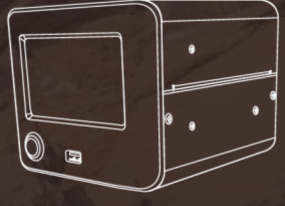
Zaxis PD



Pressure Decay Leak Tester

A User's Guide

Ver. 1.00

Zaxis PD

Pressure Decay Leak Tester

A User's Guide

Ver. 1.00

WEBSITE:
https://zaxisinc.com

EMAIL:
info@zaxisinc.com

PHONE:
801.264.1000

HEADQUARTERS:
2442 South 2570 West
West Valley City, UT 84119

***Wall or stand mounted**

*Fixture Not Included - (Example of use)

For Your Safety.

Install all equipment according to local safety codes.

Additional guidelines when working with the Zaxis PD Pressure Decay Leak Tester:

» Always wear eye protection when working with compressed gas.
» Beware of possible hazardous voltages present inside the enclosure.
» Do not attempt any maintenance procedure discussed in this guide until proper understanding of the tasks involved has been attained.

WARNING! Always disconnect power before removing cover or fuse holder.

CAUTION! Equipment requires a clean-dry air supply. Failure to comply may void warranty.

THREE YEAR LIMITED WARRANTY

Zaxis, Inc. Limited Warranty
ZAXIS INC. products are manufactured to a very high standard, however when located in physically hostile environments or when operated under non-specification voltage or pressure conditions, warranty may be voided. Please refer to your user manual for more detailed information.

ZAXIS INC., therefore, warrants only as follows: Supply clean dry air only to the unit. Each unit is identified by serial number in a permanent record of the company. If at any time with-in three years after any ZAXIS INC. product has been shipped to a customer (user), it fails to perform according to ZAXIS INC. literature, the product, with written explanation of the problem, may be returned, freight prepaid, to ZAXIS INC. for examination, repair or replacement at ZAXIS INC. expense (labor and material). All such returns must have prior ZAXIS INC. customer service authorization before returning. If, upon examination, ZAXIS INC. determines that abusive practices, non-filtered and dried air or destructive environment of operation or a combination of these factors is responsible for improper performance of the product, all labor and materials costs involved shall be at the expense of the customer.

ZAXIS INC. is not liable for special, indirect or consequential damages that may result from use, failure or malfunction of the product and any recovery against ZAXIS INC. may not be greater than the purchase price paid for the product.

No person is authorized to change the terms of this warranty.

Introduction

The Zaxis PD Leak Tester is the latest product from Zaxis designed to meet today's quality assurances demands.

The compact size of the Zaxis PD makes it easy to use in a variety of testing situations. By reducing the internal and connection volumes, the test sensitivity will increase, and test times can be reduced. This small internal volume, combined with integrated sensors and a 24bit analog to digital convertor, allows Zaxis to offer a leak tester with the highest sensitivity on the market.

This guide covers the standard Zaxis PD Leak Testers. All the current functions and features are found in this guide. Your tester could differ in installed features.

Safety and Emissions

Operating Environment Conditions:

<u>Indoor Use Only</u>

Operating Temperature Range:	5-40° C
Maximum relative humidity:	80%
Main supply voltage:	120 V ~ 60 Hz ± 10%, 2A
	Or 230 V ~ 60 Hz +/- 10%, 1A
	+24VDC +/- 5% (DC Models)
Altitude:	up to 2000 meters
Supply Air Pressure:	11 bar max. (unless otherwise specified)

- ◊ Supply air must be clean and dry.
- ◊ (10-micron filtration minimum, 5-micron recommended)

Table of Contents

1 Front Panel.

Fig. 1. Front Panel of the Zaxis PD.

1. **Touch Screen Interface (TSi)** — The liquid crystal touch screen display is the primary control of the leak tester.
2. **Start Button** — Push to Start. Push again during test to Abort.
3. **USB Port** — Port for USB storage media, such as a flash drive or portable hard drive.

Fig. 2. Bottom Panel of the Zaxis PD.

1. **Air Supply —** (air or other test gas) Connection is ¼" OD Tube. Supply gas must be clean and dry.
2. **Clamp —** (Fixture Output) 4-way valve 5/32" Tube
3. **Ethernet Connector —** ASCII communication, data output and command string input.
4. **I/O Connector -** M12 female 12 pin
5. **Test Port —** ¼-18 NPT Female
6. **Power Entry Module —** This component includes the power cord socket, on/ off switch, and the fuse holder.
   109- 255~VAC. 2A Fuse
7. **Leak Standard Port —** Female Staubli quick connect. Attach a Leak Standard for setup or verification of leak rate.
8. RS232 Port – data collection port.

3 Control Screens.

Fig. 3. About Screen for the Zaxis PD.

▶ **Run Mode —** Press this button to change to the run mode to begin testing.

Prog **Program —** Contains three sub-menus (Pressure, Fixture, and Settings) that control the parameters of the test.

Units **Units —** Engineering units and the displayed sensor resolution.

Calibrate **Calibrate —** Calibration settings.

Options **Options —** Contains eight user options (Touchscreen Calibration, Clock, I/O Setup, Data Logging, Change PIN, Serial Port, Ethernet Settings).

About **About —** Lists the firmware revision level, serial number, and contact info for Zaxis. (see Fig 3.)

3.1 Data Input.

Two data input screens are used throughout the tester's setup and operation:

1. Numeric keypad screen — used to input values for the timer and limit fields.
2. Alpha-Numeric keypad screen — used in text fields
   » Example: The Program Name Field.

Examples of each are shown below:

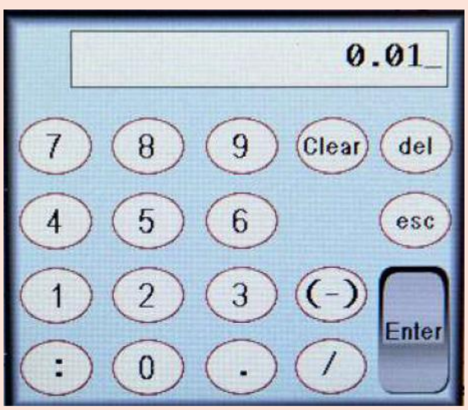


Fig. 4a. Numeric Keypad Screen.

Fig. 4b. Alpha-Numeric Keypad Screen.

!

To access: press desired data field with your finger or stylus.

Press the **SHIFT** key to change case.

3.2 Run Mode Screen.

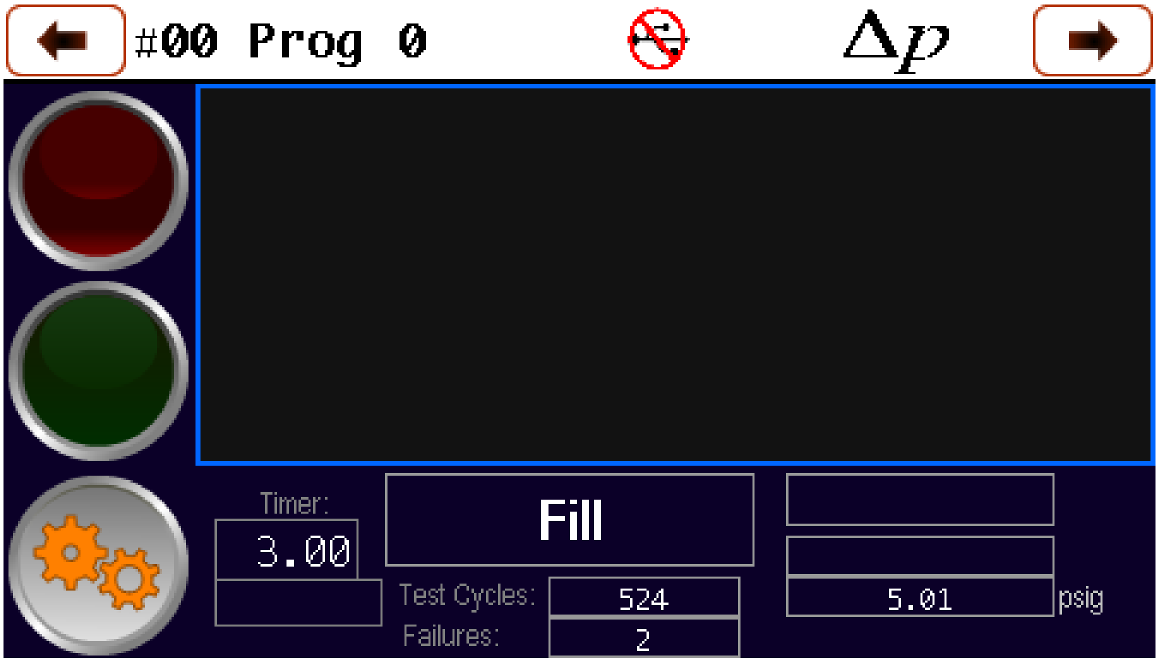


Fig. 5. Run Mode Screen.

1. **Test Fail, also can be used as Abort Input**
2. **Test Pass**
3. **Access Configuration Mode**
4. **Pressure over Time test graph**
5. **Test Result Value**
6. **Timer – Step name and remaining time**
7. **Live pressure reading**

4 Configuration.

The configuration of this unit is separated into four main menus with user configurable settings:

Prog	Program Settings
Units	Engineering Units and Resolution
Calibrate	Sensor Calibration Settings
Options	User options (Touchscreen Calibration, Clock, I/O Setup, Data Logging, Change PIN, Serial Port, and Ethernet Settings)

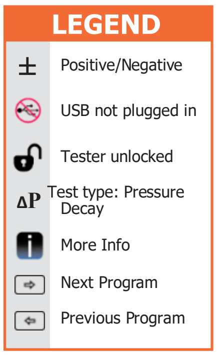
! **CAUTION!** Unauthorized changes in the calibration menus will affect the functionality of the test.

