will be at angle to each other. The openings will not be aligned.



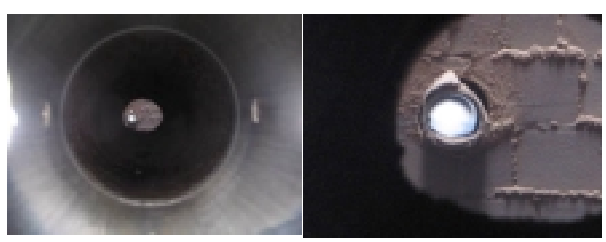


With the light beam off-center. The transmitted light beam will still reach the receiver – and the system will work. However, the received signal will be weaker, and performance will be compromised.



**Note: OFS uses an eye-safe red LED emitting only a small amount of visible light. The light beam is shown for illustration purposes**

These photographs show an example of poor mounting flange alignment. The mount on the opposite side is almost out of view. Again the OFS system was able to function, but response was less than satisfactory. The misalignment is immediately noticeable to the eye.



The OFS has proven over and over to be a top performer in flow monitoring. It is robust, reliable, and accurate, even in adverse environments; but it cannot report what it doesn't "see". Before installation, be sure that the mounting flanges are aligned properly on the focal axis from Transmitter to Receiver.

## 2.5 Flange Pipe Extension

In some instances it may be to the customer's advantage to have the mounting flange pipe section extend into the stack instead of fitting flush with the stack wall. Flush fit or protrusion makes no appreciable difference in accuracy of OFS flow measurement.
If the pipe end is to extend into the stack interior, a general rule to follow is not to let the end extend into the RATA measured stack flow area which begins at a little less than 90% of the stack inner diameter.

The 10% difference may be regarded as a laminar flow area where the flow is dampened somewhat by the stack interior surface. Since this falls outside the RATA test area, pipe protrusion should not pose a problem.

For example:

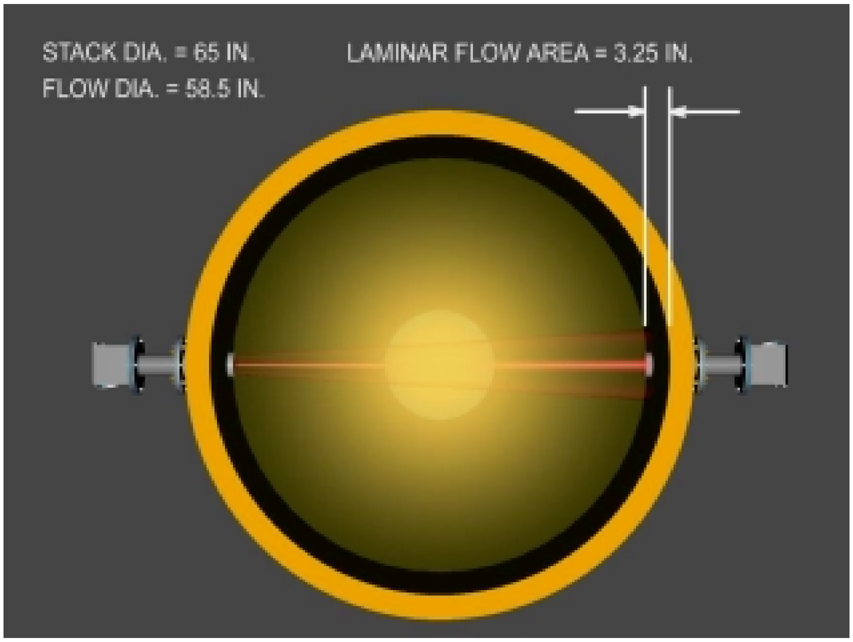



**Figure 2-4 Measured Flow Cross Section**

In this instance, the stack inner diameter is 65 inches. A 10% difference results in a measured area diameter of 58.5 inches. Therefore the flange pipes may extend up to 3.25 inches into the stack interior without impinging into the RATA measurement area.

The OFS 2000-C has a wide range of applications, and each application has it's own individual conditions. Proper flange installation and alignment is basic to them all. The guidelines shown here in brief should provide insight to most common considerations in planning or upgrading your installation.

For further help or answers to other OFS questions see Section 11 Technical Support.

## 2.6 Flange Pipe Mounting

Air infiltration through improperly sealed flanges or from double walled stacks with dead space between the inner and outer walls may cause incorrect velocity readings. Be sure that there are no openings for air to leak into (or out of) (except for purge air where necessary) Figures 2.4 & 2.5 illustrate the incorrect and correct methods of installing the OFS.

Insure that the mounting pipe (nozzle) is well sealed to the stack.

Dead space between double-walled or stacks equipped with interior liners must be bridged.

All gaskets and seals must be tight.

Note – These precautions do not apply to purge air, which is nominally under the user's control. Proper use of purge air is discussed in Section 3.5.

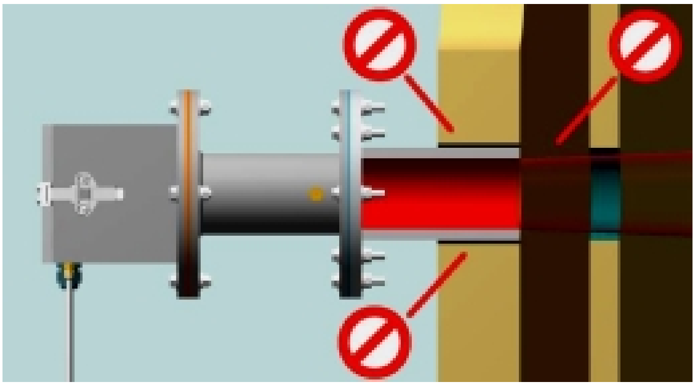


**Figure 2-5 Flange Installation - Incorrect**

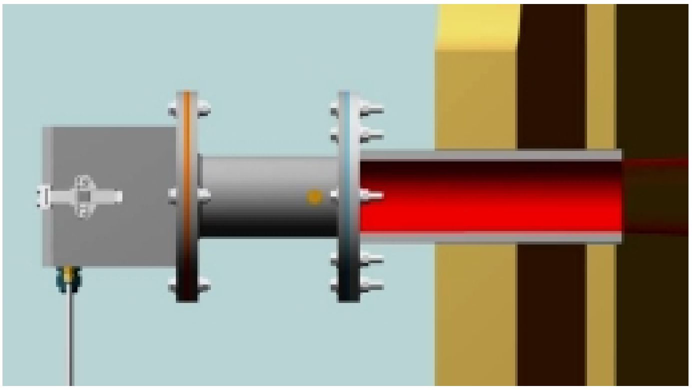


**Figure 2-6 Flange Installation - Correct**

OFS 2000-C is designed to mount to the 4 – inch ANSI 150# pipe flanges commonly used in industry. The standard dimensions are shown at right in Figure 2.6. *Note that the OSI convention is to have a bolt hole at top dead center. (The people mounting the nozzle and flange will have to know this before they do their installation)*

While this type is commonly used, it is not exclusive. Flare stacks, chemical processes, hazardous environments each have heir own unique requirements. OSI has a range of flange adapters, gate valves, sight glasses, spray rings, and other items available to cope with any mounting configuration.

Contact OSI Engineering Department regarding any special considerations.

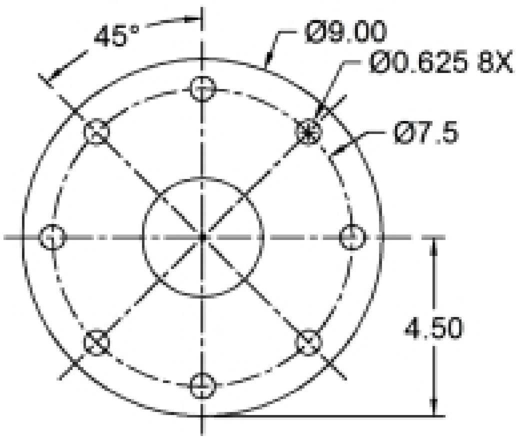



**Figure 2-7 Common Flange Dimensions**

# 3 Installation

General installation is described here.

## 3.1 Required at Transmitter or Receiver Location

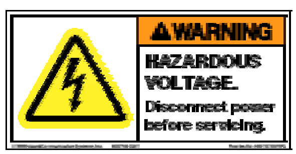
- 4-inch ANSI 150# pipe flange (9 inch diameter)
- Clean, dry, oil-free instrument grade air at 2 CFM per head

**Required at Transmitter (in addition to above)**

- Single phase, 100-240 VAC, 50/60 Hz @ 1 A power with appropriately rated and approved power disconnect device adjacent to OFS
- 1/2-inch conduit from TX housing to AC power junction box

## 3.2 Required at Control Unit Location

- Clean, dry, oil-free factory air (optional)
- Single phase, 100-240 VAC @ 1 A power with appropriately rated and approved power disconnect device adjacent to OFS
- Control Box Mounting Hardware
- 1/2-inch conduit from OFS Control Box to AC power junction box
- 1/2-inch conduit from OFS RX housing to OFS Control Box
- 1/2-inch conduit from OFS Control Box to user computer
- 4-conductor shielded cable for connection of OFS Control Box to user computer or duplex fiber optical cable for FOM option



This equipment contains hazardous voltages. Disconnect AC power before servicing. Read the entire User's Guide before proceeding with installation or maintenance!

## 3.3 Mechanical

### 3.3.1 TX/RX Units

Attach the OFS TX & RX Units to the user-supplied flanges using the hardware as shown in Figure 3.3. Mounting hardware for installation of the units is included. A detail view with dimensions in inches for the TX/RX head with Flange Adapter is shown in Figure 3.4.

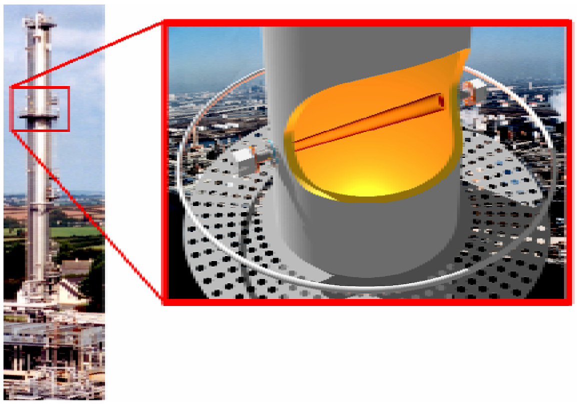


**Figure 3-1 Common Vertical Installation**

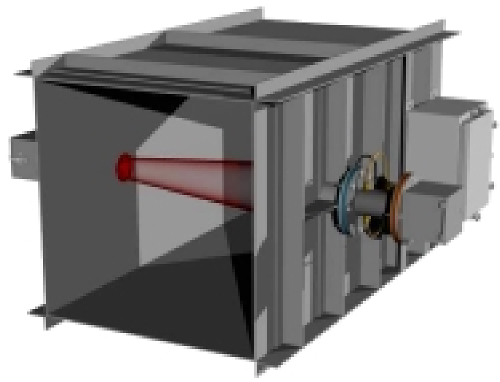


**Figure 3-2 Common Horizontal Installation**

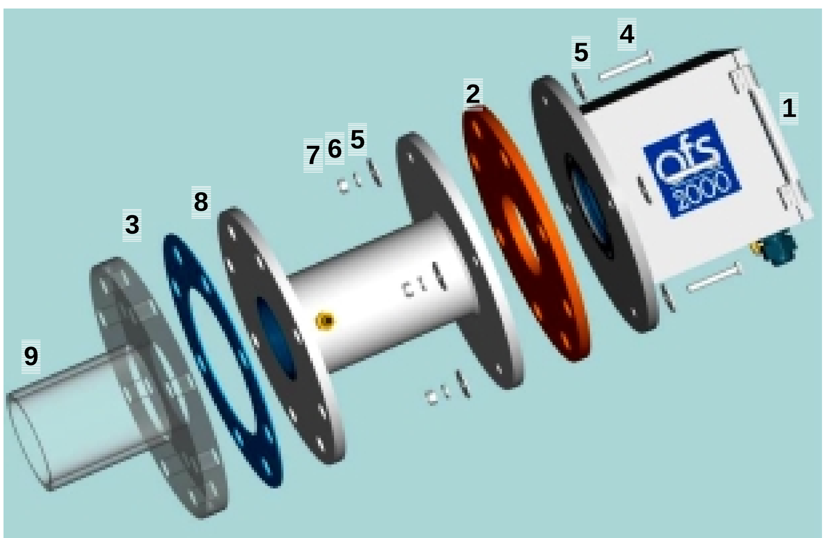



**Figure 3-3 OFS Mounting Hardware**

| ITEM | QTY | DESCRIPTION |
|---|---|---|
| 1 | 1 | OFS TX Or RX Unit |
| 2 | 1 | OFS Flange Gasket (Silicone) |
| 3 | 1 | OFS Flange Gasket (Kevlar) |
| 4 | 4 | 3/8-16x2 Inch SS Hex Bolt |
| 5 | 8 | 3/8 Inch SS Flat Washer |
| 6 | 4 | 3/8 Inch SS Lock Washer |
| 7 | 4 | 3/8-16 Inch SS Hex Nut |
| 8 | 1 | Flange Adapter |
| 9 | | Mating Flange (Customer) |

(NOTE: Items 1 through 8 are pre-assembled)

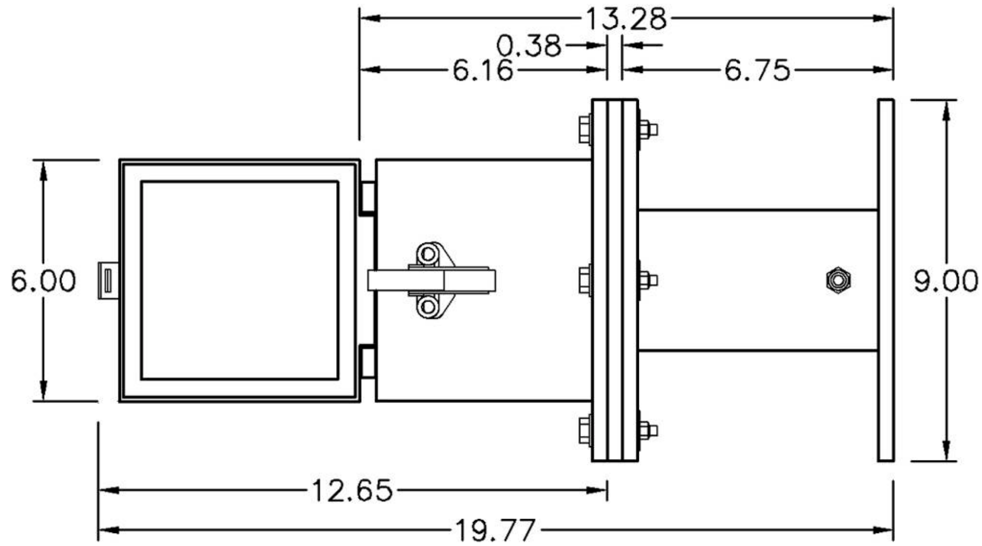



**Figure 3-4 OFS TX/RX Overall Dimensions**

Units = inches.

