



LIGHTHOUSE
WORLDWIDE SOLUTIONS

H A N D H E L D

2 0 1 6

Operating Manual

Lighthouse Worldwide Solutions

HANDHELD 2016 Particle Counter

Operating Manual

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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: Handheld Airborne Particle Counter
Model Number(s): HANDHELD 2016

Conforms to the following Product Specifications:

SAFETY EN61010-1:2001 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use Part I: General Requirements IEC 61010-1:2000

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

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.

A handwritten signature in black ink, appearing to read "Thomas C. Saunders".

Milpitas, CA - May 21, 2003

Thomas C. Saunders - Operations

Table of Contents

About this Manual

Software License Agreement	i
Text Conventions	ii
Additional Help	iii

Chapter 1 Introduction

Overview	1-1
Description	1-1
HANDHELD Specifications	1-2

Chapter 2 Unpacking, Inspecting and Installation

Unpacking and Initial Inspection	2-1
Accessories	2-2
Installation	2-2
Connecting Power	2-2
Installing the Battery	2-4
Removing the Battery	2-6
Connecting External Printer	2-7
Loading Printer Paper	2-9
Connecting to an External Computer or Facility Management System	2-13

Chapter 3 Operation

Using the instrument for the First Time	3-1
Touch Screen Overview	3-2
Menu Map	3-3
MAIN Screen	3-4
LOCATION Selection	3-8
Changing Locations	3-8
Locations and AUTO Mode	3-9
Zoomed Data View	3-10
Viewing Two Columns of Data	3-11
Viewing One Column of Data	3-12
CONFIGURATION Screen	3-14

DATA SETUP	3-15
Particle Channels	3-15
Analog Channels	3-16
SAMPLE	3-19
SETTINGS	3-22
COUNT MODE	3-22
EXAMPLE APPLICATION FOR BEEP MODE	3-23
PARTICLE DISPLAY	3-23
ALARM	3-24
Alarm Threshold	3-25
Alarm Acknowledge	3-26
CLEAR BUFFER	3-26
DEVICE SETUP	3-27
CLOCK	3-28
OPTIONS	3-30
CONTRAST ADJUST	3-30
AUDIBLE BEEP ADJUST	3-30
ALIGN TOUCH SCREEN	3-30
Alignment At Startup	3-33
AUTOSTART MODE	3-33
DiffCuml on Zoom	3-33
ONE CHANNEL	3-33
ONE SECOND REALTIME MODBUS OUTPUT	3-34
5 Second Startup	3-35
COMM ADDRESS	3-35
LOCATION	3-36
SECURITY	3-37
POWER ON PASSWORD	3-38
CONFIGURATION PASSWORD	3-39
PRINT SETUP	3-39
SERVICE	3-40
DATA	3-41
Analog Data	3-44
PRINT RECORD	3-44
PRINT RANGE (BUFFER REPORT)	3-44
Printing Buffer Report	3-46
REPORTS	3-48
Setting up the HANDHELD to Run Reports	3-52
Printing a Report	3-54
Report Requirements	3-54
ISO 14644-1	3-54
EC GMP	3-54
Sample Printouts of Standard Reports	3-55
Power Shutdown Levels	3-59

Chapter 4 Setting up the Counter

Using Report Parameters	4-1
Basic Requirements	4-1
Fed Std 209E (feet)	4-1
Fed Std 209E (metric)	4-2
ISO 14644-1	4-2
British Standard 5295 - N/A	4-3
EC GMP	4-3

Appendix A Limited Warranty

Limitation Of Warranties:	A-1
Warranty Of Repairs After Initial Two (2) Year Warranty:	A-1

Appendix B Default Settings

Appendix C Purge Test

Appendix D MODBUS Register Map v1.41

COMM Settings	D-1
Supported MODBUS Commands	D-1
Register Map	D-2
Sensor Settings Registers	D-2
Device Status	D-5
Command Register	D-5
Data and Alarm Registers	D-8
Data and Alarm Enable Registers	D-8
Enable Alarming for a Channel	D-10
Threshold Setup Registers	D-10
Setting the Alarm Threshold Value	D-12
Data Registers	D-13
Data Status Byte (30007 - 30008)	D-15
Valid Data in Channels (30073 - 30076)	D-16
Data Type Registers	D-16
Data Units Registers	D-18

Index

About this Manual

This manual describes the detailed operation and use of the Lighthouse HANDHELD 2016 Airborne Particle Counters.

Software License Agreement

SOFTWARE PROGRAM: LIGHTHOUSE HANDHELD 2016 AIRBORNE PARTICLE COUNTER

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Lighthouse Worldwide Solutions
3041 Orchard Parkway
San Jose, CA 95134

Text Conventions

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

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

The following typefaces have the following meanings:

<i>italics</i>	Represents information not to be typed or interpreted literally. For example, <i>file</i> represents a file name. Manual titles are also displayed in italics.
boldface	Introduces or emphasizes a term.
<code>Courier font</code>	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 HANDHELD 2016 Airborne Particle Counter, contact Lighthouse Worldwide Solutions:

Lighthouse Worldwide Solutions
3041 Orchard Parkway
San Jose, CA 95134 U.S.A.
(408) 228-9200
(866) 507-9200 TOLL FREE
(408) 228-9225 FAX
techsupport@golighthouse.com
www.golighthouse.com

1 Introduction

Overview

This operating guide describes how to use the Lighthouse HANDHELD 2016 Airborne Particle Counters.

The HANDHELD 2016 has up to six particle-size channels starting at 0.2 microns with a flow of 0.1 CFM and a touch screen interface. A microprocessor controls all instrument functions. Count data is displayed as cumulative or differential count.

The model number signifies the minimum particle size measured by the instrument. The number "2016" indicates a 0.2 μm minimum channel size at 0.1 CFM with up to 6 particle count channels.

The instrument 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 bursts of light into electrical pulses. The pulse height is a measure of particle size. Pulses are counted and their amplitude is measured for particle sizing. Results are displayed as particle counts in the specified size channel.

Description

Ergonomically designed and lightweight, Lighthouse HANDHELD 2016 particle counters are the newest and most advanced handheld particle counters on the market.

The HANDHELD 2016 displays cumulative or differential particle count data as well as Temperature/Relative Humidity data on its easy to read 3.8" (9.25cm) touch screen. A rechargeable battery maximizes the HANDHELD's uptime. Data is easily downloaded using the LMS XChange software.

The HANDHELD allows you to:

- Set the Sample Time
- Configure the number of samples taken in a given Location
- Sample many different locations

- Print reports (with optional, external printer) based on Federal Standard 209E (ft³), Federal Standard 209E (m³), EC GMP (if unit has 0.5 and 5.0 channels), and ISO 14644-1
- Save your data for historical data review
- Print data tables using the data transfer software included with your instrument. Additionally use LMS Express to print graphs, data tables, and standards reports.

HANDHELD Specifications

Size Range	0.2 - 2.0 µm
Channel Thresholds	Standard: 0.2, 0.3, 0.5, 0.7, 1.0, 2.0 micron
	Other sizing available; specify at time of order
Flow Rate	0.1 CFM (2.83 LPM)
Counting Efficiency	50% (per JIS)
Laser Source	Laser diode
Zero Count Level	<1 count/5 minutes (per JIS)
Calibration	NIST Traceable
Count Modes	Concentration, manual/automatic, beep, cumulative/differential
Data Storage	Up to 3000 sample records, includes particle & environmental data, plus location and time
Communication Modes	RS232 via RJ-45 to PC or printer
Supporting Software	LMS XChange Data Transfer Software
Environmental Sensors	Temperature/Relative Humidity Probe: 32-122°F (0-50°C) ±1°F (.5°C), 15-90% ±2%
Touch Screen Display	3.8" (9.25 cm), 320x240
Printer	External thermal printer (optional)
Reports	FS-209E (ft) , FS-209E (m), ISO 14644-1
Key Software Features	Historical data review, password protection
Enclosure	High impact injection molded plastic
Sample Output	Internally filtered to HEPA standards (>99.997% @ 0.3µm)

Table 1-1 Specifications

Vacuum Source	Internal pump, flow controlled
Power	Unit: +12VDC; AC/DC Adapter: 100-240V, 50-60Hz
Battery	Li-Ion, removable and rechargeable
Dimensions	8.75"(L) x 5.0"(W) x 2.5"(H) [22.23 x 12.7 x 6.35 cm]
Weight	2.2 lb (1kg)
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
Size Range	0.2 - 2.0 μm

Table 1-1 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.

2

Unpacking, Inspecting and Installation

Unpacking and Initial Inspection

Your 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 shipper immediately.

If the carton appears to be undamaged, carefully inspect the instrument for broken parts, scratches, dents, or other damage before using.

Verify the contents of the package:

- HANDHELD 2016 particle counter
- Operating manual on CD
- Isokinetic sample probe: direct mount, attached to unit
- 0.1µm Purge Filter Assembly, 0.1 CFM flow rate with tubing
- Temperature/Relative Humidity Probe
- RS-232 communication cable and connector
- Power supply (100-240VAC, 50-60Hz)
- AC Power cord
- Li-Ion battery (removable)
- LMS XChange Data Transfer Software (CD and manual)
- Calibration Certificate
- Read Me First instructions

If you are missing anything from the above list, please contact your sales representative at Lighthouse Worldwide Solutions immediately at (866) 507-9200 or techsupport@golighthouse.com.

WARNING: *Do not
ship the instrument with
the battery installed.*

Keep the carton and all packing material for reshipment for its annual calibration.

Accessories

You can order several optional accessories to tailor the unit to your needs.

- External Battery Charger with AC and car adapters
- Spare Li-Ion Battery
- Carrying Case
- Isokinetic Sample Probe
- 6 ft. Tubing (for extending Isokinetic Sampling input)
- Thermal Printer with cable (AC or battery operated)
- Validation Documentation
- LMS Express software, an analysis tool that allows the user to:
 1. Download data from the instrument
 2. Collect data real-time (LMS Express RT/RT Plus)
 2. Save data for historical review
 3. Have advanced reporting with standard reports...and much more.

Contact Lighthouse Worldwide Solutions for more details.

Installation

Connecting Power

The power input to the adapter is 100-240VAC, 50-60Hz. The unit itself takes +12VDC. A power cord and power supply are included with your HANDHELD 2016.

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

Connect the power cord using the following steps.

1. Insert the AC power jack into the power connector on the left side of your HANDHELD.

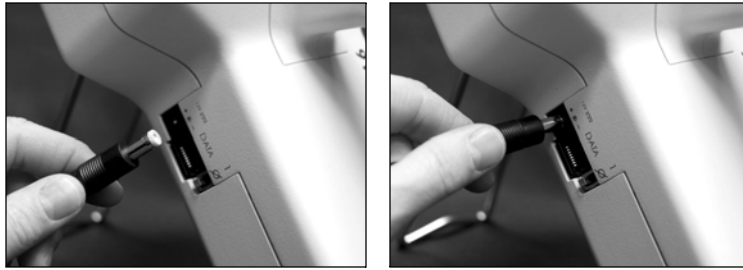


Figure 2-1 Power jack

2. Push the connector in until it will not go in any farther.



Figure 2-2 Inserting power jack.

3. Insert the power cord's power plug into an AC power source.

Installing the Battery

The HANDHELD comes with a standard rechargeable battery. An optional external battery charger is available; otherwise, the battery recharges in the unit when the unit is plugged into AC power.

Install the battery using the following instructions.

1. Make sure that the power switch is in the OFF position.
2. Open the battery compartment by sliding the battery compartment door on the bottom of the unit to the left to unlock it. When the door is unlocked, open the door. The hinge is on the right side of the door.

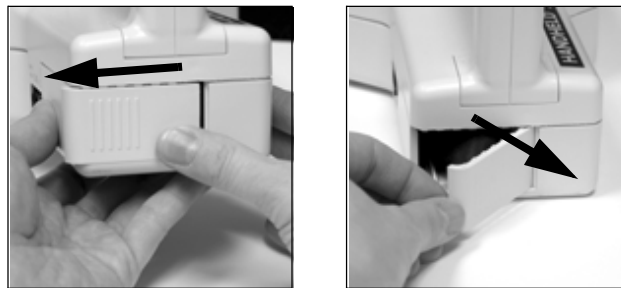


Figure 2-3 Open the battery compartment door

3. Pull the battery release ribbon out of the battery compartment.



Figure 2-4 Pull Battery release ribbon out

4. Prepare to insert the battery. Hold the battery so that the connector side is towards the HANDHELD. Place the battery into the compartment on top of the release ribbon.



Figure 2-5 Prepare to insert the battery

5. Slide the battery into the compartment and push it into the compartment until it connects and the battery is entirely inside the battery compartment.



Figure 2-6 Insert battery into battery compartment

6. Tuck the battery release ribbon over the battery.



Figure 2-7 Tuck battery release ribbon

7. Close the door so that it is flush with the bottom of the HANDHELD.

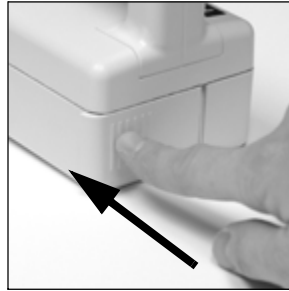


Figure 2-8 Close the Battery Compartment door

8. Slide the battery compartment door to the right until it clicks and latches.

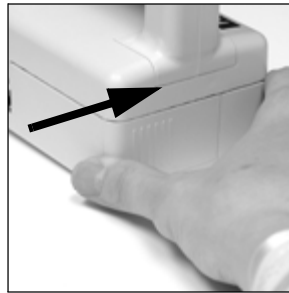


Figure 2-9 Secure the battery compartment door

WARNING: *Do not ship the instrument with the battery installed.*

Removing the Battery

1. To remove the battery, open the door to the battery compartment by sliding the door to the left to unlatch it.



Figure 2-10 Unlatch Battery Compartment door

2. Open the battery compartment door.



Figure 2-11 Open Battery Compartment door

3. Pull gently on the battery release ribbon to disconnect the battery and help slide the battery out.

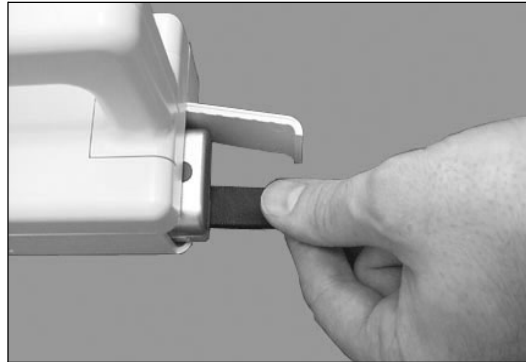


Figure 2-12 Remove Battery

Connecting External Printer

An optional external thermal printer can be attached to the HANDHELD to print reports directly from the instrument.

To connect the external printer, follow these directions:

1. Unpack your external printer and its communications cable.



Figure 2-13 HANDHELD, External Printer, and cables

2. Turn the printer over and push the battery pack into the underside of the printer. The pack will only fit one way. Insert the edge with the gold contacts first, then tilt the battery so that it slides into the printer. Press until a distinct "click" is heard.
3. The printer will not work until the battery is charged. To charge the battery, plug the printer's AC charger into the printer and into an AC power source. Charging the battery pack completely may take up to 15 hours before first use.
4. After the battery pack is charged you can use the printer while the charger is attached; however, operating with the charger alone is not possible, the battery pack must always be attached.
5. Turn the HANDHELD off and attach the RJ-45 connector to the DATA port on the HANDHELD.



Figure 2-14 Attach printer cable to DATA port

6. Attach the PS-2 end of the printer cable to back of the printer.
7. Turn on the HANDHELD.

Loading Printer Paper

To load thermal paper into the external printer, follow these directions.

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

1. Turn the printer on. Open the top cover of the printer and open a roll of thermal paper so that the end is unstuck. Hold the paper so that it will unroll from the bottom as shown below.

