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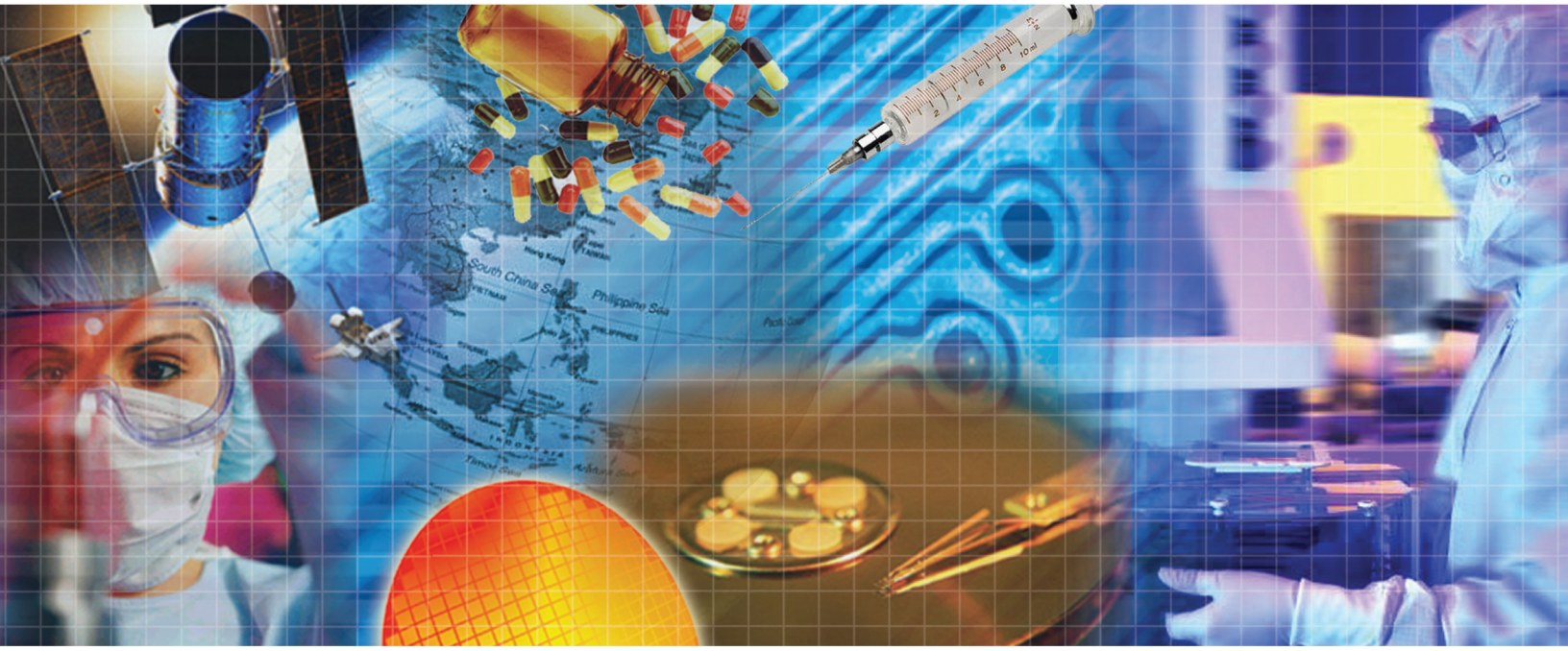
USER GUIDE

Remote particle counters (1100LD, 1104LD, 5104V)

Lighthouse

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LIGHTHOUSE
WORLDWIDE SOLUTIONS

REMOTE

1100, 1104

Airborne Particle Counter

CEMS & RS-485 Output

Operating Manual

Lighthouse Worldwide Solutions

REMOTE 1100, 1104 Airborne Particle Counter

Operating Manual

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Manufactured by:

Lighthouse Worldwide Solutions

1221 Disk Drive

Medford, Oregon 97501

LWS PN 248083363-1 Rev 4

LIGHTHOUSE
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EU DECLARATION OF CONFORMITY

Manufacturer's Name: Lighthouse Worldwide Solutions, Inc.

Manufacturer's Address: Lighthouse Worldwide Solutions, Inc.
1221 Disk Drive
Medford, OR 97501 USA

Declares that the product:

Product Name: Remote Airborne Particle Counter
Model Number(s): REMOTE 1100, 1104

Conforms to the following Product Specifications:

SAFETY	EN61010-1:2010	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use Part 1: General Requirements;
	EN61010-2-081-2-2015	Safety requirements for electrical equipment for measurement, control and laboratory use, particular requirements for automatic and semi-automatic laboratory equipment for analysis and other purposes.
LASER SAFETY	IEC 60825-1:2014	Safety of Laser Products - part 1: Equipment classification and requirements
EMC	EN61326-1:2014	Electrical Equipment for Measurement, Control and Laboratory Use EMC Requirements Part 1: General Requirements

UL 61010A-1 - UL Standard for Safety Electrical Equipment for Laboratory Use; Part 1: General Requirements
Replaces UL 3101-1

Supplementary information
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC amended by Directive 93/68/EEC and the EMC Directive 89/336/EEC amended by Directive 93/68/EEC and carries the CE marking accordingly.

Jerry Szpak

Medford, OR February 11, 2016

Jerry Szpak, Director of Engineering

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About this Manual

This manual describes the detailed operation and use of the Lighthouse ***REMOTE 1100/1104*** Airborne Particle Counters.

Text Conventions

The following typefaces have the following meanings:

Note: *A note appears in the sidebar to give extra information regarding a feature or suggestion*

WARNING: ***A warning appears in a paragraph like this and warns that doing something incorrectly could result in personal injury, damage to the instrument or loss of data.***

italics	Represents information not to be typed or interpreted literally. For example, *file* represents a file name. Manual titles are also displayed in italics.
boldface	Introduces or emphasizes a term.
`Courier font`	Indicates command syntax or text displayed by the diagnostic terminal.
`Bold Courier`	Indicates commands and information that is to be typed. Use uppercase or lowercase letters; in this manual, commands are shown in uppercase.
Helvetica Italics	Indicates a comment on a command or text output.

Additional Help

For more information about Lighthouse ***REMOTE 1100/1104*** Airborne Particle Counters, contact Lighthouse Worldwide Solutions:

1-800-945-5905 Toll Free USA
1-541-770-5905 Outside of USA

techsupport@golighthouse.com
www.golighthouse.com

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1 General Safety

Safety Considerations

Warnings and cautions are used throughout this manual and the reader should become familiar with the meaning of a warning before operating the particle counter. Most warnings will appear in the left margin of the page next to the subject or step to which it applies. Take care when performing any procedures preceded by or containing a warning. The classifications of warnings are defined as follows:

WARNING: ***There are no user-serviceable components inside the particle counter***

- LASER - pertaining to exposure to visible or invisible LASER radiation
- Electrostatic - pertaining to electrostatic discharge
- Network Connect - pertaining to communication ports and instrument damage

LASER Safety Information

This product is considered to be a Class 1 LASER product (as defined by FDA 21 CFR, §1040.10) when used under normal operation and maintenance. Performing service on the internal sensor can, however, result in exposure to invisible radiation.



Figure 1-1 Laser Warning Label

WARNING: ***The use of controls, adjustments or procedures other than those specified within this manual may result in personal injury and/or damage to this instrument.***

The particle counter has been evaluated and tested in accordance with EN 61010-1:2010, EN61010-2-081-2-2015 “Safety Requirements For Electrical Equipment for Measurement, Control and Laboratory Use”, particular requirements for automatic and semi-automatic laboratory equipment for analysis and other purposes and IEC 60825-1:2014, “Safety of LASER Products”.

For further technical assistance, contact our Technical Support Team at 1-800-945-5905 (USA Toll Free), 1-541-770-5905 (Outside of USA).

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WARNING: ***There are no user-serviceable components inside the particle counter. Only factory authorized service personnel should repair or service this instrument and its optical system.***

The use of controls, adjustments or procedures other than those specified within this manual may result in personal injury and/or damage to this instrument. Attempts by untrained personnel to disassemble, alter, modify or adjust the electronics or optics may result in personal injury and damage to the instrument and will void its warranty.

Review Lighthouse specifications before installing a DC power supply or gateway that will be designated as a power source for the R1100/1104. Attempting to use under-rated power source equipment can expose the instrument, adjacent equipment and the user to dangerous shock and fire hazards. Failure to meet the specifications as provided by Lighthouse Worldwide Solutions will void the instrument Warranty and may cause serious personal injury.

WARNING: ***The REMOTE 1100/1104 uses a 24V AC-DC power supply. It connects to the round connector shown in Figure 1-1. Handle with care and keep away from water or conductive liquids.***

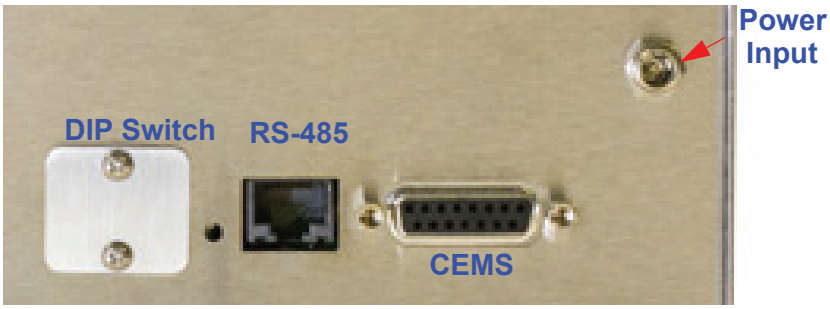


Figure 1-1 RS485, CEMS and 24VDC Power Connectors

Electrostatic Safety Information

Electrostatic discharge (ESD) can damage or destroy electronic components. Therefore, any service or maintenance work should be done at a static-safe work station. A static-safe work station requires an ESD consultant to evaluate the work environment and propose the equipment and apparel needed for just such a work station to be successful.

