KANOMAX FMT
A Kanomax Company

Scanning Threshold Particle Counter 3

Model 9010-03: User Manual

Part Number: 1979013 Version 1.0

ScanningTPC3 Model 9010-03 User Manual

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The following is a history of the ScanningTPC3 Model 9010-03 User Manual (part number 1979013):

Version	**Date**	**Change**
Version 1.0	December 2020	Initial Release

Limitation of Warranty and Liability

Kanomax FMT, Inc. offers a full 12-month repair or replacement warranty on all products sold. Warranty covers defects resulting from design or manufacturing. If any such product proves defective during this warranty period, Kanomax FMT, Inc., at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. This warranty is offered on a return to factory basis, with return shipping expense expressly at the cost of the customer. Kanomax FMT, Inc. will pay the return shipping on any materials repaired or replaced. Any repaired or replaced item assumes the remainder of the initial warranty period. Kanomax FMT, Inc. warrants only to the extent of replacement or repair of our products, and does not assume any responsibility for consequential damages. No warranty is offered on accounts with past due balances. In order to obtain service under this warranty, Customer must notify Kanomax FMT, Inc., of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. The Customer shall be responsible for packaging and shipping the defective product to the service center designated by Kanomax FMT, Inc., with shipping charges prepaid.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Kanomax FMT, Inc. shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Kanomax FMT, Inc. representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY KANOMAX FMT, INC. WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. FMT AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FMT RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. KANOMAX FMT AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER KANOMAX FMT LLC OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

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 ScanningTPC3, contact Kanomax FMT, Inc. at 651-762-7762 (USA). If you are outside of the USA, please call your authorized distributor.

Table of Contents

About This Manual

Intended Audience

The ScanningTPC3 Model 9010-03 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 ScanningTPC3 Model 9010-03 including connecting the hardware and installing the software. The manual also contains an explanation of how the ScanningTPC3 works.

Definitions

AC: Alternating Current
AFIMC: Annular Flow Ion Mobility Classifier
AFIMS: Annular Flow Ion Mobility Spectrometer
CPC: Condensation Particle Counter
DNVR: Dissolved Non-Volatile Residue
EU: European Union
FCPC: Fast Condensation Particle Counter
ID: Inner Diameter
IPA: Isopropyl Alcohol
KCl: Potassium Chloride
mA: Milliamperes
NVR: Non-Volatile Residue
kPa: Kilo Pascals
OD: Outer Diameter
OSDM: Online Sample Dilution Module
PEEK: Polyether Ether Ketone. Chemically resistant polymer commonly used for rigid components.
PFA: Perfluoralkoxy. Chemically resistant polymer commonly used in UPW tubing.
PNVR: Precipitated Non-Volatile Residue
psi: pounds per square inch
RAE: Residue After Evaporation
UF: Ultrafilter
UPW: Ultrapure Water
USB: Universal Serial Bus
VAC/VDC: Volts Alternating Current/Volts Direct Current
VIR: Volumetric Inspection Rate

Safety and Handling Procedures

Read this section to learn safe handling procedures for the ScanningTPC3 Model 9010-03.

There are limited user-serviceable parts inside the ScanningTPC3 — all repair and maintenance must be performed by a qualified service technician.

When working with the ScanningTPC3:

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 ScanningTPC3. Follow the procedures described in this manual to use the instrument safely.

Warning

Warnings are used to indicate that unsafe use of the instrument could result in serious injury to you or cause irrevocable damage to the instrument.

Caution

Cautions are used to indicate that if you do not follow the procedures described in this manual, you may damage the instrument.

Note

Notes are used to indicate important information about the operation and maintenance of the ScanningTPC3.

High Voltage Sticker

A High Voltage warning sticker attached to the ScanningTPC3 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 ScanningTPC3 is connected to earth ground and cabinet ground.

Warnings

Please familiarize yourself with the following warnings before operating the ScanningTPC3:

The ScanningTPC3 must be used following manufacturer's specifications otherwise safety cannot be guaranteed.
The ScanningTPC3 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 ScanningTPC3 cover.
When the ScanningTPC3 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 ScanningTPC3 to malfunction.
The air or nitrogen supplied to the ScanningTPC3 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 ScanningTPC3 at angles >10°.
You must drain the ScanningTPC3 before you move or ship it. Do not ship an undried/undrained ScanningTPC3 back to KanomaxFMT, Inc. Doing so will damage the detector and invalidate the warranty.
Do not subject an undrained ScanningTPC3 to freezing temperatures. Doing so will damage the detector and invalidate the warranty.

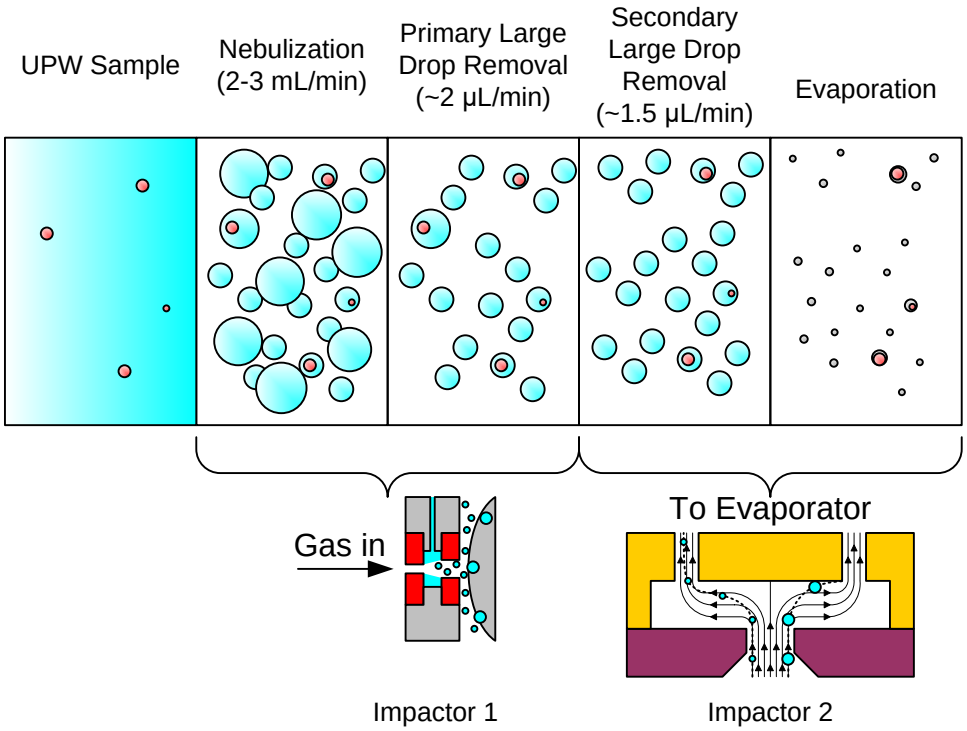
How the ScanningTPC3 Works

The ScanningTPC3 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 >3 to >15 nm.

In the ScanningTPC3, 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 ScanningTPC3 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 ScanningTPC3 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 Volumetric 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;

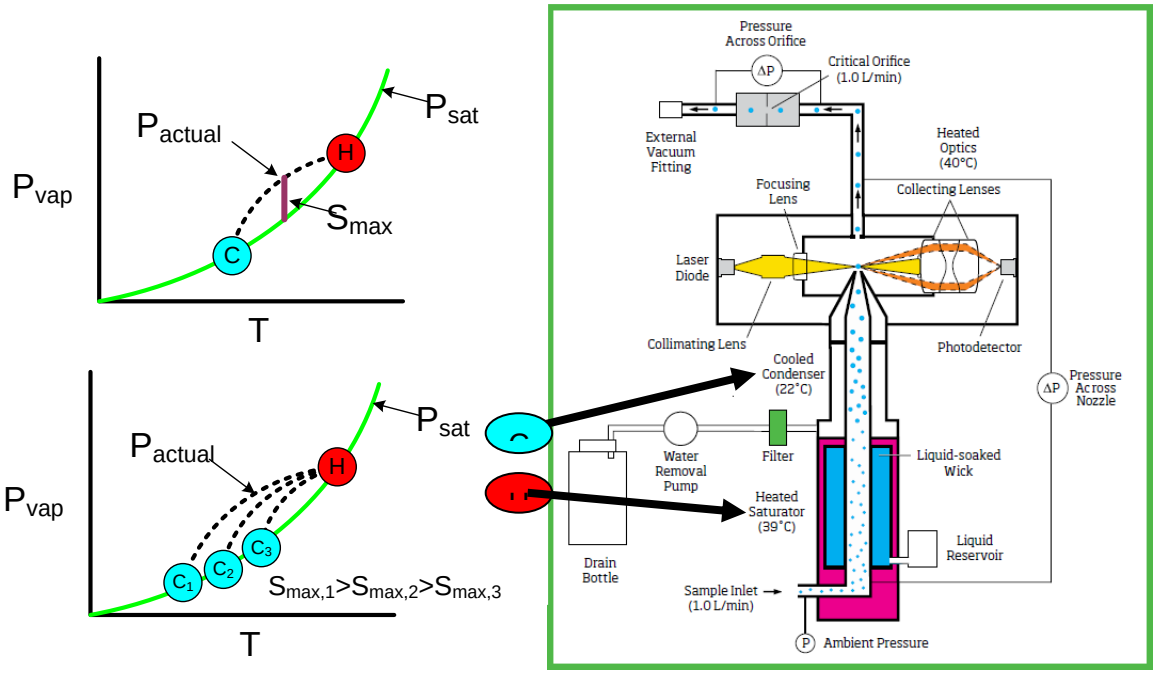
$$r = \frac{-2\gamma V_{vap}}{k_B T} \ln\left(\frac{P}{P_o}\right),$$

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 ScanningTPC3 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.

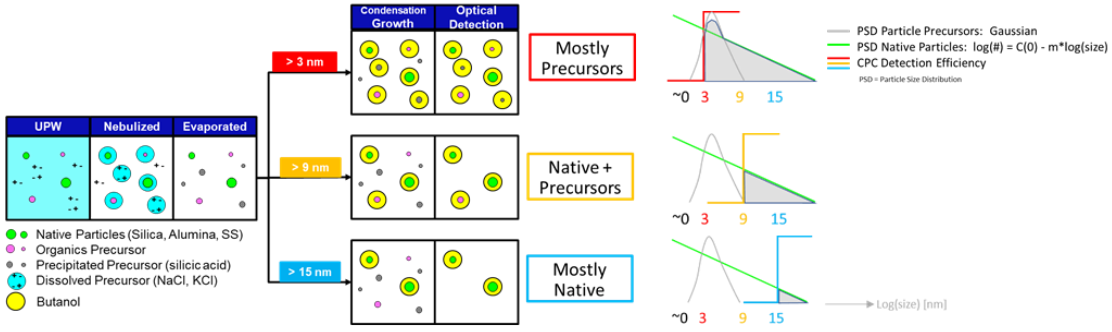
Figure 2: Schematic representation of the CPC.



TSI Incorporated 3772 CPC Brochure

The Operating Principle of the ScanningTPC3 can be visualized with the graphic below. Depending on the particle distribution and concentrations in the sample, particles and/or particle precursors may be measured. On smaller size channels, particle precursors are more likely to be measured.

For more information, please see www.KanomaxFMT.com.



Methodology for Measuring the Volumetric Inspection Rate

To relate the properties of the aerosol to the properties of the hydrosol, the value for the Volumetric Inspection Rate (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 ScanningTPC3 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 an Annular Flow Ion Mobility Spectrometer (AFIMS) placed downstream of a model 9110 NanoParticle Nebulizer (NPN). The AFIMS includes a model 3660 Annular Flow Ion Mobility Classifier (AFIMC) which acts as a size-based band-pass filter, and a model 3650 Fast Condensation Particle Counter (FCPC) as the particle detector. The combination of an ion mobility classifier and a CPC is used extensively in the aerosol field to measure aerosol properties. By using an AFIMS, 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 AFIMS, $Q_{Aerosol}$ 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 ScanningTPC3 Performance

ScanningTPC3 performance can be verified by the direct injection of size-specific concentration standards, and the built-in online sample dilution module can help the ScanningTPC3 to discriminate between particles composed of DNVR and silica by limiting DNVR introduction.

