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USER GUIDE

Handheld particle counters

Lighthouse

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Handheld
PARTICLE COUNTERS



OPERATING MANUAL

Handheld 2016, 3016, 5016

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WORLDWIDE SOLUTIONS

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Lighthouse Worldwide Solutions

HANDHELD 2016, 3016, 5016 Airborne Particle Counter Gen F

Operating Manual

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LWS Part Number: 248083400-1 Rev 8

EU DECLARATION OF CONFORMITY

Manufacturer's Name:	Lighthouse Worldwide Solutions, Inc.
Manufacturer's Address:	Lighthouse Worldwide Solutions, Inc. 1221 Disk Drive Medford, OR 97501
Declares that the product:	
Product Name:	Handheld Airborne Particle Counter
Model Number(s):	H2016, H3016, H3016IAQ, H5016

Conforms to the following European Directives and carries CE marking

LOW VOLTAGE DIRECTIVE 2014/35/EU

SAFETY	EN 61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use Part I: General Requirements IEC 61010-1:2001
	CAN/CSA C22.2 No. 1010.1-1992	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part1: General Requirements
LASER SAFETY	IEC 60825-1 Am. 2	Guidance on Laser Products: Conforms to (Laser Notice 50)

EMC DIRECTIVE 2014/30/EU

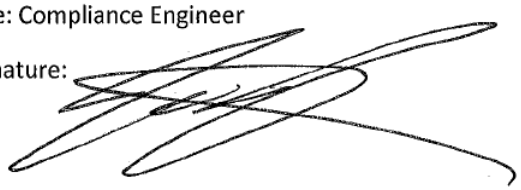
EMC	EN 61326	Electrical Equipment for Measurement, Control and Laboratory Use EMC Requirements Part 1: General Requirements Includes Amendment A1:1998;IEC 61326:1997 + A1:1998

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Signature:



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Dec 2016	6	Michael Fell	Updated Front and Back covers as part of Marketing drive to enhance LWS branding.
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July 2022	8	Alex Skrove	Updated photo of Laser label on 1-1. Corrected display size references. Changed text on 4-22 to describe proper unit behavior when in Beep mode. Added updated DOC page. Updated LWS website references.

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About this Manual

This manual describes the detailed operation and use of the Lighthouse HANDHELD 2016, 3016 and 5016 Airborne Particle Counters.

Text Conventions

The following typefaces have the following meanings:

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

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

italics	Represents information not to be typed or interpreted literally. For example, *file* represents a file name. Manual titles are also displayed in italics.
boldface	Introduces or emphasizes a term.
`Courier font`	Indicates command syntax or text displayed by the diagnostic terminal.
`Bold Courier`	Indicates commands and information that 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, 3016, 5016 Airborne Particle Counter, contact Lighthouse Worldwide Solutions:

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

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1 General Safety

General Safety

Warnings and cautions are used throughout this manual. Familiarize yourself with the meaning of a warning before operating the particle counter. All warnings will appear in the left margin of the page next to the subject or step to which it applies. Pay close attention to each warning message. Take extreme care when performing any procedure preceded by or containing a warning.

There are several classifications of Warnings directed as follows:

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

Laser Safety Information

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

WARNING: ***The use of controls, adjustments, or performance of procedures other than those specified within this manual may result in exposure to invisible (infrared) radiation that can quickly cause blindness. As a general precaution, avoid any possible exposure to laser radiation by honoring manufacturer seals and warranty stickers .***

The particle counter has been evaluated and tested in accordance with EN 61010-1:2001, “Safety Requirements For Electrical Equipment for Measurement, Control, and Laboratory Use” and IEC 60825-1 Am. 2, "Guidance on Laser Products". See Figure 1-1.



Figure 1-1 Example of Laser Warning Label

For further technical assistance, contact Lighthouse at 800-945-5905 (USA Toll Free), 541-770-5905 (Outside of USA).

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2 Introduction

Overview

This operating guide describes how to use the Lighthouse HANDHELD 2016, 3016 and 5016 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. The HANDHELD 3016 has up to six particle-size channels starting at 0.3 microns and the HANDHELD 5016 has up to six channels starting at 0.5 microns. They are otherwise identical to the 2016 model. 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 0.2µm minimum channel size at 0.1 CFM with up to 6 channels. The number “3016” indicates a 0.3 µm minimum channel size at 0.1 CFM with up to 6 channels. The number “5016” represents a 0.5µm minimum channel size at 0.1 CFM with up to six 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.

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Description

Ergonomically designed and lightweight, the Lighthouse HANDHELD 2016, 3016 and 5016 particle counters are the newest and most advanced handheld particle counters on the market. See Figure 2-1.



Figure 2-1 Handheld 3016

The HANDHELD 2016/3016/5016 displays cumulative or differential particle count data as well as Temperature/Relative Humidity data on its easy to read 3.5" (8.89cm) 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 (ft^3), ISO 146441-1, and EU GMP 2009 (if unit has 0.5 and 5.0 channels).
- 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.

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HANDHELD Specifications

Size Range	0.2 - 10.0 µm
HANDHELD 2016 Channel Thresholds	0.2, 0.3, 0.5, 0.7, 1.0, 2.0 µm
HANDHELD 3016 Channel Thresholds	0.3, 0.5, 0.7, 1.0, 2.5, 5.0 µm
HANDHELD 5016 Channel Thresholds	0.5, 0.7, 1.0, 3.0, 5.0, 10.0 µm
	Other sizing available for each model; specify at time of order
Flow Rate	0.1 CFM (2.83 LPM)
Counting Efficiency	50% (per ISO 21501-4)
Laser Source	Extreme Life Laser Diode
Zero Count Level	<1 count/5 minutes (per ISO 21501-4)
Calibration	Meets ISO 21501-4 calibration using NIST Traceable PSL spheres, DMA, and Condensation Particle Counter
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 or RS485 via RJ-45 to PC or printer
Supporting Software	LMS XChange, LMS Express/RT/RT Plus; LMSNet; LMS Pharma; LMS Pro
Environmental Sensors	Temperature/Relative Humidity Probe: 0-150°F (-17.8 to 65.6°C) ±1.8°F @ 77°F, 0-100% ± 5% @ 33%
Touch Screen Display	3.5" (8.89 cm), 320x240
Printer	External thermal printer (optional)
Reports	FS-209E (ft) , FS-209E (m), ISO 14644-1, EU GMP (0.5 and 5.0µ channels must be active)
Key Software Features	Historical data review, password protection
Enclosure	High impact injection molded plastic

Table 2-1 Specifications

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Sample Output	Internally filtered to HEPA standards (>99.97% @ 0.3µm)
Vacuum Source	Internal pump, automatic flow control
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

Table 2-1 Specifications

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

3 Unpacking, Inspecting and Installation

Initial Inspection

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

Unpacking

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

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

Verify the contents of the package against the Shipping List. If anything appears to be missing, please contact your sales representative at Lighthouse Worldwide Solutions immediately at 510-438-0500 (Sales).

To maintain your warranty, keep the undamaged shipping container and all packing material for reshipment of the instrument for annual calibration. Order replacement containers and packing materials from Lighthouse directly, or from a Lighthouse-authorized distributor.

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Shipping Instructions

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

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

1. Use the original container, nozzle caps and packing materials whenever possible. Remove any instrument battery and package it to ship separately - refer to www.rma.golighthouse.com for detailed instructions. Remove attachments, such as TRH or Iso-kinetic probes, and package to prevent physical and ESD damage.
2. If the original container and packing materials are not available, wrap the unit in “bubble pack”, surround with shock-absorbent material and place in a double-wall carton - the instrument should not rattle around when the carton is vigorously shaken. If the instrument is damaged during shipment due to inadequate user packing, the warranty may be voided and may result in additional repairs being billed to customer. You may contact Lighthouse to purchase a replacement shipping container and nozzle caps.

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

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

Accessories

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

- **External Battery Charge**r with AC and car adapters
- **Spare Li-Ion Battery** (removable and rechargeable)
- **Carrying Case**
- **Isokinetic Sample Probe**
- **6 ft. Tubing** (for extending Isokinetic sampling input)
- **Thermal Printer** with cable (AC or battery operated)
- **Validation Documentation**

Software options are also available at the Lighthouse website at www.golighthouse.com/software-firmware-downloads.

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- **LMS Express software** (standard), an analysis tool that allows the user to:
  1. Manually download data from the instrument
  2. Save data for historical review
  3. Have advanced reporting with standard reports and much more.
- **LMS Express RT software** (optional), an analysis tool that allows the user to perform the following:
  1. Download data from the instrument
  2. Collect data real time
  3. Save data for historical review
  4. Have advanced reporting with standard reports

  ...and much more.

Please contact Lighthouse Worldwide Solutions at 800-945-5905 (USA Toll Free) or 541-770-5905 (Outside of USA) for details.

Prepare Instrument for Use

Power Requirements

The power adapter input requirement is 100-240VAC, 50-60Hz, 1.25 Amps. Its output is +12VDC, 3A. A power cord and power adapter are included with your HANDHELD 2016, 3016 or 5016.

To protect the instrument from voltage spikes, Lighthouse recommends using protected power . Using an uninterruptible power supply (UPS) 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.

Install 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 as illustrated in the following instructions.

1. Make sure that the power switch is in the OFF position and the instrument’s power adapter is not connected.

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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. See Figure 3-1.

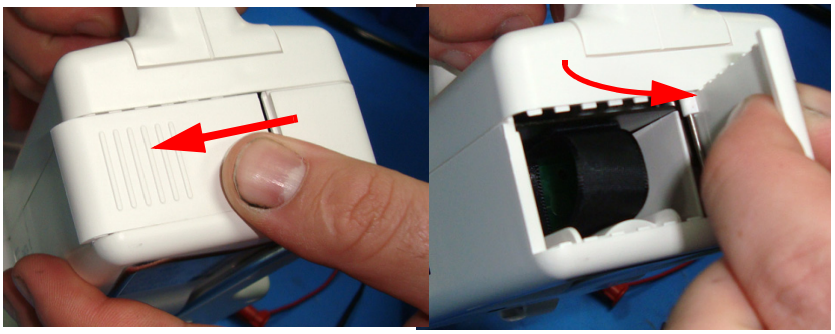


Figure 3-1 Open the Battery Compartment Door

3. Pull the battery release ribbon out of the battery compartment as shown in Figure 3-2.



Figure 3-2 Pull Battery Release Ribbon Out

4. Hold the battery connector side toward the HANDHELD. Place the battery into the compartment, on top of the release ribbon. Push the battery fully into the compartment until it connects and is entirely inside the battery compartment. See Figure 3-3.

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Figure 3-3 Insert Battery into Battery Compartment

5. Tuck the battery release ribbon over the battery. See Figure 3-4.

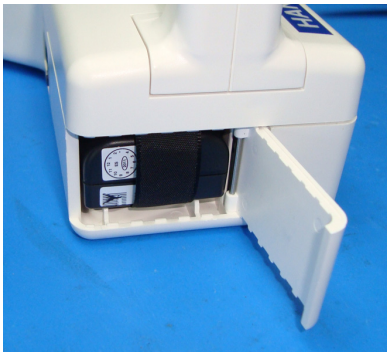


Figure 3-4 Tuck Battery Release Ribbon

6. Close the door so that it is flush with the bottom of the HANDHELD as shown in Figure 3-5.

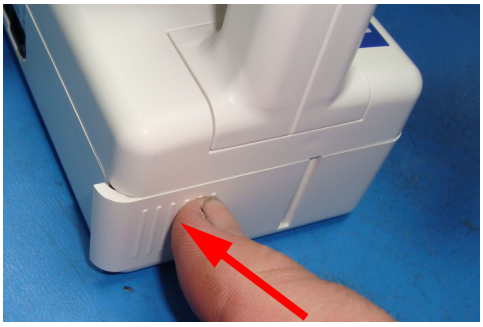


Figure 3-5 Close the Battery Compartment Door

7. Slide the battery compartment door to the right until it clicks and latches. See Figure 3-6.

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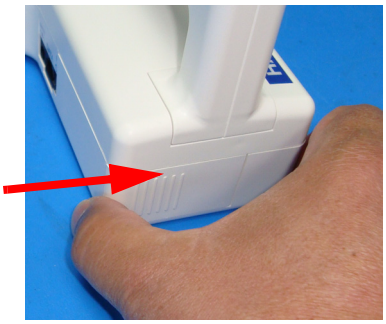


Figure 3-6 Secure the Battery Compartment Door

Connect Power

Connect the power adapter as illustrated in the following steps:

1. Insert the round DC power plug into its receptacle on the left side of the HANDHELD. See Figure 3-7.



Figure 3-7 DC Power Plug

2. Push the connector in until fully seated as shown in Figure 3-8.



Figure 3-8 Inserting DC Power Plug.

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3. Plug the adapter's AC power cord into the AC power source. The battery will begin and continue to charge until it is fully charged or DC power is removed.

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

Battery Removal

1. To remove the battery, open the door to the battery compartment by sliding the door to the left to unlatch it. See Figure 3-9.

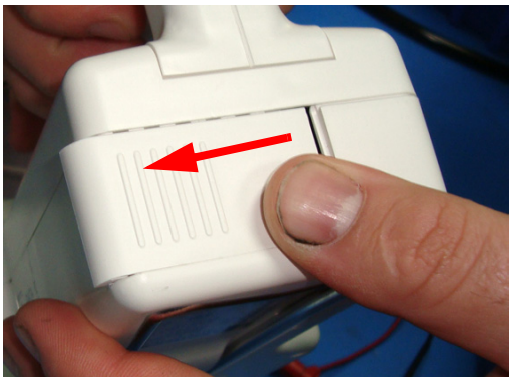


Figure 3-9 Unlatch Battery Compartment Door

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2. Swing the battery compartment door open as shown in Figure 3-10.

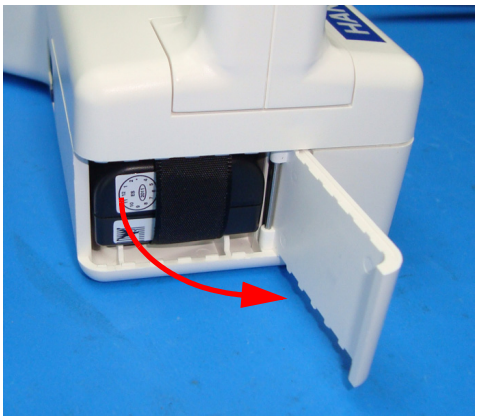


Figure 3-10 Open Battery Compartment Door

Note: *Remove the battery if the instrument will be stored for a month or longer. Leaving the battery in during storage will drain the battery to the point where it will not recharge.*

3. Hold the instrument securely then pull the battery release ribbon outward to disconnect the battery and slide the battery out. Remove the battery. See Figure 3-11.

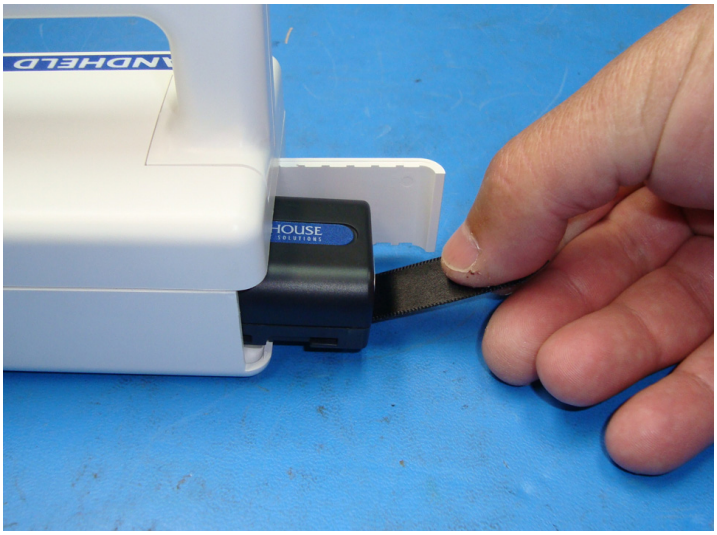


Figure 3-11 Remove Battery

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Optional Printer Accessory

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

Connect the external printer as illustrated in the printer Read Me First.



Figure 3-12 HANDHELD External Printer

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Connecting to an External Computer or Facility Management System

The HANDHELD has the ability to be connected to the Lighthouse Monitoring System (LMS), LMS Express or LMS XChange Data Transfer Software to download its data.

By transferring the instrument's data to the Lighthouse Monitoring System (LMS) or a PC running LMS Express, historical data can be stored externally for future reviewing and trending. Current LMS XChange software can export data to an Excel, .csv, or .pdf file for historical review.

Note: *The DATA port can be used for the printer or to connect HANDHELD to an external computer. It cannot be used to connect to both at the same time.*

1. To connect to the HANDHELD, insert the RJ45 end of the HANDHELD data communications cable to the DATA port as shown in Figure 3-13.

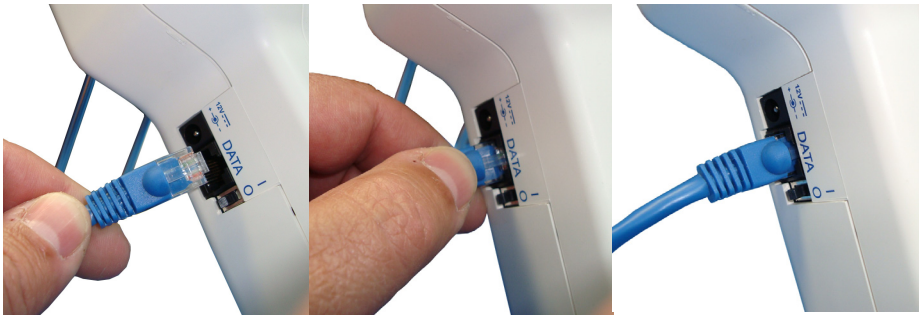


Figure 3-13 Connecting RJ45 Data Communications Cable

Note: *LMS Express allows you to upload data from your HANDHELD; LMS Express RT allows you to also collect data in real time.*

2. Connect the other end of the data communication cable to your Lighthouse Monitoring System or PC running LMS Express or LMS XChange software.

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

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4 Operation

This chapter describes how to use the HANDHELD 2016, 3016 and 5016 Airborne Particle Counters.

Using the Instrument

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

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

Sampling any gas under pressure can damage the instrument 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.

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 inlet tube on the top of the instrument. **NOTE: Do not discard the protective cap. It should be placed on the inlet tube any time the instrument is moved outside the environment being measured.**
4. The included Temperature/Relative Humidity probe can be attached to the provided receptacle 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.

