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a spectris company

Without measurement there is no control

HSLIS e-Series Particle Counter

OPERATIONS MANUAL

P/N 1000003538

HSLIS e-Series Particle Counter

Operations Manual

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P/N 1000003538 Rev V

HSLIS e-Series Particle Counter Operations Manual
P/N 1000003538 Rev V

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.

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 and UKCA Declaration of Conformity

Application of Council Directive(s):	CE	2014/30/EU, 2014/53/EU, 2014/35/EU, RoHS 2011/65/EU, 2015/863
	UKCA	Electromagnetic Compatibility Regulations 2016, Electrical Equipment (Safety) Regulations 2016 The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
Standard(s) to which Conformity is Declared:	EMC	EN 61326-1:2013 S.I. 2016 No. 1091
	Safety	EN 61010-1: 2010, 3rd, Ed. S.I. 2016 No. 1101
	RoHS	BS EN 63000:2018
Manufacturer's Name:	Particle Measuring Systems, Inc.	
Manufacturer's Address:	5475 Airport Boulevard Boulder, CO 80301 USA	
Manufacturer's Telephone/FAX:	+ 1 3034437100 / + 1 3034496870	
Distributor's Name:	Particle Measuring Systems, S.R.L.	
Distributor's Address	Via di Grotte Portella 34 00044 Frascati (Roma) ITALY	
Distributor's Telephone/FAX:	+ 39 06 90530130 / + 39 06 9051315	
Type of Equipment:	Particle Monitoring	
Model No:	HSLIS e-Series	

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: June 14, 2022

Signature:

Full Name:	Frank Panofen
Position:	Marketing Manager, Life Sciences
Place: Rome	Date: June 14, 2022

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.

Hazardous Material Leakage Procedure

1. Test with litmus paper and continue neutralization until neutral pH (7) is achieved.

– — NOTICE: — –
Do not ship contaminated instruments to Particle Measuring Systems for repair without first draining and flushing the instrument with large amounts of water!

2. If allowed by local environmental regulations, flush the neutralized contaminant down the drain (not a storm sewer) with a volume of clean water at least 100 times the volume of the neutralized contaminant.
3. If local regulations do not allow draining of the neutralized contaminant, contain it appropriately and have it disposed of by a hazardous waste disposal firm.
4. To prevent corrosion, internally-contaminated instruments must be air dried following clean-up and before reassembly.
5. Chlorinated solvents, organic solvents, or other chemicals should be contained for recycling or disposal by a hazardous waste disposal firm.
6. Using clean water, flush the instrument until it is free of chemicals.

Be sure to air dry the instrument before reassembly, packing and shipping. Fill the liquid particle counters' sample cells with a Particle Measuring Systems-approved cleaning solution and then seal the particle counter's inlet and outlet ports.

– — NOTICE: — –
Particle Measuring Systems cannot service instruments that have been contaminated with radioactive materials.

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PARTICLE MEASURING SYSTEMS®
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Table of Contents

List of Figures

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List of Tables

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Chapter 1
Introduction

The HSLIS e-Series particle counter models include:

- **HSLIS M50e**
- **HSLIS M65e**
- **HSLIS M100e**

Figure 1-1 HSLIS-M50e particle counter

These High Sensitivity Liquid In Situ Monitors (HSLIS) sample DI water or process chemicals to measure the presence of particles. These instruments use laser illumination with a high resolution optical system, collecting particle-scattered light over the range of angles ± 40°. Sizing is accomplished *in situ* by means of pulse height analysis (PHA) of the scattered light.

An HSLIS e-Series particle counter is normally used with an Ethernet connection to Facility Net[1] software running on a PC. The particle counter can also output 4-20 mA signals to PLC and SCADA systems.

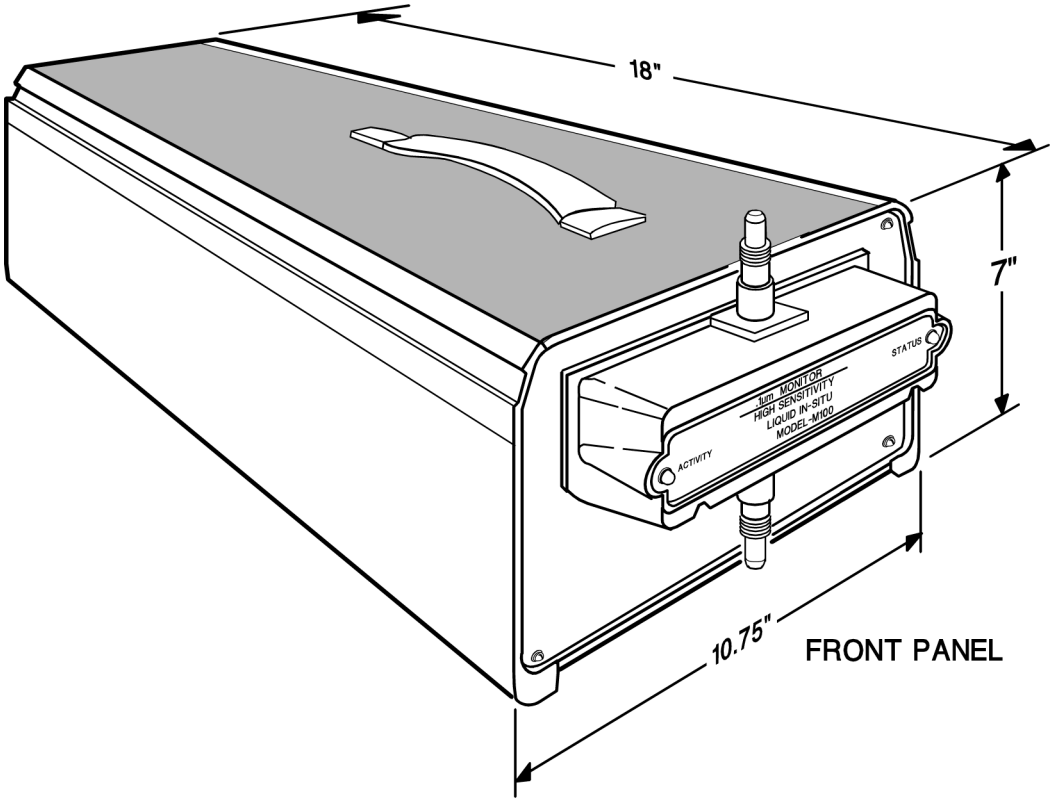
The HSLIS e-Series particle counters detect 0.05, 0.065, and 0.1 mm and larger sized particles, sizing them into four channels. The sensitivity of an HSLIS instrument is model-dependent (see **Specifications** on page 1-3).

The laser used in an HSLIS e-Series particle counter is a solid state device. The optical system includes condensing elements and collecting optics. The numerical aperture of the primary objective collecting optics provides a large solid angle for collecting particle scattering light. All glass optical elements are A-R (Anti-Reflective) coated for minimal light loss.

