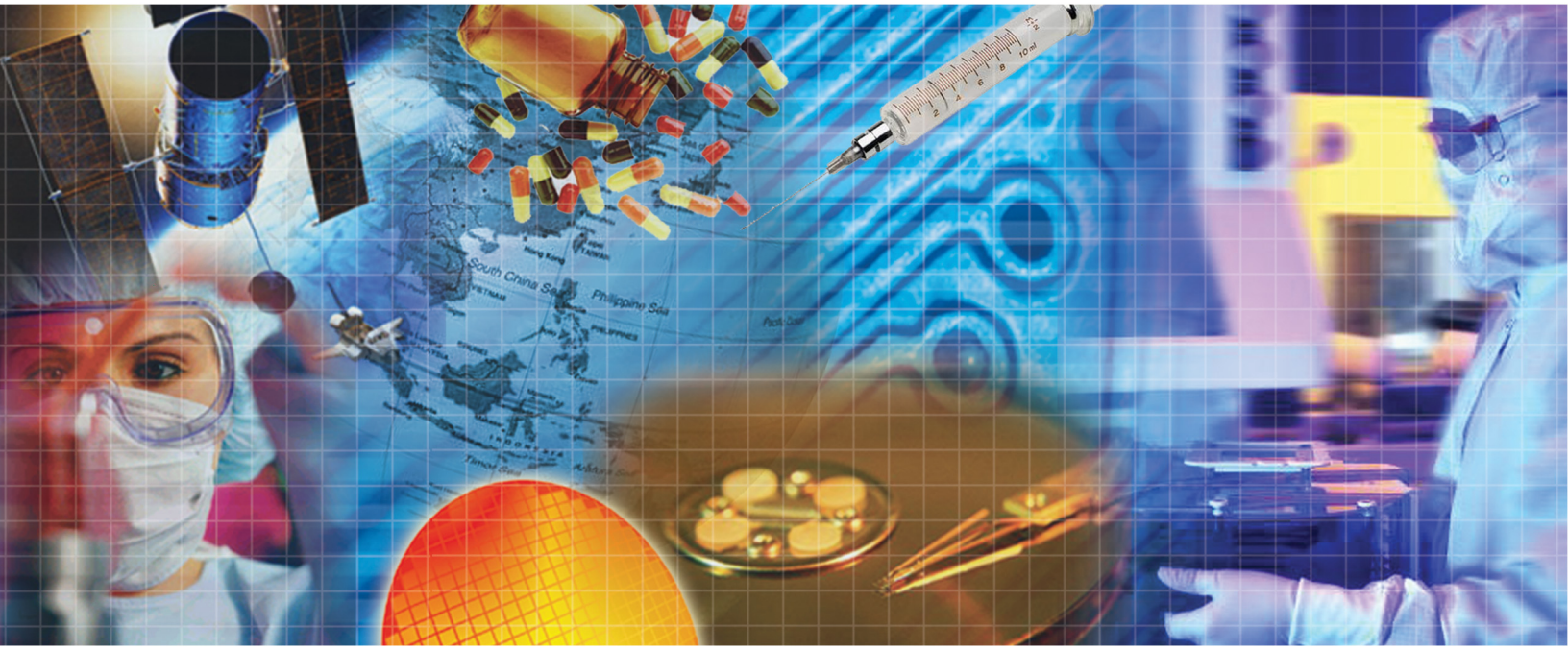

LIGHTHOUSE
WORLDWIDE SOLUTIONS
Technology That Counts!

SOLAIR

1001+

Airborne Particle Counter

Operating Manual

Lighthouse Worldwide Solutions

SOLAIR 1001+ Airborne Particle Counter

Operating Manual

LWS Part Number: 248083294-1 Rev 2

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WORLDWIDE SOLUTIONS

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: Portable Airborne Particle Counter
Model Number(s): SOLAIR 1001+

Conforms to the following Product Specifications:

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

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

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

Fremont, CA. March 7, 2008

William Shade - V.P. Engineering

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About this Manual

This manual describes the detailed operation and use of the Lighthouse SOLAIR 1001+ Airborne Particle Counters.

Software License Agreement

SOFTWARE PROGRAM: LIGHTHOUSE SOLAIR 1001+ AIRBORNE PARTICLE COUNTERS

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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 you type. You can use uppercase or lowercase letters; in this manual, commands are shown in uppercase.
Helvetica Italics	Indicates a comment on a command or text output.

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

```
hex 0D
0Dh
```

Additional Help

For more information about the Lighthouse SOLAIR 1001+ Airborne Particle Counter, contact Lighthouse Worldwide Solutions:

(800) 945-5905 Sales & Service
(510) 438-0500 Outside of USA

techsupport@golighthouse.com
www.golighthouse.com

1 General Safety

Safety Considerations

Warnings and cautions are used throughout this manual. Familiarize yourself with the meaning of a warning before operating the particle counter. 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.

Electrostatic Safety Information

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

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

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

2 Introduction

Overview

This operating manual describes how to use the Lighthouse SOLAIR 1001+.

The model number signifies the minimum particle size measured by the instrument. The number "1001" indicates a 0.1 µm minimum channel size at 0.01 CFM.

The "+" indicates the advanced model that has a color touchscreen, a built-in thermal printer and can store up to 3000 records.

SOLAIR 1001+ instruments have up to eight particle-size channels, four 4-20mA analog sensors and is available with an optional rechargeable, removable Li-Ion battery.

Note: *For lists of the standard channel sizes available for each SOLAIR model, see the SOLAIR Specifications section in this chapter.*

All SOLAIR instruments contain a microprocessor that controls all of the instruments' functions. Count data is displayed in cumulative or differential mode as raw data or normalized in particles per cubic foot or per cubic meter.

The SOLAIR uses a laser-diode light source and collection optics for particle detection. Particles scatter light from the laser diode. The collection optics collect and focus the light onto a photo diode that converts the light into electrical pulses. The pulse height is a measure of particle size. These pulses are counted and their amplitude is measured for particle sizing. Results are displayed as particle counts in the specified size channel.

Description

The Lighthouse SOLAIR instruments use the latest in optical particle counting technology. Offering a sensitivity of 0.1 µm, the 1001+ provides a regulated flow of 0.01 CFM (0.283 LPM), SOLAIRs have a wide dynamic range of particle sizes up to 25.0 µm.

Utilizing a large touch screen interface, SOLAIR instruments are easy to configure and operate.

Each SOLAIR can store an extensive amount of data from up to 8 particle count channels (for + models; 4 particle channels for base models) and up to four 4-20mA analog sensors. All data can be quickly

and reliably downloaded to a computer or printed to its printer.

Instruments in the SOLAIR family allow you to:

- Set sampling and hold times
- Configure the number of samples taken in a single location
- Connect up to four analog 4-20mA sensors
- Connect an external alarm light, buzzer, or external remote control to a relay output.
- Save your data for historical data review
- Print data tables using the included data transfer software; export data to Excel™ to build graphs or charts.

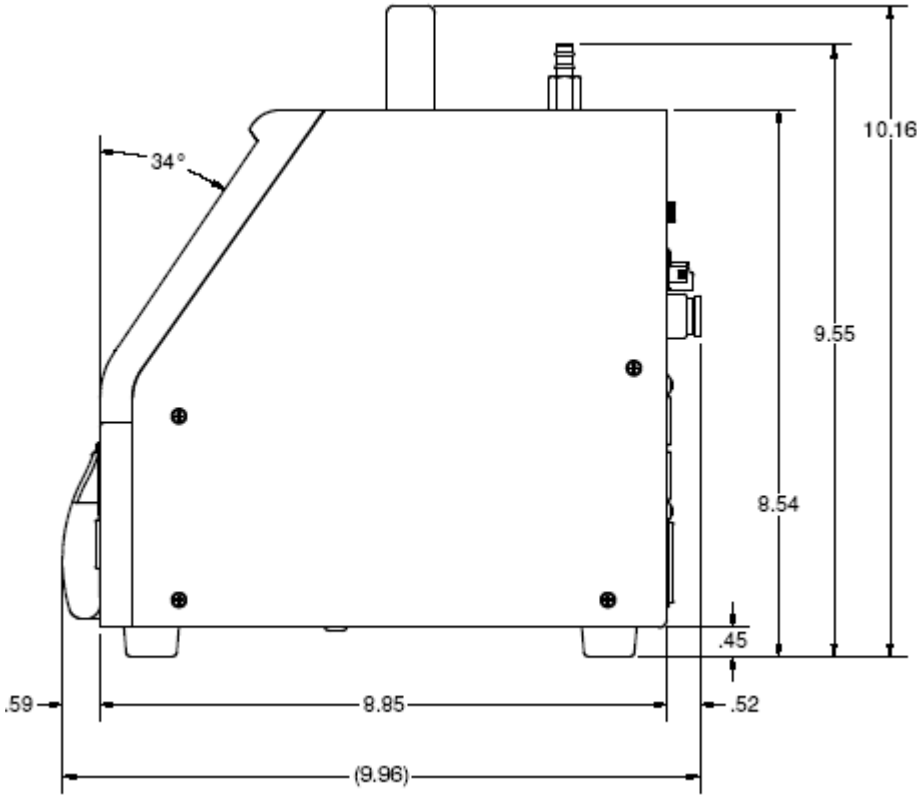


Figure 2-1 SOLAIR Dimensions

SOLAIR Specifications

Size Range	0.1 - 20.0 µm
Channel Thresholds	**1001+ Standard**: 0.1, 0.2, 0.3, 0.5, 1.0, 5.0, 10.0, 20.0µm Other channel sizes available on request
Flow Rate	0.01 CFM (0.283 LPM)
Counting Efficiency	50% @ 0.1 µm; 100% for particles > 0.15 µm (per JIS B 9921, ISO 21501-4)
Laser Source	Laser diode
Zero Count Level	<1 count/5 minutes (per JIS B 9921, ISO 21501-4)
Concentration Limits	4,000,000 Particles/ft^3 @ 5% Coincidence Loss; 8,000,000 Particles/ft^3 @ 10% Coincidence Loss per ISO 21501-4
Calibration	NIST Traceable, per ISO 21501-4
Count Modes	Concentration, manual, automatic, beep
Data Storage	Stores up to 3000 sample records. Sample records include particle & environmental data, plus location and time
Communication Modes	RS232 via RJ-45 to PC RS485/Modbus
Supporting Software	LMS XChange Data Transfer Software Optional: LMSNet, LMS Express/RT/RT+
Analog Inputs	Up to four optional 4-20mA analog sensors
Touch Screen Display	5.7" (14.47 cm), 320x240 pixels; color screen on + models
Printer	Thermal printer
Key Software Features	Historical data review, password protection on power up, alphanumeric locations, Windows-like browser user interface
Enclosure	Stainless steel
Sample Output	Internally filtered to HEPA standards (>99.997% @ 0.3µm)
Vacuum Source	Internal pump, flow controlled
Power	100-240 VAC, 50-60 Hz

Table 2-1 Solair 1001+ Specifications

Optional Battery	Li-ion, removable & rechargeable
Dimensions	9.96"(L) x 8.0"(W) x 10.16" (H) [25.3 cm x 20.32 cm x 20.81 cm]
Weight	Without battery: 12.95 lb (5.9 kg) With battery: 14.9 lb (6.8 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 Solair 1001+ Specifications

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

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 you return 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. You may 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 your Lighthouse representative or the RMA website.

Figure 3-1 SOLAIR 1001+

Accessories

Several accessories may be ordered to tailor the instrument to your needs. Some are optional and some are standard with each instrument.

- **Temp/RH Wand** (optional) - plugs into the instrument's rear panel. The 4-20mA probe monitors temperature (0° to 150° F or -17.8° to 65.6° C) and relative humidity (0% to 100%). Results are displayed, printed (if printer is available) and can be downloaded to the LMS XChange software for backing up and historical data review.

- **Air Velocity Probe** (optional) - plugs into the instrument's rear panel. The probe monitors air velocity up to 200 feet/minute (1.016 m/sec). Results are displayed, printed (if printer is available) and can be downloaded to the LMS XChange software for backing up and historical data review.

- **Differential Pressure Sensor** (optional) - plugs into the instrument's rear panel. Monitors range from 0 - 0.5" H_2O (124.5 Pa). Results are displayed, printed (if printer is available) and can be downloaded using the LMS XChange software for back ups and historical data review.

- **Filter Scanning Probe** (optional) - scans for leaks in filter assemblies.

- **Shipping Case with Wheels** (optional)

- **Internal Printer**
- **Printer Paper** (2 rolls; standard for "+" models)
- **Cleanroom Printer Paper** (optional, must be ordered in quantity of 10 rolls or more)
- **Validation Documentation** (optional)
- **Li-Ion Battery,** removable and rechargeable (optional)
- **External Battery Charger** (optional)
- **Cleanroom Cart** (optional)
- **USB-Serial Adapter** for laptops that have only a USB port and do not have a 9-pin serial port for communications
- **LMS Express software** (optional), an analysis tool that allows the user to:
  1. Collect real-time data from the instrument
  2. Manually download data from the instrument
  3. Save data for historical review
  4. Have advanced reporting with standard reports

  ...and much more.

Please contact Lighthouse Worldwide Solutions for details.

Installation

Connecting Power

The power input is 100-240VAC, 50-60Hz. A power cable is included with your SOLAIR. The power switch is located on the front of the unit.

Lighthouse recommends using protected power to protect the instrument from voltage spikes. Using an uninterruptible power supply when the SOLAIR is kept in a stationary location will help prevent damage to the instrument or loss of data in the event of a power outage.

Installing the Optional Battery

The SOLAIR 1001+ is available with an optional rechargeable Li-ion battery.

The battery may not be fully charged and needs to be installed before the instrument can be used for portable operation. The battery can be charged when it is installed in the unit or by using an optional external

battery charger. To charge the battery in the SOLAIR, install the battery then plug the SOLAIR into an AC power source.

Note: *To recharge the battery inside the unit, plug in the AC power source. The SOLAIR does not have to be powered on in order to recharge the battery.*

To install the battery, make sure that power switch on the front of the unit is in the OFF position and AC power is removed from the SOLAIR. Then follow these instructions:

5. Open the battery compartment door by turning the screw lock counterclockwise.

Figure 3-2 Battery Compartment Door

6. Insert the battery into the compartment as shown below. Ensure the battery fully seats to make contact with spring-loaded contacts.

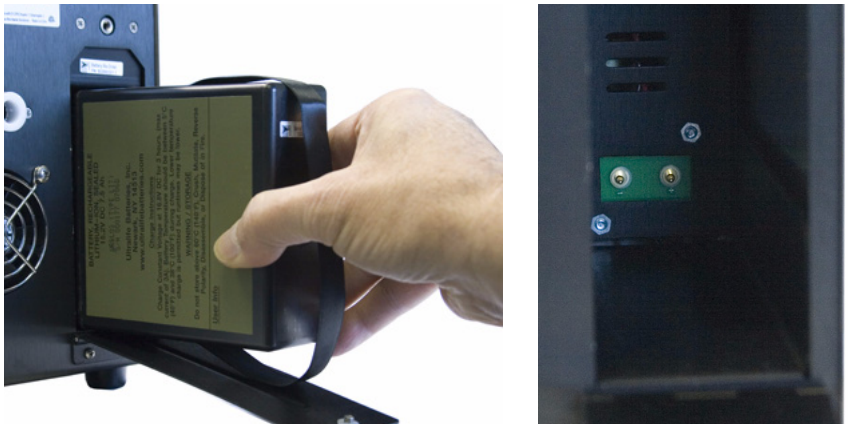


Figure 3-3 Inserting Battery

7. Push the battery all the way into the compartment, close the door and tighten the screw lock by twisting it clockwise.

Figure 3-4 Securing battery compartment

Removing the Battery

WARNING: ***Always remove the battery prior to shipping the instrument.***

1. To remove the battery, turn off the power switch, open the door and pull on the ribbon.

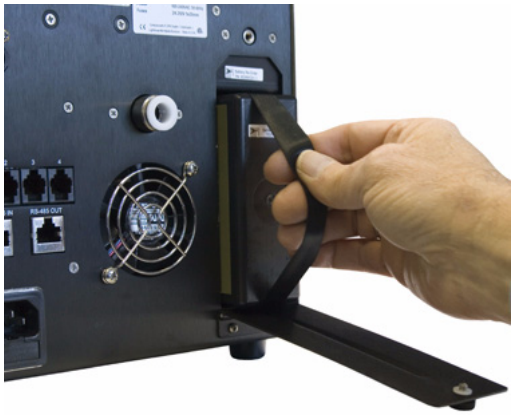


Figure 3-5 Removing battery

Loading Printer Paper

The SOLAIR 1001+ comes standard with a built-in thermal printer.

Note: *Thermal paper must be used. The printer will not print on regular paper.*

To load the thermal paper, follow these directions.

1. Grasp each side of the top of the printer door and pull outward to open.

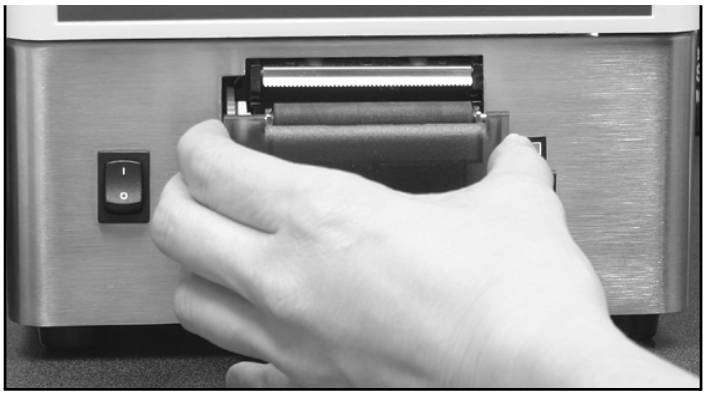


Figure 3-6 Opening printer door

2. Unroll the paper and place the roll in the printer with the paper feeding from the top.

Figure 3-7 Putting the paper into the printer

3. Make sure that the paper is lined up straight with the cutting edge.

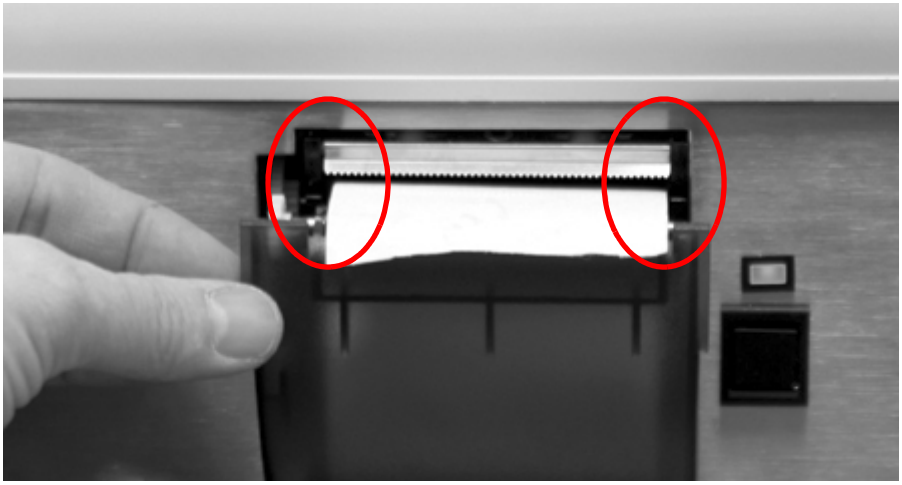


Figure 3-8 Aligning the paper

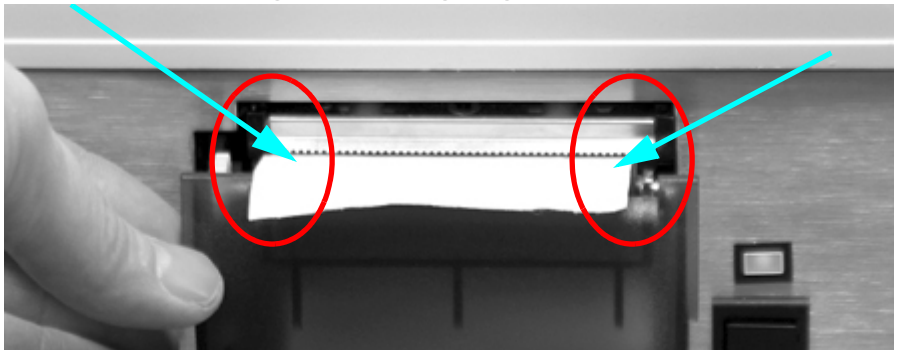


Figure 3-9 Paper NOT aligned straight

Note: *The printer door must be securely closed in order to print. If you try to print and nothing happens, press the corners of the door firmly against the chassis.*

4. Close the printer door so that about 1/2 inch or 2 centimeters of paper protrudes from the opening.

5. Press the paper feed button to ensure that the paper is loaded correctly.

Figure 3-10 Advancing the Paper

6. Tear the leading edge off by pulling the paper up against the cutting teeth.

7.