Program Settings

Three menus control all the parameters associated with the test process:

Pressure	Pressure test settings
Fixture	Fixture valve settings
Settings	Test parameters

4.1 Pressure.



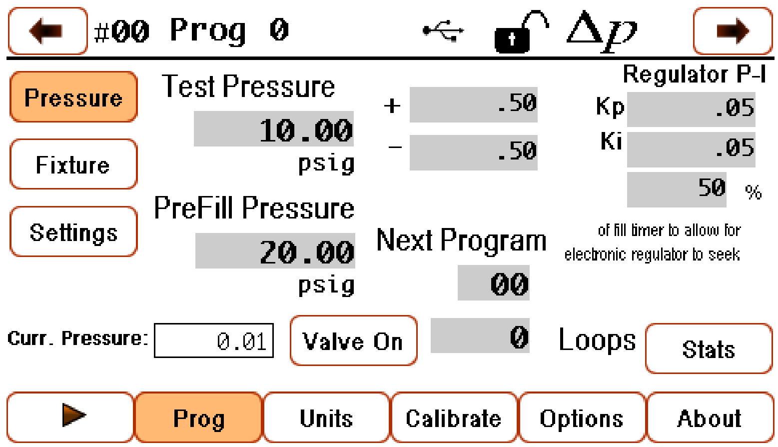


Fig. 6. Pressure Settings Screen.

! Entering the same number as the current test will not loop tests.

! A test failure will cancel the jump to the next program

1. **Test Pressure** — Press the Test Pressure data field and enter desired test pressure on the numeric keypad screen.
2. **Next Program** — Link programs together by entering the number of the next program (upper left corner) in the Next Program data field. This allows the tester to jump to the desired next program upon a pass result in the current test.
3. **Pressure Tolerance ±** — The amount of tolerance on the test pressure. Enter positive (+) and negative (-) limits in the data field to the right of the Test Pressure data field. (For example, test pressure of 5.00psi, +0.50, -0.15 would allow the test pressure to be 5.5 to 4.85psi)
4. **Current Pressure** — Displays the current pressure when Valve On is check and test port is capped.
5. **Valve On** — Check box the opens the test port valve, sets the regulator to the test pressure listed above and gives a live reading
6. **Stats** — Statistics Menu
7. **Loops** — Loops programs the specified number of times.
8. **Regulator P-I** – see 'Setting Test Pressure' section.

Setting Test Pressure

To set the test pressure, place a master part or plug onto the test port. Enter the test pressure with tolerances on the pressure screen. Navigate to the run mode and run the test. The electronic regulator will automatically output to the specified pressure.

Additional controls for the electronic regulator are available. The default values have been designed to meet the greater majority of applications and should be tried first before making changes.

Kp and Ki are variables in a feedback algorithm similar to a PID loop. Kp is the drive and Ki is the correction factor. These two settings allow for shaping of the fill curve. The default values have been designed to meet the greater majority of applications.

The % feedback value declares the percentage of time that the feedback algorithm is allowed to make adjustments. This amount of time is taken on the remaining timer. (for example, a setting of 20% would start fine tuning during the last 20% of the fill time.) Setting the value to high will cause the regulator to oscillate.

Parameters to USB

The test parameters can be either saved to or loaded from an external USB plugged into the USB port on the front of the tester. The USB memory or drive should be recognized upon installation. The ‘no symbol’ on the top of the screen will disappear from the USB symbol.

4.2 Fixture.

The fixture menu controls the fixturing (clamp) valves. The output is supplied as a four-way valve, (one normally open and one normally closed port.) The output can be used as a three-way valve by plugging the normally open port. This port will be plugged from the factory.

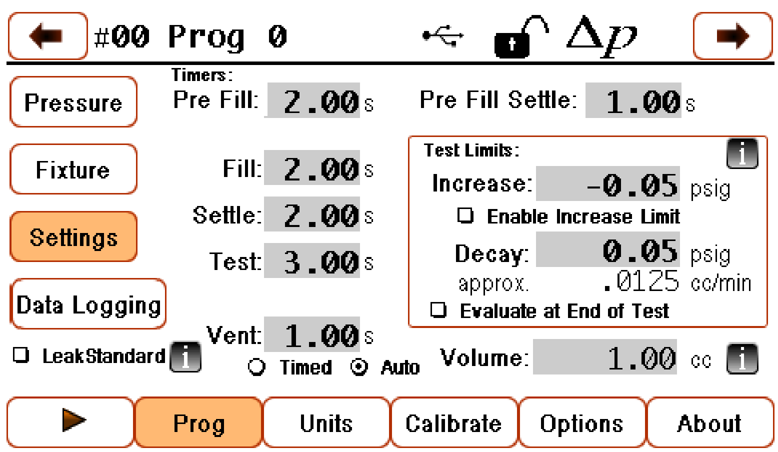
LEGEND	
±	Positive/Negative
	USB not plugged in
	Tester unlocked
ΔP	Test type: Pressure Decay
	Next Program
	Previous Program

1. **Pre-Test Op 1** — This is the delay to be set from the activation of the output to the start of the test cycle.
2. **Post-Test Op 1** — This is the delay to be set after the output deenergizes until the test status (Pass/Fail) is reported. A value of 0.0sec will de-energize the output and immediately report test status.
3. **Hold Clamps on Fail —** Keeps the clamp in their test position if the test fails. The onscreen fail indicator will flash to alert the user of failure. Pressing the flashing indicator will reset the condition and continue the Post-Test Op timer. This can also be reset by the I/O 'Abort' input.
4. **Output Results** — This is a duplicate selection point for declaring the data collection port. Output the results via USB or Ethernet. Either or both can be selected.

4.3 Settings.

LEGEND

- ± Positive/Negative
- USB not plugged in
- Tester unlocked
- ΔP Test type: Pressure Decay
- More Info
- Next Program
- Previous Program



1. **Pre-Fill —** Allows the test device to be filled at a higher pressure for increased air volume. (only needed for volumes greater than 500cc (30in^3))
2. **Fill** — The fill valves open during this timer to allow the electronic regulator to fill the test item to the specified pressure.
3. **Settle —** Fill valves close at the beginning of the step. This timer controls the amount of time to allow the test air and part to settle.
4. **Test** — The amount of time to measure the change in pressure.
5. **Data Logging** — Shortcut to the Data Logging menu

6. **Vent** — A safety mechanism to allow test pressure to be evacuated form the test part before the user removes the part from the tester. The 'timed' option runs the vent valve for the entire timer. The 'auto' option runs the vent valve until pressure reaches a pre-determined pressure (1.0psi) regardless of time remaining.

7. **Pre Fill Settle** — A settling time during fill before pressure tolerance limits are measured (typically set to half of the total fill time).
8. **Test Limits —** Limits set to the amount of pressure change before the timer expires.

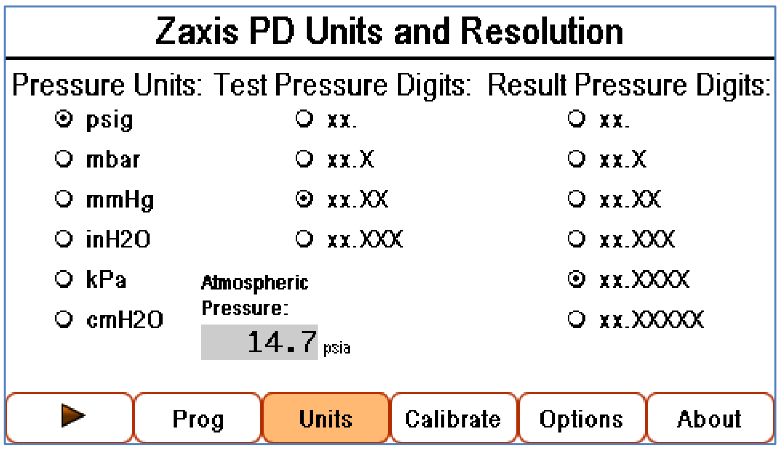
a. Increase: pressure increase during test timer to trigger failure (only used when Enabled

Increase Limit checkbox is checked – default is unchecked).

b. Decay: pressure decrease during test timer to trigger failure.

9. Volume — Combined product and tester air volume used to calculate approximate leak rate.

4.4 Units.



Engineering units and the resolution of the pressure readings can be selected from a list.

1. **Pressure Units** —

   There are six selectable engineering units:

   a. psig — pounds per square inch gauge
   b. mbar — millibars
   c. mmHg — millimeters of mercury
   d. inH2O — inches of water column
   e. kPa — kilopascals
   f. cmH20 — centimeters of water column

2. **Test Pressure Digits —** Use the radio buttons to select a resolution. (Default xx.XX)
3. **Result Pressure Digits —** Use the radio buttons to select a resolution. (Default xx.XXXX)
4. **Atmospheric Pressure** — Used in the Standard Cubic Centimeters per Minute (SCCM) leak rate calculation. (Default -sea level 14.70.

4.5 Calibrate.

Introduction to Calibration

Calibration is the process used to determine accuracy. It is the comparison of a measuring instrument against a standard to seek out possible errors in a specific range.

In 1901, the United States Government established the National Institute of Standards and Technology (NIST). This agency is tasked with maintaining standards for values of SI units and industrial standards.

All Zaxis calibrations are traceable to standards set by the NIST.

The Zaxis PD Pressure Leak Tester uses up to ten calibration points. All ten points are dynamic and can be adjusted to match the user's accuracy needs across the sensor range.

How does it work?

In the calibration mode, the pneumatic assembly will open to bring pressure or vacuum to the test port. The sensor will also be active to show the current reading.

With a pressure standard attached to the test port, the machine is taught the values from the standard. Calibration points have been selected across the range at the factory for greatest accuracy.

Two procedures will be outlined, Calibration Verification and Calibration Modification. All Zaxis models are initially calibrated at the Zaxis facility.

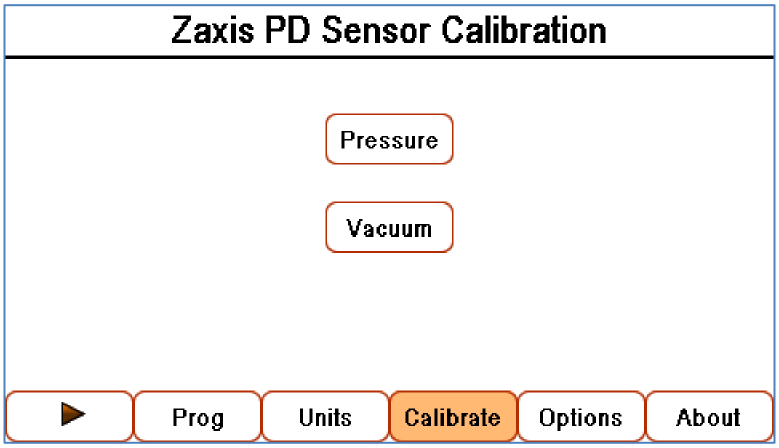
The verification procedure should be the most commonly used. If the calibration needs to be modified, use the modification procedure.

WARNING! Calibration should always be performed in units of psig.