Sampling Safety

WARNING: ***Do not attempt to sample reactive gases (such as hydrogen or oxygen) with this instrument. Reactive gases create an explosion hazard in the instrument.***

Sampling any gas under pressure can damage the instrument and void the warranty.

Sampling any gas that is not the same density as ambient air can result in inaccurate data.

Do NOT allow water, solvents, or other liquids to enter the instrument via the inlet tube - the instrument will be damaged and the warranty voided.

Disposal of Instrument



If disposal of the instrument is required, the instrument should be returned without its battery (ies) to Lighthouse Worldwide Solutions for proper disassembly and disposal of hazardous materials. An RMA is required and, other than possible shipping costs, there is no charge for this service.

Contact Lighthouse for additional information.

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2 Introduction

Overview

This operating manual introduces the Lighthouse ***REMOTE 1100, 1104*** family of Airborne Particle Counters. Included in this manual are instructions for inspecting, using and maintaining these instruments.

Description

The ***R1100*** or ***R1104*** instrument has up to four (***R1100***) or eight (***R1104***) particle size channels starting at 0.1 microns at a flow of 1.0 CFM.



Figure 2-1 *REMOTE 1104* Airborne Particle Counter

The instrument uses the Lighthouse Long-Life laser diode light source and laser beam shaping optics to illuminate a cross section of the air flow path with a laser beam. As particles move along the flow path, they cross the laser beam and scatter light. The light scattered is collected by an imaging optical system onto a photodiode. The photodiode converts this light into a voltage which is amplified.

The resulting pulse is measured for width and height. The width of the pulse is proportional to the time it takes the particle to cross the laser beam and the height (amplitude) of the pulse is equal to the amount of light scattered by each particle which is proportional to its size. Additional electronics count the particles and group them based on

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their sizes.

The ***REMOTE 1100*** or ***1104*** is effective in ultra-clean areas (such as Class 1 or Class 10) as well as in more traditional cleanzones rated as Class 100 or higher. They were designed for continuous 24/7 operation. Data is stored in a rotating buffer of 999 records that can be downloaded real-time or manually as required.

Using an external vacuum source, the instrument can be installed anywhere power and vacuum are available and where space may be limited. These instruments integrate seamlessly with large facility monitoring/management systems and transfer up to 8 channels of simultaneous particle count data using RS-485/Modbus output. Refer to Specifications in this chapter for additional instrument information.

Terms Used

Throughout this publication, the terms ***REMOTE 1100*** *or* ***1104***; ***REMOTE; R1100*** *or* ***R1104***; *instrument*; and *counter* are used interchangeably to describe these instruments. These terms are referring to the same thing.

R1100 vs R1104

The main difference between the two instruments is how they communicate and connect to monitoring systems:

The R1100 uses CEMS communication (pulses over a simple two-wire network); when a particle is detected, a pulse is generated that communicates the size based on the channel in which it was detected.

The R1104 uses MODBUS communication, which is an intelligent communication scheme that provides instrument status in addition to on-board data storage and is programmable by the data monitoring equipment.

Accessories

Both REMOTEs come standard with a 1.0 CFM purge filter but can be ordered with several accessories to tailor the instrument to special requirements. Please contact a Lighthouse Sales Engineer for detailed additional information.

Annual Calibration

The manufacturer recommends that the Lighthouse instrument be calibrated annually by a Certified Lighthouse Service Provider to ensure that it continues to perform within specification.

REMOTE 1100 Specifications

Table 2-1 *REMOTE 1100* Specifications

Size Range	0.1 - 1.0µm
Channel Thresholds	**Standard**: 0.1, 0.2, 0.3, 0.5µm
Flow Rate	1.0 CFM (28.3 LPM)
Counting Efficiency	50% (per JIS)
Light Source	Long-Life Laser Diode
Zero Count Level	<1 count/5 minutes (per JIS)
Vacuum Source	Customer-supplied Vacuum ≥18”Hg
Calibration	NIST Traceable, per ISO 21501-4
Communication Mode	CEMS (pulse output)
Data Storage	999 records, rotating buffer
Supporting Software	Lighthouse Monitoring System, LMS XChange
Power Supply	50-60Hz, 100-240VAC @1.5A; output 24VDC @ 3.0A (72W); must be LPS and certified to CE requirement
Power Input	24 VDC@1.6A min (38W min) and 2.5A max (60W)
Enclosure	Stainless Steel
Dimensions	10.5"[w] x 7.65"(h) x 3.35"(d) [26.67 x 19.43 x 8.51 cm]
Weight	7.0 lbs (3.18 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Operating Altitude	Up to 2000m
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

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REMOTE 1104 Specifications

Table 2-2 *REMOTE 1104* Specifications

Size Range	0.1 - 1.0µm
Channel Thresholds	**Standard**: 0.1, 0.15, 0.2, 0.25, 0.3, 0.5, 0.7, 1.0µm
Flow Rate	1.0 CFM (28.3 LPM)
Counting Efficiency	50% (per JIS)
Light Source	Long-Life Laser Diode
Zero Count Level	<1 count/5 minutes (per JIS)
Vacuum Source	Customer-supplied Vacuum ≥18”Hg
Calibration	NIST Traceable, per ISO 21501-4
Communication Modes	RS-485 Modbus; RS-232
Data Storage	999 records, rotating buffer
Supporting Software	Lighthouse Monitoring System, LMS XChange, LMS Express, LMS Express RT
Power Supply	50-60Hz, 100-240VAC @1.5A; output 24VDC @ 3.0A (72W); must be LPS and certified to CE requirement
Power Input	24 VDC@1.6A min (38W min) and 2.5A max (60W)
Enclosure	Stainless Steel
Dimensions	10.5"[w] x 7.65"(h) x 3.35"(d) [26.67 x 19.43 x 8.51 cm]
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Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

3 Get Started

Initial Inspection

The instrument is thoroughly inspected and tested at the factory and is ready for use upon receipt.

It is presumed that when the instrument was received, its shipping carton was inspected for damage. If the carton was damaged, the carrier was notified and the carton was saved for carrier inspection. The instrument and other components were then removed from their packing materials and inspected for broken parts, scratches, dents, or other damage. Any damage was immediately reported to Lighthouse. Damaged cartons should be replaced by calling Lighthouse Sales. Keep an undamaged carton for reshipment of the instrument for its annual factory calibration.

Shipping Instructions

Should it become necessary to return the unit to the factory for any reason, contact Lighthouse Customer Service or visit our website, www.golighthouse.com/RMA, and obtain a Return Merchandise Authorization (RMA) number. Reference this number on all shipping documentation and purchase orders. After receipt of the RMA number, follow the shipping instructions below:

WARNING:
If the instrument is damaged during return shipment due to inadequate user packing, the warranty may be voided and may result in additional costs being charged to the customer.

1. Use the original container, nozzle caps and packing materials whenever possible. The risk of expensive damage and additional charges is too high.
2. If the original container and packing materials are not available, contact Lighthouse to purchase a replacement shipping container and nozzle caps. The unit may be wrapped in “bubble pack”, surrounded with shock-absorbent material and placed in a double-walled carton - the instrument should not rattle around when the carton is vigorously shaken. If the instrument is damaged during shipment due to inadequate user packing, the warranty may be voided and all repairs required will be charged at cost.
3. Seal container securely. Mark “FRAGILE” and write the RMA number in an unmarked corner.
4. Send to the address provided by the Lighthouse representative or the RMA website.

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Installation

Basic hand and power tools are required to install the instrument in a permanent location. It should be mounted on a flat vertical surface and the Inlet-to-Outlet path must be as vertical as possible.

Choose a location that is convenient to all of the facilities required, such as electricity, vacuum and network connections and provides six-inch clearance on the left and right sides. Use of safety glasses and gloves are strongly suggested.

WARNING: ***REMOTE 1100/1104 Power Supply specifications are 100-240VAC, 47-63Hz, 1.4A input, 24VDC 3.0A output (72W max). Installation of the REMOTE must be done with easy access to the DC power connector, enabling fast manual DC removal from the REMOTE. The power supply must be installed such that the AC power cord is not obstructed and AC power can be quickly removed.***

If replacement of the power supply or its AC power cord is required, replace only with a power supply or cord having as good as or better ratings than the items provided by Lighthouse Worldwide Solutions. Attempting to use an under-rated power supply or cord can expose the instrument power supply, adjacent equipment or the user to dangerous shock and fire hazards. Failure to heed this warning can result in personal injury or death.

Maintain a minimum clearance of six inches from the left and right sides of the instrument to prevent overheating of the instrument and subsequent failure. Failure to heed this warning may result in the warranty being void and any repairs will be charged to the customer.

Every installation of measuring instruments is dependent upon facility surroundings, construction materials and points of placement. Due to these differences, specific instructions cannot be supplied in this document. The listed tools and hardware shown are typical but may not be used for every situation.



Bubble Level
Screw Driver
Pencil or pen
Wall Anchor Devices
Instrument as a Template

Items not shown:
Battery-powered Drill Motor

Figure 3-1 Required Tools

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Maintain six inches between left and right sides and any walls or objects to prevent overheating



Figure 3-2 Marking Wall for Mount Point

WARNING: ***Make sure target location is electrically safe for drilling. Wear safety glasses while drilling.***

1. Refer to Table 3-1 and Table 3-2 and set the DIP switches to desired address and communication mode.
2. Level the instrument and mark where mounting holes will be drilled. Take care to not drop the instrument while marking. Refer to Figure 3-2.



Figure 3-3 Drilling and Preparing Mounting Holes

3. Use an appropriate size drill to drill the anchor holes.
4. Install the anchors and start button-head screws but o not tighten. Place R1100/1104 on screws and tighten screws. Use flat washers to provide a stronger attachment.
5. Find an appropriate area for the power supply and place the supply so access to the AC input connector is visible. Attach the 24VDC connector to the REMOTE then attach power cord.

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6. Connect the supply to AC and observe the REMOTE LEDs. Power should come on and stay on; Flow should blink then go off. Service should turn on solid.

