Aerosol Penetrometer
TDA-100P
Operation and Maintenance Manual
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</tr>
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1. Utility Requirements

- **Compressed Air** - Clean, dry, compressed airflow rate of 10 scfm at 80 psig (283 slpm @ 5.6 kg/cm²).
  The minimum recommended air line ID (inside diameter) is 0.375 inches (9.5 mm).

  *NOTE:* Maintain the air temperature between 60 and 90 degrees Fahrenheit (70 to 75 degrees is recommended). It is highly recommended that a coalescing filter and pressure regulator be installed between the plant airline and the air inlet.

- **Power** - Stable electrical power at 115 VAC, 60 Hz (a power line conditioner and surge protection is recommended). 230 VAC, 50 Hz is optional.

  *NOTE:* A dedicated circuit is recommended for stable machine operation.

- **Ventilation** - Exhaust with a controlled negative draw capacity of greater than 180 liters per minute (see Section 5.2 - Exhaust Connection for details).

- **Ambient Conditions** - Temperature controlled environment: 68° to 85° F recommended
  Humidity controlled environment: 45% – 75% RH recommended

*PLEASE NOTE:*

*High levels of airborne particulate, i.e. carbon or free-floating media, may result in significant reduction in the equipment operational life-cycle.*

*High ambient temperatures may create particle instability.*

*Uncontrolled variations in the operating environment may result in significant shifts in the displayed mass flow and resistance values under certain conditions. See Section 11.2 Flow Calculation Menu for more information.*
2. Specifications

2.1. Physical Characteristics
Size 22 in wide x 42 in high x 30 in deep
56 cm wide x 107 cm high x 76 cm deep
Weight 185 lbs.
84 kg

2.2. Operational Requirements
Power 115 VAC, 60 Hz, 2.5A dedicated circuit recommended
230 VAC, 50 Hz, 1.25A (Optional) dedicated circuit recommended
Compressed Air Input 10 scfm @ 80 psig (283 slpm @ 5.6 kg/cm²)
Minimum recommended compressed air supply ID is 0.375 inches (9.5 mm)
System Exhaust Aerosol is exhausted from the system, while not operating in the Test Mode, at a rate of approximately 180 lpm.

2.3. Aerosol Generation
Technique Pneumatic nebulization with impaction using cold DOP/DEHP, PAO-4
Diameter 0.18 micrometer CMD (meets 42 CFR Part 84)
Geometric Std. Dev. < 1.6 (meets 42 CFR Part 84)
Concentration 20 to 150 milligrams per cubic meter (mg/m³).
Typical range 80 to 120 mg/m³
Liquid consumption ~8.8 ml using DOP/DEHP
~10.5 ml using PAO-4

2.4. Aerosol Detection
Technique Near forward light scattering
Dynamic Range 0.0001 to 200 milligrams per cubic meter (mg/m³)
Accuracy ± 1%
Sample Flow Rate Full flow through detector, 10 to 100 liters per minute (slpm)
0.35 to 3.53 cubic feet per minute (cu ft/min)

2.5. Filter Test Flow Measurement
Technique NIST traceable mass flow meter
Accuracy Teledyne (PN 5300109) ± 1.0 % full-scale
Alicat (PN 5300164) ± 0.4% of reading + 0.2% of full scale
Operating Span 0 to 120 lpm @ 21.1°C, 760 mm Hg
0 to 4.2 cubic feet per minute (cu ft/min)

2.6. Pressure Measurement
Technique Electronic pressure transducer
Accuracy ± 1.25 % of full scale
Range 0 to 100 mm water column
0 to 3.94 inches water column
Extended range available upon request

2.7. Efficiency Measurement
Flow Rate Through 10 to 100 slpm @ 21.1°C, 760 mm Hg (70°F, 29.93 In Hg)
Media 0.35 to 3.53 cubic feet per minute (cu ft/min)
Operating Range Efficiencies to 99.9995%
2.8. Communications Port

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial Port</td>
<td>RS-232</td>
</tr>
<tr>
<td>Data Bits</td>
<td>8</td>
</tr>
<tr>
<td>Baud Rate</td>
<td>9600</td>
</tr>
<tr>
<td>Parity</td>
<td>None</td>
</tr>
<tr>
<td>Stop Bit</td>
<td>1</td>
</tr>
<tr>
<td>Flow Control</td>
<td>None</td>
</tr>
<tr>
<td>Cable required</td>
<td>Null modem configuration (shown below)</td>
</tr>
</tbody>
</table>
3. Location and Functions

Before operating this unit, familiarize yourself with its features and functions. Each number in the photo is keyed to the list below.

1. **Power ON** – Green push button turns system power and air on
2. **Power OFF** – Red push button turns system power and air off
3. **Power Indicator** – Indicates that the power is on when lit
4. **Emergency Stop** – Push to remove system power and air
5. **Flow Adjustment Valve** – Rotates to adjust test flow to desired flow rate.
6. **Chuck Close Switches** – Press simultaneously to close the test chuck and start a test cycle.

*Note: Any time the chuck is closed; pressing either close switch will abort the function being performed and open the test fixture.*

7. **Function Keys** – Four function keys, labeled A through D, used in the option menus to select or change options. The display window shows the function of each key.
8. **Display Window** – Displays system information and function options
9. **Ready Indicator** – Green light indicates the unit is ready to start a new test
10. **Fault Indicator** – Yellow light indicates a system fault (see Appendix D – System Faults)
11. **Fail Indicator** – Red light indicates a failed test
12. **% Penetration Window** – Displays the % penetration readings during testing and displays set points when in Setup mode
13. **Resistance Window** – Displays the resistance (pressure drop) during testing in user selected units of measure
14. **Test Flow Window** – Displays the sample flow rate during testing in units of slpm
15. **Test Chuck** – Contains the filter under test
16. **External Pressure Ports** – Connects to an external pressure measuring device (behind metal cover).
17. **Nozzle Pressure Gauge**
18. **Vacuum Pressure Gauge**
19. **Oil Level Gauge**
20. **Dilution Air Flow meter**
21. **Start Test Button**
22. **AC Power Input** – Recessed 3-prong, AC power connector
23. **Communication Port** – RS-232 serial test data computer interface
24. **User Interface Port** – External equipment interface
25. **Main Pressure Input Port** – Input for compressed air
26. **Exhaust ‘T’** – System aerosol exhaust connection

27. **Mass Flow Meter** – Calibrated NIST Traceable mass flow meter (STP 21.1C @ 29.93 in/HG)
28. **Downstream Pressure Port** (Optional)
29. **Upstream Pressure Port** (Optional)
30. **Upstream Aerosol Port** (Optional)
31. **Downstream Aerosol Port** (Optional)
Figure 3 – Side View

32. Aerosol Generator - System aerosol generator. D, P, QD &QP versions available
33. Aerosol Generator Drip Jar – Used to collect excess aerosol condensation while operating generator
4. Features and Options

4.1. Test Types

- Percent Penetration (percentage)
- Resistance
  (differential pressure in mm/H₂O, ln/H₂O, Pa & kPa)
- Flow Rate (slpm)

4.2. Alarm Parameters

Alarm points can be set and enabled by the user (see Section 8.8 – Setup Menu). If an enabled alarm point is reached, the test immediately fails, the display flashes, and the audible alarm sounds.

4.3. Alarm (audible)

The alarm is used for prompting the operator and indicating test failures, system actions and faults.

4.4. Usage Timer

When the unit is first turned on, the penetration display window shows the cumulative time, in hours, that the unit has been in an energized state.

4.5. Data Output

Outputs test data through the RS-232 communications port. (See Section 5.3 – Communication Port)

4.6. User Interface Port

The port allows the user to interface with ancillary equipment for controlling and/or monitoring the unit. (See Section 5.4 – User Interface Port)

4.7. Power Fill

At the push of a button fills the aerosol generator system with oil from an external reservoir.
5. Installation

5.1. Input Air

Before connecting the compressed air line, check the line for any fluids or unwanted contaminants.

**NOTE:** Pre-filtering is recommended.
Connect the compressed air sample line to the Main Pressure Input Port shown in Figure 2, number 25.

**CAUTION:** For the user’s safety, make sure all the connections are secure.

5.2. Exhaust

5.2.1. Exhaust Connection

Connect the exhaust hose (end-user supplied) to the system exhaust ‘T’ output from the side as shown below in Figure 4.

**WARNING:** The top opening of the exhaust T must be left open.

**WARNING:** Improper exhaust flow will cause unstable aerosol concentration resulting in faulty test results.

**NOTE:** If the exhaust is adjusted correctly, no aerosol should exit from the top of the exhaust T to enter the area where the operator is present.

**WARNING:** Excessive exhaust flow will affect the generator’s performance.

5.3. Communications Port

Using a standard RS-232 null modem cable, connect the unit to your PC serial port. Configure your serial port to the following settings:

- Baud: 9600
- Data Bits: 8
- Parity: None
- Stop Bit: 1
- Flow Control: None

5.4. User Interface Port

The outputs are an open collector type capable of sinking 50 mA maximum for a non-inductive load. (See Table 1 below for connections & Appendix H for an example circuit).

- Ready (Output) – Indicates that the unit is ready to start a new test
- Pass (Output) – Indicates a passed test
- Fail (Output) – Indicates a failed test
- Fault (Output) – Indicates a system fault (See Table 3 – System Fault & Error Messages)
- In Cal (Output) – Indicates when the unit is in penetration calibration
- External Start (Input) – The signal used to start a test cycle from an external source. A pulse of 5-24V DC for 0.1 second will start a test cycle.

**NOTE:** This port is isolated from the unit to protect against external damage.

**Table 1 – Connector Pins & Functions**

<table>
<thead>
<tr>
<th>Connector Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>External Start</td>
</tr>
<tr>
<td>2</td>
<td>NC</td>
</tr>
<tr>
<td>3</td>
<td>Fault</td>
</tr>
<tr>
<td>4</td>
<td>Pass</td>
</tr>
<tr>
<td>5</td>
<td>NC</td>
</tr>
<tr>
<td>6</td>
<td>Ground</td>
</tr>
<tr>
<td>7</td>
<td>Ready</td>
</tr>
<tr>
<td>8</td>
<td>Fail</td>
</tr>
<tr>
<td>9</td>
<td>In Cal / Busy</td>
</tr>
</tbody>
</table>

Figure 4 - Exhaust

5.2.2. Exhaust Adjustment

Decrease the exhaust flow until the aerosol is visible at the top of the exhaust T but not entering the ambient environment.
6. Initial Setup

6.1. Verify that the input compressed air supply is connected.

6.2. Plug the unit into the proper power source.

6.3. Fill the generator to the upper fill line with the oil specified in the Factory Settings sheet (see Section 7 - Filling Methods).

**NOTE:** Over or under filling the generator will result in an unstable aerosol source.

**WARNING:** If any liquids are used other than that which is specified on the Factory Settings sheet, the generator will not function to specification.

6.4. Follow the Operations Sections 8.1 & 8.2 until the System Start menu is reached. At this point the generator should be on.

6.5. Check the aerosol exhaust adjustment (see Section 5.2.2 - Exhaust Adjustment).

6.6. Check the system settings against the Factory Settings sheet included with this manual for the specified generator. (Refer to Figures 7 and 8 in Section 13 for regulator and gauge locations.)

