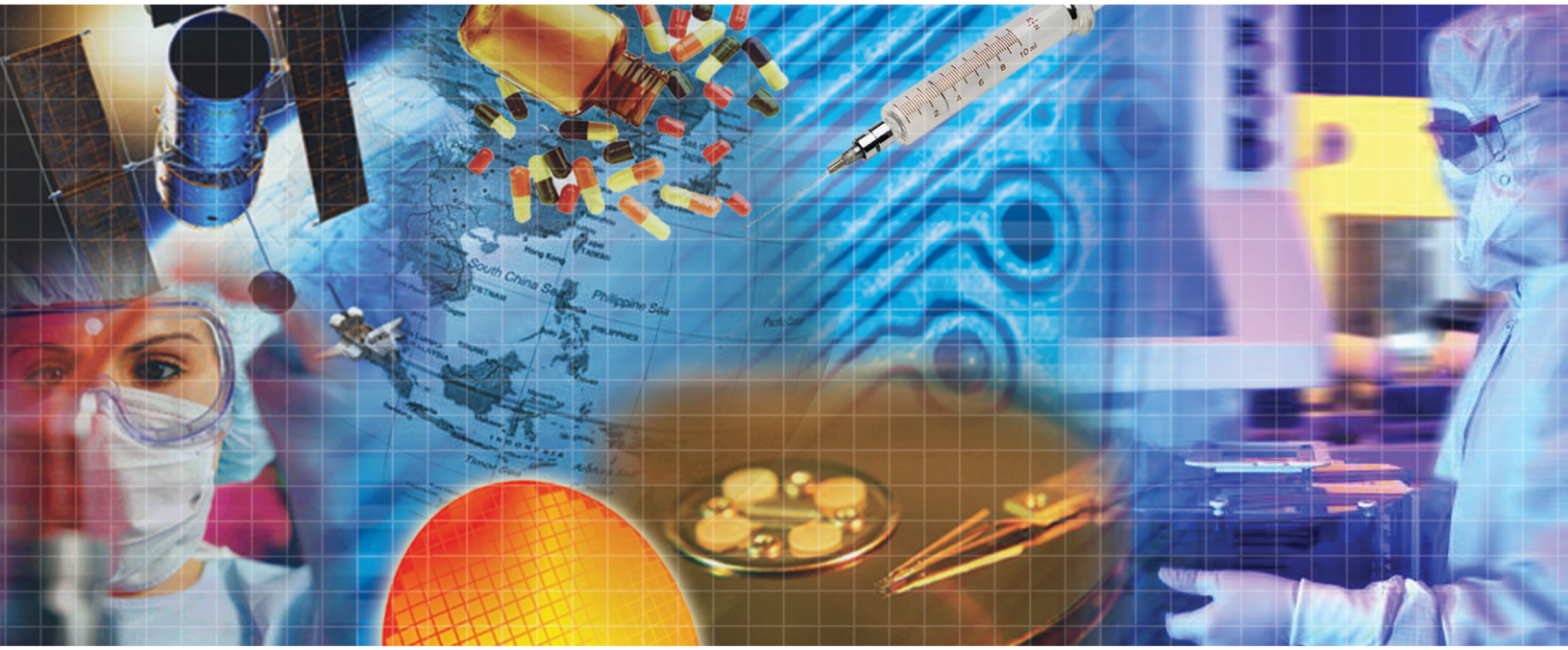

LIGHTHOUSE
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REMOTE 4 SERIES

Airborne Particle Counter

Operating Manual

Lighthouse Worldwide Solutions

REMOTE 4 Series Airborne Particle Counter

Operating Manual

LWS Part Number 248083213-1 Rev 8

EU DECLARATION OF CONFORMITY

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

Declares that the product:

Product Name:	REMOTE Airborne Particle Counter
Model Number(s):	REMOTE 2014, 3014, 3104, 5014, 5104, 50104

Conforms to the following Product Specifications:

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

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

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

Fremont, CA. May 15, 2007

William Shade - V.P. Engineering

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About this Manual

This manual describes the detailed operation and use of the Lighthouse REMOTE 4 Series Airborne Particle Counters.

Text Conventions

The following typefaces have the following meanings:

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

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

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

Additional Help

For more information about Lighthouse REMOTE 4 Series Airborne Particle Counters, contact Lighthouse Worldwide Solutions.

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

1 General Safety

Safety Considerations

Warnings and cautions are used throughout this manual. It is the user's responsibility to familiarize themselves with the meaning of a warning before operating the particle sensor. All warnings will appear in the left margin of the page next to the subject or step to which it applies. Take extreme care when doing any procedures preceded by or containing a warning.

There are several classifications of Warnings defined as follows:

- Laser - pertaining to exposure to visible or invisible Laser radiation
- Electrostatic - pertaining to electrostatic discharge

Laser Safety Information

This product contains a Laser-based sensor that is a Class 1 product (as defined by 21 CFR, Subchapter J of the Health and Safety Act of 1968) when used under normal operation and maintenance. Service procedures on the sensor can result in exposure to invisible radiation. Service should be performed only by factory-authorized personnel.

The particle counter has been evaluated and tested in accordance with EN 610109-1:1993, "Safety Requirements For Electrical Equipment for Measurement, Control, and Laboratory Use" and IEC 825-1:1993, "Safety of Laser Products".

WARNING: ***The use of controls, adjustments, or performance of procedures other than those specified within this manual may result in exposure to invisible (infrared) radiation that can quickly cause blindness.***

Figure 1-1 Warning label on unit

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

Electrostatic Safety Information

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

WARNING: ***Using a wrist-strap without an isolation resistor will increase the severity of an electrical shock.***

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

2 *Introduction*

Overview

This operating manual introduces the Lighthouse REMOTE 2014, 3014, 3104, 5014, 5104 and 50104 family of Airborne Particle Counters. Also included in this manual are instructions for inspecting, using, and maintaining the instrument.

Description

The 2014 instrument has up to four particle-size channels starting at 0.2 microns with a flow of 0.1 CFM.

The 3014 instrument has up to four particle-size channels starting at 0.3 microns with a flow of 0.1 CFM.

The 3104 instrument has up to four particle-size channels starting at 0.3 microns with a flow of 1.0 CFM.

The 5014 instrument has up to four particle-size channels starting at 0.5 microns with a flow of 0.1 CFM.

The 5104 instrument has up to four particle-size channels starting at 0.5 microns with a flow of 1.0 CFM.

The 50104 instrument has up to four particle-size channels starting at 0.5 microns with a flow of 1.0 CFM

The model number signifies the minimum particle size measured by the instrument and the flow rate. For example, the number "3014" indicates a 0.3 m channel size at 0.1 CFM.

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Figure 2-1 REMOTE 3014 Airborne Particle Counter

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

The result is the electronic circuit outputs a voltage pulse each time a particle crosses the laser beam. The width of the voltage pulse is proportional to the time it takes the particle to cross the laser beam. The amplitude of the voltage pulse is proportional to the light scattered which in turn is proportional to the size of the particle.

The voltage pulses created by the particles are then processed by additional electronics that analyzes the height of each pulse and therefore the size of each corresponding particle. Thus the number of particles at various sizes is determined.

This instrument is effective in both ultra-clean areas (such as Class 1 or Class 10) and also in more traditional cleanzones rated as Class 100 or higher. Refer to Specifications in this manual for additional instrument information.

The REMOTE 2014, 3014, 3104, 5014, 5104 and 50104 line of Airborne Particle counters was created for continuous operation 24 hours per day, 7 days per week.

Using an external vacuum source, the instrument provides versatile mounting options and can be installed where space is at a premium. The REMOTE 2014, 3014, 3104, 5014, 5104 and 50104 integrates seamlessly with large facility monitoring/management systems and transfers up to 4 channels of simultaneous particle count data using RS-485/MODBUS or RS-485 MR Protocol output.

Accessories

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

- **Isokinetic Sampling Probe 0.1 or 1.0 CFM**
- **Sample Tubing**
- **Cabling**
- **0.1µm Purge Filter Assembly 0.1 or 1.0 CFM Flow Rate with Tubing**
- **Temperature / Relative Humidity Probe**
- **Vacuum tubing per foot**
- **Cable per foot**

REMOTE 2014 Specifications

Size Range	0.2 - 2.0 m
Channel Thresholds	Standard: 0.2, 0.3 µm
	Optional: 0.2, 0.3, 0.5, 1.0 µm Other sizes available; specify at time of order
Flow Rate	0.1 CFM (2.83 LPM)
Counting Efficiency	50% (per ISO 21501-4)
Laser Source	Laser diode
Data Storage	Rotating Buffer, 2000 records
Zero Count Level	<1 count/5 minutes (per ISO 21501-4)
Calibration	NIST Traceable
Communication Modes	RS-232/RS-485 Modbus or MR Protocol
Supporting Software	Lighthouse Monitoring System, LMS XChange, LMS Express
Environmental Sensors	Optional: Temperature / Relative Humidity
Power Input Requirements	24VDC ±5% @ 620mA maximum
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Dimensions	2.0"[l] x 4.2"(w) x 3"(h) [5.0 x 10.7 x 7.6 cm]
Weight	15.6 oz (0.44 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

Table 2-1 REMOTE 2014 Specifications

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

The Service LED will turn on during sampling and remain on when annual calibration is due.

REMOTE 3014 Specifications

Size Range	0.3 - 10.0 m
Channel Thresholds	Standard: 0.3, 0.5 µm
	Optional: 0.3, 0.5, 1.0, 5.0 µm Other sizes available; specify at time of order
Flow Rate	0.1 CFM (2.83 LPM)
Counting Efficiency	50% (per ISO 21501-4)
Data Storage	Rotating Buffer, 2000 records
Laser Source	Laser diode
Zero Count Level	<1 count/5 minutes (per ISO 21501-4)
Calibration	NIST Traceable
Communication Modes	RS-232/RS-485 Modbus or MR Protocol
Supporting Software	Lighthouse Monitoring System, LMS XChange, LMS Express
Environmental Sensors	Optional: Temperature / Relative Humidity
Power Input Requirements	24VDC ±5% @ 620mA max
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Dimensions	1.7"[l] x 4.2"(w) x 3"(h) [4.3 x 10.7 x 7.6 cm]
Weight	15.6 oz (0.44 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

Table 2-2 REMOTE 3014 Specifications

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

The Service LED will turn on during sampling and remain on when annual calibration is due.