The Scattering Photodetector Module in an HSLIS e-Series particle counter houses a photodiode detector and a high gain preamplifier. The amplified signals are delivered to the PHA card and converted into pulsed data and distributed to the corresponding size channel.

1. Facility Net is referenced as the control software throughout this document, however, you can use either Facility Net or Pharmaceutical Net software from Particle Measuring Systems when you see this reference.

A current-monitoring circuit is incorporated in the laser diode assembly to determine if the laser diode is functioning properly.



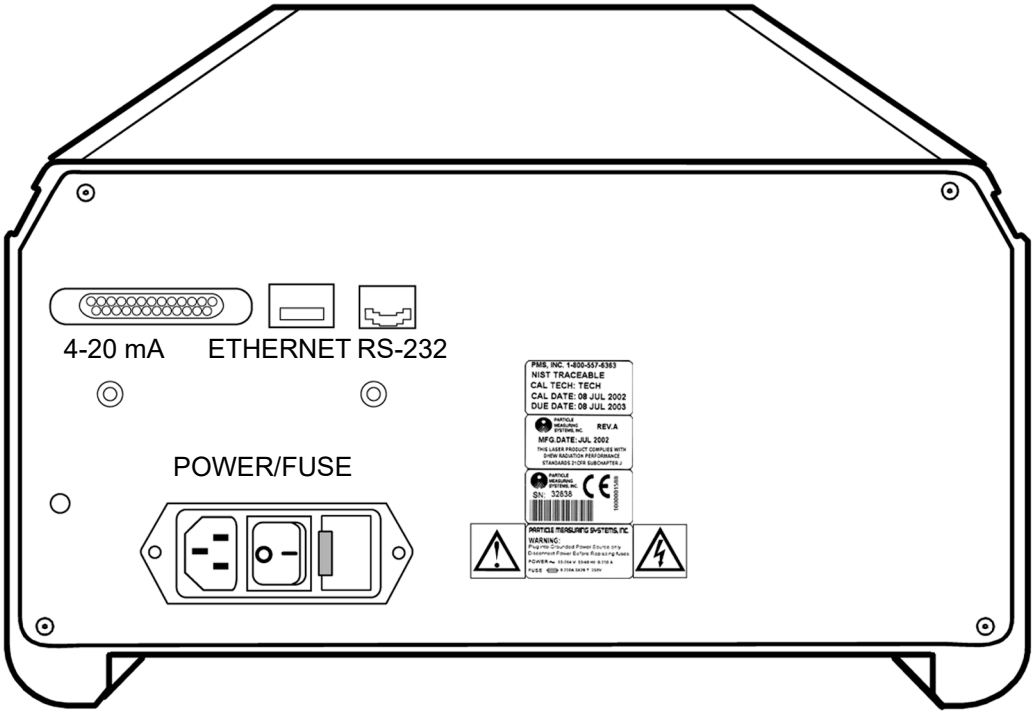


Figure 1-2 HSLIS e-Series Particle Counter – Front and Rear Views

Specifications

	M50e	M65e	M100e
Size range	0.05 – 0.2 mm	0.065 – 0.2 mm	0.1 – 1.0 mm
Channels	4	4	4
Channel sizes	0.05, 0.1, 0.15, 0.2 mm	0.065, 0.1, 0.15, 0.2 mm	0.1, 0.2, 0.5, 1.0 mm
Optimum flow rate	100 ± 10% ml/min	100 ± 10% ml/min	300 ± 10% ml/min
Sample volume	0.25 ml/min	0.6 ml/min	3.0 ml/min
Counting efficiency	100% of the sample volume		
Sample compatibility	DI water	Corrosive chemicals, HF	
Maximum concentration	10,000 counts/ml*		
Sample temperature	50 – 194 °F (10 – 90 °C)	50 – 212 °F (10 – 100 °C)	
Maximum altitude	Less than 2,000 m (6,500 ft)		
Zero count level	≤ 1000 counts/liter	≤ 2000 counts/liter	≤ 1000 counts/liter
Wetted surface materials	Delrin® Fused silica Teflon® Kel-F® Viton®	Kalrez 4079 Kel-F Sapphire Teflon	Kalrez 4079 Kel-F Sapphire Teflon
Dimensions (l x w x h)	21 x 10.75 x 7 in (53 x 27 x 18 cm)		
Altitude	6500 ft (2000 m) maximum		
Utility Requirements			
Electrical rating	100-240 V, 50-60 Hz, 1.0 A		
Fuses	250 V, 5x20 mm, T, 1.0 A		
Voltage fluctuation	AC input voltage fluctuation shall not exceed +/-10%		
Laser Classification	Class 1, complies with US 21 CFR 1040.10 and EN60825-1. Internally an enclosed Class 3B laser is used per EN60825-1.		
Calibration	Calibration materials used are traceable to the National Institute of Standards and Technology (NIST) and/or Japanese Industrial Standards (JIS).		
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.)		

* Greater than 90% accuracy (less than 10% coincidence loss) at the maximum recommended concentration.

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Chapter 2
Unpacking & Installation

Unpacking

Unpack the HSLIS e-Series particle counter and ensure that all components have been received.

Standard shipping list:

- Power cable
- RS-232 configuration cable with RJ-11 male connectors on each end
- DB-9 to RJ-11 adapter
- Ethernet crossover cable
- Operator's manual

Inspect the unit for obvious damage. If damage is found, return all unpacked materials to the shipping box and telephone the factory at 1-877-475-3317.

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.

Recycling

As a global leader in contamination monitoring, Particle Measuring Systems (PMS) has also been actively monitoring and reducing our environmental contamination over the last few years.

With your shipment, you receive packaging materials that can be 100% recycled. For up to date, detailed information about recycling the specific materials in your shipment, see our website by scanning the QR below or clicking on **this link**.

Installation

Installation consists of the following activities:

- Moving the instrument to the area where it will be used.
  See **Moving the Instrument to the Work Area** on page 2-3.
- Installing the instrument's plumbing connections.
  See **Installing the Plumbing Connections** on page 2-3.
- Installing the communications cables.
  See **Chapter 3** Set Up for Ethernet Communications.
- Installing the power connections.
  See **Connecting the Cables** on page 2-4.

Moving the Instrument to the Work Area

See your work procedures for the rules about moving an instrument into controlled areas.

Ensure that the intended instrument location is large enough and strong enough to support the HSLIS e-Series instrument. See **Specifications** on page 1-3.

Installing the Plumbing Connections

The particle counter may be plumbed to flow in either direction. Downstream restriction will preclude bubble formation in almost all sampling setups.

Position the HSLIS e-Series particle counter so that it is not difficult to reach the AC power switch on the back panel.

Required materials:

- 1/4-inch, 0.047-inch wall Teflon tubing
- Flaretek® fittings appropriate for the tube size
- Tube flaring tools
- A flow limiter with a range of 100 – 300 mL/min

>> To connect the plumbing:

1. Connect 1/4-inch, 0.047-inch wall Teflon tubing from the sample source to the Flaretek sample inlet.

NOTE: It is recommended that the instrument's bottom fitting be used for the sample inlet.

