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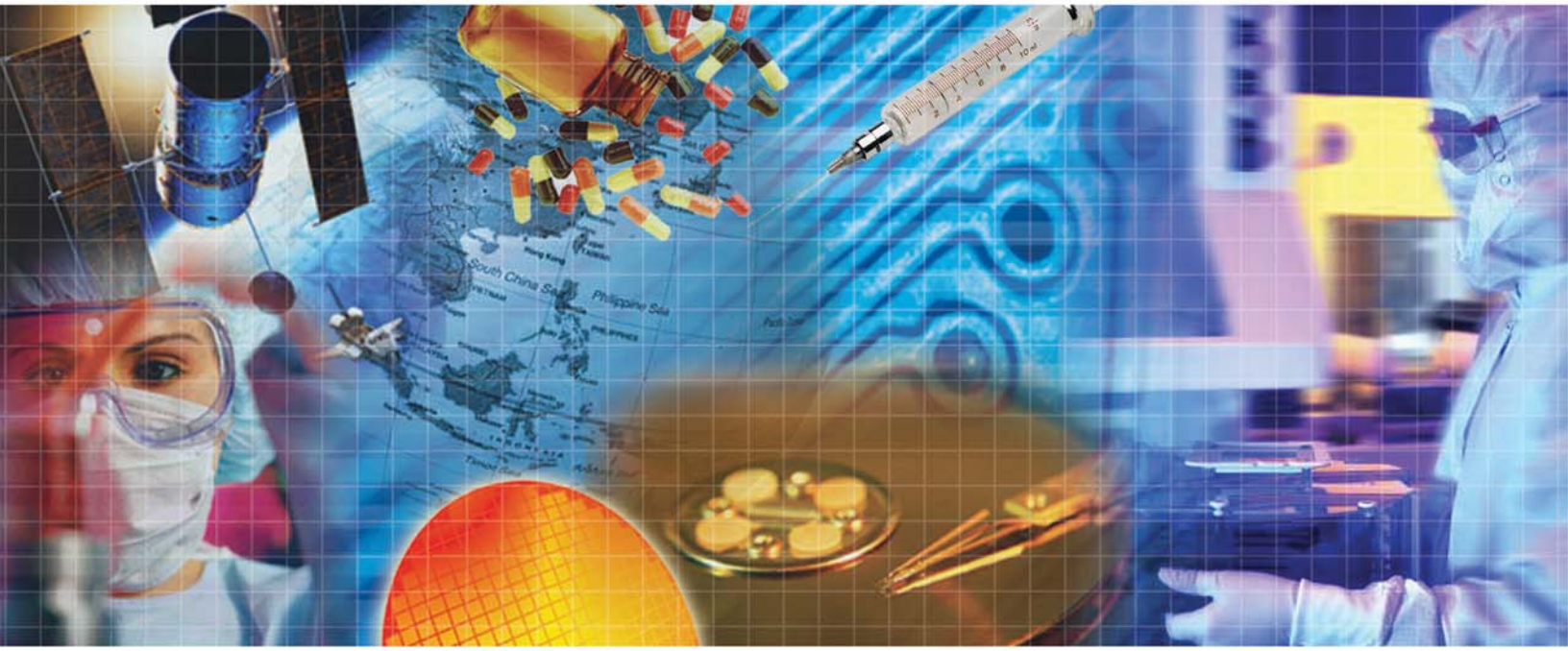
USER GUIDE

Remote liquid particle counters (LPC)

Lighthouse

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REMOTE

Liquid Particle Counter

(MODBUS Output)

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Operating Manual

Lighthouse Worldwide Solutions

REMOTE Liquid Particle Counter (MODBUS Output)

Operating Manual

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Manufactured by:

Lighthouse Worldwide Solutions

1221 Disk Drive

Medford, Oregon 97501

LWS Part Number: 248083227-1 Rev 8

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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 Liquid Particle Counter
Model Number(s): RLPC 0.1µ, RLPC 0.2µ, RLPC 0.3µ, RLPC 0.5µ MODBUS

Conforms to the following Product Specifications:

SAFETY	EN61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use Part 1: General Requirements IEC 61010-1:2000
	CAN/CSA C22.2 No. 1010.1-1992	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1: General Requirements
LASER SAFETY	IEC 60825-1 Am. 2 IEC 60601-2-22 (Laser Notice 50)	Guidance on Laser Products: Conforms to FDA 21 CFR Chapter 1 Subchapter 1
EMC	EN61326	Electrical Equipment for Measurement, Control and Laboratory Use EMC Requirements Part 1: General Requirements Includes Amendment A1:1998; IEC 61326:1997 + A1:1998

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.

Fremont, CA. March 7, 2008

William Shade - V.P. Engineering

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About this Manual

This manual describes the operation and use of the Lighthouse REMOTE Liquid Particle Counter (RLPC) with MODBUS output.

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 and/or improper storage 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 the user types.
Helvetica Italics	Indicates a comment on a command or text output.

Hexadecimal numbers are shown with the word "hex"or with a small "h" following the digits. For example:

```
hex 0D
0Dh
```

Additional Help

For more information about Lighthouse RLPC 0.1µm, RLPC 0.2µm, RLPC 0.3µm or RLPC 0.5µm Particle Counters, contact Lighthouse Worldwide Solutions.

Service and Support:
Tel: 1-800-945-5905 (Toll Free USA)
Tel: 1-541-770-5905 (Outside of USA)
techsupport@golighthouse.com

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1 General Safety

Safety Considerations

Warnings and cautions are used throughout this manual. It is the responsibilty of the the user to familiarize themselves with the meaning of a warning before operating the particle sensor. Warnings may appear in the left margin of the page next to the subject or step to which it applies or within the step itself. Take extreme care when performing any procedures preceded by or containing a warning.

There are several classifications of Warnings 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. Service procedures on the sensor can result in exposure to invisible radiation. Service should be performed only by factory-authorized personnel.

The particle counter has been evaluated and tested in accordance with EN 61010-1:2012, “Safety Requirements For Electrical Equipment for Measurement, Control and Laboratory Use” and IEC 60825-1:2007, “Safety of LASER Products”.

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.***

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

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Electrostatic Safety Information

The following information is provided to prevent damage to Lighthouse instruments or harm to humans.

WARNING: ***Using a wrist-strap without an isolation resistor will increase the severity of an electrical shock. Use of controls or adjustments or performing procedures other than those specified herein may result in hazardous radiation exposure.***

Electrostatic discharge (ESD) can damage or destroy electronic components. Therefore, all service or maintenance work should be done at a static-safe work station. A static-safe work station can be created by doing the following:

- Use a grounded conductive table mat and resistor-isolated wrist-strap combination
- Earth-ground all test instruments to prevent a buildup of static charge

2 *Introduction*

Overview

This operating manual introduces the Lighthouse Liquid Particle Counter REMOTE models RLPC 0.1µm, RLPC 0.2µm, RLPC 0.3µm and RLPC 0.5µm. Included in this manual are instructions for operation, communications and maintenance.

Description

The RLPC 0.1µm, RLPC 0.2µm, RLPC 0.3µm and RLPC 0.5µm have a range of 0.1 - 0.5µm, 0.2 - 2.0 µm, 0.3 - 3.0 µm and 0.5 - 5.0 µm at a sensitivity of 0.1 micron, 0.2 micron, 0.3 micron and 0.5 micron, respectively, and the capability of real time continuous data collection using the RS485 MODBUS protocol.

With a user-controlled flow rate of 100 ml/min., ± 5%, the RLPC sensors are designed to accurately measure up to 4 channels of simultaneous particle counts in various liquids including solvents, acids and bases (see Table 2-5 and Table 2-6 for chemical compatibilities).
.



Figure 2-1 The REMOTE Liquid Particle Counter

The instrument uses a laser diode light source and laser beam shaping optics to illuminate a cross section of the liquid flow path. As particles move through the flow cell, they enter the laser beam and scatter light. The light scattered is collected by the optical system and imaged onto a

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photodiode. The photodiode converts the light into current which is converted to voltage and amplified by the electronics.

The result is a voltage pulse each time a particle crosses the laser beam. The width of the pulse is proportional to the time it takes the particle to cross the laser beam and the pulse's amplitude is proportional to the size of the particle.

The voltage pulses created by the particles are processed by additional electronics to quantify the pulses by the size of each particle. The quantities of the various sized particles are processed and stored in the sensor's buffers or transferred via MODBUS.

The RLPC counters were created for continuous, 24 hours per day, 7 days per week operation. The instrument provides versatile mounting options allowing installation where space is at a premium. The RLPC integrates seamlessly with many large facility monitoring or management systems and transfers up to 4 channels of simultaneous particle count data using the RS485 MODBUS or RS485 MR Protocol output.

Accessories

Several accessories can be ordered to tailor the instrument to specific needs. Contact a distributor for additional information and datasheets.

RLPC 0.1µm Specifications

Table 2-1 RLPC 0.1µm Specifications

Size Range	0.1 - 0.5 µm
Channel Thresholds	Standard: 0.1, 0.2, 0.3, 0.5 µm
Flow Rate	100 ml/min, ± 5%, User-controlled
Laser Source	Laser Diode
Calibration	NIST Traceable
Data Storage	Rotating buffer, 2000 Records
Communication Modes	RS232/RS485 via RJ45 to PC, RS485/ Modbus, ASCII, Modbus or MR Protocol
LED Indicators	Power, Service, Sampling
Supporting Software	Lighthouse Monitoring System, LMS Net XChange, LMS Express and LMS Express RT
Concentration Limit	64,000 counts/ml @ 5% Coincidence Error
Power Input Requirements	24VDC@ 100mA
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Sample Inlet/Outlet Connection	1/4" Flaretek™
Sample Temperature	32 - 302°F (0 - 150°C)
Sample Pressure	150 PSI
Wetted Surface Material	Quartz, PTFE, PFA
Dimensions	5.7"(L) x 5.2"(W) x 3"(H) [14.47 x 13.2 x 7.6 cm]
Weight	3.5 lbs. (1.58 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

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RLPC 0.2µm Specifications

Table 2-2 RLPC 0.2µm Specifications

Size Range	0.2 - 2.0 µm
Channel Thresholds	Standard: 0.2, 0.3, 0.5, 0.7 µm Standard: 0.2, 0.5, 1.0, 2.0 µm
Flow Rate	100 ml/min, ± 5%, User-controlled
Laser Source	Laser Diode
Calibration	NIST Traceable
Data Storage	Rotating buffer, 2000 Records
Communication Modes	RS232/RS485 via RJ45 to PC, RS485/ Modbus, ASCII, Modbus or MR Protocol
LED Indicators	Power, Service, Sampling
Supporting Software	Lighthouse Monitoring System, LMS Net XChange, LMS Express and LMS Express RT
Concentration Limit	4,000 counts/ml @ 5% Coincidence Error
Power Input Requirements	24VDC@ 100mA
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Sample Inlet/Outlet Connection	1/4" Flaretek™
Sample Temperature	32 - 302°F (0 - 150°C)
Sample Pressure	150 PSI
Wetted Surface Material	Quartz, PTFE, PFA
Dimensions	5.7"(L) x 5.2"(W) x 3"(H) [14.47 x 13.2 x 7.6 cm]
Weight	3.5 lbs. (1.58 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

RLPC 0.3µm Specifications

Table 2-3 RLPC 0.3µm Specifications

Size Range	0.3 - 3.0 µm
Channel Thresholds	Standard: 0.3, 0.5, 0.7, 1.0 µm Standard: 0.3, 0.5, 1.0, 3.0 µm
Flow Rate	100 ml/min, ± 5%, User-controlled
Laser Source	Laser Diode
Calibration	NIST Traceable
Data Storage	Rotating buffer, 2000 Records
Communication Modes	RS232/RS485 via RJ45 to PC, RS485/ Modbus, ASCII, Modbus or MR Protocol
LED Indicators	Power, Service, Sampling
Supporting Software	Lighthouse Monitoring System, LMS Net XChange, LMS Express and LMS Express RT
Concentration Limit	4,000 counts/ml @ 5% Coincidence Error
Power Input Requirements	24VDC@ 100mA
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Sample Inlet/Outlet Connection	1/4" Flaretek™
Sample Temperature	32 - 302°F (0 - 150°C)
Sample Pressure	150 PSI
Wetted Surface Material	Quartz, PTFE, PFA
Dimensions	5.7"(L) x 5.2"(W) x 3"(H) [14.47 x 13.2 x 7.6 cm]
Weight	3.5 lbs. (1.58 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

