Models 200L, 205, 205A, 209D, A2100, A2120, A2200, A249, A2210, A2212, A2420

Laser Particle Counters

Operating Guide

Met One

Major revisions of this manual will be indicated by a new revision date and part number. Minor corrections or additions may be made at any time without changing the manual date or part number.

Publsihed January 1990, part number 701063

How to Use this Manual

Where to Start

If you have just received a new particle counter, read the following sections of this manual. If the particle counter is already set up and working, you can skip Section 1.

Section 1, *Getting Started*, read . . .
- Unpacking and Initial Inspection
- Initial Power Turn-on

Section 2, *Operation*, read . . .
- Counting Particles
- Using the Front-Panel
- Setting Programmed Functions

After reading these sections, you can use the rest of the manual as a reference. Each section of the manual has an introduction that tells you what you will find in that section. The manual also has an Appendix A that contains supplemental information that may be helpful if problems occur with the particle counter.

Manual Conventions

This manual shows front-panel nomenclature in capital letters. For example, the "enter" key will appear as ENTER in the manual. Some keys also contain labeled lights. For example, the COUNT MODE key has two lights labeled "CUM" and "DIFF". The names of these keys are followed by the names of the lights. For example, COUNT MODE: CUM/DIFF.

Each section of this manual has its own series of page numbers that are prefixed with the section number. For example, Section 1, Getting Started, is numbered 1-1, 1-2, 1-3, etc. and Section 2, Operation, is numbered 2-1, 2-2, and 2-3, etc.

Instruments Covered by this Manual

This manual covers the latest versions of the instruments listed on the title page. Manual effect from earlier versions of counters is covered in Appendix A, *Supplemental Information.*

WARRANTY

Prior to shipment, each MET ONE instrument is thoroughly inspected and tested to applicable specifications. However, should equipment failure occur, MET ONE assures its customers that prompt service and support will be available. All equipment originally manufactured by MET ONE which is found to be defective will be repaired or replaced subject to the following considerations:

TERMS AND CONDITIONS

All units/components, properly packed for handling, should be shipped freight prepaid to the MET ONE designated Service Center. Equipment will be returned to the customer's/user's site freight prepaid and invoiced. Fuses, lamps, pumps, hoses and filters are excluded from the standard replacement clause, but are covered separately on a limited exchange basis and will be exchanged up to 30 days after shipment of the equipment.

COVERAGE

Throughout the lifetime of the equipment, MET ONE will readily provide on-site or in-plant service at reasonable rates comparable to those of other manufacturers in the industry.

During the first year, the returned unit/part will be repaired and/or replaced at MET ONE's option, with no charge for labor or parts not excluded by warranty. Warranty commences with equipment shipment.

MET ONE reserves the right to replace parts under warranty with re-manufactured items. On certain items, extended warranty is available.

NON-MET ONE MANUFACTURED EQUIPMENT

Equipment provided but not manufactured by MET ONE is warranted and will be repaired to the extent and according to the current conditions of the respective equipment manufacturer's warranty.

ON-SITE WARRANTY REPAIR SERVICE

Any service provided at the customer's location will be charged at the current warranty service rate.

SERVICE CONTRACTS

On-site service contracts are available at substantial savings. Please request a quotation from a MET ONE sales or service representative.

GENERAL

Under the MET ONE Standard Warranty, Warranty Extension or On-Site Service Contract, the customer is responsible for all charges caused by modifications or additions to MET ONE equipment not approved in writing by MET ONE, or if in MET ONE's opinion the equipment has been subjected to abnormal use. "Abnormal use" for purposes of this warranty is defined as any use to which the equipment is subjected other than that use specified or intended as evidenced by purchase or sales representation. Other than the above, no other warranty, expressed or implied, shall apply to any and all such equipment furnished or sold by MET ONE, INC.

The remedies described herein shall be the purchaser's sole and exclusive remedies under this warranty. Except for the express warranties stated above, MET ONE disclaims all warranties on the MET ONE hardware and software products furnished hereunder, including all implied warranties of merchantability and fitness. The stated express warranties are in lieu of all obligations or liability on the part of MET ONE for damages, including but not limited to special, indirect or consequential damages of any kind, or loss of revenue or other financial loss, arising out of the use of MET ONE products. MET ONE's maximum liability under the express warranties contained in this section shall not, in any case, exceed the total price paid by the purchaser for the specific items involved.

Contents

Section 2: **OPERATION** (Continued)

Section 3: **PERFORMANCE VERIFICATION**

Appendix A: **SUPPLEMENTAL INFORMATION**

Appendix B: **REMOTE OPERATION**

Safety

Cautions and **Warnings** are used throughout this manual. Familiarize yourself with the meaning of each before operating the particle counter.

WARNING

A **WARNING** indicates a hazard for you. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury. Do not proceed beyond a **WARNING** until the indicated conditions are fully understood and met.

CAUTION

A **CAUTION** indicates a hazard for the particle counter. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to the counter. Do not proceed beyond a **CAUTION** symbol until the indicated conditions are fully understood and met.

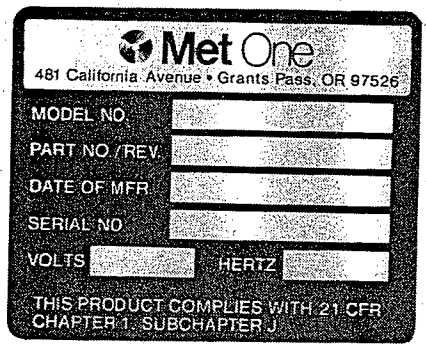
Laser Safety Information

The laser particle counter 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 both visible and invisible radiation, depending on the type of particle counter you have. Service on the counter should be performed only by factory-authorized personnel.

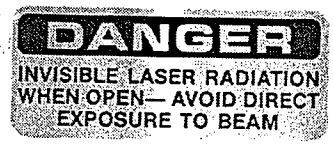
WARNING

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

Several labels are attached to the sensor for your awareness. Reproductions of the labels are shown below:

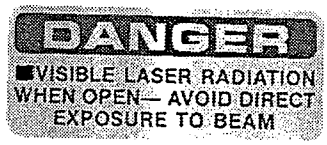


Identification/Certification Label
Located on Rear Panel



1288-33-1

Warning Label
Located on Solid-State Laser Sensor



0489-90-1

Warning Label
Located on HeNe Laser Sensor

Electrostatic Discharge

Electrostatic discharge (ESD) can damage or destroy electronic components in those counters using solid-state laser sensors (see "Specifications" in Section 1 for type of sensor in your counter). Therefore, all service or maintenance work should be done at a static-safe work station. A static-safe work station can be created by doing the following:

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

WARNING

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

CAUTION

The laser driver board, mounted on the laser sensor of the particle counter, contains wire leads from an extremely static-sensitive laser diode. Do not touch the laser driver board or any attached cables unless you are ESD protected.

Gaseous Safety Information

Several precautions should be considered when handling certain types of gases and gases under pressure. Take extreme care when doing any procedures preceeded by or containing a warning.

WARNING

Do not attempt to sample reactive gases with the particle counter. Reactive gases create an explosion hazard in the counter. Contact the factory for more information.

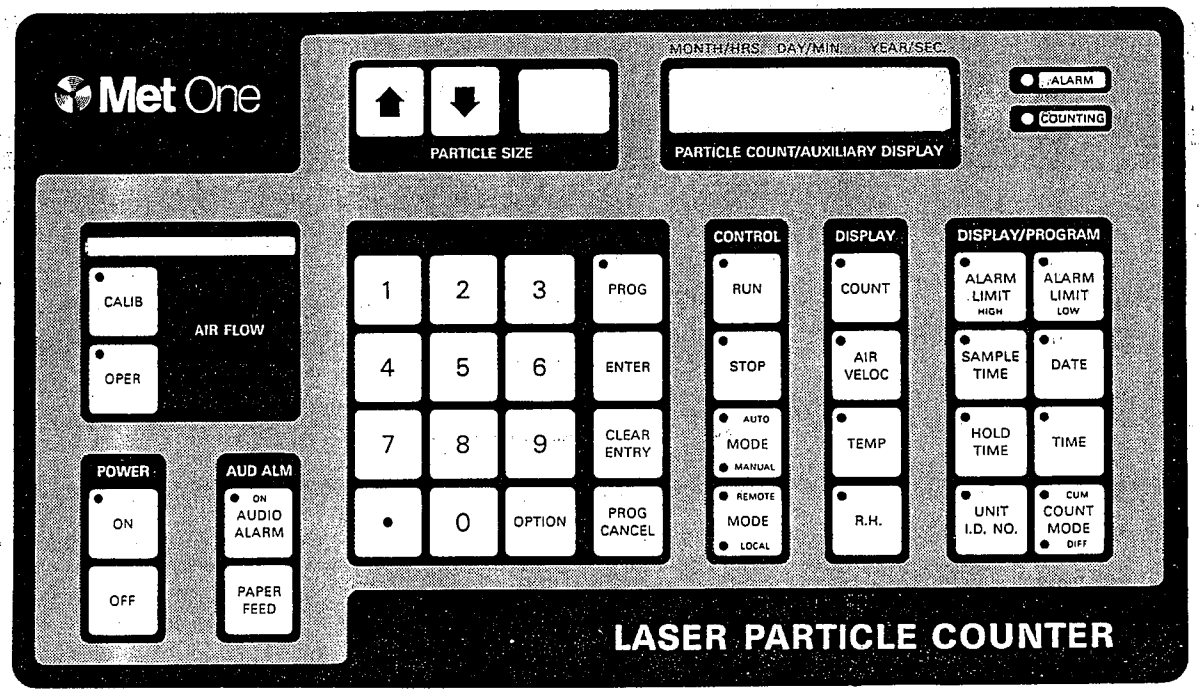
WARNING

Installing the high pressure diffuser backwards will INCREASE pressure instead of diffusing it—causing the high pressure diffuser to explode.

GETTING STARTED

Introduction

This section describes getting the particle counter ready for use, including unpacking, initial inspection, and turning the counter on, but first you will be introduced to the counter and its options, accessories, and specifications.



0889-142

Figure 1-1. Typical Laser Particle Counter

Introducing the Particle Counter

The particle counter measures airborne particles in six size ranges at the same time, and displays the number of particles in each range as a cumulative or differential count. The counter is a state-of-the-art laser-based microprocessor-controlled instrument. It provides adjustable count alarms, automatic calibration verification, and computer-controlled operation through a serial port.

The counter's laser and optical lenses create a laser beam that is used to detect particles. The airborne particles pass through the laser beam, deflecting bursts of light onto a solid-state photo diode that converts the light to an electrical pulse. The size of the pulse is proportional to particle size. The microprocessor and its associated circuitry sorts and counts these pulses.

Accessories

RH/Temp and Air Velocity Probes	Plug into the counter rear panel. The RH/Temp probe monitors relative humidity (10 to 90%) and temperature (specify 0 to 100°F, or -18 to 38°C). The air velocity probe monitors air velocity (specify 80 to 120 feet/minute, or 410 to 616 mm/second). The particle counter displays the reading of either probe.
High Pressure Diffuser	Allows the particle counter to measure in pressurized systems (30-150 psi). Connects in series with particle counter inlet.
Instrument Cart	Allows easy movement of counter between sample locations.
Carrying Case	Protects the counter during shipment or storage.

Options

The following option can be installed when you order your counter or any time thereafter if you return your counter to the factory.

External Printer	Provides same printouts as built-in printer, but at distances removed from counting area. Replaces built-in printer.

Specifications (All Counters)

Power	300 watts
Voltage	115, 100, or 230 VAC ±10% (specify one)
Frequency	50 - 60 Hz
Maximum Count Displayed	999,999
Environment (Operating):	
Temperature	12 to 41°C (55 to 105°F)
Humidity	20 to 85% relative, non-condensing
Environment (Non-Operating):	
Temperature	-40 to 71°C (-40 to 160°F)
Humidity	up to 98% relative, non-condensing

Model 200L Specifications

Size	12.25" wide x 7.0" high x 14.5" deep
Weight	32 lbs.
Light Source	Solid-state laser, single port
Laser Life	30,000 hours
Sample Flow Rate	1 cfm (0.1 cfm, 0.01 cfm optional)
Particle Size Ranges	0.3, 0.5, 1.0, 2.0, 5.0, 10.0 micron (optional sizes available)
Coincidence Error	less than 5% at 3,000,000/cf for 1 cfm flow rate

Models 205 and 205A Specifications

Size . . . . . 12.25" wide x 7.0 high x 22.0" deep

Weight . . . . . 38 lbs.

Light Source . . . . . HeNe laser, open cavity, single port

Sample Flow Rate . . . . . 1 cfm (0.1 cfm, 0.01 cfm optional)

Particle Size Ranges:

Model 205 . . . . . 0.16, 0.2, 0.3, 0.5, 1.0, 5.0 micron
Model 205A . . . . . 0.2, 0.3, 0.5, 1.0, 2.0, 5.0 micron

Coincidence Error . . . . . less than 5% at 130,000/cf for 1 cfm flow rate

Maximum Concentrations
for Continuous Operation . . . . . class 10,000 or cleaner environment

Model 209D Specifications

Size . . . . . 13.5" wide x 7.7" high x 22.6" deep

Weight . . . . . 40.4 lbs.

Light Source . . . . . HeNe laser, open cavity, single port

Laser Life . . . . . 35,000 hours

Sample Flow Rate . . . . . 1 cfm

Particle Size Ranges . . . . . 0.1, 0.2, 0.3, 0.5, 1.0, 5.0 micron

Coincidence Error . . . . . less than 5% at 830,000/cf for 0.1 cfm flow rate

Maximum Concentrations
for Continuous Operation . . . . . class 10,000 or cleaner environment

Model A249 Specifications

Size	13.5" wide x 7.7" high x 22.6" deep
Weight	40.4 lbs.
Light Source	HeNe laser, open cavity, four-port
Laser Life	35,000 hours
Sample Flow Rate	1 cfm
Particle Size Ranges	0.1, 0.2, 0.3, 0.5, 1.0, 5.0 micron
Coincidence Error	less than 5% at 90,000/cf for 1.0 cfm flow rate
Maximum Concentrations for Continuous Operation	class 10,000 or cleaner environment

Model A2120 Specifications

Size	13.5" wide x 7.7" high x 22.6" deep
Weight	40.4 lbs.
Light Source	HeNe laser, open cavity, four-port
Laser Life	35,000 hours
Sample Flow Rate	2 cfm
Particle Size Ranges	0.1, 0.2, 0.3, 0.5, 1.0, 5.0 micron
Coincidence Error	less than 5% at 90,000/cf for 2 cfm flow rate
Maximum Concentrations for Continuous Operation	class 10,000 or cleaner environment

Model A2210 Specifications

Size . . . . . 13.5" wide x 7.7" high x 22.6" deep

Weight . . . . . 40.4 lbs.

Light Source . . . . . HeNe laser, open cavity, single port

Laser Life . . . . . 35,000 hours

Sample Flow Rate . . . . . 0.1 cfm

Particle Size Ranges . . . . . 0.1, 0.2, 0.3, 0.4, 0.5, 1.0 micron

Coincidence Error . . . . . less than 5% at 800,000/cf for 0.1 cfm flow rate

Maximum Concentrations
for Continuous Operation . . . . . class 10,000 or cleaner environment

Model A2420 Specifications

Size . . . . . 12.25" wide x 7.0" high x 14.5" deep

Weight . . . . . 36 lbs.

Light Source . . . . . Solid-state laser, two-port

Laser Life . . . . . 30,000 hours

Sample Flow Rate . . . . . 2 cfm

Particle Size Ranges . . . . . 0.3, 0.5, 1.0, 2.0, 5.0, 10.0 micron (optional sizes available)

Coincidence Error . . . . . less than 5% at 100,000/cf for 2 cfm flow rate

Unpacking and Initial Inspection

The counter is thoroughly inspected and tested at the factory and is ready for use upon receipt. When received, inspect the shipping carton for damage. If the carton is damaged, notify the carrier and save the carton for carrier inspection. Inspect the counter for broken parts, scratches, dents, or other damage.

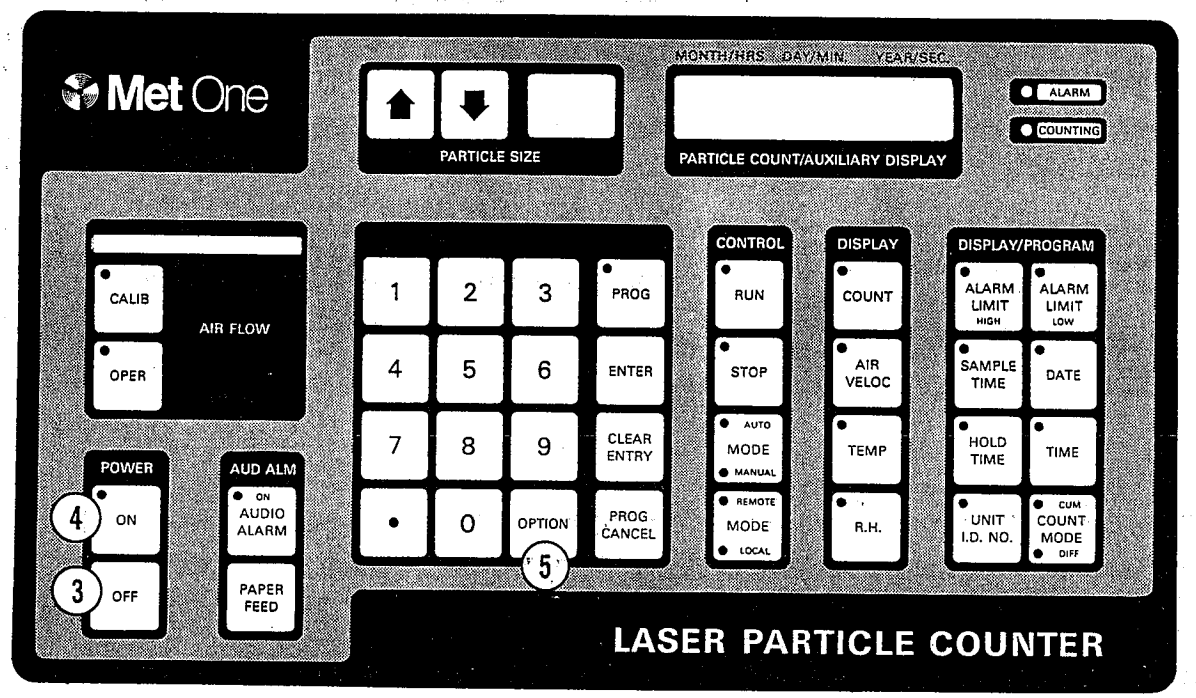
If the carton is not damaged, keep it for reshipment. For example, you may want to reuse the carton when you return the counter for the annual factory calibration.

NOTE

Shipping the counter out of the U.S.A. requires an export license. Contact the factory for more information.

Initial Power Turn-On

You are now ready to locate the counter in its working environment and turn the power on for the first time. Follow the procedure below:



0889-142-1

1. Maintain at least one inch of air space at the back and sides of the counter for proper ventilation.
2. Check rear-panel identification label for line voltage and frequency requirements.
3. Press OFF key; connect ac power cord.
4. Press ON key.
5. (This step loads default values and gives an audible tone [alarm]). Press and hold ON key. Press and hold OPTION key. Release ON first then release OPTION. Press OPTION again to cancel alarm.
6. Refer to next page.

Figure 1-1. Initial Power Turn-on

If the counter is working correctly, the front panel should be as follows:

Bar Graph	green light on
PARTICLE SIZE	(blank display)
PARTICLE COUNT/AUXILIARY DISPLAY	time display with seconds counting (may be inaccurate)
POWER ON light	on
CALIB light	on
AUDIO ALARM light	on
STOP light	on
MODE MANUAL/AUTO	MANUAL light on
MODE LOCAL/REMOTE	LOCAL light on
COUNT MODE CUM/DIFF	CUM light on
TIME light	on

When turning the counter off, always press the CALIB key before the power OFF key. Always turn the counter off before unplugging it. When the preceding procedure has been successfully completed, you are ready to begin using the counter. Refer to Section 2, *Operation.*

Shipping Instructions

Should it become necessary to return the particle counter to the factory for any reason, be sure to contact Customer Service and obtain a Return Authorization number. Reference this number on all shipping documentation and purchase orders. After receipt of the return number, follow the shipping instructions provided below.

1. Use the original container or carton and packing materials whenever possible.

2. If the original container and packing materials are not available, wrap the unit in "bubble pack" plastic; surround it with shock-absorbent material and place it in a double-wall carton.

3. Seal container or carton securely. Mark "Fragile" and enter Return Authorization number in any unmarked corner.

4. Return to the address shown on the cover of this manual.

NOTE

Shipping the counter out of the U.S.A. requires an export license. Contact the factory for more information.

OPERATION

Introduction

This section explains how to operate the particle counter. If you read, perform, and understand the first three subsections in this section, you'll be on your way to using the particle counter to its full capability.

This section contains the following subsections:

- Counting Particles — explains how to make your first measurement immediately, without having to learn all the front-panel controls.
- Using the Front Panel — introduces you to each front-panel control.
- Setting Programmed Functions — gives procedures for setting the programmed functions.
- Using the Option Key — gives procedures for using option functions through front panel controls.
- Printing Results — gives procedures for loading paper and setting printer modes and print intervals.
- Using Options and Accessories — provides instructions for operating the various optional features of the counter, such as an external printer or RH/temp probe.
- A Sample Count Using All Functions — is a procedure that leads you through a sample measurement that uses every function of the counter.

Counting Particles

Your particle counter is ready to use directly out of the shipping carton. You may want to take a sample count prior to setting up the programmed function keys. To count particles in the manual mode, use the procedure on the following page.

WARNING

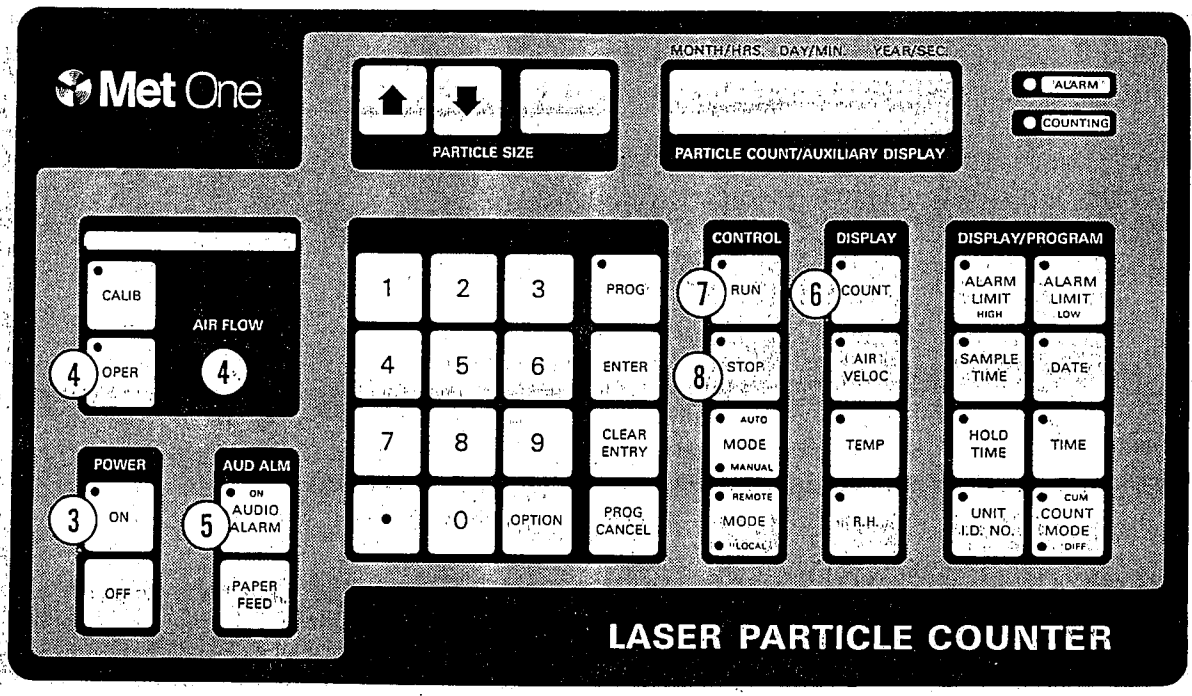
Do not attempt to sample gases with the particle counter. Reactive gases create an explosion hazard in the counter and non-reactive gases can not be accurately measured without making modifications to the counter. Some gases will damage the internal laser sensor. Contact the factory for more information.

CAUTION

- Do not perform this procedure until you have located the counter in a clean environment.
- Water, solvents, or other fluids of any type should never be put into the sensor via the inlet tube (on top of the counter).
- Never operate the counter with the inlet tube capped or plugged.

NOTE

- 1 cfm means one cubic foot of air passes through the sensor in one minute, 0.1 cfm means one-tenth of a cubic foot of air passes through the sensor in one minute.
- An air velocity probe or RH/temperature probe can be connected to the rear-panel connectors J2 and J1, respectively.



0889-142-2

1. Locate counter in a clean environment. Connect the power cord between the counter and facility power.
2. Install isokinetic probe.
3. Press ON key.
4. Press OPER key. Adjust AIR FLOW control until center-green light is on. Airflow is at the nominal flow rate of your counter.
5. If AUDIO ALARM key light is on, turn audio alarm off by pressing the AUDIO ALARM key.
6. Press COUNT.
7. Press RUN key to start counting.
8. Press STOP key to stop counting. The number of particles counted will be displayed.

