PARTICLE INSTRUMENTS

Air Quality Monitoring

Models 3031/3031-1

Ultrafine Particle Monitors

User's Manual

P/N 6001716, Revision D
March 2011

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Models 3031/3031-1

Ultrafine Particle Monitors

User's Manual

Manual History

The following is a manual history of Models 3031 and 3031-1 Ultrafine Particle Monitors (Part Number 6001716).

Revision	Date
A	July 2008
B	March 2009
C	July 2009
D	March 2011

Warranty

Part Number 6001716 / Revision D / March 2011

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Address TSI Incorporated / 500 Cardigan Road / Shoreview, MN 55126 / USA

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Seller warrants the goods sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for (12) months, or the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty. This limited warranty is subject to the following exclusions:

a. Hot-wire or hot-film sensors used with research anemometers, and certain other components when indicated in specifications, are warranted for 90 days from the date of shipment.

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Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call TSI at 1-800-874-2811 (USA) or (651) 490-2811.

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Contents

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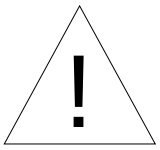
Safety

This section gives instructions to promote safe and proper handling of the Ultrafine Particle Monitors.

There are no user-serviceable parts inside the instrument. Refer all repair and maintenance to a qualified technician. All maintenance and repair information in this manual is included for use by a qualified technician.

To prevent problems, take these precautions:

- Do ***not*** remove any parts from the instrument unless you are specifically told to do so in this manual.
- Do ***not*** remove the instrument housing or covers while power is supplied to the instrument.



Caution
If the Models 3031 and 3031-1 are used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

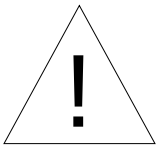
Description of Caution Symbol

The following symbol and an appropriate caution statement are used throughout the manual and on Models 3031 and 3031-1 to draw attention to any steps that require you to take cautionary measures when working with the instruments:

Caution

Caution
Caution means ***be careful***. It means if you do not follow the procedures prescribed in this manual you may do something that might result in equipment damage, or you might have to take something apart and start over again. It also indicates that important information about the operation and maintenance of this instrument is included.

Warning



W A R N I N G
Warning means that unsafe use of the instrument could result in serious injury to you or cause irrevocable damage to the instrument. Follow the procedures prescribed in this manual to use the instrument safely.

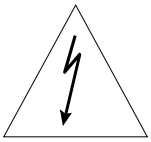
Caution or Warning Symbols

The following symbols may accompany cautions and warnings to indicate the nature and consequences of hazards:

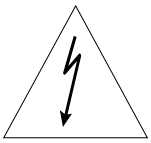
	Warns you that uninsulated voltage within the instrument may have sufficient magnitude to cause electric shock. Therefore, it is dangerous to make any contact with any part inside the instrument.
	Warns you that the instrument is susceptible to electrostatic dissipation (ESD) and ESD protection procedures should be followed to avoid damage.
	Indicates the connector is connected to earth ground and cabinet ground.

Electrical Safety

The Ultrafine Particle Monitors have high-voltage points within its cabinet. Only a qualified technician should perform service or maintenance.



W A R N I N G
High voltage is accessible in several locations within these instruments. Make sure you unplug the power source before removing the cover or performing maintenance procedures.



W A R N I N G
The device is not protected against immersive water. In case of immersive water disconnect the device from power immediately.

Fire and Explosion Safety

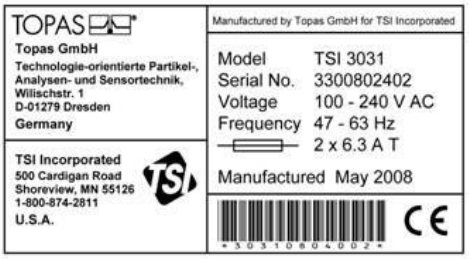
Do ***not*** feed combustible gases into the device. Arcing may occur in the Differential Mobility Analyzer.

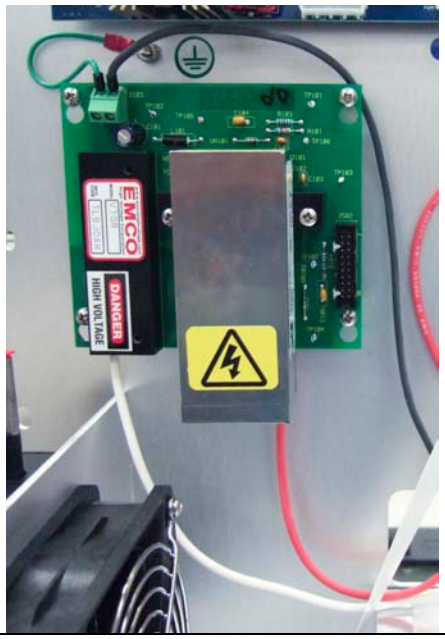
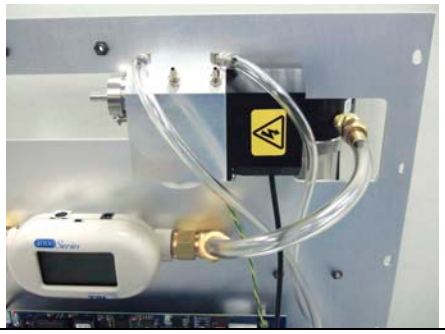
Do ***not*** use combustible or flammable aerosol substances. Carefully read the respective safety data sheet.

The device must ***not*** be operated in explosive surroundings.

Labels

The Ultrafine Particle Monitors have labels on the back of the instrument and on interior components. Labels are described below:

1 Serial Number Label (back of cabinet)	
2 High-Voltage Symbol Label (on the DMA)	

3 High-Voltage Symbol Label (on the power supply board) **4** Ground Symbol Label (above the power supply board, next to ground stud) **5** Danger Label on power supply board **6** Serial Number Label for power supply board	
7 High-Voltage Symbol Label (on the charger)	

Lifting Caution

The Ultrafine Particle Monitor weighs 40 kgs (88 lbs). To protect your back when lifting:

- **Get help from another person to move the instrument**. The instrument is equipped with handles to allow for two people to safely lift it.
- Transport the instrument on a cart whenever possible.
- Lift with your legs while keeping your back straight.
- Keep the instrument close to your body as you lift.

About This Manual

Purpose

This is an instruction manual for the operation and handling of the Model 3031 and Model 3031-1 Ultrafine Particle Monitors.

Related Product Literature

- ***Model 3031200 Environmental Sampling System Manual*** (part number 6001630 TSI Incorporated)

Getting Help

To obtain assistance with this product or to submit suggestions, please contact TSI Particle Instruments:

TSI Incorporated
500 Cardigan Road
Shoreview, MN 55126 U.S.A.
Fax: (651) 490-3824
Telephone: 1-800-874-2811 (USA) or (651) 490-2811
E-mail: technical.service@tsi.com
Web site: www.tsi.com

Submitting Comments

TSI values your comments and suggestions on this manual. Please use the comment sheet, on the last page of this manual, to send us your opinion on the manual's usability, to suggest specific improvements, or to report any technical errors.

If the comment sheet has already been used, send your comments to:

Particle Instruments
TSI Incorporated
500 Cardigan Road
Shoreview, MN 55126 U.S.A.
Fax: (651) 490-3824
E-mail Address: particle@tsi.com
Web site: www.tsi.com

CHAPTER 1

Product Overview

This chapter describes the Model 3031 and Model 3031-1 Ultrafine Particle Monitors (Figures 1-1 and 1-2, respectively), and gives an overview of how these instruments work.

Product Description

To better understand the health effects associated with ultrafine particles, there is a need to complement traditional particulate measurements (PM_{10} and $PM_{2.5}$) by establishing a network to routinely monitor ultrafine particles. The Ultrafine Particle Monitor has been specifically designed for monitoring ultrafine particles in urban environments.

The Ultrafine Particle Monitor measures the size distribution and number concentration of particles between 20 to ~1000[1] nm, with six channels of size resolution. It continuously provides the number concentration for each size channel. All data is buffered within the instrument, but can be accessed remotely via the Internet with a suitably configured Ethernet connection.

The Ultrafine Particle Monitor operates continuously, 24-hours a day, with minimal maintenance and requires no working fluids. The Ultrafine Particle Monitor has no radioactive source, so there are no special licensing requirements and no restrictions for its use or where it can be installed. The Model 3031 (Figure 1-1) fits into a standard 19-inch, rack mount cabinet, which allows it to be easily installed into existing roadside and urban air quality monitoring stations. The bench top version of this instrument (the Model 3031-1; Figure 1-2) is available for laboratory or mobile applications.

[1] The actual upper limit is set by the sampling inlet. If the inlet cyclone included in the 3031 accessory kit is used, the size range is 20 nm to ~450 nm. If the optional 3031200 Environmental Sampling System is used, the size range is 20 nm to ~800 nm. See Appendix B “Inlet Cyclone” and “Environmental Sampling System” for more information.

Figure 1-1
Model 3031 Ultrafine Particle Monitor

Figure 1-2
Model 3031-1 Ultrafine Particle Monitor

Applications

The Model 3031 Ultrafine Particle Monitor is specifically designed for use in air pollution monitoring networks. It is suitable for long-term, unattended ultrafine particle monitoring for:

- Roadside measurements
- Urban air pollution research
- Epidemiology studies
- Traffic monitoring

The Model 3031-1 is well suited for laboratory use and mobile measurements of ultrafine particles.

How the Instrument Operates

The operating principle of the Ultrafine Particle Monitor is based on diffusion charging of particles, followed by size segregation within a Differential Mobility Analyzer (DMA) and detection of the aerosol via a sensitive electrometer.

A typical field setup in a monitoring station is shown in Figure 1-3.

Using the TSI Model 3031200 Environmental Sampling System[2] a representative sample of ambient air is continuously drawn through a size selective PM_{10} inlet at a standard flow rate of 16.7 L/min. Next, the sample passes through a PM_1 cyclone which removes larger particles. The main sample stream is subsampled into the Ultrafine Particle Monitor at a flow rate of 5 L/min. A Nafion® dryer upstream of the Ultrafine Particle Monitor ensures proper conditioning of the aerosol to minimize effects due to relative humidity. The remaining 11.7 L/min of make-up air is routed through the Nafion® dryer as purge air and drawn through a vacuum pump and exhausted.

[2] Sold separately, refer to Chapter 2 “Optional Accessories” for more information.

®Nafion is a registered trademark of E.I. DuPont de Nemours.

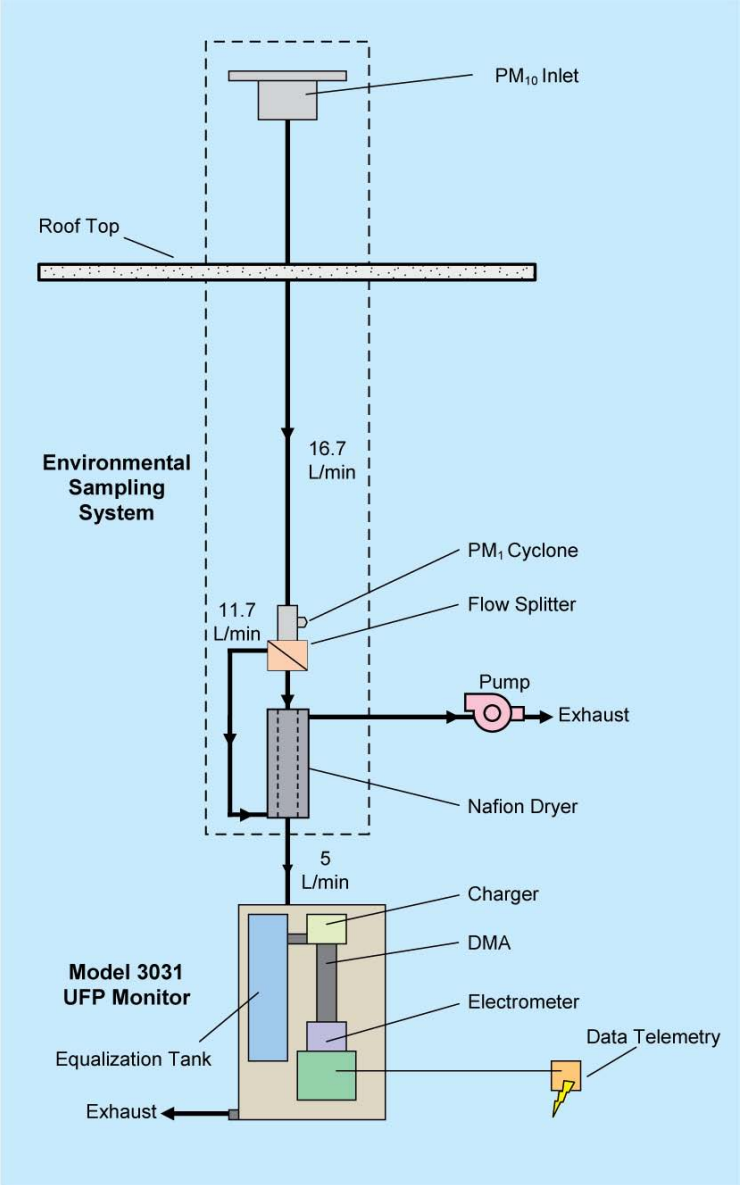


Figure 1-3
Typical Field Operation

Within the instrument, the aerosol sample mixes in an equalization tank to smooth out short-term fluctuations in the aerosol sample and then passes on to the diffusion charger, which charges all particles positive. The charged particles pass through the DMA, are collected by a filter and the imparted current is measured using a sensitive aerosol electrometer. By successively stepping up the DMA voltage and measuring the current at each step, an on-board computer calculates and stores the number concentration for each of the six size channels.

Data samples can be taken every 7.5, 10, or 15 minutes and they can be time synchronized.

Note: *7.5 minute data is less accurate than longer sample times, so it is not recommended.*

Data and system status can be viewed using a standard web interface or automatically downloaded to a spreadsheet or database. Instrument set-up parameters can also be adjusted remotely via the web interface.

For more on the theory of instrument operation, refer to Appendix B at the back of the manual.

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CHAPTER 2

Unpacking

Use the information in this chapter to unpack the Ultrafine Particle Monitor.

Packing List

As you unpack the shipping container, make certain the shipment is complete. Table 2-1 gives a packing list for the Ultrafine Particle Monitor.

Table 2-1
Ultrafine Particle Monitor Packing List

Qty	Description	Part No.
1	Model 3031 or Model 3031-1 Ultrafine Particle Monitor	3031/3031-1
5	Power Cords N. America/Japan Europe UK/Hong Kong Australia/China Switzerland	 1303053 1303075 1303230 1303229 1303235
1	Inlet Cyclone with elbow	1031568
1	User's Manual	6001716
1	Software CD	
1	Ethernet Cable	

Unpacking Instructions

The Ultrafine Particle Monitor comes assembled with protective coverings on the inlets. It is recommended that you do ***not*** remove the protective covers until you are ready to use the instrument to prevent contamination.

Save your original packaging materials for future use should you need to return the instrument to TSI for service.

If anything is missing or appears to be damaged or for technical support, contact your TSI representative, or contact TSI Customer Service at 1-800-874-2811 (USA) or 001-(651) 490-2811. Chapter 7, "Contacting Customer Service" gives instructions for returning the Ultrafine Particle Monitor to TSI Incorporated.

Ventilation Requirements

The instrument cabinet is designed to be cooled by room air drawn in through a filter from the back of the cabinet and exhausted through the sides of the cabinet. The cabinet should be installed so that the exhaust air moves efficiently through the instrument.

Moving the Instrument

Caution

The Ultrafine Particle Monitor is a heavy instrument weighing 40 kgs (88 lbs).

Protect your back when lifting:

- Get help from another person to move the instrument
- Transport the instrument on a cart whenever possible
- Lift with your legs while keeping your back straight
- Keep the instrument close to your body as you lift

Optional Accessories

Model 3031200 Environmental Sampling System

The Environmental Sampling System (Figure 2-1) is an optional accessory for use with the Ultrafine Particle Monitor. It provides representative sampling and proper conditioning of ambient outdoor aerosol for accurate size distribution and particle number measurements.

The Model 3031200 consists of:

Standard PM_{10} inlet	Provides standardized size-selective sampling of outdoor aerosol.
Sharp cut PM_1 cyclone	Removes large particles to avoid contamination of the particle measurement system.
Flow splitter	Splits the inlet sample flow to enable sub-sampling a portion of the flow into the Ultrafine Particle Monitor.
Nafion® dryer	Conditions the sample to reduce effects of relative humidity on the aerosol.

Figure 2-1
Model 3031200 Environmental Sampling System

Model 1031588 Consumables Kit

The Model 1031588 consumables kit (Figure 2-2) contains annual usage quantities of various filters and tubing used in the Ultrafine Particle Monitor. The kit includes four HEPA capsule filters, eight Balston® DFU-BX filters, four carbon cartridge filter, one wire core microfiber filter and 3 ft. Tygon® tubing (0.312" OD × 0.187" ID). Please contact your TSI representative for purchase of this kit.

Figure 2-2
Model 1031588 Consumables Kit

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CHAPTER 3

Instrument Description

Use the information in this chapter to familiarize yourself with the location and function of controls, indicators, and connectors on the Ultrafine Particle Monitor.

This chapter is organized into two sections describing the front and back panels of the instrument.

Front Panel

The main components of the front panel are a touch panel display, a round power switch with indicator light, a USB, a serial, and an Ethernet port (see Figure 3-1).

Figure 3-1
Front of the Ultrafine Particle Monitor

Touch Panel Display

An 8.4-in. SVGA (800 × 600 pixel) color display with touch screen interface is provided on the front panel. Use the touch screen and color display to view instrument status, start and stop measurements, read diagnostics, and view and change user settings.

On/Off Switch

The red colored round switch is the on/off switch. Pressing this switch turns the Ultrafine Particle Monitor on or off.

Caution
To avoid data loss, the on-board computer should be properly shut down before turning off the power (just as with a desktop computer).

Indicator Light

A steady glow of the red power light on the on/off switch indicates that the instrument is powered on. The power light goes off when the power to the Ultrafine Particle Monitor is shut off.

USB Port

The USB port is provided for use with a mass storage device (such as a flash drive or memory stick) for data backup purpose.

Ethernet Port

The Ethernet port is provided for connection to a network or the Internet. Data and system status can be viewed and downloaded using a standard web interface. Instrument set-up parameters can also be adjusted remotely via the web interface. This is the preferred method for communicating with the instrument.

Serial Port

The standard RS-232 serial port connection allows communications between a monitoring station computer (if supplied with a data access protocol) and the Ultrafine Particle Monitor. Serial commands are sent to and from the computer to collect instrument status information and measurement data.

Appendix C provides information about the “Bayern-Hessen Protocol” popular in monitoring stations in Germany.

Back Panel

As shown in Figure 3-2, the back panel has a sample inlet, sample exhaust, heat exchanger fan exhaust and a power connection.

Figure 3-2
Back of the Ultrafine Particle Monitor

Aerosol Inlet

The aerosol inlet at the back of the Ultrafine Particle Monitor has a ¼-inch OD and is designed for use with the supplied Cyclone. Tubing may be attached to the aerosol inlet for coupling with an environmental sampling system.

Heat Exchanger Fan

This fan keeps the sheath air temperature stable, near the ambient air temperature. It is provided with a guard and removable filter that should be cleaned periodically.

AC Power Connector

The AC power connector accepts a line cord (supplied) to provide AC power to the instrument. See “Connecting Power” in Chapter 4 for more information.

CHAPTER 4

Setup

This chapter gives information you need to set up the Ultrafine Particle Monitor.

Setting Up

The Ultrafine Particle Monitor is shipped fully assembled. To begin using the instrument:

1. Set the Model 3031-1 Ultrafine Particle Monitor on a level surface. 19" rack mounting is recommended for Model 3031. Ensure proper ventilation for the instrument cabinet.
2. Remove the protective caps from the sample inlet. The caps should be saved for packing the instrument for shipment.
3. Connect the sample inlet to your sampling system using 0.19-in. ID conductive silicone tubing available from TSI [Model 300178 ***or*** install the supplied cyclone on the aerosol inlet using the supplied union elbow fitting shown in Figure 4-1. Make certain the components are tightly pushed together. Tighten the nuts on the union fitting finger tight and then one-half turn with a wrench (see Swagelok® recommendations).].

   Note: *For long-term environmental monitoring, use of an effective sampling system is recommended. Make sure no condensation can occur inside the aerosol system. It is highly recommended to use an air dryer. Model 3031200 Environmental Sampling System is sold separately from TSI. Refer to Chapter 2 "Optional Accessories" section for details.*

®Swagelok is a registered trademark of Swagelok Company of Solon, Ohio, USA.

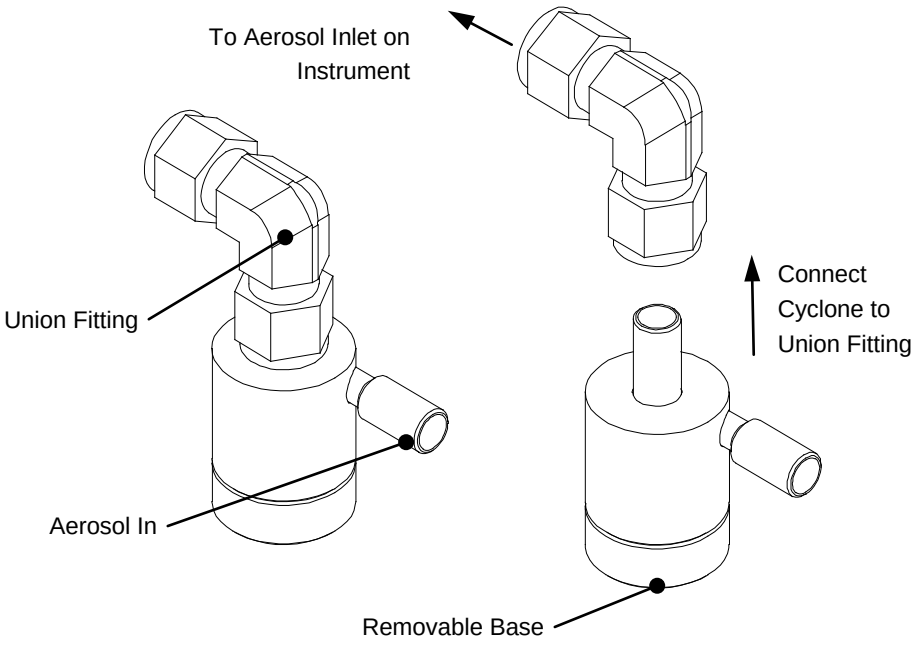


Figure 4-1
Cyclone Assembly

Connecting Power

The Ultrafine Particle Monitor is supplied with 5 power cords. Choose the cord with the appropriate connector for your country. Connect the power cord to the receptacle at the back of the instrument. Supply voltage can be 100 to 240 VAC and 50 or 60 Hz.