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RLPC 0.5µm Specifications

Table 2-4 RLPC 0.5µm Specifications

Size Range	0.5 - 5.0 µm
Channel Thresholds	Standard: 0.5, 0.7, 1.0, 2.0 µm Standard: 0.5, 1.0, 2.0, 5.0 µm
Flow Rate	100 ml/min, ± 5%, User-controlled
Laser Source	Laser Diode
Calibration	NIST Traceable
Data Storage	Rotating buffer, 2000 Records
Communication Modes	RS232/RS485 via RJ45 to PC, RS485/ Modbus, ASCII, Modbus or MR Protocol
LED Indicators	Power, Service, Sampling
Supporting Software	Lighthouse Monitoring System, LMS Net XChange, LMS Express and LMS Express RT
Concentration Limit	4,000 counts/ml @ 5% Coincidence Error
Power Input Requirements	24VDC@ 100mA
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Sample Inlet/Outlet Connection	1/4" Flaretek™
Sample Temperature	32 - 302°F (0 - 150°C)
Sample Pressure	150 PSI
Wetted Surface Material	Quartz, PTFE, PFA
Dimensions	5.7"(L) x 5.2"(W) x 3"(H) [14.47 x 13.2 x 7.6 cm]
Weight	3.5 lbs (1.58 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

RLPC Chemical Compatibility

Table 2-5 Table of LPC-Compatible Chemicals

COMPATIBLE CHEMICALS	SYMBOL
Water	H_2O
Deionized Water	H_2O, DI H_2O
Nitric Acid $\leq$ 70%	HNO_3
Sulfuric Acid $\leq$ 96%	H_2SO_4
Hydrochloric Acid, $\leq$ 37%	HCL
Ammonium Hydroxide, $\leq$ 29%	NH_4OH
Hydrogen Peroxide, $\leq$ 30%	H_2O_2
Phosphoric Acid, $\leq$ 86%	H_3PO_4
Isopropyl Alcohol	C_3H_8O
Acetone	C_3H_6O
N-methyl peri-iodine	NMPI

Table 2-6 Table of Non-Compatible Chemicals

NON-COMPATIBLE CHEMICALS	SYMBOL
EKC 265	EKC 265
EKC 830	EKC 830
Nitric Acid, $\geq$ 71%	HNO_3
Ammonium Fluoride	NH_4F
Hydrofluoric Acid, all concentrations	HF
Buffered Hydrofluoric Acid or Buffered Oxide Etch	BHF, BOE
ST-20 Solution	IPA
Tetramethylammonium Hydroxide	TMAH

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

3 Get Started

Initial Inspection

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

When received, inspect the shipping carton for damage. If the carton is damaged, notify the carrier and save the carton for carrier inspection. Inspect the unit for broken parts, scratches, dents or other damage.

If the carton is not damaged, keep it for reshipping the instrument for its annual factory calibration. RETAIN THE INLET AND OUTLET SHIPPING CAPS!

Annual Calibration

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

Shipping Instructions

Should it become necessary to return the unit to the factory for any reason, be sure to contact Customer Service and obtain a Return Material Authorization (RMA) number. Reference this number on all shipping documentation and purchase orders. After receipt of the RMA, follow the instructions below:

WARNING: ***If the sensor must be returned for service or when it is returned for calibration, the Flow Cell must be flushed with DI water or reagent grade isopropyl alcohol and blown dry with clean air and the nozzles capped. Any chemicals present in the sensor at the time of shipping require specific hazardous materials warnings on the shipping container. A Material Safety Data Sheet (MSDS) must be included for every chemical inside the sensor at the time of its shipment. If the Flow Cell is not clean and dry prior to shipping, it may be damaged (freeze-fracture, dried contaminants) and require replacement during servicing or calibration.***

1. When the conditions in the warning are met, use the original container or carton and packing materials whenever possible.

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WARNING: ***If the RLPC is damaged during shipment due to inadequate user packing, the warranty may be voided and all repairs required will be at cost.***

2. If the original container and packing materials are not available, wrap the unit in "bubble pack" plastic; surround with shock-absorbent material and place in a double-wall carton (the RLPC should not rattle around when the carton is vigorously shaken). If the RLPC is damaged during shipment due to inadequate user packing, the warranty may be voided and all repairs required will be at cost. Contact Lighthouse to purchase a replacement shipping container and nozzle caps.

3. Seal container or carton securely. Mark "FRAGILE" and write the RMA number in any unmarked corner.

4. Return to the address instructed by a Lighthouse representative.

LEDs

Understanding the LEDs

The front-panel LEDs have specific meanings when illuminated. Figure 3-1 shows location of the LEDs and gives a brief description of their meaning.



Figure 3-1 Detail of Front Panel LEDs

- The green POWER LED turns on when the instrument is powered on.
- The orange SERVICE LED will stay on steady if Laser power is out of range, the Flow Cell is dirty or contains foreign objects or the Flow Cell is filled with bubbles.

  In the event that the light is on when installing the sensor, please refer to *Appendix C, "Maintenance"* for Flow Cell cleaning instructions.
- The blue SAMPLING LED indicates that the instrument is in the sampling state.

Instrument Overview

Outlet Nozzle

The Outlet Nozzle on the top of the instrument uses ¼" flare tubing and allows the liquid sample to flow back to the system being sampled. See Figure 3-2.

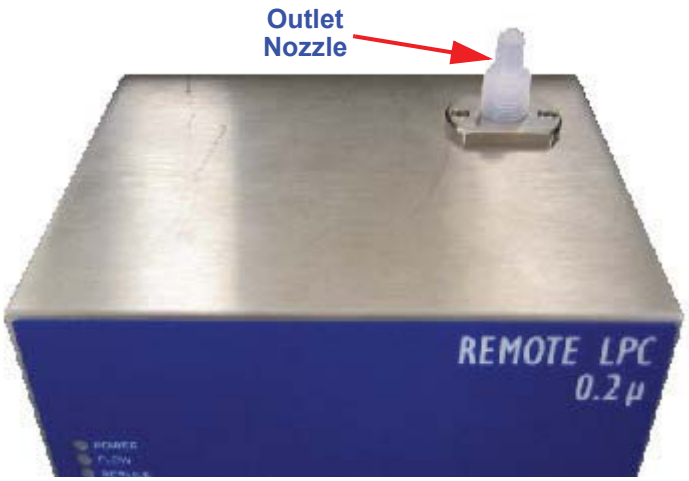


Figure 3-2 RLPC Top Connections

The ¼" flare connector on the bottom of the unit is the Inlet Nozzle and needs to be connected to the system being sampled. See Figure 3-3.

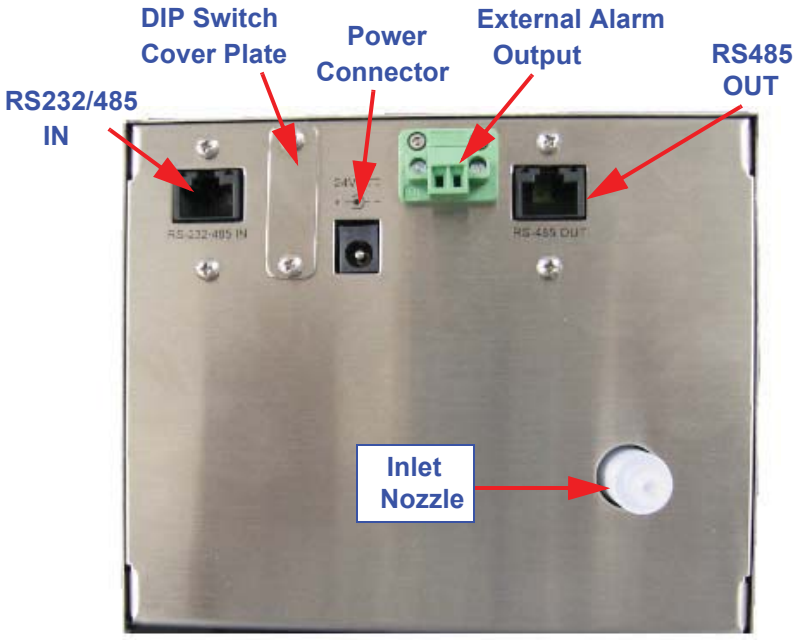


Figure 3-3 RLPC Bottom Connections

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Communication Ports

WARNING: ***When daisy chaining multiple instruments, connect IN ports only to OUT ports. DO NOT connect an IN port to another IN port. Doing so will damage the sensor and void the warranty.***

The RS232/485 IN port incorporates Serial and MODBUS communications to allow short distance point-to-point RS232 or long distance multi-point RS485 communications.

The RS232 protocol is provided for quick simple cable connections to a standard PC COM port and is used for single-unit communications only.

The RS485 protocol is provided for industrial applications with multiple devices on the same bus and requires an adapter when used with a PC. The RS485 IN and OUT connectors allow easy connections using standard CAT 5 patch cables commonly used for office LANs. Connecting the counter to a PC via RS485 requires an RS485 to RS232 converter, cables, connectors and terminator; please contact a Lighthouse Sales Representative for the LWS RS485 converter kit.

For more information, please see chapter on “Communications” on page 4-1.

RS485 Adapter Cable

WARNING: ***Failure to use the Adapter Cable in a daisy-chain network may damage the RLPC and void its warranty.***

An RS485 Adapter Cable is available as an optional accessory and must be used to connect the RLPC to an RS485 daisy-chain network. The adapter prevents damage to the instrument when it is used in daisy-chain networks. Plug it into the RS232/485 IN port before connecting the network cable to the RLPC. See Figure 3-4.



Figure 3-4 RS485 Adapter Cable

Note: *Use of the Adapter Cable for RS232 or RS485 Hub connections may not provide the desired results.*

If the RLPC will be used in a point-to-point RS232 connection, the Adapter Cable should not be used. RS232 communication to the RLPC will be blocked if the adapter is in place.

If the RLPC will be used in a star configuration using an RS485 hub, the Adapter Cable should not be used if the hub is supplying power to the instrument. Power to the RS232/485 IN port will be blocked if the adapter is in place.

DIP Switches

The DIP switches set the address of the instrument for RS485 daisy chain configurations and the communications mode. See “DIP Switch configuration for Communications Mode” on page 4-2 for details.

Positions 1-6 set the address of the instrument.

Position 7 and 8 set the communications mode.

To change the switch positions requires a small Phillips screwdriver to remove the cover plate and a small pointed tool, such as a paper clip.

Power

This REMOTE instrument uses an external 24VDC power supply. The power input is 100-240 VAC, 50-60Hz, 0.4A and output is 24VDC, 0.62A.

External Alarm Output

The External Alarm Output is a 2-wire, normally-open dry contact relay rated at 0-60V AC/DC, 1A.

The 2-position screw terminal block can be removed from the instrument by unscrewing the holding screws on either side of the connector block.

The external alarm is triggered when the alarm-enabled channel’s particle count exceeds the configured threshold. The alarm will stay active until the beginning of the next sample which resets it to Off.

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Inlet Nozzle

Note: ***The user is responsible for maintaining a nominal flow rate of 100 ml/min. ± 5% through the sensor.***

The sample source is attached using ¼" flare tubing to the Inlet Nozzle. The user is responsible for maintaining a nominal flow rate of 100 ml/min. ± 5% through the sensor to insure the accuracy of the data. See Figure 3-5.

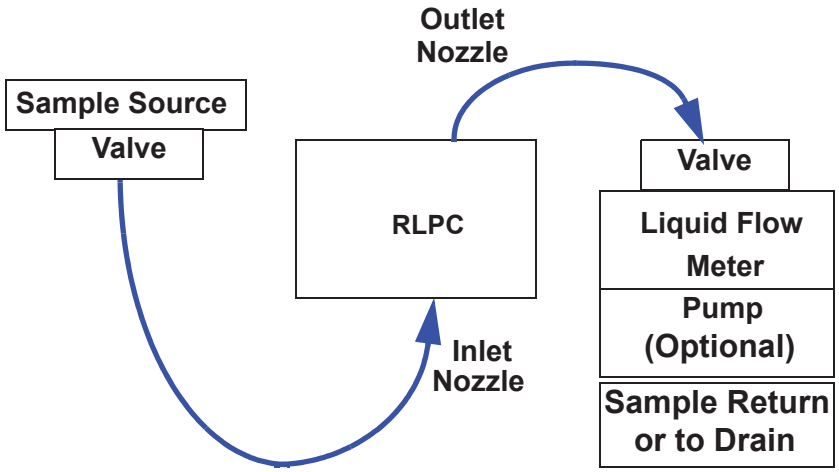


Figure 3-5 Example of an RLPC Installation

If there are any questions or problems during system setup, please contact Lighthouse Worldwide Solutions' Technical Support at techsupport@golighthouse.com.

Attaching Sensor

This section instructs on how to attach and start using the RLPC. Refer to previous sections of this chapter for electrical connection information.

WARNING: ***Please follow the standard precautions for working with liquids around electronic components.***

Use of safety measures when working with liquids around electronics cannot be stressed enough. Make sure the RLPC is physically secure before connecting any tubing or electrical cables. Use Personal Protection Equipment, such as face shields, protective garments and gloves, whenever working around hazardous liquids.

1. Make sure that there is no flow of liquid in the system and power is removed from the RLPC.

Note: *When connecting flare fittings to the RLPC, do **NOT** use a wrench or other tool to tighten the flare nut! Doing so will damage the instrument, tubing or nut. The connections **MUST** be **finger-tight** only.*

2. Connect the liquid source to the RLPC's Inlet nozzle using the provided ¼" flare tubing. Make sure the tubing is inserted firmly onto the nozzle and the knurled nut is finger tight only.

