KANOMAX FMT
A Kanomax Company

Scanning Threshold Particle Counter Model 9010: User Manual

Part Number: 1979010 Version 1.3

ScanningTPC Model 9010 User Manual

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The following is a history of the ScanningTPC Model 9010 User Manual (part number 1979010):

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Version 1.1	February 2016	Display screens and descriptions updated.
Version 1.2	June 2016	Photos Updated
Version 1.3	February 2017	Added schematic diagram. Updated notes about UPW flow and description of 4-20 mA.

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Service Policy

Knowing that inoperative or defective instruments are a detriment to our customers' satisfaction, our service policy is to give prompt attention to any known problems. If you discover any malfunction of the ScanningTPC, contact Kanomax FMT, Inc. at 651-762-7762 (USA). If you are outside of the USA, please call your authorized distributor.

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About This Manual

Intended Audience

The ScanningTPC Model 9010 User Manual is intended to be used by qualified personnel (such as technicians and engineers) in a semiconductor facility or laboratory setting.

Scope of User Manual

This user manual contains detailed instructions for the installation and set up of the ScanningTPC Model 9010 including connecting the hardware and installing the software. The manual also contains an explanation of how the ScanningTPC works.

Definitions

- UPW: Ultrapure Water
- EU: European Union
- RAE: Residue After Evaporation
- CPC: Condensation Particle Counter
- KCl: Potassium Chloride
- psi: pounds per square inch
- kPa: Kilo Pascals
- PFA: Perfluoralkoxy. Chemically resistant polymer commonly used in UPW tubing.
- PEEK: Polyether Ether Ketone. Chemically resistant polymer commonly used for rigid components.
- VAC/VDC: Volts Alternating Current/Volts Direct Current
- AC: Alternating Current
- USB: Universal Serial Bus
- mA: Milliamperes
- NVR: Non-Volatile Residue
- DNVR: Dissolved Non-Volatile Residue
- PNVR: Precipitated Non-Volatile Residue

Safety and Handling Procedures

Read this section to learn safe handling procedures for the ScanningTPC Model 9010.

There are limited user-serviceable parts inside the ScanningTPC — all repair and maintenance must be performed by a qualified service technician.

When working with the ScanningTPC:

- Do not remove any parts from the instrument unless this manual tells you to do so.
- Do not remove the instrument cover while power is supplied to the instrument.

Safety Signals

The following warning symbols and labels are used in the documentation and on the ScanningTPC. Follow the procedures described in this manual to use the instrument safely.

Warning

Warnings are used for the following purposes:

- To indicate that unsafe use of the instrument could result in serious injury to you or cause irrevocable damage to the instrument.
- To indicate that if you do not follow the procedures described in this manual, you may damage the instrument.
- To draw attention to important information about the operation and maintenance of the ScanningTPC.

Note

Notes are used to indicate important information.

High Voltage Sticker

A High Voltage warning sticker attached to the ScanningTPC warns you that uninsulated voltage within the instrument may be sufficient to give you an electric shock. Do not make contact with any part inside the instrument.

Grounding Connection Sticker

A Grounding Connection sticker attached to the Scanning indicates that the ScanningTPC is connected to earth ground and cabinet ground.

Warnings

Please familiarize yourself with the following warnings before operating the ScanningTPC:

- The ScanningTPC must be used following manufacturer's specifications otherwise safety cannot be guaranteed.
- The ScanningTPC is shipped with a key for locking the front panel. If you lose the key, contact Kanomax FMT Inc.
- All service work must be performed by qualified service technicians — only qualified service technicians should remove the ScanningTPC cover.
- When the ScanningTPC is running, there are hot surfaces inside the device. Do not remove the cover at any time unless you are a qualified service technician.
- To prevent electric shocks, ensure that all electrical outlets are grounded.
- The aerosol particles created by the nebulizer may pose a health risk if inhaled. If not connected to other instrumentation, vent the aerosol output to a fume hood.
- Follow the instructions for all inlet and outlet connections. Incorrect connections will cause the ScanningTPC to malfunction.
- The air or nitrogen supplied to the ScanningTPC must be filtered (particle-free), dried, oil-free and regulated at 50 psi. ANSI IS08573-1:2010 Class 2.
- During normal operation, do not tilt the ScanningTPC at angles >10°.
- You must drain the ScanningTPC before you move or ship it. Do not ship an undried/undrained ScanningTPC back to KanomaxFMT, Inc. Doing so will damage the detector and invalidate the warranty.
- Do not subject an undrained ScanningTPC to freezing temperatures. Doing so will damage the detector and invalidate the warranty.

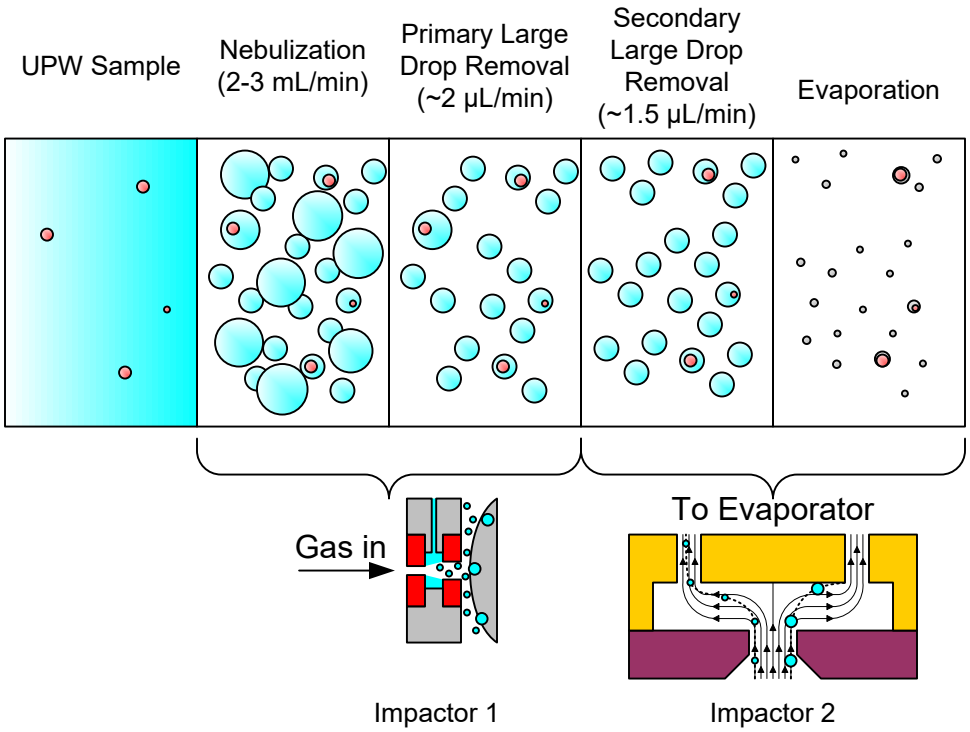
How the ScanningTPC Works

The ScanningTPC is used to characterize properties of hydrosols (particles suspended in water) and is designed for online trend monitoring of low concentration hydrosols (10^3-10^9 #/mL) for particle sizes ranging from >10 to >30 nm.

In the ScanningTPC, the particles within the hydrosol sample are aerosolized — they are dispersed into a carrier gas of clean dried air or nitrogen. Aerosolizing the hydrosol particles allows the methodology for measuring the properties of aerosol particle systems to provide a higher resolution and sensitivity than that achieved with state-of-the-art, in-situ, hydrosol measurement methods using light scattering techniques.

To aerosolize the hydrosol particles, the sample is introduced at a rate of 1-3 mL/min to a high velocity gas stream (flowing at a rate of 600-700 sccm) and then passes through a constricting orifice which nebulizes the hydrosol (creates small droplets suspended in air or nitrogen). The constricting orifice is positioned next to an adjustable impactor designed to remove large droplets from the gas stream (Figure 1). The impactor limits the vapor pressure of water in the final aerosol (to reduce condensation onto particles and transport materials) and reduces interference by aerosol particles composed of Precipitated Non-Volatile Residue (PNVR). The impactor removes approximately 99.9% of the droplets in the nebulized sample flow and the resulting waste stream passes through a drip counter (which monitors the nebulizer flow rate) before being sent to a drain. The remaining nebulized sample stream is composed of the carrier gas (600-700 sccm) containing a log-normal distribution of suspended hydrosol droplets (~2 μL/min) with a peak droplet diameter of ~300nm and a geometric standard deviation of ~1.6.

Figure 1: Schematic representation of hydrosol aerosolization. Flow rates are shown for the effective hydrosol.



The size of a particle composed of PNVR is proportional to the initial droplet size and dissolved Non-Volatile Residue (DNVR) concentration. The ScanningTPC contains a particle counter with a defined detection threshold and therefore interference by DNVR particles (even at very low concentrations) may introduce a measurement error. To mitigate this error, the ScanningTPC contains a second impactor that removes droplets larger than ~2 µm. The small amount of liquid removed by the second impactor is reintroduced to the gas stream as vapor and contributes to the water vapor pressure in the final aerosol.

After passing through the sequential impactor(s) the nebulized sample stream enters a heated tube. The gas temperature in the tube is a set value (50-120 °C) to increase the gas saturation vapor pressure of water (promoting evaporation) and to drive off semi-volatile residue. After evaporation, Non-Volatile Residue (NVR) within the droplet remains as either a particle composed solely of PNVR or as a hydrosol particle with a relatively small coating of PNVR. After evaporation, a dry 'quench' gas is introduced at a rate of 300-900 sccm to reduce the vapor pressure within the aerosol. The volumetric rate of hydrosol flow entering the evaporation tube is referred to as the Volume Inspection Rate (VIR). The properties of the resulting aerosolized hydrosol particles (including size and concentration) are

proportionally related to the native hydrosol particle concentration by the following equation:

$$C_{W,Hydrosol} = \frac{C_{W,Aerosol} \times Q_{Aerosol}}{VIR},$$

where $C_{Hydrosol}$ and $C_{Aerosol}$ are the hydrosol and aerosol concentrations (W indicates number, area, volume, or mass), $Q_{Aerosol}$ is the flowrate leaving the evaporation region (after the quench gas), and VIR is the volumetric inspection rate.

Following evaporation and quenching, the resulting aerosol is passed through a membrane-type dryer to lower the dew point of the carrier gas. The aerosol is then sampled by a condensation particle counter (CPC) which condenses supersaturated n-butyl alcohol vapor onto aerosol particles larger than a critical threshold diameter. The aerosol stream is then directed to a gas phase optical particle counter with a detection threshold diameter sufficiently larger than the dry aerosol particles. The condensed vapor causes an otherwise undetected particle to grow large enough to be counted by the detector.

