TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
Everywhereyoulook™

User Manual

Model T640
PM Mass Monitor

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TRADEMARKS

SAFETY MESSAGES

Important safety messages are provided throughout this manual for the purpose of avoiding personal injury or instrument damage. Please read these messages carefully. Each safety message is associated with a safety alert symbol, and are placed throughout this manual; the safety symbols are also located inside the instrument. It is imperative that you pay close attention to these messages, the descriptions of which are as follows:

WARNING: Electrical Shock Hazard

HAZARD: Strong oxidizer

GENERAL WARNING/CAUTION: Read the accompanying message for specific information.

CAUTION: Hot Surface Warning

Do Not Touch: Touching some parts of the instrument without protection or proper tools could result in damage to the part(s) and/or the instrument.

Technician Symbol: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

Electrical Ground: This symbol inside the instrument marks the central safety grounding point for the instrument.

CAUTION

This instrument should only be used for the purpose and in the manner described in this manual. If you use this instrument in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences.

NEVER use any TAPI analyzer to sample combustible gas(es)!

For Technical Assistance regarding the use and maintenance of this instrument or any other Teledyne API product, contact Teledyne API's Technical Support Department:

Telephone: 800-324-5190
Email: sda_techsupport@teledyne.com
or access any of the service options on our website at http://www.teledyne-api.com/

CONSIGNES DE SÉCURITÉ

Des consignes de sécurité importantes sont fournies tout au long du présent manuel dans le but d'éviter des blessures corporelles ou d'endommager les instruments. Veuillez lire attentivement ces consignes. Chaque consigne de sécurité est représentée par un pictogramme d'alerte de sécurité; ces pictogrammes se retrouvent dans ce manuel et à l'intérieur des instruments. Les symboles correspondent aux consignes suivantes:

AVERTISSEMENT : Risque de choc électrique

DANGER : Oxydant puissant

AVERTISSEMENT GÉNÉRAL / MISE EN GARDE : Lire la consigne complémentaire pour des renseignements spécifiques

MISE EN GARDE : Surface chaude

Ne pas toucher : Toucher à certaines parties de l'instrument sans protection ou sans les outils appropriés pourrait entraîner des dommages aux pièces ou à l'instrument.

Pictogramme « technicien » : Toutes les opérations portant ce symbole doivent être effectuées uniquement par du personnel de maintenance qualifié.

Mise à la terre : Ce symbole à l'intérieur de l'instrument détermine le point central de la mise à la terre sécuritaire de l'instrument.

MISE EN GARDE

Cet instrument doit être utilisé aux fins décrites et de la manière décrite dans ce manuel. Si vous utilisez cet instrument d'une autre manière que celle pour laquelle il a été prévu, l'instrument pourrait se comporter de façon imprévisible et entraîner des conséquences dangereuses.

NE JAMAIS utiliser un analyseur de gaz pour échantillonner des gaz combustibles!

WARRANTY

Warranty Policy (02024J)

Teledyne Advanced Pollution Instrumentation (TAPI), a business unit of Teledyne Instruments, Inc., provides that:

Prior to shipment, TAPI equipment is thoroughly inspected and tested. Should equipment failure occur, TAPI assures its customers that prompt service and support will be available. (For the instrument-specific warranty period, please refer to the "Limited Warranty" section in the Terms and Conditions of Sale on our website at: http://www.teledyne-api.com.

Coverage

After the warranty period and throughout the equipment lifetime, TAPI stands ready to provide on-site or in-plant service at reasonable rates similar to those of other manufacturers in the industry. All maintenance and the first level of field troubleshooting are to be performed by the customer.

Non-TAPI Manufactured Equipment

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

Product Return

All units or components returned to Teledyne API should be properly packed for handling and returned freight prepaid to the nearest designated Service Center. After the repair, the equipment will be returned, freight prepaid.

The complete Terms and Conditions of Sale can be reviewed at http://www.teledyne-api.com

CAUTION – Avoid Warranty Invalidation

Failure to comply with proper anti-Electro-Static Discharge (ESD) handling and packing instructions and Return Merchandise Authorization (RMA) procedures when returning parts for repair or calibration may void your warranty. For anti-ESD handling and packing instructions please refer to the manual, Fundamentals of ESD, PN 04786, in its "Packing Components for Return to Teledyne API's Customer Service" section. The manual can be downloaded from our website at http://www.teledyne-api.com under Product Manuals; RMA procedures are under Return Authorization.

ABOUT THIS MANUAL

This user manual, part number 08354, provides instructions for the setup, installation, and operation of the T640 Real-time Continuous PM Monitor.

Support manuals, such as electrostatic discharge (ESD) prevention and various communications, are available on the TAPI website http://www.teledyne-api.com under Product Manuals.

Note

We recommend that all users read this manual in its entirety before operating the instrument.

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1. INTRODUCTION, SPECIFICATIONS, APPROVALS, AND COMPLIANCE

The Teledyne API Model T640 with 640X Option is a real-time, continuous particulate matter (PM) mass monitor that uses scattered light spectrometry for measurement. The T640 measures 2.5 PM, and the 640X Option measures 2.5, 10, and coarse PM.

1.1. SPECIFICATIONS

Table 1-1 presents the T640 PM Mass Monitor specifications.

Table 1-1. Specifications

Parameter	Specification	
Measurement Principle	90° white-light scattering	
Light Source	Polychromatic LED	
Particle Size Resolution	0.18 – 20µm over 256 channels, combined to 64 channels for mass calculation	
PM Mass Resolution Measurement Range	0.1 – 10,000 µg/m^3	
Mass Measurement & Display Resolution	0.1 µg/m^3	
Precision	+/- 0.5 µg/m^3 (1-hr average)	
Lower Detectable Limit	< 0.1 µg/m^3 (1-hr average)	
Mass Concentration Accuracy T640 640X Option	 Exceeds US EPA Class III PM2.5 Exceeds US EPA US EPA PM10 FEM and Class III PM2.5 & PM10-2.5 FEM performance requirements for additive and multiplicative bias compared to FRM samplers	
Flow Rate T640 640X Option	 5.0-lpm 5.0-lpm + 11.67-lpm bypass flow	
Flow Accuracy	Within +/-1%; (Typically within +/- 0.5%)	
AC Power Instrument External pump (640X Option only)	Rating 110-120 V, 60 Hz 3.0 A 220V-240V, 50/60 Hz 3.0 A 110-120 V, 60 Hz 3.0 A 220V-240V, 50/60 Hz 3.0 A	Typical Power Consumption <120 W (at 120 VAC) <120 W (at 120 VAC) <360 W (at 120 VAC) <360 W (at 120 VAC)
Communication	1 Ethernet: 10/100Base-T (supports MODBUS) 2 USB device ports Optional: 1 USB com port	

Parameter	Specification
Data Storage	4 Gb memory allows for >1 year of data storage Resolution (data rate): 1-minute to 48-hour; fully user-defined
Dimensions	H x W x D: 7" x 17" x 14" (178 x 432 x 356 mm)
ASC (heater tube)	43" (1092 mm) above the lid
ASC w/T640 inlet	53.5" (1359 mm) above the lid
ASC w/640X Option inlet	70" (1778 mm) above the lid
Optional external shelter	HxWxD: 45" x 25" x 25" (1143 x 635 x 635 mm)
Weight	19 lbs (8.6 kg) w/ T640 ASC + inlet 27 lbs (12.2 kg); w/ 640X Option ASC + inlet 30 lbs (13.6 kg)
Optional external shelter	115 lbs (52 kg)
Operating Conditions	
Operating temperature	0 - 50°C, non-condensing
Ambient temperature	-40 - 60°C
Ambient Relative Humidity	0 - 100%
Sample Humidity Control	Aerosol Sample Conditioner (ASC) 24VDC 90W (max) heater controlled to 35% RH
Portability	Transportable, only needs 10 minutes of warm-up time. Must be installed in permanent or portable, weatherproof shelter. Portable shelter environmental control only required to maintain 0 - 50°C non-condensing environmental control.
Environmental Conditions	Installation Category (Over voltage Category) II Pollution Degree 2 For outdoor use only, to ≤ 5000 m altitude

[1] As defined by the US EPA [2] At constant temperature and pressure

1.2. **EPA DESIGNATION**

Teledyne Advanced Pollution Instrumentation's Model T640 PM Mass Monitor and its options are officially designated as US EPA Federal Equivalent Methods (FEMs) for determining particulate matter. The EPA designation numbers are as follows:

5.0 Lpm Model T640 PM2.5 monitor	EQPM-0516-236
16.7 Lpm Model T640 with 640X option PM2.5 monitor	EQPM-0516-238
16.7 Lpm Model T640 with 640X option PM10-2.5 monitor	EQPM-0516-240
16.7 Lpm Model T640 with 640X option PM10 monitor	EQPM-0516-239

The official List of Designated Reference and Equivalent Methods is published in the U.S. Federal Register: http://federalregister.gov/a/2016-16578. .

Comply with Code of Federal Regulations, Title 40 (downloadable from the U.S. Government Publishing Office at http://www/gpo.gov/fdsys/) and with Quality Assurance Guidance documents (available on the EPA website, http://www.epa.gov/ttn/amtic/qalist.html). Give special attention to specific regulations regarding methods for determining particulate matter.

1.3. SAFETY

IEC/EN 61010-1:2010 (3rd Edition), Safety requirements for electrical equipment for measurement, control, and laboratory use.

CE: 2006/95/EC, Low-Voltage Directive

1.4. EMC

IEC/EN 61326-1, Class A Emissions/Industrial Immunity

EN55011 (CISPR 11), Group 1, Class A Emissions

FCC 47 CFR Part 15B, Class A Emissions

CE: 2004/108/EC, Electromagnetic Compatibility Directive

2. INSTALLATION AND HARDWARE SETUP

This section addresses the procedures for unpacking the instrument and inspecting for damage, presents clearance specifications for proper ventilation, and shows the instrument layout.

2.1. UNPACKING

Verify that there is no apparent external shipping damage. If damage has occurred, please advise the shipper first, then Teledyne API.

Included with your instrument is a printed record of the final performance characterization performed on your instrument at the factory. This record, titled Final Test and Validation Data Sheet, is an important quality assurance and calibration record and should be placed in the quality records file for this instrument.

WARNING – ELECTRICAL SHOCK HAZARD

Never disconnect PCAs, wiring harnesses or electronic subassemblies while under power.

With no power to the unit, carefully remove the top cover of the instrument and check for internal shipping damage by carrying out the following steps:

1. Carefully remove the top cover and check for internal shipping damage.

a. Remove the cover screws located on the sides of the instrument.
b. Slide the cover backward until it clears the instrument's front bezel.
c. Lift the cover straight up.

2. Inspect the interior to ensure all circuit boards and other components are intact and securely seated.

3. Check the connectors of the various internal wiring harnesses and pneumatic hoses to ensure they are firmly and securely seated.

4. Verify that all of the optional hardware ordered with the unit has been installed. These are listed on the paperwork accompanying the instrument.

2.1.1. VENTILATION CLEARANCE

Whether the Monitor is set up on a bench or installed in an instrument rack, be sure to leave sufficient ventilation clearance.

Table 2-1. Ventilation Clearance

AREA	MINIMUM REQUIRED CLEARANCE
Back of the instrument	**10 cm / 4 in**
Sides of the instrument	**2.5 cm / 1 in**
Above and below the instrument	**2.5 cm / 1 in**

2.2. INSTRUMENT LAYOUT

2.2.1. FRONT PANEL

Figure 2-1 shows the front panel layout, which has the display screen, two USB ports for peripheral device connections: mouse and keyboard as alternatives to the touchscreen interface, or flash drive for uploads/downloads (devices not included).

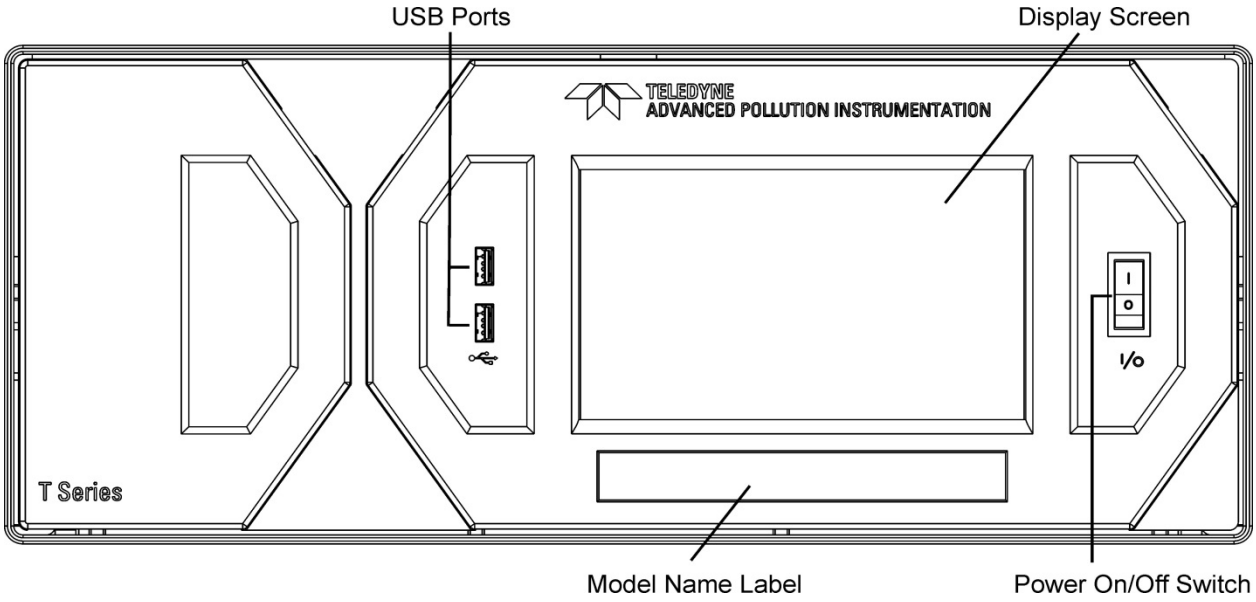


Figure 2-1. Front Panel Layout

2.2.2. **REAR PANEL**

The rear panel shows fittings and connectors for the monitor's functions as well as connectors for communication.

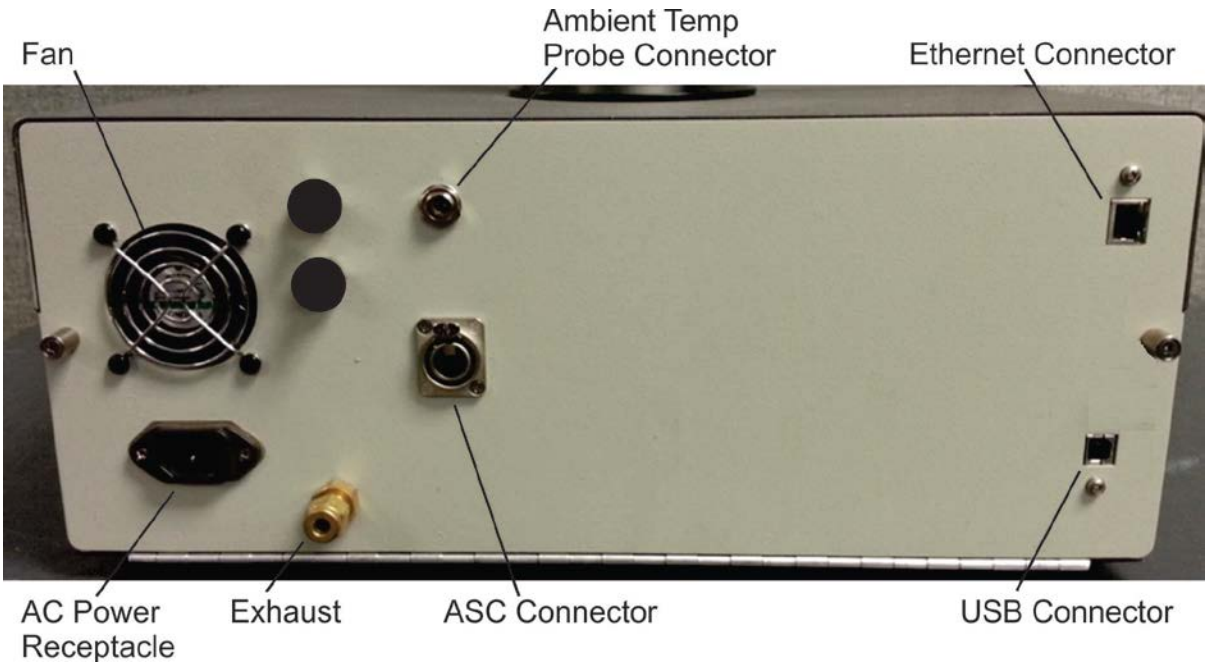


Figure 2-2. T640 Rear Panel

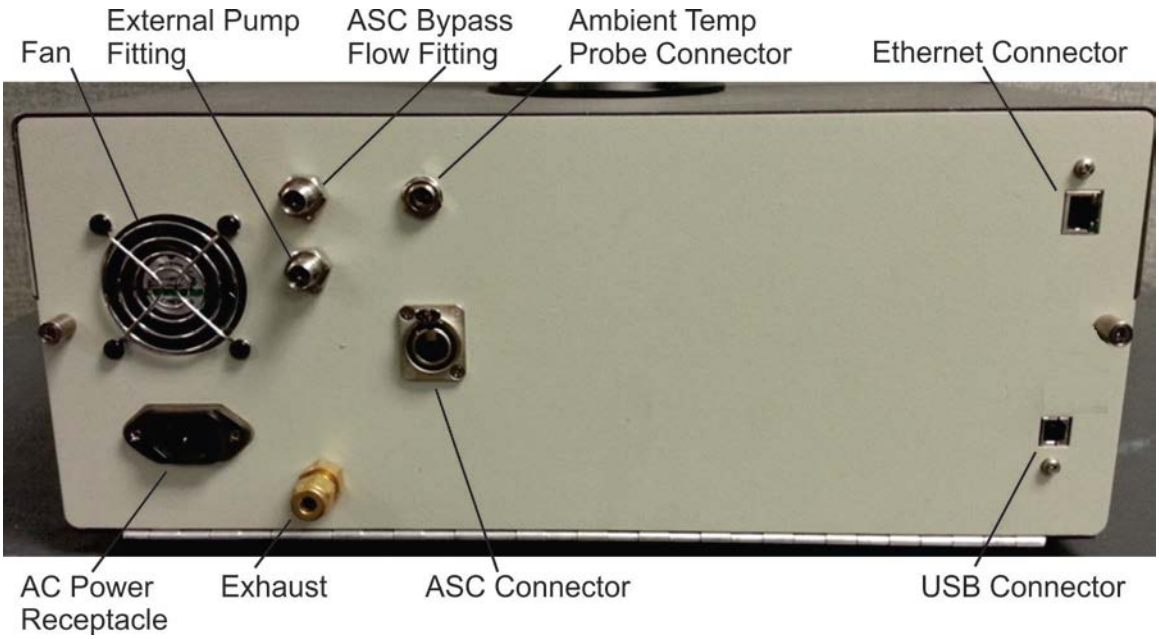


Figure 2-3. T640 with 640X Option Rear Panel

2.2.3. **INTERNAL LAYOUT**

Figure 2-4 shows the main components and assemblies of the monitor.