Calibration of this instrument is for the sensor only (not a leak calibration) and is factory set. Leak standards can be obtained from Zaxis Inc. and can be used as a transfer standard to establish applicable leak rates.

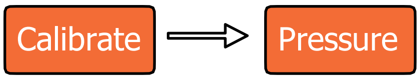
All standards should have at least three tiers of uncertainty. i.e. Zaxis has a tolerance of 0.3% FS (full scale) therefore pressure standards should be at least equal to or less than 0.1% FS.

Calibration Verification



1. Select the 'Calibrate' menu button.
2. A warning box will appear. To continue into the calibration screens press "Calibrate" .
   » Pressing "Back" will take you to the about screen.
3. Two Sensor types are shown.
   a. Pressure
   b. Vacuum

! Even though both sensor types are shown each unit will have model specific sensors installed. For details, see the calibration report shipped with the tester.



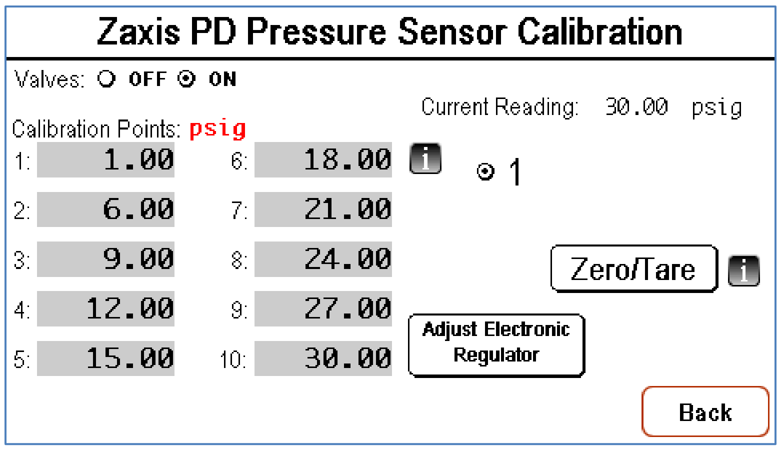


Fig. 11. PD Pressure Sensor Calibration Screen.

Enter the calibration screen and connect the test port to a pressure standard.

Valves

- » Press the Valves "ON" radio button.

Calibration Points

- » Adjust the regulator to the desired pressure reading on the pressure standard and compare the reading of the sensor (upper right corner).
- » Repeat for all required calibration points.

Zero/Tare

- » To set the 'zero' pressure set point, uncap the test port, disconnect air (if possible), Select Valves to 'Off', and touch the Zero/Tare button. The current reading should change to 0.00 psig

Adjusting pressure values is done through the firmware via buttons on the touch screen. The calibration procedure will follow as listed in this manual; the only difference is how the regulator is adjusted to achieve the set points.

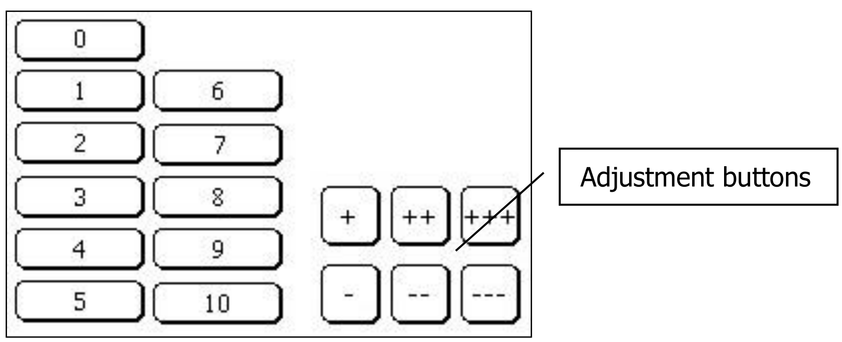
In the calibration screen and additional menu button is shown: 

This button will open the regulator control screen, inside of the calibration screen.

Six buttons will be used for increasing or decreasing the output pressure of the regulator.

+ Small Increase, ++Medium Increase, +++ Large Increase

- Small Decrease, -- Medium Decrease, ---Large Decrease



The buttons on the left side 0 through 10 (0 through 4 for vacuum) are the previous settings of the regulator for each numbered calibration point; these buttons can be used to 'jump' to the previously set pressure before beginning the fine tuning process.

A live pressure reading is shown in the upper right corner.

Once the desired pressure is maintained pressing the 'Back' button will return to the calibration screen where Cal Points can be set.

Calibration Modification

WARNING! If a calibration point data filed is pressed unintendedly, the only way to keep from changing calibration is to immediately shut-off power to the unit.

To change or fine tune a set point, do the following:

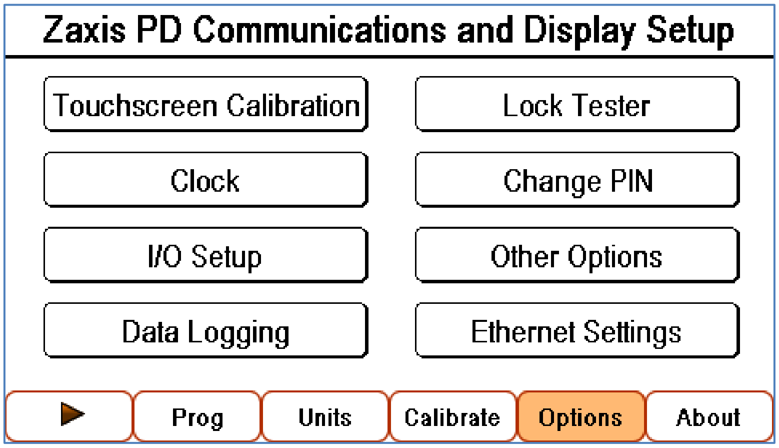
1. Adjust the regulator to the desired calibration point on the pressure standard
2. Press the value field of the calibration point to be modified.
3. A numeric keypad will appear, enter the value to be set, and select enter.
4. The current reading of the sensor will adjust to the corrections and display the new value.
5. Exit and save the calibration by pressing the “Back” button.

Calibration points should be incremental; point 1 being the lowest value. Values do not need to be whole numbers.

Zaxis PD
Pressure Decay Leak Tester

5 Options.

Fig. 12. PD Communications and Display Setup Screen.



Use these menus to control external functions to the test, data collection, and the I/O interface.

There are eight menu options:

1. Touchscreen Calibration
2. Clock
3. I/O Setup
4. Data Logging
5. Lock Tester
6. Change PIN
7. Other Options
8. Ethernet Settings

5.1 Touchscreen Calibration.

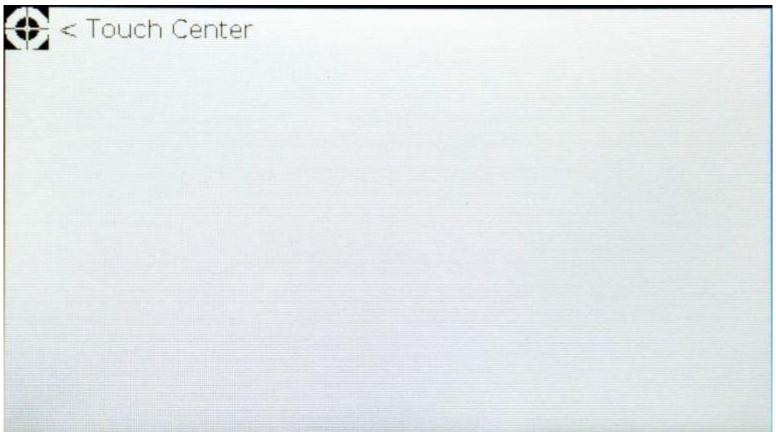


Fig. 13. Touchscreen Calibration Screen.

The touchscreen has been factory set. Typical use of the Zaxis PD will not require this function to be used.

On the calibration screen, the user is asked to touch specific targets with their stylus to adjust the touch pad to the display.

Settings will automatically save.

5.2 Clock.

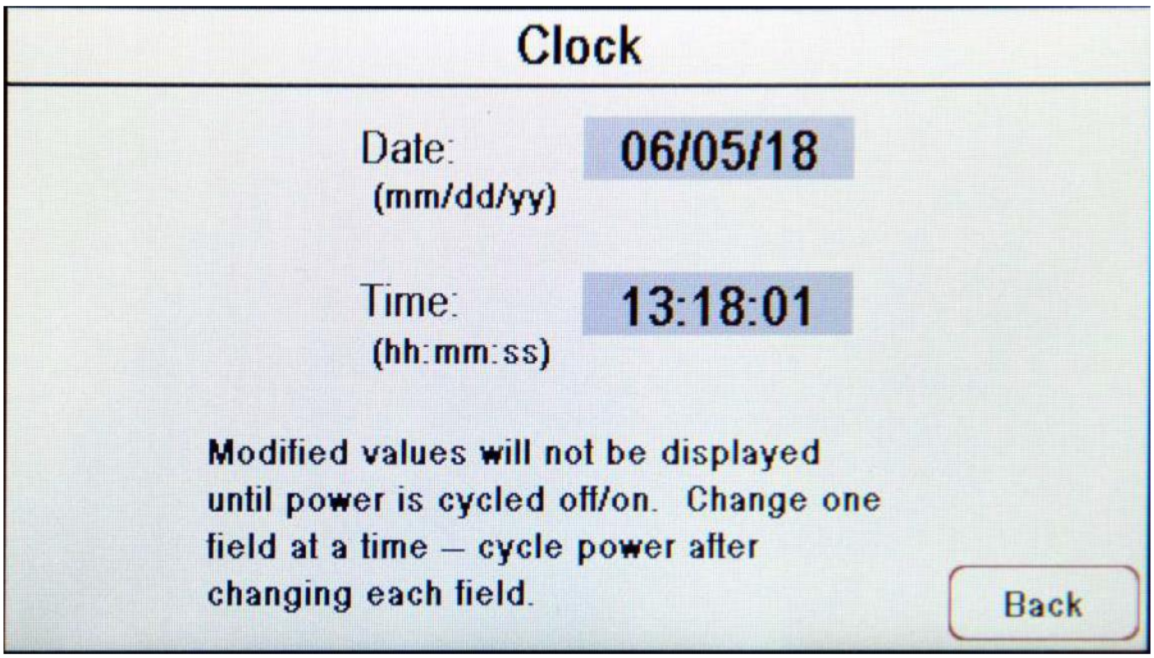


Fig. 14. Clock Settings Screen.