WARNING: ***Do NOT allow water, solvents, or other liquids 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.

7. The MAIN screen appears.
8. On the touch screen, press the START button to start the instrument.
9. “STARTING” will display when the pump is initially turned on.

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10. When the HANDHELD starts counting, “COUNTING” appears on the display. Particle counts are displayed according to the size of each particle.

Note: *The pump motor requires a minimum of 5 seconds to ramp up to full flow. Refer to “Pump Startup” on page 35.*

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.

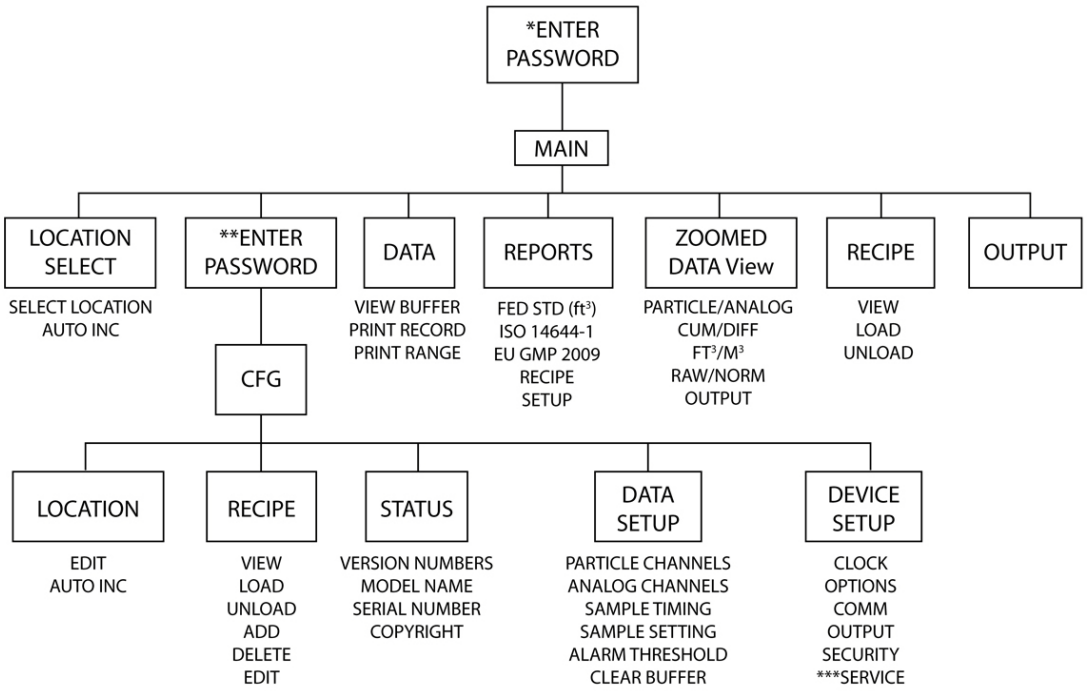
12. Press the “STOP” button to stop the instrument before the cycles are complete.

Touch Screen Overview

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. See Figure 4-1.

Menu Map



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

Figure 4-1 Menu Map

MAIN Screen

Note: *The Screen Shots shown in this chapter were taken from the 3016 model. The 2016 and 5016 screens are identical except for the channel sizes.*

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 a removable battery. When a battery is used, the battery indicator will show the level of the battery charge remaining. See Figure 4-2 & Figure 4-3.

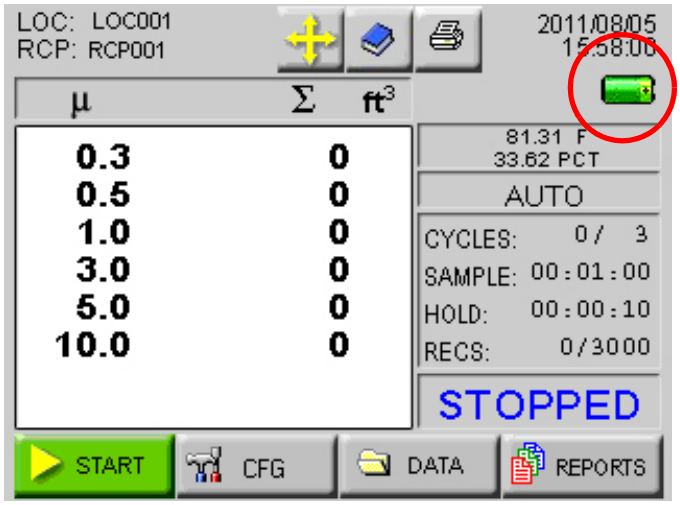


Figure 4-2 MAIN Screen - Battery Operation

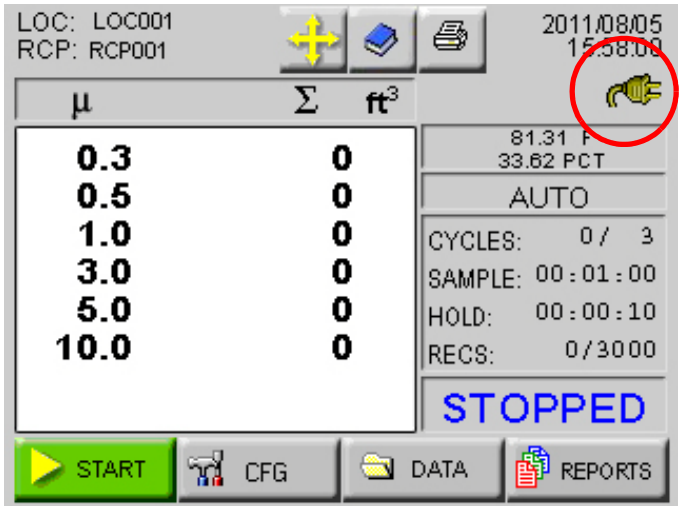


Figure 4-3 MAIN Screen - AC Operation

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

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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.



- **RECIPE button:** Allows the user to view, load and unload recipes that have been configured and saved in the recipe data base.



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

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

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

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

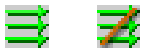
- **Battery Indicator:** Indicates that the instrument is being powered by a rechargeable battery. The amount of battery life left is denoted by the fill inside the battery icon. When the battery is low, the words "BATT LOW!" will appear on the screen and the unit will beep continually until it is plugged into its AC power cord for recharging. See Figure 4-4.



Figure 4-4 Battery Indicator Levels



- **AC Indicator:** Indicates that the instrument is being powered with its AC power cord. If the battery is installed, the HANDHELD 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.

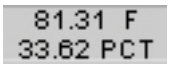
WARNING: ***If the Air Flow is insufficient, turn the instrument off and contact Lighthouse Worldwide Solutions tech support.***



- **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 e-mail 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 ((800) 945-5905 Toll Free).

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



- **Analog Data:** Gives a snapshot view of the enabled analog channels. (Analog channels are enabled by default.)

- **MODE:** Displays the current mode selected; possible modes are AUTO, MANUAL, CONCEN (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.

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.*

- **HOLD:** Displays the hold time in between cycles. The maximum hold time is 23 hours, 59 minutes, 59 seconds.

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

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

- **START/STOP:** Press START button on the screen to start counting. When running, the instrument will display "COUNTING" in the lower right portion of the screen as shown in Figure 4-5.

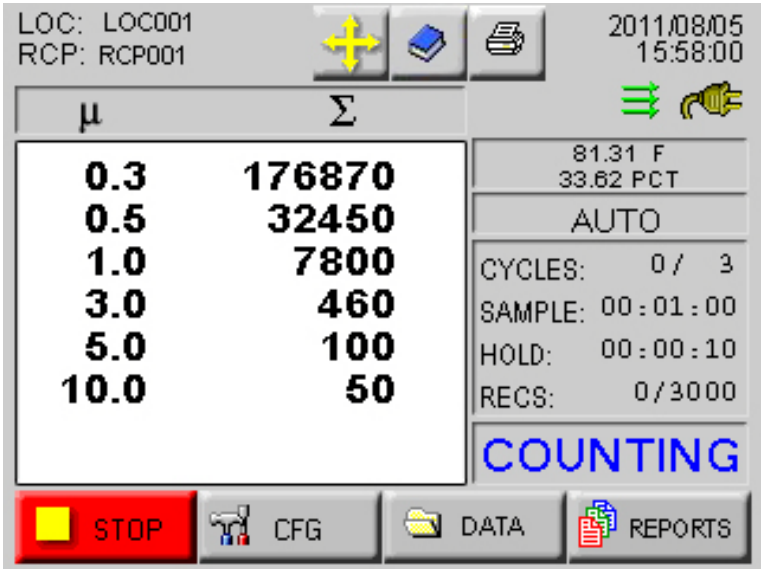


Figure 4-5 Main Screen, Counting Mode

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 Select Location screen opens as shown in Figure 4-6.

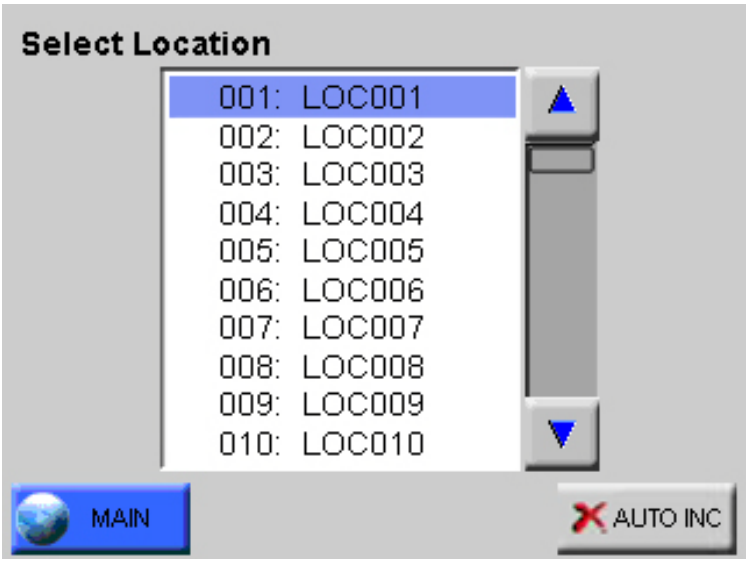


Figure 4-6 Location Select Screen

- The blue highlight 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. Locations can also be selected by touching the location name on the screen.
- Recipes associated with a specific location may also be loaded when that location is selected.



- The AUTO INC button, when activated will allow the user to advance to the next location once the current cycle is completed.
- 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 in 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.

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Zoomed Data View

Press anywhere in the Particle Data area to display the Zoomed view. See Figure 4-7.

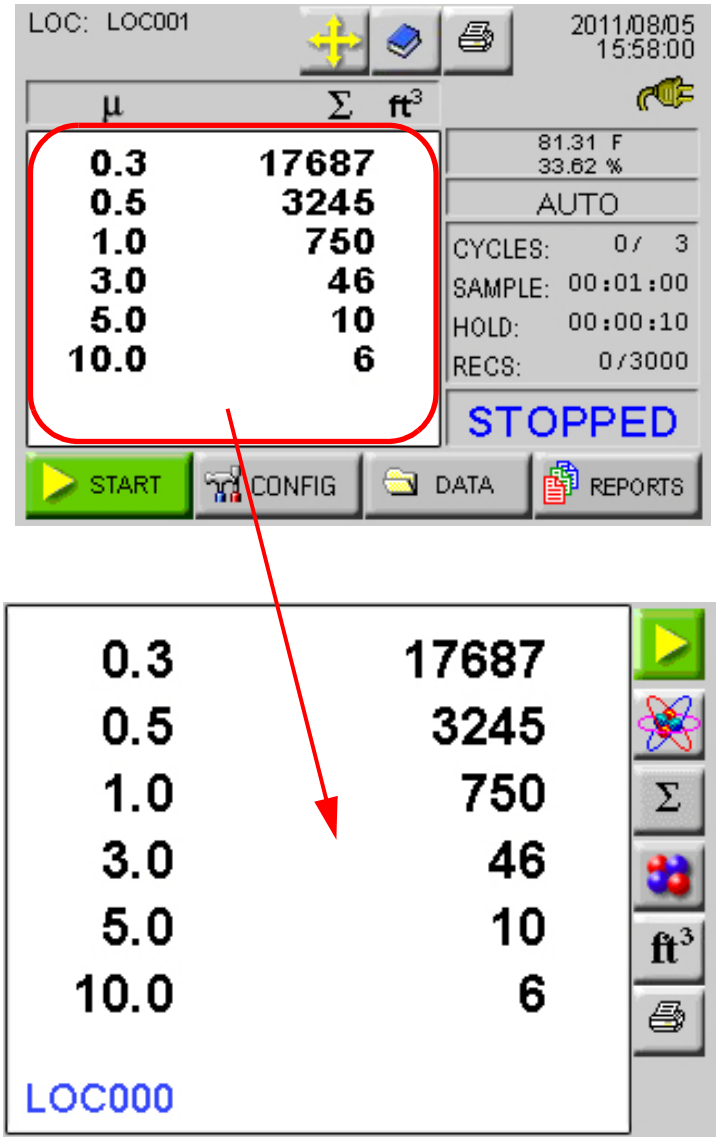


Figure 4-7 Zoomed Data View

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In Figure 4-8, the following functions can be performed using the toggle buttons on the right side bar:



Figure 4-8 Zoomed Data View Buttons

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

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Viewing Two Columns of Data

The unit can display both Differential and Cumulative data at the same time on the Zoomed View screen. To enable this feature, go to the CONFIG: Options screen as shown in Figure 4-9.

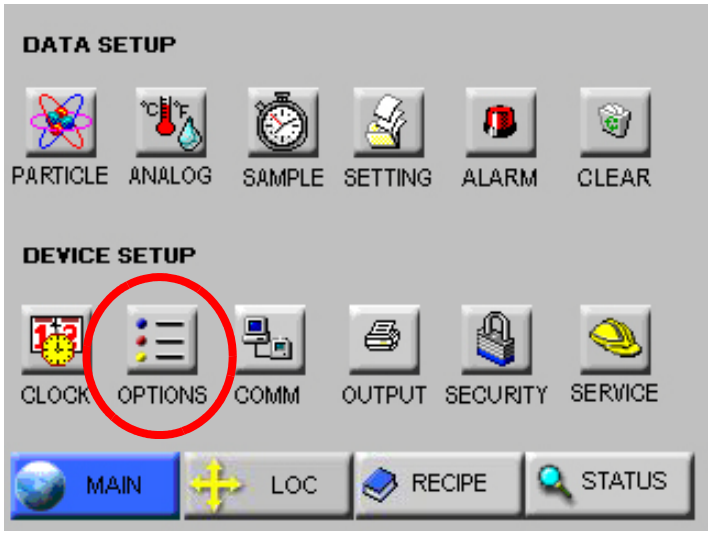


Figure 4-9 CONFIG: Options Button

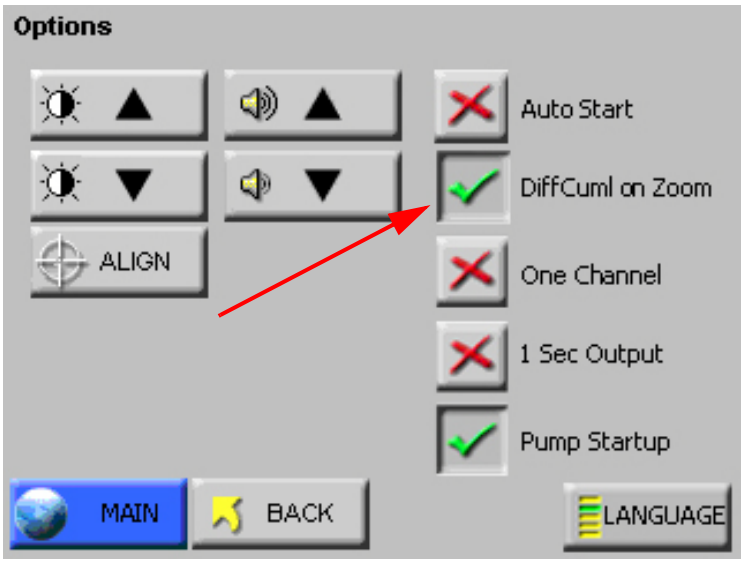


Figure 4-10 CONFIG: Options Screen

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Select the button “DiffCuml on Zoom” as shown in Figure 4-10; this will display both differential and cumulative data on the Zoomed View screen as shown in Figure 4-11.

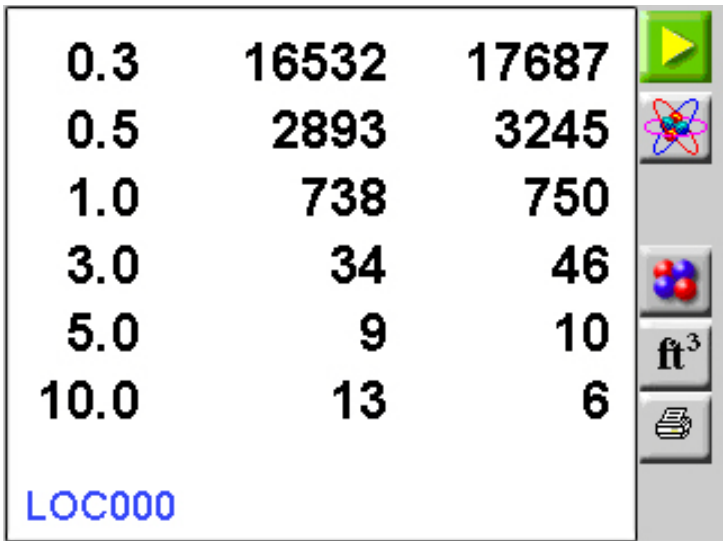


Figure 4-11 Differential and Cumulative Data in Zoomed View

The buttons available when touching the data area of the screen after selecting DiffCuml on Zoom are shown in Figure 4-12. Note the selections are different but their functions are the same as on dual display screen.



START/STOP counting

Display Particle data or Analog data

Display Raw / Normalized particle data

Display ft^3 / m^3 when configured

PRINT the last record

Figure 4-12 Diff / Cuml Screen Button Actions

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To return the instrument to the default single-column zoom view, return to the MAIN Screen view, press CONFIG, Options and deselect the button “DiffCuml on Zoom” button. See Figure 4-13.