REMOTE 3104 Specifications

Size Range	0.3 - 10.0 m
Channel Thresholds	Standard: 0.3, 0.5 µm
	Optional: 0.3, 0.5, 1.0, 5.0 µm Other sizes available; specify at time of order
Flow Rate	1.0 CFM (28.3 LPM)
Counting Efficiency	50% (per ISO 21501-4)
Data Storage	Rotating Buffer, 2000 records
Laser Source	Laser diode
Zero Count Level	<1 count/5 minutes (per ISO 21501-4)
Calibration	NIST Traceable
Communication Modes	RS-232/RS-485 Modbus or MR Protocol
Supporting Software	Lighthouse Monitoring System, LMS XChange, LMS Express
Environmental Sensors	Optional: Temperature / Relative Humidity
Power Input Requirements	24VDC ±5% @ 620mA max
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Dimensions	3.5"[l] x 4.2"(w) x 3.3"(h) [8.89 x 10.66 x 8.38 cm]
Weight	32 oz (0.90 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

Table 2-3 REMOTE 3104 Specifications

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

The Service LED will turn on during sampling and remain on when annual calibration is due.

REMOTE 5014 Specifications

Size Range	0.5 - 25.0 m
Channel Thresholds	Standard: 0.5, 5.0 µm
	Optional: 0.5, 1.0, 5.0, 10.0 µm Other sizes available; specify at time of order
Flow Rate	0.1 CFM (2.83 LPM)
Counting Efficiency	50% (per ISO 21501-4)
Data Storage	Rotating Buffer, 2000 records
Laser Source	Laser diode
Zero Count Level	<1 count/5 minutes (per ISO 21501-4)
Calibration	NIST Traceable
Communication Modes	RS-232/RS-485 Modbus or MR Protocol
Supporting Software	Lighthouse Monitoring System, LMS XChange, LMS Express
Environmental Sensors	Optional: Temperature / Relative Humidity
Power Input Requirements	24VDC ±5% @ 620mA max
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Dimensions	1.7"[l] x 4.2"(w) x 3"(h) [4.3 10.7 x 7.6 cm]
Weight	15.6 oz (0.46 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

Table 2-4 REMOTE 5014 Specifications

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

The Service LED will turn on during sampling and remain on when annual calibration is due.

REMOTE 5104 Specifications

Size Range	0.5 - 25.0 m
Channel Thresholds	Standard: 0.5, 5.0 µm
	Optional: 0.5, 1.0, 5.0, 10.0 µm Other sizes available; specify at time of order
Flow Rate	1.0 CFM (28.3 LPM)
Counting Efficiency	50% (per ISO 21501-4)
Data Storage	Rotating Buffer, 2000 records
Laser Source	Laser diode
Zero Count Level	<1 count/5 minutes (per ISO 21501-4)
Calibration	NIST Traceable
Communication Modes	RS-232/RS-485 Modbus or MR Protocol
Supporting Software	Lighthouse Monitoring System, LMS XChange, LMS Express
Environmental Sensors	Optional: Temperature / Relative Humidity
Power Input Requirements	24VDC ±5% @ 620mA max
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Dimensions	1.7"[l] x 4.2"(w) x 3"(h) [4.3 10.7 x 7.6 cm]
Weight	15.6 oz (0.44 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

Table 2-5 REMOTE 5104 Specifications

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

The Service LED will turn on during sampling and remain on when annual calibration is due.

REMOTE 50104 Specifications

Size Range	5.0 - 100.0 m
Channel Thresholds	Standard: 20.0, 30.0 µm
	Optional: 5.0, 10.0, 20.0, 30.0 µm Optional: 5.0, 10.0, 50.0, 100.0µm Optional: 5.0, 25.0, 50.0, 100.0µm
Flow Rate	1.0 CFM (28.3 LPM)
Counting Efficiency	50% (per ISO 21501-4)
Data Storage	Rotating Buffer, 2000 records
Laser Source	Laser diode
Zero Count Level	<1 count/5 minutes (per ISO 21501-4)
Calibration	NIST Traceable
Communication Modes	RS-232/RS-485 Modbus or MR Protocol
Supporting Software	Lighthouse Monitoring System, LMS XChange, LMS Express
Environmental Sensors	Optional: Temperature / Relative Humidity
Power Input Requirements	24VDC ±5% @ 620mA max
External Alarm Output	Normally Open Dry Contact Rated 0-60 V AC/DC 1 Amp
Enclosure	Stainless Steel
Dimensions	3.5" (L) x 4.2" (W) x 3.3" (H) [8.89 x 10.66 x 8.38 cm]
Weight	2 lb (0.90 kg)
Operating Temp/RH	50° F to 104° F (10° C to 40° C) / 20% to 95% non-condensing
Storage Temp/RH	14° F to 122° F (-10° C to 50° C) / Up to 98% non-condensing

Table 2-6 REMOTE 50104 Specifications

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

The Service LED will turn on during sampling and remain on when annual calibration is due.

3 Getting Started

Initial Inspection

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

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

If the carton is not damaged, keep it for reshipment when returning the instrument for the annual factory calibration.

Shipping Instructions

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

WARNING: ***If the instrument is damaged during 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, nozzle caps and packing materials whenever possible. Remove any instrument battery and package it to ship separately - refer to www.golighthouse.com/rma for detailed instructions. Remove attachments, such as TRH or Isokinetic probes, and package to prevent physical and ESD 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. Contact Lighthouse to purchase a replacement shipping container and nozzle caps.
3. Seal container or carton securely. Mark “FRAGILE” and write the Return Merchandise Authorization (RMA) number on any unmarked corner.
4. Return the instrument to the address provided by a Lighthouse representative or the RMA website.

Operation

Understanding the LEDs

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

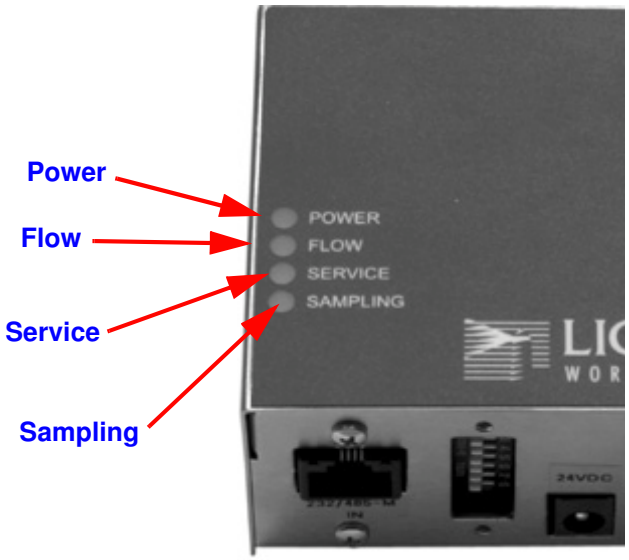


Figure 3-1 Front Panel LEDs

- The green POWER LED turns on when the instrument is powered on.
- The green FLOW LED turns on steady when the flow is within specification.
- The green FLOW LED will blink if the flow is out of specification.
- The orange SERVICE LED will stay on steady during sampling if Laser power is out of range, calibration is due, the sensor optics are dirty or the view volume contains foreign objects.
- The blue SAMPLING LED indicates that the instrument is in a sampling state.

Connections

The top of the instrument has two connections: the inlet and optional temperature/relative humidity probe.

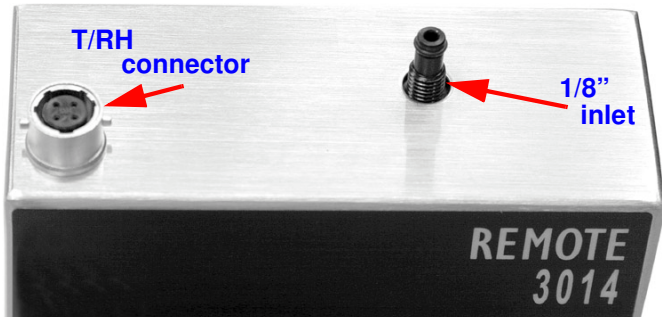


Figure 3-2 Connections on Top

The sensor can be used with a direct-mount 0.1 CFM (or 1.0 CFM for 3104/5104/50104) isokinetic probe or the probe can be attached via 1/8" ID tubing to a 1/8" inlet barb.

The optional temperature/relative humidity probe is a 0-5v sensor that can be ordered from Lighthouse Worldwide Solutions.

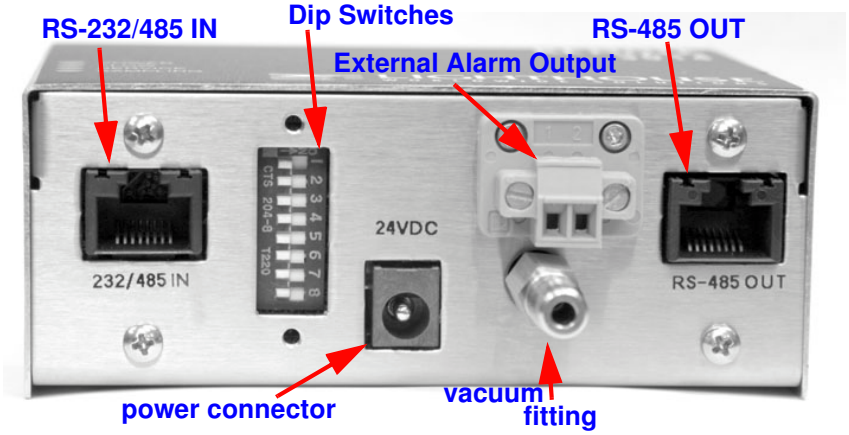


Figure 3-3 Connections on the Bottom of Instrument

Communication Ports

WARNING: ***When daisy chaining multiple instruments, only connect IN ports to OUT ports; Do not connect an IN port to another IN port. This will cause damage on the board.***

The RS-232/485 IN port is a dual purpose connection. It is a hybrid of the MODBUS over Serial standard incorporating both short distance point-to-point RS-232 and long distance multi-point RS-485.

