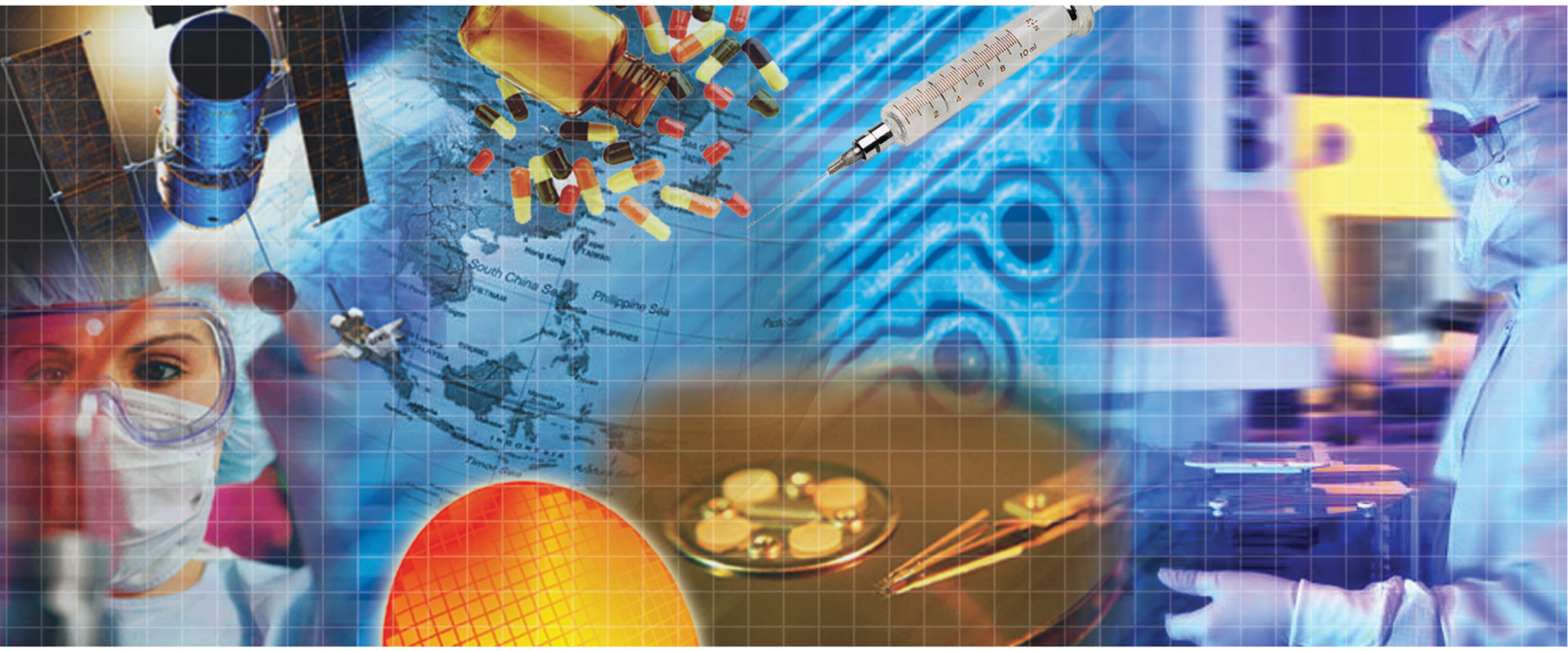

LIGHTHOUSE
WORLDWIDE SOLUTIONS

REMOTE Active Count Biological Air Sampler

Pump Instrument

Installation Guide

Lighthouse Worldwide Solutions

REMOTE Active Count Biological Air Sampler
Pump Instrument

Installation Guide

LWS Part Number: 248083401-1 Rev 5

EU DECLARATION OF CONFORMITY

Manufacturer's Name: Lighthouse Worldwide Solutions, Inc.

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

Declares that the product:

Product Name: Biological Air Sampler
Model Number(s): REMOTE Active Count

Conforms to the following Product Specifications:

SAFETY	EN61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use Part 1: General Requirements IEC 61010-1:2000
	CAN/CSA C22.2 No. 1010.1-1992	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1: General Requirements
	IEC 60825-1 Am. 2	
EMC	EN61326	Electrical Equipment for Measurement, Control and Laboratory Use EMC Requirements Part 1: General Requirements Includes Amendment A1:1998; IEC 61326:1997 + A1:1998

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

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

Fremont, CA. November7, 2011

William Shade - V.P. Engineering

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About this Manual

This manual describes the installation and operation of the Lighthouse REMOTE Active Count.

Text Conventions

The following typefaces have the following meanings:

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

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

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

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

```
hex 0D
0Dh
```

Additional Help

For more information about the Lighthouse REMOTE Active Count, contact Lighthouse Worldwide Solutions.

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

1 General Safety

Safety Considerations

Warnings and cautions are used throughout this manual. Become familiar with the meaning of a warning before operating the device sensor. All warnings will appear in the left margin of the page next to the subject or step to which it applies or as an inset prior to the step to which it pertains. Excercise 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 of USA).

2 *Introduction*

Overview

This operating manual introduces the user to the Lighthouse REMOTE Active Count Biological Air Sampler. Included in this manual are instructions for installation, operation, communications and maintenance.

Interchangeable Terms

Throughout this document, the REMOTE Active Count may be referred to as the ***REMOTE Active Count***, ***RAC***, ***biological air sampler*** or ***instrument***. For simplicity, these terms are interchangeable and mean the same thing.

Description

The REMOTE Active Count 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. The REMOTE Active Count 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 1CFM, ± 10%, the REMOTE Active Count is meant to be a component of a larger facility monitoring system. See Figure 2-1.

