OPERATIONS MANUAL

PC2400D

Digital On-Line Particle Counter

Revised 7/10/09 JC

CHEMTRAC

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SAFETY

In order to provide maximum user safety the PC2400D particle counter was designed with the following issues in mind.

- All electrical circuitry is enclosed within a protective non-conductive housing.
- No user serviceable parts.
- No user replaceable parts.
- No access to laser.

SAFETY PRECAUTIONS

It is important to review this list of precautions prior to installation.

- Do not attempt to disassemble the unit.
- Water must not be allowed to enter the housing of the unit.
- Close and fasten shut the door of the unit prior to any external cleaning to prevent water ingress.
- Do not drop or jar the unit.
- Use a mild non-abrasive cleanser when cleaning the outer cover of the unit.
- Do not modify any internal electrical wiring or electronics.
- The PC2400D sensor is equipped with a class III laser and should not be tampered with in any way. The following warning label is affixed to the laser assembly housing inside of the unit.

Laser Warning Label

WARRANTY INFORMATION

Chemtrac® Systems, Inc. warrants its equipment to be free from defects in material and workmanship for a period of one (1) year from date of shipment to the original purchaser. Upon receipt of written notice from purchaser, seller shall repair or replace the equipment (at option of Chemtrac® Systems, Inc.).

Chemtrac® Systems, Inc. assumes no responsibility for equipment damage or failure caused by:

1. Improper installation, operation, or maintenance of equipment.
2. Abnormal wear and tear on moving parts caused by some processes.
3. Acts of nature (i.e. lightning, etc.)
4. The sensor optical alignment is very sensitive to vibration. Avoid installation locations with high amounts of vibration. If drilling of enclosure is necessary, please contact the factory for guidance.

This warranty represents the exclusive remedy of damage or failure of equipment. In no event shall Chemtrac® Systems, Inc. be liable for any special, incidental, or consequential damage such as loss of production or profits.

Should you experience trouble with the equipment, please contact:

Chemtrac Systems, Inc
6991 Peachtree Industrial Blvd., Building 600
Norcross, GA 30092

Phone: 1-800-442-8722 (Inside US only), 770-449-6233
Fax: 770-447-0889
Email: chemtrac@chemtrac.com
Website: www.chemtrac.com

SECTION 1.0 GENERAL INFORMATION

1.1 UNPACKING UNIT

When unpacking the PC2400D it is important to follow the following guidelines.

1. Open box right side up.
2. Carefully remove and examine packing material for any loose items that may have fallen out of containers during shipping. **Note:** Packing material should be stored. It may be necessary to return unit for repair in the future.
3. Carefully lift the unit from the box.
4. Your PC2400D should include one of each of the following items.
   - Water Weir Kit (if specified) which consist of the following items:
     - Qty 1 water weir PN: 11000
     - Qty 2 mounting arms PN: 11010
     - Qty 2 weir clamps PN: 11015
     - Qty 1 Sample Drain Cup
   - Cleaning Kit which consist of the following
     - Qty 1 cleaning brush PN: 06578
     - Qty 2 barbed fittings PN: 9940
     - Qty 1 Wago tool PN: 11050
   - Communications cable (if specified)
   - Qty 1 RS-232/485 converter (if specified) PN: 485CSP2
   - Qty 1 operations manual

If you are missing any of the following items please contact Chemtrac for a replacement.

1.2 UNIT LABELING

Each PC2400D particle counter has a serial number label attached to the inside of the front door of the unit. Please refer to this information when inquiring on your particular unit.

1.3 FEATURES AND BENEFITS

On-line Particle Counter model PC2400D is intended for the determination of particle count and size distribution in a variety of liquid streams. Major applications include monitoring filter performance in potable water treatment plants, industrial wastewater treatment facilities and measuring suspended iron, and copper corrosion products in steam electric power plants. Particle counting is generally more sensitive than turbidity measurements for early detection of filter breakthrough. The PC2400D uses a light blockage volumetric method to determine particle count. The light source is an infrared laser diode. The sensor is designed to “detect” particles in the 2 to 900 µm range, and size particles in the2 to 100 µm range (any particles larger than 100 micron will be sized as >100 µm).

The analyzer features an entirely external sampling and measurement system. There is no danger of sample leaks damaging sensitive electronic components. The large (1 mm x 1 mm) flow cell is easy to

clean and resists clogging. The constant head overflow weir ensures stable, reproducible flow and accurate particle counts.

The PC2400D has a local backlit display which allows the user to see the individual size ranges and particle counts in each range. The display also provides the cell condition readout, which is an indication of the sensor's cleanliness and allows the user to know when cleaning is necessary. It is recommended to clean the sensor when the cell condition drops by more than 10% from the reading obtained after cleaning.

Integration to the customer's SCADA / DCS can be accomplished either via analog 4-20 mA outputs (4 output channels), or by using the digital communication features. RS/485 and RS/232 communication ports are standard on the PC2400D, and an Ethernet connection is option. Using these communication ports, the customer can communicate to the PC2400D via Modbus (ASCII, RTU, or TCP), Profibus, and Foundation Fieldbus. Some of these communication protocols are optional and do not come with your equipment unless specified when ordered.

Another option for collecting the data from a one or several PC2400D's is to use Chemtrac's TracWare software. TracWare lets the user customize particle size ranges, change sampling duration and frequency, plot trends, and prepare reports. .Furthermore, using the PC2400D's four 4-20mA analog inputs, TracsWar can also accept data from turbidity analyzers, flow meters, etc. A backwash terminal is also available to alert TracWare that a filter backwash is occurring, and a setting in the software allows the user to "zero" the data when a backwash is occurring so the spikes do not appear on the trends or in the reports. The user must provide the personal computer for running TracWare.

Note: Ninety-six particle counters can be multi-dropped on a RS485 serial communications loop. The maximum network length is 4000 ft. To avoid problems with communications, be sure to contact the factory to discuss how the RS/485 network will be laid out in the plant. A poorly designed network can result in excessive communication timeouts.

1.4 SPECIFICATIONS

GENERAL

Light Source:	Solid-state Laser Diode
Detection Method:	Light Extinction
Light Detection:	Photo diode
Flow cell:	1mm x 1mm
Cell Material:	Nituff™ coated aluminum (or PEEK plastic – Optional)
Cell Window:	Sapphire
Cell max operating pressure:	120 psi (8.27 bar)
Flow rate:	100 m/min
Dynamic Range:	2-900 µm
Signal to Noise Ratio:	>3:1 at 2 µm
Coincidence:	<10% at 15,000 per ml at 10µm

SAMPLE REQUIREMENTS

Water Temperature:	32-122° F, (0-50° C), (non-freezing)
Operating Temperature:	32-122° F, (0-50° C) Relative Humidity 20 to 85%, non-condensing
Sample Head:	24" (610 mm) water min.

MEASUREMENT

Method:	Light blockage, volumetric
Light Source:	Laser diode (780 nm, 3mW)
Detector:	Photodiode
Dynamic Range:	2 to 900 µm
Size threshold settings:	Eight (maximum); default values: 2-5, 5-10, 10-15, 15-25, 25-50, 50-75, 75-100, and >100 µm. Default settings can be changed only through digital communications (e.g. TracWare, PCComm, Modbus, etc.).
Signal-to-Noise Ratio:	3:1 at 2 µm
Coincidence Limit:	<10% at 15,000 particles/mL at 10 µm

CALIBRATION

Standards:	Latex microspheres
Method:	Six standards, normally 2, 3, 5, 7, 10, and 15 µm (nominal)
Recommended calibration frequency:	Yearly

INPUTS

Number:	Accepts up to four 4-20 mA signals from other analyzers. *Only used with digital communication options.

OUTPUTS

Number and range:	Four, 4 to 20 mA, assigned to first four size channels
Maximum load:	600 Ohms
Ranges:	0-200 cts/mL; 0-2000 cts/mL; 0-20,000 cts/mL (jumper-selectable)

BACKWASH TERMINAL

Purpose:	Wire the backwash terminal to a contact closure (user-provided) that closes when the filter backwash starts. When the contacts close, TracWare can zero the data being recorded so spikes do not appear on trends and reports.
Power:	Internal or external (3 to 32 VDC)

TracWare COMPUTER REQUIREMENTS

Operating system:	Windows 98, NT, 2000, XP, Vista
Computer:	Intel or AMD processor (1 GHZ or faster); at least 256 MB of RAM, 250 MB of hard drive space, CD ROM drive

DIGITAL COMMUNICATIONS

Serial Communication:	Standard: ·RS485 and RS232 *(RS232 to RS485 interface kit must be ordered separately)* Optional: RJ-45 (Ethernet)
Protocols:	Standard: Modified Optomux and Modbus ASCII Optional: Modbus RTU, Modbus TCP (Ethernet), Profibus, Foundation Fieldbus
Maximum network length:	4000 ft (1220 m)
Maximum number of PC2400D on network:	96

PHYSICAL DIMENSIONS

Unit Size:	13.5" (342.9mm) H, 14.25in" (361.95mm) W (Including cell), 5.5" (139.7mm) D
Total Weight:	12lbs. (5.448kg)
Power:	110 VAC / 60Hz, .5A 220 VAC / 50Hz (Optional)
Enclosure:	NEMA 4X (NEMA 4X rating is generally considered to be equivalent to IP 55/65)

1.5 WIRING SPECIFICATIONS

The following pages list the wiring requirements of the PC2400D:

- **RS 485 Communications Cable**

Belden Wire & Cable – Paired Cable	
For Low Capacitance for EIA RS-485 Applications	
Trade Number:	9841
NEC	CM
UL AWM	2919
CEC	CM
Conductor AWG:	24
Conductor Stranding:	(7x32)
Conductor DCR:	78.7 ohms/km
Conductor Type:	TC
Insulation Type:	Polyethylene
Jacket Type:	PVC
Shield Type:	Beldfoil® + TC Braid
Nominal OD:	0.232" (5.893mm)
Nominal Capacitance:	12.8 pF/ft. (42.0 pF/m)*
Nominal Capacitance:	23.0 pF/ft. (75.5 pF/m)**
Velocity of Property:	66%

Description:

Tinned copper, polyethylene insulated, twisted pairs. Overall Beldfoil® aluminum-polyester shield. 24 AWG stranded tinned copper drain wire. Overall tinned copper braid shield (90% coverage). Chrome PVC jacket (100% coverage). 30V 80°C

*Capacitance between conductors
**Capacitance between one conductor and other conductors connected to shield.

- **Backwash Cable (optional)**

(Same as RS 485 listed above)

- **Power Cable (not supplied with units shipped to EU)**

3-Core Round	
CMA Ref. No.	2182Y
Har Code No.	H03VV-F
BASEC approved	
CSA:	0.5mm^2
Current Rating:	3A
Voltage Rating	300/300/V
Nominal Dia.:	5.8mm

1.6 PARTICLE COUNTING OVERVIEW

The particle counter is one of the most sensitive and precise on-line instruments in use in water treatment today. In order to achieve and maintain optimal performance, it is imperative that proper installation and operational procedures be followed.

The sensitivity of the unit to small concentrations of particles well below the range of visibility requires that the sample be delivered to the sensor without contamination or alteration. Data produced is based on the sample volume, so flow rate must be maintained at a constant value. The flow path through the sensor is small (1mm x 1mm) in comparison to other types of on-line instruments. Strainers should be used on raw water samples, and a proper maintenance schedule must be followed.

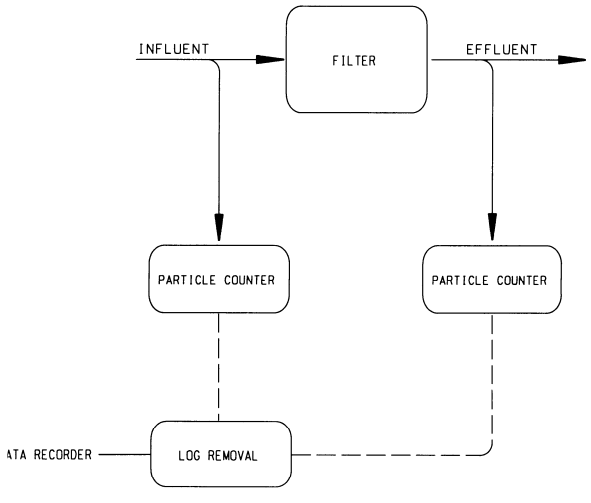
Since these instruments count and size particles, each counter produces several channels of data. This data is most useful when trended, so provision should be made for recording and storage.

Following the installation, guidelines outlined in this manual should result in proper operation with minimal problems. Individual plant requirements and layouts will vary, resulting in alterations to the procedures. The brief discussion on particle counting which follows should aid in understanding these requirements.

1.7 BASIC OPERATION

The Chemtrac Model PC2400D particle counter is designed to “count” particles 2 to 900 micron in diameter and "size" (i.e. sort by size) particles ranging from 2 to 100 microns in diameter. Particles larger than 100 micron will be sized as >100 micron particles. Particles are divided into size ranges and the number of particles counted in each of these ranges is reported in counts per milliliter. One of the most common applications in water treatment is measuring the removal efficiency of a filter for particles in the size range of Cryptosporidium and Giardia. By placing a particle counter upstream and one downstream of the filter, the "log removal” can be determined. (Log removal is the ratio of particles entering to those exiting the filter in a given size range, converted to a logarithmic scale, see Figure 1).

The particle counter consists of an optical sensor and counting electronics. A constant head overflow weir is used to maintain sample flow through the sensor, see Figure 2.