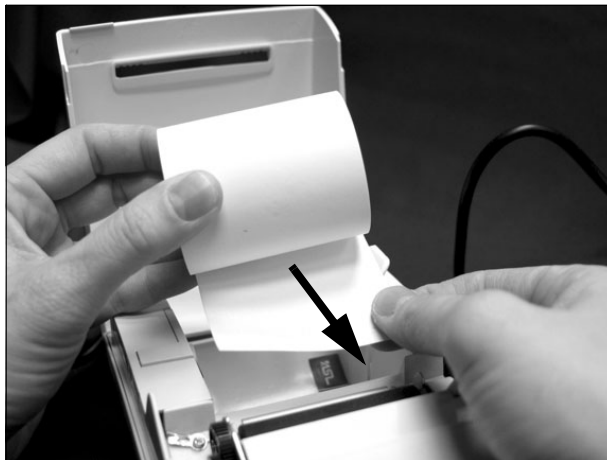


Figure 2-15 Prepare to load printer paper

2. Push and hold the printer roll lever to the right.

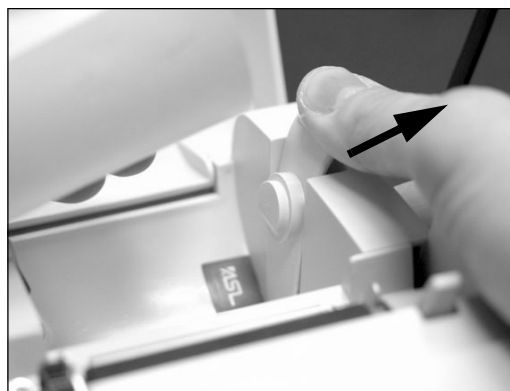


Figure 2-16 Printer roller lever

3. Lower the thermal paper into the printer's paper compartment so that it will feed from the bottom. Release the printer roll lever so that it catches the center of the paper roll's tube.

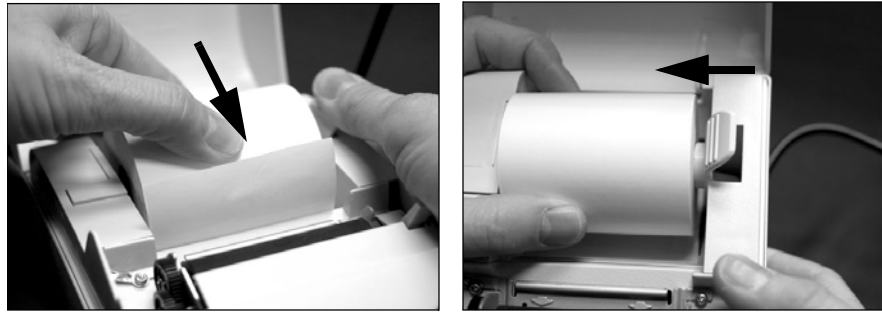


Figure 2-17 Insert thermal paper into printer

4. Unroll about 4-5 inches of paper from the end of the roll and position it over the two arrow guides (circled in the picture below) on the paper feed bar inside the printer.



Figure 2-18 Printer paper guides (circled)

5. Make sure the printer is turned on. Push the end of the paper in, under the printer's roller bar, and over the arrow guide marks, until the printer catches it.

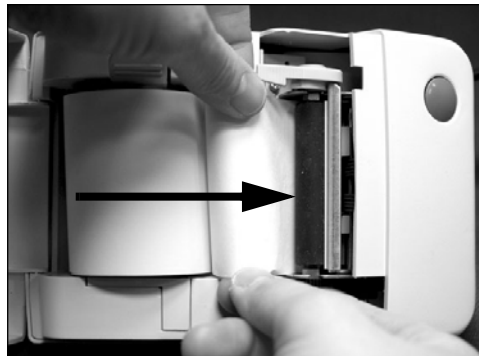


Figure 2-19 Feed paper in under print bar

Note: *The orange light on the front of the instrument indicates that the printer is out of paper.*

Do not print when there is no paper.

6. When the printer catches the end of the thermal paper, it will automatically form feed it through the printer.

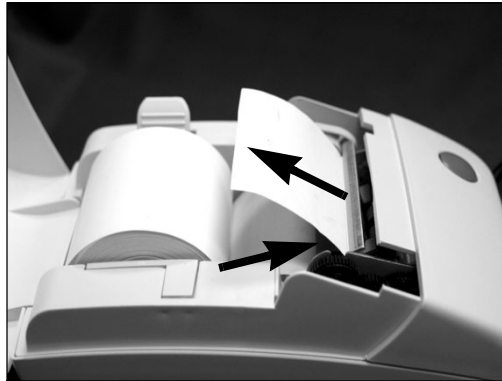


Figure 2-20 Printer form feeds paper

7. Press and hold down the form feed button on the top front of the printer to advance the paper until about 3-4" of paper sticks out of the printer.

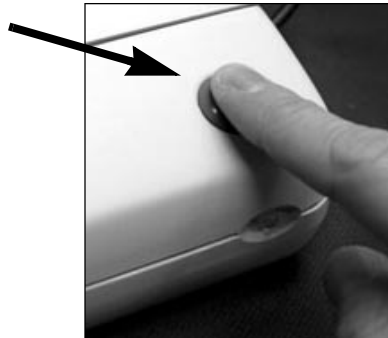


Figure 2-21 Form feed button

8. Hold the cover in one hand and the end of the thermal paper in another.



Figure 2-22 Preparing to feed paper through cover

9. Feed the end of the paper through the slot in the top of the printer's cover.



Figure 2-23 Feed paper through the printer's cover

10. Close the printer's cover. The end of the thermal paper should extend about 1-2" out of the printer.



Figure 2-24 Close the printer cover

Connecting to an External Computer or Facility Management System

The HANDHELD has the ability to connect to the Lighthouse Monitoring System (LMS), LMS Express or 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.

1. To connect the HANDHELD to the Lighthouse Monitoring System, LMS Express or LMS XChange, connect the RJ-45 HANDHELD data communications cable to HANDHELD's DATA port.

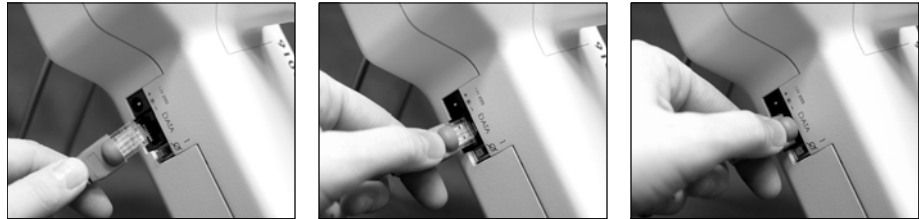


Figure 2-25 Connecting RJ-45 data communications cable

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

2. Connect the DB-9 end of the data communication cable to your Lighthouse Monitoring System, LMS Express or LMS XChange system.

Please refer to the LMS, LMS Express or LMS XChange manual for further information.

3

Operation

This chapter describes how to use the HANDHELD 2016 Airborne Particle Counter.

Using the instrument for the First Time

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 and void the warranty.

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

Contact Lighthouse for more information.

The HANDHELD comes with a charged battery and is ready to use out of the box. To start using the instrument, proceed as follows:

1. Insert the battery included with the shipment. (See Chapter 2 for instructions.)
2. Position the instrument in the environment to be measured.
3. **Remove the protective cap from the inlet tube.** To use the provided isokinetic probe, install it by connecting to the inlet tube on the top of the instrument.
4. The included Temperature/Relative Humidity probe can be attached to read environmental data.
5. Set on/off switch found on the left side of the unit to ON.
6. The Start Up screen displays on the LCD.
7. The MAIN screen appears.

WARNING: *Do NOT allow water, solvents, or other liquids to enter the instrument via the inlet tube - the instrument will be damaged and void the warranty.*

Do NOT operate the instrument with the inlet tube capped or plugged - the internal pump will be damaged and void the warranty.

Note: *The pump motor requires a minimum 5 seconds to ramp up to full flow. Refer to 5 Second Startup.*

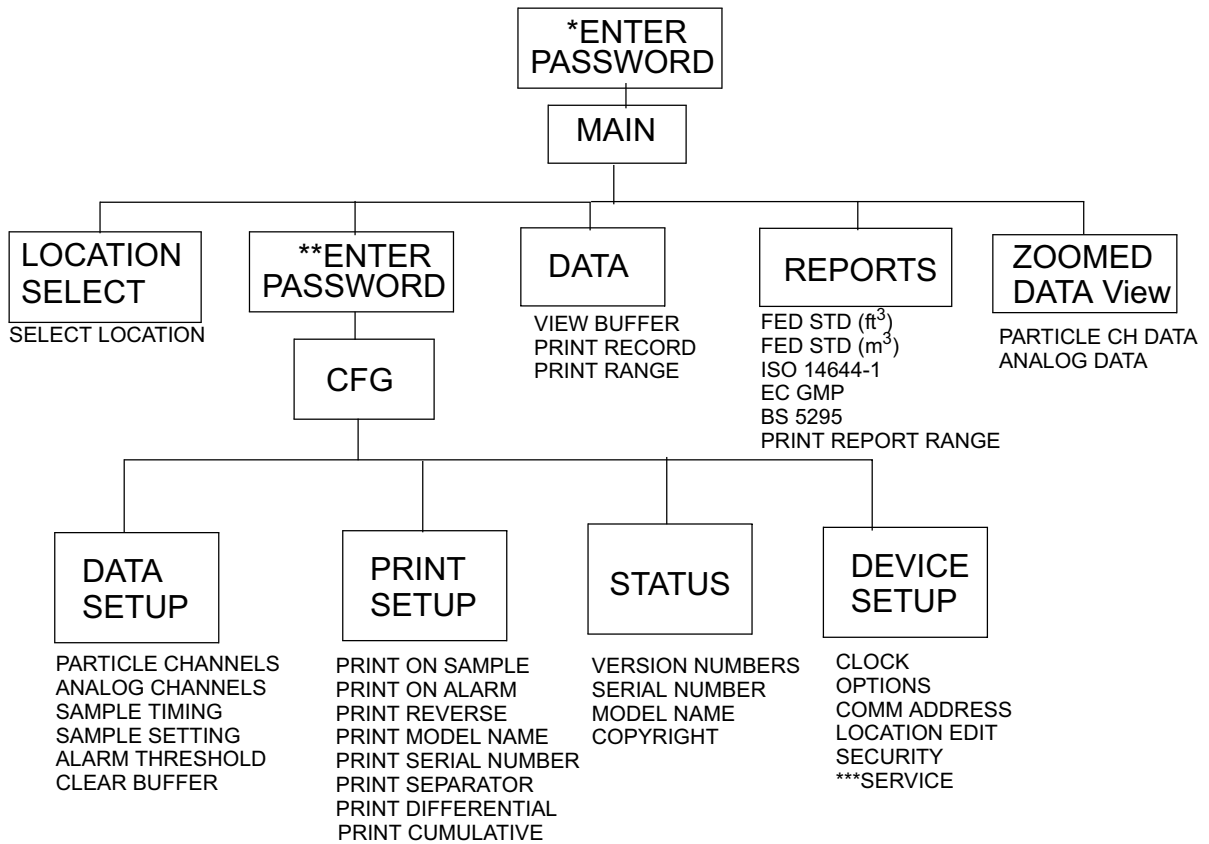
Touch Screen Overview

8. On the touch screen, press the START button to start the instrument.
9. "STARTING" will display when the pump is initially turned on.
10. When the HANDHELD starts counting, "COUNTING" appears on the display. Particle counts are displayed according to the size of each particle.
11. If the instrument is in AUTO mode with cycles and a hold time, "HOLDING" will display after each cycle and "FINISHED" will display when all the cycles are complete.
12. Press the "STOP" button to stop the instrument before the cycles are complete.

The HANDHELD incorporates a unique touch screen interface to control and configure the instrument.

This interface allows the user to easily view and configure the instrument to specific needs and applications.

Menu Map



- * If POWER ON password is enabled.
- ** If CFG password is enabled.
- *** For Authorized Service Provider Only

Figure 3-1 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 by a power supply or from its internal, removable battery. When a battery is used, the battery indicator will show the level of the battery charge remaining.

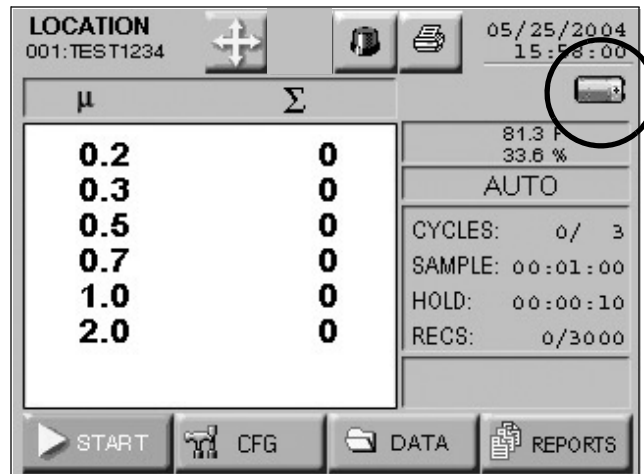


Figure 3-2 MAIN Screen - battery operated

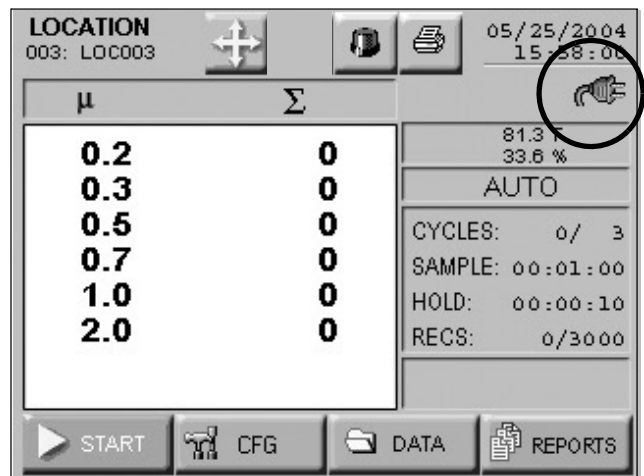






Figure 3-3 MAIN Screen - AC/DC adapter in use

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

The MAIN screen displays the following options and information.

- **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 while the instrument is Holding.
- **BACKLIGHT:** The screen has a backlight to increase the screen visibility under low light conditions. Touch anywhere on the Main screen (away from data) to turn it on. If the unit is on battery power when it is powered on, the backlight will turn on and then turn off automatically after 3 minutes. If the unit is on AC power when powered on, the backlight will remain on.
- 
 - **ALARM ACKNOWLEDGE button:** When an alarm condition occurs for any of the particle channels, the instrument 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.
- 
 - **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, ft³ vs. m³).

Note: *If two or more alarms are configured, if one alarm is activated and acknowledged, the buzzer will be reset until the next sample for all the alarms.*

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.*

If this happens, plug the power cord into the unit and make sure that the power switch on the front of the unit is on to continue counting.

The print configuration is set through the PRINT SETUP button in the Configuration screen. For more details about printing, see the the Configuration section later in this chapter.

- **Date/Time:** Displays the current date and time.
- **Battery Indicator:** Indicates that the instrument is being powered by a rechargeable battery. The amount of battery life left is denoted 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 3-4 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 the battery is installed, the instrument will charge the battery when the instrument is plugged in.



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

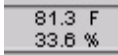
WARNING: *If the Air Flow is insufficient, turn the instrument off and contact Lighthouse Worldwide Solutions tech support.*



- **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+(866) 507-9200 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 ft³ or m³.



- **Analog Data:** Gives a snapshot view of the first two enabled analog channels.
- **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. In Concentration mode, the Sample Time will count up to 6 seconds per cycle.

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

Note: *If Hold time is greater than 1 minute, the pump will stop during that time. At the end of the hold time, the pump will restart.*

Note: *There is a one second startup during which the pump is accelerating to full power. During this time, the word "STARTING" will display.*

- **HOLD:** Displays the hold time in between cycles. The maximum hold time is 99 hours, 59 minutes and 59 seconds.
- **RECS:** This displays the current number of records stored in the instrument and the total number of records that can be stored. The data buffer is a circular buffer. The instrument can store up to 3000 records. 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 will display "COUNTING" in the lower right corner of the screen above the REPORTS button.