6.7. Power the unit off by pressing the red button on the Power switch or the Emergency Stop.
7. Filling Methods

7.1. Proper Fill Level
The generator tank is marked with an upper and lower fill line.

WARNING: Do not fill generator above the upper fill line. This condition results in liquid carry-over.

WARNING: If the generator is run with the liquid level below the lower fill line, the aerosol concentration will become unstable and give faulty test results.

NOTE: Always keep the liquid level between the fill lines.

7.2. Manual Fill
Remove the generator assembly from the unit by pulling down the retaining pin lever under the generator tank and rotating the rear of the tank outward.

Disconnect the red and black tubing attached to the back of the generator. Continue to rotate the tank outward until the tank has cleared the tank rest. Apply downward pressure on the generator assembly while gently rotating back and forth and remove it from the unit. Remove the four wing screws on the generator lid as shown in Figure 6. Remove the generator lid, and fill the generator with the specified oil to the proper level.

Reverse this procedure to re-install the generator.

NOTE: When reattaching the tubing to the generator, the red tubing connection is above the black tube.

7.3. Power Fill
Remove the lid from the auxiliary power fill tank, fill the tank with oil, and reinstall the lid. The Power Fill is available at any time when the TDA-100P is powered-on and the aerosol generator is non-operational. Press the brass “Liquid Fill” button until the proper fill level is reached. This button is located on the front of the unit above the “Flow Adjustment” valve.

NOTE: If the power fill option is used, a remote drip jar is highly recommended. This eliminates the need for frequent draining of the standard drip jar.
8. Standard Operating Sequence

In this manual, the following conventions are used:

<Function> indicates the function key that is pressed. This usually corresponds to the switch label on the bottom line of the display. If no label is present, the switches are designated “A”, “B”, “C”, and “D”, from left to right.

xx indicates a variable displayed value.

[P] Indicates the penetration display.

[R] Indicates the resistance display.

[F] Indicates the test flow display.

<CLOSE> Indicates that both of the chuck close switches should be pressed simultaneously.

<OPEN> Indicates that pressing either chuck close switch should open the chuck.

NOTE: Pressing either chuck close switch cancels the function being performed and opens the chuck.

8.1. System Initialization

8.1.1. Power On
Turn on the unit by depressing the green “Power” button.

8.1.2. System Initialization
Immediately after power on, the system will enter an initialization sequence lasting 10-15 seconds. The progress of the initialization is indicated by a series of periods on the second line of the display.

Initializing System

…………

8.1.3. System Version

ATI Version    -    n.n

n.n Software Version

[P] Hours the unit has been in operation

8.1.4. Input Air

AWAITING AIR

The unit is waiting for the input air.

8.1.5. System Vacuum

AWAITING VACUUM

The unit is waiting for the system vacuum.

8.1.6. Check Liquid Level
Check the liquid level in generator and fill if necessary. Remove any liquid in the drip jar before continuing. If the unit DIP switch configuration is set for automatic operation, this step will be bypassed.

CHECK LIQUID LEVEL

CONT

A B C D

<CONT> Continue with Startup

8.1.7. System Warm-up
The system will now enter a warm-up period to allow the aerosol generator to stabilize. The standard warm-up period is eight minutes.

SYSTEM WARMUP

BYPASS

A B C D

<BYPASS> Continue with Startup
8.2. System Start Menu

After a system start, the user will be taken directly to the penetration calibration sequence (Section 10). After this initial calibration is completed, the screen below will be displayed which provides the option of repeating the calibration or performing the Setup Sequence (Section 10).

<table>
<thead>
<tr>
<th>CALIBRATE SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
</tr>
</tbody>
</table>

<YES> Proceed to System Calibration.
<NO> Proceed to System Run Menu.

8.3. Start Cycle

At this point the machine is idle and can either initiate a test, setup operating parameters (limits and timings), calibrate the LSC, or enter a standby state.

<table>
<thead>
<tr>
<th>START CYCLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>STBY</td>
</tr>
</tbody>
</table>

<SETUP> Enters the Setup menu (Section 11).
<CAL> Enters the Calibration Sequence. (Section 10)
<STBY> Enters into Standby Mode
<CLOSE> Close chuck to begin testing

8.3.1. Test Loading

The system is waiting the designated load time prior to testing.

** LOADING **

8.3.2. Testing

Test readings are displayed for the total sample time in one-second intervals. The chuck will automatically open at the end of the test cycle if the sample time has been set.

** TESTING **

[P] Test % Penetration reading

8.3.3. Test End

Passed Test – Green indicator lit, returns to Start Cycle menu
Failed Test – Red indicator lights, failed test parameter flashes, and system enters the Failed Check menu.

8.3.4. Failed Check

The Failed Check is used to confirm a failed test. This check is optional.

** FAILED **

CONT

<CONT> Returns to Start Cycle

NOTE: This function may be bypassed if the Failed Lockout dipswitch is set or if the unit is in the Automatic Testing mode. (See Appendix A for setting locations.)
8.4. Exception Conditions

The following exceptions may occur during testing.

8.4.1. Must Calibrate

Prompts the operator that the function must be completed to proceed to the next menu.

MUST CALIBRATE

CONT

<CONT> Returns to the previous menu

8.4.2. Function Cancel

Occurs when the chuck is opened without completion of the test or setup.

CANCEL DURING TEST

CONT

<CONT> Returns to the main menu of the canceled function

8.4.3. Chuck Switch Error

The Chuck Switch Error occurs when the chuck close switches are not pressed simultaneously and held for several seconds.

CHUCK SWITCH ERROR

CONT

<CONT> Returns to the previous menu.
9. Standby Mode

The Standby Mode allows the user to turn off the aerosol generator when the system is idle.

<CONT> activates the aerosol generator

System is waiting for the aerosol generator to stabilize before returning to the System Start screen (Section 8.2). After approximately 10 minutes (or if the warm-up is bypassed), the Start Cycle menu will be shown.
10. Calibration Sequence

10.1. Barometric Pressure Menu

Note - Sections 10.1 through 10.4 are skipped unless Actual Flow Calculations is selected (Section 11.2).

This menu is used to adjust the barometric pressure setting for ‘actual’ flow rate calculations.

<table>
<thead>
<tr>
<th>SET BAR PRESSURE?</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES NO</td>
</tr>
<tr>
<td>&lt;Yes&gt; Enters into Barometric Pressure Setting menu</td>
</tr>
<tr>
<td>&lt;No&gt; Skips to Ambient Temperature Setup menu</td>
</tr>
</tbody>
</table>

10.2. Barometric Pressure Variable

Sets the barometric pressure used to calculate the “actual” flow rates.

<table>
<thead>
<tr>
<th>Bar Pressure = in Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP DWN ENTER</td>
</tr>
<tr>
<td>&lt;UP&gt; increases the variable</td>
</tr>
<tr>
<td>&lt;DWN&gt; decreases the variable</td>
</tr>
<tr>
<td>&lt;ENTER&gt; Accepts the setting and enters the next Setup menu screen</td>
</tr>
</tbody>
</table>

10.3. Ambient Temperature Menu

This menu is used to adjust the ambient temperature setting for ‘actual’ flow rate calculations.

<table>
<thead>
<tr>
<th>SET AMB TEMPERATURE?</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES NO</td>
</tr>
<tr>
<td>&lt;Yes&gt; Enters into Ambient Temperature Setting menu</td>
</tr>
<tr>
<td>&lt;No&gt; Skips to Test Flow Setup menu</td>
</tr>
</tbody>
</table>

10.4. Ambient Temperature Variable

Sets the ambient temperature used to calculate the “actual” flow rates.

<table>
<thead>
<tr>
<th>Amb Temp. = °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP DWN ENTER</td>
</tr>
<tr>
<td>[P] – (Range 0 – 100)</td>
</tr>
<tr>
<td>&lt;UP&gt; increases the variable</td>
</tr>
<tr>
<td>&lt;DWN&gt; decreases the variable</td>
</tr>
<tr>
<td>&lt;ENTER&gt; Accepts the setting and enters the next Setup menu screen</td>
</tr>
</tbody>
</table>
10.5. Test Flow Setup Menu

This menu is used to adjust the filter test flow.

<table>
<thead>
<tr>
<th>SET FILTER TEST FLOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
</tr>
</tbody>
</table>

<Yes> Enters into Test Flow Setting menu
<No> Skips to Penetration Setup menu

**NOTE:** If the TDA-100P has not had the Test Flow set since power-on this screen will not be displayed. The program will proceed immediately to the next step, Test Flow Setting.

10.6. Test Flow Setting

Insert the test filter into the chuck.

<table>
<thead>
<tr>
<th>INSERT FILTER;  CLOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXIT</td>
</tr>
</tbody>
</table>

<CLOSE> Close chuck to continue
<EXIT> Proceeds to Penetration Setup menu

**NOTE:** Any time the chuck is closed; pressing either close switch will abort the function being performed and open the chuck.

Adjust the flow adjustment valve to the proper flow setting.

Flow = nn.n

<ENTER> Accepts flow setting, opens chuck, and continues to Penetration Setup menu

**NOTE:** Allow the flow reading to stabilize for several seconds before accepting the setting.

10.7. Penetration Setup Menu

10.7.1. 100% Setting

<table>
<thead>
<tr>
<th>CLEAR CHUCK &amp; CLOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXIT</td>
</tr>
</tbody>
</table>

<EXIT> Returns to Penetration Setup menu
<CLOSE> Close chuck to proceed

**NOTE:** If the TDA-100P has not had an LSC calibration performed since power-on the EXIT option will not be available.

**NOTE:** Any time the chuck is closed, pressing either close switch will abort the function being performed.

*** CALIBRATING *\

100% Setting

The microprocessor adjusts the detector sensitivity then establishes and stores the 100% value [P] Concentration reference value.

**NOTE:** This value is only displayed if the Concentration Reference Alarm is set in the Setup menu.

* CALIBRATING *

Loading

Displayed while loading test fixture with aerosol
10.7.2. Zero Setting

* CALIBRATING *

0 SETTING

The unit establishes the zero base reference.

WAIT

The system returns to the Ready menu.
11. Setup Menu

The Setup Menu is a series of screens that are used to establish the operating parameters of the machine.

General Notes:
- A number of the parameters are numeric. These parameters are entered by incrementing or decrementing a starting value. If the increment or decrement buttons are held down, the rate of the change increases and will continue to increase as long as the button is held. When the button is released the rate will return to the initial slow rate.
- Some parameters, such as alarm limits, may be disabled to remove the corresponding alarm or function. In these cases and additional button, ENBL/DSBL (Enable/Disable), is available. When the button is labeled ENBL, its key function is to enable the parameter. When the button is labeled DSBL, its key function is to disable the parameter. Disabled parameters are shown as all dashes (“-”).
- Section 11.2, 11.3 & 11.4 for the Flow Calculation menu are used to select either standard conditions for flow value reporting or to apply a correction based on actual ambient conditions. The “ACT” feature is provided to enable more accurate sample flow values were desired or necessary.

11.1. Select Pressure Units

The 100P can display pressure differential in one of four units: inH20, inHg, Pa, and kPa. Use this choice to select the desired unit.

<table>
<thead>
<tr>
<th>Pres. Unit now</th>
<th>mmH20</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEXT</td>
<td>CONT</td>
</tr>
</tbody>
</table>

<NEXT> Selects the next available pressure unit. The top line will change to reflect the new unit of measure.