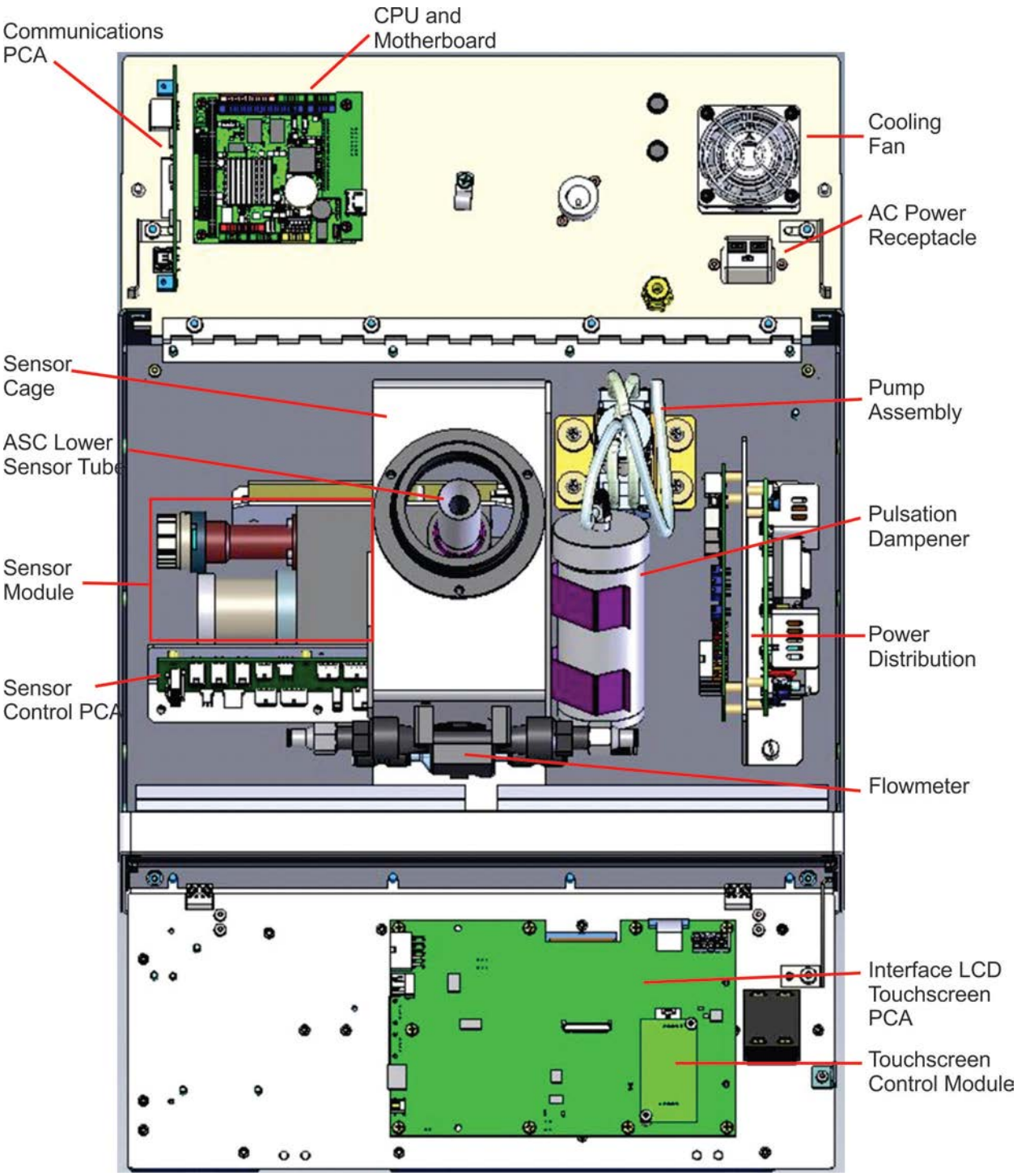


Figure 2-4. T640 Internal Layout

2.3. CONNECTIONS AND STARTUP

This section presents the various connections for setup and preparing the instrument for operation (Section 2.8).

WARNING: Electrical Shock Hazard

- **High Voltages are present inside the instrument.**
- **Ensure that the power cord being used is capable of carrying the power rating of the instrument (see rear panel label).**
- **Power connection must have functioning ground connection.**
- **Do not defeat the ground wire on power plug.**
- **Turn off instrument power before disconnecting or connecting electrical subassemblies.**
- **Do not operate with cover off.**

CAUTION: Avoid Damage to the Instrument

Do not operate under conditions outside the environmental specifications. Operating this instrument under different environmental conditions, such as corrosive or explosive environments, electric or electromagnetic fields, areas of ionizing radiation, or areas conducive to shock or vibration, could damage or destroy the instrument.

CAUTION: Avoid Damage to the Instrument

Ensure that the AC power voltage matches the voltage indicated on the instrument's model/specs label before plugging it into line power.

Note

To maintain compliance with EMC standards, any cable length must be no greater than 3 meters for all communication connections.

2.3.1. AEROSOL SAMPLE CONDITIONER (ASC) CONNECTIONS AND INSTALLATION

The ASC requires an inlet nozzle and an adapter for installation. The black inlet nozzle to the optical sensor is specific to the instrument (not interchangeable to other T640 instruments). The final assembly differs slightly between the T640 ASC and the 640X Option ASC.

1. Insert the black inlet nozzle through the center of the support collar into the top of the optical sensor, seating it tightly so that the nozzle's upper o-ring flange is flush with the upper surface of the sensor body.

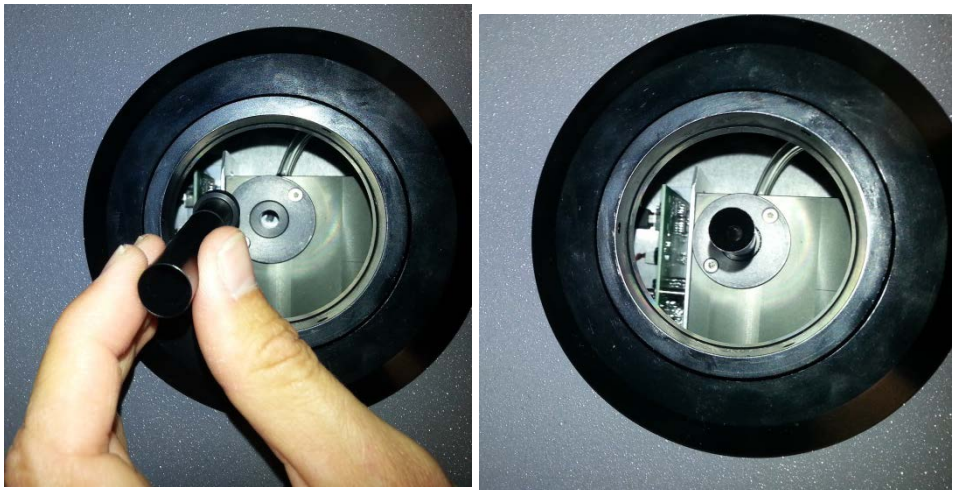


Figure 2-5. ASC Setup: Inlet Nozzle

2. Slide the aluminum adapter over the black inlet nozzle, ensuring its base is flush with the top of the optical sensor.

Figure 2-6. ASC Setup: Aluminum Adapter

3. Attach the water collector to the inlet (Figure 2-7).

Figure 2-7. Water Collector Attached to Inlet

4. Assemble the inlet and the ASC as depicted in Figure 2-8 for the T640 or in Figure 2-9 for the 640X Option, ensuring the parts fit snugly with no gaps. Note that if to be installed in a shelter with roof penetration (Section 2.6.1), leave the inlet with water collector off for the time being).

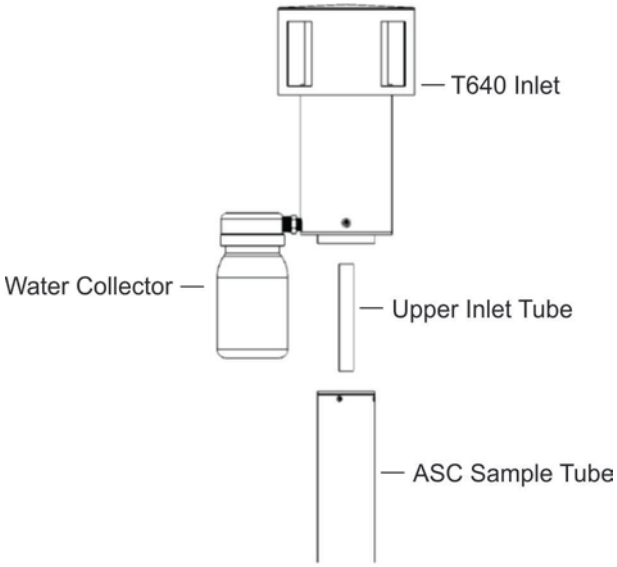


Figure 2-8. T640 Inlet (standard) and ASC Assembly

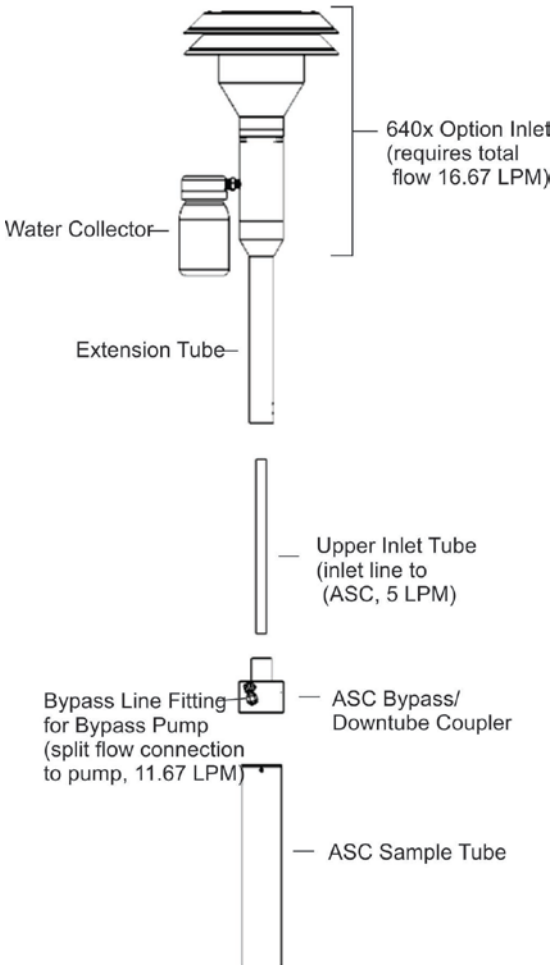


Figure 2-9. 640X Option Inlet and ASC Assembly

5. Lower the ASC into the support collar, ensuring it fits straight with no gaps.
6. Plug the ASC wiring into the rear panel connector.

2.3.2. TEMPERATURE PROBE CONNECTION

1. Plug the ambient temperature probe connector into its respective rear panel electrical port.

Figure 2-10. Ambient Temperature Probe and ASC Connections (T640 with 640X Option shown)

2. Route probe outside and insert into solar shield, ensuring solar shield maintains vertical orientation.

Figure 2-11. Ambient Temperature Probe Installed in Solar Shield

2.4. **POWER CONNECTION**

Adhering to the warning messages previously introduced (Section 2.3), insert the power cord between the instrument's AC power connector and a properly rated power outlet.

2.5. **COMMUNICATIONS INTERFACE CONNECTIONS**

For network or Internet communication with the instrument, connect an Ethernet cable from the analyzer's rear panel Ethernet interface connector to an Ethernet port. Although the analyzer is shipped with DHCP enabled by default, it should be manually assigned a static IP address. See Section 3.1.13.

For firmware updates and data downloads, use a flash drive inserted into the front panel USB port. See Sections 3.2 and 3.1.7.3.

2.6. INDOOR/OUTDOOR INSTALLATION

The T640 can be installed in an indoor or outdoor shelter with roof penetration or in an outdoor enclosure.

2.6.1. SHELTER INSTALLATION WITH ROOF PENETRATION

1. Determine the location of where the T640 will operate in the shelter.
   - The instrument should be in a location where the top of the ASC will be no less than two feet from the top of the ceiling/roof line or,
   - The instrument should be placed at a height within the shelter so that after the ASC and 8' extension sample line are installed, the inlet (on top of the 8' extension sample line) is 2-m above the roof and equal height with any other PM instrument inlets.
2. Drill a hole in the roof to accommodate the diameter of the 8' extension sample line (5/8" OD).
3. Install the provided roof flange over the hole.
   - Make sure to use good quality roof sealant for the base of the roof flange to ensure weather tightness and to prevent any leaks into the shelter
4. Without locking it down, setup the sample line tripod so that its sample line hole aligns with the hole in the roof.
   - The tripod should be setup at such a height to properly support the sample line with the inlet on top.
5. Without the inlet installed on the top of the ASC, line up the instrument so that the opening at the top of the ASC is in-line with the sample line hole/roof flange on the shelter roof.
6. Slide the 8' sample line extension down through the tripod and the roof penetration until it meets the opening at the top of the ASC.
   - The sample line should be plumb to prevent any strain on the instrument and to prevent pneumatic leaks.
   - The sample line should slide into the top of the ASC (about 2") and bottom out when in completely.
7. Lightly tighten the tripod cord grip and the roof flange cord grip around the sample line to hold it in place.
8. At the top of the sample line (on the roof), place the provided inlet collar so that its top is 3" from the top of the sample line.
   - This is for proper clearance from the base of the inlet and to prevent any instrument flooding if the inlet were to ever get water inside of it.
9. Lock down the collar once it is determined to be at the proper spot 3" from the top of the sample line.
10. Place the inlet on top of the sample line.
    - Make sure the inlet is secure. i.e. that the collar holding it is not sliding.
    - Proper installation should have the inlet 2-m above the roof.
11. Plug the ASC connector into the proper fitting on the rear panel of the T640.

12. Connect the power cable and ambient temperature sensor at back of instrument.
13. Before sealing the cord grips, power up the instrument and make sure it is running properly.
14. Perform Pressure and Flow calibrations (Section 4.1).
15. Perform PMT check with SpanDust™ (Section 4.1.4).
16. Once the T640 instrument is determined to be installed and working properly, tighten up the roof flange cord grip around the sample line.
17. Apply clear silicone caulk generously around the top end of where the cord grip rubber grommet meets the sample line to ensure complete sealing from the weather.
    - Silicone caulk seals well and can easily be removed and reapplied if the instrument needs to be removed for servicing.
18. Additionally, tighten up the tripod cord grip and lock down the feet of the tripod to fully secure the sample line.

2.6.2. **OUTDOOR ENCLOSURE INSTALLATION**

1. Place enclosure in the location where the instrument is to run.
2. The T640 instrument should be installed in the enclosure at a height where the inlet will be 2-m above ground (the base of the enclosure).
    - Make sure the optical sensor nozzle and nozzle to ASC adapter are installed on the optical sensor.
3. Once the T640 is in the enclosure and lined up with the cord grip opening on the top of the enclosure, insert the ASC into the cord grip (from above) and slide it down gently until it inserts into the ASC support of the T640.
    - The ASC should go into the T640 level and plumb, and is in completely when it is felt to bottom out onto the top of the optical sensor. This can be checked by lowering the front panel of the T640 and making sure the base of the ASC is touching the top of the optical sensor flush.
4. Plug the ASC connector into the proper fitting on the rear panel of the T640.
5. Connect the power cable and ambient temperature sensor at back of instrument.
6. Before sealing the cord grip, power up the instrument and make sure it is running properly
7. Perform Pressure and Flow calibrations (Section 4.1).
8. Perform PMT check with SpanDust™ (Section 4.1.4).
9. Once the T640 instrument is determined to be installed and working properly, tighten up the cord grip around the ASC.
10. Apply clear silicone caulk generously around the top end of where the cord grip rubber grommet meets the ASC to ensure complete sealing from the weather.
    - Silicone caulk seals well and can easily be removed and reapplied if the instrument needs to be removed for servicing.