The diameter at which a vapor will condense onto a particle is given by the Kelvin equation;

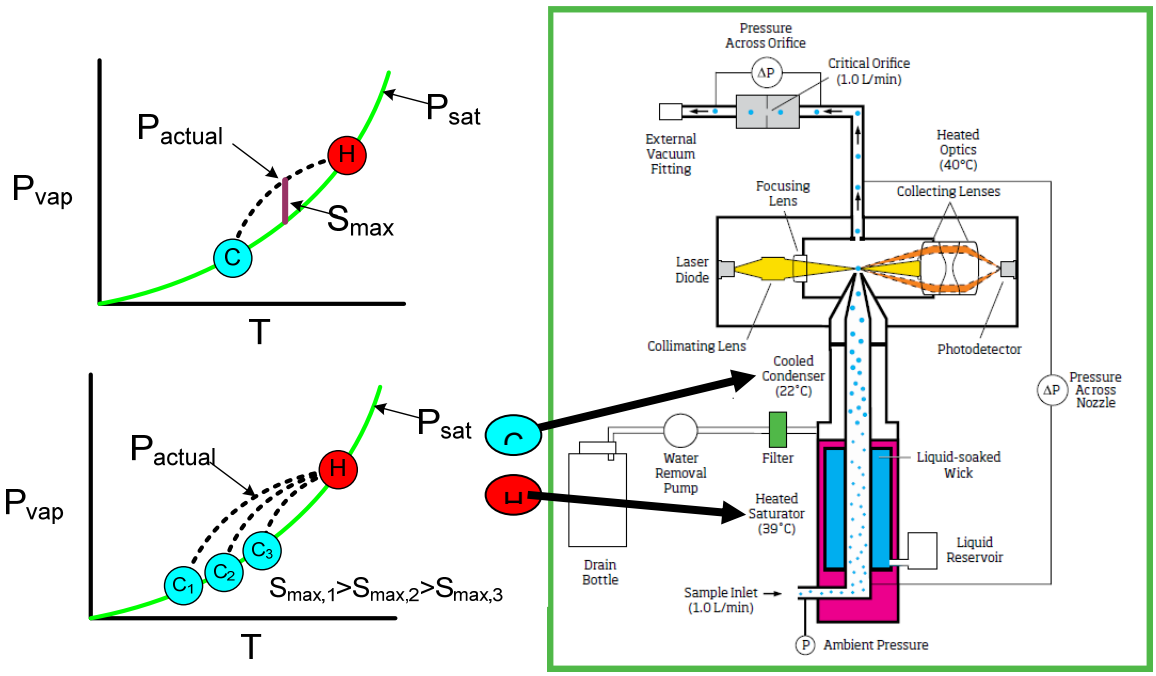
$$r = \frac{-2\gamma V_{vap}}{k_B T} \ln\left(\frac{P}{P_o}\right),$$

where γ is the surface tension and V_{vap} is the molecular volume of the condensing liquid. P_o is the vapor pressure above a flat surface of the condensing vapor, and P is the actual vapor pressure. The ratio P/P_o is commonly referred to as the Saturation Ratio, S. Varying the degree of S changes the minimum enlarged particle size. The Scanning TPC adjusts the minimum detected particle size by varying the value for S.

Aerosol enters the CPC where it is exposed to warm walls saturated with n-butyl alcohol (see Figure 2 below). The aerosol then enters a section with cooled walls which removes both heat and n-butyl alcohol vapor. Because the thermal diffusivity of air is higher than the mass diffusivity of n-butyl alcohol vapor, the gas properties will follow the dashed line shown on the P-T diagrams in Figure 2 as it reaches steady state. The maximum difference between the actual and saturated vapor pressure curves determines the value for S, which sets the minimum detected particle size. Varying the

temperature of the cold section varies the magnitude of *S* thereby changing the threshold particle diameter.

Figure 2: Schematic representation of the CPC.



TSI Incorporated 3772 CPC Brochure

Methodology for Measuring the Volumetric Inspection Rate

To relate the properties of the aerosol to the properties of the hydrosol, the value for the VIR of the device must be known. The value for the VIR is determined by measuring the number concentration of aerosol particles generated by the ScanningTPC when challenged with a hydrosol containing a known number concentration of particles. The number-concentration standard hydrosol is measured using a Liquid NanoParticle Sizing System (LNS). In the LNS, aerosolized particle size distributions are measured using a Scanning Mobility Particle Sizer (SMPS) placed downstream of a model 9110 NanoParticle Nebulizer (NPN). The SMPS includes a Differential Mobility Analyzer (DMA) which acts as a size-based band-pass filter, and a Condensation Particle Counter (CPC) as the particle detector. The combination of DMA and CPC is used extensively in the aerosol field to measure aerosol properties. By using an SMPS, particles composed of PNVR can be excluded from the measurement since these particles are typically smaller than the particles in the hydrosol standard and therefore appear as an isolated mode. An Online Sample Dilution Module (OSDM) is used within

the NPN to reduce the peak size of the PNVR particles by reducing the amount of DNVR introduced to the sample from containment and transport materials. The OSDM mixes a hydrosol sample with a stream of UPW at a nominal dilution ratio of 1000:1.

The NPN is calibrated using a well-characterized colloid volume standard composed of colloidal silica particles with a peak diameter near 30 nm and a Geometric Standard Deviation (GSD) near 1.21. The volume concentration of silica particles in the standard is determined using the following equation:

$$C_{Vol,Hydrosol} = \frac{\rho_{Hydrosol} \times mf_{Particles}}{\rho_{Particles}},$$

where $C_{Vol,Hydrosol}$ is the volume concentration of the standard, $\rho_{Hydrosol}$ is the density of the standard (determined using a calibrated pipette and mass balance), $mf_{Particles}$ is the mass fraction of silica particles (determined by evaporating and weighing known volumes of the hydrosol to dryness), and $\rho_{Particles}$ is the density of the silica particles (2.20 g/cm^3). The VIR is then determined using the following equation:

$$VIR = \frac{C_{Vol,Aerosol} Q_{Aerosol}}{C_{Vol,Hydrosol}\left(\frac{1}{DF}\right)},$$

where $C_{Vol,Aerosol}$ is the aerosol volume concentration measured by the SMPS, $Q_{Aerosol}$ is the aerosol flow rate leaving the nebulizer (including quench gas), and DF is the dilution factor which is determined by the ratio of sample flow to UPW flow in the online dilution module.

Verifying ScanningTPC Performance

Field calibration of the VIR for the ScanningTPC is not practical due to the size and complexity of the SMPS. However, ScanningTPC performance can be verified by the direct injection of size-specific concentration standards. Because the ScanningTPC is unable to discriminate between particles composed of DNVR and silica, DNVR introduction can be limited by using an online sample dilution module.

Diafiltration

Surfactants present in the volume standard can add enough DNVR to the aerosol stream that particles composed of precipitated surfactant become an interference. Therefore, the stabilizing surfactants are removed from the hydrosol using a unique method of diafiltration. In this method of

diafiltration, a semi-permeable membrane is placed between the sample and a source of clean solvent (water). The surfactant and dissolved residue pass through the membrane but the particles do not. An ultrafilter (UF) cartridge is used to prepare the diafiltered volume standard. The cartridge is operated in high cross flow (using a circulation pump) to limit retention of particles within the UF material. The sample is recirculated to improve purification. UPW is introduced to the sample side of the membrane and the surfactants and other DNVR are forced through the membrane and sent to drain. The resulting hydrosol now has a lower level of DNVR and is suitable for verification of the ScanningTPC performance when measured on a high purity water system. Particle concentration and size distribution of the standards are measured on the SMPS after diafiltration to establish the appropriate UPW dilution of the field calibration standards.

Note: The diafiltered standard has a shorter shelf life than the un-diafiltered standard. It cannot be stored at the same high concentration as the un-diafiltered standard.

Applications

The ScanningTPC is an online trend monitor for detecting 10 nm (and larger) particles in UPW systems. It cannot be used to monitor particles in solvents or acids.

How to Install the ScanningTPC

The Scanning TPC is used as a standalone instrument. For calibration, an online sample dilution module is used to introduce the challenge colloid. Installation procedures for the ScanningTPC are described on the following pages.

Unpacking the ScanningTPC

To unpack the ScanningTPC, follow these instructions:

1. Carefully remove the ScanningTPC from its shipping container. Save the original packing materials for use when shipping the ScanningTPC back to Kanomax FMT, Inc. for service, or for moving to a different location.

Warning. If the ScanningTPC is returned to Kanomax FMT, Inc. in anything other than the original shipping container, you will be charged for any damage that occurs during shipping. If you do not have the original shipping container, contact Kanomax FMT, Inc. at 651-762-7762.

2. Place the ScanningTPC on a level surface. Make sure there is an unrestricted air flow around the device. Kanomax FMT, Inc. recommends at least a 2-inch air gap on both sides and the top of the instrument.
3. Make sure all the items listed in Table 1, were included in the ScanningTPC shipment. If any of the items are missing, or damaged, please call Kanomax FMT, Inc. at 651-762-7762

Table 1: ScanningTPC Model 9010 Packing List

Part Number	Description	Quantity
Model 9010	ScanningTPC	1
1979010	ScanningTPC User Manual, Printed	1
1979012	ScanningTPC Quick Start Guide, Printed	1
1979011	Certificate of Calibration	1
2679105	USB Flash Drive containing the 1979010 User Manual	1
1330001	Power Supply Cable (USA only)	1
1330004	Communication Cable	1
1022495	CDA/N_2 Adapter Fitting	1
1800005	Cabinet Key	1
2677005	TSI Model 3772 CPC Accessory Kit	1
1980529	Model 3772 Operation and Service Manual	1

Equipment and Site Requirements

To install the ScanningTPC you will need the following equipment and site requirements:

- Unrestricted air flow around the system components.
- Access to a suitable drain for receiving waste water.
- Cleaned, dried compressed air, or nitrogen, regulated to 50-60 psi, entering the ScanningTPC. ANSI IS08573-1:2010 Class 2.
- An electrical power supply with 2 outlets, 115VAC to 230VAC.
- If the internal pump is not used, a vacuum source to connect to a ¼ outside diameter port fitting at 1 slpm, < 350 mmHg.
- 9/16 adjustable wrench.
- For UPW sampling:
    - A length of ¼ inch outside diameter PFA tubing sufficient to reach from the instrument to your water supply.
    - PFA tubing flaring tool, tube gripper, tube cutter, and heat gun.
    - Ultrapure Water supply. Note: Water pressure should be 30-70 psi (100 ml/min).
- A length of ½ in outside diameter plastic tubing (fitted with a Swagelok nut) long enough to reach from the ScanningTPC to the waste drain (maximum length of 12 ft).
- A length of ¼ inch outside diameter plastic tubing (fitted with a Swagelok nut) long enough to reach from the ScanningTPC to your air/nitrogen supply. Used to supply clean, dried compressed air or nitrogen at 25 slpm, 50-60 psi
- An electrical power supply with two outlets, 115VAC to 230VAC.
- Reagent-grade n-butyl alcohol (Butanol). Note: Alcohol consumption is approximately 150 mL/day.

Note: No tubing is supplied to connect the ScanningTPC to air or water supplies.

Flaring a Tube

The installation procedure for online analysis requires you to flare a PFA tube. You can either use a heat flaring tool provided by Entegris (customer service numbers: 952-556-4196 or 800-394-4083) or a cold flaring tool provided by Saint Gobain Performance Plastics (customer service numbers: 714-630-5818 or 800-833-5661). The following instructions describe the hot-flare method:

1. Hold a length of PFA tubing with a tube gripper.
2. Rotate one end of the tubing evenly over the heat gun.

3. As soon as the end of the tubing becomes clear, push it onto a flaring tool in your required size. Note: If you remove the tubing from the flaring tool too soon, the end shrinks. If you overheat the tube, the tubing will buckle.

4. Hold in place until the tubing is cool (at least two minutes).

5. Pull the tubing from the flare. It is now ready to attach to a fitting.

Installing the ScanningTPC

Installing the ScanningTPC includes the following procedures:

- Installing the n-butyl alcohol (Butanol) bottle bracket.
- Connecting the CPC communication cables.
- Connecting the CPC vacuum tubing.
- Connecting the ScanningTPC to your ultrapure water supply.
- Connecting the ScanningTPC to your compressed air or nitrogen supply.
- Connecting the waste outlet to a drain tube.
- Installing the n-butyl alcohol bottle.
- Connecting the power and powering on the ScanningTPC.
- Turning on the air/nitrogen supply.
- Turning on the UPW supply.