Figure 2-1 REMOTE Active Count Biological Air Sampler

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

Specifications: RAC: Pump Instrument

Table 2-1 RAC: Pump Instrument

Flow Rate	1.0 CFM (28.3 LPM)
Communication Modes	RS-232, RS-485 Modbus
LED Indications	Status (Power, Flow, Sampling)
Supporting Software	LMS Express RT, LMS Pharma, LMS Professional
Vacuum Source	Internally-controlled Clean Pump Technology
Power	100-240 VAC, 50-60Hz
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	50º F to 104º F (10º C to 40º C) / 20% to 95% non-condensing
Storage Temp/RH	14º F to 122º F (-10º C to 50º C) / Up to 98% non-condensing

3 Get Started

Initial Inspection

The REMOTE Active Count is thoroughly inspected and tested at the factory and is ready for use upon receipt.

Unpacking

It is presumed that when the shipment was received, the following took place:

1. The shipping container was inspected for damage;
2. If the container was damaged, the shipper was notified immediately.
3. The instrument was carefully inspected for broken parts, scratches, dents and other damage before use, even if the container appeared to be undamaged, and
4. Any damages were reported to Lighthouse Technical Support at 1-800-945-5905 (Toll Free USA) or 1-541-770-5905 (Outside of USA) before proceeding.

Verify the contents of the package against the shipping list. If anything appears to be missing, please contact the sales representative at Lighthouse Worldwide Solutions immediately at 1-510-438-0500.

To maintain the 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, directly, or from a Lighthouse-authorized distributor.

Shipping Instructions

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

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

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 to purchase a replacement shipping container.
3. Seal container or carton securely. Mark “FRAGILE” and write the Return Merchandise Authorization (RMA) number on any unmarked corner.
4. Send the instrument to the address provided by the Lighthouse representative or the RMA website.

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 Lighthouse. This section of the manual will illustrate installation of this connector.

Requirements

The following tools and materials are required to build / attach the sealed industrial RJ-45 connection used on the ***REMOTE Active Count***.

- Category 5e Unshielded Twisted-Pair 24AWG wire (CAT5e UTP), minimum
- CAT5e UTP plenum wire may be required for installation in ceiling plenum area
- Industrial RJ-45 plug kit
- Wire strippers
- RJ-45 crimp tool
- RS485 hub or switch (preferred) - do NOT use an 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/RJ-45 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 through the following steps:

1. Check with local regulatory agencies to determine installation restrictions and cable requirements for the application before starting cable runs.

2. Make the necessary cable “runs” and leave about two to three feet 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 ceilings or air space above a work area (plenum), plenum cable may be required.

3. Even though the RJ-45 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.

4. If STP wire is needed, the RJ-45 required for wire termination is metal-jacketed. This special RJ-45 provides a grounding point for the cable's shield. Only one end of the each cable should be grounded, which will provide the shield to block electrical noise from entering the wire but will not introduce a ground loop that results from both ends being grounded. Because RS-485 hub have 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 RJ-45 Cable connection.

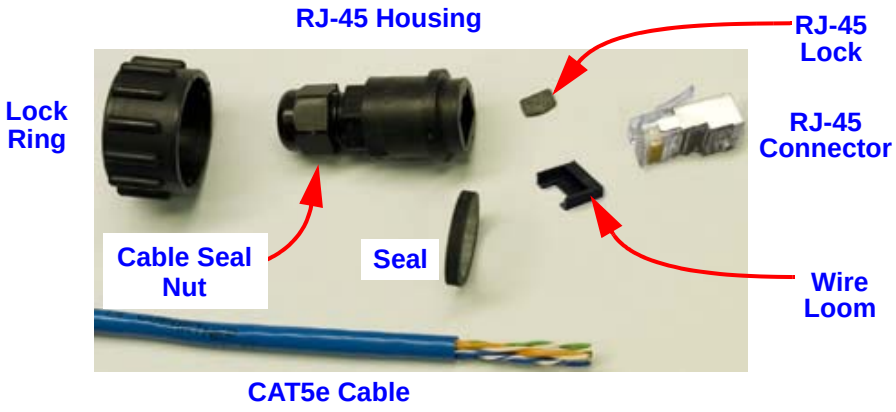

Figure 3-1 Industrial RJ-45 Cable Parts

1. Remove the contents of the Industrial RJ-45 connector from the package - do NOT dispose of or lose any pieces. Compare the contents with Figure 3-1. Contact Lighthouse 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 RJ-45 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 RJ-45 connector discarded and a new connector installed.

Figure 3-2 Housing with Cable Inserted

5. Strip 1-1/2-inch to two-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 into 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.

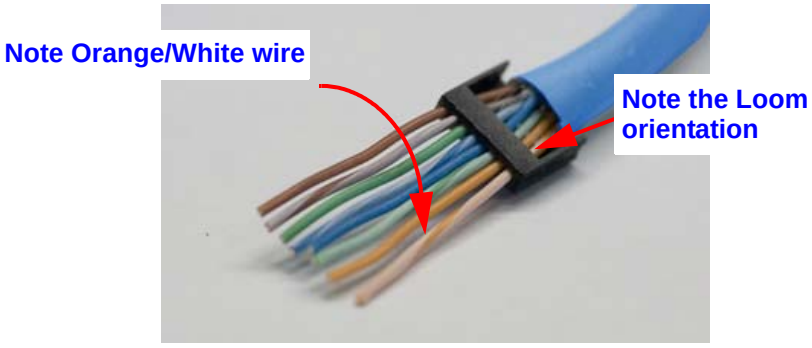

Figure 3-3 Close-up of Wire Loom

8. Note that the green pair is split up and the blue pair is out of sequence (solid color then striped) 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 RJ-45 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

Note: *The "pairing" of wires in the loom changes at positions 4 through 6.*

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.