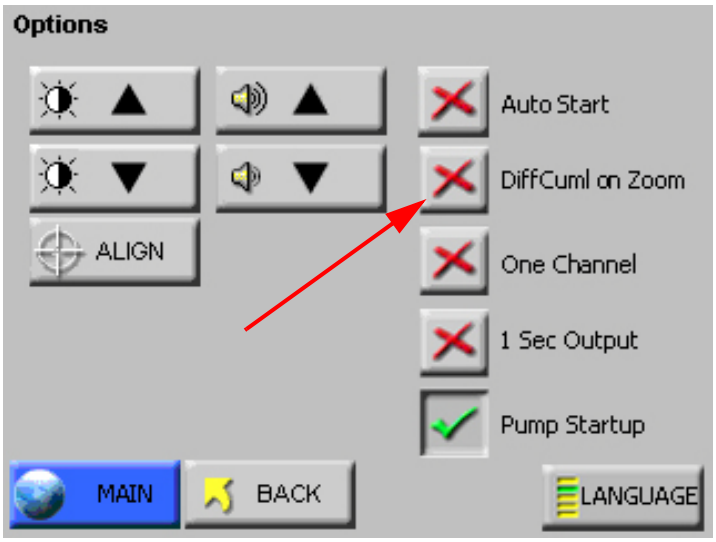


Figure 4-13 DiffCuml on Zoom Disabled

Select the MAIN button to return to the MAIN Screen view or press BACK to return to the previous level. Here, the user can choose what data type is to be displayed in one column on the Zoomed View screen.

Go to the CONFIG: Settings screen and select Differential or Cumulative for the data type. SeeFigure 4-14 .

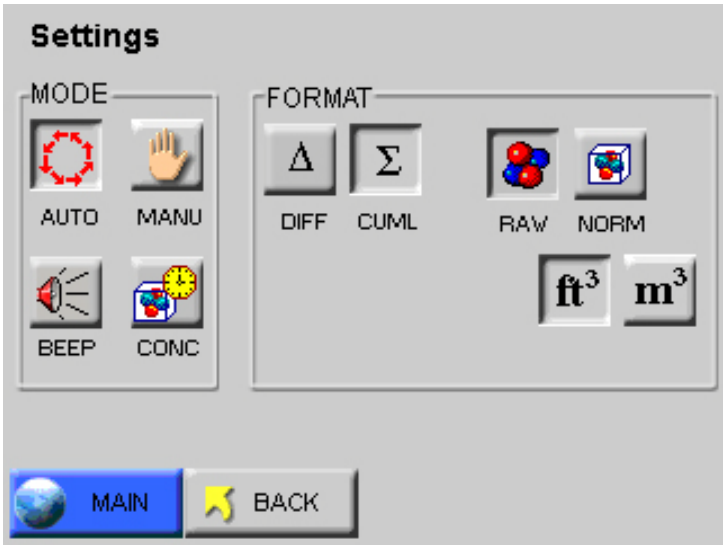


Figure 4-14 Configuration: Setting Screen

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Press the MAIN button, then tap in the data area to go into the Zoomed View. See Figure 4-15.

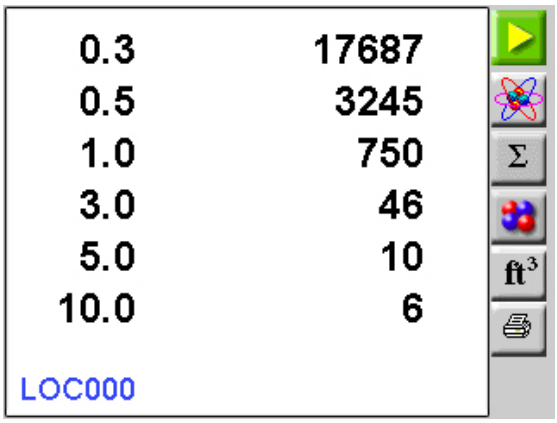


Figure 4-15 Zoomed View with Only Cumulative Data

Only one column of data is displayed.

CONFIGURATION Screen

Press CONFIG on the MAIN screen to display the Configuration screen as shown inFigure 4-16 .

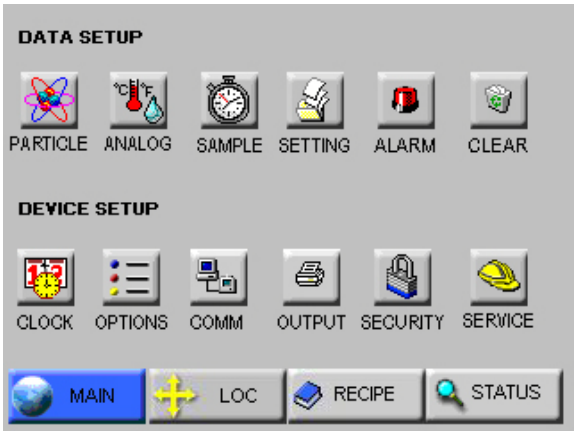


Figure 4-16 Configuration Screen

Data Setup includes buttons to enable/disable particle channels, configure analog temperature readings, 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 1 Second Output, set the instrument's communication address, enabling print functions, enable password restrictions, and/or (with proper authorization) adjust service settings.

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DATA SETUP

Figure 4-17 displays the Data Setup option buttons. These options allow the user to configure the parameters for data collection during a sample.

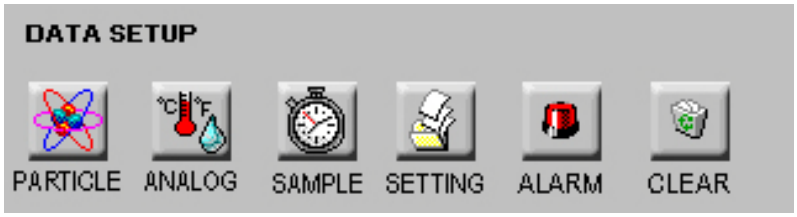


Figure 4-17 Data Setup Options



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 as shown in Figure 4-18.

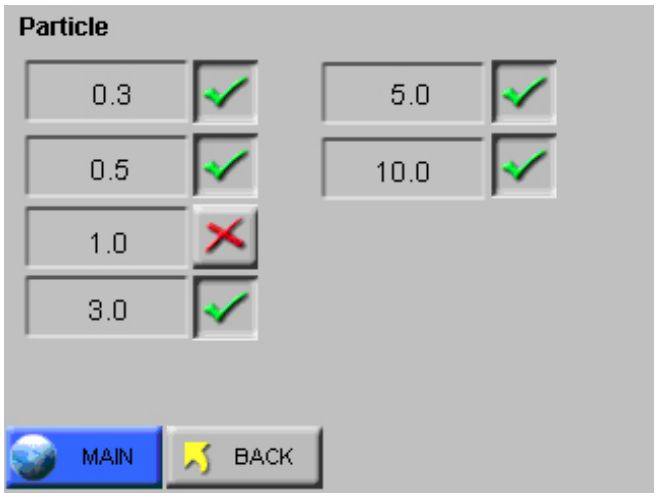


Figure 4-18 Particle Channel Configuration

Note: *The data buffer is cleared when channels are enabled or disabled. This ensures that all of the data in the buffer will 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.

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- Pressing MAIN or BACK will prompt to clear all collected data as shown in Figure 4-19.



Figure 4-19 Clear Data Screen

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

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

The channel size for disabled channel(s) 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.

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To change to Celsius, press the C button. To change to Fahrenheit, press the F button. See Figure 4-20 & Figure 4-21.

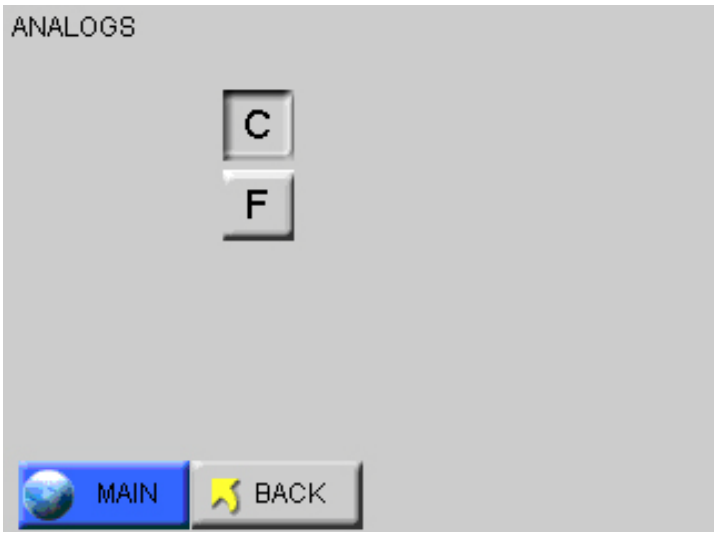


Figure 4-20 Analog Channels - Select Celsius Units

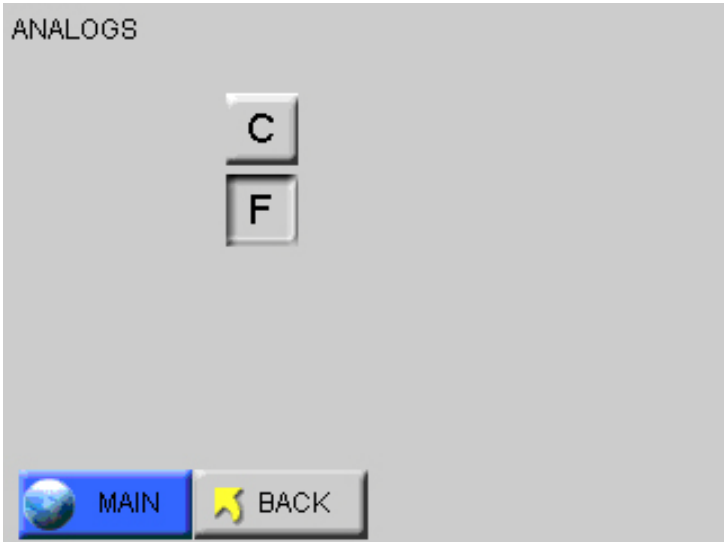


Figure 4-21 Analog Channel - Select Fahrenheit Units

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Temperature and relative humidity values appear on the MAIN screen with the units you selected as shown in Figure 4-22.

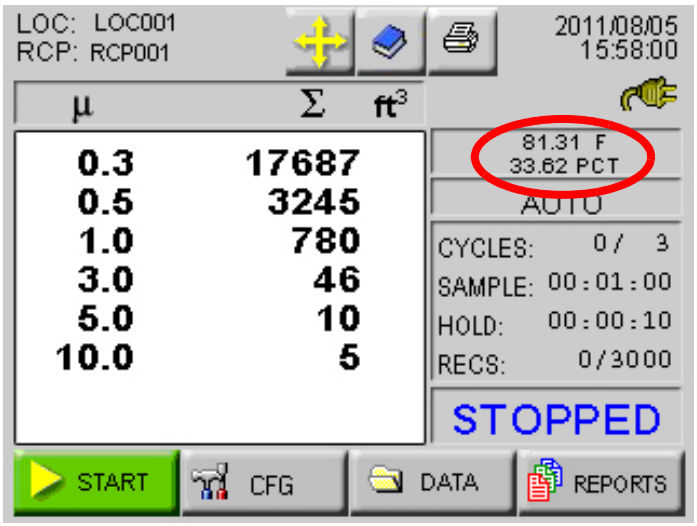


Figure 4-22 Analog Data on MAIN Screen

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. See Figure 4-23.

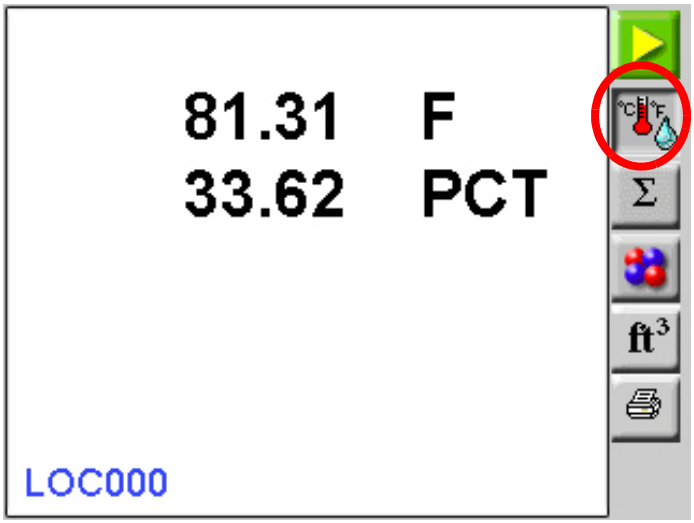


Figure 4-23 Zoomed Data View: Analog Data

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SAMPLE

Configure the Sample Time and the number of samples to be collected on the Sample screen as shown in Figure 4-24.

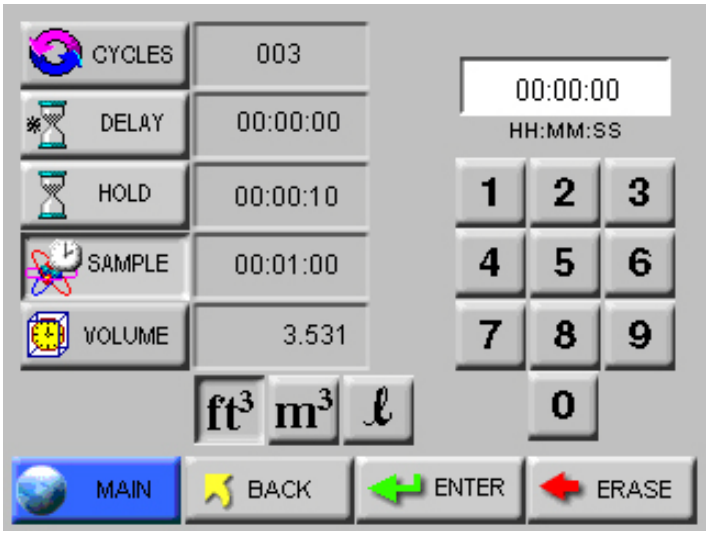


Figure 4-24 Sample Timing Configuration Screen

- **CYCLES:** The number 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.

Note: *The pump starts immediately when START is pressed. If a Start Delay is required, the Delay should not be set to less than 5 seconds or readings may be unreliable.*

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 23 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.

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

The maximum hold time is 23 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. See Figure 4-25.

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Note: *If the particle volume is liters or m^3, sample volume is displayed in liters. If the particle volume is cubic feet (ft^3), the sample volume is displayed in cubic feet (ft^3).*

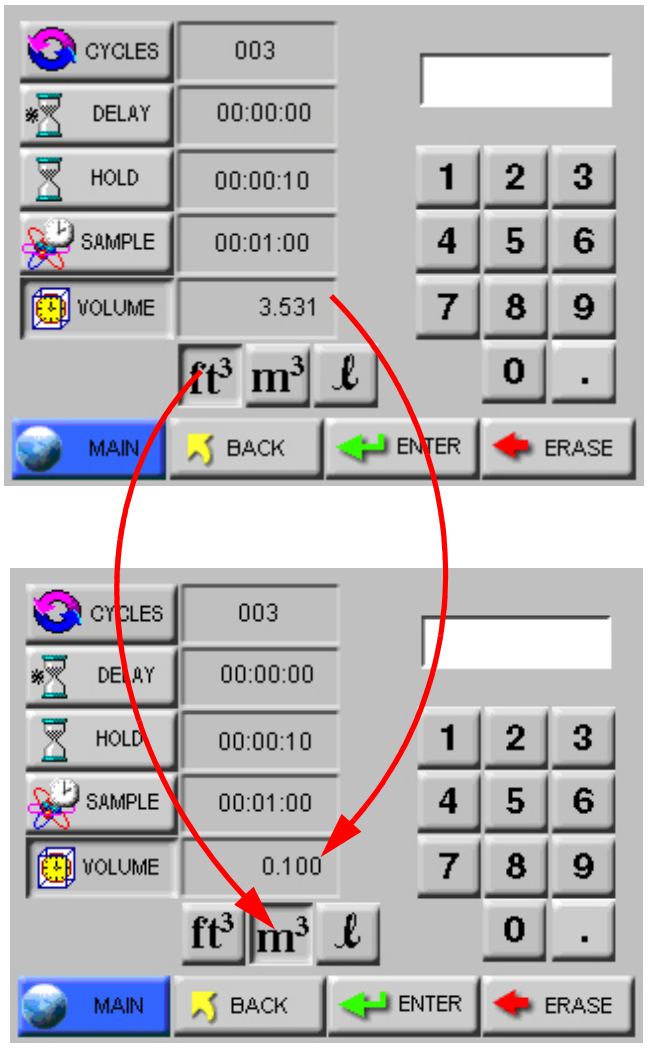


Figure 4-25 Changing Sample Volume unit of measure

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

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SETTINGS

The instrument can be configured to count in different modes and formats. See Figure 4-26.

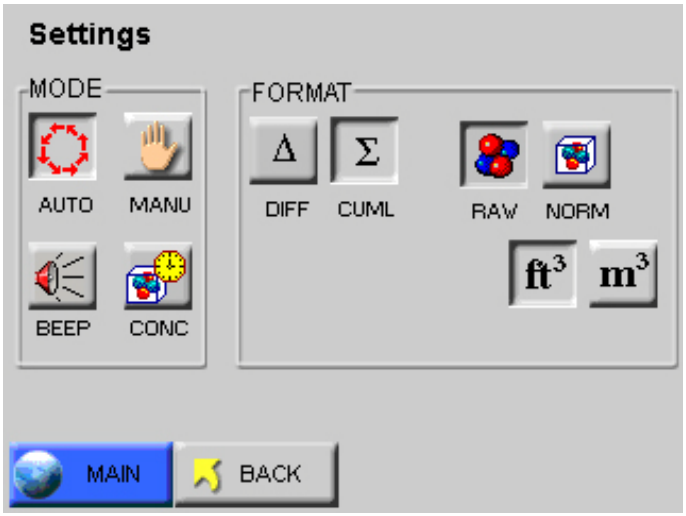


Figure 4-26 Sample Settings Screen

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. 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: *The sample time for Auto, Manual, and Beep modes count down and the sample times for Concentration mode count up.*

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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 Alarm Configuration and the instrument's sample time if 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.

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

Note: *BEEP mode only works with CUMULATIVE data.*

  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.*

  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. There will be no indication on the record, however, that the data was saved while the instrument was in BEEP mode.

Geiger Counter Mode

While in BEEP mode the instrument can be set to beep 1 to 4 beeps per second depending on the number of particles the instrument has counted per second.

To set up the instrument for Geiger Counter Mode:

1. Enable BEEP Mode.
2. Set the smallest particle channel to 1.

In Geiger Counter Mode the instrument will beep from 1 beep up to 4 beeps per second if it counts from 1 particle up to 4 particles per second. The maximum beeps per second the instrument can emit are 4 per second even if the instrument counts 100 particles per second.