3. Connect the liquid drain to the RLPC's Outlet nozzle using the provided ¼" flare tubing. Make sure the tubing is inserted securely onto the nozzle and the knurled nut is finger tight only.

4. Turn the liquid system on and allow liquid to flow through the RLPC, making sure that there are no leaks at the sensor's inlet or outlet or any other connections.

WARNING: ***If a leak occurs anywhere within the system, immediately stop the flow of liquid and repair the leak!***

5. If leaks occur, immediately stop the flow of liquid. Disconnect and clear the flare fittings and connectors of debris or burrs. Repair any other leak(s) and return to Step 1 of this section.

6. If no leaks occur, connect power to the RLPC.

7. Make sure the sample liquid is bubble-free - bubbles will be counted as particles and in large amounts may cause sensor errors.

8. Allow liquid to flow through the sensor for 10 minutes or until there are no bubbles and the Service LED is OFF. If the Service LED comes on and remains on, the flow cell should be cleaned (see *Appendix C, "Maintenance"* for cleaning instructions).

9. If there are no leaks and the service LED is off, the instrument is ready to configure the communications - refer to *Chapter 4, "Communications"*.

10. Adding devices or additional connections between the sample source and the sensor will increase the chances for leaks and bubbles - keep connections to a minimum.

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4 Communications

This chapter contains information on how to set up the RLPC to program and communicate with it.

DIP Switches

The DIP switches are behind a panel located between the RS232/485 IN port and the power connector. See Figure 4-1.



Figure 4-1 DIP Switch Cover

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

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DIP SWITCH GENERAL DEFINITIONS

Table 4-1 displays the general DIP Switch settings. OFF (DOWN) = 0, ON (UP) = 1

Note: *Use a tool with a very small, pointed tip in order to change the DIP Switch positions.*

Table 4-1 DIP Switch settings

Position #	Description	Setting
1	Binary Bit 0	Addressing, OFF=0, ON=1
2	Binary Bit 1	Addressing, OFF=0, ON=1
3	Binary Bit 2	Addressing, OFF=0, ON=1
4	Binary Bit 3	Addressing, OFF=0, ON=1
5	Binary Bit 4	Addressing, OFF=0, ON=1
6	Binary Bit 5	Addressing, OFF=0, ON=1
7	Communication Mode	Used in conjunction with DIP switch 8 to set MR, MODBUS or ASCII mode
8	Communication Mode	Used in conjunction with DIP switch 7 to set MR, MODBUS or ASCII mode

Communication Modes

There are three communication modes for the RLPC - MODBUS protocol, MR protocol and ASCII mode as shown in Table 4-2.

Table 4-2 DIP Switch configuration for Communications Mode

COMMUNICATIONS MODE	DIP SW 7	DIP SW 8
MODBUS protocol	OFF	OFF
ASCII mode	OFF	ON
MR Protocol with software addressing	ON	OFF
MR Protocol with DIP Switch addressing	ON	ON

The DIP Switches must be set before the unit is powered up. If the DIP Switches are changed, power cycle the instrument to implement the change.

DIP Switch Addressing

Note: *Because Address 0 is reserved for broadcasting in MODBUS RS485 communications, Address 1 is set both when all the DIP switches are OFF or when DIP switch1 is ON.*

For MR Protocol, Address 0 is set when all the DIP switches are OFF. Use a thin, pointed tool such as a small jeweler's screwdriver or a straightened paper clip to set the switches.

Table 4-3 shows the addresses set by DIP switches 1-6.

Table 4-3 DIP Switch Addressing

DIP SWITCHES 1 2 3 4 5 6	ADDRESS	DIP SWITCHES 1 2 3 4 5 6	ADDRESS
0 0 0 0 0 0	0 or 1	0 0 0 0 0 1	32
1 0 0 0 0 0	1	1 0 0 0 0 1	33
0 1 0 0 0 0	2	0 1 0 0 0 1	34
1 1 0 0 0 0	3	1 1 0 0 0 1	35
0 0 1 0 0 0	4	0 0 1 0 0 1	36
1 0 0 1 0 0	5	1 0 1 0 0 1	37
0 1 0 1 0 0	6	0 1 1 0 0 1	38
1 1 1 0 0 0	7	1 1 1 0 0 1	39
0 0 0 1 0 0	8	0 0 0 1 0 1	40
1 0 0 1 0 0	9	1 0 0 1 0 1	41
0 1 0 1 0 0	10	0 1 0 1 0 1	42
1 1 0 1 0 0	11	1 1 0 1 0 1	43
0 0 1 1 0 0	12	0 0 1 1 0 1	44
1 0 1 1 0 0	13	1 0 1 1 0 1	45
0 1 1 1 0 0	14	0 1 1 1 0 1	46
1 1 1 1 0 0	15	1 1 1 1 0 1	47
0 0 0 0 1 0	16	0 0 0 0 1 1	48
1 0 0 0 1 0	17	1 0 0 0 1 1	49
0 1 0 0 1 0	18	0 1 0 0 1 1	50
1 1 0 0 1 0	19	1 1 0 0 1 1	51
0 0 1 0 1 0	20	0 0 1 0 1 1	52
1 0 1 0 1 0	21	1 0 1 0 1 1	53
0 1 1 0 1 0	22	0 1 1 0 1 1	54
1 1 1 0 1 0	23	1 1 1 0 1 1	55

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Table 4-3 DIP Switch Addressing

DIP SWITCHES 1 2 3 4 5 6	ADDRESS	DIP SWITCHES 1 2 3 4 5 6	ADDRESS
0 0 0 1 1 0	24	0 0 0 1 1 1	56
1 0 0 1 1 0	25	1 0 0 1 1 1	57
0 1 0 1 1 0	26	0 1 0 1 1 1	58
1 1 0 1 1 0	27	1 1 0 1 1 1	59
0 0 1 1 1 0	28	0 0 1 1 1 1	60
1 0 1 1 1 0	29	1 0 1 1 1 1	61
0 1 1 1 1 0	30	0 1 1 1 1 1	62
1 1 1 1 1 0	31	1 1 1 1 1 1	63

Communicating with the Instrument

The RJ-45 connector marked "RS232/485 IN" shown in Figure 4-2 is used to connect the unit to a COM port of a desktop or laptop PC.



Figure 4-2 Communication Port Pin Numbers

RS232/485 IN Port

The RS232/485 IN port RJ-45 connector has both RS232 and RS485 lines. The pinouts are shown in Table 4-4.

Table 4-4 RJ-45 Pinouts

RJ-45 Pin	Signal Name
1	RS232-TX
2	RS232 RX
3	RESERVED for future use
4	RS485B
5	RS485A
6	RESERVED for future use
7	RESERVED for future use
8	GND

An RJ-45 to DB-9 modular adapter to connect the RLPC to a computer COM port is available from Lighthouse. Remove the RS485 Adapter Cable when RS232 connection is needed and reinstall the RS485 Adapter when the RS485 network is to be restored (see "RS485 Adapter Cable" on page 3-4). The pinouts of the RJ-45 to DB9 adapter are shown in Table 4-5.

WARNING: ***When daisy-chaining multiple instruments together, only connect IN ports to OUT ports. Do NOT connect an IN port to another IN port using a cable that has all 8 wires in use; board damage will occur.***

If the RS485 Adapter Cable is used, no damage will occur but data will be lost.

Table 4-5 RJ-45 to DB-9 Connections

RJ-45 Pin	Signal Name	DB-9 Pin
1	TX	2
2	RX	3
8	Ground	5
3	DTE	7

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RS485 OUT Port

The RS485 OUT port uses only 2 lines for RS485 communications. See Table 4-6.

Table 4-6 RS485 OUT Port

RJ-45 Pin	Signal Name
1	Not Used
2	Not Used
3	Not Used
4	**RS485B**
5	**RS485A**
6	Not Used
7	Not Used
8	Not Used

RS232 Communications

Note: *Refer to "RS485 Adapter Cable" on page 3-4 before setting up RS232 communications with the RLPC.*

The instrument can use RS232 communications in a point-to-point configuration. Refer to "RS485 Adapter Cable" on page 3-4.

To connect the instrument to a computer using RS232 Protocol:

1. Remove power from the instrument.
2. Connect one end of a standard Cat5 cable to the RS232/485 IN port on the instrument.
3. Attach the other end of the Cat5 cable to the DB-9 adapter. Attach the DB-9 adapter to any available COM (Serial) Port on a computer.
4. Set DIP Switch 8 to OFF (DOWN) for MODBUS or MR protocol with software addressing or to ON (UP) for ASCII mode. Refer to Table 4-2 on page 4-2.

RS485 Communications

Note: *Refer to "RS485 Adapter Cable" on page 3-4 before setting up RS485 communications with the RLPC.*

The instrument can utilize RS485 communications if the distance to the computer is more than 50 feet or the instrument will be used in a multi-point daisy chain configuration.

To use the RS485 protocol with a computer COM port, an RS485 converter must be used in the 2-wire configuration with ChB+ wired to the Cat5 cable pin 4, and ChA- wired to pin 5. Please contact a Lighthouse Sales Representative for an RS485 converter kit that includes the cables, connectors and terminators needed to set this up.

Connecting to a PC

To connect the instrument to a computer using RS485 Protocol:

1. Remove power from the instrument.
2. Connect one end of a standard Cat5 cable to an LWS RS485 converter.
3. Connect the other end of the Cat5 cable to the RS232/485 IN port on the instrument.
4. Connect the RS232 DB-9 side of the RS485 converter to a DB-9 Male to DB-9 Female straight through cable. Connect the female DB-9 to any available COM port on the computer.
5. Set DIP Switch 8 to OFF (DOWN).
6. Power on the instrument.

To daisy chain multiple units, use a Cat5 cable to connect the RS485 OUT port of the first instrument to an RS485 Adapter Cable (see "RS485 Adapter Cable" on page 3-4) that is connected to the RS232/485 IN port of the next instrument. Use adapters and ethernet cables to connect the OUT ports to the IN ports of all the units and insert a 100-ohm terminating block in the last instrument's OUT port. See Figure 4-3.



Figure 4-3 RS485 Adapter Cable

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Make sure that each RLPC has a unique address (non-zero) or a conflict will result and data will be lost.

The RLPC complies with EIA's RS485 standards for distances and number of devices on a chain. See Table 4-7.

Table 4-7 EIA Industry Standards for RS485 Communications

SPECIFICATIONS	RS485
Mode of Operation	Differential
Total Number of Drivers and Receivers on One Line (One driver active at a time for RS485 networks)	32 Drivers 32 Receivers
Maximum Cable Length	4000 ft. (1,219.2 m)
Maximum Data Rate (40 ft. - 4000 ft. for RS422/RS485)	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
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 RS485)	≥12k

5 Configuring with LWS ASCII Service Protocol

General Info

The RLPC instruments can be programmed with an ASCII terminal. The Lighthouse ASCII protocol is a simple user interface to change the device's parameters and can be used as a stand-alone or with the MODBUS or MR protocol.

Configuring with ASCII

To use an ASCII terminal, such as HyperTerminal, use the communication settings of 19200 baud, 8 Data bits, NO parity, 1 Stop bit, NO flow control as shown in Figure 5-1.