<CONT> Saves the current unit choice and proceeds with the setup process.

NOTE: The units in subsequent pressure displays will reflect the selected unit choice made here. For the purposes of this manual, we will assume that mmH20 is the selected unit.

11.2. Flow Calculation Menu

The TDA-100P has the option to adjust its flow readings to compensate for actual temperature and barometric pressure conditions. This screen is used to select between the options of entering the actual barometric pressure and temperature and using standard temperature and pressure values.

IMPORTANT: If the TDA-100P in use is equipped with an Alicat mass flow meter DO NOT select “ACT”. Alicat flow meters incorporate real-time measurement of and correction to ambient conditions. Selecting ACT will cause an overcompensation resulting in inaccuracies in the reported sample flow. In this case always select STD.

<table>
<thead>
<tr>
<th>Flow Calculation =?</th>
</tr>
</thead>
<tbody>
<tr>
<td>STD</td>
</tr>
<tr>
<td>ACT</td>
</tr>
</tbody>
</table>

<STD> Use standard values of 29.93 inches of water and 293.15° K and proceed to next step.

<ACT> Allows entering barometric pressure and ambient temperature for “Actual” flow calculations.

**For use with Teledyne mass flow meter equipped unit only**
11.3. Barometric Pressure
Sets the barometric pressure used to calculate the “Actual” flow rates.

\[
\text{Bar Pressure} = \text{nnn.nn in Hg}
\]

nnn.nn The range is 25 to 35 in Hg or the equivalent in the selected pressure unit.

<UP> increases the variable

<DWN> decreases the variable

<ENTER> Accepts the setting and enters the next Setup menu screen

11.4. Ambient Temperature
Sets the ambient temperature used to calculate the “actual” flow rates.

\[
\text{Amb. Temp.} = \text{nnn.n °C}
\]

nnn.n Range 0 – 100

<UP> increases the variable

<DWN> decreases the variable

<ENTER> Accepts the setting and enters the next Setup menu screen

11.5. Maximum Percent Penetration Variable (Alarm Point)

\[
\text{Pen Max} = \text{nnn.nnnn %}
\]

nnn.nnnn The alarm will be activated at readings greater than this set point (Range: 0.0001 - 99.9). If the digits are replaced by dashes (“-“), the alarm has been disabled.

<UP> Increases the setpoint.

<DWN> Decreases the setpoint.

<DSBL> Disable the alarm function. When pressed, “DSBL” changes to “ENBL” and the digits are replaced by dashes (“-“).

<ENBL> Enable the alarm function. When pressed, “ENBL” changes to “DSBL” and the digits of the limit are displayed.

<ENTER> Accepts the setting and enters the next Setup menu screen
11.6. Minimum Percent Penetration Variable (Alarm Point)

\[ \text{Pen Min} = \text{nnn.nnnn} \% \]

- **UP** Increases the setpoint.
- **DWN** Decreases the setpoint.
- **DSBL** Disable the alarm function. When pressed, “DSBL” changes to “ENBL” and the digits are replaced by dashes (“-”).
- **ENBL** Enable the alarm function. When pressed, “ENBL” changes to “DSBL” and the digits of the limit are displayed.
- **ENTER** Accepts the setting and enters the next Setup menu screen.

The alarm will be activated at readings less than this set point (Range: 0.0001 - 99.9). If the digits are replaced by dashes (“-”), the alarm has been disabled.

11.7. Maximum Resistance Variable (Alarm point)

\[ \text{Res Max} = \text{nnn} \text{ mmH}_2\text{O} \]

- **UP** Increases the variable
- **DWN** Decreases the variable
- **DSBL** Disable the alarm function. When pressed, “DSBL” changes to “ENBL” and the digits are replaced by dashes (“-”).
- **ENBL** Enable the alarm function. When pressed, “ENBL” changes to “DSBL” and the digits of the limit are displayed.
- **ENTER** Accepts the setting and enters the next Setup menu screen.

Alarm activated at readings greater than this set point (Range: 1 – 250 mmH2O)

11.8. Minimum Resistance Variable (Alarm point)

\[ \text{Res Min} = \text{nnn} \text{ mmH}_2\text{O} \]

- **DSBL** Disable the alarm function. When pressed, “DSBL” changes to “ENBL” and the digits are replaced by dashes (“-”).
- **ENBL** Enable the alarm function. When pressed, “ENBL” changes to “DSBL” and the digits of the limit are displayed.
- **ENTER** Accepts the setting and enters the next Setup menu screen.

Alarm activated at readings less than this set point (Range: 1 – 250 mmH2O)

11.9. Test Flow Tolerance Variable (Alarm Point)

\[ \text{Flow Tol} = \pm \text{nn lpm} \]

- **DSBL** Disable the alarm function. When pressed, “DSBL” changes to “ENBL” and the digits are replaced by dashes (“-”).
- **ENBL** Enable the alarm function. When pressed, “ENBL” changes to “DSBL” and the digits of the limit are displayed.
- **ENTER** Accepts the setting and enters the next Setup menu screen.

Alarm activated at test flow readings +/- this value (Range: 1 – 10)
11.10. Load Time Variable

The load time variable is the time from when the chuck is closed to when the test starts to sample. This time is used to establish a stable aerosol flow.

<table>
<thead>
<tr>
<th>Load Time = nn sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP DWN ENTER</td>
</tr>
</tbody>
</table>

**nn** Load time in seconds. (Range 1 – 60)

**<UP>** Increases the variable
**<DWN>** Decreases the variable
**ENTER>** Accepts the setting and enters the next Setup menu screen

11.11. Extended Load Time Variable

Sets the time from when the chuck is closed to when the test starts to sample. The extended load time is only initiated by a failed test or an LSC calibration.

**NOTE:** This variable must be equal to or greater than the “Load Time” variable.

<table>
<thead>
<tr>
<th>Ext Ld Time = nn sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP DWN ENTER</td>
</tr>
</tbody>
</table>

**nn** Extended Load Time in seconds. (Range “Load Time” – 60)

**<UP>** Increases the variable
**<DWN>** Decreases the variable
**<ENTER>** Accepts the setting and enters the next Setup menu screen
### 11.12. Sample Time Variable

The sample time variable is the length of time the test is sampled in one-second intervals. The unit displays the first test results immediately following the load time.

**NOTE:** If the sample time is disabled, the test continues until either chuck switch is pressed to end the test.

<table>
<thead>
<tr>
<th>Sample Time = nn sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP   DWN    DSBL  ENTER</td>
</tr>
</tbody>
</table>

- **nn** Time in seconds. (Range: 1 – 3600)
- **<UP>** Increases the variable
- **<DWN>** Decreases the variable
- **<DSBL>** Disable the alarm function. When pressed, “DSBL” changes to “ENBL” and the digits are replaced by dashes (“-”).
- **<ENBL>** Enable the alarm function. When pressed, “ENBL” changes to “DSBL” and the digits of the limit are displayed.
- **<ENTER>** Accepts the setting and enters the next Setup menu screen.

### 11.13. Open Time Variable

The open time variable is used to delay the start of the next test cycle.

<table>
<thead>
<tr>
<th>Open Time = nn.n sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP   DWN   ENTER</td>
</tr>
</tbody>
</table>

- **nn.n** Open Time in seconds. (Range 0.0 - 60)
- **<UP>** Increases the variable.
- **<DWN>** Decreases the variable.
- **<ENTER>** Accepts the setting and enters the next Setup menu screen.

### 11.14. Cycles to Calibration

Sets a specified number of test cycles to be completed prior to prompting for recalibration. When the set number of tests is run, the system enters the Penetration Setup menu prompting for calibration.

<table>
<thead>
<tr>
<th>Cycles to Cal = nnnn CTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP   DWN    DSBL  ENTER</td>
</tr>
</tbody>
</table>

- **nnnn** (Range 1 – 9999)
- **<UP>** Increases the variable

### 11.15. Concentration Reference Alarm

After the Penetration Setup menu, the test aerosol concentration in mg/m³ is displayed if enabled. A concentration error will occur if the concentration falls outside of the concentration window entered during the gravimetric setup. (See Section 14.1.1)

<table>
<thead>
<tr>
<th>Concentration is DSBL</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSBL   ENTER</td>
</tr>
</tbody>
</table>

- **<DSBL>** Disables the alarm function
- **<SET>** Activates the alarm function
- **<ENTER>** Accepts the setting and enters the next Setup menu screen.
11.16. Set Date and Time

11.16.1. Set/Enter screen
This screen allows the user to select whether they want to change the date/time recorded in the machine or proceed to the next screen.

<table>
<thead>
<tr>
<th>mm/dd/yy</th>
<th>hh:mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET</td>
<td>ENTER</td>
</tr>
</tbody>
</table>

- **mm**: Month (1 to 12)
- **dd**: Day of Month (1 to last day of month)
- **yy**: Last two digits of year. (The first two digits are assumed to be “20”.)
- **hh**: Hour of the day using the 24 hour clock. (0 to 23)
- **mm**: Minutes in the hour. (0 to 59)
- **<SET>**: Enters the date/time setting mode below.
- **<ENTER>**: Accepts the setting and enters the next Setup menu screen.

11.16.2. Date/Time Setting Mode
In the date/time set mode, each group of digits (month, day, year, etc.) is incremented or decremented in turn by the <UP> and <DWN> buttons. Pressing the <CONT> button will advance to the next group of digits.

<table>
<thead>
<tr>
<th>mm/dd/yy</th>
<th>hh:mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP</td>
<td>DWN</td>
</tr>
</tbody>
</table>

- **<UP>**: Increases the variable
- **<DWN>**: Decreases the variable
- **<CONT>**: Advance to the next group of digits. After the minutes group, returns to the Set/Enter Screen.
12. Maintenance

12.1. Initial Setup

The following maintenance routines should be run to familiarize the user with these functions as well as set up the unit for operation in the user’s environment: Flow Balance, Pressure Check (NOT Pressure Setup), and Gravimetric Test.

12.2. Definitions and Features

**Gravimetric** – Used to measure and set the system aerosol concentration level and alarm points (See 14.1.1)

**Flow Balance** – Used to adjust the balance between the sample and clear flow paths (See 14.1.3)

**Pressure Check and Setup** – Used to check or recalibrate the system pressure sensor to an external source (See 14.1.6 & 14.1.7 - Pressure Check and Pressure Setup)

**Security** – Used to prevent changes to the alarm values or critical load and sample times (See 14.1.10)

**LSC Check** (Light Scattering Chamber) – Used to adjust the LSC after maintenance and for general trouble shooting (See 14.1.4 or 14.1.6)

**Dip Switches** – Used for initial system setup (See Appendix A)

12.3. Scheduled Maintenance

**NOTE:** Scheduled maintenance is based on an 8-hour operating day. If operating time is increased, or the operating environment exposes the unit to large amounts of loose particulates, the frequency of maintenance operations should be increased as well.

**Daily**
- Check the liquid level in the aerosol generator tank and refill as needed.
- Check the liquid level in the drain jar and empty if necessary.
- Check the compressed air input filter for liquid and drain if necessary.

