

ActiveCountRp

Biological Air Sampler with Pump



LIGHTHOUSE
WORLDWIDE SOLUTIONS

ActiveCountRp

Biological Air Sampler with Pump



Operators Manual

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1 - General Safety

Safety Considerations

Warnings and Notes are used throughout this manual. All warnings will appear in the margin of the page next to the subject or step to which it applies. Exercise care when performing any procedures preceded by or containing a warning.

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

2 - Introduction

Overview/Description

This Operators Manual introduces the user to ActiveCountRp. Included are instructions for installation, operation, communications and maintenance.

ActiveCountRp is an active air sampling device that employs the impaction principle to impact particles bearing microbiological material onto a plate or petri dish loaded with nutrient agar. ActiveCountRp is designed to be a fixed point microbial monitoring device that assists users in automatically collecting microbial material at critical locations.

With a flow rate of 1 CFM (cubic foot per meter), $\pm 10\%$ can be part of a larger facility monitoring system.



Figure 2-1 ActiveCountRp shown with Remote Sampler Kit

The Impactor Assembly is installed on the inlet port on top of the instrument as shown in Figure 2-2.



Figure 2-2 Impactor Assembly mounted on ActiveCountRp

Specifications

Table 2-1 ActiveCountRp Instrument

Flow Rate	1.0 CFM (28.3 LPM)
Communication Modes	RS232, RS485 Modbus
LED Indicators	Status (Power, Flow, Sampling)
Supporting Software	LMS Express, LMS Pharma, LMS Professional
Vacuum Source	Internally controlled Clean Pump Technology
Power	100-240 VAC, 50-60 Hz
Enclosure	Stainless Steel
Dimensions	11"(L) x 11"(H) x 5"(W) [27.94 x 27.94 x 12.7 cm]
Weight	11 lbs. (5 kg)
Operating Temp/RH	50°F to 104°F (10°C to 20°C) / 20% to 95% non-condensing relative humidity
Storage Temp/RH	14°F to 122°F (-10°C to 50°C) / Up to 98% non-condensing relative humidity

3 - Get Started

Initial Inspection

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

Unpacking

- Inspect shipping container for damage.
- Notify the shipper if container was damaged.
- Inspect instrument for broken parts, scratches, dents or damage before use.
- Verify the contents received against the shipping list. If is missing, please contact the sales representative at Lighthouse Worldwide Solutions immediately at 1-541-770-5905.

To maintain warranty, it is advised to keep undamaged shipping containers and packing materials for reshipment of instruments for servicing or repair. For form-fitting foam items and containers, order replacement containers and packing materials only from Lighthouse Worldwide Solutions directly or from an authorized distributor.

Shipping Instructions

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

1. Use the original container and packing materials whenever possible. Refer to www.golighthouse.com/rma for detailed instructions. Remove attachments and package separately to prevent physical damage.
2. If the original container and packing materials are not available, wrap the unit in "bubble pack", surround with shock-absorbent material and place in a double-wall carton – the instrument should not rattle around when the carton is vigorously shaken. If the instrument is damaged during shipment due to inadequate user packing, the warranty may be voided and may result in additional repairs being billed to customer. You may contact Lighthouse Worldwide Solutions to purchase a replacement shipping container.
3. Seal container or carton securely. Mark "FRAGILE" and write Return Merchandise Authorization (RMA) number on any unmarked corner.
4. Send the instrument to the address provided by Lighthouse Worldwide Solutions representative or the RMA website.

WARNING

If the instrument is damaged during a return shipment due to inadequate user packing, the warranty may be voided and may result in additional repairs being billed to the customer.

Data Cable Build

An industrial RJ45 connector is required to attach the instrument to an RS485 network and may be supplied with the instrument in kit form. A replacement kit is available from LWS. This section will illustrate installation of the industrial RJ45 connector.

Requirements

The following tools and materials are required to build / attach the sealed industrial RJ45 connection used on the ActiveCountRp.

- CAT 5e Unshielded Twisted-Pair 24 AWG wire (CAT5e UTP), minimum.
- CAT5e UTP plenum wire may be required for installation in ceiling plenum area.
- Industrial RJ45 plug kit.
- Wire strippers
- RJ45 crimp tool.
- RS485 hub or switch (preferred) – DO NOT USE Ethernet Switch.

Site Preparation

WARNING

Both ends of the RS485 cable must be wired the same. References are made throughout this section to the EIA/TIA-568B standard for Ethernet/RJ45 wiring that must be followed.

Failure to wire both ends to this standard will cause failure of the instrument and may damage the instrument, the switch or both and void the respective warranties.

When all needed tools and materials are ready, proceed with the following steps:

Before starting cable runs, check with local regulatory agencies to determine installation restrictions and cable requirements for the application.

