Optical Scientific Inc.

User's Guide
OFS -2000
Optical Flow Sensor

03/26/13

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Revision Log

Rev Date	Description of Changes
12/28/00	Production Release
1/22/01	Corrected AC voltage operating range, added caution and hazard information, added PM & CM information
2/06/01	Added 4-20 ma option, updated figures, added certifications
10/10/01	Change firmware and make 4-20ma as standard Interface board. Change pages 2, 4, 5, 6, 8, 9, 14, 16-22, 26, 27, 31, 32, 34, and 35.
12/13/01	On page 33, Average Time Default is 60 seconds; User ID code Default is 01. On page 16, change cable wiring for new rx board with old interface board
1/23/02	On page 16, change cable connection. On page 30, change calibration period from 90 seconds to 120 seconds.
2/14/02	Change 2 points calibration to 3 points calibration.
4/10/02	Change from clear cover NEMA-4 box to Aluminum NEMA-4 box.
10/30/02	Change page 14 to include dimension drawing and information of flange gasket and gate valve. Correct errors on pages 27 and 29.
8/13/03	Change miscellaneous errors on pages 2, 4, 18, 22, 23, 27, 28, 29, and 33.
3/23/04	Combine Nema-4 and Rack mount manual. Change recommended spare parts.
3/24/05	Change on Pages 3, 14 and 27.
6/8/05	Change the interface board from single current loop to one current loop and one auxiliary current loop (optional).
10/9/06	Release Model 2000W with Automatic Transmitter Power Feedback Control
5/11/07	Add Installation Procedure Summary in Appendix B.
4/28/2010	Revise OFS 2000W wiring diagram in Appendix A
03/26/2013	Update entire manual to current OFS 2000 release status

OFS-2000 Certifications
UL 3101-1:1993
CSA C22.2 No. 1010.1:92
IEC 61010:1999

US C entela® Certified

OSi is an ISO-9001 Registered Company

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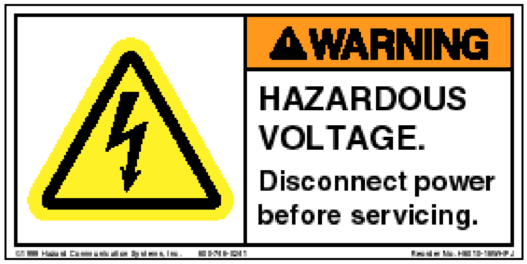
Caveats

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 OVERVIEW

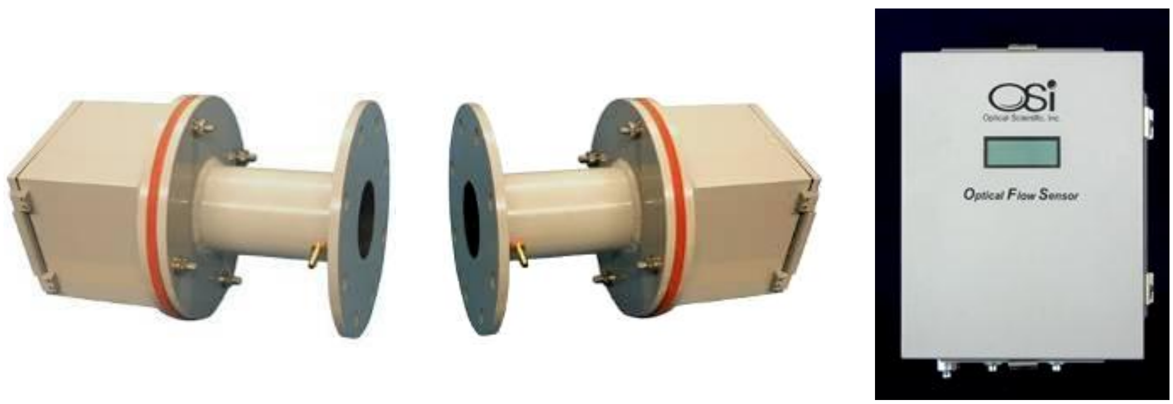
1.1 Theory of Operation

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.

- This measurement is not affected by temperature and pressure.
- It is completely non-intrusive to the air flow.

The basic system consists of:

- Transmitter a stand-alone 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



Transmitter **Receiver** **Control Unit**

Figure 1.1 OFS 2000 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

The OFS -2000CW is a valuable tool for:

- Environmental Monitoring (factory and power plant stacks, refinery flare stacks)
- Process control. (gas transfer, boiler and incinerator efficiency)
- Local airflow monitoring (exhaust vents, wind tunnels)

Environmental Monitoring

Emissions-regulated industries can use this information to calculate volumetric flow from their smokestacks. OFS is EPA - compliant.

Process Control

The OFS can measure the speed of the air or gas flow in an industrial process. The data can be integrated into the monitoring and control system.

Local Airflow Monitoring

OFS has been used to measure airflow in underground tunnel vents, roof exhaust vents, wind tunnels and other applications

1.2 OFS -2000 Specifications

Flow Performance		
Technique	Optical scintillation	
Velocity Range	0.1 to 40 m/s velocity	
Accuracy	2% of reading	
Resolution	0.1 m/s	
Response Time	User selectable: 3 sec to 600 sec	
Long Term Drift	<1% >per year	
Media Temperature	No upper limit (for temp < 150°F an activator heater may be required)	
Light Source	670 nm red LED	
Beam Divergence	5 degrees	
Optics	Quartz window	(High temp sapphire glass available)
Purge	Purge fittings supplied (Nominal recommendation is 4 CFM per system)	Factory-supplied instrument – grade purged air with 1-2 CFM (optional)
Maintenance		
Calibration check	Automatic 2- or 3-point calibration check once per day or as requested by External Calibration Check Request	
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 RX Optical Unit - LEDs indicating power ON & correct operation Control Box - LEDs indicating correct operation	
Operational Environment (Outdoor components: TX/RX Heads, NEMA 4/4X Control Box)		
Ambient Temperature	-40 to 60 C	
Dust Intrusion	IP65	
Moisture	0-100% condensing	
Data Output	4-20 mA optical isolated output Two relays for fault and calibration check indications RS-232 ASCII, fixed data string - 2 types Short with only velocity and P/F status Long with all velocity and status data - Optional Limited Distance Modem (LDM) - Optional Fiber Optic Modem (FOM) User Selectable with Integral Key Pad & Display including: Sensor ID, Baud rate (9600 standard), Averaging Time, Units of Measure	
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
Physical Characteristics		
Weight	TX & RX Optical Units	5 kg ea
	Control Box (NEMA-4),	7 kg
	Control Box (rack mount),	6 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),	30 x 40 x 25 cm
	Control Box (rack mount),	13x43x51 cm
	Flanged Adapter (spool piece)	9-in. dia. (150# 4" ANSI bolt pattern on user end) 6-inch (15 cm) long
Materials	TX & RX Optical Units	Aluminum with powder-coat paint
	Control Box	Aluminum with powder-coat paint (NEMA-4) Steel and Aluminum (rack mount)
	Adapter	Aluminum with powder-coat paint

1.3 Description of Units

The OFS -2000 has three main elements:

- Transmitter (TX) Unit [1910-100]
- Receiver (RX) Unit [1910-200]
- Control Box [1910-301 outdoor / 1910-500 indoor (rack-mount)]

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 purge air fittings to keep the light path clear.

There are two types of Control Box – Outdoor and Rack Mount. The 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 Outdoor Control Box meets NEMA-4 standards. It has nominal 1-inch diameter holes for the user to make power and signal/communications connections. The rack-mount Control Box has a power cord socket and a terminal block for the user to make signal/communication 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.

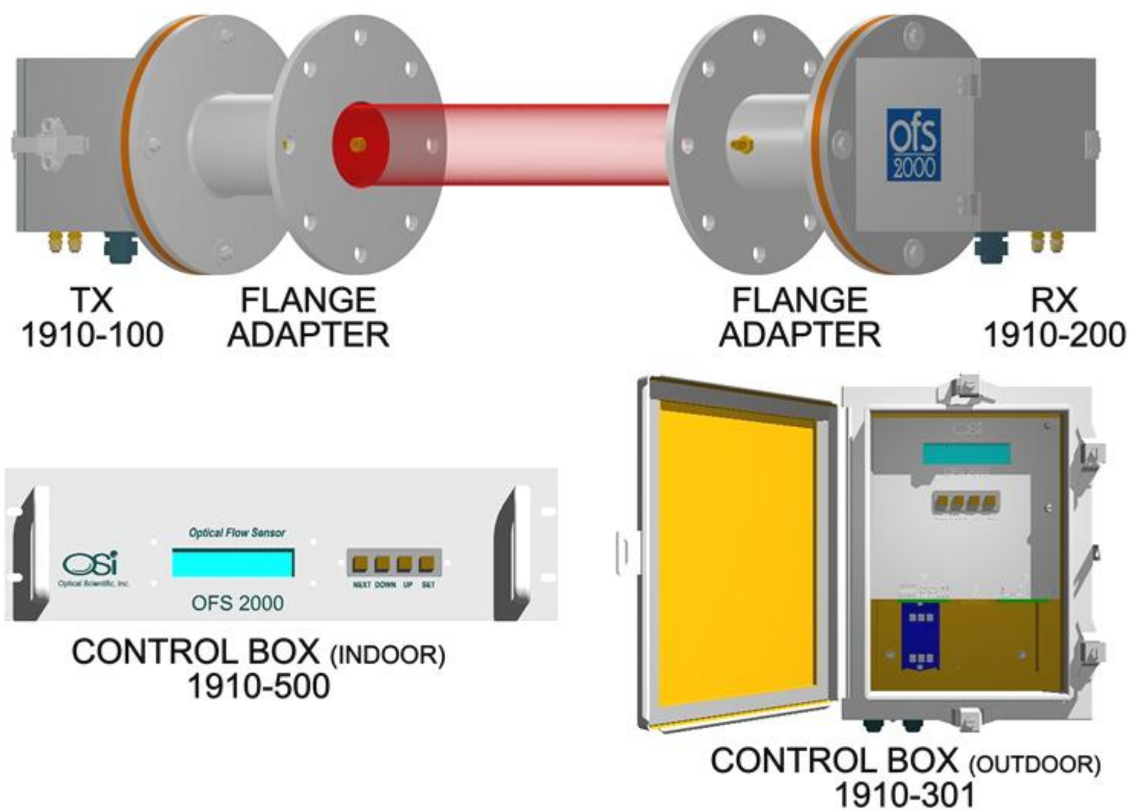


Figure 1.2 OFS System Components

1.4 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.

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.

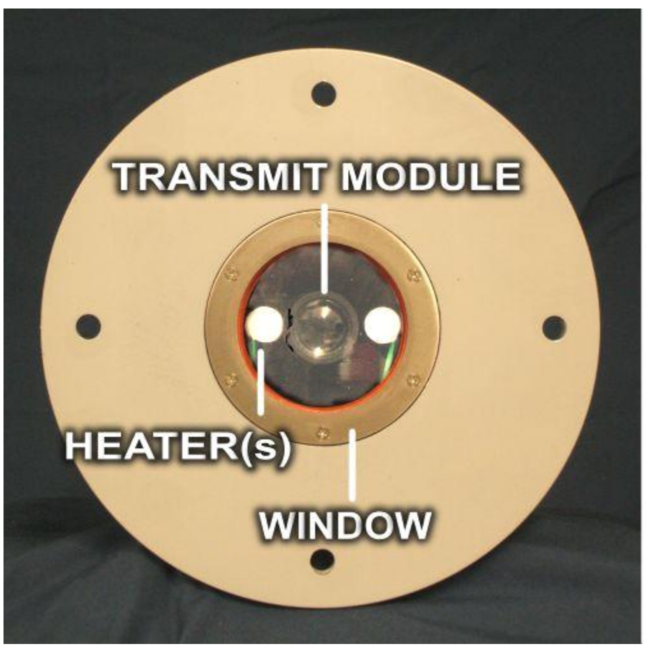
The transmitter housing contains the transmitter optical assembly and transmitter driver circuit board. The optical assembly is pre-aligned in the factory and needs no focusing, just aiming. The LED (transmitter optical module) aim is adjustable to ensure the eye-safe red light beam properly illuminates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



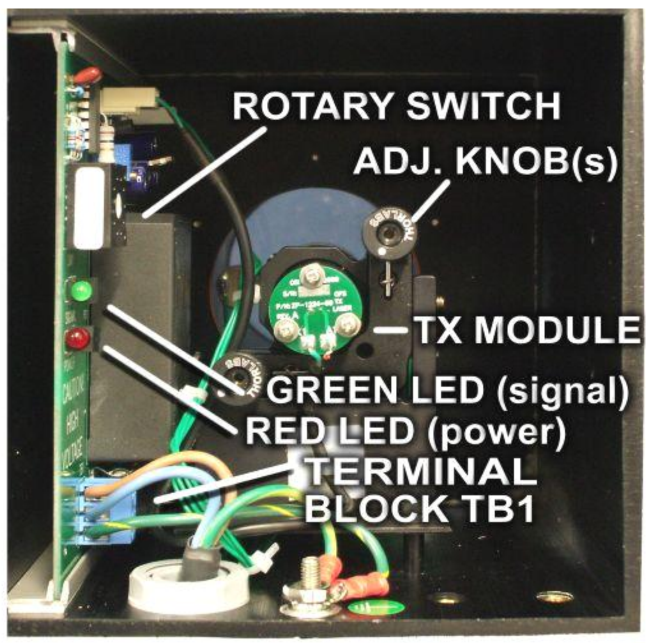


Figure 1.3 OFS 2000 Transmitter

1.5 Receiver (RX) Unit

The RX Unit, P/N 1910-200, 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 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.

Gaskets are supplied for installing the Receiver 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.

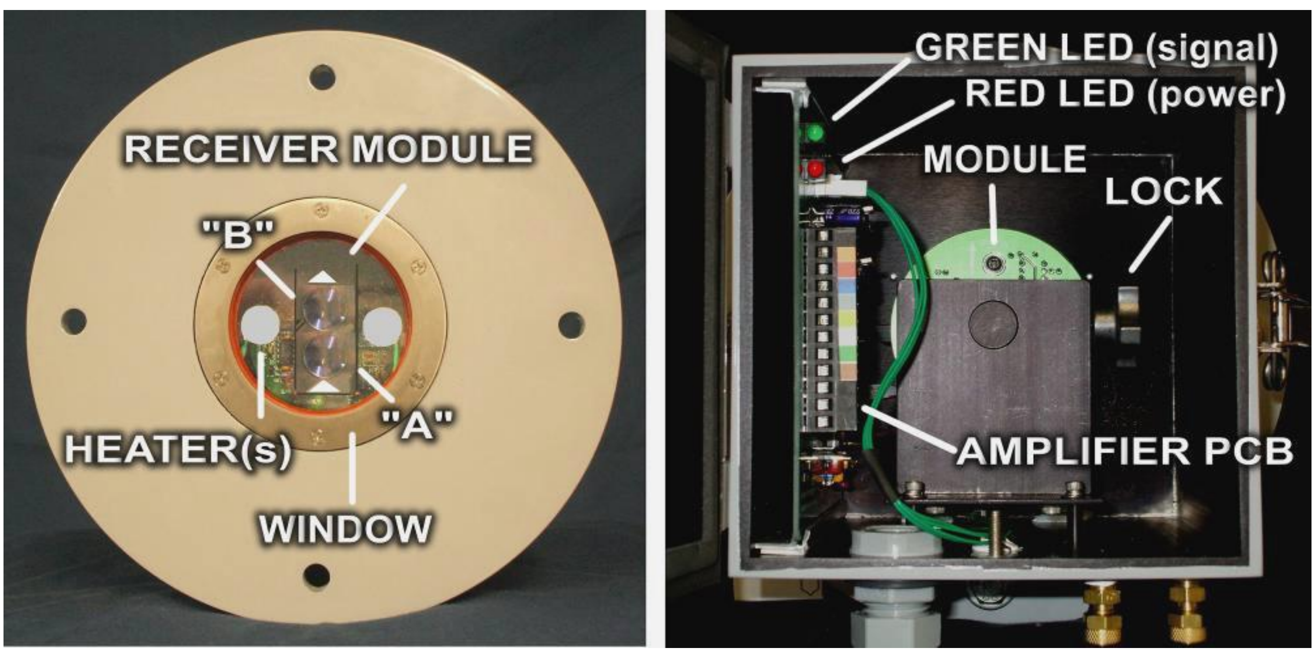


Figure 1.4 OFS Receiver

1.6 Control Box(es) Indoor And Outdoor

Control Boxes, [1910-301 and 1910-500"], contain the same components. The only difference is in the packaging and component arrangement.

1910-301 Outdoor Control Box is housed in an enclosure that meets NEMA-4 standards
(NOTE: a NEMA 4X stainless steel version enclosure is also available)
1910-500 Indoor Control Box is housed in a conventional 19" rack mount enclosure.

Customer interconnection wiring terminals are identical. The Outdoor Control Box may be hard-wired using either cables or flexible conduit at the customer's discretion. The Indoor Control Box is connected using conventional indoor power cords and cabling.

1.6.1 Outdoor Control Box

A Control Module
This board is used to display functions, control and set system operating parameters. a fluorescent display [A1] and keypad [A2] are provided on the front panel for setup and display of real-time information.

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.

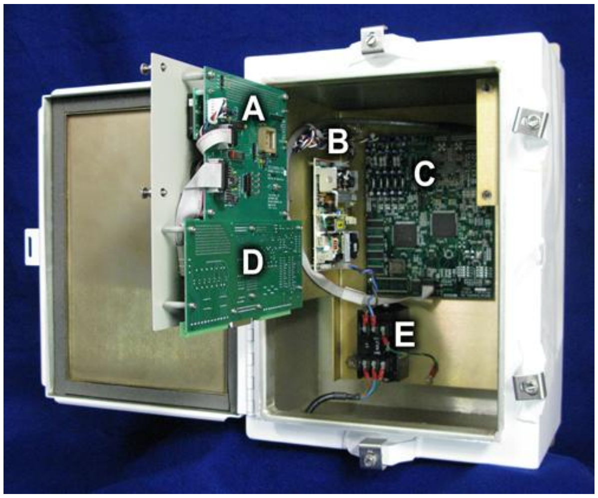
C Digital Signal Processor (DSP)
This board is a state-of-the-art digital processor used to convert the optical data from the RX Unit into flow measurements. This data is transmitted to the microcontroller to be integrated into the information data stream.

D Interface Board
Central point for all of the OFS interconnections.

- A 12-pin terminal Block (TB2) to connect the Control Box to the RX Unit. [D3]
- A DB25 connector for RS-232 output (or connection to optional FOM or LDM modules). [D2]
- A 12-pin terminal Block (TB3) to connect the Control Box 4-20 mA current loop. This terminal block also features connections for fault alarm, and manual calibration check start [D1]

Note: All data I/O connections are equipped with inductive filters and spike protection

E Surge suppressor
AC Line spike protection up to 1000 volts.



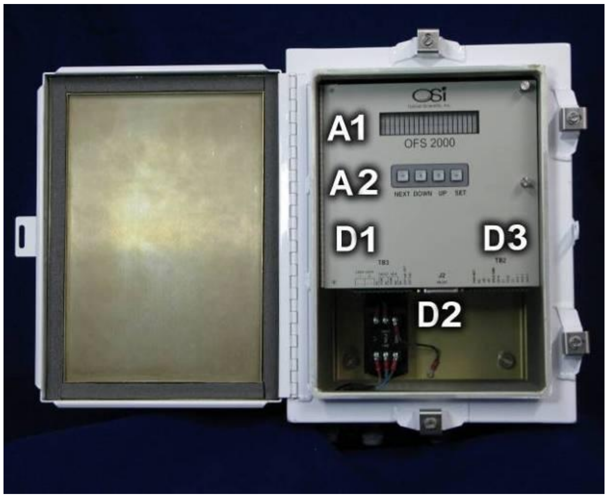


Figure 1.5 OFS Control Box (Outdoor)

1.6.2 Indoor Control Box

A Control Module
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E Surge Suppressor
AC Line spike protection up to 1000 volts.