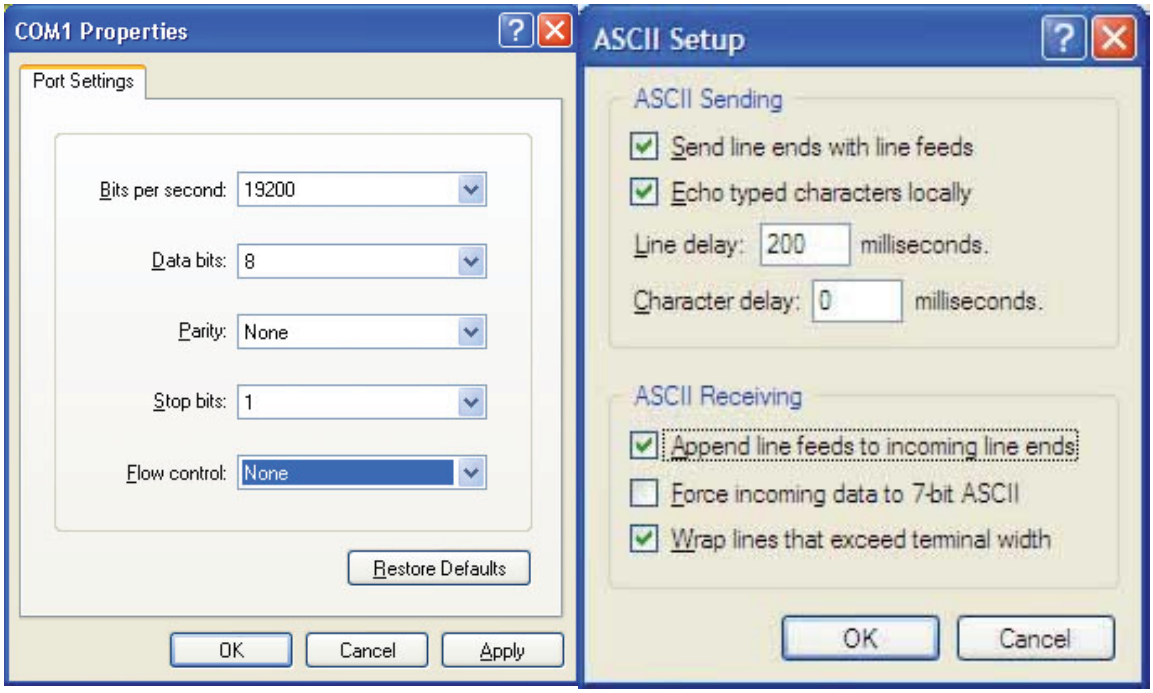


Figure 5-1 Hyperterminal Communication Settings

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ASCII Command Structure

The commands are defined as case-sensitive ASCII characters. Format is defined as:

<xx [yyyy]>

Note: *The < and > characters are part of the command and must be typed. The brackets [and] are field delimiters and are not typed.*

where:

< = Start Character

xx = Command Character

yyyy = Optional Command Parameter

> = End Character

Note: *The commands are case sensitive. If an incorrect case is used, there will be no response from the instrument.*

Handshake

Upon execution of the command, and assuming the user has typed **<V>** for Verbose, the REMOTE instrument will send a response based on the command sent.

When the unit is powered up, it sets up the counters and timers, and starts reporting data. The data will be similar to this example:

```
Sample: 0, 0; bk= 371; trh= 74.7/ 43.0; rec=95;
Sample: 0, 0; bk= 371; trh= 74.7/ 43.0; rec=96;
```

Note: *the field bk= 371 in this example, is the "backlight" function, which is a measurement of scattered light in the instrument.*

371mV=.371V

If the unit is a 4-channel instrument, the following would display:

```
Sample: 0, 0, 0, 0; bk= 371; trh= 74.7/ 43.0; rec=95;
Sample: 0, 0, 0, 0; bk= 371; trh= 74.7/ 43.0; rec=96;
```

If an invalid command is typed, there will be no response.

Getting Started

1. Start HyperTerminal with the above configuration settings.
2. Connect the RLPC instrument with an RS-232 connection from the 232/485 IN port to the PC COM port.
3. Power on the RLPC.

   The following menu will display:

```
LWS 3014 Remote/ ASCII.
Model: REMOTE LPC 0.2, LPC
```

```
 Version: 110
 Serial#: 040116001
 2004-01-13,  18:05:26
- program mode:
```

4. Type:

   <V>

   This is Verbose mode. This must be the first command sent to the instrument.

   Response:

```
<V> Verbose Mode On
```

5. Type:

   <?>

   This command displays the instrument's current configuration.

   Response:

```
<?>
 2004-01-24, 10:09:00
 <Model: REMOTE LPC 0.2, LPC
LWS Protocol
View volume = 80.0%
Flow Rate = 100.0 MLPM
Sample Time = 60 secs
Hold Time = 3 secs
Service High = 3500 mV
Service Low = 125 mV
Location = 0
Device Address = 1
Ch1 Alarm = OFF
Ch2 Alarm = OFF
Ch3 Alarm = OFF
Ch4 Alarm = OFF
Ch1 Alarm Threshold = 1000 counts
Ch2 Alarm Threshold = 1000 counts
Ch3 Alarm Threshold = 1000 counts
Ch4 Alarm Threshold = 1000 counts
Suppress Alarms = 0
Thresholds (mV) = 40, 200
Channel 1 = 0.3
Channel 2 = 0.5
```


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6. Type:

<m1>

This command displays the user menu.

Response:

```
<m1>
*** User Menu ***
<?> Display Parameters
<V> Verbose Mode
<sa> Start Counting
<sb> Stop Counting
<gd> Get Date/Time
<gm> Get Model Name
<gs> Get Serial#
<gv> Get Version Number
<gw> Get View Volume
<ta#> Set Sample Seconds
<tb#> Set Holdtime Seconds
<pa#> Set Location Num (0-999)
<aa#> Enable Alarm Channel #
<ax#> Disable Alarm Channel #
<a1#> Set Ch1 Alarm Threshold (# of counts)
<a1#> Set Ch2 Alarm Threshold (# of counts)
<a1#> Set Ch3 Alarm Threshold (# of counts)
<a1#> Set Ch4 Alarm Threshold (# of counts)
<ae#> Set Alarm Suppression #
<da#> Set Year = YY
<db#> Set Month = MM
<dc#> Set Day = DD
<dd#> Set Hour = HH
<de#> Set Minute = MMin
<df#> Set Second = SS
```

7. Type:

<ms>

This command displays the user accessible service menu.

Response:

```
<ms>
*** Service Menu ***
<ia> Don't show 1 sec data
<ib> Show 1 sec data
<gb> Get Bkgnd
<gl> Get Laser
<gh> Get Humidity
<gt> Get Temperature
```

8. If no commands are input for 60 seconds, the first sample record will display as the instrument begins to sample automatically:

```
Sample: 0, 0; bk= 371; trh= 74.7/ 43.0; rec=95;
Sample: 0, 0; bk= 371; trh= 74.7/ 43.0; rec=96;
```

Summary of Configuration Commands

The basic user configuration commands are displayed in Table 5-1.

Table 5-1 User Menu Commands <m1>

ASCII Command	Description
<?>	**Display Parameters** Displays current configuration parameters.
<V>	**Verbose Mode** Sets instrument to echo responses.
<sa>	**Start Counting** Instrument starts counting right away using configured sample time; will show first sample after sample time passes.
<sb>	**Stop Counting** Instrument stops counting; can send more programming commands after sending <V> command.
<gd>	**Get Date/Time** Displays the currently configured date and time on the Real Time Clock.
<gm>	**Get Model Name** Displays the configured model name and number of the instrument.
<gs>	**Get Serial Number** Displays the configured serial number of the instrument.
<gv>	**Get Version Number** Displays the current version of the firmware.
<gw>	**Get View Volume** Displays the percent of the sample volume measured by the RLPC (ie. if sample volume is 100ml and view volume is 80%, the volume from which measurements are taken is 80ml).

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Table 5-1 User Menu Commands <m1>

ASCII Command	Description
<ta#>	**Set Sample Seconds** Configures the sample time interval where # is the number of seconds in the sample. The minimum value is 30 seconds and maximum value is 23 hours, 59 minutes, 59 seconds, or 83699 seconds.
<tb#>	**Set Holdtime Seconds** Configures the time in between samples when the unit is not counting; # is the hold time in seconds.
<pa#>	**Set Location Num (0-999)** Configures the location of the instrument.
<aa#>	**Set Alarm Channel #** Configures the instrument to use any channel to trigger the alarm condition. Multiple channels may be used for alarming.
<a1#> <a2#> <a3#> <a4#>	**Set Alarm # Threshold (# of counts)** Configures the value at which the alarm channel must exceed in order to trigger the alarm condition. Each channel may be configured to a different threshold.
<ae#>	**Set Alarm Suppression #** The number of alarm conditions have to be greater than # in order to turn on the Alarm Relay. Used for Local Alarming.
<da#>	**Set Year = YY** Configures the 2-digit year; ex: <da04> for 2004
<db#>	**Set Month = MM** Configures the 2-digit month; ex: <db01> for 01
<dc#>	**Set Day = DD** Configures the 2-digit day; ex: <dc28> for 28
<dd#>	**Set Hour = HH** Configures the 2-digit hour; ex: <dd13> for **13**:00:00
<de#>	**Set Minute = MMin** Configures the 2-digit minute; ex: <de25> for 13:**25**:00
<df#>	**Set Second = SS** Configures the 2-digit second; ex: <df43> for 13:25:**43**

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Example: Setting Date and Time

Note: *Remember to type <V> first when first entering the ASCII programming mode.*

The REMOTE instrument was preconfigured at the factory for Pacific Standard Time (PST). To check the date and time on the instrument in ASCII mode,

1. Type:

   <gd>

   This command displays the current date and time.

   Response:

   ```
   <gd>  2003-12-21,  11:10:49
   ```

To change the date and time, follow these instructions:

2. Change the Year <daYY>:

   This command sets the year value with a 2-digit year (YY).

   Type:

   <da04>

   Response:

   ```
   <da04>  2004-12-21,  11:10:55
   ```

3. Change the Month <dbMM>:

   This command sets the month value with a 2-digit month (MM); the range is 01 - 12.

   Type:

   <db01>

   Response:

   ```
   <db01>  2004-01-21,  11:11:24
   ```


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4. Change the Day <dcDD>:

   This command sets the day value with a 2-digit day (DD); the range is 01 - 31, depending on the month.

   Type:

   <dc29>

   Response:

   ```
   <dc29>  2004-01-29,  11:11:35
   ```

5. Change the Hour <ddHH>:

   This command sets the hour value with a 2-digit hour (HH); the range is 00 - 59.

   Type:

   <dd13>

   Response:

   ```
   <dd13>  2004-01-29,  13:11:35
   ```

6. Change the Minutes <demm>:

   This command sets the minute value in 2-digit minutes (mm); the range is 00 - 59.

   Type:

   <de18>

   Response:

   ```
   <de18>  2004-01-29,  13:18:35
   ```

7. Change the Seconds <dfSS>:

   This command sets the seconds value in 2-digit seconds (SS); the range is 00 - 59.

   Type:

   <df00>

   Response:

   ```
   <df00>  2004-01-29,  13:18:00
   ```

Example: Setting Sample Time <ta#>

WARNING: ***Do NOT set the Sample Time to a value less than 30 seconds.***

The REMOTE instrument was preconfigured at the factory for 1 minute sample time. Do not set the value to less than 30 seconds. To view the current sample time on the instrument in ASCII mode,

1. Type:

   <?>

   This command displays the current sample time among the other parameters.

To change the sample time to 2 minutes (120 seconds):

2. Type:

   <ta120>

   Response:

   `<ta120>  00:02:00`

To change the sample time to 1 minute (60 seconds):

3. Type:

   <ta60>

   Response:

   `<ta60>  00:01:00`

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Example: Setting Hold Time <tb#>

The REMOTE instrument was preconfigured at the factory for no hold time. To view the current hold time on the instrument in ASCII mode,

1. Type:

   <?>

   This command displays the current hold time among the other parameters.

To change the hold time to 30 seconds:

2. Type:

   <tb30>

   Response:

   ```
   <tb30>  00:00:30
   ```

To change the hold time to 0 seconds:

3. Type:

   <tb0>

   Response:

   ```
   <tb0>  00:00:00
   ```


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Note: *In this case, "Location" indicates where the device is located, not the device's communication address.*

For MR Protocol, the Location and Device Address are the same thing.

Example: Setting Location <pa#>

The REMOTE instrument was preconfigured at the factory for Location 0. To view the current location configured on the instrument in ASCII mode,

1. Type:

   <?>

   This command displays the current Location among the other parameters.

To change the location to location 3:

2. Type:

   <pa3>

   Response:

   ```
   <pa3>  Location = 3
   ```

Example: Enable Alarm Channel <aa#>

The REMOTE instrument was preconfigured at the factory to alarm on the first channel. To view the currently configured alarm channel,

1. Type:

   <?>

   This command displays the current alarm channels within the parameter list.

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To change the alarm channel or to disable the alarm:

2. To enable Channel 1 alarm, type:

   <aa1>

   Response:

   ```
   Ch1 Alarm = ON

   Ch2 Alarm = OFF

   Ch3 Alarm = OFF

   Ch4 Alarm = OFF
   ```

3. To add the channel 2 alarm, type:

   <aa2>

   Response:

   ```
   Ch1 Alarm = ON

   Ch2 Alarm = ON

   Ch3 Alarm = OFF

   Ch4 Alarm = OFF
   ```

Example: Disabling Channel Alarm

Continuing from the previous example:

4. To disable Channel 1 alarm, type:

   <ax1>

   Response:

   ```
   Ch1 Alarm = OFF

   Ch2 Alarm = ON

   Ch3 Alarm = OFF

   Ch4 Alarm = OFF
   ```


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Example: Setting Alarm Threshold <axy>

Where x is the channel number and y is the threshold value.

The REMOTE instrument is preconfigured at the factory with an alarm threshold of 1000 counts. This means that the counter will enable the external alarm when the threshold of the alarm channel configured exceeds 1000 counts. To view the currently configured alarm threshold on the instrument,

1. Type:

   <?>

   This command displays the current alarm threshold within the parameter list.

To change the alarm threshold for Channel 1:

2. Type:

   <a1100>

   Response:

   ```
   Ch1 Alarm Threshold = 100 counts

   Ch2 Alarm Threshold = 1000 counts

   Ch3 Alarm Threshold = 1000 counts

   Ch4 Alarm Threshold = 1000 counts
   ```

   Alarm Thresholds only apply when alarm channels are enabled.