Figure 3-11 Trimming off extra paper

When the paper is torn off the door could open slightly, if left in this state the open door could prevent the instrument from printing.

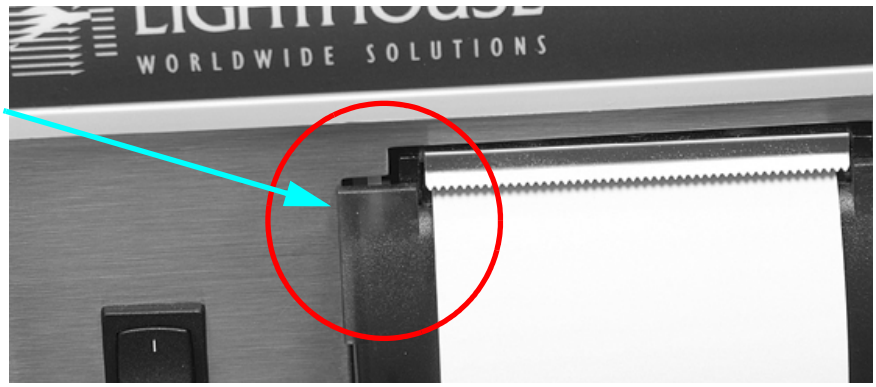


Figure 3-12 Door in good position

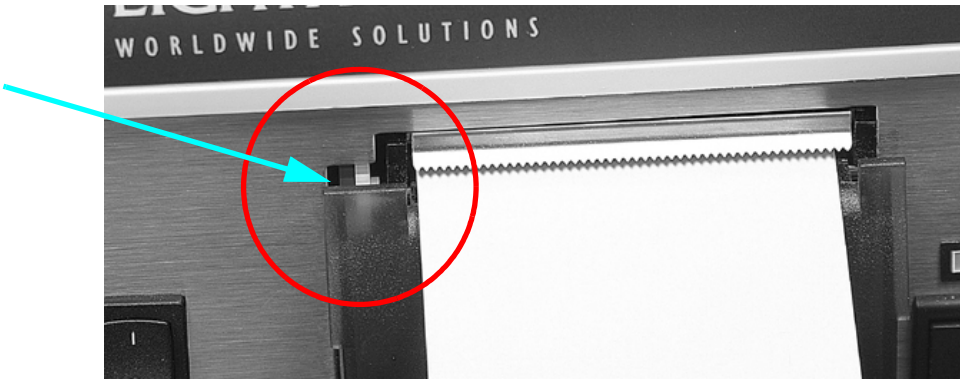


Figure 3-13 Door left slightly open

Connecting an Analog Sensor

The SOLAIR has four generic 4-20mA analog input ports on the back of the instrument. Specific details about these ports are described in Chapter 4.

Examples of analog sensors that can be used are Temperature, Relative Humidity, Air Velocity, Differential Pressure, ESD, Vibration, AMC Analyzer, and more.

Each sensor connects to the SOLAIR via an RJ-12 connector in the back of the unit.

Please refer to each sensor manual for the appropriate pinouts.

Connecting to an External Computer or Facility Management System

WARNING: ***+24VDC is present on Pin 7 of the RS-232/485 IN port.***

The SOLAIR family of instruments can be connected to the Lighthouse Monitoring System, LMS Express/RT/ RT+, or the LMS XChange Data Transfer Software in order to download data.

By downloading the data into the Lighthouse Monitoring System (LMS) or LMS Express, you can store historical data internally for future review and trending. In LMS XChange, data can be exported to a *.csv file for historical review. Up to 200 alphanumeric location names can be transferred between LMS XChange and the SOLAIR.

Note: *LMS Express allows you to download data; LMS Express RT and LMS Express RT Plus additionally allow you to collect real-time data.*

The transfer is made via the Modbus communication protocol.

Please refer to the LMS, LMS Express/RT/RT Plus or LMS XChange manuals for further information.

4 Operation

Using the Instrument for the First Time

This chapter describes how to use the SOLAIR Airborne Particle Counter. Illustrations use the SOLAIR 1001+ unless noted otherwise. The SOLAIR is ready to use out of the box. To start using the instrument, proceed as follows:

WARNING: ***Do not attempt to sample reactive gases (such as hydrogen or oxygen) with this instrument. Reactive gases create an explosion hazard in the instrument.***

Sampling any gas under pressure can damage the instrument.

Sampling any gas that is not the same density as ambient air can result in inaccurate data.

Please contact Lighthouse for more information.

1. Position the instrument in the environment to be measured.
2. Install battery according to the instructions in “Getting Started”.
3. Plug in AC power cord.
4. Remove the protective cap from the inlet tube. If desired, install the isokinetic probe by connecting the probe tubing to instrument’s inlet found on the top of the unit.
5. Set the power switch on the front panel to ON.
6. While booting, the unit displays a startup screen.
7. The MAIN screen displays.

WARNING: ***When installing the Lighthouse Worldwide Solutions TRH Probe, you must use port 1 and leave port 2 open or use port 3 and leave port 4 open. Do NOT install it on port 2 or port 4 or install another device on its "reserved" channel (port 2 when using port 1 or port 4 when using port 3). Failure to adhere to these restrictions will result in incorrect or lost data.***

8. If analog sensors were ordered, plug them into the back of the instrument.

Lighthouse sells a 4-20mA Temperature/Relative Humidity wand that attaches to Port 1 or 3. Because the wand uses two ports, if it is attached to Port 1, Port 2 must be left unoccupied. If the wand is attached to Port 3, then Port 4 must be left open. Temperature readings will display correctly only if Port 1 or 3 are used to connect the wand.

9. On the touch screen, press the "START" button to start the instrument.

10. "STARTING" will display when the pump is turned on.

WARNING: ***Never operate the instrument with the inlet tube capped or plugged as damage can occur to the internal pump.***

11. When the instrument starts counting, "COUNTING" appears on the display. Particle counts are displayed according to the size of each particle.

WARNING: ***To prevent damage to the instrument, water, solvents, or other liquids of any type should never be put into the instrument via the inlet tube.***

12. If the instrument is in the AUTO mode with cycles and a hold time, "HOLDING" will display after each cycle and "FINISHED" will display when all the cycles are complete.

13. Press the "STOP" button to stop the instrument before the cycles are complete. If the STOP button is pressed, "STOPPED" displays to indicate that the sample was stopped before it was complete.

Touch Screen Overview

The SOLAIR family of instruments incorporates a unique touch screen interface to control and configure the instrument. This interface allows the user to easily view and configure the instrument for their specific

needs and applications.

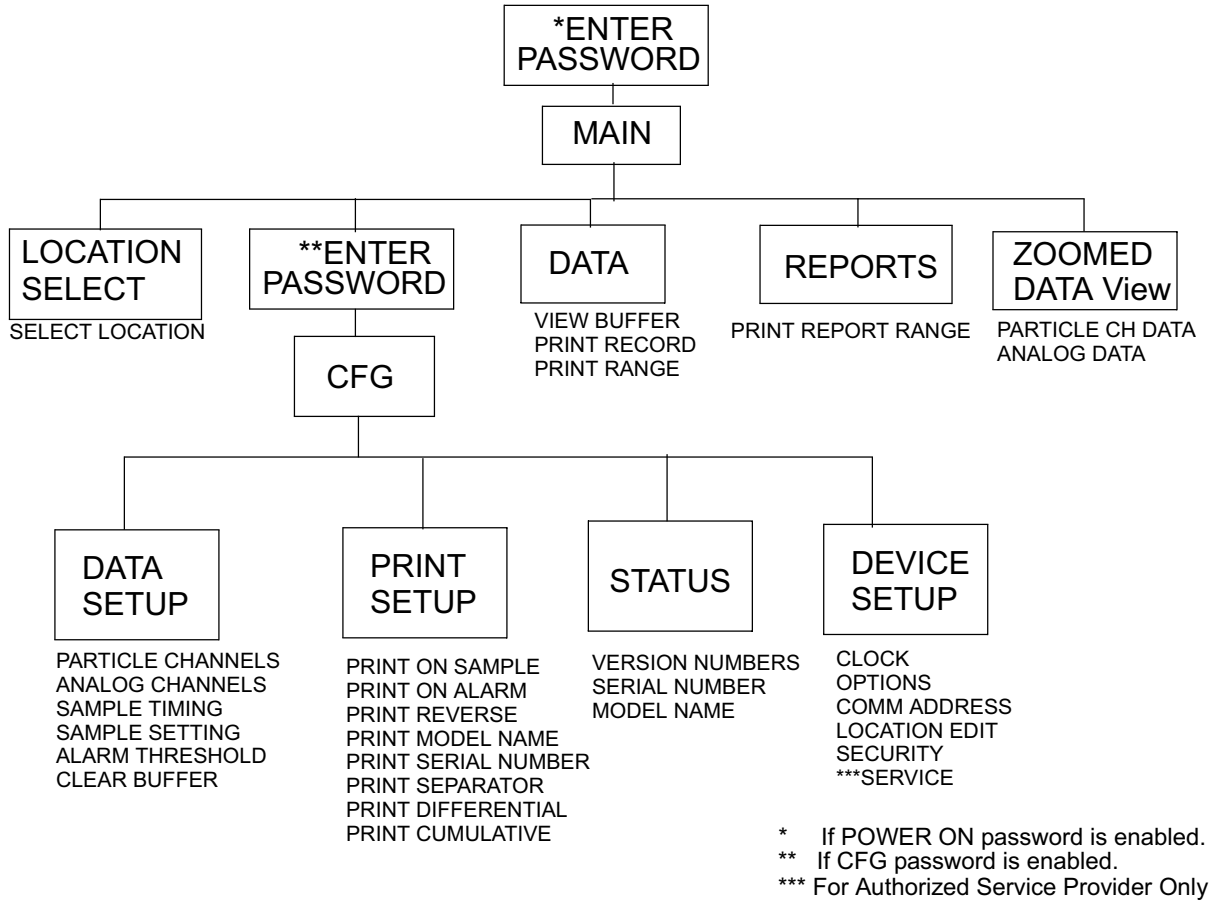


Figure 4-1 Menu Map

MAIN Screen

The MAIN screen gives the user a single snapshot view of the status of the instrument. The instrument can be powered either by AC power or its optional internal, removable battery. When the unit is on battery power, the battery indicator will show the level of the battery charge

remaining.

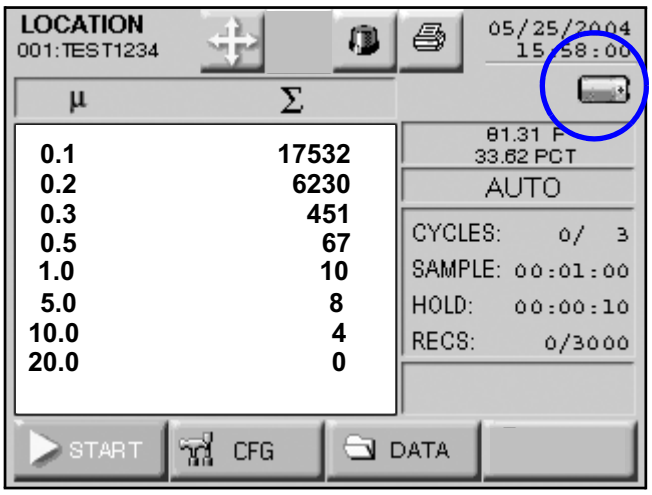


Figure 4-2 MAIN Screen - battery operated

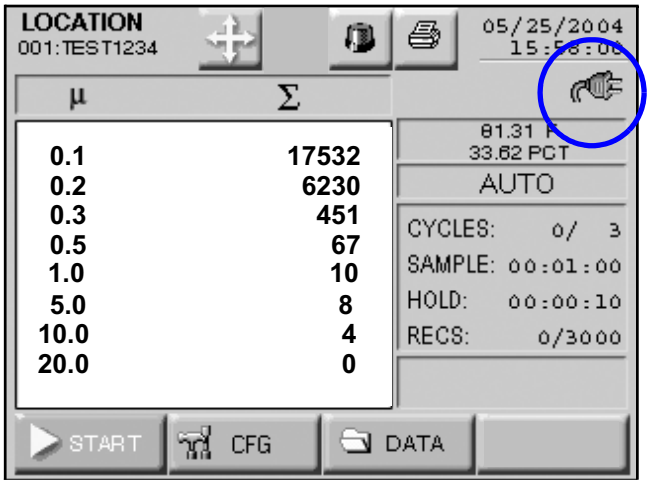


Figure 4-3 MAIN Screen - AC operated

When the AC indicator symbol is displayed, it indicates that the instrument is getting its power from an AC source.

The MAIN screen displays the following features:

- **LOCATION:** Displays the location that is currently being measured. Up to 200 alphanumeric locations can be configured.

- **LOCATION SELECT button:** Allows user to change location before sampling.

- **LOCATION + / - buttons:** When the unit starts counting, the

Location select button and the About button become + and - buttons. This allows user to increment or decrement the location during HOLD time.

- **ALARM ACKNOWLEDGE button:** When an alarm condition occurs for any of the particle channels, the SOLAIR will start to beep every second during the sampling period. The Alarm Acknowledge button can be pressed to stop the beeping for the remainder of the sampling period.

  If two or more alarms are configured, when one alarm is activated and acknowledged, the buzzer will be reset for all the alarmed channels until the next sample.

  If an external alarm light or buzzer is connected to the instrument, pressing the Alarm Acknowledge button will turn the light or buzzer off for the remainder of the sampling period.

- **PRINT LAST RECORD:** Prints the last recorded sample using the current configuration to determine the type of data printed (i.e.,cumulative vs. differential, raw vs. normalized, ft^3 vs. m^3).

  The print configuration is setup through the PRINT SETUP button in the CONFIGURATION screen. More is described on this in the Configuration section in this chapter.

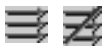
- **Date/Time:** Displays the current date and time.

Note: *If the instrument is counting when the "X" appears in the battery indicator, the pump will automatically stop to prevent the battery from discharging completely.*

- **Battery Indicator:** Indicates that the instrument is being powered by a rechargeable battery. The amount of battery life left is indicated by the fill inside the battery icon. When the battery is low, the words "BATT LOW!" will appear on the screen and the unit will beep continually until it is plugged into its AC power cord for recharging.

Figure 4-4 Battery Indicator levels from Full to Empty, left to right

- **AC Indicator:** Indicates that the instrument is being powered with its AC power cord. If battery is present, the battery will be charged when the instrument is plugged into an AC source.



- **Flow Status:** When the instrument is sampling, the Flow Indicator displays sufficient or insufficient flow.

- **Service Indicator:** Indicates that the instrument may be in need of service. If wrench displays, please contact your Authorized

Lighthouse Service Provider for assistance or send an email to techsupport@golighthouse.com.

- **µ:** The mu symbol indicates the particle sizes, in micrometers, configured for the instrument. These sizes are pre-configured at the factory. To order an instrument with different sizes, please contact a sales representative at Lighthouse (1+(800) 945-5905 Toll Free).

- **DATA DISPLAY:** This indicates whether the counts are being displayed in Differential (Diff) mode Δ or in Cumulative (Cuml) mode Σ and, if the counts are normalized to ft^3 or m^3.

- **Analog Data:** Gives a snapshot view of the first 2 analog channels, if the channels are enabled and the analog sensors are connected.

- **MODE:** Displays the current mode selected; possible modes are AUTO, MANU (Manual), CONC (Concentration) and BEEP.

- **CYCLES:** Indicates the number of times that the count will be taken at a given location in Auto mode. "1/ 3" indicates that the count is the first of three samples to be recorded at this location. The maximum number of cycles is 999. When set to 0, the unit will run in Auto mode continuously until the STOP button is pressed.

- **SAMPLE:** The Sample Time (hh:mm:ss) is the duration of one counting cycle. The Sample Time will count down on the MAIN screen when the instrument is in AUTO or Manual mode so you can see how much time is remaining in the sample period.

  The maximum sample time is 23 hours, 59 minutes and 59 seconds.

  In Concentration mode, the Sample Time will count up to 6 seconds per cycle.

Note: *If Hold time is greater than one minute, the pump will stop during that time. At the end of the hold time, the pump will restart.*

- **HOLD:** Displays the hold time in between cycles. The maximum hold time is 99 hours, 59 minutes, 59 seconds**.**

- **RECS:** This displays the current number of records stored in the instrument and the total number of records that can be stored. SOLAIR "+" models can store up to 3000 records; non-plus models store up to 1500 records. The data buffer is a circular buffer. An asterisk (*) will appear in front of counts when the buffer wraps.

- **START/STOP:** Press START button on the screen to start counting. When running, the instrument displays "COUNTING" in

the lower right corner of the screen.

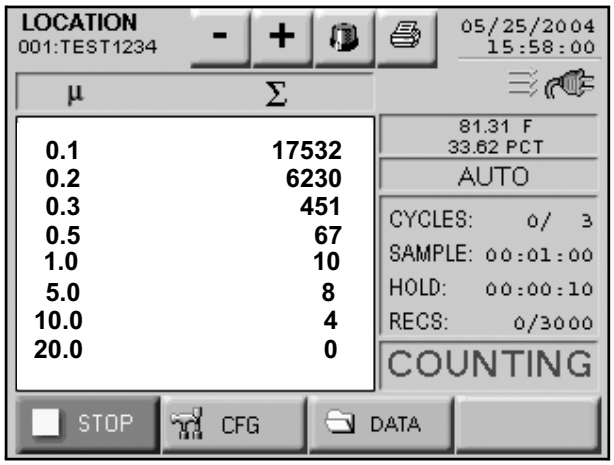


Figure 4-5 Counting mode

Press the STOP button to stop counting; the word "STOPPED" displays.

Location Selection

Changing Locations

The location number for the environment to be measured can be changed by pressing the LOCATION button at the top of the MAIN screen. The following screen will display.

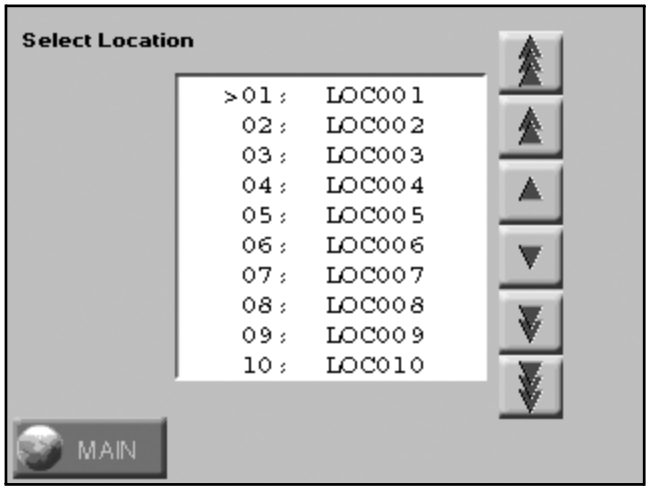


Figure 4-6 Location Select Screen

The cursor character (>) indicates which location is currently selected.

- Use the UP and DOWN arrows to select a location. The single arrows will move the cursor up and down by a single line. The double arrows displays the next block of 10 records. The triple arrows will jump to the next block of 100 records. This allows you to search through the list more quickly.

Figure 4-7 Arrow navigation keys

- Press the MAIN button to return to the MAIN screen. Whichever location is currently selected will be the location displayed on the MAIN screen.

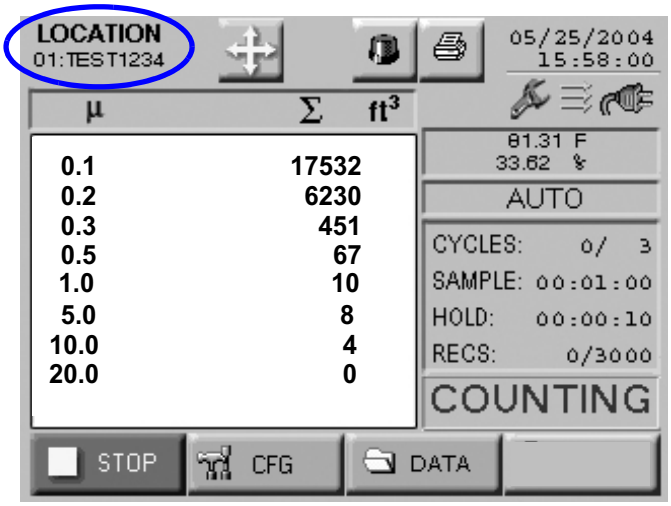


Figure 4-8 New Location Selected

Locations and AUTO Mode

When the instrument is in Automatic Mode and the START button is pressed, the instrument will start counting particles automatically according to the SAMPLE time, HOLD time and number of cycles that are configured.