---

2. Connect the same type of tubing to the sample outlet.
3. Attach a downstream flow limiter.
4. Set the flow rate to 100 or 300 mL/min., depending on the specific model.

NOTE: The flow rate should be set with an external flow controller. Whatever flow controller is used, ensure that it can be set to a flow rate of 100 mL/minute for the M50e and M65e models of the HSLIS particle counters and to a flow rate of 300 mL/minute for the M100e model of the HSLIS particle counter.

Connecting the Cables

WARNING
The terminal (I/O ports) are for use only with equipment with no accessible live parts.

WARNING
Interrupt power before connecting or disconnecting any signal cables.

>> To connect the power cable:

1. Plug the power cord into the power entry module labeled “POWER/FUSE” on the instrument’s rear panel.
2. Plug the other end of the power cord into an appropriate power source.
3. Turn on power to the HSLIS e-Series particle counter using the power switch located on the rear panel.

Status LED

Status LED Use with Facility Net

Depending on the settings selected, the status LED will be controlled by the particle counter’s hardware or by Facility Net’s alarm settings.

Status LED Use Without Facility Net

The LED is controlled by the particle counter’s hardware. In this instance the LED will normally remain green except for a low flow or laser status error. A flashing red light indicates that the sensor has failed to initialize properly.

Activity LED

This light flashes green when particles are detected. It also flashes if bubbles are present.

Chapter 3
Set Up for Ethernet Communications

When using Facility Net as your HSLIS e-Series particle counter interface, you must communicate over an Ethernet network. Before you can communicate over an Ethernet network you must set the correct IP addresses in the particle counter instrument. This chapter explains how to set those IP addresses.

HyperTerminal® terminal emulation software is used to configure the HSLIS particle counter for Ethernet communication. HyperTerminal is also used to configure the instrument for 4-20 mA output. See **Chapter 5** Operating with the 4-20 mA Outputs.

CAUTION
As with any network-capable software, do not attempt to connect the HSLIS e-Series 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, IP addresses.

Required items:

- HSLIS e-Series particle counter instrument
- RS-232 configuration cable (provided)
- A computer
- Windows® operating system and HyperTerminal loaded on the computer

Setting up your particle counter for communication over an Ethernet network requires the following processes:

- Connecting the computer to the instrument with a RS-232 cable.
  See **Connecting a Computer to the Particle Counter** on page 3-2.
- Setting up a terminal emulation session for the particle counter.
  Setting Up a Terminal Emulation Session on page 3-2.
- Running a status check of the current settings.
  Running a Status Check on page 3-5.
- Setting IP addresses.
  Setting IP Addresses on page 3-6.
- Connecting the Ethernet cable.
  Connecting the Ethernet Cable on page 3-8.

Connecting a Computer to the Particle Counter

>> To connect a computer to the particle counter:

1. Assemble the HSLIS e-Series particle counter, computer, and RS-232 cable in a suitable work location.
2. If you must build a RS-232 cable, use the following information.

Table 3-1 RS-232 cable pinouts

Pin Number	Function
Pin 1	+ 5 V
Pin 2	Transmit Þ
Pin 3	Receive Ü
Pin 4	RTS
Pin 5	CTS
Pin 6	GND

NOTE: Pin 4 and Pin 5 are shorted together.

3. With the computer and particle counter off, use the RS-232 cable to connect the two devices.
4. Start the HSLIS e-Series particle counter and the computer.
5. If the **STATUS** light turns green, continue with the following steps.

NOTE: The **ACTIVITY** LED flashes when a particle is detected.

Setting Up a Terminal Emulation Session

>> Verify the following:

- The HSLIS e-Series particle counter and the computer are connected with a RS-232 cable.
- The particle counter and the computer are on.

The first step in initializing the HSLIS e-Series particle counter is to create a dialogue with the sensor. Use a terminal emulation program to accomplish this dialogue. Below is a terminal emulation procedure using HyperTerminal.

NOTE: The following steps and images are specific to a particular version of HyperTerminal. Your version may be different and, therefore, require some variation in the steps. The overall process is the same.

>> To set up a terminal emulation session:

1. Open your HyperTerminal program. The **HyperTerminal** window appears (see **Figure 3-1**).

Figure 3-1 HyperTerminal window

NOTE: Your **HyperTerminal** window may have a different display of icons.

2. Double-click the **HyperTerminal** icon.
   The **Connection Description** window appears (see **Figure 3-2** on page 3-3).

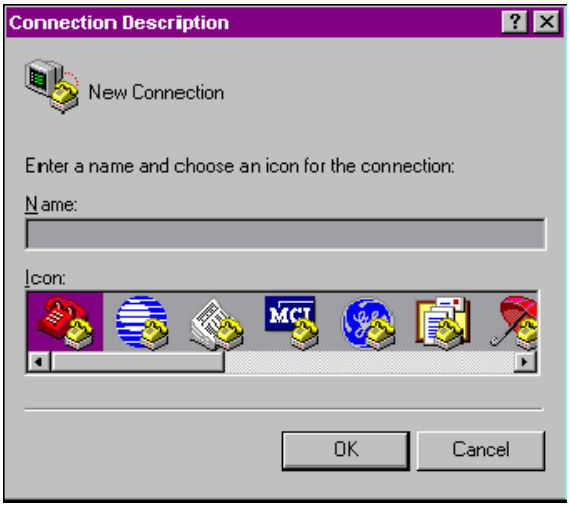

Figure 3-2 Connection Description window

3. Type a name to identify your HSLIS e-Series particle counter unit in the **Name** field. It must be a unique name for terminal emulation.
4. Click an icon in the **Icon** field to represent the particle counter in the terminal connection.
5. Click **OK**.
   The **Connect To** window appears (see **Figure 3-3**).

Figure 3-3 Connect To window

6. Complete the following fields in the **Connect To** window:

- **Country code**
- **Area code**
- **Phone number**

7. Select **Com 1** or **Direct to Com 1** in the **Connect using** field.

8. Click **OK** in the **Connect To** window.
The **Com1 Properties** window appears (see **Figure 3-4**).

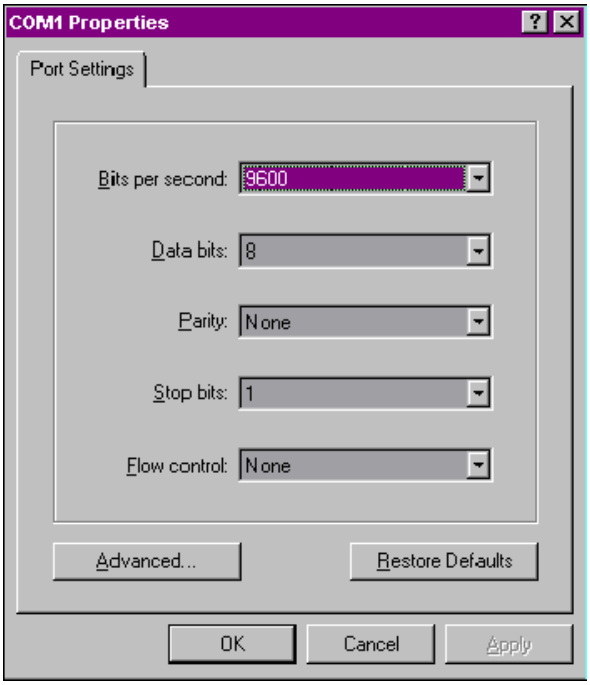

Figure 3-4 COM1 Properties window

9. Complete the following fields in the **Com1 Properties** window:

- **Bits per second** – Enter **9600**.
- **Flow control** – Enter **None**.