The value set in the smallest particle channel's alarm is the trigger for a single beep per second. If the smallest particle channel is set to 2, the instrument will beep once every second for every 2 particles the instrument counts per second.

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PARTICLE Display

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

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

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

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 (ft^3 or m^3).

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

Normalized Data = Number of Particles/Volume of Air

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

ALARM

The user can enable alarming on specific channels as illustrated in Figure 4-27.

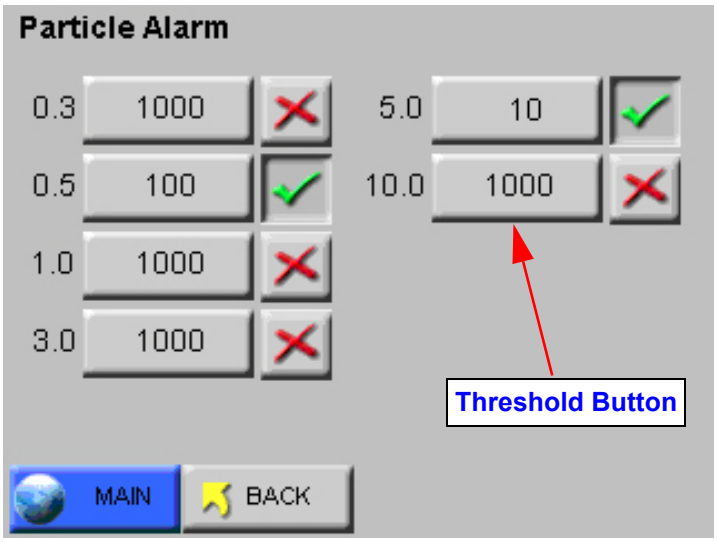


Figure 4-27 Particle Alarm Configuration, 2 Channels Enabled

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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.

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

Press the threshold button next to the enabled channel in order to set the alarm threshold for that channel. See Figure 4-28.

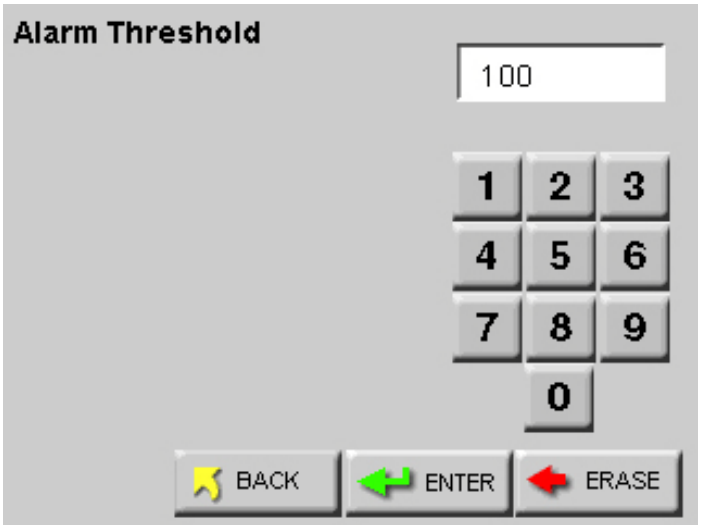


Figure 4-28 Configure Alarm Threshold

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

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 as shown in Figure 4-29.

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

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

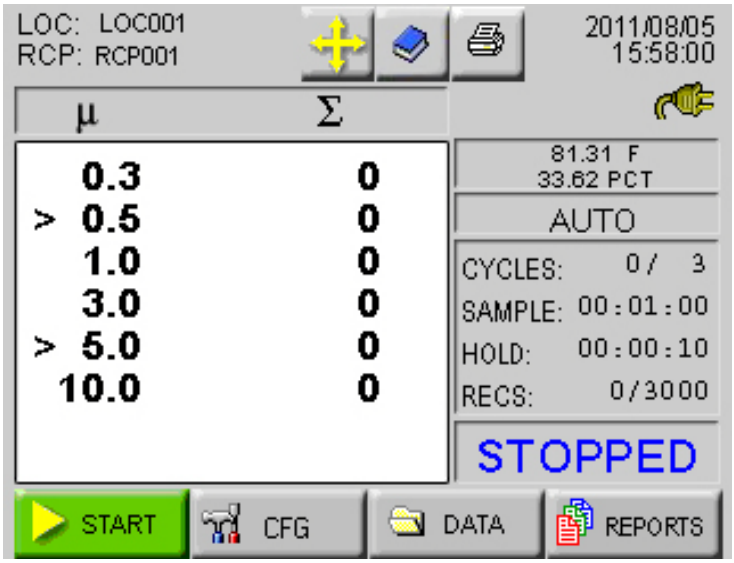


Figure 4-29 2 channels Enabled for Alarming

When a particle channel that is enabled for alarming goes into alarm, the selection cursor (>) and the channel size are highlighted in red as shown in Figure 4-30.

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 period.*

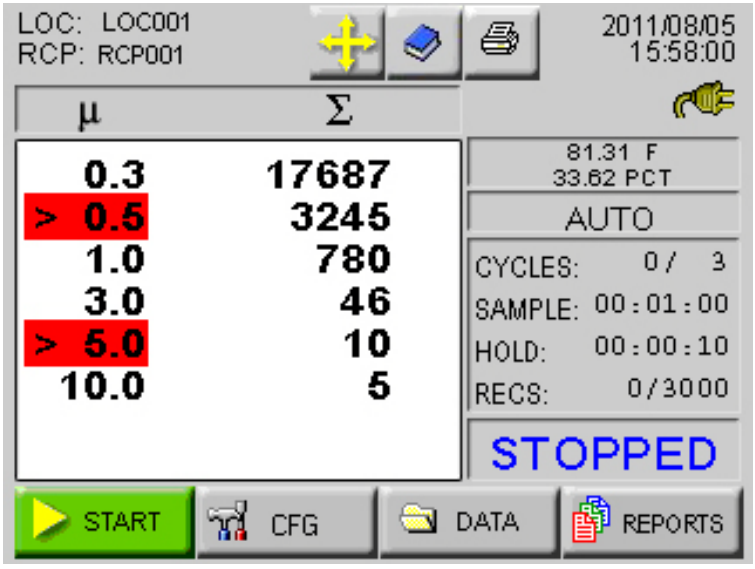


Figure 4-30 Channel in Alarm

When the instrument begins to beep in response to the Alarm settings, silence the beep by pressing anywhere on the MAIN screen. After acknowledging the alarm, the count will reset when the next sample cycle begins.

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Clear Buffer

Press the Clear Buffer button to clear the instrument's data buffer. See Figure 4-31.



Figure 4-31 Clear Buffer Screen

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

DEVICE SETUP

The Device Setup buttons allow the user to set and adjust how the instrument operates when running samples. Specific functions can be enabled and disabled for display options, data output and security. See Figure 4-32.

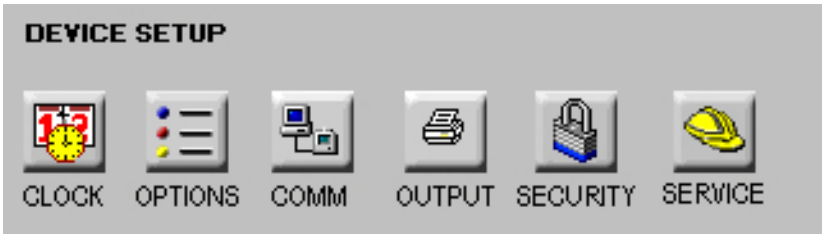


Figure 4-32 Device Setup Options

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CLOCK

Use the Clock screen to set the instrument's date and time. See Figure 4-33.

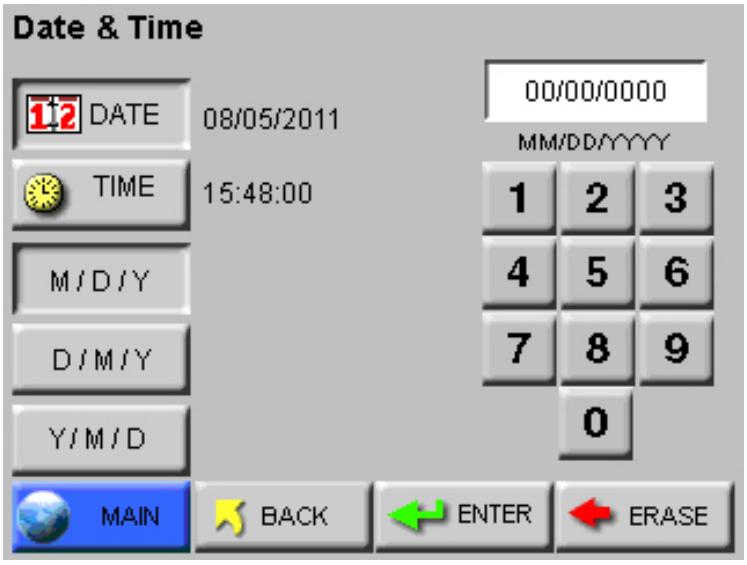


Figure 4-33 Date & Time Configuration Screen

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

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Note: *MONTH 1ST (M / D/ Y) is the default date format.*

Change the Date's format by pressing the ***M / D/ Y*** button to display the date as month-first. Alternatively pressing the ***D / M/ Y*** button displays the Date as day-first and the ***Y / M/ D*** button displays the date year-first. See Figure 4-34 and Figure 4-35.

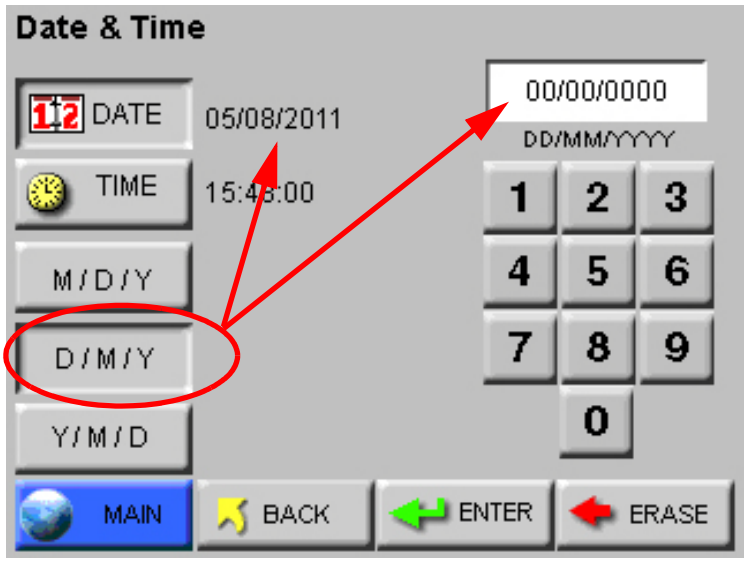


Figure 4-34 Date Option: Day First

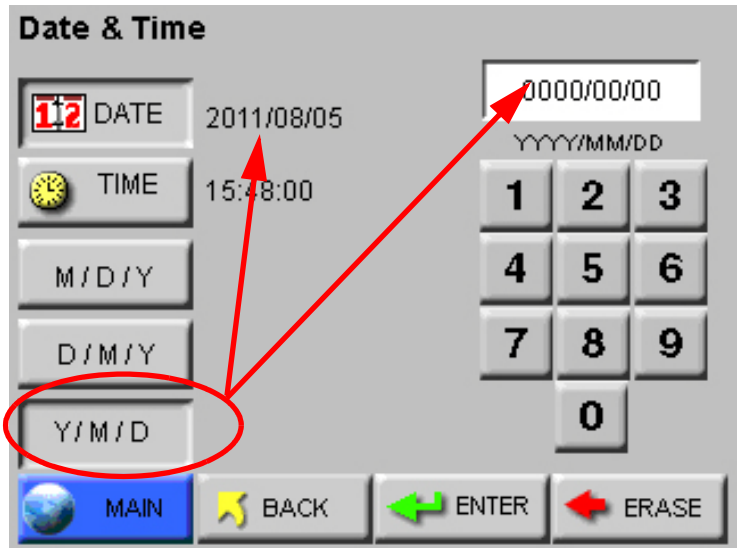


Figure 4-35 Date Option: Year First

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Set the instrument's Time by pressing the TIME button. See Figure 4-36.

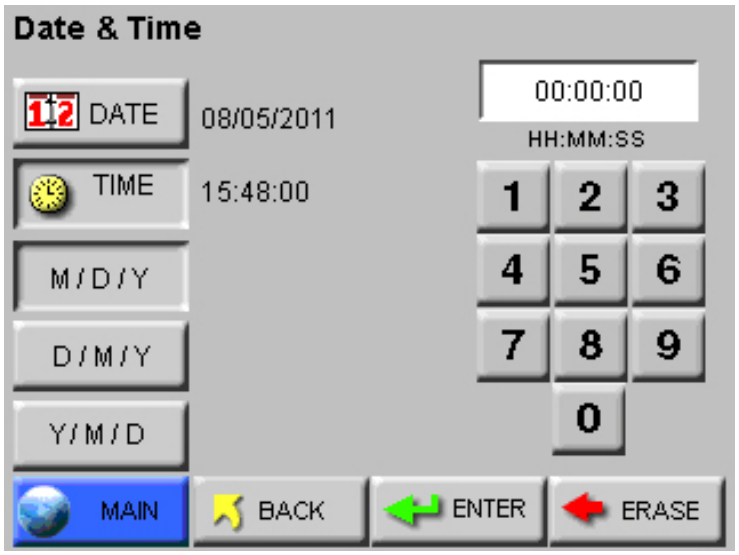


Figure 4-36 Configuring TIME

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.

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OPTIONS

Several optional configuration settings are found on the OPTIONS screen. See Figure 4-37.

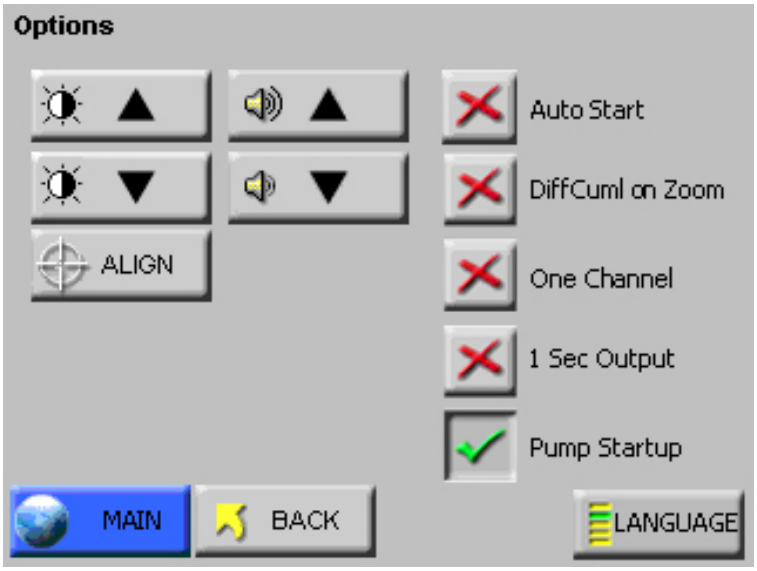
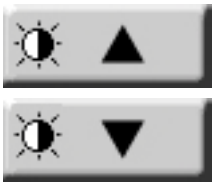


Figure 4-37 Options Configuration Screen



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.

Note: If the front panel is not responding to stimuli, you can reach the alignment screen in the following way: Power off the unit, press and hold the center of the touchscreen and power the unit back on. Release the screen when it beeps, then follow the on-screen instructions.

- Press the ALIGN button. 

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

- The screen in Figure 4-38 appears. Touch anywhere on the screen to continue calibration.

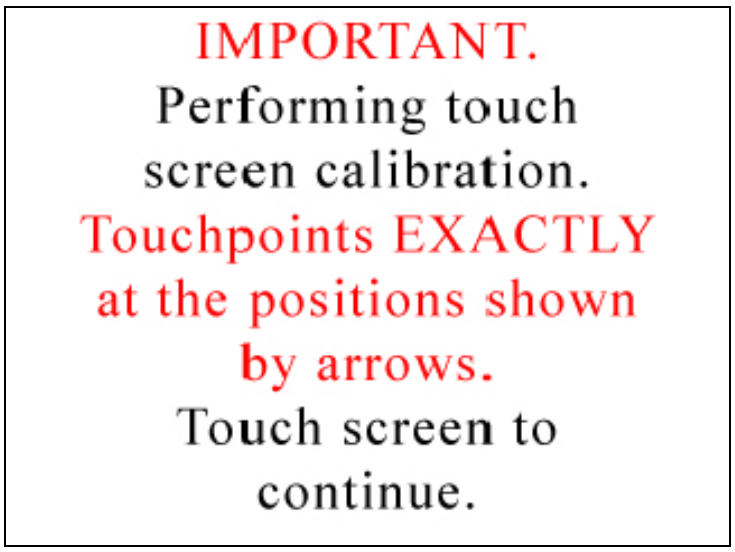


Figure 4-38 Alignment Screen 1

Note: *Using a PDA Stylus provides higher accuracy to the touch screen interface.*

- At the next screen, touch the arrow displayed in the upper right corner. This needs to be done a total of three times before continuing to the next alignment. See Figure 4-39.



Figure 4-39 Alignment Screen 2

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- The third screen displays the arrow in the upper left corner. The arrow will have to be touched three times to ensure calibration as Figure 4-40 illustrates this.



Figure 4-40 Alignment Screen 3

- The fourth alignment screen shown in Figure 4-41, displays the arrow in the at the bottom center of the screen. Touch the arrow three times to finish the alignment process.



Figure 4-41 Final Alignment Screen

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Note: *The screen alignment function can also be accessed by touching the screen when powering the instrument on.*

- Once the final alignment is complete, the following screen is displayed. See Figure 4-42. Touch anywhere in the screen to return to the OPTIONs screen.

