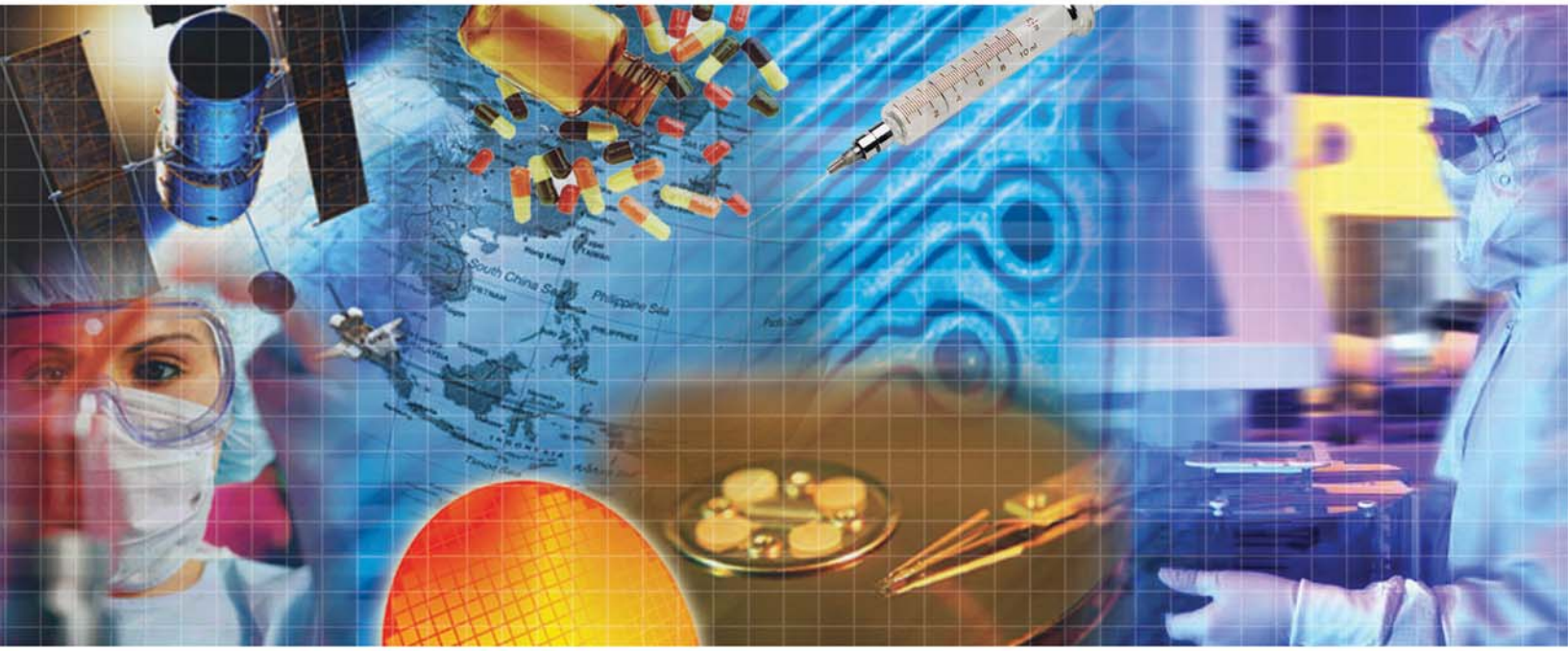

LIGHTHOUSE
WORLDWIDE SOLUTIONS

# REMOTE

# Liquid Particle Counter

## (4-20mA Output)

Operating Manual

# *Lighthouse Worldwide Solutions*

***REMOTE Liquid Particle Counters (4-20mA Output)***

***Operating Manual***

Manufactured by:

Lighthouse Worldwide Solutions

1221 Disk Drive

Medford, Oregon 97501

LWS Part Number 2489083296-1 Rev 3

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# *About This Manual*

This manual provides detailed operation and use instructions for the Lighthouse REMOTE Liquid Particle Counters (referred to as RLPC) with 4-20mA 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 are typed. Upper or lower case letters can be used; commands are shown in upper case in this manual. |
| *Helvetica Italics* | Indicates a comment on a command or text output. |

## Additional Help

For more information about Lighthouse REMOTE Liquid Particle Counters (4-20mA output), contact Lighthouse Worldwide Solutions.

Service and Support:
1-800-945-5905 (Toll Free USA)
1-541-770-5905 (Outside of USA)

techsupport@golighthouse.com
www.golighthouse.com

# 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).

# Electrostatic Safety Information

**WARNING:** ***Using a wrist-strap without an isolation resistor will increase the severity of an electrical shock. Use of control or adjustment or performance of procedure other than specified here 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 REMOTE Liquid Particle Counter 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 - 2.0µm, 0.3 - 3.0µm and 0.5 - 5.0µm at a sensitivity of 0.1 micron, 0.2 micron, 0.3 micron and 0.5 micron, respectively, using the LWS 4-20mA protocol.

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

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**Figure 2-1 RLPC 0.2µm**

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 photodiode. The photodiode converts the light into an electrical 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 size particles are processed and stored in the sensor's buffers or transferred via the 4-20mA interface.

The RLPC instruments were created for continuous, 24 hours per day, 7 days per week operation. The RLPC provides versatile mounting options allowing installation where space is at a premium. The RLPC integrates seamlessly with many large facility monitoring or management systems.

## Accessories

Several accessories can be ordered to tailor the instrument to specific needs. The accessories are listed below.