10. Click **OK** in the **Com1 Properties** window.
HyperTerminal tests COM1 to verify that the link is running.

>> To troubleshoot an HyperTerminal error:

If the link for COM1 is not functional, the error message shown in **Figure 3-5** appears:

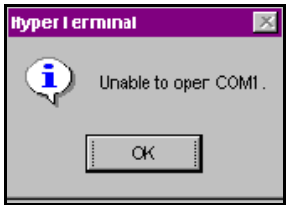

Figure 3-5 HyperTerminal error message

Ensure that the following conditions are correct:

- The HSLIS e-Series particle counter is plugged in.
- The RS-232 connection is secure between the particle counter and your computer.
- The RS-232 cable has the correct pin out configuration.
- Your settings match all of the HyperTerminal setup screens.

If you still get the “Unable to open COM1” message, contact your IT/Computer Support personnel.

Running a Status Check

The status check provides the following information:

- Addresses of the HSLIS e-Series particle counter
- Sample interval time
- Data communication channel settings
- Full scale settings for 4-20 mA

>> To run a status check with HyperTerminal:

1. Type **status** at the prompt, and press **Enter**.
A status check report of the monitor's settings appears (see **Figure 3-6**).
The monitor’s present settings are included.

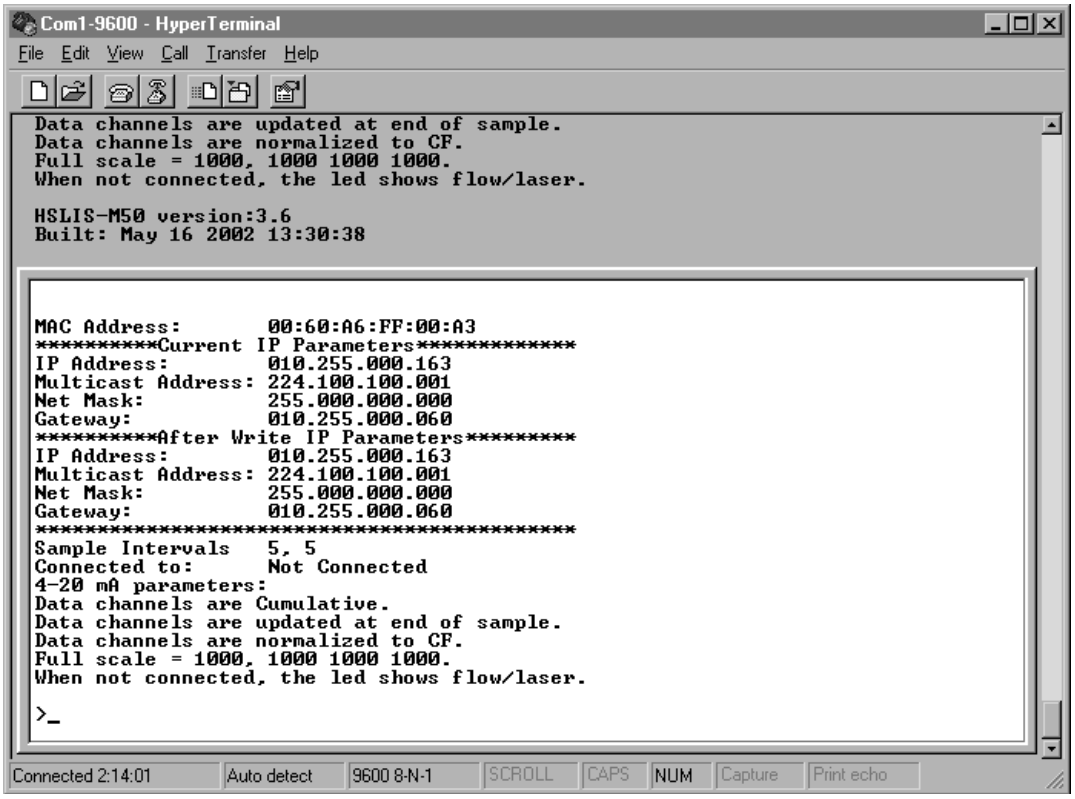

Figure 3-6 COM HyperTerminal window with **Status Check**

Setting IP Addresses

You may be using a multicast and/or gateway address as well. Commands to set these addresses are given below.

>> To set the IP address:

1. Open a HyperTerminal session for the HSLIS e-Series particle counter. The **HyperTerminal** window appears (see **Figure 3-7**).

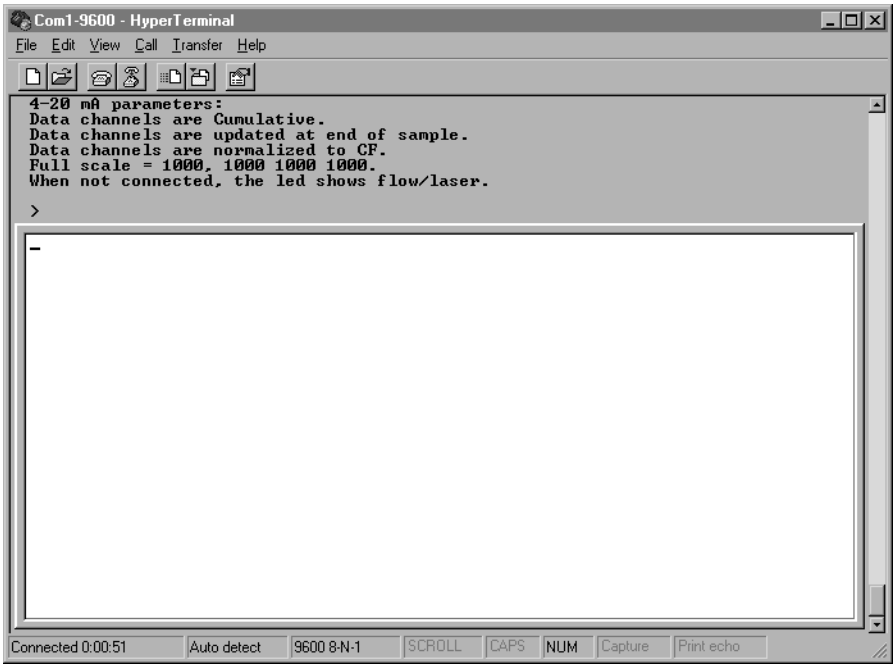

Figure 3-7 COM HyperTerminal window

2. Use the following commands, as needed, at the HyperTerminal prompt. Press **Enter** after each command line.

? Displays a command summary.