The instrument on-off switch is located on the front panel.

***Notes**: Make certain the line cord is plugged into a grounded (earth grounded) power outlet. Position the instrument so the power cord connector is not blocked and is easily accessible.*

*The internal power supply contains no user-serviceable parts. If the power supply is not operating correctly, contact TSI (see Chapter 7, "Contacting Customer Service". This instrument should **not** be used in a manner not specified by the manufacturer.*

Connecting to a Computer

The Ultrafine Particle Monitor provides a standard RS-232 serial port and an Ethernet port to allow for flexible data collection and instrument control. The user can connect the Ultrafine Particle Monitor to a computer in either of two ways:

- Connect the Ethernet port on the front of the Ultrafine Particle Monitor to a compatible network device. The Ethernet port supports communications speeds of 10 or 100 Mbps. This is the preferred method.
- Connect the serial port of a computer to the serial connector on the front of the Ultrafine Particle Monitor.

Figure 4-2
Location of Ethernet and Serial Ports

Network Configuration

Required: Computer with internet browser and proper network connection

Please note that the instrument can always be accessed using a connection with the internal IP address http://192.168.3.1 (assuming there is no conflict with that address on your network).

Steps to Establish a Connection using a Computer on an Existing Network

1. If you are connecting the instrument to an existing network, contact your network specialist to get a fixed IP address for the instrument and other network information needed in step 3 below. Also ask about any special steps needed if you need to

access the instrument through a firewall protecting the internal network.

2. On the front panel of the instrument, select **Settings** | **Network** on the touch display (***Note:*** *You must login with username-"Maintenance" and PIN "78952" to access menu items under Settings*).

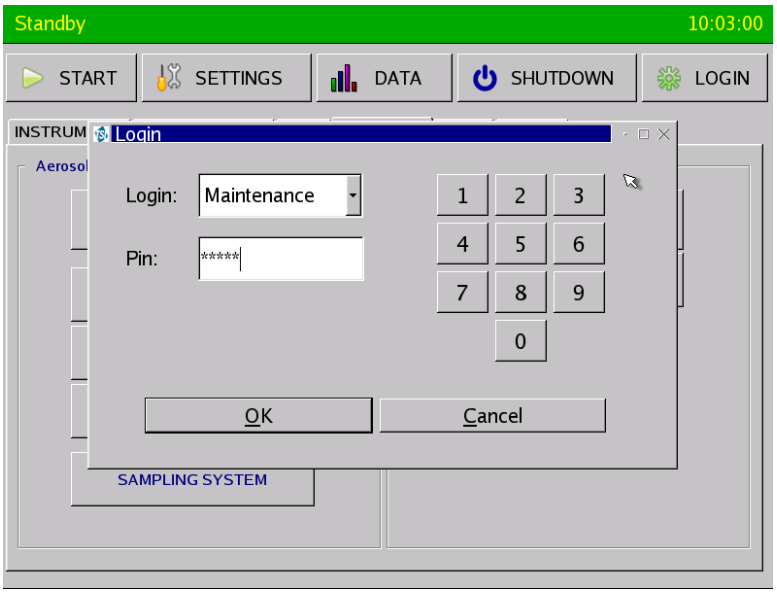


Figure 4-3
Login Screen

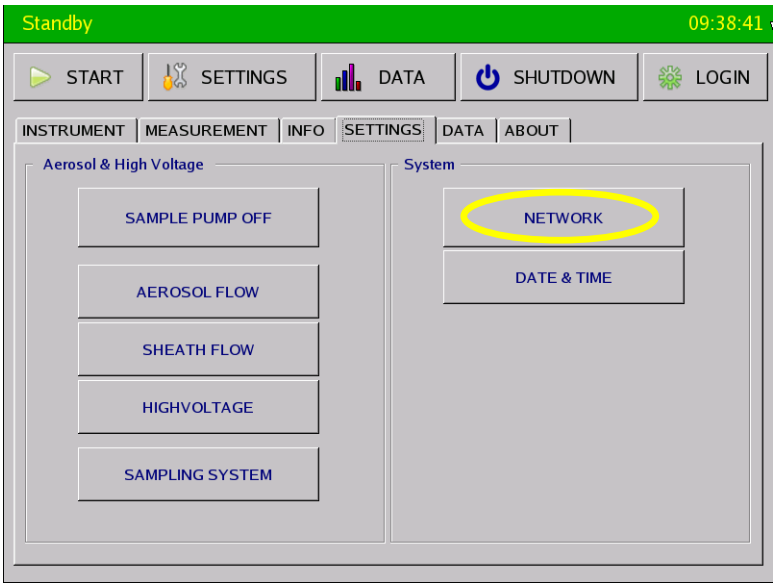


Figure 4-4
Selecting Settings for Network

3. Input the fixed instrument IP address you obtained in step 1 along with the other network settings for your network (Netmask, Gateway, and DNS server address). Click **OK**.

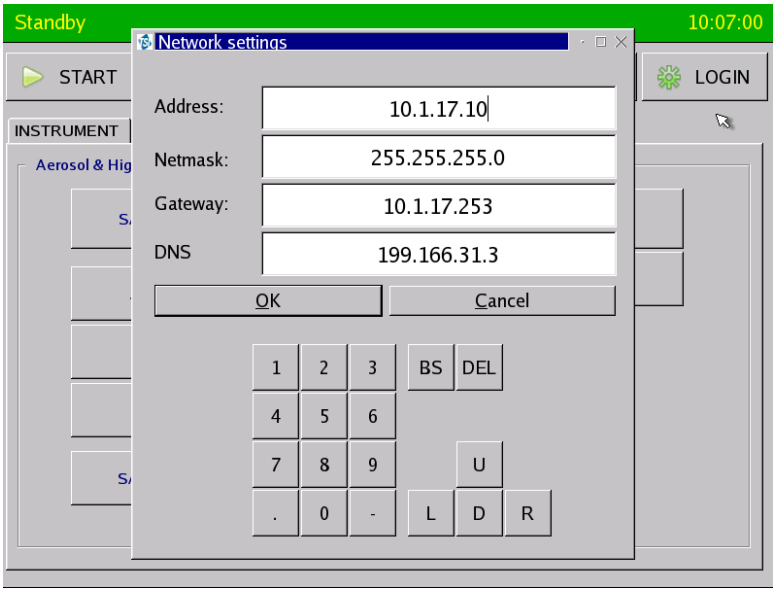


Figure 4-5
Entering Network Settings for the Instrument

4. Next you need to reboot the instrument. Press **Shutdown** and select **Reboot** on the touch panel screen of the instrument to finish the settings (Refer to Figure 4-4).

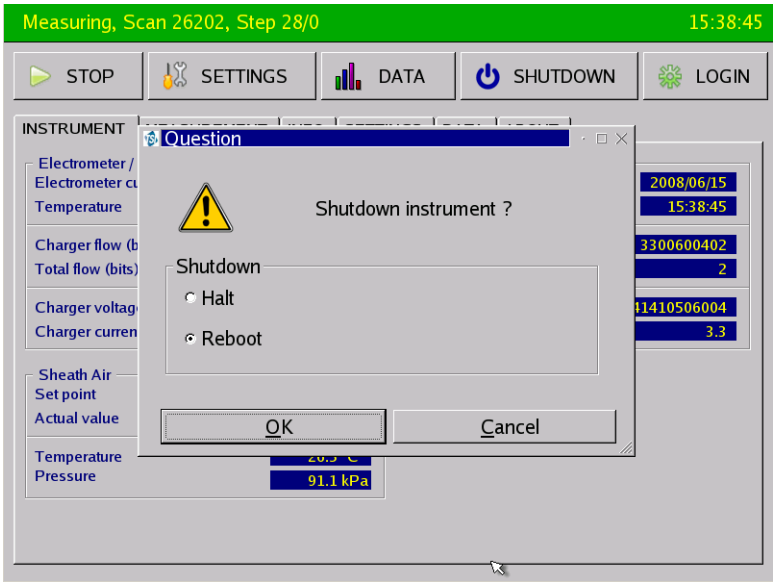


Figure 4-6
Rebooting the UFP Monitor

5. When the instrument is operating again, open your Internet browser and enter the instrument IP address you entered in step 3 (i.e., http://10.1.17.10).

6. Access is password restricted (username “user”, password “ufp”) by default. After this the status screen will appear (Figure 4-8). The menus on the left allow access to status and data in a variety of formats. The lower setup menu is accessible only by admin users (see “Advanced Network Techniques” below).

Figure 4-7
User Access and Password

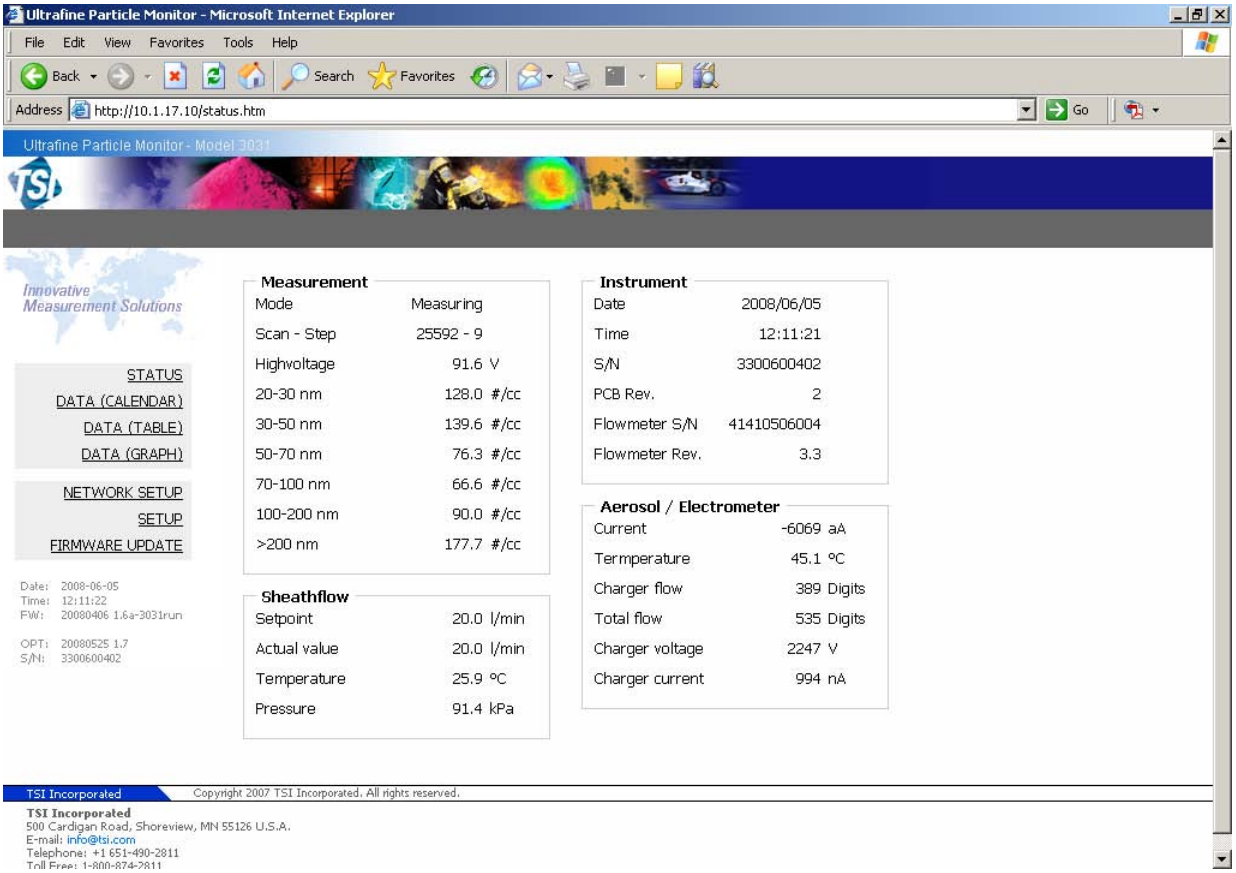


Figure 4-8
Web Interface Page with Navigation Menu on the Left Side.

Steps to Establish a Connection Directly Between a Computer and the Instrument

1. For troubleshooting or demonstration purposes, it is sometimes useful to connect a laptop computer directly to the Ethernet port of the instrument. You will need a “Crossover” Ethernet cable to connect between the computer and instrument or an Ethernet hub or router to plug the computer and instrument into. Figures are shown below for Microsoft® Windows® XP, but other operating systems would be similar.
2. On the laptop, from the windows desktop, select **Start | Connect to | Show all connections**. Right-click on **Local Area Network** and select **Properties**.

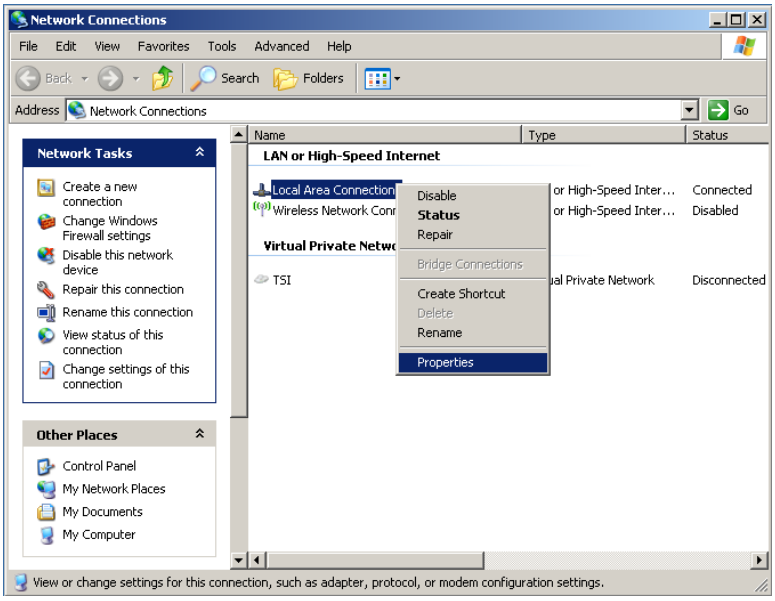


Figure 4-9
Network Settings.

3. Double-click on **Internet Protocol (TCP/IP)**.

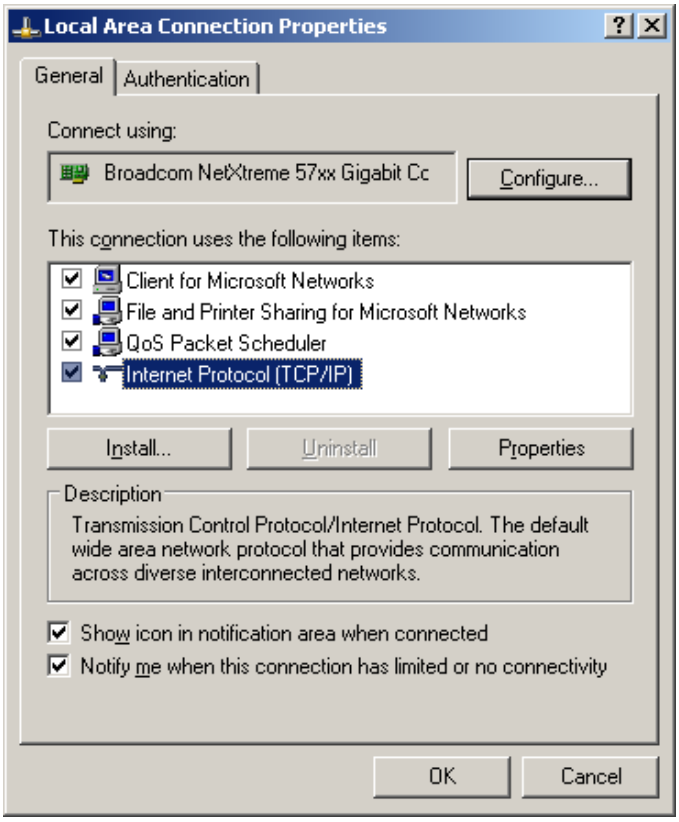


Figure 4-10
Network Properties

4. Click on **Use the following IP address** and enter the three sets of numbers as shown. Click on **OK**.

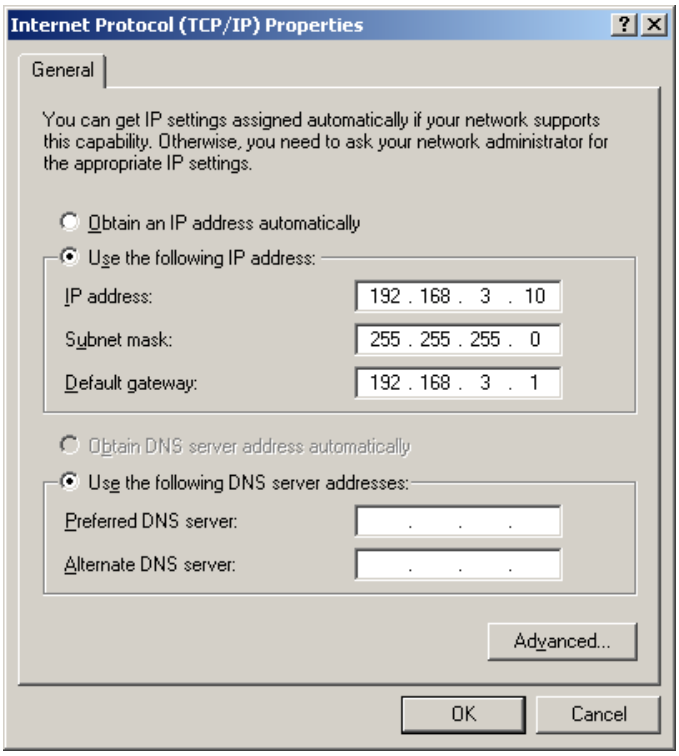


Figure 4-11
Network IP Address Settings

5. Click **OK** and **OK** again. Open web browser on the laptop and enter the following address: http://192.168.3.1.

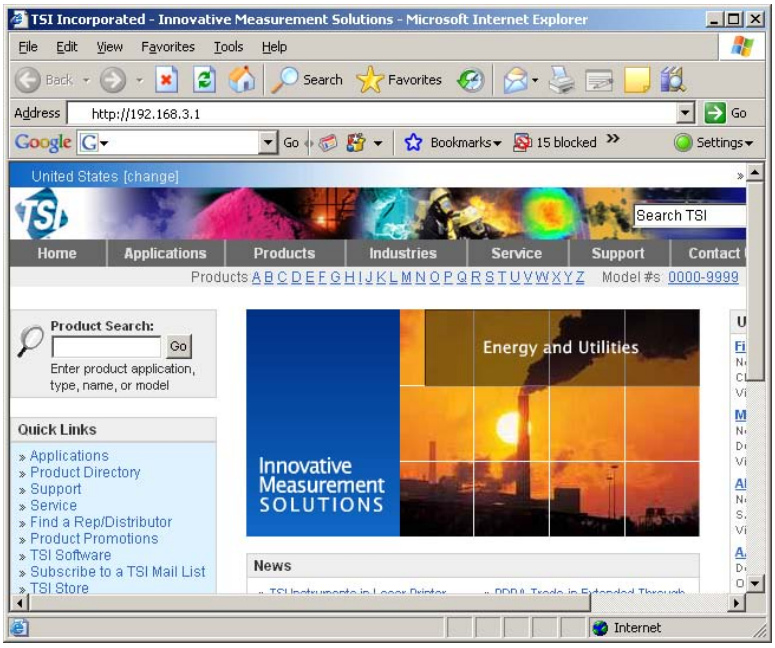


Figure 4-12
Network Settings.

6. If the laptop connects to the instrument properly, access is password restricted (username “user”, password “ufp”) by default. If you don’t get a screen like this, see next step

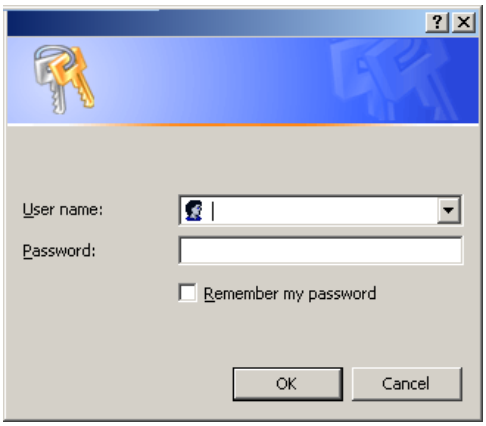


Figure 4-13
User Login.

7. Troubleshooting—If you don’t get a login screen in step 6 and get something as shown in Figure 4-14 below, try rebooting your laptop. If that doesn’t work, try shutting down the UFP and turning it back on (be sure to shut it down with the menu on the front panel rather than just turning it off. It has an on-board computer that needs to be shut down properly, just like Windows® operating system).

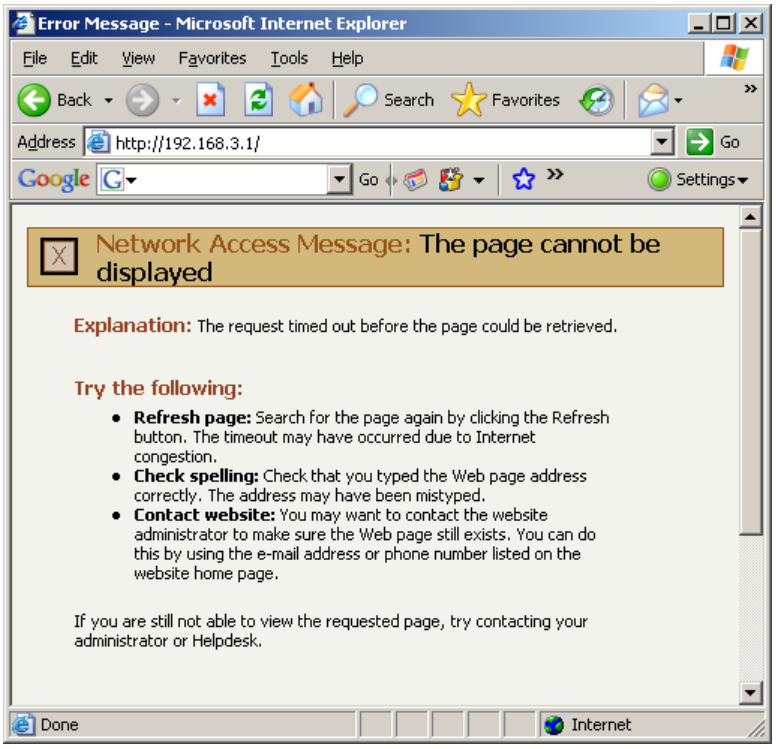


Figure 4-14
Connection Error

8. After power down, try steps 5 and 6 again. If the computer connects successfully, you should see a screen like Figure 4-8.