Figure 2-1. Particle Counter Turn-On

CAUTION

To maintain maximum counter sensitivity, do not place the counter in the operate mode if it is in a non-clean environment, unless you first attach a purge filter to the inlet tube. When transporting the counter through non-clean areas, attach a purge filter to the inlet tube.

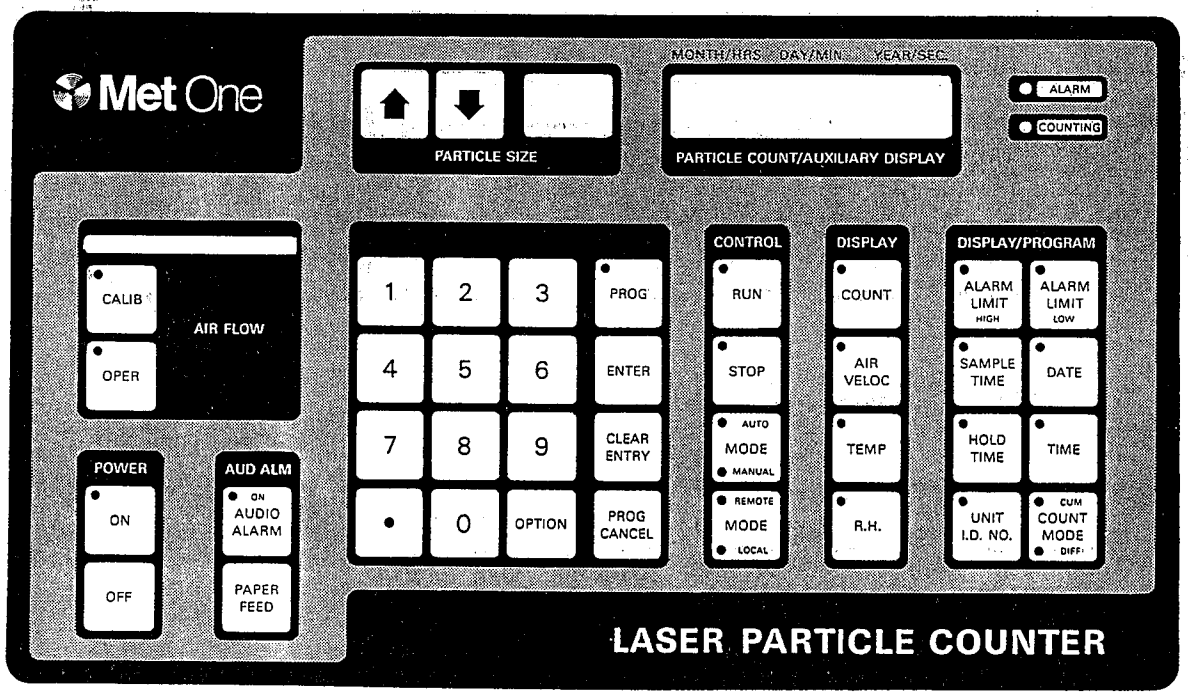
Using the Front Panel

Each front-panel key has a specific function. Some keys select the desired mode while others are used for programming limits or choosing the particle-size range. In this section, you will learn . . .

- the function of each front-panel key and display
- how to set up programmed functions

Front-Panel Keys and Indicators

The following is a list of all front-panel keys and indicators with a brief description of their function. The figure below will help you identify their location.



0889-142

Figure 2-2. Particle Counter Front Panel

CALIB ..... In the calibrate mode the pump is off and the bar graph monitors sensor status. One of the green lights should be on.

OPER ..... In the operate mode the pump is on and the bar graph indicates airflow. When a green light is on, the airflow is calibrated.

AIR FLOW . . . . . Provides airflow rate adjustment.

ON/OFF . . . . . Turns ac power on or off.

AUDIO ALARM . . . Enables or disables the audio alarm.

PARTICLE SIZE . . Selects the particle-size range to be displayed.

0 - 9 . . . . . Enters values for time, date, limits, etc.

PAPER FEED . . . . Causes printer to feed five (5) lines.

OPTION . . . . . Loads default values. Selects print, communication, and calculation modes.

Modes	Modes	Modes	Modes
0 disable printer	5 print interval	10 number of samples	13 number of records
1 enable printer	6 communications format	11 counter select number	14 EPROM part number
2 print on alarms /interval	7 baud rate	12 start/stop buffer print	96 print serial format table
3 print last count	8 enter 209D mode		97 print baud rate table
4 print mode	9 abort 209D mode		99 print options table

PROG . . . . . Selects the program mode.

ENTER . . . . . Enters all programmable functions.

CLEAR ENTRY . . Clears the key-pad entry.

PROG CANCEL . . Exits program mode without changing data.

RUN . . . . . Starts count cycle. If unit is in CALIB mode, it will go to OPER mode (pump comes on), wait five seconds, then start counting.

STOP . . . . . Stops the count cycle, infinite hold time.

MODE: . . . . . In AUTO mode, repeats count and hold cycles. In MANUAL
AUTO/MANUAL mode, enables single count cycles.

MODE: . . . . . Normally in LOCAL mode, except when computer controlled
REMOTE/LOCAL (remote), which disables CALIB, OPER, AUTO/MANUAL, RUN, STOP, PROG, and COUNT MODE keys.

COUNT MODE: . . Selects cumulative or differential count mode. Cumulative count
CUM/DIFF is the total count for the selected size range and all larger sizes. Differential count is the count for the selected size range.

COUNT . . . . . Displays count of the selected particle size.

AIR VELOC ..... Displays air velocity if probe is installed; if not, displays "....".

TEMP ..... Displays temperature if probe is installed; if not, displays "....".

R.H. ..... Displays relative humidity if probe is installed; if not, displays "....".

ALARM LIMIT HIGH .. Displays high alarm limit for the selected particle size, temperature, relative humidity and air velocity.

SAMPLE TIME .. Displays counting time period (1 sec. to 23 hr.:59 min.:59 sec.).

HOLD TIME ..... Displays time between counts (1 sec. to 23 hr.:59 min.:59 sec.).

UNIT I.D. NO. ... Displays the identification number. The number can represent identification of a location or, for multiple counters, identification of a counter.

ALARM LIMIT LOW .. Displays the low alarm limit for temperature, relative humidity, and air velocity. There is no low limit for particle count.

DATE ..... Displays the date.

TIME ..... Displays the time-of-day.

PARTICLE SIZE (display) . Displays the selected particle-size range. (2 digits)

PARTICLE COUNT (display) ..... Displays particle count or AUX DISPLAY time-of-day, date, etc. (6 digits)

ALARM light .... When on, indicates the alarm limit has been exceeded (regardless of AUDIO ALARM status).

COUNTING light . When on, the unit is performing a count cycle.

Bar Graph Lights:

Green ..... When on, indicates correct airflow in operate mode and correct sensor operation in calibrate mode.

Red (left) ..... When on, indicates low airflow in operate mode and sensor problem in calibrate mode.

Red (right) ..... When on, indicates high airflow in operate mode and sensor calibration problem in calibrate mode.

Setting Programmed Functions

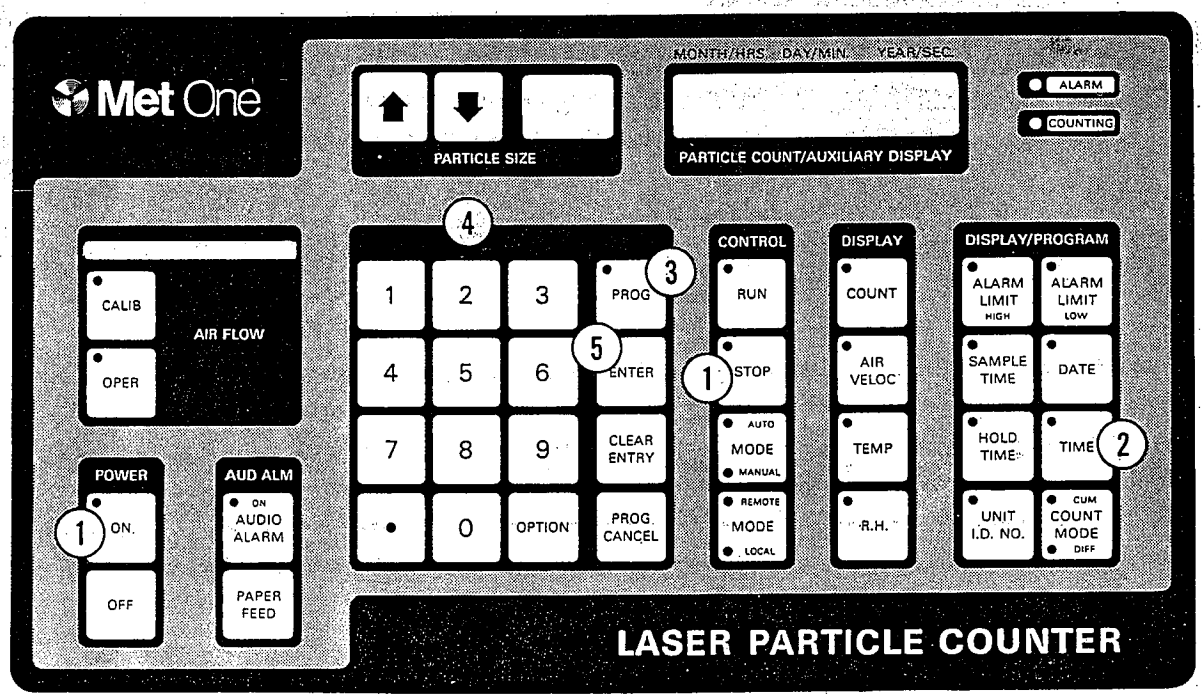
Programmed functions can be grouped into four categories:

- Time-of-day, date, and identification number
- Sample and hold times
- Alarm limits
- Number of Count Cycles

Setting these functions is described on the following pages.

Time, Date, and Identification

These parameters can be displayed by pressing the TIME, DATE, and UNIT I.D. NO. keys while in the stop mode. The identification number can represent identification of a location or a device. If you wish to set them, perform the following:



0889-142-3

1. Press ON then STOP.
2. Press key for the function to be set. For example, press TIME to set the time-of-day.
3. Press PROG.
4. Using 0 to 9 keypad, enter actual time or date. Use 24-hour clock system.
5. Press ENTER to enter number in memory. The functions appear on the printout as programmed in this procedure.

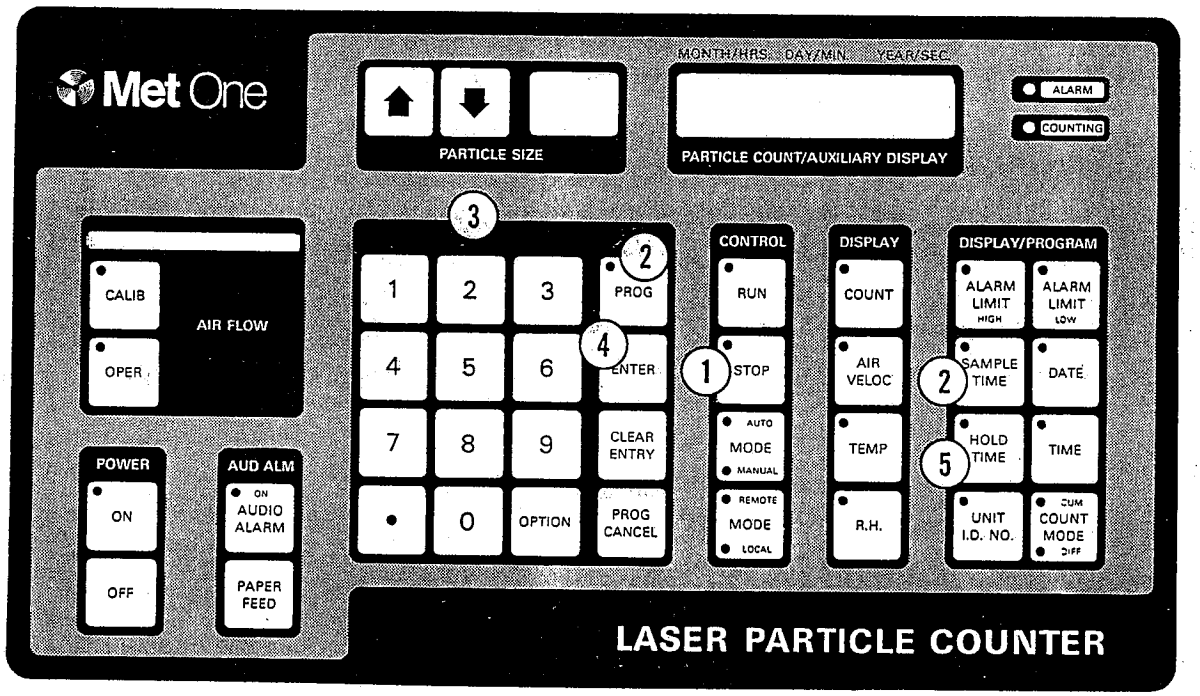
Figure 2-3. Programming Time and Date

Sample and Hold Times

The sample time is the length of time you want to sample air. Hold time is the time between samples. These times can be displayed by pressing the SAMPLE TIME or HOLD TIME keys while in the stop mode. The sample and hold cycle repeats indefinitely in the AUTO mode. Set these times as follows:

NOTE

When setting sample and hold times, an entry of 60 through 99 is an invalid command that causes the counter to run indefinitely. One minute is entered as 1.00.



0889-142-4

1. Press STOP.
2. Press SAMPLE TIME then PROG.
3. Using 0 to 9 keypad, enter desired sample time (from 1 second to 23:59:59 hours).
4. Press ENTER.
5. Press HOLD TIME then PROG.
6. Using 0 to 9 keypad, enter desired hold time (from 1 second to 23:59:59 hours).
7. Press ENTER.

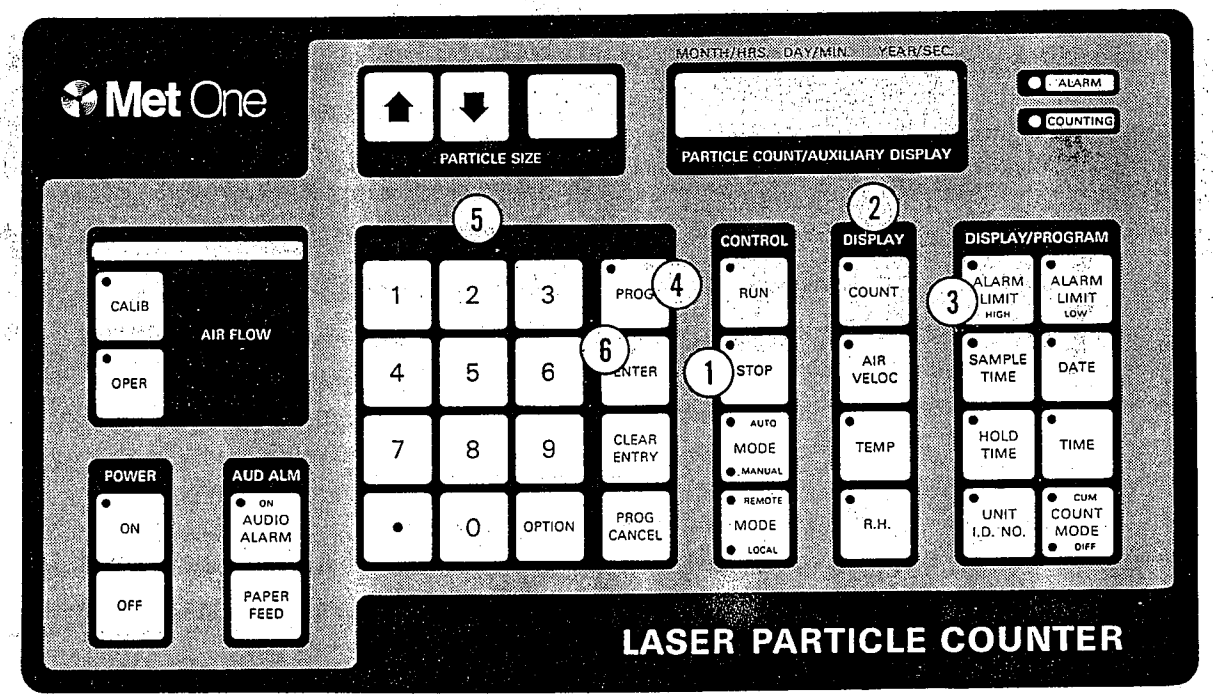
Figure 2-4. Programming Sample and Hold Times

Alarm Limits

An audible alarm can be set to occur when the count, temperature, relative humidity, or air velocity exceeds a certain limit. When count is selected, a limit for each of the six particle-size ranges may be set. To produce a "leak detector" alarm (beep for each particle detected), select the desired size range and enter an alarm limit value of one. To silence the alarm, press the AUDIO ALARM key, and to turn off the alarm, enter both an upper and lower limit value of 0 (zero). Set the alarm limits as follows:

NOTE

Alarm limits for air velocity, relative humidity, and temperature can only be displayed or programmed when the probe(s) are connected to the counter.



0889-142-5

1. Press STOP.
2. Press desired DISPLAY key for alarm limit to be set (count, air velocity, temp, or R.H.). If COUNT is selected, press PARTICLE SIZE up or down arrow to select desired particle size.
3. Press ALARM LIMIT HIGH.
4. Press PROG.
5. Using 0 to 9 keypad, enter alarm limit.
6. Press ENTER to enter limit into memory.
7. For RH, temperature, and air velocity, press ALARM LIMIT LOW and repeat steps 4-6. (There is no low limit for count.)

Figure 2-5. Programming Alarm Limits

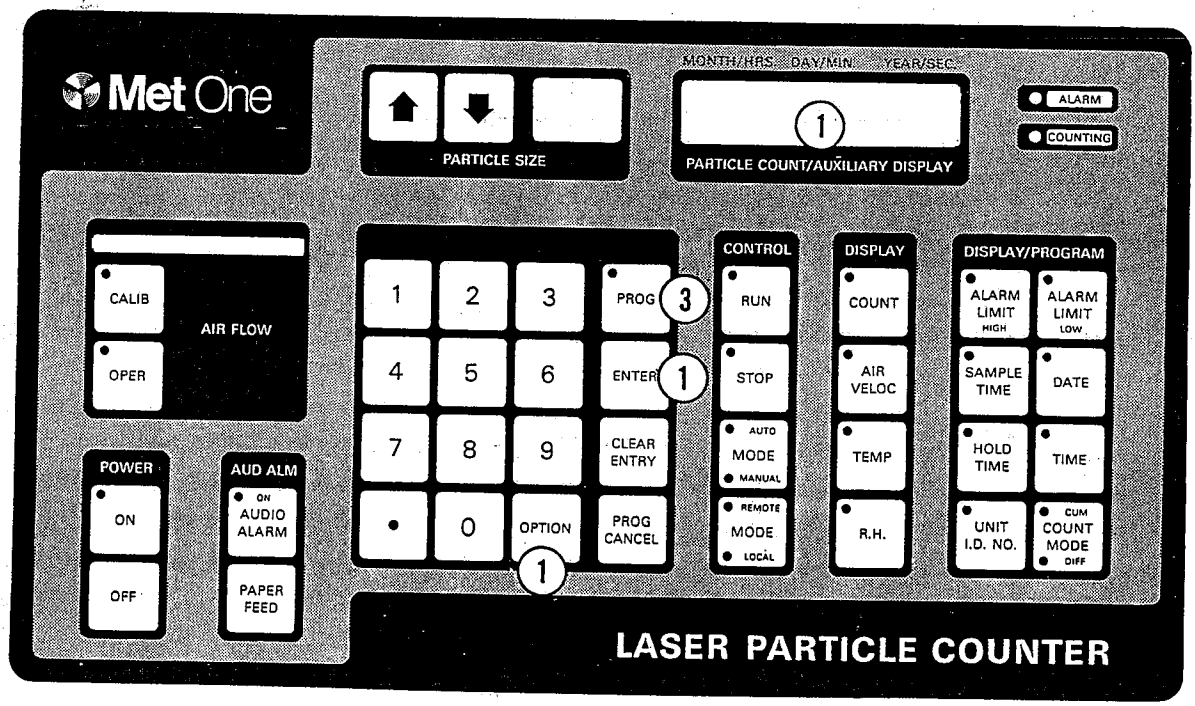
Number of Count Cycles

The counter takes count cycles in the AUTO mode. As soon as the programmed number of count cycles is reached, the counter automatically stops and enters the calibrate mode. From one to 100 count cycles can be programmed with the option mode keys. If 0 (zero) count cycles is selected, the counter will count and hold continuously until stopped.

Display the existing number of count cycles or set a new number of count cycles as follows:

NOTE

This feature was not included in earlier version counters. Refer to "Manual Backdating" in Appendix A, *Supplemental Information,* to determine the vintage of your counter.



0889-142-13

1. Press OPTION, press "10" on the 0-9 keypad, then press ENTER. The existing number of count cycles will be displayed.
2. To change number of count cycles, press PROG then enter the desired number of count cycles (from one to 100) on keypad. If you want continuous operation, enter 0 instead of a finite number.
3. Press ENTER.

Figure 2-6. Selecting Number of Count Cycles

Using the Option Key

This subsection describes how to use the OPTION key to select the following basic functions:

NOTE

Some of this information does not apply to earlier version counters. Refer to "Manual Backdating" in Appendix A, *Supplemental Information*, to determine the vintage of your counter.

- Printer Modes — Printer modes (options 0-5, 12) are described in "Setting Printer Modes" in this section.
- Serial Formats — Serial format modes (options 6 and 7) are covered in "Serial Format and Baud Rates" in Appendix B, *Remote Operation*.
- Serial Buffer Data — Printing serial buffer contents (option 12) or displaying number of samples in the serial buffer (option 13) is described in "Printing Serial Buffer Data" in this section.
- Number of Samples — The number of samples means the same as the number of count cycles. Selecting the number of samples (option 10) is described in "Number of Count Cycles" in this section.
- Counter Select Code — The counter select code (option 11) is used when more than one counter is operating on the same serial port. The counter select code is covered in "Select Codes" in Appendix B, *Remote Operation*.
- Fed-Std-209D Mode — Use of the Fed-Std-209D mode is described in "Fed-Std-209D Mode" in this section.
- EPROM Part Number Identification — Identifying the EPROM part number and the flow rate in your counter is described in "EPROM Part Number Identification" in this section.
- Options/Serial Port Table Printouts — Printing out "help tables" is described in "Options/Serial Port Table Printouts" in this section.

Fed-Std-209D Mode

NOTE

This mode originally appeared as a special option in early version counters.

Your counter will automatically calculate the statistical data required for compliance with Fed-Std-209D. When the 209D Calculations mode is selected, the counter leads you through the compliance testing process and automatically calculates and prints the results.

In the 209D mode, the counter's printer prompts the user, tracks which location is under test, and records all sampling results. You can also tell the counter to print only the averages at each location, instead of printing all sampling results. When all locations have been sampled, the printer prints the mean of averages, standard deviation, standard error, and upper 95% confidence limit.

The 209D Calculations mode will automatically take up to 100 samples at 500 different locations.

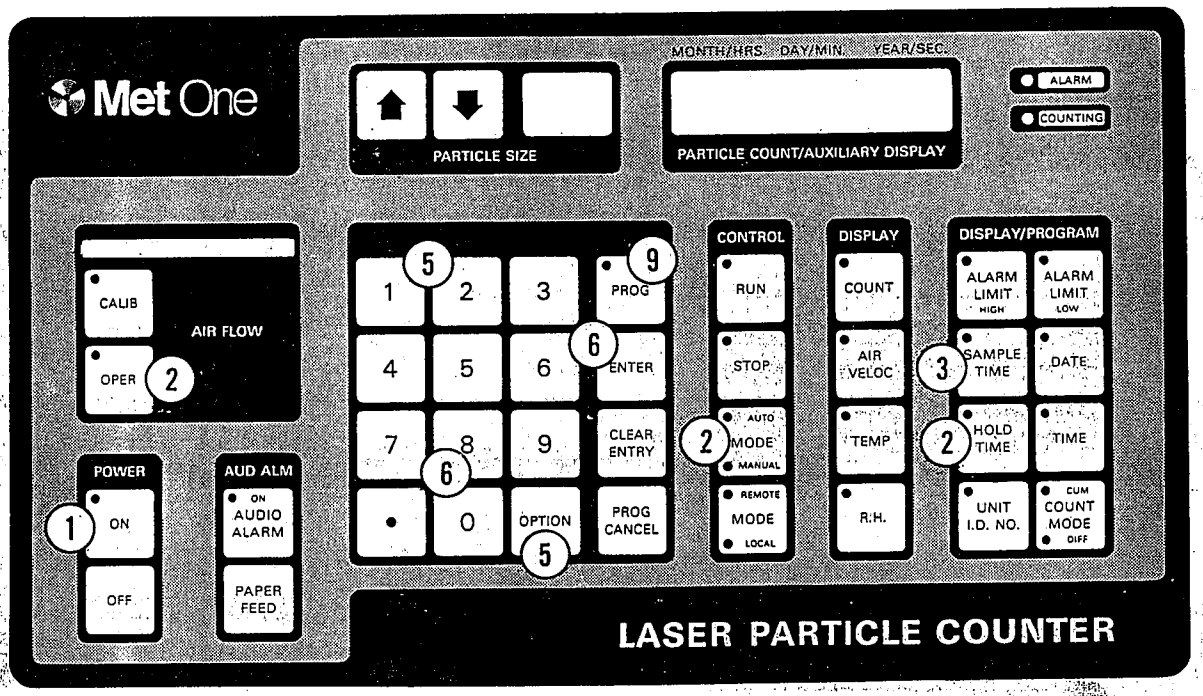
The following tips should be noted while taking Fed-Std-209D calculations:

1. Before moving to the first location, select the sample time to be used for all samples within the calculation run. The SAMPLE TIME key does not function once you have taken the first sample.