2.7. **PNEUMATICS**

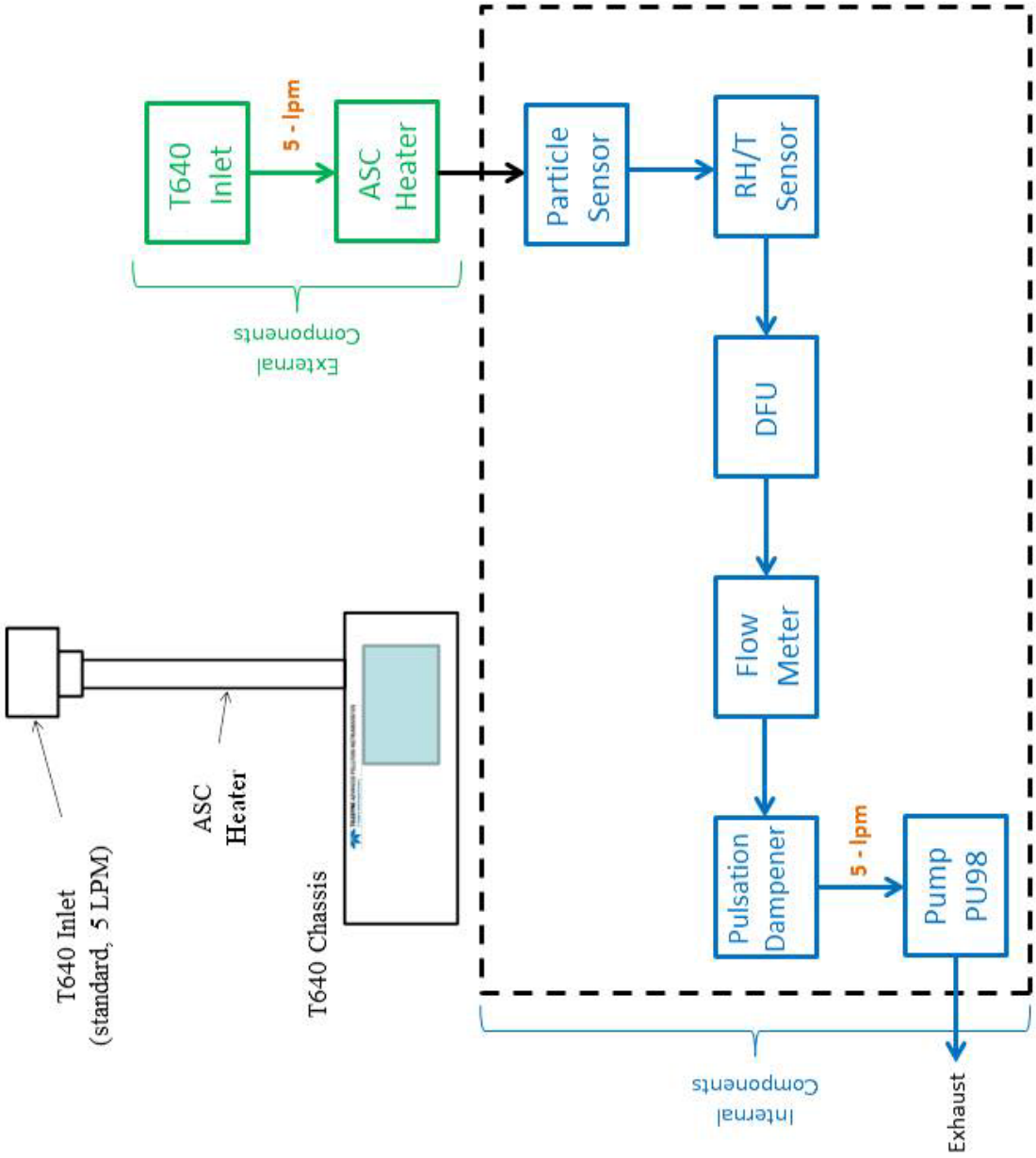


Figure 2-12. T640 Pneumatics

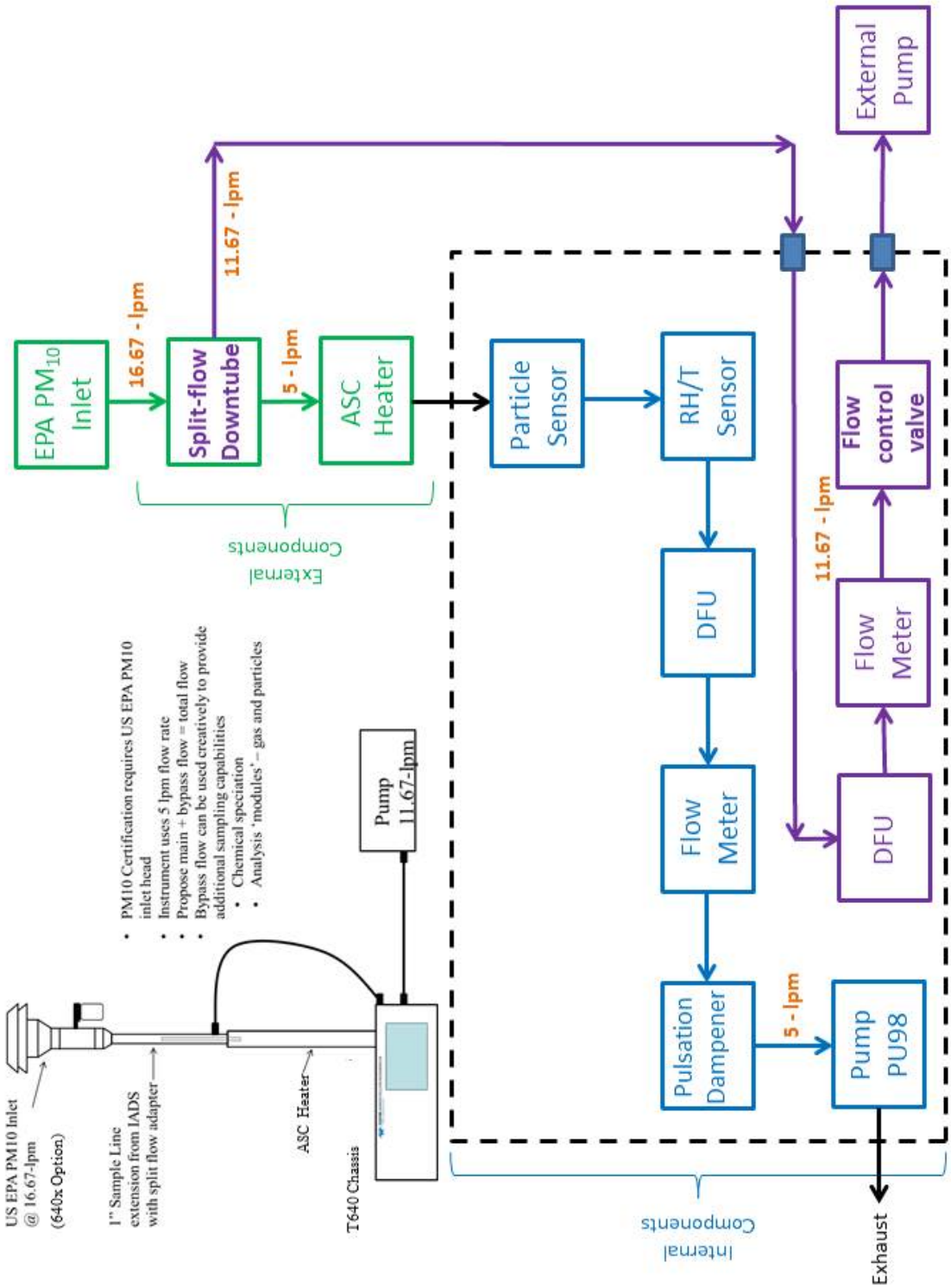


Figure 2-13. T640 with 640X Option Pneumatics

2.8. DISPLAY AND MENU NAVIGATION

The Home page shows the menu tabs in a column on the right and displays the gas name(s) and concentration reading(s) in the main portion of the screen; below that are meters displaying readings of three additional parameters (selectable in Home Configuration, Section 3.1.1). At the top of the interface are user tools and at the bottom are navigation buttons and indicators; Figure 2-14 presents a description of the NumaView™ software interface.

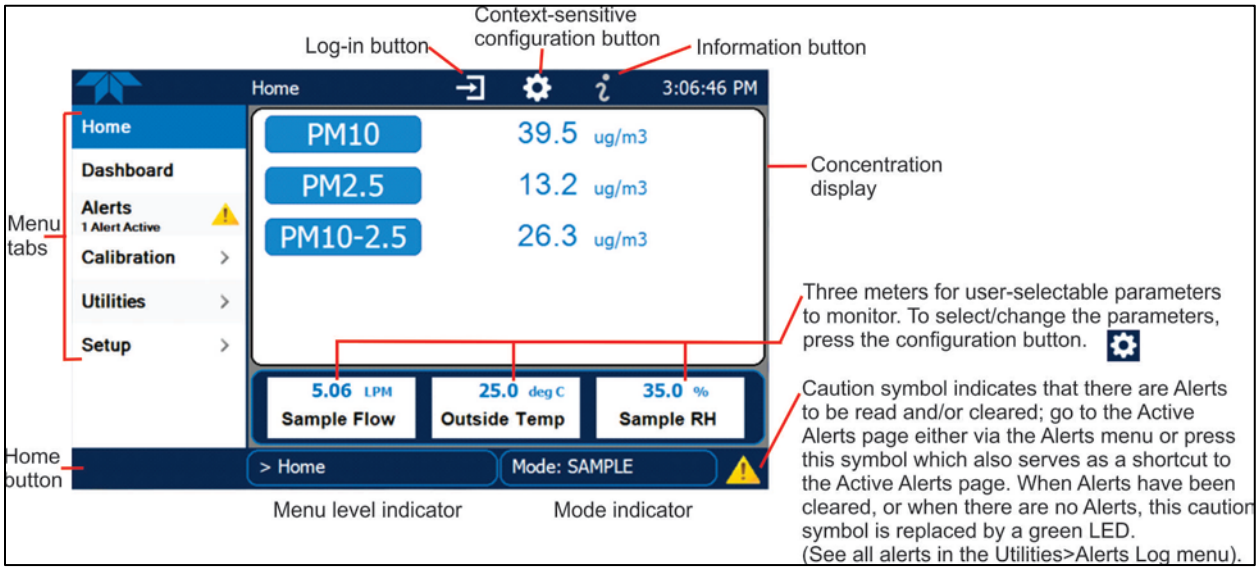


Figure 2-14. Sample Home Screen with Orientation

Figure 2-15 shows that pressing the gas name or its concentration value or a meter below displays a plot of the respective values. (Meters are selectable in HomeScreen, Section 3.1.1).

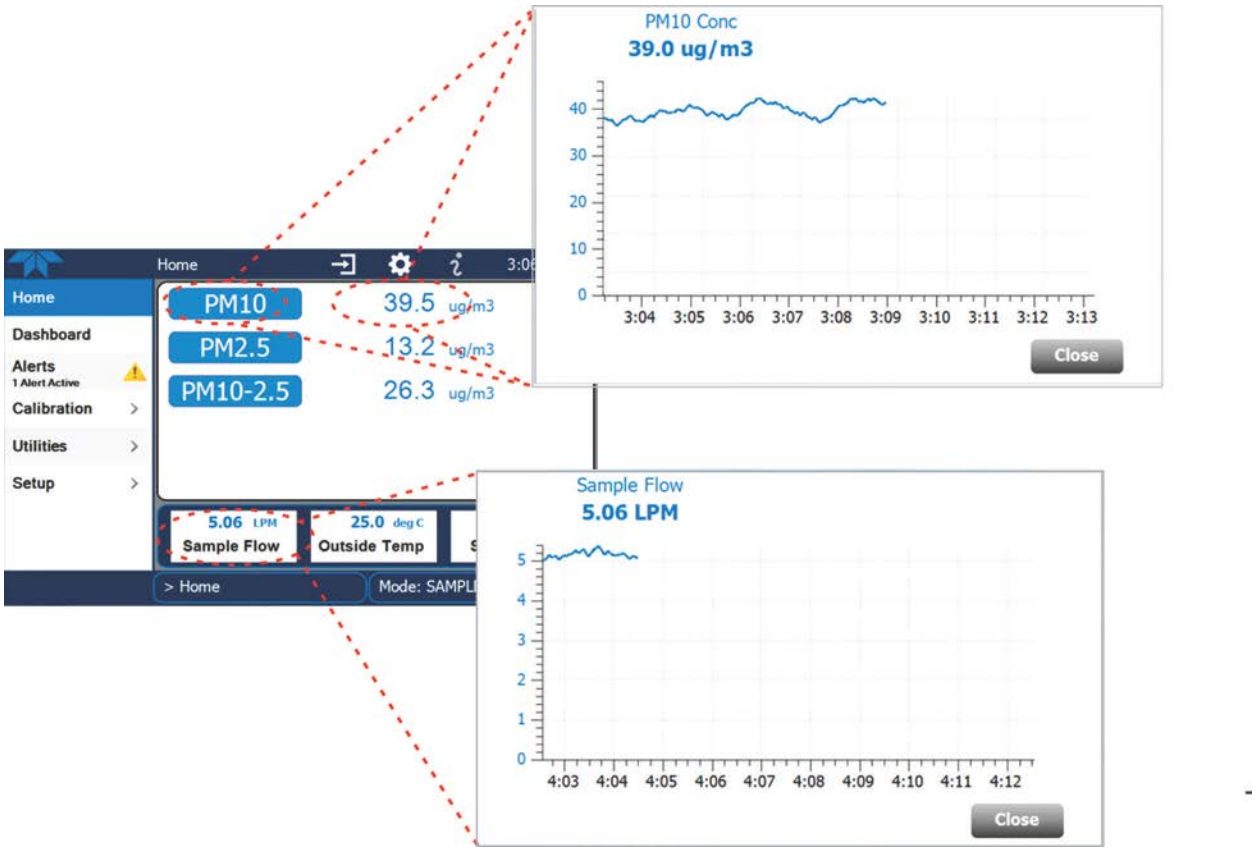


Figure 2-15. Concentration Graph and Meter Graph

2.9. STARTUP AND FUNCTIONAL CHECKS

2.9.1. STARTUP

Upon initial startup, allow the instrument to run for at least 10 minutes to reach stable operating conditions.

2.9.1.1. FUNCTIONAL CHECKS OF OPERATING PARAMETERS

After warm-up, navigate to the Dashboard screen to verify that the Monitor is functioning within allowable operating parameters (the Appendix shows the list of test functions and their expected values; the enclosed *Final Test and Validation Data sheet* lists these values as they appeared before the instrument left the factory). If not all test functions and values are displayed here, touch the configuration icon to insert additional functions into the Dashboard (Section 3.1.2 has more details).

These functions can also be used as diagnostic tools for troubleshooting a performance problem.

2.9.1.2. INITIAL SENSOR CHECKS AND ADJUSTMENTS

Instructions for checking and calibrating pressure and flow using customer-owned flow and pressure standards can be found in Sections 4.1.1, 4.1.2, and 4.1.3

Instructions for performing an optical sensor check and PMT adjustment are provided in Section 4.1.4.

3. SOFTWARE SETUP AND OPERATION

Configuration and setup instructions are provided in Section 3.1, instructions for updating firmware in Section 3.2, and operation instructions in Section 3.3.

3.1. CONFIGURATION AND SETUP

Configure pages, set up reporting parameters, and customize any of several features to suit user needs.

3.1.1. HOMESCREEN

Three meters at the bottom of Home page display user-selectable parameters and their values. To select, go to the Home Configuration page by touching the configuration button (shortcut) and following the onscreen instructions (see Figure 3-1). The Home page can also be configured through the Setup menu (Section 3.1.11).

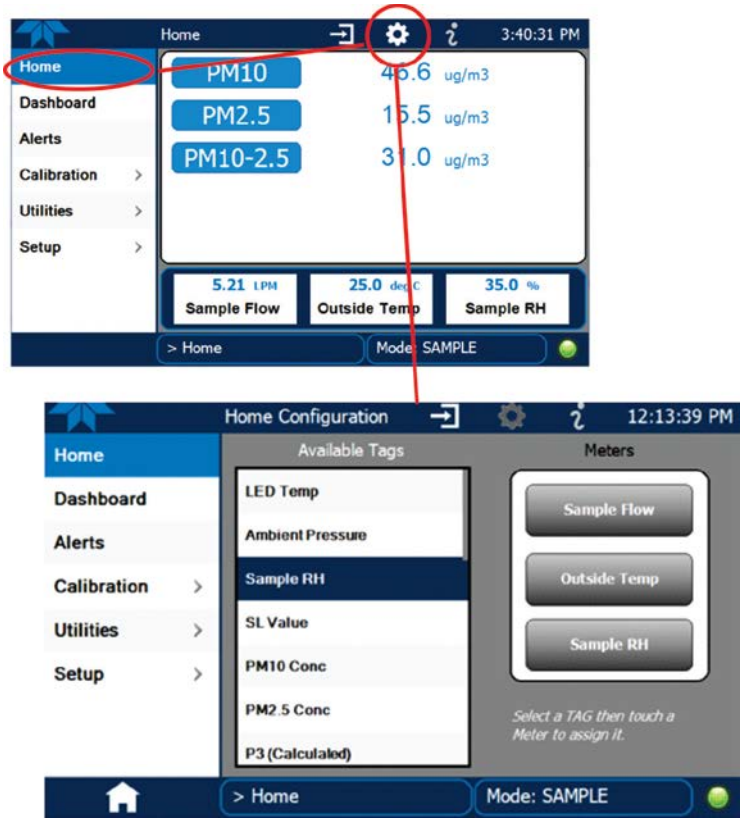


Figure 3-1. Home Configuration thru Home Page Shortcut

3.1.2. **DASHBOARD**

The Dashboard page (Figure 3-2) shows an array of user-selected parameters and their values. If there is a graphing icon in the upper right corner of a parameter, pressing that parameter displays a plot. (See Section 3.1.9 for configuration instructions).