### 3.3.2 Control Units

#### 3.3.2.1 Control Box

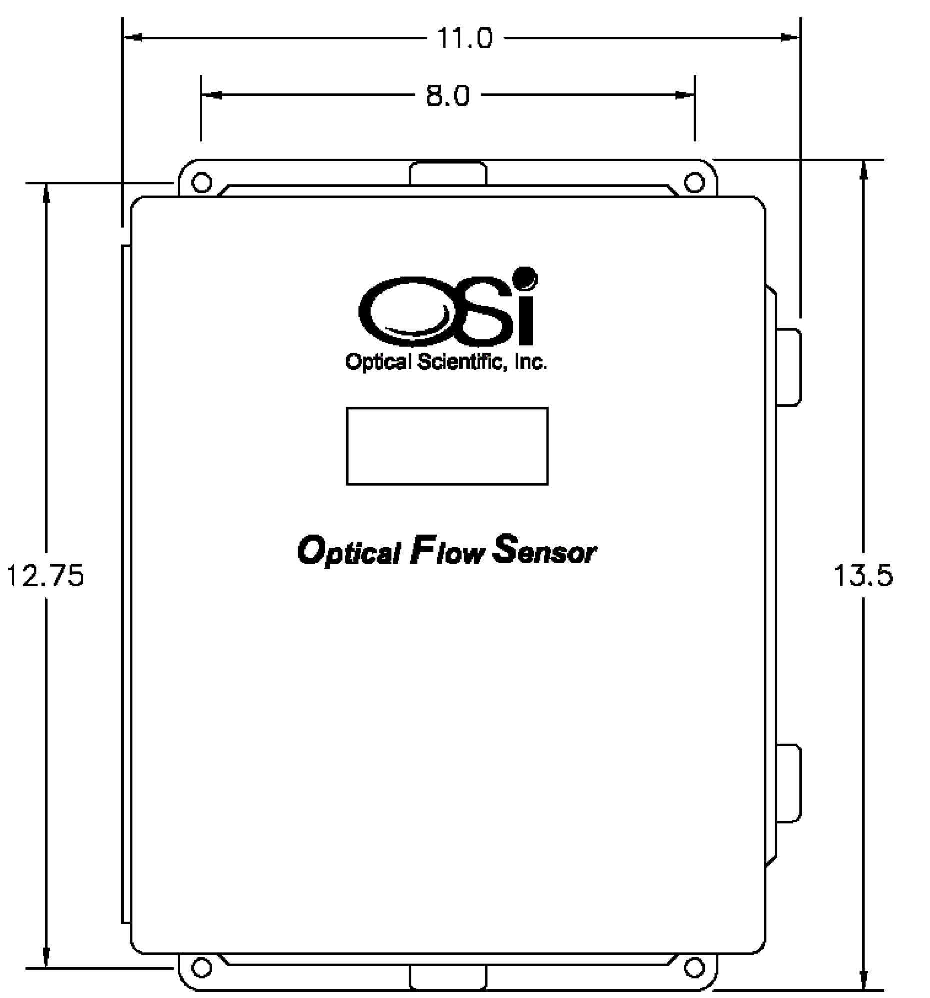



**Figure 3-5 Control Box Mounting Dimensions**

Note: Depth = 6-3/8 inches.

The Control Box may be mounted to a wall or other surface with user-supplied hardware. It should be located within 15 feet of the RX Unit if the standard P/N 1910-217 cable was ordered. The maximum length of the RX cable is 300 feet. Figure 3.5 shows the Control Box mounting hole pattern.

## 3.4 Purge Air

The function of purge air is to keep the interior atmosphere of the mounting nozzle clear, the sensor light path unobstructed and provide an air curtain to slow the rate of deposition on the window. . (Also in high flue gas temperatures the purge prevents hot gases from getting in the nozzle). In applications where the internal pressure is approximately negative 3 inches (WC) or more, and unchanging, then the purge fittings can be removed and the natural inflow of outside air through the open holes themselves is sufficient to keep the light path clear. (This is called "passive purging")

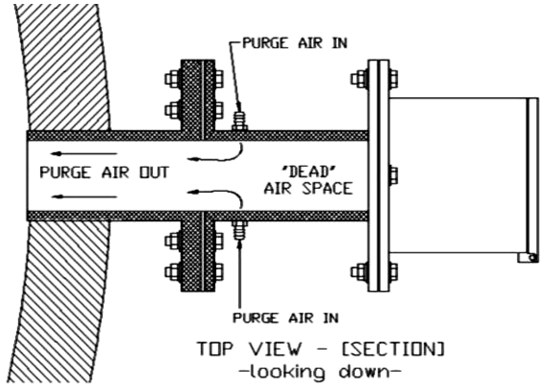
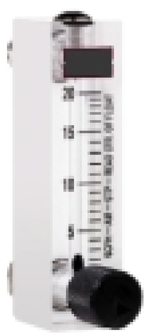



**Figure 3-6 Purge Air Detail**

If there is not a constant, unchanging negative pressure of approximately 3 inches (WC) or more then it is recommended the user apply instrument –grade compressed air (nitrogen, or other available clean gas) to the purge fittings. This purge air should be metered through a rotameter. (See Figure 3.8) The nominal volume to start with is 1 CFM per fitting. There are two fittings per spool piece and four fittings per OFS system.

**Figure 3-7 Rotameter (flow meter)**



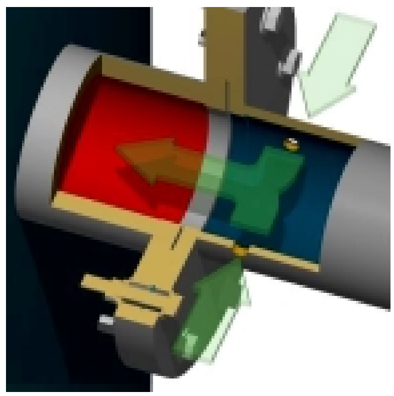


**Figure 3-8 "Natural" Air Purge**

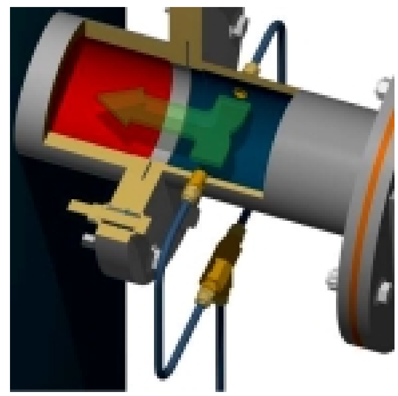


**Figure 3-9 Compressed Air Purge**

The flange adapters each have two purge holes threaded for 1/8" NPT and are supplied with fittings sized for ¼" tubing. These must be oriented so that the two holes are at right angles (90°) to the direction of the flow. This is very important. See Figures 3.11 and 3.12.

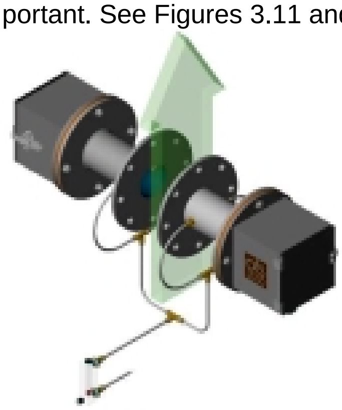


**Figure 3-10 Purge Air at 90° to Vertical Flow**

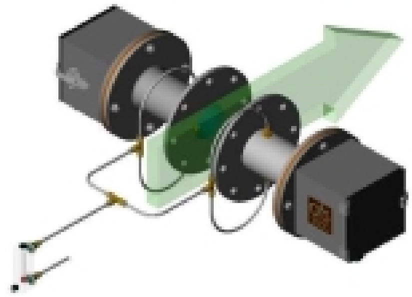


**Figure 3-11 Purge Air at 90° to Horizontal Flow**

In the final analysis, the exact amount of purge air needed is site-dependent. It is recommended that a regulator and rotameter be installed near the OFS heads to control the airflow. The user should adjust purge air incrementally until optimum balance is achieved.

## 3.5 Pressurization Air (Z-Purge Air)

In certain environments it is advisable or required for electronic equipment to maintain a positive air pressure differential in the enclosures to prevent entrance of contaminants. OFS 2000-C enclosures are fitted with pneumatic connectors for this purpose.

Pressurization air system is completely separate from the purge air system described in the previous section. When applied together, they may be supplied from the same primary source, but their control and application must be independent.

Customers may elect to configure their pressurization systems to meet their own standards and practices. OSI offers an equipment package which meets established North American requirements and has been found to work satisfactorily. This package and recommended configuration is, "designed to protect electrical equipment in Class I and Class II hazardous locations. When connected to a supply of protective gas, it will supply, regulate and monitor the protective gas supply to a protected electrical enclosure."

**Figure 3-12 Typical Z-Purge Control Unit**

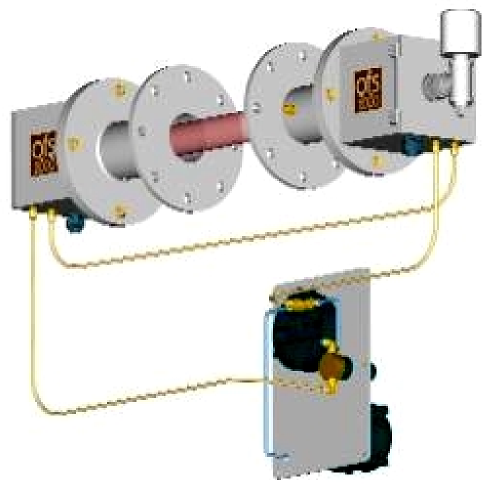


**Figure 3-13 TX/RX Z-Purge Arrangement**

Type Z applications reduce the hazardous location rating inside the enclosure from Division 2/ Zone 2 to non hazardous. This allows general purpose equipment to operate in Division 2/ Zone 2 areas. This unit is designed to meet or exceed NEC - NFPA 70, NFPA 496, EN 50016 and IEC 60079-02 requirements

**Figure 3-14 Control Box Z-Purge Arrangement**

## 3.6 AC Power Connections

Power Requirements: single phase, 100-240 VAC, 50/60 Hz @ 1 A.

### 3.6.1 Transmitter Unit

AC power connections to the TX Unit are made to TB1 of the TX circuit board located on the left inside of the TX housing. If optional power cords were ordered with the OFS, the power cords and weather-tight cord grips are included with the order. If the user is supplying the power directly from an electrical panel, it is recommended to use ½-inch flex conduit between the TX Unit and electrical panel to protect the cable from damage and noise pickup.

Connect the AC power wires as shown. Note that the green/yellow earth wire from the user supplied AC power cord should be connected to the earth ground stud in the TX Unit. The OFS is supplied with an internal green/yellow ground wire from this stud to the ground terminal on the TX Electrical Assy. Customer supplied protective earth wires must be green/yellow in color and be of the same size (gage) as the incoming mains supply conductors.

The Transmitter Board ground plane must be connected to the earth ground with a jumper (provided). Connect the line AC ground to the Transmitter enclosure.

(Note: The OFS Receiver does not require AC connection. It is powered through the RX cable connected to the control unit.)

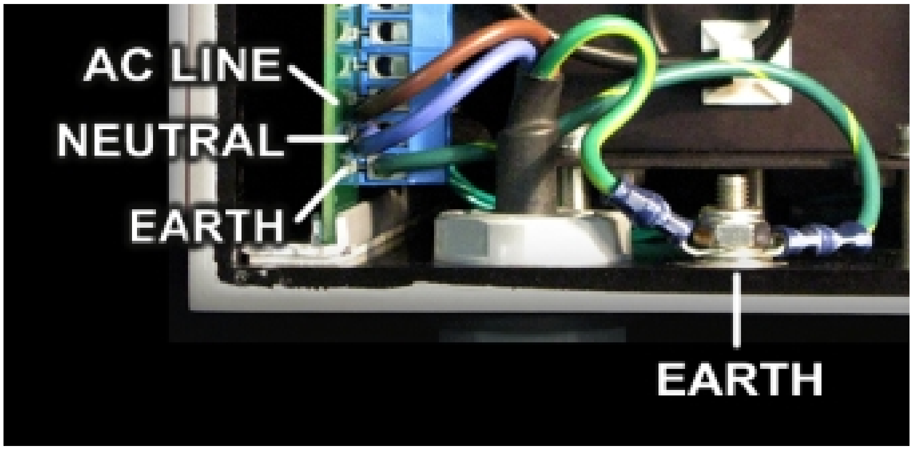



**Figure 3-15 Transmitter AC Connections**

### 3.6.2 Control Box

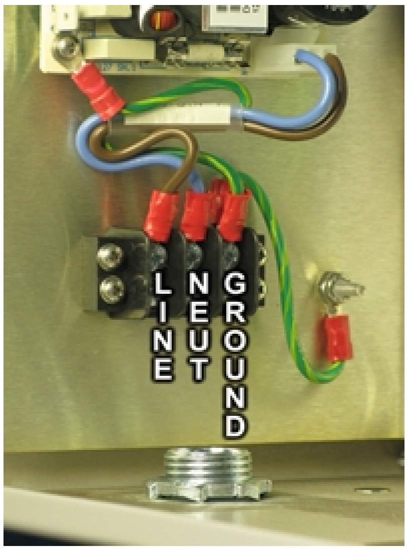



**Figure 3-16 Control Box AC Connections**

A licensed electrician may be required to make the AC power connections depending on the work and safety rules at your facility. Check with your supervisor before proceeding.