sta Displays the current firmware version number, MAC address, IP address, Multicast address, net mask address, gateway address, connection status, and 4-20 mA parameters.

set ip aaa.bbb.ccc.ddd

Sets the IP address in a decimal notation form of aaa.bbb.ccc.ddd. Each 3-digit series represents a value of 0 – 255, separated by a period (.). This address is unique to the hardware it serves. An example of a valid IP address would be 010.000.011.144.

set mask aaa.bbb.ccc.ddd

Sets the net mask address in a decimal notation form of aaa.bbb.ccc.ddd. Each 3-digit series is a value of 0 – 255, separated by a period (.). This address is unique to the hardware it serves. An example of a valid net mask address would be 255.000.000.000.

set multicast aaa.bbb.ccc.ddd

Sets the multicast address in a decimal notation form of aaa.bbb.ccc.ddd. Each 3-digit series represents a value from 0 – 255, separated by a period (.). This address is unique to the hardware it serves. An example of a valid multicast address would be 224.100.100.001.

set gateway aaa.bbb.ccc.ddd

Sets the gateway address in a decimal notation form of aaa.bbb.ccc.ddd. Each 3-digit series represents a value from 0 – 255, separated by a period (.). This address is unique to the hardware it serves. An example of a valid gateway address would be 010.255.000.060.

write

Saves the most recent changes. You must type in this command when you are finished setting up the instrument addresses or 4-20 mA parameters.

3. Press the **Enter** key after each command line.
4. Type in the **write** command after changing any of the addresses and press the **Enter** key.

NOTE: When you have programmed the particle counter, record these settings for future reference.

Address Settings for HSLIS e-Series particle counter Serial Number:

Address Settings for the Serial No. _____	
Date	
Software version	
Set by	
MAC address	
IP address	
Multicast address	
Net Mask address	
Gateway address	

After you set up the addresses, you can configure the particle counter from Facility Net. Refer to the *Facility Net User's Manual* for configuration procedures.

Connecting the Ethernet Cable

Facility Net requires a UTP Ethernet crossover cable or straight-through cable. Select the appropriate cable:

- If you are going from the HSLIS e-Series particle counter to a computer directly, use an Ethernet *crossover* cable.

- If you are connecting the monitor into a hub of other monitors, use an Ethernet *straight-through* cable between monitor and hub as well as from the hub to the computer.

NOTE: Your IT/computer support personnel may be able to assist you in procuring a cable or fabricating a custom-length cable.

Straight Through Ethernet Cable Pinouts

Table 3-2 Ethernet straight-through cable pinouts

Pin Number	Function
Pin 1	TD+
Pin 2	TD-
Pin 3	RD+
Pin 4	
Pin 5	
Pin 6	RD-
Pin 7	
Pin 8	GND

Crossover Ethernet Cable Pinouts

Table 3-3 Ethernet crossover cable pinouts

CROSSOVER CABLE PINOUTS				
Function	**Computer End**		**Particle Counter End**	**Function**
TD+	**Pin 1**	◄——►	**Pin 3**	RD+
TD-	**Pin 2**	◄——►	**Pin 6**	RD-
RD+	**Pin 3**	◄——►	**Pin 1**	TD+
	Pin 4	◄——►	**Pin 4**	
	Pin 5	◄——►	**Pin 5**	
RD-	**Pin 6**	◄——►	**Pin 2**	TD-
	Pin 7	◄——►	**Pin 7**	
GND	**Pin 8**	◄——►	**Pin 8**	GND

Chapter 4
Operations

This chapter discusses the following topics:

- Setting sample parameters
  (see below)
- Calculating sample parameters
  (see **Calculating the Sample Interval** on page 4-2)
- Using HyperTerminal as the user interface to HSLIS e-Series particle counter
  (see **Starting the HyperTerminal Program** on page 4-3)
- Using Facility Net with a HSLIS e-Series particle counter
  (see **Using Facility Net with the HSLIS e-Series Particle Counter** on page 4-4)

After completing installation by connecting tubing, flow controller, communication cables, and computer, you are ready to initialize the monitor for operation.

Setting Sample Parameters

HSLIS e-Series particle counter sample parameters are *Sample Interval*. This parameter can be set with either of the following user interfaces:

- HyperTerminal
- Facility Net

Setting sample parameters with Facility Net are beyond the scope of this manual. If you have this program, and you want to set your sample parameters through it, refer to your *Facility Net Operators Manual*. The following instructions will describe how to set your sample parameters by means of a HyperTerminal interface.

You will start the HyperTerminal program, start the pre-defined session for HSLIS e-Series particle counter, and enter your parameter commands.

NOTE: The following operations are performed from a computer that is connected to your particle counter with the provided RS-232 cable or a cable that you provide.

Calculating the Sample Interval

HSLIS M65 particle counter sample parameters are *Sample Interval*. This section discusses how the sample interval is calculated. You will use this calculation to set the sample interval when using either HyperTerminal or Facility Net. See **Setting the Sample Interval** on page 4-2

The sample interval setting is determined based on the following:

- Cleanliness of the sample (DI water or chemicals)
- Required precision – The relative precision of the data collected follows Poison statistics. Standard deviation $\approx \sqrt{\text{Ave}}$. Relative precision = S.D./Ave.

For example, if your DI water specification is 2,000 counts/liter at greater than 0.065 µm and you want a relative precision of 20%, you will need a sample interval that will produce at least 25 counts. (5/25 = 20%)

This example is calculated as follows:

- 2,000 counts/liter = 2 counts/mL
- The M65 measures 0.6 mL/minute. In 1.7 minutes it will sample one mL and produce two counts. To obtain 25 counts for the required precision, a sample interval of 21 minutes is needed. Less than 21 minutes will produce less precision.

Setting the Sample Interval

The *Sample Interval* parameter can be set with either of the following interfaces:

- HyperTerminal
- Facility Net

Setting the sample interval parameters with Facility Net is beyond the scope of this manual. If you have these programs, and you want to use them to set your sample parameters, refer to your *Facility Net Operators Manual.*

The following instructions will describe how to set your sample interval parameter by means of a HyperTerminal interface. You will start the HyperTerminal program, start the pre-defined session for the HSLIS e-Series particle counter, and enter your parameter commands.

Starting the HyperTerminal Program

NOTE: The following steps and images are specific to a particular version of HyperTerminal. Your version may be different and, therefore, require some variation in the steps. The overall process is the same.

>> To start the HyperTerminal program:

1. Start the PC.
2. Open the HyperTerminal program.
   The window shown in **Figure 4-1** appears.

Figure 4-1 HyperTerminal window

NOTE: Your HyperTerminal program version window may display a different set of icons.