3. To change the alarm threshold for channel 3 type:

   <a3500>

   Response:

   ```
   Ch1 Alarm Threshold = 100 counts

   Ch2 Alarm Threshold = 1000 counts

   Ch3 Alarm Threshold = 500 counts

   Ch4 Alarm Threshold = 1000 counts
   ```


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Example: Setting Alarm Suppression <ae#>

Note: *If more than one channel goes into alarm during a sample, it counts as only one alarm. If, for example, channels 1 and 2 go into alarm, it will count as 1, not 2, suppressed alarms.*

The number of consecutive alarm conditions have to be greater than # in order to turn on the Alarm Relay.

1. Type:

   <ae2>

   Response:

   ```
   <ae2>Suppress Alarms = 2
   ```

In the above example, the 3rd consecutive alarm condition would trigger the Alarm Relay.

Verify Configuration Changes

When done with all the updates, type <?> to list all the parameters and current values. If any of the items, need to be changed type <m1> to display the command menu to find the command to change the parameter.

When the configuration parameters are set, change DIP switch 8 to OFF, then power cycle the device to start it in MODBUS mode. It will automatically start counting and is ready to receive MODBUS commands.

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6 Programming with MR Protocol

The RLPC can be programmed using the MR Protocol. The full protocol is detailed in *Appendix A: "MR Protocol Commands" on page A-1*.

This protocol allows the instrument to be controlled remotely by a third party application or terminal program, such as ProCOMM or Windows Hyper Terminal and is compatible with Met One particle counters.

Note: *Multiple alarming is disabled by MR Protocol.*

This chapter provides the information needed to program the basic configuration for the instrument using the MR protocol.

DIP Switches

With other protocols, the instrument Location is independent of the Device Address. When using the MR Protocol, however, Location and Device Addresses are the same.

In its default configuration, the counter reads its DIP switches during power-up and reset.

To use DIP switches 1-6 for Location/Address, move Switch #7 and #8 to the ON position.

Note: *When changing the DIP switch settings, the instrument power must be cycled off and on.*

To configure the Location/Address using a software command, move switch #7 to the ON position and switch #8 to the OFF position.

Protocol Settings

The MR Protocol is defined through an RS485 interface with:

- Baud Rate: 9600
- Data Bits: 8
- Stop Bits: 1
- Parity: None
- Flow Control: None

Power On

When first powering up the instrument, if no commands are sent to the unit within 60 seconds, then it will begin sampling using the default configuration:

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- Location = 0
- Sample Time = 60 seconds
- Hold Time = 0 seconds
- Alarm channel= Disabled

Connecting the Instrument to a Terminal

To connect the instrument to a computer:

1. Remove power from the instrument.
2. Connect one end of a standard CAT5 cable to either the RS485 IN or OUT receptacle on the instrument. Pins 4 and 5 should connect to ChB and ChA, respectively, of an RS485 to RS232 converter. Do NOT use a CAT5 cross-over cable or damage to instrument will result.

WARNING: ***Do not connect RS232 signals directly to RS485 pins on the instrument. Failure to heed this warning will result in damage to the instrument, voiding its warranty.***

3. Connect the RS232 side of the converter to a COM (Serial) Port on a computer.
4. Start Hyper terminal on the computer.

Note: *Some converters require handshaking to control direction of data flow. For those converters, set Flow Control to Hardware.*

5. Configure the COM Port settings for any available COM Port. Set the Flow Control to None for most converters.
6. Configure ASCII setup as shown in Figure 6-1.

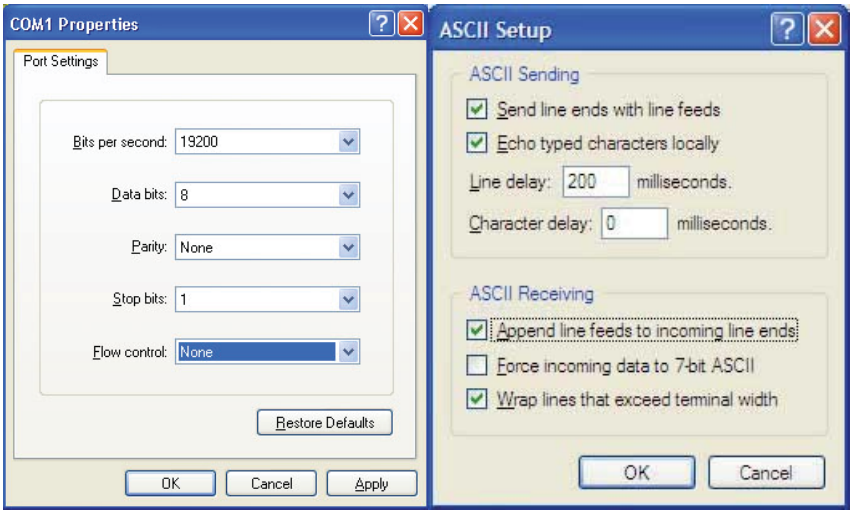


Figure 6-1 COM Port and ASCII Properties

7. Apply power to the instrument.

.Device Select Sending a Location/Address

The RLPC use a Location to identify where the device recorded its data. The device address identifies the communications address of the device. For the MR protocol, Location and Device Address are the same value, LOC.

The first step in sending commands to a counter is to wake it by sending its Location/Address. Once a unit has been selected, it remains selected until a different Location/Address is sent.

The Location/Address is configured either through the DIP Switches or through the software command **WL** depending on the configuration of DIP Switches 7 and 8. See Table 4-2 on page 4-2.

Whether configuring a device address using the DIP switches or through the **WL** command, that address must be used in Hyper terminal or ProComm to communicate with that specific device when there are multiple devices on a chain.

Note: *For laptop computers, enable NUMLOCK to access the numeric keypad. Different laptop models access NUMLOCK in different ways. Please consult laptop manual for more information.*

Example:

`Press/Hold` **`ALT`** `Key, then type` **`0128`** *{Location/Address 0}*

The subsequent commands will apply to the device at Location/Address 0.

All device select entries lie in the range of 0128 - 0191 which correspond to Location Address 0 -63. Leading zeros must be entered. See Table 6-1.

Table 6-1 Location Addresses -- Hold ALT while typing the Device Select Entry number on the numeric keypad

Device Select Entry	Location Address	Device Select Entry	Location Address
0128	0	0160	32
0129	1	0161	33
0130	2	0162	34
0131	3	0163	35
0132	4	0164	36
0133	5	0165	37

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Table 6-1 Location Addresses -- Hold ALT while typing the Device Select Entry number on the numeric keypad

Device Select Entry	Location Address	Device Select Entry	Location Address
0134	6	0166	38
0135	7	0167	39
0136	8	0168	40
0137	9	0169	41
0138	10	0170	42
0139	11	0171	43
0140	12	0172	44
0141	13	0173	45
0142	14	0174	46
0143	15	0175	47
0144	16	0176	48
0145	17	0177	49
0146	18	0178	50
0147	19	0179	51
0148	20	0180	52
0149	21	0181	53
0150	22	0182	54
0151	23	0183	55
0152	24	0184	56
0153	25	0185	57
0154	26	0186	58
0155	27	0187	59
0156	28	0188	60
0157	29	0189	61
0158	30	0190	62

Table 6-1 Location Addresses -- Hold ALT while typing the Device Select Entry number on the numeric keypad

Device Select Entry	Location Address	Device Select Entry	Location Address
0159	31	0191	63

Universal Device Select (U)

WARNING: ***Do not use Universal Select when more than one counter is powered on and connected to the same RS485 Bus.***

If the user has a single counter on the communications line and they are not sure of the address, first send a **U** command. The counter will respond to all commands given after the **U** command, regardless of its programmed Location/Address.

The **U** command provides a quick and easy way to check the configuration parameters of a single device. After determining the Location/Address of a device, it can be accessed later on a chain by using the Device Select command sequence.

If more than one counter is chained together on a single Serial Port, the use of the **U** command will cause communication problems because all counters will respond at the same time.

The **U** command is turned off by sending any Device Select address as described above.

Command:

`U` *{Unit will respond to all commands}*

`(Press/Hold) ALT 0135` *{U disabled; device at Location/Address 8 is now selected)*

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Configuration Commands

General

The general form of a Configuration Command is

AA*d*[CRLF]

WARNING: ***The MR Protocol is case sensitive. Using the incorrect case will produce undesirable results.***

where:

- **AA** is the command field and is always capitalized.
- ***d*** represents an argument, which may be numeric or a string, depending on the command. The argument immediately follows the command, with no space between them.
- **[CRLF]** means carriage return and line feed.

Note: *Unless Hyper terminal is configured to send line ends with line feeds, pressing the ENTER key sends only a carriage return. The configuration commands will wait for a Line Feed before returning a response.*

Set Alarm Limit (WA)

The Alarm Limit controls the value of the Alarm bit in the Status byte at the beginning of each record. If the number of counts in the smallest particle size reaches this value, the alarm bit will be set.

Command:

WA*d*[CRLF] *{Where **d** is a numeric value from 1 to 999999.}*

Response:

`WAd[crlf]` *{Echoing the command and the current setting}*

or, if value is invalid, just a single **?** will be sent.

Query value by typing:

WA[CRLF]

Response:

`WAd[crlf]` *{Where **d** is the current alarm threshold}*

Set Location(WL)

This function is provided as an alternate to using the DIP switches for setting the unit's Location/Address. If DIP Switch #7 is ON and #8 is OFF, it allows the Location/Address value to be changed by the WL command. This value is reported in the data record after the LOC tag.

The unit must be selected before this command can be used. If the unit is the only powered instrument on the bus, the Universal (U) command is appropriate. If other instruments are powered and are on the bus, the device's current address must be used to select it.

The change to the device's Location/Address takes place immediately, but the unit remains selected. It will continue to respond to commands until the bus is readdressed.

For example, if a device is set to Location/Address 3 and any command can be sent to it, then a **WL5** is sent, it will continue to respond to subsequent commands even though its new Location/Address is 5 until another device address is selected with the [ALT + ####] command.

Command:

WL*d*[CRLF] *{Where **d** is a value from 0 to 63}*

Response:

WL*d*[crlf]

Note: *DIP Switch 7 must be ON and DIP Switch 8 must be OFF in order for the WL command to function.*

or, if value is invalid or DIP Switch #8 is ON, a single **?** will be returned.

Query value by typing:

WL[CRLF]

Response:

WL*d*[crlf]

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Set Date & Time(WD)

Note: *There must be no spaces between characters and leading zeros must be used.*

This function is used to set the Real-Time Clock. This clock is used to date/time stamp each data record when stored. Data format is month day year hours minutes seconds.

There are no settings for time zones or Daylight Savings time.

Command:

`WDmmddyyhhmmss[CRLF]` *{No spaces}*

Response:

`WDmmddyyhhmmss[crlf]`

Query by typing:

`WD[CRLF]`

Response:

`WDmmddyy[space]hhmmss[crlf]`

Counter Setup and Data Record Commands

This group of commands is divided into three functional sections: counter setup commands, buffered record (data) commands and miscellaneous commands.

The general syntax form for each of these commands is a single capital letter.

Counter Set Up Commands

These case-sensitive commands are used to set up the sample and hold intervals for the instrument. No spaces are allowed within the commands.

Set Hold Interval (H*hhmmss*)

This command sets or queries the instrument's Hold Interval.

Example Command:

`H001000[CRLF]` *{Set Hold Interval to 10 minutes}*

Leading zeroes can be left out: **`H2000[CRLF]`** *{= 20 minutes}*
`H100[CRLF]` *{= 1 minute}*

H60[CRLF] *{= 1 minute}*
H10[CRLF] *{= 10 seconds}*

These are all valid commands.

Response:

H

Query by typing:

H[CRLF]

Response:

H001000[CRLF] *{Hold Interval = 10 minutes}*

Set Sample Interval (Lhhmmss)

WARNING: ***Do NOT set the Sample Time value to less than 30 seconds.***

Sets or queries the instrument's Sample Interval. The instrument is programmed at the factory with a default sample time of one minute. Do NOT set this value to less than 30 seconds.

Example Command:

L001500[CRLF] *{Set Sample Interval to 15 minutes}*

Leading zeroes can be left out: **L1500[CRLF]** *{= 15 minutes}*
L100[CRLF] *{= 1 minute}*
L60[CRLF] *{= 1 minute}*

These are all valid commands.

Response:

L

Query by typing:

L[CRLF]

Response:

L001500[CRLF] *{Current Sample Interval is 15 minutes}*

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Action Commands

General

Action commands are used to set the counter into Manual or Automatic mode and to control the counter Start and Stop.

The general syntax for Action commands is a single lowercase letter with no arguments.