**Included:**

- **Operating Manual on CD**
- **2 each 10-foot flared sample tubes**
- **Flow Cell Cleaning brush**
- **Micro90™ Cleaning Solution**
- **Power Supply**

**Optional:**

- **Flowmeter (Teflon® PFA or aluminum)**
- **Additional Sample Tubing**
- **Cabling**
- **REMOTE Mounting Plate**
- **RLPC Stand with Flowmeter mounting**
- **Flare nut kit with flaring tool and tubing cutter**
- **Replacement Flare nuts**
- **Replacement Flow Cell cleaning brushes**
- **Additional Micro90™ Cleaning Solution**

## RLPC 0.1µm Specifications

**Table 2-1 RLPC 0.1µm Specifications**

| | |
|---|---|
| **Size Range** | 0.1 - 0.5 µm |
| **Channel Thresholds** | Standard: 0.1, 0.2µm; 0.1, 0.3µm; 0.1, 0.5µm |
| **Flow Rate** | 100 ml/min, ± 5%, User-controlled |
| **Laser Source** | Laser Diode |
| **Calibration** | NIST Traceable |
| **Data Storage** | 250 Samples |
| **Communication Modes** | RS232C via RJ45 to PC, 4-20mA or ASCII |
| **LED Indicators** | Power, Service, Sampling |
| **Supporting Software** | Lighthouse Monitoring System, LMS XChange |
| **Concentration Limit** | 64,000 counts/ml @ 5% Coincidence Error |
| **Power Input Requirements** | 24VDC@ 150mA |
| **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 0.2µm Specifications

**Table 2-2 RLPC 0.2µm Specifications**

| | |
|---|---|
| **Size Range** | 0.2 - 2.0 µm |
| **Channel Thresholds** | Standard: 0.2, 0.3µm; 0.2, 0.5µm; 0.2, 1.0µm; Standard: 0.2, 2.0µm |
| **Flow Rate** | 100 ml/min, ± 5%, User-controlled |
| **Laser Source** | Laser Diode |
| **Calibration** | NIST Traceable |
| **Data Storage** | 250 Samples |
| **Communication Modes** | RS232C via RJ45 to PC, 4-20mA or ASCII |
| **LED Indicators** | Power, Service, Sampling |
| **Supporting Software** | Lighthouse Monitoring System, LMS XChange |
| **Concentration Limit** | 4,000 counts/ml @ 5% Coincidence Error |
| **Power Input Requirements** | 24VDC@ 150mA |
| **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, 0.5µm; 0.3, 0.7µm; 0.3, 1.0µm; Standard: 0.3, 3.0 µm |
| **Flow Rate** | 100 ml/min, ± 5%, User-controlled |
| **Laser Source** | Laser Diode |
| **Calibration** | NIST Traceable |
| **Data Storage** | 250 Samples |
| **Communication Modes** | RS232C via RJ45 to PC, 4-20mA or ASCII |
| **LED Indicators** | Power, Service, Sampling |
| **Supporting Software** | Lighthouse Monitoring System, LMS XChange |
| **Concentration Limit** | 4,000 counts/ml @ 5% Coincidence Error |
| **Power Input Requirements** | 24VDC@ 150mA |
| **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 0.5µm Specifications

**Table 2-4 RLPC 0.5µm Specifications**

| | |
|---|---|
| **Size Range** | 0.5 - 5.0 µm |
| **Channel Thresholds** | Standard: 0.5, 1.0µm; 0.5, 2.0µm; 0.5, 5.0µm |
| **Flow Rate** | 100 ml/min, ± 5%, User-controlled |
| **Laser Source** | Laser Diode |
| **Calibration** | NIST Traceable |
| **Data Storage** | 250 Samples |
| **Communication Modes** | RS232C via RJ45 to PC, 4-20mA or ASCII. |
| **LED Indicators** | Power, Service, Sampling |
| **Supporting Software** | Lighthouse Monitoring System, LMS XChange |
| **Concentration Limit** | 4,000 counts/ml @ 5% Coincidence Error |
| **Power Input Requirements** | 24VDC@ 150mA |
| **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 RLPC-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 Lighthouse instruments be calibrated annually by a Certified Lighthouse Service Provider to ensure they continue to perform within specifications.**

# 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 Lighthouse instruments be calibrated annually by a Certified Lighthouse Service Provider to ensure it 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 above warning are met, use the original container or carton and packing materials whenever possible.

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. 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. The figure below 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 red 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 while installing the sensor, please refer to *Appendix B,* “Maintenance” on page A-1 for Flow Cell cleaning instructions.

- The blue SAMPLING LED indicates the instrument is sampling.

# 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.

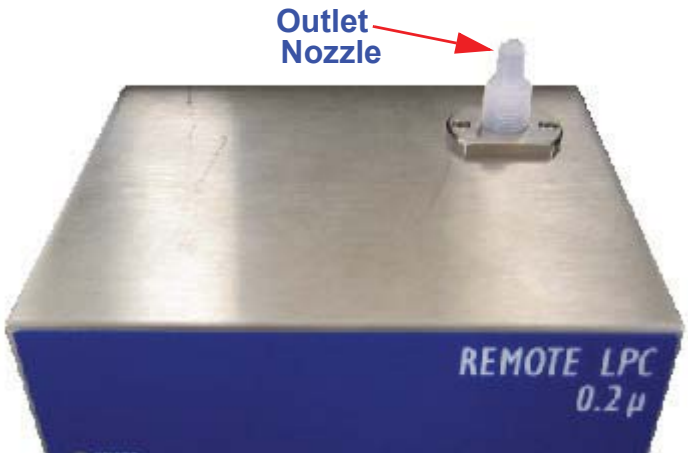


**Figure 3-2 Unit's Top Connections**

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

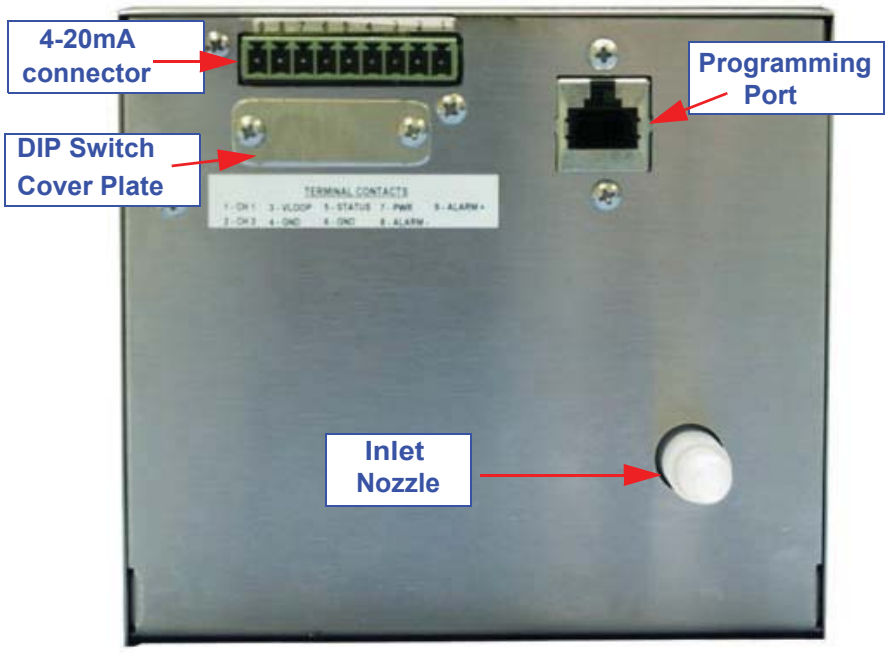


**Figure 3-3 Unit's Bottom Connections**

## 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 RJ45 port incorporates Serial communications to allow short distance point-to-point RS232; the 4-20mA connector provides standard 4-20mA 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. Please contact a Lighthouse Sales Representative for the LWS RS232 converter kit.