10. Insert the wires / loom into the RJ-45 connector (lock tab facing down) as shown in Figure 3-5 and push inward until the wire ends fully butt 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.

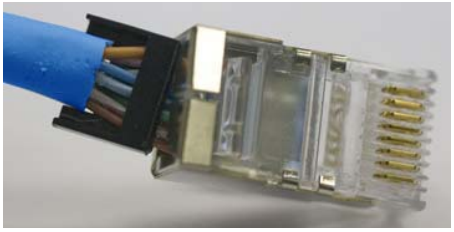

Figure 3-5 Loomed Wires Being Inserted into RJ-45

11. Insert the RJ-45 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 RJ-45 Crimp Tool

12. Check the cable wire ends in the RJ-45 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 tightly the wire ends should be against the ends of each channel.

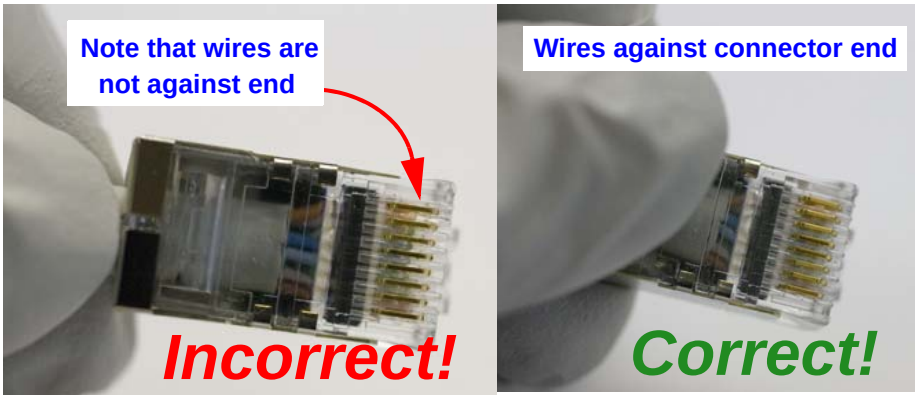

Figure 3-7 Close-up of RJ-45 Wire Detail

13. Pull on the cable to bring the RJ-45 into the connector housing. Make sure to squeeze the latch tab to allow it to enter the slot in the housing. See Figure 3-8.

Figure 3-8 Close-up of RJ-45 Latch

14. Push the RJ-45 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 through 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

RAC Pump Instrument

1. Verify that the location where the REMOTE Active Count (RAC) 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 RAC is powered OFF (switch is 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.

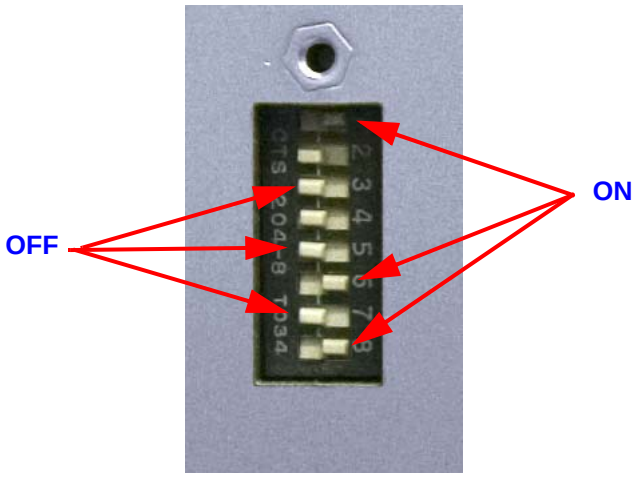

Figure 3-13 DIP Switch Positions

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.*

Note: *Optional Impactor Assemblies are available from Lighthouse. Contact a sales representative at (510) 438-0500 for more information.*

See Table 3-1 on page 13 and Table 3-2 on page 14 for DIP Switch definitions and addressing.

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

Figure 3-14 Impactor Placement on RAC

Note: *The Impactor must be less than 10 feet from the RAC.*

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 RAC AC Power Input receptacle and connect to an AC power source.

Note: *AC power must be available within 3 feet of the mounting location.*

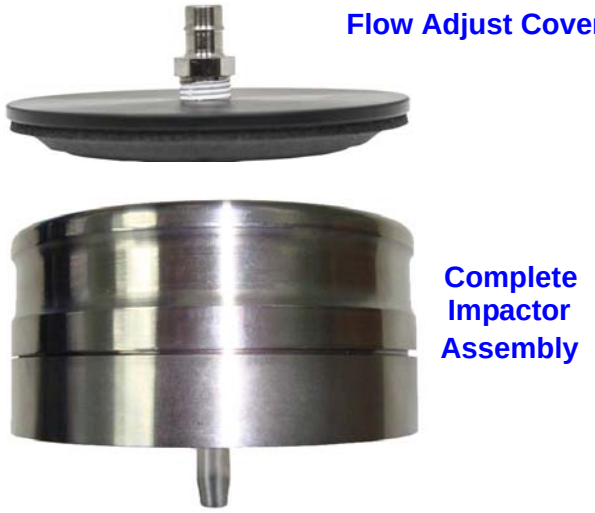

Figure 3-15 RAC Impactor Assembly, Flow Adjust Cover

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

Configure the flow settings as explained in steps 9 through 13. As each step is completed, the Save function will cause the LED to blink again.