Command:

a *{Puts the counter in Auto Mode. Once started by the 'd' command, the unit will sample for the length of the Sample Interval, hold for the length of the Hold Interval and repeat the sequence until a Stop is issued or manual mode is selected.}*

Response:

a

Command:

b *{Puts the unit in Manual Mode. Once started by the 'd' command, the unit will sample for the same length of sampling interval as in the 'a' command, but there is no Hold Interval or repeat.}*

Response:

b

Command:

c *{Start counting immediately. Instrument counts until the Stop command is sent.}*

Response:

c

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Command:

d	*{Configured using the 'a' and 'b' commands. Start counting in Automatic or Manual Mode. In automatic Mode, this command starts the count - hold - count sequence and repeats continuously. In Manual Mode, the count is started and automatically stops at the end of the Sample Interval.}*

Response:

d

Command:

e	*{Stop counting immediately. The last data record will show 0000 for its Sample Interval, as the Sample Interval is controlled by the host.}*

Response:

e

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Universal Actions Commands

General

These commands are provided for controlling multiple counters on the same bus. The commands are not echoed.

WARNING: ***The MR Protocol is case sensitive. Using the incorrect case will produce undesirable results.***

As soon as a Universal Action Command is executed, the bus drops out of Universal mode.

Command:

`ua` *{**Universal Auto Sample Mode -** Puts the counters in Auto Count mode. When the **ud** command is used, the devices will start counting in the auto mode, continuously executing individual Sample and Hold Intervals until a stop command **ue** is sent.}*

`ub` *{**Universal Manual Sample Mode -** Places the counters in Manual Count mode. When the **ud** command is sent, the devices will count in the Manual mode, each device counting through its Sample Interval one time.}*

`uC` *{**Universal Clear Buffer -** The contents of all buffers are erased.}*

`uc` *{**Universal Start Count (Computer Controlled)** -The instruments start counting and continue to count until a stop command is sent from the computer.}*

`ud` *{**Universal Start Count (Counter Controlled) -** The instruments start counting according to each unit's Sample Interval and auto/manual presets.}*

Note: *The last data record will show 0000 for Sample Interval, as the Sample Interval is controlled by the host.*

`ue` *{**Universal Stop Count -** The instruments stop counting immediately and each instrument builds a data record.}*

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Data Record Commands

The Data Record Commands are used to transfer count data from the particle counter to the computer and to control the instrument's buffer memory.

The syntax for the Data Record commands is a single capital letter with no arguments.

Send Buffered Record(A)

The instrument sends the next record in its Rotating Buffer. The record is erased from the buffer as it is sent.

Command:

A

Response:

`A[Data stream]` *{Contents of next buffered record}*

-or-

`A#` *{Buffer empty}*

Send Current Record(B)

The instrument sends the data record of the most recent sample period in the Rotating Buffer. Data is not erased from the buffer.

Command:

B

Response:

`B[Data Stream]` *{Contents of most current record}*

-or-

`B#` *{Buffer empty}*

Clear Buffer(C)

Erases all records from the instrument's Rotating Buffer.

Command:

C *{Buffer is cleared}*

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Number of Records(D)

Returns the number of records in the Rotating Buffer. The buffer will hold up to 512 records.

Command:

D

Example Response:

`D15[crlf]` *{15 records in the Rotating Buffer}*

-or-

`D0[crlf]` *{Rotating Buffer is empty}*

Retransmit Record(R)

The last record that was transmitted is sent again. The record is not erased from the Rotating Buffer.

Command:

R

Response:

`R[Retransmits last data record]`

-or-

`R#` *{No record to transmit}*

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Miscellaneous Commands

The Miscellaneous Commands are used to query the instrument about its status.

EEPROM Version(E)

Queries the instrument for its firmware revision number.

Command:

E

Response:

`E[Version Number][CRLF]` *{Where version number is a variable-length string containing alphanumeric and punctuation characters. Max length = 15 characters.}*

Operating Mode(M)

Queries the instrument for its current mode: counting, holding, stopped.

Command:

M

Response:

`MC`	*{Counting}*
`MH`	*{Holding}*
`MS`	*{Stopped}*

MODEL (T)

Queries the instrument for its model name.

Command:

T

Response:

TREMOTE3014 [crlf]

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Data Record Format

GENERAL

Each REMOTE counter can send a record of its data. The record is in the form of an ASCII string. The meaning of a particular character is dependent upon its position in the string.

Fields within the string are separated with spaces.

Figure 6-2 shows the data format of a record with only 2 channels.

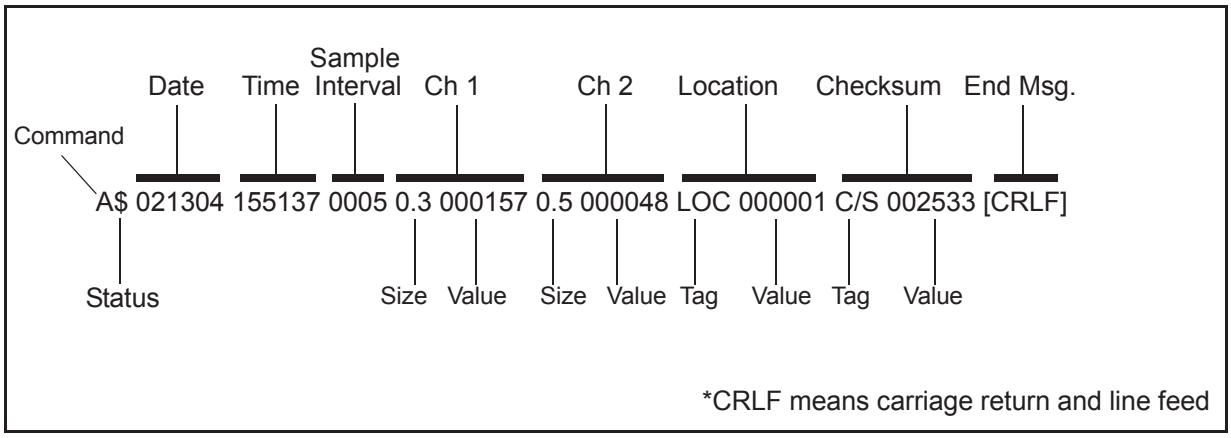


Figure 6-2 Data Record Serial Format

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Data Fields

Status: The Status character is a 1 byte field that indicates the operational status of the counter during the last sample period. This character is the string representation of an ASCII code.

For example, the Status character in the Figure above is a "$", which is ASCII 36 or, in binary, 00100100. Table 6-2 translates the Status characters into fault types. A sample interval with no faults is an ASCII 32 or 00100000, which shows in the Status character as a space.

Table 6-2 Decoding Status Characters

ASCII Character	Meaning	Decimal	Binary bit 76543210
(space)	No Alarms	32	00100000
!	Service Alert	33	00100001
$	Alarm Threshold Exceeded	36	00100100
%	Service Alert and Alarm Threshold Exceeded	37	00100101
'	Flow Alarm	96	01100000
a	Flow Alarm and Service Alert	97	01100001

Binary Bit 5 is always a one, Bit 7 is always a zero.

Note: *Spaces are used as field separators*

Date: The Date is carried in characters 3 through 8. Date format is MMDDYY.

Time: Time information is in characters 10 through 15. Time is expressed in 24 hour, or military, format in the form HHMMSS.

Sample Interval: Sample Interval information is found in characters 17 through 20. The Interval is in the form MMSS.

When the Interval is controlled by the computer through the **c** or **uc** command, the Interval characters will be all zeroes. When the Interval is

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controlled by the instrument (**d** or **ud** command), the characters represent the Sample Interval.

Tags: Tags contain three characters that identify the type of data that follows the Tag. If the data is a particle count, the Tag indicates particle size. If the data is a location number, the Tag is LOC.

Ch 1, Ch 2: These characters contain the channel size and count data from the measurements. The channel size and count are each preceded by a space.

Size: These three characters list the particle size range.

Count: Count is six characters and indicates the number of particles counted during Interval at the size range.

Location: Where multiple instruments are connected to an RS485 bus, each unit must have a unique identifying number, called a Location. The Location field contains a number in the range of 0 through 63.

Checksum: The Checksum is a six-character hexadecimal number. The first two characters are always zero. The value of the Checksum is the sum of all the ASCII codes in the record from the status character up to but not including the space just before the "C/S".

End of Message The End of Message characters follow the Checksum with no separating space. The End of message characters are a carriage return and line feed [CRLF] {ASCII 13 decimal and 10 decimal}.

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7 Programming with MODBUS Protocol

The RLPC can be programmed using the MODBUS Protocol. The full protocol is detailed in *Appendix B: "RLPC MODBUS Register Map v1.44" on page B-1*.

This chapter contains the information needed to program the basic configuration for the instrument using the MODBUS protocol.

DIP Switches

During power-up and reset, the counter reads the DIP switches on the back panel.

Note: *When changing the DIP switch settings, the instrument power must be cycled off and on.*

DIP Switches 7 and 8 must both be in the OFF position in order to use the MODBUS protocol.

Protocol Settings

The MODBUS Protocol is defined through an RS232 or RS485 interface with:

- Baud Rate: 19200
- Data Bits: 8
- Stop Bits: 1
- Parity: None
- Flow Control: None

Power On/ Auto Start

When powering up the instrument, it will begin sampling using the default configuration:

- Location = 0
- Sample Time = 60 seconds
- Hold Time = 0 seconds
- Alarm Channel = Enabled

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

To stop the sampling, send the command **10 or 12** to command register 40002.

Stopping the sampling will set the Device Status bit in Register 40003 to 0.

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Running the Instrument Using MODBUS

The applicable action commands are displayed in Table 7-1.

Table 7-1 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, and Location.
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.
10	Manual Stop. Stops sampling. Records counts since Manual Start.
11	Instrument Start (Automatic Counting). Uses defined Hold Time and Sample Time. Instrument executes samples and holds until an Instrument Stop command is issued.
12	Instrument Stop. Aborts current sample. Stops data collection.

Each of the described action commands above are written to the command register (40002).

AUTOMATIC Counting Mode

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

The instrument will continue running samples at the configured sample time until it receives a stop command. When the stop command is given, the most current data will not record to the buffer.

After setting all the instrument parameters as described in “Changing the Default Instrument Parameters” on page 7-4, write these commands to the Command register (40002):

11 Start Instrument; to start recording

12 Stop Instrument; to stop recording

MANUAL Counting Mode

In Manual counting mode, the computer starts the sample and the instrument continues counting until a stop command is given. At that point, the sample time is listed at whatever the time interval was between the start command and the stop command.

Write these commands to the Command register (40002):

9 Start Instrument; to start recording.

10 Stop Instrument; to stop recording after desired sample time.

Configuring with the MODBUS Protocol

Setting the Real Time Clock

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

Register 40027 is the high word for the real time clock; 40028 is the low word. The date/time is calculated as the number of seconds since midnight of 1/1/1970.

The date & time is stored in a 4-byte unsigned integer or as a 32-bit unsigned integer as shown in Table 7-2.

Table 7-2 Real Time Clock Registers

Register	Data Type	Description
40027	unsigned 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	unsigned 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, the Data Set registers. See Table 7-3.

Table 7-3 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]

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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).

The Real Time Clock can also be set in the ASCII programming mode without having to calculate the number of seconds from 1/1/1970. Please see “Example: Setting Date and Time” on page 5-7 for more information.

Changing the Default Instrument Parameters

The main instrument parameters involved with the operation of the REMOTE counter are Location, Sample Time, and Hold Time. See Table 7-4.

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

Sample Time and Hold Time both use 2 registers, a high word and a low word. If the desired value for any of these parameters is less than or equal to 9 hours, 6 minutes and 7 seconds (32767 seconds), then only the low word register needs to be written with the value in seconds.

The low word register for Sample Time is 40034.

The low word register for Hold Time is 40032.

Table 7-4 Instrument Parameters

Register	Data Type	Description
40026	unsigned integer	**Location number** Specifies location of Particle Counter.
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]**

Using Sensor Setting Registers

Certain configuration settings can be sent to the counter through these registers.

Sensor Setting Registers 40001 and 40003 through 40023 are protected and should not be changed.

Location (Register 40026)

For Particle Counters, this value specifies at what location a sample was recorded.

For Manifold Controllers, this value specifies the manifold position. Writing a value from 1-32 to this register will move the manifold arm to that position on the manifold. Value 0 moves the arm to the Home position.

Hold Time (Registers 40031, 40032)

The Hold Time is used for pausing in between samples for multiple cycles. If Hold Time is greater than 1 minute, the pump will turn off.

This time is specified in seconds. The maximum value is 359,999 seconds (high word: 5, low word: 32319) which is 99 hours, 59 minutes, and 59 seconds. To set the Hold Time to a value less than 9 hours, 6 minutes, 7 seconds, enter the number of seconds in the *low register* (40032).

During Hold Time, the Device Status bit is 0 (Idle).

Sample Time (Registers 40033, 40034)

WARNING: ***Do NOT set the Sample Time value to less than 30 seconds.***

The Sample Time specifies the time period of each sample, specified in seconds. The maximum value is 86,399 seconds (high word: 1, low word: 20863) which is 23 hours, 59 minutes, 59 seconds. The instrument is programmed at the factory with a default value of 60 seconds. Do NOT set this value to less than 30 seconds.