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

## DIP Switches

The DIP switches set the address of the instrument for RS232 configurations and the communications mode. See “Maintenance” on page A-1 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 9-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.

## 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.

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

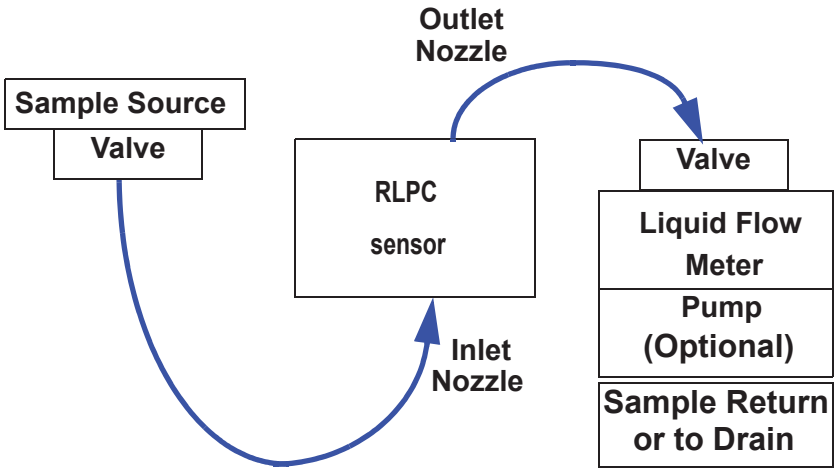


**Figure 3-4 Example of an RLPC Installation**

## Attaching Sensor

This section instructs how to attach sample tubing and wiring and start using the RLPC.

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

***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 (PPE), 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), then return to Step 1 of this section.

6. If no leaks occur, connect power 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 B,* "Maintenance" on page A-1 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, "Programming"*.

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.

## 4-20mA Wiring

Please review the following drawings for the correct wiring required by this instrument to function properly. If there are any doubts or questions, please contact Lighthouse Technical Support.

## Data Port

Connector J10 on the bottom of the instrument is used to communicate with a Facility Management System. Signals at this port include two 4-20mA data channels, an external alarm channel, power and ground.

**Table 3-1 J10 Data Connector Pinouts.**

| Pin Number | Signal | Range |
|---|---|---|
| 1 | Chan 1 | 1) 4-20mA particle count levels<br>2) 2mA Service Alert level |
| 2 | Chan 2 | 1) 4-20mA particle count levels<br>2) 2mA Service Alert level |
| 3 | VLOOP | +15VDC to +30VDC |
| 4 | Ground | |
| 5 | N/A | |
| 6 | Ground | |
| 7 | VPWR | +6VDC to +30VDC* |
| 8 | External Alarm (-) | Continuity with Pin 9 if ALARM. |
| 9 | External Alarm (+) | +40VDC at 1A maximum |

* If the application allows, VLOOP and VPWR may be connected to the same source. In that case, the VPWR is +15VDC to +30VDC.

Included with the instrument is a plug to connect the J10 connector with a Facilities Monitoring System.

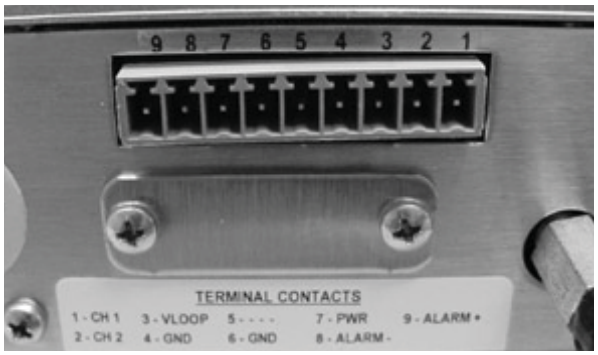


**Figure 3-5 J10 Connector, Showing Pinout**

**WARNING:** ***Make sure wiring matches that shown in the two diagrams. Otherwise, at the least, communications will be faulty and, at the worst, damage to the equipment may result.***