Advanced Network Techniques

1. Advanced (setup and network) menus can be access using the administrator account on the instrument. The last menu item “Firmware Update” can only be accessed by a super administrator (contact TSI for service).

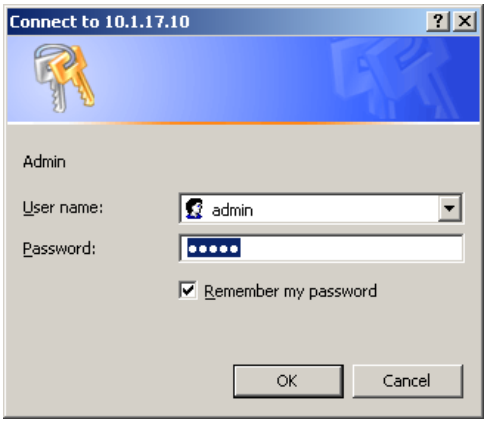


Figure 4-15
Administrator login.

2. Note that these settings are for administrators only. Changing the settings may prevent proper communications with the instrument.
3. Select the menu **Network Setup** from the left side and input the required settings (user “admin”, password “78952”).
4. If required, you can masquerade the MAC address (please ask your administrator if a MAC filter is active in your network).
5. Note that if for some reason communications are lost, the instrument can also be accessed using its internal (fixed) network address - http://192.168.3.1.
6. After making any changes to the network settings, you need to reboot the instrument. Press **Shutdown** and select **Reboot** on the touch panel screen of the instrument to finish the settings (Refer to Figure 4-4). More information on the setup options can be found in Chapter 5, under Web Interface.

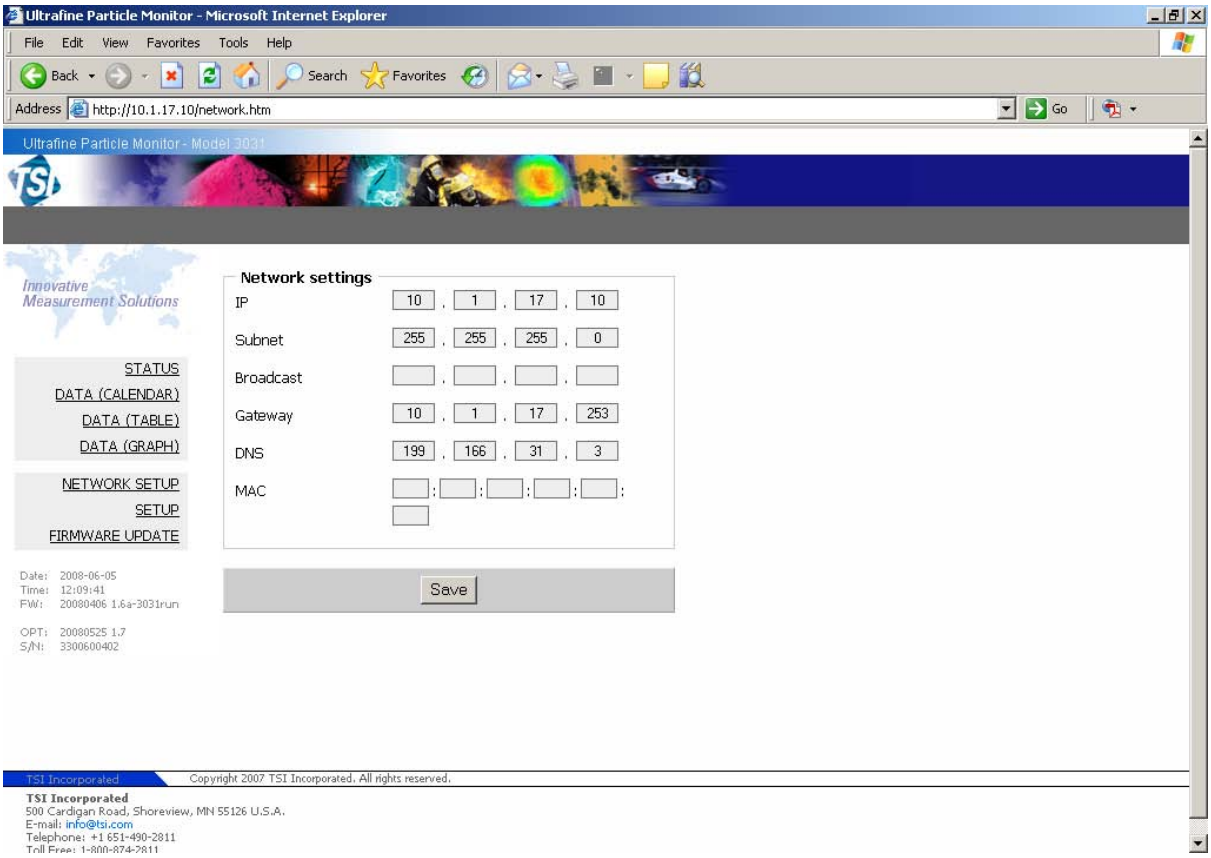


Figure 4-16
Network Setup and MAC Masquerading

CHAPTER 5

Instrument Operation

The Ultrafine Particle Monitor can be operated either using the touch screen interface on the front panel or via a web interface using a computer. This chapter describes the operation through both options.

Touch Screen Interface

The touch screen menus can be used to control what is displayed on the front panel, to check instrument status, to change instrument settings and to run a measurement. Tap the screen with a finger tip or plastic stylus to select menu items. Do ***not*** touch the screen with sharp items that may damage the screen.

After you power up the instrument, the start-up screen is displayed initially.

Figure 5-1
Touch Panel Display Showing Startup Screen

Menu Items

The front panel menu items are summarized in Table 5-1 and addressed in detail below.

Table 5-1
Front Panel Menu Structure Quick Reference

Start	Instrument (read-only)
Measurement Time	Electrometer/Charger
15 minute	Electrometer Current
10 minute	Electrometer Temperature
7.5 minute (less precise)	Charge Flow (bits)
Measurement Type	Total Flow (bits)
Time synchronous	Sheath Air
Count	Setpoint
Continuous	Actual value
Stop	Temperature
Immediately-abort the scan	Pressure
Finish the scan and stop	Instrument
Settings	Date
Aerosol and High Voltage	Time
Pump On/Off	S/N
Aerosol Flow	PCB Rev.
Sheath Flow	Flowmeter S/N
High Voltage	Flowmeter Rev.
Sampling System	Measurement (read-only)
None	Actual Measurement
Standard Inlet Cyclone	Scan
Sampling System	Step
(3031200)	Setpoint High voltage
System	Electrometer Current
Network	Charger Voltage
Date & Time	Charger Current
Data	Sheathflow
Export	Sheathflow Temperature
Display	Sheathflow Pressure
Shutdown	Last Measurement
Halt	Scan
Reboot	Date
Login	Time
Login	20-30 nm
Pin	30-50 nm
	50-70 nm
	70-100 nm
	100-200 nm
	> 200 nm
	Total Number Concentration
	Info
	About

START

Selecting **START** begins a new sample. In the popup window, select the measurement time.

Note: *7.5 minute data is less accurate than longer samples, so it is not recommended.*

Select **Time synchronous** to enable measurements to begin on a specific start time. For 15 minute measurements the scan runs on the hour and every 15 minutes after the hour (i.e., XX:00, XX:15, XX:30, XX:45). For 10 minute measurements the scan runs on the hour and every 10 minutes after the hour (i.e., XX:00, XX:10, XX:20, XX:30, XX:40, XX:50).Select **Continuous** for non-stop measurements or select **Count** for a limited specified number of runs (refer to Figure 5-2).

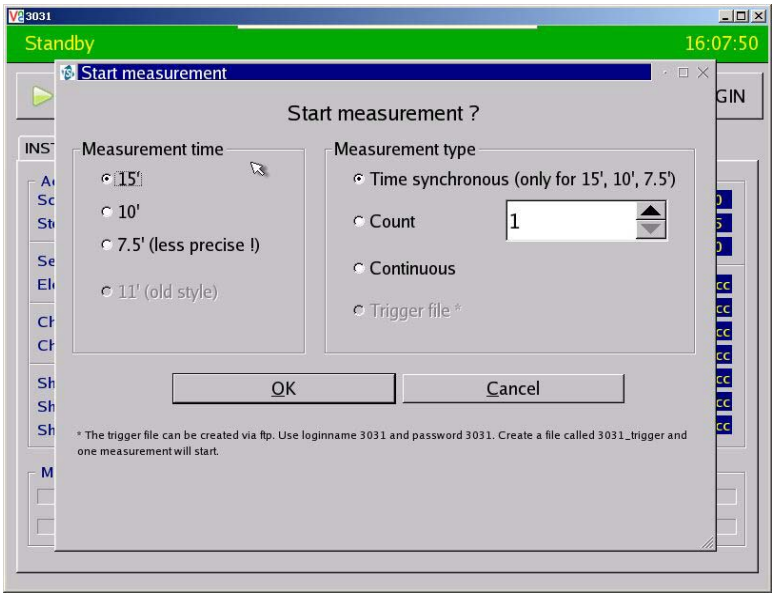


Figure 5-2
Touch Panel Display Showing START Menu Screen

STOP

Selecting **STOP** ends a measurement. In the popup window, select **Immediately-abort the scan** to stop the measurement right away. Select **Finish the scan and stop** to complete the measurement scan in progress before stopping the measurement (refer to Figure 5-3).

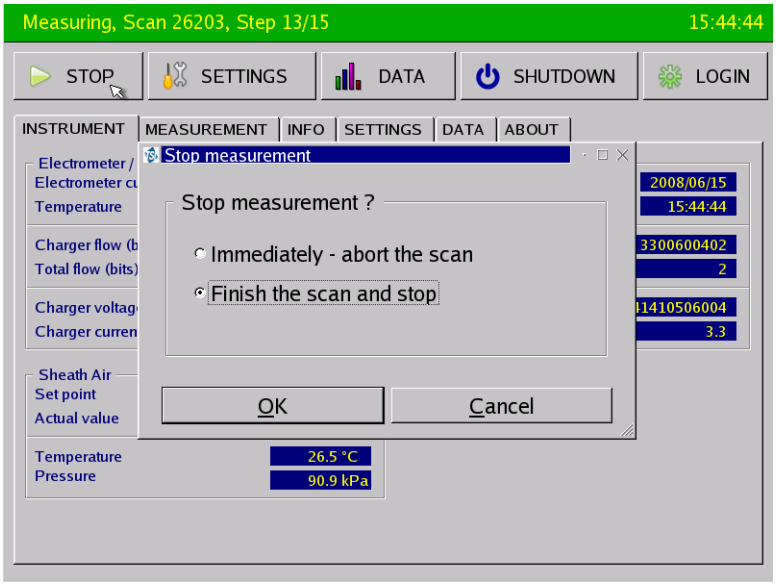


Figure 5-3
Touch Panel Display Showing STOP Menu Screen

SETTINGS

Selecting **SETTINGS** presents a list of internal parameters that you can modify/change. Refer to Table 5-2 for a description of various submenus.

Note: *The internal parameters should only be changed by a trained technician. For this reason, the access to* ***SETTINGS*** *menu is password protected. You must login as "Maintenance" with password "78952" to activate the menu items.*

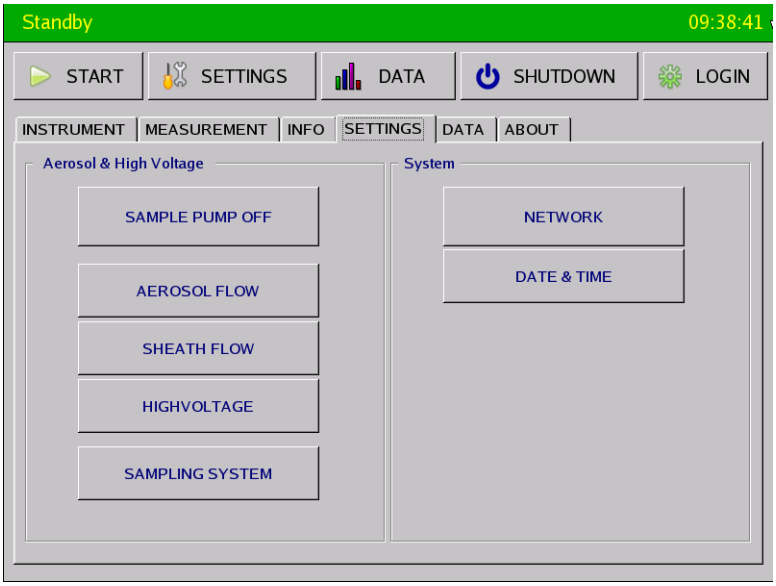


Figure 5-4
Touch Panel Display Showing SETTINGS Menu Screen

Table 5-2
Touch Screen SETTINGS Menu Items

Menu Item	Description
SAMPLE PUMP ON/OFF	Use this option to turn the electrometer pump on/off.
AEROSOL FLOW	Use this option to adjust the aerosol flow. Use a standard flowmeter to measure the flow at inlet and adjust the aerosol pump digits (bits) in the pop-up window (see Figure 5-5) until the flowmeter at inlet reads 5 L/min.
SHEATH FLOW	Use this option to adjust sheath flow (see Figure 5-6).
HIGH VOLTAGE	Use this option to change high voltage applied to the DMA (see Figure 5-7) for troubleshooting purposes.
SAMPLING SYSTEM	The UFP Monitor may be used with either the supplied cyclone or TSI Model 3031200 environmental sampling system installed at the inlet. Select either **Standard inlet cyclone** or **Sampling system (3031200)** in the pop-up window (refer to Figure 5-8). A correction for particle transmission losses through the corresponding system will be applied. In case no inlet system was used, select **None** and no correction will be applied to the data.
NETWORK	Use this option to setup a network address. Refer to section "Network Configuration" in Chapter 4 for details.
DATE & TIME	Use this option to adjust date and time, refer to Figure 5-9 for the popup window menu.

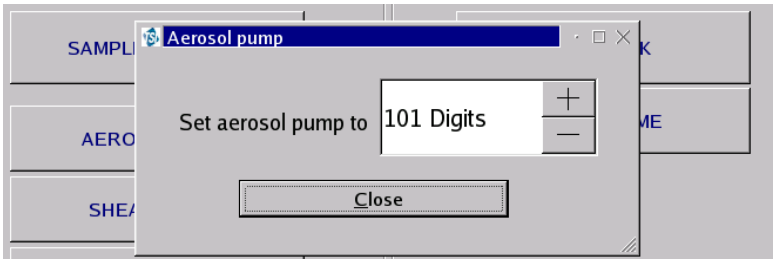


Figure 5-5
Touch Screen Pop-Up Window for Adjusting Aerosol Flow

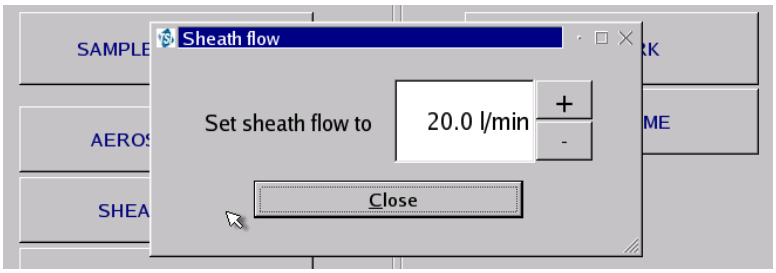


Figure 5-6
Touch Screen Pop-Up Window for Adjusting Sheath Flow

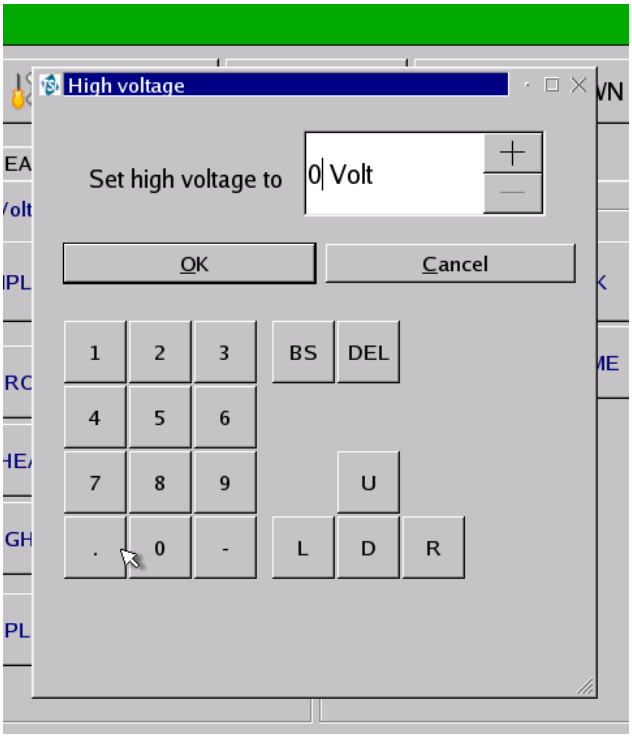


Figure 5-7
Touch Screen Pop-Up Window for Adjusting High Voltage

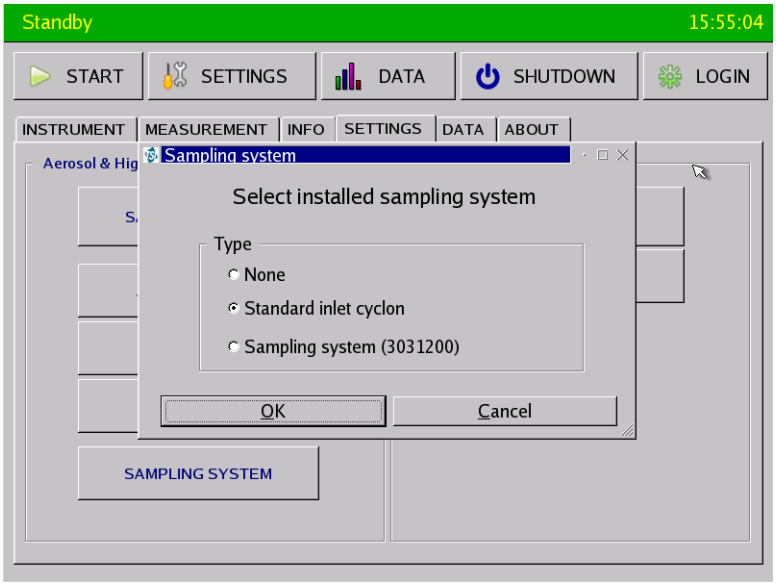


Figure 5-8
Touch Screen Pop-Up Window for Selecting Sampling System

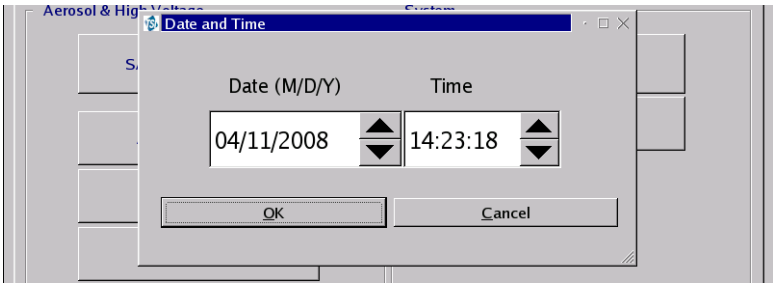


Figure 5-9
Touch Screen Pop-Up Window for Adjusting Time and Date

DATA

Selecting **DATA** displays a 3-D contour plot of particle concentrations in six size channels as a function of time. You can display the data for a particular day by scrolling to the date of interest and pressing **REFRESH**. **ZOOM IN/ZOOM OUT** functions are available to adjust the concentration scale. The **EXPORT** function allows data download into a mass storage device (refer to "Data Access" section for more details).

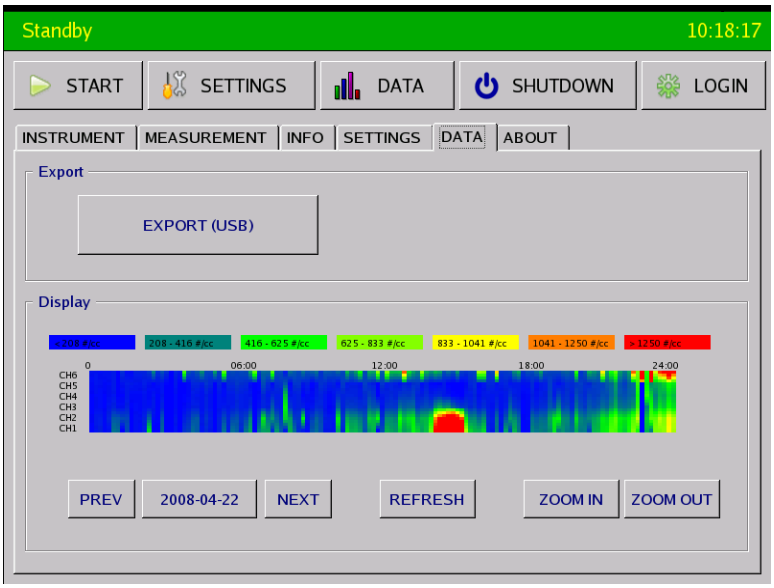


Figure 5-10
Touch Panel Display Showing DATA Menu Screen

SHUTDOWN

Selecting **SHUTDOWN** lets you halt (completely shutdown) or reboot the instrument. Always halt the instrument before turning the power off.