Figures 3 and 4 show the front and back panels of the ScanningTPC. Operation procedures take place at the front panel, whereas installation procedures are performed at the back panel of the ScanningTPC. Detailed installation instructions begin on page 10.

Figure 3: Front panel of the ScanningTPC.

Components of the back panel are shown in Figure 4 below. Internal components of the ScanningTPC are shown in Figure 5.

Figure 4: Back panel of the ScanningTPC.

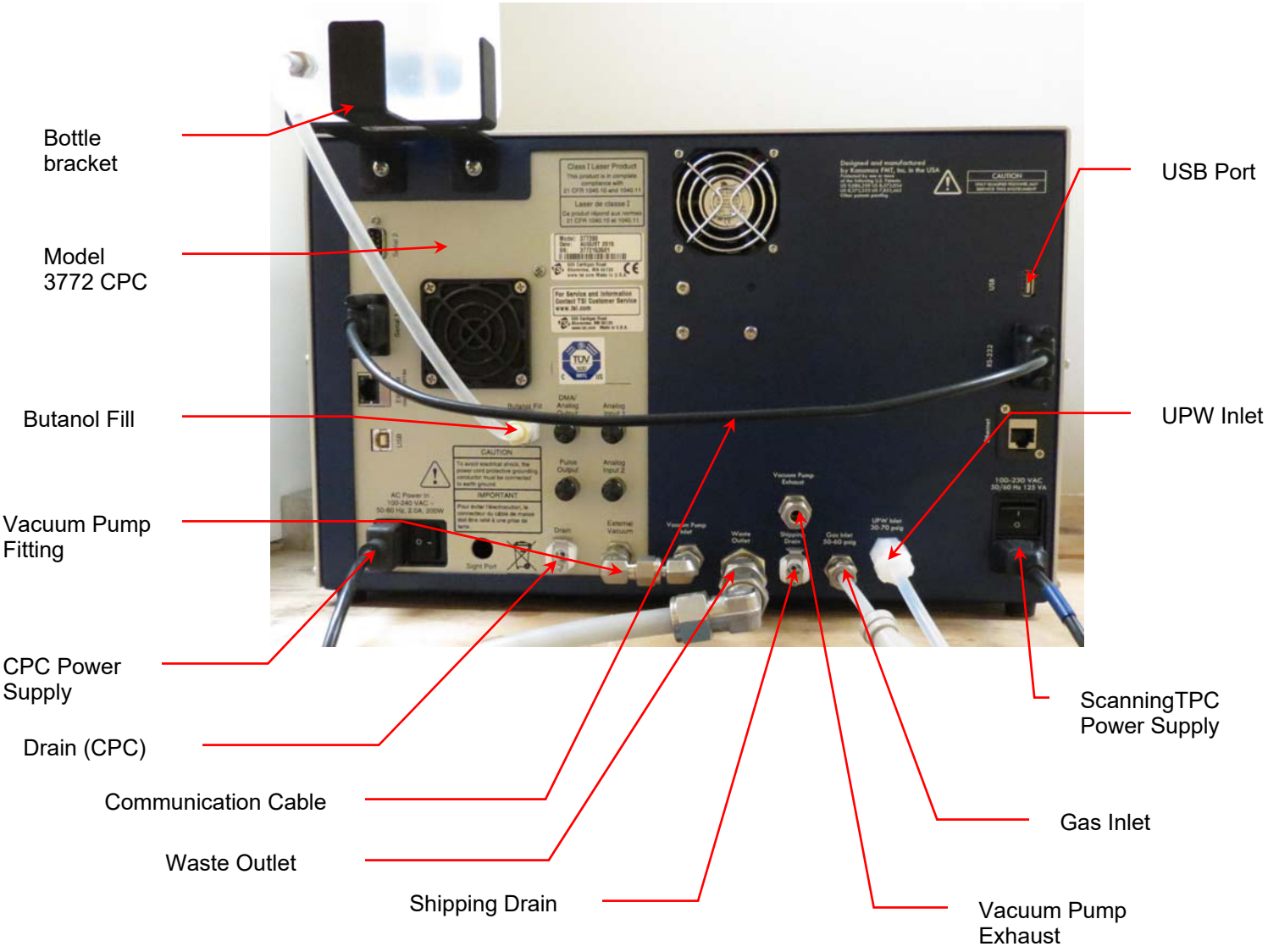
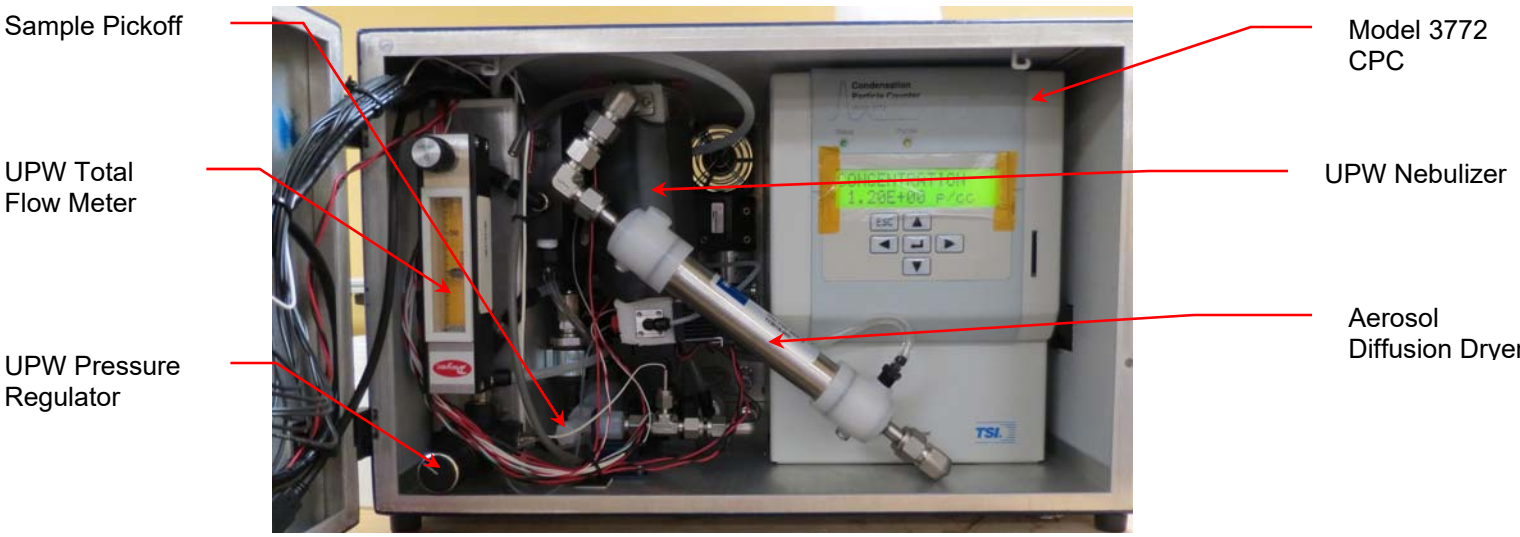


Figure 5: Internal components of the ScanningTPC.



Installing the n-Butyl Alcohol (Butanol) Bottle Bracket

To install the n-butyl alcohol bottle bracket, follow these instructions:

1. Using a Phillips screwdriver unscrew the two bottle bracket screws at the top left of the back panel.
2. Using the screws you just removed, screw the bracket into place.

Connecting the CPC Communication Cables

To connect the CPC communication cables, insert the communication cable fittings into the ports on the left and right of the back panel and tighten the thumb screws. Note: Use the **Serial 1** port on the back of the CPC.

Connecting the Vacuum Pump Tubing

The ScanningTPC is shipped with a Swagelok fitting on the vacuum pump ports. If you are using the internal vacuum pump, leave the Swagelok fitting in place.

Warning: If you use the internal pump the n-butyl alcohol vapors will exhaust through the **Vacuum Pump Exhaust** port into the room. You can exhaust the alcohol vapors to a suitable exhaust stack by attaching a ¼ in tube (not provided) to the **Vacuum Pump Exhaust** port using the provided Swagelok fitting. The tubing should not be longer than 10 ft. A tube longer than 10 ft will increase the back pressure and disrupt the CPC flow rate.

If you are using an external vacuum pump follow these instructions to connect the pump tubing:

1. Using a wrench remove the Swagelok fitting from the vacuum pump ports.

2. Connect your vacuum pump tubing to the **External Vacuum** port and tighten the fitting one half turn past finger-tight.
   Note: Kanomax FTM, Inc. does not supply tubing for connections to an external vacuum pump.

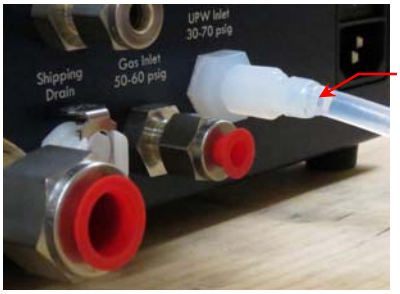
Connecting the UPW Supply

Water must be supplied to the ScanningTPC through a ¼-inch diameter PFA tube specially adapted to fit the UPW INLET fitting. To prepare the PFA tube for attachment to the UPW INLET fitting, take the following precautions:

- Make sure your hands are clean.
- Do not touch the end of the water supply tube — you may contaminate it.

To connect the ultrapure water supply, follow these instructions:

1. Cut the end of the PFA tubing evenly with a clean tube cutter.
2. Place a Flaretek nut over the end of the PFA tube before attempting to flare the end.
3. Flare the tube (see instructions on page 11).
4. Flush ultrapure water through the tube for several minutes to remove any debris created by the flaring process.
5. Unscrew the protective nut and plug from the **UPW Inlet** fitting. Keep this Flaretek nut and plug for use when moving or shipping the ScanningTPC. (See shutdown instructions on page 36).
6. Push the flared end of the tube onto the **UPW Inlet**.



Flared PFA tubing

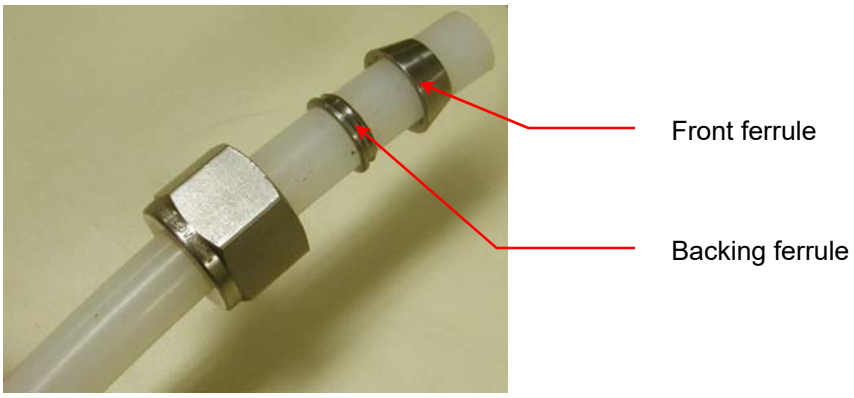
7. Slide the Flaretek nut into place and hand-tighten.