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 ScanningTPC3 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 ScanningTPC3 is an online trend monitor for detecting 3 nm (and larger) particles and particle precursors in UPW systems. It can also be used to monitor some solvents under certain conditions, namely:

- IPA 0.10 v/v at the Sample port (limited by peristaltic pump tubing); Undiluted IPA may be injected with a pressure chamber; 0.0001 v/v at nebulizer
- Hydrogen Peroxide: 0.35 v/v at sample port; 0.001 v/v at nebulizer

- Ammonia: Max pH 12 at sample inlet / pH 9 at the nebulizer
- HCl: Min pH 2 at sample inlet / pH 5 at the nebulizer

For all other chemicals and chemical blends, contact the factory.

How to Install the ScanningTPC3

The ScanningTPC3 is used as a standalone instrument. For calibration, an online sample dilution module is used to introduce the challenge colloid. Installation procedures for the ScanningTPC3 are described on the following pages.

Unpacking the ScanningTPC3

To unpack the ScanningTPC3, follow these instructions:

1. Carefully remove the ScanningTPC3 from its shipping container. Save the original packing materials for use when shipping the ScanningTPC3 back to Kanomax FMT, Inc. for service, or for moving to a different location.

Warning. If the ScanningTPC3 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 ScanningTPC3 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 the packing list were included in the ScanningTPC3 shipment. If any of the items are missing, or damaged, please call Kanomax FMT, Inc. at 651-762-7762

Equipment and Site Requirements

To install the ScanningTPC3 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 ScanningTPC3. 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 ScanningTPC3 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 ScanningTPC3 to your air/nitrogen supply. Used to supply clean, dried compressed air or nitrogen at 10 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 ScanningTPC3 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). Please refer to flaring tool manufacturers' websites for detailed instructions. For example:

Entegris:

https://www.entegris.com/content/dam/shared-product-assets/flaretek-shared/instsheet-flaretek-tube-fitting-heated-flare-2122.pdf

Saint Gobain Performance Plastics:

https://saintgobainperformanceplastics.thomasnet-navigator.com/Asset/ENC_2039.pdf

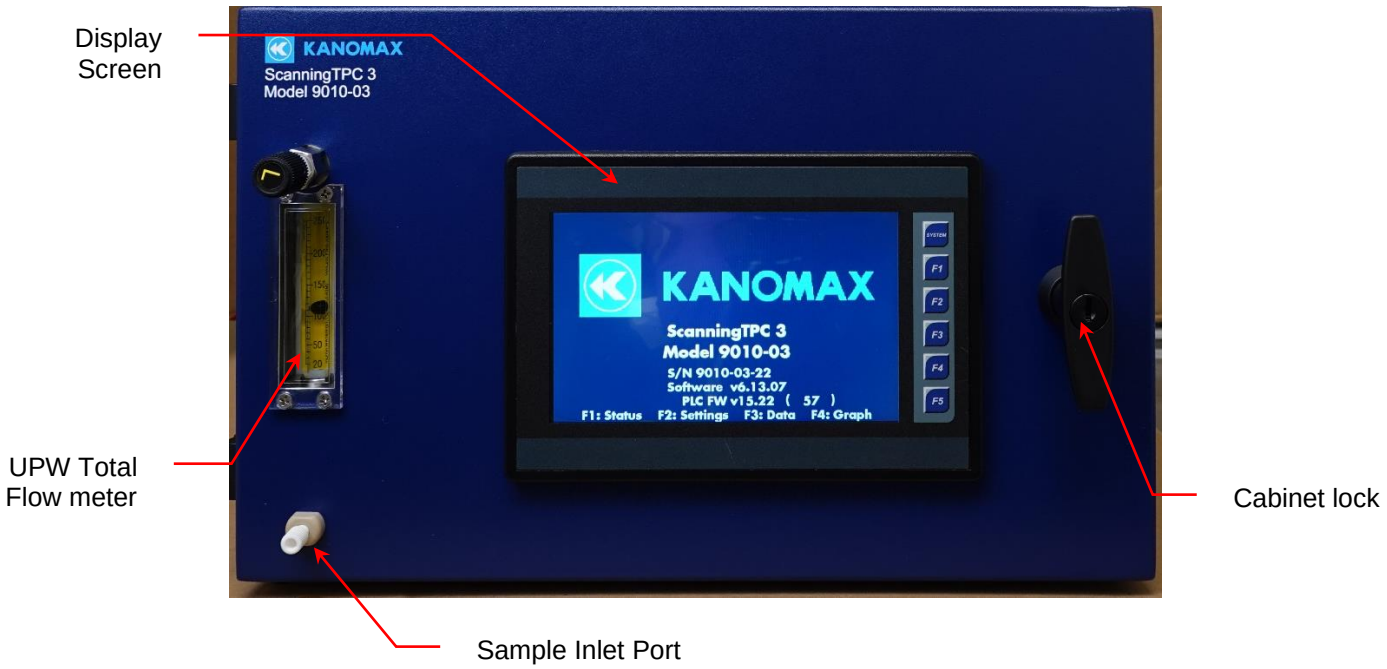
Installing the ScanningTPC3

Installing the ScanningTPC3 includes the following procedures:

- Connecting the CPC communication cables.
- Connecting the ScanningTPC3 to your ultrapure water supply.
- Connecting the ScanningTPC3 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 ScanningTPC3.
- Installing and Connecting the Pressure Vessel (Optional)
- Turning on the air/nitrogen supply.
- Turning on the UPW supply.

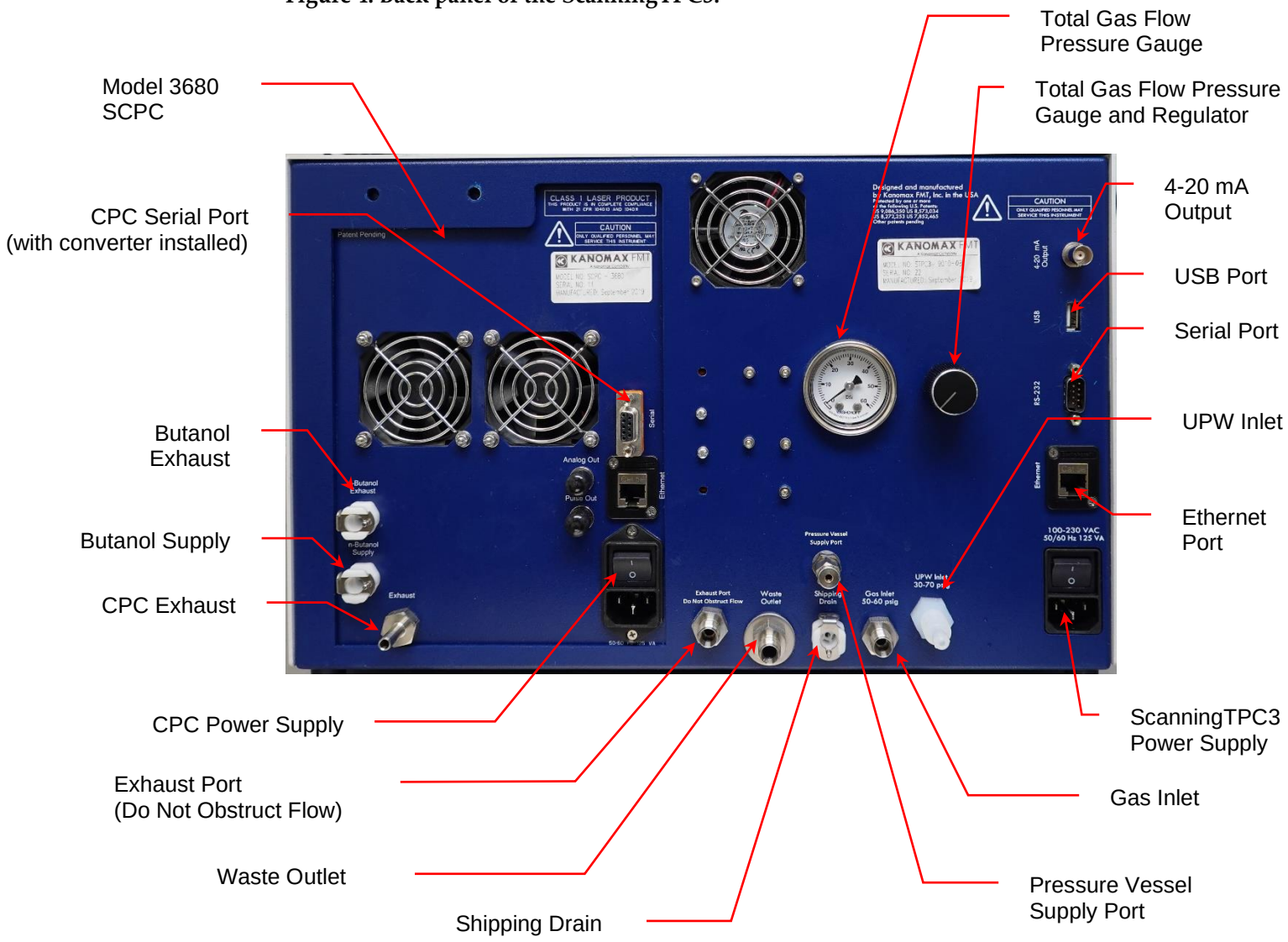
Figures 3 and 4 show the front and back panels of the ScanningTPC3. Operation procedures take place at the front panel, whereas installation procedures are performed at the back panel of the ScanningTPC3. Detailed installation instructions begin on page 11.

Figure 3: Front panel of the ScanningTPC3.



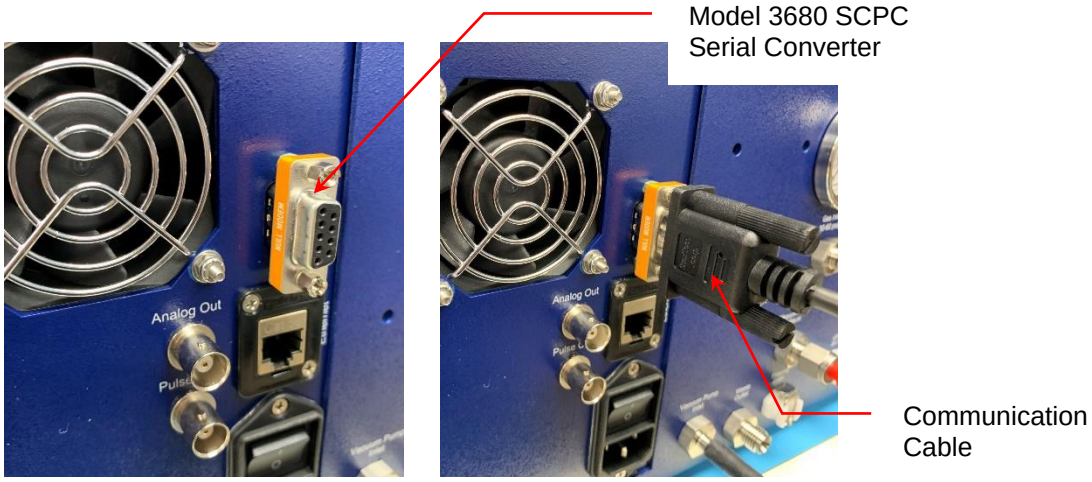
Components of the back panel are shown in Figure 4 below. Internal components of the ScanningTPC3 are shown in Figure 5.

Figure 4: Back panel of the ScanningTPC3.



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. Use the male-to-female serial converter for the Model 3680 SCPC.