When the instrument is HOLDING, move the instrument to the new location and press the Location - and + buttons to increment or decrement the Location value to the new location.

For example, to sample from two different locations that are a 5 minute walk apart, follow these instructions:

- Set Sample time as desired
- Set the Hold Time to 5 minutes
- Collect data from Location 1
- When the instrument finishes counting the first cycle and is HOLDING, move the instrument to Location 2.
- Place the instrument in Location 2 and press the - or + button on the MAIN screen to change the Location value to the new location.
- When the Hold time completes, the instrument will proceed to take the next sample at Location 2.

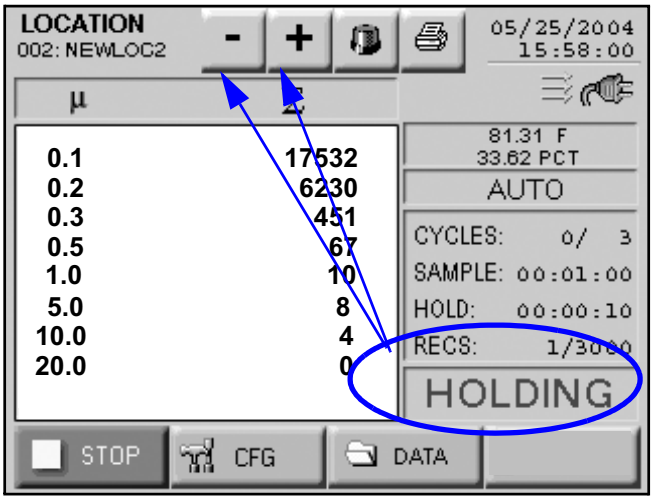


Figure 4-9 Changing Locations using - and +

- Data will be saved to the location that is displayed when the instrument finishes COUNTING and enters the HOLDING state.

- Location names can be changed using the Location Edit feature. (See the Configuration section later in this chapter for details.)

- Location names can be 8 alphanumeric characters including an underscore. (See “Location” on page 36.)

Zoomed Data View

There are 2 different Zoom views. You can either view a single column of data (differential or cumulative) in a larger font, or you can view both differential and cumulative data on the same screen in a smaller font.

Press anywhere in the Particle Data area to display the Zoomed Data View.

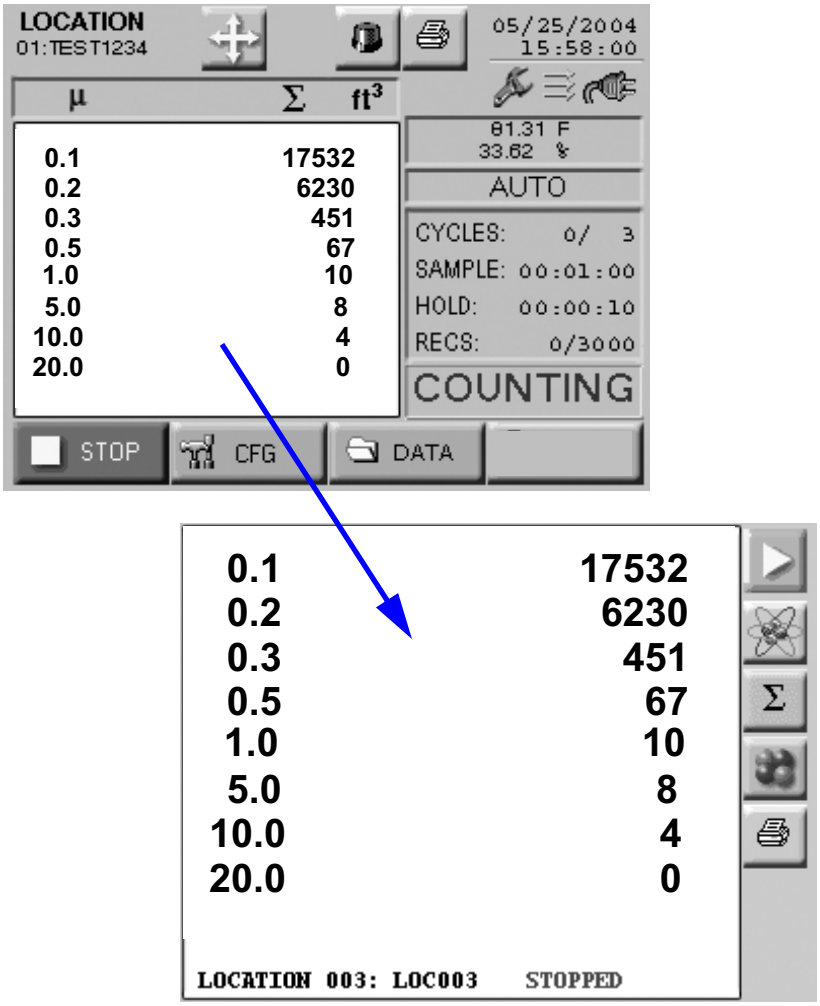


Figure 4-10 Zoomed Data View

In the Zoomed Data View, the following functions can be performed

using the toggle buttons on the side bar on the right:

- START/STOP counting
- Display Particle/Analog data
- Display Cumulative/Differential particle data
- Display Raw/Normalized particle data
- PRINT the last record

When the instrument is STOPPED or HOLDING, press anywhere in the white data area to return back to the MAIN screen.

Viewing Two Columns of Data

The unit can display both Differential and Cumulative data at the same time on the Zoomed View screen.

Go to the Configuration: Options screen.

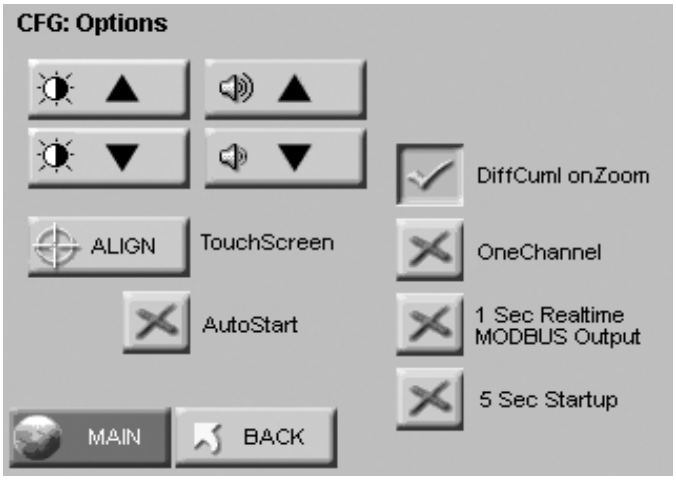


Figure 4-11 Configuration Options Screen

Select the button "DiffCuml onZoom"; this will display both

differential and cumulative data on the Zoomed View screen.

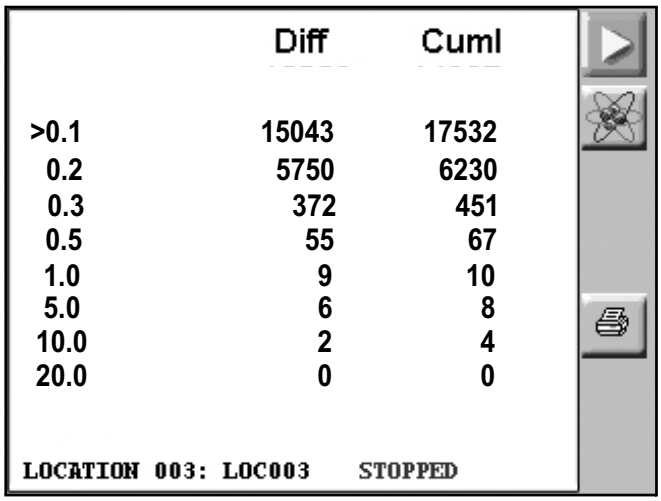


Figure 4-12 Zoomed View with Differential and Cumulative Data

Viewing One Column of Data

The unit can also display only one type of data in one column on the Zoomed View screen.

Go to the Configuration: Options screen and deselect the button "DiffCuml on Zoom" button.

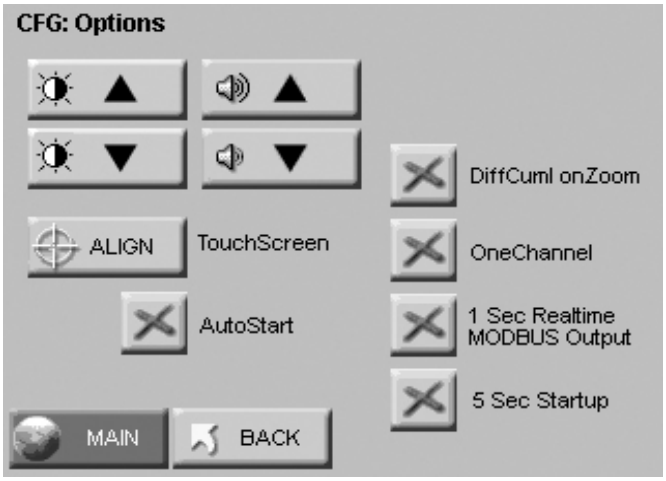


Figure 4-13 Configuration Options Screen

Go to the Configuration: Setting screen and select Differential or Cumulative for the data type.

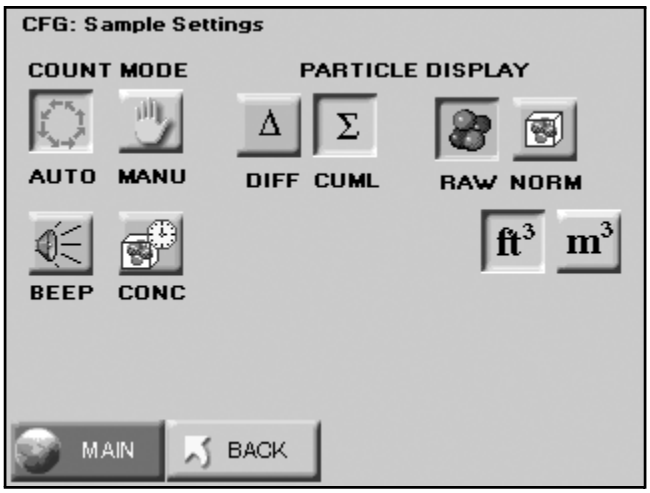


Figure 4-14 Configuration: Setting Screen

Press the MAIN button, then go into the Zoomed View.

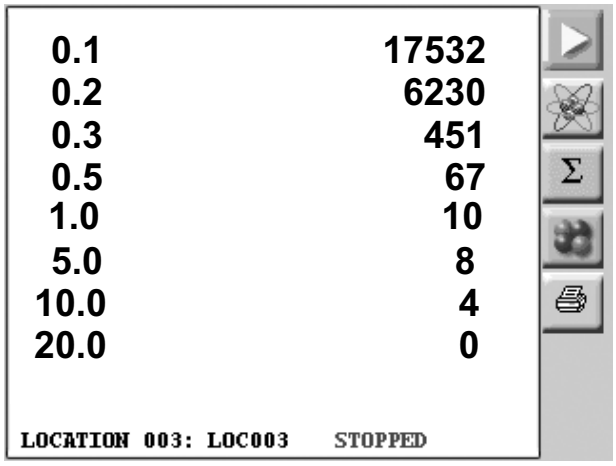


Figure 4-15 Zoomed View with Only Cumulative Data

Only one column of data is displayed.

CFG (Configuration) Screen

Press CFG on the MAIN screen to display this screen:

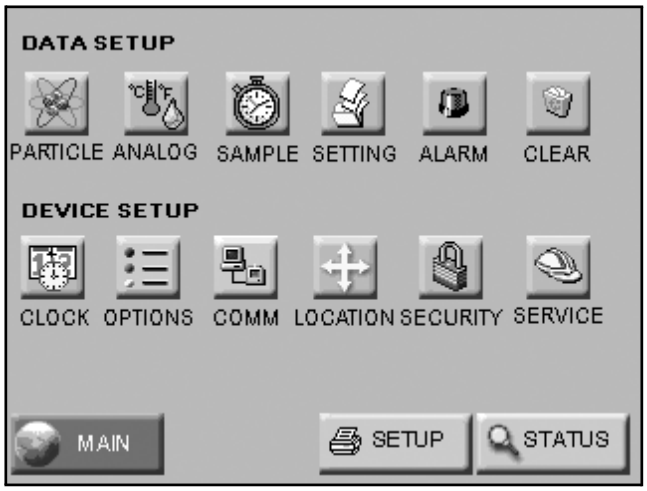


Figure 4-16 CONFIGURATION Screen

There are two sets of configuration options available on the CONFIGURATION Screen: Data Setup and Device Setup.

Data Setup includes buttons to enable/disable particle channels, analog channels, set sample record parameters, sample settings, thresholds, enable/disable alarms, and clear the data buffer.

Device Setup includes buttons to configure the instrument's date and time, set the LCD contrast, adjust the instrument's beep volume, enable the instrument to AutoStart, set it to display only one channel of data, enable real time MODBUS output, enable/disable 5 Sec Startup delay, set the instrument's communication address, edit location names, enable password restrictions, and/or (with proper authorization) adjust service settings.

Two options in the lower right corner, SETUP and STATUS, configure the printer and display the instrument's current status, respectfully.

DATA SETUP

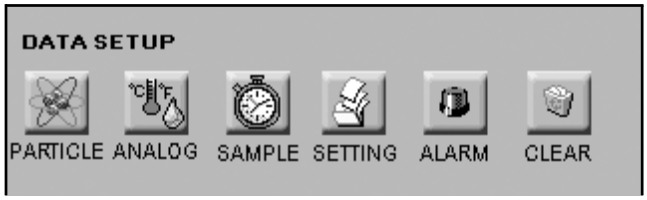


Figure 4-17 Data Setup options

Particle Channels

The instrument's particle channels can be enabled or disabled in this configuration screen. A green checkmark is displayed next to each enabled channel. A red "X" indicates that a channel is disabled.

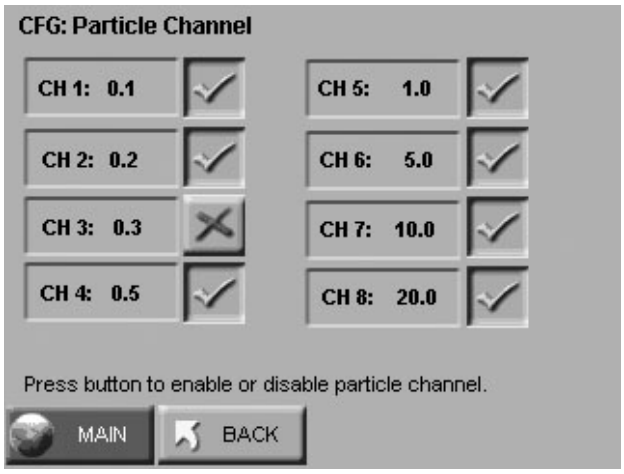


Figure 4-18 Particle Channel configuration

- The green Checkmark button is a toggle. Press it once to disable a channel and a red "X" displays to indicate that the channel is disabled. Press the button again and it will change back to the green checkmark and enable the channel.

Note: *The data buffer is cleared when channels are enabled or disabled so that all the data in the buffer have the same number of channels.*

- Pressing MAIN or BACK will prompt to clear all collected data.

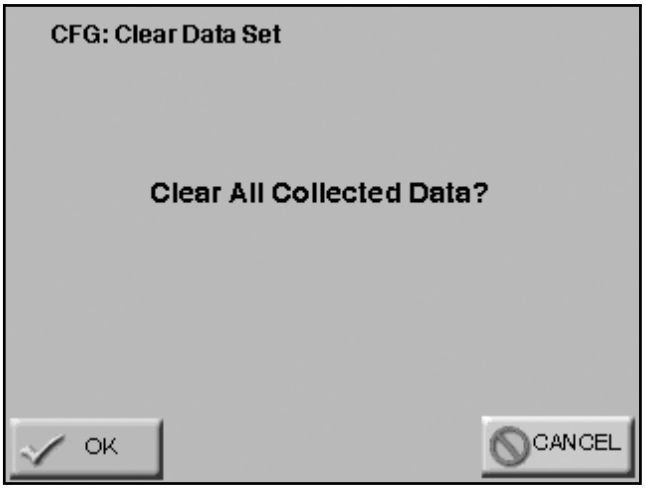


Figure 4-19 Clear Data screen

- From this screen, press CANCEL to cancel changes and return to the CONFIGURATION screen.

When channels are disabled, they are removed from the MAIN screen display, from any buffer reports and from the printouts.

The channel size label for disabled channel(s) will remain in the View Data Buffer screen. However, the instrument does not record data for disabled channels.

Analog Channels

WARNING: ***If the Lighthouse TRH Wand is connected to analog port 1 or 3, the corresponding analog port 2 or 4 cannot be used for any other analog sensors.***

Up to four 4-20mA Analog devices can be connected to the SOLAIR via the RJ-12 connectors on the back panel. The analog channels are configured in the Analog configuration screen.

Figure 4-20 Analog Channel Configuration

Press the red "X" button to enable an analog channel. Press the channel button (A1, A2, A3, or A4) to disable it.

Analog channels can be assigned a type (4 characters) and a unit of

measure (4 characters).

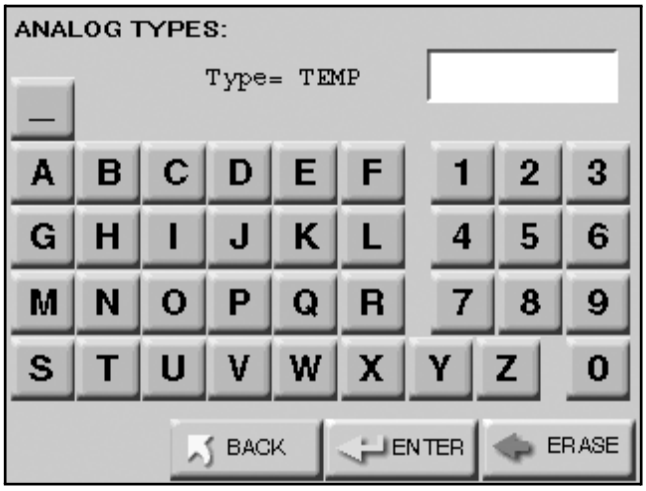


Figure 4-21 Configuring Analog Types

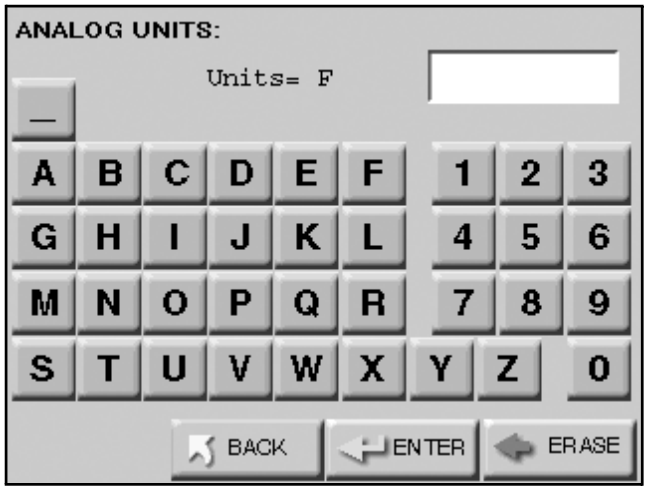


Figure 4-22 Configuring Analog Units

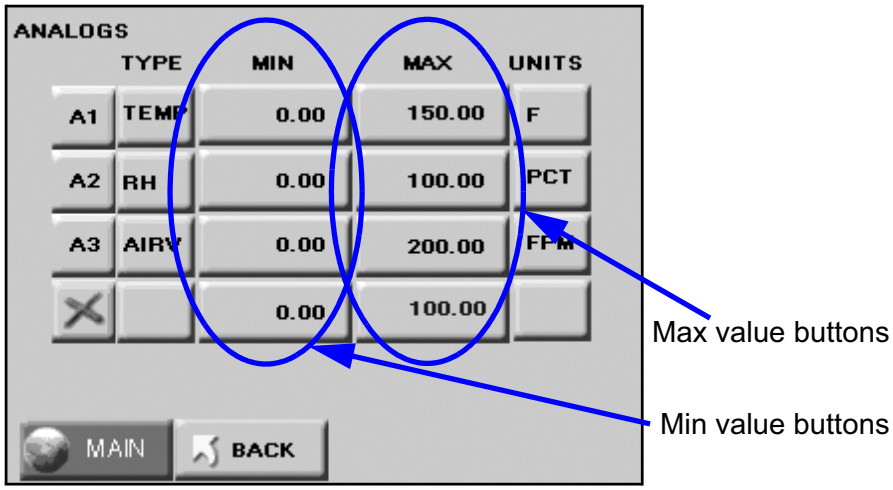


Figure 4-23 Min and Max value buttons

Note: *Changes to the analog configuration will change the calculated historical environmental values in the buffer.*

Press the Min value button for each device to enter the Minimum data range. Press the Max value button for each device to enter the Maximum data range.