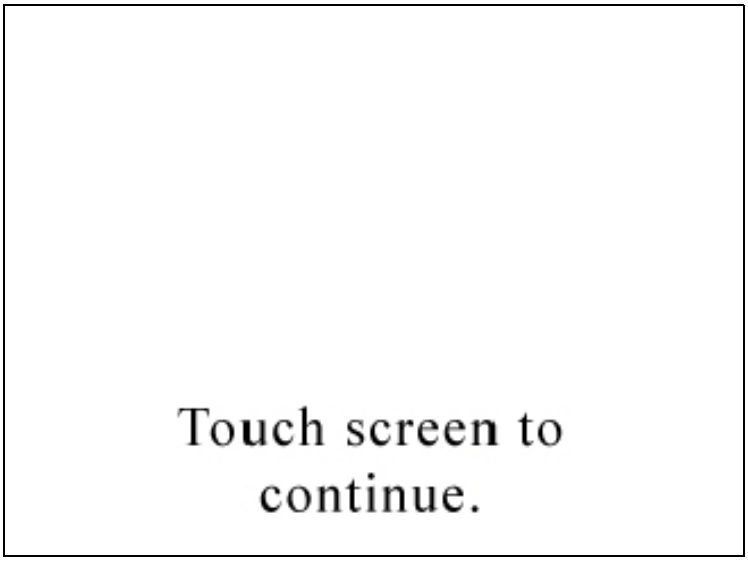


Figure 4-42 Alignment Saved Screen



Autostart Mode

When Autostart mode is enabled, set the Delay time to at least 5 seconds.

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. Data will continue to be recorded, printed and downloaded for all channels.

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

One Channel mode only affects how data is displayed on the MAIN screen. Refer to Figure 4-43.

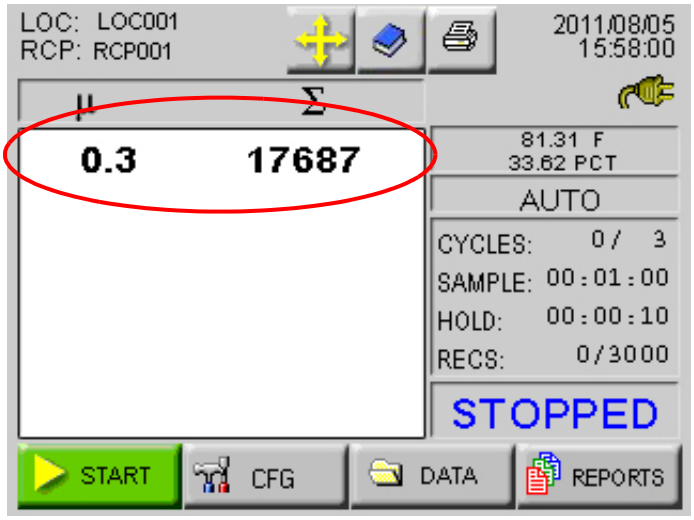


Figure 4-43 Main Screen - One Channel Option Enabled



ONE SECOND OUTPUT

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

Note: *One Second Output disables Alarming.*

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

Note: *Changing any setting (mode, sample time, hold time, etc) disables the One Second Output.*

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

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Pump Startup



This is ON by default and sets a three-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.

LANGUAGE



Pressing the LANGUAGE button allows the user to change the operating language displaying the screen shown in Figure 4-44.



Figure 4-44 Operating Language Selection Screen

Press the desired language button then BACK or MAIN. The default is English.

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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 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.

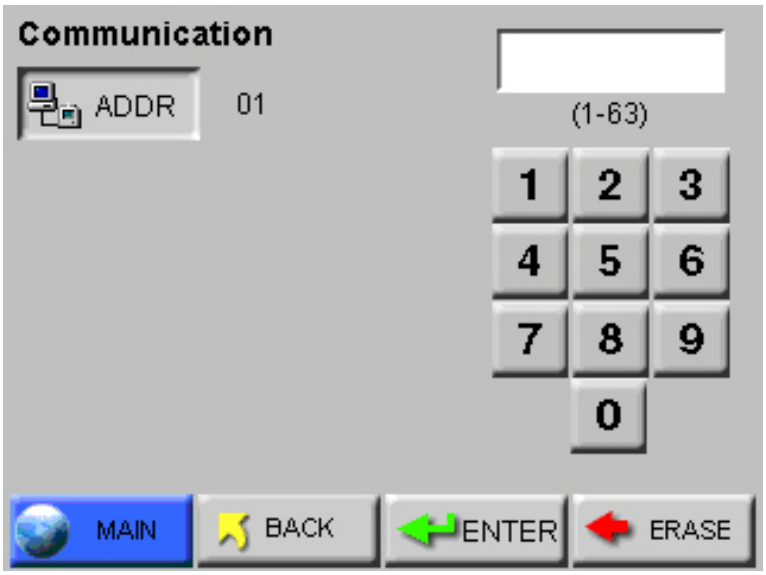


Figure 4-45 COMM Address Configuration screen

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. See Figure 4-45.

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

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OUTPUT SETUP

The Print configuration has several options for printing the data that the user sets on the Printer Setup screen shown in Figure 4-46.

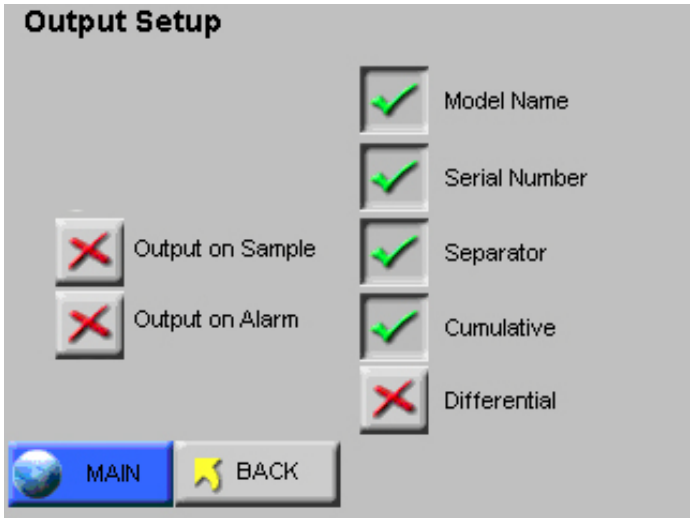


Figure 4-46 Printer Setup Screen

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

  When **Output 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.

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SECURITY

To restrict access to the instrument and/or configuring the instrument, the HANDHELD has two different password levels. See Figure 4-47.

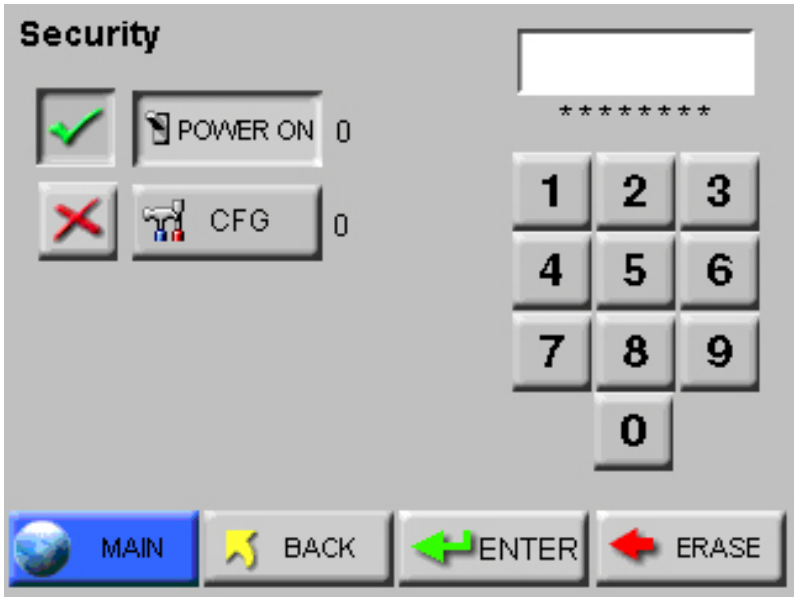


Figure 4-47 Security Password Configuration Screen

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.

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POWER ON PASSWORD

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

To require that a password must be entered before the instrument can be used, enable the POWER ON password. See Figure 4-48.

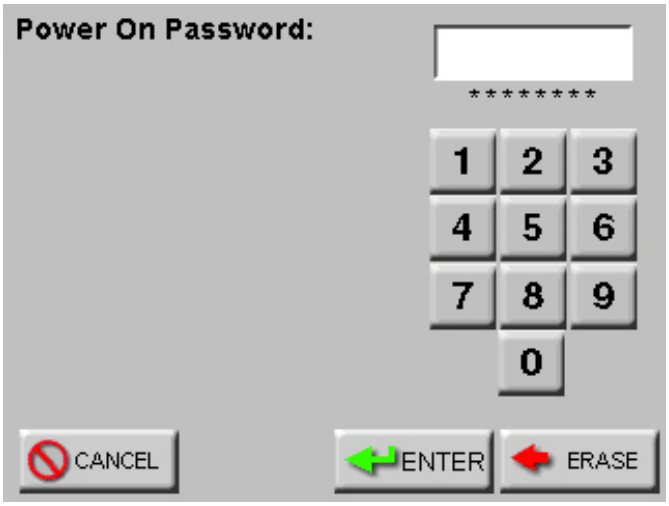


Figure 4-48 POWER ON Password Access Screen

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. See Figure 4-49.

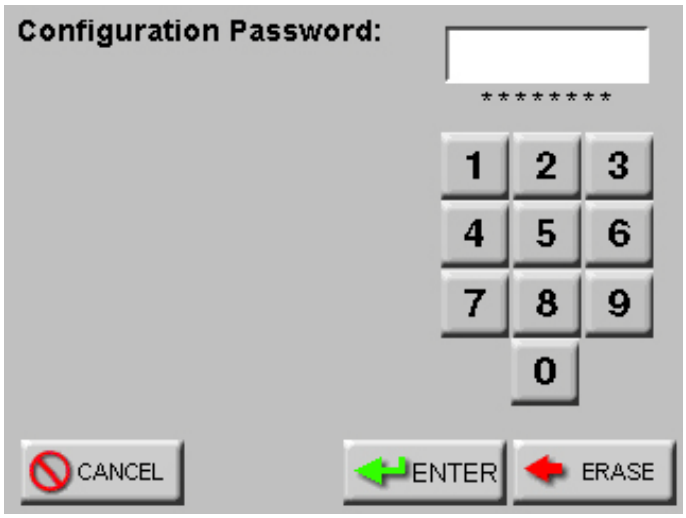


Figure 4-49 CONFIGURATION Password Access Screen

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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.

Three options on the lower CFG screen, STATUS, RECIPE and LOC display the instrument's current status, configure user recipes and locations respectfully.

STATUS



Touching the STATUS button displays the instrument programmed version of the various firmware modules as shown in Figure 4-50. This information is useful when contacting Lighthouse Technical Support personnel.

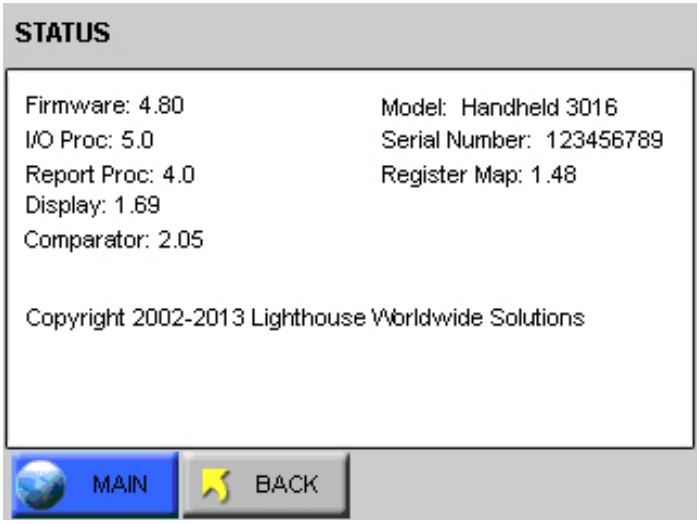


Figure 4-50 HANDHELD 3016 STATUS Screen

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RECIPE

Selecting the RECIPE button displays the Recipe setup screen. See Figure 4-51.



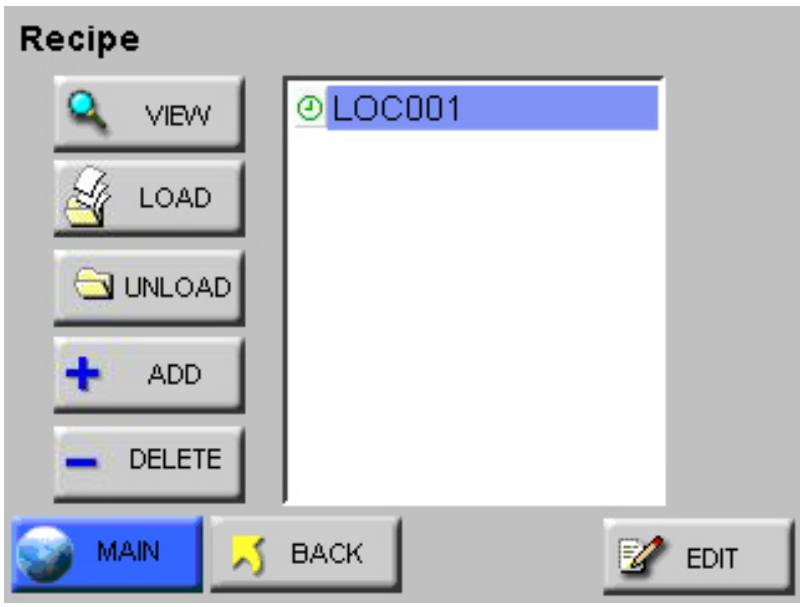


Figure 4-51 Recipe Setup Screen

The Recipe feature allows the user to save instrument settings for sampling and reports in a database that can store up to 50 recipes.



Selecting the ADD button displays the RECIPE text screen. See Figure 4-52. The recipe can be named using up to 12 characters.

Note: *If the location selected is already assigned to another recipe or if there are no available free locations, the user will not be able to add a new recipe. The "Add" button will not be displayed.*

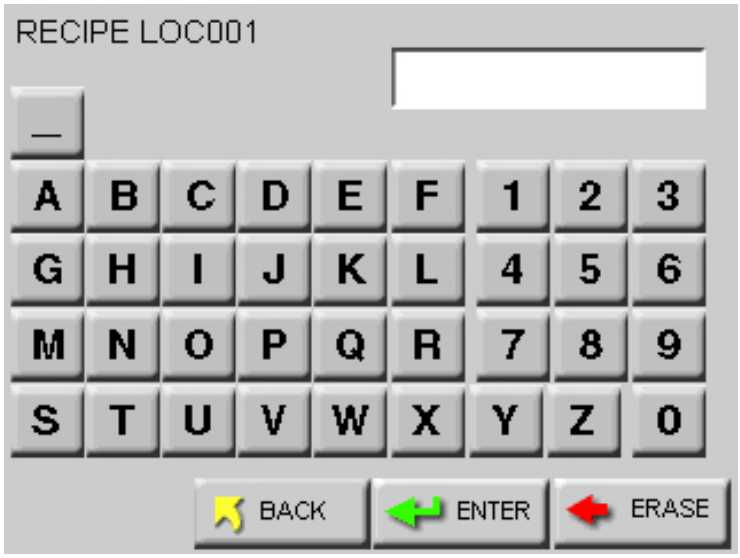


Figure 4-52 Recipe Name Screen

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Pressing the ENTER button will add the recipe to the database and display the recipe CONFIG screen as shown in Figure 4-53. Each option allows the user to configure the instrument to the current recipe.

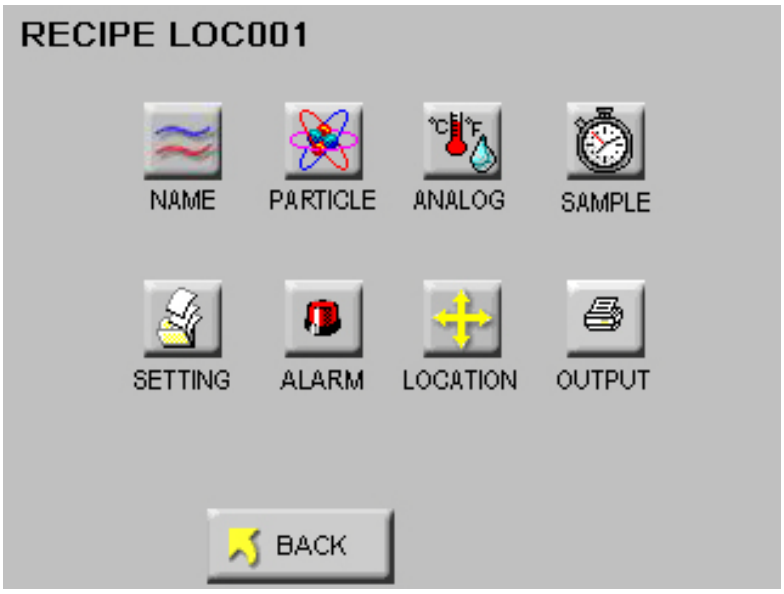


Figure 4-53 Recipe Configuration

Press the BACK button to save the settings and return to the RECIPE screen.



Pressing the EDIT button on the main RECIPE screen will allow the user to change settings on the highlighted recipe.



The LOAD and UNLOAD buttons add or remove the highlighted recipe as the instrument's current operating configuration.



The DELETE button will delete any highlighted recipes from the database.

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The VIEW button displays the current settings for the highlighted recipe. See Figure 4-54.

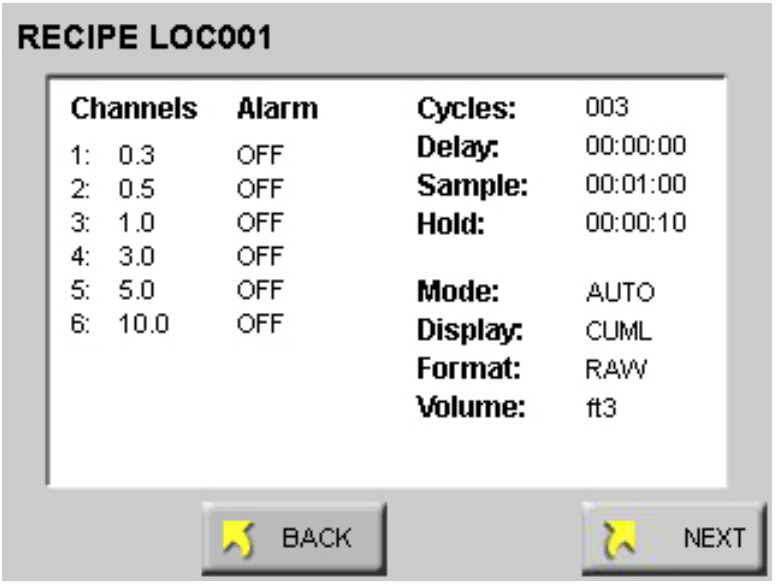


Figure 4-54 Recipe - Channel Settings

Press the NEXT button to view the analog and output settings. See Figure 4-55.