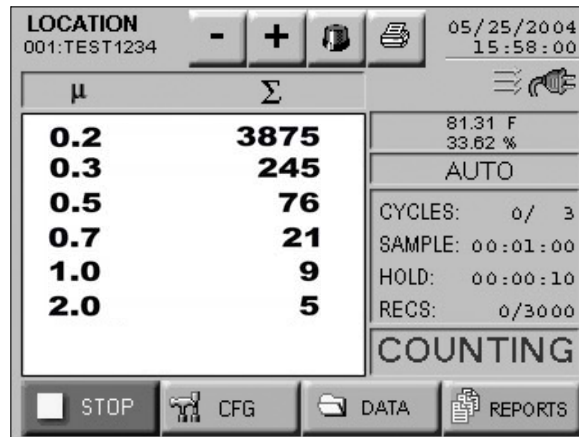


Figure 3-5 Counting mode

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



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.

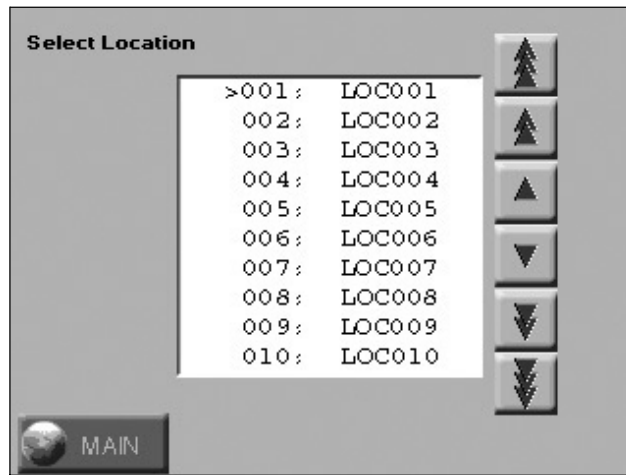


Figure 3-6 Location Select Screen

- 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 and triple arrows will move the cursor up or down 10 records or 100 records at a time, respectively.

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

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, press the Location - and + buttons to increment or decrement the location that will be saved with the data when the sample time completes.

- For example, to sample from two different locations that are a five minute walk apart, set the Hold Time to 5 minutes, collect data from location 1 during the first cycle, then, when the instrument finishes counting the first cycle and is HOLDING, move the instrument to location 2 and change the location on the instrument to location 2. The instrument will record the data with location 1 for the first sample and location 2 for the second sample.

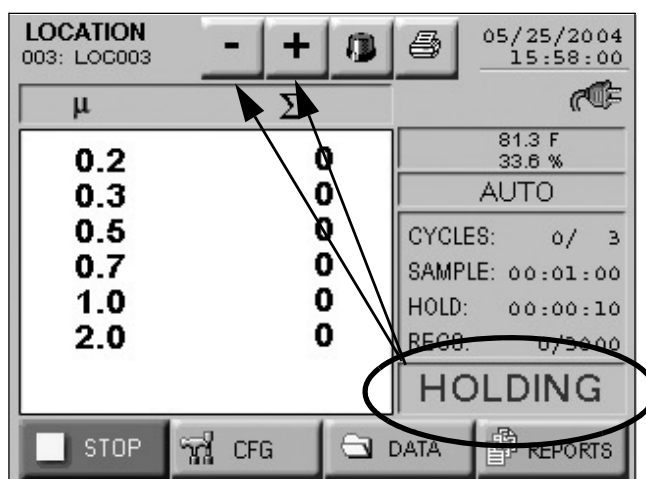


Figure 3-7 Changing Locations using - and +

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

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

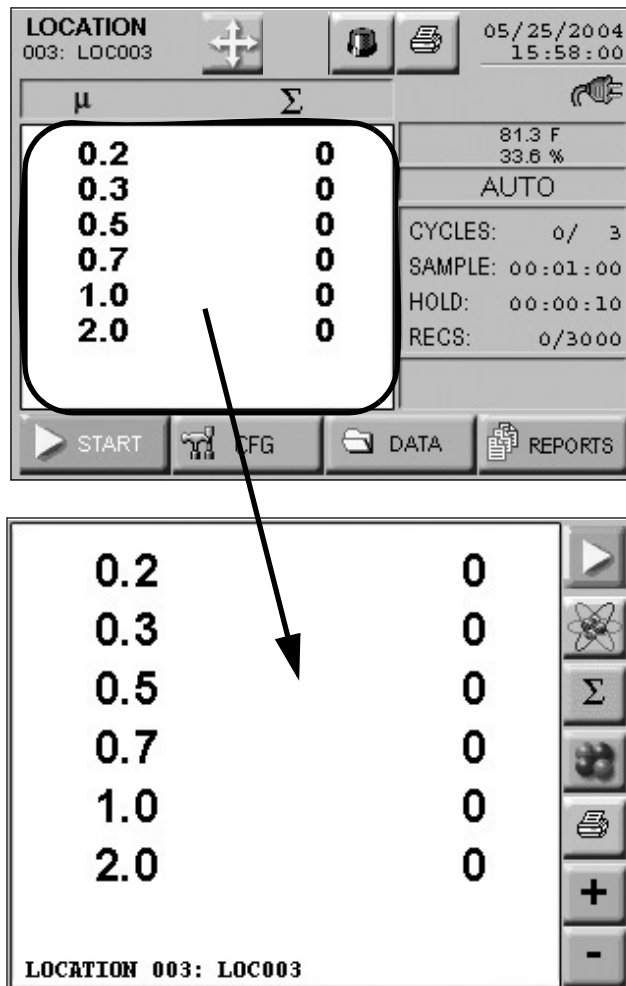











Figure 3-8 Zoomed Data View

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

- 
• Increment or decrement the location

- 
• 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 view.

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.

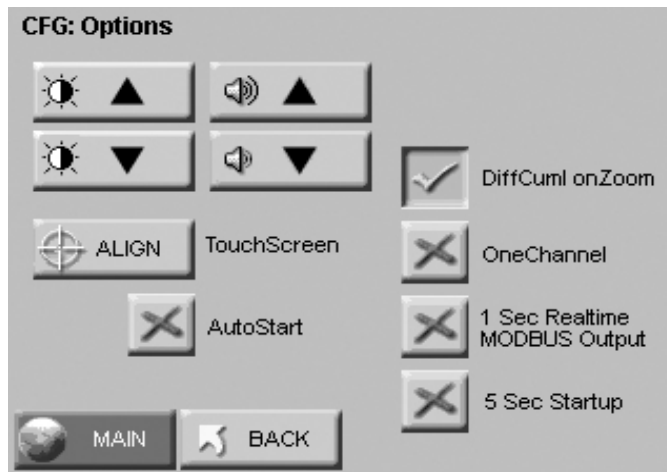


Figure 3-9 Configuration Options Screen

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

differential and cumulative data on the Zoomed View screen.

	Diff	Cuml
> 0.2	3875	5236
0.3	245	327
0.5	76	101
0.7	21	31
1.0	9	13
2.0	5	9

LOCATION 003: LOC003 STOPPED

Figure 3-10 Differential and Cumulative Data in Zoomed View

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..

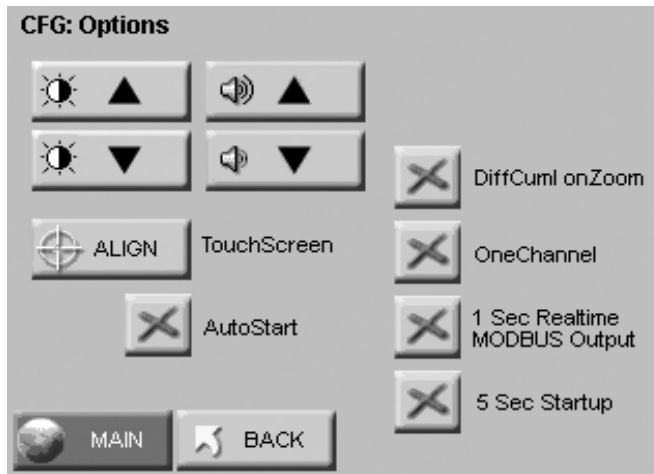


Figure 3-11 Configuration Options Screen

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

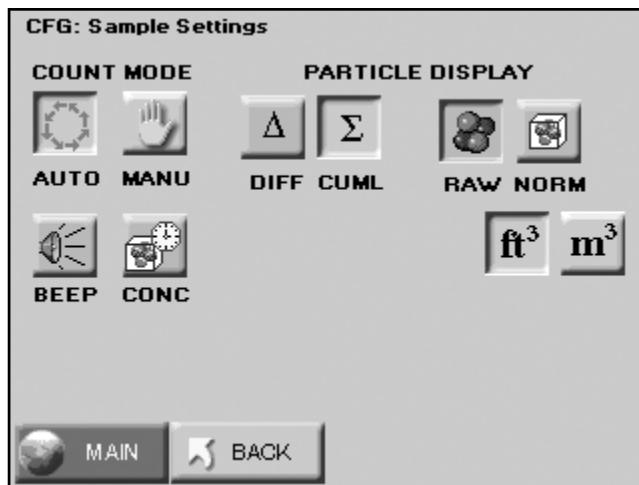


Figure 3-12 Configuration: Setting Screen

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

0.2	3875	
0.3	245	
0.5	76	
0.7	21	
1.0	9	
2.0	5	
LOCATION 003: LOC003 STOPPED		

Figure 3-13 Cumulative Data Only in Zoomed View

Only one column of data is displayed.

CONFIGURATION Screen

Press CFG on the MAIN screen to display this screen:

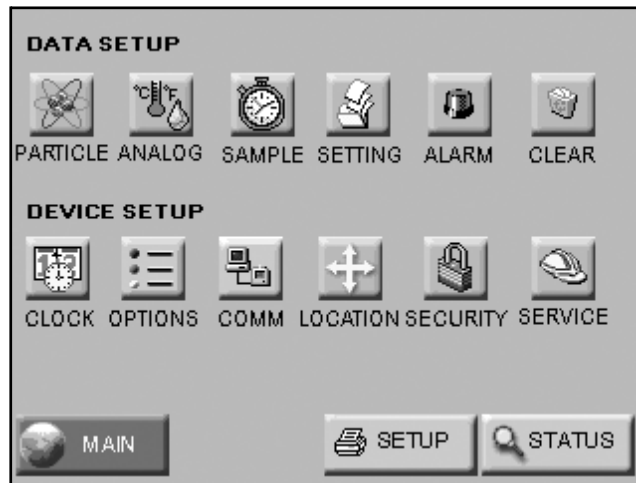


Figure 3-14 Configuration Screen

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 realtime MODBUS output, 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

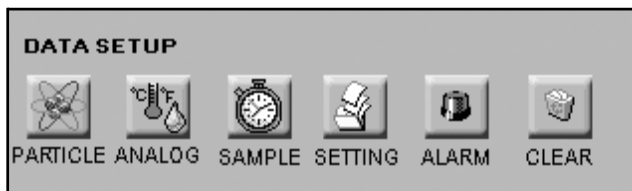


Figure 3-15 Data Setup options



Particle Channels

The instrument’s particle channels can be enabled or disabled on the Particle Channel. A checkmark is displayed next to each enabled channel.

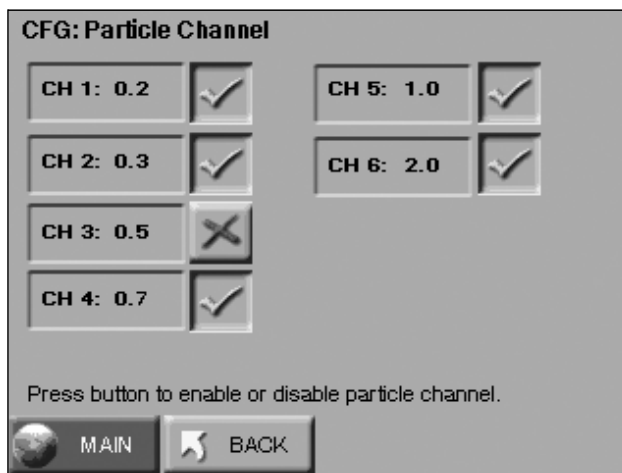


Figure 3-16 Particle Channel configuration

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.*

- The checkmark button next to each channel size is a toggle. Press it once to disable a channel and a red "X" will display, indicating that the channel is disabled. Press the button again and it will change back to the checkmark, enabling the channel.

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



Figure 3-17 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 the reports, and from the printouts.

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



Analog Channels

A Temperature and Relative Humidity probe can be connected to the HANDHELD via a connector on the top of the unit.

Users can select if the HANDHELD displays analog temperature data as Fahrenheit or Celsius by pressing the ANALOG button on the Configuration screen. The Select Temperature Units window displays.

There are two buttons on the Select Temperature Units window. The button displayed shows the units that are currently selected: F for Fahrenheit and C for Celsius.

To change to Celsius, press the F button. The "F" will disappear and the bottom button will display C for Celsius. To change to Fahrenheit, press the C button and the top button will display F for Fahrenheit.

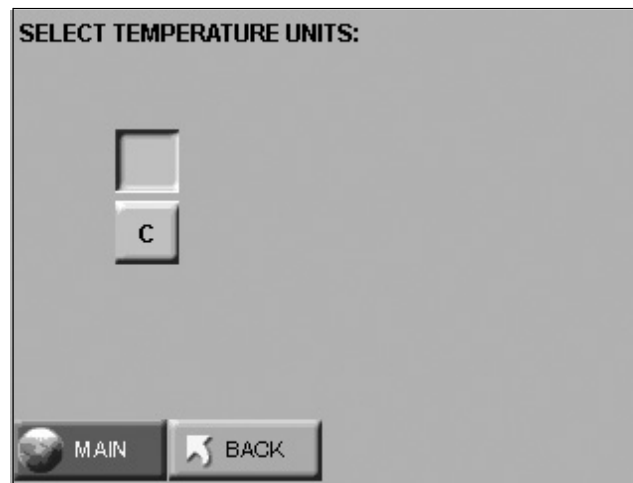


Figure 3-18 Analog Channels - Select Celsius Units

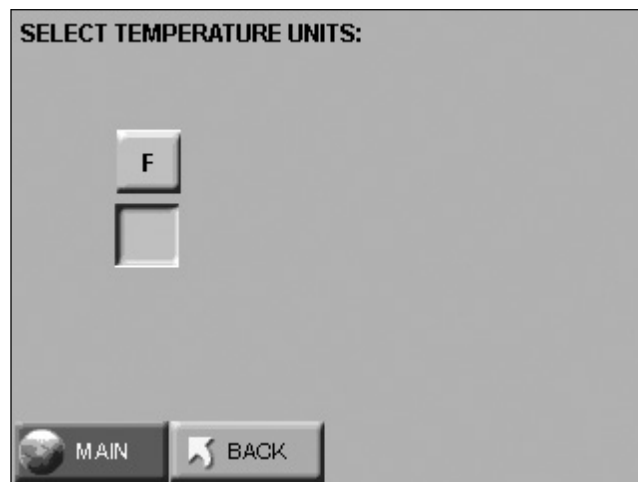


Figure 3-19 Analog Channel - Select Fahrenheit Units

Temperature and relative humidity values appear on the MAIN screen with the units you selected.

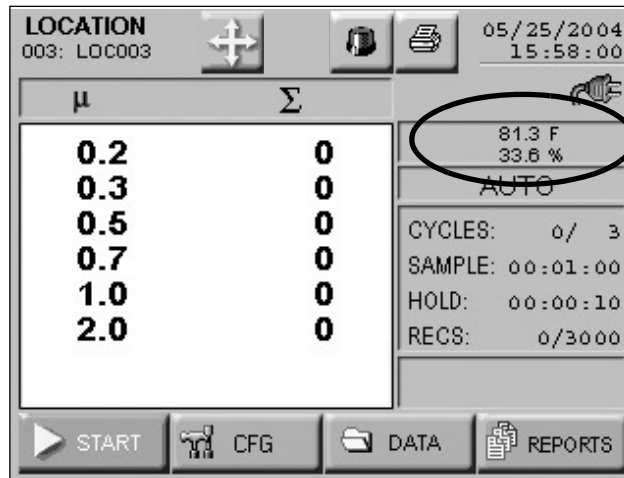


Figure 3-20 Analog data on MAIN screen

When the unit is not counting or when it is holding, you can display the instrument's current Analog data by pressing press anywhere in the Particle Data area to bring up the Zoomed Data View, then press the Analog toggle button to display Analog data.

