Instruction Manual
PN 51-PC1/rev.A
March 2002

Model PC-1

On-line Particle Counter

ROSEMOUNT® Analytical

EMERSON™ Process Management

ESSENTIAL INSTRUCTIONS
READ THIS PAGE BEFORE PROCEEDING!

Rosemount Analytical designs, manufactures, and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using, and maintaining Rosemount Analytical products. Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product. If this Instruction Manual is not the correct manual, telephone 1-800-654-7768 and the requested manual will be provided. Save this Instruction Manual for future reference.
- If you do not understand any of the instructions, contact your Rosemount representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- Install your equipment as specified in the Installation Instructions of the appropriate Instruction Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Rosemount. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look alike substitutions may result in fire, electrical hazards, or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

DANGER
HAZARDOUS AREA INSTALLATION

This sensor is not Intrinsically Safe. or Explosion Proof. Installations near flammable liquids or in hazardous area locations must be carefully evaluated by qualified on site safety personnel.

To secure and maintain an intrinsically safe installation, an appropriate transmitter/safety barrier/sensor combination must be used. The installation system must be in accordance with the governing approval agency (FM, CSA or BASEEFA/CENELEC) hazardous area classification requirements. Consult your analyzer/transmitter instruction manual for details.

Proper installation, operation and servicing of this sensor in a Hazardous Area Installation is entirely the responsibility of the user.

CAUTION
SENSOR/PROCESS APPLICATION COMPATIBILITY

The wetted sensor materials may not be compatible with process composition and operating conditions. Application compatibility is entirely the responsibility of the user.

WARNING

This product is not intended for use in the residential, commercial or light industrial environment per CE certification to EN50081-2.

Emerson Process Management

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SAFETY

In order to provide maximum user safety the PC-1 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 PC-1 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.

MODEL PC-1
ON-LINE PARTICLE COUNTER

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SECTION 1.0
DESCRIPTION AND SPECIFICATIONS

- 2 μm DETECTION LIMIT at a 3:1 signal-to-noise ratio.
- DYNAMIC RANGE: 2 - 400 μm
- EIGHT USER-SELECTABLE SIZE CHANNELS allow maximum measurement flexibility.
- CONSTANT HEAD OVERFLOW SAMPLER ensures constant flow rate and reproducible particle counts.
- LARGE EXTERNAL FLOW CELL minimizes clogging and eliminates potential damage to instrument from leaking sample.
- FOUR-LINE DISPLAY shows size range, counts/mL, operating mode, and sample number.
- USE WITH TRACWARE SOFTWARE to display trends, prepare reports, and do calculations.
- MULTI-DROP UP TO 32 PARTICLE COUNTERS on a single RS485 loop.
- FOUR ANALOG INPUTS accept flow, turbidity, etc. data from other analyzers.
- FOUR ANALOG OUTPUTS proportional to particle counts in first four channels.

1.1 FEATURES AND BENEFITS

Rosemount Analytical Model PC-1 on-line Particle Counter 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 and 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 Model PC-1 uses a light blockage volumetric method to determine particle count. The light source is an infrared laser diode. The signal-to-noise ratio is better than 3:1 at 2 μm, and the dynamic range is 2 to 400 μm. The coincidence limit at 15,000 particles/mL is less than 10%.

The analyzer features an entirely external sampling and measurement system. There is no danger of sample leaks damaging sensitive electronic components. The constant head overflow cup ensures stable reproducible flow and accurate particle counts. The large (1 mm x 1 mm) flow cell is easy to clean and resists clogging.

Using Tracware digital interface with the Model PC-1 is strongly recommended. Tracware lets the user customize particle size ranges, change sampling duration and frequency, plot trends, and prepare reports. Tracware runs on Windows 3.1, Windows 95/98, or Windows NT. The user must provide the personal computer for running Tracware. For direct connection to a SCADA system, DDE and OPC servers with client software are available on the same disk with Tracware.

Digital communication is through a non-proprietary serial interface. Thirty-two particle counters can be multi-dropped on a RS485 serial communications loop. The maximum network length is 4000 ft.

The Model PC-1 has four 0-5 VDC inputs, which can accept data from turbidity analyzers, flowmeters, etc. The PC-1 also has four 4-20 mA outputs that are assigned to the first four size channels. Three jumper-selectable size ranges are available. A backwash terminal is available to alert the user that a filter backwash is occurring.

1.2 SPECIFICATIONS

GENERAL

Electronics Enclosure: Polycarbonate, NEMA 4X

Overall Dimensions: H 36 inch, W 22 inch, D 6 inch (H 914 mm, W 559 mm, D 153 mm)

Mounting: Wall

Ambient Temperature: 32 to 122°F (0-50°C)

Humidity: 20 to 85% (non-condensing)

Power: 100 to 240 VAC, 50 to 60 Hz, 0.5 A

Flow cell dimensions: 1 mm x 1 mm

Wetted materials (overflow sampler): PVC

Wetted materials (sensor): Sapphire sensor windows, Nituff®-coated aluminum walls

Total Weight: 14.5 lb (6.6 kg)

Total Shipping Weight: 18 lb (8.5 kg). Analyzer is shipped in two packages.

RFI/EMI: EN-50081-2
EN-50082-2
LVD: EN-61010-1

SAMPLE REQUIREMENTS

Temperature: 32 to 122°F (0 to 50°C)

Pressure (maximum): 120 psi (8.3 bar)

Flow: 300 to 1000 mL/min, (overflow sampler maintains 100 mL/min sample flow to sensor)

Minimum Sample Head: 20 in. (508 mm) of water

Inlet Fitting: Barbed fitting accepts ¼ in. ID soft plastic tubing

MEASUREMENT

Method: Light blockage, volumetric

Light Source: Laser diode (780 nm, 3mW)

Detector: Photodiode

Dynamic Range: 2 to 400 nm

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 a personal computer running Tracware.

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 (factory calibration recommended)

INPUTS

Function: The PC-1 accepts up to four output signals from other analyzers.

Range: 0 to 5 VDC (For instruments providing a 4 to 20 mA output, use a 250 Ω input resistor.)

OUTPUTS

Number and range: Four, 4 to 20 mA, assigned to first four size channels

Maximum load: 600 Ω

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 shows that the filter is in backwash.

Power: Internal or external (3 to 32 VDC)

TRACWARE COMPUTER REQUIREMENTS

Operating system: Windows 3.1, Windows 95/98, or Windows NT

Computer: IBM-compatible 486DX 33 or better; 8 megs of RAM, 250 megs of hard drive space, 3.5 in. floppy drive.

DIGITAL COMMUNICATIONS

Serial Communication: Non-proprietary

Serial Standard: RS485. RS485 to RS232 interface kit must be ordered separately.

Maximum network length: 4000 ft (1220 m)

Maximum number of analyzers on network: 32

Nituff is a registered trademark of Nimet Industries.

1.3 ORDERING INFORMATION

The Model PC-1 on-line particle counter includes the electronics module, sensor, constant flow weir sampler, and connecting tubing. Tracware particle counting software and the RS485/RS232 interface must be ordered separately. The user must also provide a personal computer. (See **TRACWARE COMPUTER REQUIREMENTS**). For maximum flexibility, the use of Tracware with the Model PC-1 is strongly recommended.

MODEL PC-1	ON-LINE PARTICLE COUNTER
Code	**Description**
PC-1	On-line particle counter, complete with electronics module, sensor, and constant flow sampler.

ACCESSORIES

PN	Description
9160539	Tracware software
9160540	RS485/RS232 interface kit, includes converter, cable, and 12 Vdc power supply

SECTION 2.0 GENERAL OVERVIEW

2.1 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.

2.2 BASIC OPERATION

The Rosemount Analytical Model PC-1 particle counter is designed to count and "size" (i.e. sort by size) particles ranging from 2 to 400 microns in diameter. 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.)

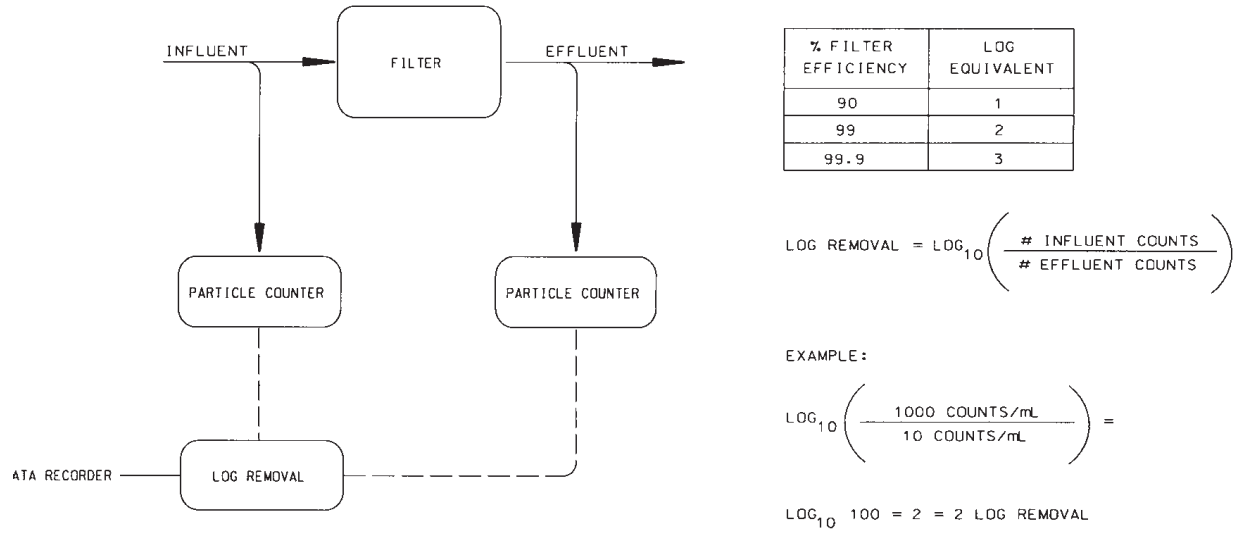
The sensor consists of an infrared laser diode, a light detector, and two transparent "windows". The detector converts light energy into electrical voltage. The laser light is directed through both windows and on to the detector. Sample flow passes between the windows, so that any particles in the sample 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.)

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. (Figure 5.)

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

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 PC-1 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 PC-1 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 low flow detector up or down the weir assembly, which decreases or increases flow (head). One of the unique features of the Rosemount Analytical counter is that the output is directly converted into particles per milliliter. Particles per ml is the unofficial "standard" for reporting particle count data. Other flow rates may be used and are set via the computer interface. Only two or three feet of system head is needed to achieve 100 ml/min (See Figure 2).