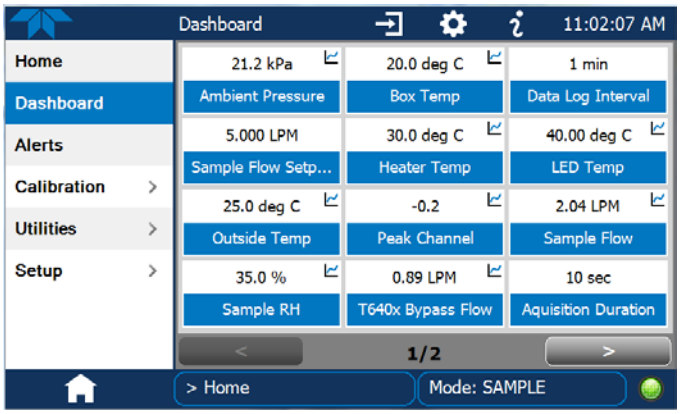


Figure 3-2. Dashboard

3.1.3. ALERTS

The Alerts screen shows the status of any active warning conditions or user-configured Events. (Events are used to define the conditions that will trigger Alerts; see Section 3.1.8 for detailed information and how to customize Events through the Home>Setup>Events menu). While Alerts can be cleared from the Alerts page, all alerts are documented and stored in the Home>Utilities>Alerts Log (Section 3.1.5).

3.1.4. UTILITIES>DATALOG VIEW

This utility provides reports on instrument data, the parameters for which are defined by the user in the data logger (Home>Setup>Data Logging). Section 3.1.7 provides instructions for configuring the data logger.

3.1.5. UTILITIES>ALERTS LOG

The Alerts Log (Figure 3-3) displays a history of Alerts (Section 3.1.3) that are triggered by factory-defined and user-defined Events (Section 3.1.8), such as warnings and alarms.

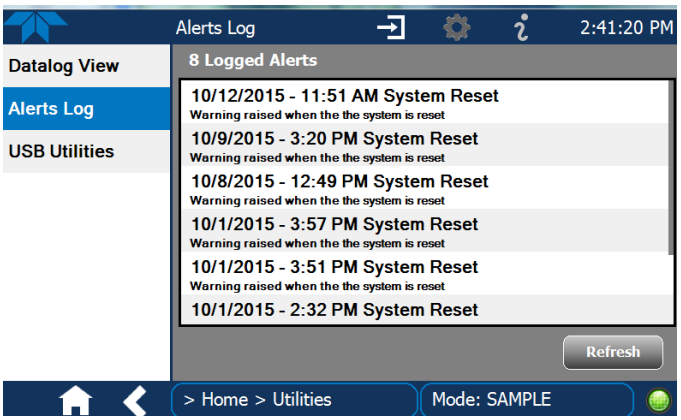


Figure 3-3. Alerts Log

3.1.6. **UTILITIES>USB UTILITIES**

The USB Utility page serves multiple purposes using a flash drive connected to the instrument's front panel USB port. One purpose is used in data logging (Section 3.1.7) for transferring data from the instrument to a flash drive (Section 3.1.7.3). Another is updating firmware (instructions in Section 3.2). (A third purpose, which is not yet available, is copying a configuration from one instrument to other instruments).

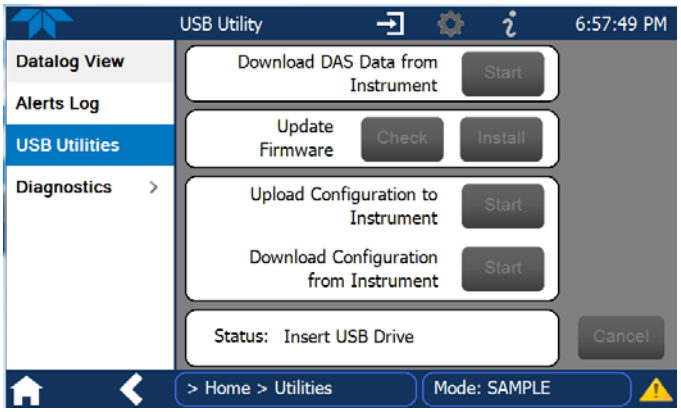


Figure 3-4. USB Utility Page

3.1.7. **SETUP>DATA LOGGING**

The Data Logger captures and stores user-defined data, which then can be downloaded from the instrument to a USB flash drive for examination and analysis. Press the ADD button to create a new log (Figure 3-5), or select an existing log from the Data Logging list and press the EDIT or DELETE button to make the desired changes (Figure 3-6). See Sections 3.1.7.1 and 3.1.7.2 for configuration details, and Section 3.1.7.3 for transferring captured instrument data to a flash drive.

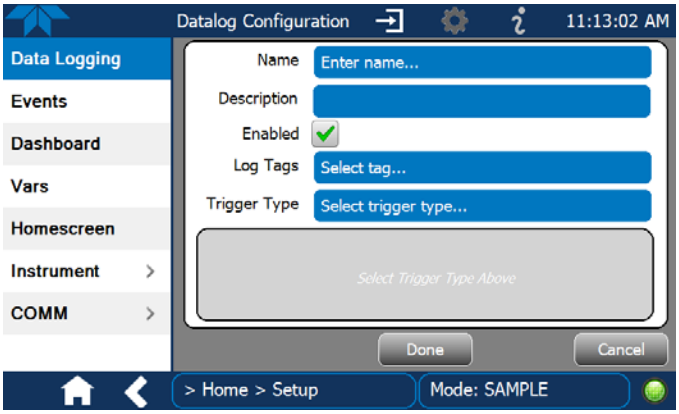


Figure 3-5. Datalog Configuration, New Log Page

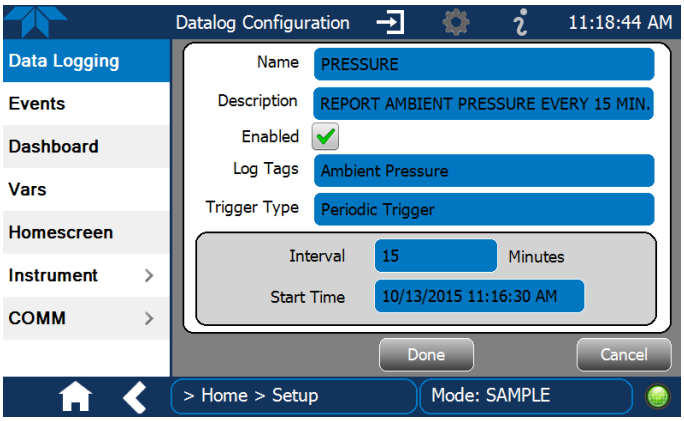


Figure 3-6. Datalog Configuration, Existing Log

3.1.7.1. CREATING A USER-DEFINED DATA LOG

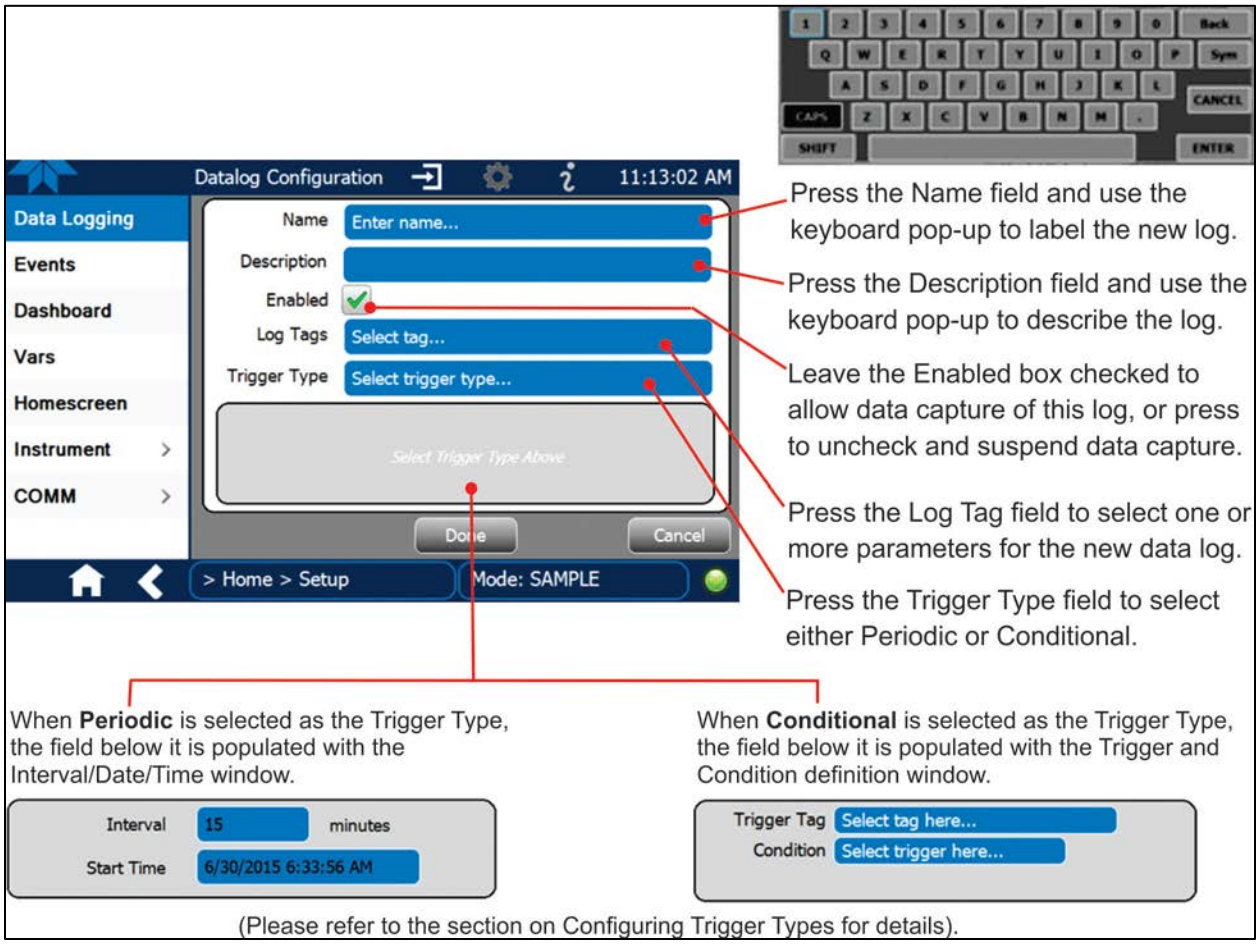


Figure 3-7. Creating a New Data Log

3.1.7.2. CONFIGURING TRIGGER TYPES

Two trigger types can be configured: periodic and conditional.

Periodic Trigger

The Periodic trigger is a timer-based trigger that is used to log data at a specific time interval. Periodic Trigger requires an interval that is set to number of minutes and a start time that is set to date and time.

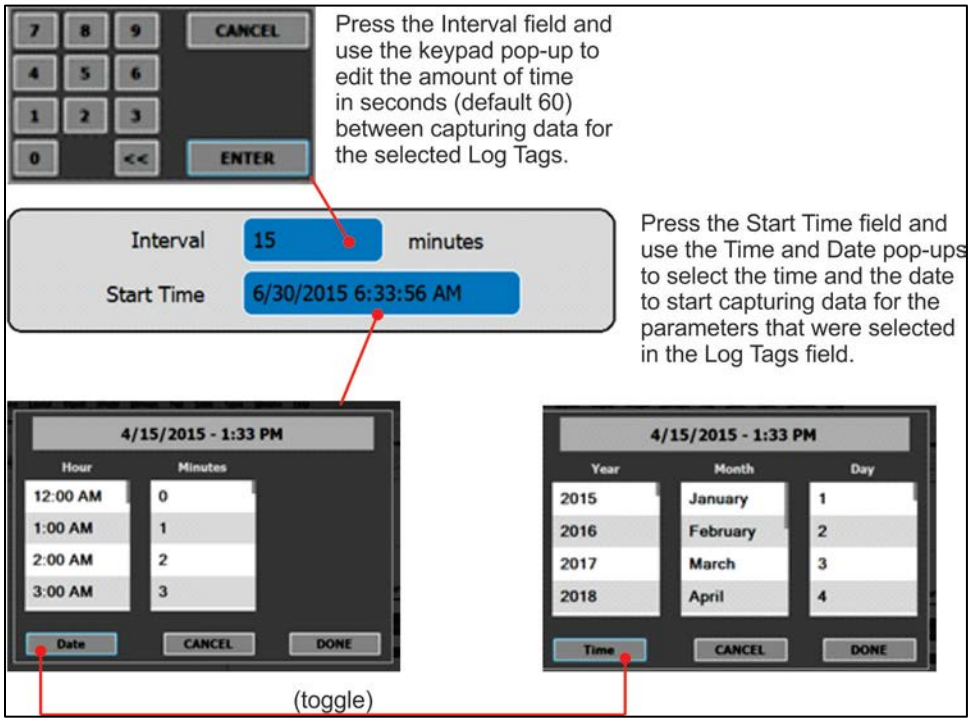


Figure 3-8. Datalog Periodic Trigger Configuration

Conditional Trigger

Conditional Trigger tracks/records data for user-selected parameters that meet specified conditions.

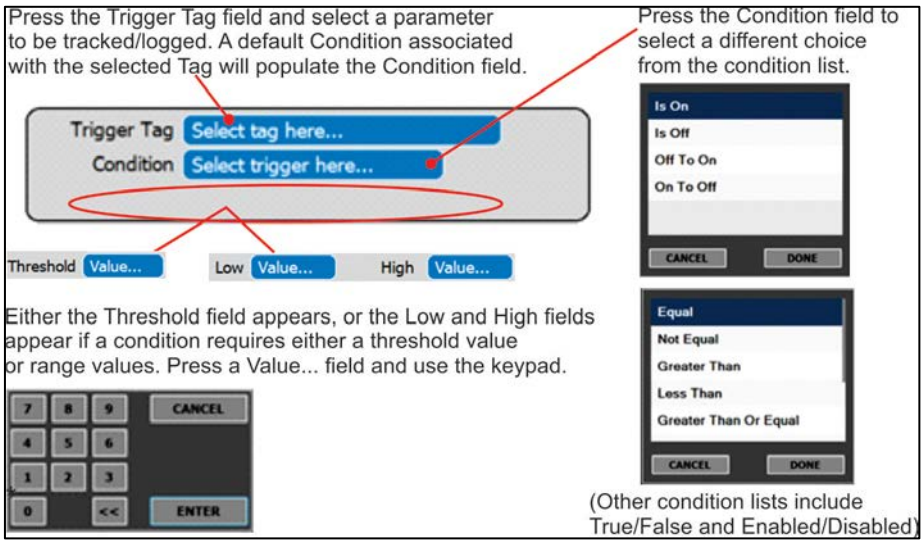


Figure 3-9. Datalog - Conditional Trigger Configuration

3.1.7.3. DOWNLOADING DAS (DATA ACQUISITION SYSTEM) DATA

In the Utilities>USB Utilities menu instrument data can be downloaded to a flash drive, as presented here.

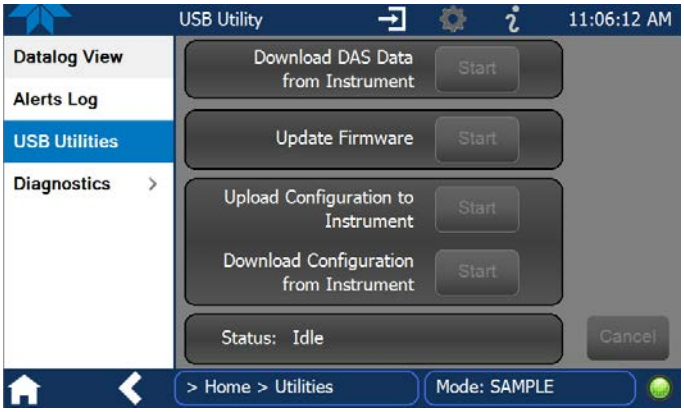


Figure 3-10. DAS Data Utility

1. Press USB Utilities menu to open the utility page (Figure 3-10).
2. Insert a flash drive into a front panel USB port and wait for the Status field to indicate that the drive has been detected and available buttons are enabled (Figure 3-11).

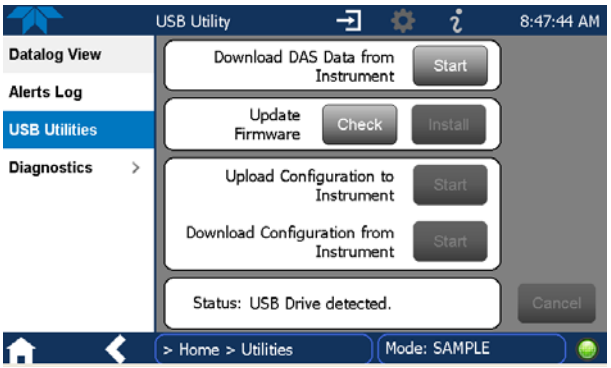


Figure 3-11. DAS Data Download

3. To copy the data to the flash drive, press the Start button next to "Download DAS Data from Instrument." (The Cancel button will be enabled).
4. Wait for the Status field to indicate that the transfer is complete and the Cancel button becomes the Done button.
5. Press the Done button, then remove the flash drive.

3.1.8. SETUP>EVENTS

Events are occurrences that relate to any operating function, and are used to define the conditions that will trigger Alerts (Sections 3.1.3 and 3.1.5). Events can provide diagnostic information about the instrument, typically referred to as "Warnings", or they can provide additional instrument functionality, such as concentration alarms.

The instrument comes from the factory with a number of pre-defined warning Events, and the Events Configuration page provides the capability for creating additional, user-defined events (Section 3.1.8.1) and editing them (Section 3.1.8.2).

To view a list of Warnings and Event tags, press the Add button, and highlight a tag to view its description.