2. In the following procedure, when PROG is pressed, the counter will wait indefinitely for you to enter a number. If you don't press PROG, after 10 seconds the counter will automatically default to the number of locations from the last verification process. If you don't have enough time, or you change your mind after entering a number, press OPTION 8 to repeat the sequence.

3. When the samples are complete, the printer will print the date, time, sample time, flow, temperature, relative humidity, and air velocity. The printer will also print the cumulative count for each sample, the average count of all location 1 samples, and the average particles per cubic foot. If you selected OPTION 2, the counts of each sample will be deleted. The printer will then prompt you to press ENTER for location 2.

To use the 209D Calculations mode, follow the procedure on the next page.



1. Position the counter at the first sample location; turn power on.

2. Put the counter in the OPER mode and adjust the AIR FLOW control until the center-green light is on. Set the HOLD TIME. Set the MODE to AUTO.

3. Set the SAMPLE TIME for the desired sample volume. A 1 cfm flow rate counter will sample 1 cubic foot in 1 minute.

4. Connect the RH/Temperature or Air Velocity probe to monitor and record these parameters during compliance testing.

5. Press OPTION, then "8", then press ENTER to enter the 209D Calculations mode (you can press OPTION, "9", and ENTER at any time to abort the mode).

6. The printout will print "ENTER NUMBER OF LOCATIONS"; press PROG, then using the 0-9 keypad, enter a number between 2 and 500 (number of locations) and then press ENTER.

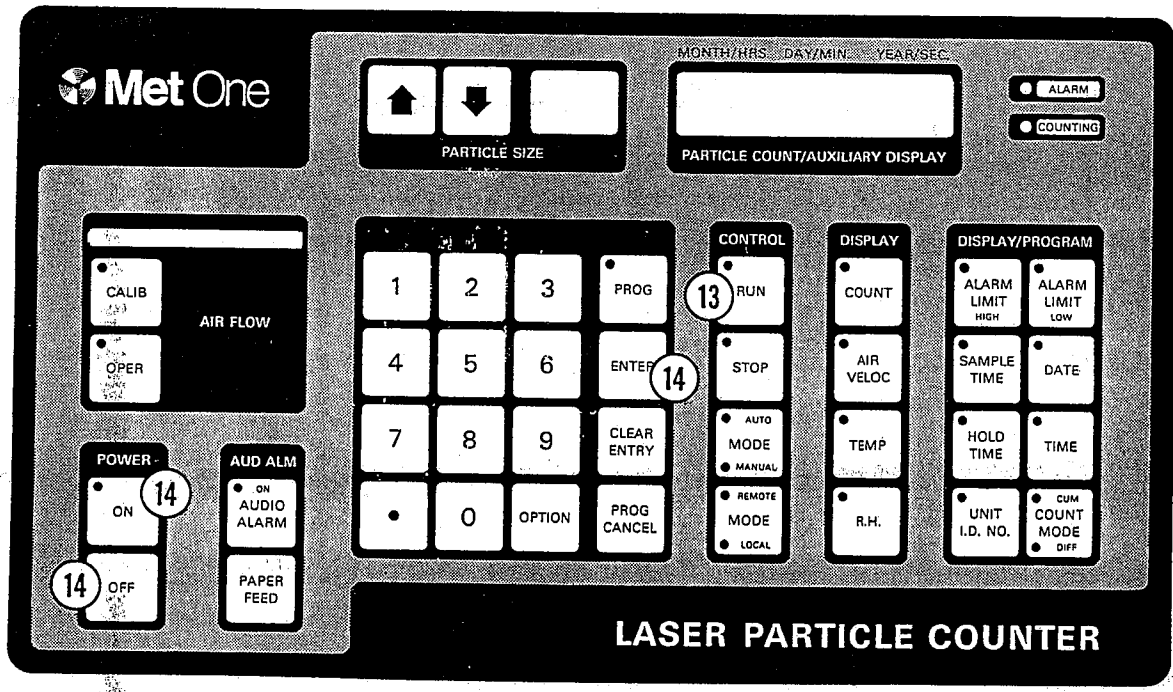
7. The printout will print "ENTER NUMBER OF SAMPLES PER LOCATION"; press PROG then enter number of samples per location (between 2 and 100), then press ENTER.

8. The printout will print "SELECT PARTICLE SIZE"; press PROG then use arrow keys to select the size, then press ENTER. Printer will display entries selected for number of locations, number of samples, and particle size.

9. Press OPTION, "1", then ENTER to select "print all samples" or OPTION, "2", then ENTER to select an "averages only" printout. See figure on the following pages for examples.

10. Continue procedure on next page.

Figure 2-7. Fed-Std-209D Calculations Procedure



0889-142-15

11. Press OPER then press ENTER. The printer will print the "LOCATION 001" header.

12. If you are taking temperature, relative humidity, or air velocity readings at location 1, position the probes now.

13. Press RUN. The COUNTING light will come on while samples are being taken. The counter will enter the STOP mode when the samples are complete.

NOTE

If you want to retake the samples at a location, press RUN again rather than ENTER. The data from the retaken sample will then be used in the calculations.

14. Press OFF. Move counter to the new location and press ON, OPER, and ENTER. The printer will print the "LOCATION 002" header.

15. Press RUN; the counter will take the Location 2 samples and print the results.

16. After the specified number of locations have been sampled, press ENTER and the counter will print the mean of averages, standard deviation, standard error, and upper 95% confidence limit for the clean room. After printing the final calculations, the counter will exit the 209D Calculations mode and revert to normal operation.

Figure 2-7. Fed-Std-209D Calculations Procedure (continued)

"Print All Samples" Mode

```
**************************************************
   MET ONE INC. F.S. 209D VERIFICATION
**************************************************
ENTER NUMBER OF LOCATIONS

ENTER NUMBER OF SAMPLES PER LOCATION

SELECT PARTICLE SIZE

LOCATIONS 2   SAMPLES 4   SIZE .3µ

PRESS "ENTER" FOR NEXT LOCATION

PRINT ALL SAMPLES

_____ LOCATION 001 _____

        DATE = 01:31:89   TIME = 14:24:18
CUM. CT    ID = 123456    SAM TIME = 00:00:15
SAMPLE     1              .3µ =      199
SAMPLE     2              .3µ =      174
SAMPLE     3              .3µ =      144
SAMPLE     4              .3µ =      143
AVERAGE =    165.00                660.00 P/CF
PRESS "ENTER"" FOR NEXT LOCATION

_____ LOCATION 002 _____

        DATE = 01:31:89   TIME = 14:24:18
CUM. CT    ID = 123456    SAM TIME = 00:00:15
SAMPLE     1              .3µ =       96
SAMPLE     2              .3µ =       71
SAMPLE     3              .3µ =       80
SAMPLE     4              .3µ =       76
AVERAGE =     80.75              323.00 P/CF
VERIFICATION COMPLETE, PRESS "ENTER"

MEAN OF AVERAGES              =    491.50
STANDARD DEVIATION            =    238.29
STANDARD ERROR                =    168.50
UPPER 95% CONFIDENCE LIMIT    =   1553.05
```

"Print Averages Only" Mode

```
**************************************************
   MET ONE INC. F.S. 209D VERIFICATION
**************************************************
ENTER NUMBER OF LOCATIONS

ENTER NUMBER OF SAMPLES PER LOCATION

SELECT PARTICLE SIZE

LOCATIONS 2   SAMPLES 4   SIZE .5µ

PRESS "ENTER" FOR NEXT LOCATION

PRINT AVERAGE ONLY

_____ LOCATION 001 _____

        DATE = 01:31:89   TIME = 14:14:51
CUM. CT    ID = 123456    SAM TIME = 00:00:15
AVERAGE =     53.75              215.00 P/CF
PRESS "ENTER" FOR NEXT LOCATION


_____ LOCATION 002 _____

DATE = 01:31:89                TIME = 14:16:53
SAMPLE TIME = 00:00:15         FLOW = 1.0 CFM
AVERAGE =     45.00              180.00 P/CF
VERIFICATION COMPLETE, PRESS "ENTER"

MEAN OF AVERAGES 53.75        =    197.50
STANDARD DEVIATION            =     24.75
STANDARD ERROR                =     17.50
UPPER 95% CONFIDENCE LIMIT    =    307.75
```

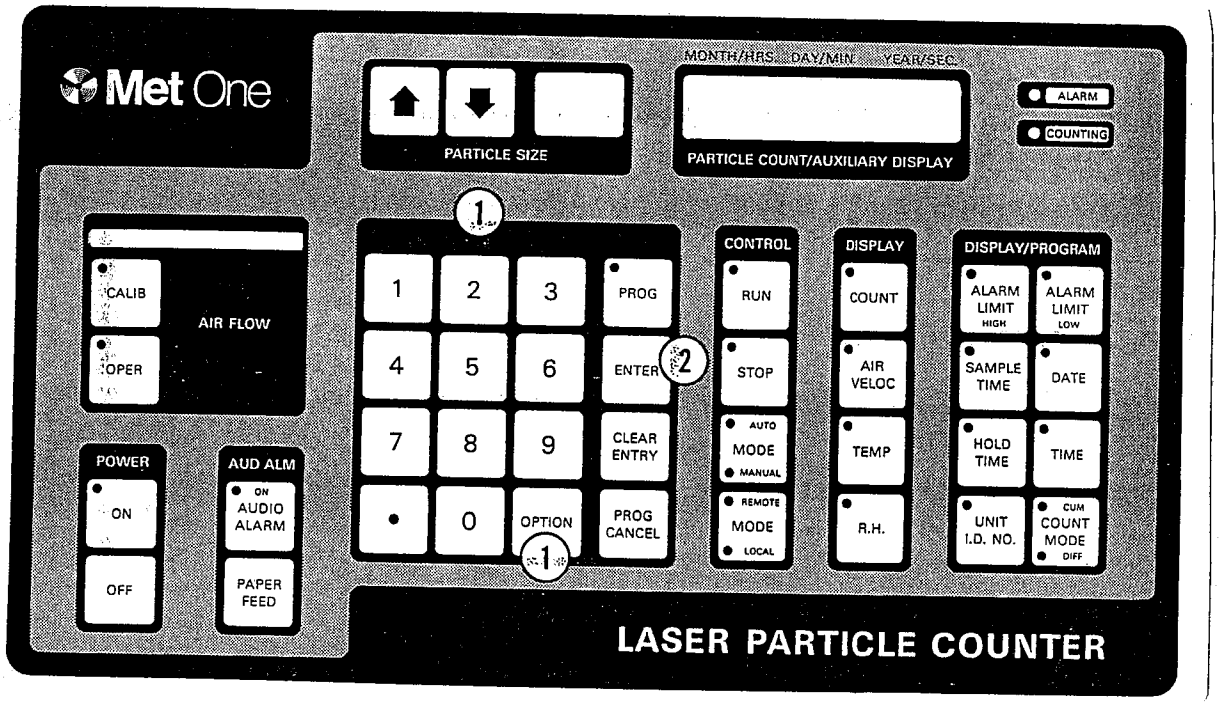
Figure 2-8. Sample 209D Verification Mode Printout

EPROM Part Number Identification

The part number of the EPROM and the flow rate in your counter can be printed out by selecting option 14. Print the EPROM part number and flow rate as follows.

NOTE

This feature was not included in early version counters. Refer to "Manual Backdating" in Appendix A, *Supplemental Information*, to determine the vintage of your counter.



0889-142-16

1. Press OPTION then press "14" using 0-9 keypad.
2. Press ENTER. The EPROM part number and flow rate of your counter will be printed.

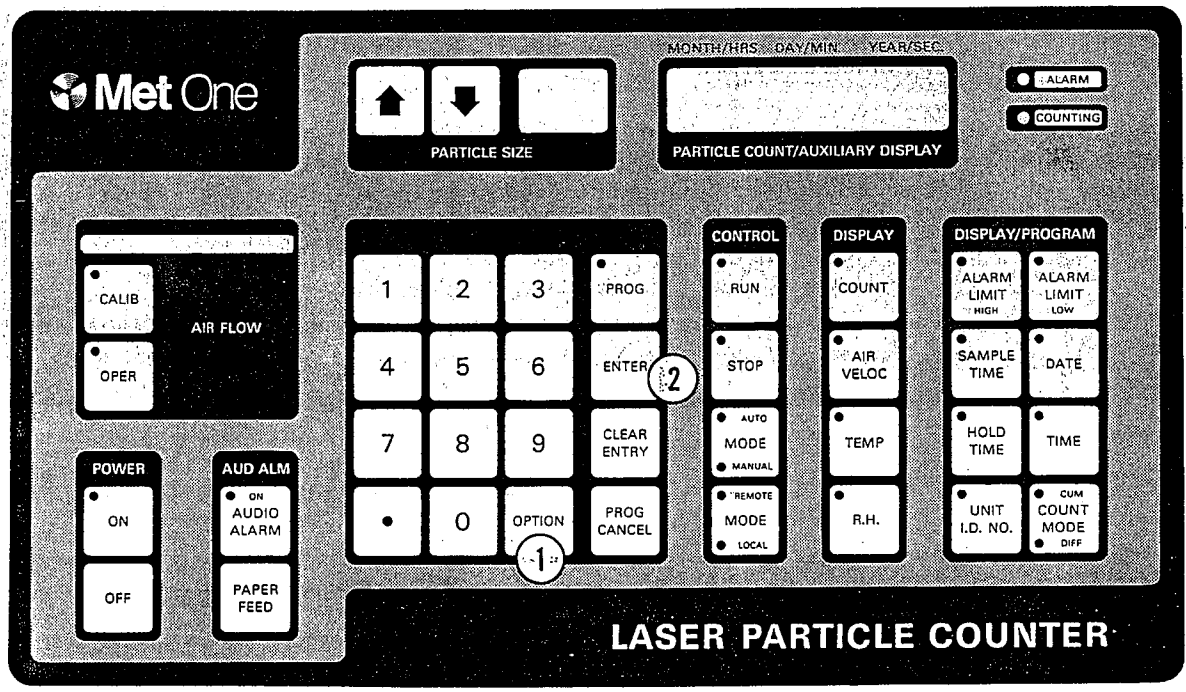
Figure 2-9. Printing EPROM Part Number

Options/Serial Port Table Printouts

A quick-access reference to all available OPTION key functions can be printed out by selecting option 99. Also a serial format table (option 96) and serial baud rate table (option 97) can be printed. Refer to following page for sample printouts. Print any of these "help" tables/list as follows:

NOTE

This feature was not included in early version counters. Refer to "Manual Backdating" in Appendix A, *Supplemental Information*, to determine the vintage of your counter.



0889-142-17

1. Press OPTION then press number (96, 97, or 99) for desired printout. If number is not pressed within five seconds, normal operation resumes.
2. Press ENTER. The selected list or table will be printed.

Figure 2-10. Selecting "Help" Printouts

Counter Options List (Option 99)

OPT.	FUNCTION
0	DISABLE THE PRINTER
1	ENABLE THE PRINTER (PRINT ALL)
2	PRINT ALARMS/INTERVALS ONLY
3	PRINT THE LAST SAMPLE
4	PRINT THE PRINTER MODE
5	(DISP/PROG) PRINT INTERVAL
6	(DISP/PROG) SERIAL FORMAT
7	(DISP/PROG) SERIAL BAUD RATE
8	ENTER 209 VERIFICATION MODE
9	ABORT 209 VERIFICATION MODE
10	(DISP/PROG) NUMBER OF SAMPLES
11	(DISP/PROG) REMOTE SELECT CODE
12	(START/STOP) PRINT SERIAL BUFFER
13	(DISP/CLEAR) SERIAL BUFFER COUNT
14	PRINT EPROM NUMBER AND FLOW RATE
96	(HELP) PRINT SERIAL FORMAT TABLE
97	(HELP) PRINT BAUD RATE TABLE
99	(HELP) PRINT OPTIONS LIST

Serial Format Table (Option 96)

NUM.	PARITY	DATA BITS	STOP BITS
0	NONE	SEVEN	ONE
1	NONE	SEVEN	TWO
2	NONE	EIGHT	ONE
3	NONE	EIGHT	TWO
4	EVEN	SEVEN	ONE
5	EVEN	SEVEN	TWO
6	EVEN	EIGHT	ONE
7	EVEN	EIGHT	TWO
8	ODD	SEVEN	ONE
9	ODD	SEVEN	TWO
10	ODD	EIGHT	ONE
11	ODD	EIGHT	TWO

Serial Baud Rate Table (Option 97)

NUM.	RATE	NUM.	RATE
0	50	1	75
2	100	3	150
4	300	5	600
6	1200	7	1800
8	2000	9	2400
10	3600	11	4800
12	7200	13	9600
14	19200		

Figure 2-11. Sample "Help" Printouts

Printing Results

Your counter may have an internal or optional external printer. Both Printers operate identically. The printer gives a permanent record of count results, including date, time, and sensor status. Operating the printer is described in these subsections:

- Interpreting the Printout
- Loading Paper
- Setting Printer Modes
- Changing Print Interval
- Printing Serial Buffer Data

Interpreting the Printout

The printer will print the particle size ranges (six) and the count and alarm limit for each range. It also prints air velocity, temperature, and relative humidity when these external sensors are connected to the counter. The printer prints at timed intervals, but it can also print only on alarm conditions. Date, time, flow rate, and ID (unit identification number) are always added to each printout. The ID number (programmable from front panel) can be used as a counter location number.

The printer operates when the counter is in either LOCAL or REMOTE (computer-controlled) mode. If in REMOTE, you may want to disable the printer to save paper.

A sample printout looks like this:

```
**********************************************************
*                    MET ONE INC.                        *
*                  (PRINTER ENABLED)                     *
**********************************************************

_____ STARTING 1 SAMPLES _____
**********ALARM**********
          DATE = 01/04/90   TIME = 02:45:39
CUM. CT    ID = 123456      SAM TIME = 00:01:00
SIZE   COUNT  LIMIT   SIZE   COUNT  LIMIT
*.3     1020   1000     .5     691   1000
1.0       41   1000    2.0      21   1000
5.0        0   1000   10.0       0   1000
_____ COMPLETED 1 SAMPLES _____
```

In this sample, the cumulative mode was selected. A sample time of one minute was also selected. The count of 1020 for size .3 micron is the total count. To determine particle count for only the .3 micron range (.30 through .49 micron), subtract .5 micron total count (691) from 1020. The * (asterisk) in front of the .3 size means the count exceeded the programmed alarm limit for that size.

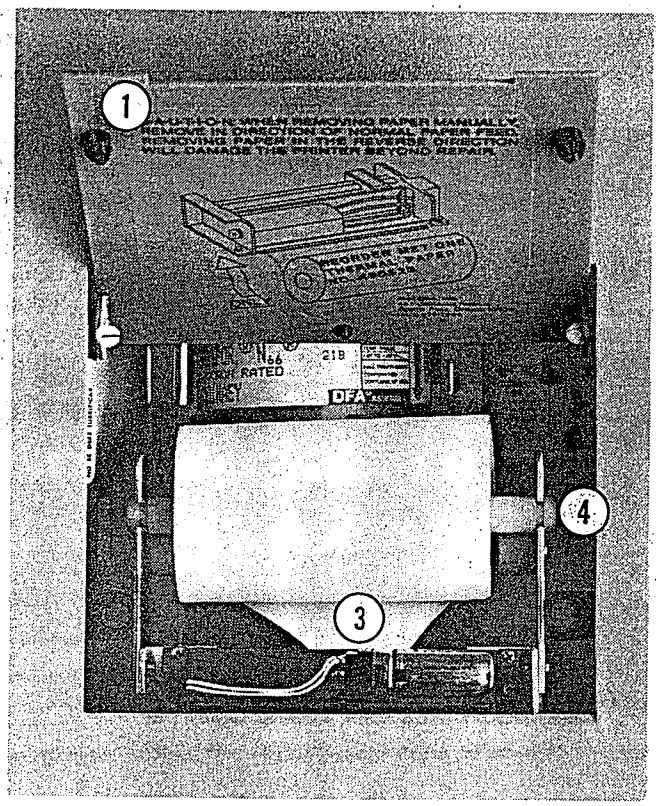
If the differential mode had been selected, the count would represent the particles counted only in that range (.30 through .49 micron, .50 through .99 micron, etc.). A sample differential mode printout would differ as follows:

```
          DATE = 01/04/90   TIME = 02:45:39
DIF. CT    ID = 123456      SAM TIME = 00:01:00
SIZE   COUNT  LIMIT   SIZE   COUNT  LIMIT
 .3      329   1000     .5     650   1000
1.0       20   1000    2.0      21   1000
5.0        0   1000   10.0       0   1000
```

Loading Paper

CAUTION

- The printer should not be operated without paper as damage may occur to the print head. If the particle counter must be operated without paper in the printer, refer to "Setting Printer Modes" in this section to disable the printer.
- Do not pull paper from printer in opposite direction of normal feed. This will damage printer.



0988-18-1

1. Open paper cover.
2. Remove any remaining paper from last roll by snipping paper at spool and pressing PAPER FEED until printer is empty.
3. Trim end of new roll to a clean arrow-shaped edge.
4. Place paper roll on spindle; slide spindle into holding bracket so that paper feeds from bottom of roll.
5. Insert tip of paper into feed mechanism. Pull paper through printer until a small click sound is heard.
6. Press PAPER FEED; printer will feed five lines. Close paper cover.

Figure 2-12. Loading Paper into the Printer.

Setting Printer Modes

There are seven printer modes to choose from. These modes are described below.

0 Disable printer . . . . . Printer will not print.

1 Enable printer . . . . . Printer will print data at end of each cycle.

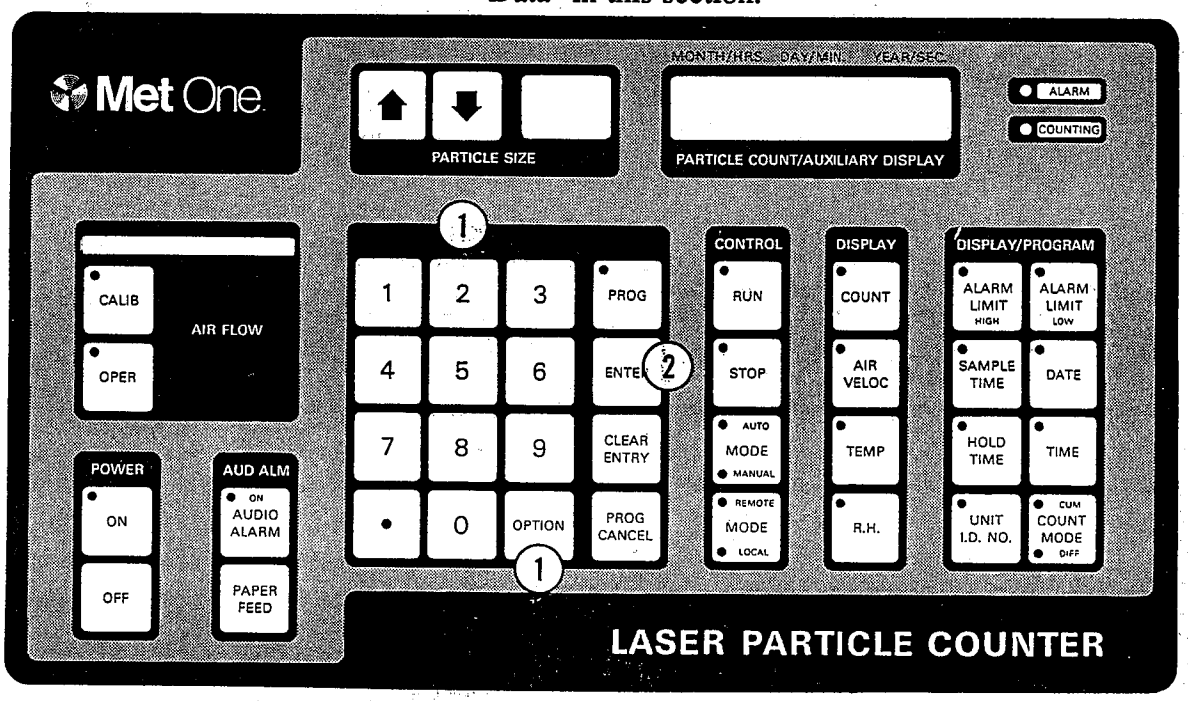
2 Print on alarms/interval . . . . Printer will either print on alarms only or print at a specified interval and when an alarm occurs. See option 5 for setting the interval.

3 Print last count . . . . . Printer will print data from the last count cycle.

4 Print the mode . . . . . Printer will print current print mode (disable, enable, or alarms/interval).

5 Print interval . . . . . Current print interval for option 2 is displayed. Refer to "Changing Print Interval" in this section.