% FILTER EFFICIENCY	LOG EQUIVALENT
90	1
99	2
99.9	3

$$\text{LOG REMOVAL} = \log_{10}\left(\frac{\#\ \text{INFLUENT COUNTS}}{\#\ \text{EFFLUENT COUNTS}}\right)$$

EXAMPLE:

$$\log_{10}\left(\frac{1000\ \text{COUNTS/mL}}{10\ \text{COUNTS/mL}}\right) =$$

$\log_{10}\ 100 = 2 = 2$ LOG REMOVAL

FIGURE 1. Log Removal

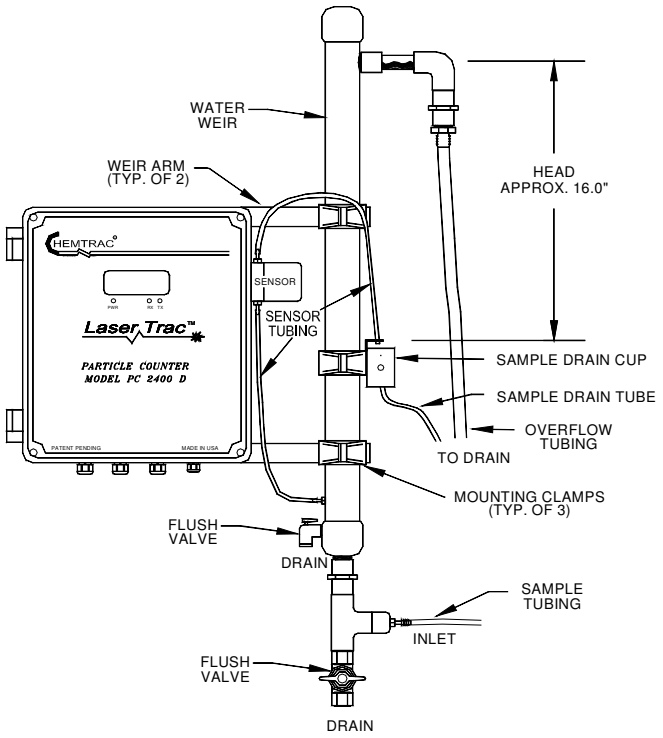


FIGURE 2. Weir Assembly

The sensor consists of an infrared laser diode, a light detector, and two transparent "windows". The detector converts light energy into electrical voltage. The laser light is directed through both windows and on to the detector. Sample flow passes between the windows, so that any particles in the sample will pass through the laser beam. Each particle will block a small percentage of the light that hits the detector, changing the electrical output of the detector. Since the particles are moving rapidly, each particle will produce a short electrical pulse at the output of the detector. The amplitude of the pulse correlates to the size of the particle. The output of the sensor is a stream of pulses of varying amplitude, each corresponding to a particle. This type of device is known as a light blocking or light extinction sensor, see Figures 3 and 4.

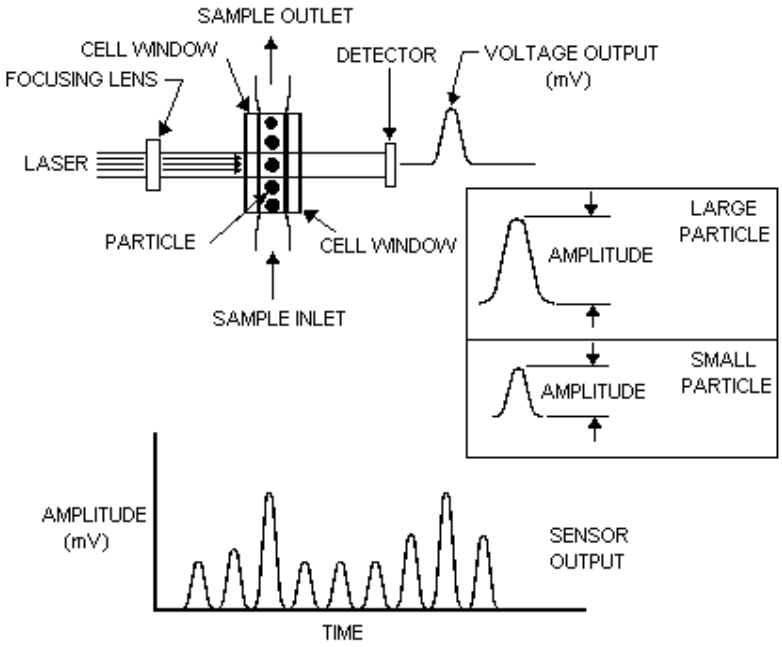


FIGURE 3. Laser Diagram 1

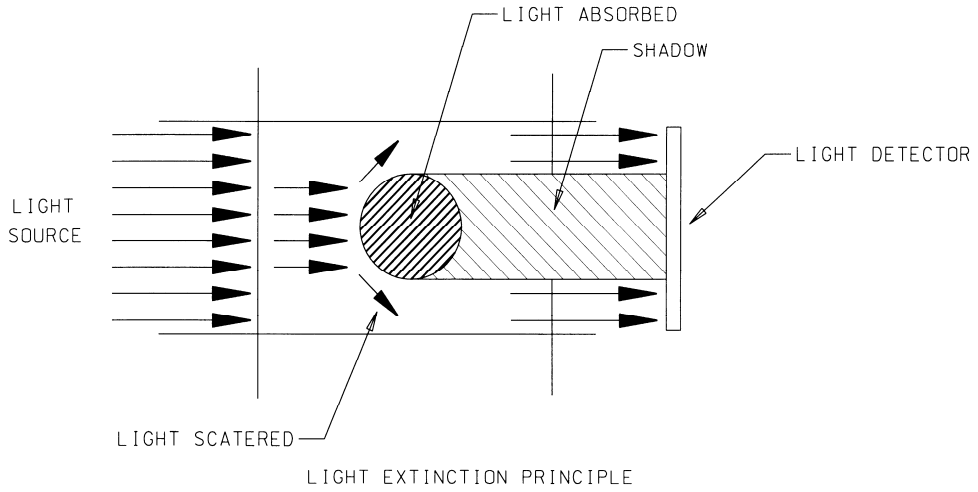


FIGURE 4. Laser Diagram 2

The amount of light blocked from the detector is the sum of the light absorbed by the particle and the light scattered or reflected by the particle. The size and composition of each particle will determine how much light is scattered and how much is absorbed. Carbon particles will absorb most of the light and scatter very little of it. Organic particles have an index of refraction close to the value of water, and tend to refract more light. The result of this is that an organic particle 5 microns in size will block less light than an inorganic particle of the same size, and will appear smaller to the particle counter. For this reason, Giardia and Cryptosporidium will be counted in size ranges several microns below their actual size. The orientation of the particle as it passes through the light beam will also affect how much light is blocked.

These factors make it necessary to count particles over a range of sizes as opposed to an exact size, see Figure 5.

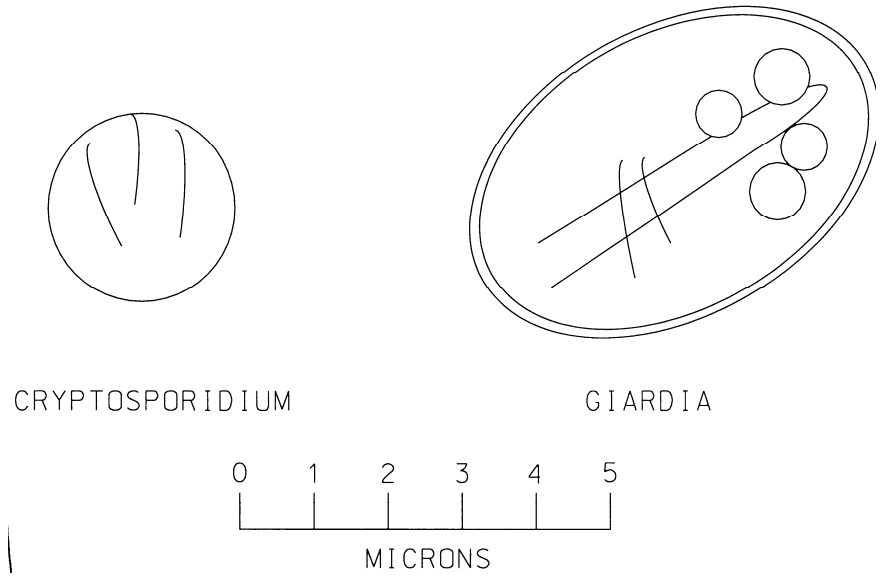


FIGURE 5. Particle Size Comparison

The sensor output is fed into the counter electronics, which sorts the pulses according to amplitude and counts them (see Figure 6).

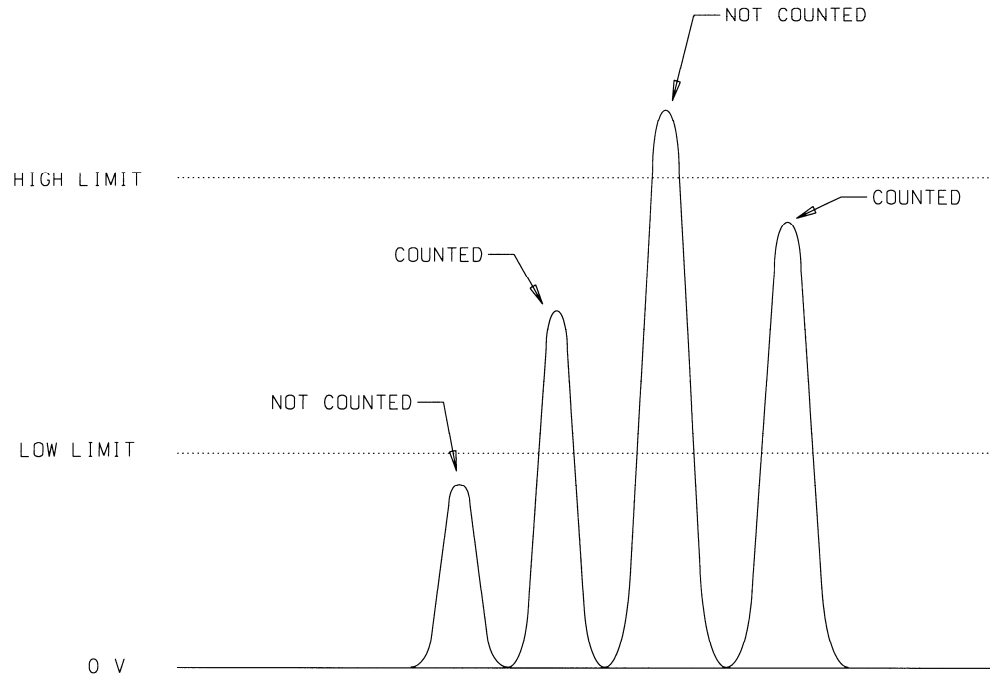


FIGURE 6. Pulse Amplitude

In a typical application, three or four ranges might be used. The first one might be set to count particles in the range from 2 to 5 microns, the second 5 to 10, the third 10 to 15, and so on. Range thresholds are set using the calibration data supplied with each sensor. The calibration chart provides the voltage equivalent for each particle size. The 2400D will automatically set range thresholds using calibration data stored in the sensor. Plotting particle size vs. voltage on a log-log scale produces a calibration curve. The critical feature of the curve is that it is monotonic, i.e. only one particle size corresponds to a specific voltage.

The Model PC2400D typically operates at a flow rate of 100 ml/min. A constant head overflow device is used to maintain this flow. Flow adjustment is accomplished by moving the drain cup up or down the weir assembly, which decreases or increases flow (head) (See Section 3.13). One of the unique features of the Chemtrac counter is that the output is directly converted into particles per milliliter. This will appear on the display as “Cnts/ml” or counts per milliliter. Other flow rates can be used and are set via the computer interface. However, the instrument is calibrated at the factory for a flow rate of 100 ml/min and the sizing accuracy will not be accurate if that flow rate is changed. If your application requires the flow the sensor to be something different than 100 ml/min, then contact the factory for assistance. Only two or three feet of system head is needed to achieve 100 ml/min, see Figure 7.

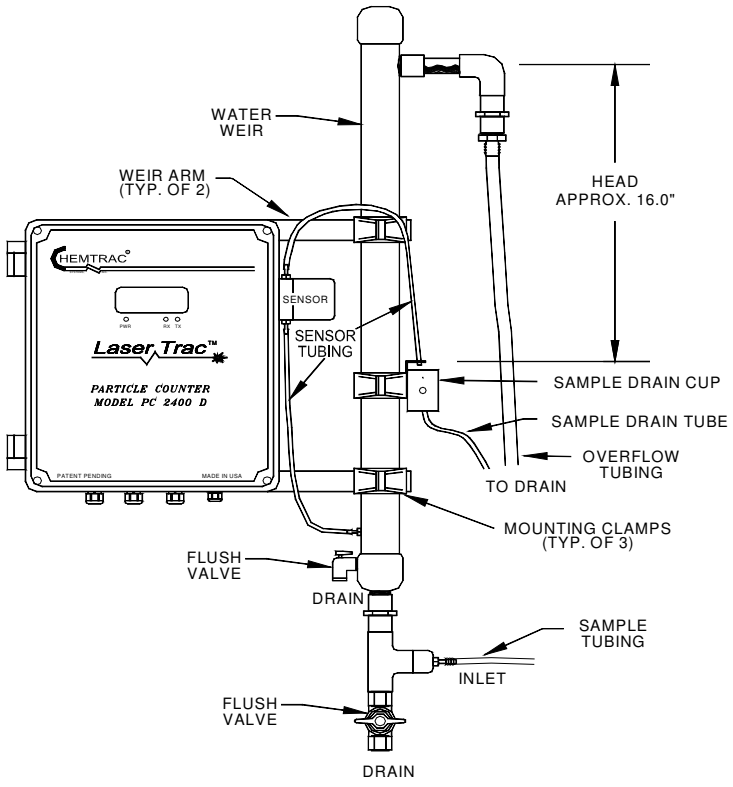


FIGURE 7. Weir Head Pressure

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SECTION 2.0 MOUNTING AND INSTALLATION

2.1 MOUNTING

PC2400D should be permanently mounted in an upright position using the mounting holes on the back of the counter. See Figure 7 for details.

2.2 WIRING SAFETY

Please observe the following safety precautions prior to wiring the unit.

