INSTRUMENT VERIFICATIONS/CALIBRATIONS

There are five basic verification checks and should always be performed in the specific order as shown below:

1. Zero Test
2. Temperature Sensor Verification
3. Pressure Sensor Verification/Calibration
4. Flow Sensor Verifications/Calibrations
5. PMT verification using SpanDust™

The acceptable ranges for each parameter are:

- Ambient Temperature: ±2 °C
- Ambient Pressure: ±10 mm Hg
- Flow: ±4% of reference standard and ±5% of design flow (16.7 LPM)

Three of the verifications can be calibrated, if necessary. There is *no adjustment for either the zero test or ambient temperature* and as such failure of one or both checks results in the need to troubleshoot rather than adjust a setting.

For the T640X flow rate, the procedure calls to *verify the total flow rate (16.67 lpm) and then the sample flow rate (5.0 lpm); however, the total flow rate cannot by itself be calibrated*. Instead, if the total flow does not meet its required tolerance, the sample flow and bypass flow are calibrated, if necessary.

NOTE: that the "**Measured**" parameter provides the value measured by the T640(x), and the "**Actual**" parameter is the value that is to be input from the reading measured by the external flow audit device.

Record results on the ***Monthly QC and Maintenance Sheet***.

Zero Test

The internal components of the T640x 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 (airtight) while the instrument pumps are running.

The Zero Test is a way to check for leaks that do not involve pulling a vacuum on the system.
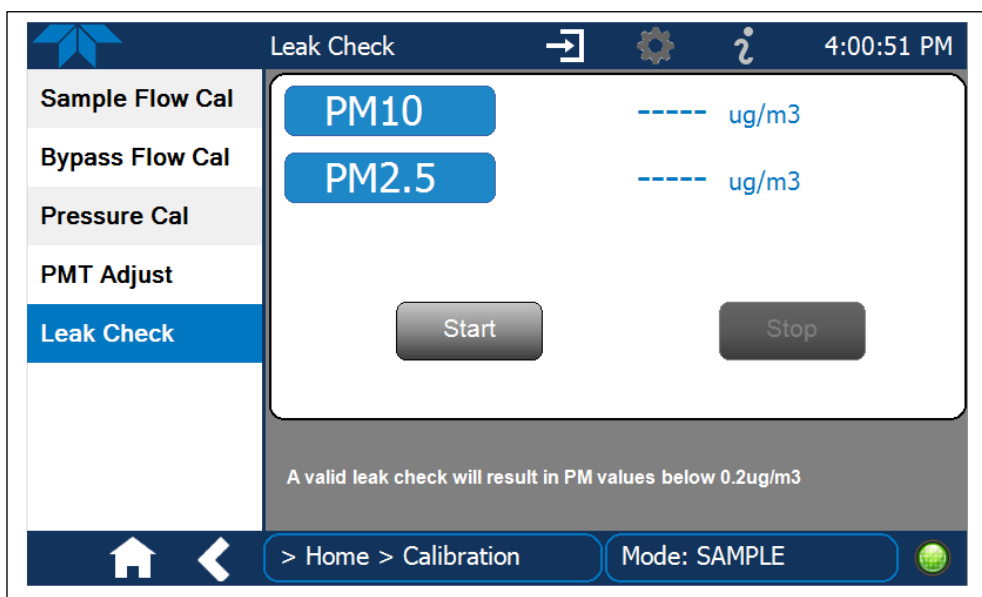
NOTE: No adjustment is made if the zero test is not acceptable, rather troubleshoot the instrument until resolved.

1. Remove the inlet and fit a HEPA filter to the sample port. Ensure the tubing is not kinked.

Leak Check HEPA
Filter/Flow Audit Adapter Kit

2. From the **Home** screen on the T640 panel display, select: **Calibration > Leak Check > Start**.

3. Observe the front panel display on the monitor until the PM values (PM10 and PM2.5 channels) are steady.

4. If each PM value reaches 0.0, accept the Zero Test and move to step 5.
   a. If data are in the range of 0.1 to 0.3, accept the data and troubleshoot. If after ten or more minutes the data are still at 0.4 or greater, identify the data as suspect on the Monthly QC and Maintenance Sheet and troubleshoot.
   b. If the PM values are not reading zero, then it's likely to be one of two issues:

        i. 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). Troubleshoot by checking each connection between monitor and HEPA filter and ensuring there is a good seal.

       ii. It is possible the HEPA filter being used is either bad or leaking. It is recommended to have a second filter handy to check.