F AC Power Entry Module

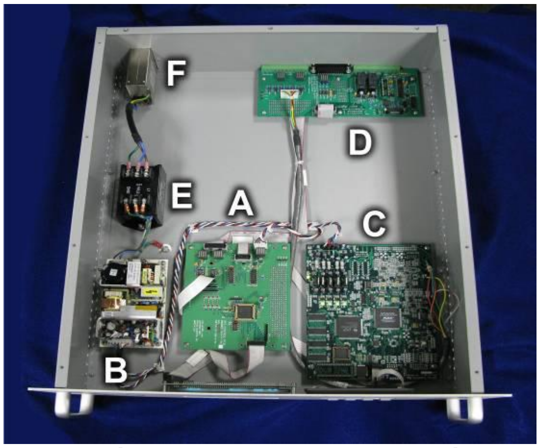


Figure 1.6 Control Box Interior

Figure 1.7 Control Box Front Panel

Figure 1.8 Control Box Rear Panel

The 4-20mA Interface Board [p/n 1910-324] is common to both control boxes and is the central cabling point for the system. The Interface Board is shown below

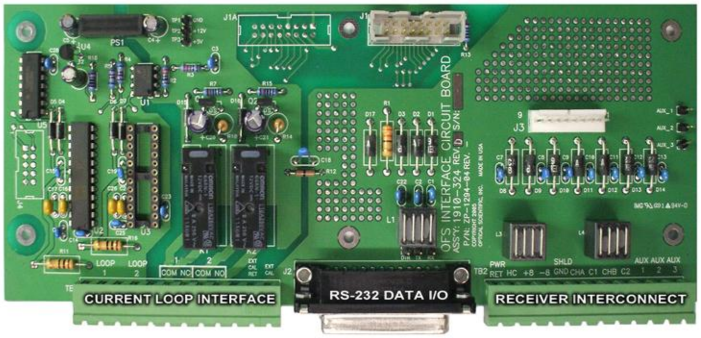


Figure 1.9 Interface Board

TB3 4-20mA and Relays **J2 Serial Port** **TB2 Receiver Terminals**

2 Pre – Installation

2.1 OFS Placement

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 to achieve a steady near-laminar flow. The common sensor sees turbulence as an error which needs to be eliminated. For OFS, turbulence is desirable. It is always easier to add turbulence than to eliminate it . 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 or more before they can become effective.

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 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.

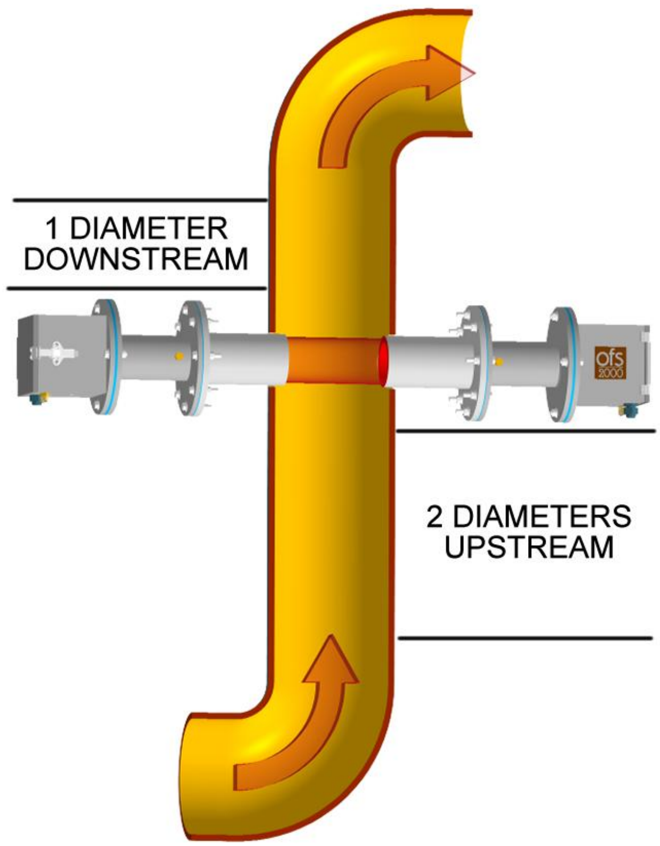


Figure 2.1 OFS Placement

Note: In cases like this shown in the figure, 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.

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

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.

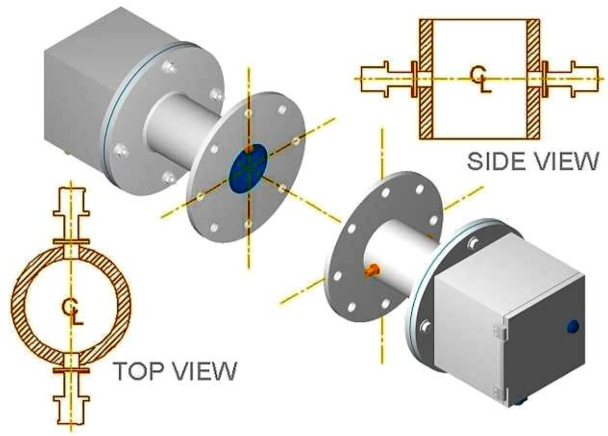
The Transmitter should be placed on the inside curve of the upstream bend

2.2 Flange Alignment Guidelines

The OFS 2000 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 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

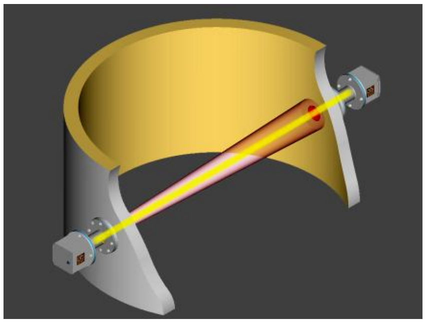


Proper care in mounting the flanges to the stack will pay off many times over.

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:

OFS 2000 User's Guide "Installation Considerations"
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.]

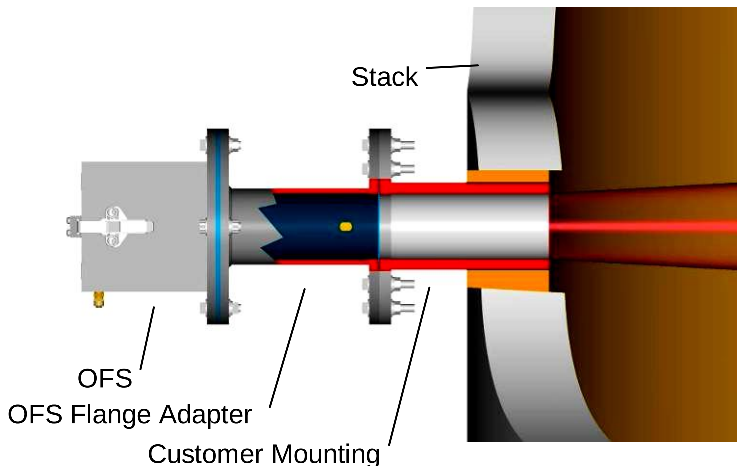
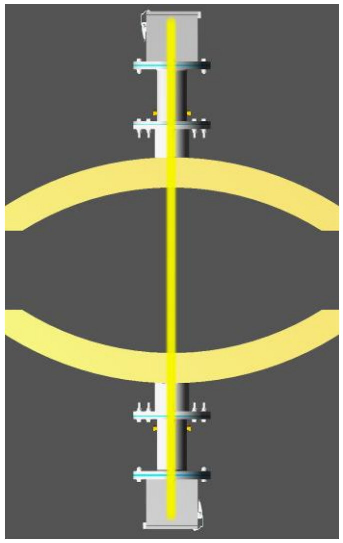


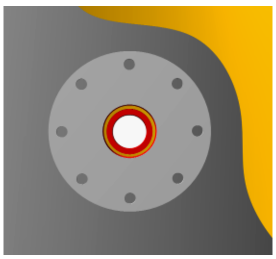
Figure 2.2 Flange Installation (cutaway)

2.3 **Flange Mounting Examples**

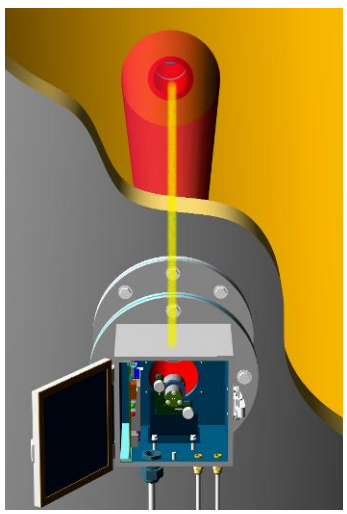
Proper
Flange Alignment

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





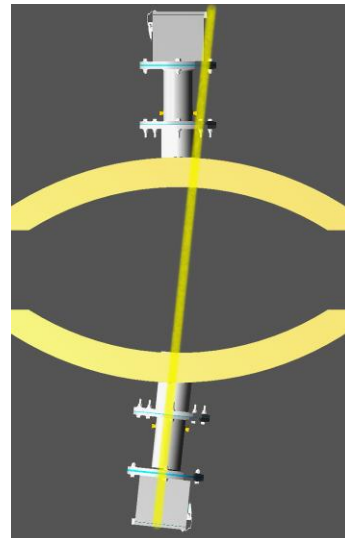
With proper care in mounting the flanges, the transmitted light beam will fall squarely on the receiver opening on the opposite side. The transmitter will require minor adjustment (aiming) for peak efficiency.

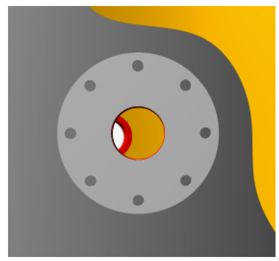


See Section 6.2 "Transmitter Setup" for further details.

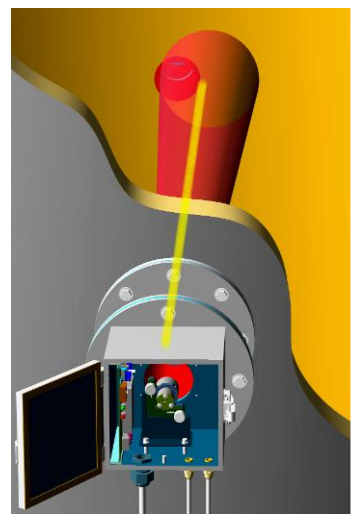
Improper
Flange Alignment

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



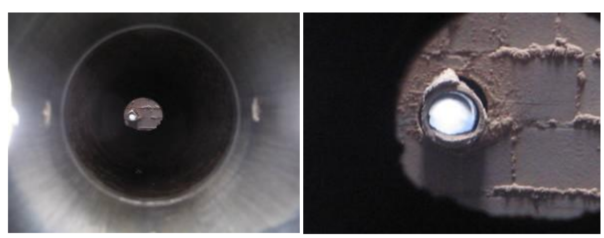


With the light beam off-center. The transmitted light beam will still reach the receiver – and the system will work. However, the received signal will be weaker, and performance will be compromised.



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.

2.4 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:

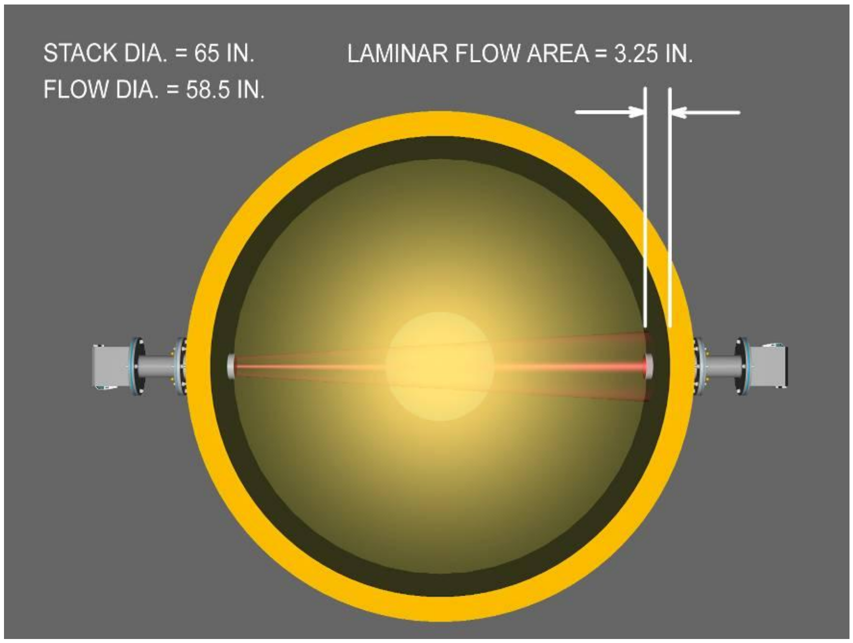


Figure 2.3 Measured Flow Cross Section

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 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 16 "Technical Support".

2.5 **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 3.4.

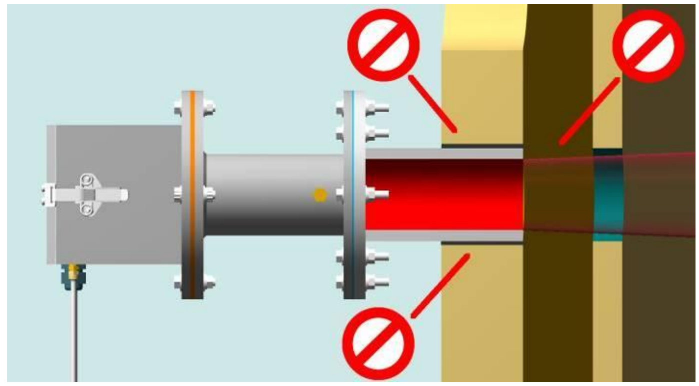


Figure 2.4 Flange Installation - Incorrect

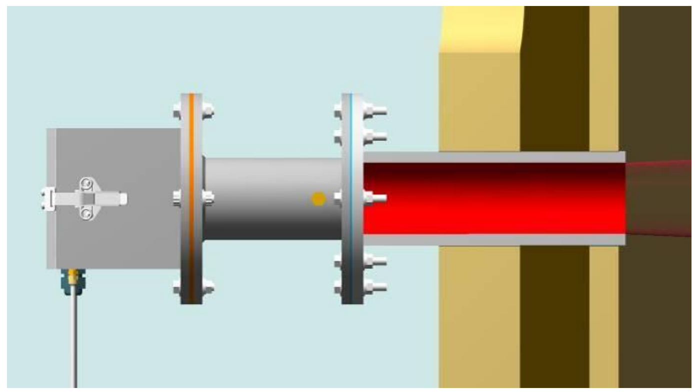


Figure 2.5 Flange Installation - Correct

OFS 2000 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. *(If the bolt pattern "straddles" the centerline, it is permissible to mount the heads tilted to one side. The receiving lenses, must simply be rotated a little to align with the axis of the flow stream.)*

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.

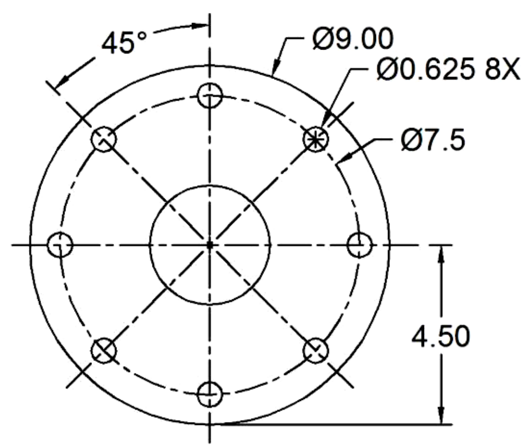


Figure 2.6 Common Flange Dimensions

3 Installation

General installation is described here.

3.1 Required at Transmitter or Receiver Location

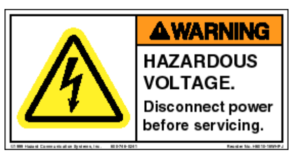
- 4-inch ANSI 150# pipe flange (9 inch diameter)
- Instrument - grade air at 2 CFM per head [See notes in Sections 3.4 "Purge Air" and 3.6 "Z-Purge Air"]

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. The top view with dimensions in inches for the TX/RX head with Flange Adapter is shown in Figure 3.4.

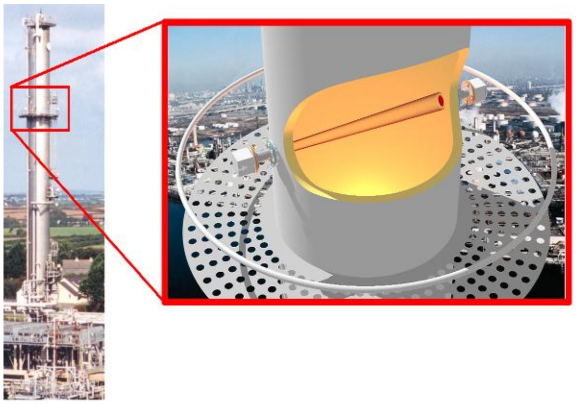


Figure 3.1 Common Vertical Installation

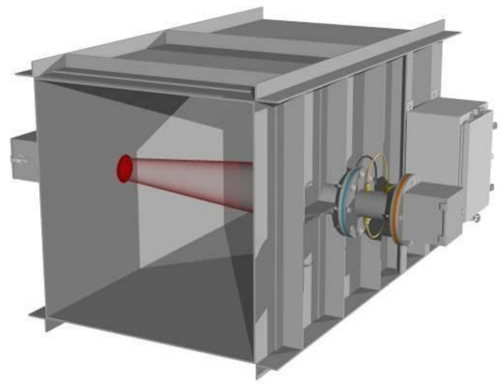


Figure 3.2 Common Horizontal Installation

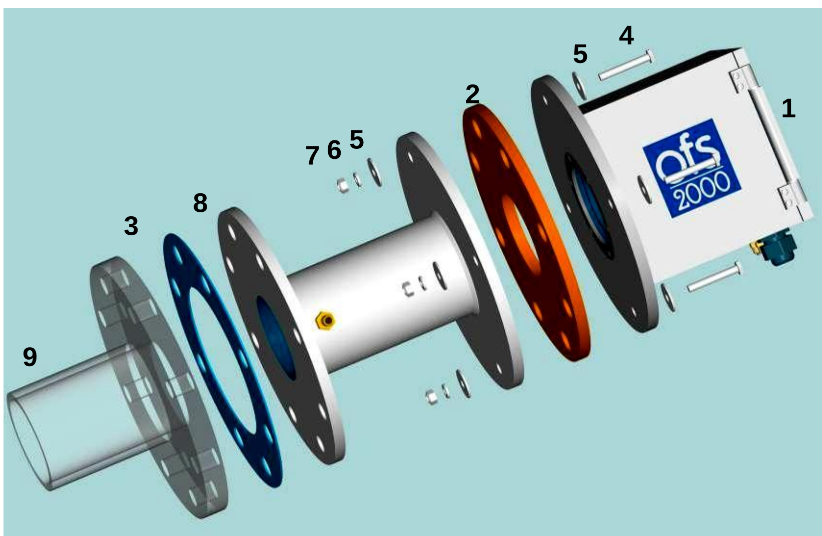


Figure 3.3 OFS Mounting Hardware

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)

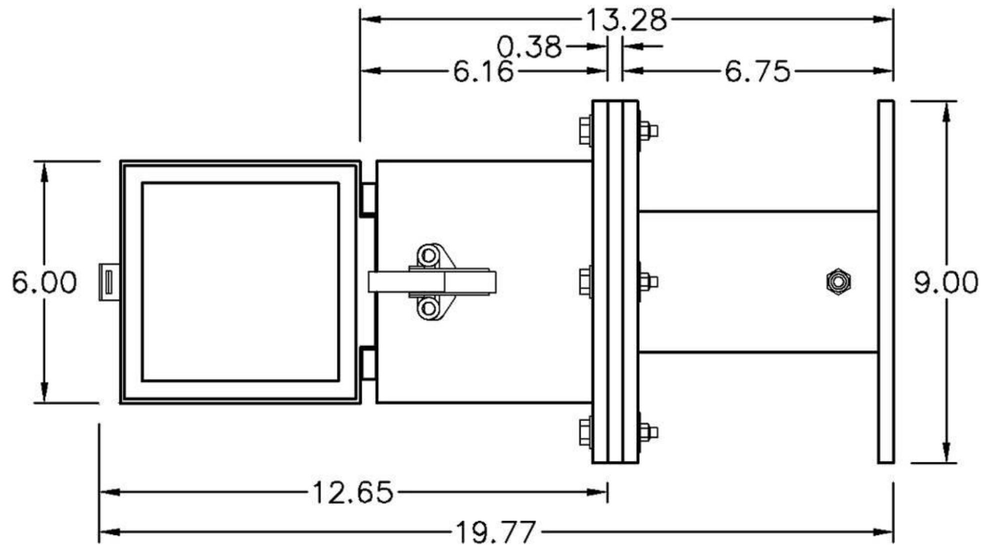


Figure 3.4 OFS TX/RX Overall Dimensions

Units = inches.