To set the Sample Time to a value less than 9 hours, 6 minutes, 7 seconds, enter the number of seconds in the *low register* (40034).

During the Sample Time, the Device Status is 1 (Sampling).

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Alarm and Threshold Registers

Alarm Enable Registers

The 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 channels are set to ALARM ENABLE. See Table 7-5.

Table 7-5 Alarm Enable/Disable Bits

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

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

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

To enable the Alarm for a particle channel, set the bit in the low word of the channel. Only one particle channel can be enabled at a time. Whichever channel is enabled last will be the channel that the alarm threshold will apply to.

Particle data registers for the Alarm Enable setting start at 43009 for the high word and 43010 for the low word for channel 1. See Table 7-6.

Table 7-6 Alarm Enable Registers

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

Table 7-6 Alarm Enable Registers

Register	Data Type	Description
43015	unsigned int	Alarm Enable for Particle Channel 4 [high]
43016	unsigned int	Alarm Enable for Particle Channel 4 [low]

Enable Alarming for a Channel

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

To enable alarming on the second channel in addition to the third channel, enable Bit 1 for register 43012. See Table 7-7.

Table 7-7 Example of Alarming on Channel 2

Registers	Particle Channel	Bit 1 Enabled
43009 - 43010	1	1
43011 - 43012	2	1
43013 - 43014	3	0
43015 - 43016	4	0

To disable alarming completely, disable Bit 1 for register 43012 and register 43014. Now, no channels are enabled for alarms.

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.

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.

The Data Status flag is set if any of the channels have a threshold exceeded state as true.

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Note: *The REMOTE comes standard with 2 particle channels; the table below shows the optional 4 channels.*

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. See Table 7-8.

Table 7-8 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]
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]

Setting the Alarm Threshold Value

The Alarm Threshold Value is set in the low register of the channels. Multiple channels can be enabled for alarms. Different thresholds can be set for each channel. See Table 7-9.

Table 7-9 Alarm Threshold Registers set to 1000

Registers	Particle Channel	Threshold Value
45009 - 45010	1	1000
45011 - 45012	2	1000
45013 - 45014	3	1000
45015 - 45016	4	1000

A MR Protocol Commands

This Protocol allows the instrument to be controlled remotely by a third party application program, such as ProCOMM or Windows HyperTerminal. MR Protocol is compatible with Met One particle counters.

COMM Settings

The MR Protocol is defined through an RS-485 interface with:

- Baud Rate:9600
- Data Bits:8
- Stop Bits:1
- Parity: None
- Flow Control = None
- Send Line Ends with Line Feeds

Device Select

Note: -- Hold ALT while typing the Device Select Entry number on the numeric keypad

Table A-1 displays software configured location addresses.

Table A-1 Software Configured Location Addresses

Device Select Entry	Location Address	Device Select Entry	Location Address
0128	0	0160	32
0129	1	0161	33
0130	2	0162	34
0131	3	0163	35
0132	4	0164	36
0133	5	0165	37
0134	6	0166	38

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Table A-1 Software Configured Location Addresses

Device Select Entry	Location Address	Device Select Entry	Location Address
0135	7	0167	39
0136	8	0168	40
0137	9	0169	41
0138	10	0170	42
0139	11	0171	43
0140	12	0172	44
0141	13	0173	45
0142	14	0174	46
0143	15	0175	47
0144	16	0176	48
0145	17	0177	49
0146	18	0178	50
0147	19	0179	51
0148	20	0180	52
0149	21	0181	53
0150	22	0182	54
0151	23	0183	55
0152	24	0184	56
0153	25	0185	57
0154	26	0186	58
0155	27	0187	59
0156	28	0188	60
0157	29	0189	61
0158	30	0190	62
0159	31	0191	63

Universal Device Select

The counter will respond to all commands given after the **U** command, regardless of its programmed Location Address.

If more than one counter is connected to the Serial Port, the use of the **U** command will cause communication problems because all counters will respond at the same time.

The **U** command is turned off by sending any Device Select address as described above.

Command:

U *{Unit will respond to all commands}*

(Press/Hold) ALT 0135 *{U disabled}*

Configuration Commands

The general forms of a Configuration Command are displayed in Table A-2 and Table A-3.

AAd[CRLF]

where:

- **AA** is the command field and is always capitalized
- **d** represents an argument, which may be numeric or a string, depending on the command. The argument immediately follows the command with no space between them.
- **[CRLF]** means carriage return and line feed. When it appears at the end of a command,

Table A-2 Command Set for Displaying Current Configuration

COMMAND	RESPONSE	DESCRIPTION
WA[ENTER]	WA#[CRLF]	Displays current Alarm Limit where # is value from 0-999999
WL[ENTER]	WL#[CRLF]	Displays software configured Location Address used when DIP switch 7 is ON and DIP switch 8 is OFF. # is value from 0-63.

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Table A-2 Command Set for Displaying Current Configuration

COMMAND	RESPONSE	DESCRIPTION
WD[ENTER]	WDmmddyy hhmmss[CRLF]	Displays current Date and Time. There are no settings for time zones or Daylight Savings Time.
H[ENTER]	Hhhmmss[CRLF]	Displays current HOLD INTERVAL in hours, minutes, seconds
L[ENTER]	Lhhmmss[CRLF]	Displays current SAMPLE INTERVAL in hours, minutes, seconds

If an invalid value is sent, the device will respond with a single **?**

Table A-3 Command Set for Configuration Parameters

COMMAND	RESPONSE	DESCRIPTION
WAd[ENTER]	WAd[CRLF]	Sets Alarm Limit to value *d* which is a numeric value from 1 to 999999.
WLd[ENTER]	WLd[CRLF]	Sets the software configurable Location Address of the device to value *d* which is a numeric value from 0 to 63.
WDmmddyyhhmmss[ENTER]	WDmmddyyhhmmss[CRLF]	Sets Real-Time clock using format: month day year hour minute second

Counter Setup Commands

Table A-4 displays the commands that are used to setup the sample and hold intervals for the instrument.

Table A-4 Particle Counter Setup Commands

COMMAND	RESPONSE	DESCRIPTION
L[ENTER]	L*hhmmss*[CRLF]	Queries the instrument's Sample Interval; displayed in hours minutes seconds.
L*hhmmss*[ENTER]	L	Sets the Sample Interval to value *hhmmss*. Leading zeroes can be left out.
H[ENTER]	H*hhmmss*[CRLF]	Queries the instrument's Hold Interval; displayed in hours minutes seconds.
H*hhmmss*[ENTER]	H	Sets the Hold Interval to value *hhmmss*. Leading zeroes can be left out.

For the Sample and Hold Intervals, 1500=15 minutes, 100=1 minute, 60=1 minute.

Action Commands

Action commands are used to set the counting mode and to control the starting and stopping of the counter. See Table A-5.

The general syntax for Action commands is a single lowercase letter with no arguments. The responses for the Action commands do not have a carriage return/line feed [CRLF].

Table A-5 Command Set for Action Commands

COMMAND	RESPONSE	DESCRIPTION
a	a	**Auto Mode:** Puts the counter into Auto Mode. When used with the [d] Start command, unit will continue to sample for the specified Sample Interval and Hold Interval repeatedly until a Stop [e] is issued or manual mode is selected.

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Table A-5 Command Set for Action Commands

COMMAND	RESPONSE	DESCRIPTION
b	b	**Manual Mode:** Puts the counter into Manual Mode. When used with the [d] Start command, unit will sample for the Sample Interval and then stop.
c	c	**Start Count:** Start counting immediately. Instrument counts until the Stop command [e] is sent. Does not use Sample Interval.
d	d	**Auto/Manual Start:** Starts the counting in either Auto or Manual Mode. Is used with [a] or [b] command.
e	e	**Stop Count:** Stops the counting immediately. The last data record will show 0000 for its Sample Interval.

Universal Action Commands

These commands are provided for controlling multiple counters on the same bus. The commands are not echoed. See Table A-6.

As soon as a Universal Action Command is executed, the bus drops out of Universal mode.

WARNING: ***The MR Protocol is case-sensitive. Using the incorrect case will produce undesirable results.***

Table A-6 Universal Actions Command Set

COMMAND	DESCRIPTION
ua	**Universal Auto Sample Mode** Puts the counters in Auto Count mode. When the **ud** command is used after this command, the devices will count in Auto Mode according to each device's sample and hold interval until a Stop command is sent. This command is not echoed.

Table A-6 Universal Actions Command Set

COMMAND	DESCRIPTION
ub	**Universal Manual Sample Mode** Puts the counters in Manual Count mode. When the **ud** command is sent, the devices will count through its Sample Interval and then stop. This command is not echoed.
uC	**Universal Clear Buffer** This command will erase the buffers on all the devices. This command is not echoed.
uc	**Universal Immediate Start (Computer Controlled)** The devices start counting and continue to count until a Stop command is sent from the computer; data record does not record a sample time. This command is not echoed.
ud	**Universal Start Count** The devices start counting according to each unit's Sample and auto/manual presets. This command is not echoed.
ue	**Universal Stop Count** The instruments stop counting immediately with this command and each instrument builds a data record. This command is not echoed.

Note: *When the **ue** command is given, the last data record will show 0000 for the Sample Interval as the Sample Interval is controlled by the host.*

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Data Record Commands

The Data Record Commands are used to transfer count data from the particle counter to the computer and to control the instrument's buffer memory. See Table A-7.

The syntax for the Data Record commands is a single capital letter with no arguments.

Table A-7 Data Record Commands

COMMAND	RESPONSE	DESCRIPTION
A	A[data record][CRLF] or A#	**Send Buffered Record:** Sends the next record in its Rotating Buffer followed by a carriage return and line feed. The record is erased from the buffer as it is sent. A# indicates the buffer is empty and is not followed by [CRLF].
B	B[data record][CRLF] or B#	**Send Current Record:** Sends the data record of the most recent sample interval in the Rotating Buffer. The record is NOT erased from the buffer. B# indicates that the buffer is empty and is not followed by [CRLF].
C	(no response)	**Clear Buffer:** Erases all records from the Rotating Buffer.
D	D*n*[CRLF] or D0[CRLF]	**Number of Records:** Returns *n* which is the number of records in the Rotating Buffer. The buffer will hold up to 1 record followed by a [CRLF]. D0 indicates that the buffer is empty; this is followed by a [CRLF].
R	R[retransmits last record sent][CRLF] or R#	**Retransmit Record:** Sends the last record that was transmitted followed by a carriage return and line feed. The record is not erased from the buffer. R# indicates that the buffer is empty and there is no record to transmit.

Other Status Commands

These commands are used to query the instrument about its status. The command letter is typed and the response is immediate. No [ENTER] key press is needed after these commands. See Table A-8.

Table A-8 Other Status Commands

COMMAND	RESPONSE	DESCRIPTION
E	E[Version number][CRLF]	**Eeprom Version:** Queries instrument for its firmware version number. The version number is a variable length string containing alphanumeric and punctuation characters and is followed by a [CRLF]. Max length = 15 characters.
M	MC or MH or MS	**Operating Mode:** Queries the instrument for its current mode: counting (MC), holding (MH), or stopped (MS). This response is not followed by a [CRLF].
T	TREMOTE3014[CRLF]	**Model:** Queries the instrument for its model name. Response is followed by a [CRLF]

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Data Record Format

GENERAL

Each REMOTE counter can send a record of its data. The record is in the form of an ASCII string. The meaning of a particular character is dependent upon its position in the string.

Fields within the string are separated with spaces.

The first character in the response is the echoed command. This character is not included in the Checksum value.

Figure A-1 shows the data format of a record for an eight channel counter. Only two channels are shown for clarity.

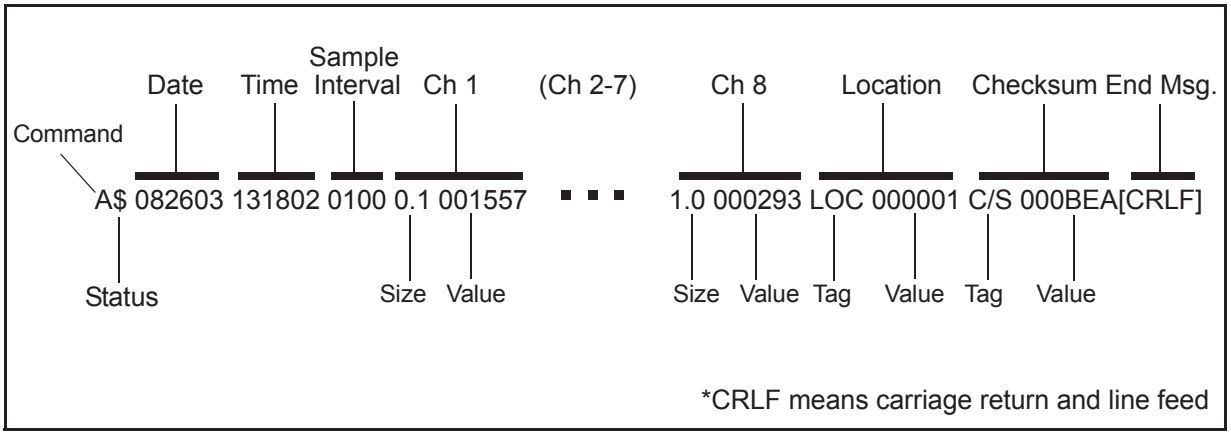


Figure A-1 Data Record Serial Format

Data Fields

Status: The Status character is a 1 byte field that indicates the operational status of the counter during the last sample period. This character is the string representation of an ASCII code. For example, the Status character in Figure A-1 is a "$", which is ASCII 36 or, in binary, 00100100. Table A-9 translates the Status characters into fault types. A sample interval with no faults is an ASCII 32 or 00100000, which shows in the Status character as a space.