## 2-Wire System

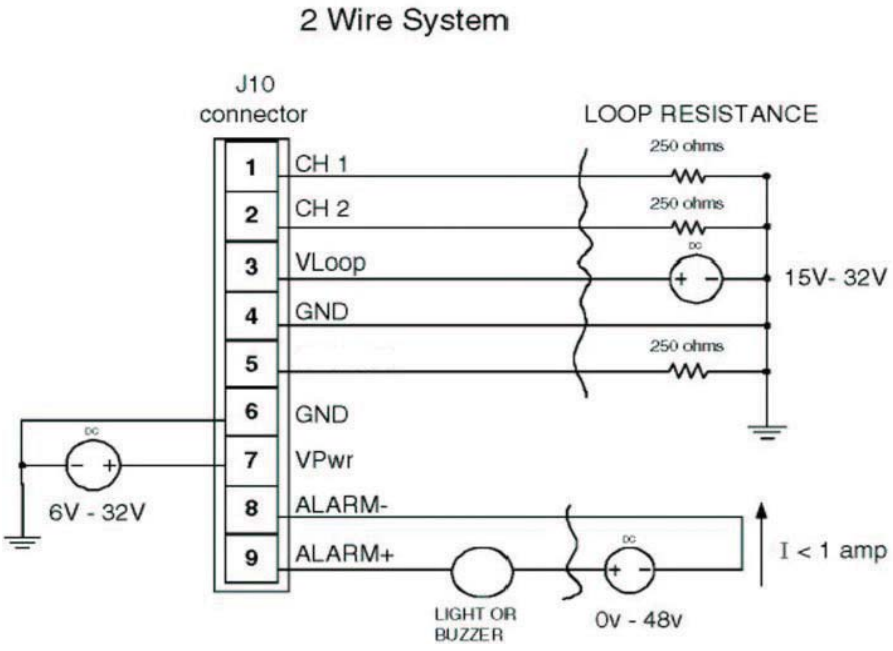


**Figure 3-6 Two-wire Communication Diagram**

## 3-Wire System

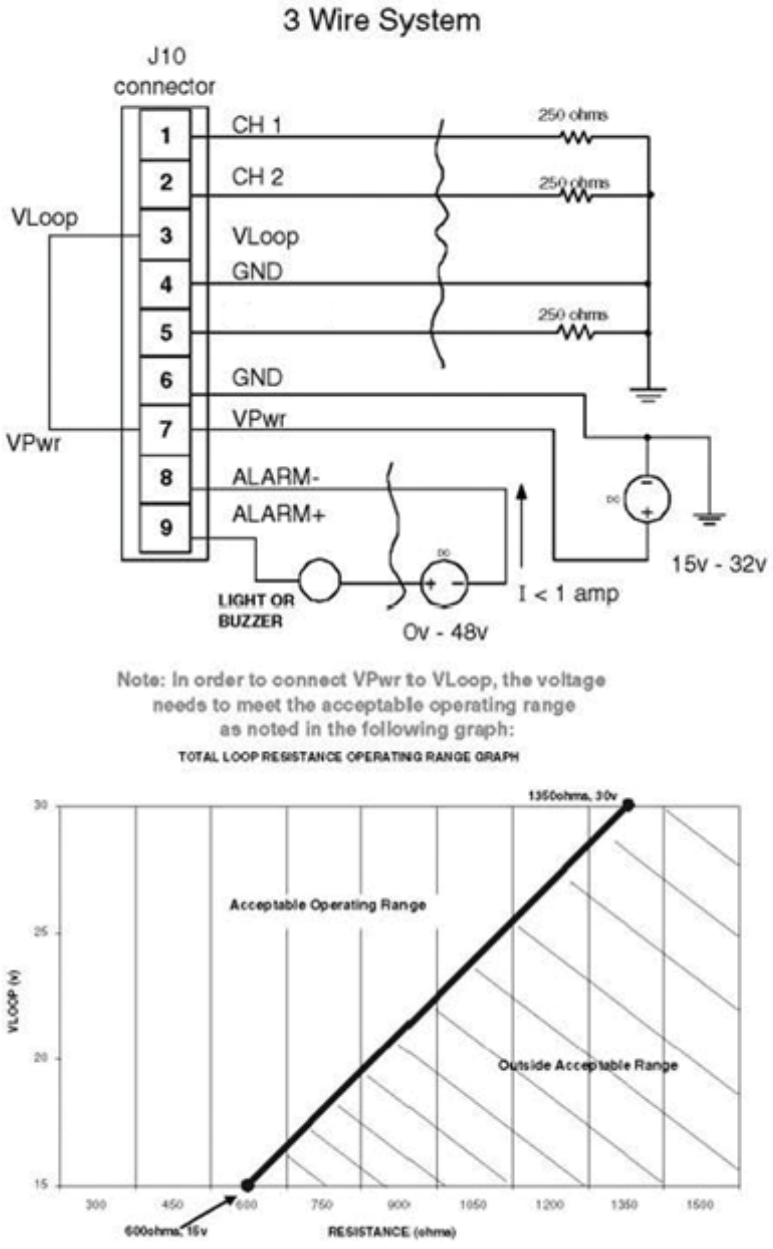


**Figure 3-7 Three-Wire Communication Diagram**

# 4 Programming

## General

The REMOTE Liquid Particle Counter (4-20mA output) family of instruments can be programmed in either of two ways. The DIP switches can be used to set the Sampling Time and Range values. If an ASCII terminal is connected to the instrument, it can program the unit's Sample Time, Range, Service High, Service Low, Alarm Threshold and Suppress Alarm Count.

This chapter contains the information needed to program the instrument.

## DIP Switches

The DIP switches are behind a panel under the Data connector J10.


**Figure 4-1 Panel Covering the DIP Switches**

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

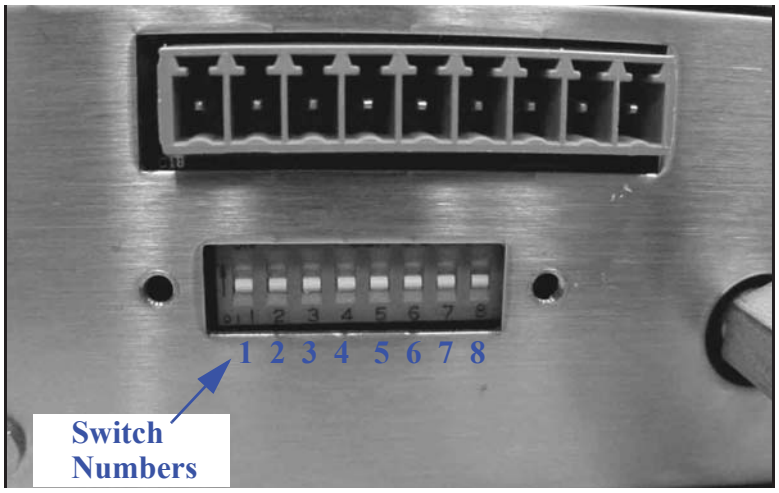


**Figure 4-2 Panel Removed, Switches Exposed**

# DIP Switch Settings

## GENERAL DEFINITIONS

OFF (DOWN) = 0, ON (UP) = 1

Switch Number1234 5678
Data 0000:0000

At Startup:

0000:0000==> Program Mode (ASCII terminal)

0000:0001==> Immediate Startup using last stored parameters

Anything Else==> DIP Switch Mode

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

## Time:Range

When a DIP switch is set to any of the pre-programmed values listed below and power applied to the instrument, information is echoed back to the terminal, if connected.

These settings affect time and range only. All other parameters, such as Alarm Value and Suppress Alarms, are left at their previous settings.

Time is the sampling time in seconds. The Range setting is applied to both channels.