1. Make the necessary cable runs and leave two to three extra feet of cable at each end as a service loop. When pulling CAT5e cable, do not allow it to kink or the cable may break internally and cause failures. Typical installations use Unshielded Twisted Pair (UTP) but Shielded Twisted Pair (STP) may be required in areas of high electrical noise equipment, such as generators, fans, and fluorescent lights. When cable has to be installed in the false ceiling or air space above a work area (plenum), plenum cable may be required.

2. Even though the RJ45 connectors used to build Ethernet cables are typically the same for either end, the connector supplied in the kit should be used on the instrument end.
3. If STP wire is needed, the RJ45 required for wire termination is metal-jacketed. This special RJ45 provides a grounding point for the cable's shield. Only one end of each cable should be grounded. Because RS485 hub has grounded connector housings, the hub end should be used for this ground connection.

Cable-build Procedure

Figure 3-1 shows the individual parts needed to assemble the Industrial RJ45 cable connection.

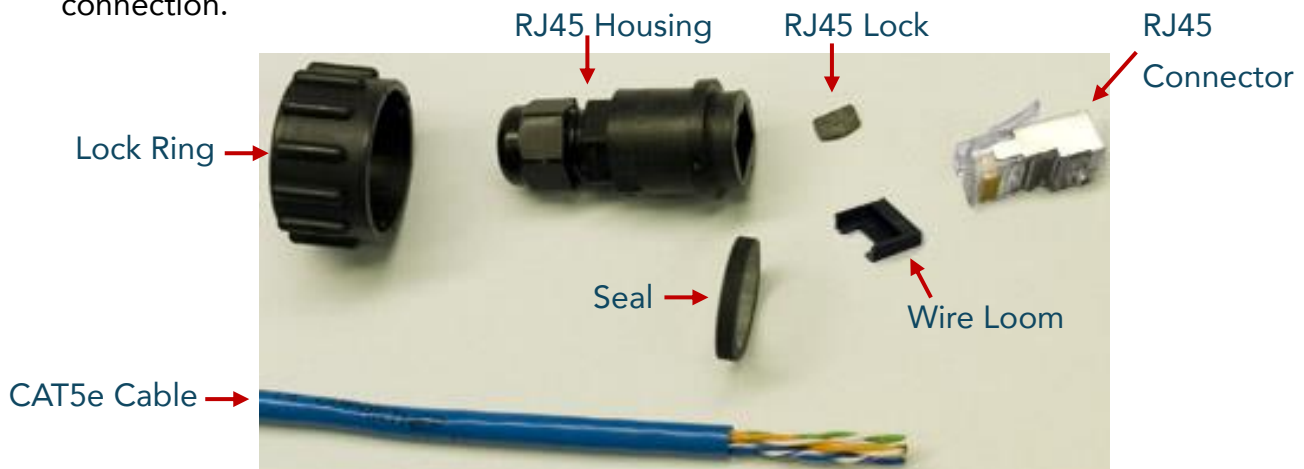


Figure 3-1 Industrial RJ45 cable parts

1. Remove the contents of the Industrial RJ45 connector from the package – do not dispose of or lose any pieces. Compare the contents with figure 3-1. Contact LWS Support if it appears that something is missing from the package or replacements are needed.
2. Remove the large Lock Ring from the Housing if they are mated.
3. Loosen the small Cable Seal Nut to allow the CAT5e cable to pass through.
4. On the instrument end of the cable, push the end of the cable through the large Lock Ring and RJ45 housing as illustrated in Figure 3-2. Make sure the Lock Ring is oriented as shown in Figure 3-2. IF it is reversed, the cable will have to be cut, the RJ45 connector discarded and a new connector installed.



Figure 3-2 Housing with Cable Inserted

5. Strip 1.5 inch to 2.0 inches of insulation from the end of the cable, taking extreme care to not nick or cut the individual wires. Do not strip the individual wires.
6. Separate the pairs of wires down to the cable's insulation. There will be an orange, a green, a blue and a brown pair of wires. Each pair will have a solid color wire and one striped wire of the pair color. Do not get them confused – the orange and brown pair may look alike in plenum cable and “swapping” these two pairs will cause failure of the cable.
7. Carefully untwist each pair and straighten the wire. The individual wires will be inserted in the Wire Loom shown in Figure 3-1 and Figure 3-3. Note the Loom's flat tray shape. Insert the wires into the loom based on the EIA/TIA-568B standard as shown in Figure 3-4.