Connecting the UPW Supply

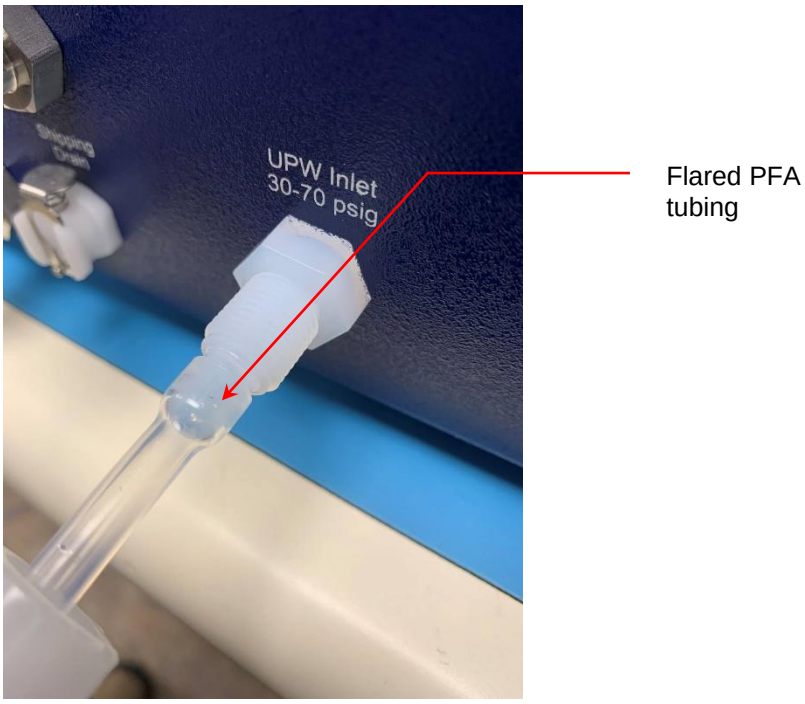
Water must be supplied to the ScanningTPC3 through a ¼-inch outer diameter PFA tube specially adapted to fit the UPW Inlet fitting. To prepare the PFA tube for attachment to the UPW Inlet fitting, take the following precautions:

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

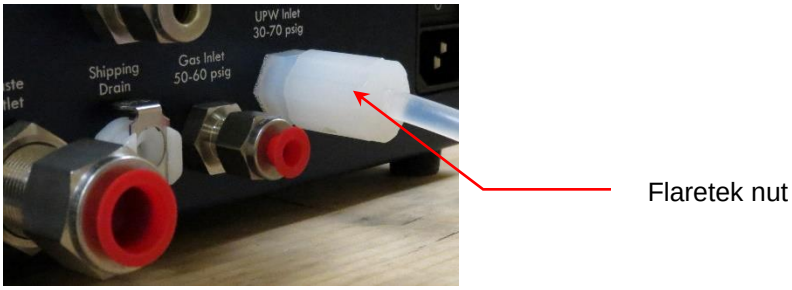
To connect the ultrapure water supply, follow these instructions:

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 12).

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 ScanningTPC3. (See shutdown instructions on page 50).
6. Push the flared end of the tube onto the **UPW Inlet**.



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

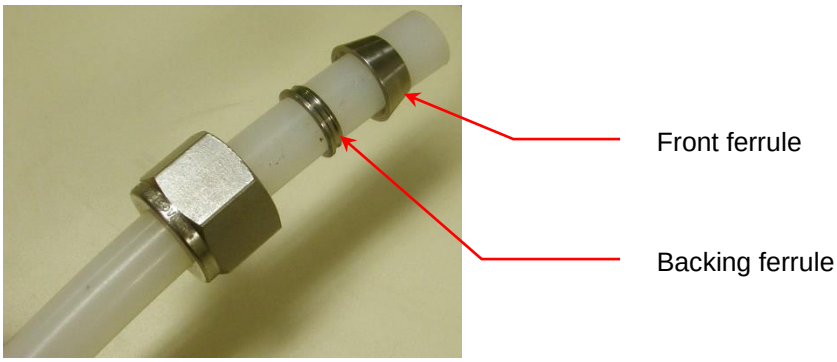


Connecting the Air or Nitrogen Supply

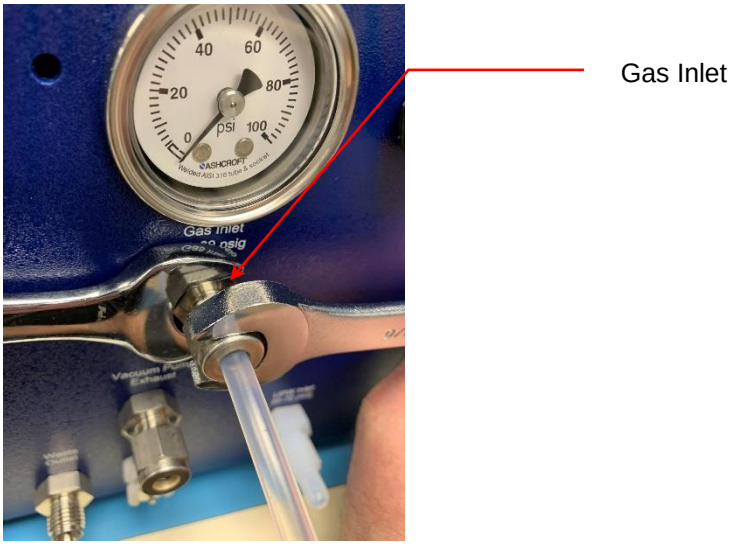
The air or nitrogen supplied to the ScanningTPC3 must be filtered, dried, oil-free and regulated at 345-414 kPa (50-60 psi). Follow these instructions to connect the compressed air or nitrogen supply:

1. Remove the protective cap from the **GAS Inlet** on the back panel. Keep the cap for use when moving or shipping the ScanningTPC3. (See shutdown instructions on page 50).

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.



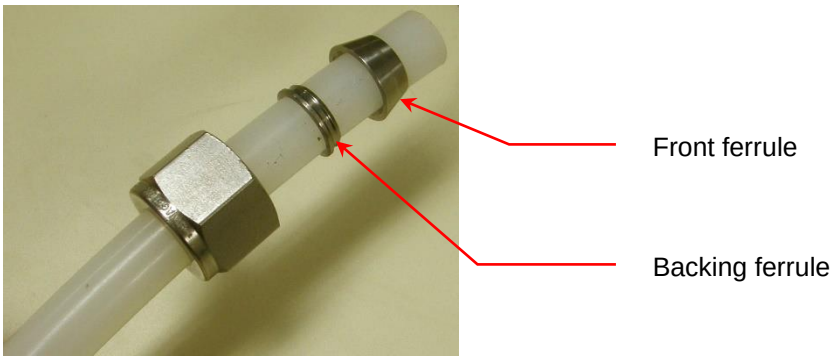
4. Connect the other end of the tube to your air/nitrogen supply.

Connecting to the Waste Drain

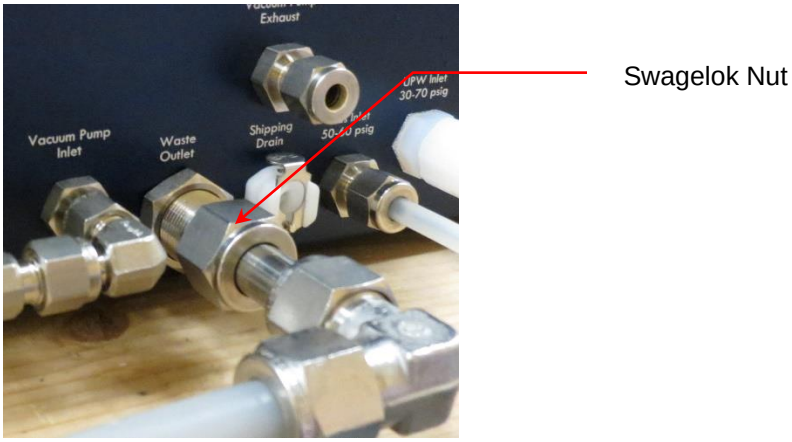
Excess sample from the nebulization module is removed from the instrument using a venturi ejector. Follow these instructions to connect the Waste Outlet to a suitable drain:

1. Remove the protective cap from the **Waste Outlet** on the back panel. Keep the cap for use when moving or shipping the ScanningTPC3. (See shutdown instructions on page 50).

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.



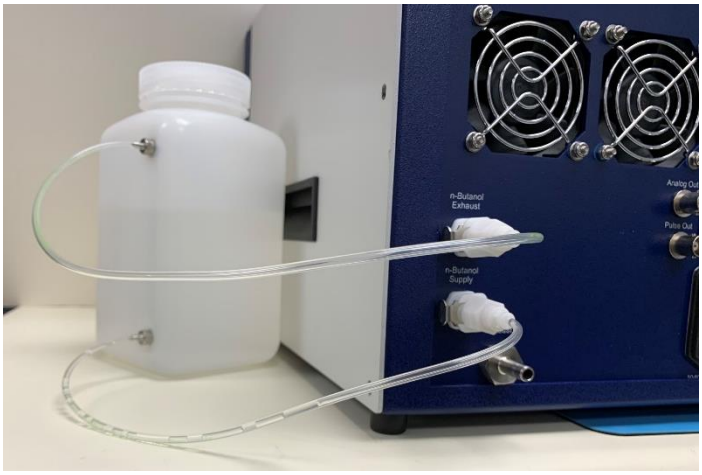
3. Place the other end of the tube over your drain. **Note**: The drain tubing should pitch downwards and vent to atmosphere.

Installing the n-Butyl Alcohol (Butanol) Bottle for Model 3680 SCPC

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

1. Add n-Butyl alcohol to the fill bottle.
2. Insert the quick-disconnect fitting from the top tubing of the n-butyl alcohol bottle into the **n-Butanol Exhaust** port.

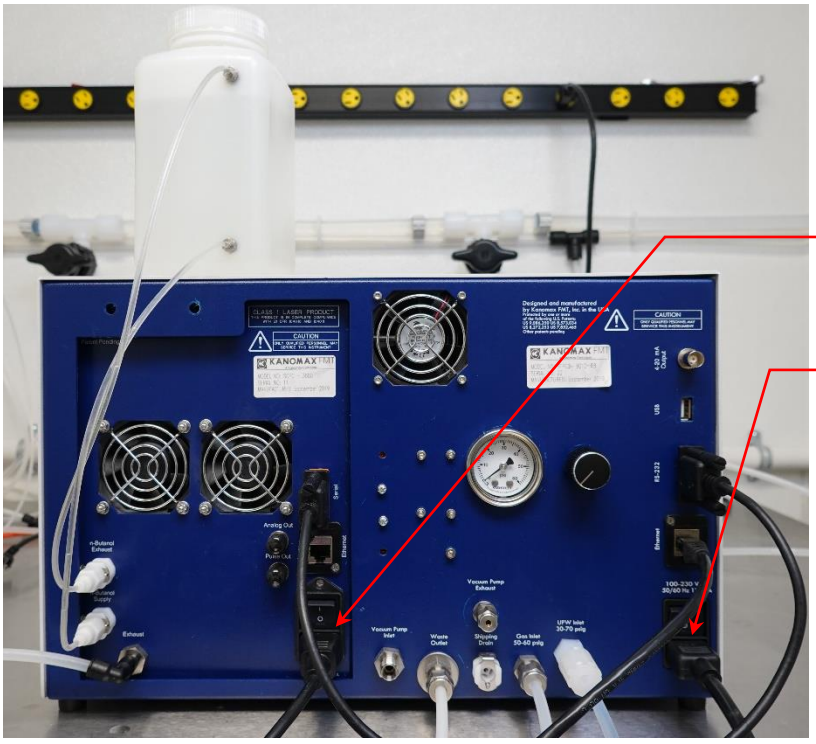
3. Insert the quick-disconnect fitting from the bottom tubing of the n-butyl alcohol bottle into the **n-Butanol Exhaust** port.



Connecting the Power

To connect the power supply, follow these instructions:

1. Plug one of the supplied power cables into the ScanningTPC3 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.

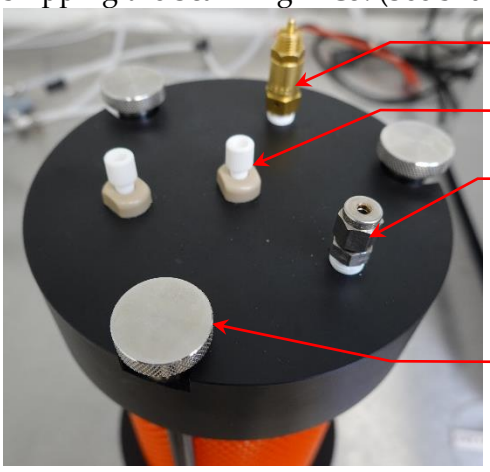
3. Turn on both power switches.

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.