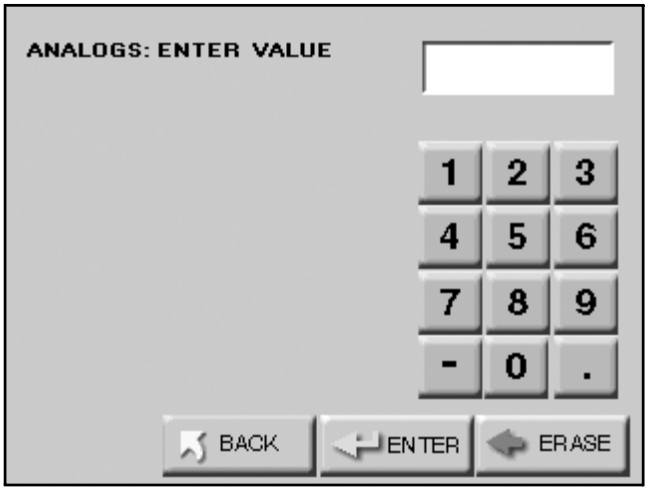


Figure 4-24 Data Entry screen for Max & Min values

Analog Data Display

On the MAIN screen, the values for Analog 1 and Analog 2 are

displayed above the instrument counting mode.

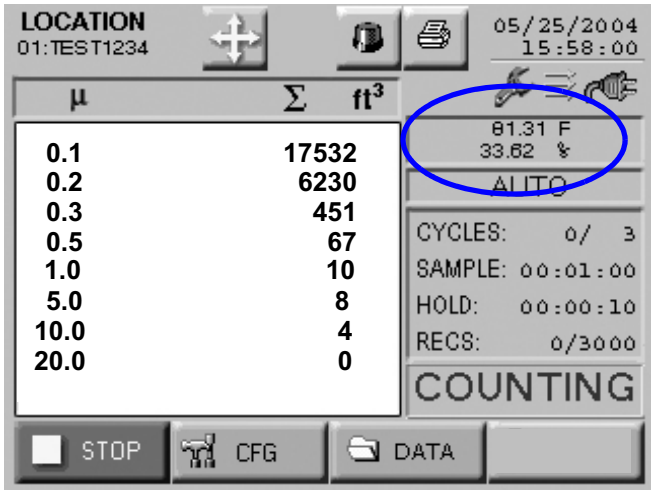


Figure 4-25 Analog data on MAIN screen

Zoomed Analog Data Display

When the instrument is Holding or is not Counting, you can press anywhere on the Particle Data display to bring up the Zoomed Data View, then toggle to analog data.

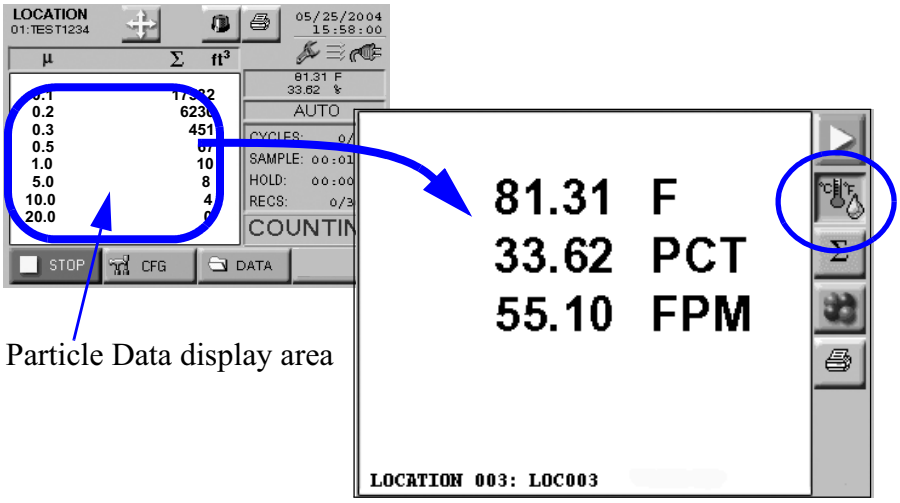


Figure 4-26 Zoomed Data View: Analog Data

Sample Time

Configure the Sample Time and the number of samples to be collected on the Sample Timing screen.

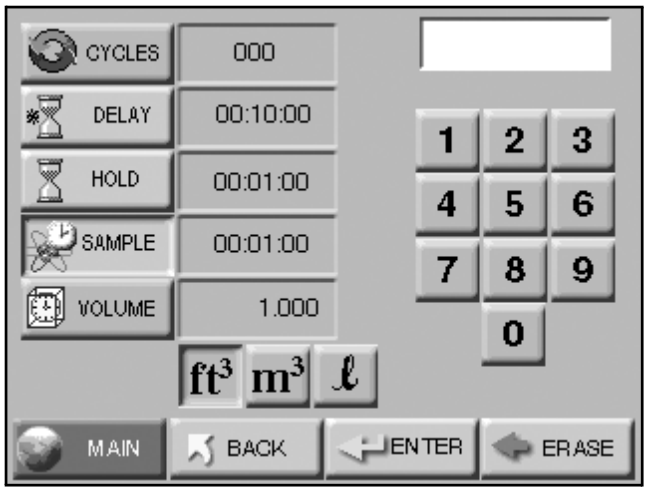


Figure 4-27 Sample Timing Configuration Screen

- **CYCLES:** The number of cycles determines how many times the instrument samples the air in a single location. This is used in AUTO and BEEP modes. The range is 0 - 999. When Cycles is set to 0, the instrument will continue running samples indefinitely until the STOP button is pressed.

  Select the CYCLES button; enter the number of desired cycles using the numeric keypad on the right. Press ERASE to erase a number, if needed. Press ENTER to set the Cycles.

- **DELAY:** The Initial Start Delay (hh:mm:ss) is the time between pressing the START button and the pump starting. This setting differs from the 5 Sec Startup (see page 3-33) which affects when the instrument will start counting. When the Delay time has expired, the 5 Sec Startup timer, if enabled, will execute. After the 5 Sec Startup time has expired, the instrument will start counting.

  The Initial Start Delay gives the operator time to exit the area under test so that the measurement is taken under a controlled condition. The maximum delay time is 99 hours, 59 minutes and 59 seconds.

  Select the DELAY button; enter the initial delay time in hours, minutes and seconds using the numeric keypad on the right.

  After the value is entered, press ENTER.

Note: *If the Hold time is set to 00:00:00 in Auto Mode, the instrument will run the samples according to the sample time and the # of cycles, but with no hold time in between cycles.*

If the Hold time is greater than one minute, the pump will shut off during the specified hold time.

- **HOLD**: The Hold Time (hh:mm:ss) is the time between count cycles when the instrument is not counting particles.

  Select the HOLD button; enter the time in hours, minutes and seconds using the numeric keypad on the right. Press ERASE to erase a number, if needed. Press ENTER to set the Hold Time.

- The maximum hold time is 99 hours, 59 minutes and 59 seconds. This field will count down to indicate how much time is left for the Hold period.

Note: *The maximum Sample Time when volume is set to ft^3 is 23:59:59.*

When the Sample Volume is measured in liters, the maximum Sample Time is 05:53:08 when the Sample Volume is at the maximum 9999.99 Liters.

For ft^3 and m^3, the maximum Sample Time is 23:59:59 for 1439.983 ft^3 and 40.776 m^3 respectively.

- **SAMPLE:**The Sample Time (hh:mm:ss) is the duration of one counting cycle. The Sample Time will count down on the MAIN screen when the instrument is in Auto or Manual mode to indicate how much time is remaining in the Sample.

  Select the SAMPLE button; enter the time in hours, minutes and seconds using the numeric keypad on the right. Press ERASE to erase a number, if needed. Press ENTER to set the Sample time.

- **SAMPLE VOLUME:** Instead of selecting a specific Sample Time, the instrument can be set to measure a specific Sample Volume in cubic feet (ft^3), cubic meters (m^3) or liters (l). When this is set, the corresponding Sample Time will automatically be set.

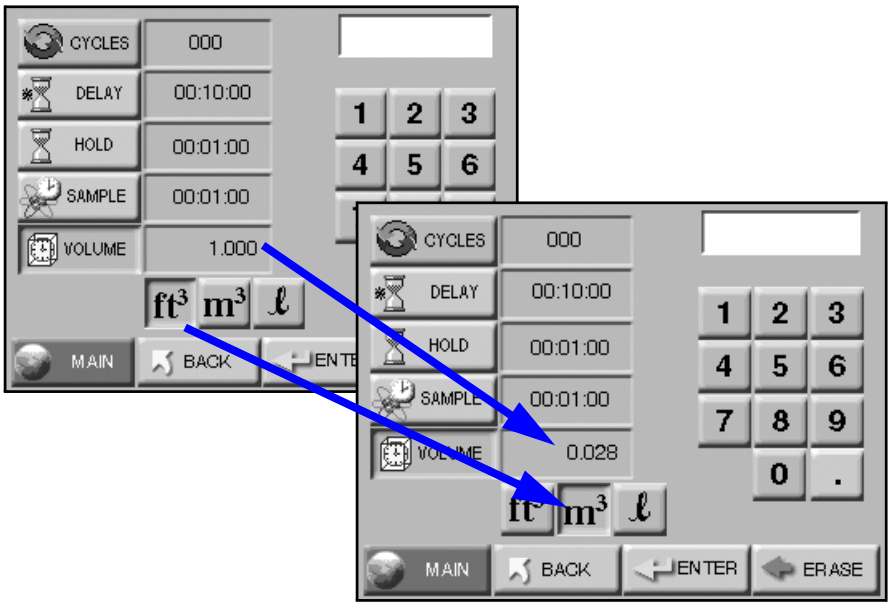


Figure 4-28 Changing Sample Volume unit of measure

Press BACK to return to the CONFIGURATION screen or press

MAIN to return to the MAIN screen.

Sample Settings

The instrument can be configured to count in different modes and formats.

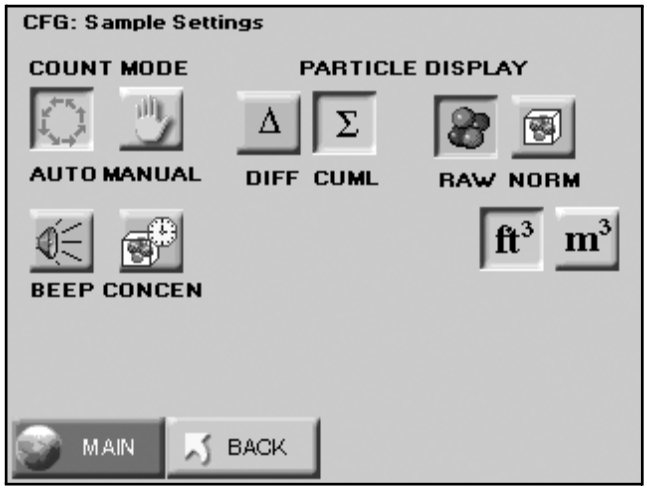


Figure 4-29 Sample settings screen

COUNT Mode

The following modes are available: Auto, Manual, Beep and Concentration.

- **AUTO (Automatic Mode)** - When the instrument is in Automatic Mode and the START button is pressed, the instrument will start counting particles automatically according to the Sample Time, Hold Time and the number of Cycles that are configured. If Cycles are set to zero (0), the instrument will continue indefinitely in Auto Mode until the STOP button is pressed.

- **MANU (Manual Mode)** - When the instrument is in Manual Mode, it will start counting when START is pressed and stop at the end of one programmed Sample Time.

- **CONC (Concentration Mode)** - When the instrument is in Concentration mode, it gives a calculated value of the concentration of particles in a volume of air, measured and displayed on the MAIN screen in either counts per cubic foot or per cubic meter.

Note: *The sample time for Auto and Manual modes counts down while the sample time for Concentration mode counts up.*

Counting starts when the START button is pressed and it will continue until the STOP button is pressed. The sample time for Concentration mode is six seconds. As the sample time on the MAIN screen counts from one to six, the particle counts are updated continuously.

Concentration data will be recorded and can be viewed in the Data View Buffer and on the printouts.

Note: *BEEP mode only works with CUMULATIVE data and for Sample Times equal to or greater than 6 seconds.*

- **BEEP** - In this mode, the instrument is pre-configured to beep according to the alarm threshold set in the Alarm configuration and the instrument's sample time when the instrument is set to collect cumulative data. Counting starts when the START button is pressed and will continue for the configured Sample time.

  If no channel is set for alarming and BEEP mode is selected, the smallest channel size will be automatically selected and its alarm threshold will be used to trigger the alarm.

  If alarming is enabled on more than one channel size, only the smallest channel size will be used to trigger the alarm in BEEP mode. Larger channel sizes will be ignored.

Note: *If BEEP mode is set to one count, the beeps may not be for every single count.*

The data will be recorded, based on the set sample time and hold time, and can be viewed in the View Buffer and on the printouts, however there will be no indication on the record that the data was saved while the instrument was in BEEP mode.

Example Application for BEEP Mode

Note: *The SOLAIR's external relay light (if attached) will turn on with every beep in BEEP mode.*

Filter scanning is one example of an application of BEEP mode.

In this application, it is recommended to set the sample time equal to or greater than 1 minute. In the alarm threshold configuration, select the channel size that is most critical to measure. Enter the desired threshold to trigger the alarm.

As a filter is scanned and the count exceeds the threshold, the instrument will beep once at every instance of the threshold.

Particle Display

Data on the instrument can be displayed in **Differential** (DIFF) or **Cumulative** (CUML) counts.

For example, if the instrument has channel sizes 0.3, 0.5, 1.0, 3.0, 5.0, and 10µm, the cumulative count for the 1µm channel is the sum of that channel's count + 3µm count + the 5µm count + the 10µm count.

The differential count for the 1µm channel is the number of particles between 1µm and 3µm.

The data displays on the MAIN screen according to whichever is selected (Diff or Cuml) from the CONFIGURATION screen.

The data format is either Raw or Normalized (NORM). **Raw** data displays the actual number of particles counted. **Normalized** data shows particle concentrations calculated from the raw data based on the settings chosen (ft^3 or m^3).

Volume of Air = Sample time (minutes) x FlowRate (cfm)

Normalized Data = Number of Particles/Volume of Air

Press BACK to return to the CONFIGURATION screen or press MAIN to return to the MAIN screen.

Particle Alarm

The instrument allows the user to enable alarming on specific channels.

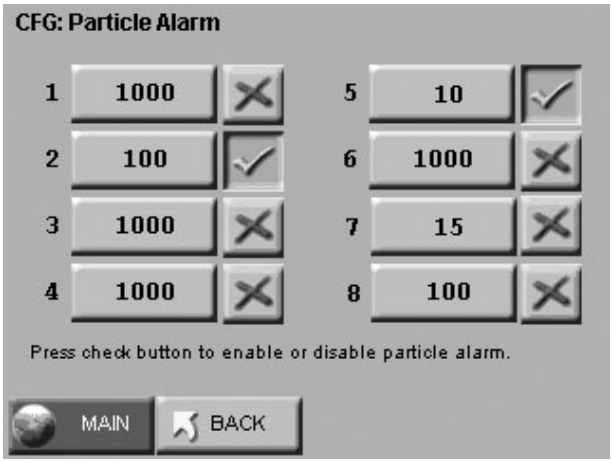


Figure 4-30 Particle Alarm Configuration with 2 channels enabled for alarming

Alarming is only applicable for AUTO and MANUAL mode. It applies only to RAW particle counts even if the instrument is displaying Normalized data.

If the counter is set to DIFFERENTIAL data, the alarm threshold will apply to the differential counts.

Note: *The buzzer volume is adjusted via a pot from the back of the instrument. Turn the pot to the left to increase the volume, and to the right to decrease the volume.*

If the counter is set to display CUMULATIVE data, the alarm threshold will apply to the cumulative counts.

To enable the alarming for any channel, press the RED "X" next to that channel. When a GREEN checkmark is displayed, that channel is enabled for alarming. Press the checkmark to disable the alarming for that channel.

Channel Alarm Threshold

Press the threshold button next to the enabled channel in order to set the alarm threshold for that channel.

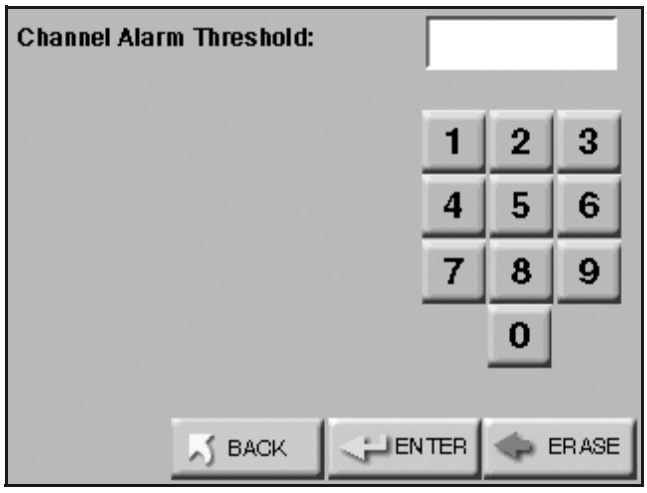


Figure 4-31 Configure Channel Alarm Threshold

Note: *To activate the alarms, the Sample Time must be greater than 1 second.*

Enter the desired alarm threshold for the selected particle channel, in numbers of particles, then press ENTER. The threshold value will be updated on the Alarm Configuration screen.

Press BACK to return to the CONFIGURATION screen or press

MAIN to return to the MAIN screen.

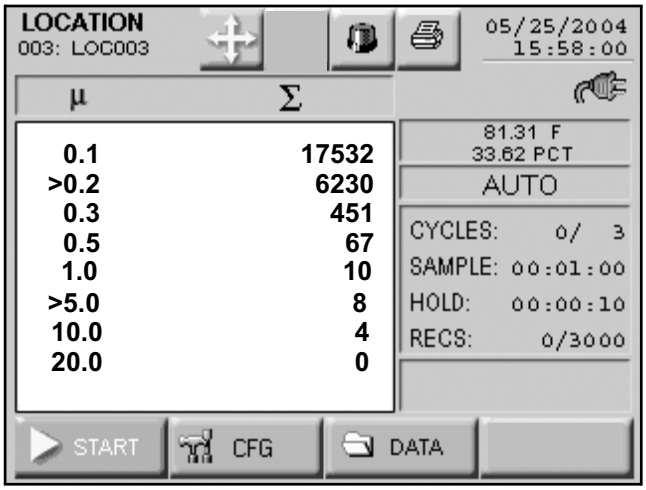


Figure 4-32 MAIN screen with 2 channels enabled for alarming

Note: *Alarms are triggered per sample record. At the end of the sample time, the alarms are reset.*

When a particle channel that is enabled for alarming goes into alarm, the selection cursor (>) becomes an asterisk (*) and the channel size is highlighted in RED.

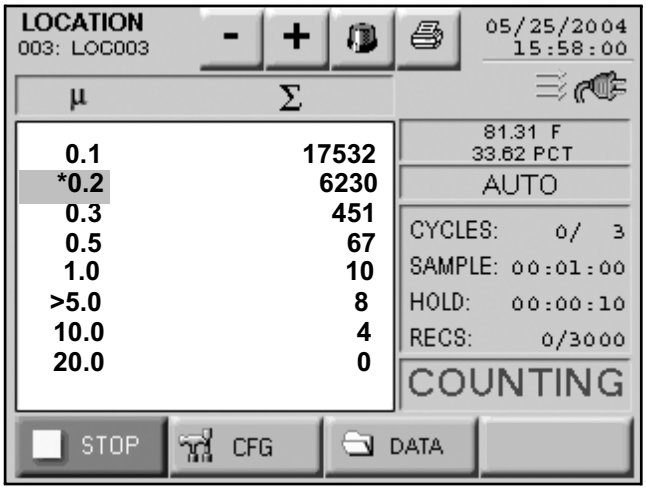


Figure 4-33 One channel in alarm and one not in alarm

Alarm Acknowledge

Note: *When alarms are enabled on two or more channels, if the user presses the Alarm Acknowledge button when the first channel goes into alarm, the alarm will not sound if the other channels' thresholds are reached within the same sample period.*

When the instrument begins to beep in response to the Alarm and Threshold settings, silence the beep by pressing the Alarm Acknowledge button on the MAIN screen.