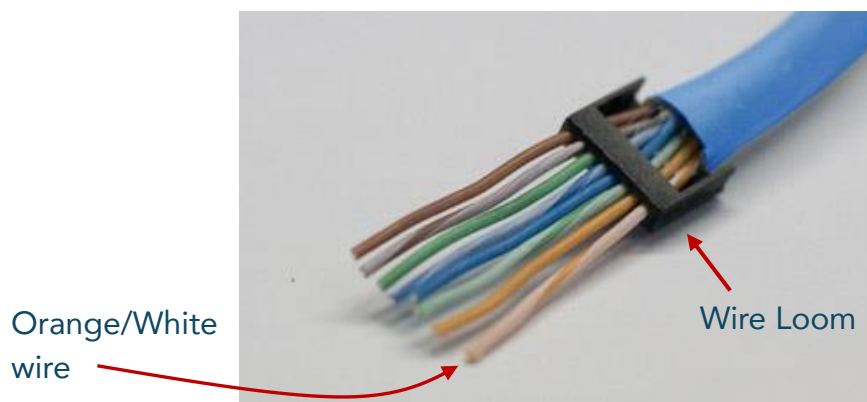


Figure 3-3 Close-up of Wire Loom

8. Note that the green pair is split up and the blue pair is out of sequence (solid color then stripped) and between the green-pair wires. When all of the wires are in the correct holes, push the loom onto the wires as far as it will go and verify that at least one-quarter inch of each wire extends beyond the edge of the loom. This allows for trimming the wires in a straight line parallel to the loom edge. One-eighth inch is required for crimping into the RJ45 connector so, in step 9, do not trim shorter than one-eighth inch (3.2 mm). Review the photos in Figure 3-4 to ensure accuracy.



Figure 3-4 EIA/TIA-568B Color Code Example

9. Continue to push the cable into the loom and trim the ends of the wires in a straight line to 1/8 inch to 3/16 inch (3.2 – 4.6 mm) as illustrated in the center panel of Figure 3-4.

NOTE: The “paring” of wires in the loom changes at positions 4 through 6.

10. Insert the wires / loom into the RJ45 connector (lock tab facing down) as shown in Figure 3-5 and push inward until the wire ends fully and against the ends of the wire channels. The loom helps to keep the wires positioned so they will go into the correct channels for crimping.



Figure 3-5 Loomed Wires Being Inserted into RJ45

11. Insert the RJ45 connector into a crimp tool similar to that shown in Figure 3-6. Maintain inward pressure while crimping the wires into their channels.



Figure 3-6 Typical RJ45 Crimp Tool

12. Check the cable wire ends in the RJ45 to make sure they have been crimped properly. Removing the connector at this point is a lot easier than after everything is installed and communication with the instrument is failing due to a poor crimp. Review Figure 3-7 for an illustration of how tight the wire ends should be against the ends of each channel.

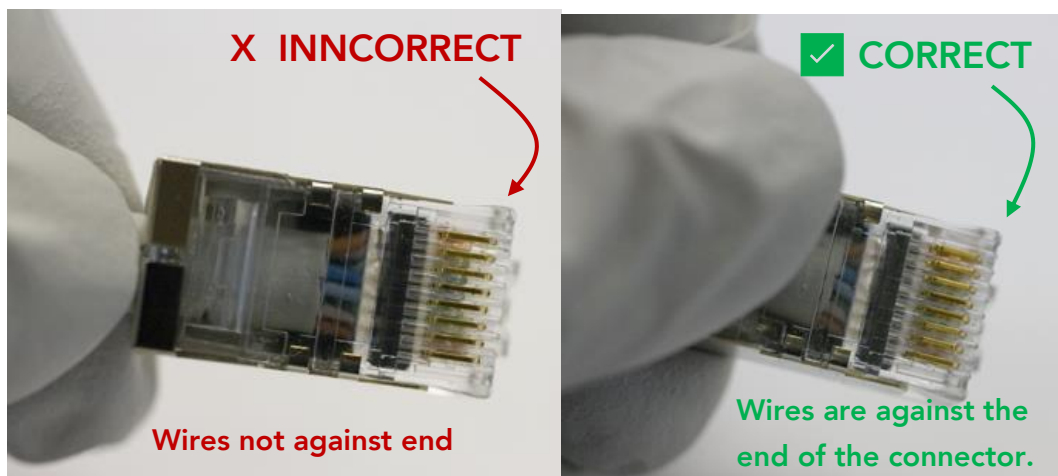


Figure 3-7 Close up of RJ45 Wire Detail

13. Pull on the cable to bring the RJ45 into the connector housing. Make sure to squeeze latch tab to allow it to enter the slot in the housing. See Figure 3-8.



Figure 3-8 Close-up of RJ45 Latch

14. Push the RJ45 connector fully into the housing and insert the Lock Clip, round edge out, as illustrated in Figure 3-9.



Figure 3-9 Lock Clip Installation

15. Hand tighten the housing cable clamping nut until snug. See Figure 3-10.



Figure 3-10 Tighten Cable Clamp Nut

16. Install the sealing ring onto the front of the connector housing. This seal is held in place when the connector is locked onto the instrument. See Figure 3-11.