The DC power supply is pre-wired to the terminal block. The user simply need to connect the electrical supply wiring.

AC Wiring Connections are (L to R)

1. AC Line [Black or Brown wire]
2. AC Neutral [White or Blue wire]
3. AC Ground [Green or Green/Yellow]

Note that this is a universal input power supply.
100-240 VAC, 50/60 Hz, 40 VA

## 3.7 User Interface Connections

The OFS has two communication modes:

| | |
|---|---|
| • Analog<br>4-20mA Current Loop Outputs<br>Fault Relay & Cal Relay<br>External Cal Switch | • Digital<br>RS-232 Serial Data Output<br>Control Interface |


**Figure 3-17 User Analog Interface Connections**

| TB3 | TB2 | TB1 |
|---|---|---|
| Four 4-20 mA Current Outputs | Relay and External Cal Contacts | Receiver Power and Signal I/O |
| Loop 1 – Velocity<br>Loop 2 - Volume<br>Loop 3 – Temperature (factory opt.)<br>Loop 4 – Pressure (factory opt) | TB2 1 – 2 Fault Relay<br>TB2 3 – 4 Cal Relay<br>TB2 5 No Connection<br>TB2 6 – 7 Ext Cal Switch connect. | TB1 -1 & 2 12V & rtn f/heater<br>TB1 3 & 4 +8/-8VDC RX power<br>TB1 5 Signal Ground<br>TB1 6 & 7 Channel A Signal<br>TB1 8 & 9 Channel B Signal |
| See Section XXXX for details | See Section XXXX for details | See Section XXXX for details |


**Figure 3-18 J5 Serial Port**

**Digital Interface**

The OFS 2000C is accessed through a female DB9 serial data port located at the bottom of the enclosure. A PC, laptop, or similar device is used for:

- Setup configuration [See Section XXXXX]
- Flow data monitoring [See Section XXXXX]
- Troubleshooting [See Section XXXXX]

Communications can be established through HyperTerminal or similar software [See Section XXXXX]

A screw-on cover is provided to protect the connector when not in use.

## 3.8 OFS 2000-C Interconnecting Cables

### 3.8.1 Transmitter and Receiver Interconnects

The OFS 2000-C Transmitter and Receiver cables are connected as shown in Figures 3.19 and 3.20.

The Receiver Cable 1910-217 supplies DC power to the receiver electronics, and signal data to the Digital Signal Processor (DSP) in the control unit. This cable connects to the receiver circuit board and TB2 of the control unit interface board.

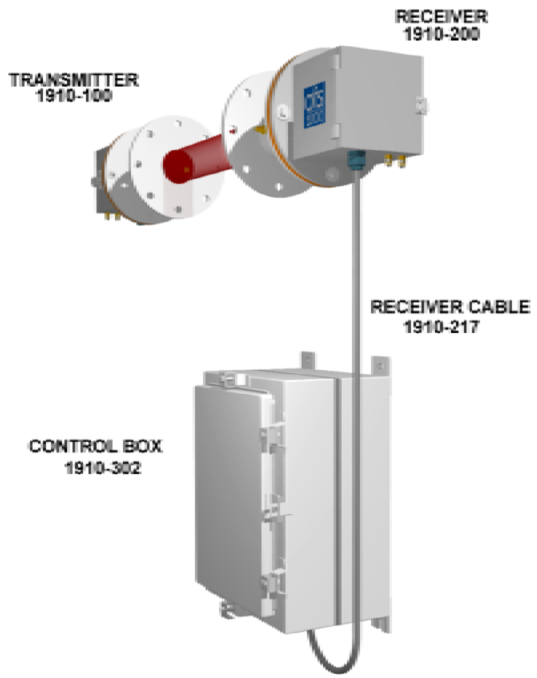



**Figure 3-19 OFS2000-C Interconnects**

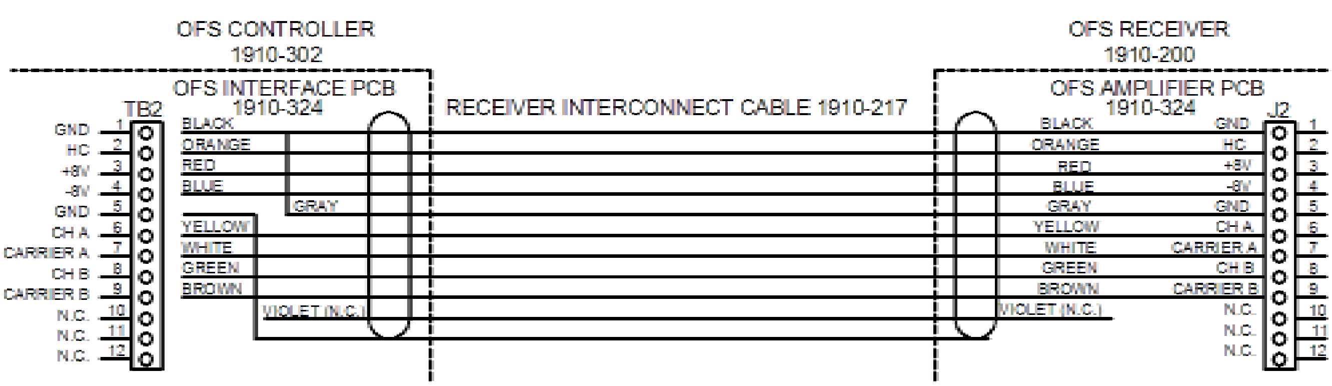



**Figure 3-20 Receiver Cable Connections**

### 3.8.2 OFS Receiver Cable

OFS Receiver Cable (1910-217) is supplied in standard length of 15 feet. Customers may order extra length up to 400 feet using the following number scheme ex. 1910-217-XXX where:

1910-217 = BASIC ASSEMBLY NUMBER   XXX = CABLE LENGTH IN FEET.

Customers may opt to make their own cables. If this is the case, the following information is provided:

Cables should be 10 conductor having an overall shield and drain wire, with the following wire colors:

| | | | |
|---|---|---|---|
| 1 | Black | 6 | Blue |
| 2 | White | 7 | Orange |
| 3 | Red | 8 | Yellow |
| 4 | Green | 9 | Violet |
| 5 | Brown | 10 | Gray |

Recommended cable types are:

| | **Cable Run Distance** | | | |
|---|---|---|---|---|
| **Mfg.** | 15 -200 feet | | 200-400 feet | |
| Belden | 9946 | 22AWG | n/a | 20AWG |
| Alpha | 5199/10C | 22AWG | 5470C | 20AWG |
| Manhattan | M4640 | 22AWG | M4666 | 20AWG |

Cable runs < 400 feet are <u>not</u> recommended.

### 3.8.3 Temperature Probe Interconnect

The Temperature Probe is equipped with a 25' cable. This cable plugs into the J3 connector at the bottom of the Control Box. The signal from the RTD in the Temperature Probe is routed to the Sensor Interface Board in the Control Box where it is processed and sent to the DSP for integration into the system data.

### 3.8.4 Activator Heater Interconnect.

The Activator Heater is equipped with a toroid current sensing coil encircling the AC line supply wire. This sends an current signal to the Sensor Interface Board to show heater status. The Activator Heater is shipped prewired with this 25' cable which connects to the J4 connector at the bottom of the Control Box.

## 3.9 4-20 mA Current Loop Connections

The terminal block TB3 of the interface board connects to isolated 4-20 mA circuitry, diagnostic relay, calibration relay and calibration check request interface. The pin designation is as follows:

| | | | |
|---|---|---|---|
| Pin 1: | Current Loop 1 - | Velocity | |
| Pin 2: | Current Loop 1 + | | |
| Pin 3: | Current Loop 2 – | Vol. Flow | |
| Pin 4: | Current Loop 2 + | | |
| Pin 5: | Current Loop 3 – | Temperature | Factory Option |
| Pin 6: | Current Loop 3 + | | |
| Pin 7: | Current Loop 4 – | Pressure | Factory Option |
| Pin 8: | Current Loop 4 + | | |

To set the full-scale range and other 4-20 mA features.
[See Section 4.2.4. Current Loop]

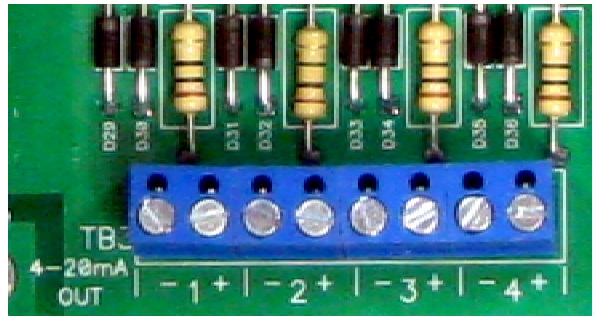



**Figure 3-21 TB3 Connections**

These four pairs are for connection of the customer's 4-20 current loop for velocity measurement. The OFS system provides a current at all times while the system is powered (4mA representing "0" flow). In common terminology, this is a "sourcing" 4-20ma loop, meaning the OFS controller provides the loop power. Do not connect wires that have a voltage on them to these terminals. The maximum loop resistance is ~600 ohms. This includes the cable resistance and the load resistor in the customer data acquisition system. Loop 1 is standard on all models.

Current Loop 1 - Velocity sets the velocity measurement range. Default velocity range is 0 to 40 m/s (meters per second). The user can opt for a lesser range by entering "Setup Mode" using the serial connection [Section 3.11].

To convert the current loop readings to velocity, use the following formula:
Velocity (m/s) = (ma – 4) X (F.S./16)
where ma is the measured loop current and F.S. is the full-scale velocity selected in m/s

Current Loop 2 - Volume is the volumetric flow output range, The output (mA) is linear, with 4 mA = 0 SCMH minimum and 20 mA = $Velocity_{MAX}$ * Stack Area * 3600 SCMH
e.g. Velocity 40 m/s and stack area 1 sq meter. F. S. Vol. Flow = 40 * 1 * 3600 = 144 k SCMH

Current Loop 3 – Temperature output is available as a factory-purchased option. The output (mA) is linear, with 4 mA = -40°C (minimum) and 20 mA = 500° C (maximum).

Current Loop 4 – Pressure output is available as a factory-purchased option. The output (mA) is linear, with 4 mA = 750 hPa (minimum) and 20 mA = 1150 hPa (maximum).

## 3.10 Fault Relay

Pins 1 & 2 are connected to a dry contact relay The contacts close when the system is powered up, and remain so during normal operation. The contacts open for:

- A and/or B voltage out of range
- Temperature probe fault
- Pressure probe fault
- Heat Activator fault
- Power failures
- Relay contact are rated 30V/5A – 250VAC/8A

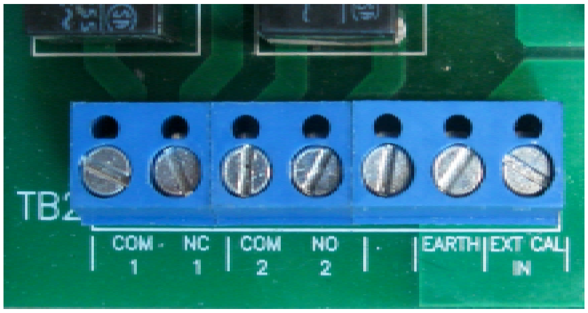



**Figure 3-22 Terminal Block 2**

### 3.11 Computer Connection


**Figure 3-23 OFS 2000C Computer Connection**

The OFS digital interface communication standard is RS-232. It may be connected to a computer, Data Acquisition System (DAS), PLCC or any other system that supports this serial communication standard. When using a computer, the user may use communication software such as ProComm or HyperTerminal, or OSI's own SQC software (recommended) to operate the system.

While some applications use the data output for flow reporting. The most common reason for using the RS-232 output is to record the microprocessor data for trouble shooting purposes, since it includes, diagnostic and calibration information. The computer outputs a delimited text file that can be imported into a spreadsheet and plotted or analyzed. An advantage of OSI's SQC software is that it creates a time stamp for every line of data so that events can be easily compared with process data.

The easiest way to ensure all data is collected is to set the main menu item described as "Output Type" to "Continuous Long" thereby ensuring the full data set is automatically available on the RS-232.

The OFS 2000C configuration setup is done using a laptop computer or PC equipped with a standard serial (RS-232) port, and Windows Hyperlink™ (or equivalent) communications software. For simplicity's sake we will refer to Hyperlink only.

To connect to the OFS simply plug a DB9 serial data cable into your serial port and to the J5 connector on the bottom of the enclosure as shown.

**Note:**
If your system uses USB connections, use the USB to Serial adapter packaged with the OFS.

When HyperTerminal is launched the Connection Description window will appear and you will be prompted to choose a name and an icon for the connection. You may choose whatever you feel suitable, and click "OK"

See HyperTerminal Setup in the following Section

### 3.11.1 HyperTerminal Setup

1. The Connect to Window will open offering dial-up, COM port or TCP/IP options. Choose the COM port corresponding to the cable connection and click "OK".

2. The COM Port Properties window will open showing Port Setting options. Choose:

   Bits per second = 9600
   Data bits = 8
   Parity = None
   Stop bits = 1
   Flow Control = None
   Click "Apply" and click "OK"

3. HyperTerminal window will become active. Click on "File" and choose "Properties" from the pull-down menu.

4. Click on the "Settings" tab.
   These may be left at default values – (select "Windows Keys" to use PC-type keyboard input)
   Click on the ASCII Setup button.

5. The ASCII Setup window will open. Select (or deselect) the following
   **ASCII sending:**
   Send line end with line feeds = select/yes
   Echo typed characters locally = select/yes
   Line delay __ milliseconds = don't care
   Character delay __ milliseconds = don't care
   **ASCII receiving:**
   Append line feeds to incoming line ends = select/yes
   Force incoming data to 7-bit ASCII = deselect/no
   Wrap lines that exceed terminal width = select/yes

6. Click "OK"

At this point the computer and OFS will be in communication. The OFS will be ready to accept control input commands and deliver flow output data. The next section will cover initial setup and control commands.