5. Record the zero results to the Monthly QC and Maintenance Sheet.

6. Once each PM channel reaches zero (0.0) for each PM metric, press "**Stop**" and then the **Home** button or **Home icon**.

7. Disconnect the HEPA filter.

8. Disassemble the zero apparatus.
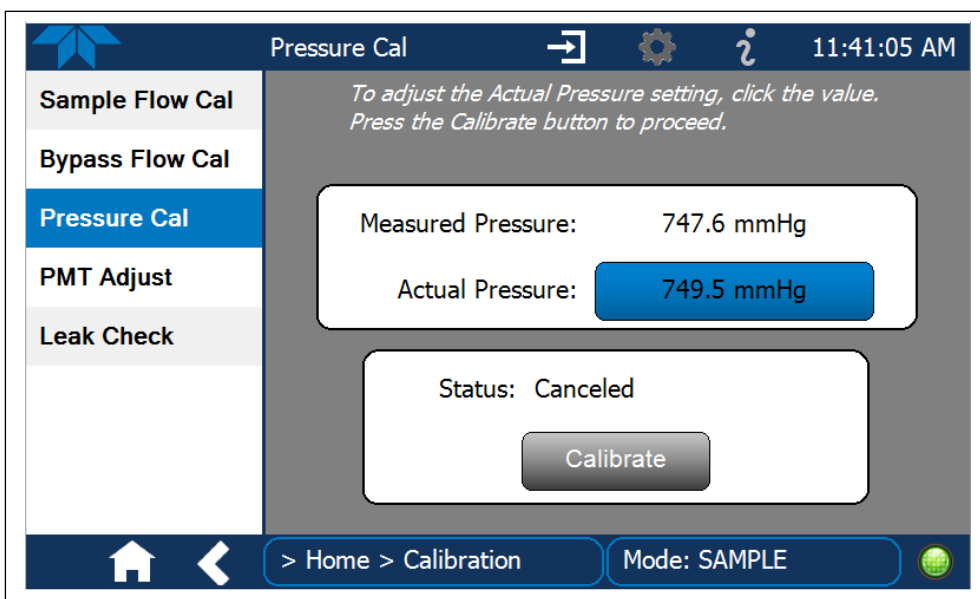
Ambient Temperature Sensor Verification

1. Identify the NIST-traceable flow audit device and connect the temperature sensor probe to the device and allow 10 minutes to equilibrate.

2. Insert the flow audit device temperature probe into the T640's ambient temperature sensor radiation shield.

3. From the **Home Menu** select **Dashboard** and observe **Ambient Temperature**.

4. While the T640 temperature sensor cannot be calibrated, it should be checked to make sure it is within +/-2 °C of the flow audit device or reference standard.

5. Record these values under the Verification column within the Monthly QC and Maintenance Sheet. Press **Home icon** to return to the Home screen.

NOTE: The temperature reading is used for volumetric flow, and once the flow has been calibrated, it is the change in temperature that really matters (rather than the temperature itself). So, if the sensor does not read exactly the same as a reference standard, that is not as important as whether their ΔT match (i.e. change in temperature over the same period of time).

Ambient Pressure Sensor Verification/Calibration

The T640 ambient pressure sensor is located within the instrument chassis. No direct pneumatic connection to the instrument needs to be made to perform this check/calibration. The units of measure can be displayed in either kPa or mmHg. This setting exists in the **VARS** menu.

1. Navigate to the **Pressure Cal** menu. Select **Calibration > Pressure Cal**.

2. Compare the "**Measured Pressure**" in this screen to the **Pressure** value observed by the flow audit device.

3. Record these values under the Verification column within the Monthly QC and Maintenance Sheet.

4. If the two values differ by ±10 mmHg, then press the value button in the "**Actual Pressure**" field, enter the pressure value measured by the **flow audit device** into the keypad pop up, and then press the "**Calibrate**" button on this screen. Following the prompt, confirm the instruments pressure sensor measurement matches the NIST-traceable pressure standard reference device closely and the procedure is complete.