## DIP Switch Settings and Meanings

1000:1000 ==> 6 seconds, 1000 counts

1000:0100 ==> 6 seconds, 10,000 counts

1000:0010 ==> 6 seconds, 100,000 counts

0100:1000 ==> 60 seconds, 1000 counts

0100:0100 ==> 60 seconds, 10,000 counts

0100:0010 ==> 60 seconds, 100,000 counts

0010:1000 ==> 600 seconds, 1000 counts

0010:0100 ==> 600 seconds, 10,000 counts

0010:0010 ==> 600 seconds, 100,000 counts

All other combinations will be set to 300 seconds, 100,000 counts

## Procedure to Set DIP Switches

1. Remove power from the instrument.
2. Set the DIP Switches to the desired Time and Range, using the information above.
3. Apply power to the instrument.

### Example Startup Echo, Reading DIP Switches:

```
Lighthouse Remote Instrument (4-20mA):
- reading dip switch:

Sample Time = 60 secs
Range1= 10000.
Range2= 1000.
Alarm Threshold = 750 counts
Suppress Alarms = 2
Service High = 3500 mV
Service Low = 125 mV
```

## Connecting the Instrument to a Terminal

The RJ-45 connector on the instrument (marked "Programming Port" in Figure 4-3) is used to interconnect the unit with a COM port on a desktop or laptop PC. Once connected and set up as an ASCII terminal, the PC can be used to program and/or monitor the instrument settings.

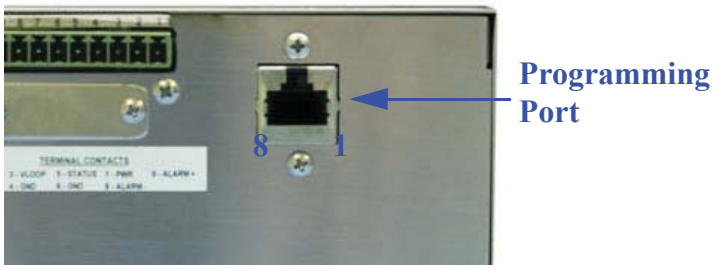


**Figure 4-3 The Programming Port, Showing Pin Numbers**

A modular adapter, RJ-45 to DB-9, is available from Lighthouse. The pinouts of the adapter are shown in the table below:

**Table 4-1 RJ-45 to DB-9 Connections**

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

To connect the instrument to a computer:

1. Remove power from the instrument.
2. Connect the RJ-45 end of the adapter cable to the Programming Port on the instrument.
3. Connect the DB-9 end of the cable to a COM (Serial) Port on a computer or use an optional USB to RS232 cable.
4. Open Hyperterminal on the computer.
5. Configure the COM Port settings as follows. Any available COM Port may be used:


**Figure 4-4 COM Port Properties**

6. Configure the ASCII settings as follows:

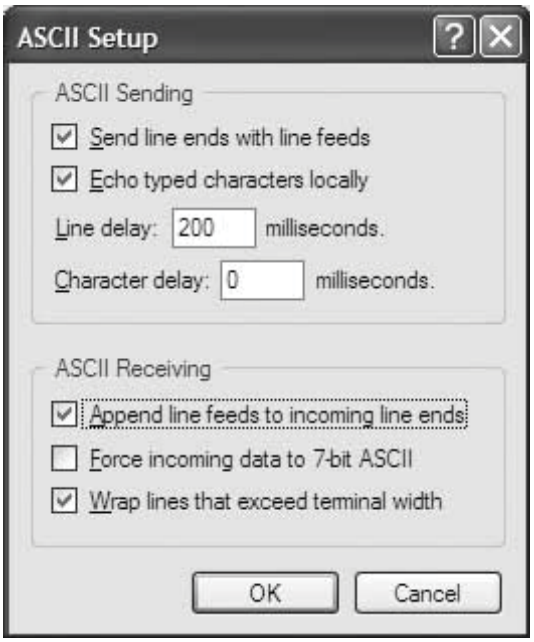


**Figure 4-5 ASCII Settings**

7. Ensure that all DIP Switches are set to 0 (OFF/DOWN).

## Power Up

If DIP Switches all = 0 ==> Program Mode:

During the first 20 seconds after power is applied, the unit waits for programming commands. If no commands are received within that time, the instrument recalls its last stored parameters (or default settings) and continues to use them.

If a programming command is received within the first 20 seconds, the command is examined and, if valid, the parameters are set and stored in non-volatile memory, overwriting the previous parameters for that command.

The instrument waits another 20 seconds for the next command and the process repeats for each command that is sent. After the last command, the timer times out and the instrument is loaded with the commands that were issued. Old parameters are used if they were not modified during this session.

Once programmed, the instrument retains its settings until they are modified. The user can set DIP Switch 8 to ON (UP, 1) to eliminate the 20 second timer when the unit is next powered up.

Lighthouse recommends before powering up the instrument to make a list of the commands and parameters to use, avoiding any unwanted timeouts.

## Session Example

The following steps should be performed to program the instrument or check its settings using the ASCII terminal.

1. Set all DIP Switches to OFF (DOWN, 0) to program the instrument and connect it to the ASCII terminal.

2. Apply power to the instrument. The Hyperterminal programming prompt is sent from the unit.

**Note:** *Capital V. The < and > characters are needed; they mark the beginning and end of the command.*

3. Type: **<V>**-- *this is Verbose mode. This must be the first command sent to see responses from the instrument*

4. Type: **<?>** -- *the unit's current settings are displayed*.

```
<?>
Flow Rate = 0.1 cfm
Sample Time = 5 secs
Range1= 10000.
```

```
Range2= 1000.
Service High = 3000 mV
Service Low = 145 mV
Alarm Channel = 1
Alarm Threshold = 1000 counts
Suppress Alarms = 2
Channel 1 =  0.3
Channel 2 =  0.5
```

5. Type: **<m1>** *-- the unit's menu is displayed to show commands to use to change parameters.*

```
<m1>
*** User Menu ***

<?> Display Parameters
<V> Verbose Mode
<sa> Start Counting
<sb> Stop Counting
<gv> Get Version Number
<ra#> Set Range 1 (counts)
<rb#> Set Range 2 (counts)
<ta#> Set Sample Seconds
<aa#> Set Alarm Channel #
<ab#> Set Alarm Threshold (# of counts)
<ae#> Set Alarm Suppression #
```

6. The instrument will wait 20 seconds after the last command is sent, then begin sampling

## ASCII Programming Syntax

Using a simple ASCII protocol, the REMOTE RL32 family of instruments can be programmed from an ASCII terminal (i.e. Hyper Terminal). The protocol format is based on a start character, followed by a command, which is then followed by a terminating character. Any characters before the start character, or after the terminating character are ignored. White spaces between command character and command parameter are ignored.