# 4 OFS System Configuration Setup

## 4.1 Checking Communications

At this point you should have serial communications established between the computer and the OFS as described in the previous section. Check the status bar at the bottom of the HyperTerminal window. You will see connection duration, bit rate configuration and other indicators.

The OFS responds to uppercase ASCII character inputs as described elsewhere in this manual, but for now we will begin by entering "V". The system will respond with firmware version and install date. This shows that the system is indeed on – line and responding.

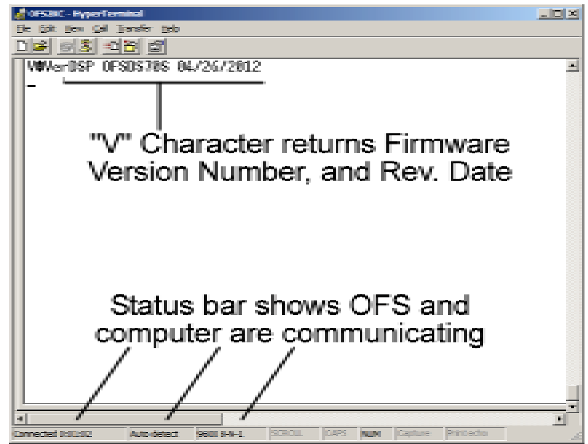



**Figure 4-1 HyperTerminal open**

## 4.2 OFS 2000C Setup

### Command Conventions

- OFS responds only to Uppercase Characters.
- Pressing the <Enter> key at any time will exit the Setup function.
- Change commands will be acknowledged in two steps
  - "Erasing Save Buffer – Done" shows the change command has been accepted
  - "Done" shows the change command has been effected.

### Setup

Setup is initiated with an "S" character.
A list of setup parameters "0" through "9" will appear.

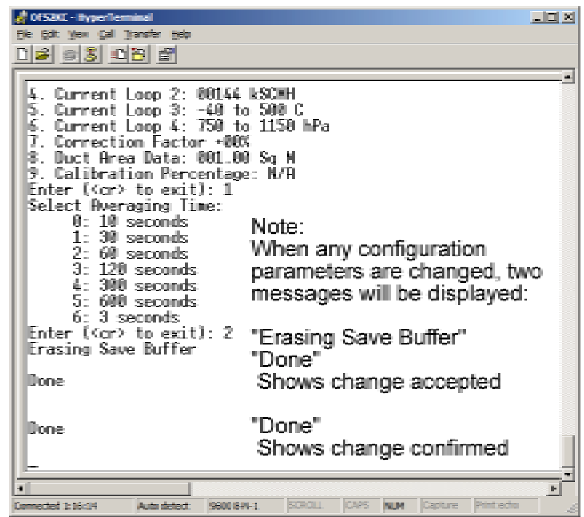



**Figure 4-2 "V" Poll Output**

### 4.2.1 Units of Measurement

You may choose

| | |
|---|---|
| 0: m/s | Meters per Second (Default) |
| 1: kph | Kilometers per Hour |
| 2: mph | Miles per Hour |
| 3: fps | Feet per Second |
| 4: fpm | Feet per Minute |

*Note: Choosing Metric or English Units here will automatically switch all system measurements to the same matching UOM.*

Enter the number for the preferred UOM. The following message will appear to show the command has been accepted.

Erasing Save Buffer
Done
Done

(You may enter "S" again to display the list and verify that the parameter has been set.)

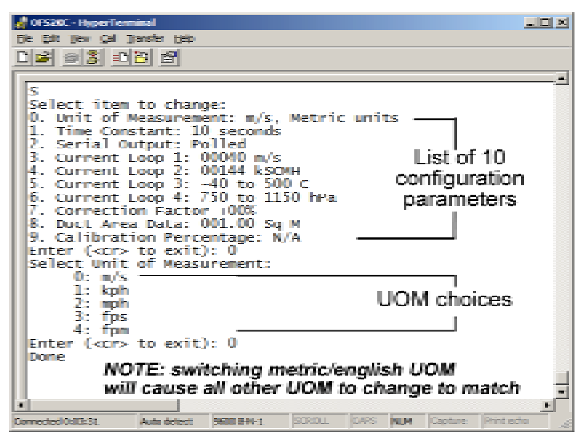



**Figure 4-3 Units of Measure**

### 4.2.2 Time Constant

Enter "S" to display the Setup parameters list, and enter "1" to choose the averaging time setting

0: 10 seconds Default
1: 30 seconds
2: 60 seconds
3: 120 seconds
4: 300 seconds
5: 600 seconds
6: 3 seconds

While setting up the meter or doing trouble shooting, the averaging time should be set to a short time duration (10 seconds or 3 seconds) for rapid response to any parameter changes. The averaging time is equivalent to a radio circuit time constant. For any step change in the input, it will take approximately 3 to 5 time constants to reach a 90% Full Scale response. Once the meter is properly set up you can change the Averaging time to a longer setting such as 60 seconds, to smooth out the response. Regardless of the averaging time, the display refreshes every 3 seconds.

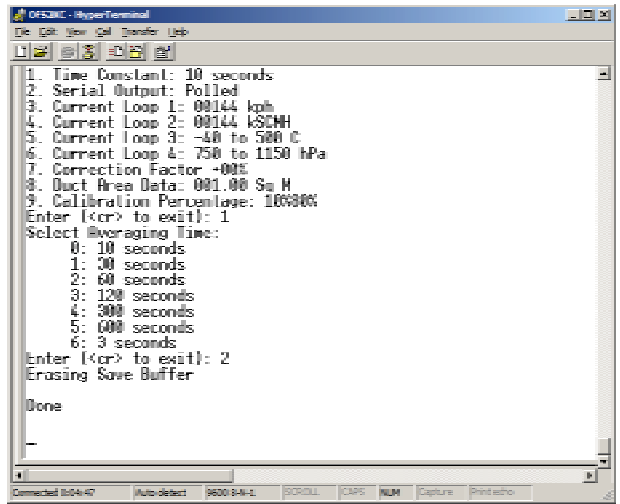



**Figure 4-4 Setup: Time Constant**

### 4.2.3 Serial Output

This function is provided for users who require digital interface for their application instead of current loop. Three output formats are available.

| | |
|---|---|
| 0: Polled | Default |
| 1: Continuous Long | Constant "C" poll output |
| 2: Continuous Short | Constant "A" poll output |

**Polled** is the normal operating mode for OFS the system will respond with "A" or "C" poll output strings according to the poll character received.

**Continuous Long** delivers a streaming "C" poll output and is intended primarily for setup, alignment or troubleshooting procedures where a complete data view is needed.

**Continuous Short** is intended primarily for setup, alignment or troubleshooting procedures and delivers a streaming "A" poll output for use when a simple velocity measurement is sufficient.

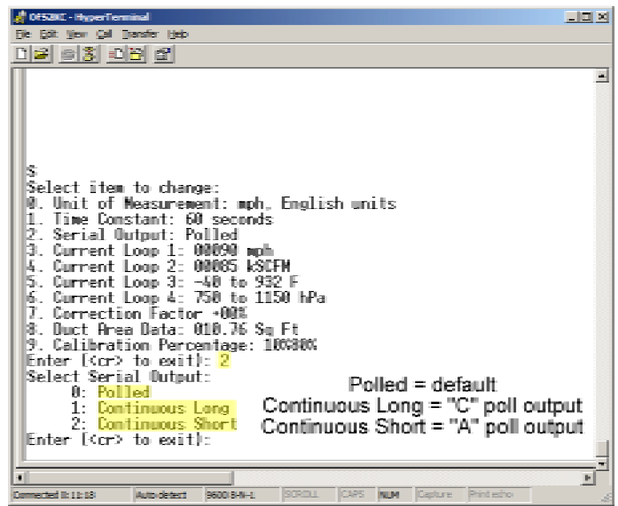



**Figure 4-5 Serial Output**

### 4.2.4 Current Loop

Four 4-20mA Outputs are available.

| | | |
|---|---|---|
| Standard | 1 | Velocity (40m/s max - default) |
| | 2 | Volume (144000 SCMH max) |
| Optional | 3 | Temp. (-40° to 500° C as shown) |
| | 4 | Pressure (750-1150 hPa as shown) |

For details on Current Loop outputs see Section 3.9

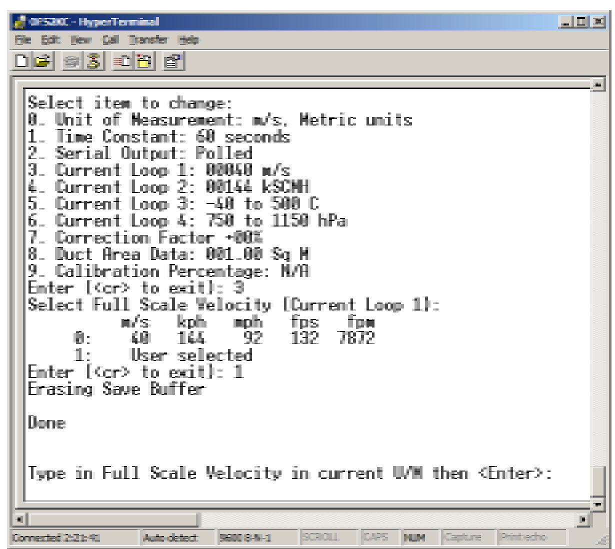



**Figure 4-6 Current Loop 1**

Current Loop (continued)

**Current Loop 1 - Velocity** sets the velocity measurement range. Default velocity range is 0 to 40 m/s (meters per second). The user can opt for a lesser range by entering "1" and following the prompt. Note: The measurement accuracy is equal whether full-range or reduced range.

**Current Loop 2 - Volume** is the volumetric flow output range, and is not a setup variable. It is displayed to show the range and confirm the UOM.

**Current Loop 3 - Temperature** is available as a factory-purchased option. It is not a setup variable. It is displayed to show the range and confirm the UOM.

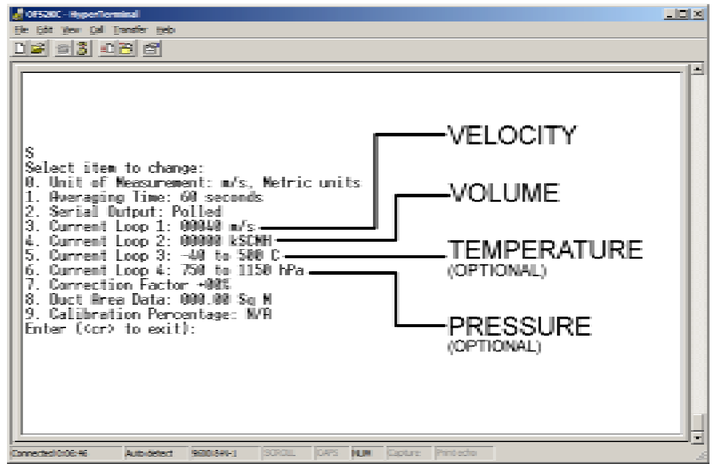



**Figure 4-7 Current Loop Assignments**

**Current Loop 4 - Pressure** and is available as a factory-purchased option. It is not a setup variable. It is displayed to show the range and confirm the UOM.

### 4.2.5 Correction Factor

In some cases there will be a consistent difference (high or low offset) between the values reported by the OFS unit and other data references - either calculated or determined by **R**elative **A**ccuracy **T**est **A**udit (RATA) procedure. In such a case, the OFS baseline can be offset to match the user's equipment.

To determine offset required: Divide the reported/calculated flow number by the OFS flow number. For example:

Reported/calculated flow = 20 m/s
OFS reported flow = 18.5 m/s
20/18.5 = 1.08[1]
1.08 = 8% so +8 should be typed in.

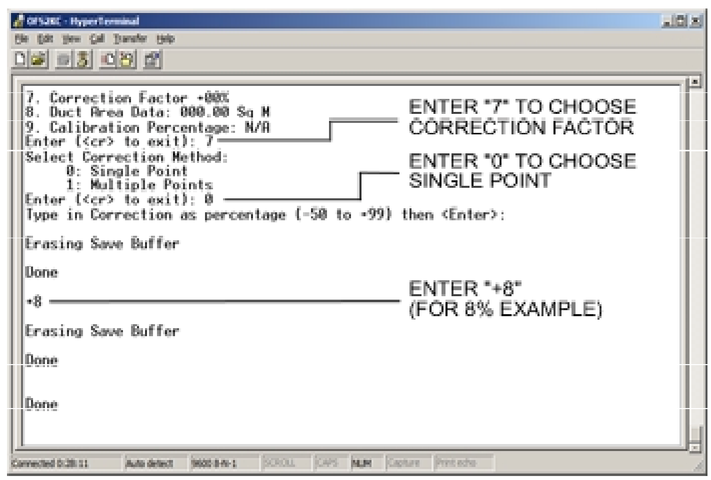



**Figure 4-8 Correction Factor Entry**

The plus (+) and minus (-) signs are required.

To clear any previous entries type in "+0" ("plus zero")

Enter an "S" command to see that the correction factor has been set.

From an instrumentation perspective, this is a single point span adjustment.

[1] (To check your figure simply multiply ex: 1.08 X 18.5 = 19.98)

### 4.2.6 Multiple Point Correction Factor
(Curve Fitting)

In the ordinary run of operation, flow will remain fairly constant, and a simple setup will meet your needs. However, in some cases the output flow from the process will vary sufficiently to require a more dynamic response to more effectively monitor a process. To that end, we have equipped OFS 2000C with a "curve fitting" feature.

Typically a curve fitting procedure is implemented as part of a **R**elative **A**ccuracy **T**est Audit (RATA) procedure – which in its progress provides the base information to fix the curve fitting points. During the RATA the customer facility is operated at Low, Medium, and High load capacity while the (independently-contracted) monitoring crew takes cross-stack measurements and collects data. For example, an electrical generating facility will operate at different levels during peak, normal, and low demand hours. The RATA crew will sample data from each period and determine an average flow figure. This may (and often does) mean several days (and nights) of "runs" to gather a cohesive 3 – point data sample. Due to customer's operating necessities, process requirements, work scheduling, weather, and other circumstances: Low, Medium, and High load data can be measured in any order during RATA. Once the average flow at each level has been determined, the information can be entered into the OFS operating system

Offset points must be entered in order of magnitude starting with the lowest value and ending with the highest value

Using this procedure, the OFS calibration set points are adjusted to match these averages. This procedure is done during the latter stage of the RATA, so that the OFS performance can be independently validated before the test is concluded.