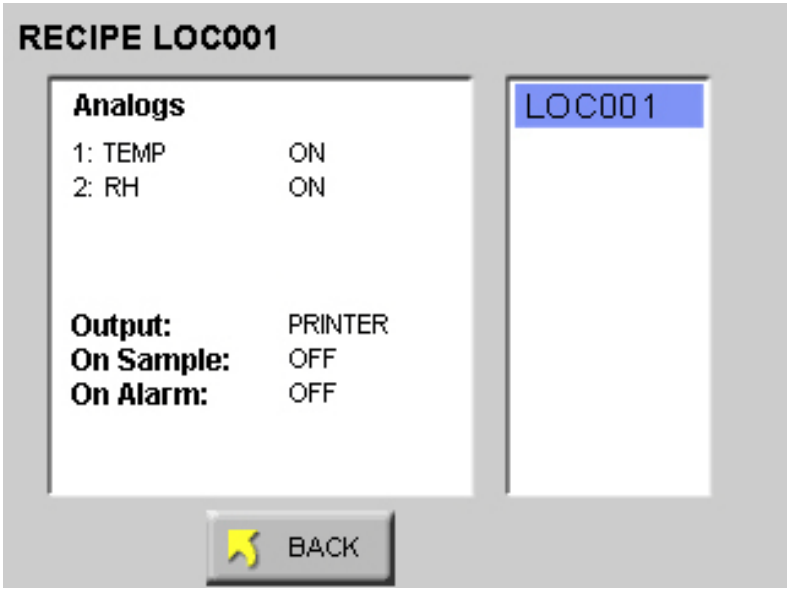


Figure 4-55 Recipe - Analog & Output Settings

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LOCATION

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



Press the LOC button on the Configuration screen to display the Select Location screen as shown in Figure 4-56.

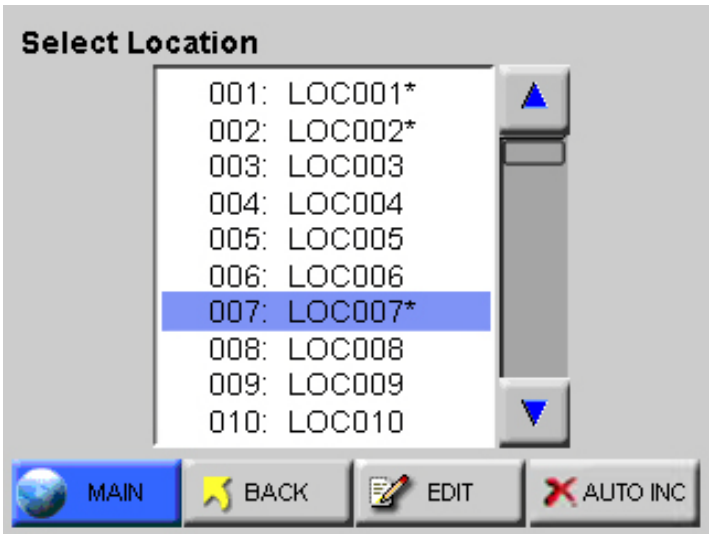


Figure 4-56 LOCATION Setup Screen

On the Select Location screen, the Location name can be selected using the UP and DOWN arrows or by touching the location name on the screen.

The following options can be enabled to configure locations for the HANDHELD.

- When enabled, the Auto Increment option will automatically select the next location after completing the programmed number of cycles. The default position is “off” when the unit is powered up.
- The unit can be configured for a maximum of 200 Locations. Each location name can be configured with a maximum of 8 characters per name.
- Recipes associated with a specific location are denoted by an asterisk (*) to the right of the location name.

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- When selecting a location with a recipe, the user is provided with the option of loading the recipe as shown in Figure 4-57. If the user chooses not to load the recipe, the location can still be used with the current settings.

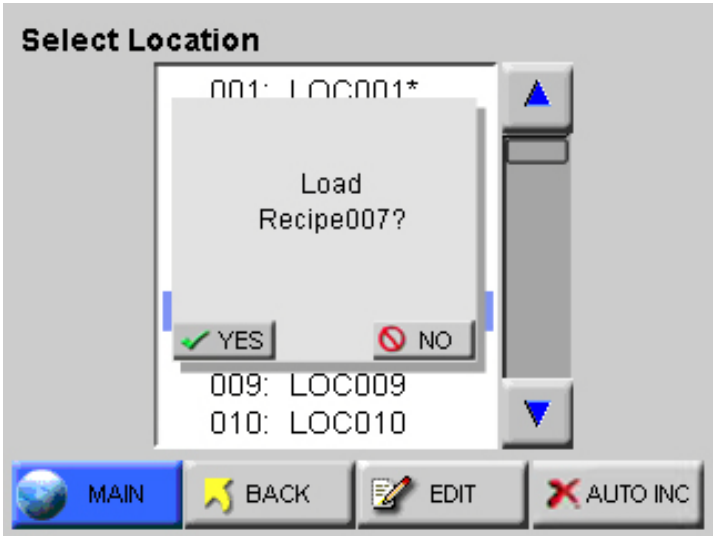


Figure 4-57 Location - Load Recipe

- If a recipe is loaded and a location is selected that is not associated with a recipe, the user is given the option to unload the current recipe. If the user chooses to keep the loaded recipe, the location will adopt the current recipe settings.



To create a name for a location, press the EDIT button to display the Edit screen. See Figure 4-58.

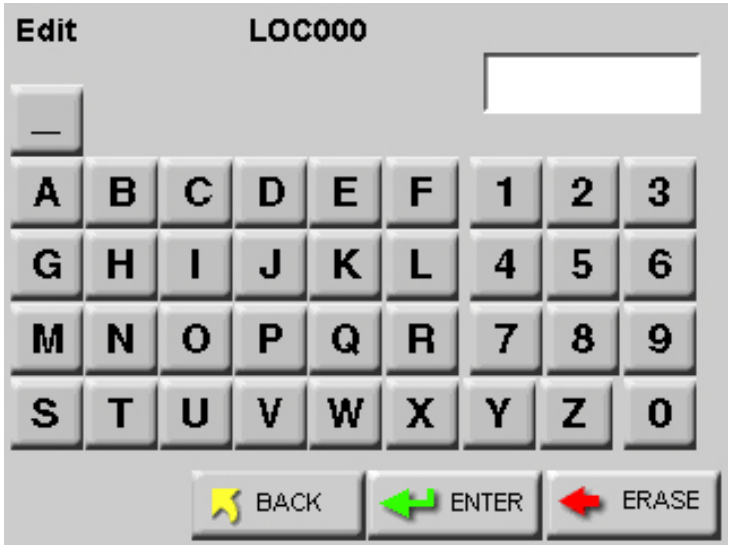


Figure 4-58 LOCATION Edit Screen

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- Type in the name of the location using the alphanumeric and underscore keys.
- Press the ERASE button to erase the last character typed, if needed.
- Press ENTER.
- 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.



Activating the AUTO INC button allows the user to select the next location once the number of cycles is completed.

- The user is prompted to move to the next location after the programmed number of cycle. See Figure 4-59.

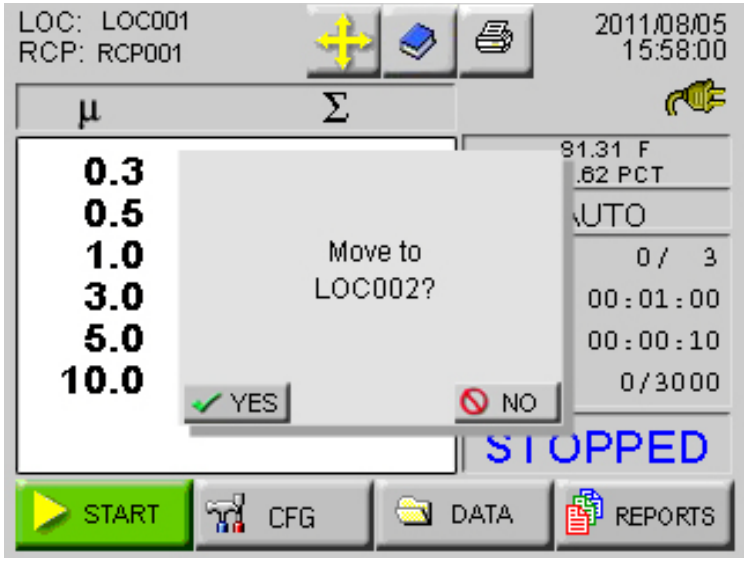


Figure 4-59 Auto Increment Prompt

The Auto Increment mode will select the next corresponding location and continue to sample using the current configuration. If the current location is using a recipe, the user will be prompted to unload the recipe before moving to the next location.

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Data View Buffer Screen

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. See Figure 4-60 & Figure 4-61.

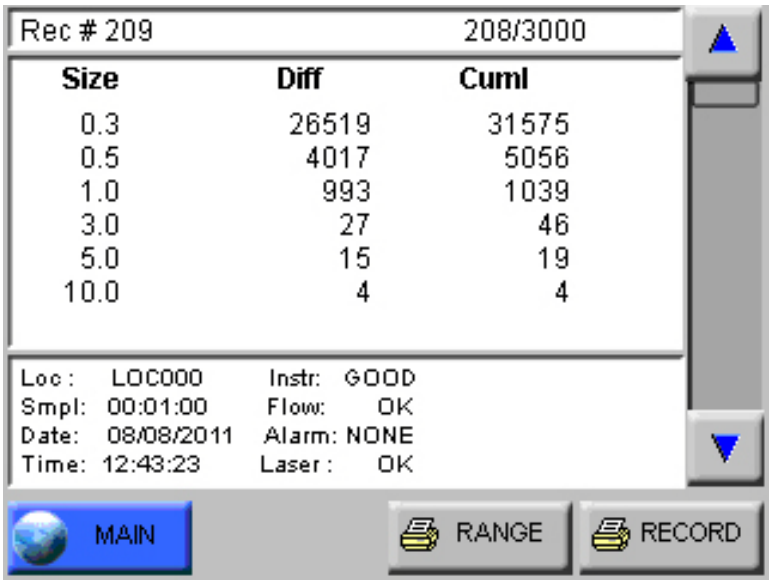


Figure 4-60 Data Screen - RAW Data

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

- The single arrow moves one record at a time.

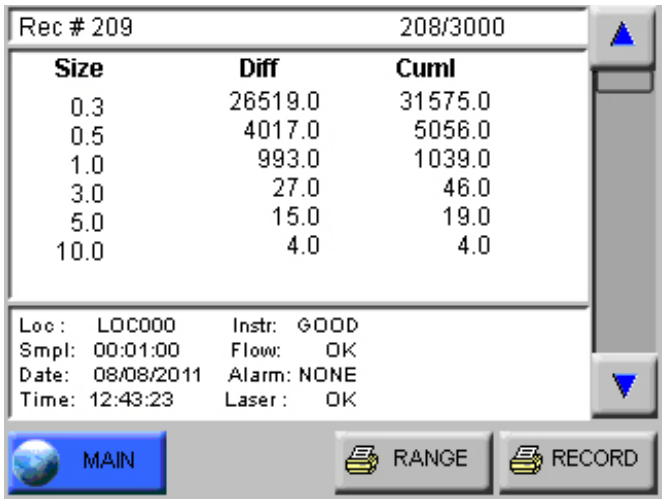


Figure 4-61 Data Screen - Normalized data in ft^3

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 is column; # indicates raw counts; ft^3 and m^3 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 ft^3 and m^3 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).

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- **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 800-945-5905 (USA Toll Free), 541-770-5905 (Outside of USA).
- **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 800-945-5905 (USA Toll Free), 541-770-5905 (Outside of USA).

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).

Printing Data View 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/ft^3” or “Particles/m^3”)
- # of samples in the report
- For each channel size:
  - Maximum Value
  - Minimum Value
  - Average
  - Standard Deviation

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The UCL calculation will be printed for each channel size if the number of locations in the range is 2 through 9. The calculation will only print if the Format settings (Setting screen) are set to CUML and NORM. Any other format settings or locations less than 2 and greater than 9 will print N/A for each channel.

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



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. See Figure 4-62.

```
**HANDHELD**
Serial #: 30804001
-----------------------
Location: 29
08-02-03, 15:34:46
Sample Time: 00:01:00
Flow: 0.1 cfm
Laser: OK
 74.7 DegF   52.2 %RH
Particle Counts:
 Size      Diff      Cumul
 0.3      29118     32543
 0.5       2572      3425
 1.0        797       853
 3.0         29        56
 5.0         24        27
```

This indicates whether the data viewed is in RAW counts or Normalized counts.

```
**HANDHELD**
Serial #: 30804001
-----------------------
Location: 29
08-02-03, 15:34:46
Sample Time: 00:01:00
Flow: 0.1 cfm
Laser: OK
 74.7 DegF   52.2 %RH
Particles/ Ft^3:
 Size      Diff      Cumul
 0.3  2222.0     2350.0
 0.5    115.0      128.0
 1.0     13.0       13.0
 3.0      0.0        0.0
 5.0      0.0        0.0
```

Figure 4-62 Examples of Output from Auto Printout of Sample

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Printing Range

- 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 as shown in Figure 4-63.

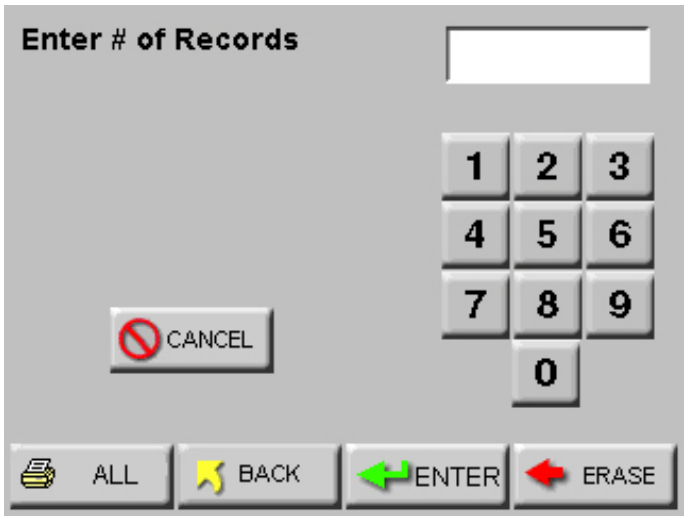


Figure 4-63 Print Range Screen

- 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.*

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```
*****  SUMMARY  *****
**HANDHELD 3016**
Serial #: 041004001
       -----
Location:    LOC002
06-20-2013, 15:34:30
Sample Time: 00:01:00
Flow:    0.1 cfm
Laser:   OK
TEMP:      66.77 F
RH:       35.71 %
Particle/ Ft^3:
Size       Cumul
 0.3      4260.0
 0.5       810.0
 1.0       580.0
 3.0       360.0
 5.0       350.0
 10.0      310.0

Location:    LOC003
^ v ^ v ^ v ^ v ^ v
Particle/ Ft^3:
Summary (Cuml):
        -----
# of samples =2
Size          Max
 0.3         4260.0
 0.5          810.0
 1.0          580.0
 3.0          360.0
 5.0          350.0
10.0          310.0

Size          Min
 0.3          3860.0
 0.5           750.0
 1.0           360.0
 3.0           240.0
 5.0           180.0
10.0           150.0