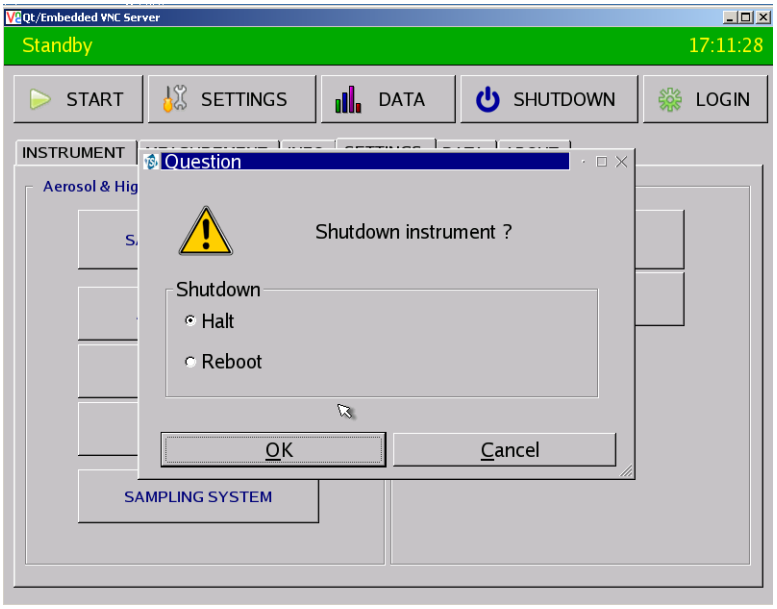


Figure 5-11
Touch Screen SHUTDOWN Menu

LOGIN

The login menu allows two types of access: (a) standard user access with username: “user”, Pin: “ufp” and (b) advanced maintenance access with username: “Maintenance”, Pin: “78952”. As a user you have access to all menus except the setup menu. To access the setup menu you must login as maintenance. Refer to Figure 5-12 to review the login pop-up window.

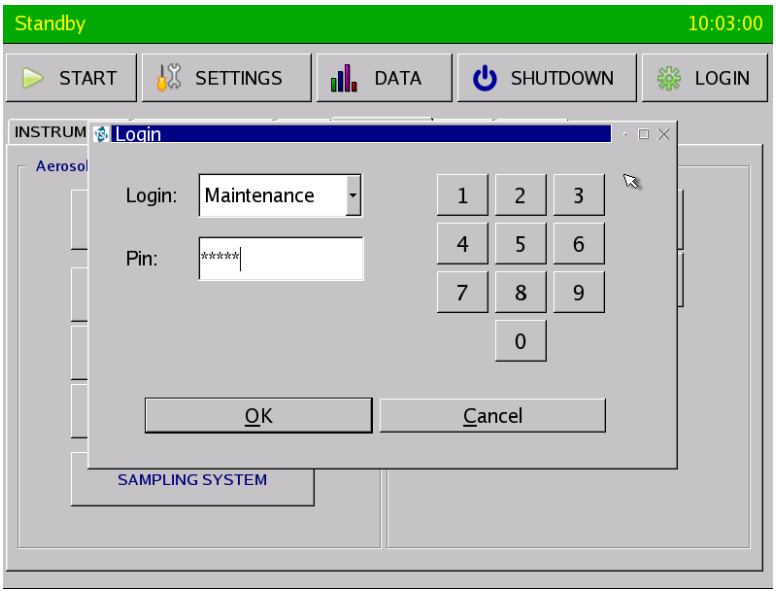


Figure 5-12
Touch Screen LOGIN Menu

INSTRUMENT

This menu displays internal system parameters to provide a quick overview of instrument status. Refer to Table 5-3 for a description of each of the parameters.

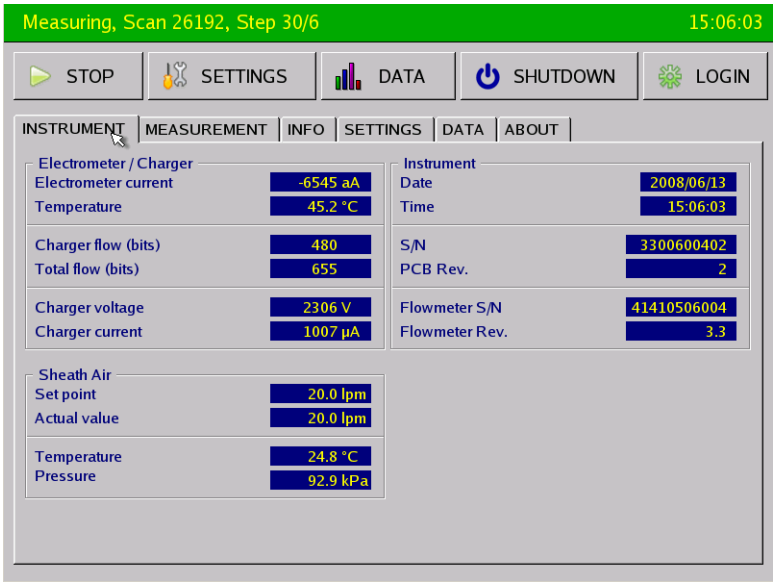


Figure 5-13
Touch Screen INSTRUMENT Menu

Table 5-3
Touch Screen INSTRUMENT Menu Items

Menu Item	Description
Electrometer/Charger	
Electrometer Current (aA)	Current of electrometer in atto Ampere
Temperature (^{o}C)	Temperature of electrometer in degree Celsius
Charger Flow (bits)	This is an internally set number of bits corresponding to a pressure drop across an orifice that provides a flow measurement.
Total Flow (bits)	Same as charger flow, but for total (inlet) flow.
Charger Voltage (V)	Voltage at the charger needle in volts
Charger Current (µA)	Ion current of the charger in micro Ampere
Sheath Air	
Setpoint (lpm)	Sheath air set flow rate in liters per minute
Actual Value (lpm)	Sheath air flow rate read by online mass flowmeter in liters per minute
Temperature (^{o}C)	Sheath air temperature in degree Celsius
Pressure (kPa)	Sheath air pressure in kilo-Pascals

Menu Item	Description
Instrument	
Date	Instrument calendar date in year/month/date
Time	Instrument clock time in hours/minutes/seconds
S/N	Instrument serial number
PCB Rev.	Instrument firmware version
Flowmeter S/N	Mass flowmeter serial number
Flowmeter Rev.	Mass flowmeter version

MEASUREMENT

This menu displays parameters related to the measurement in progress and the results of previous measurement. Refer to Table 5-4 for a description of each of the parameters.

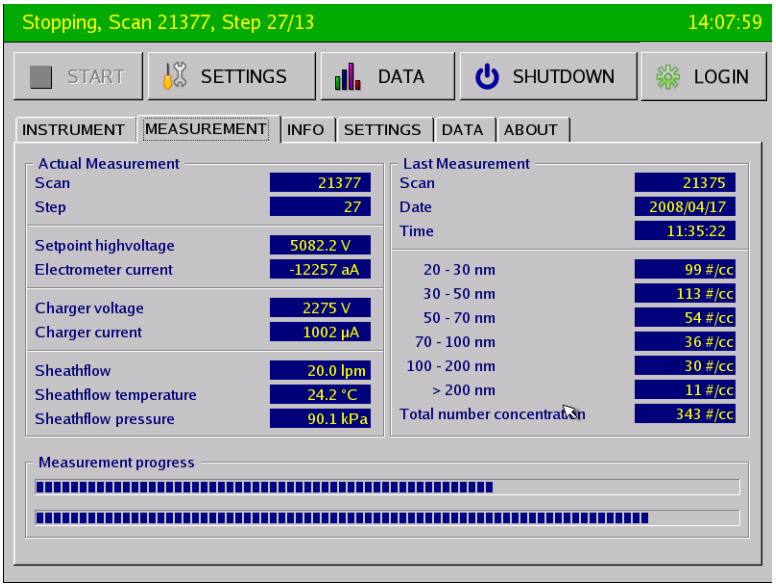


Figure 5-14
Touch Screen MEASUREMENT Menu

Table 5-4
Touch Screen MEASUREMENT Menu Items

Menu Item	Description
Actual Measurement	
Scan	Total number of measurement scans performed by the instrument
Step	Voltage step number for the measurement in progress
Setpoint high voltage (V)	High voltage applied to the DMA in volts
Electrometer current (aA)	Current of electrometer in atto Ampere
Charger voltage (v)	Voltage at the charger needle in volts
Charger current (µA)	Ion current of the charger in micro Ampere
Sheathflow temperature (^{o}C)	Sheath air temperature in degree Celsius
Sheathflow pressure (kPa)	Sheath air pressure in kilo Pascal
Last Measurement	
Scan	Scan number for the previous scan
Date	Instrument calendar date in year/month/date
Time	Instrument clock time in hours/minutes/seconds
20 to 30 nm (#/cc)	Number concentration of particles in size bins 20 to 30 nm, 30 to 50 nm, 50 to 70 nm, 70 to 100 nm, 100 to 00 nm, and >200 nm, respectively in units of numbers per cubic centimeter
30 to 50 nm (#/cc)	
50 to 70 nm (#/cc)	
70 to 100 nm (#/cc)	
100 to 200 nm(#/cc)	
>200 nm(#/cc)	
Total number concentration(#/cc)	Total number concentration of particles in units of numbers per cubic centimeter

INFO

This menu provides information about the instrument status. This dialog reads instrument status every second and updates the values for each item shown. Refer to Figure 5-15 for a view of this menu and the list of items shown.

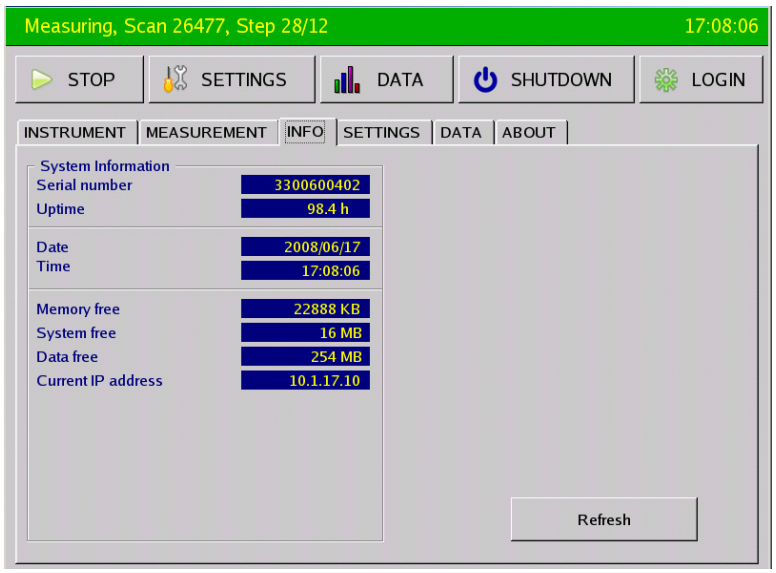


Figure 5-15
Touch Screen INFO Menu

ABOUT

This menu displays a brief description of the Ultrafine Particle Monitor and lists TSI contact information.

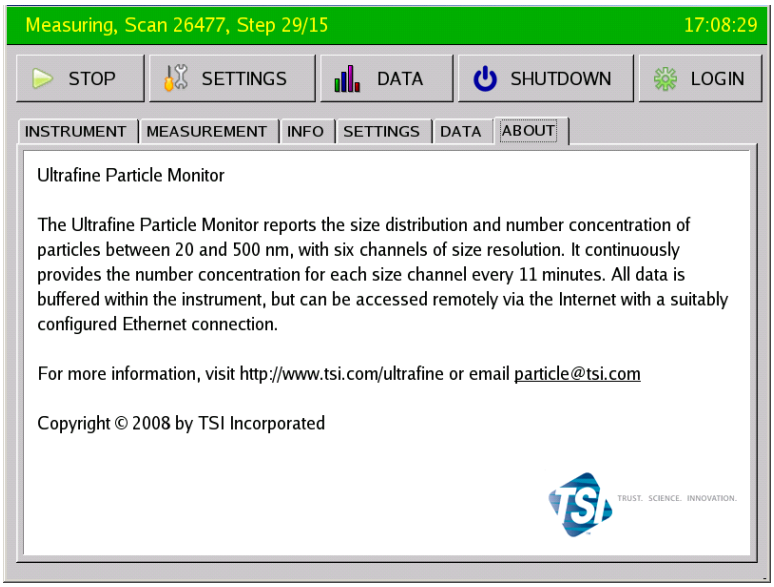


Figure 5-16
Touch Screen ABOUT Menu

Web Interface

Data and system status can be viewed and data can be downloaded using a standard web interface (Figure 5-18). Instrument set-up parameters can also be adjusted remotely via the web interface.

To display the webpage type the IP address of your instrument in the web browser, for example http://10.1.17.10. A login screen will appear (Figure 5-17); input following user name/password combinations in order to get access to various menu pages:

Normal instrument access: user/ tsi
Extended access (network, setup): admin/ 78952

The various menus available are listed and explained in Table 5-5.

Figure 5-17
Web Interface Login

Table 5-5
Menu Items on the Web Interface

Menu Item	Description
STATUS	This page displays instrument diagnostics and measurement data for the six channels, see Figure 5-18 for the list of parameters displayed. Refer to Table 5-1 and Table 5-2 for an explanation of these parameters.
DATA (CALENDAR)	This page displays a calendar month. You can scroll to the month of your choice and choose a date to display data, see Figure 5-19.
DATA (TABLE)	This page (Figure 5-23 and Figure 5-24) displays list of HTML and Text data files. Click on the date of interest to view and download data table in html or text format (refer to "Data Access" section for more details).
DATA (GRAPH)	This page (Figure 5-25) displays 3-D contour graph of size distribution data. ZOOM IN/ZOOM OUT function allows adjustment of particle concentration axis (refer to "Data Access" section for more details).
NETWORK SETUP	This page displays network settings menu. Refer to Chapter 4 "Network Configuration" for more information.
SETUP	This page (Figure 5-20) allows setup of internal parameters and additional services, see below for details.
FIRMWARE UPDATE	Use this page for upgrading the firmware (refer to Appendix D "Firmware Upgrade" for more information).

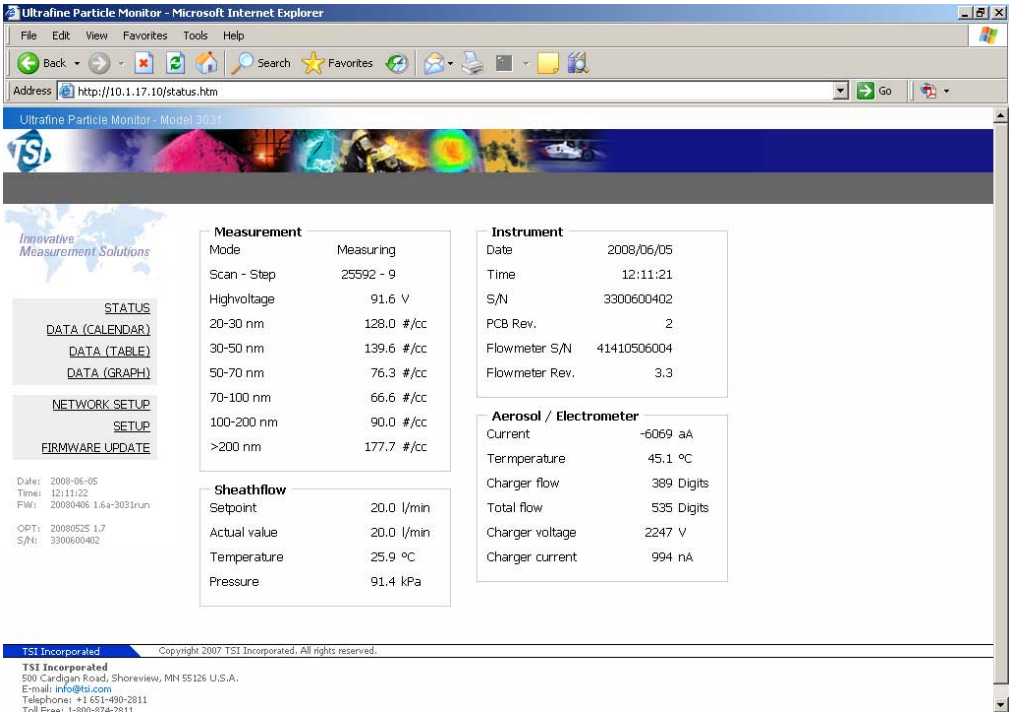


Figure 5-18
Web Interface STATUS Page with Navigation Menu on Left Side

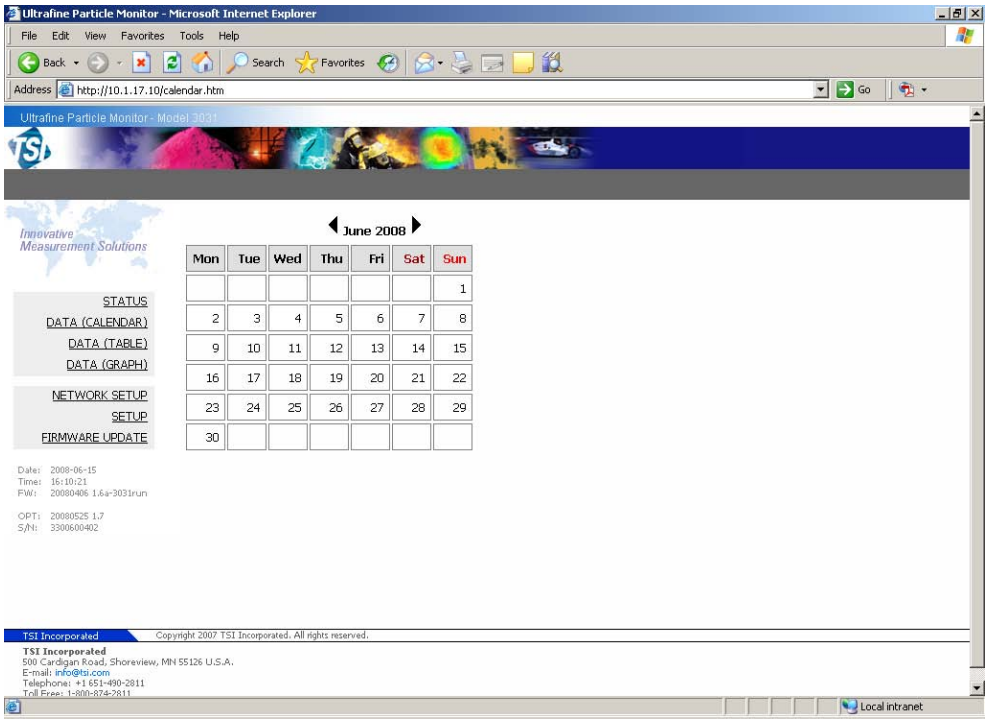


Figure 5-19
Web Interface CALENDAR Page

Setup Menu

You can set up some additional services for instrument maintenance or time adjustment. Go to the page **SETUP**. There you can set the instrument time zone (default is CET), and NTP (time and date) server address for automatic time update if one is available through your network. In addition, the serial RS-232 connection to a station computer working with the “Bayern-Hessen Protocol” can be set up. This is mainly used in Germany. For details on this protocol, see Appendix C. Your UFP Monitor can also be run as a size classifier (using serial commands); this function is used for maintenance and calibration purposes. Check the box next to “Running as Classifier” to activate this function. Notice that when running the instrument as a size classifier, size distribution data cannot be measured simultaneously.

You have to reboot the instrument to activate the settings.

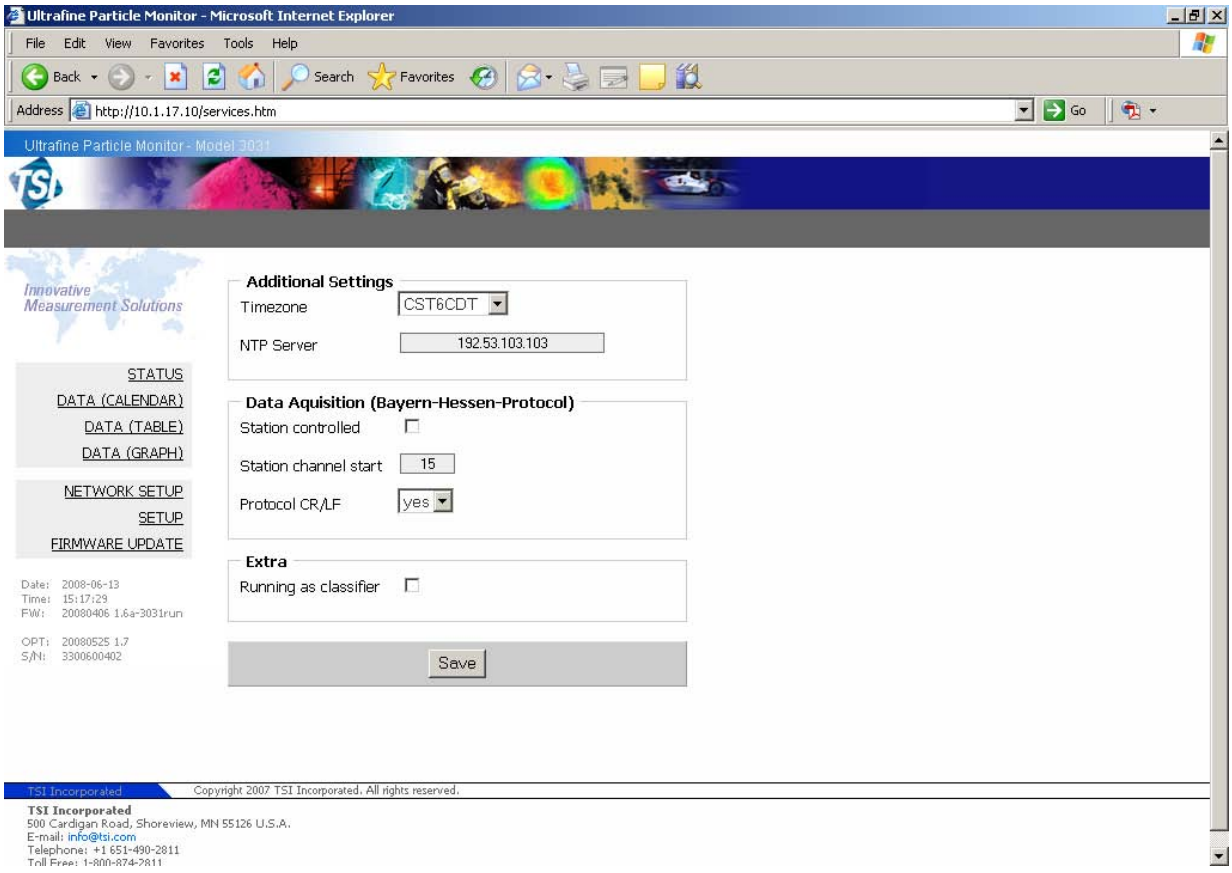


Figure 5-20
Web Interface SETUP Page

Running a Measurement

Simply use the touch panel and select the **START** menu and then select the **Measurement time** and the **Measurement type** **(**Figure 5-21). Refer to Chapter 5 “Instrument Operation/Menu Items/Start” for more information on measurement time and measurement type. If the instrument is rebooted, the measurement will be restarted with a new scan after the restart.