The RS-232 connection is provided for quick simple cable connections to a standard PC COM port.

The RS-485 connection is provided for industrial applications with multiple devices on the same bus. The RS-485 IN and OUT connectors allow for easy quality connections using standard CAT 5 patch cables commonly used for office LANs. Connecting the counter to a PC via RS-485 requires an RS-485 to RS-232 converter, cables, connectors and terminator; please contact a Lighthouse Sales Representative for the LWS RS-485 converter kit.

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

DIP Switches

The DIP switches are used for addressing the instrument for RS-485 daisy chain configurations and setting the communications mode. See “DIP Switch configuration for Communications Mode” on page 4-2 for details.

Positions 1-6 set the address of the instrument.

Position 7 and 8 set the communications mode.

The DIP Switches require a tool with a small, pointed tip in order to change. A very small screwdriver or multimeter probe can be used.

Power

This REMOTE instrument uses an external 24v power supply. Please contact a Lighthouse Sales Representative for this item.

The power input is 100-240 VAC, 47-63Hz, 0.4A.

The power output is +24V, 0.62A.

External Alarm Output

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

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

The external alarm is triggered when the particle count for the channel with alarms enabled exceeds the configured threshold. The light will stay on until the beginning of the next sample. It will then reset until the next event exceeds the threshold value.

Vacuum Inlet

The vacuum inlet uses 1/4" ID tubing.

The vacuum required must be at least 18" (45.7 cm) of Hg to maintain 0.1 or 1.0 cfm through the sensor. The flow is controlled by an internal critical orifice.

If not enough vacuum is present to provide 0.1 CFM (Models 2014, 3014, 5014) or 1.0 CFM (Models 3104, 5104, 50104), the FLOW LED will blink. In this case, please contact Lighthouse Worldwide Solutions Technical Support at techsupport@golighthouse.com.

Data Download

Lighthouse provides several software products to download, monitor and manage data gathered by the REMOTE 4 series of instruments, as well as other RS485/MODBUS counters. When these instruments are connected to an RS485 network that is monitored and managed by a PC running the Lighthouse Monitoring System (LMS) Express, Express Real Time (RT), Express or LMSNet, they are identified and can be controlled by the software. Data can be downloaded from the instruments and put into graphs and charts and archived for future use.

LMS XChange software can be used to download the instrument data directly to a standalone PC and incorporated into an Excel® spreadsheet for analysis and hard copy.

For additional information on use of these products, refer to the software Operating Manual or contact Lighthouse Sales and Support, the numbers for which are provided at the beginning of this book.

4 Communications

This chapter contains information regarding the communications hardware and how to setup the communications in order to program and communicate with the REMOTE instrument.

DIP Switches

The DIP switches are behind a panel in between the RS232/485 IN port and the power connector.

Figure 4-1 Panel Covering the DIP Switches

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

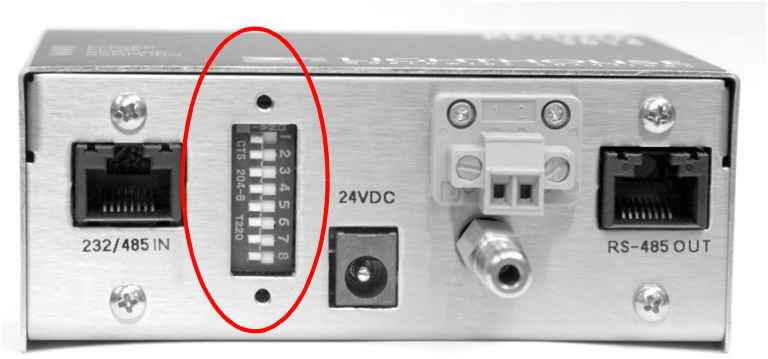


Figure 4-2 Panel Removed, Switches Exposed

DIP Switch General Definitions

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

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

Table 4-1 DIP Switch settings

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

Communication Modes

There are three communication modes for the REMOTE3014 family: MODBUS protocol, MR protocol and ASCII mode with four possible configurations. Table 4-2 displays those modes.

Table 4-2 DIP Switch configuration for Communications Mode

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

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

DIP Switch Addressing

Note: *Because Address 0 is reserved for broadcasting in MODBUS RS-485 communications, Address 1 is set both when all the DIP switches are OFF or when DIP switch1 is ON. For MR Protocol, Address 0 is set when all the DIP switches are OFF.*

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

Table 4-3 DIP Switch Addressing

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

Table 4-3 DIP Switch Addressing

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

Communicating with the Instrument

The RJ-45 connector on the instrument (marked "232/485 IN" in Figure 4-3) is used to connect the unit to a COM port on a desktop or laptop PC.

Figure 4-3 Communications Ports, Showing Pin Numbers

RS-232/485 IN Port

The RJ-45 connector on the instrument's 232/485 IN port has both RS-232 and RS-485 lines. The pinouts are displayed in Table 4-4.

Table 4-4 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

WARNING: ***When daisy-chaining multiple instruments together, only connect IN ports to OUT ports. Do NOT connect an IN port to another IN port using a cable that has all 8 wires in use; board damage will occur. If using a cable that utilizes only pins 4 and 5, no damage will occur.***

A modular adapter, RJ-45 to DB-9, to connect to the COM port of the computer is available from Lighthouse. The pinouts of the adapter are shown in Table 4-5.

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

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

RS-485 OUT Port

The RS-485 OUT port only has the 2 lines for the RS-485 communications. Table 4-6 displays the pin assignments.

Table 4-6 RS-485 OUT Port

RJ-45 Pin	Signal Name
1	Not Used
2	Not Used
3	Not Used
4	**RS-485B**
5	**RS-485A**
6	Not Used
7	Not Used
8	Not Used

RS-232 Communications

The instrument can use RS-232 communications in a point-to-point configuration.

To connect the instrument to a computer using RS-232 Protocol:

1. Remove power from the instrument.
2. Connect the RJ-45 end of the adapter cable to the 232/485-IN port on the instrument.
3. Connect the DB-9 end of the cable to a COM (Serial) Port on a computer.
4. Any available COM Port may be used.
5. Ensure that DIP Switch 8 is set to OFF (DOWN) for MODBUS or MR protocol mode; set DIP Switch 8 to ON (UP) for ASCII programming mode. Refer to Table 4-2 on page 4-2.

RS-485 Communications

The instrument can utilize RS-485 communications if the instrument is more than 50 feet from the computer or in a multi-point daisy chain configuration.

In order to use the RS-485 protocol, an RS-485 converter must be used in a 2-wire configuration where ChB+ goes to RJ-45 pin 4, ChA- goes to RJ-45 pin 5.

Lighthouse has an RS-485 converter kit that includes the cables, connectors and terminator needed to set this up; please contact a Lighthouse Sales Representative for this.

To connect the instrument to a computer using RS-485 Protocol:

1. Remove power from the instrument.
2. Connect one end of the RJ-45 cable to the RS-485 converter: pin 4 to ChB+ and pin 5 on ChA-.
3. Connect the other end of the RJ-45 cable to the 232-485 IN port on the instrument.
4. Connect the RS-232 DB9 side of the RS-485 converter to the DB9 COM port on the computer with a DB9 Male to DB9 Female straight through cable. Any available COM Port may be used.
5. Ensure that DIP Switch 8 is set to OFF (DOWN).
6. Power on the instrument.

To connect multiple units together in a daisy chain, use RJ-45 cable to connect the RS-485 OUT port of the first instrument to the 232-485 IN port of the next instrument in the chain. Continue connecting the OUT ports to the IN ports of all the units. At the end of the chain, insert a 100ohm terminating block in the last OUT port.

This instrument follows the RS-485 standards for distances and number of devices on a chain. The Electronics Industry Association (EIA) has produced standards for RS485 that deal with data communications. Table 4-7 displays the industry standards.
.

Table 4-7 EIA Industry Standards for RS485 Communications

SPECIFICATIONS	RS485
Mode of Operation	Differential
Total Number of Drivers and Receivers on One Line (One driver active at a time for RS485 networks)	32 Drivers 32 Receivers
Maximum Cable Length	4000 ft (1,219.2 m)
Maximum Data Rate (40 ft - 4000 ft for RS422/RS485)	10Mb/s - 100Kb/s
Maximum Driver Output Voltage	-7V to +12V
Driver Output Signal Level (Loaded Min.): LOADED	+/-1.5V
Driver Output Signal Level (Loaded Max.): UNLOADED	+/-6V
Driver Load Impedance (Ohms)	54
Max Driver Current in High Z State (POWER ON)	+/-100 A
Max Driver Current in High Z State (POWER OFF)	+/-100 A
Receiver Input Voltage Range	-7V to +12V
Receiver Input Sensitivity	+/-200mV
Receiver Input Resistance (Ohms), (1 Standard Load for RS485)	>=12k

5 Maintenance Procedures

Introduction

This chapter provides instructions for routine maintenance that may be required for the REMOTE 2014, 3014, 5014, 3104, 5104 and 50104 instrument.

The maintenance procedures described in this chapter are not required on regular or prescribed intervals and should be performed only if the user has reason to question the data they are receiving from the instrument.

Safety

Before performing any of the maintenance tasks described in this chapter, read Chapter 1 of this manual and become familiar with the warnings and caution labels.