^ v ^ v ^ v ^ v ^ v
Size       95% UCL
 0.3          5322.0
 0.5           969.3
 1.0          1164.1
 3.0           678.6
 5.0           801.4
10.0           734.8
```

Figure 4-64 Sample Buffer Report

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REPORTS

The HANDHELD can print the following Cleanroom Classification to Standards reports:

Federal Standard ft^3
ISO 14644-1
EU GMP 2009

Note: *The EU GMP 2009 report is only valid if the instrument is configured with the 0.5 and 5.0 micron channel sizes.*



Reports General Settings

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.

Enable the Reports feature by pressing the red "**X**" (Default position) located at the top left of the screen. The button will display a check mark indicating the feature is enabled. See Figure 4-65.

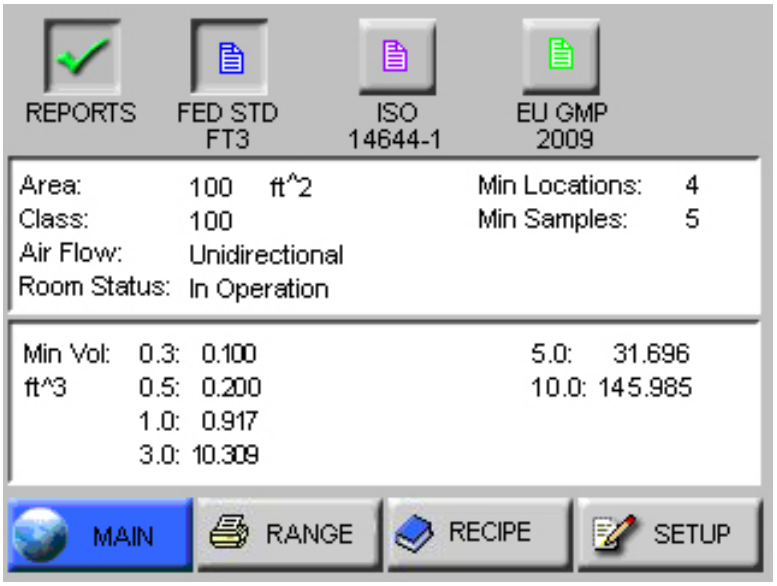


Figure 4-65 Typical Reports Screen

- Depending on the reports requirements, the number of cycles and minimum sample time will be calculated when the reports mode is enabled.
- The number of required locations will be automatically assigned to the report. The user may change locations via the reports SETUP screen.
- The display format will be changed to Normalized (normalized to ft3 for FED-209 and m3 for ISO and EU GMP). The user may change the display mode from the reports SETTINGS screen.

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- When the reports mode is enabled, the currently selected report type and minimum required samples will be displayed on the MAIN screen as shown in Figure 4-66.

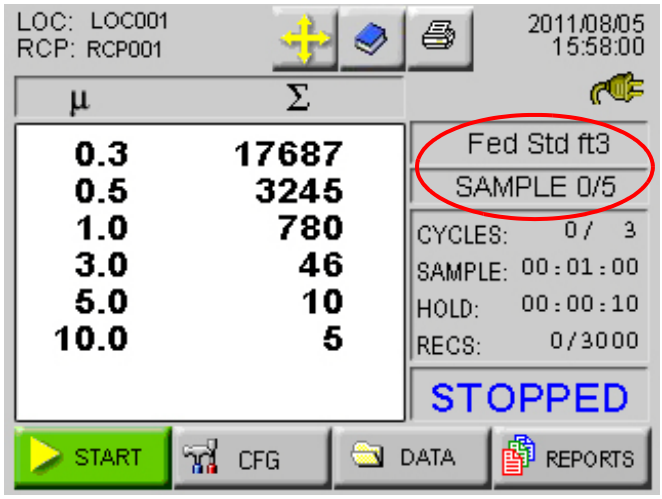


Figure 4-66 Reports Data

- The instrument keeps track of and will display on the MAIN screen the number of samples taken for the report.
- If Auto Increment is enabled, the user will be prompted to move the particle counter to the next assigned location after the completed number of cycles.
- If Printing is enabled and Auto Increment is enabled, the report will be printed after the required number of samples are completed.
- After the required number of samples have been completed, the instrument will prompt the user to disable Reports Mode as shown in Figure 4-67.

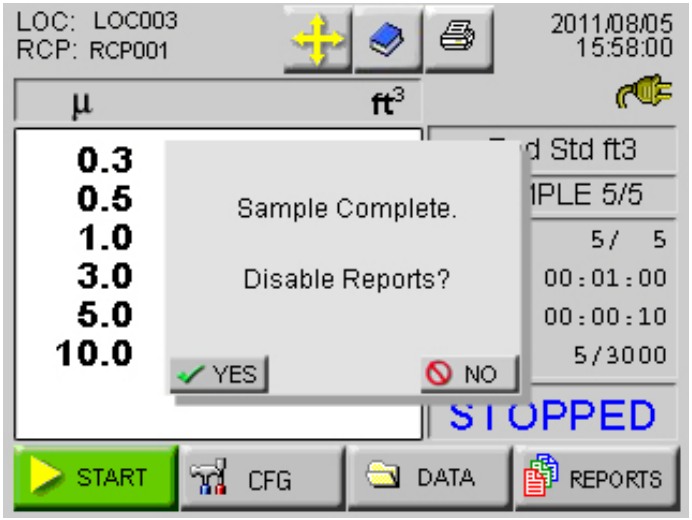


Figure 4-67 Disable Reports Prompt

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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 Report Setup screen displays as shown in Figure 4-68.

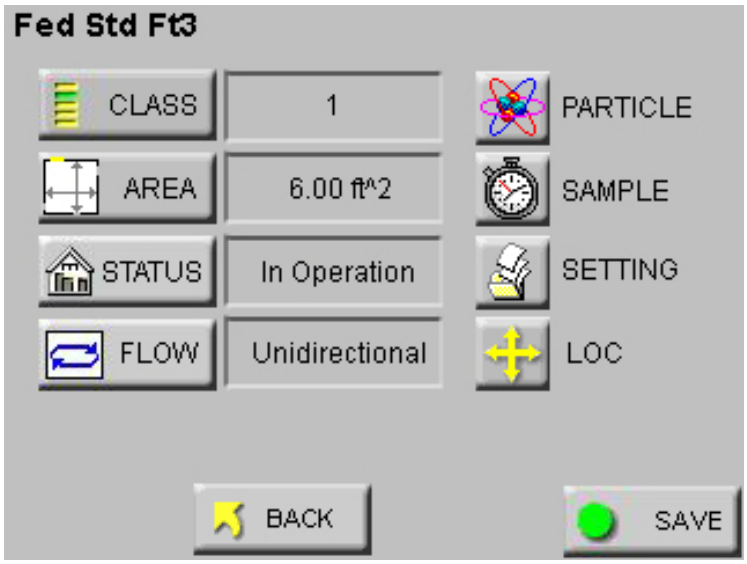


Figure 4-68 Report Setup Screen

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- Press the CLASS button and the Select Class screen displays as shown in Figure 4-69.

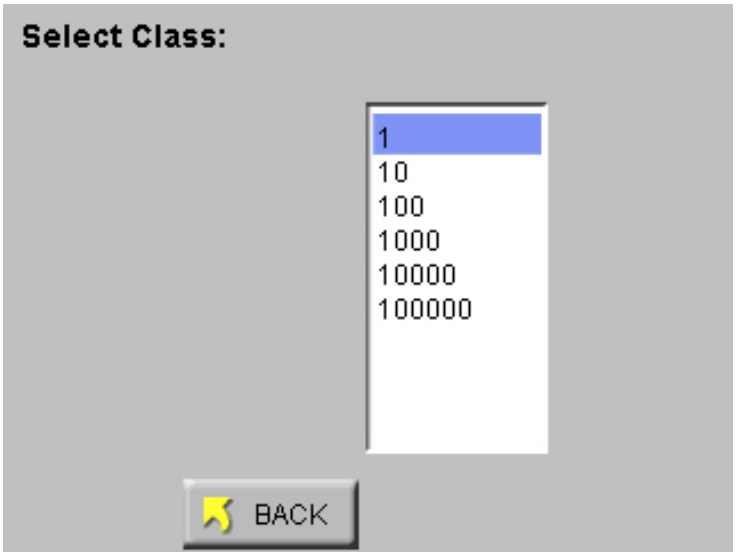


Figure 4-69 Select Class Level

- Press the displayed values to select the desired Class Level. The selected level will be highlighted in blue.

  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 ft^3 - 1, 10, 100, 1000, 10000, 100000

  ISO14644-1 - 1, 2, 3, 4, 4.8, 5, 6, 7, 8, 9

  EU GMP - A, B, C, D (Rev 2009)

  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.

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Note: *If the entered Area values needs more locations than available, a "Not enough locations" message will be displayed and the user will be asked to enter a lesser area.*

- Press the AREA button to display screen shown in Figure 4-70.

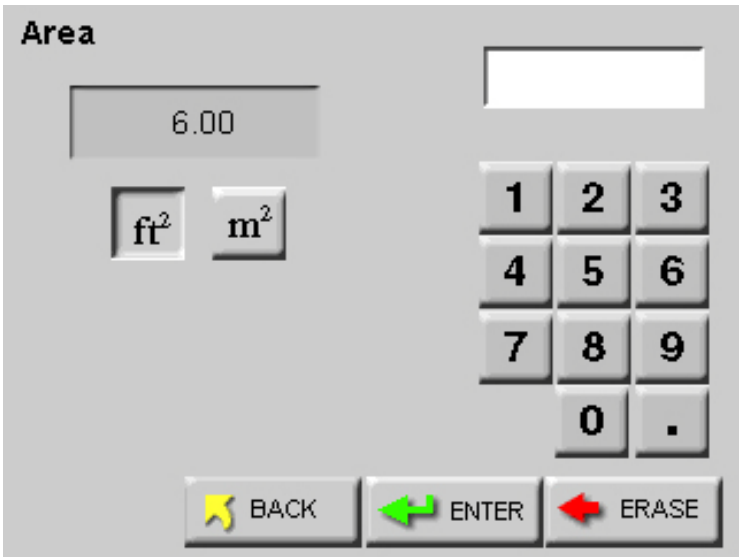


Figure 4-70 Reports Area Setup Screen

- Select the appropriate unit of measure (ft^2 or m^2) and type in the area using the keypad. Press ENTER to display the value on the screen.
- Press the BACK button.
- Press the STATUS button to display screen shown in Figure 4-71.

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

The maximum area that can be entered depends on the number of locations available on the unit.

With all 200 locations available, the Max area that can be entered is limited to a 5 digit value for ft2 and a 4 digit value for m2.

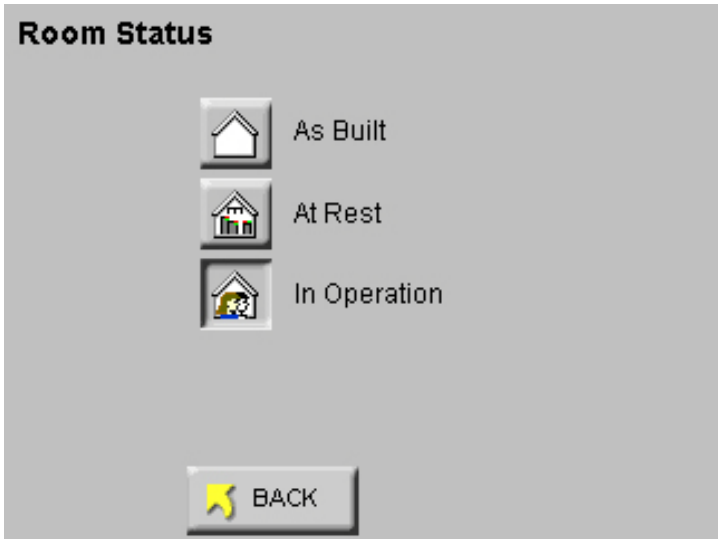


Figure 4-71 Reports Room Status Scree

- Select appropriate room status (As Built, At Rest, In Operation).
- Press the BACK button.

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- Press the FLOW button to display screen shown in Figure 4-72.

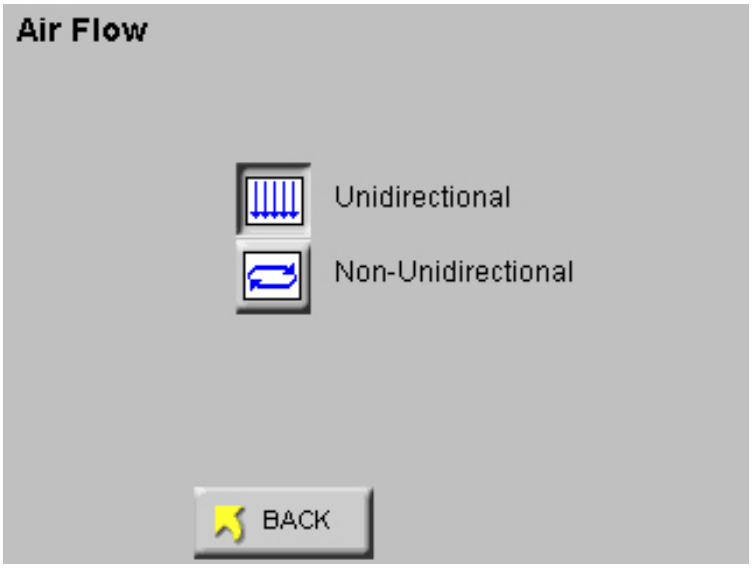


Figure 4-72 Reports Air Flow Screen

- Choose the appropriate type of air flow (Unidirectional, Non-Unidirectional), then press the BACK button to return to the SETUP screen.

Note: *Recipes and locations cannot be saved for reports if Reports are disabled and if there are not enough locations to allocate to the report. The "LOC" and "SAVE buttons will not be displayed in these cases.*

- The SETUP screen shown in Figure 4-73 will display the values that were configured in the display fields.

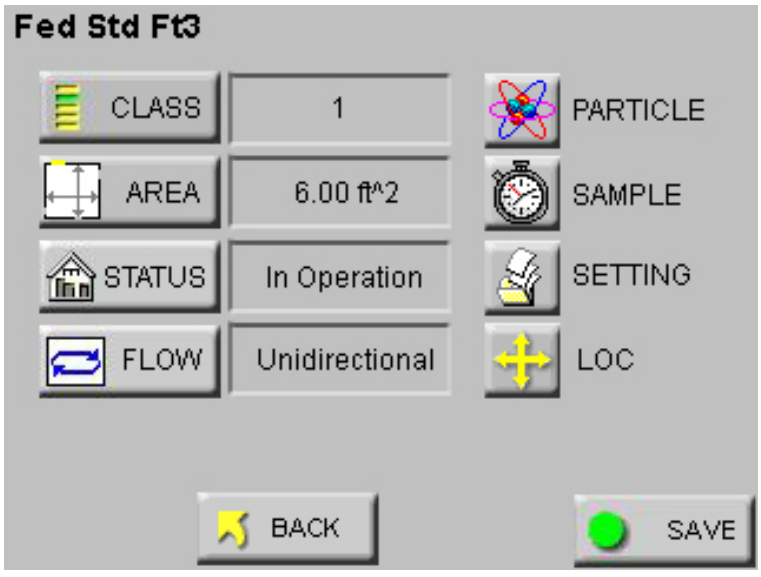


Figure 4-73 Configure the Instrument

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

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- Select the PARTICLE button to enable or disable particle channels as shown in Figure 4-74.



Figure 4-74 Reports Particle Screen

- Press the BACK button.
- Select the SAMPLE button to configure the number of Cycles, Delay time, Hold time, Sample time and Volume. See Figure 4-75.

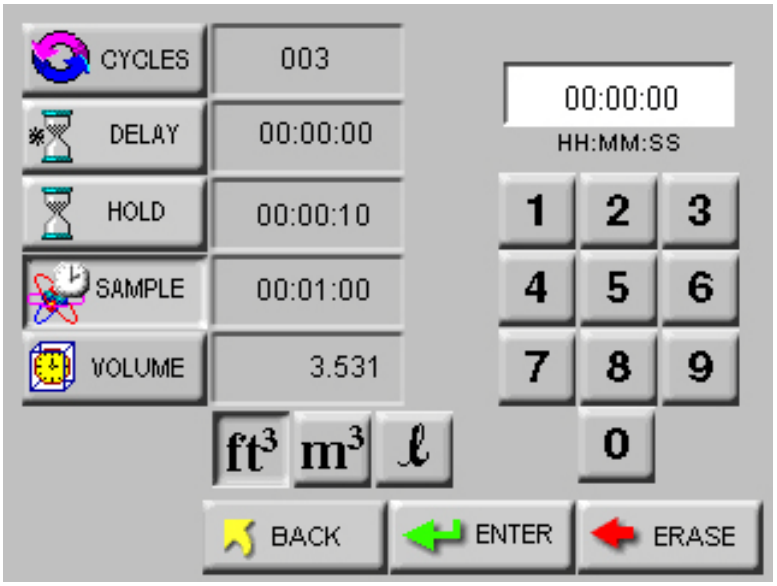


Figure 4-75 Reports Sample Screen

- Press the BACK button.

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- Select the SETTING button to format the instrument for CUML/DIFF, RAW/NORM, ft^3/m^3 as shown in Figure 4-76.

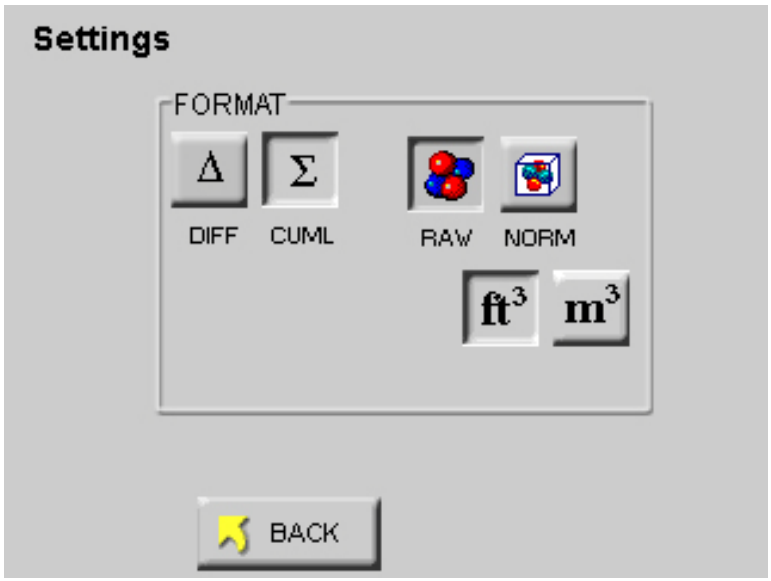


Figure 4-76 Reports Settings Screen

- Press the BACK button.
- Select the LOC button to select, add or delete locations or enable Auto Inc as shown in Figure 4-77.

Note: *If the location is already assigned to another recipe of if there are no available free locations, the user will not be able to add a new recipe. The "ADD" button will not be displayed.*

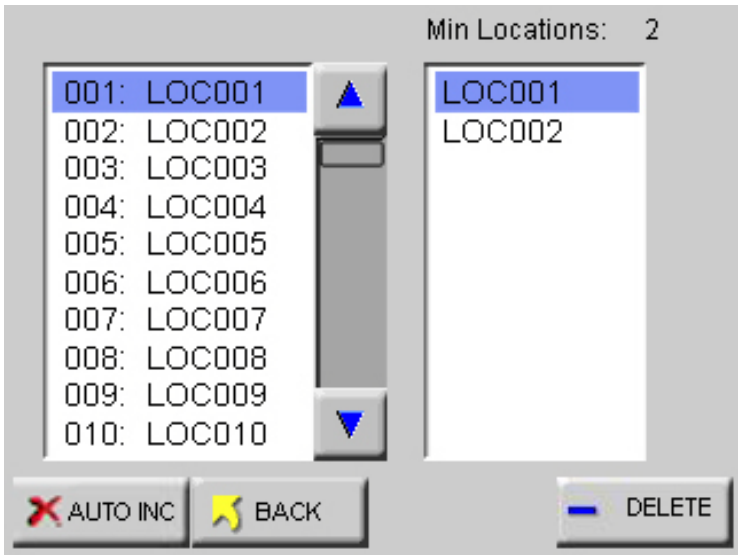


Figure 4-77 Reports Location Screen

- Press the BACK button.

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- Select BACK to return to the main REPORTs screen or select SAVE to save the configuration in the Recipe database. See Figure 4-78.

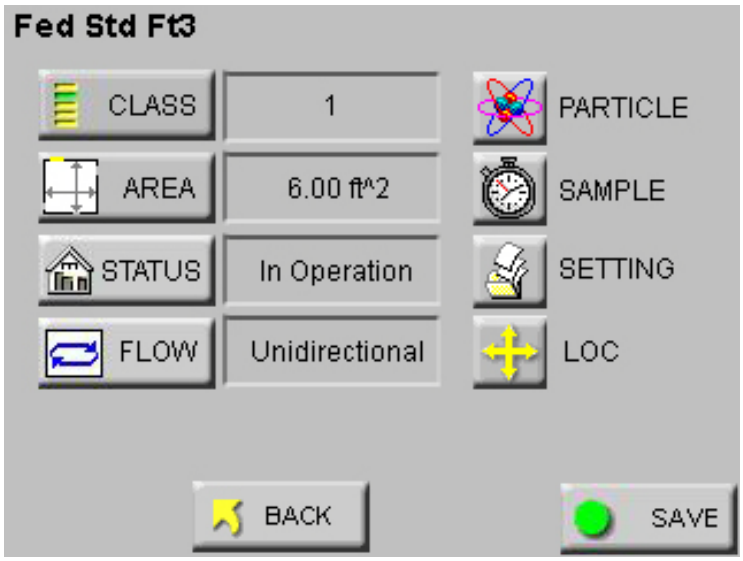


Figure 4-78 Reports Setup Screen

- When "REPORTS" are enabled, the "LOC" and "SAVE" buttons are displayed only when thre are at least the minimum number of locations needed for the recipe area available. See Figure 4-79.

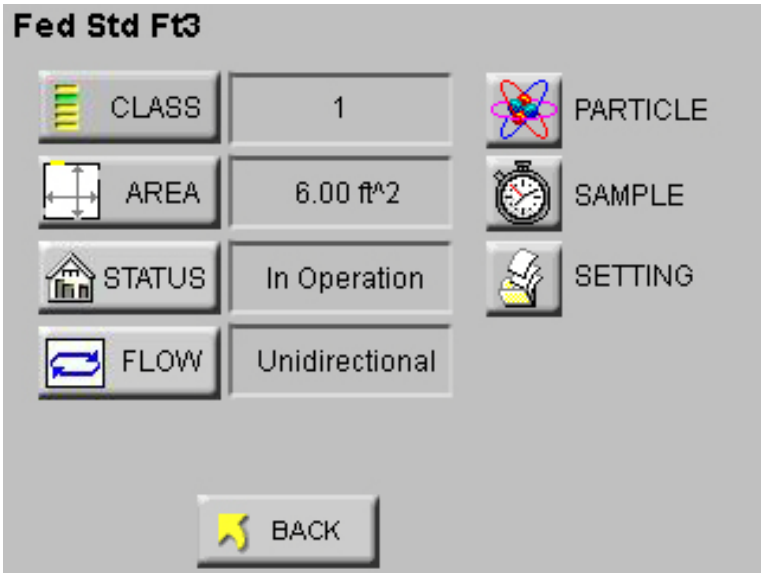


Figure 4-79 Setup Screen No LOC or SAVE Buttons

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

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Setting up Counter to Run Reports

For this example, the FED STD FT^3 report will be used. See Figure 4-80.

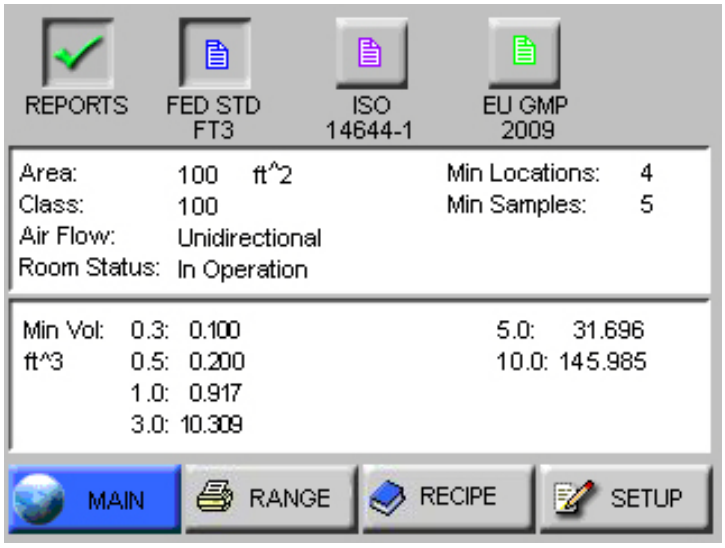


Figure 4-80 FED STD FT3 Report Screen

- Set the instrument for the Fed Std ft^3 report, 100 ft^2, Class 100, unidirectional air flow, operational room status.
- This will generate the following minimum requirements:
  - Min Locations: 4
  - Min Samples: 5

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

The number of digits allowed for area to calculate volume is limited to a 5 digit value for ft2 and a 4 digit value for m2.

Table 4-1 Table - Minimum Volume per Channel Size

Ch Size (µ)	Min Vol (ft^3)
0.3	0.100
0.5	0.200
1.0	0.917
3.0	10.309
5.0	31.696
10.0	145.985

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

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- 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.
- Press the CYCLES button.
- Set the CYCLES value for 1 and press ENTER.

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 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 forth 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.

Report Output Setup

Note: *Report Output can also be configured as a new or previously saved recipe, which can be set through the Reports option or the Recipe option.*

The Report output can be directed to an external thermal printer. To configure the destination, press CFG then OUTPUT. In the Output Setup screen, verify that the Output on Sample is enabled with a green check mark.

Printing a Report

To print a report, the user can choose to either clear the data before starting the test or run the samples and then select 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 to be included in the range.
- Press ENTER.

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- 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 continue until there is a break in the report processing.*

Report Requirements

Fed Std ft^3

This report requires a minimum of 2 locations be measured, at least 1 sample be taken per location and at least 5 samples total be taken in each cleanroom at a minimum sample volume of 0.1 cubic feet.

The 95% Upper Confidence Limit (UCL) will be calculated by the HANDHELD if the number of sampled locations is equal to or less than 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 ft^3 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

ISO 14644-1

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

Note: *The EU GMP 2009 report is only valid if the instrument is configured with the 0.5 and 5.0 micron channel sizes.*

EU GMP 2009

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

The EU GMP Report has different concentration limits for cleanroom status “At Rest” versus “In Operation”. When the cleanroom is “In Operation”, Class D is not available. The standard is not defined for Class D in an operational cleanroom.

Sample Printouts of Standard Reports

Figure 4-81, Figure 4-82 and Figure 4-83 are examples of a Federal Standard Ft3, ISO 14644-1 and a EU GMP 2009 reports.

Note: *If a recipe is loaded, the name of the recipe will be printed on the report.*