% FILTER EFFICIENCY	LOG EQUIVALENT
90	1
99	2
99.9	3

FIGURE 1. Log Removal

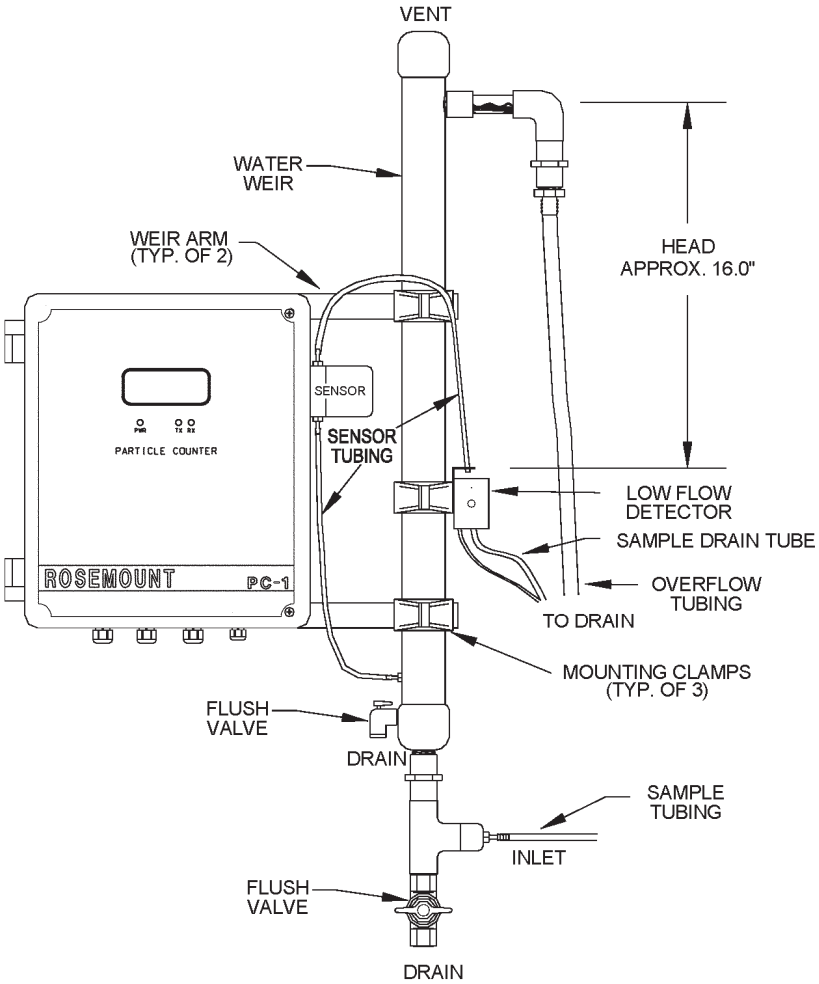


FIGURE 2. Weir Assembly

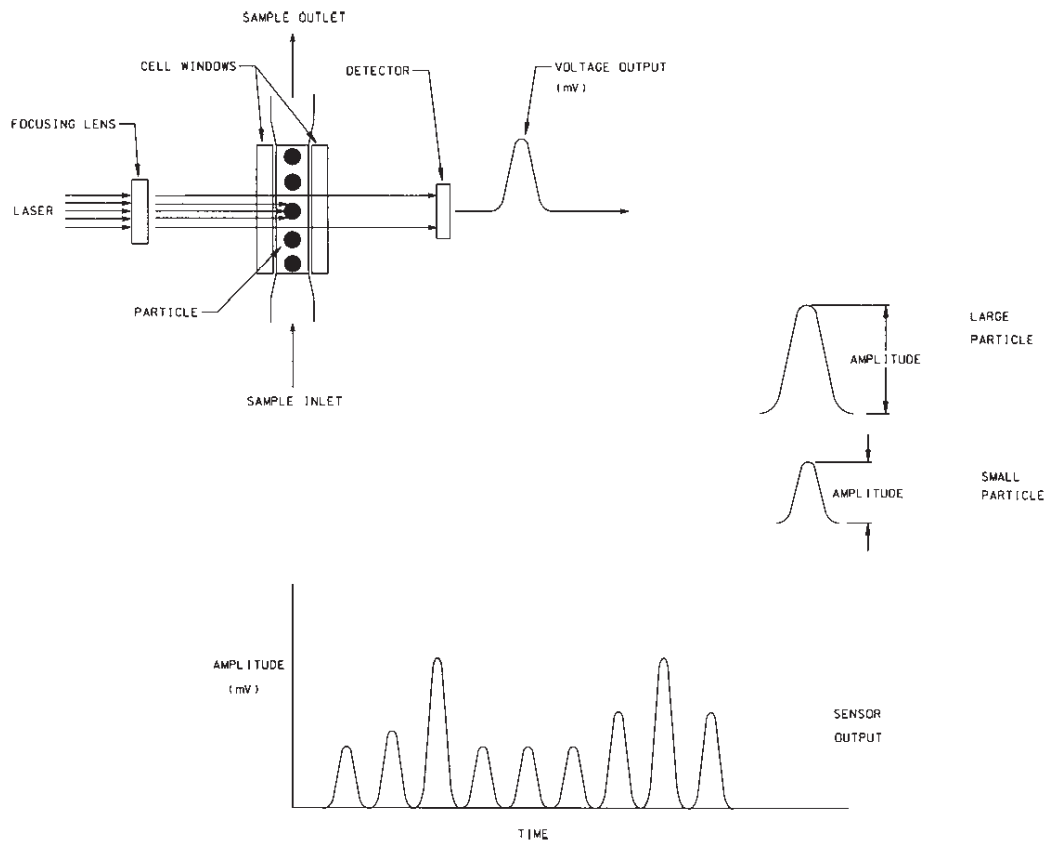


FIGURE 3. Laser Diagram 1

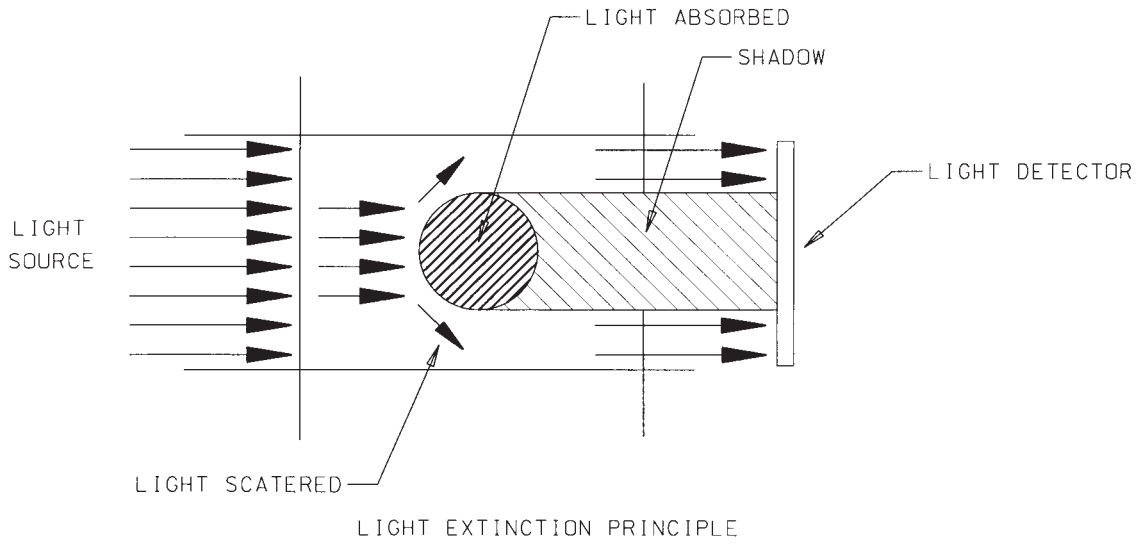


FIGURE 4. Laser Diagram 2

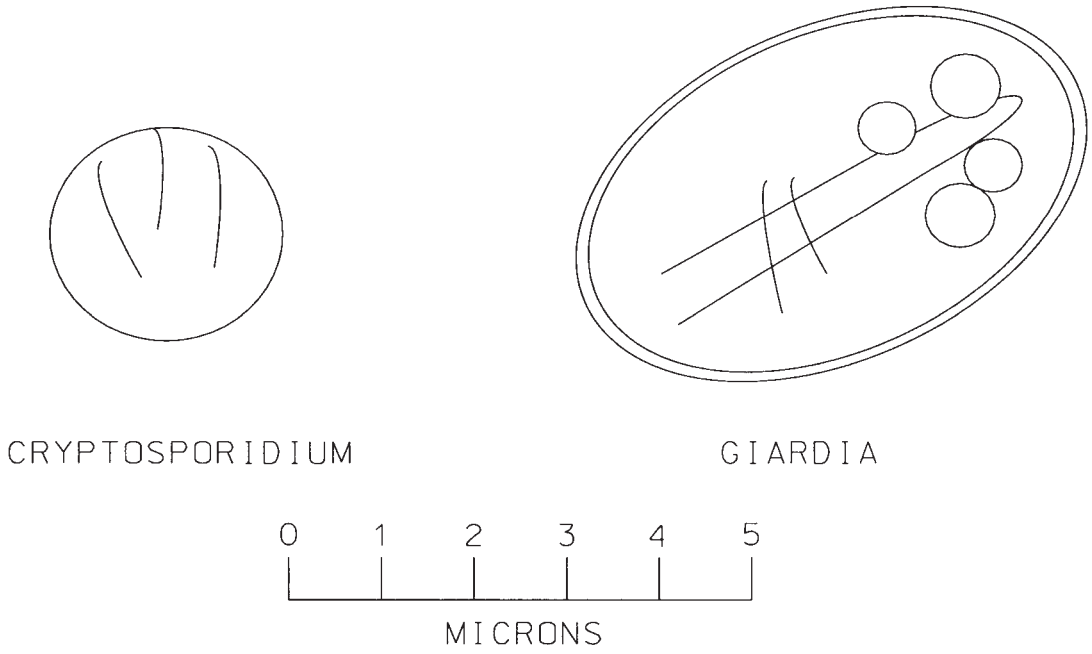


FIGURE 5. Particle Size Comparison

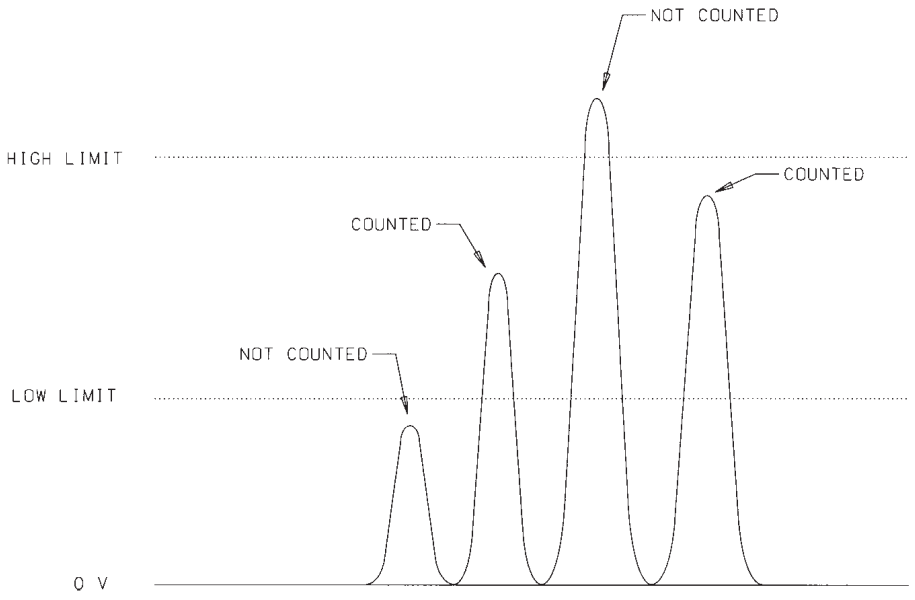


FIGURE 6. Pulse Amplitude

SECTION 3.0 MOUNTING AND INSTALLATION

3.1 MOUNTING

PC-1 should be permanently mounted in an upright position using the mounting holes on the back of the counter. See Figure 2 and Figure 7 for details.