### Command Structure

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

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

**Note:** *All command characters are lower case, except for the V (verbose).*

**<x [yyyy]>**

where:

< = Start Character

x = Command Character

yyyy = Optional Command Parameter

> = Terminating Character

## Handshake

Upon execution of the command, assuming **<V>** Verbose mode is on, the REMOTE instrument will send a response based on the value of the counts, suppress alarms, and alarm status. Examples of responses are listed below:

<ERR> = Error in Command String.

-or-

```
Sample: ch1-2: 0, 0 Range1= 5000, Range2= 2500.
```

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: ch1-2: 0, 0 Range1= 5000, Range2= 2500.
Sample: ch1-2: 0, 0 Range1= 5000, Range2= 2500.
```

## Protocol

Protocol is defined through an RS-232 interface. The hardware protocol is defined as:

Baud Rate: 9600

Data Bits: 8

Stop Bits: 1

Parity: None

Flow Control: None

## Command Set

### VERBOSE MODE

**Note:** *Upper case V*

**<V>**

Normally, VERBOSE MODE is off and the computer responds with <OK> after each command is received and correctly implemented.

Turning on VERBOSE MODE tells the computer to echo back the information to the screen.

VERBOSE MODE is required in order to program the device. It is not required to run the counter.

### GET CURRENT SETTINGS

**<?>**

Shows current parameter settings.

Type:

**<?>**

Response:

```
<?>
Flow Rate = 0.1 cfm
Sample Time = 5 secs
Range1= 10000.
Range2= 1000.
Service High = 3000 mV
Service Low = 145 mV
Alarm Channel = 1
Alarm Threshold = 1000 counts
Suppress Alarms = 2
Channel 1 =  0.3
Channel 2 =  0.5
```

### DISPLAY MENU OF COMMANDS

**<m1>**

Shows menu of commands.

Type:

**<m1>**

Response:

```
<m1>
*** User Menu ***

<?> Display Parameters
<V> Verbose Mode
<sa> Start Counting
<sb> Stop Counting
<gv> Get Version Number
<ra#> Set Range 1 (counts)
<rb#> Set Range 2 (counts)
<ta#> Set Sample Seconds
<aa#> Set Alarm Channel #
<ab#> Set Alarm Threshold (# of counts)
<ae#> Set Alarm Suppression #
```

## START/STOP COUNTING MODE

### *START Counting*

**<sa>**

This will start the device's counting mode. When implemented, the unit will wait until the sample time passes before displaying the sample data.

Type:

**<sa>**

Response:

```
<sa>START
Sample: ch1-2: 0, 0 Range1= 10000, Range2= 5000.
Sample: ch1-2: 0, 0 Range1= 10000, Range2= 5000.
```

### *STOP Counting*

**<sb>**

This will stop the device's counting mode.

Type:

**<sb>**

Response:

```
<sb>STOP
```

## GET CURRENT VERSION NUMBER

**<gv>**

Shows current version number of the device firmware.

Type:

**<gv>**

Response:

```
<gv>  Version: 010
```

## SET CHANNEL RANGES

**Note:** *Range 1 should always be greater than or equal to Range 2; Range 2 should never be greater than Range 1.*

*When using the DIP switch programming, both channels are set to the same range value.*

**<ra#>** *-- sets upper range of channel 1 where # is the range value*

**<rb#>** *-- sets upper range of channel 2 where # is the range value*

Sets upper limit to counting range. The upper limit will be equal to 20mA, and the lower range will always be 0 counts = 4 mA. If the counts exceed range limit, the counts will be set to the range limit. The maximum range is 10,000,000.

Type:

**<ra10000>**

Response:

```
<ra10000>Range1= 10000.
```

Type:

**<rb7500>**

Response:

```
<rb7500>Range2= 7500.
```

### SET SAMPLE TIME (seconds)

**Note:** *Sample times ≤5 seconds are not recommended.*

**<ta#>**

Sets sample time in # seconds, where # ≥1 and nnnn ≤ 3600.

Type:

**<ta30>**

Response:

```
<ta30>Sample Time = 30 secs
```

### SET ALARM CHANNEL

**<aa#>**

Sets the alarm channel to channel 1 or 2.

Type:

**<aa1>**

Response:

```
<aa1>Alarm Channel= 1
```

### SET ALARM THRESHOLD

**<ab#>**

Sets Alarm High count threshold for the configured alarm channel. Value # must be less than range in order to set the threshold. Set the value to 0 (zero) to disable alarm.

If the count for the configured alarm channel exceeds the threshold then:

- The red SERVICE indicator on the instrument blinks.
- The EXTERNAL ALARM relay, described below, is set.
- The alarm alert will be seen on the ASCII terminal as illustrated next:

Type:

**<ab1000>**

Response:

```
<ab1000>Alarm Threshold= 1000 counts
```

### *Hyperterminal Alarm Alert without Alarm Suppression:*

**Note:** *The field bk= 429 in this example is the "backlight" function which is a measurement of scattered light in the instrument. See SET_SERVICE_HIGH and SET_SERVICE_LOW*

In this example, the Alarm Suppress is disabled (0).

```
secs=1: ch1-2: 285, 48 , bk= 429
secs=2: ch1-2: 487, 89 , bk= 429
secs=3: ch1-2: 1699, 1033 , bk= 1049
secs=4: ch1-2: 2572, 1320 , bk= 434
secs=5: ch1-2: 3337, 1575 , bk= 429

Sample: ch1-2: 3337, 1575 Range1= 10000, Range2= 5000.
Alarms: Threshold= 1000, Channel= 1, # in a row=1

secs=1: ch1-2: 615, 228 , bk= 434, alarm alert.
secs=2: ch1-2: 1115, 382 , bk= 429, alarm alert.
secs=3: ch1-2: 1595, 502 , bk= 429, alarm alert.
secs=4: ch1-2: 2029, 637 , bk= 429, alarm alert.
secs=5: ch1-2: 2381, 738 , bk= 429, alarm alert.