3.3.2 Control Units

3.3.2.1 Control Box (Outdoor)

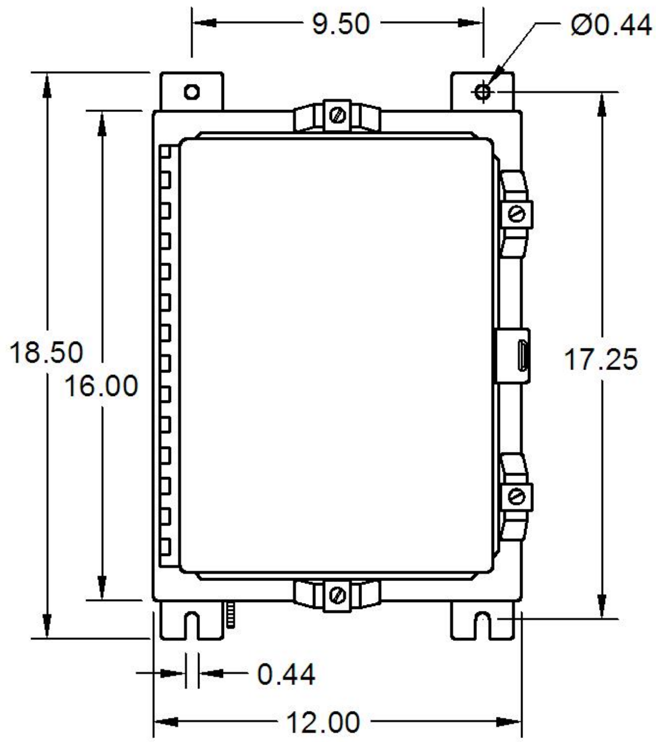


Figure 3.5 Outdoor Control Box Mounting Dimensions

Note: Depth = 9.5 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.

3.3.2.2 Control Box (Indoor)

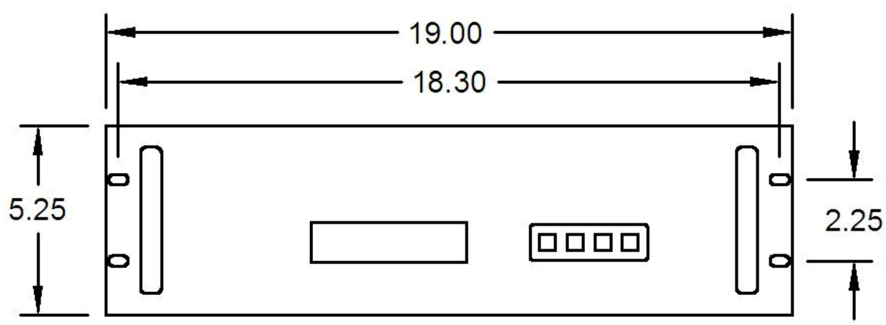


Figure 3.6 OFS 19" Rack Mountable Control Box

Note: Depth = 20 inches.

The Control Box can be mounted to any standard 19-inch rack. 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 3.6 illustrates the Control Box mounting hole pattern.

3.4 **Purge Air**

The OFS 2000, being an optical measuring device, needs to "see" clearly. The function of purge air is to keep the interior atmosphere of the mounting nozzle clear, the light path unobstructed, and provide an air barrier to slow the rate of deposition on the window. (In cases of high flue gas temperatures the purge can also prevent hot gases from entering the nozzle.)

There are two methods of supplying purge air: Passive and Active

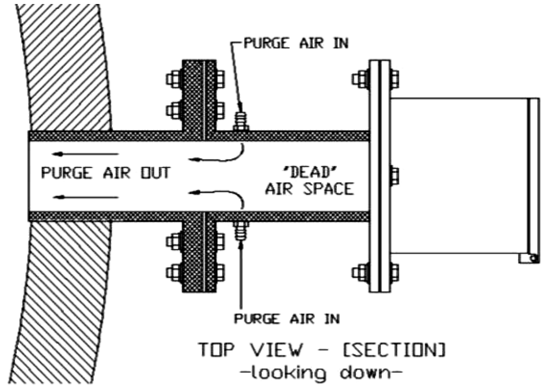


Figure 3.7 Purge Air Detail

Passive Purge
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 may be used to keep the light path clear.

NOTE:
This is no longer recommended as best practice. Passive purge can be effective and has been adapted by users wishing to economize on extra equipment. It has been found to work adequately, but due to the incidence of problems occurring from misapplication, and/or lack of control, it's use is not encouraged. The use of Active Purge, as described herein, is recommended for optimum results.

Active Purge
It is recommended the user apply instrument grade[1] compressed air (nitrogen, or other available clean gas) to the purge fittings. This purge air should be controlled 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. So: 4 CFM supplied altogether; with 2 CFM going to the Transmitter side, and 2 CFM going to the Receiver side.

Figure 3.8 Rotameter **(flow meter)**

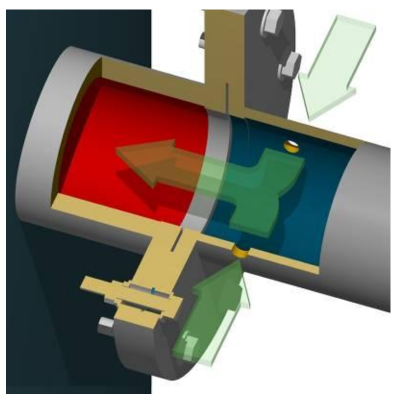


Figure 3.9 "Natural" Air Purge

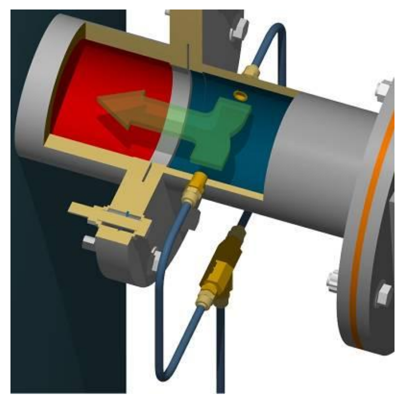


Figure 3.10 Compressed Air Purge

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: *the introduction of purge air flow aligned along the axis of stack flow may interfere with velocity measurements*.

[1] According to ISO 8573.1:
ISO Class 1-6-1 Industrial Grade Air: Efficient removal of solid particulates and oil. ISO Class 6 PDP or a 50% (or less) Rh will be maintained.

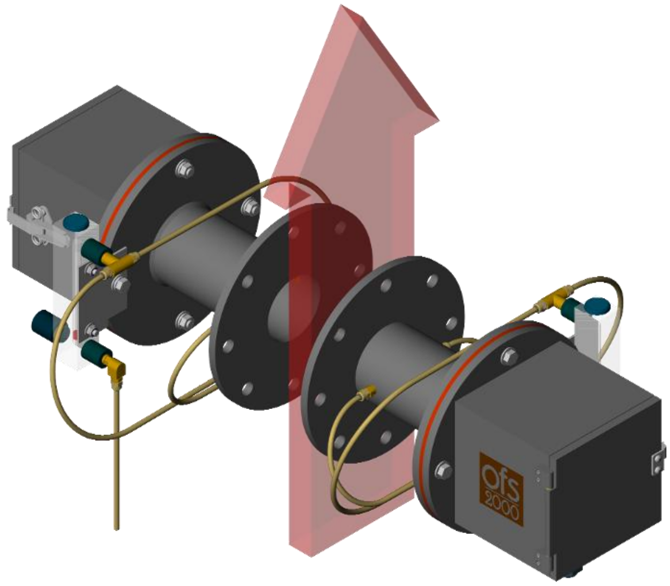


Figure 3.11 Purge Air at 90° to Vertical Flow

When the purge flow is at a right angle (90°) to the direction of the flow, any interference is minimized. Remember - the OFS measures flow along the *complete* light path. With only a small percentage of the light path purged, and at right angles to the flow direction with very minor velocity compared to the stack velocity, the effect of purge air on the measurement is reduced to the equivalent of "background noise" when compared to the strong signal supplied by the transmitter.

In the final analysis, the exact amount of purge air needed is site-dependent. The use of common sense is encouraged. The user should monitor window conditions and adjust purge air incrementally (if needed) until a balance is reached between affecting the system velocity readings and need for window cleaning. Stacks with large amounts of particulate will of course need to have windows cleaned more often than those with relatively cleaner output. Purge air (acting in conjunction with the window heaters) is intended to deter buildup of dirt or moisture and minimize the need for window cleaning - it is not possible to eliminate cleaning altogether. In the majority of cases, the initial setup as described previously is perfectly adequate to meet the customer's needs.

It is recommended that a regulator and rotameter be installed near the OFS heads to control the airflow. OSI can supply a rotameter (1910-453) specifically tailored for OFS use.

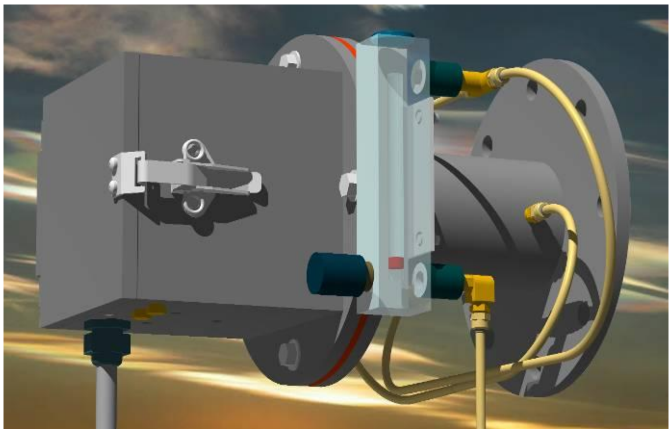


Figure 3.12 Rotameter Installation

3.5 OFS in Hazardous or High Temperature Applications

The OFS2000 can be used to measure flow for gases of 1000° F and higher. Naturally In these applications precautions must be taken to prevent harm to user personnel, and damage to the system. To that end the OFS 2000 should be installed using a gate valve for isolation and a sight glass for protection during operation.

Sight glass installation may also be warranted in applications where the flow to be measured is not particularly high temperature but instead contains hazardous materials such as corrosives, carcinogens, or other potentially harmful substances. In these cases installation of a gate valve and sight glass is also recommended.

OSI offers these two components as options which may be ordered with the systems. They are

1910-420	Cast Iron Gate Valves (2 required per system)
1910-430	Sight Glass (Fused Stainless Steel) w/ Gaskets (2 required per system)

Note: These components are rated for temperatures up to 400°F (204°C) and pressure of 920 PSI (64.7 Kg/Cm). Components with higher temperature ratings are available. Consult OSI Engineering Department.

A typical installation is shown below:

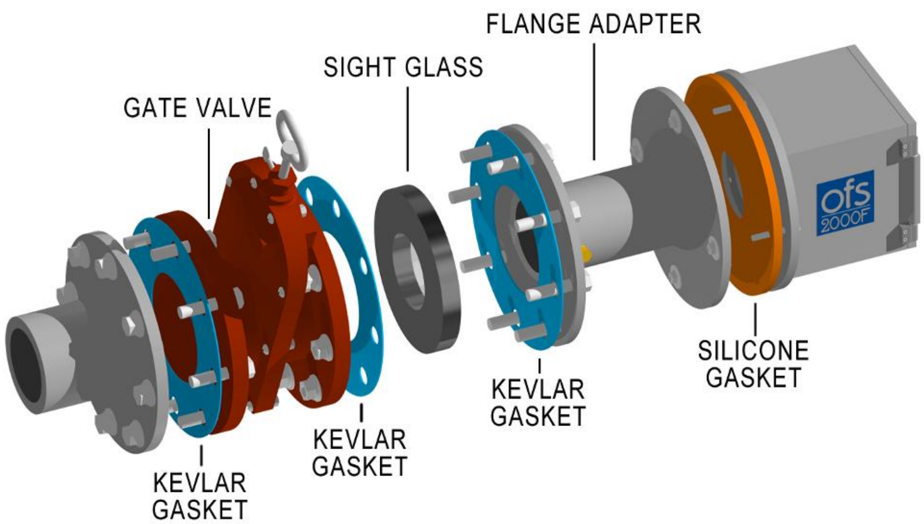


Figure 3.13 Typical Gate Valve Installation

- Install a gate valve or similar shutoff device between the flange adapter and the stack or duct mounting flange, so that the port can be closed to protect personnel when the OFS windows need cleaning or the heads need to be removed.
- Ensure that there is a good, steady instrument-grade purge air flow of 1 CFM through the flange adapter (spool piece).This will assist in reducing heat transfer, and (more importantly) assure that the sight glass and sensor windows remain clean and clear.
- In addition: for extreme high temperature cases it may be wise to install a heat shield around the stack or duct where the TX and RX heads are mounted to prevent infrared or solar radiation from heating the heads excessively. This can be at the User's discretion.

This section should cover the great majority of sight glass applications, however: If you require additional advice or consultation regarding your individual application. contact the OSI Engineering Department.

3.6 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 enclosures are fitted with pneumatic connectors for this purpose.

Pressurization air (Z-Purge Air) is *completely separate from the purge air system described in Section 3*. When applied together they may be supplied from the same primary source, but their control and application must be independent.

Figure 3.14 Z-Purge Control Unit

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.*"

Unit Specifications

- Protective Gas Supply: Air or Inert Gas
- Unit Supply Pressure: 80 - 125 psi max.
- Unit Supply Connection: 1/4" tube fitting
- Enclosure Supply: 1/4" tube fitting
- Enclosure Reference: 1/4" tube fitting
- Safe Enclosure Pressure: 0.5" w.c. / 55Kb
- Safe Press. flow rate: * 0.1 - 3.5 scfh per cf
- Class I Purge Time: See Section 3.7.2.

  * Enclosure Integrity determines actual flow rate

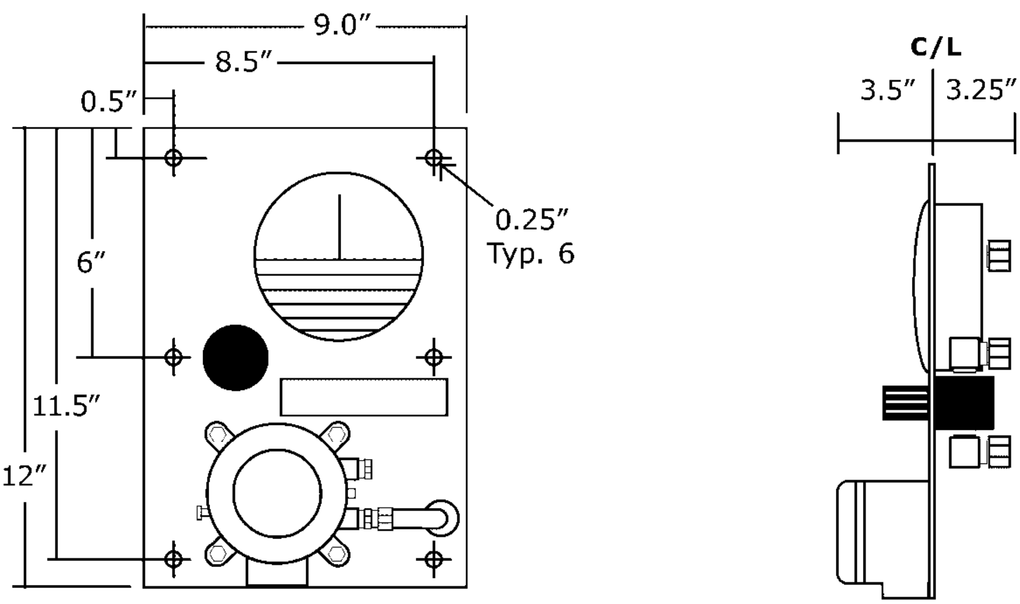


Figure 3.15 Control Unit Mounting Dimensions

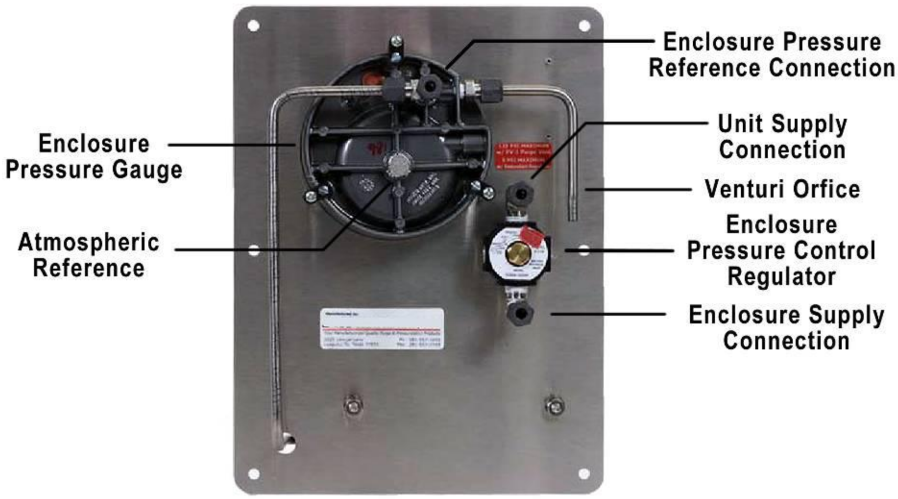


Figure 3.16 Typical Z-Purge Control Unit

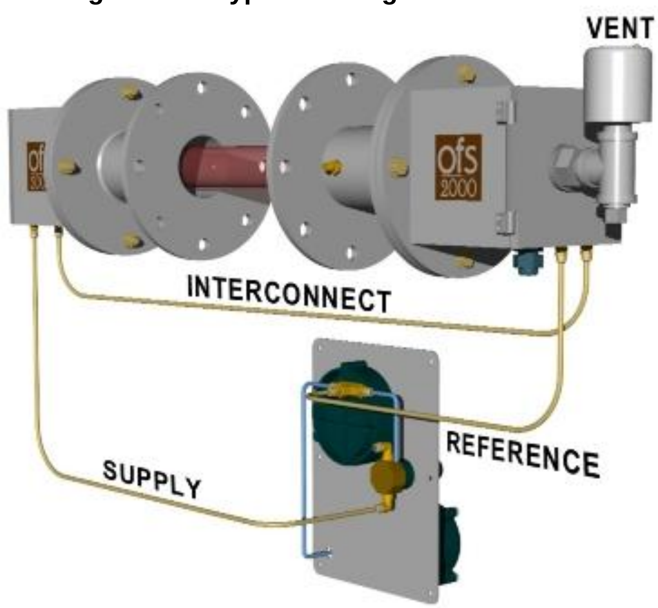


Figure 3.17 TX/RX Z-Purge Arrangement

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

Two Z-Purge control units are required – One for TX and RX units and one for the control box.

When the Z-Purge option is ordered, the OFS is shipped with vents and air fittings installed as shown in the figures. A single Z-Purge control unit serves both TX and RX enclosures, with a tubing branch connecting them. The supply air (or gas) should be routed to the unvented enclosure. The reference (or return) line should be routed back to the controller from the vented enclosure.

All Z-Purge systems MUST be equipped with purge vents.

!CAUTION!

All Z-Purge systems MUST be equipped with purge vents

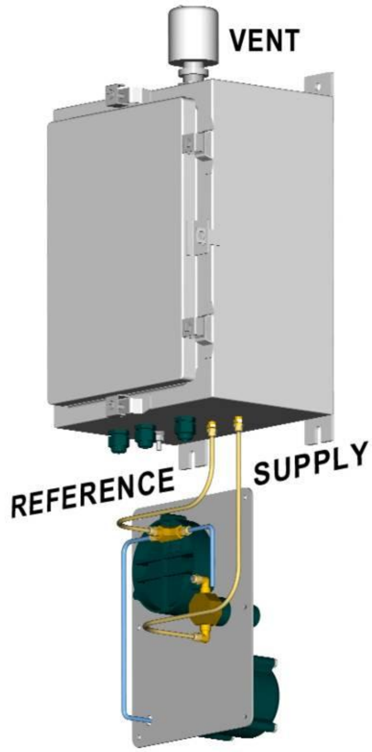


Figure 3.18 Control Box Z-Purge Arrangement

Z-Purge connection to the Control box is straightforward as shown.

The Purge Vent is a gravity-operated enclosure pressure relieving device designed to relieve excess pressure inside a protected enclosure while preventing any sparks or burning material from escaping into a classified location. A required accessory for all Z-Purge systems, the Purge Vent will begin to open when enclosure pressure exceeds approximately 0.8" w.c. and will fully open once enclosure pressure exceeds approximately 1.5". It is constructed of aluminum and stainless steel components providing corrosion protection from harsh environments.