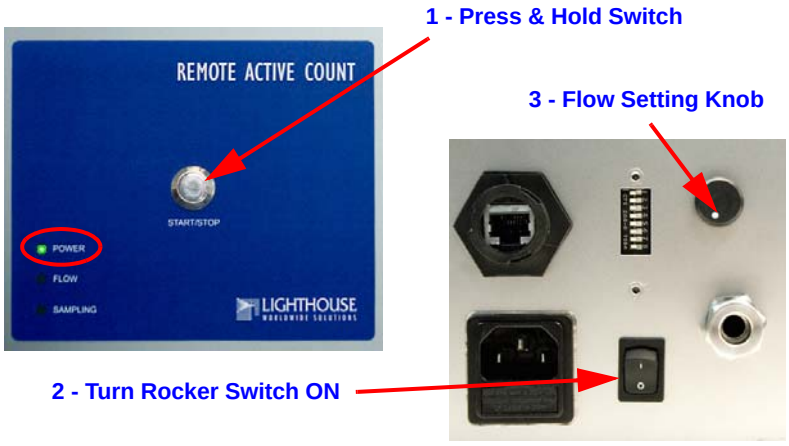

Figure 3-16 Flow Adjust Controls

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 acheived. Rotate the Impactor top piece and Cover until the highest steady state is acheived. 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 fluctuations occur. 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.

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

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 the RAC 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.

11. 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.

12. 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 the parameters.

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

14. 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 RAC Switches

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

DIP Switch General Definitions

OFF (LEFT) = 0, ON (RIGHT)= 1 as shown in Figure 3-13.

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

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 1 2 3 4 5 6	ADDRESS
1 0 0 0 0 0	1
0 1 0 0 0 0	2
1 1 0 0 0 0	3
0 0 1 0 0 0	4
1 0 1 0 0 0	5
0 1 1 0 0 0	6
1 1 1 0 0 0	7
0 0 0 1 0 0	8
1 0 0 1 0 0	9
0 1 0 10 0	10
1 1 0 1 0 0	11
0 0 1 1 0 0	12
1 0 1 1 0 0	13
0 1 1 1 0 0	14
1 1 1 1 0 0	15
0 0 0 0 1 0	16
1 0 0 0 1 0	17
0 1 0 0 1 0	18
1 1 0 0 1 0	19
0 0 1 0 1 0	20
1 0 1 0 1 0	21
0 1 1 0 1 0	22
1 1 1 0 1 0	23

Table 3-2 DIP Switch Addressing

DIP SWITCHES 1 2 3 4 5 6	ADDRESS
0 0 0 1 1 0	24
1 0 0 1 1 0	25
0 1 0 1 1 0	26
1 1 0 1 1 0	27
0 0 1 1 1 0	28
1 0 1 1 1 0	29
0 1 1 1 1 0	30
1 1 1 1 1 0	31

Attach RJ45 Cable

1. Orient the RJ-45 connector with latch tab down. The tab is only a “key” and the lock sleeve locks the cable in place.
2. Carefully insert the RJ-45 connector into the RS-485/232 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 RJ-45 Connector

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

3. Attach the opposite end of the communication cable to the RS485/232 hub, then apply power to the hub.

REMOTE Active Count RJ-45 Pinouts

The RS485/RS232 Connector has the following pinouts.

Table 3-3 RS485/RS232 Connector - RJ-45 Pinouts

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

Sample Configurations

General

The REMOTE Active Count may operate in the following ways when in sync with LMS Express RT:

- The unit can be operated using the Start/Stop button on the instrument.
- The unit can be operated using the SW button in LMS Express RT.
- There can be a 15 second delay between the instrument starting or stopping and LMS Express RT changing to a matched state. For example, if the RAC is started using the Start/Stop button on the instrument, LMS Express RT may delay (up to 15 seconds) before indicating that the instrument is running.
- When running multiple cycles, the instrument may under-sample or over-sample due to LMS Express RT rounding to the nearest second. This error is less than 5%.

Note: *The LMS Express RT software and the REMOTE ActiveCount firmware have been designed to sync during operation.*

Configure the RAC in LMS Express RT

On a PC that is connected to a gateway or hub, start LMS Express RT. See Figure 3-18.

Figure 3-18 LMS Express 7

Choose "*Data Collection*" on the LMS Express RT home page under the heading **Other Options**. On the **Data Collection** page, choose *"Real-Time Data Collection"*. See Figure 3-19.