Maintenance

Calibration

During sampling, the Service LED will illuminate and stay ON if the instrument has exceeded its CalDue Date and must be recalibrated. To maintain optimum performance of this instrument, it should be recalibrated annually by a Lighthouse Authorized Service Provider.

Purge Count Test

This section will provide the user with the procedure to check the counter for zero counts. A purge filter must be attached to the instrument and six (6) five (5) minute samples must be taken. There should be no more than 1 count on average per five-minute sample.

1. Connect the Purge filter to the sample inlet.
2. Connecting Purge filter
3. Apply power to the instrument.
4. Configure the unit to sample for 30 minutes.

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

6. Configure the unit to sample for 5 minutes with a 10-second hold.

7. Allow the instrument to take 6 samples.

8. If an average of more than one count per five-minute period is reported, allow the instrument to sample for 30 minutes to purge it, then repeat the test.

9. After the instrument has met the requirement of the Purge Count test, return the instrument to its normal location and operating status.

Fault Isolation

If the instrument does not pass the Purge Count test, please perform the following procedure:

1. Check the data over the last 6 five-minute sample times.

2. If sporadic counts over all channels are occurring, the unit may still have particles inside it. Allow the unit to sample overnight with the purge filter attached before retesting it. If the counts are still high after the overnight purge, call Lighthouse Technical Support for assistance.

3. If the data shows consistent counts in the smallest channel only, the instrument may have electrical problems and may need to be returned to Lighthouse. Call a Lighthouse Service Representative for assistance.

6 Configuring with Lighthouse ASCII Protocol

General Info

The REMOTE 2014, 3014, 3104, 5014, 5104 and 50104 family of instruments can be programmed with an ASCII terminal. The Lighthouse ASCII protocol is a simple user interface to configure the device's parameters. This ASCII configuration mode can be used in conjunction with either the MODBUS or the MR protocol to quickly set up the counter.

Terminal Setup

To use an ASCII terminal such as HyperTerminal, the settings to use are 19200 baud, 8 Data bits, NO parity, 1 Stop bit, NO flow control. See Figure 6-1.

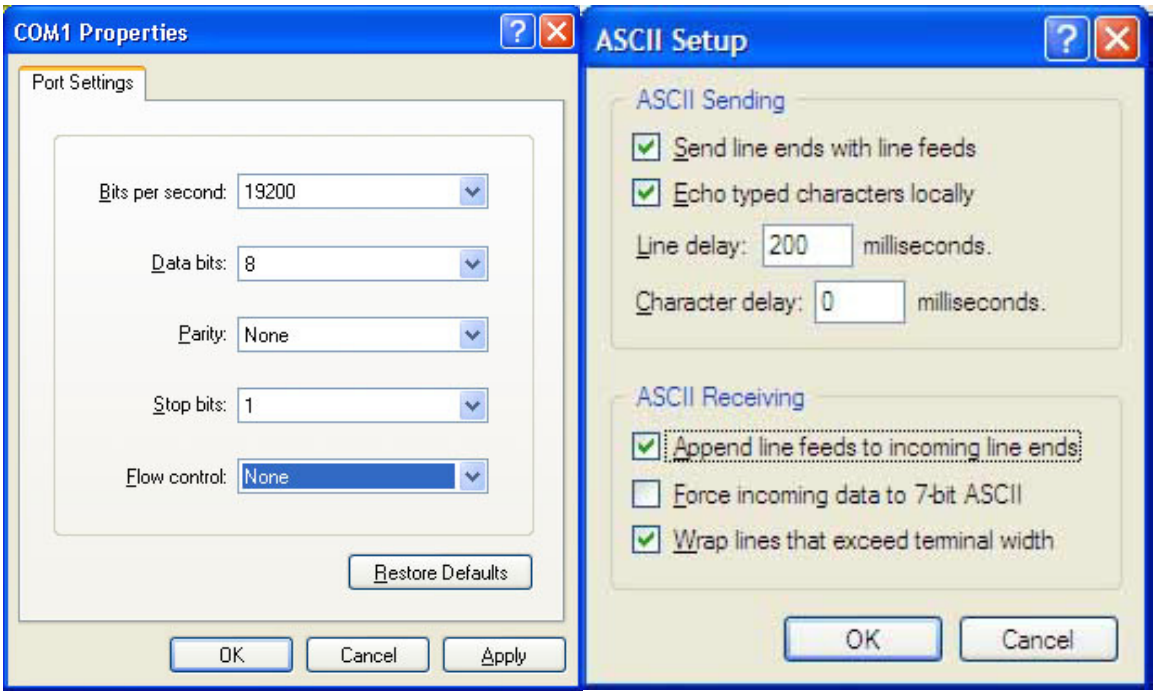


Figure 6-1 Hyperterminal Configuration Settings

ASCII Command Structure

The commands are defined as case-sensitive ASCII characters. The numeral ’1’ is used, not a lower case ’L’, and the format is defined as:

<xx [yyyy]>

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

where:

< = Start Character

xx = Command Character

yyyy = Optional Command Parameter

> = End Character

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

Handshake

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

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

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

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

371mV=.371V

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

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

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

Configuration Commands

The basic user configuration commands are described in Table 6-1.

Table 6-1 User Menu Commands <m1>

Command	Description
<?>	**Display Parameters** Displays current configuration parameters.
<V>	**Verbose Mode** Sets instrument to echo responses.
<sa>	**Start Counting** Instrument starts counting immediately using configured sample time; will show first sample after sample time passes.
<sb>	**Stop Counting** Instrument stops counting; can send more programming commands after sending <V> command.
<gc>	**Get Cal Date/Time** Displays the calibration due date.
<gd>	**Get Date/Time** Displays the current Real Time Clock date and time.
<gm>	**Get Model Name** Displays the instrument model name and number.
<gs>	**Get Serial Number** Displays the instrument serial number.
<gv>	**Get Version Number** Displays the firmware version.
<ta#>	**Set Sample Seconds** Configures the sample time interval where # is the number of seconds in the sample. The maximum value is 23 hours, 59 minutes, 59 seconds, or 83699 seconds.
<tb#>	**Set Holdtime Seconds** Configures the time between samples when the unit is not counting; # is the hold time in seconds.
<pa#>	**Set Location Num (0-999)** Configures the location of the instrument.
<aa#>	**Enable Alarm Channel #** Enables any channel (# = channel number) to trigger the alarm condition. Use values of 1 or 2 for 2-channel counters and 1, 2, 3 or 4 for 4-channel counters. Repeat for each channel desired.

Table 6-1 User Menu Commands <m1>

Command	Description
<ax#>	**Disable Alarm Channel #** Disables the alarm condition for a specific channel. Use values of 1 or 2 for 2-channel counters and 1, 2, 3 or 4 for 4-channel counters. Repeat for each channel desired.
<a1#>	**Set Channel 1 Alarm Threshold (# of counts)** The alarm channel counts must exceed # to trigger the alarm condition.
<a2#>	**Set Channel 2 Alarm Threshold (# of counts)** The alarm channel counts must exceed # to trigger the alarm condition.
<a3#>	**Set Channel 3 Alarm Threshold (# of counts)** The alarm channel counts must exceed # to trigger the alarm condition.
<a4#>	**Set Channel 4 Alarm Threshold (# of counts)** The alarm channel counts must exceed # to trigger the alarm condition.
<ae#>	**Set Alarm Suppression #** The number of alarm conditions have to exceed # to turn on the Alarm Relay. Used for Local Alarming.
<da#>	**Set Year = YY** Configures the 2 digit year; ex: <da09> for 2009
<db#>	**Set Month = MM** Configures the 2 digit month; ex: <db01> for 01
<dc#>	**Set Day = DD** Configures the 2 digit day; ex: <dc28> for 28
<dd#>	**Set Hour = HH** Configures the 2 digit hour; ex: <dd13> for **13**:00:00
<de#>	**Set Minute = MMin** Configures the 2 digit minute; ex: <de25> for 13:**25**:00
<df#>	**Set Second = SS** Configures the 2 digit second; ex: <df43> for 13:25:**43**

Getting Started

1. Start HyperTerminal with the previously established settings.
2. Connect REMOTE 2014, 3014, 3104, 5014, 5104, 50104 instrument with an RS-232 connection from the 232/485 IN port to the PC COM port.
3. Power on the REMOTE instrument.

The following menu will display:

```
 Model: REMOTE 3014
 Version: 101
 Serial#: 040116001
 2004-01-13, 18:05:26
 LWS Protocol
- program mode:
```

Verbose Mode <V>

Type **<V>**

This must be the first command sent to begin programming the instrument.

Response:

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

Display Current Settings <?>

Type **<?>**

This command displays the instrument configuration parameters.

Response:

```
<?>
 2009-01-24, 10:09:00
LWS Protocol
Flow Rate = 0.1 cfm
Sample Time = 60 secs
Hold Time = 3 secs
Service High = 4500 mV
Service Low = 250 mV
Location = 0
Device Address = 1
```

```
Ch1 Alarm = OFF
Ch2 Alarm = OFF
Ch3 Alarm = OFF
Ch4 Alarm = OFF
Ch1 Alarm Threshold = 1000 counts
Ch2 Alarm Threshold = 1000 counts
Ch3 Alarm Threshold = 1000 counts
Ch4 Alarm Threshold = 1000 counts
Suppress Alarms = 0
Thresholds (mV) = 40, 200
Channel 1 = 0.3
Channel 2 = 0.5
```

Display User Menu <m1>

Type **<m1>**

This command displays the user menu.