Flaretek nut

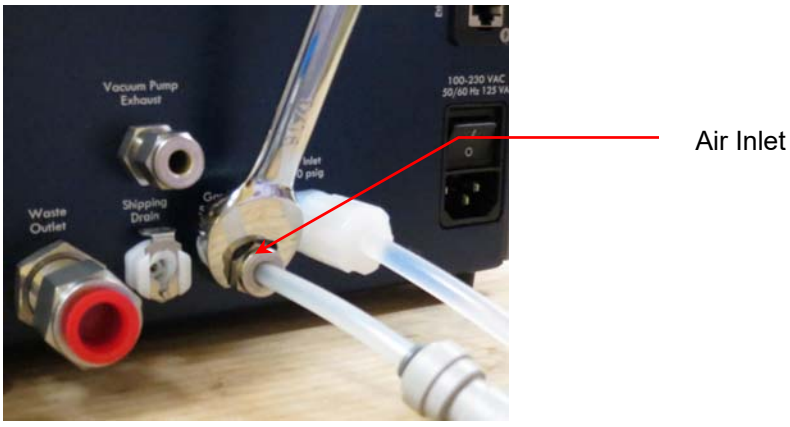
Connecting the Air or Nitrogen Supply

The air or nitrogen supplied to the ScanningTPC must be filtered, dried, oil-free and regulated at 345-414 kPa (50-60 psi). Follow these instructions to connect the compressed air or nitrogen supply:

1. Remove the protective cap from the **GAS Inlet** on the back panel. Keep the cap for use when moving or shipping the ScanningTPC. (See shutdown instructions on page 36).
2. Using a length of ¼ inch OD polyethylene tubing with a Swagelok fitting on one end, insert the tubing into the **GAS Inlet** fitting on the back panel. Note: To prevent leaks, the Swagelok ferrules must be in the order shown in the photograph below.



3. Using an adjustable wrench, tighten the Swagelok nut one turn past hand tight to swage the ferrules onto the tubing. Once the ferrules have been swaged, the fitting only requires slight tightening upon reassembly.

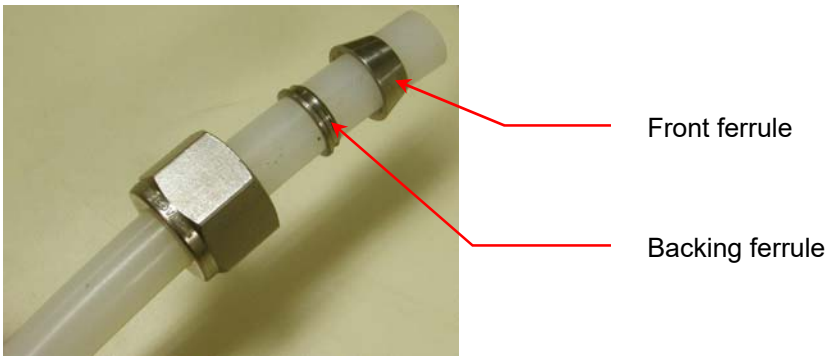


4. Connect the other end of the tube to your air/nitrogen supply.

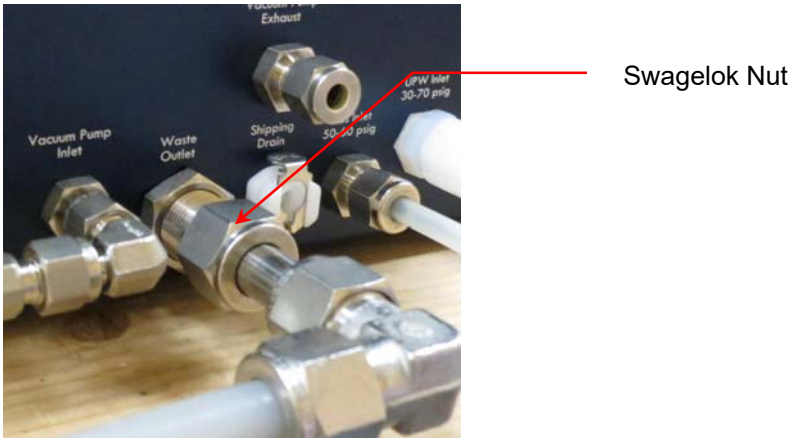
Connecting to the Waste Drain

Excess sample from the nebulization module is removed from the instrument using a venturi ejector. Follow these instructions to connect the Waste Outlet to a suitable drain:

1. Remove the protective cap from the **Waste Outlet** on the back panel. Keep the cap for use when moving or shipping the ScanningTPC. (See shutdown instructions on page 36).
2. Using a length of ½ inch OD hard plastic tubing with a Swagelok fitting on one end, insert the tubing into the **Waste Outlet** fitting on the back panel. Note: To prevent leaks, the Swagelok ferrules must be in the order shown in the photograph below.



2. Using an adjustable wrench, tighten the Swagelok nut one turn past hand-tight to swage the ferrules onto the tubing. Once the ferrules have been swaged the fitting only requires slight tightening upon reassembly. **Caution**: Do not over-tighten the fitting or you will damage the tube and/or fitting.



3. Place the other end of the tube over your drain. Note: The drain tubing should pitch downwards and vent to atmosphere.

Installing the n-Butyl Alcohol (Butanol) Bottle

Follow these instructions to install the n-butyl alcohol bottle:

1. Add n-butyl alcohol to the fill bottle.
2. Place the bottle in the bracket.
3. Press the fitting into place in the **Butanol Fill** port. Note: Purge the tubing of any bubbles before connecting to the instrument or you may receive a **Butanol low** error on the Status screen.

Connecting the Power

To connect the power supply, follow these instructions:

1. Plug one of the supplied power cables into the ScanningTPC plug receptacle on the back panel. Plug the second supplied power cable into the CPC plug receptacle on the back panel.

2. Plug each cord into an earth-grounded AC power source (100 to 240 VAC, 50 to 60 Hz, 0.6 A).
   WARNING: Ensure that the ground is secure. Connection to an improperly grounded electrical source is a severe shock hazard.
3. Turn on both power switches.
   Caution: Wait 30 minutes after turning on the power before you turn on the UPW supply to allow the evaporator to reach its correct operating temperature.

Turning on the Air/Nitrogen and UPW Supplies

To turn on the air/nitrogen and UPW supplies, follow these instructions:

1. Turn on your air/nitrogen supply.
2. After turning on the power, wait thirty minutes before turning on the UPW supply (to allow the evaporator to reach the correct temperature). Water then flows through the instrument and out through the waste line. Ensure the **UPW Inlet** has no leaks. If you see any leaks, tighten the fitting.

If you experience any problems installing your ScanningTPC, please contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

Operation Instructions

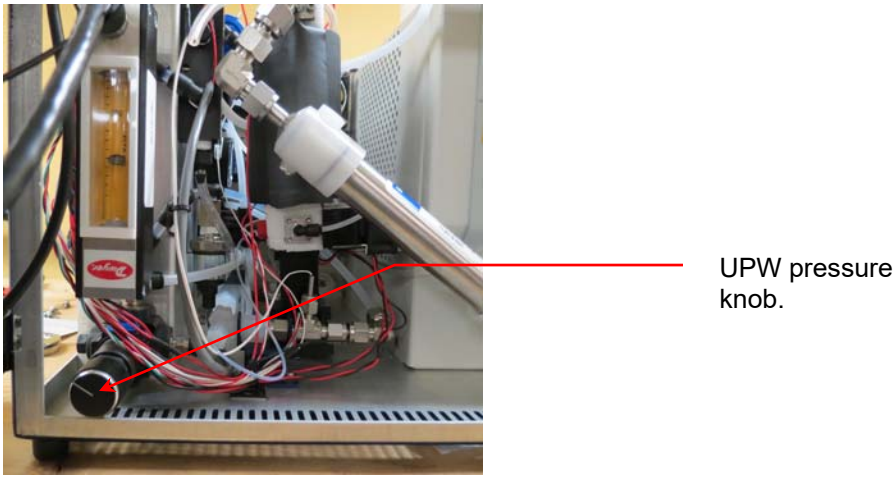
After installation, check the UPW Pressure and Total Flow rate before beginning data collection. The pressure and flow rates are linked and adjusting one may affect the other so you may have to repeat these procedures until you achieve the correct flow and pressure.

Checking the UPW Pressure

To check and change the UPW pressure, follow these instructions:

1. Using the provided key, unlock and open the cabinet door.

2. Press **F1** to display the Status screen.
3. Turn the water pressure knob in a clockwise direction to increase pressure, or in a counter-clockwise direction to decrease pressure. Check the water pressure on the Status screen until it reads 14 psi.



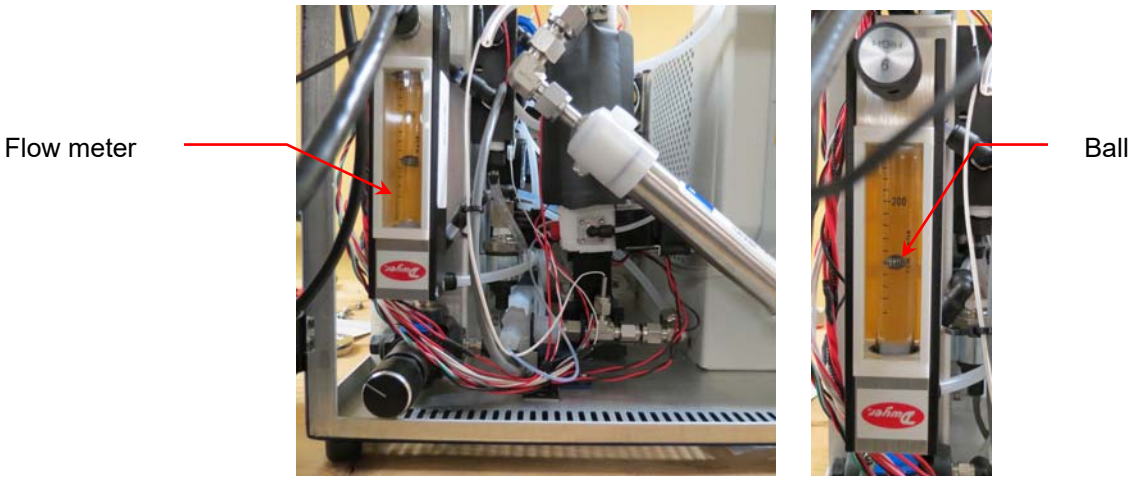
4. Close and lock the cabinet door.

Checking the Total Flow Rate

To check the Total Flow rate, follow these instructions:

1. Using the provided key, unlock and open the cabinet door.

2. Check the flow rate on the flow meter. The center of the ball should be at the 100 mL/min level.



3. If the flow does not read 100 mL/min, turn the knob on the top of the flow meter in a counter-clockwise direction to increase the flow, or in a clockwise direction to decrease the flow until it reads 100 mL/min.
4. Close and lock the cabinet door.

The Front Panel

Once all installation procedures have been completed, you are ready to begin standard operation of the ScanningTPC.

Figure 6: Front Panel of the ScanningTPC.

The Scanning TPC is operated using the touch-screen display and the F1, F2, F3, F4 buttons on the front panel.

Warning: Do not press the System button unless you are instructed to do so by Kanomax FMT Inc. (See details below.)

The buttons perform the following functions:

- **System** is reserved for use by support to facilitate system recovery. **Do not press the System button** unless you are instructed to do so by Kanomax FMT, Inc. If you press and hold the System button the following warning message is displayed.

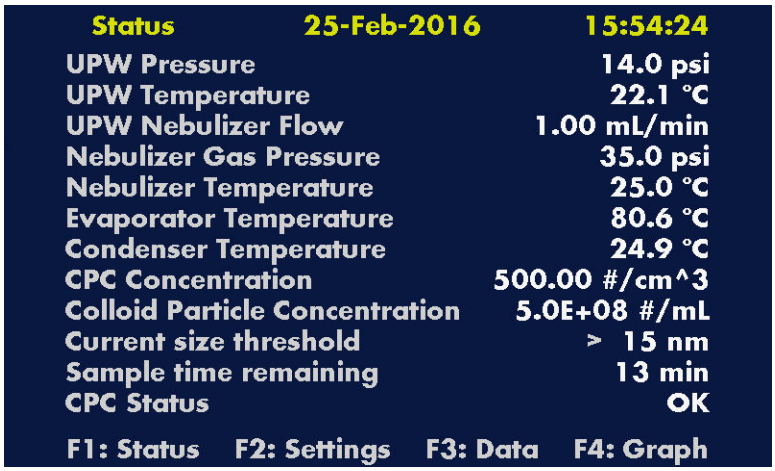
After three seconds the controller enters a low-level firmware update mode for the display screen. Once this mode has been activated you must

power-cycle the ScanningTPC to resume normal operation or you will lose configuration data, including calibration parameters.