- Power must be locally fused or switched prior to entering the unit.
- Power should be hardwired to the unit. Flexible power cords are not recommended around water.
- Disable power circuit prior to hardwiring the unit.
- Observe polarity when connecting the unit. The unit will not work and can be damaged if polarity is crossed.
- All wire connections must be tinned prior to connecting to ensure proper contact and to prevent corrosion.
- The unit must be earthed.

NOTE

The particle counter is one of the most sensitive and precise on-line instruments in use in water treatment today. In order to achieve and maintain optimal performance, it is imperative that proper installation and operational procedures be followed.

2.3 WIRING

Following the installation, guidelines outlined in this manual should result in proper operation with minimal problems. Individual plant requirements and layouts will vary, resulting in alterations to the procedures.

Disable power circuit that supplies power to the unit.

During installation, a local isolation point must be supplied.

Mount the PC2400D in the upright position (Chemtrac logo upright) using the four mounting holes on the back of the unit. Unit may be fastened to mounting brackets, pipe stand or similar.

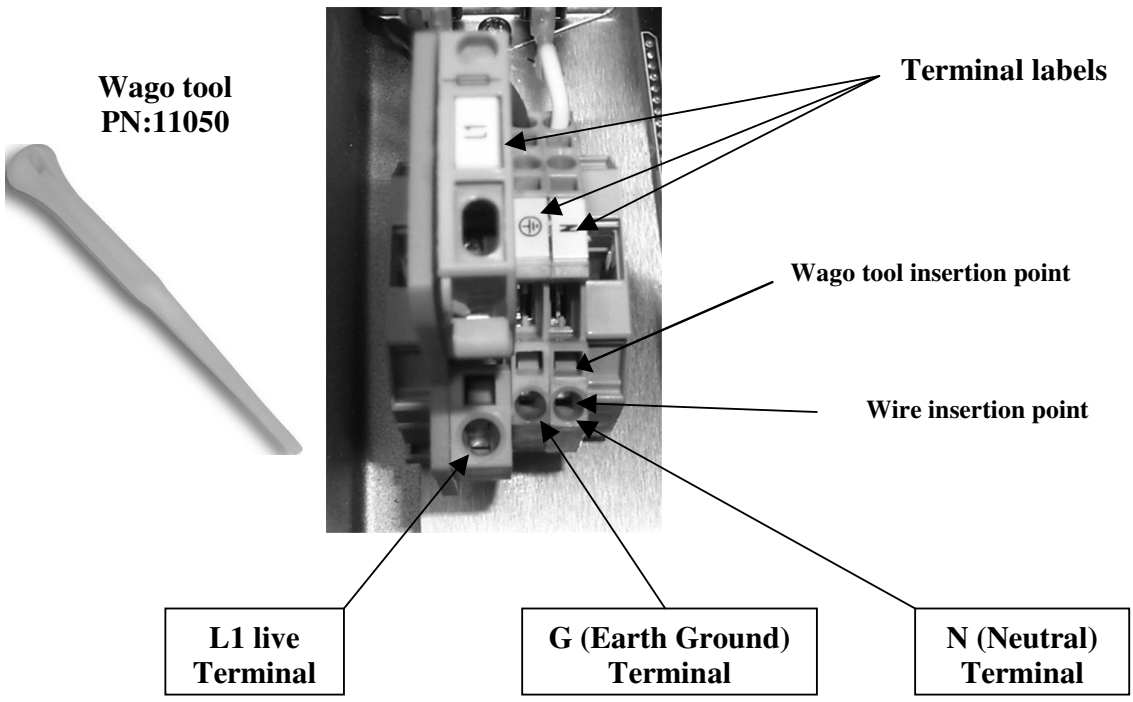
With the power off, feed the electrical supply line through the compression fitting on the furthest left side of the unit.

NOTE

When feeding wire into unit it is always important to feed through the compression fitting that is closest to that wire connection.

Electrical power should be connected in the following order (See Figure 8).

- Insert the ground (earth) wire into the middle terminal labeled “G”.
- Insert the hot wire into the left terminal labeled “L1”.
- Insert the neutral wire into the right terminal labeled “N”.



To insert wires into terminals you must first insert the sharp end of the Wago tool (PN: 11050) into the square slot of the terminal connector. This will open the terminal and allow you to insert the wire into the circular hole below.

FIGURE 8. Power Terminal Block

2.4 CONFIGURING ANALOG INPUTS (OPTIONAL)

The PC2400D provides for up to four auxiliary analog inputs. The analog inputs are designed to accept a 4 to 20 mA signal. Each input is passed through an optical isolation circuit. These circuits are designed to protect the particle counting electronics from signals that exceed the specified input values because of wiring errors, current surges, or equipment failure.

Note: The analog inputs are offered for two purposes. The first purpose is to allow the customer to bring in certain measurements like Turbidity into the TracWare software for a more complete data gathering and reporting solution. The second purpose is to allow the customer to communicate digitally with the PC2400D via a protocol like Modbus and to read in the 4-20mA output signals from instruments that are connected to the PC2400D. The analog inputs will not appear on the PC2400D's local display.

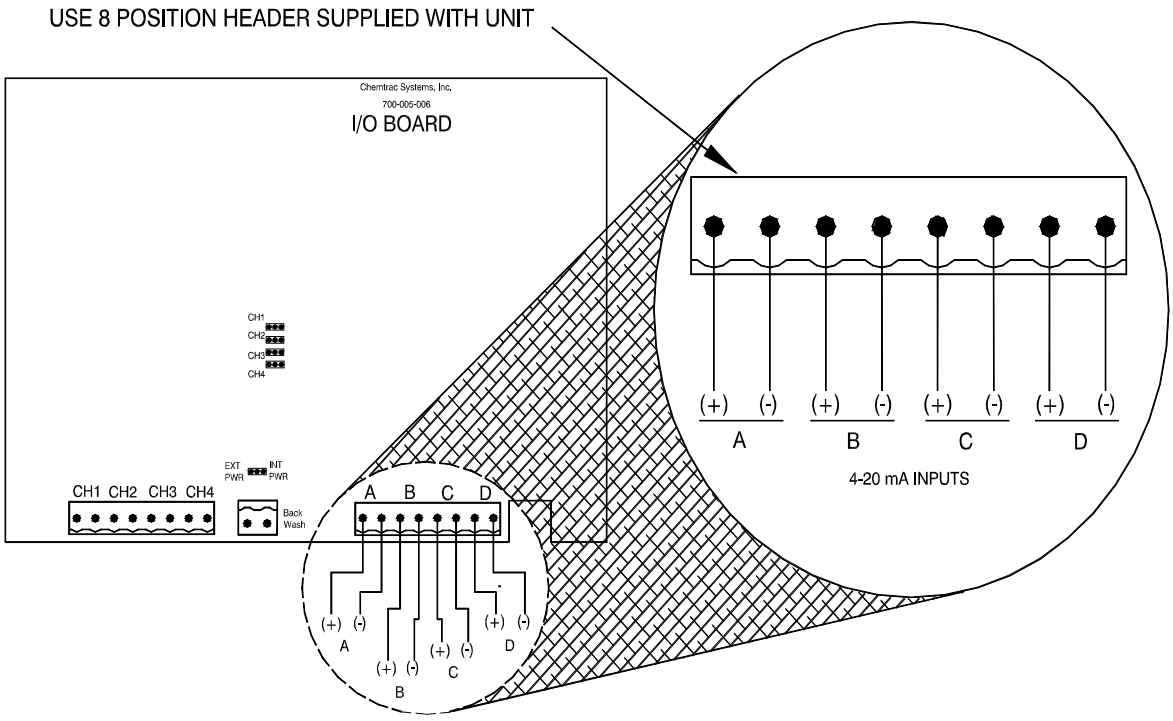


FIGURE 9. Analog Inputs

Setup of the analog inputs requires a voltmeter, computer interface (Chemtrac's TracWare software, TracComm utility software, or other user supplied program), and the operating manual for the instrument supplying the analog signal. A 4 to 20 mA test signal generator is useful. The voltmeter is used to verify that the signal is being properly transmitted to the analog input. It should not be assumed that a given instrument is transmitting a proper signal without verification. Some instruments have separate calibrations for the output signal.

Step 1: First verify that the instrument being connected to the PC2400D's analog input channel produces the proper output signal as specified in the manual for that instrument. Some instruments (such as the Hach 1720 C turbidimeter) can be programmed to put out minimum and maximum scale values to aid in configuration. Use the voltmeter to measure VDC at the input terminals. Make sure that the voltage polarity is correct, see Figure 10. Verify the voltage drop across the 250 ohm input resistance corresponds to the expected value. For example, a 4 mA input will produce 1 VDC, a 12 mA input will produce 3 VDC, and a 20 mA input will produce 5 VDC.

Step 2: Once the input signal to the particle counter has been verified, proceed with the instructions in the TracWare software manual for configuring auxiliary inputs.

It may be necessary to make slight adjustments in the instrument output or the software scale ranges to get the value recorded through the particle counter to match the displayed value on the instrument. Analog signals contain a certain amount of error. A bit of tweaking may be required to obtain satisfactory results.

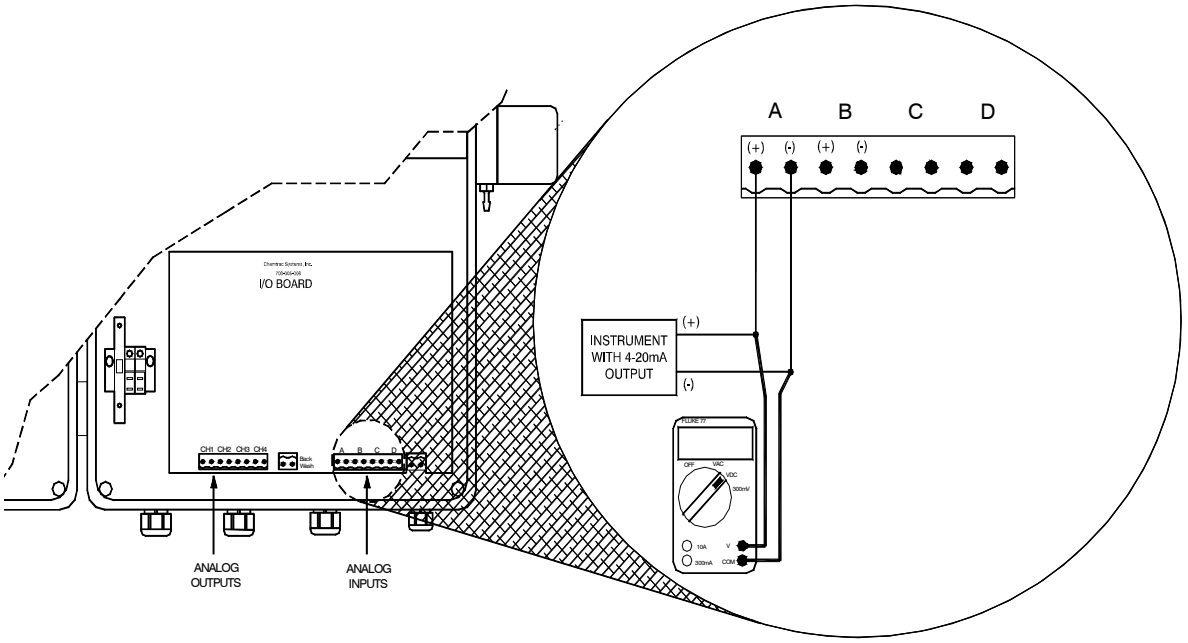


FIGURE 10. Analog Input Voltage Check

2.4.1 Additional Considerations

Analog signals are often used to drive additional receivers such as chart recorders, and PLC or RTU inputs. These instances will almost always require 4 to 20 mA current outputs. The signal loop should be connected in a series circuit as shown in Figure 11. The number of receivers that can be placed on a loop depends on the source voltage of the instrument, and the total load resistance on the receiver inputs. This information should be supplied in the instrument manual. A 12 volt source can drive up to 600 ohms, which would allow two receivers with 250 ohm input resistance.

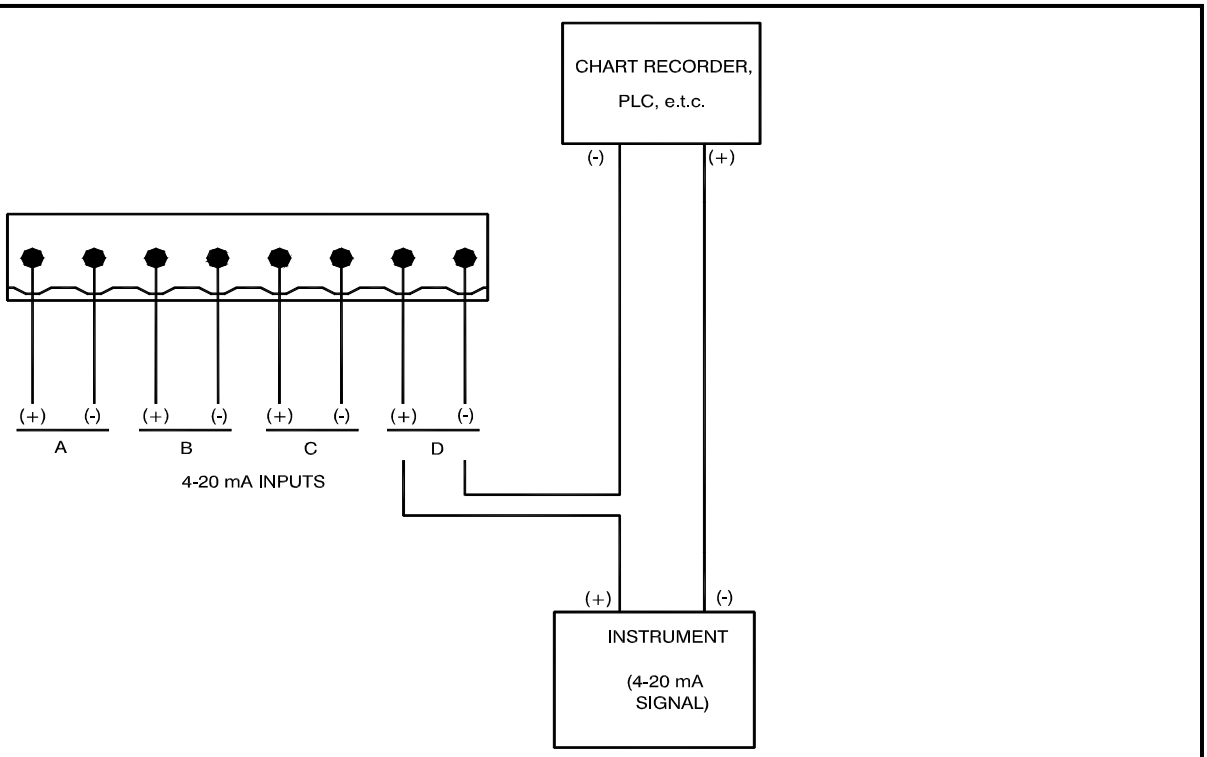


FIGURE 11. Analog Input Interconnection

2.5 CONFIGURING ANALOG OUTPUTS (OPTIONAL)

The PC2400D provides for up to four auxiliary analog output signals. These signals represent the first four Size Channels setup by the user. Each output passes through an optical isolation circuit. This circuit protects the particle counting electronics from wiring errors, current surges, or equipment failure.