6. Record these values in the Calibration column within the Monthly QC and Maintenance Sheet. Press **Home icon** to return Home screen.
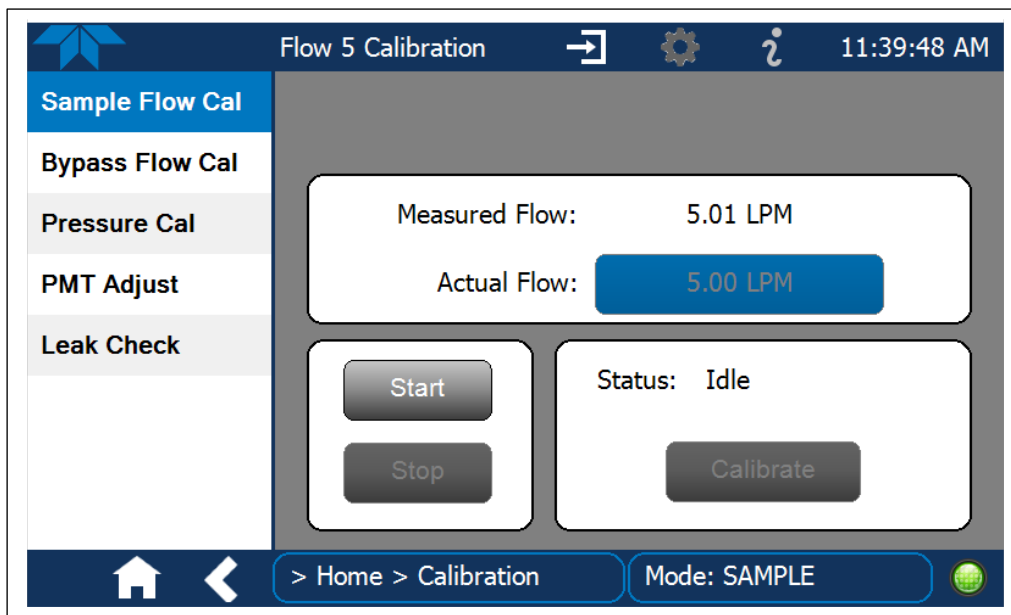

Sample Flow Verification/Calibration (5 LPM)

1. Zero or tare the flow audit device.

2. Install the NIST-traceable flow audit device on to the inlet downtube. Wait at least 1 minute for the flow to re-stabilize.
   a. The T640 will require the audit device to be installed onto the flow audit adapter to connect to the 5/8" inlet tube.

3. If the 640X Option is installed, remove the Bypass Flow Tube from the ASC tube and cap the ASC Bypass Tube elbow fitting with a Swaglok cap.

4. With the T640 running, from the Home screen go to the **Calibration > Sample Flow Cal** menu.

5. Compare the "**Measured Flow**" in this screen to the flow audit device.

6. Record these values in the Verification column within the Monthly QC and Maintenance Sheet.

7. If these values differ by more than 5%, then press the **Start** button and press the value button in the "**Actual Flow**" field, enter the value measured by the flow audit device and press the "**Calibrate**" button on this screen. The **Measured Flow** value should change to closely match the **Actual Flow** within a few seconds.

% Diff = [(flow audit device – sampler)/flow audit device] x 100

8. Record these values in the Calibration column within the Monthly QC and Maintenance Sheet.

9. Press "**Stop**" on the sample flow calibration menu to end the sample flow calibration procedure and return to normal operation. Press **Home icon** to return Home screen.

10. For the T640 with the 640X Option, leave the Bypass Tube disconnected and proceed to the bypass flow verification/calibration procedures.

11. For the T640 without the T640X Option, leave the Sample Inlet off and proceed to the PMT adjustment procedure.

For T640X Option Only: Bypass Flow Verification/Calibration (11.67 LPM)

1. Connect the NIST-traceable flow transfer standard device to the Bypass Tube that was disconnected in the Sample Flow Cal procedure above. Wait at least 1 minute for the flow to re-stabilize.
   a. Use the flow audit adapter kit to connect the Bypass Tube to the flow audit device.
   b. If running the calibration indoors at the point of the bypass flow line, make sure the short ambient temperature probe is plugged into the rear panel so the flow standard and the instrument are measuring temperature in the same location.

2. With the T640 running, go to the **Calibration** > **Bypass Flow Cal** menu.

3. Compare the "**Measured Flow**" in this screen to the flow audit device.

4. Record these values in the Verification column within the Monthly QC and Maintenance Sheet.

5. If these values differ by more than 5%, then press the "**Start**" button and press the value button in the **"Actual Flow"** field, enter the value measured by the flow audit device, and press the **Calibrate** button on this screen. The **Measured Flow** value should change to closely match the **Actual Flow** within a few seconds.

   % Diff = [(flow audit device – sampler)/flow audit device] x 100

6. Record these values in the Calibration column within the Monthly QC and Maintenance Sheet.

7. Disconnect the Swagelok cap from the ASC. Reattach the bypass line to the ASC.

8. Press "**Stop**" on the sample flow calibration menu to end the sample flow calibration procedure and return to normal operation. Press **Home icon** to return Home screen.