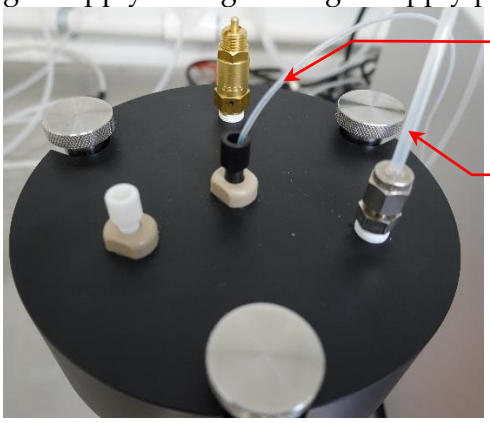
Installing and Connecting the Pressure Vessel

A pressure vessel is used to inject high purity chemicals for STPC3 measurements. To install and connect the pressure vessel for chemical injections, follow these instructions:

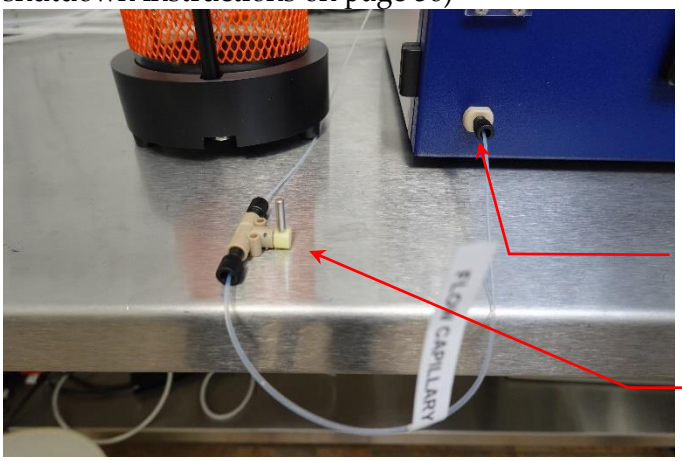
1. Unpack the pressure vessel, open the cap by unscrewing the three locking screws, remove the accessory packs from the pressure vessel and reinstall the cap.
2. Locate the ports for sample tubing and gas supply and remove their plug nut and protective cap. Keep the nut and cap for use when moving or shipping the ScanningTPC3. (See shutdown instructions on page 50)



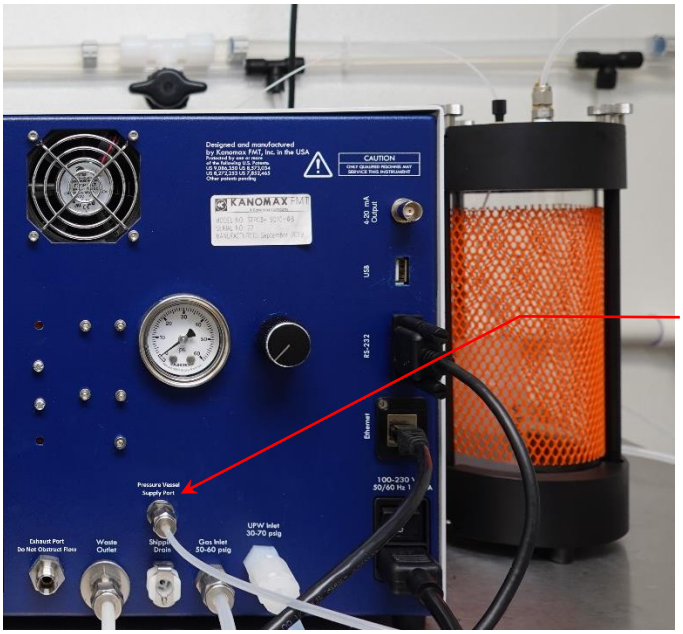
3. Insert the open end of the 1/16″ OD sample tubing through the sample tubing port and tighten positioning nut. Connect one end of the 1/8″ OD gas supply tubing to the gas supply port and tighten the Swagelok nut.



4. Remove the nut from one side of the shutoff valve and connect the open side with the end nut of the sample tubing. Remove the **Sample Inlet** plug nut from the STPC3 front panel and connect the other end of the shutoff valve assembly to the **Sample Inlet** port. Tighten all connections and shut the valve by turning its handle to perpendicular position. Keep the nut and cap for use when moving or shipping the ScanningTPC3. (See shutdown instructions on page 50)



5. Connect the other end of the gas supply tubing to the **Pressure Vessel Supply Port** on the STPC3 back panel, tighten the Swagelok nut.



Caution: Wait 2 minutes after the pressure vessel chamber pressure reaches its setpoint before you switch open the shutoff valve to avoid UPW back flow from STPC3 into the pressure vessel.

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 ScanningTPC3, please contact Kanomax FMT, Inc. at 651-762-7762, or email to ContacUs@KanomaxFMT.com. (Customers in Asia please call +81 6-6877-0183.)

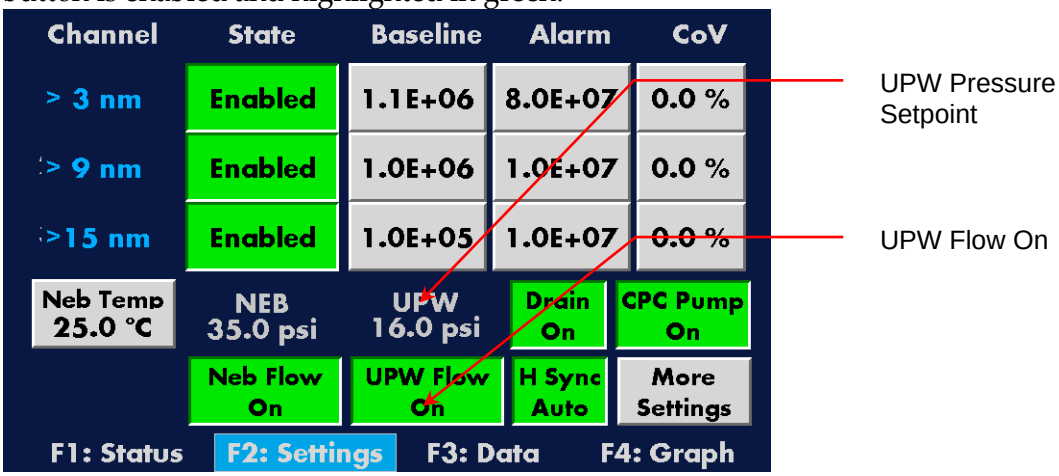
Operation Instructions

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.

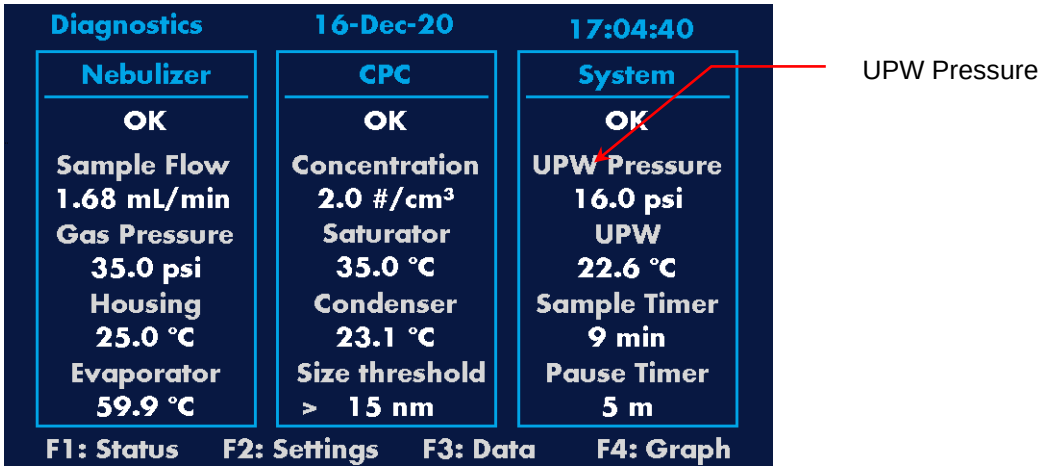
Checking the UPW Pressure

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

1. Press **F2** to display the **Settings** screen, check if the "UPW Flow On" button is enabled and highlighted in green.



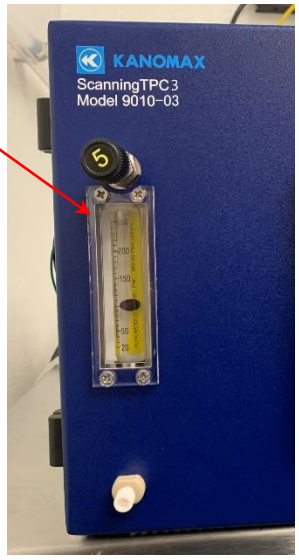
2. Press **F1** to display the **Status** screen, touch **Diagnostics** button and check if the UPW pressure reads the UPW pressure setpoint on the **Diagnostics** screen.



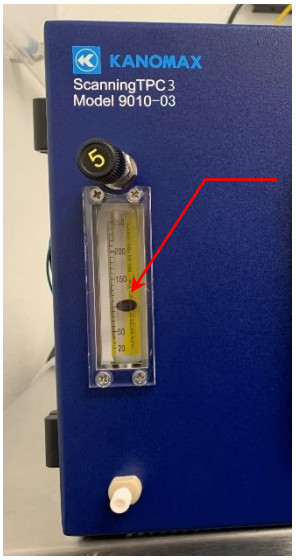
Checking the Total Flow Rate

To check the Total Flow rate, follow these instructions:

1. Locate the flow meter mounted on the front panel, to the left of the PLC screen.



2. Check the flow rate on the flow meter. The center of the float 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.

The Front Panel

Once all installation procedures have been completed, you are ready to begin standard operation of the ScanningTPC3.

Figure 6: Front Panel of the ScanningTPC3.

Buttons for operating the ScanningTPC3

The Scanning TPC3 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.)

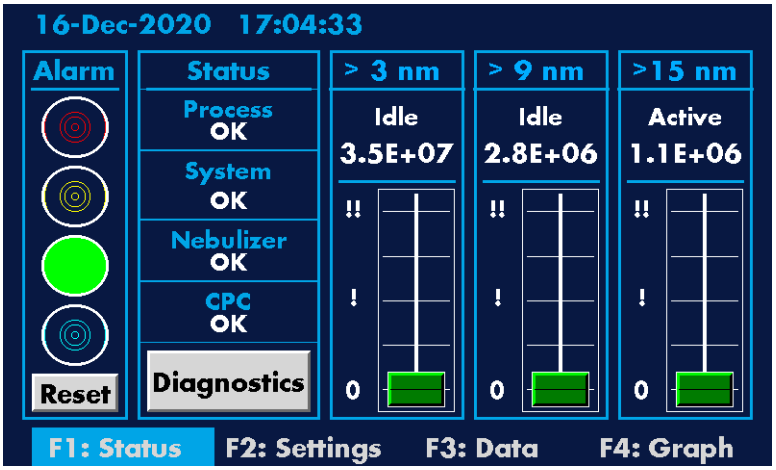
The buttons perform the following functions:

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 ScanningTPC3 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.



The following categories are displayed on the Status screen:

Alarm

The **Alarm** category displays the current overall status of operation, indicators including

Red Indicator On Steady: concentration exceeded alarm setpoint for a full cycle. This alarm requires manual reset.
Red Indicator On Blinking: fault detected and the alarm will automatically reset itself once the fault is cleared.
Yellow Indicator On Steady: parameter(s) is within 75% of alarm setpoint or no measurement channels are selected. No manual reset needed.
Green Indicator On Steady: instrument is functioning normally.
Blue Indicator On Steady: instrument is in warmup process.
Blue Indicator On Blinking: transitioning to next threshold size channel.

Note: To reset the alarm, touch **Reset** button at the bottom of the alarm tree.

Status Text

The **Status** category displays current operation status of each individual sub-system and is displayed in the respective system textbox.

System status texts include:
OK: no faults.
Fault: fault shown in Nebulizer, CPC, or System categories on Diagnostics screen.
Warmup: Nebulizer and/or CPC in warmup process.
Stabilizing: transitioning threshold size channel.
Alarm: concentration alarm occurred.

Nebulizer status texts include:
OK: no faults.
Fault: temperature out of range.
Warmup: Nebulizer in warmup process.

CPC status texts include:
OK: CPC is functioning correctly.
Fault: temperature out of range.
Warmup: saturator temperature has not reached the operating temperature setpoint.
Stabilizing: transitioning threshold size channel.
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.

Channel Indicators

The Channel Indicators category (**> 3 nm, > 9 nm,** and **> 15 nm**) indicates current operation status of each threshold size channel.

Channel Textbox status texts include:
Active: currently counting.
Idle: other channel is currently counting.
Inactive: size channel not selected.
Stabilizing: channel is in transition.

Channel Concentration status text displays the averaged concentration value for each respective channel in #/ml, and it resets at the beginning of every scanning cycle.