Response:

```
<m1>
*** User Menu ***
<?> Display Parameters
<V> Verbose Mode
<sa> Start Counting
<sb> Stop Counting
<gc> Get Cal Date/Time
<gd> Get Date/Time
<gm> Get Model Name
<gs> Get Serial#
<gv> Get Version Number
<ta#> Set Sample Seconds
<tb#> Set Holdtime Seconds
<pa#> Set Location Num (0-999)
<aa#> Enable Alarm Channel #
<ax#> Disable Alarm Channel #
<a1#> Set Alarm Threshold (# of counts)
<a2#> Set Alarm Threshold (# of counts)
<a3#> Set Alarm Threshold (# of counts)
<a4#> Set Alarm Threshold (# of counts)
<ae#> Set Alarm Suppression #
<da#> Set Year = YY
<db#> Set Month = MM
<dc#> Set Day = DD
<dd#> Set Hour = HH
<de#> Set Minute = MMin
<df#> Set Second = SS
```

Display User Service Menu <ms>

Type **<ms>**

This command displays the user accessible service menu.

Response:

```
<ms>
*** Service Menu ***
<dg#> Set Cal Year = YY
<dh#> Set Cal Month = MM
<di#> Set Cal Day = DD
<ia> Don't show 1 sec data
<ib> Show 1 sec data
<ga> Get Air Flow
<gb> Get Bkgnd
<gl> Get Laser
<gh> Get Humidity
<gt> Get Temperature
```

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

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

Example: Get CalDue Date / Time <gc>

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

The REMOTE instrument Calibration date and time are preconfigured at the factory for Pacific Standard Time (PST). The time is automatically set to midnight (00:00:00) on the date that calibration becomes due. To check the Cal date and time in ASCII mode,

Type **<gc>**

Response:

```
<gc>   2008-12-21,   00:00:00
```

Example: Get Date and Time <gd>

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

Type **<gd>**

This command displays the current date and time.

Response:

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

Change the Year <daYY>:

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

Type **<da04>**

Response:

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

Change the Month <dbMM>:

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

Type **<db01>**

Response:

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

Change the Day <dcDD>:

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

Type **<dc29>**

Response:

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

Change the Hour <ddHH>:

This command sets the hour value with a 2 digit hour (HH); the range is 00 – 23.

Type **<dd13>**

Response:

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

Change the Minutes <deMM>:

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

Type **<de18>**

Response:

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

Change the Seconds <dfSS>:

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

Type **<df00>**

Response:

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

Example: Set Sample Time <ta#>

The REMOTE instrument was preconfigured at the factory for 1 minute sample time. To view the current sample time on the instrument in ASCII mode,

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

Type **<ta120>**

Response:

```
<ta120>  00:02:00
```

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

Type **<ta60>**

Response:

```
<ta60>  00:01:00
```

Example: Set Hold Time <tb#>

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

To change the hold time to 30 seconds:

Type **<tb30>**

```
Response:

<tb30>  00:00:30
```

To change the hold time to 0 seconds:

Type **<tb0>**

```
Response:

<tb0>  00:00:00
```

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

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

Example: Set Location <pa#>

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

To change the location to location 3:

Type **<pa3>**

```
Response:

<pa3>  Location = 3
```

Example: Enable Alarm Channel <aa#>

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

To enable the alarm channel:

Type **<aa1, aa2, aa3 or aa4>**

For 2 channel devices, the range is 1-2.
For 4 channel devices, the range is 1-4.

To enable all channels, the user must type the command for each channel number. To verify channels enabled, use the <?> command.

Response:

```
<aa1>    Ch1 Alarm = ON
         Ch2 Alarm = OFF
         Ch3 Alarm = OFF
         Ch4 Alarm = OFF
```

Example: Disable Alarm Channel <ax#>

To disable the alarm channel:

Type **<ax1, ax3, ax3 or ax4>**

<ax followed by the channel number and **>** disables that channel's alarm feature without affecting the other alarms.

Response:

```
<ax1>    Ch1 Alarm = OFF
         Ch2 Alarm = OFF
         Ch3 Alarm = OFF
         Ch4 Alarm = OFF
```

Example: Set Alarm Threshold <a#value>

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

To change the alarm threshold:

Type **<a#value>**, where '#' = channel number & 'value' = the threshold value.

Response:

```
<a1500>  Ch1 Alarm threshold = 500 counts
         Ch2 Alarm threshold = 1000 counts
         Ch3 Alarm threshold = 1000 counts
         Ch4 Alarm threshold = 1000 counts
```

Now the unit will alarm when the number of counts on the alarm channel exceed 500. Each channel alarm threshold must be set to the value desired for that channel and apply when the Channel Alarm is enabled.

Example: Set Alarm Suppression <ae#>

Note: *If more than one channel goes into alarm during a sample, it will count as one alarm. For example, if Ch1 and Ch2 go into alarm, it will not count as two suppressed alarms.*

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

Type **<ae2>**

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

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

Verify Configuration Changes

To verify the changes that have made in the configuration, type <?> to list all the parameters and current values. If any of the items need to be changed, type <m1> to display the command menu to find the command to change the parameter.

When the configuration parameters are set, change DIP switch 8 to OFF and power-cycle the device to restart it in MODBUS mode.

7 Programming with MR Protocol

Note: *Due to limitations in the protocol, the multiple channel alarms and thresholds feature is not available to the MR Protocol.*

The REMOTE 2014, 3014, 3104, 5014, 5104, 50104 family of instruments can be programmed using the MR Protocol. The full protocol is detailed in Appendix A: "MR Protocol Commands" on page A-1.

This Protocol allows the instrument to be controlled remotely from a third party application program or terminal program, such as ProCOMM or Windows Hyperterminal.

MR Protocol is compatible with Met One particle counters.

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

DIP Switches

In many cases, the Location is independent of the Device Address. For the MR Protocol, the Location is the same as the Device Address.

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

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

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

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

Protocol Settings

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

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

Power On

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

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

Connecting the Remote to a Terminal

To connect the instrument to a computer:

1. Remove power from the instrument.
2. Connect one end of a CAT-5 cable with RJ-45 connectors to either the RS-485 IN or OUT receptacle on the instrument. Wire this cable so that pins 4 and 5 connect to ChB and ChA, respectively, of an RS-485 to RS-232 converter.

WARNING: ***Do not connect RS-232 signals directly to RS-485 pins on the instrument. Damage to the RS-485 transceiver chip will occur.***

3. Connect the RS-232 side of the converter to a COM (Serial) Port on a computer.
4. Open Hyperterminal on the computer.
5. Configure the COM Port settings as follows. Any available COM Port may be used. Set Flow Control to None for most converters. See Figure 7-1.

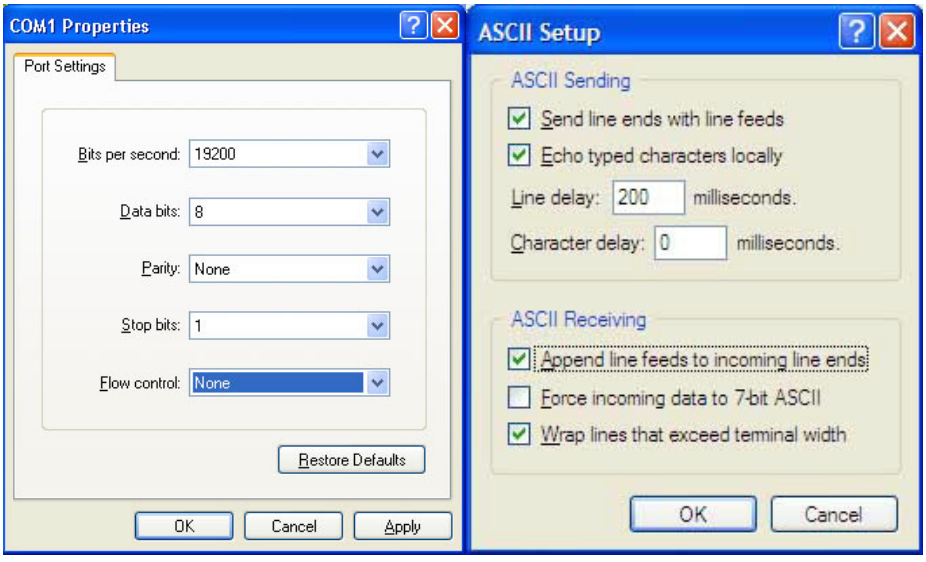


Figure 7-1 COM Port and ASCII Properties

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

6. Configure ASCII setup as shown below.
7. Apply power to the instrument.

.Device Select SENDING A LOCATION/ADDRESS

The REMOTE 2014, 3014, 3104, 5014, 5104, 50104 uses a Location to identify where the device recorded data. The device address identifies the communications address of the device. For the MR protocol, the Location and Device Address are the same value, LOC.

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

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

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

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

Example:

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

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

All device select entries lie in the range of 0128 - 0191 which correspond to Location Address 0 -63. Leading zeros must be entered. See Table 7-1.

Table 7-1 Location Addresses -- Hold ALT while typing the Device Select Entry number on the numeric keypad

Device Select Entry	Location Address	Device Select Entry	Location Address
0128	0	0160	32
0129	1	0161	33

Table 7-1 Location Addresses -- Hold ALT while typing the Device Select Entry number on the numeric keypad

Device Select Entry	Location Address	Device Select Entry	Location Address
0130	2	0162	34
0131	3	0163	35
0132	4	0164	36
0133	5	0165	37
0134	6	0166	38
0135	7	0167	39
0136	8	0168	40
0137	9	0169	41
0138	10	0170	42
0139	11	0171	43
0140	12	0172	44
0141	13	0173	45
0142	14	0174	46
0143	15	0175	47
0144	16	0176	48
0145	17	0177	49
0146	18	0178	50
0147	19	0179	51
0148	20	0180	52
0149	21	0181	53
0150	22	0182	54
0151	23	0183	55
0152	24	0184	56
0153	25	0185	57
0154	26	0186	58

Table 7-1 Location Addresses -- Hold ALT while typing the Device Select Entry number on the numeric keypad

Device Select Entry	Location Address	Device Select Entry	Location Address
0155	27	0187	59
0156	28	0188	60
0157	29	0189	61
0158	30	0190	62
0159	31	0191	63

UNIVERSAL DEVICE SELECT (U)

WARNING: ***Do not use Universal Select when more than one counter is powered on and connected to the same RS-485 Bus.***

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

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

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

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

Command:

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

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

Configuration Commands

GENERAL

The general form of a Configuration Command is

AA*d*[CRLF]

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

where:

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

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

SET ALARM LIMIT (WA)

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

Command:

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

Response:

WA*d*[crlf] *{Echoing the command and the current setting}*

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

Query value by typing:

WA[CRLF]

Response:

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

SET LOCATION (WL)

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

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

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

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

Command:

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

Response:

WL*d*[crlf]

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

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

Query value by typing:

WL[CRLF]

Response:

WL*d*[crlf]

SET DATE & TIME (WD)

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

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

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

Command:

WDmmddyyhhmmss[CRLF] *{No spaces}*

Response:

WDmmddyyhhmmss[crlf]

Query by typing:

WD[CRLF]

Response:

WDmmddyy[space]hhmmss[crlf]

Counter Setup and Data Record Commands

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

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

COUNTER SETUP COMMANDS

These commands are used to set up the sample and hold intervals for the instrument.