Figure 3-11 Install Connector Seal

17. Slide the large Lock Ring down the cable and over the cable housing body. It may need a twisting action to fully position it against its retainer ring. Verify that its larger opening is facing outward, away from the cable as shown in Figure 3-12.



Figure 3-12 Cable Connector Completed

18. The hub end of the cable run can now be terminated. The wire should be checked with an Ethernet 100baseT cable tester (not just a continuity tester) to ensure that the signals, power and ground will be reliable. Steps 6 – 12 can be used as a reference for termination of the hub end.
19. Make sure the hub power is OFF or the hub end of the cable is disconnected from the hub before connecting the cable to the instrument.

Install and Set Up

ActiveCountRp Instrument

1. Verify that the location where the ActiveCountRp will be installed is ready for installation.
 - The instrument mounts level on a flat vertical surface.
 - Cabling should be installed and ready.
 - AC power must be available within 3 feet of the mounting location.
2. Ensure that the ActiveCountRp is powered OFF (switch in OFF position).
3. Remove one DIP Switch Cover Plate screw, loosen the other, swing the cover out of the way and tighten the second screw. Verify DIP SW 1 and 6 are ON and 7 and 8 are OFF for MODBUS mode (default setting). If an address other than "1" is required, set DIP SW 1 through 5 to the desired address, up to 31.

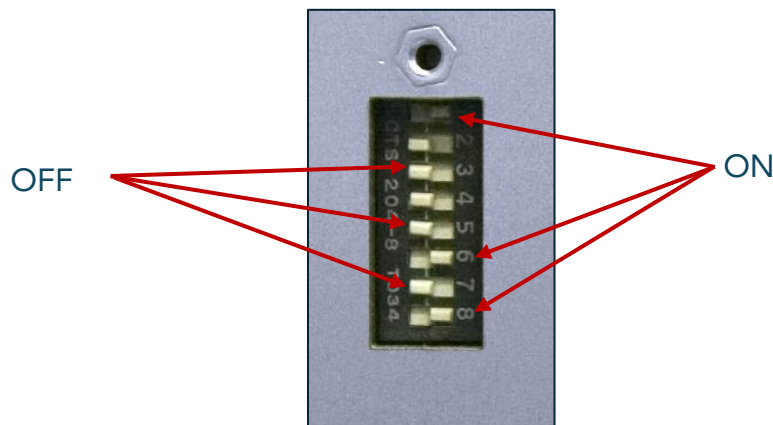


Figure 3-13 DIP Switch Positions

4. Return the cover plate to its original position, install removed screw and tighten both screws.

NOTE: Switch 8 controls the option for Fast Update. The default setting is ON.
Optional Impactor Assemblies are available from Lighthouse Worldwide Solutions.

5. Mount the ActiveCountRp then remove any protective devices. Refer to the Read-Me-First and assemble the Impactor Assembly. Install the Impactor Assembly on the ActiveCountRp to complete the following flow setting steps. See Figure 3-16.



Figure 3-14 Impactor placement on ActiveCountRp

6. Attach the flow meter via a short length of Bevaline tubing to the Flow Adjust Cover placed on the Impactor Assembly (Figure 3-15). Install the AC cord into the ActiveCountRp AC power input receptacle and connect to an AC power source.

NOTE: The Impactor must be less than 10 feet from ActiveCountRp. AC Power must be available within 3 feet of the mounting location.

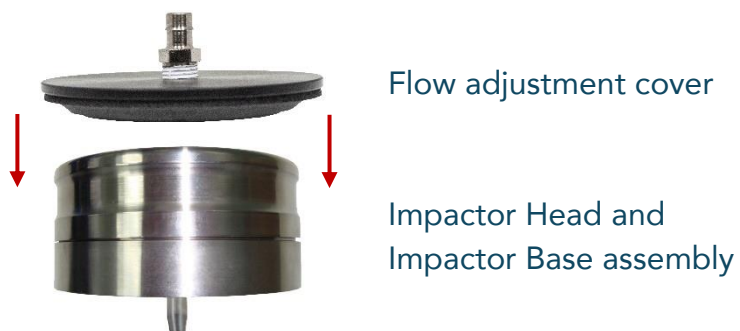


Figure 3-15 ActiveCountRp Impactor Assembly, Flow Adjust Cover

7. Press and hold the Start/Stop button on the front of the ActiveCountRp for at least ten second while applying power using the rocker switch on the bottom of the ActiveCountRp. See Figure 3-16. The Power LED should blink for a few seconds indicating the unit is in Service Mode.