3. On the **HyperTerminal** window, double-click the **HyperTerminal** icon.
   A HyperTerminal session with a **New Connection** window appears.

Entering the Sample Interval

>> To set your sample interval:

1. Start a HyperTerminal session for the HSLIS e-Series particle counter.
   The **HyperTerminal** session window appears (see **Figure 4-2**).

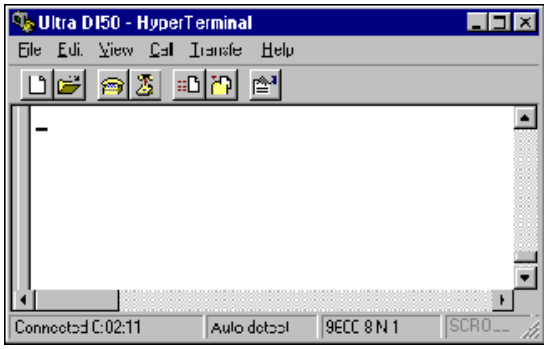

Figure 4-2 HyperTerminal session window

2. At the prompt, type the following sample interval command with the two sample interval variables, **x** and **y**, in seconds:

   set sample x y

This function sets the sample interval to **x** seconds. The maximum sample interval is represented by *y*; it is used when zero particles are detected.

3. Press the **Enter** key. A prompt appears.
4. At the prompt, type **write** and press the **Enter** key. The sampling interval changes to your specifications.

The monitor uses these sampling interval values when it is first turned on. These values are used until the values are replaced by the Ethernet interface (such as Facility Net). The values set by this function are stored in permanent memory; whereas, the values set by the Ethernet interface are lost when you turn off the power to the HSLIS e-Series particle counter.

NOTE: The sample interval parameter set from Facility Net overrides the initialization setting.

Using Facility Net with the HSLIS e-Series Particle Counter

Facility Net is a software package that provides a comprehensive account of all environmental conditions within a facility. With Facility Net, you can define parameters for each instrument such as sample intervals, flow rates, and alarm settings for multiple instruments simultaneously.

Facility Net is a Windows-based program that enables you to simultaneously view tabular displays, real-time or retrieval time plots, three dimensional histograms, status conditions, and event logs. A facility map can be observed for every monitoring instrument.

Networking capabilities are available and allow communications with other computers using the TCP/IP protocol to distribute data among many users.

If you are using a computer with the Facility Net software, you must complete the following steps.

>> To connect the particle counter to Facility Net:

1. Connect the Ethernet cable between the particle counter and computer.
2. Set addresses for the HSLIS e-Series particle counter.

After you have an Ethernet connection and the correct addressing, you can go open the Facility Net program and perform the necessary steps to add your HSLIS e-Series particle counter. You must also set up how you want your data displayed, where it is to be stored, and many other parameters. For step-by-step instructions, see the *Facility Net User Manual*.

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Chapter 5
Operating with the 4-20 mA Outputs

The HSLIS e-Series particle counter sends 4-20 mA signals that can be integrated into a SCADA, PLC (Programmable Logic Controller) or other device that can interpret 4-20 mA signals.

The following data signals are output:

- Particle data on channels 1-4
- Operational status on channel 5

The particle size for each channel is model-dependent.
For more information, see **Specifications** on page 1-3.

Particle data are translated to amperage on channels 1 through 4, based upon particle size. The actual data for channels 1 through 4 are dependent upon your choices of the following 4-20 mA variables:

- Cumulative vs. differential data
- Update interval
- Raw vs. normalized counts
- Scaling of channels 1 through 4, corresponding particle size

This section discusses setting these parameters. It also discusses each of these variables in more depth. Refer to the status check report if you wish to see the current 4-20 mA parameter settings.

Required items:

- A computer loaded with a terminal emulation software application, such as HyperTerminal
- HSLIS e-Series particle counter instrument
- RS-232 communications cable, used to connect the particle counter to the computer

Connecting a Computer to the Particle Counter

>> To connect a computer to the particle counter:

1. Assemble the HSLIS e-Series particle counter, computer, and RS-232 cable in a suitable work location.
2. If you must build an RS-232 cable, use the following information.

Table 5-1 RS-232 cable pinouts

Pin Number	Function
Pin 1	+ 5 V
Pin 2	Transmit ⇒
Pin 3	Receive ⇐
Pin 4	RTS
Pin 5	CTS
Pin 6	GND

NOTE: Pin 4 and Pin 5 are shorted together.

3. With the computer and particle counter off, use the RS-232 cable to connect the two devices together.
4. Power-up the particle counter and computer.
5. If the STATUS light turns green, continue with setting the 4-20 mA parameters.

Setting up a Terminal Emulation Session (with 4-20 mA Outputs)

The following steps enable you to communicate with the HSLIS e-Series particle counter so you can send commands from the computer to the particle counter.

>> To set up terminal emulation:

1. Connect to the HSLIS e-Series particle counter to a computer using an RS-232 cable.
2. Start the PC.
3. Open the HyperTerminal program.
   The window shown in **Figure 5-1** appears.

Figure 5-1 HyperTerminal window

NOTE: Your HyperTerminal window may display a different set of icons.

4. Double-click the **HyperTerminal** icon.
   The new HyperTerminal session appears in the **HyperTerminal** window.

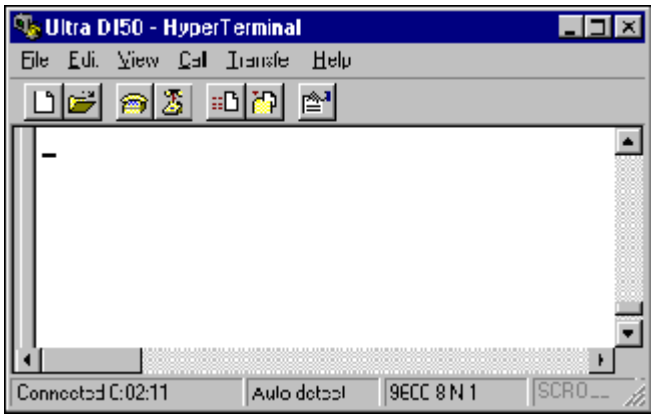

Figure 5-2 HyperTerminal window

Setting 4-20 mA Parameters

The following commands are used to set 4-20 mA parameters. The command(s) you want to execute must be typed one at a time, after the prompt icon, on the HyperTerminal session window.

>> To set the 4-20 mA parameters:

1. Connect to the HSLIS e-Series particle counter to a computer using an RS-232 cable.
2. Start HyperTerminal or another terminal emulation program.