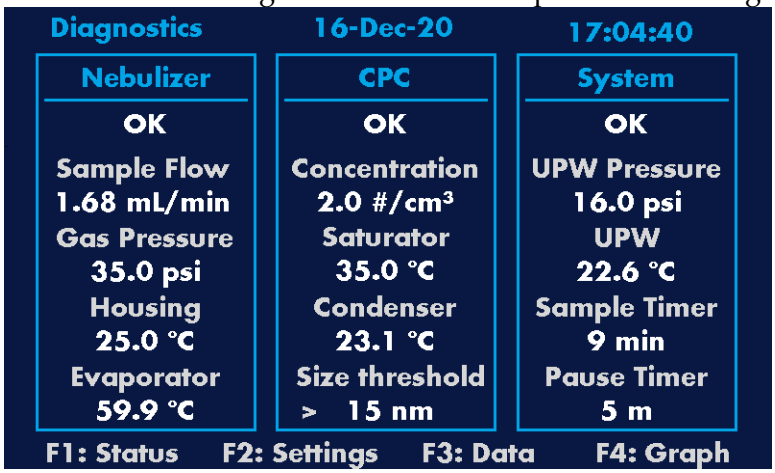
Channel Concentration Bar displays the concentration level above baseline using the equation:

$$Scale = \frac{(Conc_{Measured} - Conc_{Baseline})}{2(Conc_{Alarm} - Conc_{Baseline})}$$

The symbol "**!**" indicates the alarm concentration and "**!!**" indicates 2X the alarm concentration.

Viewing Detailed Operation Parameters

To see more detailed instrument operation parameters, touch **Diagnostics** button on **Status** screen to access the **Diagnostics** screen, all information is grouped by three major components, **Nebulizer**, **CPC**, and **System**. Text in red indicates the reading exceeds the pre-set error range, and text in yellow indicates the reading exceeds 75% of the pre-set error range.



Nebulizer

The **Nebulizer** group has the following parameters:

Status Text: same content as shown in the text box on **Status** screen.
Sample 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, with its nominal range of 2 +/- 2 ml/min.
Gas Pressure indicates the pressure at the gas manifold that supplies the nebulizer, with its setpoint at 35 +/- 1 psi.
Housing indicates the temperature of the nebulizer, nominally controlled to 25°C.
Evaporator indicates the Temperature reading of the aerosol exiting the heated evaporator, nominally controlled to 60°C.

Warning: UPW will not flow until the evaporator temperature reaches 50°C.

CPC

The **CPC** group has the following parameters:

Status Text: same content as shown in the text box on **Status** screen.
Concentration indicates the aerosol particle concentration read from the internal CPC.
Saturator indicates the saturator temperature in the internal CPC, setpoint at 35 +/- 1 degree C for Kanomax FMT SCPC.
Condenser indicates the condenser temperature in the internal CPC.

Note: setpoint varies for each threshold size, for > 3 nm, > 9 nm, > 15 nm channels, respectively.
Size Threshold indicates the current active threshold size channel.

System

The **System** group has the following parameters:

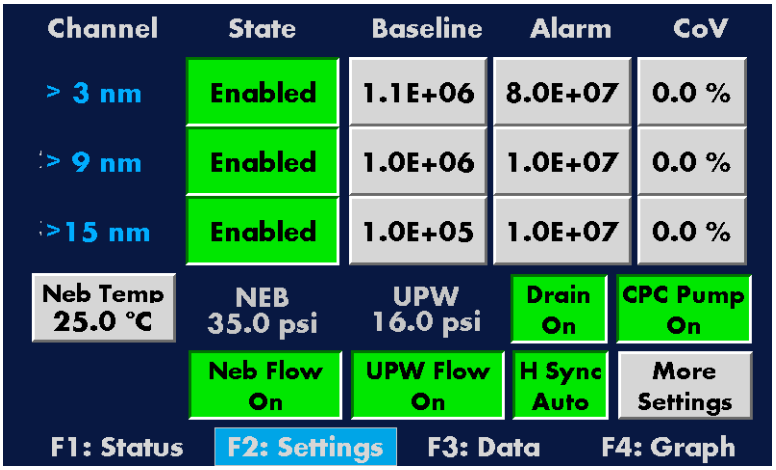
Status Text: same content as shown in the text box on **Status** screen.
UPW Pressure indicates the pressure downstream of the internal pressure regulator and is nominally set to 14 – 18 psi. The UPW Pressure setpoint is set at the factory and should not need adjusting. However, if you find that water pressure is not at the correct pressure, follow the troubleshooting instructions on page 23.
Warning: Adjusting the UPW Pressure changes the total flow into the instrument and should only be done with guidance from KFMT.
UPW Temperature indicates the temperature of the total UPW flow, measured downstream of the nebulizer sample pickoff.
Sample Timer: time remaining on current active threshold size channel.

Pause Timer: time remaining for stabilization between threshold size channels.

Viewing or Changing Instrument Settings

To view and/or change the instrument settings, press **F2** and you see the following screen.

Note: Press **More Settings** to see a menu that allows you to set the date and time, configure the network and update the firmware.



Size Bin and State

The ScanningTPC3 can count three particle size threshold channels: > 3, > 9, and > 15 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.

Baseline

Baseline indicates the reference baseline concentration used to set alarm level for the specified size channel, touch the textbox and use the pop-up keypad to type in a value. **Note**: press the decimal "." twice to enter the "E" symbol.

Alarm

Alarm indicates the alarm concentration used to set alarm level for the specified size channel, touch the textbox and use the pop-up keypad to type in a value. **Note**: press the decimal "." twice to enter the "E" symbol.

CoV

CoV sets the CoV value that activates the yellow indicator.

Nebulizer Temperature

The nebulizer temperature can be set by touching the **Neb Temp** button and using the onscreen keypad. Nominal setpoint is 25°C..

Neb Flow On or Off

Neb Flow On/Neb Flow Off is a toggle switch that allows you to turn the nebulizer gas flow on or off. **Note**: there is a 5 second delay in shutting off to allow for release of residual pressure in the electronic regulator. The UPW flow will also shut off when the Neb Flow Off is enabled.

UPW Flow On or Off

UPW Flow On/UPW Flow Off is a toggle switch that allows you to turn the UPW flow on or off. **Note**: there is a 5 second delay in shutting off to allow for release of residual pressure in the electronic regulator. The **UPW Flow On** is disabled once the **Neb Flow Off** is enabled.

Drain On or Off

Drain On/Drain Off is a toggle switch that allows you to turn the solenoid drain pump on or off. **Note**: the drain pump should always be On when the **UPW Flow On** is enabled. It may be turned off to increase pump life if the **UPW Flow Off** is enabled for an extended time period.

CPC Pump or Off

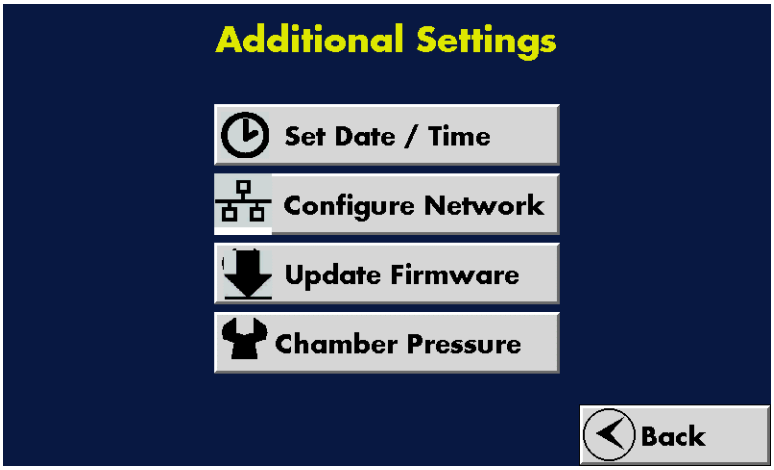
CPC Pump On/CPC Pump Off is a toggle switch that allows you to turn the CPC pump on or off. **Note**: CPC pump should always be On during a measurement operation.

Hour Sync Auto or Off

Hour Sync Auto/ Hour Sync Off is a toggle switch that allows you to force the ScanningTPC3 to restart the first active size threshold channel on the change of hour or not. **Note**: the sync only applies to the first hour change after enabling the function. Changing it from **Hour Sync Auto** to **Hour Sync Off** and then back to **Hour Sync Auto** will trigger a new sync.

Viewing Additional Settings

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



Setting the Date and Time

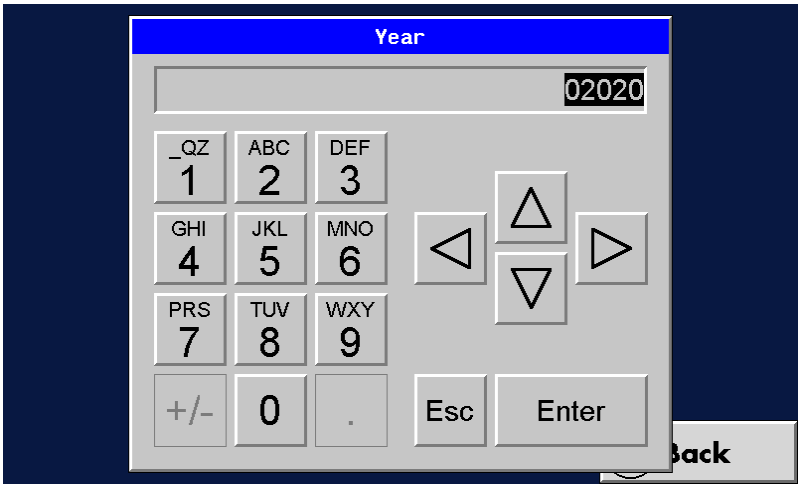
You can adjust the date and time to match your local time. If you do not, dates and times will be inaccurate on the graphs.

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.

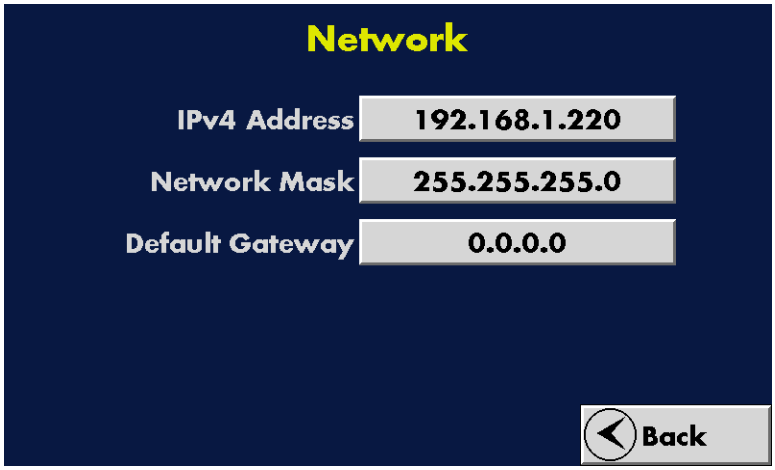


5. Press **Apply** to set the date and time using the new values.

Configuring the Network

You can configure the connection between the ScanningTPC3 and your network.

Caution: This functionality is intended to support future features. Currently you cannot control the ScanningTPC3 or obtain data using its Ethernet connection.



Updating the Firmware

If you need to update the ScanningTPC3 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:

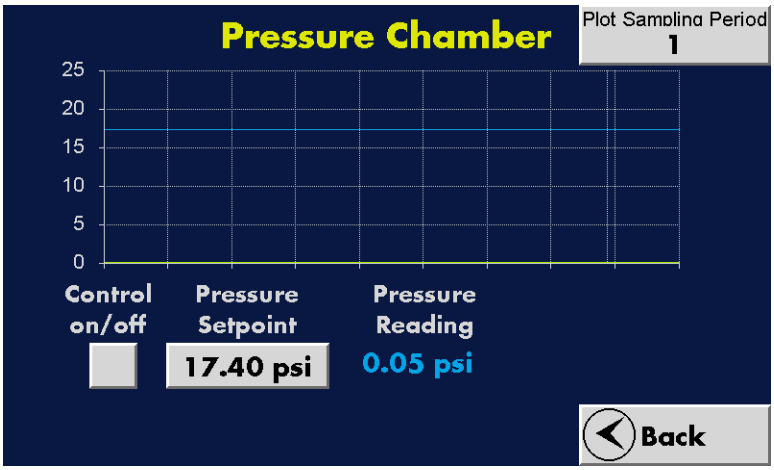
1. Copy the Kanomax FMT-provided .PGM file to a USB Flash drive or the internal microSD card.
2. Insert the USB drive into the USB port on the back panel of the ScanningTPC3.
3. Press **F2** to see the Settings screen.
4. Press **Additional Settings** > **Update Firmware**. You see the following screen.