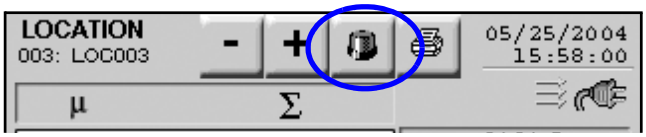


Figure 4-34 Alarm Acknowledge button

After acknowledging the alarm, the alarm count will reset when the next sample cycle begins.

Clear Data Set Buffer

The 1001+ can store up to 3000 data records in its data buffer. To clear the data buffer on the instrument, press the Clear Buffer button.

Note: *To save the instrument's data to an external source, download it using LMS XChange or LMX Express before clearing the instrument's buffer.*

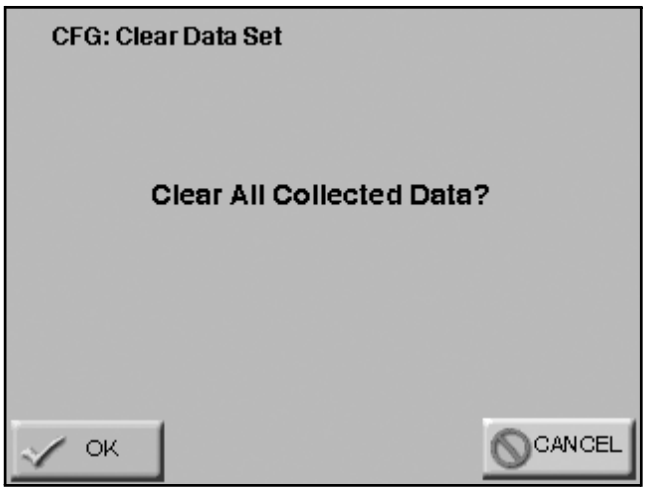


Figure 4-35 Clear Buffer message screen

Press OK to clear the data or press CANCEL to exit the screen without clearing the data.

DEVICE SETUP

Device Setup includes setting the instrument's date and time, adjusting the instrument's LCD contrast or beep volume, aligning the touchscreen, enabling autostart, enabling one channel display, enabling one second MODBUS output, setting the instrument's communications address, editing location names, enabling password restrictions, viewing the instrument's current status, and configuring the

instrument's printer.

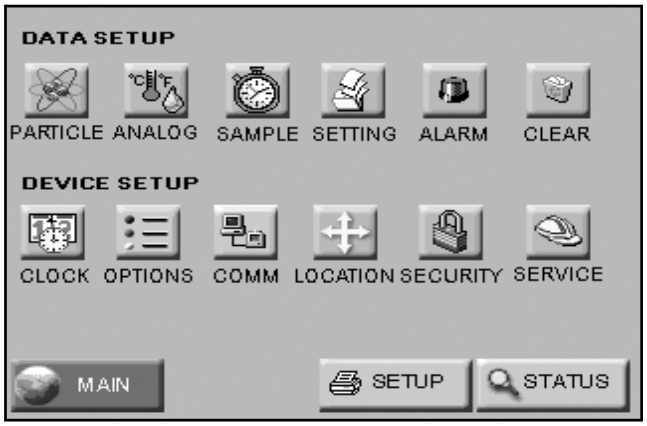


Figure 4-36 Device Setup options

Clock

Use the Clock screen to set the instrument's date and time.

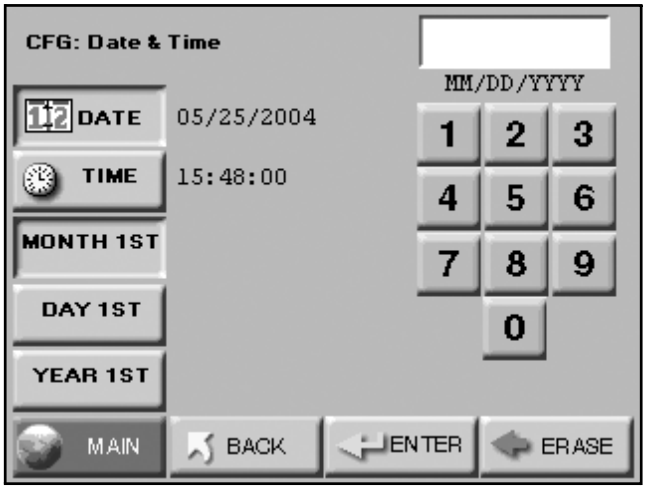


Figure 4-37 Date & Time Configuration Screen

Set the instrument's Date by entering values for the desired month, day and year and then pressing the ENTER button.

The Date can be displayed with the Month 1st (MM/DD/YYYY), Day 1st (DD/MM/YYYY), or Year 1st (YYYY/MM/DD). Month First is the default setting.

To change the date format to DD/MM/YYYY, press the Day 1st.

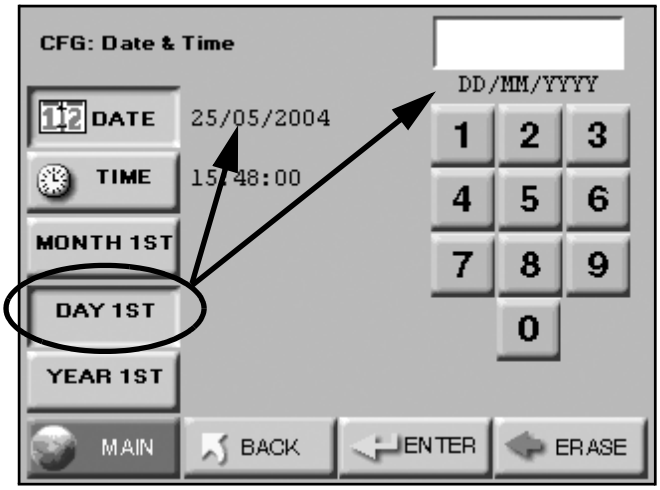


Figure 4-38 Date Option: Day first

To change the date format to YYYY/MM/DD, press the Year 1st button.

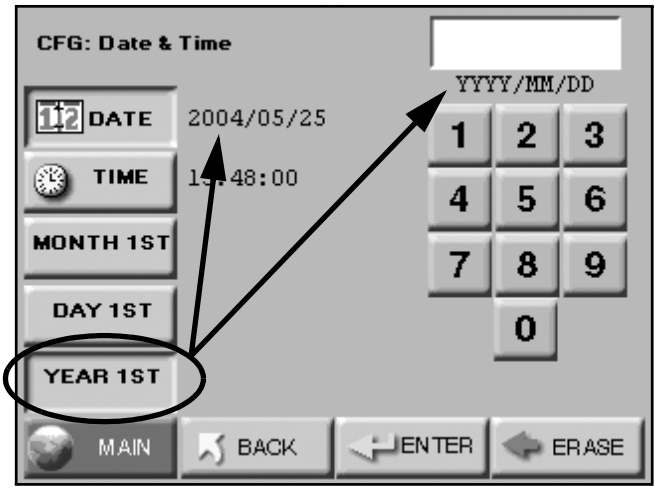


Figure 4-39 Date Option: Year first

Set the Time by pressing the TIME button.

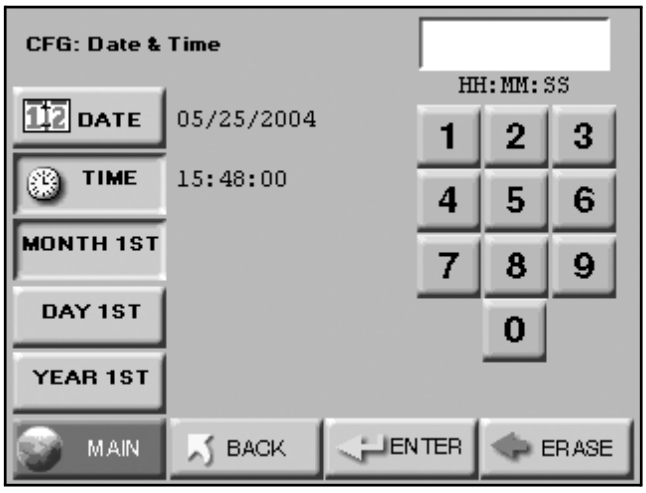


Figure 4-40 Configuring TIME

Enter the Time in hours, minutes and seconds and press ENTER to save.

Press BACK to return to the CONFIGURATION screen or press MAIN to return to the MAIN screen.

Options Screen

Optional configuration settings are found here:

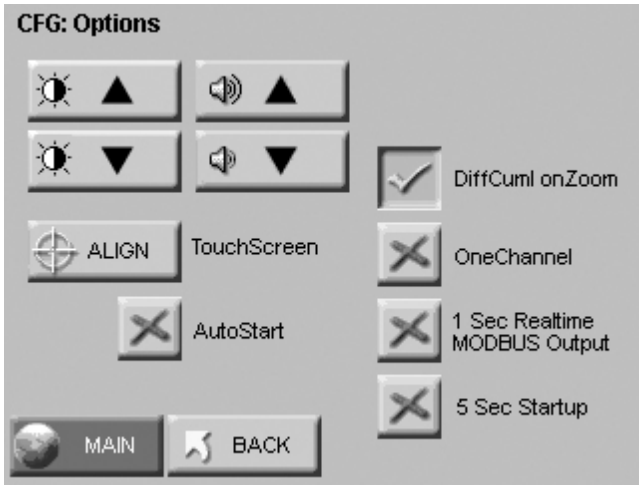


Figure 4-41 Options Configuration screen

CONTRAST Adjust

The contrast/brightness of the LCD screen can be adjusted by pressing the first set of UP and DOWN arrows.

Audible BEEP Adjust

The audio level of the BEEP can be adjusted by pressing the UP and DOWN arrows associated with the audible level.

Note: *The Audible Beep adjust applies only to the internal beeper associated with the Alarming feature and pressing the touchscreen buttons. It does not apply to the buzzer associated with BEEP mode.*

ALIGN Touch Screen

The ALIGN button allows you to align the touch screen so the locations that you touch on the screen correspond to the expected button action or function.

- Press the ALIGN button. 

WARNING: ***Be careful to touch the screen at the specified locations only. If you touch the screen elsewhere during this process, you will align the screen incorrectly.***

- The following screen appears. Touch the circle in the lower left corner: The word, OK, will appear next to the circle and step the alignment to the next screen, shown on the next page.

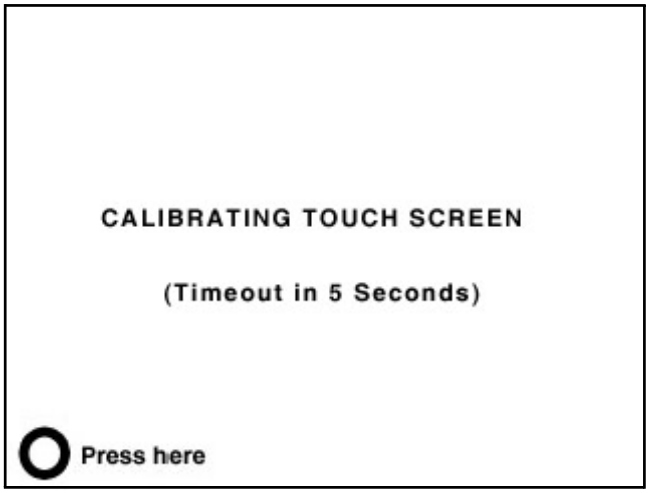


Figure 4-42 Alignment Screen 1

Note: *Using a PDA Stylus may give more accuracy to the touch screen interface.*

- At the next screen, touch the circle displayed in the upper right corner. This will finish the alignment process.

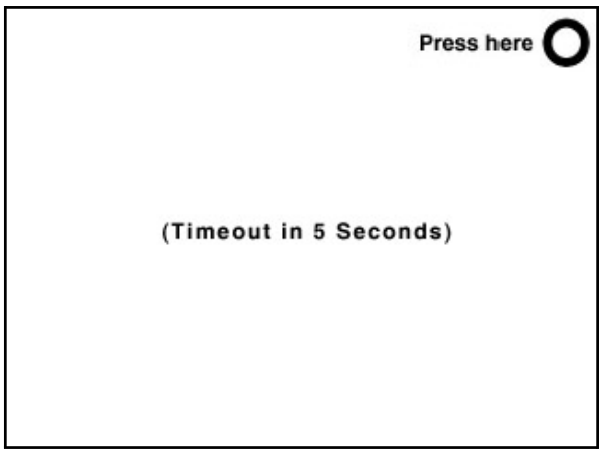


Figure 4-43 Alignment Screen 2

- The third screen displays numbered circles which must be touched in their centers to complete the operation. If the process is not completed (times out), the alignment will NOT be saved and the instrument must be power-cycled (turn power OFF, wait 15 seconds, turn power ON).

- When the screen is touched, an "X" will appear where touched. If the "X" is in the center of the circle, the next touchpoint will show. Touching the screen anywhere else will place an "X" at that point and reset the time-out to 5 seconds. Figure 3-44 illustrates this.

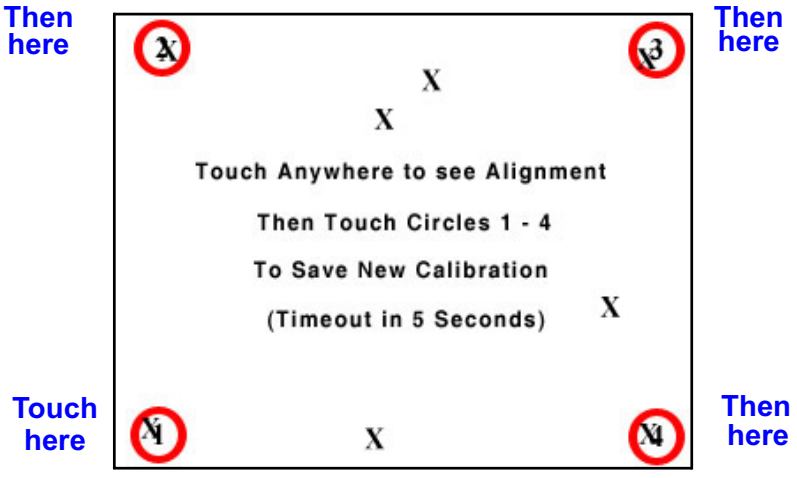


Figure 4-44 Alignment Screen 3

Final Alignment Screen

- The Final Alignment screen (Figure 3-45) will appear after the fourth circle is center-touched. When the "NEW CALIBRATION SAVED" message is displayed, the alignment has been saved and the instrument will return to the Main screen. If the process has been interrupted and needs to be restarted, cycle the power and return to the CFG, OPTIONS, ALIGN screen to start the process over.

Figure 4-45 Alignment Saved Screen

- Power cycle the unit when alignment is complete.

Alignment At Startup

Note: *If, during normal operation of the instrument, touching the buttons doesn't give the proper response or if the buttons stop working, turn off the unit and then after the screen goes blank, turn it back on.*

The Alignment screen can also be accessed by turning off the unit and then turning the unit on while touching the screen. This will bring up

the following screen:

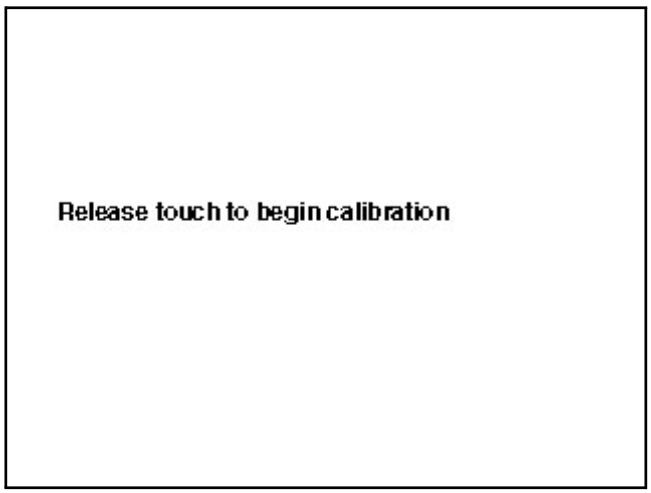


Figure 4-46 Alignment on power up

- Continue with the alignment process as described above.
- Power cycle the unit when alignment is complete.

AutoStart Mode

Note: *When Autostart mode is enabled, set the Delay time to at least 5 seconds or enable the 5 Sec Startup in CFG Options.*

If Autostart is enabled, when the instrument is powered on (or regains power after a power outage), the instrument will immediately begin sampling based on its configured mode, delay, start, and hold times.

DiffCuml on Zoom

If DiffCuml on Zoom is enabled, the counter's display will show two columns of data simultaneously - Differential and Cumulative.

OneChannel

If One Channel is enabled, only the first channel will be displayed on the MAIN screen. Data will continue to be recorded, printed, and downloaded for all channels however.

Note: *If the first channel is disabled and One Channel mode is enabled, the display and zoomed data view will be blank.*

One Channel mode only affects how data is displayed on the MAIN screen. When the instrument is in One Channel mode, data will continue to be recorded, printed, and downloaded for all channels.

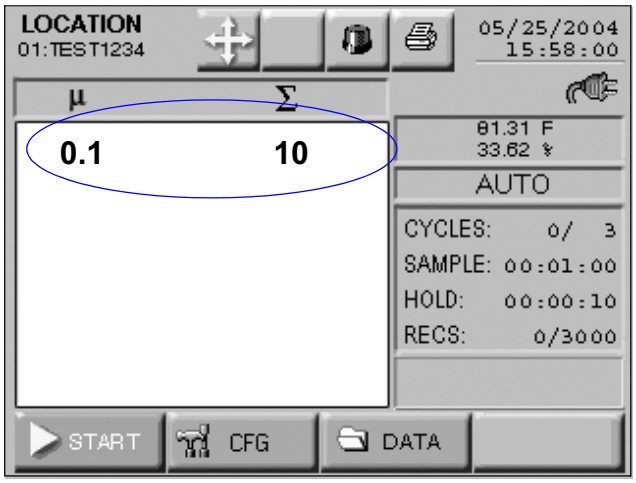
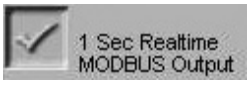


Figure 4-47 Main Screen - One Channel Option Enabled



One-Second Real Time MODBUS Output

If One Second Real Time MODBUS Output is enabled, the instrument's settings will reset to the following:

- Mode: AUTO
- Cycles: Zero
- Sample Time: One second
- Hold Time: Zero seconds
- Cumulative/Differential: Cumulative (CUML)
- Raw/Normalized: Raw

Note: *If you change <u>any</u> setting (mode, sample time, hold time, etc.), the One Second Realtime MODBUS Output mode automatically disables.*

When counting, the MAIN Screen will update continuously, and data will <u>not</u> be recorded to the data buffer.

This option is a simple recipe when using the instrument for filter scanning.

5 Second Startup

This is ON by default and sets a five-second pump ramp up time at the beginning of the first sample, or at the beginning of all samples if the HOLD time is greater than one minute, to stabilize the laser and air

flow. This setting should be left in the default mode unless special applications, such as "surface scans", require it to be disabled.

COMM Address

When this instrument is connected to a data collection system or daisy chained to other RS-485 instruments, the COMM address is used to identify the instrument.

LMS XChange or LMS Express/RT/RT+ will search for the instrument by the COMM Address specified on the Communication screen. COMM addresses range from 01 to 63.

For RS-485 communications, each device on a multi-port chain must have a unique address.

Figure 4-48 COMM Address Configuration screen

Set the COMM Address by using the numeric keypad to select the address; press ERASE to erase a number, if needed. Press ENTER to accept the value.

Press BACK to return to the CONFIGURATION screen or press MAIN to return to the MAIN screen.

Location

The SOLAIR allows up to 200 locations with alphanumeric labels.

Press the LOCATION button on the Configuration screen to display the

Select Location screen.