The analog outputs are designed to produce a 4 to 20 mA signal. The available output ranges for CH1 - CH4 (Size Channels 1-4) are determined by the setting of jumpers J1-J4 respectively. The jumpers are labeled for CH1 – CH4 on the I/O board. See Figure 12 for the location of the jumpers for the analog output range settings.

OUTPUT RANGE SETTING	
Jumper on left and center pin	0-200 cts/ml
No jumper	0-2,000 cts/ml
Jumper on center and right pin	0-20,0000 cts/ml

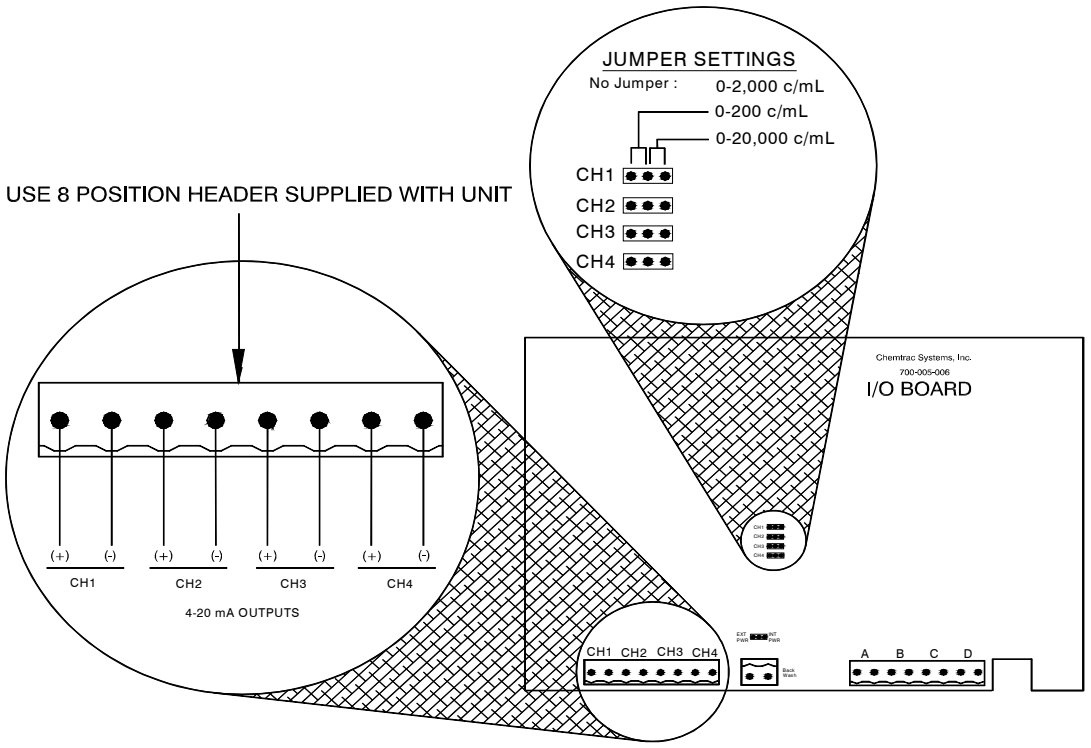


FIGURE 12. Analog Output Jumper Settings

Configuration of the analog outputs requires a multimeter, computer interface (Chemtrac's TracWare or TracComm utility software), and the operating manual for the instrument accepting the analog signal. The multimeter is used to verify that the signal is being properly transmitted from the analog output. It should not be assumed that a given instrument is transmitting a proper signal without verification.

Step 1: Use the multimeter to measure the analog output current when connected to the corresponding output terminals. Make sure that the multimeter polarity is correct and that the current is within 4 to 20 mA (See Figure 21). Verify that the instrument is producing the proper output signal by assuming 4mA equals zero counts and 20mA equals the maximum count range as determined by jumpers J1-J4 on the I/O Board.

Example: Setting CH1 range @ 0-200 counts (jumper on left side of J1) and measuring 8mA across the output you can compare the particle counter display with calculated value.

Calculated: X = Number of counts.

X = ((Measured current – 4mA) × Jumper range setting) / 16mA

Example: X = ((8 mA- 4mA) * 200 counts) / 16mA

X = 50 counts (Approximation)

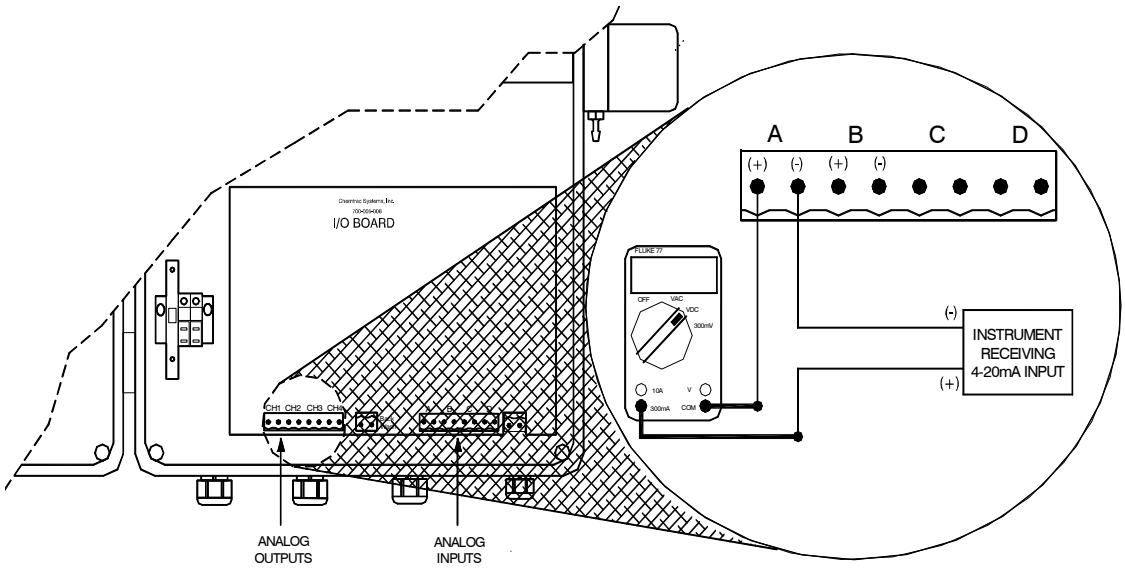
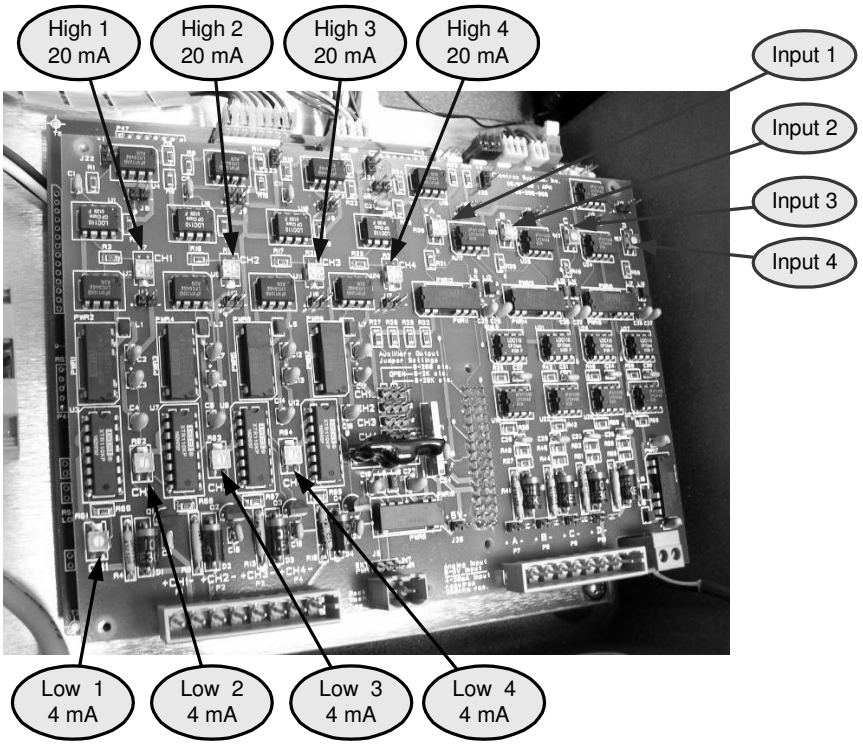


FIGURE 14. Analog Output Check

Step 2: Zero and Span trim pots are available on the IO Board (see below). Once the signals being output from the particle counter have been measured, if they are found to not be accurate, the proceed as follows: Stop flow through sensor until readings go to 0 in all channels and then adjust the 4 mA adjustment for exactly 4.00 mA. Start flow through the sensor and then adjust the 20 mA adjustment to obtain the proper mA value for the displayed reading.



2.6 BACKWASH SIGNAL (OPTIONAL)

The particle counter provides the ability to notify TracWare in the event of a filter backwash. The software then can zero the data to prevent backwash spikes from appearing on the trends or reports.

To activate the automatic backwash, the backwash terminal must be wired to a contact closure that is closed when the filter backwash occurs. The particle counter allows for the use of a dry contact closure or a contact closure that passes a voltage between 3V and 32V DC when closed. The backwash jumper, located above the backwash terminal on the I/O board, must be set according to which contact closure is being used (external power or internal power, see Figure15).

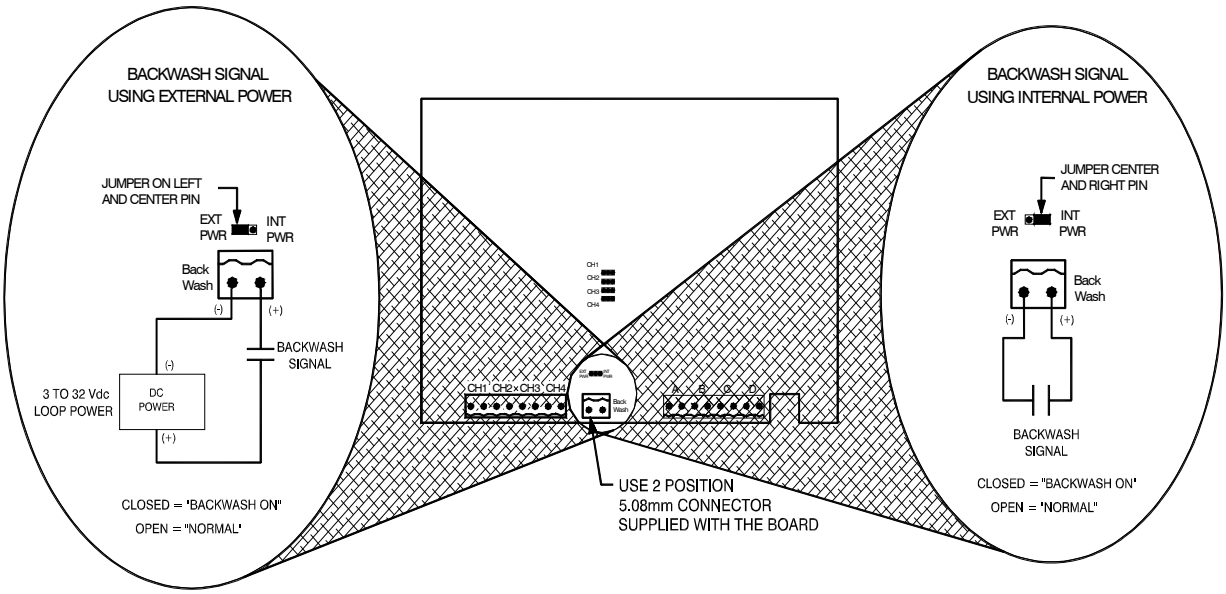


FIGURE 15. Backwash Connection

Refer to the manufacturers operating manual of the instrument accepting the analog signals to insure proper wiring and configuration. TracWare or the Traccomm utility will display the particle counts on these outputs directly. These particle counts can be compared with the SCADA system values after the input settings have been cond. It may be necessary to make slight adjustments to the accepting instruments input values in order to get the value recorded through the particle counter to match the displayed value on the instrument. Analog signals contain a certain amount of error. A bit of adjusting may be required to obtain satisfactory results.

SECTION 3.0 SAMPLING

3.1 SAMPLE CONSIDERATIONS

The high sensitivity of the particle counter makes sample handling and delivery critical for proper operation. Poor results caused by improper sample handling not only reduce the value of the instrument; they can result in regulatory penalties. An increase in a small number of particles in the filter effluent caused by poor sample control can cause a substantial decrease in log removal.