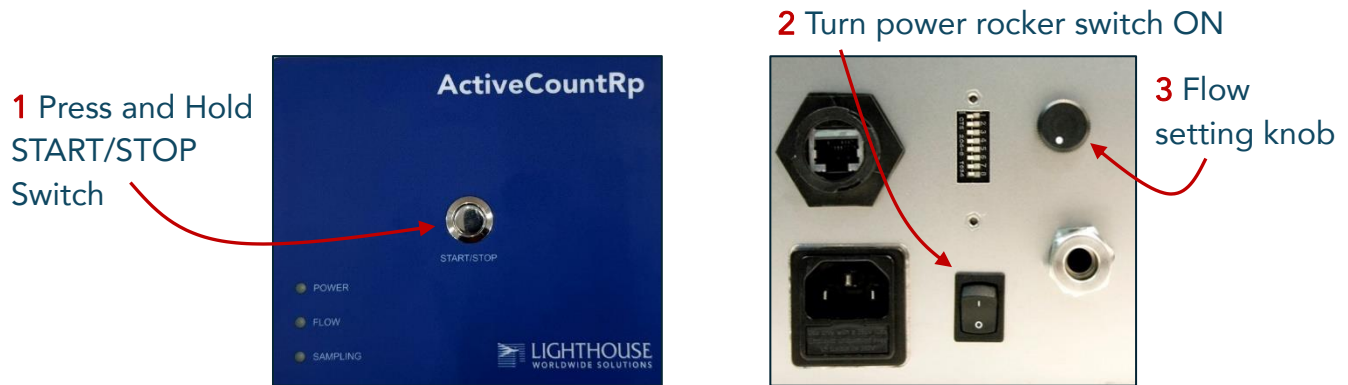


Figure 3-16 Flow Adjust Controls

8. Before making any changes to settings, watch the flow meter and press down firmly on the Flow Adjust Cover to determine if any fluctuations in the flow occur. If fluctuations do occur, rotate the Cover, press down and monitor the flow meter until a steady state is achieved. Rotate the Impactor top piece and cover until the highest steady state is achieved. Use an automatic center punch to place a mark on the outside rim of the top piece and the base, adjacent to each other.
9. If no fluctuations occur, turn the Impactor top piece to determine if any fluctuation occurs. Turn the top piece until the highest steady vacuum is achieved then use an automatic center punch to punch two marks, one on top piece and other on bottom piece adjacent to each other.
10. When the LED stops blinking, the median (28.3 lpm) flow setting is ready to be set. Use the flow meter attached to the Impactor and adjust the flow knob on the bottom of ActiveCountRp until the meter reads 28.3 lpm (1 CFM) and is steady. Briefly press the Start/Stop button to save, which blinks the LED again.

NOTE: The center punch marks provide alignment markers for mating the pieces after cleaning or dismantling.

When the LED stops blinking, the upper flow setting can be set. Adjust the flow knob until the meter reads 31.1 lpm (1.1 CFM) and is steady. Briefly press the Start/Stop button to save, which blinks the LED briefly.

11. When the LED stops blinking, the lower flow setting can be set. Adjust the flow knob until the meter reads 25.5 lpm (0.9 CFM) and is steady. Briefly press the Start/Stop button to save parameters.

12. When the LED stops blinking, settings have been saved and the pump will stop.

13. Press the start button and run one sample. Verify that the flow reads 28.3. Turn the power OFF when the sample is complete. Remove the Flow Adjust Cover, tubing and Flow Meter.

Set ActiveCountRp Switches

DIP Switch General Definitions

Table 3-1 DIP Switch Setting Definitions

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	Communication Mode	Always ON for MODBUS ASCII communication
7	Communication Mode	Always OFF for proper operation
8	Communication Mode	Fast Update – When ON, records are not saved to the buffer.

NOTE: Use a tool with a very small, pointed tip to change the DIP Switch positions.

DIP Switch Addresses

The following table details the addresses set by the binary DIP switches 1-5.

Table 3-2 DIP Switch Addressing

DIP SWITCHES	ADDRESS
100000	1
010000	2
110000	3
001000	4
101000	5
011000	6
111000	7
000100	8
100100	9
010100	10
110100	11
001100	12
101100	13
011100	14
111100	15
000010	16
100010	17
010010	18
110010	19
001010	20
101010	21
011010	22
111010	23
000110	24
100110	25
010110	26
110110	27
001110	28
101110	29
011110	30
111110	31

Attach RJ45 Cable

1. Orient the RJ45 connector with latch tab down. The tab is only a “key”, and the lock sleeve locks the cable in place.
2. Carefully insert the RJ45 connector into the RS485/232 receptacle as shown in Figure 3-17. Push in and turn the lock sleeve at the same time until the key goes into the slot. Twist clockwise until it locks.