Sample: ch1-2: 2381, 738 Range1= 10000, Range2= 5000.
Alarms: Threshold= 1000, Channel= 1, # in a row=2
```

## SET ALARM SUPPRESSION

**<ae#>**

Sets the alarm suppression for the configured alarm channel. The number of alarm conditions have to be greater than # in order to turn on the Alarm Relay.

For example, if Alarm Suppress is set to 2, then the device won't report an alarm condition via the external alarm output or the flashing service light until the 3rd consecutive alarm condition.

Type:

**<ae2>**

Response:

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

### *Hyperterminal Alarm Alert with Alarm Suppression:*

In this example, the Alarm Suppress is set to 2.

```
<ae2>Suppress Alarms = 2

secs=1: ch1-2: 0, 0 , bk= 429
secs=2: ch1-2: 681, 430 , bk= 2558
secs=3: ch1-2: 1629, 886 , bk= 444

Sample: ch1-2: 1629, 886 Range1= 10000, Range2= 5000.
Alarms: Threshold= 1000, Channel= 1, # in a row=1

secs=1: ch1-2: 828, 517 , bk= 1640
secs=2: ch1-2: 1861, 1230 , bk= 434
secs=3: ch1-2: 3149, 2177 , bk= 449

Sample: ch1-2: 3149, 2177 Range1= 10000, Range2= 5000.
Alarms: Threshold= 1000, Channel= 1, # in a row=2

secs=1: ch1-2: 450, 126 , bk= 434
secs=2: ch1-2: 1279, 530 , bk= 444
secs=3: ch1-2: 1875, 678 , bk= 439

Sample: ch1-2: 1875, 678 Range1= 10000, Range2= 5000.
Alarms: Threshold= 1000, Channel= 1, # in a row=3

secs=1: ch1-2: 697, 131 , bk= 439, alarm alert.
secs=2: ch1-2: 1215, 227 , bk= 434, alarm alert.
secs=3: ch1-2: 1505, 302 , bk= 439, alarm alert.

Sample: ch1-2: 1505, 302 Range1= 10000, Range2= 5000.
Alarms: Threshold= 1000, Channel= 1, # in a row=4
```

**Note:** *The first line starting with "Alarms" (in boldface) shows what the current alarm threshold is, which channel is set for alarming and how many alarm conditions in a row have occurred.*

**Note:** *The "alarm alert" (in boldface) doesn't display until after the 3rd consecutive alarm condition; the external alarm light goes on at this point as well.*

## Service High and Service Low

Service High and Service Low are the voltage levels at which the Service Light will go on. Those levels are compared to the "Backlight" measurement (seen as the bk= 1455 field) in every sample period. If the Backlight measurement is greater than Service High or less than Service Low, then:

**Note:** *The "normal" levels seen in these "bk" fields are examples only and are not necessarily what will be seen with the instrument.*

- the service alert appears as seen in the following Hyperterminal Service Alert example:
- J10 pins 1 and 2 (Chans 1 and 2) = 2mA
- the Service Light is turned on

The default Service High threshold is 3500.

***Hyperterminal Service Alert Example:***

```
secs=1: ch1-2: 667, 214 , bk= 463
secs=2: ch1-2: 2262, 1395 , bk= 449
secs=3: ch1-2: 2890, 1608 , bk= 434
secs=4: ch1-2: 4719, 2983 , bk= 4995, service alert.
secs=5: ch1-2: 4719, 2983 , bk= 4995, service alert.

Sample: ch1-2: 4719, 2983 Range1= 10000, Range2= 5000.
Alarms: Threshold= 1000, Channel= 1, # in a row=1
```

## Service Menu

The Service Menu is available by typing **<ms>**.

Type:

**<ms>**

Response:

```
<ms>
*** Service Menu ***
<ia> Don't show 1 sec data
<ib> Show 1 sec data
<gb> Get Bkgnd
```

### DON'T SHOW 1 SEC DATA

**<ia>**

Turns OFF 1 second data display.

Type:

**<ia>**

Response:

```
<ia>Don't show 1 sec data.
```

After starting the counter with <sa>, the device will wait until the sample time interval passes before displaying the first sample.

### SHOW 1 SEC DATA

**<ib>**

Turns ON 1 second data display.

Type:

**<ib>**

Response:

```
<ib>Show 1 sec data.
```

After starting the counter with <sa>, the device will show the samples collecting every second.

```
secs=1: ch1-2: 0, 0. , bk= 424
secs=2: ch1-2: 0, 0. , bk= 424
secs=3: ch1-2: 0, 0. , bk= 424
secs=4: ch1-2: 0, 0. , bk= 424
secs=5: ch1-2: 1, 0. , bk= 424
```

This mode can be used to view the data on a second-by-second basis for troubleshooting.

## GET BACKGROUND LIGHT VALUE

**<gb>**

Displays the current background value in milli-volts (mV).

# 5 Technical Data

## Introduction

This chapter describes the operation and programming of the instrument.

## Control Design

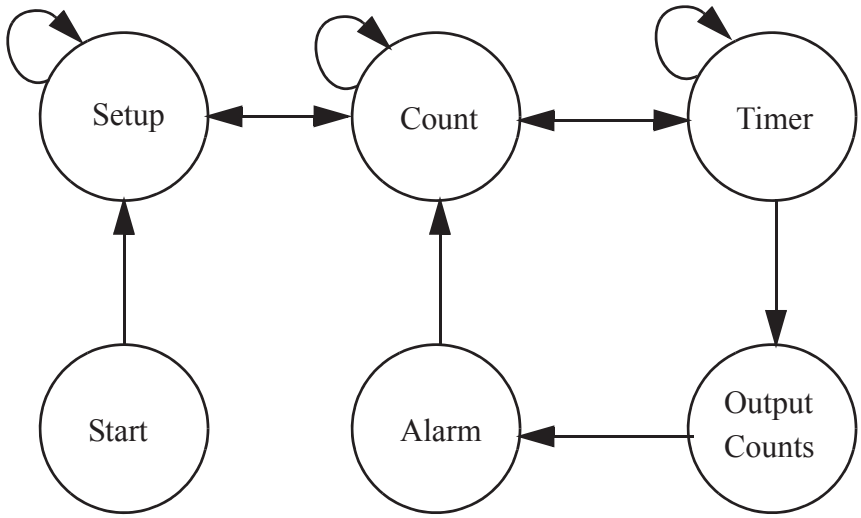


**Figure 5-1 States for the RLPC 4-20mA Particle Counter**

### START

- Starts microprocessor, and initializes hardware.

### SETUP

- If DIP Switches all = 0 ==> Program Mode:

  During the first 20 seconds, the unit waits for programming commands. If any programming commands are received within the first 20 seconds, those commands will be examined and executed. If the commands are valid, the parameters will be set. If no

commands are received (all DIP switches = 0) or if an invalid command is received, the instrument will recall its last stored parameters (or default settings) and continue to use them.

- If DIP Switches = 0000 0001 ==> Use last stored parameters

  With the DIP switches set with this value, the instrument will start up immediately using the last stored parameters.

**Startup Example:**