A measurement in progress can be stopped by pressing the **STOP** menu. To stop the scan midway, select **Immediately-abort the scan**. To complete the scan in progress, select **Finish the scan and stop** (refer to Figure 5-22).

Note: *After finishing the scan the result will be calculated. This will take a while (up to 5 minutes). In the mean time the next scan will be started.*

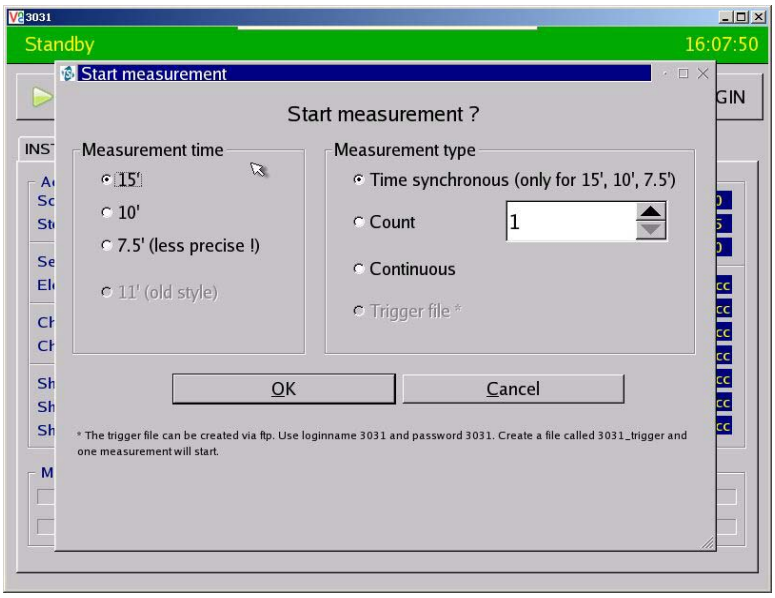


Figure 5-21
Touch Panel Display Showing START Menu Screen

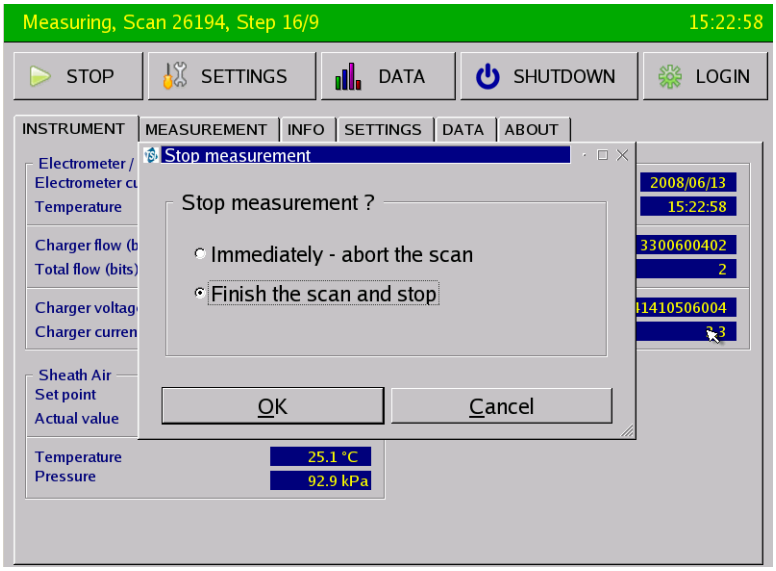


Figure 5-22
Touch Panel Display Showing STOP Menu Screen

Data Access

You can access the data stored in the instrument with different methods:

1. Display on the front panel screen.
2. Download as a text file on a mass storage device using USB port on the front panel.
3. Display in the web browser.
4. Download as text file from web interface.
5. Access the MySQL® database with Microsoft® ADO drivers and an installed ODBC driver.
6. Access the MySQL® database directly.

Note: *A working network connection is required to use options 3 to 6 (see also chapter "Network Configuration" in Chapter 4).*

®MySQL is a registered trademark of MySQL AB in the United States, the European Union and other countries.

Data Access with Web Interface

Depending on your installation, you can choose the way which will be the best. The simplest way is using a web browser. Go to the page **DATA (TABLE)** [see Figure 5-23 and Figure 5-24], where you get access to html formatted listings (Figure 5-24) or downloadable text files. For a simple way to view data, the HTML data (Figure 5-24) can be highlighted in the browser, copied to the windows clipboard and pasted into a blank Excel® spreadsheet. Excel will take care of reformatting the data.

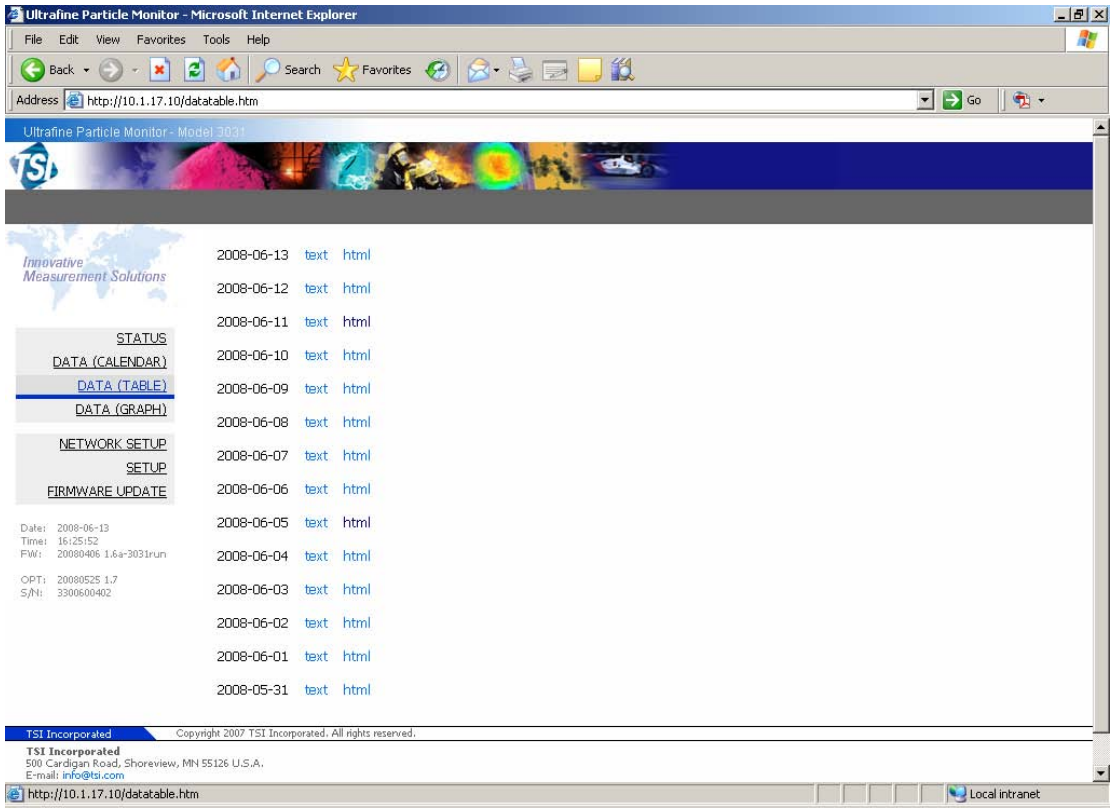


Figure 5-23
Web Interface DATA (TABLE) Page

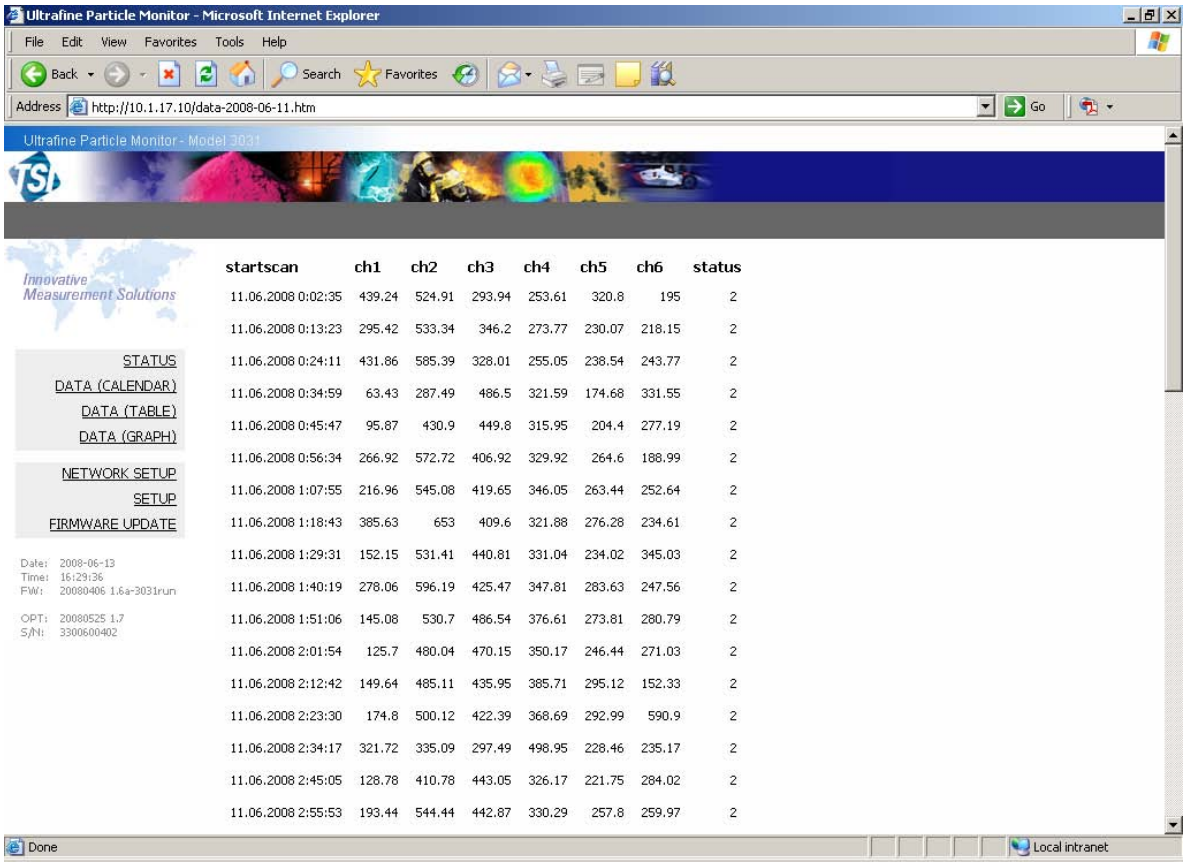
TSI 3031 Status Codes

The status code numbers associated with each 3031 data string have a specific meaning for that measurement. This ensures data integrity and data quality for each measurement.

Here is a description of each of these codes:

0	Scan not finished
1	Scan finished but no data calculated
2	Scan finished and data calculated (you can see data on the display)
3	Same as 2 but with inlet system correction (see SETTINGS => INLET SYSTEM on front panel)

The code refers to the last column of data in Figure 5-24.



startscan	ch1	ch2	ch3	ch4	ch5	ch6	status
11.06.2008 0:02:35	439.24	524.91	293.94	253.61	320.8	195	2
11.06.2008 0:13:23	295.42	533.34	346.2	273.77	230.07	218.15	2
11.06.2008 0:24:11	431.86	585.39	328.01	255.05	238.54	243.77	2
11.06.2008 0:34:59	63.43	287.49	486.5	321.59	174.68	331.55	2
11.06.2008 0:45:47	95.87	430.9	449.8	315.95	204.4	277.19	2
11.06.2008 0:56:34	266.92	572.72	406.92	329.92	264.6	188.99	2
11.06.2008 1:07:55	216.96	545.08	419.65	346.05	263.44	252.64	2
11.06.2008 1:18:43	385.63	653	409.6	321.88	276.28	234.61	2
11.06.2008 1:29:31	152.15	531.41	440.81	331.04	234.02	345.03	2
11.06.2008 1:40:19	278.06	596.19	425.47	347.81	283.63	247.56	2
11.06.2008 1:51:06	145.08	530.7	486.54	376.61	273.81	280.79	2
11.06.2008 2:01:54	125.7	480.04	470.15	350.17	246.44	271.03	2
11.06.2008 2:12:42	149.64	485.11	435.95	385.71	295.12	152.33	2
11.06.2008 2:23:30	174.8	500.12	422.39	368.69	292.99	590.9	2
11.06.2008 2:34:17	321.72	335.09	297.49	498.95	228.46	235.17	2
11.06.2008 2:45:05	128.78	410.78	443.05	326.17	221.75	284.02	2
11.06.2008 2:55:53	193.44	544.44	442.87	330.29	257.8	259.97	2

Figure 5-24
Web Interface HTML Data Listing

You can view a 3-D contour plot of size distribution data as a function of time from **DATA (GRAPH)** page (Figure 5-25).

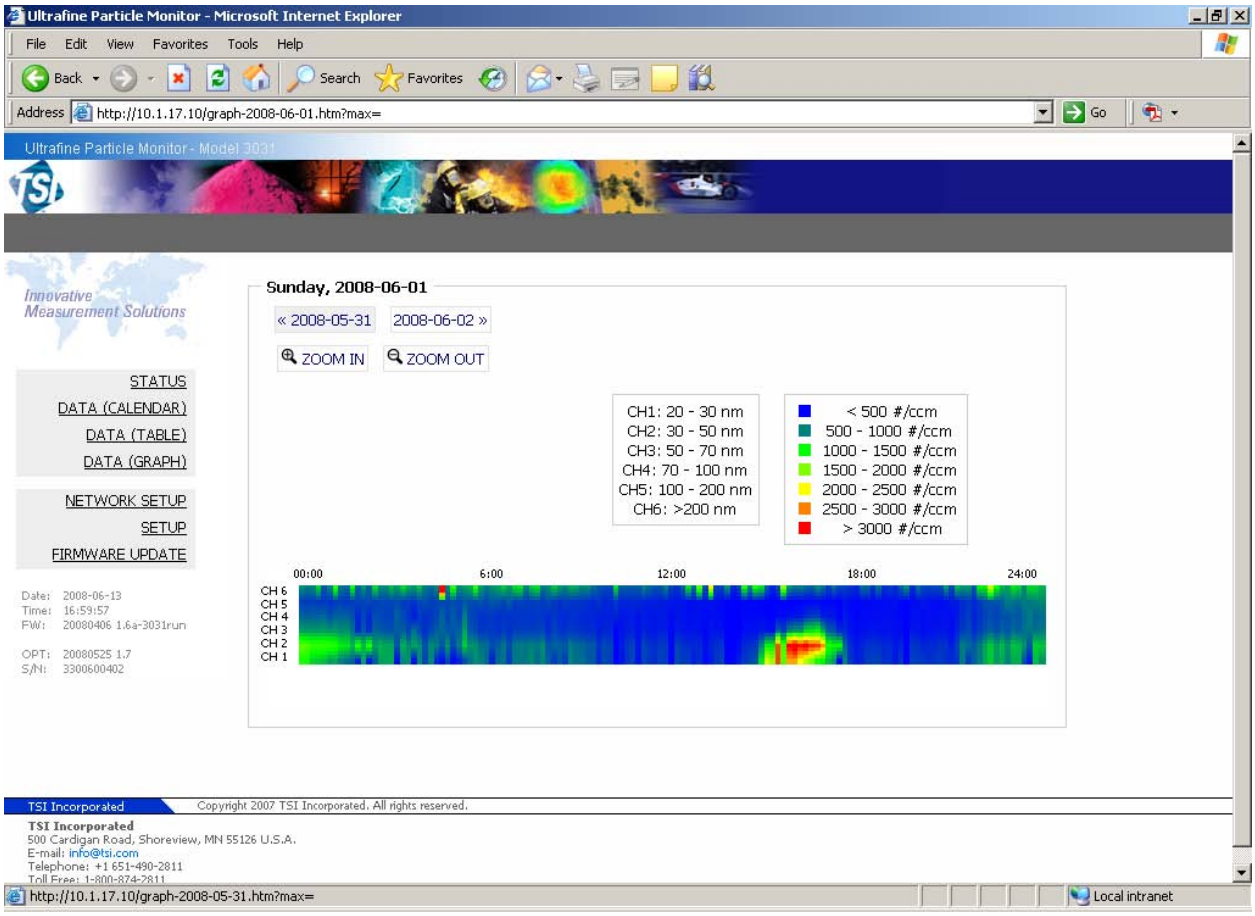


Figure 5-25
Web Interface DATA (GRAPH) Page

Data Access with Microsoft® Excel® Spreadsheet

If you always access data from the same computer, it is recommended you install the freely available MyODBC driver (from MySQL® database) and use the Microsoft® Office Excel spreadsheet supplied with your software CD. MyODBC version 3.51 software must be installed on your computer for this application to work. This software is available for download from following website: http://dev.mysql.com/and also supplied with your software CD. To run this application, open the supplied Excel sheet “3031 DataAccess.xls”. Input the date and the IP address of the instrument, and run the macro “GetUltrafine ParticleData” by pressing the ‘Refresh’ button in the Excel spreadsheet. The script will connect to the instrument and fill out the Excel spreadsheet (see Figure 5-26). The computer running the Excel script must have access to the 3031 through Ethernet (if you can access the data

using a web page, you should be able to access the data with the spreadsheet).

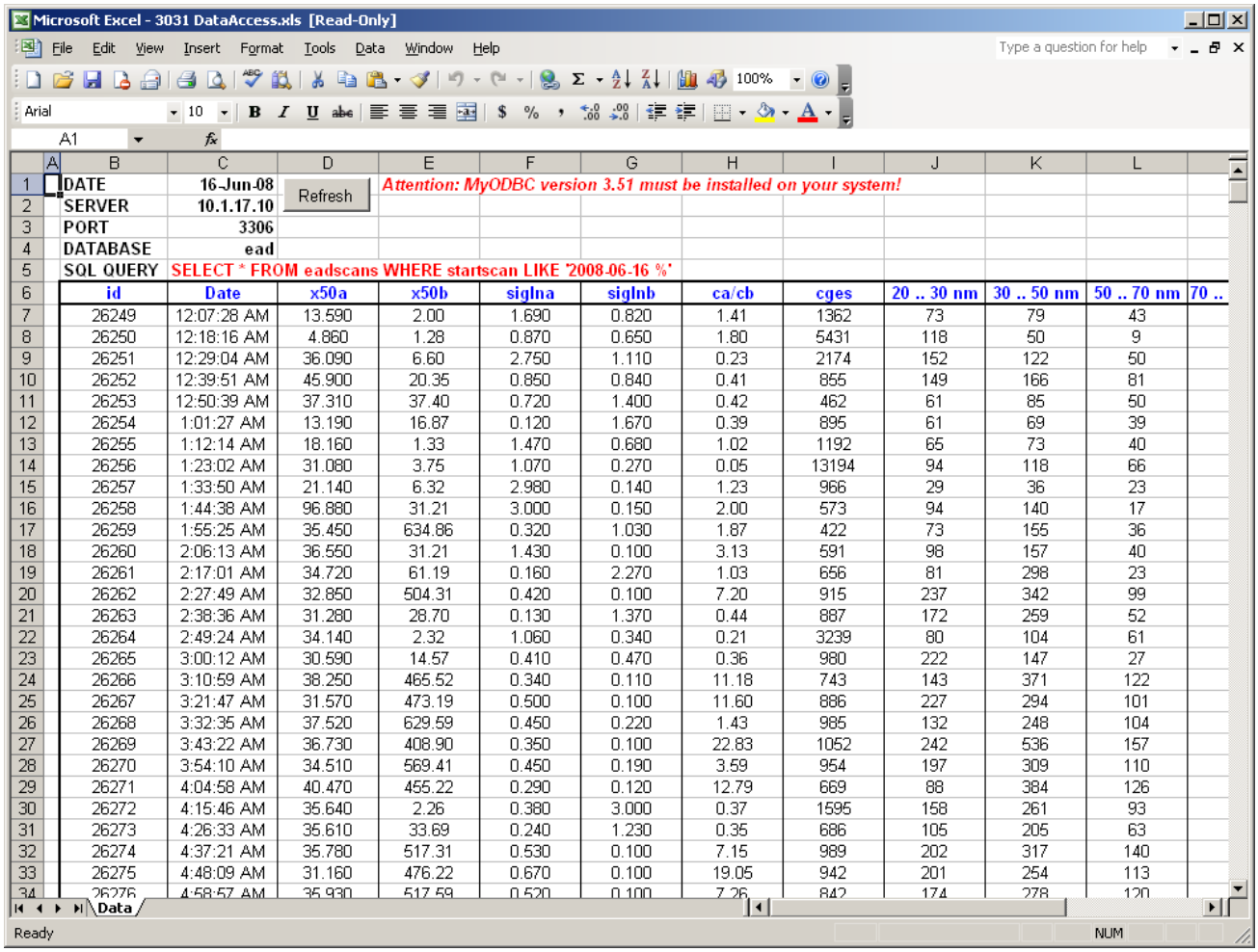


Figure 5-26
Data Access using a Microsoft® Excel® Sheet and ODBC

Data Access with MySQL® Database

Advanced users who are familiar with databases and SQL queries can get direct access to the database contained in the UFP Monitor. As with any advanced manipulation there is potential to erase or corrupt data. Please use caution when working directly with the database. Instructions for database communications are in a file “Instructions for SQL Database Communications.doc” included in the software CD supplied with your UFP Monitor.