3.2 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.

3.3 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.

1. Disable power circuit that supplies power to the unit.
2. During installation a local isolation point must be supplied.
3. Mount the PC-1 in the upright position (Rosemount Analytical logo upright) using the four mounting holes on the back of the unit. Unit may be fastened to mounting brackets, pipe stand or similar.
4. 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.

5. 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 live (hot) wire into the left terminal labeled "L1".
   - Insert the neutral wire into the right terminal labeled "N".

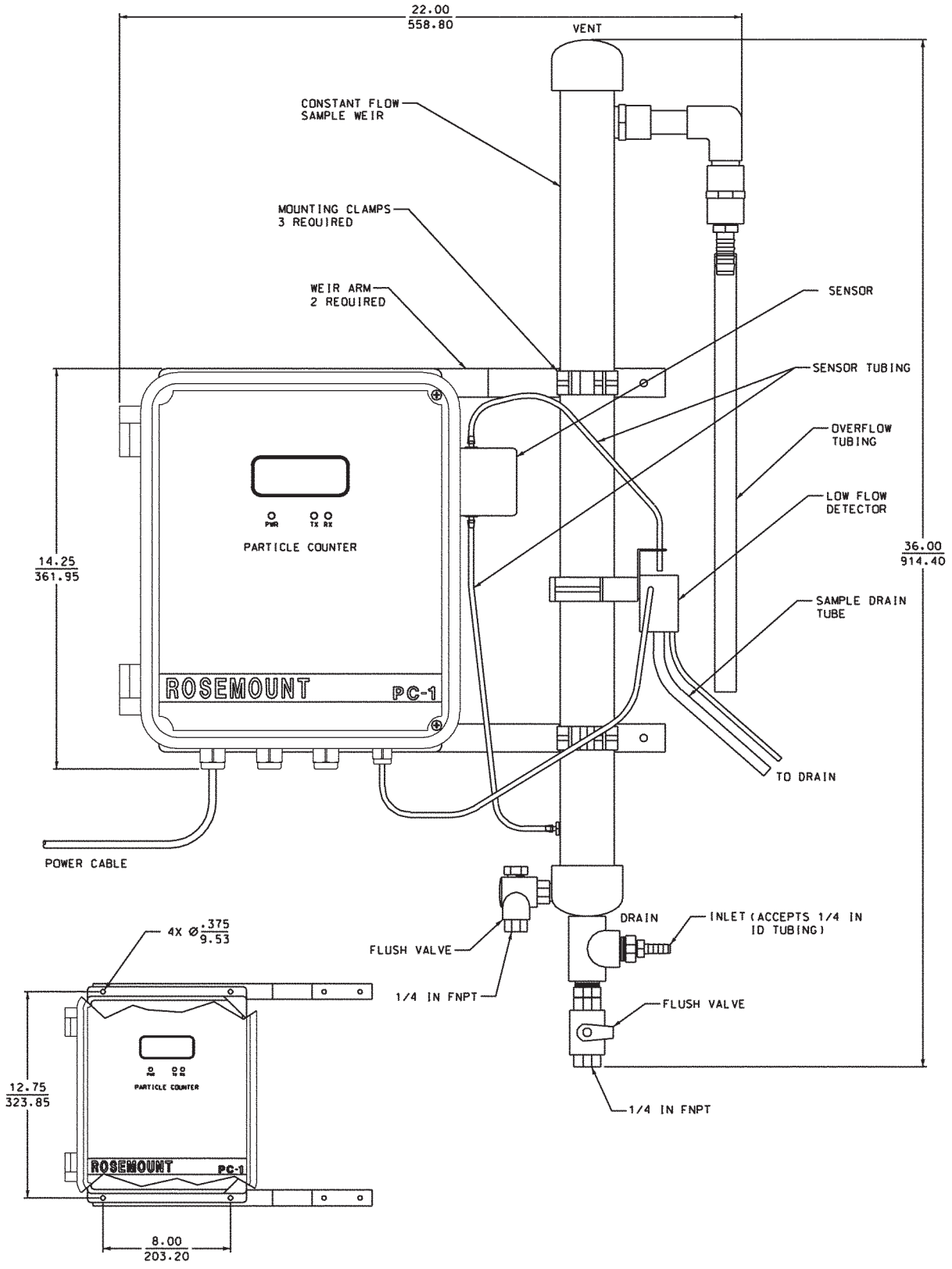


FIGURE 7. Dimensions: Model PC-1

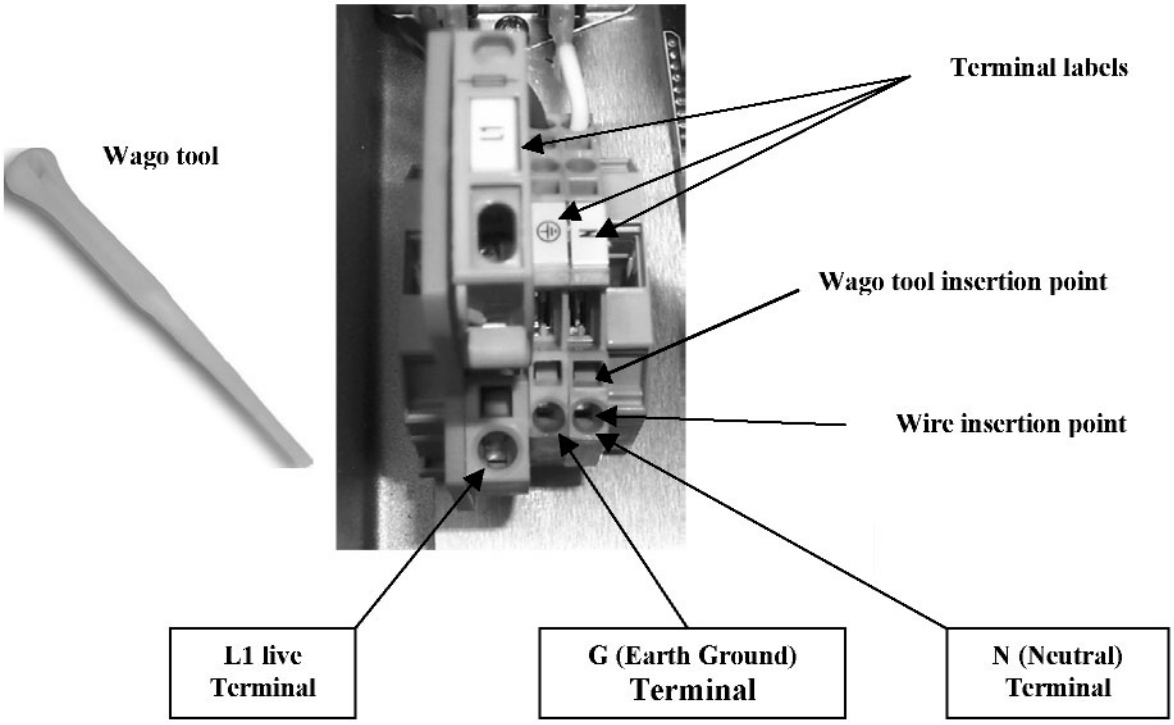


FIGURE 8. Power Terminal Block

To insert wires into terminals you must first insert the sharp end of the Wago tool 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 (see Figure 8 above).

3.4 CONFIGURING ANALOG INPUTS (OPTIONAL)

The PC-1 provides up to four auxiliary analog inputs. 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.

The analog inputs are designed to accept voltage inputs from 0 to 5 VDC. A 4 to 20 mA signal can be used by adding a 250 ohm resistor (See Figure 9). A 4 to 20 mA signal across a 250 ohm resistor will produce a 1 to 5 VDC input signal.

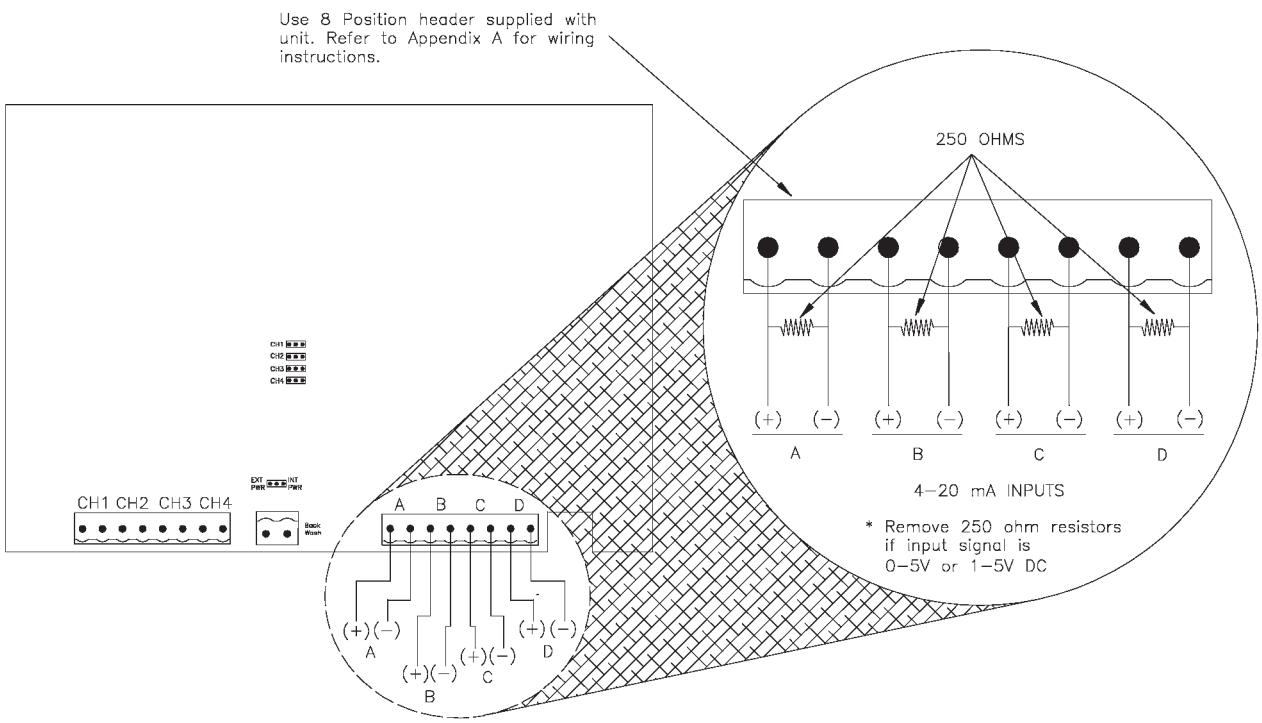


FIGURE 9. Analog Inputs

Configuration of the analog inputs requires a voltmeter, computer interface (Rosemount Analytical'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: Use the voltmeter to measure the analog signal when connected to the input terminals. Make sure that the voltage polarity is correct (See Figure 10). If a current signal is being used, make sure that the voltage drop across the input resistor corresponds to the expected value. Verify that the instrument produces the proper output signal as specified in the manual for that instrument. Some instruments can be programmed to put out minimum and maximum scale values to aid in configuration.

Step 2: Once the input signal to the particle counter has been verified, proceed with the instructions in the software manuals for configuring auxiliary inputs. The Traccomm utility will display the voltages on these inputs directly. The Tracware software requires scaling for the measured units and range, i.e., 0 to 1 NTU. Since most instruments provide 1 to 5 volt outputs (either directly or via 4 to 20 mA), and the particle counter is scaled for 0 to 5 volts, the Tracware software must be configured to take this into account. Setting the minimum scale value in Tracware to -25% of the maximum scale value does this. For example, a 0 to 1 NTU range would be set to a minimum value of -0.25 and a maximum value of 1 in Tracware software. A 0 to 500 GPM range would be set from -125 to 500. This is done in order to place the zero point at 1 volt.