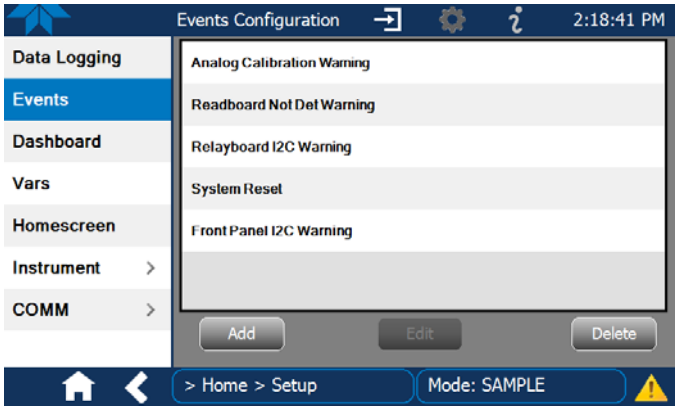


Figure 3-12. Events Page

3.1.8.1. CREATING USER-DEFINED EVENTS

In the Home>Setup>Events menu (Figure 3-12) press ADD to create a new Event. Figure 3-13 depicts what to do next. Check the **Enabled** box to track and record the Event. Check the **Visible** box to display the Event in the Alerts tab when it is triggered (the Event will be recorded whether. Check the **Latching** box to make it a Latching Event. To see a description of any tag, touch its name in the list that pops up after touching the Trigger Tag field.

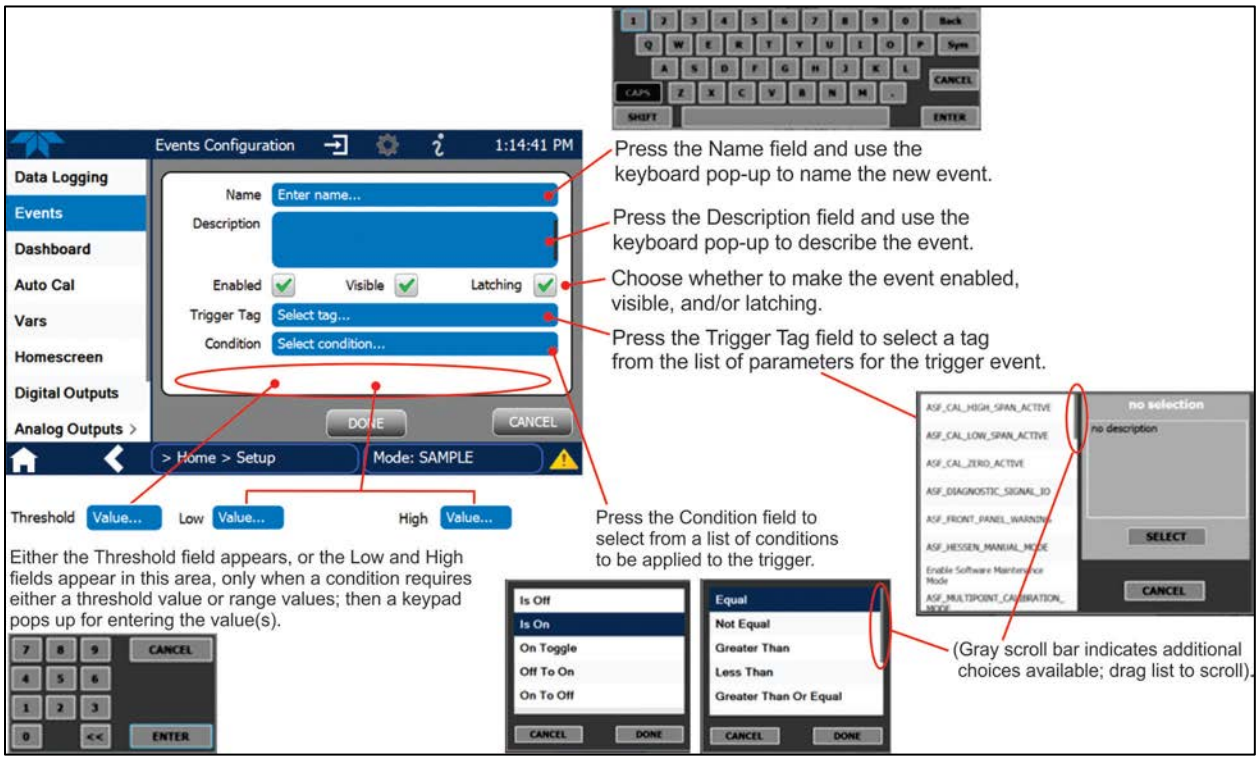


Figure 3-13. Event Configuration

3.1.8.2. EDITING OR DELETING EVENTS

Select an Event from the list in the Events page (Figure 3-12) and press the EDIT button to view or edit the details (Figure 3-14). To delete an Event, select the Event from the list in the Events page and press the DELETE button.

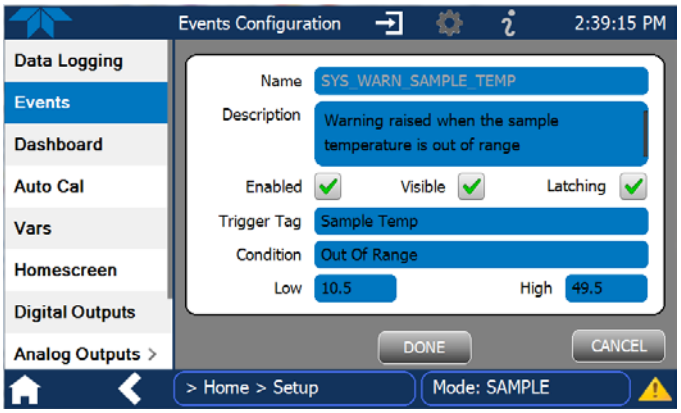


Figure 3-14. Existing Event for Viewing or Editing

3.1.9. SETUP>DASHBOARD

Configure this page either while in the Home>Dashboard page by touching the configuration button (shortcut) or through the Home>Setup>Dashboard menu (Figure 3-15). Also see Section 3.1.2 for a description of this page.

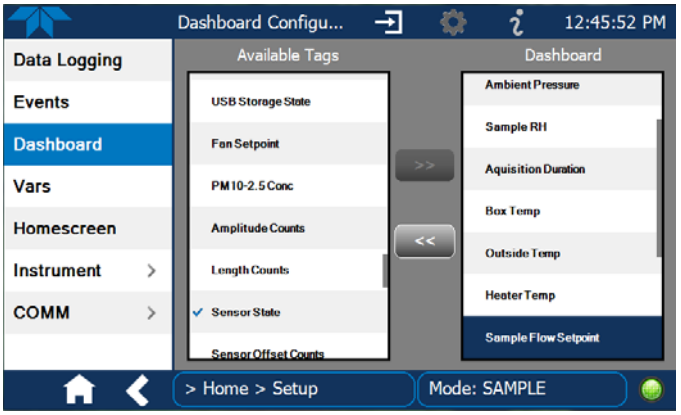


Figure 3-15. Dashboard Configuration

- To add a parameter for display in the Dashboard, make a selection from the “Available Tags” column and press the right-pointing button >>.
- To remove a parameter from the Dashboard, select a tag from the ”Dashboard” column and press the left-pointing button <<.

3.1.10. SETUP>VARS (VARIABLES)

The VARS configuration page allows selecting a Variable and pressing the Edit button to change its values or conditions. This page provides a description of each variable as it is selected/highlighted.

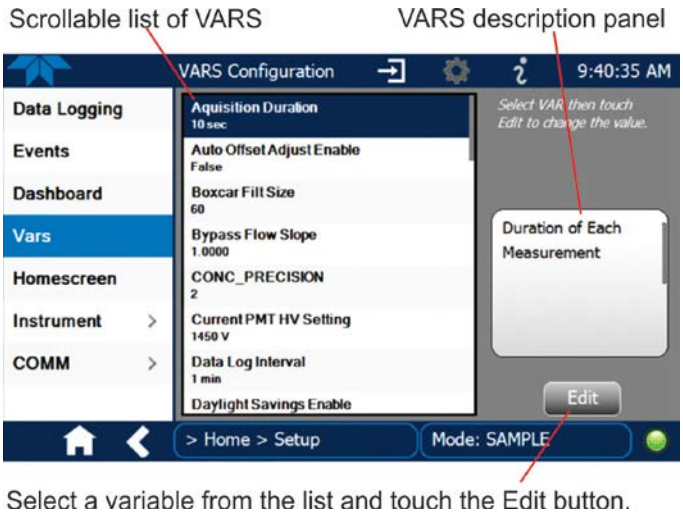


Figure 3-16. VARS Configuration Page

3.1.11. SETUP>HOMESCREEN

Select parameters for the three meters at the bottom of Home page from the Home>Setup>Homescreen menu (Figure 3-17. Home Configuration thru Setup Menu) and follow the onscreen instructions. The Home Configuration page can also be accessed by shortcut ( ) in Home (see Section 3.1.1).

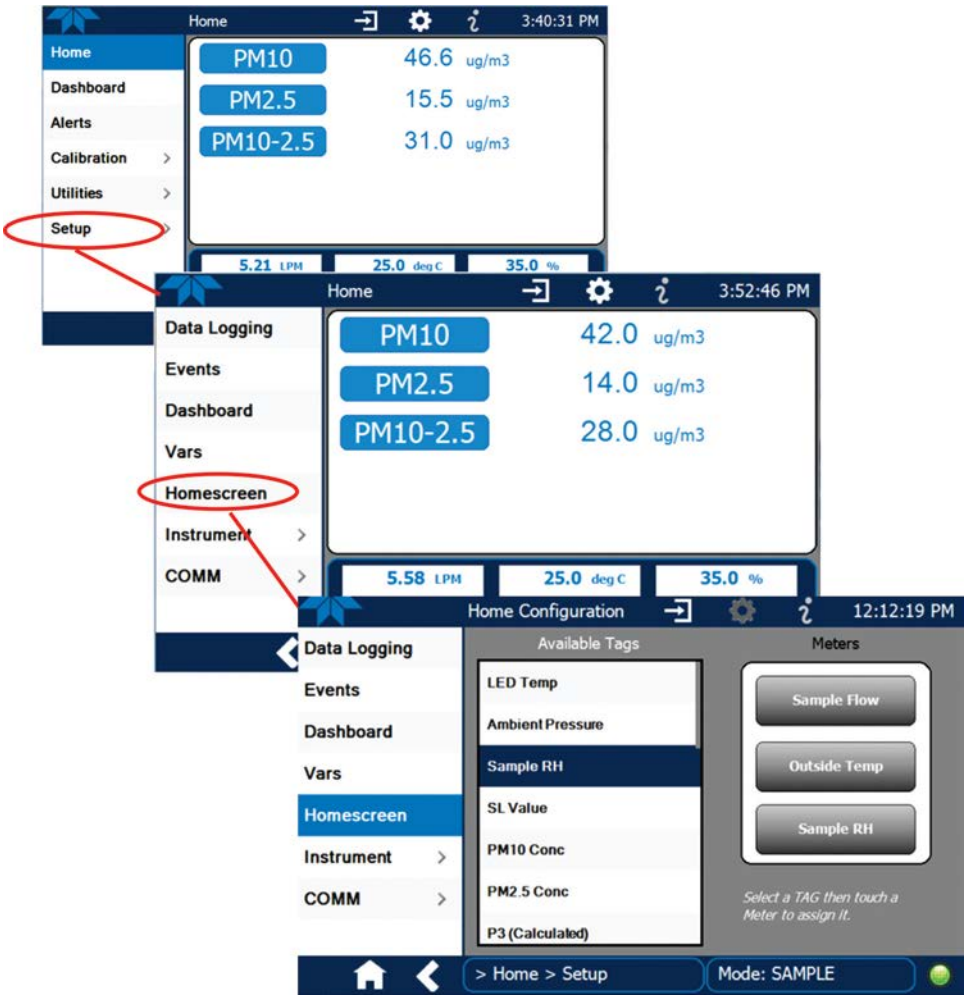


Figure 3-17. Home Configuration thru Setup Menu

3.1.12. SETUP>INSTRUMENT

The Setup>Instrument menu shows product and system information and provides access to instrument settings.

3.1.12.1. INSTRUMENT DISPLAY CALIBRATION

Although unlikely, if ever the touchscreen appears unresponsive or responds incorrectly, the screen can be calibrated via the Setup>Instrument>Display Settings menu.

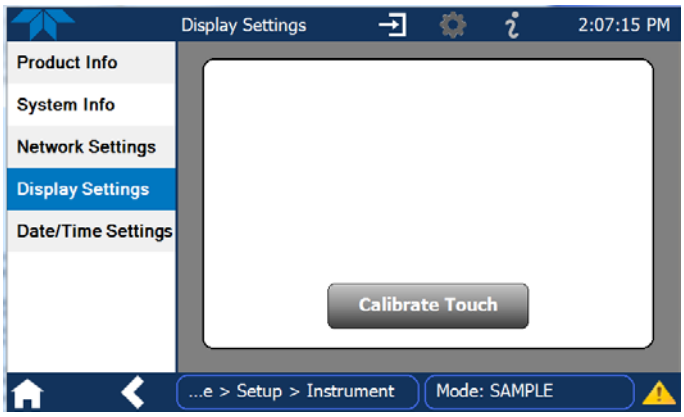


Figure 3-18. Touchscreen Calibration Page

1. Connect a mouse to either of the front panel USB ports.
2. Navigate with the pointer to Setup>Instrument>Display Settings.
3. Click on “Calibrate Touch” and a crosshair appears in the center of the display screen.

   Note that a timer function is enabled, allowing only 15 seconds to start the calibration process. If the timer expires, the instrument will exit the calibration screen and return to normal operation.
4. Click the very center of the crosshair.
5. When a new crosshair appears in the upper left corner of the screen, carefully and accurately click and hold the very center of that crosshair until it finishes shrinking, then release.
6. Repeat Step 5 for each of the corners.
7. Once the process is completed, a CANCEL and an ACCEPT button appear in the lower left corner: Test the accuracy of the calibration by touching parts of the screen and see that the mouse pointer follows your touches.
8. If you press the CANCEL button, the calibration won’t be altered. Otherwise, press the ACCEPT button.

If any difficulties persist, contact TAPI Technical Support:

sda_techsupport@teledyne.com / 800-324-5190

3.1.12.2. **INSTRUMENT DATE/TIME ADJUSTMENTS**

The Date/Time Settings menu allows changes to time zone, hour, minutes after the hour, and date, including auto-adjust for Daylight Savings Time.

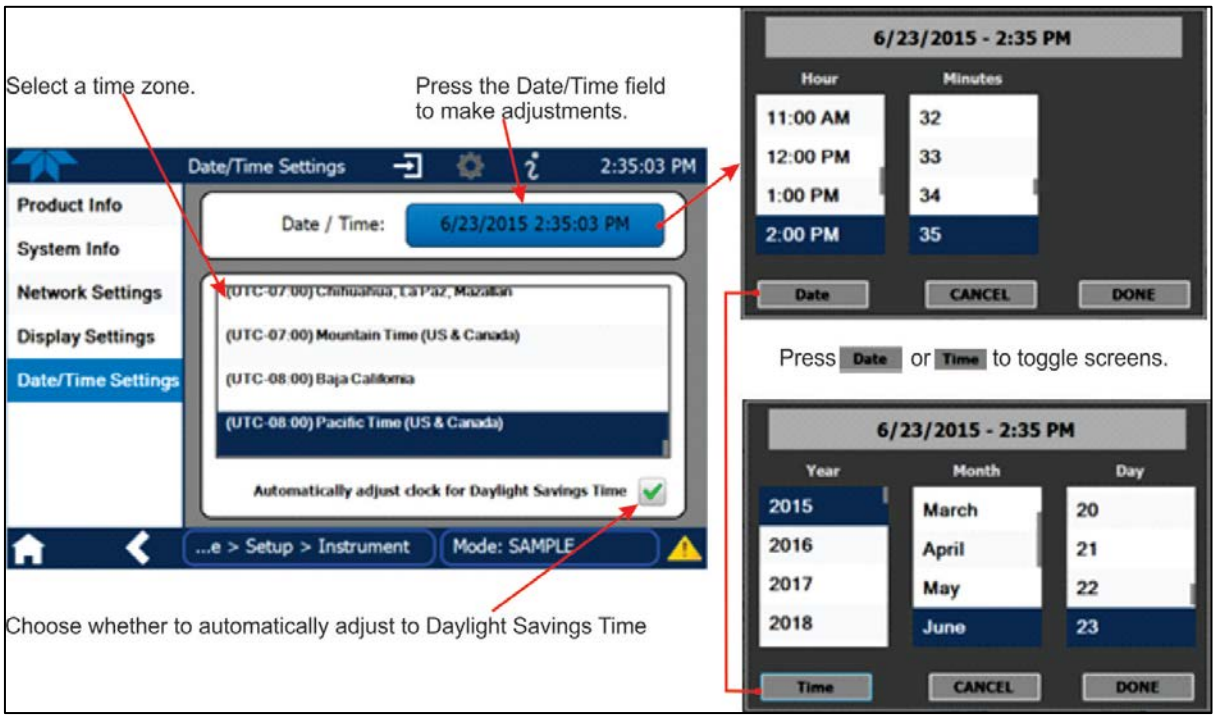


Figure 3-19. Date and Time Configuration Page

3.1.13. **COMMUNICATIONS SETUP**

The Setup>COMM menu is for configuring the communications port. (The last page on display prior to going to the Setup>COMM menu remains on display until one of the submenus is selected). The T640 supports MODBUS TCP on port 502, or a user-specified port. The TCP Port menu can be used to edit the MODBUS TCP port number. The MODBUS Register is presented in Table 3-1.