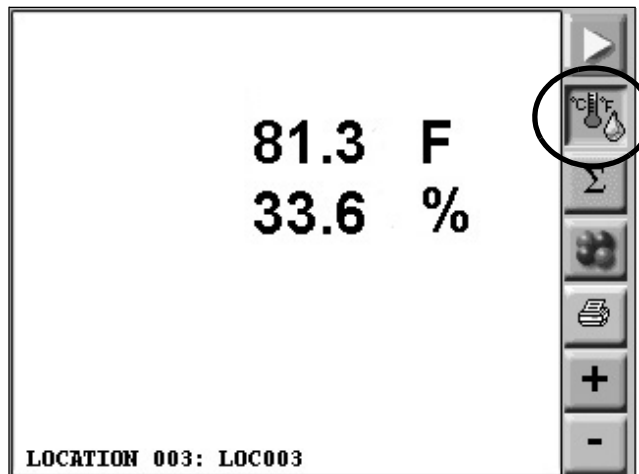


Figure 3-21 Zoomed Data View: Analog data



SAMPLE

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

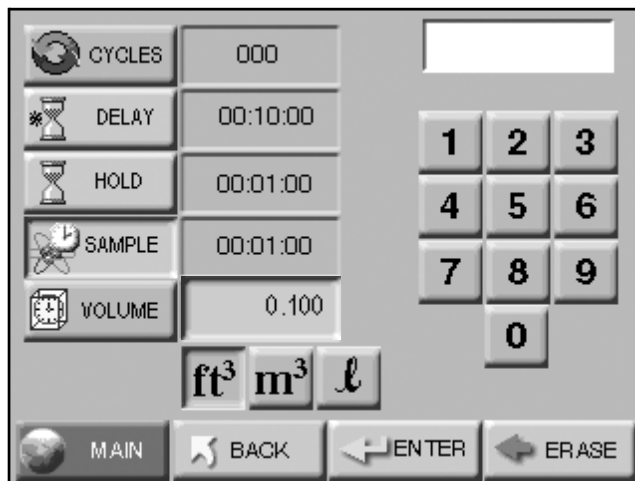


Figure 3-22 Sample Timing Configuration Screen

- CYCLES:** The number of cycles is set to determine how many times the instrument samples the air in a single location. This is used only in AUTO mode. 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 unit actually starting 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: *The pump starts immediately when START is pressed. In order to operate properly, if a Delay is set, the Delay should not be less than 5 seconds.*

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 with no hold time between cycles.*

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.

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.

Note: *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.

Note: *The maximum Sample Time is 23:59:59.*

- **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.

Note: *When the particle volume is ft^3 the minimum sample volume is 0.1 ft^3 .*

- **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.

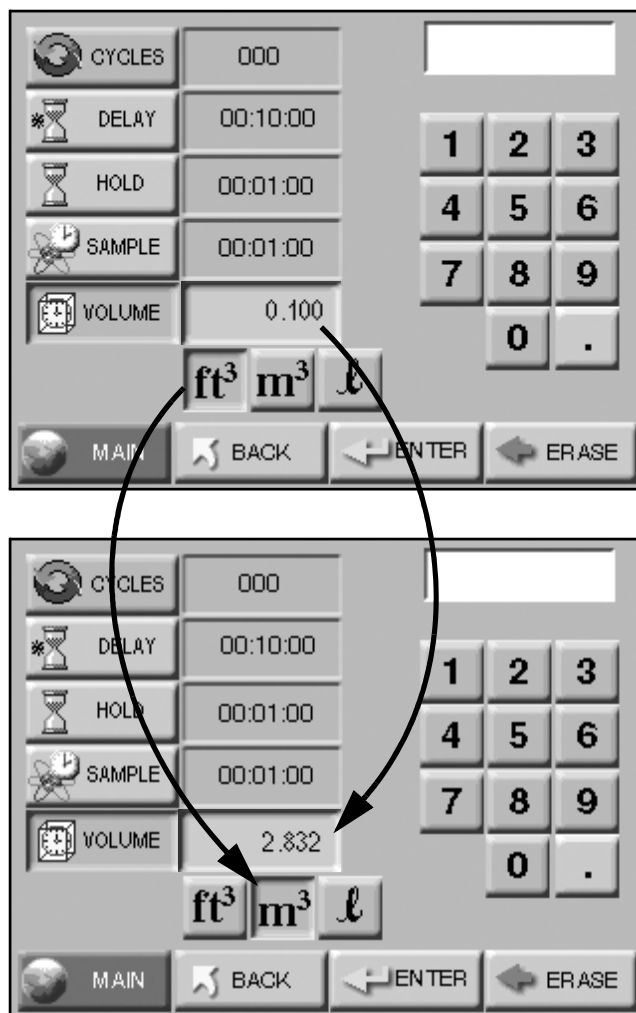


Figure 3-23 Changing Sample Volume unit of measure

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

Note: *If the particle volume is liters or m³, sample volume is displayed in liters.
If the particle volume is cubic feet (ft³), the sample volume is displayed in cubic feet (ft³).*



SETTINGS

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

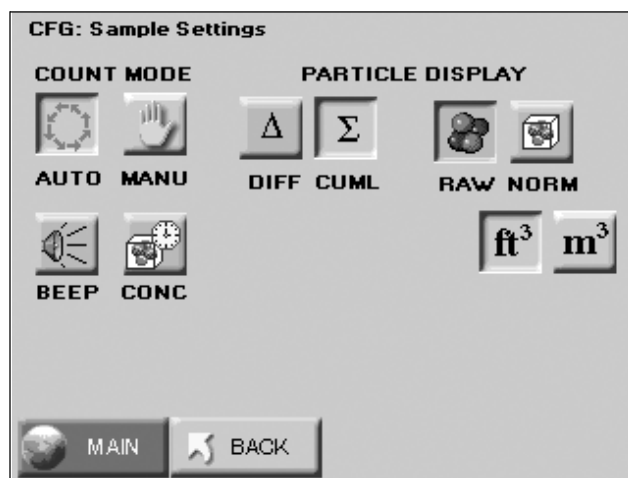


Figure 3-24 Sample settings screen

COUNT MODE

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

- **AUTO** - 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 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, Manual, and Beep modes count down and the sample times for Concentration mode count 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 screen and on the printouts.

Note: *BEEP mode only works with CUMULATIVE data and for Sample Times greater or equal to 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 one second after the START button is pressed and will continue until the STOP button is pressed or the number of configured cycles is reached.

If no channel is set for alarming, when BEEP mode is selected the instrument will automatically select the smallest channel size, at whatever the alarm threshold is set to, to alarm on.

If alarming is enabled on more than one channel, when the instrument is in BEEP mode it will beep if the alarm threshold is exceeded on any of the channels enabled for alarming.

Note: *If BEEP mode is set to one count, the beeps may not be for every single count if there are multiple counts in a second.*

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

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

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

As a filter is scanned, if the counts exceed the threshold, the instrument will beep at every instance of the threshold.

PARTICLE DISPLAY

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

For example, the cumulative count for the 1 μ m channel is the sum of that channel's count + 2.5 μ m count + the 5 μ m count.

The differential count for the 1 μ m channel is the number of particles between 1 μ m and 2.5 μ m.

The data displays on the MAIN screen according to whichever is selected (DIFF or CUML).

The data format is either Raw (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 (ft³ or m³).

$$\text{Volume of Air} = \text{Sample time (minutes)} \times \text{FlowRate (CFM)}$$

$$\text{Normalized Data} = \text{Number of Particles} / \text{Volume of Air}$$

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



ALARM

Note: *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 instrument is set to Differential data, the alarm threshold will apply to the differential counts.

If the instrument is set to display Cumulative data, the alarm threshold will apply to the cumulative counts.

The instrument allows the user to enable alarming on multiple channels. See the Particle Alarm screen in Figure 3-25.

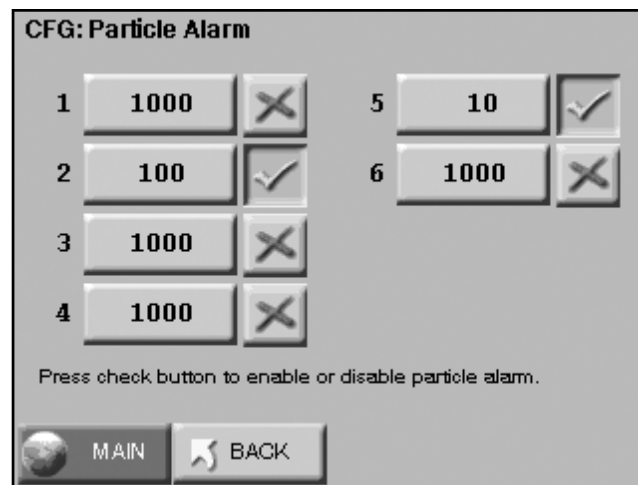


Figure 3-25 Particle Alarm Configuration with 2 channels enabled for alarming

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

Alarm Threshold

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

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

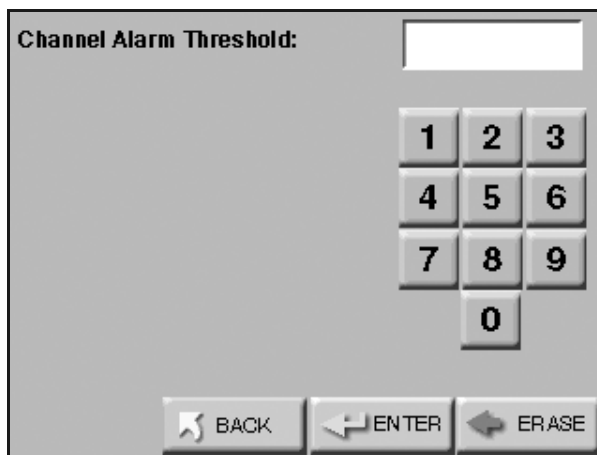


Figure 3-26 Configure Alarm Threshold

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

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

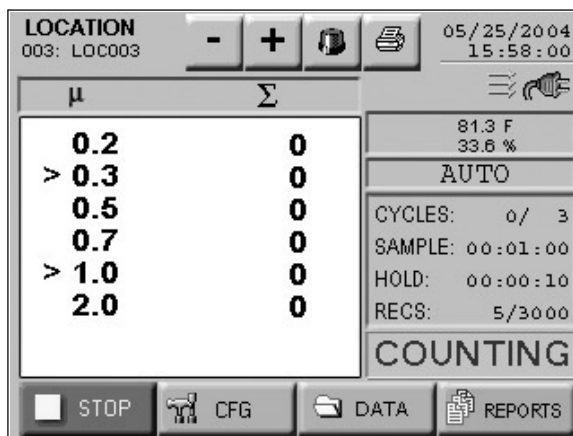


Figure 3-27 MAIN screen with 2 channels enabled for alarming

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

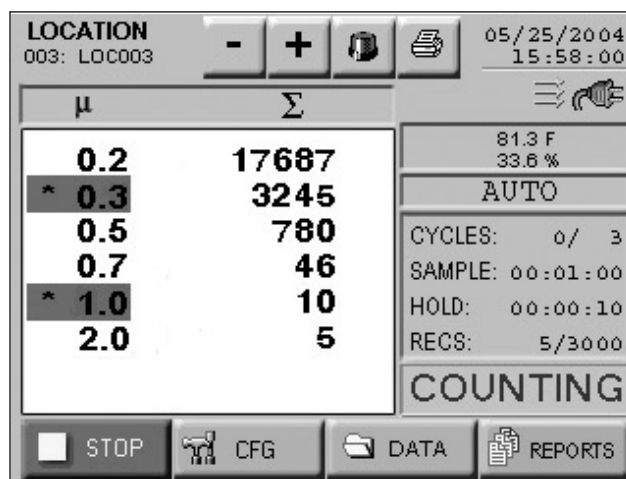


Figure 3-28 Channel in Alarm

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

Note: If alarms are enabled on two channels, if the user presses the Alarm Acknowledge button when the first channel goes into alarm, the alarm will not sound if the second channel's threshold is reached within the sample sample period.

Alarm Acknowledge

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.

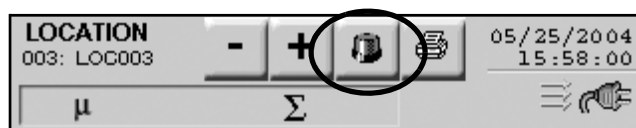


Figure 3-29 Alarm Acknowledge button

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



CLEAR BUFFER

To clear the data buffer on the instrument, press the Clear buffer button.

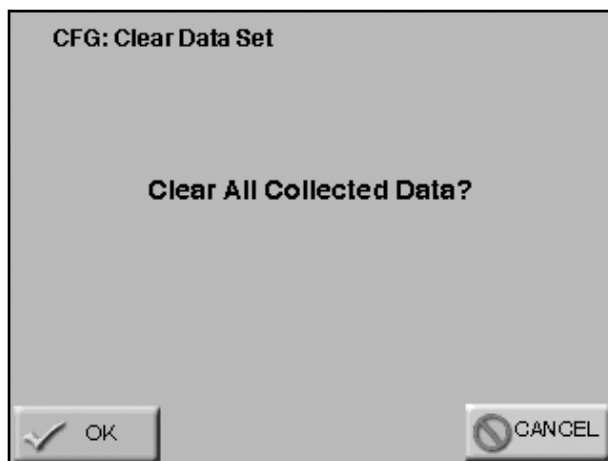


Figure 3-30 Clear Buffer message screen

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 touch-screen, 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 3-31 Device Setup options



CLOCK

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

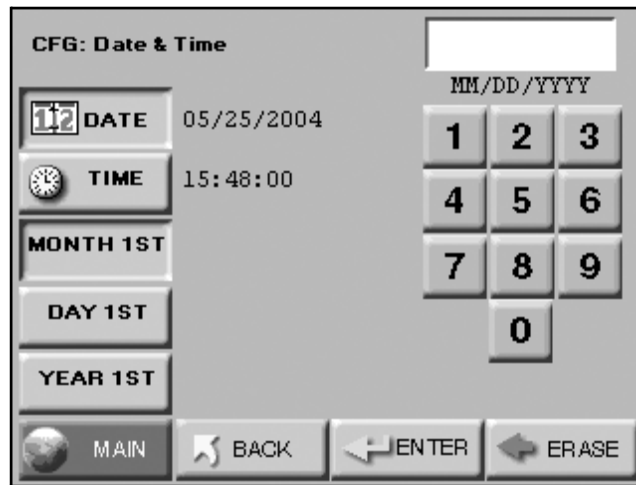


Figure 3-32 Date & Time Configuration Screen

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

Note: *MONTH 1ST (MM/DD/YYYY) is the default date format.*

Change the Date's format by pressing the MONTH 1ST button to display the date as MM/DD/YYYY. Alternatively press the DAY 1ST button to display the Date as DD/MM/YYYY or press the YEAR 1ST button to display the date as YYYY/MM/DD.