**Weekly**
Check the lower half of the chuck for debris and clean as needed.

**Monthly**
- Check the system tubing for oil buildup and replace if necessary.
- Inspect coalescing element. Replace if necessary

**Biannually**
- Check the pressure sensor against an external source and calibrate if necessary.
- Replace the Test Flow After-filter (carbon/HEPA filter).
- Replace the Reference (HEPA) filter.

**Annually**
- Clean the LSC (See 16.2)
- Mass flow meter calibration.
- Replace coalescing element
ATI can provide End-User calibration & service training for the TDA-100P upon request. Please contact ATI Customer Service for further details.

### Consumable Spare Parts List
(One-Year Supply)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Part #</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HEPA–Cap 75 mm 0 Reference</td>
<td>5500122</td>
</tr>
<tr>
<td>1</td>
<td>HEPA–Cap 75 mm MFM protection</td>
<td>5500128</td>
</tr>
<tr>
<td>1</td>
<td>Coalescing Cartridge Large particle removal</td>
<td>5500137</td>
</tr>
<tr>
<td>1</td>
<td>In-Line HEPA Pressure Differential</td>
<td>5500139</td>
</tr>
<tr>
<td>1</td>
<td>Fuse, 2.5 Amp @ 220V DC Power Supply</td>
<td>T2E0-0321</td>
</tr>
<tr>
<td>20 ft</td>
<td>Clear ½&quot; Tubing</td>
<td>5200155</td>
</tr>
<tr>
<td>20 ft</td>
<td>Black ½&quot; Tubing</td>
<td>5200157</td>
</tr>
</tbody>
</table>

### End-User Calibration Equipment List
(Required for End-User Calibration)

<table>
<thead>
<tr>
<th>Calibrated Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Volt Meter 4-1/2 digit minimum resolution @</td>
</tr>
<tr>
<td>Electronic Balance 0.001 gram minimum resolution. 0.0001 gram recommended</td>
</tr>
<tr>
<td>Pressure Calibrator 0-10 inches WC range (0-254 mm WC range)</td>
</tr>
<tr>
<td>Low Pressure Source Variable 0-10 inches WC (0-254 mm WC)</td>
</tr>
<tr>
<td>Flow Standard 0-120 LPM</td>
</tr>
<tr>
<td>Gravimetric media 47mm or 120mm diameter</td>
</tr>
<tr>
<td>Gravimetric Media Holder (if unit not equipped) 47mm or 120mm diameter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hand Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hex driver 9/64&quot; LSC Assembly Hardware</td>
</tr>
<tr>
<td>Pliers 6&quot; std/needle nose LSC Alignment hardware</td>
</tr>
<tr>
<td>Adjustable wrench 6&quot; or larger LSC removal</td>
</tr>
<tr>
<td>Screwdriver #2 Philips head, stubby LSC adj. &amp; MFM removal</td>
</tr>
<tr>
<td>Trimpot Adjustment Tool Insulated</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue Lint-free, lens cleaning</td>
</tr>
<tr>
<td>Solvent De-natured alcohol recommended</td>
</tr>
</tbody>
</table>

### Available Mechanical Spare Parts
(To minimize equipment downtime)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
<th>Part #</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Light Scattering Chamber (LSC)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Mass Flow Measurement Device</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Aerosol Generator</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Main Control PCBA</td>
<td></td>
</tr>
</tbody>
</table>
13. Maintenance Features & Locations

1. Main circuit breaker (5 Amp)
2. Power supply fuse (2 Amp time-delay)
3. Diluent flow meter (Displays in SCFH)
4. Test flow pre-filter (coalescing filter)
5. Test flow after-filter (75 mm HEPA filter) located between the mass flow meter and the test flow pre-filter (not shown)
7. Vacuum Pump (pneumatic type)
8. Light Scattering Chamber (LSC) – (not shown) located on bottom panel in the middle.
9. Dip Switches
10. Nozzle pressure gauge and adjustment
11. Diluent flow adjustment
12. Vacuum pressure gauge
13. Chuck cylinder gauge and adjustment
14. Flow Balance Valve
15. Reference Filter (HEPA filter)
16. Downstream Pressure Port (Optional)
17. Upstream Pressure Port (Optional)
18. Downstream Aerosol Port (Optional)
19. Upstream Aerosol Port (Optional)
Figure 8– Top View
14. Maintenance Menu Structure

14.1. Maintenance Menus

The menu structure within the Maintenance portion of the TDA-100P operating program is laid out in a loop. Using the <Next> and/or <Prev> keys allows navigation through the loop until arriving again at the entry point. Selecting <Cont> enters the feature displayed in the topmost row.


The 100P will enter maintenance mode in three circumstances:

1. In response to an error such as an LSC failure that requires use of maintenance mode to test and recalibrate the system.
2. If the internal memory becomes corrupted. This will require that all the maintenance calibration routines be performed to restore the machine to an operational state.
3. After a restart of the machine. To enter maintenance mode after a restart, wait until the System Version is displayed, and then press and hold the leftmost function key, ‘A’, until the display changes or a short beep is heard.
4. To re-initialize ALL values stored in the units battery-backed RAM substitute the rightmost function key, ‘D’, for the ‘A’ key called out in step 3 above.

* Please note that once this initialization has been performed the previous values cannot be recovered.

Top level Maintenance entry menu

Maint: Gravimetric

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

<Prev> Proceeds to Security selection
<Next> Proceeds to Res Offset selection
<Cont> Enters Gravimetric test
<Back> Prompts for Maintenance exit

Maint: Res Offset

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

<Prev> Returns to Gravimetric selection
<Next> Proceeds to Flow Balance selection
<Cont> Enters Res Offset
<Back> Prompts for Maintenance exit

Maint: Flow Balance

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

<Prev> Returns to Res Offset selection
<Next> Proceeds to LSC Check selection
<Cont> Enters Flow Balance
<Back> Prompts for Maintenance exit

Maint: LSC Check

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

<Prev> Returns to Flow Balance selection
<Next> Proceeds to LSC Offset selection
<Cont> Enters LSC Check
<Back> Prompts for Maintenance exit

Exit Maintenance?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

<Yes> Exits Maintenance and restarts the unit.
<No> Returns to Maintenance entry menu
### Maint: LSC Offset

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

- `<Prev>` Returns to LSC Check selection
- `<Next>` Proceeds to View Sensor selection
- `<Cont>` Enters LSC Offset
- `<Back>` Prompts for Maintenance exit

### Maint: View Sensor

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

- `<Prev>` Returns to LSC Offset selection
- `<Next>` Proceeds to Cal Sensor selection
- `<Cont>` Enters View Sensor
- `<Back>` Prompts for Maintenance exit

### Maint: Cal Sensor

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

- `<Prev>` Returns to View Sensor selection
- `<Next>` Proceeds to ID selection
- `<Cont>` Enters Cal Sensor
- `<Back>` Prompts for Maintenance exit

### Maint: ID

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

- `<Prev>` Returns to Cal Sensor selection
- `<Next>` Proceeds to Console selection
- `<Cont>` Enters ID
- `<Back>` Prompts for Maintenance exit

### Maint: Console

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

- `<Prev>` Returns to ID selection
- `<Next>` Proceeds to Security selection
- `<Cont>` Initiates Console
- `<Back>` Prompts for Maintenance exit

### Maint: Security

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

- `<Prev>` Returns to Console selection
- `<Next>` Proceeds to Gravimetric test
- `<Cont>` Enters Security
- `<Back>` Prompts for Maintenance exit
14.1.1. **Gravimetric**

A gravimetric reading is used to determine the aerosol concentration of the unit. Measuring the amount of aerosol collected and the total airflow during the sample time performs this as explained below.

<Prev> Proceeds to Security selection
<Next> Proceeds to Res Offset selection
<Cont> Enters Gravimetric test
<Back> Prompts for Maintenance exit

**Gravimetric Test**

Enter Exit

A B C D

<Enter> Enters Gravimetric test routine
<Exit> Returns to Maintenance entry menu.

**Wait**  

30 seconds remaining

30 second countdown begins before entry into Gravimetric test

**Close Chuck to Start**

Exit

A B C D

Weigh a sample of high efficiency media large enough to completely fill the test fixture opening and record the weight. No sample air flow should be able to pass through the test fixture without passing through the media.

Place the weighed media in the test fixture.

With the media in place depress both actuator switches at the same time to initiate the Gravimetric test.

**Loading -- ### sec left**

Flow = ##.# Abort

A B C D

"Sec left" is the time remaining in the Gravimetric test until completion.

"Flow=##.#" is the sample flow passing through the weighed sample in liters per minute. If the flow decreases during the test due to loading, this may be adjusted using the Flow Adjustment control.

<Abort> Stops the test in progress and returns to Maintenance entry menu.

**Loading Complete**

AvgFlow = ###.# Cont

A B C D

"AvgFlow = ###.#" is the average sample flow present during the Gravimetric test period.

<Cont> proceeds to the next step

**Loading Complete**

TotFlow = ###.# Cont

A B C D

"TotFlow = ###.#" is the total volume of sample flow that passed through the pre-weighed media during the Gravimetric test period. Record this number.

<Cont> proceeds to the next step

Determine the amount of weight increase for the media used during the gravimetric test by subtracting the starting weight from the ending weight measured after completion of "Loading"

Ending weight – starting weight = weight increase

Divide the weight increase by the recorded TotFlow value. The result obtained is the aerosol concentration expressed as weight of aerosol (ug) per volume of air (l).

Weight increase ÷ TotFlow = concentration in ug/l

**Store New Values?**

Yes No
<Yes> Proceeds to the next step, memory storage routine, to set and capture the gain levels necessary to achieve a 100% response from the available aerosol.

<No> Exits the Gravimetric test menu and returns to the Maintenance entry menu.

**Con. = ### ug/l**

<table>
<thead>
<tr>
<th>UP</th>
<th>DWN</th>
<th>ENTER</th>
</tr>
</thead>
</table>

A B C D

"Con. = ### ug/l" is calculated using the values obtained during the gravimetric test.

<UP> Increases the displayed Conc. value

<DWN> Decreases the displayed Conc. Value

<ENTER> Accepts the entered Conc. Value as the calculated aerosol concentration and continues to the next step.

**Hi Con. = ### ug/l**

<table>
<thead>
<tr>
<th>UP</th>
<th>DWN</th>
<th>ENTER</th>
</tr>
</thead>
</table>

A B C D

"Hi Con. = ### ug/l" is the upper concentration limit for the "Con Check" variable.

<UP> Increases the concentration limit

<DWN> Decreases the concentration limit

<ENTER> Accepts the value displayed as the upper concentration limit and continues to the next step

The calculated “Hi Con” value displayed will be the valued entered for “Con” + 20%. This value may be increased or decreased at the discretion of the end-user.

**Lo Con. = ### ug/l**

<table>
<thead>
<tr>
<th>UP</th>
<th>DWN</th>
<th>ENTER</th>
</tr>
</thead>
</table>

A B C D

"Lo Con. = ### ug/l" is the lower concentration limit of the “Con Check” variable.

<UP> Increases the concentration limit

<DWN> Decreases the concentration limit

<ENTER> Accepts the value displayed as the lower concentration limit and continues to the next step.

The calculated “Lo Con” value displayed will be the valued entered for “Con” - 20%. This value may be increased or decreased at the discretion of the end-user.

**Clear Chuck & Close**

Exit

| A | B | C | D |

Make sure that nothing is in the test fixture. Depress both actuator switches at the same time to initiate the completion of this routine.