Table 3-1. T640 MODBUS Register

MODBUS Register Address (decimal, 0-based)	Description
DISCRETE INPUTS REGISTERS **(single-bit; read-only)**	
0	Box Temp Warning
1	Flow Alarm
2	System Fault Warning
3	System is OK
4	System Reset Warning
5	Temperature Alarm
6	System Service Warning
7	OPC Instrument Warning
8	Sample Temperature Warning
INPUT REGISTERS **(Read-only)**	
(32-bit Integer)	
0	Pump Tachometer Reading
2	Number of total particles in the Amplitude histogram
4	Total number of particles in the Length distribution
(32-bit IEEE 754 format; read in high-word, low-word order)	
6	Real-time PM10 concentration value
8	Real-time PM2.5 concentration value
10	Real-time PM10-2.5 concentration derived by subtracting the PM2.5 value from PM10
12	Real-time PM10 tandardized concentration value
14	PM10 1Hr rolling concentration average
16	PM2.5 1Hr rolling concentration average
18	PM10-2.5 1Hr rolling concentration average
20	PM10 12Hr rolling concentration average
22	PM2.5 12Hr rolling concentration average
24	PM10-2.5 12Hr rolling concentration average
26	PM10 24Hr rolling concentration average
28	PM2.5 24Hr rolling concentration average
30	PM10-2.5 24Hr rolling concentration average
32	LED Temperature
34	Ambient Pressure
36	Humidity Sensor Reading
38	Box Temperature
40	Ambient Temperature Probe Reading

42	Temperature in the ASC Tube Jacket
44	Sample Stream Temperature at RH Sensor
46	Sample Flow5
48	640x Option Bypass Flow 11.67lpm
50	Sample Flow + Bypass Flow
52	Signal Length Max Value
54	P3 Value for Signal Length Histogram
56	Pump Duty Cycle / PWM Status - Flag at 90%
58	Proportional Valve Duty Cycle / PWM Status - Flag at 90%
60	ASC Heater Duty Cycle
HOLDING REGISTERS (Read/Write)	
(32-bit Integer)	
0	PMT voltage setting - DAC counts
2	Value returned by the send Offset Adjust function
4	PMT HVPS setting determined during cal dust calibration
(32-bit IEEE 754 format; read/write in high-word, low-word order)	
6	5-LPM Flowmeter Calibration Slope
8	640x Bypass Flowmeter Calibration Slope
10	Pressure Sensor Calibration Slope
12	Setpoint for the sample RH
14	Flow Setpoint for the optical sensor
16	Setpoint for the 640x Option bypass flow
18	RH sensor slope

The Network Settings menu is for Ethernet configuration. The address settings default to automatic configuration by Dynamic Host Configuration Protocol (DHCP). Most users will want to configure the instrument with a static IP address; click the Static radio button to manually assign a static IP address (consult your network administrator, and see Table 3-2 for information).

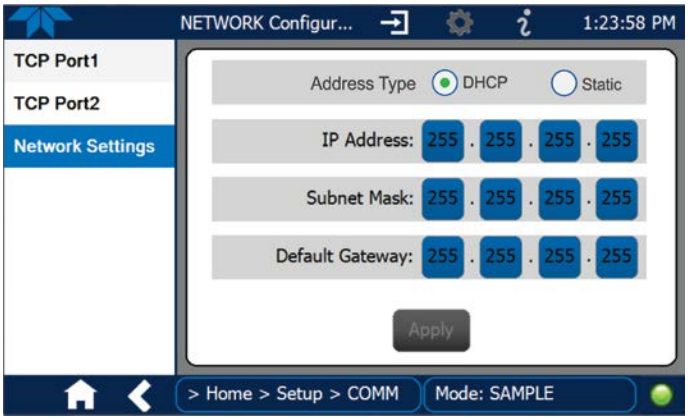


Figure 3-20. Communications Configuration, Network Settings

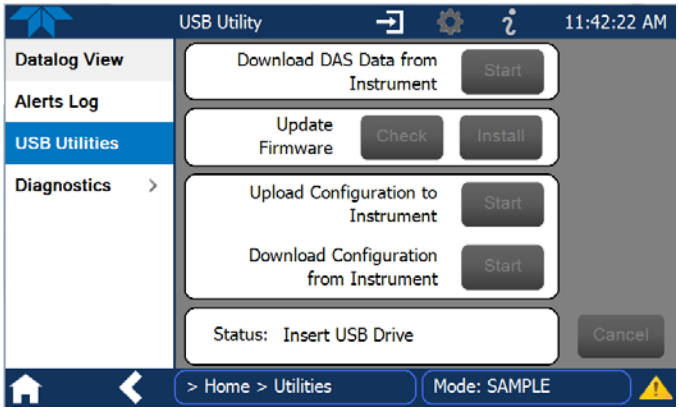
Table 3-2. LAN/Ethernet Configuration Properties

IP Address	0.0.0.0	This string of four packets of 1 to 3 numbers each (e.g. 192.168.76.55.) is the address of the instrument itself.
Subnet Mask	0.0.0.0	A string of four packets of 1 to 3 numbers each (e.g. 255.255.252.0) that identifies the LAN to which the device is connected. All addressable devices and computers on a LAN must have the same subnet mask. Any transmissions sent to devices with different subnets are assumed to be outside of the LAN and are routed through the gateway computer onto the Internet.
Default Gateway	0.0.0.0	A string of numbers very similar to the Instrument IP address (e.g. 192.168.76.1.) that is the address of the computer used by your LAN to access the Internet.

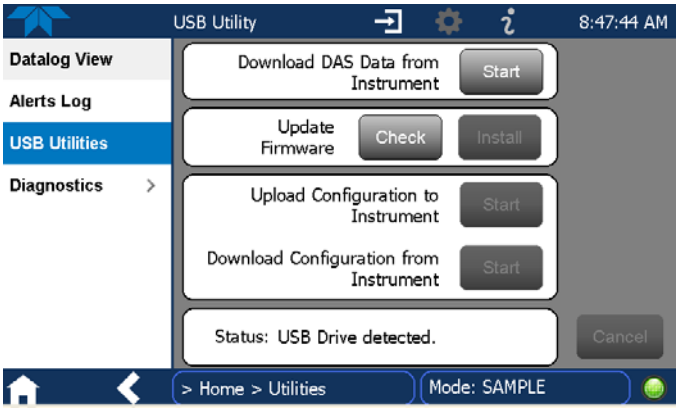
3.2. **FIRMWARE UPDATES**

To reload or update firmware, first contact Technical Support to obtain the applicable file(s): sda_techsupport@teledyne.com / 800-324-5190.

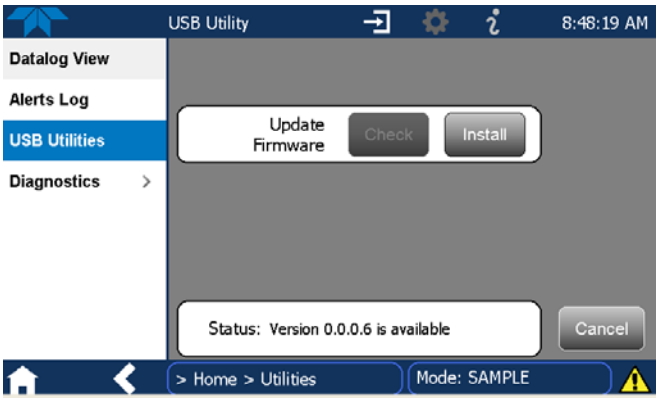
1. Follow Technical Support's instructions for copying the firmware files to a flash drive.
2. On the instrument's front panel Home menu, press USB Utilities to open the utility page.



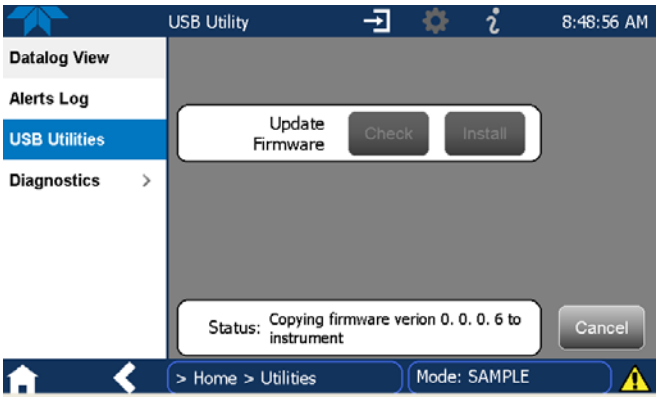
3. Insert a flash drive into a front panel USB port and wait for the Status field to indicate that the drive has been detected.



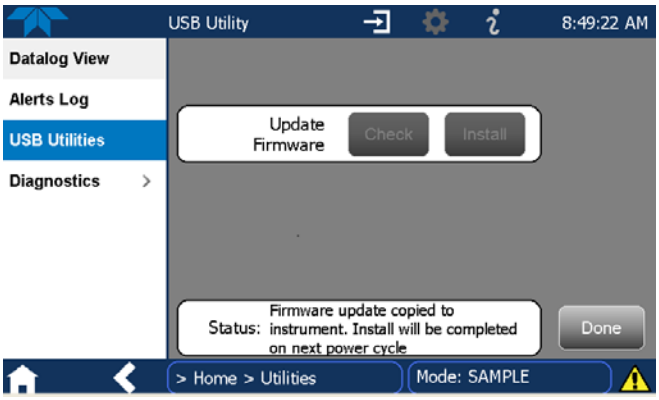
4. In the Update Firmware field, press the Check button for the instrument to determine whether the firmware on the flash drive is more recent than what is currently installed. Once it's been determined that the firmware is new, the Install button will be enabled; if the firmware version on the flash drive is the same as or older than the current firmware of the instrument, the Install button will not be enabled.



5. Press the Install button to copy the updated firmware to the instrument.



6. When complete, as indicated in the Status field, press the Done button and remove the flash drive. Power off and restart the instrument to complete the updated firmware installation process.



3.3. **OPERATION**

Upon startup, sampling begins. Allow 10-minute warming period for reliable readings.

4. ADJUSTMENTS

The following equipment, supplies, and expendables are required for sensor checks and adjustments:

- for pressure and flow: auditing device (NIST-traceable pressure standard and flow standard)
- for PMT Adjustment: SpanDust™

4.1. CALIBRATION CHECKS AND ADJUSTMENTS

IMPORTANT

IMPACT ON READINGS OR DATA
Calibrate Pressure prior to calibrating Sample or Bypass Flow.

There are three basic checks and adjustments that should always be performed in a specific order as shown below:

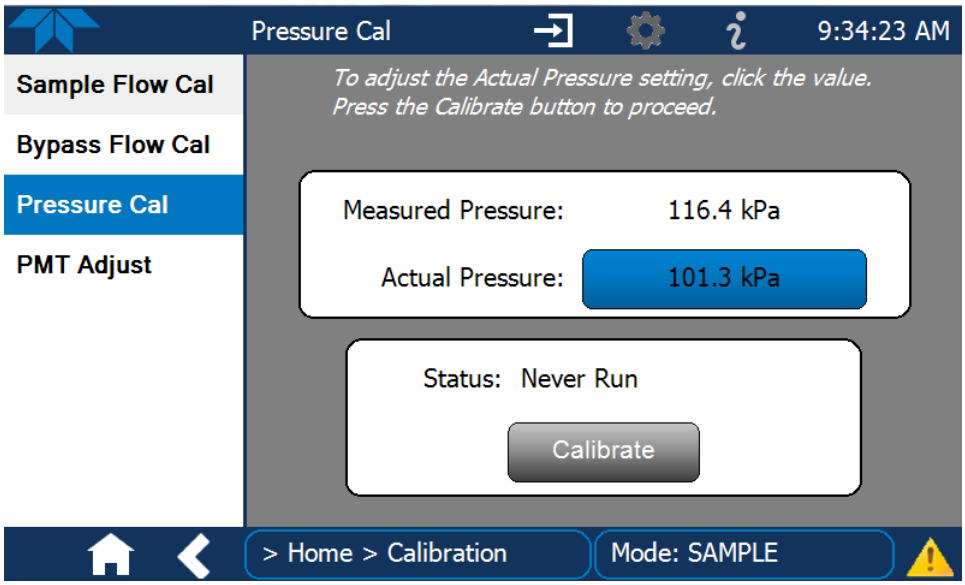
- Pressure sensor check (and calibration, if needed).
- Flow sensor check(s) (and calibration, if needed).
- PMT Adjustment using SpanDust™.

All of these functions are performed in the Calibration menu of the instrument software.

See maintenance schedule in Section 5.1 for recommended intervals for these procedures.

For the Pressure Cal and the two Flow Cal menus, note that the “Measured” parameter provides the value measured by the instrument, and the “Actual” parameter is the value that is to be input from the reading measured by the external auditing device.

4.1.1. **PRESSURE CAL**



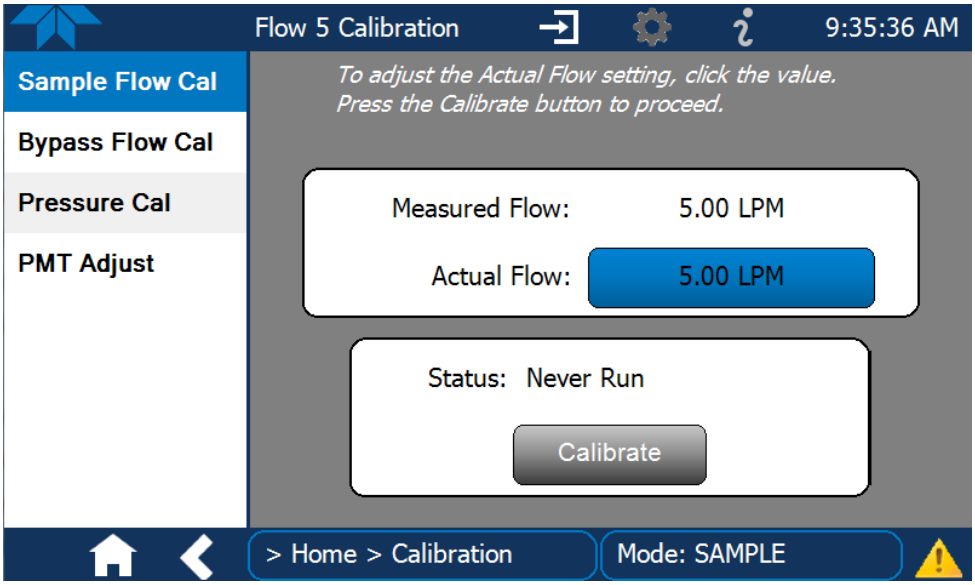
IMPORTANT: Perform this check/calibration *prior to* any flow calibration.

The pressure measurement of the T640 is for the ambient pressure that the instrument is operated in. No direct pneumatic connection to the instrument needs to be made to perform this check/calibration.

1. With the Pressure Standard operating and measuring the ambient pressure in the same room as the T640, navigate to the Pressure Cal menu.
2. Compare the “Measured Pressure” in this screen to the Pressure Standard.
3. If the two values differ by more than 5%, then press the value button in the “Actual Pressure” field, enter the value measured by the Pressure Standard, and press the “Calibrate” button on this screen.

The Measured Pressure value should change to closely match the Actual Pressure within a few seconds.

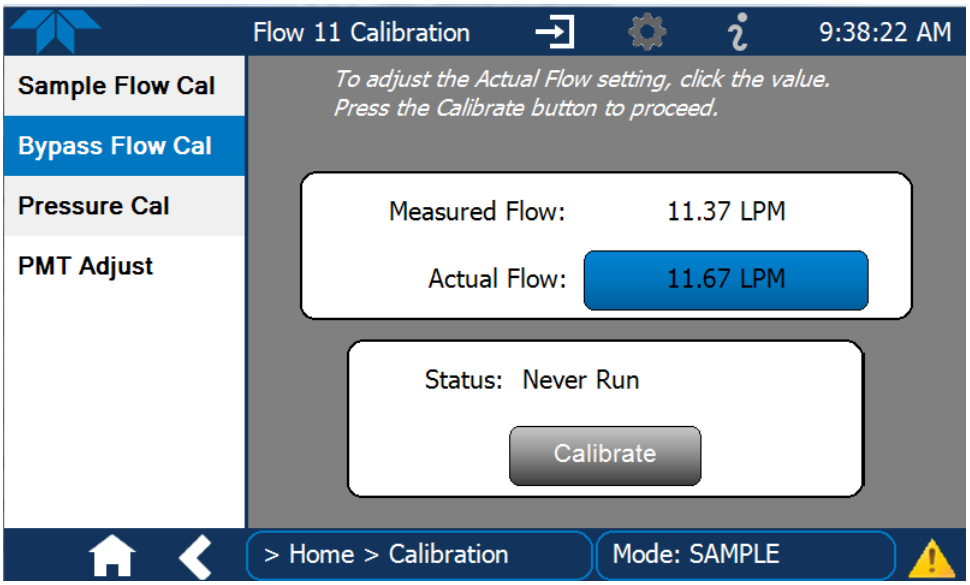
4.1.2. SAMPLE FLOW CAL (5-LPM)



IMPORTANT: Perform Pressure Cal first (Section 4.1.1).

1. Setup your NIST-traceable flow standard transfer device with the appropriate inlet for the flow to be calibrated.
2. Remove the inlet from Upper Inlet Tube.
3. If the 640X Option is installed, remove the Bypass Flow Tube from the ASC tube and cap the Bypass Tube fitting.
4. Connect the Flow Standard to the top of the Upper Inlet Tube. Wait at least one minute for the flow to re-stabilize.
5. With the T640 running, go to the Calibration>Sample Flow Cal menu.
6. Compare the “Measured Flow” in this screen to the Flow Standard.
7. If these values differ by more than 5%, then press the value button in the “Actual Flow” field, enter the value measured by the Flow Standard, and press the “Calibrate” button on this screen. The Measured Flow value should change to closely match the Actual Flow within a few seconds.
8. For the T640 with the 640X Option, leave the Bypass Tube disconnected and proceed to the bypass flow calibration procedure in Section 4.1.3.
9. For the T640 without the 640X Option, leave the Sample Inlet off and proceed to the PMT adjustment procedure in Section 4.1.4.