7. Connect to communication network.

8. Remove Inlet and Outlet caps, connect vacuum source and purge filter then verify correct Flow condition after a couple of minutes. Allow flow for several hours to purge instrument.

Operation

Before relocating the counter, power it OFF and reinstall the caps to prevent contamination of the LASER sensor.

Understanding the LEDs

The front-panel LEDs have special meanings when illuminated. The figure below shows locations of the LEDs and a description of their meaning.



Figure 3-1 Front Panel LEDs

- The green POWER LED turns on when the instrument is powered on.

- The green FLOW LED turns ON when the flow is correct, BLINKs when flow is insufficient or is zero.

Note: *If the flow (vacuum) to the instrument stops for two minutes or longer, the LASER will be turned OFF and the Service LED will turn ON. When flow has been restored, the LASER will turn ON and after 15 seconds of continuous flow, the Service LED will turn OFF.*

- If flow is OFF for 2 minutes or longer, the orange SERVICE LED turns ON steady and the LASER is turned OFF. When flow is returned, the green Flow LED is turned ON and the LASER is turned ON again. When the LASER has been ON for fifteen seconds, the SERVICE LED will turn OFF.
- The orange SERVICE LED comes ON and stays ON steady if LASER power is low, sensor optics are dirty or the view chamber contains foreign objects.
- The blue SAMPLING LED turns on when the instrument is counting.

Features

The ***REMOTE 1100*** and ***1104*** instruments have the following features:

1. RS-485 and CEMS ports
2. DIP switch control for device addressing and communication modes
3. Modbus ASCII (see “Supported Modbus Commands” on page A-1) or CEMS communication protocols
4. 999 record storage in a rotating buffer

Connections

Sample Inlet Connection

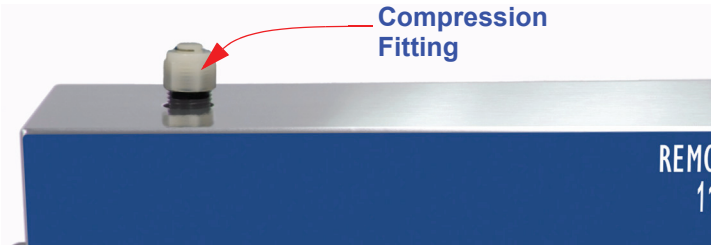


Figure 3-2 Connection on Top

The top of the instrument has only one connection, the sampling inlet. The instrument can be used with an optional 1.0 CFM barbed isokinetic probe that uses a compression sleeve and short length of tubing to attach to the compression fitting (Figure 3-2). This can be especially useful for “fixed” placement of the REMOTE. The barbed probe is attached via 1/4” ID tubing and a nut and ferrule kit (Figure 3-3). This style of probe can also be attached to a tripod for probe mobility

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without moving the REMOTE.

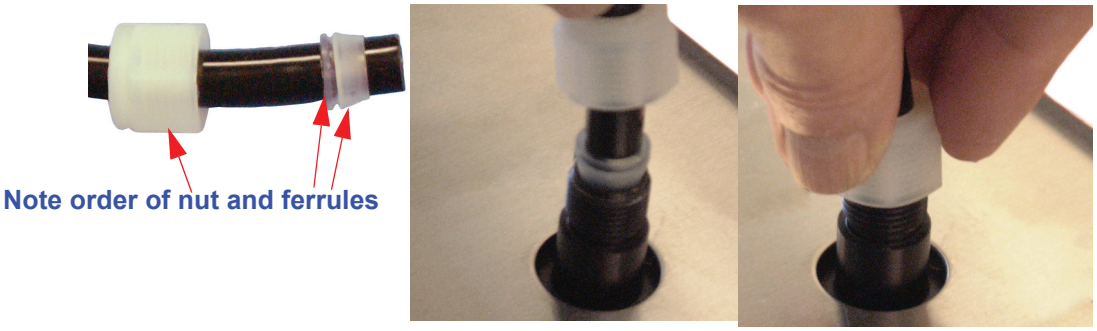


Figure 3-3 Attaching tubing with Ferrule and Nut Kit

Data Output (Mode) Options

The ***R1100***, ***R1104*** comes from the factory set as either CEMS 4-channel pulse mode or Modbus RS-485 8-channel. The instrument cannot be reconfigured in the field to a different mode.

RS-232 ASCII

Table 3-1 RS232 RJ-45 Pinouts

RJ-45 Pin	Signal Name
1	RS-232 - TX
2	RS-232 - RX
3	RESERVED for future use
4	RS-485B
5	RS-485A
6	RESERVED for future use
7	RESERVED for future use
8	GND

RS-232 Communications

WARNING: ***Contact Lighthouse Technical Support for the correct instrument configuration BEFORE attempting to use RS-232 COM mode. Failure to heed this warning can result in damage to PC, instrument or both.***

RS-232 can be used for point-to-point communication with the ***R1104*** and to configure settings on a CEMS (***R1100***) unit. To connect to the instrument using RS-232 topology, follow these steps:

1. Remove power from the instrument.
2. Connect the RJ45 end of a USB-to-RS-232 adapter cable to the Data Port on the instrument.
3. Attach the USB end to any available USB Port on the computer.

The ***R1100/1104*** RJ45 connector is multi-standard and provides both RS-232 and RS-485 connectivity. To be clear, the 'RS' nomenclature (Recommended Standard) is a wiring standard and has nothing to do with the programming steps required to get a device to respond.

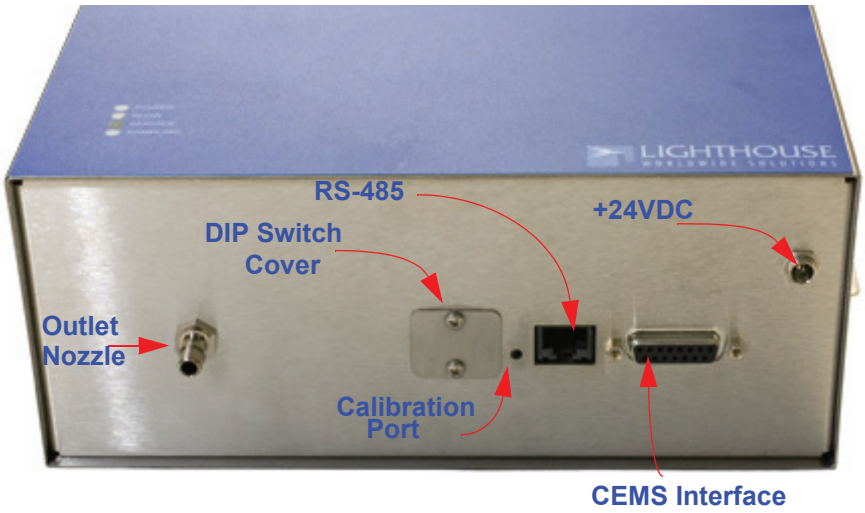


Figure 3-4 Instrument Connections

Simple Serial communications as used by HyperTerminal or another serial communications program must supply commands to the instrument that the instrument understands. These commands can change the operating parameters for the CEMS ***R1100***.

The Modbus ***R1104*** uses the Modbus ASCII communication protocol for instructions. The ***LMS 485 Gateway*** provides communication to an instrument on an RS-485 LAN while connected to an Ethernet LAN for PC communication. It requires a PC or server running a Modbus communication package, such as ***LMS Express***, ***Express RT*** or ***LMS Professional***, connected to the Ethernet LAN. A PC can usually

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connect via an Ethernet LAN to the ***LMS 485 Gateway*** without any adapters and communicate with the instrument through the ***Gateway***.

RS-485 Communications

WARNING: ***This instrument will be damaged and its warranty voided if the design of the RS-485 port is defeated to allow daisy chaining. The port is designed for a star configuration, only, where the instrument is the termination of a single cable run between it and a PC or hub.***

The ***R1104*** RS-485 port supports long distance multi-point RS-485. The ***LWS USB-to-RS-485 Adapter*** cable may be used to connect a PC USB port to an ***R1104*** or to an RS-485 LAN.

The Modbus protocol provides a programming interface for multiple devices on the same LAN. The RS-485 port allows easy connection using standard CAT5e cable commonly used for office LANs. For a detailed description of the Modbus registers and commands, please refer to "Supported Modbus Commands" on page A-1.

Attaching the ***R1104*** to an RS-485 LAN requires attention to the topology (wiring scheme of network) before and after the design phase to make sure the ***R1104*** and other instruments will perform as expected. The ***R1104*** must be used in a "star" or hub-based configuration. Do NOT attempt to configure it for daisy chaining.

Use a standard CAT5e cable to connect the ***R1104*** to the RS-485 LAN. Table 3-2 illustrates the RS-485 RJ45 pins and the signals assigned.

Table 3-2 RS-485 RJ-45 Pinouts

RJ-45 Pin	Signal Name
1	RS-232 - TX
2	RS-232 - RX
3	RESERVED for future use
4	RS-485B
5	RS-485A
6	RESERVED for future use
7	RESERVED for future use
8	GND

R1104 RS-485 Port to PC USB Port

To use the ***R1104*** RS-485 port to connect to a computer USB port, the ***LWS USB-to-RS-485 Adapter*** cable must be used. Please contact a Lighthouse Sales Representative for either the ***USB-to-RS-485 Adapter*** cable or ***USB-to-RS-232 Adapter*** cable kit.

To connect the instrument to a computer USB port using the ***USB-to-RS-485 Adapter*** cable kit:

1. Remove power from the instrument.

2. Connect the RJ45 end of an ***USB-to-RS-485 Adapter*** cable to the ***R1104*** RS-485 port.

3. Connect the USB end of the ***USB-to-RS-485 Adapter*** cable to a USB Port on the PC. Note the COM port assigned to it through Computer | Properties | Device Manager.

4. Apply power to the ***R1104***. Start an ***LMS Express*** session and assign the USB COM port to the ***R1104***. Data will be accessible after a few seconds. Allow the ***R1104*** 15 minutes to warm up for data accuracy.

Make sure that each ***REMOTE*** has a unique non-zero address or a conflict will result and data will be lost. The ***REMOTE*** complies with EIA's RS-485 standards (Table 3-3) for distances and number of devices on a chain.