5. Press **Idle** button to stop data collection and prepare the PLC for firmware upgrade. The button turns blue and it meanwhile deactivates the **Run** button.
   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** or **microSD** button, depends on where the .PGM file is located. 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**.

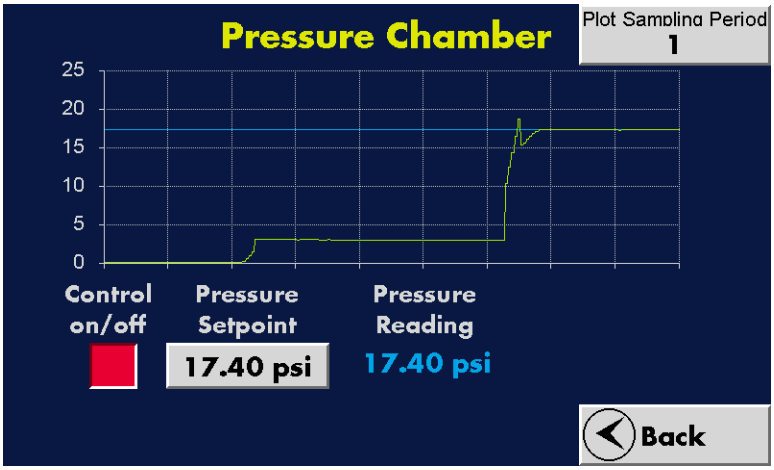
Setting the Chamber Pressure for the Pressure Vessel

The Pressure Vessel requires a stable chamber pressure to inject samples, to set its chamber pressure, follow these instructions:

1. Press **F2** on the main display screen
2. Press **More Settings** on the **Settings** screen.
3. Press **Chamber Pressure** on the **Additional Settings** screen. You see the following **Pressure Chamber** screen.



4. Touch the **Pressure Setpoint** text box to configure the chamber pressure setpoint, nominally set at 1.4 psi above the UPW pressure.
5. Touch the **Control on/off** toggle button to activate/inactivate the chamber pressure supply, **Pressure Reading** displays the real-time pressure inside the pressure vessel, and graph plots the historical data in green.



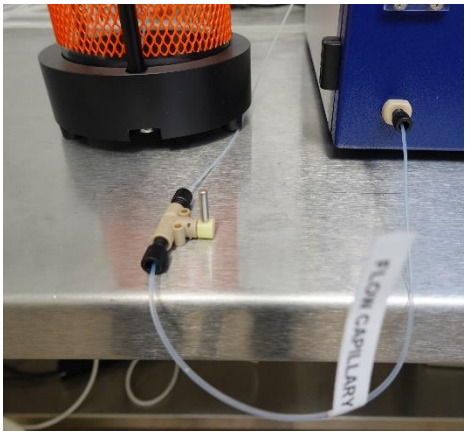
Injecting Samples using the Pressure Vessel

To inject a sample for STPC3 measurement using the pressure vessel, follow these instructions:

Warning: Do not inject sample without first confirming that the Nebulizer Gas Pressure is set to 35 psi.

1. Weigh the sample bottle with a scale and record the reading.

2. Shut the shutoff valve on the sample tubing before the STPC3 **Sample Inlet**.

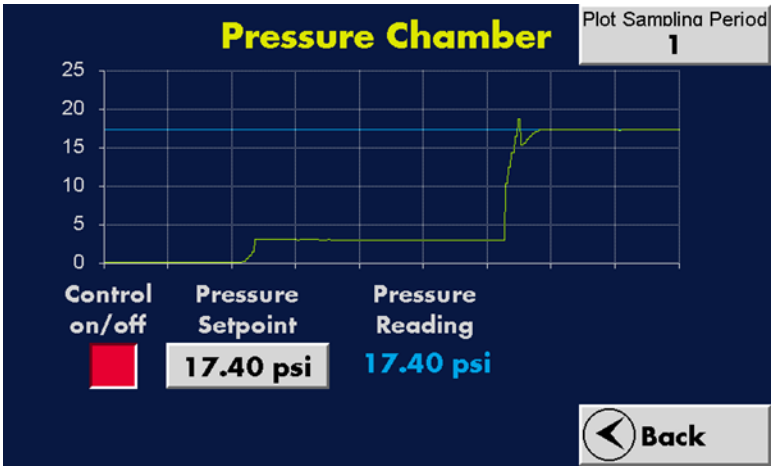


3. Remove the pressure vessel cap and insert the open end of the sample tubing into the sample bottle. It is recommended to drill a hole (approximately 1/8" in size) through the bottle cap for tubing insertion, especially for high volatile chemicals, such as IPA.

4. Sit the sample bottle in the pressure vessel and close the vessel cap by tightening the three locking screws in a rotating pattern until all are firmly fastened.

5. Press **F2** and **More Settings** button, on the **Additional Settings** screen, press **Chamber Pressure** button to view the **Pressure Chamber** screen. Set the chamber pressure (see Setting the Chamber Pressure for the Pressure Vessel on page 35).

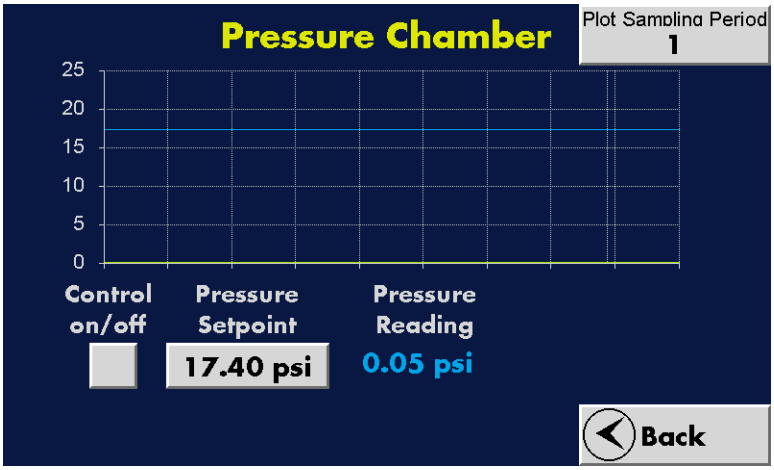
6. Touch **Control on/off** button and toggle it on (shown in red) to activate the pressure supply.



7. When **Pressure Reading** value stabilizes within +/- 0.1 psi of the **Pressure Setpoint**, turn the shutoff valve handle to open (parallel) position.

Caution: Wait 2 minutes after the pressure vessel chamber pressure reaches its setpoint before you switch open the shutoff valve to avoid UPW back flow from STPC3 into the pressure vessel.

8. To stop a sample injection from the pressure vessel, touch Control on/off button and toggle it off (shown in gray), wait until the chamber pressure is released and **Pressure Reading** value approaches zero.



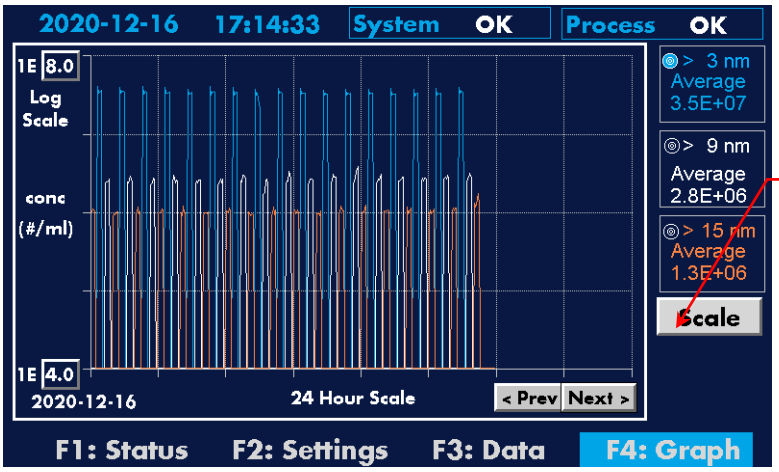
9. Open the vessel cap and remove the sample bottle from the vessel. Weigh the bottle again and record the reading.

Sample bottles used in the pressurized vessel may vary in size and may be glass or plastic; they are not supplied by Kanomax FMT Inc. When the sample is introduced from the pressurized vessel, the vessel pressure should match the normal chamber pressure (UPW pressure + 1.4 psi).

Note: The vessel has a relief valve to vent any excess pressure over 20 psi..

Viewing and Changing Graphs

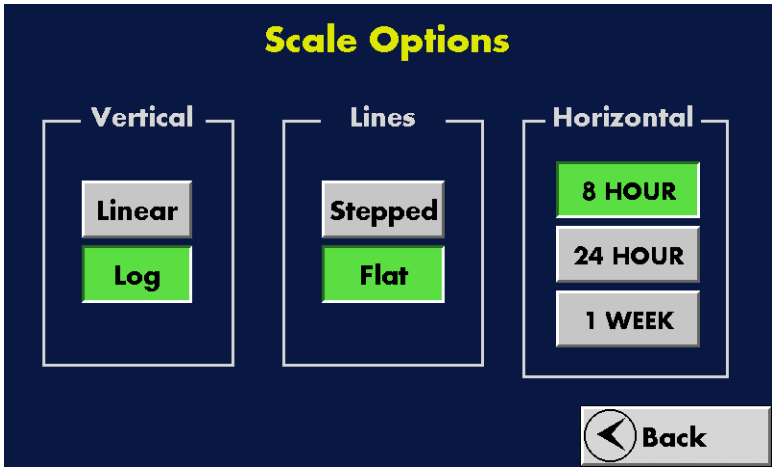
When Data plotting is turned on, press F4 to see a graph displaying trend lines of the liquid particle concentration. If the radio button next to a particle size is highlighted, that particle size is being counted. Each size is represented by a color on the graph: 3 nm = blue; 9 nm = white; 15 nm = orange.



Changing the Graph Style

To change the scale, follow these instructions:

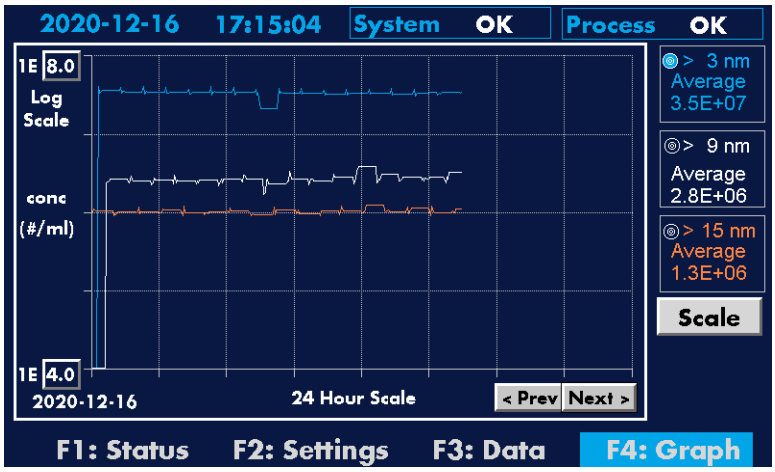
1. Press the **Scale** button on the graph.
2. On the Scale Options screen, press the buttons for the line option you require. The graph automatically updates to reflect your change.



The graph can be displayed in two styles, in **Stepped** style, plotted value goes to 0 between size threshold channels, while it stays at the last plotted value until the size channel is activated again in the **Flat** style.

In the above screen the graph is displayed in stepped style with vertical scale set to log scale from 1E3.0 to 1E8.0, and the horizontal scale set to 8 hours.

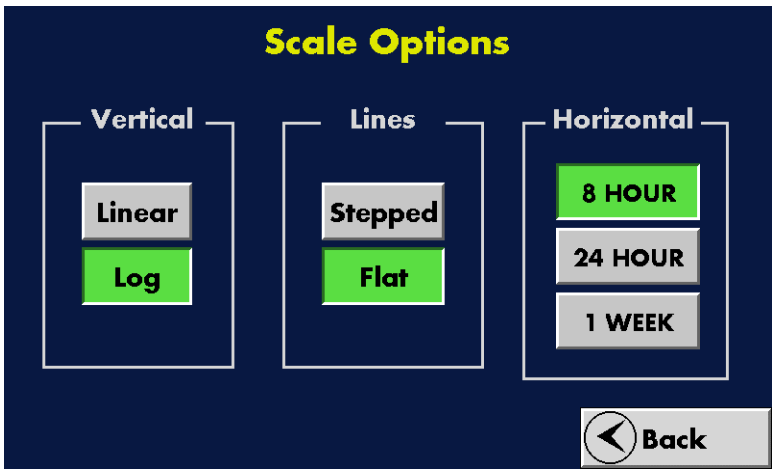
The graph below shows the same data range in flat style.