4.1.3. **BYPASS FLOW CAL (11.67-LPM)**

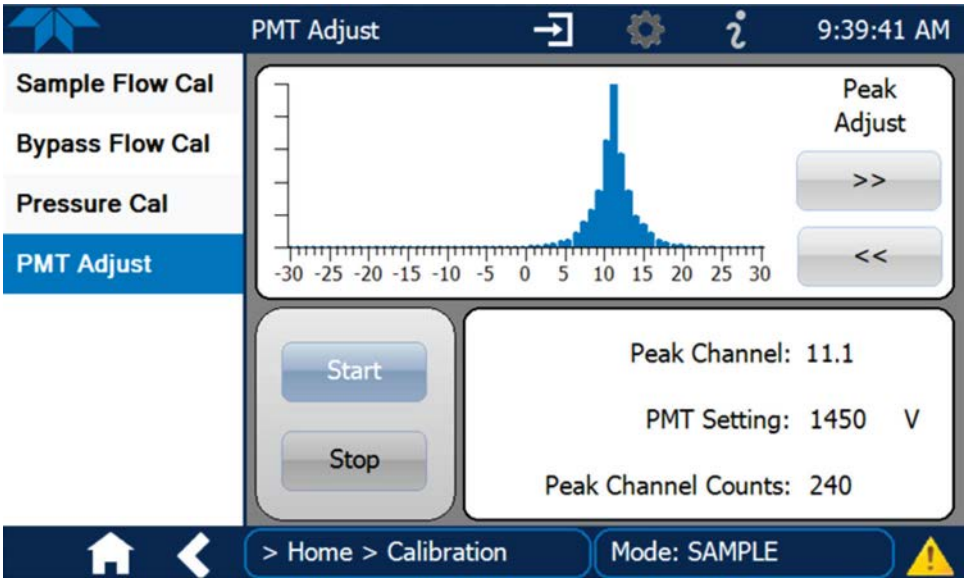


IMPORTANT: Perform Pressure Cal first (Section 4.1.1).

1. Connect theNIST-traceable flow transfer standard device to the Bypass Tube that was disconnected in the Sample Flow Cal procedure above. Wait at least one minute for the flow to re-stabilize.
2. With the T640 running, go to the Calibration>Bypass Flow Cal menu.
3. Compare the “Measured Flow” in this screen to the Flow Standard.
4. If these values differ by more than 5%, then press the value button in the Actual Flow field, enter the value measured by the Flow Standard, and press the Calibrate button on this screen.

The Measured Flow value should change to closely match the Actual Flow within a few seconds.

4.1.4. **PMT ADJUSTMENT**



The Particle Sensor PMT Adjustment uses our SpanDust™, a monodisperse dust with a specific refractive index. All T640 instrument PMTs have a very specific response to this span dust which allows for the sensor to be checked and adjusted in the field for drift caused by contamination of the optics. *It is important to note that this is not a calibration of the optical sensor based on the mass of dust being used, but simply a mechanism to check and adjust the PMT response to particles with a specific and known refractive index.*

1. Navigate to the PMT Adjust screen.
2. Remove the T640 sample inlet or the 640X Option sample inlet and press the Start button on this screen to suspend normal data acquisition and start this adjustment process.
3. Prepare the SpanDust™ bottle by uncapping the “air intake” at the bottom of the silica gel drier attached to the bottle.
4. Place the tube from the SpanDust™ bottle into the top of the Upper Inlet Tube for the instrument.
5. Ensure that the silicone tube fits snugly inside the aluminum inlet tube, and do not allow the bottle to hang, as it could dislodge the silicone tube from the inlet tube.
6. Gently tap the SpanDust™ bottle to barely agitate the contents just enough to allow the dust to be pulled into the sensor, and allow 30 seconds for the Peak Channel reading in this screen to respond.
7. If the Peak Channel reading is not at 11.3, ± 0.5, then adjust the PMT Setting by pressing the Peak Adjust left (decrement) or right (increment) buttons to center the Peak voltage. Each press of a button is 1 volt, so press the Peak Adjust button by as many times as the number of volts the reading is off.

8. Allow 30 seconds for the Peak Channel reading in this screen to respond, and if it is not at 11.3, ± 0.5, repeat the process. This could take several tries over a long period when conducted in a humid environment.
9. Once the Peak Channel reading is at 11.3, ± 0.5, reattach the sample inlet and press the Stop button to stop the adjustment process and resume normal data acquisition.

5. MAINTENANCE AND SERVICE

5.1. MAINTENANCE SCHEDULE

As a part of routine system management, preventive maintenance includes cleaning, inspections, adjustments and calibrations. Table 5-1 provides a list of actions to take and their frequencies. Section 5.2 describes procedures.

Table 5-1. Maintenance Schedule

Maintenance Action	Frequency	Reference
Clean Inlet	monthly	5.2.1 or 5.2.2
Check/Adjust PMT with SpanDust™ (measured peak, limit: 0.0 ± 0.5)	monthly or as needed e.g., high dust load	4.1.4
Check Pump Performance (PWM/PID value < 80%)	monthly	5.2.4
Check volume flow. Use NIST-traceable flow transfer standard device: 5.0 LPM ± 0.15 LPM (for T640) and 11.67 LPM ± 0.5 LPM (for 640X opt) (Standard Ambient Temperature and Pressure).	quarterly	5.2.5
Check for leaks	quarterly or as needed (Pump PWM or Valve PWM exceeds 85%)	5.2.8
Inspect and clean optical chamber and RH/T sensor.	every six months or as needed, e.g., high dust load	5.2.6
Change isposable Filter Unit (DFU) for 5-lpm flow and bypass flow (if installed)	annually or when Pump PWM Value exceeds 80%.	5.2.3
Inspect sampling line	annually or as needed	5.2.7

5.2. MAINTENANCE PROCEDURES

This section provides cleaning and maintenance information for the inlets and filters.

5.2.1. CLEANING THE T640 INLET

Figure 5-1. T640 Inlet (standard)

1. Power off the pump from the Setup>Vars>Pump Control menu.
2. Remove the sampling inlet from the sampling line.
3. Disassemble the sampling inlet: two screws at base of inlet and base plate.
4. Carefully and thoroughly remove any dust deposits from inside of the inlet.
5. Remove any insects or other debris from the filtering screen.
6. Clean all the components using water and a mild detergent.
7. Dry all components thoroughly with a clean cloth and blow compressed air through nozzles.
8. Check and, if needed, replace the o-rings located on the outside and the inside of the base plate, and grease them with vacuum grease.
9. Re-assemble the sampling inlet, sliding the baseplate back into the base of the inlet body, making sure to line up with the screw holes. The screws should be put back in to hand-tight pressure.
10. Reconnect sampling line.
11. Power up the pump from the Setup>Vars>Pump Control menu.

This procedure should be repeated per the schedule in Table 5-1.

5.2.2. **CLEANING THE US EPA PM10 INLET**

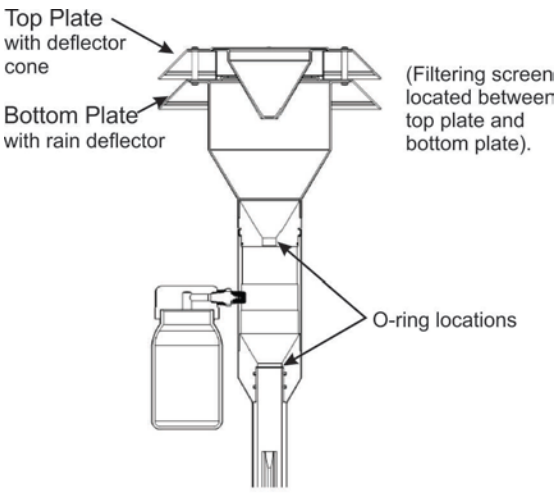


Figure 5-2. 640X Option Disassembly

1. Power off the pump from the Setup>Vars>Pump Control menu.
2. Mark each assembly point of the sampler inlet with a pen or pencil to provide “match marks” during reassembly. Critical assembly points are already “keyed.”
3. Disassemble the sample inlet unit according to the figure above, taking care to retain all the parts. Note: If the assembly screws appear frozen, the application of penetrating oil or commercial lubricant will make removal easier.
4. Remove any insects or other debris from the filtering screen.
5. Using a soft brush, cloth, and cotton swabs, lightly scrub all interior surfaces and components with distilled water and/or the general-purpose cleaner. Pay particular attention to small openings and crevices. Cotton swabs and/or a small soft brush are most helpful in these areas. Using laboratory tissue and cotton swabs moistened with distilled water, wipe all surfaces to remove any remaining deposits. Completely dry all components.
6. Check all the O-rings for distortion, cracks, fraying, lack of lubricating grease, or other problems. Apply a thin coating of vacuum grease or replace the O-rings as necessary.
7. Reassemble the unit in accordance with the previously scribed match marks. Take particular care to ensure that all O-ring seals are properly sealed and that all screws are uniformly tightened.
8. Power up the pump from the Setup>Vars>Pump Control menu.

5.2.3. CHANGING THE DISPOSABLE FILTER UNIT (DFU)

1. Power off the pump from the Setup>Vars>Pump Control menu.
2. Pull open the instrument's front panel, using the front panel finger grips.

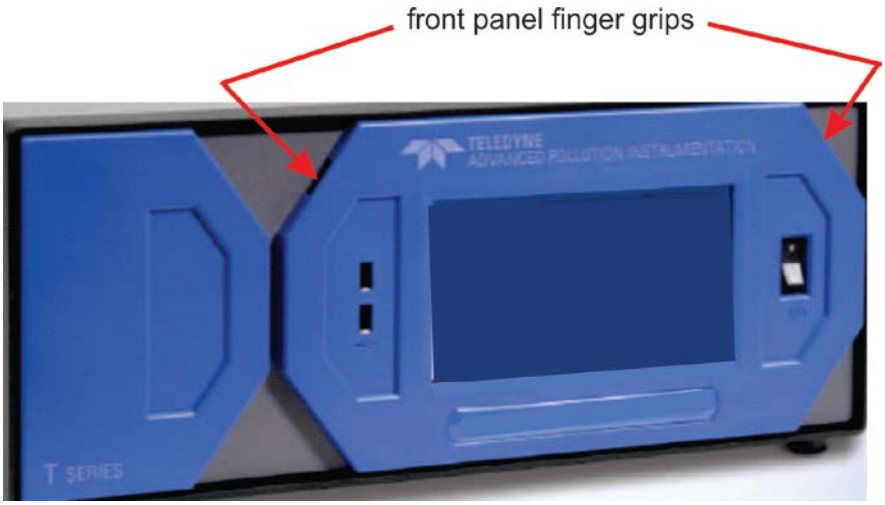


Figure 5-3. Opening the Front Panel

3. Noting its orientation, remove the old DFU by detaching from the pneumatic quick-connect fittings, and replace with a new DFU matching the orientation.

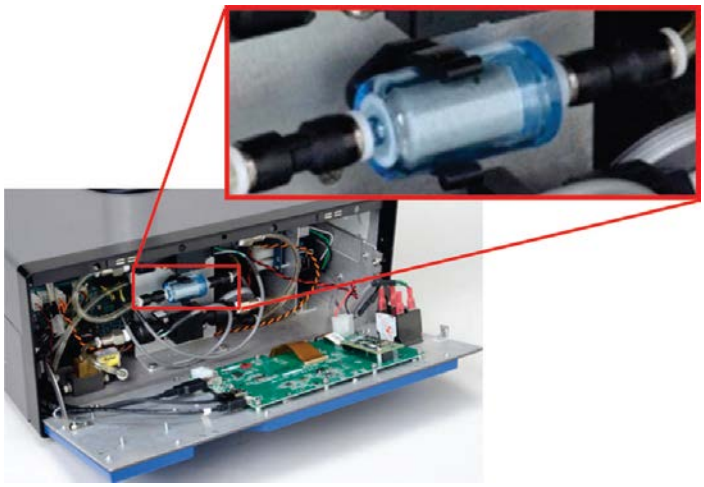


Figure 5-4. Internal DFU

4. For 640X Option only: noting its orientation, detach the filter from the quick-connect fittings and replace with new.

Figure 5-5. External DFU, (with 640X Option only)

5. Ensure the filter(s) is(are) seated snugly with no gaps, and power on the pump from the Setup>Vars>Pump Control menu.

5.2.4. CHECKING PUMP PERFORMANCE

There is one internal pump in the T640. In addition, the 640X Option has a separate external pump. The pump(s) and the valve (640X Option only) must maintain proper flow for measurement accuracy. Check their performance levels in the Dashboard (If these parameters are not found in the Dashboard, configure the Dashboard to add them; see Section 3.1.9):

- Pump PWM should be running between 35% and 80%.
- Valve PWM should be running between 35% and 85%.

If the performance levels are out of range, refer to Table 5-2 for troubleshooting guidance.

5.2.5. CHECKING THE VOLUME FLOW

Check the Sample Flow levels in the Dashboard. (If not found in the Dashboard, add it through the Dashboard configuration page; see Section 3.1.9). If out of range (5 LPM, +/- .25 LPM), refer to Table 5-2 for troubleshooting guidance.

For the 640X Option, also check the Bypass Flow levels in the Dashboard. (If not found in the Dashboard, add it through the Dashboard configuration page; see Section 3.1.9). If out of range (11.67 LPM, +/- 0.58 LPM), refer to Table 5-2 for troubleshooting guidance.

5.2.6. CLEANING THE OPTICAL CHAMBER AND THE RH/T SENSOR

1. Remove the ASC support, which straddles the sensors. Four screws secure that support to the floor of the instrument, two on each footing.

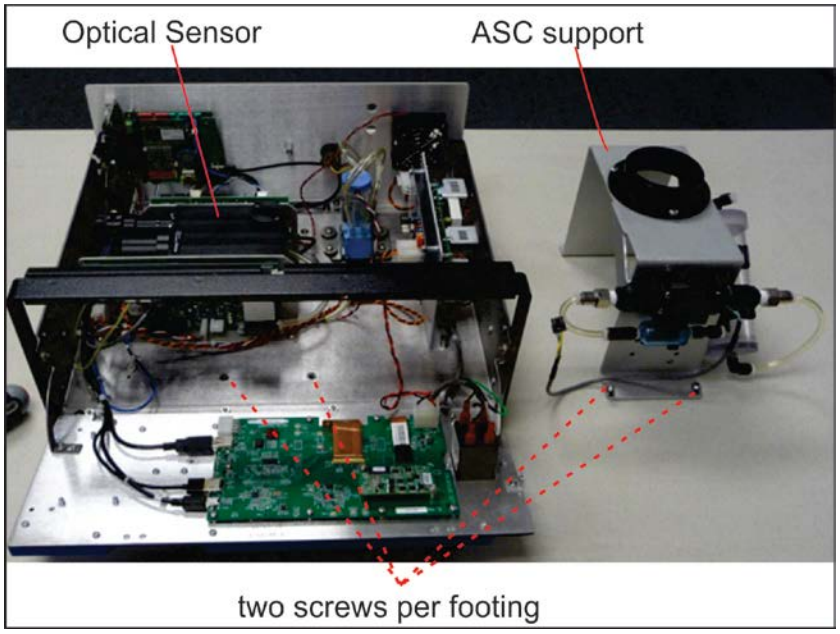


Figure 5-6. Maintenance: Optical Chamber and RH/T Sensor Access

2. Locate the optical cell, the cup at bottom of optics chamber and its tubing, and the Relative Humidity and Temperature (RH/T) sensor.

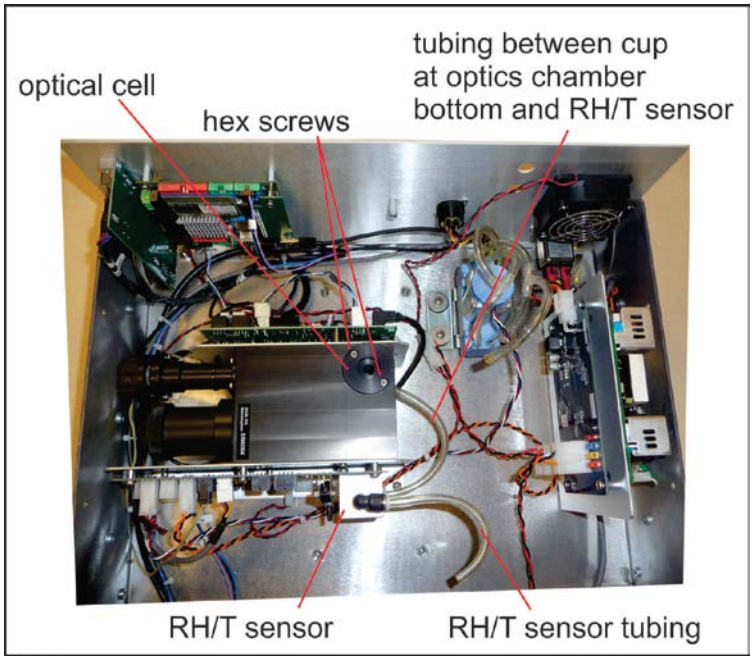


Figure 5-7. Maintenance: Location of Optics Chamber and RH/T Sensor

3. Remove optical cell from optics chamber, and remove cup, including its tubing, from optics chamber bottom; detach RH/T sensor tubing from DFU filter.