It is not difficult to achieve proper sample delivery in virtually any treatment plant. The important thing is to make sure the sample is properly representative of the process stream. There are three ways in which the sample can be distorted:

1. Adding particles to the sample stream. Choosing an improper location for the sample tap, such as the bottom of a pipe where sediment can accumulate, or an open sample point where particles can be introduced from outside the process usually causes this.

2. Losing particles from the sample stream. Long sample lines can cause particle dropout, especially at low flow rates. If the sample line must be long (more than 10 or 15 feet) a large pipe should be used and a flow rate that keeps the sample moving as fast as the process stream. Particles will settle out of standing water.

3. Altering the particle distribution. Sample pumps can chop up larger particles creating more small particles. Valves and other obstructions can cause "shedding". Particles collect on cracks and edges and then break loose later. "T" fittings can cause larger particles to miss the sample line because they can't make the sharp right angle "turn".

Of course, it is seldom possible to avoid all of these pitfalls. Frequently valves are needed to control sample flow rates, or pumps are used to get the sample to a usable point. The important thing is to minimize these problems. Filtered water can be pumped with fewer problems than raw or settled, since only very small particles are usually present, and they are less likely to be broken up. Ball valves or other types with minimal edges to trap particles can be used. "Y" fittings can be used instead of "T's".

3.1.1 Sample Taps

The diagram below shows proper and improper sample locations on a process pipe. These are the same as for any instrument requiring a representative sample flow. (See Figure 16.)

Make sure that the sample point has the minimum pressure available at all times to provide enough flow. The Chemtrac sensor requires approximately 2 feet of head to maintain a 100-ml/min flow, so ensure there will be a minimum of 2 feet of head throughout the entire filter run (i.e. during high head loss towards the end of filter run).

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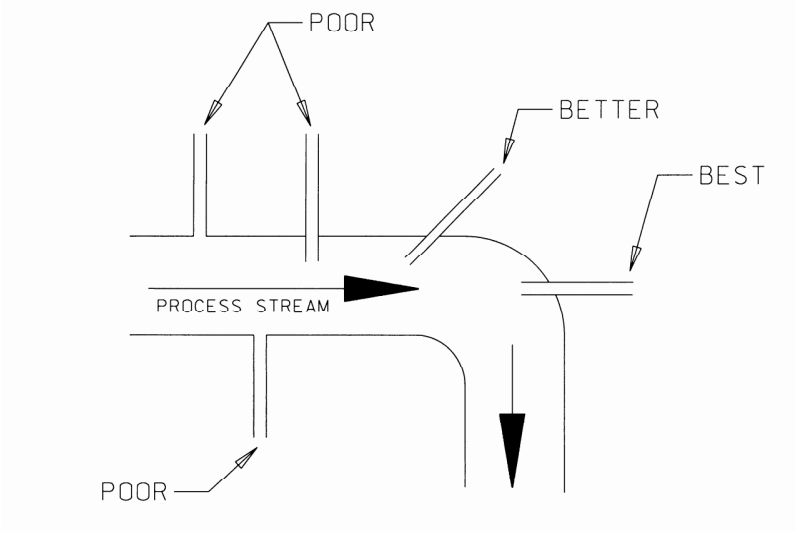


FIGURE 16. Sample Tap

3.1.2 Flow Control

Since all particle count data must be based on a sample volume, flow control is crucial to accurate and repeatable performance. The simplest and most effective way to achieve constant flow is with an overflow weir. As long as enough flow is delivered to maintain some overflow in the weir, a constant flow will be present in the sensor. If this requirement is maintained, flow will only be altered by clogging of the sensor flow cell or fouled tubing and/or barb fittings. The Chemtrac particle counter comes equipped with a sample drain cup. An optional flow switch is available to alert the operator to a loss of flow to the sensor.

3.1.3 Weir Assembly

The overflow weir assembly is designed to deliver constant flow to the sensor despite changes in source pressure. Overflow must be maintained to ensure that full flow is achieved. The clear horizontal pipe at the top of the assembly gives an indication of the amount of overflow. If the level in this pipe reaches the top, the flow will be affected. It is best to keep the overflow at the midpoint in this pipe to allow for variations in source pressure.

Weir adjustment is achieved by moving the sensor outlet via the sample drain cup, up or down the vertical pipe until the 100 ml/minute flow is achieved. This is best measured using a graduated cylinder and a stopwatch. Once in place, the flow should not change if overflow is maintained. The head required to achieve this flow rate is measured from the outlet point to the overflow level at the top of the weir. (See Figure 18.)

The weir assembly and sensor should be mounted at an elevation sufficient to achieve overflow at minimum source pressure. A ball valve can be used to regulate the flow into the weir assembly.

Important Note On Weir Installation

Weir arms are provided to help simplify the mounting of the Weir. However, some user's prefer to mount the Weir directly to a backplate versus using the Weir arms. Not using the weir arms can make it easier to remove the PC2400D if the equipment needs to be serviced . If the weir arms are not to be used, just ensure two things:

1. Make sure the clear horizontal pipe at the top of Weir is higher than the top of the PC2400D by at least 6 inches. This ensures flow will start reliably through the sensor. If the Weir is mounted too low, the flow may not re-start reliably through the sensor if flow was ever lost for any reason.

2. Mount the Weir to the right of the unit (as shown in figure 18) and insure there is a minimum of 4 inches between the Weir and the sensor (the sensor protrudes from the top right side of the enclosure). The cap on the sensor may need to be removed at some point for maintenance and mounting the Weir too close to the sensor will make it impossible to remove the cap without first removing the weir.

3.1.4 Sample Tubing

The recommended sample tubing is 1/4 " OD, 1/8" ID Tygon tubing. It is clear to allow viewing of the sample, and is good for general-purpose use. If runs longer than 10 or 15 feet are required, Teflon tubing is preferred, as it is less conducive to particle shedding. If the sample line is exposed to direct sunlight, black nylon tubing will prevent organic growth on the tubing wall. Sample tubing should be replaced on a periodic basis (e.g. once a month) to ensure fouling does not reduce flow and/or shed particles into the stream.

3.1.5 Bubbles

Bubbles can be introduced into the sample through various means (air in-leakage from loose fittings, degassing from temperature changes and/or pressure changes, etc.). The particle counter will count bubbles as particles if they are large enough, just as a turbidimeter will detect air bubbles as turbidity. The overflow weir is designed to aid in the removal of air bubbles. However, the removal of bubbles that have formed due to degassing is difficult to accomplish with a device like the overflow weir. In some cases, the sample may need to be kept pressurized through the sensor to avoid the formation of bubbles. Contact the factory for assistance if you suspect air bubbles are interfering with the measurement.

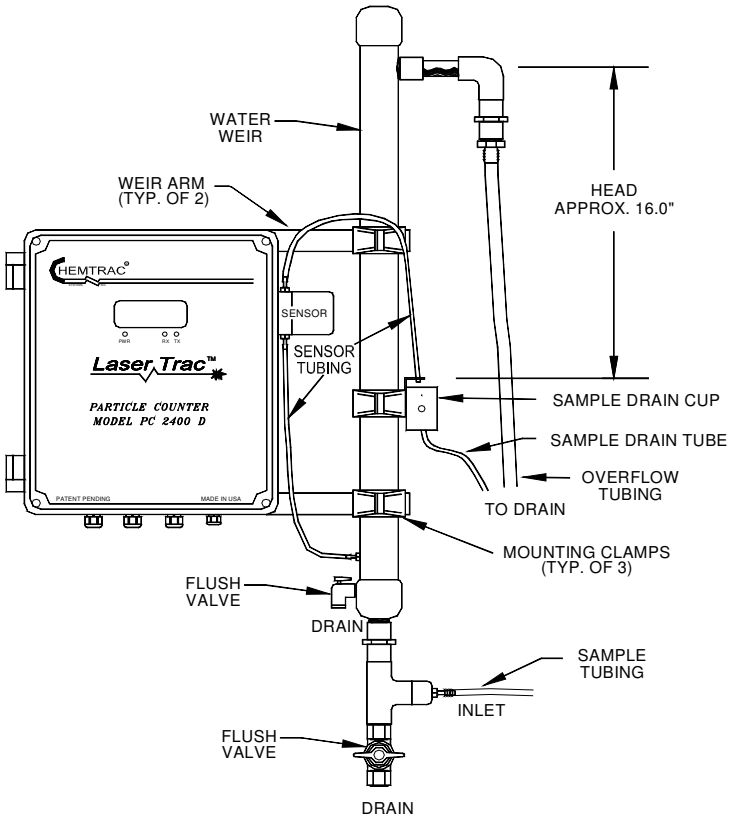


FIGURE 18. Weir Head Pressure

3.1.6 Initial Startup

It is very important to flush out all taps and valves before connecting the particle sensor. Sometimes taps or valves haven't been used for years, and can let out a slug of gunk that will clog the sensor. The sample should be brought to the weir assembly and sensor as shown in Section 4.0, 33.

Once installation is complete, the sample lines should be flushed for a brief period of time. If the particle counter output is being recorded, it is easy to tell when the lines have been sufficiently flushed, as the data will level out (See Figure 19.)

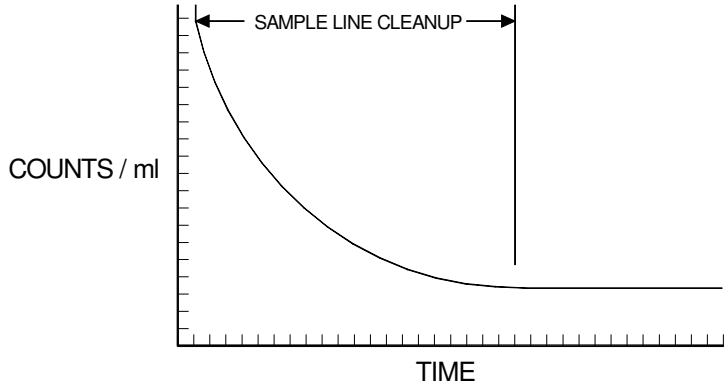


FIGURE 19. Sample Line Cleanup

3.2 COUNTER OPERATION

The Chemtrac PC2400D particle counter is shown in Section 4.0 “Diagrams”. It consists of the sensor, counter board and modules, display panel, power supplies, wiring terminals, and enclosure.

3.2.1 Sensor

The sensor contains the laser diode light source, flow cell, and detector circuit. The sample is passed through the flow cell, and pulses corresponding to each particle are output from the detector circuit. The sensor detector circuit is sealed in a NEMA rated enclosure separate from the main enclosure. This feature allows the sample to be passed through the flow cell without entering the main enclosure and exposing the electronics to potential leakage.

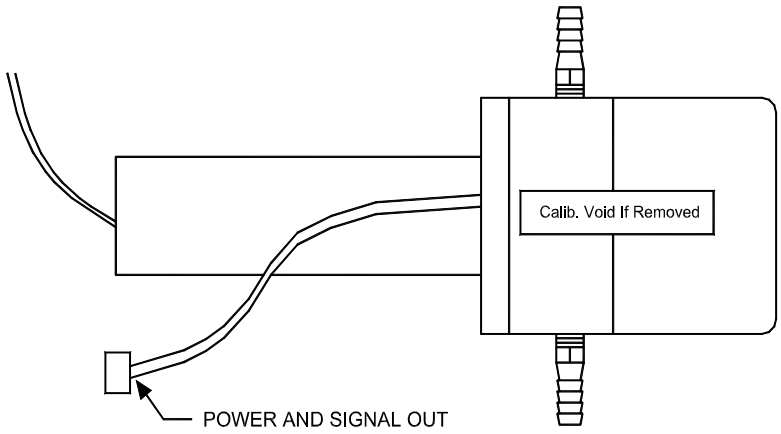


FIGURE 20. Calibration Sticker

NOTE

This small enclosure has a warranty/calibration seal, and should not be taken apart. If this seal is broken, the warranty is voided and new calibration will be required, along with repair of any damage incurred. (See Figure 20.)

3.3 RS485 COMMUNICATION AND POWER INDICATORS

The PC2400D comes equipped with three status LED’s. One red LED to indicate power and two green LED’s to indicate the unit is properly communicating with the host computer (See Figure 21). The red power LED, indicated by PWR on the cover of the PC2400D, in combination with the illuminated LCD lets the user know the unit has the appropriate power to function properly. If the power LED is dim or not illuminated, the processor and sensor will not have the power they need to function properly. Upon applying power to the unit, if both the power LED and the LCD are not brightly illuminated, the unit may not have the power it needs to function properly. If this occurs contact Chemtrac Systems as soon as possible.

The transmit and receive LED’s, indicated on the cover of the unit as TX and RX respectively, let the user verify that the unit is receiving communication from and sending communication back to the host computer. The TX (transmit) LED will light every time a data string comes down from the computer, no matter which particle counter the computer is trying to talk to. For example, if the user has ten particle counters, the TX LED will light on all ten units every time the computer sends down a data string. The RX

(receive) LED will light on an individual unit when the data string sent out by the computer matches the address of that unit.
In simple terms, the computer transmits the message “I need new data from unit #4”. The TX LED on all of the units attached to the host computer will light up to acknowledge the transmitted message got to them. Then the RX LED on unit #4 will light to say “I’m unit #4; here’s the data you want”.

With TracWare running the LED’s on each unit should flash at least once a minute. If the TX LED does not flash, there is a break in the communications line prior to this unit or a problem with the computer. If the TX LED flashes but the RX LED never flashes, the problem may be in the unit. Contact Chemtrac Systems if the LED’s do not appear to be functioning properly and communication cannot be established with the host computer.