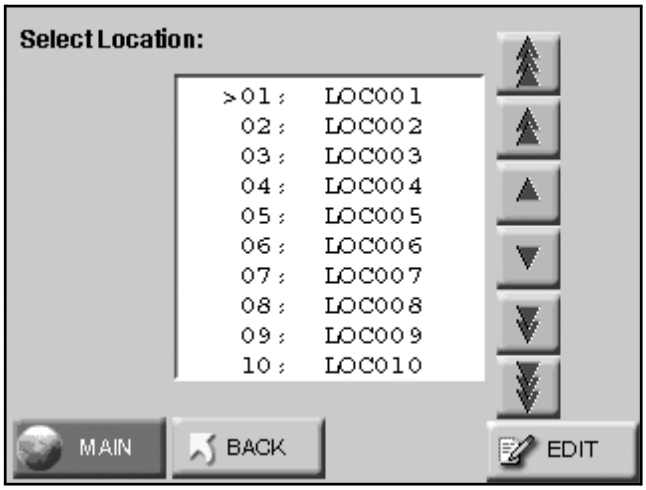


Figure 4-49 LOCATION Setup Screen

On the Select Location screen, select the Location name to be changed using the UP and DOWN arrows.

Press the EDIT button. The following screen displays:

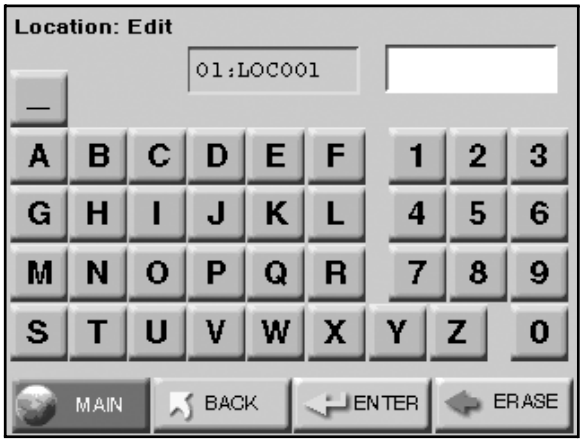


Figure 4-50 LOCATION Edit Screen

- Type in the name of the location using the alphanumeric and underscore keys.
- Press the ERASE button to erase the last character typed, if needed.
- Press ENTER to save your changes.
- Use the Arrow keys to go to the next location to be edited and press the EDIT button. Continue in the same way to edit as many Locations as desired.

- Press the BACK button to return to the Configuration screen or the MAIN button to return to the MAIN screen.

Security

The instrument has two different password levels of access.

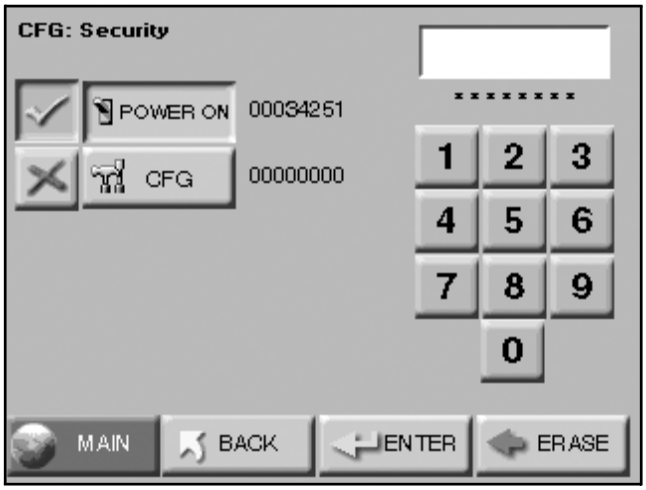


Figure 4-51 Security Password Configuration Screen

To restrict who can operate the instrument, enable the POWER ON password. When the POWER ON password is enabled, in order to use the instrument the user will be required to enter the correct password each time the instrument is turned on.

To restrict who can configure the instrument, enable the Configuration (CFG) password. When the Configuration password is enabled, the user will be required to enter the correct password before he or she can access the Configuration screen.

- To set the password for POWER ON, select the POWER ON button, then type in a password using the numeric keypad. Press the ERASE button if you make a mistake.
- Press ENTER to save.
- To set the password for configuration access, select the CFG button, then type in a password using the numeric keypad. Press the ERASE button to erase any mistakes.
- Press ENTER to save.
- Press the RED "X" button to enable either or both passwords.

- Press BACK to return to the CONFIGURATION screen or press MAIN to return to the MAIN screen.

POWER ON Password

WARNING: ***Be sure to record the unit's passwords in a safe place. If the password is lost or forgotten, contact Lighthouse Technical Support for assistance. The unit may have to be returned to the factory to reset the password.***

This sets a password that will be required in order to use the instrument. When the POWER ON password is enabled, the user will see a password access screen just after the unit is powered on.

Figure 4-52 POWER ON Password Access Screen

The instrument will remain locked until the correct password is entered.

CONFIGURATION Password

The Configuration password prevents unauthorized access to the CONFIGURATION screen.

Figure 4-53 CONFIGURATION Password Access Screen

Printer Setup

The Print configuration has several options for printing the data that the user sets on the Printer Setup screen.

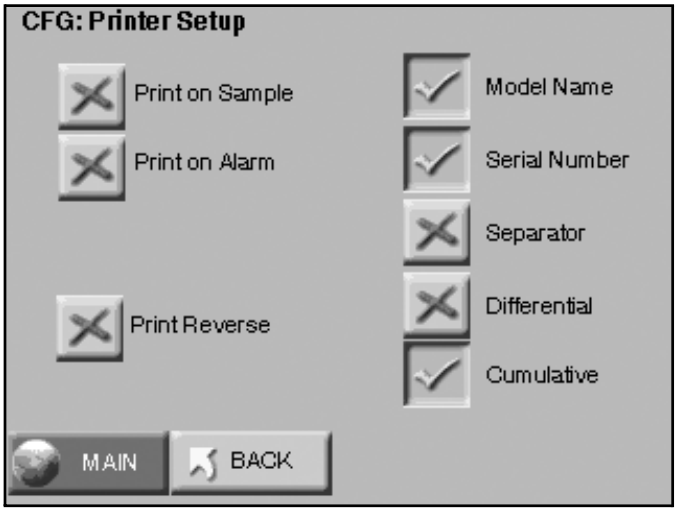


Figure 4-54 Printer Setup Screen

- **Print On Sample / Print On Alarm Toggle -** When **Print on Sample** is enabled, a single record will print at the end of every sample.

  When **Print on Alarm** is enabled, a single record printout will print at the end of any sample that experiences an alarm condition.

- **Model Name** - When enabled, the Model name of the instrument will print in the header of all printouts.

- **Serial Number** - When enabled, the Serial Number of the instrument will print in the header of all printouts.
- **Separator** - When enabled, a line separator will print after the Model Name and Serial Number in the header of all printouts.
- **Differential / Cumulative Toggle** - This toggle option specifies how the data will appear on the printouts.
- **Print Reverse** - This option reverses the direction that the printouts of single records come out of the instrument. By default, Print Reverse is disabled.

  Since all reports calculate the data in the print range and generate results at the end of the printout, no reports will print in Print Reverse mode.

Press BACK to return to the CONFIGURATION screen or press MAIN to return to the MAIN screen.

Fig. A: Print Reverse Enabled

Fig. B: Print Reverse Disabled

Figure 4-55 Print Reverse Enabled/Disabled

Trouble Shooting the Printer

ISSUE: nothing prints

Possible Causes for No Print:

- The printer door may not be completely closed (see photo below). This can be caused when a printout is torn off while pulling outward on the roll of paper.

ACTION: close the door completely

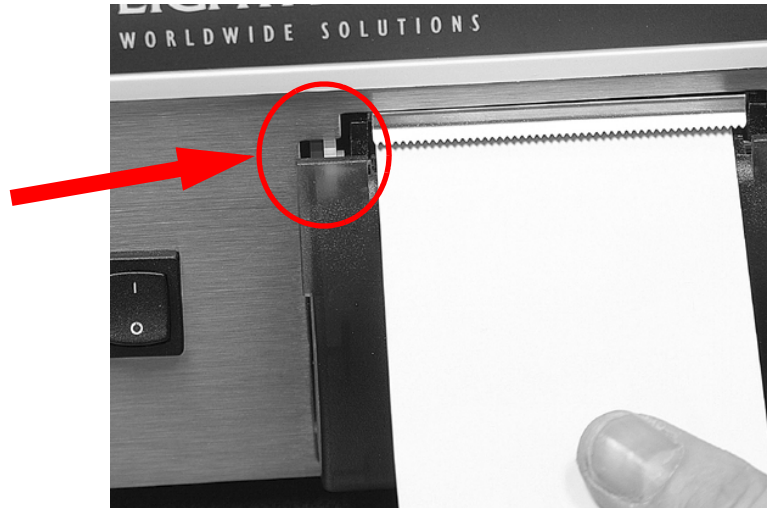


Figure 4-56 Door is not completely closed

- The printer paper may be loaded backwards.

ACTION: open the printer door and verify that the paper is feeding from the TOP of the roll (see photo below)

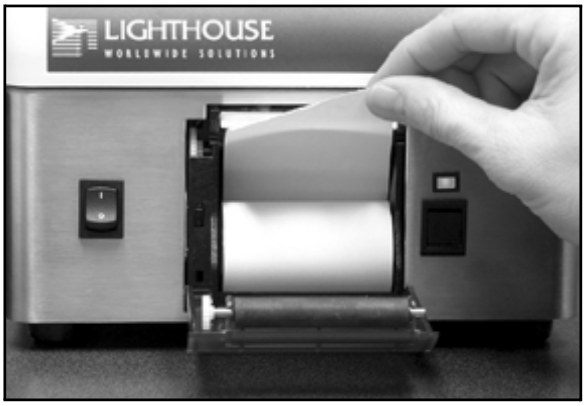


Figure 4-57 Correct paper loading position

- Non-thermal paper might have been substituted.

ACTION: replace non-thermal paper with Thermal paper.

ISSUE: printing is not straight

Possible Causes for printing not straight:

- The paper isn't aligned properly through the paper feed (see photo below).

ACTION: make sure the paper is lined up with the left and right sides of the paper feed.

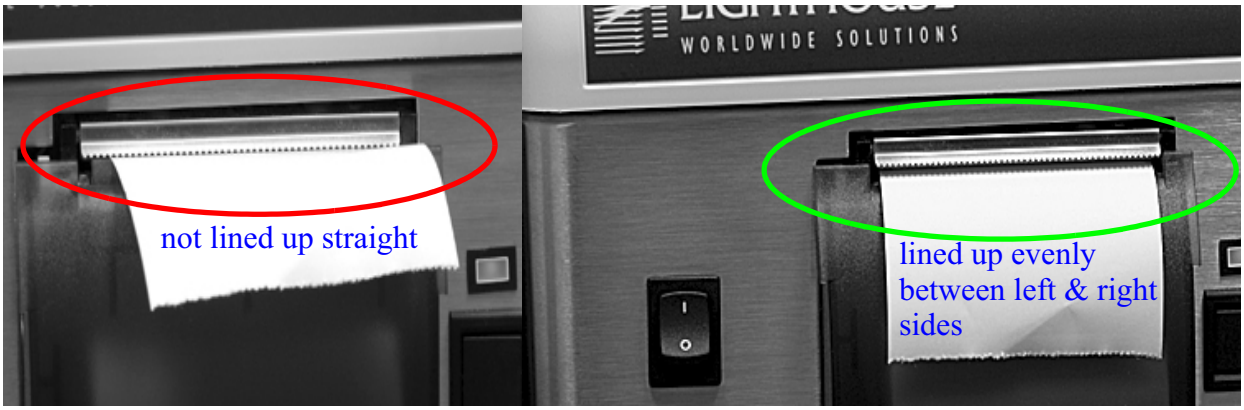


Figure 4-58 Paper alignment through paper feed

- The roll could be nearly empty, leaving a lightweight core that might get off centered if the printouts are torn off too quickly.

ACTION: put in a new roll of thermal paper.

Service

This section of the CONFIGURATION screen is reserved for Lighthouse Authorized Service Providers only. The correct service password must be entered to access this area.

Data View Buffer screen

Data stored on the instrument is viewed in the Data View Buffer. New records overwrite the first records stored after the buffer fills to its limit (3000 records for + model; 1500 for non-plus model). An asterisk (*) next to the word "Records" on the MAIN screen indicates the Buffer is full and data has wrapped. The first record shown in the Data View Buffer after data has wrapped will be the most current record and not the first record stored. In this case, older data will be lost if it hasn't been printed or transferred to a PC or management system.

Particle concentration data displays and prints in ft^3 if the Particle Volume is set to ft^3. If the Particle Volume is set to m^3 or Liters, data displays and prints in m^3.

Press the DATA button on the MAIN screen to display the Data View Buffer.

Depending on the sample setting configuration, the data displays in either RAW data mode or NORMALIZED to ft^3 or m^3.

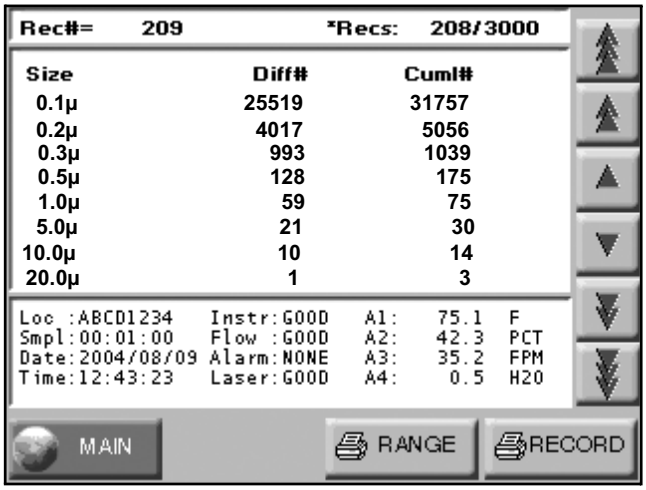


Figure 4-59 Data View Buffer Screen - RAW Data

Scroll through the data using the UP and DOWN arrow buttons.

- The single arrow moves one record at a time.
- The double arrow moves 10 records at a time.
- The triple arrow moves 100 records at a time.

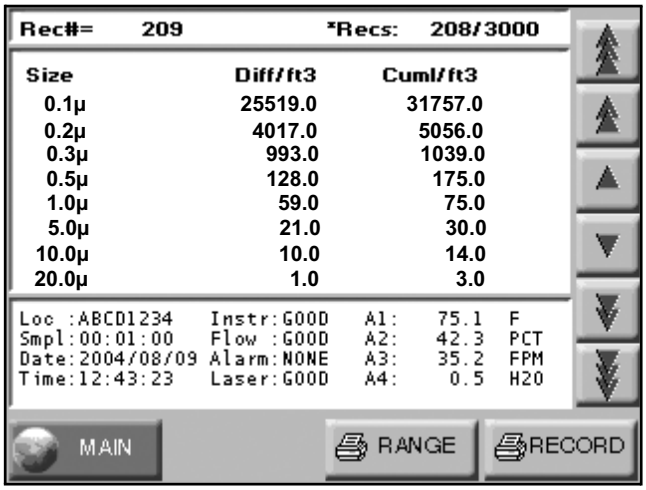


Figure 4-60 Data View Buffer Screen - Normalized data in ft^3

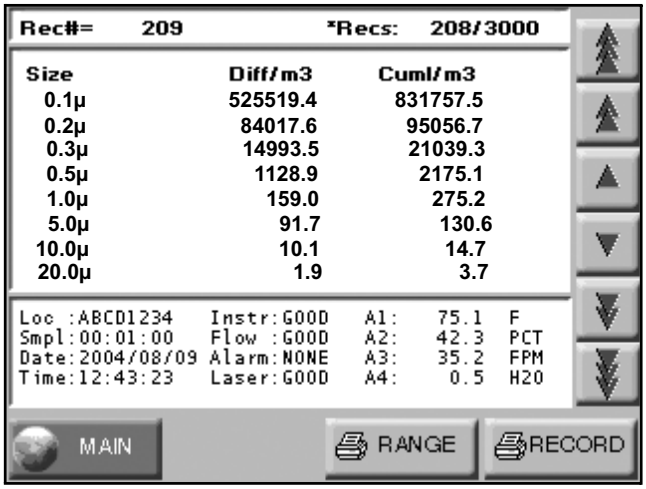


Figure 4-61 Data View Buffer Screen - Normalized data in m^3

Note: *When the buffer has wrapped, the record that is first displayed in the Data View Buffer is the newest record, not the first record stored.*

If you press the single down arrow button once, it will go to the last record in the data buffer.

The Data View Buffer screen displays the following information for each data record.

- **Rec#** - identifies which record is currently being viewed.
- ***Recs** - displays how many records are currently stored in the buffer. An asterisk (*) next to the word "Recs" means the 3000 (or 1500) record data buffer has wrapped and older data is being overwritten. The buffer is First In, First Out (FIFO).
- **Size** - lists the channel sizes configured on the instrument.
- **Diff#, Diff/ft3, Diff/m3** - lists the data in differential mode for each

channel size; if a channel has been disabled, then it will have a blank space in this column; "#" indicates raw counts; "ft3" and "m3" indicate normalized counts.

- **Cuml#, Cuml/ft3, Cuml/m3** - lists the data in cumulative mode for each channel size; if a channel has been disabled, then it will have a blank space in this column; "#" indicates raw counts; "ft3" and "m3" indicate normalized counts.

- **Loc** - indicates the location at which the data record was recorded; location name listed is the alphanumeric label that was saved.

- **Smpl** - indicates the sample time (HH:MM:SS) at which the data record was sampled.

- **Date** - indicates the instrument date on which the data record was recorded; the date is displayed in the format selected in the configuration (MM/DD/YYYY, DD/MM/YYYY or YYYY/MM/DD).

- **Time** - indicates the instrument time at which the data record was recorded (HH:MM:SS).

- **Instr** - indicates the state of the instrument at the time the data was recorded. Instrument states include GOOD or SRVC.

  If SRVC appears, printouts will say "Service Required" and the sensor may need cleaning. Please contact Lighthouse Technical Support at 1-800-945-5905.

- **Flow** - indicates the flow state of the instrument at the time the data record was recorded. Flow is recorded as OK or ALRM. If the flow was in alarm, it will print as Flow: Alert on the printouts.

- **Alarm** - indicates (NONE or YES) if the data record exceeded any of the alarm thresholds of any of the channels that were enabled for alarms. If the data record exceeded alarm thresholds, printouts show "Alarm: Yes".

- **Laser** - indicates the status of the laser at the time the data record was recorded; possible laser states include OK or SRVC. If the laser needs to be serviced, it will print as Laser: Service.

  If laser state is SRVC, please contact Lighthouse Technical Support at 1-800-945-5905.

Analog Data

If any of the Analog Channels have been configured and the corresponding analog sensor connected to the unit, they will be listed in the View Buffer screen as A1, A2, A3 or A4.

Only the channels that are enabled and have sensors connected for that data record will show data and display in the configured units of measure.

Printing Data View Buffer reports

The SOLAIR 1001+ instruments store up to 3000 records in the data buffer.

The Buffer Report prints all or a range of the records in the buffer in the format specified by the selections in the Configuration. At the end of the Buffer Report, a Summary will print the following information:

- Data displayed in Cumulative or Differential mode
- Raw ("Particle Counts") or Normalized ("Particles/ft^3" or "Particles/m^3")
- # of samples in the report

At each channel size:

- Maximum Value
- Minimum Value
- Average
- Standard Deviation

View the same data in different formats just by changing the Particle Display options in the Sample Setting screen in CONFIGURATION.

Note: *Whatever is set up in the Configuration menu will display in the Data View Buffer and on the printout.*

The Summary of the data can be viewed in the following combinations:

- Raw Counts, Differential Data
- Raw Counts, Cumulative Data
- Normalized Counts, Differential Data, Particles/ft^3
- Normalized Counts, Differential Data, Particles/m^3
- Normalized Counts, Cumulative Data, Particles/ft^3
- Normalized Counts, Cumulative Data, Particles/m^3

The following sections describe printing options available from the Data View Buffer (Data) screen:

Print Record

When you press the **PRINT RECORD** button, whatever record is currently displayed on the Data View Buffer screen will print as a single sample record. The record will print according to the settings in the Print Configuration. Refer to Figure 4-63 for a sample printout.