Changing the Graph Scale

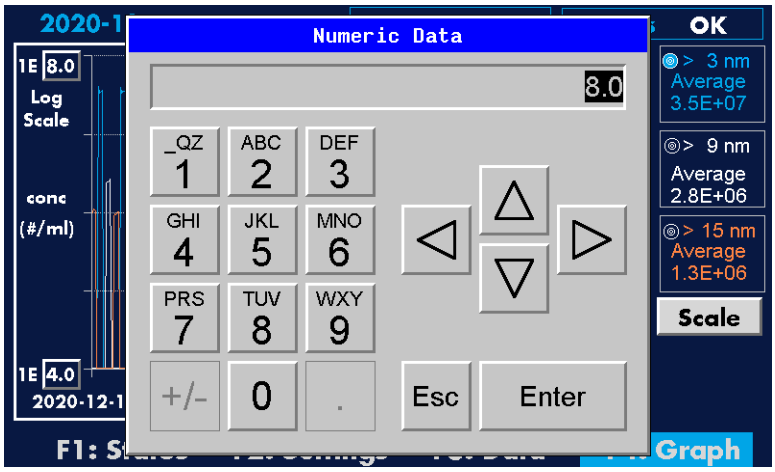
To change the scale, follow these instructions:

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



You can change the scale on the X- and Y-axes of the graph by pressing **Scale** button. Options are:

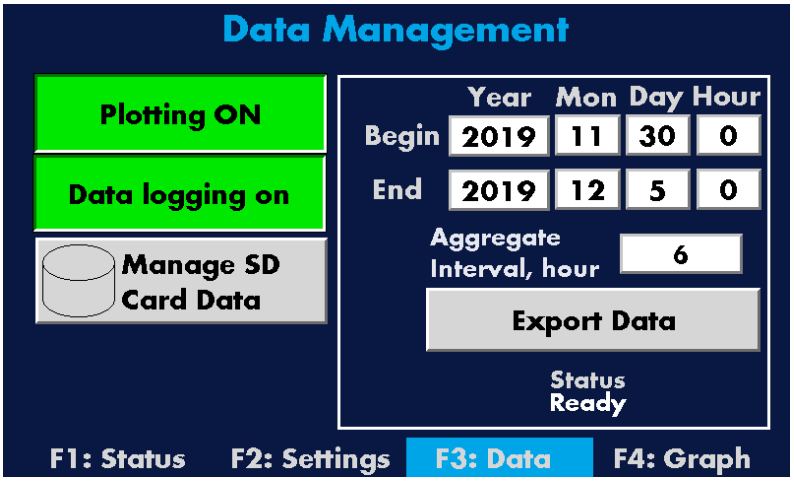
Horizontal Scale: **8 HOUR**, **24 HOUR,** and **1 WEEK**. Data gathered over 8-hour, 24-hour, and 1 week periods.
Vertical Scale: **Linear** and **Log**.
The range of the Y-axis of the graph can be configured by touching the text boxes next to the axis.



Managing Data

Data Logging

The ScanningTPC3 logs concentration and temperature data to internal memory. To manage data options and transfer data, press **F3** and you see the following screen.



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 STPC3 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:

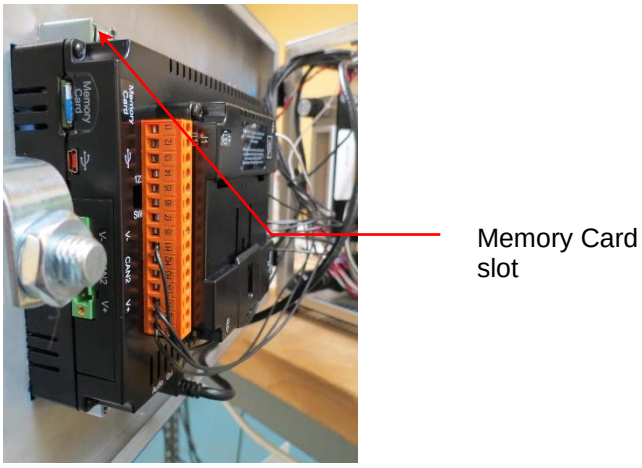
1. Press **F3**.
2. On the Data Management screen, press **Plotting off.** The button turns green and the text changes to P**lotting on**.
   Note: The button toggles between Plotting on and Plotting off. To disable data logging, press Plotting on.

Manage microSD Card Data

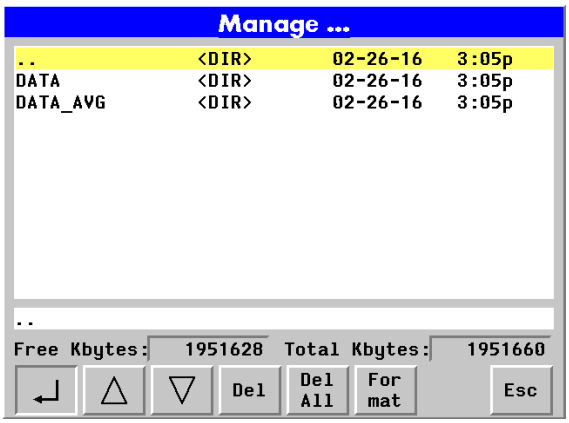
All data logged by the ScanningTPC3 is stored on the internal microSD card. **Note**: Data is not erased from the microSD card when it is transferred to an external flash drive. When the microSD card is full, it replaces the first stored data with the most recently gathered data. Data can be deleted 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.



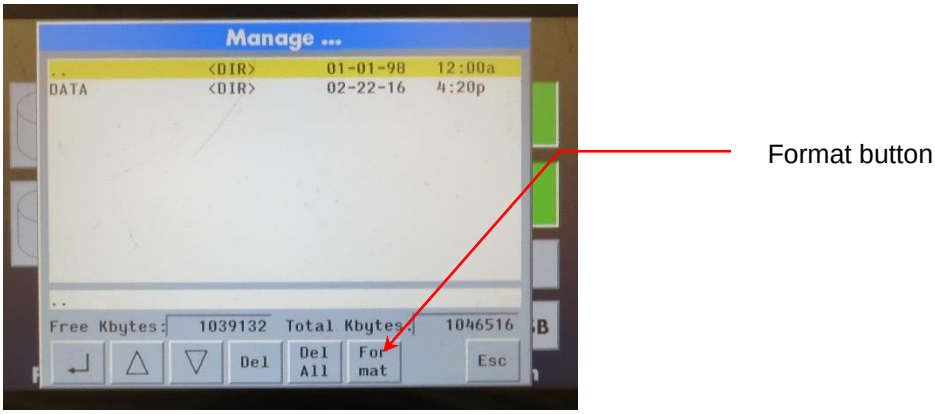
Note: The other buttons on this screen are active but you do not need to use them.

Manage USB Storage 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 STPC3 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.

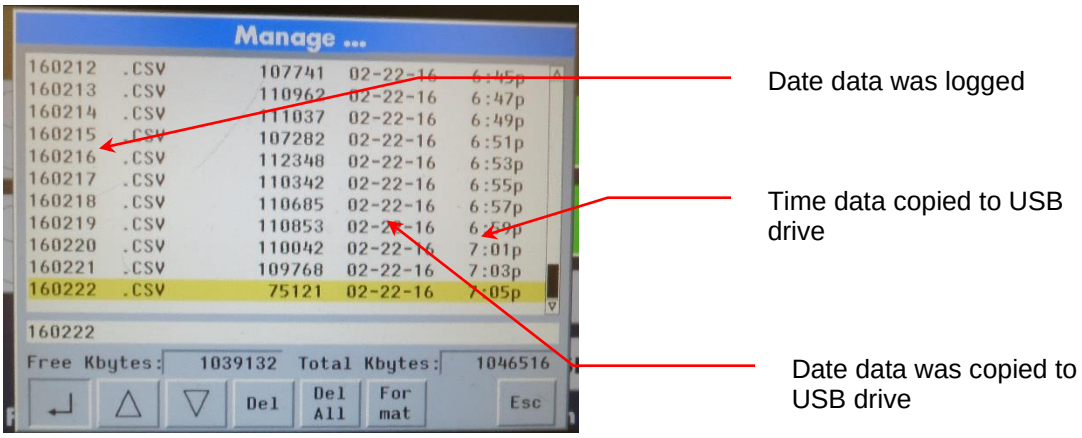
Del Delete the selected directory.

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



Export Data

The ScanningTPC3 logs concentration and temperature data to internal memory. To prepare a concatenated/averaged data file using the stored raw data and to copy the concatenated/averaged file 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 STPC3 back panel.
2. Press **F3** on the front display screen.
3. On the Data Management screen, configure the **Begin** and **End** dates for the concatenated/averaged data file, press **Export Data**. A .csv file containing all raw data from the **Begin** to the **End** date will be created and saved on the microSD card. Wait at least ten seconds for data to transfer before removing the USB Flash drive.
   Note: there is a several second delay before the **Status** indicator changes from **Ready** to **Busy**.

4-20 milliamp (mA) Output

The ScanningTPC3 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

Network connectivity

The ScanningTPC3 includes an embedded single-board computer that can make the instrument's data available via TCP/IP networks. Both wired and wireless interfaces are provided, as described in the following sections.

Wireless

The integrated IEEE 802.11ac wireless network interface acts as a local access point (i.e., creating a "hotspot"). To connect to that, follow the instructions below:

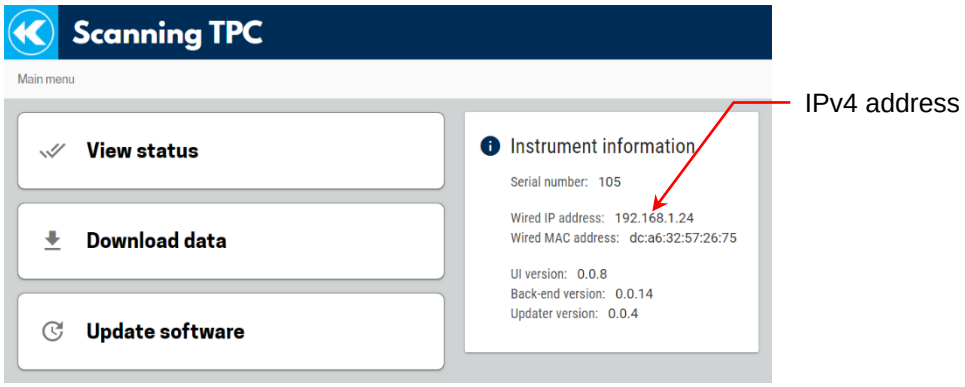
1. Bring a compatible device, such as a modern laptop, into proximity of the instrument (range is limited due to the antenna being inside of the cabinet).
2. Scan for available networks and choose the one that corresponds to the instrument. Each instrument is configured with a unique wireless network name (SSID) at the factory, e.g., "`Kanomax-STPC-SN123`".
3. Enter the corresponding password (PSK) to join the network. The default password is "`ultimatemeasurements`"
4. Once authenticated, the device will receive network configuration via the instrument's built-in DHCP server and become able to access the instrument as well as the network to which the instrument's Ethernet port is connected.

5. Using a web browser, navigate to https://www.stpc.dev/ to access the web interface for this instrument (example image shown below). Note: The built-in DNS server resolves this name to the instrument's local address in order to make this URL work properly. Consequently, use of this URL is only supported when connecting thru the instrument's wireless access point.