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.

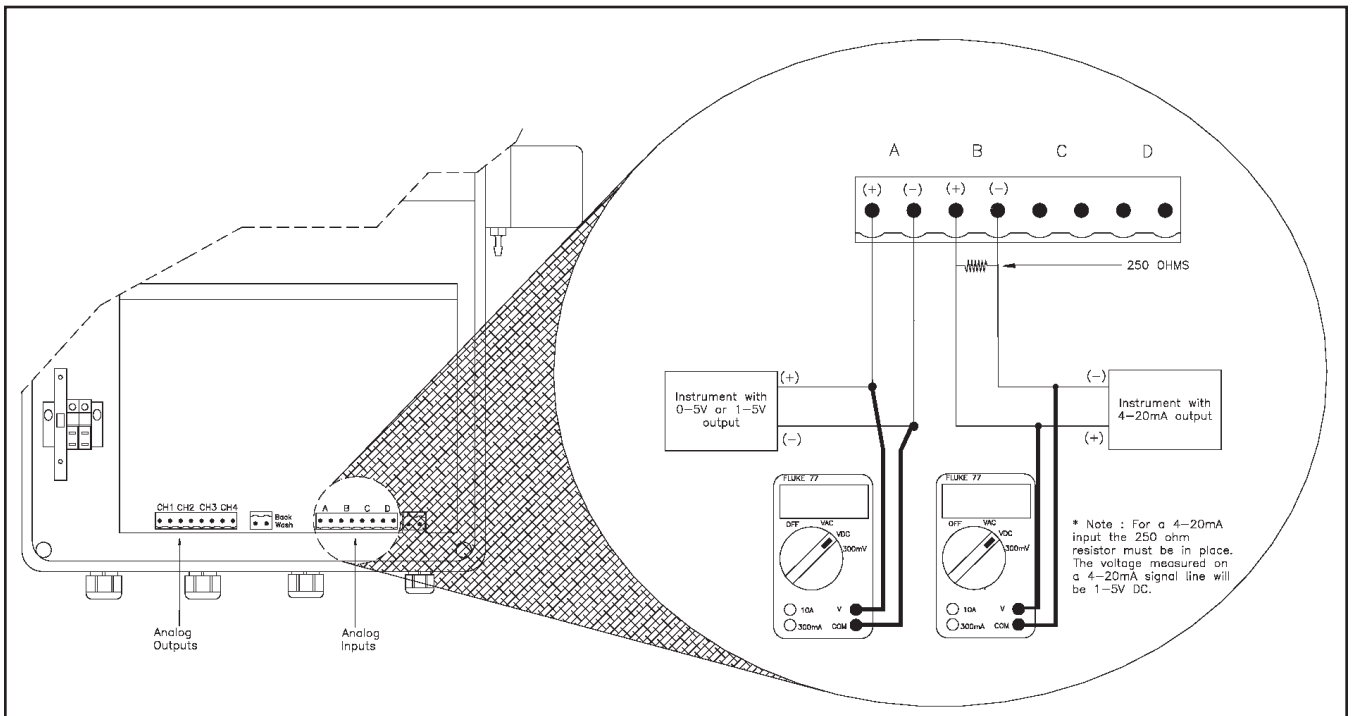


FIGURE 10. Analog Input Voltage Check

3.4.1 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 configured 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 resistors.

When choosing between voltage and current output, it is best to use current output unless the instrument is within a few feet of the particle counter. Current signals are more immune to noise pickup, and can be run over long distances without signal loss.

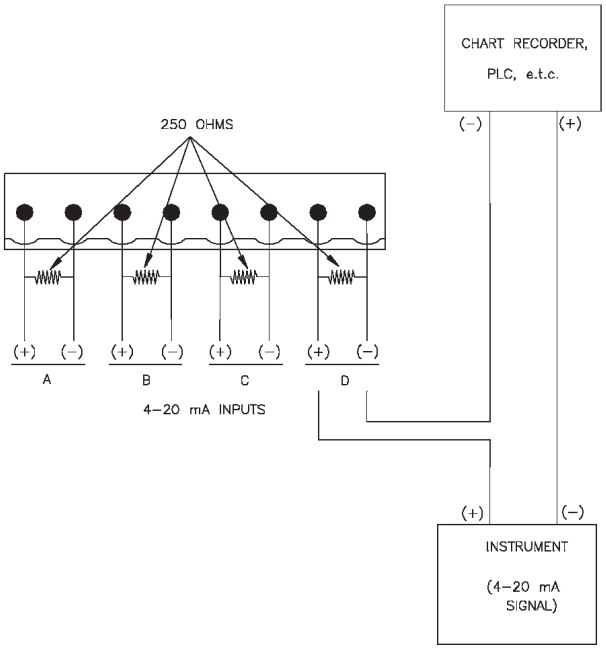


FIGURE 11. Analog Input Interconnection

3.5 CONFIGURING ANALOG OUTPUTS (OPTIONAL)

The PC-1 provides for up to four auxiliary analog output signals. These signals represent the first four Size Channels configured by the user with either Tracware or Traccomm. 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. For the location of the jumpers for the analog output range settings (see Figure 12).

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

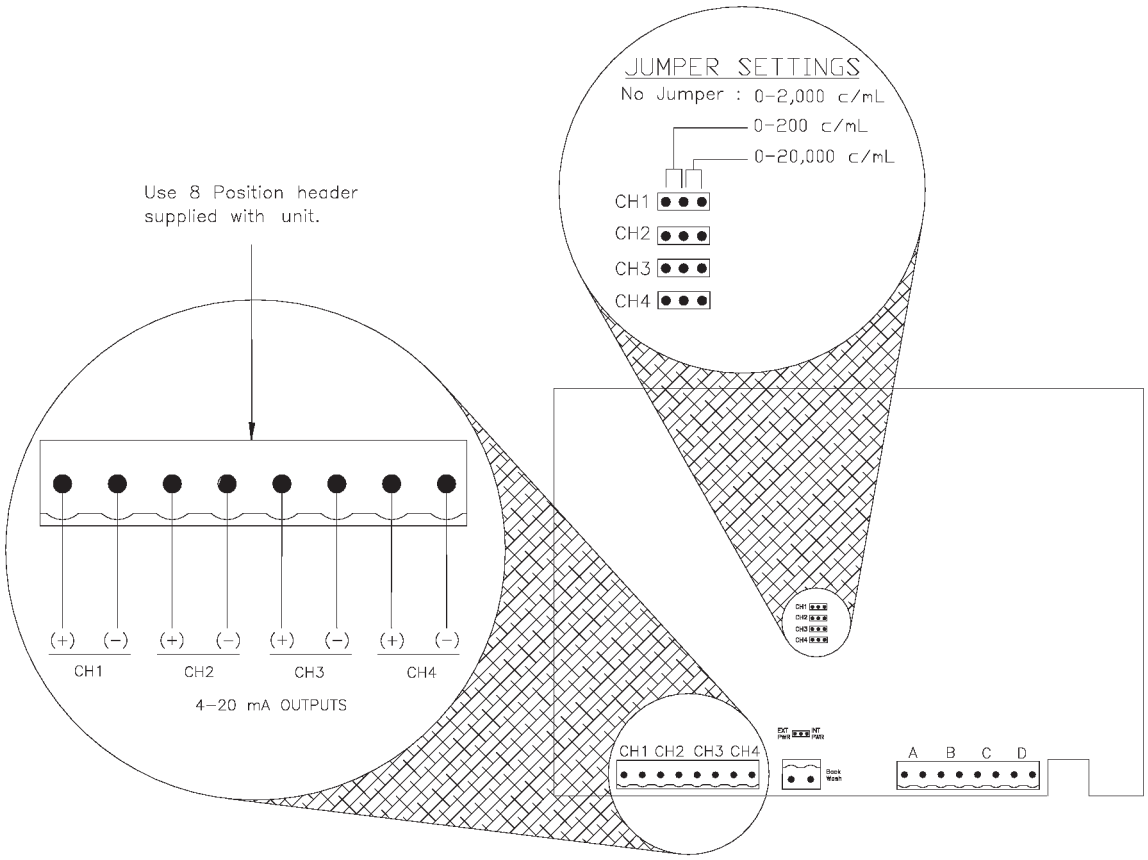


FIGURE 12. Analog Output Jumper Settings

Configuration of the analog outputs requires a multimeter, computer interface (Rosemount Analytical'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 = 40 counts (Approximation)

Step 2: Once the signals being output from the particle counter have been verified, proceed by setting the minimum and maximum input values of the PLC based on the range settings for CH1 - CH4 of the particle counter. 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 configured.

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.

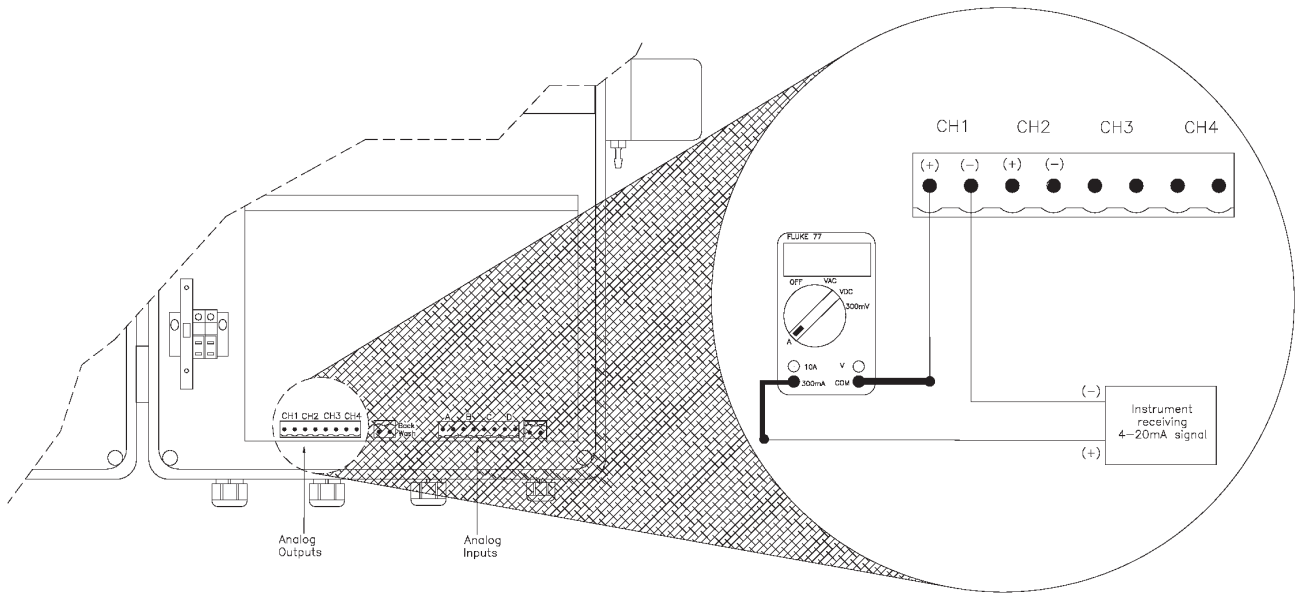


FIGURE 13. Output Voltage Check

3.6 BACKWASH SIGNAL (OPTIONAL)

The particle counter provides the ability to notify Tracware or Traccomm in the event of a filter backwash. The software then shows on the display that the filter is in backwash. This feature allows the user to identify that a filter backwash caused the sudden increase in particle counts rather than filter breakthrough or other system failure. Tracware can be notified of a filter backwash manually as discussed in the Tracware manual or, if the user chooses, can be notified automatically via the optional backwash terminal located on the optional I/O board.