Print Range

Note: *Print Reverse does not apply to printing a range of data.*

- To print a range of data from the buffer, first use the arrows on the Data screen to scroll to the first record to be included in the range. Refer to Figure 4-60 or Figure 4-61. The printout will start with the record that is displayed on the Data screen.
- Determine how many records to print. Using the arrows to scroll up and down will help but make sure the screen displays the starting record before proceeding to the next step.
- Press the **RANGE** button. The following screen displays:

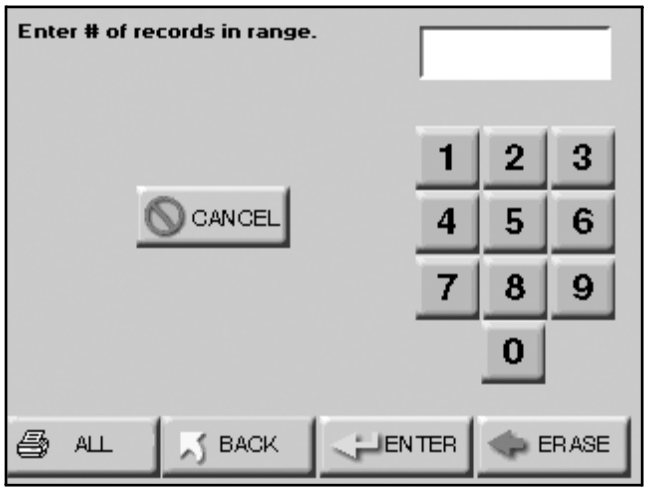


Figure 4-62 Print Range Screen

- Enter the number of records to print and press the **ENTER** button. The printer will print the number of records desired, starting with the record displayed on the Data View Buffer screen.
- Use the **ERASE** button to backspace and erase a number.
- Press **CANCEL** to cancel printing.

- Press **BACK** to return to the Data View Buffer screen without printing the report.
- If the entire buffer is to be printed, press **ALL** to print all of the stored records.

Note: *Printing ALL records may take some time if the buffer is full.*

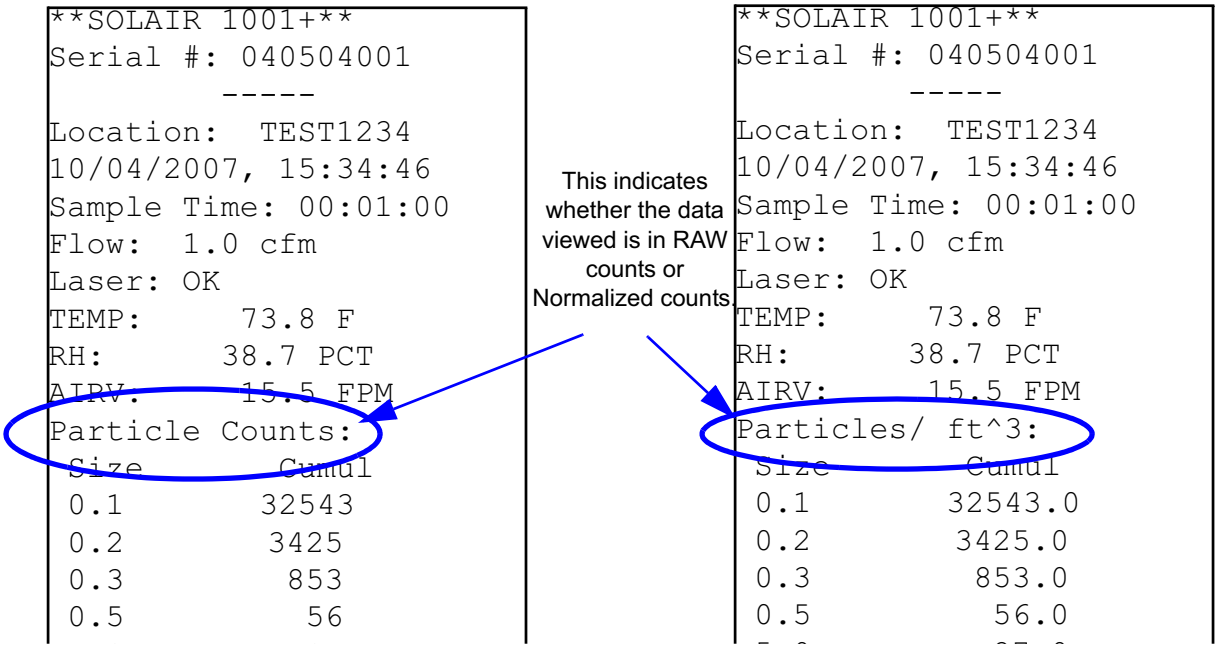


Figure 4-63 Sample Report Formats

```
Location:    TEST1234
10-10-2007,  15:34:30
Sample Time:  00:01:00
Flow:    1.0 cfm
Laser:   OK
TEMP:      73.8 F
RH:       38.7 PCT
AIRV:      15.5 FPM
Particle Counts:
Size       Cumul
 0.1       31575
 0.2        5056
 0.3        1039
 0.5          46
 1.0          19
 5.0           4

Location:    TEST1234
...

 10.0          0
^ ^ ^ ^ ^ ^ ^ ^ ^ ^
Particle Counts:
Summary (Cuml):
        -----
# of samples =3
Size          Max
 0.1         45687
 0.2          6902
 0.3          1306
 0.5            46
 1.0            19
 5.0             4

Size          Min
 0.1          1111
 0.2           152
 0.3            29
 0.5             0
 1.0             0
 5.0             0

Size          Avg
 0.1        26124.3
 0.2         4036.7
 0.3          791.3
 0.5           26.3
 1.0           10.7
 5.0            1.7

Size          Std
 0.1        22782.4
 0.2         3488.5
 0.3          673.6
```

Figure 4-64 Sample Buffer Report

Power Shutdown Levels

When the instrument is powered from its rechargeable battery, a Power Shutdown feature protects the battery from discharging completely. A complete discharge could damage the battery.

Note: *It is not recommended to allow the battery to discharge completely.*

The battery levels are as follows:

Table 4-1 Levels of Battery Life

Battery Icon	Description
	FULL
	75%
	50%
	25%
	Empty; at this level, the instrument will begin to beep and displays "BATT LOW!" on the main screen. It is recommended to connect the AC cord and plug it into an outlet at this level.
	Pump Shutdown; if the instrument is currently on and sampling, the pump will turn off and the instrument will shut down.

After the Pump Shutdown level and before the battery reaches its critical lowpoint, the instrument will shut down all power. To prevent loss of power, attach the AC cord and plug into an outlet as soon as the BATT LOW! message appears on the screen.

It takes approximately three hours for the battery to fully recharge while the SOLAIR is plugged into an AC outlet.

On a full battery, the instrument will run for approximately 3 to 3.5 hours of continuous sampling. The exact number will depend on what functions are performed (e.g., running the pump, sample printing enabled, etc.).

5 Setting up the Counter

Analog Sensors

The SOLAIR can be fitted with up to four 4-20mA Analog sensors. The Sensors are connected to the instrument with RJ-12 cables. The pinout of the cables is shown below:

Table 5-1 Analog Connector Pinout

Pin Number	Function
1	5VDC
2	Analog #1 In
3	24VDC (VCC)
4	GND (tied to Pin 6)
5	(for connectors 1 and 3) Analog #2 In (for connectors 2 and 4) no connection
6	GND

Connectors 1 and 3 have the option of counting the first two analog channels with a single cable plugged into connector 1 or in connector 3. For example, this is used for the Lighthouse TRH Wand that connects to connector 1, yet measures temperature on analog channel 1 and relative humidity on analog channel 2.

WARNING: ***If the Lighthouse TRH Wand is plugged into connector 1, do NOT plug another sensor into connector 2.***

If the wand is plugged into connector 3, do NOT plug another sensor into connector 4.

Lighthouse sensors come complete with adapters and pre-wired cables.

WARNING: ***Wiring the pins in reverse order may harm the instrument and/or the sensor.***

If the user is wiring a cable to use with a sensor from another manufacturer, please bear in mind that the connectors on telephone cables are mirror images of each other. For that reason, we have not included color coding in the table. The figure below shows the pin numbering on the back of the SOLAIR; the cable must be wired accordingly.

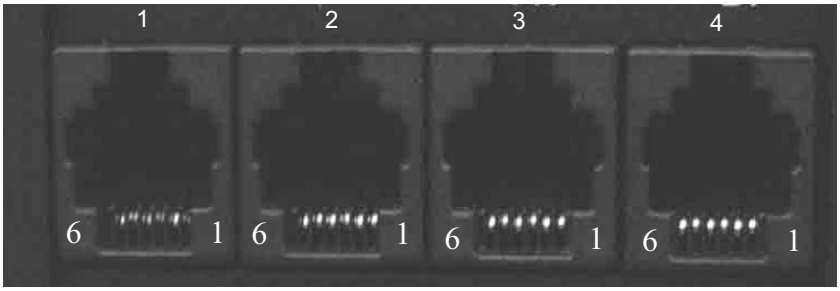


Figure 5-1 Analog Sensor Ports, Showing Pin Numbering

Note that the ports are oriented with the locking tabs at the top.

Analog Setup

WARNING: ***When installing the Lighthouse Worldwide Solutions TRH Probe, you must use port 1 and leave port 2 open or use port 3 and leave port 4 open. Do NOT install it on port 2 or port 4 or install another device on its "reserved" channel (port 2 when using port 1 or port 4 when using port 3). Failure to adhere to these restrictions will result in incorrect or lost data.***

When adding Analog Sensors to the SOLAIR's RJ-12 ports, the SOLAIR firmware must be set up to accept data from the sensors. The minimum and maximum values required for this will be found in the documents that are supplied with the devices. For example, the Calibration Certificate for the Lighthouse TRH Wand will provide temperature in both Celsius (C) and Fahrenheit (F) and relative humidity in percent (PCT). Make sure the data is entered appropriately; for example, do not use C as the UNITS for MIN and MAX values that are based on Fahrenheit (F). If the LWS TRH Wand is being used, set up the odd-numbered port as temperature and the even-numbered port as relative humidity.

The setup process is as follows:

1. From the MAIN Screen, press the CFG button.
2. On the CONFIGURATION screen, press the ANALOG button.
3. The Analog Configuration Screen displays.

Figure 5-2 Analog Configuration Screen

4. Press the red "**X**" button to enable an analog channel.

5. Press the blank TYPE button next to the enabled analog channel to enter the label tag.

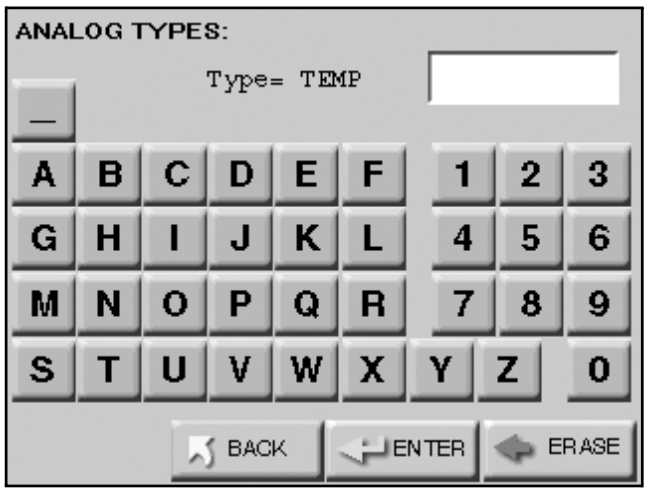


Figure 5-3 Analog Type Edit Screen

6. Type in the desired label tag for the analog channel; tag can be up to four characters.

7. Press ENTER when complete.

8. At the Analog Configuration Screen, press the MIN value button.

9. Enter the minimum value of the sensor's data range found on its documentation and press ENTER.

10. Press the MAX value button.

11. Enter the maximum value of the sensor's data range found on its documentation and press ENTER.

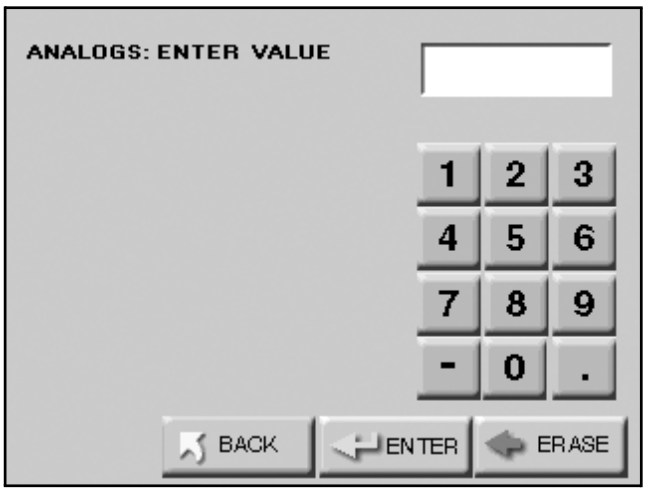


Figure 5-4 Max/Min Data Entry Screen

12. Press the UNITS button associated with the analog channel.

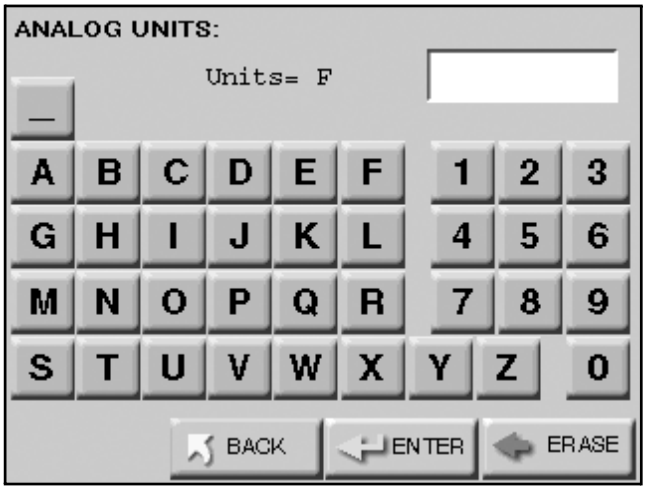


Figure 5-5 Analog Units Edit Screen

13. Enter the UNIT of measure (i.e., F for Fahrenheit, PCT for percent humidity, etc.) for the analog channel and press ENTER.

14. Continue in this same way to enable the other Analog channels as desired.

15. Press MAIN to return to the MAIN screen.

16. The Analog data can be viewed in the Zoomed Data View by pressing on the white particle data area on the screen.
17. Press the Particle button to toggle to the Analog button.
18. Any of the enabled Analog channels will be displayed here.
19. Press anywhere on the white data screen to return to the MAIN screen.

Using Report Parameters

The data provided on the screen when various parameters are set will allow users to set up the counter to meet the requirements of your Standard Operating Procedure.

6 Programming

General Information

The SOLAIR 1001+ can be programmed using the MODBUS Protocol. The full MODBUS protocol is detailed in “S1001+ MODBUS Register Map v1.45” on page B-1.

This chapter contains the information needed to program the basic configuration for the instrument to meet your needs.

Communicating with the Instrument

The RJ-45 connector on the instrument (marked "RS-232/485 IN" in Figure 5-1) is used to connect the unit to a COM port on a desktop or laptop PC.

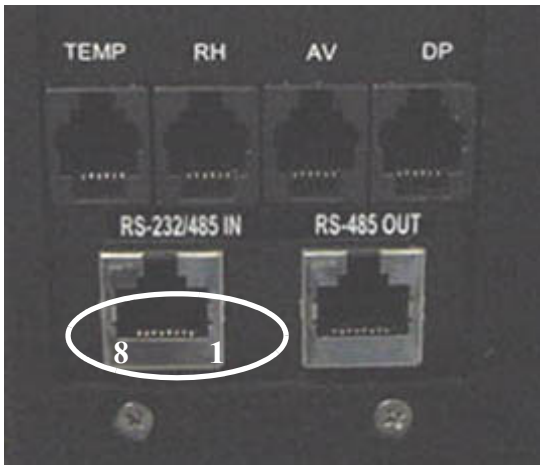


Figure 6-1 The Communications Ports, Showing Pin Numbers

RS-232/485 IN Port

WARNING: ***When connecting the instrument to an external computer via the RS-232/485 IN port, please note there is +24VDC on Pin 7***

The RJ-45 connector on the instrument's RS-232/485 IN port has both RS-232 and RS-485 lines. The pinouts are as follows:

Table 6-1 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	24VDC
8	GND

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 the table below:

Table 6-2 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

WARNING: ***When daisy-chaining multiple instruments together, only connect IN ports to OUT ports. Do NOT connect an IN port to another IN port; board damage will occur.***

The RS-485 OUT port only has the 2 lines for the RS-485 communications. This is used for daisy-chaining multiple units together.

Table 6-3 RS-485 OUT Port

RJ-45 Pin	Signal Name
1	N/A
2	N/A
3	N/A
4	**RS-485B**
5	**RS-485A**
6	N/A
7	N/A
8	N/A

RS-232 Communications

The instrument uses RS-232 communications in a single instrument configuration or RS-485 communications if the instrument is more than 50 feet from the computer or in a multi-point daisy chain 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 other end of the cable to the LWS-232 plug, then to a COM (Serial) Port on your computer.
4. Any available COM Port may be used.

RS-485 Communications

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 your Lighthouse Sales Representative for this kit.

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

1. Remove power from the instrument.
2. Connect the other end of the RJ-45 cable to the RS-485 converter: pin 4 to ChB+ and pin 5 on ChA-.
3. Connect the RS-232 side of the converter to the RJ-45/DB-9 connector.
4. Connect the DB-9 end of the cable to a COM (Serial) Port on your computer.
5. Any available COM Port may be used.

Configuring with the MODBUS Protocol

When you power up the instrument, the pump will automatically turn on after 5 seconds, and it will begin sampling using the default configuration:

- Location = 0
- Sample Time = 60 seconds
- Hold Time = 0 seconds
- Initial Delay = 0 seconds

Note: *For the full MODBUS v.1.45 register map, please refer to Appendix B.*

To stop the pump and the sampling, send the command **12** to command register 40002.

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

Setting the Real Time Clock

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

Table 6-4 Real Time Clock Registers

Register	Data Type	Description
40027	signed 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	signed 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.

Table 6-5 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).

Changing the Default Instrument Parameters

The main instrument parameters involved with the operation of the REMOTE counter are Location, Sample Time, Hold Time and Initial Delay.

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

Sample Time, Hold Time and Initial Delay all use 2 registers, a high word and a low word. If the desired value for any of these parameters is less than 9 hours, then only the low word register needs to be written (in seconds).

The low word register for Sample Time is 40034.

The low word register for Hold Time is 40032.

The low word register for Initial Delay is 40030.

Table 6-6 Instrument Parameters

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

Table 6-6 Instrument Parameters

Register	Data Type	Description
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]

Running the Instrument

The SOLAIR can be run in a few different ways. The applicable action commands are discussed here:

Table 6-7 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, 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 6-7 Action Commands

Value	Action
7	Turns local pump on.
8	Stop pump.
9	External Start Counter. The instrument samples continuously until it receives an External Stop Counter command. Does not turn on the pump. Ignores local timing parameters.
10	External Stop Counter. Records counts since External Start.
11	Instrument Start. Uses defined Initial Delay, Hold Time, Sample Interval and counting mode. Instrument executes samples and holds until an Instrument Stop command is issued. This command will start the pump.
12	Instrument Stop. Aborts current sample. Stops pump. Stops data collection.

There are 2 basic modes of operation: Manual counting and Automatic counting. Write each of the described action commands to the command register (40002).

MANUAL Counting Mode

In Manual counting mode, the sample time is based on when the counter is instructed to stop counting. At this point, a data record is recorded and the sample time is the interval between the command to start counting and the command to stop counting.

7 Start Pump

9 Start Manual Count

10 Stop Manual Count; writes a data record, uses the time interval as the sample time

The "hold" time is effectively the time between a STOP and a START command.

After the last desired sample is taken, send the following to stop the pump:

8 Stop Pump

AUTOMATIC Counting Mode

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

The instrument will continue running samples until it receives a stop command. When the stop command is given, since the device will not have completed a full sample cycle, the most current data will not record to the buffer.

After setting all the instrument parameters, run these commands:

11 Start Instrument; to start recording

12 Stop Instrument; to stop recording

7 Maintenance Procedures

Introduction

This chapter provides instructions for routine maintenance that may be required for your SOLAIR 1001+ instrument.

The maintenance procedures described in this chapter are not required on a regular or at prescribed intervals and should be performed only if you have a Service Wrench icon on the MAIN screen or you have reason to question the data you 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 inside the SOLAIR 1001+.

Maintenance

Calibration

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 you with the procedure to check the counter for zero counts. A purge filter must be attached to the instrument and fifteen (15) 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. Set Cycles to 6 so the instrument will take 6 samples.

8. If 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.

Troubleshooting

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 or several 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 your Lighthouse Service Representative for assistance.