```
Lighthouse Remote Instrument (4-20mA):
- reading dip switch:

Sample Time = 60 secs
Range1= 10000.
Range2= 1000.
Alarm Threshold = 750 counts
Suppress Alarms = 2
Service High = 3500 mV
Service Low = 125 mV
```

- DIP Switches = Anything other than (0000 0000 or 0000 0001)

  The DIP switch settings will be read and interpreted. If the combination is valid, those parameters will be chosen. Otherwise, sample time of 300 seconds and 100,000 counts will be used.

## COUNT

The instrument uses setup parameters to run, collect data, and output count and alarm data. 0 counts will be represented by 4mA, and counts equal to upper range will equal 20mA. The current output will have a direct linear relationship to the range.

- Iout= 16mA(counts/ range) + 4mA
- Vout= Iout(R-load)
- If a Service Alert occurs, both channels are set to 2mA.

## TIMER

Keeps track of time relative to sample seconds, and outputs sample data every SampleSecs.

## OUTPUT

- Outputs counts on CH1 and CH2 lines in 4-20 mA output currents.
- When counts are greater than the alarm threshold, after a "suppress" # of consecutive alarm conditions, the Alarm Relay is turned on.

## ALARM

If the CH1 or CH2 count exceeds the programmed ALARM threshold then:

- The red SERVICE indicator on the instrument blinks.
- The EXTERNAL ALARM relay, described below, is set.

## SERVICE ALERT

If the service/background light voltage is greater than the Service High, or less than Service Low limits, then:

- CH1 and CH2 outputs are set to 2mA.
- The red SERVICE indicator on the instrument is turned on steady.
- If STATUS = 4 mA ==> No Alarms and No Service Alerts.

## EXTERNAL ALARM

An ALARM condition, as described above, also closes a relay inside the instrument. Contacts of that relay are connected to the DATA connector, pins 8 (-) and 9 (+). The user may use an external power supply and a buzzer or light stick to provide local indication of an alarm condition. The contacts are rated at 40VDC, 1A maximum.

# A Maintenance

## Flow Cell Cleaning

The Flow Cell is an integral part of the RLPC sensor and must be cleaned periodically to maintain the 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 A-1).


**Figure A-1 Flow Cell Cleaning with 3/4-inch Limit**

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)

# B 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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## Numerics



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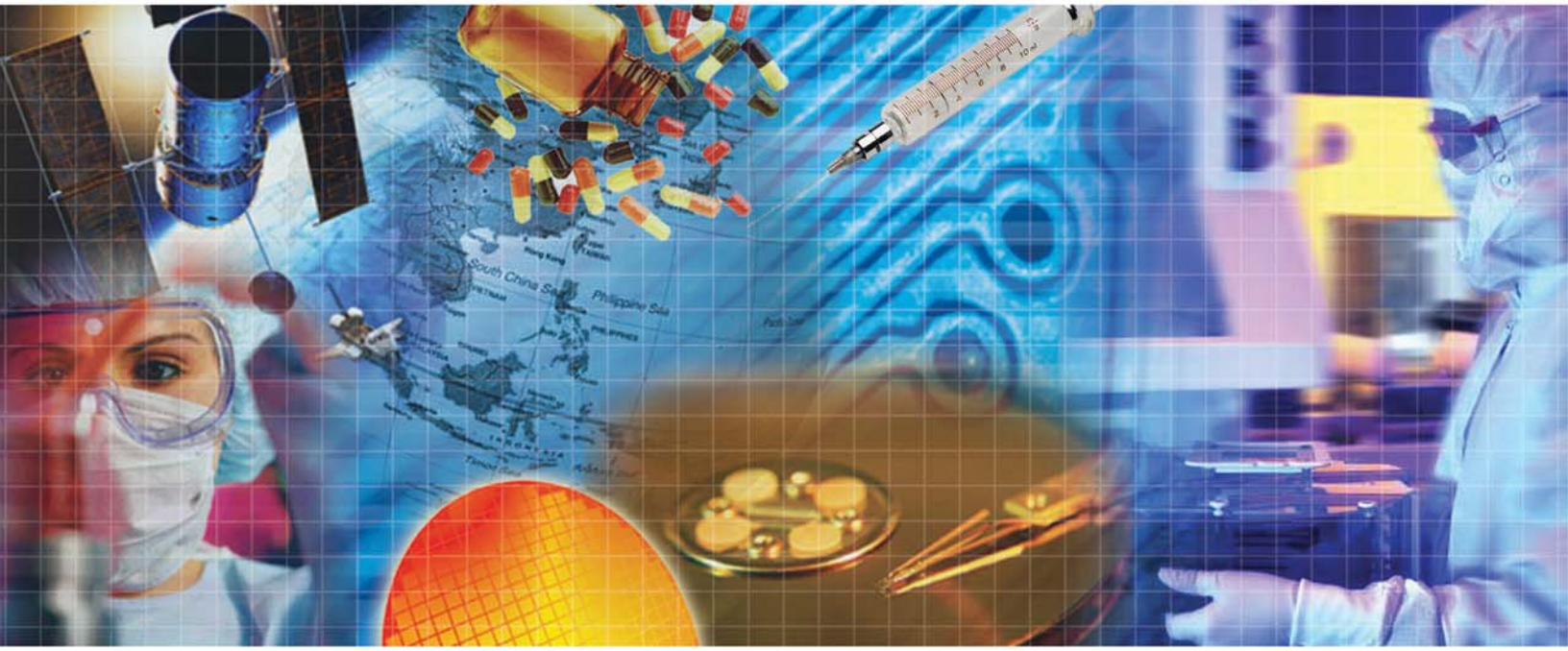
## U



## V



## W

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