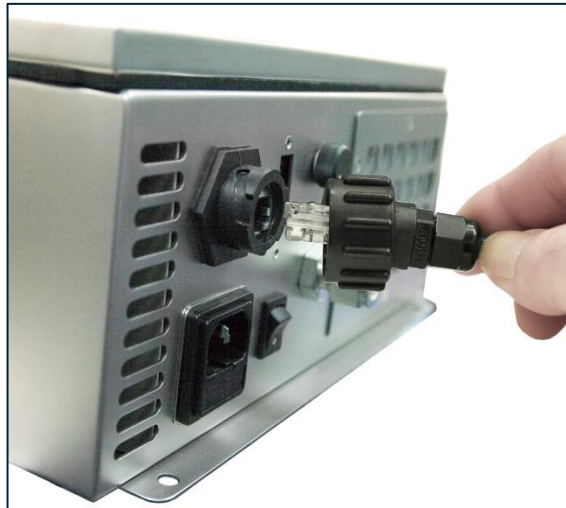


Figure 3-17 RJ45 Connector

3. Attach the opposite end of the communication cable to the RS495/232 hub, then apply power to the hub.

NOTE: The communication cable can also be connected directly to a PC.

ActiveCountRp RJ45 Pinouts

The RS485/RS232 Connector has the following pinouts.

Table 3-3 RS485/RS232 Connector RJ45 Pinouts

RJ45 Pin	Signal Name
1	RS232 TX
2	RS232 TX
3	RESERVED for future use
4	RS485B
5	RS485A
6	RESERVED for future use
7	RESERVED for future use
8	GND

Configure ActiveCountRp in Lighthouse Worldwide Solutions software.

On a PC that is connected to a gateway or hub you can configure ActiveCountRp for use with LWS software: LMS XChange, LMS Express, LMS Pharma, or LMS Pro.

- ActiveCountRp can be operated using the Start/Stop button on the unit.
- ActiveCountRp can be operated using the SW button in the software.

Operate the ActiveCountRp

Once the ActiveCountRp is installed and configured, apply power to the instrument by pressing the bottom Rocker Switch to ON (I) position. The green Power LED will light up. See Figure 3-24.



Figure 3-24 Green Power LED

Begin a sampling cycle by using the software or by pressing the Start/Stop button. The yellow Flow LED and blue Sampling LED should light up as shown in Figure 3-25.



Figure 3-25 Flow & Sampling LEDs

When a cycle is completed, the pump will shut off, and the Flow and Sampling LEDs will turn off. If the flow does not measure $1 \text{ CFM} \pm 10\%$ the Flow LED will blink until the correct flow is achieved.

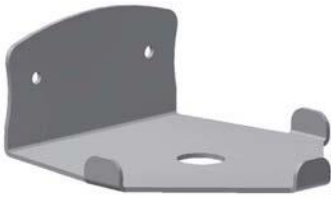
4 - Install Options

Overview

ActiveCountRp can be installed as a stand-alone unit, Impactor on top, or as a remote controlled pump unit for 'Table-Top' or 'Wall-mounted' Impactors.

ActiveCountRp Accessories

- Wall Bracket
- Tabletop Stand
- Remote Sampler Kit.



Wall Bracket bottom mount.



Impactor Top Mount



Tabletop Stand



Figure 4-1 ActiveCountRp Remote Sampler Kit & Accessories

5 - Communications

Configuring with the MODBUS Protocol

ActiveCountRp uses Modbus Map v1.49. The product name needs to be "VIABLE" for LMS Express to recognize it as ActiveCountRp.

Sample time must be calculated for the specific sample volume desired based on 1CFM flow. Sample time calculations are performed and written to ActiveCountRp by the Lighthouse Monitoring System software. Samples with multiple cycles must have the individual sample time calculate for each sample.

Configure ActiveCountRp

Table 5-1 Configure Commands

Value	Register	Action
-1	40025	Saves all writable 40025 register values to the Data Record Index.
<Location Number>	40026	Saves all writable 40026 register values to instrument Location.
0	40029	Set Initial Delay A to register 40029
0	40030	Set Initial Delay B to register 40030
<Hold Time High>	40031	Set Hold Time High to register 40031
<Hold Time Low>	40032	Set Hold Time Low to register 40032
<Sample Time High>	40033	Set Sample Time High to register 40033
<Sample Time Low>	40034	Set Sample Time Low to register 40034
<Clock High>	40035	Set Clock High to register 40035
<Clock Low>	40036	Set Clock Low to register 40036
13	40002	Saves Clock settings to register 40002
<Number of Cycles>	40053	Set number of cycles to register 40053

Running ActiveCountRp

ActiveCountRp can be run by MODBUS Protocol. The applicable action commands are displayed in Table 5-2.

Table 5-2 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.

Access ActiveCountRp Information

Table 5-3 Read Commands

Value	Register	Action
50	40001	Read Device Information: Parse through device information. Verify "VIALE" in the product name.
1	40003	Read Device Status
2	40005	Read Device Serial Number
74	30001	Get Data Record
72	41001	Get Data Types
72	42001	Get Data Units
72	43001	Get Data Enables

6 - Appendix A: MODBUS Register Map v1.49

COMM Settings

Lighthouse Worldwide Solutions particle counters using MODBUS require the following communications settings.