Up to six (6) discrete offset points may be entered. It has been shown that for the broad range of applications 3 points (Low, Medium. High) will be sufficient.

Again – this procedure should be implemented before RATA is concluded so that curve fitting performance can be verified.

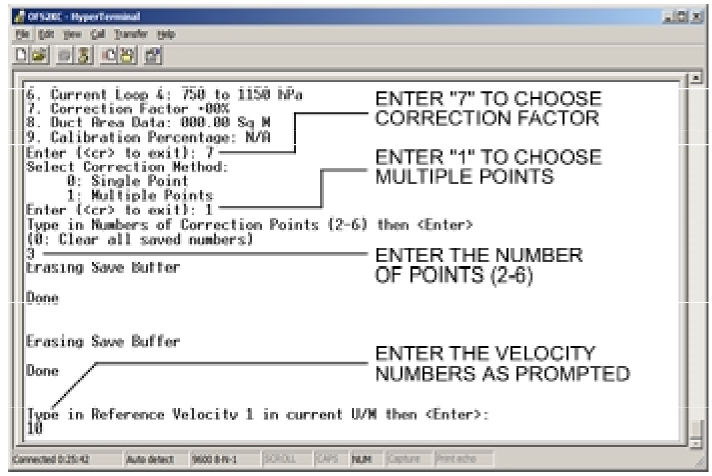



**Figure 4-9 Curve Fitting Setup**

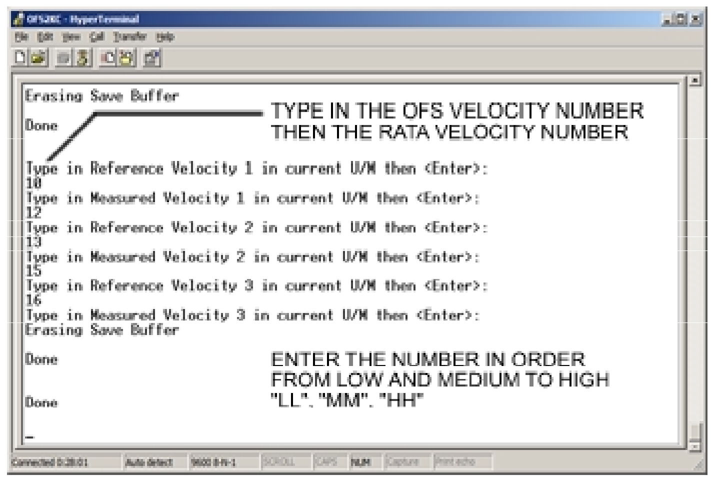



**Figure 4-10 Curve Fitting Point Entry**

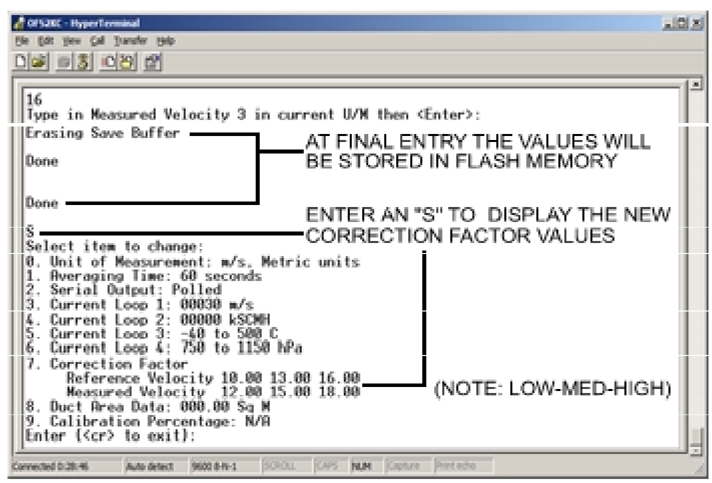



**Figure 4-11 Curve Fitting Entry Check**

**Multiple Point Correction Factor** (continued)

Should it be necessary to return the OFS to basic flow reporting, all correction factor entries may be cleared by simply entering a zero ("0") as prompted.

It is also recommended to clear correction factor settings when updating or entering new settings.

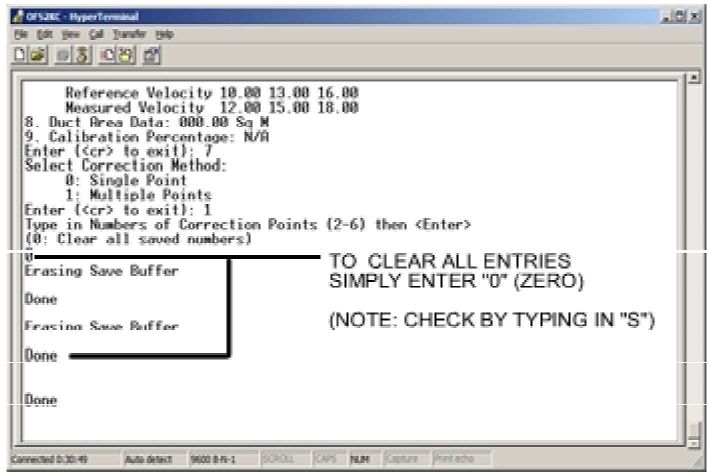



**Figure 4-12 Clearing Set Points**

### 4.2.7 Duct Area Data

The most basic element in volumetric calculations is the cross-sectional area involved.

Formula for rectangular area:

**Length X Width = Area**

Formula for circular area:

$$\pi \times R^2 = \text{Area}$$

Where:

$\pi$ = 3.1416
$R^2$ = Radius Squared

Be sure that the Units of Measure (UOM) of your measurement is the same as the UOM set in configurations step "0".

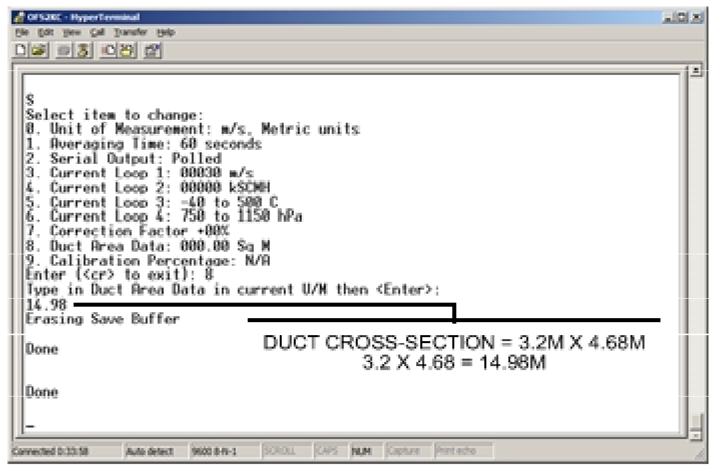



**Figure 4-13 Duct Area**

### 4.2.8 Calibration Percentage (Optional)

Calibration adjustment is not enabled for OFS 2000C models. The measurement process is drift-free.

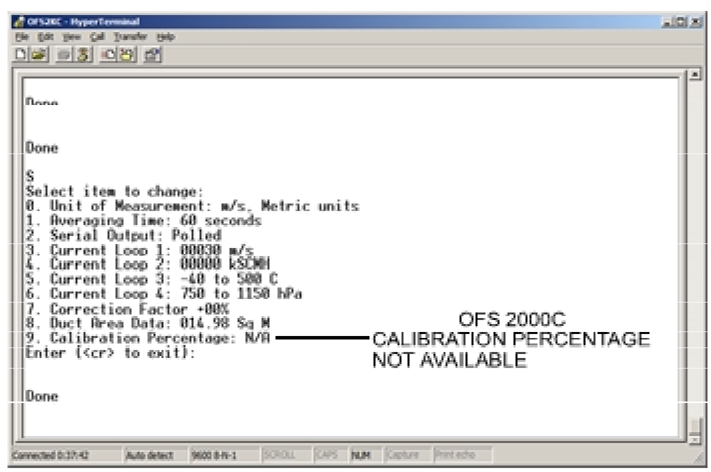



**Figure 4-14 Calibration Percentage N/A**

# 5 Poll Commands & Data Output

When being operated in RS-232 mode the OFS outputs conventional ASCII data strings in response to single character poll commands sent by the user's Data Acquisition System (DAS) or computer. Besides use in ordinary operation, the poll commands and resulting data outputs can be useful in determining system status, diagnostics, and troubleshooting.

The poll commands and descriptions are listed below:

| REQUEST | DESCRIPTION |
|---|---|
| A | Short data output character string – velocity and basic system status |
| C | Full data set including diagnostic data - recommended |
| R | Restart system<br>Note: all user-set parameters are retained and a calibration check is performed. |
| V | Displays firmware version installed |

Note: All OFS poll commands are case – sensitive. Upper-case is used throughout. See following tables for details of poll responses.

## 5.1 "A" Poll (Short Data String) Output

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Format: | ± | w | w | w | w | , | u | u | u | , | s |
| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| |
| Byte: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

### 5.1.1 "A" Poll Response Bytes

| Byte | Description | Field Symbol | Description |
|---|---|---|---|
| 1 | Flow Direction | + | "+" represents flow in direction of arrow in RX Unit. |
| 2-5 | Flow Data | wwww | Represents air velocity expressed in units of measure selected by customer |
| 6 | | , | Comma delimiter |
| 7-9 | U/M | uuu | User selected units of measure such as m/s or fps |
| 10 | | , | Comma delimiter |
| 11 | System Status | s | "P" indicates system self-test pass, "F" indicates system failure, "C" indicates ongoing calibration check, and "R" indicates system restart |
| | | | |

## 5.2 "C" Poll (Long Data String) Format

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Format: | **W** | , | w | w | w | w | w | , | u | u | u | , | **A** | , | a | a | a | a | , |
| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| |
| Byte: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Format: | **B** | , | b | b | b | b | , | **S** | , | s | s | s | s | , | **R** | , | r | r | r |
| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| |
| Byte: | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| Format: | , | **I** | , | i | i | i | i | , | **V** | , | v | v | v | v | v | , | **T** | , | t |
| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| |
| Byte: | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 |
| Format: | t | t | , | **P** | , | p | p | p | p | , | K | , | k | k | k | k | k | | |
| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | \| | | |
| Byte: | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | | |

### 5.2.1 "C" Poll Response Bytes

| Byte | Description | Field Symbol | Details |
|---|---|---|---|
| 1 | Wind Indicator | W | Fixed Field – Velocity |
| 2 | | , | Comma delimiter |
| 3-7 | Wind Data | wwwww | Represents air velocity expressed in units of measure selected by customer |
| 8 | | , | Comma delimiter |
| 9-11 | Unit of Measure | uuu | User selected units of measure such as m/s or fps |
| 12 | | , | Comma delimiter |
| 13 | Detector "A" | A | Fixed Field – Detector A Signal Strength |
| 14 | | , | Comma delimiter |
| 15-18 | Carrier Level | aaaa | Represents detector "A" carrier strength in volts from 0.10 to 9.99 volts |
| 19 | | , | Comma delimiter |
| 20 | Detector "B" | B | Fixed Field – Detector B Signal Strength |
| 21 | | , | Comma delimiter |
| 22-25 | Carrier Level | bbbb | Represents detector "B" carrier strength in volts from 0.10 to 9.99 volts |
| 26 | | , | Comma delimiter |
| 27 | System Status | S | Fixed Field – Status Codes |
| 28 | | , | Comma delimiter |
| 29-32 | Status Indicator | ssss | OFS status indicators (as described in section below) |
| 33 | | , | Comma delimiter |
| 34 | Correlation | R | Fixed Field - A & B Signal Correlation |
| 35 | | , | Comma delimiter |
| 36-38 | | rrr | Signal correlation, >30 typical |
| 39 | | , | Comma delimiter |
| 40 | | I | Fixed Field - Signal Index |
| 41 | | , | Comma delimiter |
| 42-45 | | iiii | 0 to 9999 |
| 46 | | , | Comma delimiter |
| 47 | Volumetric Flow | V | Fixed Field - Volumetric Flow |
| 48 | | , | Comma delimiter |
| 49-53 | | vvvvv | k SCFM or k SCMH (SI unit or Imperial unit) |
| 54 | | , | Comma delimiter |
| 55 | Temperature | T | Fixed Field - Temperature |
| 56 | | , | Comma delimiter |

| | | | |
|---|---|---|---|
| 57-59 | | ttt | Temp in °C or °F ( - 40 to +500 C or -40 to 932 F) |
| 60 | | , | Comma delimiter |
| 61 | Pressure | P | Fixed Field - Pressure |
| 62 | | , | Comma delimiter |
| 63-66 | | pppp | Pressure in hPa (1013 hPa = 1 Atm) |
| 67 | | , | Comma delimiter |
| 68 | Heater Rod Current | K | Fixed Field – Heater Current |
| 69 | | , | Comma delimiter |
| 70-73 | | kkkkk | Heater Current in Amp |

* If some of the Aux inputs are disabled, the corresponding data fields are dashed out so that it does not cause fault condition.

### 5.2.2 Description of Status Indicator Codes (Bytes 29-32)

| Byte | Unit of Measure | Description |
|---|---|---|
| 29 | 0 | m/s |
| | 1 | kph |
| | 2 | mph |
| | 3 | fps |
| | 4 | fpm |
| | | |
| | | |

| Byte | Averaging Time | Description (sec) |
|---|---|---|
| 30 | 0 | 10 |
| | 1 | 30 |
| | 2 | 60 |
| | 3 | 120 |
| | 4 | 300 |
| | 5 | 600 |
| | 6 | 3* |

| Byte | Operation Mode | Description |
|---|---|---|
| 31 | 0 | Normal Operation |
| | 1 | A/B out of range |
| | 2 | Velocity out of the range defined by Byte 32 |
| | 3 | N/A |
| | 4 | Calibration Mode |
| | 5 | Heater >25% current |
| | 6 | RTD Fault |
| | 7 | Pressure Sense Fault |
| | 8 | OFS restart |
| | 9 | Clean Windows |

| Byte | Full Scale Range | Description |
|---|---|---|
| 32 | 0 | 0-40 m/s |
| | 1 | 0-20 m/s |
| | 2 | 0-10 m/s |
| | 3 | 0-5 m/s |

## 6 Transmitter and Receiver Setup

### 6.1 Transmitter Setup

This procedure can be done any time consistent with plant operations, but is most easily done during primary construction, or idle periods.