Data Access from Instrument Front Panel

Select **DATA** menu. Scroll to the date of interest and press **REFRESH**. A 3-D contour plot of the data is displayed. To download data, insert a USB stick in the USB port on the instrument front panel. Select **EXPORT** on the "DATA" menu. Now select the period (date and time) for which you would like to download the data. Press **OK**. The data for selected period will be downloaded and saved in a text file on the mass storage device.

Figure 5-27
Location of USB Port on the Front Panel

Figure 5-28
Touch Panel Display Showing DATA Menu Screen

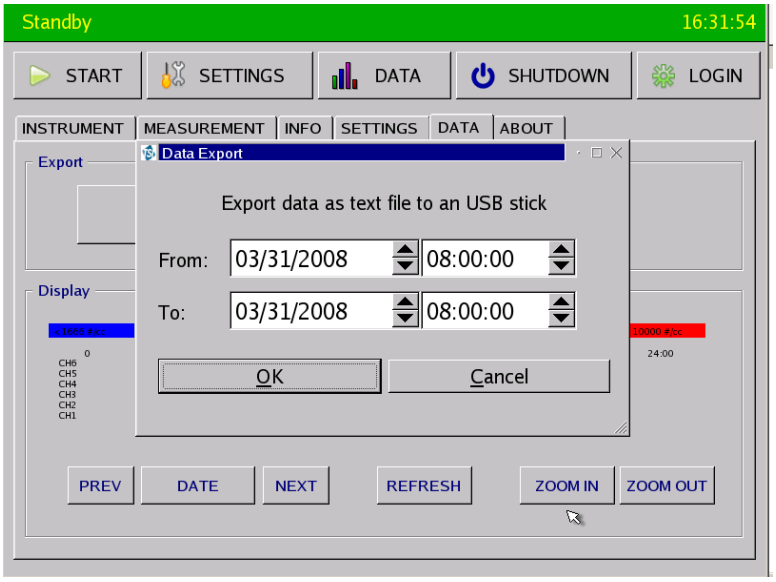


Figure 5-29
Location of USB Port on the Front Panel

Turning Off

On the touch panel screen press **SHUTDOWN** and select **Halt**, press **OK**. Then, turn the instrument off using the on/off switch on the front panel.

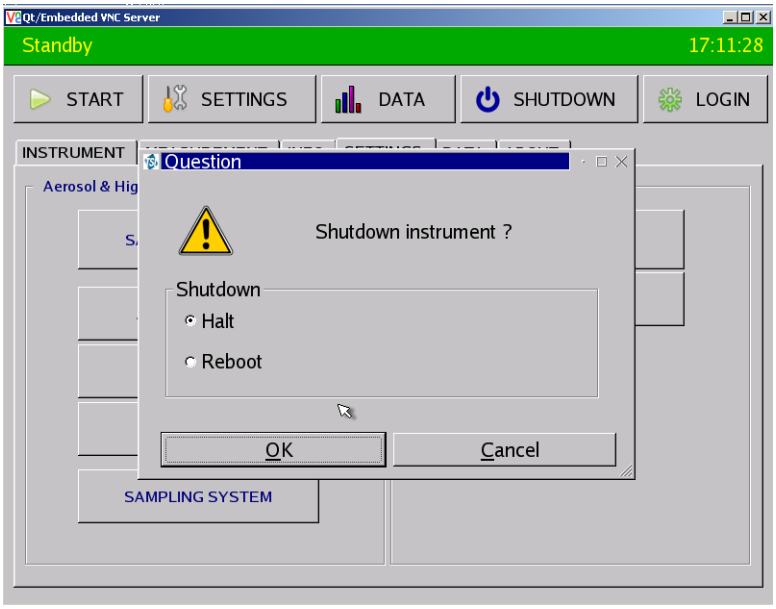


Figure 5-30
Turning off the UFP Monitor

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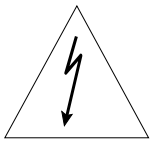
CHAPTER 6

Maintenance

The Ultrafine Particle Monitor is designed for many months of maintenance-free operation when used in environmental aerosol monitoring applications. This chapter describes basic care of the instrument, tips for quick checks and maintenance procedures.

The Ultrafine Particle Monitor is a complex instrument. Feel free to contact TSI prior to any maintenance procedure or for general questions regarding aerosol sampling.



WARNING
High voltage is accessible in several locations within this instrument. Make sure you unplug the power source before performing maintenance procedures. Only a qualified technician should perform this maintenance.

Care of the Ultrafine Particle Monitor

The supplied inlet cyclone should be typically used for *short- term* measurements *only* as it requires more frequent cleaning. Use of the standard PM_1 cyclone supplied with Model 3031200 (or equivalent) is recommended for removing large particles for long-term operation. Use of the air dryer supplied with Model 3031200 (or equivalent) is recommended to reduce humidity of the aerosol. In humid environments with high ambient temperatures and high dew points water may condense and cause damage to the instrument.

Table 6-1 gives a general indication of the maintenance requirements, sampling ambient aerosols. In applications where high concentrations may be experienced, maintenance is required more often.

Table 6-1
Maintenance Schedule

Maintenance	Time Period	Recommended Operator
Factory calibration and maintenance	1 year	Return to TSI
Remove cyclone cover and clean interior surfaces	1 to 2 weeks typically	Trained technician
Clean the inlet orifice	As needed (to troubleshoot a low inlet flow condition check and clean the orifice)	Trained technician
Replace charger charcoal filter	3 months	Trained technician
Replace charger particle filter	3 months	Trained technician
Replace pump exhaust filter	3 months	Trained Technician
Replace DMA sheath air filer	6 months	Trained technician
Replace electrometer filter	1 year	Service engineer

Consumables Kit

The Model 1031588 consumables kit contains annual usage quantities of various filters and tubing used in the Ultrafine Particle Monitor. The kit includes four HEPA capsule filters, eight Balston® DFU-BX filters, four carbon cartridge filter, one wire core microfiber filter and 3 ft. Tygon® tubing (0.312" OD × 0.187" ID). Please contact your TSI representative for purchase of this kit.

Important Note
This chapter is only intended for a qualified technician or service engineer familiar with sensitive electronics and ESD safety procedures. Only a qualified technician should perform this maintenance.

Cleaning the Cyclone

Clean the cyclone prior to the start of testing. When cleaning, refer to the illustration of the cyclone in Figure 4-1.

Separate the cyclone from the SS union fitting by loosening the hex nuts. Remove the cyclone "Removable Base" by turning it counterclockwise. Use compressed air to blow out the interior surfaces (including the inlet nozzle) and rinse in isopropyl alcohol or water. Examine the interior orifice to make sure it is clear. Dry, reassemble, and reinstall.

Accessing the Internal Components

To perform maintenance procedures, you will need access to the inside of the UFP Monitor. Outlined below is the procedure to open front and side panels of the Model 3031 and Model 3031-1 UFP Monitors.

Access from Right

Open the right side door of Model 3031-1 to gain access to the DMA and equalization tank. Model 3031 does **not** have a door on right side allowing open access.

Figure 6-1
Access from Right Side

Access from Front

1. Unlock the top door by loosening and removing two screws on the side of the door as shown in Figure 6-2.
2. Unlock the bottom door by removing two screws on top and one screw on the bottom as shown in the Figure 6-3 and Figure 6-4, respectively.

Figure 6-2
Open Front Top Door

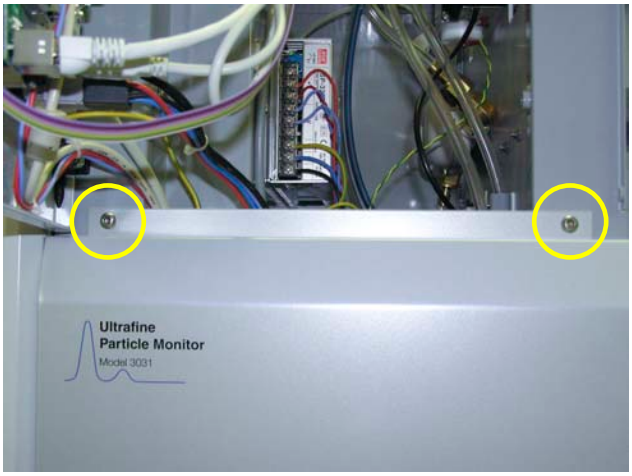


Figure 6-3
Location of Top Screws on Front Bottom Door

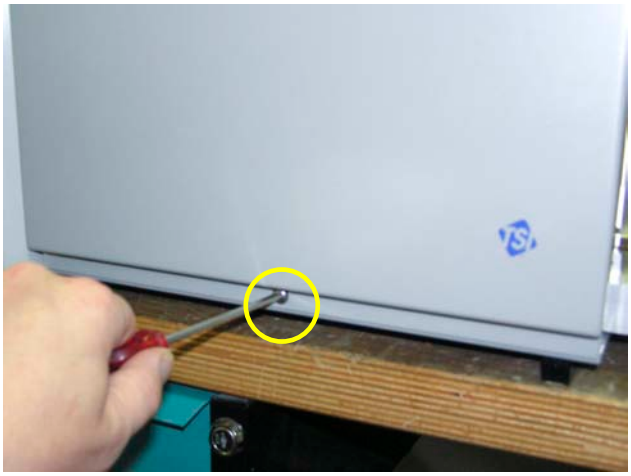


Figure 6-4
Location of Bottom Screw on Front Bottom Door

Access from Left

Open the left side door of Model 3031-1 to gain access. The Model 3031 has two screws on the side door as shown in Figure 6-5 which should be loosened and removed to open the door.

Figure 6-5
Model 3031 Left Door Showing Retaining Screws

Cleaning the Inlet Orifice

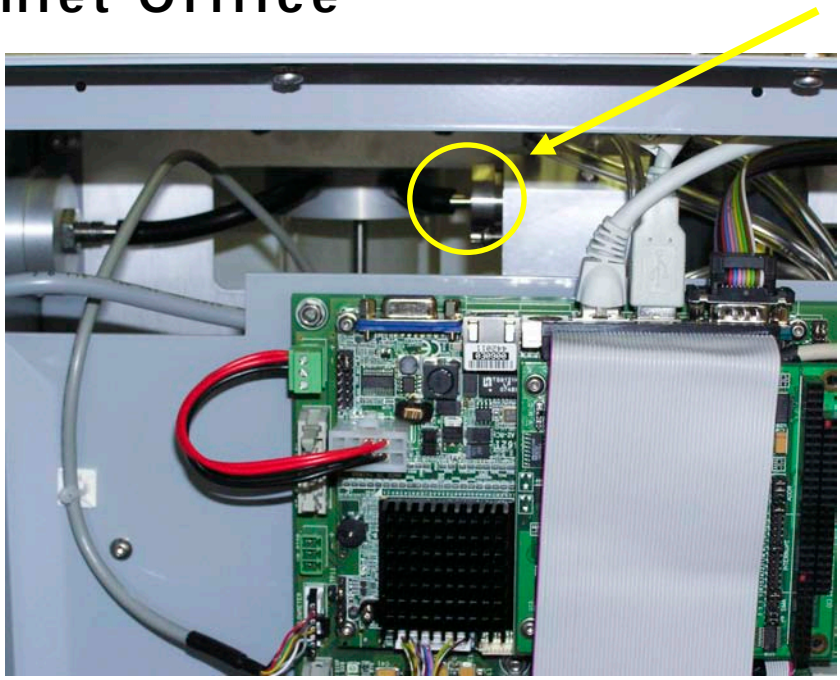


Figure 6-6
Aerosol Inlet Orifice Location

The inlet orifice is exposed to aerosol flowing through the instrument. Therefore, it is susceptible to clogging if the aerosol particle concentration is high. However, the orifice is easily cleaned. Follow the steps below to clean the orifice:

1. Shut down the instrument using the menu on the front panel and wait for it to shut down properly (similar to turning of a personal computer). Turn off the instrument using the power switch on the front panel. Disconnect the power cable.
2. If working with Model 3031-1, open the left side door. For Model 3031, loosen and remove the two screws (shown in Figure 6-1 to unlock the left protecting door before opening it.
3. Access the instrument from the left side and locate the inlet orifice as shown in Figure 6-6.
4. Remove the retaining screw of the inlet.
5. Pull the inlet straight out from the instrument.
6. Inspect the orifice using magnification to see if it is dirty.
7. If necessary, clean the orifice using warm soapy water, followed by clean water and then isopropyl alcohol and dry clean air. Re-inspect the orifice.
8. Inspect the O-rings for cuts or nicks and replace if necessary

9. Lightly grease the O-rings if they are replaced or if they have been cleaned.
10. Re-insert the inlet into the instrument and align the retaining screw hole.
11. Insert the retaining screw.
12. Close the left door.
13. Turn the instrument back on and measure the inlet flow using standard volumetric flowmeter. The flow rate should be 5 liters per minute.

Exchange Charger Filters

The charger has a bypass flow line which transports the ions from the corona generator into the mixing chamber. To prevent depositions on the corona needle this line is equipped with a particle filter and a charcoal filter.

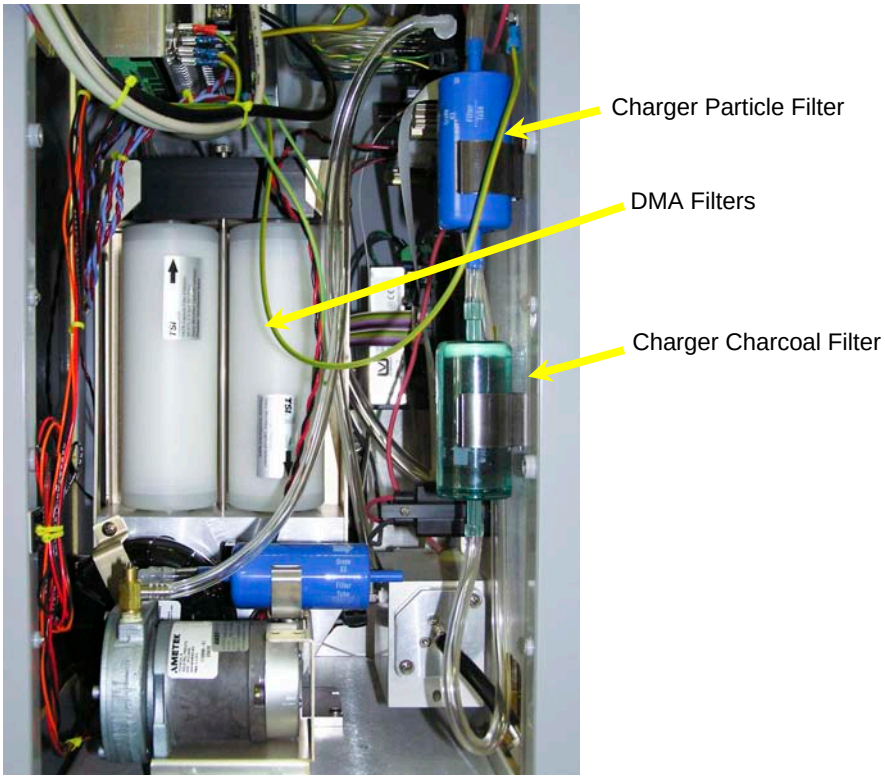


Figure 6-7
Location of Charger Charcoal and Particle Filters and DMA Filters

Exchange Charcoal Filter

To exchange the charcoal filter follow the steps below:

1. Shut down the instrument using the menu on the front panel and wait for it to shut down properly (similar to turning of a personal computer). Turn off the instrument using the power switch on the front panel. Disconnect the power cable.
2. Access the instrument from the front and locate the charcoal filter as shown in Figure 6-7.
3. Loosen the tubing upstream and downstream the filter.
4. Replace the filter in the same flow direction.
5. Reconnect the tubing.

Exchange Particle Filter

To exchange the particle filter follow the steps below:

1. Shut down the instrument using the menu on the front panel and wait for it to shut down properly (similar to turning of a personal computer). Turn off the instrument using the power switch on the front panel. Disconnect the power cable.
2. Access the instrument from the front and locate the particle filter as shown in Figure 6-7.
3. Loosen the tubing upstream and downstream the filter.
4. Replace the filter in the same flow direction.
5. Reconnect the tubing.

Exchange DMA Sheath Flow Filters

There are two filters in the Sheath Air line of the Classifier: one in between the classifier and the pump and one after the pump. The cartridges in both filters require periodic replacement.

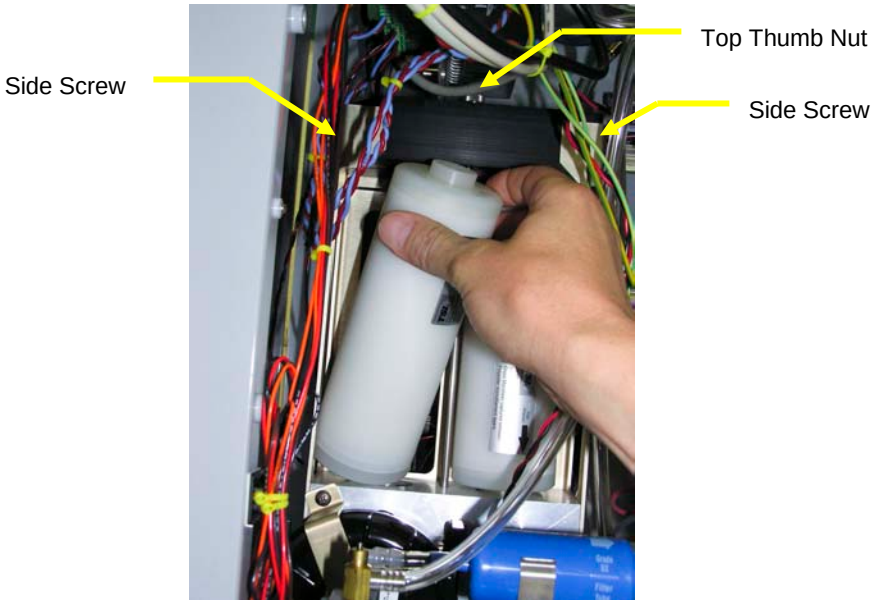


Figure 6-8
Exchange DMA Filters

To replace the filter cartridges, refer to the steps below:

1. Shut down the instrument using the menu on the front panel and wait for it to shut down properly (similar to turning of a personal computer). Turn off the instrument using the power switch on the front panel. Disconnect the power cable.
2. Access the instrument from the front and locate the DMA filters (see Figure 6-7).
3. Loosen the filter assembly support screws on both sides of the filter assembly.
4. Loosen the thumb nut on the top of the filter assembly.
5. Raise the upper assembly about 12 mm.
6. Replace the left and right filter cartridge making sure that the O-rings are in place on the top and bottom filter manifolds (see Figure 6-8). Observe the correct filter orientation.
7. Push the top manifold back down over the filters and tighten the thumbnuts evenly.
8. Replace the filter assembly support screws.

Exchange Electrometer Filter

To exchange the sampling filter follow the steps below:

1. Shut down the instrument using the menu on the front panel and wait for it to shut down properly (similar to turning of a personal computer). Turn off the instrument using the power switch on the front panel. Disconnect the power cable.
2. Access the instrument from the front and locate the electrometer at the bottom of the device next to the pump as shown in Figure 6-9.
3. Follow the white flex cable from back of the electrometer to the main board and disconnect it (see Figure 6-10).
4. Disconnect the conductive tubing (black tubing) from the electrometer inlet and Tygon® tubing (transparent tube) from the side of the electrometer.
5. Access the instrument from the right side and locate four screws retaining the electrometer located next to the DMA (see Figure 6-11).
6. Dismount the electrometer.
7. Open its front cover as shown in Figure 6-12.
8. Exchange the sampling filter as shown in Figure 6-13.
9. Reassemble and remount the electrometer.

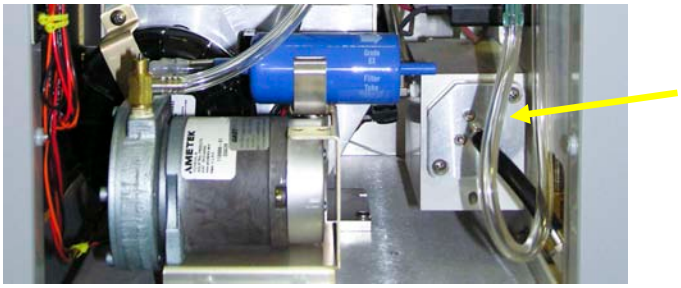


Figure 6-9
Location of Electrometer at the Bottom of Device

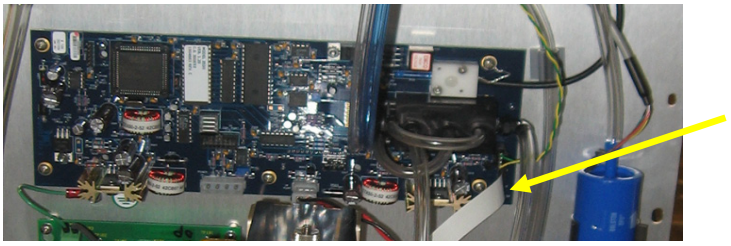


Figure 6-10
Location of Flex Cable Connection to Main Board

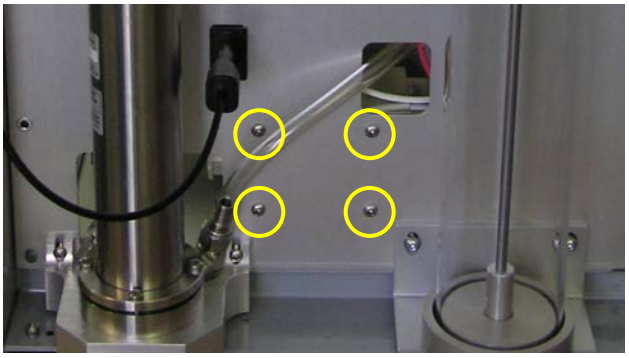


Figure 6-11
Electrometer Retaining Screws

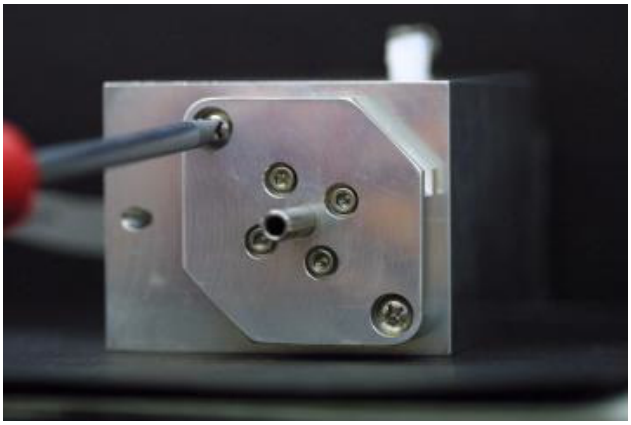


Figure 6-12
Open the Electrometer Housing

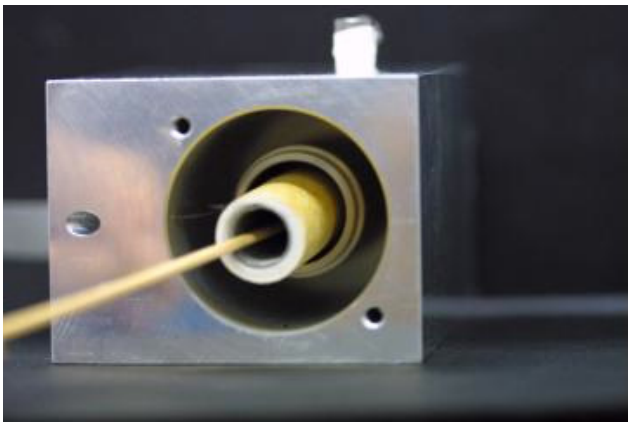


Figure 6-13
Exchange Electrometer Filter

Exchange the Pump Exhaust Filter

This filter collects the abrasion dust of the sampling pump. For this task a used filter is sufficient. For this reason this filter can be replaced by the used charger-bypass-filter.