Table 3-3 EIA Industry Standards for RS-485 Communications

SPECIFICATIONS	RS-485
Mode of Operation	Differential
Total Number of Drivers and Receivers on One Line (One driver active at a time for RS-485 networks)	32 Drivers 32 Receivers
Maximum Cable Length	4000 ft. (1,219.2 m)
Maximum Data Rate (40 ft. - 4000 ft. for RS422/RS-485)	10Mb/s - 100Kb/s
Maximum Driver Output Voltage	-7V to +12V
Driver Output Signal Level (Loaded Min.): LOADED	+/-1.5V
Driver Output Signal Level (Loaded Max.): UNLOADED	+/-6V
Driver Load Impedance (Ohms)	54
Max Driver Current in High Z State (POWER ON)	+/-100µA

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Table 3-3 EIA Industry Standards for RS-485 Communications

SPECIFICATIONS	RS-485
Max Driver Current in High Z State (POWER OFF)	+/-100µA
Receiver Input Voltage Range	-7V to +12V
Receiver Input Sensitivity	+/-200mV
Receiver Input Resistance (Ohms), (1 Standard Load for RS-485)	≥12k

DIP Switches

Table 3-4 DIP Switch 1-8 Settings

DIP#	Description	Value
1	Binary Address-1	1
2	Binary Address-2	2
3	Binary Address-3	4
4	Binary Address-4	8
5	Binary Address-5	16
6	Communication Mode	6 OFF = Pulse Mode
		6 ON = Modbus Mode
7	Pulse Count Mode	7 OFF = CUML Count
		7 ON = DIFF Count
	In Modbus Mode	7 = Reserved
8	In Pulse Mode	8 = Reserved
	In Modbus Mode	8 OFF = Fast Transfer OFF
	(Fast Transfer Mode)	8 ON = Fast Transfer ON

DIP switches 1-5 are the instrument address switches for RS-485 configurations.

DIP switch 6 switches the ***REMOTE***'s Mode between Pulse (***R1100*** CEMS pulse mode) when OFF and Modbus (***R1104*** mode) when ON. See Table 3-4 for more details.

The ***Instrument***'s operational mode is not switchable in the field.

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Power

This ***REMOTE*** instrument uses 24VDC, 3A; the center socket of the plug is +24VDC and outside sleeve is ground.

Pulse Output

If the ***REMOTE*** is factory-configured to run in CEMS (Pulse Output) mode, connect two SIU Interface Connectors to two available SIU Frequency ports. Connect twisted-pair cables between the SIU Interface Connectors and the Pulse Output DB15 on the bottom of the ***REMOTE***. Use Table 3-5 and Table 3-6 to properly wire all three DB-15s.

Table 3-5 1st DB15 Connector 1st and 2nd Channel Pinouts

First SIU Interface Connection DB15 Male Connector (Channels 1 and 2)			**REMOTE 1100** DB15 Male Connector	
Assignment	**Pin**		**Pin**	**Assignment**
Chassis Ground	1	◄►	1	Chassis Ground
CH1-	2	◄►	2	CH1-
CH1+	3	◄►	3	CH1+
CH2-	4	◄►	4	CH2-
CH2+	5	◄►	5	CH2+
Status 1-	6	◄►	6	Status1-
Status 1+	7	◄►	7	Status 1+
GND	9	◄►	9	GND

Table 3-6 2nd DB15 Connector 3rd and 4th Channel Pinouts

Second SIU Interface Connection DB15 Male Connector (Channels 3 and 4)			**REMOTE 1100** DB15 Male Connector	
Assignment	**Pin**		**Pin**	**Assignment**
CH3-	2	◄►	11	CH3-
CH3+	3	◄►	10	CH3+

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Table 3-6 2nd DB15 Connector 3rd and 4th Channel Pinouts

Second SIU Interface Connection DB15 Male Connector (Channels 3 and 4)			**REMOTE 1100** DB15 Male Connector	
Assignment	**Pin**		**Pin**	**Assignment**
CH4-	4	◄►	13	CH4-
CH4+	5	◄►	12	CH4+
GND	9	◄►	15	GND



Figure 3-5 SIU Pulse Output Connector

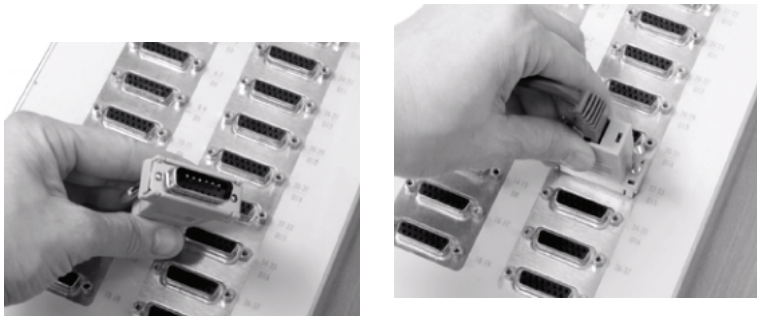


Figure 3-6 Connecting to SIU Frequency Port

Data Handling

The ***REMOTE*** stores its data in a 999-record rotating data buffer. The data can be uploaded real-time to LMS Express RT or to a Lighthouse Monitoring System. The instrument can also run standalone until it is decided to view the data. The data can be uploaded manually to ***LMS Express, Express RT*** or ***LMS XChange***. The data can be saved to an Excel xls file, a CSV file or to an HTML file.

A real-time system monitors the instrument counts on a minute-by-minute basis or for the length of the sample time. Using ***LMS Express Real Time*** (RT) or ***Lighthouse Monitoring System*** to upload the data allows historical trending of the data. Please refer to the data transfer software manuals for more information.

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4 Programming

General Information

A Modbus configured ***REMOTE 1104*** can be programmed using the Modbus Protocol via the RS-485 port. The CEMS configured ***R1100*** can be changed by using the instrument's RS-485 port and RS-232 / ASCII protocol.

This chapter contains information on how to program basic instrument functions to meet environment or system needs.

DIP Switches

The DIP switches are behind the cover plate illustrated below:

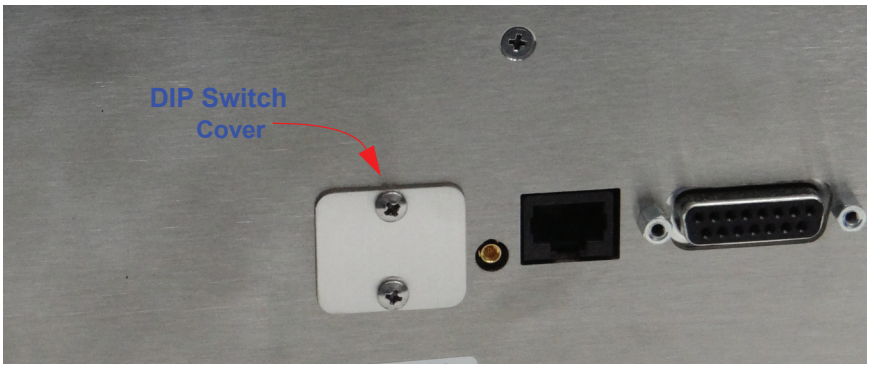


Figure 4-1 Panel Covering the DIP Switches

Remove the two Phillips head screws to expose the DIP switches.

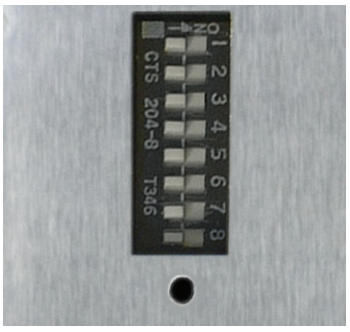


Figure 4-2 Panel Removed, Switches Exposed

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DIP Switch Settings

GENERAL DEFINITIONS

OFF (LEFT) = 0, ON (RIGHT) = 1

Table 4-1 DIP Switch settings

Position#	Description	Setting
1	Binary Bit 0	OFF=0, ON=1
2	Binary Bit 1	OFF=0, ON=1
3	Binary Bit 2	OFF=0, ON=1
4	Binary Bit 3	OFF=0, ON=1
5	Binary Bit 4	OFF=0, ON=1
6	Communication Mode	OFF: Pulse Mode ON: Modbus Mode
7	Count Mode	Pulse Mode: OFF: CUML Count ON: DIFF Count Modbus Mode: Reserved
8	Fast Transfer Mode (Save to Buffer?)	Pulse Mode: Reserved Modbus Mode: OFF: Data Saved ON: No Data Saved

Note: *The DIP Switches must be set before the unit is powered on.*

Communications Mode (DIP #6)

In order to communicate with the instrument using the Modbus protocol, DIP switch 6 must be set to ON.

Addressing (DIP 1-5)

Note: *Because Address '0' is reserved for RS-485 broadcast. Whenever all of the dip switches are OFF or when DIP switch1 is ON, the instrument address is set to '1'.*

Table 4-2 details the addresses set by the DIP switches 1-5.

Table 4-2 DIP Switch Addressing

DIP SWITCHES 1 2 3 4 5	ADDRESS
0 0 0 0 0	1
1 0 0 0 0	1
0 1 0 0 0	2
1 1 0 0 0	3
0 0 1 0 0	4
1 0 1 0 0	5

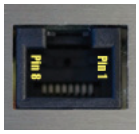
Table 4-2 DIP Switch Addressing

DIP SWITCHES 1 2 3 4 5	ADDRESS
0 1 1 0 0	6
1 1 1 0 0	7
0 0 0 1 0	8
1 0 0 1 0	9
0 1 0 1 0	10
1 1 0 1 0	11
0 0 1 1 0	12
1 0 1 1 0	13
0 1 1 1 0	14
1 1 1 1 0	15
0 0 0 0 1	16
1 0 0 0 1	17
0 1 0 0 1	18
1 1 0 0 1	19
0 0 1 0 1	20
1 0 1 0 1	21
0 1 1 0 1	22
1 1 1 0 1	23
0 0 0 1 1	24
1 0 0 1 1	25
0 1 0 1 1	26
1 1 0 1 1	27
0 0 1 1 1	28
1 0 1 1 1	29
0 1 1 1 1	30
1 1 1 1 1	31

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Communicating with the Instrument

The RJ-45 port shown on the instrument in Figure 4-1 has RS-232 capabilities and may be used to connect the unit to a desktop or laptop PC COM port when the distance to the instrument is equal to or less than 50 feet. It is, however, specifically designed to connect the ***REMOTE 1104*** to an RS-485 network. .