After a loading period, the microprocessor will adjust the sensitivity of the LSC to obtain the required voltage level. At the end of this adjustment the display will briefly show the 100% voltage level. The Sample/Clear valve then changes to the clear position to provide the LSC with particle free air. After a short delay the Clear 0 baseline voltage (stray light) will be stored to memory and briefly displayed.

The operating program then immediately returns to the top level Maintenance entry menu.

**14.1.2. Res Offset**

<table>
<thead>
<tr>
<th>Maint: Res Offset</th>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
</table>

**Res Offset - #.## mm/H2O**

<table>
<thead>
<tr>
<th>Set</th>
<th>Dsbl</th>
<th>Exit</th>
</tr>
</thead>
</table>

A B C D

"Res Offset - #.## mm/H2O" is the resistance offset value currently stored in memory.

<Set> Proceeds to the Res Offset adjustment menu below

<Enbl/Dsbl> Toggles between enabled and disabled states. The **Enabled** state displays the stored offset value (±) to be applied to each test result. The **Disabled** state displays -----.
14.1.3. Flow Balance

This routine is used to correct for air flow resistance differentials between the sample flow path and the clear airflow path. This is done to minimize response lag in the mass flow meter.

<Prev> Returns to Gravimetric selection
<Next> Proceeds to Flow Balance selection
<Cont> Enters Res Offset menu
<Exit> Returns to the Maintenance entry menu

The flow balance is adjusted by alternating between the Sample and Clear states, using the ON and OFF selections, while observing the sample flow display and adjusting the gate valve installed immediately below the 0 Reference filter. The flow balance setting is complete when the displayed values during each state match with ± 0.1 LPM.

14.1.4. LSC Check

The menu is used to observe the LSC operating voltages for basic troubleshooting purposes.

LSC Check - Close

<Exit> Returns to the Maintenance entry menu

The test fixture should be closed at this time. Closure may be accomplished using either manual actuators or an EXT Start signal sent to the User Port.

LSC Voltage = #.####

<ON>/<OFF> Enable/Disables the Sample/Clear solenoid valve.
<ON> Sample valve is enabled. The displayed voltage represents the signal generated by the 100% sample of the available aerosol concentration.
<OFF> Sample valve is disabled. The displayed voltage represents the signal generated by
sampling particle free air through the 0 Reference filter. This is the "straylight" voltage.

<Exit> Returns to the Maintenance entry menu

14.1.5. LSC Offset

<table>
<thead>
<tr>
<th>Maint: LSC Offset</th>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

Used to access and set the LSC Offset variable. The value is used to correct for signal shifts in the LSC output caused by DC power variations during operation.

<Prev> Returns to LSC Check selection

<Next> Proceeds to View Sensor selection

<Cont> Enters LSC Offset menu

<Exit> Returns to the Maintenance entry menu

Note: Under most applications this variable is more easily and accurately set using Console mode access.

<table>
<thead>
<tr>
<th>LSC Offset - -###</th>
<th>Set</th>
<th>Dsbl</th>
<th>Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

"LSC Offset - -###" displays the stored LSC Offset value. A display of "------" indicates a disabled state.

<Set> Enters LSC Offset adjustment routine.

<Dsbl>/<Enbl> Enables or disables the LSC Offset feature.

<Dsbl> indicates the feature is enabled and pressing the key will disable the LSC Offset.

<Enbl> indicates the feature is disabled and pressing the key will enable the LSC Offset.

<Exit> Returns to the Maintenance entry menu.
14.1.6. View Sensor

Maint: View Sensor

Prev Next Cont Exit
A B C D

<Prev> Returns to LSC Offset selection
<Next> Proceeds to Cal Sensor selection
<Cont> Enters View Sensor menu
<Exit> Returns to the Maintenance entry menu

The menu is intended as a troubleshooting aid and allows viewing of the raw input voltages as interpreted by the 100P microprocessor.

Selecting Pressure

Prev Next Cont Back
A B C D

<Prev> Proceeds to LSC sensor output
<Next> Proceeds to Flow sensor output
<Cont> Enters Pressure sensor output
<Back> Returns to the Maintenance entry menu

Voltage = #.### V

Exit
A B C D

“Voltage = #.### V” displays the output signal being received from the differential pressure transducer.
<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

Selecting Flow

Prev Next Cont Back
A B C D

<Prev> Proceeds to Pressure sensor output
<Next> Proceeds to Aux Flow sensor output
<Cont> Enters Flow sensor output
<Back> Returns to the Maintenance entry menu

Voltage = #.### V

Exit
A B C D

“Voltage = #.### V” displays the output signal being received from the mass flow meter.
<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

Selecting Aux Flow

Prev Next Cont Back
A B C D

This feature is currently not used and is intended for future applications.
<Prev> Proceeds to Flow sensor output
<Next> Proceeds to Temp sensor output
<Cont> Enters Aux Flow sensor output
<Back> Returns to the Maintenance entry menu

Voltage = #.### V

Exit
A B C D

“Voltage = #.### V” displays the output signal being received from the auxiliary mass flow meter, if installed and enabled.
<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

Selecting Temp

Prev Next Cont Back
A B C D

<Prev> Proceeds to Aux Flow sensor output
<Next> Proceeds to Baro Pres sensor output
<Cont> Enters Temp output
<Back> Returns to the Maintenance entry menu.
Temp = ##.## C
(Raw = #.#### V ) Exit

“Temp = ##.## C” displays the output signal being received from the PCBA mounted temperature sensor converted to degrees centigrade using the conversion constant stored in memory.

“(Raw = #.#### V)” displays the PCBA mounted temperature sensor output as a voltage.

<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

---

Selecting Baro Pres

Prev Next Cont Back
A B C D

<Prev> Proceeds to Temp sensor output
<Next> Proceeds to LSC sensor output
<Cont> Enters Baro Pres output
<Back> Returns to the Maintenance entry menu.

B.P. = ##.## inHg
(Raw = #.#### V ) Exit

“Temp = ##.## inHg” displays the output signal being received from the PCBA mounted barometric pressure sensor converted to degrees inches of mercury using a fixed conversion constant.

“(Raw = #.#### V)” displays the PCBA mounted barometric pressure sensor output as a voltage.

<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

---

Selecting LSC

Prev Next Cont Back
A B C D

<Prev> Proceeds to Baro Pres sensor output
<Next> Proceeds to Pressure sensor output
<Cont> Enters LSC sensor output

---

DAC = #, LSC=#.####

Up Dwn Samp Exit
A B C D

The View LSC screen is intended as the primary working maintenance interface for light scattering chamber. Using this screen, all necessary output is available to enable optical alignment, PMT alignment & troubleshooting as well as leak testing.

The test fixture should be closed at this time. Closure may be accomplished using either manual actuators or an EXT Start signal sent to the User Port.

“DAC = #” displays the stored gain sensitivity setting for the LSC photomultiplier tube

“LSC = #.####” displays the output voltage from the light scattering chamber under its current conditions.

<Up> Increases the DAC value by one at each press. Changes made using this feature are not retained upon exit.

<Dwn> Decreases the DAC value by one at each press. Changes made using this feature are not retained upon exit.

<Samp>/<Cler> Enable/Disables the Sample/Clear solenoid valve.

<Samp> Sample valve is disabled. The displayed voltage represents the signal generated by sampling particle free air through the 0 Reference filter. This is the “straylight” voltage.

<Cler> Sample valve is enabled. The displayed voltage represents the signal generated by the 100% sample of the available aerosol concentration.

<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

---

<Back> Returns to the Maintenance entry menu.
14.1.7. Cal Sensor

Set for – 0 - WC

CONT

A B C D

Disconnect both lines from the pressure transducer so that the transducer inlets are bleeding to atmosphere (0” water column).

Attach a pressure calibrator and pressure source in series with the transducer inlet port labeled P2 (uppermost). The pressure calibrator/source should not be sourcing pressure to the transducer at this stage.

<CONT> enters a pressure verification routine.

Pressure #.####

Exit

A B C D

“Pressure #.###” displays the output signal being received from the pressure sensor in mm/\text{H}_2\text{O} calculated using the conversion constant stored in memory.

Close any open bleed valves on the pressure calibrator/source and slowly apply pressure to the pressure transducer inlet port labeled P2.

Allow the pressure to stabilize at 10, 40 & 80 mm/\text{H}_2\text{O} and compare the TDA-100P pressure to the pressure calibrator displayed pressure. The TDA-100P pressure must correspond to the pressure calibrator display within ± 0.5 mm/\text{H}_2\text{O} at all three (3) pressure set points.

<Exit> Proceeds to the Pressure Setup menu

Pressure Setup

Exit Enter

A B C D

<Exit> Returns to Cal Sensor entry menu.

<Enter> Proceeds to pressure sensor calibration.

If all pressure set point readings in the pressure check menu were acceptable, restore the pressure transducer tubing connections and press ‘C’ <EXIT>.

If any pressures set point readings in the pressure check menu were unacceptable, press ‘D’ <ENTER>.

WARNING: The screens associated steps within this section are used to verify and/or calibrate the sensors used during the operation of the TDA-100P. Known calibration standards, specific supplies and fixtures may be required and should be readily available.

Only Trained and Authorized personnel should access these features. Improper or partial completion of the steps outlined will render the TDA-100P inoperable until successful completion.

<Prev> Returns to View Sensor selection

<Next> Proceeds to ID selection

<Cont> Enters Cal Sensor menu

<Back> Returns to the Maintenance entry menu.

Selecting Pressure

A B C D

<Prev> Proceeds to Gravimetric test.

See Section 14.1.1

<Next> Proceeds to Flow calibration menu

<Cont> Enters Pressure sensor calibration

<Back> Returns to the Maintenance entry menu.

Pressure Check?

A B C D

<Yes> enters a pressure verification menu.

<No> Proceeds to Pressure sensor calibration.
** Are You Sure? **

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<YES> Proceeds to pressure calibration

<NO> Returns to Cal Sensor entry menu.

<DEFAULT> Loads a default system pressure value to memory and returns to Cal Sensor entry menu.

**NOTE:** Loading “Default” values is not recommended except in extreme circumstances. Always be prepared to select <Yes> and set up the pressure transducer with a NIST traceable pressure calibrator.

Set for – 0 - WC

<table>
<thead>
<tr>
<th>CONT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
</tbody>
</table>

Disconnect both lines from the pressure transducer so that the transducer inlets are bleeding to atmosphere (0” water column).

Attach a pressure calibrator and pressure source in series with the transducer inlet port labeled P2 (uppermost). The pressure calibrator/source should not be sourcing pressure to the transducer at this stage.

<CONT> enters a pressure verification routine.

Record - 0 - #.####

<table>
<thead>
<tr>
<th>ENTER</th>
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</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
</tbody>
</table>

“Pressure #.###” displays the output signal being received from the pressure transducer as voltage.

<ENTER> Records the transducer output signal at the applied pressure to memory.

**NOTE:** It is important that the exact value displayed on the pressure calibrator in mm/H₂O be noted at the moment <ENTER> is pressed. This value is required for the next step.

Input Pres = ###.#

<table>
<thead>
<tr>
<th>UP</th>
<th>DWN</th>
<th>ENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Input Pres = ###.#” displays the pressure that will be use as the calibration point determined in the preceding step.