For T640X Option Only: Total Flow Verification

1. Connect the temperature probe to the NIST-traceable flow audit device and allow 10 minutes for the device to equilibration.

2. Zero or tare the flow audit device.

3. Remove the PM10 inlet head and install the flow audit device.

4. With the T640x running, from to the **Home** menu select **Dashboard** to view the Total Flow (16.67 lpm).

5. Wait at least 1 minute for the flow to re-stabilize.

6. Record the flow audit device and the T640x total flow rate on the Monthly QC Maintenance Sheet.

7. Compare the T640x Total Flow Rate to the audit device flow rate and determine if these values differ by more than 5%, (e.g., outside of 15.87 – 17.54 lpm for total flow, if sampler reads 16.7).

8. Move to verifying and calibrating the sample flow rate (5.0 lpm).
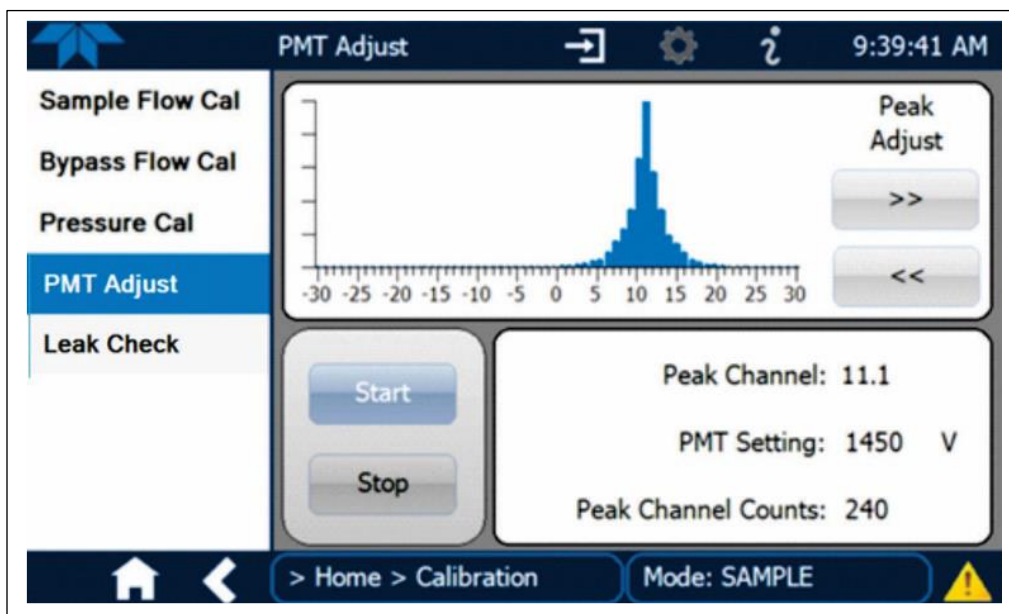
PMT Adjust (Perform Quarterly)

In addition to the monthly maintenance schedule, the T640's Span Deviation feature indicates scattering of ambient particles at a specific size and provides a representative value; the Span Deviation Track feature monitors that scattering over a rolling 48-hour period, and if the scattering deviates by ±3 on either side of 0.0 for an inordinate period, it will trigger an Alert to check whether a PMT adjustment is required. Performing the preceding checks and calibrations in the order set forth is still necessary. (Configure **Dashboard or Home screen** meters to display Span Deviation and/or Span Dev Track can be displayed in the **Setup > Dashboard** and/or in the **Setup > Home screen meters**).

The Particle Sensor PMT Adjustment uses 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.

NOTE: 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. Note the Peak Channel value written on the SpanDust™ bottle. The typical value is 11.1

8. **IMPORTANT**: use the value displayed on the SpanDust™ bottle label with +/- 0.5 channel tolerance, which will be used for example purposes below. If the bottle being used has a different peak value, follow the same procedure with the goal of peaking at that value.

9. If the Peak Channel reading is not at ± 0.5 compared with the value displayed on the SpanDust™ bottle, 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.

10. Allow 30 seconds for the Peak Channel reading in this screen to respond AND record values in the Monthly QC and Maintenance Sheet.
    a. If it is not at ± 0.5 (of the value displayed on the SpanDust™ bottle), repeat the process. This could take several tries over a long period when conducted in a humid environment.

11. Once the Peak Channel reading is at ± 0.5 of the value displayed on the SpanDust™ bottle, reattach the sample inlet and press the **Stop** button to stop the adjustment process and resume normal data acquisition. Press **Home icon** to return Home screen.