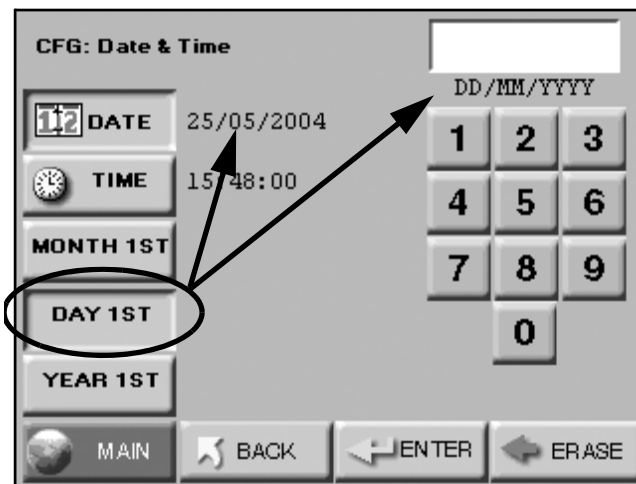


Figure 3-33 Date Option: Day first

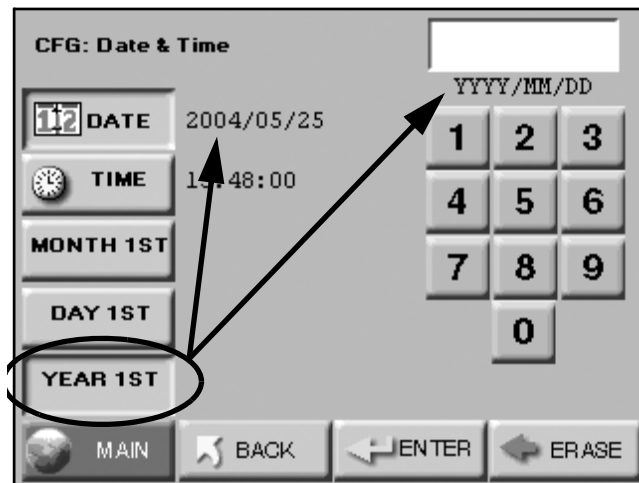


Figure 3-34 Date Option: Year first

Set the instrument's Time by pressing the TIME button.

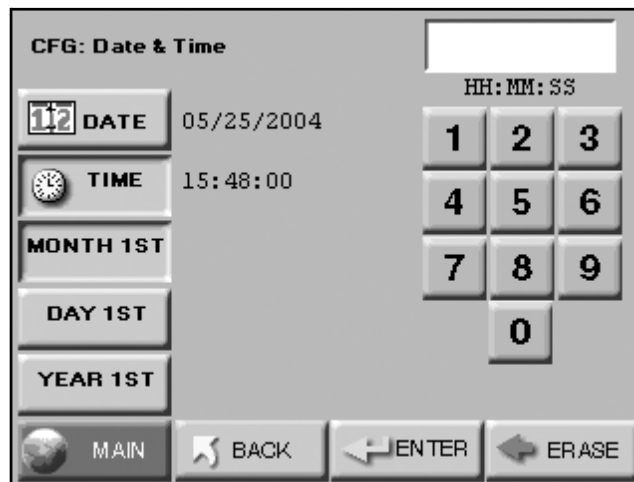


Figure 3-35 Configuring TIME

Enter the desired Time in hours, minutes and seconds then press ENTER to save the new time.

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

OPTIONS

Several optional configuration settings are found on the OPTIONS screen.

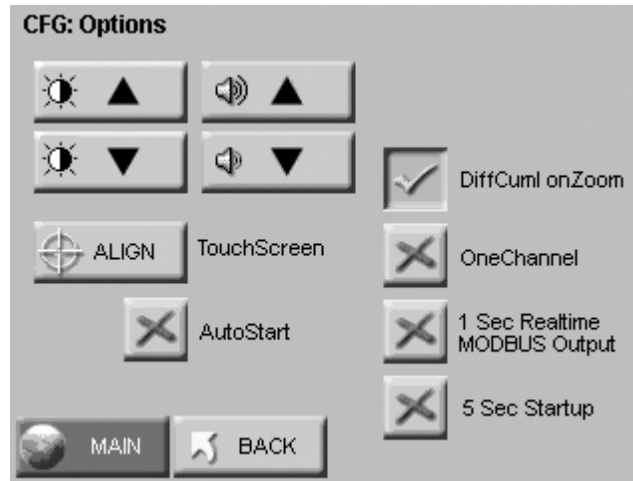


Figure 3-36 Options Configuration screen



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 second set of UP and DOWN arrows.

ALIGN TOUCH SCREEN

The ALIGN button allows you to re-align the touch screen so the locations that you touch on the screen correspond to the expected button 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:



Figure 3-37 Alignment step 1

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

- Touch the circle in the upper right corner.

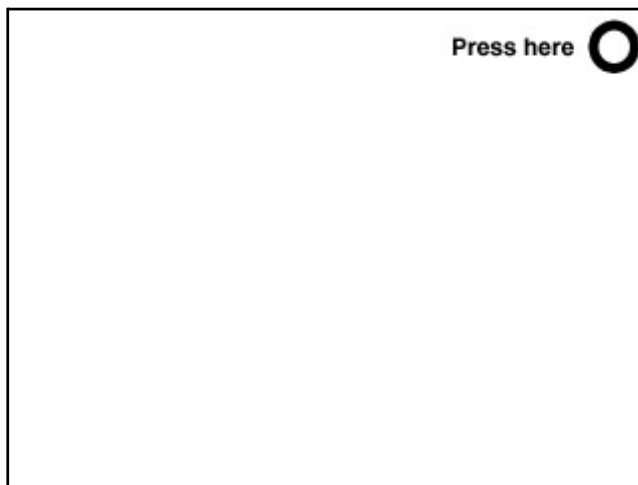


Figure 3-38 Alignment step 2

- At the Verify screen, touch the screen in a few different places outside the rectangle. An "X" appears everywhere the screen is touched to verify that the alignment.

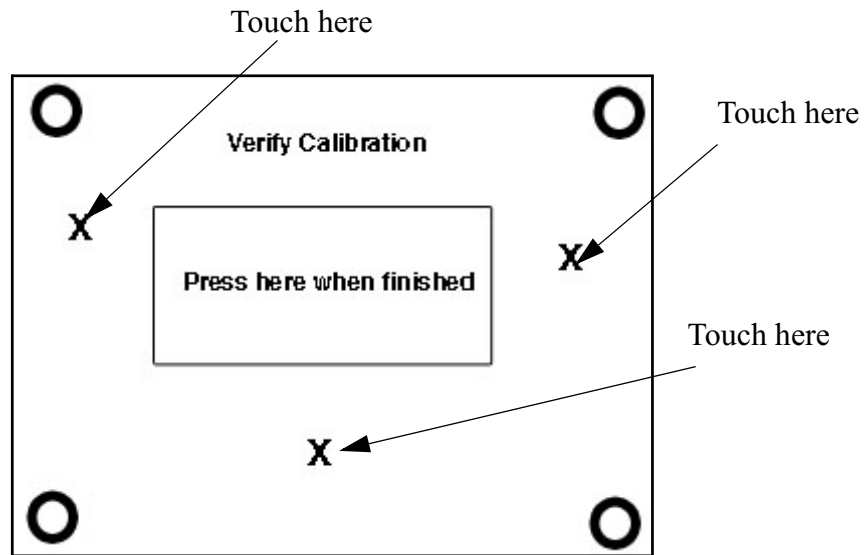


Figure 3-39 Verify Alignment of Touch Screen

- Press anywhere inside the rectangle to when you are ready to complete aligning the screen.
- The unit will save the settings and and display the MAIN screen.

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. Doing so brings up the following screen:

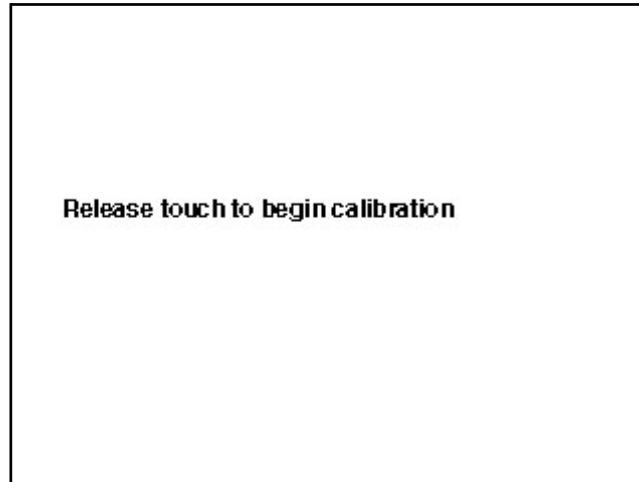


Figure 3-40 Alignment on power up

- Continue with the alignment process as described above.



AUTOSTART MODE

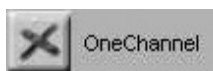
Note: *When Autostart mode is enabled, set the Delay time to at least 5 seconds or enable the 5 Sec Startup in CFG Options.*

If Autostart mode is enabled, when the instrument is powered on (or regains power after a power outage), the instrument will immediately begin sampling based 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.



ONE CHANNEL

If One Channel is enabled, only the first channel will be displayed on the MAIN screen.

Note: *If the first channel is disabled, 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.

See Figure 3-41 for an example of an instrument with One Channel enabled.

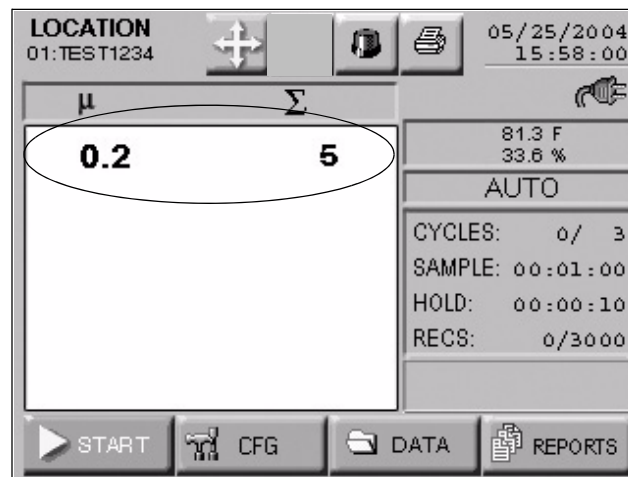


Figure 3-41 Main Screen - One Channel Option enabled



ONE SECOND REALTIME MODBUS OUTPUT

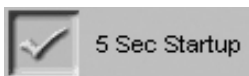
If One Second Realtime MODBUS Output is enabled, the instrument's settings reset to the following.

Note: *Alarming is not available when One Second Realtime MODBUS Output is enabled.*

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

Note: *If you change any 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 not be recorded to the data buffer.



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 the HANDHELD is connected to a data collection system or daisy chained at the end of a chain of RS-485 instruments, the instrument's COMM address is used to identify it.

LMS XChange or LMS Express/RT/RT+ will search for the instrument by the COMM Address specified on the Communication screen shown below. COMM addresses range from 1 to 63.

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

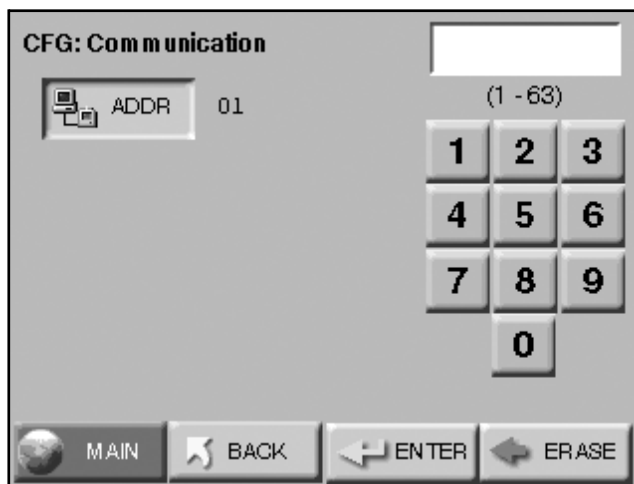


Figure 3-42 COMM Address Configuration screen

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 HANDHELD allows up to 200 different locations and associated alphanumeric labels.

Press the LOCATION button on the Configuration screen to display the Select Location screen.

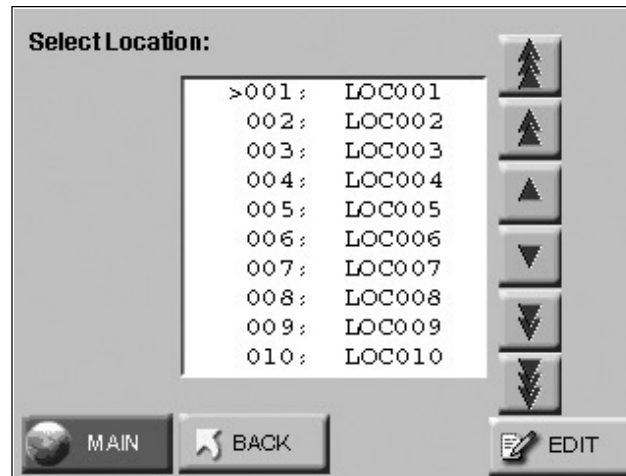


Figure 3-43 LOCATION Setup Screen

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:

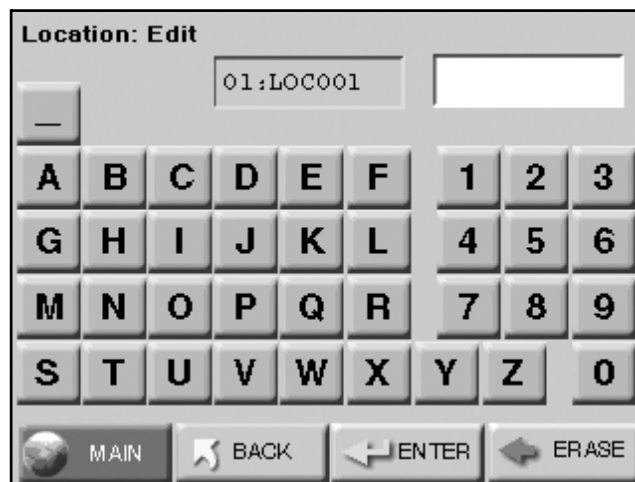


Figure 3-44 LOCATION Edit Screen

- Type in the name of the location using the alphanumeric and under-score keys.

- Press the ERASE button to erase the last character typed, if needed.
- Press ENTER.
- 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

To restrict access to the instrument and/or configuring the instrument, the HANDHELD has two different password levels.

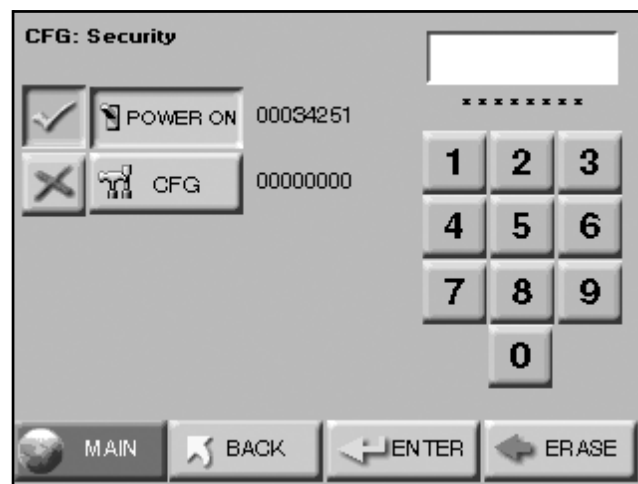


Figure 3-45 Security Password Configuration Screen

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 they can access the Configuration screen.

- To set the password for the POWER ON, select the POWER ON button, then type in a password using the numeric keypad. Press the ERASE button to delete the last character, if needed.

- Press ENTER to save.
- To set the Configuration (CFG) password, select the CFG button, then type in a password using the numeric keypad.
- Press the ERASE button to delete the last character, if needed.
- Press ENTER to save the changes.
- Press the "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 clear the password.*

To require that a password must be entered before the instrument can be used, enable the POWER ON password..



Figure 3-46 POWER ON Password Access Screen

When the POWER ON password is enabled, you will see a password access screen just after you turn the unit on. The instrument will remain locked until the correct password is entered.

CONFIGURATION PASSWORD

The Configuration password prevents unauthorized access to the Configuration screen.



Figure 3-47 CONFIGURATION Password Access Screen



PRINT SETUP

The Print configuration has several options for printing the data that the user sets on the Printer Setup screen shown in Figure 3-48.

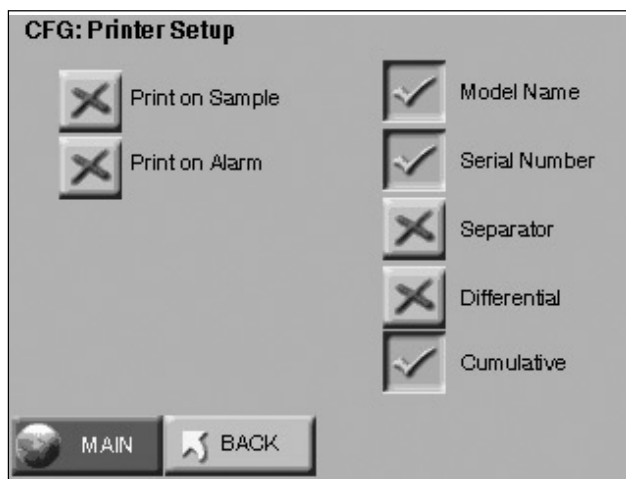


Figure 3-48 Printer Setup Screen

- **Print on Sample / Print on Alarm** - 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.