- **F1** displays the instrument status.
- **F2** allows you to view/change instrument settings.
- **F3** allows you to enable/disable data logging and plotting as well as transfer previously logged data to a USB storage device.
- **F4** displays a scatterplot of colloid concentration vs. time.
- **F5**: displays the home screen (model number, serial number, software version, and PLC firmware version information).

Viewing the Instrument Status

To view the instrument status, press F1 and you see the following screen. Values in the preferred range are displayed in white, values outside the preferred range are displayed in red and values displayed when the settings are changing are displayed in yellow.



The following indicators are displayed on the Status screen:

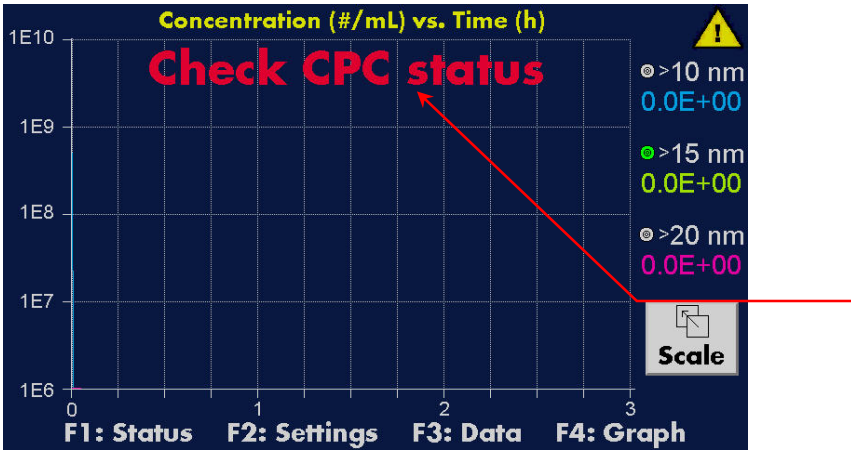
- **UPW Pressure** indicates the pressure downstream of the internal pressure regulator and is nominally set to 14 psi. The UPW Pressure is set at the factory and should not need adjusting. However, if you find that water pressure is not at the correct pressure, follow the troubleshooting instructions on page 21.
  Warning: Adjusting the UPW Pressure changes the total flow into the instrument.
  Warning: UPW will not flow until the evaporator temperature reaches 70°C.
- **UPW Temperature** indicates the temperature of the total UPW flow, measured downstream of the nebulizer sample pickoff.

- **UPW Nebulizer Flow** is the waste flow from the nebulizer. The UPW Nebulizer Flow is calculated by multiplying the drop rate by the factory-calibrated drop volume.
- **Nebulizer Gas Pressure** indicates the pressure at the gas manifold that supplies the nebulizer.
- **Nebulizer Temperature** indicates the temperature of the nebulizer, nominally controlled to 25°C.
  Warning: Changing this temperature may change the inspection volume scale factor.
- **CPC Concentration** indicates the aerosol particle concentration read from the internal CPC.
- **Colloid Particle Concentration** indicates the liquid particle concentration, calculated using CPC concentration and the ScanningTPC inspection volume rate.
- **Evaporator Temperature** indicates the Temperature reading of the aerosol exiting the heated evaporator, nominally controlled to 80°C.
  Warning: Changing this temperature may change the inspection volume scale factor.
  Warning: UPW will not flow until the evaporator temperature reaches 70°C.
- **Condenser Temperature indicates** the condenser temperature in the internal CPC.
- **CPC Status** indicates any Model 3772 CPC faults. (For more information, see below.)

CPC Status

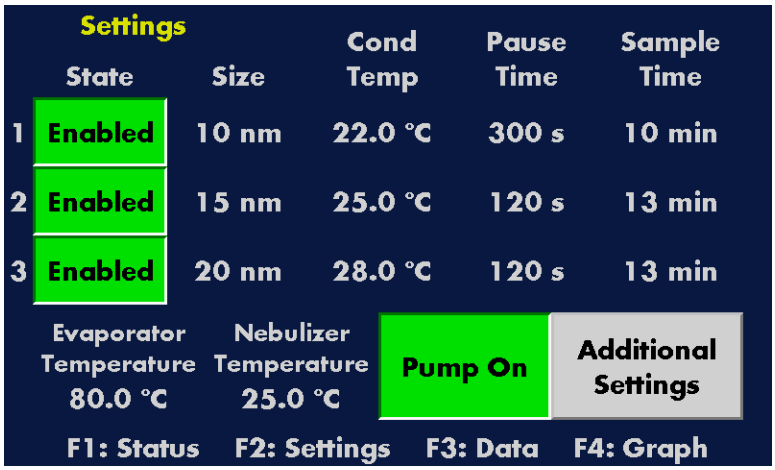
The CPC status field indicates one of the following conditions:

- **OK**: CPC is functioning correctly.
- **Vacuum Fault:** the CPC has detected a problem related to the flow rate. On the Settings screen, check that the vacuum pump is turned on and then refer to the Troubleshooting section of this manual.
- **Butanol low**: May be caused by a low level of n-butyl alcohol in the fill bottle or by air bubbles trapped in the fill tubing. If the n-butyl alcohol level in the alcohol bottle is low, refill the bottle. If the level is not low, purge the tubing of any bubbles.
- **Fault**: The CPC is indicating a fault different from the two listed here. See Troubleshooting, beginning on page 38.
  When a fault is indicated, a warning message also appears on the graph screen. Note: The CPC status displayed is only updated during data collection from the CPC (once per minute while sampling / not paused) so after a fault has been corrected the indication may still appear for some time.



Viewing or Changing Instrument Settings

To view and/or change the instrument settings, press **F2** and you see the following screen. Note: Press **Additional Settings** to see a menu that allows you to set the date and time, configure the network and update the firmware.



State and Size

The ScanningTPC can count three particle sizes: >10, >15, and >20 nm. When the State for a specific particle Size is **Enabled**, that particle size is counted. If the State is **Disabled**, that size particle is not counted. Press the button to toggle between the two states.

Cond Temp

Cond Temp is the CPC condenser control temp (sets the threshold diameter).

Pause Time

Pause Time indicates the time for the pause as the instrument switches size channels.

Sample Time

Sample Time is the time that the CPC measures particle concentration at the specified size channel.

Evaporator Temperature

The Evaporator Temp is set to 80°C.

Nebulizer Temperature

The nebulizer temperature is set to 25°C.

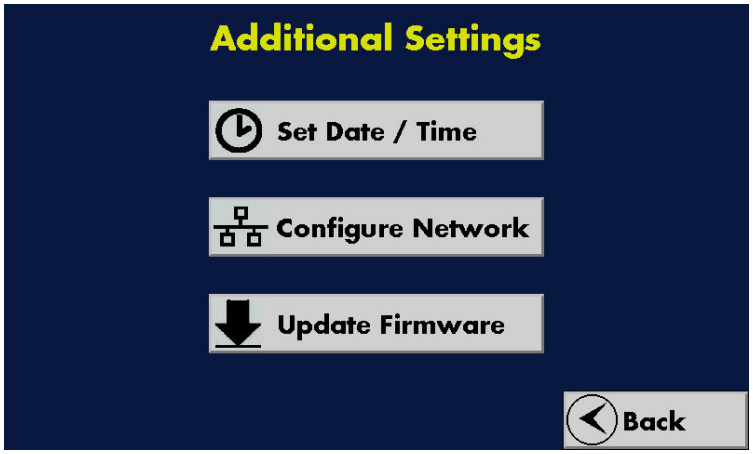
Turning the Pump On or Off

Pump On/Pump Off is a toggle switch that allows you to turn the internal vacuum pump on or off. If you are using an external vacuum pump, turn the pump Off. If you are using the internal vacuum pump, turn the pump On.

Caution: If you do not have an external pump but turn the internal pump Off, the CPC will shut down.

Viewing Additional Settings

Press **Additional Settings** to see the following menu screen.



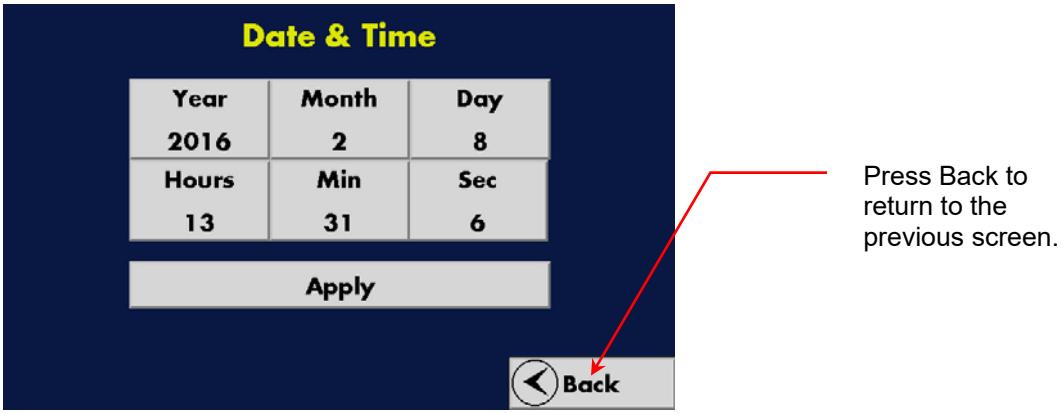
Setting the Date and Time

You can adjust the date and time to match your local time. If you do not, dates and times will be inaccurate on the graphs.

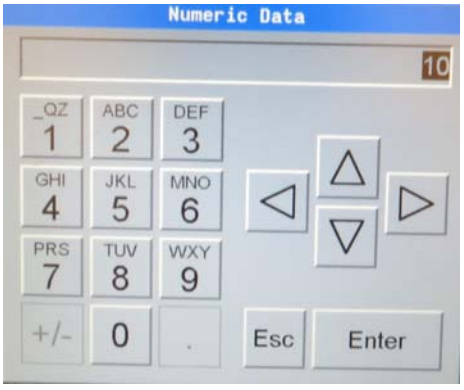
To set the date and time, follow these instructions:

1. Press **F2** on the main display screen
2. Press **Additional Settings** on the Settings screen.

3. Press **Set Date/Time** on the **Additional Settings** screen. You see the following **Date & Time** screen.



4. On the **Date & Time** screen, press the **Year, Month, Day, Hours, Min**, or **Sec** button and you see an on-screen keyboard. Use the keyboard to change the value of the corresponding date/time field.
   Use the ◁ ▷arrow keys to select a digit in the top field.
   Use the △▽ arrow keys to increase or decrease the highlighted digit.
   Use the numeric keys to enter a value for the date or time field you are changing. Note: This field always has five digits, but only values 1-12 are acceptable. Example: February is 00002.
   Press **Esc** to return to the previous screen.
   Press **Enter** to enter the value on the Date & Time screen.



5. Press **Apply** to set the date and time using the new values.

Configuring the Network

You can configure the connection between the ScanningTPC and your network.