Table A-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

Supported MODBUS Commands

Table A-2 MODBUS Registers

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

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

Register Map

Sensor Settings Registers

Instrument settings are stored in holding registers (the 4xxxx series), which are mostly read/writeable. Table A-3 describes the contents of these registers.

Table A-3 Sensor Settings Registers

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

Table A-3 Sensor Settings Registers

Register	Data Types	Description
40020	ASCII string	Model Name char[10], char[11]
40021	ASCII string	Model Name char[12], char[13]
40022	ASCII string	Model Name char[14], char[15]
40023	Unsigned integer	Flow Rate, Divide by 100 to get rate in CFM. For example, 100 = 1 CFM
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. Specifies the location of the instrument. Must be 1 to 200 (maps to location names associated with registers 40200 – 40399).
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 from 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 86,399, which equals 23h 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 86,399, which equals 23h 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]
40035	Unsigned integer	Data Set [high]. Works in conjunction with 40036. Data entered here is applied to the device through the command register.

Table A-3 Sensor Settings Registers

Register	Data Types	Description
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.
40041	ASCII string	Flow Unit. Defines unit as cfm, lpm, mlpm, char[0], char[1]
40042	ASCII string	Flow Unit. Char[2], char[3]
40043	Unsigned integer	Calibration Reference Voltage (millivolts)
...		
40049	Signed integer	Printer Options
40050	Signed integer	Device Options
40053	Unsigned integer	Cycles Set sets number of cycles.
...		
40076	ASCII string	Current Status [high] – preview of register 30007
40077	ASCII string	Current Status [low] – preview of register 30008
...		
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 strong	Location_200_char[6], char[7]

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. Printer Options (40049) displays the configuration of the instrument's printer function.

Table A-4 Printer Options

Bit	Description
0	Unused – non-writeable
1	Print on Sample (1-Enabled, 0=Disabled)
2-15	Reserved

If Bit-1 of Register 40049 is set, the instrument will print the last recorded data at the end of each sample. This feature cannot be enabled if *the One Second Data Update* feature is enabled. Device Options (40050) displays the instrument's device configuration.

Table A-5 Device Options

Bit	Description
0	Fast Download (1=Enabled, 0=Disabled) non-writeable
1	One Second Data Update (1-Enabled, 0=Disabled)
2-15	Reserved

If Bit-0 of Register 40050 is set, it indicates that the instrument is capable of Fast Download. If Bit-1 of Register 40050 is set, the instrument will display and update the data registers every second. No data will be recorded in the data buffer. Enabling this feature disables the Print on Sample feature. 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.

Device Status

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

Table A-6 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 remain 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.
12	FLOW STATUS: Set to 1 when unit's flow is out of spec, else 0.

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 the register is read, it always returns to zero.

Table A-7 Command Register

Value	Action
1	Saves all writeable 4xxxxx register values to the EEPROM.
2	Reserved for future use.
3	Clears the Data Buffer. Record count is set to zero.
4	Saves the instrument parameters in the 40xxx registers to the EEPROM. Parameters include Sample Time, Hold Time, 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 sample. Records count since Manual Start.
11	Instrument Start (Automatic Counting). Particle Counters: Uses defined Initial Delay, Hold Time, Sample Interval and counting mode. Instrument executes samples and holds until an Instrument Stop command is issued. For instruments with pumps, this command will start the pump. Manifold Controller: Uses defined Manifold Sequence. Stops counting and changing 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.
14	Manifold Controller: Clear data register bank. Bank is reset and remains 0 until next data is available or index registers are changed.
192	Changes instrument baud rate to 19200K upon command execution.
576	Changes instrument baud rate to 57600K upon command execution.
1152	Changes instrument baud rate to 115200K upon command execution.

Data Registers

Table A-8 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]
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 Integer	Valid particle channels
30076	Unsigned Integer	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 second 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)

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 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 to a value of 6 in register 30008 (bits 1 and 2 are set TRUE).

Table A-9 Data Status Byte

Bit	Description
0	Laser Alert Status 0=Laser OK 1 = Laser Alert
1	Flow Alert Status 0 = Flow Rate OK 1 = Flow Rate Alert
2	Particle Overflow Status 0 = No overflow 1 = Overflow occurred
3	Instrument Service Status 0 = Working correctly 1 = 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

The 41xxx register series is used to identify the type of data items in the 30xxx series. The Data Type registers run in parallel with the Data Registers. For example, Data Register 30041's Data Type register is 41041. Data Types are assigned 4 ASCII characters across 2 registers. If a Data Type string contains less than 4 characters, then the rest of the string is padded with NULL characters. Note that a Data Type using all four characters will not end with NULL character.

Table A-10 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: 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.