RS-485 Port

The instrument uses the Modbus ASCII protocol.

RS-485 Configuration

In order to connect a PC computer to an RS-485 network, an RS-485 to USB adapter or an RS-232 converter (2-wire configuration - ChB+ to RJ-45 pin 4 and ChA- to RJ-45 pin 5) must be used. This does not apply if the ***R1104*** is installed onto an RS-485 LAN that has the needed support hardware, such as an ***LWS RS-485 Gateway***, to provide PC access. Please refer to "RS-485 Communications" on page 3-8 for information about the ***LWS USB-to-RS-485*** adapter and its use with the ***REMOTE 1104***. Please contact a Lighthouse Sales Representative for this kit.

Configuring with the Modbus Protocol

The instrument can be configured using the Modbus protocol. It is best to use a software, such as ***LMS Express***, to communicate with the instrument, rather than using a single-command-line communication software, such as ***HyperTerminal***. ***LMS Express*** maintains the almost constant communication link that Modbus devices require when in a non-TCP environment.

To start sampling, send the command **11** to command register 40002. The instrument will begin sampling using the default configuration:

- Location = 0
- Sample Time = 60 seconds
- Hold Time = 0 seconds
- Initial Delay = 0 seconds

Note: *For the full Modbus register map, please refer to Appendix A.*

To stop the sampling, send the command **12** to command register 40002.

Note: *The automatic starting of the sampling accommodates systems that do not send a START command, but just polls the instrument for its data.*

Setting the Real Time Clock

The Real Time Clock (RTC) can be read in registers 40027 and 40028:

Table 4-3 Real Time Clock Registers

Register	Data Type	Description
40027	signed integer	Real Time Clock (RTC) [high]. Works in conjunction with 40028. Displays date and time, in number of seconds since midnight, 1/1/1970.
40028	signed integer	Real Time Clock [low]

In order to change the RTC to the current local date/time, enter the high and low values as unsigned integers to registers 40035 and 40036 respectively, which are the Data Set registers.

Table 4-4 Data Set Registers

Register	Data Type	Description
40035	unsigned integer	Data Set [high]. Works in conjunction with 40036. Data entered here is applied to the device through the command register.
40036	unsigned integer	Data Set [low]

Then write the command **13** to the command register 40002. This will write the values in the Data Set registers (40035 and 40036) to the RTC registers (40027 and 40028).

Changing the Default Instrument Parameters

The main instrument parameters involved with the operation of the ***REMOTE*** counter are Location, Sample Time, Hold Time and Initial Delay.

The Location is set by writing an unsigned integer to register 40026. The range of values is from 0 to 999.

Sample Time, Hold Time and Initial Delay all use 2 registers, a high word and a low word. If the desired value for any of these parameters is less than 9 hours 6 minutes 8 seconds, then only the low word register needs to be written (in seconds).

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The low word register for Sample Time is 40034.

The low word register for Hold Time is 40032.

The low word register for Initial Delay is 40030.

Table 4-5 Instrument Parameters

Register	Data Type	Description
40026	unsigned integer	Location number; Specifies location of Particle Counter.
40029	unsigned integer	Initial Delay [high]. Works in conjunction with 40030. Number of seconds to wait before starting the first sample. Max value is 359,999, which equals 99h 59m 59s.
40030	unsigned integer	Initial Delay [low]
40031	unsigned integer	Hold Time [high]. Works in conjunction with 40032. Number of seconds to wait between sample periods. Max value is 359,999, which equals 99h 59m 59s
40032	unsigned integer	Hold Time [low]
40033	unsigned integer	Sample Time [high]. Works in conjunction with 40034. Number of seconds to sample. Max value is 86,399, which equals 23h 59m 59s.
40034	unsigned integer	Sample Time [low]

Running the Instrument

Action commands for running the ***REMOTE*** are discussed here:

Table 4-6 Action Commands

Value	Action
1	Saves all writable 4xxxx register values to the EEPROM.
3	Clears the Data Buffer. Record count is set to zero.
4	Saves the instrument parameters in the 40xxx registers to the EEPROM. Parameters include Sample Time, Hold Time, Initial Delay, and Location.
5	Enable Remote Control. Locks out the instrument's user interface. Can only change instrument parameters via Modbus.
6	Enable Local Control. Unlocks the instrument's user interface. Instrument changes can be made at the device itself or through Modbus.
7	Start pump.
8	Stop pump.
9	External Start Counter. The instrument samples continuously until it receives an External Stop Counter command. Does not turn on the pump. Ignores local timing parameters.
10	External Stop Counter. Records counts since External Start.
11	Instrument Start. Uses defined Initial Delay, Hold Time, Sample Interval and counting mode. Instrument executes samples and holds until an Instrument Stop command is issued. This command will start the pump.
12	Instrument Stop. Aborts current sample. Stops pump. Stops data collection.

There are 2 basic modes of operation: Manual counting and Automatic counting. Write each of the described action commands to the command register (40002).

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MANUAL Counting Mode

In Manual counting mode, the sample time is based on when the counter is instructed to stop counting. At that point, a data record is recorded and the sample time is the interval between the command to start counting and the command to stop counting.

9 *Start Manual Count*

10 *Stop Manual Count*; writes a data record, uses the time interval as the sample time

The "hold" time is effectively the time between a STOP and a START command.

After the last desired sample is taken, send the following to stop the pump:

AUTOMATIC Counting Mode

In Automatic counting mode, the instrument uses the configured sample time, hold time, initial sample delay to record samples.

The instrument will continue running samples until it receives a stop command. When the stop command is given, since the device will not have completed a complete sample cycle, the most current data will not record to the buffer.

After setting all the instrument parameters, run these commands:

11 *Start Instrument*; to start recording

12 *Stop Instrument*; to stop recording

5 Maintenance Procedures

This chapter provides the user with the procedures needed to maintain the REMOTE instruments.

Safety

Before performing any of the maintenance tasks described in this chapter, review the safety warnings supplied throughout this manual.

Calibration

To maintain optimum performance of this instrument, it should be recalibrated annually by a Lighthouse Authorized Service Provider.

Cleaning

This procedure may be superseded by customer requirements; however, ***do not***, under any circumstances, apply Acetone to the REMOTE instrument.

1. To keep the interior of the laser sensor clean, remove any tubing from the air inlet and install the protective plastic cap supplied with the instrument. If the optional direct-mount Isokinetic probe is installed, do not remove the probe and install plastic cap supplied for this purpose.
2. Moisten a lint-free cloth with 99% isopropyl alcohol. The cloth should be moist, not wet.
3. Wipe down the exterior surfaces of the instrument.
4. Reverse Step 1 to return instrument to service.

Purge Test

1. Connect the Purge filter to the sample inlet. The purge filter should be a 0.1 micron, 1.0 CFM filter configured either for the standard barb fitting or the optional direct-mount Isokinetic probe.
2. Apply power to the instrument.

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3. Configure the unit via the user interface to sample for 30 minutes.

4. Allow the instrument to sample through a 30 minute period. This time allows the unit to warm up and purge any residual particles that might be inside it.

5. Configure the unit via the user interface to sample for 5 minutes and set a 10 second hold.

6. Set Cycles to 10 so the instrument will take 10 five-minute samples.

7. If an average of more than one count per five minute sample is reported, reset the instrument to sample for 30 minutes again to purge it, then repeat the Purge Test again.

8. After the instrument has met the requirement of the Purge test, remove the filter, cap the inlet for moving and return the instrument to its normal location and operating status.

9. If the instrument still fails the Purge Test, contact Lighthouse Tech Support for assistance.

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A R1104 Modbus Register Map v1.48

COMM Settings

Lighthouse particle counters with Modbus have the following communications settings:

Table A-1 Modbus Communications Settings

Baud Rate	19200
Data Bits	8
Stop Bits	1
Parity	None
Hardware Protocol	RS-232C or RS-485 Standard
Software Protocol	Modbus ASCII (supports upper/lower case)

The Modbus slave address is set on the particle counter. Valid addresses are 1-63. Address 0 is the broadcast address.

Supported Modbus Commands

Table A-2 Modbus Registers

Hex Command	Description
03	Read Holding Registers
04	Read Input Registers
06	Write Single Holding Register

See www.modbus.org for documentation on how to use these commands.

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Register Map Sensor Settings Registers

Instrument settings are stored in holding registers (the 4xxxx series), which are mostly read/writable. Not all holding registers are writable. Table A-3 describes the content of these registers.