**! CAUTION !**
AC Line voltage will be present in the transmitter enclosure.
**Take care to avoid electric shock.**

The Receiver and Transmitter Flange Adapters should be installed on the stack or duct mating flanges. The mating flanges should have been installed according to Section 2 "Pre-Installation".

Be sure that the Flange Adapter purge air fittings are aligned at right angles to the direction of flow. See Section 3.4 "Purge Air".

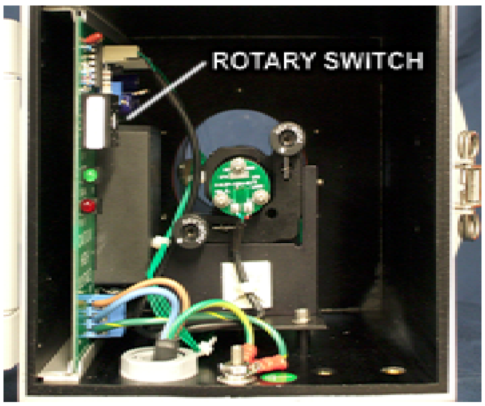



**Figure 6-1 TX Rotary Switch**

The Transmitter should be firmly mounted and have the AC wiring connected and power switched OFF. See Section 3.6 "AC Power Connections". The Receiver should NOT be mounted at this point.

All air lines and/or ancillary equipment should be connected and ready for use.

For OFS 2000 models with a rotary switch power control, see that the power is set to "1" (maximum).

Note: OFS uses a red LED and is completely eye-safe.

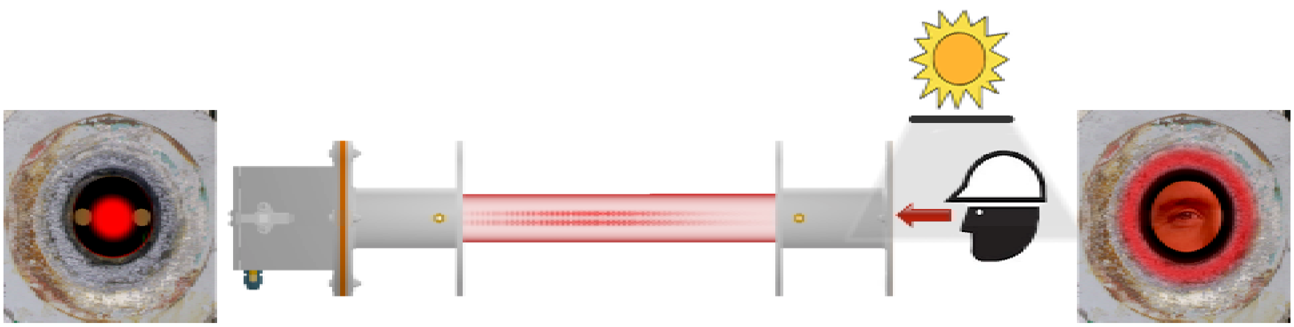


**Figure 6-2 Initial TX Alignment**

**Initial Alignment**

This simple procedure is fundamental: making sure the Transmitter module is properly aimed at the Receiver window. It is a simple naked eye measurement. It may be diffcult to accomplish in high ambient light conditions. If so, use of a sunshade, blanket, or other light blocking apparatus may make it easier to get a good view. This procedure requires two people, one at each end.

Switch the Transmitter AC Power ON, The Green and Red LEDs should light up, showing that the unit is on, and transmitting. The person at the Receiver end should look along the light path to see the Transmitter LED.

Once it is certain that the LED is visible and the person's eye is properly aligned along the centerline, the person at the other end will turn the Transmitter module adjustment knobs until maximum brightness is seen. This will complete the Transmitter initial alignment For short-range applications, this may be sufficient for satisfactory operation. For medium to longer-range applications the Transmitter Module in the TX Head should have the aim adjusted for optimum performance. See Section 7 Optical Alignment

### 6.2 Receiver Setup

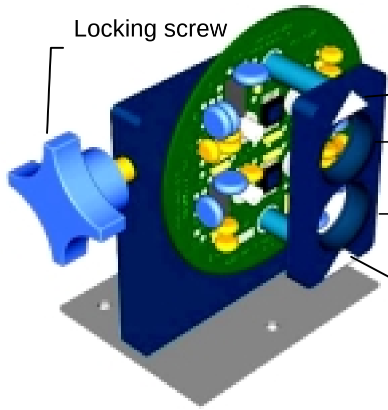



**Figure 6-3 Receiver "A" & "B" Lenses**

Loosen the locking screw on the right side of the mounting. Place your finger on the top edge of the detector board. Use your finger to rotate the board left or right until it is aligned with the direction of the flow. See Figure 6.2 for the board markings. After adjusting, be sure the module locking screw is tight and the module firmly clamped in place.

If you have not done so already, connect the receiver to the control unit and start the system. Watch the control panel display. Let the system run through it's start-up sequence and give it a few minutes to stabilize.

Mount the receiver head in place. Connect all cables and any air lines. See that all seals are tight.

The receiver module can be rotated to allow for different orientations in the mounting of the sensor head and alignment with the flow to be measured . The rear of the circuit board has a reference arrow to mark the flow direction (see Figure 6.2) The rotational orientation doesn't have to be precisely exact. A simple visual alignment along the center line of the flow will suffice. The "A" photo detector should be the first to "see" the flow stream with the "B" following

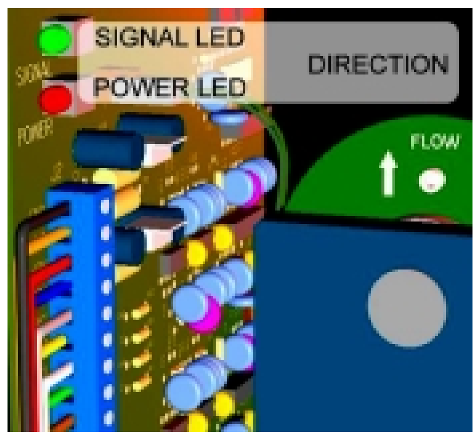



**Figure 6-4 Receiver LEDs and Flow Direction**

Check the receiver power and signal LEDs. Both should be lit. When the signal LED is lit, it shows only that a signal is being received. It is not an indicator of signal strength. You may now close and latch the receiver unit

At this point the Transmitter and Receiver . [See Section 7 Optical Alignment]

## 7 Optical Alignment

The object of this section is to assure that the transmitter is aimed squarely at the receiver and delivering the proper amount of light to produce optimum performance. OFS can (and will) function well in less-than-optimal conditions, but we do encourage the user to exercise care in this procedure. We recommend this procedure be done by two people. Alignment may be checked and adjusted whenever it is deemed necessary.

**! CAUTION !**
AC Line voltage will be present in the transmitter enclosure.
**Take care to avoid electric shock.**

Before you begin:

- The system should be operational: Transmitter, Receiver, and Control units should be installed and powered. All cables connected and Control Unit displaying active readings.
- The Transmitter and Receiver windows should be clean and the light path unobstructed.
- Turn the Transmitter power switch to “1”.
  This is to be sure the Transmitter light output is at maximum
- The Receiver head should have the detector board oriented in the direction of flow.
- The Transmitter should be sufficiently aligned so that the Receiver “Signal” LED lights up.

How well the details of the receiver board and detectors can be seen during aiming depends on several factors such as distance, the amount of mist or particulate in the gas stream, the amount of ambient light. These can combine to make it difficult to see where the “spot” of red light strikes the receiver. With proper care and attention to details as described here, difficulties can be minimized if not eliminated.

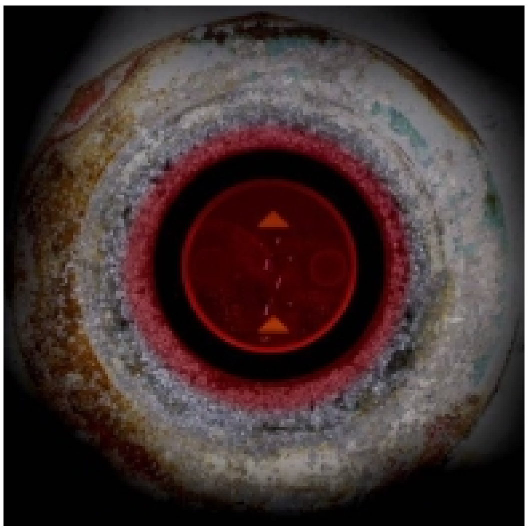


**Figure 7-1 Receiver Window "Cat’s Eyes"**

### 7.1 Alignment – Visibility/Good

Ideally the user should see the two lenses on the detector board. (The detector lens mounting is also equipped with two reflector arrows for help in determining proper aim. [See Figure 6.1 in Section 6.1 Receiver Setup]. When the transmitted light beam shines on the detector lenses, they will reflect and look like two little “cat’s eyes” at night. The key to proper aiming is to make sure the “cat’s eyes” are as bright as possible. If the detector board is clearly visible, you do not need to measure any voltages or look at the A & B readouts on the Controller display in order to aim the LED, just get the “cat’s eyes” as red as possible.

One problem that might be present is that the “cat’s eyes” image is obscured by an intense central red spot of light. This intense red spot is caused by the reflection of the LED directly back to your eye from the front surface of the window. Usually this bright red spot is somewhere in the target area but not in the very center (it is usually off to the side or up in one of the corners). It is only in the center if the heads are mounted so that the windows are exactly parallel. If this is the case, it will most likely block the detector lens reflection (“cat’s eyes” image) that you would normally be looking for. Therefore, if the a bright red spot is in the center, just aim the LED such that the red spot is as bright red as possible.

Once you are satisfied the LED is aimed:

Turn the power incrementally down from “1” (“4” = minimum) allowing a few minutes for the system to stabilize at each change, until A & B are approximately mid-range (range = 1 to 9.99) A & B voltages do not need to match

The A & B voltages should be within 30% of each other. If they are not within 30%, re-do the aim until they are as close as can be gotten. By convention, the A detector is the one that first “sees” the turbulence and is therefore the upstream detector. If the A detector voltage is too low then the beam is pointed too far in the downstream direction, and vice-versa.

If the image of the detectors (cat’s eyes) is too hard to discern because of distance or mist / particles then you will need electronic feedback of the amount of light received by the detectors to properly aim the LED. If the Controller is mounted close by you can have someone call out the A and B values from the Controller display while you adjust the LED aim. The A and B scales on the controller are 0-9.99 volts. Your job is just to get the A & B readings as high as possible (to a maximum of about 8.0) and get the values of A & B within 30% of each other. The instrument is very accepting in terms of light levels and will function anywhere in between 0.2 and 9.99 volts but the LED beam must be aimed and centered on the detector board.

## 7.2 Alignment – Visibility/Poor

If the image of the detectors (cat's eyes) is too hard to make out, and, in addition, the controller is inaccessible, then you can bring back the C1 and C2 signals (and ground) from the receiver head over to the transmitter head in a temporary cable. You can then measure the voltage potential using a voltmeter on the C1 and C2 conductors, compared to ground, as a measure of how much light is getting to the other side. C1 corresponds to the A detector and C2 the B detector. For your temporary cable terminations, just slip conductors into the appropriate terminal strip locations (C1, C2 and Ground) on TB J2 on the Receiver board. DO NOT lift the wire that is already in those locations but slip your wire in beside it and tighten the screw back down. The scale will be different than on the controller display and will be approximately 0-2.5 volts. Regardless of the voltage measured, you job is to maximize each of the A and B voltages through the aiming process, as described in the previous paragraph.

A useful exercise while aiming is to turn one of the adjustment knobs quite a number of turns in one direction (say clockwise) until the general red illumination "spot" of red light on the receiver side moves so far out of alignment that the detector board (and lenses) grow dark. At this point, stop turning and reverse the knob rotation direction and bring the red spot back, completely over the detector (making it bright again) and continue moving it until you make the detector board (and lenses) grow dark again. In doing this you will get a feel for the speed of movement of the red spot. Practice this a couple of times and now it will be easier to bring the spot back and center it on the detector board and have some confidence that it is properly centered. Do this exercise with both the Up/Down and Side-to-Side adjustment knobs.

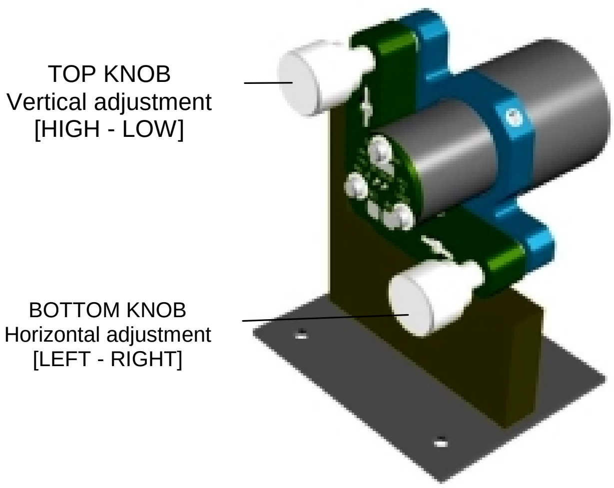



**Figure 7-2 Transmitter Module**

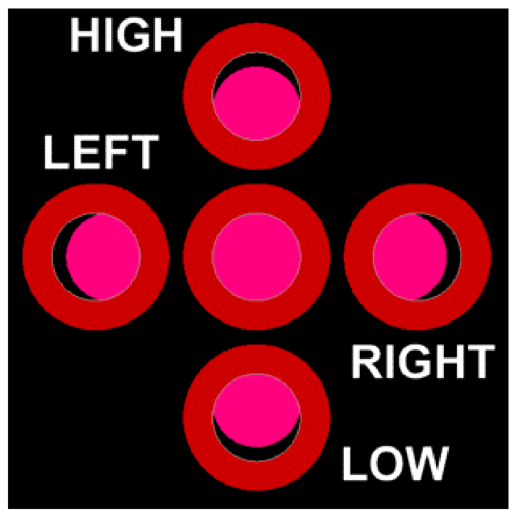



**Figure 7-3 Beam Centering**

In Figure 6.9 "Beam Centering", the outer ring represents the general red illumination spot of light that has been sent to the receiver side. The solid spot within the ring represents the detector window on the receiver side (as seen from the transmitter side). In general the goal of the aiming process is to end up with the circular detector board centered within the red spot of light that has been transmitted to the receiver side.