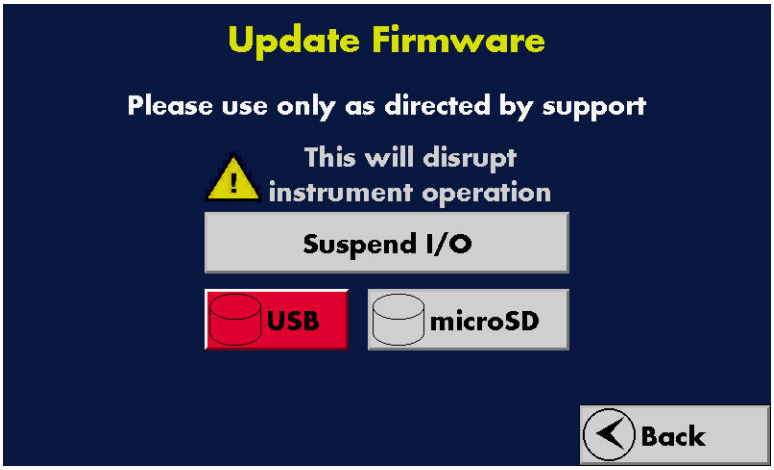
Caution: This functionality is intended to support future features. Currently you cannot control the ScanningTPC or obtain data using its Ethernet connection.

Updating the Firmware

If you need to update the ScanningTPC firmware, you will receive instructions directly from Kanomax FMT, Inc. that explain how to obtain and copy an update file onto a USB storage device. Firmware can also be upgraded using the microSD Card, but the simplest method is to use the USB port since it is physically more accessible.

To update the firmware, follow these instructions:

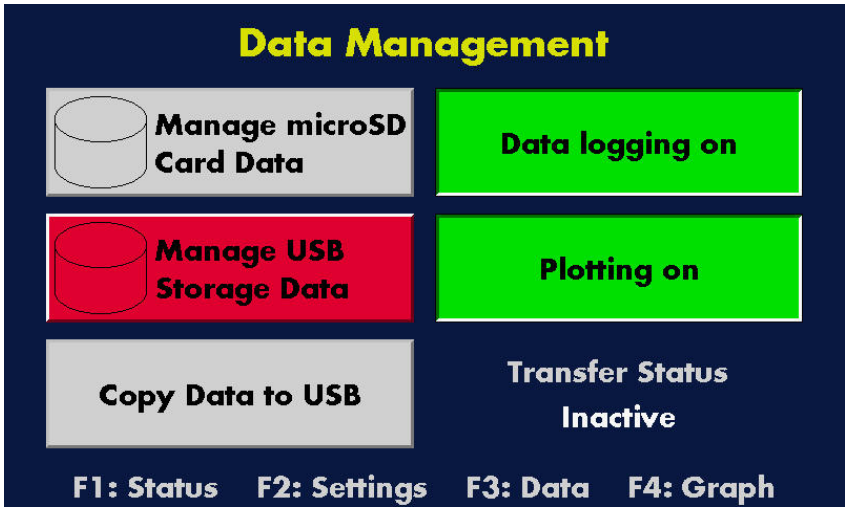
1. Copy the Kanomax FMT-provided .PGM file to a USB Flash drive.
2. Insert the USB drive into the USB port on the back panel of the ScanningTPC.
3. Press **F2** to see the Settings screen.
4. Press **Additional Settings** > **Update Firmware**. You see the following screen.



5. Press **Suspend I/O** to stop data collection. The button turns green and its text changes to Resume I/O. A 1Hz beep also sounds to indicate that I/O is suspended. If you don't do anything else, after 30 seconds the system will automatically Resume I/O.
   Caution: If you don't suspend the data collection, you may see an error message (**Program Port Owned by Ladder**) and be unable to proceed with the update.
6. Press **USB**. On the resulting screen select the .PGM file and press the Enter key. The firmware update is completed and a **Place in run mode?** message appears. Press **OK**.

Managing Data

The ScanningTPC logs concentration and temperature data to internal memory. To manage data options and transfer data, press **F3** and you see the following screen.



Data Logging

You must turn on the data logging option to log data to the internal microSD card. To turn on the data logging option, follow these instructions:

1. Press **F3**.
2. On the Data Management screen, press **Data logging off**. The button turns green and the text changes to **Data logging on**. The STPC now logs data to the internal microSD card.
   Note: The button toggles between Data logging on and Data logging off. To disable data logging, press Data logging on.

Data Plotting

You must turn on the data plotting option to plot data on the graphs. To turn on the data plotting option, follow these instructions:

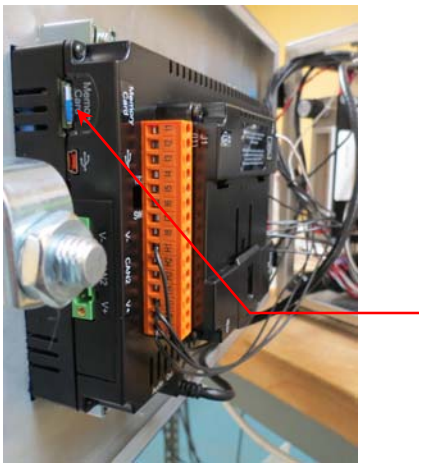
1. Press **F3**.
2. On the Data Management screen, press **Plotting off.** The button turns green and the text changes to P**lotting on**.
   Note: The button toggles between Plotting on and Plotting off. To disable data logging, press Plotting on.

Manage microSD Card Data

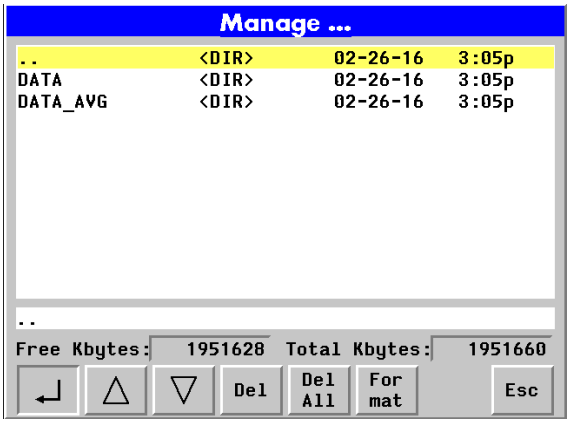
All data logged by the ScanningTPC is stored on the internal microSD card. Note: Data is not erased from the microSD card when it is transferred to an external flash drive. When the microSD card is full, it replaces the first stored data with the most recently gathered data. Data can be deleted from the card.

To replace a microSD card follow these instructions:

1. Unlock the cabinet door using the provided key.
2. Remove the old microSD card from the **Memory Card** slot on the back of the cabinet door.



3. Carefully insert a new microSD card into the **Memory Card** slot on the back of the cabinet door.
4. Press **F3**.
5. On the **Data Management** screen, press **Manage microSD Card Data**.
6. On the **Manage** screen, press **Format**. The microSD card will be formatted.



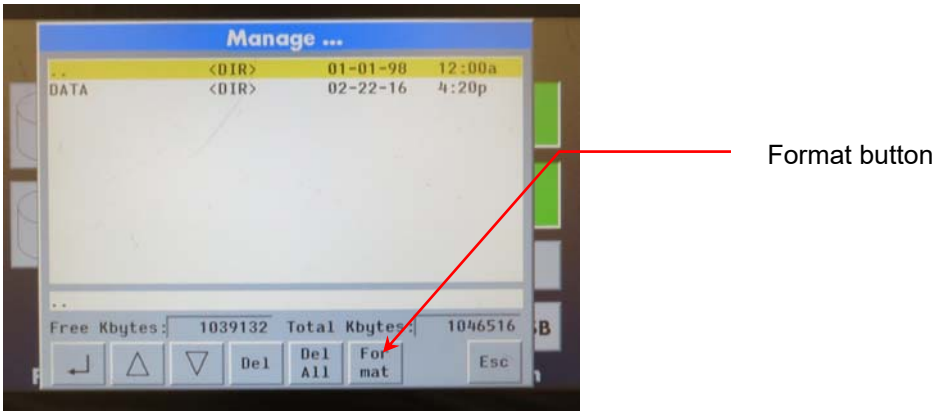
Note: The other buttons on this screen are active but you do not need to use them.

Manage USB Stored Data

The Manage USB Stored Data button allows you to check that data log files are being created on your USB Flash drive. You can browse the file system, delete files, and format the card but you cannot view the contents of files or copy and paste, etc.

To manage the USB data, follow these instructions,

1. Insert a USB Flash drive into the **USB port** on the STPC back panel.
2. Press **F3** on the front display screen.
3. On the **Data Management** screen, press **Manage USB Stored Data**. You see the Manage screen and a list of data directories.



The buttons perform the following functions.

↵ Press to move to the next data screen where files contained in the selected directory are shown.

▽△ Move up or down the list of directories to select one.

Del Delete the selected directory.

Del All Delete all directories.

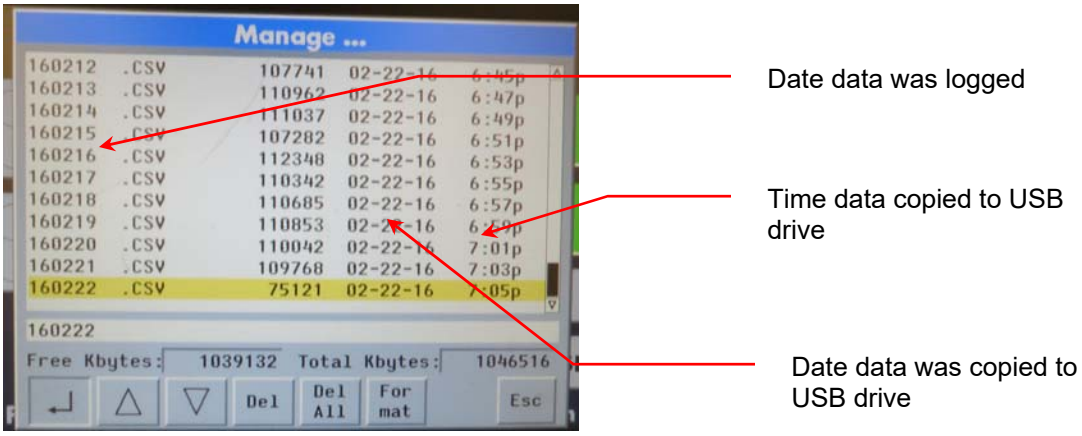
Format Format the USB Flash drive.

Esc: Return to Data Management screen.

Free Kbytes: indicates how many Kbytes of space remain on the USB Flash drive.

Total Kbytes: Indicates how many Kbytes are being used by stored data on the USB Flash drive.

4. Press ↵ to see details of the files in the selected directory. The on-screen buttons perform similar functions to those described for the previous screen.
   Date Formats:
   160222 is yymmdd Example: 2016, February 22.
   02-22-16 is ddmmyy Example: February 2, 2016



Copying Data to a USB Flash Drive

The ScanningTPC logs concentration and temperature data to internal memory. To copy stored data from the internal memory to an external USB Flash drive, follow these instructions:

1. Insert a USB Flash drive into the **USB port** on the STPC back panel.
2. Press **F3** on the front display screen.
3. On the Data Management screen, press **Copy Data to USB**. Wait at least ten seconds for data to transfer before removing the USB Flash drive.
   Note: During data transfer the **Transfer Status** is **In Progress**.