Table A-3 Sensor Settings Registers

Register	Data Type	Description
40001	unsigned integer	Modbus register map version. Matches the version number of this document. Major version digits are hundreds. Minor version digits are tens and ones. For example, v1.35 = 135d = 0087h.
40002	unsigned integer	Command register. Makes the counter execute a command. See the description of this register in the table below.
40003	unsigned integer	Device Status. [bit 0=RUNNING, bit 1=SAMPLING, bit 2=NEW DATA, bit 3=DEVICE ERROR]
40004	unsigned integer	Firmware version. Major version digits are hundreds. Minor version digits are tens and ones. For example, 210 = v2.10.
40005	unsigned integer	Serial Number [high]
40006	unsigned integer	Serial Number [low]
40007	ASCII string	Product Name char[0], char [1] (NULL terminated string)
40008	ASCII string	Product Name char[2], char [3]
40009	ASCII string	Product Name char[4], char [5]
40010	ASCII string	Product Name char[6], char [7]
40011	ASCII string	Product Name char[8], char [9]
40012	ASCII string	Product Name char[10], char [11]
40013	ASCII string	Product Name char[12], char [13]
40014	ASCII string	Product Name char[14], char [15]
40015	ASCII string	Model Name char[0], char [1] (NULL terminated string)
40016	ASCII string	Model Name char[2], char [3]
40017	ASCII string	Model Name char[4], char [5]
40018	ASCII string	Model Name char[6], char [7]
40019	ASCII string	Model Name char[8], char [9]

Table A-3 Sensor Settings Registers

Register	Data Type	Description
40020	ASCII string	Model Name char[10], char [11]
40021	ASCII string	Model Name char[12], char [13]
40022	ASCII string	Model Name char[14], char [15]
40023	unsigned integer	Flow Rate. Divide by 100 to get rate in CFM. For example, 100 = 1CFM.
40024	signed integer	Record Count. Total number of records stored in the counter.
40025	signed integer	Record Index. Zero based index to data in 30xxx register series. Must be lower than the record count (register 40024). Set this index to expose a counter's record in the 30xxx registers. Set to -1 to retrieve last record stored in the counter.
40026	unsigned integer	Location number. Particle Counters: Specifies location of Particle Counter. Must be 1 to 200 (maps to location names associated with registers 40200 - 40999). Manifold Controller: Specifies Manifold position. Values 1-32 for the Universal Manifold and values 1-6 for the MiniManifold Controller moves the arm to that position on the manifold. Value 0 moves arm to Home position.
40027	unsigned integer	Real Time Clock (RTC) [high]. Updates instrument's real-time clock. Works in conjunction with 40028. Displays date and time, in number of seconds since midnight, 1/1/1970. Can be generated by ANSI C/C++ time() function.
40028	unsigned integer	Real Time Clock [low]
40029	unsigned integer	Initial Delay [high]. Works in conjunction with 40030. Number of seconds to wait before starting the first sample. Max value is 359,999, which equals 99h 59m 59s.
40030	unsigned integer	Initial Delay [low]
40031	unsigned integer	Hold Time [high]. Works in conjunction with 40032. Number of seconds to wait between sample periods. Max value is 359,999, which equals 99h 59m 59s.
40032	unsigned integer	Hold Time [low]
40033	unsigned integer	Sample Time [high]. Works in conjunction with 40034. Number of seconds to sample. Max value is 86,399, which equals 23h 59m 59s.

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Table A-3 Sensor Settings Registers

Register	Data Type	Description
40034	unsigned integer	Sample Time [low]
40035	unsigned integer	Data Set [high]. Works in conjunction with 40036. Data entered here is applied to the device through the command register.
40036	unsigned integer	Data Set [low]
40037	unsigned integer	Alarm Mode. Type of alarming performed
40038	unsigned integer	Alarm Parameter. Control parameter for given alarm mode.
40039	unsigned integer	Laser Reference Voltage (millivolts)
40040	unsigned integer	View Volume. Divide by 100 to get percentage. For example: 6550d = 65.50%
40041	ASCII string	Flow Unit. Defines unit as cfm, lpm, mlpm.
40042	ASCII string	Flow Unit. char[2], char[3]
40043	unsigned integer	Calibration Reference Voltage (millivolts)
...		
40199	unsigned integer	Number of available alphanumeric location names (0 means alphanumeric names are not supported).
40200	ASCII string	Location_1_char[0], char[1] (NULL terminated string)
40201	ASCII string	Location_1_char[2], char[3]
40202	ASCII string	Location_1_char[4], char[5]
40203	ASCII string	Location_1_char[6], char[7]
...		
40996	ASCII string	Location_200_char[0], char[1] (NULL terminated string)
40997	ASCII string	Location_200_char[2], char[3]
40998	ASCII string	Location_200_char[4], char[5]
40999	ASCII string	Location_200_char[6], char[7]

Registers 40200-40999 are reserved for eight character names associated with location index values. Thus the name for location =3 would be located at registers 40208-40211. Up to two hundred locations can be specified.

Register 40199 indicates the number of location names supported on

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this device.

Alarm Mode (40037) defines the type of calculation performed to define an alarm condition. Alarm Mode = 0 corresponds to conventional threshold alarming; channel bit set if threshold exceeded for that given channel.

Alarm Parameter (40038) defines additional parameters that may be needed in defining an alarm mode.

The Command Register (40002) is used to make the device perform an action. This register performs an action when an integer value is written to it. The action is completed when the device sends a Modbus response. When this register is read, it always returns a zero.

Device Status

The Device Status register (40003) displays the current status of the device.

Table A-4 Device Status

Bit	Description
0	**RUNNING:** Set when a start command is executed remotely via Command 9 (manual start) or Command 11 (instrument start) or through the user interface. The flag will remained set until a stop command is executed.
1	**SAMPLING:** This is set only when the instrument is actually sampling data that is to be recorded. Caution must be used in sending a command during this time that may invalidate current sample.
2	**NEW DATA:** Set to 1 to indicate that a new data record has been recorded and it hasn't been read via modbus yet. When a data record has been read via modbus (registers 30001 to 30999), then this flag is reset to zero.
3	**DEVICE ERROR:** In the event that there is a failure on the device, this bit is set to indicate possible invalid data collected. An example of a device error could be a positioning error on a manifold device.

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Command Register

The Command Register (40002) is used to make the device perform an action. The register performs an action when an integer value is written to it. The action is completed when the device sends a Modbus response. When this register is read, it always returns a zero.

Table A-5 Command Register

Value	Action
1	Saves all writable 4xxxx register values to the device's EEPROM.
2	Reserved for future use.
3	Clears the Data Buffer. Record count is set to zero.
4	Saves the instrument parameters in the 40xxx registers to the EEPROM. Parameters include Sample Time, Hold Time, and Initial Delay.
5	Enable Remote Control. Locks out the instrument's user interface. Can only change instrument parameters via Modbus.
6	Enable Local Control. Unlocks the instrument's user interface. Instrument changes can be made at the device itself or through Modbus.
7	Turns local pump on, if applicable. Flow is regulated by an internal setpoint.
8	Stop pump, if applicable.
9	Manual Start. The instrument samples continuously until it receives a Manual Stop command. Ignores local timing parameters. Sets Sample Time for data record to equal the time interval between the Manual Start and Manual Stop command. If applicable to device, does not start pump.
10	Manual Stop. Stops sampling. Records count since Manual Start.
11	Instrument Start (Automatic Counting). Particle Counters: Uses defined Initial Delay, Hold Time, Sample Interval and counting mode. Instrument executes samples and holds until an Instrument Stop command is issued. For instruments with pumps, this command will start the pump. Manifold Controller: Uses defined Manifold Sequence. Stops counting and changing positions when an Instrument Stop command is issued.

Table A-5 Command Register

Value	Action
12	Instrument Stop. Aborts current sample. Stops pump, if applicable. Stops data collection.
13	Set Real Time Clock. Writes “Data Set” values (from Registers 40035 & 40036) to the local Real Time Clock. New time value is saved.
192	Change BAUD to 19200
576	Change BAUD to 57600
1152	Change BAUD to 115200

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Data and Alarm Registers

Data and Alarm Enable Registers

The Data and Alarm Enable input registers (43xxx series) are read/write. All enable data items are 4 bytes long and are stored across 2 registers. Byte and word ordering is big-endian. Thus, data items are formed by placing the high bytes in front of the low bytes. For example:

<High Bytes><Low Bytes> = <4 Byte Data Item>

The 43xxx register series is used to determine which particle data channel is ENABLED and which are set to ALARM ENABLE. These registers supersede the older Data Enable Registers (31xxx) which have been obsoleted.

Table A-6 Enable/Disable Bits

Bit	Description
0	DATA ENABLE (0=disable; 1=enable)
1	ALARM ENABLE (0=disable; 1=enable)

These registers run in parallel with the data registers (30xxx series). For example, data register 30010's enable register would be 43010. Data register 30016's enable register would be 43016.

Note: *Alarm Enable currently only works for Particle Channels.*

The user can enable multiple particle channels for alarming at the same time.

Particle data registers for the Enable setting start at 43009 for the high word and 43010 for the low word for particle channel 1.

Table A-7 Alarm Enable Registers

Register	Data Type	Description
43009	unsigned int	Enable for Particle Channel 1 [high] (smallest particle size starts here)
43010	unsigned int	Enable for Particle Channel 1 [low]
43011	unsigned int	Enable for Particle Channel 2 [high]
43012	unsigned int	Enable for Particle Channel 2 [low]
43013	unsigned int	Enable for Particle Channel 3 [high]
43014	unsigned int	Enable for Particle Channel 3 [low]
43015	unsigned int	Enable for Particle Channel 4 [high]

Table A-7 Alarm Enable Registers

Register	Data Type	Description
43016	unsigned int	Enable for Particle Channel 4 [low]
43017	unsigned int	Enable for Particle Channel 5 [high]
43018	unsigned int	Enable for Particle Channel 5 [low]
43019	unsigned int	Enable for Particle Channel 6 [high]
43020	unsigned int	Enable for Particle Channel 6 [low]
...		
43041	unsigned int	Enable for Analog Channel 1 [high]
43042	unsigned int	Enable for Analog Channel 1 [low]
43043	unsigned int	Enable for Analog Channel 2 [high]
43044	unsigned int	Enable for Analog Channel 2 [low]
43045	unsigned int	Enable for Analog Channel 3 [high]
43046	unsigned int	Enable for Analog Channel 3 [low]
43047	unsigned int	Enable for Analog Channel 4 [high]
43048	unsigned int	Enable for Analog Channel 4 [low]

Enable Alarming for a Channel

To enable alarming on the third particle channel, the user would enable Bit 1 for register 43014.

To disable alarming on the third channel and enable alarming on the second channel, disable Bit 1 for register 43014 and enable Bit 1 for register 43012.

To disable alarming completely, disable Bit 1 for register 43012. Now, no channels are enabled for alarms.