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

No spaces are allowed within the commands.

SET HOLD INTERVAL (H*hhmmss*)

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

Example Command:

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

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

H100[CRLF] *{= 1 minute}*
H60[CRLF] *{= 1 minute}*
H10[CRLF] *{= 10 seconds}*

These are all valid commands.

Response:

H

Query by typing:

H[CRLF]

Response:

H1000[CRLF] *{Hold Interval = 10 minutes}*

SET SAMPLE INTERVAL (Lhhmmss)

Sets or queries the instrument's Sample Interval.

Example Command:

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

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

These are all valid commands.

Response:

L

Query by typing:

L[CRLF]

Response:

L1500[CRLF] *{Current Sample Interval is 15 minutes}*

Action Commands

GENERAL

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

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

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

Command:

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

Response:

a

Command:

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

Response:

b

Command:

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

Response:

c

Command:

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

Response:

d

Command:

e *{Stop counting immediately. The data record for the sample started with command 'c' will show 0000 for its Sample Interval, as the Sample Interval is controlled by the host.}*

Response:

e

Universal Actions Commands

GENERAL

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

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

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

Command:

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

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

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

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

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

Note: *The data record for the sample started with command 'c' will show 0000 for Sample Interval, as the Sample Interval is controlled by the host.*

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

DATA RECORD COMMANDS

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

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

SEND BUFFERED RECORD (A)

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

Command:

A

Response:

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

-or-

`A#` *{Buffer empty}*

SEND CURRENT RECORD (B)

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

Command:

B

Response:

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

-or-

`B#` *{Buffer empty}*

CLEAR BUFFER (C)

Erases all records from the instrument's Buffer.

Command:

C *{Buffer is cleared}*

NUMBER OF RECORDS (D)

Returns the number of records in the Buffer. The buffer will hold up to 1 record.

Command:

D

Example Response:

`D1[crlf]` *{1 record in the Buffer}*

-or-

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

RETRANSMIT RECORD (R)

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

Command:

R

Response:

`R[Retransmits last data record]`

-or-

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

MISCELLANEOUS COMMANDS

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

EEPROM VERSION (E)

Queries the instrument for its firmware revision number.

Command:

E

Response:

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

OPERATING MODE (M)

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

Command:

M

Response:

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

MODEL (T)

Queries the instrument for its model name.

Command:

T

Response:

TREMOTE3014 [crlf]

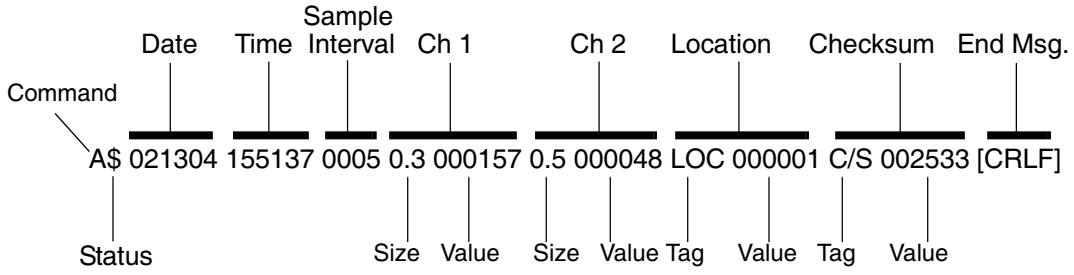
Data Record Format

GENERAL

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

Fields within the string are separated with spaces.

Figure 7-2 shows the data format of a record with only 2 channels.



*CRLF means carriage return and line feed

Figure 7-2 Data Record Serial Format

Data Fields

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

For example, the Status character in Figure 7-2 is a "$", which is ASCII 36 or, in binary, 00100100. Table 7-2 translates the Status characters into fault types. A sample interval with no faults is an ASCII 32 or 00100000, which shows in the Status character as a space.

Table 7-2 Decoding Status Characters

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

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

Note: *Spaces are used as field separators*

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

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

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

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

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

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

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

Size: These three characters list the particle size range.

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

Location: Where multiple instruments are connected to an RS-485 bus, each unit must have a unique identifying number, called a Location. The Location field contains a number in the range of 0 through 63.

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

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

8 Programming with MODBUS Protocol

The REMOTE 2014, 3014, 3104, 5014, 5104, 50104 family of instruments can be programmed using the MODBUS Protocol. The full protocol is detailed in Appendix B: “Remote 4 MODBUS Register Map v1.44” on page B-1.

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

DIP Switches

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

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

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

Protocol Settings

The MODBUS Protocol is defined through an RS-232 or RS-485 interface with:

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

Power On/ Auto Start

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

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

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

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

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

Running the Instrument Using MODBUS

The applicable action commands are displayed in Table 8-1.

Table 8-1 Action Commands

Value	Action
1	Saves all writable 4xxxx register values to the EEPROM.
3	Clears the Data Buffer. Record count is set to zero.
4	Saves the instrument parameters in the 40xxx registers to the EEPROM. Parameters include Sample Time, Hold Time, and Location.
9	Manual Start. The instrument samples continuously until it receives a Manual Stop command. Ignores local timing parameters. Sets Sample Time for data record to equal the time interval between the Manual Start and Manual Stop command.
10	Manual Stop. Stops sampling. Records counts since Manual Start.
11	Instrument Start (Automatic Counting). Uses defined Hold Time and Sample Time. Instrument executes samples and holds until an Instrument Stop command is issued.
12	Instrument Stop. Aborts current sample. Stops data collection.

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

AUTOMATIC Counting Mode

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

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

After setting all the instrument parameters as described in "Changing the Default Instrument Parameters" on page 8-5, write these commands to the Command register (40002):

11 Start Instrument; to start recording

12 Stop Instrument; to stop recording

MANUAL Counting Mode

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

Write these commands to the Command register (40002):

9 Start Instrument; to start recording.

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

Configuring with the MODBUS Protocol

Setting the Real Time Clock

The Real Time Clock (RTC) can be read in registers 40027 and 40028 as shown in Table 8-2.

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

The date & time is stored in a 4-byte unsigned integer or as a 32-bit unsigned integer.:

Table 8-2 Real Time Clock Registers

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

In order to change the RTC to the current local date/time, enter the high and low values as unsigned integers to registers 40035 and 40036 respectively, which are the Data Set registers. See Table 8-3.

Table 8-3 Data Set Registers

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

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

The Real Time Clock can also be set in the ASCII programming mode without having to calculate the number of seconds from 1/1/1970. Please see “Example: Get Date and Time <gd>” on page 6-7 for more information.

Changing the Default Instrument Parameters

The main instrument parameters involved with the operation of the REMOTE counter are Location, Sample Time, and Hold Time. See Table 8-4.

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

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

The low word register for Sample Time is 40034.

The low word register for Hold Time is 40032.

Table 8-4 Instrument Parameters

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

Using Sensor Setting Registers

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

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

Location (Register 40026)

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

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

Hold Time (Registers 40031, 40032)

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

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

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

Sample Time (Registers 40033, 40034)

The Sample Time specifies the time period of each sample. This time is specified in seconds. The maximum value of the sample time is 86,399 seconds (high word: 1, low word: 20863) which is 23 hours, 59 minutes, 59 seconds.

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

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

Alarm and Threshold Registers

Alarm Enable Registers

The Alarm Enable input registers (43xxx series) shown in Table 8-5 are read/write. All enable data items are 4 bytes long and are stored across 2 registers. Byte and word ordering is big-endian. Thus, data items are formed by placing the high bytes in front of the low bytes. For example:

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

The 43xxx register series is used to determine which particle data channels are set to ALARM ENABLE.

Table 8-5 Alarm Enable/Disable Bits

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

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

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

Enabling the Alarm for a particle channel requires setting the bit in the low word of that channel. The user can enable any or all active particle channels at a time and can set a different alarm threshold for each.

Particle data registers for the Alarm Enable setting start at 43009 for the high word and 43010 for the low word for channel 1. See Table 8-6.

Table 8-6 Alarm Enable Registers

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

Table 8-6 Alarm Enable Registers

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

Enable Alarming for a Channel

Alarm and threshold registers are independent of each other. Any one register's settings will not affect the others and any channel alarms may be enabled or disabled as the user requires. For example, to enable alarming on just the first particle channel as shown in Table 8-7, the user would enable Bit 1 by writing the value of '3' to register 43010. To disable alarming on the first channel and enable alarming on the second channel, write a '1' to register 43010 and a '3' to register 43012. To enable all alarms, write a '3' to each of the registers 43010, 43012, 43014 and 43016.

To disable alarming completely, write a '1' to the enabled register or registers (43010, 43012, 43014 or 43016).

Table 8-7 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

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

Threshold Setup Registers

Threshold data is stored in the input registers in the 45xxx series which are read/write. All threshold data items are 4 bytes long and are stored across 2 registers. Byte and word ordering is big-endian.