12 Print data in serial buffer . . Printer will print up to 100 count cycles of data in the serial buffer. Refer to "Printing Serial Buffer Data" in this section.



0889-142-6

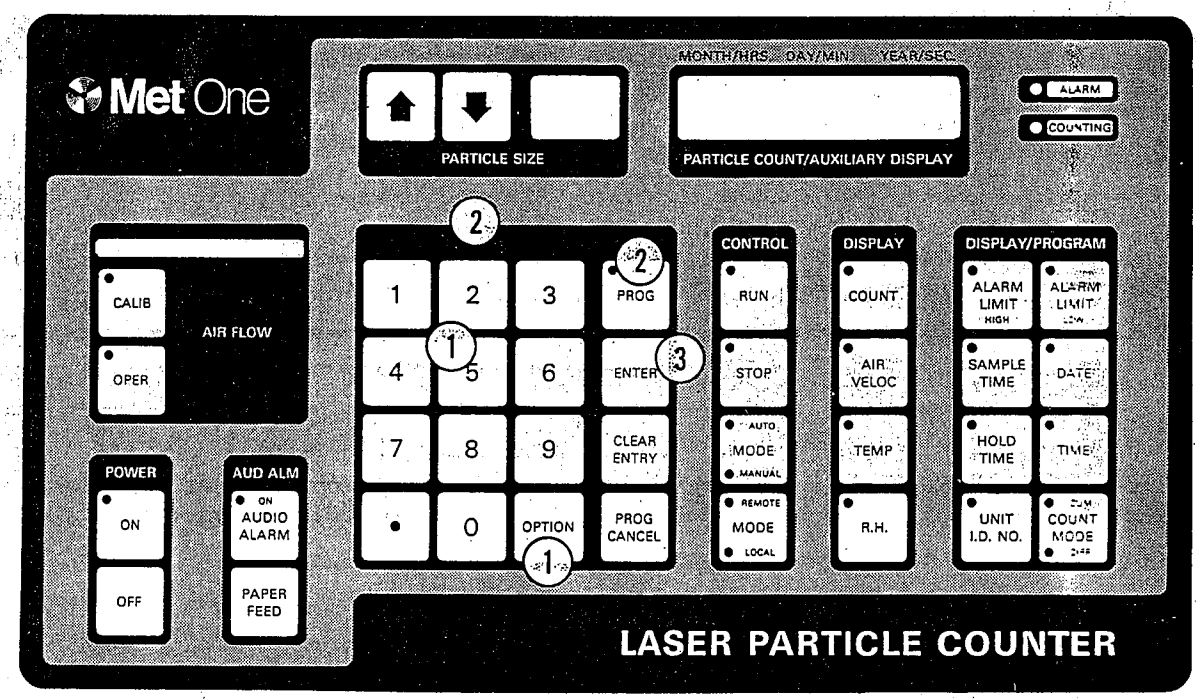
1. Press OPTION then press the number (0 thru 5 or 12) for desired mode. If number is not pressed within five seconds, normal operation resumes.
2. Press ENTER. Printing of serial buffer contents (option 12) can be stopped by repeating both steps of this procedure.

Figure 2-13. Printer Modes

Changing Print Interval

When you have selected the "Print on Alarms/Interval" printer mode (option 2), you can change the time between printouts with the procedure below.

By selecting a time of zero (0), you will disable the print on intervals, but maintain print on alarms. When printing on interval, the counter will complete the count cycle that occurs on the interval and then print the results of that count cycle. Only the results of the count cycle that occurred on the interval, and count cycles that contained alarms, will be printed.



0889-142-7

1. Press OPTION, "5", then press ENTER.
2. Press PROG. Using the 0 to 9 keypad, enter time between printouts (in minutes only — do not enter time in hours or seconds). For example, one minute would be entered as 1.
3. Press ENTER.

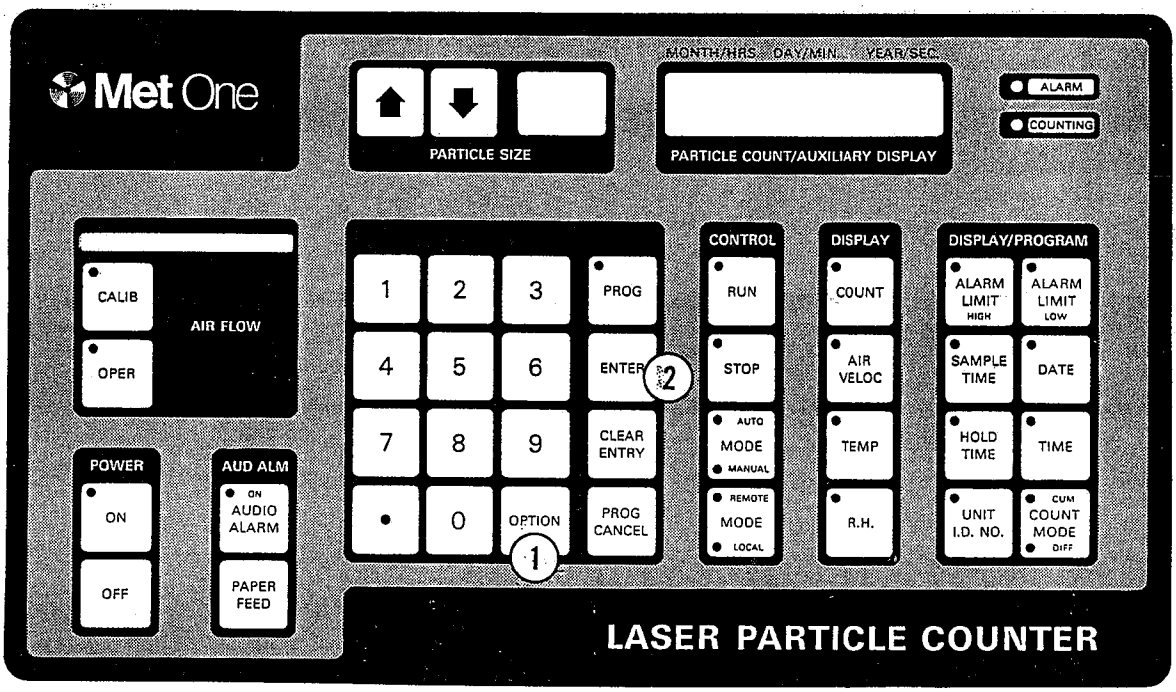
Figure 2-14. Changing Print Interval.

Printing Serial Buffer Data

The counter can store up to 100 count cycles of data in a rotating-type serial buffer then print the buffer's contents at a later time. If the counter "dumps" the contents in the form of a printout, the capability for this data to be read by a computer is lost.

NOTE

This feature was not included in early version counters. Refer to "Manual Backdating" in Appendix A, *Supplemental Information,* to determine the vintage of your counter.



0889-142-18

1. Press OPTION then press "13" to display number of samples in buffer.
2. Press OPTION then press "12" to print the contents of the serial butter. If the number is not pressed within five seconds, normal operation resumes.
3. Press ENTER. Printing of serial buffer contents (option 12) can be stopped by repeating steps 2 and 3 of this procedure.
4. To clear the serial buffer, press PROG, "0", then ENTER.

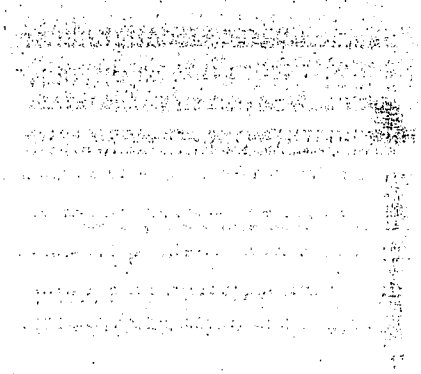
Figure 2-15. Printer Modes

Using Options and Accessories

This subsection describes how to operate the following options and accessories of the particle counter:

- RH/Temp and Air Velocity Accessory Probes
- External Printer Option
- High-Pressure Diffuser Accessory

Your counter includes the external printer option only if it was ordered when you ordered the counter.



RH/Temp and Air Velocity Accessory Probes

The particle counter has rear-panel connectors for two probes: connector J1 is for the RH/temp probe and connector J2 is for the air velocity probe. The probes can be ordered from the factory at any time. When a probe is connected to the counter, the counter front panel will display the probe reading when the appropriate DISPLAY key is pressed. For example, pressing the R.H. key displays relative humidity, pressing the TEMP key displays temperature, and pressing AIR VELOC displays the air velocity.

When the printer is enabled, the probe reading present during each count cycle will automatically be printed with the count results. Alarm limits can be set for each probe. Refer to the "Alarm Limits" subsection earlier in this section.

Unless otherwise requested, if your counter operates on 115 VAC, it has been set up to display the temperature in degrees Fahrenheit and the air velocity in feet per minute. If your counter operates on 100 VAC or 230 VAC, it has been set up to display the temperature in degrees Centigrade and air velocity in millimeters per second. If you want to convert from one to the other, contact the factory.

The following tips should be noted during use of either the RH/temp probe or air velocity probe:

1. Never touch the sensing element of the probe; it is very fragile. Sensing elements should not be exposed to caustic vapors (e.g., RTV™).

2. Keep the RH/temp probe away from exhaust fans for more accurate measurements of temperature.

3. For accurate measurements of relative humidity, allow probe to stabilize several minutes; take samples in still air.

4. When taking air velocity measurements, make sure the white sensing element is fully exposed to the direction of airflow.

An alarm limit value can be set so that if either a high or low limit is exceeded, an audible alarm will sound and the ALARM light will come on.

NOTE

Alarm limits for relative humidity and temperature can only be displayed or programmed when the probe is connected to the counter.

External Printer Option

When the external printer option is added to a counter, the internal printer is deleted and a connector for the printer cable is added to the back panel. The external printer comes with its own manual. Output to the external printer is in a parallel format, following the CENTRONICS standard. Each printer is supplied with a special AC adapter to allow printer operation on a.c. voltage. The following instructions describe connecting the printer to the particle counter:

CAUTION

Always turn counter off before connecting external printer. Connecting printer with counter on may damage counter.

1. On counter, press OFF (front panel).
2. Connect printer cable between P5 of particle counter and printer.
3. Connect AC adapter to printer.
4. On counter, press ON.

CAUTION

Do not operate external printer without paper or the print head may be damaged. If counter must be operated when paper is not in printer, refer to "Setting Printer Modes" to disable printer.

5. Set printer POWER switch to ON.

High-Pressure Diffuser Accessory

To sample pressurized air (up to 150 psi), you must use a high-pressure diffuser on the particle counter inlet line. The pressure diffuser will reduce pressures of 30-150 psi to atmospheric pressure. This allows the particle counter to maintain a calibrated airflow rate. The high-pressure diffuser accessory can be ordered at any time.

Installation

WARNING

Installing the pressure diffuser backwards will INCREASE pressure instead of diffusing it—causing the high-pressure diffuser to explode.

Install the high-pressure diffuser according to the following figure.

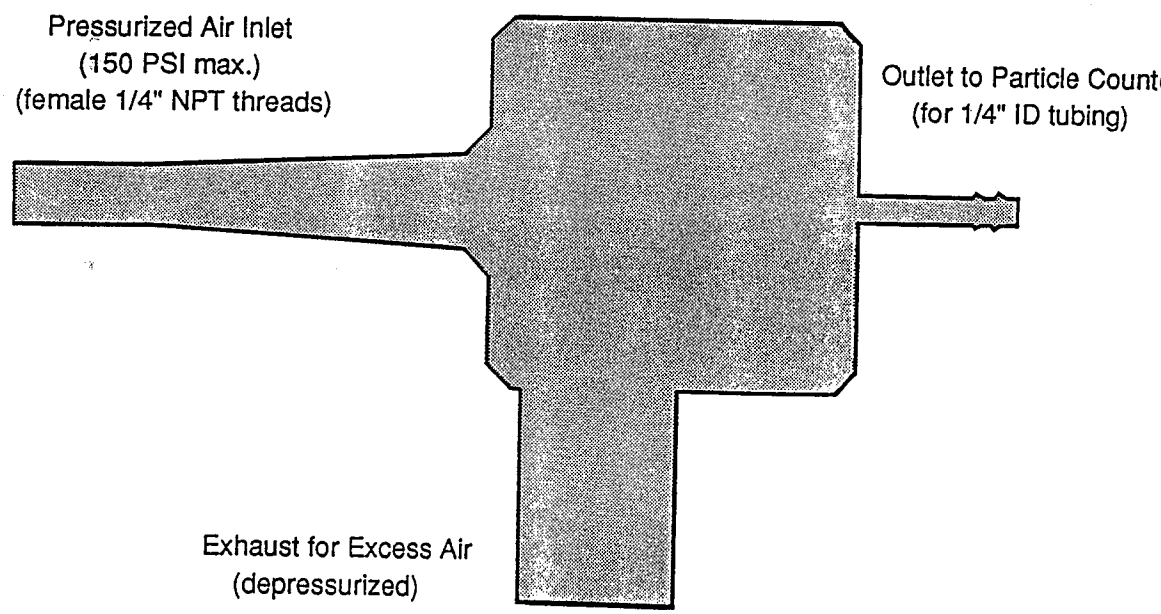
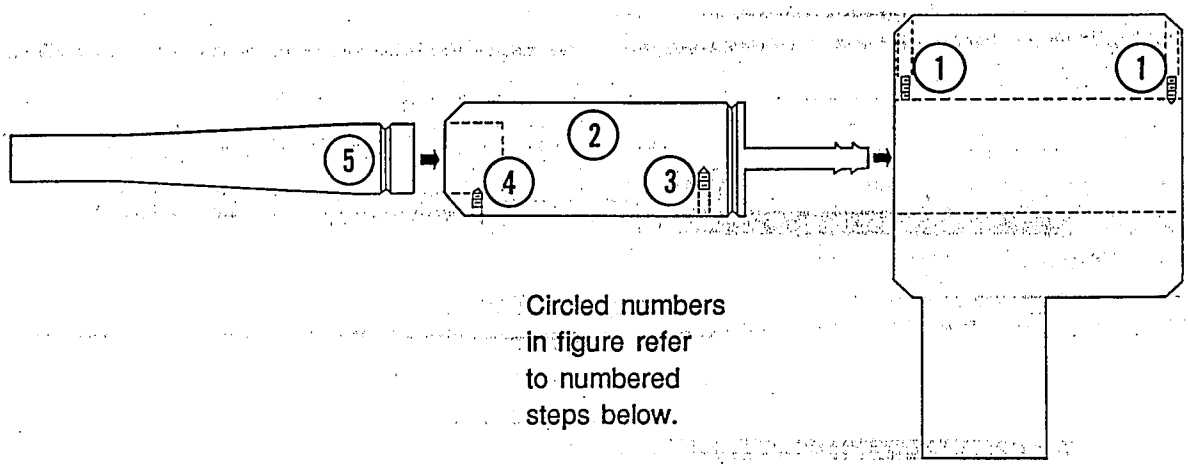


Figure 2-16. Installing the High-Pressure Diffuser

Cleaning the Diffuser

Particles can not be "generated" by the diffuser. However, the diffuser can become contaminated with particles if it is used or stored in a an uncontrolled environment, or if the sample air is extremely contaminated. If you suspect the diffuser is contributing to particle counts, clean it by following the procedure in the figure below. You will need a 0.050" allen wrench, RTV™, and an ultrasonic bath of Freon™ or isopropyl alcohol.



0889-163

1. Loosen two 0.050" allen set screws on top of diffuser.
2. Slide diffuser core from diffuser body.
3. Do not loosen set screw on outlet side of diffuser core.

CAUTION

Loosening this set screw can cause diffuser to malfunction.

To prevent this screw from loosening in ultrasonic bath, coat it with RTV™.

4. Loosen set screw on air inlet side of diffuser core.
5. Pull air inlet tube from diffuser core.
6. Place all three parts in an ultrasonic bath of Freon™ or isopropyl alcohol for 15 minutes.
7. Dry cleaned parts in a clean environment or unidirectional flow bench.
8. Check tightness of all screws as you reassemble diffuser.

Figure 2-17. Cleaning the High-Pressure Diffuser

A Sample Count Using All Functions

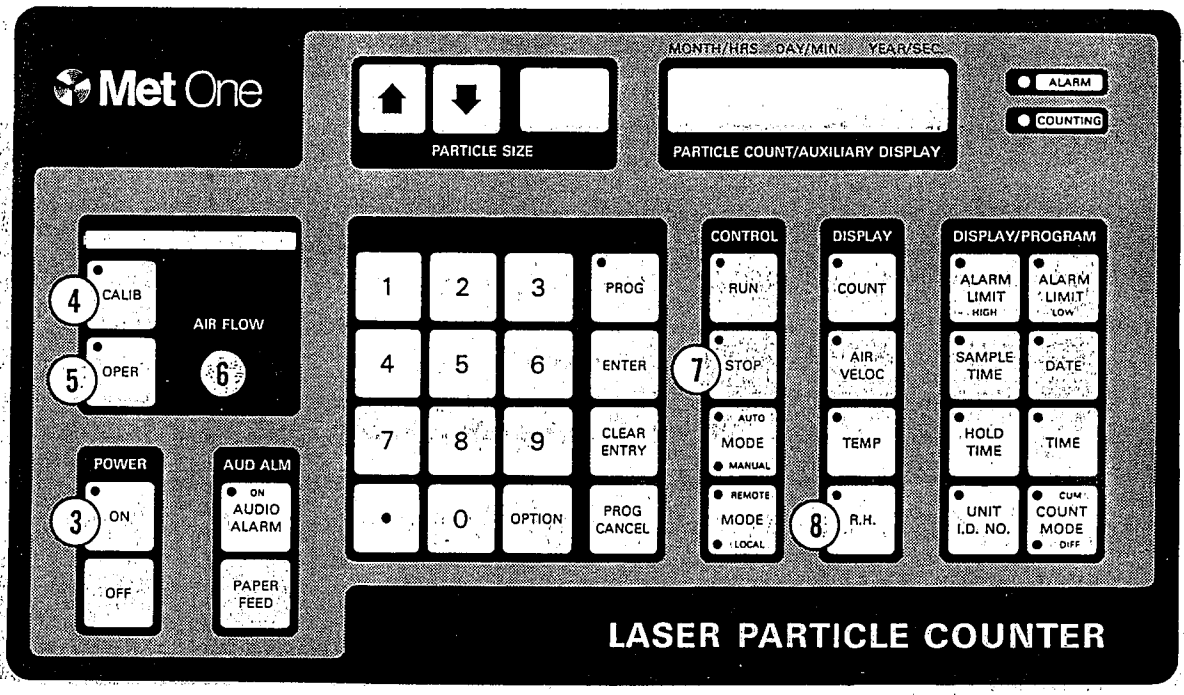
If you have read the other subsections of this section, you are ready to test air using the various functions of the particle counter. When you can complete this procedure without referring to earlier procedures, you have successfully learned how to operate the particle counter.

This sample measurement will accomplish the following:

- Sample particles for 10 count cycles at a 1-1/2 minute period and 10 second hold time between cycles.
- Establish count alarm limits of 1000 for .3 and .5 micron ranges, 200 for 1 and 2 micron ranges, and 50 for 5 and 10 micron ranges.
- Enable printer.
- Select differential count.
- Monitor relative humidity and temperature.

NOTE

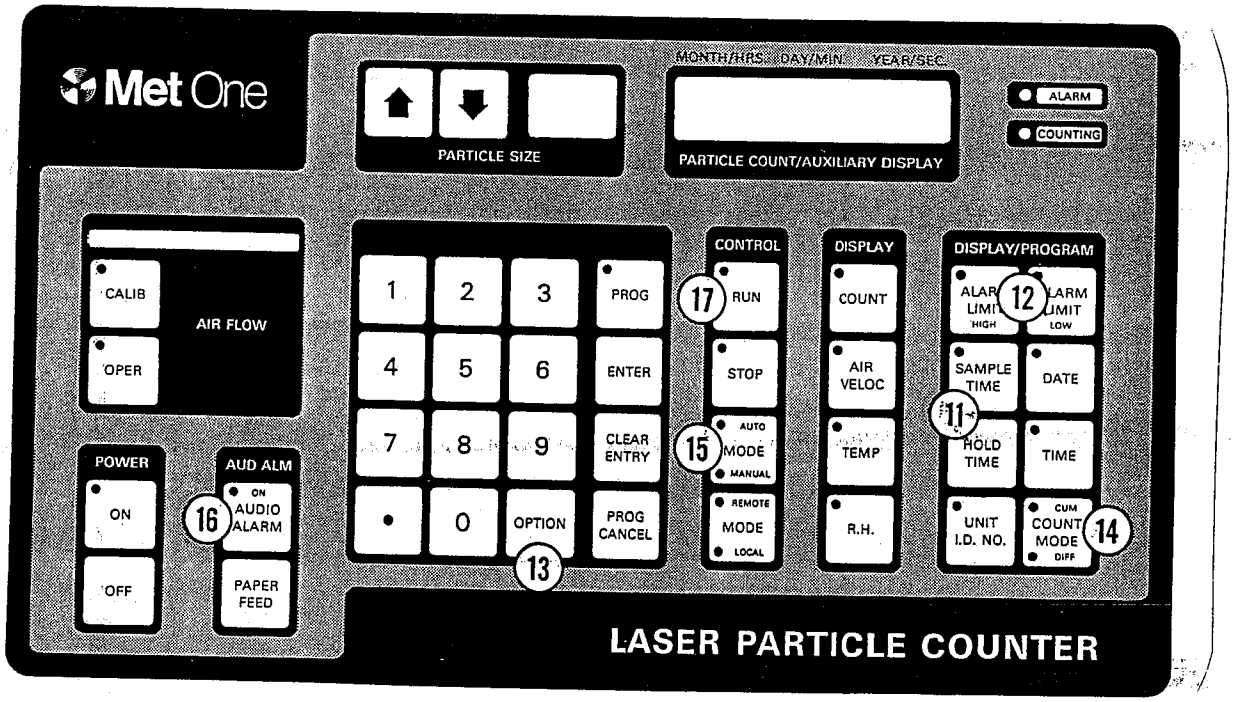
To clear an incorrect keypad entry, press CLEAR ENTRY key.



0889-142-8

1. Install isokinetic probe on sample inlet.
2. Connect RH/temp sensor to rear panel J1 connector, if desired.
3. Press ON.
4. Press CALIB and verify a green light is on.
5. Press OPER.
6. Adjust AIR FLOW control until center-green light is on.
7. Press STOP.
8. Press R.H. to display relative humidity reading and press TEMP to display temperature reading.
9. Continue procedure on next page.

Figure 2-18. Particle Counter Setup for Counting



0889-142-9

10. Set number of count cycles to 10 as described in "Number of Count Cycles".

11. Enter a SAMPLE TIME of one minute, 30 seconds and a HOLD TIME of 10 seconds as described in "Sample and Hold Times".

12. Set count alarm limits that were given in the introduction for the six particle size-ranges. If necessary, refer to "Alarm Limits".

13. Enable the printer (option 1) as described in "Setting Printer Modes".

14. Select differential count mode by pressing COUNT MODE until DIFF light is on.

15. Select auto mode by pressing MODE AUTO/MANUAL until AUTO light is on.

16. Press AUDIO ALARM until ON light is on.

17. Press RUN to start count. The counter will count for 1-1/2 minutes, hold for 10 seconds, then repeat cycle until either STOP is pressed or the 10th count cycle is completed. When the last count cycle is completed, the counter will go from OPER mode to CALIB mode. If the count exceeds the alarm limits, then an alarm will sound.

Figure 2-18. Particle Counter Setup for Counting (continued)

PERFORMANCE VERIFICATION

Introduction

This section is provided for those who must do their own verification of the particle counter's performance.

Performance verification comprises the following procedures.

- Airflow Test
- Laser Sensor Tests
- Comparison Test
- Probe Sensitivity Test

These tests ensure that the counter is operating in accordance with its own specifications and with Federal Standard 209D. Compliance with this standard is described in "Testing Methods" on the following pages.

Before you attempt to do performance verification, read "Before You Start" on the following pages.

Before You Start

Before you begin to test the particle counter, you should know the following:

- These tests are intended only as a verification of performance. They are not intended as adjustment procedures. Adjusting the counter will alter the factory calibration and void the warranty.
- A factory-certified standard counter must be used for the Comparison Test.
- The tests must be done in the order given.
- The factory offers 48-hour turn-around time (not including shipping) for calibration.

Recommended Test Equipment

The following table lists the recommended equipment needed for the tests. You can substitute other equipment if substitute equipment has the same performance characteristics as recommended models. Contact factory for critical performance specifications.

Table 3-1. Recommended Test Equipment

Instrument	Recommended Model or Part
Digital Voltmeter	H-P Model 3468B
DC Power Supply	NA
Airflow Gauge (0 - 3.0 cfm)	NA
Aerosol Generator	Model 255
Pump, Aerosol Generator	204065-1
Pulse Height Analyzer	Model 216
PSL Particles (refer to Performance Verification Record at end of this section for required particle sizes)	Duke Scientific*
Comparison Test Only:	
Factory-certified Standard Counter	(Same as counter under test)
Dispersion Chamber	206084
Nebulizer (one for each particle size)	305423

* Order from Duke Scientific, Inc., Palo Alto, CA, (415) 962-1100

Recording the Test Results

At the back of this section are several Performance Verification Record forms. We recommend that you find the specific form for your particle counter, make a copy of this form, record test results on this copy, and keep the copy for your test records.