Table A-8 Example of Alarming on Channel 2

Registers	Particle Channel	Bit 1 Enabled
43009 - 43010	1	0
43011 - 43012	2	1

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Table A-8 Example of Alarming on Channel 2

Registers	Particle Channel	Bit 1 Enabled
43013 - 43014	3	0
43015 - 43016	4	0
43017 - 43018	5	0
43019 - 43020	6	0

Use the Threshold registers to set the alarm threshold value. This is described in the next section.

Threshold Setup Registers

Threshold data is stored in the input registers in the 45xxx series which are read/write. All threshold data items are 4 bytes long and are stored across 2 registers. Byte and word ordering is big-endian. Thus, data items are formed by placing the high bytes in front of the low bytes. For example:

<High Bytes><Low Bytes> = <4 Byte Data Item>

For particle channels, the threshold value is a 32-bit unsigned integer. If the data value exceeds the threshold value and the alarm is enabled for that channel, the threshold flag in the Data Status register (30007-30008, bit 4) is set.

Note: *The table below shows the registers for an 8 channel particle counter. Counters with less channels do not use the extra registers. The smallest particle channel starts at the xxx09 position.*

The threshold registers (45xxx series) run in parallel with the data registers (30xxx series). For example, data register 30010's corresponding threshold register would be 45010. Data register 30016's threshold register would be 45016.

Table A-9 Alarm Threshold Registers

Register	Data Type	Description
45009	unsigned int	Threshold for Particle Channel 1 [high] (smallest particle size starts here)
45010	unsigned int	Threshold for Particle Channel 1 [low]
45011	unsigned int	Threshold for Particle Channel 2 [high]
45012	unsigned int	Threshold for Particle Channel 2 [low]
45013	unsigned int	Threshold for Particle Channel 3 [high]

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Table A-9 Alarm Threshold Registers

Register	Data Type	Description
45014	unsigned int	Threshold for Particle Channel 3 [low]
45015	unsigned int	Threshold for Particle Channel 4 [high]
45016	unsigned int	Threshold for Particle Channel 4 [low]
45017	unsigned int	Threshold for Particle Channel 5 [high]
45018	unsigned int	Threshold for Particle Channel 5 [low]
45019	unsigned int	Threshold for Particle Channel 6 [high]
45020	unsigned int	Threshold for Particle Channel 6 [low]

Setting the Alarm Threshold Value

The Alarm Threshold Value is set in the low register of the channels.

Table A-10 Alarm Threshold Registers set to default value

Registers	Particle Channel	Threshold Value
45009 - 45010	1	1000
45011 - 45012	2	1000
45013 - 45014	3	1000
45015 - 45016	4	1000
45017 - 45018	5	1000
45019 - 45020	6	1000

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Data Registers

Data is stored in the input registers (30xxx series), which are read-only. All data items are four bytes long and are stored across two registers. Byte and word order for particle data is big-endian. Thus, data items are formed by placing the high bytes in front of the low bytes.

Example:

<High Bytes><Low Bytes> = <4 Byte Data Item>

Analog data is little-endian. Thus, analog data items are formed by placing the low bytes in front of the high bytes.

Example:

<Low Bytes><High Bytes> = <4 Byte Data Item>

Not all particle and analog channels are necessarily active. Retrieving data from an inactive channel returns garbage. See the Data Enable Registers section of this document for details on how to record data from active channels.

This entire series of registers represents one data record in the device. The Record Index Register (40025) must be changed to index other records here.

The first record in the data buffer is located at Index=0. The most recently saved value is at Index=-1.

Table A-11 Data Registers

Register	Data Type	Description
30001	signed integer	Timestamp [high] (# of seconds since midnight, 1/1/1970)
30002	signed integer	Timestamp [low]
30003	unsigned integer	Sample Time [high] (In seconds)
30004	unsigned integer	Sample Time [low]
30005	signed integer	Location [high] (Place where data was recorded)
30006	signed integer	Location [low]
30007	unsigned integer	Device Status [high]
30008	unsigned integer	Device Status [low]
30009	unsigned integer	Particle Channel 1 [high]

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Table A-11 Data Registers

Register	Data Type	Description
30010	unsigned integer	Particle Channel 1 [low]
30011	unsigned integer	Particle Channel 2 [high]
30012	unsigned integer	Particle Channel 2 [low]
30013	unsigned integer	Particle Channel 3 [high]
30014	unsigned integer	Particle Channel 3 [low]
30015	unsigned integer	Particle Channel 4 [high]
30016	unsigned integer	Particle Channel 4 [low]
30017	unsigned integer	Particle Channel 5 [high]
30018	unsigned integer	Particle Channel 5 [low]
30019	unsigned integer	Particle Channel 6 [high]
30020	unsigned integer	Particle Channel 6 [low]
...		
30041	IEEE Float	Analog Channel 1 [high]
30042	IEEE Float	Analog Channel 1 [low]
30043	IEEE Float	Analog Channel 2 [high]
30044	IEEE Float	Analog Channel 2 [low]
30045	IEEE Float	Analog Channel 3 [high]
30046	IEEE Float	Analog Channel 3 [low]
30047	IEEE Float	Analog Channel 4 [high]
30048	IEEE Float	Analog Channel 4 [low]
...		
30073	unsigned int	Valid analog channels [bit0=ch 1, ..., bit15=ch16]
30074	unsigned int	Valid particle channels
30075	unsigned int	Alarm Flags - Analog Channels (bit 0 = channel 1 ...)
30076	unsigned int	Alarm Flags - Particle Channels

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Note: *Particle data is always a cumulative raw count regardless of the instrument's settings.*

The timestamp field indicates when the data record was recorded. Timestamps are stored as the number of seconds since 1/1/1970, the Unix time epoch. This value can be written directly into a C/C++ time_t data type to be used by ANSI C time functions.

Device Status Word (30007 - 30008)

Note: *Although Modbus sends 4 bytes of status information, Lighthouse instruments only use the first (least significant) byte.*

The registers used for the Device Status Word are 30007 and 30008.

The bit order of the Device Status Word is 7 to 0 (right to left), where bit 7 is the most significant bit and bit 0 is the least significant bit.

The bits within the Device Status Word are flagged to indicate particular conditions of the currently indexed data record.

If multiple states occur, the bits are added together. For example, a Flow Alert and a Particle Overflow would return a value of 6 in register 30008 (bits 1 and 2 are set TRUE).

Table A-12 Device Status Word

Bit	Description
0	Laser Alert Status 0 = Laser is OK 1 = Laser Alert
1	Flow Alert Status 0 = Flow Rate is OK 1 = Flow Rate Alert
2	Particle Overflow Status 0 = No overflow 1 = Overflow occurred
3	Instrument Service Status 0 = Working correctly 1 = Instrument malfunction detected.
4	Threshold High Status 0 = Threshold not exceeded 1 = Threshold exceeded
5	Threshold Low Status 0 = Threshold not exceeded 1 = Threshold exceeded
6	Instrument Sampler Status 0 = Nominal Operation 1 = Sampler Error

Bits 7 to 31 are currently unused.

Valid Data in Channels (30073 - 30076)

Register 30073 represents the flag bits corresponding to valid data present in the analog register range. The mapping is such that bit 0 set

to TRUE (=1) would correspond to valid data present in Analog Channel 1.

Register 30074 represents the flag bits corresponding to valid data present in the particle register range.

Register 30075 represents the flag bits corresponding to analog channels that have exceeded the threshold [Threshold High Registers (45xxx series)] based on alarm mode.

Register 30076 represents the flag bits corresponding to particle channels that have exceeded the threshold [Threshold High Registers (45xxx series)] based on alarm mode

Data Type Registers

Note: *All data records have the same data types assigned to them. The user does not have to read the data type registers for every record.*

The 41xxx register series is used to identify the type of data items in the 30xxx series. The Data Type registers run in parallel with the Data Registers. For example, Data Register 30041's Data Type register is 41041.

Data Types are assigned 4 ASCII characters across 2 registers. If a Data Type string contains less than 4 characters, then the rest of the string is padded with NULL characters. Note that a Data Type using all four characters will not end with a NULL character.

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Table A-13 Data Types

String	Description
TIME	Timestamp
STIM	Sample Time
SVOL	Sample Volume
LOC	Location
STAT	Status
TEMP	Temperature
RH	Relative Humidity
AIRV	Air Velocity
DPRS	Differential Pressure
ESD	Electrostatic Discharge
FLOW	Flow Rate
LASV	Laser Voltage
VOLT	Voltage
PRES	Pressure

Note: *Only Particle data types have numbers in their strings.*

Particle data items are typed specially. They contain numbers, sometimes a space and sometimes a period used as a decimal point. These entries are used to identify particle channel sizes and are always expressed in microns. These types represent raw counts only.

Table A-14 Examples of Particle Data Items

String	Description
0.3	Particle type of size 0.3 micron
1.0	Particle type of size 1.0 micron
20.0	Particle type of size 20.0 micron
.015	Particle type of size 0.015 micron or 15 nanometer

Data Units Registers

The 42xxx register series identifies the units used by data items in the

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30xxx series. These registers run in parallel with the Data Registers. For example, Data Register 30010's Units Register is 42010.

Note: *Not all data types have units.*

LWS Particle Counters may use units not on the table.

Units are stored as 4 character ASCII strings across 2 registers. If the Units string contains less than 4 characters or no characters at all, the rest of the string is padded with NULLs.

The table below shows units that may be sent by the device. Some of these units are not currently used but are reserved for future use.

Table A-15 Data Units

Units	Description	Units	Description
#	Count (For Particles)	ft/m	Feet per minute
%	Percent	m/s	Meters per second
s	Seconds	"H2O	Inches of water
min	Minutes	"Hg	Inches of mercury
hour	Hours	mmWa	Millimeters of water
F	Fahrenheit	mmHg	Millimeters of mercury
C	Celsius	cmHg	Centimeters of mercury
K	Kelvin	Pa	Pascals
ft	Feet	kPa	Kilopascals
m	Meters	Bar	Bar
ft^2	Square feet	mBar	Milli-bar
m^2	Square meters	V	Volts
ft^3	Cubic feet	mV	Milli-volts
m^3	Cubic meters	A	Amperes
L	Liters	mA	Milli-amps
CFM	Cubic feet per minute	Ohm	Ohms
CMM	Cubic meters per minute	mOhm	Milli-ohm
L/m	Liters per minute	p/f3	Particles per cubic foot
p/m3	Particles per cubic meter		

NOTE: This register bank is obsolete and is maintained for backward compatibility.