3. Enter any of the following commands at the HyperTerminal prompt, and press the **Enter** key.

set cumul n

This function selects between cumulative and differential data for the 4-20 mA channels.
If **n = 1**, the data for each channel represents the number of particles detected that are larger than the size specified for the channel. That is, cumulative data.
If **n = 0**, the data in each channel represents the particles detected between the size specified for the channel and the size specified for the next channel. That is, differential data.

set led n – Determines the source of control of the Status and Activity LEDs on the HSLIS e-Series particle counter.
If **n = 1**, the LEDs are controlled by the host. Usually Facility Net.
If **n = 0**, the LEDs are controlled by the HSLIS e-Series particle counter.

set eos n

Determines when the data is updated.
If **n = 1**, the data in each channel is updated only at the end of each sample interval. It is held constant for the duration of the subsequent sample interval.
If **n = 0**, the 4-20 mA channel is updated approximately every 20 milliseconds.

set raw n

Determines whether the particle data is raw or normalized data.
If **n = 1**, the data in each channel is the number of particles detected (raw data).
If **n = 0**, the data is divided by the sample volume in which the particles were detected. That is normalized.
Volume is expressed in milliliters.

set sca n,n,n,n

Defines the 4-20 mA channel scaling.
The lower end of the range is always defined so that 4 mA corresponds to zero (0).
The upper end of the particle count range should correspond to 20 mA.

NOTE: The units of the value **n** are defined by the settings entered by the **cumul** and **raw** commands.

---

write

Saves the most recent changes. You must type in this command when you are finished setting up your 4-20 mA parameters.

status

Displays the HSLIS e-Series particle counter configuration.

4. After entering the 4-20 mA parameters, type **write** and then press the **Enter** key. The system will change the parameters to your settings.

NOTE: If you do not send the **write** command, the parameters you have set will be lost when the instrument is powered-down.

Connecting HSLIS e-Series Particle Counter to SCADA or PLC

Connection to the 4-20 mA output option is made using a standard DE-25 D-type connector. This connector mates with the DE-25 connector located on the HSLIS e-Series Particle Counter rear panel.

There are DE-25 adapters provided for connecting a customer-provided standard cable. Alternatively a custom cable can be made using the cable pinouts in **Table 5-2**.

Table 5-2 4-20 mA cable pinouts

Pin Number	Function
1	Channel 1
2	Channel 2
3	Channel 3
4	Channel 4
5	Status
6 through 25	Ground

Factory Preset Status Levels

Laser OK	8 mA
Laser Bad	12 mA

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Chapter 6
Maintenance

Cleaning Optics

The sample cell window and optics may become dirty. Optics should only be cleaned by a technician certified by Particle Measuring Systems.

Calibration

Calibration should be checked at least once each year by a technician certified by Particle Measuring Systems. For more information contact Particle Measuring Systems.

We encourage you to schedule calibration up to one year in advance. This allows you to use your HSLIS e-Series Particle Counter right up until the scheduled calibration time, reducing any possible downtime.

Replacing Fuses

WARNING
Disconnect the unit from its power source.

The fuse drawer in the instrument's power entry module holds two 250V, 5 x 20mm, T type (time lag), 1.0A fuses.

>> To replace a fuse:

1. Ensure that you have the correct replacement fuses.
2. Disconnect the unit from its power source.
3. Use the external power switch to turn the HSLIS e-Series Particle Counter off.
4. Using a small blade screwdriver or similar tool, free the fuse drawer from the power entry module by pushing up on the tab at the bottom of the fuse drawer.
5. Pull the fuse drawer from the power entry module.

6. Replace the fuses and then replace the fuse drawer.
7. Plug the unit into its power source.
8. Start the HSLIS e-Series Particle Counter with the power switch.

DC Light

DC light is continuously monitored by the firmware. The values that vary between 0.00 (good) and 1.00 (high DC light) represent the percentage of time during the sample interval that the DC light was high. Values greater than 0.25 may indicate a deterioration in the cleanliness of the cell and optical components. Servicing may be required by a technician certified by Particle Measuring Systems.

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
LED Indications

This appendix decodes the HSLIS e-Series particle counter status and activity LED indicators. The material is organized by the type of communications, Ethernet (see below) or RS-485 (see page B-2).

Ethernet Communications

4-20 mA output and Ethernet communications are automatically and continuously available when the HSLIS e-Series particle counter is on.

4-20 mA Output

When HSLIS e-Series particle counter is controlled by a host, such as Facility Net, the firmware is set to *set led 1* and the host controls the LED function.

Status LED	
Steady green	Laser OK
Steady red	Laser bad[a]
Blinking red	Bad NIC card

Activity LED	
Off	No activity
Blinking green	Activity

a. Possible causes: laser not lasing on start up, laser power below 50%, excessive scatter, excessive particle concentration.

Ethernet Communications

HSLIS e-Series particle counter firmware is set to *Set LED 1*.

Status LED	
Blinking green	Not connected to host
Steady green	Connected to host

Activity LED	
Off	No activity
Blinking green	Activity

Status LED	
Steady amber	Warning
Steady red	Alarm

Activity LED

Use Facility Net's Event Log to identify the event that changed the LED status.

>> To see the event log:

1. Click **Configure > Alarm Setting > Alarm Priorities**.
2. Click the **Defaults** button.
3. Double-click **Laser Error**.
4. Click **OK**.

NOTE: The Status and Activity LED legend above is the default Facility Net setting. However, the LED indications can be changed with Facility Net. In this case, the LED functions, warnings, and alarms are dependent on settings within Facility Net.

4-20 mA Output without Host (Facility Net) Control

4-20 mA output is always available. When the HSLIS e-Series particle counter is operated without host control, the particle counter itself controls the Status and Activity LED and the firmware must be set to *set led 0*.

NOTE: If the HSLIS e-Series particle counter is being operated without host control and *set led 0* is not active, the Status LED will continuously blink green, meaning "Not Connected to Host." No other useful information will be communicated by the LEDs. When *set led 0* is active, the following LED legend will apply.

Status LED	
Steady green	Laser OK
Steady red	Laser bad
Blinking red	Bad NICK card

Activity LED	
Off	No activity
Blinking green	Activity

Appendix C
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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Appendix D
Modbus

Communications with the HSLIS e-Series e-Series 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 a 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 D-5.

Configuration Section

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

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 Modbus map multiplied by 100. The version will change if/when the 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 firmware version 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 factor depends on the sample flow rate. If the sample flow rate is less than 1.0 ml/min the factor is 4. If the flow rate is 1.0 ml/min or greater the factor is 3.

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 scale factor depends on the sample flow rate. If the sample flow rate is less than 1.0 ml/min the factor is 5. If the sample flow rate is 1.0 ml/min or greater the factor is 4.

30013 - 30014:
Flow Rate

Dual-register representation of the nominal flow rate in ml per minute. Can be integer or float depending on mode selected. The integer representation uses the scale factor from register 30011.

30015:
Number of Particle Channels

Processed as a variable but fixed to a value of 4 for the HSLIS e-Series.

30016:
Number of Analog Channels

Processed as a variable but fixed to a value of 2 for the HSLIS e-Series.

30017 - 30024:
Dual-Register Representation of the Particle Channel Sizes in Nanometers

The dual-register representation of the particle channel sizes in nanometers. The fixed sizes for the instrument are dependent on the type.