Note: *You can select both Differential and Cumulative printing at the same time. For normalized values with more than 8 digits, only the whole number will be printed.*

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



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

Data that is stored on the instrument is viewed in the Data Screen. When the buffer has filled to its limit of 3000 records, the newest records will overwrite the first records stored. The word "Records" on the MAIN screen will have an asterisk (*) next to it to indicate that the buffer has wrapped. When you go to the Data screen after the data has wrapped, the first record viewed will be the most current record, which will not necessarily be record #1.

If the Particle Volume is set to ft^3 , then the concentration data will display and print in ft^3 . If the Particle Volume is set to m^3 or Liters (L), then the concentration data will display and print in m^3 .

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

Depending on how the HANDHELD is configured, the data will display in either raw data mode, or be normalized to ft^3 or m^3 .

Size	Diff#	Cum#
0.2 μ	25519	31575
0.3 μ	4017	5056
0.5 μ	993	1039
0.7 μ	27	46
1.0 μ	15	19
2.0 μ	4	4

Loc: ABCD1234	Instr: G00D	A1: 75.1 F
Smpl: 0001:00	Flow : OK	A2: 42.3
Date: 2004/08/09	Alarm: NONE	
Time: 12:43:23	Laser: OK	

Figure 3-49 Data 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 data 10 records at a time.
- The triple arrow moves 100 records of data at a time.

Size	Diff/ft3	Cuml/ft3
0.2 μ	26519.0	31575.0
0.3 μ	4017.0	5056.0
0.5 μ	993.0	1039.0
0.7 μ	27.0	46.0
1.0 μ	15.0	19.0
2.0 μ	4.0	4.0

Loc: ABCD1234	Instr: G000	A1: 75.1 F
Smpl: 00:01:00	Flow : OK	A2: 42.3
Date: 2004/08/09	Alarm: NONE	
Time: 12:43:23	Laser: OK	

Figure 3-50 Data Screen - Normalized data in ft³

Size	Diff/m3	Cuml/m3
0.2 μ	936509.4	1115060.4
0.3 μ	141859.0	178550.9
0.5 μ	35067.5	36691.9
0.7 μ	953.5	41624.5
1.0 μ	529.7	671.0
2.0 μ	141.3	141.3

Loc: ABCD1234	Instr: G000	A1: 75.1 F
Smpl: 00:01:00	Flow : OK	A2: 42.3
Date: 2004/08/09	Alarm: NONE	
Time: 12:43:23	Laser: OK	

Figure 3-51 Data Screen - Normalized data in m³

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

Note: *When the buffer has wrapped, the record that is first displayed in the Data screen is the first record in the data buffer. This may not be Rec#1.*

If you press the single down arrow button once, the instrument will display the last record in the data buffer.

- **Rec#** - Identifies which record is currently viewed.
- ***Recs** - Displays how many records are currently stored in the HANDHELD's buffer. When there is an asterisk (*) next to the word "Recs", this means that the 3000 record data buffer has wrapped. The basic concept is First In, First Out (FIFO).
- **Size** - Lists the channel sizes configured on the instrument.
- **Diff#, Diff/ft3, Diff/m3** - Indicates that each channel size's data is

displayed in differential mode. If a channel was disabled, then there is a blank space in its column; # indicates raw counts; ft³ and m³ indicate normalized counts.

- **Cuml#**, **Cuml/ft3**, **Cuml/m3** - Indicates that each channel size's data is displayed in cumulative mode. If a channel was disabled, there will be a blank space in this column. # indicates raw counts while ft³ and m³ indicate normalized counts.
- **Loc** - Indicates the location at which the data record was recorded. The 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 was recorded. The date will display 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 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 1-866-507-9200.

- **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 1-866-507-9200.

Analog Data

If the Temperature/Relative Humidity probe is attached during data recording, the analog data will be listed in the Data screen as A1 (Temperature) and A2 (Relative Humidity).

PRINT RECORD

When you push the PRINT RECORD button, whatever record is currently displayed in the Data screen will print as a single sample record. The record will print according to the settings in the Print Configuration.

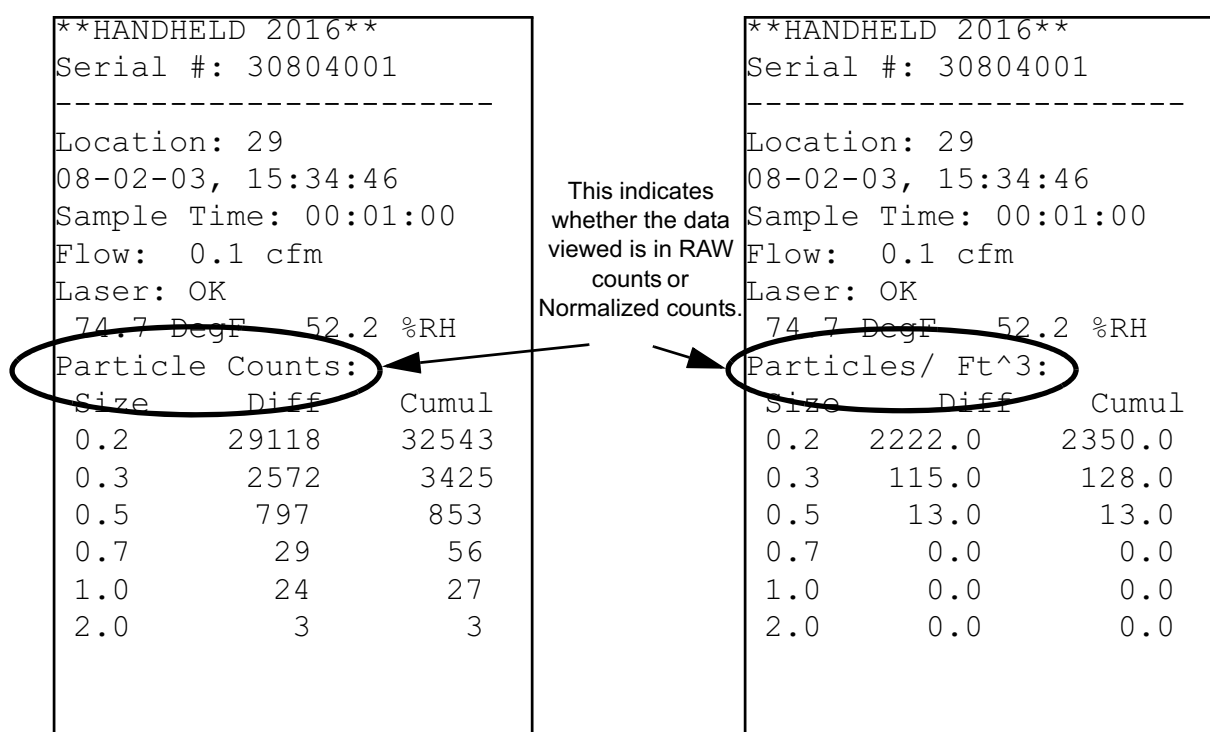


Figure 3-52 Examples of Output from Auto Printout of Sample

PRINT RANGE (BUFFER REPORT)

The instrument stores up to 3000 records in its 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, the following summary information is printed.

- Data displayed in Cumulative or Differential mode
- Raw ("Particle Counts") or Normalized ("Particles/ft³" or "Particles/m³")
- # of samples in the report
- For each channel size:
 - Maximum Value
 - Minimum Value
 - Average
 - Standard Deviation

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

The Data Summary can be viewed as:

- Raw Counts, Differential Data
- Raw Counts, Cumulative Data
- Normalized Counts, Differential Data, Particles/ft³
- Normalized Counts, Differential Data, Particles/m³
- Normalized Counts, Cumulative Data, Particles/ft³
- Normalized Counts, Cumulative Data, Particles/m³

Printing Buffer Report

- To print a range of data from the buffer, scroll to the first data record to be included in the range.
- Press the RANGE button. The following screen will display.

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

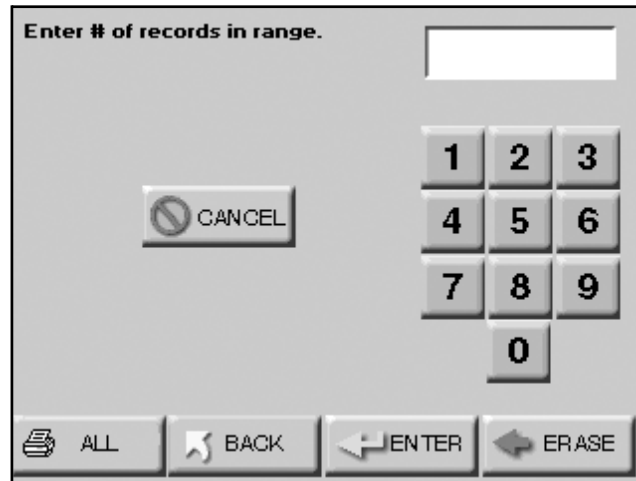


Figure 3-53 Print Range Screen

- Enter the number of records to print and press the ENTER button.
- Press ALL to print all records in the buffer.
- Press CANCEL to cancel printing.
- Press BACK to return to the View Buffer screen without printing the report.

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

```

***** SUMMARY *****
Location:      TEST1234
10-10-2004,  15:34:30
Sample Time:   00:01:00
Flow:          0.1 cfm
Laser:         OK
TEMP:          73.8 F
RH:            38.7 %
Particle Counts:
Size          Cumul
0.3           31575
0.5           5056
1.0           1039
3.0            46
5.0            19
10.0           4

Location:      TEST1234
...
10.0           0
^  ^  ^  ^  ^  ^  ^
v  v  v  v  v  v  v

Particle Counts:
Summary (Cuml):
-----
# of samples =3
Size          Max
0.2           45687
0.3           6902
0.5           1306
0.7            46
1.0            19
2.0             4

Size          Min
0.2           1111
0.3            152
0.5             29
0.7              0
1.0              0
2.0              0

Size          Avg
0.2          26124.3
0.3          4036.7
0.5           791.3
0.7            26.3
1.0            10.7
2.0             1.7

Size          Std
0.2          22782.4
0.3          3488.5
0.5           673.6

```

Figure 3-54 Sample Buffer Report

REPORTS

This instrument can print the following Cleanroom Classification to Standards reports:

Note: *The EC GMP report is only valid if the instrument is configured with the 0.5 and 5.0 micron channel sizes.*

Federal Standard 209E (ft³)

Federal Standard 209E (m³)

ISO 14644-1

EC GMP

From the MAIN screen, press the REPORTS button.

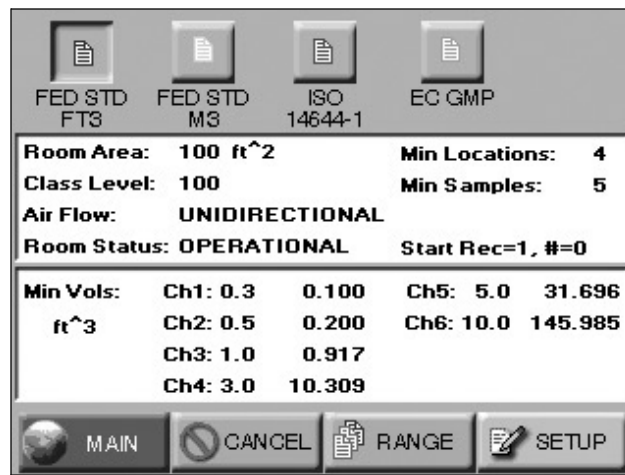


Figure 3-55 Reports Screen

Access each report via its button. The report buttons are located at the top of the Reports screen.

Note: *If the user sets the counter for a minimum volume, and takes the exact number of minimum locations and samples, the user could get a "Cannot Classify: too few locations" error if the minimum volume rounds the sample time down so that not enough samples at the minimum volume are taken.*

In this case, add one or two seconds to the sample time so that the user is not at the exact minimum volume.

When one of the report options buttons is pressed, the instrument uses the current Room Area, Class Level, Air Flow and Room Status parameters to determine the minimum number of locations, samples and volume per channel in order to classify a cleanroom with that standard.

Use these displayed minimum values to configure the instrument so that the minimum requirements needed to classify the cleanroom will be met.

In order to set parameters for a report, follow these steps:

- Select the desired report.

- Press the SETUP button; the following screen displays.

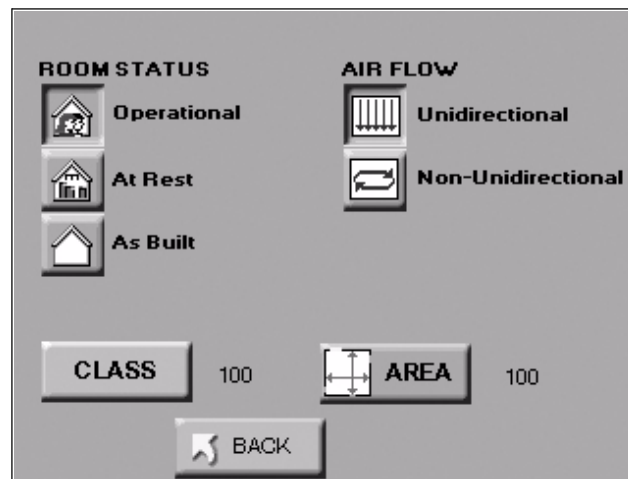


Figure 3-56 Report Setup Screen

- Select the desired **Room Status**

Below are the available Room Status', as defined for each standard:

FED_209E (ft³) and FED_209E (m³) - As-Built, At-Rest, Operational.

ISO14644-1 - As-Built, At-Rest, Operational.

EC GMP - At-Rest, Operational

- Select the room's **Air Flow**

Changing the Air Flow will affect the minimum number of locations and the minimum number of samples required at different class levels for either of the Federal Standard 209E reports. For the other reports, the Air Flow does not affect the minimum requirements.

- Press the CLASS button; the following Select Class screen displays.

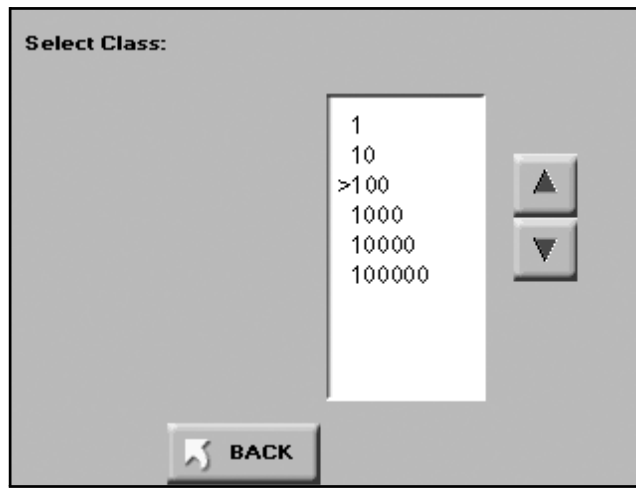


Figure 3-57 Select Class Level

- Use the UP and DOWN arrows to select the desired Class Level

Class Levels vary based on which standard has been selected in the PRINT REPORT field. Below are the available Class Levels, per standard:

FED_209E (ft³)- 1, 10, 100, 1000, 10000, 100000

FED_209E(m³) - M1.0, M1.5, M2.0, M2.5, M3.0, M3.5, M4.0, M4.5, M5.0, M5.5, M6.0, M6.5, M7.0

ISO14644-1 - 1, 2, 3, 4, 5, 6, 7, 8, 9

EC GMP - A, B, C, D

Changing the Class Level will also change the minimum number of locations, minimum number of samples, and the minimum sample volume per channel size required to satisfy the requirements of the chosen report.

- Press the BACK button.

- Press the AREA button; the following Area screen will display.