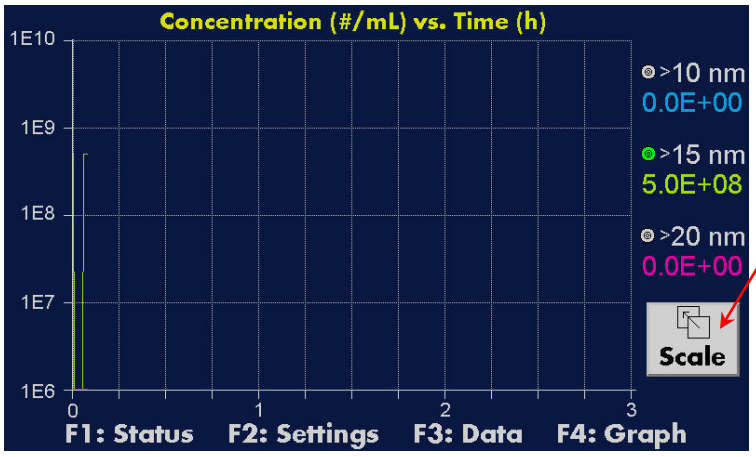
4-20 milliamp (mA) Output

The ScanningTPC provides concentration output by a 4-20 mA signal accessible from a coaxial BNC connector on the back panel. The following table describes the signal values.

4-20 mA Output	Explanation
4-4.5 mA	Reserved (no value).
4.5-5.5 mA	Active size channel: 4.5 mA = 10 nm 5.0 mA = 15 nm 5.5 mA = 20 nm. Note: This value is held during the data collection pause prior to the start of a channel measurement.
5.5-5.9	Reserved (no value).
5.9-6	Conc < 1E3 Colloid concentration is less than the lower specification limit.
6-20	Log-scaled concentration from 1E3 to 1E10 Concentration = 10 ^ (mA output/2) Example: For 10 mA output, Concentration = 10 ^ (10/2) = 1E5 #/ml

Viewing and Changing Graphs

When Data plotting is turned on, press F4 to see a graph displaying trend lines of the liquid particle concentration. If the radio button next to a particle size is green, that particle size is being counted. Each size is represented by a color on the graph: 10 nm = blue; 15 nm = green; 20 nm = red.



You can change the scale on the X- and Y- axes of the graph. In this screen the vertical scale is set to 1E6, 1E10 and the horizontal scale is set to 3 hours. Options are:

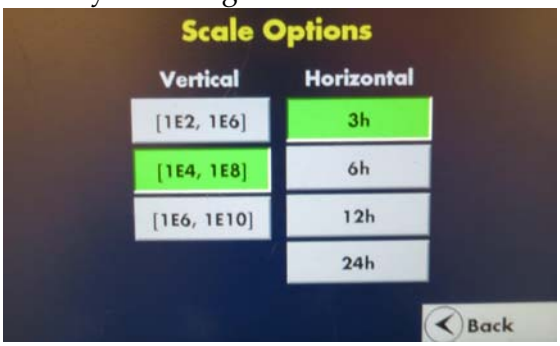
- Horizontal Scale: 3, 6, 12, and 24h. Data gathered over 3, 6, 12, and 24 hour periods.

- Vertical Scale: a logarithmic scale
  1E2, 1E6 #/ml (100 – 1,000,000)
  1E4, 1E8 #/ml (10,000 - 100,000,000)
  1E6, 1E10 #/ml (1,000,000 - 10,000,000,000)

Changing the Graph Scale

To change the scale, follow these instructions:

1. Press the Scale button on the graph.
2. On the Scale Options screen, press the buttons for the vertical and horizontal options you require. The graph automatically updates to reflect your change.



How to Shut Down the ScanningTPC for Moving or Shipping

If you need to move the ScanningTPC to another lab or facility, or if you need to ship it for service work, read this section to familiarize yourself with the precautions you should take and the procedures you should follow.

Performing any of the following improper handling techniques may damage the instrument and will invalidate the warranty:

- Shipping/transporting an undried/undrained instrument.
- Tipping > 10° during normal operation.
- Subjecting an undried/undrained instrument to freezing temperatures.

To prepare the ScanningTPC for shipping, follow these instructions:

1. Disconnect the n-butyl alcohol fitting from the **Butanol Fill** port on the back panel.
2. Remove the n-butyl alcohol fill bottle from the bracket and empty the bottle.
3. Unscrew the alcohol bracket.
4. Run the Scanning TPC on UPW water until the particle count drops to zero (approximately 12 hours). Note: If UPW is unavailable, disconnect the Aerosol Diffusion Dryer from the CPC inlet. Reinstall after drying is complete.
5. Turn off the UPW supply to the ScanningTPC.
6. Connect the provided CDA/N_2 Adapter Fitting to the **UPW Inlet**. Apply 30 psi of clean dried air or nitrogen for 2 hours. Note: The main air/nitrogen supply must remain connected during this step.
7. Plug the provided (in the Model 3772 CPC accessory kit) CPC Drain bottle into the **Shipping Drain** port on the ScanningTPC back panel and allow any water remaining in the nebulizer to drain into the bottle. Note: Tilt the device towards the back to allow the nebulizer reservoir to drain.
8. Disconnect the air or nitrogen supply line and the water waste line.
9. Disconnect the communication cables.
10. Turn off the power.
11. Place all the caps that you received with the instrument on the inlets and outlets to prevent material from entering the instrument. The Scanning TPC is now prepared for shipping or moving.
    Note: If you did not save the original protective caps, find suitable alternatives.
12. Place the instrument in its original packing materials for shipping.

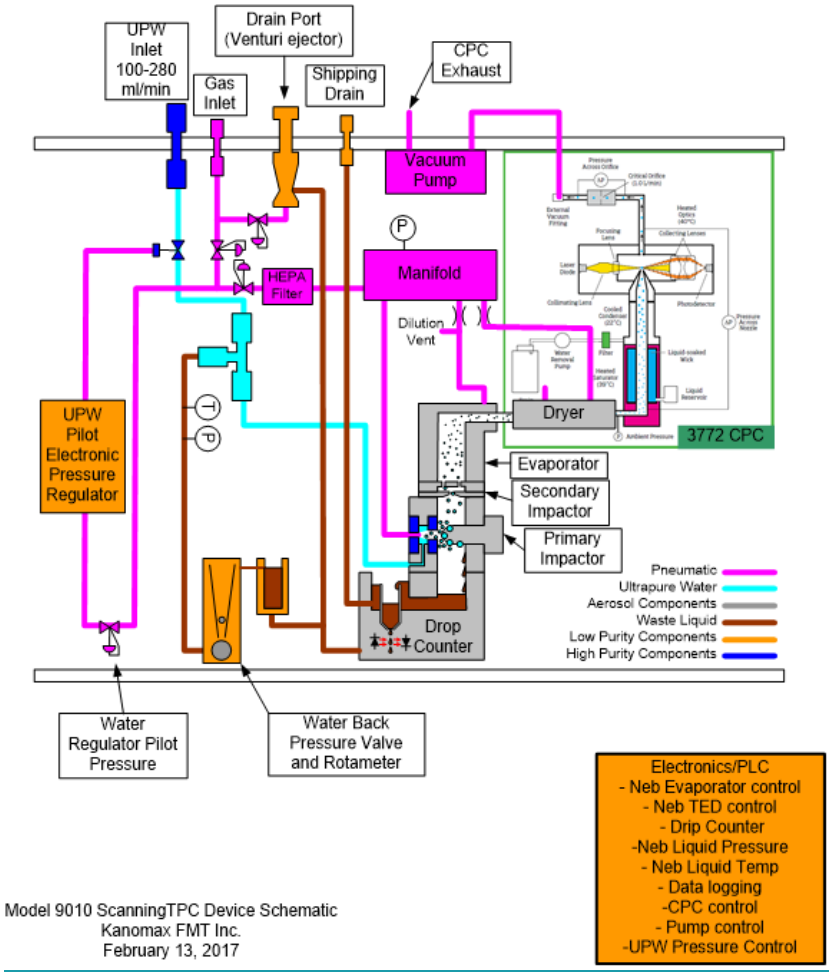
If you have any questions about shipping or moving the ScanningTPC, contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

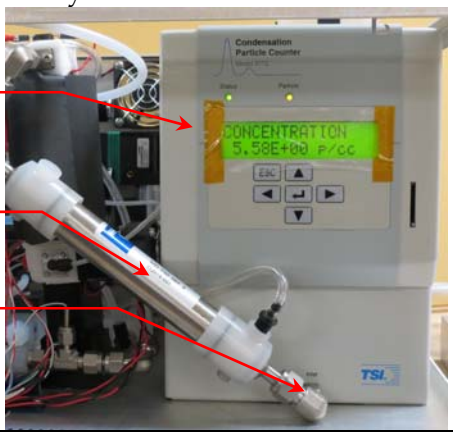
Troubleshooting

There are no user-serviceable parts inside the ScanningTPC. All repair and maintenance must be performed by a qualified service technician. If the following troubleshooting instructions do not solve your problem, contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.) Refer to the schematic diagram in figure 5 for an overview of instrument flow. When working with the ScanningTPC:

- Do not remove any parts from the instrument unless this manual tells you to do so.
- Do not remove the instrument housing or covers while power is supplied to the instrument. However, the front panel may be unlocked and opened to provide access to the CPC.

Figure 5: Schematic diagram of the ScanningTPC.



Problem	Cause	Action
No concentration displayed on ScanningTPC graphs, Model 3772 CPC shows a concentration and its status light is green.	Communications cable not installed correctly.	Verify that the communications cable is installed correctly. (See instructions on page 15.)
	CPC concentration is above/below the ScanningTPC graphing range.	On the Status screen, check that a concentration is reported. Adjust the chart scale. (See page 35.)
	Data plotting is not turned on.	On the Data Management screen, turn on the Data plotting option.
No concentration displayed on ScanningTPC graphs and Model 3772 CPC shows zero concentration with a green status light.	Air/nitrogen and/or UPW supplies not connected correctly.	Verify the air/nitrogen and/or water supplies are correctly connected. On the Status screen, confirm that the nebulizer flow rate is > 0.
	Operating temperatures and/or pressures not correct.	On the Status screen, check that all operating pressures and temperatures are correct. If they are not, check that UPW and gas are being supplied at the correct pressures.
	CPC wick saturated with water.	Disconnect the fitting from the **Butanol Fill** port and remove the alcohol bottle. Using a wrench to loosen the fitting, disconnect the aerosol dryer from the CPC. Rest the free end in the cabinet and run the CPC overnight to dry out the wick. 
	CPC Optics are flooded.	Disconnect the fitting from the **Butanol Fill** port and remove the alcohol bottle.

		Using a wrench to loosen the fitting, disconnect the aerosol dryer from the CPC. (See above photo.) Rest the free end in the cabinet and run the CPC overnight.
Model 3772 CPC status light is not green.	N-butyl alcohol flow is restricted.	Check that n-butyl alcohol is flowing to the CPC (air in tubing may stop flow).
	Internal vacuum pump is not operating correctly, tubing is kinked, or a fitting is loose.	Hold your finger lightly against the Vacuum Pump Exhaust port on the back panel to check that there is a flow. Check that the vacuum pump tubing is not kinked. Tighten (but do not over-tighten) the Swagelok fittings on the vacuum pump ports on the back panel.
	CPC fault.	Unlock and open the cabinet door. On the CPC display, use the ▼▲ arrows to select STATUS. Press Enter. Scroll through the status values and note any with an exclamation (!) mark. Refer to the Model 3772 User Manual for troubleshooting instructions for any noted faults.