<UP> Increases the displayed pressure calibration point.

<DWN> Decreases the displayed pressure calibration point.

<ENTER> Stores the entered value to memory and returns to the initial View Sensor menu, “Selecting Pressure”. 
Selecting Flow

Prev  Next  Cont  Back
A      B      C      D

<Prev> Proceeds to Pressure sensor calibration
<Next> Proceeds to Aux Flow sensor calibration
<Cont> Enters Flow sensor calibration
<Back> Returns to the Maintenance entry menu

Adj Flow to Zero

CONT   EXIT
A      B      C      D

<CONT> Continues to the flow meter zero output signal display screen.
<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

At this step the inlet and outlet sample tubing connected to the mass flow meter need to be removed and the mass flow meter ports capped. As an alternate method, the inlet and outlet of the mass flow meter may be connected together using appropriate tubing.

Flow Zero = #.####

SET   EXIT
A      B      C      D

“Flow Zero = #.####” displays the flow meter signal being received with no air flow through the sensor.
<SET> Stores the displayed voltage to memory.
<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

If a Teledyne HFM-201 flow meter is installed use the Zero Adjust trimming potentiometer on the Flow Meter to adjust the reading until just above zero (exp .0015). Turn the adjustment back until reading stays just above zero (e.g. 0.0001 to 0.0003).

Alicat M-250SLPM mass flow meters do not require this adjustment. Press <SET> and proceed to the next step.

Flow High = #.####

SET  EXIT
A      B      C      D

“Flow High = #.####” displays the flow meter signal being received with a user controlled air flow through the sensor.
<SET> Proceeds to the next step.
<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

NOTE: This option is intended for use of an End-User controlled transfer standard calibration of the mass flow meter and is possible on ALL flow meters used on the TDA-100P series. If a transfer standard calibration is not being attempted press <SET> to proceed to the next step.

At this screen a known volume of flow is introduced to the mass flow meter generating the displayed output voltage.

Press <SET> to proceed to the next step when the desired flow has stabilized.

Flow Volts = #.####

UP  DWN  ENTER
A      B      C      D

“Flow Volts = #.####” displays either the flow meter signal being received with a user controlled air flow through the sensor or allows user entry of the Ref Flow voltage (5.00VDC) from a NIST Traceable calibration sheet.
<UP> Increases the displayed flow calibration point voltage.
<DWN> Decreases the displayed flow calibration point voltage.
<ENTER> Stores the entered value to memory.
When Flow = ###.# lpm

**UP**  **DWN**  **ENTER**

A  B  C  D

“When Flow = ###.# lpm” displays the flow value that corresponds to the voltage stored as the “Flow High” calibration point.

<UP> Increases the displayed flow value.

<DWN> Decreases the displayed flow value.

<ENTER> Stores the value as the upper end of the flow calibration curve and returns to the initial View Sensor menu, “Selecting Pressure”.

Selecting Aux Flow

**Prev**  **Next**  **Cont**  **Back**

A  B  C  D

<Prev> Proceeds to Flow sensor calibration

<Next> Proceeds to Temp sensor calibration

<Cont> Enters Aux Flow sensor calibration

<Back> Returns to the Maintenance entry menu

Adj Aux Flow to Zero

**CONT**  **EXIT**

A  B  C  D

<CONT> Continues to the flow meter zero output signal display screen.

<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

At this step the inlet and outlet sample tubing connected to the auxiliary mass flow meter need to be removed and the mass flow meter ports capped. As an alternate method, the inlet and outlet of the mass flow meter may be connected together using appropriate tubing.

Flow Zero = #.####

**SET**  **EXIT**

A  B  C  D

“Flow Zero = #.####” displays the flow meter signal being received with no air flow through the sensor.

<SET> Stores the displayed voltage to memory.

<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

If a Teledyne HFM-201 flow meter is installed use the Zero Adjust trimming potentiometer on the Flow Meter to adjust the reading until just above zero (exp .0015). Turn the adjustment back until reading stays just above zero (e.g. 0.0001 to 0.0003).

Alicat M-250SLPM mass flow meters do not require this adjustment. Press <SET> and proceed to the next step.

Flow High = #.####

**SET**  **EXIT**

A  B  C  D

“Flow High = #.####” displays the flow meter signal being received with a user controlled air flow through the sensor.

<SET> Proceeds to the next step.

<Exit> Returns to the initial View Sensor menu, “Selecting Pressure”.

**NOTE:** This option is intended for use of an End-User controlled transfer standard calibration of the mass flow meter and is possible on ALL flow meters used on the TDA-100P series. If a transfer standard calibration is not being attempted press <SET> to proceed to the next step.

At this screen a known volume of flow is introduced to the mass flow meter generating the displayed output voltage.

Press <SET> to proceed to the next step when the desired flow has stabilized.

Flow Volts = #.####

**UP**  **DWN**  **ENTER**

A  B  C  D

“Flow Volts = #.####” displays either the flow meter signal being received with a user controlled air flow through the sensor or allows user entry of the Ref Flow voltage (5.00VDC) from a NIST Traceable calibration sheet.

<UP> Increases the displayed flow calibration point voltage.

<DWN> Decreases the displayed flow calibration point voltage.

<ENTER> Stores the entered value to memory.
**When Flow = ###.# lpm**

<table>
<thead>
<tr>
<th>UP</th>
<th>DWN</th>
<th>ENTER</th>
</tr>
</thead>
</table>

“When Flow = ###.# lpm” displays the flow value that corresponds to the voltage stored as the “Flow High” calibration point.

<UP> Increases the displayed flow value.

<DWN> Decreases the displayed flow value.

<ENTER> Stores the value as the upper end of the flow calibration curve and returns to the initial View Sensor menu, “Selecting Pressure”.

---

**Selecting Baro Pres**

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
</table>

<Prev> Proceeds to Temp sensor calibration

<Next> Proceeds to LSC sensor calibration

<Cont> Enters into Baro Pres calibration.

<Back> Returns to the Maintenance entry menu

---

**Not Available**

CONT

<Cont> Returns to the Maintenance entry menu.

Calibration of the barometric pressure sensor is performed at the manufacturing level. No post-manufacturing calibration is possible.

---

**Selecting Temp**

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
</table>

<Prev> Proceeds to Aux Flow sensor calibration

<Next> Proceeds to Baro Pres sensor calibration.

<Cont> Enters Temp output calibration

<Back> Returns to the Maintenance entry menu

---

**Current Temp = 20.0 C**

<table>
<thead>
<tr>
<th>UP</th>
<th>DWN</th>
<th>ENTER</th>
</tr>
</thead>
</table>

“Current Temp = 20.0 C” displays the default temperature value.

<UP> Increases the displayed temperature value.

<DWN> Decreases the displayed temperature value.

<ENTER> Stores the temperature value to memory and returns to the initial View Sensor menu, “Selecting Pressure”.

---

**Selecting LSC**

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
</table>

<Prev> Proceeds to Baro Pres sensor calibration

<Next> Proceeds to Pressure sensor calibration

<Cont> Proceeds to Gravimetric test.

See Section 14.1.1

<Back> Returns to the Maintenance entry menu

---

**14.1.8. ID**

**Maint: ID**

<table>
<thead>
<tr>
<th>Prev</th>
<th>Next</th>
<th>Cont</th>
<th>Back</th>
</tr>
</thead>
</table>

The machine ID is a, user selectable, five digit number between 00000 & 30000 which is included in the result strings output to the serial port.

<Prev> Proceeds to Cal Sensor menu

<Next> Proceeds to Console menu

<Cont> Enters ID menu

<Back> Prompts for Maintenance exit
### Set#####

**UP** | **DWN** | **ENTER**
--- | --- | ---
A | B | C | D

“Set##### displays the current value stored as the variable UNIT_ID.

<UP> Increases the ID numeric value

<DWN> Decreases the ID numeric value

<ENTER> Stores the entered value to memory.

The ability to alter the ID value is also available using the “SET UNIT_ID=#####” command through the Console feature.

### 14.1.9. Console

<table>
<thead>
<tr>
<th>Console</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prev</td>
</tr>
</tbody>
</table>

<Prev> Proceeds to ID selection

<Next> Proceeds to Security selection

<Cont> Enters Console mode

**See related Appendix**

<Back> Prompts for Maintenance exit.

**Note:** Once Console mode has been engaged an "END" command must be received through the RS-232 communication port to restore unit control panel functionality.

### 14.1.10. Security

<table>
<thead>
<tr>
<th>Maint: Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prev</td>
</tr>
</tbody>
</table>

<Prev> Proceeds to Console selection

<Next> Proceeds to Gravimetric selection

<Cont> Enters Security menu

<Back> Prompts for Maintenance exit

The security feature is available to prevent unauthorized or inadvertent access to the Setup Menu during normal operation. This prevents changes to the alarm values or critical load and sample times.

**Enable Security**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

<Yes> Enables security and restricts operator access to “Setup” parameter menu.

<No> Disables security and allows full operator access to “Setup” parameter menu.

The unit will immediately return to the Maintenance entry menu upon selection of either Yes or No.
15. Console Commands

The 100P provides a mechanism to issue commands and set and recall operating parameters through the RS-232 serial communications port. This section documents the available functions.

The console mode is initiated in one of two ways:

1) Through the Maintenance Mode Security/Console Menu (Section 14.2).

2) By request through the serial port. If an ASCII ESC (Escape, hexadecimal 1B) character is received while the TDA-100P is idle, the machine will issue a “READY?” prompt and begin console mode. If the machine is busy when the ESC character is received, the character will be held until the machine is idle.

When the 100P is ready to accept a new command, it will issue a prompt string to the serial port. The prompt string is “Ready?”. Characters sent to the serial port prior to the receipt of the prompt will be ignored. Each command sent to the serial port must be terminated by a carriage return character (0D in hexadecimal).

The available commands are: VER, END, DUMP, LOAD, SET, PROMPT, PENCAL and END. The function of each command is described below.

In the descriptions references to “PPPPP” refers to one of the operating parameters listed in the 100P Parameter Table below. Also, “VVVV” represents the value of the parameter or the value to be assigned to the parameter. The values can take several forms depending on the parameter. The forms are:

- Integer a sequence of decimal digits. For example, “150”.
- Real a sequence of decimal digits with an optional decimal point. For example, “2.3”.
- True/False A true value is entered as a “Y” (for “yes”) or an “N” (for “no”).

TDA-100P Serial Port Commands

VER Displays the version of the software.

END Terminates console entry mode and returned control to the 100P front panel buttons.

DUMP Displays the value of the 100P’s operating parameters in the form PPPPP=VVVV. Each parameter is displayed on a line by itself followed by a carriage return and line feed (hexadecimal 0D and 0A, respectively).

LOAD Accepts a series of operating parameters in the same form as that produced by the DUMP command.

SET Used to set the value of an individual operating parameter. The form of the command is “SET PPPPP=VVVV”. No additional spaces are allowed.

PROMPT This command will cause the TDA-100P to ask for changes to all of the parameters. For each parameter, the 100P will display “PPPPP[VVVV]=”, where the PPPPP is the parameter name and VVVV is the current value of the parameter. If the user wishes to leave the parameter unchanged, he can enter a carriage return. If he wishes to change the value, enter the new value of the parameter followed by a carriage return.