To exchange this filter follow the steps below:

1. Shut down the instrument using the menu on the front panel and wait for it to shut down properly (similar to turning of a personal computer). Turn off the instrument using the power switch on the front panel. Disconnect the power cable.
2. Access the instrument from front.
3. Locate the pump exhaust filter as shown in Figure 6-14.
4. Disconnect the tubing.
5. Replace the filter.
6. Reconnect the tubing.

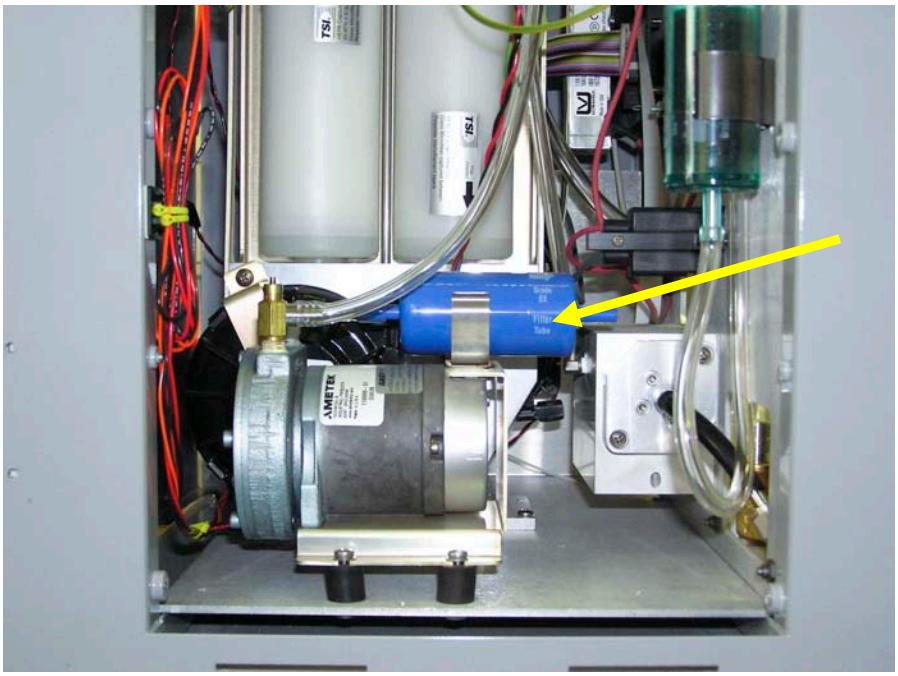


Figure 6-14
Location of the Pump Exhaust Filter

Testing for Leaks

Whenever an air leak is suspected or a significant part of airflow system has been reassembled, perform a leak check to ensure proper performance.

Plug the inlet with your finger and watch the parameter called “Pressure” under “Sheath Air” on the front panel **INSTRUMENT** menu. The pressure should drop about 20 kPa in 10 seconds. If you don't get the expected drop in value, see “Isolating Leaks” below.

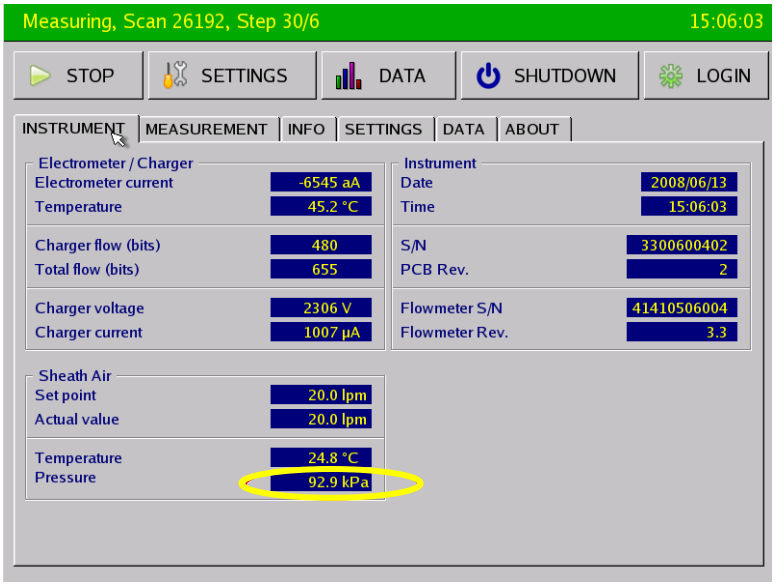


Figure 6-15
Location of the Sheath Air Pressure Reading on Front Panel

Isolating Leaks

1. Isolate the leak by wetting suspected joints with clean isopropyl alcohol while the system is under vacuum. The alcohol will be drawn into a leaky joint and evaporate.
2. After isolating the leak, repair it (usually by greasing or replacing an O-ring, or by sealing a fitting).
3. Blow low-pressure clean, dry air through the repaired section to evaporate and remove any leftover alcohol.
4. If you cannot find the leak, or cannot repair the leak, please contact TSI for assistance.

Checking and Adjusting Inlet Flow

Whenever a significant part of airflow system has been reassembled or when unexpected data readings are obtained an inlet flow check is recommended to ensure proper performance.

To check the flow and make adjustments follow the steps below:

1. Disconnect the instrument inlet from the sampling system (if using a sampling system).
2. Connect a standard volumetric flowmeter to the instrument inlet or if the supplied inlet cyclone is installed at the inlet, connect the flowmeter to the cyclone inlet. Measure and record the flow rate reading.
3. If the flow reading is lower than 5 liters per minute adjust the power of the pump. To do this, select **SETTINGS** menu on the front panel, and press **AEROSOL FLOW**. Change the pump digits reading on the pop-up window till you read 5 liters per minute in the flowmeter attached to the inlet.
4. Disconnect the flowmeter.
5. Reconnect the instrument inlet to the sampling system (if using a sampling system).

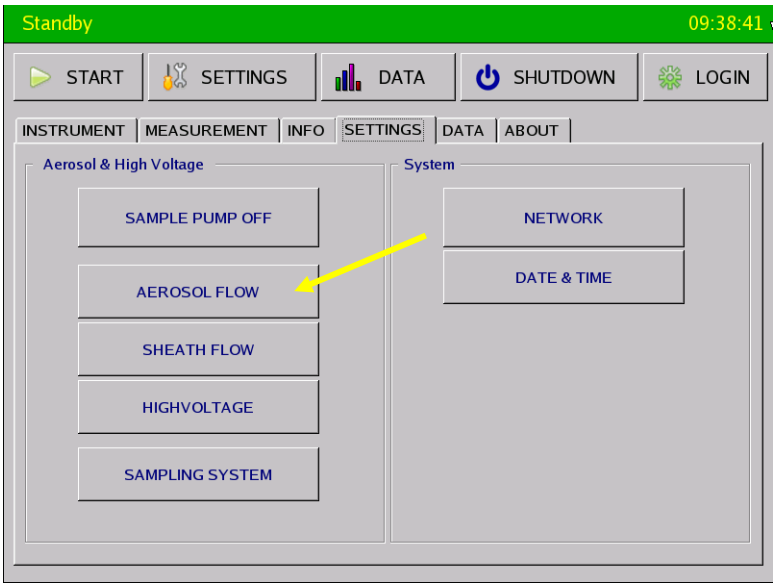


Figure 6-16
Front Panel Display Showing SETTINGS Menu with AEROSOL FLOW Submenu

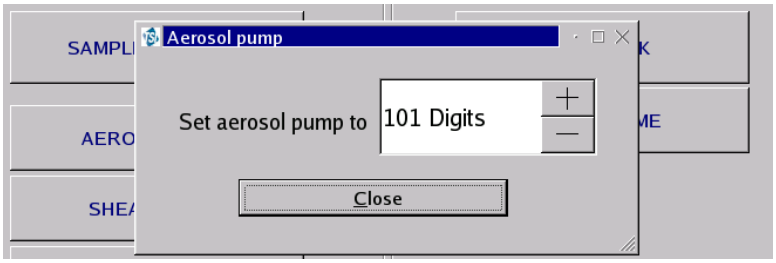
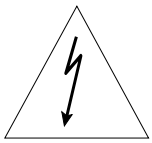


Figure 6-17
Touch Screen Pop-Up Window for Adjusting Aerosol Flow

Clean the DMA Column

The electrostatic classifier fractionates the sampled particles according to their mobility. Particles smaller than the actual cut size are deposited on the inner electrode of the DMA-column. Therefore this device has to be cleaned.



W A R N I N G
High voltage is accessible in several locations within this instrument. Make sure you unplug the power source to the instrument and unplug the high-voltage cable before disassembling the DMA or performing maintenance procedures.

***Note**: In the following procedures it is extremely important to **avoid scratching** the inner surface of the DMA. A small scratch, nick, or burr can completely disrupt the electric field inside the DMA, severely affecting its performance. It is strongly recommended that this task be performed by TSI service technicians during annual factory calibration.*

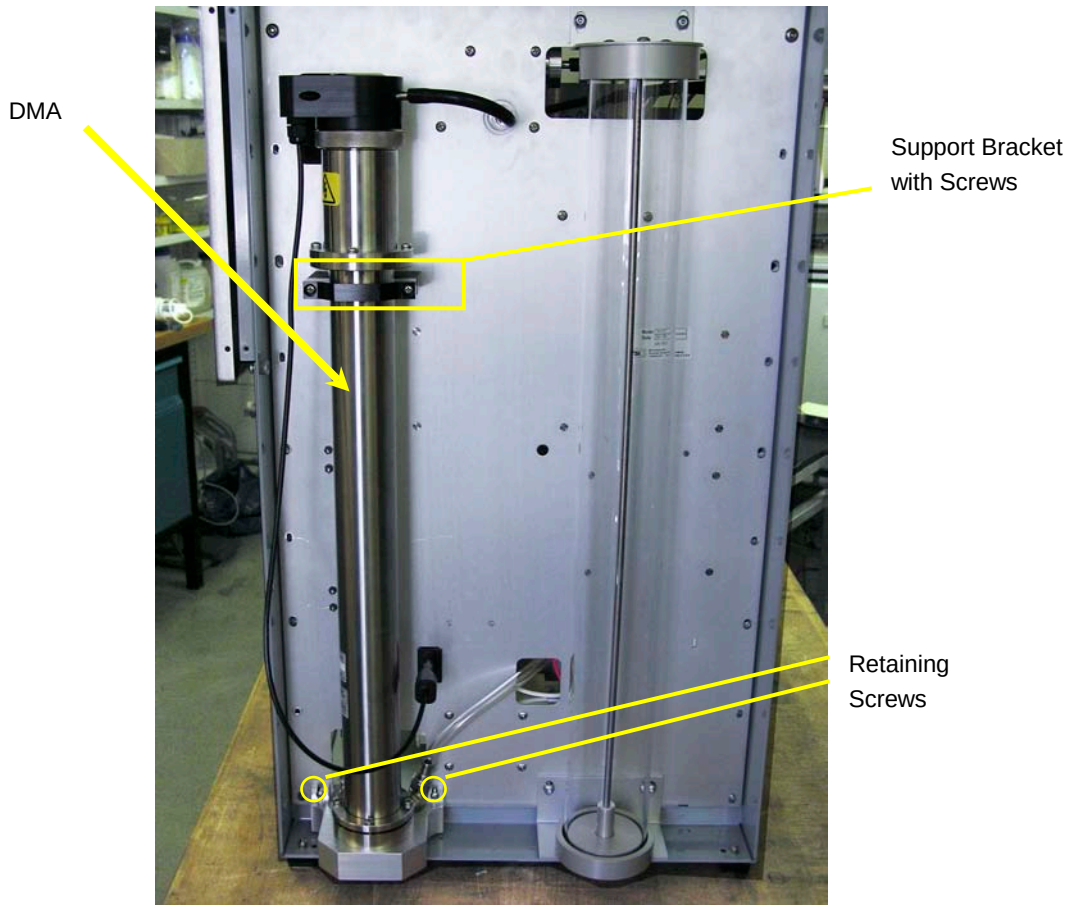


Figure 6-18
Location of the DMA

For cleaning the DMA-column follow the steps below:

1. Shut down the instrument using the menu on the front panel and wait for it to shut down properly (similar to turning of a personal computer). Turn off the instrument using the power switch on the front panel. Disconnect the power cable.
2. Access the instrument from right side.
3. Locate the DMA column shown in Figure 6-19 and follow the high voltage wire from the top of the DMA column to high voltage plug at the bottom. **Disconnect the high voltage connector** by pulling out on the connector.

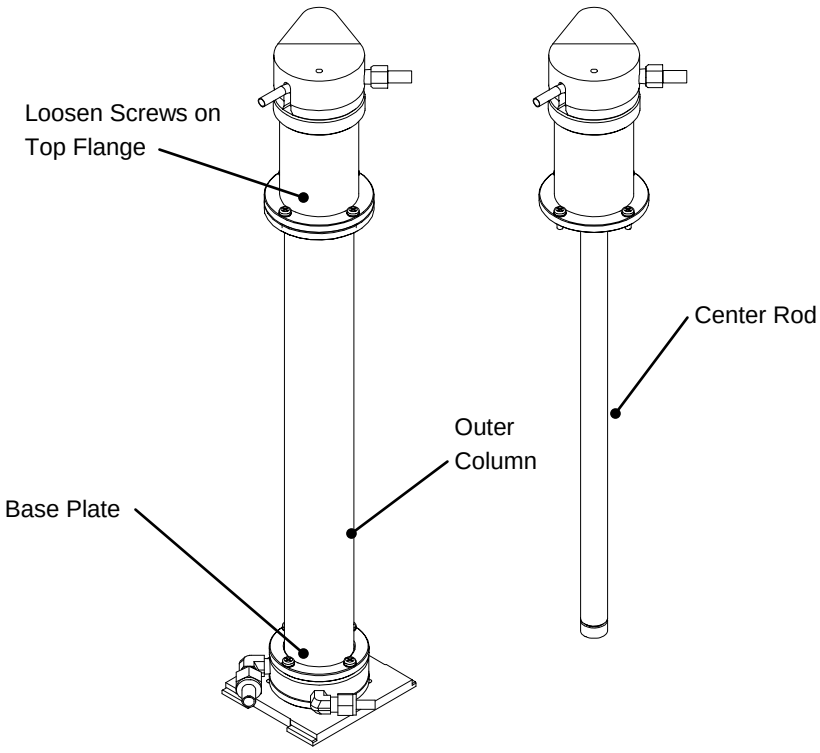


Figure 6-19
Unscrew Middle Flange to Split DMA for Cleaning

4. Disconnect tubing from the DMA column (two connections at the bottom and two at the top).
5. Loosen the two screws on the support bracket. Remove the support bracket.
6. Loosen and remove the two retaining screws on the bottom. Dismount the DMA.
7. Loosen the four screws (see Figure 6-19) on the top of the flange, leaving them one turn from complete removal. Leaving the screws partially in place, helps control the disassembly process, preventing the parts from suddenly breaking loose and banging together internally.
8. Carefully pull up on the assembly above the flange. (You may need to work the assembly back and forth to loosen the O-ring seal formed at the bottom of the center rod). Completely remove the four mounting screws.
9. Remove the analyzer's center collector rod by carefully lifting the top of the analyzer assembly up and out of the long outer tube. Do **not** bang the center rod on the interior of the outer column.

Caution

Be careful to avoid scratching the rod and the inside of the tube as you remove it. A small scratch, nick, or burr can completely disrupt the electric field inside the mobility analyzer, severely affecting its performance.

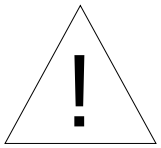
10. Visually inspect the rod for contamination. If the rod is visually quite dirty, clean it using a soft lint free cloth and isopropyl alcohol. Make sure you read the caution above.

11. Remove the Outer column by first removing the screws in the side support bracket.

12. Remove the four screws that attach the outer tube to the base plate.

13. Lift the tube up, off of the base.

14. Wash the collector rod and the inside diameter of the outer tube with a soft cloth soaked in alcohol or a mild solvent.



Caution

Avoid scratching or otherwise damaging the critical collector-rod surface and the inside diameter of the outer tube.

15. Also, take care not to dent the cone edge near the top of the collector rod or the Dacron screen inside the cone. If you dent, scratch, or otherwise damage the mobility analyzer assembly, contact TSI to discuss repairs.

16. Carefully reassemble the rod and tubing. Mount the DMA back and reinstall the support bracket.

17. Leak-test the unit.

CHAPTER 7

Contacting Customer Service

This chapter gives directions for contacting people at TSI Incorporated for technical information and directions for returning Model 3031 and Model 3031-1 Ultrafine Particle Monitor for service.

Technical Contacts

- If you have any difficulty setting up or operating the Ultrafine Particle Monitor, or if you have technical or application questions about this system, contact an applications engineer at TSI Incorporated, 1-800-874-2811 (USA) or (651) 490-2811 or e-mail technical.service@tsi.com.
- If the Ultrafine Particle Monitor does not operate properly, or if you are returning the instrument for service, visit our website at http://rma.tsi.com, or contact TSI Customer Service at 1-800-874-2811 (USA) or (651) 490-2811.

Returning the Ultrafine Particle Monitor for Service

Visit our website at http://rma.tsi.com or call TSI at 1-800-874-2811 (USA) or (651) 490-2811 for specific return instructions. Customer Service will need this information when you call:

- The instrument model number
- The instrument serial number
- A purchase order number (unless under warranty)
- A billing address
- A shipping address

Use the original packing material to return the instrument to TSI. If you no longer have the original packing material, seal off any ports to prevent debris from entering the instrument and ensure that the display and the connectors on the instrument front and back panels are protected.

APPENDIX A

Model 3031/3031-1 Specifications

The following specifications list the most important features of the Model 3031 and 3031-1 Ultrafine Particle Monitor.

Table A-1
Specifications of the Ultrafine Particle Monitor (*specifications are subject to change without notice)*

Measuring Principle.....	Electrical mobility
Particle Size range.....	20 to ~ 1000* nm 20 to ~450 nm with cyclone included in accessory kit 20 to ~800 nm with 3031200 Environmental Sampling System (optional accessory)
Total Size Resolution.....	6 channels 20 to 30 nm, 30 to 50 nm, 50 to 70 nm. 70 to 100 nm, 100 to 200 nm, and >200 nm
Concentration Range.....	500 to 10^6 particles/cm^3 at 20 nm; 50 to 10^6 particles/cm^3 at 200 nm
Sample Time.....	7.5, 10, or 15 min. (7.5 minute samples are less accurate so they are not recommended)
Environmental Operating Conditions **Ambient Temperature**..... **Ambient Humidity** ..... **Ambient Pressure**	 10 to 40°C (50 to 104°F) 0 to 90% RH (non-condensing) 90 to 110 kPa (0.89 to 1.09 atm)
Aerosol Humidity**.....	<50% RH
Inlet Flow Rate	5 L/min
Front Panel Display	8.4-in. SVGA (800 × 600 pixel) color display with touch screen interface
Interfaces.....	Ethernet RS-232 USB
Power Requirements	100 to 240 VAC, 50 to 60 Hz, (115 W)
Dimensions **Model 3031**..... **(HWD)**..... **Model 3031-1** ..... **(HWD)**.....	 19-in. frame rack 16HU 71 × 48.3 × 41 cm (28 × 19 × 16 in.) Bench top cabinet 74 × 42.8 × 42.8 cm (30 × 17 × 17 in.)

Weight	40 kg (88 lbs)
Aerosol Inlet.....	¼-inch OD
Cyclone Inlet.....	¼-inch OD

*The actual upper limit is set by the sampling inlet. See Appendix B “Inlet Cyclone” and “Environmental Sampling System” for more information.

**Sample conditioning recommended for high humidity conditions to maintain aerosol RH below 50%. Refer to Model 3031200 Environmental Sampling System.

APPENDIX B

Technical Information

Theory of Operation

Developed under the auspices of the European Union sponsored UFIPOLNET[3] project, the Ultrafine Particle Monitor incorporates field-tested technologies offering its users the highest level of reliability and performance [Zschoppe et al., 2007; Wehner et al., 2007; Gerwig et al., 2007]. The operational principle is based on diffusion charging of particles, followed by size segregation within a Differential Mobility Analyzer (DMA) and detection of the aerosol via a sensitive electrometer. The flow schematic is shown in Figure B-1. An aerosol sample is drawn into the instrument continuously at a rate of 5.0 L/min. Within the instrument, the aerosol sample mixes in an equalization tank to smooth out short-term fluctuations in the aerosol sample and then passes on to the diffusion charger as described below.

Diffusion Charger

The charging device in the Ultrafine Particle Monitor is a "Corona-Jet" charger [Medved et al., 2000]. Within the charger, the total flow of 5.0 L/min is split into 1.0 L/min passing through two filters (a carbon and a HEPA) and an ionizer and 4.0 L/min of aerosol remaining as sample flow. The flow streams are merged in a mixing chamber where particles in the aerosol flow mix with the ions carried by the filtered clean air. This patented *counter-flow diffusion charging*[4] brings the aerosol particles into a well-defined, charge state. The separation of particles the charging process more efficient and reproducible. The charged aerosol then moves onto the DMA for size segregation.