A Default Settings

Default Settings for SOLAIR Particle Counters

MENU ITEM	VALUE
LOC	LOC001
PARTICLE CHANNELS	ALL CH ENABLED
ANALOG CHANNELS	ALL CH DISABLED
# OF CYCLES	10
DELAY TIME	00:00:04
HOLD TIME	00:00:10
SAMPLE TIME	00:01:00
SAMPLE VOLUME	FT^3
COUNT MODE	AUTO
PARTICLE DISPLAY	CUML
DATA FORMAT	RAW
PARTICLE VOL	FT^3
PARTICLE ALARMS	ALL DISABLED
ALL THRESHOLDS	1000
DATE FORMAT	MONTH 1ST: MM/DD/YYYY
AUTOSTART	DISABLED
ONECHANNEL	DISABLED

Default Settings for SOLAIR Particle Counters

MENU ITEM	VALUE
1 SEC REALTIME MODBUS OUTPUT	DISABLED
5 SEC STARTUP	ENABLED
COMM ADDR	01
POWER ON PASSWORD	DISABLED: 00000000
CFG PASSWORD	DISABLED: 00000000
PRINT ON SAMPLE	DISABLED
PRINT ON ALARM	DISABLED
PRINT REVERSE	DISABLED
MODEL NAME	ENABLED
SERIAL NUMBER	ENABLED
SEPARATOR	ENABLED
DIFFERENTIAL	DISABLED
CUMULATIVE	ENABLED

B S1001+ MODBUS Register Map v1.45

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-232C or RS-485 Standard
Software Protocol	MODBUS ASCII (supports upper/lower case)

The MODBUS slave address is set on the particle counter. Valid addresses are 1-63. Address 0 is the broadcast address.

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

Table B-3 Sensor Settings Registers

Register	Data Type	Description
40020	ASCII string	Model Name char[10], char [11]
40021	ASCII string	Model Name char[12], char [13]
40022	ASCII string	Model Name char[14], char [15]
40023	unsigned integer	Flow Rate. 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 30xxx register series. Must be lower than the record count (register 40024). Set this index to expose a counter's record in the 30xxx registers. Set to -1 to retrieve last record stored in the counter.
40026	unsigned integer	Location number. Particle Counters: Specifies location of Particle Counter. Must be 1 to 200 (maps to location names associated with registers 40200 - 40999). Manifold Controller: Specifies Manifold position. Values 1-32 for the Universal Manifold and values 1-6 for the MiniManifold Controller moves the arm to that position on the manifold. Value 0 moves arm to Home position.
40027	signed integer	Real Time Clock (RTC) [high]. Updates instrument's real-time clock. Works in conjunction with 40028. Displays date and time, in number of seconds since midnight, 1/1/1970. Can be generated by ANSI C/C++ time() function.
40028	signed integer	Real Time Clock [low]
40029	unsigned integer	Initial Delay [high]. Works in conjunction with 40030. Number of seconds to wait before starting the first sample. Max value is 359,999, which equals 99h 59m 59s.
40030	unsigned integer	Initial Delay [low]
40031	unsigned integer	Hold Time [high]. Works in conjunction with 40032. Number of seconds to wait between sample periods. Max value is 359,999, which equals 99h 59m 59s.
40032	unsigned integer	Hold Time [low]
40033	unsigned integer	Sample Time [high]. Works in conjunction with 40034. Number of seconds to sample. Max value is 86,399, which equals 23h 59m 59s.

Table B-3 Sensor Settings Registers

Register	Data Type	Description
40034	unsigned integer	Sample Time [low]
40035	unsigned integer	Data Set [high]. Works in conjunction with 40036. Data entered here is applied to the device through the command register.
40036	unsigned integer	Data Set [low]
40037	unsigned integer	Alarm Mode. Type of alarming performed
40038	unsigned integer	Alarm Parameter. Control parameter for given alarm mode.
40039	unsigned integer	Laser Reference Voltage (millivolts)
40040	unsigned integer	View Volume. Divide by 100 to get percentage. For example: 6550d = 65.50%
40041	ASCII string	Flow Unit. Defines unit as cfm, lpm, mlpm.
40042	ASCII string	Flow Unit. char[2], char[3]
40043	unsigned integer	Calibration Reference Voltage (millivolts)
40047	signed integer	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].
...		
40199	unsigned integer	Number of available alphanumeric location names (0 means alphanumeric names are not supported).
40200	ASCII string	Location_1_char[0], char[1] (NULL terminated string)
40201	ASCII string	Location_1_char[2], char[3]
40202	ASCII string	Location_1_char[4], char[5]
40203	ASCII string	Location_1_char[6], char[7]
...		
40996	ASCII string	Location_200_char[0], char[1] (NULL terminated string)
40997	ASCII string	Location_200_char[2], char[3]
40998	ASCII string	Location_200_char[4], char[5]
40999	ASCII string	Location_200_char[6], char[7]

Registers 40200-40999 are reserved for eight character names

associated with location index values. Thus the name for location =3 would be located at registers 40208-40211. Up to two hundred locations can be specified.

Register 40199 indicates the number of location names supported on this device.

Alarm Mode (40037) defines the type of calculation performed to define an alarm condition. Alarm Mode = 0 corresponds to conventional threshold alarming; channel bit set if threshold exceeded for that given channel.

Alarm Parameter (40038) defines additional parameters that may be needed in defining an alarm mode.

The Command Register (40002) is used to make the device perform an action. This 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.

Device Status

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

Table B-4 Device Status

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

Command Register

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

Table B-5 Command Register

Value	Action
1	Saves all writable 4xxxx register values to the device's 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, and Initial Delay.
5	Enable Remote Control. Locks out the instrument's user interface. Can only change instrument parameters via MODBUS.
6	Enable Local Control. Unlocks the instrument's user interface. Instrument changes can be made at the device itself or through MODBUS.
7	Turns local pump on, if applicable. Flow is regulated by an internal setpoint.
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 count since Manual Start.
11	Instrument Start (Automatic Counting). Particle Counters: Uses defined Initial Delay, Hold Time, Sample Interval and counting mode. Instrument executes samples and holds until an Instrument Stop command is issued. For instruments with pumps, this command will start the pump. Manifold Controller: Uses defined Manifold Sequence. Stops counting and changing positions when an Instrument Stop command is issued.

Table B-5 Command Register

Value	Action
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.
192	Change BAUD to 19200
576	Change BAUD to 57600
1152	Change BAUD to 115200

Data and Alarm Registers

Data and Alarm Enable Registers

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

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

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

Table B-6 Enable/Disable Bits

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

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

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

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

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

Table B-7 Alarm Enable Registers

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

Table B-7 Alarm Enable Registers

Register	Data Type	Description
43016	unsigned int	Enable for Particle Channel 4 [low]
43017	unsigned int	Enable for Particle Channel 5 [high]
43018	unsigned int	Enable for Particle Channel 5 [low]
43019	unsigned int	Enable for Particle Channel 6 [high]
43020	unsigned int	Enable for Particle Channel 6 [low]
43021	unsigned int	Enable for Particle Channel 6 [high]
43022	unsigned int	Enable for Particle Channel 6 [low]
43023	unsigned int	Enable for Particle Channel 6 [high]
43024	unsigned int	Enable for Particle Channel 6 [low]
...		
43041	unsigned int	Enable for Analog Channel 1 [high]
43042	unsigned int	Enable for Analog Channel 1 [low]
43043	unsigned int	Enable for Analog Channel 2 [high]
43044	unsigned int	Enable for Analog Channel 2 [low]
43045	unsigned int	Enable for Analog Channel 3 [high]
43046	unsigned int	Enable for Analog Channel 3 [low]
43047	unsigned int	Enable for Analog Channel 4 [high]
43048	unsigned int	Enable for Analog Channel 4 [low]

Enable Alarming for a Channel

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

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

To disable alarming completely, disable Bit 1 for register 43012. Now,

no channels are enabled for alarms.

Table B-8 Example of Alarming on Channel 2

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

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

Threshold Setup Registers

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

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

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

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

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

threshold register would be 45016.

Table B-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]
45024	unsigned int	Threshold for Particle Channel 8 [low]

Setting the Alarm Threshold Value

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

Table B-10 Alarm Threshold Registers set to default value

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

Table B-10 Alarm Threshold Registers set to default value

Registers	Particle Channel	Threshold Value
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 for particle data is big-endian. Thus, data items are formed by placing the high bytes in front of the low bytes.

Example:

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

Analog data is little-endian. Thus, analog data items are formed by placing the low bytes in front of the high bytes.

Example:

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

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

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

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

Table B-11 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]

Table B-11 Data Registers

Register	Data Type	Description
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]
...		
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]
...		
30073	unsigned int	Valid analog channels [bit0=ch 1, ..., bit15=ch16]

Table B-11 Data Registers

Register	Data Type	Description
30074	unsigned int	Valid particle channels
30075	unsigned int	Alarm Flags - Analog Channels (bit 0 = channel 1 ...)
30076	unsigned int	Alarm Flags - Particle Channels

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

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

Device Status Word (30007 - 30008)

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

The registers used for the 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-12 Device Status Word

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

Table B-12 Device Status Word

Bit	Description
6	Instrument Sampler Status 0 = Nominal Operation 1 = Sampler Error

Bits 7 to 31 are currently unused.

Valid Data in Channels (30073 - 30076)

Register 30073 represents the flag bits corresponding to valid data present in the analog register range. The mapping is such that bit 0 set to TRUE (=1) would correspond to valid data present in Analog Channel 1.

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

Register 30075 represents the flag bits corresponding to analog channels that have exceeded the threshold [Threshold High Registers (45xxx series)] based on alarm mode.

Register 30076 represents the flag bits corresponding to particle channels that have exceeded the threshold [Threshold High Registers (45xxx series)] based on alarm mode

Data Type Registers

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

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

Data Types are assigned 4 ASCII characters across 2 registers. If a Data Type string contains less than 4 characters, then the rest of the string is padded with NULL characters. Note that a Data Type using all four characters will not end with a NULL character.

Table B-13 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-14 Examples of Particle Data Items

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

Data Units Registers

The 42xxx register series identifies the units used by data items in the

30xxx series. These registers run in parallel with the Data Registers. For example, Data Register 30010's Units Register is 42010.

Note: *Not all data types have units.*

LWS Particle Counters may use units not on the table.

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

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

Table B-15 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		

NOTE: This register bank is obsolete and is maintained for backward compatibility.

C Using MODBUS for Real Time Flow and Laser Current

This Appendix will provide the user with the procedure to read the SOLAIR 1001+ counter's flow and laser current in real time through MODBUS.

Required Equipment and Software

- PC with an available RS-232C or USB COM port;
- LWS232 DB9-RJ45 4-wire adapter or LWS232 and USB-serial adapter;
- CAT5 data cable;
- SOLAIR 1001+;
- MANIFOLD CONTROLLER and MANIFOLD (if the flow is read through the MANIFOLD CONTROLLER);
- MODBUS software tool.

Procedure for Computer to Instrument, only

WARNING: ***There is +24VDC on Pin 7 of the RS-232/485 IN port.***

Note: *Data obtained from a SOLAIR directly through MODBUS is real time and has not been stored on the SOLAIR. Data format is "little-endian" - refer to Appendix B, MODBUS Register Map v1.45 for more information.*

1. Attach the LWS232 to the computer's COM port. If a USB port is to be used, attach the LWS232 to the USB-serial adapter, then to the computer's USB port.
2. Attach one end of the CAT5 data cable to the RJ45 connector of the LWS232.
3. Attach the free end of the CAT5 data cable to the RS232/485 IN port of the SOLAIR 1001+.

4. Apply power to the SOLAIR 1001+.
5. Press START in the MAIN screen of the SOLAIR 1001+.
6. Start the MODBUS software tool on the computer system.
7. For flow values, read registers 30067 and 30068 as Float32:
    - Flow value will be shown in CFM, for example:
        - Flow rate = 1.0 CFM displays 1;
        - Flow rate < 1.0 CFM displays 0.9;
        - Flow rate > 1.0 CFM displays 1.1
8. For laser values, read registers 30069 and 30070 as Float32:
    - Laser value is displayed as a percentage of the value set during calibration of the instrument. For example, if the value during calibration is 1.0V and the current value is 1.20V, the display will show 120.000. If the current value is 0.5V, the displayed value will be 50.000.

D Limited Warranty

Limitation Of Warranties:

A. Lighthouse Worldwide Solutions (LWS) warrants that all equipment shall be free from defects in material and workmanship under normal use for a period of two years from date of shipment to Buyer except that LWS does not warrant that operation of the software will be completely uninterrupted or error free or that all program errors will be corrected. Buyer shall be responsible for determining that the equipment is suitable for Buyer's use and that such use complies with any applicable local, state, or federal law. Provided that Buyer notifies LWS in writing of any claimed defect in the equipment immediately upon discovery and any such equipment is returned to the original shipping point, transportation charges prepaid, within two years from date of shipment to Buyer and upon examination LWS determines to its satisfaction that such equipment is defective in material or workmanship, i.e. contains a defect arising out of the manufacture of the equipment and not a defect caused by other circumstances, including, but not limited to accident, misuse, unforeseeable use, neglect, alteration, improper installation, improper adjustment, improper repair, or improper testing, LWS shall, at its option, repair or replace the equipment, shipment to Buyer prepaid. LWS shall have reasonable time to make such repairs or to replace such equipment. Any repair or replacement of equipment shall not extend the period of warranty. If the Instrument is modified or in any way altered without the explicit written consent of LWS then the warranty is null and void. This warranty is limited to a period of two years, except as noted below, without regard to whether any claimed defects were discoverable or latent on the date of shipment. The length of warranty for pumps in hand held particle counters is one (1) year. Batteries and accessories with all products are warranted for one (1) year. Fuses and purge filters carry no warranty. If a third party battery is used in the product, the product warranty is null and void. If the battery is charged by a third party battery charger the battery warranty is null and void.

B. If Buyer shall fail to pay when due any portion of the purchase price or any other payment required from Buyer to LWS under this contract or otherwise, all warranties and remedies granted under this Section may, at LWS's option, be terminated.

C. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER REPRESENTATIONS, WARRANTIES AND COVENANTS, EXPRESS OR IMPLIED WITH RESPECT TO THE EQUIPMENT AND ANY DEFECTS THEREIN OF ANY NATURE WHATEVER, INCLUDING AND WITHOUT LIMITATION WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. LWS SHALL NOT BE LIABLE FOR, AND BUYER ASSUMES ALL RISK OF, ANY ADVICE OR FAILURE TO PROVIDE ADVICE BY LWS TO BUYER REGARDING THE EQUIPMENT OR BUYERS USE OF THE SAME. UNDER NO CIRCUMSTANCES SHALL LWS BE LIABLE TO BUYER UNDER ANY TORT, NEGLIGENCE, STRICT LIABILITY, OR PRODUCT LIABILITY CLAIM AND BUYER AGREES TO WAIVE SUCH CLAIMS. LWS's SOLE AND EXCLUSIVE LIABILITY AND BUYERS SOLE AND EXCLUSIVE REMEDY, FOR ANY NONCONFORMITY OR DEFECT IN THE PRODUCTS OR ANYTHING DONE IN CONNECTION WITH THIS CONTRACT, IN TORT, (INCLUDING NEGLIGENCE), CONTRACT, OR OTHERWISE, SHALL BE AS SET FORTH IN THE SUBSECTION A HEREOF AS LIMITED BY SUBSECTION B HEREOF. THIS EXCLUSIVE REMEDY SHALL NOT HAVE FAILED OF ITS ESSENTIAL PURPOSE (AS THAT TERM IS USED IN THE UNIFORM COMMERCIAL CODE) PROVIDED THAT THE SELLER REMAINS WILLING TO REPAIR OR REPLACE DEFECTIVE EQUIPMENT (AS DEFINED IN SUBSECTION A) WITH A COMMERCIALLY REASONABLE TIME AFTER RECEIVING SUCH EQUIPMENT. BUYER SPECIFICALLY ACKNOWLEDGES THAT SELLER'S PRICE FOR THE EQUIPMENT IS BASED UPON THE LIMITATIONS OF LWS'S LIABILITY AS SET FORTH IN THIS CONTRACT.

Warranty Of Repairs After Initial Two (2) Year Warranty:

A. Upon expiration of the initial two-year warranty, all parts and repairs completed by an authorized Lighthouse repair technician are subject to a six (6) month warranty.

B. Other than the above, LWS makes no warranty of any kind, expressed or implied, except that the products manufactured and sold by LWS shall be free from defects in materials and workmanship and shall conform to LWS's specifications; Buyer assumes all risk and liability resulting from use of the products whether used singly or in combination with other products. If instrument is modified or in any way altered without the explicit written consent of LWS, then the warranty is null and void.

C. WARRANTY REPAIRS SHALL BE COMPLETED AT THE FACTORY, BY AN AUTHORIZED SERVICE LOCATION, BY AN AUTHORIZED SERVICE TECHNICIAN, OR ON SITE AT BUYER'S FACILITY BY A LIGHTHOUSE AUTHORIZED EMPLOYEE. BUYER PAYS FREIGHT TO FACTORY; SELLER WILL PAY STANDARD RETURN FREIGHT DURING THE WARRANTY PERIOD. BUYER MAY SELECT A FASTER METHOD OF SHIPMENT AT ITS OWN EXPENSE.

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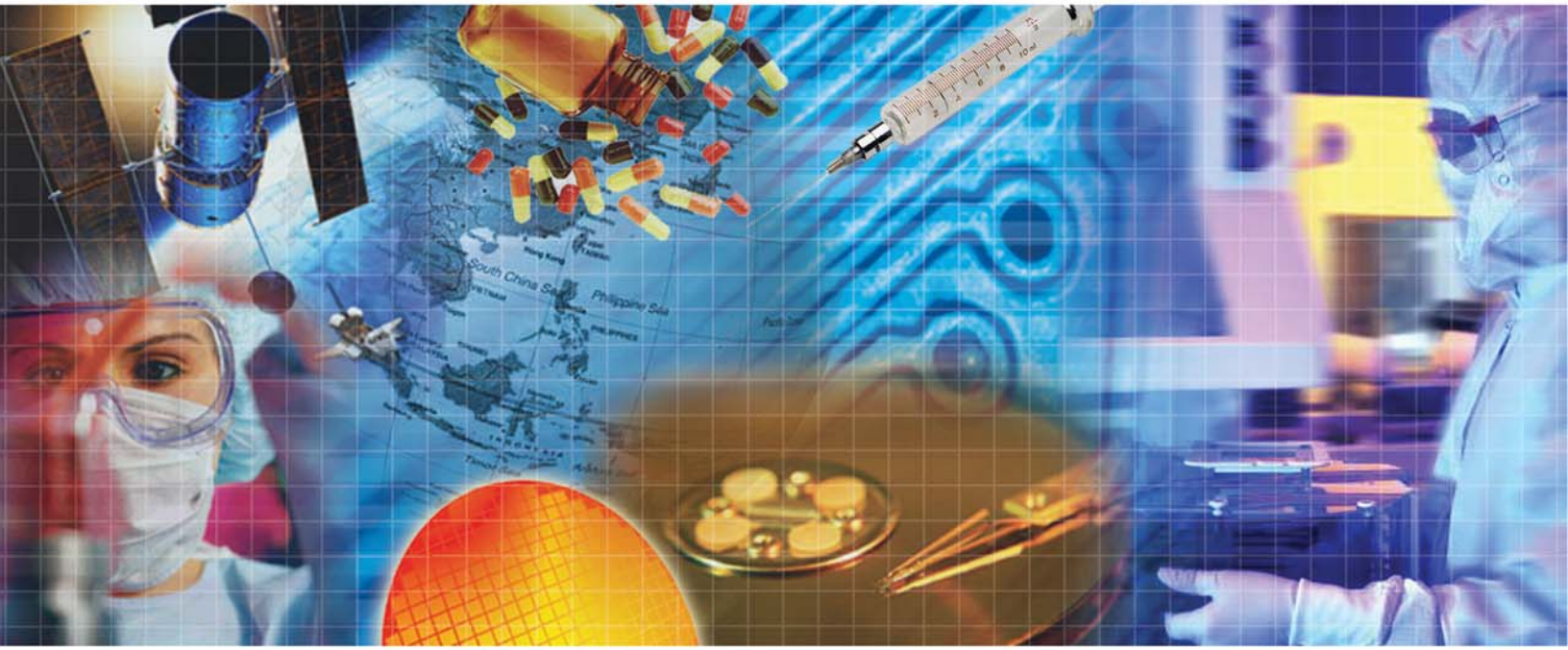

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