To modify either the time or date, touch the field to be changed with you finger or stylus. A numeric keypad screen will open.

Changes will not appear until the unit's power has been cycle on/off.

Change one field at a time and cycle power after changing each field.

5.3 I/O Setup.

Binary Programmable Selection Bits

Each stored program can be called by a digital bit pattern. Radio buttons select the number of programs to be used by the I/O. With a selection made, this will override the ability to make a selection on the run screen and will always return to the program selected by the active inputs. For example; if a selector switch is wired for three tests (BCD 1, 2). If there are no active bits the test displayed will be program 0.

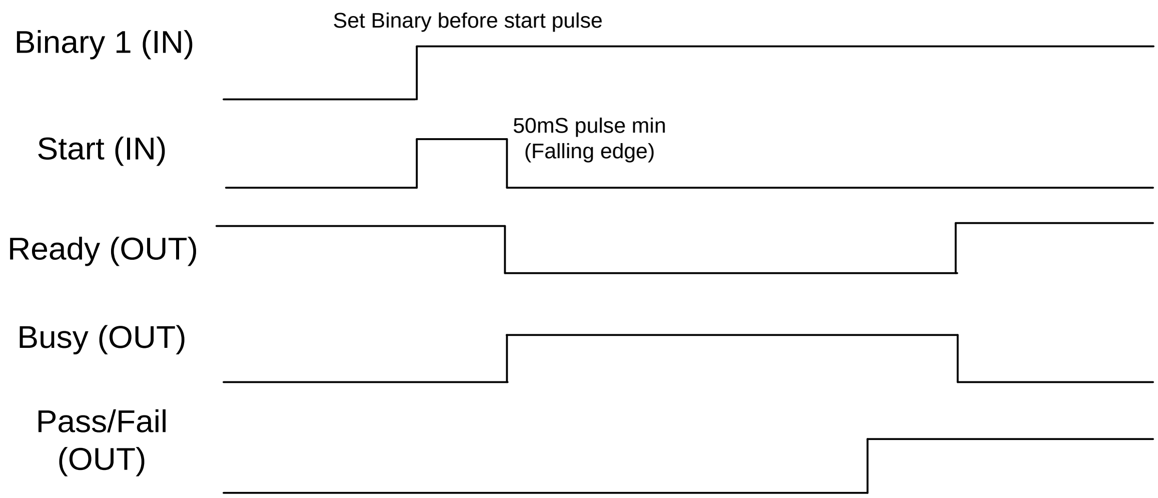
Program Start Mode

There are three options to start.

Start on Input 1: Activating input 1 on the I/O connection will start the cycle. The input starts the test on the trailing edge of the signal. This selection is the default, and also allows the start button to run initiate the test. (Input 1)

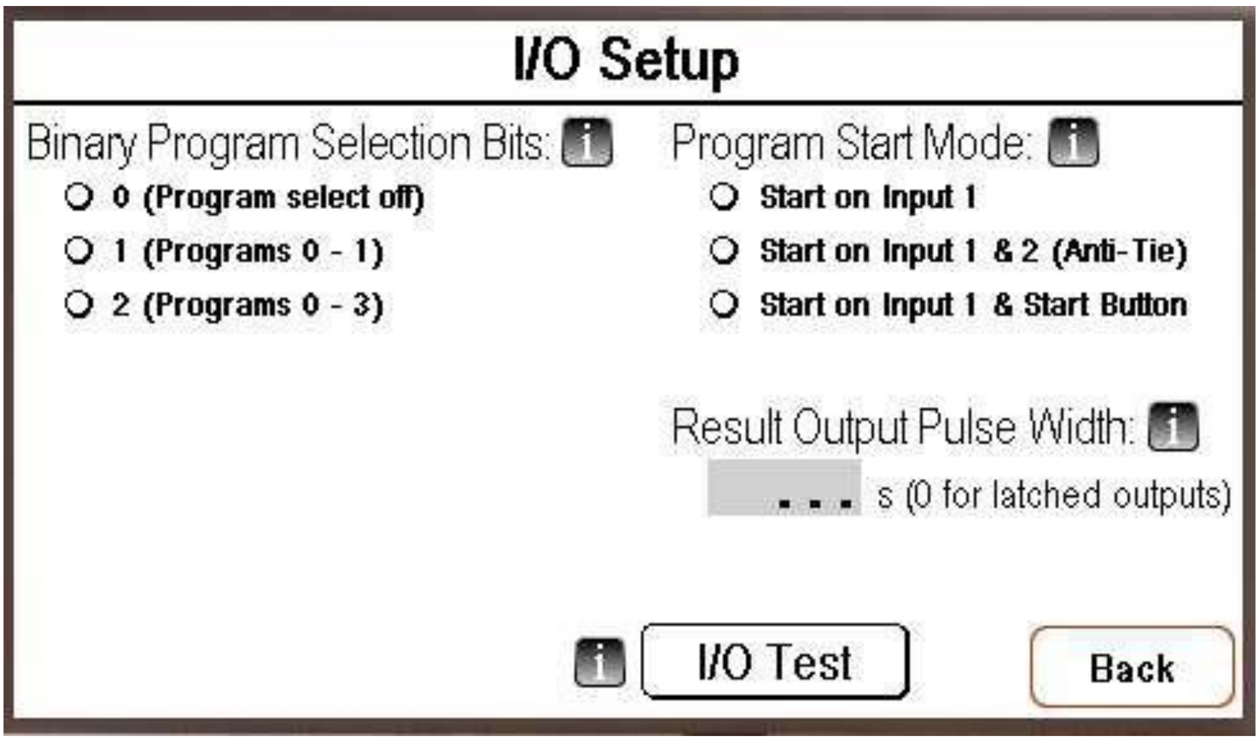
Start on Input 1&2 (Anti-tie): This option is used when an operator needs to be clear of movement in the fixture. Two separate switches must be contacted within 300msec of each other, one switch cannot be held closed while the other is triggered. (Inputs 1 and 2) Both inputs must be held for the entire Pre-Test Op timer.

Start on Input 2 (Anti-tie) & Start Button: This option has a condition to be met before the test can proceed. Input 1 on the I/O connector must be held active before the START button is pressed. Typical application: door interlock option. If the input 1 is released before the test ends, the test will abort.



Pin number	Label	Wire Color Zaxis Cable #100267 (5meter)
1	+24VDC Supply	Brown
2	Start	Blue
3	Anti-Tie	White
4	Binary 1	Green
5	Binary 2	Pink
6	Abort	Yellow
7	Not Used	Black
8	Pass	Grey
9	Fail	Red
10	Ready	Purple
11	Busy	Grey/Pink
12	Supply Common	Red/Blue

5.4 USB Quick Start



I/O Test
This screen allows the user to test the input bit pattern to help de bug wiring from the remote control (PLC etc). The value from the input register will display when the input is held active. (See I/O pin out chart for Input Test Values).

Result Output Pulse Width
The pulse width of the pass/fail outputs can be specified.

The Top of your screen will display whether or not a USB Thumb Drive is inserted and recognized. Figure 1.1 Shows a that either a USB Thumb Drive is inserted and recognized. Figure 1.2 shows that a USB Thumb Drive is not inserted or isn’t being recognized.

Figure 1.1 USB is NOT recognized

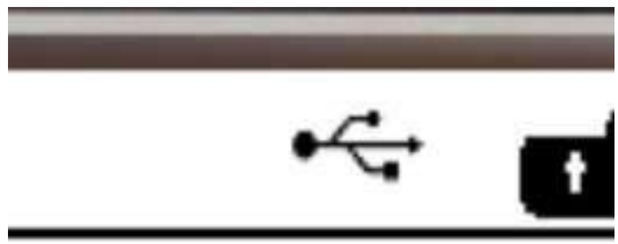


Figure 1.2 USB is recognized

In the case that a thumb drive is inserted but isn’t recognized ‘Mount’ the drive by going to Setting -> Data Logging and Press the ‘Mount’ button.

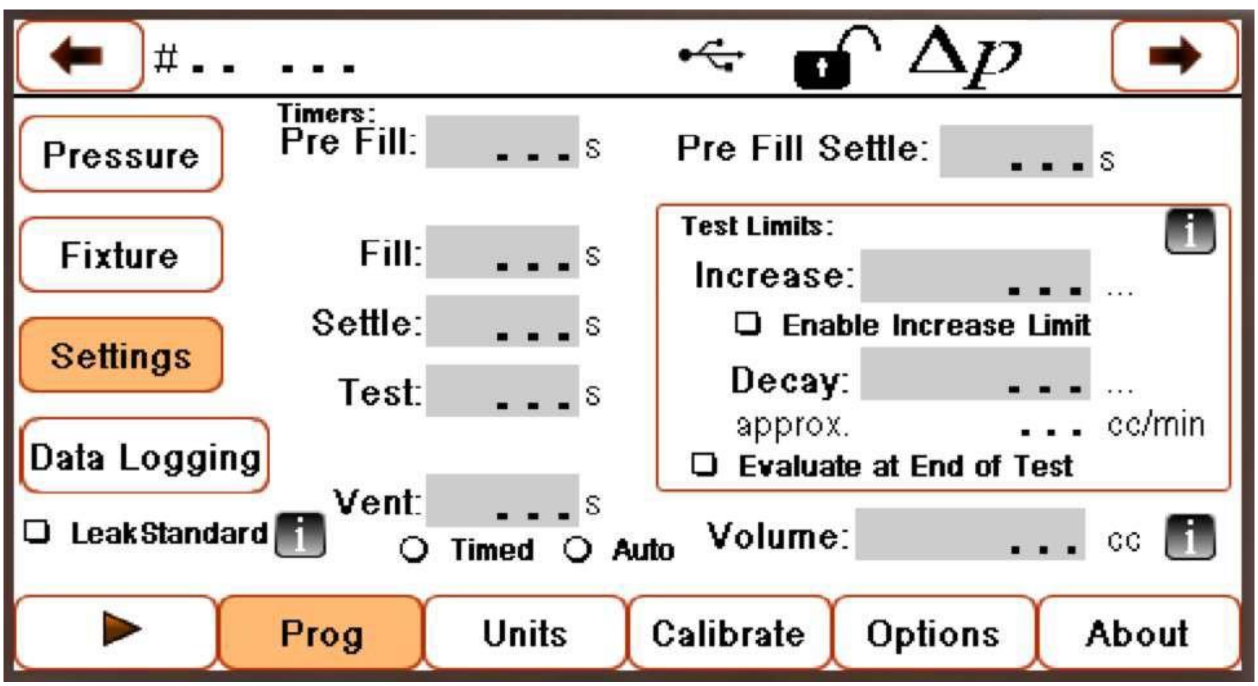


Figure 1.3

- If the USB drive does not mount, make sure you are using a High-Quality thumb drive and that the File System is formatted in Fat 32. NTFS Formats will not work