If the Counter Doesn't Meet Specifications

If the counter does not perform as indicated by these tests, then the counter may need recalibration or repair. Refer to "Shipping Instructions" in Section 1 for information on returning the counter to the factory for service.

Test Methods

The test methods used in this section are the same as the methods used at the factory. With the exception of testing the internal laser sensor, the counter is tested as a complete system.

The test methods conform to the following sections of Federal Standard 209D:

Sections B30.1 and B50.1. These sections apply directly to the Comparison Test. This test uses monodisperse latex spheres to test particle-size ranges and counts. The spheres are traceable in accuracy of mean diameter to the standards of ASTM F328, Microscopic Measurement, or to NIST (National Institute of Standards and Technology), as applicable. Typical sphere sizes are given in Performance Verification Record at end of this section.

This test also uses the apparatus described in ASTM F649, consisting of a mixing chamber, an aerosol generator using a nebulizer, and a standard counter of the same design and model as the counter under test.

The aerosol generator inserts the particles into the mixing chamber at a reasonably constant concentration. The particles swirl and disperse within the chamber. The counters draw the aerosol through two outlet tubes at a rate of 1,500 to 2,500 particles per minute. Both counters are set for the same flow rate and sample time.

A technician compares the count at the smallest particle ranges of the counter under test to the standard counter. Several runs are made with the same particle size to confirm the results.

This test method is the simplest, most reliable technique for simultaneously sampling from a common source. Using this method, you can hold a ±10% tolerance between counters of like flow rate.

The Pulse Height Test, part of the Laser Sensor Tests, also uses the same traceable monodisperse latex spheres (particles) as the Comparison Tests. The particles are aerosolized and drawn through the sensor. A pulse height analyzer verifies the peak voltage output of the sensor for each particle size. These sensor outputs are compared to the sensor standard curve that was developed at the factory.

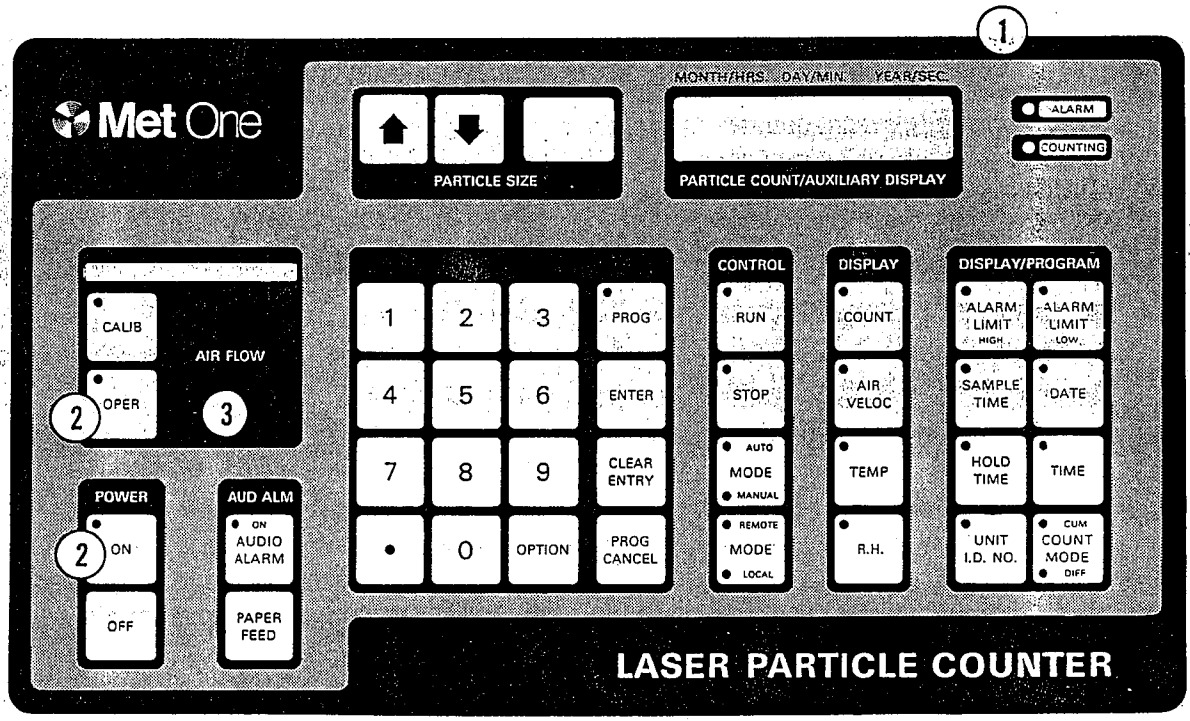
Section B50.1.2. This section applies to the Air Flow Test. The method of measurement used in this test does not introduce head in the flow system. The accuracy of the flow circuit is ±5% at 70 degrees Fahrenheit.

Airflow Test

This test ensures the airflow rate is calibrated, the front-panel airflow display is accurate, and the air pump is healthy.

NOTE

Do not use a ball-type rotameter to monitor airflow. This type of meter affects measurement accuracy because lifting the ball loads the airflow circuit. Use a digital or gauge-type meter.



0889-142-11

1. Connect airflow gauge to sensor inlet tube.
2. Press ON then OPER.
3. Turn AIR FLOW control all the way counterclockwise (clockwise for some counters) until airflow gauge reads maximum; verify airflow gauge reads equal to or greater than value given in the Performance Verification Record.
4. Adjust AIR FLOW control for airflow gauge reading between the limits given in the Performance Verification Record and verify bar-graph display center-green light is on.
5. Turn counter power off then remove airflow gauge.

Figure 3-1. Testing Airflow

Laser Sensor Tests

These tests verify that the laser sensor functions according to the factory standards. This subsection contains the following tests:

- Calibrate Mode Test — checks the bar-graph display for green light.
- Zero Count/Purge Test — checks for sensor contamination.
- Pulse Height Test — measures sensor performance.

Calibrate Mode Test

Press CALIB and observe the bar-graph display. A green light should be on. This indicates that the sensor electronics are working correctly. If a red light on the left side of the bar graph is on, return counter to factory for repair. If a red light on the right side of the bar graph is on, purge sensor as described on following pages. If a green light still does not come on, return counter to factory for repair.

Zero Count/Purge Test

Zero counting verifies that particles have not contaminated the counter, causing high particle counts. To zero count, the counter counts while sampling air through an absolute filter, which blocks particles.

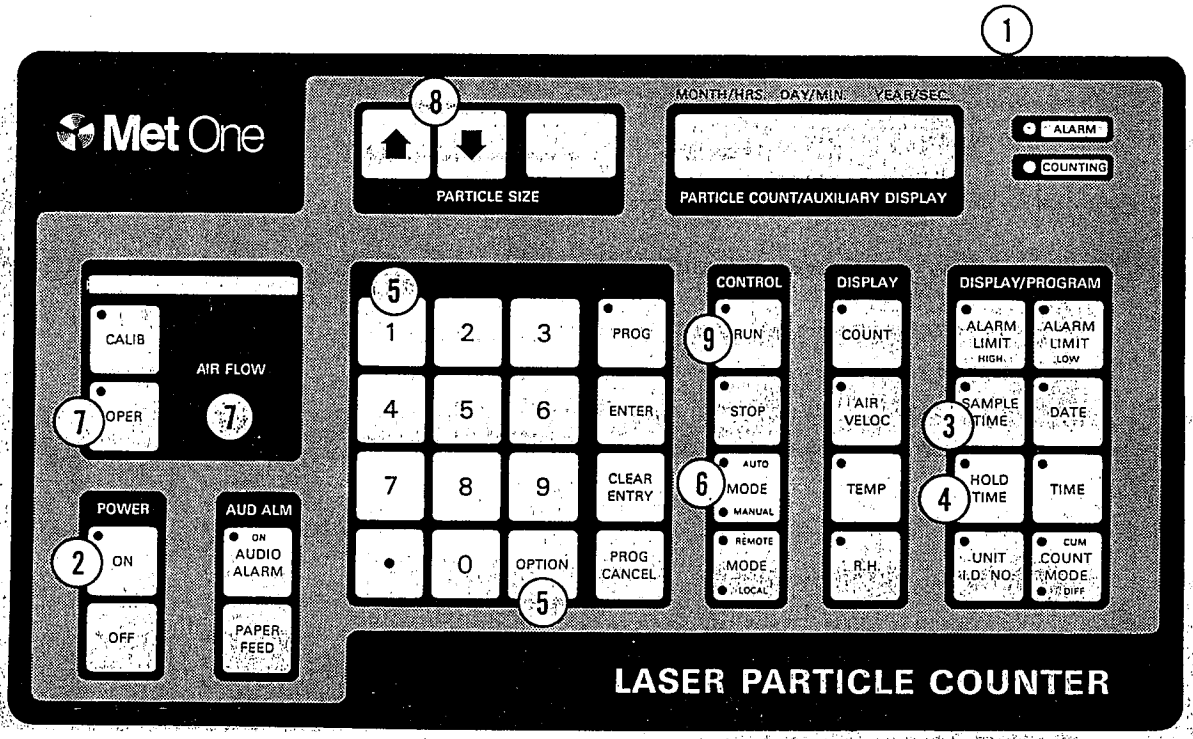
In this procedure, the counter will begin sampling air through the absolute filter. The counter will take one-minute samples, spaced five seconds apart, and print the count results. If the count is zero, and a green light is on in the calibrate mode, the counter is functioning within specification. If the counter does not "zero count" in a reasonable time, the sensor should be purged.

Sensor purging is a process for removing contaminants, such as particles, lint, or dust from the sensor. To purge the sensor, allow the counter to run for 24 hours at maximum airflow. To save paper, select Disable Printer mode.

If after purging the counter still will not zero count, there may be air leaks in the external tubing or filter, or the counter may need to be recalibrated. Return counter to the factory for calibration.

CAUTION

Never put liquids/vapors into the sensor. They will damage the sensor, which will then need factory service.



0889-142-10

1. Attach a 0.1 micron purge filter assembly to sensor inlet tube.
2. Press ON. If counter is already on, press STOP.
3. Enter SAMPLE TIME of 1 minute (1.00).
4. Enter a HOLD TIME of five seconds.
5. Select OPTION "1" to enable printer.
6. Place counter in AUTO mode.
7. Press OPER and then adjust AIRFLOW.
8. Select the smallest PARTICLE SIZE range.
9. Press RUN key to begin zero counting.

Figure 3-2. Zero Counting

Pulse Height Test

There are three pulse height tests in this subsection; one test for each of the three types of sensors now used in particle counters. Refer to "Specifications" in Section 1 for the type of sensor in your counter. These tests ensure that sensor performance has not degraded since factory calibration. The tests use an aerosol generator, pump, and pulse height analyzer.

WARNING

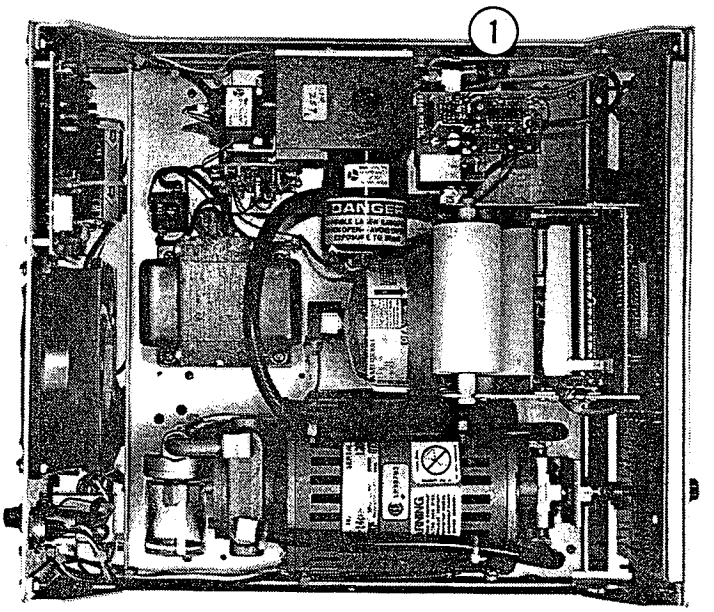
The tests require access to the interior of the counter chassis, which contains dangerous parts. Accidentally touching the wrong part can cause cuts from the cooling fan blades or electrical shock from internal power components.

CAUTION

Sensors containing laser diodes (refer to "Specifications" in Section 1), contain a diode that is extremely sensitive to static and may easily be destroyed or damaged. Proper anti-static procedures should be used during the laser sensor tests.

Single-Port Sensor Pulse Height Test

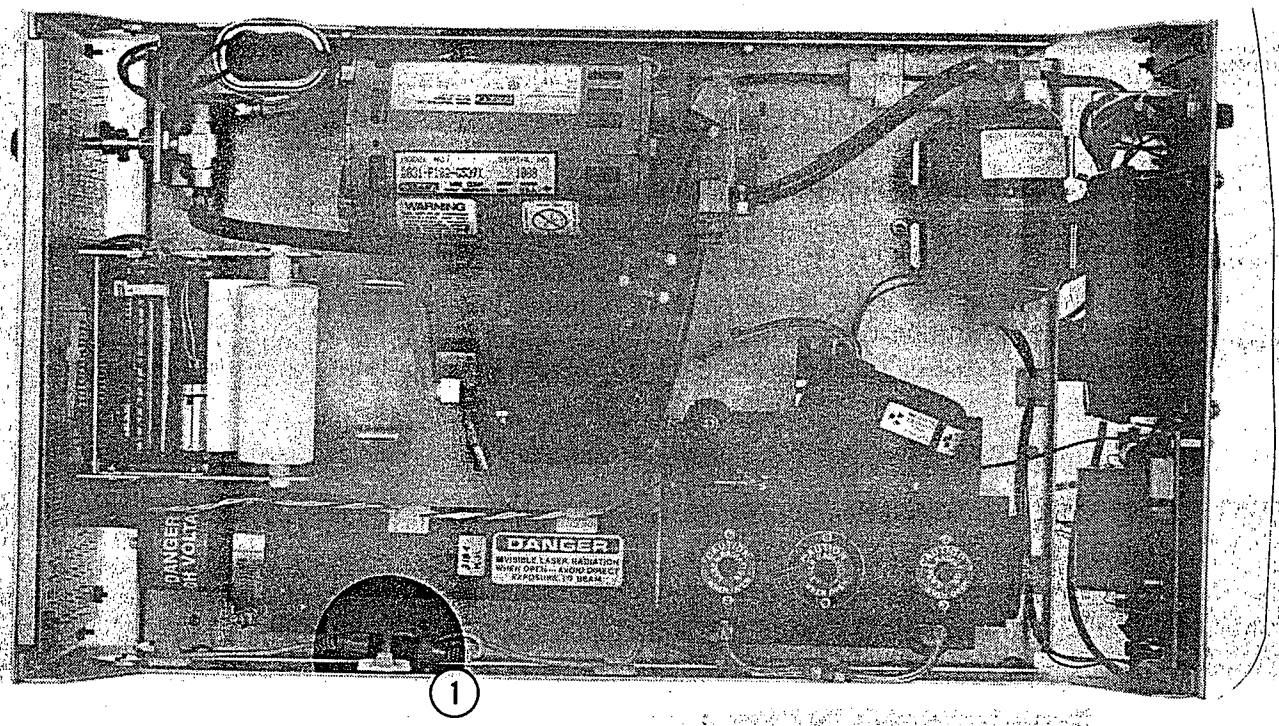
Counters With Laser Diode-type Sensor



1288-69-3

Figure 3-3. Testing Pulse Height — Single-Port Sensors

Counters With HeNe-type Sensors



0489-94-3

1. Connect pulse height analyzer to sensor output at phono jack. Program pulse height analyzer for count limit of 10,000.
2. With aerosol generator, apply the smallest size latex spheres, indicated in Performance Verification Record, to sensor inlet tube.
3. Press ON then OPER; adjust particle flow from aerosol generator to desired rate.
4. On pulse height analyzer, find mV value that corresponds to largest particle count. Compare this mV value to corresponding threshold voltage given on "Report of Calibration" supplied with your counter. Record your new measured value on Performance Verification Record.
5. Repeat steps 2-4 for other particle sizes in Performance Verification Record.

Figure 3-3. Testing Pulse Height — Single-Port Sensors (continued)

Dual-Port and Four-Port Sensors Pulse Height Test

To determine type of sensor in your particle counter, refer to your counter model number under "Specifications" in Section 1. The particle counters have multiple sets of collection optics and photo detectors. The test below will measure pulse heights from each photo detector for each particle size.

Do the pulse height test below at the sensor output side of phono jack J1. If you have a dual-port sensor, repeat the test at phono jack J2. If you have a four-port sensor, repeat the test at phono jacks J2, J3, and J4. Locate phono jacks by removing the bottom cover of the counter and by locating the comparator board. The comparator board is mounted piggyback on the main C.P.U. board. On the board are attached two (or four) phono cables labeled J1 and J2 (or J1, J2, J3, and J4). Follow the cable until the phono jack is located.

1. Connect pulse-height analyzer to sensor output at phono jack. Program pulse height analyzer for count limit of 10,000.
2. With aerosol generator, apply the smallest size latex spheres, indicated in Performance Verification Record, to sensor inlet tube.
3. Press ON then OPER; adjust particle flow from aerosol generator to desired rate.
4. On pulse height analyzer, find mV value that corresponds to largest particle count. Compare this mV value to corresponding threshold voltage given on "Report of Calibration" supplied with your counter. Record your new measured value on Performance Verification Record.
5. Repeat step 4 for J2. If you have a four-port sensor, repeat step 4 for J3 and for J4.
6. Repeat steps 1 through 5 for other particle sizes in Performance Verification Record.

Comparison Test

To do the comparison test, you need a factory-certified standard counter (same model number and flow rate as being tested), an aerosol generator, a nebulizer, and a dispersion chamber.

The counter under test and the standard counter simultaneously sample particles from the dispersion chamber. The counts of both counters are compared at the smallest size ranges using monodisperse latex spheres.

1. Prepare for test by connecting equipment as shown in the following figure.

2. Refer to Performance Verification Record at the end of this section for the size of monodisperse latex spheres required to test the smallest particle-size range. Install these spheres in the particle generator.

3. Turn the particle generator on. Apply power to both counters. Put both counters in the STOP mode. Set both counters for auto mode, lowest size range, and a sample time of one minute.

4. Simultaneously press RUN on both counters. Adjust aerosol generator to provide for a particle concentration, as measured by the standard, of approximately 10,000 particles/cf.

5. Allow both counters to run for three periods (runs) then press STOP on both counters. Average the results of the three runs. The counter under test should count within 10% of the standard counter.

6. Repeat steps 2 - 5 for the next size range using size of monodisperse latex spheres indicated in Performance Verification Record at end of this section.

7. Record the percentage difference in counts in Performance Verification Record.

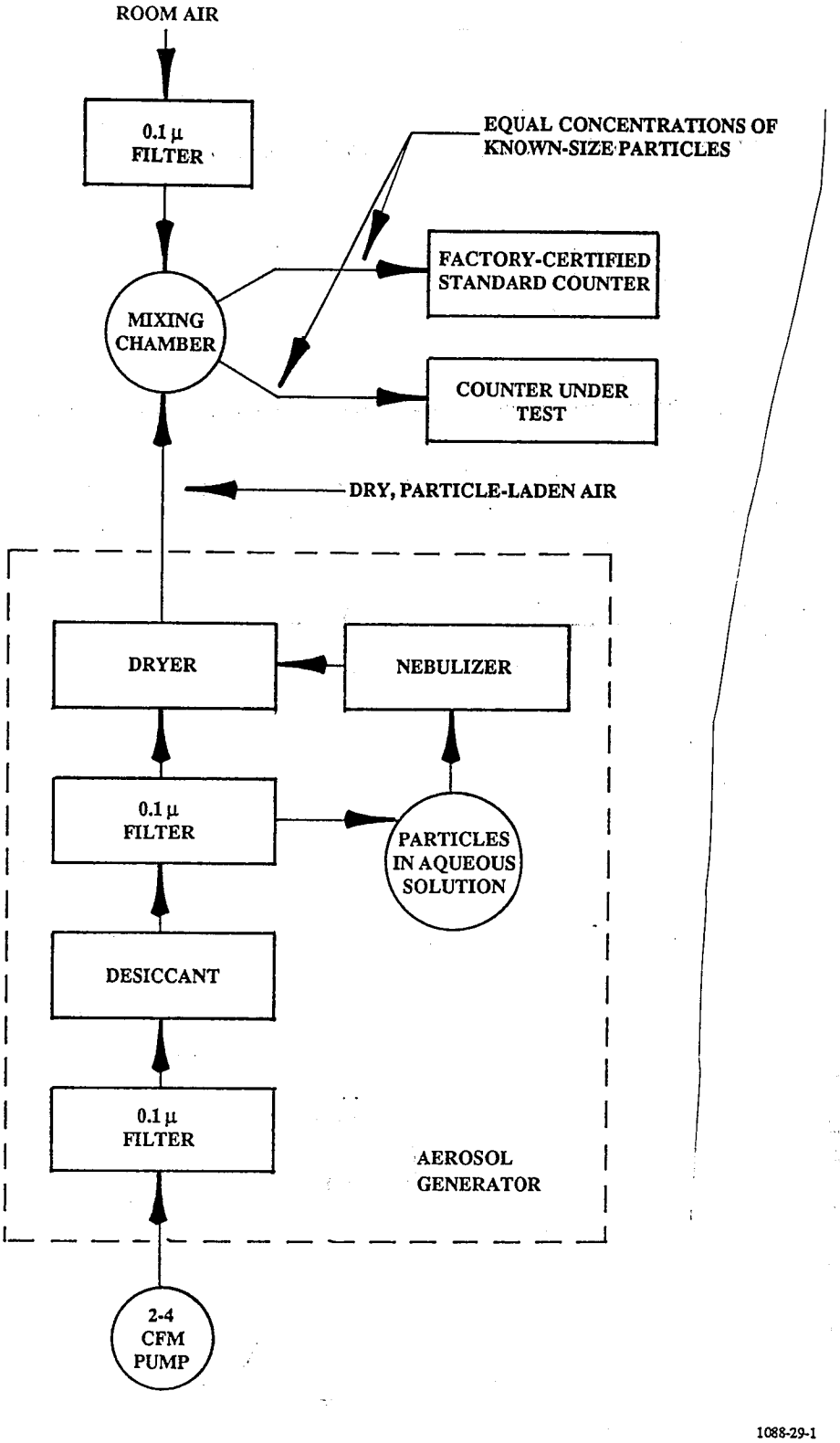
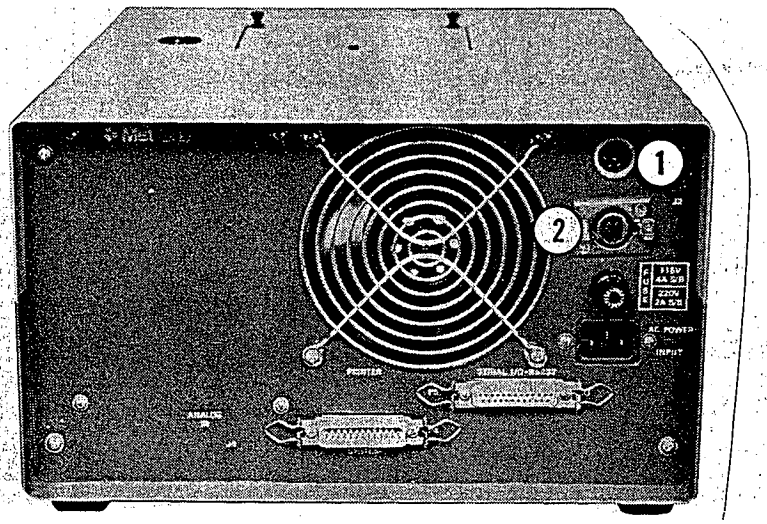
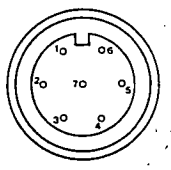


Figure 3-4. Comparison Test Setup

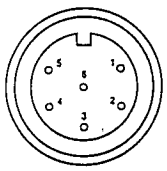
Probe Sensitivity Test

This test applies to both RH/temp and air velocity probes. Two different RH/temp probes have been manufactured during the life of this counter. The rear-panel connector for this probe differs depending on when your counter was manufactured. See the figure below for pin detail of each connector type. If the counter fails to meet the limits given in the Performance Verification Record for any part of this test, return the counter to the factory for service.





Detail of Old Connector J1



Detail of New Connector J1

1088-31-1

1. To check RH/temp sensitivity, apply +5.000 V (+10.000 V for old-style connector) to pin 2 of RH/temp connector J1 on the counter rear panel. Connect J1, pin 6 to pin 5 (pin 7 to pin 5 on old-style connector). Ground your power supply to pin 5 (both).

2. Press R.H. key and verify counter display reads between values given in Performance Verification Record. Record reading.

3. Repeat step 1 but apply +5.000 V (+10.000 V for old-style connector) to J1, pin 4 then press TEMP and verify display is within the limits given in Performance Verification Record. Record reading.

4. To check air velocity sensitivity, apply +10.000 V to J2, pin 2 (J2 pin numbers appear on the connector). Connect J2, pin 4 to pin 3 and ground power supply to pin 3.