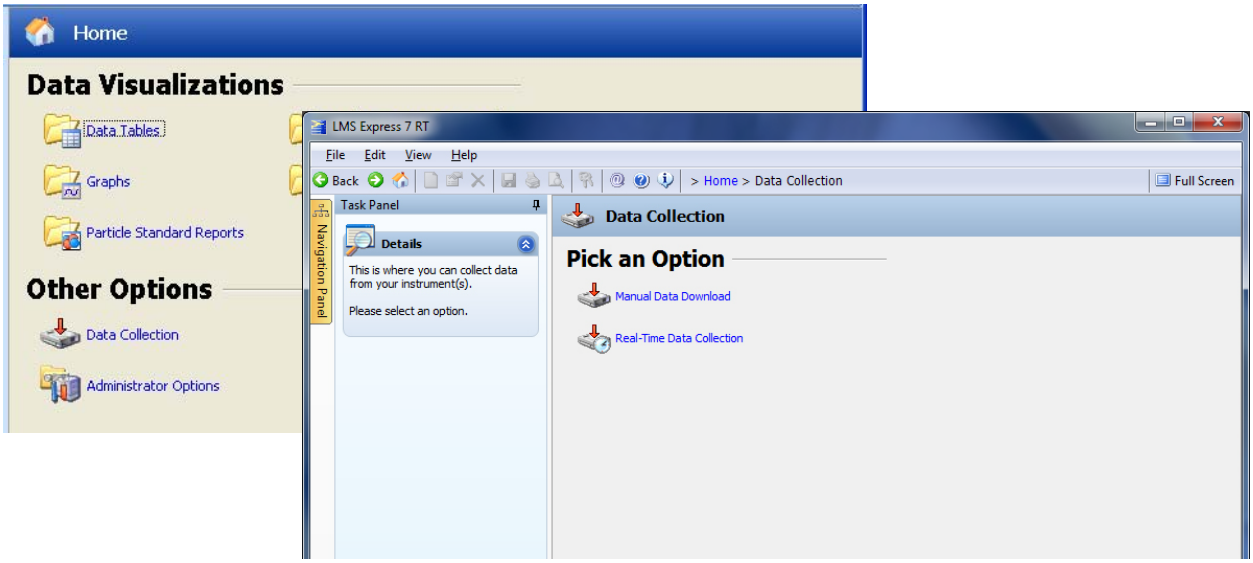

Figure 3-19 Data Collection Options

Select *Add Network Connection* in the **Connection Task Panel** and enter the IP address as shown in Figure 3-20. A COM port can also be selected and configured.

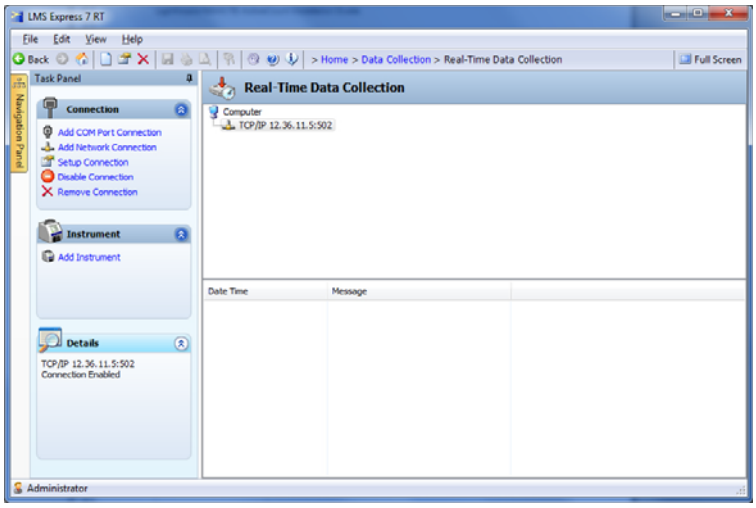

Figure 3-20 Add a Network Connection

Select *Add Instrument* in the **Instrument Task Panel** to setup the instrument driver.
In the **Setup Instrument Driver** dialog box, confirm that the **Instrument Enable** check box is active. Select a location for the **Instrument Location**, leave the **Instrument Address** at *1* and select the *LWS Remote Active Count* from the **Instrument Type** drop-down menu. See Figure 3-21.

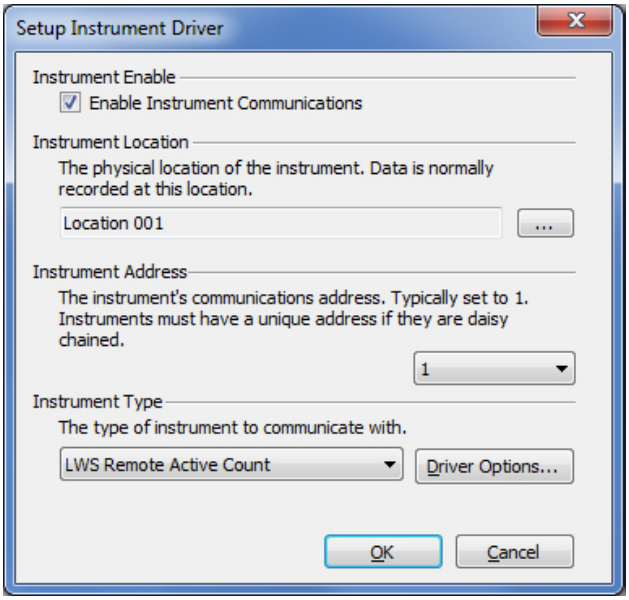

Figure 3-21 Setup Instrument Device

Select the **Driver Options** button. Verify the **Sample Volume** is set to *1* and *Meters Cubed*. Leave the **Time Between Samples** at *zero* and the

Number of Cycles at *1* and press OK to return to Setup dialog. Select OK again to start the RAC on a cycle. See Figure 3-22 and Figure 3-23.