5.4 USB Quick Start

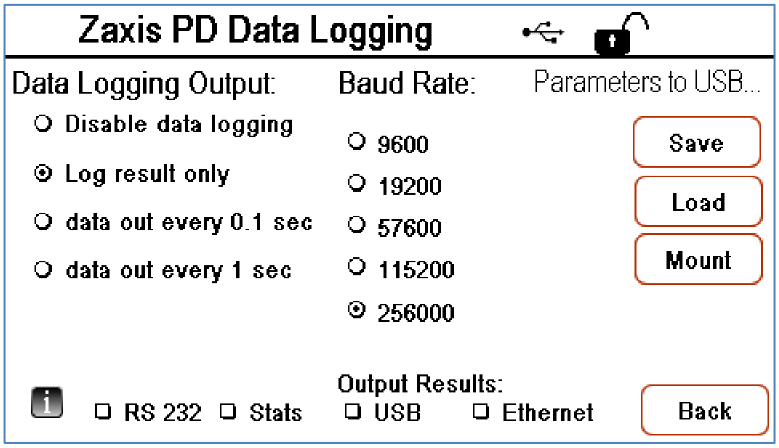


Fig. 1.4 Data Logging Screen

Now that the USB Thumb Drive is mounted there are three different things that can be saved to the Thumb Drive.

In Figure 1.4 to save all the test parameters to the Thumb Drive by pressing 'Save' under the "Parameters to USB" Label. To restore saved parameters or copy to a separate machine pressing the 'Load' button.

In Figure 1.4 under "Output Results" by clicking 'USB' to save your "Data Logging Output" to the USB Thumb Drive. If "Disable data logging" is selected under "Data Logging Output" no data will be saved to the USB Thumb Drive.

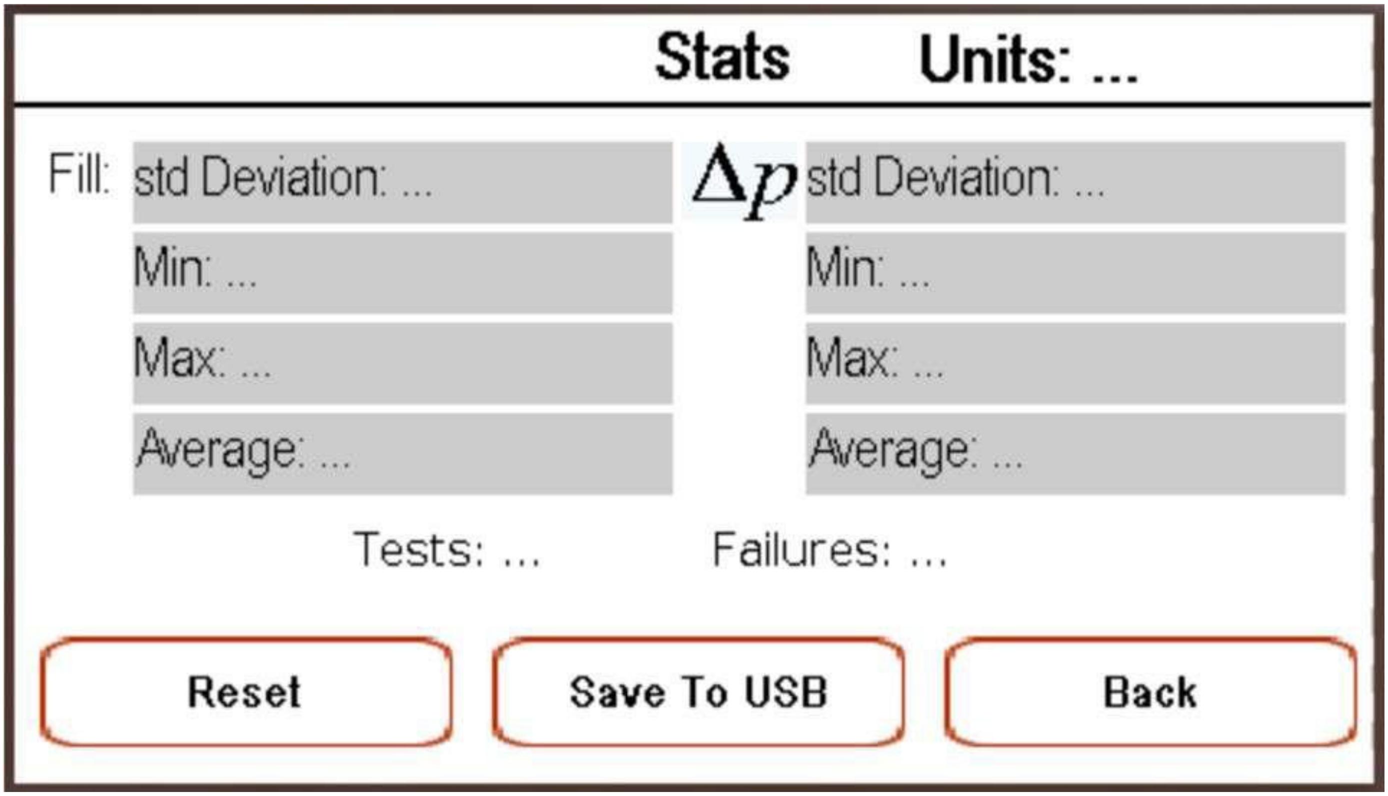


Fig. 1.6 Save To USB Screen

To view statistical data from your tests by go to Pressure->Stats.

In Figure 1.6 you have the option to save the last 30 tests to a USB Thumb Drive by pressing "Save To USB". If a USB Thumb Drive is inserted while running tests the statistical data will be save to the Thumb Drive every 30 tests automatically.

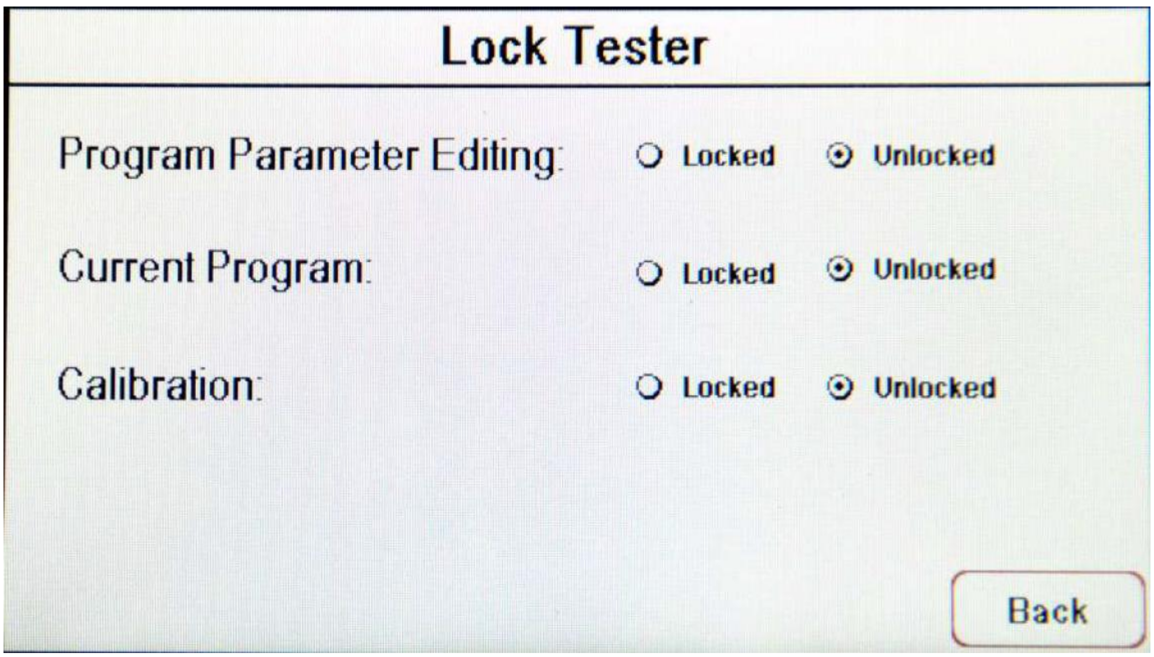


Fig. 15. Lock Tester Screen.

There are three lockable sections of the Zaxis PD.

Select the section to lock by touching its radio button. A PIN number must be set for the lock to be active.

5.6 Change PIN.

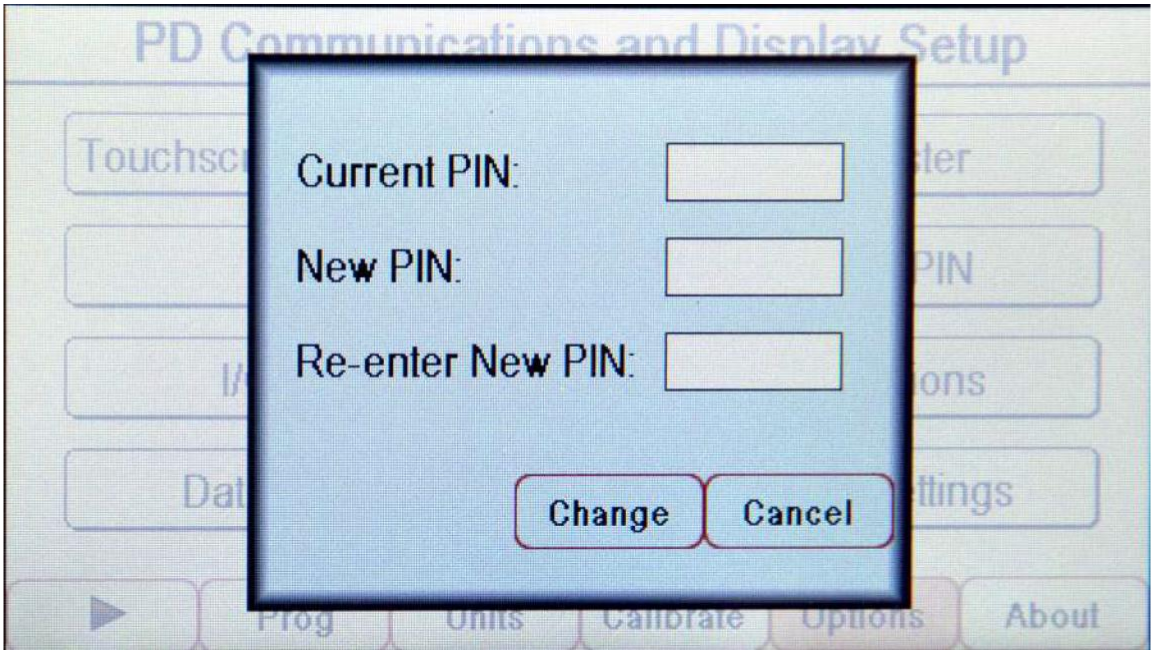


Fig. 16. Change PIN Screen.