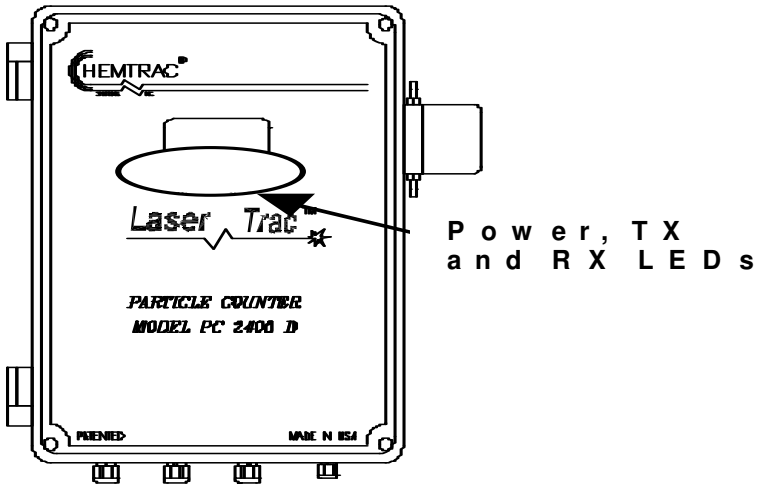


FIGURE 21. TX, RX Led Location

3.4 CLEANING AND TROUBLE SHOOTING PROCEDURE

The flow cell in the PC2400D series sensors is 1mm x 1mm, the largest in the particle counting industry for a 2 micron sensor, but still quite small in comparison to other instruments used in potable water treatment. It is paramount that a consistent flow rate be maintained, since the data produced by the particle counter is based on the sample volume (particles per milliliter). These factors necessitate that a proper maintenance schedule be followed to ensure maximum performance.

If adequate system pressure is available, the constant head overflow weir will maintain an accurate flow rate through the sensor. If this is achieved, flow problems will only be caused by clogging of the flow cell or fouling of the tubing and barb fittings. Obviously, the more turbid the sample, the more likely clogging / fouling will occur. If raw water is being sampled, it is recommended that a small mesh strainer be placed in line before the sensor to catch debris. The mesh screen should be sized to be slightly smaller than the flow cell size. It is usually not necessary to use a strainer on settled water, as particles as large as 1mm will not be hard enough to lodge in the flow cell. Filtered water rarely causes problems, and those are usually related to backwashing. Occasionally a piece of rust or a small foreign object will come through the sample line.

Several methods may be used to clear a clogged flow cell. One of the most effective tools is a small can of compressed air (available at Radio Shack or most hardware stores). Remove the tubing from both sides of the flow cell and blow the air through the flow cell from the top of the flow cell (opposite direction

from the flow). If compressed air is not available run the liquid sample in from the top of the flow cell and increase the flow rate. It is generally not advisable to use the cleaning brush to unclog the flow cell, as the brush can be torn up. The flow cell windows are sapphire, which is scratch resistant, but it is not recommended that pieces of wire or other objects be used to clear clogs. Once the clog is removed, a light can be shined through the sensor to allow visual inspection. The flow cell opening is large enough to see through when clear.

NOTE

Prior to connecting the sensor, the sample line should be flushed thoroughly. Failure to do this is a common cause of clogged sensors.

Routine cleaning of the flow cell should be performed after clearing a clog as well as on a regular basis. How often the flow cell should be cleaned will vary from plant to plant. The cell condition is monitored by the particle counter electronics, and can be used as an indication of when cleaning is necessary. A drop of 10 to 15% in the value of the cell condition indicates that cleaning should be performed.

NOTE

The particle counter can still count particles with a dirty flow cell, but the accuracy be diminished.

Any standard laboratory cleaner can be used to clean the flow cell. If iron or manganese buildup is a problem, vinegar, or another slightly acidic liquid, can be used. Manganese or iron buildup will affect other instruments in the plant, and any effective cleaner for those instruments should work with the particle sensor as well. The cleaner can be flushed through the flow cell, or applied using the cleaning brush. The sapphire window material and the external flow cell design make brush cleaning a safe and effective method for removing tough contaminants. Whether brush cleaning is necessary will be determined by the individual water system.

3.4.1 Non-brush Cleaning

Fill a large syringe with cleaner (diluted to 1 or 2% with deionized water) and attach it to the top flow cell barb with a short piece of tubing (See Figure 22). Squeeze the syringe to introduce the cleaner into the sensor and let it sit for a few minutes and then inject some more and let that stand a few more minutes. Finally, force the remaining cleaner rapidly through the flow cell. The rapid flow should remove most buildup that has occurred in the sensor and bring the cell condition back up to an acceptable level. Non-brush cleaning is not a replacement for cleaning with a brush, but it useful when you don't have a brush on hand.

3.4.2 Brush Cleaning

Apply a couple of drops of diluted cleaner to brush and insert brush from top of sensor until it rests snugly in the flow cell (See Figure 23). Turn the brush a couple of times and remove.

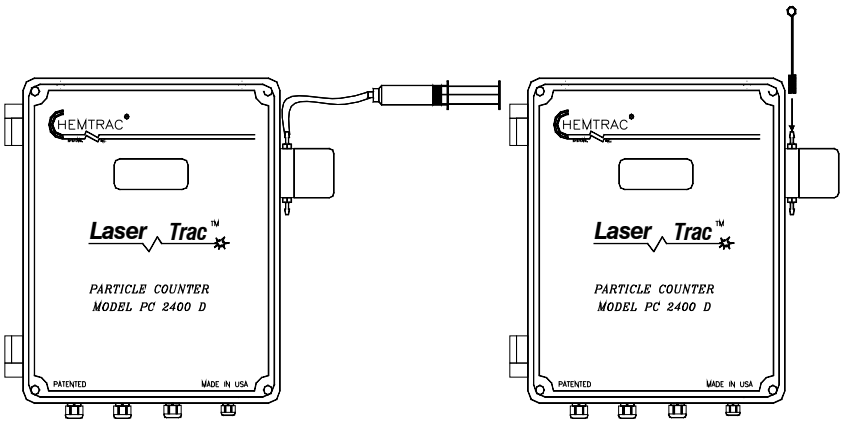


FIGURE 22. Non-Brush **FIGURE 23. Brush**

NOTE

The small size of the brush makes it easy to bend or damage. Do not force the brush into the flow cell. It should fit into the flow cell with light pressure.

Once cleaning has been performed, reattach flow lines and allow a minute or so for the flow cell to flush out. Verify that the cell condition indicator is close to full value. If it is not, repeat the procedure.

NOTE

The cell condition indicator is not valid if water is not flowing through the flow cell.

TROUBLE SHOOTING PROCEDURE (verification procedure)

1. Clean the sensor per operations manual using brush supplied by Chemtrac **PART # 06578.** Connect approx. three (3) feet of **NEW**, **CLEAN**, tubing to the sensor **INLET** & one (1) foot to the **OUTLET.**
2. Set a 1-gallon (2-4 liter) bottle of **DISTILLED** water (purchased from local store) on top of the particle counter, remove cap, & insert tubing to approx. ½ the bottle depth.
3. Start siphon through the sensor by applying suction to the outlet tubing. Sample flow should be approximately **100ml/min.** Be sure there are no kinks in the tubing or blockages in the sensor inlet/outlet fittings. (Flow will decline as the bottle empties, but isn't important for purpose of this test.) Total particle count, **2 microns & higher**, should be 5-50 per ml, after 5-10 min.
4. Stop sample flow. Counts should be **zero (0)** in all size channels.

If **DISTILLED water isn't available, water prepared by reverse osmosis filtration is acceptable.

SECTION 4.0 DIAGRAMS

CAUTION!

The sensor optical alignment is very sensitive to vibration. Avoid installation in locations with high amounts of vibration. If drilling of enclosure is necessary, please contact the factory for guidance.

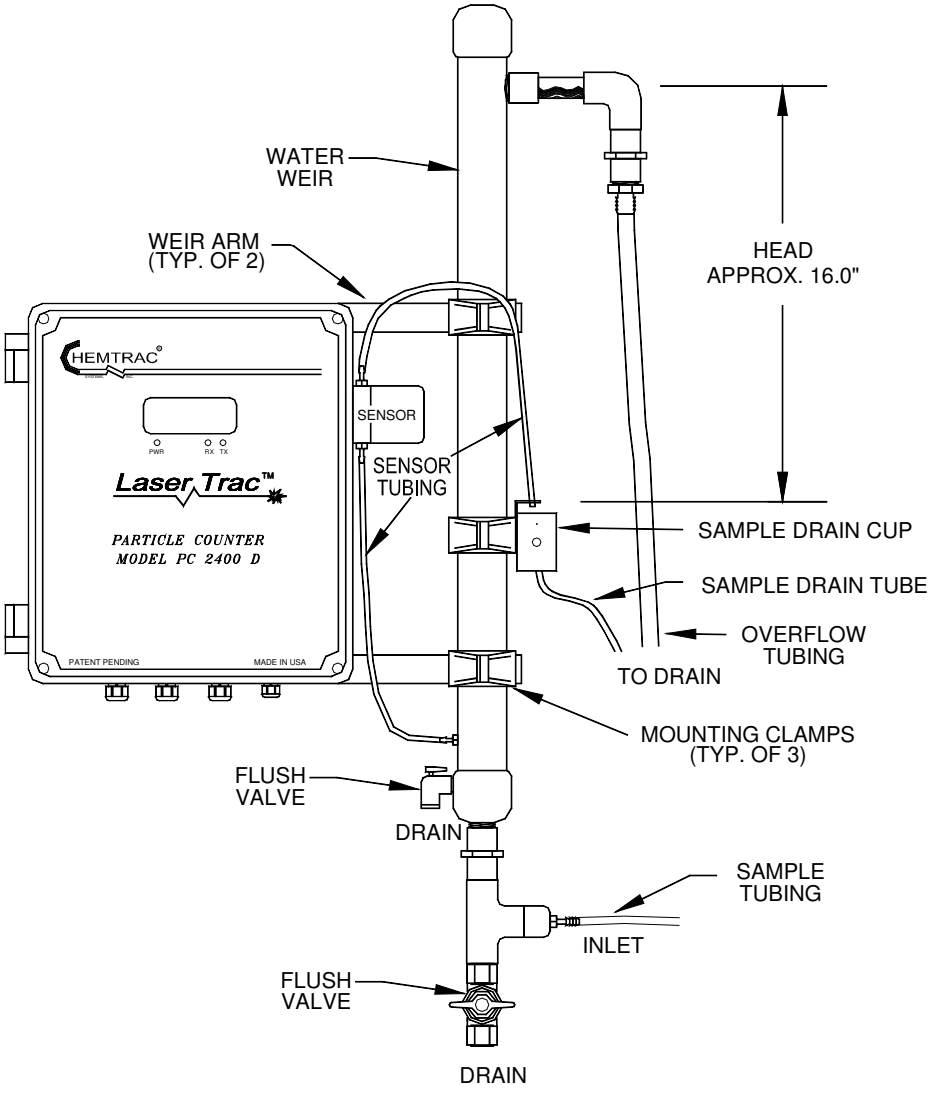


FIGURE 24. System Components

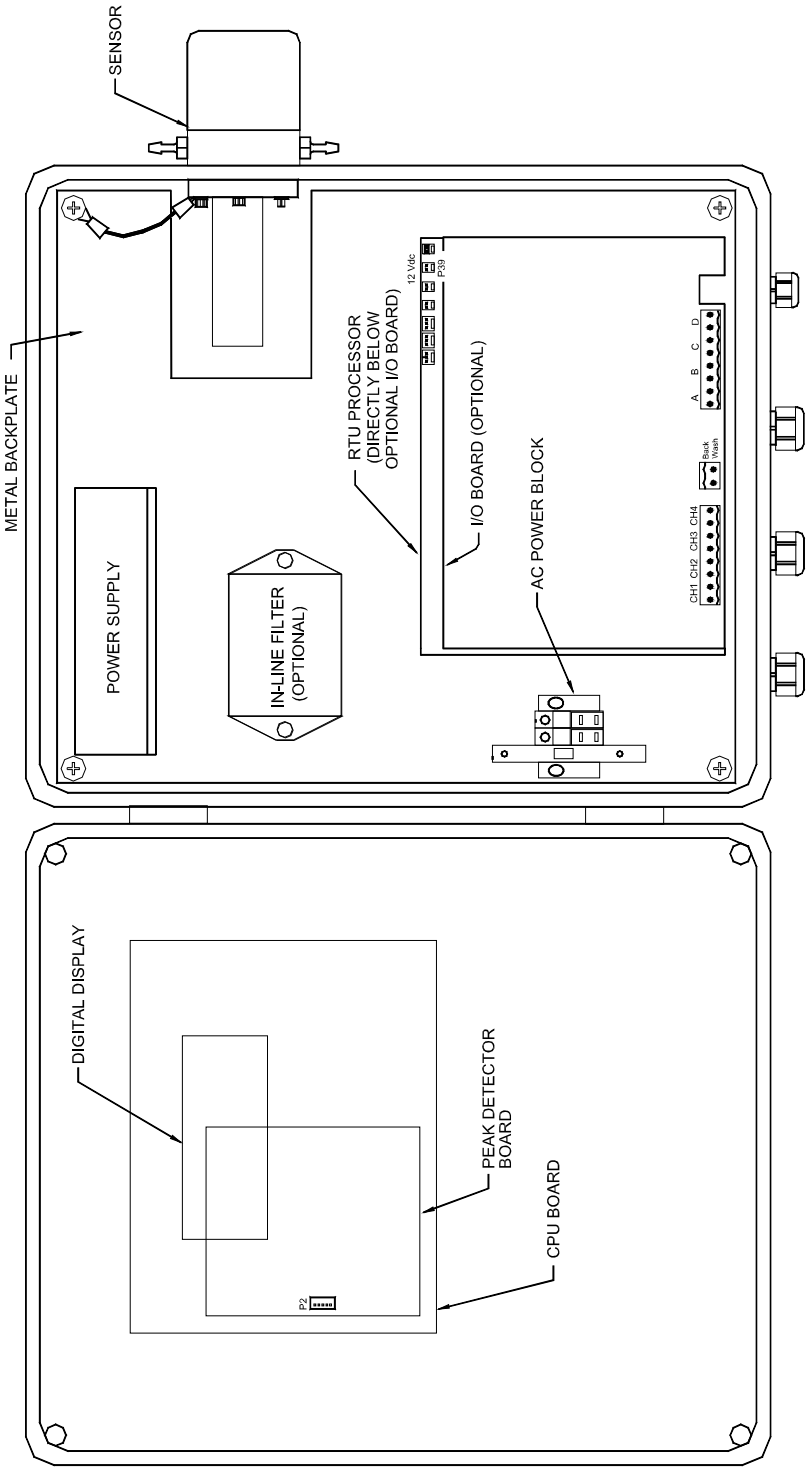


FIGURE 25. Internal Components
(Shown with Optional I/O Board)