**Figure 7-4 Front Panel Display (example)**

Observe the A and B signal voltage readings on the control panel display. These represent the amount of light reaching the A and B detectors on the receiver board using a scale of 0-10 volts. These may shift up and down slightly according to variations in air flow between the transmitter and receiver.

***Note:*** *These values do not have to be identical for the OFS to operate correctly.*

At this point, the alignment should be very good and voltage values should be at maximum value for your particular installation. If you are still unsure that the aim is correct, repeat the alignment procedures

The A & B voltages do not have to be identical for the OFS to operate correctly. Generally, A & B voltages should be within a maximum of 30% of each other. Velocity measurement is not dependent on the amplitude of the A & B channels. .The OFS is very accepting in terms of light levels and will function anywhere in between 0.2 and 9.99 volts as long as the LED beam has been aimed and centered on the detector board.

## 8 Correlation

The Correlation output ("Corr") on the display as shown in Figure 6.10 is a very important diagnostic indicator. The Receiver photodetectors measure scintillation, which is the variation of light caused by it's passage through pockets of air with different temperature and density. With OFS 2000, the pockets of air are moving through the fixed LED beam are the natural turbulence eddies in the flowing air. The light detectors are aligned with the flow so that the A detector "sees" the eddies first, then the B detector "sees" them. The two detectors are close enough to each other that the eddies do not have time to be destroyed, i.e., the same eddies pass in front of the A detector, and the B detector. The scintillation signal recorded by the A detector is a unique "fingerprint" of those eddies. When that same set of eddies then passes in front of the downstream B detector, the scintillation "fingerprint" will have the same shape.

The computer then essentially starts a stopwatch when it first sees the fingerprint in the A detector and then stops the stopwatch when it sees the same fingerprint in the B detector. It then knows how much time it has taken for a specific set of eddies to move the fixed distance that separates the detectors. From this time and distance knowledge, it can calculate and report the velocity of the moving air. This measurement is continuous and uninterrupted.

The correlation output is a unitless number in the range of 0 to 999. It is the measure of how well the fingerprint shapes correlate in terms of shape in the most recent information from the A and B detectors. By extensive field experience it has been determined that when the correlation number is consistently over 100 the fingerprint match is good enough that we can be confident it was made by the same set of eddies and the velocity output will be within specifications.

Various factors may affect the shape match of the scintillation fingerprints and therefore the correlation output. Strong signals with high correlation numbers are relatively immune, but one factor should be mentioned for the sake of thoroughness. This most significant detractor is "noise". This is not electronic noise per se, but physical or optical noise which then affects the signal with much the same result as the electronic variety.

In most installations the total noise signal is proportionately small compared to the scintillation signal and contributes very little to the overall signal pattern that is being compared between the A and B detectors. However, if, for example, the scintillation signal is weak (the gases are cold and laminar) and/or the noise signals are strong (say there is high electrical noise, mechanical vibration, or conflicting air turbulence flows in the image), then the overall signal pattern will no longer be dominated by the scintillation signal from the flow eddies. In this case it may be that the A shape and B shape will no longer match and cause correlation to degrade. However, this condition can be overcome.

The OFS 2000 is designed to operate properly in a wide range of conditions. Following the instructions in this User's Guide, and other OSI application notes, should result in a non-problematic, well-functioning system. If your correlation number does NOT remain over 100, the condition may be remedied without extreme measures. Discussion of specifics at this point is not within the scope of this manual. Contact OSI for assistance in correcting this condition.

If you find your Corr output is low, it is wise to continuously record the RS-232 output (See Section 5 Data Collection) so the data collected has all the diagnostics and output information available such that the problem can be analyzed, diagnosed and solved.

# 9 Initial Check and Start-Up

## 9.1 Initial Check

It is advisable to read through this manual before initial start of the system but if you are already familiar with the analyzer and just need a quick startup guide, follow these steps. . Although this procedure may be done at any time, for best results it should be performed while the user's process is running. (For system command functions see (Section 4 "Configuration Setup" on p. 31)

1. Check the installation. See that all components are connected and aligned properly.
2. See that the Transmitter and Receiver windows are clean and the light path unobstructed.
3. If purge air is to be used, see that it is connected and operating properly. [See Section 3.5 Purge Air]
4. Make a safety check of all electrical wiring and connections.
5. Check all cabling connections.
6. Apply power to the transmitter and the control box.
7. See that the "Power" and "Signal" LEDs in the Transmitter and Receiver Units are illuminated.
8. Aim the transmitters LED [See Section 6 Optical Alignment]
9. Observe the Control Unit front panel see that the display steps through initialization and reports voltage levels, correlation and flow.
10. Set the flow rate unit of measure to the type preferred.
11. Set the time-constant to the longest time-constant allowed. Factory default is 1-minute.
12. Set the current loop limit to the just above the highest flow rate.
13. Leave OFS running for at least 15 minutes while the installation is operating. Check the correlation value, if it is steady and higher than 100, the system should perform satisfactorily. [See Section 7 Correlation]
14. If the correlation is lower than 100 or vacillating, restart the system. Operating settings will not be lost..
15. Observe and record the flow velocity(ies) and compare with expected or independently measured velocity(ies). If there is a difference, enter a correction factor. [See Section 8.2.3 Correction Factor]
16. At this point it may be judged whether or not the OFS is operating properly. If it is found to be working properly the user may proceed with operations.

## 9.2 Visual Indicators

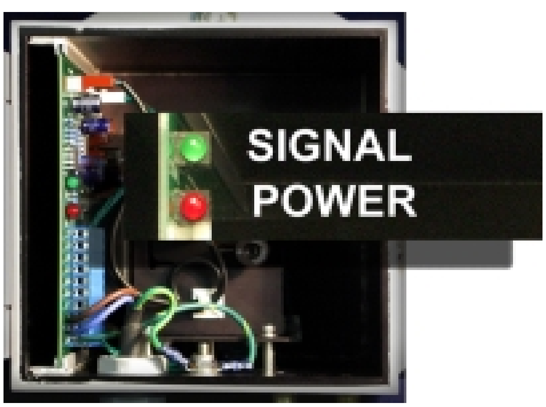



**Figure 9-1 Transmitter LEDs**

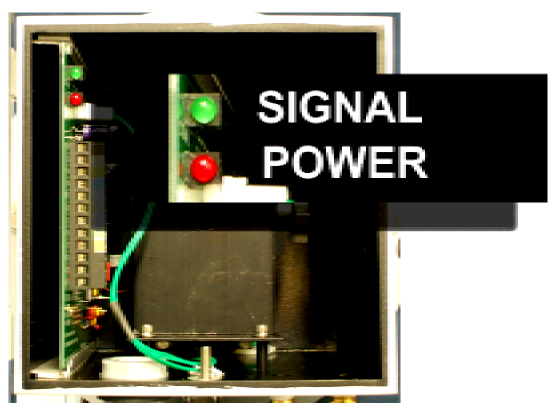



**Figure 9-2 Receiver LEDs**

Transmitter
Red power LED is ON - The system is powered. (110-240VAC)
Red power LED is OFF - The system is not powered.
Green signal LED is ON - The transmitter LED is on and modulated properly
Green signal LED is OFF - The transmitter LED is off or not modulated properly.

Receiver -
Red power LED is ON - The system is powered. (+/- 8VDC from Control Box)
Red power LED is OFF - The system is not powered.
Green signal LED is ON - Light from the transmitter is being detected.
Green signal LED is OFF - The transmitter is not being detected

**Visual Indicators** (continued)

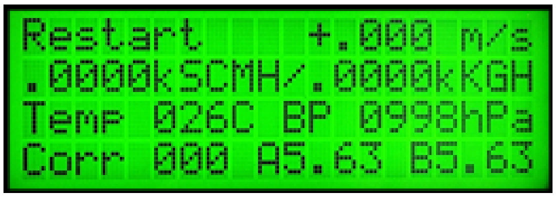



**Figure 9-3 Control Enclosure Display**

When AC power is supplied to the Control Box, the front panel display will illuminate. The system will show “Restart” until the system is completely initialized. The system will start to report immediately, but will take a few minutes to stabilize for proper measurement. Note: The control box supplies DC power to the Receiver.

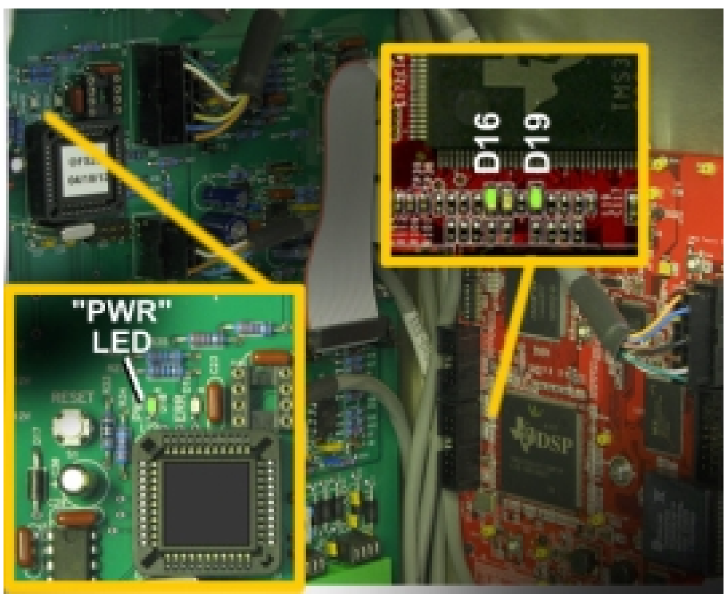



**Figure 9-4 Control & DSP Indicator LED's**

Look inside the Control Enclosure and see that the LEDs on the Control Interface and DSP Board are illuminated. These LEDs show that the PC boards are powered

Once the system is operating. The Control enclosure door must be closed and firmly clamped shut.

If there are questions regarding the system, collect system data as shown on p 45 and contact OSI Technical Support.

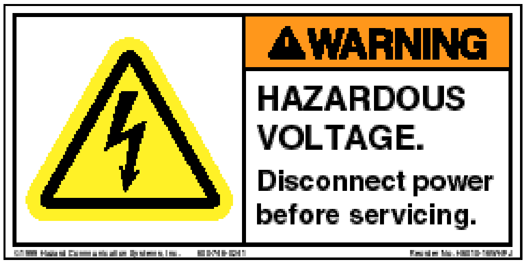
OSI Technical Support
techsupport@opticalscientific.com
Tel: 301 963 3630 xt 216
Fax: 301 948 4670
9AM – 5PM Eastern Time Monday – Friday (except national holidays)
Telephone assistance for overseas customers is available by appointment. E-mail at least 1 business day in advance

Have your:
Unit Serial Number
Software Version (“V” poll)
System data sample

## 10 Maintenance and Troubleshooting

### 10.1 Safety

This equipment does not contain any operator replaceable parts. Only trained personnel are allowed to service this equipment.




This equipment contains hazardous voltages. Disconnect AC power before servicing. Read the entire User's Guide before proceeding with installation or maintenance!

### 10.2 Preventive Maintenance

The following preventative maintenance (PM) actions are recommended:

**Monthly**

Record the information displayed on the controller monthly in a dedicated PM log book for each meter. (This helps establish the rate of deposition of dirt on the windows and therefore your window cleaning PM work. It also helps when you have to diagnose a problem which has appeared and you want to compare with the way it used to look)

**Biannually** (or when cleaning windows)

- Installation condition check– Inspect the TX Head, RX Head and Control Box for proper installation. Verify that all mounting bolts are installed and secure. Verify that the TX/RX Head mounting gaskets are installed, in good condition, and not leaking air. Check the power and signal cables to verify that they are tight and not frayed.
- See that the purge air (if applied) is flowing properly.
- Check the aim
- Visual indicator check – Verify that the LED indicators are illuminated per the “Visual Indicators” check section above.
- Window fouling check – Using the Control Box digital display, verify that the A & B voltages are > 0.5 volts or have not decreased significantly from the last PM check. If less than 0.5 volt, follow the steps in Section “Window Cleaning Procedure” to clean the windows.

#### 10.2.1 Window Cleaning Procedure

- Loosen the top TX/RX Head mounting flange bolt and take off the remaining three.
- Carefully rotate the TX/RX Head around the remaining top bolt so that the window is exposed.
- Use commonly available glass cleaner or alcohol to flood the glass windows.
  (Be careful they may be HOT)
- Use a soft cloth to wipe away any dirt accumulation
- If desired, spray a thin film of Rain-X on the glass and let it dry
- Reinstall the TX/RX Heads.
- Check the optical alignment (it should not need re-alignment if it was already aligned before you started).

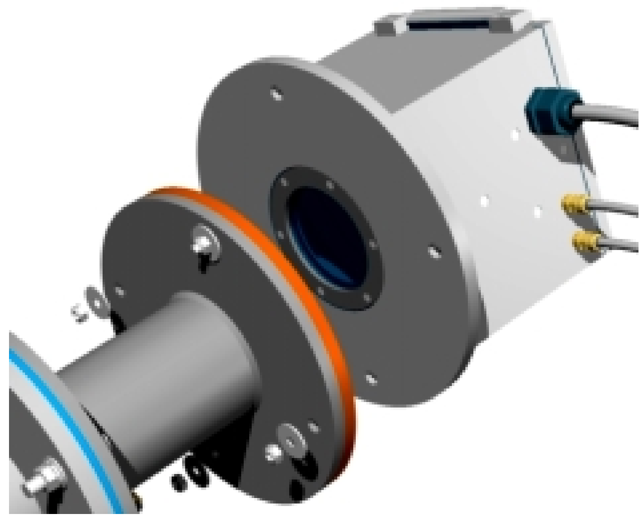


**Figure 10-1 Window Cleaning**

## 11 Troubleshooting

If there is a problem, fault or malfunction, you first have to identify what it is, where it is and then what it is caused by, before you can correct it. Some of the following sections can help you complete these steps.