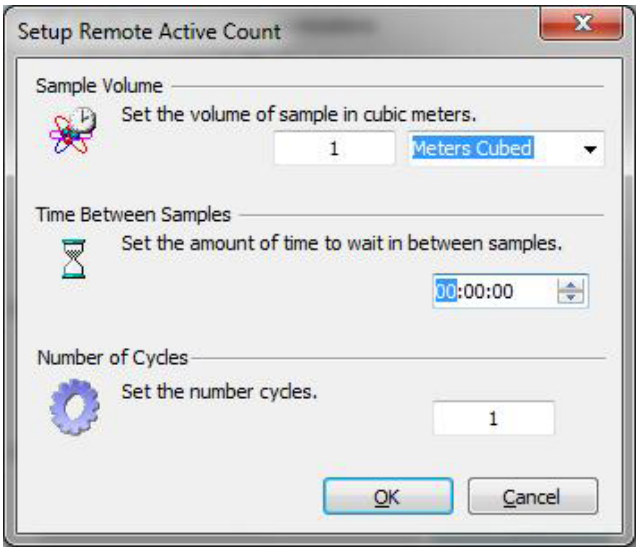

Figure 3-22 Setup Remote Active Count

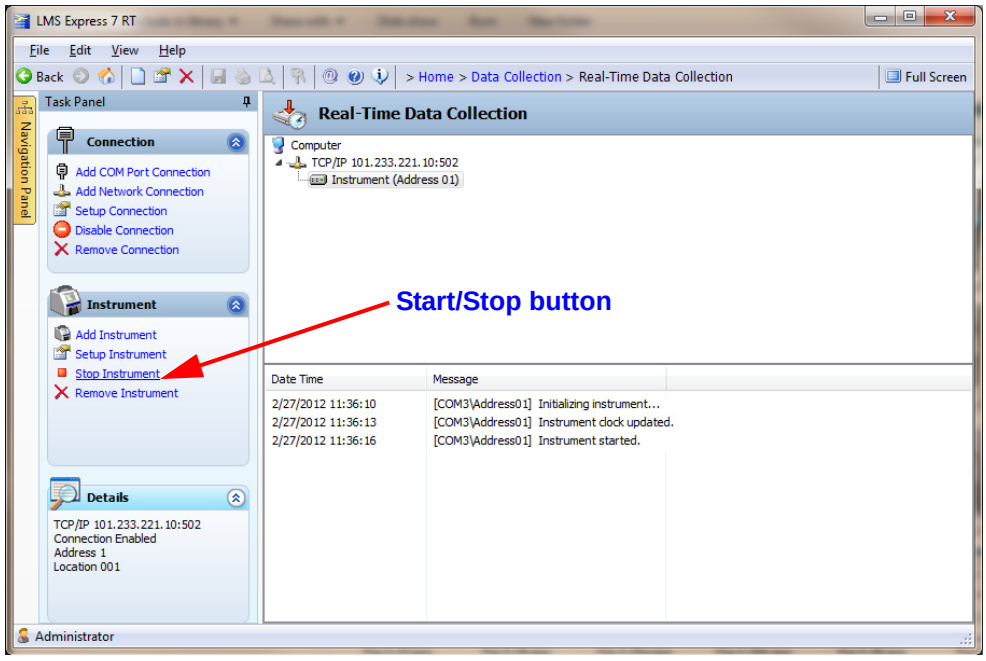

Figure 3-23 RAC System in Cycle

After the initial cycle has been completed, the instrument is now configured and can be controlled through LMS Express RT or by the Start/Stop button on the instrument.

Operate the RAC

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

Figure 3-24 Green Power LED

Note: *LMS Express RT only measures the estimated volume of sample for the Remote Active Count.*

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

Figure 3-25 Flow & Sampling LEDs

When the cycle is completed, the pump will shut off and the Flow and Sampling LEDs will turn off. If the flow does not measure 1 CFM ± 10% the Flow LED will blink until the correct flow is achieved.

4 *Install Options*

Overview

The REMOTE Active Count Pump 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.

Optional Components

A number of components have been designed for use with the RAC Pump to provide flexibile installation within facilities with layouts that don’t meet standard design criteria.

1. The RAC can be installed as a table-top unit with a top-mount Impactor;
2. The RAC can be wall-mounted and the Impactor can be slaved to a wall bracket or table-top stand;
3. The RAC can be equipment-mounted in a process location where needed;
4. Additional options may be discussed with Lighthouse Technical Support at 1-800-945-5905 (Toll Free USA) or 1-541-770-5905 (Outside of USA) before proceeding.

Figure 4-1 shows various optional components to customize the installation to meet the site needs.

RAC Pump Add-ons

Figure 4-1 Assorted RAC Accessories

5 Communications

Configuring with the MODBUS Protocol

The REMOTE Active Count uses Modbus Map v1.49. The product name needs to be “VIABLE” for LMS Express to recognize it as a RAC.

Note: Sample time must be calculated for the specific sample volume desired based on 1CFM flow. Sample time calculations are performed and written to the REMOTE Active Count by LMS Express.

Samples with multiple cycles must have the individual sample time calculated for each sample.

Configure the RAC

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 the number of cycles to register 40053.

Running the RAC

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

Table 5-2 Action Commands

Value	Register	Action
1	40002	Saves all writable 40002 register values to the EEPROM.
5	40002	Enable Remote Mode. Locks out the instrument's user interface. Can only change instrument parameters via MODBUS.
11	40002	Instrument Start. Uses defined Initial Delay, Hold Time, Sample Interval and counting mode. Instrument executes samples and holds until an Instrument Stop command is issued. This command will start the pump.
12	40002	Instrument Stop. Aborts current sample. Stops pump. Stops data collection.

Access RAC Information

Table 5-3 Read Commands

Value	Register	Action
50	40001	Read Device Information: Parse through device information. Verify "VIABLE" 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

A MODBUS Register Map v1.49

COMM Settings

Lighthouse 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

The MODBUS slave address is set on the particle counter.