Since it is gravity-operated, the Purge Vent MUST be installed in a true vertical position for proper operation.

3.6.1 Unit Tubing Instructions

1. Connect 1" Protective Gas Supply Header to Unit Supply Connection using 1/4" tubing. Protective Gas Supply tubing should not exceed 15 feet length and 5 bends.

2. Connect Unit Enclosure Supply Connection to the Enclosure Supply bulkhead fitting using 1/4" tubing. Enclosure Supply tubing should not exceed 5 feet in length and 5 bends.

3. Connect Unit Enclosure Reference Connection to the Enclosure Reference bulkhead fitting using 1/4" .035 welded or seamless wall stainless steel, fully reamed tubing. Enclosure Reference tubing should not exceed 20 feet length and 5 bends.

3.6.2 Pressurization Unit Set Up

Class I installations require a 4 or 5 volume exchange through the protected enclosure while maintaining a positive pressure. To determine unit flow rate, temporarily install a 0 - 10 scfh rotameter between the unit and the protected enclosure. Class II installations proceed to step 1.

1. Enclosure Pressure Control Regulator is closed and Protective Gas Supply is ON.

2. Adjust Redundant Regulator, if utilized, to 5 psi maximum or skip to step 3 if enclosure is equipped with a Model PV-3 Purge Vent.

3. Test Purge Vent, if utilized. Using the eraser end of a pencil or similar object, insert from inside the enclosure to confirm vent relief ball is operating properly. Note: Side mounted, Model PV-3-S, remove plug from bottom of tee fitting to test vent.

4. Close and Seal Protected Enclosure.

5. Slowly turn Enclosure Pressure Control Regulator CW until a "Safe" 0.5" w.c. reading is shown on the Enclosure Pressure Gauge. Note: If unable to achieve a " Safe" enclosure pressure, carefully check all enclosure connections and doors for leakage. Seal as needed.

6. Class I, confirm and document Protective Gas flow shown on temporarily installed flowmeter. Use formulas below to determine purge time required, 5 minutes minimum.

(Total Enclosure Volume x 4)/Flow rate
(Total Enclosure Volume x 5)/Flow rate

7. Mark purge time on Unit start up instruction name tag using a permanent marker.

8. Set up is complete. Remove any test equipment and proceed with operations.

3.6.3 Pressurization Unit Operation

1. Ensure Protected Enclosure Power is OFF, Enclosure Pressure Control Regulator is closed, Protective Gas Supply is ON and alarm system is activated (if utilized).

2. If utilized, test Purge Vent for proper operation. [See Section 3.6.2 Pressurization Unit Set Up"]

3. Class II Only - Remove all Dust from protected enclosure.

4. Close and Seal Protected Enclosure.

5. Slowly turn Enclosure Pressure Control Regulator CW until a "Safe" 0.5" W.C. reading is shown on the Enclosure Pressure Gauge.

6. Class I Only - Allow unit to purge protected enclosure for the required time marked on Unit Start Up Instructions. 5 minutes minimum. [See Section 3.7.2 Pressurization Unit Operation"]

7. Confirm protected enclosure "Safe" pressure is stable. Energize protected enclosure equipment.

8. Loss of "safe" pressure requires immediate attention. Protected enclosure power should be de-energized if "Safe" pressure cannot be restored within a reasonable amount of time.

3.7 AC Power Connections

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

3.7.1 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 (gauge) 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 3.19 Transmitter AC Connections

3.7.2 Control Boxes

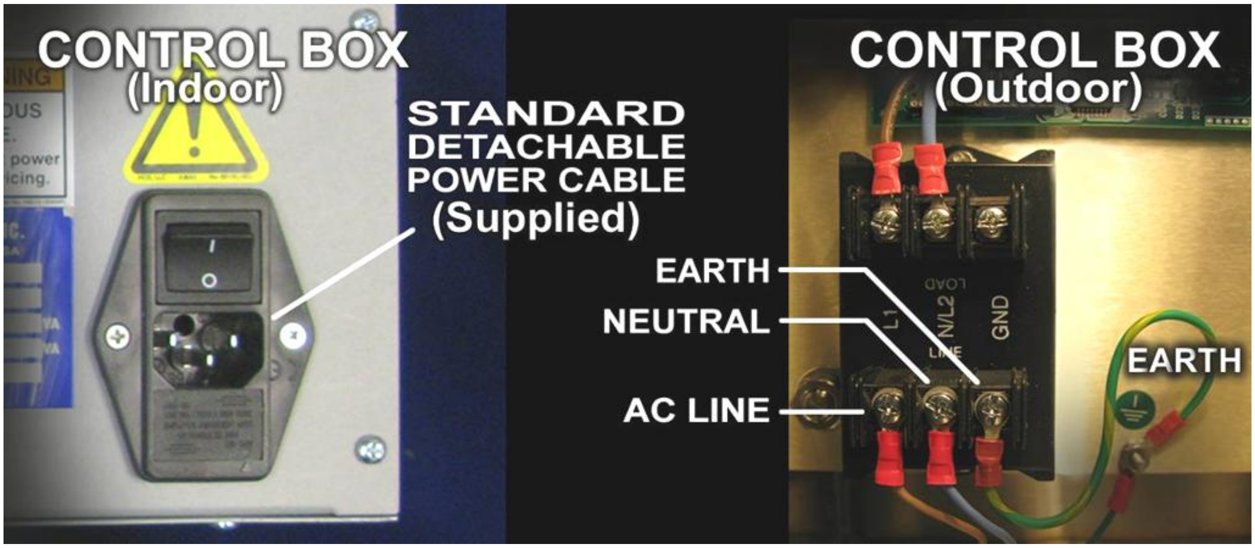


Figure 3.20 Control Box AC Connections

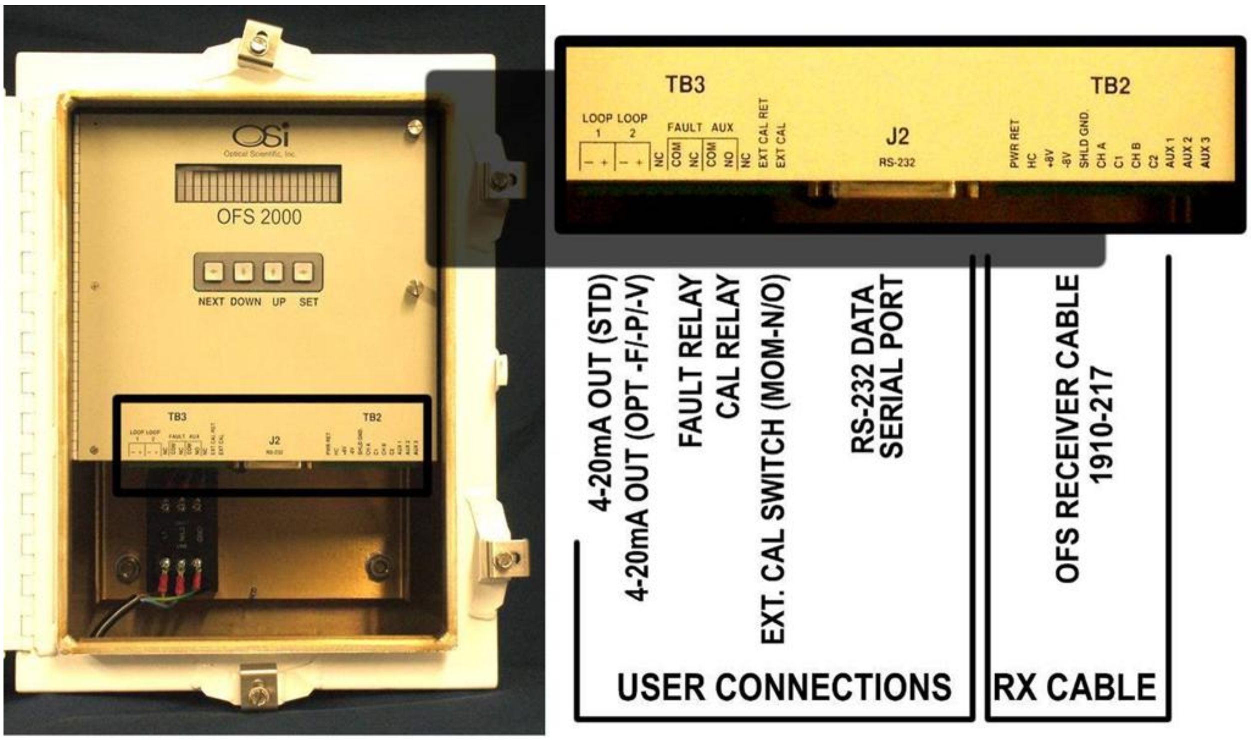
A licensed electrician may be required to make the AC power connections depending on the work and safety rules at your facility. Check with your supervisor before proceeding.

3.8 User Interface Connections

The OFS has two communication modes:

- 4-20mA Current Loop Output
- RS-232 Serial Data Output

Figure 3.21 User Interface Connections



TB3

The 4-20mA current loop connections are at terminal block TB3 pins 1 and 2.

Other pins are provided for
Second current loop (OFS 2000 -F/-P/ V)
Fault Indicator Relay
Calibration Indicator Relay
Remote switch for Cal. Initialization

J2

The RS-232 link is found at DB25 female socket J2.
A Limited – Distance Modem (LDM) may be used

Fiber-Optic Modem (FOM) may also be used

TB2

Receiver cable 1910-217 (supplied with unit) Connects here.
This cable carries DC power to the receiver unit along with raw flow data from the receiver to the DSP.

3.9 OFS 2000 Interconnecting Cables

The OFS 2000 cables are connected as shown in Figures 3.22 and 3.23.

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.

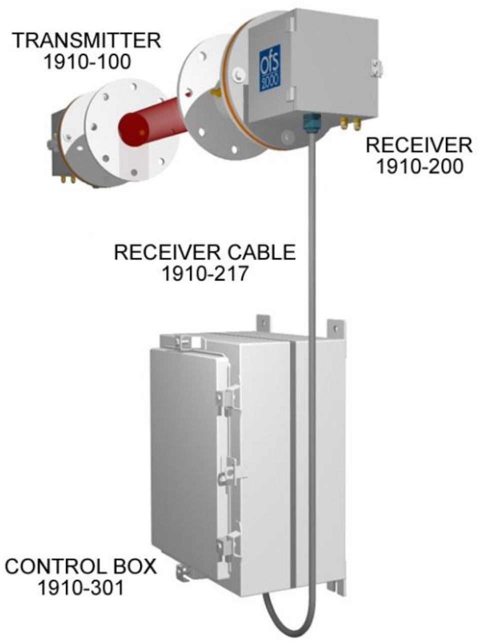


Figure 3.22 OFS2000 Interconnects

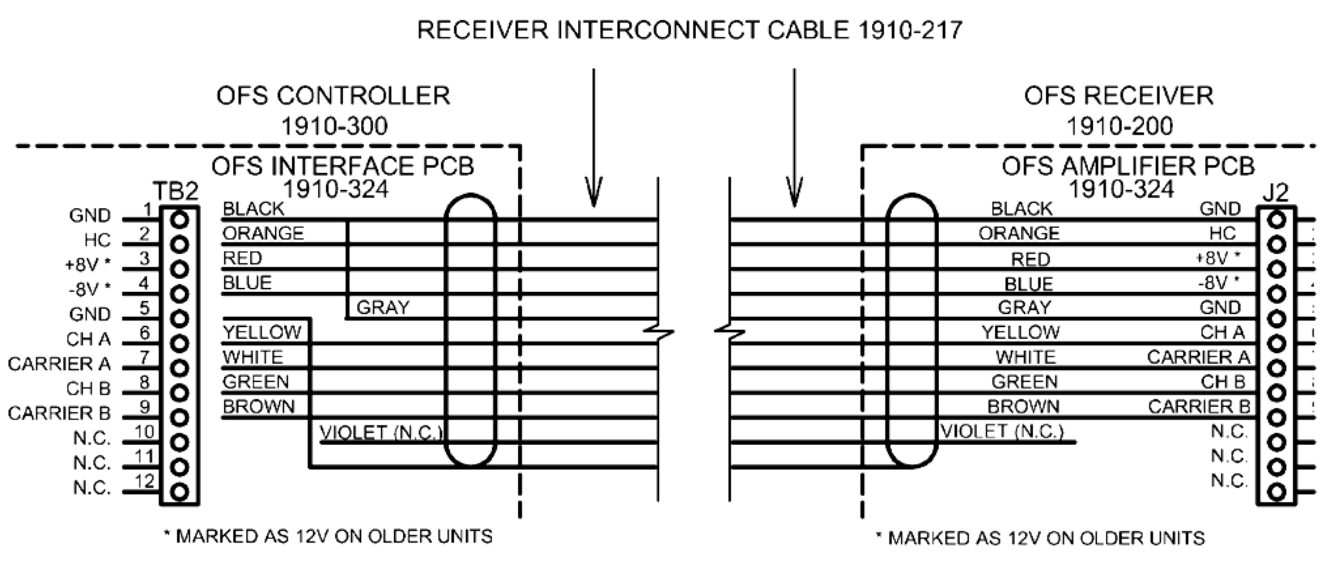


Figure 3.23 Receiver Cable Connections

3.9.1 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.

3.10 4-20 mA Current Loop And Relay 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 –
- Pin 2: Current Loop +
- Pin 3: Auxiliary Current Loop –
- Pin 4: Auxiliary Current Loop +
- Pin 5: No Connection
- Pin 6: Fault Relay Common (COM1)
- Pin 7: Fault Relay Normally Closed (NC1)
- Pin 8: Calibration Relay Common (COM2)
- Pin 9: Calibration Relay Normally Open (NO2)
- Pin 10: No Connection
- Pin 11: External Calibration Return
- Pin 12: External Calibration (ext_cal)

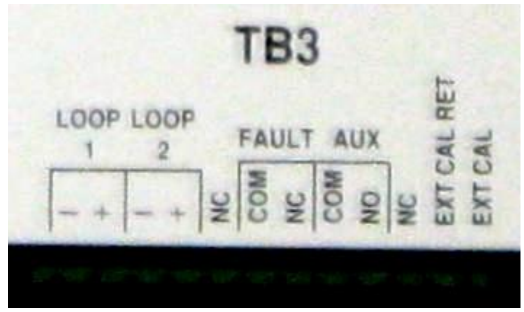


Figure 3.24 TB3 Connections

Pins 1 and 2 are for connection of the customer's 4-20 current loop. 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.

Pins 3 and 4 are for a second current loop connection. These are only active on OFS 2000 - F/ -V/ or /-P models.

To set the full-scale calibration and other 4-20 mA features. [See Section 8.2.2 "Display and Keypad""]

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

Pins 6 and 7 are for fault monitoring. They are connected to a dry contact relay The contacts open when the system is powered up, and remain so during normal operation. The contacts close for:
Signal out of range
Calibration failure
Power failures
Relay contact are rated 30V/5A – 250VAC/8A

Pins 8 and 9 are for calibration mode indication The contacts open when the system is powered up, and remain so during normal operation. The contacts close during system calibration check cycle.

Pins 11 and 12 are for connection to an external momentary normally-open switch. A command to start calibration check cycle is activated when the pins are shorted for more than 0.1 seconds.

3.11 RS-232 Connections

The OFS Interface Board J2 DB25 serial port (DCE)		Personal Computer DB-25 serial port (DTE)		Laptop computer DB-9 serial port	
Pin 2:	RX	Pin 2:	TX	Pin 2:	RX
Pin 3:	TX	Pin 3:	RX	Pin 3:	TX
Pins 1 and 7:	Return	Pin 7:	Return	Pin 5:	Return

A DB-25 male to female (PC side) cable should be used because it has pin-to-pin straight connection

A DB-25 male (OFS) to DB-9 female (PC) cable should be used because it has a crossover between Pins 2 and 3, and pin 5 of DB-9 is connected to pin 7 of DB-25.

3.11.1 Limited Distance Modem (LDM) Connections

The LDM option is available for installations where the Control Box must be installed more than 100 feet from the user’s computer. The LDM converts the RS-232 levels to current loops for noise free, long distance transmission. Using 24 AWG wire, the LDM will transmit over 3 miles at 9600 baud.

LDMs are used in pairs, one installed in the Control Box and one at the remote computer. The user must supply a 2 twisted pair cable with shield to connect between the LDMs. As shown in Figure 3.25, the pairs are installed in a crossed pattern with the TX of one LDM connecting to the RX of the other LDM, and vice versa. Since OFS is configured as a DCE device and the user’s computer is configured as DTE, the LDM connected to OFS should be set as DTE and the LDM connected to computer should be set as DCE.

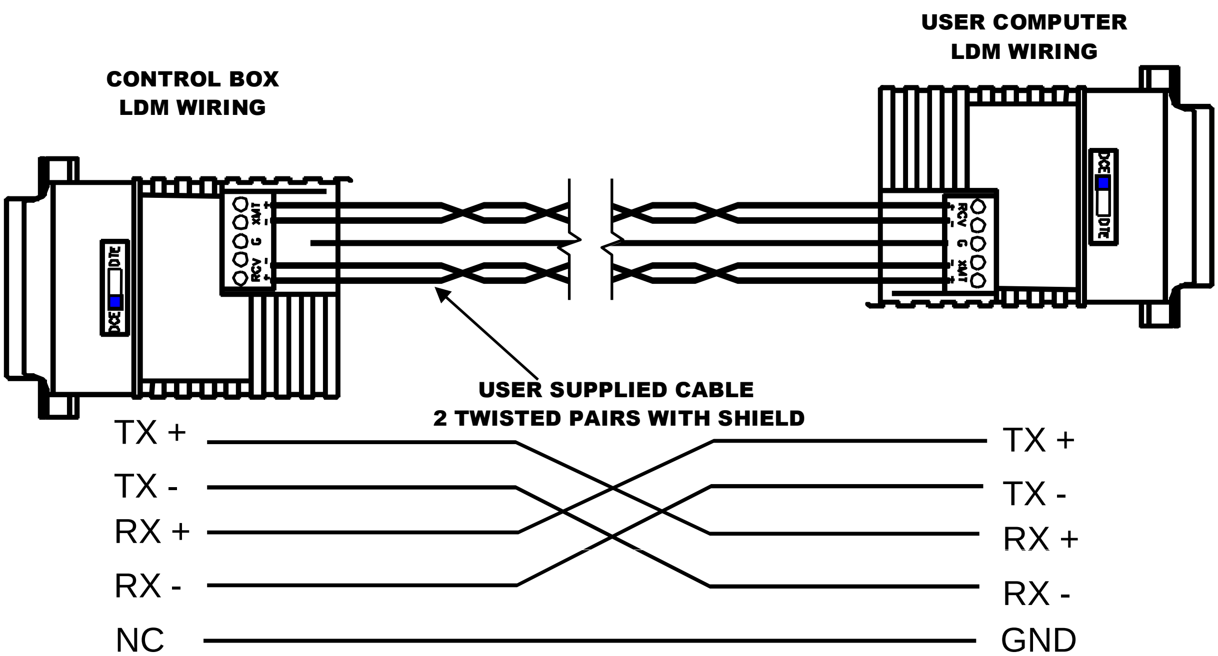


Figure 3.25 LDM Connection

3.11.2 Fiber Optic Modem (FOM) Connections

The FOM option is available for installations where the Control Box must be connected via a fiber to the user's computer. The FOM converts the RS-232 levels to light pulses for noise free, long distance transmission. Using two multi-mode fibers (62.5/125), the FOM will transmit over 1 mile at 28.8 kbps.

FOMs are used in pairs, one DB-25 male connector is plugged in J2 on the Control Box and one at the remote computer. Since OFS is configured as a DCE device and the user's computer is configured as DTE, the FOM at the OFS side should be configured as DTE and the FOM at the user's computer side should be configured as DCE for proper data communication. The user must supply dual multi-mode 62/152 fibers with ST type connectors to connect between the FOMs. As shown in Figure 3.25, the fibers are installed in a crossed pattern with the TX (Out) of one FOM connecting to the RX (In) of the other FOM.