PENCAL Initiates an LSC calibration cycle.
16. LSC Maintenance

16.1. Photomultiplier Tube Replacement

A. Loosen the wing nut on the top of the Photomultiplier Tube Elbow (see Figure 9) and lift out the Phototube housing.
B. Remove and replace the phototube.
C. Insert the housing back into the elbow.
D. Turn on the unit power and enter the Main Maintenance menu LSC Check (Section 5.3). Turn off the aerosol to obtain the low reading.
E. Rotate the phototube housing until the highest reading is achieved.
F. Tighten the wing nut.

NOTE: Follow the aligning procedure if any other changes were made to the LSC assembly.

16.2. Cleaning

A. Remove the power from the unit.
B. Remove the LSC from the unit.

NOTE: Do not remove the Light Assembly screw or loosen the Light End Plate screws during cleaning.
C. Remove the three thumbnuts and the Photomultiplier Tube Elbow (See Figure 10).
D. Remove the three screws securing the Lens End Plate to the Sample Cone.
E. Remove the three screws securing the Light Barrel to the Sample Cone.
F. Wipe the outer lens on the Light Barrel with a clean, lint free cloth to eliminate all foreign matter.

NOTE: Do not disturb the rubber aperture.
G. Wipe the lens and Lens End Plate with a clean, lint free cloth to eliminate all foreign matter.
H. Inspect the inside of the Sample Cone and remove any buildup or foreign matter.

NOTE: Any lint or foreign matter left in the Cone or on the lenses will decrease the sensitivity of the LSC.
I. Reverse this procedure to reassemble the LSC and to reinstall it into the unit.
16.3. Aligning

A. Turn on the unit power and enter the Main Maintenance menu LSC Check. Turn off the aerosol to obtain the low reading.

B. If the Light Assembly was removed, loosen and move in and out until the lowest reading is displayed. Tighten the screw when completed.

**NOTE:** If the Light Assembly is started from the full in position and pulled out, the reading will start high, drop, then increase and drop again when the assembly is in the out position. The low point of the first drop is the correct setting.

C. If the Light End Plate was moved, loosen the thumbscrews and realign the plate even with the barrel. Tighten the screws when completed.

D. Loosen the thumbscrews on the Photomultiplier Tube Elbow and adjust for the lowest reading. Tighten the screws when completed.

E. Repeat the Light Assembly adjustment procedure for the lowest reading.
## Appendix A. Dip Switch Settings

<table>
<thead>
<tr>
<th>Switch Number</th>
<th>Definition</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not used</td>
<td>Not Used</td>
</tr>
</tbody>
</table>
| 2             | External Air Chuck Control  | **Off**–Chuck close air controlled by unit (Default)  
|               |                             | **On** – Chuck close air controlled externally. Unit ignores position sensor inputs |
| 3             | Not used                    | Not Used                                                                 |
| 4             | Remote Mode                 | **Off** – Normal operation (Default)  
|               |                             | **On** – Remote operation. Unit bypasses normal operator prompts.          |
| 5             | Chuck Close Audible         | **Off** – No Audible (Default)  
|               |                             | **On** – Audible beep when chuck starts to close                           |
| 6             | Chuck Latched               | **Off** – No audible (Default)  
|               |                             | **On** – Audible beep when chuck is closed                                |
| 7             | Not Used                    | Not Used                                                                 |
| 8             | Alarm Prompt                | **Off** – Disables user input requirement (Default)  
|               |                             | **On** – Requires user input to clear alarm state                         |
Appendix B. TDA-100P Operating Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIT_ID</td>
<td>A numeric identifier that can be used to distinguish one TDA-100P from another. This number is</td>
</tr>
<tr>
<td></td>
<td>included in the result output string reported at the serial port.</td>
</tr>
<tr>
<td>PENMAX</td>
<td>Maximum allowed penetration during a test. An alarm will be raised if this limit is exceeded.</td>
</tr>
<tr>
<td>PENMAX_ON</td>
<td>“Y” if maximum penetration limit is enabled; if “N” the upper limit will not be tested.</td>
</tr>
<tr>
<td>PENMIN</td>
<td>Minimum allowed penetration during a test. An alarm will be raised if the sample penetration</td>
</tr>
<tr>
<td></td>
<td>falls below this limit.</td>
</tr>
<tr>
<td>PEN_MIN_ON</td>
<td>“Y” if minimum penetration limit is enabled; if “N” the upper limit will not be tested.</td>
</tr>
<tr>
<td>RESMAX</td>
<td>Maximum allowed resistance during a test. An alarm will be raised if this limit is exceeded.</td>
</tr>
<tr>
<td>RESMAX_ON</td>
<td>“Y” if maximum resistance limit is enabled; if “N” the upper limit will not be tested.</td>
</tr>
<tr>
<td>RESMIN</td>
<td>Minimum allowed resistance during a test. An alarm will be raised if the sample resistance falls</td>
</tr>
<tr>
<td></td>
<td>below this limit.</td>
</tr>
<tr>
<td>RESMIN_ON</td>
<td>“Y” if minimum resistance limit is enabled; if “N” the upper limit will not be tested.</td>
</tr>
<tr>
<td>FLOW_TOL</td>
<td>Allowable variation tolerance of the sample flow during testing in LPM.</td>
</tr>
<tr>
<td>FLOW_TOL_ON</td>
<td>“Y” if flow tolerance limit is enabled; if “N” the limits will not be tested.</td>
</tr>
<tr>
<td>CYC_TO_CAL</td>
<td>Number of test cycles performed between mandatory recalibrations.</td>
</tr>
<tr>
<td>CYC_TO_CAL_ON</td>
<td>“Y” if the mandatory calibration based on test count is enforced.</td>
</tr>
<tr>
<td>LOAD_TIME</td>
<td>Delay time (in seconds) allowed for aerosol loading and stabilization.</td>
</tr>
<tr>
<td>LOAD_TIME_ON</td>
<td>“Y” if load time will be used. If “N”, load time will be ignored.</td>
</tr>
<tr>
<td>SAMP_TIME</td>
<td>Sample testing time (in seconds).</td>
</tr>
<tr>
<td>SAMP_TIME_ON</td>
<td>“Y” if sample testing is limited to the value of “SAMP_TIME”. If “N”, testing will run continuously</td>
</tr>
<tr>
<td></td>
<td>until an alarm limit is exceeded or the chuck is opened by the operator.</td>
</tr>
<tr>
<td>EXT_LOAD_TIME</td>
<td>Extended load time (in seconds). Extended load time is used on the first test after calibration</td>
</tr>
<tr>
<td></td>
<td>and after a limit error.</td>
</tr>
<tr>
<td>RES_OFF</td>
<td>Provides an end-user feature to shift the displayed pressure differential by a fixed amount due</td>
</tr>
<tr>
<td></td>
<td>to sample path variations occurring in non-encapsulating test fixtures. Default setting is 0.</td>
</tr>
<tr>
<td>RES_OFF_ON</td>
<td>“N” disables the resistance offset. Default setting is N (Disabled).</td>
</tr>
<tr>
<td>ZERO_OFF</td>
<td>An offset in Analog to Digital converter counts that is be applied to the LSC reading, at each</td>
</tr>
<tr>
<td></td>
<td>test cycle, during calculation of the % Penetration. Default setting of -120.</td>
</tr>
<tr>
<td>ZERO_OFF_ON</td>
<td>“N” disables the zero offset. Default setting is N (Disabled)</td>
</tr>
<tr>
<td>CAL_100</td>
<td>100% LSC Reading from gravimetric calibration</td>
</tr>
<tr>
<td>FLOWCON</td>
<td>Flow calibration slope constant</td>
</tr>
<tr>
<td>FLOWZERO</td>
<td>Zero flow output level for flow sensor (in counts)</td>
</tr>
<tr>
<td>GRAVCN</td>
<td>LSC slope constant created during gravimetric calibration</td>
</tr>
<tr>
<td>GRAVHI</td>
<td>Upper response limit of the 100% penetration reading (set during gravimetric routine).</td>
</tr>
<tr>
<td>GRAVLO</td>
<td>Lower response limit of the 100% penetration reading (set during gravimetric routine).</td>
</tr>
<tr>
<td>LSC_DAC</td>
<td>LSC DAC (Gain) Setting</td>
</tr>
<tr>
<td>RESCON</td>
<td>Pressure (resistance) calibration slope constant</td>
</tr>
<tr>
<td>TLEVEL</td>
<td>Trace Level determines the amount of diagnostic information displayed through the serial port.</td>
</tr>
<tr>
<td></td>
<td>Available levels are 0, 1, and 3, representing minimal, normal and maximum amounts of output.</td>
</tr>
<tr>
<td></td>
<td>Default value of 0 to match legacy output content.</td>
</tr>
<tr>
<td>QZT</td>
<td>Quick Zero Tolerance is a factor applied to the LSC reading returned at the start of each test</td>
</tr>
<tr>
<td></td>
<td>cycle to determine if the LSC state has recovered from the previous test. 0=Off. Default value</td>
</tr>
<tr>
<td></td>
<td>of 6.</td>
</tr>
</tbody>
</table>

For operating revisions ≥1.17

| BPSENSTYPE         | Specifies the type of barometric pressure sensor installed. 0=None (Default), 1 = MPX4105A, 2= |
|                    | MPX5100A                                                     |
| FLOWSENSTYPE       | Specifies the mass flow meter installed.                    |
|                    | A=Alicat (Default), T=Teledyne Hastings                     |

For operating revisions ≥2.0

| ALT100PCT          | “N” disables the non-encapsulating feature (Default). Default setting is N (Disabled). “Y”     |
|                    | enables non-encapsulating feature utilizing an optional dedicated valve for obtaining 100%    |
|                    | during daily ‘PenCal’ routine.                                      |
Appendix C. Default Settings

The table below lists the default values for the TDA-100P operating parameters. In the event of a failure in the internal parameter memory, the parameters will be reset to these defaults.