### 11.1 General Troubleshooting Guidelines

If there is a suspected problem with a component and you have spares or a spare system, change out large components one at a time such as the controller , transmitter, receiver, receiver cable etc, until you have isolated which component the problem is in. Once isolated to a large component you can continue changing out smaller and smaller components until you have identified exactly where the problem resides.

***OSI strongly recommends the purchase of spare components***.

For what seem to be small glitches or lock-ups, cycle the power.

For a quick check to prove the LED is on (and windows clear), remove the receiver module from the mounting stand and look back through the hole that will be left in the stand, towards the LED

If you cannot see a clear image of the detector board when aiming the LED then it is wise to take the heads right off to inspect the windows from the other side and the ports for obstruction or dirt buildup.

Sometimes stack/duct gases cool in the nozzles and spool pieces and create fog and mist, which can weaken the correlation. To see if mist is forming, keep the heads installed and use a small bright Maglite™ or similar flashlight from the transmitter side and look into the nozzle through the transmitter window by looking at all possible angles around the LED module. Carefully look from far down the interior of the pipe near the stack wall location right up to the window. It sometimes takes some patience and time for your eye to adjust and to get the right angle of the flashlight. If mist formation is noticeable, try increasing the purge to drive it out of the nozzle.

If there are unusual lock-ups or behavior sometimes it may be a poor connection on the receiver cable. Unplug the receiver cable, blow out and clean off the connectors and re-connect it

If a problem is very perplexing, take the heads down to a bench and set up the system with the controller on the bench. Use a small hair dryer for the airflow and test that the system works.

If the air flow is extremely moist / wet, then condensed water will pool in the bottom of the spool piece. In this case drill a ¼ inch hole at the bottom of the spool piece about 1 inch away from the process side. This weep hole will allow the water to drain.

If (after consulting with OSI Tech Support) it is determined that there is a problem with a circuit board. You may order a replacement from OSI. Operating firmware or DSP software are not field replaceable or upgradeable unless done by OSI or OSI-approved personnel. The circuit boards must be returned to OSI fro this operation to be performed.

**NOTE:**
**It may be necessary to remove and/or replace circuit boards.**
**These boards are NOT "hot swap".**
**Power to the system must be shut OFF before removing and/or replacing circuit boards.**

## 11.2 Control Enclosure Troubleshooting

There are no user-serviceable parts in the Control enclosure. Information provided herein may be helpful when contacting OSI Technical Support.

The Control/Interface Board and DSP (Digital Signal Processing) board have indicator LED's which will show PCB activity and may help in isolating faults

**11.2.1 DSP Indicator LEDs**
A quick look at the 4 indicating LEDs will show any problems.

D14 lit and pulsing [LED0]
D15 lit and steady [LED1]
D16 lit and steady [GP12]
D19 lit and steady [GP15]

If any of the LED's aren't lit, check the power outputs at the system DC power supply. If the power supply voltages are good, check that all the cables are firmly seated.

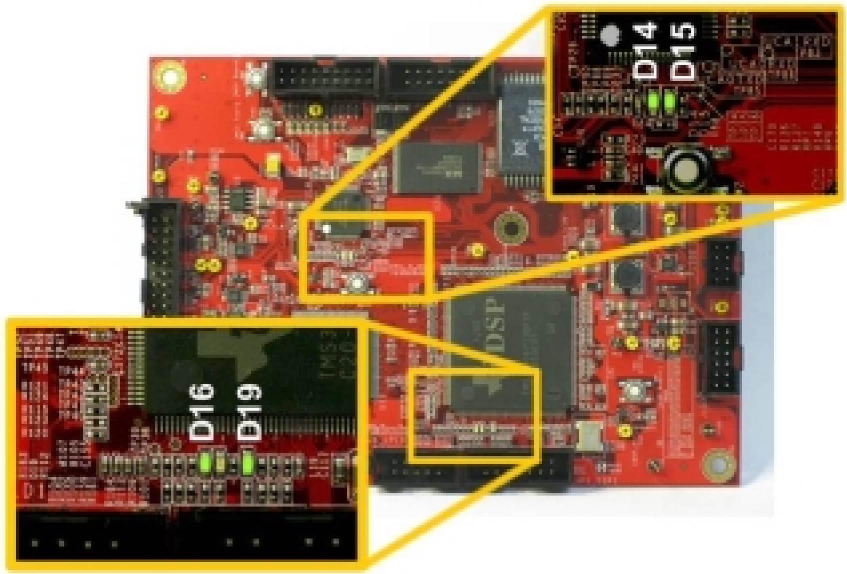



**Figure 11-1 DSP Indicators**

**11.2.2 Control/Interface Indicators**
If the system "freezes" or "locks up" or will not respond to the "V" or "R" poll characters, check the "PWR" (Power) and "ERR" (Error) LEDs on the Control/Interface Board.
If the PWR LED is not lit, check the AC Line Voltage and the DC power supply output voltages. If the "ERR" LED is lit, press and hold the nearby "RESET" button.

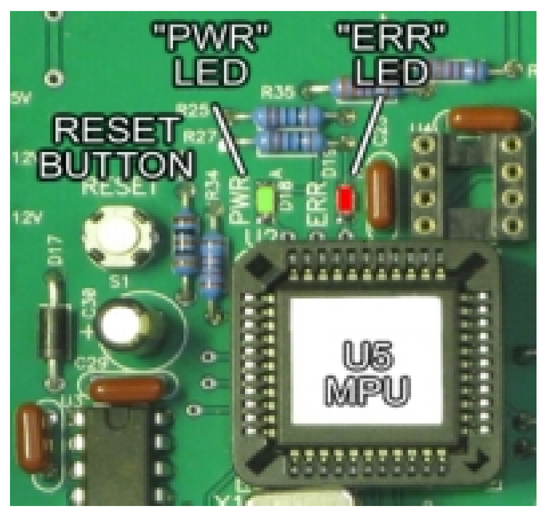



**Figure 11-2 Control/Interface LEDs**

## 11.3 Transmitter Troubleshooting

**11.3.1 Transmitter "Power" Led Not Lit**
Check the AC voltage at the transmitter PCB terminal block. If there is AC voltage present. replace the transmitter board. If there is no AC voltage present, check the AC supply line for fault.

**11.3.2 Transmitter "Signal" Led Not Lit**
Be sure the transmitter module wiring is firmly connected.
Replace the transmitter module.
Replace the transmitter PCB.

## 11.4 Receiver Troubleshooting

**11.4.1 Receiver "Power" Led Not Lit**
Check the +/- 8VDC voltages at the receiver PCB terminal block. If there is voltage present. Replace the receiver PCB. If there is no DC voltage present, check the DC supply line for fault.

#### 11.4.2 Receiver "Signal" Led Not Lit

Be sure the transmitter is transmitting
Be sure the light beam path is unobstructed and the windows are clear.
Check alignment as shown previously in this document.
Be sure the receiver module wiring is firmly connected.
Replace the receiver module.
Replace the receiver PCB.

## 11.5 Error Messages

### 11.5.1 Warning (2) Velocity Out Of Range

### 11.5.2 Warning (9) Clean Lens

This message appears when the received signal drops below acceptable strength for a prolonged period of time, indicating that the windows have become obscured. [See Section XXXXX]

### 11.5.3 Fault (1) A and/or B Out of Range

This message appears when received signal levels are above or below the 1.0 to 9.99 Volt range. This means that the incoming modulated light beam is too weak for the photodetectors to pick up or so strong that the photodetectors are saturated.

### 11.5.4 Fault (3) Input Voltage Out of Range

### 11.5.5 Fault (5) Heating Activity Error

### 11.5.6 Fault (6) Temperature Probe Error

### 11.5.7 Fault (7) Pressure Probe Error

The OFS is a robust, accurate instrument with a wide range of acceptance. It will report accurately anywhere within it's range of parameters, and operate reliably in adverse environments. However, problems do arise. Should you find it necessary, contact OSI Technical Support [See Section 11 Technical Support]

## 12 Technical Support


**OSI Technical Support**
techsupport@opticalscientific.com
Tel: 301 963 3630 xt 216
Fax: 301 948 4670
9AM – 5PM Eastern Time  Monday – Friday (except national holidays)


Telephone assistance for overseas customers is available by appointment.
E-mail at least 1 business day in advance.

### 12.1 Before Calling Technical Support

Please have or be able to provide

- Unit or system model designation :OFS 2000 –W (-F/-V, etc.)
- Unit or system serial number
- A significant "C" poll data sample (minimum 1 hour showing a sample of behavior in question) [See Section 4 Poll Commands and Data Output and Section 5 Data Collection]
- Details of the site and installation (stack diameter, purge air, application, site location, etc.)
- Your name, phone number, and e-mail address

Also you may wish to briefly review the topics listed below:

- **Check Transmitter and Receiver Alignment**

It is possible that during periodic cleaning or maintenance of the TX and RX Units the alignment can be disturbed. In a well - aligned installation the effect of movement is negligible. In a marginally aligned installation, this can affect transmission and reception of the light beam. [See Section 2.2 Flange Alignment Guidelines]

- **Understanding what the A & B numbers mean:**

A and B channel voltages are simply indicators of the strength of the received light beam. The A & B range is 1-9.9 volts. They do not have to be identical. They can vary up and down with conditions in the flow. OFS will report reliably anywhere within that range. Signal strength does not relate to accuracy of measurement.

The conditions to avoid are: signal saturation, and loss of signal, both of which will be indicated by "signal out of range" message on the Control Panel display. These conditions can be caused by a number of factors, such as misalignment, excess output from the Transmitter, blockage of the light beam, and others readily imagined.

- **Understanding "Correlation" number on the Control Panel display:**

The OFS measures the variation of light caused by change in density and movement of air. This is sensed by twin photodetectors "A" and "B" in the receiver. The correlation number is generated by the DSP in direct relationship to thermal turbulence in the air sample from one detector to the next. A correlation number of 100 or over is considered "good". For more details about correlation [See Section 7 Correlation]

A low-temperature, slow-moving air mass will have little thermal turbulence (low correlation). A hot, rapidly-moving air mass will show a great deal of thermal turbulence (elevated correlation). A minimum threshold flow temperature of 100° F (38° C) will be generally sufficient for good correlation. If low correlation is a constant problem, contact OSI Engineering Dept.

- **OFS Calibration Check**

The OFS is essentially drift-free. However, periodic calibration check is required; often by mandate if not by simple good practice. Many users avail themselves of the automatic 24 – hour calibration setting. Otherwise a simple scheduled calibration cycle is adequate. The thing to remember is that the OFS calibrates itself to an internal reference completely ignoring whatever is being currently reported. Any data output during a calibration cycle should be ignored.

- **Purge Air**

Each User's circumstances are different. Generally the idea is to use purge air to keep the flange interior/beam path clear and free of stack / duct gases. Use clean, dry, instrument grade air. Make sure the purge fittings are aligned 90° to the flow axis. The nominal purge recommendation is 1 CFM per purge fitting on the spool piece (and there are 4 fittings per OFS system). [See Section 3.5 Purge Air]

- **4/20 mA Current Loop**

The interface board outputs a current in relation to the air flow. 4 mA = 0 airflow. The remaining 16mA up to 20 depends on what the scale is set to at the Control Panel. The user should be able to connect a multimeter to pins 1 and 2 of TB3 and read at least 4mA when the system is ON. [See Section 3.10 4-20 mA Current Loop And Relay Connections] Refer to "Maximum and Minimum Current Test"

- **RS-232 Data**

This can be the a most revealing tool for diagnostics and troubleshooting. RS-232 data output contains detailed information regarding unit status as well as the flow rate data. It is generated as a response to a "C" poll character sent by the customer's data logger or personal computer. [See Section 4 Poll Commands and Data Output]

# 13 Spare Parts

## 13.1 Recommended Spare Parts

For OFS installations where multiple units are installed or where it is “process critical”, We recommend purchase of an entire unit as a spare to keep downtime to a minimum. For installations where a short down-time is acceptable, we recommend these spares, shown below along with the complete table of available spares. The recommended spares list is ordered based on an industry-wide average of needed replacement modules over the past ten years

1. **Receiver (RX) Amplifier PCB, p/n 1910-213** - Includes dual channel preamp and demodulation circuits
2. **Transmitter (TX) Driver PCB, p/n 1910-113** – Includes power supply and LED driving circuit.
3. **Quartz Glass Window Kit with Heater, p/n 1910-115-1**
4. **Window Retaining Ring w/ Gaskets & Screws, p/n 1910-808**
5. **Control/Iterface (DSP) PCB p/n 1910-311-1**
6. **Digital Signal Processor (DSP) PCB p/n 1910-312**

## 13.2 Available Spare Parts

| Unit | Sub Assembly | P/N |
|---|---|---|
| **TX Head Unit** | Complete TX Head Assembly | 1910-100-1 |
| | TX LED Module | 1910-110-1 |
| | TX Adjuster Mount (incl. LED module) | 1910-111-1 |
| | TX Driver PCB | 1910-113-1 |
| | | |
| **RX Head Unit** | Complete RX Head Assembly | 1910-200-1 |
| | RX Preamp w/optics assembly and stub | 1910-210 |
| | Receiver Amplifier PCB | 1910-213 |
| | Receiver Cable (nnn = overall length in feet) | 1910-217-nnn |
| | | |
| **TX/RX Head** | TX/RX Adapter Flange Mount | 1910-116 |
| | Quartz Glass Window Kit with Heater (one window) | 1910-115-1 |
| | Window Retaining Ring w/gaskets & screws | 1910-808-1 |
| | 4 inch Kevlar Flange Gasket (min. order 2) | FS-1456-00 |
| | | |
| **Control Box** | Complete NEMA4 Control Unit Assembly | 1910-302-1 |
| | Control/Interface PCB | 1910-311-1 |
| | DSP Circuit Board | 2827-312 |
| | AC Power Supply | MP-1010-00 |

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