5. Press AIR VELOC and verify display is within limits given in Performance Verification Record. Record reading.

Figure 3-5. Testing Probe Sensitivity

Table 3-2. Performance Verification Record for Model 200L Counters

Model _____ Date _____

Serial Number _____

Procedure	Minimum	Actual	Maximum
Airflow Test			
Maximum Flow	1.3 cfm	_____ cfm	--
Calibrated Flow	left green	_____	right green
Laser Sensor Tests			
Calibrate Mode Test	left green	_____	right green
Zero Count Test	0 count/cf	_____	0 count/cf
Pulse Height Test			
1.09 µm spheres (1 micron threshold)	--	_____ V	--
2.02 µm spheres (2 micron threshold)	--	_____ V	--
Comparison Test			
0.3 micron range (0.312 µm spheres)	-10%	_____ %	+10%
0.5 micron range (0.519 µm spheres)	-10%	_____ %	+10%
Probe Sensitivity Test			
R.H. display	99.0	_____	101.0
Temperature display	99.0	_____	101.0
Air Velocity display	198.0	_____	202.0

Table 3-3. Performance Verification Record for Model 205, 205A Counters

Model _____ Date _____

Serial Number _____

Procedure	Minimum	Actual	Maximum
Airflow Test			
Maximum Flow	1.1 cfm	_____ cfm	--
Calibrated Flow	left green	_____	right green
Laser Sensor Tests			
Calibrate Mode Test	left green	_____	right green
Zero Count Test	0 count/cf	_____	3 counts/cf
Pulse Height Test			
0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
Comparison Test			
Model 205:			
0.16 micron range (0.173 µm spheres)	-10%	_____ %	+10%
0.2 micron range (0.220 µm spheres)	-10%	_____ %	+10%
0.3 micron range (0.312 µm spheres)	-10%	_____ %	+10%
0.5 micron range (0.519 µm spheres)	-10%	_____ %	+10%
Model 205A:			
0.2 micron range (0.220 µm spheres)	-10%	_____ %	+10%
0.3 micron range (0.312 µm spheres)	-10%	_____ %	+10%
Probe Sensitivity Test			
R.H. display	99.0	_____	101.0
Temperature display	99.0	_____	101.0
Air Velocity display	198.0	_____	202.0

Table 3-4. Performance Verification Record for Model 209D Counter

Model _____ Date _____

Serial Number _____

Procedure	Minimum	Actual	Maximum
Airflow Test			
Maximum Flow	1.1 cfm	_____ cfm	--
Calibrated Flow	left green	_____	right green
Laser Sensor Tests			
Calibrate Mode Test	left green	_____	right green
Zero Count Test	0 count/cf	_____	0 count/cf
Pulse Height Test			
0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
Comparison Test			
0.1 micron range (0.173 µm spheres)	-10%	_____ %	+10%
0.2 micron range (0.220 µm spheres)	-10%	_____ %	+10%
0.3 micron range (0.312 µm spheres)	-10%	_____ %	+10%
Probe Sensitivity Test			
R.H. display	99.0	_____	101.0
Temperature display	99.0	_____	101.0
Air Velocity display	198.0	_____	202.0

Table 3-5. Performance Verification Record for Model A249 Counter

Model _____ Date _____

Serial Number _____

Procedure	Minimum	Actual	Maximum
Airflow Test			
Maximum Flow	1.1 cfm	_____ cfm	--
Calibrated Flow	left green	_____	right green
Laser Sensor Tests			
Calibrate Mode Test	left green	_____	right green
Zero Count Test	0 count/cf	_____	6 counts/cf
Pulse Height Test			
J1: 0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
J2: 0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
J3: 0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
J4: 0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
Comparison Test			
0.1 micron range (0.109 µm spheres)	-10%	_____ %	+10%
0.2 micron range (0.220 µm spheres)	-10%	_____ %	+10%
0.3 micron range (0.312 µm spheres)	-10%	_____ %	+10%
Probe Sensitivity Test			
R.H. display	99.0	_____	101.0
Temperature display	99.0	_____	101.0
Air Velocity display	198.0	_____	202.0

Table 3-6. Performance Verification Record for Model A2120 Counter

Model _____ Date _____

Serial Number _____

Procedure	Minimum	Actual	Maximum
Airflow Test			
Maximum Flow	2.1 cfm	_____ cfm	--
Calibrated Flow	left green	_____	right green
Laser Sensor Tests			
Calibrate Mode Test	left green	_____	right green
Zero Count Test	0 count/cf	_____	6 counts/cf
Pulse Height Test			
J1: 0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
J2: 0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
J3: 0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
J4: 0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
Comparison Test			
0.1 micron range (0.109 µm spheres)	-10%	_____ %	+10%
0.2 micron range (0.220 µm spheres)	-10%	_____ %	+10%
0.3 micron range (0.312 µm spheres)	-10%	_____ %	+10%
Probe Sensitivity Test			
R.H. display	99.0	_____	101.0
Temperature display	99.0	_____	101.0
Air Velocity display	198.0	_____	202.0

Table 3-7. Performance Verification Record for Model A2210 Counter

Model _____ Date _____

Serial Number _____

Procedure	Minimum	Actual	Maximum
Airflow Test			
Maximum Flow	0.095 cfm	_____ cfm	0.105 cfm
Calibrated Flow	left green	_____	right green
Laser Sensor Tests			
Calibrate Mode Test	left green	_____	right green
Zero Count Test	0 count/cf	_____	3 counts/cf
Pulse Height Test			
0.519 µm spheres (0.5 micron threshold)	--	_____ V	--
1.09 µm spheres (1 micron threshold)	--	_____ V	--
Comparison Test			
0.1 micron range (0.109 µm spheres)	-10%	_____ %	+10%
0.2 micron range (0.220 µm spheres)	-10%	_____ %	+10%
0.3 micron range (0.312 µm spheres)	-10%	_____ %	+10%
0.4 micron range (0.416 µm spheres)	-10%	_____ %	+10%
Probe Sensitivity Test			
R.H. display	99.0	_____	101.0
Temperature display	99.0	_____	101.0
Air Velocity display	198.0	_____	202.0

Table 3-8. Performance Verification Record for Model A2420 Counter

Model _____ Date _____

Serial Number _____

Procedure	Minimum	Actual	Maximum
Airflow Test			
Maximum Flow	2.1 cfm	_____ cfm	--
Calibrated Flow	left green	_____	right green
Laser Sensor Tests			
Calibrate Mode Test	left green	_____	right green
Zero Count Test	0 count/cf	_____	0 counts/cf
Pulse Height Test			
J1: 1.09 µm spheres (1 micron threshold)	--	_____ V	--
2.02 µm spheres (2 micron threshold)	--	_____ V	--
J2: 1.09 µm spheres (1 micron threshold)	--	_____ V	--
2.02 µm spheres (2 micron threshold)	--	_____ V	--
Comparison Test			
0.3 micron range (0.312 µm spheres)	-10%	_____ %	+10%
0.5 micron range (0.519 µm spheres)	-10%	_____ %	+10%
Probe Sensitivity Test			
R.H. display	99.0	_____	101.0
Temperature display	99.0	_____	101.0
Air Velocity display	198.0	_____	202.0

PREVENTING PROBLEMS

Introduction

The particle counter was built to be reliable. Its mechanical and electrical parts are rugged. As a result, most problems with the counter are not due to counter failure, but come from misuse or a lack of normal maintenance.

This section describes the particle counter's intended use, common operating mistakes, and the best operating and maintenance practices. Understanding these subjects will help you get many years of trouble-free service from the counter.

The section is organized as follows:

- Using Counters in Various Environments - discusses common problems when using the counter in controlled (clean) and uncontrolled (greater than class 100,000) environments.
- Common Operating Mistakes - gives examples of common operator errors that may damage the particle counter.
- Best Practices - describes some simple operating steps and maintenance procedures that will ensure the best counter performance.

NOTE

In this section, assumption is made that you have already read Section 2, *Operation*. Please read Section 2 before proceeding.

Using Counters in Various Environments

Particle counters are used to measure the amount of airborne particles in two types of environments: controlled and uncontrolled.

Controlled environments are class 100,000 or cleaner "cleanrooms" (as defined by Federal Standard 209D). Cleanrooms control airborne contamination. Industry uses cleanrooms to build sensitive products, such as pharmaceuticals and integrated circuits. Incorrect use of the counter in cleanrooms may degrade accuracy.

Uncontrolled environments are any environments that do not meet the criteria for Class 100,000 cleanrooms. Examples are areas containing dust or the outdoors. When used in uncontrolled environments, the counter requires increased maintenance to prevent measurement problems. Using the counter in these environments is described below.

Controlled Environment

The most common problem in this environment is accidentally sampling (measuring) the wrong air, or something other than air.

There are two ways this happens. The first accident involves misusing the isokinetic probe. The probe should be kept at least 12 inches from any forms of liquid, such as vapors. The suction at the open end of the probe is strong, and liquid can be quickly pulled into the probe. The second accident occurs during the aseptic washing of a clean room. Often the counter is used to automatically monitor a cleanroom through tubing. Because the counter monitors automatically, it can easily be forgotten. Turn the counter off during this washing.

CAUTION

Sampling liquids will damage the counter. This damage requires factory repair. For more information, refer to "Sampling Errors" in this section.

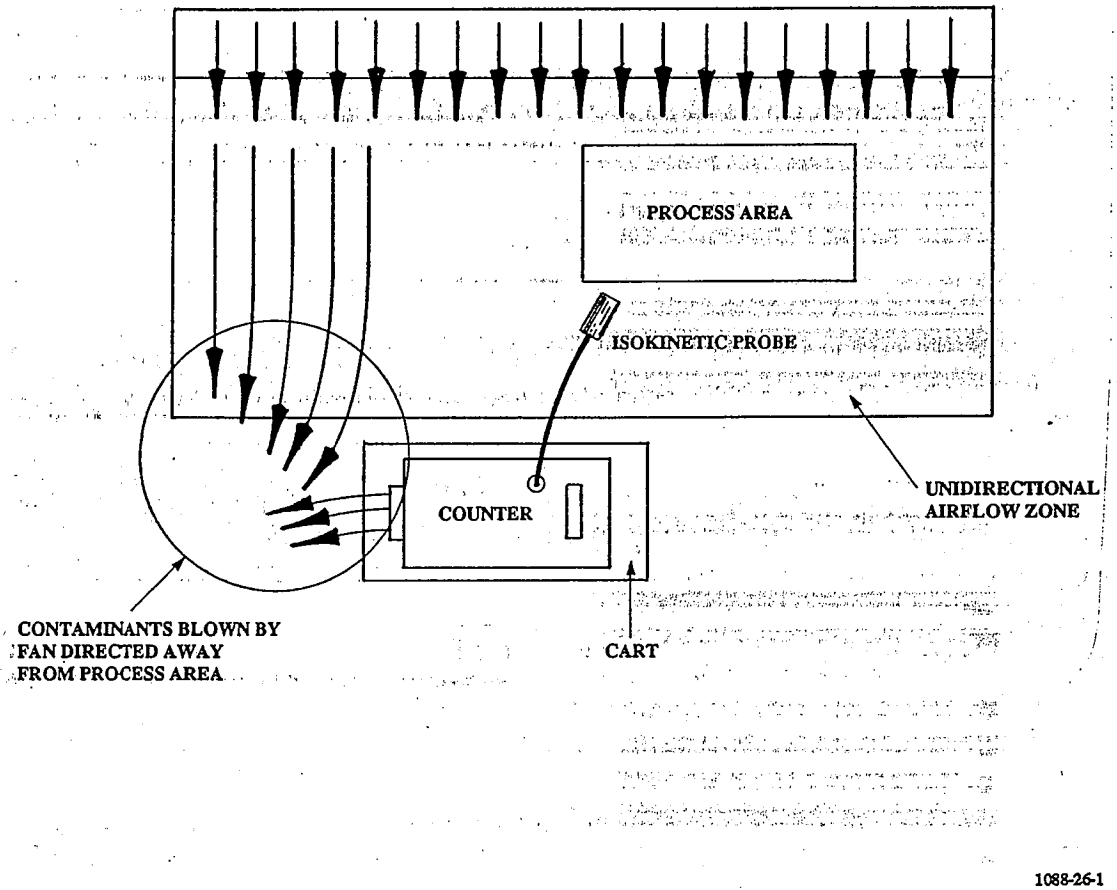


Figure 4-1. Sampling in a Unidirectional Flow

Uncontrolled Environment

CAUTION

Particle counters with 0.2 micron sensitivity and greater are not recommended for use in uncontrolled environments.

The most common problem in this environment is the uncontrolled nature of the environment. This environment may contain contaminants. Contaminants are high concentrations of airborne particles or airborne lint and dust.

Contaminants can lodge in the sensor inlet tube, coming loose later and erroneously raising the particle count. They can also clog the printer.

Contaminants on the inlet tube or in the sensor can be minimized by frequently purging the counter. Purging is a process that draws clean air through the sensor, blowing out contaminants that may have accumulated.

In the calibration mode, the bar graph display can indicate the need for purging. If the red lights on the right side of the bar graph display come on, purge the counter. If purging does not fix the problem, and your counter has a HeNe-type sensor, refer to "Cleaning the Sensor" in Appendix A for a step-by-step procedure for sensor cleaning. Otherwise, refer to the Service Manual or call Customer Service.

If your uncontrolled environment has typical particle counts of greater than 200,000/cf, the counter should be purged every day. For a step-by-step purging procedure, refer to "Zero Count/Purge Test" in Section 3.

If your uncontrolled environment contains airborne dust, regular internal cleaning of the counter chassis is required. If you move the counter from an uncontrolled to a controlled environment, first clean the interior of the counter. Otherwise, contaminants that may have been pulled into the counter could be blown out and affect the sensitive cleanroom measurements. For a step-by-step procedure for internal cleaning, refer to "Internal Cleaning" in this section.

Common Operating Mistakes

Some operating mistakes are widespread, occurring frequently among different users. Service personnel frequently see repair work caused by these mistakes. Reading this subsection will help you to avoid these mistakes.

Sampling Errors

Most operator mistakes involve sampling with an isokinetic probe. The probe has a strong suction so that it can sample large amounts of air. Sampling errors that damage the counter come from drawing something into the probe other than air. Here is a partial list of the wrong things to sample:

- Plastic dust. This melts inside the counter, clogging the air pump. This dust can also coat the optics of the internal sensor.
- Powdered materials. Units have been returned for service with coal dust coating the sensor.
- Liquids. The sensor is designed for air, not liquid. Liquids coat the sensor and ruin its calibration. Sometimes liquids can be suspended in air, such as oil droplets. Oil will adhere to the internal optics of the sensor.
- Smoke. Cigarette smoke contaminates the sensor.
- Adhesives and corrosives in vaporous form. These are sometimes found in damaged sensors.

As a general guideline, keep the probe at least 12 inches from loose materials, dust, sprays, etc.

If you are also using the RH/temperature probe, do not expose it to caustic vapors (i.e. RTV). The sensing element of the probe may be damaged.

Restricting Sample-Air Flow

Another common operator mistake is using the AIR FLOW control to turn off the air pump instead of putting the counter in the calibrate mode. The AIR FLOW control was designed to compensate for minor variations in airflow resistance caused by using different isokinetic probes or intake tubing. Using the AIR FLOW control to completely shut off the pump strains the pump. This strain will destroy the pump.

Restricting the inside diameter of the intake air line to less than 1/4th of an inch will increase pump wear. Custom designed isokinetic probes and intake tubing should have a minimum intake diameter of 1/4 of an inch. Intake tubing should not be kinked. Never cap the sample air inlet tube or the isokinetic probe when the counter is on (OPER mode).

Restricting Cooling Air

The counter cooling fan is on the rear panel. If the rear panel, and thus the fan, is pushed against a wall, or blocked in any way, the inside of the counter can get too hot, causing the counter to malfunction. Usually this malfunction can be fixed by resetting the counter. Occasionally the counter may be permanently damaged.

One way of accidentally blocking cooling air is to install the counter in a cabinet. If cabinet installation is necessary, you must vent the cooling fan air out of the cabinet through a straight hose or tube of five-inch diameter. The tube cannot be blocked or filtered in any way. The cabinet must also be vented to allow air intake and prevent a vacuum from developing. (Provide enough venting and air intake for a PAMOTOR Model 4600X fan or equivalent.)

Best Practices

Most problems with particle measurements can be prevented by developing a few good habits and some regular maintenance. Most maintenance can be done as a regular part of operation.

Proper Operation

For easy, successful counter operation, use this procedure every time you operate the counter.

1. Turn the counter on.
2. If the counter is not already in the CALIB mode, press CALIB.

   In the calibrate mode, the air pump is off and the bar graph indicates if the internal optical sensor is calibrated. (The calibrate mode is a "secondary calibration" as defined in Federal Standard 209D.)
3. Verify a green light on the bar graph is on.

   If a green light is on, the optical sensor is within factory calibration. If a red light is on, refer to the Service Manual or call Customer Service. Measurements may be invalid if a red light is on.
4. Select the operate mode by pressing OPER.

   In the operate mode, the air pump is on and the bar graph indicates if the airflow is calibrated. When the center-green light is on, the airflow rate is the nominal value ±5%.
5. If necessary, adjust the AIR FLOW control until the bar graph center-green light is on.

   If you make measurements when the center-green light is not on, then the airflow rate is uncalibrated and the particle count measurements are misleading. If the airflow will not adjust to the center-green light, refer to the Service Manual or call Customer Service.
6. (Optional) Verify the alarm limits are set correctly for your measurement.
7. Make your measurements.
8. After your measurements are complete, put the counter in the calibrate mode by pressing CALIB.

9. Verify the bar graph green light is on.

   If a red light is on, your previous measurements may not be accurate. Refer to the Service Manual or contact factory Customer Service.

10. Turn the counter off.

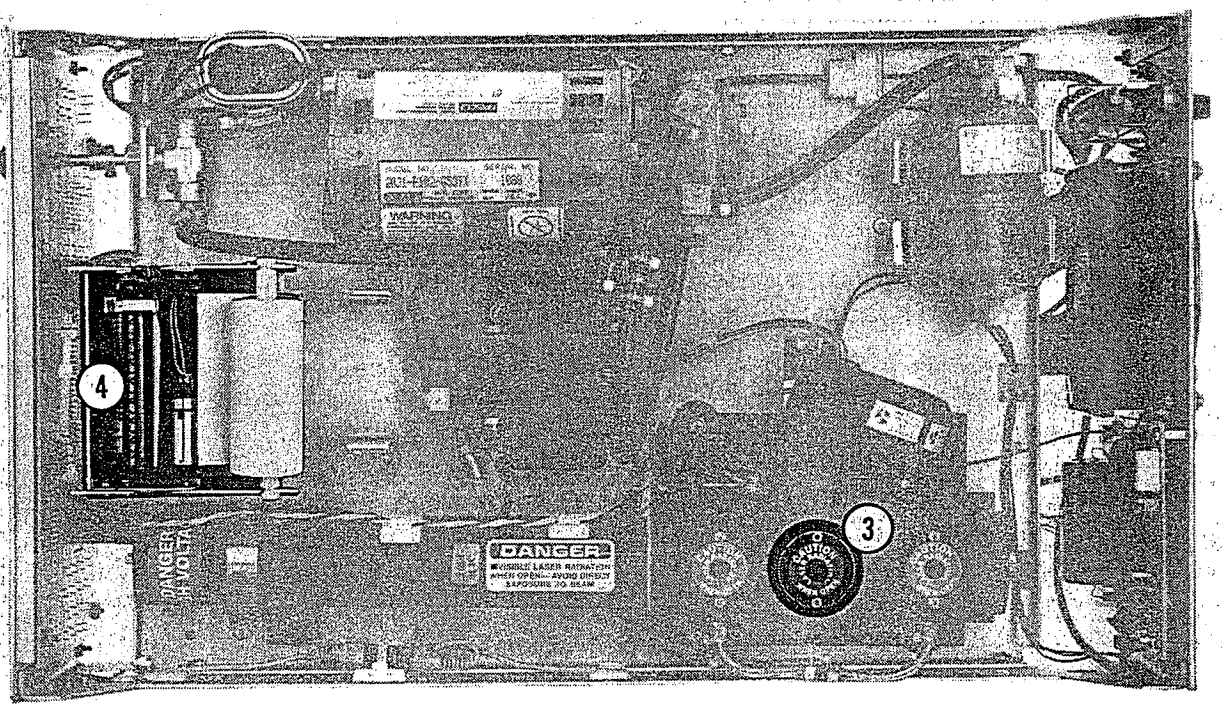
    Turning the counter off in the operate mode, or unplugging the counter before you turn it off, can cause the counter's internal computer to make mistakes. When this happens, some or all of the front-panel controls may not function. This problem can be fixed by resetting which is described in "Resetting the Counter" in Appendix A.

11. Leave the counter plugged in.

    Leave the counter plugged in whenever possible, to preserve the internal battery. The battery maintains counter memory, which remembers all your settings such as alarm limits. The battery can support the counter memory for one year.

Internal Cleaning

The counter contains a cooling fan to keep the air pump cool. If the counter is operated in an uncontrolled environment, the fan may pull contaminants into the chassis. This internal cleaning procedure uses compressed nitrogen to blow contaminants from the chassis. When you should clean the chassis depends on how you use the counter. For an internal cleaning schedule, refer to "Maintenance Schedules" in this section.



0489-94-1

WARNING

Failure to unplug counter and then touching internal parts can result in severe electrical shock.

1. Press CALIB then OFF then unplug counter.
2. Remove top and bottom covers. Each cover is attached with six screws, three on each side of counter.
3. Cap sensor inlet tube. Using compressed nitrogen, at less than 25 lbs/square inch, blow contaminants and dust from counter. Clean both top and bottom of chassis.
4. Clean both printer guide rod and cam with compressed nitrogen. Gently remove any strings or hair on rod or cam.

CAUTION

Do not put any lubricants or cleaners on printer guide-rod or cam. Damage to printer may result.

Figure 4-2. Internal Cleaning

Maintenance Schedule

Refer to the Maintenance Schedule table at the back of this section for a schedule of maintenance procedures described in this section. The table assumes daily use of the particle counter. The table indicates that as the operating environment becomes less controlled, the need for maintenance increases.

The maintenance procedures should also be done under the following conditions:

- When you move the counter from a less controlled to a more controlled environment, do zero counting. This will ensure that contaminants from the less controlled environment are not affecting the sensor and giving unusually high readings.

- When you move the counter from a class 100,000 or worse environment to a cleaner environment, do an internal cleaning. This will control the possibility of contaminating the cleaner environment.

- When you check the calibrate mode, if the red lights to the right of the bar graph are on, this usually indicates sensor contamination. Purge the sensor. If purging does not eliminate the problem and your counter has a HeNe-type sensor, refer to "Cleaning the Sensor" in Appendix A for a step-by-step procedure for sensor cleaning. Otherwise, refer to the Service Manual or contact factory Customer Service.

The factory puts a tag on the top cover after every calibration (see figure on following page. This tag shows the last date of factory calibration, and when the next calibration is due.

Factory service/repair is available with five day turn-around time; calibration is available with 48 hour turn-around time (excluding shipping time).

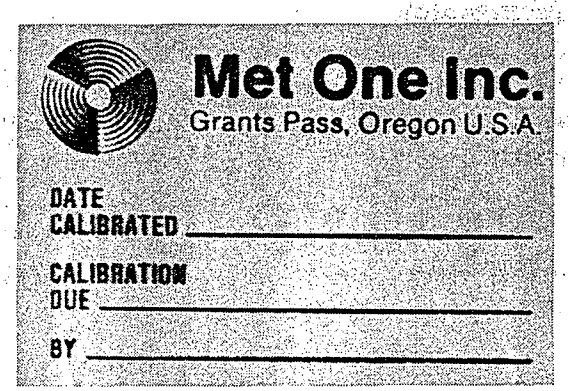
The air pump should be serviced after 4,000 hours of operation. In most cases, it is sufficient to service the pump during the annual calibration. If the counter is used continuously, you should have the pump serviced every six months.

CAUTION

Failure to service the air pump after 4,000 hours of use can damage the pump.

Table 4-1. Maintenance Schedule

	Controlled Environments (by cleanroom class)					Uncontrolled Environments	
	10	**100**	**1,000**	**10,000**	**100,000**	**>100,000**	**Dusty**
Calibrate Mode	every use	every use	every use	every use	every use	every use	every use
Zero Counting	weekly	weekly	weekly	weekly	daily	daily	daily
Sensor Purging	NA	NA	NA	weekly	weekly	every use	every use
Calibration	annually	annually	annually	annually	annually	annually	annually



1288-56-1

Figure 4-3. Calibration Tag

REMOTE OPERATION

Introduction

This section describes particle counter operation by a computer. You can use a computer to control the count cycles and then read and process the data. This section contains the following subsections:

- Preparing for Remote Operation — describes setting up the counter and computer hardware.
- Command and Data Syntax — lists the counter commands and describes command and data responses.
- Programming Example — shows how to use the counter commands to take an air sample and then read the results.

NOTE

- This section does not apply to particle counters having earlier version EPROMs. Refer to "Manual Backdating" in Appendix A for information on earlier-version counters.
- In this section, assumption is made that you understand front-panel operation of the counter, operation of your computer and the serial data bus.

Preparing for Remote Operation

To communicate with the counter, the computer must have an asynchronous, serial port and compatible communication modes and baud rates. The following procedure will set up the counter for computer operation.