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 Figure 14).

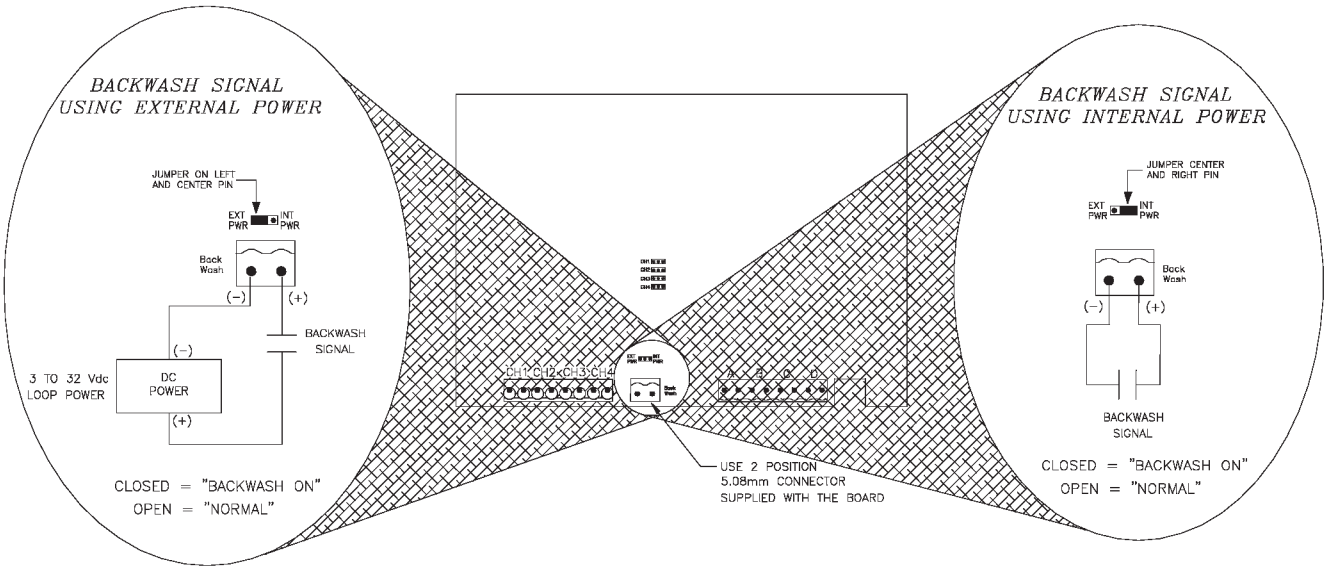


FIGURE 14. Backwash Connection

SECTION 4.0 SAMPLING

4.1 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".

4. 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".

4.1.1 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 15.)

Make sure that the sample point has the minimum pressure available at all times to provide enough flow. The Rosemount Analytical sensor requires approximately 2 feet of head to maintain a 100 ml/min flow.

If the sensors are to be moved around, temporary sample points can be used. Turbidity overflow weirs provide a good location, as does weighting the tubing and dropping it into a settling basin.

4.1.2 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. The Rosemount Analytical particle counter comes equipped with a low flow detector that will alert the operator to a drop in the flow rate. This detector monitors the output flow of the sensor and alarms when flow drops 5% (See Figure 16). Refer to the "External Wiring Connections" in section 4.0 for connecting the low flow detector to the particle counter.

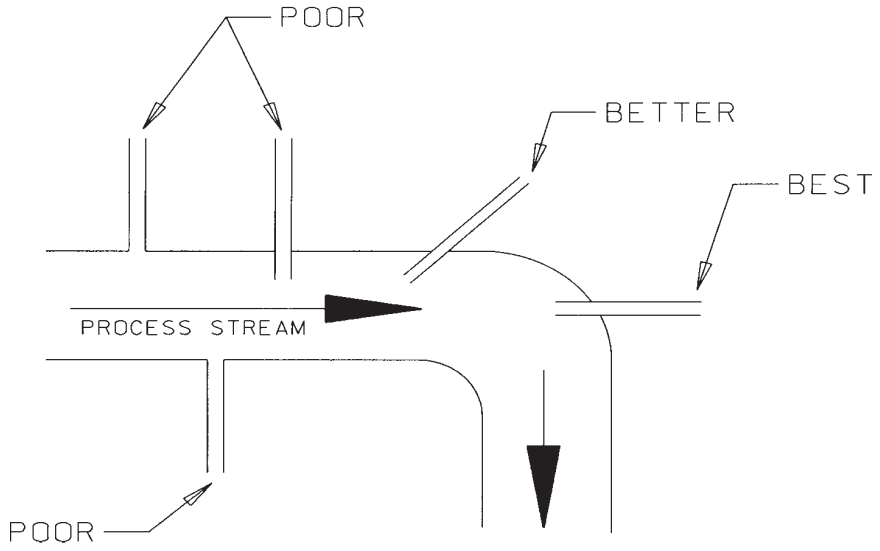


FIGURE 15. Sample Tap

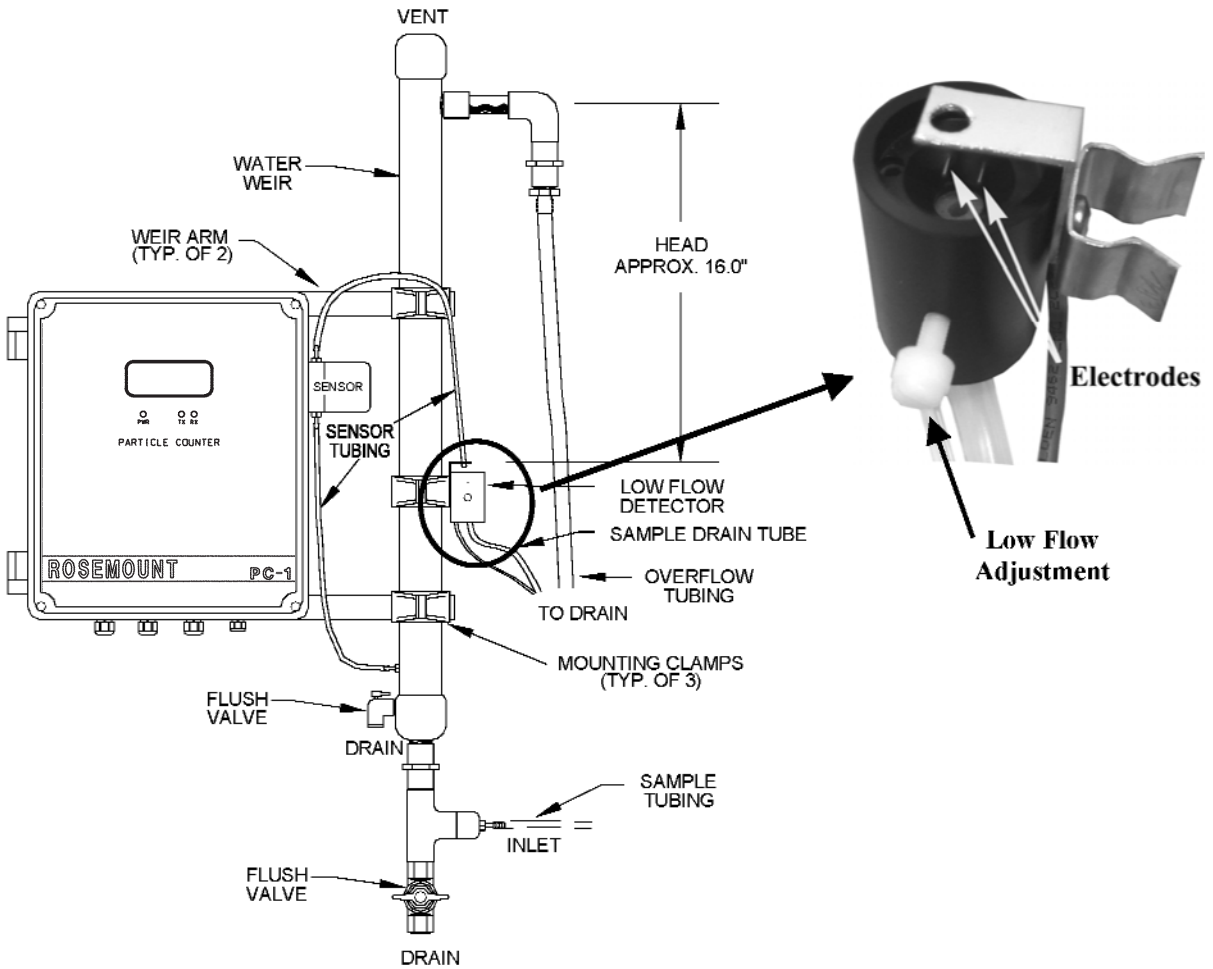


FIGURE 16. Low Flow Detector

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. If the overflow fills up, the flow rate will be affected.

Weir adjustment is achieved by moving the sensor outlet via the low flow detector 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 2.)

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.

4.1.3 FLOW METER (OPTIONAL)

The electronic flow meter is set to measure the flow rate between 50 and 200 ml/min. This value is used by the particle counter to determine the particle counts per ml for each sample. This flow value is included in the data output from the unit. Refer to "External Wiring Connections" in section 5.0 for connecting a flow meter to the particle counter.

4.1.4 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.

4.1.5 BUBBLES

Bubbles can be introduced into the sample if air is pulled in, or if the temperature of the sample is allowed to increase while in the sample line. The particle counter will count bubbles if they are large enough, just as a turbidimeter will. The overflow weir is designed to keep enough pressure on the sample inlet to prevent bubbles from forming. Flow is directed through the sensor from the bottom for the same reason. Unless the plant has an overall problem with entrained air in the source water, which will affect most of the plant instrumentation, there should be no bubble problems with the particle counters that can't be avoided by proper sample handling.

4.1.6 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 5.0.

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 17.)

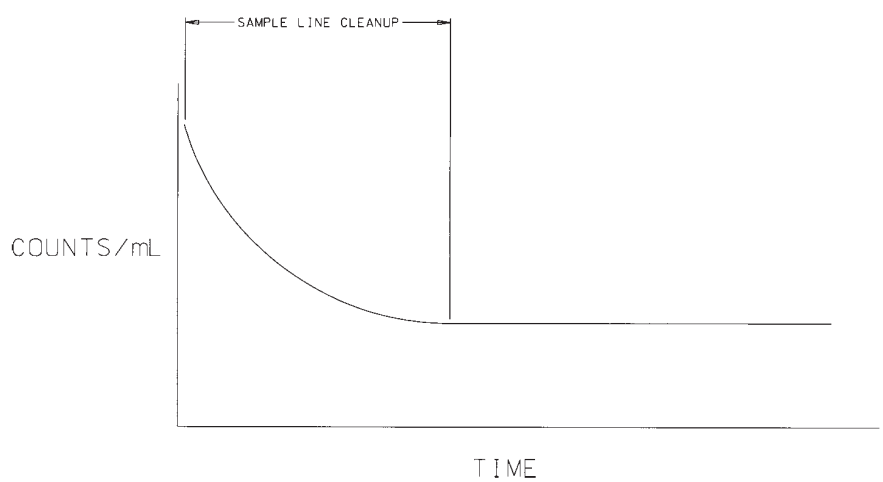


FIGURE 17. Sample Line Clean-Up

4.2 COUNTER OPERATION

The Rosemount Analytical PC-1 particle counter is shown in section 5.0 "Diagrams". It consists of the sensor, counter board and modules, display panel, power supplies, wiring terminals, and enclosure.

4.2.1 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.

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 18.)

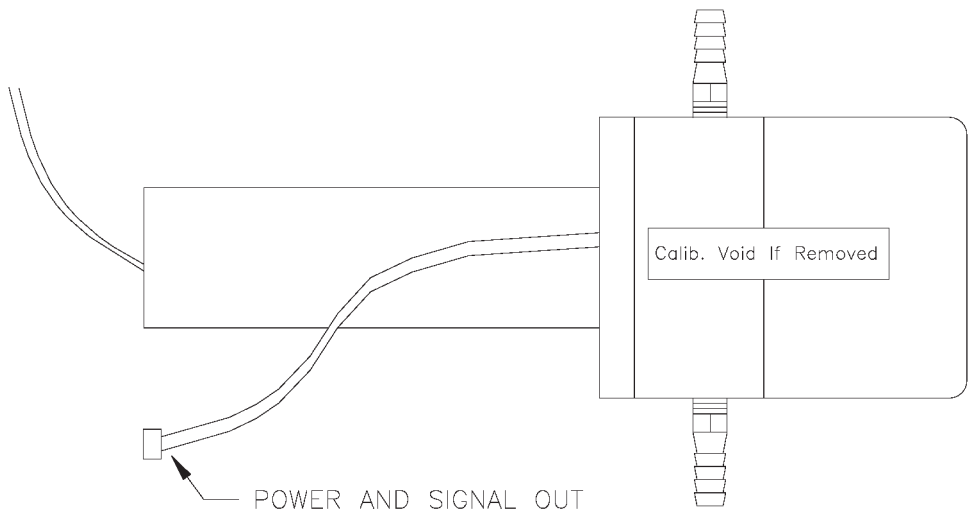


FIGURE 18. Calibration Sticker

4.3 RS485 COMMUNICATION AND POWER INDICATORS

The PC-1 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 19). The red power LED, indicated by PWR on the cover of the PC-1, 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 Rosemount Analytical 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 Rosemount Analytical if the LED's do not appear to be functioning properly and communication can not be established with the host computer.

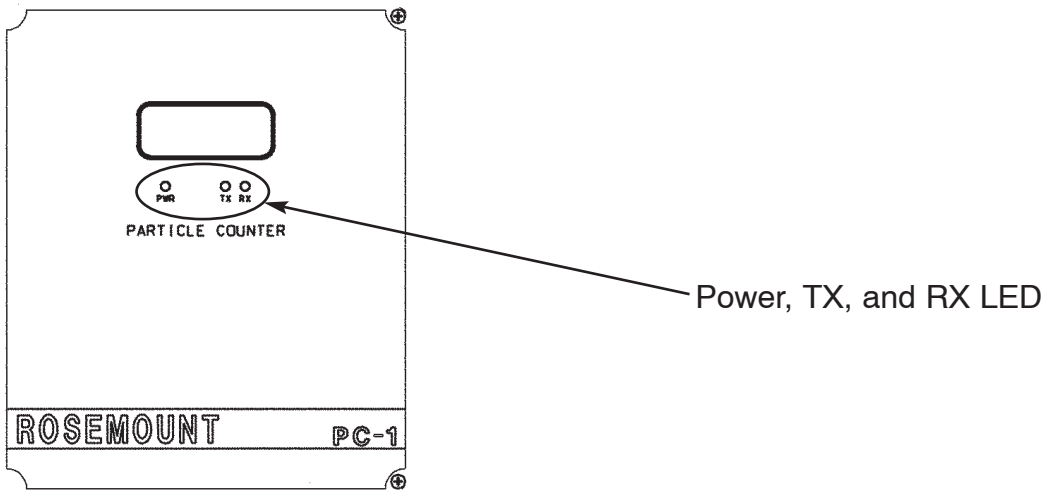


FIGURE 19. TX, RX LED Location

4.4 CLEANING PROCEDURE

The flow cell in the PC-1 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. Obviously, the more turbid the sample, the more likely clogging 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 20% 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 will 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.

4.4.1 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 20). Squeeze the syringe to force the cleaner rapidly through the flow cell.

4.4.2 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 21). Turn the brush a couple of times and remove.

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.