Nebulizer Flow reads 0.	UPW pressure is out of range.	On the Status screen, check that the UPW Pressure is 14 ± 0.2 psi. If the pressure is not correct, adjust the pressure following the instructions beginning on page 44 below. If the pressure does not reach the correct operating level, verify the UPW supply pressure is >30 psi.
	Sensor is wet.	Check below the nebulizer to see if drops are forming at the drip counter. If drops are forming, the sensor is probably wet. Turn off UPW supply and allow to dry for 24 hours. Turn the UPW supply back on. If the sensor is still wet, increase the Venturi drain pressure. (See increasing/decreasing pressure to Venturi Drain on page 46.)
	Nebulizer is clogged.	Check below the nebulizer to see if drops are forming at the drip counter. If no drops are forming the nebulizer is probably clogged. Contact Kanomax FMT, Inc. for instructions.
Status screen displays CPC Status **Vacuum Fault** message.	Internal vacuum pump is not operating correctly, tubing is kinked, or a fitting is loose.	Hold your finger lightly against the Vacuum Pump Exhaust port on the back panel to check that there is a flow. Check that the vacuum pump tubing is not kinked. Tighten (but do not over-tighten) the Swagelok fittings on the vacuum pump ports on the back panel.
Status screen displays CPC Status **Butanol Low** message.	n-butyl alcohol (Butanol) bottle is almost empty.	Refill the bottle.

Status screen displays CPC Status **Fault** message.	The CPC has a fault.	Unlock and open the cabinet door. On the CPC display, use the ▼▲ arrows to select STATUS. Press Enter. Scroll through the status values and note any with an exclamation (!) mark. Refer to the Model 3772 User Manual for troubleshooting instructions for any noted faults.
Water leaking from ScanningTPC.	Loose fitting.	Check all fittings and tighten any that are loose. (Do not over-tighten.)
	Water flowing from base of nebulizer. Venturi waste ejector not operating properly	See Increasing/Decreasing Pressure to Venturi Drain on page 46.
Water pressure > or < 14 ± 0.1 psi.	UPW or gas supply pressure changed.	See Increasing/Decreasing the UPW Pressure on page 44.
Nebulizer gas pressure not reading 35 psi	Gas supply pressure changed.	See Increasing/Decreasing Nebulizer Gas Pressure on page 45.
Evaporator temperature does not reach set point (80°C).	Nebulizer evaporator may be flooded.	Shut off the UPW supply and run the ScanningTPC for 12 hours to dry it out. Confirm that UPW isn't supplied to the ScanningTPC before the evaporator reaches the set operating temperature. Note: During installation, you should wait 30 minutes after turning on the power before you turn on the UPW water to allow the evaporator to reach its set point temperature. Note: UPW will not flow until the evaporator temperature reaches 70°C.
Nebulizer unable to hold set point temperature (22°C).	Extreme ambient temperature or defective cooling components.	Contact Kanomax FMT, Inc. for instructions.
STPC does not recognize external USB Flash drive	Manage USB Storage Data screen displays **Media Card not Present**	Power cycle the ScanningTPC.

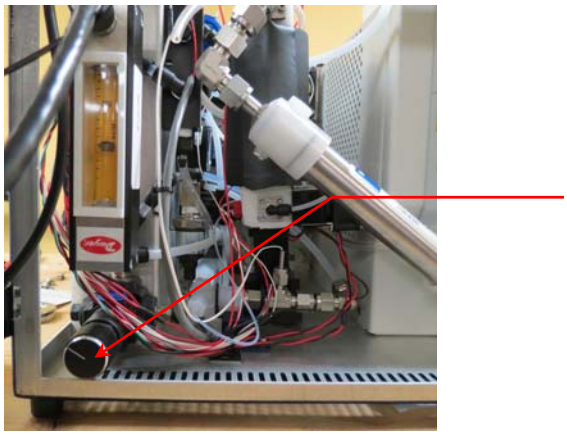
Lost Key	N/A	Contact Kanomax FMT, Inc. for a replacement.

Increasing/Decreasing the UPW Pressure

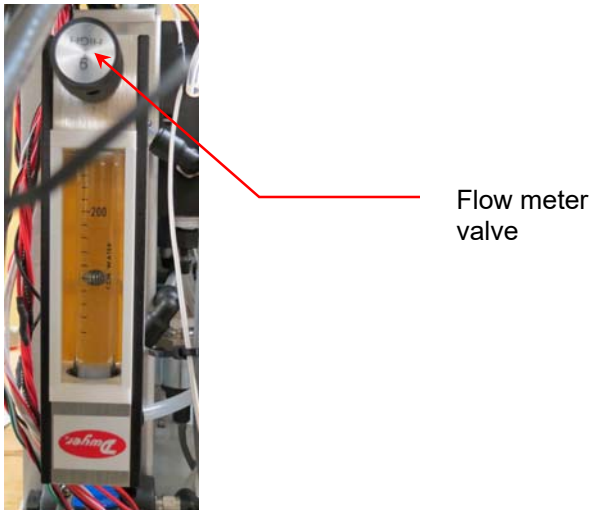
To increase or decrease the UPW pressure, follow these instructions:

1. Using the provided key, unlock and open the cabinet door.

2. Press **F1** to display the Status screen.
3. Turn the water pressure regulator knob clockwise to increase pressure, or counter-clockwise to decrease pressure. Check the water pressure on the status screen until you reach 14 psi.



4. Adjust the flow meter valve to reach 100 ml/min of flow (measured from the center of the ball). Readjust UPW pressure if necessary.

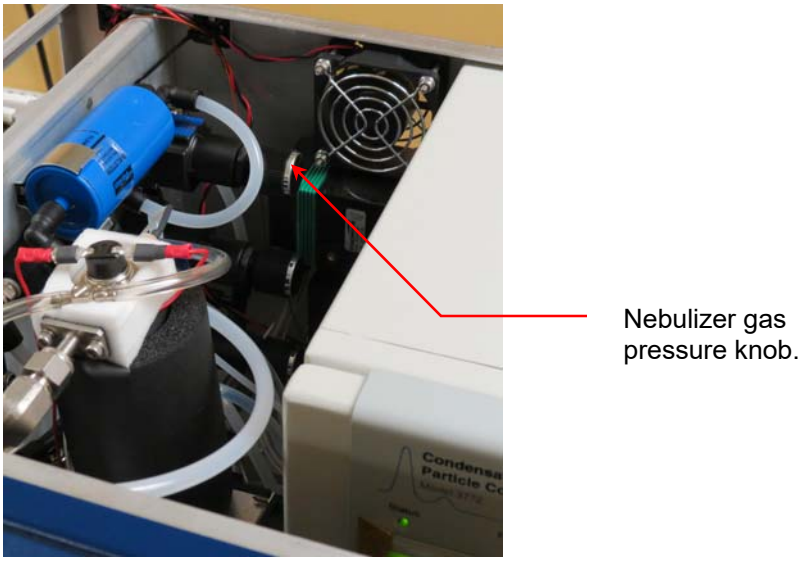


5. Close and lock the cabinet door.

Increasing/Decreasing Nebulizer Gas Pressure

To increase or decrease the Nebulizer gas pressure, follow these instructions:

1. Unscrew the eight screws holding the cabinet cover in place and save for reuse.
2. Press **F1** to display the **Status** screen.
3. Locate the Nebulizer Gas Pressure knob.

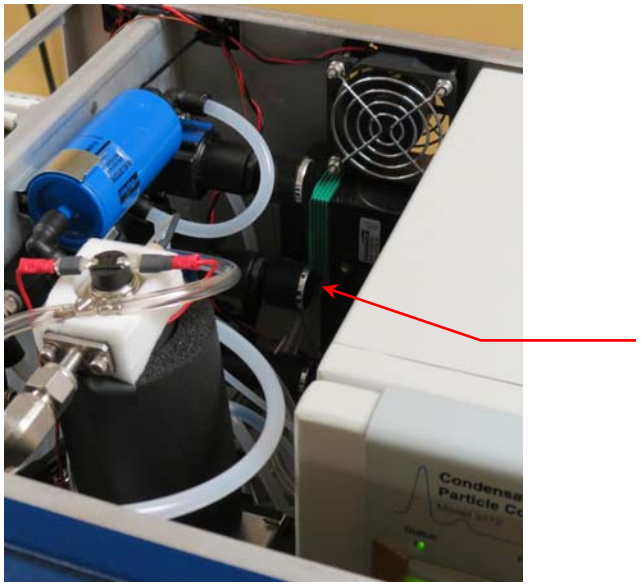


4. Turn the knob in a clockwise direction to increase the pressure and a counter clockwise direction to decrease the pressure. Check the **Status** screen as you do this until the Nebulizer pressure reaches 35 psi.
5. Replace the cabinet cover and screw in place.

Increasing/Decreasing Pressure to the Venturi Drain

If the waste drain is leaking you may need to increase venture pressure. Follow these instructions to increase the pressure:

1. Unscrew the eight screws holding the cabinet cover in place and save for reuse.
2. Locate the Venturi Pressure knob immediately below the nebulizer gas pressure knob.



3. Turn the knob in a clockwise direction to increase the pressure, or a counter-clockwise direction to decrease pressure.
4. When the leaking stops, replace the cabinet cover and screw in place.

Appendix A: Acknowledgements

The ultrafine nebulization method used in this device is based on technology licensed from CT Associates, Inc. (CTA). We offer our sincere thanks to Don Grant, Gary Van Schooneveld, and Mark Litchy for their invention, their clever insights to this unique technology, and the gracious feedback they have provided during the development of this product. Patent numbers 8,272,253 and 8,573,034 have been issued to CTA and licensed by Kanomax FMT, Inc.

Appendix B: ScanningTPC Specifications

ScanningTPC Specifications

Measurement range	10E3 – 10E10 particles/mL
Inspection volume rate	>1 μL/min >10 μL/min
Threshold sizes	10-20 nm user selectable in 5 nm increments (50% detection efficiency)
Number of size channels	1-3
Dead time between channel adjustment	2-5 mins
Total flow rate	50-280 mL/min
Response time to concentration change	< 30 seconds
Inlet Water Pressure (online)	200-500 kPa (30 - 70 psig)
Compressed air/nitrogen flow rate/pressure	25 std L/min CDA or Nitrogen, 345-414 kPa (50-60 psi) ANSI IS08573-1:2010 Class 2 for compressed air
Maximum UPW nonvolatile residue	200 ppt at 10 nm threshold, 1 ppb at 20 nm
Wetted Surface Materials	PFA, PTFE, PEEK, sapphire, 316L stainless steel
Detector working fluid	Reagent grade n-butyl alcohol
Working fluid consumption rate	Approx. 150 mL/day (bottle lasts for one week)
Detector vacuum	Internal pump or external flow rate of 1 std/min at 400 mbar absolute
Ambient Temperature Range	15-35°C (59-95°F)
Ambient Relative Humidity Range	0-85% non-condensing
Maximum Water Temperature	80°C (176°F)
Dimensions (WxDxH)	16.7 x 16.8 x 10.5 (16.8 with bottle) ins; 42 x 43 x 27 (43 with bottle) cms
Weight	16.1 kg (35.5 lb)
Power (Nebulizer)	Universal 100 - 240 VAC 50/60 Hz, 90 W max
Power (CPC)	Universal 100 - 240 VAC 50/60 Hz, 210 W max
Output	RJ-45 for Modbus, USB Flash Drive
Internal storage	Micro SD
Ultrapure Water Inlet	¼ inch PFA Flaretek®
Waste Outlet	½ inch SS Swagelok®
Compressed Air inlet	¼ inch SS Swagelok®
Detector vacuum	¼ inch SS Swagelok® port
Display	7 inch TFT Color, touch panel
Shipping Drain	Colder brand quick disconnect

Appendix B: Specifications

Flaretek® is a registered trademark of Entegris, Inc.
Swagelok® is a registered trademark of Swagelok Company.

Specifications subject to change without notice.

Appendix C: References

Derek Oberreit, David Blackford, Gary Van Schooneveld, Mark Litchy, Don Grant, "Introducing a 10 nm Particle Counter for Ultrapure Water." Authors' PowerPoint presentation at the UPW conference, Phoenix, AZ December 2014.

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