<table>
<thead>
<tr>
<th>Default Parameter</th>
<th>Default Value</th>
<th>Unit</th>
<th>Enabled Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure unit</td>
<td>mm/H2O</td>
<td>mm/H2O</td>
<td>NA</td>
</tr>
<tr>
<td>Flow Calculation</td>
<td>STD</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Pen Max</td>
<td>0.0299</td>
<td>Percentage</td>
<td>Y</td>
</tr>
<tr>
<td>Pen Min</td>
<td>0.0005</td>
<td>Percentage</td>
<td>N</td>
</tr>
<tr>
<td>Max Resistance</td>
<td>25.0</td>
<td>mm of H₂O</td>
<td>Y</td>
</tr>
<tr>
<td>Min Resistance</td>
<td>2.0</td>
<td>mm of H₂O</td>
<td>N</td>
</tr>
<tr>
<td>Flow Tolerance</td>
<td>2.0</td>
<td>lpm</td>
<td>Y</td>
</tr>
<tr>
<td>Load Time</td>
<td>8.0</td>
<td>Seconds</td>
<td>Y</td>
</tr>
<tr>
<td>Extended Load Time</td>
<td>12.0</td>
<td>Seconds</td>
<td>Y</td>
</tr>
<tr>
<td>Sample Time</td>
<td>1.0</td>
<td>Seconds</td>
<td>Y</td>
</tr>
<tr>
<td>Open Time</td>
<td>0.0</td>
<td>Seconds</td>
<td>Y</td>
</tr>
<tr>
<td>Cycles to Cal</td>
<td>1000</td>
<td>Counts</td>
<td>Y</td>
</tr>
<tr>
<td>Con Check</td>
<td>NA</td>
<td>mg/m³ or µg/l</td>
<td>N</td>
</tr>
</tbody>
</table>
## Appendix D. Fault and Error Messages

<table>
<thead>
<tr>
<th>Error Message</th>
<th>Problem Fault</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSC PROBLEM</td>
<td>No LSC output or LSC output less than 30% of initial reading</td>
<td>Check LSC LED</td>
</tr>
<tr>
<td>PRES SENSOR</td>
<td>Memory Error. Memory storage corrupted or missing</td>
<td>Pressure sensor needs to be calibrated. If problem persists, contact manufacturer</td>
</tr>
<tr>
<td>GRAVIMETRIC</td>
<td>Memory Error. Memory storage corrupted or missing</td>
<td>Run system gravimetric test. If problem persists, contact manufacturer</td>
</tr>
<tr>
<td>CON SYSTEM ERROR</td>
<td>Penetration reading exceeded maximum available span</td>
<td>Check generator level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check drip jar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check for proper dilution air</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check nozzle pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean LSC and run gravimetric test</td>
</tr>
<tr>
<td>CON TO HI</td>
<td>Concentration check higher than Hi setting from gravimetric test</td>
<td>Check generator level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check drip jar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check for proper dilution air</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check nozzle pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean LSC and run gravimetric test</td>
</tr>
<tr>
<td>CON TO LOW</td>
<td>Concentration check lower than Low setting from gravimetric test</td>
<td>Check generator level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check drip jar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check for proper dilution air</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check nozzle pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean LSC and run gravimetric test</td>
</tr>
<tr>
<td>CHECK ORIFICE</td>
<td>Generator tank pressure too high</td>
<td>Remove generator and check impactor orifice for obstruction</td>
</tr>
<tr>
<td>TURN MAIN POWER OFF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHECK VACUUM</td>
<td>The system has lost vacuum or signal from the mass flow meter</td>
<td>Check vacuum system</td>
</tr>
<tr>
<td>TURN MAIN POWER OFF</td>
<td></td>
<td>Check mass flow meter cabling</td>
</tr>
<tr>
<td>SYSTEM ERROR</td>
<td>General system fault</td>
<td>Turn power off, wait two minutes and turn power on</td>
</tr>
<tr>
<td>TURN POWER OFF</td>
<td></td>
<td>If problem persists contact manufacturer</td>
</tr>
<tr>
<td>CHECK SYSTEM AIR</td>
<td>System pressure switch has not actuated.</td>
<td>Verify adequate pressure supply of 10 cfm @ 80 psig to unit.</td>
</tr>
<tr>
<td>TURN MAIN POWER OFF</td>
<td></td>
<td>Verify incoming compressed air supply line has a min 0.375” ID (9.5 mm).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check system pressure switch operation.</td>
</tr>
</tbody>
</table>
Appendix E. TDA-100P Pneumatic flow diagram- (1700134 Rev E)
TDA-100P Pneumatic flow diagram legend
(1700134 Rev E)

CF1  Coalescing Filter, Compressed air
SW   Switch, Main Pressure, 70 psi
RG1  Regulator, Precision, Vacuum pump, 2-120 psi
RG2  Regulator, Precision, Diluent flow, 2-40 psi
RG3  Regulator, Precision, Nozzle pressure, 2-120 psi
RG4  Regulator, Air cylinder, 0-100 psi
RG5  Regulator, External Liquid fill, 0-100 psi
SV1  Solenoid valve, Main air
SV2  Solenoid valve, Air cylinder control
SV3  Solenoid valve, Generator Nozzle
SV4  Solenoid valve, Sample/Clear vacuum
SV5  Solenoid valve, Purge air
VP1  Vacuum pump, High-flow venturi type
FM1  Flow Meter 1, Mass, 0-120 SLPM
FM2  Flow Meter 2, Dilution Air, 60-600 SCFH
LSC  Light Scattering Chamber
HF1  Capsule filter, HEPA
CF2  Coalescing Filter, LSC Sample air
ACF1 Capsule filter, Activated Carbon / HEPA
NV2  Needle valve, Purge air control
GV1  Gate valve, Flow balance control
Appendix F. TDA-100P Electrical Wiring diagram - (T00P-1315 Rev D)
TDA-100P Electrical Wiring diagram legend
(T00P-1315 Rev D)

CB1   Main circuit breaker, 5-amp
CR1   Main control relay
F1    Fuse, 1-amp
LF1   Power supply line filter
PCBA  Printed circuit board assembly
SV1   Main air shut-off solenoid valve
SV2   Air cylinder control solenoid valve
SV3   Aerosol generator nozzle solenoid valve
SV4   Sample/Clear solenoid valve
SV5   Purge air solenoid valve
SV6   0 / 100% Solenoid valve (optional / non-encapsulating units)
PS1   DC Power supply
LSC   Light scattering chamber
E-STOP Emergency stop
Appendix G. Remote Mode Operation

In remote mode, the TDA100P can be controlled from an external computer through a combination of the user interface port and commands sent and received through the serial port. The remote mode is selected by DIP switch 2 (two) and 4 (four) (See Appendix A). The program trace level (TLEVEL parameter) should also be set to level 1 for remote operation (See Section 15 & Appendix B).

When the machine is restarted in this mode:

1) The machine will wait for air.
2) The check level prompt is bypassed.
3) The system warm-up will proceed.
4) Personnel will be required to either enter or bypass barometric pressure and ambient temperature selection.
5) The message “Insert Filter; and Close” will print on the VF display. Personnel will be required to close the test fixture locally or through an HMI, and an external start signal sent through the user interface port.
6) The sample flow rate is then adjusted using the “Flow Adjustment “ valve located on the front panel and accepted using the ‘D’ function key on the control panel.
7) The machine will enter an LSC calibration cycle. In the calibration cycle:
   a. The machine will remain busy.
   b. The message “!Close Chuck” will be sent to the serial port, while the message “Clear Chuck & Close” will print on the VF display. In response to this, the chuck should be closed, and an external start signal sent to the machine through the user interface port.
   c. Upon receipt of the external start, a 100% calibration will be performed.
   d. At the end of the 100% calibration, two messages will be sent to the serial port. The first: “PENCAL: LSC_100% = nnnnnn” will display the penetration calibration constants. The second: “PENCAL: Res Tare = nnnnnn” will display the resistance tare value. The numbers in the above strings will not occupy a fixed number of digits; they will be as large as needed to represent the values.
   e. A 0 (zero) baseline routine will be performed with no external intervention required.
   f. At the end of the calibration process, the “Ready” contact at the User Interface port will become active.

**Note:** The calibration beginning from step 7 will also be entered if a “PENCAL” command is sent to the RS-232 port using the console command protocol (See Section 15) or the number of cycles specified by the “Cycles to Cal” variable is exceeded.

Other operational features of the machine can be controlled through parameter setting commands available as described in the Console Commands section of this manual (See Section 15).

The RS-232 printed statements listed above are the minimum that will be printed during these stages of unit operation. As greater levels of program trace output are enabled there may be significantly more data available at the RS-232 port.
Appendix H. USER INTERFACE Circuit Example

Notes:
1) External Start is assert by closing switch S14 (for equivalent, providing a small current to the 1800's pin 11). The current should not exceed 3mA.
2) No output, or the output is digital, or the output is open collector, the external Start can be provided the load on the 1800's outputs.
Appendix I. TDA-100P International Warranty

Air Techniques International

Air Techniques International, hereinafter referred to as ATI, warrants the equipment purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purpose for which it is designed, for a period of (1) one year from the date of shipment. ATI further warrants that the equipment will perform in accordance with the technical specifications accompanying the formal equipment offer.

ATI will repair or replace any such defective items that may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within thirty (30) days after discovery thereof and that inspection by ATI, if required, indicates the validity of such claim to ATI’s satisfaction; and
2. That the defect is not the result of damage incurred in shipment to or from our factory; and
3. That the equipment has not been altered in any way whether as to design or use, whether by replacement parts not supplied or approved by ATI, or otherwise; and
4. That any equipment or accessories furnished but not manufactured by ATI, or not of ATI design, shall be subject only to such adjustments as ATI may obtain from the supplier thereof.

ATI’s obligation under this warranty is limited to the repair or replacement of defective parts with the exception noted above. If the equipment includes a scattering chamber, ATI’s warranty does not extend to contamination of the scattering chamber by foreign material.

At ATI’s option, any defective equipment that fails within the warranty period shall be returned to ATI’s factory for inspection, properly packed with shipping charges prepaid. No equipment shall be returned to ATI without prior issuance of a return authorization by ATI.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by ATI and the foregoing warranty shall constitute the Buyer’s sole right and remedy. In no event does ATI assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of ATI products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.
Appendix J. TDA-100P Auto Fill Instructions

1. Remove the left side panel of the TDA-100P by sliding forward and lifting upward until it is clear its retaining brackets.

2. Connect one of the supplied six (6) foot long ¼" Bev-A-Line® tubes from the “Auto Fill” button fitting (located on the rear of the front panel directly above the “Flow Adjust” valve) to the fitting marked 5 on Drawing T00P-1503.

3. Connect a second piece of ¼" Bev-A-Line® tubing between the fitting marked 4 on Drawing T00P-1503 and the plastic elbow fitting located on the side of the generator tank assembly.

4. Remove the small plastic drain jar from the generator tank and connect the third piece of ¼" Bev-A-Line® tubing to the straight plastic drain fitting. Insert the other end of this tube through the cap of the supplied 1-gallon plastic container.

5. Fill the liquid reservoir, marked 1 on Drawing T00P-1503, with the liquid being used to produce aerosol.

6. Reattach the left side panel of the TDA-100P while routing the three (3) sections of Bev-A-Line® tubing through the gap machined in the lower edge of the panel.
## Appendix K. Manual Revision

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 2007</td>
<td>G</td>
</tr>
<tr>
<td>September 2007</td>
<td>H</td>
</tr>
<tr>
<td>February 2008</td>
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### Base Manual version
- September 2007 G

### Limited release ‘C’ compiled firmware manual
- September 2007 H

### Released revision of manual to incorporate changes brought about by ‘C’ compiled firmware
- February 2008 J

### Update “User Interface” port specifications. 50ma sink/non-inductive load
- May 2008 K

- Update “Appendix C”.

### Added revision tracker table

### Added hyperlink function within manual

### Updated “Appendix D” to include “Check System Air” error message

### Maintenance menu sequence correction
- July 2011 L

### Update “Appendix C – Default Settings”.

### Correct sequence for start-up calibration in Appendix G
- PENCAL correction in Appendix G
- TLEVEL correction in Appendix G for “!Close Chuck” prompt
- Figure 2B Automatic-Back View labeling correction

### Added operating parameters ‘BPSENSTYPE’, ‘FLOWSENSTYPE’ & ‘ALT100PCT’ to Appendix B (p45) & deleted unused ‘LSC_LOWLIM’.
- March 2012 N

### Added User Interface circuit example

### Re-sequence Gravimetric test verbiage (Page 29) to clarify necessary steps for completion
- May 2012 P

### Added/Updated information on calibration, spare parts, installation and liquid consumption
- May 2014 R
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