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

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

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

The threshold registers (45xxx series) shown in Table 8-8, 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 8-8 Alarm Threshold Registers

Register	Data Type	Description
45009	unsigned int	Threshold for Particle Channel 1 [high] (smallest particle size starts here)
45010	unsigned int	Threshold for Particle Channel 1 [low]
45011	unsigned int	Threshold for Particle Channel 2 [high]
45012	unsigned int	Threshold for Particle Channel 2 [low]
45013	unsigned int	Threshold for Particle Channel 3 [high]
45014	unsigned int	Threshold for Particle Channel 3 [low]
45015	unsigned int	Threshold for Particle Channel 4 [high]
45016	unsigned int	Threshold for Particle Channel 4 [low]

Setting the Alarm Threshold Value

The Alarm Threshold Value is set in the low register of the channels. Each channel has independent threshold value registers. Since any or all channels can be enabled for alarms at any given time, each threshold value applies to the corresponding channel. Setting a value for channel 1 as 100 will not affect channel 2 setting of, say, 500. See Table 8-9.

Table 8-9 Alarm Threshold Registers set to 1000

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

A MR Protocol Commands

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

COMM Settings

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

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

Device Select

Table A-1 displays software configured location addresses.

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

Device Select Entry	Location Address	Device Select Entry	Location Address
0128	0	0160	32
0129	1	0161	33
0130	2	0162	34
0131	3	0163	35
0132	4	0164	36
0133	5	0165	37
0134	6	0166	38
0135	7	0167	39
0136	8	0168	40

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

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

Universal Device Select

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

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

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

Command:

U *{Unit will respond to all commands}*

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

Configuration Commands

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

AAd[CRLF]

where:

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

Table A-2 Command Set for Displaying Current Configuration

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

Table A-2 Command Set for Displaying Current Configuration

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

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

Table A-3 Command Set for Configuration Parameters

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

Counter Setup Commands

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

Table A-4 Particle Counter Setup Commands

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

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

Action Commands

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

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

Table A-5 Command Set for Action Commands

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

Table A-5 Command Set for Action Commands

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

Universal Action Commands

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

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

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

Table A-6 Universal Actions Command Set

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

Table A-6 Universal Actions Command Set

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

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

Data Record Commands

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

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

Table A-7 Data Record Commands

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

Other Status Commands

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

Table A-8 Other Status Commands

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

Data Record Format

GENERAL

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

Fields within the string are separated with spaces.

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

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

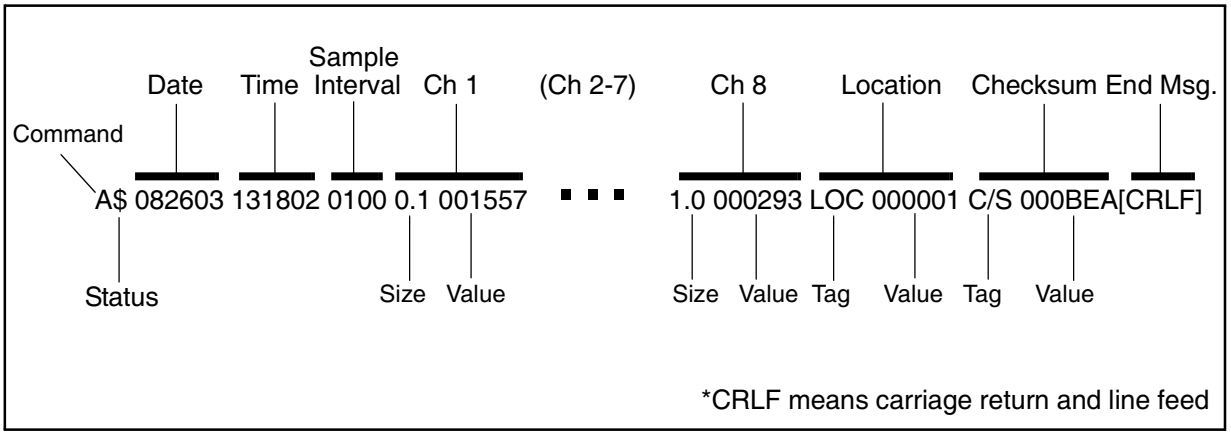


Figure A-1 Data Record Serial Format

Data Fields

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

Table A-9 Decoding Status Characters

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

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

Note: *Spaces are used as field separators*

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

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

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

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

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

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

Ch 1...Ch 8: These characters contain the channel size and count data from the measurements. The channel size and count are each preceded by a space.

Size: These three characters list the particle size range.

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

Location: Where multiple instruments are connected to an RS-485 bus, each unit must have a unique identifying number, called a Location. The Location field contains a number in the range of 0 through 63.

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

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

B Remote 4 MODBUS Register Map v1.44

COMM Settings

Lighthouse particle counters with MODBUS have the following communications settings:

Table B-1 MODBUS Communications Settings

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

The MODBUS slave address is set on the particle counter.

Note: *Remote 4 currently supports only upper case.*

Supported MODBUS Commands

Table B-2 MODBUS Registers

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

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

Register Map

Sensor Settings Registers

Instrument settings are stored in holding registers (the 40xxx series), which are mostly read/writable. Not all holding registers are writable. Table B-3 describes the content of these registers.

Table B-3 Sensor Settings Registers

Register	Data Type	Description
40001	unsigned integer	MODBUS register map version. Matches the version number of this document. Major version digits are hundreds. Minor version digits are tens and ones. For example, 135d = v1.35.
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]
40004	unsigned integer	Firmware version. Major version digits are hundreds. Minor version digits are tens and ones. For example, 235d=v2.35
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]
40020	ASCII string	Model Name char[10], char [11]

Table B-3 Sensor Settings Registers

Register	Data Type	Description
40021	ASCII string	Model Name char[12], char [13]
40022	ASCII string	Model Name char[14], char [15]
40023	unsigned integer	Flow Rate. See registers 40041-40042 for flow rate units. Divide by 100 to get rate in CFM. For example, 100 = 1CFM
40024	signed integer	Record Count. Total number of records stored in the counter
40025	signed integer	Record Index. Zero based index to data in 3xxxx register series. Must be lower than the record count (register 40024). Set this index to expose a counter's record in the 3xxxx registers. Set to -1 to retrieve last record stored in the counter.
40026	unsigned integer	Location number Particle Counters: Specifies location of Particle Counter. Must be 1 to 200 (maps to location names associated with registers 40200 - 40999). Manifold Controller: Specifies Manifold position. Values 1-32 for the Universal Manifold and values 1-6 for the MiniManifold Controller moves the arm to that position on the manifold. Value 0 moves arm to Home position.
40027	signed integer	Real Time Clock (RTC) [high]. Displays instrument's real-time clock. Works in conjunction with 40028. Displays date and time, in number of seconds since midnight, 1/1/1970. Can be generated by ANSI C/C++ time() function.
40028	signed integer	Real Time Clock [low]
40029	unsigned integer	Initial Delay [high]. Works in conjunction with 40030. Number of seconds to wait before starting the first sample. Max value is 359,999, which equals 99h 59m 59s.
40030	unsigned integer	Initial Delay [low]
40031	unsigned integer	Hold Time [high]. Works in conjunction with 40032. Number of seconds to wait between sample periods. Max value is 359,999, which equals 99h 59m 59s
40032	unsigned integer	Hold Time [low]
40033	unsigned integer	Sample Time [high]. Works in conjunction with 40034. Number of seconds to sample. Max value is 86,399, which equals 23h 59m 59s.
40034	unsigned integer	Sample Time [low]

Table B-3 Sensor Settings Registers

Register	Data Type	Description
40035	unsigned integer	Data Set [high]. Works in conjunction with 40036. Updates the instrument's real time clock. Setting is the number of seconds since midnight, 1/1/1970. This number can be generated by the ANSI C/C++ time() function.
40036	unsigned integer	Data Set [low]
...		
40039	unsigned integer	Laser Reference Voltage (millivolts)
...		
40041	ASCII string	Flow Unit - Defines the Unit that FlowRate value is based on. char[0], char[1]. (NULL-terminated string)
40042	ASCII string	Flow Unit. char[2], char[3]
40043	unsigned integer	Calibration Reference Voltage (millivolts)
...		
40047	signed integer	Remote 4: Calibration Due Date [high]. Indicates when instrument is due for calibration. This number can be generated by the ANSI C/C++ time() function.
40048	signed integer	Calibration Due Date [low].
...		
40050	signed integer	Device Options

Device Options

The Device Options register (40050) displays the configuration of the instrument

If Bit 0 of Register 40050 is set, it indicates that the instrument is capable of Fast Download.

Table B-4: Device Options

Bits	Description
0	Fast Download (1 - Enabled, 0 - Disabled) - non writable

Device Status

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

Table B-5 Device Status

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

Command Register

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

Table B-6 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.
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.

Table B-6 Command Register

Value	Action
7	Turns local pump on, if applicable.
8	Stop pump, if applicable.
9	Manual Start. The instrument samples continuously until it receives a Manual Stop command. Ignores local timing parameters. Sets Sample Time for data record to equal the time interval between the Manual Start and Manual Stop command. If applicable to device, does not start pump.
10	Manual Stop. Stops sampling. Records 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.

Alarm and Threshold Registers

Alarm Enable Registers

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

Note: *These registers currently apply only to ALARM enable/disable,* ***not*** *to Channel enable/disable.*

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

The 43xxx register series is used to determine which particle data

channels are set to ALARM ENABLE.

Table B-7 Alarm Enable/Disable Bits

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

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

Note: *Alarm Enable currently only works for Particle Channels. Any or all channels and their alarm thresholds can be enabled and configured independently of each other.*

To enable the Alarm for a particle channel, set the bit in the low word of that channel. Because Bit-0 is reserved and must always be ON, only Bit-1 will change for any channel alarm setting and Bit-0 must always be written as a '1'. What this means is that these registers will receive a '3' to turn the setting ON and a '1' to turn it OFF.