Table A-9 Decoding Status Characters

ASCII Character	Meaning	Decimal	Binary bit 76543210
(space)	No Alarms	32	00100000
!	Service Alert	33	00100001
$	Alarm Threshold Exceeded	36	00100100
%	Service Alert and Alarm Threshold Exceeded	37	00100101
'	Flow Alarm	96	01100000
a	Flow Alarm and Service Alert	97	01100001

Binary Bit 5 is always a one, Bit 7 is always a zero.

Note: *Spaces are used as field separators.*

Date: The Date is carried in characters 3 through 8, formatted as MMDDYY.

Time: Time information is in characters 10 through 15. Time is expressed in 24-hour format as HHMMSS.

Sample Interval: Sample Interval information is found in characters 17 through 20. The Interval is in the form MMSS.

When the Interval is controlled by the computer through the **c** or **uc** command, the Interval characters will be all zeroes. When the Interval is controlled by the instrument (**d** or **ud** command),

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	the characters represent the Sample Interval.
Tags:	Tags contain three characters that identify the type of data that follows the Tag. If the data is a particle count, the Tag indicates particle size. If the data is a location number, the Tag is LOC.
Ch 1...Ch 8:	These characters contain the channel size and count data from the measurements. The channel size and count are each preceded by a space.
Size:	These three characters list the particle size range.
Count:	Count is six characters and indicates the number of particles counted during Interval at the size range.
Location:	Where multiple instruments are connected to an RS-485 bus, each unit must have a unique identifying number, called a Location. The Location field contains a number in the range of 0 through 63.
Checksum:	The Checksum is a six-character hexadecimal number. The first two characters are always zero. The value of the Checksum is the sum of all the ASCII codes in the record from the status character up to but not including the space just before the "C/S".
End of Message	The End of Message characters follow the Checksum with no separating space. The End of message characters are a carriage return and line feed [CRLF] {ASCII 13 decimal and 10 decimal}.

B RLPC MODBUS Register Map v1.44

COMM Settings

Lighthouse particle counters using MODBUS require the following communications settings:

Table B-1 MODBUS Communications Settings

Baud Rate	19200
Data Bits	8
Stop Bits	1
Parity	None
Hardware Protocol	RS485, USB and Ethernet
Software Protocol	MODBUS ASCII (supports upper/lower case) MODBUS TCP

The MODBUS slave address is set on the particle counter.

Supported MODBUS Commands

Table B-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 B-3 describes the contents of these registers.

Table B-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 B-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	Value = Flow Rate. For example, 100d = 100.
40024	unsigned integer	Record Count. Total number of records stored in the counter.
40025	unsigned 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	signed 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	signed 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.
40034	unsigned integer	Sample Time [low]

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Table B-3 Sensor Settings 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]
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 char[0], char[1] (NULL terminated string).
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 this device.

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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.

Device Status

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

Table B-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.

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 B-5 Command Register

Value	Action
1	Saves all writable 4xxxx register values to the EEPROM.
2	Reserved for future use.
3	Clears the Data Buffer. Record count is set to zero.

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Table B-5 Command Register

Value	Action
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 local pump, if applicable - perform before 9 below.
8	Stop pump, if applicable - perform after 10 below.
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 counts 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 position when Instrument Stop command is issued.
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.

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 integer data is big-endian. Thus, data items are formed by placing the high bytes in front of the low bytes.

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Example:

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

IEEE floating point has big-endian byte order and little-endian word order. 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 B-6 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	Data Status [high]
30008	unsigned integer	Data Status [low]
30009	unsigned integer	Particle Channel 1 [high]
30010	unsigned integer	Particle Channel 1 [low]
30011	unsigned integer	Particle Channel 2 [high]

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Table B-6 Data Registers

Register	Data Type	Description
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]
30021	unsigned integer	Particle Channel 7 [high]
30022	unsigned integer	Particle Channel 7 [low]
30023	unsigned integer	Particle Channel 8 [high]
30024	unsigned integer	Particle Channel 8 [low]
...		
30074	unsigned int	Valid particle channels
30076	unsigned int	Alarm Flags - Particle Channels

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.

Data Status Byte (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 Data Status Byte are 30007 and 30008.

The bit order of the Data Status Byte is 7 to 0, where bit 7 is the most significant bit and bit 0 is the least significant bit.

The bits within the Data Status Byte 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 B-7 Data Status Byte

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 (30074)

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

Alarm Flags in Channels (30076)

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

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string is padded with NULL characters. Note that a Data Type using all four characters will not end with a NULL character.

Table B-8 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 B-9 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

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Data Units Registers

The 42xxx register series identifies the units used by data items in the 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 B-10 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	LPM	Liters per minute

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Table B-10 Data Units

Units	Description	Units	Description
PCT	Percent	MLPM	Milliliters per minute
SEC	Seconds	IHG	Inches of mercury
p/L	Particles per liter	p/ml	Particles per milliliter

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 B-11 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 B-12 Alarm Enable Registers

Register	Data Type	Description
43009	unsigned int	Enable for Particle Channel 1 [high] (smallest particle size starts here)

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Table B-12 Alarm Enable Registers

Register	Data Type	Description
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]
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]
43021	unsigned int	Enable for Particle Channel 7 [high]
43022	unsigned int	Enable for Particle Channel 7 [low]
43023	unsigned int	Enable for Particle Channel 8 [high]
43024	unsigned int	Enable for Particle Channel 8 [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

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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 B-13 Example of Alarming on Channel 2

Registers	Particle Channel	Bit 1 Enabled
43009 - 43010	1	0
43011 - 43012	2	1
43013 - 43014	3	0
43015 - 43016	4	0
43017 - 43018	5	0
43019 - 43020	6	0
43021 - 43022	7	0
43023 - 43024	8	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.

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Note: *The table below shows the registers for an 8 channel particle counter. Counters with fewer 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 B-14 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]
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]
45021	unsigned int	Threshold for Particle Channel 7 [high]
45022	unsigned int	Threshold for Particle Channel 7 [low]
45023	unsigned int	Threshold for Particle Channel 8 [high]
45024	unsigned int	Threshold for Particle Channel 8 [low]

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Setting the Alarm Threshold Value

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

Table B-15 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
45021 - 45022	7	1000
45023 - 45024	8	1000

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C Maintenance

Flow Cell Cleaning

The flow cell is an integral part of the RLPC sensor and must be cleaned periodically to maintain counting accuracy of the sensor.

The RLPC sensor will detect when its flow cell needs cleaning and indicate this by turning on the service LED. Refer to "Understanding the LEDs" on page 2, *Chapter 3, 'Get Started",* for LED details.

WARNING: ***Please follow all standard precautions for working with liquids around electronic devices. Use Personal Protection Equipment, such as face shields and gloves, when working with hazardous liquids.***

Note: *Some resistance will be felt as the cleaning brush enters the flow cell. Do not force the brush if too much resistance is encountered. Do NOT insert more than 3/4-inch from start of flow cell entry.*

Cleaning Procedure

The flow cell cleaning brush is included in the RLPC package.

1. Turn off power to the RLPC and disconnect all cables.
2. Stop liquid flow to the RLPC.
3. Wrap a towel around the outlet nozzle to prevent liquid from spilling on the sensor.
4. Unscrew the flare nuts on the inlet and outlet nozzles, remove the tubing and make sure the instrument drains the liquid safely.
5. Dip the flow cell cleaning brush into Micro90™ cleaning solution.
6. Insert the cleaning brush into the outlet nozzle until a resistance is felt. Measure 3/4" from the Outlet Nozzle tip and move thumb and forefinger to this point (refer to Figure C-1).



Figure C-1 Flow Cell Cleaning with Brush

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7. Carefully push the cleaning brush into the cell this distance and pull out but maintain the 3/4-inch difference between in and out and do not pull it out of the cell completely. The limitations prevent the brush from exiting the flow cell inside the sensor, which may allow the brush stem to scratch the sapphire cell wall, which will void the instrument warranty.
8. Repeat the brush cleaning 8 to 10 times.
9. Remove the brush and reconnect the flare tubing to the Inlet and Outlet Nozzles.
10. Make sure that all tubing connected to the RLPC are securely connected.

WARNING: ***Do NOT allow any liquid that has been used to flush the sensor of contamination to re-enter the sampling system.***

11. Turn on liquid flow through the RLPC for one minute to flush any bubbles and residue out of the flow cell. This liquid should NOT be allowed to re-enter the sampling system and should be safely discarded.
12. Reconnect power to the RLPC and verify the service light is off to determine if the flow cell was cleaned successfully.

If this fails to resolve the issue, contact Lighthouse Technical Support at 1-800-945-5905 (Toll Free USA) or 1-541-770-5905 (Outside of USA).

D 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 hand held 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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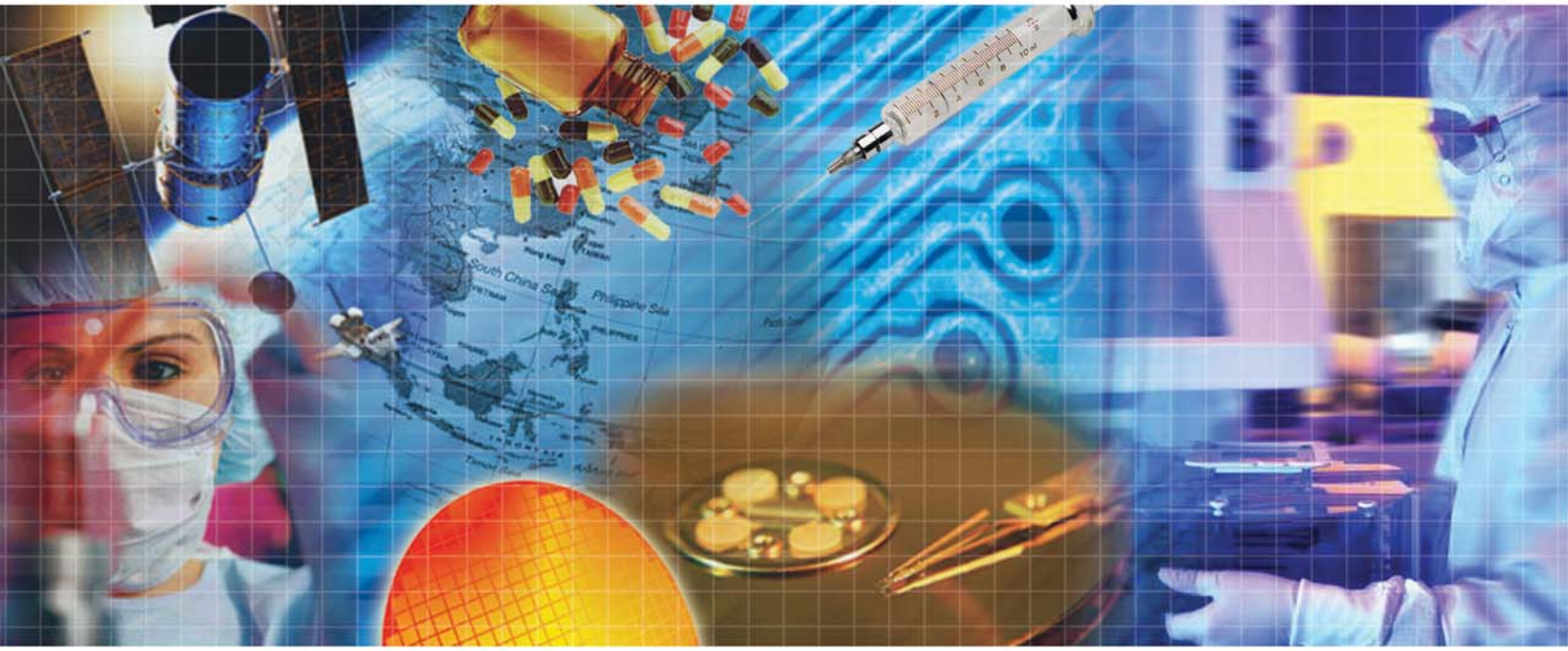
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