Table D-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 or 4
30012	unary	Scale: Volume	Multiplier in fixed: Volume	4 or 5
30013	dual	Flow Rate (high)	Flow * 10 Scale cfm	Float Mode
30014	dual	Flow Rate (low)	Flow * 10 Scale cfm	Float Mode
30015	unary	Number of Particle Channels	Fixed number of sizes	4 fixed

Table D-1 Input Register – Configuration (Continued)

Input Registers		Description (Configuration)	Comment	Notes
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	Type
30019	dual	Channel 2 Size (high)	nanometers	
30020	dual	Channel 2 Size (low)	nanometers	Type
30021	dual	Channel 3 Size (high)	nanometers	
30022	dual	Channel 3 Size (low)	nanometers	Type
30023	dual	Channel 4 Size (high)	nanometers	
30024	dual	Channel 4 Size (low)	nanometers	Type

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., 2012)

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 D-5** on page -13.

30214:
Device State

Least Significant byte (LSB) is State. Most Significant Byte (MSB) is sub-state. Values are defined in **Table D-5** on page -13.

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 is 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 a value 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 D-5** on page -13.

30222 - 30223:
Flow Rate

Dual-register representation of the data packet flow rate in ml 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 cubic feet. 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 the HSLIS e-Series.

30227:
Number of Particle Channels

Processed as a variable but fixed to a value of 4 for the HSLIS e-Series.

30228:
Number of Analog Channels

Processed as a variable but fixed to a value of 2 for the HSLIS e-Series.

30229 - 30236:
Cumulative Particle Data

Dual-register representation of particle size counts.

30237 - 30238: Analog Data

Dual-register representation of the data packet analog value. Can be integer or float depending on the 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 D-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
30219	dual	Sample Time (low)	Seconds * 100	Float
30220	dual	Data Packet Status (high)	Bit Mask	
30221	dual	Data Packet Status (low)	Bit Mask	
30222	dual	Flow Rate (high)	Flow * 10 Scale cfm	Float
30223	dual	Flow Rate (low)	Flow * 10 Scale cfm	Float
30224	dual	Volume (high)	Volume * 10 Scale	Float
30225	dual	Volume (low)	Volume * 10 Scale	Float
30226	unary	Location	Location value	n/a
30227	unary	Number Particle Channels	Variable across types	4 fixed

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

Input Registers		Description (Data Packet)	Comment	Notes
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	
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	DC Light (high)	Analog 1 * 10000	Float Mode
30238	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 no specific/optional coils defined for the HSLIS e-Series.

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 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 the HSLIS e-Series. 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
A value of zero will command continuous processing.

40006: Delay Time
Time, in seconds, processed between each sample. Not used for the HSLIS e-Series.

40007 - 40032: Spare

Table D-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	Seconds
Spare	unary	26 spare registers	Reserve future "common" registers

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 HSLIS e-Series.

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

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

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

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 HSLIS e-Series.

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 HSLIS e-Series.

Read: 1=Sample Volume, 0=Sample Interval

Write: 1=Sample Volume, 0=Sample Interval

00/10 - 00/32: Spare.

Read: Always 0

Write: No effect

Table D-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	In-Line
00/06	Status LED: Red	On/Off	Status LED: Red Control	In-Line
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	23 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.

Associated Values for Specific Registry Entries

Table D-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	
	0x0004	Hardware Good	

Modbus Processing Example

The following flowchart provides a basic example of controlling the HSLIS e-Series 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.

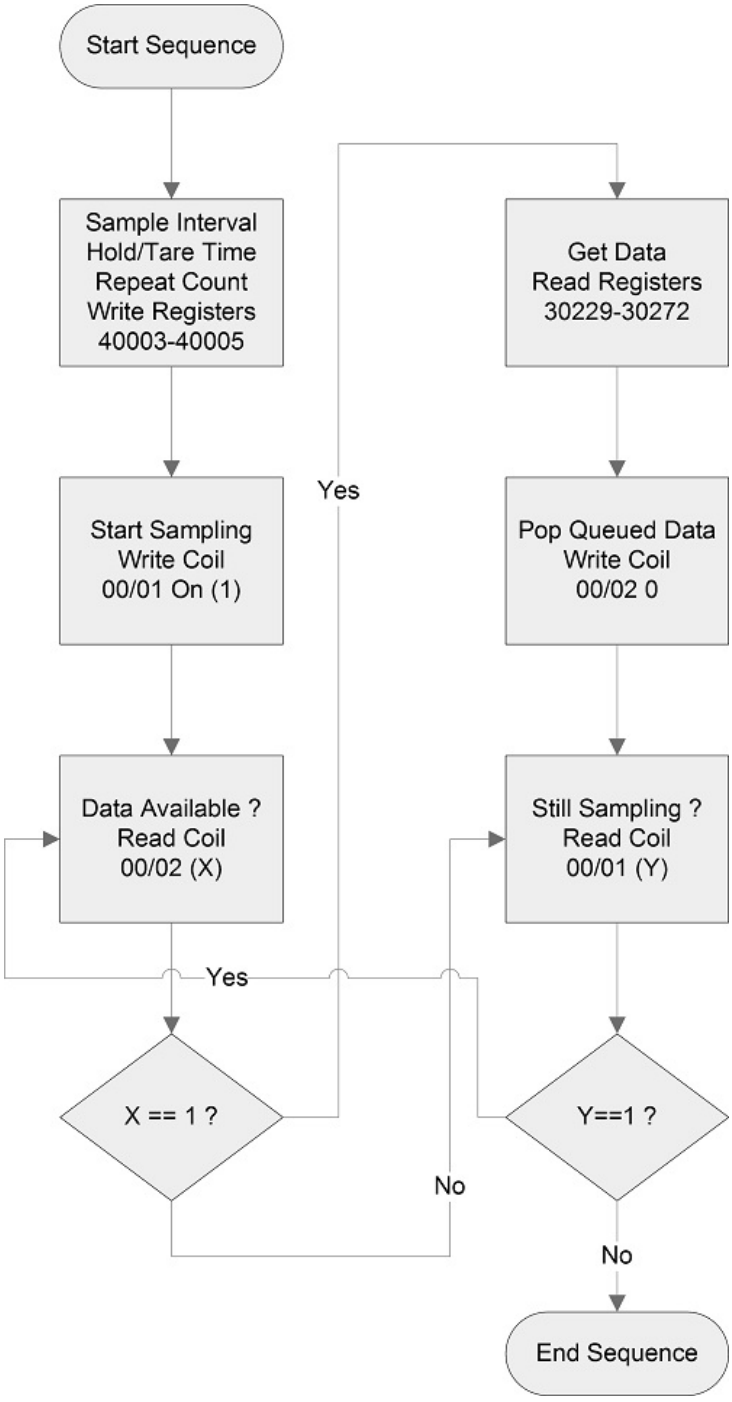

Figure D-1 Modbus flowchart

Index

P

R

S

T

U

V

W

Z