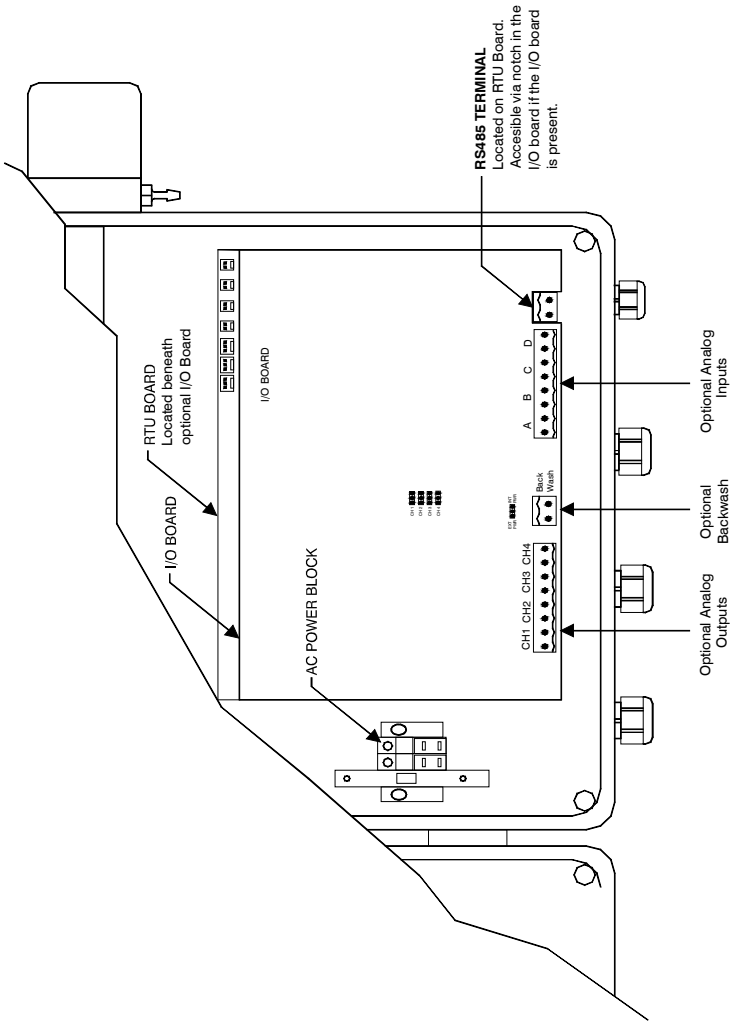


FIGURE 26. External Wiring Connections
(Shown with Optional I/O Board)

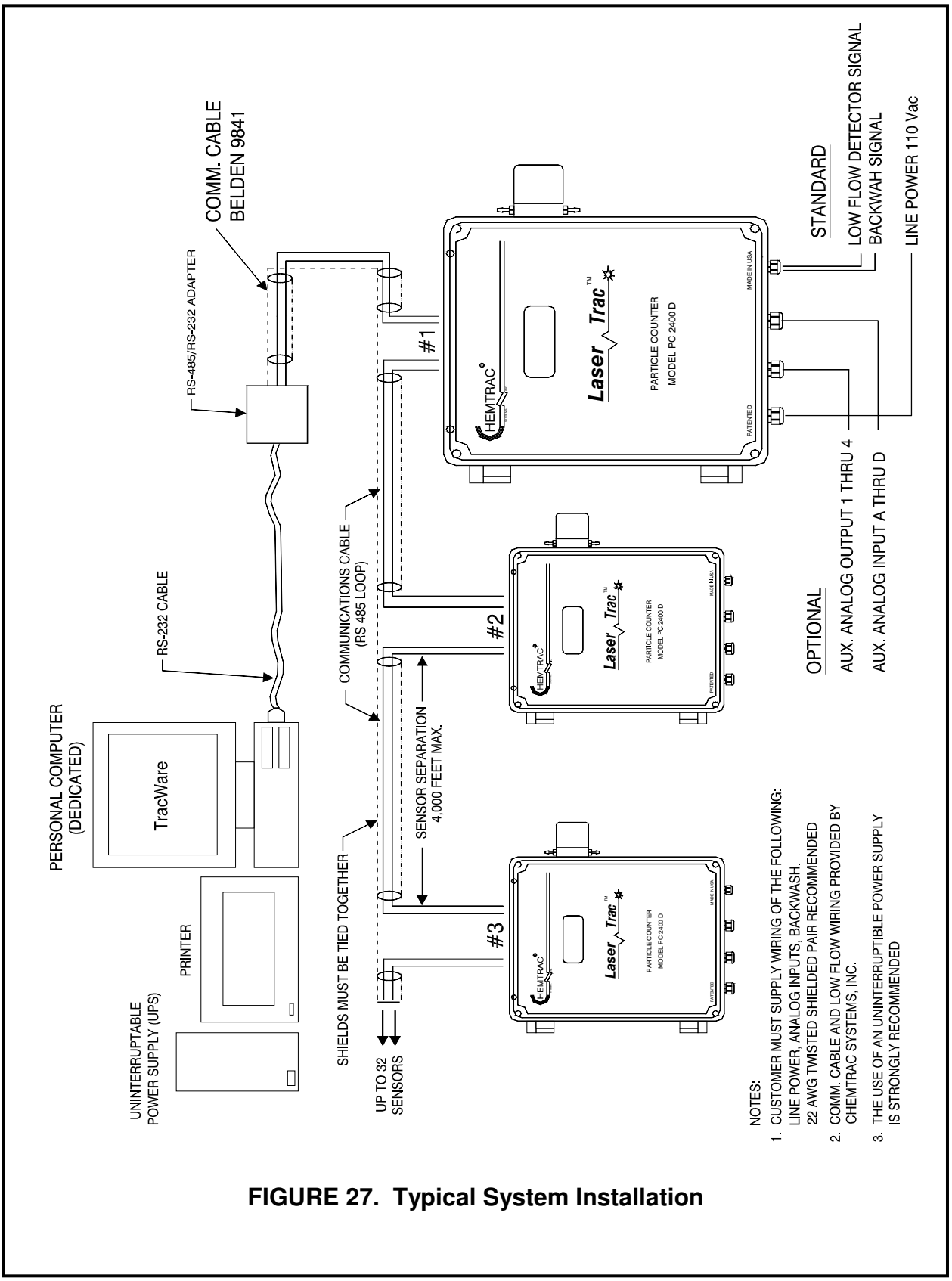


FIGURE 27. Typical System Installation

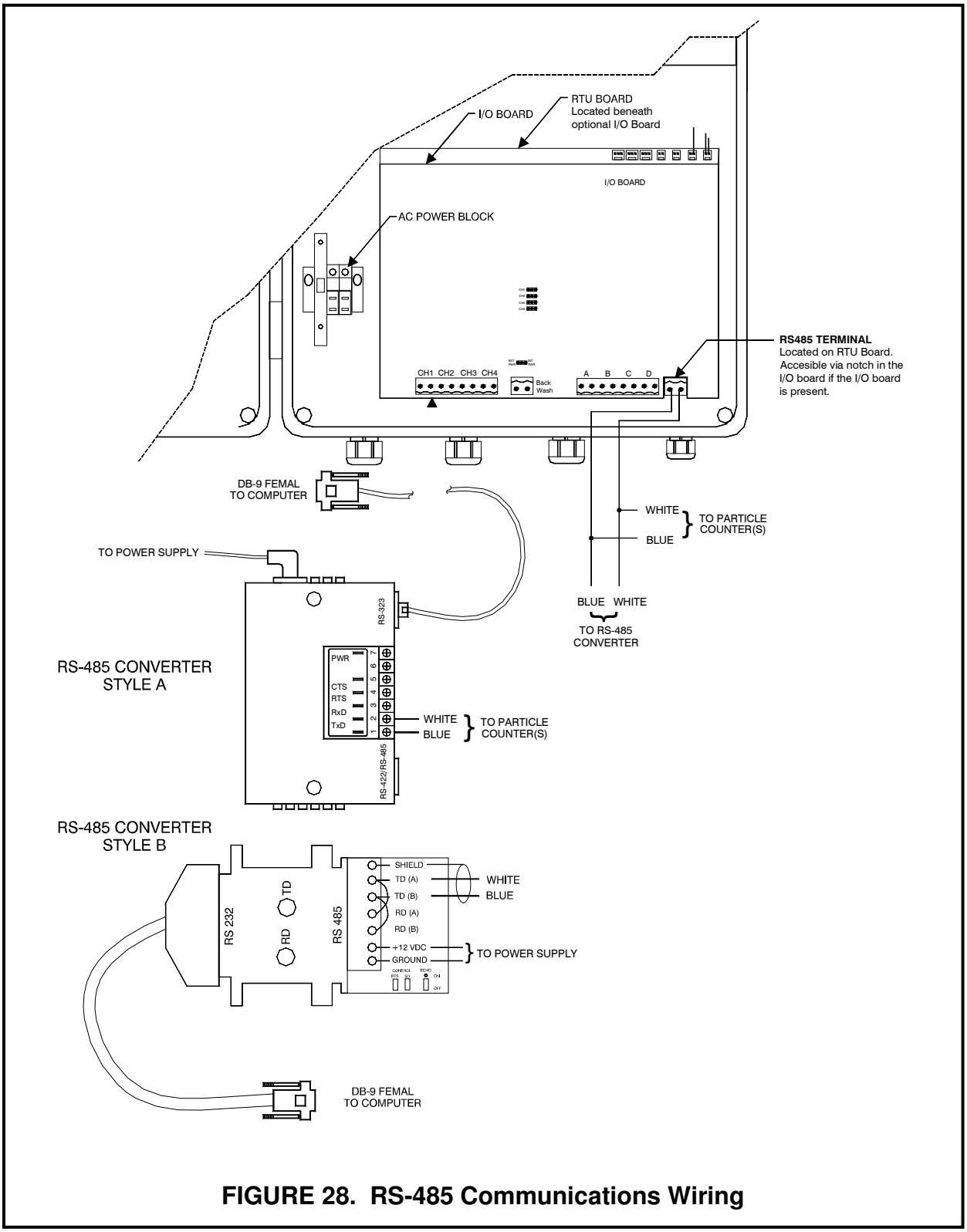


FIGURE 28. RS-485 Communications Wiring

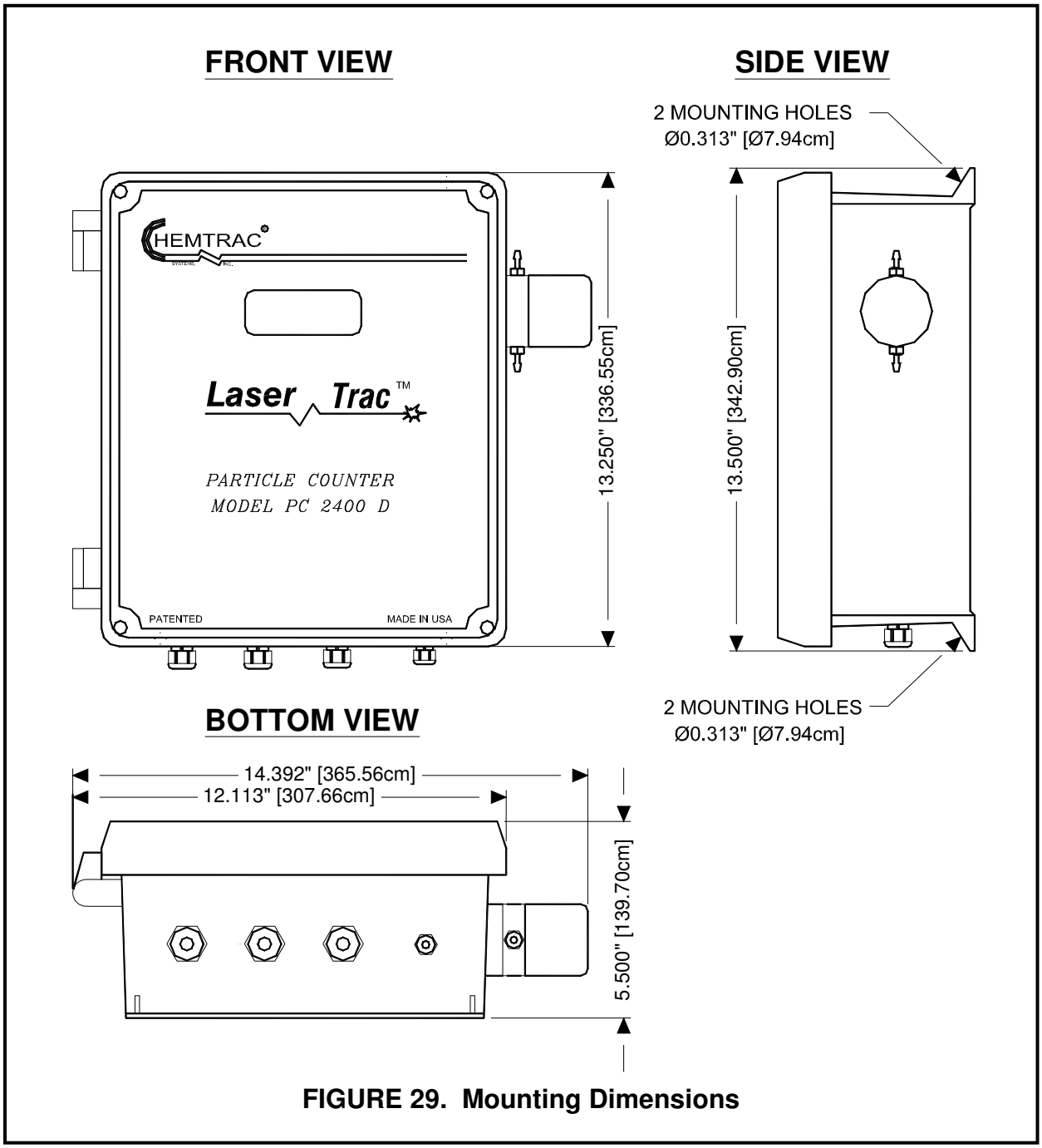


FIGURE 29. Mounting Dimensions

CAUTION!