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

Table A-11 Examples of Particle Data Items

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

Data Units Registers

The 42xxx register series identifies the units used by data items in the 30xxx series. Data Register 30010's Units Register is 42010.

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 NULL's.

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

Table A-12 Data Units

Units	Description	Units	Description
#	Count (for particles)	ft/m	Feet per meter
%	Percent	m/s	Meters per second
S	Seconds	"H ² O	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

Table A-12 Data Units

Units	Description	Units	Description
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 feet
p/m3	Particles per cubic meter	LPM	Liters per minute
PCT	Percent	MLPM	Milliliters per minute
SEC	Seconds	IHG	Inches of mercury
p/L	Particles per liter	p/ml	Particles per millimeter

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 high bytes in front of the low bytes. For example:

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

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

Table A-13 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.

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

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

Table A-14 Alarm Enable Registers

Register	Data Type	Description
43009	Unsigned Integer	Enable for Particle Channel 1 [high] (smallest particle size start here)
43010	Unsigned Integer	Enable for Particle Channel 1 [low]
43011	Unsigned Integer	Enable for Particle Channel 2 [high]
43012	Unsigned Integer	Enable for Particle Channel 2 [low]
43013	Unsigned Integer	Enable for Particle Channel 3 [high]
43014	Unsigned Integer	Enable for Particle Channel 3 [low]
43015	Unsigned Integer	Enable for Particle Channel 4 [high]
43016	Unsigned Integer	Enable for Particle Channel 4 [low]
43017	Unsigned Integer	Enable for Particle Channel 5 [high]
43018	Unsigned Integer	Enable for Particle Channel 5 [low]
43019	Unsigned Integer	Enable for Particle Channel 6 [high]
43020	Unsigned Integer	Enable for Particle Channel 6 [low]
43021	Unsigned Integer	Enable for Particle Channel 7 [high]
43022	Unsigned Integer	Enable for Particle Channel 7 [low]
43023	Unsigned Integer	Enable for Particle Channel 8 [high]
43024	Unsigned Integer	Enable for Particle Channel 8 [low]
43041	Unsigned Integer	Enable for Analog Channel 1 [high]
43042	Unsigned Integer	Enable for Analog Channel 1 [low]
43043	Unsigned Integer	Enable for Analog Channel 2 [high]
43044	Unsigned Integer	Enable for Analog Channel 2 [low]
43045	Unsigned Integer	Enable for Analog Channel 3 [high]
43046	Unsigned Integer	Enable for Analog Channel 3 [low]
43047	Unsigned Integer	Enable for Analog Channel 4 [high]
43048	Unsigned Integer	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 particle channel and enable alarming on the second channel, disable Bit 1 for register 43014 and enable Bit 1 for register 43012.

To disable alarming completely, disable Bit 1 for register 44012. Now, no channels are enabled for alarms.

Table A-15 Example of Alarming on Channel 2

Registers	Particle Channel	Bit 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:

$$\text{<High Bytes><Low Bytes> = <4 Byte Data Item>}$$

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 the channel, the threshold flag in the Dat Status register (30007 – 30008, bit 4) is set.

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

Table A-16 Alarm Threshold Registers

Register	Data Type	Description
45009	Unsigned Integer	Threshold for Particle Counter Channel 1 [high] (smallest particle size start here)
45010	Unsigned Integer	Threshold for Particle Channel 1 [low]
45011	Unsigned Integer	Threshold for Particle Channel 2 [high]
45012	Unsigned Integer	Threshold for Particle Channel 2 [low]
45013	Unsigned Integer	Threshold for Particle Channel 3 [high]
45014	Unsigned Integer	Threshold for Particle Channel 3 [low]
45015	Unsigned Integer	Threshold for Particle Channel 4 [high]
45016	Unsigned Integer	Threshold for Particle Channel 4 [low]
45017	Unsigned Integer	Threshold for Particle Channel 5 [high]
45018	Unsigned Integer	Threshold for Particle Channel 5 [low]
45019	Unsigned Integer	Threshold for Particle Channel 6 [high]
45020	Unsigned Integer	Threshold for Particle Channel 6 [low]
45021	Unsigned Integer	Threshold for Particle Channel 7 [high]
45022	Unsigned Integer	Threshold for Particle Channel 7 [low]
45023	Unsigned Integer	Threshold for Particle Channel 8 [high]
45024	Unsigned Integer	Threshold for Particle Channel 8 [low]

Setting the Alarm Threshold

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

Table A-17 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

7 - Appendix 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 handheld 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 to 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 FORGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER PRESENTATIONS, WARRANTIES AND COVENANTS, EXPRESS OR IMPLIED WITH RESPECT TO THE EQUIPMENT AND ANY DEFECTS THEREIN OF ANY NATURE WHATSOEVER, 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 BUYER'S 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 BUYER'S 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 COMMERCIALY 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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