1. Verify the serial cable is compatible with both the computer and the counter. Refer to "Serial Cables" on the following pages.

2. Set the counter communication mode and baud rate to match the computer. Refer to "Serial Formats and Baud Rates" on the following pages.

3. Set the counter select code. Refer to "Select Codes" on the following pages.

4. Connect the computer serial port and counter "SERIAL I/O-RS232" port together with the serial cable.

CAUTION

Accidentally connecting the serial cable to the SYSTEM port on the counter can damage the counter.

5. Place the counter in the remote mode by pressing the MODE: REMOTE/LOCAL key until the REMOTE light is on.

NOTE

The remote mode prevents local, front-panel operation by a person, and enables operation only by a computer. In the remote mode, the OPER, CALIB, MODE: AUTO/MANUAL, COUNT MODE: CUM/DIFF, RUN, STOP, and PROG keys will not function. To restore front-panel operation, press the MODE: REMOTE/LOCAL key until the LOCAL light is on.

Serial Cables

CAUTION

To avoid internal circuit board damage, the serial cable must be wired as shown in the following figure. The figure shows wiring for a 25-pin connector on the computer. If your computer uses a nine-pin connector, use a nine-pin to 25-pin adapter cable. Both cables are available from the factory.

NOTE

Two 0-20 mA current loops (one loop for input data and one for output data) are required to operate multiple counters with one serial port. The wiring of the current loops will vary with different computers and current sources. Contact the factory for wiring information.

NOTE

The counter will operate with three wires (transmit, receive, common) in the voltage mode (+12V). This is possible because handshaking is accomplished via the transmit and receive lines.

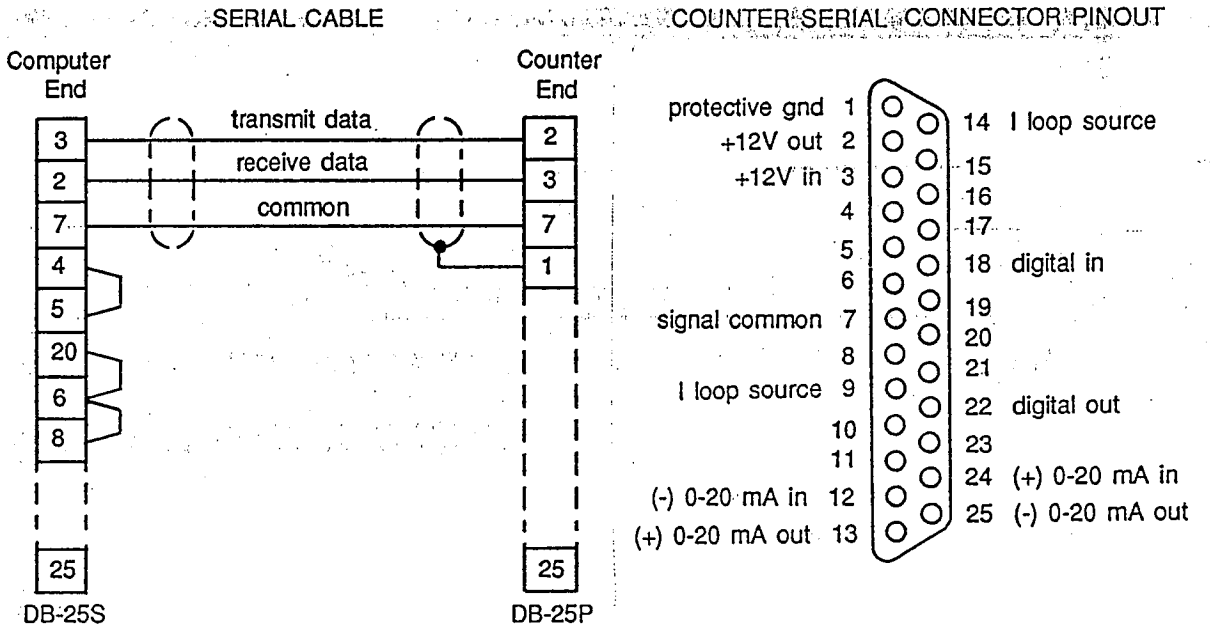


Figure 5-1. Cable Diagram (IBM PC-type Serial Ports)

Serial Format and Baud Rates

Serial communication format and baud rates can be selected from the front panel. Unless otherwise requested, the unit will be set at the factory as follows:

- 9600 baud (does not apply to early-version counters. Refer to Appendix A for information on earlier counters.)
- communication mode 3 (no parity, 8 data bits, 2 stop bits)

NOTE

- You can print out a table of available communication modes or baud rates by selecting Option 96 or 97, respectively. Refer to "Options/Serial Port Table Printout" in Section 2 (does not apply to earlier-version counters).
- The following procedure differs slightly for earlier-version counters. Refer to "Manual Backdating" in *Appendix A — Supplemental Information*, for information on earlier-version counters.

To change these settings, use the procedure below:

1. Press MODE REMOTE/LOCAL key until LOCAL light is on.
2. Press OPTION key; PROG light comes on.
3. While PROG light is on, press "6" (serial communication) or "7" (baud rate), then press ENTER; the existing format or rate number will be displayed.
4. While existing number is displayed, press PROG then enter new number for desired format or rate (see tables below).
5. Press ENTER key.

Table 5-1. Serial Communication Modes (OPTION "6")

Number	Parity	Data Bits	Stop Bits
0	none	7	1
1	none	7	2
2	none	8	1
3	none	8	2
4	even	7	1
5	even	7	2
6	even	8	1
7	even	8	2
8	odd	7	1
9	odd	7	2
10	odd	8	1
11	odd	8	2

Table 5-2. Baud Rates (OPTION "7")

Number	Rate	Number	Rate
0	50	8	2000
1	75	9	2400
2	100	10	3600
3	150	11	4800
4	300	12	7200
5	600	13	9600
6	1200	14	19200
7	1800		

Select Codes

In an air-monitoring system, several counters may use the same serial port. Some of these counters may also control air sampling manifolds that sample from multiple stations (locations).

To prevent simultaneous talking on the serial port, the computer addresses each counter by a unique "counter select" number. Once a counter has been selected, the computer tells the counter which manifold station it wants to talk to by sending "device select" numbers. Each device select number is assigned by the counter. Counter select and device select numbers are described below.

Counter Select: The counter will not respond to any command on the serial port until it receives its counter select code or the universal select code. The counter select number must be programmed into the counter using the OPTION key on the front panel. Up to 64 counters can be assigned a unique identification number. The number through the serial interface differs as shown in the table below.

You enter a unique counter select number, from 0 to 63, into each particle counter by pressing OPTION, "11", ENTER, PROG, number, ENTER.

Table 5-3. Counter Select Codes

Counter Select Number (programmed)	Counter Response (received thru SIO port)
0	128
1	129
2	130
3	131
•	•
•	•
63	191

NOTE

In some early version counters, the counter select number was programmed with the UNIT I.D. key where Unit I.D. Number = Counter Select Number – 128.

Device Select: The computer communicates with the counter to access data from the different manifold stations. After first selecting the counter, the computer must send the appropriate device select number (from the following tables) to select data from a particular station.

Table 5-4. Model 230 Manifold Device Selects

Manifold Station	Device Select
0	192
1	193
2	194
3	195
4	196
5	197
6	198
7	199
8	200
9	201
10	202
11	203
12	204
13	205
14	206

Table 5-5. Model 231 Manifold Device Selects

Manifold Station	Device Select
1	192
2	193
3	194
4	195
5	196
6	197
7	198
8	199
9	200
10	201
11	202
12	203
13	204
14	205
15	206
16	207

Command and Data Syntax

The counter responds to single-character ASCII commands and sends a data record that varies in length based on content. The command and data syntax is defined below.

NOTE

All particle counters contain a "rotating-type" serial buffer meaning the newest data into the buffer replaces the oldest existing data in the buffer.

Commands

The single-character ASCII commands described below are generic commands that work with all counter models.

d **Start Counting:** (counter controlled) The counter will begin counting and control the count cycle based on the front-panel settings for period (sample time) and hold time.

c **Start Counting:** (computer controlled) The counter will begin counting without waiting for an even second boundary. Counting will continue until stopped by the computer. The count cycle should be timed by the computer.

e **Stop Counting:** The counter will immediately stop counting without waiting for an even second boundary.

C **Clear Buffer:** All contents of the counter's rotating buffer will be erased.

D **Send Number of Records:** The counter will send the number of records in the rotating buffer (does not apply to earlier-version counters).

F **Send Flow Rate:** The nominal flow rate of the counter will be sent (does not apply to earlier-version counters).

A **Send Record:** The next record in the counter's rotating buffer will be sent. If the rotating buffer is empty, a "#" will be sent. Each record is erased from the buffer as it is sent.

R **Resend Record:** The last record sent will be resent. Records sent prior to the last record have been permanently erased.

h **Standby Mode:** The counter will enter a mode that may turn off air pumps or shut down sensors to conserve power or reduce equipment wear.

g **Active Mode:** The counter will enter a mode that prepares it for counting. For example, the air pump may turn on to purge the air path.

U **Universal Select:** The counter will respond to all commands after receiving this command, regardless of which select code is programmed into the counter.

CAUTION

Do not use the Universal Select command when more than one counter is on the same port or multiple counters will respond at the same time, causing communication problems. Instead, use the counter select number programmed through option "11"; refer to "Counter Select" in this section.

128-191 **Counter Select:** The counter will respond to all subsequent commands when it is sent a number that matches its select code. The counter is deselected, or made unresponsive to computer commands, by selecting another counter, i.e. sending a number between 128 and 191 that does not equal the counter's select code.

192-255 **Device Select:** When the counter is sent a number that matches a device number, the counter will select the manifold station. The station is deselected by selecting another station.

Command Responses

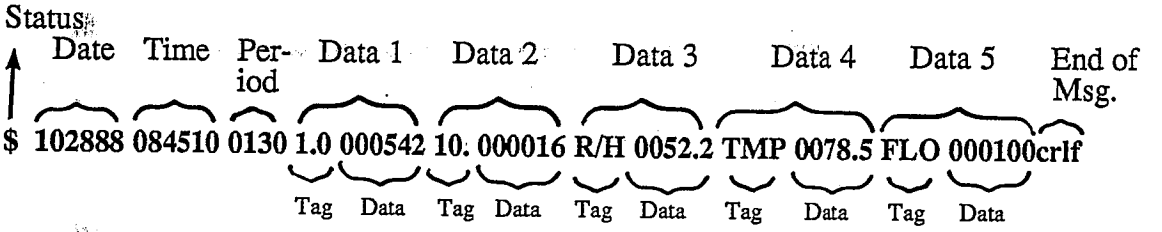
The counter will respond to all commands and select codes by sending the command characters back to the computer. If the counter does not recognize a command, it will send a "?" character back to the computer. If the computer is asking for a record from an empty buffer, the counter will send a "#" character. If the computer is asking for a record that has already been sent, the counter will send a "#" character unless the computer uses the Resend Record command.

If the counter's serial communication mode sets parity and there is a parity or framing error, the counter will not send any command characters back to the computer.

Data

Each counter, regardless of model number, can send a record of its data. The data record is a string of ASCII characters where position in the string identifies the character's meaning. String length changes with the amount of data points available from the counter. Each data point is preceded by a three-character tag that identifies the type of data that follows in the next six data characters. In the following example, the bold characters comprise a data record and the non-bold words describe the meaning of characters. Four channels were not shown in the example. Also, **FLO** (Data 5) applies only to new version counters.

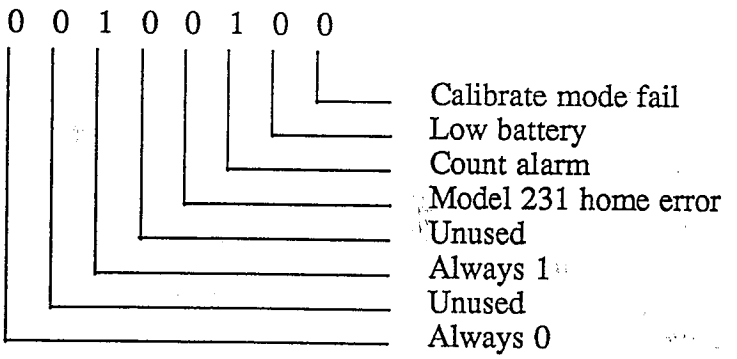
Example:



Status: When translated to a binary byte, this character will indicate the status of the counter. For example, the ASCII character "$" has a decimal value of 36, which when converted to a binary byte sets the 3rd and 6th bits:

0 0 1 0 0 1 0 0

Each bit that is set indicates the following:



In this example the ASCII character "$" translates to a status byte that is indicating a "Count Alarm".

Date: Date information is carried in the 3rd through 8th characters of the record. The 2nd character is always a space, to separate the status character from the date characters. The date is arranged as MMDDYY (Month Day Year). In the example above the date is October 28, 1988, the day the counter collected the data in the record.

Time: Time information is carried in the 10th through the 15th characters of the record. The 9th character is always a space, to separate the date from the time. The time is arranged as HHMMSS (Hours Minutes Seconds) military time. In the example above the time is 8:45 A.M. and 10 seconds.

Period: The period is the sample time, or the length of counting time. The period information is carried in the 17th through 20th characters. The 16th character is always a space, to separate the time from the period. The period is presented in minutes and seconds. In the example above the period was 1 minute and 30 seconds. When the period is controlled by the computer (e command), the period characters will be zeros. When the period (sample time) is controlled by the counter (d command), the period characters will represent the sample time.

Data 1, 2, 3, 4, and 5: These characters contain data from the different counter measurements. Each data value is preceded by a 3-character tag that identifies the type of data that follows. The tags and data are each preceded by a space character for separation. The record will contain as many tag/data elements as required (a minimum of seven and a maximum of ten).

Tags: The tags contain three characters that identify the type of data that will follow. If the data is a particle count, the tag will indicate the particle size. In the example above the first two tags indicate that particle count data follows for the 1.0 and 10.0 micron particle size ranges. If the data is relative humidity or temperature readings, the tag will indicate this with the appropriate characters. In the example above the third tag indicates relative humidity data will follow and the fourth tag indicates that temperature data will follow. The record data will be in the following units of measure:

Particle Counts . . . . . counts
Temperature . . . . . °F (or optional °C)
Relative Humidity . . . . %
Air Velocity . . . . . f/m (or mm/sec)
Flow Rate . . . . . % of nominal (does not apply to earlier-version counters)

Data: The data are six characters, preceded by a space.

End of Message: The end of message characters will immediately follow the last tag/data element. There will be no separating space. The end of message characters are a carriage return and line feed.

Programming Example

This section demonstrates how the counter commands should be used.

Example 1: A stand-alone counter completes two count cycles and sends the resulting data records.

Sequence	Counter Commands	Explanation
1	<turn counter on>	- -
2	<set up front panel>	Unit I.D., Remote Mode, Count Mode, and Auto/Manual Mode must be set from the front panel
3	<130>	counter is sent its select code
4	<g>	counter is put in the active mode
5	<wait>	program allows time to purge air path
6	<c>	program starts the sample
7	<wait>	program times the sample
8	<e>	program stops the sample
9	<A>	program requests data record from counter and stores it for future processing. Data is sent when current count cycle is complete.
10	<h>	program puts counter in standby to conserve power and equipment wear
11	<wait>	program waits until next sample is required and then loops up to step 4

Example 2: A manifold allows the counter to serially sample air at multiple locations. In this example, a counter samples a Model 231 manifold at two locations to complete a count cycle, then sends the resulting data records to the computer.

Sequence	Counter Commands	Explanation
1	<turn counter and manifold on>	- -
2	<set up front panel>	Unit I.D., Remote Mode, Count Mode, and Auto/Manual Mode must be set from the front panel. Manifold front-panel settings are not required.
3	<130>	the counter is sent its select code
4	<g>	counter is put in the active mode
5	<192>	device 1 of the manifold is selected
6	<wait>	program allows time to purge air path of counter and manifold. Manifold requires a 15 second minimum wait.
7	<c>	program starts the sample
8	<wait>	program times the sample
9	<e>	program stops the sample
10	<A>	program requests data record from counter and stores it for future processing
11	repeat 6 - 10	program repeats these steps for station select 193 (station 2) and any other stations that are to be sampled
12	<h>	program puts counter in standby mode to conserve power and save equipment wear
13	<wait>	program waits until more samples are required and then loops to step 4

Appendix A

SUPPLEMENTAL INFORMATION

Introduction

This section contains supplemental information that may be helpful if simple problems occur during normal use of your particle counter and information to backdate this manual for earlier versions of the counter. The section has the following subsections:

- Resetting the Counter
- Replacing the Fuses
- Cleaning the Sensor
- Manual Backdating

Resetting the Counter

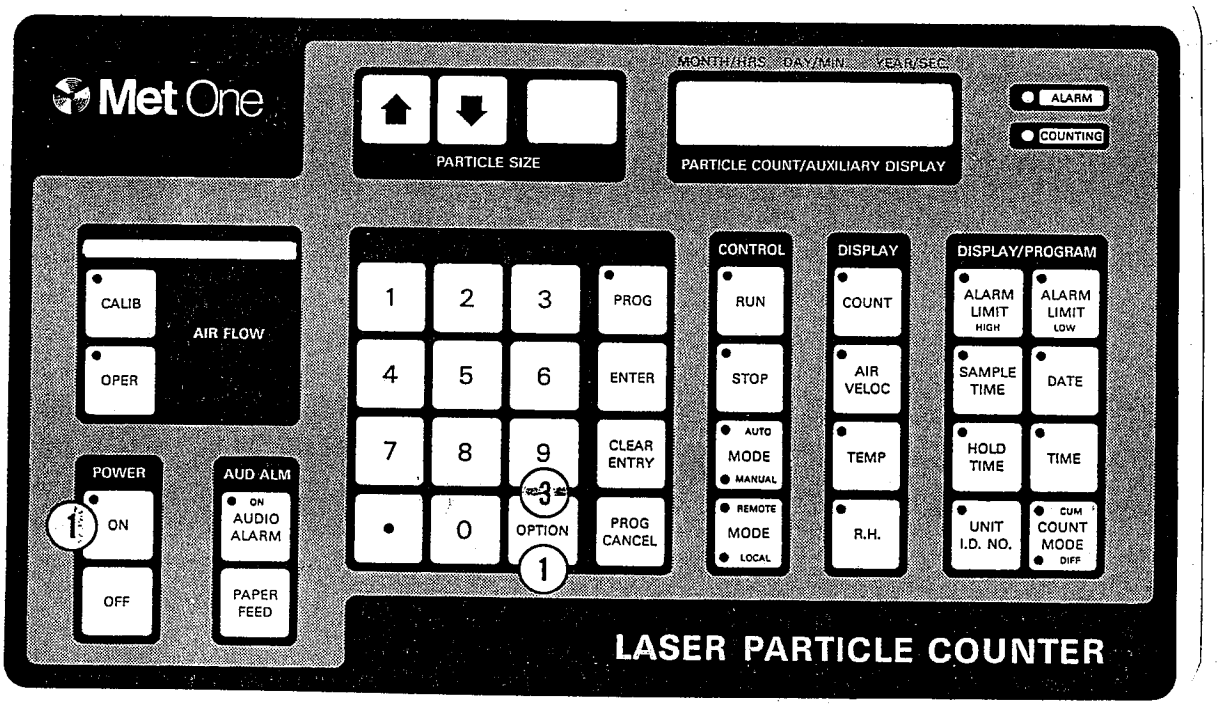
This procedure clears the counter memory and restarts its microprocessor.

CAUTION

Resetting the counter will erase the values that have been preset for the programmed functions: time and date, alarm limits, sample and hold times. All sample data stored in the internal data registers and programming instructions will also be erased.

NOTE

If the results in Step 2 do not occur, disconnect all external equipment and repeat this procedure. Reconnect one piece of equipment and repeat procedure to determine which piece of external equipment is the source of the problem.



0889-142-12

1. Press and hold ON key. Press and hold OPTION key.
2. Release ON. An audible alarm should sound and "------" should be displayed. Release OPTION.
3. Press and release OPTION again to cancel alarm and reset counter.
4. Reenter programmed functions. Refer to Section 2 for instructions, if necessary.

Figure A-1. Resetting the Counter

Replacing the Fuses

The counter has two fuses. A fuse for main power protection is located on the rear panel. A fuse for circuit board protection is located on the CPU board. Visual inspection of the fuses is not enough to determine if they have blown. If you suspect a fuse has blown, replace it.

If the main power fuse tends to blow when the counter is turned on, or if the fuse blows again after you have replaced it, suspect a damaged air pump. Disconnect the pump power cable. After the cable is disconnected, replace the fuse again and check if the counter will work (except air flow). If the counter works, the air pump vanes may be broken or the pump may be faulty.

1. Turn power off and disconnect AC power cord.

WARNING

Failure to disconnect electrical power cord can result in electrical shock.

2. On the counter back panel, push black fuse cap in and rotate counterclockwise.
3. Pull old fuse from cap; insert new fuse of same rating.
4. Reinstall fuse holder with new fuse; press and rotate clockwise.
5. Remove bottom cover.
6. Locate fuse on large circuit board. The fuse is in the corner of the board that is closest to the rear-panel fan. There is a small battery and transformer close to the fuse.
7. Pull or pry fuse from snap-type holder; insert new fuse of same rating.
8. Reinstall bottom cover.

Cleaning the Sensor

The following procedure is for particle counters using HeNe-type sensors. To determine what type sensor is in your counter, refer to "Specifications" in Section 1 (model number of your counter is on the rear-panel identification label). The calibrate mode uses the bar-graph display to indicate sensor condition. When one of the red lights on the left side of the bar-graph display comes on in the calibrate mode, the sensor should be cleaned.

If cleaning does not correct the problem, or if one of the red lights on the right side comes on, then the particle counter must be returned to the factory for repair. Refer to "Shipping Instructions" in Section 1.

Cleaning the sensor is a tedious process that requires patience and precise technique. The objective of the process is to remove film or dust from the sensor mirror and Brewster's window — *without* causing further contamination. This is not easily accomplished, since one speck of dust or a thin layer of film, invisible to the eye, can contaminate the sensor.

Do not clean the sensor unless the calibrate mode indicates cleaning is required. The sensor does not need annual cleaning. If the counter won't zero count, but the calibrate mode shows a green light, cleaning the sensor probably will not help.

CAUTION

Do not attempt to use this procedure if your counter is not equipped with an open-cavity HeNe laser sensor. Refer to "Specifications" in Section 1 for type light source in your particle counter.

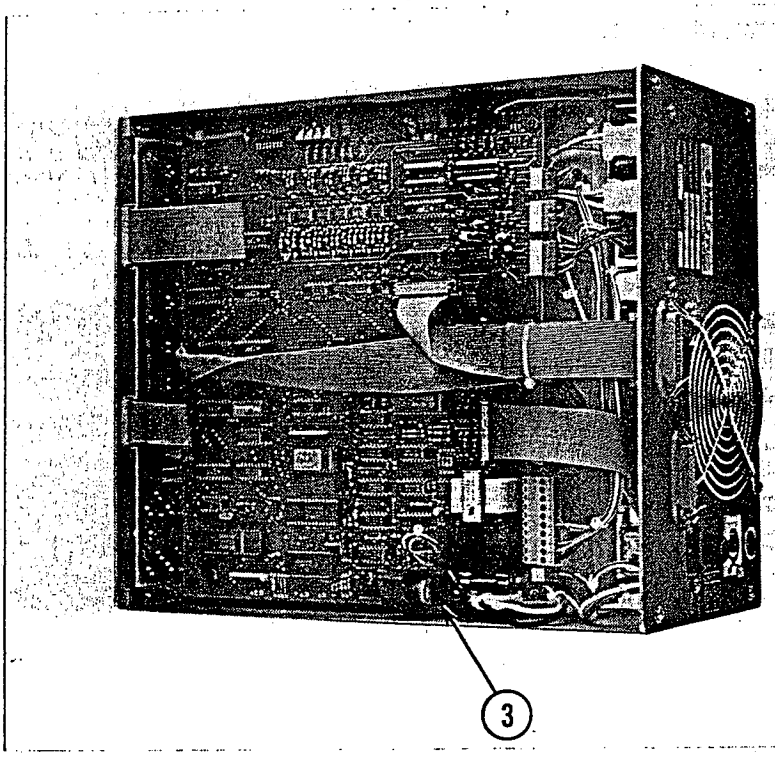
NOTE

- Spectrographic-grade alcohol and medical-grade cotton applicators should be used.
- The following figures show two different type of sensors. Use the sensor illustration that most closely resembles the sensor in your counter.

Replacing the Battery

The counter contains an internal battery that maintains the counter's memory. If the counter is left unplugged for a long time (a year or more), the battery can lose its charge. Full charge voltage is +3.5 to +3.7 Volts. If the battery has discharged or is faulty, it will have to be replaced.