The sensor optical alignment is very sensitive to vibration. Avoid installation in locations with high amounts of vibration. If drilling of enclosure is necessary, please contact the factory for guidance.

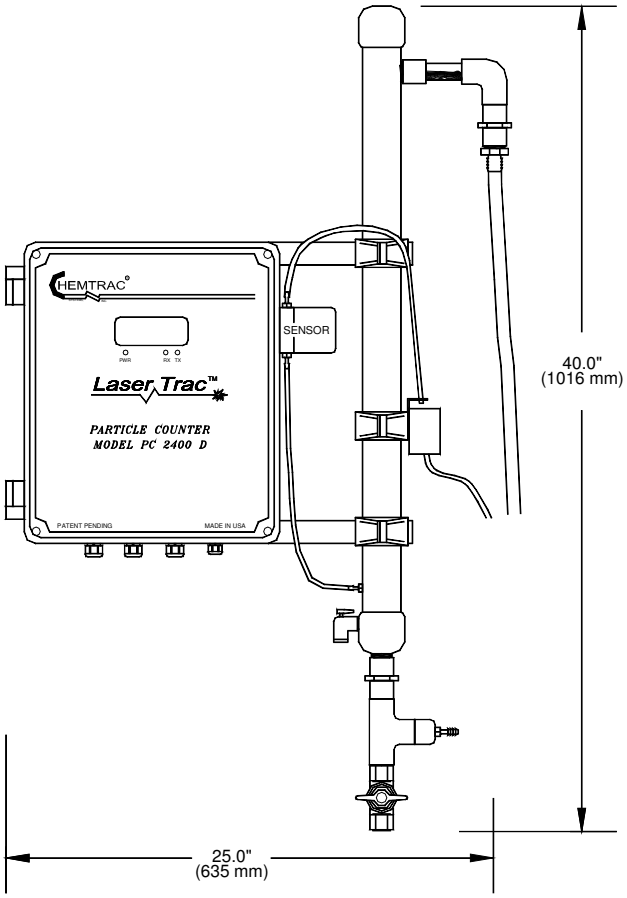


FIGURE 30. Mounting Dimensions

CAUTION!

The sensor optical alignment is very sensitive to vibration. Avoid installation in locations with high amounts of vibration. If drilling of enclosure is necessary, please contact the factory for guidance.

SECTION 5.0 SPARE PARTS LIST

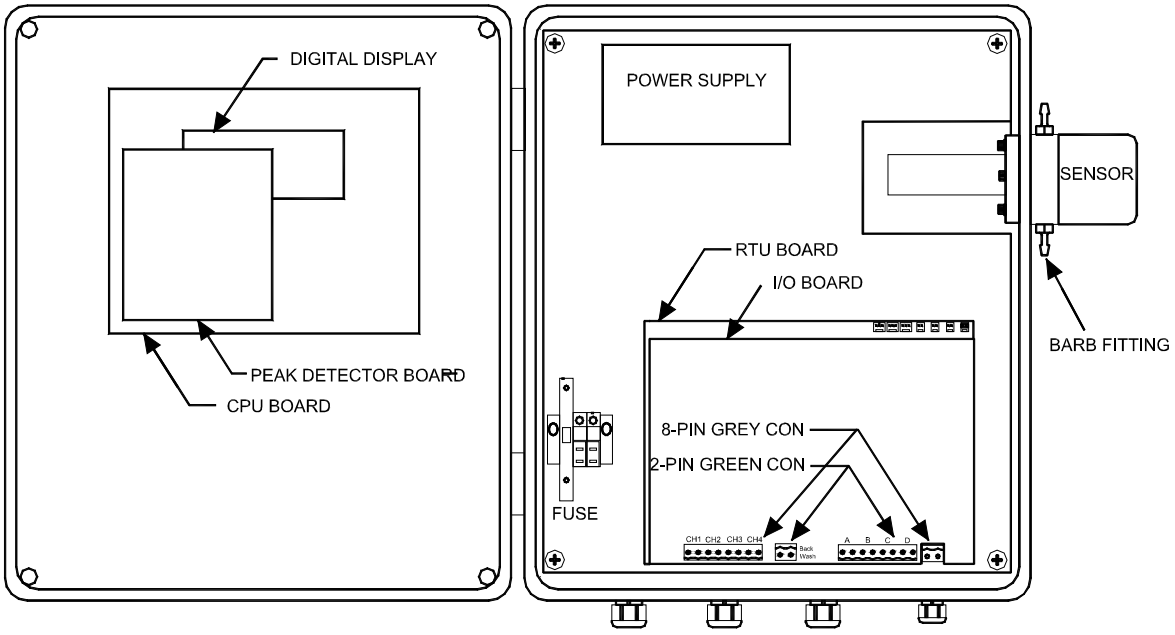


FIGURE 31. Parts Location

Part #	Qty.	Description
11360	1	CPU Board
11380	1	Peak Detector Board
11370	1	RTU Board
11395	1	I/O Board
9940	2	Barb Fitting
11671	6	Two Pin Shunt Jumper
4307	1	1 Amp Fuse
9850	1	RS-232 Comm Cable Ass.
11000	1	Water Weir (see Figure 12)
11682	2	Two Pin Green Connector
11655	2	Eight Pin Grey Connector

5.1 RECOMMENDED SPARE PARTS

Part #	Qty.	Description
11420	50ft	Sample Tubing
9940	10 (1pkg)	Barb Fitting
4307	10	1 Amp Fuse
9930	5	Sensor Cleaning Brush

5.2 ORDERING SPARE PARTS

To place an order for spare parts you may either call, e-mail, or fax Chemtrac Systems Inc. directly or contact your local distributor or representative. The following information should be included in the your request; model number and serial number of Particle Counter, part number(s), qty, and description of parts needed. Pricing and availability are available upon request.

Normal lead-time in stock parts is 1 to 2 days.

Chemtrac Systems Inc.
6991 Peachtree Industrial Blvd. Building 600
Norcross GA 30092

Ph: Inside US 1-800-442-8722, 770-449-6233
Fx: 770-447-0889
e-mail: chemtrac@chemtrac.com
www.chemtrac.com

Addendum

PC2400D Particle Counter with Cell Condition Output Option

The **PC 2400 D** is available with an analog output to allow remote monitoring of the cell voltage level. The **PC 2400 D** with cell voltage output option is equip with a voltage-rescaling module (See Figure 32). The voltage-rescaling module is provided to convert the cell voltage of 0 to 3.8 to 4 to 20 mA DC output signal.

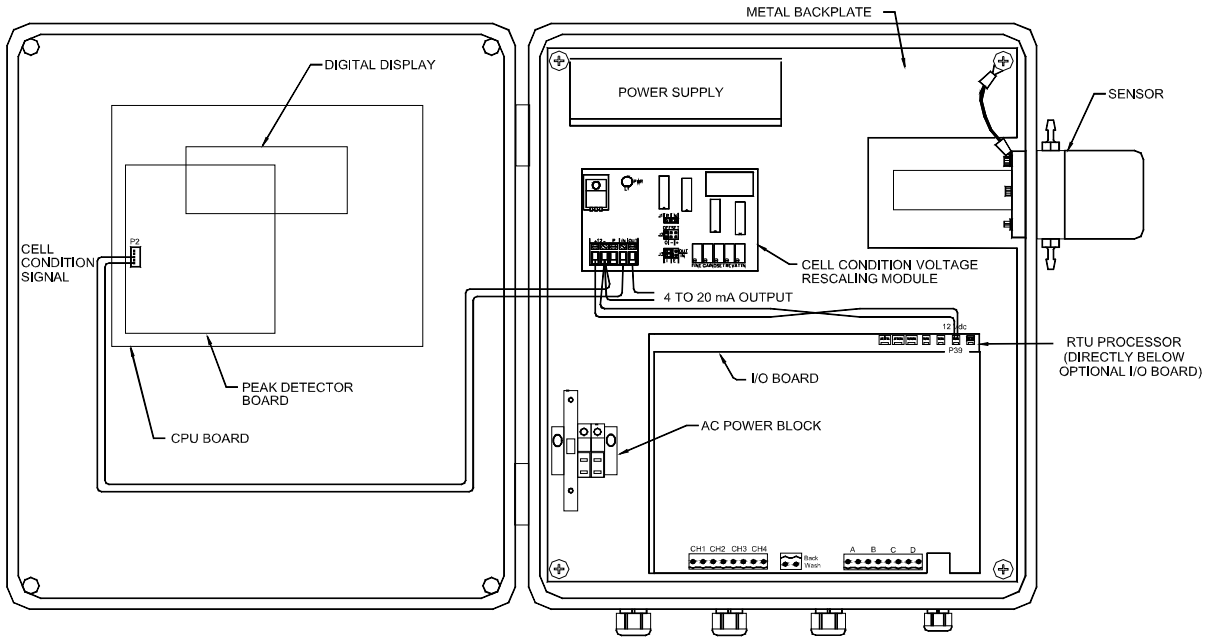


FIGURE 32. Voltage-Rescaling Module

No field calibration required for the voltage-rescaling module. The field connection of the voltage-rescaling module for the 4 to 20 mA output is between “-24“ and “OUT” terminals, see Figure 33 below.

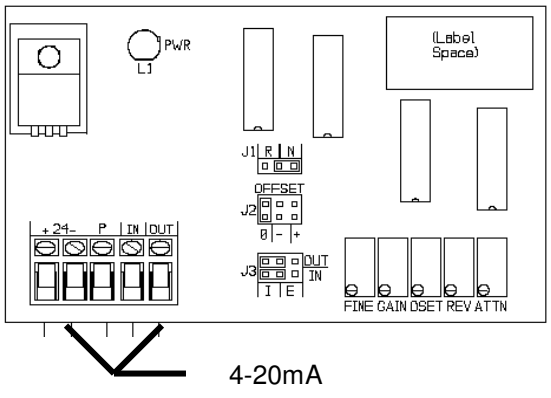
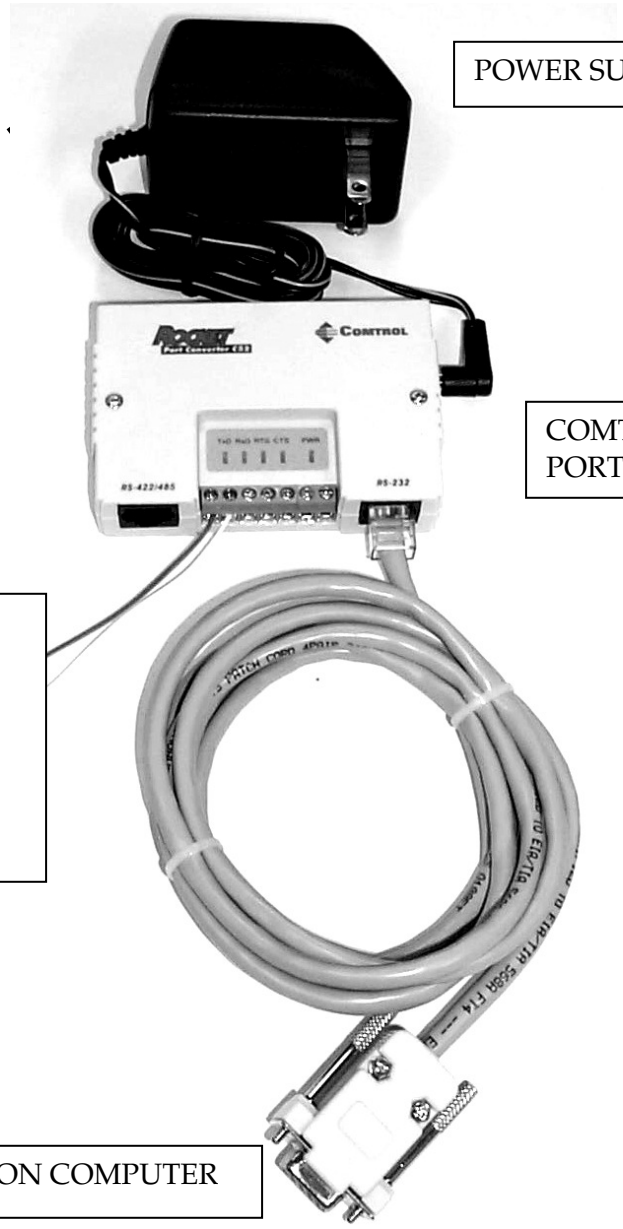


FIGURE 33. Analog Output Connection

PC2400D COMMUNICATION KIT



POWER SUPPLY

COMTROL ROCKET PORT CONVERTER

TO PC2400D RS-485 COMMUNICATION.

WIRE CONNECTION:

- BLUE OR BLACK WIRE TO PIN 1
- WHITE TO PIN 2

TO RS-232 COMM PORT ON COMPUTER

ERROR: undefined
OFFENDING COMMAND:

STACK: