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Without measurement there is no control

LiQuilaz® II E and S Liquid Particle Counters

OPERATIONS MANUAL

P/N 1000023550

LiQuilaz® II E and S
Liquid Particle Counters
Operations Manual

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P/N 1000023550 Rev C

LiQuilaz® II E and S Series Particle Counters Operations Manual
P/N 1000023550 Rev C

Quality Statement

The Quality Policy of Particle Measuring Systems is to strive to meet or exceed the needs and expectations of our customers, and to align the activities of all employees with the common focus of customer satisfaction through continuous improvement in the quality of our products and services.

Environmental Information

This equipment must be properly disposed of at end-of-life by means of an authorized waste management system. Contact our Customer Response Center at (877) 475-3317 or (303) 443-7100 (International Telephone +1 3034437100) for dismantling and disposal information.

Manual Conventions

WARNING
A warning in the text is used to notify the user of the potential for bodily injury or death.

CAUTION
A caution in the text is used to highlight an item that if not done, or incorrectly done, could damage the instrument and/or any materials or devices affected by the instrument.

– — NOTICE — –
A notice in the text is an instructional communication regarding requirements or policies issued by Particle Measuring Systems.

t

NOTE: A note in the text is used to highlight an item that is of operational importance to the user.

It is important that you observe cautions and warnings while performing the procedures described in this manual. Caution and warning labels are located on and inside the instrument to alert you to potentially hazardous conditions. Please familiarize yourself with this information.

CE – Declaration of Conformity

CE - Declaration of Conformity

Application of Council Directive(s):	2004/108/EC, 2006/95/EC, RoHS 2011/65/EU	
Standard(s) to which Conformity is Declared:	EMC	EN 61326-1: 2013
	Safety	EN 61010-1: 2010, 3rd Ed. EN 60825-1: 2014

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Manufacturer's Telephone / FAX:	+01 3034437100 / +01 3034496870
Distributor's Name:	Particle Measuring Systems, S.R.L.
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	00044 Frascati (Roma) ITALY
Distributor's Telephone/FAX:	+39 06 90530130/ +39 06 9051315
Type of Equipment:	Particle Counter
Model No:	LiQuilaz II

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Signature: 	
Full Name:	Scott MacLaughlin
Position:	Director of Engineering
Place: Boulder	**Date:** September 20, 2019

Signature: 	
Full Name:	Giovanni Scialo
Position:	Vice President Life Sciences
Place: Rome	**Date:** September 20, 2019

CAUTION

All I/O cables and accessories must meet current factory specifications in order for this unit to remain in compliance with CE marking requirements. Consult the factory for details.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

PARTICLE MEASURING SYSTEMS®
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Chapter 1
Getting Started

The LiQuilaz® II E and S Series Liquid Particle Counters are sensors designed to measure particles in liquids. A sensor contains a liquid handling and optical system as well as electronics that measure the size of the particles sampled and transmit data to the data display system.

The sensor requires AC power, connections to bring the liquid to the sensor, and a connection to a data display system. Particle Measuring Systems supplies several software packages that support the LiQuilaz II, including Facility Net, Pharmaceutical Net, SamplerSight, or SamplerSight-Pharma software.

The LiQuilaz II E Series Liquid Particle Counter has the following variations:

LiQuilaz II E20P
A 20 mL per minute version that is intended for use with the SLS-2000 sampler.

LiQuilaz II E20
A 70 mL per minute version that is intended for an online installation.

LiQuilaz II E15P
A 20 mL per minute version that is intended for use with the SLS-2000 sampler or online installation.

The LiQuilaz II S Series Liquid Particle Counter has the following variations:

LiQuilaz II S05

A 80 mL per minute version with 0.5 µm sensitivity.

LiQuilaz II S03

A 80 mL per minute version with 0.3 µm sensitivity.

LiQuilaz II S02

A 50 mL per minute version with 0.2 µm sensitivity.

NOTE: All S units are also available in a 20 mL per minute flowrate version.

Figure 1-1 LiQuilaz II Liquid Particle Counter for online applications

LiQuilaz II E Model Specifications

Table 1-1 Specifications for LiQuilaz II E Liquid Particle Counters

	E20P	E20	E15P
Size range	2 – 125 µm	2 – 125 µm	1.5 – 125 µm
Flow rate[a]	20 mL/min ±10%	70 mL/min. ±10%	20 mL/min ±10%
Size channels	User-adjustable from 1 to 15		
Resolution	Less than 10% at 10 µm		
Wetted surfaces	Fused silica, black quartz, Kalrez®, and Kel-F®		
Liquid connections	3 mm flare or 1/4-inch Flaretek®		
Pressure range	0 – 100 psi		
Sample temperature	50 – 122 °F (10 – 50°C)		
Maximum concentration[b]	10,000 particles/mL		
Dimensions (l, w, h)	12.75 x 4.25 x 4.5 in (32.4 x 10.8 x 11.4 cm)		
Weight	6.1 lb (2.8 kg)		
Communication modes	5-wire, RS-485, DB-9 connectors, PMS serial communications protocol, 10/100BaseT Ethernet, PMS Ethernet Protocol, Modbus TCP		

a. When the LiQuilaz II E20 Liquid Particle Counter is used with a SLS Family, the optimum flow rate is 20 mL/min. Operating at a greater flow rate may cause cavitation, depending upon the sample viscosity and dissolved gases in the sample.
b. Greater than 90% accuracy (less than 10% coincidence loss) at maximum recommended concentration

LiQuilaz II S Model Specifications

Table 1-2 Specifications for LiQuilaz II S Liquid Particle Counters

	S02	S03	S05
Size range	0.2 – 2.0 µm	0.3 – 3.0 µm	0.5 – 20.0 µm
Flow rate[a]	50 mL/min. ±10%	80 mL/min. ±10%	80 mL/min. ±10%
	-- 20 mL/min. ±10% available for all S-series models --		
Size channels	User-adjustable from 1 to 15		
Volume sampled	100%		
Maximum concentration[b]	10,000 per ml		
Sample temperature[c]	32 – 302 °F (0 – 150 °C)		
Zero count level	≤ 25 counts per liter	≤ 15 counts per liter	≤ 15 counts per liter
Pressure range	0 - 100 psi		
Wetted surface materials	Sapphire, Teflon®, Kalrez 4079, and Kel-F®		
Dimensions (l, w, h)	12.75 × 4.25 × 4.5 in (32.4 × 10.8 × 11.4 cm)		
Weight	6.1 lb (2.8 kg)		
Communication modes	5-wire, RS-485, DB-9 connectors, PMS serial communications protocol, 10/100BaseT Ethernet, PMS Ethernet Protocol, Modbus TCP		
Calibration fluid	DI water		
Calibration	Materials used are traceable to USA NIST and/or Japanese Institute of Standards (JIS).		

a. The S02, S03 and S05 can be ordered with a 20 mL/min flow rate.
b. Greater than 90% accuracy (less than 10% coincidence loss) at maximum recommended concentration
c. 100 °C max. for sulfuric acid (H_2SO_4)

LiQuilaz II Common Specifications

Table 1-3 Common specifications of the LiQuilaz II E and S series

Utility Requirements	
Electrical rating	100 - 240V, 50/60 Hz, 0.75 A
Voltage fluctuation	AC input voltage fluctuation shall not exceed ±10%
Fuses	250 V~, 5 x 20 mm, T, 0.75 A (P/N 1000013202)
Laser classification	Class I, complies with US 21 CFR 1040.10 and EN 60825-1. Internally an enclosed Class 3B laser is used per EN 60825-1.
Installation Requirements	
	Indoor use only. Pollution degree 2 Over-voltage Category II Ordinary protection (Not protected against harmful ingress of moisture) Class I Equipment (Electrical earth ground from the mains power source to the product input is required for safety.)
Environment	Temperature: 50 – 95 °F (10 – 35) °C Humidity: non-condensing
Maximum Altitude	6,562 ft (2000 m)

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Chapter 2
Unpacking and Connection

If the shipping container shows signs of damage such as crushing, depressions, water damage, etc. be sure to notify the shipper and Particle Measuring Systems before continuing. Notify Particle Measuring Systems at 1-877-475-3317, or ***support@pmeasuring.com***. Follow any instructions you receive on how to proceed.

If the shipping container appears to be in good condition, continue to carefully unpack and inspect each item. Store the shipping container and its packing materials for use when returning the instrument for calibration or repair. This is important because an inadequate shipping container could void your warranty.

If anything is missing, contact Particle Measuring Systems Customer Response Center at 1-877-475-3317, or ***support@pmeasuring.com***.

If all of the materials are included and undamaged, store the packing materials. It is important to keep these materials because warranties may not apply if return shipping containers are inadequate.

Unpacking

>> To unpack your shipment

1. Open the container.
2. Carefully remove the instrument and inspect it for damage.
3. If the instrument has been damaged in shipment, notify the shipper and Particle Measuring Systems. Repackage the instrument in the original packing materials.
4. If the instrument is not damaged, store the packing materials.

Shipkit Accessories

The following accessories are included with the instrument:

1. Ethernet cable, P/N 1000011477

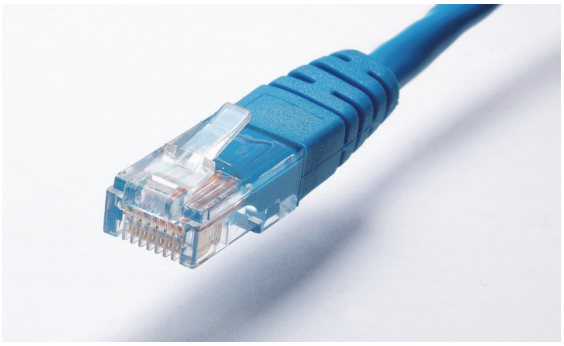

Figure 2-1 Ethernet cable

2. USB to RS-232 adaptor, P/N 1000023262

Figure 2-2 USB to RS-232 adaptor

3. RS-232 to RJ-12 cable, P/N PMS-CD1995

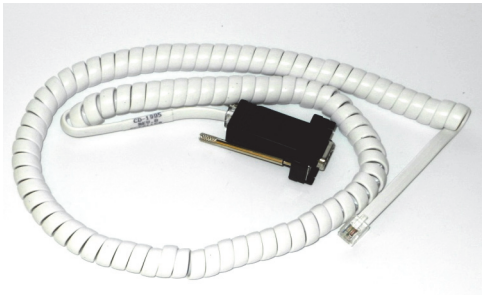

Figure 2-3 RS-232 (DB-9 to RJ-12) cable

4. Appropriate power cord (dependent on country)

Figure 2-4 Example power cord (US)

5. Capillary Cleaning Floss (S models only), P/N 1000009363

Figure 2-5 Pre-cut floss

6. Capillary Cleaning Kit (one of the following included as appropriate for the model ordered)
   a. Capillary Cleaning Kit for sensors with no adaptor or 3 mm on-line adaptor (S and E), P/N CK400

Figure 2-6 Capillary Cleaning Kit for sensors with no adaptor

b. Capillary Cleaning Kit for sensors with Flaretek online adaptor, P/N CK200-1

Figure 2-7 Capillary Cleaning Kit for sensors with adaptor

7. LiQuilaz II Operations Manual (this document), P/N 1000023550

Optional Accessories

The following accessories are optional purchases:

1. USB to opto-isolated RS-485 LiQuilaz adaptor, P/N 1000021389

Figure 2-8 USB to RS-485 converter with 10 ft cable

2. Cable Network OUT to Network IN (10 ft), P/N PMS-CD1050-00

Figure 2-9 Cable Network OUT to Network IN (10 ft)

3. Liquid Installation Kit (P/N 90351040), which includes:
   a. (1) 25 feet of 1/4-inch PFA tubing
   b. (1) Flaretek flaring tool
   c. (5) PVDF 1/4-inch flare nuts
   d. (1) Male flare connector

Figure 2-10 Liquid Installation Kit

Identifying Components and Connections

Liquid Connections

The liquid connections to the LiQuilaz II S series liquid particle counters are made through either the 3 mm connections directly on the sensor or through the Flaretek® connections on the interface bracket (see **Figure 2-11**).

Sensors configured to operate with samplers will typically utilize 3 mm tubing. Sensors configured to operate online will typically utilize 1/4-inch (6 mm) Flaretek fittings.

Figure 2-11 LiQuilaz II Liquid Particle Counter (Online version)

Indicator Lights

An Activity LED and a Status LED are located on the front panel next to the liquid connections. The Activity LED is illuminated upon detection of each particle and failure of the laser. This indicator is used to easily verify proper operation of the unit.

The Status LED can be configured via a serial setup command (see **"set led n"** on page G-2). Default configuration (**set led 1**) is below:

Flashing green	No Ethernet connection to host computer
Green	Laser OK AND connected to host via Ethernet
Red	Laser error OR Ethernet protocol error

Communications Connectors

There are multiple communication connectors on the rear panel (see **Figure 2-12**).

An Ethernet connector is available for use. This supports PMS protocol programs such as Facility Net, and Modbus TCP for use with custom solutions.

Two DB-9 (female and male) connectors which support RS-485 and hardware sampling are also available. The second connector is available for daisy chaining to other sensors on the network.

An RJ-12 connector is available for RS-232 setup and communications. This connector attaches to the PMS-CD1995 adaptor, which can be connected to a standard 9-pin PC serial port.

A standard IEC AC power entry module, with a power switch, is also located on this panel.

Figure 2-12 LiQuilaz II Liquid Particle Counter (rear panel)

Installation Requirements

Power	100 - 240 VAC, 50/60 Hz, 0.75 A
RS-485 Data cable	5 wire RS-485 (DB-9)
	Pin 1 shield
	Pin 2 Tx +
	Pin 3 Tx -
	Pin 4 Rx +
	Pin 5 Rx -
	Pin 6 sample +
	Pin 8 sample –
Liquid connections	3 mm zero dead volume fitting or 1/4-inch Flaretek

AC Fuse

>> To replace a fuse:

WARNING
Disconnect the power cord from its power source.

1. Unplug the power cord from rear panel of the LiQuilaz II Liquid Particle Counter.
2. Use a small blade screwdriver, or similar tool, to remove the cover/fuse drawer from the power entry module (located on the instrument rear panel).
3. Choose the following:

   250 V~, 5x20 mm, T, 0.75 A

4. Reinstall the cover/fuse drawer assembly.

Online Version Installation

The LiQuilaz II E20 flow rate is 70 mL/minute ±10% and is typically installed directly into a process line.

The LiQuilaz II E15P flow rate is 20 mL/minute ±10%; for online applications 1/4-inch Flaretek fittings may be specified.

A data cable connects the liquid particle counter unit to a PC running Facility Net, Pharmaceutical Net, SamplerSight, or SamplerSight-Pharma software that provides the user interface.

Installation Requirements

Required Items That Are Not Provided

- Liquid Installation Kit
- Tubing, 1/4-inch, Teflon
- Tube-flaring tools
- Communications cable: Ethernet OR Ethernet Crossover cable (included)

>> To connect the LiQuilaz II (Online version):

1. Place the particle counter unit where it will have sturdy support and be free of drips and spray.
2. Position the PC at the location from which the LiQuilaz II Online will be controlled and monitored.
3. Connect a standard IEC AC power cord to the rear panel power module.
4. Connect a communications cable between the sensor and the data display system. There are multiple options for communications. See the **Communication Options** on page 2-11.
5. Cut length of tubing required to connect from the process line to the liquid particle counter. The Liquid Installation Kit includes 25 ft of 1/4-inch PFA tubing.
6. Flare the tube end that will connect to the LiQuilaz II.

Figure 2-13 Flared tubing

7. Connect the flared input tube end to the right Flaretek fitting.

8. Connect the flared output tube end to the left Flaretek fitting.

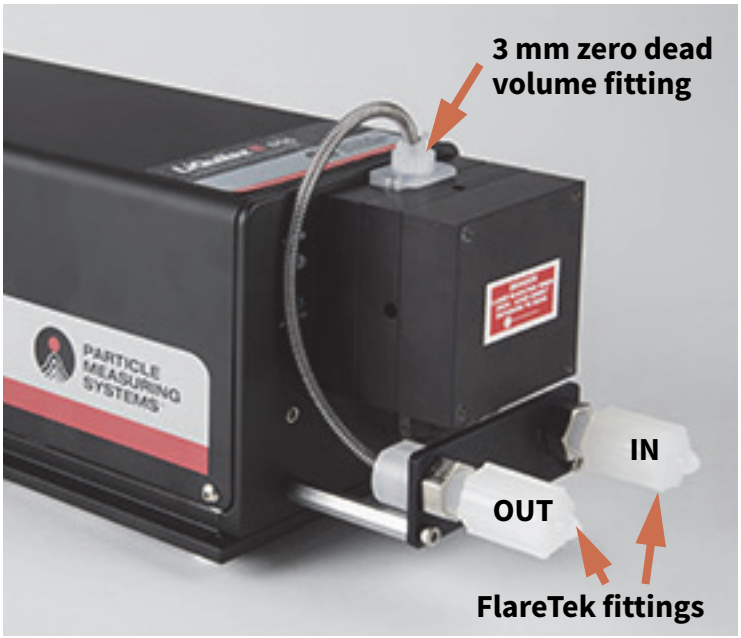

Figure 2-14 LiQuilaz II tube connections

9. Connect the input tube to the process line.
10. Connect the output tube to an appropriate flow control device capable of controlling the sample flow rate to the specified sensor flow rate.

NOTE: The flow control/device must be made of material compatible with the specific fluid or chemical being sampled.

NOTE: Installation set-up and procedures must follow the appropriate chemical safety regulations for your facility.

11. Ensure the liquid particle counter power switch is in the **OFF** position.
12. Connect the power cable from the liquid particle counter to an appropriate power source.
13. Put the liquid particle counter's power switch to the **ON** position.

Communication Options

The LiQuilaz II offers multiple communication options.

Facility Net

Connect using Ethernet or RS-485. When communicating via Ethernet, Facility Net V4.0 or newer is recommended. V3.3 can be used by setting Retro mode in the LiQuilaz II. This causes the instrument to appear as a HSLIS sensor so that it can be recognized by the older Facility Net version. Please see **"set inst(rument) retro n"** on page G-3 in **Appendix G**, Serial Setup Command List.

Ethernet communication settings and options must be set via RS-232 setup commands in **Appendix E**, Configuring for Ethernet.

SamplerSight or SamplerSight Pharma

Connect using RS-485. An opto-isolated RS-485 to USB adaptor with a 10ft RS-485 cable to the LiQuilaz II is available (P/N 1000021389).

SamplerSight software can only operate one sensor at a time. If more than one sensor must be connected via RS-485 via daisy-chain, use FacilityNet software instead.

Modbus TCP

Connect using Ethernet. Communication settings and options must be set via RS-232 setup commands in **Appendix E**, Configuring for Ethernet. Modbus protocol is an industry standard protocol that is provided for customers who need to interface to a custom computer program or SCADA system. By default the LiQuilaz II is configured with Modbus disabled. Use serial command **"set mode 1"** as described in **Appendix G**, Serial Setup Command List to enable Modbus. The Modbus protocol for the LiQuilaz II is described in **Appendix C**, Modbus TCP Protocol.

RS-232

This is primarily a configuration interface to program the LiQuilaz II for the communication methods mentioned above. An RS-232 adaptor pigtail (P/N PMS-CD1995) and a USB to RS-232 adaptor (P/N 1000023262) are supplied as accessories to the LiQuilaz II to facilitate setup. Please see **Appendix G**, Serial Setup Command List for serial commands and **Appendix F**, Serial Communications Overview for basic serial communications information if necessary.

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Chapter 3
Maintenance

This chapter is a basic maintenance guide for LiQuilaz II liquid particle counters.

Occasional cleaning is required of the liquid capillary and it is the customer's responsibility to perform the cleaning when necessary. The need for capillary cleaning and the general health of the capillary can be improved by continuously running water through the system when not in use. In addition, the capillary should never be allowed to dry out, as this could permanently damage the capillary.

The user can perform only the following maintenance:

- Cleaning the capillary with the provided capillary cleaning kit
- Replacing fuses
- Replacing the tubing

Capillary Cleaning

This section is a basic guide to capillary cleaning for LiQuilaz II sensor capillaries. Occasional cleaning is required of the liquid capillary and it is the customer's responsibility to perform the cleaning when necessary.

The need for capillary cleaning and the general health of the capillary can be improved by continuously running water through the system when it is not in use. In addition, the capillary should never be allowed to dry out, as this could permanently damage the capillary.

Clean the capillary when the DC Light reading exceeds the recommended limits:

DC Light Specifications	
LiQuilaz II S liquid particle counter, model S02	< 0.5 Volts
LiQuilaz II S liquid particle counter, model S03/S05	< 0.05 Volts
LiQuilaz II E liquid particle counter, all models	> 7 Volts

A capillary cleaning kit is included with every LiQuilaz II sensor.

Required materials:

- Capillary cleaning kit
- A standard laboratory glassware cleaning solution

Cleaning Solution

When selecting an appropriate cleaning solution, consider the types of contamination that will have deposited onto the capillary from the most recent fluid sampled. For instance, if DI water was sampled last, bacteria, or particles are the most likely sources of contamination.

If solvents were sampled last, optical hazing due to chemical impurities is most likely. Both of these situations can be easily remedied using high-quality laboratory glassware cleaner such Micro-90® or Radiacwash™. A 5% solution of glassware cleaner in ultra-pure DI water should be used.

CAUTION

Do NOT remove the 4-40 socket head screws from the fittings. Doing so will compromise the capillary seal and result in fluid leaking onto circuit boards and extensive damage.
Only remove 3mm zero dead volume fittings from the inlet/outlet connections.

WARNING

Before removing the LiQuilaz II Liquid Particle Counter from a CLS-700 sampler, make sure the sample inlet and outlet tubes are first connected together, or directed into an appropriate drain. Failure to do so could result in severe personal injury, as water from the sampler will be forced out of the open tubing under pressure.

Capillary Cleaning (Online Version, E and S Series)

>> To clean the capillary:

1. Turn off and unplug the particle counter.
2. Isolate the liquid particle counter from its fluid source.
3. Disconnect the sample inlet and outlet fittings.

Figure 3-1 LiQuilaz II fittings

4. Fill each syringe from the capillary cleaning kit with 5 ml of cleaning solution mixed to the recommended strength.

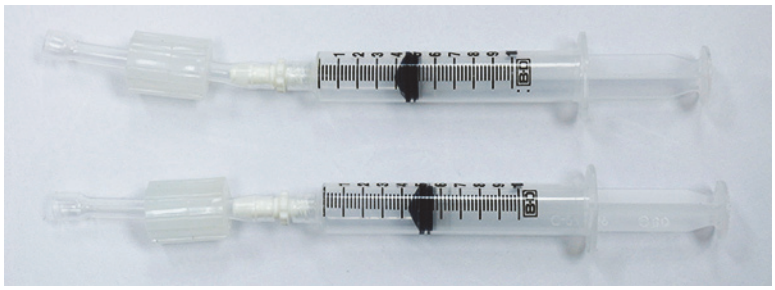

Figure 3-2 Capillary Cleaning Kit syringes

5. Connect the filled syringes to the particle counter's sample inlet and outlet connections.
6. Press one syringe plunger all the way into the syringe cylinder.
7. Force the cleaning solution back and forth between the two syringes for 30 seconds to 1 minute.

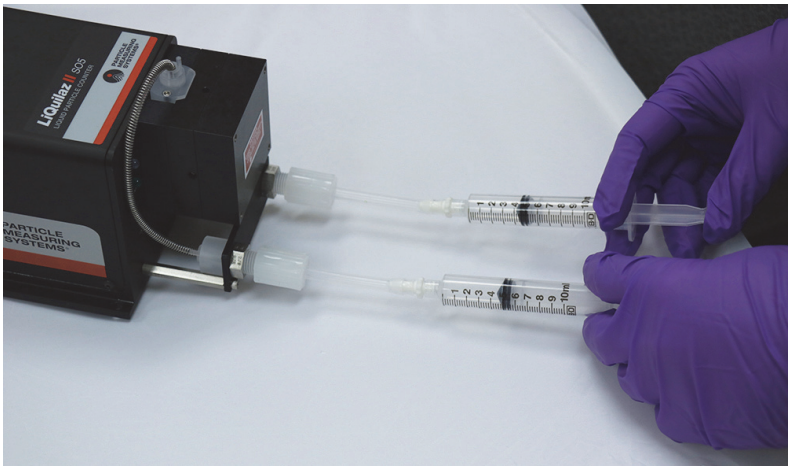

Figure 3-3 Pumping cleaning solution through the capillary

8. Disconnect the inlet syringe first, then the outlet syringe.
9. Connect the inlet to DI water and the outlet to a suitable drain.
10. Flush the cleaning solution from the particle counter with DI water.
    a. Connect the liquid particle counter inlet to a source of ultra-pure deionized water.
    b. Direct the liquid particle counter outlet to a drain suitable for the cleaning fluid.
    c. Flush the cleaning fluid from the particle counter for 3 - 5 minutes with DI water.
11. Setup the liquid particle counter tubing and run the particle counter while checking the DC Light level.
12. If the DC Light remains out of the instrument's designated specification, repeat the cleaning process.
13. If after further cleaning the DC Light remains outside the instrument's designated specification, please contact your local Particle Measuring Systems Service Center.

DC Light Specifications	
LiQuilaz II S liquid particle counter, model S02	< 0.5 Volts
LiQuilaz II S liquid particle counter, model S03/S05	< 0.05 Volts
LiQuilaz II E liquid particle counter, all models	> 7 Volts

If cleaning is unsuccessful and you are using an S series LiQuilaz sensor, follow the cleaning procedure in Applying Additional Capillary Cleaning Techniques (for S Series only) or return the LiQuilaz II Liquid Particle Counter to the Particle Measuring Systems Service Department.

Applying Additional Capillary Cleaning Techniques (for S Series only)

In cases where polymers were sampled, the most likely cause of contamination is trace polymer dried to the capillary. In this case, the polymer will probably require long term soaking in the appropriate solvent to facilitate removal of the contaminant.

Using the solvent with the cleaning syringes after soaking (assuming compatibility), should dislodge the residual contamination. Follow this with a DI flush, and, if necessary, additional cleaning with a glassware cleaner.

Sometimes the source of contamination is aggressively attached to the surface of the capillary. When these rare events occur, using cleaning syringes will not be sufficiently effective to return the DC Light value to acceptable limits. Under these situations, using a product called Super Floss® manufactured by Oral-B®, can sometimes dislodge the contamination.

CAUTION
Do NOT use floss on the LiQuilaz II E20P particle counter. Floss will damage the capillary on this unit.

>> To clean the liquid capillary using floss:

Follow these steps ONLY after an unsuccessful series of attempts to clean the capillary with the syringes.

1. Isolate the particle counter from all fluid sources by disconnecting any tubing from the inlet and outlet fittings.

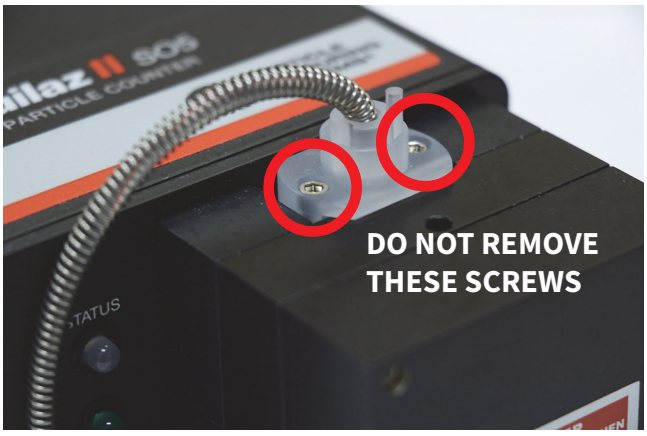

Figure 3-4 Screws near the tubing - DO NOT REMOVE

2. Carefully remove the top locking pin using a pair of needle nose pliers.

Figure 3-5 Locking pin removal

3. Use the 3-prong wrench (P/N 1000014376, supplied in the ship kit) to unscrew the fitting from the top capillary mount.

Figure 3-6 3-prong wrench placement

4. Gently lift the tubing out of the top capillary mount.

Figure 3-7 Tubing removed from capillary mount

CAUTION
Be very careful not to spill any fluid onto the gaps between the metal sections of the LiQuilaz II housing. Immediately wipe up any spills.

5. Remove the bottom locking pin and use the 3-prong wrench to remove the fitting from the bottom capillary mount.

Figure 3-8 Locking pin removal from bottom capillary mount

6. Remove a single strand of Super Floss from its package.

7. Identify the unwaxed end of the Super Floss and insert it through the capillary.

CAUTION
One end of the Super Floss is stiffened with wax, while the other is only compressed into stiff dental floss. Never pass the waxed end through the capillary.

8. As the spongy section of the Super Floss reaches the capillary, wet it lightly with cleaning solution.

NOTE: When selecting an appropriate cleaning solution, consider the types of contamination that will have deposited onto the capillary from the most recent fluid sampled.
For instance, if DI water was sampled last, bacteria, or particles are the most likely sources of contamination. If solvents were sampled last, optical hazing due to chemical impurities is most likely. Both of these situations can be easily remedied using high-quality laboratory glassware cleaner such Micro-90 or Radiacwash. A 5% solution of glassware cleaner in ultra-pure DI water should be used.

9. Gently pull the wetted portion of the Super Floss back and forth through the capillary for 10-15 seconds.

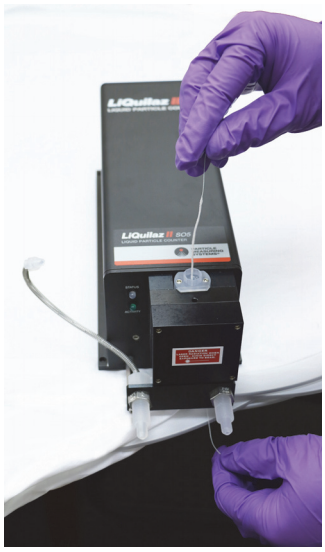

Figure 3-9 Superfloss cleaning action

NOTE: The best technique is to pull on one end of the Super Floss without holding onto the other end. Then, release the side you were pulling, and begin pulling from the other end. This will allow the floss to remain large and spongy as it travels through the capillary, contacting all surfaces of the capillary.

10. After 10-15 seconds of flossing action, remove the Super Floss from the capillary. Remember to remove the floss from the same direction that it was inserted. Do NOT pull the waxed-end through the capillary.

11. Reconnect the bottom fitting to the capillary mount using the 3-prong wrench, followed by the top fitting. The fitting should be snug (2 in-lbs), but do not overtighten.

12. Check for correct alignment of the fitting inside capillary mount. Ensure the locking pin can be inserted.

NOTE: If you are having trouble with alignment, gently tighten the fitting. Do not loosen.

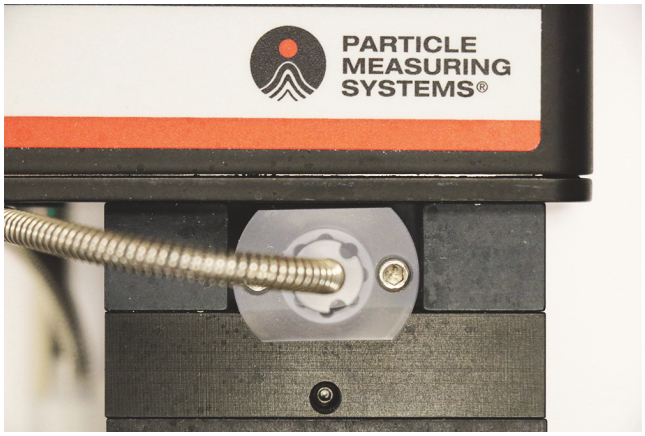

Figure 3-10 Hole alignment for locking pin insertion

13. Insert the locking pins into each fitting.

14. Connect the liquid particle counter inlet to a source of ultra-pure, deionized water.

15. Direct the liquid particle counter outlet to a drain suitable for cleaning fluid.

16. Flush cleaning fluid from the liquid particle counter with DI water for 3-5 minutes.
a. Check all fittings for leaks. Correct as required prior to testing unit on chemicals.

17. Check the DC Light using the provided software.

- If the DC Light fails to meet the following sensor specifications, repeat cleaning with one additional strand of Super Floss.
- If the DC light still does not meet sensor specifications, return the LiQuilaz II Liquid Particle Counter to Particle Measuring Systems Service Department.

DC Light Specifications	
LiQuilaz II S liquid particle counter, model S02	< 0.5 Volts
LiQuilaz II S liquid particle counter, model S03/S05	< 0.05 Volts
LiQuilaz II E liquid particle counter, all models	> 7 Volts

Calibration

If you are using SamplerSight-Pharma as your user interface, you can calibrate the LiQuilaz II E20, LiQuilaz II E20P and LiQuilaz II E15P instruments. Refer to the Calibration chapter in the *SamplerSight-Pharma User Guide*.

Otherwise, contact Particle Measuring Systems Service.

Fuses

The following procedure applies to all LiQuilaz II models.

WARNING
Disconnect the power cord from its power source.

Required items:

- Small flat-bladed tool such as a small screw driver
- Fuses: 250 V~, 5 x 20 mm, T, 0.75 A

>> To replace the fuses:

1. Use the LiQuilaz II Liquid Particle Counter power switch (located where the power cable connects) to turn off power.
2. Disconnect the power cable from the particle counter's power entry module.

NOTE: The black plastic assembly that the power cable connects to is called the *power entry module*. The power entry module also contains the fuse tray.

3. Use a tool like a flat-bladed screwdriver to open the fuse tray on the power entry module.
4. Remove the old fuses.
5. Install the correct replacement fuses.
6. Replace the fuse receptacle covers.
7. Restore power.

Chapter 4
Operation

After the LiQuilaz II Liquid Particle Counter has been connected to its sample source, connected to the PC, and connected to electrical power it is ready to be run from the PC by means of Facility Net, Pharmaceutical Net, SamplerSight, or SamplerSight-Pharma.

User Interface (Controls, Data Display, Data Collection)

The user interface is the Particle Measuring Systems *Facility Net*, *Pharmaceutical Net*, *SamplerSight*, or *SamplerSight-Pharma* software running on a separate PC.

- A Syringe Sampler version of a LiQuilaz II instrument is connected to the PC through its sampler.
- An Online version of a LiQuilaz II is connected to the PC directly with a communications cable.

After configuration, the user interface software controls all operating functions including the following:

- Sampling parameters: sample volume and sample interval (the interval between samples)
- Data collection
- Data display
- Alarms

All directions and options for configuring software are beyond the scope of this manual. See the appropriate software user's manual for a full description of how to use the user interface software with samplers and particle counters: *Facility Net User Manual, Pharmaceutical Net User Manual, SamplerSight User Guide, or SamplerSight-Pharma User Guide.*

Capillary Protection

Never allow the LiQuilaz II to completely dry. If it is to be disconnected from the process line or its sampler (SLS Family), fill it with a 10% solution of your laboratory glassware cleaner and water. Plug up the inlet and outlet with appropriate fittings.

Status LED

A status LED on the front panel next to the liquid connections illuminates as follows (when sensor configuration is default or **set led 1**):

Flashing green	No Ethernet connection to host computer
Green	Laser OK AND connected to host via Ethernet
Red	Laser error OR Ethernet protocol error

The status LED can be configured via a serial setup command (see “set led n” on page G-2). When communicating via RS-485, use “**set led 0**”. Otherwise the LED will flash green, since there is no Ethernet host attached.

Activity LED

An activity LED (located below the status LED, see **Figure 4-1**) illuminates when a particle is detected, providing a quick indication of whether the instrument is sampling. The Activity LED will stay illuminated if a laser error is detected.

Figure 4-1 Activity and Status LEDs

Appendix A
International Precautions

WARNING

This instrument is designated as a Class 1 laser product and complies with US 21 CFR 1040.10 and EN 60825-1. Use of controls, or adjustment, or performance of procedures other than those specified in this manual may result in hazardous radiation exposure.

AVERTISSEMENT

Cet appareil est classé comme produit laser de Catégorie 1 et est conforme aux normes US 21 CFR 1040.10 et EN 60825-1. L'utilisation de commandes, de réglages ou l'exécution de procédures autres que celles spécifiées dans le présent document peut provoquer une exposition à des radiations dangereuses.

WARNUNG

Bei diesem Gerät handelt es sich um ein Laserprodukt der Klasse 1, welches den Normen US 21 CFR 1040.10 und EN 60825-1 entspricht. Das Justieren der Lasereinheit, das Verändern des Gerätes oder Einsatzbereiche, die nicht den Vorgaben dieser Anleitung für das Gerät entsprechen, können dazu führen, dass gefährliches Laserlicht austritt.

ATTENZIONE

Lo strumento è classificato come prodotto laser di Classe 1 e rispetta l'US 21 CFR 1040.10 e l'EN 60825-1. L'uso dei comandi o la regolazione dello strumento, o l'esecuzione delle procedure con metodi non conformi a quanto specificato in questo manuale posso provocare una pericolosa esposizione alle radiazioni.

ADVERTENCIA

Este instrumento está catalogado como producto láser de Clase 1 y cumple con las normativas US 21 CFR 1040.10 y EN 60825-1. El uso de controles o el ajuste o la realización de procedimientos que no sean los especificados en este manual pueden provocar la exposición a radiación pveligrosa.

Hazard Symbols

The meaning of hazard symbols appearing on the equipment is as follows:

Symbol	Nature of Hazard
	Attention, consult accompanying documents.
	Dangerous High Voltage
	Warning – Laser radiation! Avoid exposure to beam.

Symboles de risque

Des symboles représentant les risques sont placés sur l'appareil. Leur signification est la suivante:

Symbole	Nature du risque
	Attention, consulter les documents d’accompagnement
	Danger Electricite
	Avertissement – Rayonnement laser ! Éviter toute exposition au faisceau.

Warnschilder

Die, an dem Gerat angebrachten Warnschilder haben folgende Bedeutungen:

Symbol	Gefahrenart
	Achtung! In den beiliegenden Unterlagen nachschlagen
	Achtung Hochspannung
	Warnung – Laserstrahlung! Nicht in den Strahl blicken.

Simboli di pericolo

Il significato dei simboli di pericolo che appaiono sugli strumenti il seguente:

Simbolo	Natura del pericolo
	Attenzione. Consultare i documenti allegati
	Tensione Pericolosa
	Avvertenza – Radiazione laser! Evitare l'esposizione ai raggi

Simbolos de peligro

Los simbolos de peligro que aparecen en el equipo significan:

Símbolo	Naturaleza del Peligro
	Atención, consultar los documentos adjuntos.
	Peligro alto voltaje.
	Advertencia – ¡Radiación láser! Evite exponerse al rayo.

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Appendix B
RS-485 Communication Protocol

The LiQuilaz II Liquid Particle Counter is a smart sensor designed to measure particles in liquids. To accommodate fast histogram displays and remote data collection functions the LiQuilaz II Liquid Particle Counter supports both the Fast and Slow communication protocols. A description of the protocols is covered in the following sections.

Operation Commands

The following is a presentation of typical command sequences that are processed to perform specific operations. The operations may be one-time command sequences (i.e., instrument initialization) or command sequences that are performed repeatedly (i.e., polling for data). A detailed explanation of each command is contained in the protocol section.

Instrument Initialization

The following command sequence is typical during initialization or re-initialization of the instrument:

CSR CDT CMODE

This sequence does the following:

- Performs a software reset
- Sets the current date/time into the instrument
- Sets the instrument into the correct operational mode

NOTE: The operational mode should be set to 1 for regular time-based operation. If the mode is set to other than 1, it is assumed the sensor is attached to an SLS Family sampler or CLS-700.

Sample Initialization

The following command sequence is typical when starting the instrument:

CSI CSIZE CSS

This sequence does the following:

- Sets the desired sample interval
- Sets the channel size values
- Starts the LiQuilaz II sampling

Data Processing

The LiQuilaz II can be polled for data in the following two ways:

Slow protocol
which is how all the regular commands are transmitted.

Fast protocol
where the term “Fast” refers to the ability to get data as a sample is created, not just at the end of a completed sample. It should be noted that a combination of “Slow” and “Fast” data polling is allowed.

Slow Polling

The following sequence is typical for a “Slow” data poll:

Once the LiQuilaz II has started sampling the user must poll the instrument to check its data queue. This is done by transmitting the **CQC** command. The instrument responds with a RQC and two values.

- If the first value is -1, the instrument is not sampling and needs to be re-initialized and started as outlined in the Instrument Initialization on page B-1 and Sample Initialization on page B-2 sections.
- If the instrument responds with a value of **0**, there is no data at this time; send another **CQC** command.
- If the instrument responds with a value of **1** or greater, data is present.

To receive the stored data, the user now must transmit the **CTD** command.

If the data is received with no problems, the user should issue the **CPQ** command to “pop” the data off of the LiQuilaz II data queue.

If the data is not received correctly, the **CTD** command can be reissued.

This procedure can be repeated until the user no longer wishes to receive sample data.

The second value reported by the sensor with the RQC response represents its sampling status (1=Sampling).

NOTE: The CQC command is typically transmitted to the instrument at twice the sample interval.

NOTE: The RS-485 interface in the LiQuilaz II presents a fixed data queue of 10.

The LiQuilaz II will respond with a value of -1 to a CQC command only after a software reset has occurred. A software reset can occur due to power-up, a CSR command from the user, or an error detected by the watch-dog interrupt.

Fast Polling

The logical sequence of events while performing the “Fast” data poll is identical to those for the “Slow” data poll with the following exceptions:

- The address of the instrument, logically combined with the value 80Hex, is transmitted instead of the CQC command.
- The response to the “Fast” poll command contains the status (sampling or not).

The queue count is used just like it was used in the “Slow” data poll procedure.

NOTE: The “Fast” poll command is not typically transmitted any faster than 3 times in one second.

Slow Protocol

The Slow protocol general communication procedure has a “command/response sequence.” For each command directed to a LiQuilaz II Liquid Particle Counter, a response is generated by the unit. The format of the response depends on the particular command. See Slow Protocol Commands on page B-5 for a complete listing of the LiQuilaz II Liquid Particle Counter commands. These commands and responses are formatted and packeted to ensure error-free communication. The formatting and packeting process is discussed in the following paragraphs.

The process of building a packet can be divided into three logical steps as described below.

First Logical Step

The address of the node is added to the beginning of the data, and a checksum is added to the end of the data. This produces the following un-formatted data structure.

ADDRESS HIGH BYTE|ADDRESS LOW BYTE|FIRST DATA BYTE|SECOND DATA BYTE|...|LAST DATA BYTE|CHECKSUM HIGH BYTE|CHECKSUM LOW BYTE

NOTE: “|” is used for readability and does not exist in the actual data packet.

NOTE: CHECKSUM is a 16-bit unsigned integer sum of the unformatted data including the address with the carry bit ignored, if an overflow occurs during the calculation. STX and ETX are not included in the check sum.

Second Logical Step

This step minimizes difficulties when the network includes devices such as modems. Only visible ASCII characters (32–126), with the exception of the packet delimiting STX and ETX, are transmitted on the network. The non-visible characters and non-ASCII characters are run through the conversion formula shown below before they are transmitted. STX and ETX are used as packet delimiters. They are not visible characters and do not cause problems as the NUL, DEL and other 8-bit data characters can.

Value of Byte		**Character(s) transmitted i.e., byte 1H, byte 2H**
byte	<20H	7BH, byte + 20H
7B	<=byte <80H	7CH, byte - 5BH
80H	<= byte <COH	7DH, byte - 60H
COH	<= byte	7EH, byte - AOH
otherwise		byte

A typical command and response packet at this point in the formatting and packeting process will have the following appearance:

Command -> CQC

Response -> RQC

This particular LiQuilaz II has an address of 1.

Command transmitted to LiQuilaz II:

ASCII	->	{ {!CQC{ ->8
Hex	->	7B207B214351437B207E38

Response transmitted by the LiQuilaz II:

ASCII	->	{ {!RQC -1 0 {!}U
Hex	->	7B207B21525143202D3120307B217D55

Third Logical Step

Preface the ASCII packet formed in the second step with a ASCII STX character and terminate it with an ASCII ETX character (STX = 2, ETX = 3).

The system transmission parameters are listed below.

Baud Rate	9600
Parity	None
Bit Transmitted	8
Stop Bits	1

Slow Protocol Commands

Command	Response	Purpose
NOTE: Commands are case sensitive		
CMODE n	RMODE	Select time-based or sample-based sampling mode
CSI n	RSI	Set the sample interval, in seconds, for the time-based mode
CDT ...	RDT	Set date and time
CTD	RTD ...	Transmit a data report
CPQ	RPQ	Remove the oldest record from queue
CFQ	RFQ	Delete all untransmitted reports
CQC	RQC n s	Return the number of reports on the transmission queue and the sampling status
CSR	RSR	Software reset
CSS	RSS	Start time-based sampling mode
CTS	RTS	Terminate current sample and stop sampling
CVER	RVER ...	Request LiQuilaz II software version
CSATH ...	RSATH n	Set absolute PHA thresholds
CRATH	RRATH ...	Read absolute PHA thresholds
CSPHA ...	RSPHA n	Set the PHA parameters
CRPHA	RRPHA ...	Read PHA parameters
CSIZE ...	RSIZE n	Set channel sizes
CRSIZE	RRSIZE ...	Read channel sizes
CSTAB ...	RSTAB n	Set table values
CRTAB	RRTAB	Read table values
CADDRESS n	RADDRESS n	Set instrument address

Detailed Description of Slow Protocol Commands and Responses

CMODE n

Selects either time-based sampling for in-situ applications, or sampler-based sampling. When n = 1, time-based mode is selected. When n is other than 1, sampler-based sampling is selected. The default is time-based sampling.

In sampler-based mode, the LiQuilaz II Liquid Particle Counter will begin a sample and accumulate counts whenever the hardware sampling control line is asserted. A sample is ended in this mode when the hardware sampling-control line is unasserted.

In time-based mode, the LiQuilaz II Liquid Particle Counter continuously collects samples using the duration set with the CSI command. The CSS command starts the sample process.

CSI n

Sets the sample interval, in seconds, for time-based sampling. 1 < n < 28800.

CDT yyyy/mm/dd/ hh:mm:ss

Sets date and time for the LiQuilaz II. If the instrument is sampling when this command is issued, the sample will be aborted and the LiQuilaz II will stop sampling.

CTD

Transmit the report currently on the top of the transmission queue. The detailed format of the report is shown below.
(Note that this is the unformatted data report.)

<STX>	Begin report flag. The STX character is 2.
ADDRESS	Address of responding LiQuilaz II. Range between 1 and 99.
RTD <LF> TI hh:mm:ss <LF>	Time the data was taken. This is the start of the sample interval.
DA yy/mm/dd <LF>	Date the sample was taken.
NC n <LF>	Number of channels. 0 < n < 31.
SI n.n <LF>	Length of the sample interval. The sample interval will be between 0.0 and 85899345.49.
L0 n <LF>	bit n.1 = Laser Status 1 = Laser Good Status 0 = Laser Bad bit n.2 = Not Used bit n.3 = Flow Rate 1 = Flow Rate Good Flow Rate 0 = Flow Rate Bad bit n.4 = Not Used bit n.5 = Not Used bit n.6 = Not Used bit n.7 = Not Used bit n.8 = Not Used

NOTE: Bit n.3, the sample signal line for the sample-based mode, is only valid in the time-based mode.

DC n <LF>	D.C. light voltage. The max voltage is 10 Volts. 0 < n < 4095; 10 Volts corresponds to 4095.
1 n <LF>	Smallest channel particle count. 0 < n < 4294967295
2 n <LF>	0 < n < 4294967295
3 n <LF>	0 < n < 4294967295
. <	
.	
.	
nc n <LF>	Largest channel particle count. 0 < nc < 32; 0 < n < 4294967295
CHKSUM <LF>	Check sum of the data packet. 0 <= CHKSUM <= 65536
<EXT>	The ETX character is 3.

Channel 1 is the channel with the smallest size threshold (i.e., smallest particle bin).

CPQ

Pop Queue- Discards the report currently on the top of the transmission-queue (the oldest record). This command does not disturb the sampling process.

CFQ

Flush queue - Discards all reports on the transmission-queue if not sampling.

CQC

Queue Count - Returns the number of reports on the transmission queue and the sampling status (1 = sampling).

CSR

Software reset - The system does its best to simulate a hardware reset, typically by stopping keep-alive strobes to a hardware watchdog device. The RSR response will be transmitted after the LiQuilaz II has reset.

CSS

Start sampling — starts continuous time-base sampling. When the LiQuilaz II is in sampler mode, this command has no effect. If the instrument is currently sampling, it will abort the sample and start a new sample.

CTS

Terminate sampling - causes the LiQuilaz II to stop continuous time-mode sampling and return to the idle state. This command has no effect during Sampler mode.

CVER

The LiQuilaz II will return the original version string of the software currently running since it is used by the DOS calibration program, and then appends the current version information. This version can be a string of up to 200 characters in this format: RVER LIQUILAZ VERSION 3.2, 01/11/99 (1.08 51), Built: April 27, 2017

CSATH nc n1 n2 n3 ... n(nc)

Set absolute PHA thresholds.
nc = the number of thresholds to be programmed.
nc through n(nc) are addresses that represent the RAM location boundaries of the channels. For example, channel 1 runs from n1 to n2, channel 2 runs from n2 to n3 and the last channel is all locations greater than n(nc).
The maximum values for nc and n are 31 and 8191 respectively for the LiQuilaz II Liquid Particle Counter. The values are stored in battery backup RAM. The last values used are the default values on power up. Returns 1 if the values are accepted or 0 if sampling or the values are out-of- range.

CRATH

Read absolute PHA thresholds. The response is RRATH nc 1 2 3 ... nc. The first number (nc) is the number of thresholds that are currently programmed. Following the numbers are **nc** addresses that represent the RAM location boundaries of the channels.
For example, channel 1 runs from n1 to n2, channel 2 runs from n2 to n3 and the last channel is all locations greater than n(nc). The maximum values for nc and n are 31 and 8191 respectively for the LiQuilaz II Liquid Particle Counter.

CSPHA ...

Stores the current state of the PHA. The values are stored in battery backup RAM. The last values used will be the default values on power up. The response to the command is RSPHA n, where n = 1 is a valid state of the PHA and n = 0 is an invalid state. The detailed format of the command is as follows.

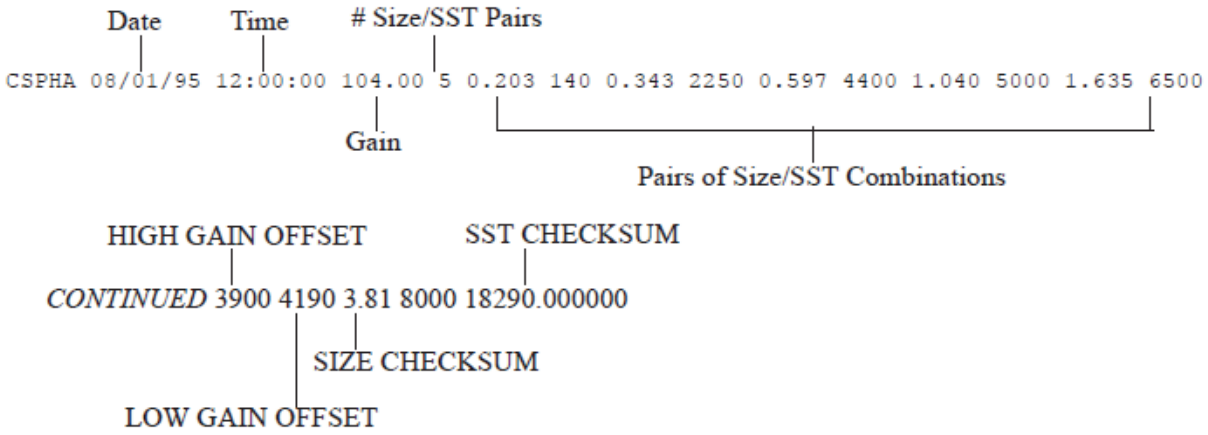
Below is the format for the calibration string in the LiQuilaz II Liquid Particle Counter. The calibration strings for the S-Series and E-Series are slightly different. The calibration string created by SamplerSight-Pharma (for E20 or E15P) appends the calibrated flow rate to the end of the string. The S series calibration strings have checksums, and the E series calibration strings do not.

The following calibration information will be downloaded and uploaded as an ASCII string. The format is as follows:

Date	<MM/DD/YY>
Time	<HH:MM:SS>
Gain	(double)
No. Size/SST pairs	(int)
Pairs of Size/SST Combinations	
Size	(double)
SST	(int)
High Gain Offset	(int)
Low Gain Offset	(int)
Size Checksum	(double)
SST Checksum	(double)

Each token within the string is separated by spaces (character 0 x 20), and the string is null terminated.

The following example for CSPHA and CRPHA are for an S-series instrument:



CRPHA

Returns the current state of the PHA in the following format:
CRPHA 08/01/95 12:00:00 104.00 5 0.203 140 0.343 2250 0.597 4400 1.040 5000 1.635 6500 3900 4190 3.81 8000 18290.000000

CSIZE nc n1 n2 n3 ... n(nc)

Set channel sizes. The first number (nc) is the number of sizes to be used. There are then nc actual sizes to set. Returns 1 if sizes are acceptable or 0 if sampling or the sizes are incorrect.

CRSIZE

Read channel sizes. The response is RRSIZE nc n1 n2 n3 ... n(nc); where n is a channel size. This will yield data only if the channel sizes were set with the CSIZE command.

CSTAB nc a1 b1 a2 b2 ... a(nc) b(nc)

Set table values. The first number (nc) is the number of table entries. There are then, nc actual table entry pairs. Each pair of values represents size * 1000 and a corresponding threshold value. Returns 1 if entries are acceptable or 0 if sampling or the entries are incorrect.

CRTAB

Read table values. The response is RRTAB nc a1 b1 a2 b2 ... a(nc) b(nc); where a is a channel size * 1000 and b is a threshold value. This will yield data only if the table values were set with the CSTAB command.

CADDRESS n

Set instrument Address. 0 < n < 99. Instrument will respond with RADDRESS n at original address.

Each device will respond with the STX character of a response within a device-specific time, about 4 seconds. If no response is received within this time a time-out fault condition should be assumed by the host computer.

Fast Protocol

The Fast communication protocol allows the Data Display System to acquire the most recent data for the sample in progress. This mode operates concurrently with, and independently of, the Slow protocol mode. To initiate a Fast poll, the Data Display System need only transmit the address of the desired device. The address of a device that supports the Fast communication mode is the same as the address of the Slow mode, except that the most significant bit of the address will be set. For example: if the device's network address is 1, the address for the Fast mode is 129).

The following information is transmitted back to the Data Display System per each poll:

1) ADDRESS	A one-byte device address.
2) SAMPLE_INTERVAL	A 4-byte unsigned number that is the time elapsed since the start of the sample. (56th of a second)
3) LASER/FLOW STATUS	bit n.1 = Laser Status 1 = Laser Good Laser Status 0 = Laser Bad bit n.2 = Not Used bit n.3 = Flow Rate 1 = Flow Rate Good Flow Rate 0 = Flow Rate Bad bit n.4 = Not Used bit n.5 = Not Used bit n.6 = Not Used bit n.7 = Not Used bit n.8 = Not Used
	NOTE: The bit n.3 is only valid in the time-based mode. The bit n.3 is the sample signal line for the sample-based mode.
4) SAMPLE_STATUS	Time-base mode only: A 1-byte number. The most significant bit represents the sampling status. The low 7 bits represents the Queue Count. The Queue Count in the Slow and Fast protocols are identical. Sampler base mode: Status=1→Sampling Status=0→Not Sampling
5) DC_LIGHT	A 2-byte unsigned numberDC Light that is the DC Light voltage in steps of 2.44 mv/bit (i.e., 4095 = 10 Volts).
6) NUMBER_CHANNELS	A 1 byte number that is the number of channels currently programmed into the device.
7) unsigned long CHANNELn	A 4-byte number that is the number of particles found in the nth channel. CHANNEL 1 has the smallest size threshold. Each channel is an unsigned long counter. If the device is programmed to have n = 16 channels, a total of 64 bytes can be expected back in this field. See the examples on pages page B-11 and page B-12.
8) CHECK_SUM	A 2-byte value that is the sum of all the bytes in the "unformatted data packet" with the exception of the STX, ETX, and checksum itself. The carry bit in the addition is ignored. It is transmitted as Low Byte, High Byte.

Formatting Data

The data is in straight binary format with an STX at the start of the packet and an ETX at the end. Since the STX and the ETX may be valid values in the actual data, the following data formatting algorithm must be used to prevent confusion between data in the packet and delimiting characters:

FORMAT ALGORITHM:

packet = STX B1 B2 ...BK ...BN ETX

```
if Bk equals STX, ETX or FF(hex)
   transmit FF(HEX)
   transmit Bk exored with 80(hex)
else
   transmit Bk
```

Since the node does not respond to any commands other than those sent to its address, the host computer will initiate a Fast protocol transmission by sending a single 8-bit address character on the network. The lower 7 bits of this character will have a value between 0 and 99 that corresponds to the node's main network address. The upper (most significant) bit of the address character will be a 1, indicating that a Fast protocol response is being requested. After recognizing its address, the node responds with the following report with each line describing a single character. Note that this is the unformatted packet, before it is sent to the format algorithm.

```
<STX>
ADDRESS
SI.4
SI.3
SI.2
SI.1
LASER/FLOW STATUS
SAMPLE_STATUS
DC_LIGHT.2
DC_LIGHT.1
NUMBER_CHANNELS
CHANNEL1.4
CHANNEL1.3
CHANNEL1.2
CHANNEL1.1
CHANNEL2.4
CHANNEL2.3
CHANNEL2.2
CHANNEL2.1
CHANNEL3.4
CHANNEL3.3
CHANNEL3.2
CHANNEL3.1
:
.
CHANNELn.4
CHANNELn.3
CHANNELn.2
CHANNELn.1
CHECK_SUM.2
CHECK_SUM.1
<<ETX>>
```

CHANNEL 1 is the channel with the smallest size threshold. CHECK_SUM is a 16-bit unsigned summation of all bytes. The STX and ETX characters are not included in the checksum. The carry-bit is ignored if overflow occurs during calculation of the checksum.

Each device responds with the STX character of a report within approximately 1 second of the receipt of its address. If no response is received within this time, a time-out fault condition should be assumed by the host computer.

Example:

NOTE: All numbers are in hexadecimal.

Address transmitted by Data Display System -> 81
Response from LiQuilaz II-E20 ->
028100000000100FF7F000F0000000000000000000000000000000000000000000000000000000000000900103

This LiQuilaz II-E20 responded with the following information:

STX	-> 02	
ADDRESS	-> 81	
SAMPLE_INTERVAL	-> 00000000	
LASER/FLOW STATUS	-> 01	
SAMPLE_STATUS	-> 00	
DC_LIGHT	-> FF7F00	= 00FFHEX
NUMBER_CHANNELS	-> 0F	
CHANNEL1	-> 00000000	
CHANNEL2	-> 00000000	
CHANNEL3	-> 00000000	
CHANNEL4	-> 00000000	
CHANNEL5	-> 00000000	
CHANNEL6	-> 00000000	
CHANNEL7	-> 00000000	
CHANNEL8	-> 00000000	
CHANNEL9	-> 00000000	
CHANNEL10	-> 00000000	
CHANNEL11	-> 00000000	
CHANNEL12	-> 00000000	
CHANNEL13	-> 00000000	
CHANNEL14	-> 00000000	
CHANNEL15	-> 00000000	
CHECKSUM	-> 9001	= 190 HEX
ETX	-> 03	

Appendix C
Modbus TCP Protocol

Communications with the LiQuilaz II particle counter are available via Modbus TCP. The instrument presents a single TCP/IP Ethernet connection at port 502 using the standard Modbus protocol.

Two specification documents were used in the development of the Modbus interface:

- "MODBUS MESSAGING ON TCP/IP IMPLEMENTATION GUIDE V1.0b"
- "MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b"

The Modbus protocol, as implemented in this instrument, utilizes generic 0-based addressing.

Modbus Overview

Each register in the Modbus map is defined to be 16 bits. The map can contain three distinct sections:

1	**Input registers**	Read Only information for ID and data collection
2	**Holding registers**	Read/Write parameters for configuring the device
3	**Coils**	Read/Write individual bits to control the device

The supported functions include:

1 Read Coils
3 Read Holding Registers
4 Read Input Registers
5 Write Single Coil
6 Write Single Holding Register
15 Write Multiple Coils
16 Write Multiple Holding Registers
22 Mask Write Holding Register
23 Read/Write Multiple Holding Registers

- Any registers accessed but not defined will generate an address error.
- Spare coils/registers will "set" without error and always return a zero value.
- Registers set with invalid data will return a function error.

The map delineates three types of register assemblies:

1 **Unary**: an individual register

2 **Dual**: a register pair used for a 32 bit representation

3 **String**: a group of registers containing ASCII bytes

There is a setting available that toggles the interpretation of selected dual-register values. These values can be interpreted as integer representations of floating point numbers with a fixed scaling factor or as IEEE-754 floating point representations of that value. Refer to the register map to determine which register pairs have this feature applied. This setting can be made in the setup interface, and saved in non-volatile storage, or set real-time via the associated coil.

Even though the Modbus protocol itself is standard, the contents of the registers are application-specific. A description of the register map is the definitive specification for that application interface. The following Modbus register map has comments and notes to help with its intended use.

Input Registers

The input registers are in two sections: **Configuration** and **Data**.

The **Configuration** section description begins on this page.

The **Data** section description begins on page **C-6**.

Configuration Section

The **Configuration** section contains:

- Modbus Map Version
- Sensor Firmware Version
- Product Name
- Flow Rate and Volume Scale Factors
- Flow Rate
- Number of Channels (Particle & Analog)
- Particle Channel sizes

30001: **Modbus Map Version**	This is a fixed value representing the version number of the LiQuilaz II Modbus map multiplied by 100. The version can change if/when the basic structure of the map and/or processing associated with the structure of the map is adjusted. Note: Additions and/or definitions to the spare entries will not generally require a version change - they will simply be annotated as to the applicability to that particular instrument. The same reasoning is applied to unique registers and/or coils for a particular instrument - they will simply be annotated as being specific to that device.
30002: **Sensor Firmware Version**	This is a value representing the version number of the firmware multiplied by 100.
30003 - 30010: **Product Name**	Product name entered using ASCII bytes and positioned as shown in the map.
30011: **Flow Rate Scale Factor**	The power of 10 multiplied to the flow rate and then entered into registers 30013/30014 and 30222/30223. Used when the floating-point representation is disabled. The LiQuilaz II uses a value of 3 to represent a fixed scaling factor of 1000 for flow rate.
30012: **Volume Scale Factor**	The power of 10 multiplied to the volume and then entered into registers 30224/30225. Used when the floating-point representation is disabled. The LiQuilaz II uses a value of 2 to represent a fixed scaling factor of 100 for volume.
30013 - 30014: **Flow Rate**	Dual-register representation of the nominal flow rate in milliliters per minute. Can be integer or float depending on mode selected. The integer representation uses scale factor from register 30011.
30015: **Number of Particle Channels**	Processed as a variable but fixed to a value of 16 for LiQuilaz II. Although the LiQuilaz II will show a fixed value of 16 indicating that the maximum allowed number of channels is 16, fewer channels may be configured and the currently unused size channels will be loaded with a value of zero.
30016: **Number of Analog Channels**	Processed as a variable but fixed to a value of 1 for LiQuilaz II.
30017 - 30048: **Dual-Register Representation of the Particle Channel Sizes in Nanometers**	The LiQuilaz II allows for a variable number of channels and variable sizes for each channel. All 16 channels can be read, and unused size channels will show a value of zero.

Table C-1 Input Register – Configuration

Input Registers		Description (Configuration)	Comment	Notes
30001	unary	Modbus Map Version	Version 1.00 (Static 100)	
30002	unary	Sensor Firmware Version	Encoded Firmware version	
30003	unary	Product Name: Char 00, 01	Product Name	
30004	string	Product Name: Char 02, 03	Product Name	
30005	string	Product Name: Char 04, 05	Product Name	
30006	string	Product Name: Char 06, 07	Product Name	
30007	string	Product Name: Char 08, 09	Product Name	
30008	string	Product Name: Char 10, 11	Product Name	
30009	string	Product Name: Char 12, 13	Product Name	
30010	string	Product Name: Char 14, 15	Product Name	
30011	unary	Scale: Flow Rate	Multiplier in fixed: Flow Rate	3 (1000)
30012	unary	Scale: Volume	Multiplier in fixed: Volume	2 (100)
30013	dual	Flow Rate (high)	Flow * 10^{Scale}	Float Mode
30014	dual	Flow Rate (low)	Flow * 10^{Scale}	Float Mode
30015	unary	Number of Particle Channels	Fixed number of sizes	16 fixed
30016	unary	Number of Analog Channels	Fixed number of analogs	1 fixed
30017	dual	Channel 1 Size (high)	nanometers	
30018	dual	Channel 1 Size (low)	nanometers	Variable
30019	dual	Channel 2 Size (high)	nanometers	
30020	dual	Channel 2 Size (low)	nanometers	Variable
30021	dual	Channel 3 Size (high)	nanometers	
30022	dual	Channel 3 Size (low)	nanometers	Variable
30023	dual	Channel 4 Size (high)	nanometers	
30024	dual	Channel 4 Size (low)	nanometers	Variable
30025	dual	Channel 5 Size (high)	nanometers	
30026	dual	Channel 5 Size (low)	nanometers	Variable
30027	dual	Channel 6 Size (high)	nanometers	
30028	dual	Channel 6 Size (low)	nanometers	Variable
30029	dual	Channel 7 Size (high)	nanometers	
30030	dual	Channel 7 Size (low)	nanometers	Variable
30031	dual	Channel 8 Size (high)	nanometers	

Table C-1 Input Register – Configuration (Continued)

Input Registers		Description (Configuration)	Comment	Notes
30032	dual	Channel 8 Size (low)	nanometers	Variable
30033	dual	Channel 9 Size (high)	nanometers	
30034	dual	Channel 9 Size (low)	nanometers	Variable
30035	dual	Channel 10 Size (high)	nanometers	
30036	dual	Channel 10 Size (low)	nanometers	Variable
30037	dual	Channel 11 Size (high)	nanometers	
30038	dual	Channel 11 Size (low)	nanometers	Variable
30039	dual	Channel 12 Size (high)	nanometers	
30040	dual	Channel 12 Size (low)	nanometers	Variable
30041	dual	Channel 13 Size (high)	nanometers	
30042	dual	Channel 13 Size (low)	nanometers	Variable
30043	dual	Channel 14 Size (high)	nanometers	
30044	dual	Channel 14 Size (low)	nanometers	Variable
30045	dual	Channel 15 Size (high)	nanometers	
30046	dual	Channel 15 Size (low)	nanometers	Variable
30047	dual	Channel 16 Size (high)	nanometers	
30048	dual	Channel 16 Size (low)	nanometers	Variable

Data Section

The **Data** section contains:

- Calibration Date
- Serial Number
- Device Status
- Device State
- Number of data samples in queue
- Sample Data information

The **Data** section starts with what would have normally been considered configuration information - calibration date and serial number. This was added to allow for a single contiguous read when this particular information was desired along with the regular sample data. If not desired, then start reading at register 30212.

30201: **Calibration Date (Month)**	A value between 1 and 12.
30202: **Calibration Date (Day)**	A value between 1 and 31.
30203: **Calibration Date (Year)**	A value representing the year (e.g., 2017)
30204 - 30211: **Serial Number**	Serial number entered using ASCII bytes and positioned as shown in the map.
30212 - 30213: **Device Status**	Dual-register representation of device status. Integer bit mask matching the current coil selections for convenience. The host can use this to check for data availability, data format, etc while reading the data. A separate coil read would not be required. Values are defined in **Table C-5** on page C-17.
30214: **Device State**	Least Significant byte (LSB) is State. Most Significant Byte (MSB) is sub-state. Values are defined in **Table C-5**.
30215: **Number of Data Samples in the Queue**	A value of zero is identical to no data available (coil 00/02 read as zero). The queue size setting will determine if the data register section shows real-time data or stored data. If the queue size setting has been set to one, the sample data will always represent the last real-time data packet and the queue value will be set to one if there is a data packet available. If the queue size setting is set greater than one, the sample data will represent the last data queued and the queue value will be set to one if there is any queued data available. The two types of data presentation are supported by the same Modbus register map and are delineated by how the host system processes the register/coil fields and the instrument queue setting. The data register section can be forced to show real-time data by setting the queue size to one or to show queued data by setting the queue size greater than one. Queued data is always presented oldest first. The queue size command is “set queue #” where # is between 1 and 1440.

30216 - 30217: **Time Stamp**	Dual-register representation of data packet time stamp. Integer value (type defined as time_t) representing start date/ time in seconds since January 1, 1970.
30218 - 30219: **Sample Time**	Dual-register representation of data packet sample interval processed in units of seconds. Can be integer or float depending on mode selected. The integer representation is time in seconds multiplied by 100.
30220- 30221: **Data Packet Status**	Values are defined in **Table C-5** on page C-17.
30222 - 30223: **Flow Rate**	Dual-register representation of the data packet flow rate in milliliters per minute. Can be integer or float depending on mode selected. The integer representation uses the scale factor from register 30011.
30224 - 30225: **Volume**	Dual-register representation of the data packet volume in milliliters. Can be integer or float depending on mode selected. The integer representation uses scale factor from register 30012.
30226: **Location**	Index of location value associated with data packet. Not used for LiQuilaz II.
30227: **Number of Particle Channels**	Processed as a variable since the LiQuilaz II can queue data packets which were collected using a varying number of selected channels. If a varying number of size channels are processed, it is up to the host to track the sizes specified for each data set or to delete the queued data after a size channel adjustment.
30228: **Number of Analog Channels**	Processed as a variable but fixed to a value of 1 for LiQuilaz II.
30229 - 30260: **Cumulative Particle Data**	Dual-register representation of particle size counts. Currently unused size channels will be loaded with a value of zero.
30261 - 30262: **Analog Data**	Dual-register representation of the data packet analog value. Can be integer or float depending on mode selected. The integer value represents the scaled DC Light input multiplied by 10000. Integer representation limited to a value between -214748.3648 to 214748.3647.

Table C-2 Input Register – Data Packet

Input Registers		Description (Data Packet)	Comment	Notes
30201	unary	Calibration Date (Month)	Calibration Date	
30202	unary	Calibration Date (Day)	Calibration Date	
30203	unary	Calibration Date (Year)	Calibration Date	
30204	string	Serial Number: Char 00, 01	Serial Number	
30205	string	Serial Number: Char 02, 03	Serial Number	
30206	string	Serial Number: Char 04, 05	Serial Number	
30207	string	Serial Number: Char 06, 07	Serial Number	
30208	string	Serial Number: Char 08, 09	Serial Number	
30209	string	Serial Number: Char 10, 11	Serial Number	
30210	string	Serial Number: Char 12, 13	Serial Number	
30211	string	Serial Number: Char 14, 15	Serial Number	
30212	unary	Device Status (high)	Device Status Mask	
30213	unary	Device Status (low)	Device Status Mask	
30214	unary	Device State	Device State	
30215	unary	Number of data samples in queue	Number of samples in queue	
30216	dual	Time Stamp (high)	time_t	
30217	dual	Time Stamp (low)	time_t	
30218	dual	Sample Time (high)	Seconds * 100	Float Mode
30219	dual	Sample Time (low)	Seconds * 100	Float Mode
30220	dual	Data Packet Status (high)	Bit Mask	
30221	dual	Data Packet Status (low)	Bit Mask	
30222	dual	Flow Rate (high)	Flow * 10^{Scale}	Float Mode
30223	dual	Flow Rate (low)	Flow * 10^{Scale}	Float Mode
30224	dual	Volume (high)	Volume * 10^{Scale}	Float Mode
30225	dual	Volume (low)	Volume * 10^{Scale}	Float Mode
30226	unary	Location	Location value	n/a
30227	unary	Number Particle Channels	Variable across types	Variable (1-16)
30228	unary	Number Analog Channels	Variable across types	1 fixed
30229	dual	Particle Channel 1 (high)	Cumulative Raw Ch1	
30230	dual	Particle Channel 1 (low)	Cumulative Raw Ch1	
30231	dual	Particle Channel 2 (high)	Cumulative Raw Ch2	
30232	dual	Particle Channel 2 (low)	Cumulative Raw Ch2	

Table C-2 Input Register – Data Packet (Continued)

Input Registers		Description (Data Packet)	Comment	Notes
30233	dual	Particle Channel 3 (high)	Cumulative Raw Ch3	
30234	dual	Particle Channel 3 (low)	Cumulative Raw Ch3	
30235	dual	Particle Channel 4 (high)	Cumulative Raw Ch4	
30236	dual	Particle Channel 4 (low)	Cumulative Raw Ch4	
30237	dual	Particle Channel 5 (high)	Cumulative Raw Ch5	
30238	dual	Particle Channel 5 (low)	Cumulative Raw Ch5	
30239	dual	Particle Channel 6 (high)	Cumulative Raw Ch6	
30240	dual	Particle Channel 6 (low)	Cumulative Raw Ch6	
30241	dual	Particle Channel 7 (high)	Cumulative Raw Ch7	
30242	dual	Particle Channel 7 (low)	Cumulative Raw Ch7	
30243	dual	Particle Channel 8 (high)	Cumulative Raw Ch8	
30244	dual	Particle Channel 8 (low)	Cumulative Raw Ch8	
30245	dual	Particle Channel 9 (high)	Cumulative Raw Ch9	
30246	dual	Particle Channel 9 (low)	Cumulative Raw Ch9	
30247	dual	Particle Channel 10 (high)	Cumulative Raw Ch10	
30248	dual	Particle Channel 10(low)	Cumulative Raw Ch10	
30249	dual	Particle Channel 11 (high)	Cumulative Raw Ch11	
30250	dual	Particle Channel 11 (low)	Cumulative Raw Ch11	
30251	dual	Particle Channel 12 (high)	Cumulative Raw Ch12	
30252	dual	Particle Channel 12 (low)	Cumulative Raw Ch12	
30253	dual	Particle Channel 13 (high)	Cumulative Raw Ch13	
30254	dual	Particle Channel 13(low)	Cumulative Raw Ch13	
30255	dual	Particle Channel 14 (high)	Cumulative Raw Ch14	
30256	dual	Particle Channel 14 (low)	Cumulative Raw Ch14	
30257	dual	Particle Channel 15 (high)	Cumulative Raw Ch15	
30258	dual	Particle Channel 15 (low)	Cumulative Raw Ch15	
30259	dual	Particle Channel 16 (high)	Cumulative Raw Ch16	
30260	dual	Particle Channel 16 (low)	Cumulative Raw Ch16	
30261	dual	DC Light (high)	Analog 1*10000	Float Mode
30262	dual	DC Light (low)	Analog 1*10000	Float Mode

Holding Registers

Like the coils, spares are in place between the "standard" registers and those that are designated as specific/optional. There are additional registers, in the LiQuilaz II, which allow the host application to set the number of size channels (1-16) and the size of each channel. The minimum number of size channels is 1 and the maximum is 16. The size channels have to start at channel 1, be contiguous, ascending and be between the minimum and maximum size allowed for the sensor being integrated.

If sample setting holding registers are sent while the unit is sampling, it will transition to a state of Idle.

40001 - 40002: **Real Time Clock**	Dual-register representation of current date & time. Integer value (type defined as time_t) representing date/time in seconds since January 1, 1970. The Network Time Protocol (NTP) feature can be enabled to automatically update the real-time clock if a NTP server is available and would make use of these registers unnecessary.
40003: **Sample Interval/Sample Volume**	This register is only used in the Sample Interval mode for LiQuilaz II. This register represents the number of seconds to run each sample. The allowed sample interval is 1 to 28800 seconds (8 hours).
40004: **Hold/Tare Time**	Time, in seconds, processed between the start command and starting the first sample. The allowed tare time is 0 to 28800 seconds (8 hours).
40005: **Repeat Count**	Number of samples to process. A value of zero will command continuous processing.
40006: **Delay Time**	Time, in seconds, processed between each sample. Not used for LiQuilaz II.
40007 - 40032: **Spare**	
40033: **Number of Channels**	This register must be set, whenever the instrument channels are changed via Modbus. This register must be written, even if the number of channels is not changing.
40034 - 40065: **Size Channels**	Dual-register writable particle channel sizes in nanometers. These registers must be written to set the desired instrument channels via Modbus. The instrument allows from 1 to 16 channels to be used. Channels must be ordered in increasing size from 1 to N. When N is less than 16, only write the first 2 * N registers. For example to configure the instrument for 0.5um, 1.0um and 1.5um channels, the following registers must be written: 40033 = 3, 40034-40035 = 500, 40036-40037=1000, 40038-40039=1500

Table C-3 Holding Registers

Holding Registers		Description (Setup)	Comment
40001	dual	Real Time Clock (high)	time_t
40002	dual	Real Time Clock (low)	time_t
40003	unary	Sample Interval/Volume	Seconds
40004	unary	Hold/Tare Time	Seconds
40005	unary	Repeat Count	Repeat Count
40006	unary	Delay Time	n/a
Spare	unary	26 spare registers	Reserve future "common" registers
40033	unary	Number Channels to Process	Minimum 1, Maximum 16
40034	dual	Channel 01 Size (high)	nanometers
40035	dual	Channel 01 Size (low)	nanometers
40036	dual	Channel 02 Size (high)	nanometers
40037	dual	Channel 02 Size (low)	nanometers
40038	dual	Channel 03 Size (high)	nanometers
40039	dual	Channel 03 Size (low)	nanometers
40040	dual	Channel 04 Size (high)	nanometers
40041	dual	Channel 04 Size (low)	nanometers
40042	dual	Channel 05 Size (high)	nanometers
40043	dual	Channel 05 Size (low)	nanometers
40044	dual	Channel 06 Size (high)	nanometers
40045	dual	Channel 06 Size (low)	nanometers
40046	dual	Channel 07 Size (high)	nanometers
40047	dual	Channel 07 Size (low)	nanometers
40048	dual	Channel 08 Size (high)	nanometers
40049	dual	Channel 08 Size (low)	nanometers
40050	dual	Channel 09 Size (high)	nanometers
40051	dual	Channel 09 Size (low)	nanometers
40052	dual	Channel 10 Size (high)	nanometers
40053	dual	Channel 10 Size (low)	nanometers

Table C-3 Holding Registers (Continued)

Holding Registers		Description (Setup)	Comment
40054	dual	Channel 11 Size (high)	nanometers
40055	dual	Channel 11 Size (low)	nanometers
40056	dual	Channel 12 Size (high)	nanometers
40057	dual	Channel 12 Size (low)	nanometers
40058	dual	Channel 13 Size (high)	nanometers
40059	dual	Channel 13 Size (low)	nanometers
40060	dual	Channel 14 Size (high)	nanometers
40061	dual	Channel 14 Size (low)	nanometers
40062	dual	Channel 15 Size (high)	nanometers
40063	dual	Channel 15 Size (low)	nanometers
40064	dual	Channel 16 Size (high)	nanometers
40065	dual	Channel 16 Size (low)	nanometers

Coils

Like the holding registers, spares are in place between the "standard" coils and those that are specific/optional. There are no specific/optional coils defined for the LiQuilaz II.

00/01: The data collection coil will enable/disable sampling.

Read: 1=Sampling Enabled, 0=Sampling Disabled.

Write: 1=Start Sampling, 0=Stop Sampling.

00/02: The data available coil is used to both inform the host that data is now available and to delete the queued data packet (if present).

Read: 1=Data Available, 0=No Data Available.

Write: 0=Delete queued data element, 1=No effect

If the queue size setting has been set to one, the sample data will always represent the last real-time data packet and the data deleted will be the only data present.

If the queue size setting is set greater than one, the oldest data packet in the queue will be deleted.

00/03: The data clear coil will delete all data in the queue.

Read: Always 0

Write: 1=Delete all queued data, 0=No effect

00/04: The reset sensor coil will reset the sensor.

Read: Always 0

Write: 1=Reset sensor, 0=No effect

00/05: Green Status LED.

Read: 1=LED On, 0=LED Off

Write: 1=LED On, 0=LED Off

00/06: Red Status LED.

Read: 1=LED On, 0=LED Off

Write: 1=LED On, 0=LED Off

00/07: External Alarm. Not applicable for the LiQuilaz II.

Read: Always 0

Write: No effect

00/08: IEEE-754 Float. The float control will change the specified registers from a dual-register integer with fixed scaling to a dual-register IEEE-754 float representation. The IEEE-754 version is likely to yield better resolution but it is not part of the official Modbus specification. This value can also be set into non-volatile storage via the setup interface command "set instrument float".

Read: 1=Float mode enabled, 0=Float mode disabled

Write: 1=Float mode enabled, 0=Float mode disabled

00/09: Sample Volume Mode. Not applicable for the LiQuilaz II.

Read: 1=Sample Volume, 0=Sample Interval

Write: 1=Sample Volume, 0=Sample Interval

00/10 - 00/31: Spare.

Read: Always 0

Write: No effect

Table C-4 Coils

Coils	Description (Coils)		Comment	
00/01	Data Collection	On/Off	Sampling Control	
00/02	Data Available	Yes/No	Data Available/Queue Control	
00/03	Data Clear	Toggle	Data Queue Delete	
00/04	Reset Sensor	Toggle	Reset control	
00/05	Status LED: Green	On/Off	Status LED: Green Control	
00/06	Status LED: Red	On/Off	Status LED: Red Control	
00/07	External Alarm	On/Off	External alarm	n/a
00/08	IEEE-754 Float	On/Off	Modbus Float representation	
00/09	Volume Mode	On/Off	Sample Volume or Interval	n/a
Spare	22 spare coils		Reserve "common" coils	

Data Packet Processing

The unit can provide real-time data or queued data or both. There is only one section of input registers assigned for data to handle this information.

If the unit is setup to queue data then the data shown is the oldest data in the queue. The data available coil (00/02) will be set on a read if there is data in the queue. The data available coil (00/02) can be cleared and written (i.e., set coil to zero) in which case that data element shown is popped-off of the queue. If there is more data in the queue, the new data will be shown and the data available coil (00/02) will be set again right away. If there is no more data in the queue, the data available coil (00/02) will only be set again once the next sample is completed.

If the queue is set to one, then the data shown is always the last data processed and is representative of real-time data only. Since the queue is circular - the next sample will replace the single one in the queue.

If the queue is set to a value greater than one, then the data shown is the oldest in the queue. Any data collected once the queue is full will cause the oldest data to be discarded.

Queued data will always be available - even when not sampling.

If there is no data available - the input registers (associated with the actual sample collected) will yield zeros. This is done instead of generating an execution exception so that the customer can simply read the data packet, along with the Device Status (i.e., current coil settings), in one command.

Since the LiQuilaz II can queue data packets which were collected using a varying number of selected channels. If a varying number of size channels are processed, it is up to the host to track the sizes specified for each data set or to delete the queued data after a size channel adjustment.

Processing of 32-bit Register Value

Some parameters such as particle counts are 32 bit values. Modbus does not natively support 32 bit data; however, it is common in industry to use two 16 bit registers to create a single 32 bit value. Here are two methods for doing this:

- Add the value as two unsigned numbers.

Example:

[32-Bit Unsigned Reg] = [16 Bit Low Unsigned] + 65536 * [16 Bit High Unsigned]

- Use arithmetic OR and left- shift operation.

Example:

[32-Bit Unsigned Reg] =

([16 Bit High Unsigned] << 16-bit left-shift)

{arithmetic OR} [16 Bit Low Unsigned]

Never combine the values as signed integers or floating point value. If the final value is signed, convert the 32-Bit Unsigned value to a 32-Bit signed value after combining the unsigned 16 bit values. If the final value is a floating point value, interpret the final 32-Bit value as floating point after combining the numbers as unsigned 16 bit integers.

Associated Values for Specific Registry Entries

Table C-5 Associated values for specific registry entries

Device Status Entries	0x0001	Data Collection	Matches the common coil settings
	0x0002	Data Available	
	0x0004	Data Clear	
	0x0008	Reset	
	0x0010	Green Status	
	0x0020	Red Status	
	0x0040	External Alarm	
	0x0080	IEEE Float mode	
	0x0100	Volume Mode	n/a
Device State Entries (LSB)	0	Idle	
	1	Sampling	
Device SubState Entries (MSB)	0	Idle	Normal
	0	Sampling	Normal
	1	Sampling	Hold/Tare
Data Packet Status Entries Low Register	0x0001	Laser Good	
	0x0002	Flow Good	

Modbus Processing Example

The following flowchart provides a basic example of controlling the LiQuilaz II using Modbus protocol. The flowchart is meant to be a starting point. It does not detail error handling and does not provide other functionalities which may be desired. The Optional Processing shown at the start of the flowchart sets the instrument channels. These may be set by the serial setup interface. The channel settings are non-volatile, so they only need to be set once when the instrument is first installed and configured.

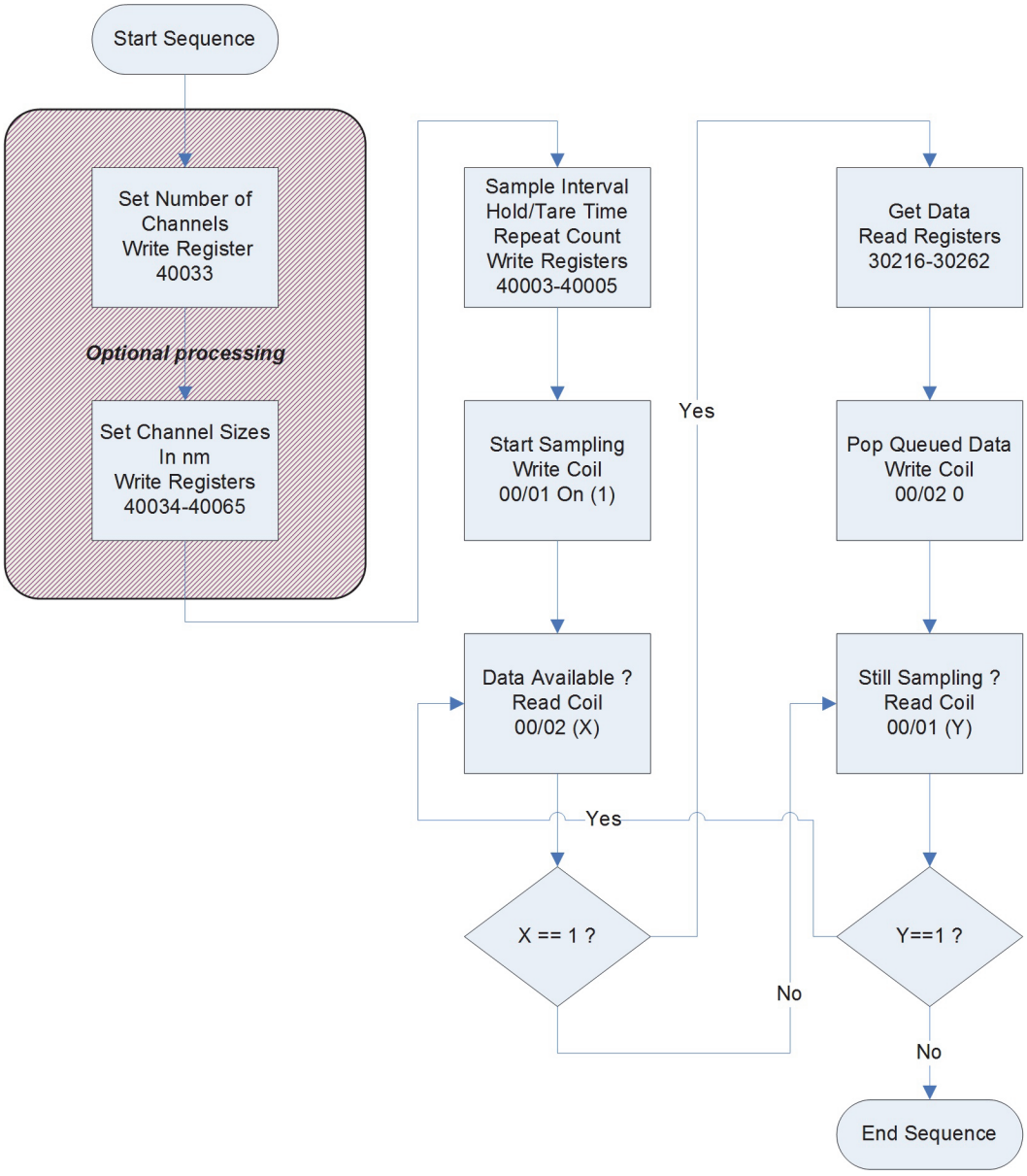


Figure C-1 Modbus flowchart for LiQuilaz II sensor

Appendix D
Ethernet Communications Overview

This Appendix provides the following basic details on Ethernet communications:

- **Ethernet Addressing Basics**, this page
- **MAC Address** on page D-3
- **Static IP Addresses versus DHCP Addresses** on page D-4
- **Troubleshooting Ethernet Connectivity** on page D-4
- **Instrument to Laptop Ethernet Setup** on page D-7

IT Department

The Information Technology or IT department of an organization is responsible for configuring and controlling the corporate network. Any time an Ethernet enabled instrument is attached to a corporate network, IT must be involved, since a static (i.e., fixed) IP address is required by the instrument. The IT department is responsible for assigning fixed addresses.

Ethernet Addressing Basics

Particle Measuring Systems instruments must be properly configured for Ethernet communications in order to work. There are multiple numeric parameters required to properly configure an instrument and a small error in one or more of these parameters can result in no communications, or worse—sporadic communications.

All instruments support the common IPv4 standard. Valid addresses are in the range of 0.0.0.0 to 255.255.255.255. The number 255 corresponds to the special value of 0xFF in hexadecimal. Numbers 256 or larger are not valid. Each number in the dot sequence is sometimes called an octet.

There are four different parameters to configure:

- IP Address—*Required*
- Network Mask—*Required*
- Gateway Address—*Depends on network. May be blank or 0.0.0.0*
- Multicast Address—*Used only in Facility Net. Default value is generally OK.*

These parameters are described in detail below.

IP Address

The Internet Protocol (IP) address consists of two portions:

- a network portion
  and
- a location portion

In the analogy of a telephone number, there is an area code and a phone number. Unlike a telephone number, the network (or area code) portion of an IP address can be set to different numbers of digits. It is not a fixed size like an area code. The location portion is the rest of the number – everything that is not part of the network portion. The definition of what is network and what is location is done by the network mask, described below.

Although there are a great many numbers in the range of 0.0.0.0 to 255.255.255.255, in almost all circumstances instruments are placed on a segregated private network that uses a greatly reduced set of numbers. The valid ranges are shown in **Table D-1**.

Table D-1 Private IPv4 Network Ranges

Address Class	Start	End
A (24 Bit Range)	10.0.0.0	10.255.255.255
B (20 Bit Range)	172.16.0.0	172.31.255.255
C (16 Bit Range)	192.168.0.0	192.168.255.255

Particle Measuring Systems provides a unique default address in the Class A range for every instrument. Whenever the instrument is set to default parameters or factory defaults, this address is restored.

Network Mask

The network mask is used to discern the network portion of the IP address from the location portion. From a telephone number analogy, it segregates the area code from the phone number. It is easy to set the mask incorrectly, and when it is incorrect, it can result in sporadic communication problems. For example, in Facility Net an instrument can be seen as available via a Multicast probe, but trying to control the instrument causes a communications error.

The mask is actually a 32 bit binary number consisting of some number of 1's followed by enough 0's to make 32 bits. The length of the 1's depends on the network Address Class (i.e., area code size) as well as sub-netting (i.e., something done by IT). **Table D-2** shows the default network mask for each address class.

Table D-2 Default Network Mask Values

Address Class	Default Network Mask
A (24 Bit Range) (e.g., 10.X.X.X)	255.0.0.0
B (20 Bit Range) (e.g., 172.16.X.X)	255.240.0.0
C (16 Bit Range) (e.g., 192.168.X.X)	255.255.0.0

When a Particle Measuring Systems instrument is set to default parameter or factory defaults, the network mask is set to **255.0.0.0**. This corresponds with the **10.X.X.X** address which is also set.

For large systems, IT personnel will dictate a network mask value and the value may be different from what is shown in the table. Make sure the network mask is set as specified by IT. All PCs, routers and instruments on a network must use exactly the same network mask, or communication problems will arise.

Gateway Address

The gateway address is a special address used to allow communications outside of the local network. In the telephone analogy, it allows placing long distance calls. In many (if not most) situations, a gateway address is not required.

The default gateway address set when restoring defaults to a Particle Measuring Systems instrument is **10.255.0.60**. This address should be cleared or set to whatever is required by IT.

Multicast Address

The multicast address is used by Facility Net to query all instruments attached to a local network. The valid multicast address range is defined as **224.0.0.0** to **239.255.255.255**. From a practical standpoint addresses in the **224.0.X.X** range should not be used as many of them are reserved for other communications.

Particle Measuring Systems assigns a factory default multicast address of **224.100.100.1** to all instruments. This address generally does not need to be changed. The exception is when sensors are integrated into a large network. In this situation, IT may recommend an alternative multicast address to avoid network conflicts.

MAC Address

All Ethernet devices have a MAC (Media Access Control) address. This address may be thought of as an Ethernet serial number. It is unique for all devices. If an instrument needs to be replaced with a different instrument for either calibration or service, the service technician will duplicate the old instrument's IP address into the new instrument. However, the MAC address of the new instrument will be unique.

In Particle Measuring Systems instruments the MAC address is set during production. The value is permanently stored in non-volatile memory on the main processor circuit board. (The MAC address will change if the main circuit board is replaced.) The MAC address may be displayed via the HyperTerminal® (i.e., RS-232 service interface) by using the **status** command.

Routers and switches keep track of which MAC address is attached where. For that reason, it is important for the instrument to tell a router or switch who is attached. For all Particle Measuring Systems instruments, this is done at least once when the

instrument boots. In some newer instruments, the MAC address is announced to the switch or router every time a network connection is detected. Without this mechanism, it would be possible for routers to operate for an extended period of time without recognizing which MAC address is mapped to which IP address.

Static IP Addresses versus DHCP Addresses

All Particle Measuring Systems instruments use a static IP address. This means the address is predefined. The address is used to identify the instrument when data is collected. In contrast, many computers use a dynamic IP address (i.e., DHCP or Dynamic Host Configuration Protocol).

In order for dynamically configured devices and statically configured devices to be mixed on the same network, some mechanism must be used to segregate the DHCP address range from the static address range. This mechanism is a standard configuration parameter set in the router. The IT Department is typically responsible for delineating the address range.

If static and dynamic addresses are not properly segregated, it may result in duplicate addresses and unexpected network behavior.

Troubleshooting Ethernet Connectivity

>> These steps may be used to check communications to an Ethernet device.

1. Check for light on LEDs of the Ethernet connector. There should be at least one light lit solid to indicate a connection. If not, there is hardware connection problem.

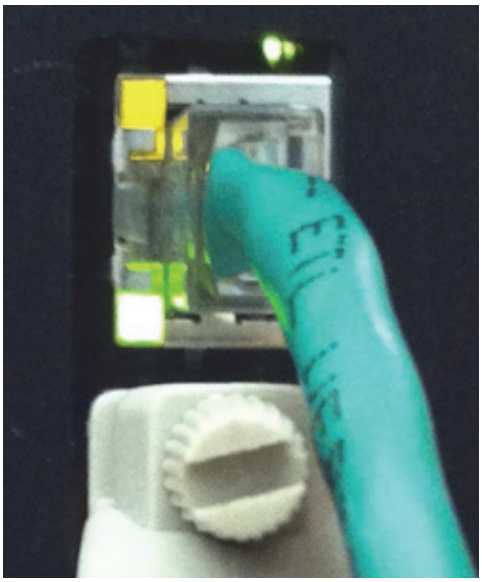


Figure D-1 Ethernet port connectivity LED

a. Is the cable bad?

a.1 Try a different cable.

a.2 If a direct laptop to instrument connection is being done, a cross-over cable may be required. Cross-over cables are specially marked as such. Particle Measuring Systems P/N 1000011477 is a cross-over cable.

b. Is the other end of the cable alive?
Does a known good device work when connected instead?

2. Verify the device can talk using **PING**.

a. Open a command shell on a PC, and type
PING aaa.bbb.ccc.ddd
where aaa.bbb.ccc.ddd is the address of the device.
If there is no response, then there is an addressing problem.

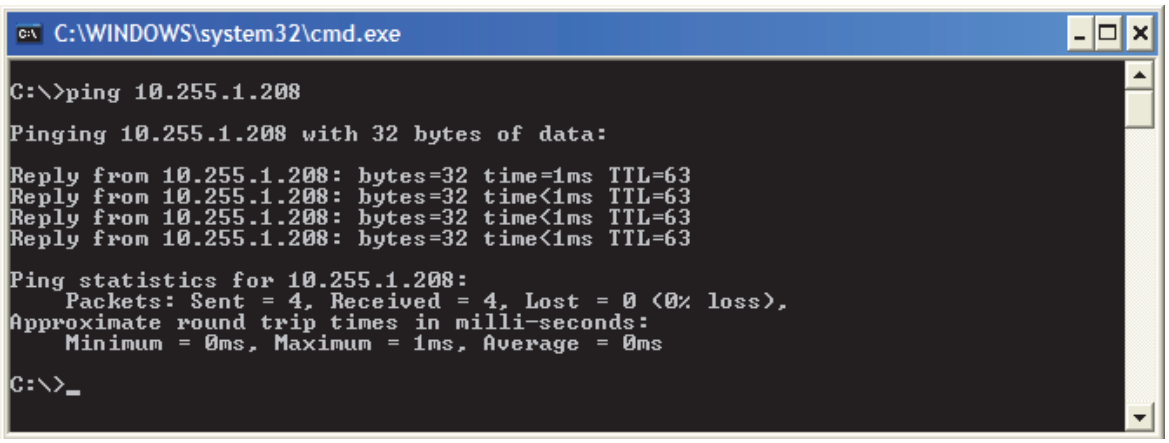


Figure D-2 Example for **PING** test

b. Make sure the PC and the device being talked to are on the same network.

c. Check the PC's address by opening a command shell and typing **ipconfig**.

c.1 Is the Mask the same on both the PC and the device?

c.2 Is the network portion of the address the same on both the PC and the device?

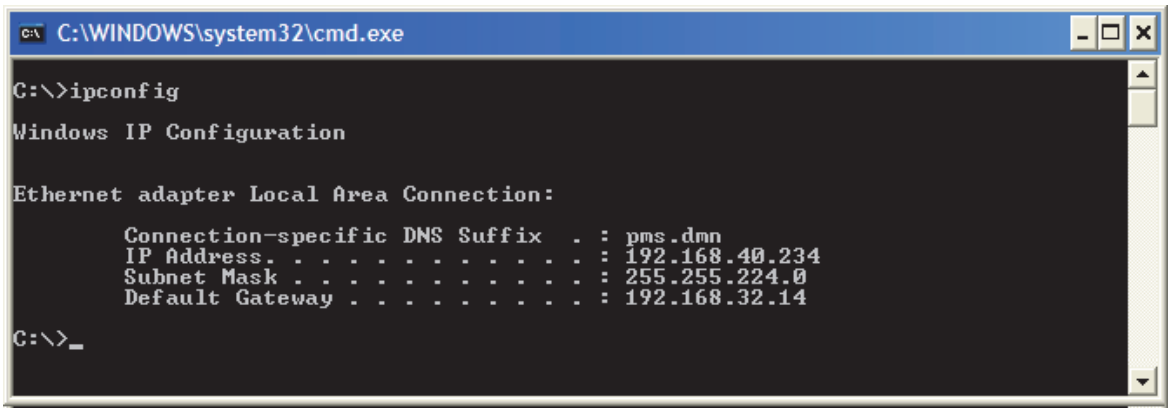


Figure D-3 Example for **ipconfig** command

d. Does an LED on the device's Ethernet connector blink when a PING is transmitted to it?
If not there may be an addressing error with the device, or a configuration problem with the router or switch the device is attached to.

d.1 Try re-powering the device to re-establish communications with the router or switch.

Instrument to Laptop Ethernet Setup

There are two ways to establish a direct Ethernet link between a laptop (or other PC) and a Particle Measuring Systems instrument. The first way is to modify the PC Ethernet settings to work with the existing instrument settings. The second way is to modify the instrument settings to work with the existing PC settings. Since PCs are typically configured for DHCP, this method is less obvious; however for certain applications (such as demos or testing) this method may be advantageous.

Cabling between a laptop and instrument can often be done with a standard Cat 5 Ethernet cable. Older computers and older instrument designs may require an Ethernet cross-over cable to communicate properly. This is available from Particle Measuring Systems as P/N 1000011477. Newer computers use a mechanism called Auto-MDIX to do the cross-over within the computer or instrument automatically.

Method 1: Modifying the IP Settings on a PC

This method allows using the existing instrument address.

At the end of the communications session, the laptop will contain an address that will prevent normal communications to the corporate network. The procedure must be undone after the session.

1. Retrieve the network address parameters from the instrument. This can be done using a HyperTerminal serial link and the "**status"** command.
2. Determine a compatible network address and mask to set the PC.
   For example, an instrument has address **10.12.43.217** and mask value **255.255.0.0**.
   The PC must use exactly the same mask value (i.e., **255.255.0.0**).
   The address can be selected as any valid address so long as the network portion is kept the same. Therefore, **10.12.43.216** would be acceptable, and **10.12.0.1** could also be used.
3. Configure the PC to talk at the selected address:
   a. Navigate to the **Local Area Connection Properties** window.

In Windows 10	In Windows 7
Start **Settings** **Network & Internet** **Change adapter options**	**Start** **Control Panel** **Network and Internet** **Network and Sharing Center** **Change Adapter Settings**

   a.1 There may be more than one choice to select at this step.
   Choose the item labeled **LAN** or **Local Area Connection**.

NOTE: Do not select anything with the word “Wireless” or the word “Virtual”.

a.2 Right click on the adaptor, and then select **Properties**.
A window similar to that shown in **Figure D-4** on page **D-8** should be displayed

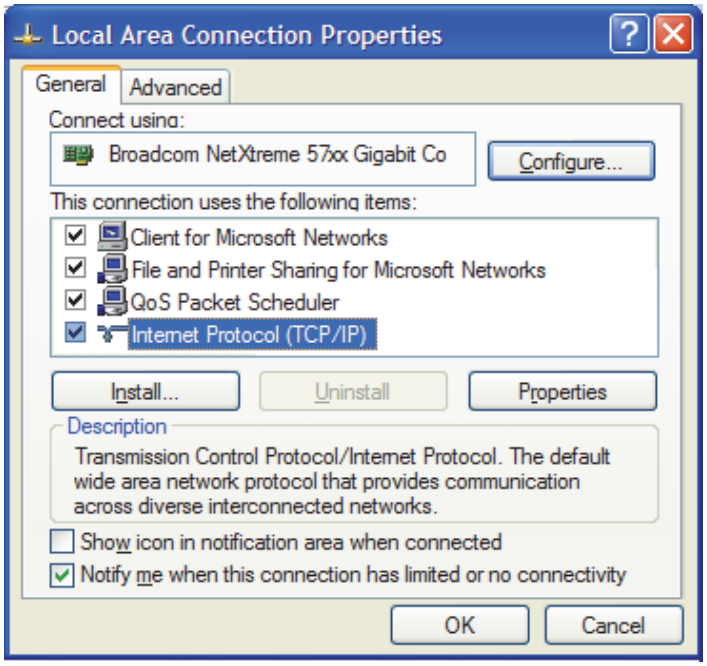


Figure D-4 Local Area Connection Properties window

b. Select the item **Internet Protocol (TCP/IP)**. If given an option for **Version 4** or **Version 6**, select the one titled **Internet Protocol Version 4**.

c. Click the **Properties** button in the **Local Area Connection Properties** window. The **Internet Protocol (TCP/IP) Properties** window appears (see **Figure D-5**).

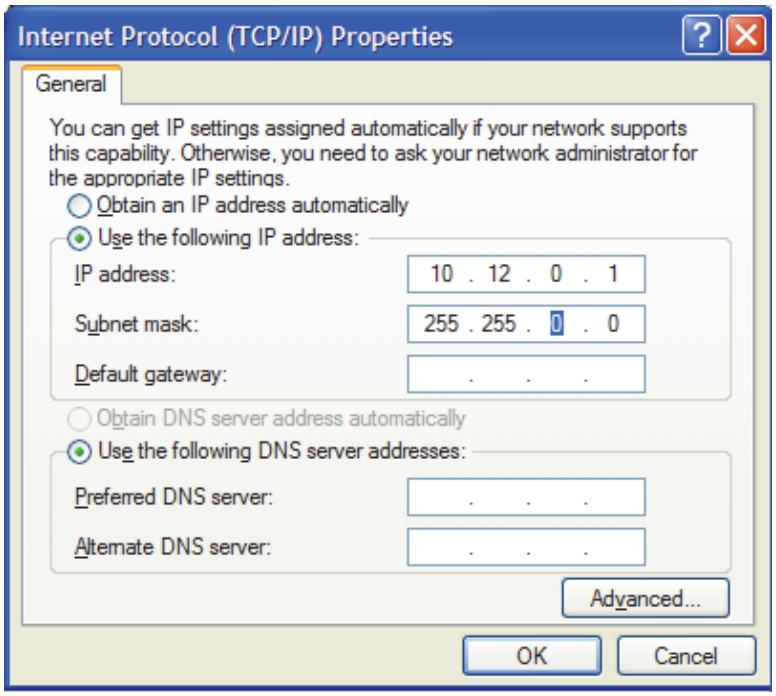


Figure D-5 Internet Protocol (TCP/IP) Properties window

d. Record the existing settings on the **Internet Protocol (TCP/IP) Properties** window.
These settings will need to be restored after the instrument communication session is complete.

e. Change the settings on the **Internet Protocol (TCP/IP) Properties** window to use the network address and mask determined above. See **Figure D-5** on page -9 for an example. The **Default gateway** and **DNS server** values should be left blank.

f. Click the **OK** button to close the **Internet Protocol (TCP/IP) Properties** window.

g. Click the **OK** button to close the **Local Area Connection Properties** window.

4. The PC is now configured.

5. Attach a network cable between the PC and the instrument.

6. Use the procedure **Troubleshooting Ethernet Connectivity** on page D-4 to check the connection is functioning.

Method 2: Modifying the Settings on an Instrument

This method takes advantage of a Microsoft Windows feature called Automatic Private IP Addressing or APIPA.

APIPA allows a PC to automatically assign itself an IP address even when no DHCP server is present to provide an address to the PC. Translated this means that by assigning the right address to an instrument, it will talk one to one with a Windows machine without setting an address on the Windows machine.

The address range of **169.254.0.1** through **169.254.255.254** is reserved for APIPA.

1. Attach the instrument to a HyperTerminal link.
2. Set the instrument addresses as follows:

IP address	169.254.0.1
Mask	255.255.0.0
Gateway	0.0.0.0 (or blank)

3. After setting the addresses, use the **write** command to save the addresses. The instrument will reboot and apply the new address settings.
4. Attach a network cable between the PC and the instrument.
5. Use the procedure **Troubleshooting Ethernet Connectivity** on page D-4 to check the connection is functioning.

Appendix E
Configuring for Ethernet

Configuration Basics

Configuration is the process of entering Ethernet settings that will allow the LiQuilaz II Liquid Particle Counter to communicate over a specific network.

Appropriate Ethernet settings are required for both the PMS Ethernet protocol, used with Facility Net, and the Modbus TCP protocol (see **Appendix C,** "Modbus TCP Protocol") for use with third party applications.

NOTE: The following information assumes that the user has a working knowledge of terminal emulation software such as HyperTerminal®.

When to Configure the Sensor

The sensor should have the appropriate Ethernet settings configured **before** it is wired to a network. This can be performed either before fluidic installation, if access to the back of the sensor is problematic, or in-situ, if back panel access is not an issue.

Required Hardware and Software

- RS-232 cable and USB to RS-232 adaptor (if the PC lacks a serial port)
- Computer loaded with terminal emulation software

NOTE: Microsoft Windows® includes a terminal emulator called HyperTerminal. Other terminal emulator programs, are widely available. Your IT administrator or microcomputer support person may be able to provide assistance.

RS-232 Cable

A suitable cable (PMS-CD1995) is provided in your shipment. The wiring for this cable is as follows:

Table E-1 RS-232 Pin Outs (RJ-12 jack)

Pin 1	DSR
Pin 2	**Transmit ®**
Pin 3	**Receive ¬**
Pin 4	RTS
Pin 5	CTS
Pin 6	GND

NOTE: Pins 1, 4, and Pin 5 are shorted together.

Setting Configuration Addresses for Ethernet

Follow these steps to configure the LiQuilaz II Liquid Particle Counter to communicate with Facility Net by means of an Ethernet network.

CAUTION

As with any network-capable software, do not attempt to connect the LiQuilaz II liquid particle counter to a network without your network administrator's cognizance and explicit permission. The administrator will need to approve, and in most cases will issue, addresses.

To configure the Sensor:

1. Connect the LiQuilaz II Liquid Particle Counter to a computer that has terminal emulation software.
2. Start the terminal emulation software and select the appropriate Serial Port on your PC. Windows Device Manager may be used to find the required setting.
3. Set the following communication parameters:

Table E-2 Terminal Emulator Communications Parameters

Baud Rate	9600
Data Bits	8
Parity	N
Stop Bits	1
Flow Control	Off
Parity Check	Off
Carrier Detect	Off
Connector	Appropriate to hardware (COM1, for example)

When communications are established with the unit, a prompt appears. Enter the Configuration commands (see "Configuration Commands" below) to set the following addresses:

4. Set the IP address.
5. Set the multicast address.
6. Set the Net mask.
7. Set the gateway address.
8. Enter the "write" command.

Configuration Commands

?

Displays a command summary for the selected operational mode (a summary of the information in this table).

Sta(tus)

Displays the following information:

- Current firmware version number
- MAC address
- IP address
- Multicast address
- Net mask
- Gateway
- Queue size (applicable for PMS Ethernet and Modbus TCP connections)
  Note: The RS-485 has its own queue fixed to 10.
- Connection status (if used with Facility Net)
- Operational mode

Set ip aaa.bbb.ccc.ddd

The IP address is used when communicating across networks. This command sets the address in the form of aaa.bbb.ccc.ddd. Each three-digit series is a value of 0–255, separated by a period (**.**) character. An example of a valid IP address is **010.255.000.060**.

Set mas(k) aaa.bbb.ccc.ddd

Sets the network mask address using a decimal notation form of aaa.bbb.ccc.ddd. Each three-digit series is a value of 0-255 separated by a period (.) character. The mask separates the network address from the host address. This address is common to all devices on the logical network. Usually the mask will be similar to 255.255.255.000. Your network administrator will tell you if you need to enter this field.

Set mul(ticast) aaa.bbb.ccc.ddd

The multicast address must be set when using Facility Net. This command sets the multicast address in a decimal notation form of aaa.bbb.ccc.ddd. Each three-digit series is a value of 0-255 separated by a period (.) character. This address is unique to the hardware it serves. An example of a valid multicast address is: **224.100.100.001**.

Set gat(eway) aaa.bbb.ccc.ddd

The gateway address is used when communicating across different networks. This command sets the gateway address in a form of aaa.bbb.ccc.ddd. Each three-digit series is a value of 0-255 separated by a period (.) character. Use gateway 000.000.000.000 if no gateway device is available on the network. An example of a valid gateway address is: **010.255.000.060**.

Set que(ue) x

Enter a data queue size in order to buffer data while the unit is not connected.

The value of **x** can be set anywhere between 1 and 1440. The queue size to enter depends on the specific application. In general, the value should be made large enough to minimize data loss when disconnected, but not so large as to create significant delays in the reception of real-time data when reconnected.

The LiQuilaz II Liquid Particle Counter will:

- Continue sampling if it was initially started, and then disconnected
- Queue up to the number of samples defined by the queue size
- Once full, older data will be overwritten by newer data
- Unload the queued data in chronological order when reconnected
- Periodically delete elements of the queue for which Facility Net has received the data

Set mode x

The unit will run under one of two Ethernet operational modes: PMS Operational Mode or Modbus Mode. When shipped from the factory, the unit is in the PMS Operational Mode.

- When the value of **x** is set to zero (**0**), the unit will reboot into the PMS Operational Mode.
- When the value of **x** is set to two (**1**), the unit will reboot into the Modbus Mode.

Select the PMS Operational Mode for use with Facility Net.

Select the Modbus mode to communicate via Modbus TCP (see **Appendix C,** “Modbus TCP Protocol”).

Write

Saves the most recent changes. ***You must send this command*** after setting up the instrument, or your parameters will be lost when the sensor is de-energized.

NOTE: When the programming is complete, record these settings for future reference.

Unit Serial Number:

TCP/IP Settings for the LiQuilaz II Liquid Particle Counter :

Date			
Software Version			
Set By			
MAC Address			
IP Address			
Multicast Address			
Net Mask Address			
Gateway Address			

Viewing Configuration Settings

Type **sta**(**tus**) and press the **Enter** key to display the LiQuilaz II Liquid Particle Counter's configuration settings, software version, and connection status.

If this command does not produce any kind of activity on the display screen:

- the terminal emulator may be set up incorrectly, or
- the cable may be improperly connected or faulty

Connecting the Ethernet Cable

The LiQuilaz II Liquid Particle Counter communicates with Facility Net or third party Modbus application by means of a CAT 5 UTP Ethernet cable. The sensor is designed to work best with a CAT 5 UTP cable. Other types of Ethernet cable may produce excess noise. An Information Systems Manager, Network Administrator, or other appropriate computer support personnel may be able to assist in procuring a cable or fabricating a custom-length cable.

When connecting the LiQuilaz II Liquid Particle Counter to a network, Facility Net will find the sensor on the network utilizing the Multicast Address and UDP. Based on your configuration, refer to the *Facility Net Operations Manual*.

Appendix F
Serial Communications Overview

The elimination of a serial port on laptop computers and the elimination of HyperTerminal software in Windows 7 require service personnel to prepare beforehand in order to have the right tools for serial communications.

This Appendix includes the following sections that describe set up and troubleshooting for serial communications:

- **Adapters and Cables** on page F-2
  - **USB Serial Port Adapter** on page F-2
  - **Serial Cable** on page F-3
  - **RJ-12 Cable and Adapter** on page F-3
- **Connector Signals** on page F-4
- **Communication Software Options** on page F-5
  - **HyperTerminal** on page F-5
  - **PuTTY** on page F-6
  - **Tera Term** on page F-7
- **Communications Configuration** on page F-8
  - **ENODE Specific Settings** on page F-8
- **Troubleshooting Serial Communications** on page F-9
  - **No Communications** on page F-9
  - **Dropped Characters or Strange Characters** on page F-9
  - **Unexpected Characters** on page F-9

Adapters and Cables

Several hardware items are needed for attaching PCs to various Particle Measuring Systems instruments. Not all the items are required all the time; however, having all the items shown will provide a reasonably complete serial connection tool suite.

USB Serial Port Adapter

Newer computers (especially laptops) no longer include a serial port.

USB to Serial adapters are available to resolve this issue. Particle Measuring Systems has P/N 1000023262 (see **Figure F-1**).

Figure F-1 USB serial adaptor

USB driver for Windows

Windows machines will require a driver to be installed for the USB serial adaptor. The drivers are specific to the model of adaptor used and operating system installed. Incorrect drivers can occasionally be a problem. If the adaptor does not operate correctly, the driver is usually at fault.

Serial Cable

Serial cables are available in assorted varieties. The most useful version is a “straight” or “straight-through” cable with DE-9 male and female connectors (see **Figure F-2**).

Figure F-2 Serial cable with DE-9 male and female connectors

There are numerous variants on serial cables including null-modem (also called cross-over) cables. In addition, some cables have DB-25 or other less useful connectors.

The recommended straight cable will not require male/male or male/female or null modem adapters for most Particle Measuring Systems instruments.

RJ-12 Cable and Adapter

Some Particle Measuring Systems instruments (usually those with smaller form factors) use an RJ-12 modular adaptor for serial communication.

The adaptor and cable may be purchased from Particle Measuring Systems as P/N PMS-CD1995 (see **Figure F-3**). The DE-9 side of the adaptor will attach directly to a PC serial port or a USB to serial adaptor.

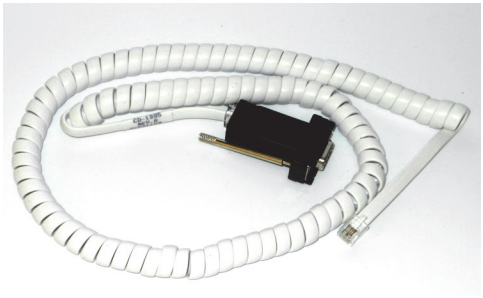


Figure F-3 RJ-12 adaptor and cable

Connector Signals

Table F-1 shows the standard PC serial port connection. The highlighted signals (RX, TX and Ground) are required signals for Particle Measuring System instruments. The signals shown in italics are not used.

Table F-1 Standard PC Serial Port (DB-9)

Pin	In/Out	Description
1	*In*	*DCD (Data Carrier Detect)*
2	**In**	**RX (Receive)**
3	**Out**	**TX (Transmit)**
4	*Out*	*DTR (Data Terminal Ready)*
5		**Ground**
6	*In*	*DSR (Data Set Ready)*
7	*Out*	*RTS (Request to Send)*
8	*In*	*CTS (Clear to Send)*
9	*In*	*RI (Ring Indicator)*

Table F-2 shows the RJ-12 connector pinout for many Particle Measuring Systems instruments. Pins shown as *instrument dependent* are not usually available. On some instruments, the pins may be tied together to simulate hardware flow control. On other instruments, the pins are not used at all. See instrument-specific documentation to verify the details.

An adaptor cable is provided with instruments that use this interface. Order P/N PMS-CD1995.

Table F-2 RJ-12 Instrument Connector

Pin	In/Out	Description
1	*In*	*DSR (instrument dependent)*
2	**Out**	TX (Transmit)
3	**In**	RX (Receive)
4	*Out*	*RTS (instrument dependent)*
5	*In*	*CTS (instrument dependent)*
6		Ground

Communication Software Options

Users of Windows XP can use the built-in program HyperTerminal for configuring serial communications. Windows 7 no longer includes this program. The following alternative utilities available as downloads are discussed:

- HyperTerminal, this page
- **PuTTY** on page F-6
- **Tera Term** on page F-7

HyperTerminal

Due to its use in Windows XP (as well as older versions) HyperTerminal remains the most ubiquitous program available for serial communications. It is available for Windows 7 users as a purchased download from Hilgraeve (http://www.hilgraeve.com) as well as other sites.

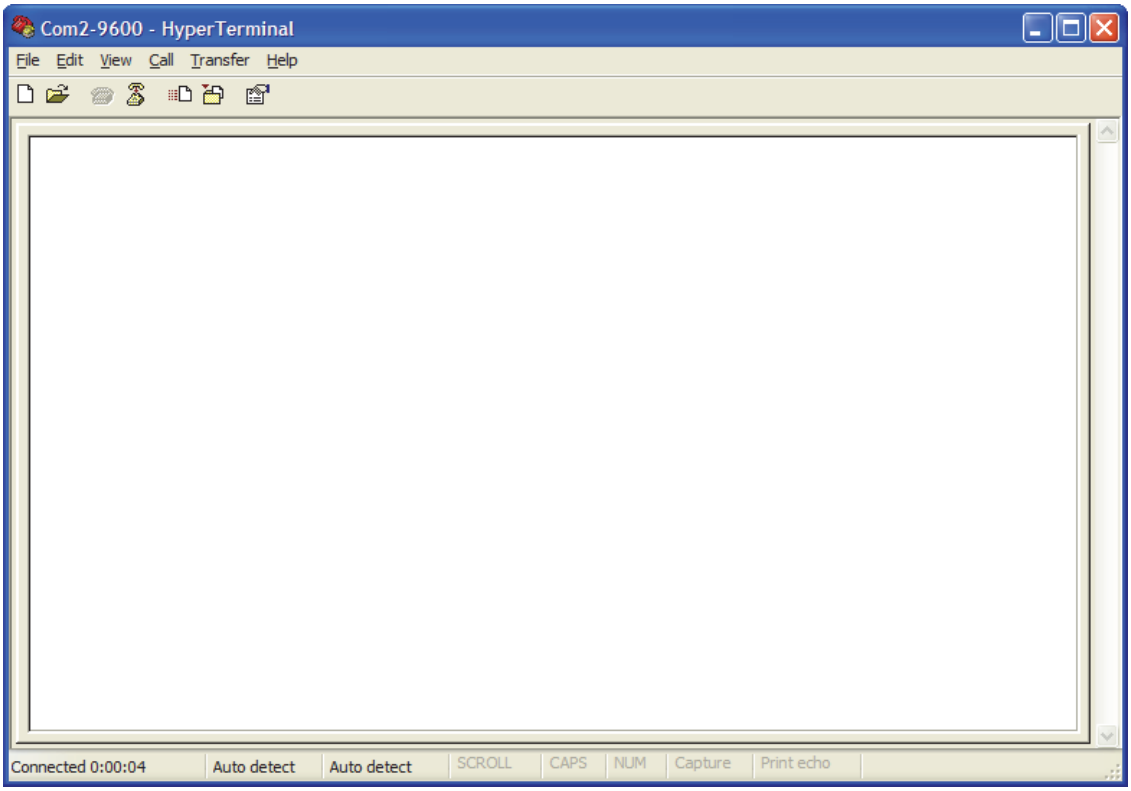


Figure F-4 HyperTerminal window

PuTTY

PuTTY is an open-source (i.e., free) terminal emulator for Windows. It is available here:

- http://www.putty.org

or here:

- http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html.

PuTTY software interface screen shots are shown in **Figure F-5** and **Figure F-6**.

The default color scheme uses a black terminal window. This can be changed to a white terminal window by going to the "**Colours**" setup, and then clicking the box titled "**Use system colours**".

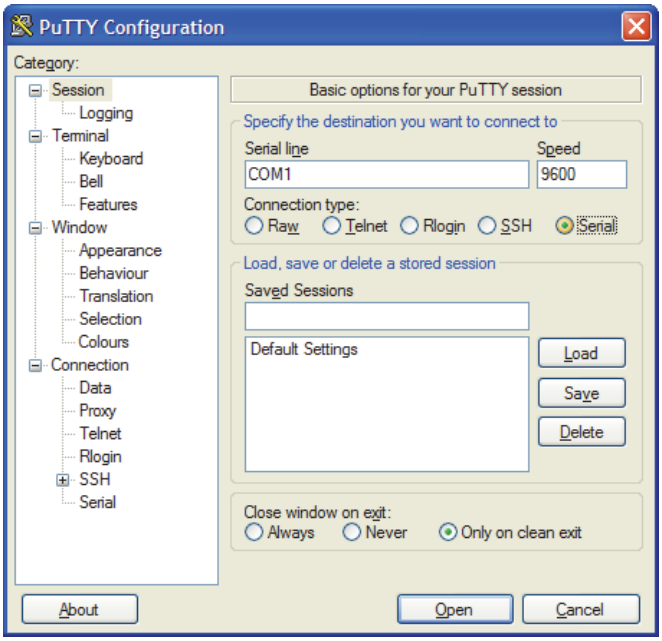


Figure F-5 PuTTY **Configuration** window

Figure F-6 PuTTY **Main** window

Tera Term

Tera Term is another free terminal emulator. It is a somewhat larger download than PuTTY described above. It is available at:

- http://en.sourceforge.jp/projects/ttssh2/releases/.

Tera Term also uses a black main window. It can be reversed under the **Setup Window** option.

Tera Term software interface screen shots are shown in **Figure F-7** and **Figure F-8**.

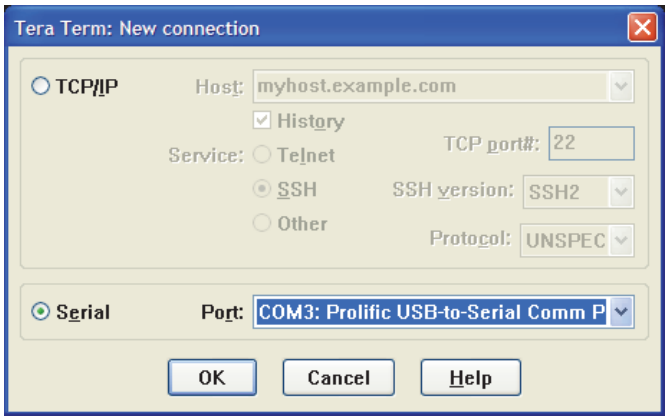


Figure F-7 Tera Term **Setup** window

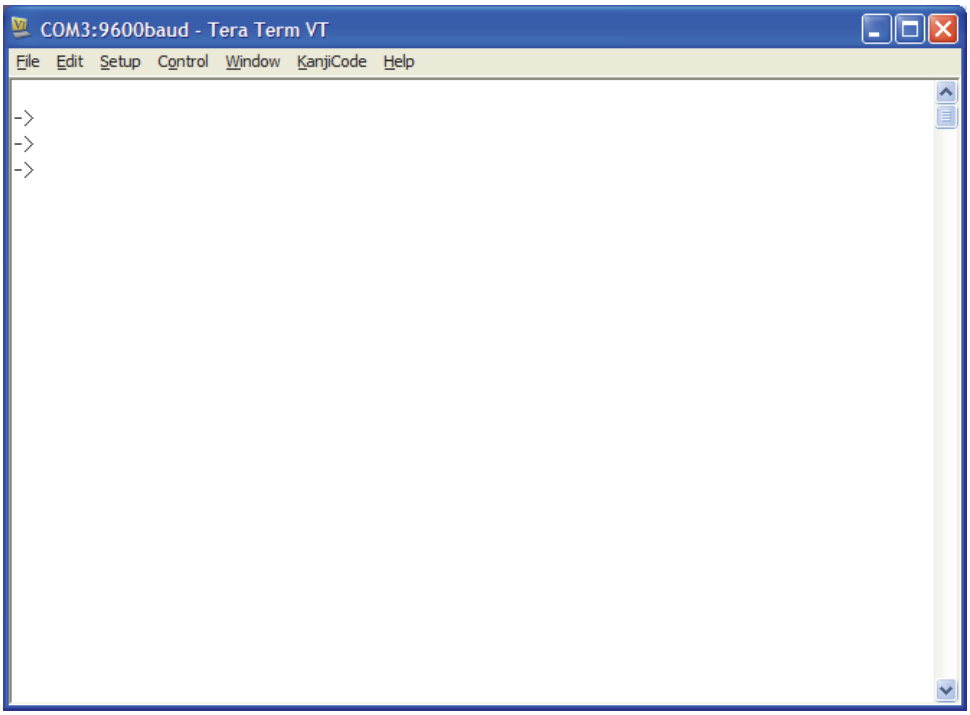


Figure F-8 Tera Term **Main** window (colors reversed)

Communications Configuration

The default communication parameters for all Particle Measuring Systems instruments are as listed in **Table F-3**:

Table F-3 Communication parameters

Baud	9600 (This can be changed on the LiQuilaz II Liquid Particle Counter front panel.)
Parity	None
Data Bits	8
Stop Bits	1
Flow Control	Xon/Xoff (none is also OK)

ENODE Specific Settings

The ENODE requires additional settings for communications. These are not covered in this appendix. In addition, not all the settings are supported by PuTTY or Tera Term.

Troubleshooting Serial Communications

Here are some basic troubleshooting guidelines.

No Communications

Is all the cabling correct?

- Add a null-modem adaptor and see if that resolves the issue.

Is the right COM port selected in the communication settings?

- If using a USB to serial adaptor, use the Windows Device Manager to find the correct COM port.

Are the communication settings correct? Is the software set for 9600,N,8,1?

- If the problem is with a LiQuilaz II, check the instrument's communications setup screen.

Is hardware flow control enabled?

- If so, disable it.

Dropped Characters or Strange Characters

Is the baud rate correct?

- Verify that hardware flow control is not enabled.

Is there a problem with the serial port on the PC?

- Bad USB to Serial adaptor drivers can cause issues.

Unexpected Characters

- If there are extra blank lines, check the <CR> and <LF> input translation.
- If characters are duplicated, half duplex mode may be enabled. Use full duplex mode.

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Appendix G
Serial Setup Command List

Definitions of serial setup commands are provided in this appendix.

NOTE: The characters at the end of a command word that appear in brackets "()" are optional.

Serial Setup Command List

Table G-1 Serial setup command list

Command	
"?" or "help"	Print an on-line command summary. The summary contains the following text: **?** or **help** -- Yields this message **data** -- Toggles data dump on/off **default** -- Set IP parameters to defaults **nvsram** -- Dumps contents of non-volatile storage **reset** or **reboot** -- Reset/reboot the hardware **set gateway ddd.ddd.ddd.ddd** -- TCP: sets the gateway address **set ip ddd.ddd.ddd.ddd** -- TCP: sets the IP address in decimal **set led n** -- Sets LED mode 1=connection, 0=status **set mask ddd.ddd.ddd.ddd** -- TCP: sets the network mask **set mode n** -- Ethernet: Mode 0=PMS, 1=Modbus **set multicast ddd.ddd.ddd.ddd** -- TCP: sets the multicast address **set ntp ddd.ddd.ddd.ddd** -- TCP: sets NTP Server address **set queue n** -- Set data queue between 1 and 1440 **set sample n** -- Sets the sample interval to n secs **set serdump n** -- Sets the device to dump data at boot, if 1 **set telnet n** -- TCP: Telnet enabled, if 1 **set inst float n** -- Ethernet: Modbus float, if 1 **set inst ntp n** -- Ethernet: NTP Client enabled, if 1 **set inst retro n** -- Ethernet: Retro mode for Facility Net, if 1 **status** -- Displays the current settings **write** -- Save all parameters and reset

Table G-1 Serial setup command list (Continued)

Command	
“dat(a)”	Toggle data dump for diagnostic purposes. Unit responds with “Data mode is turned on” if was off or “Data mode is turned off” if was on. The data dump feature will always be off after reboot. The count data presented is cumulative. The data includes Laser Status (LS), Interval (IN), DC Light (DC), Flow Rate (FL), Volume (VL) and (NC) channels (1-16) and then the particle counts.
“default”	Quick setup of TCP/IP defaults. These settings will be saved after the “write” command is issued. The unit will “default” to the following settings, where the xxx.yyy.zzz values come from the last 3 octets of the MAC address: IP Address:10.xxx.yyy.zzz Gateway:10.255.0.60 Net Mask:255.0.0.0 Multicast:224.100.100.1 **Note:** These settings are especially useful at PMS. The default gateway address is the address of the sensor router at the plant and the IP is guaranteed to be unique by virtue of the MAC address.
“nvsram”	Display contents of all non-volatile storage.
“reset” or “reboot”	Complete firmware reboot of unit.
“set gat(e) aaa.bbb.ccc.ddd” Range Limits 0 – 255	Set Ethernet gateway address. The values ddd represent decimal entries for each address octet. Do not use leading zeros. This setting will be saved after the “write” command is issued.
“set ip aaa.bbb.ccc.ddd” Range Limits 0 – 255	Set Ethernet IP (Internet Protocol) address. The values aaa.bbb.ccc.ddd represent decimal entries for each address octet. Do not use leading zeros. This setting will be saved after the “write” command is issued.
“set led n”	Set the operation of the Status LED. If “n” is 1 then LED is in host run mode, otherwise LED is run internally when not connected. If in host run mode, the LED will flash green if not connected. This setting will be saved after the “write” command is issued. Note that the status LED is always under external control when the unit is connected via the PMS or Modbus operational mode.
“set mas(k) aaa.bbb.ccc.ddd” Range Limits 0 – 255	Set Ethernet Net mask. The values aaa.bbb.ccc.ddd represent decimal entries applied to each IP address octet. Do not use leading zeros. The net mask is used by the TCP/IP stack to filter access to addressable sub-nets. Normally an entered octet is either 255 (must match exactly) or 0 (does not need to match at all). This setting will be saved after the “write” command is issued.

Table G-1 Serial setup command list (Continued)

Command	
“set mod(e) n”	Set the Ethernet operational mode between PMS or Modbus. If “n” is 0 then PMS, if “1” then Modbus. The unit will automatically reboot after the command.
“set mul(ticast) aaa.bbb.ccc.ddd” Range Limits 0 – 255	Set Ethernet multicast address. The values aaa.bbb.ccc.ddd represent decimal entries for each address octet. Do not use leading zeros. The multicast address is normally only used by Facility Net. This address must match the multicast address entered in Facility Net in order to have the full configuration utilities presented in the configuration dialog. This setting will be saved after the “write” command is issued.
“set ntp aaa.bbb.ccc.ddd”	Set Ethernet NTP (Network Time Protocol) address. The values aaa.bbb.ccc.ddd represent decimal entries for each address octet. Do not use leading zeros. This setting will be saved after the “write” command is issued.
“set que(ue) n”	Set the data queue size for use in the PMS and Modbus Operational modes. The value for “n” should be between 1 and 1440. The unit will automatically reboot after the command.
“set sam(ple) n”	Set sample interval into the unit. The sample interval “n” needs to be a positive integer greater than or equal to 1 and less than or equal to 28800. The units are in seconds. The unit will stop sampling if this parameter is changed during a run state. This setting will be saved after the “write” command is issued.
“set serdump n”	Set the unit to dump serial data. If “n” is 1 then serial dump is enabled, otherwise it is disabled. This setting will be saved after the “write” command is issued. Unlike the associated “data” command, this feature allows a method by which the unit can automatically dump data after boot. This feature is indicated in the status message if enabled.
“set telnet n”	Set the Telnet setting. If “n” is 1 then the Telnet server is enabled, otherwise disabled. This can be used for security purposes, the Telnet server is enabled by default. This setting will be saved after the “write” command is issued.
“set inst(rument) float n”	Set the Modbus float register representation setting. If “n” is 1 then the float representation is in effect, otherwise the integer representation is in effect. This setting will be saved after the “write” command is issued.
“set inst(rument) ntp n”	Set the NTP setting. If “n” is 1 then the NTP client is enabled, otherwise disabled. This setting will be saved after the “write” command is issued.
“set inst(rument) retro n”	Set the retro mode. If “n” is 1 then the retro mode is enabled, otherwise disabled. This setting will present the Family Name of “HSLIS” for use by versions of Facility Net prior to 4.0. This setting will be saved after the “write” command is issued.

Table G-1 Serial setup command list (Continued)

Command	

“sta(tus)”	Provide a current list of settings in the unit.
	The unit will respond to a “status” command with a serial number and/or calibration date appended to the bottom if either or both of those parameters are entered.
	See example response below:
	`LiQuilazII-E15P Version:1.08 51`
	`Built: April 27, 2017`
	`MAC Address: 00:60:A6:FF:02:AC`
	`**********Current IP Parameters*************`
	`IP Address: 010.255.002.172`
	`Multicast Address: 224.100.100.001`
	`Net Mask: 255.000.000.000`
	`Gateway: 010.255.000.060`
	`NTP Address: 000.000.000.000`
	`**********After Write IP Parameters*********`
	`IP Address: 010.255.002.172`
	`Multicast Address: 224.100.100.001`
	`Net Mask: 255.000.000.000`
	`Gateway: 010.255.000.060`
	`NTP Address: 000.000.000.000`
	`****************************************`
	
	`Sample Interval: 5`
	`Connected to: Not Connected`
	`When not connected, the led flashes green`
	`Data Queue set at: 480`
	`Ethernet Connection via PMS Protocol`
	`Serial Num: 12345`
	`Calibrated: 01/31/2017`
	
	`Mode: Time`
	`Start: On`
	`State: Sampling`
	`Repeat: 0`
	`Tare: 0`

“write”	Writes all current non-volatile storage settings into the EPROM.

Appendix H
有毒或有害的物质和元素

.

Part Name 部件名称	有毒或有害的物质和元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴联苯醚 (PBDE)
电源供应	X	O	X	O	O	O
印刷电路装配	X	O	X	O	O	O
光学元件	X	O	X	O	O	O
激光	X	O	X	O	O	O
机械部件	X	O	X	O	O	O
电缆	X	O	X	O	O	O
机电	X	O	X	O	O	O

O: 表示用于部件的所有同族物质中所含的有毒或有害物质低于SJ/T11363-2006规定的限度要求。

X: 表示用于部件的至少一种同族物质中所含的有毒或有害物质高于SJ/T11363-2006规定的限度要求。

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