To lock the tester, a Personal Identification Number (PIN – 4 digits) must be established. The current PIN from the factory is blank.

! **The Current PIN from the factory is blank.**

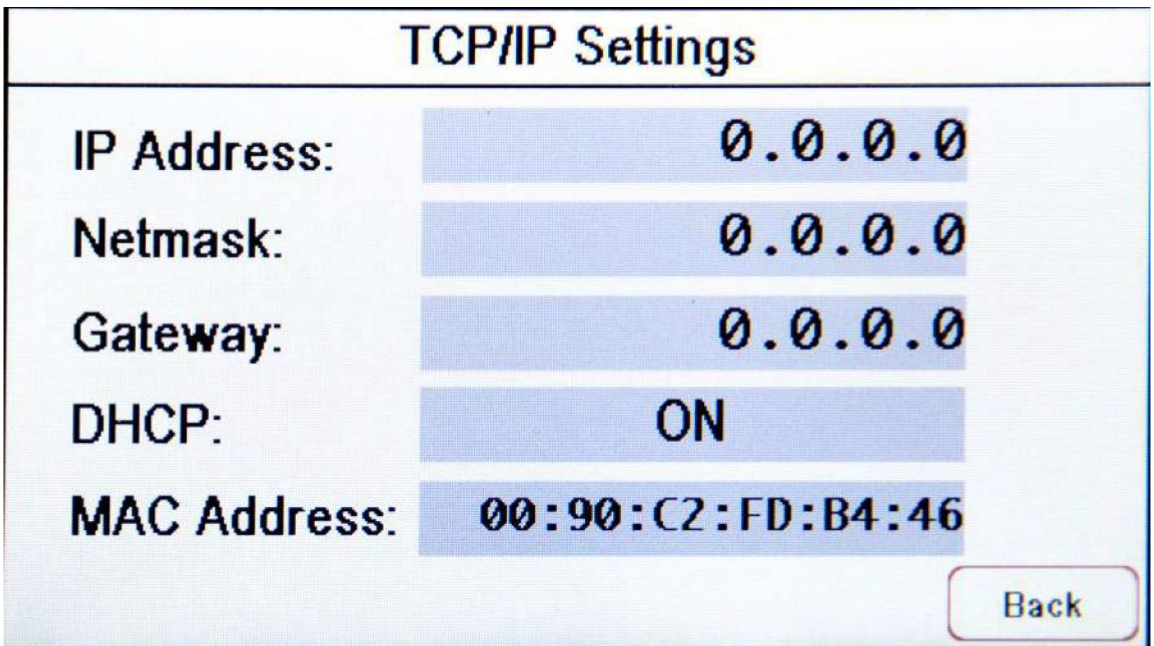


Fig. 17. TCP/IP Settings Screen.

ASCII Data Over the Ethernet

Test data can be collected via the Ethernet connection on the rear panel of the Zaxis PD.

To collect data on a laptop, connect the crossover Ethernet cable to a terminal emulation program, such as HyperTerminal.

5.7 Ethernet Settings.

If your primary network connection is done wirelessly, you will need to connect the cable from the Zaxis to your laptop and cycle the power (turn off/turn on) on the Zaxis.

Verify that the Ethernet from the socket is active by looking for a green light inside the machine, towards the bottom of the Ethernet jack.

Ethernet Settings

The following directions are for Windows based operating systems:

1. On your computer: find the IP address of the computer by running the command prompt found in START → Accessories. Or type command in the start menu's search bar.
2. On the command line: type ipconfig, this will display all the data associated with the Ethernet connections.
3. Scroll down to the section Ethernet adapter Local Area Connection and record the value of the IPv4-Address.
4. On the Zaxis PD: under OPTIONS → ETHERNET SETTINGS, turn the DHCP selection to OFF.
5. The IP address of the Zaxis should be set to one address higher than the IP address of the laptop.
   » Example: If the laptop is: 169.254.96.1, set the Zaxis to 169.254.96.2.
6. Verify that the correct sections have been made in the Data Logging menu for the type of data you wish to collect (Results, 0.1sec, etc.).
7. Verify that Output Results in the PROG menu have the Ethernet box selected for every test you wish to collect.

6 Reference.

6.1 Test Tooling and Fixtures.

To achieve accurate and repeatable results, tested units must be presented to the tester in the same fashion every time. The tooling must also be robust enough to withstand daily repeated use.

The following are some key points to keep in mind in your tooling and fixture designs:

- **Operator Safety**
  - Zero-access, No pinch points
  - Ergonomically designed
  - Simple load/unload
- **Material Selection**
  - Stainless Steel
  - Anodized Aluminum
  - Delrin, etc.
- **Sealing Forces —** Exerted forces should not mask possible leaks.
- **Single or Multi-purpose —** Should the tool be dedicated to a single task or fit multiple models?
- **Size —** How much production space do you have?
- **Component Selection —** Custom designed pieces or off-the-shelf technology?

Zaxis can deliver a complete turn-key system designed to your specifications.

6.2 Engineering Data.

Converting Pressure to Flow Rate

You can determine the leak rate in flow units (cubic centimeters per minute) based on the pressures measured by the Zaxis. In a pressure decay test, the Zaxis holds the pressure drop on the main screen. The pressure drop is the delta pressure (ΔP) in the formula.

Delta time (Δt) is the test timer value set in the Zaxis's pressure decay program (provided the test passes). With this timer being set in seconds, simply divide by 60 to get the delta time in minutes.

Volume is the part volume plus the Zaxis's internal test circuit (approx. 1cc) plus the volume of connections between the Zaxis's test port and the product. The total volume (for our example) must be in cubic centimeters.

Atmosphere is the absolute barometric pressure in mbar (approx. 1000 mbar at sea level). This number changes with weather conditions.

$$\textbf{Leak Rate}\ (\text{cc/m}) = \frac{\Delta \textbf{P}\ (\text{psi}) \bullet \textbf{Volume}\ (\text{cc})}{\Delta \textbf{t}\ (\text{minutes}) \bullet \textbf{Atm}\ (\text{psi})}$$

Δ**P** = Decay in pressure, value shown at end of test.
Δ**t** = Test step time in minutes (test time reads in seconds divide by 60).
Volume = Volume of product and leak tester and any fixture volume.
Atm = Atmosphere pressure (psia) eg sea level = 14.7 at 68˚F. Adjust at elevation is required.

6.3 Physical Laws.

Presented here is an abbreviated history and overview of the fundamental laws of physics dealing with pressure and flow measurement.

Pressure — In physics, pressure is a force measured in terms of its distribution over a given area. This is expressed as force (F) divided by a unit area (A) of the surface area to which the force is applied. Air pressure most commonly refers to a force exerted uniformly in all directions. Force x Area = Pressure.

Absolute Pressure — Pressure measured with respect to zero pressure (a very high vacuum).

Gauge Pressure — Pressure measured with respect to surrounding air pressure (the pressure exerted by the weight of the atmosphere).

Barometric Pressure — the surrounding pressure caused by the atmosphere. At average sea level, barometric pressure is approximately 14.7 pounds per square inch, or 29.9 inches of mercury. This is equivalent to 101.3 Kilopascals.

Negative Pressure (Vacuum) — Vacuum is defined as a volume void of matter. For practical purposes, this means a volume where as much matter as possible has been removed. A perfect vacuum does not exist even in the depths of space, where any given volume will probably contain one or more particles of matter or one or more units of energy, which is the equivalent of matter (Relativity). Even a vacuum with no measurable energy level is only a “virtual” vacuum.

Air Composition — Our atmosphere is composed almost entirely of oxygen and nitrogen in their diatomic forms (two atoms bound together by chemical forces). Diatomic nitrogen makes up approximately 78% of the total molecules in the atmosphere. Diatomic oxygen represents nearly 21%. The inert noble gas, argon, accounts for about 0.9%, and the remaining 0.1% is composed of many trace gases, the most significant being carbon dioxide and water vapor. Water vapor is present in highly variable quantities ranging from 0 to 4% by volume.

Air Density — If the atmosphere was like water and incompressible, pressure would decrease uniformly as you went up. In reality, the atmosphere is compressible and density (mass per unit volume) is proportional to pressure. This relationship, call Boyle's Law, implies that density decreases with height in atmosphere. As height increases, less mass remains above a given point; therefore, less pressure is exerted. At sea level, the density of air is about 1 kg per cubic meter (8 oz. per cubic foot). Both pressure and density decrease by about a factor of 10 for every 16 km (10 miles) increase in altitude.

Density does not depend solely on pressure. For a given pressure, density is inversely proportional to temperature. This relationship, known as Charles's Law, implies that the depth of an air column bounded by two constant-pressure surfaces will increase as the temperature in the column increases.

Density varies mostly with pressure over large vertical distances; at constant height, pressure variation with temperature becomes important. In the low atmosphere, air is heavy, with a stable mass of roughly one kilogram per cubic meter (1 oz/cubic foot). A room of 500 cubic meters (650 cubic yards) thus contains 0.05 metric ton of air. At an altitude of 3 km (2 miles); however, density is 30% less than at sea level.

This difference in air density can cause variations in flow readings from one location to another when elevations differ and no corrections are made.

Fluids vs. Solids — The distinguishing feature of a fluid (gas or liquid), in contrast to a solid, is how easily the fluid can be deformed. If a shearing force — even a very small force — is applied to a fluid, the fluid will move and continue to move as long as the shear acts on it. For example, the force of gravity causes water poured from a cup to flow. Water continues to flow as long as the cup is tilted. If the cup is turned back up, the flow stops. The wall of the cup has balanced the forces.

Gas vs. Liquid — Unlike liquids, gases cannot be poured as easily from one open container into another, but they deform under shear stress just the same. Because shear stresses result from relative motion, stresses are equivalent whether the fluid flows past a stationary object or the object moves through the fluid.