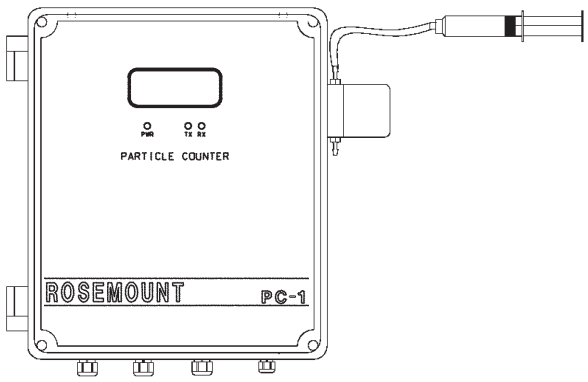


FIGURE 20. Non-Brush Cleaning

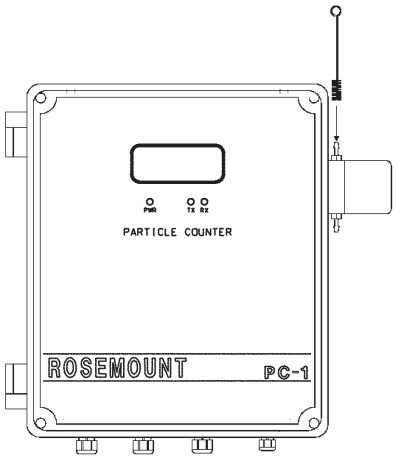


FIGURE 21. Brush Cleaning

SECTION 5.0 DIAGRAMS

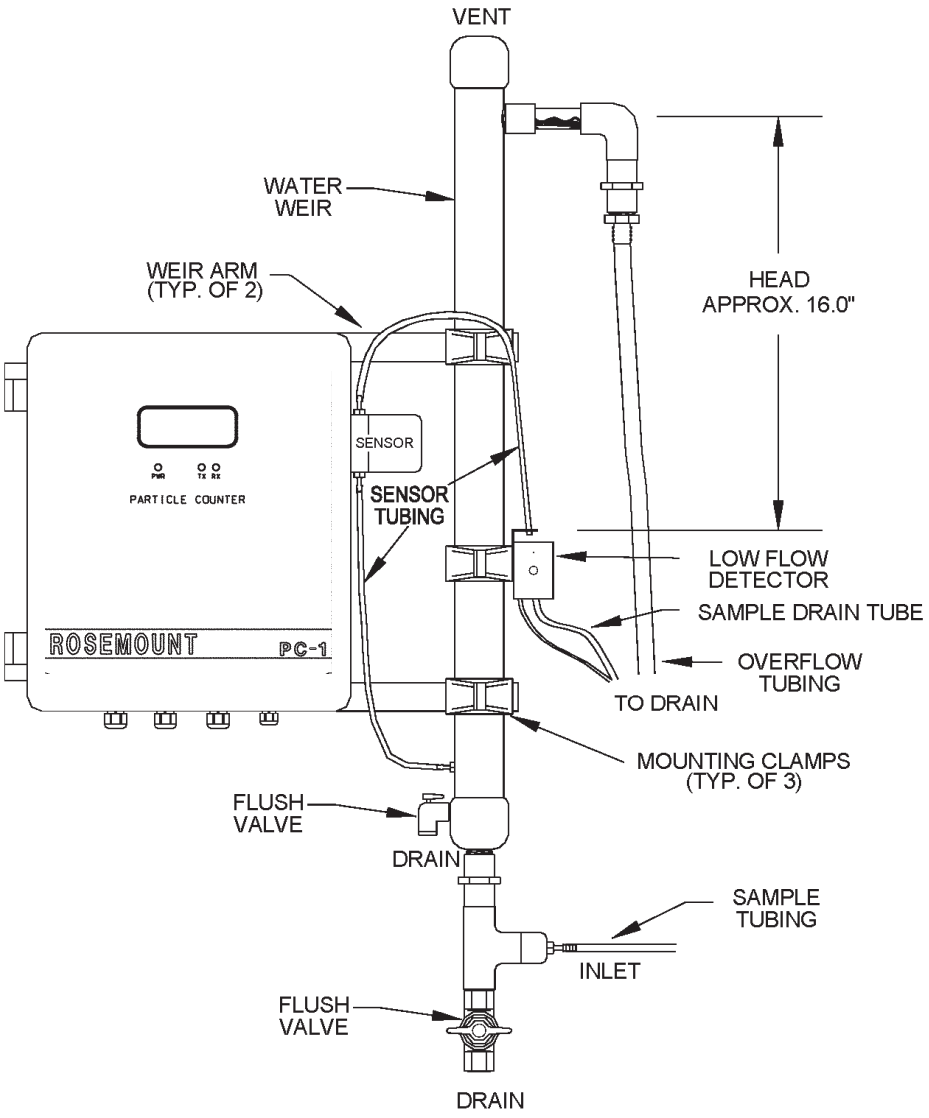


FIGURE 22. System Components

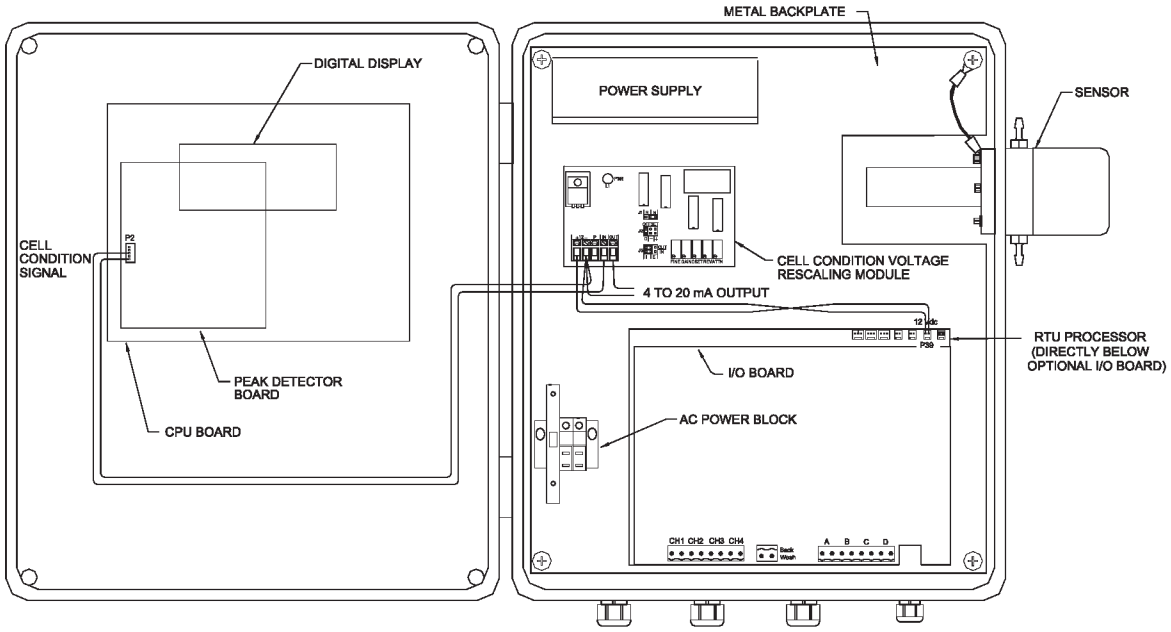


FIGURE 23. Internal Components

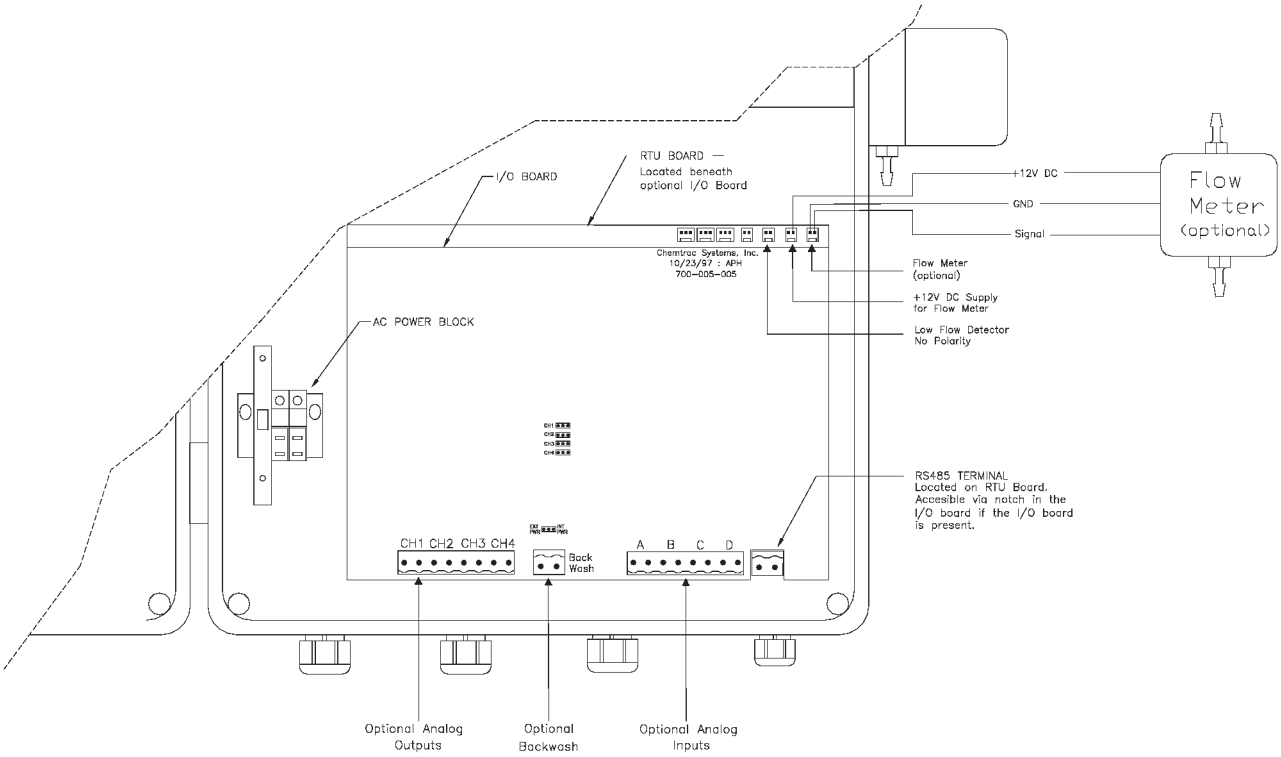


FIGURE 24. External Wiring Connections

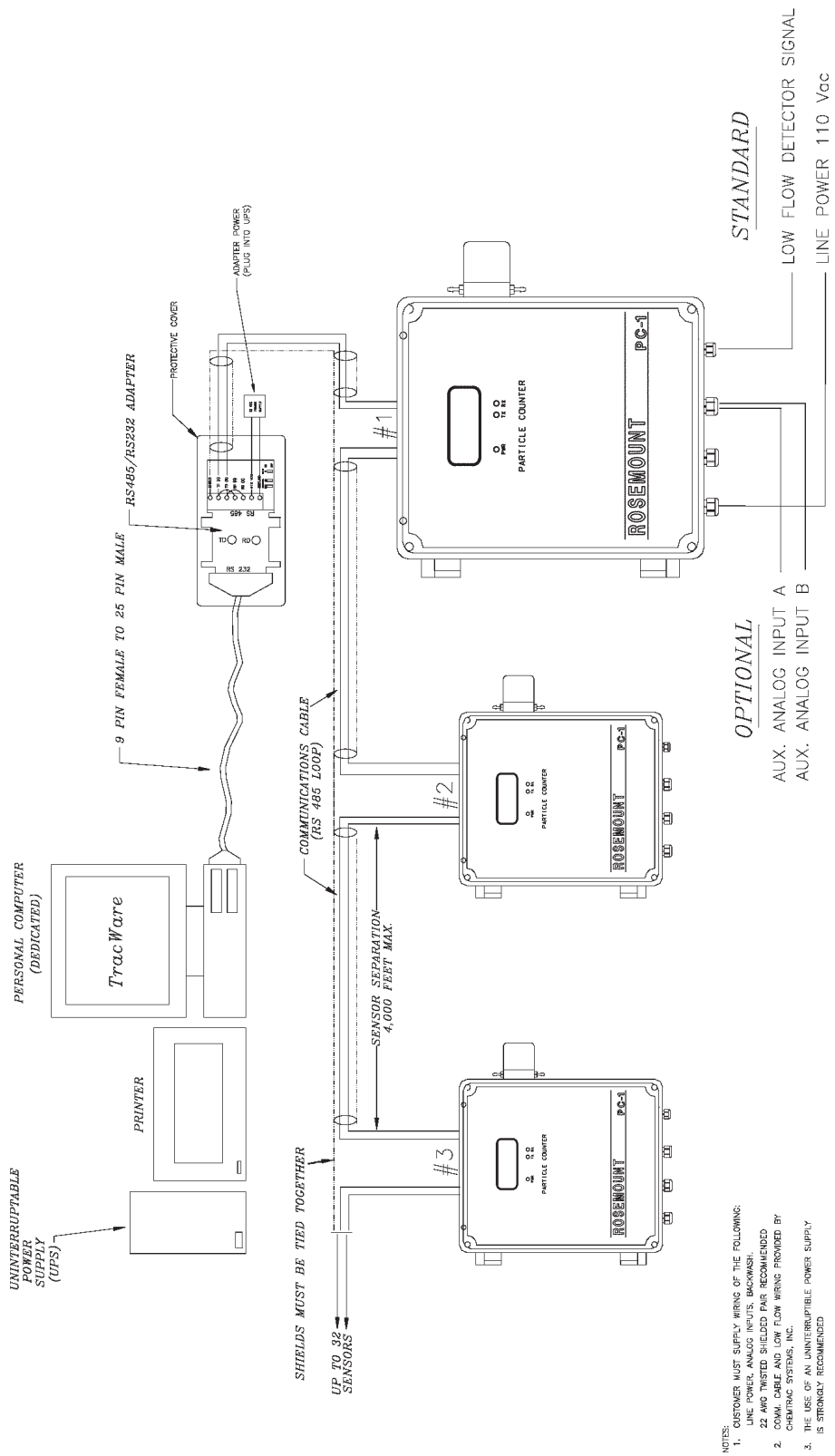


FIGURE 25. Typical System Installation

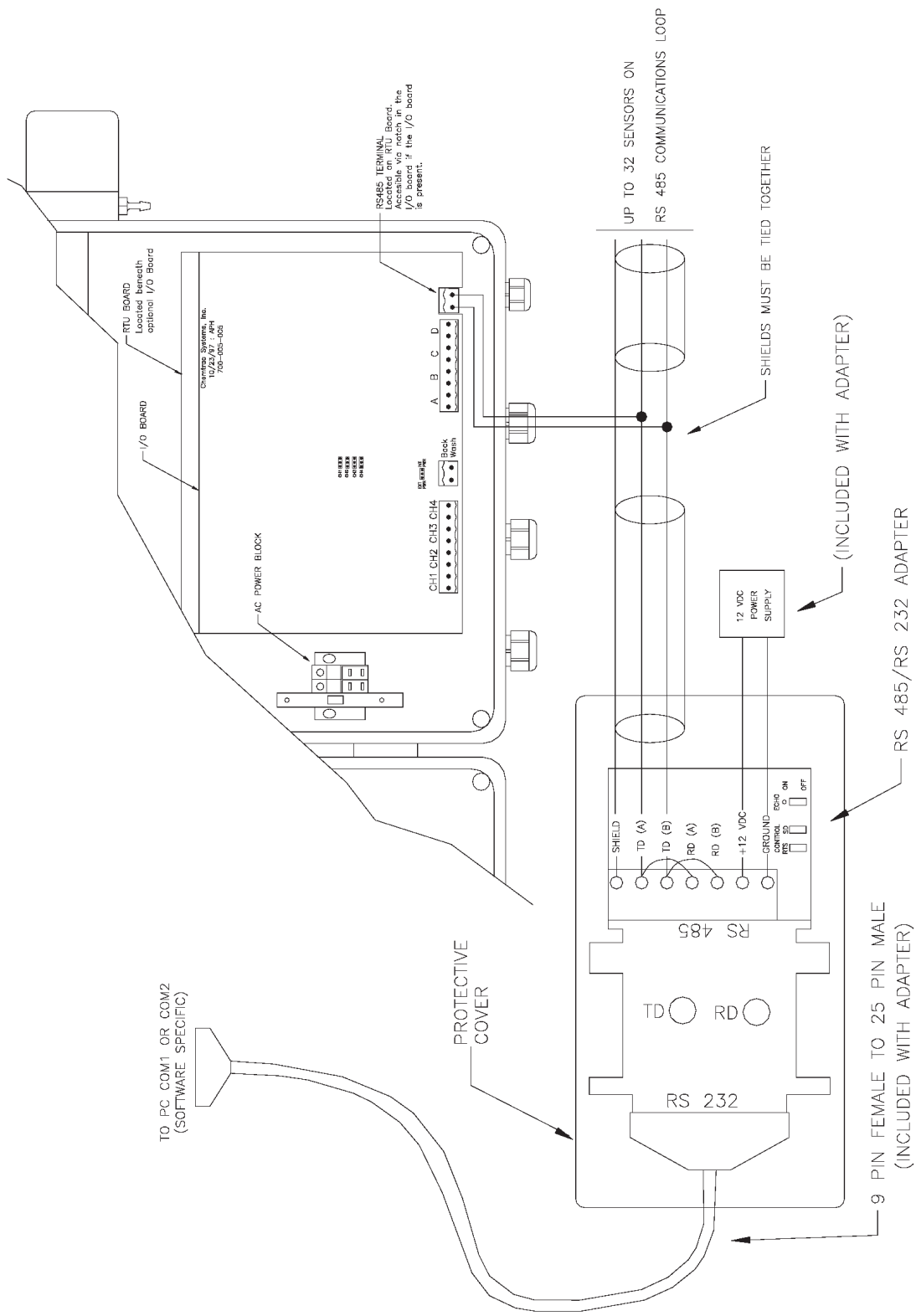


FIGURE 26. RS485 Communications Wiring

SECTION 6.0 SPARE PARTS AND ACCESSORIES

RECOMMENDED SPARE PARTS

See Figure 27.