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/writable. Not all holding registers are writable. 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 the description of this register in the table below.
40003	unsigned integer	Device Status. [bit 0=RUNNING, bit 1=SAMPLING, bit 2=NEW DATA, bit 3=DEVICE ERROR, 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 Type	Description
40020	ASCII string	Model Name char[10], char [11]
40021	ASCII string	Model Name char[12], char [13]
40022	ASCII string	Model Name char[14], char [15]
40023	unsigned integer	Flow Rate. Divide by 100 to get rate in CFM. For example, 100 = 1CFM.
40024	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 - 40 9).
40027	signed integer	Real Time Clock (RTC) [high]. Updates instrument's real-time clock. Works in conjunction with 40028. Displays date and time, in number of seconds since midnight, 1/1/1970. Can be generated by ANSI C/C++ time() function.
40028	signed integer	Real Time Clock [low]
40029	unsigned integer	Initial Delay [high]. Works in conjunction with 40030. Number of seconds to wait before starting the first sample. Max value is 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 Type	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. For example: 6550d = 65.50%
40041	ASCII string	Flow Unit. Defines unit as cfm, lpm, mlpm char[0], char[1] (NULL terminated string).
40042	ASCII string	Flow Unit. char[2], char[3]
40043	unsigned integer	Calibration Reference Voltage (millivolts)
...		
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]

Table A-3 Sensor Settings Registers

Register	Data Type	Description
40999	ASCII string	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 remained set until a stop command is executed.
1	**SAMPLING:** This is set only when the instrument is actually sampling data that is to be recorded. Caution must be used in sending a command during this time that may invalidate current sample.
2	**NEW DATA:** Set to 1 to indicate that a new data record has been recorded and it hasn't been read via modbus yet. When a data record has been read via modbus (registers 30001 to 30999), then this flag is reset to zero.
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 this register is read, it always returns a zero.

Table A-7 Command Register

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

Table A-7 Command Register

Value	Action
4	Saves the instrument parameters in the 40xxx registers to the EEPROM. Parameters include Sample Time, Hold Time, Initial Delay, and Location.
5	Enable Remote Control. Locks out the instrument's user interface. Can only change instrument parameters via MODBUS.
6	Enable Local Control. Unlocks the instrument's user interface. Instrument changes can be made at the device itself or through MODBUS.
7	Start local pump, if applicable - perform before 9 below.
8	Stop pump, if applicable - perform after 10 below.
9	Manual Start. The instrument samples continuously until it receives a Manual Stop command. Ignores local timing parameters. Sets Sample Time for data record to equal the time interval between the Manual Start and Manual Stop command. If applicable to device, does not start pump.
10	Manual Stop. Stops sampling. Records counts since Manual Start.
11	Instrument Start (Automatic Counting). Particle Counters: Uses defined Initial Delay, Hold Time, Sample Interval and counting mode. Instrument executes samples and holds until an Instrument Stop command is issued. For instruments with pumps, this command will start the pump. Manifold Controller: Uses defined Manifold Sequence. Stops counting and changing position when Instrument Stop command is issued.
12	Instrument Stop. Aborts current sample. Stops pump, if applicable. Stops data collection.
13	Set Real Time Clock. Writes "Data Set" values (from Registers 40035 & 40036) to the local Real Time Clock. New time value is saved.
14	Manifold Controller: Clear data register bank. Bank is reset and remains 0 until ne 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.

Table A-7 Command Register

Value	Action
1152	Changes instrument baud rate to 115200K upon command execution.

Data Registers

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

Example:

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

IEEE floating point has big-endian byte order and little-endian word order. Thus, analog data items are formed by placing the low bytes in front of the high bytes.

Example:

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

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

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

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

Table 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]

Table A-8 Data Registers

Register	Data Type	Description
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 int	Valid particle channels
30076	unsigned int	Alarm Flags - Particle Channels

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

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

Data Status Byte (30007 - 30008)

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

The registers used for the Data Status Byte are 30007 and 30008.

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

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

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

Table A-9 Data Status Byte

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

Bits 7 to 31 are currently unused.

Valid Data in Channels (30074)

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

Alarm Flags in Channels (30076)

Register 30076 represents the flag bits corresponding to particle

channels that have exceeded the threshold [Threshold High Registers (45xxx series)] based on alarm mode

Data Type Registers

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

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

Data Types are assigned 4 ASCII characters across 2 registers. If a Data Type string contains less than 4 characters, then the rest of the string is padded with NULL characters. Note that a Data Type using all four characters will not end with a 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: ***Only Particle data types have numbers in their strings.***

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

Table A-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. These registers run in parallel with the Data Registers. For example, Data Register 30010's Units Register is 42010.

Note: ***Not all data types have units.***

LWS Particle Counters may use units not on the table.

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

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

Table A-12 Data Units

Units	Description	Units	Description
#	Count (For Particles)	ft/m	Feet per minute
%	Percent	m/s	Meters per second
s	Seconds	"H2O	Inches of water
min	Minutes	"Hg	Inches of mercury
hour	Hours	mmWa	Millimeters of water
F	Fahrenheit	mmHg	Millimeters of mercury
C	Celsius	cmHg	Centimeters of mercury
K	Kelvin	Pa	Pascals
ft	Feet	kPa	Kilopascals

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 foot
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 milliliter

Data and Alarm Registers

Data and Alarm Enable Registers

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

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

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

Table 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.

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

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

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

Table A-14 Alarm Enable Registers

Register	Data Type	Description
43009	unsigned int	Enable for Particle Channel 1 [high] (smallest particle size starts here)
43010	unsigned int	Enable for Particle Channel 1 [low]
43011	unsigned int	Enable for Particle Channel 2 [high]
43012	unsigned int	Enable for Particle Channel 2 [low]
43013	unsigned int	Enable for Particle Channel 3 [high]
43014	unsigned int	Enable for Particle Channel 3 [low]
43015	unsigned int	Enable for Particle Channel 4 [high]
43016	unsigned int	Enable for Particle Channel 4 [low]
43017	unsigned int	Enable for Particle Channel 5 [high]
43018	unsigned int	Enable for Particle Channel 5 [low]
43019	unsigned int	Enable for Particle Channel 6 [high]
43020	unsigned int	Enable for Particle Channel 6 [low]
43021	unsigned int	Enable for Particle Channel 7 [high]
43022	unsigned int	Enable for Particle Channel 7 [low]
43023	unsigned int	Enable for Particle Channel 8 [high]
43024	unsigned int	Enable for Particle Channel 8 [low]
43041	unsigned int	Enable for Analog Channel 1 [high]
43042	unsigned int	Enable for Analog Channel 1 [low]
43043	unsigned int	Enable for Analog Channel 2 [high]
43044	unsigned int	Enable for Analog Channel 2 [low]