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

Table B-8 Alarm Enable Registers

Register	Data Type	Description
43009	unsigned int	Alarm Enable for Particle Channel 1 [high] (smallest particle size starts here)
43010	unsigned int	Alarm Enable for Particle Channel 1 [low]
43011	unsigned int	Alarm Enable for Particle Channel 2 [high]
43012	unsigned int	Alarm Enable for Particle Channel 2 [low]
43013	unsigned int	Alarm Enable for Particle Channel 3 [high]
43014	unsigned int	Alarm Enable for Particle Channel 3 [low]
43015	unsigned int	Alarm Enable for Particle Channel 4 [high]
43016	unsigned int	Alarm Enable for Particle Channel 4 [low]
43017	unsigned int	Alarm Enable for Particle Channel 5 [high]
43018	unsigned int	Alarm Enable for Particle Channel 5 [low]
43019	unsigned int	Alarm Enable for Particle Channel 6 [high]
43020	unsigned int	Alarm Enable for Particle Channel 6 [low]

Table B-8 Alarm Enable Registers

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

Enable Alarming for a Channel

To enable alarming on particle channel #1, write a ’3’ to register 43010, which enables its Bit 1 and maintains Bit 0 as ’1’. To disable alarming on channel 1 and enable it on channel 2, write a ’1’ to register 43010 and a ’3’ to register 43012. To enable all, write a ’3’ to 43010, 43012, 43014 and 43016.

To disable alarming completely, write a ’1’ to disable Bit 1 to registers 43010, 43012, 43014 and 43016.

Table 9: 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 B-9 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 Data Status flag is set if any of the channels have a threshold exceeded state as true.

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

Table B-9 Alarm Threshold Registers

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

Table B-9 Alarm Threshold Registers

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

Setting the Alarm Threshold Value

Note: *Thresholds are independent of each so the value set for one channel does not affect another.*

The Alarm Threshold Value is set in the low register of the channels. Each channel has independent threshold value registers. Setting a value for channel 1 as 100 will not affect channel 2 setting of, say, 500.

Table 10: Alarm Threshold Registers set to 1000

Registers	Particle Channel	Threshold Value
45009 - 45010	1	1000
45011 - 45012	2	1000
45013 - 45014	3	1000
45015 - 45016	4	1000
45017 - 45018	5	1000
45019 - 45020	6	1000
45021 - 45022	7	1000
45023 - 45024	8	1000

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 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>

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

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

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

Table B-10 Data Registers

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

Table B-10 Data Registers

Register	Data Type	Description
30041	IEEE Float	Analog Channel 1 [high]
30042	IEEE Float	Analog Channel 1 [low]
30043	IEEE Float	Analog Channel 2 [high]
30044	IEEE Float	Analog Channel 2 [low]
30045	IEEE Float	Analog Channel 3 [high]
30046	IEEE Float	Analog Channel 3 [low]
30047	IEEE Float	Analog Channel 4 [high]
30048	IEEE Float	Analog Channel 4 [low]
30065	IEEE Float	Background Voltage [low] (percentage based on Calibration Reference value) - REMOTE 4
30066	IEEE Float	Background Voltage [high]
30067	IEEE Float	Flow Value [low] (0.0 if flow is below reference, 1.0 if flow is within reference, 1.1 if flow is above reference)
30068	IEEE Float	Flow Value [high]
30069	IEEE Float	Laser Voltage [low] (Percentage based on Laser Reference value)
30070	IEEE Float	Laser Voltage [high]

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

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

Device Status Word

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

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

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

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

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

Table B-11 Device Status Word

Bit	Description
0	Laser Alert Status 0 = Laser is good 1 = Laser Alert
1	Flow Alert Status 0 = Flow Rate is good 1 = Flow Rate Alert
2	Particle Overflow Status 0 = No overflow 1 = Overflow occurred
3	Instrument Service Status 0 = Working correctly 1 = Instrument malfunction detected.
4	Particle Threshold Exceeded Status 0 = Threshold not exceeded 1 = Threshold exceeded

Data Enable Registers

Note: *All data records have the same enable states. The user does not have to read the enable registers for every record.*

The 31xxx register series is used to determine which data items in 30xxx are enabled. Enabled items contain recorded data. Data retrieved from disabled items return garbage. Data items are disabled for particle and analog channels not supported by the device or when the device software is configured not to record data for those items.

The Enable Registers (31xxx series) run in parallel with the Data Registers (30xxx series). For example, Data Register 30010's Enable Register is 31010. Data Register 30016's Enable Register is 31016.

The 31xxx register states are:

00000000h = Disabled
FFFFFFFFh = Enabled

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 32xxx register series is used to identify the type of data 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 32041.

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 B-12 Data Types

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

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

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

Table B-13 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 33xxx register series identifies the units used by data items in the

30xxx series. The Units Registers run in parallel with the Data Registers. For example, Data Register 30010's Units Register is 33010.

Note: *Not all data types have units.*

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. Note that a Units string using all 4 characters does not end with a NULL.

Note: *Be aware that LWS Particle Counters may use units not on the table.*

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

Table B-14 Data Units

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

C Limited Warranty

Limitation Of Warranties:

A. Lighthouse Worldwide Solutions (LWS) warrants that all equipment shall be free from defects in material and workmanship under normal use for a period of two years from date of shipment to Buyer except that LWS does not warrant that operation of the software will be completely uninterrupted or error free or that all program errors will be corrected. Buyer shall be responsible for determining that the equipment is suitable for Buyer's use and that such use complies with any applicable local, state, or federal law. Provided that Buyer notifies LWS in writing of any claimed defect in the equipment immediately upon discovery and any such equipment is returned to the original shipping point, transportation charges prepaid, within two years from date of shipment to Buyer and upon examination LWS determines to its satisfaction that such equipment is defective in material or workmanship, i.e. contains a defect arising out of the manufacture of the equipment and not a defect caused by other circumstances, including, but not limited to accident, misuse, unforeseeable use, neglect, alteration, improper installation, improper adjustment, improper repair, or improper testing, LWS shall, at its option, repair or replace the equipment, shipment to Buyer prepaid. LWS shall have reasonable time to make such repairs or to replace such equipment. Any repair or replacement of equipment shall not extend the period of warranty. If the Instrument is modified or in any way altered without the explicit written consent of LWS then the warranty is null and void. This warranty is limited to a period of two years, except as noted below, without regard to whether any claimed defects were discoverable or latent on the date of shipment. The length of warranty for pumps in 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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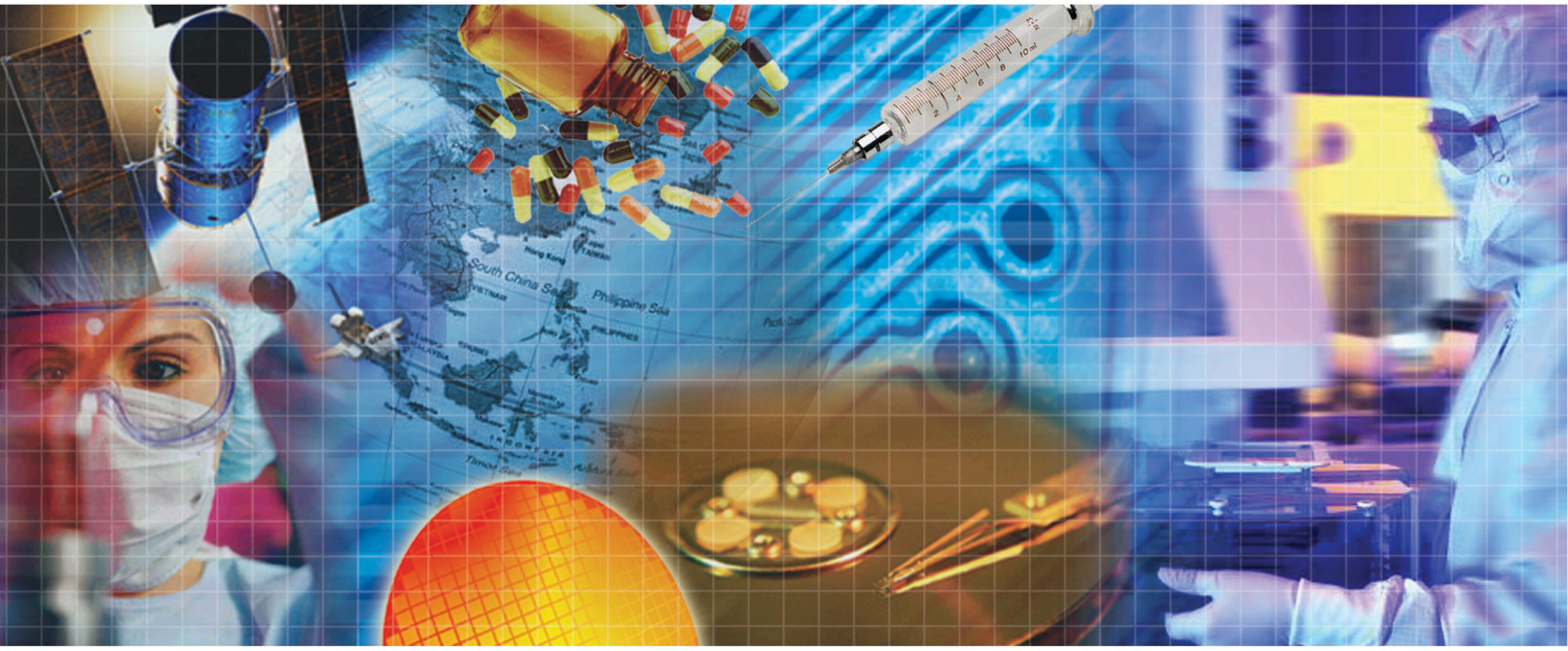

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