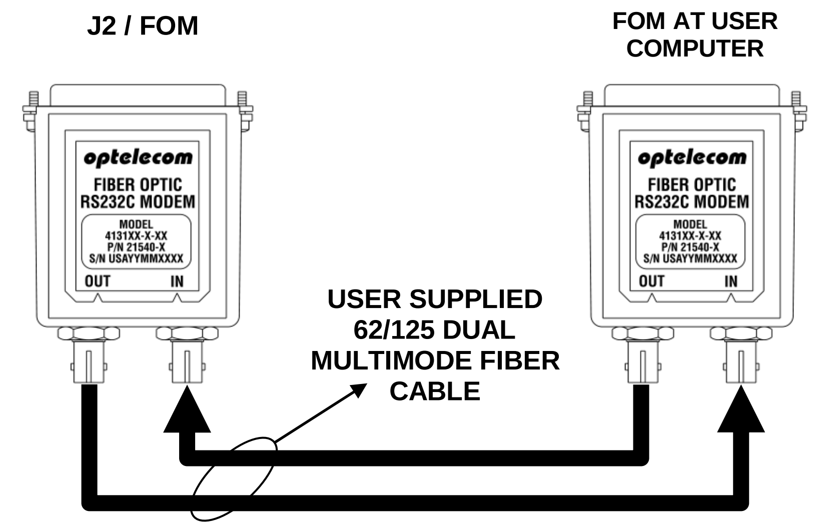


Figure 3.26 Fiber Optic Modem Connection

3.12 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 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. [See Section 8.2.2 "Display and Keypad"]

Com Port Settings
9600 baud
1 start bit
8 data bits
0 parity
1 stop bit

Wiring connections are conventional serial port DB9 or DB25. [See Section 3.11 "RS-232 Connection"]

4 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 Note: all user-set parameters are retained and a calibration check is performed.
V	Displays firmware version installed
X	Starts Curve Fitting Routine

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

4.1 "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

4.1.1 "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

4.2 "C" Poll (Long Data String) Format

Format:	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	,	L	,	±	l	.
	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Byte:	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Format:	l	,	H	,	±	h	.	h	,	R	,	r	r	r	,	U	,	u	u
	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
Byte:	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Format:	u	u	,	M	,	±	m	.	m										
	|	|	|	|	|	|	|	|	|										
Byte:	58	59	60	61	62	63	64	65	66										

(Hatched bytes 60–66:) 3-point calibration only for the extra medium calibration point

4.2.1 "C" Poll Response Bytes

Byte	Description	Field Symbol	Details
1	Wind Indicator	W	Fixed Field – Velocity
2		,	Comma delimiter
3	Wind Direction	±	"+" represents flow in direction of arrow in RX Unit
4-7	Wind Data	wwww	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	Low Cal Point	L	Fixed Field – Low Calibration Point
35		,	Comma delimiter
36		+ or -	"+" indicates calibration value is greater than reference, "-" indicates calibration value is less than reference.
37-39	Offset Percentage	l.l	Last calibration value compared to low reference value (~10% span), in %
40		,	Comma delimiter
41	High Cal Point	H	Fixed Field – High Calibration Point
42		,	Comma delimiter
43		+ or -	"+" indicates calibration value is greater than reference, "-" indicates calibration value is less than reference.
44-46	Offset Percentage	h.h	Last calibration value compared to high reference value (~60% span), in %
47		,	Comma delimiter
48	Correlation	R	Fixed Field – A & B Signal Correlation
49		,	Comma delimiter
50-52		rrr	Signal correlation, >30 typical
53		,	Comma delimiter
54	Unprocessed Vel	U	Fixed Field-Unprocessed Velocity
55		,	Comma delimiter
56-59		uuuu	Unprocessed Value
60		,	Comma delimiter
61	Mid Cal Point	M	Fixed Field – Medium Calibration Point
62		,	Comma delimiter
63		+ or -	"+" indicates calibration value is greater than reference, "-" indicates calibration value is less than reference.
64-66	Offset Percentage	m.m	Last calibration value compared to medium reference value (~30% span), in %

4.2.2 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, 6, 7	N/A
	8	OFS reset
	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

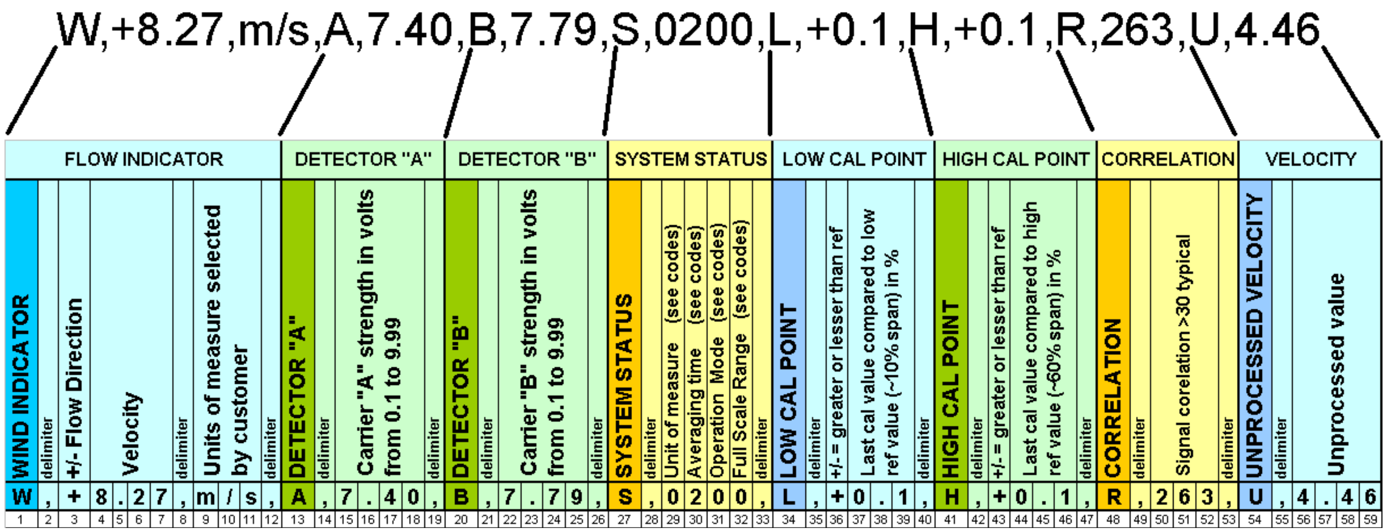
- Note: 3 second time constant is used for testing only and is not recommended for operation.

4.3 Reading The Output Data

Results from a "C" poll is used here for illustration
It is a simple comma-delimited ASCII text string 59 characters long. Typically it will look something like this:

W,+8.27,m/s,A,7.40,B,7.79,S,0200,L,+0.1,H,+0.1,R,263,U,4.46

Figure 4.1 Data Fields and Bytes



What this shows:
Flow = 8.27 Meters per second - Outward
Carrier "A" signal = 7.40 Volts DC
Carrier "B" signal = 7.79 Volts DC
System status
- Units of Measure = m/s
- Averaging Time = 60 sec.
- Operation Mode = Normal
- Full Scale Range = 0-40 m/s

Low Cal Offset Percentage = +10%
High Cal Offset Percentage = +10%
Signal Correlation = 263
Velocity (Unprocessed) = 4.46

STATUS CODES							
byte 29		byte 30		byte 31		byte 32	
Code	Measure	Code	Avg (sec)	Code	Operation Mode	Code	Scale Range
0	m/s	0	10	0	Normal	0	0-40 m/s
1	kph	1	30	1	A/B Out of range	1	0-20 m/s
2	mph	2	60	2	Velocity out of range set by byte 32	2	0-10 m/s
3	fps	3	120			3	0-5 m/s
4	fpm	4	300	3	N/A		
		5	600	4	Calibration Mode		
		6	3	5, 6, 7	N/A		
				8	Reset		
				9	Clean Windows		

Figure 4.2 Status Codes

In short, this unit is operating satisfactorily. Note: This is a typical example for reference. Actual operations can and will vary significantly depending on the customer's application.

5 Data Collection

Figure 5.1 Connect PC to Controller

The most effective tool in determining how the OFS is performing is by examining the RS-232 data output. A PC can be connected directly to the J2 connector at the control box.

Basic Requirements:

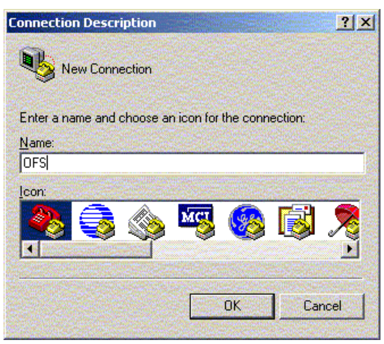
- Personal Computer
- Null Modem Cable
- Communication Software

OSI's SQC software is recommended, (HyperTerminal, ProComm, etc. may be used.)

With OSI's SQC Software: just connect the cable and follow the screen prompts.

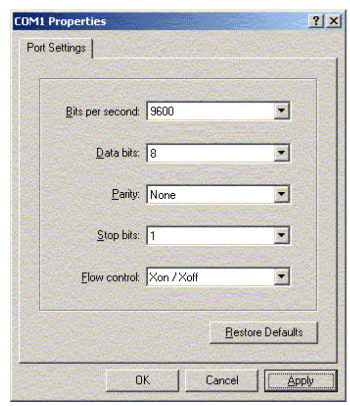
With HyperTerminal: Click "Start", point to "All Programs", point to "Accessories", point to "Communications", and then click "HyperTerminal". *Note: This practice is* *__not__* *a substitute for SQC or data logging software*

Choose an icon and give it a name

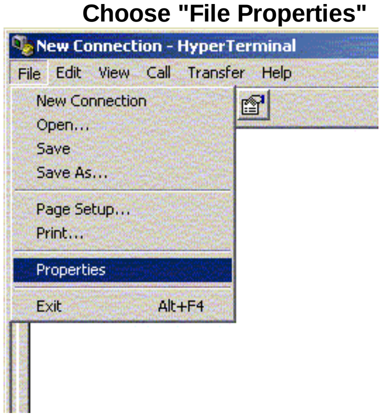


Choose a COM port (usually COM1)

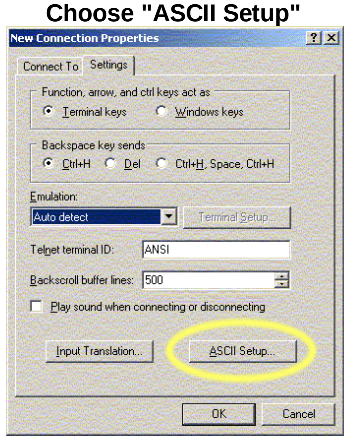
Set: 9600 - 8 - 0 - 1



Choose "File Properties"



Choose "ASCII Setup"



Choose "Append Line feeds"

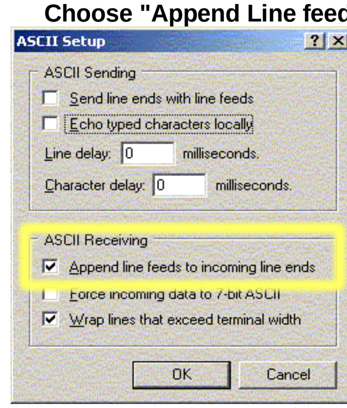


Figure 5.2 HyperTerminal setup steps

Data Collection (continued)

5.1 Using "C" Poll.

Once you are connected, start HyperTerminal and click on the icon you created to open the COM port.

Check the Control Panel to see that the output type is set to "Polled Single". [See Section 8.2.2 "Display and Keypad"]

Type "C" (upper case) and hit <enter>.You will receive an output data string from the unit.

POLL CHARACTERS ARE CASE SENSITIVE - USE UPPER CASE

Typical result from a "C" poll:

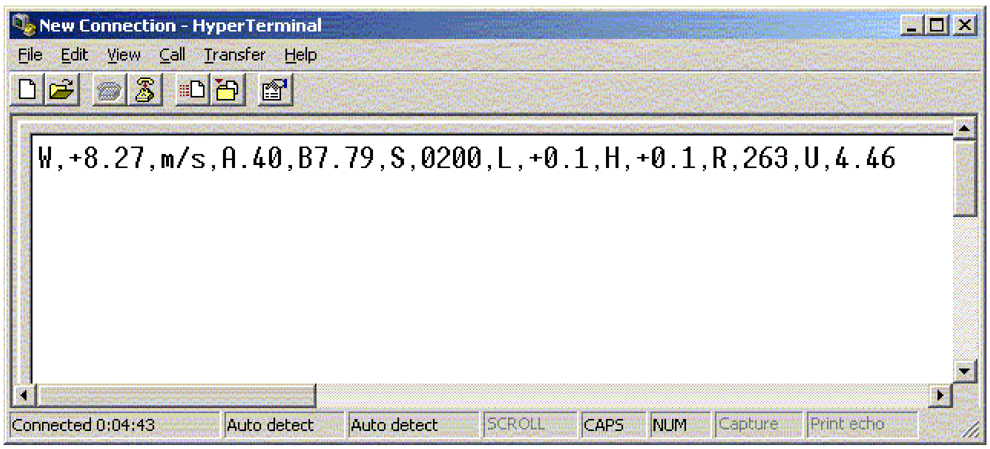


Figure 5.3 HyperTerminal Data Display

Remember - for every data output line you will have to enter a "C" character. Minimum interval would be 10 seconds. Recommended interval is 60 seconds. Remember, the purpose of the data collection in this case is for problem analysis. Often proper analysis will require several hours of data over and above the minimum hours worth, so plan accordingly.

5.2 Using Continuous Polling

An alternate method is to set the OFS to automatically output data in a steady stream. To do this, use the Control Panel Keypad to select "Continuous Long" as the output type. [See Section 8.2.2 "Display and Keypad"]

Connect the computer. Set up and start HyperTerminal as described previously. The OFS will begin to automatically output a complete data string <u>every 3 seconds</u>. This is useful for troubleshooting but can result in very large file sizes if long-term data is to be collected for analysis purposes.

Once a significant data sample has been gathered, it can be checked using Windows™ Notepad or other ASCII text editor/viewer. [Refer to Section 4 "Poll Commands and Data Output"]

6 Optical Alignment

Before you begin: The Transmitter and Receiver heads should be installed and powered. The Receiver head should have the detector board oriented in the direction of flow. (See Below.) The Transmitter should be sufficiently aligned so that the Receiver "Signal" LED lights up. [See Section 6.2 Transmitter Setup"]

6.1 Receiver Setup

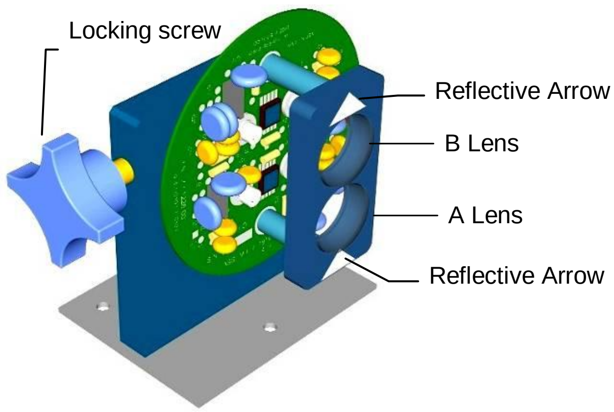


Figure 6.1 Receiver "A" & "B" Lenses

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

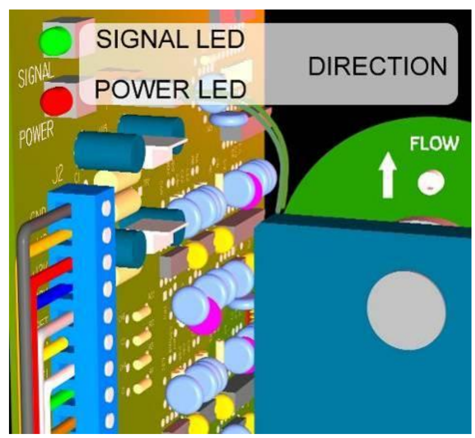


Figure 6.2 Receiver LEDs and Flow Direction

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

If you have not done so already, aim the LED in the transmitter at this point. [See Section 6.2 "Transmitter Setup"]

6.2 Transmitter Setup

The Transmitter uses an eye-safe red LED.[1] The Receiver module is equipped with reflectors to aid in sighting. Note: Under certain operating conditions, it may be difficult to see the reflection from the receiver module.

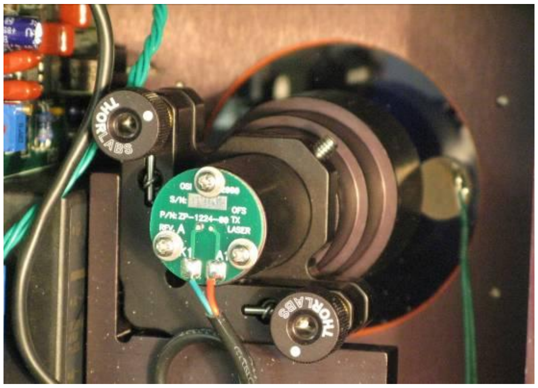


Figure 6.3 OFS 2000 TX Module

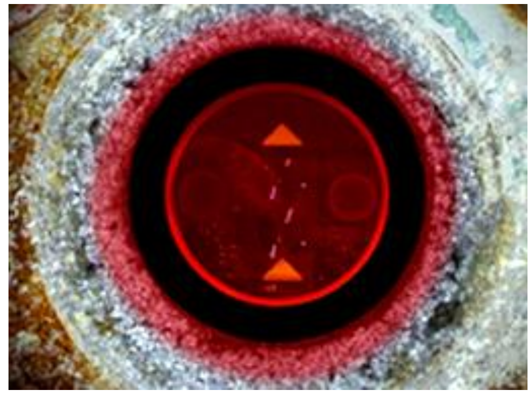


Figure 6.4 OFS 2000 RX Window

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

Turn the Transmitter power ON. Open the transmitter rear door. See that the power and signal LEDs are lit [2]. Look over the top of the LED barrel through the transmitter window to the receiver nozzle opening. You should see some evidence of the red light shining on the receiver window and illuminating the detector board behind it. If you have the optional target reflector installed you should see a bright reflection from it. Although care is taken in the initial installation of the mounting flanges, the beam may not be properly centered.

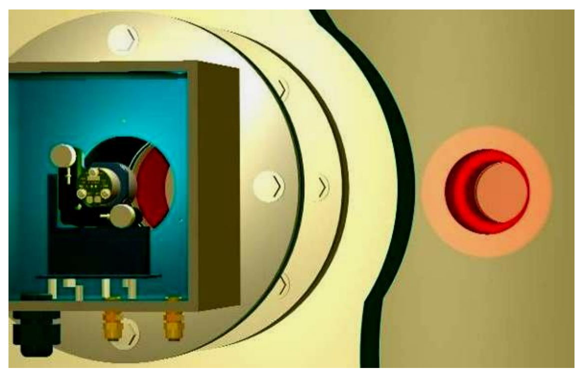


Figure 6.5 Centering Light Beam

Figure 6.6 TX Rear View

Note: You will have to peer through the transmitter window to determine where the light beam is striking on the receiver side. Daylight or ambient light may make this difficult to see. You can use a dark cloth or jacket to block this light from entering your vision. Patience in this part of the procedure will be well rewarded.

[1] Some versions of the LED module have the word "Laser" on the circuit board where the wire connects. It is NOT a laser, it is an LED.
OFS is completely eye-safe.

[2] The Signal LED just shows that the Transmitter LED is operating. It is not an indicator of signal strength.

Transmitter Setup (continued)

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

With the light beam generally centered on the receiver, you can now begin to optimize the transmitter/receiver setup. The object is to get the beam as evenly centered as you can (shown by relative equality of A & B voltages) with the A & B voltage values somewhere in mid-range.

Note: Absolutely "perfect conditions" are rarely possible. OFS is designed with wide acceptance tolerance. Reading through the other sections of this guide will show that the OFS will work satisfactorily if the values are anywhere within limits. These sections are to assist you in getting the system set up so that it will operate in the most optimal manner for your particular installation.

1. Set the rotary switch on the transmitter board to maximum power ("1"). See Figures 1.3 and 6.6.

2. Adjust transmitter module knobs until the red spot is centered on the detector board in the receiver nozzle opening. The upper knob adjusts the light beam up and down, the lower knob adjusts the beam side-to-side. Adjust the transmitter module until the beam is centered as shown in Figures 6.5, 6.7 and 6.9. [See also Section 2.2 "Flange Alignment Guidelines"]

3. Check the A & B Channel voltage values shown at the Control Box display. Voltage max = 9.9, Voltage min = 0.2. If voltage values are at, or over, maximum, reduce power by turning the rotary switch to "2" (If the A & B voltage values are too high or too low "Signal Out of Range" message will display. Note: Minimum power setting is "4".

4. Repeat step 3 with observations until the A & B voltages are in-range and you are relatively confident that you have the transmitter light beam centered on the receiver with adequate signal strength to proceed with the next section. [6.2.1. "Transmitter Aiming Considerations."]