```
*************
Fed Standard 209E_Ft^3
**HANDHELD 3016**
Serial #: 130602021
Targeted Class:   10000
Room Area:       10.00ft^2
Room Status: Operational
Air Flow: Unidirect
Min Loc: 2
Min Samples/Room: 5
Recipe: TEST
        -----
06/20/2013, 09:09:08
        -----

Particle Size: 0.3
Cumulative, p/ft^3
Vol Req:      0.100 ft^3
Concen Limit:      30800
        -----
Loc Samples   AvgConcen
LOC001  5         6114.0
LOC002  5         4572.0
        -----
Mean:              5343.0
StdDev:            1090.4
StdError:           771.0
95% UCL:          10208.0
Min Vol:        0.100 ft^3
        -----

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

Loc Samples   AvgConcen
```

Figure 4-81 Sample Federal Standard 209E (ft^3) report

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Note: *If a recipe is loaded, the name of the recipe will be printed on the report.*

```
*************
ISO 14644-1
**HANDHELD 3016**
Serial#: 130602001
Targeted Class: 8
Room Area:       1.49 m^2
Room Status: Operational
Air Flow: Unidirect
Min Locations: 2
Min Samples/Room: 2
Recipe: TEST
        -----
06/19/2004, 18:10:17
        -----

Particle Size: 0.5
Cumulative, p/m^3
Vol Req:      2.000 L
Concen Limit: 3520000
        -----
Loc Samples   AvgConcen
LOC003  2        13949.3
LOC004  2        11477.3
        -----
Mean:             12713.3
StdDev:            1748.0
StdError:          1236.0
95% UCL:          20500.2
Min Vol:          2.832 L
        -----

Particle Size: 1.0
Cumulative, p/m^3
Vol Req:      2.000 L
Concen Limit:   832000
        -----
Loc Samples   AvgConcen
LOC003  2         7062.9
LOC004  2         7769.2
        -----
Mean:              7416.1
StdDev:             499.4
```

Figure 4-82 Sample ISO 14644-1 report

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Note: *If a recipe is loaded, the name of the recipe will be printed on the report.*

```
************
EU GMP 2009
**HANDHELD 3016**
Serial #: 130602021
Targeted Class: C
Room Area:       1.49 m^2
Room Status: Operational
Air Flow: Unidirect
Min Locations: 2
Min Samples/Room: 2
Recipe: TEST
        -----
06/21/2013, 09:12:09
        -----

Particle Size: 0.5
Cumulative, p/m^3
Vol Req:      2.000 L
Concen Limit:    3520000
        -----
Loc Samples   AvgConcen
LOC001  2        8872.8
LOC002  2       23228.2
        -----
Mean:           16050.5
StdError:       10150.8
StdDev:          7177.7
95% UCL:        61270.1
Min Vol:       56.634 L
        -----

Particle Size: 5.0
Cumulative, p/m^3
Vol Req:      2.000 L
Concen Limit:      29000
        -----
Loc Samples   AvgConcen
LOC001  2         194.2
LOC002  2         317.8
```

Figure 4-83 Sample EU GMP 2009 report

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Power Shutdown Levels

When the HANDHELD 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 displayed in Table 4-2.

Table 4-2 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.

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5 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 fulfill 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.

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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.

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.

EU GMP 2009

The EU GMP 2009 only applies to 2 channel sizes: 0.5µ and 5.0µ.

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).

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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.

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6 Maintenance Procedures

This Chapter provides the user with the procedures to perform in maintaining the HANDHELD instrument.

Safety

Before performing any of the maintenance tasks described in this chapter, review safety warnings that are supplied throughout this manual.

Calibration

To maintain optimum performance of this instrument, it should be recalibrated annually by a Lighthouse Authorized Service Provider.

Cleaning

This procedure may be superceded by customer requirements; however, do not under any circumstances apply Acetone to the HANDHELD instrument.

1. To keep the interior of the instrument clean, remove the isokinetic probe from the air inlet and install the protective plastic cap supplied with the instrument.
2. Moisten a lint-free cloth with isopropyl alcohol. The cloth should be moist, not wet.
3. Wipe down the exterior surfaces of the instrument.

Purge Test

1. Connect the Purge filter to the sample inlet. The purge filter should be a 0.1 micron, 0.1 CFM filter. Ten (10) five (5) minute samples should be taken. There should be no more than 1 count on average per five-minute sample.
2. Apply power to the instrument.
3. Configure the unit via the touchscreen interface to sample for 30 minutes.

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

5. Configure the unit via the touchscreen interface to sample for 5 minutes and set a 10 second hold.

6. Set Cycles to 10 so the instrument will take 10 five-minute samples.

7. If an average of more than one count per five 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 Tech Support for assistance at 800-945-5905 (USA Toll Free), 541-770-5905 (Outside of USA).

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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 LIABILITY, OR PRODUCT LIABILITY CLAIM AND BUYER AGREES TO WAIVE SUCH CLAIMS. LWS's SOLE AND EXCLUSIVE LIABILITY AND BUYERS SOLE AND EXCLUSIVE REMEDY, FOR ANY NONCONFORMITY OR DEFECT IN THE PRODUCTS OR ANYTHING DONE IN CONNECTION WITH THIS CONTRACT, IN TORT, (INCLUDING NEGLIGENCE), CONTRACT, OR OTHERWISE, SHALL BE AS SET FORTH IN THE SUBSECTION A HEREOF AS LIMITED BY SUBSECTION B HEREOF. THIS EXCLUSIVE REMEDY SHALL NOT HAVE FAILED OF ITS ESSENTIAL PURPOSE (AS THAT TERM IS USED IN THE UNIFORM COMMERCIAL CODE) PROVIDED THAT THE SELLER REMAINS WILLING TO REPAIR OR REPLACE DEFECTIVE EQUIPMENT (AS DEFINED IN SUBSECTION A) WITH A COMMERCIALLY REASONABLE TIME AFTER RECEIVING SUCH EQUIPMENT. BUYER SPECIFICALLY ACKNOWLEDGES THAT SELLER'S PRICE FOR THE EQUIPMENT IS BASED UPON THE LIMITATIONS OF LWS'S LIABILITY AS SET FORTH IN THIS CONTRACT.

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

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

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

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

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B HANDHELD Default Settings

MENU Items and their 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	M/D/Y
PRINT SAMPLE	OFF
PRINT ALARM	OFF

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C HANDHELD MODBUS Register Map v1.48

COMM Settings

Lighthouse particle counters with MODBUS have the following communications settings:

Table C-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 C-2 MODBUS Registers

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

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

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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 C-3 describes the content of these registers.

Table C-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]

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Table C-3 Sensor Settings Registers

Register	Data Type	Description
40020	ASCII string	Model Name char[10], char [11]
40021	ASCII string	Model Name char[12], char [13]
40022	ASCII string	Model Name char[14], char [15]
40023	unsigned integer	Flow Rate. Divide by 100 to get rate in CFM. For example, 100 = 1CFM.
40024	signed integer	Record Count. Total number of records stored in the counter.
40025	signed integer	Record Index. Zero based index to data in 30xxx register series. Must be lower than the record count (register 40024). Set this index to expose a counter's record in the 30xxx registers. Set to -1 to retrieve last record stored in the counter.
40026	unsigned integer	Location number. Particle Counters: Specifies location of Particle Counter. Must be 1 to 200 (maps to location names associated with registers 40200 - 40999). Manifold Controller: Specifies Manifold position. Values 1-32 for the Universal Manifold and values 1-6 for the MiniManifold Controller moves the arm to that position on the manifold. Value 0 moves arm to Home position.
40027	signed integer	Real Time Clock (RTC) [high]. Updates instrument's real-time clock. Works in conjunction with 40028. Displays date and time, in number of seconds since midnight, 1/1/1970. Can be generated by ANSI C/C++ time() function.
40028	signed integer	Real Time Clock [low]
40029	unsigned integer	Initial Delay [high]. Works in conjunction with 40030. Number of seconds to wait before starting the first sample. Max value is 86,399, which equals 23h 59m 59s.
40030	unsigned integer	Initial Delay [low]
40031	unsigned integer	Hold Time [high]. Works in conjunction with 40032. Number of seconds to wait between sample periods. Max value is 86,399, which equals 23h 59m 59s.
40032	unsigned integer	Hold Time [low]
40033	unsigned integer	Sample Time [high]. Works in conjunction with 40034. Number of seconds to sample. Max value is 86,399, which equals 23h 59m 59s.

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Table C-3 Sensor Settings Registers

Register	Data Type	Description
40034	unsigned integer	Sample Time [low]
40035	unsigned integer	Data Set [high]. Works in conjunction with 40036. Data entered here is applied to the device through the command register.
40036	unsigned integer	Data Set [low]
40037	unsigned integer	Alarm Mode. Type of alarming performed
40038	unsigned integer	Alarm Parameter. Control parameter for given alarm mode.
40039	unsigned integer	Laser Reference Voltage (millivolts)
40040	unsigned integer	View Volume. Divide by 100 to get percentage. For example: 6550d = 65.50%
40041	ASCII string	Flow Unit. Defines unit as cfm, lpm, mlpm.
40042	ASCII string	Flow Unit. char[2], char[3]
40043	unsigned integer	Calibration Reference Voltage (millivolts)
40047	signed integer	Calibration Due Date [high]. Indicates when instrument is due for calibration. this number can be generated by the ANSI C/ C++ time() function.
40048	signed integer	Calibration Due Date [low].
...		
40199	unsigned integer	Number of available alphanumeric location names (0 means alphanumeric names are not supported).
40200	ASCII string	Location_1_char[0], char[1] (NULL terminated string)
40201	ASCII string	Location_1_char[2], char[3]
40202	ASCII string	Location_1_char[4], char[5]
40203	ASCII string	Location_1_char[6], char[7]
...		
40996	ASCII string	Location_200_char[0], char[1] (NULL terminated string)
40997	ASCII string	Location_200_char[2], char[3]
40998	ASCII string	Location_200_char[4], char[5]
40999	ASCII string	Location_200_char[6], char[7]

Registers 40200-40999 are reserved for eight character names

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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 C-4 Device Status

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

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Table C-4 Device Status

Bit	Description
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 C-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.

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Table C-5 Command Register

Value	Action
11	Instrument Start (Automatic Counting). Particle Counters: Uses defined Initial Delay, Hold Time, Sample Interval and counting mode. Instrument executes samples and holds until an Instrument Stop command is issued. For instruments with pumps, this command will start the pump. Manifold Controller: Uses defined Manifold Sequence. Stops counting and changing positions when an Instrument Stop command is issued.
12	Instrument Stop. Aborts current sample. Stops pump, if applicable. Stops data collection.
13	Set Real Time Clock. Writes "Data Set" values (from Registers 40035 & 40036) to the local Real Time Clock. New time value is saved.
192	Change BAUD to 19200
576	Change BAUD to 57600
1152	Change BAUD to 115200

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Data and Alarm Registers

Data and Alarm Enable Registers

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

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

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

Table C-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 C-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]

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Table C-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]
...		
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 C-8 Example of Alarming on Channel 2

Registers	Particle Channel	Bit 1 Enabled
43009 - 43010	1	0
43011 - 43012	2	1

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Table C-8 Example of Alarming on Channel 2

Registers	Particle Channel	Bit 1 Enabled
43013 - 43014	3	0
43015 - 43016	4	0
43017 - 43018	5	0
43019 - 43020	6	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 C-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]

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Table C-9 Alarm Threshold Registers

Register	Data Type	Description
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]

Setting the Alarm Threshold Value

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

Table C-10 Alarm Threshold Register Default Values

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

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Data Registers

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

Example:

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

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

Example:

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

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

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

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

Table C-11 Data Registers

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

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Table C-11 Data Registers

Register	Data Type	Description
30010	unsigned integer	Particle Channel 1 [low]
30011	unsigned integer	Particle Channel 2 [high]
30012	unsigned integer	Particle Channel 2 [low]
30013	unsigned integer	Particle Channel 3 [high]
30014	unsigned integer	Particle Channel 3 [low]
30015	unsigned integer	Particle Channel 4 [high]
30016	unsigned integer	Particle Channel 4 [low]
30017	unsigned integer	Particle Channel 5 [high]
30018	unsigned integer	Particle Channel 5 [low]
30019	unsigned integer	Particle Channel 6 [high]
30020	unsigned integer	Particle Channel 6 [low]
...		
30041	IEEE Float	Analog Channel 1 [high]
30042	IEEE Float	Analog Channel 1 [low]
30043	IEEE Float	Analog Channel 2 [high]
30044	IEEE Float	Analog Channel 2 [low]
30045	IEEE Float	Analog Channel 3 [high]
30046	IEEE Float	Analog Channel 3 [low]
30047	IEEE Float	Analog Channel 4 [high]
30048	IEEE Float	Analog Channel 4 [low]
...		
30073	unsigned int	Valid analog channels [bit0=ch 1, ..., bit15=ch16]
30074	unsigned int	Valid particle channels
30075	unsigned int	Alarm Flags - Analog Channels (bit 0 = channel 1 ...)
30076	unsigned int	Alarm Flags - Particle Channels

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

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

Device Status Word (30007 - 30008)

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

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

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

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

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

Table C-12 Device Status Word

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

Bits 7 to 31 are currently unused.

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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.

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Table C-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 C-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

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Data Units Registers

The 42xxx register series identifies units used by data items in the 30xxx series and 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 C-15 Data Units

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

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

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