Replacing the battery will clear the counter memory. All programmed settings will have to be reentered. Replace the battery using the following procedure:



0988-16-1

1. Turn power off and unplug the counter.

WARNING

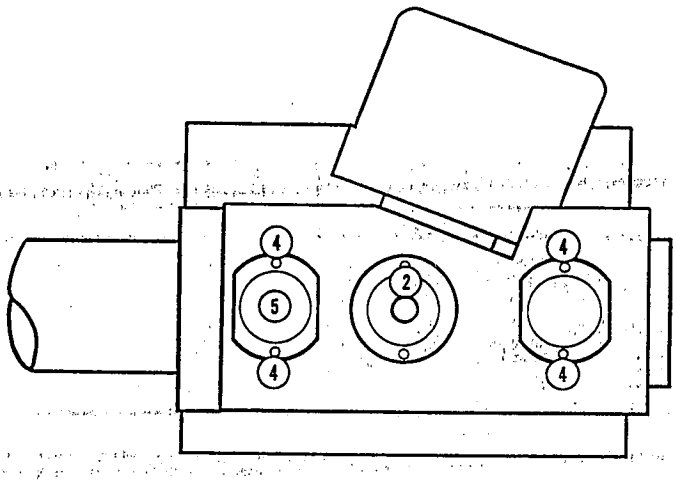
Failure to unplug counter creates a risk of severe electrical shock.

2. Remove six screws securing bottom cover; remove cover.
3. Pull battery from its holder by firmly grasping the flexible "handle" and pulling hard.
4. Install new battery, making sure polarity on battery matches carrier polarity.
5. Reinstall bottom cover with six screws.

Figure A-1A. Replacing Internal Battery

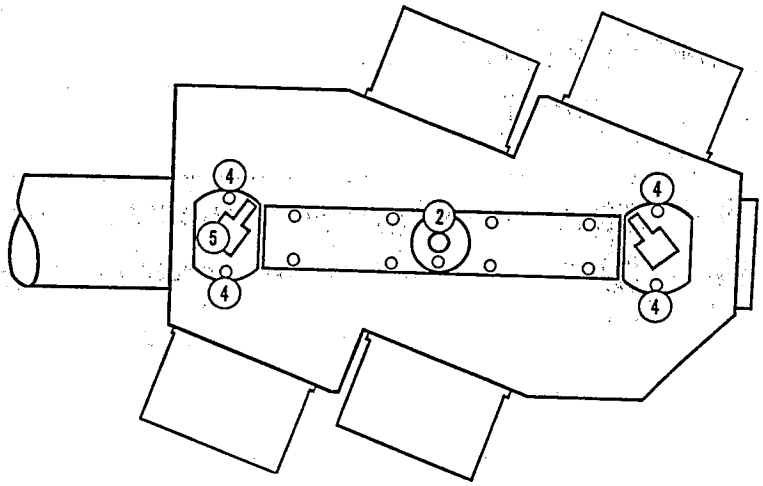
Single-Port Sensor

Circled numbers in figure refer to numbered steps below.



1089-178-1

Four-Port Sensor



1088-176-1

WARNING

Do not disconnect ground strap from sensor. Disconnecting strap creates risk of electrical shock from 1,700 volts.

1. Remove counter top cover.
2. Connect a purge filter or two-foot length of tubing to sensor inlet tube to prevent contaminants from entering the sensor.
3. Turn counter on; press CALIB until CALIB light comes on.
4. Remove screws on front and rear covers of sensor. Do not remove covers at this time.
5. To ensure your safety before proceeding, perform the following steps:
   A. Lift front cover from sensor.
   B. Place a sheet of notebook paper over opening.

WARNING

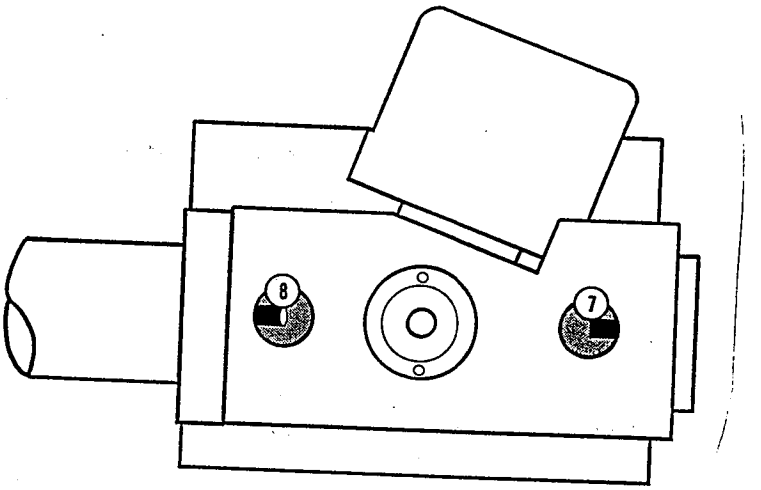
If you see a bright-red, 1/10th" spot on the paper, turn counter off and replace rear cover. This spot indicates a potentially hazardous condition. Contact the factory immediately. Do not attempt to complete this procedure.

6. Continue procedure on next page.

Figure A-2. Sensor Cleaning

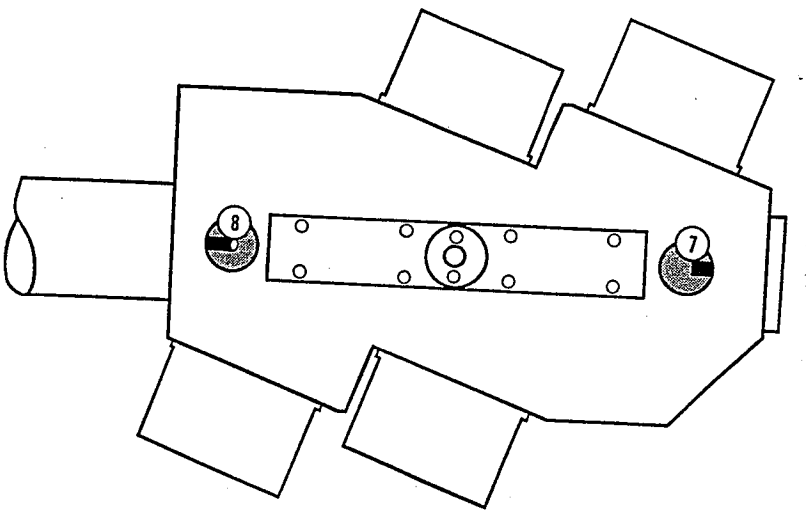
Single-Port Sensor

Circled numbers in figure refer to numbered steps below.



1089-179-1

Four-Port Sensor



1088-177-1

7. Apply a small amount of spectrographic-grade alcohol to a cotton applicator. Lift rear cover from sensor. With one swiping motion, use applicator to clean exposed mirror. Immediately replace rear cover.

8. Apply a small amount of alcohol to a new applicator. Lift front cover from sensor. With one swiping motion, clean exposed "Brewster's window". Immediately replace front cover.

9. Check bar-graph display to see if a green light is on. If a green light is not on, repeat steps 7 and 8 until a green light is on. The mirror and window may need to be cleaned many times. Sometimes the first few cleanings will make the problem worse before it gets better. This job requires patience. If a green light can not be obtained, counter needs factory service.

10. Securely tighten both front and rear covers. Reinstall counter top cover.

Figure A-2. Sensor Cleaning (continued)

Manual Backdating

This subsection changes this manual so that it is accurate for early versions of the laser particle counter, single-board models and up. The following changes either affect the entire manual or individual sections, in which case the change is listed by section name.

As of this printing, manual backdating consists of differences in the manual that are necessary to document earlier version EPROMs having the following part numbers: 204530-1, 204603-1, 204853-1, and 204996-1. You can determine what EPROM your counter has; the part number is on the EPROM chip, U33, located on the C.P.U. board in your counter.

NOTE

Information in this subsection does not apply if your counter contains the latest version EPROM, part number 2080114-1, Rev. A.

Getting Started Section

In the "Specifications" subsection, earlier version Model 209D particle counters were available with sample flow rates also of 0.01 cfm (single-port sensor) and 1.0 cfm (multi-port sensor).

Operation Section

The subsection "Using the Fed-Std-209D Mode" in this manual originally appeared as an option under the "Using Options and Accessories" subsection. Early version counters will only have this mode if ordered as an option when the counter was originally ordered.

The following information applies to particle counters with earlier version EPROMs. The differences can be grouped into the following categories:

- Printing Results
- Differential Pressure Special Option (ΔP)

Printing Results

A sample printout in the cumulative mode (with an alarm) —

```
**********ALARM**********
DATE = 01/30/89          TIME = 02:45:39
CUM. COUNT               SAMPLE TIME = 00:01:00

SIZE   COUNT  LIMIT   SIZE   COUNT  LIMIT
*.1    1020   1000    .2     691    1000
.3     41     1000    .5     21     1000
1.0    0      1000    5.0    0      1000
```

A sample printout in the differential mode (no alarm) —

```
DATE = 01/30/89          TIME = 02:45:39
DIF.COUNT                SAMPLE TIME = 00:01:00

SIZE   COUNT  LIMIT   SIZE   COUNT  LIMIT
.1     329    1000    .2     650    1000
.3     20     1000    .5     21     1000
1.0    0      1000    5.0    0      1000
```

Differential Pressure Special Option (ΔP)

If your counter was special ordered with the Differential Pressure Option, it has a rear-panel connector for a differential pressure sensor and front-panel controls for a differential pressure readout and alarm limits.

Operation

When the ΔP option is added to the counter, the UNIT I.D. key is replaced with a ΔP key. When pressed, the ΔP key displays the differential pressure value from the sensor on the counter's display. This value is displayed in millimeters or inches of water, depending on how you ordered the ΔP option. You can program alarm limits for differential pressure as follows:

1. Press ΔP key then ALARM LIMIT HIGH key.

2. Press PROG key. Using the 0-9 key pad, enter the new high limit. For example, for a high limit of 2.2 key in the number 220.

3. Press the ENTER key. The desired value of 2.2 will be displayed.

The low limit is programmed in the same manner except using the ALARM LIMIT LOW key. Note that during programming of the limit number no decimal is displayed.

Since the UNIT I.D. key has been replaced with the ΔP key, the unit identification number is now programmed with the OPTION key in the following manner:

1. Press STOP key then press OPTION key (PROG light will turn on) followed by the "8" key.

2. The current unit identification number will be displayed. Enter a new unit identification number by pressing PROG key within five seconds of when you pressed the "8" key. Enter the new limit using the 0-9 keypad, then press the ENTER key. The number will be displayed for five seconds.

Remote Operation

The current differential pressure value can be read by a computer through the serial port by sending the ASCII character "R" to the counter. The counter will respond by echoing the "R" and then sending six bytes of ASCII data, MSB first.

Connector Pinout

The differential pressure connector on the counter rear panel is wired as follows:

Pin	Signal
1	common
2	signal input from sensor
3	shorted to pin 4
4	shorted to pin 3
5	+15 V power to sensor

ΔP Cable

You can purchase a ΔP cable from the factory that will connect the particle counter to a ΔP sensor. The sensor end of the cable has three wiring lugs that contain the following signals:

Wire	Signal
black	common
white	signal from sensor
red	+15 V power to sensor

You can specify the length of the cable when you order.

Remote Operation Appendix

The following information applies to particle counters with earlier version EPROMs. The differences in serial communications for counters having an EPROM with part number 204530-1, 204603-1, 204853-1, or 204996-1 can be grouped into the following categories:

- Serial Connector Pinout
- Communication Modes and Baud Rates
- Preparing for System Operation
- Reading the Station Record Buffer
- Command Reference

Serial Connector Pinout

CAUTION

To avoid internal circuit board damage, the serial cable must be made as shown in the figure below.

NOTE

Two 0-20 mA current loops (one loop for input data and one for output data) are required to operate multiple counters with one serial port. The wiring of the current loops will vary with different computers and current sources. Contact the factory for wiring information.

NOTE

The counter will operate with three wires (transmit, receive, common) in the voltage mode (+12V). This is possible because handshaking is accomplished via the transmit and receive lines.

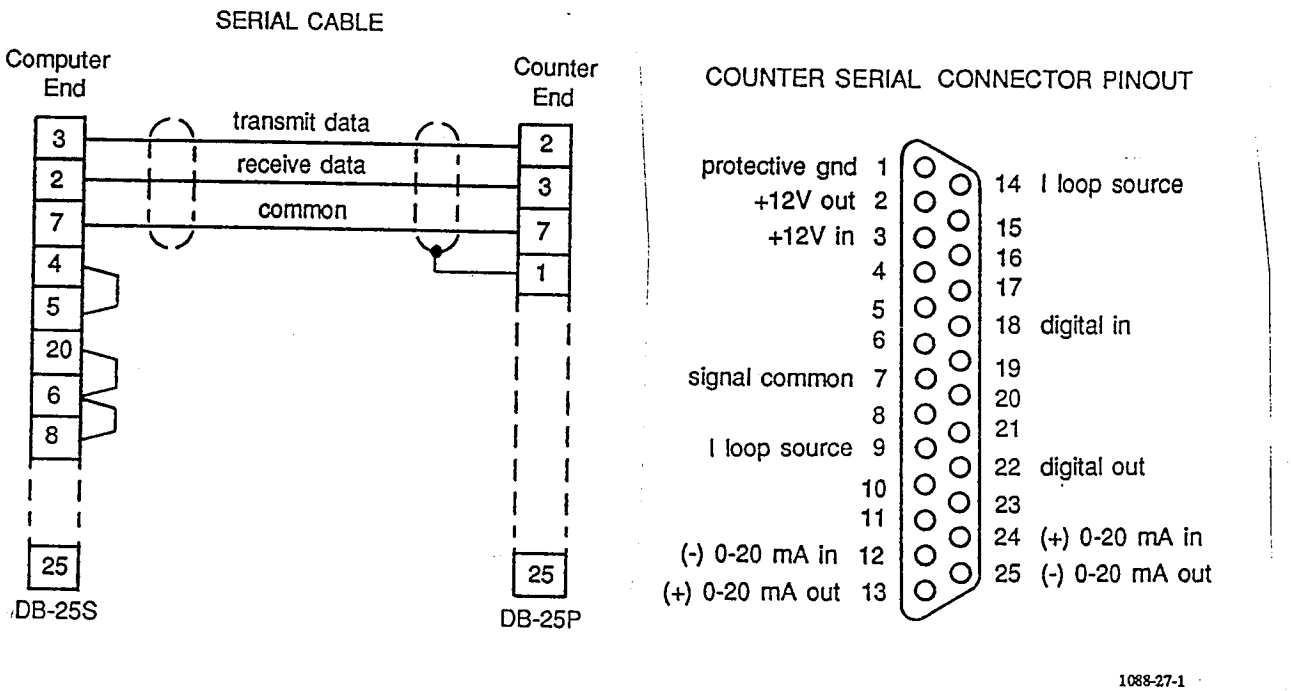


Figure A-1. Cable Diagram (IBM PC-type Serial Ports)

Communication Modes and Baud Rates

Communication modes and baud rates can be selected from the front panel. Unless otherwise requested, the unit will be set at the factory as follows:

- 300 baud
- communication mode 3 (no parity, 8 data bits, 2 stop bits)

You can change these settings as shown in the following procedure.

1. Press MODE REMOTE/LOCAL key until LOCAL light is on.
2. Press OPTION key
3. Press "6" (serial communication) or "7" (baud rate)
4. Press PROG key then enter the number for desired format or rate
5. Press the ENTER key.

Table A-1. Serial Communication Modes (OPTION "6")

Number	Parity	Data Bits	Stop Bits
0	none	7	1
1	none	7	2
2	none	8	1
3	none	8	2
4	even	7	1
5	even	7	2
6	even	8	1
7	even	8	2
8	odd	7	1
9	odd	7	2
10	odd	8	1
11	odd	8	2

Table A-2. Baud Rates (OPTION "7")

Number	Rate	Number	Rate
0	50	8	2000
1	75	9	2400
2	100	10	3600
3	150	11	4800
4	300	12	7200
5	600	13	9600
6	1200	14	19200
7	1800		

Preparing for System Operation

Using multiple counters, manifolds, and multiplexers, you can build a complete air sampling system for a cleanroom facility. The manifolds allow each counter to serially sample air at multiple locations (called stations). The multiplexer allows the computer to collect data from multiple RH/Temp and Air Velocity probes.

NOTE

If your counter contains the 209D calculations option, then it does not support air sampling manifolds. This subsection on air sampling systems does not apply to counters containing the 209D calculations option.

In a system, all counters may use the same serial port. To prevent simultaneous talking, the computer addresses each counter by the last digit of its UNIT I.D. number. For example: ASCII 6 (ACK) will select (reset) any counter with an ID number ending with a six (6).

Two 0-20 mA current loops (one loop for input data and one for output data) are required to operate multiple counters with one computer. The wiring of the current loops will vary with different computers and current sources. We recommend that you contact the factory for serial wiring information.

CAUTION

Do not connect the manifold cable to the counter serial port. This can damage both the counter and the manifold. The manifold cable should connect to the counter "SYSTEM" port. The serial cable should connect to the counter "SERIAL I/O-RS232" port.

Reading the Station Record Buffer

The counter has a record buffer that holds up to 30 records of station data. This buffer allows the counter and manifold to acquire data without interrupting the computer, see the following pages.

To read the buffer, the computer first sends a Unit I.D. to the counter, and the counter responds in the standard manner. The computer then transmits a Dump Station Record command. The counter responds by either echoing the command, if there is data available, or the counter sends the End Of Data response if there is no data available.

After receiving the echo, the computer can request data with the Next Byte command. The counter will then send a data byte for each Next Byte command until the complete record is sent. The counter will send an End Of Data when the computer empties the record buffer.

Any command word received during the transfer will be executed in the normal manner, and the current record is not removed from the buffer.

The format and content for the 64 bytes of ASCII data are as follows:

Station number MSB, station number LSB, 5 blanks, carriage return
6 digits of time MSB to LSB, blank, carriage return
6 digits for size 1 MSB to LSB, blank, carriage return
6 digits for size 2 MSB to LSB, blank, carriage return
6 digits for size 3 MSB to LSB, blank, carriage return
6 digits for size 4 MSB to LSB, blank, carriage return
6 digits for size 5 MSB to LSB, blank, carriage return
6 digits for size 6 MSB to LSB, blank, carriage return

A typical example using this format is given in the following table.

Table A-3. Station Record Buffer Format

Function	ASCII Hexadecimal	ASCII Symbols	Decimal Value
Station Nbr	30, 30, 20, 20, 20, 20, 20, D	00	00
Time	30, 39, 33, 36, 31, 32, 20, D	093612	09:36:12
size 1	30, 30, 31, 32, 35, 33, 20, D	001253	1,253
size 2	30, 30, 30, 87, 82, 31, 20, D	000941	41
size 3	30, 30, 30, 36, 38, 35, 20, D	000685	85
size 4	30, 30, 30, 33, 39, 38, 20, D	000398	398
size 5	30, 30, 30, 31, 32, 30, 20, D	000120	120
size 6	30, 30, 30, 30, 38, 36, 20, D	000086	86
Notes: ASCII 20 = space, ASCII D = carriage return			

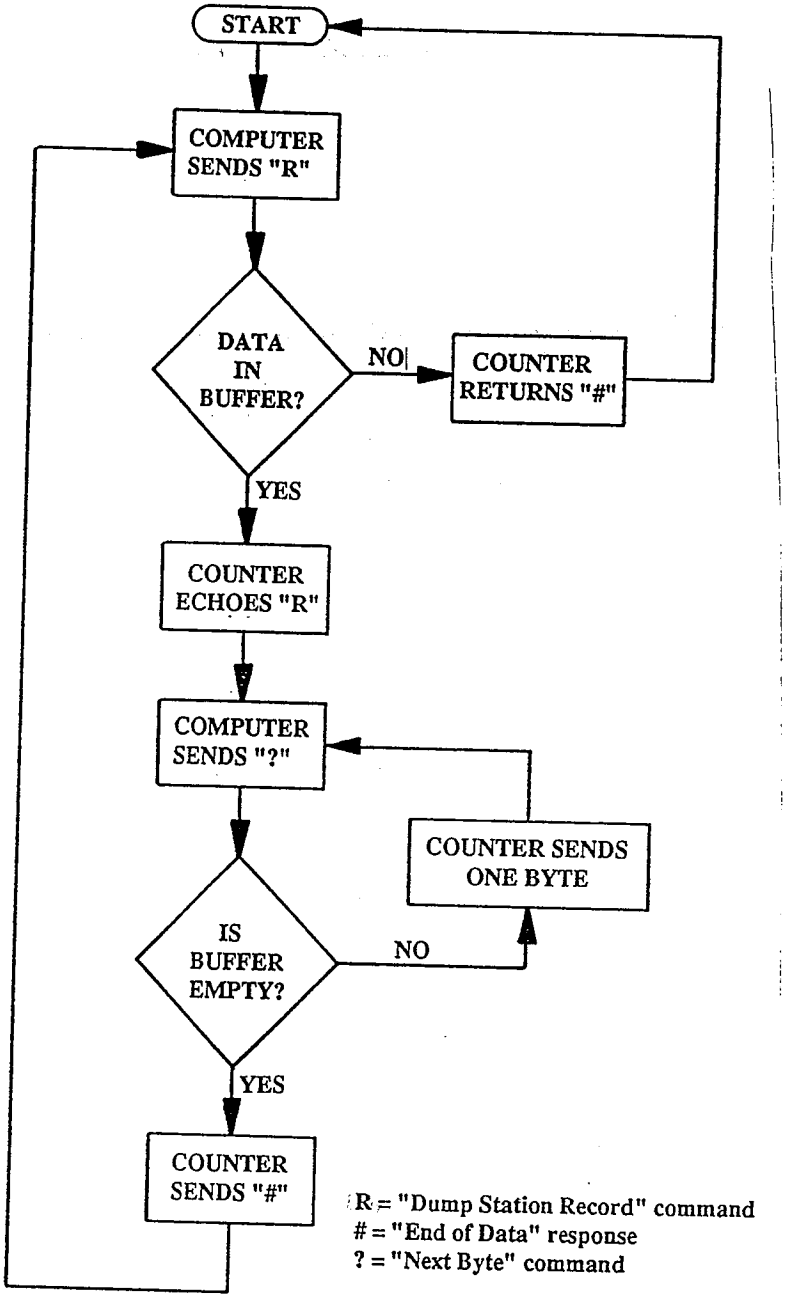


Figure A-3. Reading the Station Record Buffer

Command Reference

There are two types of particle counter command words: data request and control request. Refer to tables on the following pages for specific codes. Also included are illegal commands and reset commands.

Data Request Commands

When the computer sends a data request, the counter will echo the data request. After the computer receives the echo, it can gate in each byte of data by sending the Next Byte command. The data will be sent in ASCII code, MSB first. If the counter receives more Next Byte commands than required to send the data, it will send the End Of Data code for each additional Next Byte command. The computer may request data at any time. Particle count data will be sent from the last completed count.

The unit must be in OPER mode to get air flow data, and in CALIB mode to get calibrate circuit data. Some of the data will need to be divided to get the actual value. Refer to the following table.

Table A-4. Data Modification

Data	Divide by
air flow	200 (1 cfm) 2000 (0.1 cfm)
temperature	10
humidity	10
calibrate	2

Table A-5. Data Request Commands in ASCII

Command	ASCII Symbol	Hexa-decimal	Data Response
Size 1 Count	A	41	Echo, 6 Bytes, MSB first
Size 2 Count	B	42	"
Size 3 Count	C	43	"
Size 4 Count	D	44	"
Size 5 Count	E	45	"
Size 6 Count	F	46	"
Temperature	G	47	"
Relative Humidity	H	48	"
Air Velocity	I	49	"
Air Flow	J	4A	"
Time (Hrs:Min:Sec)	K	4B	"
Date (Mon/Day/Yr)	L	4C	"
Unit ID Number	M	4D	"
Calibrate Circuit	N	4E	"
Sample Time	O	4F	"
Dump Station Data*	P	50	Echo, Stn Data, MSB first
Station Number*	Q	51	Echo, 2 Bytes, MSB first
Dump Station Records*	R	52	Echo, 64 Bytes for each buffer record (30 records)

* Not supported in counters containing the 209D calculations option.

Control Request Commands

The computer sends control requests to select modes (CALIB, OPER), to obtain mode information (see table below), and to start or stop a count cycle. The counter will respond by echoing the control request or sending the mode word. See the following table for control requests.

Table A-6. Control Request Commands - ASCII

Command	ASCII Symbol	Hexa-decimal	Command Response	ASCII Symbol	Hexa-decimal
Mode Request	a	61	Local	q	71
			Remote Calibrate	r	72
			Remote Operate Holding	s	73
			Remote Operate Counting	t	4
			Remote Operate Stopped	u	75
Operate Mode	b	62	echo	b	62
Calibrate Mode	c	63	echo	c	63
Start Count	d	64	echo	d	64
Stop Count	e	65	echo	e	65
Turn Sensor On*	g	67	echo	g	67
Turn Sensor Off*	h	8	echo	h	8
			Miscellaneous Responses		
			Send Next Byte	?	3F
			Reset All Devices	(LF)	A
			Counter Select and Reset (where x = 0 to 9)		x
			Illegal Command	*	2A
			End of Data	#	23
			Time Set	S	53

* Not supported in newer counters.

Illegal Commands

If the computer sends a control request that conflicts with the mode (e.g., a start count command when in CALIB mode), the unit will send the mode word. If the computer sends an illegal command word, the particle counter will send Illegal Command.

Reset Command

The reset command word Reset Device, will establish communications with the particle counter. When the reset code is received, the counter will reset and send back Reset Device if in remote mode, or Local if in local mode. When multiple counters are used on the same serial port, the reset command is the last digit of the UNIT I.D. number.