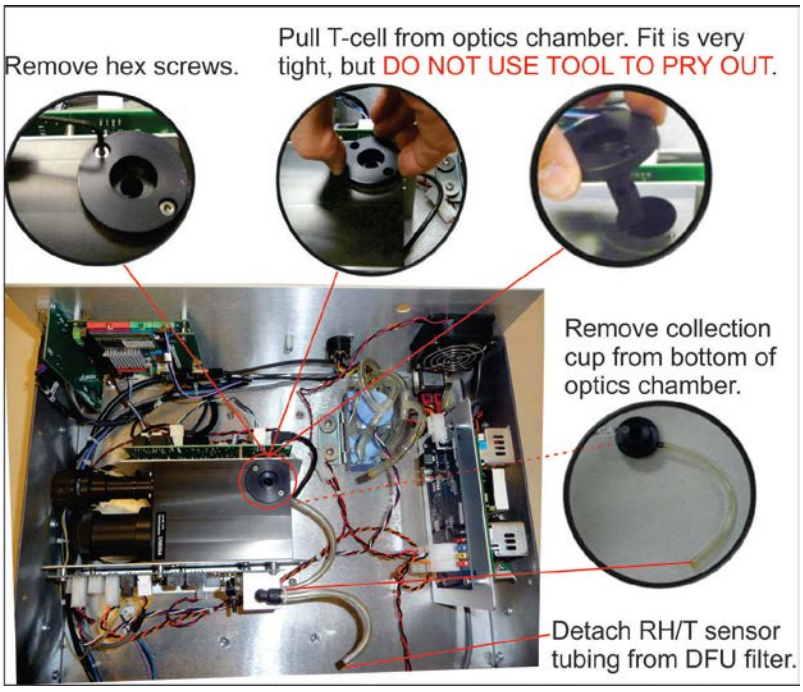


Figure 5-8. Maintenance: Optical Chamber Disassembly

4. Clean the optics chamber interior surfaces, ensuring to include windows, with a lint-free cloth.

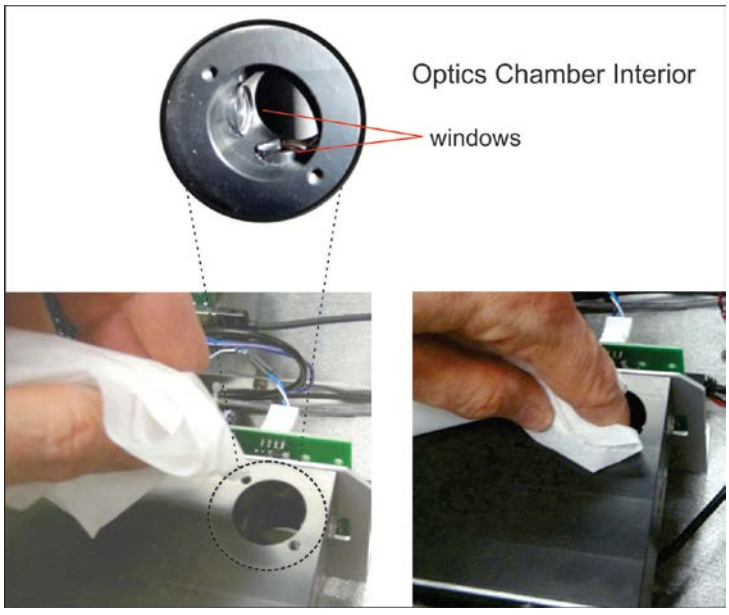


Figure 5-9. Maintenance: Optics Chamber Windows

5. Use a can of compressed gas made specifically for electronics to blow any dust or other debris from the optics chamber, from the cup, from the bottom of the optics chamber, and from the tubing.

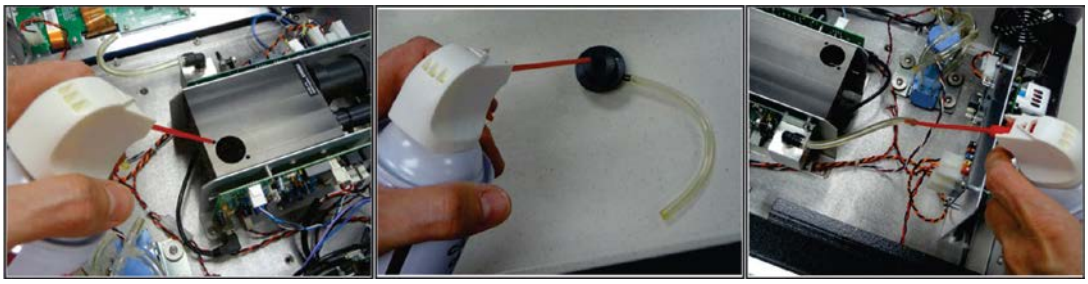


Figure 5-10. Maintenance: Final Dusting

6. When finished, reassemble optics chamber components; reinsert cup to bottom of optics chamber; reconnect tubing from cup in bottom of chamber to RH/T sensor and from RH/T sensor to the DFU filter, and reinstall the ASC support.
7. Close instrument, and perform a PMT sensor check with the SpanDust™ (Section 4.1.4).

5.2.7. INSPECTING THE SAMPLING LINE

Look inside the sampling line for debris or dust on the walls. If needed, push a rag or a paper towel through the line; then use a can of compressed gas made specifically for electronics to blow through the line for final cleaning.

5.2.8. CHECKING FOR LEAKS

The internal components of the T640 are not meant to be under strict vacuum as what would normally be done in a leak test. So, to avoid damage to internal components, it is recommended that the inlet never be capped (air tight) while the instrument pump is running.

The **Zero Test** is a way to check for leaks that do not involve pulling a vacuum on the system.

1. Remove the inlet and fit a HEPA filter to the sample port.
2. Observe the PM values on the front panel display.
3. Within a few minutes, the PM values should be at zero.
4. If the PM values are not reading zero, then there may be a leak in the system above the optical sensor (i.e. from the optical sensor nozzle up to where the HEPA filter was fitted).
   - Note, it is also possible the HEPA filter being used is either bad or leaking. Always have a second filter handy to check.
   - If the PM values do read zero, then there is not a leak above the optical sensor.

5.3. TROUBLESHOOTING AND SERVICE

This section provides guidance for resolving fault conditions and possible flow and calibration problems.

5.3.1. FAULT DIAGNOSIS

The Alerts log may be useful in diagnosing faults. Table 5-2 lists some of the Alerts that are triggered by faults, describes their likely causes, and provides possible solutions.

Table 5-2. Alerts and Recommendations

Message	Description	Possible Solution(s)
System Reset	Warning raised when the system is reset	Normal power cycle occurred? If not, check external power source.
Sample Flow High	The Sample Flow is greater than 5.25 lpm	Check pneumatic fittings. Re-calibrate flow.
Sample Flow Low	The Sample Flow is less than 4.75 lpm	Check pneumatics. Check for blockages. Re-calibrate flow.
Bypass Flow High	The Bypass Flow is greater than 12.25 lpm	Check pneumatic fittings. Re-calibrate flow.
Bypass Flow Low	The Bypass Flow is less than 11.08 lpm	Check pneumatics. Check for blockages. Re-calibrate flow.
Sample RH High	The Sample RH is above the setpoint	Check if ASC is plugged in. Check control board if ASC control LED is illuminated. Check if water is in the sensor.
Check LED	If the LED temperature is equal to the box temperature, the LED may be OFF	Cycle power. Call Tech Support.
Check PMT	The PMT HV setting is out of range (800 – 2200)	Check Sensor with SpanDust™. Perform an optical chamber cleaning. Call Tech Support.
Sample Flow Slope OOR	The Sample Flow Calibration Slope is Out Of Range	Check pneumatics for leaks. Re-run flow calibration. Call Tech Support.
BYPS Flow Slope OOR	The Bypass Flow Calibration Slope is Out Of Range	Check pneumatics for leaks. Re-run flow calibration. Call Tech Support.
Check Int Pump	Check the internal pump if the PWM is > 80	Check pneumatics for blockages. Check pneumatics for leaks. Check flow calibration. Replace pump.
Check Ext Pump	Check the external pump and/or bypass flow control valve if valve PID > 85	Check pneumatics for blockages. Check pneumatics for leaks. Check external pump. Check flow calibration. External pump, or bypass flow control valve may need replacing.
Sample Temp Warning	Sample Temperature Warning (>60)	Check ASC (is it latched ON?) Ensure proper climate and ventilation for instrument.

Message	Description	Possible Solution(s)
Box Temp Warning	Box Temperature Warning (>60)	Ensure proper climate and ventilation for instrument.
AMB Press Slope OOR	Ambient Pressure Calibration Slope is out of range	Check calibration (make sure units match calibration device). Replace pressure sensor. Call Tech Support.

5.3.2. FLOW PROBLEMS

If a flow auditing device indicates any problems with flow, check to ensure the following:

- all connections are seated tightly and evenly (no gaps)
- the inlet is not clogged or blocked
- the pump is running and is within its PWM range (35% - 80%).

After making any adjustments, run a flow calibration and recheck the flow rate. If problems persist, please contact Technical Support.

5.3.3. CALIBRATION PROBLEMS

Call our Technical Support Department for technical assistance.

5.3.4. TECHNICAL ASSISTANCE

If this manual and its troubleshooting / service sections do not solve your problems, technical assistance may be obtained from:

Teledyne API Technical Support,
9970 Carroll Canyon Road, Ste A
San Diego, California 92131-1106 USA

Toll-free Phone: 800-324-5190
Phone: +1 858-657-9800
Fax: +1 858-657-9816
Email: sda_techsupport@teledyne.com
Website: http://www.teledyne-api.com/

Before contacting Teledyne API Technical Support, fill out the problem report form in the Appendix, which is also available online for electronic submission at http://www.teledyne-api.com under Technical Support Forms.

6. PRINCIPLES OF OPERATION

The Model T640 PM Mass Monitor is an optical aerosol spectrometer that converts optical measurements to mass measurements with sharp accuracy by determining sampled particle size via scattered light at the single particle level according to Lorenz-Mie Theory.

Briefly, the sampling head draws in ambient air with different-sized particles, which are dried with the Aerosol Sample Conditioner (ASC) and moved into the optical particle sensor where scattered light intensity is measured to determine particle size diameter. The particles move separately into the T-aperture through an optically differentiated measurement volume that is homogeneously illuminated with polychromatic light. The polychromatic light source, an LED, combined with a 90° scattered light detection achieves a precise and unambiguous calibration curve in the Mie range, resulting in a large size resolution.

Each particle generates a scattered light impulse that is detected at an 85° to 95° angle where amplitude and signal length are measured; the amplitude (height) of the scattered light impulse is directly related to the particle size diameter.

The T-aperture and simultaneous signal length measurements eliminate border zone error, which is characterized by the partial illumination of particles at the border of the measurement range.

6.1. SAMPLING SYSTEM

There are several components that are part of drawing in and measuring aerosol samples: the inlet, the Aerosol Sample Conditioner (ASC), an optical particle sensor, a flow sensor, and pump.

6.1.1. INLET

The inlet for the T640 is designed to allow complete transmission of all particle sizes.

The US EPA PM10 inlet used for the 640X Option samples at 16.67-LPM to mechanically size-cut the aerosol intake for sampling particles at 10 microns and under.

6.1.2. AEROSOLSSAMPLE CONDITIONER (ASC)

The ASC removes volatile components (mainly water) of the aerosol to avoid false particle size. Its operation includes an air sensor for measuring ambient temperature and humidity in order to dynamically adjust the heating of the ASC tube for moisture/humidity compensation.

6.1.3. OPTICAL PARTICLE SENSOR

The optical particle sensor is the main sensor in the instrument. This sensor analyzes the particles, categorizing them by size and making the conversion to a mass concentration.

6.1.4. FLOW SENSOR AND PUMP CONTROL

The T640 operates using ambient and pressure compensated mass flow, for accurate control of flow to actual volumetric conditions. The flow stream is measured (main flow at 5 LPM for T640 and bypass at 11.67 for 640X Option), and a feedback loop triggers the pump drive voltage adjustments to maintain a constant flow (5 LPM in the T640, 16.67 LPM in the 640x Option).

The internal vacuum pump is a 24V DC pump controlled by a pulse-width modulation (PWM) feedback control for consistently accurate flow to the sensor.

The external vacuum pump (640X Option only) uses either a 110-120 or 220-240VAC pump. The bypass flow system is controlled by an ambient and pressure compensated mass flow controller in combination with a pneumatic valve for consistently accurate flow.

6.2. **ELECTRONIC BLOCK DIAGRAM**

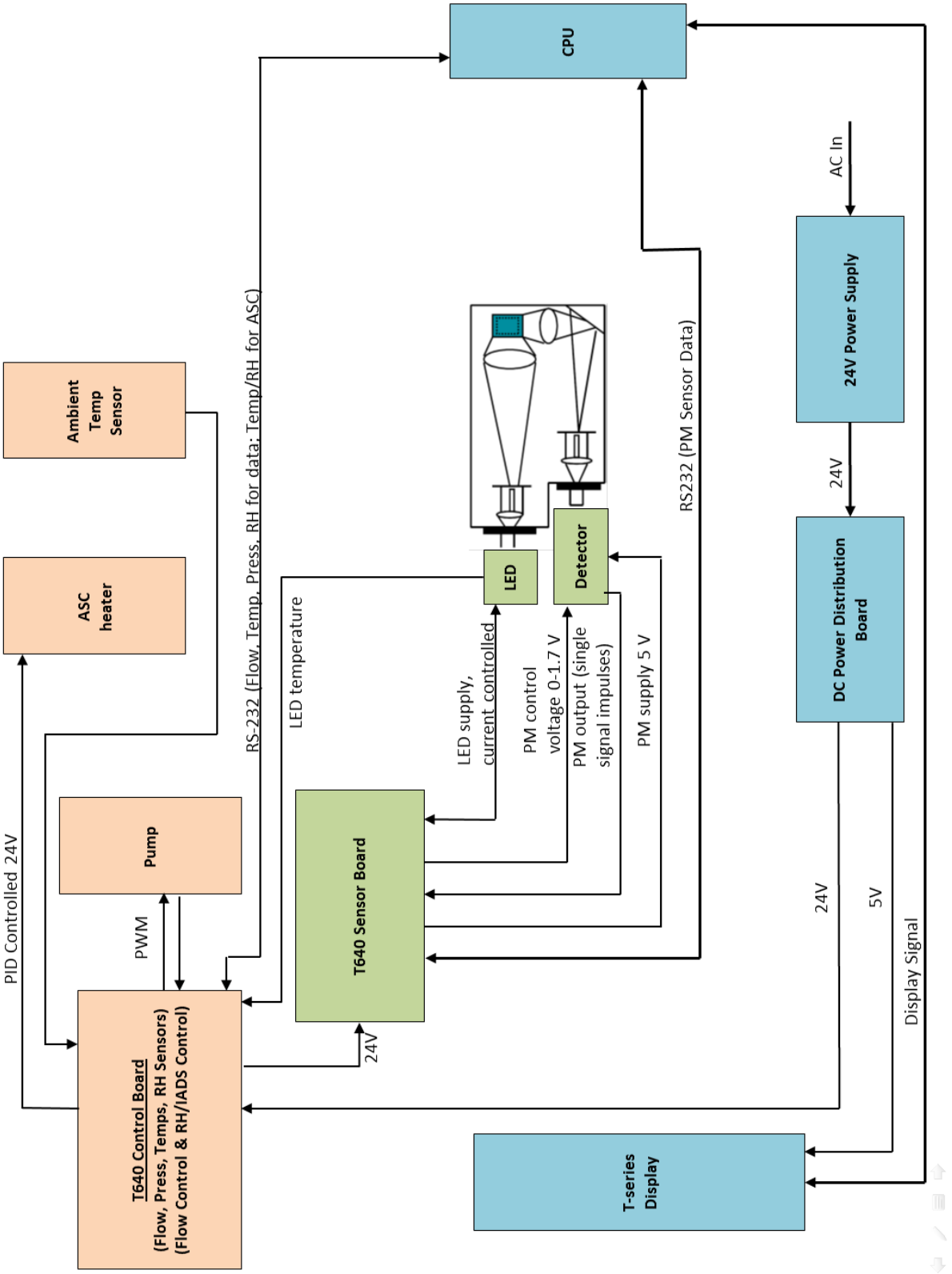


Figure 6-1.T640 with 640X Option Electronic Block Diagram

APPENDIX

(Reference 08343B DCN7303)

CUSTOMER:_____ PHONE: _____

CONTACT NAME: _____ FAX NO.

SITE ADDRESS:

MODEL TYPE: _____ SERIAL NO.: _____ FIRMWARE REVISION:

Are there any failure messages?

PLEASE COMPLETE THE FOLLOWING TABLE FOR THE T640:

PARAMETER	RECORDED VALUE	ACCEPTABLE VALUE
Sample Flow	LPM	5.0LPM ±1%
Sample Flow Slope		1.0 ±5%
Ambient Pressure		Within 1% of audit device
Ambient Pressure Slope		1.0 ±5%
Sample RH	%	≤35% (controlled by ASC)
Box Temp	°C	0-60°C
Ambient Temp	°C	-40 - 60°C
LED Temp	°C	≤70°C
Sample Temp	°C	Between ambient and box temp
P3 (Calculated) *		45 - 55
PMT HV Setting	V	1200 – 2200V
Pump PWM		<80
640x Option Bypass Flow	LPM	11.67 (±1%)
640x Option Bypass Flow Slope	LPM	1.0 ±5%

* Used for diagnostics only and should not be set/reset without explicit direction from TAPI Tech Support. If P3 (Calculated) does not appear in the Dashboard, configure the Dashboard (Section 3.1.9) to display it.

What is the measured Sample flow rate? _____liters/min

What are the failure symptoms? _____

_____

_____

_____

_____

_____

What tests have you done in trying to solve the problem? _____

_____

_____

_____

_____

Thank you for providing this information. Your assistance enables Teledyne Instruments to respond faster to the problem that you are encountering.

OTHER NOTES: _____

_____

_____

_____

_____

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_____

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TELEDYNE API TECHNICAL SUPPORT

Email: sda_techsupport@teledyne.com

PHONE: +1 858-657-9800 TOLL FREE: (800) 324-5190 FAX: +1 858-657-9816