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B Zero Count Test

How to Run the Test

This is the Zero Count Test procedure. A Purge (Zero Count) Filter must be attached to the instrument and 6 five-minute samples must be taken. There should be no more than 1 count, average, per five-minute sample. The purge filter should be a 0.1 micron filter at 1.0 CFM.

1. Connect the instrument to the monitoring system.
2. Attach the Purge Filter to the sample inlet.
3. Apply power to the instrument.
4. Allow the instrument to sample through a 30 minute period. This time allows the LASER to warm up and the instrument to purge any residual particles inside.
5. Configure the unit to sample for 5 minutes with a 10-second HOLD time.
6. Allow the instrument to perform 6 five-minute samples.
7. If the average count for the total of the six sample periods is NOT less than one per five minute period or if more than one count occurs in ANY five-minute sample period, allow the instrument to sample for an additional 30 minutes to purge it and repeat the test.
8. If the instrument still fails the Zero Count Test, call Lighthouse Technical Support for assistance.
9. After the instrument meets the requirements of the Zero Count test, turn it off, remove the Purge Filter and return the instrument to its normal location and operating status.

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C Limited Warranty

Limitation Of Warranties:

A. Lighthouse Worldwide Solutions (LWS) warrants that all equipment shall be free from defects in material and workmanship under normal use for a period of two years from date of shipment to Buyer except that LWS does not warrant that operation of the software will be completely uninterrupted or error free or that all program errors will be corrected. Buyer shall be responsible for determining that the equipment is suitable for Buyer's use and that such use complies with any applicable local, state, or federal law. Provided that Buyer notifies LWS in writing of any claimed defect in the equipment immediately upon discovery and any such equipment is returned to the original shipping point, transportation charges prepaid, within two years from date of shipment to Buyer and upon examination LWS determines to its satisfaction that such equipment is defective in material or workmanship, i.e. contains a defect arising out of the manufacture of the equipment and not a defect caused by other circumstances, including, but not limited to accident, misuse, unforeseeable use, neglect, alteration, improper installation, improper adjustment, improper repair, or improper testing, LWS shall, at its option, repair or replace the equipment, shipment to Buyer prepaid. LWS shall have reasonable time to make such repairs or to replace such equipment. Any repair or replacement of equipment shall not extend the period of warranty. If the Instrument is modified or in any way altered without the explicit written consent of LWS then the warranty is null and void. This warranty is limited to a period of two years, except as noted below, without regard to whether any claimed defects were discoverable or latent on the date of shipment. The length of warranty for pumps in the HANDHELD and REMOTE 'P' particle counters is one (1) year. Batteries and accessories with all products are warranted for one (1) year. Fuses and purge filters carry no warranty. If a third party battery is used in the product, the product warranty is null and void. If the battery is charged by a third party battery charger the battery warranty is null and void.

B. If Buyer shall fail to pay when due any portion of the purchase price or any other payment required from Buyer to LWS under this contract or otherwise, all warranties and remedies granted under this Section may, at LWS's option, be terminated.

C. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER REPRESENTATIONS, WARRANTIES AND COVENANTS, EXPRESS OR IMPLIED WITH RESPECT TO THE EQUIPMENT AND ANY DEFECTS THEREIN OF ANY NATURE WHATEVER, INCLUDING AND WITHOUT LIMITATION WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. LWS SHALL NOT BE LIABLE FOR, AND BUYER ASSUMES ALL RISK OF, ANY ADVICE OR FAILURE TO PROVIDE ADVICE BY LWS TO BUYER REGARDING THE EQUIPMENT OR BUYERS USE OF THE SAME. UNDER NO CIRCUMSTANCES SHALL LWS BE LIABLE TO BUYER UNDER ANY TORT, NEGLIGENCE, STRICT LIABILITY, OR PRODUCT LIABILITY CLAIM AND BUYER AGREES TO WAIVE SUCH CLAIMS. LWS's SOLE AND EXCLUSIVE LIABILITY AND BUYERS SOLE AND EXCLUSIVE REMEDY, FOR ANY NONCONFORMITY OR DEFECT IN THE PRODUCTS OR ANYTHING DONE IN CONNECTION WITH THIS CONTRACT, IN TORT, (INCLUDING NEGLIGENCE), CONTRACT, OR OTHERWISE, SHALL BE AS SET FORTH IN THE SUBSECTION A HEREOF AS LIMITED BY SUBSECTION B HEREOF. THIS EXCLUSIVE REMEDY SHALL NOT HAVE FAILED OF ITS ESSENTIAL PURPOSE (AS THAT TERM IS USED IN THE UNIFORM COMMERCIAL CODE) PROVIDED THAT THE SELLER REMAINS WILLING TO REPAIR OR REPLACE DEFECTIVE EQUIPMENT (AS DEFINED IN SUBSECTION A) WITH A COMMERCIALLY REASONABLE TIME AFTER RECEIVING SUCH EQUIPMENT. BUYER SPECIFICALLY ACKNOWLEDGES THAT SELLER'S PRICE FOR THE EQUIPMENT IS BASED UPON THE LIMITATIONS OF LWS'S LIABILITY AS SET FORTH IN THIS CONTRACT.

Warranty Of Repairs After Initial Two (2) Year Warranty:

A. Upon expiration of the initial two-year warranty, all parts and repairs completed by an authorized Lighthouse repair technician are subject to a six (6) month warranty.

B. Other than the above, LWS makes no warranty of any kind, expressed or implied, except that the products manufactured and sold by LWS shall be free from defects in materials and workmanship and shall conform to LWS's specifications; Buyer assumes all risk and liability resulting from use of the products whether used singly or in combination with other products. If instrument is modified or in any way altered without the explicit written consent of LWS, then the warranty is null and void.

C. WARRANTY REPAIRS SHALL BE COMPLETED AT THE FACTORY, BY AN AUTHORIZED SERVICE LOCATION, BY AN AUTHORIZED SERVICE TECHNICIAN, OR ON SITE AT BUYER'S FACILITY BY A LIGHTHOUSE AUTHORIZED EMPLOYEE. BUYER PAYS FREIGHT TO FACTORY; SELLER WILL PAY STANDARD RETURN FREIGHT DURING THE WARRANTY PERIOD. BUYER MAY SELECT A FASTER METHOD OF SHIPMENT AT ITS OWN EXPENSE.

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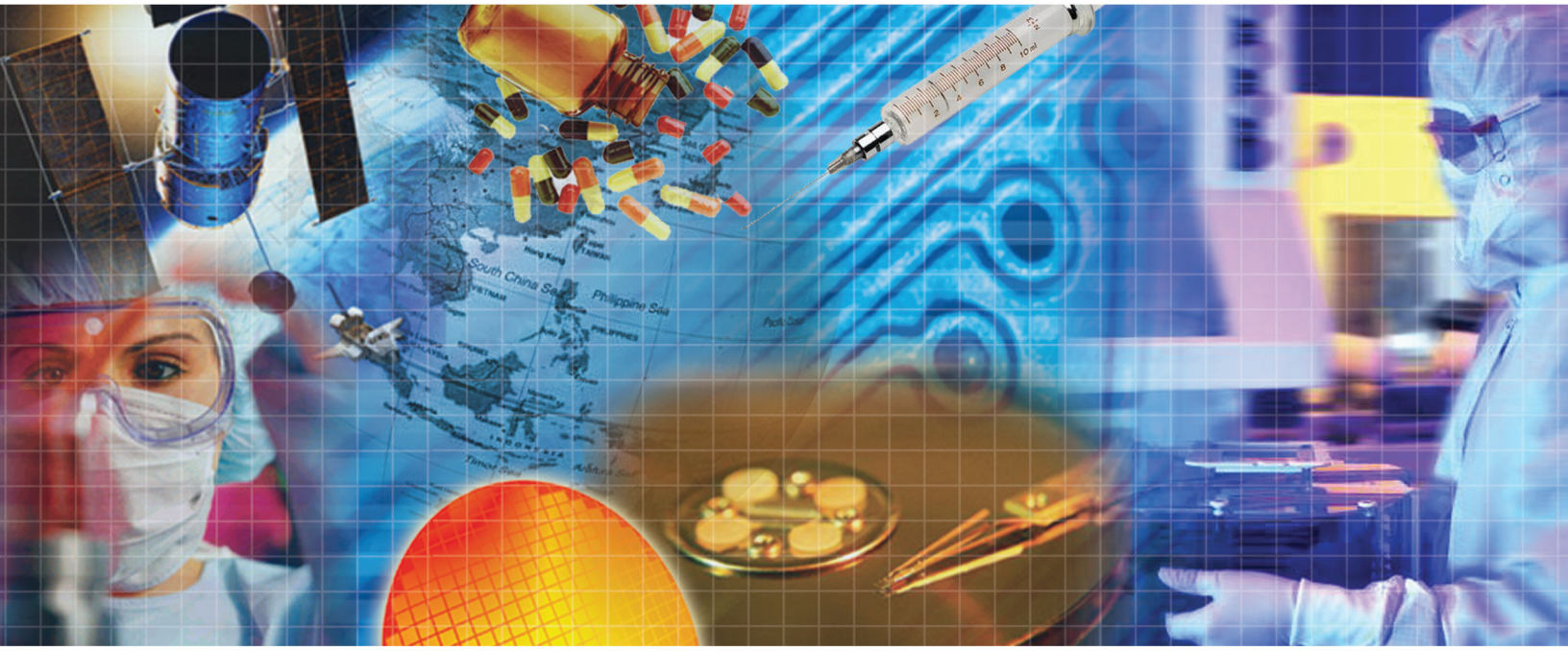
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