6.2.1 Transmitter Aiming Considerations

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.

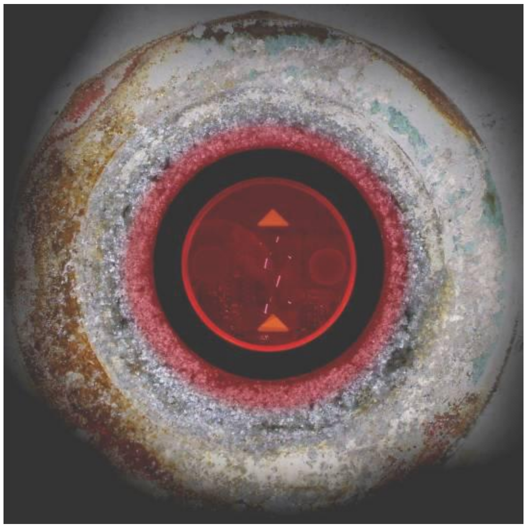


Figure 6.7 Receiver Window "Cat's Eyes"

Ideally the user should see the two lenses on the detector board. (The detector lens mounting is also equipped with two Scotchlite™ 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, the A & B voltages should be within 30% of each other although. If they are not within 30%, re-do the aim until they are. 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. Without the AGC cable connected the LED is driven to maximum power so there may be segment as you pan the aim up and down and side to side where the A & B values max out at 9.99. If this is the case, with practice, you will have to try and stop the pan in the approximate middle of this 9.99 maximum plateau. If the readings never get to 9.99, then 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.

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.

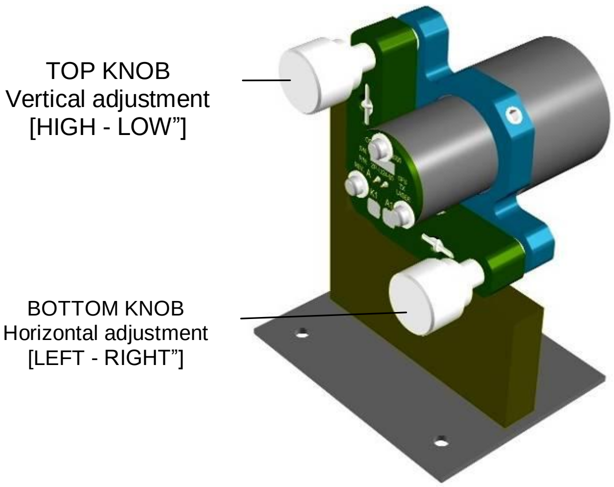


Figure 6.8 Transmitter Module

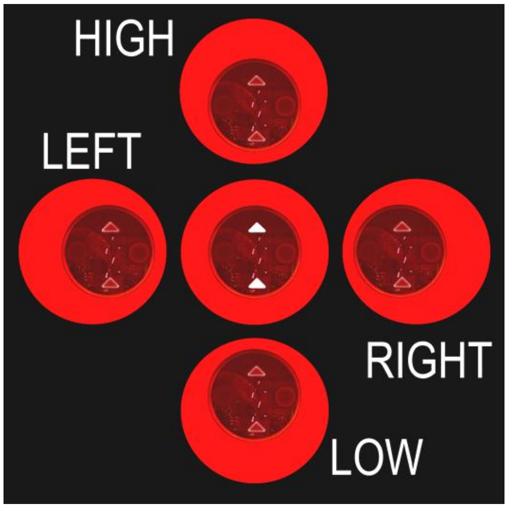


Figure 6.9 Beam Centering

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 6.10 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.*

If you have followed the steps in Section 6.2 "Transmitter Setup", the alignment should be very good and voltage values may be at or around 7.00 (or lower) but a maximum value for your particular installation. If you are still unsure that the aim is correct, repeat the aiming procedure in the transmitter set-up section above..

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.

7 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.

8 Initial Check and Start-Up

8.1 Initial Check

Check visual indicators
Perform the OFS power-up initialization
Initiate an OFS auto calibration
Set-up using keypad & display

8.1.1 Visual Indicators

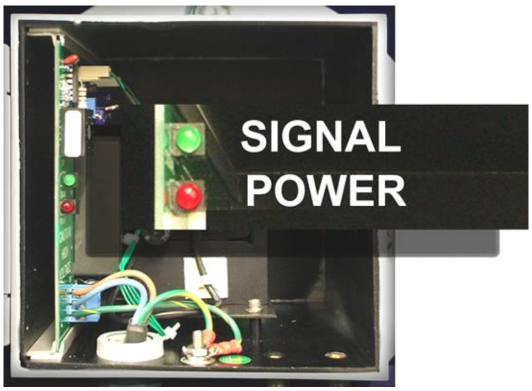


Figure 8.1 Transmitter LEDs

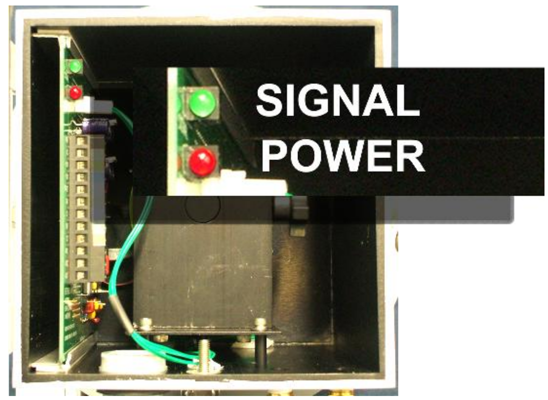


Figure 8.2 Receiver LEDs

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

Control Box

When AC power is supplied to the Control Box, the front panel display will illuminate. Note: The control box supplies power to the Receiver. Swing open the control box front panel (or lift upper panel cover, if an indoor unit) and see that the five green LEDs on the DSP Board are illuminated. These LEDs indicate that the various power supplies are operational.

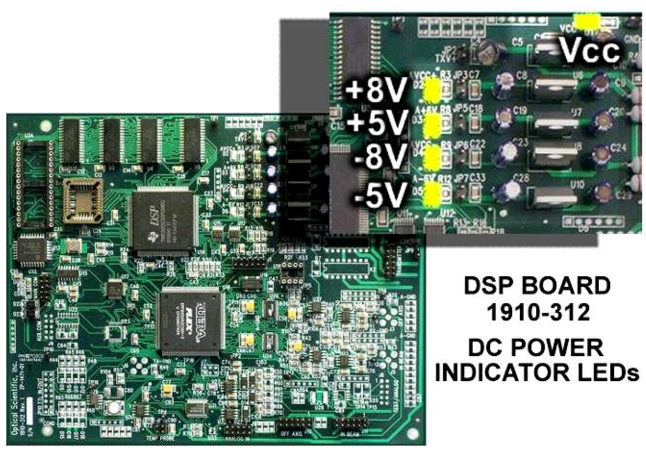


Figure 8.3 DSP Power LEDs

8.2 OFS Start-Up

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 8.2.2 "Display and Keypad"]

Check the installation. See that all components are connected and aligned properly.

See that the Transmitter and Receiver windows are clean and the light path unobstructed.

If purge air is to be used, see that it is connected and operating properly. [See Section 3.4 "Purge Air"]

Make a safety check of all electrical wiring and connections.

Check all cabling connections.

Apply power to the transmitter and the control box.

Observe the "Power" and "Signal" LEDs in the Transmitter and Receiver Units. See that they are illuminated.

Aim the transmitters LED [See Section 6 "Optical Alignment"]

Observe the Control Unit front panel see that the display steps through initialization and reports voltage levels, correlation and flow.

Set the flow rate unit of measure to the type preferred by the customer.

Set the time-constant to the longest time-constant allowed. Factory default is 1-minute.

Set the current loop limit to the just above the highest flow rate.

Initiate manual calibration check cycle. See that the system passes the calibration check. [See Section 8.2.6 "Calibration Verification"]

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"]

If the correlation is lower than 100 or vacillating, restart the system. Operating settings will not be lost..

Observe the flow rate. 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 8.2.4 "Correction Factor"]

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.

If there are questions regarding the system, contact OSI Technical Support as shown in the last section of this User's Guide.

8.2.1 OFS Initial Display Sequence

When the OFS is first powered on, the front panel display will show a series of initialization messages.

	O	p	t	i	c	a	l		S	c	i	e	n	t	i	f	i	c	
							O	F	S										

C	o	p	y	r	i	g	h	t		2	0	0	0	-	2	0	0	1	
	O	p	t	i	c	a	l		T	e	c	h	n	o	l	o	g	y	

R	e	s	t	a	r	t				C	o	r	r		A	a	.	a	a
w	w	w	w		m	/	s			r	r	r			B	b	.	b	b

The following screen is the normal operation data display. The "wwww" characters are the flow velocity in the units of measure shown (m/s in this example). The "rrr" characters are the signal correlation (typically in the range of 30 to 999). The 4 bytes of data beginning with A are the received signal strength of optical channel A (0.1 to 9.99 volts). The 4 bytes of data beginning with B are the received signal strength of optical channel B (0.1 to 9.99 volts).

	V	e	l						C	o	r	r			A	a	.	a	a
w	w	w	w		m	/	s		r	r	r				B	b	.	b	b

Press the NEXT (◀) key once to display the time since last calibration check (HH:MM).

T	i	m	e		S	i	n	c	e		C	a	l		0	0	:	0	0

Press NEXT (◀) again to display the calibration errors (% error from standard value) when last calibration check was carried out.

C	a	l	i	b	r	a	t	I	o	n		V	a	l	u	e	s		
L	o	w	+	0	.	0		H	i	g	h		+	0	.	0			

If 3-point calibration is selected, the following is displayed

C	a	l	i	b	r	a	t	I	o	n		V	a	l	u	e	s		
L	+	0	.	0			M	+	0	.	0			H	+	0	.	0	

Pressing the NEXT (◀) key one more time returns the display to normal.

8.2.2 Display and Keypad

The Control Box features a digital display module and 4-position keypad that may be used to enter all user parameters. To access the Menu press and hold the SET key for at least 3 seconds. This will bring up the first Menu item which is "Units of Measure". The following keys are used:

The NEXT (◀) key is used to accept the selection and move to the next available parameter.

The SET (▶) key is used to accept the selection and exit to operational mode.

The Press the UP (▲) or DOWN (▼) keys to move up and down to the available choices of a given parameter such as 9600 baud, 14,400 baud, etc.

The tables describe each user - selectable parameter, available choices, and how to use the keypad to navigate within the parameter.

Units of Measure	Press ▼ or ▲ keys to select a new unit of measure. Press NEXT to select and advance to the next parameter or SET to select and exit set-up function.
Meters per Second	Default
Km per Hour	
Miles per Hour	
Feet per Second	
Feet per minute	

Averaging Time	Press ▼ or ▲ keys to select a new averaging time. Press NEXT to select and advance to the next parameter or SET to select and exit set-up function.
3 Seconds	Not recommended for operation. Setup, testing and diagnostics only.
10 Seconds	
30 Seconds	
60 Seconds	Default
2 Minutes	
5 Minutes	
10 Minutes	
NOTE: While setting up the meter for the first time 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 data. Regardless of the averaging time, the display refreshes every 3 seconds.	

Baud Rate RS-232 output only	Press ▼ or ▲ keys to select a new baud rate. Press NEXT to select and advance to the next parameter or SET to select and exit set-up function.
300 Baud	
1200 Baud	
2400 Baud	
4800 Baud	
9600 Baud	Default
14,400 Baud	
19,200 Baud	
28,800 Baud	

Unit ID Code RS-485 output only	Press ▼ or ▲ keys to select an ID code. Press NEXT to select and advance to the next parameter or SET to select and exit set-up function. (This function is only used if the RS-485 Interface has been installed)
#00 ID Not Enabled	
#01	Default
|	
#99	

Output Type (digital output)	Press ▼ or ▲ keys to select a new output type. Press NEXT to select and advance to the next parameter or SET to select and exit set-up function.
Continuous Short	Automatically outputs the short data string every 3 seconds.
Continuous Long	Automatically outputs the long data string every 3 seconds.
Polled Single	Default – send “A” or “C” poll to obtain short or long data string.
Polled with ID	Send “Axx” or “Cxx” poll to obtain short or long data string where “xx” is the ID code selected. (This function is only used if the RS-485 Interface has been installed)

Correction Factor 00 % (1.00)	This feature allows the user to offset the OFS velocity to match the velocity of a known standard. To increase the reported OFS velocity, press the ▲ key once for each +1% of correction desired. To decrease the reported OFS velocity, press the ▼ key once for each -1% of correction desired. Press NEXT to advance to the next parameter or SET to select and exit set-up function.

Show Curve Fitting Value (Curve fitting can only be inputted via a laptop computer)	Press ▲ key to show current OFS and Ref values up to 6 points. If there is no curve fit installed in the meter only dashes will be displayed. Press NEXT to advance to the next display.
Curve Fitting Units	Default is Meter per Second. Press ▼ or ▲ keys to select a new unit of measure. Press NEXT to advance to the next display.
Curve Fitting Values OFS1=xx.x Ref1=yy.y	The final curve fitting values are displayed line by line. Press NEXT to show the next pair values until all points are displayed.

Change Calibration Setting Press ▲ to Start	Press ▲ key to change calibration setting. Press NEXT to advance to the next menu.
24 hour Auto Calibration	Press ▲ key to toggle from Enable to Disable.
Calibration Duration	Press ▲ key to increase in 30 seconds increment up to 270 seconds. Setting to 0 seconds disables auto calibration.
Calibration Point Low High	Press ▲ key to toggle between 2-point calibration (Low – High) and 3-point calibration (Low – Medium – High).
Calibration Low	Press ▲ key to increase or ▼ key to decrease by 1% of the Low Calibration as percentage of full scale selected (DEFAULT is 10%).
Calibration Medium (optional)	Press ▲ key to increase or ▼ key to decrease by 1% of the Mid Calibration as percentage of full scale selected (DEFAULT is 30%).
Calibration High	Press ▲ key to increase or ▼ key to decrease by 1% of the High Calibration as percentage of full scale selected (DEFAULT is 60%).

Calibration Check Press ▲ to Start	If ▲ key pressed, calibration process will begin. If calibration is not desired, press NEXT to advance to the next parameter or SET to select and exit set-up function.
Requested	
In Progress	Continues for ~2 minutes

4-20 mA Current Loop Users Only!

Current Loop xx.x m/s Full Scale	Press ▼ or ▲ keys to select a full-scale velocity (m/s)* for the current loop. Press NEXT to select and advance to the next parameter or SET to select and exit set-up function.
40 m/s	Default
20 m/s	
10 m/s	
5 m/s	
Maximum Current Test	Sends 20 ma to the loop
Minimum Current Test	Sends minimum current, 0 or 4 ma, to the loop

* If using unit other than m/s, equivalent velocity in that unit shows on the menu automatically.
** The Current Loop can be set to 0-20mA and be set to default to 0 or 4mA on fault condition. These menu items are accessed by pressing the NEXT and DOWN keys simultaneously when the "Current Loop" menu item is displayed.

Current Loop 1 Data NORMAL	Press the ▲ key to toggle between Normal and Uncorrected data to drive current loop (If no curve fitting, they are the same.)

8.2.3 Check Firmware Version Procedure

This procedure can be used to check the firmware version installed in the OFS.

1. Press & hold the SET (▶) key until the display changes to "Unit of Measure".
2. Repeat press NEXT (◀) key until the display shows "Show Curve Fitting".
3. Press the NEXT (◀) & DOWN (▼) keys at same time. The display will show:

   "DSP_W-----."

   Write down the entire display.

4. Press UP (▲) key 4 times. The display will show:

   "Ver_-----."

   Write down the entire display.

5. Press SET (▶) key. The display will return to normal mode.

8.2.4 Correction Factor

In some cases there will be a consistent difference (high or low) between the values reported by the OFS unit and independent data references - either calculated or reported by other sensors. In such a case, the OFS baseline can be aligned to match the user's equipment. This is done by using the front panel keypad to enter a correction factor.

Determine offset required: Divide the reported/calculated flow number by the OFS flow number:

Reported/calculated flow = 20 m/s
OFS reported flow = 18.5 m/s
20/18.5 = 1.08 (1.08 X 18.5 = 19.98)

So --- 1.08 will be your correction factor.

Figure 8.4 Correction Factor Display

Press and hold the SET ► key to enter the setup menu.

Press the NEXT ◄ key to step thru the menu selections until you come to Correction Factor.
Press the UP ▲ or DOWN ▼ keys to select percentage in 1% increments.
Press the SET ► key to save and exit the setup menu.

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

8.2.5 Curve Fitting

Most process applications run at a single load and only a single point span adjustment capability is required. This is satisfied by the Correction Factor function. However, some applications operate at multiple loads or have continuous load adjustment. In this case there may be a need for a multiple point span adjustment. For this purpose a six point segmented curve fitting function has been built into the software. This function is started via the 2-way communication capability in the RS-232 serial port. This is a simple matter of entering calculated references into the DSP software by means of a laptop computer. to enable the OFS to respond correctly to these unique conditions.

This function is available when required, but this must NOT be undertaken except by trained personnel or with the oversight of OSI Technical Support.

8.2.6 Calibration Verification

The OFS measurement is essentially drift - free. The system is stable without internal adjustment being required. Nonetheless, periodic calibration checks are recommended (and often mandated) In the interests of compliance and as proof of accuracy, the OFS is equipped with an internal calibration check routine. Calibration check may be initiated manually as part of a fixed schedule, or automatically on a 24- hour cycle

The internal calibration check capability of the OFS is a check of the ability of the system to measure flow signals properly. An internal signal generator produces signals that simulate different flow readings (as a percentage of full scale). This verifies that the signal processor performance matches NIST standards.

Note: System calibration check is completely independent of current measurements. Calibration may last as long as 4 min. and 30 sec. During this period the OFS is effectively off-line as it is not generating useful data.

Manual calibration checks may be activated by:

- Sending an ASCII "R" character over the serial interface
- Using the keypad to enter the calibration check command
- Momentarily closing a switch connected to pins 11 and 12 at TB3 on the user interface.

Automatic calibration check cycle is enabled by keypad commands. The calibration check will occur at 24 – hour intervals, starting when the cycle is initiated. Calibration check cycles may be initiated manually while the automatic calibration check is enabled. The 24 – hour interval will then resume based on this newly-established starting point.

During calibration check cycle, the OFS injects precise phase shifted frequency pairs that represent (by default)10% of the full range (Zero Calibration), 30% of the full range (Mid Calibration) and 60% of the full range (Span Calibration). For example, at 40 m/s full scale. (The user may change these % of F.S. values to what ever they want using the front panel menu).

Zero Calibration = 40 m/s * 10% = 4.0 m/s
Mid Calibration = 40 m/s * 30% = 12.0 m/s
Span Calibration = 40 m/s * 60% = 24.0 m/s

At the beginning of the calibration check, OFS goes into Zero calibration for duration of 30 to 270 seconds as set up by the user in the menu. It is followed by Medium and Span calibrations for the same duration each. The calibration check signals are sent out on both the analog (4-20mA) and digital outputs. To record a stable calibration reading in your DAS, we recommend sampling the data for 10 seconds before the end of each calibration check period. If any of the calibration values are outside the range of ±3% of standard value, the calibration check is treated as failure and the Fault relay will change state.

For 2-point calibration, only the zero and span calibrations apply. (The user can select a 2 or 3 point calibration from the front panel menu)

The same applies to other units chosen. The full-scale ranges in other units are

m/s	Kph	mph	Fps	fpm
0 - 40 m/s	144	92	132	7872
0 - 20 m/s	72	46	66	3936
0 - 10 m/s	36	23	33	1968
0 - 5 m/s	18	11.5	16.5	984

During calibration check the following will occur:
Byte 31 of the "C" poll ASCII data string is changed from a 0 to a 4 to an 8 data.
Byte 11 of the "A" poll short data string is set to C.
For 4-20 mA users, the calibration relay is activated to alert the user that calibration check is taking place.

In the event of a calibration check failure, byte 43 of the "C" poll ASCII data string is set to either a 5 or 6 to indicate an error and the fault relay changes state.

Calibration Verification (continued)

The time since last calibration check and the latest calibration error values may be observed on the OFS Control Box digital display. Press the NEXT (() key once to display the time since last calibration check (HH:MM) and twice to display the calibration errors (% error from standard value). Pressing the key one more time returns it to normal.

8.3 External Calibration

External calibration of the flow meter is when it's readings are tested in comparison to on-site, real-time flow measurements (at the same location) while the system is installed and in actual operation.