Ethernet

The Gigabit Ethernet (IEEE 802.3ab) interface is configured to act as a DHCP client so that it can be automatically configured for the network to which it is attached. (If another configuration mechanism is desired, please contact Kanomax FMT, Inc.) Use one of the following methods to determine the IP address associated with the device:

- Connect to the instrument's web interface using its wireless access point (see previous section) and observe the details shown in the "Instrument information" panel shown on the right. (See example image below)



- Use the dynamic DNS hostname configured at the factory. If the network to which the instrument is connected provides Internet access the device will automatically attempt to register its IP address with a hostname corresponding to its serial number (e.g., `sn123.stpc.dev`) by sending an HTTP(S) request to an external dynamic DNS provider. If the network allows this traffic, then you should be able to connect to the device within 15 minutes of connecting it to the network. Simply navigate to the corresponding URL in a web browser, e.g., https://sn123.stpc.dev/

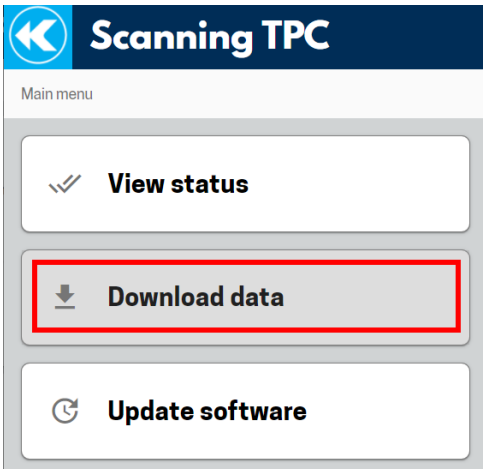
- Check the lease information provided by your DHCP server. For convenience, you may want to configure an address reservation associated with the MAC address of the instrument's Ethernet interface and associate it with an `stpc.dev` hostname on your local

DNS server. Note: Please consult with your local network administrator for assistance related to DHCP and DNS configuration; network administration is beyond the scope of this document.

Web Interface

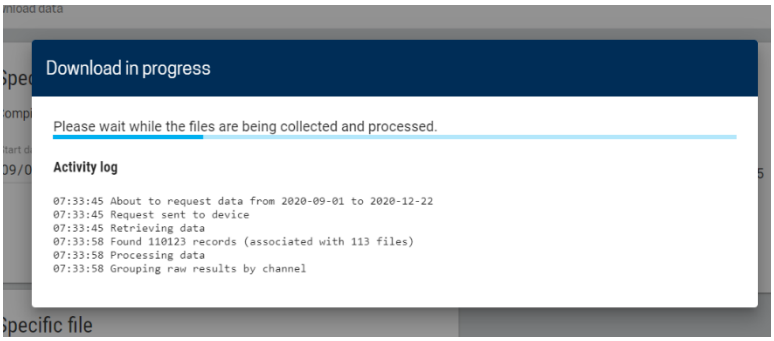
Once connected to a network, the instrument's web interface may be used to download measurement data or update its internal software.

1. Using a modern web browser, navigate to the URL associated with the instrument, e.g., https://sn123.stpc.dev/ (see previous sections for more information)
2. Click the "Download data" button shown on the main menu

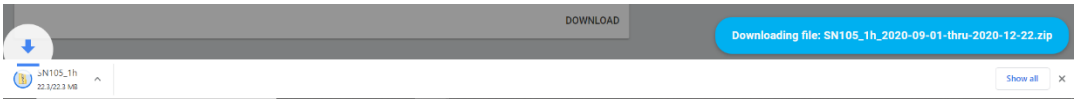


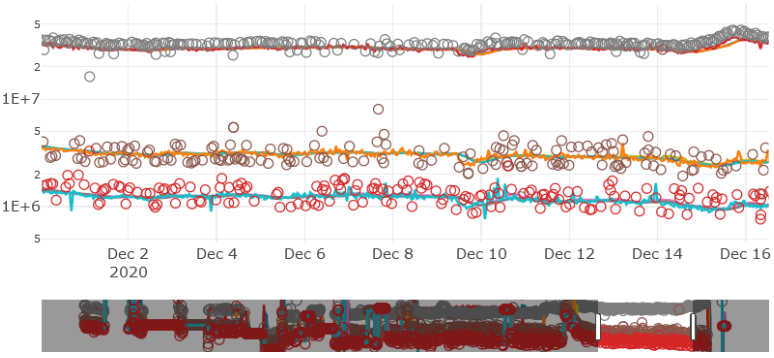
3. Click the "Download" button in the lower-right corner of the main panel ("Specific time period"). Optionally, the settings affecting the first and last dates to include as well as the aggregation interval may be adjusted prior to initiating the download.

4. Wait for the data to be processed. This process typically takes about 5 minutes but varies depending on the amount of data involved and the other tasks being performed by the embedded single-board computer.



5. Once finished, a zip file should automatically begin downloading. This archive contains a CSV (comma-separated values format) file with the processed data suitable for importing into other software for analysis. It also includes the original (unprocessed) data files collected from the instrument and a stand-alone (offline) web page that can be used to visualize the data within a web browser.





Additional protocols

For more information regarding other network communication protocol options, such as Modbus and SECS/GEM, please contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

How to Shut Down the ScanningTPC3 for Moving or Shipping

If you need to move the ScanningTPC3 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 ScanningTPC3 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 TPC3 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 ScanningTPC3.
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 ScanningTPC3 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 TPC3 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.

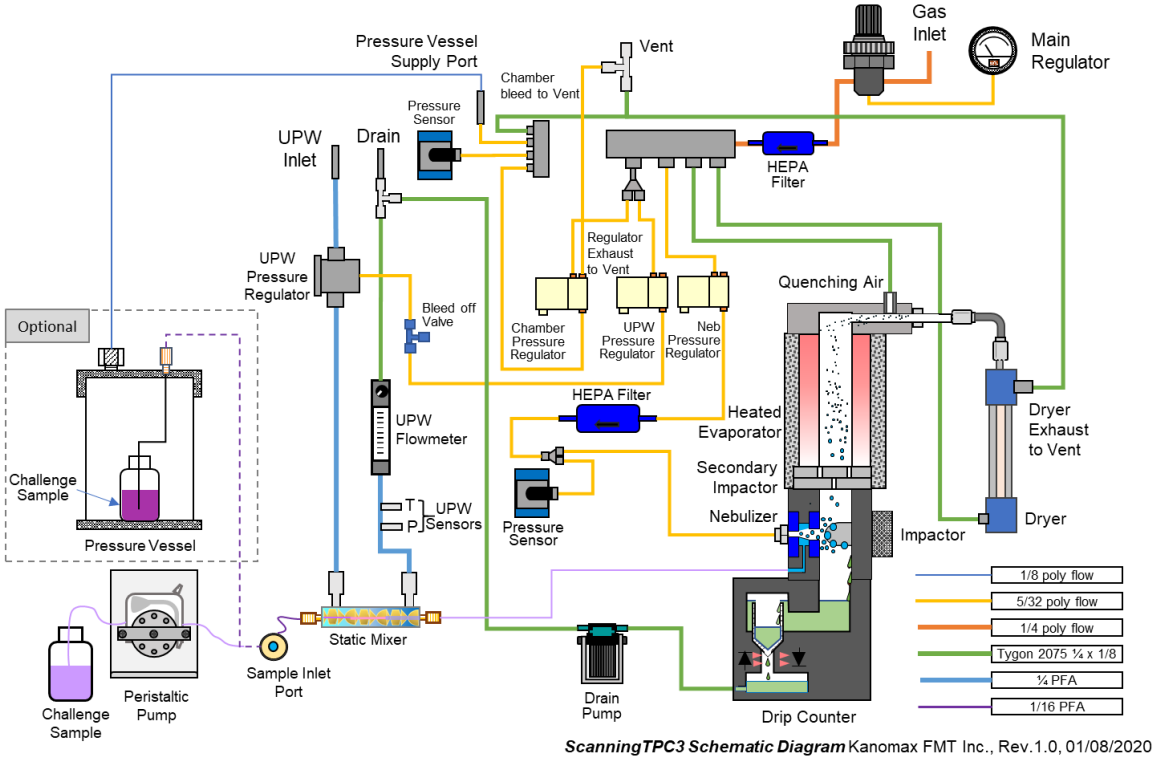
If you have any questions about shipping or moving the ScanningTPC3, contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

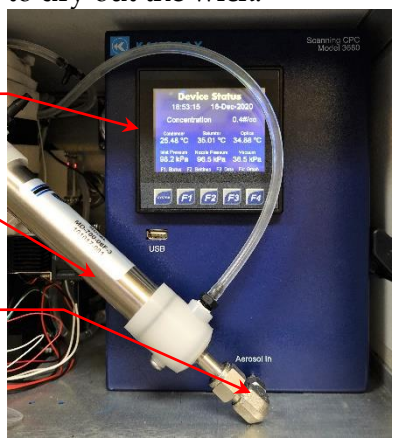
Troubleshooting

There are no user-serviceable parts inside the ScanningTPC3. 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 ScanningTPC3:

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.
Unlocking and opening the cabinet door while power is supplied to the instrument must be done by a qualified service technician.

Figure 2: Schematic diagram of the ScanningTPC3 Model 9010-03.



Problem	Cause	Action
No concentration displayed on ScanningTPC3 graphs, SCPC shows a zero concentration	Communications cable not installed correctly.	Verify that the communications cable is installed correctly. (See instructions on page 15.)
	CPC concentration is above/below the ScanningTPC3 graphing range.	On the Status screen, check that a concentration is reported. Adjust the chart scale. (See page **Error! Bookmark not defined.**.)
	Data plotting is not turned on.	On the Data Management screen, turn on the Data plotting option.
No concentration displayed on ScanningTPC3 graphs and SCPC shows a zero concentration.	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 3680 SCPC is counting zero.	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, press F1 to view the Device Status. Note any parameter value shown in red color.

Nebulizer Flow reads 0.	UPW pressure is out of range.	On the Status screen, check that the UPW Pressure is setpoint ± 0.2 psi. If the pressure is not correct, adjust the pressure following the instructions beginning on page **Error! Bookmark not defined.** 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 **Error! Bookmark not defined.**.)
	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, press F1 to view the Device Status and note any value shown in red color. Refer to the Model 3680 SCPC User Manual for troubleshooting instructions for any noted faults.
Water leaking from ScanningTPC3.	Loose fitting.	Check all fittings and tighten any that are loose. (Do not over-tighten.)
	Water flowing from base of nebulizer. Drain pump not operating properly.	Contact Kanomax FMT, Inc. for instructions.
Water pressure > or < 14 ± 0.1 psi.	Electronic regulator is not operating properly.	Contact Kanomax FMT, Inc., for instructions.
Nebulizer gas pressure not reading 35 psi	Electronic regulator is not operating properly.	Contact Kanomax FMT, Inc., for instructions.
Evaporator temperature does not reach set point (60°C).	Nebulizer evaporator may be flooded.	Shut off the UPW supply and run the ScanningTPC3 for 12 hours to dry it out. Confirm that UPW isn't supplied to the ScanningTPC3 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 50°C.
Nebulizer unable to hold set point temperature (25°C).	Extreme ambient temperature or defective cooling components.	Contact Kanomax FMT, Inc. for instructions.
STPC3 does not recognize external USB Flash drive	Manage USB Storage Data screen displays **Media Card not Present**	Power cycle the ScanningTPC3.
Lost Key	N/A	Contact Kanomax FMT, Inc. for a replacement.

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: ScanningTPC3 Specifications

ScanningTPC3 Specifications

Measurement range	10E3 – 10E10 particles/mL
Inspection volume rate	0.5 – 3.0 μL/min
Threshold sizes	3, 9, 15 nm user selectable (50% detection efficiency)
Number of size channels	1-3
Dead time between channel adjustment	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	2.5 std L/min CDA or Nitrogen, 340-410 kPa (50-60 psi) ANSI IS08573-1:2010 Class 2 for compressed air
Wetted Surface Materials	PFA, PTFE, PEEK, sapphire
Detector working fluid	Reagent-grade (or better) n-Butyl alcohol
Working fluid consumption rate	Approximately 150 mL/day (bottle lasts for one week when cycling all three channels)
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%
Maximum Water Temperature	50°C (122°F)
Dimensions (WxDxH)	42 × 43 × 27 (43 with bottle) cms, 16.7 × 16.8 × 10.5 (16.8 with bottle) inches
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
Communication Interfaces	Ethernet, Wi-Fi, USB, Analog 4 – 20 mA
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. https://www.kanomaxfmt.com/wp-content/uploads/2020/11/scanningtpc_paper_upw_2014_conference.pdf

Derek Oberreit, Steve Kosier, Siqin He, Jihyeon Lee, "Development and Evaluation of a 3 nm Ultrpure Liquid Quality Monitor," UPMicro 2020.

https://www.kanomaxfmt.com/wp-content/uploads/2020/11/KFMT-STPC3-UPM20-Development-and-Evaluation-of-a-3-nm-UltraPure-Liquid-Quality-Monitor.pdf

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