Although a fluid can deform easily under an applied force, the fluid's viscosity creates resistance to this force. The viscosity of gases, which is much less than that of liquids, increases slightly as the temperature increases, whereas that of liquids decreases when the temperature increases. Fluid mechanics is mostly concerned with Newtonian fluids, or those in which stress, viscosity, and rate of strain are linearly related.

Pressure and Density — Pressure and density are considered mechanical properties of the fluid, although they are also thermodynamic properties related to the temperature and entropy of the fluid. For a small change in pressure, the density of a gas is essentially unaffected.

For this reason, gas and all liquids can be considered incompressible. However, if density changes are significant in flow problems, then the flow must be considered compressible. Compressibility effects result when the speed of the flow approaches the speed of sound.

Fluid Flow — Real Fluids Equations concerning the flow of real fluids are complex. In turbulent flow, the equations are not completely known. Laminar flow is described by the Navier-Stokes equations, for which answers can be derived only in simple cases. Only by using large computers can answers be derived in more complex flow situations. Experimentation is still important for fully correlating theory with actual flow.

Laminar vs. Turbulent Flow — When flow velocity increases, the flow becomes unstable, and changes from laminar to turbulent flow. In turbulent flow, gas particles start moving in highly irregular and difficult-to-predict paths. Eddies form transfers momentum over distances varying from a few millimeters (as in controlled laboratory experiments) to several meters (as in a large room or other structure). Equations for turbulent flow are more complex than the formulas for laminar flow. For most answers, they require empirical relations derived from controlled experiments.

Whether a flow is laminar or turbulent generally can be determined by calculating the Reynolds number (Re) of the flow. The Reynolds number is the product of the density (designated by the Greek lower-case letter rho {ρ}), a characteristic length L, and a characteristic velocity v, all divided by the coefficient of viscosity (designated by the Greek lower-case letter mu {μ}):

$$Re = (\rho)\, Lv/\mu$$

Reynolds Number (Re) — The Reynolds number has no unit of measure; it is a pure number. As long as Reynolds number is small, the flow remains laminar. When the Reynolds number becomes greater than a critical value, the flow becomes turbulent.

With rho {ρ}, L, and mu {μ} constant, Re varies simply as velocity changes. For flow in smooth round pipes, critical value is about 2,000, with L equal to the diameter of the pipe.

Pascal's Law — In 1653, Blaise Pascal came up with the idea that in a fluid at rest, the pressure on any surface exerts a force perpendicular to the surface and independent of the direction or orientation of the surface. Any added pressure applied to the fluid is transmitted equally to every point in the fluid. Pascal used his idea to invent the hydraulic press. Pascal's principle is often used in devices that multiply an applied force and transmit it to a point of application.

Examples include: the hydraulic jack, and the pneumatic cylinder.

Gas Law — The actions of gases under varying conditions of temperature, pressure, and volume can be described and predicted by a set of equations or gas laws. These laws were determined by measurements of actual gases and are valid for all substances in the gaseous state.

Measurements on gases were first published by Robert Boyle in 1660. He figured out that if an enclosed amount of gas is compressed until it is half its original volume, while the temperature is kept constant, the pressure doubles. Quantitatively, Boyle's Law is:

$PV = \text{Constant}$

Where the value of the constant depends on the temperature and the amount of gas present.

Jacques Charles studied relationships between the temperature and volume of gases, while maintaining a constant pressure. He saw a steady increase in volume as temperature increased, finding that for every degree Celsius rise in temperature, the gas volume increased by 1/273 of its volume at zero degrees C.

Charles's Law and Kelvin Temperature — Charles's observations led to the absolute (Kelvin) temperature scale. Since the gas, according to the equation, would have zero volume at –273 degrees C. Kelvin defined the absolute temperature scale so that absolute zero equals negative 273 degrees C and each absolute degree is the same size as a Celsius degree.

The modern value for absolute zero is –273.15 degrees C. This temperature scale allows Charles's Law to be written $V/T = \text{Constant}$, where V is the volume of the gas, T is the temperature on the absolute scale, and the constant depends on the pressure and the amount of gas present.

In 1802, Joseph Guy-Lussac experimented with the relationships between pressure and temperature and came up with an equation a lot like Charles's Law:

P/T = Constant.

Generalized Gas Law — We can combine Boyle's, Charles's and Gay-Lussac's laws to express this generalized gas law:

PV/T = Constant

Where the value of the constant depends on the amount of gas present and T is the absolute (or Kelvin) temperature.

Ideal Gas Law — The Generalized Gas Law can be written in a slightly different manner:

PV = nRT

When written this way, it is called the Ideal-Gas Law. R is the gas constant and n is the number of moles of gas. The gas constant can be examined experimentally as R = 0.082 liter atm/Kelvin moles. Knowing R, the fourth variable can be evaluated if any three are known.

The gas laws are valid for most gases at moderate temperatures and pressures. At low temperatures and high pressures, gases deviate from the above laws because the molecules are moving slowly at low temperatures and they are closer together on the average at higher pressures.

Ideal vs. Real Gas — Gases are typified as ideal or real. The ideal gas follows certain gas laws exactly; whereas, a real gas closely follows these laws only at low density. Ideal behavior can be ascribed to a real gas, if its molecules are separated by very large distances; so that intermolecular attraction is negligible.

6.4 Glossary.

A List of useful terms and where to find additional information.

A

Abort a test, how to — Press the start button during the test. ABORT pops up in the status box telling you the process has stopped. An aborted test does not register on the tested or reject counters.

Atmosphere (1) — in this guide, atmosphere means room air pressure. Atmospheric pressure is nearly synonymous with barometric pressure—an external force pushing on all sides of every object on earth's surface. During a flow test, product being tested must flow into atmosphere, which causes a resistance to flow called back-pressure. Room atmosphere can change due to fluctuations in air conditioning or changing weather conditions. **(2)** The word atmosphere can refer to a unit of measure equal to pressure at average sea level. By convention, one atmosphere equals 1 bar. To say a test was taken at one atmosphere means the test was made at (or converted to) average sea level.

B

Barometric Pressure — Also called atmospheric pressure. The force caused by the mass of air pressing down on the earth. Barometric pressure changes with elevation and weather conditions. The Zaxis's regulator compensates for changes in barometric pressure to provide a constant relative output.

C

Calibration — Comparison of a device (such as the Zaxis) to a standard that is in turn calibrated to an even more accurate standard.

Calibration Data — Values entered into Zaxis through software calibration. Calibration data is stored as a look-up table in the Zaxis's non-volatile RAM and is used to linearize pressure and flow transducer output at known pressures and flow rates.

Calibration Screen — Calibration allows comparison of the Zaxis to pressure and flow standards. The calibration screen shows the Zaxis's actual reading and the pre-programmed target value the technician compares to the pressure of flow standard. Only qualified technicians who have proper training and resources should calibrate the Zaxis.

Counters — The Zaxis records the total number of tests performed (both pass and fail) and the number of rejects (fail only). Running totals are displayed in the Test Cycles and Failures fields on the Main screen.

Counters, (Reset) — By selecting the "Cycles" or "Failures" numeric fields, the "Reset Counters" dialogue box will appear, press the clear button then press "OK".

Coupling Port — The coupling port supplies air pressure to product sealing fixtures or other external pneumatic components. Generally, the port labeled "2" on front of Zaxis is used for coupling air output.

Coupling Pressure — The air pressure supplied to external fixtures. Coupling pressure must be the same as line or test pressure specified by the customer at order unless additional pneumatic components are added.

Coupling Time — A delay timer used to apply a clamp or seal to product under test before the product is filled with air. Coupling time gives fixtures enough time to seal product before Zaxis applies test pressure.

D

Decay — The amount of pressure a product can lose during a test period before going out of an established tolerance. Also called pressure drop.

E

Event — The pressure change that signals the change in the device under tests condition. This trigger is used to end the test and compare the pressure reading to the limit settings for pass/fail status.

F

Fail Light — The Zaxis's red indicator with an X-mark. The fail light turns on whenever a test exceeds established parameters.

Firmware — The set of instructions stored in programmable read-only memory (Flash) that controls Zaxis's operation. Firmware cannot be altered by the customer.

Firmware Version (How to find) — The version of firmware running Zaxis is displayed on the 'About' screen.

Fixturing — A fixture is a device connected externally to the Zaxis. Fixtures can be mechanical, electrical, pneumatic, or combinations of all. Typical fixtures are pneumatic clamps that seal products during a pressure decay or flow test. The Zaxis can supply air from the coupling port to operate pneumatic fixtures. Customers must specify at the time of order whether they want coupling pressure to be line or test pressure. Many fixturing options are possible.

Flow Standard — (1) A measuring instrument or certified restrictor that can be connected to the Zaxis as part of a flow calibration. The flow standard must have adequate accuracy, stability, and repeatability needed to calibrate the Zaxis. The flow standard must have current calibration documentation if the customer requires accuracy traceability. **(2)** A calibrated device to challenge the tester on an as needed basis. This device is calibrated and traceable. For example, a daily verification can be done to ensure the tester will still find the required flow value.

Foot Switch — An optional switch that connects to the back of the Zaxis that the operator can use to start a test cycle. This switch has the same function as the START button on the front of the Zaxis.

G

Gage Pressure — A force referenced to barometric pressure. The Zaxis uses a gage regulator to keep the pressure constant as barometric pressure changes.

Gross Leak — A leak that causes a drop below the test pressure minus the pressure tolerance in the settle step.

I

Interface — Communication between the Zaxis and a peripheral device such as a computer or printer. The Zaxis PD has three interfaces: an Ethernet port, discrete I/O points, and a footswitch connector.

I/O (Input/Output) — Connections the Zaxis uses to communicate with computers or Programmable Logic Controllers (PLCs). The Zaxis I/O includes inputs to change and start programs and output pass/fail status.

L

Leak Rate — A pressure drop over time can be stated as a leak rate. For example: 0.1 mbar per second is a leak rate. A leak rate can also be stated in flow units such as 4 cc/minute.

Leak Test — See Pressure Decay Test, Flow Test.

Link Programs, how to — In the Program Screen select the Next Prog: field, press the Clear button, and enter the program number you want to link. Press Enter. If no link is desired, set this field to the same program number.

Linked Programs — Two or more programs can be linked (consecutively connected) to perform multiple actions during a single test cycle. For example: a flow program can be set to follow a pressure decay program. When the operator presses the START switch, Zaxis runs through a flow test then goes to a pressure test. If product goes out of parameter at any point in either test, the fail light turns on and the test ends.