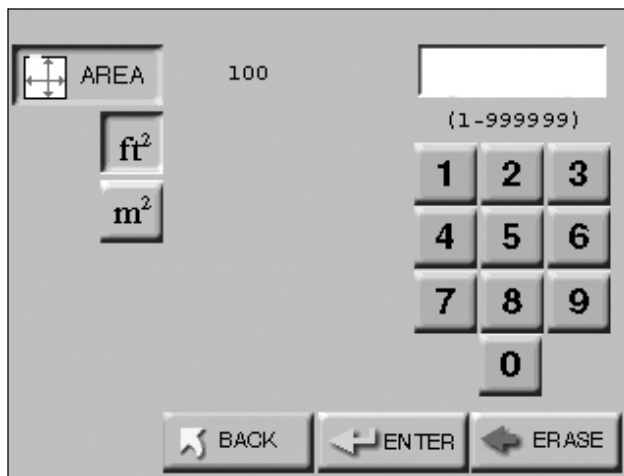


Figure 3-58 Reports Room Area Setup Screen

- Select appropriate unit of measure (ft^2 or m^2).
- Type in the Room Area and press ENTER.
- Press the BACK button.
- At the Report Setup Screen, confirm the values, then press the BACK button.
- The main REPORTS screen displays; note the values that were generated for Min Locations, Min Samples, and Min Vols.

Note: *The minimum area that can be entered is 6 ft^2 or 1 m^2 .*

Note: *The Minimum Volumes are measured in the standard measurement required by each specific report.*

Use this information to set up the instrument to meet or exceed the minimum requirements.

The next section contains an example of setting up the instrument to run a report.

Setting up the HANDHELD to Run Reports

For this example, the FED STD FT3 report will be used.

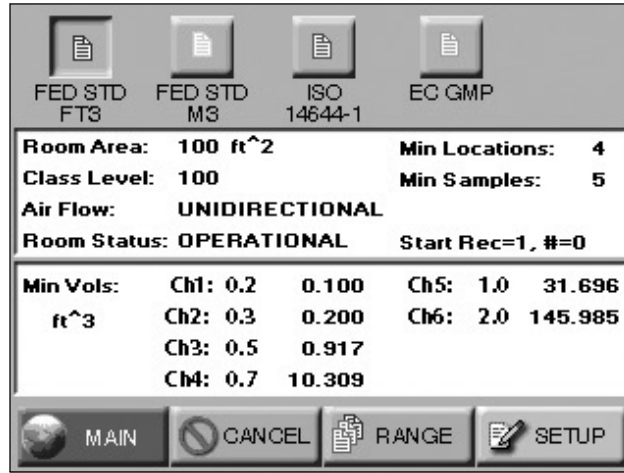


Figure 3-59 Report Screen

- Set the instrument for the Fed Std 209e (ft³) report, 100 ft², Class 100, unidirectional air flow, operational room status.
- This will generate the following minimum requirements:
 - Min Locations: 4
 - Min Samples: 5
 - Min Volumes for each channel:

Ch Size (μ)	Min Vol (ft ³)
0.2	0.100
0.3	0.200
0.5	0.917
0.7	10.309
1.0	31.696
2.0	145.985

Figure 3-60 Table - Minimum volume per channel size

Based on the minimum requirements displayed, configure the instrument as follows:

- Press MAIN to return to the MAIN screen.
- Press CFG to enter the Configuration screen.
- Press SAMPLE to set the Sample time.
- Press the VOLUME button to set the instrument's sample volume.
- Type in 146 and press ENTER. This sets the instrument for the channel size with the largest minimum volume requirement.

Note: *The Sample time automatically changes to 1:28 (1 minute, 28 seconds).*

Note: *This is all that is needed to meet the minimum requirements to classify the report.*

Increase any of the configuration parameters in order to meet additional reporting needs.

- Press the CYCLES button.
- Set the CYCLES value for 1 and press ENTER.
- Press the MAIN button.
- Press the Location Select button at the top of the screen.
- Select the location where the first measurement will be taken.
- Press START. Let the instrument record 1 sample at the first location.
- After the instrument has recorded the sample, change the Location using the Location Select button.
- Then move the instrument to the second location and press START.
- After the instrument has recorded the second sample, continue to change the Location setting before recording at the next location, then move it to the third and fourth locations, taking at least one sample at each location. At one location take 2 samples.
- After the instrument finishes recording at the last location, and the instrument has a total of at least 5 samples, the instrument is ready to print the report.

Printing a Report

To print a report, the user can choose to either clear the data before starting the test or running the samples and then selecting the range of data to include in the report.

- Once the user has collected the necessary samples, press REPORTS from the MAIN screen.
- Press the RANGE button on the REPORTS screen
- Using the ARROW buttons, scroll to the first record in the range of data for the report.
- Press the RANGE button on the Data View Screen.
- Type in the number of records in the range.
- Press ENTER.
- The display will return to the main REPORTS screen and start printing the report.
- To stop printing, press the CANCEL button.

Note: *If CANCEL is pressed, the report may not stop printing right away. It will wait until there is a break in the report processing.*

Report Requirements

ISO 14644-1

The ISO14644-1 standard requires a minimum of 60 second Sample Time for each sample recorded.

EC GMP

The EC GMP Standard Report requires that the unit has the channel sizes 0.5 μ and 5.0 μ as these are the only channels that apply to this standard.

The EC GMP Report has different concentration limits for cleanroom status "At Rest" versus "Operational". When the cleanroom is "Operational", Class D is not available. The standard is not defined for Class D in an Operational cleanroom.

Sample Printouts of Standard Reports

```

*****
Federal Standard 209E_Ft^3
**HANDHELD 2016**
Serial #: xxxxxxxx
Targeted Class: 10000
Room Area: 10ft^2
Room Status: Operational
Air Flow: Unidirectional
Min Locations: 2
Min Samples/Room: 5
-----
10/10/2004, 17:35:47
-----

Particle Size: 0.3
Cumulative, p/ft^3
Vol Req: 0.100 ft^3
Concen Limit: 30800
-----

Loc  Samples  AvgConcen
1      3      155.9
3      3      258.9
-----

Mean: 207.4
StdDev: 72.8
StdError: 51.5
95% UCL: 532.2
Min Vol: 1.467 ft^3
-----

Particle Size: 0.5
Cumulative, p/ft^3
Vol Req: 0.100 ft^3
Concen Limit: 10000
-----

Loc  Samples  AvgConcen
1      3      10.2
3      3      26.8
-----
    
```

Figure 3-61 Sample Federal Standard 209E (ft³) report

```

*****
Federal Standard 209E_M^3
**HANDHELD 2016**
Serial #: xxxxxxxx
Targeted Class: M7.0
Room Area: 100m^2
Room Status: Operational
Air Flow: Unidirectional
Min Locations: 3
Min Samples/Room: 5
-----
10/10/2004, 17:35:47
-----

Particle Size: 0.3
Cumulative, p/m^3
Vol Req: 2.830 L
Concen Limit: 30799907
-----
Loc Samples AvgConcen
  1      3      5505.9
  3      3      9141.7
 101     1         0.0
-----
Mean: 4882.5
StdDev: 4602.6
StdError: 2657.3
95% UCL: 12641.9
Min Vol: 41.531 L
-----

Particle Size: 0.5
Cumulative, p/m^3
Vol Req: 2.830 L
Concen Limit: 9999970
-----
Loc Samples AvgConcen
  1      3      361.2
  3      3      947.1
 101     1         0.0
-----
Mean: 436.1

```

Figure 3-62 Sample Federal Standard 209E (m³) report


```

*****
ISO 14644-1
**HANDHELD 2016**
Serial#: xxxxxxxx
Targeted Class: 9
Room Area:          9 m^2
Room Status: Operational
Air Flow: Unidirectional
Min Locations: 3
Min Samples/Room: 3
-----
10/10/2004, 18:10:17
-----

Particle Size: 0.3
Cumulative, p/m^3
Vol Req:          2.000 L
Concen Limit: 99999999.9
-----
Loc  Samples  AvgConcen
  1      3      5505.9
  3      3      9141.7
101     1         0.0
-----
Mean:              4882.5
StdDev:            4602.6
StdError:          2657.3
95% UCL:           12588.7
Min Vol:           41.531 L
-----

Particle Size: 0.5
Cumulative, p/m^3
Vol Req:          2.000 L
Concen Limit: 35199903
-----
Loc  Samples  AvgConcen
  1      3      361.2
  3      3      947.1
101     1         0.0
-----
Mean:              436.1
StdDev:            478.0

```

Figure 3-63 Sample ISO 14644-1 report

```

*****
EC GMP
**HANDHELD 2016**
Serial #: xxxxxxxx
Targeted Class: A
Room Area: 9 m^2
Room Status: Operational
Air Flow: Unidirectional
Min Locations: 1
Min Samples/Room: 1
-----
10/10/2004, 14:12:09
-----

Particle Size: 0.5
Cumulative, p/m^3
Vol Req: 1.000 L
Concen Limit: 3500
-----
Loc Samples AvgConcen
  1 3 361.2
  3 3 947.1
-----
Mean: 654.1
StdDev: 414.3
Min Vol: 41.531 L
-----

Particle Size: 5.0
Cumulative, p/m^3
Vol Req: 1.000 L
Concen Limit: 0
-----
Loc Samples AvgConcen
  1 3 0.0
  3 3 0.0
-----
Mean: 0.0
StdDev: 0.0
Min Vol: 41.531 L

```

Figure 3-64 Sample EC GMP 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 3-1 Levels of Battery Life

Battery Icon	Description
	FULL
	75%
	50%
	25%
	Empty; at this level, the instrument will begin to beep and will display "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 low point, 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.

4

Setting up the Counter

Using Report Parameters

Besides printing reports, the Report Setup screen can be used to display each report's minimum requirements - such as how many data records are required and from how many different locations data must be recorded to meet a given class for a given cleanroom area.

Once the user knows these requirements, the user can configure the HANDHELD so that the data collected will pass the report's requirements.

Note: *In order to review reports, the optional printer must be attached to the HANDHELD.*

For each report type, as the user changes the Room Area, the Class Level, and sometimes the Air Flow or the Room Status, the values for the Minimum Locations, Minimum Samples and Minimum Volume may change and will be calculated for the requirements for each report type.

These values are indicated on the screen so that the user can configure the instrument appropriately to ensure the samples recorded meet the requirements for the report selected.

Basic Requirements

Each of the reports have some basic requirements that, if not met, cause the report to FAIL classifying the cleanroom immediately.

Fed Std 209E (feet)

This report requires a minimum of 2 locations measured.

At least 1 sample per location must be taken.

At least 5 samples in total must be taken in the cleanroom.

The minimum sample volume must be at least 0.1 cubic feet.

The 95% Upper Confidence Limit (UCL) must be calculated if the number of sampled locations is less than or equal to 9.

Air flow (Unidirectional vs. Non-unidirectional) will have an effect on the minimum locations and minimum samples required. In general, the Non-unidirectional option requires more of both locations and samples.

For the Fed Std 209E (ft) report, the classification for a particle size is based on its samples taken from all locations in the cleanroom. Each particle size is given one of the following results:

- A classification rating which will be one of the possible classifications (1, 10, 100, 1000, 10000, 100000).
- "Unable to Classify" if it fails one of the above requirements.
- An "Out of Range" if the calculated classification at that particle count exceeds 100,000.

Fed Std 209E (metric)

This report requires a minimum of 2 locations.

At least 1 sample must be taken per location.

At least 5 samples must be taken in total in the cleanroom. Take a different number of samples at different locations.

The minimum sample volume must be at least 0.00283 cubic meters (which equals 0.1 cubic feet).

The 95% Upper Confidence Limit (UCL) must be calculated if the number of sampled locations is less than or equal to 9.

The classification for a particle size is calculated based on its samples taken from all locations in the cleanroom. If 9 or less locations have been sampled, then the classification is based on the 95% UCL. If more than 9 locations have been sampled, then the classification is based on the Mean.

ISO 14644-1

The minimum number of locations is 1.

At least 1 sample must be taken per location.

At least 3 samples, total, must be taken in the cleanroom. The user can take a different number of samples at different locations.

The minimum sample volume is 2 liters.

This report has a minimum Sample Time of 1 minute. If the Sample Time is less than that, the entire room would fail the classification.

The 95% Upper Confidence Limit (UCL) must be calculated if the

number of sampled locations is less than or equal to 9.

British Standard 5295 - N/A

The British Standard report is not applicable to the HANDHELD because it requires at least .848CFM.

EC GMP

The EC GMP only applies to 2 channel sizes: 0.5 μ and 5.0 μ .

There are only 4 Classes: A, B, C, D, and 2 cleanroom states: At Rest and Operational.

Class D is not applicable when the cleanroom is Operational.

If one of these channel sizes is not present, the report cannot classify the room.

The standard does not define a minimum number of sample locations or a minimum number of samples. In order to take a measurement, at least 1 location and 1 sample are required by the counter.

The standard does not require a minimum sample volume. The volume of air must be shown in liters (L).

The classification for a particle size is determined based on the mean of all average concentrations taken from all locations in the cleanroom. If the mean exceeds all limits, then the classification is "Out of Range".

The counter will only print channels 0.5 and 5.0 in this report. If either channel is not available on the HANDHELD, then this report will not be valid.

A *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 LIA-

BILITY, 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 COMMERCIALY REASONABLE TIME AFTER RECEIVING SUCH EQUIPMENT. BUYER SPECIFICALLY ACKNOWLEDGES THAT SELLER'S PRICE FOR THE EQUIPMENT IS BASED UPON THE LIMITATIONS OF LWS'S LIABILITY AS SET FORTH IN THIS CONTRACT.

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

- A. Upon expiration of the initial two-year warranty, all parts and repairs completed by an authorized Lighthouse repair technician are subject to a six (6) month warranty.
- B. Other than the above, LWS makes no warranty of any kind, expressed or implied, except that the products manufactured and sold by LWS shall be free from defects in materials and workmanship and shall conform to LWS's specifications; Buyer assumes all risk and liability resulting from use of the products whether used singly or in combination with other products. If instrument is modified or in any way altered without the explicit written consent of LWS, then the warranty is null and void.
- C. WARRANTY REPAIRS SHALL BE COMPLETED AT THE FACTORY, BY AN AUTHORIZED SERVICE LOCATION, BY AN AUTHORIZED SERVICE TECHNICIAN, OR ON SITE AT BUYER'S FACILITY BY A LIGHTHOUSE AUTHORIZED EMPLOYEE. BUYER PAYS FREIGHT TO FACTORY; SELLER WILL PAY STANDARD RETURN FREIGHT DURING THE WARRANTY PERIOD. BUYER MAY SELECT A FASTER METHOD OF SHIPMENT AT ITS OWN EXPENSE.

B

Default Settings

Table B-1 HANDHELD Default Settings

MENU ITEM	VALUE
LOC	001
MODE	AUTO
DATA DISPLAY	CUML
DATA FORMAT	RAW
PARTICLE VOL	FT ³
ENVIRON UNIT	US
PASSWORD	000000
SAMPLE TIME	00:01:00
HOLD TIME	00:00:10
# OF CYCLES	10
COMM ADDR	001
AUDIBLE ALERT	OFF
THRESHOLD	1000
STORAGE SETUP	ALL CH ON
DATE FORMAT	MM/DD/YYYY
PRINT SAMPLE	OFF
PRINT ALARM	OFF

C

Purge Test

This Appendix is the procedure to check the counter for Zero Counts. A 0.1 micron, 0.1 CFM purge filter must be attached to the instrument and ten (10) one (1) minute samples taken. There should be no more than 1 count on average per one-minute sample.

1. Connect the Purge filter to the sample inlet.
2. Apply power to the instrument.
3. Configure the unit via the touchscreen interface to sample for 30 minutes.
4. Start the instrument and allow it to run a 30 minute sample. This allows it to warm up and purge any residual particles that may be inside.
5. Configure the unit sample time for 1 minute and set a 10 second hold.
6. Set Cycles to 10 so the instrument will take 10 one minute samples.
7. If an average of more than one count per one minute sample is reported, reset the instrument to sample for 30 minutes again to purge it, then repeat the Purge Test again.
8. After the instrument has met the requirement of the Purge test, return the instrument to its normal location and operating status.
9. If the instrument still fails the Purge Test, contact Lighthouse Technical Support for assistance.