Table A-14 Alarm Enable Registers

Register	Data Type	Description
43045	unsigned int	Enable for Analog Channel 3 [high]
43046	unsigned int	Enable for Analog Channel 3 [low]
43047	unsigned int	Enable for Analog Channel 4 [high]
43048	unsigned int	Enable for Analog Channel 4 [low]

Enable Alarming for a Channel

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

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

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

Table A-15 Example of Alarming on Channel 2

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

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

Threshold Setup Registers

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

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

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

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

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

Table A-16 Alarm Threshold Registers

Register	Data Type	Description
45009	unsigned int	Threshold for Particle Channel 1 [high] (smallest particle size starts here)
45010	unsigned int	Threshold for Particle Channel 1 [low]
45011	unsigned int	Threshold for Particle Channel 2 [high]
45012	unsigned int	Threshold for Particle Channel 2 [low]
45013	unsigned int	Threshold for Particle Channel 3 [high]
45014	unsigned int	Threshold for Particle Channel 3 [low]
45015	unsigned int	Threshold for Particle Channel 4 [high]
45016	unsigned int	Threshold for Particle Channel 4 [low]
45017	unsigned int	Threshold for Particle Channel 5 [high]
45018	unsigned int	Threshold for Particle Channel 5 [low]
45019	unsigned int	Threshold for Particle Channel 6 [high]
45020	unsigned int	Threshold for Particle Channel 6 [low]
45021	unsigned int	Threshold for Particle Channel 7 [high]
45022	unsigned int	Threshold for Particle Channel 7 [low]

Table A-16 Alarm Threshold Registers

Register	Data Type	Description
45023	unsigned int	Threshold for Particle Channel 8 [high]
45024	unsigned int	Threshold for Particle Channel 8 [low]

Setting the Alarm Threshold Value

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

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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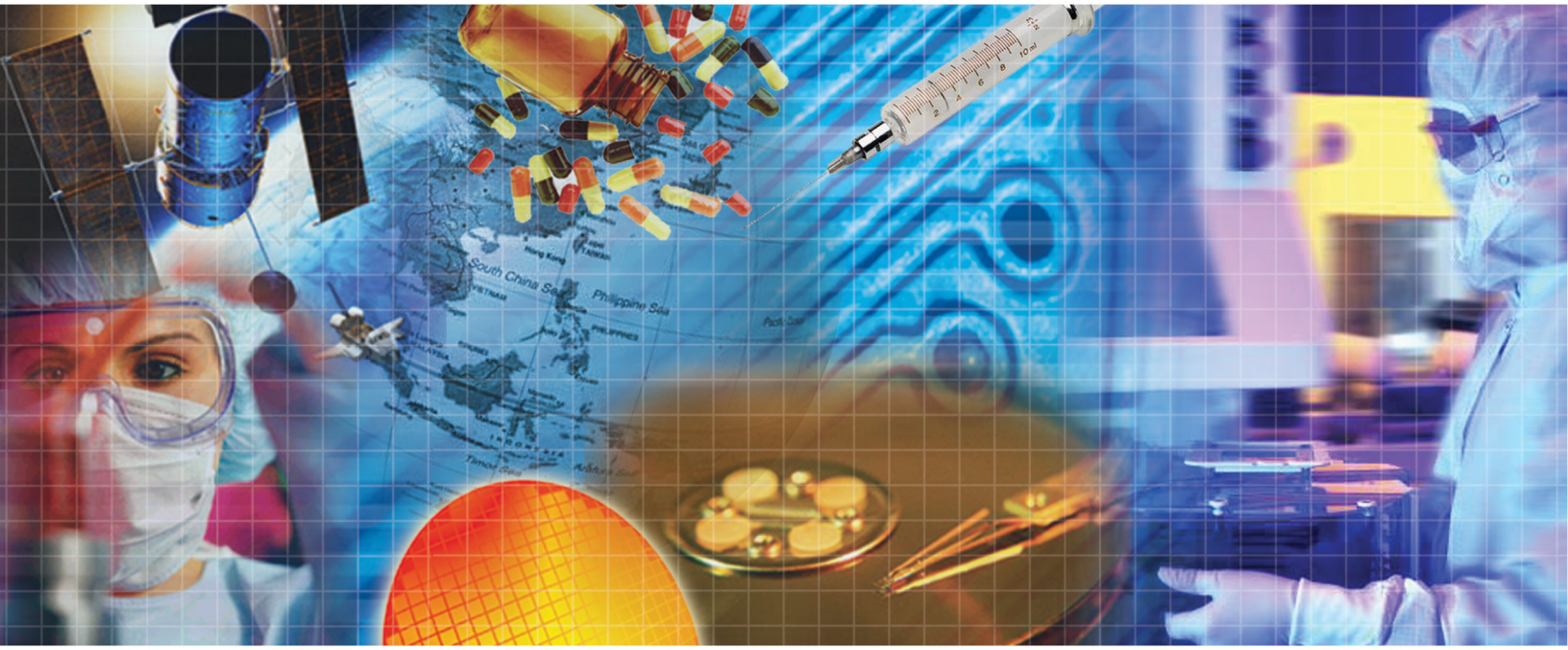

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