[3] UFIPOLNET stands for Ultrafine Particle Size Distributions in Air-Pollution Monitoring Networks.

[4] US Patent No. 6,544,484

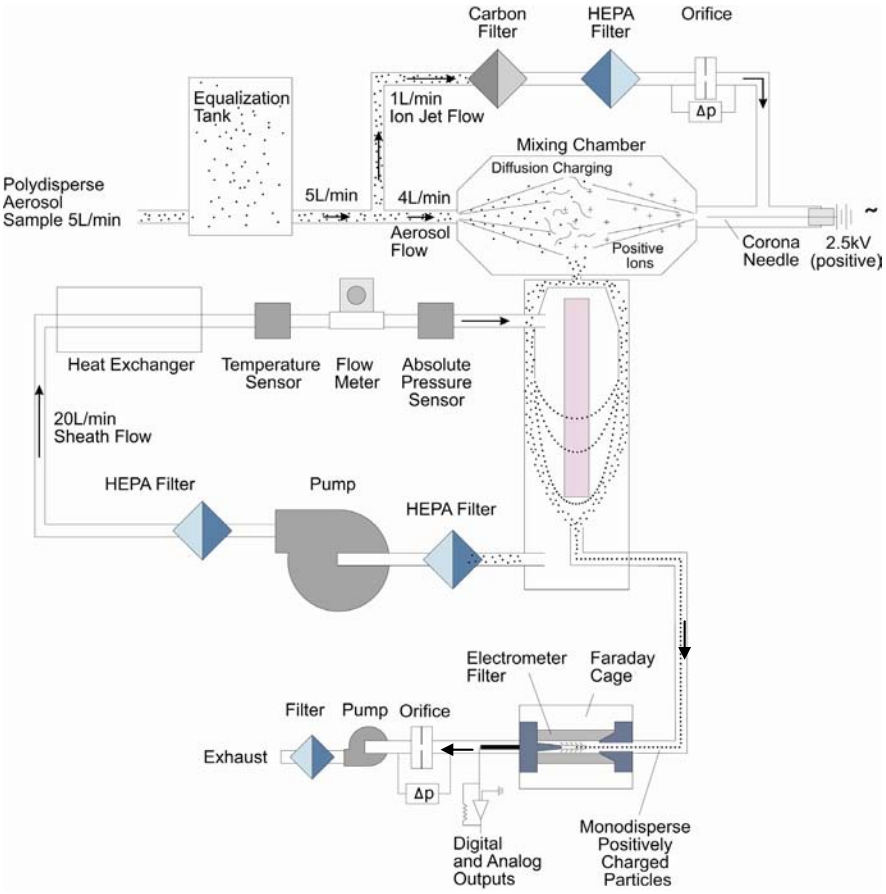


Figure B-1
Flow Schematic

Differential Mobility Analyzer

The DMA contains two concentric metal cylinders, an outer cylinder and the inner *high voltage* cylindrical rod. The polydisperse aerosol and sheath air are introduced at the top of the DMA column and flow down the annular space between the cylinders. The aerosol surrounds the inner core of sheath air, and both flows pass down the annulus with no mixing of the two laminar streams. The inner cylinder, the collector rod, is maintained at a controlled negative voltage, while the outer cylinder is electrically grounded. This creates an electric field between the two cylinders. The electric field causes positively charged particles to be attracted through the sheath air to the negatively charged collector rod. Particles are precipitated along the length of the collector rod (see Figure B-2). The location of the precipitating particles depends on the particle electrical mobility, the DMA flow rate, and the DMA geometry. Particles with a high electrical mobility are precipitated along the upper portion of the rod; particles with a low electrical mobility are collected on the lower portion of the rod. Particles within a narrow range of electrical mobility exit with the monodisperse air flow through a small slit

located at the bottom of the collector rod. These particles are transferred to the electrometer to determine the particle concentration. The remaining particles are removed from the sheath flow with a high efficiency filter and routed to the top of the column as a re-circulating flow.

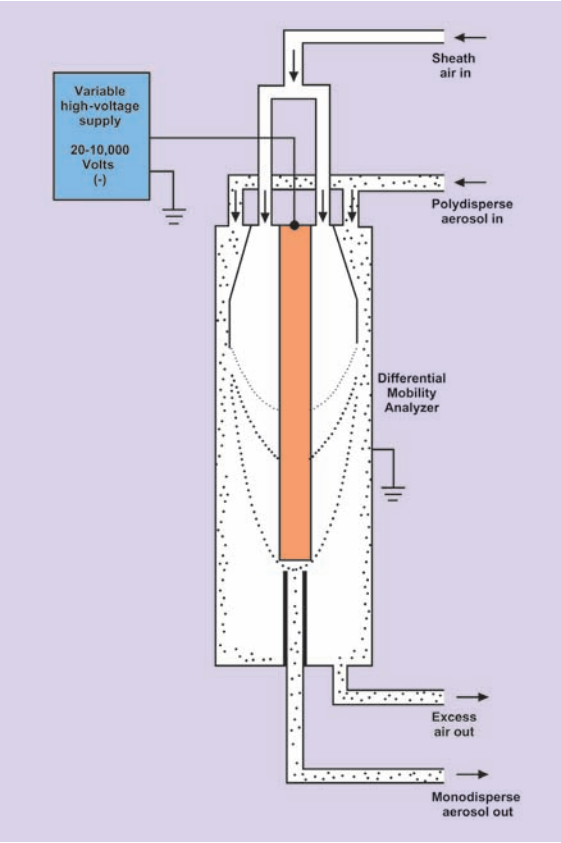


Figure B-2
Flow Schematic of the Differential Mobility Analyzer

Electrometer

After leaving DMA, the aerosol enters a faraday cage where the particles, and their charge, are collected on particle filter. The filter is conductive, and is electrically connected to the input of a sensitive electrometer amplifier. By successively stepping the DMA voltage and measuring the current at each step with the electrometer, an on-board computer calculates and reports the number concentration for each of the six size channels. One measurement cycle takes 10 minutes (approx.) with an additional 1 minute zeroing time between cycles.

Inlet Cyclone

The inlet cyclone provides a way of removing a known cut size of particles from the inlet stream. A cyclone has the advantage over other methods (such as an impactor) of being able to handle high dust loading conditions over a long period of time, with a relatively small pressure drop. The cyclone provided with the Ultrafine Particle Monitor is designed to have a d_{50} cut point of 450 nm at a flow rate of 5.0 L/min (see Figure B-3 below). The design is based on work by Kenny and Gussman [2000] on an extra sharp cut cyclone (ESCC).

Note: *The UFP Monitor corrects for inlet cyclone penetration efficiencies if you select the* ***Standard Inlet Cyclone*** *option under the* ***SETTINGS*** *menu (refer to "Touch Screen Interface" in Chapter 5).*

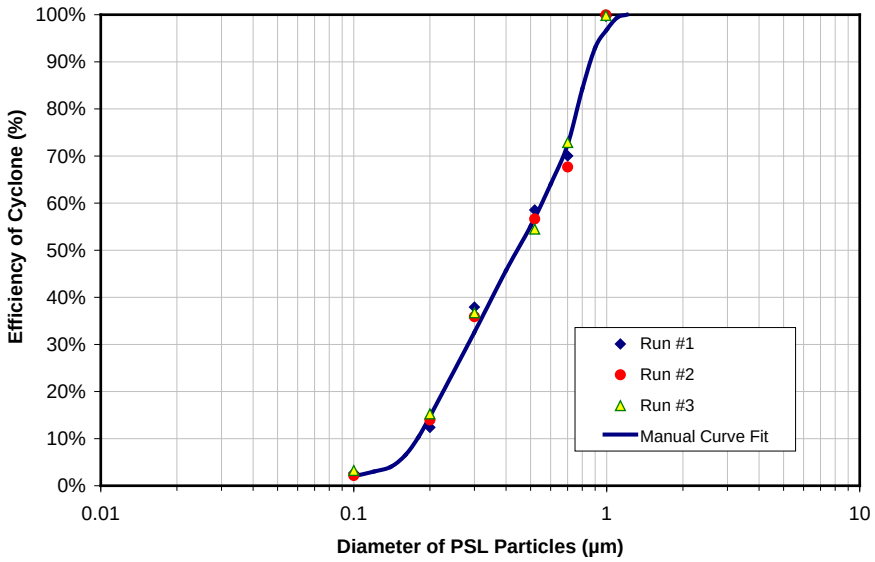


Figure B-3
Efficiency Curve of Ultrafine Particle Monitor Inlet Cyclone

Environmental Sampling System

To ensure standardized sampling of the aerosol flow from outdoor air, a standard PM_{10} inlet (flow rate 16.7 L/min) in combination with a PM_1 sharp cut cyclone is recommended to be installed prior to the UFP Monitor. Removal of larger particles from the sampling flow avoids contamination of the instrument. During transportation from the inlet to the system the aerosol may be lost to tubing walls due to gravitation and diffusion. Therefore, the tubing should be kept as short as possible and should not contain sharp bends. The

tubing should consist of stainless steel, for short connections conductive silicone tubing available from TSI might be an alternative. The sample flow should be laminar at any point of the inlet line. In humid environments with high ambient temperatures and high dew points the water may condense in the sampling tubes when entering the air conditioned monitoring enclosure leading to an increase in particle diameter. To avoid these problems, use of a dryer as part of the sampling system is recommended.

TSI Model 3031200 Environmental Sampling System is optimal for long-term outdoor air monitoring with the UFP Monitor. It consists of a standard PM_{10} inlet, a sharp cut PM_1 cyclone, a flow splitter and a Nafion® dryer. Thus, providing representative sampling and optimal conditioning of the outdoor aerosol for accurate measurements and proper instrument performance. The transmission efficiency for submicrometer aerosols through the Model 3031200 is recorded in table below. Notice that the UFP Monitor corrects for the transmission losses if you select the **Sampling system (3031200)** option under the **SETTINGS** menu (refer to "Touch Screen Interface" in Chapter 5).

Table B-1
Transmission Efficiencies* of Model 3031200 Environmental Sampling System.

Particle Size (nm)	Transmission Efficiency
20 to 30 nm	85 %
30 to 50 nm	91 %
70 to 100 nm	97 %
100 to 200 nm	98 %
> 200 nm	99 %

*Measured at 16.7 L/min inlet flow and 5 L/min sample flow; transmission efficiencies available for submicrometer particles (< 1 µm) only.

References

Gerwig W. et al. (2007) "UFIPOLNET: Concentration of particle number distributions at 4 stations in Europe," presented at the *European Aerosol Conference*, September 2007, Salzburg, Austria.

Kenny, L.C. and R.A. Gussman [2000] "A Direct Approach to the Design of Cyclones for Aerosol-Monitoring Applications," *Journal of Aerosol Science*, **31:1407-1420**.

Medved, A., Dorman, F., Kaufman, S.L., and Pöcher, A. (2000) "A New Corona-based Charger for Aerosol Particles," *Journal of Aerosol Science*, **31:P616-P617**.

Wehner B. et al. (2007) “The new Ultrafine Particle 300: Comparison with a DMPS,” presented at the *European Aerosol Conference*, September 2007, Salzburg, Austria.

Zschoppe A.; Hilleman, A and Caldow R. (2007) “Aerosol mobility spectrometry based on diffusion charging,” presented at the *European Aerosol Conference*, September 2007, Salzburg, Austria.

APPENDIX C

Bayern-Hessen Protocol

The Ultrafine Particle Monitor can be connected using the serial RS-232 port with a monitoring station computer running a custom data acquisition protocol. This appendix provides information about the popular "Bayern-Hessen Protocol" popular in Germany.

Information includes:

- Pin connectors
- Baud rate
- Parity
- Channel description
- List of operating and error states.

Making a Connection

Connect the serial port of an IBM-compatible computer to the SERIAL PORT connector on the front of the Ultrafine Particle Monitor (Figure C-1). The computer should be configured for communications settings of 9600 Baud, 8 bits, No Parity, and 1 stop bit (8-N-1).

Pin Connectors

The Ultrafine Particle Monitor has a single 9-pin, D-subminiature connector port on the front panel (see Figure C-2). This communication port is configured at the factory to work with RS-232 type devices.

Table C-1 provides the signal connections.

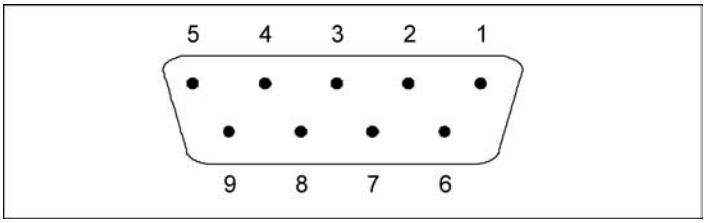


Figure C-1
SERIAL PORT Pin Designations

Table C-1
Signal Connections for RS-232 Configurations

Pin Number	RS-232 Signal
1	—
2	Transmit Output
3	Receive Input
4	—
5	GND
6	—
7	—
8	—
9	—

Figure C-2
Location of Serial Port

Baud Rate

The baud-rate setting is the rate of communication in terms of bits per second (baud). The Ultrafine Particle Monitor uses a baud rate setting of 9600. For proper communications, make sure that all software used with the instrument is set at the appropriate rate.

Channel Description

Index*	No.	Name	Dimension	Comment
170	1	CH1	P/ccm	20 to 30 nm
171	2	CH2	P/ccm	30 to 50 nm
172	3	CH3	P/ccm	50 to 70 nm
173	4	CH4	P/ccm	70 to 100 nm
174	5	CH5	P/ccm	100 to 200 nm
175	6	CH6	P/ccm	> 200 nm
176	7	TEMPERATURE DMA	°C	
177	8	PRESSURE DMA	kPa	
178	9	SAMPLE FLOW	-	AD-reading value, may be changed in the future
179	10	CHARGER FLOW	-	AD-reading value, may be changed in the future
180	11	CHARGER VOLTAGE	V	
181	12	CHARGER CURRENT	nA	
182	13	SHEATH FLOW	lpm	
183	14	HUMIDITY	%	foreseen as extension for dew point detection

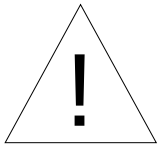
List of Operating and Error States

Operation states/ bit Number		Dimension	Default	State “0“	Condition "1"	Condition "0"
B 0	Internal instrument off	-	-	Internal instruments switched on	Internal off	Normal operation
B 1	Maintenance	-	-	Maintenance in progress	Maintenance	Normal operation
B 2	Temperature (DMA) OK	°C	-	Temperature in the normal range	not "0"	15 < value < 30
B 3	Pressure (DMA) OK	Pa	101325	max ±25 % from std air pressure (pn)	not "0"	0.75*pn < value <1.25*pn
B 4	Sample flow OK	L/min	5	max ±5 % from setpoint	not "0"	4.75 < value < 5.25
B 5	Charger flow OK	L/min	4	max ±5 % from setpoint	not "0"	3.80 < value < 4.20
B 6	Charger voltage OK	V	1500	max ±5 % from setpoint	not "0"	1425 < value < 1575
B 7	Charger current OK	µA	1	max ±5 % from setpoint	not "0"	0.95 < value < 1.05

Error states / bit number		Dimension	Default	Description	Condition "1"	Condition "0"
F 0	lower concentration limit	aA	2000	max. value of electrometer readings < 2000 aA	no value > 2000	not "1"
F 1	Inversion problem - search space	bool	-	search-space boundaries reached	"1"	"0"
F 2	Inversion problem - Fiterror	%	50	fit error beyond limit	value > limit	not "1"
F 3	measurement not completed	bool	-	internal scan state = "0"	"0"	"2"
F 4	Error sheathflow DMA	l/min	20	±5 %	not "0"	19 < value < 21
F 5	Error humidity	% rH	70	threshold value exceeded	not "0"	0 < value < 70
F 6	Error high voltage	bool	-	high voltage backreading not successful	"1"	"0"
F 7	wire break	bool	-	Communication error	Com. error	Com. OK

APPENDIX D

Firmware Update



WARNING
The instrument can be damaged if you interrupt the update progress! ***Never*** use firmware other than that provided by the manufacturer. Do ***not*** interrupt the power supply and don't switch off the instrument. The update progress will take few minutes.

It is only possible to update the firmware or the optional complete package. You have to do the steps twice for a complete update.

A working network connection is required (see also "Network Configuration" in Chapter 4).

Instrument Firmware Update

Note: *You will need a unique username and password to access FIRMWARE UPDATE page. This will be provided by TSI.*

The firmware update is done as follows:

1. Open your internet browser and open the instrument page.
2. Go to the page **FIRMWARE UPDATE** (*Username and password provided with instructions for firmware update.*)
3. Select the correspondent firmware (e.g. firmware330_xxx.bin, refer to Figure D-1).
4. Upload.

Note: *You can only update with a filename starting with "firmware". Otherwise the instrument does not accept the file. The instrument will reboot automatically.*

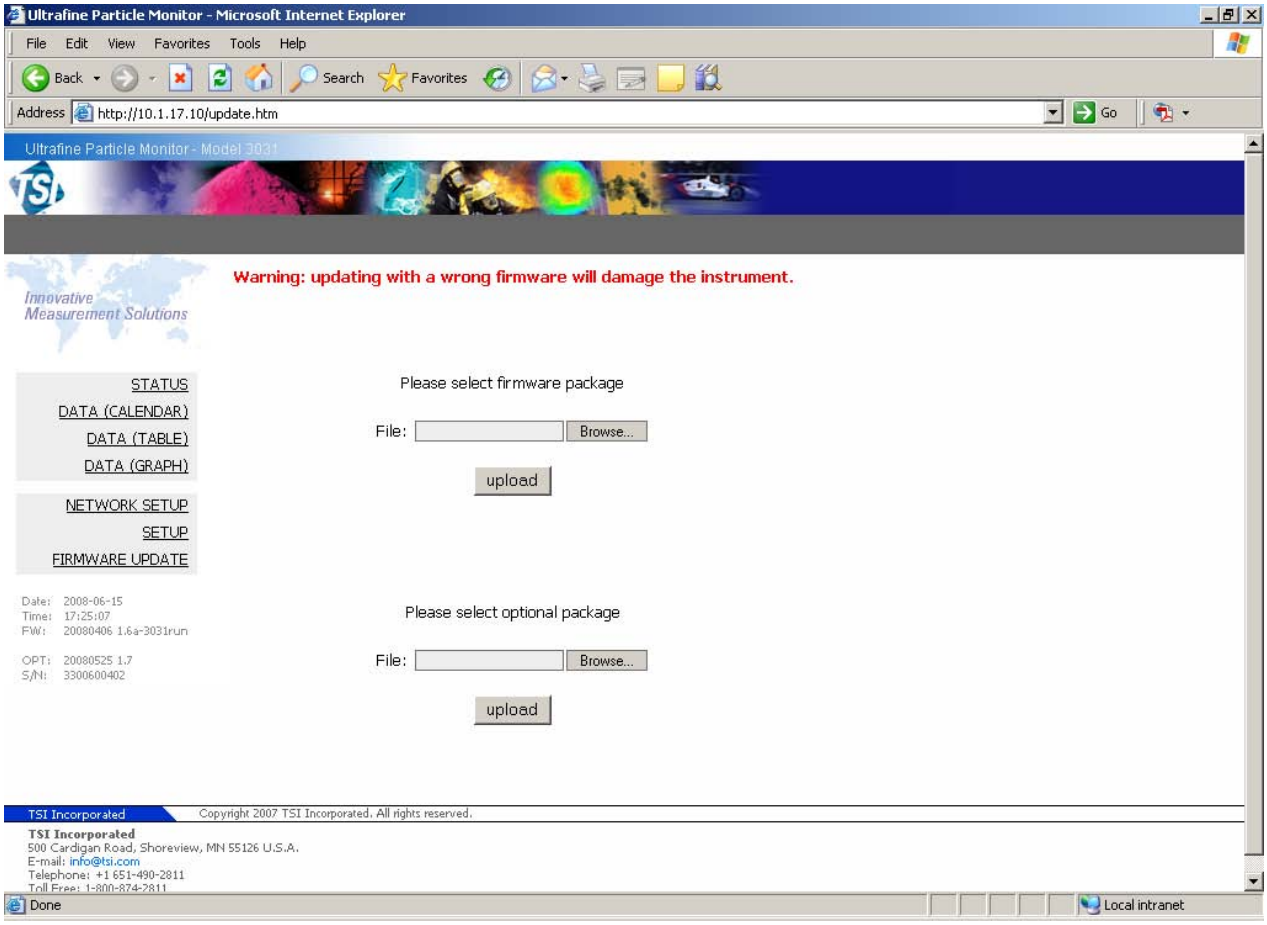


Figure D-1
Firmware Update

Instrument Firmware Update (optional package)

The optional package update is done as follows:

***Note**: You will need a unique username and password to access FIRMWARE UPDATE page. This will be provided by TSI.*

1. Open your internet browser and open the instrument page.
2. Go to the page **FIRMWARE UPDATE** (Username and password provided with instructions for new firmware).
3. Select the correspondent optional package (e.g. optional330_xxx.bin, refer to Figure D-1).
4. Upload.

The instrument will reboot automatically.

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Reader's Comments Sheet

Please help us improve our manuals by completing and returning this questionnaire to the address listed in the "About This Manual" section or e-mail your comments to particle@tsi.com. Feel free to attach a separate sheet of comments.

Manual Title Models 3031/3031-1 Ultrafine Particle Monitors **P/N** 6001716 **Rev** D

1. Was the manual easy to understand and use?

☐ Yes ☐ No

Please identify any problem area(s) _____

_____

2. Was there any incorrect or missing information? (please explain) _____

_____

3. Please rate the manual according to the following features:

	Good	Adequate	Poor
Readability	☐	☐	☐
Accuracy	☐	☐	☐
Completeness (is everything there?)	☐	☐	☐
Organization (finding what you need)	☐	☐	☐
Quality and number of illustrations	☐	☐	☐
Quality and number of examples	☐	☐	☐

Comments: _____

_____

4. Which part(s) of this manual did you find most helpful? _____

_____

_____

5. Rate your level of experience with the product:

☐ Beginning ☐ Intermediate ☐ Expert

6. Please provide us with the following information:

Name _____ Address _____

Title _____ _____

Company _____ _____

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