Liquid Crystal Display (LCD) — The Zaxis's display is a LCD device that provides setup prompts, menu options, test results, and other system information.

M

Main Digital Screen — This readout shows the pressure and flow values during pressure decay flow and burst testing. The way the main digital screen functions, varies with each testing mode.

Measurement Units — See Units of Measure.

Menu — A menu is a list of setup or programming options. See also Setup Screen.

P

Pass Light — The Zaxis's green indicator with check mark. The pass light turns on after the tester completes a test that remains within established parameters.

Prefill — A higher pressure than test pressure programmed in the pre-pressure field. Pre-pressure settle time is time allowed to settle before continuing to fill timer.

Pressure — The relative force of a compressed air or gas. The Zaxis is generally configured to use psig, which is the force of compressed gas relative to barometric pressure. Alternatively, mbar (millibar of 1/1000 bar), mmHg (millimeters of mercury), inH2O (inches of water) or kPa (Kilo Pascal) may be selected.

Pressure Decay Test — Pressure decay testing is used to test products for leaks by trapping pressure inside and then measuring pressure loss. The abbreviation PD is often used in this guide to refer to pressure decay.

Pressure Regulator — The Zaxis uses a precision pressure regulator that controls line pressure. The pressure regulator is adjusted during setup to set test pressure.

Pressure Standard — A precision measuring instrument that can be connected to Zaxis as part of a pressure or flow calibration. The pressure standard must have the required accuracy, stability, and repeatability to measure Zaxis's output. The pressure standard must have current calibration documentation if the customer needs to prove accuracy traceability.

Pressure Tolerance — The plus or minus allowable change in the test pressure. If the pressure fails to achieve this amount during the Fill step, a "LO Pressure" error will report. If the pressure exceeds this mark during the Fill step, a "HI Pressure "error will report. If the test pressure falls below the mark during the Settle step, a "Gross Leak" error will report.

Pressure Transducer — An electro-mechanical device (also called a sensor) that converts pneumatic pressure into electrical signals. The Zaxis's pressure transducers are rugged, accurate, repeatable, and have a very low internal volume.

Programs — Data (such as test pressure, test time, and reject levels) entered by the user and stored in the Zaxis's battery-backed RAM. A program is setup in Zaxiss Program screen. The Zaxis has 100 test programs.

Program Screen — This screen is used to enter all setpoints and limits concerning the pressure decay test. The program screen has a header that tells you the program number for which you are currently setting parameters.

R

Reject Level — The amount of pressure drop allowed in a pressure decay test. This value is set in the program setup screen. The reject level, together with test time, determines the amount of acceptable leak rate.

S

Set point — A programmable threshold value (usually a minimum and maximum value) used to establish a testing tolerance.

Settle — A time interval following fill phase that allows product to stabilize before the Zaxis starts the measurement phase. Longer settle times are often required in products constructed of flexible materials.

Standard Cubic Centimeters per Minute (SCCM) — This is a flow measurement standardized to 68 degrees Fahrenheit and 14.7 psi (average sea level).

Stored Programs — A set of instructions (parameters) that can be set by the customer to run a variety of tests. Users can alter stored programs to meet specific product testing needs. Programs are configured in Zaxis Program screen and are kept in NVRAM (Non-volatile).

T

Target — A preprogrammed number that Zaxis stores in firmware used to calibrate the Zaxis's pressure and flow sensors. The target value is matched to a pressure or flows standard to create a lookup table for sensor linearity adjustment.

Test Circuit — The pneumatic tubing, fittings, valves, and sensors that make up Zaxis's internal air passages. The volume of gas trapped inside the pressure decay test circuit is about 1.0 cubic centimeter.

Test Cycle — A test cycle is all Zaxis-controlled testing activities that occur from the time the START switch is pressed to the time the operator removes the tested product. One test cycle can have multiple tests by linking programs in Zaxis's Program screen. Multiple tests in one test cycle are sometimes called a test series.

Test Phases — The three testing modes (decay, flow, and burst) each have individual phases or intervals of testing. Pressure decay has four possible time intervals that can be set: coupling, fill, settle, and test. A flow test has three phases: coupling, fill, and test. A burst test has just two possible phases: coupling and test.

Test Port — The bulkhead fitting (or fittings) on the Zaxis's front panel. The product to be tested is connected to the test port. From the test port, the Zaxis can supply positive pressure or vacuum for a variety of leak and flow test. Customized Zaxiss could have multiple test ports. See Bulkhead Fitting.

Test Pressure — Test pressure is the level of air pressure used to inflate product under test. Test pressure is set by adjusting the regulator on the rear panel of the Zaxis. Test pressure can only be set if the Zaxis has supply air connected to the back fitting and the output port is blocked with a leak-tight cap.

Timers — The Zaxis uses microprocessor timers to establish time intervals for a variety of test functions. Time values are set in the Zaxis's Program screen by the user to control coupling time, fill time, settle time, and test time. Timers are calibrated in seconds with a maximum setting of 999.9 seconds. See Program Screen.

U

Units of Measure — The Zaxis can display pressure, flow, and time in several user-selectable measurement units. Changing units of measure is made through the Setup screen.

V

Valves — The Zaxis contains modular solenoid valve blocks that direct the flow of air (or other gas) through measurement circuits. The number, type, and arrangement of valves in an Zaxis tester can be customized for special applications.

Vent (Also called **Dump** or **Exhaust**) — The final step in a test. The vent step is primarily used as a safety to vent any pressure away from the operator before removal of the test part. Disabling the Vent will not affect the test result. After the Zaxis completes a test, the vent valve is activated to open the product into the Zaxis's internal chamber. If a vent step is not required (for instance if you want to unplug product to vent pressure), set the Vent timer to 0.0 and uncheck the Auto box.

7 Maintenance/ Troubleshooting.

WARNING! Disconnect power before servicing the unit.

Special Precautions

If at any time the cover is removed from the tester for service, verify that the flex-ribbons connecting the display to the main Printed Circuit Board (PCB) and the main PCB to the I/O are seated and square to the connectors (See Fig. 16). Out of alignment flex ribbons will cause damage to the PCB.

7.1 Internal Leak Self Test.

At the factory a baseline leak test is performed to verify leak-tightness and functionality. This test is a good indicator of an internal leak. The parameters are listed below:

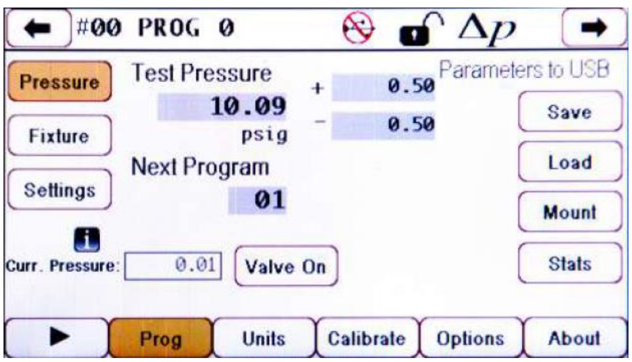


Fig. 19a. Pressure settings screen.

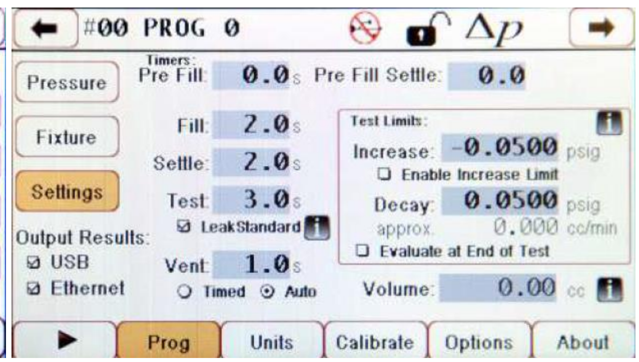


Fig. 19b. Settings screen.

Running a capped port test with these parameters should yield a decay value less than 0.005 psig (0.344 mbar).

Valve Manifold

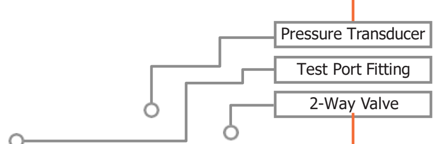


Fig. 20. Valve manifold.

The most common place for leaks to occur is at the junction of the test port fitting to the valve manifold.

Pnuematic Diagram

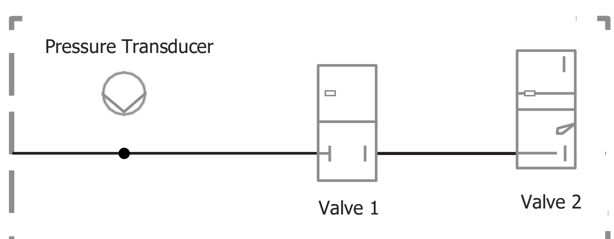


Fig. 21. Pnuematic Diagram

When the test pressure is vented, the airflow path is through Valve 1 (on) and out to atmosphere through Valve 2 (off).

Debris from test parts or dirty air can be trapped between the spider seal and valve seat of the 2-way valve, holding the valve in an open position.

7.2 Valve Cleaning.

Debris from test parts or dirty incoming air can be trapped in the 2-Way valve, holding the valve in an open position.

The valve is accessed by loosening the knurled ring in the center of the valve counterclockwise. Once separated the spider seal and spacer ring can be removed to inspect the valve seat and surrounding area for debris. The spider seal can also hold debris.

The valve is re-assembled by placing the spider seal into the lower section of the valve with the bottom facing the valve seat, followed by the spacer ring, and lastly the valve coil is pressed into the lower section secured by the knurled ring.

7.4 Fuse.

WARNING! Disconnect power before removing fuse holder.

Fig. 23. Fuse.

The installed fuses are: 5 X 20mm, 250V F 2.0A. Both line and neutral are fused. The fuse should be seated towards the insertion end of the cradle

8 Mounting.

1

Fixture purchased separately. Contact us for pricing.

2

Zaxis PD - Compact size, easy transport from desktop to wall mount or fixture

3

Zaxis PD metal backplate comes with four pre-drilled holes for mounting screws

4

Place Zaxis PD on top two screws then screw bottom two screws. Once secure, tighten all screws.

5

Connect all connectors and test ports including power and air supply

6

Begin set up and start testing. Zaxis PD includes USB drive for exporting data quickly.