D

MODBUS Register Map v1.41

COMM Settings

Lighthouse particle counters with MODBUS have the following communications settings:

Table D-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 D-2 Supported MODBUS Commands

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 D-3 describes the content of these registers.

Table D-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 D-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. <u>Particle Counters</u> : Specifies location of Particle Counter. Must be 1 to 200 (maps to location names associated with registers 40200 - 40999). <u>Manifold Controller</u> : 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	unsigned 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	unsigned 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 D-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 char[0], char[1] (NULL terminated string).
40042	ASCII string	Flow Unit. char[2], char[3]
...		
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 D-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 remain set until a stop command is executed.
1	SAMPLING: This is set only when the instrument is actually sampling data that is to be recorded. Caution must be used in sending a command during this time that may invalidate current sample.
2	NEW DATA: Set to 1 to indicate that a new data record has been recorded and it hasn't been read via modbus yet. When a data record has been read via modbus (registers 30001 to 30999), then this flag is reset to zero.
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 D-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). <u>Particle Counters</u> : 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. <u>Manifold Controller</u> : Uses defined Manifold Sequence. Stops counting and changing positions when an Instrument Stop command is issued.
12	Instrument Stop. Aborts current sample. Stops pump, if applicable. Stops data collection.

Table D-5 Command Register

Value	Action
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 supercede the older Data Enable Registers (31xxx) which have been obsoleted.

Table D-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 D-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 D-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 7 [high]
43022	unsigned int	Enable for Particle Channel 7 [low]
43023	unsigned int	Enable for Particle Channel 8 [high]
43024	unsigned int	Enable for Particle Channel 8 [low]
43041	unsigned int	Enable for Analog Channel 1 [high]
43042	unsigned int	Enable for Analog Channel 1 [low]
43043	unsigned int	Enable for Analog Channel 2 [high]
43044	unsigned int	Enable for Analog Channel 2 [low]
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 D-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 D-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 D-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
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 integer data is big-endian. Thus, data items are formed by placing the high bytes in front of the low bytes.

Example:

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

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

Example:

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

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

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

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

Table D-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	Data Status [high]
30008	unsigned integer	Data Status [low]

Table D-11 Data Registers

Register	Data Type	Description
30009	unsigned integer	Particle Channel 1 [high]
30010	unsigned integer	Particle Channel 1 [low]
30011	unsigned integer	Particle Channel 2 [high]
30012	unsigned integer	Particle Channel 2 [low]
30013	unsigned integer	Particle Channel 3 [high]
30014	unsigned integer	Particle Channel 3 [low]
30015	unsigned integer	Particle Channel 4 [high]
30016	unsigned integer	Particle Channel 4 [low]
30017	unsigned integer	Particle Channel 5 [high]
30018	unsigned integer	Particle Channel 5 [low]
30019	unsigned integer	Particle Channel 6 [high]
30020	unsigned integer	Particle Channel 6 [low]
30021	unsigned integer	Particle Channel 7 [high]
30022	unsigned integer	Particle Channel 7 [low]
30023	unsigned integer	Particle Channel 8 [high]
30024	unsigned integer	Particle Channel 8 [low]
...		
30041	IEEE Float	Analog Channel 1 [low]
30042	IEEE Float	Analog Channel 1 [high]
30043	IEEE Float	Analog Channel 2 [low]
30044	IEEE Float	Analog Channel 2 [high]
30045	IEEE Float	Analog Channel 3 [low]
30046	IEEE Float	Analog Channel 3 [high]
30047	IEEE Float	Analog Channel 4 [low]
30048	IEEE Float	Analog Channel 4 [high]
...		

Table D-11 Data Registers

Register	Data Type	Description
30073	unsigned int	Valid analog channels [bit0=ch 1, ..., bit3=ch4]
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.

Data Status Byte (30007 - 30008)

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

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

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

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

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

Table D-12 Data Status Byte

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

Table D-12 Data Status Byte

Bit	Description
5	Threshold Low Status 0 = Threshold not exceeded 1 = Threshold exceeded
6	Instrument Sampler Status 0 = Nominal Operation 1 = Sampler Error

Bits 7 to 31 are currently unused.

Valid Data in Channels (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 D-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 D-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 D-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	LPM	Liters per minute

Table D-15 Data Units

Units	Description	Units	Description
PCT	Percent	MLPM	Milliliters per minute
SEC	Seconds	IHG	Inches of mercury
p/L	Particles per liter	p/ml	Particles per milliliter

Index

Numerics

5 Second Startup 3-35

A

AC Indicator 3-4, 3-5

Accessories, list of 2-2

 Carrying Case 2-2

 External Battery Charger 2-2

 Isokinetic Sample Probe 2-2

 Spare Li-Ion Battery 2-2

 Thermal Printer 2-2

 Validation Documentation 2-2

Air Flow 3-49, 4-1

Alarm Acknowledge 3-26

Alarm Acknowledge button 3-5

Alarm Enable Registers D-8

Alarm Registers

 Enable Alarming D-10

Alarm Setup 3-24

Alarm Status 3-43

Alarm Threshold 3-24, 3-25

Alarms

 Acknowledge 3-5

Align Touch Screen 3-30

 At Startup 3-33

 Verify 3-32

Analog Channels 3-16

Analog Data 3-6

Audible Beep Adjust 3-30

AUTO 3-22

Automatic Mode 3-6

Autostart 3-33, 3-34

B

Backlight 3-5

BATT LOW! 3-59

Battery 1-3

Battery Indicator 3-4, 3-5

Battery Life 3-59

BEEP 3-23

Beep Mode 3-6

big-endian data D-13

British Standard 5295 4-3

C

Calibration 1-2

CFG password

 Enabling 3-38

Changing Locations 3-8

Channel Threshold 1-2

Class Level 3-50, 3-52, 4-1

Clear Buffer 3-26

Clock 3-28

COMM Address 3-35

Command Register D-5

Communication Modes 1-2

Communications Settings D-1

CONC 3-22

Concentration Mode 3-6, 3-22

Configuration 3-14

 Alarm Setup 3-24

 Alarm Threshold 3-24

 Align Touch Screen 3-30

 Analog Channels 3-16

 Audible Beep Adjust 3-30

 Beep Mode 3-23

 Clock Setup 3-28

 COMM Address 3-35

 Contrast Adjust 3-30

 Cycles 3-19

 Delay 3-19

 Device Setup 3-27

 Hold Time 3-20

- Location 3-36
- Location Setup 3-36
- Options 3-30
- Particle Channels 3-15
- Particle Display 3-23
- Passwords 3-37
- Print Setup 3-39
- Sample Setting 3-22
- Sample Time 3-20
- Sample Timing 3-19
- Sample Volume 3-20
- Security 3-37
- Service Screen 3-40
- Configuration Password 3-39
- Configuration Screen 3-14
 - Data Setup 3-14
 - Device Setup 3-14
- Connecting Power 2-2
- Connecting to External Computer 2-13
- Contrast Adjust 3-30
- Count Mode 3-22
 - Auto 3-22
 - Concentration 3-22
 - Manual 3-22
- Count Modes 1-2
- Counting Efficiency 1-2
- Cumulative 3-23
- Cycles 3-6, 3-19

D

- Data Display 3-6
- Data Registers D-13
 - Device Status Word D-15
- Data Setup 3-14, 3-15
- Data Storage 1-2
- Data Type Registers D-16
- Data Units Registers D-18
- Date Format Option 3-28
- Date/Time Display 3-5
- Date/Time Setup 3-28
- Delay 3-19
- Device Setup 3-14, 3-27
- Device Status D-5
- Device Status Word D-15
- DiffCuml on Zoom 3-33

- Differential 3-23
- Dimensions 1-3

E

- EC GMP 3-48, 3-54, 4-3
- Enable Alarming D-10
- Environmental Sensors 1-2

F

- Features 1-1
- Fed Std 209E 4-1, 4-2
 - feet 4-1
 - metric 4-2
- Federal Standard 209E (ft3) 3-48
- Federal Standard 209E (m3) 3-48
- Flow Rate 1-2
- Flow Status 3-6, 3-43

H

- HANDHELD 3016 particle counter 1-1
- Hold Time 3-6, 3-20
- How particle counter works 1-1
- How to use 3-1

I

- Initial Delay 3-19
- Installing Probe 3-1
- Installing the Battery 2-4
- ISO 14644-1 3-48, 4-2

L

- Laser Diode, how it works 1-1
- Laser Source 1-2
- Laser Status 3-43
- Limitation Of Warranties A-1
- little-endian data D-13
- Location 3-5, 3-8, 3-36
 - + / - buttons 3-5
 - Changing in Auto Mode 3-9

Select 3-5

M

Main Screen 3-4
 MANUAL 3-22
 Manual Mode 3-6
 Menu Map 3-3
 Minimum Locations 4-1
 Minimum Samples 4-1
 Minimum Volume 4-1
 MODBUS output
 One second 3-34
 Mode 3-6
 Auto 3-6
 Beep 3-6
 Concentration 3-6
 Manual 3-6
 Model number
 Explanation 1-1

N

Normalized 3-24
 Number of Records 3-6

O

One Channel 3-33
 One channel mode 3-33
 One second output 3-34
 Operating Temp/RH 1-3
 Operation 3-1
 Operational room status 3-52
 Options 3-30

P

Package Contents 2-1
 Paper, Thermal 2-9
 Particle Channels 3-15
 Particle Display 3-23
 Power 1-3, 3-4
 Power On Password 3-37, 3-38

Power Shutdown Levels 3-59
 Print Cumulative Data 3-40
 Print Differential Data 3-40
 Print Last Record 3-11
 Print Model Name 3-40
 Print On Alarm 3-39
 Print On Sample 3-39
 Print Record Button 3-44
 Print Separator 3-40
 Print Serial Number 3-40
 Print Setup 3-39
 Print Cumulative Data 3-40
 Print Differential Data 3-40
 Print Model Name 3-40
 Print On Alarm 3-39
 Print On Sample 3-39
 Print Separator 3-40
 Print Serial Number 3-40

Printer

 Thermal Paper 2-9
 Printer Options 3-39
 Printer, optional 1-2
 Printing Buffer Report 3-46
 Printing Reports 3-54
 Purge Check C-1

R

Raw 3-24
 Realtime output 3-34
 Register Map D-2
 Removing the Battery 2-6
 Report Parameters 4-1
 Report Requirements 3-54
 EC GMP 3-54
 Report Setup screen 4-1
 Reports 1-2
 Air Flow 3-49
 Class Level 3-50, 3-52
 EC GMP 3-48
 Federal Standard 209E (ft3) 3-48
 Federal Standard 209E (m3) 3-48
 ISO 14644-1 3-48
 Operational room status 3-52
 Printing 3-54
 Room Area 3-51

- Room Status 3-49
- Sample Printout
 - EC GMP 3-58
 - Federal Standard 209E (ft3) 3-55
 - Federal Standard 209E (m3) 3-56
 - ISO 14644-1 3-57
- Unidirectional air flow 3-52
- Room Area 3-51, 4-1
- Room Status 3-49, 4-1

S

- Sample 3-19
- Sample Setting 3-22
 - Count Mode 3-22
- Sample Time 3-6, 3-20
- Sample Timing 3-19
- Sample Volume 3-20
- Screen
 - Backlight 3-5
- Security 3-37
- Select Location 3-5
- Sensor Settings Registers D-2
- Service 3-40
- Service Indicator 3-6
- Setting the Alarm Threshold Value D-12
- Specifications 1-2
- Standard Report
 - British Standard 5295 4-3
 - EC GMP 4-3
 - Fed Std 209E 4-1, 4-2
 - ISO 14644-1 4-2
- Start/Stop Button 3-7
- Storage Temp/RH 1-3
- Summary Report 3-44
- Supported MODBUS Commands D-1
- Supporting Software 1-2

T

- Thermal Paper 2-9
- Threshold Setup Registers D-10
 - Setting the Alarm Threshold Value D-12
- Touch Screen Display 1-2
- Touch Screen Overview 3-2

U

- Unidirectional air flow 3-52
- Unpacking the Counter 2-1
- Using the Counter
 - First Use 3-1

V

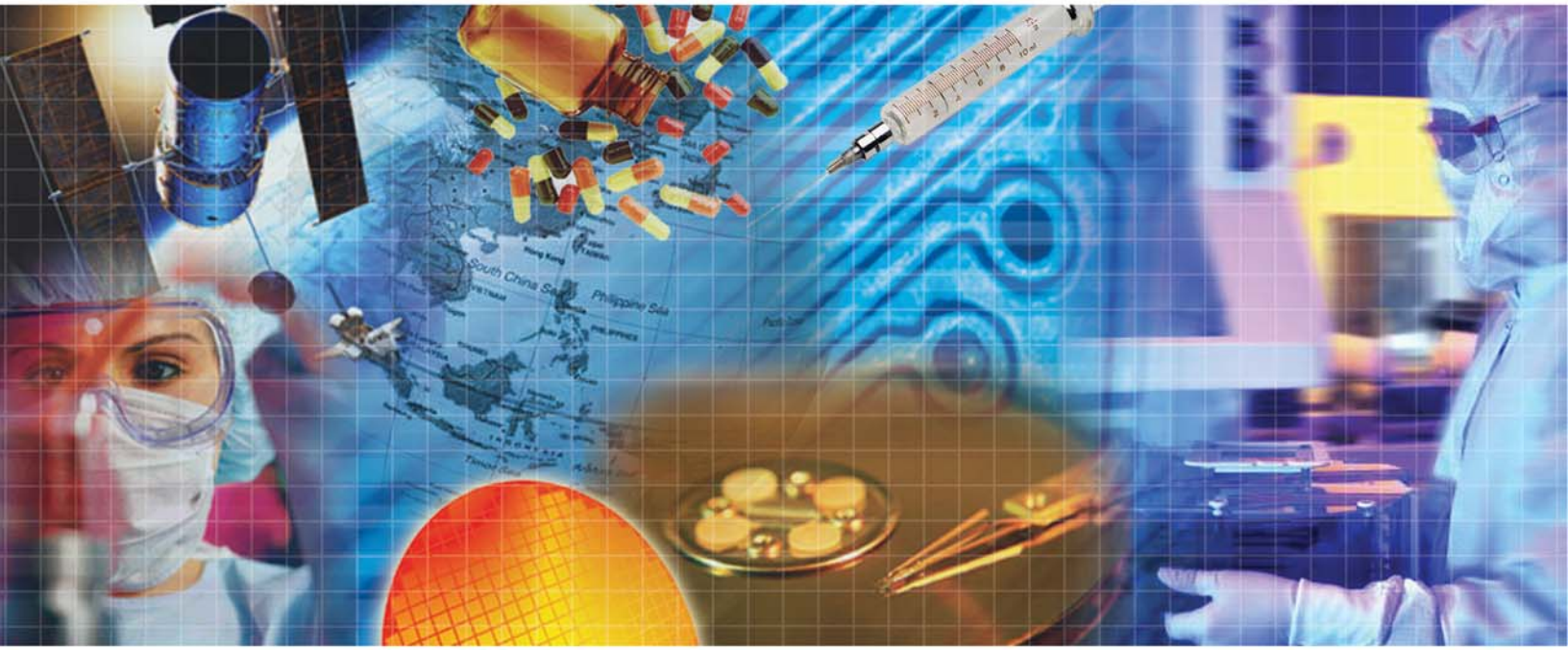
- Vacuum Source 1-3
- Verify Touch Screen Alignment 3-32
- View Buffer
 - Alarm Status 3-43
 - Analog Data 3-44
 - Flow Status 3-43
 - Laser Status 3-43
 - Print Record 3-44
- View Buffer Screen 3-42
- Viewing Analog Data 3-44

W

- Warranty Of Repairs After Initial Two (2) Year
 - Warranty A-1
- Weight 1-3

Z

- Zero Count Check C-1
- Zero Count Level 1-2
- Zoomed Data View 3-10
 - Print Last Record 3-11
 - View Analog Data 3-10
 - View Particle Data 3-10



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