Description	Qty.
CPU Board	1
Peak Detector Board	1
RTU Board	1
I/O Board	1
Sensor	1
Barb Fitting	2
Two Pin Shunt Jumper	6
1 Amp Fuse	1
RS-232 Comm Cable Ass.	1
Water Weir (see page 12)	1
Two Pin Green Connector	2
Eight Pin Grey Connector	2
Sample Tubing	50ft
Barb Fitting	10 (1pkg)
1 Amp Fuse	10
Sensor Cleaning Brush	5

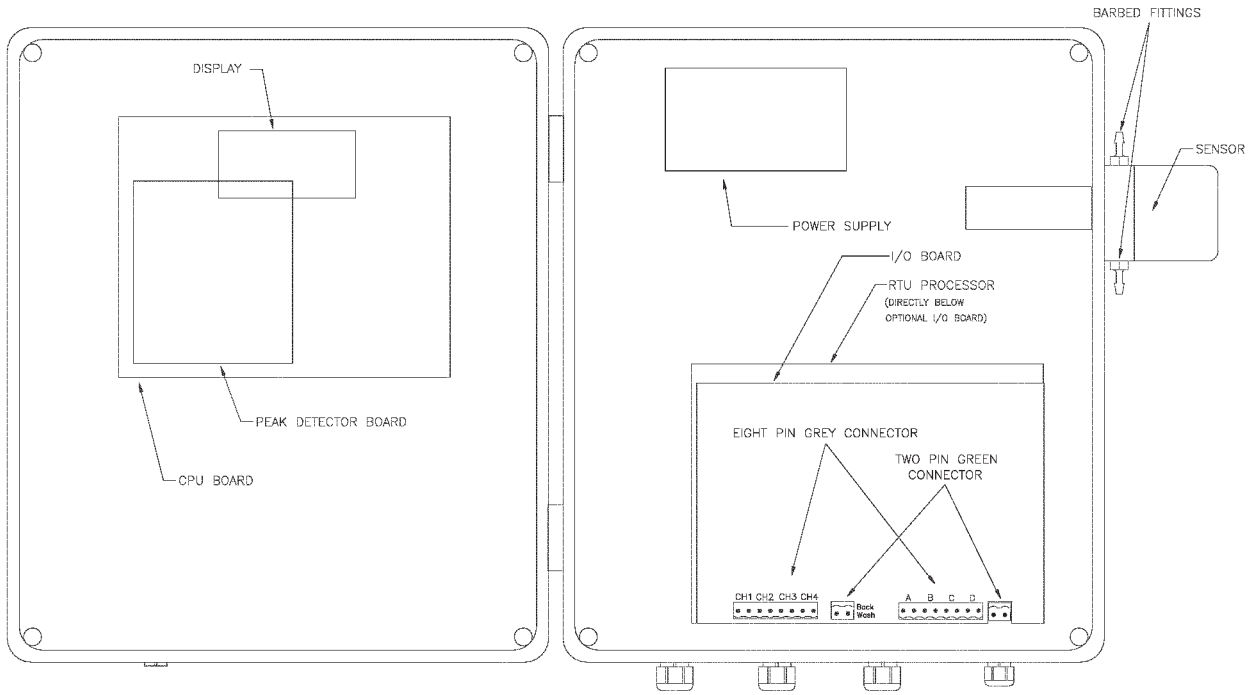


FIGURE 27. Spare Parts

SECTION 7.0 PC-1 PARTICLE COUNTER WITH CELL CONDITION OUTPUT OPTION

The PC-1 is available with an analog output to allow remote monitoring of the cell voltage level. The PC-1 with cell voltage output option is equipped with a voltage-rescaling module (See Figure 28). The voltage-rescaling module is provided to convert the cell voltage of 0 to 3.8 to 4 to 20 mA DC output signal.

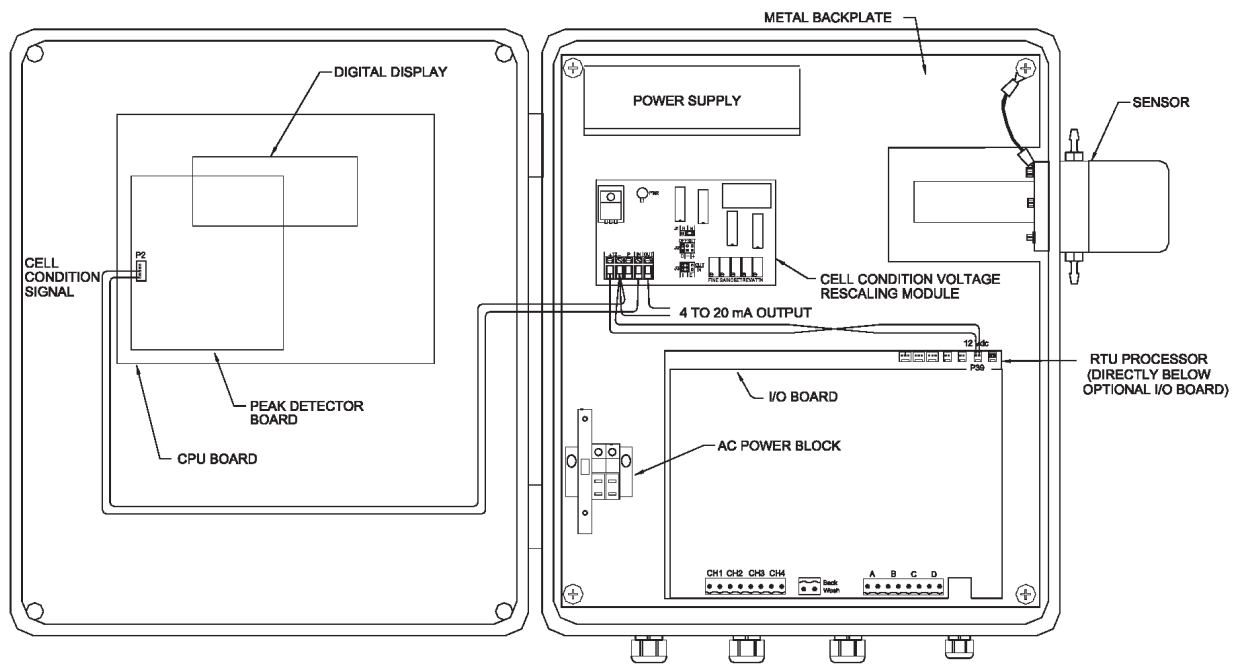


FIGURE 28. Model PC-1 equipped with a voltage-rescaling module.

No field calibration is 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 29.

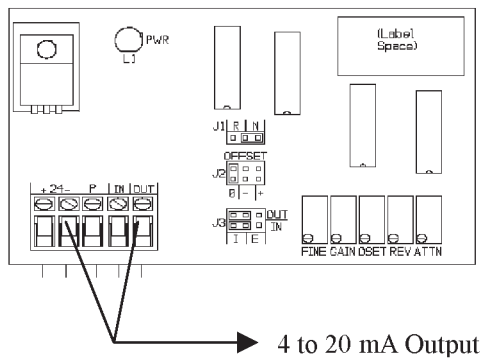


FIGURE 29. Wiring for voltage-rescaling module.

SECTION 8.0
RETURN OF MATERIAL

8.1 GENERAL.

To expedite the repair and return of instruments, proper communication between the customer and the factory is important. Before returning a product for repair, call 1-949-757-8500 for a Return Materials Authorization (RMA) number.

8.2 WARRANTY REPAIR.

The following is the procedure for returning instruments still under warranty:

1. Call Rosemount Analytical for authorization.
2. To verify warranty, supply the factory sales order number or the original purchase order number. In the case of individual parts or sub-assemblies, the serial number on the unit must be supplied.
3. Carefully package the materials and enclose your “Letter of Transmittal” (see Warranty). If possible, pack the materials in the same manner as they were received.
4. Send the package prepaid to:

   Rosemount Analytical Inc.
   Liquid Division
   2400 Barranca Parkway
   Irvine, CA 92606

   Attn: Factory Repair

   RMA No. _____

   Mark the package: Returned for Repair

   Model No. ____

8.3 NON-WARRANTY REPAIR.

The following is the procedure for returning for repair instruments that are no longer under warranty:

1. Call Rosemount Analytical for authorization.
2. Supply the purchase order number, and make sure to provide the name and telephone number of the individual to be contacted should additional information be needed.
3. Do Steps 3 and 4 of Section 8.2.

NOTE

Consult the factory for additional information regarding service or repair.

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Canada	Kuwait	Taiwan
Chile	Malaysia	Thailand
China	Mexico	Tobago
Colombia	Netherlands	Trinidad
Costa Rica	New Zealand	Tunisia
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Denmark	Oman	United Arab Emirates
Egypt	Pakistan	United Kingdom
Ecuador	Paraguay	Uruguay
Finland	Peru	Uzbekistan
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Germany	Poland	Yemen
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Hong Kong	Puerto Rico	
Hungary	Qatar	

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WARRANTY

Goods and part(s) (excluding consumables) manufactured by Seller are warranted to be free from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of shipment by Seller. Consumables, pH electrodes, membranes, liquid junctions, electrolyte, O-rings, etc. are warranted to be free from defects in workmanship and material under normal use and service for a period of ninety (90) days from date of shipment by Seller. Goods, part(s) and consumables proven by Seller to be defective in workmanship and / or material shall be replaced or repaired, free of charge, F.O.B. Seller's factory provided that the goods, parts(s), or consumables are returned to Seller's designated factory, transportation charges prepaid, within the twelve (12) month period of warranty in the case of goods and part(s), and in the case of consumables, within the ninety (90) day period of warranty. This warranty shall be in effect for replacement or repaired goods, part(s) and consumables for the remaining portion of the period of the twelve (12) month warranty in the case of goods and part(s) and the remaining portion of the ninety (90) day warranty in the case of consumables. A defect in goods, part(s) and consumables of the commercial unit shall not operate to condemn such commercial unit when such goods, parts(s) or consumables are capable of being renewed, repaired or replaced.

The Seller shall not be liable to the Buyer, or to any other person, for the loss or damage, directly or indirectly, arising from the use of the equipment or goods, from breach of any warranty or from any other cause. All other warranties, expressed or implied are hereby excluded.

IN CONSIDERATION OF THE STATED PURCHASE PRICE OF THE GOODS, SELLER GRANTS ONLY THE ABOVE STATED EXPRESS WARRANTY. NO OTHER WARRANTIES ARE GRANTED INCLUDING, BUT NOT LIMITED TO, EXPRESS AND IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

RETURN OF MATERIAL

Material returned for repair, whether in or out of warranty, should be shipped prepaid to:

PC-1 Repair Center
6991 Peachtree Industrial Blvd.
Building 600
Norcross, GA 30092

The shipping container should be marked:

Return for Repair
Model _____

The returned material should be accompanied by a letter of transmittal which should include the following information (make a copy of the "Return of Materials Request" found on the last page of the Manual and provide the following thereon):

1. Location type of service, and length of time of service of the device.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the returned material.
4. Statement as to whether warranty or non-warranty service is requested.
5. Complete shipping instructions for return of the material.

Adherence to these procedures will expedite handling of the returned material and will prevent unnecessary additional charges for inspection and testing to determine the problem with the device.

If the material is returned for out-of-warranty repairs, a purchase order for repairs should be enclosed.

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