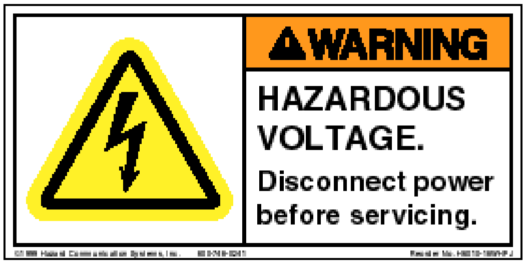
These calibration tests are known in the United States as "RATA", (Relative Accuracy Test Audit) and may be mandated most commonly by federal, state, local, or other authorities. In the United States, the principal authority is the Environmental Protection Agency (EPA).

These tests are conducted by an accredited independent testing company contracted by the user for that purpose, and therefore outside the scope of this manual. This manual is to provide the user with all necessary information and instruction to install, adjust, and operate the OFS 2000 so that it will perform acceptably and conform properly to the actual conditions it is required to measure.

9 Maintenance

9.1 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!

9.2 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 9.2.1 “Window Cleaning Procedure” to clean the windows.

9.2.1 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).

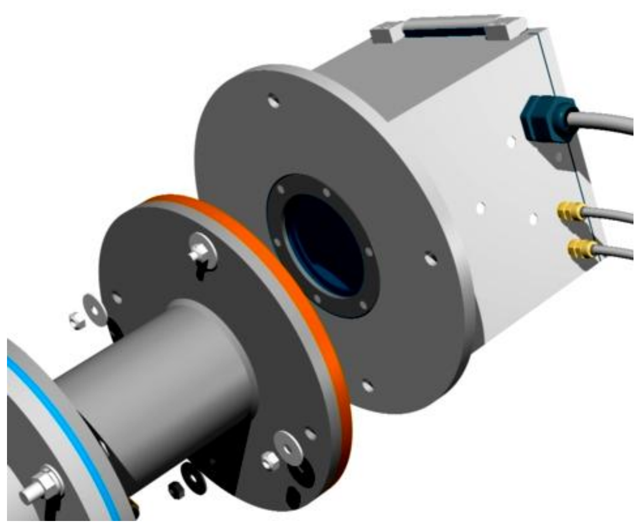


Figure 9.1 Window Cleaning

10 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. 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 3.4 "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.

- **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"]

10.1 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.

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 16 "Technical Support"]

10.2 Power and Signal Checks

10.2.1 DSP Power and Signal

A quick look at the 5 power level indicating LEDs will show any power problems. 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, replace the board.

Another source of problems is reversing the connection at the DSP "Main Com" connector J2. This can happen during service or when changing boards. Be sure the red stripe is oriented as shown here in Figure 10.1.

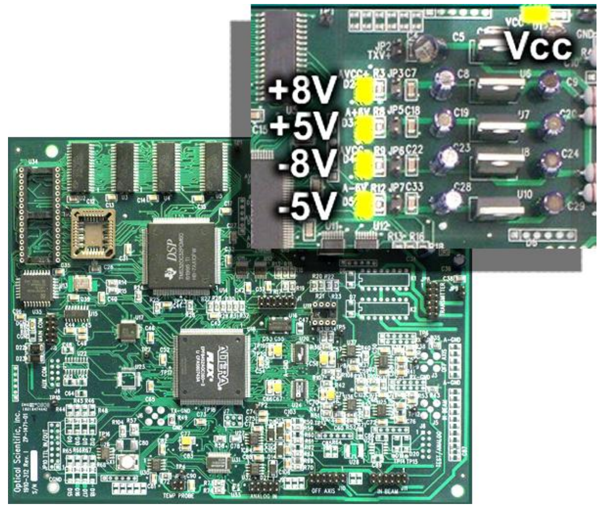


Figure 10.1 DSP Power Indicators

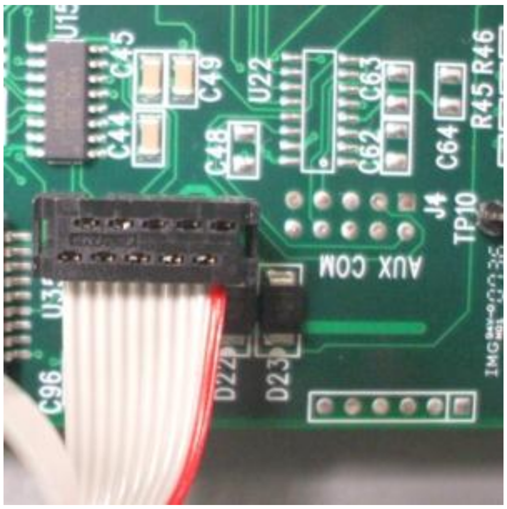


Figure 10.2 DSP "Main Com

10.2.2 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.

10.2.3 Transmitter "Signal" Led Not Lit

Be sure the transmitter module wiring is firmly connected.
Replace the transmitter module.
Replace the transmitter PCB.

10.2.4 Receiver "Power" Led Not Lit

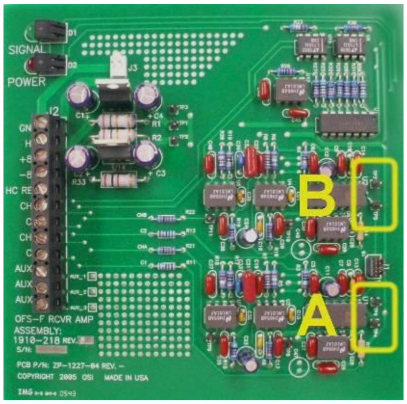
Check the +/- 8VDC voltages at the receiver PCB terminal block. If there is voltage present. Replace the receiver PCB. If there is no DC voltage present, check the DC supply line for fault.

10.2.5 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.

10.2.6 Signal Voltage Checks - Receiver

A DMM to measure signal voltages directly from test points on the Receiver Amplifier circuit board. We do NOT recommend this as a standard procedure, but it can be tried if you are having difficulty determining good alignment.



There are two sets of test points on the board to measure the raw output from the Receiver Module

	Channel A			Channel B	
TP-4	Gnd	**>1VAC**	**TP-5**	Gnd	**>1VAC**
TP-6	Signal		**TP-7**	Signal	

The way the circuit is designed, anything over 1VAC is acceptable. Maximum depends on how well the system is aligned, and how much light reaches the receiver.

Open the Receiver and slide the Amplifier PCB out until you can easily reach the test points. Take care not to pull on the ribbon cable or the window heater wires. Make sure the receiver module is aligned with the direction of flow.

Connect the multimeter to A and B in turn and observe the voltage levels as you turn the transmitter module adjustment knobs. When voltage levels on both channels have reached peak values, optimum alignment has been reached.

10.2.7 Signal Voltage Checks – Receiver/Control Unit

These measurements are NOT a valid determination of system performance. They are simple tests to verify system function and assist field personnel in tracing problems. Refer to Sections 3.9.1 for cabling diagram.

The Outdoor (NEMA-4) and the Indoor (Rack Mount) Control Units use the same Interface Board and cable connections. A DMM capable of reading millivolts AC range is necessary. Checking the Outdoor Controller TB2 voltages is relatively straightforward. To measure the Rack Mount Controller TB2 you will need to get to the rear of the box where the receiver cable connects to TB2

Controller TB2		Voltage	Receiver J2	
1	GND Receiver DC return	Signal Ground	1	GND Receiver DC return
2	HC (Window Heater Supply)	+12 VDC	2	HC (Window Heater Supply)
3	+8V Receiver Board Power	+8VDC	3	+8V Receiver Board Power
4	-8V Receiver Board Power	-8VDC	4	-8V Receiver Board Power
5	GND for cable shield	Earth Ground	5	GND Receiver DC return
6	Carrier A	>1 VDC	7	A Channel Carrier

10.3 Control Box Troubleshooting

Digital display not illuminated with expected format	• Using voltmeter, verify AC voltage applied on Surge Suppressor Module. • Verify 5 LEDs are illuminated on DSP PCB. • If LEDs not illuminated, replace Control Box Power Supply • If LEDs are illuminated, replace Control Module 1910-309
RS-232 not communicating	• Verify digital display is updating with corrected data • Verify correct TX/RX wiring • Replace Interface PCB 1910-324 • Replace Control Module 1910-309
Velocity data near zero with A/B between 1 and 8 volts and correlation (R) >30	• Verify that orientation arrows on RX Optical Assembly are pointing in direction of known flow. • Replace DSP PCB 1910-312
Auto Calibration reports incorrect results	• Replace DSP PCB 1910-312
Display shows "DSP Timeout error"	• Replace DSP PCB 1910-312
4-20 mA not operating	• Measure current with multimeter across TB3 pins 1 & 2. If 4mA is not present, replace Interface PCB 1910-324
Reported velocity not in agreement with standards	• Enter correction factor

10.4 Error Messages

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.

10.4.1 Channel A/B Out of Range

This is due most likely to loss of signal. See that:

- beam path is clear
- the transmitter is operating
- the transmitter is properly aligned
- receiver module is oriented in the direction of flow

10.4.2 DSP Timeout

This message is generally a good indication of a problem with the DSP circuit board. Replace the board.

11 Spare Parts

11.1 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. **4-20 ma / RS-232 Interface PCB, p/n 1910-324** (2000/2000) / 1910-324-1 (all other models) – All outside wires (control and power) pass through this board, with individual surge protection on all lines.
2. **Receiver (RX) Amplifier PCB, p/n 1910-213** (All exc. 2000F) / 1910-218 (2000F) – Includes dual channel preamp and demodulation circuits
3. **Transmitter (TX) Driver PCB, p/n 1910-113** – Includes power supply and LED driving circuit.
4. **Quartz Glass Window Kit with Heater, p/n 1910-115-1** – These and the retaining rings below are the only elements that comes in contact with flue gas.
5. **Window Retaining Ring w/ Gaskets & Screws, p/n 1910-808** – Specify 3 hole / aluminum (older units) or 6 hole stainless steel (newer / current units) version.
6. **Digital Signal Processor (DSP) PCB p/n 1910-312**
7. **AC Surge Suppressor, p/n MZ-0383-00** – Protects control unit from heavy power line surges (lightning, etc).

11.2 Available Spare Parts

Unit	Sub Assembly	P/N
TX Head Unit	Complete TX Head Assembly	1910-100
	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
	RX Preamp w/ Optics Assy. & 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
	4 inch Kevlar Flange Gasket (min. order 2)	FS-1456-00
	Window Retaining Kit w/ Heater (One Window)	1910-808-1
Control Box	Complete Rack Mount Control Unit Assembly	1910-500
	Complete NEMA4 Control Unit Assembly	1910-301
	Control Module (Keypad/Display)	1910-309
	Control PCB	1910-311
	4 Button Keypad	MK-1290-00
	VFD Display	ML-1291-00
	DSP PCB	1910-312
	AC Power Supply	MP-1010-00
	AC Surge Suppressor	MZ-0383-00
	Dual 4-20 mA loops and RS-232 Interface PCB	1910-324

12 Appendix A OFS 2000 Thermal Activator

12.1 OVERVIEW

12.1.1 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.

Hot, turbulent, moving air provides optimum scintillation, and is a perfect medium for OFS operation. OFS has a wide range of acceptance. It has been proved to work well even under adverse conditions. However, some applications cannot provide sufficient signal-to-noise ratio (SNR). In our case, signal is the thermal or density turbulence while noise is vibration and electrical interference.. In these circumstances, applying heat to increase the amount of thermal turbulence present has been found to work very well. To that end, OSI offers the Thermal Activator option.

The Thermal Activator Option is simply a bar heater installed in the stack/duct approximately 8" upstream of the OFS Receiver. The heater may (or may not – depending on application requirements) have a companion temperature probe installed 24" further upstream for measurement purposes should the user desire to monitor temperature.

The best practice is to have the heater installed upstream on the Receiver side. The maximum effect of the heater is then concentrated in the portion of the light path closest to the Receiver window. This raises the scintillation in the immediate area to a level where the detectors can "lock on" to the scintillation movement.

It should be noted *the addition of heat to raise scintillation characteristics has no effect on the OFS path-averaging flow measurement*. The added turbulence in the portion of the measurement path simply serves to "jump start" the DSP measurement algorithm so it can focus in on the proper measurement range. The actual measurement calculations are still done based on the full path length.

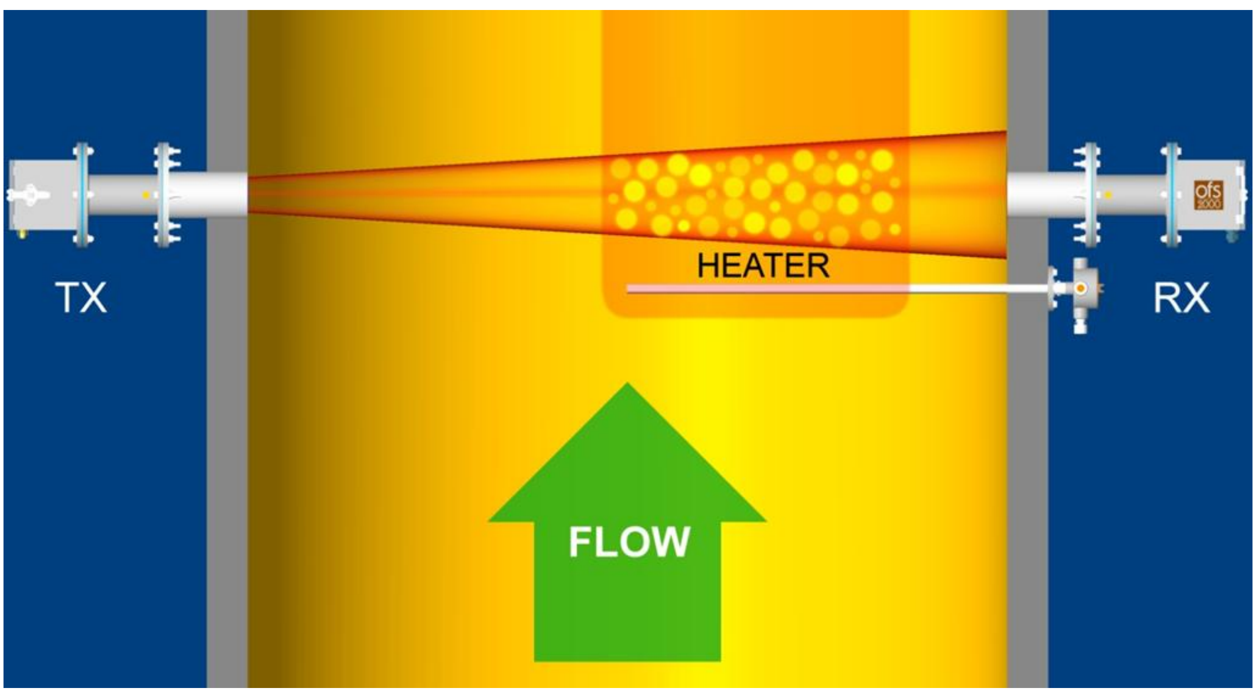


Figure 12.1 Typical Thermal Activator Setup

12.2 General Heater Specifications

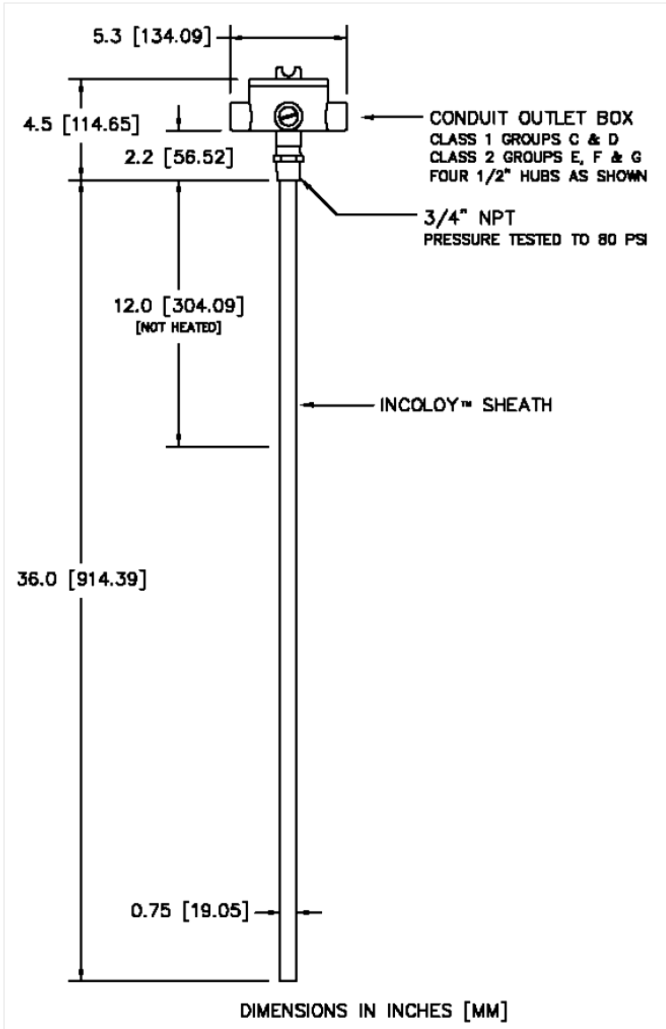


Figure 12.2 Thermal Activator Dimensions

Operational Environment		
Ambient Temperature	-40 to 60 C	
Power Requirements	120 VAC, 50/60 Hz, 7A -or- 240VAC, 50/60 Hz, 3.5A (depending on user line power)	
Physical Characteristics		
Weight	4 lb 12 oz.	
Dimensions	Heater Rod	36" L X 3/4" Dia.
	Connector Hub (NEMA-7),	2" X 3-1/2" Dia. w/1/2" NPT conduit conn.
Materials		
	Heater Rod	Incoloy™/Inconel™
	Connector Hub (NEMA-7),	Aluminum

12.3 Thermal Activator Wiring

These figures show basic wiring connections. (See Note at bottom of page)

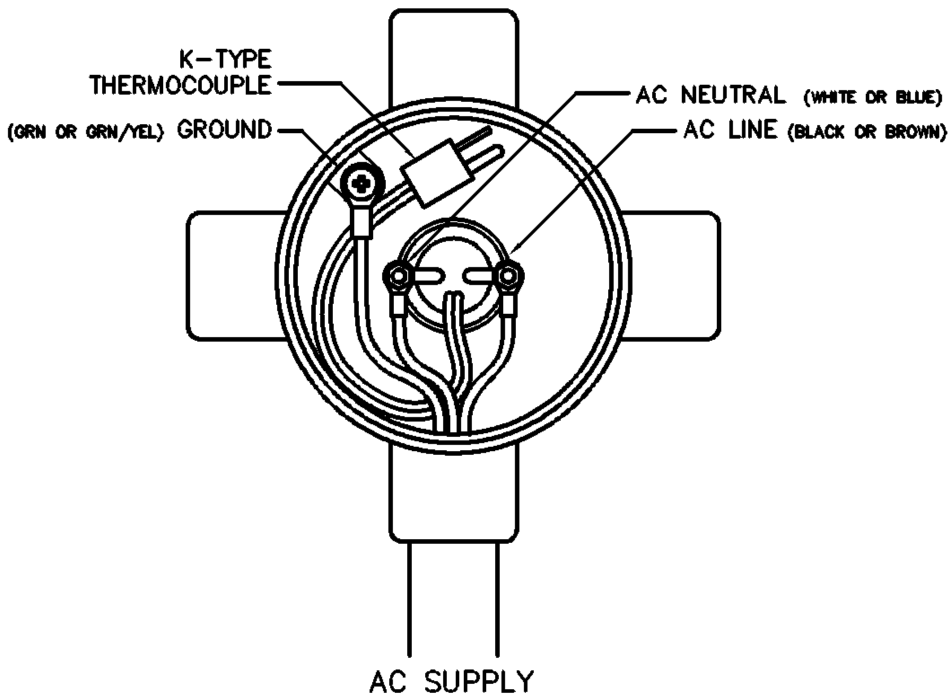


Figure 12.3 Heater Wiring

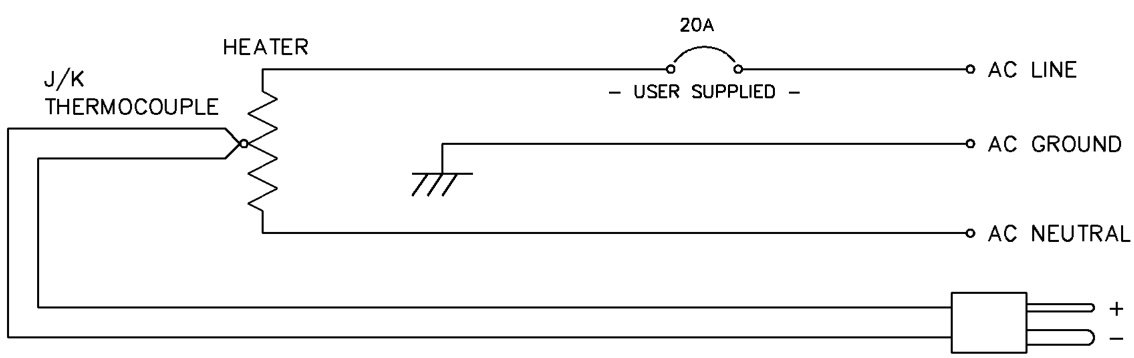


Figure 12.4 Heater Schematic

Note: *The use of the thermocouple (for temperature control purposes and/or monitoring) is at the discretion of the user and outside the scope of this guide.* ***OSI*** *has no recommendations and does not warrant it's use or warrant the performance or behavior of any temperature controller attached thereto.*

12.4 Description of Units

The Thermal Activator is typically used to excite scintillation where air flow temperature may drop below 150°F [65.6°C"] As a side note, the Thermal Activator is generally not required for use in flare applications. Even though the media temperatures involved are quite low, the fact that there are multiple sources of different media densities ensures that there is sufficient thermal and/or density turbulence present to sense and measure the flow velocity.

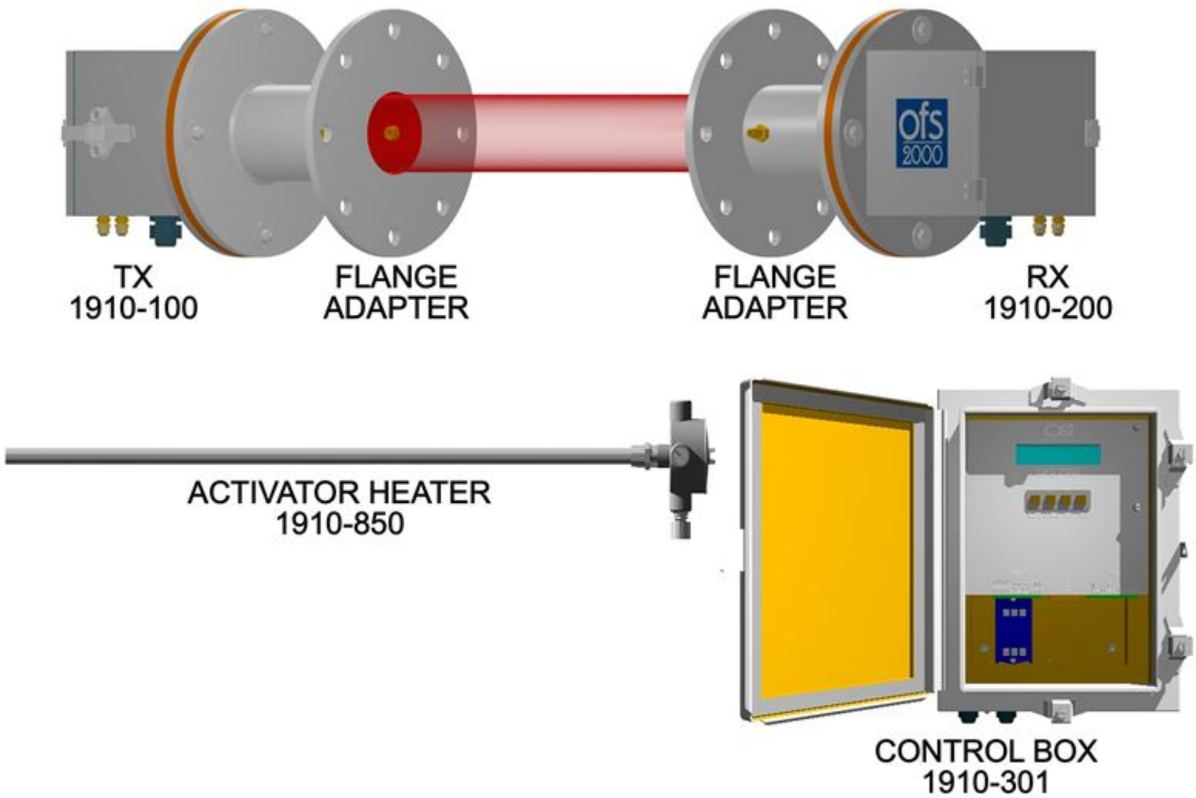


Figure 12.5 OFS 2000 and Thermal Activator Components

The major components of the OFS 2000 with Thermal Activator System are shown in the figure above. The OFS Thermal Activator is intended for "low temperature" airflow applications. See Figure 12.1 for an illustration of the application.

Heaters can be specified to suit your application. Consult OSI Engineering Department before ordering.

12.5 Thermal Activator

Figure 12.6 Thermal Activator

The Standard Thermal Activator is rated at 800W @ 120V or 240V 50/60Hz [P/N 1910-850 = 120V; 1910-850-1 = 240VAC "] Other wattages are available by special order for special applications. It is recommended that a dedicated branch circuit controlled with a circuit 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 a NEMA 7 rated housing suitable for use in Class I, Div. 1 & 2, Groups C,D environments. The heater element is equipped with a K-type thermocouple.

Figure 12.7 Heater Thermocouple

!CAUTION!

800W heater can reach temperatures of over 1000°F [538°C"] when unregulated. Do not operate without sufficient airflow to dissipate heat and/or proper control.

13 Pre – Installation

13.1 Thermal Activator Placement

In addition to the general placement considerations described in the Section 2 of this guide, proper allowance must be made for the location of the Thermal Activator [1910-850/850-1"].

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. A certain amount of shifting may be allowed for as not all sites are ideal, but the more critical parameter is the 8" centerline distance between the heater and the light path. This should be adhered to as closely as reasonable..

The following figure shows a typical OFS-2000 installation in a horizontal duct. *Note: Regardless of OFS model type or orientation vertical or horizontal, the thermal activator placement remains the same.*

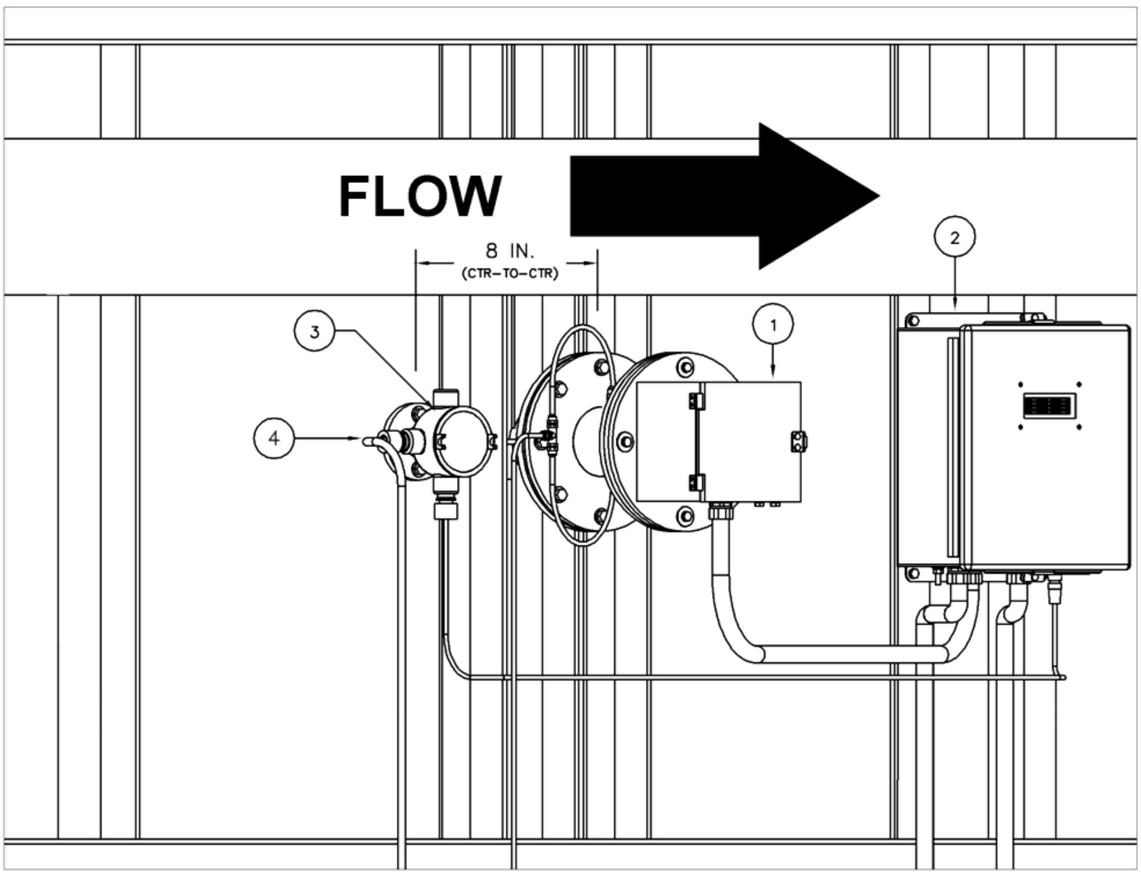


Figure 13.1 Typical Thermal Activator Setup

Component Description

1	Receiver Unit [1910-200"]	Centered on axis with transmitter (opposite side)
2	Control Unit [1910-301"]	Contains DSP/Sensor and Customer Interface
3	Thermal Activator [1910-850 series"]	Mounts in 3/4" NPT fitting 8" upstream on center with RX
4	Heater AC Supply	Dedicated AC line

14 Installation

Thermal Activators require a 3/4" NPT port installed on centerline with the OFS Receiver and 8 inches upstream of the light path. The heater should have a dedicated AC line of suitable gauge (based on wattage and distance), controlled by a circuit breaker. The heater head has connection hubs threaded for 1/2" NPT suitable for liquid tight flexible conduit fittings. Electrical requirements can vary depending on the heater ordered. Consult your Sales Order or Application Profile.

15 Appendix B OFS Curve Fitting Procedure

15.1 Introduction

In the ordinary run of operation for an incinerator, boiler, or manufacturing process, stack or vent flow will remain fairly constant, and a simple OFS 2000 Flow Meter 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 meet EPA requirements, or to more effectively monitor a production process. To that end, we have equipped OFS 2000 with a "curve fitting" feature. This feature is alluded to in the body of this User's Guide. Since this procedure can be somewhat critical and lies outside the general run of applications, it is included in this appendix.

We must stress that the procedure described herein should be undertaken by experienced personnel familiar with emissions and process control issues.

Typically a curve fitting procedure is implemented as part of a **R**elative **A**ccuracy **T**est Audit (RATA) procedure – which in it's 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.

Once the average flow at each level has been determined, the information can be entered into the OFS operating system. Using this procedure, the OFS calibration set points are adjusted to match these averages. This is procedure done during the latter stage of the RATA, so that the OFS performance can be independently validated before the test is concluded.

15.2 Equipment Setup

To perform multipoint offset to adjust the OFS measurement to the reference, one has to use computer to input the data to OFS. The front panel on OFS can only show inputted multipoint offset data but can't perform any system flow measurement change. (Correction factor is the exception, but that lies outside the scope of this procedure.) This is to protect the data from being altered arbitrarily by unauthorized personnel.

There are many types of computers, operating systems, and communications software packages in use. For simplicity's sake we will use the most common: Windows XP and the HyperTerminal application as installed on a common laptop PC. The elements are simple and easily adaptable to other platforms.

15.2.1 OFS and Computer Setup

1. See that the OFS is powered up and operating normally.
2. Connect a serial cable to the computer serial port (typically a DB9) and to the OFS Control Unit J2 (DB25) connector.
3. See Section 5 "Data Collection" for instructions on connecting and setting up communications.
4. If Automatic Calibration Check cycle is enabled, temporarily disable it using keypad commands. (See Section 8.2.2 in the User Guide). This will prevent the system from interrupting the procedure with a calibration check.
5. Remove any Correction Factor that may have been entered (Set to "1"). See Section 8 in the User Guide.
6. See that you have the set point information from the RATA and proceed with the next section.

15.2.2 Curve Fitting Procedure

To perform multipoint offset to adjust the OFS measurement to the reference, one has to use computer to input the data to OFS. The front panel on OFS can only show inputted multipoint offset data but can't perform any change. This is to prevent the setup from being altered arbitrarily by unauthorized personnel.

Caution --- before you begin:

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.

For example: Low load data will be determined, then High load, and Medium load last of all – or in other sequence, depending on the operation of the facility at that time. This can take up to several days again – depending on the plant operating requirements

No matter the order of collection: for proper operation of the curve fitting, the averaged flow figures must be entered into the OFS in *ascending* order:

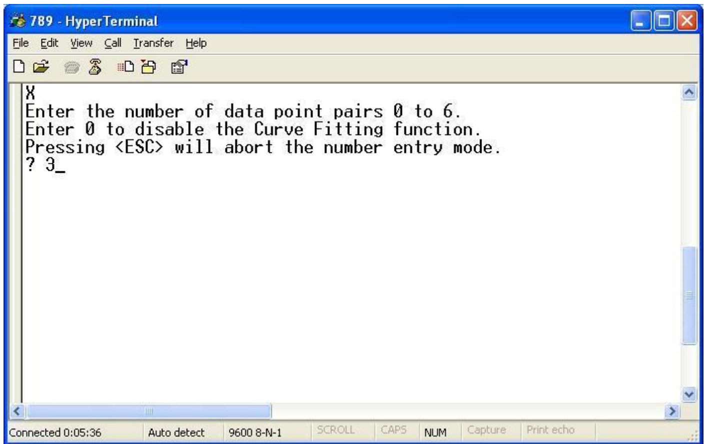
1. Low Load set point
2. Medium Load set point
3. High Load set point.

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

15.3 Curve Fitting Data Entry

With the OFS operating properly and PC communication established (see previous sections) you can begin:

Send "X" (upper case) to OFS. The following message will display:



Up to six curve fitting points are available. These are generally used only where customer's critical process control make them necessary. Three-point curve fitting is considered adequate and the most cost-effective.

At this point the User should enter "3"

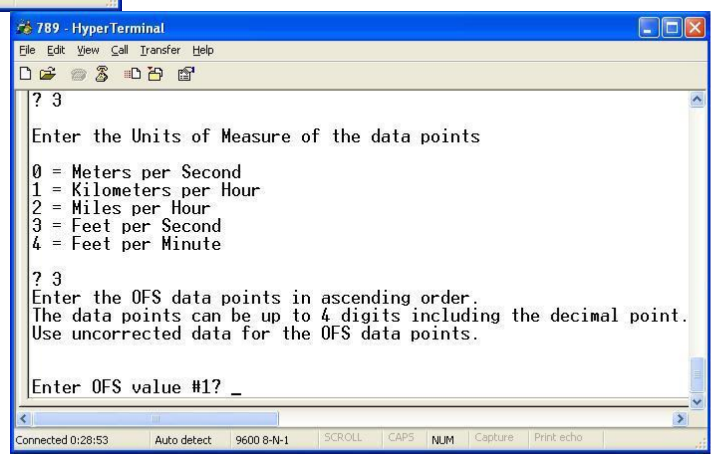
Entering "0" will dump any existing entries and return the user to the beginning.

Pressing "ESC" will halt the procedure.

When the number of points has been entered you will be prompted to enter the Units of Measure (UOM) you wish to use. In this example we enter "3" for "Feet per Second".

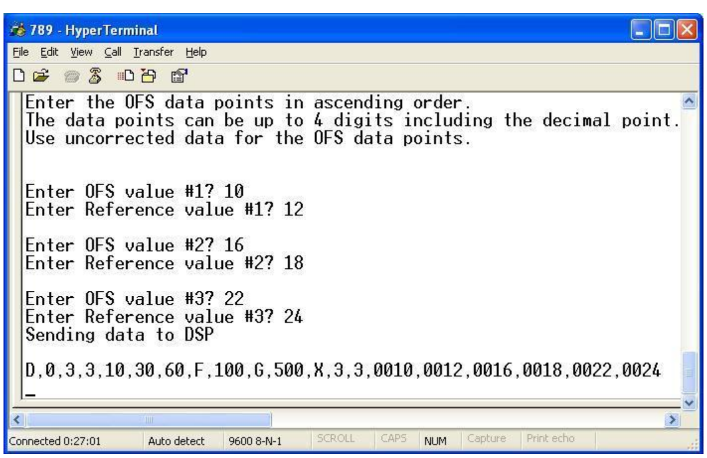
Once the UOM has been chosen, you will be prompted to enter the three data sets in ascending order: #1 Low, #2 Medium, and #3 High. The sets will consist of first: the OFS velocity reading; second: the measured velocity reading determined by the RATA team.

For this example we are going to assume the OFS is reporting 2fps low as compared to the cross-stack measurement.



The figures for this example will be:

1. OFS 11fps/RATA 12fps, 2. OFS 16fps/RATA 18fps, 3. OFS 22fps/RATA 24fps



You will be prompted to enter in the velocity values in sequence one at a time. OFS velocity reading followed by the RATA reading.

At the conclusion of the last entry, the OFS will upload the information.

After a few moments the data string will display as shown showing the successful upload. (Characters after the "X")

At his point you may press the "ESC" key and terminate the procedure.

15.4 Curve Fitting Verification

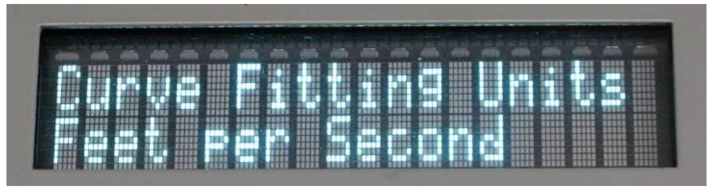
Once the curve fitting information has been entered into the firmware, it should be checked to make sure it is properly installed. This can be checked by using the controller keypad.

Press and hold "Set" to enter the Setup Menu

Press "Next" until you come to "Show Curve Fitting Values".

Press the "Up" key to step through the values as entered.

The first shown will be Units of Measure (UOM).



Press "Next" key to step through the remainder of the entries.

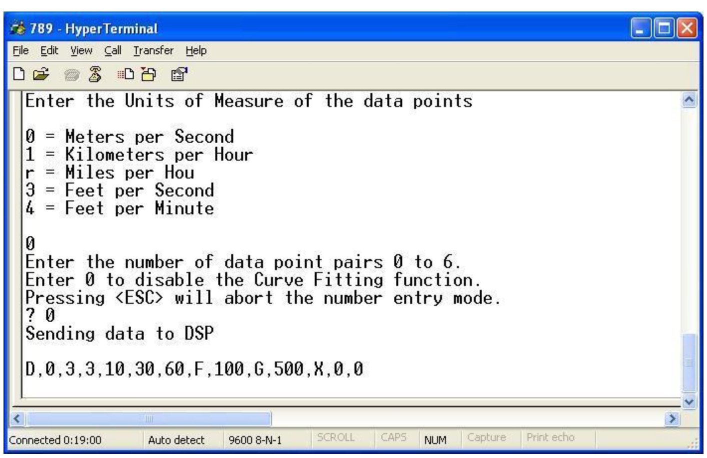
The next will be the first curve fitting point (Low), following that will be the second curve fitting point (Medium), and last will be the third curve fitting point (High).

Another press of the "Next" key will return you to "Setup" level.

At this point the curve fitting procedure is completed. The remainder of the RATA should now be initiated to verify that the unit is performing properly.

This procedure may be re-initiated if necessary if it is found advisable to make further small adjustments.

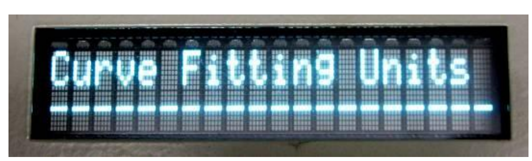
This check should be done every time there is any access to the curve fitting function.



To dump or remove all curve fitting points:

Enter "0" (zero) when prompted to enter data point pairs. OFS will show "sending data to DSP" then will show a sequence ex:

"D, 0, 1, 2, 10, --, 60, F, 100, G, 500, X, 0, 0". When the last two comma-divided items are 0, the curve fitting points have been removed. Verification procedure will show no display.



16 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.

16.1 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**
- **Details of site and installation** (stack diameter, purge air, application, location, etc.)
- **Your name, phone number, and e-mail address**

The more information you can provide – the better we can help you.

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